SIMP Documentation

version

SIMP

November 28, 2017

Contents

Welcome to the SIMP documentation!

This is the documentation for the 6.1.0-0 release of SIMP, which is compatible with CentOS and Red Hat Enterprise Linux (RHEL). This guide will walk a user through the process of installing and managing a **SIMP** system. It also provides a mapping of security features to security requirements, which can be used to document a system's security conformance.

The System Integrity Management Platform (**SIMP**) is an **Open Source** framework designed around the concept that individuals and organizations should not need to repeat the work of automating the basic components of their operating system infrastructure.

Expanding upon this philosophy, SIMP also aims to take care of routine policy compliance to include **NIST 800-53**, **FIPS** 140-2, the **DISA STIG**, and the **SCAP Security Guide**.

By using the **Puppet** automation stack, SIMP is working toward the concept of a self-healing infrastructure that, when used with a consistent configuration management process, will allow users to have confidence that their systems not only start in compliance but remain in compliance over time.

Finally, SIMP has a goal of remaining flexible enough to properly maintain your operational infrastructure. To this end, where possible, the SIMP components are written to allow all security-related capabilities to be easily adjusted to meet the needs of individual applications.

Level of Knowledge

SIMP is designed for use by system administrators or users with a strong background using Linux operating systems. The core applications that make up SIMP and require prerequisite knowledge are:

- **Puppet** - 4.0 or later
- **Domain Name System** (DNS) - BIND 9
- **Dynamic Host Configuration Protocol** (DHCP) - Internet Systems Consortium (ISC) DHCP
- **Lightweight Directory Access Protocol** (LDAP) - OpenLDAP
- RedHat Kickstart (including all tools behind it) - **Trivial File Transfer Protocol** (TFTP), PXELinux, etc.
- Apache
- **Yellowdog Updater, Modified** (YUM)
- Rsyslog Version 3+
- **Internet Protocol Tables** (IPtables) (Basic knowledge of the rules)
- **Auditd** (Basic knowledge of how the daemon works)
- **Advanced Intrusion Detection Environment** (AIDE) (Basic knowledge of the rules)
- Basic **X.509**-based **PKI** Key Management

SIMP does as much initial setup and configuration of these tools as possible. However, without at least some understanding, you will be unable to tailor a SIMP system to fit the desired environment. A general understanding of how to control and manipulate these tools from the **command line interface** (CLI) will be necessary, as SIMP does not come stock with a **graphical user interface** (GUI).

Knowledge of scripting and **Ruby** programming will also help to further customize a SIMP install but is not required for routine use.

Contents:

For The Impatient

Welcome to the SIMP documentation!

What is SIMP?

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Diving Right In

The fastest way to get started with **SIMP** is to use one of the following two guides:

1. You need an ISO for bare metal or VM installation
    - *gsg-installing_simp_from_an_iso*
2. You have an existing system
    - *gsg-installing_simp_from_a_repository*

You should then follow the *simp-user-guide* to start configuring the system.

SIMP 6.1.0-0

Contents

Welcome to the SIMP documentation!

This release is known to work with:

- RHEL 6.9 x86_64
- RHEL 7.4 x86_64
- CentOS 6.9 x86_64
- CentOS 7.0 1708 x86_64

Breaking Changes

Warning

This release of SIMP is **NOT** backwards compatible with the 4.X and 5.X releases. **Direct upgrades will not work!**

At this point, do not expect any of our code moving forward to work with Puppet 3.

If you find any issues, please file bugs!

Breaking Changes Since 6.0.0-0

Upgrade Issues

- You **MUST** read the Upgrading from SIMP-6.0.0 to SIMP-6.1.0 section of the documentation for this upgrade. There were several RPM issues that require manual intervention for a clean upgrade.
  - The docs can be found at Read The Docs on the internet or under `/usr/share/doc` when the `simp-doc.noarch` RPM is installed.

Significant Updates

Puppetserver Log Issues

You may have noticed that you were not getting `puppetserver` logs recorded either on the file system or via `rsyslog`. We fixed the issue as identified in SIMP-4049 but we cannot safely upgrade existing systems to fix the issue.

To enable log collection via `rsyslog` (the default), you will need to add the following to your puppet server's hieradata:

- `rsyslog::udp_server: true`
- `rsyslog::udp_listen_address: '127.0.0.1'`

By default, this file will be located at `/etc/puppetlabs/code/environments/simp/hieradata/hosts/puppet.<your.domain>.yaml`

Puppetserver auth.conf

If you are upgrading from SIMP-6.0.0-0 to a later version:

- The legacy `auth.conf` (`/etc/puppetlabs/puppet/auth.conf`) has been deprecated
- `pupmod-simp-pupmod` will back up legacy puppet `auth.conf` after upgrade
- The puppetserver's `auth.conf` is now managed by Puppet

- You will need to re-produce any custom work done to legacy `auth.conf` in the new `auth.conf`, via the `puppet_authorization::rule` defined type
- The stock rules are managed in `pupmod::master::simp_auth`

No Longer Delivering ClamAV DAT Files

Given the wide spacing of SIMP releases, the team determined that it was ineffective for us to maintain the `simp-rsync-clamav` RPM with upstream ClamAV DAT file updates.

From this point forward, SIMP will not ship with updated ClamAV DAT files and we highly recommend updating your DAT files from the authoritative upstream sources.

SNMP Support Added

We have re-added SNMP support after a thorough re-assessment and update from our legacy `snmp` module. We now build upon a community module and wrap the SIMP-specific components on top of it.

Preparing for Puppet 5

We are in the process of updating all of our modules to include tests for Puppet 5 and, so far, things have gone quite well. Our expectation is that the update to Puppet 5 will be seamless for existing SIMP 6 installations.

Non-Breaking Version Updates

Many modules had dependencies that were updated in a manner that was breaking for the downstream module, but which did not affect the SIMP infrastructure. This caused quite a few of the SIMP modules to have version updates with no changes other than an update to the `metadata.json` file.

In general, this was due to dropping support for Puppet 3.

Long Puppet Compiles with AIDE Database Initialization

In order to expose `aide` database configuration errors during a Puppet compilation, the database initialization is no longer handled as a background process.

When the AIDE database must be initialized, this can extend the time for a Puppet compilation by **several minutes**. At the console the Puppet compilation will appear to pause at `(/Stage[main]/Aide/Exec[update_aide_db])`.

Security Announcements

- CVE-2017-2299
  - Versions of the puppetlabs-apache module prior to 1.11.1 and 2.1.0 make it very easy to accidentally misconfigure TLS trust.
  - SIMP brings in version puppetlabs-apache 2.1.0 to mitigate this issue.

RPM Updates

Package	Old Version	New Version
puppet-agent	1.8.3-1	1.10.6-1
puppet-client-tools	1.1.0-0	1.2.1-1
puppetdb	4.3.0-1	4.4.0-1

puppetdb-termini	4.3.0-1	4.4.0-1
puppetserver	2.7.2-1	2.8.0-1

Removed Modules

pupmod-herculesteam-augeasproviders

- This was a meta-module that simply required all other `augeasproviders_*` modules and was both not in use by the SIMP framework and was causing user confusion.

pupmod-herculesteam-augeasproviders_base

- Has internal bugs and was not in use by any SIMP components

Security Updates

pupmod-puppetlabs-apache

- Updated to 2.1.0 to fix CVE-2017-2299

Fixed Bugs

pupmod-simp-aide

- Fixed a bug where `aide` reports and errors were not being sent to syslog
- Now use FIPS-appropriate Hash algorithms when the system is in FIPS mode
- No longer hide AIDE initialization failures during Puppet runs
- Ensure that `aide` now properly retains the output database in accordance with the STIG checks

pupmod-simp-auditd

- Changed a typo in auditing `faillock` to the correct watch path

pupmod-simp-compliance_markup

- Fixed an issue where a crash would occur when `null` values were in the compliance markup data

pupmod-simp-libreswan

- Fixed issues when running `libreswan` on a FIPS-enabled system

pupmod-simp-logrotate

- Ensure that `nodateext` is set if the `dateext` parameter is set to `false`

pupmod-simp-simp_openldap

- Fixed an issue where `pki::copy` was not correctly hooked into the server service logic. This caused the OpenLDAP server to fail to restart if a new host certificate was placed on the system.
- Fixed an idempotency issue due to an `selinux` context not being set

pupmod-simp-simp_options

- Made some parameter fixes for a bug in Puppet 5 (PUP-8124)

pupmod-simp-pam

- Enable `pam_tty_audit` for `sudo` commands

pupmod-simp-simp

- Changed the `simp::sssd::client::min_id` parameter to `500` from `1000`
  - Having `min_id` at `1000` was causing intermittent retrieval errors for the `administrators` group (and potentially other supplementary groups) that users may be assigned to. This led to the potential of users below `1000` being left unable to log into their system and was reproduced using the stock `administrators` group.
  - The wording of the `sssd.conf` man page for `min_id` leads us to believe that the behavior of non-primary groups may not be well defined.

pupmod-simp-simp_rsyslog

- Ensure that `aide` and `snmp` logs are forwarded to remote syslog servers as part of the *security relevant* logs
- Persist `aide` logs on the remote syslog server in its own directory since the logs can get quite large

pupmod-simp-sssd

- Updated the `Sssd::DebugLevel` Data Type to handle all variants specified in the `sssd.conf` man page
- No longer add `try_inotify` by default since the auto-detection should suffice
- Ensure that an empty `sssd::domains` Array cannot be passed and set the maximum length to 255 characters

pupmod-simp-stunnel

- Improved the SysV init scripts to be more safe when killing `stunnel` services
- The `stunnel` PKI certificates are owned by the correct UID
- Fixed the init scripts for starting `stunnel` when SELinux was disabled
- Added a `systemd` unit for EL7+ systems
- Updated the `systemd` unit files to run stunnel in the foreground

pupmod-simp-svckill

- Fixed a bug in which `svckill` could fail on servers for which there are no aliased `systemd` services

simp-core

- Fixed several issues with the ISO build task: `rake beaker:suites[rpm_docker]`

simp-environment

- Fixed a bug where a relabel of the filesystem would incorrectly change **all** SELinux contexts on any environment files in `/var/simp/environments` with the exception of the default `simp` environment.
- Added the following items to the default puppet server hieradata file at `/etc/puppetlabs/code/environments/simp/hieradata/hosts/puppet.your.domain.yaml` to enable the UDP log server on `127.0.0.1` so that the `puppetserver` logs can be processed via `rsyslog` by default.
  - `rsyslog::udp_server: true`
  - `rsyslog::udp_listen_address: '127.0.0.1'`

simp-rsync

- Fixed a bug where a relabel of the filesystem would incorrectly change **all** SELinux contexts on any environment files in `/var/simp/environments` with the exception of the default `simp` environment.

New Features

pupmod-camptocamp-systemd

- Added as a SIMP core module

pupmod-vshn-gitlab

- Added as a SIMP extra

pupmod-simp-autofs

- Allow pinning of the `samba` and `autofs` packages to work around bugs in `autofs` that do not allow proper functionality when working with `stunnel`
  - autofs EL6 Beaker Bug Report
  - autofs EL7 Beaker Bug Report

pupmod-simp-clamav

- Added the option to not manage ClamAV data **at all**

pupmod-simp-compliance_markup

- Converted all of the module data to JSON for efficiency

pupmod-simp-krb5

- Allow users to modify the owner, group, and mode of various global kerberos-related files

pupmod-simp-logrotate

- Made the logrotate target directory configurable

pupmod-simp-pam

- Changed `pam_cracklib.so` to `pam_pwquality.so` in EL7 systems

pupmod-simp-pupmod

- Added a SHA256-based option to generate the minute parameter for a client's `puppet agent` cron entry based on its IP Address
  - This option is intended mitigate the undesirable clustering of client `puppet agent` runs, when the number of IPs to be transformed is less than the minute range over which the randomization is requested (60) and/or the client IPs are not linearly assigned

pupmod-simp-simp_gitlab

- Added as a SIMP extra

pupmod-simp-selinux

- Added a reboot notification on appropriate SELinux state changes
- Ensure that a `/.autorelabel` file is created on appropriate SELinux state changes
  - This capability is *disabled* by default due to issues discovered with the autorelabel process in the operating system

pupmod-simp-simp_snmpd

- Added SNMP support back into SIMP!

pupmod-simp-simplib

- Updated `rand_cron` to allow the use of a SHA256-based algorithm specifically to improve randomization in systems that have non-linear IP address schemes
- Added a `simplib::assert_metadata_os` function that will read the `operatingsystem_support` field of a module's `metadata.json` and fail if the target OS is not in the supported list
  - This can be globally disabled by setting the variable `simplib::assert_metadata::options` to `{ 'enable' => false }`
- Began deprecation of legacy Puppet 3 functions by Puppet 4 counterparts. At this time, no deprecation warnings will be generated but this will change in a later release of SIMP 6.

pupmod-simp-timezone

- Forked `saz/timezone` since our Puppet 4 PR was not reviewed and no other Puppet 4 support seemed forthcoming

pupmod-simp-tpm

- Refactoring and updates to make using the TPM module easier and safer

- Addition of an `instances` feature to the TPM provider so that `puppet resource tpm_ownership` works as expected
- Changed the `owner_pass` to `well-known` by default in `tpm_ownership`
- Removed `ensure` in favor of `owned` in `tpm_ownership`

pupmod-simp-vsftpd

- Change `vsftpd` to use TLS 1.2 instead of TLS 1.0 by default

pupmod-voxpupuli-yum

- Added as a SIMP core module

simp-doc

- A large number of documentation changes and updates have been made
- It is **HIGHLY RECOMMENDED** that you review the new documentation

simp-rsync

- Removed the `simp-rsync-clamav` sub-package * SIMP will no longer ship with updated ClamAV DAT files

simp-utils

- Moved the default LDIF example files out of the `simp-doc` RPM and into `simp-utils` for wider accessibility

Known Bugs

- There is a bug in `Facter 3` that causes it to segfault when printing large unsigned integers - FACT-1732
  - This may cause your run to crash if you run `puppet agent -t --debug`
- The `krb5` module may have issues in some cases, validation pending
- The graphical `switch user` functionality does not work. We are working with the vendor to discover a solution
- The upgrade of the `simp-gpgkeys-3.0.1-0.noarch` RPM on a SIMP server fails to set up the keys in `/var/www/yum/SIMP/GPGKEYS`. This problem can be worked around by either uninstalling `simp-gpgkeys-3.0.1-0.noarch` prior to the SIMP 6.1.0 upgrade, or reinstalling the newer `simp-gpgkeys` RPM after the upgrade.
- An upgrade of the `pupmod-saz-timezone-3.3.0-2016.1.noarch` RPM to the `pupmod-simp-timezone-4.0.0-0.noarch` RPM fails to copy the installed files into `/etc/puppetlabs/code/environments/simp/modules`, when the `simp-adapter` is configured to execute the copy. This problem can be worked around by either uninstalling `pupmod-saz-timezone-3.3.0-2016.1.noarch` prior to the SIMP 6.1.0 upgrade, or reinstalling the `pupmod-simp-timezone-4.0.0-0.noarch` RPM after the upgrade.
- Setting selinux to disabled can cause stunnel daemon fail. Using the permissive mode of selinux does not cause these issues.

Welcome to the SIMP documentation!

SIMP Getting Started Guide

Welcome to SIMP!

Introduction

What is SIMP?

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Getting Started

Warning

Please take a look at the *faq* documentation prior to installing SIMP. The most relevant questions for new users will always be at the top of the list.

This document provides a quick overview of how to get started with building and setting up your SIMP environment.

Once you're done setting up your environment, you should proceed to the *simp-user-guide* for utilizing SIMP to its full potential.

If issues still remain, please drop us a line on the SIMP Development Mailing List.

Note

The fastest method for getting started with SIMP is to follow the *gsg-installing_simp_from_a_repository* guide.

This is the method that you want to use if you are installing on any sort of existing system.

Note

If you need to build an ISO, you should follow the *gsg-building_simp_from_tarball* guide.

Known OS Compatibility

- **SIMP 6.1.0-0**
- **CentOS 6.9**
  - **ISO #1:** CentOS-6.9-x86_64-bin-DVD1.iso
  - **Checksum:** d27cf37a40509c17ad70f37bc743f038c1feba00476fe6b69682aa424c399ea6
  - **ISO #2:** CentOS-6.9-x86_64-bin-DVD2.iso
  - **Checksum:** 631b8640460f46a8139a6a7cbbac5f3594d08c32945449b6bbd65234929ce7a4
- **RedHat 6.9**
  - **ISO #1:** rhel-server-6.9-x86_64-dvd.iso
  - **Checksum:** 3f961576e9f81ea118566f73f98d7bdf3287671c35436a13787c1ffd5078cf8e

Installing SIMP From An ISO

The benefits of using a SIMP ISO are:

- Suitable for enclave or offline environments
- It is the easiest way to get started and ensure that all files are present
- Your SIMP load will have a disk partitioning scheme compatible with most security guides
- Your system will start in `FIPS` mode
- Your disks can be encrypted
  - Please pay attention to the caveats in the *ig-disk-encryption* section

Obtaining the ISO

The SIMP ISO can be downloaded from the official SIMP ISO Share.

Installation

The ISO will install on any system that supports the underlying operating system.

When you first boot the ISO, there will be a menu of options. You can either modify the installation according to those instructions or simply hit <Enter> to proceed with the automated installation.

Afterwards, you should proceed with the *simp-installation-guide*.

Installing SIMP From A Repository

Using the official SIMP YUM repositories is the simplest method for getting up and running with SIMP on an existing infrastructure. If you are using a virtual infrastructure, such as AWS, Microsoft Azure, Google Cloud, or your own internal VM stack, this is the method that you will want to use.

Note

This method does **not** modify your system's partitioning scheme or encryption scheme to meet any regulatory policies. If you want an example of what that should look like either see the *simp-installation-guide* or check out the Kickstart files in the simp-core Git repository.

Enable EPEL

Note

RHEL systems will need to enable the EPEL Repositories manually.

```
$ sudo yum install epel-release -y
$ sudo yum install pygpgme yum-utils
```

Install The SIMP-Project Repositories

Add the following to `/etc/yum.repos.d/simp-project.repo`, replacing 6 with the appropriate version of SIMP. If the repo file does not exist, create it. The repo file contents for `SIMP 6.X` is shown below.

If you don't know what versions map together, please see the *faq-simp_version_guide*.

Important

RHEL Users should replace `$releasever` below with the actual release version.

This would be 7 for RHEL 7 and 6 for RHEL 6

Note

The 'dependencies' repository may contain items from external vendors, most notably Puppet, Inc. and EPEL but may also contain non-SIMP project files that have been compiled for distribution.

Warning

The **whitespace** and **alignment** shown before the additional gpgkey values **must be preserved**

```
[simp-project_6_X]
name=simp-project_6_X
baseurl=https://packagecloud.io/simp-project/6_X/el/$releasever/$basearch
gpgcheck=1
enabled=1
gpgkey=https://raw.githubusercontent.com/NationalSecurityAgency/SIMP/master/GPGKEYS/RPM-GPG-KE
sslverify=1
sslcacert=/etc/pki/tls/certs/ca-bundle.crt
metadata_expire=300

[simp-project_6_X_dependencies]
name=simp-project_6_X_dependencies
baseurl=https://packagecloud.io/simp-project/6_X_Dependencies/el/$releasever/$basearch
gpgcheck=1
enabled=1
gpgkey=https://raw.githubusercontent.com/NationalSecurityAgency/SIMP/master/GPGKEYS/RPM-GPG-KE
       https://yum.puppetlabs.com/RPM-GPG-KEY-puppetlabs
       https://yum.puppetlabs.com/RPM-GPG-KEY-puppet
       https://apt.postgresql.org/pub/repos/yum/RPM-GPG-KEY-PGDG-96
       https://artifacts.elastic.co/GPG-KEY-elasticsearch
```

```
       https://grafanarel.s3.amazonaws.com/RPM-GPG-KEY-grafana
       https://getfedora.org/static/352C64E5.txt
sslverify=1
sslcacert=/etc/pki/tls/certs/ca-bundle.crt
metadata_expire=300
```

Rebuild The Yum Cache

```
$ sudo yum makecache
```

Install the SIMP Server

1. Select the simp-adapter package appropriate for the version of Puppet you will be using
   - **simp-adapter-foss**: Version appropriate for FOSS Puppet
   - **simp-adapter-pe**: Version appropriate for Puppet Enterprise
2. Install the simp-adapter package

```
$ sudo yum install -y simp-adapter-foss
```

3. Install the remaining SIMP packages

```
$ sudo yum install -y simp
```

> ***Note***
>
> The `simp` RPM installs the SIMP core Puppet modules. Breaking changes in these modules trigger a breaking change update in SIMP itself.
>
> There are a large number of additional 'extra' modules that may be individually installed. Search for `pupmod` via `yum` to discover what is available.
>
> If you wish to install all of the extra modules, you can simply run `sudo yum install -y simp-extras`

Configure and Bootstrap the SIMP Server

1. `su` to `root`
2. Type `simp config` and configure the system as prompted.
   - `simp config` will prompt you for system settings and then apply the smallest settings subset that is required to bootstrap the system.
   - When applicable, `simp config` will present you with a recommendation for each setting. To keep a recommended value, press **Enter**. Otherwise, enter your desired value.
   - `simp config` generates a log file containing details of the configuration selected and actions taken.
   - For more details about the installation variables set by `simp config` and the corresponding actions, see *Initial_Configuration*.
   - For a list of additional options, type `simp help config`.
     - `simp config --dry-run` will run through all of the `simp config` prompts without applying any changes to the system. This is the option to run to become familiar with the variables set by `simp config` or generate a configuration file to be used as a template for subsequent `simp config` runs.

- `simp config -a <Config File>` will load a previously generated configuration in lieu of prompting for settings, and then apply the settings. This is the option to run for systems that will be rebuilt often.

> ***Note***
>
> Once `simp config` has been run, three SIMP configuration files will be generated:
>
> - `/root/.simp/simp_conf.yaml`: File containing all your `simp config` settings; can include additional settings related to ones you entered and other settings required for SIMP.
> - `/etc/puppetlabs/code/environments/simp/hieradata/simp_config_settings.yaml`: File containing global hieradata relevant to SIMP clients and the SIMP server.
> - `/etc/puppetlabs/code/environments/simp/hieradata/hosts/<host>.yaml`: SIMP server host YAML file.

3. Type `simp bootstrap`

> ***Note***
>
> If progress bars are of equal length and the bootstrap finishes quickly, a problem has occurred. This is most likely due to an error in SIMP configuration. Refer to the previous step and make sure that all configuration options are correct.

4. Reboot your system

```
$ reboot
```

Bootstrap SIMP Clients

Use the `runpuppet` script from the newly created SIMP server to bootstrap your clients. That script can be acquired in one of two ways:

1. Use a SIMP server as a kickstart server, see *Client_Management* for details on how to take advantage of SIMP to make this easier.
2. If another server is to be used as a kickstart server, you can still use our distributed and tested provisioning script, `runpuppet`.

   Add the `simp::server::kickstart::runpuppet` class to your kickstart server node to use `runpuppet`. The file can be placed in an existing web server by setting the `location` parameter. Here's an example that could be placed in a kickstarting profile class:

   ```
   class { 'simp::server::kickstart::runpuppet':
     location => '/var/www/web/server/path/runpuppet'
   }
   ```

> ***Note***
>
> This would be the general technique that you would use to auto-bootstrap your clients via `user-data` scripts in cloud environments.
>
> You should take care to ensure that your environment is protected prior to running the `runpuppet` script across the Internet. You may want to package it as a signed RPM specific to your environment and deploy it independently.

Be ready to sign your client credentials as systems check in with the server!

Run the script on a client. This example assumes the first option from above:

```
# Remove the ``--insecure`` option if your system has a certificate signed
# by a well-known CA.

$ curl --insecure https://<puppet.server.fqdn>/ks/runpuppet | bash
```

Preparing For Non-RPM Install

Keydist, Rsync, and The Alternate Module Path

SIMP uses an alternative module path, `/var/simp/environments/<environment>/` , which is set in each environment`s `environment.conf`. Currently, it contains rsync assets and PKI data, custom to each host. Here is an example from a fresh install:

```
$ tree -L 1 /var/simp/environments/production
/var/simp/environments/production
├── rsync
└── site_files
```

- `rsync` is a tree that stores data that will be copied over to modules. We have chosen rsync for these applications because of how it handles large files and large amounts of files. See *rsync_justification*
- `site_files` is a place to store private files that may not belong in the control repo or another data source. An example of this would be host-based x509 certificates (which are used heavily by SIMP).

Create the `site_files`, `simp_autofiles`, and `keydist` directories:

```
$ mkdir -p /var/simp/environments/production/{site_files/modules/pki_files/files/keydist}
$ chown root.puppet /var/simp/environments/<environment>/site_files
$ chmod -R g+rX /var/simp/environments/<environment>/{site_files,simp_autofiles}
```

The rsync directory is special. When installed from an ISO via RPM, the rsync data and folder structure is laid out in a particular manner. Clone the rsync repository and modify it to make it equivalent to RPM install:

```
$ git clone https://github.com/simp/simp-rsync.git /tmp/simp-rsync
$ mv -f /tmp/simp-rsync/environments/simp/rsync /var/simp/environments/<environment>/
$ ln -s /var/simp/environments/<environment>/rsync/RedHat /var/simp/environments/<environment>/
$ chmod u+rwx,g+rX,o+rX /var/simp{,/environments,/environments/production}
```

Warning

Be careful when copying the first rsync environment around. There are hidden files in each folder, including rsync .shares files. There is a fact in the simp module that checks for those files. The fact is ingested by `simp::server::rsync_shares` and rsync shares are created on the Puppet server.

If `simp_options::clamav` is set to true, the following step is required, otherwise you can skip it.

Install clamav-update and download the latest database using the following config and commands, replacing <environment> with your environment.

```
$ cat << EOF > /tmp/freshclam.conf
DatabaseDirectory /var/simp/environments/<environment>/rsync/Global/clamav
```

```
DatabaseMirror database.clamav.net
Bytecode yes
EOF
```

```
$ yum install -y clamav-update
$ freshclam -u root --config-file=/tmp/freshclam.conf
```

Other Miscellany

You may need to bring in the SIMP dependencies repository:

```
$ curl -s https://packagecloud.io/install/repositories/simp-project/6_X_Dependencies/script.rpm
```

Installing SIMP Using r10k or Code Manager

`r10k` and **`Code Manager`** are products that automate the development and deployment of a **`Puppet`** infrastructure. SIMP supports the usage of these tools, with a little tweaking.

Read the introduction documentation on whichever of these technologies that is being used:

- Code Manager: https://docs.puppet.com/pe/latest/code_mgr.html
- r10k: https://github.com/puppetlabs/r10k/blob/master/README.mkd

Note

r10k will be used to reference both r10k itself and Code Manager throughout this document. If you are using Code Manager, skip to Setting Up Your Control Repo

Important

This document will assume the SIMP server has internet access. If your system does not have internet access, you will need to adjust paths to point to your internal mirrors.

> ***Note***
>
> This method does *not* modify your system's partitioning scheme or encryption scheme to meet any regulatory policies. If you want an example of what that should look like either see the *simp-installation-guide* or check out the Kickstart files in the simp-core Git repository.

Preparing Your System

Follow the *preparing_for_non_rpm_install* guide.

Installation of r10k

On the system intended to be the Puppet server, run the following command to install the `r10k` ruby gem into the vendor ruby that comes with the `puppet-agent` AIO package:

```
$ /opt/puppetlabs/puppet/bin/gem install r10k
```

`r10k` can be used by calling the absolute path of the executable (unless added to `$PATH`):

```
$ /opt/puppetlabs/puppet/bin/r10k help
```

Setting Up Your Control Repository

Follow the *howto-setup-a-simp-control-repository* guide.

Minimum Classes For Classification

Server

Open Source

To manage the puppetserver, include the following classes:

- `simp`
- `simp::server`
- `pupmod::master`

PE

In a PE environment, The SIMP Server will normally be the Master of Masters (MoM). Currently, Compile Masters (CMs) are not automatically supported out of the box, and require extra configuration to ensure they remain in sync.

- `simp`
- `simp::server`

Agents

Agents will require the `simp` class at a minimum. SIMP ships with 'scenarios', which are essentially pre-bundled groups of modules that profile nodes for various tasks. See the *Classification and Data* documentation for more information. Depending on the function of your production environment, and your choice of scenario, you will want to populate Hiera with required parameters. See *Initial_Configuration* for a list of base parameters and their description.

Running Puppet For The First Time

SIMP doesn't configure the puppetserver to listen on the typical port and CA port, so the first time the puppet agent is run, you may have to specify the `ca_port` and `server`. An example:

```
$ puppet agent -t --ca_port 8141 --server puppet.your.domain
```

SIMP also provides a provisioning script called runpuppet. Run this script during provisioning and it will (provided autosign is configured) attempt to connect to your puppetserver as defined in `simp_options` and run puppet a few times in order to get the new system in order.

Warning

SIMP, by default, implements `tcpwrappers` and PAM access restrictions. The root user should always be able to log in at a console, but if there is no console, like in AWS, be sure to add a user to the PAM whitelist and give it sudo powers:

```
pam::access::rule { 'ec2user':
  origins    => ['ALL'],
  permission => '+',
  users      => ['ec2user']
}
sudo::user_specification { 'ec2user':
  user_list => ['ec2user'],
  cmnd      => ['ALL']
}
```

SIMP also moves the location of the ssh authorized_keys file to `/etc/ssh/local_keys/%u`, so copy it there before logging out.

Notes About SIMP Infrastructure

SIMP, when installed from the ISO, moves packages into `/var/www/yum` and creates a `yum` repo in itself. SIMP modules, notably the `simp::yum` class, assumes this. You will have to set `simp::yum::os_update_url` to a CentOS Updates URL.

Building a SIMP ISO

If you want the full SIMP experience where you maximize compliance with the widest selection of targeted standards, you'll want to build and install from a SIMP ISO.

The following guides provide an overview of the supported build methods.

Warning

Prior to starting any build method, you will need to ensure that you follow the instructions in *gsg-environment_preparation*.

Environment Preparation

Getting Started

Warning

Please use a **non-root** user for building SIMP!

Ensure Sufficient Entropy

The SIMP build generates various keys and does quite a bit of package signing. As such, your system must be able to keep its entropy pool full at all times. If you check `/proc/sys/kernel/random/entropy_avail` and it shows a number below **1024**, then you should either make sure that rngd is running and pointed to a hardware source (preferred) or install and use **haveged**.

```
$ sudo yum install haveged
$ sudo systemctl start haveged
$ sudo systemctl enable haveged
```

Set Up Ruby

We highly recommend using **RVM** to make it easy to develop and test against several versions of **Ruby** at once without damaging your underlying Operating System.

RVM Installation

The following commands, taken from the RVM Installation Page can be used to install **RVM** for your user.

```
$ gpg2 --keyserver hkp://keys.gnupg.net --recv-keys \
    409B6B1796C275462A1703113804BB82D39DC0E3
$ \curl -sSL https://get.rvm.io | bash -s stable --ruby=2.1.9
$ source ~/.rvm/scripts/rvm
```

Set the Default Ruby

You'll want to use **Ruby** 2.1.9 as your default **RVM** for SIMP development.

```
$ rvm use --default 2.1.9
```

Note

Once this is done, you can simply type `rvm use 2.1.9`.

Bundler

The next important tool is Bundler. Bundler makes it easy to install Gems and their dependencies. It gets this information from the Gemfile found in the root of each repo. The Gemfile contains all of the gems required for working with the repo. More info on Bundler can be found on the Bundler Rationale Page and more information on Rubygems can be found at Rubygems.org.

```
$ rvm all do gem install bundler
```

Set Up Docker

Docker is typically provided by an OS repository. You may need to enable that repository depending on your distribution.

```
$ sudo yum install docker
```

The Docker package may not provide a *dockerroot* group. If it does not exist post installation, create it:

```
$ sudo groupadd dockerroot
```

Allow your (non-root) user to run docker:

```
$ sudo usermod -aG dockerroot <user>
```

When you build your system make sure you set the default size for the docker container or the iso build may not work properly:

in `/etc/sysconfig/docker-storage`:

DOCKER_STORAGE_OPTIONS= --storage-opt dm.basesize=100G

> ***Note***
>
> You may need to log out and log back in before your user is able to run as dockerroot.

As root, edit `/etc/docker/daemon.json` and change the ownership of the docker daemon socket:

```
{
  "live-restore": true,
  "group": "dockerroot"
}
```

Start the docker daemon:

```
$ sudo systemctl start docker
$ sudo systemctl enable docker
```

Building SIMP From Tarball

> ***Note***
>
> Building SIMP from a pre-built tarball is the fastest method for getting a known stable build of a SIMP ISO and should be preferred over other methods.

Getting Started

> ***Warning***
>
> Please have your environment prepared as specified by *gsg-environment_preparation* before continuing.

Download the SIMP release tarball, found on our SIMP artifacts repository.

Download the latest tarball according to your needs. If you are not sure what version you need, check the *faq-simp_version_guide*.

- The latest 6.1.0-0 release (for CentOS 6)
- The latest 6.1.0-0 release (for CentOS 7)

- The latest checksums

Generating The ISO

Clone simp-core:

```
$ git clone https://github.com/simp/simp-core
```

Change into the `simp-core` directory and make sure you are on the correct branch for your target SIMP version:

```
$ cd simp-core
$ git checkout tags/6.1.0-0 # for SIMP 6.1
```

Run `bundle install` to make sure that all of the build tools and dependencies are installed and up to date:

```
$ bundle install
```

Copy the pre-built tarball to the `DVD_Overlay` directory that corresponds with the version of base OS you want to build. For instance, if you wanted to build with CentOS-7,

```
$ cp </path/to/.tar> build/distributions/CentOS/7/x86_64/DVD_Overlay
```

Run the `build:auto` rake task to create a bootable ISO:

> ***Note***
>
> Do **not** add any whitespace before or after the commas. This is an artifact of using rake.

```
$ RSYNC_NO_SELINUX_DEPS=yes bundle exec rake build:auto[<directory containing source ISOs>,6.X
```

Build ENV vars:

- `SIMP_BUILD_docs` - (yes|no) - Toggle doc builds.
  - The docs take a long time to build!
- `RSYNC_NO_SELINUX_DEPS` - (yes|no) - Force the earliest version of `policycoreutils<-python>` and `selinux-policy<-devel>` for the major EL release.
  - In order to maintain the backward compatibility of simp-rsync with each major EL release, we must bring in the selinux policies supplied by the original major EL release being built. SELinux policies are forward compatible during a major release, but not necessarily backwards compatible. If you opt to use repositories that bring in updated selinux policies, you will need to set this to YES.
- `BEAKER_destroy` - (yes|no) - Setting `BEAKER_destroy=no` will preserve the docker container used to build SIMP.

Once the process completes, you should have a bootable SIMP ISO, in: `build/distributions/<OS>/<rel>/<arch>/SIMP_ISO/`

Building SIMP From Source

Getting Started

Please have your environment prepared as specified by *gsg-environment_preparation* before continuing.

Download the CentOS/RedHat installation media:

- SIMP_6.X:
  - Refer to `release_mappings.yaml` to determine the distribution ISO compatible with the version of SIMP you want to build. `release_mappings.yaml` is maintained the simp-core module in the `build/distributions/<distribution>/<release>/<arch>` directory.
- SIMP_5.X: CentOS-7-x86_64-DVD-1611.iso
- SIMP_4.X: DVD1 and DVD2 of the CentOS 6.8 release. For example, CentOS-6.8-x86_64-bin-DVD1.iso

Generating The ISO!

Clone simp-core:

```
$ git clone https://github.com/simp/simp-core
$ cd simp-core
```

Check out your desired branch of SIMP:

- To check out a stable SIMP release, check out a tag (*Recommended*):

```
$ git checkout tags/6.1.0-0
```

- To check out an unstable SIMP release, check out the latest `master`:

```
$ git checkout master
```

Run `bundle` to make sure that all of the build tools and dependencies are installed and up to date:

```
$ bundle install
```

Make an `ISO` directory, and copy in the CentOS/RHEL installation media:

```
$ mkdir ISO
$ cp </path/to/dvd*.iso> ISO
```

Run the `rpm_docker` beaker suite, toggling build options with environment variables:

```
$ <build ENV vars> bundle exec rake beaker:suites[rpm_docker]
```

Build ENV vars:

- `SIMP_BUILD_docs` - (yes|no) - Toggle doc builds.
  - The docs take a long time to build!
- `RSYNC_NO_SELINUX_DEPS` - (yes|no) - Force the earliest version of `policycoreutils<-python>` and `selinux-policy<-devel>` for the major EL release.
  - In order to maintain the backward compatibility of simp-rsync with each major EL release, we must bring in the selinux policies supplied by the original major EL release being built. SELinux policies are forward compatible during a major release, but not necessarily backwards compatible. If you opt to use repositories that bring in updated selinux policies, you will need to set this to YES.
- `BEAKER_destroy` - (yes|no) - Setting `BEAKER_destroy=no` will preserve the docker container used to build SIMP.

Once the process completes, you should have a bootable SIMP ISO, in: `build/distributions/<OS>/<rel>/<arch>/SIMP_ISO/`

After You Build

You may have noticed that a development GPG key has been generated for the build.

This key is only valid for one week from generation and has been specifically generated for your ISO build.

Doing this allows you to have a validly signed set of RPMs while reducing the risk that you will have invalid RPMs distributed around your infrastructure.

> ***Note***
>
> If you need to build and sign your RPMs with your own key, you can certainly do so using the `rpm --resign` command.

The new development key will be placed at the root of your ISO and will be called `RPM-GPG-KEY-SIMP_dev`. This key can be added to your clients, or served via a web server, if you need to install from a centralized **`yum`** repository.

Please see the Red Hat Guide to Configuring YUM and YUM Repositories for additional information.

Installing SIMP from an ISO

Contents:

Introduction

This chapter will walk a user through the process of installing the **`SIMP`** server.

For client installation, please see the *simp-user-guide*.

> ***Warning***
>
> There are default passwords present on the system that should be changed prior to deploying the system.
>
> **Please make sure that you change these passwords!**
>
> For a list of the passwords, see *ig-default-passwords*

SIMP Server Installation

This chapter provides guidance on installing, configuring, and bootstrapping the SIMP server using the SIMP Utility, `simp`.

System Requirements

The scalability of SIMP correlates to the scalability of Puppet. From the Puppet tuning guide, a number of factors contribute to scalability, including:

- Speed and quantity of available hardware
- Number of nodes, and frequency of check-in
- Number of modules in your module path
- Amount of hieradata

While there are no official hardware requirements, we recommend the following **for your SIMP server**:

- **2** CPUs and **4 GB** of RAM, at a minimum
- **2 - 4** CPUs and **8 GB** of RAM to serve up to *1,000* nodes

The SIMP team recommends allocating the latter, in addition to a minimum of **50 GB** HDD space. Again, these are not hard requirements, but anything less may not leave adequate room for logs, applications, rsync data, etc.

> ***Note***
>
> If you want to optimize the Puppet server, the Puppet tuning guide is a good place to start. Use the advanced memory debugging guide for further optimization.

Using the SIMP Utility

In these instructions we will be using the `config` and `bootstrap` commands of the SIMP Utility, `simp`. The SIMP Utility does not assist users through the entire configuration process; however, it does make the initial configuration easier and more repeatable.

> ***Note***
>
> For a list of the commands `simp` provides, type `simp help`. Type `simp help <Command>` for more information on a specific command.

SIMP Default Passwords

Below is a table containing the default passwords found on a basic SIMP server upon install.

> ***Important***
>
> All default passwords must be changed during the initial configuration process.

Utility	Password
Grub	GrubPassword
Root User	RootPassword
Simp User	UserPassword

Table: SIMP Default Passwords

Preparing the SIMP Server Environment

1. Boot the system and ensure the SIMP ISO is selected.
    - If you do not have a SIMP ISO, see *gsg-building_simp_from_tarball*.
2. Press *Enter* to run the standard SIMP install, or choose from the customized options list.
    - For a detailed description of the the disk encryption enabled via the `simp_disk_crypt` boot option, see *ig-disk-encryption*.
3. When the installation is complete, the system will restart automatically.
4. Change the `root` user password
    a. At the console, log on as `root` and type the default password shown in **Table 2.1.**

b. Type the default password again when prompted for the (current) UNIX password.

c. Type a new password when prompted for the New Password. Retype the password when prompted.

5. Change the `simp` user password

a. At the console, log on as `simp` and type the default password shown in **Table 2.1.**

b. Type the default password again when prompted for the (current) UNIX password.

c. Type a new password when prompted for the New Password. Retype the password when prompted.

Installing the SIMP Server

Important

Correct time across all systems is important to the proper functioning of SIMP and Puppet in general.

If a user has trouble connecting to the Puppet server and errors regarding certificate validation appear, check the Puppet server and client times to ensure they are synchronized.

Warning

Keep in mind as the installation process begins that Puppet does not work well with capital letters in host names. Therefore, they should not be used.

1. Log on as `simp` and run `su -` to gain root access.
2. Type `simp config` and configure the system as prompted.

- `simp config` will prompt you for system settings and then apply the smallest settings subset that is required to bootstrap the system.
- When applicable, `simp config` will present you with a recommendation for each setting (variable). To keep a recommended value, press *Enter*. Otherwise, enter your desired value.
- `simp config` generates a log file containing details of the configuration selected and actions taken.
- For more details about the installation variables set by `simp config` and the corresponding actions, see *Initial_Configuration*.
- For a list of additional options, type `simp help config`.
  - `simp config --dry-run` will run through all of the `simp config` prompts without applying any changes to the system. This is the option to run to become familiar with the variables set by `simp config` or generate a configuration file to be used as a template for subsequent `simp config` runs.
  - `simp config -a <Config File>` will load a previously generated configuration (aka the 'answers' file) in lieu of prompting for settings, and then apply the settings. This is the option to run for systems that will be rebuilt often. Please note, however, if you edit the answers file, only configuration settings for which you would be prompted by `simp config` can be modified in that file. Any changes made to settings that `simp config` automatically determines will be ignored.

Note

Once `simp config` has been run, three SIMP configuration files will be generated:

- `/root/.simp/simp_conf.yaml`: File containing all your `simp config` settings; can include additional settings related to ones you entered and other settings required for SIMP.
- `/etc/puppetlabs/code/environments/simp/hieradata/simp_config_settings.yaml`: File containing global hieradata relevant to SIMP clients and the SIMP server.
- `/etc/puppetlabs/code/environments/simp/hieradata/hosts/<host>.yaml`: SIMP server host YAML file.

3. Type `simp bootstrap`

Note

If progress bars are of equal length and the bootstrap finishes quickly, a problem has occurred. This is most likely due to an error in SIMP configuration. Refer to the previous step and make sure that all configuration options are correct.

4. Type `reboot`

Performing Post-installation Setup on the SIMP Server

1. Log on as `simp` and run `su -` to gain root access.
2. Run puppet for the first time.

   Type: `puppet agent -t`
3. Copy CentOS RHEL_MAJOR_MINOR_VERSION ISO(s) to the server and unpack using the `unpack_dvd` utility. This creates a new tree under `/var/www/yum/CentOS`.

   Type: `unpack_dvd CentOS-RHEL_MAJOR_VERSION-x86_64-DVD-####.iso`
4. Update your system using yum. The updates applied will be dependent on what ISO you initially used.

   Type: `yum clean all; yum makecache`
5. Run puppet.

   Type: `puppet agent -t`
6. Reboot your system:

   Type `reboot`

Disk Encryption

The default **`ISO`** and kickstart files in SIMP now encrypt the first physical volume if the `simp_disk_crypt` option is provided at the boot command line.

Warning

The system is set to **automatically** decrypt at boot! This means that the password is embedded in the **`initrd`** file.

Note

The `/boot` directory is **not** encrypted, since that would prevent the system from booting automatically.

Method

When enabled, SIMP implements disk encryption, with automatic decryption, so that users have the option to use their own keys in the future. Alternatively, users may remove the system local keys and require that a password be entered at each boot.

The primary goal of providing automatic decryption was to give users a clean and seamless experience when using the initial system. It is understood that this is not best practice since automatic decryption of the disks requires the system to embed the password files in the system **`initrd`**.

Disk encryption was not enabled by default for two reasons. The first is that it can take an unacceptable amount of time to build a system if enough entropy is not present. The second is that a lot of hardware contains the ability to encrypt the disk at that level. If this is present, the utility of a second layer of disk encryption is not necessarily warranted or a good idea.

Implementation

The system keys are referenced in `/etc/crypttab` and, by default, reside at `/etc/.cryptcreds`. At build time, these files are copied into all **`initrd`** files present on the system. This ensures that all kernels can successfully boot the system.

The `/etc/dracut.conf` file is also updated to ensure that any new kernel loads will be able to boot successfully.

Warning

The `/etc/.cryptcreds` file **is** encrypted when the system is off. However, a copy is in the unencrypted **`initrd`** files in `/boot` and should not be considered secure from physical access to the raw disk image.

Note

Please be aware that **all** characters in the `/etc/.cryptcreds` file are part of the password. The lack of a trailing newline is **very** important.

Replacing the Current Password

> ***Note***
>
> The underlying system uses **LUKS**, so any usage outside of this document should refer to the **LUKS** implementation that matches your system version.

To change the password, you will need to perform the following steps.

1. Back up the original password file
   - If something goes amiss, you're seriously going to need this
2. Get the **UUID** of your partition
   - This will be in the `/etc/crypttab` file. You'll want the entire `UUID=<uuid>` string
3. Create the new password
   - Remember that this needs to be **exactly** what you will use. If you ever expect to type this at the command line, don't forget to strip your trailing spaces.

```
#!/usr/bin/python

import sys
import random
import string

# The length of the new password
length = 1024

# What the password should consist of
charset = string.lowercase+string.uppercase+string.digits

passfile = open('/etc/.cryptcreds.new','w')

passfile.write("".join(random.choice(charset) for i in range(length)))
```

4. Update the key
   - There is a faster way to do this in **EL** 7, but this method works on both systems

```
$ cryptsetup luksAddKey --key-slot 1 --key-file /etc/.cryptcreds UUID=<uuid> /etc/.cryp
$ cryptsetup luksKillSlot --key-file /etc/.cryptcreds 0

$ cryptsetup luksAddKey --key-slot 0 --key-file /etc/.cryptcreds.new UUID=<uuid> /etc/.
$ cryptsetup luksKillSlot --key-file /etc/.cryptcreds.new 1

# Only do this step if the previous steps succeeded!
$ mv /etc/.cryptcreds.new /etc/.cryptcreds
```

5. Update your **initrd** files
   - You want to make sure to update **all** of your **initrd** files since you'll want to be able to boot from any kernel.

```
for x in `ls -d /lib/modules/*`; do
  installed_kernel=`basename $x`
  dracut -f "/boot/initramfs-${installed_kernel}.img" $installed_kernel
done
```

Removing the Password File

If you wish to remove the password file from your system, you will need to perform the following steps:

1. Back up the password file!
   - If you lose this, you won't be able to get into your system after reboot
2. Using your favorite text editor, remove the *install_items* line in */etc/dracut.conf* that contains the reference to */etc/.cryptcreds*
3. Remove the */etc/.cryptcreds* file from the system
4. Update your **`initrd`** files
   - You want to make sure to update **all** of your **`initrd`** files since you'll want to be able to boot from any kernel.

```
for x in `ls -d /lib/modules/*`; do
  installed_kernel=`basename $x`
  dracut -f "/boot/initramfs-${installed_kernel}.img" $installed_kernel
done
```

Initial Configuration

The goal of `simp config` is to allow the user to quickly configure the SIMP server with minimal user input/operations. To that end `simp config` sets installation variables based on information gathered from the user, existing system settings, and SIMP security requirements. It then applies the smallest subset of these system settings that is required to bootstrap the system with Puppet. Both the installation variables and their application via `simp config` are described in subsections that follow.

Installation Variables

This section describes the installation variables set by `simp config`. Although the table that follows lists all possible installation variables, the user will not be prompted for all of them, nor will all of them appear in the configuration files generated by `simp config`. Some of these variables will be automatically set based on other installation variables, system settings, or SIMP security requirements. Others will be omitted because either they are unnecessary for a particular site configuration, or their defaults are appropriate. Also, please note that variables beginning with 'cli::' are only used internally by `simp config`, itself. The 'cli::' variables are written to `simp_conf.yaml`, but not persisted to any Puppet hieradata files.

Important

- Not all the settings listed below can be preset in a configuration file input to `simp config`, via either `-a <Config File>` or `-A <Config File>`. Only settings for which you would be prompted, if you ran `simp config` interactively, can be preset. All other settings will be automatically determined by `simp config`, disregarding your input.
- `simp config` behaves differently (asks different questions, automatically determines different settings) depending on the SIMP installation type. This is because it can safely assume certain server setup has been done, only if SIMP has been installed from the SIMP-provided ISO. For example, consider a `simp` local user. When SIMP is installed from ISO, `simp config` can safely assume that this user is the backup user installed by the ISO to prevent server lockout. As such, `su` and `ssh` privileges for the `simp` user should be allowed. For non-ISO installs, however, it would not be prudent for `simp config` to grant just any `simp` user both `su` and `ssh` privileges.
- `simp config` detects that SIMP has been installed from a SIMP-provided ISO by the presence of `/etc/yum.repos.d/simp_filesystem.repo`.

Variable	Description
cli::is_ldap_server	Whether the SIMP server will also be the LDAP server.
cli::network::dhcp	Whether to use DHCP for the network; *dhcp* to enable DHCP, *static* otherwise
cli::network::gateway	Default gateway
cli::network::hostname	FQDN of server
cli::network::interface	Network interface to use
cli::network::ipaddress	IP address of server
cli::network::netmask	Netmask of the system
cli::network::set_up_nic	Whether to set up the network interface; *true* or *false*
cli::set_grub_password	Whether to set a GRUB password on the server; *true* or *false*
cli::set_production_to_simp	Whether to set default Puppet environment to 'simp'; *true* or *false*
cli::simp::scenario	SIMP scenario; *simp* = full SIMP system, *simp_lite* = SIMP system with some security features disabled for clients, *poss* = SIMP system with all security features disabled for clients.
cli::use_internet_simp_yum_repos	Whether to configure SIMP nodes to use internet SIMP and SIMP dependency YUM repositories.
grub::password	GRUB password hash
puppetdb::master::config::puppetdb_port	Port used by the puppet database
puppetdb::master::config::puppetdb_server	DNS name or IP of puppet database server
simp_openldap::server::conf::rootpw	LDAP Root password hash
simp_options::dns::search	Search domain for DNS
simp_options::dns::servers	List of DNS servers for the managed hosts
simp_options::fips	Enable FIPS-140-2 compliance; *true* or *false*; value automatically set to detected system FIPS status
simp_options::ldap	Whether to use LDAP; *true* or *false*
simp_options::ldap::base_dn	LDAP Server Base Distinguished Name
simp_options::ldap::bind_dn	LDAP Bind Distinguished Name
simp_options::ldap::bind_hash	LDAP Bind password hash
simp_options::ldap::bind_pw	LDAP Bind password
simp_options::ldap::master	LDAP master URI
simp_options::ldap::sync_dn	LDAP Sync Distinguished Name
simp_options::ldap::sync_hash	LDAP Sync password hash
simp_options::ldap::sync_pw	LDAP Sync password
simp_options::ldap::uri	List of LDAP server URIs
simp_options::ntpd::servers	NTP servers

simp_options::puppet::ca	FQDN of Puppet Certificate Authority (CA)
simp_options::puppet::ca_port	Port Puppet CA will listen on
simp_options::puppet::server	FQDN of the puppet server
simp_options::sssd	Whether to use SSSD
simp_options::syslog::failover_log_servers	IP addresses of failover log servers
simp_options::syslog::log_servers	IP addresses of primary log servers
simp_options::trusted_nets	Subnet used for clients managed by the puppet server
simp::runlevel	Default system run level; 1-5
simp::server::allow_simp_user	Whether to allow local 'simp' user su and ssh privileges.
simp::yum::repo::local_os_updates::enable_repo	Whether to enable the SIMP-managed, OS Update YUM repository that the SIMP ISO installs on the SIMP server.
simp::yum::repo::local_os_updates::servers	YUM server(s) for SIMP-managed, OS Update packages
simp::yum::repo::local_simp::enable_repo	Whether to enable the SIMP-managed, SIMP and SIMP dependency YUM repository that the SIMP ISO installs on the SIMP server.
simp::yum::repo::local_simp::servers	YUM server(s) for SIMP-managed, SIMP and SIMP dependency packages
sssd::domains	List of SSSD domains
svckill::mode	Strategy svckill should use when it encounters undeclared services; *enforcing* = shutdown and disable all services not listed in your manifests or the exclusion file *warning* = only report what undeclared services should be shut down and disabled, without actually making the changes to the system
useradd::securetty	A list of TTYs for which the root user can login

simp config Actions

In addition to creating the three configuration, YAML files, `simp config` performs a limited set of actions in order to prepare the system for bootstrapping. Although the table that follows lists all possible `simp config` actions, not all of these actions will apply for all site configurations.

Category	Actions Performed
Certificates	If no certificates for the host are found in `/var/simp/environments/simp/site_files/pki_files/ files/keydist`, `simp config` will use SIMP's FakeCA to generate interim host certificates. These certificates, which are independent of the certificates managed by Puppet, are required by SIMP and should be replaced by certificates from an official **`Certificate Authority`**, as soon as is practical.
Digest Algorithm for FIPS	When the system is in **`FIPS`** mode, `simp config` will set the Puppet digest algorithm to *sha256* to prevent any Puppet-related actions executed by `simp config` from using MD5 checksums. Note that this is **not** all that must be done to enable FIPS. The complete set of actions required to support FIPS is handled by `simp bootstrap`.

GRUB	When the user selects to set the GRUB password `simp config` will set the password in the appropriate grub configuration file, `/etc/grub.conf` or `/etc/grub2.cfg`.
LDAP	When the SIMP server is also an LDAP server, `simp config` • Adds `simp::server::ldap` to the SIMP server host YAML file, which allows the SIMP server to act as a LDAP server • Adds the hash of the user-supplied LDAP root password to the SIMP server host YAML file as `simp_openldap::server::conf::rootpw` to the SIMP
Lockout Prevention	When the SIMP server is installed from ISO, the install creates a local *simp* user that the SIMP server configures to have both su and ssh privileges. (This user is provided to prevent server lockout, as, per security policy, SIMP by default disables logins via ssh for all users, including 'root'.) So, when SIMP is **not** installed from ISO, `simp config` does the following: • Warns the operator of this problem • Writes a lock file containing details on how to rectify the problem. This lock file prevents `simp bootstrap` from running until the user manually fixes the problem. • Turns off the SIMP server configuration that allows su and ssh privileges for an inapplicable *simp* user.
Network	• When the user selects to configure the network interface, `simp config` uses Puppet to set the network interface parameters in system networking files and to bring up the interface. • `simp config` sets the hostname.
Puppet	• Copies SIMP modules installed via RPM in `/usr/share/simp` into the Puppet environments directory `/etc/puppetlabs/code/environments` if necessary. • When selected, sets the default Puppet environment to 'simp', backing up the existing 'production' environment, if it exists. • Creates/updates `/etc/puppetlabs/puppet/autosign.conf`. • Updates the following Puppet settings: `digest_algorithm`, `keylength`, `server`, `ca_server`, `ca_port`, and `trusted_server_facts`. • Updates `/etc/hosts` to ensure a puppet server entry exists.
SIMP Hiera & Site Manifest	• Sets the `$simp_scenario` variable in the site.pp of the 'simp' environment to the user-selected scenario. • If a host YAML file for the SIMP server does not already exist in `/etc/puppetlabs/code/environments/simp/hieradata/hosts` does not already exist, `simp config` will create one from a SIMP template. • Updates the SIMP server host YAML file with appropriate PuppetDB settings. • Creates YAML file containing global hieradata relevant to both the SIMP server and SIMP clients in the 'simp', environment, `simp/hieradata/simp_config_settings.yaml`

YUM	• When the SIMP filesystem YUM repo from an ISO install exists (`/etc/yum.repos.d/simp_filesystem.repo`), `simp config`
	  • Configures SIMP server to act as a YUM server for the on-server repo, by adding the `simp::server::yum` class to the SIMP server host YAML file.
	  • Configures SIMP clients to use the SIMP server's YUM repos by adding `simp::yum::repo::local_os_updates` and `simp::yum::repo::local_simp` classes to `simp_config_settings.yaml`.
	  • Disables the use of the `simp::yum::repo::local*` repos in the SIMP server's host YAML file, as it is already configured to use the more efficient, filesystem repo.
	  • Updates the appropriate OS YUM Updates repository, contained at `/var/www/yum/OSTYPE/MAJORRELEASE/ARCH`.
	  • Disables any default CentOS repos.
	• When the SIMP filesystem YUM repo does not exist, but the user wants to use internet repos `simp config`
	  • Enables internet SIMP server repos in the SIMP server host YAML file by adding the `simp::yum::repo::internet_simp_server` class.
	  • Enables internet SIMP dependency repos for both SIMP clients and in the SIMP server by adding the `simp::yum::repo::internet_simp_dependencies` class to `simp_config_settings.yaml`.
	• When the SIMP filesystem YUM repo does not exist and the user does not want to use internet repos, `simp config`
	  • Checks the configuration of the SIMP server's YUM repos via `repoquery`. If this check fails, writes a lock to prevent `simp bootstrap` from running until the user manually fixes the issue.
	  • Reminds the user to (manually) set up YUM repos for SIMP clients.

SIMP User Guide

Contents:

Introduction

This chapter will walk a user through instructions on administering a **SIMP** system, including the processes for managing clients and users.

Level of Knowledge

SIMP is designed for use by system administrators or users with a strong background using Linux operating systems. The core applications that make up SIMP and require prerequisite knowledge are:

- **Puppet** - 4.0 or later
- **Domain Name System** (DNS) - BIND 9
- **Dynamic Host Configuration Protocol** (DHCP) - Internet Systems Consortium (ISC) DHCP
- **Lightweight Directory Access Protocol** (LDAP) - OpenLDAP

- RedHat Kickstart (including all tools behind it) - **Trivial File Transfer Protocol** (TFTP), PXELinux, etc.
- Apache
- **Yellowdog Updater, Modified** (YUM)
- Rsyslog Version 3+
- **Internet Protocol Tables** (IPtables) (Basic knowledge of the rules)
- **Auditd** (Basic knowledge of how the daemon works)
- **Advanced Intrusion Detection Environment** (AIDE) (Basic knowledge of the rules)
- Basic **X.509**-based **PKI** Key Management

SIMP does as much initial setup and configuration of these tools as possible. However, without at least some understanding, you will be unable to tailor a SIMP system to fit the desired environment. A general understanding of how to control and manipulate these tools from the **command line interface** (CLI) will be necessary, as SIMP does not come stock with a **graphical user interface** (GUI).

Knowledge of scripting and **Ruby** programming will also help to further customize a SIMP install but is not required for routine use.

SIMP Defined

The System Integrity Management Platform (**SIMP**) is an **Open Source** framework designed around the concept that individuals and organizations should not need to repeat the work of automating the basic components of their operating system infrastructure.

Expanding upon this philosophy, SIMP also aims to take care of routine policy compliance to include **NIST 800-53**, **FIPS** 140-2, the **DISA STIG**, and the **SCAP Security Guide**.

By using the **Puppet** automation stack, SIMP is working toward the concept of a self-healing infrastructure that, when used with a consistent configuration management process, will allow users to have confidence that their systems not only start in compliance but remain in compliance over time.

Finally, SIMP has a goal of remaining flexible enough to properly maintain your operational infrastructure. To this end, where possible, the SIMP components are written to allow all security-related capabilities to be easily adjusted to meet the needs of individual applications.

Client Management

This chapter provides guidance to install and configure SIMP clients, via kickstart, with the resources supplied by the SIMP ISO.

This guide also assumes that your SIMP server is a **yum** package repository.

System Requirements

Client systems should meet the following minimum requirements:

- Hardware/**Virtual Machine** (VM) : Capable of running RHEL 6 or 7 x86_64
- RAM: 512 MB
- HDD: 20 GB

Configuring the Puppet Master

Perform the following actions as `root` on the Puppet Master system **prior** to attempting to install a client.

Add the Kickstart server profile

In the Puppet server-specific hiera file (by default located at `/etc/puppetlabs/code/environments/simp/hieradata/hosts/puppet.<your.domain>.yaml`), add the `simp::server::kickstart` class.

```
---
classes:
  - simp::server::kickstart
```

This profile class adds management of bind_dns and named, as well as sets up the example provisioning script.

After adding the above class, run puppet: `puppet agent -t`.

Configure DNS

In SIMP, numerous and/or large configuration files are distributed via `rsync` by Puppet to minimize management cost. These managed files presently include DNS configuration files and can be found at `/var/simp/environments/simp/rsync/<OSTYPE>/<MAJORRELEASE>/bind_dns/default`.

This section is not a complete manual for named. For more complete documentation on how to set up named, see named(8) and named.conf(5).

The following configuration steps are for a SIMP-managed setup. However, you can use an existing DNS infrastructure.

1. Navigate to `/var/simp/environments/simp/rsync/<OSTYPE>/<MAJORRELEASE>/bind_dns/default`
2. Modify the named files to correctly reflect the environment.
   - The relevant files under `bind_dns/default` are as follows:
     - `named/etc/named.conf`
     - `named/etc/zones/your.domain`
     - `named/var/named/forward/your.domain.db`
     - `named/var/named/reverse/0.0.10.db`
   - Review `named/etc/named.conf` and update the following:
     - Update the **`IP`** for allow-query and allow-recursion
     - Delete any unnecessary zone stanzas (i.e. forwarding) if not necessary
     - Substitute in the **`FQDN`** of your domain for all occurrences of `your.domain`
   - Add clients to `named/var/named/forward/your.domain.db` and `named/var/named/reverse/0.0.10.db` and then rename these files to appropriately match your environment.
3. Type `puppet agent -t --tags named` on the Puppet Master to apply the changes.
4. Validate DNS and ensure the `/etc/resolv.conf` is updated appropriately.
5. If an error about the `rndc.key` appears when starting named, see the Bind Documentation. Once you have resolved the issue, re-run the puppet command `puppet agent -t` on the Puppet Master to apply.

> ***Note***
>
> You can adjust the list of clients in your `named/var/named/forward/<your.domain>.db` and `named/var/named/reverse/<your reverse domain>.db` files at any time. Just remember to run `puppet agent -t --tags named` on the Puppet Server to propagate these updates.

Configure DHCP

Perform the following actions as `root` on the Puppet Master system prior to attempting to install a client.

Open the `/var/simp/environments/simp/rsync/<OSTYPE>/Global/dhcpd/dhcpd.conf` file and edit it to suit the necessary environment.

Make sure the following is done in the `dhcpd.conf` :

- The `next-server` setting in the `pxeclients` class block points to the IP Address of the **`TFTP`** server.
- Create a Subnet block and edit the following:
  - Make sure the **router** and **netmask** are correct for your environment.
  - Enter the hardware ethernet and fixed-address for each client that will be kickstarted. For increased security, it is suggested that SIMP environments not allow clients to pick random IP Address in a subnet. The MAC address must be associated with and IP Address here. (You can add additional ones as needed.)
  - Enter the domain name for option **domain-name**
  - Enter the IP Address of the DNS server for option **domain-name-servers**

Save and close the file.

Run `puppet agent -t` on the Puppet Master to apply the changes.

Configure PXE Boot

Sample kickstart templates have been provided in the `/var/www/ks` directory on the SIMP server and on the SIMP DVD under `/ks`. Pre-boot images are located in the DVD under `/images/pxeboot`. If you have an existing **`Preboot Execution Environment`** (PXE) setup you can use these to PXE a SIMP client. Follow your own sites procedures for this.

In this section we describe how to configure the Kickstart and TFTP servers to PXE boot a SIMP client. (The DHCP server setup, also required for PXE booting, is discussed in and earlier chapter.)

Note

This example sets up a PXE boot for a system that is the same OS as the SIMP Server. If you are setting up a PXE boot for a different OS then you must make sure that the OS packages are available for all systems you are trying to PXE boot through YUM. There are notes throughout the instructions to help in setting multiple OS but they are not comprehensive. You should understand DHCP, KS, YUM and TFTP relationships for PXE booting before attempting this.

Setting Up Kickstart

This section describes how to configure the kickstart server.

1. Locate the following files in the `/var/www/ks` directory
   - `pupclient_x86_64.cfg`
   - `diskdetect.sh`
2. Open each of the files and follow the instructions provided within them to replace the variables. You need to know the IP Addresses of the YUM, Kickstart, and TFTPserver. (They default to the simp server in `simp config`).

- `pupclient_x86_64.cfg`: Replace the variables noted at the top and generate and enter the passwords.
- `diskdetect.sh`: The `diskdetect.sh` script is responsible for detecting the first active disk and applying a disk configuration. Edit this file to meet any necessary requirements or use this file as a starting point for further work. It will work as is for most systems as long as your disk device names are in the list.

3. Type `chown root.apache /var/www/ks/*` to ensure that all files are owned by `root` and in the apache group.
4. Type `chmod 640 /var/www/ks/*` to change the permissions so the owner can read and write the file and the apache group can only read.

Note

The URLs and locations in the file are setup for a default SIMP install. That means the same OS and version as the SIMP server, all servers in one location (on the SIMP server) and in specific directories. If you have installed these servers in a different location than the defaults, you may need to edit URLs or directories.

Note

If you want to PXE boot more than this operating system, make a copy of these files, name them appropriately and update URLS and links inside and anything else you may need. (You must know what you are doing before attempting this.) If you are booting more than one OS you must also make sure your YUM server has the OS packages for the other OSs. By default the YUM server on SIMP has the packages only for the version of OS installed on the SIMP server.

Setting up TFTP

This section describes the process of setting up static files and manifests for **`TFTP`**.

Static Files

Verify the static files are in the correct location:

Type `cd /var/simp/environments/simp/rsync/<OSTYPE>/Global/tftpboot`

(<OSTYPE> and <MAJORRELEASE> under rsync are the type and version of the SIMP **server**)

Verify there is a `linux-install` directory and cd to this directory.

Under the linux-install directory you should find a directory named `OSTYPE-MAJORRELEASE.MINORRELEASE-ARCH` and a link to this directory named `OSTYPE-MAJORRELEASE-ARCH`.

Under OSTYPE-MAJORRELEASE.MINORRELEASE-ARCH you should find the files:

- initrd.img
- vmlinuz

If these are not there then you must create the directories as needed and copy the files from `/var/www/yum/<OSTYPE>/<MAJORRELEASE>/<ARCH>/images/pxeboot` or from the images directory on the SIMP DVD.

> ***Important***
>
> The link is what is used in the TFTP configuration files.

Manifest

Create a site manifest for the TFTP server on the Puppet server.

1. Create the file `/etc/puppetlabs/code/environments/simp/modules/site/manifests/tftpboot.pp`. Use the source code example below.

   - Replace KSSERVER with the IP address of Kickstart server (or the code to look up the IP Address using **Hiera**).
   - Replace OSTYPE, MAJORRELEASE and ARCH with the correct values for the systems you will be PXE booting.
   - MODEL_NAME is usually of the form OSTYPE_MAJORRELEASE_ARCH for consistency.

```
# for CentOS/RedHat 7
class site::tftpboot {
  include '::tftpboot'

  tftpboot::linux_model { 'el7_x86_64':
    kernel => 'OSTYPE-MAJORRELEASE-ARCH/vmlinuz',
    initrd => 'OSTYPE-MAJORRELEASE-ARCH/initrd.img',
    ks     => "https://KSSERVER/ks/pupclient_x86_64.cfg",
    extra  => "inst.noverifyssl ksdevice=bootif\nipappend 2"
  }

  ::tftpboot::assign_host { 'default': model => 'el7_x86_64' }
}
```

```
# For CentOS/RedHat 6
# Note the difference in the `extra` arguments here.
class site::tftpboot {
  include '::tftpboot'

  tftpboot::linux_model { 'el6_x86_64':
    kernel => 'OSTYPE-MAJORRELEASE-ARCH/vmlinuz',
    initrd => 'OSTYPE-MAJORRELEASE-ARCH/initrd.img',
    ks     => "https://KSSERVER/ks/pupclient_x86_64.cfg",
    extra  => "noverifyssl ksdevice=bootif\nipappend 2"
  }

  tftpboot::assign_host { 'default': model => 'el6_x86_64' }
}
```

2. Add the tftpboot site manifest on your puppet server node via Hiera. Create the file (or edit if it exists): `/etc/puppetlabs/code/environments/simp/hieradata/hosts/<tftp.server.fqdn>.yaml`. (By default the TFTP server is the same as your puppet server so it should exist.) Add the following example code to that yaml file.

```
---
classes:
  - 'site::tftpboot'
```

3. After updating the above file, type `puppet agent -t --tags tftpboot` on the Puppet server.

Note

To PXE boot more OSs, create, in the tftpboot.pp file, a `tftpboot::linux_model` block for each OS type using the extra directories and kickstart files created using the notes in previous sections. Point individual systems to them by adding assign_host lines with their MAC pointing to the appropriate model name.

Apply Certificates

All clients in a SIMP system must have **Public Key Infrastructure** (PKI) keypairs generated for the server. These keys reside in the `/var/simp/environments/simp/site_files/pki_files/files/keydist` directory on the SIMP server and are served to the clients over the puppet protocol.

Note

These keypairs are **not** the keys that the Puppet server uses for its operation. Do not get the two confused.

See Certificate Management for more information.

This section provides guidance on installing official certificates or, as an interim measure, generating certificates from the Fake (self-signing) Certificate Authority provided by SIMP.

Installing Official Certificates

Below are the steps to install official certificates for a SIMP client on the SIMP server:

1. Copy the certificates received from a proper **CA** to the SIMP server.
2. Add the keys for the node to `/var/simp/environments/simp/site_files/pki_files/files/keydist`.

   a. Type
   `mkdir -p /var/simp/environments/simp/site_files/pki_files/files/keydist/***<Client Syste`

   b. Type
   ```
   mv ***<Certificate Directory>***/***<FQDN>***.[pem|pub] \
   /var/simp/environments/simp/site_files/pki_files/files/keydist/***<FQDN>***
   ```

   c. Type
   `chown -R root.puppet /var/simp/environments/simp/site_files/pki_files/files/keydist`

   d. Type
   `chmod -R u=rwX,g=rX,o-rwx /var/simp/environments/simp/site_files/pki_files/files/keydist`
3. Create and populate the `/var/simp/environments/simp/site_files/pki_files/files/keydist/cacerts` directory.

a. Type `cd /var/simp/environments/simp/site_files/pki_files/files/keydist`

b. Type `mkdir cacerts` and copy the root CA public certificates into cacerts in Privacy Enhanced Mail (PEM) format (one per file).

c. Type `cd cacerts`

d. Type
```
for file in *.pem; do ln -s $file `openssl x509 -in $file -hash -noout`.0; done
```

Generating Certificates from the Fake CA

If server certificates have not or could not be obtained at the time of client installation, SIMP provides a way to create them for the system, so that it will work until proper certificates are provided.

> ***Note***
>
> This option should not be used for any operational system that can use proper enterprise PKI certificates.

Below are the steps to generate the certificates using the SIMP-provided, Fake CA.

1. Type `cd /var/simp/environments/simp/FakeCA`
2. Type `vi togen`
3. Remove old entries from the file and add the **`Fully Qualified Domain Name`** (FQDN) of the systems (one per line) for which certificates will be created.

   > ***Note***
   >
   > To use alternate DNS names for the same system, separate the names with commas and without spaces.
   >
   > For example, `.name,alt.name1,alt.name2.`

4. Type `wc cacertkey`

   > ***Note***
   >
   > Ensure that the `cacertkey` file is not empty. If it is, enter text into the file; then save and close the file.

5. Type `./gencerts_nopass.sh auto`

   > ***Note***
   >
   > To avoid using the default Fake CA values, remove the `auto` statement from the `./gencerts_nopass.sh` command.

> ***Warning***
>
> If the `clean.sh` command is run after the certificates have been generated, you will not be able to generate new host certificates under the old CA. To troubleshoot certificate problems, see the Troubleshooting Certificate Issues section.

If issues arise while generating keys, type `cd /etc/puppetlabs/code/environments/simp/FakeCA` to navigate to the `/etc/puppetlabs/code/environments/simp/FakeCA` directory, then type `./clean.sh` to start over.

After running the `clean.sh` script, type `./gencerts_nopass.sh` to run the script again using the previous procedure table.

Setting Up the Client

The following lists the steps to **PXE** boot the system and set up the client.

1. Set up your client's **BIOS** or virtual settings to boot off the network.
2. Make sure the **MAC** address of the client is set up in **DHCP** (see Configure DHCP for more info.)
3. Restart the system.
4. Once the client installs, reboots, and begins to bootstrap, it will check in for the first time.
5. Puppet will not autosign puppet certificates by default and waitforcert is enabled. The client will check in every 30 seconds for a signed cert. Log on to the puppet server and run `puppet cert sign <puppet.client.fqdn>`.

Upon successful deployment of a new client, it is highly recommended that *LDAP administrative accounts <Managing LDAP Users>* be created.

Troubleshooting Puppet Issues

If the client has been kickstarted, but is not communicating with the Puppet server, try the following options:

- Check the forward and reverse **DNS** entries on the client and server; both must be correct. The `nslookup` command will help here.
- Check the time on the systems. More than an hour's difference will cause serious issues with certificates.
- Remove `/etc/puppetlabs/puppet/ssl` on the client system; run `puppet cert --clean ***<Client Host Name>***` on the Puppet server and try again.

Troubleshooting Certificate Issues

If host certificates do not appear to be working, ensure that all certificates verify against the installed **CA** certificates.

The table below lists the steps to determine which certificates are working and which are not.

1. Navigate to `/var/simp/environments/simp/site_files/pki_files/files/keydist`
2. Run `find . -name "****<your.domain>*.pub" -exec openssl verify -CApath cacerts {} \;`

   The screen displays `./<Host Name>.<Your.Domain>/<Hostname>.<Your.Domain>.pub: OK` If anything other than OK appears for each host, analyze the error and ensure that the CA certificates are correct.
   If the TXT_DB error number **2** appears, revoke the certificate that is being regenerated. The table below lists the steps to revoke the certificate.

3. Navigate to `/var/simp/environments/simp/site_files/pki_files/files/keydist`
4. Run

```
OPENSSL_CONF=default.cnf openssl ca -revoke \
keydist/*<Host to Revoke>*/*<Host to Revoke>*.pub
```

SIMP Administration

This chapter provides guidance on general administration practices applicable to SIMP environments.

> ***Important***
>
> It is important to remember that SIMP approaches system configuration from a least privilege, defense in depth, mindset where possible.

Classification and Data

Node Classification in SIMP

From the Puppet, Inc website:

> Hiera is a key/value lookup tool for configuration data, built to set node-specific data without repeating yourself.

SIMP uses **`Hiera`** to attempt to make configuration of the overall system easier for our end users by providing a simple, centralized, method for setting class parameters using automatic parameter lookup and as a method for basic node classification.

It is **highly recommended** that you read the Hiera Documentation prior to jumping into using a SIMP system.

Hiera in SIMP

As mentioned, SIMP users are expected to make extensive use of Hiera to set parameters, particularly those that are deep within the code.

The default Hiera hierarchy used by SIMP looks like the following:

```
---
:backends:
  - 'yaml'
:hierarchy:
  # Most specific
  - 'hosts/%{trusted.certname}'
  - 'hosts/%{facts.fqdn}'
  - 'hosts/%{facts.hostname}'
  - 'domains/%{facts.domain}'
  - '%{facts.os.family}'
  - '%{facts.os.name}/%{facts.os.release.full}'
  - '%{facts.os.name}/%{facts.os.release.major}'
  - '%{facts.os.name}'
  - 'hostgroups/%{::hostgroup}'
  - 'default'
  - 'compliance_profiles/%{::compliance_profile}'
  - 'simp_config_settings'
  - 'scenarios/%{::simp_scenario}'
```

```
  # Least specific
:logger: 'puppet'
:yaml:
  :datadir: '/etc/puppetlabs/code/environments/%{::environment}/hieradata'
```

Warning

This may not be accurate for your version of SIMP, please check your local Hiera settings!

The rest of this document will use this hierarchy as a reference.

Assigning Classes to Nodes

Assigning classes to nodes can be done in a few ways in SIMP. First, there is a a `lookup` function in `/etc/puppetlabs/code/environments/simp/manifests/site.pp` that looks for an array called `classes` in your hierarchy. It also looks for an array called `class_exclusions`, which can be used to remove classes from the classes array. The classes that are included are the result of `$classes - $class_exclusions`. If classes need to be added to all nodes, a `classes` array could be added to the `default.yaml` in your hieradata, like this:

```
---
  classes:
    - 'site::example_class'
---
```

A similar array could be created in any other layer in the hierarchy, and it will be merged with the 'unique' strategy by the `lookup` function noted above.

The SIMP profile module also includes other classes needed for a secure baseline, which are discussed below in the simp scenarios section.

Assigning Defined Types to Nodes

Defined types do not have the ability to receive parameters via Hiera in the traditional sense. To include a defined type on a node, one could use `create_resources`, but this is messy and discouraged. Instead, create your own profile or add a class to the SIMP `site` module such as: `/etc/puppetlabs/code/environments/simp/modules/site/manifests/my_site.pp`.

Note

You can find a working example of this in the Configure PXE Boot section of the documentation

SIMP File Structure

The default puppet environment in SIMP, located at `/etc/puppetlabs/code/environments/simp`, contains almost all necessary files for a Puppet infrastructure. It will look like this on a fresh SIMP system:

```
/etc/puppetlabs/code/environments/simp/
├── environment.conf
├── hieradata/
├── manifests/
└── modules/
```

- `environment.conf` - Sets the environment to include the second SIMP modulepath.

- `manifests/` - Contains site.pp and all other node manifests.
- `hieradata/` - Default location of the yaml files which contain your node data
- `modules/` - Default install location of Puppet modules. Each module RPM copies files here during installation from `/usr/share/simp/modules`.

Second Modulepath

SIMP utilizes a second modulepath to ensure that deployment tools like r10k don't squash keydist and some krb5 files. The path is `/var/simp/environments/simp/site_files/`. Apply Certificates are stored there.

Hiera

```
/etc/puppetlabs/code/environments/simp/hieradata/
├── CentOS -> RedHat/
├── compliance_profiles/
├── default.yaml
├── hostgroups/
├── hosts/
├── RedHat/
├── scenarios/
└── simp_config_settings.yaml
```

- `hieradata/hosts/` - By populating this directory with some.host.name.yaml file, you can assign parameters to host some.host.name
- `hieradata/domains/` - Same principal as hosts, but domain names.
- `hieradata/Redhat/` - RedHat-specific hiera settings.
- `hieradata/CentOS/` - CentOS-specific hiera settings, symlinked to `hieradata/Redhat/`.
- `hieradata/hostgroups/` - The hostgroup of a node can be computed in *site.pp*. Nodes assigned to hostgroup *$hostgroup* will read hiera from a file named *<hostgroup>.yaml* in this directory.
- `hieradata/default.yaml` - Settings that should be applied to the entire infrastructure.
- `hieradata/simp_config_settings.yaml` - Contains the variables needed to configure SIMP. Added by `simp config`.
- `hieradata/scenarios/` - Directory containing SIMP Scenarios, set in `manifests/site.pp`.

`/etc/puppetlabs/puppet/hiera.yaml` - Hiera's config file, used to control the hierarchy of your backends. The order of the files above mirrors that order in the distributed hiera.yaml.

SIMP Scenarios

SIMP scenarios are groups of classes, settings, and simp_options that ensure the system is compliant and secure.

There are currently four SIMP scenarios: - *simp* - *simp_lite* - *poss* - *remote_access*

The *simp* scenario includes all security features enabled by default, including iptables and svckill. This scenario is what stock SIMP used to look like in previous releases.

The *simp_lite* scenario offers many security features, with a few explicitly turned off. This scenario was designed to make it easier to implement SIMP in an existing environment, because it might not be trivial to flip SELinux to Enforcing on all nodes.

The *poss* option is the barebones option. It only includes the pupmod class, to configure Puppet agent on clients. All of the simp_options default to false, so SIMP will not do a lot of modification to clients through Puppet when using this scenario.

The *remote_access* scenario includes the SSH module and the authentication stack, namely PAM and nsswitch. This scenario is useful for those who want to retain remote access to their machine while leaving virtually everything else untouched.

Note

The SIMP or Puppet server is exempt from most of these settings, and will be using most features from the *simp* scenario by default. The SIMP server should only have services on it related to Puppet and systems management, and SIMP modules all work with all security features enabled. See the `puppet.your.domain.yaml` in the `hieradata/hosts` directory for details.

Integrating Applications

This section describes how to integrate external applications into the SIMP managed infrastructure.

For most applications, there are only three SIMP control components that must be addressed for successful product integration.

IPTables

By default, the SIMP system drops all **incoming** connections to the server, save port 22. Port 22 is allowed from **all** external sources since there is no safe way to restrict this that will not lock users out of freshly installed systems in some cases.

The default SIMP **`IPTables`** start-up sequence has been set to *fail safe*. This means that if the IPTables rules cannot cleanly apply, the system will only allow port 22 into the system for SSH troubleshooting and recovery.

There are many examples of how to use the IPTables module in the source code; the Apache module at `/etc/puppetlabs/code/environments/simp/modules/simp_apache` is a particularly good example. You can also reference the Defined Types in the IPTables Puppet module to understand their purpose and choose the best option.

Local Access Controls

Following defense in depth best practice, SIMP does not trust a single system to determine the access that someone has to a system. All system accesses are, by default, restricted to users in the `administrators` group.

If you have an application that needs to use a login shell for configuration, or to run the service, you will need to follow the guidance in PAM Access Restrictions to ensure that your local user accounts have appropriate system access.

Note

This **does** affect `sudo` accounts! If your application is using a `sudo` account in a startup script, please consider switching to `runuser` since it is not affected by PAM controls.

Service Kill

To ensure that the system does not run unnecessary services, the SIMP team implemented a `svckill.rb` script to stop any service (not process) that is not properly defined in the Puppet catalog.

To prevent services from stopping, refer to the instructions in the My Services Are Dying! Troubleshooting section.

As of SIMP 6.0.0, the `svckill` Puppet Resource will now warn you that it would kill items by default and you will explicitly need to enable `svckill` enforcement.

General Administration

This section provides information on the standard administrative techniques used when managing SIMP systems.

Various philosophical decisions are also covered to help users understand why SIMP does some of the things that it does.

Warning

While working with the system, keep in mind that **`Puppet`** does not work well with capital letters in host names.

DO NOT USE CAPITAL LETTERS IN HOST NAMES

The SIMP Environment

SIMP fully supports Puppet Environments and, by default, installs into an environment named `simp`. This environment is symlinked to the `production` environment by `simp config` but that symlink will **not** be overwritten on update so you may freely change or replace the symlink to meet your needs.

There are a couple of paths on the system that are environment related.

/var/simp

This space holds all static, non-Puppet created files. It is generally used for large binary items that will be centrally delivered via rsync and for files that are too dangerous to add to a version control system. These include things like the SIMP rsync materials and the Infrastructure keys.

This space is environment aware and you will note that there is an `environments` directory under `/var/simp` with, by default, the `simp` environment represented. If you add new environments, you will need to replicate the appropriate structure from the `simp` environment into your custom environment.

This space also holds FakeCA. See Infrastructure Certificates.

Note

For more information on the SIMP rsync structure, please see HOWTO Work with the SIMP Rsync Shares

/opt/puppetlabs/server/data/puppetserver/simp

This space holds all non-static, Puppet **server** created files. This is used by both passgen() and the `krb5` Puppet module for storing dynamically generated server-side content.

Like `/var/simp` this space is also environment aware but you should never need to manually adjust anything in this directory space.

Package Management

The SIMP infrastructure has a consistent philosophy that managed packages should be at the latest version in the available repositories whenever the system is brought into alignment by **Puppet**.

All SIMP produced modules should, by default, have their versions set to `present` but `simp_options`, when set initially by `simp config`, should set that to `latest` across the environment.

The rationale behind this is that it is far easier to update a set of repositories than it is to precisely pin versions of all packages managed on a given system. Since repositories are generally common packages, the ability to create a set of symlinks that represent the latest tested state of a system should be far simpler than doing minutia management across your Puppet code.

Workflow

The general workflow to keep your system properly up to date would be as follows.

> ***Note***
>
> We **highly** recommend using **Beaker** for testing these scenarios

1. Update the **Test** repository
2. Assign a test node to the repository via a `yumrepo` resource
3. Run Puppet and evaluate the results
4. Run a full system update and evaluate the results
    - This simulates the Nightly Updates, if enabled
5. If all goes well, migrate the changes to the **Production** repository
6. Let Puppet do the rest

See Nightly Updates for more information on setting up the repositories and providing packages to your clients.

Nightly Updates

All SIMP systems are configured, by default, to do a YUM update of the entire system on a nightly basis. When the update task runs, it will pull **ALL** updates that the system is aware of.

> ***Note***
>
> Refer to HOWTO Exclude YUM Repositories for additional configuration information.

> ***Note***
>
> See HOWTO Modify the Nightly Update Schedule for information on changing the nightly update schedule or disabling the nightly updates altogether.

To use this effectively, packages that all systems will receive should be placed into the `Updates` repository provided with SIMP. Any packages that will only go to specific system sets should then be placed into adjunct repositories under `/var/www/yum` and the user will point specific systems at those

repositories using the `yumrepo` Puppet Type. Any common packages can be either symlinked or hard linked between repositories for efficiency.

Changing the Default Repositories

By default, SIMP stores **YUM** information in the following directories:

- `/var/www/yum`

The base SIMP repository is in `/var/www/yum/SIMP` and it is highly unlikely that you would want to modify anything in this directory.

By default, access to the YUM repository is restricted to the networks contained in the `simp_options::trusted_nets` parameter. For this section, we will assume that this is sufficient.

The Operating System Repos

The default location for the **Operating System** (OS) repositories, on the Puppet server, is `/var/www/yum/<OSTYPE>/<MAJORRELEASE>/x86_64`.

An `Updates` repository has been configured in this space. All OS updates should be placed within this directory.

You should run the following in the `Updates` directory after **ANY** package addition or removal within that directory.

```
$ createrepo .
$ chown -R root.apache ./*
$ find . -type f -exec chmod 640 {} \;
$ find . -type d -exec chmod 750 {} \;
```

Adding a Custom Repository

For this section, we will assume that you have a repository named `foo` that you would like to expose to your systems. To do this, perform the following:

```
$ cd /var/www/yum
$ mkdir foo
$ cd foo
$ -- copy all RPMs into the folder
$ createrepo .
$ chown -R root.apache ./*
$ find . -type f -exec chmod 640 {} \;
$ find . -type d -exec chmod 750 {} \;
```

Note

For more information on managing YUM repos, please see the Red Hat local repository Documentation.

Configuring the Clients

Now that you've added this repository, you're going to want to add it to your clients.

The best way to do this is to make it part of your site profile. You **can** make it part of your module, but you will need to wrap it in a Defined Type so that the server parameter can be modified.

To add it to your clients, use the puppet yumrepo Type. You can find more information in the Puppet Type Reference.

The following is a basic yumrepo example:

```
yumrepo { example:
  baseurl         => "http://your.server.fqdn/yum/foo",
  enabled         => 1,
  enablegroups    => 0,
  gpgcheck        => 0,
  keepalive       => 0,
  metadata_expire => 3600
}
```

Session Auditing

By default, a SIMP system uses **Sudosh** to enable logging the output of sudo sessions to Rsyslog.

To open a sudo session from a regular user to root, you should type sudo sudosh.

sudosh logs are stored in /var/log/sudosh.log. Sessions can be replayed by typing sudosh-syslog-replay.

> ***Note***
>
> The SIMP system does not allow the root user to execute sudo by default per common configuration guidance.

> ***Note***
>
> If you built your system from an ISO, you will probably have a local simp user that has the ability to run sudo su - root directly and bypass sudosh.
>
> This is meant as an emergency 'break glass' user and should be removed or disabled once your environment is configured to your satisfaction.

User Accounts

The SIMP team tests both local and **LDAP** account access to systems. Other modes of access may function but are not tested by the SIMP test suite at this time.

We recommend that LDAP be used for adding all human users so that there is no conflict with multiple system updates and synchronization. For more information on managing LDAP users, refer to the User Management chapter.

If you need to create local system accounts, you can use the user and group Native Types.

Certificate Management

This section describes the two different types of certificates used in a SIMP system and how to manage them. For information on initial certificate setup, refer to the Apply Certificates section of Client Management.

Infrastructure Certificates

Server certificates are the standard **PKI** certificates assigned either by an official **CA** (preferred) or generated using the FakeCA utility offered by SIMP. Generated certificates are placed in the `/etc/pki/simp` directory of all managed systems. These certificates are set to expire annually. To change this, edit the following files with the number of days for the desired lifespan of the certificates:

> ***Note***
>
> This assumes that the user has generated Certificates with the FakeCA provided by SIMP. If official certificates are being used, these settings **must be changed within the official CA, not on the SIMP system**.

- `/var/simp/environments/simp/FakeCA/CA`
- `/var/simp/environments/simp/FakeCA/ca.cnf`
- `/var/simp/environments/simp/FakeCA/default\_altnames.cnf`
- `/var/simp/environments/simp/FakeCA/default.cnf`
- `/var/simp/environments/simp/FakeCA/user.cnf`

In addition, any certificates that have already been created and signed will have a config file containing all of its details in `/var/simp/environments/simp/FakeCA/output/conf/`.

> ***Important***
>
> Editing any entries in the above mentioned config files will **not** affect existing certificates. Existing certificates must be regenerated if you need to make changes.

The following is an example of how to change the expiration time from one year (the default) to five years for any newly created certificate.

```
for file in $(grep -rl 365 /var/simp/environments/simp/FakeCA/)
do
   sed -i 's/365/1825/' $file
done
```

Puppet Certificates

Puppet certificates are issued and maintained strictly within Puppet. They are different from the server certificates and should be managed with the `puppet cert` utility.

For documentation on the `puppet cert` tool, visit the Puppet Inc. cert manual.

You can find the location for the Puppet certificates on your system by running `puppet config print ssldir`.

> ***Note***
>
> By default, Puppet certificates expire every five (5) years.

The SIMP Utility

The SIMP server provides a command line utility called `simp` that is an interface into SIMP-specific settings and subsystems.

You can get information on the `simp` utility by running `simp help` on your SIMP server.

simp passgen

Throughout the SIMP codebase, you may find references to the `passgen()` function. This function auto-generates passwords and stores them in `/opt/puppetlabs/server/data/puppetserver/simp/environments/<environment>/simp_autofiles/gen_passwd` on the Puppet server.

For more information, see the passgen() documentation.

Graphical User Interfaces

SIMP was designed as a minimized system, but you may occasionally need a GUI. Refer to the Graphical Desktop Setup documentation for information on setting up GUIs for the systems.

Apply Certificates

All clients in a SIMP system must have **`Public Key Infrastructure`** (PKI) keypairs generated for the server. These keys reside in the `/var/simp/environments/simp/site_files/pki_files/files/keydist` directory on the SIMP server and are served to the clients over the puppet protocol.

Note

These keypairs are **not** the keys that the Puppet server uses for its operation. Do not get the two confused.

See Certificate Management for more information.

This section provides guidance on installing official certificates or, as an interim measure, generating certificates from the Fake (self-signing) Certificate Authority provided by SIMP.

Installing Official Certificates

Below are the steps to install official certificates for a SIMP client on the SIMP server:

1. Copy the certificates received from a proper **`CA`** to the SIMP server.
2. Add the keys for the node to `/var/simp/environments/simp/site_files/pki_files/files/keydist`.
   a. Type
   `mkdir -p /var/simp/environments/simp/site_files/pki_files/files/keydist/***<Client Syste`
   b. Type
   ```
   mv ***<Certificate Directory>***/***<FQDN>***.[pem|pub] \
   /var/simp/environments/simp/site_files/pki_files/files/keydist/***<FQDN>***
   ```
   c. Type
   `chown -R root.puppet /var/simp/environments/simp/site_files/pki_files/files/keydist`
   d. Type
   `chmod -R u=rwX,g=rX,o-rwx /var/simp/environments/simp/site_files/pki_files/files/keydist`
3. Create and populate the `/var/simp/environments/simp/site_files/pki_files/files/keydist/cacerts` directory.
   a. Type `cd /var/simp/environments/simp/site_files/pki_files/files/keydist`

b. Type `mkdir cacerts` and copy the root CA public certificates into cacerts in Privacy Enhanced Mail (PEM) format (one per file).

c. Type `cd cacerts`

d. Type
```
for file in *.pem; do ln -s $file `openssl x509 -in $file -hash -noout`.0; done
```

Generating Certificates from the Fake CA

If server certificates have not or could not be obtained at the time of client installation, SIMP provides a way to create them for the system, so that it will work until proper certificates are provided.

> ***Note***
>
> This option should not be used for any operational system that can use proper enterprise PKI certificates.

Below are the steps to generate the certificates using the SIMP-provided, Fake CA.

1. Type `cd /var/simp/environments/simp/FakeCA`
2. Type `vi togen`
3. Remove old entries from the file and add the **`Fully Qualified Domain Name`** (FQDN) of the systems (one per line) for which certificates will be created.

   > ***Note***
   >
   > To use alternate DNS names for the same system, separate the names with commas and without spaces.
   >
   > For example, `.name,alt.name1,alt.name2.`

4. Type `wc cacertkey`

   > ***Note***
   >
   > Ensure that the `cacertkey` file is not empty. If it is, enter text into the file; then save and close the file.

5. Type `./gencerts_nopass.sh auto`

   > ***Note***
   >
   > To avoid using the default Fake CA values, remove the `auto` statement from the `./gencerts_nopass.sh` command.

> ***Warning***
>
> If the `clean.sh` command is run after the certificates have been generated, you will not be able to generate new host certificates under the old CA. To troubleshoot certificate problems, see the Troubleshooting Certificate Issues section.

If issues arise while generating keys, type `cd /etc/puppetlabs/code/environments/simp/FakeCA` to navigate to the `/etc/puppetlabs/code/environments/simp/FakeCA` directory, then type `./clean.sh` to start over.

After running the `clean.sh` script, type `./gencerts_nopass.sh` to run the script again using the previous procedure table.

User Management

This chapter explains how to manage users in the default SIMP environment.

Managing Users with Lightweight Directory Access Protocol (LDAP)

Prepare SIMP ldifs

SIMP natively uses OpenLDAP for user and group management. Actionable copies of the **LDAP** Data Interchange Format (.ldif) files can be found on the system in the `/usr/share/simp/ldifs` directory. Copy these files into `/root/ldifs` and fix their Distinguished Names:

```
$ mkdir /root/ldifs
$ cp /usr/share/simp/ldifs/* /root/ldifs
$ cd /root/ldifs
$ sed -i 's/dc=your,dc=domain/<your actual DN information>/g' \*.ldif
```

Warning

Do not leave any extraneous spaces in LDIF files!

```
# Use `:set list` in vim to see hidden spaces at the end of lines.

# Use the following to strip out inappropriate characters

sed -i \
  's/\\(^[[:graph:]]\*:\\)[[:space:]]\*\\ ([[:graph:]]\*\\) \\[[:space:]]\*$/\\1\\2/' \
  file.ldif
```

Note

Use the [and] characters to scroll right when using ELinks.

Add a User

Users can be added with or without a password. Follow the instructions in the following sections.

Note

Every user must belong to a unique, primary group, but can optionally belong to one or more, secondary groups.

Warning

This process should not be used to create users or groups for daemon processes unless the user has experience.

Add a User with a Password

To add a user with a password to the system, along with a unique group for that user:

1. Login to the LDAP server as `root`.
2. Use the `slappasswd` command to generate a password hash for a user.
3. Edit the `/root/ldifs/add_user_with_password.ldif` shown below.

```
dn: cn=<username>,ou=Group,dc=your,dc=domain
objectClass: posixGroup
objectClass: top
cn: <username>
gidNumber: <Unique GID Number>
description: "<Group Description>"

dn: uid=<username>,ou=People,dc=your,dc=domain
uid: <username>
```

```
cn: <username>
givenName: <First Name>
sn: <Last Name>
mail: <e-mail address>
objectClass: inetOrgPerson
objectClass: posixAccount
objectClass: top
objectClass: shadowAccount
objectClass: ldapPublicKey
shadowMax: 180
shadowMin: 1
shadowWarning: 7
shadowLastChange: 10701
sshPublicKey: <some SSH public key>
loginShell: /bin/bash
uidNumber: <some UID number above 1000>
gidNumber: <GID number from above>
homeDirectory: /home/<username>
userPassword: <slappasswd generated SSHA hash>
pwdReset: TRUE
```

4. Type the following, substituting your DN information for `dc=your,dc=domain`:

```
$ ldapadd -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/add_user_with_password.ldif
```

Ensure that an administrative account is created as soon as the SIMP system has been properly configured. Administrative accounts should belong to the `administrators` LDAP group (gidNumber 700). Members of this LDAP group can utilize sudo sudosh for privilege escalation.

Note

The `pwdReset: TRUE` command causes the user to change the assigned password at the next login. This command is useful to pre-generate the password first and change it at a later time.

This command appears to be broken in some versions of `nss_ldap`. Therefore, to avoid future issues set `shadowLastChange` to a value around 10000.

Warning

The initial password set for a user must conform to the password policy or the user will not be able to login and change his/her password, even though the password reset has been enabled by `pwdReset: TRUE`.

Add a User without a Password

To add a user without a password to the system, along with a unique group for that user

1. Login to the LDAP server as `root`.
2. Edit the `/root/ldifs/add_user_no_password.ldif` shown below.

```
dn: cn=<username>,ou=Group,dc=your,dc=domain
objectClass: posixGroup
```

```
objectClass: top
cn: <username>
gidNumber: <Unique GID Number>
description: "<Group Description>"

dn: uid=<username>,ou=People,dc=your,dc=domain
uid: <username>
cn: <username>
givenName: <First Name>
sn: <Last Name>
mail: <e-mail address>
objectClass: inetOrgPerson
objectClass: posixAccount
objectClass: top
objectClass: shadowAccount
objectClass: ldapPublicKey
sshPublicKey: <some SSH public key>
loginShell: /bin/bash
uidNumber: <some UID number above 1000>
gidNumber: <GID number from above>
homeDirectory: /home/<username>
```

3. Type the following, substituting your DN information for dc=your,dc=domain:

```
$ ldapadd -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/add_user_no_password.ldif
```

Remove a User

To remove a user from the system, along with a unique group for that user:

1. Login to the LDAP server as root.
2. Edit the /root/ldifs/del_user.ldif shown below.

```
dn: cn=<User UID>,ou=Group,dc=example,dc=domain
changeType: delete

dn: uid=<User UID>,ou=People,dc=example,dc=domain
changeType: delete
```

3. Type the following, substituting your DN information for dc=your,dc=domain:

```
$ ldapmodify -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/del_user.ldif
```

Additional Common LDAP Operations

As described below, other useful operations can be executed using the remaining LDIF files.

Add a Group

SIMP systems are preconfigured with two groups:

- administrators (700): Group that has both sudosh and ssh privileges
- users (100): Group that does not have sudosh or ssh privileges

To add another group:

1. Login to the LDAP server as root.
2. Edit the /root/ldifs/add_group.ldif shown below.

```
dn: cn=<groupname>,ou=Group,dc=your,dc=domain
objectClass: posixGroup
objectClass: top
cn: <groupname>
gidNumber: <Unique GID number>
description: "<Some useful group description>"
```

3. Type the following, substituting your DN information for dc=your,dc=domain:

```
$ ldapadd -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/add_group.ldif
```

Remove a Group

To remove a group:

1. Login to the LDAP server as root.
2. Edit the /root/ldifs/del_group.ldif shown below.

```
dn: cn=<Group Name>,ou=Group,dc=your,dc=domain
changetype: delete
```

3. Type the following, substituting your DN information for dc=your,dc=domain:

```
$ ldapmodify -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/del_group.ldif
```

Add Users to a Group

To add users to a group:

1. Login to the LDAP server as root.
2. Edit the /root/ldifs/add_to_group.ldif shown below.

```
dn: cn=<Group Name>,ou=Group,dc=your,dc=domain
changetype: modify
add: memberUid
memberUid: <UID1>
memberUid: <UID2>
...
memberUid: <UIDX>
```

3. Type the following, substituting your DN information for dc=your,dc=domain:

```
$ ldapmodify -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/add_to_group.ldif
```

Remove Users from a Group

To remove users from a group:

1. Login to the LDAP server as root.
2. Edit the /root/ldifs/del_to_group.ldif shown below.

```
dn: cn=<Group Name>,ou=Group,dc=your,dc=domain
changetype: modify
```

```
delete: memberUid
memberUid: <UID1>
memberUid: <UID2>
...
memberUid: <UIDX>
```

3. Type the following, substituting your DN information for dc=your,dc=domain:

```
$ ldapmodify -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/del_from_group.ldif
```

Update a User's SSH Public Key

To update an SSH public key:

1. Login to the LDAP server as root.
2. Edit the /root/ldifs/mod_sshkey.ldif shown below.

```
dn: uid=<User UID>,ou=People,dc=your,dc=domain
changetype: modify
replace: sshPublicKey
sshPublicKey: <User OpenSSH Public Key>
```

3. Type the following, substituting your DN information for dc=your,dc=domain:

```
ldapmodify -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldif/mod_sshkey.ldif
```

Force a Password Reset

To force a password reset for a user:

1. Login to the LDAP server as root.
2. Edit the /root/ldifs/force_password_reset.ldif shown below.

```
dn: uid=<username>,ou=People,dc=your,dc=domain
changetype: modify
replace: pwdReset
pwdReset: TRUE
-
replace: shadowLastChange
shadowLastChange: 10101
```

3. Type the following, substituting your DN information for dc=your,dc=domain:

```
$ ldapmodify -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/force_password_reset.ldif
```

Note

The ldapmodify command is only effective when using the *ppolicy* overlay. In addition, the user's **shadowLastChange** must be changed to a value prior to the expiration date to force a **PAM** reset.

Lock an LDAP Account

To lock an LDAP account:

1. Login to the LDAP server as `root`.
2. Edit the `/root/ldifs/lock_user.ldif` shown below.

```
dn: uid=<username>,ou=People,dc=your,dc=domain
changetype: modify
replace: pwdAccountLockedTime
pwdAccountLockedTime: 000001010000Z
-
delete: sshPublicKey
-
replace: userPassword
userPassword: !!
```

3. Type the following, substituting your DN information for `dc=your,dc=domain`:

```
$ ldapmodify -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
-f /root/ldifs/lock_user.ldif
```

> ***Note***
>
> The `ldapmodify` command is only effective when using the *ppolicy* overlay.

Unlock an LDAP Account

To unlock an LDAP account:

1. Login to the LDAP server as `root`.
2. Edit the `/root/ldifs/unlock_account.ldif` shown below.

```
dn: uid=<User UID>,ou=People,dc=your,dc=domain
changetype: modify
delete: pwdAccountLockedTime
```

3. Type the following, substituting your DN information for `dc=your,dc=domain`:

```
$ ldapmodify -Z -x -W -D "cn=LDAPAdmin,ou=People,dc=your,dc=domain" \
 -f /root/ldifs/unlock_account.ldif
```

> ***Note***
>
> The `ldapmodify` command is only effective when using the *ppolicy* overlay.

Troubleshooting Issues

If a user's password is changed in LDAP or the user changes it shortly after its initial setup, the "Password too young to change" error may appear. In this situation, apply the `pwdReset:TRUE` option to the user's account as described in Add a User with a Password.

Managing Local/Service Users

Though the SIMP team **highly recommends** using *LDAP <Managing LDAP Users>* to centrally manage your users, you may occasionally need to set up a **service account** or specific local users on your systems.

This section walks you through doing this in a way that is compatible with SIMP.

The following examples assume that you are using the `site` module to manage site-specific puppet manifests. The examples may easily be extrapolated into defined types if you wish but are presented as classes for simplicity.

If you are not familiar with setting up **SSH** keys, you may want to follow the relevant GitHub documentation.

Local User Account

```
class site::local_account {
  include '::ssh'

  $_local_account_user  = 'localuser'
  $_local_account_group = 'localgroup'
  $_local_account_id    = '1778'

  # You'll probably want this in /home unless you're using NFS
  $_local_account_homedir = "/home/${_local_account_user}"

  # You'll need to get this from the user as it is their public key.
  $_local_account_ssh_public_key = 'AAA...=='

  group { $_local_account_group:
    gid       => $_local_account_id,
    allowdupe => false,
  }

  user { $_local_account_user:
    uid        => $_local_account_id,
    allowdupe  => false,
    gid        => $_local_account_group,
    home       => $_local_account_homedir,
    managehome => true,
    shell      => '/bin/bash'
  }

  # If you want your local user to have a password (no key),
  # omit this block and manually assign a password to the user
  # after creation (passwd <user>)
  file { "/etc/ssh/local_keys/${_local_account_user}":
    owner  => 'root',
    group  => $_local_account_group,
    mode   => '0644',
    content => $_local_account_ssh_public_key
  }

  sudo::user_specification { $_local_account_user:
    user_list => [$_local_account_user],
    host_list => [$::fqdn],
    runas     => 'root',
    cmnd      => ['/bin/cat /var/log/app.log'],
```

```
    passwd    => false
  }

  # Allow this account from everywhere
  pam::access::rule { "Allow ${_local_account_user}":
    users   => [$_local_account_user],
    origins => ['ALL']
  }
}
```

Service Account

```
class site::service_account {
  include '::ssh'

  $_svc_account_user    = 'svcuser'
  $_svc_account_group   = 'svcgroup'
  $_svc_account_id      = '1779'
  $_svc_account_homedir = "/var/local/${_svc_account_user}"

  # Since this is a service account, automatically generate an SSH key for
  # the user and store it on the Puppet master for distribution.
  $_svc_account_ssh_private_key = ssh_autokey($_svc_account_user, '2048', true)
  $_svc_account_ssh_public_key  = ssh_autokey($_svc_account_user, '2048')

  group { $_svc_account_group:
    gid       => $_svc_account_id,
    allowdupe => false,
  }

  user { $_svc_account_user:
    uid        => $_svc_account_id,
    allowdupe  => false,
    gid        => $_svc_account_group,
    home       => $_svc_account_homedir,
    managehome => true,
    shell      => '/bin/bash'
  }

  file { "${_svc_account_homedir}/.ssh":
    ensure => directory,
    owner  => $_svc_account_user,
    group  => $_svc_account_group,
    mode   => '0600'
  }

  file { "${_svc_account_homedir}/.ssh/id_rsa":
    mode    => '0600',
    owner   => $_svc_account_user,
    group   => $_svc_account_group,
    content => $_svc_account_ssh_private_key
  }

   # In SIMP sshd is configured to use authorized_keys files in /etc/ssh/local_keys
  file { "/etc/ssh/local_keys/${_svc_account_user}":
```

```
    owner  => 'root',
    group  => $_svc_account_group,
    mode   => '0644',
    content => "ssh-rsa ${_svc_account_ssh_public_key}"
  }

  sudo::user_specification { $_svc_account_user:
    user_list => [$_svc_account_user],
    host_list => [$facts['fqdn']],
    runas     => 'root',
    cmnd      => ['/bin/cat /var/log/app.log'],
    passwd    => false
  }

  # Allow this service account from everywhere
  pam::access::rule { "Allow ${_svc_account_user}":
    users   => [$_svc_account_user],
    origins => ['ALL']
  }
}
```

Testing

The table below lists the steps to test that the configuration was applied correctly.

1. Log on to a server that has the template code configuration applied.
2. Type `su - <USERNAME>`
3. Type `exec /usr/bin/ssh-agent /bin/bash` to ensure that ssh-agent has a shell running.
4. Type `/usr/bin/ssh-add` to attach the user's certificates.
5. **Optional**: Type `/usr/bin/ssh-add -l` to double check that the user's certificates were added successfully.
6. Type `ssh <HOST>` to SSH to a target machine that has the template code configuration applied.

If successful, the user should be authenticated and gain access to the target machine without entering a password.

If the user is prompted for a password, check to see if the permissions are set up properly and that the certificate keys are in the correct locations. In addition, check the `/etc/security/access.conf` file to ensure that it contains the user or user's group in an allow statement. See `access.conf(5)` for details.

Managing SSSD LOCAL Domain And Users

Though the SIMP team **highly recommends** using *LDAP <Managing LDAP Users>* to centrally manage your users, you may wish to create users within the SSSD LOCAL provider domain. Note that you can run LOCAL and LDAP domains concurrently!

This section walks you through doing this in a way that is compatible with SIMP.

The following examples assume that you are using the `site` module to set up your users. The examples may easily be extrapolated into defined types if you wish but are presented as classes for simplicity.

SSSD LOCAL Domain

Set up a LOCAL domain in SSSD. If one already exists in /etc/sssd/sssd.conf, you can optionally skip this step. If the LOCAL domain is not managed with SIMP, you may experience difficulties.

```
class site::sssd_local {

  sssd::provider::local { 'LOCAL': }

  sssd::domain { 'LOCAL':
    description   => 'Default Local Domain',
    id_provider   => 'local',
    auth_provider => 'local'
  }
}
```

In `default.yaml`:

```
classes:
  - 'site::sssd_local'
```

In **`Hiera`**, you will need to add the LOCAL sssd domain to `sssd::domains` if it does not already exist. If you wish to include the LOCAL domain in all of `$simp_options::trusted_nets`, simply add `sssd::domains` variable to `default.yaml`, copy existing domains from `simp_config_settings.yaml` and add `local` to the list of domain `id_providers`.

In `default.yaml`:

```
sssd::domains:
  - 'LOCAL'
  - <existing domains, ex. LDAP>
```

Run puppet. A LOCAL domain should be created and referenced in `/etc/sssd/sssd.conf`. The sssd service should be running.

Adding an SSSD Local User

Create a local user, using `sss_useradd`. See the `sss_useradd` man page for more options.

```
sss_useradd <user> -h </path/to/home/dir> -u <uid> -m -k /etc/skell
```

To update an EL6 system, perform the following step

```
vipw
<user>:x:<uid>:<gid>::</path/to/home/dir>:/bin/bash
```

Next, set the user's password. As root, run:

```
passwd <user>
```

Giving The User Access

```
pam::access::rule { '<user> access':
  permission => '+',
  users      => ['<user>'],
  origins    => ['ALL'],
  order      => 1000
}

sudo::user_specification { '<user> privs':
  user_list => ["<user>"],
  host_list => [$::fqdn],
  runas     => 'root',
  cmnd      => ['/bin/cat /var/log/app.log'],
```

```
  passwd    => false
}
```

You're done! You should be able to `id <user>`, `su - <user>`, and run commands allowed by sudo rules.

Test authentication by ssh-ing as the `user` onto the host machine, with the password specified after user creation. If you want to set up an ssh key, you may want to follow the relevant GitHub documentation.

Upgrading SIMP

SIMP follows Semantic Versioning 2.0.0 and has the following versioning structure: `X.Y.Z`, where

- X indicates breaking changes
- Y indicates new features
- Z indicates bug fixes.

This section describes both the general, recommended upgrade procedures for X, Y, or Z releases, as well as any version-specific upgrade procedures.

Important

To minimize upgrade problems in your production environment, we strongly recommend you

- Carefully read the Changelog for the version to which you are upgrading, as well as the Changelogs for any interim versions you are skipping over.
- Test your upgrades in a development environment before deploying to a production environment.
- Backup any critical server data/configurations prior to executing the upgrade to a production environment.
- On each managed server, ensure you have a local user with `su` and `ssh` privileges to prevent lockout.

General Upgrade Instructions

Incremental Updates

For Y and Z SIMP changes, you should feel comfortable dropping the changes directly into your test systems. The promotion cycle from test to production should be short and painless.

For RPM-based systems, a simple `yum update` should suffice after adding the necessary packages to your site `yum` repositories. If you are using `r10k` or Code Manager, you will need to work with the upstream Git repositories as appropriate for your workflow.

Note

If you started with an ISO installation, an easy way to get your entire local SIMP distribution updated is to download the new SIMP ISO and run `unpack_dvd </path/to/ISO>`.

Important

Be sure to review any version-specific upgrade instructions prior to executing the incremental upgrade. Although this type of upgrade will not contain any breaking changes, there may be specific instructions that you should follow to facilitate the upgrade process.

Breaking Changes

If the X version number has changed then you should expect **major** breaking changes to the way SIMP works. Please carefully read the Changelog and the new User's Guide and do **not** deploy these changes directly on top of your production environment.

Important

Upgrading SIMP does **not** require re-kicking your clients, even if some core services move to the new Puppet node. All software configurations can be updated in Puppet, as needed.

New Server Creation and Client Migration

The recommended method for upgrading breaking changes is to create a new Puppet Server and migrate your data and clients to it. This process follows the path of least destruction; we will guide you through how to back up the existing Puppet server, create a new server, and transfer your clients.

1. Set up a new Puppet server that will house your new SIMP environment.

   ### *Note*

   You must ensure that this node can be reached by any client that is to be migrated. The new system will not interfere with your existing Puppet system unless you specifically configure it to do so.

   ### *Important*

   Do **NOT** destroy your old Puppet server until everything has been successfully migrated and is in production under the new server.

2. Consider vital services other than Puppet that are housed on your current Puppet server node (eg. DNS, DHCP, LDAP, custom kickstart, YUM, NFS, etc.). You may choose to keep many of these services running on your old Puppet server node. Anything not preserved must be migrated to a new system.

Back Up the Existing Puppet Server

Prior to any modifications to your infrastructure, we **highly** recommend following *ug-howto-back-up-the-puppet-master*.

Create a New Server

Obtain an official SIMP ISO or point your server at the latest YUM Repositories and follow the *simp-installation-guide*.

Follow the *Client_Management* guide, and set up services as needed. Remember, you can opt-out of any core services (DNS, DHCP, etc.) you want your clients or old Puppet server to run! If you want the new Puppet server to run services the existing Puppet server ran, you may be able to use the backup of the `rsync` directories from the old system.

Warning

Do not blindly drop `rsync` (or other) materials from the old Puppet server onto the new one. This is a breaking version and the required structures for these components may have changed.

When you *ug-apply-certificates* you may wish to transfer client certs to the new server. If you are using the FakeCA and still wish to preserve the certificates, follow the *ug-apply-certificates-official-certificates* guidance, and treat the existing Puppet server as your 'proper CA'.

Promote the New Puppet Server and Transfer Your Clients

Follow the *ug-howto-change-puppet-servers* guide to begin integration of your new Puppet server into the existing environment.

Note

You should *always* start migration with a small number of **least critical** clients!

Retire the Old Puppet Server

Once you have transferred the management of all your clients over to the new Puppet server, you may safely retire the old Puppet server.

Version-Specific Upgrade Instructions

Upgrading from SIMP-6.0.0 to SIMP-6.1.0

Important

It is *highly recommended* that you read the information in this section in its entirety.

Upgrade Script

There were several issues found during the SIMP 6.0.0 to 6.1.0 upgrade that necessitated the creation of an upgrade script that is to be run on your SIMP puppet servers.

Note

No changes are required on your clients for the upgrade to succeed.

The upgrade script, `/usr/share/simp/upgrade_scripts/upgrade_simp_6.0.0_to_6.1.0`, will assist with the upgrade from `6.0.0` to `6.1.0`, taking into account all of the specific issues. This script is available in the `simp-utils-6.1.0` package provided by SIMP 6.1.0 or the simp-utils repository.

As always, back up your system prior to upgrading!

> ***Note***
>
> This script assumes that you're upgrading from the SIMP RPMs!
>
> If you have chosen some other installation method, you'll need to follow the general steps outlined in the script.

To perform the upgrade, with `root` permissions:

1. Upgrade the `simp-utils` package, *only*, by executing `yum update -y simp-utils`.
2. Run the script. It will:
    1. Run a `yum -y update`.
    2. Reinstall `simp-gpgkeys` and `pupmod-simp-timezone` due to RPM issues.
    3. Stop and uninstall the PostgresSQL 9.4 server to prevent `postgresql` upgrade issues.
    4. Restart the `puppetserver` process.
    5. Run `puppet agent -t`.
        - Some systems have shown issues with the `postgresql` upgrade during this step.

Update auth.conf

The legacy `auth.conf`, `/etc/puppetlabs/puppet/auth.conf`, has been deprecated. `pupmod-simp-pupmod` will back up the legacy `auth.conf` after the upgrade.

The puppetserver's `auth.conf` is now managed by Puppet. You will need to reproduce any custom work done to legacy `auth.conf` via the new `puppet_authorization::rule` define. The stock rules are managed in `pupmod::master::simp_auth`.

Set up ClamAV DAT Files Updates

Given the wide spacing of SIMP releases, the team determined that it was ineffective for us to maintain the `simp-rsync-clamav` RPM with upstream ClamAV DAT file updates.

From this point forward, SIMP will not ship with updated ClamAV DAT files and we highly recommend updating your DAT files from the authoritative upstream sources. See the ClamAV Virus Database FAQ for instructions on how to automatically update these files.

Prepare system for PostgreSQL upgrade

During the Puppet-managed upgrade, from PostgreSQL 9.4 to PostgreSQL 9.6, the PostgreSQL 9.4 data is not automatically imported into the 9.6 database. If for any reason you need to retain this data, which normally is quite transitory, see Upgrading a PostgreSQL Cluster for detailed instructions.

Troubleshooting Common Issues

How to troubleshoot common problems that occur when installing and using SIMP.

My Services Are Dying!

The following section describes how to mitigate issues relating to destructive reasoning and avoiding destruction of the SIMP system.

Destructive Reasoning with svckill

Most security guides that have been published on the Internet strongly suggest disabling all services that are not necessary for system operation. However, to list every possible service that may be controlled by the chkconfig type on a given system in a manifest would not be useful and would bloat the memory space of the running Puppet process.

As an alternative solution, the SIMP Team implemented the svckill module that runs with every Puppet run.

The svckill module:

- Collects a list of all services on the system. These are the same services that the user sees after typing `chkconfig --list`
- Ignores certain critical services, including Puppet, IPtables, and the network.
- Collects a list of all services that are defined in the manifests and modules.
- Ensures that every service that is defined in the manifests and modules is excluded from the list of services to kill.
- Kills and disables everything else.

Avoiding Destruction

If certain services should not be killed, declare them in the node manifest space or in the *svckill::ignore* array in hiera.

Note

The key is to declare the services and not set them to any other option. By adding them to the manifest, the *svckill* module will ignore them.

The example below demonstrates this in a manifest, assuming that the *keepmealive* service is added to the *chkconfig*.

```
#Preventing a service from being killed by svckill
service { "keepmealive": }
```

Why Can't I Login?!

If you've reached this page, you're having issues logging into your system with a newly created account.

In almost all cases, this is because either your user has not been placed in a group allowed to access the system, your **DNS** is setup incorrectly, or your **PKI** certificates are invalid.

SSSD Password Checks

SSSD has been made the default name service caching service in SIMP. During this process, we discovered that SSSD will enforce password complexity restrictions **upon login**. This means that, if your password does not meet the system password complexity requirements, you will not be able to login until an administrator changes your password to something stronger.

For the default complexity rules, see the *faq-password-complexity* FAQ.

PAM Access Restrictions

By default, SIMP uses the `pam_access.so` **PAM** module to restrict access on each individual host. While this may not seem as flexible as some methods, it is the most failsafe method for ensuring that you don't accidentally interrupt services due to network issues connecting to your **LDAP** server.

To allow a user to access a particular system, you need to use the pam::access::rule define as shown below.

```
pam::access::rule { 'Allow the security group into the system':
  users   => ['(security)'],
  origins => ['ALL'],
  comment => 'The core security team'
}

pam::access::rule { 'Allow bob into the system from the proxy only':
  users   => ['bob'],
  origins => ["proxy.${facts['domain']}"],
  comment => 'Bob the proxied'
}
```

Faillock

If a user fails to authenticate properly in **5** consecutive tries (the default `pam::deny`), **PAM** will lock the account.

To see a list of user authentication attempts, run `faillock`.

If a user is marked as invalid (I) or reaches the max number of attempts, you will need to reset `faillock` before authentication can occur. To do so, run

```
$ faillock --reset --user <user>
```

LDAP Lockout

If your account is in LDAP, you may have locked yourself out. Like **PAM**, **LDAP** has a maximum number of logins, **5** by default. See `openldap::server::conf::default_ldif::ppolicy_pwd_max_failure`.

To determine if the account is locked, run the following on the LDAP server:

```
$ slapcat -a uid=<user>
```

If you see `pwdAccountLockedTime` then the account is locked, and you will need to follow the instructions in *unlock-ldap-label* to unlock it.

Troubleshooting DNS

If **PAM** is not the issue, you may be having **DNS** issues. This can evidence itself in two ways.

First, per the 'Bob' example above, you may be using an **FQDN** to identify a host on your network. If **DNS** is not properly configured, then there is no way for the host to understand that you should have access from this remote system.

Second, the default **PKI** settings in SIMP ensure that all connections are validated against the **FQDN** of the client system. In the case of an **LDAP** connection, a misconfiguration in DNS may result in an inability to authenticate against the **LDAP** service.

In the following sections, we will assume that we have a host named `system.my.domain` with the IP address `1.2.3.4`.

Testing a Forward Lookup

The following should return the expected IP address for your system.

```
$ dig +short system.my.domain
```

Testing a Reverse Lookup

The following should return the expected hostname for your system. This hostname **must** be either the primary name in the **PKI** certificate or a valid alternate name.

```
$ dig +short -x 1.2.3.4
```

PKI Issues

If both PAM and DNS appear to be correct, you should next validate that your **PKI** certificates are both valid and functional.

See *pki_validation* for additional guidance.

Checking Your SIMP PKI Communication

SIMP comes with a fully functional **Public Key Infrastructure** in the guise of an aptly named Fake CA.

The Fake CA can be very useful for getting your environment running prior to obtaining proper certificates from an official CA.

> ***Warning***
>
> The Fake CA is **not** hardware backed by default and should not be used for sensitive cryptographic operations unless there is no other alternative

Each Puppet environment contains its own Fake CA and, therefore, you must know which environment is serving the systems that are having issues prior to proceeding.

For this section, we will assume that it is the 'simp' environment located at the active environment path.

> ***Note***
>
> Just as with Puppet certificates, the time on your system must be correct and your DNS must be fully functional. Check that these are correct before proceeding.

For the remainder of this section, we will assume that the **FQDN** of the system with issues is 'system.my.domain' and the LDAP server to which it is attempting to connect is 'ldap.my.domain'.

Navigate to the environment *keydist* directory and validate the system certificates.

When validating certificates, you want to make sure that there are no errors regarding your certificate or **CA**. Ideally, the command will simply return the string 'OK'.

```
$ cd /var/simp/environments/`puppet config print environment`/site_files/pki_files/files/keydis

# Validate the client system
$ openssl verify -CApath cacerts system.my.domain

# Validate the LDAP system
$ openssl verify -CApath cacerts ldap.my.domain
```

If there are any issues, you may need to follow the steps in *Certificates* to generate new certificates for one or more of your hosts.

Puppet Certificate Issues

Puppet Client Certificate Issues

Most of the time, clients will have certificate issues due to the system clock not being properly set. Before taking any other measures, make sure that your system clock is correct on both the master and the clients!

If you need to fix client certificate issues outside of time, first make sure that you don't have a certificate already in place on your Puppet server.

```
$ puppet cert list --all
```

If you **do** have a certificate in place, and need to register a client with the same name, remove that client's certificate from the system.

```
$ puppet cert clean <fqdn.of.the.client>
```

Warning

If you delete the Puppet server's certificate, you will need to re-deploy Puppet certificates to **all** of your nodes!

Warning

NEVER RUN ``puppet cert clean --all``

Puppet Client Re-Registration

If, for some reason, you need to re-register your client with a new server, simply run the following on your client once the server is ready.

```
$ rm -rf `puppet config print ssldir`
$ puppet agent -t
```

Puppet Server Certificate Issues

Warning

This is destructive to your Puppet communications. This should only be used if you have no other options.

If the Puppet server has certificate issues, regenerate the server CAs. To do this, remove the contents of the *ssl* folder and regenerate those `.pem` files.

The following table lists the steps to regenerate the server CAs:

```
$ service puppetserver stop
$ rm -rf /etc/puppetlabs/puppet/ssl
$ puppet cert list --all
$ puppet cert --generate ***<fqdn>***
$ service puppetserver start
$ puppet agent --test
```

SIMP HOWTO Guides

This chapter provides guidance on configuration of various common capabilities in the SIMP system.

The order is loosely based on the number of times a given question is asked with more commonly sought items towards the top.

HOWTO Setup a SIMP Control Repository

A control repository contains the modules, hieradata, and roles/profiles required in a Puppet infrastructure. Managing the control repo with GIT allows sysadmins to utilize a workflow when updating and developing their infrastructure.

Note

Refer to Puppet, Inc's control repository documentation for more information.

SIMP distributes a partial control repository:

- On the filesystem of an installed SIMP system:

```
$ tree -L 1 /usr/share/simp/environments/simp/
/usr/share/simp/environments/simp/
├── environment.conf
├── FakeCA
├── hieradata
├── manifests
└── modules
```

- In our environment repository :

```
$ tree -L 1 src/assets/simp-environment/environments/simp
src/assets/simp-environment/environments/simp
├── environment.conf
├── hieradata/
└── manifests/
```

To begin creating your control repository, make a directory, say `r10k_production`, and copy in the contents of the `simp-environment-skeleton` or `environments/simp` from a live system, depending on your needs.

Modules are defined in a Puppetfile. We keep up-to-date Puppetfiles in the base of our simp-core repository. For best results, download `Puppetfile.stable` to the base of the `r10k_production` directory, using the following snippet:

```
$ curl -o Puppetfile https://github.com/simp/simp-core/blob/<release>/Puppetfile.stable
```

Note

The example Puppetfile is labeled stable, meaning that the versions of the modules it contains are the ones contained in the last SIMP release. You can go to any previous release and download a Puppetfile with references to older modules from the git history of the simp-core repo.

Our Puppetfile pulls down every dependency SIMP needs, including more than just Puppet modules. Remove non-Puppet modules by editing the downloaded Puppetfile and erasing the lines `moduledir 'src'` to `moduledir 'src/puppet/modules`.

If want your data layer to be SIMP-like, create a `hiera.yaml` file at the base of the `r10k_production` directory, and add the following content:

> ***Note***
>
> For more information about data in SIMP, see the *Classification and Data* documentation.

```
---

# This is the default hiera.yaml file
# Feel free to modify the hierarchy to suit your needs but please
# leave the simp* entries in place at the bottom of the list
:backends:
  - 'yaml'
  - 'json'
:hierarchy:
  - 'hosts/%{trusted.certname}'
  - 'hosts/%{facts.fqdn}'
  - 'hosts/%{facts.hostname}'
  - 'domains/%{facts.domain}'
  - '%{facts.os.family}'
  - '%{facts.os.name}/%{facts.os.release.full}'
  - '%{facts.os.name}/%{facts.os.release.major}'
  - '%{facts.os.name}'
  - 'hostgroups/%{::hostgroup}'
  - 'default'
  - 'compliance_profiles/%{::compliance_profile}'
  - 'simp_config_settings'
  - 'scenarios/%{::simp_scenario}'
:logger: 'puppet'
# When specifying a datadir:
# # 1) Make sure the directory exists
# # 2) Make sure the directory reflects the hierarchy
:yaml:
  :datadir: '/etc/puppetlabs/code/environments/%{::environment}/hieradata'
:json:
  :datadir: '/etc/puppetlabs/code/environments/%{::environment}/hieradata'
```

Run `git init .` at the base of the `r10k_production` directory and commit changes to a `production` branch. Push the `production` branch to a repository of your choosing.

HOWTO Disable SSH

If SSH is included in your SIMP scenario and you wish to cherry-pick it out of the class list and cease to manage its configuration, add the following hiera:

```
---
simp::classes:
  - '--ssh'
```

SVCKill will *not* automatically kill sshd when you cease management of the module; it is whitelisted in the default `svckill::ignore_default` list. If you want svckill to kill running sshd processes, include:

```
---
svckill::ignore:
  - '--sshd'
```

HOWTO Modify the Nightly Update Schedule

By default, SIMP applies *ug-sa-ga-nightly-updates* from all configured repositories.

This behavior is controlled by the simp::yum::schedule class and the parameters therein can be used to modify the schedule.

If you simply want to disable the nightly updates, you can set `simp::yum::schedule::enable` to `false` in **Hiera**.

HOWTO Modify The Puppet Cron Schedule

SIMP deploys a cron-job, via `pupmod::agent::cron`, to run a non-daemonized puppet agent to ensure compliance, over time. By default, the cron-job is run twice every hour on a semi-random interval, to ensure all agents do not run puppet simultaneously. Additionally, the cron-job forcibly re-enables the puppet agent every 4.5 hours.

Overriding Timing Parameters

In the example below, Puppet runs are scheduled during working hours, 0900-1700 M..F, twice every hour, in random intervals.

```
# Restrict puppet runs during working hours
pupmod::agent::cron::weekday: ['1-5']
pupmod::agent::cron::hour: ['9-17']
pupmod::agent::cron::minute: 'rand'
pupmod::agent::cron::run_timeframe: 60
pupmod::agent::cron::runs_per_timeframe: 2
```

For more information about timing parameters, refer to the `pupmod::agent::cron` class documentation.

HOWTO Work with the SIMP Rsync Shares

When we added support for multiple environments, the SIMP rsync space in `/var/simp/environments/simp/rsync` became quite complex.

This will guide you through the new rsync layout as well as providing guidance on setting up new rsync shares for your various components.

This is very SIMP-specific and does not preclude you from using rsync however you like. However, if you want multi-environment support, you'll need to replicate something like what we've done for your custom directories.

Why SIMP Uses Rsync

Rsync support was introduced in SIMP in the early days due to the fact that the Puppet native file synchronization mechanisms were relatively horrible at syncing large files (too much in memory) and large numbers of files in a directory tree (too many resources and system load).

Rsync neatly solves both of these issues and is present on all SIMP systems by default.

By default, SIMP wraps all rsync connections in an Stunnel connection to provide encrypted connections. Additionally, SIMP adds randomly generated passwords to sensitive shares to prevent unauthorized connections.

You can restrict this as far as necessary in your environment but the defaults should suit most needs.

Standard Capabilities

The standard SIMP rsync shares exist at `/var/simp/environments/simp/rsync`. This is an assumed path and changing this path will break some aspects of the system.

Within this directory, you will find a set of files with the name `.shares`. This file is used by the fact `simp_rsync_environments` to indicate that all directories at the given location should be added as rsync shared directories.

The data structure in the `simp_rsync_environments` is based on the **lower cased** name of the containing directory. This means that there should **NEVER** be two directories with the same name at the same level of the directory hierarchy. In this case, the last one present alphabetically will win.

As a concrete example, given the following directory structure:

```
var
└── simp
    └── environments
        └── simp
            └── rsync
                ├── Global
                │   ├── .shares
                │   └── clamav
                │       ├── main.cvd
                │       ├── daily.cld
                │       └── bytecode.cld
                ├── .rsync.facl
                ├── README
                └── RedHat
                    ├── Global
                    │   ├── freeradius
                    │   ├── .shares
                    │   ├── tftpboot
                    │   │   └── linux-install
                    │   │       └── README
                    │   ├── dhcpd
                    │   │   ├── dhcpd.conf
                    │   │   └── LICENSE
                    │   ├── snmp
                    │   │   ├── mibs
                    │   │   └── dlmod
                    │   └── apache
                    │       └── www
                    │           ├── cgi-bin
                    │           ├── error
                    │           │   └── include
                    │           ├── icons
                    │           │   └── small
                    │           └── html
                    ├── 6
                    │   ├── bind_dns
                    │   │   └── LICENSE
                    │   └── .shares
                    └── 7
                        ├── bind_dns
                        │   └── LICENSE
                        └── .shares
```

The following would be returned by the `simp_rsync_environments` fact:

```
{
  "simp": {
    "id": "simp",
    "rsync": {
```

```
      "id": "rsync",
      "global": {
        "id": "Global",
        "shares": [
          "clamav"
        ]
      },
      "redhat": {
        "id": "RedHat",
        "6": {
          "id": "6",
          "shares": [
            "bind_dns"
          ]
        },
        "7": {
          "id": "7",
          "shares": [
            "bind_dns"
          ]
        },
        "global": {
          "id": "Global",
          "shares": [
            "freeradius",
            "tftpboot",
            "dhcpd",
            "snmp",
            "apache"
          ]
        }
      }
    }
  }
}
```

Breaking this down, the following data is shown:

```
 {
  "downcased_directory_name": {
    "id": "Original_Directory_Name",
    "downcased_subdirectory_name": {
      "id": "Original_Subdirectory_Name",
      "shares": [
        "Directory One",
        "directory two"
      ]
    }
  }
}
```

Note

The presence of the `.shares` file in the directory tree tells the `simp_rsync_environments` fact that all directories at that level are to be exposed as shares in the returned data structure.

That said, it is up to your Puppet logic to actually expose them as such!

See the `simp::server::rsync_shares` class to see how we do this for the default rsync shares.

Supporting Additional Environments

Generally, in a SIMP environment, you are going to want to start with the directory structure that we have and simply copy the entire data structure to a directory with your custom name.

Warning

Be sure not to copy any sensitive information into the space!

For example, if you wanted to create the standard dev/test/prod structure, and assuming that `production` is already symlinked to `simp`:

```bash cd /var/simp/environments cp -a simp dev cp -a simp test ```

After this, you will now have an enhanced `simp_rsync_environments` data structure that holds all of the information for the `dev`, `test`, `production`, and `simp` environments.

You can then manipulate the contents of the different environments to suit your needs.

Note

The contents of the various rsync directories are not under version control by default. While you may add them to a VCS of your choosing (SVN, Git, etc...), there may be some VERY large files present in these directories.

Make sure your system can handle the load before adding rsync content into a VCS!

Disabling Stunnel

If you decide to disable stunnel, you will need to specify your rsync server in **Hiera**, if it is not already specified.

Warning

If you disable stunnel, your data and any rsync access credentials will be passed in the clear!

```
---
simp_options::rsync::server: <rsync_server_fqdn>
```

Additionally, you will need to ensure your firewall is open on the rsync port. Include the following on the node acting as the rsync server.
```

```
class site::rsync_iptables (
  Simplib::Netlist $allow      = simplib::lookup('simp_options::trusted_nets'),
  Simplib::Port    $rsync_port = 873
){
  iptables::listen::tcp_stateful { "rsync_shares":
    trusted_nets => $allow,
    dports       => $rsync_port
  }
}
```

HOWTO Set up Central Log Collection

This section covers methods of centralized log collection supported by SIMP.

Centralized Rsyslog

SIMP provides a pre-built set of classes within the *rsyslog* module for enabling centralized logging within the infrastructure.

There are no provisions here for setting up shared storage or deduplication. This is inherently not a use case that Rsyslog is well designed for and we suggest that you look at an alternative. We have incorporated the combination of *Elasticsearch, Logstash, and Grafana* (ELG) into the SIMP ecosystem as a well-known, Open Source, software collection.

> **Note**
>
> For an overview of how to use Hiera to manage class parameters, please see *Classification and Data*.

Preparation

The `simp_rsyslog` Profile Module

A profile module, simp_rsyslog, is provided to help configure systems for logging.

The `simp_rsyslog` class is included on systems if the `simp` or `simp_lite` *scenarios <simp scenarios>* are used and by default configures local logging.

If scenarios are not being used, include the `simp_rsyslog` class on all systems including the log server. If you're using the default SIMP install, you can add it to the `simp::classes` array. Otherwise, you'll need to use a standard Puppet `include` mechanism.

What is Logged

The `simp_rsyslog` module uses the following parameters:

```
simp_rsyslog::default_logs     # A Hash of the default system logs to be collected
simp_rsyslog::log_collection   # Use this Hash to add logs to the default set
```

There are also Booleans available to enable collection of certain logs, such as those from OpenLDAP. See the `simp_rsyslog` module for more details.

The Log Hash Format

The Hashes mentioned above are complex in nature but provide a clean interface to most aspects of log collection targeted to most users.

The **`Puppet Data Type`** representation of the Hashes is as follows:

```
Hash[
  Enum[
    'programs',
    'facilities',
    'msg_starts',
    'msg_regex'
  ],
  Array[String]
]
```

This means that you can have a `Hash`, with any of the keys `programs`, `facilities`, `msg_starts`, or `msg_regex` followed by an `Array` of `Strings`.

Using the following example `Hash`:

```
{
  'programs'   => [ 'sudo' ],
  'facilities' => [ 'cron.*' ],
  'msg_starts' => [ 'IMPORTANT:' ],
  'msg_regex'  => [ '*bad_guys*' ]
}
```

The `programs` line would match the following due to the highlighted section:

- 2017-03-14T15:26:53.589793+00:00 sample.host.name **sudo**: test_user : TTY=pts/0 ; PWD=/home/test_user ; USER=root ; COMMAND=/bin/sudosh

The `facilities` line would match the following because the listed facility is `cron`:

- 2017-03-14T15:26:53.589793+00:00 sample.host.name CROND[31415]: (root) CMD (run-parts /etc/cron.hourly)

The `msg_starts` line would match the following due to the highlighted section:

- 2017-03-14T15:26:53.589793+00:00 sample.host.name kernel: **IMPORTANT:** This is an important message

The `msg_regex` line would match the following due to the highlighted section:

- 2017-03-14T15:26:53.589793+00:00 sample.host.name kernel: This system was prodded by **bad_guys** and should be watched

Set Log Servers

The list of log servers are usually set during `simp config`, and placed in the `simp_config_settings.yaml` **Hiera** file.

If this value needs to be changed, either `simp config` can be run again or the values below can be overridden in `default.yaml`:

```
simp_options::syslog::log_servers:
  - 'logserver1.fullyqualified.domain'
  - 'logserver2.fullyqualified.domain'
simp_options::syslog::failover_log_servers:
  - 'failoverserver1.fullyqualified.domain'
  - 'failoverserver2.fullyqualified.domain'
```

If you list more than one primary log server your logs will be forwarded to **all** of the log servers in the array.

Failover log servers are optional.

Warning

If log forwarding is enabled on your log server, make sure you override the log server settings to NOT include itself. This will cause looping and will fill the disks on the system very quickly with repeated messages.

Note

It is common in big environments to use **DNS** aliases or to cluster servers so determining the name a server is using for logging is not straightforward. Because of this SIMP can not reliably determine if a host is forwarding to itself.

TLS

If encryption is going to be used, make sure the certificates are in place. See the *Certificates* documentation to understand how SIMP modules distribute certificates.

If SIMP is not being used to distribute certificates, the naming convention used for PKI variables can be found in `rsyslog::config/pki`.

Enable the Client

To set up the clients enter the following settings in the default.yaml or similar **Hiera** file to reach all clients:

```
#If using TLS
simp_rsyslog::forward_logs: true
rsyslog::enable_tls_logging: true
```

or

```
#If not using TLS
simp_rsyslog::forward_logs: true
rsyslog::pki: false
rsyslog::enable_tls_logging: false
```

Enable the Server

To set up the server enter the following in the server's **Hiera** file:

```
# If using TLS
simp_rsyslog::is_server: true
simp_rsyslog::forward_logs: false
rsyslog::tls_tcp_server: true
```

or

```
# If NOT using TLS
simp_rsyslog::is_server: true
simp_rsyslog::forward_logs: false
rsyslog::tcp_server: true
rsyslog::tls_tcp_server: false
```

After puppet has run on all the systems, the logs from the clients will be stored in `/var/log/hosts/<client name>` directory on the log server.

`simp_rsyslog` also sets up log rotation for these files by default using the `logrotate` module.

Forwarding Log Files from a Log Server

If the log server needs to forward logs to another server, edit its **Hiera** file. Set `simp_rsyslog::forward_logs` to `true` and make sure that the `log_servers` array used on the relevant node does not include itself in the list. For example for a server using TLS:

```
simp_rsyslog::is_server: true
simp_rsyslog::forward_logs: true
rsyslog::tls_tcp_server: true
simp_options::syslog::log_servers:
  - 'some-other-log-server.that.is.not.me'
simp_options::syslog::failover_log_servers:
  - 'some-other-failover-server.that.is.not.me'
```

This will forward the server's own logs, and all received client logs, to the specified servers.

Elasticsearch, Logstash, and Grafana

This chapter provides instruction for getting a basic configuration of **Logstash** working in a SIMP environment.

If these instructions don't work for you, please take a look at the README in the *simp_logstash* profile module, particularly the acceptance tests in the `spec/acceptance` directory.

Known Issues

1. Per Elasticsearch, you may have issues retaining existing data, when you upgrade from Elasticsearch 2.X to 5.X. See the Elasticsearch Upgrade Guide for detailed instructions on how to safely upgrade, *before* you upgrade SIMP's **ELG** stack.
2. The current `simp_grafana` module, version 1.0.4, only works if `simp_options::ldap` is set to `true`.
3. SIMP's Grafana dashboards have not been updated to work with the latest ELG stack.

The `simp_grafana` and SIMP Grafana dashboard issues will be addressed in upcoming releases of these components.

Obtaining the Required Packages

Because SIMP's **ELG** profile modules are optional components in the SIMP infrastructure, the ELG packages are not included in the SIMP distribution.

You will need to proceed to the vendor sites to obtain the required RPMs and **put them in an accessible YUM repository**. The SIMP modules were designed with the assumption that you would be using a repository for all of your installations.

The following versions have been tested against the SIMP ELG Stack:

Package	Version
elasticsearch	5.6
elasticsearch-curator	5.0
logstash	5.6
grafana	4.2

Logstash

Logstash is an Open Source tool that provides a means for SIMP implementations to have logs and events collected, filtered, and forwarded to another host. SIMP comes with three separate but related modules:

- **simp_logstash:**
  - SIMP profile module that installs the RPMs and configuration needed for log inputs, filters, and outputs.
  - Uses the logstash module.
- **simp_elasticsearch:**
  - SIMP profile module that installs the RPMs and configuration needed for Elasticsearch.
  - Uses the elasticsearch module.
- **simp_grafana:**
  - SIMP profile module that installs the RPMs and configuration needed for the Grafana web interface.
  - Uses the grafana module.

> ***Warning***
>
> The simp_logstash class is incompatible with the SIMP `simp_rsyslog::server` class!
>
> You cannot enable both of them on the same sever.

Logstash Architecture

The Logstash architecture is quite straightforward. It takes inputs from various sources, optionally applies filters, and outputs the results to a specified target. It's likely that you can already forward logs to Logstash and output them in a useful format as part of your existing architecture.

Logstash filters can manipulate logs after ingest and before output. Examples of existing filters include fixing logs to split/combine lines, adding fields, normalizing time stamps, and adding GeoIP fields. Depending on the type of log manipulation that is desired, there is likely a filter and Logstash documentation that already exists.

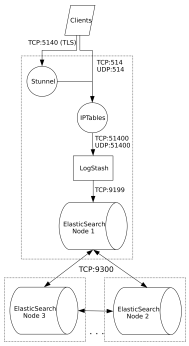
SIMP Logstash Architecture

Combining the simp_logstash, simp_elasticsearch, and simp_grafana modules provides a functioning log collection, reduction, and search capability. Unless scale dictates otherwise, these three modules can easily be applied to a single host.

The intent of providing Logstash in SIMP is to replace the default *Rsyslog* server with a capability that is easier to search and analyze over time. Once your Logstash server is set up, you simply need to direct your hosts to forward logs to your Logstash server. In a default SIMP configuration, this can be done by setting the `$simp_options::syslog::log_servers` variable in **`Hiera`**.

It is up to each implementation to define and apply filters that meet their local requirements. While multiple Logstash output targets may be defined, simp_logstash only defines the Elasticsearch output by default. Please see the Elasticsearch Puppet module for details on how to define additional output targets.

The following diagram depicts the standard SIMP data flow through the Logstash system.



SIMP Logstash Deployment

Logstash, SIMP, and Security

The provided SIMP modules for Logstash, Elasticsearch, and Grafana have been built with connection security in mind. Overriding these settings could adversely affect the security of the logging infrastructure. The following list describes the security features in place with the default SIMP module settings:

Warning

The native (Java) Elasticsearch connections, e.g., node-to-node connections, are not encrypted!

This will be remedied in SIMP in the future, as sufficient methods are found. Presently, you can look at the SIMP IPSec implementation to encrypt communication between your Elasticsearch nodes. Alternatively, you can purchase a subscription to the Elasticsearch Security plugin as part of Elasticsearch X-Pack.

- **User Name and Password Protection for Grafana:**

  The Grafana web can be exposed to a defined list of hosts. If you are connecting to Grafana from anything other than the localhost, a user name and password is required for authentication. Both **LDAP** and local database users are supported. By default, only an admin account is created. SIMP will automatically generate that password.

- **Syslog over Stunnel:**

  The default behavior in SIMP is to encrypt syslog traffic using native **TLS** in rsyslog. The logstash syslog configuration is setup to listen on a stunnel port, which then forwards to the local logstash syslog listener. Unencrypted traffic is also supported for network devices.

- **Limiting Web Actions:**

  The Grafana module restricts what HTTP commands a user can perform on the Elasticsearch data store. Full **POST** action must be given to the Logstash nodes and some nodes may require **DELETE** capabilities. Logstash hosts should be tightly controlled so that administrative users cannot modify data inside of Elasticsearch with carefully crafted commands. This is one reason that we use syslog on the local hosts.

Important

The Puppet modules for Logstash, Grafana, and Elasticsearch contain dozens of variables that may be manipulated.

You should read each product's documentation and ensure you understand any setting that is changed from the default SIMP values. Changes can affect both security and functionality of the system.

Logstash Setup

Logstash System Requirements

The storage requirements for Logstash and Elasticsearch vary depending on how long you plan on keeping logs. When using Elasticsearch, the logs are formatted for Elasticsearch and stored in `/var/elasticsearch`. You can also configure how many days of data you wish to keep in Elasticsearch (`keep_days => '99'`). Therefore, you should ensure you have enough space on `/var` to keep your defined number of days worth of logs.

As you grow your Elasticsearch cluster to handle increasing log loads, you will want to ensure that your keep_days is set to handle your entire cluster appropriately.

Note

You should have at least 4G of memory available on any Elasticsearch node.

Important

It is not advised to install the ELG stack on your Puppet management infrastructure as both tend to use large amounts of system resources.

Recommended SIMP Logstash Setup

The following example can be applied to a single host with a large `/var` volume and 4GB of memory.

You can extend and replicate this setup on as many systems as necessary to provide ingest and dashboard redundancy. Alternatively, you can split Grafana and Logstash to allow greater resource dedication.

We do recommend that you have an Elasticsearch node on the Logstash system to reduce the likelihood that Logstash will hang when trying to find a non-existent storage node.

Optimization of your Elasticsearch infrastructure depends on many factors and should be handled once you decide how far your system is going to expand. Please be aware that scaling is highly dependent on how your actually use your cluster in production.

We would recommend a search on Elasticsearch Scaling prior to setting up your initial cluster.

The following configuration assumes Logstash and one Elasticsearch node are collocated on one host, `es1.<your domain>`:

```
---
# Add these settings to your Logstash node

## Set up Logstash ##

# Listen on unencrypted UDP for legacy network devices
#
```

```
simp_logstash::input::syslog::listen_plain_udp


# Send all output to the local Elasticsearch instance
#
simp_logstash::outputs :
  - 'elasticsearch'

# Keep 30 days of logs
#
simp_logstash::clean::keep_days: '30'

## Set up Elasticsearch ##

# Make this unique per cluster!  The elasticsearch service
# for the cluster will be named
#
#    elasticsearch-<cluster_name>
#
simp_elasticsearch::cluster_name : 'some_unique_cluster_name'

# The default value for simp_elasticsearch::bind_host assumes
# an Elasticsearch host only has one interface. If this is not
# true, set this to the appropriate value for each Elasticsearch
# host in your system.
#
simp_elasticsearch::bind_host : "%{::ipaddress}"

# This needs to be a list of *all* of the Elasticsearch nodes in the
# cluster, (including the host with Logstash and Elasticsearch).
# This is done to restrict communications to only trusted nodes
#
# Any node not entered here will not be connected to and will not
# be allowed to communicate with the cluster.
#
simp_elasticsearch::unicast_hosts :
  - "es1.%{::domain}:9300"

# Add your Grafana hosts to the apache ACL.
simp_elasticsearch::http_method_acl :
  'limits' :
    'hosts' :
      'grafana.%{::domain}' : 'defaults'

# Turn off client SSL verification *only* if you are connecting
# to Grafana.  Otherwise, the default setting of 'require'
# is best!
#
simp_elasticsearch::simp_apache::ssl_verify_client: 'none'


## Classes that you need to include for this setup

classes:
  - 'simp_elasticsearch'
  - 'simp_logstash'
```

```
  # Include this if you wish to auto-purge your Elasticsearch records
  - 'simp_logstash::clean'
```

Deploying Additional Elasticsearch Nodes

When more than one Elasticsearch node are to be deployed in your system, configuration of these nodes may be more easily handled using a group match to pull your **Hiera** settings. To do this, you should add the following to your `site.pp` file for your environment.

```
if $trusted['certname'] =~ /es\d+\.your\.domain/ {
  $hostgroup = 'elasticsearch'
}
```

Then, ensure that a file called 'elasticsearch.yaml' is present in the `/etc/puppetlabs/code/environments/simp/hieradata/hostgroups/` directory and contains the following content.

```
---
# All nodes running elasticsearch in your cluster should use
# these settings.

simp_elasticsearch::cluster_name: 'some_unique_cluster_name'

# Remember, this must be the *complete* list of Elasticsearch nodes.
#
simp_elasticsearch::unicast_hosts :
  - "es1.%{::domain}:9300"
  - "es2.%{::domain}:9300"
  - "es3.%{::domain}:9300"
  - "es4.%{::domain}:9300"

classes:
  - 'simp_elasticsearch'
```

Make sure you point your clients to the Logstash server by setting the `$simp_options::syslog::log_servers` variable to the FQDN of the Logstash server in **Hiera**. You will also need to set `simp_rsyslog::forward_logs: true` and `rsyslog::enable_tls_logging: true`, to ensure logs are sent to Logstash Stunnel listener.

Deploying Grafana

Now that you have a functional logging setup, you'll probably want to deploy a GUI to provide the ability to generate user dashboards as well as dynamic log analysis.

The SIMP team chose to support the Open Source Grafana project due to its builtin authentication and access control support. While the Grafana is great at visualizing data, it can be challenging to explore your logs. You could easily point Kibana or another tool of your choosing at your Elasticsearch cluster. You could also install Kibana alongside Grafana. Since Kibana does not offer (free and open source) access control, you can configure Kibana to listen to local host only and tightly control who can SSH to your Kibana node.

Note

By default, the Grafana administrative password is randomly set using simplib passgen(). You can use the *simp passgen* command to obtain the password for your environment.

Note

The `rubygem-toml` package must be present on your puppet compile servers for the Grafana puppet module to function properly.

On your puppet master, you can install the toml gem by executing `puppetserver gem install toml`.

If you do not install this via Kickstart, you will need two runs of Puppet to complete the Grafana installation since the TOML Ruby Gem will not be able to be installed prior to Puppet loading.

Warning

Do **not** point Grafana directly at your Elasticsearch node unless you have a single-node deployment.

Grafana has the ability to put **extreme** loads on your Elasticsearch infrastructure with poorly formed queries and should be connected to a node that is not used for ingest. This also helps prevent any vulnerabilities in Grafana from providing direct access to your Elasticsearch infrastructure.

Targeting your Grafana host or hostgroup, apply the following **Hiera** settings.

```
---
# Array of networks that are allowed to access your Grafana dashboard.
# Uses the standard SIMP 'simp_options::trusted_nets' semantics.
#
# In this case, instead of using the default of
# ``simp_options::trusted_nets``, we're allowing everyone in and
# trusting that Grafana will do properly authenticate users using
# the LDAP configured via the ``simp_options::ldap`` parameters.

simp_grafana::trusted_nets:
  - 'ALL'

classes:
  - 'simp_grafana'
```

After your Puppet run, you should be able to connect to port 8443 on your Grafana host and authenticate with the administrative user.

Grafana LDAP Integration

SIMP uses Grafana roles and maps them to **LDAP** groups to provide access control.

When you apply the SIMP Grafana class, Grafana will be configured for LDAP authentication (assuming you are using SIMP LDAP). The table below describes the Grafana roles.

Grafana Roles

Grafana Role	SIMP LDAP Role	Permissions
Viewer	simp_grafana_viewers	Can only view dashboards, not save / create them.
Read Only Editors	simp_grafana_editors_ro	Can edit graphs and queries but not save dashboards.
Editor	simp_grafana_editors	Can view, update and create dashboards.

Admin	simp_grafana_admins	Everything an Editor can plus edit and add data sources and organization users.

All the system administrator needs to do is to create the LDAP groups and assign users to those groups. An example `ldif` for creating the viewers group is as follows:

```
dn: cn=simp_grafana_viewers,ou=Group,dc=your,dc=domain
objectClass: posixGroup
objectClass: top
cn: simp_grafana_viewers
gidNumber: <Unique GID number>
description: "Grafana Viewers"
```

An `ldif` such as the one below could then be used to add users to that group:

```
dn: cn=simp_grafana_viewers,ou=Group,dc=your,dc=domain
changetype: modify
add: memberUid
memberUid: <UID1>
memberUid: <UID2>
...
memberUid: <UIDX>
```

More information on managing LDAP users can be found in the *User_Management* section. Refer to the `simp_grafana` module for additional information on using the puppet module to manage Grafana LDAP configuration.

Grafana Dashboards

SIMP can optionally install default Grafana dashboards, contained in the `simp_grafana` RPM. To install the dashboards in Grafana, set `simp_grafana::simp_dashboards: true` in the Hiera configuration for your Grafana node. The dashboards will reside in `/var/lib/grafana/dashboards` and will be read-only. If you want to modify any of them, via the Grafana GUI, you must first save a copy of each dashboard you want to customize.

HOWTO Change Puppet Servers

It may be necessary to change the Puppet Server. To point a particular client to a new Puppet Server, follow the steps in the sections below.

> ***Note***
>
> All commands in this section should be run as the `root` user.

On the Old Puppet Server

Collect the Client's Server-Side Artifacts

Until SIMP implements a shared Puppet data store (expected 2017-Q2), you will need to manually copy some artifacts from the old server to the new server

To do this, run:

```
$ find `puppet config --section master print vardir`/simp -name "*<client-fqdn>*" -exec tar --
$ find /var/simp/environments -name "*<client-fqdn>*" -exec tar --selinux --xattrs -rpvf <clie
```

Then, pull all of the relevant Hiera configuration for the node:

```
$ find /etc/puppetlabs/code/environments -name "<client-hostname>.yaml" -exec tar --selinux --
$ find /etc/puppetlabs/code/environments -name "<client-fqdn>.yaml" -exec tar --selinux --xatt
```

Remove all of the node specific Hiera data:

```
$ find /etc/puppetlabs/code/environments -name "<client-fqdn>.yaml" --delete
```

Note

You may have Hiera YAML files with the short name of the host still in place but those are too dangerous to automatically delete since they may match multiple hosts.

Reload the `puppetserver` process:

```
$ puppetserver_reload
```

On the New Puppet Server

Warning

This assumes that the new Puppet Server is set up identically to the old Puppet Server. If it is not, you will need to verify that the artifacts in the `tar` file are correctly placed.

Unpack the `<client-hostname>_transfer.tar` archive onto the system:

```
tar --selinux --xattrs -C / -xvf <client-hostname>_transfer.tar
```

Reload the `puppetserver` process:

```
puppetserver_reload
```

On Each Client

Warning

Make sure you are running these commands **on the client**. If you run them on the server, you have a very high risk of making your Puppet infrastructure inoperable.

Remove the Client Puppet Certificates

To remove all legacy SSL material, run `rm -rf `puppet config --section agent ssldir``

Update the Puppet Config

Note

If upgrading from SIMP 4 or 5 to SIMP 6 you will need to upgrade your puppet agent to the Puppet 4.0 agent before it can connect to the new puppet server. A fix is being worked under SIMP-3049. If you

installed from the ISO, the simp repo on the SIMP 6 server contains the correct rpm. Point to the correct repo and run `yum install puppet-agent`. This will also remove the old version.

Enter the following changes into `/etc/puppetlabs/puppet/puppet.conf`.

```
server = new.puppet.master.fqdn
ca_server = new.puppet.master.fqdn
ca_port = 8141
```

Run Puppet

Assuming the new Puppet Server has been set up to properly accept the client, execute a full Puppet run using `puppet agent --test`.

If everything was done properly, the client will now be synchronized with the new Puppet Server.

If you find issues, refer to the *Client_Management* section of the documentation and ensure that the new Puppet Server was set up properly.

HOWTO Discard Mail to Root

In many environments, you may have a central log collection facility, such as Logstash, for analyzing your log data. In this case, you may want to disable the default behavior of sending all e-mail to root.

The simplest method of discarding root's e-mail is to redirect it to `/dev/null` on the system using the following Puppet code.

Warning

This is a **very** brute force approach and should only be used if you are **absolutely sure** that you want to discard all of root's e-mail on your systems.

```
postfix::alias { 'root':
  values => '/dev/null'
}
```

HOWTO Exclude YUM Repositories

By default, SIMP applies updates from all available repositories on a nightly basis. This ensures that bug fixes and security updates are applied to all systems without minute management in Puppet manifests. This section provides guidance on how to include or exclude specific repositories from nightly YUM updates.

Methodology

The `simp::yum::schedule::repos` and `simp::yum::schedule::disable` variables in the simp module control which repositories are enabled for nightly updating. Both variables must be specified in array format.

`simp::yum::schedule::repos` is used to specify an array of repositories from which updates are provided; no other repositories will be used.

`simp::yum::schedule::disable` is used to specify an array of repositories from which updates are not provided; all other repositories will be used.

HOWTO Configure NFS

All implementations are based on `pupmod-simp-nfs`, `pupmod-simp-simp_nfs`, and `pupmod-simp-simp`.

> ***Note***
>
> `pupmod-simp-simp_nfs` and `pupmod-simp-nfs` are not core modules, and may need to be installed prior to following this guide.

Known Issues

Stunnel and Autofs

The `autofs` packages that were released with CentOS 6.8 (autofs-5.0.5-122) and CentOS 7.3 (autofs-5.0.7-56) worked properly over a stunnel connection.

The release shipped with CentOS 6.9 (**5.0.5-132**) and with CentOS 7.4 (**5.0.7-69**) prevents any connection from happening to the local stunnel process and breaks mounts to remote systems over stunnel connections.

To use NFS over stunnel and automount directories the old package must be used. To determine what version of autofs is installed, run `automount -V`.

To force the package to the version wanted despite the fact that a newer version is available:

First make sure the package is available via your package-management facility then set the package version in hiera:

In CentOS 7.4:

```
---
autofs::autofs_package_ensure:  '5.0.7-56.el7'
```

In Centos 6.9

```
---
autofs::autofs_package_ensure:  '5.0.5-122.el6'
```

This problem has been identified as bugs in autofs and are being publicly tracked.

- CentOS 6.9 https://bugs.centos.org/view.php?id=13575.
- CentOS 7.4 https://bugs.centos.org/view.php?id=14080.

If you have any further questions about this please contact the SIMP Team.

Autofs Option in nfs::client::mount

The autofs option in nfs::client::mount resource currently only works with indirect wild-card mounts. For all other autofs options use the autofs module directly.

SIMP-2944 in JIRA Bug Tracking.

Kerberos and Home Directories

The kerberos module is not fully integrated with home directories at this time.

SIMP-1407 in JIRA Bug Tracking.

Exporting Arbitrary Directories

Goal: Export `/var/nfs_share` on the server, mount as `/mnt/nfs` on the client.

> ***Note***
>
> If anything in this section does not make sense, there is a full working example of how to export NFS home directories in the `simp_nfs` module.

Server

In `site/manifests/nfs_server.pp`:

```
class site::nfs_server (
  Stdlib::AbsolutePath                          $data_dir     = '/var/nfs_share',
  Simplib::Netlist                              $trusted_nets = simplib::lookup('simp_optio
  Array[Enum['none','sys','krb5','krb5i','krb5p']] $sec          = ['sys']
){
  include '::nfs::server'

  file { $data_dir:
    ensure => 'directory',
    owner  => 'root',
    group  => 'root',
    mode   => '0644'
  }

  if !$::nfs::stunnel {
    nfs::server::export { 'nfs_share':
      clients     => $trusted_nets,
      export_path => $data_dir,
      sec         => $sec,
```

```
      require     => File[$data_dir]
    }
  }
  else {
    # Stunnel needs to point at the local host
    nfs::server::export { 'nfs_share':
      clients     => ['127.0.0.1'],
      export_path => $data_dir,
      sec         => $sec,
      require     => File[$data_dir]
    }
  }
}
```

In hosts/<your_server_fqdn>.yaml:

```
nfs::is_server: true

classes:
  - 'site::nfs_server'
```

Client

In site/manifests/nfs_client.pp:

```
 class site::nfs_client (
  Simplib::Host                                $nfs_server,
  Enum['none','sys','krb5','krb5i','krb5p']    $sec = 'sys'
){

   $_mnt_point = '/mnt/nfs'

   file { "${_mnt_point}":
     ensure => 'directory',
     mode   => '755',
     owner  => 'root',
     group  => 'root'
   }

   nfs::client::mount { "${_mnt_point}":
     nfs_server  => $nfs_server,
     remote_path => '/var/nfs_share',
     sec         => $sec,
     at_boot     => true,
     autofs      => false,
     require     => File["${_mnt_point}"]
   }
}
```

In hosts/<your_client_fqdn>.yaml:

```
nfs::is_server: false
site::nfs_client::nfs_server: <your nfs server>

classes:
  - 'site::nfs_client'
```

Warning

Non-wildcard indirect autofs mounts configured via `nfs::client::mount` are not working properly at this time. See SIMP-2944 in our JIRA Bug Tracking. You may wish to manually configure the mount via `autofs::map::master`, and `autofs::map::entry` instead.

Note

The `simp_nfs` module contains a further example that includes the use of a NFS root on the server and indirect autofs with wildcards on the client.

Exporting Home Directories

Goal: Export home directories for LDAP users.

Utilize the SIMP profile module `simp_nfs`:

1. `simp_nfs`: Manages client and server configurations for managing NFS home directories.
2. `simp_nfs::create_home_dirs`: Optional hourly cron job that binds to a **LDAP** server, `simp_options::ldap::uri` by default, and creates a NFS home directory for all users in the LDAP server. Also expires any home directories for users that no longer exist in LDAP.

Note

The NFS daemon may take time to reload after module application. If your users do not have home directories immediately after application or it takes a while to log in, don't panic!

Note

Any users logged onto a host at the time of module application will not have their home directories re-mounted until they log out and log back in.

default.yaml

```
nfs::is_server: false
simp_nfs::home_dir_server: <your nfs server>

classes:
  - simp_nfs
```

Server

```
nfs::is_server: true
simp_nfs::export_home::create_home_dirs: true

classes:
  - simp_nfs::export::home
```

Enabling/Disabling Stunnel

Stunnel is a means to encrypt your NFS data.

Enable

If `simp_options::stunnel` is set to `true`, you need only specify the following, in the server's **`YAML`** file:

> ***Note***
>
> The following is set to prevent a cyclical connection of stunnel to itself, in the event the server is a client of itself.

```
nfs::client::stunnel::nfs_server: <your nfs server>
```

If `simp_options::stunnel` is set to `false` and you don't wish to globally enable stunnel, you will also need to set the following, in default.yaml:

```
nfs::stunnel: true
```

Disable

If `simp_options::stunnel` is set to `true`, but you don't want your NFS traffic to go through stunnel, set the following, in default.yaml:

```
nfs::stunnel: false
```

If `simp_options::stunnel` is set to `false` then stunnel is already disabled.

Enabling Kerberos

> ***Warning***
>
> This functionality is incomplete. It does not work with home directories. See ticket SIMP-1407 in our JIRA Bug Tracking .

In addition to the sharing code (not the stunnel code) above, add the following:

default.yaml

```
classes:
  - 'krb5::keytab'

nfs::secure_nfs: true
simp_options::krb5: true

krb5::kdc::auto_keytabs::global_services:
  - 'nfs'
```

Server

```
classes:
  - 'krb5::kdc'
```

Clients

```
nfs::is_server: false

classes:
  - 'simp_nfs'
```

HOWTO Configure iptables NAT Rules

See the documentation in the `iptables` module itself for general usage.

Add NAT Rules

The user may be required to add **`Network Address Translation`** (NAT) rules to the iptables ruleset. To achieve this using the iptables module, the `iptables::rule` input statement should be used.

The example below shows an iptables NAT rule.

Example of an iptables NAT Rule

```
iptables::rule { 'nat_global':
  table    => 'nat',
  first    => true,
  absolute => true,
  header   => false,
  content  => '
  :PREROUTING ACCEPT [0:0]
  :POSTROUTING ACCEPT [0:0]
  :OUTPUT ACCEPT [0:0]
  '
}

iptables::rule { 'nat_test':
  table   => 'nat',
  header  => false,
  content => '-A PREROUTING --physdev-in eth1 -j DROP'
}
```

HOWTO Configure SNMPD

This document details how to use the `pupmod-simp-simp_snmpd` profile to configure the SNMP daemon.

Simple instructions to configure the snmpd daemon using the `pupmod-simp-simp_snmpd` profile module are described in its README file.

Note

`pupmod-simp-simp_snmpd` and `puppet-snmp` are not core modules and may need to be installed prior to following this guide.

SNMPD Configuration

There are two primary configuration directories:

- `/etc/snmp/simp_snmpd.d`
  - Files managed by puppet

- `/etc/snmp/user_snmpd.d`
  - Files not managed by puppet
  - Extended configurations should be placed here
  - Settings in this directory will override settings in the `simp_snmpd.d` directory

`snmptrapd` is disabled by default. The daemon can be enabled, but `pupmod-simp-simp_snmpd` will not configure it. If you need to run `snmptrapd`, set `simp_snmpd::trap_service_ensure` and `simp_snmpd::trap_service_startatboot` appropriately, and place any configuration files in `/etc/snmp/user_trapd.d`, with a `.conf` extension.

Agent Addresses and Firewall

By default, `pupmod-simp-simp_snmpd` configures `snmpd` to listen on the local interface. Use `simp_snmpd::agentaddress` to toggle what interfaces snmpd will listen on.

> ### *Note*
>
> `simp_snmpd::agentaddress` is an array of strings, that should follow the format defined in the man page for snmpd, under the `LISTENING ADDRESS` section.

The following is an example agent address:

```
---
simp_snmpd::agentaddress:
  - upd:161
  - tcp:%{facts.fqdn}:161
```

If `simp_options::firewall` is turned on, `pupmod-simp-simp_snmpd` will parse the array of listening addresses to determine what ports should be opened. It does not, at this time, do anything for ipx or pvc. `simp_snmpd::trusted_nets` is used to determine what networks can access the ports.

> ### *Note*
>
> If the agent address is set in a conf file in the user directory, but not in hiera or in the simp_snmpd resource call, `pupmod-simp-simp_snmpd` will not open the ports in the firewall.

Access

`pupmod-simp-simp_snmpd` configures `SNMP v3`, with

- User-based Security Model (USM)
- View-based Access Control Model (VACM).

The profile module, by default, installs two users:

- `snmp_ro` is configured for read only access to system view
- `snmp_rw` is configured for read/write access to everything

User passwords are auto-generated and stored on the puppet server in the passgen directory:

`/opt/puppetlabs/server/data/puppetserver/simp/environments/production/simp_autofile/gen_passwd`.

Access is configured by `/etc/snmp/simp_snmpd.d/access.conf`

- To create the `access.conf` file, the profile modules uses a set of hashes.
- The default hashes are in the `data/common.yaml` file.
- These hashes are merged with any hash you defined in the hiera files on the puppetserver. Merging is described in ` Puppet docs <https://docs.puppet.com/puppet/4.10/hiera_merging.html>`_
- To remove something from the default hash add the name of object with no keys

> ***Note***
>
> To remove a user, or modify their password, the `snmpusm` utility must be used, or remove `/var/lib/net-simp` and run puppet. Changing the password in the hash or removing the keys will not change the password of an existing user.

Example hashes used to create users, views, group and give access:

User Hash

```
simp_snmpd::v3_users_hash
  username:
    authtype: MD5|SHA
    privtype: DES|AES
    privpass: 'your priv password'
    authpass: 'your auth password'
```

- If authtype or privtype is missing, it will use the modules `$defauthtype` and `$defprivtype`
- If either of the passwords are missing, it will be automatically generated using passgen

View Hash

```
simp_snmpd::view_hash:
  viewname:
    included: [array of oids to include]
    excluded: [array of oids to exclude]
```

- One or both of included, excluded needs to be specified. Any number of OIDs can be listed
- It will create one view line for each oid in the list with exclude or include

Group Hash

```
simp_snmpd::group_hash:
  groupname:
    model: The security model to use (default to defsecuritymodel)
    secname: [array of user names to include in this group]
```

- It does not verify the user exists

Access Hash

```
simp_snmpd::access _hash:
  accessname:
    vread: view to use for reading access (default none)
    vwrite: view to use for write access (default none)
    vnotify: view to use for notify (default none)
    level:  priv|auth|noauth (default is defsecuritylevel)
    model: the model to use (default is defsecuritymodel)
    context: context to use (default "")
    prefx:  prefix for the context exact| prefix (default exact)
    groups: [array of groups to create this access for]
```

- It does not verify the group exists
- The access name is just a place holder
- For all hashes, anything with a default does not need to be included in the hash

> ***Note***
>
> Any views, groups, or access lines set up in user conf files will be in addition to anything anything configured in the hash.

Remove Values From Default Hash

If you do not want the default user, or any of the views, groups, or access created, you can pass and empty hash and it will ignore that setting:

```
---
simp_snmpd::v3_user_hash:
 snmp_ro:
 myuser:
   authpass: 'HardToBreakPassword'
   privpass: 'OtherPassword'
simp_snmpd::group:
 readonly_group:
   secname: myuser
```

- The above example will not create the snmp_ro user and add myuser. If the snmp_ro user is already created it will not delete it.
- It will override the default definition of readonly_group
- The quickest way to delete users or change the password is to configure the hashes and the remove the /var/lib/net-simp directory, stop the snmpd daemon, and run puppet.

Client

By default, `net-snmp-utils` and it dependencies are not installed, including snmpd utilities like snmpget, snmpset, snmpwalk. Set `simp_snmpd::manage_client` to `true` to install them:

```
simp_snmpd::manage_client: true
```

Note

After installation, the default security model, level, authentication, and privacy types will be configured. No default passwords will be configured.

Rsync MIBS and DLMODS

Rsync can be used to push out custom MIBS and dynamically loaded shared objects, or dlmod.

By default, rsync will copy MIBS into the directory used by net-snmp. To copy them elsewhere, set simp_snmpd::rsync_mibs_dir to the fully qualified path.

Note

The module will rsync the files to a MIBS directory under that path and add the directory to the MIBS path.

DLMODS are copied the same way as MIBS, using the rsync_dlmod_dir as the destination, creating a dlmod directory. In order to load dlmods, you must add the name of the module to the isimp_snmpd::dlmods list. This will create a dlmod.conf file in simp_snmpd. The .so extension will be added. See the Dynamically Loadable Modules modules section in man page of snmpd.conf for more information.

Below is an example showing how to activate rsync of MIBS and dlmods:

```
---
simp_snmpd::rsync_dlmod: true
simp_snmpd::rsync_mibs: true
simp_snmpd::dlmods:
  - mymodulename
```

HOWTO Enable Kerberos

For the latest documentation, see the documentation in the SIMP KRB5 Puppet Module.

The module helps administrators get a working **KDC** in place and clients configured to use the KDC.

The module, by default, sets up a fully functional KDC in your environment and generates keytabs for one admin user, and all of your hosts that it can discover via *keydist <Certificates>*.

Important

If you want to let SIMP automatically handle all of your hosts, you should follow the README included with the SIMP provided krb5 Puppet module and you should **NOT** proceed with this guide.

Note

The keydist discovery only works if the KDC is on the same system as your Puppet Server!

Warning

For distribution of keys to work properly, you **must** add `/var/simp/environments/<environment>/site_files` to your environment's `environment.conf` file and restart the `puppetserver` process.

The default in the `simp` environment is:

```
modulepath = modules:/var/simp/environments/**simp**/site_files:$basemodulepath
```

Beginning with krb5

The following sections give a brief guide on how to get started with manual Kerberos configuration and distribution of keytabs, for more information, please see the official Red Hat documentation.

Creating Admin Principals

ACL Configuration

The following Puppet code snippet will create an **`ACL`** for your admin user that is **probably** appropriate for your organization.

```
krb5_acl { "${facts['domain']}_admin":
  principal       => "*/admin@${facts['domain']}",
  operation_mask  => '*'
}
```

Create Your Admin Principal

Your first principal will be an admin principal and will be allowed to manage the environment since it is in the `admin` group. This **must** be created on the KDC system.

Run the following command, as root, to create your principal:

```
# /usr/sbin/kadmin.local -r YOUR.DOMAIN -q "addprinc <username>/admin"
```

You can now do everything remotely using this principal. Load it using:

```
$ /usr/bin/kinit <username>/admin
```

Creating Host Principals

Before you can really do anything with your hosts, you need to ensure that the host itself has a keytab.

SIMP uses the `/var/simp/environments/<client_environment>/site_files/krb5_files/files/keytabs/<client_fqdn>` directory for each host to securely distribute keytabs to the clients.

On the KDC, generate a principal for each host in your environment using the following command:

```
# /usr/sbin/kadmin.local -r YOUR.DOMAIN -q 'addprinc -randkey host/<fqdn>'
```

Create Your Keytabs

Then, create a separate keytab file for each of your created hosts using the following command:

```
# /usr/sbin/kadmin.local -r YOUR.DOMAIN -q 'ktadd -k <fqdn>.keytab host/<fqdn>'
```

Propagate the Keytabs

Move all of the resulting keytab files SECURELY to `/var/simp/environments/<client_environment>/site_files/krb5_files/keytabs/<fqdn>` on the Puppet server as appropriate for each file.

> ***Note***
>
> Make sure that all of your keytab directories are readable by the group **puppet** and not the entire world!

Then, update your node declarations to `include '::krb5::keytab'`.

Once the Puppet Agent runs on the clients, your keytabs will copied to `/etc/krb5_keytabs`. The keytab matching the system `fqdn` will be set in place as the default system keytab.

HOWTO Manage Workstation Infrastructures

This chapter describes example code used to manage client workstations with a SIMP system including GUIs, repositories, virtualization, Network File System (NFS), printing, and Virtual Network Computing (VNC).

To begin, install the following Puppet modules:

```
class site::workstation_packages {

  $package_list = [
    'pupmod-simp-gdm',
    'pupmod-simp-gnome',
    'pupmod-simp-simp_nfs',
    'pupmod-simp-vnc',
    'pupmod-simp-libvirt',
  ]

  package { $package_list :
    ensure => installed,
  }
}
```

Create A Workstation Profile Class

Below is an example class, `/etc/puppetlabs/code/environments/simp/modules/site/manifests/workstation.pp`, that could be set up a user workstation. Each `site::` class is described in the subsequent sections.

```
class site::workstation {
  include 'site::gui'
  include 'site::repos'
  include 'site::virt'
  include 'site::print::client'

  # Make sure everyone can log into all nodes.
  # If you want to change this, simply remove this line and add
  # individual entries to your nodes as appropriate
  pam::access::rule { "Allow Users":
    comment => 'Allow all users in the "users" group to access the system from anywhere.',
    users   => ['(users)'],
    origins => ['ALL']
  }
```

```
  # General Use Packages
  package { [
    'pidgin',
    'vim-enhanced',
    'tmux',
    'git'
  ]: ensure => installed
  }
}
```

Graphical Desktop Setup

Below is an example manifest called /etc/puppetlabs/code/environments/simp/modules/site/manifests/gui.pp for setting up a graphical desktop on a user workstation.

```
class site::gui (
  Boolean $libreoffice = true
) {

  include 'gdm'
  include 'gnome'
  include 'vnc::client'
  # Browser and e-mail client are not installed by default.
  include 'mozilla::firefox'
  include 'mozilla::thunderbird'


  Class['Gnome'] -> Class['Site::gui']

  #SIMP gnome package provides a basic interface.
  #Add gnome extensions for the users.
  package { [
    'gnome-color-manager',
    'gnome-shell-extension-windowsNavigator',
    'gnome-shell-extension-alternate-tab',
    ]:
     ensure => installed,
  }

  #Gui applications
  if $libreoffice {
    package { 'libreoffice': ensure => installed }
  }
}
```

Workstation Repositories

For the site repos use the puppet resource yumrepo to create repo files to point to repositories.

```
class site::repos {
  yumrepo { 'myrepo':
    #what ever parameters you need
  }
}
```

Virtualization on User Workstations

Below is an example manifest called /etc/puppetlabs/code/environments/simp/modules/site/manifests/virt.pp for allowing virtualization on a system.

```
# We allow users to run VMs on their workstations.
# If you don't want this, just don't include this class.
# If this is installed, VM creation and management is still limited by PolicyKit

class site::virt {
  include 'libvirt::kvm'
  include 'libvirt::ksm'
  include 'swap'
  include 'network'

  #set up a local bridge on the network
  network::eth { "em1":
    bridge => 'br0',
    hwaddr => $facts['macaddress_em1']
  }

  network::eth { "br0":
    net_type => 'Bridge',
    hwaddr   => $facts['macaddress_em1'],
    require  => Network::Eth['em1']
  }

  #add virt-manager package
  package { 'virt-manager': ensure => 'latest' }

  # Create polkit policy to allow users in virsh users group to use libvirt
  class { 'libvirt::polkit':
    ensure => present,
    group  => 'virshusers',
    local  => true,
    active => true
  }

  #Create group and add users.
  group{ 'virshusers':
    members => ['user1','user2']
  }

}
```

To set swappiness values use hiera:

```
# Settings for swap for creating/running virtual machines
swap::high_swappiness: 80
swap::max_swappiness: 100
```

Printer Setup

Below are example manifests for setting up a printing environment.

Setting up a Print Client

Below is an example manifest called /etc/puppetlabs/code/environments/simp/modules/site/manifests/print/client.pp for setting up a print client on EL6.

```
class site::print::client inherits site::print::server {
  polkit::local_authority { 'print_support':
    identity           => ['unix_group:*'],
    action             => 'org.opensuse.cupskhelper.mechanism.*',
    section_name       => 'Allow all print management permissions',
    result_any         => 'yes',
    result_interactive => 'yes',
    result_active      => 'yes'
  }

  package { 'cups-pdf': ensure => 'latest' }
  package { 'cups-pk-helper': ensure => 'latest' }
  package { 'system-config-printer': ensure => 'present' }
}
```

Setting up a Print Server

Below is an example manifest called /etc/puppetlabs/code/environments/simp/modules/site/manifests/print/server.pp for setting up a print server.

```
class site::print::server {

  # Note, this is *not* set up for being a central print server.
  # You'll need to add the appropriate IPTables rules for that to work.
  package { 'cups': ensure => 'latest' }

  service { 'cups':
    enable     => 'true',
    ensure     => 'running',
    hasrestart => 'true',
    hasstatus  => 'true',
    require    => Package['cups']
  }
}
```

Create A Workstation Hostgroup

Edit the site.pp file to create a hostgroup for the workstations. The following will make all nodes whose names start with ws followed any number of digits use the hieradata/hostgroup/workstation.yaml instead of the default:

```
case $facts['hostname'] {
  /^ws\d+.*/: { $hostgroup = 'workstation' }
  default:    { $hostgroup = 'default'     }
}
```

The workstation.yaml file will include settings for all the workstations. An example yaml file:

```
---

#Set the run level so it will bring up a graphical interface
simp::runlevel: 'graphical'
timezone::timezone: 'EST'
```

```
#Settings for home server. See HOWTO NFS for more info.
nfs::is_server: false
simp_nfs::home_dir_server: myhome.server.com

#The site::workstation manifest will do most of the work.
classes:
  - site::workstation
  - simp_nfs
```

VNC Setup

Virtual Network Computing (VNC) is a tool that is used to manage desktops and workstations remotely through the standard setup or a proxy.

VNC Standard Setup

Note

You must have the `pupmod-simp-vnc` RPM installed to use VNC on your system!

To enable remote access via VNC on the system, include `vnc::server` in Hiera for the node.

The default VNC setup that comes with SIMP can only be used over SSH and includes three default settings:

Setting Type	Setting Details
Standard	Port: 5901 Resolution: 1024x768@16
Low Resolution	Port: 5902 Resolution: 800x600@16
High Resolution	Port: 5903 Resolution: 1280x1024@16

Table: VNC Default Settings

To connect to any of these settings, SSH into the system running the VNC server and provide a tunnel to `127.0.0.1:<VNC Port>`. Refer to the SSH client's documentation for specific instructions.

To set up additional VNC port settings, refer to the code in `/etc/puppetlabs/code/environments/simp/modules/vnc/manifests/server.pp` for examples.

Important

Multiple users can log on to the same system at the same time with no adverse effects; however, none of these sessions are persistent.

To maintain a persistent VNC session, use the `vncserver` application on the remote host. Type `man vncserver` to reference the manual for additional details.

VNC Through a Proxy

The section describes the process to VNC through a proxy. This setup provides the user with a persistent VNC session.

Important

In order for this setup to work, the system must have a VNC server (`vserver.your.domain`), a VNC client (`vclnt.your.domain`), and a proxy (`proxy.your.domain`). A `vuser` account must also be set up as the account being used for the VNC. The `vuser` is a common user that has access to the server, client, and proxy.

Modify Puppet

If definitions for the machines involved in the VNC do not already exist in Hiera, create an `/etc/puppetlabs/code/environments/simp/hieradata/hosts/vserv.your.domain.yaml` file. In the client hosts file, modify or create the entries shown in the examples below. These additional modules will allow vserv to act as a VNC server and vclnt to act as a client.

VNC Server node

```
# vserv.your.domain.yaml
classes:
  - 'gnome'
  - 'mozilla::firefox'
  - 'vnc::server'
```

VNC client node

```
# vclnt.your.domain.yaml
classes:
  - 'gnome'
  - 'mozilla::firefox'
  - 'vnc::client'
```

Run the Server

As `vuser` on `vserv.your.domain`, type `vncserver`.

The output should mirror the following:

> New 'vserv.your.domain:<Port Number> (vuser)' desktop is vserv.your.domain:<Port Number>

Starting applications specified in `/home/vuser/.vnc/xstartup` Log file is `/home/vuser/.vnc/vserv.your.domain:<Port Number>.log`

Note

Remember the port number; it will be needed to set up an SSH tunnel.

Set up an SSH Tunnel

Set up a tunnel from the client (vclnt), through the proxy server (proxy), to the server (vserv). The table below lists the steps to set up the tunnel.

1. On the workstation, type
   `ssh -l vuser -L 590***<Port Number>*:localhost:590***<Port Number>***proxy.your.domain**

> ***Note***
>
> This command takes the user to the proxy.

2. On the proxy, type `ssh -l vuser -L 590***<Port Number>*:localhost:590***<Port Number>***vserv.your.domain**`

> ***Note***
>
> This command takes the user to the VNC server.

Table: Set Up SSH Tunnel Procedure

> ***Note***
>
> The port number in 590<*Port Number*> is the same port number as previously described. For example, if the <*Port Number*> was 6, then all references below to 590<*Port Number*> become 5906.

Set Up Clients

On `vclnt.your.domain`, type `vncviewer localhost:590\ ***<Port Number>***` to open the Remote Desktop viewer.

Troubleshooting VNC Issues

If nothing appears in the terminal window, X may have crashed. To determine if this is the case, type `ps -ef | grep XKeepsCrashing`

If any matches result, stop the process associated with the command and try to restart `vncviewer` on `vclnt.your.domain`.

HOWTO Back up the Puppet Master

This section details the steps required to back up the Puppet Master.

> ***Note***
>
> A default SIMP installation can use Git as a rudimentary method to back up the Puppet master. If a different method is preferred, the user must install and configure it first.

1. Backup `/etc/puppetlabs/puppet/ssl`
2. Backup `/etc/puppetlabs/puppet`
3. Backup `/var/simp`
4. Backup `\`puppet config --section master print vardir\`/simp`
5. **Optional:** Backup `/var/www`

Simple Full Backup Command

```
`bash tar --selinux --xattrs -czpvf simp_backup-$(date +%Y-%m-%d).tar.gz /etc/puppetlabs
 /var/simp `puppet config --section master print vardir`/simp /var/www /var/simp `
```

Simple Full Restore Command

```
`bash    # WARNING: This will overwrite your current system files!
tar --selinux --xattrs -C / -xzpvf simp_backup-<date>.tar.gz `
```

HOWTO Configure a Puppet Server Behind a NAT

> ***Attention!***
>
> This page was written for Puppet 3 and SIMP versions less than 6.

This section provides guidance for when the Puppet server is behind a NAT but is managing hosts outside the NAT.

Your puppet server certificate must have all names in it that are used by any client. To update your certificates follow the guidance:

1. Add the alternative certificate names (in a comma-separated list) in /etc/puppetlabs/puppet/puppet.conf

```
[main]

dns_alt_names = hostname.your.domain,hostname.your.other.domain
```

2. Regenerate ALL certificates on Puppet:

https://docs.puppet.com/puppet/3.8/ssl_regenerate_certificates.html

In Section 2 of the web page above that says update your Puppetdb certificates follow the instructions in Step 3, option A at this location:

https://docs.puppet.com/puppetdb/2.3/install_from_source.html#step-3-option-a-run-the-ssl-configuration-script

HOWTO Enable Redundant LDAP

This section describes how to set up redundant OpenLDAP servers in SIMP. These servers are also referred to as "slave" servers.

Set up the Master

The easiest way to set up an LDAP master is to set it up on the Puppet server using `simp config` during the initial configuration of the Puppet server. This is done by answering "yes" when asked if you want to use LDAP during your initial `simp config` run and answering the basic questions it asks you. If it is not desirable to have the LDAP server on the Puppet server, a LDAP server can be set up on an alternate server by including the `simp::server::ldap` on the node of your choice.

> ***Note***
>
> If you use another node, you may want to re-run `simp config` and answer the questions with this new LDAP master server in mind.

If you don't want to run `simp config` again, you will need to configure the following settings in **Hiera**:

```
# === ldap ===
# Whether or not to use LDAP on this system.
# If you disable this, modules will not attempt to use LDAP where possible.
simp_options::ldap: true

# The Base DN of the LDAP server
simp_options::ldap::base_dn: "dc=your,dc=domain"

# LDAP Bind Distinguished Name
simp_options::ldap::bind_dn: "cn=hostAuth,ou=Hosts,%{hiera('ldap::base_dn')}"

# The LDAP bind password
simp_options::ldap::bind_pw: "MyRandomlyGeneratedLargePassword"

# The salted LDAP bind password hash
simp_options::ldap::bind_hash: "{SSHA}9nByVJSZFBe8FfMkar1ovpRxJLdB0Crr"

# The DN of the LDAP sync user
simp_options::ldap::sync_dn: "cn=LDAPSync,ou=Hosts,%{hiera('ldap::base_dn')}"

# The LDAP sync password
simp_options::ldap::sync_pw: "MyOtherRandomVeryLargePassword"

# The SSHA hash for ldap::sync_pw
simp_options::ldap::sync_hash: "{SSHA}VlgYUmRzyuuKZXM3L8RT28En/eqtuTUO"

# The LDAP root DN.
simp_options::ldap::root_dn: "cn=LDAPAdmin,ou=People,%{hiera('ldap::base_dn')}"

# The LDAP root password hash.
# If you set this with simp config, type the password and the hash will be
# generated for you.'
simp_openldap::server::conf::rootpw: "{SSHA}GSCDnNF6KMXBf1F8eIe5xvQxVJou3zGu"

# This is the LDAP master in URI form (ldap://server)
simp_options::ldap::master: ldap://ldap_server1.your.domain

# === ldap::uri ===
# List of OpenLDAP servers in URI form (ldap://server)
simp_options::ldap::uri:
  - ldap://ldap_server1.your.domain

# === sssd::domains ===
# A list of domains for SSSD to use.
# `simp config` will automatically populate this field with `FQDN` if
# `use_fqdn` is true, otherwise it will comment out the field.
#
sssd::domains:
  - LDAP
```

Add the simp::server::ldap class into the yaml file for the LDAP server in Hiera, for example: hieradata/hosts/ldap_server1.your.domain.yaml:

```
classes :
  - 'simp::server::ldap'
```

Leave any other classes that are there if they are needed. Run the Puppet agent on the LDAP server until it runs cleanly. Run the agent on the Puppet server. Once all the other clients update against the Puppet server, they will be able to authenticate against the LDAP server. Adding users and groups is described in the *User_Management*.

Note

Information on how the create salted ({SSHA}) passwords can be found at the OpenLDAP site.

Set up the Redundant (Slave) Servers

Default Settings

Once the LDAP master is ready, LDAP slave nodes can be configured to replicate data from the master. These servers are read-only, and modifications cannot be made to LDAP entries while the master is down.

Slave nodes can be configured via Hiera by setting `simp::server::ldap::is_slave` to `true`, setting the replication id (RID) , and adding the `simp::server::ldap` class. This will set up your redundant server using the defaults. To do these three things, add the following lines to the `hieradata/hosts/ldap_server2.your.domain.yaml` file:

```
simp_openldap::server::conf::rootpw: "{SSHA}GSCDnNF6KMXBf1F8eIe5xvQxVJou3zGu"
simp::server::ldap::is_slave: true
simp::server::ldap::rid: 888

classes :
  - 'simp::server::ldap'
```

To make other clients aware of this server, add the redundant server's URI to lists of URIs in the `hieradata/default.yaml` file:

```
# === ldap::uri ===
# List of OpenLDAP servers in URI form (ldap://server)
simp_options::ldap::uri:
  - ldap://ldap_server1.your.domain
  - ldap://ldap_server2.your.domain
```

Note

To see the defaults for LDAP replication in SIMP, review the parameters passed to the module `simp_openldap/manifests/server/syncrepl.pp`. These parameters are used to add the replication settings to the `syncrepl.conf` file. Definitions can be found in the syncrepl.conf (5) man page.

Custom Replication Settings

If settings other than the defaults are needed, create a manifest under `site` and use the `simp_openldap::server::syncrepl` class with the necessary parameters.

In this example, the site profile is called `site::ldap_slave` and the RID of the server is 999 (these can be changed). One setting, `sizelimit`, is being overwritten but you can overwrite any number of them.

```
class site::ldap_slave {
```

```
  include 'simp::server::ldap'

  # custom settings:
  simp_openldap::server::syncrepl { '999':
    sizelimit  => '5000',
  }
}
```

The name of the `simp_openldap::server::syncrepl` instance must be a unique replication id.

Place this file in the `site` module's `manifests/` directory using the name *ldapslave.pp*. Include this class from the slave server's Hiera YAML file:

```
classes :
  - 'site::ldap_slave'
```

Lastly, add the server to the URI listing in `default.yaml` so all the clients know about it once they have updated from the Puppet server.

Promote a Slave Node

Slave nodes can be promoted to act as the LDAP master node. To do this, change the node classifications of the relevant hosts. For a node with the default settings, just remove the `simp::server::ldap::is_slave : true` from the server's Hiera YAML file and change the setting for the master LDAP in Hiera. This setting is needed by all LDAP servers. (It defaults to the Puppet server if it is not set.)

```
# This is the LDAP master in URI form (ldap://server)
simp_options::ldap::master: ldap://ldap_server2.your.domain
```

For a redundant server set up using custom settings, remove the call to the custom class and replace it with the call to the `site::ldap_server` class in the servers yaml file and set the master setting in the Hiera as shown above.

In both cases, if the current master is not down, make sure it has completed replication before changing the settings. Once the settings are changed, run `puppet agent -t` on the LDAP server. After the next Puppet run on all the hosts the server will be promoted to master and all the slaves will point to it.

Remove a Node or Demote a Master

To demote a master, simply configure it as slave in either of the configurations above after the new master has been configured and put in place. Then run the Puppet agent. Lastly, manually remove the active database from the server. (Check the setting `simp_openldap::server::conf::directory` setting for the location of the files.)

To remove an LDAP server, first remove the server from the `simp_options::ldap::uri` settings in Hiera. Give the clients time to update from the Puppet server so they do not attempt to call it. Then remove relevant settings from it's Hiera .yaml file and run the Puppet agent.

Troubleshooting

If the system is not replicating, it is possible that another user has updated the `simp_options::ldap::sync_pw` and `simp_options::ldap::sync_hash` entries in Hiera file without also updating the value in LDAP itself; this is the most common issue reported by users. If simp config was used to to set up the server these values are in the `simp_config_settings.yaml` file.

Currently, SIMP cannot self-modify the LDAP database directly; therefore, the LDAP Administrator needs to perform this action. Refer to the *User_Management* chapter for more information on manipulating entries in LDAP.

The example below shows the changes necessary to update the `simp_options::ldap::sync` information in LDAP.

Update `simp_options::ldap::sync` Information in LDAP Examples:

```
dn: cn=LDAPSync,ou=People,dc=your,dc=domain
changetype: modify
replace: userPassword
userPassword: <Hash from simp_options::ldap::sync_hash>
```

Further Information

The OpenLDAP site contains more information on configuring and maintaining OpenLDAP servers.

HOWTO Enable SFTP Restricted Accounts

This section describes the method for restricting an account to **`SSH File Transfer Protocol`** (SFTP) access only.

Add a User

Create a user account based on the following example.

```
user { "foo":
  uid   => <UID>,
  gid   => <GID>,
  shell => '/usr/libexec/openssh/sftp-server'
}
```

Modify `/etc/shells`

To allow your user to use the `sftp-server` application as a shell, you will need to add custom shell to `useradd::shells` in **`Hiera`** as shown below.

```
useradd::shells:
  - /usr/libexec/openssh/sftp-server
```

HOWTO Setup SSH Authorized Keys

This section provides guidance on managing SSH keys within the SIMP environment.

LDAP Enabled

When enabled, ssh keys are both stored and retrieved directly from LDAP.

See Also: *Managing Users with LDAP <Managing LDAP Users>*

Without LDAP

If not using LDAP, or in addition to LDAP, SSH authorized keys can be placed in `/etc/ssh/local_keys/<USERNAME>`. This location can be changed by setting the `ssh::server::conf::authorizedkeysfile` parameter in **`Hiera`** or your **`ENC`**.

See Also: *Managing Local/Service Users <local_user_management>*

HOWTO Restrict Network Access to SSH

Like most SIMP modules, the SSH module utilizes a `trusted_nets` parameter to control access to the SSH service via both IPTables and TCPWrappers.

Since there is no way for the SIMP installation to successfully guess where you may be connecting from, or know about your particular network architecture, it defaults to allowing SSH connections from **any** host.

It is understandable that you may want to restrict this further. To do so, you simply need to set the `ssh::server::conf::trusted_nets` to an `Array` of networks or hosts from which you would like to connect.

Example: Set Trusted Nets to Alternate Networks via Hiera

```
---
ssh::server::conf::trusted_nets :
  - 1.2.3.4
  - 10.1.2.0/24
  - 192.168.0.0/16
```

You can find more information on `trusted_nets` in the *List of Installation Variables* in the *Initial_Configuration* section of the *getting-started-guide*.

HOWTO Upgrade SIMP

See the *ug-upgrade-simp* documentation on guidance for upgrading SIMP systems.

How to Manage a TPM Device With SIMP

This document serves as a guide to enable and use TPM devices in SIMP. Currently, only **`TPM` 1.2** and EL7 are supported.

TPM features in SIMP:

- Taking ownership
- Enabling basic **`IMA`** measuring
  - Setting custom IMA policy (broken)
- Enabling a TPM-based PKCS#11 interface
- Intel TXT and Trusted Boot

We do not support clearing ownership, EVM, or measured boot at this time. `ima-evm-utils` and kernel support are not available on SIMP platforms.

Requirements

General Requirements:

- A host with a TPM 1.2 chip on the motherboard
- A legacy, non-UEFI bootloader
- A BIOS password (one should be required to enable the TPM)
- Easy physical access to the machine to enter the BIOS password

Trusted Boot Hardware Requirements:

- A CPU with Intel Trusted Execution Technology (TXT)
- A chipset with Intel Trusted Execution Technology (TXT)

Starting With TPM

Follow the steps below to enable and take ownership of the **TPM**.

1. Ensure the system has a TPM by checking the `has_tpm` fact, the `status` section of the tpm structured fact, or by checking the sys path manually. You can also look for the character device `/dev/tpm0`.

```
$ facter -p has_tpm
true
$ facter -p tpm.status
...
owned: 0,
enabled: 1,
active: 1,
...
$ cat /sys/class/tpm/tpm0/device/active
1
$ file /dev/tpm0
/dev/tpm0: character special (10/224)
```

2. A BIOS password must be set to make sure no third parties can boot the host. Please set the admin password and the user password in the BIOS. If there is an option to require password at boot time, enable it. Do not enable Intel Platform Trust Technology (PTT) or Intel TXT at this time.
3. Before a TPM can be accessed by the operating system, it must first be enabled. This has to be done in the BIOS. Refer to the documentation provided with the hardware.
4. At this point, the SIMP TPM module can take over management of the device. Add `tpm` to the host's hieradata according to the example below or use the `tpm_ownership` type directly.

```
classes:
  - tpm

tpm::take_ownership: true
tpm::ownership::advanced_facts: true
```

> ***Note***
>
> The `tpm_ownership` type does not support clearing the TPM. The process could possibly be destructive and has been left to be a manual process.

5. Run puppet

Enabling Trusted Boot (tboot)

General Process

The steps in the section below provide guidance and automation to perform the following:

1. Set BIOS password
2. Activate and own the TPM
3. Install the `tboot` package and reboot into the `tboot no policy` kernel entry
4. Download SINIT and put it in `/boot`
5. Generate a policy and install it in the TPM NVRAM and `/boot`
6. Update GRUB

7. Reboot into a measured state

For more information about tboot in general, reference external documentation:

- https://fedoraproject.org/wiki/Tboot
- The `tboot` docs found in `/usr/share/tboot-*/*`
- https://wiki.gentoo.org/wiki/Trusted_Boot

s://software.intel.com/sites/default/files/managed/2f/7f/Config_Guide_for_Trusted_Compute_Pools_in_RHEL_OpenStack_Plat

Steps

1. Enable Intel TXT and VT-d in the BIOS
2. Boot into the kernel you want to trust (don't worry, this kernel will be preserved!)
3. Follow the instructions in 'Starting With TPM' and ensure:
   - The TPM is owned
   - You know the owner password
   - The SRK password is 'well-known' (`-z`)
4. Go to the Intel site and download the appropriate SINIT binary for your platform. Place this binary on a webserver, on the host itself, or in a profile module. This can't be distributed by SIMP for licensing reasons.
5. Add the following settings to your hieradata for nodes that will be using Trusted Boot. It is recommended to use a *hostgroup* for this.
   - `tpm::tboot::sinit_name` - The name of the binary downloaded in the previous step
   - `tpm::tboot::sinit_source` - Where Puppet can find this binary
   - `tpm::tboot::owner_password` - The owner password

   Here is an example used for testing:

```
tpm::tboot::sinit_name: 2nd_gen_i5_i7_SINIT_51.BIN
tpm::tboot::sinit_source: 'file:///root/txt/2nd_gen_i5_i7-SINIT_51/2nd_gen_i5_i7_SINIT_51.B
tpm::tboot::owner_password: "%{alias('tpm::ownership::owner_pass')}"
```

6. Add the `tpm::tboot` class to the classes array with `tpm`
   - The `tpm::tboot` class adds two boot entries to the GRUB configuration. One should read `tboot`, and there should be one above it called something along the lines of `tboot, no policy`.
   - The Trusted Boot process requires booting into the tboot kernel before creating the policy, so we have opted to create both entries. The intermediate, `no policy` boot option can later be removed by setting `tpm::tboot::intermediate_grub_entry` to `false` in hiera.
7. Reboot into the `tboot, no policy` kernel entry
8. Puppet should run at next boot, and create the policy. Log in, ensure `/boot/list.data` exists. If not, run puppet again.
9. Reboot into the `tboot` kernel entry.
10. Verify that the system has completed a measured launch by running `txt-stat` or checking the `tboot` fact

```
# txt-stat
# facter -p tboot
```

Trusted Boot debugging tips and warnings

- The `parse_err` command will show the error code, ready to lookup in the error table included in the zip
- The `tboot` kernel option `min_ram=0x2000000` (which is default) is **REQUIRED** on systems with more than 4GB of memory
- Trusted Boot measures the file required to boot into a Linux environment, and updating those file will cause a system to boot into an untrusted state. Be careful updating the `kernel` packages and rebuilding the `initramfs` (or running `dracut`).

Enable basic IMA measuring

This section assumes the previous section is complete, the TPM in the host is owned, and it is being managed with Puppet.

IMA is a neat tool that hashes the contents of a system, and stores that hash in the TPM. IMA is a kernel-level tool, and needs a few kernel parameters and reboots to be completely set up.

1. Follow the above steps ensure the tpm is owned
2. Modify the hieradata and add just one line:

```
tpm::ima: true
```

3. Run puppet, then reboot.

Managing IMA policy

> ***Warning***
>
> This automated management of IMA policy is disabled for now. The policy generated tends to cause systems to become read only.

This module can also support modifying what files IMA watching by editing the `/sys/kernel/security/ima/policy`. Reference the module source file, located at `<environment path>/modules/tpm/manifests/ima/policy.pp` for further details on what can and cannot be measured.

> ***Warning***
>
> Pushing poorly configured policy can result in a read-only system. A reboot will fix the issue, but with a TPM you will have to enter the password again. Be very careful not to push bad policy. That being said, the module itself should generate proper policy and simultaneously make it difficult to generate malformed policy.

IMA Appraisal

IMA Appraisal is the process that actually measures the state of the file and will stop changes to the filesystem if there is a issue detected.

1. Run puppet once with `tpm::use_ima: true`, like it was set up earlier.
2. Disable the puppet agent on the host

```
$ puppet agent --disable
```

3. Make sure / and /home are mounted with the i_version option. They are created by default with these options enabled.
4. Add the ima_appraise=fix kernel parameter temporarily

```
$ puppet resource kernel_parameter ima_appraise ensure=present value=fix
```

5. Reboot
6. The files on the system must now be measured and saved. In order to do this, every file owned by root and included in the policy must be touched. This step will take some time.

```
$ find / \( -fstype rootfs -o -fstype ext4 \) -type f -uid 0 -exec head -n 1 '{}' > /dev/nu
```

7. After that process finishes, set the ima_appraise kernel parameter to enforce.

> ***Note***
>
> In kernels above 4.0, we would opt for the log parameter instead of enforce. For now, enforce is all we have. Be aware, this may cause your system not to boot.

```
$ puppet resource kernel_parameter ima_appraise ensure=present value=enforce
$ # or add it to a puppet manifest
```

1. Reboot

Package Data

Base Packages

Information about the base SIMP packages is best gathered from the simp RPM and the RPM metadata on your system.

The dependencies for the simp RPM are those that are required for basic SIMP functionality and may be obtained as follows from an **installed system**:

```
for x in `rpm -q --requires simp | cut -f 1 -d' '`; do
  rpm -q --qf "%{NAME} %{VERSION}\n" $x | grep -v 'not installed';
done
```

The dependencies for the simp-extras RPM are those that are **not** required for basic SIMP functionality and may be obtained as follows from an **installed system**:

```
for x in `rpm -q --requires simp-extras | cut -f 1 -d' '`; do
  rpm -q --qf "%{NAME} %{VERSION}\n" $x | grep -v 'not installed';
done
```

External Packages

Quite a few external packages are available to, and used by, the SIMP infrastructure.

These are defined, with sources, per OS and architecture in the packages.yaml files under the build directory in the simp-core repository.

To find the particular package list for your version of SIMP, you can go to:

https://github.com/simp/simp-core/blob/<version>/build/distributions/<os>/<os_version>/<arch>/yum_data/packages.yaml

So, if you're using SIMP 6.0.0 on CentOS 6 and an x86_64 architecture, you would navigate to:

`https://github.com/simp/simp-core/blob/6.0.0/build/distributions/CentOS/6/x86_64/yum_data/packages.yaml`

Indices and tables

- *genindex*
- *search*

Contributing to SIMP

Introduction

Thank you for taking interest in contributing to the SIMP project!

We firmly believe that this type of project can't be accomplished by a single team and that everything matters from bug reports to documentation patches.

Contribution Procedure

We use the standard GitHub workflow for SIMP development with the exception that we use a Squash and Merge merge method for pulling in changes. This is done to to maintain a more legible commit history on *master*.

1. Search the SIMP JIRA for an open ticket that is relevant to the issue or open a new one.
2. Use the GitHub GUI to fork and clone the repository (we'll use `pupmod-simp-iptables` for the rest of this walkthrough)
3. Clone the repo you want to work on:
   - `git clone git@github.com:<YOUR_GITHUB_NAME>/pupmod-simp-iptables iptables`
4. Enter the directory and create a feature branch: `git checkout -b SIMP-XXXX`
5. Do your work! *(Including tests, of course)*
6. Commit your work. We will squash your pull request into one commit when we merge it, so you can use as many commits as you'd like.

   > **Important**
   >
   > The **first** commit should use the Commit Message Conventions

7. Push your changes to Github on your feature branch:
   - `git push origin SIMP-XXXX`
8. Using the GitHub GUI, create a pull request from your feature branch to the branch of the original repo that you want to contribute to. Leave the 'Allow edits from maintainers' checkbox checked to let a team member add add commits to your pull request.
9. Travis-CI will run the spec tests for the branch and a member of the SIMP team will review your submission. You should receive emails from Github as code reviews progress.

Commit Message Conventions

An example commit message that following the SIMP conventions:

```
(SIMP-999) Fix the broken thing [50 chars max]

Discussion about the fix (if needed) [each line: 72 chars max]

SIMP-998 #comment Comment on a related issue [72 chars max]
SIMP-999 #close
```

The first commit message should be the following format:

- First line:
  - Start with the Issue name in parentheses [e.g., `(SIMP-999)`], followed by a summary of the change
  - No longer than **50** characters
  - Followed by a line of white space
- Subsequent lines:
  - Each line should be no longer than **72** characters
  - Describe the previous behavior, why it was changed, and the changes in detail
- Issue references:
  - JIRA issues can be referenced at the end of the commit message
  - It is recommended to only use JIRA Smart Commit Tags `#comment` and `#close`
  - Avoid `#resolve` and `#time` as it will not update JIRA until after the issue is merged

Maintenance Procedure

If you're a SIMP maintainer, you're in the right spot! Otherwise, you'll want to head over to the *gsg-contributors_guide-contribution_procedure*.

This section exists to document the correct procedure for SIMP Maintainers to update and release code. These procedures are above and beyond the *gsg-contributors_guide-contribution_procedure*.

Amending Changes to Submitted Pull Requests

Note

It is recommended that all SIMP Maintainers use the hub Git extensions and all examples in this section will expect that hub is installed and ready for use.

1. Clone the source repo:
   - `git clone https://github.com/simp/simp-doc doc`

Important

We use `git clone` instead of `hub clone` so that we can't accidentally push to the main SIMP repositories. While we have protected branches for the critical components, one wrong command and and life can get unpleasant.

2. Pull down the pull request (PR) as found on the GitHub GUI. The local branch should match the branch in the PR (for example, branch SIMP-XXXX):
    - `hub checkout https://github.com/simp/simp-doc/pull/9999 SIMP-XXXX`
3. Review the code or make your additional changes
    - `HACK HACK HACK`
4. Add a new commit with your changes:
    - `git commit -a -m "I made the docs better"`
5. Set up the target repo for a push:
    - `hub remote set-url -p jeefberkey`
6. Push your new commit to the feature branch of the **owner** of the pull request. In this example, the owner is *jeefberkey*, and the feature branch name is *SIMP-XXXX*: `hub push jeefberkey HEAD:SIMP-XXXX`
7. The pull request has been updated, and participants have received an email

Tagging and Releasing Components

> ## *Warning*
>
> The intent of this section is to list the current state of the SIMP Team's release processes. Since these processes are constantly being improved and automated, you can expect this section content to evolve as well and may be best served by reading the version from the `master` branch of the `simp-doc` repository.

This section describes the release procedures for SIMP. The SIMP Team releases:

- Individual Puppet modules as tar files to PuppetForge
- Individual Puppet modules as signed RPMs to packagecloud and the SIMP Archive
- Ruby gems for building and testing to RubyGems.org
- SIMP system dependencies as signed RPMs to packagecloud and the SIMP Archive
- SIMP-system ISOs to simp-project.com

SIMP component releases listed above are based off of an official GitHub release the SIMP Team has made to a corresponding SIMP GitHub project. In the case of a SIMP ISO, the component release tag is for the `simp-core` project, which compiles existing, released component RPMs and dependencies into an ISO.

> ## *Note*
>
> The SIMP ISO includes RPMs for Puppet modules that are not maintained by SIMP. When a suitable signed RPM does not already exist for such a module (e.g., `kmod` Puppet module maintained by `camptocamp`), SIMP builds a signed RPM for that project, using one of that project's GitHub release tags.
>
> All modules provided by the SIMP Project, are directly sourced from SIMP-controlled repository forks. We do not pull directly from upstream sources.

Component Versioning

Version Philosophy

SIMP follows Semantic Versioning 2.0.0 and has the following versioning structure: `X.Y.Z`, where

- X indicates breaking changes
- Y indicates new features
- Z indicates bug fixes.

When can a component be released?

A component can be released when

- X, Y, or Z changes have been made.
- All dependencies of the component has been released.
- If a SIMP-owned component, all unit, acceptance, and integration tests pass.
- If a SIMP-owned component, the version number has been appropriately bumped and the corresponding changelog has been updated.

The SIMP project version/changelog files are as follows:

Component Type	Version Files	Changelog Files
SIMP-owned Puppet module	`metadata.json` and `CHANGELOG`	`CHANGELOG`
Ruby gem	`lib/simp/\*\*/version.rb` and either `build/<name>.spec` or `CHANGELOG.md`	`build/<name>.spec` or `CHANGELOG.md`
Other ISO-related project	`build/<name>.spec`	`build/<name>.spec`
`simp-doc`	auto-generated	`CHANGELOG`
SIMP ISO (`simp-core`)	`Changelog.rst` and `src/assets/simp/build/simp.spec`	`Changelog.rst` and `src/assets/simp/build/simp.spec`

What file changes require a version change?

Any changes to mission impacting (significant) files require a new release. In general, this includes the `metadata.json`, `CHANGELOG` and `hiera.yaml` files for Puppet modules, as well as files in the following directories:

- `build/`
- `data/`
- `files/`
- `functions/`
- `lib/`
- `manifests/`
- `scripts/`
- `share/`
- `src/`
- `templates/`
- `types/`

Changes to the following do not typically warrant a new release of a component:

- Any hidden file/directory (entry that begins with a `.` such as `.rspec`, `.gitignore`, `.gitlab-ci.yml`)
- `Gemfile`
- `Gemfile.lock`
- `Rakefile`
- `spec/`
- `doc/`

What version/changelog linters are available?

In the `simp-rake-helpers` Ruby gem, we have the following version/changelog-related linters for SIMP Puppet modules:

- `changelog_annotation`: Generates an appropriate annotated tag entry from a `CHANGELOG`. Errors are logged. The results must be carefully examined to ensure the output is correct, when errors are logged.
- `compare_latest_tag`: Compares mission-impacting files with the latest tag and identifies the relevant files that have changed. When mission-impacting files have changed, fails if:
  1. Latest version cannot be extracted from the top-most `CHANGELOG` entry.
  2. The latest version in the `CHANGELOG` (minus the release qualifier) does not match the version in the `metadata.json` file.
  3. A version bump is required but not recorded in both the `CHANGELOG` and `metadata.json` files.
  4. The latest version is smaller than the latest tag (version regression).
- `pkg::check_version`: Compares all files with the closest tag and logs an error if any files have changed, but the version has not been updated, or the versions in the `metadata.json` and `CHANGELOG` files do not match.

Note

Moving forward, these linters will be enhanced to handle the version/changelog nuances of the other projects SIMP releases and will be included as tests in all TravisCI builds.

SIMP-Owned Puppet Module Tag And Release Procedures

This section will describe the partially-automated, release procedures we use for SIMP-owned Puppet modules.

For demonstration purposes, we will be using the `pupmod-simp-iptables` project, which uses the `master` branch as its development branch.

Note

You can identify whether a Puppet module is owned by SIMP, by examining the outer-most `name` entry in the module's `metadata.json` file. The value for the `name` key will be of the form *<owner>-<module name>*.

Pre-Release Checklist

The bulk of the work to release a component is to verify that the component is ready for release. Below is the list of verifications that must be executed before proceeding with the release. If any of these checks fail, the problem identified must be fixed before you can proceed with the tag and release steps.

- Verify a release is warranted
- Verify the CHANGELOG
- Verify the component's dependencies
- Verify a Puppet module can be created
- Verify RPMs can be created
- Verify unit tests pass
- Verify acceptance tests pass
- Verify interoperability with last SIMP release
- Verify the component RPM upgrade succeeds
- Verify the component yields valid SIMP ISOs
- Verify the component works in an actual SIMP system

Verify a release is warranted

This check verifies a new release is warranted and the version has been properly update:

1. Clone the component repository and checkout the development branch to be tagged

```
git clone https://github.com/simp/pupmod-simp-iptables.git
cd pupmod-simp-iptables
git checkout master # this step isn't needed for master branch
```

2. Run the `compare_latest_tag` rake task

```
bundle update
bundle exec rake compare_latest_tag
```

> ***Important***
>
> If this check indicates no new tag is required, there is no reason to continue with the release procedures.

Verify the CHANGELOG

This check verifies that the CHANGELOG information can be properly extracted:

1. Run the `changelog_annotation` rake task

```
bundle exec rake changelog_annotation
```

2. Manually verify the changelog information is emitted.
   - It should begin with `Release of x.y.z` and then be followed by one or more comment blocks. For example,

```
Release of 6.0.3

* Thu Aug 10 2017 Nick Markowski <nmarkowski@keywcorp.com> - 6.0.3-0
  - Updated iptables::listen::tcp_stateful example to pass valid
    Iptables::DestPort types to dports
```

- It should be understandable.
- It should be free from typos.
- Any parsing error messages emitted should *only* be for changelog entries for earlier versions.

> ***Important***
>
> The changelog information emitted will be used as the content of the GitHub release notes.

Verify the component's dependencies

This check verifies the component's dependencies are correct in the `metadata.json`:

- Verify that the dependencies in the `metadata.json` file are complete. This means that the sources of all external functions/classes used within the module are listed in the `metadata.json`.
- Verify that the version constraints for each dependency are correct.

> ***Important***
>
> Beginning with `simp-rake-helpers-4.1.0`, the RPM dependencies for a component will determined from its `metadata.json` file, and if present, the component's entry in the `simp-core/build/rpm/dependencies.yaml`.

Verify a Puppet module can be created

This check verifies that a PuppetForge-deployable Puppet module can be created:

```
bundle exec rake metadata_lint
puppet module build
```

Verify RPMs can be created

This check verifies that an RPM can be generated for this module from `simp-core`:

1. Clone `simp-core`

   ```
   git clone https://github.com/simp/simp-core.git
   ```

2. Update the URL for the component under test `Puppetfile.tracking`, if needed

   ```
   cd simp-core
   vi Puppetfile.tracking
   ```

3. Build RPM

   ```
   bundle update
   bundle exec rake deps:checkout
   bundle exec rake pkg:single[iptables]
   ```

> ***Note***
>
> This command will build the RPM for the OS of the server on which it was executed.

Verify unit tests pass

This check verifies that the component's unit tests have succeeded in TravisCI:

- Navigate to the project's TravisCI results page and verify the tests for the development branch to be tagged and released have passed. For our project, this page is https://travis-ci.org/simp/pupmod-simp-iptables/branches

> ***Important***
>
> If the tests in TravisCI fail, you **must** fix them before proceeding. The automated release procedures will only succeed, if the unit tests succeed in TravisCI.

Verify acceptance tests pass

This check verifies that the component's acceptance tests have succeeded:

- Run the `beaker:suites` rake task with and without FIPS enabled

```
BEAKER_fips=yes bundle exec rake beaker:suites
bundle exec rake beaker:suites
```

> ***Note***
>
> - For older projects that have not been updated to use test suites, you may have to run the `acceptance` rake task, instead.
> - If the GitLab instance for the project is current (it is sync'd every 3 hours), you can look at the latest acceptance test results run by GitLab. For our project, the results will be at https://gitlab.com/simp/pupmod-simp-iptables/pipelines.

Verify interoperability with last SIMP release

This check verifies that this version of the component interoperates with the last full SIMP release. For many components, the best automated way of doing this is by running the `simp-core` and `pupmod-simp-simp` acceptance tests, as these tests provide extensive, multi-component, integration tests.

1. Checkout the `simp-core` project for the last SIMP release. For this discussion, we will assume it is `6.0.0-1`.

```
git clone https://github.com/simp/simp-core.git
cd simp-core
git fetch -t origin
git checkout tags/6.0.0-1  # can use a ref spec in lieu of a tag
```

2. Create a `Puppetfile.tracking` file that is a copy of the `Puppetfile.stable` file for which this component version and any newer dependencies this version itself requires have been updated.
3. Run the default `simp-core` acceptance tests

```
bundle update
bundle exec rake beaker:suites
```

4. Checkout the version of `pupmod-simp-simp` corresponding to the last `simp-core` release

```
bundle exec rake deps:checkout
cd src/puppet/modules/pupmod-simp-simp
```

5. Create a `.fixtures.yml` file that overlays the contents of the `Puppetfile.stable` file 3 directories above, with this component version and any newer dependencies this version itself requires.

   > ***Note***
   >
   > Currently, there are prototype utilities to generate the `.fixtures.yml` file for you. When these utilities are released, this documentation will be (thankfully) updated.

6. Run the acceptance tests with and without FIPS mode enabled

```
bundle update

BEAKER_fips=yes bundle exec rake beaker:suites
bundle exec rake beaker:suites

BEAKER_fips=yes bundle exec rake beaker:suites[base_apps]
bundle exec rake beaker:suites[base_apps]

BEAKER_fips=yes bundle exec rake beaker:suites[no_simp_server]
bundle exec rake beaker:suites[no_simp_server]

BEAKER_fips=yes bundle exec rake beaker:suites[scenario_one_shot]
bundle exec rake beaker:suites[scenario_one_shot]

BEAKER_fips=yes bundle exec rake beaker:suites[scenario_poss]
bundle exec rake beaker:suites[scenario_poss]

BEAKER_fips=yes bundle exec rake beaker:suites[scenario_remote_access]
bundle exec rake beaker:suites[scenario_remote_access]
```

Verify the component RPM upgrade succeeds

This check verifies that the RPM for this component can be used to upgrade the last full SIMP release. For both CentOS 6 and CentOS 7, do the following:

1. Bring up a CentOS server that was booted from the last SIMP ISO release and for which `simp config` and `simp bootstrap` has been run.

   > ***Note***
   >
   > If the VirtualBox for the last SIMP ISO was created by the simp-packer project, you can simply setup the appropriate VirtualBox network for that box and then bring up that bootstrapped image with `vagrant up`.

2. Copy the component RPM generated from the above RPM verification check to the server and install with yum. For example,

```
sudo yum install pupmod-simp-iptables-6.0.3-1.noarch.rpm
```

> ***Note***
>
> - If the component requires updated dependencies, those RPMs will have to be built and installed at the same time.
> - Puppet agent runs will be tested in Verify the component works in an actual SIMP system

Verify the component yields valid SIMP ISOs

This check verifies that with this component, valid SIMP ISOs for for CentoOS 6 and CentOS 7 can be built. An ISO is considered to be valid when a SIMP server can be booted from it, configured via `simp config`, and then bootstrapped via `simp bootstrap`. For CentOS 6 and CentOS 7:

1. Login to a machine that has Docker installed and the `docker` service running.

> ***Important***
>
> In our development environment, the version of Docker that is available with CentOS works best.

2. Checkout the `simp-core` project for the last SIMP release. For this discussion, we will assume it is `6.0.0-1`.

```
git clone https://github.com/simp/simp-core.git
cd simp-core
git fetch -t origin
git checkout tags/6.0.0-1
```

3. Create a `Puppetfile.tracking` file that contains the contents of `Puppetfile.stable` in which the URLs for the component and any of its updated dependencies have been updated to reference the versions under test.
4. Populate `simp-core/ISO` directory with CentOS6/7 distribution ISOs

```
mkdir ISO
cp /net/ISO/Distribution_ISOs/CentOS-6.9-x86_64-bin-DVD*.iso ISO/
cp /net/ISO/Distribution_ISOs/CentOS-7-x86_64-1708.iso ISO/
```

5. Build each ISO for CentOS 6 and CentOS 7. For example,

```
bundle update
SIMP_BUILD_docs=no \
SIMP_BUILD_verbose=yes \
SIMP_PKG_verbose=yes \
bundle exec rake beaker:suites[rpm_docker]
```

> ***Important***
>
> 1. By default, the `default.yml` for the `rpm_docker` suite builds an ISO for CentOS 7. You must manually edit the `default.yml` file to disable the `el7-build-server` instead of the `el6-build-server`, in order to create a CentOS 6 ISO.
> 2. The most reliable way to build each ISO is from a clean checkout of `simp-core`.

6. Use simp-packer to verify the SIMP ISO can be bootstrapped, when booted with the default options.

Verify the component works in an actual SIMP system

This is the *Eat Our Own Dogfood* soak test. It verifies that the component operates as expected on a typical SIMP system. For this verification, we install the component via R10K in the SIMP development environment:

1. Create a branch in the control repo for the version under test.
2. Use the module-portion of the `Puppetfile.tracking` from the ISO-build-verification step as the Puppetfile for the environment.
3. Deploy the environment using r10k. In this example our environment will be `simp_6_1_0_test`

```
/opt/puppetlabs/puppet/bin/r10k deploy environment simp_6_1_0_test -p
```

4. Assign nodes to the test environment using the installed ENC
5. Verify `puppet agent -t` successfully runs for each node assigned to the test environment.

Release to GitHub and Deploy to PuppetForge

Each SIMP component is configured to automatically create a GitHub release and push the release to PuppetForge, when an annotated tag is created for the GitHub project **and** the TravisCI tests for the annotated tag push succeed.

To create the releases from an annotated tag:

1. Clone the component repository and checkout the development branch to be tagged

```
git clone git@github.com:simp/pupmod-simp-iptables.git
cd pupmod-simp-iptables
git checkout master # this step isn't needed for master branch
```

2. Generate the changelog content

```
bundle update
bundle exec rake changelog_annotation > foo
```

3. Create the annotated tag. In this example the content of 'foo' is:

```
Release of 6.0.2

* Wed May 24 2017 Brandon Riden <brandon.riden@onyxpoint.com> - 6.0.2-0
```

```
  - Added a workaround for Puppet 4.10 type issues
    - There was a bug in Puppet where all lookup() Hash keys were being converted
      into Strings even if they were another data type
    - This is fixed in Puppet > 4.10.2 but this patch will remain for backwards
      compatibility
  - Update puppet dependency in metadata.json
  - Remove OBE pe dependency in metadata.json
```

```
git tag -a 6.0.2 -F foo
git push origin 6.0.2
```

> ***Note***
>
> For markdown-style changelogs, you will need to specify `--cleanup=whitespace` so comment headers are not stripped.

4. Verify TravisCi completes successfully

> ***Important***
>
> If any of the required TravisCI builds for the project fail, for example due to intermittent connectivity problems with GitHub, you can complete the release process by manually restarting the failed build on the Travis page for that build.

5. Verify release exists on GitHub. This release will have been created by `simp-auto`.

Other Puppet Module Release Procedures

This section will describe the release procedures for Puppet module projects for which SIMP is not the owner. In these procedures, the SIMP Team will release RPMs of these projects, using SIMP forks to which **no SIMP modifications have been made**. The purpose of these forks is simply to retain a backup copy of the official repositories in the case that the upstream repositories are compromised or taken down unexpectedly.

> ***Note***
>
> We **highly** recommend that you keep copies of all external repositories as a clone in your internal systems if you are deploying via `r10k` or Code Manager.

> ***Important***
>
> If the owner has made unreleased modifications to the project that are essential to SIMP *OR* the SIMP Team has an outstanding pull request for the project with essential changes, the SIMP Team must take ownership of this version of the Puppet module to release it. This is the only way for SIMP to release the modified version to PuppetForge.

Note

You can identify whether a Puppet module is owned by SIMP, by examining the outer-most `name` entry in the module's `metadata.json` file. The value for the `name` key will be of the form *<owner>-<module name>*.

Pre-Release Checklist

For each project, the verification required is to ensure the version desired has already been released to GitHub and PuppetForge by the project owner and has been used for testing SIMP components in unit (rspec), acceptance (beaker), and SIMP ISO validation (packer) tests:

1. Verify the version required has an official GitHub release.
2. Verify the version required has been released to PuppetForge.
3. Verify the `.fixtures.yml` and `metadata.json` for SIMP components that depend upon the component match the version being released.
4. Verify the `Puppetfile.tracking` file of the `simp-core` project match the version being released.

Build Signed RPM and Deploy to packagecloud

If a New RPM Needs to be Built

1. Build the RPM for the component that you wish to publish

```
git clone simp-core
git checkout master # or an appropriate branch
bundle update
bundle exec rake pkg:single[MODULE_NAME or PATH]
```

Note

If, for some reason, the above does not work, you can go into the target component and run `rake pkg:rpm`

The output will be in the `dist` directory of the targeted artifact

1. Pass the RPM over to an authorized signing team member who will sign it using `rpm --resign`

Publish to PackageCloud

- `package_cloud push simp-project/REPO_NAME/el/OS_MAJOR_VERSION /path/to/packages`

Ruby Gem Release Procedures

This section will decribe the release procedures for the SIMP Ruby gems used to build and test SIMP components. The relevant components include

- `rubygem-simp-beaker-helpers`
- `rubygem-simp-build-helpers`
- `rubygem-simp-rake-helpers`

- `rubygem-simp-rspec-puppet-facts`

> ***Note***
>
> `rubygem-simp-cli` is covered in *gsg-contributors_guide-other-iso-related-release-procedures*.

For demonstration purposes, we will be using the `simp-rake-helpers` project, which uses the `master` branch as its development branch.

Pre-Release Checklist

The bulk of the work to release a component is to verify that the component is ready for release. Below is the list of verifications that must be executed before proceeding with the release. If any of these steps fail, the problem identified must be fixed before you can proceed with the tag and release steps.

- Verify a release is warranted
- Verify the CHANGELOG
- Verify the component's dependencies
- Verify a Ruby gem can be created
- Verify unit tests pass
- Verify acceptance tests pass
- Verify gem works for SIMP projects

Verify a release is warranted

This check verifies a new release is warranted and the version has been properly updated:

1. Clone the component repository and checkout the development branch to be tagged

```
git clone https://github.com/simp/rubygem-simp-rake-helpers.git
cd rubygem-simp-rake-helpers
git checkout master # this step isn't needed for master branch
```

2. Manually compare manually the development branch with the last release tag. (The existing rake task `compare_latest_tag` won't necessarily work here.)

```
git fetch -t origin

# manually figure out which is last tag

git diff tags/<last release tag> --name-only

# manually verify mission-impacting changes have been
# made (i.e., changes that warrant a release) and the
# version has been updated in the CHANGELOG.md, version.rb
# and/or TBD file.
```

Verify the changelog

This check verifies that the changelog information is available and can be extracted

- Manually inspect the appropriate file (e.g., CHANGELOG.md) (The existing rake task `changelog_annotation` won't necessarily work here.)

Verify the component's dependencies

This check verifies that the component's dependencies are correct in the `Gemfile` and `<component>.gemspec`

- Manually inspect the `Gemfile` and `<component>.gemspec` to look for inconsistencies or missing runtime dependencies.

Verify a Ruby gem can be created

This check verifies that a Ruby gem can be created for this component:

```
bundle update
bundle exec rake pkg:gem
```

Verify unit tests pass

This check verifies that the component's unit tests have succeeded in TravisCI:

- Navigate to the project's TravisCI results page and verify the tests for the development branch to be tagged and released have passed. For our project, this page is https://travis-ci.org/simp/rubygem-simp-rake-helpers/branches

> ***Important***
>
> If the tests in TravisCI fail, you **must** fix them before proceeding. The automated release procedures will only succeed, if the unit tests succeed in TravisCI.

Verify acceptance tests pass

This check verifies that the component's acceptance tests have succeeded:

- Run the appropriate acceptance test rake task, if it exists. For this project, `rake -T` shows that `rake acceptance` is the appropriate task

```
bundle exec rake acceptance
```

> ***Note***
>
> If the GitLab instance for the project is configured and current (it is sync'd every 3 hours), you can look at the latest acceptance test results run by GitLab. For our project, the results would be at https://gitlab.com/simp/rubygem-simp-rake-helpers/pipelines.

Verify gem works for SIMP projects

This check verifies that SIMP components can use this gem for build and test tasks.

1. Install the gem you just built, locally.

```
rvm all do gem install dist/simp-rake-helpers-4.0.1.gem
```

2. Download the latest versions of most of the SIMP components using the `simp-core` project.

```
git clone https://github.com/simp/simp-core.git
cd simp-core
bundle update
bundle exec rake deps:checkout
```

3. If the major version number for the gem has increased, for the following projects, update their Gemfiles to permit the newer version
   - All projects in `src/assets/`
   - The `simp-doc` project in `src/doc`
   - All SIMP-owned projects in `src/puppet/modules/`
4. In each project listed above, execute the rake tasks affected by the changes. In this case, we assume the spec task was affected.

```
bundle update
bundle exec rake spec
```

Release To GitHub and Deploy to RubyGems.org

At this time, most but not all of the SIMP Ruby build and test gems are configured to automatically release from an annotated tag. So, this section will describe both the automated steps and the manual steps required to release SIMP Ruby gems to GitHub and RubyGems.org.

Common Release Steps

Most of the SIMP Ruby gems are configured to automatically create a GitHub release and push the release to RubyGems.org, when an annotated tag is created for the GitHub project **and** the TravisCI tests for the annotated tag push succeed.

To create the releases from an annotated tag:

1. Clone the component repository and checkout the development branch to be tagged

```
git clone git@github.com:simp/rubygem-simp-rake-helpers.git
cd rubygem-simp-rake-helpers
git checkout BRANCH # this step isn't needed for master branch
```

2. Generate the changelog content
   - `rake changelog_annotation > foo`
3. Create the annotated tag. In this example the content of `foo` is:

   Release of 4.0.1

   - Reverted the bundler pinning since it was causing too many issues on CI systems

```
git tag -a 4.0.1 -F foo
git push origin 4.0.1
```

> ***Note***
>
> For markdown-style changelogs, you will need to specify `--cleanup=whitespace` so comment headers are not stripped.

4. Verify TravisCi completes successfully

> ***Important***
>
> If any of the required TravisCI builds for the project fail, for example due to intermittent connectivity problems with GitHub, you can complete the release process by manually restarting the failed build on the Travis page for that build.

Automated Release Steps

This section applies to gems that have a `deploy` stage with a `releases` provider in their `.travis.yml` file.

1. Verify release exists on GitHub. This release will have been created by `simp-auto`.
2. Verify release exists on RubyGems.org.

Manual Release Steps

For any gem that has not been configured to automatically release from an annotated tag, you must manually release the gem.

To create the releases from an annotated tag:

1. Create a release of the annotated tag on GitHub.
   - Select the `Draft a new release` button.
   - Click in the `Tag version` box and then select the annotated release version from the drop-down menu.
   - Select the `Publish release` button. The changelog information for the annotated tag will automatically appear as the release notes.
2. Publish to RubyGems.org

> **Note**
>
> This requires that you have a GPG key in place that allows you to publish to RubyGems.org and is valid for the Gem that you are attempting to push.

   - Run `gem build simp-rake-helpers.gemspec`
   - Run `gem push simp-rake-helpers-4.0.1.gem`

Other ISO-Related Project Release Procedures

This section will describe the release procedures we use for the miscellaneous, non-Puppet-module components required to build a SIMP ISO. The relevant components include

- `rubygem-simp-cli`
- `simp-adapter`
- `simp-doc`
- `simp-environment`
- `simp-gpgkeys`
- `simp-rsync`
- `simp-utils`

For demonstration purposes, we will be using the `simp-adapter` project, which uses the `master` branch as its development branch.

Pre-Release Checklist

The bulk of the work to release each component is to verify that the component is ready for release. Below is the list of verifications that must be executed before proceeding with the release. If any of these steps fail, the problem identified must be fixed before you can proceed with the tag and release steps.

- Verify a release is warranted

- Verify the changelog
- Verify RPMs can be created
- Verify unit tests pass
- Verify acceptance tests pass
- Verify the component RPM upgrade succeeds
- Verify the component yields valid SIMP ISOs

Verify a release is warranted

The check verifies a new release is warranted and the version has been properly updated.

1. Clone the component repository and checkout the development branch to be tagged

```
git clone https://github.com/simp/simp-adapter.git
cd simp-adapter
git checkout master # this step isn't needed for master branch
```

2. Manually compare manually the development branch with the last release tag. (The existing rake task `compare_latest_tag` won't necessarily work here.)

```
git fetch -t origin

# manually figure out which is last tag

git diff tags/<last release tag> --name-only

# manually verify mission-impacting changes have been
# made (i.e., changes that warrant a release) and the
# version has been updated in the CHANGELOG, version.rb
# and/or build/<component>.spec file.
```

Verify the changelog

This check verifies the changelog information is available and can be extracted:

- Manually inspect the appropriate file (CHANGELOG or %changelog section of <component>.spec file). (The existing rake task `changelog_annotation` won't necessarily work here.)
- FIXME `simp-doc` has its own `CHANGELOG`, but requires the `Changelog.rst` from `simp-core` to be current as well. It may make more sense to move the `simp-doc` release into the instructions for releasing a SIMP ISO.

Verify RPMs can be created

This check verifies that an RPM can be generated for this module from `simp-core`:

1. Clone `simp-core`

```
git clone https://github.com/simp/simp-core.git``
```

2. Update the URL for the component under test `Puppetfile.tracking`, if needed

```
cd simp-core
vi Puppetfile.tracking
```

3. Build RPM

```
bundle update
bundle exec rake deps:checkout
bundle exec rake pkg:single[adapter]
```

Note

This command will build the RPM for the OS of the server on which it was executed.

Verify unit tests pass

This check verifies that the component's unit tests have succeeded in TravisCI:

- Navigate to the project's TravisCI results page and verify the tests for the development branch to be tagged and released have passed. For our project, this page is https://travis-ci.org/simp/simp-adapter/branches

Important

If the tests in TravisCI fail, you **must** fix them before proceeding. The automated release procedures will only succeed, if the unit tests succeed in TravisCI.

Verify acceptance tests pass

This check verifies that the component's acceptance tests have succeeded:

- Run the appropriate acceptance test rake task, if it exists. For this project, `rake beaker:suites` is the appropriate task

```
bundle exec rake beaker:suites
```

Note

If the GitLab instance for the project is configured and current (it is sync'd every 3 hours), you can look at the latest acceptance test results run by GitLab. For our project, the results would be at https://gitlab.com/simp/simp-adapter/pipelines.

Verify the component RPM upgrade succeeds

This check verifies that the RPM for this component can be used to upgrade the last full SIMP release. For both CentOS 6 and CentOS 7, do the following:

1. Bring up a CentOS server that was booted from the appropriate SIMP ISO and for which `simp config` and `simp bootstrap` has been run.

   ### Note

   If the VirtualBox for the last SIMP ISO was created by the simp-packer project, you can simply setup the appropriate VirtualBox network for that box and then bring up that bootstrapped image with `vagrant up`.

2. Copy the component RPM generated from the above RPM verification step to the server and install with yum. For example,

```
sudo yum install simp-adapter-0.0.3-0.el7.noarch.rpm
```

> ***Note***
>
> If the component requires updated dependencies, those RPMs will have to be built and installed at the same time.

3. Verify the `puppet agent` runs succeed on the Puppet master
   - login as root
   - execute `puppet agent -t`
4. Execute any other verifications unique to the component

Verify the component yields valid SIMP ISOs

This check verifies that with this component, valid SIMP ISOs for for CentoOS 6 and CentOS 7 can be built. An ISO is considered to be valid when a SIMP server can be booted from it, configured via `simp config`, and then bootstrapped via `simp bootstrap`. For CentOS 6 and CentOS 7:

1. Login to a machine that has Docker installed and the `docker` service running.

> ***Important***
>
> In our development environment, the version of Docker that is available with CentOS works best.

2. Checkout the `simp-core` project for the last SIMP release. For this discussion, we will assume it is `6.0.0-1`.

```
git clone https://github.com/simp/simp-core.git``
cd simp-core
git fetch -t origin
git checkout tags/6.0.0-1
```

3. Create a `Puppetfile.tracking` file that contains the contents of `Puppetfile.stable` in which the URLs for the component and any of its updated dependencies have been updated to reference the versions under test.
4. Populate `simp-core/ISO` directory with CentOS6/7 distribution ISOs

```
mkdir ISO
cp /net/ISO/Distribution_ISOs/CentOS-6.9-x86_64-bin-DVD*.iso ISO/
cp /net/ISO/Distribution_ISOs/CentOS-7-x86_64-1708.iso ISO/
```

5. Build each ISO for CentOS 6 and CentOS 7. For example,

```
bundle update
SIMP_BUILD_docs=no \
SIMP_BUILD_verbose=yes \
SIMP_PKG_verbose=yes \
bundle exec rake beaker:suites[rpm_docker]
```

> ***Important***
>
> 1. By default, the `default.yml` for the `rpm_docker` suite builds an ISO for CentOS 7. You must manually edit the `default.yml` file to disable the `el7-build-server` instead of the `el6-build-server`, in order to create a CentOS 6 ISO.
> 2. The most reliable way to build each ISO is from a clean checkout of `simp-core`.

6. Use simp-packer to verify the SIMP ISO can be bootstrapped, when booted with the default options.

Release to GitHub

At this time only one ISO-related SIMP project (`rubygem-simp-cli`) is configured to automatically release to GitHub. So, this section will decribe both the automated steps and the manual steps required to release the other ISO-related projects to GitHub.

Automated Release Steps

Some SIMP ISO-related project are configured to automatically create a GitHub release, when an annotated tag is created for the GitHub project **and** the TravisCI tests for the annotated tag push succeed. Such a project will contain a deploy step for the `releases` provider in its `.travis.yml` file.

To create the a release from an annotated tag:

1. Clone the component repository and checkout the development branch to be tagged

```
git clone git@github.com:simp/rubygem-simp-cli.git
cd rubygem-simp-cli
git checkout master # this step isn't needed for master branch
```

2. Generate the changelog content
   - Manually extract the changelog content from the `CHANGELOG.md`, `CHANGELOG`, or `build/<component>.spec` file and write into a file. In this example, the written file will be `foo`.
3. Create the annotated tag. In this example the content of 'foo' is:

```
Release of 4.0.4

* Mon Oct 16 2017 Trevor Vaughan <tvaughan@onyxpoint.com> - 4.0.4
  - Fix intermittent failure in RPM builds due to missing rubygems
```

```
git tag -a 4.0.4 -F foo
git push origin 4.0.4
```

> ***Note***
>
> For markdown-style changelogs, you will need to specify `--cleanup=whitespace` so comment headers are not stripped.

4. Verify TravisCi completes successfully

> ***Important***
>
> If any of the required TravisCI builds for the project fail, for example due to intermittent connectivity problems with GitHub, you can complete the release process by manually restarting the failed build on the Travis page for that build.

5. Verify release exists on GitHub. This release will have been created by `simp-auto`.

Manual Release Steps

Some SIMP ISO-related projects require manual steps to generate a GitHub release. None of these projects will contain a deploy step in its `.travis.yml` file.

To create the release from an annotated tag:

1. Clone the component repository and checkout the development branch to be tagged

```
git clone git@github.com:simp/simp-adapter.git
cd simp-adapter
git checkout master # this step isn't needed for master branch
```

2. Generate the changelog content
   - Manually extract the changelog content from the `build/<name>.spec`, file and write into a file. In this example, the written file will be `foo`.
3. Create the annotated tag. In this example the content of 'foo' is:

```
Release of 0.0.5

* Fri Oct 20 2017 Trevor Vaughan <tvaughan@onyxpoint.com> - 0.0.5-0
  - Fixed the Changelog dates
```

```
git tag -a 0.0.5 -F foo
git push origin 0.0.5
```

> ***Note***
>
> For markdown-style changelogs, you will need to specify `--cleanup=whitespace` so comment headers are not stripped.

4. Verify TravisCi completes successfully
5. Create a release of the annotated tag on GitHub.
   - Select the `Draft a new release` button.
   - Click in the `Tag version` box and then select the annotated release version from the drop-down menu.
   - Select the `Publish release` button. The changelog information for the annotated tag will automatically appear as the release notes.

Build Signed RPM and Deploy to packagecloud

Build Signed RPM and Deploy to packagecloud

If a New RPM Needs to be Built

1. Build the RPM for the component that you wish to publish

```
git clone simp-core
git checkout master # or an appropriate branch
bundle update
bundle exec rake pkg:single[MODULE_NAME or PATH]
```

> ***Note***
>
> If, for some reason, the above does not work, you can go into the target component and run `rake pkg:rpm`

The output will be in the `dist` directory of the targeted artifact

1. Pass the RPM over to an authorized signing team member who will sign it using `rpm --resign`

Publish to PackageCloud

- `package_cloud push simp-project/REPO_NAME/el/OS_MAJOR_VERSION /path/to/packages`

ISO Release Procedures

This section will describe the partially-automated, release procedures we use for SIMP ISOs.

Pre-Release Checklist

The bulk of the work to release both **EL** 6 and **EL** 7 versions of a SIMP ISO is to verify that each ISO is ready for release. Below is the list of verifications that must be executed **for each ISO**, before proceeding with the release of that ISO. If any of these steps fail, the problem identified must be fixed before you can proceed with the tag and release steps.

Update Policy Evaluation Response Reports

Since one of the main goals of SIMP is to assist with compliance of various standards, we should add a response to the latest security scans that we use.

Given that most scanners are only one view on the world and often are not flexible enough to meet all possible solutions to a given policy, it is expected that there will be explanations of both false positives as well as helpful material on why the SIMP framework is compliant for the benefit of our users.

These scans should be added, as applicable, to the *security-conop-evaluation-artifacts* section of the documentation.

Verify RPMs are available in PackageCloud

This check is to verify that all artifacts used to create the ISO exist as signed RPMs in PackageCloud. This will include:

- SIMP-owned Puppet modules
- Other Puppet modules
- SIMP utility RPMs (`rubygem-simp-cli`, `simp-adapter`, `simp-utils`, etc.)
- `simp-doc`
- SIMP application RPMs
- External vendor application RPMs
- OS RPMs

For nearly all the projects listed in `Puppetfile.tracking`, you can verify that the RPMs for those projects exist by executing the `pkg:check_published` Rake command:

1. Checkout the `simp-core` project.
   ```
   git clone https://github.com/simp/simp-core.git
   cd simp-core
   ```
2. Verify the `Puppetfile.tracking` file contains the component tags for the release.
3. Execute the `pkg:check_published` Rake command
   ```
   bundle exec rake pkg:check_published > check_published.out
   ```
4. Examine the `check_published.out` content to verify that, except for the `simp-doc` project, no projects lists `RPM Publish Required:` or `Git Release Tag Required:`. What you should see are lines such as:
   ```
   ...
   Found Existing Remote RPM: pupmod-simp-stunnel-6.1.0-0.noarch.rpm
   Found Existing Remote RPM: pupmod-simp-sudo-5.0.3-0.noarch.rpm
   Found Existing Remote RPM: pupmod-simp-sudosh-6.0.1-0.noarch.rpm
   ...
   ```

   > ***Important***
   >
   > If you see a message like `Warning:  Unable to generate build-specific YUM cache`, your results are invalid, as connection to PackageCloud failed.

5. Manually verify the appropriate `simp-doc` RPM exists at PackageCloud.

For the external vendor RPMs

- Upload all vendor RPMs to the `VERSION_Dependencies` repository in PackageCloud. Any existing RPMs will not be overwritten.
  - `package_cloud push simp-project/VERSION_Dependencies/el/OS_MAJOR_VERSION /path/to/packag`

> ***Warning***
>
> **DO NOT** push any Core Operating System RPMs up to PackageCloud, those should be retrieved from official vendor sources.

Verify a valid Puppetfile exists

This check is to verify that that `Puppetfile.tracking` file for the `simp-core` project is complete and accurate:

- It includes all the SIMP-owed Puppet modules, other Puppet modules that are dependencies of SIMP-owned Puppet modules, and utilities to configure the SIMP system when installed from ISO.
- The URL for each artifact corresponds to the tag for its signed, published RPM.

Verify the Changelog.rst

This check is to verify that the `simp-core` Changelog.rst has been updated:

- Manually inspect

Verify the dependencies.yaml

This check is to verify that `simp-core/build/rpm/dependencies.yaml` contains the correct adjustments to the RPM dependencies, obsoletes, requires, and/or release fields for any of the components listed in the `Puppetfile.tracking` file.

Manually inspect the file to verify there are entries for

- All non-SIMP Puppet modules that have more dependencies listed in their `metadata.json` files than are actually required on a SIMP system. Each entry must list all the relevant dependencies in a `:requires` element.
- Any component that has changed name (e.g. `pupmod-saz-timezone` changing to `pupmod-simp-timezone`). Each entry must list the package and version obsoleted in an `:obsoletes` element.
- Any component for which for which the RPM release field must be specified (e.g. a component with a RPM-packaging-only change). Each entry must list a `:requires` element.

Verify the simp-core RPMs can be created

This check verifies that an RPM can be generated for `simp-core`:

```
git clone https://github.com/simp/simp-core.git
cd simp-core/src/assets/simp
bundle update
bundle exec rake pkg:rpm
```

Note

This command will build the RPM for the OS of the server on which it was executed.

Verify simp-core tests pass

This check verifies that the `simp-core` unit and acceptance test have succeeded.

To verify that the `simp-core` unit tests have succeeded, examine the test results in TravisCI.

- Navigate to the project's TravisCI results page and verify the tests for the development branch to be tagged and released have passed. For our project, this page is https://travis-ci.org/simp/simp-core/branches

> ***Important***
>
> If the tests in TravisCI fail, you **must** fix them before proceeding. The automated release procedures will only succeed, if the unit tests succeed in TravisCI.

To verify that the `simp-core` acceptance tests have succeeded

1. Checkout the `simp-core` project for the last SIMP release.

```
git clone https://github.com/simp/simp-core.git
cd simp-core
```

2. Run the default `simp-core` acceptance tests

```
bundle update
bundle exec rake beaker:suites
```

> ***Note***
>
> If the GitLab instance for `simp-core` is current (it is sync'd every 3 hours), you can look at the latest acceptance test results run by GitLab, instead. The results will be at https://gitlab.com/simp/simp-core/pipelines.

Verify ISOs can be created

This check verifies that SIMP ISOs for CentOS 6 and CentOS 7 can be built from the local `simp-core` clone and RPMs pushed to PackageCloud. For CentOS 6 and CentOS 7:

1. Login to a machine that has Docker installed and the `docker` service running.

> ***Important***
>
> In our development environment, the version of Docker that is available with CentOS works best.

2. Checkout the `simp-core` project for the last SIMP release.

```
git clone https://github.com/simp/simp-core.git
cd simp-core
```

3. Populate `simp-core/ISO` directory with CentOS 6/7 distribution ISOs

```
mkdir ISO
cp /net/ISO/Distribution_ISOs/CentOS-6.9-x86_64-bin-DVD*.iso ISO/
cp /net/ISO/Distribution_ISOs/CentOS-7-x86_64-1708.iso ISO/
```

4. Build each ISO for CentOS 6 and CentOS 7. For example,

```
bundle update
SIMP_BUILD_docs=no \
SIMP_BUILD_verbose=yes \
SIMP_PKG_verbose=yes \
bundle exec rake beaker:suites[rpm_docker]
```

> ***Important***
>
> 1. By default, the `default.yml` for the `rpm_docker` suite builds an ISO for CentOS 7. You must manually edit the `default.yml` file to disable the `el7-build-server` instead of the `el6-build-server`, in order to create a CentOS 6 ISO.
> 2. The most reliable way to build each ISO is from a clean checkout of `simp-core`.

5. Verify none of the RPMs in the ISO that SIMP would have generated are signed by the SIMP development GPG key. For example, for a CentOS 7 build:

```
cd build/distributions/CentOS/7/x86_64/SIMP/RPMS/noarch

# The 7da6f216 key ID may change as the SIMP signing keys get updated over time
# The output of this command should be *EMPTY*
rpm -q --qf '%{NAME}-%{VERSION}-%{RELEASE} %{SIGPGP:pgpsig} %{SIGGPG:pgpsig}\n' -p * | grep
```

Verify SIMP ISO boot options work

This hefty check verifies that a server booted from the SIMP ISO can be bootstrapped for the 'simp' scenario and following boot options:

- Using default boot option
- Using disk encryption boot option
- Using FIPS disabled boot option
- Using disk encryption and FIPS disabled boot options
- Using simp-prompt option
- Using simp-prompt and disk encryption boot options
- Using simp-prompt and FIPS disabled boot options
- Using simp-prompt, disk encryption, and FIPS disabled boot options
- Using linux-min boot option
- Using linux-min and disk encryption boot options
- Using linux-min and FIPS disabled boot options
- Using linux-min, disk encryption, and FIPS disabled boot options

For the default boot options with/without encryption and the FIPS disabled boot option with/without encryption test cases, the simp-packer project is the easiest way to verify a SIMP VM can be booted from the ISO and bootstrapped. Otherwise, the check has to be done manually:

- Boot a VM with the SIMP ISO
- Select the appropriate boot options
- Once the server boots, login to the server as root
- Bootstrap the system

```
simp config
simp bootstrap
reboot
```

- Login to the server as root and run `puppet agent -t` until the results are stable
- Verify the server is/is not in FIPS mode by inspecting */proc/sys/crypto/fips_enabled*

- Verify the appropriate disk is/is not encrypted by executing

```
blkid
```

- Verify the appropriate disk partitioning

```
lsblk
```

> ***Important***
>
> For the `linux-min` test cases, the only verification required is verification that the server boots up.

Verify component interoperability

This check verifies, with `simp-core` and `pupmod-simp-simp` acceptance tests, that this aggregation of module versions interoperate. (These tests provide extensive, cross-component, integration tests.)

> ***Note***
>
> If `simp-core` and `pupmod-simp-simp` acceptance tests have effectively already passed on one of our continuous integration platforms (e.g., in GitLab), you can skip this painful step. However, you must be sure that the tests were run with the correct component versions.

1. Checkout the `simp-core` project.

```
git clone https://github.com/simp/simp-core.git
cd simp-core
```

2. Verify the `Puppetfile.tracking` file contains the component tags for the release.
3. Run the default `simp-core` acceptance tests

```
bundle update
bundle exec rake beaker:suites
```

4. Checkout the version of `pupmod-simp-simp` corresponding to this `simp-core` version

```
bundle exec rake deps:checkout
cd src/puppet/modules/pupmod-simp-simp
```

5. Create a `.fixtures.yml` file that sets the version of each dependency to the version contained in the `Puppetfile.tracking` file for this ISO release.
6. Run **all** the functioning acceptance tests with and without FIPS mode enabled

```
bundle update

BEAKER_fips=yes bundle exec rake beaker:suites
bundle exec rake beaker:suites

BEAKER_fips=yes bundle exec rake beaker:suites[base_apps]
bundle exec rake beaker:suites[base_apps]

BEAKER_fips=yes bundle exec rake beaker:suites[no_simp_server]
bundle exec rake beaker:suites[no_simp_server]

BEAKER_fips=yes bundle exec rake beaker:suites[scenario_one_shot]
bundle exec rake beaker:suites[scenario_one_shot]
```

```
BEAKER_fips=yes bundle exec rake beaker:suites[scenario_poss]
bundle exec rake beaker:suites[scenario_poss]

BEAKER_fips=yes bundle exec rake beaker:suites[scenario_remote_access]
bundle exec rake beaker:suites[scenario_remote_access]
```

Verify otherwise untested capabilities

This check verifies that all other major capabilities (not otherwise tested in acceptance/simp-packer tests) do function as advertised:

> ### *Note*
>
> In order to speed time to market, the goal is to automate as many of these manual tests as possible!

- A SIMP client can be PXE booted using the kickstart files from the SIMP ISO
- A SIMP client can use the SIMP server for DNS
- A SIMP ISO can be bootstrapped for the 'simp-lite' scenario with default boot options
- A 'simp-lite' client operates with a SIMP server
  - login operations (PAM, LDAP, local user)
  - NFS operations (home directory)
  - logging operations (rsyslog)
  - auditing operations
- A SIMP ISO can be bootstrapped for the 'poss' scenario with default boot options
- A 'simp-poss' client operates with a SIMP server
- The SIMP server can be converted from FIPS enabled to FIPS disabled mode.
- The SIMP server can be converted from Selinux enforcing to Selinux permissive.
- The SIMP server can be converted from Selinux permissive to Selinux enforcing.
- A local user with sudo privileges can be created and login to both the SIMP server and client on CentOS 6 and CentOS 7.
- An LDAP user user in the `administrators` group can login to both the SIMP server and client on CentOS 6 and CentOS 7.
- Local and LDAP users can change their passwords on both the SIMP server and client on CentOS 6 and CentOS 7.
- The Rsyslog rules from `simp_rsyslog`, `syslog` and SIMP application modules (`aide`, `sudosh`, etc.) result in application log messages being written to the correct local and remote log files.

> ### *Note*
>
> Although the `simp_rsyslog` and `syslog` modules have excellent acceptance tests, neither has a full-system test to verify integration with actual log producers. The tests for these modules use `logger` as a mock message sender.

- The compliance map reports for a full SIMP system are accurate.
  - No reports list non-compliant configuration that is really a parameter mismatches. (Parameter tested differs from parameter that should have been tested; value tested differs from actual values allowed, etc.)
  - SIMP server and SIMP client reports are generated.
- `simp-utils` executables that are not tested otherwise work as advertised
  - `unpack_dvd`
  - `gen_ldap_update`
  - `updaterepos`
- The *howto-guides* are still correct.

Verify SIMP server RPM install

This check verifies that CentOS 6 and CentOS 7 SIMP servers can be installed using the set of RPMs contained in the SIMP ISOs The verification steps largely follow the details in *gsg-installing_simp_from_a_repository*. All RPMs except the `simp-core` RPM should be able to be pulled from PackageCloud.

Verify SIMP server RPM upgrade

This check verifies that the set of RPMs in the SIMP ISO can upgrade the last full SIMP release.

1. Bring up a CentOS server that was booted from the appropriate SIMP ISO and for which `simp config` and `simp bootstrap` has been run.

   > **Note**
   >
   > If the VirtualBox for the last SIMP ISO was created by the simp-packer project, you can simply setup the appropriate VirtualBox network for that box and then bring up that bootstrapped image with `vagrant up`.

2. Copy the SIMP and system RPMs packaged in the SIMP ISO to the server and install with yum.
   - FIXME Should put RPMs into appropriate updates repos, run something like the following

     ```
     cd <updates dir>
     createrepo .
     chown -R root.apache ./*
     find . -type f -exec chmod 640 {} \;
     find . -type d -exec chmod 750 {} \;
     yum clean all;
     yum make cache
     yum update
     ```
3. Verify `puppet agent -t` runs cleanly
4. Verify no custom content is removed by the upgrade (e.g., `environments/simp/modules/site/manifests`, content in `environments/simp/hieradata`)

Verify SIMP server R10K install

This check verifies that CentOS 6 and CentOS 7 SIMP servers can be installed via **`r10k`**. Since this capability is already automatically tested in a `simp-core` acceptance test, all verification is handled by Verify simp-core tests pass.

Release simp-core *to GitHub and PuppetForge*

simp-core is configured to to automatically create a GitHub release and push the (meta-module) release to PuppetForge, when an annotated tag is created for the GitHub project **and** the TravisCI tests for the annotated tag push succeed.

To create the releases from an annotated tag:

1. Clone the component repository and checkout the development branch to be tagged

```
git clone git@github.com:simp/simp-core.git
cd simp-core
git checkout master # this step isn't needed for master branch
```

2. Create the annotated tag for the release. In this example, we are assuming the version is 6.1.0 and we are using the full Changelog.rst content.

```
git tag -a 6.0.2 -F Changelog.rst --cleanup--whitespace
git push origin 6.0.2
```

3. Verify TravisCi completes successfully

> ***Important***
>
> If any of the required TravisCI builds for the project fail, for example due to intermittent connectivity problems with GitHub, you can complete the release process by manually restarting the failed build on the Travis page for that build.

4. Verify release exists on GitHub. This release will have been created by simp-auto.

Build Signed simp-core RPM and Deploy to packagecloud

> ***Note***
>
> For simp-core, the pkg:single path will need to be used. Specifically, src/assets/simp

Build Signed RPM and Deploy to packagecloud

If a New RPM Needs to be Built

1. Build the RPM for the component that you wish to publish

```
git clone simp-core
git checkout master # or an appropriate branch
bundle update
bundle exec rake pkg:single[MODULE_NAME or PATH]
```

> ***Note***
>
> If, for some reason, the above does not work, you can go into the target component and run rake pkg:rpm
>
> The output will be in the dist directory of the targeted artifact

1. Pass the RPM over to an authorized signing team member who will sign it using `rpm --resign`

Publish to PackageCloud

- `package_cloud push simp-project/REPO_NAME/el/OS_MAJOR_VERSION /path/to/packages`

Build Final ISO and Deploy to simp-project

Building the Final ISO

The `build::auto` Rake task will pull all upstream published RPMs for any repositories that are listed as part of the target distribution `yum_repos` metadata.

The final ISO should be built from published RPMs by running `SIMP_BUILD_docs=yes rake build:auto[<path to ISOs>]` on the **same operating system version for which you are building**.

The `rpm_docker` acceptance test has good working examples of this process.

> ***Important***
>
> Validate that no RPMs that were included into the ISO were signed by the generated development GPG key. If they were, then there is a disconnect between the published RPMs and the local component repository versions.

Publishing to simp-project.com

The final ISO should be provided to personnel with upload access to the `ISO/SIMP` directory of `https://simp-project.com` for final delivery.

Notify Mailing List

Upon release of a new version of SIMP, an e-mail should be sent to the following mailing lists:

- simp-announce@googlegroups.com
- simp-users@googlegroups.com
- simp-dev@googlegroups.com

The standard text should be something like the following (feel free to edit with any pertinent information and update all of the links).

The standard subject is: **SIMP {VERSION} Has Been Released!**

> ***Warning***
>
> Be 100% sure that all links work prior to sending the message!

Release Candidate/Alpha/Beta

All,

> We've just dropped the {first|second|etc...} Release Candidate for SIMP {VERSION} and would appreciate any feedback that you can provide.
>
> IMPORTANT: Please read the {old version} to {new version} upgrade guide in detail!
>
> The repositories over at PackageCloud have been updated and a release repository has been added to the archive server.
>
> You can also download an ISO if you want to experiment with the new features from a fresh system.
>
> Thanks,
>
> {Your Name}

Final Release

> All,
>
> We're pleased to announce the general availability of SIMP {VERSION}!
>
> IMPORTANT: Please read the {old version} to {new version} upgrade guide in detail!
>
> The repositories over at PackageCloud have been updated and a release repository has been added to the archive server.
>
> You can also download an ISO if you need a clean installation.
>
> Thanks,
>
> {Your Name}

Testing on FIPS Systems

If you're running a system that requires compliance with **`NIST 800-53`** or **`NIST 800-171`**, you may find that having your system **`FIPS`**-enabled is causing your workflow to simply fall apart.

Since we try to eat our own dog food, we try to develop on SIMP as much is as practical and have the following advice that works at the time of writing this document.

Many of the tools that we use are getting better, and we have been diligent about filing bugs with projects that fail to meet the requirements set out by FIPS or which simply crash due to being run on a FIPS enabled system. We do understand that not all operations require FIPS security but, unfortunately, the underlying software simply can't tell whether an algorithm is being used for security or convenience.

Bundler

Bundler is probably the first hurdle that you will encounter.

There is an original bug that we filed that has a fix released in Bundler 1.14.X. While this has worked for us (and is what we recommend), apparently there were some issues with the patch and it was reverted. Likewise, a new bug has been filed that is tracking current progress and we have faith that the team will get it fully fixed in the near future.

To pin your runs to a FIPS-compatible Bundler, you will need to both install a non-crashing version, as well as ensure that you always use that version during your runs.

A simple method for doing this would be to do the following:

```
gem install bundler -v 1.14.6
alias bundle='bundle _1.14.6_'
```

RSpec-Puppet

There is one change that you need to make to your `spec/spec_helper.rb` file to ensure that `rspec` does not attempt to use MD5 checksums.

You simply need to add something like the following to your `RSpec.configure` section:

```
RSpec.configure do |c|
  c.before(:each) do
    Puppet[:digest_algorithm] = 'sha256'
  end
end
```

Useful Resources

- GitHub Guides
- TravisCI
- SIMP Project Status Links
  - Open Changes
  - Changes that need attention
  - Failing Changes in TravisCI
  - Pending Changes
  - Merged Changes

SIMP Security Concepts

Contents:

Introduction

This manual describes the security concepts of the SIMP system. The system was originally designed to meet a specific set of technical security controls using industry best practices and has been modified recently to meet as many of the security controls provided by the National Institute of Standards and Technology's (`NIST`) special publication 800-53 as possible.

This manual outlines three categories of security:

- **Technical Architecture**: discusses the technical approaches to securing the system
- **Operational Security**: discusses the security of SIMP in an operational setting
- **Information System Management**: discusses how SIMP helps achieve security in terms of system management

A brief discussion of how the SIMP system helps achieve categories of controls is provided; additional technical details regarding each control can be found in the *SIMP_Security_Control_Mapping*.

When possible, the NIST security control identifier will be found at the end of a concept to provide the reader with a reference to the specific control that is being discussed. The identifier is written as [AB-X(Y)], where A is the control family, X is the control section, and Y is the control enhancement.

Note

At present, this document will **not** be mapped to any additional standards since there are available mappings of the 800-53 to various other security frameworks.

If you believe that we are missing anything in particular, please file a bug!

Technical Security

This chapter contains SIMP security concepts that are related to the technical security controls described in **NIST 800-53**.

Identification and Authentication

This section addresses the identification and authentication of users and devices.

User Identification and Authentication

Identification and authentication of system and service users can occur at either the **Operating System** level or globally in the SIMP architecture. While local accounts and groups can be created manually, the SIMP team suggests adding users using the native Puppet user and group types. System users can authenticate their access using Secure Shell (SSH) keys or passwords. For more centralized control, identify and authenticate users by using the Lightweight Directory Access Protocol (**LDAP**). [*IA-2*]

The SIMP team recommends using **LDAP** as the primary source for user management and provides a functional default OpenLDAP configuration for this purpose. **LDAP** and Pluggable Authentication Modules (**PAM**) work together closely and, with the default SIMP configuration, the PAM settings are enforced on top of the LDAP settings for two layers of control. Due to this partnership, items such as account lockouts may need to be reset on both the local system and the LDAP server. If the suggested settings in the SIMP-provided default LDAP Directory Interchange Formats (**LDIF**) are not used, implementations must ensure that security is maintained through manual procedures. Use of group accounts for users is strongly discouraged. System services may need to have accounts, but all of these should be managed by Puppet using the user and group native types. [*IA-2 (5)*].

Device Identification and Authentication

Devices are identified by a Media Access Control (**MAC**) address prior to receiving an **IP** address via the Dynamic Host Configuration Protocol (**DHCP**). In the default SIMP architecture, **IP** addresses are fixed mappings to their associated **MAC** address (i.e., not assigned dynamically). There is no authentication for the binding of **MAC** addresses to **IP** addresses due to the nature of the **DHCP** protocol.

Device authentication occurs through the mapping of the MAC to the IP through the internally controlled DHCP and the mapping of the IP to the host name through the internally controlled Domain Name System (DNS) service for each individual Puppet client. After kickstart, each client system generates an internal cryptographic identifier and communicates that information with the Puppet server to be approved by an administrator at a later time. All further communication between the Puppet server and the clients over the Puppet protocol is encrypted subsequently and authenticated with this identifier. Automatic approval can be set up in tightly controlled environments; however, this option is not suggested for open environments. [*IA-3*, *IA-3 (3)*]

Identifier Management

Managing user identifiers (also known as user names) involves administrative procedures that are unique for each implementation. Disabling unused local accounts is the only control that SIMP can enforce technologically. In this case, if an account has an expired password that has not been changed 35 days after expiration, the account will be disabled. If a user does not have a password (e.g., he or she only authenticates with SSH keys), then there is no inherent technological mechanism for enforcement due to the nature of the software. [*IA-4e.*]

Authenticator Management

Authenticators for users are passwords and/or **SSH** keys; the management of each is implementation specific. SSH keys do not expire; therefore, implementations must provide a procedure for removing invalid keys. Removing public keys from LDAP is one practical solution.

When using passwords, local and LDAP passwords provided for users should be set to change at first login. This is the default in the SIMP-provided LDIFs. Once a user attempts to change a password, the settings in PAM and LDAP enforce complexity requirements.

For the default password complexity rules see the *faq-password-complexity* FAQ.

[*IA-5*, *IA-5 (1)*, *IA-5 (4)*]

Password aging and history is enforced through a combination of **PAM** and **LDAP**. By default, the previous **24** passwords cannot be reused.

[*IA-5 (1)(e)*]

There are a number of default passwords in SIMP that are required for installation. Each implementation requires the user to change the default passwords and protect the new passwords. In addition, there are embedded passwords within the SIMP system that are used due to a lack of software-supported alternatives.

Please see the *simp-user-guide* for additional information.

Access Control

This section describes the various levels of access control, including account management, access enforcement, information flow enforcement, separation of duties, least privilege, session controls, permitted actions without identification and authentication, security attributes, and remote access.

Account Management

Account management procedures should be created and maintained for each implementation of SIMP. The procedures should include the information listed in **NIST 800-53** control *AC-2*. SIMP has the mechanisms in place to enforce most account management policies. The mechanisms for account management have several default settings including:

- Central account management using OpenLDAP. [*AC-2 (1)*]
- Password expiration.
  - Local accounts expire 35 days after password expiration. [*AC-2 (3)*]
  - **LDAP** accounts do not expire automatically due to inactivity; implementations should audit LDAP accounts regularly.
- Auditing of administrative actions to capture local account creation and modifications to **LDAP** accounts is done via the `/var/log/slapd_audit.log` file and `/var/log/audit/audit.log` for local accounts. [*AC-2 (4)*]
- Shell sessions timeout after **15 minutes** of inactivity. [*AC-2 (5)*]
  - This can be circumvented by running a command that opens an endless pipe such as `/bin/cat`. However, this command cannot be enforced more heavily due to the high likelihood of breaking system applications. If the optional gnome module is used, the GNOME screen saver will lock the screen after **15 minutes** of inactivity.
- Assignment of users into groups locally or centrally via LDAP. [*AC-2 (7)*]
  - By default, SIMP will have an administrators groups that has the ability to run `sudosh`. Implementations should further define administrators or user groups and limit them with the Puppet `sudo` class.

Access Enforcement

SIMP uses the implementation of Discretionary Access Control (**DAC**) that is native to Linux. Specific file permissions have been assigned based on published security guidance for Red Hat, CentOS, and UNIX.

Default permissions on files created by users are enforced with user file access mask settings (using the `umask` command) that allow only the owner to read and write to the file. Implementations may further extend the access control in UNIX by restricting access to application files or using the file Access Control List (**`ACL`**) commands `getfacl` and `setacl`. Users of SIMP should not change file permissions on operating system files as it may decrease the overall security of the system. If a group needs access to a particular file or directory, use the `setfacl` command to allow the necessary access without lessening the permissions on the system. [*AC-3*]

Information Flow Enforcement

`IPTables` on each SIMP system is controlled by the IPTables Puppet module. When developing a new module, the IPTables rules needed for an application should be included with the module by calling the appropriate methods from the IPTables module. The end result should be a running IPTables rule set that includes the default SIMP rules and any rules needed for applications. The default communications allowed are included in *default_server_ports* and *default_client_ports*. [*AC-4*]

Default Server Ports

Application	Direction	Protocol	Transport	Ports	Comment
Puppet	Localhost	HTTP	TCP	8140	The port upon which the Puppet master listens for client connections via Apache
PuppetCA	In	HTTPS	TCP	8141	This is used to ensure that Apache can verify all certificates from external systems properly prior to allowing access to Puppet.
Apache/YUM	In	HTTP	TCP	443	This is used for YUM and is encrypted using https.
DHCPD	In	DHCP/BOOTP	TCP/UDP	546,547	DHCP pooling is disabled by default and should only be used if the implementation requires the use of this protocol.
TFTP	In	TFTP	TCP/UDP	69	This is used for kickstart. It could also be used to update network devices. TFTP does not support encryption.
rsyslog	Out	syslog	TCP/UDP	6514	This is encrypted when communicating with a SIMP syslog server (not installed by default).

named	In/Out	DNS	TCP/UDP	53	Inbound connections happen to the locally managed hosts. Outbound connections happen to other domains per the normal operations of DNS.
NTPD	Out	NTP	TCP/UDP	123	Only connects to an external time source by default.
SSHD	In	SSH	TCP	22	SSH is always allowed from any source IP by default.
stunnel	In	TLS	TCP	8730	Stunnel is a protected connection for rsyncing configuration files to Puppet clients.
rsync	Localhost	RSYNC	TCP	873	This accepts connections to the localhost and forwards through Stunnel.
LDAP	In	LDAP	TCP	389	Connections are protected by bi-directional, authenticated encryption.
LDAPS	In	LDAPS	TCP	636	Used for LDAP over SSL.

Default Client Ports

Application	Direction	Protocol	Transport	Ports	Comment
Puppet	Out	HTTPS	TCP	8140	Communications to the Puppet server.
rsyslog	Out	syslog	TCP/UDP	6514	This is encrypted when communicating with a SIMP syslog server.
DNS Client	Out	DNS	TCP/UDP	53	Normal name resolution.
NTPD	Out	NTP	TCP/UDP	123	Only connects to an external time source by default.
SSHD	In	SSH	TCP	22	SSH is allowed from any source IP by default.
LDAP	Out	LDAP	TCP	389	Connections are protected by bi-directional authenticated encryption.

Separation of Duties

SIMP enforces separation of duties using account groups. Groups are created with each implementation to separate roles or duties properly. The SIMP team recommends that this management be done using the **posixGroup** object in **LDAP** for full **OS** support. [*AC-5*]

Least Privilege

SIMP does not allow `root` to directly **SSH** into a system. Direct access to the `root` user must occur via a console (or at a virtual instance of the physical console) to log on. Otherwise, users must log on as themselves and perform privileged commands using `sudo` or `sudosh`. [*AC-6*]

NIST 800-53 least privilege security controls give people access to objects only as needed. SIMP provides only the needed software, services, and ports to allow the system to be functional and scalable. The system then relies on a given implementation to perform proper account management and user role assignments. [*AC-6*]

Session Controls

SIMP provides a number of security features for sessions. These features include:

- Accounts are locked after **five** invalid log on attempts over a **15 minute** period. The account is then locked for **15 minutes**. No administrator action is required to unlock an account. [*AC-7*]
- System banners are presented to a user both before and after logging on. The default banner should be customized for each implementation. [*AC-8*]
- After a successful log on, the date, time, and source of the last log on is presented to the user. The number of failed log on attempts since the last log on is also provided. [*AC-9* and *AC-9 (1)*]
- A limit of **10** concurrent SSH sessions are allowed per user. This can be further limited if an implementation decides it is set too high. Given the way SSH is used in most operational settings, this default value is reasonable. [*AC-10*]
- Session lock only applies if the `windowmanager::gnome` module is used. Sessions lock automatically after **15 minutes** of inactivity. Users must authenticate their access with valid credentials to reestablish a session. [*AC-11*]

Permitted Actions Without Identification and Authentication

SIMP has a number of applications that do not require both identification and authentication. These services are listed below along with an explanation of why these aspects are not required. Implementations should include any additional services that do require identification and/or authentication. [*AC-14*]

Service/Application	Rationale
TFTP	TFTP is a simple file transfer application that, in the SIMP environment, does not allow for writing to the files being accessed. This application is primarily used to support the Preboot Execution Environment (PXE) booting of hosts and the updating of network devices. There is no option to authenticate systems at this level by protocol design. TFTP is limited to a user's local subnet using IPtables and is enforced additionally with TCPWrappers.

DHCP	By default, system IP addresses are not pooled, but are rather statically assigned to a client, which is identified by the MAC address. DHCP is limited to the local subnet.
Apache/YUM	RPMs are stored in a directory for systems to use for both kickstart and package updating. Sensitive information should never be stored here. Apache/YUM is limited to the local subnet.
DNS	The DNS protocol does not require identification nor authentication. DNS is limited to the local subnet.

Table: Actions Without Identification and Authentication

Security Attributes

`SELinux` is fully enforcing, in targeted mode, in SIMP. SELinux is an implementation of **`Mandatory Access Control`**. It can be set to enforcing mode during the SIMP configuration or turned on at a later time. All of the SIMP packaged modules have been designed to work with SELinux set to enforcing. [*AC-16*]

Remote Access

Remote access in SIMP is performed over **`SSH`**, specifically using the OpenSSH software. OpenSSH provides both confidentiality and integrity of remote access sessions. The SSH **`IPTables`** rules allow connections from any host. SSH relies on other Linux mechanisms to provide identification and authentication of a user. As discussed in the auditing section, user actions are audited with the audit daemon (`auditd`) and **`sudosh`**. [*AC-17*]

Systems and Communications Protection

The following sections provide information regarding application partitioning, shared resources, and various levels of protection for systems and communications.

User and Administration Application Separation (Application Partitioning)

SIMP can be used in a variety of ways. The most common is a platform for hosting other services or applications. In that case, there are only administrative users present. Users with accounts will be considered as a type of privileged user.

SIMP can also be used as a platform for workstations or general users performing non-administrative activities. In both cases, general users with accounts on an individual host are allowed access to the host using the `pam::access` module, so long as they have an account on the target host. No user may perform or have access to administrative functions unless given `sudo` or **`sudosh`** privileges via Puppet.

Shared Resources

There are several layers of access control that prevent the unauthorized sharing of resources in SIMP. Account access, operating system **`DAC`** settings, and the use of **`PKI`** collectively prevent resources from being shared in ways that were not intended. [*SC-4*]

Denial of Service Protection

SIMP has limited ability to prevent or limit the effects of Denial of Service (**DoS**) attacks. The primary measures in place are to drop improperly formatted packets using **IPTables** and Kernel configurations such as **SYN cookies**. [*SC-5*]

Boundary Protection

SIMP does not provide boundary protection. [SC-7]

Transmission Security

SIMP traffic is protected with protocols that provide confidentiality and integrity of data while in transit. The tables in *Flow_Enforcement* describe the protocols used to encrypt traffic and explain the protocols that cannot be protected at the transmission layer. **SSH**, and **TLS** all provide data transmission integrity and confidentiality. The software that controls them on Red Hat and CentOS are OpenSSH and OpenSSL. The SIMP team takes industry guidance into consideration when configuring these services. For example, the list the cryptographic ciphers available is limited to the highest ciphers that SIMP needs. All others are disabled. [*SC-8*, *SC-9*, *SC-23*, *SC-7*]

Single User Mode

SIMP systems have a password requirement for single user mode. In the event maintenance needs to be performed at a system console, users must be in possession of the `root` password before they can be authenticated. Bootloader passwords are also set to prevent unauthorized modifications to boot parameters. [*SC-24*]

PKI and Cryptography

SIMP has two native certificate authorities. The first is known as *Fake CA*. A local certificate authority is used to create properly formed server certificates if an implementation does not have other means of obtaining them. Many SIMP services require certificates; therefore, SIMP provides this tool for testing or for situations where other certificates are not available. The second certificate authority, *Puppet CA*, is built into Puppet. Puppet creates, distributes, and manages certificates that are specifically for Puppet.

The *Fake CA* certificates should be replaced with your own hardware-generated certificates if at all possible. The *Puppet CA* may be replaced but please understand all ramifications to the infrastructure before doing so.

More information on the Puppet CA can be found in the Puppet Labs security documentation. [*SC-17*, *SC-13*]

> ***Warning***
>
> Fake CA certificates should not be used in an operational setting unless no better options are available.

Mobile Code

SIMP does not use mobile code; however, there are not any particular tools that will prevent its use. [*SC-18*]

Protection of Information at Rest

SIMP provides the capability to enable Full Disk Encryption (FDE) by default. However, in the interest of automated reboots, the initial **randomly generated** key is baked into the `initrd`. Please see the *ig-disk-encryption* section of the Installation Guide for details. [*SC-28*]

Audit and Accountability

This section discusses the content, storage, and protection of auditable events.

Auditable Events

`Auditd` and `Rsyslog` provide the foundation for SIMP auditing. `Auditd` performs the majority of the security-related events; however, other Linux logs also have security information in them and are captured using `rsyslog`.

The default auditable events for SIMP were developed based on several industry best practices including those from the SCAP Security Guide and several government configuration guides. The suggested rules by those guides were fine-tuned so the audit daemon would not fill logs with useless records or reduce performance. These guides should be referenced for a detailed explanation of why rules are applied. Additional justification can be found in the comments of the SIMP audit rules found in the appendix of this guide. [*AU-2*]

The SIMP development team reviews every release of the major security guides for updated auditable events suggestions. Each of those suggestions is reviewed and applied if deemed applicable. [*AU-2 (3)*]

Privileged commands are audited as part of the SIMP auditing configuration. This is accomplished by monitoring `sudo` commands with `auditd`. The output of session interaction for administrators that use **`sudosh`** are also logged. Each `sudosh` session can be reviewed using `sudosh-replay` and are also sent to `rsyslog`. [*AU-2 (4)*]

Content of Audit Records

Audit records capture the following information [*AU-3*]:

- Date and Time
- UID and GID of the user performing the action
- Command
- Event ID
- Key
- Node Hostname/IP Address
- Login Session ID
- Executable

Audit Storage

Audit logs are stored locally on a separate partition in the `/var/log` directory. The size of this partition is configurable. Other default audit storage configurations include:

- A syslog log is written when the audit partition has **75MB** free. (This can be changed to e-mail, if an e-mail infrastructure is in place.) [*AU-5a.*, *AU-5 (1)*]
- The log file rotates once it reaches **30MB**.

Audit Reduction and Response

SIMP provides a means to capture the proper information for audit records and stores them centrally. Each implementation must decide and document how it reduces, analyzes, and responds to audit events. [*AU-5*]

`Auditd`, like all services in SIMP, is controlled by Puppet. Stopping the service without disabling Puppet means the service will always be started automatically during a Puppet run. The files that control the audit configuration will also revert to their original state if changed manually on a client node. In the

event `auditd` fails, the system will continue to operate. Several security guides have suggested that the system should shut down if `auditd` fails for any reason. To prevent operational issues, SIMP will not shut down, but will provide an alert via `syslog` when this happens. [*AU-5 (1)*]

SIMP also comes with an optional module for the Elasticsearch/Logstash/Grafana (ELG) stack. These three open source tools can be combined to parse, index, and visualize logs. There are also SIMP provided dashboards for the Kibana web interface. Implementations can build their own dashboards to meet local security or functional needs for log reduction and management. [*AU-6*]

See *Elasticsearch, Logstash, and Grafana* for more information.

Protection of Audit Information

The primary means of protecting the audit logs is through the use of file permissions. Audit records are stored in the `/var/log` directory and can only be accessed by `root`. Audit logs are rotated off daily if the implementation has not developed a way of offloading the logs to another location where they can be backed up. Lastly, if the `rsyslog::stock::log_server` module is implemented, logs are transmitted to the log server over a TLS protected link.

Time Synchronization

Each SIMP client (including the Puppet Master) has `ntpd` enabled by default. Part of the installation directs the clients to a time server. If no servers are available, the SIMP clients can use the Puppet Master as the central time source. Audit logs receive their time stamp from the local server's system clock; therefore, the SIMP client must be connected to a central time source for timestamps in audit logs to be accurate.

Operational Security

This chapter contains SIMP security concepts that are related to the operational security controls in **`NIST 800-53`**.

Configuration Management

This section describes the management of various configurations within SIMP.

Baseline Configurations

SIMP baselines include configuration settings and Puppet modules. Currently, baselines are maintained for both Red Hat/CentOS 6.x, and Red Hat/CentOS 7.x. Each configuration item that is managed by a Puppet module has an RPM installed on the Puppet Master in the form of `pupmod-name-x.x.x-x`. This process allows for one main SIMP baseline to be maintained and modules to be upgraded easily. An overall SIMP RPM is also installed on the Puppet Master, which denotes the version number of SIMP that is installed. [*CM-2*, *CM-2 (2)*, *CM-2 (3)*, *CM-6*]

SIMP installs a minimal set of **`RPM`** packages, which can be found in the kickstart files on the ISO. RPMs, services, and IPTables rules all use a whitelist stance for allowing access or installation. [*CM-2 (5)*]

- Additional RPMs must be installed by each implementation.
- Services must be declared explicitly or they will be disabled by Puppet
- IPTables rules must allow a service explicitly.

Managing Configuration Changes

Configuration change approvals are managed by each implementation; SIMP only provides the mechanisms to apply changes on clients. A combination of Puppet, rsync, and **`YUM`** is used to apply those changes across any number of target Puppet clients. All changes made are audited with `auditd` or are logged to via `syslog`. [*CM-3a.*, *CM-3 (3)*]

Linux systems are made up of hundreds of configuration files that can contain numerous of settings. SIMP does not make an attempt to manage all of the settings in every file. Instead, critical operating system files or files that need to be controlled centrally are managed. Implementations can manage additional files if they are deemed necessary. [*CM-6*]

Security Verification and Flaw Remediation

SIMP cannot detect flaws automatically; each implementation is responsible for tracking flaws. However, SIMP provides a way for flaws to be fixed across all clients. One or all of the following can help automate flaw remediation [*CM-6*, *SI-2*, *SI-2 (1)*, *SI-2 (4)*]:

- **Puppet:**
  - Apply a configuration change to files that are managed by Puppet.
- **rsync:**
  - Use this mechanism to deliver a file to a client. This can be used with or without Puppet to synchronize files.
- **YUM:**
  - Update packages nightly with YUM. Placing an updated package in YUM and running a YUM update manually, or allowing time for the cron job to run, will ensure packages on all clients are updated. Otherwise, a cron job will perform a daily update of packages with YUM.
- **MCollective:**
  - Allow users to execute **specific** commands across large numbers of nodes in an auditable, distributed, and scalable, fashion.

The extent of security verification that is performed currently is based on changes to files that Puppet or the Advanced Intrusion Detection Environment (AIDE) provides. There are also Security Content Automation Protocol (SCAP) profiles available from the SCAP-Security-Guide project that check security configuration settings. [*SI-6*]

Malicious Code Protection

For most environments, SIMP will use ClamAV to protect against malicious code. Rsync is used to push out new definitions, which should be updated by the local administrator regularly. SIMP also comes with a `mcafee::uvscan` module that manages an installation of uvscan, if it is preferred. The module can configure `.dat` file updates to occur over `rsync`.

Both the ClamAV and McAfee modules provide a method to run a scan via cron on a customer scheduled basis. [*SI-3*]

SIMP also comes with the `chkrootkit` tool to check for *rootkits*. The tool runs as a cron job and places its output into syslog. [*SI-3*]

Software and Information Integrity

Unauthorized changes to a local client can be detected by Puppet or AIDE (for any file managed by Puppet). In the event that a managed file is changed locally, Puppet will revert the file back to its original state. It is important to note that this is a function of Puppet and is intended to be more of a configuration management feature rather than a security feature. If a Puppet client has been compromised, the Puppet Master may not have the ability to retake control over that client. However, the Puppet Master can configure all other nodes to deny traffic from the compromised node if they are configured by the administrator to do so. There are additional configuration files that are checked by AIDE, which is triggered by a cron job. AIDE logs any detected file changes in syslog. Each implementation may add additional files that are managed by Puppet or watched by AIDE. The AIDE baseline database is updated periodically to handle the installation and updating of system RPMs and reduce false positives. [*SI-7*, *SI-7 (1)*, *SI-7 (2)*, *SI-7 (3)*]

Remote Maintenance

Remote maintenance can be performed on SIMP using **SSH**. Local maintenance can be performed at the console or via serial port (if available). SSH sessions are tracked and logged using the security features built into SIMP. Console access requires someone to have access to the physical (or virtual) console along with the `root` password. Auditing of those actions also occurs in accordance with the configured audit policy. It is up to the implementer to decide how to distribute authentication information for remote maintenance. [*MA-4*, *MA-4 (1)*, *MA-6*]

Incident Response

While Puppet is not intended to be a security product primarily, its features help provide security functionality such as dynamic reconfigurations and wide-scale consistent mitigation application. If an implementation chooses, they can leverage Puppet's ability to reconfigure systems as part of incident response.

SIMP also delivers an MCollective infrastructure which can be used to rapidly query for system state or apply hotfixes in a scalable manner. [*IR-1*]

Contingency Planning

SIMP does not provide any direct support for contingency planning. Some of the mechanisms provided by SIMP might be used to support an implementation's contingency plan.

System Backup and Recovery

SIMP does not directly support any particular backup and recovery product. Solutions vary widely, and should be determined as part of an implementation's broader contingency plan. SIMP provides mechanisms that might be used to support backup and recovery procedures.

Administrators seeking FOSS software to implement backup and recovery solutions may be interested in products such as Bacula, BackupPC, duplicity, and scat.

Information System Management

This chapter contains SIMP security concepts that are related to the management security controls in **NIST 800-53**.

Risk Assessment

This section describes the process of identifying risks within a system.

SIMP Self Risk Assessment

Risk can be found in any system. The SIMP team is constantly evaluating the system and the settings to minimize inherit risk. Most risks can be mitigated by processes and procedures at the implementation level. The following table describes the known areas in SIMP. [*RA-1*]

Risk	Possible Mitigations
Disabling Puppet: This can cause the clients to be out of sync with the Puppet Master.	SIMP attempts to force a break on any locks and restart Puppet on all clients after a time of 4*runinterval (30 minutes by default). Implementations should ensure that further steps have not been taken to disable Puppet and should monitor their logs. Administrators can use the puppetlast command on the Puppet Master to detect servers that have not checked in within a reasonable time period.

Out of Date Patches: SIMP can be built with the RPMs from CentOS or Red Hat. Those RPMs should be assumed out of date at the time a system is initially installed (if using the SIMP DVD).	Implementations should obtain the latest RPMs and apply them in a reasonable manner. All SIMP systems will, by default, attempt to update all packages using YUM nightly. Therefore, having an updated repository will ensure that the systems are updated on a regular basis.
Poor Account Management: SIMP security access control is based on users being created and managed over time. Giving shell access to unnecessary users allows them the opportunity to escalate privileges.	Use the default `LDIF` files and local user modules to ensure that account settings remain restrictive. Ensure the system has policies and procedures in place to manage accounts. Finally, ensure that users are in appropriate groups with limited privileges.

Table: SIMP Risk

Vulnerability Scanning

The SIMP development and security team performs regular vulnerability scanning of the product using commercial and open source tools. Results and mitigations for findings from those tools can be provided upon request. [*CA-2*, *RA-5*]

Security Assessment and Authorization

Assessment and authorization varies by implementation. Implementations are encouraged to use documentation artifacts provided by the SIMP team to assist with assessment and authorization. [*CA-2*]

> ***Note***
>
> Should users find issues with internal assessments, the SIMP team highly encourages them to submit a bug report using our Bug Tracker

Evaluation Artifacts

This section presents various artifacts that are the result of either public review or internal team evaluation using various compliance scanners.

If you have data that you feel should be added here, please contact us using our *help-public-resources* or enter a PR against the simp-doc project.

SCAP Scan Results

Components have different `SCAP` scans that apply to their systems.

The SCAP Security Guide is the general metric by which SIMP systems are measured.

The associated `SCAP` profile should be referenced in each associated document.

The following scan results are available for the various subsystems:

> ***Note***
>
> This is an **example report template** to be used when responding to SCAP Scan results.
>
> The following is a short example from a CentOS 7 scan. You will need to adjust all content as appropriate.

TEMPLATE - SSG Scan - EL 7 STIG

- Scan Date: 1/1/1970
- SIMP Version: `6.1.0-RC1`
- SSG Version: `0.1.36`
- Data Stream: `ssh-centos7-ds.xml`
- SIMP Enforcement Profile: `disa_stig`

Terminology:

Finding
: Valid issues found by the scanner

Alternate Implementation
: Valid implementations per policy that do not match the scan

Exception
: Items that will need to be declared as a policy exception for the stated reason

False Positive
: Bugs in the scanner that should be reported

Ensure gpgcheck Enabled for Repository Metadata

- Rule ID: `xccdf_org.ssgproject.content_rule_ensure_gpgcheck_repo_metadata`
- Type: **Exception**
- **Recommend SSG Feedback**
  - This should not be a `high` severity if using TLS
  - This opens potential vulnerabilities to all client systems
  - Discussion ongoing on SSG mailing list and OpenSCAP/scap-security-guide#2455

Justification

The way that YUM works means that all GPG keys become **trusted** by the entire system. Enabling repository metadata signatures globally means that RPMs will be trusted that come from any system with a trusted GPG key and may allow software to be installed on systems that does not come from the vendor.

Configure Periodic Execution of AIDE

- Rule ID: `xccdf_org.ssgproject.content_rule_aide_periodic_cron_checking`
- Type: **Alternate Implementation**

Notes

We use the Puppet `cron` resource to add the AIDE rule to the `root` user's `crontab`.

System Result

```
# crontab -l

# Puppet Name: aide_schedule                          5 4 *
* 0 /bin/nice -n 19 /usr/sbin/aide -C
```

Build and Test AIDE Database

- Rule ID: `xccdf_org.ssgproject.content_rule_aide_build_database`
- Type: **False Positive**

System Result

```
# ls /var/lib/aide/
aide.db.gz
```

Record Attempts to Alter Logon and Logout Events - faillock

- Rule ID: `xccdf_org.ssgproject.content_rule_audit_rules_login_events_faillock`
- Type: **Finding**

Notes

Marked as a valid finding and tracked as SIMP-4047

How to Run a SCAN

1. Download the latest SSG Release OVAL ZIP file onto the target system
2. Unzip the downloaded file and cd into the directory
3. Make sure that you have the `openscap-scanner` package installed

```
p xccdf eval --profile <profile_name> --results ~/scan-output.xml --report ~/scan-output.html ssg-<OS>
```

You can get the list of available profiles by running `oscap info ssg-<OS>-ds.xml`

For example, to run the `STIG` profile on `CentOS 7`, you would run the following command:

```
oscap xccdf eval --profile xccdf_org.ssgproject.content_profile_stig-rhel7-disa --results ~/scan-outp
```

InSpec Scan Results

SIMP components may have different **`InSpec`** scans that apply to their systems.

The associated **`InSpec`** profile should be referenced in each associated document.

The following scan results are available:

- **Links will be added here to the various subsystems as they are made available**

SIMP Security Control Mapping

This is the security control mapping for SIMP. The document has two main sections. The first section contains the security components, which in our case are SIMP modules. Each component is documented and mapped to the security control sources. The second contains security control sources which are references or reference documents that contain security guidance.

Contents:

SIMP Components

This section contains the security documentation for SIMP modules (represented as components).

SIMP

Module Name: `pupmod-simp-simp`

This puppet module provides a set of default classes that will be useful to most users and which form the foundation of the core SIMP installation.

Access Enforcement

SIMP uses a combination of discretionary and mandatory access control configurations to protect the operating system and the applications installed. Both forms of access control are built upon a model where a subject's (user or process) access to an object is controlled by the underlying operating system.

System Access

The `simp::admin` class provides a default set of accesses to SIMP systems.

By default, the `administrators` group may access the system and may gain access to the `root` account via passwordless `sudo`. Passwordless `sudo` was chosen since many systems run without passwords and only key access. This may be changed by setting the appropriate `Boolean` in the class.

These users may access the system from any location via `ssh`.

Users in the `security` group may access all systems from the `simp_options::trusted_nets` setting and are restricted to privileged use of a specific set of auditing-related commands which have been selected to disallow escalation of privileges.

Mountpoint Control

The `simp::mountpoints` class puts some specific access control configurations in place. The `/tmp`, `/var/tmp`, and `/dev/shm` directories have `nodev`, `noexec`, and `nosuid` set to prevent users from misusing the systems global read/write directories.

Additionally, `/sys` is mounted with `nodev` and `noexec`.

References: *AC-3*

Account Management

SIMP makes several account management decisions that are part of the overall account management strategy. One of those cases is the use of passwordless sudo for any user in the `administrators` or `auditors` groups. This is on by default due to the expected use of SSH keys and lack of local passwords.

References: *AC-2*, *AC-6 (1)*

Audit Events

SIMP logs successful and unsuccessful logins. Logins from unknown users are also logged. These settings are found in the `/etc/login.defs` file and are activated by default.

References: *AU-2*

Audit Storage Capacity

When a SIMP client serves as syslog server, logrotate is used to help manage storage capacity. The following log rotate rules are applied:

- Logs are rotated weekly
- A maximum of 12 rotated logs are stored

References: *AU-4*

Authenticator Management

The operating system protects locally stored passwords by hashing them. SIMP maximizes that protection by using the SHA512 algorithm.

Passwords expire every 180 days, must be at least 1 day old to be changed, and users are warned 14 days before the password will expire.

References: *IA-5c.*, *IA-5f.*, *IA-5h.*

Authorize Access to Security Functions

One of the main mechanisms to control access to security functions is the use of sudo. SIMP installs the following sudo rules

Account	Sudo Commands	Run As Account	Password Required
administrators	/usr/bin/sudosh	root	no
administrators	/usr/sbin/puppetd	root	no
administrators	/usr/sbin/puppetca	root	no
administrators	/bin/rm -rf /var/lib/puppet/ssl	root	no
auditors	/bin/cat, /bin/ls, /usr/bin/lsattr, /sbin/aureport, /sbin/ausearch, /sbin/lspci, /sbin/lsusb, /sbin/lsmod, /usr/sbin/lsof, /bin/netstat, /sbin/ifconfig -a, /sbin/route, /sbin/route -[venC], /usr/bin/getent, /usr/bin/tail	root	no

References: *AC-6 (1)*

Authorized Software

SIMP builds and configures centralized YUM repositories which are hosted on the SIMP server. These repositories host all of the packages that are needed to install a SIMP server and client. Additionally, all of the packages available on a CentOS/RedHat ISO are also placed in a repository.

All of the repositories installed by the SIMP module require packages to the signed with a known GPG key.

References: *CM-7 (5)*

Baseline Configuration

SIMP uses `crond` to schedule a number of jobs that help keep systems in a consistent and known baseline. The `simp` module ensures that the `cron` daemon is installed and running on all systems.

Specifically, the **`puppet`** agent is run via `cron` as is `aide` and a small number of maintenance tasks.

References: *CM-2 (1)*

Boundary Protection

The `simp::sysctl` class uses the kernel's sysctl `rp_filter` (reverse path) setting to drop spoofed IPv4 packets.

It also enables the use of `tcp_syncookies` to resist SYN flood attacks.

Finally, several classes in the `simp` module enable **`IPTables`** in a deny-by-default mode.

References: *SC-7*

Centralized Management of Planned Audit Record Content

SIMP centrally controls what audit events are recorded on the clients. The SIMP module controls which of the those events are sent to local **`syslog`** daemon so that they may be forwarded to a central syslog server. The following list contains the conditions to be met for the SIMP logs to be sent to syslog.

- $programname == 'sudosh'
- $programname =='yum'
- $syslogfacility-text == 'cron'
- $syslogfacility-text == 'authpriv'
- $syslogfacility-text == 'local5'
- $syslogfacility-text == 'local6
- $syslogfacility-text == 'local7'
- $syslogpriority-text == 'emerg'
- $syslogfacility-text == 'kern' and $msg startswith 'IPT:'

SIMP also has a stock **`rsyslog`** module which is able to configure an `rsyslog` server for centralized collection. The stock `rsyslog` server configures the `rsyslog` daemon to accept logs from SIMP clients and places them in `/var/log/hosts/`. The following files are created for each host in that directory:

- sudosh.log
- httpd.log
- dhcpd.log
- puppet-agent-err.log
- puppet-agent.log
- puppet-master.log
- audit.log
- slapd.log

- iptables.log
- secure.log
- messages.log
- maillog.log
- cron.log
- spooler.log
- boot.log

References: *AU-3 (2)*, *AU-13 (2)*, *AU-6 (4)*

Concurrent Session Controls

A limit of 10 concurrent sessions are allowed per user. This value is controlled by the operating system's Pluggable Authentication Modules(PAM) module pam_limits.so setting.

References: *AC-10*

Configuration Management Policy and Procedures

All software developed and delivered under SIMP has a version associated with it. The aggregation of those components come together to make up a SIMP version. The current installed version of SIMP is written to a local file `/etc/simp/simp/version`.

References: *CM-1*

Cryptographic Protection

SIMP enables Federal Information Processing Standard(**`FIPS`**) mode. FIPS Publication 140-2, is a computer security standard, developed by a U.S. Government and industry working group to validate the quality of cryptographic modules. FIPS publications (including 140-2) can be found at the following URL: http://csrc.nist.gov/publications/PubsFIPS.html. Enabling FIPS mode installs an integrity checking package and modifies ciphers available for applications to use.

References: *SC-13*

Denial of Service Protection

SIMP takes several measures to reduce the chances of Denial of Service (DoS) attacks. The primary measures in place are to limit traffic with IPTables and set several kernel parameters. The kernel parameters set include limiting ICMP redirects, logging martian packets, ignoring ICMP broadcast traffic, ignoring bogus ICMP errors, and enabling protection against SYN cookies.

References: *SC-5*

Disable Inactive Accounts

Local accounts are disabled 35 days after their password expires. This is enforced using the 'inactive' value in the `/etc/default/useradd` file.

References: *AC-2 (3)*

Discretionary Access Control

SIMP uses the implementation of Discretionary Access Control (DAC) that is native to Linux. Specific file permissions have been assigned based on published security guidance for Red Hat, CentOS, and UNIX.

To ensure default permissions are as restrictive as possible, the user's **`umask`** is set to 0077 while the daemon umask is set to 0027.

References: *AC-3 (4)*

Error Handling

Core dumps are disabled in SIMP. Core dump files may contain sensitive information and therefore are not written to disk.

References: *SI-11*, *CP-12*

Flaw Remediation

Continuous Remediation

Additionally, `puppet` runs on a regular basis to pull the system back into a known good state against a controlled configuration baseline.

System Updates

The **`YUM`** client is configured to point to all SIMP repositories. Each night, a `cron` job runs `yum update` to install updated packages on each SIMP client. Therefore any packages in a repository are delivered within a 24 hour time period.

References: *SI-2*

Identification and Authentication

By default, The `root` user may not log into the system from any console, remote or local.

References: *IA-2*

Identification and Authentication

SIMP uses the SSSD client to authenticate with the SIMP LDAP server. The SSSD client is configured to:

- Use LDAP
- Use autofs
- Use sudo
- Use SSH
- Enforce a minimum user ID of 500

References: *IA-2*

Least Functionality

Whenever possible, SIMP prevents kernel modules that could cause harm or are unnecessary from loading. The operating system's modprobe blacklist feature is used to stop the following kernel modules from loading:

- bluetooth
- cramfs
- dccp
- dccp_ipv4
- dccp_ipv6
- freevxfs
- hfs

- hfsplus
- ieee1394
- jffs2
- net-pf-31
- rds
- sctp
- squashfs
- tipc
- udf
- usb-storage

Certain applications or application features are also explicitly disabled. The``hosts.equiv`` (part of the r-series of commands) is disabled. Prelinking, which changes binaries to increase startup time, is also disabled.

References: *CM-7*

Least Privilege

SIMP utilizes the cron daemon's access control by implementing the cron.allow feature. Only users in the cron.allow file are allowed to schedule cron jobs. Only the `root` user is in that file. The cron.deny file is forced to be absent, therefore all other users are denied the ability to schedule jobs.

The AT and incron services have the same access control configuration setup. Only the `root` user can schedule jobs and all other users are denied.

References: *AC-6*

Malicious Code Protection

SIMP installs the chkrootkit tool. Chkrootkit scans systems for the presence of rootkits. A cron job runs chkrootrootkit once per day.

References: *SI-3*, *SI-3a.*

Predictable Failure Prevention

SIMP uses TCP to transmit syslog messages. TCP has built in transmission retries and reliability of packet delivery.

References: *SI-13*

Previous Login Notification

SIMP implements PAM's lastlog module to display previous login information. When a user logs into a host, the previous session's login time, source host, and terminal is displayed.

References: *AC-9*, *AC-9 (1)*, *AC-9 (2)*

Privileged Accounts

SIMP systems require a password when the system enters single user mode. In the event system maintenance needs to be performed at the system console, users must have the `root` password to be authenticated. Grub passwords are also set to prevent unauthorized modifications to boot parameters.

References: *AC-6 (5)*

Role Based Access Control

SIMP creates a group called `administrators`. The `administrators` group is for privileged users and is configured to have `root` level access to the system.

References: *AC-2 (7)*

Secure Name / Address Resolution Service

To protect against DNS spoofing, the `/etc/host` file is configured to log the potentially spoofed name lookups.

References: *SC-20*

Session Lock

Sessions do not "lock". Instead, when there is a shell open and idle for 15 minutes, the session will timeout. This applies only when the shell is not running a command/process. Once the session is terminated, the user must reestablish the shell via console or SSH.

References: *AC-11a.*, *AC-11b.*

Session Termination

Sessions are terminated after three failed logins. Users must start a new session to make additional attempts to authenticate. Sessions will also timeout after 60 seconds if not attempt is made to authenticate. Lastly, when prompted to change a password, a user has 3 attempts to successfully change it before the session is terminated.

References: *AC-12*

System Use Notification

A default SIMP warning banner is presented to the user prior to login. The content of that banner is:

```
---------------------------------- ATTENTION ----------------------------------
                    THIS IS A RESTRICTED COMPUTER SYSTEM

This computer system, and all related equipment, networks, and network devices
are provided for authorised use only.  All systems controlled by this
organisation will be monitored for all lawful purposes.  Monitoring includes
the totality of the operating system and connected networks.  No events on this
system are excluded from record and there are no exclusions from this policy.

Use of this system constitutes consent to full monitoring of your activities
for use by the authorised monitoring organisation.  Unauthorised use of this
system, including uninvited connections, may subject you to criminal
prosecution.

The data collected from this system may be used for any purpose by the
collecting organisation.  If you do not agree to this monitoring, discontinue
use of the system IMMEDIATELY.
```

References: *AC-8a.*, *AC-8a.2.*, *AC-8a.3.*, *AC-8c.1.*

AIDE

Module Name: `pupmod-simp-aide`

This module installs AIDE and creates a baseline set of rules and files that should be monitored.

Automated Notifications of Integrity Violations

When an integrity event is detected by AIDE, the event is written both to a local AIDE log and to syslog. When combined with a central logging capability, all AIDE events can be stored and searched from a central location.

References *SC-7 (2)*

Software, Firmware, and Information Integrity

AIDE is installed and configured. SIMP configures a default set of files to be monitored. When a change is made to one of those files, AIDE will log that event.

The default list of files include:

```
/boot   NORMAL
/bin    NORMAL
/sbin   NORMAL
/lib    NORMAL
/opt    NORMAL
/usr    NORMAL
/root   NORMAL
!/usr/src
!/usr/tmp
/etc    PERMS
!/etc/mtab
!/etc/.*~
/etc/exports  NORMAL
/etc/fstab    NORMAL
/etc/passwd   NORMAL
/etc/group    NORMAL
/etc/gshadow  NORMAL
/etc/shadow   NORMAL
/etc/security/opasswd   NORMAL
/etc/hosts.allow   NORMAL
/etc/hosts.deny    NORMAL
/etc/sudoers NORMAL
/etc/skel NORMAL
/etc/logrotate.d NORMAL
/etc/resolv.conf DATAONLY
/etc/nscd.conf NORMAL
/etc/securetty NORMAL
/etc/profile NORMAL
/etc/bashrc NORMAL
/etc/bash_completion.d/ NORMAL
/etc/login.defs NORMAL
/etc/zprofile NORMAL
/etc/zshrc NORMAL
/etc/zlogin NORMAL
/etc/zlogout NORMAL
/etc/profile.d/ NORMAL
/etc/X11/ NORMAL
/etc/yum.conf NORMAL
/etc/yumex.conf NORMAL
/etc/yumex.profiles.conf NORMAL
/etc/yum/ NORMAL
/etc/yum.repos.d/ NORMAL
/var/log   LOG
```

```
!/var/log/sa
!/var/log/aide/aide.log
!/var/log/aide/aide.report
/etc/audit/ LSPP
/etc/libaudit.conf LSPP
/usr/sbin/stunnel LSPP
/var/spool/at LSPP
/etc/at.allow LSPP
/etc/at.deny LSPP
/etc/cron.allow LSPP
/etc/cron.deny LSPP
/etc/cron.d/ LSPP
/etc/cron.daily/ LSPP
/etc/cron.hourly/ LSPP
/etc/cron.monthly/ LSPP
/etc/cron.weekly/ LSPP
/etc/crontab LSPP
/var/spool/cron/root LSPP
/etc/login.defs LSPP
/etc/securetty LSPP
/var/log/faillog LSPP
/var/log/lastlog LSPP
/etc/hosts LSPP
/etc/sysconfig LSPP
/etc/inittab LSPP
/etc/grub LSPP
/etc/rc.d LSPP
/etc/ld.so.conf LSPP
/etc/localtime LSPP
/etc/sysctl.conf LSPP
/etc/modprobe.d/00_simp_blacklist.conf LSPP
/etc/pam.d LSPP
/etc/security LSPP
/etc/aliases LSPP
/etc/postfix LSPP
/etc/ssh/sshd_config LSPP
/etc/ssh/ssh_config LSPP
/etc/stunnel LSPP
/etc/vsftpd.ftpusers LSPP
/etc/vsftpd LSPP
/etc/issue LSPP
/etc/issue.net LSPP
/etc/cups LSPP
!/var/log/and-httpd
```

References: *SC-7*

Transfer to Alternate Storage

The AIDE logs are configured to be sent to syslog. In a default SIMP install, this does not send them to an external host until one is defined.

References: *AU-4 (1)*

Apache

Module Name: `pupmod-simp-apache`

This Puppet module provides the capability to configure Apache and component sites.

Audit Storage and Capacity

The Apache logs are written to the `/var/log` partition. This puts them on the same logical volume as the audit logs. That volume is mounted on a separate partition so that log space does not interfere with operations.

References: *AU-4*

Automated Central Management / Application / Verification

SIMP uses rsync (over stunnel) to keep files in `/var/www` synchronized between all web servers. Any files that need to be the same on all web servers are then managed from the puppet master.

References: *CM-7 (1)*

Content of Audit Records

The SIMP Apache configuration uses the following string to populate the Apache logs: `%h %l %u %t "%r" %>s %b "%{Referer}i" "%{User-Agent}i"`

That will capture the remote hostname, the request log ID, the remote username, the time of the request, the first line of the request, the request status, the size of the response, the referrer, and the user agent used for the request.

There is an additional log file written for SSL logs. The following string is used for that log: `%t %h %{SSL_CLIENT_S_DN_CN}x %{SSL_PROTOCOL}x %{SSL_CIPHER}x \"%r\" %b %s`

That will capture the time stamp, hostname, the distinguished name of the client certification, SSL protocol used, first line of the request, size of the response, and the request status.

References: *AU-3*

Information Flow Enforcement

The Apache module explicitly opens up ports 80 and 443 for the root web servers by using IPTables rules. The connecting source IPs are limited to the value of `$simp_options::trusted_nets`, which for most installs is the local network.

References: *AC-4*

Least Privilege

The Apache service runs under the apache user and apache group. This is allows directory permissions to limit the service's access to files/directories not owned by the apache user/group. The apache user does not have a valid login shell.

References: *AC-6*

Mandatory Access Control

When SELinux is enabled in SIMP, Apache is configured to run within a context. Booleans specific to apache are also set.

References: *AC-3*, *AC-3 (4)*

Transfer to Alternate Storage

The Apache logs are configured to be sent to syslog. In a default SIMP install, this does not send them to an external host until one is defined.

References: *AU-4 (1)*

Transmission Confidentiality and Integrity

The SIMP server/puppet master has an SSL enabled Apache web server running on port 443. The protocols are limited to TLSv1, TLSv1.1, and TLSv1.2. If the web client does not support those protocols, the connection will be rejected. The certificates are in the `/etc/httpd/conf/pki` directory.

References: *SC-8*

Auditd

Module Name: `pupmod-simp-auditd`

This Puppet module provides the capability to configure auditd and rules affecting your system.

Audit Events

SIMP audit rules were built by using industry best practices gathered over the years. The heaviest reliance has been on the SCAP-Security Guide (SSG). SIMP aims for a balance between performance and operational needs so the settings are rarely an exact match from these guides.

The following audit rules are applied to SIMP systems:

```
## For audit 1.6.5 and higher
##

# Ignore errors
# This may sound counterintuitive, but we'd rather skip bad rules and load the
# rest than miss half the file.  Warnings are still logged in the daemon
# restart output.
-i

## Remove any existing rules
-D

## Continue loading rules on failure.
# Particularly with the automatically generated nature of these rules in
# Puppet, it is possible that one or more may fail to load. We want to continue
# in that case so that we audit as much as possible.
-c

## Increase buffer size to handle the increased number of messages.
## Feel free to increase this if the machine panic's
# Default: 8192
-b 32768

## Set failure mode to panic
# Default: 2
-f 1

## Rate limit messages
# Default: 0
# If you set this to non-zero, you almost definitely want to set -f to 1 above.
-r 0

## Get rid of all anonymous and daemon junk.  It clogs up the logs and doesn't
# do anyone # any good.
-a exit,never -F auid=-1

# Ignore system services. In most guides this is tagged onto every rule but
```

```
# that just makes for more processing time.
-a exit,never -F auid!=0 -F auid<500

## unsuccessful file operations
-a always,exit -F arch=b64 -S creat -S mkdir -S mknod -S link -S symlink -S
mkdirat -S mknodat -S linkat -S symlinkat -S openat -S open -S close -S rename
-S truncate -S ftruncate -S rmdir -S unlink -S unlinkat -F exit=-EPERM -k access
-a always,exit -F arch=b32 -S creat -S mkdir -S mknod -S link -S symlink -S
mkdirat -S mknodat -S linkat -S symlinkat -S openat -S open -S close -S rename
-S truncate -S ftruncate -S rmdir -S unlink -S unlinkat -F exit=-EPERM -k access

-a always,exit -F perm=a -F exit=-EPERM -k access

# Permissions auditing
-a always,exit -F arch=b64 -S chown -S fchmod -S fchmodat -S fchown -S fchownat
-S lchown -S setxattr -S lsetxattr -S fsetxattr -S removexattr -S lremovexattr
-S fremovexattr -k perm_mod
-a always,exit -F arch=b32 -S chown -S fchmod -S fchmodat -S fchown -S fchownat
-S lchown -S setxattr -S lsetxattr -S fsetxattr -S removexattr -S lremovexattr
-S fremovexattr -k perm_mod

# Audit useful items that someone does when su'ing to root.
# Had to add an entry at the top for getting rid of anonymous records.  They
# are only moderately useful and contain *way* too much noise since this covers
# things like cron as well.

-a always,exit -F arch=b64 -F auid!=0 -F uid=0 -S capset -S mknod -S pivot_root
-S quotactl -S setsid -S settimeofday -S setuid -S swapoff -S swapon -k
su-root-activity
-a always,exit -F arch=b32 -F auid!=0 -F uid=0 -S capset -S mknod -S pivot_root
-S quotactl -S setsid -S settimeofday -S setuid -S swapoff -S swapon -k
su-root-activity

# Audit the execution of suid and sgid binaries.
-a always,exit -F arch=b64 -F euid=0 -F uid!=0 -S execve -k suid-root-exec
-a always,exit -F arch=b32 -F euid=0 -F uid!=0 -S execve -k suid-root-exec

## Audit the loading and unloading of kernel modules.
-w /sbin/insmod -p x -k modules
-w /sbin/rmmod -p x -k modules
-w /sbin/modprobe -p x -k modules
-a always,exit -F arch=b64 -S init_module -S delete_module -k modules
-a always,exit -F arch=b32 -S init_module -S delete_module -k modules

## Things that could affect time
-a exit,always -F arch=b32 -S adjtimex -S stime -S clock_settime -S settimeofday
-k audit_time_rules
-a exit,always -F arch=b64 -S adjtimex -S clock_settime -S settimeofday -k
audit_time_rules

-w /etc/localtime -p wa -k audit_time_rules

## Things that could affect system locale
-a always,exit -F arch=b32 -S sethostname -S setdomainname -k
audit_network_modifications
-a always,exit -F arch=b64 -S sethostname -S setdomainname -k
```

```
audit_network_modifications
-w /etc/issue -p wa -k audit_network_modifications
-w /etc/issue.net -p wa -k audit_network_modifications
-w /etc/hosts -p wa -k audit_network_modifications
-w /etc/sysconfig/network -p wa -k audit_network_modifications

# Mount options.
-a always,exit -F arch=b32 -S mount -S umount -S umount2 -k mount
-a always,exit -F arch=b64 -S mount -S umount2 -k mount

# audit umask changes.
# This is uselessly noisy.
# -a exit,always -S umask -k umask

-w /etc/group -p wa -k audit_account_changes
-w /etc/group- -p wa -k audit_account_changes
-w /etc/passwd -p wa -k audit_account_changes
-w /etc/passwd- -p wa -k audit_account_changes
-w /etc/gshadow -p wa -k audit_account_changes
-w /etc/shadow -p wa -k audit_account_changes
-w /etc/shadow- -p wa -k audit_account_changes
-w /etc/security/opasswd -p wa -k audit_account_changes

-w /etc/selinux/ -p wa -k MAC-policy

-w /var/log/faillog -p wa -k logins
-w /var/log/lastlog -p wa -k logins

-w /var/run/utmp -p wa -k session
-w /var/run/btmp -p wa -k session
-w /var/run/wtmp -p wa -k session

-w /etc/sudoers -p wa -k CFG_sys

# Generally good things to audit.
-w /boot/grub/grub.conf -p wa -k CFG_grub
-w /etc/aliases -p wa -k CFG_sys
-w /etc/anacrontab -p wa -k CFG_cron
-w /etc/at.deny -p wa -k CFG_sys
-w /etc/bashrc -p wa -k CFG_shell
-w /etc/cron.d -p wa -k CFG_cron
-w /etc/cron.daily -p wa -k CFG_cron
-w /etc/cron.deny -p wa -k CFG_cron
-w /etc/cron.hourly -p wa -k CFG_cron
-w /etc/cron.monthly -p wa -k CFG_cron
-w /etc/cron.weekly -p wa -k CFG_cron
-w /etc/crontab -p wa -k CFG_cron
-w /etc/csh.cshrc -p wa -k CFG_shell
-w /etc/csh.login -p wa -k CFG_shell
-w /etc/default -p wa -k CFG_sys
-w /etc/exports -p wa -k CFG_sys
-w /etc/fstab -p wa -k CFG_sys
-w /etc/host.conf -p wa -k CFG_sys
-w /etc/hosts.allow -p wa -k CFG_sys
-w /etc/hosts.deny -p wa -k CFG_sys
-w /etc/initlog.conf -p wa -k CFG_sys
```

```
-w /etc/inittab -p wa -k CFG_sys
-w /etc/issue -p wa -k CFG_sys
-w /etc/issue.net -p wa -k CFG_sys
-w /etc/krb5.conf -p wa -k CFG_sys
-w /etc/ld.so.conf -p wa -k CFG_sys
-w /etc/ld.so.conf.d -p wa -k CFG_sys
-w /etc/login.defs -p wa -k CFG_sys
-w /etc/modprobe.conf.d -p wa -k CFG_sys
-w /etc/modprobe.d/00_simp_blacklist.conf -p wa -k CFG_sys
-w /etc/nsswitch.conf -p wa -k CFG_sys
-w /etc/pam.d -p wa -k CFG_pam
-w /etc/pam_smb.conf -p wa -k CFG_pam
-w /etc/profile -p wa -k CFG_shell
-w /etc/rc.d/init.d -p wa -k CFG_sys
-w /etc/rc.local -p wa -k CFG_sys
-w /etc/rc.sysinit -p wa -k CFG_sys
-w /etc/resolv.conf -p wa -k CFG_sys
-w /etc/securetty -p wa -k CFG_sys
-w /etc/security -p wa -k CFG_security
-w /etc/services -p wa -k CFG_services
-w /etc/shells -p wa -k CFG_shell
-w /etc/snmp/snmpd.conf -p wa -k CFG_sys
-w /etc/ssh/sshd_config -p wa -k CFG_sys
-w /etc/sysconfig -p wa -k CFG_sys
-w /etc/sysctl.conf -p wa -k CFG_sys
-w /etc/xinetd.conf -p wa -k CFG_xinetd
-w /etc/xinetd.d -p wa -k CFG_sys
-w /etc/yum.conf -p wa -k yum-config
-w /etc/yum.repos.d -p wa -k yum-config
-w /lib/firmware/microcode.dat -p wa -k CFG_sys
-w /var/spool/at -p wa -k CFG_sys
-a exit,always -F arch=b32 -S ptrace -k paranoid
-a exit,always -F arch=b64 -S ptrace -k paranoid
-a always,exit -F arch=b32 -S personality -k paranoid
-a always,exit -F arch=b64 -S personality -k paranoid
-w /etc/aide.conf -p wa -k CFG_aide
-w /etc/aide.conf.d/default.aide -p wa -k CFG_aide
-w /etc/rc.d/init.d/auditd -p wa -k auditd
-w /var/log/audit.log -p wa -k audit-logs
-w /etc/pam_ldap.conf -p a -k CFG_etc_ldap
-w /etc/pki/private -p wa -k PKI
-w /etc/pki/public -p wa -k PKI
-w /etc/pki/cacerts -p wa -k PKI
-w /etc/pki/private/blade01.my.domain.pem -p wa -k PKI
-w /etc/pki/public/blade01.my.domain.pub -p wa -k PKI
-a always,exit -F dir=/etc/puppet -F uid!=puppet -p wa -k Puppet_Config
-a always,exit -F dir=/var/log/puppet -F uid!=puppet -p wa -k Puppet_Log
-a always,exit -F dir=/var/run/puppet -F uid!=puppet -p wa -k Puppet_Run
-a always,exit -F dir=$vardir/ssl -F uid!=puppet -p wa -k Puppet_SSL
-w /var/log/audit.log.1 -p rwa -k audit-logs
-w /var/log/audit.log.2 -p rwa -k audit-logs
-w /var/log/audit.log.3 -p rwa -k audit-logs
-w /var/log/audit.log.4 -p rwa -k audit-logs
-w /var/log/audit.log.5 -p rwa -k audit-logs
-w /etc/init/ -p wa -k CFG_upstart
```

References: *AU-2*

Audit Generation

SIMP enables auditd on all systems. Auditd is the userspace component to the Linux Auditing System. It's responsible for writing audit records to the disk. Viewing the logs is done with the ausearch or aureport utilities. Configuring the audit rules is done with the auditctl utility. During startup, the rules in /etc/audit/audit.rules are read by auditctl.

The audit daemon is configured to initiate auditing at boot time.

References: *AU-12*, *AU-12a.*, *AU-12c.*

Audit Reviews and Updates

SIMP developers are constantly reviewing the audit rules for accuracy, relevance, and performance. Rules are added and in some cases removed as security requirements change or as we find ways to improve the performance of auditd.

References: *AU-2 (3)*

Audit Storage Capacity

To help manage the amount of local storage occupied by audit logs, the following rules are applied:

- A maximum of 5 log files are retained. The oldest is removed when the logs are rotated.
- Files can reach a maximum of 24 Mb before being rotated.

References: *AU-4*

Content of Audit Records

The Linux audit daemon contains event type, date/time, host, and outcome of events by default. Each event type has a varying level of detail depending on the audited action. The auditd documentation should be referred to for the event types.

References: *AU-3*

Response to Audit Processing Failures

The auditing dispatcher is system that allows external applications to access and make use of the auditd daemon in real time. When the internal queue of the audit dispatcher is full, a message is sent to syslog.

References: *AU-5*

Response To Audit Processing Failures - Audit Storage Capacity

Auditd has been configured to handle audit failures or potential failures due to storage capacity. Those settings include:

- Send a warning to syslog when there is less than 75Mb of space on the audit partition (space_left).
- Suspend the audit daemon when there is less than 50Mb of space left on the audit partition (admin_space_left).

References: *AU-5 (1)*

Transfer to Alternate Storage

The audit logs are configured to be sent to syslog. In a default SIMP install, this does not send them to an external host until one is defined.

References: *AU-4 (1)*

ClamAV

Module Name: `pupmod-simp-clamav`

This module installs and configures ClamAV. ClamAV is a command line malicious code detection tool.

Malicious Code Protection

SIMP installs and configures ClamAV. ClamAV is a command line malicious code detection tool.

ClamAV is scheduled to run once per day and scans `/tmp`, `/var/tmp`, and `/dev/shm`.

References: *SI-3*, *SI-3a.*

Transfer to Alternate Storage

The ClamAV logs are configured to be sent to syslog. In a default SIMP install, this does not send them to an external host until one is defined.

References: *AU-4 (1)*

Compliance

Module Name: `pupmod-simp-compliance_markup`

This module adds a function to enable compliance annotations in Puppet code.

Automated Central Management / Application / Verification

SIMP has a custom function that is embedded within the module code to validate each variable. Those variables are then verified against SIMP default configuration settings using hiera. Each time puppet runs on a client, the hiera variables are validated against SIMP defaults.

References: *CM-7 (1)*

IPTables

Module Name: `pupmod-simp-iptables`

The *iptables* module manages all IPTables and IP6Tables rules in an atomic fashion. All rules are applied only once per puppet agent run during the application of the last executed *iptables* resource.

Boundary Protection

The SIMP IPTables module adds an IPtables rule that will prevent external IP addresses from being able to send spoofed packets to your system. This applies to IPv6 traffic. IPv4 spoofing is prevented using the rp_filter sysctl setting.

References: *SC-7*

Enable / Disable Security Policy Filters

Only the root user or a user who has escalated to root can modify the IPtables filters.

References: *AC-4 (10)*

Information Flow Enforcement

IPTables is installed and running on all SIMP clients. IPtables controls the flow of inbound traffic by limiting IP addresses, protocols, and port numbers.

The default IPTables rules:

- Allow all outbound traffic
- Allow ping
- Allow traffic from established connections
- Drop broadcast traffic
- Drop multicast traffic
- Drop all other traffic

References: *AC-4*, *CM-7b.*

Named/Bind

Module Name: `pupmod-simp-named`

This Puppet module provides the capability to configure either a chrooted named process or a caching nameserver.

Automated Central Management / Application / Verification

Named configuration files are synchronized between the puppet master and the named servers using rsync.

References: *CM-7 (1)*

Information Flow Enforcement

The named module explicitly opens TCP and UDP ports 53 for the DNS by using IPTables rules. The connecting source IPs are limited to the value of `$simp_options::trusted_nets` which for most installs is the local network.

References: *AC-4*

Least Functionality

The SIMP named service is configured to run within a chroot jail. This ensures that the service cannot see or access files outside of named directory. Should the named service become remotely compromised, the attack cannot be escalated to other parts of the file system.

References: *CM-7*

Least Privilege

The named service runs under the `named` user and `named` group. This is allows directory permissions to limit the service's access to files/directories not owned by the `apache` user/group. The `named` user does not have a valid login shell.

References: *AC-6*

OpenLDAP

Module Name: `pupmod-simp-openldap`

This Puppet module provides the capability to configure OpenLDAP servers and clients.

Access Enforcement

User password history (shadowLastChange) is written to the LDAP server. For this to happen, the user is given write access to their own shadowLastChange entry in LDAP.

References: *AC-3*

Audit Storage Capacity

Logrotate is used to help manage log storage capacity. The following log rotate rules are applied to OpenLDAP:

- Logs are rotated daily
- A maximum of 7 rotated logs are stored

References: *AU-4*

Authenticator Management

Authenticator strength is enforced using slapo-ppolicy overlay for LDAP. The ppolicy overlay is then configured to use PAM cracklib to enforce complexity.

For the default password complexity rules see the *faq-password-complexity* FAQ.

The integration point between the remote LDAP server and PAM is the pam_ldap pam module. SIMP configures pam_ldap to point to the SIMP LDAP server and communicates using TLS.

References: *IA-5 (1)(a)*, *IA-5 (1)(e)*

Content of Audit Records

All LDAP transactions to the LDAP database are audited and written to `/var/log/slapd.audit/` in LDIF format.

References: *AU-3*

Device Identification and Authentication

There is an account and password setup to authenticate devices needing to synchronize with the LDAD server. The username for that account is LDAPSync and the account and associated password are stored in LDAP.

There is also an account for a device to authenticate prior to being allowed to do anything else with the LDAP server. The username for that account is hostAuth and the account is stored in LDAP.

References: *IA-3*

Identification and Authentication (Organizational Users)

The pam_ldap module ensures that the username is mapped to the uid portion of the DN in LDAP.

The pam_ldap module is configured to tell the clients to ignore the following user names, forcing them to be authenticated locally:

- root
- bin
- daemon
- adm
- lp
- mail
- operator
- nobody
- dbus
- ntp

- saslauth
- postfix
- sshd
- puppet
- stunnel
- nscd
- haldaemon
- clamav
- rpcuser
- rpc
- clam
- nfsnobody
- rpm
- nslcd
- avahi
- gdm
- rtkit
- pulse
- hsqldb
- radvd
- apache
- tomcat

There as an ldap account created for LDAP administration. The username for that account is `LDAPAdmin`.

References: *IA-2*

Information Flow Enforcement

Since TCPWrappers has a default deny policy in place, a specific entry is added to allow all hosts to connect to the slapd service.

The OpenLDAP module explicitly opens up ports 389 (LDAP) and 636 (LDAPS) using IPTables rules. The connecting source IPs are limited to the value of `$simp_options::trusted_nets` which for most installs is the local network.

References: *AC-4*

Least Privilege

The OpenLDAP service runs under the `ldap` user and `ldap` group. This is allows directory permissions to limit the service's access to files/directories not owned by the `ldap` user/group. The ldap user does not have a valid login shell.

The default LDAP server policy denies all users access to everything (default deny). Access to LDAP entries are explicitly added.

References: *AC-6*

Transfer to Alternate Storage

The LDAP logs are configured to be sent to syslog. In a default SIMP install, this does not send them to an external host until one is defined.

References: *AU-4 (1)*

Transmission Confidentiality and Integrity

The pam_ldap OpenLDAP module is configured to use TLS to communicate with the LDAP server. It currently only supports TLSv1, TLSv2, and SSLv3. Supporting SSLv3 is a limitation of OpenLDAP.

References: *SC-8*

PAM

Module Name: `pupmod-simp-pam`

This Puppet module provides the capability to configure various PAM settings on the system.

Included are capabilities to manage:

- system-auth
- Group-based access to the system
- access.conf

The system-auth settings are a bit draconian, but simple enough to work within.

Authenticator Management

Authenticator strength is enforced using pam_cracklib.so. The SIMP settings ensure that passwords:

- Have at least four characters that are different from the previous password
- Do not repeat a character more than two times in a row
- Do not have the username (forward or reversed) in the password
- Have at lease one character from three of the four classes: upper, lower, number, special character
- Have at least 14 characters
- Are not the same as any of the previous 24 passwords

Passwords are hashed using the SHA512 algorithm. Each password is hashed using 1000 rounds.

References: *IA-5 (1)(a)*, *IA-5 (1)(e)*

Discretionary Access Control

When creating a home directory for the first time, PAM creates that directory using the umask of `0077`.

References: *AC-2*

Group Authentication

SIMP does not use group accounts for authenticators. Instead, users are added to a group. In the case of the `administrators` group, a user first authenticates to their account, and then escalates to `root` using sudo.

References: *IA-2 (5)*

Least Privilege

SIMP uses the access conf file to identify which accounts can login to a system. After all other identification and authentication checks have passed, the pam access.conf file is checked to ensure the user is allowed to login. SIMP allows `root` and the `administrators` group to login to all systems and the `simp` user to login to the puppet master. All other users must be explicitly added to the access.conf file using the SIMP pam module.

References: *AC-6*

Privileged Accounts

Linux historically uses the wheel group to as an administrators group. SIMP makes use of the sudoers file with more granular group permissions. The PAM module enforces that only the root user is in the wheel group.

References: *AC-6 (5)*

Unsuccessful Login Attempts

A user is allowed three failed logins per session. After the third unsuccessful login attempt, the user is disconnected and must initiate a new session in order to make additional attempts.

After 5 failed login attempts in a time 15 minute span, the account is locked for a period of 15 minutes.

The root user account will be locked for one hour after 5 failed login attempts.

References: *AC-7*, *AC-7(b)*, *IA-11*

Pupmod

Module Name: `pupmod-simp-pupmod`

This Puppet module provides the capability to configure both puppet servers and puppet clients.

The ability to switch puppetd from a system service to a cron job is also supported.

Access Enforcement

The puppet master uses a whitelist to determine which puppet clients can connect to the puppet master. The certificate of the connecting client must match the fully qualified domain name of the system. If it doesn't, then the connection is denied.

References: *AC-3*

Audit Events

The following puppet files are added to the audit rules so that modifications to them are audited by auditd.

- `-a always,exit -F dir=${confdir} -F uid!=puppet -p wa -k Puppet_Config`
- `-a always,exit -F dir=${logdir} -F uid!=puppet -p wa -k Puppet_Log`
- `-a always,exit -F dir=${rundir} -F uid!=puppet -p wa -k Puppet_Run`
- `-a always,exit -F dir=${ssldir} -F uid!=puppet -p wa -k Puppet_SSL`

References: *AU-2*

Audit Storage and Capacity

The Puppet logs are written to the `/var/log` partition. This puts them on the same logical volume as the audit logs. That volume is mounted on a separate partition so that log space does not interfere with operations.

The puppet master logs reports from client puppet runs in `/var/lib/puppet/reports`. The SIMP pupmod puppet module purges reports older than 7 days.

References: *AU-4*

Automated Change Implementation

The most prominent tool in the SIMP architecture is Puppet. Puppet is a client/server tool where managed nodes run the Puppet agent application. One or more servers run the Puppet master application in the form of Puppet Server.

The Puppet agent sends facts to the Puppet master and request a catalog. The master compiles and returns that node's catalog, using several sources of information it has access to.

Once it receives a catalog, Puppet agent applies it by checking each resource the catalog describes. If it finds any resources that are not in their desired state, it makes any changes necessary to correct them. After applying the catalog, the agent submits a report to the Puppet master.

Puppet clients have a cron job configured to run the puppet agent every 30 minutes.

References: *CM-3 (3)*

Content of Audit Records

The puppet master's log level is set to `WARN`. Any changes that are made during a run of the puppet agent, are logged to the client's log file.

References: *AU-3*

Information Flow Enforcement

The pupmod module explicitly opens up ports 8140 and 8141 using IPTables rules. Port 8140 is the puppet master port and 8141 is the certificate authority port. The connecting source IPs are limited to the value of `$trusted_nets`, which for most installs is the local network.

References: *AC-4*

Public Key Infrastructure

Puppet has it's own public key infrastructure (PKI) that is used exclusively for the puppet application. The PKI is used to provide access control and protect communications between the puppet master and the clients.

Additional information on Puppet and PKI can be found at https://docs.puppet.com/background/ssl/certificates_pki.html.

SIMP installs a cron job that will download a copy of the certificate revocation list(CRL) two times per day. If there is a client certificate that needs to be revoked, they can be added to the CRL and will no longer be able to connect to the puppet master.

References: *SC-17*

Transfer to Alternate Storage

The puppet logs are configured to be sent to syslog facility local6. In a default SIMP install, this does not send them to an external host until one is defined.

References: *AU-4 (1)*

Transmission Confidentiality and Integrity

The SIMP server/puppet master uses TLS for communications between the puppet master and clients. The protocols for that communications are limited to TLSv1, TLSv1.1, and TLSv1.2.

References: *SC-8*

Rsync

Module Name: `pupmod-simp-rsync`

This Puppet module provides the capability to configure an rsync server. The intent is for this server to be run encrypted via a stunnel channel.

Client rsync rules have not been integrated into this module at this time.

Access Enforcement

SIMP rsync is limited to read only so that files can not be remotely modified.

References: *AC-3*

Information Flow Enforcement

The rsync server port (over stunnel) is open to the IP addresses defined by the value of `$simp_options::trusted_nets`, which for most installs is the local network.

References: *AC-4*

Transmission Confidentiality and Integrity

Rsync is not encrypted. To mitigate this, SIMP only allows rsync to listen on the local host. The server to client communications is then protected using the SIMP stunnel module.

References: *SC-8*

SSH

Module Name: `pupmod-simp-ssh`

This Puppet module manages the configuration of the system-wide SSH server and client.

Authenticator Management

The SSH daemon disallows the use of empty passwords. Additionally, the SSH daemon uses PAM to support authenticator security.

References: *IA-5c.*

Cryptographic Key Establishment and Management

The SSH server is configured to use the system's existing system certificates. Those certificates are stored in `/etc/pki` and are used to generated the SSH server certificates stored in `/etc/ssh`.

References: *SC-12*

Cryptographic Protection

In the default FIPS mode, the SSH daemon limits the key exchange algorithms to:

- ecdh-sha2-nistp521
- ecdh-sha2-nistp384
- ecdh-sha2-nistp256
- diffie-hellman-group-exchange-sha256

In the default FIPS mode, the SSH daemon limits the message authentication code (MAC) algorithms to:

- hmac-sha2-256
- hmac-sha1'

In the default FIPS mode, the SSH client limits the key exchange algorithms to:

- aes256-gcm@openssh.com
- aes128-gcm@openssh.com

In the default FIPS mode, the SSH client limits the MAC algorithms to:

- hmac-sha2-256
- hmac-sha1'

References: *SC-13*

Information Flow Enforcement

The SSH module explicitly opens up port 22 for the SSH server by using IPTables rules.

Since TCPWrappers has a default deny policy in place, a specific entry is added to allow all hosts to connect to the SSH service.

References: *AC-4*

Least Privilege

The SSH service runs under the `ssh` user and `ssh` group. This is allows directory permissions to limit the service's access to files/directories not owned by the `ssh` user/group. The ssh user does not have a valid login shell.

X11 forwarding over SSH is explicitly disallowed. This limits the exposure of the SSH server to networks outside of the control of SIMP.

References: *AC-6*

Privileged Accounts

The SSH daemon disables root login. The root user is only allowed to login locally.

References: *AC-6 (5)*, *AC-6 (2)*

System Use Notification

The SSH daemon is configured to use the `/etc/issue.net` file to present a banner prior to login.

References: *AC-8a.*

Transfer to Alternate Storage

The SSH logs are configured to be sent to the syslog facility `AUTHPRIV`. In a default SIMP install, this does not send them to an external host until one is defined.

References: *AU-4 (1)*

Stunnel

Module Name: `pupmod-simp-stunnel`

This Puppet module provides the capability to configure stunnel channels on your system.

Access Enforcement

Stunnel verifies the client certificate as a form of access control. It only checks that the client certificate is valid.

References: *AC-3*

Least Functionality

The SIMP stunnel service is configured to run within a chroot jail. This ensures that the service cannot see or access files outside of stunnel directory. Should the stunnel service become remotely compromised, the attack cannot be escalated to other parts of the file system.

References: *CM-7*

Least Privilege

The stunnel service runs under the `stunnel` user and `stunnel` group. This allows directory permissions to limit the service's access to files/directories not owned by the `stunnel` user/group. The stunnel user does not have a valid login shell.

References: *AC-6*

Transfer to Alternate Storage

The stunnel logs are configured to be sent to syslog. In a default SIMP install, this does not send them to an external host until one is defined.

References: *AU-4 (1)*

Transmission Confidentiality and Integrity

The stunnel module is a framework used by other modules to encrypt communications for applications that might not natively support it.

The cipher negotiation is determined by the OpenSSL ciphers. In a default SIMP system, this will be TLSv1.1 or higher.

The certificates used for stunnel are in the `/etc/pki` directory.

References: *SC-8*

Sudo

Module Name: `pupmod-simp-sudo`

This Puppet module manages the sudoers infrastructure.

Authorize Access to Security Functions

The SIMP Sudoers module make use of the operating system's sudo capability to grant access to privileged functions. Specific rules are written to grant each user/group access to privileged command(s).

References: *AC-6 (1)*

Sudosh

Module Name: `pupmod-simp-sudosh`

This Puppet module provides the capability to use Sudosh with logging to rsyslog.

Session Audit

The sudosh tool is installed on each SIMP node. It` logs the terminal output of user's terminal session, which is written to the log file `/var/log/sudosh/log`. Another utility, `sudosh-replay` can be used to replay the session.

The PAM module `pam_tty_audit` is used to record keystrokes during a `root` user's session. Additional accounts can be audited by adding them to the parameter `pam::tty_audit_users`,

Note

As a safeguard against recording sensitive credentials (such as passwords), both `sudosh` and `pam_tty_audit` do NOT record when echo is turned off.

Warning

The audit logs **WILL RECORD SENSITIVE DETAILS** (such as passwords) for any scripts or applications that:

- Do _not_ protect terminal output while entering or echoing sensitive data
- AND are run by an audited user (e.g., `root`)

It is therefore HIGHLY RECOMMENDED to update any such scripts or applications to turn of echo during these sensitive operations.

References: *AU-14*

TCP Wrappers

Module Name: `pupmod-simp-tcpwrappers`

This Puppet module allows you to manage `/etc/hosts.allow`, `/etc/hosts.deny` is set to ALL:ALL by default.

Information Flow Enforcement

TCP Wrappers is enabled on SIMP systems. TCP Wrappers is a host-based networking ACL system, used to filter access to IP addresses. It allows host or subnetwork IP addresses, names and/or ident query replies, to be used as tokens on which to filter for access control purposes.

TCP Wrappers uses the `/etc/hosts.allow` and the `/etc/hosts.deny` files to configure the access control.

References: *AC-4*

Least Privilege

SIMP configures tcpwrappers to deny all, meaning that a service will be denied access to the TCP stack unless it is explicitly allowed. Each SIMP module that needs access to the TCP stack has an entry added to the host.allow file using this tcpwrappers module.

References: *AC-6*

Security Control Sources

NIST 800-53 Rev4

Control Family: ACCESS CONTROL

AC-1 : ACCESS CONTROL POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the AC family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

AC-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

AC-1a.1.

An access control policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

AC-1a.2.

Procedures to facilitate the implementation of the access control policy and associated access controls; and

AC-1b.

Reviews and updates the current:

AC-1b.1.

Access control policy [Assignment: organization-defined frequency]; and

AC-1b.2.

Access control procedures [Assignment: organization-defined frequency].

Control Family: ACCESS CONTROL

AC-2 : ACCOUNT MANAGEMENT

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Information system account types include, for example, individual, shared, group, system, guest/anonymous, emergency, developer/manufacturer/vendor, temporary, and service. Some of the account management requirements listed above can be implemented by organizational information systems. The identification of authorized users of the information system and the specification of access privileges reflects the requirements in other security controls in the security plan. Users requiring administrative privileges on information system accounts receive additional scrutiny by appropriate organizational personnel (e.g., system owner, mission/business owner, or chief information security officer) responsible for approving such accounts and privileged access. Organizations may choose to define access privileges or other attributes by account, by type of account, or a combination of both. Other attributes required for authorizing access include, for example, restrictions on time-of-day, day-of-week, and point-of-origin. In defining other account attributes, organizations consider system-related requirements (e.g., scheduled maintenance, system upgrades) and mission/business requirements, (e.g., time zone differences, customer requirements, remote access to support travel requirements). Failure to consider these factors could affect information system availability. Temporary and emergency accounts are accounts intended for short-term use. Organizations establish temporary accounts as a part of normal account activation procedures when there is a need for short-term accounts without the demand for immediacy in account activation. Organizations establish emergency accounts in response to crisis situations and with the need for rapid account activation. Therefore, emergency account activation may bypass normal account authorization processes. Emergency and temporary accounts are not to be confused with infrequently used accounts (e.g., local logon accounts used for special tasks defined by organizations or when network resources are unavailable). Such accounts remain available and are not subject to automatic disabling or removal dates. Conditions for disabling or deactivating accounts include, for example: (i) when shared/group, emergency, or temporary accounts are no longer required; or (ii) when individuals are transferred or terminated. Some types of information system accounts may require specialized training.

Related Controls: AC-3, AC-4, AC-5, AC-6, AC-10, AC-17, AC-19, AC-20, AU-9, IA-2, IA-4, IA-5, IA-8, CM-5, CM-6, CM-11, MA-3, MA-4, MA-5, PL-4, SC-13

AC-2a.

Identifies and selects the following types of information system accounts to support organizational missions/business functions: [Assignment: organization-defined information system account types];

AC-2b.

Assigns account managers for information system accounts;

AC-2c.

Establishes conditions for group and role membership;

AC-2d.

Specifies authorized users of the information system, group and role membership, and access authorizations (i.e., privileges) and other attributes (as required) for each account;

AC-2e.

Requires approvals by [Assignment: organization-defined personnel or roles] for requests to create information system accounts;

AC-2f.

Creates, enables, modifies, disables, and removes information system accounts in accordance with [Assignment: organization-defined procedures or conditions];

AC-2g.

Monitors the use of information system accounts;

AC-2h.

Notifies account managers:

AC-2h.1.

When accounts are no longer required;

AC-2h.2.

When users are terminated or transferred; and

AC-2h.3.

When individual information system usage or need-to-know changes;

AC-2i.

Authorizes access to the information system based on:

AC-2i.1.

A valid access authorization;

AC-2i.2.

Intended system usage; and

AC-2i.3.

Other attributes as required by the organization or associated missions/business functions;

AC-2j.

Reviews accounts for compliance with account management requirements [Assignment: organization-defined frequency]; and

AC-2k.

Establishes a process for reissuing shared/group account credentials (if deployed) when individuals are removed from the group.

AC-2 (1) : AUTOMATED SYSTEM ACCOUNT MANAGEMENT

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs automated mechanisms to support the management of information system accounts.

Note

The use of automated mechanisms can include, for example: using email or text messaging to automatically notify account managers when users are terminated or transferred; using the information system to monitor account usage; and using telephonic notification to report atypical system account usage.

AC-2 (2) : REMOVAL OF TEMPORARY / EMERGENCY ACCOUNTS

Baseline-Impact: *MODERATE*, **HIGH**

The information system automatically [Selection: removes; disables] temporary and emergency accounts after [Assignment: organization-defined time period for each type of account].

Note

This control enhancement requires the removal of both temporary and emergency accounts automatically after a predefined period of time has elapsed, rather than at the convenience of the systems administrator.

AC-2 (3) : DISABLE INACTIVE ACCOUNTS

Baseline-Impact: *MODERATE*, **HIGH**

The information system automatically disables inactive accounts after [Assignment: organization-defined time period].

AC-2 (4) : AUTOMATED AUDIT ACTIONS

Baseline-Impact: *MODERATE*, **HIGH**

The information system automatically audits account creation, modification, enabling, disabling, and removal actions, and notifies [Assignment: organization-defined personnel or roles].

Related Controls: AU-2, AU-12

AC-2 (5) : INACTIVITY LOGOUT

Baseline-Impact: HIGH

The organization requires that users log out when [Assignment: organization-defined time-period of expected inactivity or description of when to log out].

Related Controls: SC-23

AC-2 (6) : DYNAMIC PRIVILEGE MANAGEMENT

The information system implements the following dynamic privilege management capabilities: [Assignment: organization-defined list of dynamic privilege management capabilities].

Note

In contrast to conventional access control approaches which employ static information system accounts and predefined sets of user privileges, dynamic access control approaches (e.g., service-oriented architectures) rely on run time access control decisions facilitated by dynamic privilege management. While user identities may remain relatively constant over time, user privileges may change more frequently based on ongoing mission/business requirements and operational needs of organizations. Dynamic privilege management can include, for example, the immediate revocation of privileges from users, as opposed to requiring that users terminate and restart their sessions to reflect any changes in privileges. Dynamic privilege management can also refer to mechanisms that change the privileges of users based on dynamic rules as opposed to editing specific user profiles. This type of privilege management includes, for example, automatic adjustments of privileges if users are operating out of their normal work times, or if information systems are under duress or in emergency maintenance situations. This control enhancement also includes the ancillary effects of privilege changes, for example, the potential changes to encryption keys used for communications. Dynamic privilege management can support requirements for information system resiliency.

Related Controls: AC-16

AC-2 (7) : ROLE-BASED SCHEMES

The organization:

Note

Privileged roles are organization-defined roles assigned to individuals that allow those individuals to perform certain security-relevant functions that ordinary users are not authorized to perform. These privileged roles include, for example, key management, account management, network and system administration, database administration, and web administration.

AC-2 (7)(a)

Establishes and administers privileged user accounts in accordance with a role-based access scheme that organizes allowed information system access and privileges into roles;

AC-2 (7)(b)

Monitors privileged role assignments; and

AC-2 (7)(c)

Takes [Assignment: organization-defined actions] when privileged role assignments are no longer appropriate.

AC-2 (8) : DYNAMIC ACCOUNT CREATION

The information system creates [Assignment: organization-defined information system accounts] dynamically.

Note

Dynamic approaches for creating information system accounts (e.g., as implemented within service-oriented architectures) rely on establishing accounts (identities) at run time for entities that were previously unknown. Organizations plan for dynamic creation of information system accounts by establishing trust relationships and mechanisms with the appropriate authorities to validate related authorizations and privileges.

Related Controls: AC-16

AC-2 (9) : RESTRICTIONS ON USE OF SHARED / GROUP ACCOUNTS

The organization only permits the use of shared/group accounts that meet [Assignment: organization-defined conditions for establishing shared/group accounts].

AC-2 (10) : SHARED / GROUP ACCOUNT CREDENTIAL TERMINATION

The information system terminates shared/group account credentials when members leave the group.

AC-2 (11) : USAGE CONDITIONS

Baseline-Impact: HIGH

The information system enforces [Assignment: organization-defined circumstances and/or usage conditions] for [Assignment: organization-defined information system accounts].

Note

Organizations can describe the specific conditions or circumstances under which information system accounts can be used, for example, by restricting usage to certain days of the week, time of day, or specific durations of time.

AC-2 (12) : ACCOUNT MONITORING / ATYPICAL USAGE

Baseline-Impact: HIGH

The organization:

Note

Atypical usage includes, for example, accessing information systems at certain times of the day and from locations that are not consistent with the normal usage patterns of individuals working in organizations.

Related Controls: CA-7

AC-2 (12)(a)

Monitors information system accounts for [Assignment: organization-defined atypical usage]; and

AC-2 (12)(b)

Reports atypical usage of information system accounts to [Assignment: organization-defined personnel or roles].

AC-2 (13) : DISABLE ACCOUNTS FOR HIGH-RISK INDIVIDUALS

Baseline-Impact: HIGH

The organization disables accounts of users posing a significant risk within [Assignment: organization-defined time period] of discovery of the risk.

Note

Users posing a significant risk to organizations include individuals for whom reliable evidence or intelligence indicates either the intention to use authorized access to information systems to cause harm or through whom adversaries will cause harm. Harm includes potential adverse impacts to organizational operations and assets, individuals, other organizations, or the Nation. Close coordination between authorizing officials, information system administrators, and human resource managers is essential in order for timely execution of this control enhancement.

Related Controls: PS-4

Control Family: ACCESS CONTROL

AC-3 : ACCESS ENFORCEMENT

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system enforces approved authorizations for logical access to information and system resources in accordance with applicable access control policies.

Note

Access control policies (e.g., identity-based policies, role-based policies, control matrices, cryptography) control access between active entities or subjects (i.e., users or processes acting on behalf of users) and passive entities or objects (e.g., devices, files, records, domains) in information systems. In addition to enforcing authorized access at the information system level and recognizing that information systems can host many applications and services in support of organizational missions and business operations, access enforcement mechanisms can also be employed at the application and service level to provide increased information security.

Related Controls: AC-2, AC-4, AC-5, AC-6, AC-16, AC-17, AC-18, AC-19, AC-20, AC-21, AC-22, AU-9, CM-5, CM-6, CM-11, MA-3, MA-4, MA-5, PE-3

AC-3 (1) : RESTRICTED ACCESS TO PRIVILEGED FUNCTIONS

[Withdrawn: Incorporated into AC-6].

AC-3 (2) : DUAL AUTHORIZATION

The information system enforces dual authorization for [Assignment: organization-defined privileged commands and/or other organization-defined actions].

Note

Dual authorization mechanisms require the approval of two authorized individuals in order to execute. Organizations do not require dual authorization mechanisms when immediate responses are necessary to ensure public and environmental safety. Dual authorization may also be known as two-person control.

Related Controls: CP-9, MP-6

AC-3 (3) : MANDATORY ACCESS CONTROL

The information system enforces [Assignment: organization-defined mandatory access control policy] over all subjects and objects where the policy:

Note

Mandatory access control as defined in this control enhancement is synonymous with nondiscretionary access control, and is not constrained only to certain historical uses (e.g., implementations using the Bell-LaPadula Model). The above class of mandatory access control policies constrains what actions subjects can take with information obtained from data objects for which they have already been granted access, thus preventing the subjects from passing the information to unauthorized subjects and objects. This class of mandatory access control policies also constrains what actions subjects can take with respect to the propagation of access control privileges; that is, a subject with a privilege cannot pass that privilege to other subjects. The policy is uniformly enforced over all subjects and objects to which the information system has control. Otherwise, the access control policy can be circumvented. This enforcement typically is provided via an implementation that meets the reference monitor concept (see AC-25). The policy is bounded by the information system boundary (i.e., once the information is passed outside of the control of the system, additional means may be required to ensure that the constraints on the information remain in effect). The trusted subjects described above are granted privileges consistent with the concept of least privilege (see AC-6). Trusted subjects are only given the minimum privileges relative to the above policy necessary for satisfying organizational mission/business needs. The control is most applicable when there is some policy mandate (e.g., law, Executive Order, directive, or regulation) that establishes a policy regarding access to sensitive/classified information and some users of the information system are not authorized access to all sensitive/classified information resident in the information system. This control can operate in conjunction with AC-3 (4). A subject that is constrained in its operation by policies governed by this control is still able to operate under the less rigorous constraints of AC-3 (4), but policies governed by this control take precedence over the less rigorous constraints of AC-3 (4). For example, while a mandatory access control policy imposes a constraint preventing a subject from passing information to another subject operating at a different sensitivity label, AC-3 (4) permits the subject to pass the information to any subject with the same sensitivity label as the subject.

Related Controls: AC-25, SC-11

AC-3 (3)(a)

Is uniformly enforced across all subjects and objects within the boundary of the information system;

AC-3 (3)(b)

Specifies that a subject that has been granted access to information is constrained from doing any of the following;

AC-3 (3)(b)(1)

Passing the information to unauthorized subjects or objects;

AC-3 (3)(b)(2)

Granting its privileges to other subjects;

AC-3 (3)(b)(3)

Changing one or more security attributes on subjects, objects, the information system, or information system components;

AC-3 (3)(b)(4)

Choosing the security attributes and attribute values to be associated with newly created or modified objects; or

AC-3 (3)(b)(5)

Changing the rules governing access control; and

AC-3 (3)(c)

Specifies that [Assignment: organization-defined subjects] may explicitly be granted [Assignment: organization-defined privileges (i.e., they are trusted subjects)] such that they are not limited by some or all of the above constraints.

AC-3 (4) : DISCRETIONARY ACCESS CONTROL

The information system enforces [Assignment: organization-defined discretionary access control policy] over defined subjects and objects where the policy specifies that a subject that has been granted access to information can do one or more of the following:

Note

When discretionary access control policies are implemented, subjects are not constrained with regard to what actions they can take with information for which they have already been granted access. Thus, subjects that have been granted access to information are not prevented from passing (i.e., the subjects have the discretion to pass) the information to other subjects or objects. This control enhancement can operate in conjunction with AC-3 (3). A subject that is constrained in its operation by policies governed by AC-3 (3) is still able to operate under the less rigorous constraints of this control enhancement. Thus, while AC-3 (3) imposes constraints preventing a subject from passing information to another subject operating at a different sensitivity level, AC-3 (4) permits the subject to pass the information to any subject at the same sensitivity level. The policy is bounded by the information system boundary. Once the information is passed outside of the control of the information system, additional means may be required to ensure that the constraints remain in effect. While the

older, more traditional definitions of discretionary access control require identity-based access control, that limitation is not required for this use of discretionary access control.

AC-3 (4)(a)

Pass the information to any other subjects or objects;

AC-3 (4)(b)

Grant its privileges to other subjects;

AC-3 (4)(c)

Change security attributes on subjects, objects, the information system, or the information system's components;

AC-3 (4)(d)

Choose the security attributes to be associated with newly created or revised objects; or

AC-3 (4)(e)

Change the rules governing access control.

AC-3 (5) : SECURITY-RELEVANT INFORMATION

The information system prevents access to [Assignment: organization-defined security-relevant information] except during secure, non-operable system states.

Note

Security-relevant information is any information within information systems that can potentially impact the operation of security functions or the provision of security services in a manner that could result in failure to enforce system security policies or maintain the isolation of code and data. Security-relevant information includes, for example, filtering rules for routers/firewalls, cryptographic key management information, configuration parameters for security services, and access control lists. Secure, non-operable system states include the times in which information systems are not performing mission/business-related processing (e.g., the system is off-line for maintenance, troubleshooting, boot-up, shut down).

Related Controls: CM-3

AC-3 (6) : PROTECTION OF USER AND SYSTEM INFORMATION

[Withdrawn: Incorporated into MP-4 and SC-28].

AC-3 (7) : ROLE-BASED ACCESS CONTROL

The information system enforces a role-based access control policy over defined subjects and objects and controls access based upon [Assignment: organization-defined roles and users authorized to assume such roles].

Note

Role-based access control (RBAC) is an access control policy that restricts information system access to authorized users. Organizations can create specific roles based on job functions and the authorizations (i.e., privileges) to perform needed operations on organizational information systems associated with the organization-defined roles. When users are assigned to the organizational roles, they inherit the authorizations or privileges defined for those roles. RBAC simplifies privilege administration for organizations because privileges are not assigned directly to every user (which can be a significant number of individuals for mid- to large-size organizations) but are instead acquired through role assignments. RBAC can be implemented either as a mandatory or discretionary form of access control. For organizations implementing RBAC with mandatory access controls, the requirements in AC-3 (3) define the scope of the subjects and objects covered by the policy.

AC-3 (8) : REVOCATION OF ACCESS AUTHORIZATIONS

The information system enforces the revocation of access authorizations resulting from changes to the security attributes of subjects and objects based on [Assignment: organization-defined rules governing the timing of revocations of access authorizations].

Note

Revocation of access rules may differ based on the types of access revoked. For example, if a subject (i.e., user or process) is removed from a group, access may not be revoked until the next time the object (e.g., file) is opened or until the next time the subject attempts a new access to the object. Revocation based on changes to security labels may take effect immediately. Organizations can provide alternative approaches on how to make revocations immediate if information systems cannot provide such capability and immediate revocation is necessary.

AC-3 (9) : CONTROLLED RELEASE

The information system does not release information outside of the established system boundary unless:

Note

Information systems can only protect organizational information within the confines of established system boundaries. Additional security safeguards may be needed to ensure that such information is adequately protected once it is passed beyond the established information system boundaries. Examples of information leaving the system boundary include transmitting information to an external information system or printing the information on one of its printers. In cases where the information system is unable to make a determination of the adequacy of the protections provided by entities outside its boundary, as a mitigating control, organizations determine procedurally whether the external information systems are providing adequate security. The means used to determine the adequacy of the security provided by external information systems include, for example, conducting inspections or periodic testing, establishing agreements between the organization and its counterpart organizations, or some other process. The means used by external entities to protect the information received need not be the same as those used by the organization, but the means employed are sufficient to provide consistent adjudication of the security policy to protect the information. This control enhancement requires information systems to employ technical or procedural means to

validate the information prior to releasing it to external systems. For example, if the information system passes information to another system controlled by another organization, technical means are employed to validate that the security attributes associated with the exported information are appropriate for the receiving system. Alternatively, if the information system passes information to a printer in organization-controlled space, procedural means can be employed to ensure that only appropriately authorized individuals gain access to the printer. This control enhancement is most applicable when there is some policy mandate (e.g., law, Executive Order, directive, or regulation) that establishes policy regarding access to the information, and that policy applies beyond the realm of a particular information system or organization.

AC-3 (9)(a)

The receiving [Assignment: organization-defined information system or system component] provides [Assignment: organization-defined security safeguards]; and

AC-3 (9)(b)

[Assignment: organization-defined security safeguards] are used to validate the appropriateness of the information designated for release.

AC-3 (10) : AUDITED OVERRIDE OF ACCESS CONTROL MECHANISMS

The organization employs an audited override of automated access control mechanisms under [Assignment: organization-defined conditions].

Related Controls: AU-2, AU-6

Control Family: ACCESS CONTROL

AC-4 : INFORMATION FLOW ENFORCEMENT

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system enforces approved authorizations for controlling the flow of information within the system and between interconnected systems based on [Assignment: organization-defined information flow control policies].

Note

Information flow control regulates where information is allowed to travel within an information system and between information systems (as opposed to who is allowed to access the information) and without explicit regard to subsequent accesses to that information. Flow control restrictions include, for example, keeping export-controlled information from being transmitted in the clear to the Internet, blocking outside traffic that claims to be from within the organization, restricting web requests to the Internet that are not from the internal web proxy server, and limiting information transfers between organizations based on data structures and content. Transferring information between information systems representing different security domains with different security policies introduces risk that such transfers violate one or more domain security policies. In such situations, information owners/stewards provide guidance at designated policy enforcement points between interconnected systems. Organizations consider mandating specific architectural solutions when required to enforce specific security

policies. Enforcement includes, for example: (i) prohibiting information transfers between interconnected systems (i.e., allowing access only); (ii) employing hardware mechanisms to enforce one-way information flows; and (iii) implementing trustworthy regrading mechanisms to reassign security attributes and security labels.

Organizations commonly employ information flow control policies and enforcement mechanisms to control the flow of information between designated sources and destinations (e.g., networks, individuals, and devices) within information systems and between interconnected systems. Flow control is based on the characteristics of the information and/or the information path. Enforcement occurs, for example, in boundary protection devices (e.g., gateways, routers, guards, encrypted tunnels, firewalls) that employ rule sets or establish configuration settings that restrict information system services, provide a packet-filtering capability based on header information, or message-filtering capability based on message content (e.g., implementing key word searches or using document characteristics). Organizations also consider the trustworthiness of filtering/inspection mechanisms (i.e., hardware, firmware, and software components) that are critical to information flow enforcement. Control enhancements 3 through 22 primarily address cross-domain solution needs which focus on more advanced filtering techniques, in-depth analysis, and stronger flow enforcement mechanisms implemented in cross-domain products, for example, high-assurance guards. Such capabilities are generally not available in commercial off-the-shelf information technology products.

Related Controls: AC-3, AC-17, AC-19, AC-21, CM-6, CM-7, SA-8, SC-2, SC-5, SC-7, SC-18

AC-4 (1) : OBJECT SECURITY ATTRIBUTES

The information system uses [Assignment: organization-defined security attributes] associated with [Assignment: organization-defined information, source, and destination objects] to enforce [Assignment: organization-defined information flow control policies] as a basis for flow control decisions.

Note

Information flow enforcement mechanisms compare security attributes associated with information (data content and data structure) and source/destination objects, and respond appropriately (e.g., block, quarantine, alert administrator) when the mechanisms encounter information flows not explicitly allowed by information flow policies. For example, an information object labeled Secret would be allowed to flow to a destination object labeled Secret, but an information object labeled Top Secret would not be allowed to flow to a destination object labeled Secret. Security attributes can also include, for example, source and destination addresses employed in traffic filter firewalls. Flow enforcement using explicit security attributes can be used, for example, to control the release of certain types of information.

Related Controls: AC-16

AC-4 (2) : PROCESSING DOMAINS

The information system uses protected processing domains to enforce [Assignment: organization-defined information flow control policies] as a basis for flow control decisions.

Note

Within information systems, protected processing domains are processing spaces that have controlled interactions with other processing spaces, thus enabling control of information flows between these

spaces and to/from data/information objects. A protected processing domain can be provided, for example, by implementing domain and type enforcement. In domain and type enforcement, information system processes are assigned to domains; information is identified by types; and information flows are controlled based on allowed information accesses (determined by domain and type), allowed signaling among domains, and allowed process transitions to other domains.

AC-4 (3) : DYNAMIC INFORMATION FLOW CONTROL

The information system enforces dynamic information flow control based on [Assignment: organization-defined policies].

Note

Organizational policies regarding dynamic information flow control include, for example, allowing or disallowing information flows based on changing conditions or mission/operational considerations. Changing conditions include, for example, changes in organizational risk tolerance due to changes in the immediacy of mission/business needs, changes in the threat environment, and detection of potentially harmful or adverse events.

Related Controls: SI-4

AC-4 (4) : CONTENT CHECK ENCRYPTED INFORMATION

The information system prevents encrypted information from bypassing content-checking mechanisms by [Selection (one or more): decrypting the information; blocking the flow of the encrypted information; terminating communications sessions attempting to pass encrypted information; [Assignment: organization-defined procedure or method]].

Related Controls: SI-4

AC-4 (5) : EMBEDDED DATA TYPES

The information system enforces [Assignment: organization-defined limitations] on embedding data types within other data types.

Note

Embedding data types within other data types may result in reduced flow control effectiveness. Data type embedding includes, for example, inserting executable files as objects within word processing files, inserting references or descriptive information into a media file, and compressed or archived data types that may include multiple embedded data types. Limitations on data type embedding consider the levels of embedding and prohibit levels of data type embedding that are beyond the capability of the inspection tools.

AC-4 (6) : METADATA

The information system enforces information flow control based on [Assignment: organization-defined metadata].

Note

Metadata is information used to describe the characteristics of data. Metadata can include structural metadata describing data structures (e.g., data format, syntax, and semantics) or descriptive metadata describing data contents (e.g., age, location, telephone number). Enforcing allowed information flows based on metadata enables simpler and more effective flow control. Organizations consider the trustworthiness of metadata with regard to data accuracy (i.e., knowledge that the metadata values are correct with respect to the data), data integrity (i.e., protecting against unauthorized changes to metadata tags), and the binding of metadata to the data payload (i.e., ensuring sufficiently strong binding techniques with appropriate levels of assurance).

Related Controls: AC-16, SI-7

AC-4 (7) : ONE-WAY FLOW MECHANISMS

The information system enforces [Assignment: organization-defined one-way information flows] using hardware mechanisms.

AC-4 (8) : SECURITY POLICY FILTERS

The information system enforces information flow control using [Assignment: organization-defined security policy filters] as a basis for flow control decisions for [Assignment: organization-defined information flows].

Note

Organization-defined security policy filters can address data structures and content. For example, security policy filters for data structures can check for maximum file lengths, maximum field sizes, and data/file types (for structured and unstructured data). Security policy filters for data content can check for specific words (e.g., dirty/clean word filters), enumerated values or data value ranges, and hidden content. Structured data permits the interpretation of data content by applications. Unstructured data typically refers to digital information without a particular data structure or with a data structure that does not facilitate the development of rule sets to address the particular sensitivity of the information conveyed by the data or the associated flow enforcement decisions. Unstructured data consists of: (i) bitmap objects that are inherently non language-based (i.e., image, video, or audio files); and (ii) textual objects that are based on written or printed languages (e.g., commercial off-the-shelf word processing documents, spreadsheets, or emails). Organizations can implement more than one security policy filter to meet information flow control objectives (e.g., employing clean word lists in conjunction with dirty word lists may help to reduce false positives).

AC-4 (9) : HUMAN REVIEWS

The information system enforces the use of human reviews for [Assignment: organization-defined information flows] under the following conditions: [Assignment: organization-defined conditions].

Note

Organizations define security policy filters for all situations where automated flow control decisions are possible. When a fully automated flow control decision is not possible, then a human review may be employed in lieu of, or as a complement to, automated security policy filtering. Human reviews may also be employed as deemed necessary by organizations.

AC-4 (10) : ENABLE / DISABLE SECURITY POLICY FILTERS

The information system provides the capability for privileged administrators to enable/disable [Assignment: organization-defined security policy filters] under the following conditions: [Assignment: organization-defined conditions].

Note

For example, as allowed by the information system authorization, administrators can enable security policy filters to accommodate approved data types.

AC-4 (11) : CONFIGURATION OF SECURITY POLICY FILTERS

The information system provides the capability for privileged administrators to configure [Assignment: organization-defined security policy filters] to support different security policies.

Note

For example, to reflect changes in security policies, administrators can change the list of "dirty words" that security policy mechanisms check in accordance with the definitions provided by organizations.

AC-4 (12) : DATA TYPE IDENTIFIERS

The information system, when transferring information between different security domains, uses [Assignment: organization-defined data type identifiers] to validate data essential for information flow decisions.

Note

Data type identifiers include, for example, filenames, file types, file signatures/tokens, and multiple internal file signatures/tokens. Information systems may allow transfer of data only if compliant with data type format specifications.

AC-4 (13) : DECOMPOSITION INTO POLICY-RELEVANT SUBCOMPONENTS

The information system, when transferring information between different security domains, decomposes information into [Assignment: organization-defined policy-relevant subcomponents] for submission to policy enforcement mechanisms.

Note

Policy enforcement mechanisms apply filtering, inspection, and/or sanitization rules to the policy-relevant subcomponents of information to facilitate flow enforcement prior to transferring such information to different security domains. Parsing transfer files facilitates policy decisions on source, destination, certificates, classification, attachments, and other security-related component differentiators.

AC-4 (14) : SECURITY POLICY FILTER CONSTRAINTS

The information system, when transferring information between different security domains, implements [Assignment: organization-defined security policy filters] requiring fully enumerated formats that restrict data structure and content.

Note

Data structure and content restrictions reduce the range of potential malicious and/or unsanctioned content in cross-domain transactions. Security policy filters that restrict data structures include, for example, restricting file sizes and field lengths. Data content policy filters include, for example: (i) encoding formats for character sets (e.g., Universal Character Set Transformation Formats, American Standard Code for Information Interchange); (ii) restricting character data fields to only contain alpha-numeric characters; (iii) prohibiting special characters; and (iv) validating schema structures.

AC-4 (15) : DETECTION OF UNSANCTIONED INFORMATION

The information system, when transferring information between different security domains, examines the information for the presence of [Assignment: organized-defined unsanctioned information] and prohibits the transfer of such information in accordance with the [Assignment: organization-defined security policy].

Note

Detection of unsanctioned information includes, for example, checking all information to be transferred for malicious code and dirty words.

Related Controls: SI-3

AC-4 (16) : INFORMATION TRANSFERS ON INTERCONNECTED SYSTEMS

[Withdrawn: Incorporated into AC-4].

AC-4 (17) : DOMAIN AUTHENTICATION

The information system uniquely identifies and authenticates source and destination points by [Selection (one or more): organization, system, application, individual] for information transfer.

Note

Attribution is a critical component of a security concept of operations. The ability to identify source and destination points for information flowing in information systems, allows the forensic reconstruction of events when required, and encourages policy compliance by attributing policy violations to specific organizations/individuals. Successful domain authentication requires that information system labels distinguish among systems, organizations, and individuals involved in preparing, sending, receiving, or disseminating information.

Related Controls: IA-2, IA-3, IA-4, IA-5

AC-4 (18) : SECURITY ATTRIBUTE BINDING

The information system binds security attributes to information using [Assignment: organization-defined binding techniques] to facilitate information flow policy enforcement.

Note

Binding techniques implemented by information systems affect the strength of security attribute binding to information. Binding strength and the assurance associated with binding techniques play an important part in the trust organizations have in the information flow enforcement process. The binding techniques affect the number and degree of additional reviews required by organizations.

Related Controls: AC-16, SC-16

AC-4 (19) : VALIDATION OF METADATA

The information system, when transferring information between different security domains, applies the same security policy filtering to metadata as it applies to data payloads.

Note

This control enhancement requires the validation of metadata and the data to which the metadata applies. Some organizations distinguish between metadata and data payloads (i.e., only the data to which the metadata is bound). Other organizations do not make such distinctions, considering metadata and the data to which the metadata applies as part of the payload. All information (including metadata and the data to which the metadata applies) is subject to filtering and inspection.

AC-4 (20) : APPROVED SOLUTIONS

The organization employs [Assignment: organization-defined solutions in approved configurations] to control the flow of [Assignment: organization-defined information] across security domains.

Note

Organizations define approved solutions and configurations in cross-domain policies and guidance in accordance with the types of information flows across classification boundaries. The Unified Cross Domain Management Office (UCDMO) provides a baseline listing of approved cross-domain solutions.

AC-4 (21) : PHYSICAL / LOGICAL SEPARATION OF INFORMATION FLOWS

The information system separates information flows logically or physically using [Assignment: organization-defined mechanisms and/or techniques] to accomplish [Assignment: organization-defined required separations by types of information].

Note

Enforcing the separation of information flows by type can enhance protection by ensuring that information is not commingled while in transit and by enabling flow control by transmission paths

perhaps not otherwise achievable. Types of separable information include, for example, inbound and outbound communications traffic, service requests and responses, and information of differing security categories.

AC-4 (22) : ACCESS ONLY

The information system provides access from a single device to computing platforms, applications, or data residing on multiple different security domains, while preventing any information flow between the different security domains.

Note

The information system, for example, provides a desktop for users to access each connected security domain without providing any mechanisms to allow transfer of information between the different security domains.

Control Family: ACCESS CONTROL

AC-5 : SEPARATION OF DUTIES

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Separation of duties addresses the potential for abuse of authorized privileges and helps to reduce the risk of malevolent activity without collusion. Separation of duties includes, for example: (i) dividing mission functions and information system support functions among different individuals and/or roles; (ii) conducting information system support functions with different individuals (e.g., system management, programming, configuration management, quality assurance and testing, and network security); and (iii) ensuring security personnel administering access control functions do not also administer audit functions.

Related Controls: AC-3, AC-6, PE-3, PE-4, PS-2

AC-5a.

Separates [Assignment: organization-defined duties of individuals];

AC-5b.

Documents separation of duties of individuals; and

AC-5c.

Defines information system access authorizations to support separation of duties.

Control Family: ACCESS CONTROL

AC-6 : LEAST PRIVILEGE

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs the principle of least privilege, allowing only authorized accesses for users (or processes acting on behalf of users) which are necessary to accomplish assigned tasks in accordance with organizational missions and business functions.

Note

Organizations employ least privilege for specific duties and information systems. The principle of least privilege is also applied to information system processes, ensuring that the processes operate at privilege levels no higher than necessary to accomplish required organizational missions/business functions. Organizations consider the creation of additional processes, roles, and information system accounts as necessary, to achieve least privilege. Organizations also apply least privilege to the development, implementation, and operation of organizational information systems.

Related Controls: AC-2, AC-3, AC-5, CM-6, CM-7, PL-2

AC-6 (1) : AUTHORIZE ACCESS TO SECURITY FUNCTIONS

Baseline-Impact: *MODERATE*, **HIGH**

The organization explicitly authorizes access to [Assignment: organization-defined security functions (deployed in hardware, software, and firmware) and security-relevant information].

Note

Security functions include, for example, establishing system accounts, configuring access authorizations (i.e., permissions, privileges), setting events to be audited, and setting intrusion detection parameters. Security-relevant information includes, for example, filtering rules for routers/firewalls, cryptographic key management information, configuration parameters for security services, and access control lists. Explicitly authorized personnel include, for example, security administrators, system and network administrators, system security officers, system maintenance personnel, system programmers, and other privileged users.

Related Controls: AC-17, AC-18, AC-19

AC-6 (2) : NON-PRIVILEGED ACCESS FOR NONSECURITY FUNCTIONS

Baseline-Impact: *MODERATE*, **HIGH**

The organization requires that users of information system accounts, or roles, with access to [Assignment: organization-defined security functions or security-relevant information], use non-privileged accounts or roles, when accessing nonsecurity functions.

Note

This control enhancement limits exposure when operating from within privileged accounts or roles. The inclusion of roles addresses situations where organizations implement access control policies such as role-based access control and where a change of role provides the same degree of assurance

in the change of access authorizations for both the user and all processes acting on behalf of the user as would be provided by a change between a privileged and non-privileged account.

Related Controls: PL-4

AC-6 (3) : NETWORK ACCESS TO PRIVILEGED COMMANDS

Baseline-Impact: HIGH

The organization authorizes network access to [Assignment: organization-defined privileged commands] only for [Assignment: organization-defined compelling operational needs] and documents the rationale for such access in the security plan for the information system.

Note

Network access is any access across a network connection in lieu of local access (i.e., user being physically present at the device).

Related Controls: AC-17

AC-6 (4) : SEPARATE PROCESSING DOMAINS

The information system provides separate processing domains to enable finer-grained allocation of user privileges.

Note

Providing separate processing domains for finer-grained allocation of user privileges includes, for example: (i) using virtualization techniques to allow additional privileges within a virtual machine while restricting privileges to other virtual machines or to the underlying actual machine; (ii) employing hardware and/or software domain separation mechanisms; and (iii) implementing separate physical domains.

Related Controls: AC-4, SC-3, SC-30, SC-32

AC-6 (5) : PRIVILEGED ACCOUNTS

Baseline-Impact: *MODERATE*, **HIGH**

The organization restricts privileged accounts on the information system to [Assignment: organization-defined personnel or roles].

Note

Privileged accounts, including super user accounts, are typically described as system administrator for various types of commercial off-the-shelf operating systems. Restricting privileged accounts to specific personnel or roles prevents day-to-day users from having access to privileged information/functions. Organizations may differentiate in the application of this control enhancement between allowed privileges for local accounts and for domain accounts provided organizations retain the ability to control information system configurations for key security parameters and as otherwise necessary to sufficiently mitigate risk.

Related Controls: CM-6

AC-6 (6) : PRIVILEGED ACCESS BY NON-ORGANIZATIONAL USERS

The organization prohibits privileged access to the information system by non-organizational users.

Related Controls: IA-8

AC-6 (7) : REVIEW OF USER PRIVILEGES

The organization:

> ## Note
>
> The need for certain assigned user privileges may change over time reflecting changes in organizational missions/business function, environments of operation, technologies, or threat. Periodic review of assigned user privileges is necessary to determine if the rationale for assigning such privileges remains valid. If the need cannot be revalidated, organizations take appropriate corrective actions.

Related Controls: CA-7

AC-6 (7)(a)

Reviews [Assignment: organization-defined frequency] the privileges assigned to [Assignment: organization-defined roles or classes of users] to validate the need for such privileges; and

AC-6 (7)(b)

Reassigns or removes privileges, if necessary, to correctly reflect organizational mission/business needs.

AC-6 (8) : PRIVILEGE LEVELS FOR CODE EXECUTION

The information system prevents [Assignment: organization-defined software] from executing at higher privilege levels than users executing the software.

> ## Note
>
> In certain situations, software applications/programs need to execute with elevated privileges to perform required functions. However, if the privileges required for execution are at a higher level than the privileges assigned to organizational users invoking such applications/programs, those users are indirectly provided with greater privileges than assigned by organizations.

AC-6 (9) : AUDITING USE OF PRIVILEGED FUNCTIONS

Baseline-Impact: *MODERATE*, **HIGH**

The information system audits the execution of privileged functions.

Note

Misuse of privileged functions, either intentionally or unintentionally by authorized users, or by unauthorized external entities that have compromised information system accounts, is a serious and ongoing concern and can have significant adverse impacts on organizations. Auditing the use of privileged functions is one way to detect such misuse, and in doing so, help mitigate the risk from insider threats and the advanced persistent threat (APT).

Related Controls: AU-2

AC-6 (10) : PROHIBIT NON-PRIVILEGED USERS FROM EXECUTING PRIVILEGED FUNCTIONS

Baseline-Impact: *MODERATE*, **HIGH**

The information system prevents non-privileged users from executing privileged functions to include disabling, circumventing, or altering implemented security safeguards/countermeasures.

Note

Privileged functions include, for example, establishing information system accounts, performing system integrity checks, or administering cryptographic key management activities. Non-privileged users are individuals that do not possess appropriate authorizations. Circumventing intrusion detection and prevention mechanisms or malicious code protection mechanisms are examples of privileged functions that require protection from non-privileged users.

Control Family: ACCESS CONTROL

AC-7 : UNSUCCESSFUL LOGON ATTEMPTS

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system:

Note

This control applies regardless of whether the logon occurs via a local or network connection. Due to the potential for denial of service, automatic lockouts initiated by information systems are usually temporary and automatically release after a predetermined time period established by organizations. If a delay algorithm is selected, organizations may choose to employ different algorithms for different information system components based on the capabilities of those components. Responses to unsuccessful logon attempts may be implemented at both the operating system and the application levels.

Related Controls: AC-2, AC-9, AC-14, IA-5

AC-7a.

Enforces a limit of [Assignment: organization-defined number] consecutive invalid logon attempts by a user during a [Assignment: organization-defined time period]; and

AC-7b.

Automatically [Selection: locks the account/node for an [Assignment: organization-defined time period]; locks the account/node until released by an administrator; delays next logon prompt according to [Assignment: organization-defined delay algorithm]] when the maximum number of unsuccessful attempts is exceeded.

AC-7 (1) : AUTOMATIC ACCOUNT LOCK

[Withdrawn: Incorporated into AC-7].

AC-7 (2) : PURGE / WIPE MOBILE DEVICE

The information system purges/wipes information from [Assignment: organization-defined mobile devices] based on [Assignment: organization-defined purging/wiping requirements/techniques] after [Assignment: organization-defined number] consecutive, unsuccessful device logon attempts.

Note

This control enhancement applies only to mobile devices for which a logon occurs (e.g., personal digital assistants, smart phones, tablets). The logon is to the mobile device, not to any one account on the device. Therefore, successful logons to any accounts on mobile devices reset the unsuccessful logon count to zero. Organizations define information to be purged/wiped carefully in order to avoid over purging/wiping which may result in devices becoming unusable. Purging/wiping may be unnecessary if the information on the device is protected with sufficiently strong encryption mechanisms.

Related Controls: AC-19, MP-5, MP-6, SC-13

Control Family: ACCESS CONTROL

AC-8 : SYSTEM USE NOTIFICATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system:

Note

System use notifications can be implemented using messages or warning banners displayed before individuals log in to information systems. System use notifications are used only for access via logon interfaces with human users and are not required when such human interfaces do not exist. Organizations consider system use notification messages/banners displayed in multiple languages based on specific organizational needs and the demographics of information system users. Organizations also consult with the Office of the General Counsel for legal review and approval of warning banner content.

AC-8a.

Displays to users [Assignment: organization-defined system use notification message or banner] before granting access to the system that provides privacy and security notices consistent with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance and states that:

AC-8a.1.

Users are accessing a U.S. Government information system;

AC-8a.2.

Information system usage may be monitored, recorded, and subject to audit;

AC-8a.3.

Unauthorized use of the information system is prohibited and subject to criminal and civil penalties; and

AC-8a.4.

Use of the information system indicates consent to monitoring and recording;

AC-8b.

Retains the notification message or banner on the screen until users acknowledge the usage conditions and take explicit actions to log on to or further access the information system; and

AC-8c.

For publicly accessible systems:

AC-8c.1.

Displays system use information [Assignment: organization-defined conditions], before granting further access;

AC-8c.2.

Displays references, if any, to monitoring, recording, or auditing that are consistent with privacy accommodations for such systems that generally prohibit those activities; and

AC-8c.3.

Includes a description of the authorized uses of the system.

Control Family: ACCESS CONTROL

AC-9 : PREVIOUS LOGON (ACCESS) NOTIFICATION

Priority: P0

The information system notifies the user, upon successful logon (access) to the system, of the date and time of the last logon (access).

Note

This control is applicable to logons to information systems via human user interfaces and logons to systems that occur in other types of architectures (e.g., service-oriented architectures).

Related Controls: AC-7, PL-4

AC-9 (1) : UNSUCCESSFUL LOGONS

The information system notifies the user, upon successful logon/access, of the number of unsuccessful logon/access attempts since the last successful logon/access.

AC-9 (2) : SUCCESSFUL / UNSUCCESSFUL LOGONS

The information system notifies the user of the number of [Selection: successful logons/accesses; unsuccessful logon/access attempts; both] during [Assignment: organization-defined time period].

AC-9 (3) : NOTIFICATION OF ACCOUNT CHANGES

The information system notifies the user of changes to [Assignment: organization-defined security-related characteristics/parameters of the user's account] during [Assignment: organization-defined time period].

AC-9 (4) : ADDITIONAL LOGON INFORMATION

The information system notifies the user, upon successful logon (access), of the following additional information: [Assignment: organization-defined information to be included in addition to the date and time of the last logon (access)].

Note

This control enhancement permits organizations to specify additional information to be provided to users upon logon including, for example, the location of last logon. User location is defined as that information which can be determined by information systems, for example, IP addresses from which network logons occurred, device identifiers, or notifications of local logons.

Control Family: ACCESS CONTROL

AC-10 : CONCURRENT SESSION CONTROL

Priority: P3

Baseline-Impact: HIGH

The information system limits the number of concurrent sessions for each [Assignment: organization-defined account and/or account type] to [Assignment: organization-defined number].

Note

Organizations may define the maximum number of concurrent sessions for information system accounts globally, by account type (e.g., privileged user, non-privileged user, domain, specific

application), by account, or a combination. For example, organizations may limit the number of concurrent sessions for system administrators or individuals working in particularly sensitive domains or mission-critical applications. This control addresses concurrent sessions for information system accounts and does not address concurrent sessions by single users via multiple system accounts.

Control Family: ACCESS CONTROL

AC-11 : SESSION LOCK

Priority: P3

Baseline-Impact: *MODERATE*, **HIGH**

The information system:

Note

Session locks are temporary actions taken when users stop work and move away from the immediate vicinity of information systems but do not want to log out because of the temporary nature of their absences. Session locks are implemented where session activities can be determined. This is typically at the operating system level, but can also be at the application level. Session locks are not an acceptable substitute for logging out of information systems, for example, if organizations require users to log out at the end of workdays.

Related Controls: AC-7

AC-11a.

Prevents further access to the system by initiating a session lock after [Assignment: organization-defined time period] of inactivity or upon receiving a request from a user; and

AC-11b.

Retains the session lock until the user reestablishes access using established identification and authentication procedures.

AC-11 (1) : PATTERN-HIDING DISPLAYS

Baseline-Impact: *MODERATE*, **HIGH**

The information system conceals, via the session lock, information previously visible on the display with a publicly viewable image.

Note

Publicly viewable images can include static or dynamic images, for example, patterns used with screen savers, photographic images, solid colors, clock, battery life indicator, or a blank screen, with the additional caveat that none of the images convey sensitive information.

Control Family: ACCESS CONTROL

AC-12 : SESSION TERMINATION

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The information system automatically terminates a user session after [Assignment: organization-defined conditions or trigger events requiring session disconnect].

Note

This control addresses the termination of user-initiated logical sessions in contrast to SC-10 which addresses the termination of network connections that are associated with communications sessions (i.e., network disconnect). A logical session (for local, network, and remote access) is initiated whenever a user (or process acting on behalf of a user) accesses an organizational information system. Such user sessions can be terminated (and thus terminate user access) without terminating network sessions. Session termination terminates all processes associated with a user's logical session except those processes that are specifically created by the user (i.e., session owner) to continue after the session is terminated. Conditions or trigger events requiring automatic session termination can include, for example, organization-defined periods of user inactivity, targeted responses to certain types of incidents, time-of-day restrictions on information system use.

Related Controls: SC-10, SC-23

AC-12 (1) : USER-INITIATED LOGOUTS / MESSAGE DISPLAYS

The information system:

Note

Information resources to which users gain access via authentication include, for example, local workstations, databases, and password-protected websites/web-based services. Logout messages for web page access, for example, can be displayed after authenticated sessions have been terminated. However, for some types of interactive sessions including, for example, file transfer protocol (FTP) sessions, information systems typically send logout messages as final messages prior to terminating sessions.

AC-12 (1)(a)

Provides a logout capability for user-initiated communications sessions whenever authentication is used to gain access to [Assignment: organization-defined information resources]; and

AC-12 (1)(b)

Displays an explicit logout message to users indicating the reliable termination of authenticated communications sessions.

Control Family: ACCESS CONTROL

AC-13 : SUPERVISION AND REVIEW - ACCESS CONTROL

[Withdrawn: Incorporated into AC-2 and AU-6].

Control Family: ACCESS CONTROL

AC-14 : PERMITTED ACTIONS WITHOUT IDENTIFICATION OR AUTHENTICATION

Priority: P3

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses situations in which organizations determine that no identification or authentication is required in organizational information systems. Organizations may allow a limited number of user actions without identification or authentication including, for example, when individuals access public websites or other publicly accessible federal information systems, when individuals use mobile phones to receive calls, or when facsimiles are received. Organizations also identify actions that normally require identification or authentication but may under certain circumstances (e.g., emergencies), allow identification or authentication mechanisms to be bypassed. Such bypasses may occur, for example, via a software-readable physical switch that commands bypass of the logon functionality and is protected from accidental or unmonitored use. This control does not apply to situations where identification and authentication have already occurred and are not repeated, but rather to situations where identification and authentication have not yet occurred. Organizations may decide that there are no user actions that can be performed on organizational information systems without identification and authentication and thus, the values for assignment statements can be none.

Related Controls: CP-2, IA-2

AC-14a.

Identifies [Assignment: organization-defined user actions] that can be performed on the information system without identification or authentication consistent with organizational missions/business functions; and

AC-14b.

Documents and provides supporting rationale in the security plan for the information system, user actions not requiring identification or authentication.

AC-14 (1) : NECESSARY USES

[Withdrawn: Incorporated into AC-14].

Control Family: ACCESS CONTROL

AC-15 : AUTOMATED MARKING

[Withdrawn: Incorporated into MP-3].

Control Family: ACCESS CONTROL

AC-16 : SECURITY ATTRIBUTES

Priority: P0

The organization:

Note

Information is represented internally within information systems using abstractions known as data structures. Internal data structures can represent different types of entities, both active and passive. Active entities, also known as subjects, are typically associated with individuals, devices, or processes acting on behalf of individuals. Passive entities, also known as objects, are typically associated with data structures such as records, buffers, tables, files, inter-process pipes, and communications ports. Security attributes, a form of metadata, are abstractions representing the basic properties or characteristics of active and passive entities with respect to safeguarding information. These attributes may be associated with active entities (i.e., subjects) that have the potential to send or receive information, to cause information to flow among objects, or to change the information system state. These attributes may also be associated with passive entities (i.e., objects) that contain or receive information. The association of security attributes to subjects and objects is referred to as binding and is typically inclusive of setting the attribute value and the attribute type. Security attributes when bound to data/information, enables the enforcement of information security policies for access control and information flow control, either through organizational processes or information system functions or mechanisms. The content or assigned values of security attributes can directly affect the ability of individuals to access organizational information.

Organizations can define the types of attributes needed for selected information systems to support missions/business functions. There is potentially a wide range of values that can be assigned to any given security attribute. Release markings could include, for example, US only, NATO, or NOFORN (not releasable to foreign nationals). By specifying permitted attribute ranges and values, organizations can ensure that the security attribute values are meaningful and relevant. The term security labeling refers to the association of security attributes with subjects and objects represented by internal data structures within organizational information systems, to enable information system-based enforcement of information security policies. Security labels include, for example, access authorizations, data life cycle protection (i.e., encryption and data expiration), nationality, affiliation as contractor, and classification of information in accordance with legal and compliance requirements. The term security marking refers to the association of security attributes with objects in a human-readable form, to enable organizational process-based enforcement of information security policies. The AC-16 base control represents the requirement for user-based attribute association (marking). The enhancements to AC-16 represent additional requirements including information system-based attribute association (labeling). Types of attributes include, for example, classification level for objects and clearance (access authorization) level for subjects. An example of a value for both of these attribute types is Top Secret.

Related Controls: AC-3, AC-4, AC-6, AC-21, AU-2, AU-10, SC-16, MP-3

AC-16a.

Provides the means to associate [Assignment: organization-defined types of security attributes] having [Assignment: organization-defined security attribute values] with information in storage, in process, and/or in transmission;

AC-16b.

Ensures that the security attribute associations are made and retained with the information;

AC-16c.

Establishes the permitted [Assignment: organization-defined security attributes] for [Assignment: organization-defined information systems]; and

AC-16d.

Determines the permitted [Assignment: organization-defined values or ranges] for each of the established security attributes.

AC-16 (1) : DYNAMIC ATTRIBUTE ASSOCIATION

The information system dynamically associates security attributes with [Assignment: organization-defined subjects and objects] in accordance with [Assignment: organization-defined security policies] as information is created and combined.

Note

Dynamic association of security attributes is appropriate whenever the security characteristics of information changes over time. Security attributes may change, for example, due to information aggregation issues (i.e., the security characteristics of individual information elements are different from the combined elements), changes in individual access authorizations (i.e., privileges), and changes in the security category of information.

Related Controls: AC-4

AC-16 (2) : ATTRIBUTE VALUE CHANGES BY AUTHORIZED INDIVIDUALS

The information system provides authorized individuals (or processes acting on behalf of individuals) the capability to define or change the value of associated security attributes.

Note

The content or assigned values of security attributes can directly affect the ability of individuals to access organizational information. Therefore, it is important for information systems to be able to limit the ability to create or modify security attributes to authorized individuals.

Related Controls: AC-6, AU-2

AC-16 (3) : MAINTENANCE OF ATTRIBUTE ASSOCIATIONS BY INFORMATION SYSTEM

The information system maintains the association and integrity of [Assignment: organization-defined security attributes] to [Assignment: organization-defined subjects and objects].

Note

Maintaining the association and integrity of security attributes to subjects and objects with sufficient assurance helps to ensure that the attribute associations can be used as the basis of automated

policy actions. Automated policy actions include, for example, access control decisions or information flow control decisions.

AC-16 (4) : ASSOCIATION OF ATTRIBUTES BY AUTHORIZED INDIVIDUALS

The information system supports the association of [Assignment: organization-defined security attributes] with [Assignment: organization-defined subjects and objects] by authorized individuals (or processes acting on behalf of individuals).

Note

The support provided by information systems can vary to include: (i) prompting users to select specific security attributes to be associated with specific information objects; (ii) employing automated mechanisms for categorizing information with appropriate attributes based on defined policies; or (iii) ensuring that the combination of selected security attributes selected is valid. Organizations consider the creation, deletion, or modification of security attributes when defining auditable events.

AC-16 (5) : ATTRIBUTE DISPLAYS FOR OUTPUT DEVICES

The information system displays security attributes in human-readable form on each object that the system transmits to output devices to identify [Assignment: organization-identified special dissemination, handling, or distribution instructions] using [Assignment: organization-identified human-readable, standard naming conventions].

Note

Information system outputs include, for example, pages, screens, or equivalent. Information system output devices include, for example, printers and video displays on computer workstations, notebook computers, and personal digital assistants.

AC-16 (6) : MAINTENANCE OF ATTRIBUTE ASSOCIATION BY ORGANIZATION

The organization allows personnel to associate, and maintain the association of [Assignment: organization-defined security attributes] with [Assignment: organization-defined subjects and objects] in accordance with [Assignment: organization-defined security policies].

Note

This control enhancement requires individual users (as opposed to the information system) to maintain associations of security attributes with subjects and objects.

AC-16 (7) : CONSISTENT ATTRIBUTE INTERPRETATION

The organization provides a consistent interpretation of security attributes transmitted between distributed information system components.

Note

In order to enforce security policies across multiple components in distributed information systems (e.g., distributed database management systems, cloud-based systems, and service-oriented architectures), organizations provide a consistent interpretation of security attributes that are used in access enforcement and flow enforcement decisions. Organizations establish agreements and processes to ensure that all distributed information system components implement security attributes with consistent interpretations in automated access/flow enforcement actions.

AC-16 (8) : ASSOCIATION TECHNIQUES / TECHNOLOGIES

The information system implements [Assignment: organization-defined techniques or technologies] with [Assignment: organization-defined level of assurance] in associating security attributes to information.

Note

The association (i.e., binding) of security attributes to information within information systems is of significant importance with regard to conducting automated access enforcement and flow enforcement actions. The association of such security attributes can be accomplished with technologies/techniques providing different levels of assurance. For example, information systems can cryptographically bind security attributes to information using digital signatures with the supporting cryptographic keys protected by hardware devices (sometimes known as hardware roots of trust).

AC-16 (9) : ATTRIBUTE REASSIGNMENT

The organization ensures that security attributes associated with information are reassigned only via re-grading mechanisms validated using [Assignment: organization-defined techniques or procedures].

Note

Validated re-grading mechanisms are employed by organizations to provide the requisite levels of assurance for security attribute reassignment activities. The validation is facilitated by ensuring that re-grading mechanisms are single purpose and of limited function. Since security attribute reassignments can affect security policy enforcement actions (e.g., access/flow enforcement decisions), using trustworthy re-grading mechanisms is necessary to ensure that such mechanisms perform in a consistent/correct mode of operation.

AC-16 (10) : ATTRIBUTE CONFIGURATION BY AUTHORIZED INDIVIDUALS

The information system provides authorized individuals the capability to define or change the type and value of security attributes available for association with subjects and objects.

Note

The content or assigned values of security attributes can directly affect the ability of individuals to access organizational information. Therefore, it is important for information systems to be able to limit the ability to create or modify security attributes to authorized individuals only.

Control Family: ACCESS CONTROL

AC-17 : REMOTE ACCESS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Remote access is access to organizational information systems by users (or processes acting on behalf of users) communicating through external networks (e.g., the Internet). Remote access methods include, for example, dial-up, broadband, and wireless. Organizations often employ encrypted virtual private networks (VPNs) to enhance confidentiality and integrity over remote connections. The use of encrypted VPNs does not make the access non-remote; however, the use of VPNs, when adequately provisioned with appropriate security controls (e.g., employing appropriate encryption techniques for confidentiality and integrity protection) may provide sufficient assurance to the organization that it can effectively treat such connections as internal networks. Still, VPN connections traverse external networks, and the encrypted VPN does not enhance the availability of remote connections. Also, VPNs with encrypted tunnels can affect the organizational capability to adequately monitor network communications traffic for malicious code. Remote access controls apply to information systems other than public web servers or systems designed for public access. This control addresses authorization prior to allowing remote access without specifying the formats for such authorization. While organizations may use interconnection security agreements to authorize remote access connections, such agreements are not required by this control. Enforcing access restrictions for remote connections is addressed in AC-3.

Related Controls: AC-2, AC-3, AC-18, AC-19, AC-20, CA-3, CA-7, CM-8, IA-2, IA-3, IA-8, MA-4, PE-17, PL-4, SC-10, SI-4

AC-17a.

Establishes and documents usage restrictions, configuration/connection requirements, and implementation guidance for each type of remote access allowed; and

AC-17b.

Authorizes remote access to the information system prior to allowing such connections.

AC-17 (1) : AUTOMATED MONITORING / CONTROL

Baseline-Impact: *MODERATE*, **HIGH**

The information system monitors and controls remote access methods.

Note

Automated monitoring and control of remote access sessions allows organizations to detect cyber attacks and also ensure ongoing compliance with remote access policies by auditing connection activities of remote users on a variety of information system components (e.g., servers, workstations, notebook computers, smart phones, and tablets).

Related Controls: AU-2, AU-12

AC-17 (2) : PROTECTION OF CONFIDENTIALITY / INTEGRITY USING ENCRYPTION

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements cryptographic mechanisms to protect the confidentiality and integrity of remote access sessions.

Note

The encryption strength of mechanism is selected based on the security categorization of the information.

Related Controls: SC-8, SC-12, SC-13

AC-17 (3) : MANAGED ACCESS CONTROL POINTS

Baseline-Impact: *MODERATE*, **HIGH**

The information system routes all remote accesses through [Assignment: organization-defined number] managed network access control points.

Note

Limiting the number of access control points for remote accesses reduces the attack surface for organizations. Organizations consider the Trusted Internet Connections (TIC) initiative requirements for external network connections.

Related Controls: SC-7

AC-17 (4) : PRIVILEGED COMMANDS / ACCESS

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Related Controls: AC-6

AC-17 (4)(a)

Authorizes the execution of privileged commands and access to security-relevant information via remote access only for [Assignment: organization-defined needs]; and

AC-17 (4)(b)

Documents the rationale for such access in the security plan for the information system.

AC-17 (5) : MONITORING FOR UNAUTHORIZED CONNECTIONS

[Withdrawn: Incorporated into SI-4].

AC-17 (6) : PROTECTION OF INFORMATION

The organization ensures that users protect information about remote access mechanisms from unauthorized use and disclosure.

Related Controls: AT-2, AT-3, PS-6

AC-17 (7) : ADDITIONAL PROTECTION FOR SECURITY FUNCTION ACCESS

[Withdrawn: Incorporated into AC-3 (10)].

AC-17 (8) : DISABLE NONSECURE NETWORK PROTOCOLS

[Withdrawn: Incorporated into CM-7].

AC-17 (9) : DISCONNECT / DISABLE ACCESS

The organization provides the capability to expeditiously disconnect or disable remote access to the information system within [Assignment: organization-defined time period].

Note

This control enhancement requires organizations to have the capability to rapidly disconnect current users remotely accessing the information system and/or disable further remote access. The speed of disconnect or disablement varies based on the criticality of missions/business functions and the need to eliminate immediate or future remote access to organizational information systems.

Control Family: ACCESS CONTROL

AC-18 : WIRELESS ACCESS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Wireless technologies include, for example, microwave, packet radio (UHF/VHF), 802.11x, and Bluetooth. Wireless networks use authentication protocols (e.g., EAP/TLS, PEAP), which provide credential protection and mutual authentication.

Related Controls: AC-2, AC-3, AC-17, AC-19, CA-3, CA-7, CM-8, IA-2, IA-3, IA-8, PL-4, SI-4

AC-18a.

Establishes usage restrictions, configuration/connection requirements, and implementation guidance for wireless access; and

AC-18b.

Authorizes wireless access to the information system prior to allowing such connections.

AC-18 (1) : AUTHENTICATION AND ENCRYPTION

Baseline-Impact: *MODERATE*, **HIGH**

The information system protects wireless access to the system using authentication of [Selection (one or more): users; devices] and encryption.

Related Controls: SC-8, SC-13

AC-18 (2) : MONITORING UNAUTHORIZED CONNECTIONS

[Withdrawn: Incorporated into SI-4].

AC-18 (3) : DISABLE WIRELESS NETWORKING

The organization disables, when not intended for use, wireless networking capabilities internally embedded within information system components prior to issuance and deployment.

Related Controls: AC-19

AC-18 (4) : RESTRICT CONFIGURATIONS BY USERS

Baseline-Impact: HIGH

The organization identifies and explicitly authorizes users allowed to independently configure wireless networking capabilities.

Note

Organizational authorizations to allow selected users to configure wireless networking capability are enforced in part, by the access enforcement mechanisms employed within organizational information systems.

Related Controls: AC-3, SC-15

AC-18 (5) : ANTENNAS / TRANSMISSION POWER LEVELS

Baseline-Impact: HIGH

The organization selects radio antennas and calibrates transmission power levels to reduce the probability that usable signals can be received outside of organization-controlled boundaries.

Note

Actions that may be taken by organizations to limit unauthorized use of wireless communications outside of organization-controlled boundaries include, for example: (i) reducing the power of wireless transmissions so that the transmissions are less likely to emit a signal that can be used by adversaries outside of the physical perimeters of organizations; (ii) employing measures such as TEMPEST to

control wireless emanations; and (iii) using directional/beam forming antennas that reduce the likelihood that unintended receivers will be able to intercept signals. Prior to taking such actions, organizations can conduct periodic wireless surveys to understand the radio frequency profile of organizational information systems as well as other systems that may be operating in the area.

Related Controls: PE-19

Control Family: ACCESS CONTROL

AC-19 : ACCESS CONTROL FOR MOBILE DEVICES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

A mobile device is a computing device that: (i) has a small form factor such that it can easily be carried by a single individual; (ii) is designed to operate without a physical connection (e.g., wirelessly transmit or receive information); (iii) possesses local, non-removable or removable data storage; and (iv) includes a self-contained power source. Mobile devices may also include voice communication capabilities, on-board sensors that allow the device to capture information, and/or built-in features for synchronizing local data with remote locations. Examples include smart phones, E-readers, and tablets. Mobile devices are typically associated with a single individual and the device is usually in close proximity to the individual; however, the degree of proximity can vary depending upon on the form factor and size of the device. The processing, storage, and transmission capability of the mobile device may be comparable to or merely a subset of desktop systems, depending upon the nature and intended purpose of the device. Due to the large variety of mobile devices with different technical characteristics and capabilities, organizational restrictions may vary for the different classes/types of such devices. Usage restrictions and specific implementation guidance for mobile devices include, for example, configuration management, device identification and authentication, implementation of mandatory protective software (e.g., malicious code detection, firewall), scanning devices for malicious code, updating virus protection software, scanning for critical software updates and patches, conducting primary operating system (and possibly other resident software) integrity checks, and disabling unnecessary hardware (e.g., wireless, infrared). Organizations are cautioned that the need to provide adequate security for mobile devices goes beyond the requirements in this control. Many safeguards and countermeasures for mobile devices are reflected in other security controls in the catalog allocated in the initial control baselines as starting points for the development of security plans and overlays using the tailoring process. There may also be some degree of overlap in the requirements articulated by the security controls within the different families of controls. AC-20 addresses mobile devices that are not organization-controlled.

Related Controls: AC-3, AC-7, AC-18, AC-20, CA-9, CM-2, IA-2, IA-3, MP-2, MP-4, MP-5, PL-4, SC-7, SC-43, SI-3, SI-4

AC-19a.

Establishes usage restrictions, configuration requirements, connection requirements, and implementation guidance for organization-controlled mobile devices; and

AC-19b.

Authorizes the connection of mobile devices to organizational information systems.

AC-19 (1) : USE OF WRITABLE / PORTABLE STORAGE DEVICES

[Withdrawn: Incorporated into MP-7].

AC-19 (2) : USE OF PERSONALLY OWNED PORTABLE STORAGE DEVICES

[Withdrawn: Incorporated into MP-7].

AC-19 (3) : USE OF PORTABLE STORAGE DEVICES WITH NO IDENTIFIABLE OWNER

[Withdrawn: Incorporated into MP-7].

AC-19 (4) : RESTRICTIONS FOR CLASSIFIED INFORMATION

The organization:

Related Controls: CA-6, IR-4

AC-19 (4)(a)

Prohibits the use of unclassified mobile devices in facilities containing information systems processing, storing, or transmitting classified information unless specifically permitted by the authorizing official; and

AC-19 (4)(b)

Enforces the following restrictions on individuals permitted by the authorizing official to use unclassified mobile devices in facilities containing information systems processing, storing, or transmitting classified information:

AC-19 (4)(b)(1)

Connection of unclassified mobile devices to classified information systems is prohibited;

AC-19 (4)(b)(2)

Connection of unclassified mobile devices to unclassified information systems requires approval from the authorizing official;

AC-19 (4)(b)(3)

Use of internal or external modems or wireless interfaces within the unclassified mobile devices is prohibited; and

AC-19 (4)(b)(4)

Unclassified mobile devices and the information stored on those devices are subject to random reviews and inspections by [Assignment: organization-defined security officials], and if classified information is found, the incident handling policy is followed.

AC-19 (4)(c)

Restricts the connection of classified mobile devices to classified information systems in accordance with [Assignment: organization-defined security policies].

AC-19 (5) : FULL DEVICE / CONTAINER-BASED ENCRYPTION

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs [Selection: full-device encryption; container encryption] to protect the confidentiality and integrity of information on [Assignment: organization-defined mobile devices].

Note

Container-based encryption provides a more fine-grained approach to the encryption of data/information on mobile devices, including for example, encrypting selected data structures such as files, records, or fields.

Related Controls: MP-5, SC-13, SC-28

Control Family: ACCESS CONTROL

AC-20 : USE OF EXTERNAL INFORMATION SYSTEMS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization establishes terms and conditions, consistent with any trust relationships established with other organizations owning, operating, and/or maintaining external information systems, allowing authorized individuals to:

Note

External information systems are information systems or components of information systems that are outside of the authorization boundary established by organizations and for which organizations typically have no direct supervision and authority over the application of required security controls or the assessment of control effectiveness. External information systems include, for example: (i) personally owned information systems/devices (e.g., notebook computers, smart phones, tablets, personal digital assistants); (ii) privately owned computing and communications devices resident in commercial or public facilities (e.g., hotels, train stations, convention centers, shopping malls, or airports); (iii) information systems owned or controlled by nonfederal governmental organizations; and (iv) federal information systems that are not owned by, operated by, or under the direct supervision and authority of organizations. This control also addresses the use of external information systems for the processing, storage, or transmission of organizational information, including, for example, accessing cloud services (e.g., infrastructure as a service, platform as a service, or software as a service) from organizational information systems.

For some external information systems (i.e., information systems operated by other federal agencies, including organizations subordinate to those agencies), the trust relationships that have been established between those organizations and the originating organization may be such, that no explicit terms and conditions are required. Information systems within these organizations would not be considered external. These situations occur when, for example, there are pre-existing sharing/trust agreements (either implicit or explicit) established between federal agencies or organizations subordinate to those agencies, or when such trust agreements are

specified by applicable laws, Executive Orders, directives, or policies. Authorized individuals include, for example, organizational personnel, contractors, or other individuals with authorized access to organizational information systems and over which organizations have the authority to impose rules of behavior with regard to system access. Restrictions that organizations impose on authorized individuals need not be uniform, as those restrictions may vary depending upon the trust relationships between organizations. Therefore, organizations may choose to impose different security restrictions on contractors than on state, local, or tribal governments. This control does not apply to the use of external information systems to access public interfaces to organizational information systems (e.g., individuals accessing federal information through www.usa.gov). Organizations establish terms and conditions for the use of external information systems in accordance with organizational security policies and procedures. Terms and conditions address as a minimum: types of applications that can be accessed on organizational information systems from external information systems; and the highest security category of information that can be processed, stored, or transmitted on external information systems. If terms and conditions with the owners of external information systems cannot be established, organizations may impose restrictions on organizational personnel using those external systems.

Related Controls: AC-3, AC-17, AC-19, CA-3, PL-4, SA-9

AC-20a.

Access the information system from external information systems; and

AC-20b.

Process, store, or transmit organization-controlled information using external information systems.

AC-20 (1) : LIMITS ON AUTHORIZED USE

Baseline-Impact: *MODERATE*, **HIGH**

The organization permits authorized individuals to use an external information system to access the information system or to process, store, or transmit organization-controlled information only when the organization:

Note

This control enhancement recognizes that there are circumstances where individuals using external information systems (e.g., contractors, coalition partners) need to access organizational information systems. In those situations, organizations need confidence that the external information systems contain the necessary security safeguards (i.e., security controls), so as not to compromise, damage, or otherwise harm organizational information systems. Verification that the required security controls have been implemented can be achieved, for example, by third-party, independent assessments, attestations, or other means, depending on the confidence level required by organizations.

Related Controls: CA-2

AC-20 (1)(a)

Verifies the implementation of required security controls on the external system as specified in the organization's information security policy and security plan; or

AC-20 (1)(b)

Retains approved information system connection or processing agreements with the organizational entity hosting the external information system.

AC-20 (2) : PORTABLE STORAGE DEVICES

Baseline-Impact: *MODERATE*, **HIGH**

The organization [Selection: restricts; prohibits] the use of organization-controlled portable storage devices by authorized individuals on external information systems.

Note

Limits on the use of organization-controlled portable storage devices in external information systems include, for example, complete prohibition of the use of such devices or restrictions on how the devices may be used and under what conditions the devices may be used.

AC-20 (3) : NON-ORGANIZATIONALLY OWNED SYSTEMS / COMPONENTS / DEVICES

The organization [Selection: restricts; prohibits] the use of non-organizationally owned information systems, system components, or devices to process, store, or transmit organizational information.

Note

Non-organizationally owned devices include devices owned by other organizations (e.g., federal/state agencies, contractors) and personally owned devices. There are risks to using non-organizationally owned devices. In some cases, the risk is sufficiently high as to prohibit such use. In other cases, it may be such that the use of non-organizationally owned devices is allowed but restricted in some way. Restrictions include, for example: (i) requiring the implementation of organization-approved security controls prior to authorizing such connections; (ii) limiting access to certain types of information, services, or applications; (iii) using virtualization techniques to limit processing and storage activities to servers or other system components provisioned by the organization; and (iv) agreeing to terms and conditions for usage. For personally owned devices, organizations consult with the Office of the General Counsel regarding legal issues associated with using such devices in operational environments, including, for example, requirements for conducting forensic analyses during investigations after an incident.

AC-20 (4) : NETWORK ACCESSIBLE STORAGE DEVICES

The organization prohibits the use of [Assignment: organization-defined network accessible storage devices] in external information systems.

Note

Network accessible storage devices in external information systems include, for example, online storage devices in public, hybrid, or community cloud-based systems.

Control Family: ACCESS CONTROL

AC-21 : INFORMATION SHARING

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

> ***Note***
>
> This control applies to information that may be restricted in some manner (e.g., privileged medical information, contract-sensitive information, proprietary information, personally identifiable information, classified information related to special access programs or compartments) based on some formal or administrative determination. Depending on the particular information-sharing circumstances, sharing partners may be defined at the individual, group, or organizational level. Information may be defined by content, type, security category, or special access program/compartment.

Related Controls: AC-3

AC-21a.

Facilitates information sharing by enabling authorized users to determine whether access authorizations assigned to the sharing partner match the access restrictions on the information for [Assignment: organization-defined information sharing circumstances where user discretion is required]; and

AC-21b.

Employs [Assignment: organization-defined automated mechanisms or manual processes] to assist users in making information sharing/collaboration decisions.

AC-21 (1) : AUTOMATED DECISION SUPPORT

The information system enforces information-sharing decisions by authorized users based on access authorizations of sharing partners and access restrictions on information to be shared.

AC-21 (2) : INFORMATION SEARCH AND RETRIEVAL

The information system implements information search and retrieval services that enforce [Assignment: organization-defined information sharing restrictions].

Control Family: ACCESS CONTROL

AC-22 : PUBLICLY ACCESSIBLE CONTENT

Priority: P3

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

In accordance with federal laws, Executive Orders, directives, policies, regulations, standards, and/or guidance, the general public is not authorized access to nonpublic information (e.g., information protected under the Privacy Act and proprietary information). This control addresses information systems that are controlled by the organization and accessible to the general public, typically without identification or authentication. The posting of information on non-organization information systems is covered by organizational policy.

Related Controls: AC-3, AC-4, AT-2, AT-3, AU-13

AC-22a.

Designates individuals authorized to post information onto a publicly accessible information system;

AC-22b.

Trains authorized individuals to ensure that publicly accessible information does not contain nonpublic information;

AC-22c.

Reviews the proposed content of information prior to posting onto the publicly accessible information system to ensure that nonpublic information is not included; and

AC-22d.

Reviews the content on the publicly accessible information system for nonpublic information [Assignment: organization-defined frequency] and removes such information, if discovered.

Control Family: ACCESS CONTROL

AC-23 : DATA MINING PROTECTION

Priority: P0

The organization employs [Assignment: organization-defined data mining prevention and detection techniques] for [Assignment: organization-defined data storage objects] to adequately detect and protect against data mining.

Note

Data storage objects include, for example, databases, database records, and database fields. Data mining prevention and detection techniques include, for example: (i) limiting the types of responses provided to database queries; (ii) limiting the number/frequency of database queries to increase the work factor needed to determine the contents of such databases; and (iii) notifying organizational personnel when atypical database queries or accesses occur. This control focuses on the protection of organizational information from data mining while such information resides in organizational data stores. In contrast, AU-13 focuses on monitoring for organizational information that may have been mined or otherwise obtained from data stores and is now available as open source information residing on external sites, for example, through social networking or social media websites.

Control Family: ACCESS CONTROL

AC-24 : ACCESS CONTROL DECISIONS

Priority: P0

The organization establishes procedures to ensure [Assignment: organization-defined access control decisions] are applied to each access request prior to access enforcement.

Note

Access control decisions (also known as authorization decisions) occur when authorization information is applied to specific accesses. In contrast, access enforcement occurs when information systems enforce access control decisions. While it is very common to have access control decisions and access enforcement implemented by the same entity, it is not required and it is not always an optimal implementation choice. For some architectures and distributed information systems, different entities may perform access control decisions and access enforcement.

AC-24 (1) : TRANSMIT ACCESS AUTHORIZATION INFORMATION

The information system transmits [Assignment: organization-defined access authorization information] using [Assignment: organization-defined security safeguards] to [Assignment: organization-defined information systems] that enforce access control decisions.

Note

In distributed information systems, authorization processes and access control decisions may occur in separate parts of the systems. In such instances, authorization information is transmitted securely so timely access control decisions can be enforced at the appropriate locations. To support the access control decisions, it may be necessary to transmit as part of the access authorization information, supporting security attributes. This is due to the fact that in distributed information systems, there are various access control decisions that need to be made and different entities (e.g., services) make these decisions in a serial fashion, each requiring some security attributes to make the decisions. Protecting access authorization information (i.e., access control decisions) ensures that such information cannot be altered, spoofed, or otherwise compromised during transmission.

AC-24 (2) : NO USER OR PROCESS IDENTITY

The information system enforces access control decisions based on [Assignment: organization-defined security attributes] that do not include the identity of the user or process acting on behalf of the user.

Note

In certain situations, it is important that access control decisions can be made without information regarding the identity of the users issuing the requests. These are generally instances where preserving individual privacy is of paramount importance. In other situations, user identification information is simply not needed for access control decisions and, especially in the case of distributed information systems, transmitting such information with the needed degree of assurance may be very expensive or difficult to accomplish.

Control Family: ACCESS CONTROL

AC-25 : REFERENCE MONITOR

Priority: P0

The information system implements a reference monitor for [Assignment: organization-defined access control policies] that is tamperproof, always invoked, and small enough to be subject to analysis and testing, the completeness of which can be assured.

Note

Information is represented internally within information systems using abstractions known as data structures. Internal data structures can represent different types of entities, both active and passive. Active entities, also known as subjects, are typically associated with individuals, devices, or processes acting on behalf of individuals. Passive entities, also known as objects, are typically associated with data structures such as records, buffers, tables, files, inter-process pipes, and communications ports. Reference monitors typically enforce mandatory access control policies&#65533;a type of access control that restricts access to objects based on the identity of subjects or groups to which the subjects belong. The access controls are mandatory because subjects with certain privileges (i.e., access permissions) are restricted from passing those privileges on to any other subjects, either directly or indirectly&#65533;that is, the information system strictly enforces the access control policy based on the rule set established by the policy. The tamperproof property of the reference monitor prevents adversaries from compromising the functioning of the mechanism. The always invoked property prevents adversaries from bypassing the mechanism and hence violating the security policy. The smallness property helps to ensure the completeness in the analysis and testing of the mechanism to detect weaknesses or deficiencies (i.e., latent flaws) that would prevent the enforcement of the security policy.

Related Controls: AC-3, AC-16, SC-3, SC-39

Control Family: AWARENESS AND TRAINING

AT-1 : SECURITY AWARENESS AND TRAINING POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the AT family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

AT-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

AT-1a.1.

A security awareness and training policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

AT-1a.2.

Procedures to facilitate the implementation of the security awareness and training policy and associated security awareness and training controls; and

AT-1b.

Reviews and updates the current:

AT-1b.1.

Security awareness and training policy [Assignment: organization-defined frequency]; and

AT-1b.2.

Security awareness and training procedures [Assignment: organization-defined frequency].

Control Family: AWARENESS AND TRAINING

AT-2 : SECURITY AWARENESS TRAINING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization provides basic security awareness training to information system users (including managers, senior executives, and contractors):

Note

Organizations determine the appropriate content of security awareness training and security awareness techniques based on the specific organizational requirements and the information systems to which personnel have authorized access. The content includes a basic understanding of the need for information security and user actions to maintain security and to respond to suspected security incidents. The content also addresses awareness of the need for operations security. Security awareness techniques can include, for example, displaying posters, offering supplies inscribed with security reminders, generating email advisories/notices from senior organizational officials, displaying logon screen messages, and conducting information security awareness events.

Related Controls: AT-3, AT-4, PL-4

AT-2a.

As part of initial training for new users;

AT-2b.

When required by information system changes; and

AT-2c.

[Assignment: organization-defined frequency] thereafter.

AT-2 (1) : PRACTICAL EXERCISES

The organization includes practical exercises in security awareness training that simulate actual cyber attacks.

Note

Practical exercises may include, for example, no-notice social engineering attempts to collect information, gain unauthorized access, or simulate the adverse impact of opening malicious email attachments or invoking, via spear phishing attacks, malicious web links.

Related Controls: CA-2, CA-7, CP-4, IR-3

AT-2 (2) : INSIDER THREAT

Baseline-Impact: *MODERATE*, **HIGH**

The organization includes security awareness training on recognizing and reporting potential indicators of insider threat.

Note

Potential indicators and possible precursors of insider threat can include behaviors such as inordinate, long-term job dissatisfaction, attempts to gain access to information not required for job performance, unexplained access to financial resources, bullying or sexual harassment of fellow employees, workplace violence, and other serious violations of organizational policies, procedures, directives, rules, or practices. Security awareness training includes how to communicate employee and management concerns regarding potential indicators of insider threat through appropriate organizational channels in accordance with established organizational policies and procedures.

Related Controls: PL-4, PM-12, PS-3, PS-6

Control Family: AWARENESS AND TRAINING

AT-3 : ROLE-BASED SECURITY TRAINING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization provides role-based security training to personnel with assigned security roles and responsibilities:

Note

Organizations determine the appropriate content of security training based on the assigned roles and responsibilities of individuals and the specific security requirements of organizations and the information systems to which personnel have authorized access. In addition, organizations provide enterprise architects, information system developers, software developers, acquisition/procurement officials, information system managers, system/network administrators, personnel conducting configuration management and auditing activities, personnel performing independent verification and validation activities, security control assessors, and other personnel having access to system-level software, adequate security-related technical training specifically tailored for their assigned duties. Comprehensive role-based training addresses management, operational, and technical roles and responsibilities covering physical, personnel, and technical safeguards and countermeasures. Such training can include for example, policies, procedures, tools, and artifacts for the organizational security roles defined. Organizations also provide the training necessary for individuals to carry out their responsibilities related to operations and supply chain security within the context of organizational information security programs. Role-based security training also applies to contractors providing services to federal agencies.

Related Controls: AT-2, AT-4, PL-4, PS-7, SA-3, SA-12, SA-16

AT-3a.

Before authorizing access to the information system or performing assigned duties;

AT-3b.

When required by information system changes; and

AT-3c.

[Assignment: organization-defined frequency] thereafter.

AT-3 (1) : ENVIRONMENTAL CONTROLS

The organization provides [Assignment: organization-defined personnel or roles] with initial and [Assignment: organization-defined frequency] training in the employment and operation of environmental controls.

Note

Environmental controls include, for example, fire suppression and detection devices/systems, sprinkler systems, handheld fire extinguishers, fixed fire hoses, smoke detectors, temperature/humidity, HVAC, and power within the facility. Organizations identify personnel with specific roles and responsibilities associated with environmental controls requiring specialized training.

Related Controls: PE-1, PE-13, PE-14, PE-15

AT-3 (2) : PHYSICAL SECURITY CONTROLS

The organization provides [Assignment: organization-defined personnel or roles] with initial and [Assignment: organization-defined frequency] training in the employment and operation of physical security controls.

Note

Physical security controls include, for example, physical access control devices, physical intrusion alarms, monitoring/surveillance equipment, and security guards (deployment and operating procedures). Organizations identify personnel with specific roles and responsibilities associated with physical security controls requiring specialized training.

Related Controls: PE-2, PE-3, PE-4, PE-5

AT-3 (3) : PRACTICAL EXERCISES

The organization includes practical exercises in security training that reinforce training objectives.

Note

Practical exercises may include, for example, security training for software developers that includes simulated cyber attacks exploiting common software vulnerabilities (e.g., buffer overflows), or spear/whale phishing attacks targeted at senior leaders/executives. These types of practical exercises help developers better understand the effects of such vulnerabilities and appreciate the need for security coding standards and processes.

AT-3 (4) : SUSPICIOUS COMMUNICATIONS AND ANOMALOUS SYSTEM BEHAVIOR

The organization provides training to its personnel on [Assignment: organization-defined indicators of malicious code] to recognize suspicious communications and anomalous behavior in organizational information systems.

Note

A well-trained workforce provides another organizational safeguard that can be employed as part of a defense-in-depth strategy to protect organizations against malicious code coming in to organizations via email or the web applications. Personnel are trained to look for indications of potentially suspicious email (e.g., receiving an unexpected email, receiving an email containing strange or poor grammar, or receiving an email from an unfamiliar sender but who appears to be from a known sponsor or contractor). Personnel are also trained on how to respond to such suspicious email or web communications (e.g., not opening attachments, not clicking on embedded web links, and checking the source of email addresses). For this process to work effectively, all organizational personnel are trained and made aware of what constitutes suspicious communications. Training personnel on how to recognize anomalous behaviors in organizational information systems can potentially provide early warning for the presence of malicious code. Recognition of such anomalous behavior by organizational personnel can supplement automated malicious code detection and protection tools and systems employed by organizations.

Control Family: AWARENESS AND TRAINING

AT-4 : SECURITY TRAINING RECORDS

Priority: P3

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Documentation for specialized training may be maintained by individual supervisors at the option of the organization.

Related Controls: AT-2, AT-3, PM-14

AT-4a.

Documents and monitors individual information system security training activities including basic security awareness training and specific information system security training; and

AT-4b.

Retains individual training records for [Assignment: organization-defined time period].

Control Family: AWARENESS AND TRAINING

AT-5 : CONTACTS WITH SECURITY GROUPS AND ASSOCIATIONS

[Withdrawn: Incorporated into PM-15].

Control Family: AUDIT AND ACCOUNTABILITY

AU-1 : AUDIT AND ACCOUNTABILITY POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the AU family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

AU-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

AU-1a.1.

An audit and accountability policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

AU-1a.2.

Procedures to facilitate the implementation of the audit and accountability policy and associated audit and accountability controls; and

AU-1b.

Reviews and updates the current:

AU-1b.1.

Audit and accountability policy [Assignment: organization-defined frequency]; and

AU-1b.2.

Audit and accountability procedures [Assignment: organization-defined frequency].

Control Family: AUDIT AND ACCOUNTABILITY

AU-2 : AUDIT EVENTS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

An event is any observable occurrence in an organizational information system. Organizations identify audit events as those events which are significant and relevant to the security of information systems and the environments in which those systems operate in order to meet specific and ongoing audit needs. Audit events can include, for example, password changes, failed logons, or failed accesses related to information systems, administrative privilege usage, PIV credential usage, or third-party credential usage. In determining the set of auditable events, organizations consider the auditing appropriate for each of the security controls to be implemented. To balance auditing requirements with other information system needs, this control also requires identifying that subset of auditable events that are audited at a given point in time. For example, organizations may determine that information systems must have the capability to log every file access both successful and unsuccessful, but not activate that capability except for specific circumstances due to the potential burden on system performance. Auditing requirements, including the need for auditable events, may be referenced in other security controls and control enhancements. Organizations also include auditable events that are required by applicable federal laws, Executive Orders, directives, policies, regulations, and standards. Audit records can be generated at various levels of abstraction, including at the packet level as information traverses the network. Selecting the appropriate level of abstraction is a critical aspect of an audit capability and can facilitate the identification of root causes

to problems. Organizations consider in the definition of auditable events, the auditing necessary to cover related events such as the steps in distributed, transaction-based processes (e.g., processes that are distributed across multiple organizations) and actions that occur in service-oriented architectures.

Related Controls: AC-6, AC-17, AU-3, AU-12, MA-4, MP-2, MP-4, SI-4

AU-2a.

Determines that the information system is capable of auditing the following events: [Assignment: organization-defined auditable events];

AU-2b.

Coordinates the security audit function with other organizational entities requiring audit-related information to enhance mutual support and to help guide the selection of auditable events;

AU-2c.

Provides a rationale for why the auditable events are deemed to be adequate to support after-the-fact investigations of security incidents; and

AU-2d.

Determines that the following events are to be audited within the information system: [Assignment: organization-defined audited events (the subset of the auditable events defined in AU-2 a.) along with the frequency of (or situation requiring) auditing for each identified event].

AU-2 (1) : COMPILATION OF AUDIT RECORDS FROM MULTIPLE SOURCES

[Withdrawn: Incorporated into AU-12].

AU-2 (2) : SELECTION OF AUDIT EVENTS BY COMPONENT

[Withdrawn: Incorporated into AU-12].

AU-2 (3) : REVIEWS AND UPDATES

Baseline-Impact: *MODERATE*, **HIGH**

The organization reviews and updates the audited events [Assignment: organization-defined frequency].

Note

Over time, the events that organizations believe should be audited may change. Reviewing and updating the set of audited events periodically is necessary to ensure that the current set is still necessary and sufficient.

AU-2 (4) : PRIVILEGED FUNCTIONS

[Withdrawn: Incorporated into AC-6 (9)].

Control Family: AUDIT AND ACCOUNTABILITY

AU-3 : CONTENT OF AUDIT RECORDS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system generates audit records containing information that establishes what type of event occurred, when the event occurred, where the event occurred, the source of the event, the outcome of the event, and the identity of any individuals or subjects associated with the event.

Note

Audit record content that may be necessary to satisfy the requirement of this control, includes, for example, time stamps, source and destination addresses, user/process identifiers, event descriptions, success/fail indications, filenames involved, and access control or flow control rules invoked. Event outcomes can include indicators of event success or failure and event-specific results (e.g., the security state of the information system after the event occurred).

Related Controls: AU-2, AU-8, AU-12, SI-11

AU-3 (1) : ADDITIONAL AUDIT INFORMATION

Baseline-Impact: *MODERATE*, **HIGH**

The information system generates audit records containing the following additional information: [Assignment: organization-defined additional, more detailed information].

Note

Detailed information that organizations may consider in audit records includes, for example, full text recording of privileged commands or the individual identities of group account users. Organizations consider limiting the additional audit information to only that information explicitly needed for specific audit requirements. This facilitates the use of audit trails and audit logs by not including information that could potentially be misleading or could make it more difficult to locate information of interest.

AU-3 (2) : CENTRALIZED MANAGEMENT OF PLANNED AUDIT RECORD CONTENT

Baseline-Impact: HIGH

The information system provides centralized management and configuration of the content to be captured in audit records generated by [Assignment: organization-defined information system components].

Note

This control enhancement requires that the content to be captured in audit records be configured from a central location (necessitating automation). Organizations coordinate the selection of required audit content to support the centralized management and configuration capability provided by the information system.

Related Controls: AU-6, AU-7

Control Family: AUDIT AND ACCOUNTABILITY

AU-4 : AUDIT STORAGE CAPACITY

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization allocates audit record storage capacity in accordance with [Assignment: organization-defined audit record storage requirements].

Note

Organizations consider the types of auditing to be performed and the audit processing requirements when allocating audit storage capacity. Allocating sufficient audit storage capacity reduces the likelihood of such capacity being exceeded and resulting in the potential loss or reduction of auditing capability.

Related Controls: AU-2, AU-5, AU-6, AU-7, AU-11, SI-4

AU-4 (1) : TRANSFER TO ALTERNATE STORAGE

The information system off-loads audit records [Assignment: organization-defined frequency] onto a different system or media than the system being audited.

Note

Off-loading is a process designed to preserve the confidentiality and integrity of audit records by moving the records from the primary information system to a secondary or alternate system. It is a common process in information systems with limited audit storage capacity; the audit storage is used only in a transitory fashion until the system can communicate with the secondary or alternate system designated for storing the audit records, at which point the information is transferred.

Control Family: AUDIT AND ACCOUNTABILITY

AU-5 : RESPONSE TO AUDIT PROCESSING FAILURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system:

Note

Audit processing failures include, for example, software/hardware errors, failures in the audit capturing mechanisms, and audit storage capacity being reached or exceeded. Organizations may choose to define additional actions for different audit processing failures (e.g., by type, by location, by severity, or a combination of such factors). This control applies to each audit data storage repository (i.e., distinct information system component where audit records are stored), the total audit storage capacity of organizations (i.e., all audit data storage repositories combined), or both.

Related Controls: AU-4, SI-12

AU-5a.

Alerts [Assignment: organization-defined personnel or roles] in the event of an audit processing failure; and

AU-5b.

Takes the following additional actions: [Assignment: organization-defined actions to be taken (e.g., shut down information system, overwrite oldest audit records, stop generating audit records)].

AU-5 (1) : AUDIT STORAGE CAPACITY

Baseline-Impact: HIGH

The information system provides a warning to [Assignment: organization-defined personnel, roles, and/or locations] within [Assignment: organization-defined time period] when allocated audit record storage volume reaches [Assignment: organization-defined percentage] of repository maximum audit record storage capacity.

Note

Organizations may have multiple audit data storage repositories distributed across multiple information system components, with each repository having different storage volume capacities.

AU-5 (2) : REAL-TIME ALERTS

Baseline-Impact: HIGH

The information system provides an alert in [Assignment: organization-defined real-time period] to [Assignment: organization-defined personnel, roles, and/or locations] when the following audit failure events occur: [Assignment: organization-defined audit failure events requiring real-time alerts].

Note

Alerts provide organizations with urgent messages. Real-time alerts provide these messages at information technology speed (i.e., the time from event detection to alert occurs in seconds or less).

AU-5 (3) : CONFIGURABLE TRAFFIC VOLUME THRESHOLDS

The information system enforces configurable network communications traffic volume thresholds reflecting limits on auditing capacity and [Selection: rejects; delays] network traffic above those thresholds.

Note

Organizations have the capability to reject or delay the processing of network communications traffic if auditing such traffic is determined to exceed the storage capacity of the information system audit

function. The rejection or delay response is triggered by the established organizational traffic volume thresholds which can be adjusted based on changes to audit storage capacity.

AU-5 (4) : SHUTDOWN ON FAILURE

The information system invokes a [Selection: full system shutdown; partial system shutdown; degraded operational mode with limited mission/business functionality available] in the event of [Assignment: organization-defined audit failures], unless an alternate audit capability exists.

Note

Organizations determine the types of audit failures that can trigger automatic information system shutdowns or degraded operations. Because of the importance of ensuring mission/business continuity, organizations may determine that the nature of the audit failure is not so severe that it warrants a complete shutdown of the information system supporting the core organizational missions/business operations. In those instances, partial information system shutdowns or operating in a degraded mode with reduced capability may be viable alternatives.

Related Controls: AU-15

Control Family: AUDIT AND ACCOUNTABILITY

AU-6 : AUDIT REVIEW, ANALYSIS, AND REPORTING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Audit review, analysis, and reporting covers information security-related auditing performed by organizations including, for example, auditing that results from monitoring of account usage, remote access, wireless connectivity, mobile device connection, configuration settings, system component inventory, use of maintenance tools and nonlocal maintenance, physical access, temperature and humidity, equipment delivery and removal, communications at the information system boundaries, use of mobile code, and use of VoIP. Findings can be reported to organizational entities that include, for example, incident response team, help desk, information security group/department. If organizations are prohibited from reviewing and analyzing audit information or unable to conduct such activities (e.g., in certain national security applications or systems), the review/analysis may be carried out by other organizations granted such authority.

Related Controls: AC-2, AC-3, AC-6, AC-17, AT-3, AU-7, AU-16, CA-7, CM-5, CM-10, CM-11, IA-3, IA-5, IR-5, IR-6, MA-4, MP-4, PE-3, PE-6, PE-14, PE-16, RA-5, SC-7, SC-18, SC-19, SI-3, SI-4, SI-7

AU-6a.

Reviews and analyzes information system audit records [Assignment: organization-defined frequency] for indications of [Assignment: organization-defined inappropriate or unusual activity]; and

AU-6b.

Reports findings to [Assignment: organization-defined personnel or roles].

AU-6 (1) : PROCESS INTEGRATION

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs automated mechanisms to integrate audit review, analysis, and reporting processes to support organizational processes for investigation and response to suspicious activities.

Note

Organizational processes benefiting from integrated audit review, analysis, and reporting include, for example, incident response, continuous monitoring, contingency planning, and Inspector General audits.

Related Controls: AU-12, PM-7

AU-6 (2) : AUTOMATED SECURITY ALERTS

[Withdrawn: Incorporated into SI-4].

AU-6 (3) : CORRELATE AUDIT REPOSITORIES

Baseline-Impact: *MODERATE*, **HIGH**

The organization analyzes and correlates audit records across different repositories to gain organization-wide situational awareness.

Note

Organization-wide situational awareness includes awareness across all three tiers of risk management (i.e., organizational, mission/business process, and information system) and supports cross-organization awareness.

Related Controls: AU-12, IR-4

AU-6 (4) : CENTRAL REVIEW AND ANALYSIS

The information system provides the capability to centrally review and analyze audit records from multiple components within the system.

Note

Automated mechanisms for centralized reviews and analyses include, for example, Security Information Management products.

Related Controls: AU-2, AU-12

AU-6 (5) : INTEGRATION / SCANNING AND MONITORING CAPABILITIES

Baseline-Impact: HIGH

The organization integrates analysis of audit records with analysis of [Selection (one or more): vulnerability scanning information; performance data; information system monitoring information; [Assignment: organization-defined data/information collected from other sources]] to further enhance the ability to identify inappropriate or unusual activity.

Note

This control enhancement does not require vulnerability scanning, the generation of performance data, or information system monitoring. Rather, the enhancement requires that the analysis of information being otherwise produced in these areas is integrated with the analysis of audit information. Security Event and Information Management System tools can facilitate audit record aggregation/consolidation from multiple information system components as well as audit record correlation and analysis. The use of standardized audit record analysis scripts developed by organizations (with localized script adjustments, as necessary) provides more cost-effective approaches for analyzing audit record information collected. The correlation of audit record information with vulnerability scanning information is important in determining the veracity of vulnerability scans and correlating attack detection events with scanning results. Correlation with performance data can help uncover denial of service attacks or cyber attacks resulting in unauthorized use of resources. Correlation with system monitoring information can assist in uncovering attacks and in better relating audit information to operational situations.

Related Controls: AU-12, IR-4, RA-5

AU-6 (6) : CORRELATION WITH PHYSICAL MONITORING

Baseline-Impact: HIGH

The organization correlates information from audit records with information obtained from monitoring physical access to further enhance the ability to identify suspicious, inappropriate, unusual, or malevolent activity.

Note

The correlation of physical audit information and audit logs from information systems may assist organizations in identifying examples of suspicious behavior or supporting evidence of such behavior. For example, the correlation of an individual's identity for logical access to certain information systems with the additional physical security information that the individual was actually present at the facility when the logical access occurred, may prove to be useful in investigations.

AU-6 (7) : PERMITTED ACTIONS

The organization specifies the permitted actions for each [Selection (one or more): information system process; role; user] associated with the review, analysis, and reporting of audit information.

Note

Organizations specify permitted actions for information system processes, roles, and/or users associated with the review, analysis, and reporting of audit records through account management techniques. Specifying permitted actions on audit information is a way to enforce the principle of least

privilege. Permitted actions are enforced by the information system and include, for example, read, write, execute, append, and delete.

AU-6 (8) : FULL TEXT ANALYSIS OF PRIVILEGED COMMANDS

The organization performs a full text analysis of audited privileged commands in a physically distinct component or subsystem of the information system, or other information system that is dedicated to that analysis.

Note

This control enhancement requires a distinct environment for the dedicated analysis of audit information related to privileged users without compromising such information on the information system where the users have elevated privileges including the capability to execute privileged commands. Full text analysis refers to analysis that considers the full text of privileged commands (i.e., commands and all parameters) as opposed to analysis that considers only the name of the command. Full text analysis includes, for example, the use of pattern matching and heuristics.

Related Controls: AU-3, AU-9, AU-11, AU-12

AU-6 (9) : CORRELATION WITH INFORMATION FROM NONTECHNICAL SOURCES

The organization correlates information from nontechnical sources with audit information to enhance organization-wide situational awareness.

Note

Nontechnical sources include, for example, human resources records documenting organizational policy violations (e.g., sexual harassment incidents, improper use of organizational information assets). Such information can lead organizations to a more directed analytical effort to detect potential malicious insider activity. Due to the sensitive nature of the information available from nontechnical sources, organizations limit access to such information to minimize the potential for the inadvertent release of privacy-related information to individuals that do not have a need to know. Thus, correlation of information from nontechnical sources with audit information generally occurs only when individuals are suspected of being involved in a security incident. Organizations obtain legal advice prior to initiating such actions.

Related Controls: AT-2

AU-6 (10) : AUDIT LEVEL ADJUSTMENT

The organization adjusts the level of audit review, analysis, and reporting within the information system when there is a change in risk based on law enforcement information, intelligence information, or other credible sources of information.

Note

The frequency, scope, and/or depth of the audit review, analysis, and reporting may be adjusted to meet organizational needs based on new information received.

Control Family: AUDIT AND ACCOUNTABILITY

AU-7 : AUDIT REDUCTION AND REPORT GENERATION

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The information system provides an audit reduction and report generation capability that:

Note

Audit reduction is a process that manipulates collected audit information and organizes such information in a summary format that is more meaningful to analysts. Audit reduction and report generation capabilities do not always emanate from the same information system or from the same organizational entities conducting auditing activities. Audit reduction capability can include, for example, modern data mining techniques with advanced data filters to identify anomalous behavior in audit records. The report generation capability provided by the information system can generate customizable reports. Time ordering of audit records can be a significant issue if the granularity of the timestamp in the record is insufficient.

Related Controls: AU-6

AU-7a.

Supports on-demand audit review, analysis, and reporting requirements and after-the-fact investigations of security incidents; and

AU-7b.

Does not alter the original content or time ordering of audit records.

AU-7 (1) : AUTOMATIC PROCESSING

Baseline-Impact: *MODERATE*, **HIGH**

The information system provides the capability to process audit records for events of interest based on [Assignment: organization-defined audit fields within audit records].

Note

Events of interest can be identified by the content of specific audit record fields including, for example, identities of individuals, event types, event locations, event times, event dates, system resources involved, IP addresses involved, or information objects accessed. Organizations may define audit event criteria to any degree of granularity required, for example, locations selectable by general networking location (e.g., by network or subnetwork) or selectable by specific information system component.

Related Controls: AU-2, AU-12

AU-7 (2) : AUTOMATIC SORT AND SEARCH

The information system provides the capability to sort and search audit records for events of interest based on the content of [Assignment: organization-defined audit fields within audit records].

Note

Sorting and searching of audit records may be based upon the contents of audit record fields, for example: (i) date/time of events; (ii) user identifiers; (iii) Internet Protocol (IP) addresses involved in the event; (iv) type of event; or (v) event success/failure.

Control Family: AUDIT AND ACCOUNTABILITY

AU-8 : TIME STAMPS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system:

Note

Time stamps generated by the information system include date and time. Time is commonly expressed in Coordinated Universal Time (UTC), a modern continuation of Greenwich Mean Time (GMT), or local time with an offset from UTC. Granularity of time measurements refers to the degree of synchronization between information system clocks and reference clocks, for example, clocks synchronizing within hundreds of milliseconds or within tens of milliseconds. Organizations may define different time granularities for different system components. Time service can also be critical to other security capabilities such as access control and identification and authentication, depending on the nature of the mechanisms used to support those capabilities.

Related Controls: AU-3, AU-12

AU-8a.

Uses internal system clocks to generate time stamps for audit records; and

AU-8b.

Records time stamps for audit records that can be mapped to Coordinated Universal Time (UTC) or Greenwich Mean Time (GMT) and meets [Assignment: organization-defined granularity of time measurement].

AU-8 (1) : SYNCHRONIZATION WITH AUTHORITATIVE TIME SOURCE

Baseline-Impact: *MODERATE*, **HIGH**

The information system:

Note

This control enhancement provides uniformity of time stamps for information systems with multiple system clocks and systems connected over a network.

AU-8 (1)(a)

Compares the internal information system clocks [Assignment: organization-defined frequency] with [Assignment: organization-defined authoritative time source]; and

AU-8 (1)(b)

Synchronizes the internal system clocks to the authoritative time source when the time difference is greater than [Assignment: organization-defined time period].

AU-8 (2) : SECONDARY AUTHORITATIVE TIME SOURCE

The information system identifies a secondary authoritative time source that is located in a different geographic region than the primary authoritative time source.

Control Family: AUDIT AND ACCOUNTABILITY

AU-9 : PROTECTION OF AUDIT INFORMATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system protects audit information and audit tools from unauthorized access, modification, and deletion.

Note

Audit information includes all information (e.g., audit records, audit settings, and audit reports) needed to successfully audit information system activity. This control focuses on technical protection of audit information. Physical protection of audit information is addressed by media protection controls and physical and environmental protection controls.

Related Controls: AC-3, AC-6, MP-2, MP-4, PE-2, PE-3, PE-6

AU-9 (1) : HARDWARE WRITE-ONCE MEDIA

The information system writes audit trails to hardware-enforced, write-once media.

Note

This control enhancement applies to the initial generation of audit trails (i.e., the collection of audit records that represents the audit information to be used for detection, analysis, and reporting purposes) and to the backup of those audit trails. The enhancement does not apply to the initial generation of audit records prior to being written to an audit trail. Write-once, read-many (WORM) media includes, for example, Compact Disk-Recordable (CD-R) and Digital Video Disk-Recordable (DVD-R). In contrast, the use of switchable write-protection media such as on tape cartridges or Universal Serial Bus (USB) drives results in write-protected, but not write-once, media.

Related Controls: AU-4, AU-5

AU-9 (2) : AUDIT BACKUP ON SEPARATE PHYSICAL SYSTEMS / COMPONENTS

Baseline-Impact: HIGH

The information system backs up audit records [Assignment: organization-defined frequency] onto a physically different system or system component than the system or component being audited.

Note

This control enhancement helps to ensure that a compromise of the information system being audited does not also result in a compromise of the audit records.

Related Controls: AU-4, AU-5, AU-11

AU-9 (3) : CRYPTOGRAPHIC PROTECTION

Baseline-Impact: HIGH

The information system implements cryptographic mechanisms to protect the integrity of audit information and audit tools.

Note

Cryptographic mechanisms used for protecting the integrity of audit information include, for example, signed hash functions using asymmetric cryptography enabling distribution of the public key to verify the hash information while maintaining the confidentiality of the secret key used to generate the hash.

Related Controls: AU-10, SC-12, SC-13

AU-9 (4) : ACCESS BY SUBSET OF PRIVILEGED USERS

Baseline-Impact: *MODERATE*, **HIGH**

The organization authorizes access to management of audit functionality to only [Assignment: organization-defined subset of privileged users].

Note

Individuals with privileged access to an information system and who are also the subject of an audit by that system, may affect the reliability of audit information by inhibiting audit activities or modifying audit records. This control enhancement requires that privileged access be further defined between audit-related privileges and other privileges, thus limiting the users with audit-related privileges.

Related Controls: AC-5

AU-9 (5) : DUAL AUTHORIZATION

The organization enforces dual authorization for [Selection (one or more): movement; deletion] of [Assignment: organization-defined audit information].

Note

Organizations may choose different selection options for different types of audit information. Dual authorization mechanisms require the approval of two authorized individuals in order to execute. Dual authorization may also be known as two-person control.

Related Controls: AC-3, MP-2

AU-9 (6) : READ ONLY ACCESS

The organization authorizes read-only access to audit information to [Assignment: organization-defined subset of privileged users].

Note

Restricting privileged user authorizations to read-only helps to limit the potential damage to organizations that could be initiated by such users (e.g., deleting audit records to cover up malicious activity).

Control Family: AUDIT AND ACCOUNTABILITY

AU-10 : NON-REPUDIATION

Priority: P2

Baseline-Impact: HIGH

The information system protects against an individual (or process acting on behalf of an individual) falsely denying having performed [Assignment: organization-defined actions to be covered by non-repudiation].

Note

Types of individual actions covered by non-repudiation include, for example, creating information, sending and receiving messages, approving information (e.g., indicating concurrence or signing a contract). Non-repudiation protects individuals against later claims by: (i) authors of not having

authored particular documents; (ii) senders of not having transmitted messages; (iii) receivers of not having received messages; or (iv) signatories of not having signed documents. Non-repudiation services can be used to determine if information originated from a particular individual, or if an individual took specific actions (e.g., sending an email, signing a contract, approving a procurement request) or received specific information. Organizations obtain non-repudiation services by employing various techniques or mechanisms (e.g., digital signatures, digital message receipts).

Related Controls: SC-12, SC-8, SC-13, SC-16, SC-17, SC-23

AU-10 (1) : ASSOCIATION OF IDENTITIES

The information system:

Note

This control enhancement supports audit requirements that provide organizational personnel with the means to identify who produced specific information in the event of an information transfer. Organizations determine and approve the strength of the binding between the information producer and the information based on the security category of the information and relevant risk factors.

Related Controls: AC-4, AC-16

AU-10 (1)(a)

Binds the identity of the information producer with the information to [Assignment: organization-defined strength of binding]; and

AU-10 (1)(b)

Provides the means for authorized individuals to determine the identity of the producer of the information.

AU-10 (2) : VALIDATE BINDING OF INFORMATION PRODUCER IDENTITY

The information system:

Note

This control enhancement prevents the modification of information between production and review. The validation of bindings can be achieved, for example, by the use of cryptographic checksums. Organizations determine if validations are in response to user requests or generated automatically.

Related Controls: AC-3, AC-4, AC-16

AU-10 (2)(a)

Validates the binding of the information producer identity to the information at [Assignment: organization-defined frequency]; and

AU-10 (2)(b)

Performs [Assignment: organization-defined actions] in the event of a validation error.

AU-10 (3) : CHAIN OF CUSTODY

The information system maintains reviewer/releaser identity and credentials within the established chain of custody for all information reviewed or released.

Note

Chain of custody is a process that tracks the movement of evidence through its collection, safeguarding, and analysis life cycle by documenting each person who handled the evidence, the date and time it was collected or transferred, and the purpose for the transfer. If the reviewer is a human or if the review function is automated but separate from the release/transfer function, the information system associates the identity of the reviewer of the information to be released with the information and the information label. In the case of human reviews, this control enhancement provides organizational officials the means to identify who reviewed and released the information. In the case of automated reviews, this control enhancement ensures that only approved review functions are employed.

Related Controls: AC-4, AC-16

AU-10 (4) : VALIDATE BINDING OF INFORMATION REVIEWER IDENTITY

The information system:

Note

This control enhancement prevents the modification of information between review and transfer/release. The validation of bindings can be achieved, for example, by the use of cryptographic checksums. Organizations determine validations are in response to user requests or generated automatically.

Related Controls: AC-4, AC-16

AU-10 (4)(a)

Validates the binding of the information reviewer identity to the information at the transfer or release points prior to release/transfer between [Assignment: organization-defined security domains]; and

AU-10 (4)(b)

Performs [Assignment: organization-defined actions] in the event of a validation error.

AU-10 (5) : DIGITAL SIGNATURES

[Withdrawn: Incorporated into SI-7].

Control Family: AUDIT AND ACCOUNTABILITY

AU-11 : AUDIT RECORD RETENTION

Priority: P3

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization retains audit records for [Assignment: organization-defined time period consistent with records retention policy] to provide support for after-the-fact investigations of security incidents and to meet regulatory and organizational information retention requirements.

Note

Organizations retain audit records until it is determined that they are no longer needed for administrative, legal, audit, or other operational purposes. This includes, for example, retention and availability of audit records relative to Freedom of Information Act (FOIA) requests, subpoenas, and law enforcement actions. Organizations develop standard categories of audit records relative to such types of actions and standard response processes for each type of action. The National Archives and Records Administration (NARA) General Records Schedules provide federal policy on record retention.

Related Controls: AU-4, AU-5, AU-9, MP-6

AU-11 (1) : LONG-TERM RETRIEVAL CAPABILITY

The organization employs [Assignment: organization-defined measures] to ensure that long-term audit records generated by the information system can be retrieved.

Note

Measures employed by organizations to help facilitate the retrieval of audit records include, for example, converting records to newer formats, retaining equipment capable of reading the records, and retaining necessary documentation to help organizational personnel understand how to interpret the records.

Control Family: AUDIT AND ACCOUNTABILITY

AU-12 : AUDIT GENERATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system:

Note

Audit records can be generated from many different information system components. The list of audited events is the set of events for which audits are to be generated. These events are typically a subset of all events for which the information system is capable of generating audit records.

Related Controls: AC-3, AU-2, AU-3, AU-6, AU-7

AU-12a.

Provides audit record generation capability for the auditable events defined in AU-2 a. at [Assignment: organization-defined information system components];

AU-12b.

Allows [Assignment: organization-defined personnel or roles] to select which auditable events are to be audited by specific components of the information system; and

AU-12c.

Generates audit records for the events defined in AU-2 d. with the content defined in AU-3.

AU-12 (1) : SYSTEM-WIDE / TIME-CORRELATED AUDIT TRAIL

Baseline-Impact: HIGH

The information system compiles audit records from [Assignment: organization-defined information system components] into a system-wide (logical or physical) audit trail that is time-correlated to within [Assignment: organization-defined level of tolerance for the relationship between time stamps of individual records in the audit trail].

Note

Audit trails are time-correlated if the time stamps in the individual audit records can be reliably related to the time stamps in other audit records to achieve a time ordering of the records within organizational tolerances.

Related Controls: AU-8, AU-12

AU-12 (2) : STANDARDIZED FORMATS

The information system produces a system-wide (logical or physical) audit trail composed of audit records in a standardized format.

Note

Audit information that is normalized to common standards promotes interoperability and exchange of such information between dissimilar devices and information systems. This facilitates production of event information that can be more readily analyzed and correlated. Standard formats for audit records include, for example, system log records and audit records compliant with Common Event Expressions (CEE). If logging mechanisms within information systems do not conform to standardized formats, systems may convert individual audit records into standardized formats when compiling system-wide audit trails.

AU-12 (3) : CHANGES BY AUTHORIZED INDIVIDUALS

Baseline-Impact: HIGH

The information system provides the capability for [Assignment: organization-defined individuals or roles] to change the auditing to be performed on [Assignment: organization-defined information system components] based on [Assignment: organization-defined selectable event criteria] within [Assignment: organization-defined time thresholds].

Note

This control enhancement enables organizations to extend or limit auditing as necessary to meet organizational requirements. Auditing that is limited to conserve information system resources may be extended to address certain threat situations. In addition, auditing may be limited to a specific set of events to facilitate audit reduction, analysis, and reporting. Organizations can establish time thresholds in which audit actions are changed, for example, near real-time, within minutes, or within hours.

Related Controls: AU-7

Control Family: AUDIT AND ACCOUNTABILITY

AU-13 : MONITORING FOR INFORMATION DISCLOSURE

Priority: P0

The organization monitors [Assignment: organization-defined open source information and/or information sites] [Assignment: organization-defined frequency] for evidence of unauthorized disclosure of organizational information.

Note

Open source information includes, for example, social networking sites.

Related Controls: PE-3, SC-7

AU-13 (1) : USE OF AUTOMATED TOOLS

The organization employs automated mechanisms to determine if organizational information has been disclosed in an unauthorized manner.

Note

Automated mechanisms can include, for example, automated scripts to monitor new posts on selected websites, and commercial services providing notifications and alerts to organizations.

AU-13 (2) : REVIEW OF MONITORED SITES

The organization reviews the open source information sites being monitored [Assignment: organization-defined frequency].

Control Family: AUDIT AND ACCOUNTABILITY

AU-14 : SESSION AUDIT

Priority: P0

The information system provides the capability for authorized users to select a user session to capture/record or view/hear.

Note

Session audits include, for example, monitoring keystrokes, tracking websites visited, and recording information and/or file transfers. Session auditing activities are developed, integrated, and used in consultation with legal counsel in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, or standards.

Related Controls: AC-3, AU-4, AU-5, AU-9, AU-11

AU-14 (1) : SYSTEM START-UP

The information system initiates session audits at system start-up.

AU-14 (2) : CAPTURE/RECORD AND LOG CONTENT

The information system provides the capability for authorized users to capture/record and log content related to a user session.

AU-14 (3) : REMOTE VIEWING / LISTENING

The information system provides the capability for authorized users to remotely view/hear all content related to an established user session in real time.

Control Family: AUDIT AND ACCOUNTABILITY

AU-15 : ALTERNATE AUDIT CAPABILITY

Priority: P0

The organization provides an alternate audit capability in the event of a failure in primary audit capability that provides [Assignment: organization-defined alternate audit functionality].

Note

Since an alternate audit capability may be a short-term protection employed until the failure in the primary auditing capability is corrected, organizations may determine that the alternate audit capability need only provide a subset of the primary audit functionality that is impacted by the failure.

Related Controls: AU-5

Control Family: AUDIT AND ACCOUNTABILITY

AU-16 : CROSS-ORGANIZATIONAL AUDITING

Priority: P0

The organization employs [Assignment: organization-defined methods] for coordinating [Assignment: organization-defined audit information] among external organizations when audit information is transmitted across organizational boundaries.

Note

When organizations use information systems and/or services of external organizations, the auditing capability necessitates a coordinated approach across organizations. For example, maintaining the identity of individuals that requested particular services across organizational boundaries may often be very difficult, and doing so may prove to have significant performance ramifications. Therefore, it is often the case that cross-organizational auditing (e.g., the type of auditing capability provided by service-oriented architectures) simply captures the identity of individuals issuing requests at the initial information system, and subsequent systems record that the requests emanated from authorized individuals.

Related Controls: AU-6

AU-16 (1) : IDENTITY PRESERVATION

The organization requires that the identity of individuals be preserved in cross-organizational audit trails.

Note

This control enhancement applies when there is a need to be able to trace actions that are performed across organizational boundaries to a specific individual.

AU-16 (2) : SHARING OF AUDIT INFORMATION

The organization provides cross-organizational audit information to [Assignment: organization-defined organizations] based on [Assignment: organization-defined cross-organizational sharing agreements].

Note

Because of the distributed nature of the audit information, cross-organization sharing of audit information may be essential for effective analysis of the auditing being performed. For example, the audit records of one organization may not provide sufficient information to determine the appropriate or inappropriate use of organizational information resources by individuals in other organizations. In some instances, only the home organizations of individuals have the appropriate knowledge to make such determinations, thus requiring the sharing of audit information among organizations.

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-1 : SECURITY ASSESSMENT AND AUTHORIZATION POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the CA family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

CA-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

CA-1a.1.

A security assessment and authorization policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

CA-1a.2.

Procedures to facilitate the implementation of the security assessment and authorization policy and associated security assessment and authorization controls; and

CA-1b.

Reviews and updates the current:

CA-1b.1.

Security assessment and authorization policy [Assignment: organization-defined frequency]; and

CA-1b.2.

Security assessment and authorization procedures [Assignment: organization-defined frequency].

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-2 : SECURITY ASSESSMENTS

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Organizations assess security controls in organizational information systems and the environments in which those systems operate as part of: (i) initial and ongoing security authorizations; (ii) FISMA annual assessments; (iii) continuous monitoring; and (iv) system development life cycle activities. Security assessments: (i) ensure that information security is built into organizational information systems; (ii) identify weaknesses and deficiencies early in the development process; (iii) provide essential information needed to make risk-based decisions as part of security authorization processes; and (iv) ensure compliance to vulnerability mitigation procedures. Assessments are conducted on the implemented security controls from Appendix F (main catalog) and Appendix G (Program Management controls) as documented in System Security Plans and Information Security Program Plans. Organizations can use other types of assessment activities such as vulnerability scanning and system monitoring to maintain the security posture of information systems during the entire life cycle. Security assessment reports document assessment results in sufficient detail as deemed necessary by organizations, to determine the accuracy and completeness of the reports and whether the security controls are implemented correctly, operating as intended, and producing the desired outcome with respect to meeting security requirements. The FISMA requirement for assessing security controls at least annually does not require additional assessment activities to those activities already in place in organizational security authorization processes. Security assessment results are provided to the individuals or roles appropriate for the types of assessments being conducted. For example, assessments conducted in support of security authorization decisions are provided to authorizing officials or authorizing official designated representatives.

To satisfy annual assessment requirements, organizations can use assessment results from the following sources: (i) initial or ongoing information system authorizations; (ii) continuous monitoring; or (iii) system development life cycle activities. Organizations ensure that security assessment results are current, relevant to the determination of security control effectiveness, and obtained with the appropriate level of assessor independence. Existing security control assessment results can be reused to the extent that the results are still valid and can also be supplemented with additional assessments as needed. Subsequent to initial authorizations and in accordance with OMB policy, organizations assess security controls during continuous monitoring. Organizations establish the frequency for ongoing security control assessments in accordance with organizational continuous monitoring strategies. Information Assurance Vulnerability Alerts provide useful examples of vulnerability mitigation procedures. External audits (e.g., audits by external entities such as regulatory agencies) are outside the scope of this control.

Related Controls: CA-5, CA-6, CA-7, PM-9, RA-5, SA-11, SA-12, SI-4

CA-2a.

Develops a security assessment plan that describes the scope of the assessment including:

CA-2a.1.

Security controls and control enhancements under assessment;

CA-2a.2.

Assessment procedures to be used to determine security control effectiveness; and

CA-2a.3.

Assessment environment, assessment team, and assessment roles and responsibilities;

CA-2b.

Assesses the security controls in the information system and its environment of operation [Assignment: organization-defined frequency] to determine the extent to which the controls are implemented correctly, operating as intended, and producing the desired outcome with respect to meeting established security requirements;

CA-2c.

Produces a security assessment report that documents the results of the assessment; and

CA-2d.

Provides the results of the security control assessment to [Assignment: organization-defined individuals or roles].

CA-2 (1) : INDEPENDENT ASSESSORS

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs assessors or assessment teams with [Assignment: organization-defined level of independence] to conduct security control assessments.

Note

Independent assessors or assessment teams are individuals or groups who conduct impartial assessments of organizational information systems. Impartiality implies that assessors are free from any perceived or actual conflicts of interest with regard to the development, operation, or management of the organizational information systems under assessment or to the determination of security control effectiveness. To achieve impartiality, assessors should not: (i) create a mutual or conflicting interest with the organizations where the assessments are being conducted; (ii) assess their own work; (iii) act as management or employees of the organizations they are serving; or (iv) place themselves in positions of advocacy for the organizations acquiring their services. Independent assessments can be obtained from elements within organizations or can be contracted to public or private sector entities outside of organizations. Authorizing officials determine the required level of independence based on the security categories of information systems and/or the ultimate risk to organizational operations, organizational assets, or individuals. Authorizing officials also determine if the level of assessor independence provides sufficient assurance that the results are sound and can be used to make credible, risk-based decisions. This includes determining whether contracted security assessment services have sufficient independence, for example, when information system owners are not directly involved in contracting processes or cannot unduly influence the impartiality of assessors conducting assessments. In special situations, for example, when organizations that own the information systems are small or organizational structures require that assessments are conducted by individuals that are in the developmental, operational, or management chain of system owners, independence in assessment processes can be achieved by ensuring that assessment results are carefully reviewed and analyzed by independent teams of experts to validate the completeness, accuracy, integrity, and reliability of the results. Organizations recognize that assessments performed for purposes other than direct support to authorization decisions are, when performed by assessors with sufficient independence, more likely to be useable for such decisions, thereby reducing the need to repeat assessments.

CA-2 (2) : SPECIALIZED ASSESSMENTS

Baseline-Impact: HIGH

The organization includes as part of security control assessments, [Assignment: organization-defined frequency], [Selection: announced; unannounced], [Selection (one or more): in-depth monitoring; vulnerability scanning; malicious user testing; insider threat assessment; performance/load testing; [Assignment: organization-defined other forms of security assessment]].

Note

Organizations can employ information system monitoring, insider threat assessments, malicious user testing, and other forms of testing (e.g., verification and validation) to improve readiness by exercising organizational capabilities and indicating current performance levels as a means of focusing actions to improve security. Organizations conduct assessment activities in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, and standards. Authorizing officials approve the assessment methods in coordination with the organizational risk executive function. Organizations can incorporate vulnerabilities uncovered during assessments into vulnerability remediation processes.

Related Controls: PE-3, SI-2

CA-2 (3) : EXTERNAL ORGANIZATIONS

The organization accepts the results of an assessment of [Assignment: organization-defined information system] performed by [Assignment: organization-defined external organization] when the assessment meets [Assignment: organization-defined requirements].

Note

Organizations may often rely on assessments of specific information systems by other (external) organizations. Utilizing such existing assessments (i.e., reusing existing assessment evidence) can significantly decrease the time and resources required for organizational assessments by limiting the amount of independent assessment activities that organizations need to perform. The factors that organizations may consider in determining whether to accept assessment results from external organizations can vary. Determinations for accepting assessment results can be based on, for example, past assessment experiences one organization has had with another organization, the reputation that organizations have with regard to assessments, the level of detail of supporting assessment documentation provided, or mandates imposed upon organizations by federal legislation, policies, or directives.

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-3 : SYSTEM INTERCONNECTIONS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control applies to dedicated connections between information systems (i.e., system interconnections) and does not apply to transitory, user-controlled connections such as email and website browsing. Organizations carefully consider the risks that may be introduced when information systems are connected to other systems with different security requirements and security controls, both within organizations and external to organizations. Authorizing officials determine the risk associated with information system connections and the appropriate controls employed. If interconnecting systems have the same authorizing official, organizations do not need to develop Interconnection Security Agreements. Instead, organizations can describe the interface characteristics between those interconnecting systems in their respective security plans. If interconnecting systems have different authorizing officials within the same organization, organizations can either develop Interconnection Security Agreements or describe the interface characteristics between systems in the security plans for the respective systems. Organizations may also incorporate Interconnection Security Agreement information into formal contracts, especially for interconnections established between federal agencies and nonfederal (i.e., private sector) organizations. Risk considerations also include information systems sharing the same networks. For certain technologies (e.g., space, unmanned aerial vehicles, and medical devices), there may be specialized connections in place during preoperational testing. Such connections may require Interconnection Security Agreements and be subject to additional security controls.

Related Controls: AC-3, AC-4, AC-20, AU-2, AU-12, AU-16, CA-7, IA-3, SA-9, SC-7, SI-4

CA-3a.

Authorizes connections from the information system to other information systems through the use of Interconnection Security Agreements;

CA-3b.

Documents, for each interconnection, the interface characteristics, security requirements, and the nature of the information communicated; and

CA-3c.

Reviews and updates Interconnection Security Agreements [Assignment: organization-defined frequency].

CA-3 (1) : UNCLASSIFIED NATIONAL SECURITY SYSTEM CONNECTIONS

The organization prohibits the direct connection of an [Assignment: organization-defined unclassified, national security system] to an external network without the use of [Assignment: organization-defined boundary protection device].

Note

Organizations typically do not have control over external networks (e.g., the Internet). Approved boundary protection devices (e.g., routers, firewalls) mediate communications (i.e., information flows) between unclassified national security systems and external networks. This control enhancement is required for organizations processing, storing, or transmitting Controlled Unclassified Information (CUI).

CA-3 (2) : CLASSIFIED NATIONAL SECURITY SYSTEM CONNECTIONS

The organization prohibits the direct connection of a classified, national security system to an external network without the use of [Assignment: organization-defined boundary protection device].

Note

Organizations typically do not have control over external networks (e.g., the Internet). Approved boundary protection devices (e.g., routers, firewalls) mediate communications (i.e., information flows) between classified national security systems and external networks. In addition, approved boundary protection devices (typically managed interface/cross-domain systems) provide information flow enforcement from information systems to external networks.

CA-3 (3) : UNCLASSIFIED NON-NATIONAL SECURITY SYSTEM CONNECTIONS

The organization prohibits the direct connection of an [Assignment: organization-defined unclassified, non-national security system] to an external network without the use of [Assignment; organization-defined boundary protection device].

Note

Organizations typically do not have control over external networks (e.g., the Internet). Approved boundary protection devices (e.g., routers, firewalls) mediate communications (i.e., information flows) between unclassified non-national security systems and external networks. This control enhancement is required for organizations processing, storing, or transmitting Controlled Unclassified Information (CUI).

CA-3 (4) : CONNECTIONS TO PUBLIC NETWORKS

The organization prohibits the direct connection of an [Assignment: organization-defined information system] to a public network.

Note

A public network is any network accessible to the general public including, for example, the Internet and organizational extranets with public access.

CA-3 (5) : RESTRICTIONS ON EXTERNAL SYSTEM CONNECTIONS

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs [Selection: allow-all, deny-by-exception; deny-all, permit-by-exception] policy for allowing [Assignment: organization-defined information systems] to connect to external information systems.

Note

Organizations can constrain information system connectivity to external domains (e.g., websites) by employing one of two policies with regard to such connectivity: (i) allow-all, deny by exception, also

known as blacklisting (the weaker of the two policies); or (ii) deny-all, allow by exception, also known as whitelisting (the stronger of the two policies). For either policy, organizations determine what exceptions, if any, are acceptable.

Related Controls: CM-7

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-4 : SECURITY CERTIFICATION

[Withdrawn: Incorporated into CA-2].

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-5 : PLAN OF ACTION AND MILESTONES

Priority: P3

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Plans of action and milestones are key documents in security authorization packages and are subject to federal reporting requirements established by OMB.

Related Controls: CA-2, CA-7, CM-4, PM-4

CA-5a.

Develops a plan of action and milestones for the information system to document the organization's planned remedial actions to correct weaknesses or deficiencies noted during the assessment of the security controls and to reduce or eliminate known vulnerabilities in the system; and

CA-5b.

Updates existing plan of action and milestones [Assignment: organization-defined frequency] based on the findings from security controls assessments, security impact analyses, and continuous monitoring activities.

CA-5 (1) : AUTOMATION SUPPORT FOR ACCURACY / CURRENCY

The organization employs automated mechanisms to help ensure that the plan of action and milestones for the information system is accurate, up to date, and readily available.

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-6 : SECURITY AUTHORIZATION

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Security authorizations are official management decisions, conveyed through authorization decision documents, by senior organizational officials or executives (i.e., authorizing officials) to authorize operation of information systems and to explicitly accept the risk to organizational operations and assets, individuals, other organizations, and the Nation based on the implementation of agreed-upon security controls. Authorizing officials provide budgetary oversight for organizational information systems or assume responsibility for the mission/business operations supported by those systems. The security authorization process is an inherently federal responsibility and therefore, authorizing officials must be federal employees. Through the security authorization process, authorizing officials assume responsibility and are accountable for security risks associated with the operation and use of organizational information systems. Accordingly, authorizing officials are in positions with levels of authority commensurate with understanding and accepting such information security-related risks. OMB policy requires that organizations conduct ongoing authorizations of information systems by implementing continuous monitoring programs. Continuous monitoring programs can satisfy three-year reauthorization requirements, so separate reauthorization processes are not necessary. Through the employment of comprehensive continuous monitoring processes, critical information contained in authorization packages (i.e., security plans, security assessment reports, and plans of action and milestones) is updated on an ongoing basis, providing authorizing officials and information system owners with an up-to-date status of the security state of organizational information systems and environments of operation. To reduce the administrative cost of security reauthorization, authorizing officials use the results of continuous monitoring processes to the maximum extent possible as the basis for rendering reauthorization decisions.

Related Controls: CA-2, CA-7, PM-9, PM-10

CA-6a.

Assigns a senior-level executive or manager as the authorizing official for the information system;

CA-6b.

Ensures that the authorizing official authorizes the information system for processing before commencing operations; and

CA-6c.

Updates the security authorization [Assignment: organization-defined frequency].

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-7 : CONTINUOUS MONITORING

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization develops a continuous monitoring strategy and implements a continuous monitoring program that includes:

Note

Continuous monitoring programs facilitate ongoing awareness of threats, vulnerabilities, and information security to support organizational risk management decisions. The terms continuous and ongoing imply that organizations assess/analyze security controls and information security-related risks at a frequency sufficient to support organizational risk-based decisions. The results of continuous monitoring programs generate appropriate risk response actions by organizations. Continuous monitoring programs also allow organizations to maintain the security authorizations of information systems and common controls over time in highly dynamic environments of operation with changing mission/business needs, threats, vulnerabilities, and technologies. Having access to security-related information on a continuing basis through reports/dashboards gives organizational officials the capability to make more effective and timely risk management decisions, including ongoing security authorization decisions. Automation supports more frequent updates to security authorization packages, hardware/software/firmware inventories, and other system information. Effectiveness is further enhanced when continuous monitoring outputs are formatted to provide information that is specific, measurable, actionable, relevant, and timely. Continuous monitoring activities are scaled in accordance with the security categories of information systems.

Related Controls: CA-2, CA-5, CA-6, CM-3, CM-4, PM-6, PM-9, RA-5, SA-11, SA-12, SI-2, SI-4

CA-7a.

Establishment of [Assignment: organization-defined metrics] to be monitored;

CA-7b.

Establishment of [Assignment: organization-defined frequencies] for monitoring and [Assignment: organization-defined frequencies] for assessments supporting such monitoring;

CA-7c.

Ongoing security control assessments in accordance with the organizational continuous monitoring strategy;

CA-7d.

Ongoing security status monitoring of organization-defined metrics in accordance with the organizational continuous monitoring strategy;

CA-7e.

Correlation and analysis of security-related information generated by assessments and monitoring;

CA-7f.

Response actions to address results of the analysis of security-related information; and

CA-7g.

Reporting the security status of organization and the information system to [Assignment: organization-defined personnel or roles] [Assignment: organization-defined frequency].

CA-7 (1) : INDEPENDENT ASSESSMENT

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs assessors or assessment teams with [Assignment: organization-defined level of independence] to monitor the security controls in the information system on an ongoing basis.

Note

Organizations can maximize the value of assessments of security controls during the continuous monitoring process by requiring that such assessments be conducted by assessors or assessment teams with appropriate levels of independence based on continuous monitoring strategies. Assessor independence provides a degree of impartiality to the monitoring process. To achieve such impartiality, assessors should not: (i) create a mutual or conflicting interest with the organizations where the assessments are being conducted; (ii) assess their own work; (iii) act as management or employees of the organizations they are serving; or (iv) place themselves in advocacy positions for the organizations acquiring their services.

CA-7 (2) : TYPES OF ASSESSMENTS

[Withdrawn: Incorporated into CA-2].

CA-7 (3) : TREND ANALYSES

The organization employs trend analyses to determine if security control implementations, the frequency of continuous monitoring activities, and/or the types of activities used in the continuous monitoring process need to be modified based on empirical data.

Note

Trend analyses can include, for example, examining recent threat information regarding the types of threat events that have occurred within the organization or across the federal government, success rates of certain types of cyber attacks, emerging vulnerabilities in information technologies, evolving social engineering techniques, results from multiple security control assessments, the effectiveness of configuration settings, and findings from Inspectors General or auditors.

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-8 : PENETRATION TESTING

Priority: P2

Baseline-Impact: HIGH

The organization conducts penetration testing [Assignment: organization-defined frequency] on [Assignment: organization-defined information systems or system components].

Note

Penetration testing is a specialized type of assessment conducted on information systems or individual system components to identify vulnerabilities that could be exploited by adversaries. Such

testing can be used to either validate vulnerabilities or determine the degree of resistance organizational information systems have to adversaries within a set of specified constraints (e.g., time, resources, and/or skills). Penetration testing attempts to duplicate the actions of adversaries in carrying out hostile cyber attacks against organizations and provides a more in-depth analysis of security-related weaknesses/deficiencies. Organizations can also use the results of vulnerability analyses to support penetration testing activities. Penetration testing can be conducted on the hardware, software, or firmware components of an information system and can exercise both physical and technical security controls. A standard method for penetration testing includes, for example: (i) pretest analysis based on full knowledge of the target system; (ii) pretest identification of potential vulnerabilities based on pretest analysis; and (iii) testing designed to determine exploitability of identified vulnerabilities. All parties agree to the rules of engagement before the commencement of penetration testing scenarios. Organizations correlate the penetration testing rules of engagement with the tools, techniques, and procedures that are anticipated to be employed by adversaries carrying out attacks. Organizational risk assessments guide decisions on the level of independence required for personnel conducting penetration testing.

Related Controls: SA-12

CA-8 (1) : INDEPENDENT PENETRATION AGENT OR TEAM

The organization employs an independent penetration agent or penetration team to perform penetration testing on the information system or system components.

Note

Independent penetration agents or teams are individuals or groups who conduct impartial penetration testing of organizational information systems. Impartiality implies that penetration agents or teams are free from any perceived or actual conflicts of interest with regard to the development, operation, or management of the information systems that are the targets of the penetration testing. Supplemental guidance for CA-2 (1) provides additional information regarding independent assessments that can be applied to penetration testing.

Related Controls: CA-2

CA-8 (2) : RED TEAM EXERCISES

The organization employs [Assignment: organization-defined red team exercises] to simulate attempts by adversaries to compromise organizational information systems in accordance with [Assignment: organization-defined rules of engagement].

Note

Red team exercises extend the objectives of penetration testing by examining the security posture of organizations and their ability to implement effective cyber defenses. As such, red team exercises reflect simulated adversarial attempts to compromise organizational mission/business functions and provide a comprehensive assessment of the security state of information systems and organizations. Simulated adversarial attempts to compromise organizational missions/business functions and the information systems that support those missions/functions may include technology-focused attacks (e.g., interactions with hardware, software, or firmware components and/or mission/business processes) and social engineering-based attacks (e.g., interactions via email, telephone, shoulder surfing, or personal conversations). While penetration testing may be largely laboratory-based testing, organizations use red team exercises to provide more comprehensive assessments that reflect

real-world conditions. Red team exercises can be used to improve security awareness and training and to assess levels of security control effectiveness.

Control Family: SECURITY ASSESSMENT AND AUTHORIZATION

CA-9 : INTERNAL SYSTEM CONNECTIONS

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control applies to connections between organizational information systems and (separate) constituent system components (i.e., intra-system connections) including, for example, system connections with mobile devices, notebook/desktop computers, printers, copiers, facsimile machines, scanners, sensors, and servers. Instead of authorizing each individual internal connection, organizations can authorize internal connections for a class of components with common characteristics and/or configurations, for example, all digital printers, scanners, and copiers with a specified processing, storage, and transmission capability or all smart phones with a specific baseline configuration.

Related Controls: AC-3, AC-4, AC-18, AC-19, AU-2, AU-12, CA-7, CM-2, IA-3, SC-7, SI-4

CA-9a.

Authorizes internal connections of [Assignment: organization-defined information system components or classes of components] to the information system; and

CA-9b.

Documents, for each internal connection, the interface characteristics, security requirements, and the nature of the information communicated.

CA-9 (1) : SECURITY COMPLIANCE CHECKS

The information system performs security compliance checks on constituent system components prior to the establishment of the internal connection.

Note

Security compliance checks may include, for example, verification of the relevant baseline configuration.

Related Controls: CM-6

Control Family: CONFIGURATION MANAGEMENT

CM-1 : CONFIGURATION MANAGEMENT POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

> ***Note***
>
> This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the CM family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

CM-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

CM-1a.1.

A configuration management policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

CM-1a.2.

Procedures to facilitate the implementation of the configuration management policy and associated configuration management controls; and

CM-1b.

Reviews and updates the current:

CM-1b.1.

Configuration management policy [Assignment: organization-defined frequency]; and

CM-1b.2.

Configuration management procedures [Assignment: organization-defined frequency].

Control Family: CONFIGURATION MANAGEMENT

CM-2 : BASELINE CONFIGURATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization develops, documents, and maintains under configuration control, a current baseline configuration of the information system.

Note

This control establishes baseline configurations for information systems and system components including communications and connectivity-related aspects of systems. Baseline configurations are documented, formally reviewed and agreed-upon sets of specifications for information systems or configuration items within those systems. Baseline configurations serve as a basis for future builds, releases, and/or changes to information systems. Baseline configurations include information about information system components (e.g., standard software packages installed on workstations, notebook computers, servers, network components, or mobile devices; current version numbers and patch information on operating systems and applications; and configuration settings/parameters), network topology, and the logical placement of those components within the system architecture. Maintaining baseline configurations requires creating new baselines as organizational information systems change over time. Baseline configurations of information systems reflect the current enterprise architecture.

Related Controls: CM-3, CM-6, CM-8, CM-9, SA-10, PM-5, PM-7

CM-2 (1) : REVIEWS AND UPDATES

Baseline-Impact: *MODERATE*, **HIGH**

The organization reviews and updates the baseline configuration of the information system:

Related Controls: CM-5

CM-2 (1)(a)

[Assignment: organization-defined frequency];

CM-2 (1)(b)

When required due to [Assignment organization-defined circumstances]; and

CM-2 (1)(c)

As an integral part of information system component installations and upgrades.

CM-2 (2) : AUTOMATION SUPPORT FOR ACCURACY / CURRENCY

Baseline-Impact: HIGH

The organization employs automated mechanisms to maintain an up-to-date, complete, accurate, and readily available baseline configuration of the information system.

Note

Automated mechanisms that help organizations maintain consistent baseline configurations for information systems include, for example, hardware and software inventory tools, configuration management tools, and network management tools. Such tools can be deployed and/or allocated as common controls, at the information system level, or at the operating system or component level (e.g., on workstations, servers, notebook computers, network components, or mobile devices). Tools can be used, for example, to track version numbers on operating system applications, types of

software installed, and current patch levels. This control enhancement can be satisfied by the implementation of CM-8 (2) for organizations that choose to combine information system component inventory and baseline configuration activities.

Related Controls: CM-7, RA-5

CM-2 (3) : RETENTION OF PREVIOUS CONFIGURATIONS

Baseline-Impact: *MODERATE*, **HIGH**

The organization retains [Assignment: organization-defined previous versions of baseline configurations of the information system] to support rollback.

Note

Retaining previous versions of baseline configurations to support rollback may include, for example, hardware, software, firmware, configuration files, and configuration records.

CM-2 (4) : UNAUTHORIZED SOFTWARE

[Withdrawn: Incorporated into CM-7].

CM-2 (5) : AUTHORIZED SOFTWARE

[Withdrawn: Incorporated into CM-7].

CM-2 (6) : DEVELOPMENT AND TEST ENVIRONMENTS

The organization maintains a baseline configuration for information system development and test environments that is managed separately from the operational baseline configuration.

Note

Establishing separate baseline configurations for development, testing, and operational environments helps protect information systems from unplanned/unexpected events related to development and testing activities. Separate baseline configurations allow organizations to apply the configuration management that is most appropriate for each type of configuration. For example, management of operational configurations typically emphasizes the need for stability, while management of development/test configurations requires greater flexibility. Configurations in the test environment mirror the configurations in the operational environment to the extent practicable so that the results of the testing are representative of the proposed changes to the operational systems. This control enhancement requires separate configurations but not necessarily separate physical environments.

Related Controls: CM-4, SC-3, SC-7

CM-2 (7) : CONFIGURE SYSTEMS, COMPONENTS, OR DEVICES FOR HIGH-RISK AREAS

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

When it is known that information systems, system components, or devices (e.g., notebook computers, mobile devices) will be located in high-risk areas, additional security controls may be implemented to counter the greater threat in such areas coupled with the lack of physical security relative to organizational-controlled areas. For example, organizational policies and procedures for notebook computers used by individuals departing on and returning from travel include, for example, determining which locations are of concern, defining required configurations for the devices, ensuring that the devices are configured as intended before travel is initiated, and applying specific safeguards to the device after travel is completed. Specially configured notebook computers include, for example, computers with sanitized hard drives, limited applications, and additional hardening (e.g., more stringent configuration settings). Specified safeguards applied to mobile devices upon return from travel include, for example, examining the device for signs of physical tampering and purging/reimaging the hard disk drive. Protecting information residing on mobile devices is covered in the media protection family.

CM-2 (7)(a)

Issues [Assignment: organization-defined information systems, system components, or devices] with [Assignment: organization-defined configurations] to individuals traveling to locations that the organization deems to be of significant risk; and

CM-2 (7)(b)

Applies [Assignment: organization-defined security safeguards] to the devices when the individuals return.

Control Family: CONFIGURATION MANAGEMENT

CM-3 : CONFIGURATION CHANGE CONTROL

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Configuration change controls for organizational information systems involve the systematic proposal, justification, implementation, testing, review, and disposition of changes to the systems, including system upgrades and modifications. Configuration change control includes changes to baseline configurations for components and configuration items of information systems, changes to configuration settings for information technology products (e.g., operating systems, applications, firewalls, routers, and mobile devices), unscheduled/unauthorized changes, and changes to remediate vulnerabilities. Typical processes for managing configuration changes to information systems include, for example, Configuration Control Boards that approve proposed changes to systems. For new development information systems or systems undergoing major upgrades, organizations consider including representatives from development organizations on the Configuration Control Boards. Auditing of changes includes activities before and after changes are made to organizational information systems and the auditing activities required to implement such changes.

Related Controls: CA-7, CM-2, CM-4, CM-5, CM-6, CM-9, SA-10, SI-2, SI-12

CM-3a.

Determines the types of changes to the information system that are configuration-controlled;

CM-3b.

Reviews proposed configuration-controlled changes to the information system and approves or disapproves such changes with explicit consideration for security impact analyses;

CM-3c.

Documents configuration change decisions associated with the information system;

CM-3d.

Implements approved configuration-controlled changes to the information system;

CM-3e.

Retains records of configuration-controlled changes to the information system for [Assignment: organization-defined time period];

CM-3f.

Audits and reviews activities associated with configuration-controlled changes to the information system; and

CM-3g.

Coordinates and provides oversight for configuration change control activities through [Assignment: organization-defined configuration change control element (e.g., committee, board)] that convenes [Selection (one or more): [Assignment: organization-defined frequency]; [Assignment: organization-defined configuration change conditions]].

CM-3 (1) : AUTOMATED DOCUMENT / NOTIFICATION / PROHIBITION OF CHANGES

Baseline-Impact: HIGH

The organization employs automated mechanisms to:

CM-3 (1)(a)

Document proposed changes to the information system;

CM-3 (1)(b)

Notify [Assignment: organized-defined approval authorities] of proposed changes to the information system and request change approval;

CM-3 (1)(c)

Highlight proposed changes to the information system that have not been approved or disapproved by [Assignment: organization-defined time period];

CM-3 (1)(d)

Prohibit changes to the information system until designated approvals are received;

CM-3 (1)(e)

Document all changes to the information system; and

CM-3 (1)(f)

Notify [Assignment: organization-defined personnel] when approved changes to the information system are completed.

CM-3 (2) : TEST / VALIDATE / DOCUMENT CHANGES

Baseline-Impact: *MODERATE*, **HIGH**

The organization tests, validates, and documents changes to the information system before implementing the changes on the operational system.

Note

Changes to information systems include modifications to hardware, software, or firmware components and configuration settings defined in CM-6. Organizations ensure that testing does not interfere with information system operations. Individuals/groups conducting tests understand organizational security policies and procedures, information system security policies and procedures, and the specific health, safety, and environmental risks associated with particular facilities/processes. Operational systems may need to be taken off-line, or replicated to the extent feasible, before testing can be conducted. If information systems must be taken off-line for testing, the tests are scheduled to occur during planned system outages whenever possible. If testing cannot be conducted on operational systems, organizations employ compensating controls (e.g., testing on replicated systems).

CM-3 (3) : AUTOMATED CHANGE IMPLEMENTATION

The organization employs automated mechanisms to implement changes to the current information system baseline and deploys the updated baseline across the installed base.

CM-3 (4) : SECURITY REPRESENTATIVE

The organization requires an information security representative to be a member of the [Assignment: organization-defined configuration change control element].

Note

Information security representatives can include, for example, senior agency information security officers, information system security officers, or information system security managers. Representation by personnel with information security expertise is important because changes to information system configurations can have unintended side effects, some of which may be security-relevant. Detecting such changes early in the process can help avoid unintended, negative consequences that could ultimately affect the security state of organizational information systems. The configuration change control element in this control enhancement reflects the change control elements defined by organizations in CM-3.

CM-3 (5) : AUTOMATED SECURITY RESPONSE

The information system implements [Assignment: organization-defined security responses] automatically if baseline configurations are changed in an unauthorized manner.

Note

Security responses include, for example, halting information system processing, halting selected system functions, or issuing alerts/notifications to organizational personnel when there is an unauthorized modification of a configuration item.

CM-3 (6) : CRYPTOGRAPHY MANAGEMENT

The organization ensures that cryptographic mechanisms used to provide [Assignment: organization-defined security safeguards] are under configuration management.

Note

Regardless of the cryptographic means employed (e.g., public key, private key, shared secrets), organizations ensure that there are processes and procedures in place to effectively manage those means. For example, if devices use certificates as a basis for identification and authentication, there needs to be a process in place to address the expiration of those certificates.

Related Controls: SC-13

Control Family: CONFIGURATION MANAGEMENT

CM-4 : SECURITY IMPACT ANALYSIS

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization analyzes changes to the information system to determine potential security impacts prior to change implementation.

Note

Organizational personnel with information security responsibilities (e.g., Information System Administrators, Information System Security Officers, Information System Security Managers, and Information System Security Engineers) conduct security impact analyses. Individuals conducting security impact analyses possess the necessary skills/technical expertise to analyze the changes to information systems and the associated security ramifications. Security impact analysis may include, for example, reviewing security plans to understand security control requirements and reviewing system design documentation to understand control implementation and how specific changes might affect the controls. Security impact analyses may also include assessments of risk to better understand the impact of the changes and to determine if additional security controls are required. Security impact analyses are scaled in accordance with the security categories of the information systems.

Related Controls: CA-2, CA-7, CM-3, CM-9, SA-4, SA-5, SA-10, SI-2

CM-4 (1) : SEPARATE TEST ENVIRONMENTS

Baseline-Impact: HIGH

The organization analyzes changes to the information system in a separate test environment before implementation in an operational environment, looking for security impacts due to flaws, weaknesses, incompatibility, or intentional malice.

Note

Separate test environment in this context means an environment that is physically or logically isolated and distinct from the operational environment. The separation is sufficient to ensure that activities in the test environment do not impact activities in the operational environment, and information in the operational environment is not inadvertently transmitted to the test environment. Separate environments can be achieved by physical or logical means. If physically separate test environments are not used, organizations determine the strength of mechanism required when implementing logical separation (e.g., separation achieved through virtual machines).

Related Controls: SA-11, SC-3, SC-7

CM-4 (2) : VERIFICATION OF SECURITY FUNCTIONS

The organization, after the information system is changed, checks the security functions to verify that the functions are implemented correctly, operating as intended, and producing the desired outcome with regard to meeting the security requirements for the system.

Note

Implementation is this context refers to installing changed code in the operational information system.

Related Controls: SA-11

Control Family: CONFIGURATION MANAGEMENT

CM-5 : ACCESS RESTRICTIONS FOR CHANGE

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization defines, documents, approves, and enforces physical and logical access restrictions associated with changes to the information system.

Note

Any changes to the hardware, software, and/or firmware components of information systems can potentially have significant effects on the overall security of the systems. Therefore, organizations permit only qualified and authorized individuals to access information systems for purposes of initiating changes, including upgrades and modifications. Organizations maintain records of access to ensure that configuration change control is implemented and to support after-the-fact actions should organizations discover any unauthorized changes. Access restrictions for change also include software

libraries. Access restrictions include, for example, physical and logical access controls (see AC-3 and PE-3), workflow automation, media libraries, abstract layers (e.g., changes implemented into third-party interfaces rather than directly into information systems), and change windows (e.g., changes occur only during specified times, making unauthorized changes easy to discover).

Related Controls: AC-3, AC-6, PE-3

CM-5 (1) : AUTOMATED ACCESS ENFORCEMENT / AUDITING

Baseline-Impact: HIGH

The information system enforces access restrictions and supports auditing of the enforcement actions.

Related Controls: AU-2, AU-12, AU-6, CM-3, CM-6

CM-5 (2) : REVIEW SYSTEM CHANGES

Baseline-Impact: HIGH

The organization reviews information system changes [Assignment: organization-defined frequency] and [Assignment: organization-defined circumstances] to determine whether unauthorized changes have occurred.

Note

Indications that warrant review of information system changes and the specific circumstances justifying such reviews may be obtained from activities carried out by organizations during the configuration change process.

Related Controls: AU-6, AU-7, CM-3, CM-5, PE-6, PE-8

CM-5 (3) : SIGNED COMPONENTS

Baseline-Impact: HIGH

The information system prevents the installation of [Assignment: organization-defined software and firmware components] without verification that the component has been digitally signed using a certificate that is recognized and approved by the organization.

Note

Software and firmware components prevented from installation unless signed with recognized and approved certificates include, for example, software and firmware version updates, patches, service packs, device drivers, and basic input output system (BIOS) updates. Organizations can identify applicable software and firmware components by type, by specific items, or a combination of both. Digital signatures and organizational verification of such signatures, is a method of code authentication.

Related Controls: CM-7, SC-13, SI-7

CM-5 (4) : DUAL AUTHORIZATION

The organization enforces dual authorization for implementing changes to [Assignment: organization-defined information system components and system-level information].

Note

Organizations employ dual authorization to ensure that any changes to selected information system components and information cannot occur unless two qualified individuals implement such changes. The two individuals possess sufficient skills/expertise to determine if the proposed changes are correct implementations of approved changes. Dual authorization may also be known as two-person control.

Related Controls: AC-5, CM-3

CM-5 (5) : LIMIT PRODUCTION / OPERATIONAL PRIVILEGES

The organization:

Note

In many organizations, information systems support multiple core missions/business functions. Limiting privileges to change information system components with respect to operational systems is necessary because changes to a particular information system component may have far-reaching effects on mission/business processes supported by the system where the component resides. The complex, many-to-many relationships between systems and mission/business processes are in some cases, unknown to developers.

Related Controls: AC-2

CM-5 (5)(a)

Limits privileges to change information system components and system-related information within a production or operational environment; and

CM-5 (5)(b)

Reviews and reevaluates privileges [Assignment: organization-defined frequency].

CM-5 (6) : LIMIT LIBRARY PRIVILEGES

The organization limits privileges to change software resident within software libraries.

Note

Software libraries include privileged programs.

Related Controls: AC-2

CM-5 (7) : AUTOMATIC IMPLEMENTATION OF SECURITY SAFEGUARDS

[Withdrawn: Incorporated into SI-7].

Control Family: CONFIGURATION MANAGEMENT

CM-6 : CONFIGURATION SETTINGS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Configuration settings are the set of parameters that can be changed in hardware, software, or firmware components of the information system that affect the security posture and/or functionality of the system. Information technology products for which security-related configuration settings can be defined include, for example, mainframe computers, servers (e.g., database, electronic mail, authentication, web, proxy, file, domain name), workstations, input/output devices (e.g., scanners, copiers, and printers), network components (e.g., firewalls, routers, gateways, voice and data switches, wireless access points, network appliances, sensors), operating systems, middleware, and applications. Security-related parameters are those parameters impacting the security state of information systems including the parameters required to satisfy other security control requirements. Security-related parameters include, for example: (i) registry settings; (ii) account, file, directory permission settings; and (iii) settings for functions, ports, protocols, services, and remote connections. Organizations establish organization-wide configuration settings and subsequently derive specific settings for information systems. The established settings become part of the systems configuration baseline.

Common secure configurations (also referred to as security configuration checklists, lockdown and hardening guides, security reference guides, security technical implementation guides) provide recognized, standardized, and established benchmarks that stipulate secure configuration settings for specific information technology platforms/products and instructions for configuring those information system components to meet operational requirements. Common secure configurations can be developed by a variety of organizations including, for example, information technology product developers, manufacturers, vendors, consortia, academia, industry, federal agencies, and other organizations in the public and private sectors. Common secure configurations include the United States Government Configuration Baseline (USGCB) which affects the implementation of CM-6 and other controls such as AC-19 and CM-7. The Security Content Automation Protocol (SCAP) and the defined standards within the protocol (e.g., Common Configuration Enumeration) provide an effective method to uniquely identify, track, and control configuration settings. OMB establishes federal policy on configuration requirements for federal information systems.

Related Controls: AC-19, CM-2, CM-3, CM-7, SI-4

CM-6a.

Establishes and documents configuration settings for information technology products employed within the information system using [Assignment: organization-defined security configuration checklists] that reflect the most restrictive mode consistent with operational requirements;

CM-6b.

Implements the configuration settings;

CM-6c.

Identifies, documents, and approves any deviations from established configuration settings for [Assignment: organization-defined information system components] based on [Assignment: organization-defined operational requirements]; and

CM-6d.

Monitors and controls changes to the configuration settings in accordance with organizational policies and procedures.

CM-6 (1) : AUTOMATED CENTRAL MANAGEMENT / APPLICATION / VERIFICATION

Baseline-Impact: HIGH

The organization employs automated mechanisms to centrally manage, apply, and verify configuration settings for [Assignment: organization-defined information system components].

Related Controls: CA-7, CM-4

CM-6 (2) : RESPOND TO UNAUTHORIZED CHANGES

Baseline-Impact: HIGH

The organization employs [Assignment: organization-defined security safeguards] to respond to unauthorized changes to [Assignment: organization-defined configuration settings].

Note

Responses to unauthorized changes to configuration settings can include, for example, alerting designated organizational personnel, restoring established configuration settings, or in extreme cases, halting affected information system processing.

Related Controls: IR-4, SI-7

CM-6 (3) : UNAUTHORIZED CHANGE DETECTION

[Withdrawn: Incorporated into SI-7].

CM-6 (4) : CONFORMANCE DEMONSTRATION

[Withdrawn: Incorporated into CM-4].

Control Family: CONFIGURATION MANAGEMENT

CM-7 : LEAST FUNCTIONALITY

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Information systems can provide a wide variety of functions and services. Some of the functions and services, provided by default, may not be necessary to support essential organizational operations (e.g., key missions, functions). Additionally, it is sometimes convenient to provide multiple services from single information system components, but doing so increases risk over limiting the services provided by any one component. Where feasible, organizations limit component functionality to a single function per device (e.g., email servers or web servers, but not both). Organizations review functions and services provided by information systems or individual components of information systems, to determine which functions and services are candidates for elimination (e.g., Voice Over Internet Protocol, Instant Messaging, auto-execute, and file sharing). Organizations consider disabling unused or unnecessary physical and logical ports/protocols (e.g., Universal Serial Bus, File Transfer Protocol, and Hyper Text Transfer Protocol) on information systems to prevent unauthorized connection of devices, unauthorized transfer of information, or unauthorized tunneling. Organizations can utilize network scanning tools, intrusion detection and prevention systems, and end-point protections such as firewalls and host-based intrusion detection systems to identify and prevent the use of prohibited functions, ports, protocols, and services.

Related Controls: AC-6, CM-2, RA-5, SA-5, SC-7

CM-7a.

Configures the information system to provide only essential capabilities; and

CM-7b.

Prohibits or restricts the use of the following functions, ports, protocols, and/or services: [Assignment: organization-defined prohibited or restricted functions, ports, protocols, and/or services].

CM-7 (1) : PERIODIC REVIEW

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

The organization can either make a determination of the relative security of the function, port, protocol, and/or service or base the security decision on the assessment of other entities. Bluetooth, FTP, and peer-to-peer networking are examples of less than secure protocols.

Related Controls: AC-18, CM-7, IA-2

CM-7 (1)(a)

Reviews the information system [Assignment: organization-defined frequency] to identify unnecessary and/or nonsecure functions, ports, protocols, and services; and

CM-7 (1)(b)

Disables [Assignment: organization-defined functions, ports, protocols, and services within the information system deemed to be unnecessary and/or nonsecure].

CM-7 (2) : PREVENT PROGRAM EXECUTION

Baseline-Impact: *MODERATE*, **HIGH**

The information system prevents program execution in accordance with [Selection (one or more): [Assignment: organization-defined policies regarding software program usage and restrictions]; rules authorizing the terms and conditions of software program usage].

Related Controls: CM-8, PM-5

CM-7 (3) : REGISTRATION COMPLIANCE

The organization ensures compliance with [Assignment: organization-defined registration requirements for functions, ports, protocols, and services].

Note

Organizations use the registration process to manage, track, and provide oversight for information systems and implemented functions, ports, protocols, and services.

CM-7 (4) : UNAUTHORIZED SOFTWARE / BLACKLISTING

Baseline-Impact: *MODERATE*,

The organization:

Note

The process used to identify software programs that are not authorized to execute on organizational information systems is commonly referred to as blacklisting. Organizations can implement CM-7 (5) instead of this control enhancement if whitelisting (the stronger of the two policies) is the preferred approach for restricting software program execution.

Related Controls: CM-6, CM-8, PM-5

CM-7 (4)(a)

Identifies [Assignment: organization-defined software programs not authorized to execute on the information system];

CM-7 (4)(b)

Employs an allow-all, deny-by-exception policy to prohibit the execution of unauthorized software programs on the information system; and

CM-7 (4)(c)

Reviews and updates the list of unauthorized software programs [Assignment: organization-defined frequency].

CM-7 (5) : AUTHORIZED SOFTWARE / WHITELISTING

Baseline-Impact: HIGH

The organization:

Note

The process used to identify software programs that are authorized to execute on organizational information systems is commonly referred to as whitelisting. In addition to whitelisting, organizations consider verifying the integrity of white-listed software programs using, for example, cryptographic checksums, digital signatures, or hash functions. Verification of white-listed software can occur either prior to execution or at system startup.

Related Controls: CM-2, CM-6, CM-8, PM-5, SA-10, SC-34, SI-7

CM-7 (5)(a)

Identifies [Assignment: organization-defined software programs authorized to execute on the information system];

CM-7 (5)(b)

Employs a deny-all, permit-by-exception policy to allow the execution of authorized software programs on the information system; and

CM-7 (5)(c)

Reviews and updates the list of authorized software programs [Assignment: organization-defined frequency].

Control Family: CONFIGURATION MANAGEMENT

CM-8 : INFORMATION SYSTEM COMPONENT INVENTORY

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Organizations may choose to implement centralized information system component inventories that include components from all organizational information systems. In such situations, organizations ensure that the resulting inventories include system-specific information required for proper component accountability (e.g., information system association, information system owner). Information deemed necessary for effective accountability of information system components includes, for example, hardware inventory specifications, software license information, software version numbers, component owners, and for networked components or devices, machine names and network addresses. Inventory specifications include, for example, manufacturer, device type, model, serial number, and physical location.

Related Controls: CM-2, CM-6, PM-5

CM-8a.

Develops and documents an inventory of information system components that:

CM-8a.1.

Accurately reflects the current information system;

CM-8a.2.

Includes all components within the authorization boundary of the information system;

CM-8a.3.

Is at the level of granularity deemed necessary for tracking and reporting; and

CM-8a.4.

Includes [Assignment: organization-defined information deemed necessary to achieve effective information system component accountability]; and

CM-8b.

Reviews and updates the information system component inventory [Assignment: organization-defined frequency].

CM-8 (1) : UPDATES DURING INSTALLATIONS / REMOVALS

Baseline-Impact: *MODERATE*, **HIGH**

The organization updates the inventory of information system components as an integral part of component installations, removals, and information system updates.

CM-8 (2) : AUTOMATED MAINTENANCE

Baseline-Impact: HIGH

The organization employs automated mechanisms to help maintain an up-to-date, complete, accurate, and readily available inventory of information system components.

Note

Organizations maintain information system inventories to the extent feasible. Virtual machines, for example, can be difficult to monitor because such machines are not visible to the network when not in use. In such cases, organizations maintain as up-to-date, complete, and accurate an inventory as is deemed reasonable. This control enhancement can be satisfied by the implementation of CM-2 (2) for organizations that choose to combine information system component inventory and baseline configuration activities.

Related Controls: SI-7

CM-8 (3) : AUTOMATED UNAUTHORIZED COMPONENT DETECTION

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

This control enhancement is applied in addition to the monitoring for unauthorized remote connections and mobile devices. Monitoring for unauthorized system components may be accomplished on an ongoing basis or by the periodic scanning of systems for that purpose. Automated mechanisms can be implemented within information systems or in other separate devices. Isolation can be achieved, for example, by placing unauthorized information system components in separate domains or subnets or otherwise quarantining such components. This type of component isolation is commonly referred to as sandboxing.

Related Controls: AC-17, AC-18, AC-19, CA-7, SI-3, SI-4, SI-7, RA-5

CM-8 (3)(a)

Employs automated mechanisms [Assignment: organization-defined frequency] to detect the presence of unauthorized hardware, software, and firmware components within the information system; and

CM-8 (3)(b)

Takes the following actions when unauthorized components are detected: [Selection (one or more): disables network access by such components; isolates the components; notifies [Assignment: organization-defined personnel or roles]].

CM-8 (4) : ACCOUNTABILITY INFORMATION

Baseline-Impact: HIGH

The organization includes in the information system component inventory information, a means for identifying by [Selection (one or more): name; position; role], individuals responsible/accountable for administering those components.

Note

Identifying individuals who are both responsible and accountable for administering information system components helps to ensure that the assigned components are properly administered and organizations can contact those individuals if some action is required (e.g., component is determined to be the source of a breach/compromise, component needs to be recalled/replaced, or component needs to be relocated).

CM-8 (5) : NO DUPLICATE ACCOUNTING OF COMPONENTS

Baseline-Impact: *MODERATE*, **HIGH**

The organization verifies that all components within the authorization boundary of the information system are not duplicated in other information system component inventories.

Note

This control enhancement addresses the potential problem of duplicate accounting of information system components in large or complex interconnected systems.

CM-8 (6) : ASSESSED CONFIGURATIONS / APPROVED DEVIATIONS

The organization includes assessed component configurations and any approved deviations to current deployed configurations in the information system component inventory.

Note

This control enhancement focuses on configuration settings established by organizations for information system components, the specific components that have been assessed to determine compliance with the required configuration settings, and any approved deviations from established configuration settings.

Related Controls: CM-2, CM-6

CM-8 (7) : CENTRALIZED REPOSITORY

The organization provides a centralized repository for the inventory of information system components.

Note

Organizations may choose to implement centralized information system component inventories that include components from all organizational information systems. Centralized repositories of information system component inventories provide opportunities for efficiencies in accounting for organizational hardware, software, and firmware assets. Such repositories may also help organizations rapidly identify the location and responsible individuals of system components that have been compromised, breached, or are otherwise in need of mitigation actions. Organizations ensure that the resulting centralized inventories include system-specific information required for proper component accountability (e.g., information system association, information system owner).

CM-8 (8) : AUTOMATED LOCATION TRACKING

The organization employs automated mechanisms to support tracking of information system components by geographic location.

Note

The use of automated mechanisms to track the location of information system components can increase the accuracy of component inventories. Such capability may also help organizations rapidly identify the location and responsible individuals of system components that have been compromised, breached, or are otherwise in need of mitigation actions.

CM-8 (9) : ASSIGNMENT OF COMPONENTS TO SYSTEMS

The organization:

Note

Organizations determine the criteria for or types of information system components (e.g., microprocessors, motherboards, software, programmable logic controllers, and network devices) that are subject to this control enhancement.

Related Controls: SA-4

CM-8 (9)(a)

Assigns [Assignment: organization-defined acquired information system components] to an information system; and

CM-8 (9)(b)

Receives an acknowledgement from the information system owner of this assignment.

Control Family: CONFIGURATION MANAGEMENT

CM-9 : CONFIGURATION MANAGEMENT PLAN

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization develops, documents, and implements a configuration management plan for the information system that:

Note

Configuration management plans satisfy the requirements in configuration management policies while being tailored to individual information systems. Such plans define detailed processes and procedures for how configuration management is used to support system development life cycle activities at the information system level. Configuration management plans are typically developed during the development/acquisition phase of the system development life cycle. The plans describe how to move changes through change management processes, how to update configuration settings and baselines, how to maintain information system component inventories, how to control development, test, and operational environments, and how to develop, release, and update key documents. Organizations can employ templates to help ensure consistent and timely development and implementation of configuration management plans. Such templates can represent a master configuration management plan for the organization at large with subsets of the plan implemented on a system by system basis. Configuration management approval processes include designation of key management stakeholders responsible for reviewing and approving proposed changes to information systems, and personnel that conduct security impact analyses prior to the implementation of changes to the systems. Configuration items are the information system items (hardware, software, firmware, and documentation) to be configuration-managed. As information systems continue through the system development life cycle, new configuration items may be identified and some existing configuration items may no longer need to be under configuration control.

Related Controls: CM-2, CM-3, CM-4, CM-5, CM-8, SA-10

CM-9a.

Addresses roles, responsibilities, and configuration management processes and procedures;

CM-9b.

Establishes a process for identifying configuration items throughout the system development life cycle and for managing the configuration of the configuration items;

CM-9c.

Defines the configuration items for the information system and places the configuration items under configuration management; and

CM-9d.

Protects the configuration management plan from unauthorized disclosure and modification.

CM-9 (1) : ASSIGNMENT OF RESPONSIBILITY

The organization assigns responsibility for developing the configuration management process to organizational personnel that are not directly involved in information system development.

Note

In the absence of dedicated configuration management teams assigned within organizations, system developers may be tasked to develop configuration management processes using personnel who are not directly involved in system development or integration. This separation of duties ensures that organizations establish and maintain a sufficient degree of independence between the information system development and integration processes and configuration management processes to facilitate quality control and more effective oversight.

Control Family: CONFIGURATION MANAGEMENT

CM-10 : SOFTWARE USAGE RESTRICTIONS

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Software license tracking can be accomplished by manual methods (e.g., simple spreadsheets) or automated methods (e.g., specialized tracking applications) depending on organizational needs.

Related Controls: AC-17, CM-8, SC-7

CM-10a.

Uses software and associated documentation in accordance with contract agreements and copyright laws;

CM-10b.

Tracks the use of software and associated documentation protected by quantity licenses to control copying and distribution; and

CM-10c.

Controls and documents the use of peer-to-peer file sharing technology to ensure that this capability is not used for the unauthorized distribution, display, performance, or reproduction of copyrighted work.

CM-10 (1) : OPEN SOURCE SOFTWARE

The organization establishes the following restrictions on the use of open source software: [Assignment: organization-defined restrictions].

Note

Open source software refers to software that is available in source code form. Certain software rights normally reserved for copyright holders are routinely provided under software license agreements that permit individuals to study, change, and improve the software. From a security perspective, the major advantage of open source software is that it provides organizations with the ability to examine the source code. However, there are also various licensing issues associated with open source software including, for example, the constraints on derivative use of such software.

Control Family: CONFIGURATION MANAGEMENT

CM-11 : USER-INSTALLED SOFTWARE

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

If provided the necessary privileges, users have the ability to install software in organizational information systems. To maintain control over the types of software installed, organizations identify permitted and prohibited actions regarding software installation. Permitted software installations may include, for example, updates and security patches to existing software and downloading applications from organization-approved "app stores." Prohibited software installations may include, for example, software with unknown or suspect pedigrees or software that organizations consider potentially malicious. The policies organizations select governing user-installed software may be organization-developed or provided by some external entity. Policy enforcement methods include procedural methods (e.g., periodic examination of user accounts), automated methods (e.g., configuration settings implemented on organizational information systems), or both.

Related Controls: AC-3, CM-2, CM-3, CM-5, CM-6, CM-7, PL-4

CM-11a.

Establishes [Assignment: organization-defined policies] governing the installation of software by users;

CM-11b.

Enforces software installation policies through [Assignment: organization-defined methods]; and

CM-11c.

Monitors policy compliance at [Assignment: organization-defined frequency].

CM-11 (1) : ALERTS FOR UNAUTHORIZED INSTALLATIONS

The information system alerts [Assignment: organization-defined personnel or roles] when the unauthorized installation of software is detected.

Related Controls: CA-7, SI-4

CM-11 (2) : PROHIBIT INSTALLATION WITHOUT PRIVILEGED STATUS

The information system prohibits user installation of software without explicit privileged status.

Note

Privileged status can be obtained, for example, by serving in the role of system administrator.

Related Controls: AC-6

Control Family: CONTINGENCY PLANNING

CP-1 : CONTINGENCY PLANNING POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the CP family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

CP-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

CP-1a.1.

A contingency planning policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

CP-1a.2.

Procedures to facilitate the implementation of the contingency planning policy and associated contingency planning controls; and

CP-1b.

Reviews and updates the current:

CP-1b.1.

Contingency planning policy [Assignment: organization-defined frequency]; and

CP-1b.2.

Contingency planning procedures [Assignment: organization-defined frequency].

Control Family: CONTINGENCY PLANNING

CP-2 : CONTINGENCY PLAN

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Contingency planning for information systems is part of an overall organizational program for achieving continuity of operations for mission/business functions. Contingency planning addresses both information system restoration and implementation of alternative mission/business processes when systems are compromised. The effectiveness of contingency planning is maximized by considering such planning throughout the phases of the system development life cycle. Performing contingency planning on hardware, software, and firmware development can be an effective means of achieving information system resiliency. Contingency plans reflect the degree of restoration required for organizational information systems since not all systems may need to fully recover to achieve the level of continuity of operations desired. Information system recovery objectives reflect applicable laws, Executive Orders, directives, policies, standards, regulations, and guidelines. In addition to information system availability, contingency plans also address other security-related events resulting in a reduction in mission and/or business effectiveness, such as malicious attacks compromising the confidentiality or integrity of information systems. Actions addressed in contingency plans include, for example, orderly/graceful degradation, information system shutdown, fallback to a manual mode, alternate information flows, and operating in modes reserved for when systems are under attack. By closely coordinating contingency planning with incident handling activities, organizations can ensure that the necessary contingency planning activities are in place and activated in the event of a security incident.

Related Controls: AC-14, CP-6, CP-7, CP-8, CP-9, CP-10, IR-4, IR-8, MP-2, MP-4, MP-5, PM-8, PM-11

CP-2a.

Develops a contingency plan for the information system that:

CP-2a.1.

Identifies essential missions and business functions and associated contingency requirements;

CP-2a.2.

Provides recovery objectives, restoration priorities, and metrics;

CP-2a.3.

Addresses contingency roles, responsibilities, assigned individuals with contact information;

CP-2a.4.

Addresses maintaining essential missions and business functions despite an information system disruption, compromise, or failure;

CP-2a.5.

Addresses eventual, full information system restoration without deterioration of the security safeguards originally planned and implemented; and

CP-2a.6.

Is reviewed and approved by [Assignment: organization-defined personnel or roles];

CP-2b.

Distributes copies of the contingency plan to [Assignment: organization-defined key contingency personnel (identified by name and/or by role) and organizational elements];

CP-2c.

Coordinates contingency planning activities with incident handling activities;

CP-2d.

Reviews the contingency plan for the information system [Assignment: organization-defined frequency];

CP-2e.

Updates the contingency plan to address changes to the organization, information system, or environment of operation and problems encountered during contingency plan implementation, execution, or testing;

CP-2f.

Communicates contingency plan changes to [Assignment: organization-defined key contingency personnel (identified by name and/or by role) and organizational elements]; and

CP-2g.

Protects the contingency plan from unauthorized disclosure and modification.

CP-2 (1) : COORDINATE WITH RELATED PLANS

Baseline-Impact: *MODERATE*, **HIGH**

The organization coordinates contingency plan development with organizational elements responsible for related plans.

Note

Plans related to contingency plans for organizational information systems include, for example, Business Continuity Plans, Disaster Recovery Plans, Continuity of Operations Plans, Crisis Communications Plans, Critical Infrastructure Plans, Cyber Incident Response Plans, Insider Threat Implementation Plan, and Occupant Emergency Plans.

CP-2 (2) : CAPACITY PLANNING

Baseline-Impact: HIGH

The organization conducts capacity planning so that necessary capacity for information processing, telecommunications, and environmental support exists during contingency operations.

Note

Capacity planning is needed because different types of threats (e.g., natural disasters, targeted cyber attacks) can result in a reduction of the available processing, telecommunications, and support services originally intended to support the organizational missions/business functions. Organizations may need to anticipate degraded operations during contingency operations and factor such degradation into capacity planning.

CP-2 (3) : RESUME ESSENTIAL MISSIONS / BUSINESS FUNCTIONS

Baseline-Impact: *MODERATE*, **HIGH**

The organization plans for the resumption of essential missions and business functions within [Assignment: organization-defined time period] of contingency plan activation.

Note

Organizations may choose to carry out the contingency planning activities in this control enhancement as part of organizational business continuity planning including, for example, as part of business impact analyses. The time period for resumption of essential missions/business functions may be dependent on the severity/extent of disruptions to the information system and its supporting infrastructure.

Related Controls: PE-12

CP-2 (4) : RESUME ALL MISSIONS / BUSINESS FUNCTIONS

Baseline-Impact: HIGH

The organization plans for the resumption of all missions and business functions within [Assignment: organization-defined time period] of contingency plan activation.

Note

Organizations may choose to carry out the contingency planning activities in this control enhancement as part of organizational business continuity planning including, for example, as part of business impact analyses. The time period for resumption of all missions/business functions may be dependent on the severity/extent of disruptions to the information system and its supporting infrastructure.

Related Controls: PE-12

CP-2 (5) : CONTINUE ESSENTIAL MISSIONS / BUSINESS FUNCTIONS

Baseline-Impact: HIGH

The organization plans for the continuance of essential missions and business functions with little or no loss of operational continuity and sustains that continuity until full information system restoration at primary processing and/or storage sites.

Note

Organizations may choose to carry out the contingency planning activities in this control enhancement as part of organizational business continuity planning including, for example, as part of business impact analyses. Primary processing and/or storage sites defined by organizations as part of contingency planning may change depending on the circumstances associated with the contingency (e.g., backup sites may become primary sites).

Related Controls: PE-12

CP-2 (6) : ALTERNATE PROCESSING / STORAGE SITE

The organization plans for the transfer of essential missions and business functions to alternate processing and/or storage sites with little or no loss of operational continuity and sustains that continuity through information system restoration to primary processing and/or storage sites.

Note

Organizations may choose to carry out the contingency planning activities in this control enhancement as part of organizational business continuity planning including, for example, as part of business impact analyses. Primary processing and/or storage sites defined by organizations as part of contingency planning may change depending on the circumstances associated with the contingency (e.g., backup sites may become primary sites).

Related Controls: PE-12

CP-2 (7) : COORDINATE WITH EXTERNAL SERVICE PROVIDERS

The organization coordinates its contingency plan with the contingency plans of external service providers to ensure that contingency requirements can be satisfied.

Note

When the capability of an organization to successfully carry out its core missions/business functions is dependent on external service providers, developing a timely and comprehensive contingency plan may become more challenging. In this situation, organizations coordinate contingency planning activities with the external entities to ensure that the individual plans reflect the overall contingency needs of the organization.

Related Controls: SA-9

CP-2 (8) : IDENTIFY CRITICAL ASSETS

Baseline-Impact: *MODERATE*, **HIGH**

The organization identifies critical information system assets supporting essential missions and business functions.

Note

Organizations may choose to carry out the contingency planning activities in this control enhancement as part of organizational business continuity planning including, for example, as part of business impact analyses. Organizations identify critical information system assets so that additional safeguards and countermeasures can be employed (above and beyond those safeguards and countermeasures routinely implemented) to help ensure that organizational missions/business functions can continue to be conducted during contingency operations. In addition, the identification of critical information assets facilitates the prioritization of organizational resources. Critical information system assets include technical and operational aspects. Technical aspects include, for example, information technology services, information system components, information technology products, and mechanisms. Operational aspects include, for example, procedures (manually executed operations) and personnel (individuals operating technical safeguards and/or executing manual procedures). Organizational program protection plans can provide assistance in identifying critical assets.

Related Controls: SA-14, SA-15

Control Family: CONTINGENCY PLANNING

CP-3 : CONTINGENCY TRAINING

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization provides contingency training to information system users consistent with assigned roles and responsibilities:

Note

Contingency training provided by organizations is linked to the assigned roles and responsibilities of organizational personnel to ensure that the appropriate content and level of detail is included in such training. For example, regular users may only need to know when and where to report for duty during contingency operations and if normal duties are affected; system administrators may require additional training on how to set up information systems at alternate processing and storage sites; and managers/senior leaders may receive more specific training on how to conduct mission-essential functions in designated off-site locations and how to establish communications with other governmental entities for purposes of coordination on contingency-related activities. Training for contingency roles/responsibilities reflects the specific continuity requirements in the contingency plan.

Related Controls: AT-2, AT-3, CP-2, IR-2

CP-3a.

Within [Assignment: organization-defined time period] of assuming a contingency role or responsibility;

CP-3b.

When required by information system changes; and

CP-3c.

[Assignment: organization-defined frequency] thereafter.

CP-3 (1) : SIMULATED EVENTS

Baseline-Impact: HIGH

The organization incorporates simulated events into contingency training to facilitate effective response by personnel in crisis situations.

CP-3 (2) : AUTOMATED TRAINING ENVIRONMENTS

The organization employs automated mechanisms to provide a more thorough and realistic contingency training environment.

Control Family: CONTINGENCY PLANNING

CP-4 : CONTINGENCY PLAN TESTING

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

> ***Note***
>
> Methods for testing contingency plans to determine the effectiveness of the plans and to identify potential weaknesses in the plans include, for example, walk-through and tabletop exercises, checklists, simulations (parallel, full interrupt), and comprehensive exercises. Organizations conduct testing based on the continuity requirements in contingency plans and include a determination of the effects on organizational operations, assets, and individuals arising due to contingency operations. Organizations have flexibility and discretion in the breadth, depth, and timelines of corrective actions.

Related Controls: CP-2, CP-3, IR-3

CP-4a.

Tests the contingency plan for the information system [Assignment: organization-defined frequency] using [Assignment: organization-defined tests] to determine the effectiveness of the plan and the organizational readiness to execute the plan;

CP-4b.

Reviews the contingency plan test results; and

CP-4c.

Initiates corrective actions, if needed.

CP-4 (1) : COORDINATE WITH RELATED PLANS

Baseline-Impact: *MODERATE*, **HIGH**

The organization coordinates contingency plan testing with organizational elements responsible for related plans.

Note

Plans related to contingency plans for organizational information systems include, for example, Business Continuity Plans, Disaster Recovery Plans, Continuity of Operations Plans, Crisis Communications Plans, Critical Infrastructure Plans, Cyber Incident Response Plans, and Occupant Emergency Plans. This control enhancement does not require organizations to create organizational elements to handle related plans or to align such elements with specific plans. It does require, however, that if such organizational elements are responsible for related plans, organizations should coordinate with those elements.

Related Controls: IR-8, PM-8

CP-4 (2) : ALTERNATE PROCESSING SITE

Baseline-Impact: HIGH

The organization tests the contingency plan at the alternate processing site:

Related Controls: CP-7

CP-4 (2)(a)

To familiarize contingency personnel with the facility and available resources; and

CP-4 (2)(b)

To evaluate the capabilities of the alternate processing site to support contingency operations.

CP-4 (3) : AUTOMATED TESTING

The organization employs automated mechanisms to more thoroughly and effectively test the contingency plan.

Note

Automated mechanisms provide more thorough and effective testing of contingency plans, for example: (i) by providing more complete coverage of contingency issues; (ii) by selecting more realistic test scenarios and environments; and (iii) by effectively stressing the information system and supported missions.

CP-4 (4) : FULL RECOVERY / RECONSTITUTION

The organization includes a full recovery and reconstitution of the information system to a known state as part of contingency plan testing.

Related Controls: CP-10, SC-24

Control Family: CONTINGENCY PLANNING

CP-5 : CONTINGENCY PLAN UPDATE

[Withdrawn: Incorporated into CP-2].

Control Family: CONTINGENCY PLANNING

CP-6 : ALTERNATE STORAGE SITE

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Alternate storage sites are sites that are geographically distinct from primary storage sites. An alternate storage site maintains duplicate copies of information and data in the event that the primary storage site is not available. Items covered by alternate storage site agreements include, for example, environmental conditions at alternate sites, access rules, physical and environmental protection requirements, and coordination of delivery/retrieval of backup media. Alternate storage sites reflect the requirements in contingency plans so that organizations can maintain essential missions/business functions despite disruption, compromise, or failure in organizational information systems.

Related Controls: CP-2, CP-7, CP-9, CP-10, MP-4

CP-6a.

Establishes an alternate storage site including necessary agreements to permit the storage and retrieval of information system backup information; and

CP-6b.

Ensures that the alternate storage site provides information security safeguards equivalent to that of the primary site.

CP-6 (1) : SEPARATION FROM PRIMARY SITE

Baseline-Impact: *MODERATE*, **HIGH**

The organization identifies an alternate storage site that is separated from the primary storage site to reduce susceptibility to the same threats.

Note

Threats that affect alternate storage sites are typically defined in organizational assessments of risk and include, for example, natural disasters, structural failures, hostile cyber attacks, and errors of omission/commission. Organizations determine what is considered a sufficient degree of separation between primary and alternate storage sites based on the types of threats that are of concern. For one particular type of threat (i.e., hostile cyber attack), the degree of separation between sites is less relevant.

Related Controls: RA-3

CP-6 (2) : RECOVERY TIME / POINT OBJECTIVES

Baseline-Impact: HIGH

The organization configures the alternate storage site to facilitate recovery operations in accordance with recovery time and recovery point objectives.

CP-6 (3) : ACCESSIBILITY

Baseline-Impact: *MODERATE*, **HIGH**

The organization identifies potential accessibility problems to the alternate storage site in the event of an area-wide disruption or disaster and outlines explicit mitigation actions.

Note

Area-wide disruptions refer to those types of disruptions that are broad in geographic scope (e.g., hurricane, regional power outage) with such determinations made by organizations based on organizational assessments of risk. Explicit mitigation actions include, for example: (i) duplicating backup information at other alternate storage sites if access problems occur at originally designated alternate sites; or (ii) planning for physical access to retrieve backup information if electronic accessibility to the alternate site is disrupted.

Related Controls: RA-3

Control Family: CONTINGENCY PLANNING

CP-7 : ALTERNATE PROCESSING SITE

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Alternate processing sites are sites that are geographically distinct from primary processing sites. An alternate processing site provides processing capability in the event that the primary processing site is not available. Items covered by alternate processing site agreements include, for example, environmental conditions at alternate sites, access rules, physical and environmental protection requirements, and coordination for the transfer/assignment of personnel. Requirements are specifically allocated to alternate processing sites that reflect the requirements in contingency plans to maintain essential missions/business functions despite disruption, compromise, or failure in organizational information systems.

Related Controls: CP-2, CP-6, CP-8, CP-9, CP-10, MA-6

CP-7a.

Establishes an alternate processing site including necessary agreements to permit the transfer and resumption of [Assignment: organization-defined information system operations] for essential missions/business functions within [Assignment: organization-defined time period consistent with recovery time and recovery point objectives] when the primary processing capabilities are unavailable;

CP-7b.

Ensures that equipment and supplies required to transfer and resume operations are available at the alternate processing site or contracts are in place to support delivery to the site within the organization-defined time period for transfer/resumption; and

CP-7c.

Ensures that the alternate processing site provides information security safeguards equivalent to those of the primary site.

CP-7 (1) : SEPARATION FROM PRIMARY SITE

Baseline-Impact: *MODERATE*, **HIGH**

The organization identifies an alternate processing site that is separated from the primary processing site to reduce susceptibility to the same threats.

Note

Threats that affect alternate processing sites are typically defined in organizational assessments of risk and include, for example, natural disasters, structural failures, hostile cyber attacks, and errors of omission/commission. Organizations determine what is considered a sufficient degree of separation between primary and alternate processing sites based on the types of threats that are of concern. For one particular type of threat (i.e., hostile cyber attack), the degree of separation between sites is less relevant.

Related Controls: RA-3

CP-7 (2) : ACCESSIBILITY

Baseline-Impact: *MODERATE*, **HIGH**

The organization identifies potential accessibility problems to the alternate processing site in the event of an area-wide disruption or disaster and outlines explicit mitigation actions.

Note

Area-wide disruptions refer to those types of disruptions that are broad in geographic scope (e.g., hurricane, regional power outage) with such determinations made by organizations based on organizational assessments of risk.

Related Controls: RA-3

CP-7 (3) : PRIORITY OF SERVICE

Baseline-Impact: *MODERATE*, **HIGH**

The organization develops alternate processing site agreements that contain priority-of-service provisions in accordance with organizational availability requirements (including recovery time objectives).

Note

Priority-of-service agreements refer to negotiated agreements with service providers that ensure that organizations receive priority treatment consistent with their availability requirements and the availability of information resources at the alternate processing site.

CP-7 (4) : PREPARATION FOR USE

Baseline-Impact: HIGH

The organization prepares the alternate processing site so that the site is ready to be used as the operational site supporting essential missions and business functions.

Note

Site preparation includes, for example, establishing configuration settings for information system components at the alternate processing site consistent with the requirements for such settings at the primary site and ensuring that essential supplies and other logistical considerations are in place.

Related Controls: CM-2, CM-6

CP-7 (5) : EQUIVALENT INFORMATION SECURITY SAFEGUARDS

[Withdrawn: Incorporated into CP-7].

CP-7 (6) : INABILITY TO RETURN TO PRIMARY SITE

The organization plans and prepares for circumstances that preclude returning to the primary processing site.

Control Family: CONTINGENCY PLANNING

CP-8 : TELECOMMUNICATIONS SERVICES

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization establishes alternate telecommunications services including necessary agreements to permit the resumption of [Assignment: organization-defined information system operations] for essential missions and business functions within [Assignment: organization-defined time period] when the primary telecommunications capabilities are unavailable at either the primary or alternate processing or storage sites.

Note

This control applies to telecommunications services (data and voice) for primary and alternate processing and storage sites. Alternate telecommunications services reflect the continuity requirements in contingency plans to maintain essential missions/business functions despite the loss of primary telecommunications services. Organizations may specify different time periods for primary/alternate sites. Alternate telecommunications services include, for example, additional organizational or commercial ground-based circuits/lines or satellites in lieu of ground-based

communications. Organizations consider factors such as availability, quality of service, and access when entering into alternate telecommunications agreements.

Related Controls: CP-2, CP-6, CP-7

CP-8 (1) : PRIORITY OF SERVICE PROVISIONS

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Organizations consider the potential mission/business impact in situations where telecommunications service providers are servicing other organizations with similar priority-of-service provisions.

CP-8 (1)(a)

Develops primary and alternate telecommunications service agreements that contain priority-of-service provisions in accordance with organizational availability requirements (including recovery time objectives); and

CP-8 (1)(b)

Requests Telecommunications Service Priority for all telecommunications services used for national security emergency preparedness in the event that the primary and/or alternate telecommunications services are provided by a common carrier.

CP-8 (2) : SINGLE POINTS OF FAILURE

Baseline-Impact: *MODERATE*, **HIGH**

The organization obtains alternate telecommunications services to reduce the likelihood of sharing a single point of failure with primary telecommunications services.

CP-8 (3) : SEPARATION OF PRIMARY / ALTERNATE PROVIDERS

Baseline-Impact: HIGH

The organization obtains alternate telecommunications services from providers that are separated from primary service providers to reduce susceptibility to the same threats.

Note

Threats that affect telecommunications services are typically defined in organizational assessments of risk and include, for example, natural disasters, structural failures, hostile cyber/physical attacks, and errors of omission/commission. Organizations seek to reduce common susceptibilities by, for example, minimizing shared infrastructure among telecommunications service providers and achieving sufficient geographic separation between services. Organizations may consider using a single service provider in situations where the service provider can provide alternate telecommunications services meeting the separation needs addressed in the risk assessment.

CP-8 (4) : PROVIDER CONTINGENCY PLAN

Baseline-Impact: HIGH

The organization:

Note

Reviews of provider contingency plans consider the proprietary nature of such plans. In some situations, a summary of provider contingency plans may be sufficient evidence for organizations to satisfy the review requirement. Telecommunications service providers may also participate in ongoing disaster recovery exercises in coordination with the Department of Homeland Security, state, and local governments. Organizations may use these types of activities to satisfy evidentiary requirements related to service provider contingency plan reviews, testing, and training.

CP-8 (4)(a)

Requires primary and alternate telecommunications service providers to have contingency plans;

CP-8 (4)(b)

Reviews provider contingency plans to ensure that the plans meet organizational contingency requirements; and

CP-8 (4)(c)

Obtains evidence of contingency testing/training by providers [Assignment: organization-defined frequency].

CP-8 (5) : ALTERNATE TELECOMMUNICATION SERVICE TESTING

The organization tests alternate telecommunication services [Assignment: organization-defined frequency].

Control Family: CONTINGENCY PLANNING

CP-9 : INFORMATION SYSTEM BACKUP

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

System-level information includes, for example, system-state information, operating system and application software, and licenses. User-level information includes any information other than system-level information. Mechanisms employed by organizations to protect the integrity of information system backups include, for example, digital signatures and cryptographic hashes. Protection of system backup information while in transit is beyond the scope of this control. Information system backups reflect the requirements in contingency plans as well as other organizational requirements for backing up information.

Related Controls: CP-2, CP-6, MP-4, MP-5, SC-13

CP-9a.

Conducts backups of user-level information contained in the information system [Assignment: organization-defined frequency consistent with recovery time and recovery point objectives];

CP-9b.

Conducts backups of system-level information contained in the information system [Assignment: organization-defined frequency consistent with recovery time and recovery point objectives];

CP-9c.

Conducts backups of information system documentation including security-related documentation [Assignment: organization-defined frequency consistent with recovery time and recovery point objectives]; and

CP-9d.

Protects the confidentiality, integrity, and availability of backup information at storage locations.

CP-9 (1) : TESTING FOR RELIABILITY / INTEGRITY

Baseline-Impact: *MODERATE*, **HIGH**

The organization tests backup information [Assignment: organization-defined frequency] to verify media reliability and information integrity.

Related Controls: CP-4

CP-9 (2) : TEST RESTORATION USING SAMPLING

Baseline-Impact: HIGH

The organization uses a sample of backup information in the restoration of selected information system functions as part of contingency plan testing.

Related Controls: CP-4

CP-9 (3) : SEPARATE STORAGE FOR CRITICAL INFORMATION

Baseline-Impact: HIGH

The organization stores backup copies of [Assignment: organization-defined critical information system software and other security-related information] in a separate facility or in a fire-rated container that is not collocated with the operational system.

Note

Critical information system software includes, for example, operating systems, cryptographic key management systems, and intrusion detection/prevention systems. Security-related information includes, for example, organizational inventories of hardware, software, and firmware components. Alternate storage sites typically serve as separate storage facilities for organizations.

Related Controls: CM-2, CM-8

CP-9 (4) : PROTECTION FROM UNAUTHORIZED MODIFICATION

[Withdrawn: Incorporated into CP-9].

CP-9 (5) : TRANSFER TO ALTERNATE STORAGE SITE

Baseline-Impact: HIGH

The organization transfers information system backup information to the alternate storage site [Assignment: organization-defined time period and transfer rate consistent with the recovery time and recovery point objectives].

Note

Information system backup information can be transferred to alternate storage sites either electronically or by physical shipment of storage media.

CP-9 (6) : REDUNDANT SECONDARY SYSTEM

The organization accomplishes information system backup by maintaining a redundant secondary system that is not collocated with the primary system and that can be activated without loss of information or disruption to operations.

Related Controls: CP-7, CP-10

CP-9 (7) : DUAL AUTHORIZATION

The organization enforces dual authorization for the deletion or destruction of [Assignment: organization-defined backup information].

Note

Dual authorization ensures that the deletion or destruction of backup information cannot occur unless two qualified individuals carry out the task. Individuals deleting/destroying backup information possess sufficient skills/expertise to determine if the proposed deletion/destruction of backup information reflects organizational policies and procedures. Dual authorization may also be known as two-person control.

Related Controls: AC-3, MP-2

Control Family: CONTINGENCY PLANNING

CP-10 : INFORMATION SYSTEM RECOVERY AND RECONSTITUTION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization provides for the recovery and reconstitution of the information system to a known state after a disruption, compromise, or failure.

Note

Recovery is executing information system contingency plan activities to restore organizational missions/business functions. Reconstitution takes place following recovery and includes activities for returning organizational information systems to fully operational states. Recovery and reconstitution operations reflect mission and business priorities, recovery point/time and reconstitution objectives, and established organizational metrics consistent with contingency plan requirements. Reconstitution includes the deactivation of any interim information system capabilities that may have been needed during recovery operations. Reconstitution also includes assessments of fully restored information system capabilities, reestablishment of continuous monitoring activities, potential information system reauthorizations, and activities to prepare the systems against future disruptions, compromises, or failures. Recovery/reconstitution capabilities employed by organizations can include both automated mechanisms and manual procedures.

Related Controls: CA-2, CA-6, CA-7, CP-2, CP-6, CP-7, CP-9, SC-24

CP-10 (1) : CONTINGENCY PLAN TESTING

[Withdrawn: Incorporated into CP-4].

CP-10 (2) : TRANSACTION RECOVERY

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements transaction recovery for systems that are transaction-based.

Note

Transaction-based information systems include, for example, database management systems and transaction processing systems. Mechanisms supporting transaction recovery include, for example, transaction rollback and transaction journaling.

CP-10 (3) : COMPENSATING SECURITY CONTROLS

[Withdrawn: Addressed through tailoring procedures].

CP-10 (4) : RESTORE WITHIN TIME PERIOD

Baseline-Impact: HIGH

The organization provides the capability to restore information system components within [Assignment: organization-defined restoration time-periods] from configuration-controlled and integrity-protected information representing a known, operational state for the components.

Note

Restoration of information system components includes, for example, reimaging which restores components to known, operational states.

Related Controls: CM-2

CP-10 (5) : FAILOVER CAPABILITY

[Withdrawn: Incorporated into SI-13].

CP-10 (6) : COMPONENT PROTECTION

The organization protects backup and restoration hardware, firmware, and software.

Note

Protection of backup and restoration hardware, firmware, and software components includes both physical and technical safeguards. Backup and restoration software includes, for example, router tables, compilers, and other security-relevant system software.

Related Controls: AC-3, AC-6, PE-3

Control Family: CONTINGENCY PLANNING

CP-11 : ALTERNATE COMMUNICATIONS PROTOCOLS

Priority: P0

The information system provides the capability to employ [Assignment: organization-defined alternative communications protocols] in support of maintaining continuity of operations.

Note

Contingency plans and the associated training and testing for those plans, incorporate an alternate communications protocol capability as part of increasing the resilience of organizational information systems. Alternate communications protocols include, for example, switching from Transmission Control Protocol/Internet Protocol (TCP/IP) Version 4 to TCP/IP Version 6. Switching communications protocols may affect software applications and therefore, the potential side effects of introducing alternate communications protocols are analyzed prior to implementation.

Control Family: CONTINGENCY PLANNING

CP-12 : SAFE MODE

Priority: P0

The information system, when [Assignment: organization-defined conditions] are detected, enters a safe mode of operation with [Assignment: organization-defined restrictions of safe mode of operation].

Note

For information systems supporting critical missions/business functions including, for example, military operations and weapons systems, civilian space operations, nuclear power plant operations, and air traffic control operations (especially real-time operational environments), organizations may choose to identify certain conditions under which those systems revert to a predefined safe mode of operation. The safe mode of operation, which can be activated automatically or manually, restricts the types of activities or operations information systems could execute when those conditions are

encountered. Restriction includes, for example, allowing only certain functions that could be carried out under limited power or with reduced communications bandwidth.

Control Family: CONTINGENCY PLANNING

CP-13 : ALTERNATIVE SECURITY MECHANISMS

Priority: P0

The organization employs [Assignment: organization-defined alternative or supplemental security mechanisms] for satisfying [Assignment: organization-defined security functions] when the primary means of implementing the security function is unavailable or compromised.

Note

This control supports information system resiliency and contingency planning/continuity of operations. To ensure mission/business continuity, organizations can implement alternative or supplemental security mechanisms. These mechanisms may be less effective than the primary mechanisms (e.g., not as easy to use, not as scalable, or not as secure). However, having the capability to readily employ these alternative/supplemental mechanisms enhances overall mission/business continuity that might otherwise be adversely impacted if organizational operations had to be curtailed until the primary means of implementing the functions was restored. Given the cost and level of effort required to provide such alternative capabilities, this control would typically be applied only to critical security capabilities provided by information systems, system components, or information system services. For example, an organization may issue to senior executives and system administrators one-time pads in case multifactor tokens, the organization's standard means for secure remote authentication, is compromised.

Related Controls: CP-2

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-1 : IDENTIFICATION AND AUTHENTICATION POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the IA family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

IA-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

IA-1a.1.

An identification and authentication policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

IA-1a.2.

Procedures to facilitate the implementation of the identification and authentication policy and associated identification and authentication controls; and

IA-1b.

Reviews and updates the current:

IA-1b.1.

Identification and authentication policy [Assignment: organization-defined frequency]; and

IA-1b.2.

Identification and authentication procedures [Assignment: organization-defined frequency].

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-2 : IDENTIFICATION AND AUTHENTICATION (ORGANIZATIONAL USERS)

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system uniquely identifies and authenticates organizational users (or processes acting on behalf of organizational users).

Note

Organizational users include employees or individuals that organizations deem to have equivalent status of employees (e.g., contractors, guest researchers). This control applies to all accesses other than: (i) accesses that are explicitly identified and documented in AC-14; and (ii) accesses that occur through authorized use of group authenticators without individual authentication. Organizations may require unique identification of individuals in group accounts (e.g., shared privilege accounts) or for detailed accountability of individual activity. Organizations employ passwords, tokens, or biometrics to authenticate user identities, or in the case multifactor authentication, or some combination thereof. Access to organizational information systems is defined as either local access or network access. Local access is any access to organizational information systems by users (or processes acting on behalf of users) where such access is obtained by direct connections without the use of networks. Network access is access to organizational information systems by users (or processes acting on behalf of users)

where such access is obtained through network connections (i.e., nonlocal accesses). Remote access is a type of network access that involves communication through external networks (e.g., the Internet). Internal networks include local area networks and wide area networks. In addition, the use of encrypted virtual private networks (VPNs) for network connections between organization-controlled endpoints and non-organization controlled endpoints may be treated as internal networks from the perspective of protecting the confidentiality and integrity of information traversing the network.

Organizations can satisfy the identification and authentication requirements in this control by complying with the requirements in Homeland Security Presidential Directive 12 consistent with the specific organizational implementation plans. Multifactor authentication requires the use of two or more different factors to achieve authentication. The factors are defined as: (i) something you know (e.g., password, personal identification number [PIN]); (ii) something you have (e.g., cryptographic identification device, token); or (iii) something you are (e.g., biometric). Multifactor solutions that require devices separate from information systems gaining access include, for example, hardware tokens providing time-based or challenge-response authenticators and smart cards such as the U.S. Government Personal Identity Verification card and the DoD common access card. In addition to identifying and authenticating users at the information system level (i.e., at logon), organizations also employ identification and authentication mechanisms at the application level, when necessary, to provide increased information security. Identification and authentication requirements for other than organizational users are described in IA-8.

Related Controls: AC-2, AC-3, AC-14, AC-17, AC-18, IA-4, IA-5, IA-8

IA-2 (1) : NETWORK ACCESS TO PRIVILEGED ACCOUNTS

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system implements multifactor authentication for network access to privileged accounts.

Related Controls: AC-6

IA-2 (2) : NETWORK ACCESS TO NON-PRIVILEGED ACCOUNTS

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements multifactor authentication for network access to non-privileged accounts.

IA-2 (3) : LOCAL ACCESS TO PRIVILEGED ACCOUNTS

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements multifactor authentication for local access to privileged accounts.

Related Controls: AC-6

IA-2 (4) : LOCAL ACCESS TO NON-PRIVILEGED ACCOUNTS

Baseline-Impact: HIGH

The information system implements multifactor authentication for local access to non-privileged accounts.

IA-2 (5) : GROUP AUTHENTICATION

The organization requires individuals to be authenticated with an individual authenticator when a group authenticator is employed.

Note

Requiring individuals to use individual authenticators as a second level of authentication helps organizations to mitigate the risk of using group authenticators.

IA-2 (6) : NETWORK ACCESS TO PRIVILEGED ACCOUNTS - SEPARATE DEVICE

The information system implements multifactor authentication for network access to privileged accounts such that one of the factors is provided by a device separate from the system gaining access and the device meets [Assignment: organization-defined strength of mechanism requirements].

Related Controls: AC-6

IA-2 (7) : NETWORK ACCESS TO NON-PRIVILEGED ACCOUNTS - SEPARATE DEVICE

The information system implements multifactor authentication for network access to non-privileged accounts such that one of the factors is provided by a device separate from the system gaining access and the device meets [Assignment: organization-defined strength of mechanism requirements].

IA-2 (8) : NETWORK ACCESS TO PRIVILEGED ACCOUNTS - REPLAY RESISTANT

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements replay-resistant authentication mechanisms for network access to privileged accounts.

Note

Authentication processes resist replay attacks if it is impractical to achieve successful authentications by replaying previous authentication messages. Replay-resistant techniques include, for example, protocols that use nonces or challenges such as Transport Layer Security (TLS) and time synchronous or challenge-response one-time authenticators.

IA-2 (9) : NETWORK ACCESS TO NON-PRIVILEGED ACCOUNTS - REPLAY RESISTANT

Baseline-Impact: HIGH

The information system implements replay-resistant authentication mechanisms for network access to non-privileged accounts.

Note

Authentication processes resist replay attacks if it is impractical to achieve successful authentications by recording/replaying previous authentication messages. Replay-resistant techniques include, for example, protocols that use nonces or challenges such as Transport Layer Security (TLS) and time synchronous or challenge-response one-time authenticators.

IA-2 (10) : SINGLE SIGN-ON

The information system provides a single sign-on capability for [Assignment: organization-defined information system accounts and services].

Note

Single sign-on enables users to log in once and gain access to multiple information system resources. Organizations consider the operational efficiencies provided by single sign-on capabilities with the increased risk from disclosures of single authenticators providing access to multiple system resources.

IA-2 (11) : REMOTE ACCESS - SEPARATE DEVICE

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements multifactor authentication for remote access to privileged and non-privileged accounts such that one of the factors is provided by a device separate from the system gaining access and the device meets [Assignment: organization-defined strength of mechanism requirements].

Note

For remote access to privileged/non-privileged accounts, the purpose of requiring a device that is separate from the information system gaining access for one of the factors during multifactor authentication is to reduce the likelihood of compromising authentication credentials stored on the system. For example, adversaries deploying malicious code on organizational information systems can potentially compromise such credentials resident on the system and subsequently impersonate authorized users.

Related Controls: AC-6

IA-2 (12) : ACCEPTANCE OF PIV CREDENTIALS

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system accepts and electronically verifies Personal Identity Verification (PIV) credentials.

Note

This control enhancement applies to organizations implementing logical access control systems (LACS) and physical access control systems (PACS). Personal Identity Verification (PIV) credentials are those credentials issued by federal agencies that conform to FIPS Publication 201 and supporting guidance documents. OMB Memorandum 11-11 requires federal agencies to continue implementing the requirements specified in HSPD-12 to enable agency-wide use of PIV credentials.

Related Controls: AU-2, PE-3, SA-4

IA-2 (13) : OUT-OF-BAND AUTHENTICATION

The information system implements [Assignment: organization-defined out-of-band authentication] under [Assignment: organization-defined conditions].

Note

Out-of-band authentication (OOBA) refers to the use of two separate communication paths to identify and authenticate users or devices to an information system. The first path (i.e., the in-band path), is used to identify and authenticate users or devices, and generally is the path through which information flows. The second path (i.e., the out-of-band path) is used to independently verify the authentication and/or requested action. For example, a user authenticates via a notebook computer to a remote server to which the user desires access, and requests some action of the server via that communication path. Subsequently, the server contacts the user via the user's cell phone to verify that the requested action originated from the user. The user may either confirm the intended action to an individual on the telephone or provide an authentication code via the telephone. This type of authentication can be employed by organizations to mitigate actual or suspected man-in the-middle attacks. The conditions for activation can include, for example, suspicious activities, new threat indicators or elevated threat levels, or the impact level or classification level of information in requested transactions.

Related Controls: IA-10, IA-11, SC-37

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-3 : DEVICE IDENTIFICATION AND AUTHENTICATION

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system uniquely identifies and authenticates [Assignment: organization-defined specific and/or types of devices] before establishing a [Selection (one or more): local; remote; network] connection.

Note

Organizational devices requiring unique device-to-device identification and authentication may be defined by type, by device, or by a combination of type/device. Information systems typically use either shared known information (e.g., Media Access Control [MAC] or Transmission Control Protocol/Internet Protocol [TCP/IP] addresses) for device identification or organizational authentication solutions (e.g., IEEE 802.1x and Extensible Authentication Protocol [EAP], Radius server with EAP-Transport Layer Security [TLS] authentication, Kerberos) to identify/authenticate devices on local and/or wide area networks. Organizations determine the required strength of authentication mechanisms by the security categories of information systems. Because of the challenges of applying this control on large scale, organizations are encouraged to only apply the control to those limited number (and type) of devices that truly need to support this capability.

Related Controls: AC-17, AC-18, AC-19, CA-3, IA-4, IA-5

IA-3 (1) : CRYPTOGRAPHIC BIDIRECTIONAL AUTHENTICATION

The information system authenticates [Assignment: organization-defined specific devices and/or types of devices] before establishing [Selection (one or more): local; remote; network] connection using bidirectional authentication that is cryptographically based.

Note

A local connection is any connection with a device communicating without the use of a network. A network connection is any connection with a device that communicates through a network (e.g., local area or wide area network, Internet). A remote connection is any connection with a device communicating through an external network (e.g., the Internet). Bidirectional authentication provides stronger safeguards to validate the identity of other devices for connections that are of greater risk (e.g., remote connections).

Related Controls: SC-8, SC-12, SC-13

IA-3 (2) : CRYPTOGRAPHIC BIDIRECTIONAL NETWORK AUTHENTICATION

[Withdrawn: Incorporated into IA-3 (1)].

IA-3 (3) : DYNAMIC ADDRESS ALLOCATION

The organization:

Note

DHCP-enabled clients obtaining leases for IP addresses from DHCP servers, is a typical example of dynamic address allocation for devices.

Related Controls: AU-2, AU-3, AU-6, AU-12

IA-3 (3)(a)

Standardizes dynamic address allocation lease information and the lease duration assigned to devices in accordance with [Assignment: organization-defined lease information and lease duration]; and

IA-3 (3)(b)

Audits lease information when assigned to a device.

IA-3 (4) : DEVICE ATTESTATION

The organization ensures that device identification and authentication based on attestation is handled by [Assignment: organization-defined configuration management process].

Note

Device attestation refers to the identification and authentication of a device based on its configuration and known operating state. This might be determined via some cryptographic hash of the device. If device attestation is the means of identification and authentication, then it is important that patches and updates to the device are handled via a configuration management process such that the those patches/updates are done securely and at the same time do not disrupt the identification and authentication to other devices.

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-4 : IDENTIFIER MANAGEMENT

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization manages information system identifiers by:

Note

Common device identifiers include, for example, media access control (MAC), Internet protocol (IP) addresses, or device-unique token identifiers. Management of individual identifiers is not applicable to shared information system accounts (e.g., guest and anonymous accounts). Typically, individual identifiers are the user names of the information system accounts assigned to those individuals. In such instances, the account management activities of AC-2 use account names provided by IA-4. This control also addresses individual identifiers not necessarily associated with information system accounts (e.g., identifiers used in physical security control databases accessed by badge reader systems for access to information systems). Preventing reuse of identifiers implies preventing the assignment of previously used individual, group, role, or device identifiers to different individuals, groups, roles, or devices.

Related Controls: AC-2, IA-2, IA-3, IA-5, IA-8, SC-37

IA-4a.

Receiving authorization from [Assignment: organization-defined personnel or roles] to assign an individual, group, role, or device identifier;

IA-4b.

Selecting an identifier that identifies an individual, group, role, or device;

IA-4c.

Assigning the identifier to the intended individual, group, role, or device;

IA-4d.

Preventing reuse of identifiers for [Assignment: organization-defined time period]; and

IA-4e.

Disabling the identifier after [Assignment: organization-defined time period of inactivity].

IA-4 (1) : PROHIBIT ACCOUNT IDENTIFIERS AS PUBLIC IDENTIFIERS

The organization prohibits the use of information system account identifiers that are the same as public identifiers for individual electronic mail accounts.

Note

Prohibiting the use of information systems account identifiers that are the same as some public identifier such as the individual identifier section of an electronic mail address, makes it more difficult for adversaries to guess user identifiers on organizational information systems.

Related Controls: AT-2

IA-4 (2) : SUPERVISOR AUTHORIZATION

The organization requires that the registration process to receive an individual identifier includes supervisor authorization.

IA-4 (3) : MULTIPLE FORMS OF CERTIFICATION

The organization requires multiple forms of certification of individual identification be presented to the registration authority.

Note

Requiring multiple forms of identification, such as documentary evidence or a combination of documents and biometrics, reduces the likelihood of individuals using fraudulent identification to establish an identity, or at least increases the work factor of potential adversaries.

IA-4 (4) : IDENTIFY USER STATUS

The organization manages individual identifiers by uniquely identifying each individual as [Assignment: organization-defined characteristic identifying individual status].

Note

Characteristics identifying the status of individuals include, for example, contractors and foreign nationals. Identifying the status of individuals by specific characteristics provides additional information about the people with whom organizational personnel are communicating. For example, it might be useful for a government employee to know that one of the individuals on an email message is a contractor.

Related Controls: AT-2

IA-4 (5) : DYNAMIC MANAGEMENT

The information system dynamically manages identifiers.

Note

In contrast to conventional approaches to identification which presume static accounts for preregistered users, many distributed information systems including, for example, service-oriented architectures, rely on establishing identifiers at run time for entities that were previously unknown. In these situations, organizations anticipate and provision for the dynamic establishment of identifiers.

Preestablished trust relationships and mechanisms with appropriate authorities to validate identities and related credentials are essential.

Related Controls: AC-16

IA-4 (6) : CROSS-ORGANIZATION MANAGEMENT

The organization coordinates with [Assignment: organization-defined external organizations] for cross-organization management of identifiers.

Note

Cross-organization identifier management provides the capability for organizations to appropriately identify individuals, groups, roles, or devices when conducting cross-organization activities involving the processing, storage, or transmission of information.

IA-4 (7) : IN-PERSON REGISTRATION

The organization requires that the registration process to receive an individual identifier be conducted in person before a designated registration authority.

Note

In-person registration reduces the likelihood of fraudulent identifiers being issued because it requires the physical presence of individuals and actual face-to-face interactions with designated registration authorities.

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-5 : AUTHENTICATOR MANAGEMENT

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization manages information system authenticators by:

Note

Individual authenticators include, for example, passwords, tokens, biometrics, PKI certificates, and key cards. Initial authenticator content is the actual content (e.g., the initial password) as opposed to requirements about authenticator content (e.g., minimum password length). In many cases, developers ship information system components with factory default authentication credentials to allow for initial installation and configuration. Default authentication credentials are often well known, easily discoverable, and present a significant security risk. The requirement to protect individual authenticators may be implemented via control PL-4 or PS-6 for authenticators in the possession of individuals and by controls AC-3, AC-6, and SC-28 for authenticators stored within organizational information systems (e.g., passwords stored in hashed or encrypted formats, files containing encrypted or hashed passwords accessible with administrator privileges). Information systems support individual authenticator management by organization-defined settings and restrictions for

various authenticator characteristics including, for example, minimum password length, password composition, validation time window for time synchronous one-time tokens, and number of allowed rejections during the verification stage of biometric authentication. Specific actions that can be taken to safeguard authenticators include, for example, maintaining possession of individual authenticators, not loaning or sharing individual authenticators with others, and reporting lost, stolen, or compromised authenticators immediately. Authenticator management includes issuing and revoking, when no longer needed, authenticators for temporary access such as that required for remote maintenance. Device authenticators include, for example, certificates and passwords.

Related Controls: AC-2, AC-3, AC-6, CM-6, IA-2, IA-4, IA-8, PL-4, PS-5, PS-6, SC-12, SC-13, SC-17, SC-28

IA-5a.

Verifying, as part of the initial authenticator distribution, the identity of the individual, group, role, or device receiving the authenticator;

IA-5b.

Establishing initial authenticator content for authenticators defined by the organization;

IA-5c.

Ensuring that authenticators have sufficient strength of mechanism for their intended use;

IA-5d.

Establishing and implementing administrative procedures for initial authenticator distribution, for lost/compromised or damaged authenticators, and for revoking authenticators;

IA-5e.

Changing default content of authenticators prior to information system installation;

IA-5f.

Establishing minimum and maximum lifetime restrictions and reuse conditions for authenticators;

IA-5g.

Changing/refreshing authenticators [Assignment: organization-defined time period by authenticator type];

IA-5h.

Protecting authenticator content from unauthorized disclosure and modification;

IA-5i.

Requiring individuals to take, and having devices implement, specific security safeguards to protect authenticators; and

IA-5j.

Changing authenticators for group/role accounts when membership to those accounts changes.

IA-5 (1) : PASSWORD-BASED AUTHENTICATION

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system, for password-based authentication:

> ***Note***
>
> This control enhancement applies to single-factor authentication of individuals using passwords as individual or group authenticators, and in a similar manner, when passwords are part of multifactor authenticators. This control enhancement does not apply when passwords are used to unlock hardware authenticators (e.g., Personal Identity Verification cards). The implementation of such password mechanisms may not meet all of the requirements in the enhancement. Cryptographically-protected passwords include, for example, encrypted versions of passwords and one-way cryptographic hashes of passwords. The number of changed characters refers to the number of changes required with respect to the total number of positions in the current password. Password lifetime restrictions do not apply to temporary passwords. To mitigate certain brute force attacks against passwords, organizations may also consider salting passwords.

Related Controls: IA-6

IA-5 (1)(a)

Enforces minimum password complexity of [Assignment: organization-defined requirements for case sensitivity, number of characters, mix of upper-case letters, lower-case letters, numbers, and special characters, including minimum requirements for each type];

IA-5 (1)(b)

Enforces at least the following number of changed characters when new passwords are created: [Assignment: organization-defined number];

IA-5 (1)(c)

Stores and transmits only cryptographically-protected passwords;

IA-5 (1)(d)

Enforces password minimum and maximum lifetime restrictions of [Assignment: organization-defined numbers for lifetime minimum, lifetime maximum];

IA-5 (1)(e)

Prohibits password reuse for [Assignment: organization-defined number] generations; and

IA-5 (1)(f)

Allows the use of a temporary password for system logons with an immediate change to a permanent password.

IA-5 (2) : PKI-BASED AUTHENTICATION

Baseline-Impact: *MODERATE*, **HIGH**

The information system, for PKI-based authentication:

Note

Status information for certification paths includes, for example, certificate revocation lists or certificate status protocol responses. For PIV cards, validation of certifications involves the construction and verification of a certification path to the Common Policy Root trust anchor including certificate policy processing.

Related Controls: IA-6

IA-5 (2)(a)

Validates certifications by constructing and verifying a certification path to an accepted trust anchor including checking certificate status information;

IA-5 (2)(b)

Enforces authorized access to the corresponding private key;

IA-5 (2)(c)

Maps the authenticated identity to the account of the individual or group; and

IA-5 (2)(d)

Implements a local cache of revocation data to support path discovery and validation in case of inability to access revocation information via the network.

IA-5 (3) : IN-PERSON OR TRUSTED THIRD-PARTY REGISTRATION

Baseline-Impact: *MODERATE*, **HIGH**

The organization requires that the registration process to receive [Assignment: organization-defined types of and/or specific authenticators] be conducted [Selection: in person; by a trusted third party] before [Assignment: organization-defined registration authority] with authorization by [Assignment: organization-defined personnel or roles].

IA-5 (4) : AUTOMATED SUPPORT FOR PASSWORD STRENGTH DETERMINATION

The organization employs automated tools to determine if password authenticators are sufficiently strong to satisfy [Assignment: organization-defined requirements].

Note

This control enhancement focuses on the creation of strong passwords and the characteristics of such passwords (e.g., complexity) prior to use, the enforcement of which is carried out by organizational information systems in IA-5 (1).

Related Controls: CA-2, CA-7, RA-5

IA-5 (5) : CHANGE AUTHENTICATORS PRIOR TO DELIVERY

The organization requires developers/installers of information system components to provide unique authenticators or change default authenticators prior to delivery/installation.

Note

This control enhancement extends the requirement for organizations to change default authenticators upon information system installation, by requiring developers and/or installers to provide unique authenticators or change default authenticators for system components prior to delivery and/or installation. However, it typically does not apply to the developers of commercial off-the-shelve information technology products. Requirements for unique authenticators can be included in acquisition documents prepared by organizations when procuring information systems or system components.

IA-5 (6) : PROTECTION OF AUTHENTICATORS

The organization protects authenticators commensurate with the security category of the information to which use of the authenticator permits access.

Note

For information systems containing multiple security categories of information without reliable physical or logical separation between categories, authenticators used to grant access to the systems are protected commensurate with the highest security category of information on the systems.

IA-5 (7) : NO EMBEDDED UNENCRYPTED STATIC AUTHENTICATORS

The organization ensures that unencrypted static authenticators are not embedded in applications or access scripts or stored on function keys.

Note

Organizations exercise caution in determining whether embedded or stored authenticators are in encrypted or unencrypted form. If authenticators are used in the manner stored, then those representations are considered unencrypted authenticators. This is irrespective of whether that representation is perhaps an encrypted version of something else (e.g., a password).

IA-5 (8) : MULTIPLE INFORMATION SYSTEM ACCOUNTS

The organization implements [Assignment: organization-defined security safeguards] to manage the risk of compromise due to individuals having accounts on multiple information systems.

Note

When individuals have accounts on multiple information systems, there is the risk that the compromise of one account may lead to the compromise of other accounts if individuals use the same authenticators. Possible alternatives include, for example: (i) having different authenticators on all systems; (ii) employing some form of single sign-on mechanism; or (iii) including some form of one-time passwords on all systems.

IA-5 (9) : CROSS-ORGANIZATION CREDENTIAL MANAGEMENT

The organization coordinates with [Assignment: organization-defined external organizations] for cross-organization management of credentials.

Note

Cross-organization management of credentials provides the capability for organizations to appropriately authenticate individuals, groups, roles, or devices when conducting cross-organization activities involving the processing, storage, or transmission of information.

IA-5 (10) : DYNAMIC CREDENTIAL ASSOCIATION

The information system dynamically provisions identities.

Note

Authentication requires some form of binding between an identity and the authenticator used to confirm the identity. In conventional approaches, this binding is established by pre-provisioning both the identity and the authenticator to the information system. For example, the binding between a username (i.e., identity) and a password (i.e., authenticator) is accomplished by provisioning the identity and authenticator as a pair in the information system. New authentication techniques allow the binding between the identity and the authenticator to be implemented outside an information system. For example, with smartcard credentials, the identity and the authenticator are bound together on the card. Using these credentials, information systems can authenticate identities that have not been pre-provisioned, dynamically provisioning the identity after authentication. In these situations, organizations can anticipate the dynamic provisioning of identities. Preestablished trust relationships and mechanisms with appropriate authorities to validate identities and related credentials are essential.

IA-5 (11) : HARDWARE TOKEN-BASED AUTHENTICATION

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system, for hardware token-based authentication, employs mechanisms that satisfy [Assignment: organization-defined token quality requirements].

Note

Hardware token-based authentication typically refers to the use of PKI-based tokens, such as the U.S. Government Personal Identity Verification (PIV) card. Organizations define specific requirements for tokens, such as working with a particular PKI.

IA-5 (12) : BIOMETRIC-BASED AUTHENTICATION

The information system, for biometric-based authentication, employs mechanisms that satisfy [Assignment: organization-defined biometric quality requirements].

Note

Unlike password-based authentication which provides exact matches of user-input passwords to stored passwords, biometric authentication does not provide such exact matches. Depending upon the type of biometric and the type of collection mechanism, there is likely to be some divergence from the presented biometric and stored biometric which serves as the basis of comparison. There will likely be both false positives and false negatives when making such comparisons. The rate at which the false accept and false reject rates are equal is known as the crossover rate. Biometric quality requirements include, for example, acceptable crossover rates, as that essentially reflects the accuracy of the biometric.

IA-5 (13) : EXPIRATION OF CACHED AUTHENTICATORS

The information system prohibits the use of cached authenticators after [Assignment: organization-defined time period].

IA-5 (14) : MANAGING CONTENT OF PKI TRUST STORES

The organization, for PKI-based authentication, employs a deliberate organization-wide methodology for managing the content of PKI trust stores installed across all platforms including networks, operating systems, browsers, and applications.

IA-5 (15) : FICAM-APPROVED PRODUCTS AND SERVICES

The organization uses only FICAM-approved path discovery and validation products and services.

Note

Federal Identity, Credential, and Access Management (FICAM)-approved path discovery and validation products and services are those products and services that have been approved through the FICAM conformance program, where applicable.

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-6 : AUTHENTICATOR FEEDBACK

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system obscures feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals.

Note

The feedback from information systems does not provide information that would allow unauthorized individuals to compromise authentication mechanisms. For some types of information systems or system components, for example, desktops/notebooks with relatively large monitors, the threat (often referred to as shoulder surfing) may be significant. For other types of systems or components, for example, mobile devices with 2-4 inch screens, this threat may be less significant, and may need to be balanced against the increased likelihood of typographic input errors due to the small keyboards. Therefore, the means for obscuring the authenticator feedback is selected accordingly. Obscuring the feedback of authentication information includes, for example, displaying asterisks when users type passwords into input devices, or displaying feedback for a very limited time before fully obscuring it.

Related Controls: PE-18

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-7 : CRYPTOGRAPHIC MODULE AUTHENTICATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system implements mechanisms for authentication to a cryptographic module that meet the requirements of applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance for such authentication.

Note

Authentication mechanisms may be required within a cryptographic module to authenticate an operator accessing the module and to verify that the operator is authorized to assume the requested role and perform services within that role.

Related Controls: SC-12, SC-13

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-8 : IDENTIFICATION AND AUTHENTICATION (NON-ORGANIZATIONAL USERS)

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system uniquely identifies and authenticates non-organizational users (or processes acting on behalf of non-organizational users).

Note

Non-organizational users include information system users other than organizational users explicitly covered by IA-2. These individuals are uniquely identified and authenticated for accesses other than

those accesses explicitly identified and documented in AC-14. In accordance with the E-Authentication E-Government initiative, authentication of non-organizational users accessing federal information systems may be required to protect federal, proprietary, or privacy-related information (with exceptions noted for national security systems). Organizations use risk assessments to determine authentication needs and consider scalability, practicality, and security in balancing the need to ensure ease of use for access to federal information and information systems with the need to protect and adequately mitigate risk. IA-2 addresses identification and authentication requirements for access to information systems by organizational users.

Related Controls: AC-2, AC-14, AC-17, AC-18, IA-2, IA-4, IA-5, MA-4, RA-3, SA-12, SC-8

IA-8 (1) : ACCEPTANCE OF PIV CREDENTIALS FROM OTHER AGENCIES

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system accepts and electronically verifies Personal Identity Verification (PIV) credentials from other federal agencies.

Note

This control enhancement applies to logical access control systems (LACS) and physical access control systems (PACS). Personal Identity Verification (PIV) credentials are those credentials issued by federal agencies that conform to FIPS Publication 201 and supporting guidance documents. OMB Memorandum 11-11 requires federal agencies to continue implementing the requirements specified in HSPD-12 to enable agency-wide use of PIV credentials.

Related Controls: AU-2, PE-3, SA-4

IA-8 (2) : ACCEPTANCE OF THIRD-PARTY CREDENTIALS

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system accepts only FICAM-approved third-party credentials.

Note

This control enhancement typically applies to organizational information systems that are accessible to the general public, for example, public-facing websites. Third-party credentials are those credentials issued by nonfederal government entities approved by the Federal Identity, Credential, and Access Management (FICAM) Trust Framework Solutions initiative. Approved third-party credentials meet or exceed the set of minimum federal government-wide technical, security, privacy, and organizational maturity requirements. This allows federal government relying parties to trust such credentials at their approved assurance levels.

Related Controls: AU-2

IA-8 (3) : USE OF FICAM-APPROVED PRODUCTS

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization employs only FICAM-approved information system components in [Assignment: organization-defined information systems] to accept third-party credentials.

Note

This control enhancement typically applies to information systems that are accessible to the general public, for example, public-facing websites. FICAM-approved information system components include, for example, information technology products and software libraries that have been approved by the Federal Identity, Credential, and Access Management conformance program.

Related Controls: SA-4

IA-8 (4) : USE OF FICAM-ISSUED PROFILES

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system conforms to FICAM-issued profiles.

Note

This control enhancement addresses open identity management standards. To ensure that these standards are viable, robust, reliable, sustainable (e.g., available in commercial information technology products), and interoperable as documented, the United States Government assesses and scopes identity management standards and technology implementations against applicable federal legislation, directives, policies, and requirements. The result is FICAM-issued implementation profiles of approved protocols (e.g., FICAM authentication protocols such as SAML 2.0 and OpenID 2.0, as well as other protocols such as the FICAM Backend Attribute Exchange).

Related Controls: SA-4

IA-8 (5) : ACCEPTANCE OF PIV-I CREDENTIALS

The information system accepts and electronically verifies Personal Identity Verification-I (PIV-I) credentials.

Note

This control enhancement: (i) applies to logical and physical access control systems; and (ii) addresses Non-Federal Issuers (NFIs) of identity cards that desire to interoperate with United States Government Personal Identity Verification (PIV) information systems and that can be trusted by federal government-relying parties. The X.509 certificate policy for the Federal Bridge Certification Authority (FBCA) addresses PIV-I requirements. The PIV-I card is suitable for Assurance Level 4 as defined in OMB Memorandum 04-04 and NIST Special Publication 800-63, and multifactor authentication as defined in NIST Special Publication 800-116. PIV-I credentials are those credentials issued by a PIV-I provider whose PIV-I certificate policy maps to the Federal Bridge PIV-I Certificate Policy. A PIV-I provider is cross-certified (directly or through another PKI bridge) with the FBCA with policies that have been mapped and approved as meeting the requirements of the PIV-I policies defined in the FBCA certificate policy.

Related Controls: AU-2

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-9 : SERVICE IDENTIFICATION AND AUTHENTICATION

Priority: P0

The organization identifies and authenticates [Assignment: organization-defined information system services] using [Assignment: organization-defined security safeguards].

Note

This control supports service-oriented architectures and other distributed architectural approaches requiring the identification and authentication of information system services. In such architectures, external services often appear dynamically. Therefore, information systems should be able to determine in a dynamic manner, if external providers and associated services are authentic. Safeguards implemented by organizational information systems to validate provider and service authenticity include, for example, information or code signing, provenance graphs, and/or electronic signatures indicating or including the sources of services.

IA-9 (1) : INFORMATION EXCHANGE

The organization ensures that service providers receive, validate, and transmit identification and authentication information.

IA-9 (2) : TRANSMISSION OF DECISIONS

The organization ensures that identification and authentication decisions are transmitted between [Assignment: organization-defined services] consistent with organizational policies.

Note

For distributed architectures (e.g., service-oriented architectures), the decisions regarding the validation of identification and authentication claims may be made by services separate from the services acting on those decisions. In such situations, it is necessary to provide the identification and authentication decisions (as opposed to the actual identifiers and authenticators) to the services that need to act on those decisions.

Related Controls: SC-8

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-10 : ADAPTIVE IDENTIFICATION AND AUTHENTICATION

Priority: P0

The organization requires that individuals accessing the information system employ [Assignment: organization-defined supplemental authentication techniques or mechanisms] under specific [Assignment: organization-defined circumstances or situations].

Note

Adversaries may compromise individual authentication mechanisms and subsequently attempt to impersonate legitimate users. This situation can potentially occur with any authentication mechanisms employed by organizations. To address this threat, organizations may employ specific techniques/mechanisms and establish protocols to assess suspicious behavior (e.g., individuals accessing information that they do not typically access as part of their normal duties, roles, or

responsibilities, accessing greater quantities of information than the individuals would routinely access, or attempting to access information from suspicious network addresses). In these situations when certain preestablished conditions or triggers occur, organizations can require selected individuals to provide additional authentication information. Another potential use for adaptive identification and authentication is to increase the strength of mechanism based on the number and/or types of records being accessed.

Related Controls: AU-6, SI-4

Control Family: IDENTIFICATION AND AUTHENTICATION

IA-11 : RE-AUTHENTICATION

Priority: P0

The organization requires users and devices to re-authenticate when [Assignment: organization-defined circumstances or situations requiring re-authentication].

Note

In addition to the re-authentication requirements associated with session locks, organizations may require re-authentication of individuals and/or devices in other situations including, for example: (i) when authenticators change; (ii), when roles change; (iii) when security categories of information systems change; (iv), when the execution of privileged functions occurs; (v) after a fixed period of time; or (vi) periodically.

Related Controls: AC-11

Control Family: INCIDENT RESPONSE

IR-1 : INCIDENT RESPONSE POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the IR family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

IR-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

IR-1a.1.

An incident response policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

IR-1a.2.

Procedures to facilitate the implementation of the incident response policy and associated incident response controls; and

IR-1b.

Reviews and updates the current:

IR-1b.1.

Incident response policy [Assignment: organization-defined frequency]; and

IR-1b.2.

Incident response procedures [Assignment: organization-defined frequency].

Control Family: INCIDENT RESPONSE

IR-2 : INCIDENT RESPONSE TRAINING

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization provides incident response training to information system users consistent with assigned roles and responsibilities:

Note

Incident response training provided by organizations is linked to the assigned roles and responsibilities of organizational personnel to ensure the appropriate content and level of detail is included in such training. For example, regular users may only need to know who to call or how to recognize an incident on the information system; system administrators may require additional training on how to handle/remediate incidents; and incident responders may receive more specific training on forensics, reporting, system recovery, and restoration. Incident response training includes user training in the identification and reporting of suspicious activities, both from external and internal sources.

Related Controls: AT-3, CP-3, IR-8

IR-2a.

Within [Assignment: organization-defined time period] of assuming an incident response role or responsibility;

IR-2b.

When required by information system changes; and

IR-2c.

[Assignment: organization-defined frequency] thereafter.

IR-2 (1) : SIMULATED EVENTS

Baseline-Impact: HIGH

The organization incorporates simulated events into incident response training to facilitate effective response by personnel in crisis situations.

IR-2 (2) : AUTOMATED TRAINING ENVIRONMENTS

Baseline-Impact: HIGH

The organization employs automated mechanisms to provide a more thorough and realistic incident response training environment.

Control Family: INCIDENT RESPONSE

IR-3 : INCIDENT RESPONSE TESTING

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The organization tests the incident response capability for the information system [Assignment: organization-defined frequency] using [Assignment: organization-defined tests] to determine the incident response effectiveness and documents the results.

Note

Organizations test incident response capabilities to determine the overall effectiveness of the capabilities and to identify potential weaknesses or deficiencies. Incident response testing includes, for example, the use of checklists, walk-through or tabletop exercises, simulations (parallel/full interrupt), and comprehensive exercises. Incident response testing can also include a determination of the effects on organizational operations (e.g., reduction in mission capabilities), organizational assets, and individuals due to incident response.

Related Controls: CP-4, IR-8

IR-3 (1) : AUTOMATED TESTING

The organization employs automated mechanisms to more thoroughly and effectively test the incident response capability.

Note

Organizations use automated mechanisms to more thoroughly and effectively test incident response capabilities, for example: (i) by providing more complete coverage of incident response issues; (ii) by selecting more realistic test scenarios and test environments; and (iii) by stressing the response capability.

Related Controls: AT-2

IR-3 (2) : COORDINATION WITH RELATED PLANS

Baseline-Impact: *MODERATE*, **HIGH**

The organization coordinates incident response testing with organizational elements responsible for related plans.

Note

Organizational plans related to incident response testing include, for example, Business Continuity Plans, Contingency Plans, Disaster Recovery Plans, Continuity of Operations Plans, Crisis Communications Plans, Critical Infrastructure Plans, and Occupant Emergency Plans.

Control Family: INCIDENT RESPONSE

IR-4 : INCIDENT HANDLING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Organizations recognize that incident response capability is dependent on the capabilities of organizational information systems and the mission/business processes being supported by those systems. Therefore, organizations consider incident response as part of the definition, design, and development of mission/business processes and information systems. Incident-related information can be obtained from a variety of sources including, for example, audit monitoring, network monitoring, physical access monitoring, user/administrator reports, and reported supply chain events. Effective incident handling capability includes coordination among many organizational entities including, for example, mission/business owners, information system owners, authorizing officials, human resources offices, physical and personnel security offices, legal departments, operations personnel, procurement offices, and the risk executive (function).

Related Controls: AU-6, CM-6, CP-2, CP-4, IR-2, IR-3, IR-8, PE-6, SC-5, SC-7, SI-3, SI-4, SI-7

IR-4a.

Implements an incident handling capability for security incidents that includes preparation, detection and analysis, containment, eradication, and recovery;

IR-4b.

Coordinates incident handling activities with contingency planning activities; and

IR-4c.

Incorporates lessons learned from ongoing incident handling activities into incident response procedures, training, and testing, and implements the resulting changes accordingly.

IR-4 (1) : AUTOMATED INCIDENT HANDLING PROCESSES

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs automated mechanisms to support the incident handling process.

Note

Automated mechanisms supporting incident handling processes include, for example, online incident management systems.

IR-4 (2) : DYNAMIC RECONFIGURATION

The organization includes dynamic reconfiguration of [Assignment: organization-defined information system components] as part of the incident response capability.

Note

Dynamic reconfiguration includes, for example, changes to router rules, access control lists, intrusion detection/prevention system parameters, and filter rules for firewalls and gateways. Organizations perform dynamic reconfiguration of information systems, for example, to stop attacks, to misdirect attackers, and to isolate components of systems, thus limiting the extent of the damage from breaches or compromises. Organizations include time frames for achieving the reconfiguration of information systems in the definition of the reconfiguration capability, considering the potential need for rapid response in order to effectively address sophisticated cyber threats.

Related Controls: AC-2, AC-4, AC-16, CM-2, CM-3, CM-4

IR-4 (3) : CONTINUITY OF OPERATIONS

The organization identifies [Assignment: organization-defined classes of incidents] and [Assignment: organization-defined actions to take in response to classes of incidents] to ensure continuation of organizational missions and business functions.

Note

Classes of incidents include, for example, malfunctions due to design/implementation errors and omissions, targeted malicious attacks, and untargeted malicious attacks. Appropriate incident response actions include, for example, graceful degradation, information system shutdown, fall back to manual mode/alternative technology whereby the system operates differently, employing deceptive measures, alternate information flows, or operating in a mode that is reserved solely for when systems are under attack.

IR-4 (4) : INFORMATION CORRELATION

Baseline-Impact: HIGH

The organization correlates incident information and individual incident responses to achieve an organization-wide perspective on incident awareness and response.

Note

Sometimes the nature of a threat event, for example, a hostile cyber attack, is such that it can only be observed by bringing together information from different sources including various reports and reporting procedures established by organizations.

IR-4 (5) : AUTOMATIC DISABLING OF INFORMATION SYSTEM

The organization implements a configurable capability to automatically disable the information system if [Assignment: organization-defined security violations] are detected.

IR-4 (6) : INSIDER THREATS - SPECIFIC CAPABILITIES

The organization implements incident handling capability for insider threats.

Note

While many organizations address insider threat incidents as an inherent part of their organizational incident response capability, this control enhancement provides additional emphasis on this type of threat and the need for specific incident handling capabilities (as defined within organizations) to provide appropriate and timely responses.

IR-4 (7) : INSIDER THREATS - INTRA-ORGANIZATION COORDINATION

The organization coordinates incident handling capability for insider threats across [Assignment: organization-defined components or elements of the organization].

Note

Incident handling for insider threat incidents (including preparation, detection and analysis, containment, eradication, and recovery) requires close coordination among a variety of organizational components or elements to be effective. These components or elements include, for example, mission/business owners, information system owners, human resources offices, procurement offices,

personnel/physical security offices, operations personnel, and risk executive (function). In addition, organizations may require external support from federal, state, and local law enforcement agencies.

IR-4 (8) : CORRELATION WITH EXTERNAL ORGANIZATIONS

The organization coordinates with [Assignment: organization-defined external organizations] to correlate and share [Assignment: organization-defined incident information] to achieve a cross-organization perspective on incident awareness and more effective incident responses.

Note

The coordination of incident information with external organizations including, for example, mission/business partners, military/coalition partners, customers, and multitiered developers, can provide significant benefits. Cross-organizational coordination with respect to incident handling can serve as an important risk management capability. This capability allows organizations to leverage critical information from a variety of sources to effectively respond to information security-related incidents potentially affecting the organization's operations, assets, and individuals.

IR-4 (9) : DYNAMIC RESPONSE CAPABILITY

The organization employs [Assignment: organization-defined dynamic response capabilities] to effectively respond to security incidents.

Note

This control enhancement addresses the deployment of replacement or new capabilities in a timely manner in response to security incidents (e.g., adversary actions during hostile cyber attacks). This includes capabilities implemented at the mission/business process level (e.g., activating alternative mission/business processes) and at the information system level.

Related Controls: CP-10

IR-4 (10) : SUPPLY CHAIN COORDINATION

The organization coordinates incident handling activities involving supply chain events with other organizations involved in the supply chain.

Note

Organizations involved in supply chain activities include, for example, system/product developers, integrators, manufacturers, packagers, assemblers, distributors, vendors, and resellers. Supply chain incidents include, for example, compromises/breaches involving information system components, information technology products, development processes or personnel, and distribution processes or warehousing facilities.

Control Family: INCIDENT RESPONSE

IR-5 : INCIDENT MONITORING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization tracks and documents information system security incidents.

Note

Documenting information system security incidents includes, for example, maintaining records about each incident, the status of the incident, and other pertinent information necessary for forensics, evaluating incident details, trends, and handling. Incident information can be obtained from a variety of sources including, for example, incident reports, incident response teams, audit monitoring, network monitoring, physical access monitoring, and user/administrator reports.

Related Controls: AU-6, IR-8, PE-6, SC-5, SC-7, SI-3, SI-4, SI-7

IR-5 (1) : AUTOMATED TRACKING / DATA COLLECTION / ANALYSIS

Baseline-Impact: HIGH

The organization employs automated mechanisms to assist in the tracking of security incidents and in the collection and analysis of incident information.

Note

Automated mechanisms for tracking security incidents and collecting/analyzing incident information include, for example, the Einstein network monitoring device and monitoring online Computer Incident Response Centers (CIRCs) or other electronic databases of incidents.

Related Controls: AU-7, IR-4

Control Family: INCIDENT RESPONSE

IR-6 : INCIDENT REPORTING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

The intent of this control is to address both specific incident reporting requirements within an organization and the formal incident reporting requirements for federal agencies and their subordinate organizations. Suspected security incidents include, for example, the receipt of suspicious email communications that can potentially contain malicious code. The types of security incidents reported, the content and timeliness of the reports, and the designated reporting authorities reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Current federal policy requires that all federal agencies (unless specifically exempted from such requirements) report security incidents to the United States Computer Emergency Readiness Team (US-CERT) within specified time frames designated in the US-CERT Concept of Operations for Federal Cyber Security Incident Handling.

Related Controls: IR-4, IR-5, IR-8

IR-6a.

Requires personnel to report suspected security incidents to the organizational incident response capability within [Assignment: organization-defined time period]; and

IR-6b.

Reports security incident information to [Assignment: organization-defined authorities].

IR-6 (1) : AUTOMATED REPORTING

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs automated mechanisms to assist in the reporting of security incidents.

Related Controls: IR-7

IR-6 (2) : VULNERABILITIES RELATED TO INCIDENTS

The organization reports information system vulnerabilities associated with reported security incidents to [Assignment: organization-defined personnel or roles].

IR-6 (3) : COORDINATION WITH SUPPLY CHAIN

The organization provides security incident information to other organizations involved in the supply chain for information systems or information system components related to the incident.

Note

Organizations involved in supply chain activities include, for example, system/product developers, integrators, manufacturers, packagers, assemblers, distributors, vendors, and resellers. Supply chain incidents include, for example, compromises/breaches involving information system components, information technology products, development processes or personnel, and distribution processes or warehousing facilities. Organizations determine the appropriate information to share considering the value gained from support by external organizations with the potential for harm due to sensitive information being released to outside organizations of perhaps questionable trustworthiness.

Control Family: INCIDENT RESPONSE

IR-7 : INCIDENT RESPONSE ASSISTANCE

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization provides an incident response support resource, integral to the organizational incident response capability that offers advice and assistance to users of the information system for the handling and reporting of security incidents.

Note

Incident response support resources provided by organizations include, for example, help desks, assistance groups, and access to forensics services, when required.

Related Controls: AT-2, IR-4, IR-6, IR-8, SA-9

IR-7 (1) : AUTOMATION SUPPORT FOR AVAILABILITY OF INFORMATION / SUPPORT

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs automated mechanisms to increase the availability of incident response-related information and support.

Note

Automated mechanisms can provide a push and/or pull capability for users to obtain incident response assistance. For example, individuals might have access to a website to query the assistance capability, or conversely, the assistance capability may have the ability to proactively send information to users (general distribution or targeted) as part of increasing understanding of current response capabilities and support.

IR-7 (2) : COORDINATION WITH EXTERNAL PROVIDERS

The organization:

Note

External providers of information system protection capability include, for example, the Computer Network Defense program within the U.S. Department of Defense. External providers help to protect, monitor, analyze, detect, and respond to unauthorized activity within organizational information systems and networks.

IR-7 (2)(a)

Establishes a direct, cooperative relationship between its incident response capability and external providers of information system protection capability; and

IR-7 (2)(b)

Identifies organizational incident response team members to the external providers.

Control Family: INCIDENT RESPONSE

IR-8 : INCIDENT RESPONSE PLAN

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

It is important that organizations develop and implement a coordinated approach to incident response. Organizational missions, business functions, strategies, goals, and objectives for incident response help to determine the structure of incident response capabilities. As part of a comprehensive incident response capability, organizations consider the coordination and sharing of information with external organizations, including, for example, external service providers and organizations involved in the supply chain for organizational information systems.

Related Controls: MP-2, MP-4, MP-5

IR-8a.

Develops an incident response plan that:

IR-8a.1.

Provides the organization with a roadmap for implementing its incident response capability;

IR-8a.2.

Describes the structure and organization of the incident response capability;

IR-8a.3.

Provides a high-level approach for how the incident response capability fits into the overall organization;

IR-8a.4.

Meets the unique requirements of the organization, which relate to mission, size, structure, and functions;

IR-8a.5.

Defines reportable incidents;

IR-8a.6.

Provides metrics for measuring the incident response capability within the organization;

IR-8a.7.

Defines the resources and management support needed to effectively maintain and mature an incident response capability; and

IR-8a.8.

Is reviewed and approved by [Assignment: organization-defined personnel or roles];

IR-8b.

Distributes copies of the incident response plan to [Assignment: organization-defined incident response personnel (identified by name and/or by role) and organizational elements];

IR-8c.

Reviews the incident response plan [Assignment: organization-defined frequency];

IR-8d.

Updates the incident response plan to address system/organizational changes or problems encountered during plan implementation, execution, or testing;

IR-8e.

Communicates incident response plan changes to [Assignment: organization-defined incident response personnel (identified by name and/or by role) and organizational elements]; and

IR-8f.

Protects the incident response plan from unauthorized disclosure and modification.

Control Family: INCIDENT RESPONSE

IR-9 : INFORMATION SPILLAGE RESPONSE

Priority: P0

The organization responds to information spills by:

Note

Information spillage refers to instances where either classified or sensitive information is inadvertently placed on information systems that are not authorized to process such information. Such information spills often occur when information that is initially thought to be of lower sensitivity is transmitted to an information system and then is subsequently determined to be of higher sensitivity. At that point, corrective action is required. The nature of the organizational response is generally based upon the degree of sensitivity of the spilled information (e.g., security category or classification level), the security capabilities of the information system, the specific nature of contaminated storage media, and the access authorizations (e.g., security clearances) of individuals with authorized access to the contaminated system. The methods used to communicate information about the spill after the fact do not involve methods directly associated with the actual spill to minimize the risk of further spreading the contamination before such contamination is isolated and eradicated.

IR-9a.

Identifying the specific information involved in the information system contamination;

IR-9b.

Alerting [Assignment: organization-defined personnel or roles] of the information spill using a method of communication not associated with the spill;

IR-9c.

Isolating the contaminated information system or system component;

IR-9d.

Eradicating the information from the contaminated information system or component;

IR-9e.

Identifying other information systems or system components that may have been subsequently contaminated; and

IR-9f.

Performing other [Assignment: organization-defined actions].

IR-9 (1) : RESPONSIBLE PERSONNEL

The organization assigns [Assignment: organization-defined personnel or roles] with responsibility for responding to information spills.

IR-9 (2) : TRAINING

The organization provides information spillage response training [Assignment: organization-defined frequency].

IR-9 (3) : POST-SPILL OPERATIONS

The organization implements [Assignment: organization-defined procedures] to ensure that organizational personnel impacted by information spills can continue to carry out assigned tasks while contaminated systems are undergoing corrective actions.

Note

Correction actions for information systems contaminated due to information spillages may be very time-consuming. During those periods, personnel may not have access to the contaminated systems, which may potentially affect their ability to conduct organizational business.

IR-9 (4) : EXPOSURE TO UNAUTHORIZED PERSONNEL

The organization employs [Assignment: organization-defined security safeguards] for personnel exposed to information not within assigned access authorizations.

Note

Security safeguards include, for example, making personnel exposed to spilled information aware of the federal laws, directives, policies, and/or regulations regarding the information and the restrictions imposed based on exposure to such information.

Control Family: INCIDENT RESPONSE

IR-10 : INTEGRATED INFORMATION SECURITY ANALYSIS TEAM

Priority: P0

The organization establishes an integrated team of forensic/malicious code analysts, tool developers, and real-time operations personnel.

Note

Having an integrated team for incident response facilitates information sharing. Such capability allows organizational personnel, including developers, implementers, and operators, to leverage the team knowledge of the threat in order to implement defensive measures that will enable organizations to deter intrusions more effectively. Moreover, it promotes the rapid detection of intrusions, development of appropriate mitigations, and the deployment of effective defensive measures. For example, when an intrusion is detected, the integrated security analysis team can rapidly develop an appropriate response for operators to implement, correlate the new incident with information on past intrusions, and augment ongoing intelligence development. This enables the team to identify adversary TTPs that are linked to the operations tempo or to specific missions/business functions, and to define responsive actions in a way that does not disrupt the mission/business operations. Ideally, information security analysis teams are distributed within organizations to make the capability more resilient.

Control Family: MAINTENANCE

MA-1 : SYSTEM MAINTENANCE POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the MA family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for

the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

MA-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

MA-1a.1.

A system maintenance policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

MA-1a.2.

Procedures to facilitate the implementation of the system maintenance policy and associated system maintenance controls; and

MA-1b.

Reviews and updates the current:

MA-1b.1.

System maintenance policy [Assignment: organization-defined frequency]; and

MA-1b.2.

System maintenance procedures [Assignment: organization-defined frequency].

Control Family: MAINTENANCE

MA-2 : CONTROLLED MAINTENANCE

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the information security aspects of the information system maintenance program and applies to all types of maintenance to any system component (including applications) conducted by any local or nonlocal entity (e.g., in-contract, warranty, in-house, software maintenance agreement). System maintenance also includes those components not directly associated with information processing and/or data/information retention such as scanners, copiers, and printers. Information necessary for creating effective maintenance records includes, for example: (i) date and time of maintenance; (ii) name of individuals or group performing the maintenance; (iii) name of escort, if necessary; (iv) a description of the maintenance performed; and (v) information system components/equipment removed or replaced (including identification numbers, if applicable). The level of detail included in maintenance records can be informed by the security categories of

organizational information systems. Organizations consider supply chain issues associated with replacement components for information systems.

Related Controls: CM-3, CM-4, MA-4, MP-6, PE-16, SA-12, SI-2

MA-2a.

Schedules, performs, documents, and reviews records of maintenance and repairs on information system components in accordance with manufacturer or vendor specifications and/or organizational requirements;

MA-2b.

Approves and monitors all maintenance activities, whether performed on site or remotely and whether the equipment is serviced on site or removed to another location;

MA-2c.

Requires that [Assignment: organization-defined personnel or roles] explicitly approve the removal of the information system or system components from organizational facilities for off-site maintenance or repairs;

MA-2d.

Sanitizes equipment to remove all information from associated media prior to removal from organizational facilities for off-site maintenance or repairs;

MA-2e.

Checks all potentially impacted security controls to verify that the controls are still functioning properly following maintenance or repair actions; and

MA-2f.

Includes [Assignment: organization-defined maintenance-related information] in organizational maintenance records.

MA-2 (1) : RECORD CONTENT

[Withdrawn: Incorporated into MA-2].

MA-2 (2) : AUTOMATED MAINTENANCE ACTIVITIES

Baseline-Impact: HIGH

The organization:

Related Controls: CA-7, MA-3

MA-2 (2)(a)

Employs automated mechanisms to schedule, conduct, and document maintenance and repairs; and

MA-2 (2)(b)

Produces up-to date, accurate, and complete records of all maintenance and repair actions requested, scheduled, in process, and completed.

Control Family: MAINTENANCE

MA-3 : MAINTENANCE TOOLS

Priority: P3

Baseline-Impact: *MODERATE*, **HIGH**

The organization approves, controls, and monitors information system maintenance tools.

Note

This control addresses security-related issues associated with maintenance tools used specifically for diagnostic and repair actions on organizational information systems. Maintenance tools can include hardware, software, and firmware items. Maintenance tools are potential vehicles for transporting malicious code, either intentionally or unintentionally, into a facility and subsequently into organizational information systems. Maintenance tools can include, for example, hardware/software diagnostic test equipment and hardware/software packet sniffers. This control does not cover hardware/software components that may support information system maintenance, yet are a part of the system, for example, the software implementing "ping," "ls," "ipconfig," or the hardware and software implementing the monitoring port of an Ethernet switch.

Related Controls: MA-2, MA-5, MP-6

MA-3 (1) : INSPECT TOOLS

Baseline-Impact: *MODERATE*, **HIGH**

The organization inspects the maintenance tools carried into a facility by maintenance personnel for improper or unauthorized modifications.

Note

If, upon inspection of maintenance tools, organizations determine that the tools have been modified in an improper/unauthorized manner or contain malicious code, the incident is handled consistent with organizational policies and procedures for incident handling.

Related Controls: SI-7

MA-3 (2) : INSPECT MEDIA

Baseline-Impact: *MODERATE*, **HIGH**

The organization checks media containing diagnostic and test programs for malicious code before the media are used in the information system.

Note

If, upon inspection of media containing maintenance diagnostic and test programs, organizations determine that the media contain malicious code, the incident is handled consistent with organizational incident handling policies and procedures.

Related Controls: SI-3

MA-3 (3) : PREVENT UNAUTHORIZED REMOVAL

Baseline-Impact: HIGH

The organization prevents the unauthorized removal of maintenance equipment containing organizational information by:

Note

Organizational information includes all information specifically owned by organizations and information provided to organizations in which organizations serve as information stewards.

MA-3 (3)(a)

Verifying that there is no organizational information contained on the equipment;

MA-3 (3)(b)

Sanitizing or destroying the equipment;

MA-3 (3)(c)

Retaining the equipment within the facility; or

MA-3 (3)(d)

Obtaining an exemption from [Assignment: organization-defined personnel or roles] explicitly authorizing removal of the equipment from the facility.

MA-3 (4) : RESTRICTED TOOL USE

The information system restricts the use of maintenance tools to authorized personnel only.

Note

This control enhancement applies to information systems that are used to carry out maintenance functions.

Related Controls: AC-2, AC-3, AC-5, AC-6

Control Family: MAINTENANCE

MA-4 : NONLOCAL MAINTENANCE

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

> ***Note***
>
> Nonlocal maintenance and diagnostic activities are those activities conducted by individuals communicating through a network, either an external network (e.g., the Internet) or an internal network. Local maintenance and diagnostic activities are those activities carried out by individuals physically present at the information system or information system component and not communicating across a network connection. Authentication techniques used in the establishment of nonlocal maintenance and diagnostic sessions reflect the network access requirements in IA-2. Typically, strong authentication requires authenticators that are resistant to replay attacks and employ multifactor authentication. Strong authenticators include, for example, PKI where certificates are stored on a token protected by a password, passphrase, or biometric. Enforcing requirements in MA-4 is accomplished in part by other controls.

Related Controls: AC-2, AC-3, AC-6, AC-17, AU-2, AU-3, IA-2, IA-4, IA-5, IA-8, MA-2, MA-5, MP-6, PL-2, SC-7, SC-10, SC-17

MA-4a.

Approves and monitors nonlocal maintenance and diagnostic activities;

MA-4b.

Allows the use of nonlocal maintenance and diagnostic tools only as consistent with organizational policy and documented in the security plan for the information system;

MA-4c.

Employs strong authenticators in the establishment of nonlocal maintenance and diagnostic sessions;

MA-4d.

Maintains records for nonlocal maintenance and diagnostic activities; and

MA-4e.

Terminates session and network connections when nonlocal maintenance is completed.

MA-4 (1) : AUDITING AND REVIEW

The organization:

Related Controls: AU-2, AU-6, AU-12

MA-4 (1)(a)

Audits nonlocal maintenance and diagnostic sessions [Assignment: organization-defined audit events]; and

MA-4 (1)(b)

Reviews the records of the maintenance and diagnostic sessions.

MA-4 (2) : DOCUMENT NONLOCAL MAINTENANCE

Baseline-Impact: *MODERATE*, **HIGH**

The organization documents in the security plan for the information system, the policies and procedures for the establishment and use of nonlocal maintenance and diagnostic connections.

MA-4 (3) : COMPARABLE SECURITY / SANITIZATION

Baseline-Impact: HIGH

The organization:

> ***Note***
>
> Comparable security capability on information systems, diagnostic tools, and equipment providing maintenance services implies that the implemented security controls on those systems, tools, and equipment are at least as comprehensive as the controls on the information system being serviced.

Related Controls: MA-3, SA-12, SI-3, SI-7

MA-4 (3)(a)

Requires that nonlocal maintenance and diagnostic services be performed from an information system that implements a security capability comparable to the capability implemented on the system being serviced; or

MA-4 (3)(b)

Removes the component to be serviced from the information system prior to nonlocal maintenance or diagnostic services, sanitizes the component (with regard to organizational information) before removal from organizational facilities, and after the service is performed, inspects and sanitizes the component (with regard to potentially malicious software) before reconnecting the component to the information system.

MA-4 (4) : AUTHENTICATION / SEPARATION OF MAINTENANCE SESSIONS

The organization protects nonlocal maintenance sessions by:

Related Controls: SC-13

MA-4 (4)(a)

Employing [Assignment: organization-defined authenticators that are replay resistant]; and

MA-4 (4)(b)

Separating the maintenance sessions from other network sessions with the information system by either:

MA-4 (4)(b)(1)

Physically separated communications paths; or

MA-4 (4)(b)(2)

Logically separated communications paths based upon encryption.

MA-4 (5) : APPROVALS AND NOTIFICATIONS

The organization:

> ## *Note*
>
> Notification may be performed by maintenance personnel. Approval of nonlocal maintenance sessions is accomplished by organizational personnel with sufficient information security and information system knowledge to determine the appropriateness of the proposed maintenance.

MA-4 (5)(a)

Requires the approval of each nonlocal maintenance session by [Assignment: organization-defined personnel or roles]; and

MA-4 (5)(b)

Notifies [Assignment: organization-defined personnel or roles] of the date and time of planned nonlocal maintenance.

MA-4 (6) : CRYPTOGRAPHIC PROTECTION

The information system implements cryptographic mechanisms to protect the integrity and confidentiality of nonlocal maintenance and diagnostic communications.

Related Controls: SC-8, SC-13

MA-4 (7) : REMOTE DISCONNECT VERIFICATION

The information system implements remote disconnect verification at the termination of nonlocal maintenance and diagnostic sessions.

> ## *Note*
>
> Remote disconnect verification ensures that remote connections from nonlocal maintenance sessions have been terminated and are no longer available for use.

Related Controls: SC-13

Control Family: MAINTENANCE

MA-5 : MAINTENANCE PERSONNEL

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control applies to individuals performing hardware or software maintenance on organizational information systems, while PE-2 addresses physical access for individuals whose maintenance duties place them within the physical protection perimeter of the systems (e.g., custodial staff, physical plant maintenance personnel). Technical competence of supervising individuals relates to the maintenance performed on the information systems while having required access authorizations refers to maintenance on and near the systems. Individuals not previously identified as authorized maintenance personnel, such as information technology manufacturers, vendors, systems integrators, and consultants, may require privileged access to organizational information systems, for example, when required to conduct maintenance activities with little or no notice. Based on organizational assessments of risk, organizations may issue temporary credentials to these individuals. Temporary credentials may be for one-time use or for very limited time periods.

Related Controls: AC-2, IA-8, MP-2, PE-2, PE-3, PE-4, RA-3

MA-5a.

Establishes a process for maintenance personnel authorization and maintains a list of authorized maintenance organizations or personnel;

MA-5b.

Ensures that non-escorted personnel performing maintenance on the information system have required access authorizations; and

MA-5c.

Designates organizational personnel with required access authorizations and technical competence to supervise the maintenance activities of personnel who do not possess the required access authorizations.

MA-5 (1) : INDIVIDUALS WITHOUT APPROPRIATE ACCESS

Baseline-Impact: HIGH

The organization:

Note

This control enhancement denies individuals who lack appropriate security clearances (i.e., individuals who do not possess security clearances or possess security clearances at a lower level than required) or who are not U.S. citizens, visual and electronic access to any classified information, Controlled Unclassified Information (CUI), or any other sensitive information contained on organizational

information systems. Procedures for the use of maintenance personnel can be documented in security plans for the information systems.

Related Controls: MP-6, PL-2

MA-5 (1)(a)

Implements procedures for the use of maintenance personnel that lack appropriate security clearances or are not U.S. citizens, that include the following requirements:

MA-5 (1)(a)(1)

Maintenance personnel who do not have needed access authorizations, clearances, or formal access approvals are escorted and supervised during the performance of maintenance and diagnostic activities on the information system by approved organizational personnel who are fully cleared, have appropriate access authorizations, and are technically qualified;

MA-5 (1)(a)(2)

Prior to initiating maintenance or diagnostic activities by personnel who do not have needed access authorizations, clearances or formal access approvals, all volatile information storage components within the information system are sanitized and all nonvolatile storage media are removed or physically disconnected from the system and secured; and

MA-5 (1)(b)

Develops and implements alternate security safeguards in the event an information system component cannot be sanitized, removed, or disconnected from the system.

MA-5 (2) : SECURITY CLEARANCES FOR CLASSIFIED SYSTEMS

The organization ensures that personnel performing maintenance and diagnostic activities on an information system processing, storing, or transmitting classified information possess security clearances and formal access approvals for at least the highest classification level and for all compartments of information on the system.

Related Controls: PS-3

MA-5 (3) : CITIZENSHIP REQUIREMENTS FOR CLASSIFIED SYSTEMS

The organization ensures that personnel performing maintenance and diagnostic activities on an information system processing, storing, or transmitting classified information are U.S. citizens.

Related Controls: PS-3

MA-5 (4) : FOREIGN NATIONALS

The organization ensures that:

Related Controls: PS-3

MA-5 (4)(a)

Cleared foreign nationals (i.e., foreign nationals with appropriate security clearances), are used to conduct maintenance and diagnostic activities on classified information systems only when the systems are jointly owned and operated by the United States and foreign allied governments, or owned and operated solely by foreign allied governments; and

MA-5 (4)(b)

Approvals, consents, and detailed operational conditions regarding the use of foreign nationals to conduct maintenance and diagnostic activities on classified information systems are fully documented within Memoranda of Agreements.

MA-5 (5) : NONSYSTEM-RELATED MAINTENANCE

The organization ensures that non-escorted personnel performing maintenance activities not directly associated with the information system but in the physical proximity of the system, have required access authorizations.

Note

Personnel performing maintenance activities in other capacities not directly related to the information system include, for example, physical plant personnel and janitorial personnel.

Control Family: MAINTENANCE

MA-6 : TIMELY MAINTENANCE

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The organization obtains maintenance support and/or spare parts for [Assignment: organization-defined information system components] within [Assignment: organization-defined time period] of failure.

Note

Organizations specify the information system components that result in increased risk to organizational operations and assets, individuals, other organizations, or the Nation when the functionality provided by those components is not operational. Organizational actions to obtain maintenance support typically include having appropriate contracts in place.

Related Controls: CM-8, CP-2, CP-7, SA-14, SA-15

MA-6 (1) : PREVENTIVE MAINTENANCE

The organization performs preventive maintenance on [Assignment: organization-defined information system components] at [Assignment: organization-defined time intervals].

Note

Preventive maintenance includes proactive care and servicing of organizational information systems components for the purpose of maintaining equipment and facilities in satisfactory operating condition. Such maintenance provides for the systematic inspection, tests, measurements, adjustments, parts replacement, detection, and correction of incipient failures either before they occur or before they develop into major defects. The primary goal of preventive maintenance is to avoid/mitigate the consequences of equipment failures. Preventive maintenance is designed to preserve and restore equipment reliability by replacing worn components before they actually fail. Methods of determining what preventive (or other) failure management policies to apply include, for example, original equipment manufacturer (OEM) recommendations, statistical failure records, requirements of codes, legislation, or regulations within a jurisdiction, expert opinion, maintenance that has already been conducted on similar equipment, or measured values and performance indications.

MA-6 (2) : PREDICTIVE MAINTENANCE

The organization performs predictive maintenance on [Assignment: organization-defined information system components] at [Assignment: organization-defined time intervals].

Note

Predictive maintenance, or condition-based maintenance, attempts to evaluate the condition of equipment by performing periodic or continuous (online) equipment condition monitoring. The goal of predictive maintenance is to perform maintenance at a scheduled point in time when the maintenance activity is most cost-effective and before the equipment loses performance within a threshold. The predictive component of predictive maintenance stems from the goal of predicting the future trend of the equipment's condition. This approach uses principles of statistical process control to determine at what point in the future maintenance activities will be appropriate. Most predictive maintenance inspections are performed while equipment is in service, thereby minimizing disruption of normal system operations. Predictive maintenance can result in substantial cost savings and higher system reliability. Predictive maintenance tends to include measurement of the item. To evaluate equipment condition, predictive maintenance utilizes nondestructive testing technologies such as infrared, acoustic (partial discharge and airborne ultrasonic), corona detection, vibration analysis, sound level measurements, oil analysis, and other specific online tests.

MA-6 (3) : AUTOMATED SUPPORT FOR PREDICTIVE MAINTENANCE

The organization employs automated mechanisms to transfer predictive maintenance data to a computerized maintenance management system.

Note

A computerized maintenance management system maintains a computer database of information about the maintenance operations of organizations and automates processing equipment condition data in order to trigger maintenance planning, execution, and reporting.

Control Family: MEDIA PROTECTION

MP-1 : MEDIA PROTECTION POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

> ***Note***
>
> This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the MP family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

MP-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

MP-1a.1.

A media protection policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

MP-1a.2.

Procedures to facilitate the implementation of the media protection policy and associated media protection controls; and

MP-1b.

Reviews and updates the current:

MP-1b.1.

Media protection policy [Assignment: organization-defined frequency]; and

MP-1b.2.

Media protection procedures [Assignment: organization-defined frequency].

Control Family: MEDIA PROTECTION

MP-2 : MEDIA ACCESS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization restricts access to [Assignment: organization-defined types of digital and/or non-digital media] to [Assignment: organization-defined personnel or roles].

Note

Information system media includes both digital and non-digital media. Digital media includes, for example, diskettes, magnetic tapes, external/removable hard disk drives, flash drives, compact disks, and digital video disks. Non-digital media includes, for example, paper and microfilm. Restricting non-digital media access includes, for example, denying access to patient medical records in a community hospital unless the individuals seeking access to such records are authorized healthcare providers. Restricting access to digital media includes, for example, limiting access to design specifications stored on compact disks in the media library to the project leader and the individuals on the development team.

Related Controls: AC-3, IA-2, MP-4, PE-2, PE-3, PL-2

MP-2 (1) : AUTOMATED RESTRICTED ACCESS

[Withdrawn: Incorporated into MP-4 (2)].

MP-2 (2) : CRYPTOGRAPHIC PROTECTION

[Withdrawn: Incorporated into SC-28 (1)].

Control Family: MEDIA PROTECTION

MP-3 : MEDIA MARKING

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

The term security marking refers to the application/use of human-readable security attributes. The term security labeling refers to the application/use of security attributes with regard to internal data structures within information systems (see AC-16). Information system media includes both digital and non-digital media. Digital media includes, for example, diskettes, magnetic tapes, external/removable hard disk drives, flash drives, compact disks, and digital video disks. Non-digital media includes, for example, paper and microfilm. Security marking is generally not required for media containing information determined by organizations to be in the public domain or to be publicly releasable. However, some organizations may require markings for public information indicating that the information is publicly releasable. Marking of information system media reflects applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance.

Related Controls: AC-16, PL-2, RA-3

MP-3a.

Marks information system media indicating the distribution limitations, handling caveats, and applicable security markings (if any) of the information; and

MP-3b.

Exempts [Assignment: organization-defined types of information system media] from marking as long as the media remain within [Assignment: organization-defined controlled areas].

Control Family: MEDIA PROTECTION

MP-4 : MEDIA STORAGE

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

> ***Note***
>
> Information system media includes both digital and non-digital media. Digital media includes, for example, diskettes, magnetic tapes, external/removable hard disk drives, flash drives, compact disks, and digital video disks. Non-digital media includes, for example, paper and microfilm. Physically controlling information system media includes, for example, conducting inventories, ensuring procedures are in place to allow individuals to check out and return media to the media library, and maintaining accountability for all stored media. Secure storage includes, for example, a locked drawer, desk, or cabinet, or a controlled media library. The type of media storage is commensurate with the security category and/or classification of the information residing on the media. Controlled areas are areas for which organizations provide sufficient physical and procedural safeguards to meet the requirements established for protecting information and/or information systems. For media containing information determined by organizations to be in the public domain, to be publicly releasable, or to have limited or no adverse impact on organizations or individuals if accessed by other than authorized personnel, fewer safeguards may be needed. In these situations, physical access controls provide adequate protection.

Related Controls: CP-6, CP-9, MP-2, MP-7, PE-3

MP-4a.

Physically controls and securely stores [Assignment: organization-defined types of digital and/or non-digital media] within [Assignment: organization-defined controlled areas]; and

MP-4b.

Protects information system media until the media are destroyed or sanitized using approved equipment, techniques, and procedures.

MP-4 (1) : CRYPTOGRAPHIC PROTECTION

[Withdrawn: Incorporated into SC-28 (1)].

MP-4 (2) : AUTOMATED RESTRICTED ACCESS

The organization employs automated mechanisms to restrict access to media storage areas and to audit access attempts and access granted.

Note

Automated mechanisms can include, for example, keypads on the external entries to media storage areas.

Related Controls: AU-2, AU-9, AU-6, AU-12

Control Family: MEDIA PROTECTION

MP-5 : MEDIA TRANSPORT

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Information system media includes both digital and non-digital media. Digital media includes, for example, diskettes, magnetic tapes, external/removable hard disk drives, flash drives, compact disks, and digital video disks. Non-digital media includes, for example, paper and microfilm. This control also applies to mobile devices with information storage capability (e.g., smart phones, tablets, E-readers), that are transported outside of controlled areas. Controlled areas are areas or spaces for which organizations provide sufficient physical and/or procedural safeguards to meet the requirements established for protecting information and/or information systems.

Physical and technical safeguards for media are commensurate with the security category or classification of the information residing on the media. Safeguards to protect media during transport include, for example, locked containers and cryptography. Cryptographic mechanisms can provide confidentiality and integrity protections depending upon the mechanisms used. Activities associated with transport include the actual transport as well as those activities such as releasing media for transport and ensuring that media enters the appropriate transport processes. For the actual transport, authorized transport and courier personnel may include individuals from outside the organization (e.g., U.S. Postal Service or a commercial transport or delivery service). Maintaining accountability of media during transport includes, for example, restricting transport activities to authorized personnel, and tracking and/or obtaining explicit records of transport activities as the media moves through the transportation system to prevent and detect loss, destruction, or tampering. Organizations establish documentation requirements for activities associated with the transport of information system media in accordance with organizational assessments of risk to include the flexibility to define different record-keeping methods for the different types of media transport as part of an overall system of transport-related records.

Related Controls: AC-19, CP-9, MP-3, MP-4, RA-3, SC-8, SC-13, SC-28

MP-5a.

Protects and controls [Assignment: organization-defined types of information system media] during transport outside of controlled areas using [Assignment: organization-defined security safeguards];

MP-5b.

Maintains accountability for information system media during transport outside of controlled areas;

MP-5c.

Documents activities associated with the transport of information system media; and

MP-5d.

Restricts the activities associated with the transport of information system media to authorized personnel.

MP-5 (1) : PROTECTION OUTSIDE OF CONTROLLED AREAS

[Withdrawn: Incorporated into MP-5].

MP-5 (2) : DOCUMENTATION OF ACTIVITIES

[Withdrawn: Incorporated into MP-5].

MP-5 (3) : CUSTODIANS

The organization employs an identified custodian during transport of information system media outside of controlled areas.

Note

Identified custodians provide organizations with specific points of contact during the media transport process and facilitate individual accountability. Custodial responsibilities can be transferred from one individual to another as long as an unambiguous custodian is identified at all times.

MP-5 (4) : CRYPTOGRAPHIC PROTECTION

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements cryptographic mechanisms to protect the confidentiality and integrity of information stored on digital media during transport outside of controlled areas.

Note

This control enhancement applies to both portable storage devices (e.g., USB memory sticks, compact disks, digital video disks, external/removable hard disk drives) and mobile devices with storage capability (e.g., smart phones, tablets, E-readers).

Related Controls: MP-2

Control Family: MEDIA PROTECTION

MP-6 : MEDIA SANITIZATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control applies to all information system media, both digital and non-digital, subject to disposal or reuse, whether or not the media is considered removable. Examples include media found in scanners, copiers, printers, notebook computers, workstations, network components, and mobile devices. The sanitization process removes information from the media such that the information cannot be retrieved or reconstructed. Sanitization techniques, including clearing, purging, cryptographic erase, and destruction, prevent the disclosure of information to unauthorized individuals when such media is reused or released for disposal. Organizations determine the appropriate sanitization methods recognizing that destruction is sometimes necessary when other methods cannot be applied to media requiring sanitization. Organizations use discretion on the employment of approved sanitization techniques and procedures for media containing information deemed to be in the public domain or publicly releasable, or deemed to have no adverse impact on organizations or individuals if released for reuse or disposal. Sanitization of non-digital media includes, for example, removing a classified appendix from an otherwise unclassified document, or redacting selected sections or words from a document by obscuring the redacted sections/words in a manner equivalent in effectiveness to removing them from the document. NSA standards and policies control the sanitization process for media containing classified information.

Related Controls: MA-2, MA-4, RA-3, SC-4

MP-6a.

Sanitizes [Assignment: organization-defined information system media] prior to disposal, release out of organizational control, or release for reuse using [Assignment: organization-defined sanitization techniques and procedures] in accordance with applicable federal and organizational standards and policies; and

MP-6b.

Employs sanitization mechanisms with the strength and integrity commensurate with the security category or classification of the information.

MP-6 (1) : REVIEW / APPROVE / TRACK / DOCUMENT / VERIFY

Baseline-Impact: HIGH

The organization reviews, approves, tracks, documents, and verifies media sanitization and disposal actions.

Note

Organizations review and approve media to be sanitized to ensure compliance with records-retention policies. Tracking/documenting actions include, for example, listing personnel who reviewed and approved sanitization and disposal actions, types of media sanitized, specific files stored on the media, sanitization methods used, date and time of the sanitization actions, personnel who performed the sanitization, verification actions taken, personnel who performed the verification, and disposal action taken. Organizations verify that the sanitization of the media was effective prior to disposal.

Related Controls: SI-12

MP-6 (2) : EQUIPMENT TESTING

Baseline-Impact: HIGH

The organization tests sanitization equipment and procedures [Assignment: organization-defined frequency] to verify that the intended sanitization is being achieved.

Note

Testing of sanitization equipment and procedures may be conducted by qualified and authorized external entities (e.g., other federal agencies or external service providers).

MP-6 (3) : NONDESTRUCTIVE TECHNIQUES

Baseline-Impact: HIGH

The organization applies nondestructive sanitization techniques to portable storage devices prior to connecting such devices to the information system under the following circumstances: [Assignment: organization-defined circumstances requiring sanitization of portable storage devices].

Note

This control enhancement applies to digital media containing classified information and Controlled Unclassified Information (CUI). Portable storage devices can be the source of malicious code insertions into organizational information systems. Many of these devices are obtained from unknown and potentially untrustworthy sources and may contain malicious code that can be readily transferred to information systems through USB ports or other entry portals. While scanning such storage devices is always recommended, sanitization provides additional assurance that the devices are free of malicious code to include code capable of initiating zero-day attacks. Organizations consider nondestructive sanitization of portable storage devices when such devices are first purchased from the manufacturer or vendor prior to initial use or when organizations lose a positive chain of custody for the devices.

Related Controls: SI-3

MP-6 (4) : CONTROLLED UNCLASSIFIED INFORMATION

[Withdrawn: Incorporated into MP-6].

MP-6 (5) : CLASSIFIED INFORMATION

[Withdrawn: Incorporated into MP-6].

MP-6 (6) : MEDIA DESTRUCTION

[Withdrawn: Incorporated into MP-6].

MP-6 (7) : DUAL AUTHORIZATION

The organization enforces dual authorization for the sanitization of [Assignment: organization-defined information system media].

Note

Organizations employ dual authorization to ensure that information system media sanitization cannot occur unless two technically qualified individuals conduct the task. Individuals sanitizing information system media possess sufficient skills/expertise to determine if the proposed sanitization reflects applicable federal/organizational standards, policies, and procedures. Dual authorization also helps to ensure that sanitization occurs as intended, both protecting against errors and false claims of having performed the sanitization actions. Dual authorization may also be known as two-person control.

Related Controls: AC-3, MP-2

MP-6 (8) : REMOTE PURGING / WIPING OF INFORMATION

The organization provides the capability to purge/wipe information from [Assignment: organization-defined information systems, system components, or devices] either remotely or under the following conditions: [Assignment: organization-defined conditions].

Note

This control enhancement protects data/information on organizational information systems, system components, or devices (e.g., mobile devices) if such systems, components, or devices are obtained by unauthorized individuals. Remote purge/wipe commands require strong authentication to mitigate the risk of unauthorized individuals purging/wiping the system/component/device. The purge/wipe function can be implemented in a variety of ways including, for example, by overwriting data/information multiple times or by destroying the key necessary to decrypt encrypted data.

Control Family: MEDIA PROTECTION

MP-7 : MEDIA USE

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization [Selection: restricts; prohibits] the use of [Assignment: organization-defined types of information system media] on [Assignment: organization-defined information systems or system components] using [Assignment: organization-defined security safeguards].

Note

Information system media includes both digital and non-digital media. Digital media includes, for example, diskettes, magnetic tapes, external/removable hard disk drives, flash drives, compact disks, and digital video disks. Non-digital media includes, for example, paper and microfilm. This control also applies to mobile devices with information storage capability (e.g., smart phones, tablets, E-readers). In contrast to MP-2, which restricts user access to media, this control restricts the use of certain types of media on information systems, for example, restricting/prohibiting the use of flash drives or external hard disk drives. Organizations can employ technical and nontechnical safeguards (e.g., policies, procedures, rules of behavior) to restrict the use of information system media. Organizations may restrict the use of portable storage devices, for example, by using physical cages on

workstations to prohibit access to certain external ports, or disabling/removing the ability to insert, read or write to such devices. Organizations may also limit the use of portable storage devices to only approved devices including, for example, devices provided by the organization, devices provided by other approved organizations, and devices that are not personally owned. Finally, organizations may restrict the use of portable storage devices based on the type of device, for example, prohibiting the use of writeable, portable storage devices, and implementing this restriction by disabling or removing the capability to write to such devices.

Related Controls: AC-19, PL-4

MP-7 (1) : PROHIBIT USE WITHOUT OWNER

Baseline-Impact: *MODERATE*, **HIGH**

The organization prohibits the use of portable storage devices in organizational information systems when such devices have no identifiable owner.

Note

Requiring identifiable owners (e.g., individuals, organizations, or projects) for portable storage devices reduces the risk of using such technologies by allowing organizations to assign responsibility and accountability for addressing known vulnerabilities in the devices (e.g., malicious code insertion).

Related Controls: PL-4

MP-7 (2) : PROHIBIT USE OF SANITIZATION-RESISTANT MEDIA

The organization prohibits the use of sanitization-resistant media in organizational information systems.

Note

Sanitization-resistance applies to the capability to purge information from media. Certain types of media do not support sanitize commands, or if supported, the interfaces are not supported in a standardized way across these devices. Sanitization-resistant media include, for example, compact flash, embedded flash on boards and devices, solid state drives, and USB removable media.

Related Controls: MP-6

Control Family: MEDIA PROTECTION

MP-8 : MEDIA DOWNGRADING

Priority: P0

The organization:

Note

This control applies to all information system media, digital and non-digital, subject to release outside of the organization, whether or not the media is considered removable. The downgrading process,

when applied to system media, removes information from the media, typically by security category or classification level, such that the information cannot be retrieved or reconstructed. Downgrading of media includes redacting information to enable wider release and distribution. Downgrading of media also ensures that empty space on the media (e.g., slack space within files) is devoid of information.

MP-8a.

Establishes [Assignment: organization-defined information system media downgrading process] that includes employing downgrading mechanisms with [Assignment: organization-defined strength and integrity];

MP-8b.

Ensures that the information system media downgrading process is commensurate with the security category and/or classification level of the information to be removed and the access authorizations of the potential recipients of the downgraded information;

MP-8c.

Identifies [Assignment: organization-defined information system media requiring downgrading]; and

MP-8d.

Downgrades the identified information system media using the established process.

MP-8 (1) : DOCUMENTATION OF PROCESS

The organization documents information system media downgrading actions.

Note

Organizations can document the media downgrading process by providing information such as the downgrading technique employed, the identification number of the downgraded media, and the identity of the individual that authorized and/or performed the downgrading action.

MP-8 (2) : EQUIPMENT TESTING

The organization employs [Assignment: organization-defined tests] of downgrading equipment and procedures to verify correct performance [Assignment: organization-defined frequency].

MP-8 (3) : CONTROLLED UNCLASSIFIED INFORMATION

The organization downgrades information system media containing [Assignment: organization-defined Controlled Unclassified Information (CUI)] prior to public release in accordance with applicable federal and organizational standards and policies.

MP-8 (4) : CLASSIFIED INFORMATION

The organization downgrades information system media containing classified information prior to release to individuals without required access authorizations in accordance with NSA standards and policies.

Note

Downgrading of classified information uses approved sanitization tools, techniques, and procedures to transfer information confirmed to be unclassified from classified information systems to unclassified media.

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-1 : PHYSICAL AND ENVIRONMENTAL PROTECTION POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the PE family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

PE-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

PE-1a.1.

A physical and environmental protection policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

PE-1a.2.

Procedures to facilitate the implementation of the physical and environmental protection policy and associated physical and environmental protection controls; and

PE-1b.

Reviews and updates the current:

PE-1b.1.

Physical and environmental protection policy [Assignment: organization-defined frequency]; and

PE-1b.2.

Physical and environmental protection procedures [Assignment: organization-defined frequency].

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-2 : PHYSICAL ACCESS AUTHORIZATIONS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control applies to organizational employees and visitors. Individuals (e.g., employees, contractors, and others) with permanent physical access authorization credentials are not considered visitors. Authorization credentials include, for example, badges, identification cards, and smart cards. Organizations determine the strength of authorization credentials needed (including level of forge-proof badges, smart cards, or identification cards) consistent with federal standards, policies, and procedures. This control only applies to areas within facilities that have not been designated as publicly accessible.

Related Controls: PE-3, PE-4, PS-3

PE-2a.

Develops, approves, and maintains a list of individuals with authorized access to the facility where the information system resides;

PE-2b.

Issues authorization credentials for facility access;

PE-2c.

Reviews the access list detailing authorized facility access by individuals [Assignment: organization-defined frequency]; and

PE-2d.

Removes individuals from the facility access list when access is no longer required.

PE-2 (1) : ACCESS BY POSITION / ROLE

The organization authorizes physical access to the facility where the information system resides based on position or role.

Related Controls: AC-2, AC-3, AC-6

PE-2 (2) : TWO FORMS OF IDENTIFICATION

The organization requires two forms of identification from [Assignment: organization-defined list of acceptable forms of identification] for visitor access to the facility where the information system resides.

Note

Acceptable forms of government photo identification include, for example, passports, Personal Identity Verification (PIV) cards, and drivers' licenses. In the case of gaining access to facilities using automated mechanisms, organizations may use PIV cards, key cards, PINs, and biometrics.

Related Controls: IA-2, IA-4, IA-5

PE-2 (3) : RESTRICT UNESCORTED ACCESS

The organization restricts unescorted access to the facility where the information system resides to personnel with [Selection (one or more): security clearances for all information contained within the system; formal access authorizations for all information contained within the system; need for access to all information contained within the system; [Assignment: organization-defined credentials]].

Note

Due to the highly sensitive nature of classified information stored within certain facilities, it is important that individuals lacking sufficient security clearances, access approvals, or need to know, be escorted by individuals with appropriate credentials to ensure that such information is not exposed or otherwise compromised.

Related Controls: PS-2, PS-6

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-3 : PHYSICAL ACCESS CONTROL

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control applies to organizational employees and visitors. Individuals (e.g., employees, contractors, and others) with permanent physical access authorization credentials are not considered visitors. Organizations determine the types of facility guards needed including, for example, professional physical security staff or other personnel such as administrative staff or information system users. Physical access devices include, for example, keys, locks, combinations, and card readers. Safeguards for publicly accessible areas within organizational facilities include, for example, cameras, monitoring by guards, and isolating selected information systems and/or system components in secured areas. Physical access control systems comply with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance. The Federal Identity, Credential, and Access Management Program provides implementation guidance for identity, credential, and access management capabilities for physical access control systems. Organizations

have flexibility in the types of audit logs employed. Audit logs can be procedural (e.g., a written log of individuals accessing the facility and when such access occurred), automated (e.g., capturing ID provided by a PIV card), or some combination thereof. Physical access points can include facility access points, interior access points to information systems and/or components requiring supplemental access controls, or both. Components of organizational information systems (e.g., workstations, terminals) may be located in areas designated as publicly accessible with organizations safeguarding access to such devices.

Related Controls: AU-2, AU-6, MP-2, MP-4, PE-2, PE-4, PE-5, PS-3, RA-3

PE-3a.

Enforces physical access authorizations at [Assignment: organization-defined entry/exit points to the facility where the information system resides] by;

PE-3a.1.

Verifying individual access authorizations before granting access to the facility; and

PE-3a.2.

Controlling ingress/egress to the facility using [Selection (one or more): [Assignment: organization-defined physical access control systems/devices]; guards];

PE-3b.

Maintains physical access audit logs for [Assignment: organization-defined entry/exit points];

PE-3c.

Provides [Assignment: organization-defined security safeguards] to control access to areas within the facility officially designated as publicly accessible;

PE-3d.

Escorts visitors and monitors visitor activity [Assignment: organization-defined circumstances requiring visitor escorts and monitoring];

PE-3e.

Secures keys, combinations, and other physical access devices;

PE-3f.

Inventories [Assignment: organization-defined physical access devices] every [Assignment: organization-defined frequency]; and

PE-3g.

Changes combinations and keys [Assignment: organization-defined frequency] and/or when keys are lost, combinations are compromised, or individuals are transferred or terminated.

PE-3 (1) : INFORMATION SYSTEM ACCESS

Baseline-Impact: HIGH

The organization enforces physical access authorizations to the information system in addition to the physical access controls for the facility at [Assignment: organization-defined physical spaces containing one or more components of the information system].

Note

This control enhancement provides additional physical security for those areas within facilities where there is a concentration of information system components (e.g., server rooms, media storage areas, data and communications centers).

Related Controls: PS-2

PE-3 (2) : FACILITY / INFORMATION SYSTEM BOUNDARIES

The organization performs security checks [Assignment: organization-defined frequency] at the physical boundary of the facility or information system for unauthorized exfiltration of information or removal of information system components.

Note

Organizations determine the extent, frequency, and/or randomness of security checks to adequately mitigate risk associated with exfiltration.

Related Controls: AC-4, SC-7

PE-3 (3) : CONTINUOUS GUARDS / ALARMS / MONITORING

The organization employs guards and/or alarms to monitor every physical access point to the facility where the information system resides 24 hours per day, 7 days per week.

Related Controls: CP-6, CP-7

PE-3 (4) : LOCKABLE CASINGS

The organization uses lockable physical casings to protect [Assignment: organization-defined information system components] from unauthorized physical access.

PE-3 (5) : TAMPER PROTECTION

The organization employs [Assignment: organization-defined security safeguards] to [Selection (one or more): detect; prevent] physical tampering or alteration of [Assignment: organization-defined hardware components] within the information system.

Note

Organizations may implement tamper detection/prevention at selected hardware components or tamper detection at some components and tamper prevention at other components. Tamper detection/prevention activities can employ many types of anti-tamper technologies including, for

example, tamper-detection seals and anti-tamper coatings. Anti-tamper programs help to detect hardware alterations through counterfeiting and other supply chain-related risks.

Related Controls: SA-12

PE-3 (6) : FACILITY PENETRATION TESTING

The organization employs a penetration testing process that includes [Assignment: organization-defined frequency], unannounced attempts to bypass or circumvent security controls associated with physical access points to the facility.

Related Controls: CA-2, CA-7

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-4 : ACCESS CONTROL FOR TRANSMISSION MEDIUM

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization controls physical access to [Assignment: organization-defined information system distribution and transmission lines] within organizational facilities using [Assignment: organization-defined security safeguards].

Note

Physical security safeguards applied to information system distribution and transmission lines help to prevent accidental damage, disruption, and physical tampering. In addition, physical safeguards may be necessary to help prevent eavesdropping or in transit modification of unencrypted transmissions. Security safeguards to control physical access to system distribution and transmission lines include, for example: (i) locked wiring closets; (ii) disconnected or locked spare jacks; and/or (iii) protection of cabling by conduit or cable trays.

Related Controls: MP-2, MP-4, PE-2, PE-3, PE-5, SC-7, SC-8

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-5 : ACCESS CONTROL FOR OUTPUT DEVICES

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The organization controls physical access to information system output devices to prevent unauthorized individuals from obtaining the output.

Note

Controlling physical access to output devices includes, for example, placing output devices in locked rooms or other secured areas and allowing access to authorized individuals only, and placing output devices in locations that can be monitored by organizational personnel. Monitors, printers, copiers, scanners, facsimile machines, and audio devices are examples of information system output devices.

Related Controls: PE-2, PE-3, PE-4, PE-18

PE-5 (1) : ACCESS TO OUTPUT BY AUTHORIZED INDIVIDUALS

The organization:

> ***Note***
>
> Controlling physical access to selected output devices includes, for example, placing printers, copiers, and facsimile machines in controlled areas with keypad access controls or limiting access to individuals with certain types of badges.

PE-5 (1)(a)

Controls physical access to output from [Assignment: organization-defined output devices]; and

PE-5 (1)(b)

Ensures that only authorized individuals receive output from the device.

PE-5 (2) : ACCESS TO OUTPUT BY INDIVIDUAL IDENTITY

The information system:

> ***Note***
>
> Controlling physical access to selected output devices includes, for example, installing security functionality on printers, copiers, and facsimile machines that allows organizations to implement authentication (e.g., using a PIN or hardware token) on output devices prior to the release of output to individuals.

PE-5 (2)(a)

Controls physical access to output from [Assignment: organization-defined output devices]; and

PE-5 (2)(b)

Links individual identity to receipt of the output from the device.

PE-5 (3) : MARKING OUTPUT DEVICES

The organization marks [Assignment: organization-defined information system output devices] indicating the appropriate security marking of the information permitted to be output from the device.

Note

Outputs devices include, for example, printers, monitors, facsimile machines, scanners, copiers, and audio devices. This control enhancement is generally applicable to information system output devices other than mobiles devices.

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-6 : MONITORING PHYSICAL ACCESS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Organizational incident response capabilities include investigations of and responses to detected physical security incidents. Security incidents include, for example, apparent security violations or suspicious physical access activities. Suspicious physical access activities include, for example: (i) accesses outside of normal work hours; (ii) repeated accesses to areas not normally accessed; (iii) accesses for unusual lengths of time; and (iv) out-of-sequence accesses.

Related Controls: CA-7, IR-4, IR-8

PE-6a.

Monitors physical access to the facility where the information system resides to detect and respond to physical security incidents;

PE-6b.

Reviews physical access logs [Assignment: organization-defined frequency] and upon occurrence of [Assignment: organization-defined events or potential indications of events]; and

PE-6c.

Coordinates results of reviews and investigations with the organizational incident response capability.

PE-6 (1) : INTRUSION ALARMS / SURVEILLANCE EQUIPMENT

Baseline-Impact: *MODERATE*, **HIGH**

The organization monitors physical intrusion alarms and surveillance equipment.

PE-6 (2) : AUTOMATED INTRUSION RECOGNITION / RESPONSES

The organization employs automated mechanisms to recognize [Assignment: organization-defined classes/types of intrusions] and initiate [Assignment: organization-defined response actions].

Related Controls: SI-4

PE-6 (3) : VIDEO SURVEILLANCE

The organization employs video surveillance of [Assignment: organization-defined operational areas] and retains video recordings for [Assignment: organization-defined time period].

Note

This control enhancement focuses on recording surveillance video for purposes of subsequent review, if circumstances so warrant (e.g., a break-in detected by other means). It does not require monitoring surveillance video although organizations may choose to do so. Note that there may be legal considerations when performing and retaining video surveillance, especially if such surveillance is in a public location.

PE-6 (4) : MONITORING PHYSICAL ACCESS TO INFORMATION SYSTEMS

Baseline-Impact: HIGH

The organization monitors physical access to the information system in addition to the physical access monitoring of the facility as [Assignment: organization-defined physical spaces containing one or more components of the information system].

Note

This control enhancement provides additional monitoring for those areas within facilities where there is a concentration of information system components (e.g., server rooms, media storage areas, communications centers).

Related Controls: PS-2, PS-3

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-7 : VISITOR CONTROL

[Withdrawn: Incorporated into PE-2 and PE-3].

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-8 : VISITOR ACCESS RECORDS

Priority: P3

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Visitor access records include, for example, names and organizations of persons visiting, visitor signatures, forms of identification, dates of access, entry and departure times, purposes of visits, and names and organizations of persons visited. Visitor access records are not required for publicly accessible areas.

PE-8a.

Maintains visitor access records to the facility where the information system resides for [Assignment: organization-defined time period]; and

PE-8b.

Reviews visitor access records [Assignment: organization-defined frequency].

PE-8 (1) : AUTOMATED RECORDS MAINTENANCE / REVIEW

Baseline-Impact: HIGH

The organization employs automated mechanisms to facilitate the maintenance and review of visitor access records.

PE-8 (2) : PHYSICAL ACCESS RECORDS

[Withdrawn: Incorporated into PE-2].

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-9 : POWER EQUIPMENT AND CABLING

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization protects power equipment and power cabling for the information system from damage and destruction.

Note

Organizations determine the types of protection necessary for power equipment and cabling employed at different locations both internal and external to organizational facilities and environments of operation. This includes, for example, generators and power cabling outside of buildings, internal cabling and uninterruptable power sources within an office or data center, and power sources for self-contained entities such as vehicles and satellites.

Related Controls: PE-4

PE-9 (1) : REDUNDANT CABLING

The organization employs redundant power cabling paths that are physically separated by [Assignment: organization-defined distance].

Note

Physically separate, redundant power cables help to ensure that power continues to flow in the event one of the cables is cut or otherwise damaged.

PE-9 (2) : AUTOMATIC VOLTAGE CONTROLS

The organization employs automatic voltage controls for [Assignment: organization-defined critical information system components].

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-10 : EMERGENCY SHUTOFF

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

> ***Note***
>
> This control applies primarily to facilities containing concentrations of information system resources including, for example, data centers, server rooms, and mainframe computer rooms.

Related Controls: PE-15

PE-10a.

Provides the capability of shutting off power to the information system or individual system components in emergency situations;

PE-10b.

Places emergency shutoff switches or devices in [Assignment: organization-defined location by information system or system component] to facilitate safe and easy access for personnel; and

PE-10c.

Protects emergency power shutoff capability from unauthorized activation.

PE-10 (1) : ACCIDENTAL / UNAUTHORIZED ACTIVATION

[Withdrawn: Incorporated into PE-10].

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-11 : EMERGENCY POWER

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization provides a short-term uninterruptible power supply to facilitate [Selection (one or more): an orderly shutdown of the information system; transition of the information system to long-term alternate power] in the event of a primary power source loss.

Related Controls: AT-3, CP-2, CP-7

PE-11 (1) : LONG-TERM ALTERNATE POWER SUPPLY - MINIMAL OPERATIONAL CAPABILITY

Baseline-Impact: HIGH

The organization provides a long-term alternate power supply for the information system that is capable of maintaining minimally required operational capability in the event of an extended loss of the primary power source.

Note

This control enhancement can be satisfied, for example, by the use of a secondary commercial power supply or other external power supply. Long-term alternate power supplies for the information system can be either manually or automatically activated.

PE-11 (2) : LONG-TERM ALTERNATE POWER SUPPLY - SELF-CONTAINED

The organization provides a long-term alternate power supply for the information system that is:

Note

This control enhancement can be satisfied, for example, by the use of one or more generators with sufficient capacity to meet the needs of the organization. Long-term alternate power supplies for organizational information systems are either manually or automatically activated.

PE-11 (2)(a)

Self-contained;

PE-11 (2)(b)

Not reliant on external power generation; and

PE-11 (2)(c)

Capable of maintaining [Selection: minimally required operational capability; full operational capability] in the event of an extended loss of the primary power source.

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-12 : EMERGENCY LIGHTING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization employs and maintains automatic emergency lighting for the information system that activates in the event of a power outage or disruption and that covers emergency exits and evacuation routes within the facility.

Note

This control applies primarily to facilities containing concentrations of information system resources including, for example, data centers, server rooms, and mainframe computer rooms.

Related Controls: CP-2, CP-7

PE-12 (1) : ESSENTIAL MISSIONS / BUSINESS FUNCTIONS

The organization provides emergency lighting for all areas within the facility supporting essential missions and business functions.

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-13 : FIRE PROTECTION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization employs and maintains fire suppression and detection devices/systems for the information system that are supported by an independent energy source.

Note

This control applies primarily to facilities containing concentrations of information system resources including, for example, data centers, server rooms, and mainframe computer rooms. Fire suppression and detection devices/systems include, for example, sprinkler systems, handheld fire extinguishers, fixed fire hoses, and smoke detectors.

PE-13 (1) : DETECTION DEVICES / SYSTEMS

Baseline-Impact: HIGH

The organization employs fire detection devices/systems for the information system that activate automatically and notify [Assignment: organization-defined personnel or roles] and [Assignment: organization-defined emergency responders] in the event of a fire.

Note

Organizations can identify specific personnel, roles, and emergency responders in the event that individuals on the notification list must have appropriate access authorizations and/or clearances, for example, to obtain access to facilities where classified operations are taking place or where there are information systems containing classified information.

PE-13 (2) : SUPPRESSION DEVICES / SYSTEMS

Baseline-Impact: HIGH

The organization employs fire suppression devices/systems for the information system that provide automatic notification of any activation to Assignment: organization-defined personnel or roles] and [Assignment: organization-defined emergency responders].

Note

Organizations can identify specific personnel, roles, and emergency responders in the event that individuals on the notification list must have appropriate access authorizations and/or clearances, for

example, to obtain access to facilities where classified operations are taking place or where there are information systems containing classified information.

PE-13 (3) : AUTOMATIC FIRE SUPPRESSION

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs an automatic fire suppression capability for the information system when the facility is not staffed on a continuous basis.

PE-13 (4) : INSPECTIONS

The organization ensures that the facility undergoes [Assignment: organization-defined frequency] inspections by authorized and qualified inspectors and resolves identified deficiencies within [Assignment: organization-defined time period].

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-14 : TEMPERATURE AND HUMIDITY CONTROLS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control applies primarily to facilities containing concentrations of information system resources, for example, data centers, server rooms, and mainframe computer rooms.

Related Controls: AT-3

PE-14a.

Maintains temperature and humidity levels within the facility where the information system resides at [Assignment: organization-defined acceptable levels]; and

PE-14b.

Monitors temperature and humidity levels [Assignment: organization-defined frequency].

PE-14 (1) : AUTOMATIC CONTROLS

The organization employs automatic temperature and humidity controls in the facility to prevent fluctuations potentially harmful to the information system.

PE-14 (2) : MONITORING WITH ALARMS / NOTIFICATIONS

The organization employs temperature and humidity monitoring that provides an alarm or notification of changes potentially harmful to personnel or equipment.

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-15 : WATER DAMAGE PROTECTION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization protects the information system from damage resulting from water leakage by providing master shutoff or isolation valves that are accessible, working properly, and known to key personnel.

Note

This control applies primarily to facilities containing concentrations of information system resources including, for example, data centers, server rooms, and mainframe computer rooms. Isolation valves can be employed in addition to or in lieu of master shutoff valves to shut off water supplies in specific areas of concern, without affecting entire organizations.

Related Controls: AT-3

PE-15 (1) : AUTOMATION SUPPORT

Baseline-Impact: HIGH

The organization employs automated mechanisms to detect the presence of water in the vicinity of the information system and alerts [Assignment: organization-defined personnel or roles].

Note

Automated mechanisms can include, for example, water detection sensors, alarms, and notification systems.

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-16 : DELIVERY AND REMOVAL

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization authorizes, monitors, and controls [Assignment: organization-defined types of information system components] entering and exiting the facility and maintains records of those items.

Note

Effectively enforcing authorizations for entry and exit of information system components may require restricting access to delivery areas and possibly isolating the areas from the information system and media libraries.

Related Controls: CM-3, MA-2, MA-3, MP-5, SA-12

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-17 : ALTERNATE WORK SITE

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Alternate work sites may include, for example, government facilities or private residences of employees. While commonly distinct from alternative processing sites, alternate work sites may provide readily available alternate locations as part of contingency operations. Organizations may define different sets of security controls for specific alternate work sites or types of sites depending on the work-related activities conducted at those sites. This control supports the contingency planning activities of organizations and the federal telework initiative.

Related Controls: AC-17, CP-7

PE-17a.

Employs [Assignment: organization-defined security controls] at alternate work sites;

PE-17b.

Assesses as feasible, the effectiveness of security controls at alternate work sites; and

PE-17c.

Provides a means for employees to communicate with information security personnel in case of security incidents or problems.

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-18 : LOCATION OF INFORMATION SYSTEM COMPONENTS

Priority: P3

Baseline-Impact: HIGH

The organization positions information system components within the facility to minimize potential damage from [Assignment: organization-defined physical and environmental hazards] and to minimize the opportunity for unauthorized access.

Note

Physical and environmental hazards include, for example, flooding, fire, tornadoes, earthquakes, hurricanes, acts of terrorism, vandalism, electromagnetic pulse, electrical interference, and other forms of incoming electromagnetic radiation. In addition, organizations consider the location of physical entry points where unauthorized individuals, while not being granted access, might nonetheless be in close proximity to information systems and therefore increase the potential for unauthorized access to organizational communications (e.g., through the use of wireless sniffers or microphones).

Related Controls: CP-2, PE-19, RA-3

PE-18 (1) : FACILITY SITE

The organization plans the location or site of the facility where the information system resides with regard to physical and environmental hazards and for existing facilities, considers the physical and environmental hazards in its risk mitigation strategy.

Related Controls: PM-8

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-19 : INFORMATION LEAKAGE

Priority: P0

The organization protects the information system from information leakage due to electromagnetic signals emanations.

Note

Information leakage is the intentional or unintentional release of information to an untrusted environment from electromagnetic signals emanations. Security categories or classifications of information systems (with respect to confidentiality) and organizational security policies guide the selection of security controls employed to protect systems against information leakage due to electromagnetic signals emanations.

PE-19 (1) : NATIONAL EMISSIONS / TEMPEST POLICIES AND PROCEDURES

The organization ensures that information system components, associated data communications, and networks are protected in accordance with national emissions and TEMPEST policies and procedures based on the security category or classification of the information.

Control Family: PHYSICAL AND ENVIRONMENTAL PROTECTION

PE-20 : ASSET MONITORING AND TRACKING

Priority: P0

The organization:

Note

Asset location technologies can help organizations ensure that critical assets such as vehicles or essential information system components remain in authorized locations. Organizations consult with the Office of the General Counsel and the Senior Agency Official for Privacy (SAOP)/Chief Privacy Officer (CPO) regarding the deployment and use of asset location technologies to address potential privacy concerns.

Related Controls: CM-8

PE-20a.

Employs [Assignment: organization-defined asset location technologies] to track and monitor the location and movement of [Assignment: organization-defined assets] within [Assignment: organization-defined controlled areas]; and

PE-20b.

Ensures that asset location technologies are employed in accordance with applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance.

Control Family: PLANNING

PL-1 : SECURITY PLANNING POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

> ***Note***
>
> This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the PL family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

PL-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

PL-1a.1.

A security planning policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

PL-1a.2.

Procedures to facilitate the implementation of the security planning policy and associated security planning controls; and

PL-1b.

Reviews and updates the current:

PL-1b.1.

Security planning policy [Assignment: organization-defined frequency]; and

PL-1b.2.

Security planning procedures [Assignment: organization-defined frequency].

Control Family: PLANNING

PL-2 : SYSTEM SECURITY PLAN

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Security plans relate security requirements to a set of security controls and control enhancements. Security plans also describe, at a high level, how the security controls and control enhancements meet those security requirements, but do not provide detailed, technical descriptions of the specific design or implementation of the controls/enhancements. Security plans contain sufficient information (including the specification of parameter values for assignment and selection statements either explicitly or by reference) to enable a design and implementation that is unambiguously compliant with the intent of the plans and subsequent determinations of risk to organizational operations and assets, individuals, other organizations, and the Nation if the plan is implemented as intended. Organizations can also apply tailoring guidance to the security control baselines in Appendix D and CNSS Instruction 1253 to develop overlays for community-wide use or to address specialized requirements, technologies, or missions/environments of operation (e.g., DoD-tactical, Federal Public Key Infrastructure, or Federal Identity, Credential, and Access Management, space operations). Appendix I provides guidance on developing overlays.

Security plans need not be single documents; the plans can be a collection of various documents including documents that already exist. Effective security plans make extensive use of references to policies, procedures, and additional documents (e.g., design and implementation specifications) where more detailed information can be obtained. This reduces the documentation requirements associated with security programs and maintains security-related information in other established management/operational areas related to enterprise architecture, system development life cycle, systems engineering, and acquisition. For example, security plans do not contain detailed contingency plan or incident response plan information but instead provide explicitly or by reference, sufficient information to define what needs to be accomplished by those plans.

Related Controls: AC-2, AC-6, AC-14, AC-17, AC-20, CA-2, CA-3, CA-7, CM-9, CP-2, IR-8, MA-4, MA-5, MP-2, MP-4, MP-5, PL-7, PM-1, PM-7, PM-8, PM-9, PM-11, SA-5, SA-17

PL-2a.

Develops a security plan for the information system that:

PL-2a.1.

Is consistent with the organization's enterprise architecture;

PL-2a.2.

Explicitly defines the authorization boundary for the system;

PL-2a.3.

Describes the operational context of the information system in terms of missions and business processes;

PL-2a.4.

Provides the security categorization of the information system including supporting rationale;

PL-2a.5.

Describes the operational environment for the information system and relationships with or connections to other information systems;

PL-2a.6.

Provides an overview of the security requirements for the system;

PL-2a.7.

Identifies any relevant overlays, if applicable;

PL-2a.8.

Describes the security controls in place or planned for meeting those requirements including a rationale for the tailoring decisions; and

PL-2a.9.

Is reviewed and approved by the authorizing official or designated representative prior to plan implementation;

PL-2b.

Distributes copies of the security plan and communicates subsequent changes to the plan to [Assignment: organization-defined personnel or roles];

PL-2c.

Reviews the security plan for the information system [Assignment: organization-defined frequency];

PL-2d.

Updates the plan to address changes to the information system/environment of operation or problems identified during plan implementation or security control assessments; and

PL-2e.

Protects the security plan from unauthorized disclosure and modification.

PL-2 (1) : CONCEPT OF OPERATIONS

[Withdrawn: Incorporated into PL-7].

PL-2 (2) : FUNCTIONAL ARCHITECTURE

[Withdrawn: Incorporated into PL-8].

PL-2 (3) : PLAN / COORDINATE WITH OTHER ORGANIZATIONAL ENTITIES

Baseline-Impact: *MODERATE*, **HIGH**

The organization plans and coordinates security-related activities affecting the information system with [Assignment: organization-defined individuals or groups] before conducting such activities in order to reduce the impact on other organizational entities.

Note

Security-related activities include, for example, security assessments, audits, hardware and software maintenance, patch management, and contingency plan testing. Advance planning and coordination includes emergency and nonemergency (i.e., planned or nonurgent unplanned) situations. The process defined by organizations to plan and coordinate security-related activities can be included in security plans for information systems or other documents, as appropriate.

Related Controls: CP-4, IR-4

Control Family: PLANNING

PL-3 : SYSTEM SECURITY PLAN UPDATE

[Withdrawn: Incorporated into PL-2].

Control Family: PLANNING

PL-4 : RULES OF BEHAVIOR

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control enhancement applies to organizational users. Organizations consider rules of behavior based on individual user roles and responsibilities, differentiating, for example, between rules that apply to privileged users and rules that apply to general users. Establishing rules of behavior for some types of non-organizational users including, for example, individuals who simply receive data/information from federal information systems, is often not feasible given the large number of such users and the limited nature of their interactions with the systems. Rules of behavior for both organizational and non-organizational users can also be established in AC-8, System Use Notification. PL-4 b. (the signed acknowledgment portion of this control) may be satisfied by the security awareness training and role-based security training programs conducted by organizations if such

training includes rules of behavior. Organizations can use electronic signatures for acknowledging rules of behavior.

Related Controls: AC-2, AC-6, AC-8, AC-9, AC-17, AC-18, AC-19, AC-20, AT-2, AT-3, CM-11, IA-2, IA-4, IA-5, MP-7, PS-6, PS-8, SA-5

PL-4a.

Establishes and makes readily available to individuals requiring access to the information system, the rules that describe their responsibilities and expected behavior with regard to information and information system usage;

PL-4b.

Receives a signed acknowledgment from such individuals, indicating that they have read, understand, and agree to abide by the rules of behavior, before authorizing access to information and the information system;

PL-4c.

Reviews and updates the rules of behavior [Assignment: organization-defined frequency]; and

PL-4d.

Requires individuals who have signed a previous version of the rules of behavior to read and re-sign when the rules of behavior are revised/updated.

PL-4 (1) : SOCIAL MEDIA AND NETWORKING RESTRICTIONS

Baseline-Impact: *MODERATE*, **HIGH**

The organization includes in the rules of behavior, explicit restrictions on the use of social media/networking sites and posting organizational information on public websites.

Note

This control enhancement addresses rules of behavior related to the use of social media/networking sites: (i) when organizational personnel are using such sites for official duties or in the conduct of official business; (ii) when organizational information is involved in social media/networking transactions; and (iii) when personnel are accessing social media/networking sites from organizational information systems. Organizations also address specific rules that prevent unauthorized entities from obtaining and/or inferring non-public organizational information (e.g., system account information, personally identifiable information) from social media/networking sites.

Control Family: PLANNING

PL-5 : PRIVACY IMPACT ASSESSMENT

[Withdrawn: Incorporated into Appendix J, AR-2].

Control Family: PLANNING

PL-6 : SECURITY-RELATED ACTIVITY PLANNING

[Withdrawn: Incorporated into PL-2].

Control Family: PLANNING

PL-7 : SECURITY CONCEPT OF OPERATIONS

Priority: P0

The organization:

Note

The security CONOPS may be included in the security plan for the information system or in other system development life cycle-related documents, as appropriate. Changes to the CONOPS are reflected in ongoing updates to the security plan, the information security architecture, and other appropriate organizational documents (e.g., security specifications for procurements/acquisitions, system development life cycle documents, and systems/security engineering documents).

Related Controls: PL-2

PL-7a.

Develops a security Concept of Operations (CONOPS) for the information system containing at a minimum, how the organization intends to operate the system from the perspective of information security; and

PL-7b.

Reviews and updates the CONOPS [Assignment: organization-defined frequency].

Control Family: PLANNING

PL-8 : INFORMATION SECURITY ARCHITECTURE

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

This control addresses actions taken by organizations in the design and development of information systems. The information security architecture at the individual information system level is consistent with and complements the more global, organization-wide information security architecture described in PM-7 that is integral to and developed as part of the enterprise architecture. The information security architecture includes an architectural description, the placement/allocation of security functionality (including security controls), security-related information for external interfaces, information being exchanged across the interfaces, and the protection mechanisms associated with each interface. In addition, the security architecture can include other important security-related information, for example, user roles and access privileges assigned to

each role, unique security requirements, the types of information processed, stored, and transmitted by the information system, restoration priorities of information and information system services, and any other specific protection needs.

In today's modern architecture, it is becoming less common for organizations to control all information resources. There are going to be key dependencies on external information services and service providers. Describing such dependencies in the information security architecture is important to developing a comprehensive mission/business protection strategy. Establishing, developing, documenting, and maintaining under configuration control, a baseline configuration for organizational information systems is critical to implementing and maintaining an effective information security architecture. The development of the information security architecture is coordinated with the Senior Agency Official for Privacy (SAOP)/Chief Privacy Officer (CPO) to ensure that security controls needed to support privacy requirements are identified and effectively implemented. PL-8 is primarily directed at organizations (i.e., internally focused) to help ensure that organizations develop an information security architecture for the information system, and that the security architecture is integrated with or tightly coupled to the enterprise architecture through the organization-wide information security architecture. In contrast, SA-17 is primarily directed at external information technology product/system developers and integrators (although SA-17 could be used internally within organizations for in-house system development). SA-17, which is complementary to PL-8, is selected when organizations outsource the development of information systems or information system components to external entities, and there is a need to demonstrate/show consistency with the organization's enterprise architecture and information security architecture.

Related Controls: CM-2, CM-6, PL-2, PM-7, SA-5, SA-17, Appendix J

PL-8a.

Develops an information security architecture for the information system that:

PL-8a.1.

Describes the overall philosophy, requirements, and approach to be taken with regard to protecting the confidentiality, integrity, and availability of organizational information;

PL-8a.2.

Describes how the information security architecture is integrated into and supports the enterprise architecture; and

PL-8a.3.

Describes any information security assumptions about, and dependencies on, external services;

PL-8b.

Reviews and updates the information security architecture [Assignment: organization-defined frequency] to reflect updates in the enterprise architecture; and

PL-8c.

Ensures that planned information security architecture changes are reflected in the security plan, the security Concept of Operations (CONOPS), and organizational procurements/acquisitions.

PL-8 (1) : DEFENSE-IN-DEPTH

The organization designs its security architecture using a defense-in-depth approach that:

Note

Organizations strategically allocate security safeguards (procedural, technical, or both) in the security architecture so that adversaries have to overcome multiple safeguards to achieve their objective. Requiring adversaries to defeat multiple mechanisms makes it more difficult to successfully attack critical information resources (i.e., increases adversary work factor) and also increases the likelihood of detection. The coordination of allocated safeguards is essential to ensure that an attack that involves one safeguard does not create adverse unintended consequences (e.g., lockout, cascading alarms) by interfering with another safeguard. Placement of security safeguards is a key activity. Greater asset criticality or information value merits additional layering. Thus, an organization may choose to place anti-virus software at organizational boundary layers, email/web servers, notebook computers, and workstations to maximize the number of related safeguards adversaries must penetrate before compromising the information and information systems.

Related Controls: SC-29, SC-36

PL-8 (1)(a)

Allocates [Assignment: organization-defined security safeguards] to [Assignment: organization-defined locations and architectural layers]; and

PL-8 (1)(b)

Ensures that the allocated security safeguards operate in a coordinated and mutually reinforcing manner.

PL-8 (2) : SUPPLIER DIVERSITY

The organization requires that [Assignment: organization-defined security safeguards] allocated to [Assignment: organization-defined locations and architectural layers] are obtained from different suppliers.

Note

Different information technology products have different strengths and weaknesses. Providing a broad spectrum of products complements the individual offerings. For example, vendors offering malicious code protection typically update their products at different times, often developing solutions for known viruses, Trojans, or worms according to their priorities and development schedules. By having different products at different locations (e.g., server, boundary, desktop) there is an increased likelihood that at least one will detect the malicious code.

Related Controls: SA-12

Control Family: PLANNING

PL-9 : CENTRAL MANAGEMENT

Priority: P0

The organization centrally manages [Assignment: organization-defined security controls and related processes].

Note

Central management refers to the organization-wide management and implementation of selected security controls and related processes. Central management includes planning, implementing, assessing, authorizing, and monitoring the organization-defined, centrally managed security controls and processes. As central management of security controls is generally associated with common controls, such management promotes and facilitates standardization of security control implementations and management and judicious use of organizational resources. Centrally-managed security controls and processes may also meet independence requirements for assessments in support of initial and ongoing authorizations to operate as part of organizational continuous monitoring. As part of the security control selection process, organizations determine which controls may be suitable for central management based on organizational resources and capabilities. Organizations consider that it may not always be possible to centrally manage every aspect of a security control. In such cases, the security control is treated as a hybrid control with the control managed and implemented either centrally or at the information system level. Controls and control enhancements that are candidates for full or partial central management include, but are not limited to: AC-2 (1) (2) (3) (4); AC-17 (1) (2) (3) (9); AC-18 (1) (3) (4) (5); AC-19 (4); AC-22; AC-23; AT-2 (1) (2); AT-3 (1) (2) (3); AT-4; AU-6 (1) (3) (5) (6) (9); AU-7 (1) (2); AU-11, AU-13, AU-16, CA-2 (1) (2) (3); CA-3 (1) (2) (3); CA-7 (1); CA-9; CM-2 (1) (2); CM-3 (1) (4); CM-4; CM-6 (1); CM-7 (4) (5); CM-8 (all); CM-9 (1); CM-10; CM-11; CP-7 (all); CP-8 (all); SC-43; SI-2; SI-3; SI-7; and SI-8.

Control Family: PERSONNEL SECURITY

PS-1 : PERSONNEL SECURITY POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the PS family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

PS-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

PS-1a.1.

A personnel security policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

PS-1a.2.

Procedures to facilitate the implementation of the personnel security policy and associated personnel security controls; and

PS-1b.

Reviews and updates the current:

PS-1b.1.

Personnel security policy [Assignment: organization-defined frequency]; and

PS-1b.2.

Personnel security procedures [Assignment: organization-defined frequency].

Control Family: PERSONNEL SECURITY

PS-2 : POSITION RISK DESIGNATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Position risk designations reflect Office of Personnel Management policy and guidance. Risk designations can guide and inform the types of authorizations individuals receive when accessing organizational information and information systems. Position screening criteria include explicit information security role appointment requirements (e.g., training, security clearances).

Related Controls: AT-3, PL-2, PS-3

PS-2a.

Assigns a risk designation to all organizational positions;

PS-2b.

Establishes screening criteria for individuals filling those positions; and

PS-2c.

Reviews and updates position risk designations [Assignment: organization-defined frequency].

Control Family: PERSONNEL SECURITY

PS-3 : PERSONNEL SCREENING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Personnel screening and rescreening activities reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, guidance, and specific criteria established for the risk designations of assigned positions. Organizations may define different rescreening conditions and frequencies for personnel accessing information systems based on types of information processed, stored, or transmitted by the systems.

Related Controls: AC-2, IA-4, PE-2, PS-2

PS-3a.

Screens individuals prior to authorizing access to the information system; and

PS-3b.

Rescreens individuals according to [Assignment: organization-defined conditions requiring rescreening and, where rescreening is so indicated, the frequency of such rescreening].

PS-3 (1) : CLASSIFIED INFORMATION

The organization ensures that individuals accessing an information system processing, storing, or transmitting classified information are cleared and indoctrinated to the highest classification level of the information to which they have access on the system.

Related Controls: AC-3, AC-4

PS-3 (2) : FORMAL INDOCTRINATION

The organization ensures that individuals accessing an information system processing, storing, or transmitting types of classified information which require formal indoctrination, are formally indoctrinated for all of the relevant types of information to which they have access on the system.

Note

Types of classified information requiring formal indoctrination include, for example, Special Access Program (SAP), Restricted Data (RD), and Sensitive Compartment Information (SCI).

Related Controls: AC-3, AC-4

PS-3 (3) : INFORMATION WITH SPECIAL PROTECTION MEASURES

The organization ensures that individuals accessing an information system processing, storing, or transmitting information requiring special protection:

Note

Organizational information requiring special protection includes, for example, Controlled Unclassified Information (CUI) and Sources and Methods Information (SAMI). Personnel security criteria include, for example, position sensitivity background screening requirements.

PS-3 (3)(a)

Have valid access authorizations that are demonstrated by assigned official government duties; and

PS-3 (3)(b)

Satisfy [Assignment: organization-defined additional personnel screening criteria].

Control Family: PERSONNEL SECURITY

PS-4 : PERSONNEL TERMINATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization, upon termination of individual employment:

Note

Information system-related property includes, for example, hardware authentication tokens, system administration technical manuals, keys, identification cards, and building passes. Exit interviews ensure that terminated individuals understand the security constraints imposed by being former employees and that proper accountability is achieved for information system-related property. Security topics of interest at exit interviews can include, for example, reminding terminated individuals of nondisclosure agreements and potential limitations on future employment. Exit interviews may not be possible for some terminated individuals, for example, in cases related to job abandonment, illnesses, and nonavailability of supervisors. Exit interviews are important for individuals with security clearances. Timely execution of termination actions is essential for individuals terminated for cause. In certain situations, organizations consider disabling the information system accounts of individuals that are being terminated prior to the individuals being notified.

Related Controls: AC-2, IA-4, PE-2, PS-5, PS-6

PS-4a.

Disables information system access within [Assignment: organization-defined time period];

PS-4b.

Terminates/revokes any authenticators/credentials associated with the individual;

PS-4c.

Conducts exit interviews that include a discussion of [Assignment: organization-defined information security topics];

PS-4d.

Retrieves all security-related organizational information system-related property;

PS-4e.

Retains access to organizational information and information systems formerly controlled by terminated individual; and

PS-4f.

Notifies [Assignment: organization-defined personnel or roles] within [Assignment: organization-defined time period].

PS-4 (1) : POST-EMPLOYMENT REQUIREMENTS

The organization:

Note

Organizations consult with the Office of the General Counsel regarding matters of post-employment requirements on terminated individuals.

PS-4 (1)(a)

Notifies terminated individuals of applicable, legally binding post-employment requirements for the protection of organizational information; and

PS-4 (1)(b)

Requires terminated individuals to sign an acknowledgment of post-employment requirements as part of the organizational termination process.

PS-4 (2) : AUTOMATED NOTIFICATION

Baseline-Impact: HIGH

The organization employs automated mechanisms to notify [Assignment: organization-defined personnel or roles] upon termination of an individual.

Note

In organizations with a large number of employees, not all personnel who need to know about termination actions receive the appropriate notifications or, if such notifications are received, they may not occur in a timely manner. Automated mechanisms can be used to send automatic alerts or notifications to specific organizational personnel or roles (e.g., management personnel, supervisors, personnel security officers, information security officers, systems administrators, or information technology administrators) when individuals are terminated. Such automatic alerts or notifications

can be conveyed in a variety of ways, including, for example, telephonically, via electronic mail, via text message, or via websites.

Control Family: PERSONNEL SECURITY

PS-5 : PERSONNEL TRANSFER

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control applies when reassignments or transfers of individuals are permanent or of such extended durations as to make the actions warranted. Organizations define actions appropriate for the types of reassignments or transfers, whether permanent or extended. Actions that may be required for personnel transfers or reassignments to other positions within organizations include, for example: (i) returning old and issuing new keys, identification cards, and building passes; (ii) closing information system accounts and establishing new accounts; (iii) changing information system access authorizations (i.e., privileges); and (iv) providing for access to official records to which individuals had access at previous work locations and in previous information system accounts.

Related Controls: AC-2, IA-4, PE-2, PS-4

PS-5a.

Reviews and confirms ongoing operational need for current logical and physical access authorizations to information systems/facilities when individuals are reassigned or transferred to other positions within the organization;

PS-5b.

Initiates [Assignment: organization-defined transfer or reassignment actions] within [Assignment: organization-defined time period following the formal transfer action];

PS-5c.

Modifies access authorization as needed to correspond with any changes in operational need due to reassignment or transfer; and

PS-5d.

Notifies [Assignment: organization-defined personnel or roles] within [Assignment: organization-defined time period].

Control Family: PERSONNEL SECURITY

PS-6 : ACCESS AGREEMENTS

Priority: P3

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Access agreements include, for example, nondisclosure agreements, acceptable use agreements, rules of behavior, and conflict-of-interest agreements. Signed access agreements include an acknowledgement that individuals have read, understand, and agree to abide by the constraints associated with organizational information systems to which access is authorized. Organizations can use electronic signatures to acknowledge access agreements unless specifically prohibited by organizational policy.

Related Controls: PL-4, PS-2, PS-3, PS-4, PS-8

PS-6a.

Develops and documents access agreements for organizational information systems;

PS-6b.

Reviews and updates the access agreements [Assignment: organization-defined frequency]; and

PS-6c.

Ensures that individuals requiring access to organizational information and information systems:

PS-6c.1.

Sign appropriate access agreements prior to being granted access; and

PS-6c.2.

Re-sign access agreements to maintain access to organizational information systems when access agreements have been updated or [Assignment: organization-defined frequency].

PS-6 (1) : INFORMATION REQUIRING SPECIAL PROTECTION

[Withdrawn: Incorporated into PS-3].

PS-6 (2) : CLASSIFIED INFORMATION REQUIRING SPECIAL PROTECTION

The organization ensures that access to classified information requiring special protection is granted only to individuals who:

Note

Classified information requiring special protection includes, for example, collateral information, Special Access Program (SAP) information, and Sensitive Compartmented Information (SCI). Personnel security criteria reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance.

PS-6 (2)(a)

Have a valid access authorization that is demonstrated by assigned official government duties;

PS-6 (2)(b)

Satisfy associated personnel security criteria; and

PS-6 (2)(c)

Have read, understood, and signed a nondisclosure agreement.

PS-6 (3) : POST-EMPLOYMENT REQUIREMENTS

The organization:

Note

Organizations consult with the Office of the General Counsel regarding matters of post-employment requirements on terminated individuals.

PS-6 (3)(a)

Notifies individuals of applicable, legally binding post-employment requirements for protection of organizational information; and

PS-6 (3)(b)

Requires individuals to sign an acknowledgment of these requirements, if applicable, as part of granting initial access to covered information.

Control Family: PERSONNEL SECURITY

PS-7 : THIRD-PARTY PERSONNEL SECURITY

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Third-party providers include, for example, service bureaus, contractors, and other organizations providing information system development, information technology services, outsourced applications, and network and security management. Organizations explicitly include personnel security requirements in acquisition-related documents. Third-party providers may have personnel working at organizational facilities with credentials, badges, or information system privileges issued by organizations. Notifications of third-party personnel changes ensure appropriate termination of privileges and credentials. Organizations define the transfers and terminations deemed reportable by security-related characteristics that include, for example, functions, roles, and nature of credentials/privileges associated with individuals transferred or terminated.

Related Controls: PS-2, PS-3, PS-4, PS-5, PS-6, SA-9, SA-21

PS-7a.

Establishes personnel security requirements including security roles and responsibilities for third-party providers;

PS-7b.

Requires third-party providers to comply with personnel security policies and procedures established by the organization;

PS-7c.

Documents personnel security requirements;

PS-7d.

Requires third-party providers to notify [Assignment: organization-defined personnel or roles] of any personnel transfers or terminations of third-party personnel who possess organizational credentials and/or badges, or who have information system privileges within [Assignment: organization-defined time period]; and

PS-7e.

Monitors provider compliance.

Control Family: PERSONNEL SECURITY

PS-8 : PERSONNEL SANCTIONS

Priority: P3

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Organizational sanctions processes reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Sanctions processes are described in access agreements and can be included as part of general personnel policies and procedures for organizations. Organizations consult with the Office of the General Counsel regarding matters of employee sanctions.

Related Controls: PL-4, PS-6

PS-8a.

Employs a formal sanctions process for individuals failing to comply with established information security policies and procedures; and

PS-8b.

Notifies [Assignment: organization-defined personnel or roles] within [Assignment: organization-defined time period] when a formal employee sanctions process is initiated, identifying the individual sanctioned and the reason for the sanction.

Control Family: RISK ASSESSMENT

RA-1 : RISK ASSESSMENT POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the RA family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

RA-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

RA-1a.1.

A risk assessment policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

RA-1a.2.

Procedures to facilitate the implementation of the risk assessment policy and associated risk assessment controls; and

RA-1b.

Reviews and updates the current:

RA-1b.1.

Risk assessment policy [Assignment: organization-defined frequency]; and

RA-1b.2.

Risk assessment procedures [Assignment: organization-defined frequency].

Control Family: RISK ASSESSMENT

RA-2 : SECURITY CATEGORIZATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Clearly defined authorization boundaries are a prerequisite for effective security categorization decisions. Security categories describe the potential adverse impacts to organizational operations, organizational assets, and individuals if organizational information and information systems are comprised through a loss of confidentiality, integrity, or availability. Organizations conduct the security categorization process as an organization-wide activity with the involvement of chief information officers, senior information security officers, information system owners, mission/business owners, and information owners/stewards. Organizations also consider the potential adverse impacts to other organizations and, in accordance with the USA PATRIOT Act of 2001 and Homeland Security Presidential Directives, potential national-level adverse impacts. Security categorization processes carried out by organizations facilitate the development of inventories of information assets, and along with CM-8, mappings to specific information system components where information is processed, stored, or transmitted.

Related Controls: CM-8, MP-4, RA-3, SC-7

RA-2a.

Categorizes information and the information system in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance;

RA-2b.

Documents the security categorization results (including supporting rationale) in the security plan for the information system; and

RA-2c.

Ensures that the authorizing official or authorizing official designated representative reviews and approves the security categorization decision.

Control Family: RISK ASSESSMENT

RA-3 : RISK ASSESSMENT

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Clearly defined authorization boundaries are a prerequisite for effective risk assessments. Risk assessments take into account threats, vulnerabilities, likelihood, and impact to organizational operations and assets, individuals, other organizations, and the Nation based on the operation and use of information systems. Risk assessments also take into account risk from external parties (e.g., service providers, contractors operating information systems on behalf of the organization, individuals accessing organizational information systems, outsourcing entities). In accordance with OMB policy and related E-authentication initiatives, authentication of public users accessing federal information systems may also be required to protect nonpublic or privacy-related information. As such, organizational assessments of risk also address public access to federal information systems.

Risk assessments (either formal or informal) can be conducted at all three tiers in the risk management hierarchy (i.e., organization level, mission/business process level, or information system level) and at any phase in the system development life cycle. Risk assessments can also be conducted at various steps in the Risk Management Framework, including categorization, security control selection, security control implementation, security control assessment, information system authorization, and security control monitoring. RA-3 is noteworthy in that the control must be partially implemented prior to the implementation of other controls in order to complete the first two steps in the Risk Management Framework. Risk assessments can play an important role in security control selection processes, particularly during the application of tailoring guidance, which includes security control supplementation.

Related Controls: RA-2, PM-9

RA-3a.

Conducts an assessment of risk, including the likelihood and magnitude of harm, from the unauthorized access, use, disclosure, disruption, modification, or destruction of the information system and the information it processes, stores, or transmits;

RA-3b.

Documents risk assessment results in [Selection: security plan; risk assessment report; [Assignment: organization-defined document]];

RA-3c.

Reviews risk assessment results [Assignment: organization-defined frequency];

RA-3d.

Disseminates risk assessment results to [Assignment: organization-defined personnel or roles]; and

RA-3e.

Updates the risk assessment [Assignment: organization-defined frequency] or whenever there are significant changes to the information system or environment of operation (including the identification of new threats and vulnerabilities), or other conditions that may impact the security state of the system.

Control Family: RISK ASSESSMENT

RA-4 : RISK ASSESSMENT UPDATE

[Withdrawn: Incorporated into RA-3].

Control Family: RISK ASSESSMENT

RA-5 : VULNERABILITY SCANNING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Security categorization of information systems guides the frequency and comprehensiveness of vulnerability scans. Organizations determine the required vulnerability scanning for all information system components, ensuring that potential sources of vulnerabilities such as networked printers, scanners, and copiers are not overlooked. Vulnerability analyses for custom software applications may require additional approaches such as static analysis, dynamic analysis, binary analysis, or a hybrid of the three approaches. Organizations can employ these analysis approaches in a variety of tools (e.g., web-based application scanners, static analysis tools, binary analyzers) and in source code reviews. Vulnerability scanning includes, for example: (i) scanning for patch levels; (ii) scanning for functions, ports, protocols, and services that should not be accessible to users or devices; and (iii) scanning for improperly configured or incorrectly operating information flow control mechanisms. Organizations consider using tools that express vulnerabilities in the Common Vulnerabilities and Exposures (CVE) naming convention and that use the Open Vulnerability Assessment Language (OVAL) to determine/test for the presence of vulnerabilities. Suggested sources for vulnerability information include the Common Weakness Enumeration (CWE) listing and the National Vulnerability Database (NVD). In addition, security control assessments such as red team exercises provide other sources of potential vulnerabilities for which to scan. Organizations also consider using tools that express vulnerability impact by the Common Vulnerability Scoring System (CVSS).

Related Controls: CA-2, CA-7, CM-4, CM-6, RA-2, RA-3, SA-11, SI-2

RA-5a.

Scans for vulnerabilities in the information system and hosted applications [Assignment: organization-defined frequency and/or randomly in accordance with organization-defined process] and when new vulnerabilities potentially affecting the system/applications are identified and reported;

RA-5b.

Employs vulnerability scanning tools and techniques that facilitate interoperability among tools and automate parts of the vulnerability management process by using standards for:

RA-5b.1.

Enumerating platforms, software flaws, and improper configurations;

RA-5b.2.

Formatting checklists and test procedures; and

RA-5b.3.

Measuring vulnerability impact;

RA-5c.

Analyzes vulnerability scan reports and results from security control assessments;

RA-5d.

Remediates legitimate vulnerabilities [Assignment: organization-defined response times] in accordance with an organizational assessment of risk; and

RA-5e.

Shares information obtained from the vulnerability scanning process and security control assessments with [Assignment: organization-defined personnel or roles] to help eliminate similar vulnerabilities in other information systems (i.e., systemic weaknesses or deficiencies).

RA-5 (1) : UPDATE TOOL CAPABILITY

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs vulnerability scanning tools that include the capability to readily update the information system vulnerabilities to be scanned.

Note

The vulnerabilities to be scanned need to be readily updated as new vulnerabilities are discovered, announced, and scanning methods developed. This updating process helps to ensure that potential vulnerabilities in the information system are identified and addressed as quickly as possible.

Related Controls: SI-3, SI-7

RA-5 (2) : UPDATE BY FREQUENCY / PRIOR TO NEW SCAN / WHEN IDENTIFIED

Baseline-Impact: *MODERATE*, **HIGH**

The organization updates the information system vulnerabilities scanned [Selection (one or more): [Assignment: organization-defined frequency]; prior to a new scan; when new vulnerabilities are identified and reported].

Related Controls: SI-3, SI-5

RA-5 (3) : BREADTH / DEPTH OF COVERAGE

The organization employs vulnerability scanning procedures that can identify the breadth and depth of coverage (i.e., information system components scanned and vulnerabilities checked).

RA-5 (4) : DISCOVERABLE INFORMATION

Baseline-Impact: HIGH

The organization determines what information about the information system is discoverable by adversaries and subsequently takes [Assignment: organization-defined corrective actions].

Note

Discoverable information includes information that adversaries could obtain without directly compromising or breaching the information system, for example, by collecting information the system is exposing or by conducting extensive searches of the web. Corrective actions can include, for example, notifying appropriate organizational personnel, removing designated information, or changing the information system to make designated information less relevant or attractive to adversaries.

Related Controls: AU-13

RA-5 (5) : PRIVILEGED ACCESS

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements privileged access authorization to [Assignment: organization-identified information system components] for selected [Assignment: organization-defined vulnerability scanning activities].

Note

In certain situations, the nature of the vulnerability scanning may be more intrusive or the information system component that is the subject of the scanning may contain highly sensitive information. Privileged access authorization to selected system components facilitates more thorough vulnerability scanning and also protects the sensitive nature of such scanning.

RA-5 (6) : AUTOMATED TREND ANALYSES

The organization employs automated mechanisms to compare the results of vulnerability scans over time to determine trends in information system vulnerabilities.

Related Controls: IR-4, IR-5, SI-4

RA-5 (7) : AUTOMATED DETECTION AND NOTIFICATION OF UNAUTHORIZED COMPONENTS

[Withdrawn: Incorporated into CM-8].

RA-5 (8) : REVIEW HISTORIC AUDIT LOGS

The organization reviews historic audit logs to determine if a vulnerability identified in the information system has been previously exploited.

Related Controls: AU-6

RA-5 (9) : PENETRATION TESTING AND ANALYSES

[Withdrawn: Incorporated into CA-8].

RA-5 (10) : CORRELATE SCANNING INFORMATION

The organization correlates the output from vulnerability scanning tools to determine the presence of multi-vulnerability/multi-hop attack vectors.

Control Family: RISK ASSESSMENT

RA-6 : TECHNICAL SURVEILLANCE COUNTERMEASURES SURVEY

Priority: P0

The organization employs a technical surveillance countermeasures survey at [Assignment: organization-defined locations] [Selection (one or more): [Assignment: organization-defined frequency]; [Assignment: organization-defined events or indicators occur]].

Note

Technical surveillance countermeasures surveys are performed by qualified personnel to detect the presence of technical surveillance devices/hazards and to identify technical security weaknesses that could aid in the conduct of technical penetrations of surveyed facilities. Such surveys provide evaluations of the technical security postures of organizations and facilities and typically include thorough visual, electronic, and physical examinations in and about surveyed facilities. The surveys also provide useful input into risk assessments and organizational exposure to potential adversaries.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-1 : SYSTEM AND SERVICES ACQUISITION POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the SA family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

SA-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

SA-1a.1.

A system and services acquisition policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

SA-1a.2.

Procedures to facilitate the implementation of the system and services acquisition policy and associated system and services acquisition controls; and

SA-1b.

Reviews and updates the current:

SA-1b.1.

System and services acquisition policy [Assignment: organization-defined frequency]; and

SA-1b.2.

System and services acquisition procedures [Assignment: organization-defined frequency].

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-2 : ALLOCATION OF RESOURCES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Resource allocation for information security includes funding for the initial information system or information system service acquisition and funding for the sustainment of the system/service.

Related Controls: PM-3, PM-11

SA-2a.

Determines information security requirements for the information system or information system service in mission/business process planning;

SA-2b.

Determines, documents, and allocates the resources required to protect the information system or information system service as part of its capital planning and investment control process; and

SA-2c.

Establishes a discrete line item for information security in organizational programming and budgeting documentation.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-3 : SYSTEM DEVELOPMENT LIFE CYCLE

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

A well-defined system development life cycle provides the foundation for the successful development, implementation, and operation of organizational information systems. To apply the required security controls within the system development life cycle requires a basic understanding of information security, threats, vulnerabilities, adverse impacts, and risk to critical missions/business functions. The security engineering principles in SA-8 cannot be properly applied if individuals that design, code, and test information systems and system components (including information technology products) do not understand security. Therefore, organizations include qualified personnel, for example, chief information security officers, security architects, security engineers, and information system security officers in system development life cycle activities to ensure that security requirements are incorporated into organizational information systems. It is equally important that developers include individuals on the development team that possess the requisite security expertise and skills to ensure that needed security capabilities are effectively integrated into the information system. Security awareness and training programs can help ensure that individuals having key security roles and responsibilities have the appropriate experience, skills, and expertise to conduct assigned system development life cycle activities. The effective integration of security requirements into enterprise architecture also helps to ensure that important security considerations are addressed early in the system development life cycle and that those considerations are directly related to the organizational mission/business processes. This process also facilitates the integration of the information security architecture into the enterprise architecture, consistent with organizational risk management and information security strategies.

Related Controls: AT-3, PM-7, SA-8

SA-3a.

Manages the information system using [Assignment: organization-defined system development life cycle] that incorporates information security considerations;

SA-3b.

Defines and documents information security roles and responsibilities throughout the system development life cycle;

SA-3c.

Identifies individuals having information security roles and responsibilities; and

SA-3d.

Integrates the organizational information security risk management process into system development life cycle activities.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-4 : ACQUISITION PROCESS

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization includes the following requirements, descriptions, and criteria, explicitly or by reference, in the acquisition contract for the information system, system component, or information system service in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, standards, guidelines, and organizational mission/business needs:

Note

Information system components are discrete, identifiable information technology assets (e.g., hardware, software, or firmware) that represent the building blocks of an information system. Information system components include commercial information technology products. Security functional requirements include security capabilities, security functions, and security mechanisms. Security strength requirements associated with such capabilities, functions, and mechanisms include degree of correctness, completeness, resistance to direct attack, and resistance to tampering or bypass. Security assurance requirements include: (i) development processes, procedures, practices, and methodologies; and (ii) evidence from development and assessment activities providing grounds for confidence that the required security functionality has been implemented and the required security strength has been achieved. Security documentation requirements address all phases of the system development life cycle.

Security functionality, assurance, and documentation requirements are expressed in terms of security controls and control enhancements that have been selected through the tailoring process. The security control tailoring process includes, for example, the specification of parameter values through the use of assignment and selection statements and the specification of platform dependencies and implementation information. Security documentation provides user and administrator guidance regarding the implementation and operation of security controls. The level of detail required in security documentation is based on the security category or classification level of the information system and the degree to which organizations depend on the stated security capability, functions, or mechanisms to meet overall risk response expectations (as defined in the organizational risk management strategy). Security requirements can also include organizationally mandated configuration settings specifying allowed functions, ports, protocols, and services. Acceptance criteria for information systems, information system components, and information system services are defined in the same manner as such criteria for any organizational acquisition or procurement. The Federal Acquisition Regulation (FAR) Section 7.103 contains information security requirements from FISMA.

Related Controls: CM-6, PL-2, PS-7, SA-3, SA-5, SA-8, SA-11, SA-12

SA-4a.

Security functional requirements;

SA-4b.

Security strength requirements;

SA-4c.

Security assurance requirements;

SA-4d.

Security-related documentation requirements;

SA-4e.

Requirements for protecting security-related documentation;

SA-4f.

Description of the information system development environment and environment in which the system is intended to operate; and

SA-4g.

Acceptance criteria.

SA-4 (1) : FUNCTIONAL PROPERTIES OF SECURITY CONTROLS

Baseline-Impact: *MODERATE*, **HIGH**

The organization requires the developer of the information system, system component, or information system service to provide a description of the functional properties of the security controls to be employed.

Note

Functional properties of security controls describe the functionality (i.e., security capability, functions, or mechanisms) visible at the interfaces of the controls and specifically exclude functionality and data structures internal to the operation of the controls.

Related Controls: SA-5

SA-4 (2) : DESIGN / IMPLEMENTATION INFORMATION FOR SECURITY CONTROLS

Baseline-Impact: *MODERATE*, **HIGH**

The organization requires the developer of the information system, system component, or information system service to provide design and implementation information for the security controls to be employed that includes: [Selection (one or more): security-relevant external system interfaces; high-level design; low-level design; source code or hardware schematics; [Assignment: organization-defined design/implementation information]] at [Assignment: organization-defined level of detail].

Note

Organizations may require different levels of detail in design and implementation documentation for security controls employed in organizational information systems, system components, or information system services based on mission/business requirements, requirements for trustworthiness/resiliency, and requirements for analysis and testing. Information systems can be partitioned into multiple subsystems. Each subsystem within the system can contain one or more modules. The high-level design for the system is expressed in terms of multiple subsystems and the interfaces between subsystems providing security-relevant functionality. The low-level design for the system is expressed in terms of modules with particular emphasis on software and firmware (but not excluding hardware)

and the interfaces between modules providing security-relevant functionality. Source code and hardware schematics are typically referred to as the implementation representation of the information system.

Related Controls: SA-5

SA-4 (3) : DEVELOPMENT METHODS / TECHNIQUES / PRACTICES

The organization requires the developer of the information system, system component, or information system service to demonstrate the use of a system development life cycle that includes [Assignment: organization-defined state-of-the-practice system/security engineering methods, software development methods, testing/evaluation/validation techniques, and quality control processes].

Note

Following a well-defined system development life cycle that includes state-of-the-practice software development methods, systems/security engineering methods, quality control processes, and testing, evaluation, and validation techniques helps to reduce the number and severity of latent errors within information systems, system components, and information system services. Reducing the number/severity of such errors reduces the number of vulnerabilities in those systems, components, and services.

Related Controls: SA-12

SA-4 (4) : ASSIGNMENT OF COMPONENTS TO SYSTEMS

[Withdrawn: Incorporated into CM-8 (9)].

SA-4 (5) : SYSTEM / COMPONENT / SERVICE CONFIGURATIONS

The organization requires the developer of the information system, system component, or information system service to:

Note

Security configurations include, for example, the U.S. Government Configuration Baseline (USGCB) and any limitations on functions, ports, protocols, and services. Security characteristics include, for example, requiring that all default passwords have been changed.

Related Controls: CM-8

SA-4 (5)(a)

Deliver the system, component, or service with [Assignment: organization-defined security configurations] implemented; and

SA-4 (5)(b)

Use the configurations as the default for any subsequent system, component, or service reinstallation or upgrade.

SA-4 (6) : USE OF INFORMATION ASSURANCE PRODUCTS

The organization:

> ***Note***
>
> COTS IA or IA-enabled information technology products used to protect classified information by cryptographic means may be required to use NSA-approved key management.

Related Controls: SC-8, SC-12, SC-13

SA-4 (6)(a)

Employs only government off-the-shelf (GOTS) or commercial off-the-shelf (COTS) information assurance (IA) and IA-enabled information technology products that compose an NSA-approved solution to protect classified information when the networks used to transmit the information are at a lower classification level than the information being transmitted; and

SA-4 (6)(b)

Ensures that these products have been evaluated and/or validated by NSA or in accordance with NSA-approved procedures.

SA-4 (7) : NIAP-APPROVED PROTECTION PROFILES

The organization:

Related Controls: SC-12, SC-13

SA-4 (7)(a)

Limits the use of commercially provided information assurance (IA) and IA-enabled information technology products to those products that have been successfully evaluated against a National Information Assurance partnership (NIAP)-approved Protection Profile for a specific technology type, if such a profile exists; and

SA-4 (7)(b)

Requires, if no NIAP-approved Protection Profile exists for a specific technology type but a commercially provided information technology product relies on cryptographic functionality to enforce its security policy, that the cryptographic module is FIPS-validated.

SA-4 (8) : CONTINUOUS MONITORING PLAN

The organization requires the developer of the information system, system component, or information system service to produce a plan for the continuous monitoring of security control effectiveness that contains [Assignment: organization-defined level of detail].

Note

The objective of continuous monitoring plans is to determine if the complete set of planned, required, and deployed security controls within the information system, system component, or information system service continue to be effective over time based on the inevitable changes that occur. Developer continuous monitoring plans include a sufficient level of detail such that the information can be incorporated into the continuous monitoring strategies and programs implemented by organizations.

Related Controls: CA-7

SA-4 (9) : FUNCTIONS / PORTS / PROTOCOLS / SERVICES IN USE

Baseline-Impact: *MODERATE*, **HIGH**

The organization requires the developer of the information system, system component, or information system service to identify early in the system development life cycle, the functions, ports, protocols, and services intended for organizational use.

Note

The identification of functions, ports, protocols, and services early in the system development life cycle (e.g., during the initial requirements definition and design phases) allows organizations to influence the design of the information system, information system component, or information system service. This early involvement in the life cycle helps organizations to avoid or minimize the use of functions, ports, protocols, or services that pose unnecessarily high risks and understand the trade-offs involved in blocking specific ports, protocols, or services (or when requiring information system service providers to do so). Early identification of functions, ports, protocols, and services avoids costly retrofitting of security controls after the information system, system component, or information system service has been implemented. SA-9 describes requirements for external information system services with organizations identifying which functions, ports, protocols, and services are provided from external sources.

Related Controls: CM-7, SA-9

SA-4 (10) : USE OF APPROVED PIV PRODUCTS

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization employs only information technology products on the FIPS 201-approved products list for Personal Identity Verification (PIV) capability implemented within organizational information systems.

Related Controls: IA-2, IA-8

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-5 : INFORMATION SYSTEM DOCUMENTATION

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control helps organizational personnel understand the implementation and operation of security controls associated with information systems, system components, and information system services. Organizations consider establishing specific measures to determine the quality/completeness of the content provided. The inability to obtain needed documentation may occur, for example, due to the age of the information system/component or lack of support from developers and contractors. In those situations, organizations may need to recreate selected documentation if such documentation is essential to the effective implementation or operation of security controls. The level of protection provided for selected information system, component, or service documentation is commensurate with the security category or classification of the system. For example, documentation associated with a key DoD weapons system or command and control system would typically require a higher level of protection than a routine administrative system. Documentation that addresses information system vulnerabilities may also require an increased level of protection. Secure operation of the information system, includes, for example, initially starting the system and resuming secure system operation after any lapse in system operation.

Related Controls: CM-6, CM-8, PL-2, PL-4, PS-2, SA-3, SA-4

SA-5a.

Obtains administrator documentation for the information system, system component, or information system service that describes:

SA-5a.1.

Secure configuration, installation, and operation of the system, component, or service;

SA-5a.2.

Effective use and maintenance of security functions/mechanisms; and

SA-5a.3.

Known vulnerabilities regarding configuration and use of administrative (i.e., privileged) functions;

SA-5b.

Obtains user documentation for the information system, system component, or information system service that describes:

SA-5b.1.

User-accessible security functions/mechanisms and how to effectively use those security functions/mechanisms;

SA-5b.2.

Methods for user interaction, which enables individuals to use the system, component, or service in a more secure manner; and

SA-5b.3.

User responsibilities in maintaining the security of the system, component, or service;

SA-5c.

Documents attempts to obtain information system, system component, or information system service documentation when such documentation is either unavailable or nonexistent and takes [Assignment: organization-defined actions] in response;

SA-5d.

Protects documentation as required, in accordance with the risk management strategy; and

SA-5e.

Distributes documentation to [Assignment: organization-defined personnel or roles].

SA-5 (1) : FUNCTIONAL PROPERTIES OF SECURITY CONTROLS

[Withdrawn: Incorporated into SA-4 (1)].

SA-5 (2) : SECURITY-RELEVANT EXTERNAL SYSTEM INTERFACES

[Withdrawn: Incorporated into SA-4 (2)].

SA-5 (3) : HIGH-LEVEL DESIGN

[Withdrawn: Incorporated into SA-4 (2)].

SA-5 (4) : LOW-LEVEL DESIGN

[Withdrawn: Incorporated into SA-4 (2)].

SA-5 (5) : SOURCE CODE

[Withdrawn: Incorporated into SA-4 (2)].

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-6 : SOFTWARE USAGE RESTRICTIONS

[Withdrawn: Incorporated into CM-10 and SI-7].

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-7 : USER-INSTALLED SOFTWARE

[Withdrawn: Incorporated into CM-11 and SI-7].

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-8 : SECURITY ENGINEERING PRINCIPLES

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization applies information system security engineering principles in the specification, design, development, implementation, and modification of the information system.

Note

Organizations apply security engineering principles primarily to new development information systems or systems undergoing major upgrades. For legacy systems, organizations apply security engineering principles to system upgrades and modifications to the extent feasible, given the current state of hardware, software, and firmware within those systems. Security engineering principles include, for example: (i) developing layered protections; (ii) establishing sound security policy, architecture, and controls as the foundation for design; (iii) incorporating security requirements into the system development life cycle; (iv) delineating physical and logical security boundaries; (v) ensuring that system developers are trained on how to build secure software; (vi) tailoring security controls to meet organizational and operational needs; (vii) performing threat modeling to identify use cases, threat agents, attack vectors, and attack patterns as well as compensating controls and design patterns needed to mitigate risk; and (viii) reducing risk to acceptable levels, thus enabling informed risk management decisions.

Related Controls: PM-7, SA-3, SA-4, SA-17, SC-2, SC-3

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-9 : EXTERNAL INFORMATION SYSTEM SERVICES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

External information system services are services that are implemented outside of the authorization boundaries of organizational information systems. This includes services that are used by, but not a part of, organizational information systems. FISMA and OMB policy require that organizations using external service providers that are processing, storing, or transmitting federal information or operating information systems on behalf of the federal government ensure that such providers meet the same security requirements that federal agencies are required to meet. Organizations establish relationships with external service providers in a variety of ways including, for example, through joint ventures, business partnerships, contracts, interagency agreements, lines of business arrangements, licensing agreements, and supply chain exchanges. The responsibility for managing risks from the use of external information system services remains with authorizing officials. For services external to organizations, a chain of trust requires that organizations establish and retain a level of confidence that each participating provider in the potentially complex consumer-provider relationship provides adequate protection for the services rendered. The extent and nature of this chain of trust varies based on the relationships between organizations and the external providers. Organizations document the basis for trust relationships so the relationships can be monitored over time. External information system services documentation includes government, service providers, end user security roles and responsibilities, and service-level agreements. Service-level agreements define expectations of performance for security controls, describe measurable outcomes, and identify remedies and response requirements for identified instances of noncompliance.

Related Controls: CA-3, IR-7, PS-7

SA-9a.

Requires that providers of external information system services comply with organizational information security requirements and employ [Assignment: organization-defined security controls] in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance;

SA-9b.

Defines and documents government oversight and user roles and responsibilities with regard to external information system services; and

SA-9c.

Employs [Assignment: organization-defined processes, methods, and techniques] to monitor security control compliance by external service providers on an ongoing basis.

SA-9 (1) : RISK ASSESSMENTS / ORGANIZATIONAL APPROVALS

The organization:

Note

Dedicated information security services include, for example, incident monitoring, analysis and response, operation of information security-related devices such as firewalls, or key management services.

Related Controls: CA-6, RA-3

SA-9 (1)(a)

Conducts an organizational assessment of risk prior to the acquisition or outsourcing of dedicated information security services; and

SA-9 (1)(b)

Ensures that the acquisition or outsourcing of dedicated information security services is approved by [Assignment: organization-defined personnel or roles].

SA-9 (2) : IDENTIFICATION OF FUNCTIONS / PORTS / PROTOCOLS / SERVICES

Baseline-Impact: *MODERATE*, **HIGH**

The organization requires providers of [Assignment: organization-defined external information system services] to identify the functions, ports, protocols, and other services required for the use of such services.

Note

Information from external service providers regarding the specific functions, ports, protocols, and services used in the provision of such services can be particularly useful when the need arises to

understand the trade-offs involved in restricting certain functions/services or blocking certain ports/protocols.

Related Controls: CM-7

SA-9 (3) : ESTABLISH / MAINTAIN TRUST RELATIONSHIP WITH PROVIDERS

The organization establishes, documents, and maintains trust relationships with external service providers based on [Assignment: organization-defined security requirements, properties, factors, or conditions defining acceptable trust relationships].

Note

The degree of confidence that the risk from using external services is at an acceptable level depends on the trust that organizations place in the external providers, individually or in combination. Trust relationships can help organization to gain increased levels of confidence that participating service providers are providing adequate protection for the services rendered. Such relationships can be complicated due to the number of potential entities participating in the consumer-provider interactions, subordinate relationships and levels of trust, and the types of interactions between the parties. In some cases, the degree of trust is based on the amount of direct control organizations are able to exert on external service providers with regard to employment of security controls necessary for the protection of the service/information and the evidence brought forth as to the effectiveness of those controls. The level of control is typically established by the terms and conditions of the contracts or service-level agreements and can range from extensive control (e.g., negotiating contracts or agreements that specify security requirements for the providers) to very limited control (e.g., using contracts or service-level agreements to obtain commodity services such as commercial telecommunications services). In other cases, levels of trust are based on factors that convince organizations that required security controls have been employed and that determinations of control effectiveness exist. For example, separately authorized external information system services provided to organizations through well-established business relationships may provide degrees of trust in such services within the tolerable risk range of the organizations using the services. External service providers may also outsource selected services to other external entities, making the trust relationship more difficult and complicated to manage. Depending on the nature of the services, organizations may find it very difficult to place significant trust in external providers. This is not due to any inherent untrustworthiness on the part of providers, but to the intrinsic level of risk in the services.

SA-9 (4) : CONSISTENT INTERESTS OF CONSUMERS AND PROVIDERS

The organization employs [Assignment: organization-defined security safeguards] to ensure that the interests of [Assignment: organization-defined external service providers] are consistent with and reflect organizational interests.

Note

As organizations increasingly use external service providers, the possibility exists that the interests of the service providers may diverge from organizational interests. In such situations, simply having the correct technical, procedural, or operational safeguards in place may not be sufficient if the service providers that implement and control those safeguards are not operating in a manner consistent with the interests of the consuming organizations. Possible actions that organizations might take to address such concerns include, for example, requiring background checks for selected service

provider personnel, examining ownership records, employing only trustworthy service providers (i.e., providers with which organizations have had positive experiences), and conducting periodic/unscheduled visits to service provider facilities.

SA-9 (5) : PROCESSING, STORAGE, AND SERVICE LOCATION

The organization restricts the location of [Selection (one or more): information processing; information/data; information system services] to [Assignment: organization-defined locations] based on [Assignment: organization-defined requirements or conditions].

Note

The location of information processing, information/data storage, or information system services that are critical to organizations can have a direct impact on the ability of those organizations to successfully execute their missions/business functions. This situation exists when external providers control the location of processing, storage or services. The criteria external providers use for the selection of processing, storage, or service locations may be different from organizational criteria. For example, organizations may want to ensure that data/information storage locations are restricted to certain locations to facilitate incident response activities (e.g., forensic analyses, after-the-fact investigations) in case of information security breaches/compromises. Such incident response activities may be adversely affected by the governing laws or protocols in the locations where processing and storage occur and/or the locations from which information system services emanate.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-10 : DEVELOPER CONFIGURATION MANAGEMENT

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization requires the developer of the information system, system component, or information system service to:

Note

This control also applies to organizations conducting internal information systems development and integration. Organizations consider the quality and completeness of the configuration management activities conducted by developers as evidence of applying effective security safeguards. Safeguards include, for example, protecting from unauthorized modification or destruction, the master copies of all material used to generate security-relevant portions of the system hardware, software, and firmware. Maintaining the integrity of changes to the information system, information system component, or information system service requires configuration control throughout the system development life cycle to track authorized changes and prevent unauthorized changes. Configuration items that are placed under configuration management (if existence/use is required by other security controls) include: the formal model; the functional, high-level, and low-level design specifications; other design data; implementation documentation; source code and hardware schematics; the running version of the object code; tools for comparing new versions of security-relevant hardware descriptions and software/firmware source code with previous versions; and test fixtures and documentation. Depending on the mission/business needs of organizations and the nature of the contractual relationships in place, developers may provide configuration management support during the operations and maintenance phases of the life cycle.

Related Controls: CM-3, CM-4, CM-9, SA-12, SI-2

SA-10a.

Perform configuration management during system, component, or service [Selection (one or more): design; development; implementation; operation];

SA-10b.

Document, manage, and control the integrity of changes to [Assignment: organization-defined configuration items under configuration management];

SA-10c.

Implement only organization-approved changes to the system, component, or service;

SA-10d.

Document approved changes to the system, component, or service and the potential security impacts of such changes; and

SA-10e.

Track security flaws and flaw resolution within the system, component, or service and report findings to [Assignment: organization-defined personnel].

SA-10 (1) : SOFTWARE / FIRMWARE INTEGRITY VERIFICATION

The organization requires the developer of the information system, system component, or information system service to enable integrity verification of software and firmware components.

Note

This control enhancement allows organizations to detect unauthorized changes to software and firmware components through the use of tools, techniques, and/or mechanisms provided by developers. Integrity checking mechanisms can also address counterfeiting of software and firmware components. Organizations verify the integrity of software and firmware components, for example, through secure one-way hashes provided by developers. Delivered software and firmware components also include any updates to such components.

Related Controls: SI-7

SA-10 (2) : ALTERNATIVE CONFIGURATION MANAGEMENT PROCESSES

The organization provides an alternate configuration management process using organizational personnel in the absence of a dedicated developer configuration management team.

Note

Alternate configuration management processes may be required, for example, when organizations use commercial off-the-shelf (COTS) information technology products. Alternate configuration management processes include organizational personnel that: (i) are responsible for reviewing/approving proposed changes to information systems, system components, and information system services; and (ii) conduct security impact analyses prior to the implementation of any changes to systems, components, or services (e.g., a configuration control board that considers security impacts of changes during development and includes representatives of both the organization and the developer, when applicable).

SA-10 (3) : HARDWARE INTEGRITY VERIFICATION

The organization requires the developer of the information system, system component, or information system service to enable integrity verification of hardware components.

Note

This control enhancement allows organizations to detect unauthorized changes to hardware components through the use of tools, techniques, and/or mechanisms provided by developers. Organizations verify the integrity of hardware components, for example, with hard-to-copy labels and verifiable serial numbers provided by developers, and by requiring the implementation of anti-tamper technologies. Delivered hardware components also include updates to such components.

Related Controls: SI-7

SA-10 (4) : TRUSTED GENERATION

The organization requires the developer of the information system, system component, or information system service to employ tools for comparing newly generated versions of security-relevant hardware descriptions and software/firmware source and object code with previous versions.

Note

This control enhancement addresses changes to hardware, software, and firmware components between versions during development. In contrast, SA-10 (1) and SA-10 (3) allow organizations to detect unauthorized changes to hardware, software, and firmware components through the use of tools, techniques, and/or mechanisms provided by developers.

SA-10 (5) : MAPPING INTEGRITY FOR VERSION CONTROL

The organization requires the developer of the information system, system component, or information system service to maintain the integrity of the mapping between the master build data (hardware drawings and software/firmware code) describing the current version of security-relevant hardware, software, and firmware and the on-site master copy of the data for the current version.

Note

This control enhancement addresses changes to hardware, software, and firmware components during initial development and during system life cycle updates. Maintaining the integrity between the master copies of security-relevant hardware, software, and firmware (including designs and source code) and the equivalent data in master copies on-site in operational environments is essential to ensure the availability of organizational information systems supporting critical missions and/or business functions.

SA-10 (6) : TRUSTED DISTRIBUTION

The organization requires the developer of the information system, system component, or information system service to execute procedures for ensuring that security-relevant hardware, software, and firmware updates distributed to the organization are exactly as specified by the master copies.

Note

The trusted distribution of security-relevant hardware, software, and firmware updates helps to ensure that such updates are faithful representations of the master copies maintained by the developer and have not been tampered with during distribution.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-11 : DEVELOPER SECURITY TESTING AND EVALUATION

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization requires the developer of the information system, system component, or information system service to:

Note

Developmental security testing/evaluation occurs at all post-design phases of the system development life cycle. Such testing/evaluation confirms that the required security controls are implemented correctly, operating as intended, enforcing the desired security policy, and meeting established security requirements. Security properties of information systems may be affected by the interconnection of system components or changes to those components. These interconnections or changes (e.g., upgrading or replacing applications and operating systems) may adversely affect previously implemented security controls. This control provides additional types of security testing/evaluation that developers can conduct to reduce or eliminate potential flaws. Testing custom software applications may require approaches such as static analysis, dynamic analysis, binary analysis, or a hybrid of the three approaches. Developers can employ these analysis approaches in a variety of tools (e.g., web-based application scanners, static analysis tools, binary analyzers) and in source code reviews. Security assessment plans provide the specific activities that developers plan to carry out including the types of analyses, testing, evaluation, and reviews of software and firmware components, the degree of rigor to be applied, and the types of artifacts produced during those processes. The depth of security testing/evaluation refers to the rigor and level of detail associated with the assessment process (e.g., black box, gray box, or white box testing). The coverage of security testing/evaluation refers to the scope (i.e., number and type) of the artifacts included in the assessment process. Contracts specify the acceptance criteria for security assessment plans, flaw remediation processes, and the evidence that the plans/processes have been diligently applied. Methods for reviewing and protecting assessment plans, evidence, and documentation are commensurate with the security category or classification level of the information system. Contracts may specify documentation protection requirements.

Related Controls: CA-2, CM-4, SA-3, SA-4, SA-5, SI-2

SA-11a.

Create and implement a security assessment plan;

SA-11b.

Perform [Selection (one or more): unit; integration; system; regression] testing/evaluation at [Assignment: organization-defined depth and coverage];

SA-11c.

Produce evidence of the execution of the security assessment plan and the results of the security testing/evaluation;

SA-11d.

Implement a verifiable flaw remediation process; and

SA-11e.

Correct flaws identified during security testing/evaluation.

SA-11 (1) : STATIC CODE ANALYSIS

The organization requires the developer of the information system, system component, or information system service to employ static code analysis tools to identify common flaws and document the results of the analysis.

Note

Static code analysis provides a technology and methodology for security reviews. Such analysis can be used to identify security vulnerabilities and enforce security coding practices. Static code analysis is most effective when used early in the development process, when each code change can be automatically scanned for potential weaknesses. Static analysis can provide clear remediation guidance along with defects to enable developers to fix such defects. Evidence of correct implementation of static analysis can include, for example, aggregate defect density for critical defect types, evidence that defects were inspected by developers or security professionals, and evidence that defects were fixed. An excessively high density of ignored findings (commonly referred to as ignored or false positives) indicates a potential problem with the analysis process or tool. In such cases, organizations weigh the validity of the evidence against evidence from other sources.

SA-11 (2) : THREAT AND VULNERABILITY ANALYSES

The organization requires the developer of the information system, system component, or information system service to perform threat and vulnerability analyses and subsequent testing/evaluation of the as-built system, component, or service.

Note

Applications may deviate significantly from the functional and design specifications created during the requirements and design phases of the system development life cycle. Therefore, threat and vulnerability analyses of information systems, system components, and information system services prior to delivery are critical to the effective operation of those systems, components, and services. Threat and vulnerability analyses at this phase of the life cycle help to ensure that design or implementation changes have been accounted for, and that any new vulnerabilities created as a result of those changes have been reviewed and mitigated.

Related Controls: PM-15, RA-5

SA-11 (3) : INDEPENDENT VERIFICATION OF ASSESSMENT PLANS / EVIDENCE

The organization:

Note

Independent agents have the necessary qualifications (i.e., expertise, skills, training, and experience) to verify the correct implementation of developer security assessment plans.

Related Controls: AT-3, CA-7, RA-5, SA-12

SA-11 (3)(a)

Requires an independent agent satisfying [Assignment: organization-defined independence criteria] to verify the correct implementation of the developer security assessment plan and the evidence produced during security testing/evaluation; and

SA-11 (3)(b)

Ensures that the independent agent is either provided with sufficient information to complete the verification process or granted the authority to obtain such information.

SA-11 (4) : MANUAL CODE REVIEWS

The organization requires the developer of the information system, system component, or information system service to perform a manual code review of [Assignment: organization-defined specific code] using [Assignment: organization-defined processes, procedures, and/or techniques].

Note

Manual code reviews are usually reserved for the critical software and firmware components of information systems. Such code reviews are uniquely effective at identifying weaknesses that require knowledge of the application's requirements or context which are generally unavailable to more automated analytic tools and techniques such as static or dynamic analysis. Components benefiting from manual review include for example, verifying access control matrices against application controls and reviewing more detailed aspects of cryptographic implementations and controls.

SA-11 (5) : PENETRATION TESTING

The organization requires the developer of the information system, system component, or information system service to perform penetration testing at [Assignment: organization-defined breadth/depth] and with [Assignment: organization-defined constraints].

Note

Penetration testing is an assessment methodology in which assessors, using all available information technology product and/or information system documentation (e.g., product/system design specifications, source code, and administrator/operator manuals) and working under specific constraints, attempt to circumvent implemented security features of information technology products and information systems. Penetration testing can include, for example, white, gray, or black box testing with analyses performed by skilled security professionals simulating adversary actions. The objective of penetration testing is to uncover potential vulnerabilities in information technology products and information systems resulting from implementation errors, configuration faults, or other operational deployment weaknesses or deficiencies. Penetration tests can be performed in conjunction with automated and manual code reviews to provide greater levels of analysis than would ordinarily be possible.

SA-11 (6) : ATTACK SURFACE REVIEWS

The organization requires the developer of the information system, system component, or information system service to perform attack surface reviews.

Note

Attack surfaces of information systems are exposed areas that make those systems more vulnerable to cyber attacks. This includes any accessible areas where weaknesses or deficiencies in information systems (including the hardware, software, and firmware components) provide opportunities for adversaries to exploit vulnerabilities. Attack surface reviews ensure that developers: (i) analyze both design and implementation changes to information systems; and (ii) mitigate attack vectors generated as a result of the changes. Correction of identified flaws includes, for example, deprecation of unsafe functions.

SA-11 (7) : VERIFY SCOPE OF TESTING / EVALUATION

The organization requires the developer of the information system, system component, or information system service to verify that the scope of security testing/evaluation provides complete coverage of required security controls at [Assignment: organization-defined depth of testing/evaluation].

Note

Verifying that security testing/evaluation provides complete coverage of required security controls can be accomplished by a variety of analytic techniques ranging from informal to formal. Each of these techniques provides an increasing level of assurance corresponding to the degree of formality of the analysis. Rigorously demonstrating security control coverage at the highest levels of assurance can be provided by the use of formal modeling and analysis techniques including correlation between control implementation and corresponding test cases.

SA-11 (8) : DYNAMIC CODE ANALYSIS

The organization requires the developer of the information system, system component, or information system service to employ dynamic code analysis tools to identify common flaws and document the results of the analysis.

Note

Dynamic code analysis provides run-time verification of software programs, using tools capable of monitoring programs for memory corruption, user privilege issues, and other potential security problems. Dynamic code analysis employs run-time tools to help to ensure that security functionality performs in the manner in which it was designed. A specialized type of dynamic analysis, known as fuzz testing, induces program failures by deliberately introducing malformed or random data into software programs. Fuzz testing strategies derive from the intended use of applications and the functional and design specifications for the applications. To understand the scope of dynamic code analysis and hence the assurance provided, organizations may also consider conducting code coverage analysis (checking the degree to which the code has been tested using metrics such as percent of subroutines tested or percent of program statements called during execution of the test suite) and/or concordance analysis (checking for words that are out of place in software code such as non-English language words or derogatory terms).

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-12 : SUPPLY CHAIN PROTECTION

Priority: P1

Baseline-Impact: HIGH

The organization protects against supply chain threats to the information system, system component, or information system service by employing [Assignment: organization-defined security safeguards] as part of a comprehensive, defense-in-breadth information security strategy.

Note

Information systems (including system components that compose those systems) need to be protected throughout the system development life cycle (i.e., during design, development, manufacturing, packaging, assembly, distribution, system integration, operations, maintenance, and retirement). Protection of organizational information systems is accomplished through threat awareness, by the identification, management, and reduction of vulnerabilities at each phase of the life cycle and the use of complementary, mutually reinforcing strategies to respond to risk. Organizations consider implementing a standardized process to address supply chain risk with respect to information systems and system components, and to educate the acquisition workforce on threats, risk, and required security controls. Organizations use the acquisition/procurement processes to require supply chain entities to implement necessary security safeguards to: (i) reduce the likelihood of unauthorized modifications at each stage in the supply chain; and (ii) protect information systems and information system components, prior to taking delivery of such systems/components. This control also applies to information system services. Security safeguards include, for example: (i) security controls for development systems, development facilities, and external connections to development systems; (ii) vetting development personnel; and (iii) use of tamper-evident packaging during shipping/warehousing. Methods for reviewing and protecting development plans, evidence, and documentation are commensurate with the security category or classification level of the information system. Contracts may specify documentation protection requirements.

Related Controls: AT-3, CM-8, IR-4, PE-16, PL-8, SA-3, SA-4, SA-8, SA-10, SA-14, SA-15, SA-18, SA-19, SC-29, SC-30, SC-38, SI-7

SA-12 (1) : ACQUISITION STRATEGIES / TOOLS / METHODS

The organization employs [Assignment: organization-defined tailored acquisition strategies, contract tools, and procurement methods] for the purchase of the information system, system component, or information system service from suppliers.

Note

The use of acquisition and procurement processes by organizations early in the system development life cycle provides an important vehicle to protect the supply chain. Organizations use available all-source intelligence analysis to inform the tailoring of acquisition strategies, tools, and methods. There are a number of different tools and techniques available (e.g., obscuring the end use of an information system or system component, using blind or filtered buys). Organizations also consider creating incentives for suppliers who: (i) implement required security safeguards; (ii) promote transparency into their organizational processes and security practices; (iii) provide additional vetting of the processes and security practices of subordinate suppliers, critical information system components, and services; (iv) restrict purchases from specific suppliers or countries; and (v) provide contract language regarding the prohibition of tainted or counterfeit components. In addition, organizations consider minimizing the time between purchase decisions and required delivery to limit opportunities for adversaries to corrupt information system components or products. Finally, organizations can use trusted/controlled distribution, delivery, and warehousing options to reduce

supply chain risk (e.g., requiring tamper-evident packaging of information system components during shipping and warehousing).

Related Controls: SA-19

SA-12 (2) : SUPPLIER REVIEWS

The organization conducts a supplier review prior to entering into a contractual agreement to acquire the information system, system component, or information system service.

Note

Supplier reviews include, for example: (i) analysis of supplier processes used to design, develop, test, implement, verify, deliver, and support information systems, system components, and information system services; and (ii) assessment of supplier training and experience in developing systems, components, or services with the required security capability. These reviews provide organizations with increased levels of visibility into supplier activities during the system development life cycle to promote more effective supply chain risk management. Supplier reviews can also help to determine whether primary suppliers have security safeguards in place and a practice for vetting subordinate suppliers, for example, second- and third-tier suppliers, and any subcontractors.

SA-12 (3) : TRUSTED SHIPPING AND WAREHOUSING

[Withdrawn: Incorporated into SA-12 (1)].

SA-12 (4) : DIVERSITY OF SUPPLIERS

[Withdrawn: Incorporated into SA-12 (13)].

SA-12 (5) : LIMITATION OF HARM

The organization employs [Assignment: organization-defined security safeguards] to limit harm from potential adversaries identifying and targeting the organizational supply chain.

Note

Supply chain risk is part of the advanced persistent threat (APT). Security safeguards and countermeasures to reduce the probability of adversaries successfully identifying and targeting the supply chain include, for example: (i) avoiding the purchase of custom configurations to reduce the risk of acquiring information systems, components, or products that have been corrupted via supply chain actions targeted at specific organizations; (ii) employing a diverse set of suppliers to limit the potential harm from any given supplier in the supply chain; (iii) employing approved vendor lists with standing reputations in industry, and (iv) using procurement carve outs (i.e., exclusions to commitments or obligations).

SA-12 (6) : MINIMIZING PROCUREMENT TIME

[Withdrawn: Incorporated into SA-12 (1)].

SA-12 (7) : ASSESSMENTS PRIOR TO SELECTION / ACCEPTANCE / UPDATE

The organization conducts an assessment of the information system, system component, or information system service prior to selection, acceptance, or update.

Note

Assessments include, for example, testing, evaluations, reviews, and analyses. Independent, third-party entities or organizational personnel conduct assessments of systems, components, products, tools, and services. Organizations conduct assessments to uncover unintentional vulnerabilities and intentional vulnerabilities including, for example, malicious code, malicious processes, defective software, and counterfeits. Assessments can include, for example, static analyses, dynamic analyses, simulations, white, gray, and black box testing, fuzz testing, penetration testing, and ensuring that components or services are genuine (e.g., using tags, cryptographic hash verifications, or digital signatures). Evidence generated during security assessments is documented for follow-on actions carried out by organizations.

Related Controls: CA-2, SA-11

SA-12 (8) : USE OF ALL-SOURCE INTELLIGENCE

The organization uses all-source intelligence analysis of suppliers and potential suppliers of the information system, system component, or information system service.

Note

All-source intelligence analysis is employed by organizations to inform engineering, acquisition, and risk management decisions. All-source intelligence consists of intelligence products and/or organizations and activities that incorporate all sources of information, most frequently including human intelligence, imagery intelligence, measurement and signature intelligence, signals intelligence, and open source data in the production of finished intelligence. Where available, such information is used to analyze the risk of both intentional and unintentional vulnerabilities from development, manufacturing, and delivery processes, people, and the environment. This review is performed on suppliers at multiple tiers in the supply chain sufficient to manage risks.

Related Controls: SA-15

SA-12 (9) : OPERATIONS SECURITY

The organization employs [Assignment: organization-defined Operations Security (OPSEC) safeguards] in accordance with classification guides to protect supply chain-related information for the information system, system component, or information system service.

Note

Supply chain information includes, for example: user identities; uses for information systems, information system components, and information system services; supplier identities; supplier processes; security requirements; design specifications; testing and evaluation results; and system/component configurations. This control enhancement expands the scope of OPSEC to include suppliers and potential suppliers. OPSEC is a process of identifying critical information and subsequently analyzing friendly actions attendant to operations and other activities to: (i) identify

those actions that can be observed by potential adversaries; (ii) determine indicators that adversaries might obtain that could be interpreted or pieced together to derive critical information in sufficient time to cause harm to organizations; (iii) implement safeguards or countermeasures to eliminate or reduce to an acceptable level, exploitable vulnerabilities; and (iv) consider how aggregated information may compromise the confidentiality of users or uses of the supply chain. OPSEC may require organizations to withhold critical mission/business information from suppliers and may include the use of intermediaries to hide the end use, or users, of information systems, system components, or information system services.

SA-12 (10) : VALIDATE AS GENUINE AND NOT ALTERED

The organization employs [Assignment: organization-defined security safeguards] to validate that the information system or system component received is genuine and has not been altered.

Note

For some information system components, especially hardware, there are technical means to help determine if the components are genuine or have been altered. Security safeguards used to validate the authenticity of information systems and information system components include, for example, optical/nanotechnology tagging and side-channel analysis. For hardware, detailed bill of material information can highlight the elements with embedded logic complete with component and production location.

SA-12 (11) : PENETRATION TESTING / ANALYSIS OF ELEMENTS, PROCESSES, AND ACTORS

The organization employs [Selection (one or more): organizational analysis, independent third-party analysis, organizational penetration testing, independent third-party penetration testing] of [Assignment: organization-defined supply chain elements, processes, and actors] associated with the information system, system component, or information system service.

Note

This control enhancement addresses analysis and/or testing of the supply chain, not just delivered items. Supply chain elements are information technology products or product components that contain programmable logic and that are critically important to information system functions. Supply chain processes include, for example: (i) hardware, software, and firmware development processes; (ii) shipping/handling procedures; (iii) personnel and physical security programs; (iv) configuration management tools/measures to maintain provenance; or (v) any other programs, processes, or procedures associated with the production/distribution of supply chain elements. Supply chain actors are individuals with specific roles and responsibilities in the supply chain. The evidence generated during analyses and testing of supply chain elements, processes, and actors is documented and used to inform organizational risk management activities and decisions.

Related Controls: RA-5

SA-12 (12) : INTER-ORGANIZATIONAL AGREEMENTS

The organization establishes inter-organizational agreements and procedures with entities involved in the supply chain for the information system, system component, or information system service.

Note

The establishment of inter-organizational agreements and procedures provides for notification of supply chain compromises. Early notification of supply chain compromises that can potentially adversely affect or have adversely affected organizational information systems, including critical system components, is essential for organizations to provide appropriate responses to such incidents.

SA-12 (13) : CRITICAL INFORMATION SYSTEM COMPONENTS

The organization employs [Assignment: organization-defined security safeguards] to ensure an adequate supply of [Assignment: organization-defined critical information system components].

Note

Adversaries can attempt to impede organizational operations by disrupting the supply of critical information system components or corrupting supplier operations. Safeguards to ensure adequate supplies of critical information system components include, for example: (i) the use of multiple suppliers throughout the supply chain for the identified critical components; and (ii) stockpiling of spare components to ensure operation during mission-critical times.

SA-12 (14) : IDENTITY AND TRACEABILITY

The organization establishes and retains unique identification of [Assignment: organization-defined supply chain elements, processes, and actors] for the information system, system component, or information system service.

Note

Knowing who and what is in the supply chains of organizations is critical to gaining visibility into what is happening within such supply chains, as well as monitoring and identifying high-risk events and activities. Without reasonable visibility and traceability into supply chains (i.e., elements, processes, and actors), it is very difficult for organizations to understand and therefore manage risk, and to reduce the likelihood of adverse events. Uniquely identifying acquirer and integrator roles, organizations, personnel, mission and element processes, testing and evaluation procedures, delivery mechanisms, support mechanisms, communications/delivery paths, and disposal/final disposition activities as well as the components and tools used, establishes a foundational identity structure for assessment of supply chain activities. For example, labeling (using serial numbers) and tagging (using radio-frequency identification [RFID] tags) individual supply chain elements including software packages, modules, and hardware devices, and processes associated with those elements can be used for this purpose. Identification methods are sufficient to support the provenance in the event of a supply chain issue or adverse supply chain event.

SA-12 (15) : PROCESSES TO ADDRESS WEAKNESSES OR DEFICIENCIES

The organization establishes a process to address weaknesses or deficiencies in supply chain elements identified during independent or organizational assessments of such elements.

Note

Evidence generated during independent or organizational assessments of supply chain elements (e.g., penetration testing, audits, verification/validation activities) is documented and used in follow-on processes implemented by organizations to respond to the risks related to the identified weaknesses and deficiencies. Supply chain elements include, for example, supplier development processes and supplier distribution systems.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-13 : TRUSTWORTHINESS

Priority: P0

The organization:

Note

This control helps organizations to make explicit trustworthiness decisions when designing, developing, and implementing information systems that are needed to conduct critical organizational missions/business functions. Trustworthiness is a characteristic/property of an information system that expresses the degree to which the system can be expected to preserve the confidentiality, integrity, and availability of the information it processes, stores, or transmits. Trustworthy information systems are systems that are capable of being trusted to operate within defined levels of risk despite the environmental disruptions, human errors, and purposeful attacks that are expected to occur in the specified environments of operation. Trustworthy systems are important to mission/business success. Two factors affecting the trustworthiness of information systems include: (i) security functionality (i.e., the security features, functions, and/or mechanisms employed within the system and its environment of operation); and (ii) security assurance (i.e., the grounds for confidence that the security functionality is effective in its application). Developers, implementers, operators, and maintainers of organizational information systems can increase the level of assurance (and trustworthiness), for example, by employing well-defined security policy models, structured and rigorous hardware, software, and firmware development techniques, sound system/security engineering principles, and secure configuration settings (defined by a set of assurance-related security controls in Appendix E).

Assurance is also based on the assessment of evidence produced during the system development life cycle. Critical missions/business functions are supported by high-impact systems and the associated assurance requirements for such systems. The additional assurance controls in Table E-4 in Appendix E (designated as optional) can be used to develop and implement high-assurance solutions for specific information systems and system components using the concept of overlays described in Appendix I. Organizations select assurance overlays that have been developed, validated, and approved for community adoption (e.g., cross-organization, governmentwide), limiting the development of such overlays on an organization-by-organization basis. Organizations can conduct criticality analyses as described in SA-14, to determine the information systems, system components, or information system services that require high-assurance solutions. Trustworthiness requirements and assurance overlays can be described in the security plans for organizational information systems.

Related Controls: RA-2, SA-4, SA-8, SA-14, SC-3

SA-13a.

Describes the trustworthiness required in the [Assignment: organization-defined information system, information system component, or information system service] supporting its critical missions/business functions; and

SA-13b.

Implements [Assignment: organization-defined assurance overlay] to achieve such trustworthiness.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-14 : CRITICALITY ANALYSIS

Priority: P0

The organization identifies critical information system components and functions by performing a criticality analysis for [Assignment: organization-defined information systems, information system components, or information system services] at [Assignment: organization-defined decision points in the system development life cycle].

Note

Criticality analysis is a key tenet of supply chain risk management and informs the prioritization of supply chain protection activities such as attack surface reduction, use of all-source intelligence, and tailored acquisition strategies. Information system engineers can conduct an end-to-end functional decomposition of an information system to identify mission-critical functions and components. The functional decomposition includes the identification of core organizational missions supported by the system, decomposition into the specific functions to perform those missions, and traceability to the hardware, software, and firmware components that implement those functions, including when the functions are shared by many components within and beyond the information system boundary. Information system components that allow for unmediated access to critical components or functions are considered critical due to the inherent vulnerabilities such components create. Criticality is assessed in terms of the impact of the function or component failure on the ability of the component to complete the organizational missions supported by the information system. A criticality analysis is performed whenever an architecture or design is being developed or modified, including upgrades.

Related Controls: CP-2, PL-2, PL-8, PM-1, SA-8, SA-12, SA-13, SA-15, SA-20

SA-14 (1) : CRITICAL COMPONENTS WITH NO VIABLE ALTERNATIVE SOURCING

[Withdrawn: Incorporated into SA-20].

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-15 : DEVELOPMENT PROCESS, STANDARDS, AND TOOLS

Priority: P2

Baseline-Impact: HIGH

The organization:

Note

Development tools include, for example, programming languages and computer-aided design (CAD) systems. Reviews of development processes can include, for example, the use of maturity models to determine the potential effectiveness of such processes. Maintaining the integrity of changes to tools and processes enables accurate supply chain risk assessment and mitigation, and requires robust configuration control throughout the life cycle (including design, development, transport, delivery, integration, and maintenance) to track authorized changes and prevent unauthorized changes.

Related Controls: SA-3, SA-8

SA-15a.

Requires the developer of the information system, system component, or information system service to follow a documented development process that:

SA-15a.1.

Explicitly addresses security requirements;

SA-15a.2.

Identifies the standards and tools used in the development process;

SA-15a.3.

Documents the specific tool options and tool configurations used in the development process; and

SA-15a.4.

Documents, manages, and ensures the integrity of changes to the process and/or tools used in development; and

SA-15b.

Reviews the development process, standards, tools, and tool options/configurations [Assignment: organization-defined frequency] to determine if the process, standards, tools, and tool options/configurations selected and employed can satisfy [Assignment: organization-defined security requirements].

SA-15 (1) : QUALITY METRICS

The organization requires the developer of the information system, system component, or information system service to:

Note

Organizations use quality metrics to establish minimum acceptable levels of information system quality. Metrics may include quality gates which are collections of completion criteria or sufficiency standards representing the satisfactory execution of particular phases of the system development project. A quality gate, for example, may require the elimination of all compiler warnings or an explicit determination that the warnings have no impact on the effectiveness of required security capabilities.

During the execution phases of development projects, quality gates provide clear, unambiguous indications of progress. Other metrics apply to the entire development project. These metrics can include defining the severity thresholds of vulnerabilities, for example, requiring no known vulnerabilities in the delivered information system with a Common Vulnerability Scoring System (CVSS) severity of Medium or High.

SA-15 (1)(a)

Define quality metrics at the beginning of the development process; and

SA-15 (1)(b)

Provide evidence of meeting the quality metrics [Selection (one or more): [Assignment: organization-defined frequency]; [Assignment: organization-defined program review milestones]; upon delivery].

SA-15 (2) : SECURITY TRACKING TOOLS

The organization requires the developer of the information system, system component, or information system service to select and employ a security tracking tool for use during the development process.

Note

Information system development teams select and deploy security tracking tools, including, for example, vulnerability/work item tracking systems that facilitate assignment, sorting, filtering, and tracking of completed work items or tasks associated with system development processes.

SA-15 (3) : CRITICALITY ANALYSIS

The organization requires the developer of the information system, system component, or information system service to perform a criticality analysis at [Assignment: organization-defined breadth/depth] and at [Assignment: organization-defined decision points in the system development life cycle].

Note

This control enhancement provides developer input to the criticality analysis performed by organizations in SA-14. Developer input is essential to such analysis because organizations may not have access to detailed design documentation for information system components that are developed as commercial off-the-shelf (COTS) information technology products (e.g., functional specifications, high-level designs, low-level designs, and source code/hardware schematics).

Related Controls: SA-4, SA-14

SA-15 (4) : THREAT MODELING / VULNERABILITY ANALYSIS

The organization requires that developers perform threat modeling and a vulnerability analysis for the information system at [Assignment: organization-defined breadth/depth] that:

Related Controls: SA-4

SA-15 (4)(a)

Uses [Assignment: organization-defined information concerning impact, environment of operations, known or assumed threats, and acceptable risk levels];

SA-15 (4)(b)

Employs [Assignment: organization-defined tools and methods]; and

SA-15 (4)(c)

Produces evidence that meets [Assignment: organization-defined acceptance criteria].

SA-15 (5) : ATTACK SURFACE REDUCTION

The organization requires the developer of the information system, system component, or information system service to reduce attack surfaces to [Assignment: organization-defined thresholds].

Note

Attack surface reduction is closely aligned with developer threat and vulnerability analyses and information system architecture and design. Attack surface reduction is a means of reducing risk to organizations by giving attackers less opportunity to exploit weaknesses or deficiencies (i.e., potential vulnerabilities) within information systems, information system components, and information system services. Attack surface reduction includes, for example, applying the principle of least privilege, employing layered defenses, applying the principle of least functionality (i.e., restricting ports, protocols, functions, and services), deprecating unsafe functions, and eliminating application programming interfaces (APIs) that are vulnerable to cyber attacks.

Related Controls: CM-7

SA-15 (6) : CONTINUOUS IMPROVEMENT

The organization requires the developer of the information system, system component, or information system service to implement an explicit process to continuously improve the development process.

Note

Developers of information systems, information system components, and information system services consider the effectiveness/efficiency of current development processes for meeting quality objectives and addressing security capabilities in current threat environments.

SA-15 (7) : AUTOMATED VULNERABILITY ANALYSIS

The organization requires the developer of the information system, system component, or information system service to:

Related Controls: RA-5

SA-15 (7)(a)

Perform an automated vulnerability analysis using [Assignment: organization-defined tools];

SA-15 (7)(b)

Determine the exploitation potential for discovered vulnerabilities;

SA-15 (7)(c)

Determine potential risk mitigations for delivered vulnerabilities; and

SA-15 (7)(d)

Deliver the outputs of the tools and results of the analysis to [Assignment: organization-defined personnel or roles].

SA-15 (8) : REUSE OF THREAT / VULNERABILITY INFORMATION

The organization requires the developer of the information system, system component, or information system service to use threat modeling and vulnerability analyses from similar systems, components, or services to inform the current development process.

Note

Analysis of vulnerabilities found in similar software applications can inform potential design or implementation issues for information systems under development. Similar information systems or system components may exist within developer organizations. Authoritative vulnerability information is available from a variety of public and private sector sources including, for example, the National Vulnerability Database.

SA-15 (9) : USE OF LIVE DATA

The organization approves, documents, and controls the use of live data in development and test environments for the information system, system component, or information system service.

Note

The use of live data in preproduction environments can result in significant risk to organizations. Organizations can minimize such risk by using test or dummy data during the development and testing of information systems, information system components, and information system services.

SA-15 (10) : INCIDENT RESPONSE PLAN

The organization requires the developer of the information system, system component, or information system service to provide an incident response plan.

Note

The incident response plan for developers of information systems, system components, and information system services is incorporated into organizational incident response plans to provide the type of incident response information not readily available to organizations. Such information may be extremely helpful, for example, when organizations respond to vulnerabilities in commercial off-the-shelf (COTS) information technology products.

Related Controls: IR-8

SA-15 (11) : ARCHIVE INFORMATION SYSTEM / COMPONENT

The organization requires the developer of the information system or system component to archive the system or component to be released or delivered together with the corresponding evidence supporting the final security review.

Note

Archiving relevant documentation from the development process can provide a readily available baseline of information that can be helpful during information system/component upgrades or modifications.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-16 : DEVELOPER-PROVIDED TRAINING

Priority: P2

Baseline-Impact: HIGH

The organization requires the developer of the information system, system component, or information system service to provide [Assignment: organization-defined training] on the correct use and operation of the implemented security functions, controls, and/or mechanisms.

Note

This control applies to external and internal (in-house) developers. Training of personnel is an essential element to ensure the effectiveness of security controls implemented within organizational information systems. Training options include, for example, classroom-style training, web-based/computer-based training, and hands-on training. Organizations can also request sufficient training materials from developers to conduct in-house training or offer self-training to organizational personnel. Organizations determine the type of training necessary and may require different types of training for different security functions, controls, or mechanisms.

Related Controls: AT-2, AT-3, SA-5

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-17 : DEVELOPER SECURITY ARCHITECTURE AND DESIGN

Priority: P1

Baseline-Impact: HIGH

The organization requires the developer of the information system, system component, or information system service to produce a design specification and security architecture that:

Note

This control is primarily directed at external developers, although it could also be used for internal (in-house) development. In contrast, PL-8 is primarily directed at internal developers to help ensure that organizations develop an information security architecture and such security architecture is integrated or tightly coupled to the enterprise architecture. This distinction is important if/when organizations outsource the development of information systems, information system components, or information system services to external entities, and there is a requirement to demonstrate consistency with the organization's enterprise architecture and information security architecture.

Related Controls: PL-8, PM-7, SA-3, SA-8

SA-17a.

Is consistent with and supportive of the organization's security architecture which is established within and is an integrated part of the organization's enterprise architecture;

SA-17b.

Accurately and completely describes the required security functionality, and the allocation of security controls among physical and logical components; and

SA-17c.

Expresses how individual security functions, mechanisms, and services work together to provide required security capabilities and a unified approach to protection.

SA-17 (1) : FORMAL POLICY MODEL

The organization requires the developer of the information system, system component, or information system service to:

Note

Formal models describe specific behaviors or security policies using formal languages, thus enabling the correctness of those behaviors/policies to be formally proven. Not all components of information systems can be modeled, and generally, formal specifications are scoped to specific behaviors or policies of interest (e.g., nondiscretionary access control policies). Organizations choose the particular formal modeling language and approach based on the nature of the behaviors/policies to be described and the available tools. Formal modeling tools include, for example, Gypsy and Zed.

SA-17 (1)(a)

Produce, as an integral part of the development process, a formal policy model describing the [Assignment: organization-defined elements of organizational security policy] to be enforced; and

SA-17 (1)(b)

Prove that the formal policy model is internally consistent and sufficient to enforce the defined elements of the organizational security policy when implemented.

SA-17 (2) : SECURITY-RELEVANT COMPONENTS

The organization requires the developer of the information system, system component, or information system service to:

Note

Security-relevant hardware, software, and firmware represent the portion of the information system, component, or service that must be trusted to perform correctly in order to maintain required security properties.

Related Controls: SA-5

SA-17 (2)(a)

Define security-relevant hardware, software, and firmware; and

SA-17 (2)(b)

Provide a rationale that the definition for security-relevant hardware, software, and firmware is complete.

SA-17 (3) : FORMAL CORRESPONDENCE

The organization requires the developer of the information system, system component, or information system service to:

Note

Correspondence is an important part of the assurance gained through modeling. It demonstrates that the implementation is an accurate transformation of the model, and that any additional code or implementation details present have no impact on the behaviors or policies being modeled. Formal methods can be used to show that the high-level security properties are satisfied by the formal information system description, and that the formal system description is correctly implemented by a description of some lower level, for example a hardware description. Consistency between the formal top-level specification and the formal policy models is generally not amenable to being fully proven. Therefore, a combination of formal/informal methods may be needed to show such consistency. Consistency between the formal top-level specification and the implementation may require the use of an informal demonstration due to limitations in the applicability of formal methods to prove that the specification accurately reflects the implementation. Hardware, software, and firmware mechanisms strictly internal to security-relevant hardware, software, and firmware include, for example, mapping registers and direct memory input/output.

Related Controls: SA-5

SA-17 (3)(a)

Produce, as an integral part of the development process, a formal top-level specification that specifies the interfaces to security-relevant hardware, software, and firmware in terms of exceptions, error messages, and effects;

SA-17 (3)(b)

Show via proof to the extent feasible with additional informal demonstration as necessary, that the formal top-level specification is consistent with the formal policy model;

SA-17 (3)(c)

Show via informal demonstration, that the formal top-level specification completely covers the interfaces to security-relevant hardware, software, and firmware;

SA-17 (3)(d)

Show that the formal top-level specification is an accurate description of the implemented security-relevant hardware, software, and firmware; and

SA-17 (3)(e)

Describe the security-relevant hardware, software, and firmware mechanisms not addressed in the formal top-level specification but strictly internal to the security-relevant hardware, software, and firmware.

SA-17 (4) : INFORMAL CORRESPONDENCE

The organization requires the developer of the information system, system component, or information system service to:

Note

Correspondence is an important part of the assurance gained through modeling. It demonstrates that the implementation is an accurate transformation of the model, and that any additional code or implementation details present has no impact on the behaviors or policies being modeled. Consistency between the descriptive top-level specification (i.e., high-level/low-level design) and the formal policy model is generally not amenable to being fully proven. Therefore, a combination of formal/informal methods may be needed to show such consistency. Hardware, software, and firmware mechanisms strictly internal to security-relevant hardware, software, and firmware include, for example, mapping registers and direct memory input/output.

Related Controls: SA-5

SA-17 (4)(a)

Produce, as an integral part of the development process, an informal descriptive top-level specification that specifies the interfaces to security-relevant hardware, software, and firmware in terms of exceptions, error messages, and effects;

SA-17 (4)(b)

Show via [Selection: informal demonstration, convincing argument with formal methods as feasible] that the descriptive top-level specification is consistent with the formal policy model;

SA-17 (4)(c)

Show via informal demonstration, that the descriptive top-level specification completely covers the interfaces to security-relevant hardware, software, and firmware;

SA-17 (4)(d)

Show that the descriptive top-level specification is an accurate description of the interfaces to security-relevant hardware, software, and firmware; and

SA-17 (4)(e)

Describe the security-relevant hardware, software, and firmware mechanisms not addressed in the descriptive top-level specification but strictly internal to the security-relevant hardware, software, and firmware.

SA-17 (5) : CONCEPTUALLY SIMPLE DESIGN

The organization requires the developer of the information system, system component, or information system service to:

Related Controls: SC-3

SA-17 (5)(a)

Design and structure the security-relevant hardware, software, and firmware to use a complete, conceptually simple protection mechanism with precisely defined semantics; and

SA-17 (5)(b)

Internally structure the security-relevant hardware, software, and firmware with specific regard for this mechanism.

SA-17 (6) : STRUCTURE FOR TESTING

The organization requires the developer of the information system, system component, or information system service to structure security-relevant hardware, software, and firmware to facilitate testing.

Related Controls: SA-11

SA-17 (7) : STRUCTURE FOR LEAST PRIVILEGE

The organization requires the developer of the information system, system component, or information system service to structure security-relevant hardware, software, and firmware to facilitate controlling access with least privilege.

Related Controls: AC-5, AC-6

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-18 : TAMPER RESISTANCE AND DETECTION

Priority: P0

The organization implements a tamper protection program for the information system, system component, or information system service.

Note

Anti-tamper technologies and techniques provide a level of protection for critical information systems, system components, and information technology products against a number of related threats including modification, reverse engineering, and substitution. Strong identification combined with tamper resistance and/or tamper detection is essential to protecting information systems, components, and products during distribution and when in use.

Related Controls: PE-3, SA-12, SI-7

SA-18 (1) : MULTIPLE PHASES OF SDLC

The organization employs anti-tamper technologies and techniques during multiple phases in the system development life cycle including design, development, integration, operations, and maintenance.

Note

Organizations use a combination of hardware and software techniques for tamper resistance and detection. Organizations employ obfuscation and self-checking, for example, to make reverse engineering and modifications more difficult, time-consuming, and expensive for adversaries. Customization of information systems and system components can make substitutions easier to detect and therefore limit damage.

Related Controls: SA-3

SA-18 (2) : INSPECTION OF INFORMATION SYSTEMS, COMPONENTS, OR DEVICES

The organization inspects [Assignment: organization-defined information systems, system components, or devices] [Selection (one or more): at random; at [Assignment: organization-defined frequency], upon [Assignment: organization-defined indications of need for inspection]] to detect tampering.

Note

This control enhancement addresses both physical and logical tampering and is typically applied to mobile devices, notebook computers, or other system components taken out of organization-controlled areas. Indications of need for inspection include, for example, when individuals return from travel to high-risk locations.

Related Controls: SI-4

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-19 : COMPONENT AUTHENTICITY

Priority: P0

The organization:

> ***Note***
>
> Sources of counterfeit components include, for example, manufacturers, developers, vendors, and contractors. Anti-counterfeiting policy and procedures support tamper resistance and provide a level of protection against the introduction of malicious code. External reporting organizations include, for example, US-CERT.

Related Controls: PE-3, SA-12, SI-7

SA-19a.

Develops and implements anti-counterfeit policy and procedures that include the means to detect and prevent counterfeit components from entering the information system; and

SA-19b.

Reports counterfeit information system components to [Selection (one or more): source of counterfeit component; [Assignment: organization-defined external reporting organizations]; [Assignment: organization-defined personnel or roles]].

SA-19 (1) : ANTI-COUNTERFEIT TRAINING

The organization trains [Assignment: organization-defined personnel or roles] to detect counterfeit information system components (including hardware, software, and firmware).

SA-19 (2) : CONFIGURATION CONTROL FOR COMPONENT SERVICE / REPAIR

The organization maintains configuration control over [Assignment: organization-defined information system components] awaiting service/repair and serviced/repaired components awaiting return to service.

SA-19 (3) : COMPONENT DISPOSAL

The organization disposes of information system components using [Assignment: organization-defined techniques and methods].

> ***Note***
>
> Proper disposal of information system components helps to prevent such components from entering the gray market.

SA-19 (4) : ANTI-COUNTERFEIT SCANNING

The organization scans for counterfeit information system components [Assignment: organization-defined frequency].

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-20 : CUSTOMIZED DEVELOPMENT OF CRITICAL COMPONENTS

Priority: P0

The organization re-implements or custom develops [Assignment: organization-defined critical information system components].

Note

Organizations determine that certain information system components likely cannot be trusted due to specific threats to and vulnerabilities in those components, and for which there are no viable security controls to adequately mitigate the resulting risk. Re-implementation or custom development of such components helps to satisfy requirements for higher assurance. This is accomplished by initiating changes to system components (including hardware, software, and firmware) such that the standard attacks by adversaries are less likely to succeed. In situations where no alternative sourcing is available and organizations choose not to re-implement or custom develop critical information system components, additional safeguards can be employed (e.g., enhanced auditing, restrictions on source code and system utility access, and protection from deletion of system and application files.

Related Controls: CP-2, SA-8, SA-14

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-21 : DEVELOPER SCREENING

Priority: P0

The organization requires that the developer of [Assignment: organization-defined information system, system component, or information system service]:

Note

Because the information system, system component, or information system service may be employed in critical activities essential to the national and/or economic security interests of the United States, organizations have a strong interest in ensuring that the developer is trustworthy. The degree of trust required of the developer may need to be consistent with that of the individuals accessing the information system/component/service once deployed. Examples of authorization and personnel screening criteria include clearance, satisfactory background checks, citizenship, and nationality. Trustworthiness of developers may also include a review and analysis of company ownership and any relationships the company has with entities potentially affecting the quality/reliability of the systems, components, or services being developed.

Related Controls: PS-3, PS-7

SA-21a.

Have appropriate access authorizations as determined by assigned [Assignment: organization-defined official government duties]; and

SA-21b.

Satisfy [Assignment: organization-defined additional personnel screening criteria].

SA-21 (1) : VALIDATION OF SCREENING

The organization requires the developer of the information system, system component, or information system service take [Assignment: organization-defined actions] to ensure that the required access authorizations and screening criteria are satisfied.

Note

Satisfying required access authorizations and personnel screening criteria includes, for example, providing a listing of all the individuals authorized to perform development activities on the selected information system, system component, or information system service so that organizations can validate that the developer has satisfied the necessary authorization and screening requirements.

Control Family: SYSTEM AND SERVICES ACQUISITION

SA-22 : UNSUPPORTED SYSTEM COMPONENTS

Priority: P0

The organization:

Note

Support for information system components includes, for example, software patches, firmware updates, replacement parts, and maintenance contracts. Unsupported components (e.g., when vendors are no longer providing critical software patches), provide a substantial opportunity for adversaries to exploit new weaknesses discovered in the currently installed components. Exceptions to replacing unsupported system components may include, for example, systems that provide critical mission/business capability where newer technologies are not available or where the systems are so isolated that installing replacement components is not an option.

Related Controls: PL-2, SA-3

SA-22a.

Replaces information system components when support for the components is no longer available from the developer, vendor, or manufacturer; and

SA-22b.

Provides justification and documents approval for the continued use of unsupported system components required to satisfy mission/business needs.

SA-22 (1) : ALTERNATIVE SOURCES FOR CONTINUED SUPPORT

The organization provides [Selection (one or more): in-house support; [Assignment: organization-defined support from external providers]] for unsupported information system components.

Note

This control enhancement addresses the need to provide continued support for selected information system components that are no longer supported by the original developers, vendors, or manufacturers when such components remain essential to mission/business operations. Organizations can establish in-house support, for example, by developing customized patches for critical software components or secure the services of external providers who through contractual relationships, provide ongoing support for the designated unsupported components. Such contractual relationships can include, for example, Open Source Software value-added vendors.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-1 : SYSTEM AND COMMUNICATIONS PROTECTION POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the SC family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

SC-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

SC-1a.1.

A system and communications protection policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

SC-1a.2.

Procedures to facilitate the implementation of the system and communications protection policy and associated system and communications protection controls; and

SC-1b.

Reviews and updates the current:

SC-1b.1.

System and communications protection policy [Assignment: organization-defined frequency]; and

SC-1b.2.

System and communications protection procedures [Assignment: organization-defined frequency].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-2 : APPLICATION PARTITIONING

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system separates user functionality (including user interface services) from information system management functionality.

Note

Information system management functionality includes, for example, functions necessary to administer databases, network components, workstations, or servers, and typically requires privileged user access. The separation of user functionality from information system management functionality is either physical or logical. Organizations implement separation of system management-related functionality from user functionality by using different computers, different central processing units, different instances of operating systems, different network addresses, virtualization techniques, or combinations of these or other methods, as appropriate. This type of separation includes, for example, web administrative interfaces that use separate authentication methods for users of any other information system resources. Separation of system and user functionality may include isolating administrative interfaces on different domains and with additional access controls.

Related Controls: SA-4, SA-8, SC-3

SC-2 (1) : INTERFACES FOR NON-PRIVILEGED USERS

The information system prevents the presentation of information system management-related functionality at an interface for non-privileged users.

Note

This control enhancement ensures that administration options (e.g., administrator privileges) are not available to general users (including prohibiting the use of the grey-out option commonly used to eliminate accessibility to such information). Such restrictions include, for example, not presenting administration options until users establish sessions with administrator privileges.

Related Controls: AC-3

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-3 : SECURITY FUNCTION ISOLATION

Priority: P1

Baseline-Impact: HIGH

The information system isolates security functions from nonsecurity functions.

Note

The information system isolates security functions from nonsecurity functions by means of an isolation boundary (implemented via partitions and domains). Such isolation controls access to and protects the integrity of the hardware, software, and firmware that perform those security functions. Information systems implement code separation (i.e., separation of security functions from nonsecurity functions) in a number of ways, including, for example, through the provision of security kernels via processor rings or processor modes. For non-kernel code, security function isolation is often achieved through file system protections that serve to protect the code on disk, and address space protections that protect executing code. Information systems restrict access to security functions through the use of access control mechanisms and by implementing least privilege capabilities. While the ideal is for all of the code within the security function isolation boundary to only contain security-relevant code, it is sometimes necessary to include nonsecurity functions within the isolation boundary as an exception.

Related Controls: AC-3, AC-6, SA-4, SA-5, SA-8, SA-13, SC-2, SC-7, SC-39

SC-3 (1) : HARDWARE SEPARATION

The information system utilizes underlying hardware separation mechanisms to implement security function isolation.

Note

Underlying hardware separation mechanisms include, for example, hardware ring architectures, commonly implemented within microprocessors, and hardware-enforced address segmentation used to support logically distinct storage objects with separate attributes (i.e., readable, writeable).

SC-3 (2) : ACCESS / FLOW CONTROL FUNCTIONS

The information system isolates security functions enforcing access and information flow control from nonsecurity functions and from other security functions.

Note

Security function isolation occurs as a result of implementation; the functions can still be scanned and monitored. Security functions that are potentially isolated from access and flow control enforcement functions include, for example, auditing, intrusion detection, and anti-virus functions.

SC-3 (3) : MINIMIZE NONSECURITY FUNCTIONALITY

The organization minimizes the number of nonsecurity functions included within the isolation boundary containing security functions.

Note

In those instances where it is not feasible to achieve strict isolation of nonsecurity functions from security functions, it is necessary to take actions to minimize the nonsecurity-relevant functions within the security function boundary. Nonsecurity functions contained within the isolation boundary are considered security-relevant because errors or maliciousness in such software, by virtue of being within the boundary, can impact the security functions of organizational information systems. The design objective is that the specific portions of information systems providing information security are of minimal size/complexity. Minimizing the number of nonsecurity functions in the security-relevant components of information systems allows designers and implementers to focus only on those functions which are necessary to provide the desired security capability (typically access enforcement). By minimizing nonsecurity functions within the isolation boundaries, the amount of code that must be trusted to enforce security policies is reduced, thus contributing to understandability.

SC-3 (4) : MODULE COUPLING AND COHESIVENESS

The organization implements security functions as largely independent modules that maximize internal cohesiveness within modules and minimize coupling between modules.

Note

The reduction in inter-module interactions helps to constrain security functions and to manage complexity. The concepts of coupling and cohesion are important with respect to modularity in software design. Coupling refers to the dependencies that one module has on other modules. Cohesion refers to the relationship between the different functions within a particular module. Good software engineering practices rely on modular decomposition, layering, and minimization to reduce and manage complexity, thus producing software modules that are highly cohesive and loosely coupled.

SC-3 (5) : LAYERED STRUCTURES

The organization implements security functions as a layered structure minimizing interactions between layers of the design and avoiding any dependence by lower layers on the functionality or correctness of higher layers.

Note

The implementation of layered structures with minimized interactions among security functions and non-looping layers (i.e., lower-layer functions do not depend on higher-layer functions) further enables the isolation of security functions and management of complexity.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-4 : INFORMATION IN SHARED RESOURCES

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system prevents unauthorized and unintended information transfer via shared system resources.

Note

This control prevents information, including encrypted representations of information, produced by the actions of prior users/roles (or the actions of processes acting on behalf of prior users/roles) from being available to any current users/roles (or current processes) that obtain access to shared system resources (e.g., registers, main memory, hard disks) after those resources have been released back to information systems. The control of information in shared resources is also commonly referred to as object reuse and residual information protection. This control does not address: (i) information remanence which refers to residual representation of data that has been nominally erased or removed; (ii) covert channels (including storage and/or timing channels) where shared resources are manipulated to violate information flow restrictions; or (iii) components within information systems for which there are only single users/roles.

Related Controls: AC-3, AC-4, MP-6

SC-4 (1) : SECURITY LEVELS

[Withdrawn: Incorporated into SC-4].

SC-4 (2) : PERIODS PROCESSING

The information system prevents unauthorized information transfer via shared resources in accordance with [Assignment: organization-defined procedures] when system processing explicitly switches between different information classification levels or security categories.

Note

This control enhancement applies when there are explicit changes in information processing levels during information system operations, for example, during multilevel processing and periods processing with information at different classification levels or security categories. Organization-defined procedures may include, for example, approved sanitization processes for electronically stored information.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-5 : DENIAL OF SERVICE PROTECTION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system protects against or limits the effects of the following types of denial of service attacks: [Assignment: organization-defined types of denial of service attacks or references to sources for such information] by employing [Assignment: organization-defined security safeguards].

Note

A variety of technologies exist to limit, or in some cases, eliminate the effects of denial of service attacks. For example, boundary protection devices can filter certain types of packets to protect

information system components on internal organizational networks from being directly affected by denial of service attacks. Employing increased capacity and bandwidth combined with service redundancy may also reduce the susceptibility to denial of service attacks.

Related Controls: SC-6, SC-7

SC-5 (1) : RESTRICT INTERNAL USERS

The information system restricts the ability of individuals to launch [Assignment: organization-defined denial of service attacks] against other information systems.

Note

Restricting the ability of individuals to launch denial of service attacks requires that the mechanisms used for such attacks are unavailable. Individuals of concern can include, for example, hostile insiders or external adversaries that have successfully breached the information system and are using the system as a platform to launch cyber attacks on third parties. Organizations can restrict the ability of individuals to connect and transmit arbitrary information on the transport medium (i.e., network, wireless spectrum). Organizations can also limit the ability of individuals to use excessive information system resources. Protection against individuals having the ability to launch denial of service attacks may be implemented on specific information systems or on boundary devices prohibiting egress to potential target systems.

SC-5 (2) : EXCESS CAPACITY / BANDWIDTH / REDUNDANCY

The information system manages excess capacity, bandwidth, or other redundancy to limit the effects of information flooding denial of service attacks.

Note

Managing excess capacity ensures that sufficient capacity is available to counter flooding attacks. Managing excess capacity may include, for example, establishing selected usage priorities, quotas, or partitioning.

SC-5 (3) : DETECTION / MONITORING

The organization:

Note

Organizations consider utilization and capacity of information system resources when managing risk from denial of service due to malicious attacks. Denial of service attacks can originate from external or internal sources. Information system resources sensitive to denial of service include, for example, physical disk storage, memory, and CPU cycles. Common safeguards to prevent denial of service attacks related to storage utilization and capacity include, for example, instituting disk quotas, configuring information systems to automatically alert administrators when specific storage capacity thresholds are reached, using file compression technologies to maximize available storage space, and imposing separate partitions for system and user data.

Related Controls: CA-7, SI-4

SC-5 (3)(a)

Employs [Assignment: organization-defined monitoring tools] to detect indicators of denial of service attacks against the information system; and

SC-5 (3)(b)

Monitors [Assignment: organization-defined information system resources] to determine if sufficient resources exist to prevent effective denial of service attacks.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-6 : RESOURCE AVAILABILITY

Priority: P0

The information system protects the availability of resources by allocating [Assignment: organization-defined resources] by [Selection (one or more); priority; quota; [Assignment: organization-defined security safeguards]].

Note

Priority protection helps prevent lower-priority processes from delaying or interfering with the information system servicing any higher-priority processes. Quotas prevent users or processes from obtaining more than predetermined amounts of resources. This control does not apply to information system components for which there are only single users/roles.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-7 : BOUNDARY PROTECTION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system:

Note

Managed interfaces include, for example, gateways, routers, firewalls, guards, network-based malicious code analysis and virtualization systems, or encrypted tunnels implemented within a security architecture (e.g., routers protecting firewalls or application gateways residing on protected subnetworks). Subnetworks that are physically or logically separated from internal networks are referred to as demilitarized zones or DMZs. Restricting or prohibiting interfaces within organizational information systems includes, for example, restricting external web traffic to designated web servers within managed interfaces and prohibiting external traffic that appears to be spoofing internal addresses. Organizations consider the shared nature of commercial telecommunications services in the implementation of security controls associated with the use of such services. Commercial telecommunications services are commonly based on network components and consolidated management systems shared by all attached commercial customers, and may also include third party-provided access lines and other service elements. Such transmission services may represent sources of increased risk despite contract security provisions.

Related Controls: AC-4, AC-17, CA-3, CM-7, CP-8, IR-4, RA-3, SC-5, SC-13

SC-7a.

Monitors and controls communications at the external boundary of the system and at key internal boundaries within the system;

SC-7b.

Implements subnetworks for publicly accessible system components that are [Selection: physically; logically] separated from internal organizational networks; and

SC-7c.

Connects to external networks or information systems only through managed interfaces consisting of boundary protection devices arranged in accordance with an organizational security architecture.

SC-7 (1) : PHYSICALLY SEPARATED SUBNETWORKS

[Withdrawn: Incorporated into SC-7].

SC-7 (2) : PUBLIC ACCESS

[Withdrawn: Incorporated into SC-7].

SC-7 (3) : ACCESS POINTS

Baseline-Impact: *MODERATE*, **HIGH**

The organization limits the number of external network connections to the information system.

Note

Limiting the number of external network connections facilitates more comprehensive monitoring of inbound and outbound communications traffic. The Trusted Internet Connection (TIC) initiative is an example of limiting the number of external network connections.

SC-7 (4) : EXTERNAL TELECOMMUNICATIONS SERVICES

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Related Controls: SC-8

SC-7 (4)(a)

Implements a managed interface for each external telecommunication service;

SC-7 (4)(b)

Establishes a traffic flow policy for each managed interface;

SC-7 (4)(c)

Protects the confidentiality and integrity of the information being transmitted across each interface;

SC-7 (4)(d)

Documents each exception to the traffic flow policy with a supporting mission/business need and duration of that need; and

SC-7 (4)(e)

Reviews exceptions to the traffic flow policy [Assignment: organization-defined frequency] and removes exceptions that are no longer supported by an explicit mission/business need.

SC-7 (5) : DENY BY DEFAULT / ALLOW BY EXCEPTION

Baseline-Impact: *MODERATE*, **HIGH**

The information system at managed interfaces denies network communications traffic by default and allows network communications traffic by exception (i.e., deny all, permit by exception).

Note

This control enhancement applies to both inbound and outbound network communications traffic. A deny-all, permit-by-exception network communications traffic policy ensures that only those connections which are essential and approved are allowed.

SC-7 (6) : RESPONSE TO RECOGNIZED FAILURES

[Withdrawn: Incorporated into SC-7 (18)].

SC-7 (7) : PREVENT SPLIT TUNNELING FOR REMOTE DEVICES

Baseline-Impact: *MODERATE*, **HIGH**

The information system, in conjunction with a remote device, prevents the device from simultaneously establishing non-remote connections with the system and communicating via some other connection to resources in external networks.

Note

This control enhancement is implemented within remote devices (e.g., notebook computers) through configuration settings to disable split tunneling in those devices, and by preventing those configuration settings from being readily configurable by users. This control enhancement is implemented within the information system by the detection of split tunneling (or of configuration settings that allow split tunneling) in the remote device, and by prohibiting the connection if the remote device is using split tunneling. Split tunneling might be desirable by remote users to communicate with local information system resources such as printers/file servers. However, split tunneling would in effect allow unauthorized external connections, making the system more vulnerable to attack and to exfiltration of organizational information. The use of VPNs for remote connections, when adequately provisioned with appropriate security controls, may provide the organization with sufficient assurance that it can effectively treat such connections as non-remote connections from the confidentiality and integrity perspective. VPNs thus provide a means for allowing

non-remote communications paths from remote devices. The use of an adequately provisioned VPN does not eliminate the need for preventing split tunneling.

SC-7 (8) : ROUTE TRAFFIC TO AUTHENTICATED PROXY SERVERS

Baseline-Impact: HIGH

The information system routes [Assignment: organization-defined internal communications traffic] to [Assignment: organization-defined external networks] through authenticated proxy servers at managed interfaces.

Note

External networks are networks outside of organizational control. A proxy server is a server (i.e., information system or application) that acts as an intermediary for clients requesting information system resources (e.g., files, connections, web pages, or services) from other organizational servers. Client requests established through an initial connection to the proxy server are evaluated to manage complexity and to provide additional protection by limiting direct connectivity. Web content filtering devices are one of the most common proxy servers providing access to the Internet. Proxy servers support logging individual Transmission Control Protocol (TCP) sessions and blocking specific Uniform Resource Locators (URLs), domain names, and Internet Protocol (IP) addresses. Web proxies can be configured with organization-defined lists of authorized and unauthorized websites.

Related Controls: AC-3, AU-2

SC-7 (9) : RESTRICT THREATENING OUTGOING COMMUNICATIONS TRAFFIC

The information system:

Note

Detecting outgoing communications traffic from internal actions that may pose threats to external information systems is sometimes termed extrusion detection. Extrusion detection at information system boundaries as part of managed interfaces includes the analysis of incoming and outgoing communications traffic searching for indications of internal threats to the security of external systems. Such threats include, for example, traffic indicative of denial of service attacks and traffic containing malicious code.

Related Controls: AU-2, AU-6, SC-38, SC-44, SI-3, SI-4

SC-7 (9)(a)

Detects and denies outgoing communications traffic posing a threat to external information systems; and

SC-7 (9)(b)

Audits the identity of internal users associated with denied communications.

SC-7 (10) : PREVENT UNAUTHORIZED EXFILTRATION

The organization prevents the unauthorized exfiltration of information across managed interfaces.

Note

Safeguards implemented by organizations to prevent unauthorized exfiltration of information from information systems include, for example: (i) strict adherence to protocol formats; (ii) monitoring for beaconing from information systems; (iii) monitoring for steganography; (iv) disconnecting external network interfaces except when explicitly needed; (v) disassembling and reassembling packet headers; and (vi) employing traffic profile analysis to detect deviations from the volume/types of traffic expected within organizations or call backs to command and control centers. Devices enforcing strict adherence to protocol formats include, for example, deep packet inspection firewalls and XML gateways. These devices verify adherence to protocol formats and specification at the application layer and serve to identify vulnerabilities that cannot be detected by devices operating at the network or transport layers. This control enhancement is closely associated with cross-domain solutions and system guards enforcing information flow requirements.

Related Controls: SI-3

SC-7 (11) : RESTRICT INCOMING COMMUNICATIONS TRAFFIC

The information system only allows incoming communications from [Assignment: organization-defined authorized sources] to be routed to [Assignment: organization-defined authorized destinations].

Note

This control enhancement provides determinations that source and destination address pairs represent authorized/allowed communications. Such determinations can be based on several factors including, for example, the presence of source/destination address pairs in lists of authorized/allowed communications, the absence of address pairs in lists of unauthorized/disallowed pairs, or meeting more general rules for authorized/allowed source/destination pairs.

Related Controls: AC-3

SC-7 (12) : HOST-BASED PROTECTION

The organization implements [Assignment: organization-defined host-based boundary protection mechanisms] at [Assignment: organization-defined information system components].

Note

Host-based boundary protection mechanisms include, for example, host-based firewalls. Information system components employing host-based boundary protection mechanisms include, for example, servers, workstations, and mobile devices.

SC-7 (13) : ISOLATION OF SECURITY TOOLS / MECHANISMS / SUPPORT COMPONENTS

The organization isolates [Assignment: organization-defined information security tools, mechanisms, and support components] from other internal information system components by implementing physically separate subnetworks with managed interfaces to other components of the system.

Note

Physically separate subnetworks with managed interfaces are useful, for example, in isolating computer network defenses from critical operational processing networks to prevent adversaries from discovering the analysis and forensics techniques of organizations.

Related Controls: SA-8, SC-2, SC-3

SC-7 (14) : PROTECTS AGAINST UNAUTHORIZED PHYSICAL CONNECTIONS

The organization protects against unauthorized physical connections at [Assignment: organization-defined managed interfaces].

Note

Information systems operating at different security categories or classification levels may share common physical and environmental controls, since the systems may share space within organizational facilities. In practice, it is possible that these separate information systems may share common equipment rooms, wiring closets, and cable distribution paths. Protection against unauthorized physical connections can be achieved, for example, by employing clearly identified and physically separated cable trays, connection frames, and patch panels for each side of managed interfaces with physical access controls enforcing limited authorized access to these items.

Related Controls: PE-4, PE-19

SC-7 (15) : ROUTE PRIVILEGED NETWORK ACCESSES

The information system routes all networked, privileged accesses through a dedicated, managed interface for purposes of access control and auditing.

Related Controls: AC-2, AC-3, AU-2, SI-4

SC-7 (16) : PREVENT DISCOVERY OF COMPONENTS / DEVICES

The information system prevents discovery of specific system components composing a managed interface.

Note

This control enhancement protects network addresses of information system components that are part of managed interfaces from discovery through common tools and techniques used to identify devices on networks. Network addresses are not available for discovery (e.g., network address not published or entered in domain name systems), requiring prior knowledge for access. Another obfuscation technique is to periodically change network addresses.

SC-7 (17) : AUTOMATED ENFORCEMENT OF PROTOCOL FORMATS

The information system enforces adherence to protocol formats.

Note

Information system components that enforce protocol formats include, for example, deep packet inspection firewalls and XML gateways. Such system components verify adherence to protocol formats/specifications (e.g., IEEE) at the application layer and identify significant vulnerabilities that cannot be detected by devices operating at the network or transport layers.

Related Controls: SC-4

SC-7 (18) : FAIL SECURE

Baseline-Impact: HIGH

The information system fails securely in the event of an operational failure of a boundary protection device.

Note

Fail secure is a condition achieved by employing information system mechanisms to ensure that in the event of operational failures of boundary protection devices at managed interfaces (e.g., routers, firewalls, guards, and application gateways residing on protected subnetworks commonly referred to as demilitarized zones), information systems do not enter into unsecure states where intended security properties no longer hold. Failures of boundary protection devices cannot lead to, or cause information external to the devices to enter the devices, nor can failures permit unauthorized information releases.

Related Controls: CP-2, SC-24

SC-7 (19) : BLOCKS COMMUNICATION FROM NON-ORGANIZATIONALLY CONFIGURED HOSTS

The information system blocks both inbound and outbound communications traffic between [Assignment: organization-defined communication clients] that are independently configured by end users and external service providers.

Note

Communication clients independently configured by end users and external service providers include, for example, instant messaging clients. Traffic blocking does not apply to communication clients that are configured by organizations to perform authorized functions.

SC-7 (20) : DYNAMIC ISOLATION / SEGREGATION

The information system provides the capability to dynamically isolate/segregate [Assignment: organization-defined information system components] from other components of the system.

Note

The capability to dynamically isolate or segregate certain internal components of organizational information systems is useful when it is necessary to partition or separate certain components of dubious origin from those components possessing greater trustworthiness. Component isolation

reduces the attack surface of organizational information systems. Isolation of selected information system components is also a means of limiting the damage from successful cyber attacks when those attacks occur.

SC-7 (21) : ISOLATION OF INFORMATION SYSTEM COMPONENTS

Baseline-Impact: HIGH

The organization employs boundary protection mechanisms to separate [Assignment: organization-defined information system components] supporting [Assignment: organization-defined missions and/or business functions].

Note

Organizations can isolate information system components performing different missions and/or business functions. Such isolation limits unauthorized information flows among system components and also provides the opportunity to deploy greater levels of protection for selected components. Separating system components with boundary protection mechanisms provides the capability for increased protection of individual components and to more effectively control information flows between those components. This type of enhanced protection limits the potential harm from cyber attacks and errors. The degree of separation provided varies depending upon the mechanisms chosen. Boundary protection mechanisms include, for example, routers, gateways, and firewalls separating system components into physically separate networks or subnetworks, cross-domain devices separating subnetworks, virtualization techniques, and encrypting information flows among system components using distinct encryption keys.

Related Controls: CA-9, SC-3

SC-7 (22) : SEPARATE SUBNETS FOR CONNECTING TO DIFFERENT SECURITY DOMAINS

The information system implements separate network addresses (i.e., different subnets) to connect to systems in different security domains.

Note

Decomposition of information systems into subnets helps to provide the appropriate level of protection for network connections to different security domains containing information with different security categories or classification levels.

SC-7 (23) : DISABLE SENDER FEEDBACK ON PROTOCOL VALIDATION FAILURE

The information system disables feedback to senders on protocol format validation failure.

Note

Disabling feedback to senders when there is a failure in protocol validation format prevents adversaries from obtaining information which would otherwise be unavailable.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-8 : TRANSMISSION CONFIDENTIALITY AND INTEGRITY

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system protects the [Selection (one or more): confidentiality; integrity] of transmitted information.

Note

This control applies to both internal and external networks and all types of information system components from which information can be transmitted (e.g., servers, mobile devices, notebook computers, printers, copiers, scanners, facsimile machines). Communication paths outside the physical protection of a controlled boundary are exposed to the possibility of interception and modification. Protecting the confidentiality and/or integrity of organizational information can be accomplished by physical means (e.g., by employing protected distribution systems) or by logical means (e.g., employing encryption techniques). Organizations relying on commercial providers offering transmission services as commodity services rather than as fully dedicated services (i.e., services which can be highly specialized to individual customer needs), may find it difficult to obtain the necessary assurances regarding the implementation of needed security controls for transmission confidentiality/integrity. In such situations, organizations determine what types of confidentiality/integrity services are available in standard, commercial telecommunication service packages. If it is infeasible or impractical to obtain the necessary security controls and assurances of control effectiveness through appropriate contracting vehicles, organizations implement appropriate compensating security controls or explicitly accept the additional risk.

Related Controls: AC-17, PE-4

SC-8 (1) : CRYPTOGRAPHIC OR ALTERNATE PHYSICAL PROTECTION

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements cryptographic mechanisms to [Selection (one or more): prevent unauthorized disclosure of information; detect changes to information] during transmission unless otherwise protected by [Assignment: organization-defined alternative physical safeguards].

Note

Encrypting information for transmission protects information from unauthorized disclosure and modification. Cryptographic mechanisms implemented to protect information integrity include, for example, cryptographic hash functions which have common application in digital signatures, checksums, and message authentication codes. Alternative physical security safeguards include, for example, protected distribution systems.

Related Controls: SC-13

SC-8 (2) : PRE / POST TRANSMISSION HANDLING

The information system maintains the [Selection (one or more): confidentiality; integrity] of information during preparation for transmission and during reception.

Note

Information can be either unintentionally or maliciously disclosed or modified during preparation for transmission or during reception including, for example, during aggregation, at protocol transformation points, and during packing/unpacking. These unauthorized disclosures or modifications compromise the confidentiality or integrity of the information.

Related Controls: AU-10

SC-8 (3) : CRYPTOGRAPHIC PROTECTION FOR MESSAGE EXTERNALS

The information system implements cryptographic mechanisms to protect message externals unless otherwise protected by [Assignment: organization-defined alternative physical safeguards].

Note

This control enhancement addresses protection against unauthorized disclosure of information. Message externals include, for example, message headers/routing information. This control enhancement prevents the exploitation of message externals and applies to both internal and external networks or links that may be visible to individuals who are not authorized users. Header/routing information is sometimes transmitted unencrypted because the information is not properly identified by organizations as having significant value or because encrypting the information can result in lower network performance and/or higher costs. Alternative physical safeguards include, for example, protected distribution systems.

Related Controls: SC-12, SC-13

SC-8 (4) : CONCEAL / RANDOMIZE COMMUNICATIONS

The information system implements cryptographic mechanisms to conceal or randomize communication patterns unless otherwise protected by [Assignment: organization-defined alternative physical safeguards].

Note

This control enhancement addresses protection against unauthorized disclosure of information. Communication patterns include, for example, frequency, periods, amount, and predictability. Changes to communications patterns can reveal information having intelligence value especially when combined with other available information related to missions/business functions supported by organizational information systems. This control enhancement prevents the derivation of intelligence based on communications patterns and applies to both internal and external networks or links that may be visible to individuals who are not authorized users. Encrypting the links and transmitting in continuous, fixed/random patterns prevents the derivation of intelligence from the system communications patterns. Alternative physical safeguards include, for example, protected distribution systems.

Related Controls: SC-12, SC-13

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-9 : TRANSMISSION CONFIDENTIALITY

[Withdrawn: Incorporated into SC-8].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-10 : NETWORK DISCONNECT

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The information system terminates the network connection associated with a communications session at the end of the session or after [Assignment: organization-defined time period] of inactivity.

Note

This control applies to both internal and external networks. Terminating network connections associated with communications sessions include, for example, de-allocating associated TCP/IP address/port pairs at the operating system level, or de-allocating networking assignments at the application level if multiple application sessions are using a single, operating system-level network connection. Time periods of inactivity may be established by organizations and include, for example, time periods by type of network access or for specific network accesses.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-11 : TRUSTED PATH

Priority: P0

The information system establishes a trusted communications path between the user and the following security functions of the system: [Assignment: organization-defined security functions to include at a minimum, information system authentication and re-authentication].

Note

Trusted paths are mechanisms by which users (through input devices) can communicate directly with security functions of information systems with the requisite assurance to support information security policies. The mechanisms can be activated only by users or the security functions of organizational information systems. User responses via trusted paths are protected from modifications by or disclosure to untrusted applications. Organizations employ trusted paths for high-assurance connections between security functions of information systems and users (e.g., during system logons). Enforcement of trusted communications paths is typically provided via an implementation that meets the reference monitor concept.

Related Controls: AC-16, AC-25

SC-11 (1) : LOGICAL ISOLATION

The information system provides a trusted communications path that is logically isolated and distinguishable from other paths.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-12 : CRYPTOGRAPHIC KEY ESTABLISHMENT AND MANAGEMENT

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization establishes and manages cryptographic keys for required cryptography employed within the information system in accordance with [Assignment: organization-defined requirements for key generation, distribution, storage, access, and destruction].

Note

Cryptographic key management and establishment can be performed using manual procedures or automated mechanisms with supporting manual procedures. Organizations define key management requirements in accordance with applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance, specifying appropriate options, levels, and parameters. Organizations manage trust stores to ensure that only approved trust anchors are in such trust stores. This includes certificates with visibility external to organizational information systems and certificates related to the internal operations of systems.

Related Controls: SC-13, SC-17

SC-12 (1) : AVAILABILITY

Baseline-Impact: HIGH

The organization maintains availability of information in the event of the loss of cryptographic keys by users.

Note

Escrowing of encryption keys is a common practice for ensuring availability in the event of loss of keys (e.g., due to forgotten passphrase).

SC-12 (2) : SYMMETRIC KEYS

The organization produces, controls, and distributes symmetric cryptographic keys using [Selection: NIST FIPS-compliant; NSA-approved] key management technology and processes.

SC-12 (3) : ASYMMETRIC KEYS

The organization produces, controls, and distributes asymmetric cryptographic keys using [Selection: NSA-approved key management technology and processes; approved PKI Class 3 certificates or prepositioned keying material; approved PKI Class 3 or Class 4 certificates and hardware security tokens that protect the user's private key].

SC-12 (4) : PKI CERTIFICATES

[Withdrawn: Incorporated into SC-12].

SC-12 (5) : PKI CERTIFICATES / HARDWARE TOKENS

[Withdrawn: Incorporated into SC-12].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-13 : CRYPTOGRAPHIC PROTECTION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system implements [Assignment: organization-defined cryptographic uses and type of cryptography required for each use] in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, and standards.

Note

Cryptography can be employed to support a variety of security solutions including, for example, the protection of classified and Controlled Unclassified Information, the provision of digital signatures, and the enforcement of information separation when authorized individuals have the necessary clearances for such information but lack the necessary formal access approvals. Cryptography can also be used to support random number generation and hash generation. Generally applicable cryptographic standards include FIPS-validated cryptography and NSA-approved cryptography. This control does not impose any requirements on organizations to use cryptography. However, if cryptography is required based on the selection of other security controls, organizations define each type of cryptographic use and the type of cryptography required (e.g., protection of classified information: NSA-approved cryptography; provision of digital signatures: FIPS-validated cryptography).

Related Controls: AC-2, AC-3, AC-7, AC-17, AC-18, AU-9, AU-10, CM-11, CP-9, IA-3, IA-7, MA-4, MP-2, MP-4, MP-5, SA-4, SC-8, SC-12, SC-28, SI-7

SC-13 (1) : FIPS-VALIDATED CRYPTOGRAPHY

[Withdrawn: Incorporated into SC-13].

SC-13 (2) : NSA-APPROVED CRYPTOGRAPHY

[Withdrawn: Incorporated into SC-13].

SC-13 (3) : INDIVIDUALS WITHOUT FORMAL ACCESS APPROVALS

[Withdrawn: Incorporated into SC-13].

SC-13 (4) : DIGITAL SIGNATURES

[Withdrawn: Incorporated into SC-13].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-14 : PUBLIC ACCESS PROTECTIONS

[Withdrawn: Capability provided by AC-2, AC-3, AC-5, AC-6, SI-3, SI-4, SI-5, SI-7, SI-10].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-15 : COLLABORATIVE COMPUTING DEVICES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system:

Note

Collaborative computing devices include, for example, networked white boards, cameras, and microphones. Explicit indication of use includes, for example, signals to users when collaborative computing devices are activated.

Related Controls: AC-21

SC-15a.

Prohibits remote activation of collaborative computing devices with the following exceptions: [Assignment: organization-defined exceptions where remote activation is to be allowed]; and

SC-15b.

Provides an explicit indication of use to users physically present at the devices.

SC-15 (1) : PHYSICAL DISCONNECT

The information system provides physical disconnect of collaborative computing devices in a manner that supports ease of use.

Note

Failing to physically disconnect from collaborative computing devices can result in subsequent compromises of organizational information. Providing easy methods to physically disconnect from such devices after a collaborative computing session helps to ensure that participants actually carry out the disconnect activity without having to go through complex and tedious procedures.

SC-15 (2) : BLOCKING INBOUND / OUTBOUND COMMUNICATIONS TRAFFIC

[Withdrawn: Incorporated into SC-7].

SC-15 (3) : DISABLING / REMOVAL IN SECURE WORK AREAS

The organization disables or removes collaborative computing devices from [Assignment: organization-defined information systems or information system components] in [Assignment: organization-defined secure work areas].

Note

Failing to disable or remove collaborative computing devices from information systems or information system components can result in subsequent compromises of organizational information including, for example, eavesdropping on conversations.

SC-15 (4) : EXPLICITLY INDICATE CURRENT PARTICIPANTS

The information system provides an explicit indication of current participants in [Assignment: organization-defined online meetings and teleconferences].

Note

This control enhancement helps to prevent unauthorized individuals from participating in collaborative computing sessions without the explicit knowledge of other participants.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-16 : TRANSMISSION OF SECURITY ATTRIBUTES

Priority: P0

The information system associates [Assignment: organization-defined security attributes] with information exchanged between information systems and between system components.

Note

Security attributes can be explicitly or implicitly associated with the information contained in organizational information systems or system components.

Related Controls: AC-3, AC-4, AC-16

SC-16 (1) : INTEGRITY VALIDATION

The information system validates the integrity of transmitted security attributes.

Note

This control enhancement ensures that the verification of the integrity of transmitted information includes security attributes.

Related Controls: AU-10, SC-8

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-17 : PUBLIC KEY INFRASTRUCTURE CERTIFICATES

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization issues public key certificates under an [Assignment: organization-defined certificate policy] or obtains public key certificates from an approved service provider.

Note

For all certificates, organizations manage information system trust stores to ensure only approved trust anchors are in the trust stores. This control addresses both certificates with visibility external to organizational information systems and certificates related to the internal operations of systems, for example, application-specific time services.

Related Controls: SC-12

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-18 : MOBILE CODE

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Decisions regarding the employment of mobile code within organizational information systems are based on the potential for the code to cause damage to the systems if used maliciously. Mobile code technologies include, for example, Java, JavaScript, ActiveX, Postscript, PDF, Shockwave movies, Flash animations, and VBScript. Usage restrictions and implementation guidance apply to both the selection and use of mobile code installed on servers and mobile code downloaded and executed on individual workstations and devices (e.g., smart phones). Mobile code policy and procedures address preventing the development, acquisition, or introduction of unacceptable mobile code within organizational information systems.

Related Controls: AU-2, AU-12, CM-2, CM-6, SI-3

SC-18a.

Defines acceptable and unacceptable mobile code and mobile code technologies;

SC-18b.

Establishes usage restrictions and implementation guidance for acceptable mobile code and mobile code technologies; and

SC-18c.

Authorizes, monitors, and controls the use of mobile code within the information system.

SC-18 (1) : IDENTIFY UNACCEPTABLE CODE / TAKE CORRECTIVE ACTIONS

The information system identifies [Assignment: organization-defined unacceptable mobile code] and takes [Assignment: organization-defined corrective actions].

Note

Corrective actions when unacceptable mobile code is detected include, for example, blocking, quarantine, or alerting administrators. Blocking includes, for example, preventing transmission of word processing files with embedded macros when such macros have been defined to be unacceptable mobile code.

SC-18 (2) : ACQUISITION / DEVELOPMENT / USE

The organization ensures that the acquisition, development, and use of mobile code to be deployed in the information system meets [Assignment: organization-defined mobile code requirements].

SC-18 (3) : PREVENT DOWNLOADING / EXECUTION

The information system prevents the download and execution of [Assignment: organization-defined unacceptable mobile code].

SC-18 (4) : PREVENT AUTOMATIC EXECUTION

The information system prevents the automatic execution of mobile code in [Assignment: organization-defined software applications] and enforces [Assignment: organization-defined actions] prior to executing the code.

Note

Actions enforced before executing mobile code, include, for example, prompting users prior to opening electronic mail attachments. Preventing automatic execution of mobile code includes, for example, disabling auto execute features on information system components employing portable storage devices such as Compact Disks (CDs), Digital Video Disks (DVDs), and Universal Serial Bus (USB) devices.

SC-18 (5) : ALLOW EXECUTION ONLY IN CONFINED ENVIRONMENTS

The organization allows execution of permitted mobile code only in confined virtual machine environments.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-19 : VOICE OVER INTERNET PROTOCOL

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Related Controls: CM-6, SC-7, SC-15

SC-19a.

Establishes usage restrictions and implementation guidance for Voice over Internet Protocol (VoIP) technologies based on the potential to cause damage to the information system if used maliciously; and

SC-19b.

Authorizes, monitors, and controls the use of VoIP within the information system.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-20 : SECURE NAME / ADDRESS RESOLUTION SERVICE (AUTHORITATIVE SOURCE)

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system:

Note

This control enables external clients including, for example, remote Internet clients, to obtain origin authentication and integrity verification assurances for the host/service name to network address resolution information obtained through the service. Information systems that provide name and address resolution services include, for example, domain name system (DNS) servers. Additional artifacts include, for example, DNS Security (DNSSEC) digital signatures and cryptographic keys. DNS resource records are examples of authoritative data. The means to indicate the security status of child zones includes, for example, the use of delegation signer resource records in the DNS. The DNS security controls reflect (and are referenced from) OMB Memorandum 08-23. Information systems that use technologies other than the DNS to map between host/service names and network addresses provide other means to assure the authenticity and integrity of response data.

Related Controls: AU-10, SC-8, SC-12, SC-13, SC-21, SC-22

SC-20a.

Provides additional data origin authentication and integrity verification artifacts along with the authoritative name resolution data the system returns in response to external name/address resolution queries; and

SC-20b.

Provides the means to indicate the security status of child zones and (if the child supports secure resolution services) to enable verification of a chain of trust among parent and child domains, when operating as part of a distributed, hierarchical namespace.

SC-20 (1) : CHILD SUBSPACES

[Withdrawn: Incorporated into SC-20].

SC-20 (2) : DATA ORIGIN / INTEGRITY

The information system provides data origin and integrity protection artifacts for internal name/address resolution queries.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-21 : SECURE NAME / ADDRESS RESOLUTION SERVICE (RECURSIVE OR CACHING RESOLVER)

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system requests and performs data origin authentication and data integrity verification on the name/address resolution responses the system receives from authoritative sources.

Note

Each client of name resolution services either performs this validation on its own, or has authenticated channels to trusted validation providers. Information systems that provide name and address resolution services for local clients include, for example, recursive resolving or caching domain name system (DNS) servers. DNS client resolvers either perform validation of DNSSEC signatures, or clients use authenticated channels to recursive resolvers that perform such validations. Information systems that use technologies other than the DNS to map between host/service names and network addresses provide other means to enable clients to verify the authenticity and integrity of response data.

Related Controls: SC-20, SC-22

SC-21 (1) : DATA ORIGIN / INTEGRITY

[Withdrawn: Incorporated into SC-21].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-22 : ARCHITECTURE AND PROVISIONING FOR NAME / ADDRESS RESOLUTION SERVICE

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information systems that collectively provide name/address resolution service for an organization are fault-tolerant and implement internal/external role separation.

Note

Information systems that provide name and address resolution services include, for example, domain name system (DNS) servers. To eliminate single points of failure and to enhance redundancy, organizations employ at least two authoritative domain name system servers, one configured as the primary server and the other configured as the secondary server. Additionally, organizations typically deploy the servers in two geographically separated network subnetworks (i.e., not located in the same physical facility). For role separation, DNS servers with internal roles only process name and address resolution requests from within organizations (i.e., from internal clients). DNS servers with external roles only process name and address resolution information requests from clients external to organizations (i.e., on external networks including the Internet). Organizations specify clients that can access authoritative DNS servers in particular roles (e.g., by address ranges, explicit lists).

Related Controls: SC-2, SC-20, SC-21, SC-24

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-23 : SESSION AUTHENTICITY

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system protects the authenticity of communications sessions.

Note

This control addresses communications protection at the session, versus packet level (e.g., sessions in service-oriented architectures providing web-based services) and establishes grounds for confidence at both ends of communications sessions in ongoing identities of other parties and in the validity of information transmitted. Authenticity protection includes, for example, protecting against man-in-the-middle attacks/session hijacking and the insertion of false information into sessions.

Related Controls: SC-8, SC-10, SC-11

SC-23 (1) : INVALIDATE SESSION IDENTIFIERS AT LOGOUT

The information system invalidates session identifiers upon user logout or other session termination.

Note

This control enhancement curtails the ability of adversaries from capturing and continuing to employ previously valid session IDs.

SC-23 (2) : USER-INITIATED LOGOUTS / MESSAGE DISPLAYS

[Withdrawn: Incorporated into AC-12 (1)].

SC-23 (3) : UNIQUE SESSION IDENTIFIERS WITH RANDOMIZATION

The information system generates a unique session identifier for each session with [Assignment: organization-defined randomness requirements] and recognizes only session identifiers that are system-generated.

Note

This control enhancement curtails the ability of adversaries from reusing previously valid session IDs. Employing the concept of randomness in the generation of unique session identifiers helps to protect against brute-force attacks to determine future session identifiers.

Related Controls: SC-13

SC-23 (4) : UNIQUE SESSION IDENTIFIERS WITH RANDOMIZATION

[Withdrawn: Incorporated into SC-23 (3)].

SC-23 (5) : ALLOWED CERTIFICATE AUTHORITIES

The information system only allows the use of [Assignment: organization-defined certificate authorities] for verification of the establishment of protected sessions.

Note

Reliance on certificate authorities (CAs) for the establishment of secure sessions includes, for example, the use of Secure Socket Layer (SSL) and/or Transport Layer Security (TLS) certificates. These certificates, after verification by the respective certificate authorities, facilitate the establishment of protected sessions between web clients and web servers.

Related Controls: SC-13

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-24 : FAIL IN KNOWN STATE

Priority: P1

Baseline-Impact: HIGH

The information system fails to a [Assignment: organization-defined known-state] for [Assignment: organization-defined types of failures] preserving [Assignment: organization-defined system state information] in failure.

Note

Failure in a known state addresses security concerns in accordance with the mission/business needs of organizations. Failure in a known secure state helps to prevent the loss of confidentiality, integrity, or availability of information in the event of failures of organizational information systems or system components. Failure in a known safe state helps to prevent systems from failing to a state that may cause injury to individuals or destruction to property. Preserving information system state information facilitates system restart and return to the operational mode of organizations with less disruption of mission/business processes.

Related Controls: CP-2, CP-10, CP-12, SC-7, SC-22

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-25 : THIN NODES

Priority: P0

The organization employs [Assignment: organization-defined information system components] with minimal functionality and information storage.

Note

The deployment of information system components with reduced/minimal functionality (e.g., diskless nodes and thin client technologies) reduces the need to secure every user endpoint, and may reduce the exposure of information, information systems, and services to cyber attacks.

Related Controls: SC-30

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-26 : HONEYPOTS

Priority: P0

The information system includes components specifically designed to be the target of malicious attacks for the purpose of detecting, deflecting, and analyzing such attacks.

Note

A honeypot is set up as a decoy to attract adversaries and to deflect their attacks away from the operational systems supporting organizational missions/business function. Depending upon the specific usage of the honeypot, consultation with the Office of the General Counsel before deployment may be needed.

Related Controls: SC-30, SC-44, SI-3, SI-4

SC-26 (1) : DETECTION OF MALICIOUS CODE

[Withdrawn: Incorporated into SC-35].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-27 : PLATFORM-INDEPENDENT APPLICATIONS

Priority: P0

The information system includes: [Assignment: organization-defined platform-independent applications].

Note

Platforms are combinations of hardware and software used to run software applications. Platforms include: (i) operating systems; (ii) the underlying computer architectures, or (iii) both. Platform-independent applications are applications that run on multiple platforms. Such applications promote portability and reconstitution on different platforms, increasing the availability of critical functions within organizations while information systems with specific operating systems are under attack.

Related Controls: SC-29

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-28 : PROTECTION OF INFORMATION AT REST

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system protects the [Selection (one or more): confidentiality; integrity] of [Assignment: organization-defined information at rest].

Note

This control addresses the confidentiality and integrity of information at rest and covers user information and system information. Information at rest refers to the state of information when it is located on storage devices as specific components of information systems. System-related information requiring protection includes, for example, configurations or rule sets for firewalls, gateways, intrusion detection/prevention systems, filtering routers, and authenticator content. Organizations may employ different mechanisms to achieve confidentiality and integrity protections, including the use of cryptographic mechanisms and file share scanning. Integrity protection can be achieved, for example, by implementing Write-Once-Read-Many (WORM) technologies. Organizations may also employ other security controls including, for example, secure off-line storage in lieu of online storage when adequate protection of information at rest cannot otherwise be achieved and/or continuous monitoring to identify malicious code at rest.

Related Controls: AC-3, AC-6, CA-7, CM-3, CM-5, CM-6, PE-3, SC-8, SC-13, SI-3, SI-7

SC-28 (1) : CRYPTOGRAPHIC PROTECTION

The information system implements cryptographic mechanisms to prevent unauthorized disclosure and modification of [Assignment: organization-defined information] on [Assignment: organization-defined information system components].

Note

Selection of cryptographic mechanisms is based on the need to protect the confidentiality and integrity of organizational information. The strength of mechanism is commensurate with the security category and/or classification of the information. This control enhancement applies to significant concentrations of digital media in organizational areas designated for media storage and also to limited quantities of media generally associated with information system components in operational environments (e.g., portable storage devices, mobile devices). Organizations have the flexibility to either encrypt all information on storage devices (i.e., full disk encryption) or encrypt specific data structures (e.g., files, records, or fields). Organizations employing cryptographic mechanisms to protect information at rest also consider cryptographic key management solutions.

Related Controls: AC-19, SC-12

SC-28 (2) : OFF-LINE STORAGE

The organization removes from online storage and stores off-line in a secure location [Assignment: organization-defined information].

Note

Removing organizational information from online information system storage to off-line storage eliminates the possibility of individuals gaining unauthorized access to the information through a network. Therefore, organizations may choose to move information to off-line storage in lieu of protecting such information in online storage.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-29 : HETEROGENEITY

Priority: P0

The organization employs a diverse set of information technologies for [Assignment: organization-defined information system components] in the implementation of the information system.

Note

Increasing the diversity of information technologies within organizational information systems reduces the impact of potential exploitations of specific technologies and also defends against common mode failures, including those failures induced by supply chain attacks. Diversity in information technologies also reduces the likelihood that the means adversaries use to compromise one information system component will be equally effective against other system components, thus further increasing the adversary work factor to successfully complete planned cyber attacks. An increase in diversity may add complexity and management overhead which could ultimately lead to mistakes and unauthorized configurations.

Related Controls: SA-12, SA-14, SC-27

SC-29 (1) : VIRTUALIZATION TECHNIQUES

The organization employs virtualization techniques to support the deployment of a diversity of operating systems and applications that are changed [Assignment: organization-defined frequency].

Note

While frequent changes to operating systems and applications pose configuration management challenges, the changes can result in an increased work factor for adversaries in order to carry out successful cyber attacks. Changing virtual operating systems or applications, as opposed to changing actual operating systems/applications, provide virtual changes that impede attacker success while reducing configuration management efforts. In addition, virtualization techniques can assist organizations in isolating untrustworthy software and/or software of dubious provenance into confined execution environments.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-30 : CONCEALMENT AND MISDIRECTION

Priority: P0

The organization employs [Assignment: organization-defined concealment and misdirection techniques] for [Assignment: organization-defined information systems] at [Assignment: organization-defined time periods] to confuse and mislead adversaries.

Note

Concealment and misdirection techniques can significantly reduce the targeting capability of adversaries (i.e., window of opportunity and available attack surface) to initiate and complete cyber attacks. For example, virtualization techniques provide organizations with the ability to disguise information systems, potentially reducing the likelihood of successful attacks without the cost of having multiple platforms. Increased use of concealment/misdirection techniques including, for

example, randomness, uncertainty, and virtualization, may sufficiently confuse and mislead adversaries and subsequently increase the risk of discovery and/or exposing tradecraft. Concealment/misdirection techniques may also provide organizations additional time to successfully perform core missions and business functions. Because of the time and effort required to support concealment/misdirection techniques, it is anticipated that such techniques would be used by organizations on a very limited basis.

Related Controls: SC-26, SC-29, SI-14

SC-30 (1) : VIRTUALIZATION TECHNIQUES

[Withdrawn: Incorporated into SC-29 (1)].

SC-30 (2) : RANDOMNESS

The organization employs [Assignment: organization-defined techniques] to introduce randomness into organizational operations and assets.

Note

Randomness introduces increased levels of uncertainty for adversaries regarding the actions organizations take in defending against cyber attacks. Such actions may impede the ability of adversaries to correctly target information resources of organizations supporting critical missions/business functions. Uncertainty may also cause adversaries to hesitate before initiating or continuing attacks. Misdirection techniques involving randomness include, for example, performing certain routine actions at different times of day, employing different information technologies (e.g., browsers, search engines), using different suppliers, and rotating roles and responsibilities of organizational personnel.

SC-30 (3) : CHANGE PROCESSING / STORAGE LOCATIONS

The organization changes the location of [Assignment: organization-defined processing and/or storage] [Selection: [Assignment: organization-defined time frequency]; at random time intervals]].

Note

Adversaries target critical organizational missions/business functions and the information resources supporting those missions and functions while at the same time, trying to minimize exposure of their existence and tradecraft. The static, homogeneous, and deterministic nature of organizational information systems targeted by adversaries, make such systems more susceptible to cyber attacks with less adversary cost and effort to be successful. Changing organizational processing and storage locations (sometimes referred to as moving target defense) addresses the advanced persistent threat (APT) using techniques such as virtualization, distributed processing, and replication. This enables organizations to relocate the information resources (i.e., processing and/or storage) supporting critical missions and business functions. Changing locations of processing activities and/or storage sites introduces uncertainty into the targeting activities by adversaries. This uncertainty increases the work factor of adversaries making compromises or breaches to organizational information systems much more difficult and time-consuming, and increases the chances that adversaries may inadvertently disclose aspects of tradecraft while attempting to locate critical organizational resources.

SC-30 (4) : MISLEADING INFORMATION

The organization employs realistic, but misleading information in [Assignment: organization-defined information system components] with regard to its security state or posture.

Note

This control enhancement misleads potential adversaries regarding the nature and extent of security safeguards deployed by organizations. As a result, adversaries may employ incorrect (and as a result ineffective) attack techniques. One way of misleading adversaries is for organizations to place misleading information regarding the specific security controls deployed in external information systems that are known to be accessed or targeted by adversaries. Another technique is the use of deception nets (e.g., honeynets, virtualized environments) that mimic actual aspects of organizational information systems but use, for example, out-of-date software configurations.

SC-30 (5) : CONCEALMENT OF SYSTEM COMPONENTS

The organization employs [Assignment: organization-defined techniques] to hide or conceal [Assignment: organization-defined information system components].

Note

By hiding, disguising, or otherwise concealing critical information system components, organizations may be able to decrease the probability that adversaries target and successfully compromise those assets. Potential means for organizations to hide and/or conceal information system components include, for example, configuration of routers or the use of honeynets or virtualization techniques.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-31 : COVERT CHANNEL ANALYSIS

Priority: P0

The organization:

Note

Developers are in the best position to identify potential areas within systems that might lead to covert channels. Covert channel analysis is a meaningful activity when there is the potential for unauthorized information flows across security domains, for example, in the case of information systems containing export-controlled information and having connections to external networks (i.e., networks not controlled by organizations). Covert channel analysis is also meaningful for multilevel secure (MLS) information systems, multiple security level (MSL) systems, and cross-domain systems.

Related Controls: AC-3, AC-4, PL-2

SC-31a.

Performs a covert channel analysis to identify those aspects of communications within the information system that are potential avenues for covert [Selection (one or more): storage; timing] channels; and

SC-31b.

Estimates the maximum bandwidth of those channels.

SC-31 (1) : TEST COVERT CHANNELS FOR EXPLOITABILITY

The organization tests a subset of the identified covert channels to determine which channels are exploitable.

SC-31 (2) : MAXIMUM BANDWIDTH

The organization reduces the maximum bandwidth for identified covert [Selection (one or more); storage; timing] channels to [Assignment: organization-defined values].

Note

Information system developers are in the best position to reduce the maximum bandwidth for identified covert storage and timing channels.

SC-31 (3) : MEASURE BANDWIDTH IN OPERATIONAL ENVIRONMENTS

The organization measures the bandwidth of [Assignment: organization-defined subset of identified covert channels] in the operational environment of the information system.

Note

This control enhancement addresses covert channel bandwidth in operational environments versus developmental environments. Measuring covert channel bandwidth in operational environments helps organizations to determine how much information can be covertly leaked before such leakage adversely affects organizational missions/business functions. Covert channel bandwidth may be significantly different when measured in those settings that are independent of the particular environments of operation (e.g., laboratories or development environments).

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-32 : INFORMATION SYSTEM PARTITIONING

Priority: P0

The organization partitions the information system into [Assignment: organization-defined information system components] residing in separate physical domains or environments based on [Assignment: organization-defined circumstances for physical separation of components].

Note

Information system partitioning is a part of a defense-in-depth protection strategy. Organizations determine the degree of physical separation of system components from physically distinct components in separate racks in the same room, to components in separate rooms for the more critical components, to more significant geographical separation of the most critical components. Security categorization can guide the selection of appropriate candidates for domain partitioning. Managed interfaces restrict or prohibit network access and information flow among partitioned information system components.

Related Controls: AC-4, SA-8, SC-2, SC-3, SC-7

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-33 : TRANSMISSION PREPARATION INTEGRITY

[Withdrawn: Incorporated into SC-8].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-34 : NON-MODIFIABLE EXECUTABLE PROGRAMS

Priority: P0

The information system at [Assignment: organization-defined information system components]:

Note

The term operating environment is defined as the specific code that hosts applications, for example, operating systems, executives, or monitors including virtual machine monitors (i.e., hypervisors). It can also include certain applications running directly on hardware platforms. Hardware-enforced, read-only media include, for example, Compact Disk-Recordable (CD-R)/Digital Video Disk-Recordable (DVD-R) disk drives and one-time programmable read-only memory. The use of non-modifiable storage ensures the integrity of software from the point of creation of the read-only image. The use of reprogrammable read-only memory can be accepted as read-only media provided: (i) integrity can be adequately protected from the point of initial writing to the insertion of the memory into the information system; and (ii) there are reliable hardware protections against reprogramming the memory while installed in organizational information systems.

Related Controls: AC-3, SI-7

SC-34a.

Loads and executes the operating environment from hardware-enforced, read-only media; and

SC-34b.

Loads and executes [Assignment: organization-defined applications] from hardware-enforced, read-only media.

SC-34 (1) : NO WRITABLE STORAGE

The organization employs [Assignment: organization-defined information system components] with no writeable storage that is persistent across component restart or power on/off.

Note

This control enhancement: (i) eliminates the possibility of malicious code insertion via persistent, writeable storage within the designated information system components; and (ii) applies to both fixed and removable storage, with the latter being addressed directly or as specific restrictions imposed through access controls for mobile devices.

Related Controls: AC-19, MP-7

SC-34 (2) : INTEGRITY PROTECTION / READ-ONLY MEDIA

The organization protects the integrity of information prior to storage on read-only media and controls the media after such information has been recorded onto the media.

Note

Security safeguards prevent the substitution of media into information systems or the reprogramming of programmable read-only media prior to installation into the systems. Security safeguards include, for example, a combination of prevention, detection, and response.

Related Controls: AC-5, CM-3, CM-5, CM-9, MP-2, MP-4, MP-5, SA-12, SC-28, SI-3

SC-34 (3) : HARDWARE-BASED PROTECTION

The organization:

SC-34 (3)(a)

Employs hardware-based, write-protect for [Assignment: organization-defined information system firmware components]; and

SC-34 (3)(b)

Implements specific procedures for [Assignment: organization-defined authorized individuals] to manually disable hardware write-protect for firmware modifications and re-enable the write-protect prior to returning to operational mode.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-35 : HONEYCLIENTS

Priority: P0

The information system includes components that proactively seek to identify malicious websites and/or web-based malicious code.

Note

Honeyclients differ from honeypots in that the components actively probe the Internet in search of malicious code (e.g., worms) contained on external websites. As with honeypots, honeyclients require some supporting isolation measures (e.g., virtualization) to ensure that any malicious code discovered during the search and subsequently executed does not infect organizational information systems.

Related Controls: SC-26, SC-44, SI-3, SI-4

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-36 : DISTRIBUTED PROCESSING AND STORAGE

Priority: P0

The organization distributes [Assignment: organization-defined processing and storage] across multiple physical locations.

Note

Distributing processing and storage across multiple physical locations provides some degree of redundancy or overlap for organizations, and therefore increases the work factor of adversaries to adversely impact organizational operations, assets, and individuals. This control does not assume a single primary processing or storage location, and thus allows for parallel processing and storage.

Related Controls: CP-6, CP-7

SC-36 (1) : POLLING TECHNIQUES

The organization employs polling techniques to identify potential faults, errors, or compromises to [Assignment: organization-defined distributed processing and storage components].

Note

Distributed processing and/or storage may be employed to reduce opportunities for adversaries to successfully compromise the confidentiality, integrity, or availability of information and information systems. However, distribution of processing and/or storage components does not prevent adversaries from compromising one (or more) of the distributed components. Polling compares the processing results and/or storage content from the various distributed components and subsequently voting on the outcomes. Polling identifies potential faults, errors, or compromises in distributed processing and/or storage components.

Related Controls: SI-4

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-37 : OUT-OF-BAND CHANNELS

Priority: P0

The organization employs [Assignment: organization-defined out-of-band channels] for the physical delivery or electronic transmission of [Assignment: organization-defined information, information system components, or devices] to [Assignment: organization-defined individuals or information systems].

Note

Out-of-band channels include, for example, local (nonnetwork) accesses to information systems, network paths physically separate from network paths used for operational traffic, or nonelectronic paths such as the US Postal Service. This is in contrast with using the same channels (i.e., in-band channels) that carry routine operational traffic. Out-of-band channels do not have the same vulnerability/exposure as in-band channels, and hence the confidentiality, integrity, or availability compromises of in-band channels will not compromise the out-of-band channels. Organizations may employ out-of-band channels in the delivery or transmission of many organizational items including, for example, identifiers/authenticators, configuration management changes for hardware, firmware, or software, cryptographic key management information, security updates, system/data backups, maintenance information, and malicious code protection updates.

Related Controls: AC-2, CM-3, CM-5, CM-7, IA-4, IA-5, MA-4, SC-12, SI-3, SI-4, SI-7

SC-37 (1) : ENSURE DELIVERY / TRANSMISSION

The organization employs [Assignment: organization-defined security safeguards] to ensure that only [Assignment: organization-defined individuals or information systems] receive the [Assignment: organization-defined information, information system components, or devices].

Note

Techniques and/or methods employed by organizations to ensure that only designated information systems or individuals receive particular information, system components, or devices include, for example, sending authenticators via courier service but requiring recipients to show some form of government-issued photographic identification as a condition of receipt.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-38 : OPERATIONS SECURITY

Priority: P0

The organization employs [Assignment: organization-defined operations security safeguards] to protect key organizational information throughout the system development life cycle.

Note

Operations security (OPSEC) is a systematic process by which potential adversaries can be denied information about the capabilities and intentions of organizations by identifying, controlling, and protecting generally unclassified information that specifically relates to the planning and execution of sensitive organizational activities. The OPSEC process involves five steps: (i) identification of critical information (e.g., the security categorization process); (ii) analysis of threats; (iii) analysis of vulnerabilities; (iv) assessment of risks; and (v) the application of appropriate countermeasures. OPSEC safeguards are applied to both organizational information systems and the environments in which those systems operate. OPSEC safeguards help to protect the confidentiality of key information

including, for example, limiting the sharing of information with suppliers and potential suppliers of information system components, information technology products and services, and with other non-organizational elements and individuals. Information critical to mission/business success includes, for example, user identities, element uses, suppliers, supply chain processes, functional and security requirements, system design specifications, testing protocols, and security control implementation details.

Related Controls: RA-2, RA-5, SA-12

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-39 : PROCESS ISOLATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The information system maintains a separate execution domain for each executing process.

Note

Information systems can maintain separate execution domains for each executing process by assigning each process a separate address space. Each information system process has a distinct address space so that communication between processes is performed in a manner controlled through the security functions, and one process cannot modify the executing code of another process. Maintaining separate execution domains for executing processes can be achieved, for example, by implementing separate address spaces. This capability is available in most commercial operating systems that employ multi-state processor technologies.

Related Controls: AC-3, AC-4, AC-6, SA-4, SA-5, SA-8, SC-2, SC-3

SC-39 (1) : HARDWARE SEPARATION

The information system implements underlying hardware separation mechanisms to facilitate process separation.

Note

Hardware-based separation of information system processes is generally less susceptible to compromise than software-based separation, thus providing greater assurance that the separation will be enforced. Underlying hardware separation mechanisms include, for example, hardware memory management.

SC-39 (2) : THREAD ISOLATION

The information system maintains a separate execution domain for each thread in [Assignment: organization-defined multi-threaded processing].

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-40 : WIRELESS LINK PROTECTION

Priority: P0

The information system protects external and internal [Assignment: organization-defined wireless links] from [Assignment: organization-defined types of signal parameter attacks or references to sources for such attacks].

Note

This control applies to internal and external wireless communication links that may be visible to individuals who are not authorized information system users. Adversaries can exploit the signal parameters of wireless links if such links are not adequately protected. There are many ways to exploit the signal parameters of wireless links to gain intelligence, deny service, or to spoof users of organizational information systems. This control reduces the impact of attacks that are unique to wireless systems. If organizations rely on commercial service providers for transmission services as commodity items rather than as fully dedicated services, it may not be possible to implement this control.

Related Controls: AC-18, SC-5

SC-40 (1) : ELECTROMAGNETIC INTERFERENCE

The information system implements cryptographic mechanisms that achieve [Assignment: organization-defined level of protection] against the effects of intentional electromagnetic interference.

Note

This control enhancement protects against intentional jamming that might deny or impair communications by ensuring that wireless spread spectrum waveforms used to provide anti-jam protection are not predictable by unauthorized individuals. The control enhancement may also coincidentally help to mitigate the effects of unintentional jamming due to interference from legitimate transmitters sharing the same spectrum. Mission requirements, projected threats, concept of operations, and applicable legislation, directives, regulations, policies, standards, and guidelines determine levels of wireless link availability and performance/cryptography needed.

Related Controls: SC-12, SC-13

SC-40 (2) : REDUCE DETECTION POTENTIAL

The information system implements cryptographic mechanisms to reduce the detection potential of wireless links to [Assignment: organization-defined level of reduction].

Note

This control enhancement is needed for covert communications and protecting wireless transmitters from being geo-located by their transmissions. The control enhancement ensures that spread spectrum waveforms used to achieve low probability of detection are not predictable by unauthorized individuals. Mission requirements, projected threats, concept of operations, and applicable legislation, directives, regulations, policies, standards, and guidelines determine the levels to which wireless links should be undetectable.

Related Controls: SC-12, SC-13

SC-40 (3) : IMITATIVE OR MANIPULATIVE COMMUNICATIONS DECEPTION

The information system implements cryptographic mechanisms to identify and reject wireless transmissions that are deliberate attempts to achieve imitative or manipulative communications deception based on signal parameters.

Note

This control enhancement ensures that the signal parameters of wireless transmissions are not predictable by unauthorized individuals. Such unpredictability reduces the probability of imitative or manipulative communications deception based upon signal parameters alone.

Related Controls: SC-12, SC-13

SC-40 (4) : SIGNAL PARAMETER IDENTIFICATION

The information system implements cryptographic mechanisms to prevent the identification of [Assignment: organization-defined wireless transmitters] by using the transmitter signal parameters.

Note

Radio fingerprinting techniques identify the unique signal parameters of transmitters to fingerprint such transmitters for purposes of tracking and mission/user identification. This control enhancement protects against the unique identification of wireless transmitters for purposes of intelligence exploitation by ensuring that anti-fingerprinting alterations to signal parameters are not predictable by unauthorized individuals. This control enhancement helps assure mission success when anonymity is required.

Related Controls: SC-12, SC-13

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-41 : PORT AND I/O DEVICE ACCESS

Priority: P0

The organization physically disables or removes [Assignment: organization-defined connection ports or input/output devices] on [Assignment: organization-defined information systems or information system components].

Note

Connection ports include, for example, Universal Serial Bus (USB) and Firewire (IEEE 1394). Input/output (I/O) devices include, for example, Compact Disk (CD) and Digital Video Disk (DVD) drives. Physically disabling or removing such connection ports and I/O devices helps prevent exfiltration of information from information systems and the introduction of malicious code into systems from those ports/devices.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-42 : SENSOR CAPABILITY AND DATA

Priority: P0

The information system:

Note

This control often applies to types of information systems or system components characterized as mobile devices, for example, smart phones, tablets, and E-readers. These systems often include sensors that can collect and record data regarding the environment where the system is in use. Sensors that are embedded within mobile devices include, for example, cameras, microphones, Global Positioning System (GPS) mechanisms, and accelerometers. While the sensors on mobiles devices provide an important function, if activated covertly, such devices can potentially provide a means for adversaries to learn valuable information about individuals and organizations. For example, remotely activating the GPS function on a mobile device could provide an adversary with the ability to track the specific movements of an individual.

SC-42a.

Prohibits the remote activation of environmental sensing capabilities with the following exceptions: [Assignment: organization-defined exceptions where remote activation of sensors is allowed]; and

SC-42b.

Provides an explicit indication of sensor use to [Assignment: organization-defined class of users].

SC-42 (1) : REPORTING TO AUTHORIZED INDIVIDUALS OR ROLES

The organization ensures that the information system is configured so that data or information collected by the [Assignment: organization-defined sensors] is only reported to authorized individuals or roles.

Note

In situations where sensors are activated by authorized individuals (e.g., end users), it is still possible that the data/information collected by the sensors will be sent to unauthorized entities.

SC-42 (2) : AUTHORIZED USE

The organization employs the following measures: [Assignment: organization-defined measures], so that data or information collected by [Assignment: organization-defined sensors] is only used for authorized purposes.

Note

Information collected by sensors for a specific authorized purpose potentially could be misused for some unauthorized purpose. For example, GPS sensors that are used to support traffic navigation

could be misused to track movements of individuals. Measures to mitigate such activities include, for example, additional training to ensure that authorized parties do not abuse their authority, or (in the case where sensor data/information is maintained by external parties) contractual restrictions on the use of the data/information.

SC-42 (3) : PROHIBIT USE OF DEVICES

The organization prohibits the use of devices possessing [Assignment: organization-defined environmental sensing capabilities] in [Assignment: organization-defined facilities, areas, or systems].

Note

For example, organizations may prohibit individuals from bringing cell phones or digital cameras into certain facilities or specific controlled areas within facilities where classified information is stored or sensitive conversations are taking place.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-43 : USAGE RESTRICTIONS

Priority: P0

The organization:

Note

Information system components include hardware, software, or firmware components (e.g., Voice Over Internet Protocol, mobile code, digital copiers, printers, scanners, optical devices, wireless technologies, mobile devices).

Related Controls: CM-6, SC-7

SC-43a.

Establishes usage restrictions and implementation guidance for [Assignment: organization-defined information system components] based on the potential to cause damage to the information system if used maliciously; and

SC-43b.

Authorizes, monitors, and controls the use of such components within the information system.

Control Family: SYSTEM AND COMMUNICATIONS PROTECTION

SC-44 : DETONATION CHAMBERS

Priority: P0

The organization employs a detonation chamber capability within [Assignment: organization-defined information system, system component, or location].

Note

Detonation chambers, also known as dynamic execution environments, allow organizations to open email attachments, execute untrusted or suspicious applications, and execute Universal Resource Locator (URL) requests in the safety of an isolated environment or virtualized sandbox. These protected and isolated execution environments provide a means of determining whether the associated attachments/applications contain malicious code. While related to the concept of deception nets, the control is not intended to maintain a long-term environment in which adversaries can operate and their actions can be observed. Rather, it is intended to quickly identify malicious code and reduce the likelihood that the code is propagated to user environments of operation (or prevent such propagation completely).

Related Controls: SC-7, SC-25, SC-26, SC-30

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-1 : SYSTEM AND INFORMATION INTEGRITY POLICY AND PROCEDURES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

This control addresses the establishment of policy and procedures for the effective implementation of selected security controls and control enhancements in the SI family. Policy and procedures reflect applicable federal laws, Executive Orders, directives, regulations, policies, standards, and guidance. Security program policies and procedures at the organization level may make the need for system-specific policies and procedures unnecessary. The policy can be included as part of the general information security policy for organizations or conversely, can be represented by multiple policies reflecting the complex nature of certain organizations. The procedures can be established for the security program in general and for particular information systems, if needed. The organizational risk management strategy is a key factor in establishing policy and procedures.

Related Controls: PM-9

SI-1a.

Develops, documents, and disseminates to [Assignment: organization-defined personnel or roles]:

SI-1a.1.

A system and information integrity policy that addresses purpose, scope, roles, responsibilities, management commitment, coordination among organizational entities, and compliance; and

SI-1a.2.

Procedures to facilitate the implementation of the system and information integrity policy and associated system and information integrity controls; and

SI-1b.

Reviews and updates the current:

SI-1b.1.

System and information integrity policy [Assignment: organization-defined frequency]; and

SI-1b.2.

System and information integrity procedures [Assignment: organization-defined frequency].

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-2 : FLAW REMEDIATION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Organizations identify information systems affected by announced software flaws including potential vulnerabilities resulting from those flaws, and report this information to designated organizational personnel with information security responsibilities. Security-relevant software updates include, for example, patches, service packs, hot fixes, and anti-virus signatures. Organizations also address flaws discovered during security assessments, continuous monitoring, incident response activities, and system error handling. Organizations take advantage of available resources such as the Common Weakness Enumeration (CWE) or Common Vulnerabilities and Exposures (CVE) databases in remediating flaws discovered in organizational information systems. By incorporating flaw remediation into ongoing configuration management processes, required/anticipated remediation actions can be tracked and verified. Flaw remediation actions that can be tracked and verified include, for example, determining whether organizations follow US-CERT guidance and Information Assurance Vulnerability Alerts. Organization-defined time periods for updating security-relevant software and firmware may vary based on a variety of factors including, for example, the security category of the information system or the criticality of the update (i.e., severity of the vulnerability related to the discovered flaw). Some types of flaw remediation may require more testing than other types. Organizations determine the degree and type of testing needed for the specific type of flaw remediation activity under consideration and also the types of changes that are to be configuration-managed. In some situations, organizations may determine that the testing of software and/or firmware updates is not necessary or practical, for example, when implementing simple anti-virus signature updates. Organizations may also consider in testing decisions, whether security-relevant software or firmware updates are obtained from authorized sources with appropriate digital signatures.

Related Controls: CA-2, CA-7, CM-3, CM-5, CM-8, MA-2, IR-4, RA-5, SA-10, SA-11, SI-11

SI-2a.

Identifies, reports, and corrects information system flaws;

SI-2b.

Tests software and firmware updates related to flaw remediation for effectiveness and potential side effects before installation;

SI-2c.

Installs security-relevant software and firmware updates within [Assignment: organization-defined time period] of the release of the updates; and

SI-2d.

Incorporates flaw remediation into the organizational configuration management process.

SI-2 (1) : CENTRAL MANAGEMENT

Baseline-Impact: HIGH

The organization centrally manages the flaw remediation process.

Note

Central management is the organization-wide management and implementation of flaw remediation processes. Central management includes planning, implementing, assessing, authorizing, and monitoring the organization-defined, centrally managed flaw remediation security controls.

SI-2 (2) : AUTOMATED FLAW REMEDIATION STATUS

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs automated mechanisms [Assignment: organization-defined frequency] to determine the state of information system components with regard to flaw remediation.

Related Controls: CM-6, SI-4

SI-2 (3) : TIME TO REMEDIATE FLAWS / BENCHMARKS FOR CORRECTIVE ACTIONS

The organization:

Note

This control enhancement requires organizations to determine the current time it takes on the average to correct information system flaws after such flaws have been identified, and subsequently establish organizational benchmarks (i.e., time frames) for taking corrective actions. Benchmarks can be established by type of flaw and/or severity of the potential vulnerability if the flaw can be exploited.

SI-2 (3)(a)

Measures the time between flaw identification and flaw remediation; and

SI-2 (3)(b)

Establishes [Assignment: organization-defined benchmarks] for taking corrective actions.

SI-2 (4) : AUTOMATED PATCH MANAGEMENT TOOLS

[Withdrawn: Incorporated into SI-2].

SI-2 (5) : AUTOMATIC SOFTWARE / FIRMWARE UPDATES

The organization installs [Assignment: organization-defined security-relevant software and firmware updates] automatically to [Assignment: organization-defined information system components].

Note

Due to information system integrity and availability concerns, organizations give careful consideration to the methodology used to carry out automatic updates. Organizations must balance the need to ensure that the updates are installed as soon as possible with the need to maintain configuration management and with any mission or operational impacts that automatic updates might impose.

SI-2 (6) : REMOVAL OF PREVIOUS VERSIONS OF SOFTWARE / FIRMWARE

The organization removes [Assignment: organization-defined software and firmware components] after updated versions have been installed.

Note

Previous versions of software and/or firmware components that are not removed from the information system after updates have been installed may be exploited by adversaries. Some information technology products may remove older versions of software and/or firmware automatically from the information system.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-3 : MALICIOUS CODE PROTECTION

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Information system entry and exit points include, for example, firewalls, electronic mail servers, web servers, proxy servers, remote-access servers, workstations, notebook computers, and mobile devices. Malicious code includes, for example, viruses, worms, Trojan horses, and spyware. Malicious code can also be encoded in various formats (e.g., UUENCODE, Unicode), contained within compressed or hidden files, or hidden in files using steganography. Malicious code can be transported by different means including, for example, web accesses, electronic mail, electronic mail attachments, and portable storage devices. Malicious code insertions occur through the exploitation of information

system vulnerabilities. Malicious code protection mechanisms include, for example, anti-virus signature definitions and reputation-based technologies. A variety of technologies and methods exist to limit or eliminate the effects of malicious code. Pervasive configuration management and comprehensive software integrity controls may be effective in preventing execution of unauthorized code. In addition to commercial off-the-shelf software, malicious code may also be present in custom-built software. This could include, for example, logic bombs, back doors, and other types of cyber attacks that could affect organizational missions/business functions. Traditional malicious code protection mechanisms cannot always detect such code. In these situations, organizations rely instead on other safeguards including, for example, secure coding practices, configuration management and control, trusted procurement processes, and monitoring practices to help ensure that software does not perform functions other than the functions intended. Organizations may determine that in response to the detection of malicious code, different actions may be warranted. For example, organizations can define actions in response to malicious code detection during periodic scans, actions in response to detection of malicious downloads, and/or actions in response to detection of maliciousness when attempting to open or execute files.

Related Controls: CM-3, MP-2, SA-4, SA-8, SA-12, SA-13, SC-7, SC-26, SC-44, SI-2, SI-4, SI-7

SI-3a.

Employs malicious code protection mechanisms at information system entry and exit points to detect and eradicate malicious code;

SI-3b.

Updates malicious code protection mechanisms whenever new releases are available in accordance with organizational configuration management policy and procedures;

SI-3c.

Configures malicious code protection mechanisms to:

SI-3c.1.

Perform periodic scans of the information system [Assignment: organization-defined frequency] and real-time scans of files from external sources at [Selection (one or more); endpoint; network entry/exit points] as the files are downloaded, opened, or executed in accordance with organizational security policy; and

SI-3c.2.

[Selection (one or more): block malicious code; quarantine malicious code; send alert to administrator; [Assignment: organization-defined action]] in response to malicious code detection; and

SI-3d.

Addresses the receipt of false positives during malicious code detection and eradication and the resulting potential impact on the availability of the information system.

SI-3 (1) : CENTRAL MANAGEMENT

Baseline-Impact: *MODERATE*, **HIGH**

The organization centrally manages malicious code protection mechanisms.

Note

Central management is the organization-wide management and implementation of malicious code protection mechanisms. Central management includes planning, implementing, assessing, authorizing, and monitoring the organization-defined, centrally managed flaw malicious code protection security controls.

Related Controls: AU-2, SI-8

SI-3 (2) : AUTOMATIC UPDATES

Baseline-Impact: *MODERATE*, **HIGH**

The information system automatically updates malicious code protection mechanisms.

Note

Malicious code protection mechanisms include, for example, signature definitions. Due to information system integrity and availability concerns, organizations give careful consideration to the methodology used to carry out automatic updates.

Related Controls: SI-8

SI-3 (3) : NON-PRIVILEGED USERS

[Withdrawn: Incorporated into AC-6 (10)].

SI-3 (4) : UPDATES ONLY BY PRIVILEGED USERS

The information system updates malicious code protection mechanisms only when directed by a privileged user.

Note

This control enhancement may be appropriate for situations where for reasons of security or operational continuity, updates are only applied when selected/approved by designated organizational personnel.

Related Controls: AC-6, CM-5

SI-3 (5) : PORTABLE STORAGE DEVICES

[Withdrawn: Incorporated into MP-7].

SI-3 (6) : TESTING / VERIFICATION

The organization:

Related Controls: CA-2, CA-7, RA-5

SI-3 (6)(a)

Tests malicious code protection mechanisms [Assignment: organization-defined frequency] by introducing a known benign, non-spreading test case into the information system; and

SI-3 (6)(b)

Verifies that both detection of the test case and associated incident reporting occur.

SI-3 (7) : NONSIGNATURE-BASED DETECTION

The information system implements nonsignature-based malicious code detection mechanisms.

Note

Nonsignature-based detection mechanisms include, for example, the use of heuristics to detect, analyze, and describe the characteristics or behavior of malicious code and to provide safeguards against malicious code for which signatures do not yet exist or for which existing signatures may not be effective. This includes polymorphic malicious code (i.e., code that changes signatures when it replicates). This control enhancement does not preclude the use of signature-based detection mechanisms.

SI-3 (8) : DETECT UNAUTHORIZED COMMANDS

The information system detects [Assignment: organization-defined unauthorized operating system commands] through the kernel application programming interface at [Assignment: organization-defined information system hardware components] and [Selection (one or more): issues a warning; audits the command execution; prevents the execution of the command].

Note

This control enhancement can also be applied to critical interfaces other than kernel-based interfaces, including for example, interfaces with virtual machines and privileged applications. Unauthorized operating system commands include, for example, commands for kernel functions from information system processes that are not trusted to initiate such commands, or commands for kernel functions that are suspicious even though commands of that type are reasonable for processes to initiate. Organizations can define the malicious commands to be detected by a combination of command types, command classes, or specific instances of commands. Organizations can define hardware components by specific component, component type, location in the network, or combination therein. Organizations may select different actions for different types/classes/specific instances of potentially malicious commands.

Related Controls: AU-6

SI-3 (9) : AUTHENTICATE REMOTE COMMANDS

The information system implements [Assignment: organization-defined security safeguards] to authenticate [Assignment: organization-defined remote commands].

Note

This control enhancement protects against unauthorized commands and replay of authorized commands. This capability is important for those remote information systems whose loss, malfunction, misdirection, or exploitation would have immediate and/or serious consequences (e.g., injury or death, property damage, loss of high-valued assets or sensitive information, or failure of important missions/business functions). Authentication safeguards for remote commands help to ensure that information systems accept and execute in the order intended, only authorized commands, and that unauthorized commands are rejected. Cryptographic mechanisms can be employed, for example, to authenticate remote commands.

Related Controls: SC-12, SC-13, SC-23

SI-3 (10) : MALICIOUS CODE ANALYSIS

The organization:

Note

The application of selected malicious code analysis tools and techniques provides organizations with a more in-depth understanding of adversary tradecraft (i.e., tactics, techniques, and procedures) and the functionality and purpose of specific instances of malicious code. Understanding the characteristics of malicious code facilitates more effective organizational responses to current and future threats. Organizations can conduct malicious code analyses by using reverse engineering techniques or by monitoring the behavior of executing code.

SI-3 (10)(a)

Employs [Assignment: organization-defined tools and techniques] to analyze the characteristics and behavior of malicious code; and

SI-3 (10)(b)

Incorporates the results from malicious code analysis into organizational incident response and flaw remediation processes.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-4 : INFORMATION SYSTEM MONITORING

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

Information system monitoring includes external and internal monitoring. External monitoring includes the observation of events occurring at the information system boundary (i.e., part of perimeter defense and boundary protection). Internal monitoring includes the observation of events

occurring within the information system. Organizations can monitor information systems, for example, by observing audit activities in real time or by observing other system aspects such as access patterns, characteristics of access, and other actions. The monitoring objectives may guide determination of the events. Information system monitoring capability is achieved through a variety of tools and techniques (e.g., intrusion detection systems, intrusion prevention systems, malicious code protection software, scanning tools, audit record monitoring software, network monitoring software). Strategic locations for monitoring devices include, for example, selected perimeter locations and near server farms supporting critical applications, with such devices typically being employed at the managed interfaces associated with controls SC-7 and AC-17. Einstein network monitoring devices from the Department of Homeland Security can also be included as monitoring devices. The granularity of monitoring information collected is based on organizational monitoring objectives and the capability of information systems to support such objectives. Specific types of transactions of interest include, for example, Hyper Text Transfer Protocol (HTTP) traffic that bypasses HTTP proxies. Information system monitoring is an integral part of organizational continuous monitoring and incident response programs. Output from system monitoring serves as input to continuous monitoring and incident response programs. A network connection is any connection with a device that communicates through a network (e.g., local area network, Internet). A remote connection is any connection with a device communicating through an external network (e.g., the Internet). Local, network, and remote connections can be either wired or wireless.

Related Controls: AC-3, AC-4, AC-8, AC-17, AU-2, AU-6, AU-7, AU-9, AU-12, CA-7, IR-4, PE-3, RA-5, SC-7, SC-26, SC-35, SI-3, SI-7

SI-4a.

Monitors the information system to detect:

SI-4a.1.

Attacks and indicators of potential attacks in accordance with [Assignment: organization-defined monitoring objectives]; and

SI-4a.2.

Unauthorized local, network, and remote connections;

SI-4b.

Identifies unauthorized use of the information system through [Assignment: organization-defined techniques and methods];

SI-4c.

Deploys monitoring devices:

SI-4c.1.

Strategically within the information system to collect organization-determined essential information; and

SI-4c.2.

At ad hoc locations within the system to track specific types of transactions of interest to the organization;

SI-4d.

Protects information obtained from intrusion-monitoring tools from unauthorized access, modification, and deletion;

SI-4e.

Heightens the level of information system monitoring activity whenever there is an indication of increased risk to organizational operations and assets, individuals, other organizations, or the Nation based on law enforcement information, intelligence information, or other credible sources of information;

SI-4f.

Obtains legal opinion with regard to information system monitoring activities in accordance with applicable federal laws, Executive Orders, directives, policies, or regulations; and

SI-4g.

Provides [Assignment: organization-defined information system monitoring information] to [Assignment: organization-defined personnel or roles] [Selection (one or more): as needed; [Assignment: organization-defined frequency]].

SI-4 (1) : SYSTEM-WIDE INTRUSION DETECTION SYSTEM

The organization connects and configures individual intrusion detection tools into an information system-wide intrusion detection system.

SI-4 (2) : AUTOMATED TOOLS FOR REAL-TIME ANALYSIS

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs automated tools to support near real-time analysis of events.

Note

Automated tools include, for example, host-based, network-based, transport-based, or storage-based event monitoring tools or Security Information and Event Management (SIEM) technologies that provide real time analysis of alerts and/or notifications generated by organizational information systems.

SI-4 (3) : AUTOMATED TOOL INTEGRATION

The organization employs automated tools to integrate intrusion detection tools into access control and flow control mechanisms for rapid response to attacks by enabling reconfiguration of these mechanisms in support of attack isolation and elimination.

SI-4 (4) : INBOUND AND OUTBOUND COMMUNICATIONS TRAFFIC

Baseline-Impact: *MODERATE*, **HIGH**

The information system monitors inbound and outbound communications traffic [Assignment: organization-defined frequency] for unusual or unauthorized activities or conditions.

Note

Unusual/unauthorized activities or conditions related to information system inbound and outbound communications traffic include, for example, internal traffic that indicates the presence of malicious code within organizational information systems or propagating among system components, the unauthorized exporting of information, or signaling to external information systems. Evidence of malicious code is used to identify potentially compromised information systems or information system components.

SI-4 (5) : SYSTEM-GENERATED ALERTS

Baseline-Impact: *MODERATE*, **HIGH**

The information system alerts [Assignment: organization-defined personnel or roles] when the following indications of compromise or potential compromise occur: [Assignment: organization-defined compromise indicators].

Note

Alerts may be generated from a variety of sources, including, for example, audit records or inputs from malicious code protection mechanisms, intrusion detection or prevention mechanisms, or boundary protection devices such as firewalls, gateways, and routers. Alerts can be transmitted, for example, telephonically, by electronic mail messages, or by text messaging. Organizational personnel on the notification list can include, for example, system administrators, mission/business owners, system owners, or information system security officers.

Related Controls: AU-5, PE-6

SI-4 (6) : RESTRICT NON-PRIVILEGED USERS

[Withdrawn: Incorporated into AC-6 (10)].

SI-4 (7) : AUTOMATED RESPONSE TO SUSPICIOUS EVENTS

The information system notifies [Assignment: organization-defined incident response personnel (identified by name and/or by role)] of detected suspicious events and takes [Assignment: organization-defined least-disruptive actions to terminate suspicious events].

Note

Least-disruptive actions may include, for example, initiating requests for human responses.

SI-4 (8) : PROTECTION OF MONITORING INFORMATION

[Withdrawn: Incorporated into SI-4].

SI-4 (9) : TESTING OF MONITORING TOOLS

The organization tests intrusion-monitoring tools [Assignment: organization-defined frequency].

Note

Testing intrusion-monitoring tools is necessary to ensure that the tools are operating correctly and continue to meet the monitoring objectives of organizations. The frequency of testing depends on the types of tools used by organizations and methods of deployment.

Related Controls: CP-9

SI-4 (10) : VISIBILITY OF ENCRYPTED COMMUNICATIONS

The organization makes provisions so that [Assignment: organization-defined encrypted communications traffic] is visible to [Assignment: organization-defined information system monitoring tools].

Note

Organizations balance the potentially conflicting needs for encrypting communications traffic and for having insight into such traffic from a monitoring perspective. For some organizations, the need to ensure the confidentiality of communications traffic is paramount; for others, mission-assurance is of greater concern. Organizations determine whether the visibility requirement applies to internal encrypted traffic, encrypted traffic intended for external destinations, or a subset of the traffic types.

SI-4 (11) : ANALYZE COMMUNICATIONS TRAFFIC ANOMALIES

The organization analyzes outbound communications traffic at the external boundary of the information system and selected [Assignment: organization-defined interior points within the system (e.g., subnetworks, subsystems)] to discover anomalies.

Note

Anomalies within organizational information systems include, for example, large file transfers, long-time persistent connections, unusual protocols and ports in use, and attempted communications with suspected malicious external addresses.

SI-4 (12) : AUTOMATED ALERTS

The organization employs automated mechanisms to alert security personnel of the following inappropriate or unusual activities with security implications: [Assignment: organization-defined activities that trigger alerts].

Note

This control enhancement focuses on the security alerts generated by organizations and transmitted using automated means. In contrast to the alerts generated by information systems in SI-4 (5), which

tend to focus on information sources internal to the systems (e.g., audit records), the sources of information for this enhancement can include other entities as well (e.g., suspicious activity reports, reports on potential insider threats).

Related Controls: AC-18, IA-3

SI-4 (13) : ANALYZE TRAFFIC / EVENT PATTERNS

The organization:

SI-4 (13)(a)

Analyzes communications traffic/event patterns for the information system;

SI-4 (13)(b)

Develops profiles representing common traffic patterns and/or events; and

SI-4 (13)(c)

Uses the traffic/event profiles in tuning system-monitoring devices to reduce the number of false positives and the number of false negatives.

SI-4 (14) : WIRELESS INTRUSION DETECTION

The organization employs a wireless intrusion detection system to identify rogue wireless devices and to detect attack attempts and potential compromises/breaches to the information system.

Note

Wireless signals may radiate beyond the confines of organization-controlled facilities. Organizations proactively search for unauthorized wireless connections including the conduct of thorough scans for unauthorized wireless access points. Scans are not limited to those areas within facilities containing information systems, but also include areas outside of facilities as needed, to verify that unauthorized wireless access points are not connected to the systems.

Related Controls: AC-18, IA-3

SI-4 (15) : WIRELESS TO WIRELINE COMMUNICATIONS

The organization employs an intrusion detection system to monitor wireless communications traffic as the traffic passes from wireless to wireline networks.

Related Controls: AC-18

SI-4 (16) : CORRELATE MONITORING INFORMATION

The organization correlates information from monitoring tools employed throughout the information system.

Note

Correlating information from different monitoring tools can provide a more comprehensive view of information system activity. The correlation of monitoring tools that usually work in isolation (e.g., host monitoring, network monitoring, anti-virus software) can provide an organization-wide view and in so doing, may reveal otherwise unseen attack patterns. Understanding the capabilities/limitations of diverse monitoring tools and how to maximize the utility of information generated by those tools can help organizations to build, operate, and maintain effective monitoring programs.

Related Controls: AU-6

SI-4 (17) : INTEGRATED SITUATIONAL AWARENESS

The organization correlates information from monitoring physical, cyber, and supply chain activities to achieve integrated, organization-wide situational awareness.

Note

This control enhancement correlates monitoring information from a more diverse set of information sources to achieve integrated situational awareness. Integrated situational awareness from a combination of physical, cyber, and supply chain monitoring activities enhances the capability of organizations to more quickly detect sophisticated cyber attacks and investigate the methods and techniques employed to carry out such attacks. In contrast to SI-4 (16) which correlates the various cyber monitoring information, this control enhancement correlates monitoring beyond just the cyber domain. Such monitoring may help reveal attacks on organizations that are operating across multiple attack vectors.

Related Controls: SA-12

SI-4 (18) : ANALYZE TRAFFIC / COVERT EXFILTRATION

The organization analyzes outbound communications traffic at the external boundary of the information system (i.e., system perimeter) and at [Assignment: organization-defined interior points within the system (e.g., subsystems, subnetworks)] to detect covert exfiltration of information.

Note

Covert means that can be used for the unauthorized exfiltration of organizational information include, for example, steganography.

SI-4 (19) : INDIVIDUALS POSING GREATER RISK

The organization implements [Assignment: organization-defined additional monitoring] of individuals who have been identified by [Assignment: organization-defined sources] as posing an increased level of risk.

Note

Indications of increased risk from individuals can be obtained from a variety of sources including, for example, human resource records, intelligence agencies, law enforcement organizations, and/or other credible sources. The monitoring of individuals is closely coordinated with management, legal, security, and human resources officials within organizations conducting such monitoring and complies with federal legislation, Executive Orders, policies, directives, regulations, and standards.

SI-4 (20) : PRIVILEGED USERS

The organization implements [Assignment: organization-defined additional monitoring] of privileged users.

SI-4 (21) : PROBATIONARY PERIODS

The organization implements [Assignment: organization-defined additional monitoring] of individuals during [Assignment: organization-defined probationary period].

SI-4 (22) : UNAUTHORIZED NETWORK SERVICES

The information system detects network services that have not been authorized or approved by [Assignment: organization-defined authorization or approval processes] and [Selection (one or more): audits; alerts [Assignment: organization-defined personnel or roles]].

Note

Unauthorized or unapproved network services include, for example, services in service-oriented architectures that lack organizational verification or validation and therefore may be unreliable or serve as malicious rogues for valid services.

Related Controls: AC-6, CM-7, SA-5, SA-9

SI-4 (23) : HOST-BASED DEVICES

The organization implements [Assignment: organization-defined host-based monitoring mechanisms] at [Assignment: organization-defined information system components].

Note

Information system components where host-based monitoring can be implemented include, for example, servers, workstations, and mobile devices. Organizations consider employing host-based monitoring mechanisms from multiple information technology product developers.

SI-4 (24) : INDICATORS OF COMPROMISE

The information system discovers, collects, distributes, and uses indicators of compromise.

Note

Indicators of compromise (IOC) are forensic artifacts from intrusions that are identified on organizational information systems (at the host or network level). IOCs provide organizations with valuable information on objects or information systems that have been compromised. IOCs for the discovery of compromised hosts can include for example, the creation of registry key values. IOCs for network traffic include, for example, Universal Resource Locator (URL) or protocol elements that indicate malware command and control servers. The rapid distribution and adoption of IOCs can improve information security by reducing the time that information systems and organizations are vulnerable to the same exploit or attack.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-5 : SECURITY ALERTS, ADVISORIES, AND DIRECTIVES

Priority: P1

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization:

Note

The United States Computer Emergency Readiness Team (US-CERT) generates security alerts and advisories to maintain situational awareness across the federal government. Security directives are issued by OMB or other designated organizations with the responsibility and authority to issue such directives. Compliance to security directives is essential due to the critical nature of many of these directives and the potential immediate adverse effects on organizational operations and assets, individuals, other organizations, and the Nation should the directives not be implemented in a timely manner. External organizations include, for example, external mission/business partners, supply chain partners, external service providers, and other peer/supporting organizations.

Related Controls: SI-2

SI-5a.

Receives information system security alerts, advisories, and directives from [Assignment: organization-defined external organizations] on an ongoing basis;

SI-5b.

Generates internal security alerts, advisories, and directives as deemed necessary;

SI-5c.

Disseminates security alerts, advisories, and directives to: [Selection (one or more): [Assignment: organization-defined personnel or roles]; [Assignment: organization-defined elements within the organization]; [Assignment: organization-defined external organizations]]; and

SI-5d.

Implements security directives in accordance with established time frames, or notifies the issuing organization of the degree of noncompliance.

SI-5 (1) : AUTOMATED ALERTS AND ADVISORIES

Baseline-Impact: HIGH

The organization employs automated mechanisms to make security alert and advisory information available throughout the organization.

Note

The significant number of changes to organizational information systems and the environments in which those systems operate requires the dissemination of security-related information to a variety of organizational entities that have a direct interest in the success of organizational missions and business functions. Based on the information provided by the security alerts and advisories, changes may be required at one or more of the three tiers related to the management of information security risk including the governance level, mission/business process/enterprise architecture level, and the information system level.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-6 : SECURITY FUNCTION VERIFICATION

Priority: P1

Baseline-Impact: HIGH

The information system:

Note

Transitional states for information systems include, for example, system startup, restart, shutdown, and abort. Notifications provided by information systems include, for example, electronic alerts to system administrators, messages to local computer consoles, and/or hardware indications such as lights.

Related Controls: CA-7, CM-6

SI-6a.

Verifies the correct operation of [Assignment: organization-defined security functions];

SI-6b.

Performs this verification [Selection (one or more): [Assignment: organization-defined system transitional states]; upon command by user with appropriate privilege; [Assignment: organization-defined frequency]];

SI-6c.

Notifies [Assignment: organization-defined personnel or roles] of failed security verification tests; and

SI-6d.

[Selection (one or more): shuts the information system down; restarts the information system; [Assignment: organization-defined alternative action(s)]] when anomalies are discovered.

SI-6 (1) : NOTIFICATION OF FAILED SECURITY TESTS

[Withdrawn: Incorporated into SI-6].

SI-6 (2) : AUTOMATION SUPPORT FOR DISTRIBUTED TESTING

The information system implements automated mechanisms to support the management of distributed security testing.

Related Controls: SI-2

SI-6 (3) : REPORT VERIFICATION RESULTS

The organization reports the results of security function verification to [Assignment: organization-defined personnel or roles].

Note

Organizational personnel with potential interest in security function verification results include, for example, senior information security officers, information system security managers, and information systems security officers.

Related Controls: SA-12, SI-4, SI-5

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-7 : SOFTWARE, FIRMWARE, AND INFORMATION INTEGRITY

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The organization employs integrity verification tools to detect unauthorized changes to [Assignment: organization-defined software, firmware, and information].

Note

Unauthorized changes to software, firmware, and information can occur due to errors or malicious activity (e.g., tampering). Software includes, for example, operating systems (with key internal components such as kernels, drivers), middleware, and applications. Firmware includes, for example, the Basic Input Output System (BIOS). Information includes metadata such as security attributes associated with information. State-of-the-practice integrity-checking mechanisms (e.g., parity checks, cyclical redundancy checks, cryptographic hashes) and associated tools can automatically monitor the integrity of information systems and hosted applications.

Related Controls: SA-12, SC-8, SC-13, SI-3

SI-7 (1) : INTEGRITY CHECKS

Baseline-Impact: *MODERATE*, **HIGH**

The information system performs an integrity check of [Assignment: organization-defined software, firmware, and information] [Selection (one or more): at startup; at [Assignment: organization-defined transitional states or security-relevant events]; [Assignment: organization-defined frequency]].

Note

Security-relevant events include, for example, the identification of a new threat to which organizational information systems are susceptible, and the installation of new hardware, software, or firmware. Transitional states include, for example, system startup, restart, shutdown, and abort.

SI-7 (2) : AUTOMATED NOTIFICATIONS OF INTEGRITY VIOLATIONS

Baseline-Impact: HIGH

The organization employs automated tools that provide notification to [Assignment: organization-defined personnel or roles] upon discovering discrepancies during integrity verification.

Note

The use of automated tools to report integrity violations and to notify organizational personnel in a timely matter is an essential precursor to effective risk response. Personnel having an interest in integrity violations include, for example, mission/business owners, information system owners, systems administrators, software developers, systems integrators, and information security officers.

SI-7 (3) : CENTRALLY-MANAGED INTEGRITY TOOLS

The organization employs centrally managed integrity verification tools.

Related Controls: AU-3, SI-2, SI-8

SI-7 (4) : TAMPER-EVIDENT PACKAGING

[Withdrawn: Incorporated into SA-12].

SI-7 (5) : AUTOMATED RESPONSE TO INTEGRITY VIOLATIONS

Baseline-Impact: HIGH

The information system automatically [Selection (one or more): shuts the information system down; restarts the information system; implements [Assignment: organization-defined security safeguards]] when integrity violations are discovered.

Note

Organizations may define different integrity checking and anomaly responses: (i) by type of information (e.g., firmware, software, user data); (ii) by specific information (e.g., boot firmware, boot firmware for a specific types of machines); or (iii) a combination of both. Automatic implementation of specific safeguards within organizational information systems includes, for example, reversing the changes, halting the information system, or triggering audit alerts when unauthorized modifications to critical security files occur.

SI-7 (6) : CRYPTOGRAPHIC PROTECTION

The information system implements cryptographic mechanisms to detect unauthorized changes to software, firmware, and information.

Note

Cryptographic mechanisms used for the protection of integrity include, for example, digital signatures and the computation and application of signed hashes using asymmetric cryptography, protecting the confidentiality of the key used to generate the hash, and using the public key to verify the hash information.

Related Controls: SC-13

SI-7 (7) : INTEGRATION OF DETECTION AND RESPONSE

Baseline-Impact: *MODERATE*, **HIGH**

The organization incorporates the detection of unauthorized [Assignment: organization-defined security-relevant changes to the information system] into the organizational incident response capability.

Note

This control enhancement helps to ensure that detected events are tracked, monitored, corrected, and available for historical purposes. Maintaining historical records is important both for being able to identify and discern adversary actions over an extended period of time and for possible legal actions. Security-relevant changes include, for example, unauthorized changes to established configuration settings or unauthorized elevation of information system privileges.

Related Controls: IR-4, IR-5, SI-4

SI-7 (8) : AUDITING CAPABILITY FOR SIGNIFICANT EVENTS

The information system, upon detection of a potential integrity violation, provides the capability to audit the event and initiates the following actions: [Selection (one or more): generates an audit record; alerts current user; alerts [Assignment: organization-defined personnel or roles]; [Assignment: organization-defined other actions]].

Note

Organizations select response actions based on types of software, specific software, or information for which there are potential integrity violations.

Related Controls: AU-2, AU-6, AU-12

SI-7 (9) : VERIFY BOOT PROCESS

The information system verifies the integrity of the boot process of [Assignment: organization-defined devices].

Note

Ensuring the integrity of boot processes is critical to starting devices in known/trustworthy states. Integrity verification mechanisms provide organizational personnel with assurance that only trusted code is executed during boot processes.

SI-7 (10) : PROTECTION OF BOOT FIRMWARE

The information system implements [Assignment: organization-defined security safeguards] to protect the integrity of boot firmware in [Assignment: organization-defined devices].

Note

Unauthorized modifications to boot firmware may be indicative of a sophisticated, targeted cyber attack. These types of cyber attacks can result in a permanent denial of service (e.g., if the firmware is corrupted) or a persistent malicious code presence (e.g., if code is embedded within the firmware). Devices can protect the integrity of the boot firmware in organizational information systems by: (i) verifying the integrity and authenticity of all updates to the boot firmware prior to applying changes to the boot devices; and (ii) preventing unauthorized processes from modifying the boot firmware.

SI-7 (11) : CONFINED ENVIRONMENTS WITH LIMITED PRIVILEGES

The organization requires that [Assignment: organization-defined user-installed software] execute in a confined physical or virtual machine environment with limited privileges.

Note

Organizations identify software that may be of greater concern with regard to origin or potential for containing malicious code. For this type of software, user installations occur in confined environments of operation to limit or contain damage from malicious code that may be executed.

SI-7 (12) : INTEGRITY VERIFICATION

The organization requires that the integrity of [Assignment: organization-defined user-installed software] be verified prior to execution.

Note

Organizations verify the integrity of user-installed software prior to execution to reduce the likelihood of executing malicious code or code that contains errors from unauthorized modifications. Organizations consider the practicality of approaches to verifying software integrity including, for example, availability of checksums of adequate trustworthiness from software developers or vendors.

SI-7 (13) : CODE EXECUTION IN PROTECTED ENVIRONMENTS

The organization allows execution of binary or machine-executable code obtained from sources with limited or no warranty and without the provision of source code only in confined physical or virtual machine environments and with the explicit approval of [Assignment: organization-defined personnel or roles].

Note

This control enhancement applies to all sources of binary or machine-executable code including, for example, commercial software/firmware and open source software.

SI-7 (14) : BINARY OR MACHINE EXECUTABLE CODE

Baseline-Impact: HIGH

The organization:

Note

This control enhancement applies to all sources of binary or machine-executable code including, for example, commercial software/firmware and open source software. Organizations assess software products without accompanying source code from sources with limited or no warranty for potential security impacts. The assessments address the fact that these types of software products may be very difficult to review, repair, or extend, given that organizations, in most cases, do not have access to the original source code, and there may be no owners who could make such repairs on behalf of organizations.

Related Controls: SA-5

SI-7 (14)(a)

Prohibits the use of binary or machine-executable code from sources with limited or no warranty and without the provision of source code; and

SI-7 (14)(b)

Provides exceptions to the source code requirement only for compelling mission/operational requirements and with the approval of the authorizing official.

SI-7 (15) : CODE AUTHENTICATION

The information system implements cryptographic mechanisms to authenticate [Assignment: organization-defined software or firmware components] prior to installation.

Note

Cryptographic authentication includes, for example, verifying that software or firmware components have been digitally signed using certificates recognized and approved by organizations. Code signing is an effective method to protect against malicious code.

SI-7 (16) : TIME LIMIT ON PROCESS EXECUTION W/O SUPERVISION

The organization does not allow processes to execute without supervision for more than [Assignment: organization-defined time period].

Note

This control enhancement addresses processes for which normal execution periods can be determined and situations in which organizations exceed such periods. Supervision includes, for example, operating system timers, automated responses, or manual oversight and response when information system process anomalies occur.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-8 : SPAM PROTECTION

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The organization:

Note

Information system entry and exit points include, for example, firewalls, electronic mail servers, web servers, proxy servers, remote-access servers, workstations, mobile devices, and notebook/laptop computers. Spam can be transported by different means including, for example, electronic mail, electronic mail attachments, and web accesses. Spam protection mechanisms include, for example, signature definitions.

Related Controls: AT-2, AT-3, SC-5, SC-7, SI-3

SI-8a.

Employs spam protection mechanisms at information system entry and exit points to detect and take action on unsolicited messages; and

SI-8b.

Updates spam protection mechanisms when new releases are available in accordance with organizational configuration management policy and procedures.

SI-8 (1) : CENTRAL MANAGEMENT

Baseline-Impact: *MODERATE*, **HIGH**

The organization centrally manages spam protection mechanisms.

Note

Central management is the organization-wide management and implementation of spam protection mechanisms. Central management includes planning, implementing, assessing, authorizing, and monitoring the organization-defined, centrally managed spam protection security controls.

Related Controls: AU-3, SI-2, SI-7

SI-8 (2) : AUTOMATIC UPDATES

Baseline-Impact: *MODERATE*, **HIGH**

The information system automatically updates spam protection mechanisms.

SI-8 (3) : CONTINUOUS LEARNING CAPABILITY

The information system implements spam protection mechanisms with a learning capability to more effectively identify legitimate communications traffic.

Note

Learning mechanisms include, for example, Bayesian filters that respond to user inputs identifying specific traffic as spam or legitimate by updating algorithm parameters and thereby more accurately separating types of traffic.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-9 : INFORMATION INPUT RESTRICTIONS

[Withdrawn: Incorporated into AC-2, AC-3, AC-5, AC-6].

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-10 : INFORMATION INPUT VALIDATION

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system checks the validity of [Assignment: organization-defined information inputs].

Note

Checking the valid syntax and semantics of information system inputs (e.g., character set, length, numerical range, and acceptable values) verifies that inputs match specified definitions for format and content. Software applications typically follow well-defined protocols that use structured messages (i.e., commands or queries) to communicate between software modules or system components. Structured messages can contain raw or unstructured data interspersed with metadata or control information. If software applications use attacker-supplied inputs to construct structured messages without properly encoding such messages, then the attacker could insert malicious commands or special characters that can cause the data to be interpreted as control information or metadata. Consequently, the module or component that receives the tainted output will perform the

wrong operations or otherwise interpret the data incorrectly. Prescreening inputs prior to passing to interpreters prevents the content from being unintentionally interpreted as commands. Input validation helps to ensure accurate and correct inputs and prevent attacks such as cross-site scripting and a variety of injection attacks.

SI-10 (1) : MANUAL OVERRIDE CAPABILITY

The information system:

Related Controls: CM-3, CM-5

SI-10 (1)(a)

Provides a manual override capability for input validation of [Assignment: organization-defined inputs];

SI-10 (1)(b)

Restricts the use of the manual override capability to only [Assignment: organization-defined authorized individuals]; and

SI-10 (1)(c)

Audits the use of the manual override capability.

SI-10 (2) : REVIEW / RESOLUTION OF ERRORS

The organization ensures that input validation errors are reviewed and resolved within [Assignment: organization-defined time period].

Note

Resolution of input validation errors includes, for example, correcting systemic causes of errors and resubmitting transactions with corrected input.

SI-10 (3) : PREDICTABLE BEHAVIOR

The information system behaves in a predictable and documented manner that reflects organizational and system objectives when invalid inputs are received.

Note

A common vulnerability in organizational information systems is unpredictable behavior when invalid inputs are received. This control enhancement ensures that there is predictable behavior in the face of invalid inputs by specifying information system responses that facilitate transitioning the system to known states without adverse, unintended side effects.

SI-10 (4) : REVIEW / TIMING INTERACTIONS

The organization accounts for timing interactions among information system components in determining appropriate responses for invalid inputs.

Note

In addressing invalid information system inputs received across protocol interfaces, timing interactions become relevant, where one protocol needs to consider the impact of the error response on other protocols within the protocol stack. For example, 802.11 standard wireless network protocols do not interact well with Transmission Control Protocols (TCP) when packets are dropped (which could be due to invalid packet input). TCP assumes packet losses are due to congestion, while packets lost over 802.11 links are typically dropped due to collisions or noise on the link. If TCP makes a congestion response, it takes precisely the wrong action in response to a collision event. Adversaries may be able to use apparently acceptable individual behaviors of the protocols in concert to achieve adverse effects through suitable construction of invalid input.

SI-10 (5) : RESTRICT INPUTS TO TRUSTED SOURCES AND APPROVED FORMATS

The organization restricts the use of information inputs to [Assignment: organization-defined trusted sources] and/or [Assignment: organization-defined formats].

Note

This control enhancement applies the concept of whitelisting to information inputs. Specifying known trusted sources for information inputs and acceptable formats for such inputs can reduce the probability of malicious activity.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-11 : ERROR HANDLING

Priority: P2

Baseline-Impact: *MODERATE*, **HIGH**

The information system:

Note

Organizations carefully consider the structure/content of error messages. The extent to which information systems are able to identify and handle error conditions is guided by organizational policy and operational requirements. Information that could be exploited by adversaries includes, for example, erroneous logon attempts with passwords entered by mistake as the username, mission/business information that can be derived from (if not stated explicitly by) information recorded, and personal information such as account numbers, social security numbers, and credit card numbers. In addition, error messages may provide a covert channel for transmitting information.

Related Controls: AU-2, AU-3, SC-31

SI-11a.

Generates error messages that provide information necessary for corrective actions without revealing information that could be exploited by adversaries; and

SI-11b.

Reveals error messages only to [Assignment: organization-defined personnel or roles].

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-12 : INFORMATION HANDLING AND RETENTION

Priority: P2

Baseline-Impact: LOW, *MODERATE*, **HIGH**

The organization handles and retains information within the information system and information output from the system in accordance with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and operational requirements.

Note

Information handling and retention requirements cover the full life cycle of information, in some cases extending beyond the disposal of information systems. The National Archives and Records Administration provides guidance on records retention.

Related Controls: AC-16, AU-5, AU-11, MP-2, MP-4

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-13 : PREDICTABLE FAILURE PREVENTION

Priority: P0

The organization:

Note

While MTTF is primarily a reliability issue, this control addresses potential failures of specific information system components that provide security capability. Failure rates reflect installation-specific consideration, not industry-average. Organizations define criteria for substitution of information system components based on MTTF value with consideration for resulting potential harm from component failures. Transfer of responsibilities between active and standby components does not compromise safety, operational readiness, or security capability (e.g., preservation of state variables). Standby components remain available at all times except for maintenance issues or recovery failures in progress.

Related Controls: CP-2, CP-10, MA-6

SI-13a.

Determines mean time to failure (MTTF) for [Assignment: organization-defined information system components] in specific environments of operation; and

SI-13b.

Provides substitute information system components and a means to exchange active and standby components at [Assignment: organization-defined MTTF substitution criteria].

SI-13 (1) : TRANSFERRING COMPONENT RESPONSIBILITIES

The organization takes information system components out of service by transferring component responsibilities to substitute components no later than [Assignment: organization-defined fraction or percentage] of mean time to failure.

SI-13 (2) : TIME LIMIT ON PROCESS EXECUTION WITHOUT SUPERVISION

[Withdrawn: Incorporated into SI-7 (16)].

SI-13 (3) : MANUAL TRANSFER BETWEEN COMPONENTS

The organization manually initiates transfers between active and standby information system components [Assignment: organization-defined frequency] if the mean time to failure exceeds [Assignment: organization-defined time period].

SI-13 (4) : STANDBY COMPONENT INSTALLATION / NOTIFICATION

The organization, if information system component failures are detected:

Note

Automatic or manual transfer of components from standby to active mode can occur, for example, upon detection of component failures.

SI-13 (4)(a)

Ensures that the standby components are successfully and transparently installed within [Assignment: organization-defined time period]; and

SI-13 (4)(b)

[Selection (one or more): activates [Assignment: organization-defined alarm]; automatically shuts down the information system].

SI-13 (5) : FAILOVER CAPABILITY

The organization provides [Selection: real-time; near real-time] [Assignment: organization-defined failover capability] for the information system.

Note

Failover refers to the automatic switchover to an alternate information system upon the failure of the primary information system. Failover capability includes, for example, incorporating mirrored information system operations at alternate processing sites or periodic data mirroring at regular intervals defined by recovery time periods of organizations.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-14 : NON-PERSISTENCE

Priority: P0

The organization implements non-persistent [Assignment: organization-defined information system components and services] that are initiated in a known state and terminated [Selection (one or more): upon end of session of use; periodically at [Assignment: organization-defined frequency]].

Note

This control mitigates risk from advanced persistent threats (APTs) by significantly reducing the targeting capability of adversaries (i.e., window of opportunity and available attack surface) to initiate and complete cyber attacks. By implementing the concept of non-persistence for selected information system components, organizations can provide a known state computing resource for a specific period of time that does not give adversaries sufficient time on target to exploit vulnerabilities in organizational information systems and the environments in which those systems operate. Since the advanced persistent threat is a high-end threat with regard to capability, intent, and targeting, organizations assume that over an extended period of time, a percentage of cyber attacks will be successful. Non-persistent information system components and services are activated as required using protected information and terminated periodically or upon the end of sessions. Non-persistence increases the work factor of adversaries in attempting to compromise or breach organizational information systems.

Non-persistent system components can be implemented, for example, by periodically re-imaging components or by using a variety of common virtualization techniques. Non-persistent services can be implemented using virtualization techniques as part of virtual machines or as new instances of processes on physical machines (either persistent or non-persistent).The benefit of periodic refreshes of information system components/services is that it does not require organizations to first determine whether compromises of components or services have occurred (something that may often be difficult for organizations to determine). The refresh of selected information system components and services occurs with sufficient frequency to prevent the spread or intended impact of attacks, but not with such frequency that it makes the information system unstable. In some instances, refreshes of critical components and services may be done periodically in order to hinder the ability of adversaries to exploit optimum windows of vulnerabilities.

Related Controls: SC-30, SC-34

SI-14 (1) : REFRESH FROM TRUSTED SOURCES

The organization ensures that software and data employed during information system component and service refreshes are obtained from [Assignment: organization-defined trusted sources].

Note

Trusted sources include, for example, software/data from write-once, read-only media or from selected off-line secure storage facilities.

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-15 : INFORMATION OUTPUT FILTERING

Priority: P0

The information system validates information output from [Assignment: organization-defined software programs and/or applications] to ensure that the information is consistent with the expected content.

Note

Certain types of cyber attacks (e.g., SQL injections) produce output results that are unexpected or inconsistent with the output results that would normally be expected from software programs or applications. This control enhancement focuses on detecting extraneous content, preventing such extraneous content from being displayed, and alerting monitoring tools that anomalous behavior has been discovered.

Related Controls: SI-3, SI-4

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-16 : MEMORY PROTECTION

Priority: P1

Baseline-Impact: *MODERATE*, **HIGH**

The information system implements [Assignment: organization-defined security safeguards] to protect its memory from unauthorized code execution.

Note

Some adversaries launch attacks with the intent of executing code in non-executable regions of memory or in memory locations that are prohibited. Security safeguards employed to protect memory include, for example, data execution prevention and address space layout randomization. Data execution prevention safeguards can either be hardware-enforced or software-enforced with hardware providing the greater strength of mechanism.

Related Controls: AC-25, SC-3

Control Family: SYSTEM AND INFORMATION INTEGRITY

SI-17 : FAIL-SAFE PROCEDURES

Priority: P0

The information system implements [Assignment: organization-defined fail-safe procedures] when [Assignment: organization-defined failure conditions occur].

Note

Failure conditions include, for example, loss of communications among critical system components or between system components and operational facilities. Fail-safe procedures include, for example, alerting operator personnel and providing specific instructions on subsequent steps to take (e.g., do nothing, reestablish system settings, shut down processes, restart the system, or contact designated organizational personnel).

Related Controls: CP-12, CP-13, SC-24, SI-13

Control Family: PROGRAM MANAGEMENT

PM-1 : INFORMATION SECURITY PROGRAM PLAN

The organization:

Note

Information security program plans can be represented in single documents or compilations of documents at the discretion of organizations. The plans document the program management controls and organization-defined common controls. Information security program plans provide sufficient information about the program management controls/common controls (including specification of parameters for any assignment and selection statements either explicitly or by reference) to enable implementations that are unambiguously compliant with the intent of the plans and a determination of the risk to be incurred if the plans are implemented as intended.

The security plans for individual information systems and the organization-wide information security program plan together, provide complete coverage for all security controls employed within the organization. Common controls are documented in an appendix to the organization's information security program plan unless the controls are included in a separate security plan for an information system (e.g., security controls employed as part of an intrusion detection system providing organization-wide boundary protection inherited by one or more organizational information systems). The organization-wide information security program plan will indicate which separate security plans contain descriptions of common controls. Organizations have the flexibility to describe common controls in a single document or in multiple documents. In the case of multiple documents, the documents describing common controls are included as attachments to the information security program plan. If the information security program plan contains multiple documents, the organization specifies in each document the organizational official or officials responsible for the development, implementation, assessment, authorization, and monitoring of the respective common controls. For example, the organization may require that the Facilities Management Office develop, implement, assess, authorize, and continuously monitor common physical and environmental protection controls from the PE family when such controls are not associated with a particular information system but instead, support multiple information systems.

Related Controls: PM-8

PM-1a.

Develops and disseminates an organization-wide information security program plan that:

PM-1a.1.

Provides an overview of the requirements for the security program and a description of the security program management controls and common controls in place or planned for meeting those requirements;

PM-1a.2.

Includes the identification and assignment of roles, responsibilities, management commitment, coordination among organizational entities, and compliance;

PM-1a.3.

Reflects coordination among organizational entities responsible for the different aspects of information security (i.e., technical, physical, personnel, cyber-physical); and

PM-1a.4.

Is approved by a senior official with responsibility and accountability for the risk being incurred to organizational operations (including mission, functions, image, and reputation), organizational assets, individuals, other organizations, and the Nation;

PM-1b.

Reviews the organization-wide information security program plan [Assignment: organization-defined frequency];

PM-1c.

Updates the plan to address organizational changes and problems identified during plan implementation or security control assessments; and

PM-1d.

Protects the information security program plan from unauthorized disclosure and modification.

Control Family: PROGRAM MANAGEMENT

PM-2 : SENIOR INFORMATION SECURITY OFFICER

The organization appoints a senior information security officer with the mission and resources to coordinate, develop, implement, and maintain an organization-wide information security program.

Note

The security officer described in this control is an organizational official. For a federal agency (as defined in applicable federal laws, Executive Orders, directives, policies, or regulations) this official is the Senior Agency Information Security Officer. Organizations may also refer to this official as the Senior Information Security Officer or Chief Information Security Officer.

Control Family: PROGRAM MANAGEMENT

PM-3 : INFORMATION SECURITY RESOURCES

The organization:

Note

Organizations consider establishing champions for information security efforts and as part of including the necessary resources, assign specialized expertise and resources as needed. Organizations may designate and empower an Investment Review Board (or similar group) to manage and provide oversight for the information security-related aspects of the capital planning and investment control process.

Related Controls: PM-4, SA-2

PM-3a.

Ensures that all capital planning and investment requests include the resources needed to implement the information security program and documents all exceptions to this requirement;

PM-3b.

Employs a business case/Exhibit 300/Exhibit 53 to record the resources required; and

PM-3c.

Ensures that information security resources are available for expenditure as planned.

Control Family: PROGRAM MANAGEMENT

PM-4 : PLAN OF ACTION AND MILESTONES PROCESS

The organization:

Note

The plan of action and milestones is a key document in the information security program and is subject to federal reporting requirements established by OMB. With the increasing emphasis on organization-wide risk management across all three tiers in the risk management hierarchy (i.e., organization, mission/business process, and information system), organizations view plans of action and milestones from an organizational perspective, prioritizing risk response actions and ensuring consistency with the goals and objectives of the organization. Plan of action and milestones updates are based on findings from security control assessments and continuous monitoring activities. OMB FISMA reporting guidance contains instructions regarding organizational plans of action and milestones.

Related Controls: CA-5

PM-4a.

Implements a process for ensuring that plans of action and milestones for the security program and associated organizational information systems:

PM-4a.1.

Are developed and maintained;

PM-4a.2.

Document the remedial information security actions to adequately respond to risk to organizational operations and assets, individuals, other organizations, and the Nation; and

PM-4a.3.

Are reported in accordance with OMB FISMA reporting requirements.

PM-4b.

Reviews plans of action and milestones for consistency with the organizational risk management strategy and organization-wide priorities for risk response actions.

Control Family: PROGRAM MANAGEMENT

PM-5 : INFORMATION SYSTEM INVENTORY

The organization develops and maintains an inventory of its information systems.

Note

This control addresses the inventory requirements in FISMA. OMB provides guidance on developing information systems inventories and associated reporting requirements. For specific information system inventory reporting requirements, organizations consult OMB annual FISMA reporting guidance.

Control Family: PROGRAM MANAGEMENT

PM-6 : INFORMATION SECURITY MEASURES OF PERFORMANCE

The organization develops, monitors, and reports on the results of information security measures of performance.

Note

Measures of performance are outcome-based metrics used by an organization to measure the effectiveness or efficiency of the information security program and the security controls employed in support of the program.

Control Family: PROGRAM MANAGEMENT

PM-7 : ENTERPRISE ARCHITECTURE

The organization develops an enterprise architecture with consideration for information security and the resulting risk to organizational operations, organizational assets, individuals, other organizations, and the Nation.

Note

The enterprise architecture developed by the organization is aligned with the Federal Enterprise Architecture. The integration of information security requirements and associated security controls into the organization's enterprise architecture helps to ensure that security considerations are addressed by organizations early in the system development life cycle and are directly and explicitly related to the organization's mission/business processes. This process of security requirements integration also embeds into the enterprise architecture, an integral information security architecture consistent with organizational risk management and information security strategies. For PM-7, the information security architecture is developed at a system-of-systems level (organization-wide), representing all of the organizational information systems. For PL-8, the information security architecture is developed at a level representing an individual information system but at the same time, is consistent with the information security architecture defined for the organization. Security requirements and security control integration are most effectively accomplished through the application of the Risk Management Framework and supporting security standards and guidelines. The Federal Segment Architecture Methodology provides guidance on integrating information security requirements and security controls into enterprise architectures.

Related Controls: PL-2, PL-8, PM-11, RA-2, SA-3

Control Family: PROGRAM MANAGEMENT

PM-8 : CRITICAL INFRASTRUCTURE PLAN

The organization addresses information security issues in the development, documentation, and updating of a critical infrastructure and key resources protection plan.

Note

Protection strategies are based on the prioritization of critical assets and resources. The requirement and guidance for defining critical infrastructure and key resources and for preparing an associated critical infrastructure protection plan are found in applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance.

Related Controls: PM-1, PM-9, PM-11, RA-3

Control Family: PROGRAM MANAGEMENT

PM-9 : RISK MANAGEMENT STRATEGY

The organization:

Note

An organization-wide risk management strategy includes, for example, an unambiguous expression of the risk tolerance for the organization, acceptable risk assessment methodologies, risk mitigation strategies, a process for consistently evaluating risk across the organization with respect to the organization's risk tolerance, and approaches for monitoring risk over time. The use of a risk executive function can facilitate consistent, organization-wide application of the risk management strategy. The organization-wide risk management strategy can be informed by risk-related inputs from other sources both internal and external to the organization to ensure the strategy is both broad-based and comprehensive.

Related Controls: RA-3

PM-9a.

Develops a comprehensive strategy to manage risk to organizational operations and assets, individuals, other organizations, and the Nation associated with the operation and use of information systems;

PM-9b.

Implements the risk management strategy consistently across the organization; and

PM-9c.

Reviews and updates the risk management strategy [Assignment: organization-defined frequency] or as required, to address organizational changes.

Control Family: PROGRAM MANAGEMENT

PM-10 : SECURITY AUTHORIZATION PROCESS

The organization:

Note

Security authorization processes for information systems and environments of operation require the implementation of an organization-wide risk management process, a Risk Management Framework, and associated security standards and guidelines. Specific roles within the risk management process include an organizational risk executive (function) and designated authorizing officials for each organizational information system and common control provider. Security authorization processes are integrated with organizational continuous monitoring processes to facilitate ongoing understanding and acceptance of risk to organizational operations and assets, individuals, other organizations, and the Nation.

Related Controls: CA-6

PM-10a.

Manages (i.e., documents, tracks, and reports) the security state of organizational information systems and the environments in which those systems operate through security authorization processes;

PM-10b.

Designates individuals to fulfill specific roles and responsibilities within the organizational risk management process; and

PM-10c.

Fully integrates the security authorization processes into an organization-wide risk management program.

Control Family: PROGRAM MANAGEMENT

PM-11 : MISSION/BUSINESS PROCESS DEFINITION

The organization:

Note

Information protection needs are technology-independent, required capabilities to counter threats to organizations, individuals, or the Nation through the compromise of information (i.e., loss of confidentiality, integrity, or availability). Information protection needs are derived from the mission/business needs defined by the organization, the mission/business processes selected to meet the stated needs, and the organizational risk management strategy. Information protection needs determine the required security controls for the organization and the associated information systems supporting the mission/business processes. Inherent in defining an organization's information protection needs is an understanding of the level of adverse impact that could result if a compromise of information occurs. The security categorization process is used to make such potential impact determinations. Mission/business process definitions and associated information protection requirements are documented by the organization in accordance with organizational policy and procedure.

Related Controls: PM-7, PM-8, RA-2

PM-11a.

Defines mission/business processes with consideration for information security and the resulting risk to organizational operations, organizational assets, individuals, other organizations, and the Nation; and

PM-11b.

Determines information protection needs arising from the defined mission/business processes and revises the processes as necessary, until achievable protection needs are obtained.

Control Family: PROGRAM MANAGEMENT

PM-12 : INSIDER THREAT PROGRAM

The organization implements an insider threat program that includes a cross-discipline insider threat incident handling team.

Note

Organizations handling classified information are required, under Executive Order 13587 and the National Policy on Insider Threat, to establish insider threat programs. The standards and guidelines that apply to insider threat programs in classified environments can also be employed effectively to improve the security of Controlled Unclassified Information in non-national security systems. Insider threat programs include security controls to detect and prevent malicious insider activity through the centralized integration and analysis of both technical and non-technical information to identify potential insider threat concerns. A senior organizational official is designated by the department/agency head as the responsible individual to implement and provide oversight for the program. In addition to the centralized integration and analysis capability, insider threat programs as a minimum, prepare department/agency insider threat policies and implementation plans, conduct host-based user monitoring of individual employee activities on government-owned classified computers, provide insider threat awareness training to employees, receive access to information from all offices within the department/agency (e.g., human resources, legal, physical security, personnel security, information technology, information system security, and law enforcement) for insider threat analysis, and conduct self-assessments of department/agency insider threat posture.

Insider threat programs can leverage the existence of incident handling teams organizations may already have in place, such as computer security incident response teams. Human resources records are especially important in this effort, as there is compelling evidence to show that some types of insider crimes are often preceded by nontechnical behaviors in the workplace (e.g., ongoing patterns of disgruntled behavior and conflicts with coworkers and other colleagues). These precursors can better inform and guide organizational officials in more focused, targeted monitoring efforts. The participation of a legal team is important to ensure that all monitoring activities are performed in accordance with appropriate legislation, directives, regulations, policies, standards, and guidelines.

Related Controls: AC-6, AT-2, AU-6, AU-7, AU-10, AU-12, AU-13, CA-7, IA-4, IR-4, MP-7, PE-2, PS-3, PS-4, PS-5, PS-8, SC-7, SC-38, SI-4, PM-1, PM-14

Control Family: PROGRAM MANAGEMENT

PM-13 : INFORMATION SECURITY WORKFORCE

The organization establishes an information security workforce development and improvement program.

Note

Information security workforce development and improvement programs include, for example: (i) defining the knowledge and skill levels needed to perform information security duties and tasks; (ii) developing role-based training programs for individuals assigned information security roles and responsibilities; and (iii) providing standards for measuring and building individual qualifications for incumbents and applicants for information security-related positions. Such workforce programs can also include associated information security career paths to encourage: (i) information security professionals to advance in the field and fill positions with greater responsibility; and (ii) organizations to fill information security-related positions with qualified personnel. Information security workforce

development and improvement programs are complementary to organizational security awareness and training programs. Information security workforce development and improvement programs focus on developing and institutionalizing core information security capabilities of selected personnel needed to protect organizational operations, assets, and individuals.

Related Controls: AT-2, AT-3

Control Family: PROGRAM MANAGEMENT

PM-14 : TESTING, TRAINING, AND MONITORING

The organization:

Note

This control ensures that organizations provide oversight for the security testing, training, and monitoring activities conducted organization-wide and that those activities are coordinated. With the importance of continuous monitoring programs, the implementation of information security across the three tiers of the risk management hierarchy, and the widespread use of common controls, organizations coordinate and consolidate the testing and monitoring activities that are routinely conducted as part of ongoing organizational assessments supporting a variety of security controls. Security training activities, while typically focused on individual information systems and specific roles, also necessitate coordination across all organizational elements. Testing, training, and monitoring plans and activities are informed by current threat and vulnerability assessments.

Related Controls: AT-3, CA-7, CP-4, IR-3, SI-4

PM-14a.

Implements a process for ensuring that organizational plans for conducting security testing, training, and monitoring activities associated with organizational information systems:

PM-14a.1.

Are developed and maintained; and

PM-14a.2.

Continue to be executed in a timely manner;

PM-14b.

Reviews testing, training, and monitoring plans for consistency with the organizational risk management strategy and organization-wide priorities for risk response actions.

Control Family: PROGRAM MANAGEMENT

PM-15 : CONTACTS WITH SECURITY GROUPS AND ASSOCIATIONS

The organization establishes and institutionalizes contact with selected groups and associations within the security community:

Note

Ongoing contact with security groups and associations is of paramount importance in an environment of rapidly changing technologies and threats. Security groups and associations include, for example, special interest groups, forums, professional associations, news groups, and/or peer groups of security professionals in similar organizations. Organizations select groups and associations based on organizational missions/business functions. Organizations share threat, vulnerability, and incident information consistent with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance.

Related Controls: SI-5

PM-15a.

To facilitate ongoing security education and training for organizational personnel;

PM-15b.

To maintain currency with recommended security practices, techniques, and technologies; and

PM-15c.

To share current security-related information including threats, vulnerabilities, and incidents.

Control Family: PROGRAM MANAGEMENT

PM-16 : THREAT AWARENESS PROGRAM

The organization implements a threat awareness program that includes a cross-organization information-sharing capability.

Note

Because of the constantly changing and increasing sophistication of adversaries, especially the advanced persistent threat (APT), it is becoming more likely that adversaries may successfully breach or compromise organizational information systems. One of the best techniques to address this concern is for organizations to share threat information. This can include, for example, sharing threat events (i.e., tactics, techniques, and procedures) that organizations have experienced, mitigations that organizations have found are effective against certain types of threats, threat intelligence (i.e., indications and warnings about threats that are likely to occur). Threat information sharing may be bilateral (e.g., government-commercial cooperatives, government-government cooperatives), or multilateral (e.g., organizations taking part in threat-sharing consortia). Threat information may be highly sensitive requiring special agreements and protection, or less sensitive and freely shared.

Related Controls: PM-12, PM-16

Indices and tables

- *genindex*
- *search*

Vulnerability Supplement

This section provides supplementary guidance regarding specific actions or information relevant to vulnerability reactions on SIMP systems.

Warning

This should in **no way** take the place of vendor recommendations. Users should, in all cases, refer to the vendor documentation for the latest information and any official mitigations.

Contents:

Stack Clash

Official Information

- Red Hat Stack Guard Page
- CVE-2017-1000364
- CVE-2017-1000366
- Qualys Blog Post

Supplementary Guidance

In accordance with the Qualys Blog Post, we attempted to determine if there was some method of partially mitigating the attack without needing to reboot a given system.

Unfortunately, as noted in the post, our results were found to be **very** dangerous for production systems so we have added the appropriate information here in case, for some reason, you cannot reboot your systems.

The information tested below was tested to allow a graphical desktop to run and will need to be set much lower to mitigate against a large number of attacks. But, it may be better than nothing.

Warning

Setting stack and address limits in PAM affects ALL processes on the system. It is *very* important that you do not limit space needed by critical applications.

Note

Setting PAM limits will NOT guarantee immunity from Stack Clash exploits, but will reduce the chance of large-footprint attacks. It is *highly* recommended you upgrade your kernel or obtain a vendor patch to protect your machines from attack. Setting limits in PAM is a last ditch effort when upgrading is not feasible.

Before applying limits to your system, estimate the amount of stack and address space used by critical applications. We have created a space estimation script to assist with limit calculation.

We have run the script on a SIMP system with many of the component modules installed, and have created the following class with defaults based off of the results. You may find you need to adjust limits or supplement the class with additional limits.

```
# Mitigate suceptibility to the 'stack clash' exlpoit by limiting
# the stack size and address size for local and remote users.
#
# These limitations do NOT guarantee immunity from the exploit, but
# reduce the chance of large-footprint attacks.
#
# NOTE: Before applying this to your system, you should estimate
# the amount of stack and address space used by authorized
# applications.  You may find you need to adjust limits or augment
# this list to best suit your system.
#
# A tool for calculating the largest consumers of stack and address
# space can be found here:
#   https://gist.github.com/trevor-vaughan/8f28ac8d908b3379fa9cee97b910ac54
#
# @param ignore_list
#   Any parameter in this list will be given unlimited stack and
#   address space.
#
#   Default: Ignore root, dbus, gdm. Root and dbus serve critical
#   roles and are unlimited for obvious reasons. GDM is a stack
#   heavy application that must be unlimited, or users run the
#   risk of loosing GUI access to their system.
#
# @param stack_limit
#   The max stack size, in KB, that applications not in the
#   ignore_list will be limited to.
#
# @param address_limit
#   The max address size, in KB, that applications not in the
#   ignore_list will be limited to.
#
# @author SIMP Team
#
class simp::pam_limits::stack_clash(
  Array[String] $ignore_list   = ['root','dbus','gdm'],
  Integer       $stack_limit   = 262144,
  Integer       $address_limit = 4194304
){

  pam::limits::rule { 'ignore_stack':
    domains => $ignore_list,
    type    => '-',
    item    => 'stack',
    value   => 'unlimited',
    order   =>   1
  }

  pam::limits::rule { 'ignore_as':
    domains => $ignore_list,
    type    => '-',
    item    => 'as',
    value   => 'unlimited',
```

```
    order   =>   1
  }

  pam::limits::rule { 'limit_stack':
    domains => ['*'],
    type    => '-',
    item    => 'stack',
    value   => $stack_limit,
    order   =>  999
  }

  pam::limits::rule { 'limit_as':
    domains => ['*'],
    type    => '-',
    item    => 'as',
    value   => $address_limit,
    order   =>  999
  }

}
```

Indices and tables

- *genindex*
- *search*

Help

The SIMP team is here to help!

Please see the following for a list of resources.

Frequently Asked Questions

This chapter addresses some of the frequently asked questions (FAQ) about SIMP.

SIMP Version Guide

The SIMP versioning system has caused some confusion over time and this document serves as the authoritative reference for clarification.

Top-Level SIMP for 6.X+

> **Note**
>
> This is the version number that you get when you run *rpm -q simp*

The top level SIMP version for SIMP releases from 6.0.0 onward will be following Semantic Versioning 2.0.0.

In short, this means (from the reference):

Given a version number *MAJOR.MINOR.PATCH*, increment the:

#. MAJOR version when you make incompatible API changes
#. MINOR version when you add functionality in a backwards-compatible manner
#. PATCH version when you make backwards-compatible bug fixes

Top-Level SIMP for SIMP before 6.X

> **Note**
>
> This is the version number that you get when you run *rpm -q simp*

The top level SIMP version for SIMP releases prior to the 6.0.0 release have the following structure given the format *MAJOR.MINOR.PATCH*:

#. MAJOR version when the version of EL changes
#. MINOR version when you make incompatible API changes
#. PATCH version when you add functionality in a backwards-compatible manner
#. FIXES version when you make backwards-compatible bug fixes

The last releases mapped in this manner are as follows:

- 5.X => EL 7
- 4.X => EL 6

Sub-Component Versioning

For all versions of SIMP, sub-components follow Semantic Versioning 2.0.0.

How can the root user login

Keeping in line with general best practice, SIMP does not allow `root` to login to the system remotely or at local terminals by default.

However, there may be cases where you need to login as `root` for perfectly valid reasons.

Enabling Terminal Logins

To allow `root` to login at the terminal, you will need to set the `useradd::securetty` `Array` to include all `tty` devices from which you wish to allow `root` access.

For example, to allow the `root` user to login at the first three virtual consoles and the first serial device, you would place the following in **`hiera`**:

```
useradd::securetty:
  - tty0
  - tty1
  - tty2
  - ttyS0
```

> **Important**
>
> If you are working on a system that was not installed from an ISO, you should do this before running `simp bootstrap`. Otherwise, unless you have set up other users, you may not be able to log into your system.

Enabling Remote SSH Logins

If you need to allow remote `root` logins over SSH (we **highly** advise against this), you can add the following to **`hiera`**:

```
ssh::server::conf::permitrootlogin: true
```

What is the Password Complexity for SIMP?

The following is the default password requirements for a standard SIMP system. This is based off of an amalgam of various password policies and may vary based on individual policies that are set for your installation.

The default complexity is enforced in both **`PAM`** and **`LDAP`**.

Complexity Rules

- 14 Characters or greater
- 1 Upper case letter
- 1 Lower case letter
- 1 Number
- 1 Special character
- No more than 2 repetitions of the same character
- No more than 4 characters in a monotonic character sequence
- Must not be one of the last 24 passwords that you have used

Note

Locked out accounts **will** unlock automatically after 15 minutes for non-root users and one minute for the root user.

Why does SIMP use rsync?

SIMP uses *rsync* to manage both large files and large numbers of small files. This is to reduce the number of resources in the catalog and take advantage of rsync's syncing engine to reduce network load and Puppet run times.

The common SIMP use cases for rsync include:

- clamav
- tftpboot
- named
- dhcpd

Large Files

Both the system kickstart images, and the clamav virus definitions are fairly large (100MB+). This isn't itself an issue. However, as the file changes over time, Puppet would have to transfer the entire file every time it changes.

To access the accuracy of a file defined in the catalog, Puppet checksums the file and compares it to the checksum of the expected content. This process could take a long time, depending on the size of the file. If the sums don't match, Puppet replaces and transfers the entire file. Rsync is smarter than that, and only replaces the parts of the file that need replacing. In this case, rsync saves bandwidth, Puppet run time, and a few CPU cycles.

Large Numbers of Files

named and dhcpd are the opposite situation. In both of these cases, they may manage large numbers of files. Typically, like above, Puppet would have to checksum every file and see if it needed changing, with each file setting up a new connection to the Puppet server transferring each file individually. A small number of file resources wouldn't be the end of the world when managing something with Puppet, but rsync limits every one of these files to one transaction and one resource. If you have a highly complex site, without rsync, this could grow your catalog to the point where Puppet would have a difficult time processing the entries in a timely manner. Syncing directories in this fashion also allows for configuration to be managed outside of the Puppet space.

Where are the rsync files?

SIMP distributes the rsync materials in the `simp-rsync` rpm, which installs a file tree in `/var/simp/environments/simp/rsync`. These directories are shared by the `simp::server::rsync_shares` class, which is included on the SIMP server if the `simp_options::rsync` catalyst is enabled.

Common Selinux issues

How to recover from SELINUX policy failure

If you experience a failed boot after running `simp bootstrap` with an error that says something along the lines of `Failed to load SELINUX policy, freezing`, follow these instructions:

1. Reboot into single user mode or a rescue shell (instructions on EL6 and EL7). You may need your GRUB password that was set during `simp config`.
2. Reinstall the selinux policy: `yum reinstall -y selinux-policy-targeted`
3. Tell the kernel to relabel all files during next boot: `touch /.autorelabel`
4. Reboot

Puppet-Related Issues

Running Puppet Agent in Debug Mode Crashes

The FACT-1732 bug, present in some versions of Facter 3, can cause *facter* to crash when attempting to print Bignum level numbers.

> ## *Note*
>
> On a 64-bit system, a `Bignum` value is `(2**62)` or higher

This will affect runs of `puppet agent -t --debug` as well as `facter -p`.

It is highly likely that you will have one of these values from the `shmall` fact provided by the `simplib` module.

Welcome to the SIMP documentation!

Public Resources

Many resources are available for getting help with SIMP. For FOSS support, as the community can handle it, you are welcome to use one of the following resources.

Live Chat

- SIMP Project HipChat
  - No account is required for this room. However, if you are going to participate regularly, please consider signing up for a HipChat account as it will allow you to receive offline messages.
  - If you choose to sign up, we recommend using a modifier to your email address such as *yourname+simp@gmail.com* since HipChat binds your account to the group that you join.

Mailing Lists

- SIMP Q&A Board
  - A Question and Answer board for the general community
- SIMP Users Mailing List
  - General user discussion
- SIMP Developers List
  - Discussion about development
- SIMP Announcement List
  - Announcements about changes to the SIMP environment
- SIMP Security List (security@simp-project.com)
  - A post-only alias for alerting the SIMP team to security issues
  - Use GPG Key 214BCB69 if you would like to encrypt messages
  - If members of the U.S. Government wish to report a Security issue, please send a message to this alias indicating that you wish to file a report over official channels and someone will contact you with further instructions.

Bug Tracking

If you find a bug, we'd like to encourage you to file a bug in our JIRA Bug Tracking system. That said, we're happy to hear about issues in whatever manner is easiest for you.

Commercial Resources

Full commercial support and consulting services are available for SIMP and the underlying components!

Details and contact information are available on the SIMP Project Homepage.

Indices and tables

- *genindex*
- *search*

License

Legal Notice

Contact

If you have questions please contact the SIMP team. simp@simp-project.org

Glossary of Terms

Note

Many terms here have been reproduced from various locations across the Internet and are governed by the licenses surrounding the source material. Please see the reference links for specifics on usage and reproducibility.

ACL : Access Control List

A list of permissions attached to an object. An ACL specifies which users or system processes are granted access to objects, as well as what operations are allowed on given objects. Each entry in a typical ACL specifies a subject and an operation.

AIDE : Advanced Intrusion Detection Environment

An intrusion detection system for checking the integrity of files under Linux. AIDE can be used to help track file integrity by comparing a snapshot of the system's files prior to and after a suspected incident. It is maintained by Rami Lehti and Pablo Virolainen.

Auditd

The userspace component to the Linux Auditing System. It is responsible for writing audit records to the disk. Viewing the logs is done with the ausearch or aureport utilities. Configuring the audit rules is done with the auditctl utility. During startup, the rules in /etc/audit/audit.rules are read by auditctl. The audit daemon itself has some configuration options that the admin may wish to customize. They are found in the auditd.conf file.

Beaker

An acceptance testing harness, written in Ruby, by the Puppet team.

Source: Beaker Source Repository:

BIOS : Basic Input/Output System

A type of firmware used to perform hardware initialization during the booting process (power-on startup) on IBM PC compatible computers.

Source: Wikipedia: BIOS

CA : Certificate Authority

An entity that issues `X.509` digital certificates.

CentOS : Community Enterprise Operating System

An Enterprise-grade Operating System that is mostly compatible with a prominent Linux distribution.

CLI : Command Line Interface

A means of interacting with a computer program where the user (or client) issues commands to the program in the form of successive lines of text (command lines).

Source: Wikipedia: Command Line Interface

Code Manager

[Puppet] Code Manager automates the management and deployment of your `Puppet` code. Push code updates to your source control repo, and then Puppet syncs the code to your masters, so that all your servers start running the new code at the same time, without interrupting agent runs.

Source: Managing code with Code Manager See Also: `r10k`

Control Repo

A version control repository containing all of the required modules, data, and configuration for a Puppet environment.

See Puppet, Inc documentation: https://docs.puppet.com/pe/latest/cmgmt_control_repo.html

CPU : Central Processing Unit

A central processing unit (CPU) is the electronic circuitry within a computer that carries out the instructions of a computer program by performing the basic arithmetic, logical, control and input/output (I/O) operations specified by the instructions

Source: Wikipedia: Central Processing Unit

DAC : Discretionary Access Control

A type of access control defined by the Trusted Computer System Evaluation Criteria "as a means of restricting access to objects based on the identity of subjects and/or groups to which they belong. The controls are discretionary in the sense that a subject with a certain access permission is capable of passing that permission (perhaps indirectly) on to any other subject (unless restrained by mandatory access control)".

Source: Wikipedia: Discretionary access control

DHCP : Dynamic Host Configuration Protocol

A network protocol that enables a server to automatically assign an IP address to a computer.

DNS : Domain Name System

A database system that translates a computer's fully qualified domain name into an IP address and the reverse.

Docker

Docker containers wrap a piece of software in a complete filesystem that contains everything needed to run: code, runtime, system tools, system libraries – anything that can be installed on a server. This guarantees that the software will always run the same, regardless of its environment.

Source: Docker: What is Docker?

DoS : Denial of Service : Denial of Service Attack

An attempt to make a machine or network resource unavailable to its intended users, such as to temporarily or indefinitely interrupt or suspend services of a host connected to the Internet.

Source: Wikipedia: Denial-of-service attack

DSL : Domain Specific Language

A computer language specialized to a particular application domain.

Source: Wikipedia: Domain-specific language

EL : Enterprise Linux

In the context of SIMP, EL is a generic term for *Enterprise Linux* and covers both **RHEL** and **CentOS** as well as other **RHEL** derivatives such as Oracle Linux.

Elasticsearch

A distributed, RESTful search and analytics engine capable of solving a growing number of use cases. As the heart of the Elastic Stack, it centrally stores your data so you can discover the expected and uncover the unexpected.

Source: Elasticsearch Homepage

ELG

An acronym for **Elasticsearch**, **Logstash**, and **Grafana**

ENC : External Node Classifier

An arbitrary script or application which can tell **Puppet** which classes a node should have. It can replace or work in concert with the node definitions in the main site manifest (site.pp).

The Puppet Enterprise Console and The Foreman are two examples of External Node Classifiers.

Source: External Node Classifiers

EPEL : Extra Packages for Enterprise Linux

A Fedora Special Interest Group that creates, maintains, and manages a high quality set of additional packages for **Enterprise Linux**, including, but not limited to, Red Hat Enterprise Linux (**RHEL**), **CentOS** and Scientific Linux (SL), Oracle Linux (OL).E

EPEL packages are usually based on their Fedora counterparts and will never conflict with or replace packages in the base Enterprise Linux distributions. EPEL uses much of the same infrastructure as Fedora, including buildsystem, bugzilla instance, updates manager, mirror manager and more.

Source: EPEL Homepage

Facter

Cross-platform system profiling library for use with **Puppet** and other management tools. It discovers and reports per-node facts, which are available in your Puppet manifests as variables.

Source: Facter Documentation

FIPS : Federal Information Processing Standard

Federal Information Processing Standards (FIPS) Publications are standards issued by **NIST** after approval by the Secretary of Commerce pursuant to the Federal Information Security Management Act (FISMA)

The particular standard of note in SIMP is FIPS 140-2

Source: FIPS Publications

FOSS : Open Source

Following an Open Source Initiative approved License.

See: The Open Source Definition

FQDN : Fully Qualified Domain Name

A domain name that specifies its exact location in the tree hierarchy of the **DNS**. It specifies all domain levels, including the top-level domain and the root zone. An FQDN is distinguished by its unambiguity; it can only be interpreted one way.

git

A version control system that supports branches.

GPG : GnuPG : Gnu Privacy Guard

A complete and free implementation of the OpenPGP standard as defined by RFC4880 (also known as PGP).

Source: GnuPG Homepage

Grafana

A system of pluggable panels and data sources allowing easy extensibility and a variety of panels, including fully featured graph panels with rich visualization options. There is built in support for many of the most popular time series data sources.

Source: Grafana Homepage

GUI : Graphical User Interface

A type of interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation.

Source: Wikipedia: Graphical User Interface

HDD : Hard Disk Drive

A device for storing and retrieving digital information, primarily computer data.

Hiera

A key/value lookup tool for configuration data, built to make **Puppet** better and let you set node-specific data without repeating yourself.

Source: Hiera Overview

IMA : Integrity Management Architecture

The integrity subsystem is to detect if files have been accidentally or maliciously altered, both remotely and locally.

Source: IMA Sourceforge Page

initrd

The *Initial RAMDisk*. A complete environment that is loaded at boot time to enable booting the rest of the operating system.

InSpec

An open-source testing framework for infrastructure with a human-readable language for specifying compliance, security and other policy requirements.

Source: InSpec Homepage

IP : IP Address : Internet Protocol Address

A numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication.

Source: Wikipedia: IP Address

IP6Tables : Internet Protocol 6 Tables

A user space application that provides an interface to the IPv6 firewall rules on modern Linux systems.

IPTables : Internet Protocol Tables

A user space application that provides an interface to the IPv4 firewall rules on modern Linux systems.

ISO : ISO 9660

A file system standard published by the International Organization for Standardization (ISO) or optical disc media.

Source: Wikipedia: ISO_9660

KDC : Key Distribution Center

Part of a cryptosystem intended to reduce the risks inherent in exchanging keys. KDCs often operate in systems within which some users may have permission to use certain services at some times and not at others.

Kerberos

A computer network authentication protocol that works on the basis of "tickets" to allow nodes communicating over a non-secure network to prove their identity to one another in a secure manner.

LDAP : Lightweight Directory Access Protocol

A protocol for querying and modifying LDAP directory services including information such as names, addresses, email, phone numbers, and other information from an online directory.

LDIF : Lightweight Directory Interchange Format

A standard plain text data interchange format for representing **LDAP** (Lightweight Directory Access Protocol) directory content and update requests. LDIF conveys directory content as a set of records, one record for each object (or entry). It also represents update requests, such as Add, Modify, Delete, and Rename, as a set of records, one record for each update request.

Source: Wikipedia: LDAP Data Interchange Format

Logstash

An open source, server-side data processing pipeline that ingests data from a multitude of sources simultaneously, transforms it, and then sends it to your favorite “stash.”

Source: Logstash Homepage

LUKS : Linux Unified Key Setup

The standard for Linux hard disk encryption.

See: The LUKS Homepage

MAC : MAC Address : Media Access Control : Media Access Control Address

A unique identifier assigned to network interfaces for communications on the physical network segment.

Source: Wikipedia: MAC address

Mandatory Access Control

A type of access control by which the operating system constrains the ability of a subject or initiator to access or generally perform some sort of operation on an object or target.

Source: Wikipedia: Mandatory access control

NAT : Network Address Translation

The process of modifying IP address information in IP packet headers while in transit across a traffic routing device.

NFS : Network File System

A distributed file system protocol that allows a user on a client computer to access files over a network in a manner similar to how local storage is accessed.

NIST : National Institute of Standards and Technology

The National Institute of Standards and Technology (NIST) was founded in 1901 and now part of the U.S. Department of Commerce. NIST is one of the nation's oldest physical science laboratories.

Source: NIST - About NIST

NIST 800-171 : NIST SP 800-171 : NIST Special Publication 800-171

Protecting Controlled Unclassified Information in Nonfederal Information Systems and Organizations

See: SP 800-171

NIST 800-53 : NIST SP 800-53 : NIST Special Publication 800-53

Security and Privacy Controls for Federal Information Systems and Organizations

See: SP 800-53

NIST SP : NIST Special Publication

A set of publications that provide computer/cyber/information security and guidelines, recommendations, and reference materials.

See: NIST Special Publications

OpenSCAP

The OpenSCAP project provides tools that are free to use anywhere you like, for any purpose. Availability of the code results in greater portability – anyone can send patches to add support for their platform of choice.

Source: OpenSCAP Features

OS : Operating System

System software that manages computer hardware and software resources and provides common services for computer programs. All computer programs, excluding firmware, require an operating system to function.

Source: Wikipedia: Operating system

PAM : Pluggable Authentication Modules

A mechanism to integrate multiple low-level authentication schemes into a high-level application programming interface (API). It allows programs that rely on authentication to be written independent of the underlying authentication scheme.

PEM : Privacy Enhanced Mail

An early standard for securing electronic mail. This is the public-key of a specific certificate. This is also the format used for Certificate Authority certificates.

PERL : Practical Extraction and Report Language

A high-level, general-purpose, interpreted, dynamic programming language. PERL was originally developed by Larry Wall in 1987 as a general-purpose Unix scripting language to make report processing easier.

PKI : Public Key Infrastructure

A security architecture that has been introduced to provide an increased level of confidence for exchanging information over an increasingly insecure Internet. PKI enables users of a basically insecure public networks, such as the Internet, to securely authenticate to systems and exchange data. The exchange of data is done by using a combination of cryptographically bound public and private keys.

Puppet

An **`Open Source`** configuration management tool written and maintained by Puppet, Inc. Written as a Ruby **`DSL`**, Puppet provides a declarative language that allows system administrators to provide a consistently applied management infrastructure. Users describes system resource and resource state in the Puppet language. Puppet discovers system specific information via **`Facter`** and compiles Puppet manifests into a system-specific catalog containing resources and resource dependencies, which are applied to each client system.

Puppet Data Type

Added in Puppet version 4, strong data types allow for the enforcement of inherent parameter validation as well as a better understanding of what function the data performs in classes.

See: Language: Data Types

Puppetfile

A Ruby file that contains references to Puppet modules.

See the Puppetfile spec: https://github.com/puppetlabs/r10k/blob/master/doc/puppetfile.mkd

PXE : Preboot Execution Environment

An environment to boot computers using a network interface independently of data storage devices (like hard disks) or installed operating systems.

r10k

A code management tool that uses **git** branches to automate the development and deployment of **Puppet** code.

Rake : Ruby Make

A Make-like program implemented in Ruby.

Source: Rake Homepage

RAM : Random Access Memory

A form of computer data storage. A random access device allows stored data to be accessed in nearly the same amount of time for any storage location, so data can be accessed quickly in any random order.

Red Hat : Red Hat® : Red Hat®, Inc.

A collection of many different software programs, developed by Red Hat®, Inc. and other members of the Open Source community. All software programs included in Red Hat Enterprise Linux® are GPG signed by Red Hat®, Inc. to indicate that they were supplied by Red Hat®, Inc.

See also **RHEL**.

RHEL : Red Hat Enterprise Linux

A commercial Linux operating system produced by **Red Hat®**, Inc. RHEL is designed to provide an Enterprise-ready Linux distribution suitable to multiple target applications.

RPM : RPM Package Manager

A package management system. The name RPM is associated with the .rpm file format, files in this format, software packaged in such files, and the package manager itself. RPM was developed primarily for GNU/Linux distributions; the file format is the baseline package format of the Linux Standard Base.

RSA

An algorithm for public-key cryptography that is based on the presumed difficulty of factoring large integers, the factoring problem. RSA stands for Ron Rivest, Adi Shamir and Leonard Adleman, who first publicly described it in 1977.

Rsyslog

An open-source software utility used on UNIX and Unix-like computer systems for forwarding log messages in an IP network. It implements the basic syslog protocol, extends it with content-based filtering, rich filtering capabilities, flexible configuration options and adds features such as using TCP for transport.

Source: Wikipedia: Rsyslog

Ruby

A dynamic, reflective, general-purpose object-oriented programming language that combines syntax inspired by Perl with Smalltalk-like features. Ruby originated in Japan during the mid-1990s and was first developed and designed by Yukihiro "Matz" Matsumoto. It was influenced primarily by Perl, Smalltalk, Eiffel, and Lisp. Ruby supports multiple programming paradigms, including functional, object oriented, imperative and reflective. It also has a dynamic type system and automatic memory management; it is therefore similar in varying respects to Smalltalk, Python, Perl, Lisp, Dylan, Pike, and CLU.

RVM : Ruby Version Manager

command-line tool which allows you to easily install, manage, and work with multiple **Ruby** environments from interpreters to sets of gems.

Source: RVM Homepage

SCAP : Security Content Automation Protocol

A synthesis of interoperable specifications derived from community ideas.

Source: SCAP Homepage

SELinux

A Linux kernel security module that provides a mechanism for supporting access control security policies, including United States Department of Defense–style mandatory access controls (MAC).

Source: Wikipedia: Security-Enhanced Linux

Service Account

An account that is not for use by a human user but which still requires login access to a host.

SFTP : SSH File Transfer Protocol

A network protocol that provides file access, file transfer, and file management functionalities over any reliable data stream. It was designed by the Internet Engineering Task Force (IETF) as an extension of the Secure Shell protocol (**SSH**) version 2.0 to provide secure file transfer capability, but is also intended to be usable with other protocols.

SIMP : System Integrity Management Platform

A security framework that sits on top of **RHEL** or **CentOS**.

SSG : SCAP Security Guide

A security policy written in a form of **SCAP** documents. The security policy created in SCAP Security Guide covers many areas of computer security and provides the best-practice solutions. The guide consists of rules with very detailed description and also includes proven remediation scripts, optimized for target systems. SCAP Security Guide, together with **OpenSCAP** tools, can be used for auditing your system in an automated way.

Source: OpenSCAP Homepage

See Also: **SCAP**

SSH : Secure Shell

An application for secure data communication, remote shell services, or command execution between networked computers. SSH utilizes a server/client model for point-to-point secure communication.

SSL : Secure Sockets Layer

The standard security technology for using **PKI** keys to provide a secure channel between two servers.

See also **TLS**.

SSSD : System Security Services Daemon

A daemon that provides access to identity and authentication remote resource through a common framework that can provide caching and offline support to the system.

Source: *SSSD Homepage <https://pagure.io/SSSD/sssd>*

STIG : DISA STIG : Defense Information Systems Agency Secure Technical Implementation Guide

Configuration standards for DOD IA and IA-enabled devices/systems.

Source: DISA IASE

Sudosh

An application that acts as an echo logger to enhance the auditing of privileged activities at the command line of the operating system. Utilities are available for playing back sudosh sessions in real time.

SYN cookies : syncookies

A technique used to resist SYN flood attacks.

Source: Wikipedia: SYN cookies

Syslog

A set of standards for sending log messages across the network.

source: Wikipedia: syslog

tboot : Trusted Boot

See **TXT**.

TFTP : Trivial File Transfer Protocol

A file transfer protocol generally used for automated transfer of configuration or boot files between machines in a local environment.

TLS : Transport Layer Security

A cryptographic protocol that provides network communications security. TLS and **SSL** encrypt the segments of network connections above the Transport Layer, using asymmetric cryptography for privacy and a keyed message authentication codes for message reliability.

See also **SSL**.

TPM : Trusted Platform Module

An international standard for a secure cryptoprocessor, which is a dedicated microcontroller designed to secure hardware by integrating cryptographic keys into devices.

Source: Wikipedia: Trusted Platform Module

TTY

A Unix command that prints to standard output the name of the terminal connected to standard input. The name of the program comes from teletypewriter, abbreviated "TTY".

TXT : Trusted Execution Technology

A hardware feature designed to harden platforms from the emerging threats of hypervisor attacks, BIOS, or other firmware attacks, malicious root kit installations, or other software-based attacks. It increases protection by allowing greater control of the launch stack through a Measured Launch Environment (MLE) and enabling isolation in the boot process.

Source: Intel Trusted Execution Technology: White Paper

umask

Umask is a command that determines the settings of a mask that controls how file permissions are set for newly created files. It also may refer to a function that sets the mask, or it may refer to the mask itself, which is formally known as the file mode creation mask. The mask is a grouping of bits, each of which restricts how its corresponding permission is set for newly created files. The bits in the mask may be changed by invoking the umask command.

Source: Wikipedia: umask

UUID : Universally Unique Identifier

A 128-bit unique value that is generally written as groups of hexadecimal digits separated by hyphens.

See also: UUIDGEN(1)

Vagrant

A tool for building complete development environments. With an easy-to-use workflow and focus on automation, Vagrant lowers development environment setup time, increases development/production parity, and makes the "works on my machine" excuse a relic of the past.

Source: Vagrant: About Vagrant

VirtualBox

A general-purpose full virtualizer for x86 hardware, targeted at server, desktop and embedded use.

Source: VirtualBox: About VirtualBox

VM : Virtual Machine

An isolated guest operating system installation running within a host operating system.

VNC : Virtual Network Computing

A graphical desktop sharing system that uses the remote framebuffer (RFB) protocol to control another computer remotely. It transmits the keyboard and mouse events from one computer to another, relaying the graphical screen updates back in the other direction, over a network.

WAN : Wide Area Network

A computer networking technology used to transmit ata over long distances, and between different Local Area Networks (LANs), Metropolitan Area Networks (MANs), and other localized computer networking architectures.

X.509

An ITU-T standard for a public key infrastructure (PKI) and Privilege Management Infrastructure (PMI). X.509 specifies, amongst other things, standard formats for public key certificates, certificate revocation lists, attribute certificates, and a certification path validation algorithm.

Source: Wikipedia: X.509

YAML : YAML Ain't Markup Language

A human friendly data serialization standard for all programming languages.

Source: YAML Homepage

YUM : Yellowdog Updater, Modified

A software installation tool for Linux. It is a complete software management system that works with RPM files. YUM is designed to be used over a network or the Internet.

See also **RPM**.

Indices and tables

- *genindex*
- *search*