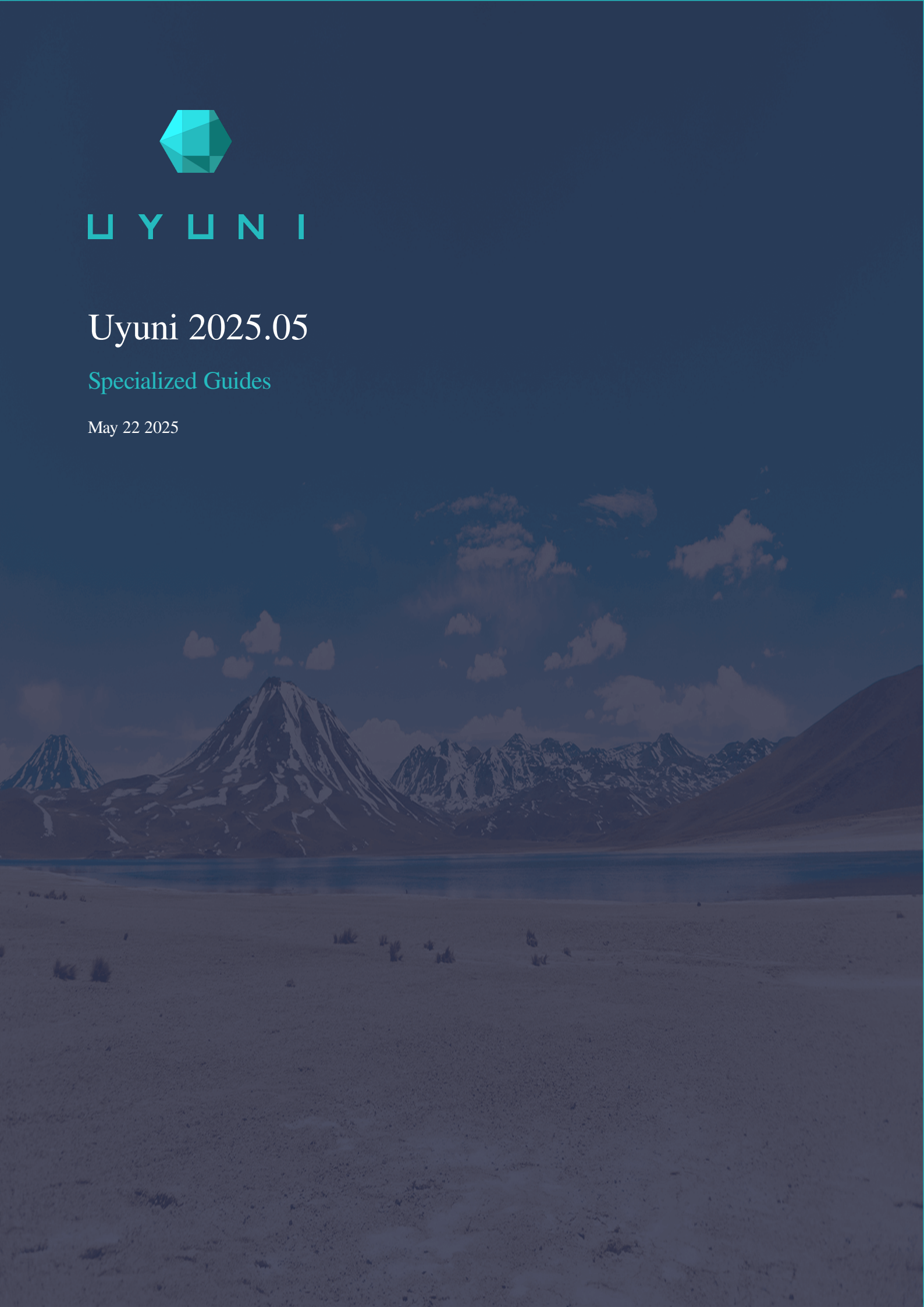


Uyuni 2025.05

Specialized Guides

May 22 2025

Chapter 1. Preface

Specialized Guides
Uyuni 2025.05

This guide provides an overview of specialized topics and functionalities within Uyuni.

It is designed to help users with basic, routine, and advanced tasks, explaining each step's purpose and outlining the various options available to customize your approach.

For more in-depth information, refer to the following specialized guides:

- **Specialized-guides › Salt**
- **Specialized-guides › Large-deployments**
- **Specialized-guides › Qs-sap**

Publication Date: 2025-05-22

Contents

Chapter 2. Salt Guide Overview

Salt is a remote execution engine, configuration management and orchestration system used by Uyuni to manage clients.

In Uyuni, the Salt master runs on the Uyuni Server, allowing you to register and manage Salt clients.

This book is designed to be a primer for using Salt with Uyuni.

For more information about Salt, see the Salt documentation at https://docs.saltproject.io/en/latest/contents.html.

The current version of Salt in Uyuni is '3006.0'.

2.1. Terminology

Beacon

Beacons allow you to use the Salt event system to monitor non-Salt processes. Clients can use beacons to connect to various system processes for constant monitoring. When a monitored activity occurs, an event is sent on the Salt event bus that can then trigger a reactor.

To use beacons on SUSE Linux Enterprise Server Salt clients, install the `python-pyinotify` package. For Red Hat Enterprise Linux systems, install the `python-inotify` package.

For more information on beacons, see https://docs.saltproject.io/en/latest/topics/beacons/

Broker

The Salt broker allows clients to pass commands to each other. The broker acts like a switch, therefore peer communication will only work for clients on the same network, or connected to the same proxy.

For more information on Salt and peer communication, see https://docs.saltproject.io/en/latest/ref/peer.html.

Environment

Uyuni implements Salt with a single environment. Multiple Salt environments are not supported.

Formulas

Formulas are collections of Salt States that contain generic parameter fields. Formulas are used within Uyuni to assist with configuring Salt clients. Some formulas have extensive configuration options, and use forms to help organize them in the Uyuni Web UI.

For more information about formulas, see **Specialized-guides › Salt**.

Grains

Grains provide information about the hardware of a client. This includes the operating system, IP

addresses, network interfaces, and memory. When you run a Salt command any modules and functions are run locally from the system being called.

For more information on grains, see https://docs.saltproject.io/en/latest/topics/grains/.

Highstate

This term is used when you apply all outstanding states to all targeted clients at the same time. The highstate must be applied when doing changes to systems, including enabling and disabling formulas.

Key Fingerprints

Key fingerprints are exchanged between the Uyuni Server and Salt clients to verify the identity of the server and the client. This prevents Salt clients from connecting to the wrong server. You can see the fingerprints of your Salt clients by navigating to **Salt › Keys**.

Master

The Salt master issues commands to its attached clients. In Uyuni, the Salt master must be the Uyuni Server.

Minions

Salt clients that are connected to and controlled by the Salt master on the Uyuni Server. In Uyuni, these are sometimes referred to as Salt clients. This is a difference in terminology only.

Modules

Functions within Salt are stored in modules. Salt modules are stored on clients and the Uyuni Server within the `/usr/lib/python*/site-packages/salt/` directory. There are many types of Salt modules, including state and execution modules. You can write your own Salt modules using Python.

For a complete list of available Salt modules, see https://docs.saltproject.io/en/latest/ref/index.html.

Pillars

Pillars are created on the Uyuni Server. They contain information about a client or group of clients. Pillars allow you to send confidential information to a targeted client or group of clients. Pillars are useful for sensitive data, configuration of clients, variables, and any arbitrary data.

For more information on pillars, see https://docs.saltproject.io/en/latest/topics/tutorials/pillar.html.

States

States are configuration templates. They allow you to describe what each of your systems should look like, including the applications and services that are installed and running. States are applied to the target client. This automates the process of bringing a large number of systems into a known state, and then maintaining them.

Do not update the `salt` package using states. Update all other system packages using states. You can then update the `salt` package from the Uyuni Web UI as a separate step.

For more information on states, see https://docs.saltproject.io/en/latest/topics/tutorials/starting_states.html.

For more Salt terminology, see https://docs.saltproject.io/en/latest/glossary.html.

2.2. Salt Command

Salt commands have three main components: target, function, and arguments. The calls are constructed in this format:

```
salt 'target' <function> [arguments]
```

The target defines the client, or group of clients, on which to run the function.

The function is the particular task to be run.

Arguments provide any extra data required by the function.

2.2.1. Salt Targets

Salt command targets allow you to specify a client or group of clients. There are several different targets you can use.

General Targeting

List available grains on all clients:

```
salt '*' grains.ls
```

Target a specific client:

```
salt 'web1.example.com' test.ping
```

Glob Targeting

Target all clients using a particular domain:

```
salt '*example.com' test.ping
```

Target all clients using a particular label:

```
salt 'label*' test.ping
```

List Targeting

Specify a flat list of clients, using their IDs:

```
salt -L 'client_ID1, client_ID2, client_ID3' test.ping
```

Regular Expression Targeting

You can also define targets with PCRE-compliant regular expressions:

```
salt -E '(?!web)' test.ping
```

IP Address Targeting

List available client IP addresses:

```
salt '*' network.ip_addrs
```

Target a specific client IP address:

```
salt -S '172.31.60.74' test.ping
```

Target all clients on a subnet:

```
salt -S 172.31.0.0/16 test.ping
```

For more on targeting, see https://docs.saltproject.io/en/latest/topics/targeting/.

2.2.2. Salt Execution Modules

When you have specified a target, provide the module and function to execute on the target.

Find which modules can be executed on the target:

```
salt '*' sys.doc
```

For a full list of callable modules, see https://docs.saltproject.io/en/latest/ref/modules/all/index.html.

2.2.3. Salt Function Arguments

Functions accept arguments for any extra data.

For example, the `pkg.install` function requires an argument specifying which package to install:

```
salt '*' pkg.install yast2
```

You can provide more than one argument to a function, with spaces between them. For example:

```
salt '*' cmd.run 'echo "Hello: $FIRST_NAME"' env='{FIRST_NAME: "John"}'
```

2.3. Often Used Salt Commands

This section contains the most commonly used Salt commands. For a complete list of available Salt commands, see https://docs.saltproject.io/en/latest/ref/cli/index.html.

salt-run

Display all clients that are running:

```
salt-run manage.up
```

Display all clients that are not running:

```
salt-run manage.down
```

Display the current status of all Salt clients:

```
salt-run manage.status
```

Check the version of Salt running on the Uyuni Server and active clients:

```
salt-run manage.versions
```

salt-cp

Copy a file to a client or set of clients:

```
salt-cp '*' foo.conf /root
```

salt-key -l

List public keys:

```
salt-key -l all
```

salt-key -a my-minion

Accept pending key for a minion:

```
salt-key -a my-minion
```

salt-key -A

Accept all pending keys:

```
salt-key -A
```

salt grains

List all available grains:

```
salt '*' grains.ls
```

List collected grain system data:

```
salt '*' grains.items
```

2.4. Salt States and Pillars

States are configuration templates. They allow you to describe what each of your systems should look like, including the applications and services that are installed and running. Salt state files are referred to as SLS (SaLt State) files.

States are applied to the target systems by matching relevant state data to clients. The state data comes from Uyuni in the form of package and custom states.

You can target clients at three specific levels of hierarchy and priority: individual clients, system groups, and organization. Individual clients have priority over groups, and groups have priority over the organization.

For example:

- The Organization requires that version 1 is installed. All clients are part of the same Organization.
- Group A requires that version 2 is installed. Client1, Client2, and Client3 are part of Group A.
- Group B requires any version installed. Client4 is part of Group B.

Leading to these possible scenarios:

- Client1 wants package removed, package is removed (Client Level)
- Client2 wants version 2, gets version 2 (Client Level)

- Client3 wants any version, gets version 2 (Group Level)
- Client4 wants any version, gets version 1 (Organization Level)

For more information on Salt states, see https://docs.saltproject.io/en/latest/topics/states/.

You can create custom Salt states with Uyuni. For more information, see **Specialized-guides › Salt**.

2.4.1. Group States

Pillar data can be used to perform bulk actions, like applying all assigned states to clients within the group. This section contains some examples of bulk actions that you can take using group states.

To perform these actions, you will need to determine the ID of the group that you want to manipulate. You can determine the Group ID by using the `spacecmd` command:

```
spacecmd group_details
```

These examples use an example Group ID of `GID`.

To apply all states assigned to the group:

```
salt -I 'group_ids:GID' state.apply custom.group_GID
```

To apply any state (whether or not it is assigned to the group):

```
salt -I 'group_ids:GID' state.apply ``state``
```

To apply a custom state:

```
salt -I 'group_ids:2130' state.apply manager_org_1.``customstate``
```

Apply the highstate to all clients in the group:

```
salt -I 'group_ids:GID' state.apply
```

2.4.2. Salt Pillars

Uyuni exposes a small amount of internal data as pillars which can be used with custom states. Pillars are created on the Uyuni Server, and contain information about a client or group of clients. For custom information in pillars, see **Client-configuration › Custom-info**. Pillars are useful for sensitive data, configuration of clients, variables, and any arbitrary data.

Pillars are managed either automatically by Uyuni, or manually by the user.

If you change pillar data on the server (Salt master) the actual pillar data on the client (minion) is updated only after calling `saltutil.refresh_pillar` for the client.

Otherwise it could happen that `pillar.items` and `pillar.get` calls would produce different results with different values of pillars that were not refreshed.

To avoid hard-coding organization IDs within SUSE Linux Enterprise Server files, a pillar entry is added for each organization:

```
org-files-dir: relative_path_to_files
```

The specified file is available for all clients which belong to the organization.

This is an example of a pillar located at `/etc/motd`:

```
file.managed:
    - source: salt://{{ pillar['org-files-dir']}}/motd
    - user: root
    - group: root
    - mode: 644
```

For more information on Salt pillars, see https://docs.saltproject.io/en/latest/topics/pillar/.

2.4.3. Download Endpoint

By default, Uyuni assumes that the download endpoint to use is the FQDN of the Uyuni Server or Proxy. However, there are some cases where you might like to use a different FQDN as the download endpoint. The most common example is if you need to use load balancing, caching proxies, or in environments with complicated networking requirements.

To change the package download endpoint, you can manually adjust three Salt pillars: * `pkg_download_point_protocol`, defaults to `https`. * `pkg_download_point_host`, defaults to the FQDN of the Uyuni Server (or Proxy, if in use). * `pkg_download_point_port`, defaults to `443`.

If you do not adjust these pillars directly, Uyuni will fall back to the default values.

Procedure: Changing the Package Download Endpoint Pillar

1. Navigate to `/srv/pillar/` and create a file called `top.sls` with these contents:

```
base:
  '*':
    - pkg_download_points
```

This example directs Salt to look at the `pkg_download_points.sls` file to determine the base URL to use. You can adjust this file to target different clients or groups, depending on your environment.

2. Remain in `/srv/pillar/` and create a file called `pkg_download_points.sls` with the base URLs you want to use. For example:

```
pkg_download_point_protocol: http
pkg_download_point_host: example.com
pkg_download_point_port: 444
```

3. OPTIONAL: If you want to use external pillars, for example Group IDs, open the master configuration file and set the `ext_pillar_first` parameter to `true`. You can then use Group IDs to set conditional values, for example:

```
{% if pillar['group_ids'] is defined and 8 in pillar['group_ids'] %}
  pkg_download_point_protocol: http
  pkg_download_point_host: example.com
  pkg_download_point_port: 444
{% else %}
  pkg_download_point_protocol: ftp
  pkg_download_point_host: example.com
  pkg_download_point_port: 445
{%- endif %}
```

4. OPTIONAL: You can also use grains to set conditional values, for example:

```
{% if grains['fqdn'] == 'client1.example.com' %}
    pkg_download_point: example1.com
{% elif grains['fqdn'] == 'client2.example.com'' %}
    pkg_download_point: example2.com
{% else %}
    pkg_download_point: example.com
{% endif %}
```

2.5. GPG Encrypted Pillars

Salt has support to transparently decrypt GPG-encrypted Pillar data built-in. The decryption happens on the Salt Master.

2.5.1. Generate GPG keyring for Salt Master

The GPG keyring can be specified in `/etc/salt/master` or in its own file under `/etc/salt/master.d/`, for example `/etc/salt/master.d/gpg-pillar.conf`.

Always create a separate keyring for the Salt Master.

Procedure: Generating key pair

1. On the Salt Master create GPG home directory and restrict its permissions:

```
mkdir /etc/salt/gpgkeys
chmod 700 /etc/salt/gpgkeys
```

2. Generate a key pair interactively.

The password must be empty.

```
gpg --gen-key --homedir /etc/salt/gpgkeys
```

3. Salt does not run with root permissions on SUSE Linux Enterprise and openSUSE distributions.

```
chown -R salt:salt /etc/salt/gpgkeys
```

4. Configure Salt Master to use the new GPG home directory

```
echo 'gpg_keydir: /etc/salt/gpgkeys' >/etc/salt/master.d/gpg-pillar.conf
systemctl reload-or-restart salt-master
```

2.5.2. Use GPG for encrypting Pillar secrets

Salt GPG renderer decrypts GPG encrypted contents that are ASCI-armored. To use the GPG renderer in a Pillar YAML file, change

```
#!yaml
```

to

```
#!yaml|gpg
```

Encrypting pillar secrets can be done anywhere as long as the GPG and the public key generated in Procedure: Generating key pair are available.

In this example, "MLM Salt Master" is the GPG key's UID created earlier.

```
echo 't0ps3cr3t' | gpg --armor --batch --encrypt --recipient "MLM Salt Master"
```

When the GPG encrytped contents are created and available as ASCII-armored output, this output can be used as a multi-line string in a pillar YAML file:

```
#!yaml|gpg
```

```
secret:
  my-secret: |
    -----BEGIN PGP MESSAGE-----

    hQEMA3OrmRaWrqgqAQf/ej8xV+nO3HVbQRCeJgCmt5ZjnogT++HHeFzXymfr1SgT
    XySyAqpIZB2N6MjZXtupO2sCmG6fzqtmnW+vRsZhQG8PAqzRtAekFuVbXzgkigBk
    338yOdyltVBtMONnkHFQ+7EP1tfJnWLCVrJ1I42vGFLZf2AD1xhbjewCcoaK82J4
    f8u9U/dxgV0N6na28WG5m6YU5Reu1Ca37PXHuqA/0XZl65DY63xaMPMDHZEi1wkU
    GXU7OsiL1dO0/sST1Awo5i99kVt/kA6DCGDuxTNpLrauNLOKUbtwcxvavtNZGwdQ
    yI9zWVx8qerWE0aO3M7zVDJftv77faV2ENiqzaadvtJHAZynW4GW7rSuP1RXFzlB
    DOAmzdRuIJwiLC9R2BKu3x+avReQb6xoz7eF7WthC0H0dz4mYakwPlVZ5yqYa/+G
    83i951rqAGI=
    =g+ji
    -----END PGP MESSAGE-----
```

When the pillar is assigned to a system with `top.sls`, the GPG encrypted pillar data is available in a decrypted format.

The client's in-memory cache is only updated on startup or when running execution module functions that trigger a cache refresh such as `saltutil.refresh_pillar`, `pillar.items`, or `state.apply`.

```
MLM-sles15sp1.tf.local:
    ----------
    my-secret:
        t0p s3cr3t!
```

2.5.3. Export the GPG key

To export the GPG key, use the command:

```
gpg --export 'MLM Salt Master' --homedir /etc/salt/gpgkeys --output MLM-salt-master.gpg
```

Here 'MLM Salt Master' is the name used during key generation.

The `MLM-salt-master.gpg` public key can be freely shared.

2.6. Custom Salt States

You can create your own custom Salt states with Uyuni as centrally managed configuration channels. Custom states are stored as Salt state files on the Uyuni Server with a `.sls` extension.

2.6.1. Create a New Custom Salt Channel

You can use the Uyuni Web UI to create and edit custom Salt state files. You must create a state channel first, with an initial state named `init.sls`. The `init.sls` file is used to reference all other state files within the channel. The custom states that you create using the Web UI are stored on the Uyuni Server in the the `/srv/susemanager/salt/<organization>/` directory.

After the channel is created with an `init.sls` file, you can write additional state files in the Web UI. Alternatively, you can upload existing state files to use within your state channel, or import them from other channels or clients.

Procedure: Creating a Custom Salt Channel and Initial State

1. In the Uyuni Web UI, navigate to **Configuration › Channels**.
2. Click Create State Channel.
3. In the `Name` field, type a name for your state.
4. In the `Label` field, type a label. Use alphanumeric characters, hyphens, and underscores. Do not use spaces.
5. In the `Description` field, type a short description of the configuration your state performs.
6. In the `SLS Contents` field, type the contents of your `init.sls` state. If you want to reference file templates in this configuration channel, ensure your file starts by specifying the source of the managed file, using this syntax:

```
file.managed:
  - source: salt://<org_name>/<channel_name>/etc/<ID>/<filename>
```

```
 Example custom state files are given later in this section.
. Click btn:[Update Channel] to save your state.
```

Procedure: Adding Additional Files to a Custom State Channel

1. In the Uyuni Web UI, navigate to **Configuration › Channels**. . Click the name of the channel you want to add files to.
2. To create a new file, click Create configuration file and type the contents of the file.
3. To upload an existing file, click Upload Configuration Files and select the file to upload.
4. To copy an existing file, click Import a File from Another Channel or System and select the file to copy.

Procedure: Editing a Custom Salt State

1. In the Uyuni Web UI, navigate to **Configuration › Channels**.
2. Click View/Edit <filename>.sls File.
3. Make your changes to the file.
4. Click Update Configuration File to save your state.

You can also manage revisions, compare the state to others in your organization, and download the `.sls` file from this dialog.

Procedure: Assigning a Client to a Custom Salt State

1. In the Uyuni Web UI, navigate to **Configuration › Channels**.
2. Click the name of the state you want to assign a client to.
3. Navigate to the **Systems › Target Systems** tab.
4. Check the clients you want to assign.
5. Click Subscribe systems.

For more information about Salt state modules, see https://docs.saltproject.io/en/latest/ref/states/all/index.html.

2.6.2. Example Custom State Files

This section contains some example custom state files. Use these as a basis for writing your own custom states.

Listing 1. Example: Manage a File

```
my_config_change_id:
  file.managed:
    - name: /etc/my.conf
    - source: salt://example_org/example_channel/etc/my.conf
    - user: root
    - group: root
    - mode: 644
    - template: jinja
```

Listing 2. Example: Package Management

```
my_pkg_id:
  pkg.installed:
    - refresh: True
    - pkgs:
      - glibc
      - kernel-default
      - hello: 1.0-42
```

Listing 3. Example: Remote Command

```
ip_forward-on:
  cmd.run:
    - name: echo "1" > /proc/sys/net/ipv4/ip_forward
    - onlyif:
      - test `cat /proc/sys/net/ipv4/ip_forward` -eq 0
```

Listing 4. Example: Service Management

```
time_service_id:
  service.running:
    - name: chronyd
    - enable: True
```

2.6.3. Custom State to Trust a GPG Key

By default, operating systems trust only their own GPG keys when they are installed, and do not trust keys provided by third party packages. The clients can be successfully bootstrapped without the GPG key being trusted. However, you cannot install new third party packages or update them until the keys are trusted.

Salt clients are set to trust SUSE tools channels GPG keys when they are bootstrapped. For all other clients and channels, you need to manually trust third party GPG keys.

If you are bootstrapping Salt clients from the Uyuni Web UI, you can use a custom Salt state to trust the GPG key.

Procedure: Trusting a GPG Key With a Custom Salt State

1. Locate the key that you need to trust. Ensure you have the correct key, and that you also have the fingerprint used to verify the key. This information is available from the vendor or, in some cases, from a key server.
2. Copy the key to a file location where the client can access it. We recommend saving it in the `/srv/www/htdocs/pub/` directory, where all user public files must be saved.
3. In the Uyuni Web UI, navigate to **Configuration › Channels**.
4. Click Create State Channel.
5. In the `Name` field, type a name for your state. For example, `GPG Key Trusts`.
6. In the `Label` field, type a label. For example, `GPG_Key_Trusts`.
7. In the `Description` field, type a short description of the configuration your state performs. For example, `Trusts GPG Keys for CentOS`.
8. In the `SLS Contents` field, create a state to retrieve the appropriate key from the Uyuni Server and trust it on the client. The exact contents of your state varies depending on your client operating system. For example:

```
rpm_trust_gpg_key:
  cmd.run:
    - name: rpm --import https://{{ salt['pillar.get']('mgr_server') }}/pub/<third-
party-gpg>.key
    - unless: rpm -q gpg-pubkey-<key_id>

deb_trust_gpg_key:
  mgrcompat.module_run:
    - name: pkg.add_repo_key
    - path: https://{{ salt['pillar.get']('mgr_server') }}/pub/<third-party-gpg>.key
```

```
  Alternatively, you can add GPG keys to a configuration channel, using a managed file
to deploy them directly on the client.
  In this case, you would use a local path to the key, rather than a URL.
. Click btn:[Update Channel] to save your state.
. Navigate to menu:Configuration[Channels] and click the name of the state you want to
assign a client to.
. Navigate to the menu:Systems[Target Systems] tab and check the clients you want to
assign.
. Click btn:[Subscribe systems].
```

```
When the configuration file is next run on the client, the GPG key is trusted.
```

Alternatively, you can manage your GPG keys from your own repository hosted on an external file management system.

2.6.4. Apply a custom state at highstate

To apply a custom state at highstate create a mapping in `/srv/salt/top.sls`. This short example maps the `test` state to the system group `12`:

```
# /srv/salt/top.sls
base:
  'group_ids:12':
    - match: pillar
    - test
```

2.7. Salt File Locations and Structure

There are several ways to set up the Salt file structure. This section describes how Salt is supported and set up as part of Uyuni Server. The main configuration file is `/etc/salt/master.d/susemanager.conf`.

Do not edit the `/etc/salt/master.d/susemanager.conf` configuration file. This file belongs to the `spacewalk-setup` package and is marked as `%config`. When SUSE updates the `spacewalk-setup` package, the `susemanager.conf` file is overwritten, and any customization is lost. Instead, add your own configuration file to the `/etc/salt/master.d/` directory. This prevents the update process from deleting your settings from the main `susemanager.conf` configuration file.

Some settings from `/etc/salt/master.d/susemanager.conf` that can help with finding configuration options:

```
# Configure different file roots. Custom salt states should only be placed in
# /srv/salt.
# Users should not touch other directories listed here.
file_roots:
  base:
    - /usr/share/susemanager/salt
    - /usr/share/salt-formulas/states
    - /usr/share/susemanager/formulas/states
    - /srv/susemanager/salt
    - /srv/salt

# Configure different pillar roots. Custom pillar data should only be placed
# in /srv/pillar.
# Users should not touch other directories listed here.
pillar_roots:
  base:
    - /srv/pillar
```

When you are working with `/etc/salt/master.d/susemanager.conf`, be aware that:

- Files listed are searched in the order they appear
- The first matching file found is called

The Uyuni Server reads Salt state data from five root directories:

`/usr/share/susemanager/salt`

This directory is shipped and updated with Uyuni and includes certificate setup and common state logic to be applied to packages and channels.

Do not edit or add custom Salt data to this directory.

`/usr/share/salt-formulas/states`

`/usr/share/susemanager/formulas/states`

These directories are shipped and updated with Uyuni or additional extensions. They include states for Salt formulas.

Do not edit or add custom Salt data to this directory.

`/srv/susemanager/salt`

This directory is generated by Uyuni, based on assigned channels and packages for clients, groups, and organizations. This directory will be overwritten and regenerated. It is the Salt equivalent of the Uyuni database.

Do not edit or add custom Salt data to this directory.

Within this directory, each organization has a sub-directory.

Listing 5. Example: SLS File Directory Structure

```
├──── manager_org_<org id>
│    ├──── files
│    │    ... files needed by states (uploaded by users)...
│    └──── state.sls
        ... other SLS files (created by users)...
For example:
├──── manager_org_TESTING
│    ├──── files
│    │    └──── motd     # user created
│    │    ... other files needed by states ...
│    └──── motd.sls     # user created
           ... other SLS files ...
```

`/srv/salt`

This directory is used for custom state data, modules, and related data. Uyuni does not operate or use this directory directly. The state data in this directory is used by the client highstate, and is merged with the total state result generated by Uyuni. Use this directory for custom Salt data.

The Uyuni Server reads Salt pillar data from two root directories:

/usr/share/susemanager/pillar

This directory is generated by Uyuni. It is shipped and updated together with Uyuni.

Do not edit or add custom Salt data to this directory.

/srv/pillar

By default, Uyuni does not operate or use this directory directly. The custom pillar data in this directory is merged with the pillar result created by Uyuni. Use this directory for custom Salt pillar data.

You can use the `gitfs` fileserver backend to serve Salt data from git repositories. For more information, see **Specialized-guides › Salt**.

2.8. The gitfs Fileserver Backend

In Uyuni, `pygit2` is the supported Python interface to git. When `pygit2` is installed the `gitfs` fileserver backend is available and it is a supported feature.

Configuration options are set in the `/etc/salt/master` file, or in a separate configuration file in the `/etc/salt/master.d/` directory. The basic settings are:

fileserver_backend

List of fileserver backends that the Salt master checks for files in the order they are defined. Options:

- `roots`: Files local on the Salt master (Uyuni Server). `roots` is required to keep the product running. You can only enable `gitfs` optionally. Additionally, SUSE strongly recommends to prefer `roots` (local files) over `gitfs`. The standard backend.
- `gitfs`: Files stored in one or more git repositories. The repositories are defined with `gitfs_remotes`.

  Example:

  ```
  fileserver_backend:
    - roots
    - git
  ```

gitfs_remotes

List of git repositories. `git://`, `https://`, `file://`, or `ssh://` URLs can be configured. For SSH remotes, a `scp`-like syntax is also supported; for example: `gitlab@gitlab.example.com:universe/setup.git`. Then you can also specify options for credentials, file locations, or branches such as `pubkey`, `privkey`, `root`,`base`.

Example:

```
gitfs_remotes:
  - https://example.com/myformulas/formula.git
  - gitlab@gitlab.example.com:universe/setup.git:
    - pubkey: /var/lib/salt/.ssh/id_rsa_gitlab.pub
    - privkey: /var/lib/salt/.ssh/id_rsa_gitlab
    - root: srv/salt
    - base: master
```

ext_pillar

List of external pillar interfaces. Salt can also serve pillar data from one or more git repositories. For syntax and options, also see the `gitfs_remotes` setting.

Example:

```
ext_pillar:
  - git:
    - master gitlab@gitlab.example.com:universe/setup.git:
      - root: srv/pillar
      - pubkey: /var/lib/salt/.ssh/id_rsa_gitlab.pub
      - privkey: /var/lib/salt/.ssh/id_rsa_gitlab
```

For more information, see:

- https://docs.saltproject.io/en/latest/topics/tutorials/gitfs.html
- https://docs.saltproject.io/en/latest/ref/configuration/master.html

2.9. Install Using Yomi

Yomi (yet one more installer) is an installer for SUSE and openSUSE operating systems. Yomi is designed as a Salt state, and can be used for installing SUSE operating systems on new systems.

In Uyuni, Yomi can be used as part of provisioning new clients, as an alternative to AutoYaST.

Yomi consists of two components:

- The Yomi formula, which contains the Salt states and modules required to perform the installation.
- The operating system image, which includes the pre-configured `salt-minion` service.

Both components can be used independently of Uyuni, or integrated with it. This section describes how to use it with Uyuni.

- For more information about using Yomi independently, see https://github.com/openSUSE/yomi.
- For build assets, see https://build.opensuse.org/project/show/systemsmanagement:yomi.

To use Yomi for installing a client operating system, follow this process:

- Install the `yomi-formula` package.

- Prepare the Salt pillar for the new installation.
- Boot the new client using the PXE boot image for Yomi.

To use Yomi with Uyuni, ensure you have enough available memory. To boot from USB or DVD image, you need at least 512 MB. To boot from a PXE server, you need at least 2 GB.

2.9.1. Install the Yomi Formula

Before you begin, you need to install the Yomi formula, which is available as a package in Uyuni.

The `yomi-formula` package contains the Salt states and modules that describe the Yomi state, and the formulas with forms to create the pillar. It also contains documentation about the different sections of the pillar, and some examples about how to parameterize installations based on openSUSE, MicroOS, or SLE.

The formula package performs these actions:

- Adds a new configuration file called `yomi-formula.conf` in the `/etc/salt/master.d/` directory. This configuration file defines the Python module and Salt states required by Yomi.
- Installs the Yomi Salt states in the `/usr/share/salt-formulas/states/` directory.
- Provides some example configuration files in the `/usr/share/yomi/` directory.
- Installs the required forms and sub-forms in the `/usr/share/salt-formulas/metadata/` directory.
- Provides some pillar examples in the `/usr/share/yomi/pillar/` directory.

Procedure: Installing the Yomi Formula

1. On the Uyuni Server, at the command prompt, as root, install the `yomi-formula` package:

```
zypper in yomi-formula
```

2. Restart services:

```
systemctl restart salt-master.service
```

For more information about the Yomi formula, see **Specialized-guides › Salt**.

2.9.2. Install the PXE Image

To provision a new client, you need an operating system image to boot from. You can use any image that contains a `salt-minion` service enabled, together with a minimal set of tools that are required during the installation, for example `parted` or `btrfstools`.

Yomi provides an already prepared image, based on openSUSE Tumbleweed, openSUSE Leap (for Uyuni), or SLE (for SUSE Multi-Linux Manager). For Uyuni, the image is packaged as an RPM. This is done in a similar way to how `pxe-default-image` is distributed.

The package installs a standard PXE OEM image generated by Kiwi, the initial kernel and initrd in the `/srv/pxe-yomi-image/` directory, and the second stage kernel, initrd and image in the `/srv/pxe-yomi-image/image` directory.

Procedure: Installing the PXE Image

1. On the Uyuni Server, at the command prompt, as root, install the `pxe-yomi-image` service:

```
zypper in pxe-yomi-image-opensuse15
```

When you have the package installed, you can register Yomi in Cobbler.

2.9.3. Register Yomi in Cobbler

Uyuni uses Cobbler to manage the PXE boot service, so you will need to register the image in Cobbler.

Procedure: Registering the Yomi Image in Cobbler

1. On the Uyuni Server, at the command prompt, as root, create a directory for the Yomi image:

```
mkdir /srv/tftpboot/pxe-yomi-image
```

2. Define a distribution in Cobbler, including the path to install the second stage kernel and initrd, the location of the full image, and any further kernel options. Adjust this command to include the correct version of the product, and the TFTP server address:

```
cobbler distro add \
  --name=pxe-yomi-image \
  --kernel=/srv/pxe-yomi-image/linux \
  --initrd=/srv/pxe-yomi-image/initrd \
  --boot-files='/srv/tftpboot/pxe-yomi-image/image.initrd=/srv/pxe-yomi-image/image/pxe
-yomi-image-opensuse15.x86_64-1.0.0.initrd /srv/tftpboot/pxe-yomi-
image/image.kernel=/srv/pxe-yomi-image/image/pxe-yomi-image-opensuse15.x86_64-
1.0.0.kernel /srv/tftpboot/pxe-yomi-image/image.md5=/srv/pxe-yomi-image/image/pxe-yomi-
image-opensuse15.x86_64-1.0.0.md5 /srv/tftpboot/pxe-yomi-
image/image.config.bootoptions=/srv/pxe-yomi-image/image/pxe-yomi-image-opensuse15-
x86_64-1.0.0.config.bootoptions /srv/tftpboot/pxe-yomi-image/image.xz=/srv/pxe-yomi-
image/image/pxe-yomi-image-opensuse15.x86_64-1.0.0.xz' \
  --kernel-options='rd.kiwi.install.pxe rd.kiwi.install.image=tftp://<server-
address>/pxe-yomi-image/image.xz rd.kiwi.ramdisk ramdisk_size=2097152 net.ifnames=1'
```

By default, the `salt-minion` service in `pxe-yomi-image` is configured to find the Salt master under the `salt` address. If the DNS server is not able to resolve this address, you need to adjust the `kernel-options` parameter from the Cobbler command that register the distribution, and add a new kernel command line of `ym.master=master_address`. This will override the default configuration for the `salt-minion`.

Procedure: Registering the Yomi Profile in Cobbler

1. On the Uyuni Server, at the command prompt, as root, define a profile in Cobbler based on the image.

```
cobbler profile add \
  --name pxe-yomi-profile \
  --distro=pxe-yomi-image
```

2. OPTIONAL: Create a system in Cobbler. If you know the MAC address for the new client to be provisioned, you can have it boot directly from the Yomi image.

```
cobbler system add \
   --name=yomi \
   --mac=00:11:22:33:44:55 \
   --profile=pxe-yomi-profile
```

3. When the new node has been provisioned, remove the temporary Cobbler system:

```
cobbler system remove --name=yomi
```

2.9.4. Example Salt Pillar Preparation

The parameters of the new installation are defined with a Salt pillar. The pillar includes parameters that the Yomi state requires during the installation, including the partitions, file systems, repositories, packages installed, and services enabled.

The pillar is defined using the formulas with forms. In this example, we prepare the pillar for a minimal openSUSE Tumbleweed installation. You can find examples for MicroOS or SLES in the example directory `/usr/share/yomi/pillar/`.

To begin, boot the client that you want to provision using the Yomi PXE boot image, using the Cobbler procedures described earlier in this section.

When the `salt-minion` service is running on the new client, accept the key by navigating to **Salt › Keys**. When the key is accepted, you can view and manage the client by navigating to **Systems › Overview**. Navigate to the `Formulas` tab, and add all the Yomi Installer formulas to the client. When you have added all the formulas, complete the forms and sub-forms. This section outlines each form and provides example settings for a minimal installation. For a detailed explanation of every option, see **Specialized-guides › Salt**.

Yomi

The Yomi form contains some general configuration options. For example, the keyboard language and layout, the locale information, and the option to perform a full reset of the system after provisioning.

For this example, set the `Reboot` parameter to `yes`.

Yomi Storage

This sub-form provides information about the devices, partitioning, file system (including the BtrFS subvolumes, for example), and LVM and RAID configuration.

For this example, we assume that the new client has a single device named `/dev/sda`, and that it belongs to a non-UEFI system. In this case, we have only three partitions: one for the boot loader, one for swap and one for the system. We also expect to have an ext4 file system for the root directory.

Device 1:

- Device: /dev/sda
- Label: GPT
- Initial Gap: 1 MB

Create three partitions:

- Partition 1:
  - Partition Number: 1
  - Partition Size: 1 MB
  - Partition Type: boot
- Partition 2:
  - Partition Number: 2
  - Partition Size: 1024 MB
  - Partition Type: swap
- Partition 3:
  - Partition Number: 3
  - Partition Size: rest
  - Partition Type: linux

Create two file systems:

- Filesystem 1:
  - Partition: /dev/sda2
  - Filesystem: swap
- Filesystem 2:
  - Partition: /dev/sda3
  - Filesystem: ext4
  - Mountpoint: /

Yomi Bootloader

This sub-form provides details required for GRUB.

Set these parameters:

- Device: /dev/sda
- Theme: selected

The `Kernel` parameter can be used for the GRUB `append` section.

Yomi Software

This form provides the different repositories and packages to install. You can also register the product in this form, using SUSEConnect, and install the different modules after registering.

For this example we are going to install a very minimal openSUSE Tumbleweed distribution, using publicly available repositories. For production deployments, you will need to provide a local repository.

Add a new repository: * Repository Name: repo-oss * Repository URL: http://download.opensuse.org/tumbleweed/repo/oss/

Add these packages: * pattern:enhanced_base * glibc-locale * kernel-default

You can also add patterns and products, together with packages, by using the correct prefix.

Yomi Services

By default Yomi is installed with the `salt-minion` service, but you must enable it.

Add a new enabled service:

- Service 1:
  - Service: salt-minion

Yomi Users

This form sets out the system users. In this example, we have a single root user. To provide a password, you must use the hashed version of the password, not the plain text. This behavior is set to be changed in future versions of Yomi.

- User 1:
  - Username: root
  - Password Hash: 1wYJUgpM5$RXMMeASDc035eXNbYWFl0

2.9.5. Monitor the Installation

You can monitor the installation as it progresses, using the `monitor` tool from Yomi. You can continue monitoring as the highstate is applied to the new client. To use the tool, you will need to have enabled

`Events` in the Yomi formula, and have the `salt-api` service activated.

For more information about the `salt-api` service, and how to use the `monitor` tool, see https://github.com/openSUSE/yomi.

2.10. Configuration Modules

Salt uses execution and state modules to define, apply, and orchestrate configuration of your devices. Uyuni provides a set of modules called Uyuni configuration modules, that you can use to configure both SUSE Multi-Linux Manager and Uyuni Servers.

You can use the Uyuni configuration modules directly or using SLS files. They are are especially useful if you have multiple Uyuni Servers, for example in Hub installations, but they are also useful for smaller installations.

For more information about using Hub, see **Specialized-guides › Large-deployments**.

You can use Uyuni configuration modules to configure:

- Organizations
- Users
- User permissions
- System groups
- Activation Keys

For more information about Salt execution modules, see https://docs.saltproject.io/en/latest/topics/tutorials/modules.html.

For more information about Salt state modules, see https://docs.saltproject.io/en/latest/topics/tutorials/starting_states.html.

2.10.1. Install Configuration Modules

The Uyuni configuration modules are available in the `uyuni-config-modules` package. On the Uyuni Server, at the command prompt, as root, use this command:

```
zypper in uyuni-config-modules
```

This package also installs detailed API descriptions, indications on pillar settings, and examples. When you have installed the package, navigate to `/usr/share/doc/packages/uyuni-config-modules/`.

2.11. Salt Formulas

Formulas are collections of Salt States that contain generic parameter fields. Formulas allow for reliable reproduction of a specific configuration. Some formulas are supplied by SUSE, or you can install formulas from RPM packages or an external git repository.

Formulas work best for large, non-trivial, configurations. For smaller tasks, use a state rather than a formula. Formulas and states both act as a kind of configuration documentation. When you have written and stored the configuration, they provide a snapshot of your infrastructure.

Formula data can be managed using the XMLRPC API.

You can use the Uyuni Web UI to apply Uyuni formulas. The most commonly used formulas are documented in this section.

Alternatively, you can use pre-written formulas as a starting point for your own custom formulas. Pre-written formulas are available from https://github.com/saltstack-formulas.

For more information on custom formulas, see **Specialized-guides › Salt**.

2.11.1. Formulas Provided by Uyuni

Some formulas are installed by default with Uyuni. Other official formulas can be installed as RPM packages. When the formula is installed, you can activate them using the Uyuni Web UI.

For information about writing custom formulas, see **Specialized-guides › Salt**.

2.11.1.1. Install Formulas with Zypper

Formulas are provided in the Uyuni pool software channel.

If a formula uses the same name as an existing Salt state, the two names will collide, and could result in the formula being used instead of the state. Always check states and formulas to avoid name clashes.

Procedure: Installing Formulas with Zypper

1. On the Uyuni Server, at the command prompt, search for available formulas:

```
zypper se --type package formula
```

2. Get more information about a formula:

```
zypper info <formula_name>
```

3. On the Uyuni Server, at the command prompt, as root, install the formula:

```
zypper in <formula_name>
```

2.11.1.2. Activate Formulas from the Web UI

Formulas provided by Uyuni, or formulas that you have installed, can be activated using the Uyuni Web UI.

Procedure: Activate Formulas from the Web UI

1. In the Uyuni Web UI, navigate to **Systems › List**, select the client you want to activate the formula for.
2. Navigate to the **Systems › Formulas** tab, and check the formula you want to activate.
3. Click Save.
4. Navigate to the new subtab for the formula, and configure the formula as required.
5. Apply the highstate.

2.11.2. Bind Formula

The Bind formula is used to configure the Domain Name System (DNS) on the branch server. POS terminals will use the DNS on the branch server for name resolution of Saltboot specific hostnames.

When you are configuring the Bind formula for a branch server with a dedicated internal network, check that you are using the same fully qualified domain name (FQDN) on both the external and internal branch networks. If the FQDN does not match on both networks, the branch server will not be recognized as a proxy server.

The following procedure outlines a standard configuration with two zones. Adjust it to suit your own environment.

Zone 1 is a regular domain zone. Its main purpose is to resolveSaltboot hostnames such as TFTP, FTP, or Salt. It can also resolve the terminal names if configured.

Zone 2 is the reverse zone of Zone 1. Its main purpose is to resolve IP addresses back to hostnames. Zone 2 is primarily needed for the correct determination of the FQDNs of the branch.

Procedure: Configuring Bind with Two Zones

1. Check the `Bind` formula, click `Save`, and navigate to the **Formulas › Bind** tab.
2. In the `Config` section, select `Include Forwarders`.
3. In the `Configured Zones` section, use these parameters for Zone 1:
    - In the `Name` field, enter the domain name of your branch network (for example: `branch1.example.com`).
    - In the `Type` field, select `master`.
4. Click `Add item` to add a second zone, and set these parameters for Zone 2:
    - In the `Name` field, use the reverse zone for the configured IP range (for example: `com.example.branch1`).

- In the `Type` field, select `master`

5. In the `Available Zones` section, use these parameters for Zone 1:
   - In the `Name` field, enter the domain name of your branch network (for example: `branch1.example.org`).
   - In the `File` field, type the name of your configuration file.
6. In the `Start of Authority (SOA)` section, use these parameters for Zone 1:
   - In the `Nameserver (NS)` field, use the FQDN of the branch server (for example: `branchserver.branch1.example.org`).
   - In the `Contact` field, use the email address for the domain administrator.
   - Keep all other fields as their default values.
7. In the `Records` section, in subsection `A`, use these parameters to set up an A record for Zone 1:
   - In the `Hostname` field, use the hostname of the branch server (for example: `branchserver`).
   - In the `IP` field, use the IP address of the branch server (for example, `192.168.1.5`).
8. In the `Records` section, subsection `NS`, use these parameters to set up an NS record for Zone 1:
   - In the input box, use the hostname of the branch server (for example: `branchserver`).
9. In the `Records` section, subsection `CNAME`, use these parameters to set up CNAME records for Zone 1:
   - In the `Key` field, enter `tftp`, and in the `Value` field, type the hostname of the branch server (for example: `branchserver`).
   - Click `Add Item`. In the `Key` field, enter `ftp`, and in the `Value` field, type the hostname of the branch server.
   - Click `Add Item`. In the `Key` field, enter `dns`, and in the `Value` field, type the hostname of the branch server.
   - Click `Add Item`. In the `Key` field, enter `dhcp`, and in the `Value` field, type the hostname of the branch server.
   - Click `Add Item`. In the `Key` field, enter `salt`, and in the `Value` field, type the FQDN of the branch server (for example: `branchserver.branch1.example.org`).
10. Set up Zone 2 using the same parameters as for Zone 1, but ensure you use the reverse details:
    - The same SOA section as Zone 1.
    - Empty A and CNAME records.
    - Additionally, configure in Zone 2:
      - `Generate Reverse` field by the network IP address set in branch server network formula (for example, `192.168.1.5/24`).

- For Zones should specify the domain name of your branch network (for example, branch1.example.org).

11. Click Save Formula to save your configuration.
12. Apply the highstate.

Reverse name resolution on terminals might not work for networks that are inside one of these IPv4 private address ranges:

- 10.0.0.0/8
- 172.16.0.0/12
- 192.168.0.0/16

If you encounter this problem, go to the Options section of the Bind formula, and click Add item:

- In the Options field, enter empty-zones-enable.
- In the Value field, select No.

2.11.3. Branch Network Formula

The Branch Network formula is used to configure the networking services required by the branch server, including DHCP, DNS, TFTP, PXE, and FTP.

The formula is used only for connecting Uyuni Proxy 4.3. with Uyuni Server 5.0. Do not use this formula if you want to connect Uyuni Proxy 5.0.

2.11.3.1. Set Up a Branch Server Networking

The branch server can be configured to use networking in many different ways. The most common ways provide either a dedicated or shared LAN for terminals.

2.11.3.1.1. Set Up a Branch Server with a Dedicated LAN

In this configuration, the branch server requires at least two network interfaces: one acts as a WAN to communicate with the SUSE Multi-Linux Manager server, and the other one acts as an isolated LAN to communicate with terminals.

This configuration allows for the branch server to provide DHCP, DNS, TFTP, PXE, and FTP services to terminals. These services can be configured with Salt formulas in the SUSE Multi-Linux Manager Web UI.

Procedure: Setting Up a Branch Server with a Dedicated LAN

1. In the SUSE Multi-Linux Manager Web UI, open the details page for the branch server, and navigate to the Formulas tab.

2. In the `Branch Network` section, set these parameters:
    - Keep `Dedicated NIC` checked.
    - In the `NIC` field, enter the name of the network device that is connected to the internal LAN.
    - In the `IP` field, enter the static IP address to be assigned to the branch server on the internal LAN.
    - In the `Netmask` field, enter the network mask of the internal LAN.
3. Check `Enable Route` if you want the branch server to route traffic from internal LAN to WAN.
    - Check `Enable NAT` if you want the branch server to convert addresses from internal LAN to WAN.
    - Select the `bind` DNS forwarder mode.
    - Check DNS forwarder fallback if you want to rely on an external DNS if the branch DNS fails.
    - Specify the working directory, and the directory owner and group.

2.11.3.1.2. Set up a Branch Server with a Shared Network

In this configuration, the branch server has only one network interface card, which is used to connect to the SUSE Multi-Linux Manager server as well as the terminals.

This configuration allows for the branch server to provide DNS, TFTP, PXE, and FTP services to terminals. These services can be configured with Salt formulas in the SUSE Multi-Linux Manager Web UI. Optionally, the branch server can also provide DHCP services in this configuration.

If DHCP services are not provided by the branch server, ensure that your external DHCP configuration is set correctly:

- The `next-server` option must point to the branch server for PXE boot to work.
- The `filename` option must correctly identify the network boot program (by default, this is `/boot/pxelinux`).
- The `domain-name-servers` option must point to the branch server for correct host name resolution.

Procedure: Setting Up a Branch Server with a Shared Network

1. In the SUSE Multi-Linux Manager Web UI, open the details page for the branch server, and navigate to the `Formulas` tab.
2. In the `Branch Network` section, set these parameters:
    - Keep `Dedicated NIC` unchecked.
    - Enable services on the branch server's firewall. Ensure you include DNS, TFTP, and FTP services.

- Select the `bind` DNS forwarder mode.
- Check DNS forwarder fallback if you want to rely on an external DNS if the branch DNS fails.
- Specify the working directory, and the directory owner and group.

2.11.3.2. Set up Branch Server Terminal Naming

In this configuration it is required to fill at least `Branch Identification`. This identifies Branch Server in Retail subsystem and is also used to better organize terminals with their respective branch servers.

Procedure: Setting up a Branch Server Identification

1. In the SUSE Multi-Linux Manager Web UI, open the details page for the branch server, and navigate to the `Formulas` tab.
2. In the `Terminal Naming` section, enter the `Branch Identification` string.
3. Click Save to save your changes.
4. Apply the highstate.

It is also possible to set various options about terminal naming, for more information about terminal naming see **Retail › Retail-terminal-names**.

2.11.4. DHCPd Formula

The DHCPd formula is used to configure the DHCP service on the branch server.

Procedure: Configuring DHCP

1. In the SUSE Multi-Linux Manager Web UI, open the details page for the branch server, and navigate to the Formulas tab.
2. Check the `Dhcpd` formula, and click Save.
3. Navigate to the **Formulas › Dhcpd** tab, and set these parameters:
   - In the `Domain Name` field, enter the domain name for the branch server (for example: `branch1.example.com`).
   - In the `Domain Name Server` field, enter either the IP address or resolvable FQDN of the branch DNS server (for example: `192.168.1.5`).
   - In the `Listen Interfaces` field, enter the name of the network interface used to connect to the local branch network (for example: `eth1`).
4. Navigate to the `Network Configuration (subnet)` section, and use these parameters for Network1:
   - In the `Network IP` field, enter the IP address of the branch server network (for example: `192.168.1.0`).

- In the Netmask field, enter the network mask of the branch server network (for example: 255.255.255.0).
- In the Domain Name field, enter the domain name for the branch server network (for example: branch1.example.com).

5. In the Dynamic IP Range section, use these parameters to configure the IP range to be served by the DHCP service:
   - In the first input box, set the lower bound of the IP range (for example: 192.168.1.51).
   - In the second input box, set the upper bound of the IP range (for example: 192.168.1.151).
6. In the Broadcast Address field, enter the broadcast IP address for the branch network (for example: 192.168.1.255).
7. In the Routers field, enter the IP address to be used by routers in the branch server network (for example: 192.168.1.5).
8. In the Next Server field, enter the hostname or IP address of the branch server (for example: 192.168.1.5).
9. In the Filename field, if you are booting a client using PXE, type the path to the PXE bootloader. There is usually no need to change the default value of /boot/pxelinux.0.
10. In the Filename Efi field, if you are booting a UEFI client using PXE, type the path to the PXE bootloader. There is usually no need to change the default value of /boot/shim.efi.
11. In the Filename Http field, if you are booting a UEFI client using HTTP, type http://branchserver/saltboot/boot/shim.efi.
12. Click Save Formula to save your configuration.
13. Apply the highstate.

2.11.5. Image Synchronization Formula

The Image Synchronization formula is used to configure when OS images are synchronized to the branch server, and to specify which images to synchronize.

If this formula is not enabled, synchronization must be started manually, and all images will be synchronized.

Procedure: Configuring Image Synchronization

1. In the SUSE Multi-Linux Manager Web UI, open the details page for the branch server, and navigate to the Formulas tab.
2. Check the Image Synchronize formula, and click Save.
3. Navigate to the **Formulas › Image Synchronize** tab, and set these parameters:
   - Check the Include Image Synchronization in Highstate field to have image synchronization occur every time highstate is applied. This ensures that you do not have to

perform image synchronization manually, however it requires a high bandwidth environment.

- In the `Synchronize only the listed images` field, click Add item to add the images you want to have synchronized automatically. Alternatively, you can leave this list blank to have all images synchronized.

4. Click Save Formula to save your configuration.
5. Apply the highstate.

The Image Synchronization state does not delete cached images. If you are running out of disk space, check the size of the Salt client cache directory, and delete it if required. By default, the directory is located at `/var/cache/salt/minion`.

2.11.6. Liberate Formula

The liberate formula migrates systems from EL clients such as CentOS 7 or Red Hat Enterprise Linux 9 to SUSE Liberty Linux. With this formula the conversion will take place during the client onboarding on Uyuni.

The Liberate Formula comes preinstalled within the server container.

2.11.6.1. Configure Uyuni

To provide all the software channels for SUSE Liberty Linux on the Uyuni Server, proceed as follows.

Procedure: Providing SUSE Customer Center credentials

1. Sign in to SUSE Customer Center at https://scc.suse.com.
2. Navigate to `My Organization`, and select your organization.
3. Navigate to **Users › Organization Credentials** and take note of your organization username and password.
4. In the Uyuni Web UI, navigate to **Admin › Setup Wizard › Organization Credentials** to add the credentials to your Uyuni Server.
5. Click Add new credential, and enter the SUSE Customer Center username and password noted in a previous step.

Procedure: Synchronizing the SLL/SLES-ES channels:

1. In the Uyuni Web UI, navigate to **Admin › Setup Wizard › Products**
2. Select the SUSE Liberty Linux Channels that you will use:
   - EL7 LTSS: `SUSE Linux Enterprise Server with Expanded Support LTSS 7 x86_64`
   - EL7: `SUSE Linux Enterprise Server with Expanded Support 7 x86_64`
   - EL8: `RHEL or SLES ES or CentOS 8 Base`

- EL9: `RHEL and Liberty 9 Base`

3. Click the top right button Add products.

Initial sychronization can take considerable time. You can check progress by accessing the server machine via SSH and monitoring the logs using:

```
tail -f /var/log/rhn/reposync/*
```

Procedure: Creating one Activation Key per SUSE Liberty Linux parent channel

1. Note: Activation Keys are the way to register systems and automatically assign them to the required software and configuration channels corresponding to them.
2. In the Uyuni Web UI, navigate to **Systems › Activation Keys**, and click the top right button Create key.
3. In the `Activation Key` dialog, set the fields:

Description

Enter some text describing the activation key.

Key

Enter the identifier of the key. For example [literal`sll9-default` for EL 9 systems. Note: Keys will have a numeric prefix depending on the organization, so that they are unique.

Usage

Leave blank.

Base Channel

Select one base channel:

- EL7 LTSS: `RES-7-LTSS-Updates for x86_64`
- EL7: `RHEL x86_64 Server 7`
- EL8: `RHEL8-Pool for x86_64`
- EL9: `EL9-Pool for x86_64`

Child Channel

Include all child channels.

Add-On system type

Leave all blank.

Contact Method

Default

Universal Default

Leave unchecked.

4. Click Create Activation Key.

2.11.6.2. Add Liberate formula and assign it to activation keys

When installed, the formula can be assigned to an Activation Key by creating a System Group:

Procedure: Assigning system group and assigning liberate formula

1. In the Uyuni Web UI, navigate to **Systems › System Groups**, and click the Create Group button in top right corner.
2. In the dialog, fill in the following data:

   Name

   liberate

   Description

   Systems to be converted to SUSE Liberty Linux

3. From the `liberate` System Group page, navigate go to the `Formulas` tab.
4. Select the `Liberate` formula, and click Save. A new tab called `Liberate` will appear.
5. On the `Liberate` tab, you see the `Reinstall all packages after conversion` option. Keep it checked if you want to reinstall all the packages during the migration. This way you ensure all the packages will have SUSE signatures and no previous package will be kept. If you do not want to change the state of your system during the migration, uncheck this option and click the Save Formula button. In this case, you can re-install the packages later.

Now a system group exists that has assigned the `Liberate` formula. This formula will be applied only once to migrate the system to SUSE Liberty Linux, even if you run it multiple times. With the next procedure, assign the system group to the Activation Key.

Procedure: Assigning the system group to the Activation Key

1. In the Uyuni Web UI, navigate to **Systems › Activation Keys**.
2. Select the Activation Key, for example `sll9-default` for the EL 9 systems.
3. From the Activation Key page navigate to the **Groups › Join** tab, select the `liberate` group, and click the Join Selected Groups button. The group will be assigned to the Activation Key

Procedure: Applying migrate directly during registration

1. From the Activation Key page, navigate to the `Details` tab.
2. Navigate to the `Configuration File Deployment` section, and checkb the `Deploy configuration files to systems on registration`option.

3. Click Update Activation Key.

When you register a system with this key it will perform the migration automatically.

2.11.6.3. Register a new system and proceed to the migration

There are two ways to onboard (or register) a new client with the Activation Key:

Client-configuration › Registration-webui

This is intended for a one-off registration or for testing purposes.

Client-configuration › Registration-bootstrap

This is intended to be used for mass registration.

2.11.6.4. For already registered clients

Software channels, system group membership, and formulas can be assigned to any already registered client. This method makes use of the bootstrap script mentioned above.

Procedure: Creating an Reactivation key

1. In the Uyuni Web UI, open the System Details page of any registered client you want to migrate to SUSE Liberty Linux.
2. Click the `Reactivation` tab. If there is already a key listed, you can use it. If not, click Generate New Key, and copy the entire key. The key will start with `re-`.
3. SSH into this client and set the environment variable to be the key that you copied:

```
export REACTIVATION_KEY=re-xxxxxxxxxxxxx
```

4. Run the bootstrap script from **Client-configuration › Registration-bootstrap**, and the system will re-register using the same profile as before, but with the newly assigned SUSE Liberty Linux context.

2.11.7. Monitoring Formula

The monitoring services in Uyuni are configured using formulas with forms. The package is installed by default, and contains these formulas:

- Grafana
- Prometheus
- Prometheus Exporters

For more information about using monitoring, see **Administration › Monitoring**.

2.11.7.1. Grafana

Procedure: Configuring the Grafana Formula

1. Navigate to the **Formulas › Grafana** tab, and set these parameters in the `Grafana` section:
    - Check the `Enabled` box to enable Grafana visualizations.

`Initial admin password` is used on the first run only, and Grafana UI prompts to change it. This field cannot be used to change the Grafana password. For more information on how to change the password, see **Administration › Monitoring**.

2. For each Prometheus data source you want to use, in the **Datasources › Prometheus** section, click `+`, and set these parameters:
    - In the `Datasource name` field, type a name to identify the data source.
    - In the `Prometheus URL` field, type the used protocol, the location of the Prometheus server, and append port `9090`. For example, `http://example.com:9090`. In case TLS encryption is enabled in Prometheus formula make sure to use `https` protocol and FQDN.
    - In the fields `Prometheus server username` and `Prometheus server password`, enter basic authentication credentials for Prometheus server matching the ones in Prometheus formula.
3. In the `Dashboards` section, check the dashboards you want to use:
    - `Uyuni server dashboard`
    - `Uyuni clients dashboard`
    - `PostgreSQL dashboard`
    - `Apache HTTPD dashboard`
    - `Kubernetes cluster dashboard`
    - `Kubernetes etcd dashboard`
    - `Kubernetes namespaces dashboard`
4. Click `Save Formula` to save your configuration.

2.11.7.2. Prometheus

Procedure: Configuring the Prometheus Formula

1. Navigate to the **Formulas › Prometheus** tab, and set these parameters in the `Prometheus` section:
    - Check the `Enabled` box to enable Prometheus monitoring.
    - In the `Scrape interval` field, type the frequency of data scraping, in seconds. For example, `15` will scrape data every fifteen seconds.
    - In the `Evaluation interval` field, type the frequency of rules evaluation, in seconds. For example, `15` will evaluate alerting and aggregation rules every fifteen seconds.

2. In the `TLS` section, set these parameters:
    - Check the `Enabled` box to enable the secure configuration on Prometheus server.
    - In the `Server Certificate` field, type the path to the TLS server certificate.
    - In the `Server Key` field, type the path to the TLS server key.
    - In the `User` field, type the user name for Prometheus server.
    - In the `Password Hash` field, type the password for Prometheus server hashed with bcrypt.
3. In the `Uyuni Server` section, set these parameters:
    - Check the `Enabled` box to enable monitoring on this server.
    - Check the `Autodiscover clients` box to enable Prometheus to automatically find and monitor new clients when they are added to the server.
    - In the `Username` field, type the user name of the Prometheus account on the server.
    - In the `Password` field, type the password of the Prometheus account on the server.
    - In the `Targets TLS` section, set these parameters:
        - Check the `Enabled` box to enable the secure configuration for auto-discovered targets.
        - In the `CA Certificate` field, type the path to the Certificate Authority certificate.
        - In the `Client Certificate` field, type the path to the TLS client certificate for authentication.
        - In the `Client Key` field, type the path to the TLS client key for authentication.
4. In the `Alerting` section, set these parameters:
    - Check the `Enable local Alertmanager service` box to enable the alert manager service.
    - Check the `Use local Alertmanager` box to use the local alert manager service.
5. For each alert manager you want to use, in the **Alerting › Alertmanagers** section, click  , and set these parameters:
    - In the `IP Address:Port` field, type the location of the alert manager target, including the port number.
6. To use a rule file, in the **Alerting › Rule Files** section, click  , and set these parameters:
    - In the `Rule Files` field, type the location of the rule file you want to use.
7. To add a custom scrape configuration, in the `User defined scrape configurations` section, click  , and set these parameters:
    - In the `Job name` field, type a unique job name for your configuration.
    - In the `Files` field, type the location pattern of file service discovery files you want to use. For more information, see the upstream documentation https://prometheus.io/docs/prometheus/

latest/configuration/configuration/#file_sd_config.

8. Click Save Formula to save your configuration.

The formula does not generate and deploy the TLS certificates and keys. Ensure the files are present on the Salt client and readable for the user `prometheus` before applying the highstate. For more information about generating client and server certificates, see **Administration › Monitoring**.

2.11.7.3. Prometheus Exporters

Procedure: Configuring the Prometheus Exporters Formula

1. Navigate to the **Formulas › Prometheus Exporters** tab, and set these parameters in the `Node Exporter` section:
   - Check the `Enabled` box to enable the node exporter.
   - In the `Arguments` field, type any customized arguments for this exporter. For example, `--web.listen-address=":9100"`.
2. In the `Apache Exporter` section:
   - Check the `Enabled` box to enable the Apache exporter.
   - In the `Arguments` field, type any customized arguments for this exporter. For example, `--telemetry.address=":9117"`.
3. In the `Postgres Exporter` section:
   - Check the `Enabled` box to enable the PostreSQL exporter.
   - In the `Data source Name` field, type the name of the data source to use.
   - In the `Arguments` field, type any customized arguments for this exporter. For example, `--web.listen-address=":9187"`.
4. In the `TLS` section:
   - Check the `Enabled` box to enable the secure configuration.
   - In the `CA Certificate` field, type the path to the Certificate Authority certificate.
   - In the `Server Certificate` field, type the path to the TLS server certificate.
   - In the `Server Key` field, type the path to the TLS server key.
5. Click Save Formula to save your configuration.

2.11.7.3.1. File-based service discovery

It is possible to define monitored targets using file-based service discovery provided in the Prometheus formula. This is a basic example demonstrating the usage:

```
[
```

```
  {
    "targets": [ "<client1>:9100", "<client2>:9100" ],
    "labels": {
      "role": "<MLM-client>",
      "job": "<MLM-refclient>"
    }
  },
  {
    "targets": [ "<server>:80" ],
    "labels": {
      "role": "<MLM-server>",
      "job": "<MLM-refhost>",
      "__metrics_path__": "/rhn/metrics"
    }
  }
]
```

For more information, see https://prometheus.io/docs/guides/file-sd/.

2.11.7.3.2. TLS certificates and keys

The formula does not generate and deploy the TLS certificates and keys. Ensure the files are present on the Salt client and readable for the user `prometheus` before applying the highstate. For more information about generating client and server certificates, see **Administration › Monitoring**.

2.11.7.4. Activate Forms

When you have completed and saved all the forms, apply the highstate.

For more information about using monitoring, see **Administration › Monitoring**.

2.11.8. PXE Formula

The PXE formula is used to configure PXE booting on the branch server.

The formula is used only for connecting Uyuni Proxy 4.3. with Uyuni Server 5.0. Do not use this formula if you want to connect Uyuni Proxy 5.0.

Procedure: Configuring PXE Booting

1. In the SUSE Multi-Linux Manager Web UI, open the details page for the branch server, and navigate to the `Formulas` tab.
2. Select the `Pxe` formula, and click `Save`.
3. Navigate to the **Formulas › Pxe** tab, and set these parameters:
    - In the `Kernel Filename` field, keep the default value.
    - In the `Initrd Filename` field, keep the default value.
    - If the terminals connecting to this branch server are running arm64 architecture, check the `Enable ARM64 UEFI boot` box. Leave unchecked for x86-64.
    - In the `Kernel Filename for ARM64` field, keep the default value.

- In the `Initrd Filename for ARM64` field, keep the default value.
- In the `Kernel Command Line Parameters` field, keep the default value. For more information about possible values, see Saltboot Kernel Command Line Parameters.
- In the `PXE root directory` field, enter the path to the Saltboot directory (for example, `/srv/saltboot`).

4. Click `Save Formula` to save your configuration.
5. Apply the highstate.

2.11.8.1. Saltboot Kernel Command Line Parameters

Saltboot supports common kernel parameters and Saltboot-specific kernel parameters. All the parameters can be entered in the `Kernel Command Line Parameters` field of the PXE formula.

`kiwidebug=1`

Starts a shell on tty2 during boot and enables debug logging in Salt.

Do not use this parameter in a production environment as it creates a major security hole. This parameter should be used only in a development environment for debug purposes.

`MASTER`

Overrides auto-detection of the Salt master. For example:

```
MASTER=myproxy.domain.com
```

`SALT_TIMEOUT`

Overrides the local boot fallback timeout if the Salt master does not apply the Saltboot state within this timeout (default: 60 seconds). For example:

```
SALT_TIMEOUT=300
```

`DISABLE_HOSTNAME_ID`

If the terminal has a hostname assigned by DHCP, it is by default used as a minion ID. Setting this option to `1` disables this mechanism, and SMBios information will be used as a minion ID.

`DISABLE_UNIQUE_SUFFIX`

Setting this option to `1` disables adding random generated suffix to terminal minion ID.

If you set this parameter make sure your terminal has either a unique hostname provided by DHCP and DNS, or the terminal hardware comes with a unique serial number stored in its SMBios memory. Otherwise there is a risk of terminal minion ID duplicity, and bootstrapping the minion will fail.

The following parameters (`MINION_ID_PREFIX`, `salt_device`, `root`) are usually autoconfigured and should be used only in specific conditions such as debugging or development:

`MINION_ID_PREFIX`

Branch ID set in the Branch Network formula form.

`salt_device`

Device that contains the Salt configuration.

`root`

Device that contains the already deployed root file system. Used for falling back to local boot.

2.11.9. Saline Formula

Saline in Uyuni monitoring is configured using formulas with forms. The package is installed by default, and contains these formulas:

- Saline Prometheus
- Saline Grafana

These formulas are extending the configuration of Grafana and Prometheus created with Monitoring Formulas.

2.11.9.1. Saline Prometheus

Procedure: Configuring the Saline Prometheus Formula

1. Navigate to the **Formulas › Saline Prometheus** tab, and set these parameters in the `Saline Prometheus` section:
    - Check the `Enable Saline scrape configuration` box to enable Saline Prometheus monitoring.
    - Check the `Saline secure connection (HTTPS)` to use secure connection to Saline (used by default).
2. Click Save Formula to save your configuration.

2.11.9.2. Saline Grafana

Procedure: Configuring the Saline Grafana Formula

1. Navigate to the **Formulas › Saline Grafana** tab, and set these parameters in the `Saline Grafana` section:
2. In the `Dashboards` section, check the dashboards you want to use:
    - `Uyuni server dashboard with Saline`
    - `Uyuni Saline States Job dashboard`

3. Click Save Formula to save your configuration.

2.11.9.3. Activate Forms

When you have completed and saved all the forms, apply the highstate.

- For more information about configuring Prometheus and Grafana with formulas, see Monitoring Formulas.
- For more information about using monitoring, see **Administration › Monitoring**.

2.11.10. Saltboot Formula

The Saltboot formula is used to configure disk images and partitioning for the selected hardware type.

The Saltboot formula is meant to be used as a group formula. Enable and configure Saltboot formula for hardware type groups.

To apply changes to a terminal, terminal needs to be restarted. Applying highstate does not have any effect on running terminals.

Procedure: Configuring the Hardware Type Group with Saltboot

1. Open the details page for your new hardware type group, and navigate to the `Formulas` tab.
2. Select the Saltboot formula and click Save.
3. Navigate to the **Formulas › Saltboot** tab.
4. In the `Disk 1` section, set these parameters:
    - In the `Disk symbolic ID` field, enter a custom name for the disk (for example, `disk1`).
    - In the `Device type` field, select `DISK`.
    - In the `Disk device` field, select the device that corresponds to the device name on the target machine or asterisk `*`, see Disk Selection in Saltboot Formula.
    - In the `RAID level` field, leave it empty.
    - In the `Disk Label` field, select `gpt`.
5. In the `Partition` section, set these parameters for `Partition 1`:
    - In the `Partition symbolic ID` field, enter a custom name for the partition (for example, `p1`).
    - In the `Partition size` use value 500.
    - In the `Device mount point` use `/boot/efi`.
    - In the `Filesystem format` use `vfat`.
    - In the `OS Image to deploy` field, leave it empty.

- In the `Partition encryption password` field, leave it empty.
- In the `Partition flags` use `boot`.

6. In the `Partition` section, set these parameters for `Partition 2`:
   - In the `Partition symbolic ID` field, enter a custom name for the partition (for example, `p2`).
   - In the `Partition size` field, specify a size for the partition in Mebibytes (MiB).
   - In the `Device mount point` field, select a location to mount the partition (for example, `/data`).
   - In the `Filesystem format` field, select your preferred format (for example, `xfs`).
   - In the `OS Image to deploy` field, leave it empty.
   - In the `Partition encryption password` field, enter a password if you want to encrypt the partition.
   - In the `Partition flags` field, leave it empty.
7. In the `Partition` section, set these parameters for `Partition 3`:
   - In the `Partition symbolic ID` field, enter a custom name for the partition (for example, `p3`).
   - In the `Partition size` field, specify a size for the partition in Mebibytes (MiB).
   - In the `Device mount point` field, leave it empty.
   - In the `Filesystem format` field, select `swap`.
   - In the `OS Image to deploy` field, leave it empty.
   - In the `Partition encryption password` field, enter a password if you want to encrypt the partition.
   - In the `Partition flags` field, select `swap`.
8. In the `Partition` section, set these parameters for `Partition 4`:
   - In the `Partition symbolic ID` field, enter a custom name for the partition (for example, `p4`).
   - In the `Partition size` field, leave it empty. This will ensure the partition uses up all remaining space.
   - In the `Device mount point` field, select `/`.
   - In the `Filesystem format` field, leave it empty.
   - In the `OS Image to deploy` field, enter the name of the image to deploy.
   - In the `Image version` field, leave it empty. This will ensure you use the latest available version.

- In the `Partition encryption password` field, enter a password if you want to encrypt the partition.
- In the `Partition flags` field, leave it empty.

9. Click Save Formula to save your configuration.

2.11.10.1. Special Partition Types

The Saltboot formula helps you with setting up special partition types.

For terminal to be able to boot locally, either `BIOS grub` or `EFI` partition must be configured.

2.11.10.1.1. BIOS grub Partition

A BIOS grub partition is needed for local booting from a `GPT` disk on non-EFI machines. For more information, see https://en.wikipedia.org/wiki/BIOS_boot_partition.

In the formula, enter the following options:

```
Partition Symbolic ID: p1
Partition Size (MiB): 50
Partition Flags: bios_grub
```

Leave the other fields empty.

2.11.10.1.2. EFI Partition

An EFI partition is needed for local booting on EFI machines, `Partition Table Type` must be `GPT`. For more information, see https://en.wikipedia.org/wiki/EFI_system_partition.

In the formula, enter the following options:

```
Partition Symbolic ID: p1
Partition Size (MiB): 500
Device Mount Point: /boot/efi
Filesystem Format: vfat
Partition Flags: boot
```

Leave the other fields empty.

2.11.10.2. Disk Selection in Saltboot Formula

When there is only one disk present on target hardware (including USB drives), use an asterisk `*` to automatically select the disk device.

When there are multiple disks, use an asterisk `*` in the device path. In this example, SATA disks are differentiated from USB disks:

```
/dev/disk/by-path/*-ata-1
/dev/disk/by-path/*usb*
```

If the entered value does not contain `/`, the entered value is automatically prepended by `/dev/disk/by-path/`. For example, `*usb*` is the same as `/dev/disk/by-path/*usb*`.

If you prefer to select specific devices, you can this format in the disk device field:

- symbolic names (for example: `/dev/sda`)
- by-path (for example: `/dev/disk/by-path/..`)
- by-id (for example: `/dev/disk/by-id/⋯`)

To see a list of available devices from the command prompt, press `Esc` while waiting for key approval.

2.11.10.3. Troubleshooting the Saltboot Formula

`msdos` Disklabel Limitations

On the `msdos` disk label, you can create a maximum of four primary partitions. Extended partitions are not supported. If you need more than four partitions, use the `GPT` disk label instead.

2.11.11. TFTPd Formula

The TFTPd formula is used to configure the TFTP service on the Uyuni for Retail branch server.

The formula is used only for connecting Uyuni Proxy 4.3. with Uyuni Server 5.0. Do not use this formula if you want to connect Uyuni Proxy 5.0.

Procedure: Configuring TFTP

1. In the SUSE Multi-Linux Manager Web UI, open the details page for the branch server, and navigate to the `Formulas` tab.
2. Select the `Tftpd` formula, and click Save.
3. Navigate to the **Formulas › Tftpd** tab, and set these parameters:
    - In the `Internal Network Address` field, enter the IP address of the branch server (for example: `192.168.1.5`).
    - In the `TFTP Base Directory` field, enter the path to the Saltboot directory (for example, `/srv/saltboot`).
    - In the `Run TFTP Under User` field, enter `saltboot`.
4. Click Save Formula to save your configuration.
5. Apply the highstate.

2.11.12. Virtualization Guest Formula

The Virtualization Guest formula is used to configure settings for virtual machine.

Open the `Tuning` pull-down checklist and select from the following virtual machine performance tuning settings:

- `Disable IRQ balancing`.
- `Disable Kernel Samepage Merging (KSM)`. Reduces performance overhead by not sharing memory across virtual machines.
- `Optimizations for KVM passed through host CPU`. Requires the KVM hint-dedicated option to be set on the VM definition.

When configured, click Save Formula to save your configuration, and apply the highstate.

2.11.13. Virtualization Host Formula

The Virtualization Host formula is used to configure settings for a virtualization host.

Hypervisor

Select KVM or Xen as the hypervisor.

Create default storage pool

Create default virtual network

- Default pool: Open the pull-down list and enter the directory name of the default storage pool.
- Default net: Open the pull-down list and configure the default virtual network by setting the `Mode` (`NAT` or `Bridge`) and the `Bridge name`.

Tuning

Enable IOMMU support (x86_64).

When configured, click Save Formula to save your configuration, and apply the highstate.

2.11.14. Yomi Formula

The Yomi (yet one more installer) installer for SUSE and openSUSE operating systems is configured using formulas with forms.

The `yomi-formula` package provides these formulas:

- Yomi
- Yomi Storage
- Yomi Bootloader
- Yomi Software

- Yomi Services
- Yomi Users

Procedure: Install the Yomi Formulas with Forms

1. On the Uyuni Server, at the command prompt, as root, install the `yomi-formula` package:

```
zypper in yomi-formula
```

2. Restart services:

```
systemctl restart salt-master.service
```

When the formula package is installed, you need to install the PXE Yomi image on the client, boot the client you want to provision, and enable the Yomi formulas on the client. For more information on preparing Yomi clients for provisioning, see **Specialized-guides › Salt**.

Procedure: Configuring the Yomi Formula

1. Navigate to the **Formulas › Yomi** tab, and set these parameters in the `General Configuration` section:
    - Check the `Events` box to allow monitoring.
    - In the `Reboot` field, select `yes` to instruct the client to reboot after installation.
    - Check the `Snapper` box if you are using the btrfs file system on the client.
    - In the `Locale` field, select the region and encoding for systemd to use on the client. For example: `en_US.utf8` for US English and UTF-8.
    - In the `Keymap` field, select the appropriate keyboard layout. For example: `us` for a US keyboard layout.
    - In the `Timezone` field, select the timezone for the client to use. For example: `America/New_York` for EST.
    - In the `Hostname` field, enter the hostname for the client to use. Leave this blank if you are using DHCP to provide the hostname.
    - In the `Machine Id` field, enter a machine identification number for the client. Leave this blank to have systemd generate one automatically.
    - In the `Target` field, enter a systemd target unit.
2. Click `Save Formula` to save your configuration.

Procedure: Configuring the Yomi Storage Formula

1. Navigate to the **Formulas › Yomi Storage** tab, and set these parameters in the **Partitions › Config** section:

- In the `Labels` field, select the default partition table type to use.
- In the `Initial Gap` field, select the default amount of space to leave before the first partition. For example: `1 MB`, or use `0` to leave no space between partitions.

2. For each device that you want to configure, in the **Partitions › Devices** section, click +, and set these parameters:
   - In the `Device` field, type the mount point for the device. For example, `/dev/sda`.
   - In the `Label` field, select the partition table type to use, if it is different from the default label you selected.
   - In the `Initial Gap` field, select the amount of space to leave before the first partition, if it is different from the default space you specified.
3. For each partition that you want to create, in the **Partitions › Devices › Partitions** section, click +, and set these parameters:
   - In the `Partition Number` field, enter a number for the partition. The number you enter here is appended to the device name to identify the partition. For example, partition number `1` on device `/dev/sda` can be identified as `/dev/sda1`.
   - In the `Partition Name` field, enter a name for the partition. Leave this blank if you have entered a partition number in the previous field.
   - In the `Partition Size` field, enter a size for the partition. For example: `500 MB`. Use `rest` to use all the remaining free space.
4. For each file system that you want to create, in the `Filesystems` section, click +, and set these parameters:
   - In the `Partition` field, select the partition to create the file system on. For example, `/dev/sda1`.
   - In the `Filesystem` field, select the file system type to create.
   - In the `Mountpoint` field, type the mount point for the file system. For example: `/` for root.
5. Click Save Formula to save your configuration.

If you want to use LVM or RAID on your devices, click + in the appropriate sections, and complete the details for your environment.

Procedure: Configuring the Yomi Bootloader Formula

1. Navigate to the **Formulas › Yomi Bootloader** tab, and set these parameters in the `Bootloader` section:
   - In the `Device` field, type the path for the bootloader. For example, `/dev/sda`.
   - In the `Timeout` field, select the number of seconds grub will wait before booting the default menu entry.
   - In the `Kernel` field, type any additional kernel parameters you want to use. Any kernel

parameters you add here will be appended to the `GRUB_CMDLINE_LINUX_DEFAULT` line during boot.

- In the `Terminal` field, type the terminal to use for both terminal input and output.
- In the `Serial Command` field, type parameters for using the serial port. Use this only if you are using the serial console as the default terminal.
- In the `Gfxmode` field, type the resolution to use for the graphical terminal. Use this only if you are using the graphical console as the default terminal.
- Check the `Theme` box to use GRUB2 default branding package.
- Check the `Disable OS Prober` box to disable using the OS prober to discover other installed operating systems.

2. Click Save Formula to save your configuration.

Procedure: Configuring the Yomi Software Formula

1. Navigate to the **Formulas › Yomi Software** tab, and set these parameters in the **Software › Configuration** section:
   - Check the `Minimal` box to use a minimal installation, which only installs packages listed as `Required`.
2. For each repository that you want to add, in the **Software › Repositories** section, click +, and set these parameters:
   - In the `Repository Name` field, type a name for the repository.
   - In the `Repository URL` field, type the location of the repository.
3. To add packages from each repository, in the **Software › Packages** section, click +, and set these parameters:
   - In the **Software › Packages** field, type the names of the packages to install, or type a pattern to search for the appropriate packages. For example, `pattern:enhanced_base glibc-locale`, or `kernel-default`.
4. In the **Software › Image** section, set these parameters:
   - In the `Image URL` field, type the location of the operating system ISO image to use.
   - In the `Md5` field, type the MD5 hash to use to verify the ISO.
5. In the **SUSEConect › Config** section, set these parameters:
   - In the `Registration Code` field, type the registration code for the client you are installing. You can obtain this code from SUSE Customer Center.
   - In the `Email` field, type the administrator email address to use.
   - In the `Url` field, type the address of the registration server to use. For example, use `https://scc.suse.com`, to register with SUSE Customer Center.

- In the `Version` field, type the version of the product you are registering.

6. For each product that you want to register, in the **SUSEConnect › Products** section, click `+`, and set these parameters:
   - In the `Product` field, type each product you want to register. For example, `<product_name>/1.1/x86`, for version 1.1 with x86 architecture.
   - In the **SUSEConnect › Packages** field, type the names of the packages to install, or type a pattern to search for the appropriate packages. For example, `pattern:enhanced_base glibc-locale`, or `kernel-default`.
7. Click `Save Formula` to save your configuration.

Procedure: Configuring the Yomi Services Formula

1. Navigate to the **Formulas › Yomi Services** tab, and set these parameters:
   - Check the `Install salt-minion` box to install and configure the client as a Salt client.
2. For each service you want to enable, in the **Services › Enabled** section, click `+`, and set these parameters:
   - In the `Service` field, type the name of the service to enable. For example, `salt-minion`.
3. For each service you want to disable, in the **Services › Disabled** section, click `+`, and set these parameters:
   - In the `Service` field, type the name of the service to disable.
4. Click `Save Formula` to save your configuration.

Procedure: Configuring the Yomi Users Formula

1. Navigate to the **Formulas › Yomi Users** tab.
2. For each user you want to create, in the `Users` section, click `+`, and set these parameters:
   - In the `Username` field, type the name of the new user.
   - In the `Password Hash` field, type the hashed version of the password to use.
3. To add a certificate for each user, in the **Users › Certificates** section, click `+`, and add the certificate to the `Certificate` field.
4. Click `Save Formula` to save your configuration.

When you have completed and saved all the forms, apply the highstate.

For more information about using Yomi, see **Specialized-guides › Salt**.

2.11.15. Custom Salt Formulas

This section contains information about writing custom formulas, including formulas with forms. You can write your own custom formulas, and make them available to client systems in the Uyuni Web UI.

For information about the formulas provided by Uyuni, see **Specialized-guides › Salt**.

2.11.15.1. File Structure Overview

RPM-based formulas must be placed in a specific directory structure to ensure that they work correctly. A formula contains two separate directories: `states`, and `metadata`. Folders in these directories need to have exactly matching names.

The formula states directory contains anything necessary for a Salt state to work independently. This includes `.sls` files, a `map.jinja` file and any other required files. This directory should only be modified by RPMs and should not be edited manually. For example, the `locale-formula` states directory is located in:

```
/usr/share/susemanager/formulas/states/locale/
```

To create formulas with forms, the metadata directory contains a `form.yml` file. The `form.yml` file defines the forms for Uyuni. The metadata directory also contains an optional `metadata.yml` file with additional information about the formula. For example, the `locale-formula` metadata directory is located in:

```
/usr/share/susemanager/formulas/metadata/locale/
```

If you have a custom formula that is not in an RPM, it must be in a state directory configured as a Salt file root. Custom state formula data must be in:

```
/srv/salt/<custom-formula-name>/
```

Custom metadata information must be in:

```
/srv/formula_metadata/<custom-formula-name>/
```

All custom folders must contain a `form.yml` file. These files are detected as form recipes and are applied to groups and systems from the Web UI:

```
/srv/formula_metadata/<custom-formula-name>/form.yml
```

The Salt formula directory changed in Uyuni 4.0. The old directory location, `/usr/share/susemanager/formulas`, will continue to work for some time. You should ensure that you update to the new directory location, `/usr/share/salt-formulas/` as soon as possible.

2.11.15.2. Define Formula with Forms Data

Uyuni requires a file called `form.yml`, to describe how formula data should look within the Web UI. The `form.yml` file is used by Uyuni to generate the desired formula with forms, with values editable by a user.

The file contains a list of editable attributes that start with a `$` sign. These attributes are used to determine how to display the formula in the Uyuni Web UI.

For example, the `form.yml` that is included with the `locale-formula` is in:

```
/usr/share/susemanager/formulas/metadata/locale/form.yml
```

Part of that file looks like this:

```
timezone:
  $type: group

  name:
    $type: select
    $values: ["CET",
              "Etc/Zulu"
              ]
    $default: CET

  hardware_clock_set_to_utc:
    $type: boolean
    $default: True
...
```

All values that start with a `$` sign are annotations used to display the UI that users interact with. These annotations are not part of pillar data itself and are handled as metadata.

This section lists the available attributes:

$type

The most important attribute is the `$type` attribute. It defines the type of the pillar value and the form-field that is generated. The supported types are:

- `text`
- `password`
- `number`
- `url`
- `email`
- `date`
- `time`
- `datetime`

- `boolean`
- `color`
- `select`
- `group`
- `edit-group`
- `namespace`
- `hidden-group` (obsolete, renamed to `namespace`)

The text attribute is the default and does not need to be specified explicitly.

Many of these values are self-explanatory:

- The `text` type generates a simple text field
- The `password` type generates a password field
- The `color` type generates a color picker

The `group`, `edit-group`, and `namespace` (formerly `hidden-group`) types do not generate an editable field and are used to structure form and pillar data. All these types support nesting.

The `group` and `namespace` types differ slightly. The `group` type generates a visible border with a heading. The `namespace` type shows nothing visually, and is only used to structure pillar data.

The `edit-group` type allows you to structure and restrict editable fields in a more flexible way. The `edit-group` type is a collection of items of the same kind. Collections can have these four shapes:

- List of primitive items
- List of dictionaries
- Dictionary of primitive items
- Dictionary of dictionaries

The size of each collection is variable. Users can add or remove elements.

For example, `edit-group` supports the `$minItems` and `$maxItems` attributes, which simplifies complex and repeatable input structures. These, and also `itemName`, are optional.

$default

Allows you to specify a default value to be displayed. This default value will be used if no other value is entered. In an `edit-group` it allows you to create initial members of the group and populate them with specified data.

$optional

This type is a Boolean attribute. If it is `true` and the field is empty in the form, then this field will not be generated in the formula data and the generated dictionary will not contain the field name key. If it is `false` and the field is empty, the formula data will contain a `<field name>: null` entry.

$ifEmpty

This type is used if the field is empty. This usually occurs because the user did not provide a value. The `ifEmpty` type can only be used when `$optional` is `false` or not defined. If `$optional` is `true`, then `$ifEmpty` is ignored. In this example, the `DP2` string would be used if the user leaves the field empty:

```
displayName:
  $type: string
  $ifEmpty: DP2
```

$name

Allows you to specify the name of a value that is shown in the form. If this value is not set, the pillar name is used and capitalized without underscores and dashes. Reference it in the same section with `${name}`.

$help and $placeholder

These attributes are used to give a user a better understanding of what the value should be. The `$help` type defines the message a user sees when hovering over a field The `$placeholder` type displays a gray placeholder text in the field

Use `$placeholder` only with text fields like text, password, email or date fields. Do not add a placeholder if you also use `$default`, as it will hide the placeholder.

$key

Applicable only if the `edit-group` has the shape of a dictionary. When the pillar data is a dictionary, the `$key` attribute determines the key of an entry in the dictionary.

For example:

```
user_passwords:
  $type: edit-group
  $minItems: 1
  $prototype:
    $key:
        $type: text
    $type: text
  $default:
    alice: secret-password
    bob: you-shall-not-pass
```

Pillar:

```
user_passwords:
  alice:
    secret-password
  bob:
    you-shall-not-pass
```

$minItems and $maxItems

In an `edit-group`, `$minItems` and `$maxItems` specifies the lowest and highest numbers for the group.

$itemName

In an `edit-group`, `$itemName` defines a template for the name to be used for the members of the group.

$prototype

In an `edit-group`, `$prototype` is mandatory and defines the default pre-filled values for newly added members in the group.

$scope

Specifies a hierarchy level at which a value may be edited. Possible values are `system`, `group`, and `readonly`.

The default value is `$scope: system`, allows values to be edited at group and system levels. A value can be entered for each system but if no value is entered the system will fall back to the group default.

The `$scope: group` option makes a value editable only for a group. On the system level you will be able to see the value, but not edit it.

The `$scope: readonly` option makes a field read-only. It can be used to show data to the user, but will not allow them to edit it. This option should be used in combination with the `$default` attribute.

$visibleIf

Deprecated in favor of `$visible`.

Allows you to show a field or group if a simple condition is met. An example condition is:

```
some_group#another_group#my_checkbox == true
```

The left part of the condition is the path to another value, and groups are separated by `#` signs. The middle section of the condition should be either `==` for a value to be equal or `!=` for values that should be not equal. The last field in the statement can be any value which a field should have or not have.

The field with this attribute associated with it will be shown only when the condition is met. In this example the field will be shown only if `my_checkbox` is checked. The ability to use conditional statements is not limited to check boxes. It may also be used to check values of select-fields, text-fields, and similar.

A check box should be structured like this:

```
some_group:
  $type: group

  another_group:
    $type: group

      my_checkbox:
        $type: boolean
```

Relative paths can be specified using prefix dots. One dot indicates a sibling, two dots indicate a parent, and so on. This is mostly useful for `edit-group`.

```
some_group:
  $type: group

  another_group:
    $type: group

    my_checkbox:
      $type: boolean

    my_text:
      $visibleIf: .my_checkbox == true

  yet_another_group:
    $type: group

    my_text2:
      $visibleIf: ..another_group#my_checkbox == true
```

If you use multiple groups with the attribute, you can allow a users to select an option and show a completely different form, dependent upon the selected value.

Values from hidden fields can be merged into the pillar data and sent to the client. A formula must check the condition again and use the appropriate data. For example:

```
show_option:
  $type: checkbox
some_text:
  $visibleIf: .show_option == true
```

```
{% if pillar.show_option %}
do_something:
  with: {{ pillar.some_text }}
{% endif %}
```

$values

Can only be used together with `$type` Use to specify the different options in the select-field. `$values` must be a list of possible values to select. For example:

```
select_something:
  $type: select
  $values: ["option1", "option2"]
```

Or:

```
select_something:
  $type: select
  $values:
    - option1
    - option2
```

$visible

Allows you to show a field or group if a condition is met. You must use the jexl expression language to write the condition.

Example structure:

```
some_group:
  $type: group

  another_group:
    $type: group

      my_checkbox:
        $type: boolean
```

An example condition is:

```
formValues.some_group.another_group.my_checkbox == true
```

The field with this attribute will only show if the condition is met. In this example, the field will show only if `my_checkbox` is checked. You can also choose other elements for the conditional statement, such as select fields or text fields.

If you use multiple groups with the attribute, users can select an option that will show a completely different form, depending on the selected value.

Values from hidden fields can be merged into the pillar data and sent to the client. A formula must check the condition again and use the appropriate data. For example:

```
show_option:
  $type: checkbox
some_text:
```

```
  $visible: this.parent.value.show_option == true
```

```
{% if pillar.show_option %}
do_something:
  with: {{ pillar.some_text }}
{% endif %}
```

$disabled

Allows you to disable a field or group if a condition is met. You must use the jexl expression language to write the condition.

If specified at group level it will disable all fields in that group.

$required

Fields with this attribute are mandatory. Supports using the jexl expresion language.

$match

Allows using a regular expression to validate the content of a text field.

It supports the regular expression features existing in JavaScript.

Example:

```
      hardware:
        $type: text
        $name: Hardware Type and Address
        $placeholder: Enter hardware-type hardware-address (for example, "ethernet
AA:BB:CC:DD:EE:FF")
        $help: Hardware Identifier - prefix is mandatory
        $match: "\\w+ [A-Z]{2}:[A-Z]{2}:[A-Z]{2}:[A-Z]{2}:[A-Z]{2}:[A-Z]{2}"
```

2.11.15.2.1. Expression language

You must use the jexl expression language to write conditions.

Given a structure like this:

```
some_group:
  $type: group

  another_group:
    $type: group

      my_checkbox:
        $type: boolean
```

An example condition is:

```
formValues.some_group.another_group.my_checkbox == true
```

Absolute paths must begin with `formValues`.

Specify relative paths using `this.parent.value` to define the value of the parent.

You can also refer to the parent of the parent, with `this.parent.parent.value`. This is mostly useful for `edit-group` elements.

Example for relative paths:

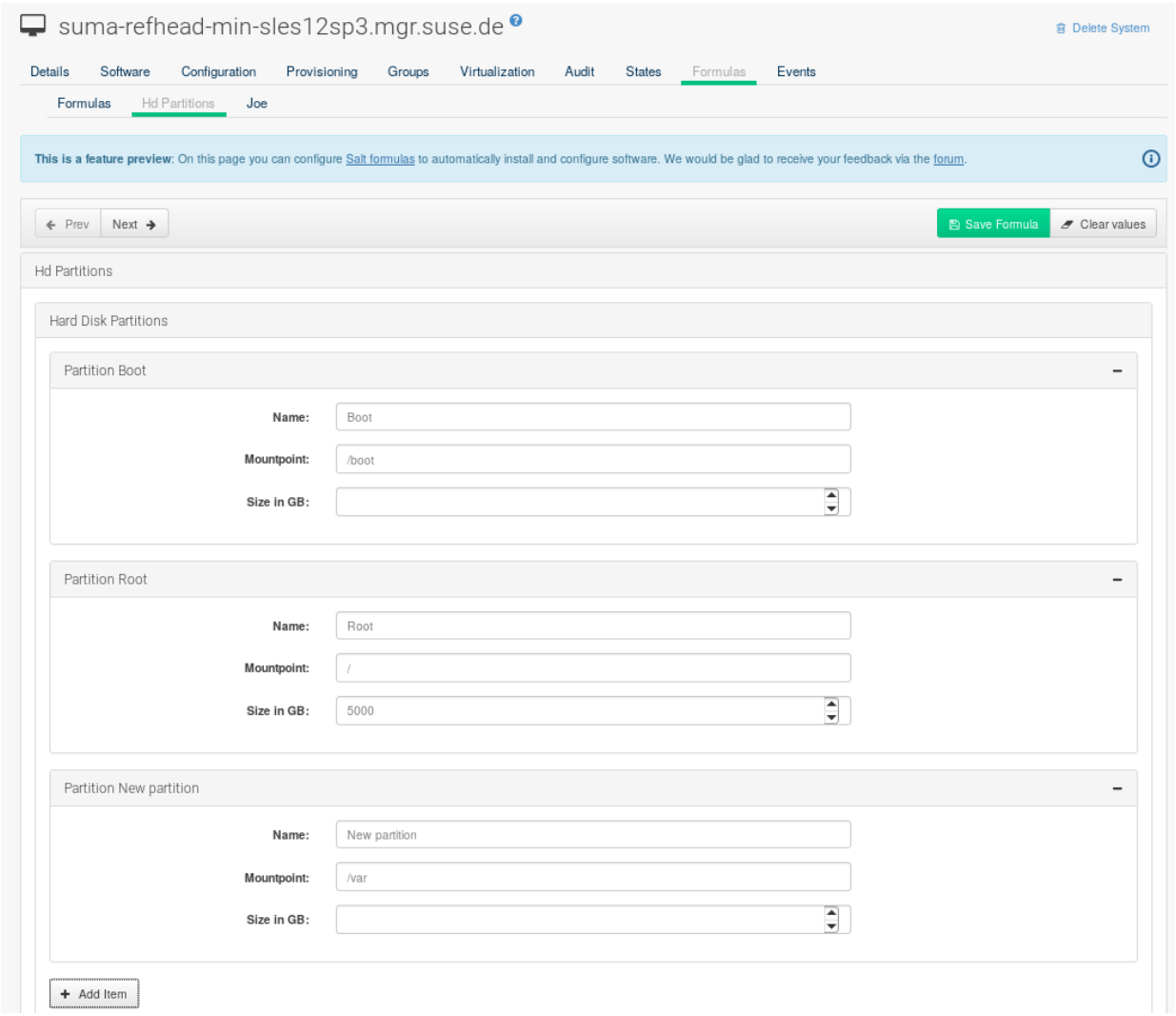
```
some_group:
  $type: group

  another_group:
    $type: group

    my_checkbox:
      $type: boolean

    my_text:
      $visible: this.parent.value.my_checkbox

  yet_another_group:
    $type: group

    my_text2:
      $visible: this.parent.parent.value.another_group.my_checkbox
```

Listing 6. Example: Basic edit-group

```
partitions:
  $name: "Hard Disk Partitions"
  $type: "edit-group"
  $minItems: 1
  $maxItems: 4
  $itemName: "Partition ${name}"
  $prototype:
    name:
      $default: "New partition"
    mountpoint:
      $default: "/var"
    size:
      $type: "number"
      $name: "Size in GB"
  $default:
    - name: "Boot"
      mountpoint: "/boot"
    - name: "Root"
      mountpoint: "/"
      size: 5000
```

Click Add to fill the form with the default values.

The formula is called `hd-partitions` and will appear as `Hd Partitions` in the Web UI.



To remove the definition of a partition click the minus symbol in the title line of an inner group.

When you are finished, click Save Formula.

Listing 7. Example: Nested edit-group

```
users:
  $name: "Users"
  $type: edit-group
  $minItems: 2
  $maxItems: 5
  $prototype:
    name:
      $default: "username"
    password:
      $type: password
    groups:
      $type: edit-group
      $minItems: 1
      $prototype:
        group_name:
          $type: text
  $default:
    - name: "root"
      groups:
        - group_name: "users"
```

```
        - group_name: "admins"
    - name: "admin"
      groups:
        - group_name: "users"
```

2.11.15.3. Writing Salt Formulas

Salt formulas are pre-written Salt states. You can use Jinja to configure formulas with pillar data.

Basic Jinja syntax is:

```
pillar.some.value
```

When you are sure a pillar exists, use this syntax:

```
salt['pillar.get']('some:value', 'default value')
```

You can also replace the `pillar` value with `grains`. For example, `grains.some.value`.

Using data this way makes the formula configurable. In this example, a specified package is installed in the `package_name` pillar:

```
install_a_package:
  pkg.installed:
    - name: {{ pillar.package_name }}
```

You can also use more complex constructs such as `if/else` and `for-loops` to provide greater functionality:

```
{% if pillar.installSomething %}
something:
  pkg.installed
{% else %}
anotherPackage:
  pkg.installed
{% endif %}
```

Another example:

```
{% for service in pillar.services %}
start_{{ service }}:
  service.running:
    - name: {{ service }}
{% endfor %}
```

Jinja also provides other helpful functions. For example, you can iterate over a dictionary:

```
{% for key, value in some_dictionary.items() %}
do_something_with_{{ key }}: {{ value }}
{% endfor %}
```

You can have Salt manage your files (for example, configuration files for a program), and change them with pillar data.

In this example, Salt copies the file `salt-file_roots/my_state/files/my_program.conf` on the server to `/etc/my_program/my_program.conf` on the client and template it with Jinja:

```
/etc/my_program/my_program.conf:
  file.managed:
    - source: salt://my_state/files/my_program.conf
    - template: jinja
```

This example allows you to use Jinja in the file, like the previous example for states:

```
some_config_option = {{ pillar.config_option_a }}
```

2.11.15.4. Separate Data

Separating data from a state can increase flexibility and make it easier to re-use. You can do this by writing values into a separate file named `map.jinja`. This file must be within the same directory as the state files.

This example sets `data` to a dictionary with different values, depending on which system the state runs on. It will also merge data with the pillar using the `some.pillar.data` value so you can access `some.pillar.data.value` by using `data.value`.

You can choose to override defined values from pillars. For example, by overriding `some.pillar.data.package` in this example:

```
{% set data = salt['grains.filter_by']({
    'Suse': {
        'package': 'packageA',
        'service': 'serviceA'
    },
    'RedHat': {
        'package': 'package_a',
        'service': 'service_a'
    }
}, merge=salt['pillar.get']('some:pillar:data')) %}
```

When you have created a map file, you can maintain compatibility with multiple system types while accessing deep pillar data in a simpler way.

Now you can import and use `data` in any file. For example:

```
{% from "some_folder/map.jinja" import data with context %}

install_package_a:
  pkg.installed:
    - name: {{ data.package }}
```

You can define multiple variables by copying the `{% set ...%}` statement with different values and then merge it with other pillars. For example:

```
{% set server = salt['grains.filter_by']({
    'Suse': {
        'package': 'my-server-pkg'
    }
}, merge=salt['pillar.get']('myFormula:server')) %}
{% set client = salt['grains.filter_by']({
    'Suse': {
        'package': 'my-client-pkg'
    }
}, merge=salt['pillar.get']('myFormula:client')) %}
```

To import multiple variables, separate them with a comma. For example:

```
{% from "map.jinja" import server, client with context %}
```

For more information about conventions to use when writing formulas, see https://docs.saltproject.io/en/latest/topics/development/conventions/formulas.html.

2.11.15.5. Generated Pillar Data

Pillar data is generated by Uyuni when events occur like generating the highstate. You can use an external pillar script to generate pillar data for packages and group IDs, and include all pillar data for a system:

```
/usr/share/susemanager/modules/pillar/MLM_minion.py
```

The process is executed like this:

1. The `MLM_minion.py` script starts and finds all formulas for a system by checking the `group_formulas.json` and `server_formulas.json` files.
2. The script loads the values for each formula (groups and from the system) and merges them with the highstate. By default, if no values are found, a group overrides a system if `$scope: group`.
3. The script also includes a list of formulas applied to the system in a pillar named `formulas`.

This structure makes it possible to include states. In this example, the top file is specifically generated by the `mgr_master_tops.py` script. The top file includes a state called `formulas` for each system. This includes the `formulas.sls` file located in `/usr/share/susemanager/formulas/states` or `/usr/share/salt-formulas/states/`. The content looks similar to this:

```
include: {{ pillar["formulas"] }}
```

This pillar includes all formulas that are specified in the pillar data generated from the external pillar script.

Formulas should be created directly after Uyuni is installed. If you encounter any problems with formulas check these things first:

- The external pillar script (`MLM_minion.py`) must include formula data.
- Data is saved to `/srv/susemanager/formula_data` and the `pillar` and `group_pillar` sub-directories. These directories should be automatically generated by the server.
- Formulas must be included for every client listed in the top file. Currently this process is initiated by the `mgr_master_tops.py` script which includes the `formulas.sls` file located in `/usr/share/susemanager/formulas/states/` or `/usr/share/salt-formulas/states/`. This directory must be a salt file root. File roots are configured on the salt-master (Uyuni) located at `/etc/salt/master.d/susemanager.conf`.

2.12. Salt SSH

Salt SSH allows Salt commands and states to be issued directly over SSH. SSH connections are created on demand, when the server executes an action on a client.

For more information about Salt SSH, see https://docs.saltproject.io/en/latest/topics/ssh/.

2.12.1. SSH Connection Methods

In Uyuni there are two SSH connection methods, `ssh-push` and `ssh-push-tunnel`. In both methods the server initiates an SSH connection to the client to execute a Salt call.

In the `ssh-push` method, the package manager works as normal, and the HTTP or HTTPS connection is directly created.

In the `ssh-push-tunnel` method, the server creates an HTTP or HTTPS connection through an SSH tunnel. The HTTP connection initiated by the package manager is redirected through the tunnel using `/etc/hosts` aliasing. Use this method for in-place firewall environments that block HTTP or HTTPS connections between server and client.

2.12.2. Salt SSH Integration

As with all Salt calls, Uyuni invokes `salt-ssh` via the `salt-api`.

Salt SSH relies on a roster to obtain details such as hostname, ports, and the SSH parameters of a client. Uyuni keeps these details in the database and makes them available to Salt SSH by using the `uyuni` roster module, or by generating a temporary roster file on bootstrapping new clients with the Web UI. The

location of the temporary roster file is supplied to Salt SSH using the `roster-file` option. For the registered clients `roster` set to `uyuni` is used instead to get the roster from the database with `uyuni` salt roster module.

It is not recommended to run `salt-ssh` as `root` user. This can cause permission issues the next time Uyuni tries to use Salt SSH. Use `mgr-salt-ssh`, which changes the effective user to `salt` and avoids file permission issues. If you want to use `mgr-salt-ssh` with a user other than `root`, the user should have the permission to change effective user to `salt`.

`mgr-salt-ssh` uses `roster` set to `uyuni` by default, if neither `roster` nor `roster-file` specified in the command line. It helps to call Salt commands to the registered Salt SSH clients with no roster file generation.

2.12.3. Authentication

Salt SSH supports both password and key authentication. Uyuni uses both methods:

Password authentication is used only when bootstrapping. During the bootstrap step the key of the server is not authorized on the client and therefore a password must be used for a connection to be made. The password is used transiently in a temporary roster file used for bootstrapping and the roster file is removed on finishing processing the event. This password is not stored.

All other common Salt calls use key authentication. During the bootstrap step the SSH key of the server is authorized on the client and added to the client `/.ssh/authorized_keys` file. Subsequent calls no longer require a password.

2.12.4. User Account

The user for Salt SSH calls made by Uyuni is taken from the `ssh_push_sudo_user` setting. By default, the user is root.

If bootstrapping with default settings fail, check whether the client allows root login with ssh.

If the value of `ssh_push_sudo_user` is not root, then the `--sudo` options of `salt-ssh` are used. For this user you must configure the `NOPASSWD` option in the `sudoers` file. At least, set the python binary with the version number; for example:

```
<USER> ALL=(ALL) NOPASSWD:/usr/bin/python3.6
```

2.12.5. HTTP Redirection

The `ssh-push-tunnel` method requires traffic to be redirected through an SSH tunnel. This allows traffic to bypass firewalls blocking a direct connection between the client and the server.

This is achieved by using port 1233 in the repository URL:

```
https://MLM-server:1233/repourl...
```

You can alias the MLM-server hostname to `localhost` in `/etc/hosts`:

```
127.0.0.1       localhost    MLM-server
```

The server creates a reverse SSH tunnel that connects `localhost:1233` on the client to `MLM-server:443`:

```
ssh ... -R 1233:MLM-server:443
```

This means that the package manager will actually connect to `localhost:1233`, which is then forwarded to `MLM-server:443` by the SSH tunnel.

The package manager can contact the server only if the tunnel is open, which occurs only when the server executes an action on the client.

Manual package manager operations that require server connectivity are not possible in this case.

2.12.6. Call Sequence

Salt SSH calls run in this sequence:

1. Set `roster` parameter to `uyuni` for registered clients or prepare the Salt roster on bootstrapping for the call
    a. Create remote port forwarding option if the contact method is `ssh-push-tunnel`
    b. Compute the `ProxyCommand` if the client is connected through a proxy
    c. Create Roster content
2. Create a temporary roster file (only in case of bootstrapping new client)
3. Execute a synchronous `salt-ssh` call using the API
4. Remove the temporary roster file (only in case of bootstrapping new client)

The roster content contains:

- `hostname`
- `user`
- `port`

- `remote_port_forwards`: The remote port forwarding SSH option
- `ssh_options`: Other ssh options:
  - `ProxyCommand`: If the client connects through a proxy
- `timeout`: defaults to 180 seconds
- `minion_opts`:
  - `master`: Set to the minion ID if the contact method is `ssh-push-tunnel`
- `ssh_pre_flight`: The path to the shell script executed on the client before running any Salt command
- `ssh_pre_flight_args`: The list of arguments to call the pre flight script on the client

2.12.7. Bootstrap Sequence

This section describes the sequence of events when clients are registered to a Salt master. While bootstrapping is a type of Salt SSH call, the sequence differs slightly from regular SSH calls.

Bootstrapping uses Salt SSH for communication between the master and the client. This happens for both regular and SSH clients.

1. For a regular Salt client, generate and pre-authorize the Salt key of the client.
2. For an SSH client, if a proxy was selected, retrieve the SSH public key of the proxy using the `mgrutil.chain_ssh_cmd` runner. The runner copies the public key of the proxy to the server using SSH. If needed, it can chain multiple SSH commands to reach the proxy across multiple hops.
3. Generate pillar data for bootstrap. The pillar data is compiled and stored on the Salt master, and retrieved by the client.
4. Generate the roster for bootstrapping into a temporary file on the client. You can use the roster by passing it to the Salt API, with this command:

   ```
   mgr-salt-ssh --roster-file=<temporary_bootstrap_roster> minion state.apply
   certs,<bootstrap_state>`
   ```

   For `bootstrap_state`, use `bootstrap` for regular clients or `ssh_bootstrap` for SSH clients.

The way the client retrieves the pillar data depends on the contact method you have chosen for your client:

- If you are using the `ssh-push-tunnel` contact method, ensure you have completed the remote port forwarding option.
- If the client connects through a proxy, ensure you have completed the `ProxyCommand` option. This depends on your proxy configuration, including how many proxies you need to connect through.

Pillar data contains:

- mgr_server: The hostname of the Salt master
- mgr_origin_server: The hostname of the Uyuni Server
- minion_id: The hostname of the client to bootstrap
- contact_method: The connection type
- mgr_sudo_user: The user for `salt-ssh`
- activation_key: If selected
- minion_pub: The pre-authorized public client key
- minion_pem: The pre-authorized private client key
- proxy_pub_key: The public SSH key that was retrieved from the proxy if the target is an SSH client and a proxy was selected

The roster content contains:

- `hostname`
- `user`
- `password`
- `port`
- `remote_port_forwards`: the remote port forwarding SSH option
- `ssh_options`: other SSH options:
  - `ProxyCommand` if the client connects through a proxy
- `timeout`: defaults to 180 seconds
- `ssh_pre_flight`: The path to the pre flight shell script (default: `/usr/share/susemanager/salt-ssh/preflight.sh`)
- `ssh_pre_flight_args`: The list of arguments to call the pre flight script on the client

This image provides an overview of the Salt SSH bootstrap process.

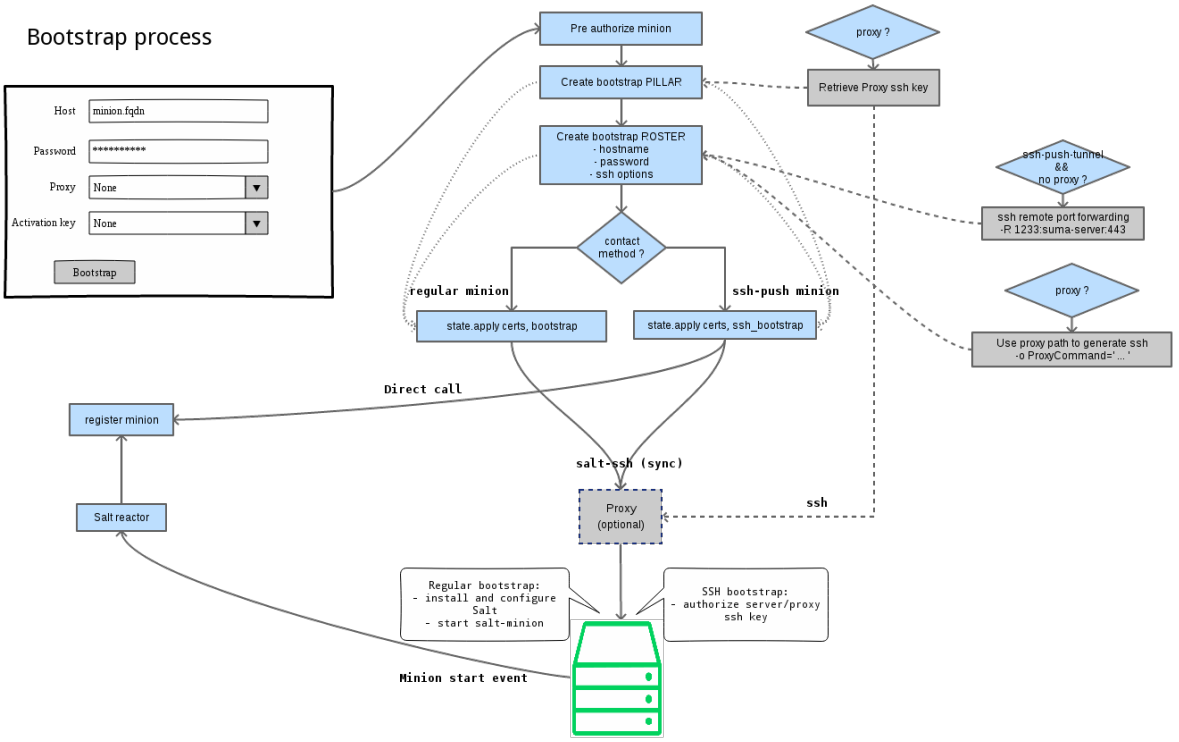
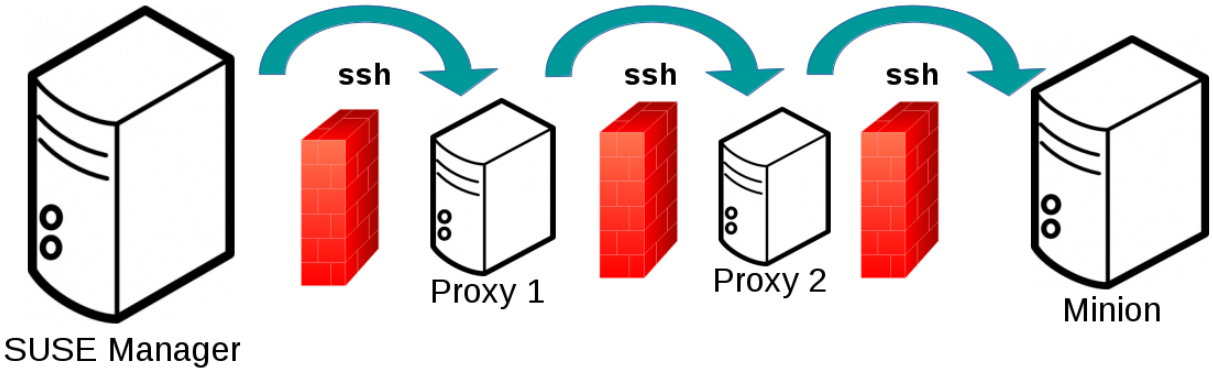


Figure 1. Salt SSH Bootstrap Process

2.12.8. Proxy Support

Salt SSH works with Uyuni Proxy by chaining the SSH connection from one server or proxy to the next. This is also known as a multi-hop or multi-gateway SSH connection.

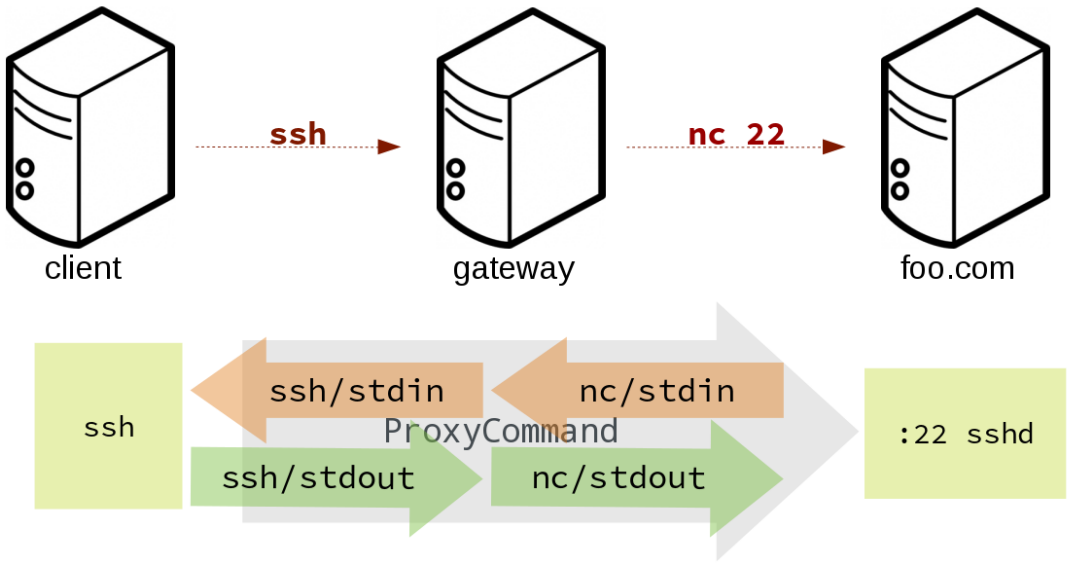


Uyuni uses `ProxyCommand` to redirect SSH connections through proxies. This options invokes an arbitrary command that is expected to connect to the SSH port on the target host. The SSH process uses standard input and output of the command to communicate with the remote SSH daemon.

`ProxyCommand` replaces a TCP/IP connection. It does not perform any authorization or encryption. Its role is simply to create a byte stream to the remote SSH daemon port.

This image depicts a client connecting to a server that is behind a gateway. In this example `netcat` is used to pipe port 22 of the target host into the SSH standard input/output:

```
ssh -o ProxyCommand=<stdio/stdout to remote port> ...
ssh -o ProxyCommand='ssh gateway nc foo.com 22' root@foo.com
```



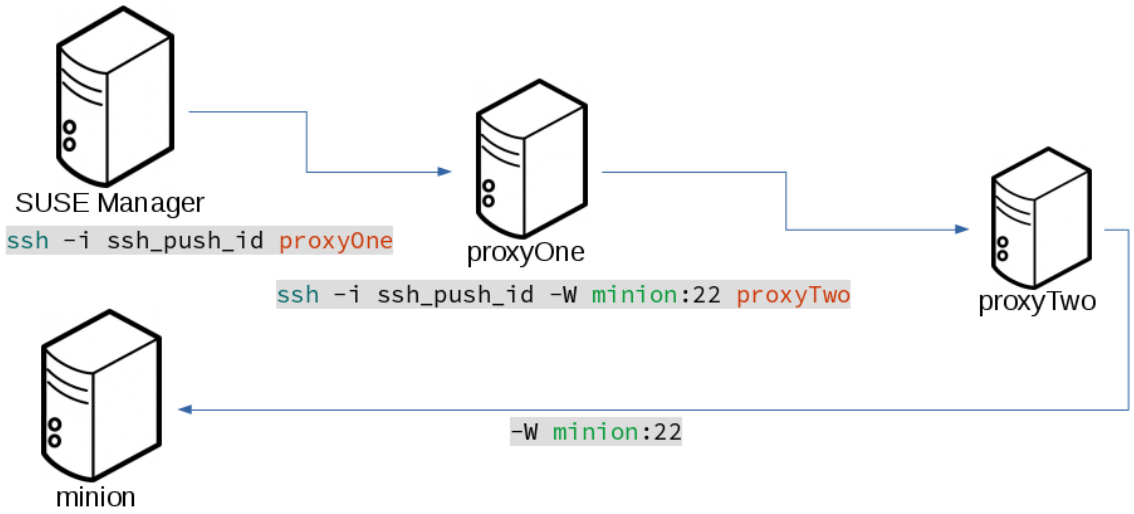
The Salt SSH calls run in this sequence when a proxy is in use:

1. Uyuni initiates the SSH connection.
2. `ProxyCommand` uses SSH to create a connection from the server to the client through the proxies.

This example uses `ProxyCommand` with two proxies and the `ssh-push` method:

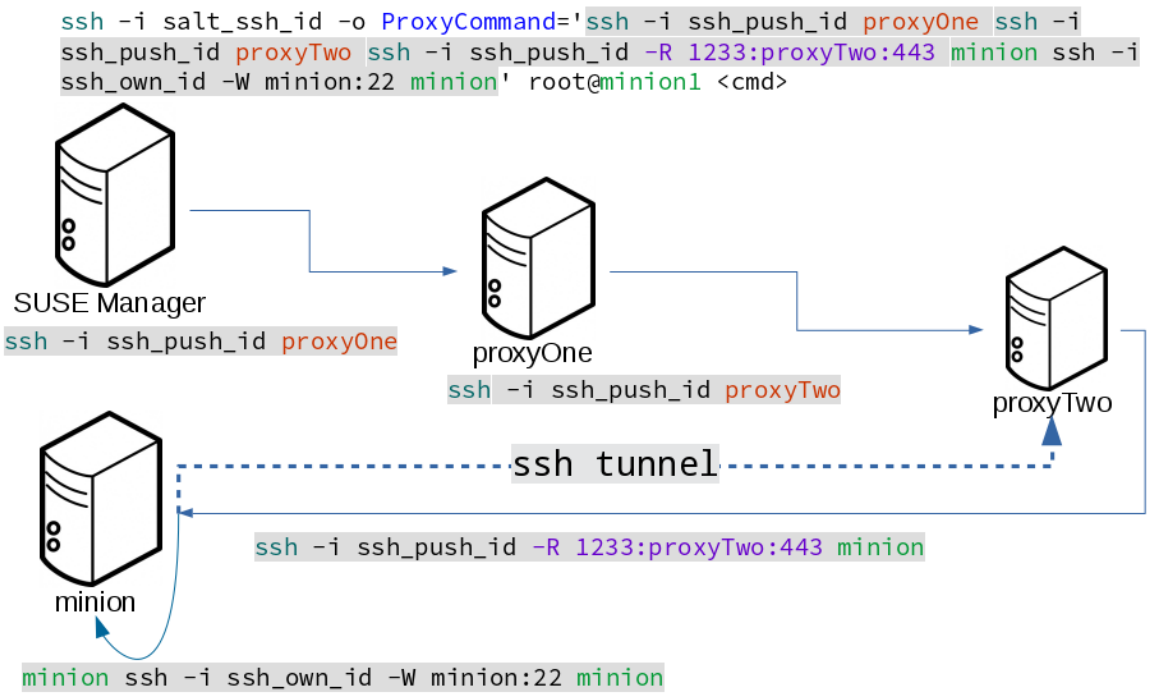
```
# Connect the server to the first proxy:
/usr/bin/ssh -i /srv/susemanager/salt/salt_ssh/mgr_ssh_id -o StrictHostKeyChecking=no -o
User=mgrsshtunnel  proxy1

# Connect the first proxy to the second, and forward standard input/output on the client to
client:22 using the `-W` option:
/usr/bin/ssh -i /var/lib/spacewalk/mgrsshtunnel/.ssh/id_susemanager_ssh_push -o
StrictHostKeyChecking=no -o User=mgrsshtunnel -W client:22  proxy2
```

```
ssh -i salt_ssh_id -o ProxyCommand='ssh -i ssh_push_id proxyOne ssh -i
ssh_push_id proxyTwo -W minion:22' root@minion <cmd>
```



This example uses `ProxyCommand` with two proxies and the `ssh-push-tunnel` method:

```
# Connect the server to the first proxy:
/usr/bin/ssh -i /srv/susemanager/salt/salt_ssh/mgr_ssh_id -o User=mgrsshtunnel  proxy1

# Connect the first proxy to the second:
/usr/bin/ssh -i /home/mgrsshtunnel/.ssh/id_susemanager_ssh_push -o User=mgrsshtunnel  proxy2

# Connect the second proxy to the client and open an reverse tunnel (-R 1233:proxy2:443) from
the client to the HTTPS port on the second proxy:
/usr/bin/ssh -i /home/mgrsshtunnel/.ssh/id_susemanager_ssh_push -o User=root -R
1233:proxy2:443 client

# Connect the client to itself and forward the standard input/output of the server to the SSH
port of the client (-W client:22).
This is equivalent to `ssh ... proxy2 netcat client 22`` and is needed because SSH does not
allow both the reverse tunnel (-R 1233:proxy2:443) and the standard input/output forward (-W
client:22) in the same command.
/usr/bin/ssh -i /root/.ssh/mgr_own_id -W client:22 -o User=root client
```

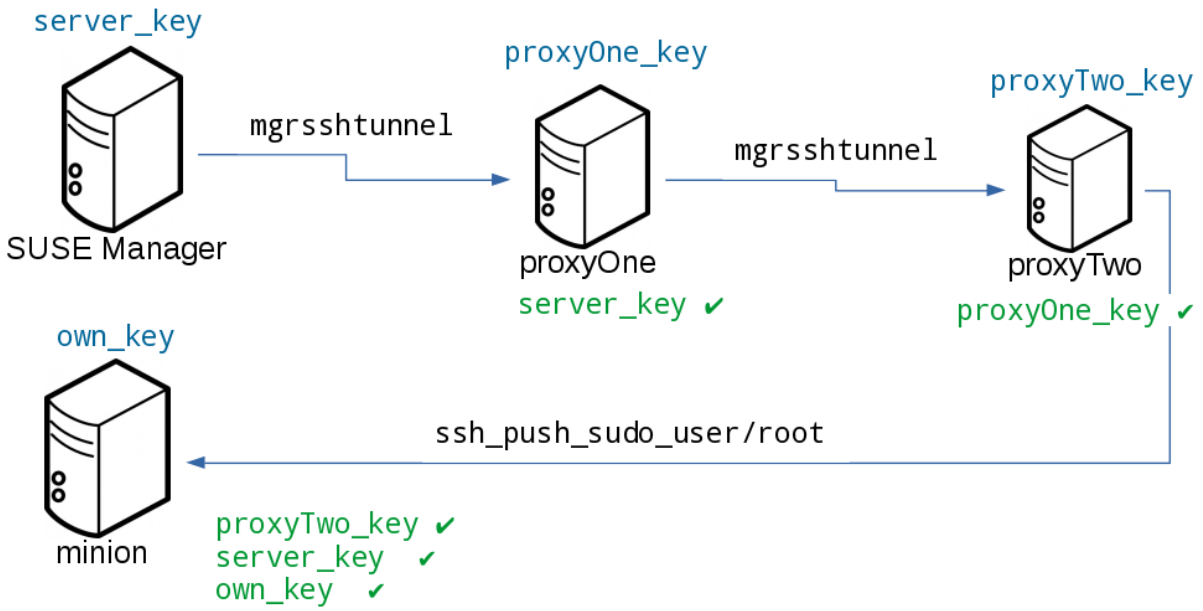


2.12.9. Users and SSH Key Management

To connect to a proxy, the parent server or proxy uses a specific user called `mgrsshtunnel`. When `mgrsshtunnel` connects, the SSH configuration of the proxy will force the execution of `/usr/sbin/mgr-proxy-ssh-force-cmd`. This is a simple shell script that allows only the execution of `scp`, `ssh`, or `cat` commands.

The connection to the proxy or client is authorized using SSH keys in this sequence:

1. The server connects to the client and to the first proxy using the key in `/srv/susemanager/salt/salt_ssh/mgr_ssh_id`.
2. Each proxy has its own key pair in `/home/mgrsshtunnel/.ssh/id_susemanager_ssh_push`.
3. Each proxy authorizes the key of the parent proxy or server.
4. The client authorizes its own key.

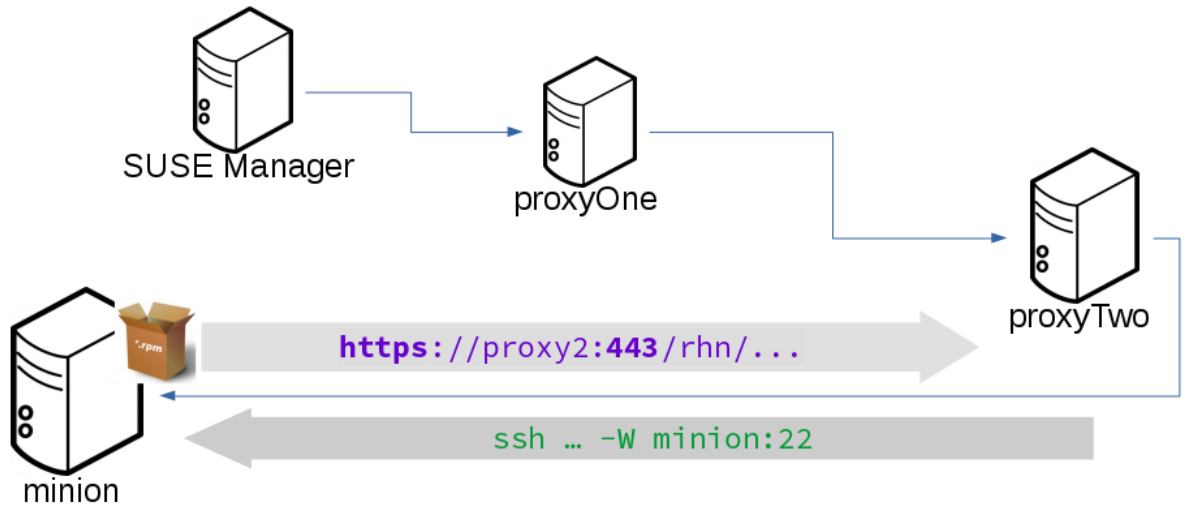


2.12.10. Repository Access with a Proxy

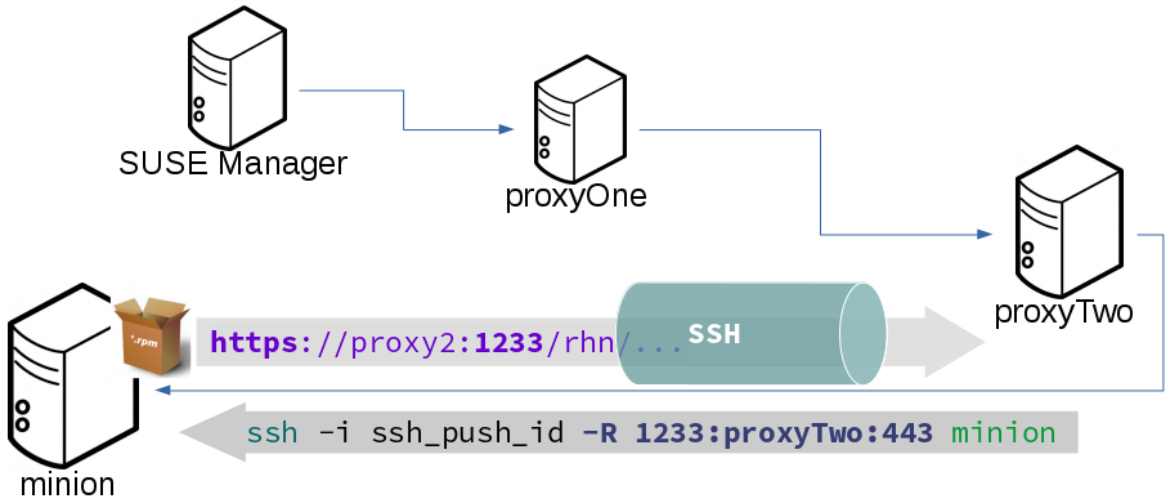
When Uyuni connects to a repository using a proxy, it can use either `ssh-push` or `ssh-push-tunnel`.

In both methods the client connects to the proxy to retrieve package and repository information.

In the `ssh-push` method, the package manager connects directly to the proxy using HTTP or HTTPS. This works in cases where there is no firewall between the client and the proxy that blocks HTTP connections initiated by the client.



In the `ssh-push-tunnel` method, the HTTP connection to the proxy is redirected through a reverse SSH tunnel.



2.12.11. Proxy Setup

When the `spacewalk-proxy` package is installed on the proxy, the `mgrsshtunnel` user is created.

The initial configuration with `configure-proxy.sh` occurs using this sequence:

1. An SSH key pair is generated, or an existing keypair is imported.
2. The SSH key of the parent server or proxy is retrieved to authorize it on the proxy.
3. The `ssh` daemon on the proxy is configured to restrict the `mgrsshtunnel` user. This is done by the `mgr-proxy-ssh-push-init` script, which is called from `configure-proxy.sh`. It does not have to be manually invoked.

The parent key is retrieved by calling an HTTPS endpoint on the parent server or proxy. The first endpoint tried is `https://$PARENT/pub/id_susemanager_ssh_push.pub`. If the parent is a proxy then this will return the public SSH key of the proxy.

If a 404 error is received from that endpoint, then the parent is assumed to be a server not a proxy, and `https://$PARENT/rhn/manager/download/saltssh/pubkey` is tried instead.

If an SSH key exists at `/srv/susemanager/salt/salt_ssh/mgr_ssh_id.pub` on the server it is returned.

If the public key does not exist because `salt-ssh` has not been invoked yet, a key will be generates by calling the `mgrutil.ssh_keygen` runner.

Salt SSH generates a keypair the first time it is invoked with `/srv/susemanager/salt/salt_ssh/mgr_ssh_id`. The sequence in this section is needed if a proxy is configured before Salt SSH was invoked for the first time.

2.12.12. Rotate SSH keys

The SSH key is used on `salt-ssh` managed systems. Additionally, it is used on Uyuni Proxies for the user `mgrsshtunnel`. Normal systems managed with the Salt `default` method are not affected and do not have this key configured.

Procedure: Rotating SSH keys

1. On the Uyuni Server, as user `root`, change to user `salt`:

```
su -s /bin/bash - salt
```

2. Create a new SSH key:

```
ssh-keygen -N "" -t rsa -q -f /var/lib/salt/.ssh/new_mgr_ssh_id
```

3. Copy the public key into the Salt filesystem to make it usable in a Salt state:

```
cp /var/lib/salt/.ssh/new_mgr_ssh_id.pub /srv/susemanager/salt/salt_ssh/
```

4. Change back to user `root` again:

```
exit
```

5. Rollout the new key to all systems that need it. Applying the `util.mgr_rotate_saltssh_key` state will limit the changes to `salt-ssh` managed systems and proxies:

```
salt '*' state.apply util.mgr_rotate_saltssh_key
mgr-salt-ssh '*' state.apply util.mgr_rotate_saltssh_key
```

6. Move the old key away and make the new key the standard key. Rename `mgr_ssh_id` key to `disabled_mgr_ssh_id` and `new_mgr_ssh_id` key to `mgr_ssh_id` in the SSH keystore of the user `salt` as well as in the Salt filesystem for the public keys:

```
su -s /bin/bash - salt
cd .ssh
mv mgr_ssh_id disabled_mgr_ssh_id
mv mgr_ssh_id.pub disabled_mgr_ssh_id.pub
mv new_mgr_ssh_id mgr_ssh_id
mv new_mgr_ssh_id.pub mgr_ssh_id.pub
cd /srv/susemanager/salt/salt_ssh/
mv mgr_ssh_id.pub disabled_mgr_ssh_id.pub
mv new_mgr_ssh_id.pub mgr_ssh_id.pub
```

7. OPTIONAL: When containerized proxies exist, re-create the configuration to get the new SSH key into the proxy configuration. Restart the containers with the new configuration. It is also possible to change the existing configuration on the podman host (`ssh.yaml`). Change the value of

`server_ssh_key_pub` with the content of the current `mgr_ssh_id.pub`.

8. To remove the disabled keys from the `authorized_keys` files of the [literal]salt-ssh`` managed systems and the proxies, apply the state a second time:

```
salt '*' state.apply util.mgr_rotate_saltssh_key
mgr-salt-ssh '*' state.apply util.mgr_rotate_saltssh_key
```

2.13. Salt Rate Limiting

Salt is able to run commands in parallel on a large number of clients. This can potentially create large amounts of load on your infrastructure. You can use these rate-limiting parameters to control the load in your environment.

These parameters are all configured in the `/etc/rhn/rhn.conf` configuration file.

Salt commands that are executed from the command line are not subject to these parameters.

2.13.1. Batching

There are two parameters that control how actions are sent to clients, one for the batch size, and one for the delay.

When the Uyuni Server sends a batch of actions to the target clients, it will send it to the number of clients determined in the batch size parameter. After the specified delay period, commands will be sent to the next batch of clients. The number of clients in each subsequent batch is equal to the number of clients that have completed in the previous batch.

Choosing a lower batch size will reduce system load and parallelism, but might reduce overall performance for processing actions.

The batch size parameter sets the maximum number of clients that can execute a single action at the same time. Adjust the `java.salt_batch_size` parameter. Defaults to 200.

Increasing the delay increases the chance that multiple clients will have completed before the next action is issued (more clients are grouped together in subsequent batches), resulting in fewer overall commands, and reducing load.

The batch delay parameter sets the amount of time, in seconds, to wait after a command from the previous batch is processed before beginning to process the command on the next client. Adjust the `java.salt_batch_delay` parameter. Defaults to 1.0 seconds.

2.13.2. Disabling the Salt Mine

In older versions, Uyuni used a tool called Salt mine to check client availability. The Salt mine would cause clients to contact the server every hour, which created significant load. With the introduction of a

more efficient mechanism in Uyuni 3.2, the Salt mine is no longer required. Instead, the Uyuni Server uses Taskomatic to ping only the clients that appear to have been offline for twelve hours or more, with all clients being contacted at least once in every twenty four hour period by default. You can adjust this by changing the `web.system_checkin_threshold` parameter in `rhn.conf`. The value is expressed in days, and the default value is `1`.

Newly registered Salt clients will have the Salt mine disabled by default. If the Salt mine is running on your system, you can reduce load by disabling it. This is especially effective if you have a large number of clients.

Disable the Salt mine by running this command on the server:

```
salt '*' state.sls util.mgr_mine_config_clean_up
```

This will restart the clients and generate some Salt events to be processed by the server. If you have a large number of clients, handling these events could create excessive load. To avoid this, you can execute the command in batch mode with this command:

```
salt --batch-size 50 '*' state.sls util.mgr_mine_config_clean_up
```

You will need to wait for this command to finish executing. Do not end the process with `Ctrl` + `C`.

2.14. Scaling Minions (Large Scale Deployments)

Uyuni is designed by default to work on small and medium scale installations. For installations with more than 1000 clients per Uyuni Server, adequate hardware sizing and parameter tuning must be performed.

For more information on managing large scale deployments, see **Specialized-guides › Large-deployments**.

2.15. Salt Connectivity

Depending on the size and spreadness of the environment where Uyuni is used some connectivity issues are possible. There are no common recommendations for all the possible use cases as the environments could be very different expecially if public clouds instances are involved.

2.15.1. Minions Connectivity

In case clients are losing the connection to the Uyuni Server (or Uyuni Proxy if involved), they are unreachable from the Uyuni Server Web UI or with command line tools. To understand such a connection issue check if the client is not reachable from the Uyuni Server with `salt MINION_ID test.ping`, while `venv-salt-call test.ping` (or `salt-call test.ping` if non-bundle Salt is used on the client) is working fine on the client side. If this is the case, it is recommended to set `tcp_keepalive` parameters.

The parameters with the values from the example below can be used as a starting point to look for settings, which could prevent cases of connection loss without restoring for some environments. It is recommended to put the parameters in the separate drop-in configuration file like `/etc/venv-salt-minion/minion.d/tuning-keepalives.conf` or `/etc/salt/minion.d/tuning-keepalives.conf`, depending on the minion type used on the client side.

Listing 8. Example: Keepalive Parameters Example Values

```
######      Keepalive settings        ######
############################################
# ZeroMQ now includes support for configuring SO_KEEPALIVE if supported by
# the OS. If connections between the minion and the master pass through
# a state tracking device such as a firewall or VPN gateway, there is
# the risk that it could tear down the connection the master and minion
# without informing either party that their connection has been taken away.
# Enabling TCP Keepalives prevents this from happening.

# Overall state of TCP Keepalives, enable (1 or True), disable (0 or False)
# or leave to the OS defaults (-1), on Linux, typically disabled. Default True, enabled.
tcp_keepalive: True

# How long before the first keepalive should be sent in seconds. Default 300
# to send the first keepalive after 5 minutes, OS default (-1) is typically 7200 seconds
# on Linux see /proc/sys/net/ipv4/tcp_keepalive_time.
tcp_keepalive_idle: 10

# How many lost probes are needed to consider the connection lost. Default -1
# to use OS defaults, typically 9 on Linux, see /proc/sys/net/ipv4/tcp_keepalive_probes.
tcp_keepalive_cnt: 3

# How often, in seconds, to send keepalives after the first one. Default -1 to
# use OS defaults, typically 75 seconds on Linux, see
# /proc/sys/net/ipv4/tcp_keepalive_intvl.
tcp_keepalive_intvl: 10
```

2.15.2. Proxies Connectivity

`salt-broker` service is used on Uyuni Proxies to forward Salt traffic between the Uyuni Server and `salt-minion` service used on the client side. It is possible that `salt-broker` and all the clients behind it could be affected with the same issue as the clients directly connected to the Uyuni Server. The issue could be fixed with the same parameters as recommended for the minions, but specified in `/etc/salt/broker` on each Uyuni Proxy.

Uyuni Proxy connectivity can also suffer when the connectivity to the Uyuni Server is lost for a quite long interval. In such a case Proxy connected clients started to retry the authentication to the `salt-master` service on the Uyuni Server. This situation could be potentially dangerous because it could lead to collecting large amount of ZeroMQ messages with authentication attemps in the interal buffer of ZeroMQ sockets used inside the `salt-broker` service. Then, on restoring the connection to the `salt-master` all of the pending messages will be pushed to it. It could lead to the issues on Uyuni Server side with `salt-master` service, because it could be impossible to serve all the cached requests in appropriate time or even to the complete denial of the service.

To avoid such situation a set of tuning parameters is available. As the most important one, `wait_for_backend` should be set to `True`. This prevents opening the sockets for the clients behind the

proxy while the connectivity to the `salt-master` service is not established. In this case the messages from the clients are not collected in the internal buffers. `drop_after_retries` is setting the number of retries before closing the sockets to drop the cached messages. The other parameters could help to fine tune the behavior for the environment.

Setting timeouts, intervals and `drop_after_retries` to lower values are making `salt-broker` service more aggressive on detecting the connection loss to the `salt-master`, so that it puts the clients behind the proxy to the conditions closer as they are connected directly to the Uyuni Server. Increasing the values could provide some benefits in case if the network channel between the Uyuni Proxy and Uyuni Server is not stable enough, the message buffering can provide some flexibility while re-establishing the connection.

Listing 9. Example: Values for Keepalive Parameters

```
######   ZeroMQ connection options    ######
################################################
# For more details about the following parameters check ZeroMQ documentation:
# http://api.zeromq.org/4-2:zmq-setsockopt
# All of these parameters will be set to the backend sockets
# (from the salt-broker to the salt-master)

# connect_timeout (sets ZMQ_CONNECT_TIMEOUT)
# default: 0
# value unit: milliseconds
# Sets how long to wait before timing-out a connect to the remote socket.
# 0 could take much time, so it could be better to set to more strict value
# for particular environment depending on the network conditions.
# The value equal to 10000 is setting 10 seconds connect timeout.
connect_timeout: 3000

# reconnect_ivl (sets ZMQ_RECONNECT_IVL)
# default: 100
# value unit: milliseconds
# Sets the interval of time before reconnection attempt on connection drop.
reconnect_ivl: 1000

# heartbeat_ivl (sets ZMQ_HEARTBEAT_IVL)
# default: 0
# value unit: milliseconds
# This parameter is important for detection of loosing the connection.
# In case of value equal to 0 it is not sending heartbits.
# It's better to set to more relevant value for the particular environment,
# depending on possible network issues.
# The value equal to 20000 (20 seconds) works good for most cases.
heartbeat_ivl: 5000

# heartbeat_timeout (sets ZMQ_HEARTBEAT_TIMEOUT)
# default: 0
# value unit: milliseconds
# Sets the interval of time to consider that the connection is timed out
# after sending the heartbeat and not getting the response on it.
# The value equal to 60000 (1 minute) is considering the connection is down
# after 1 minute of no response to the heartbeat.
heartbeat_timeout: 10000


######   Other connection options    ######
# The following parameters are not related to ZeroMQ,
# but the internal parameters of the salt-broker.
# drop_after_retries
```

```
# default: -1
# value unit: number of retries
# Drop the frontend sockets of the salt-broker in case if it reaches
# the number of retries to reconnect to the backend socket.
# -1 means not drop the frontend sockets
# It's better to choose more relevant value for the particular environment.
# 10 can be a good choise for most of the cases.
drop_after_retries: 5

# wait_for_backend
# default: False
# The main aim of this parameter is to prevent  collecting the messages
# with the open frontend socket and prevent pushing them on connecting
# the backend socket to prevent large number of messages to be pushed
# at once to salt-master.
# It's better to set it to True if there is significant numer of minions
# behind the salt-broker.
wait_for_backend: True
```

2.16. Monitoring Salt Events

In some cases the Salt event bus could publish significant amount of events with a high rate, what could make it hard to analyze. Getting the statistics based on the events published in the Salt event bus can help to identify possible weak points and perform Salt internals profiling.

2.16.1. Saline

Saline is a powerful tool designed to function as a Prometheus exporter, enabling the collection of metrics based on events from the Salt event bus. These metrics are derived from event data available on the Salt master, similar to what is accessible through the command:

```
mgrctl exec -ti -- salt-run state.event
```

Saline is distributed as a separate container image, `server-saline`, for use with Uyuni Server. All related commands and operations should be executed on the Uyuni Server container host system.

In addition to its role as a Prometheus exporter, Saline also provides the `saline-formula`, which simplifies configuration of Prometheus and Grafana dashboards, enhancing monitoring and visualization capabilities.

2.16.2. Saline deployment

To deploy Saline on the Uyuni Server use `mgradm upgrade podman` with `--saline-replicas 1`. Saline can be deployed during the installation of the Uyuni Server using `mgradm install podman` with `--saline-replicas 1`. The only possible values for `--saline-replicas` are `1` or `0`. After finishing the deployment `Uyuni-saline.service` should be configured on the Uyuni Server host system.

2.16.3. Salt master configuration recommendations

It is recommended to add `master_stats: True` and adjust the value of `master_stats_event_iter: 60` if needed. Then restart `salt-master` to get the detailed statistics of internal Salt calls. This can be help with tuning large scale deployment installations.

2.16.4. Saline formula

To configure Prometheus and Grafana dashboards, see **Specialized-guides › Salt**.

2.16.5. Removing Saline

To remove Saline from the Uyuni Server use `mgradm upgrade podman` with `--saline-replicas 0`.

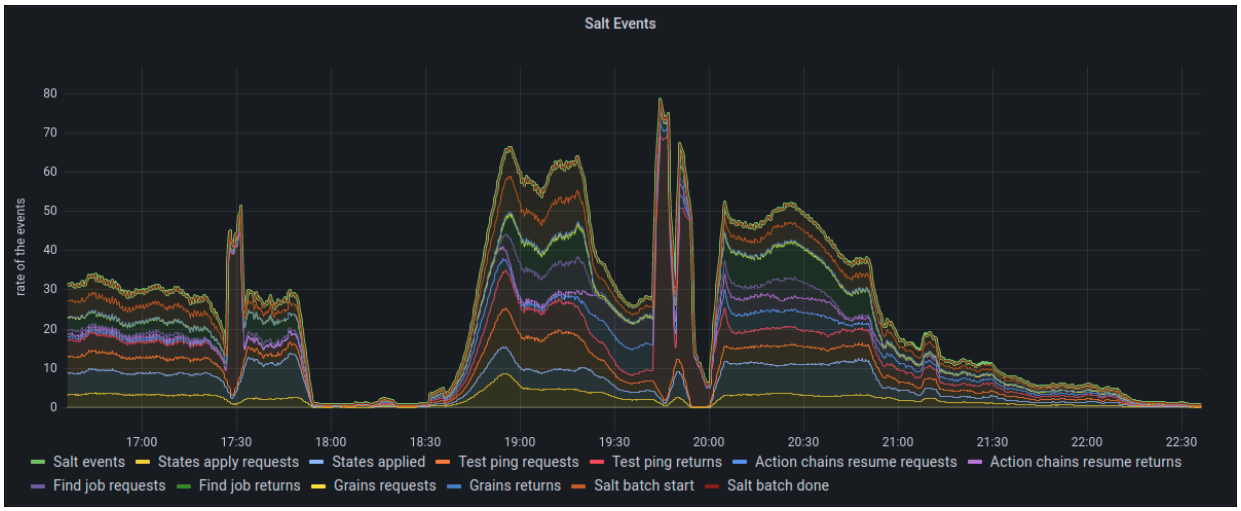
2.16.6. Examples of resulting Grafana dashboards

2.16.6.1. Uyuni Server (with Saline) dashboard

The dashboard represents Salt events with the different views presented on the panels.

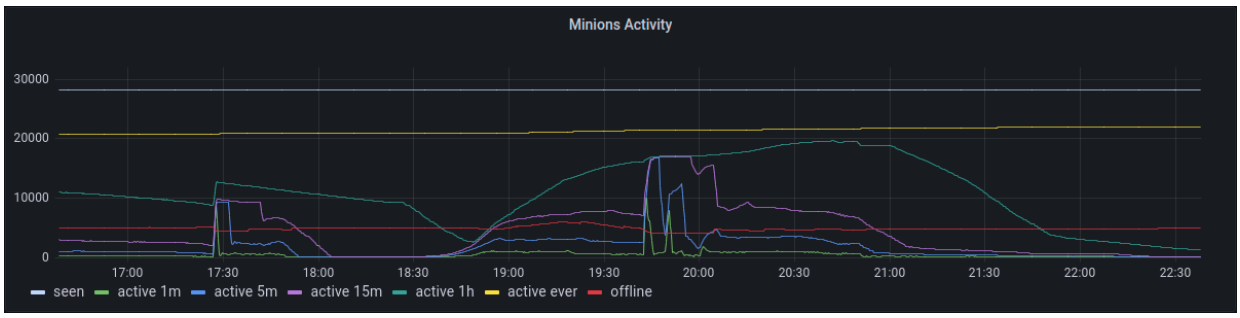
2.16.6.2. Salt Events

The panel represents all the Salt events grouped by categories. `Salt events` represents the total number of all categories of the events.



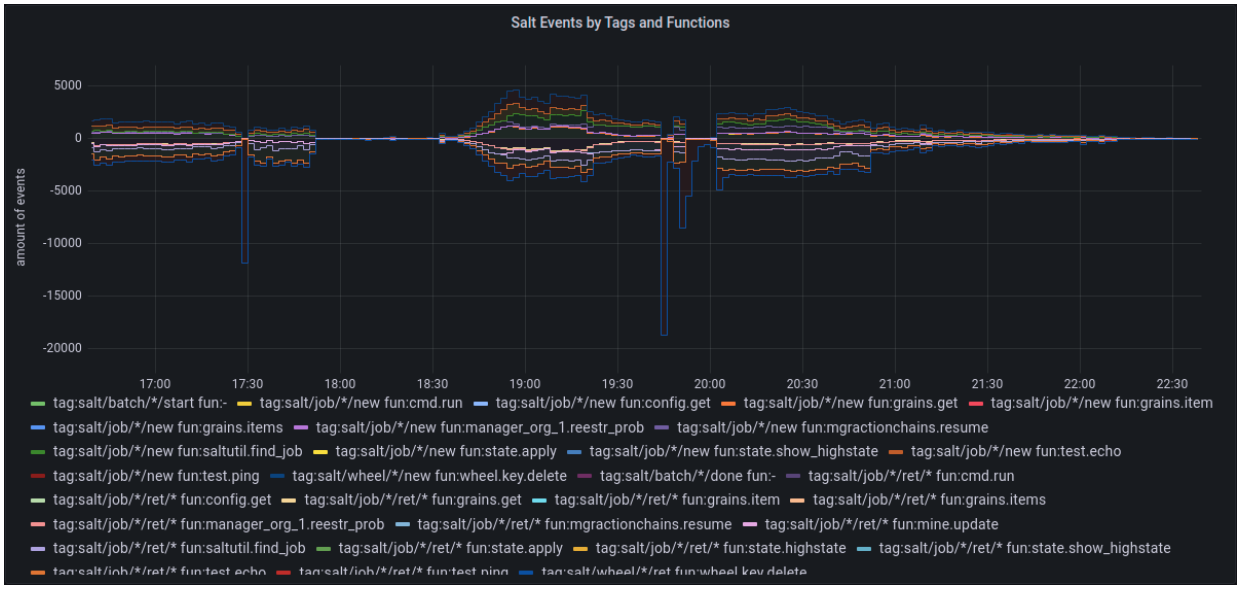
2.16.6.3. Minions Activity

The panel provides the minions activity status for the specified interval of times. It shows the amount of minions which were active in last minute, 5 minutes, 15 minutes, 1 hour or considered offline on this moment of time or even ever seen (could be targeted or either responded or not) or active.



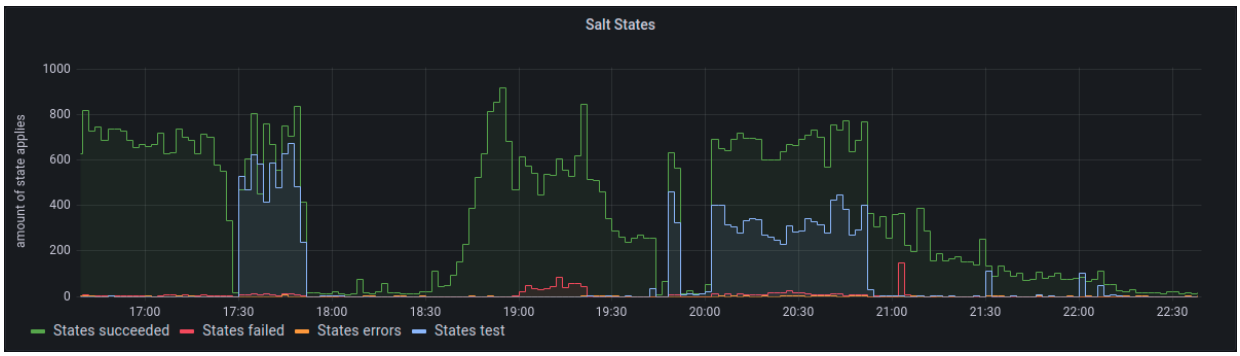
2.16.6.4. Salt Events by Tags and Functions

The panel provides the detailed representation of Salt Events with the event spread by direction The events which are send to the minions are presented on the positive side of the axis, while the events received from the minions are presented on the negative side.



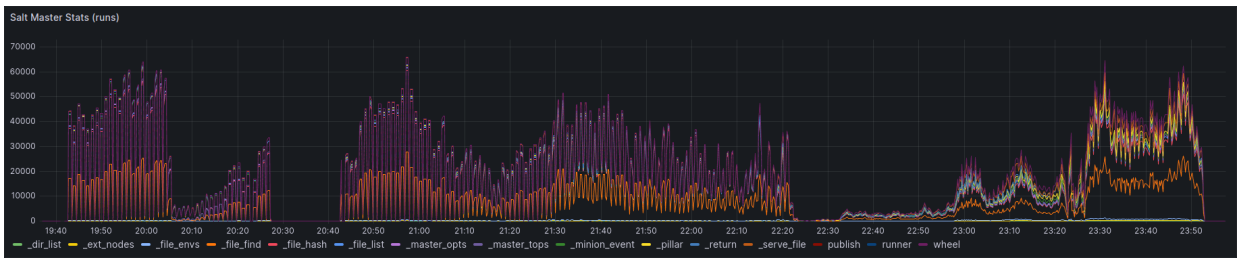
2.16.6.5. Salt States

The panel represents states apply process events grouped by the status: succeeded, failed, causing errors or applied in the test mode.



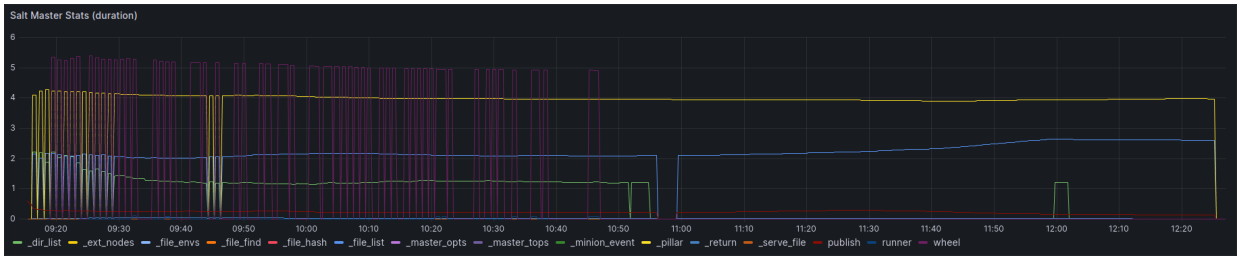
2.16.6.6. Salt Master Stats (runs)

The panel represents the number of internal calls grouped by function, which are exposed with Salt stats.



2.16.6.7. Salt Master Stats (avg. duration)

The panel represents the average duration of internal calls grouped by function, which are exposed with Salt stats.



2.16.7. Saline State Jobs dashboard

The dashboard represents Salt state apply process, it can be used for detailed monitoring of the internals of state apply process initiated for a number of targets.

2.16.7.1. Salt State Jobs (instant)

The panel represents an instant view of the state functions calls represented in the table view.

Salt State Jobs (instant)

Function	MODS	Test	Targeted	Progress	Succeeded	Failed ↓	Timed out
state.apply	manager_org_1.UpdateA...	-	1	100%	0%	100%	0%
state.highstate	HIGHSTATE	-	17	100%	24%	76%	0%
state.apply	util.systeminfo	-	21181	100%	96%	3%	2%
state.apply	util.synccustomall, hard...	-	48	100%	96%	2%	2%
state.apply	HIGHSTATE	-	77	100%	95%	1%	4%
state.apply	manager_org_1.test_exa...	-	20596	100%	83%	0%	17%
state.apply	packages.profileupdate	-	10756	100%	99%	0%	1%
state.apply	minion.install-ptf	-	29	100%	100%	0%	0%

2.16.7.2. Salt States Profiling

The panel provides the table of state functions calls with the detailed profiling data that can be used for state optimization.

Salt States Profiling

SLS	State ID	Function	Succeeded	Avg. duration (succ.)	Failed	Avg. duration (fail.)
manager_org_1.test	test_chromium-gost-s...	pkg.latest	8162	2.85 min	435	1.82 min
manager_org_1.test	test_chromium-gost-s...	pkg.installed	12	1.84 min	0	-
minion.install-ptf	salt-minion-upgrade	pkg.installed	7	1.33 min	0	-
util.syncmodules	sync_modules	module.run	41667	36.3 s	545	4.02 min
util.syncgrains	sync_grains	module.run	42106	26.8 s	107	4.10 min
util.syncbeacons	sync_beacons	module.run	27787	26.0 s	19	3.82 min
packages.profileupdate	products	module.run	14408	6.42 s	0	-
manager_org_1.test	/etc/skel/Desktop/re...	file.managed	8173	6.00 s	436	576 ms
channels	mgrchannels_repo	file.managed	323	3.81 s	0	-

2.17. Salt timeouts

2.17.1. General Salt timeouts

Salt features two timeout parameters called `timeout` and `gather_job_timeout` that are relevant during the execution of Salt commands and jobs—it does not matter whether they are triggered using the command line interface or API. These two parameters are explained in the following article.

This is a normal workflow when all clients are well reachable:

- A Salt command or job is executed:

```
salt '*' test.ping
```

- Salt master publishes the job with the targeted clients into the Salt PUB channel.
- Clients take that job and start working on it.
- Salt master is looking at the Salt RET channel to gather responses from the clients.
- If Salt master gets all responses from targeted clients, then everything is completed and Salt master will return a response containing all the client responses.

If some of the clients are down during this process, the workflow continues as follows:

1. If `timeout` is reached before getting all expected responses from the clients, then Salt master would trigger an aditional job (a Salt `find_job` job) targeting only pending clients to check whether the job is already running on the client.
2. Now `gather_job_timeout` is evaluated. A new counter is now triggered.
3. If this new `find_job` job responds that the original job is actually running on the client, then Salt master will wait for that client's response for another `gather_job_timeout` interval before issuing the next `find_job` job.
4. In case of reaching `gather_job_timeout` without having any response from the client (neither for the initial `test.ping` nor for the `find_job` job), Salt master will return with only the gathered responses from the responding clients.

By default, Uyuni globally sets `timeout` and `gather_job_timeout` to 120 seconds. So, in the worst case, a Salt call targeting unreachable clients will end up *with 240 seconds of waiting* until getting a response.

You can configure these values differently by creating a `/etc/salt/master.d/custom.conf` configuration file according to syntax in `/etc/salt/master.conf`.

2.17.2. Presence Ping Timeouts

Before Actions are executed on Salt clients, whether they scheduled via the Web UI or the API, Uyuni performs a "presence ping" command to ensure the respective `salt-minion` processes are active and able to respond. Then, a ping gather job runs on the Salt master to handle the incoming pings from the clients. Actual commands will begin only after all clients have either responded to the ping, or timed out.

The presence ping is an ordinary Salt command, but is not subject to the same timeout parameters as all other Salt commands (`timeout`/`gather_job_timeout`, described above). Rather, it has its own parameters (`java.salt_presence_ping_timeout` /`java.salt_presence_ping_gather_job_timeout`) that can be set in `/etc/rhn/rhn.conf`.

To allow for quicker detection of unresponsive clients, the timeout values for presence pings are by default significantly shorter than the general defaults. You can configure the presence ping parameters in `/etc/rhn/rhn.conf`, however the default values should be sufficient in most cases.

A lower total presence ping timeout value will increase the chance of false negatives. In some cases, a client might be marked as non-responding, when it is responding but did not respond quickly enough. Additionally, setting this total presence ping timeout value too low could result in a client hanging at the boot screen. A higher total presence ping timeout will increase the accuracy of the test, as even slow clients will respond to the presence ping before timing out. Additionally, a higher presence ping timeout could limit throughput if you are targeting a large number of clients, when some of them are slow.

If a client does not reply to a ping within the allocated time, it is marked as `not available`, and is excluded from the command. The Web UI shows a `minion is down or could not be contacted` message in this case.

The presence ping timeout parameter changes the timeout setting for the presence ping, in seconds. Adjust the `java.salt_presence_ping_timeout` parameter. Defaults to 4 seconds.

The presence ping gather job parameter changes the timeout setting for gathering the presence ping, in seconds. Adjust the `java.salt_presence_ping_gather_job_timeout` parameter. Defaults to 1 second.

2.17.3. Salt SSH Clients (SSH Push)

Salt SSH clients are slightly different than regular clients (zeromq). Salt SSH clients do not use Salt PUB/RET channels but a wrapper Salt command inside of an SSH call. Salt `timeout` and `gather_job_timeout` are not playing a role here.

Uyuni defines a timeout for SSH connections in `/etc/rhn/rhn.conf`:

```
# salt_ssh_connect_timeout = 180
```

Chapter 3. Large Deployments Guide Overview

Uyuni is designed by default to work on small and medium scale installations. For installations with more than 1000 clients per Uyuni Server, adequate hardware sizing and parameter tuning must be performed.

There is no hard maximum number of supported systems. Many factors can affect how many clients can reliably be used in a particular installation. Factors can include which features are used, and how the hardware and systems are configured.

There are two main ways to manage large scale deployments. You can manage them with a single Uyuni Server, or you can use multiple servers in a hub. Both methods are described in this book.

With large scale environments one should also consider the usage of Uyuni Proxies. Sizing and location of the Proxies will dependent on the deployment topology. For more information, see **Installation-and-upgrade › Install-proxy**.

Additionally, if you are operating within a Retail environment, you can use Uyuni for Retail to manage large deployments of point-of-service terminals. There is an introduction to Uyuni for Retail in this book.

Tuning and monitoring large scale deployments can differ from smaller installations. This book contains guidance for both tuning and monitoring within larger installations.

3.1. Hardware Requirements

Not all problems can be solved with better hardware, but choosing the right hardware is an absolute necessity for large scale deployments.

The minimum requirements for the Uyuni Server are:

- Eight or more recent x86-64 CPU cores.
- 32 GiB RAM. For installations with thousands of clients, use 64 GB or more.
- Fast I/O storage devices, such as locally attached SSDs. For PostgreSQL data directories, we recommend locally attached RAID-0 SSDs.

If the Uyuni Server is virtualized, enable the `elevator=none` kernel command line option, for the best input/output performance. You can check the current status with `cat /sys/block/<DEVICE>/queue/scheduler`. This command will display a list of available schedulers with the currently active one in brackets. To change the scheduler before a reboot, use `echo none > /sys/block/<DEVICE>/queue/scheduler`.

The minimum requirements for the Uyuni Proxy are:

- One Uyuni Proxy per 500-1000 clients, depending on available network bandwidth.
- Two or more recent x86-64 CPU cores.
- 16 GB RAM, and sufficient storage for caching.

Clients should never be directly attached to the Uyuni Server in production systems.

In large scale installations, the Uyuni Proxy is used primarily as a local cache for content between the server and clients. Using proxies in this way can substantially reduce download time for clients, and decrease Server egress bandwidth use.

The number of clients per proxy will affect the download time. Always take network structure and available bandwidth into account.

We recommend you estimate the download time of typical usage to determine how many clients to connnect to each proxy. To do this, you will need to estimate the number of package upgrades required in every patch cycle. You can use this formula to calculate the download time:

```
Size of updates * Number of clients / Theoretical download speed / 60
```

For example, the total time needed to transfer 400 MB of upgrades through a physical link speed of 1 GB/s to 3000 clients:

```
400 MB  * 3000 / 119 MB/s / 60 = 169 min
```

3.2. Using a Single Server to Manage Large Scale Deployments

This section discusses how to set up a single Uyuni Server to manage a large number of clients. It contains some recommendations for hardware and networking, and an overview of the tuning parameters that you need to consider in a large scale deployment.

3.2.1. Operation Recommendations

This section contains a range of recommendations for large scale deployments.

Always start small and scale up gradually. Monitor the server as you scale to identify problems early.

3.2.1.1. Client Onboarding Rate

The rate at which Uyuni can onboard clients is limited and depends on hardware resources. Onboarding clients at a faster rate than Uyuni is configured for will build up a backlog of unprocessed keys. This slows down the process and can potentially exhaust resources. We recommend that you limit the acceptance key rate programmatically. A safe starting point would be to onboard a client every 15 seconds. You can do that with this command:

```
for k in $(salt-key -l un|grep -v Unaccepted); do salt-key -y -a $k; sleep 15; done
```

3.2.1.2. Clients and the RNG

All communication to and from clients is encrypted. During client onboarding, Salt uses asymmetric cryptography, which requires available entropy from the Random Number Generator (RNG) facility in the kernel. If sufficient entropy is not available from the RNG, it will significantly slow down communications. This is especially true in virtualized environments. Ensure enough entropy is present, or change the virtualization host options.

You can check the amount of available entropy with the `cat /proc/sys/kernel/random/entropy_avail`. It should never be below 100-200.

3.2.1.3. Clients Running with Unaccepted Salt Keys

Idle clients which have not been onboarded, that is clients running with unaccepted Salt keys, consume more resources than idle clients that have been onboarded. Generally, this consumes about an extra 2.5 Kb/s of inbound network bandwidth per client. For example, 1000 idle clients will consume about 2.5 Mb/s extra. This consumption will reduce almost to zero when onboarding has been completed for all clients. Limit the number of non-onboarded clients for optimal performance.

3.2.1.4. Disabling the Salt Mine

In older versions, Uyuni used a tool called Salt Mine to check client availability. The Salt Mine would cause clients to contact the server every hour, which created significant load. Since the introduction of a more efficient mechanism in Uyuni 3.2, the Salt Mine is no longer required. Instead, the Uyuni Server uses Taskomatic to ping only the clients that appear to have been offline for twelve hours or more, with all clients being contacted at least once in every twenty four hour period by default. You can adjust this by changing the `web.system_checkin_threshold` parameter in `rhn.conf`. The value is expressed in days, and the default value is `1`.

Newly registered clients will have the Salt Mine disabled by default. If the Salt Mine is running on your system, you can reduce load by disabling it. This is especially effective if you have a large number of clients.

Disable the Salt Mine by running this command on the server:

```
salt '*' state.sls util.mgr_mine_config_clean_up
```

This will restart the clients and generate some Salt events to be processed by the server. If you have a large number of clients, handling these events could create excessive load. To avoid this, you can execute the command in batch mode with this command:

```
salt --batch-size 50 '*' state.sls util.mgr_mine_config_clean_up
```

You will need to wait for this command to finish executing. Do not end the process with `Ctrl` + `C`.

3.2.1.5. Disable Unnecessary Taskomatic Jobs

To minimize wasted resources, you can disable non-essential or unused Taskomatic jobs.

You can see the list of Taskomatic jobs in the Uyuni Web UI, at **Admin › Task Schedules**.

To disable a job, click the name of the job you want to disable, select `Disable Schedule`, and click Update Schedule.

To delete a job, click the name of the job you want to delete, and click Delete Schedule.

We recommend disabling these jobs:

- Daily comparison of configuration files: `compare-configs-default`
- Hourly synchronization of Cobbler files: `cobbler-sync-default`
- Daily gatherer and subscription matcher: `gatherer-matcher-default`

Do not attempt to disable any other jobs, as it could prevent Uyuni from functioning correctly.

3.2.1.6. Swap and Monitoring

It is especially important in large scale deployments that you keep your Uyuni Server constantly monitored and backed up.

Swap space use can have significant impacts on performance. If significant non-transient swap usage is detected, you can increase the available hardware RAM.

You can also consider tuning the Server to consume less memory. For more information on tuning, see **Specialized-guides › Salt**.

3.2.1.7. AES Key Rotation

Communications from the Salt Master to clients is encrypted with a single AES key. The key is rotated when:

- The `salt-master` process is restarted, or
- Any minion key is deleted (for example, when a client is deleted from Uyuni)

After the AES key has been rotated, all clients must re-authenticate to the master. By default, this happens next time a client receives a message. If you have a large number of clients (several thousands), this can cause a high CPU load on the Uyuni Server. If the CPU load is excessive, we recommend that you delete keys in batches, and in off-peak hours if possible, to avoid overloading the server.

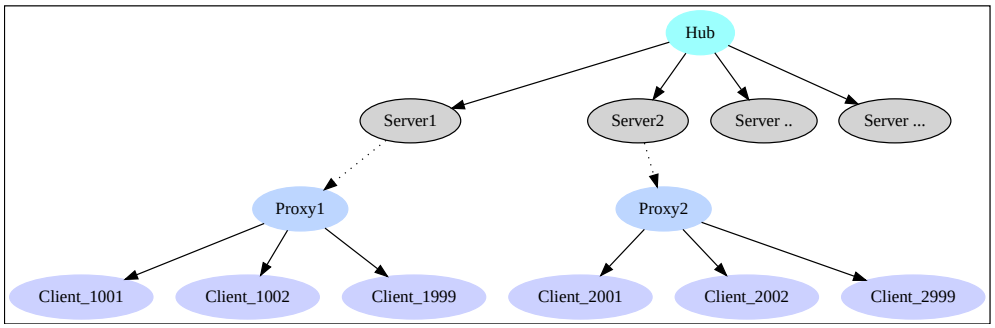
For more information, see:

- https://docs.saltproject.io/en/latest/topics/tutorials/intro_scale.html#too-many-minions-re-authing
- https://docs.saltproject.io/en/getstarted/system/communication.html

3.3. Multiple Servers with Hub to Manage Large Scale Deployments

If you need to manage a large number of clients, in most cases you can do so with a single Uyuni Server, tuned appropriately. However, if you need to manage tens of thousands of clients, you might find it easier to use multiple Uyuni Servers, in a hub, to manage them.

Uyuni Hub helps you manage very large deployments. The typical Hub topology looks like this:



To copy contents between servers, you can use Inter-Server Synchronization (ISS). ISS allows you to export data from one server (source) and import it on another (target) server. For more information, see **Administration › Iss_intro**.

3.3.1. Hub Requirements

To set up a Hub installation, you require:

- One central Uyuni Server, which acts as the Hub Server.
- One or more additional Uyuni Servers, registered to the Hub. This document refers to these additional servers as peripheral servers.
- Any number of clients registered to the peripheral servers.
- Ensure the Hub Server and all peripheral servers are running Uyuni 5.0 or higher.

3.3.1.1. Hub Server

Deploy the central Uyuni Server, which acts as the Hub Server, with the `mgradm` command. Add `--hubxmlrpc-replicas 1` to the `mgradm install` command line. For example:

```
mgradm install podman MLM.example.com --hubxmlrpc-replicas 1
```

For more information about hub server deployment, see **Specialized-guides › Large-deployments**.

The Hub Server must not have clients registered to it. Clients should only be registered to the Peripheral Servers.

3.3.1.1.1. SSL Certificates

The Hub Server's and the Peripheral Servers' SSL certificates must be signed by the same CA. There are two ways to fulfill this requirement:

- Use third party certificates.
- Deploy the Hub Server first and use it to generate the certificates for the Peripheral Servers. For more information, see specialized-guides:large-deployments/hub-reqs.pdf.

3.3.1.1.2. Generate the Certificates for Peripheral Servers

If you will use third party provided Certificates, you can skip this procedure.

Procedure: Generating the Certificates for Peripheral Servers

1. From the container host, enter the shell in the Hub Server container with:

```
mgrctl term
```

2. On the command line, run `rhn-ssl-tool` for each Peripheral Server (replace placeholders such as `COUNTRY`, `STATE`, `example.com`, etc. with values from your environment):

```
rhn-ssl-tool --gen-server --dir="/root/ssl-build" --set-country="COUNTRY" \
  --set-state="STATE" --set-city="CITY" --set-org="ORGANIZATION" \
  --set-org-unit="ORGANIZATION UNIT" --set-email="name@example.com" \
  --set-hostname="HOSTNAME" --set-cname="example.com"
```

3. Copy these files to the Peripheral Server host:
   - `/root/ssl-build/RHN-ORG-TRUSTED-SSL-CERT`
   - `/root/ssl-build/HOSTNAME/server.crt`
   - `/root/ssl-build/HOSTNAME/server.key`

3.3.1.2. Peripheral Servers

Deploy the peripheral servers with `mgradm`. For more information about deploying with `mgradm`, see **Installation-and-upgrade › Container-deployment**.

Procedure:Deploying and Registering Peripheral Servers

1. Prepare Peripheral Server hosts.
2. On each Peripheral Server host:
   - Copy `RHN-ORG-TRUSTED-SSL-CERT` to `/etc/pki/trust/anchors/` and run `update-ca-certificates`.
   - Deploy the Peripheral Server with:

```
mgradm install podman --ssl-ca-root RHN-ORG-TRUSTED-SSL-CERT \
  --ssl-server-cert server.crt --ssl-server-key server.key
```

3. On each Peripheral Server host register Peripheral Server to the Hub Server:

```
mgradm hub register --api-server <HUB_FQDN> --api-user <HUB_ADMIN> \
  --api-password <HUB_ADMIN_PASSWORD>
```

Peripheral Servers must be registered to the Hub Server as foreign clients. Standard registration methods cannot be used.

Peripheral Servers must be registered to the Hub Server directly, do not use a proxy.

Optionally, it is possible to register the podman container host as a standard client (Salt minion) and manage it from Uyuni Server.

Now the XMLRPC API is available and reportdb synchronization will take place.

3.3.2. Hub Deployment with XMLRPC

You can deploy a hub environment either with third party certificates or with self-generated certificates.

For more information about SSL certificates, see specialized-guides:large-deployments/hub-reqs.pdf.

3.3.2.1. With Third Party Certificates

Prepare third party certificates for both the Hub Server and the Peripheral servers first.

3.3.2.1.1. Hub Server Installation

Procedure: Installing the Hub Server

1. Install a container host with SL Micro. For more information about SL Micro as a container host, see installation-and-upgrade:container-deployment/mlm/server-deployment-mlm.pdf.
2. On the container host, deploy Uyuni as the hub server using the third party certificate. Add `--hubxmlrpc-replicas 1` to the `mgradm install` command line. For example:

```
mgradm install podman --ssl-ca-root CA-Certificate.crt --ssl-server-cert hub.crt --ssl
-server-key hub.key --hubxmlrpc-replicas 1
```

For more information about deploying with `mgradm`, see installation-and-upgrade:container-deployment/mlm/server-deployment-mlm.pdf.

3.3.2.1.2. Peripheral Servers

Procedure: Installing peripheral servers using third party certificates

1. Preliminary Requirement: A certificate for every peripheral server (for example, `server.crt`) and a key (for example, `server.key`).
2. Preliminary Requirement: CA Certificate.

3. Preliminary Requirement: Hub server installation. For more information, see specialized-guides:large-deployments/hub-install.pdf.
    - On every peripheral server host, copy the same CA to `/etc/pki/trust/anchors/` and run `update-ca-certificates`.
    - On every peripheral server host, install Uyuni using the following command (replace appropriately the names of the certificates):

```
mgradm install podman --ssl-ca-root CA-Certificate.crt --ssl-server-cert server.crt
--ssl-server-key server.key
```

3.3.2.2. With Self-Generated Certificates

3.3.2.2.1. Hub Server Installation

Procedure: Installing the hub server

1. Install a container host with SL Micro. For more information about SL Micro as a container host, see installation-and-upgrade:container-deployment/mlm/server-deployment-mlm.pdf.
2. On the container host, deploy Uyuni as the hub server. Add `--hubxmlrpc-replicas 1` to the `mgradm install` command line. For example:

```
mgradm install podman MLM.example.com --hubxmlrpc-replicas 1
```

   For more information about deploying with `mgradm`, see installation-and-upgrade:container-deployment/mlm/server-deployment-mlm.pdf.

3.3.2.2.2. Peripheral Servers

Procedure: Peripheral Servers with Self-Generated Certificates

1. Preliminary Requirement: Hub server installation. For more information, see specialized-guides:large-deployments/hub-install.pdf.
2. On the container host of the hub server, enter the server container with:

```
mgrctl term
```

3. Inside the container, run `rhn-ssl-tool` for every pheripheral server:

```
rhn-ssl-tool --gen-server --dir="/root/ssl-build" --set-country="COUNTRY" \
  --set-state="STATE" --set-city="CITY" --set-org="ORGANIZATION" \
  --set-org-unit="ORGANIZATION UNIT" --set-email="name@example.com" \
  --set-hostname=PERIPHAL --set-cname="example.com"
```

4. For every peripheral server:

- From the hub server container, copy `/root/ssl-build/RHN-ORG-TRUSTED-SSL-CERT`, `/root/ssl-build/<hostname>/server.crt` and `/root/ssl-build/<hostname>/server.key` to the peripheral server host.
- On every peripheral server host, copy `RHN-ORG-TRUSTED-SSL-CERT` to `/etc/pki/trust/anchors/`, and run `update-ca-certificates`.
- On every peripheral server host, deploy Uyuni with:

```
mgradm install podman --ssl-ca-root RHN-ORG-TRUSTED-SSL-CERT --ssl-server-cert
server.crt --ssl-server-key server.key
```

- Finally, on every peripheral server host, register the peripheral server to the hub server:

```
mgradm hub register --api-password <hub password> --api-server <hub fqdn> --api-user
<hub admin>
```

3.3.2.3. Background Information

Checking the following hub configuration settings is optional.

On the container host, find environment variables in `/etc/systemd/system/uyuni-hub-xmlrpc.service` generated by `mgradm`. If needed, you can customize these variables with `Environment=`settings in a user created `/etc/systemd/system/uyuni-hub-xmlrpc.service.d/local.conf` `systemd` configuration file on the container host.

It will override settings in `/etc/hub/hub.conf` inside the server container. It is the same file for all containers.

- `HUB_API_URL`: URL to the Hub Server XMLRPC API endpoint. Use the default value if you are installing `hub-xmlrpc-api` on the Hub Server. It is set automatically in the systemd unit file during the installation.
- `HUB_CONNECT_TIMEOUT`: the maximum number of seconds to wait for a response when connecting to a Server. Use the default value in most cases.
- `HUB_REQUEST_TIMEOUT`: the maximum number of seconds to wait for a response when calling a Server method. Use the default value in most cases.
- `HUB_CONNECT_USING_SSL`: use HTTPS instead of HTTP for communicating with peripheral Servers. Recommended for a secure environment. It is always enabled.

3.3.3. Using the Hub XMLRPC API

When XMLRPC API is running, connect to the service at port 2830 using any XMLRPC-compliant client libraries. For examples, see **Specialized-guides › Large-deployments**.

Logs are saved in `/var/log/hub/hub-xmlrpc-api.log`. Logs are rotated weekly, or when the log file size reaches the specified limit. By default, the log file size limit is 10 MB.

3.3.4. Hub XMLRPC API Namespaces

The Hub XMLRPC API operates in a similar way to the Uyuni API. For Uyuni API documentation, see https://documentation.suse.com/MLM.

The Hub XMLRPC API exposes the same methods that are available from the server's XMLRPC API, with a few differences in parameter and return types. Additionally, the Hub XMLRPC API supports some Hub-specific end points which are not available in the Uyuni API.

The Hub XMLRPC API supports three different namespaces:

- The `hub` namespace is used to target the Hub XMLRPC API Server. It supports Hub-specific XMLRPC endpoints which are primarily related to authentication.
- The `unicast` namespace is used to target a single server registered in the hub. It redirects any call transparently to one specific server and returns any value as if the server's XMLRPC API endpoint was used directly.
- The `multicast` namespace is used to target multiple peripheral servers registered in the hub. It redirects any call transparently to all the specified servers and returns the results in the form of a `map`.
- If you do not specify a namespace, all calls are transparently redirected to the underlying Uyuni Server XMLRPC API of the Hub Server. This allows you to call all available methods on the Uyuni Server XMLRPC API.

Methods called without specifying any of the above namespaces will be forwarded to the normal XMLRPC API of the hub. This is the API exposed on ports 80 and 443.

Some important considerations for hub namespaces:

- Individual server IDs can be obtained using `client.hub.listServerIds(hubSessionKey)`.
- The `unicast` namespace assumes all methods receive `hubSessionKey` and serverID as their first two parameters, then any other parameter as specified by the regular Server API.

```
client.unicast.[namespace].[methodName](hubSessionKey, serverId, param1, param2)
```

- The `hubSessionKey` can be obtained using different authentication methods. For more information, see **Specialized-guides › Large-deployments**.
- The `multicast` namespace assumes all methods receive `hubSessionKey`, a list of `ServerID` values, then lists of per-server parameters as specified by the regular server XMLRPC API. The return value is a `map`, with `Successful` and `Failed` entries for each server involved in the call.

```
client.multicast.[namespace].[methodname](hubSessionKey, [serverId1, serverId2],
[param1_s1, param1_s2], [param2_s1, param2_s2])
```

3.3.5. Hub XMLRPC API Authentication Modes

The Hub XMLRPC API supports three different authentication modes:

- Manual mode (default): API credentials must be explicitly provided for each server.
- Relay mode: the credentials used to authenticate with the Hub are also used to authenticate to each server. You must provide a list of servers to connect to.
- Auto-connect mode: credentials are reused for each server, and any peripheral server you have access to is automatically connected.

3.3.5.1. Authentication Examples

This section provides examples of each authentication method.

Example: Manual Authentication

In manual mode, credentials have to be explicitly provided for each peripheral server before you can connect to it.

A typical workflow for manual authentication is:

1. Credentials for the Hub are passed to the `login` method, and a session key for the Hub is returned (`hubSessionKey`).
2. Using the session key from the previous step, Uyuni Server IDs are obtained for all the peripheral servers attached to the Hub via the `hub.listServerIds` method.
3. Credentials for each peripheral server are provided to the `attachToServers` method. This performs authentication against each server's XMLRPC API endpoint.
4. A `multicast` call is performed on a set of servers. This is defined by `serverIds`, which contains the IDs of the servers to target. In the background, `system.list_system` is called on each server's XMLRPC API
5. Hub aggregates the results and returns the response in the form of a `map`. The map has two entries:
    - `Successful`: list of responses for those peripheral servers where the call succeeded.
    - `Failed`: list of responses for those peripheral servers where the call failed.

If you want to call a method on just one Uyuni Server, then Hub API also provides a `unicast` namespace. In this case, the response will be a single value and not a map, in the same way as if you called that Uyuni server's API directly.

Listing 10. Example Python Script for Manual Authentication:

```
#!/usr/bin/python3
```

```
import xmlrpc.client

HUB_XMLRPC_API_URL = "<HUB_XMLRPC_API_URL>"
HUB_USERNAME = "<USERNAME>"
HUB_PASSWORD = "<PASSWORD>"

client = xmlrpc.client.ServerProxy(HUB_XMLRPC_API_URL, verbose=0)

hubSessionKey = client.hub.login(HUB_USERNAME, HUB_PASSWORD)

# Get the server IDs
serverIds = client.hub.listServerIds(hubSessionKey)

# For simplicity, this example assumes you are using the same username and password here, as
on the hub server.
# However, in most cases, every server has its own individual credentials.
usernames = [HUB_USERNAME for s in serverIds]
passwords = [HUB_PASSWORD for s in serverIds]

# Each server uses the credentials set above, client.hub.attachToServers needs
# them passed as lists with as many elements as there are servers.
client.hub.attachToServers(hubSessionKey, serverIds, usernames, passwords)

# Perform the operation
systemsPerServer = client.multicast.system.list_systems(hubSessionKey, serverIds)
successfulResponses = systemsPerServer["Successful"]["Responses"]
failedResponses = systemsPerServer["Failed"]["Responses"]

for system in successfulResponses:
  print(system)

# Log out
client.hub.logout(hubSessionKey)
```

Example: Relay Authentication

In relay authentication mode, the credentials used to sign in to the Hub API are also used to sign in into the APIs of the peripheral servers the user wants to work with. In this authentication mode, it is assumed that the same credentials are valid for every server, and that they correspond to a user with appropriate permissions.

After signing in, you must call the `attachToServers` method. This method defines the servers to target in all subsequent calls.

A typical workflow for relay authentication is:

1. Credentials for the Hub are passed to the `loginWithAuthRelayMode` method, and a session key for the Hub is returned (`hubSessionKey`).
2. Using the session key from the previous step, Uyuni Server IDs are obtained for all the peripheral servers attached to the Hub via the `hub.listServerIds` method
3. A call to `attachToServers` is made, and the same credentials used to sign in to the Hub are passed to each server. This performs authentication against each server's XMLRPC API endpoint.
4. A `multicast` call is performed on a set of servers. This is defined by `serverIds`, which contains the IDs of the servers to target. In the background, `system.list_system` is called on each server's XMLRPC API.

5. Hub aggregates the results and returns the response in the form of a `map`. The map has two entries:
    - `Successful`: list of responses for those peripheral servers where the call succeeded.
    - `Failed`: list of responses for those peripheral servers the call failed.

Listing 11. Example Python Script for Relay Authentication:

```
#!/usr/bin/python3
import xmlrpc.client

HUB_XMLRPC_API_URL = "<HUB_XMLRPC_API_URL>"
HUB_USERNAME = "<USERNAME>"
HUB_PASSWORD = "<PASSWORD>"

client = xmlrpc.client.ServerProxy(HUB_XMLRPC_API_URL, verbose=0)

hubSessionKey = client.hub.loginWithAuthRelayMode(HUB_USERNAME, HUB_PASSWORD)

# Get the server IDs
serverIds = client.hub.listServerIds(hubSessionKey)

# Authenticate those servers(same credentials will be used as of hub to authenticate)
client.hub.attachToServers(hubSessionKey, serverIds)

# Perform the needed operation
systemsPerServer = client.multicast.system.list_systems(hubSessionKey, serverIds)
successfulResponses = systemsPerServer["Successful"]["Responses"]
failedResponses = systemsPerServer["Failed"]["Responses"]

for system in successfulResponses:
  print(system)

# Log out
client.hub.logout(hubSessionKey)
```

Example: Auto-Connect Authentication

Auto-connect mode is similar to relay mode, it uses the Hub credentials to sign in in to all peripheral servers. However, there is no need to use the `attachToServers` method, as auto-connect mode connects to all available peripheral servers. This occurs at the same time as you sign in to the Hub.

A typical workflow for auto-connect authentication is:

1. Credentials for the Hub are passed to the `loginWithAutoconnectMode` method, and a session key for the Hub is returned (`hubSessionKey`).
2. A `multicast` call is performed on a set of servers. This is defined by `serverIds`, which contains the IDs of the servers to target. In the background, `system.list_system` is called on each server's XMLRPC API.
3. Hub aggregates the results and returns the response in the form of a `map`. The map has two entries:
    - `Successful`: list of responses for those peripheral servers where the call succeeded.
    - `Failed`: list of responses for those peripheral servers where the call failed.

Listing 12. Example Python Script for Auto-Connect Authentication:

```
#!/usr/bin/python3
import xmlrpc.client

HUB_XMLRPC_API_URL = "<HUB_XMLRPC_API_URL>"
HUB_USERNAME = "<USERNAME>"
HUB_PASSWORD = "<PASSWORD>"

client = xmlrpc.client.ServerProxy(HUB_XMLRPC_API_URL, verbose=0)

loginResponse = client.hub.loginWithAutoconnectMode(HUB_USERNAME, HUB_PASSWORD)
hubSessionKey = loginResponse["SessionKey"]

# Get the server IDs
serverIds = client.hub.listServerIds(hubSessionKey)

# Perform the needed operation
systemsPerServer = client.multicast.system.list_systems(hubSessionKey, serverIds)
successfulResponses = systemsPerServer["Successful"]["Responses"]
failedResponses = systemsPerServer["Failed"]["Responses"]

for system in successfulResponses:
  print(system)

# Log out
client.hub.logout(hubSessionKey)
```

3.3.6. Hub Reporting

The Hub prepares and provides content for multiple peripheral Uyuni Servers. The goal of the reporting feature is to get data from these Servers back and have combined reporting data available on the Hub. The data is made available for external Reporting Tools.

3.3.6.1. Architecture

The main database is a PostgreSQL database in the Uyuni Hub system. It stores all the information collected from all the servers, and aggregates them. Every peripheral Server has its own reporting database where the information is collected for that system. In summary:

- the DB in Uyuni Hub stores, collects and aggregates data coming from all the DBs of the peripheral Servers,
- the DB in Uyuni Hub stores also its own data from the systems directly connected and managed by the Hub,
- the DB in peripheral Uyuni Server stores its own data,
- the reporting tool can be connected either to the Hub or to any Uyuni Server.

3.3.6.2. Setup

The reporting database and schema are set up by default using the local PostgreSQL server. The reporting database is a separate database accessible via the network.

As a requirement we expect all server certificates are signed by the same Root

> Certificate Authority (CA). The whole Uyuni Hub environment should be using only one Root CA.
>
> For more information about certificates, see specialized-guides:large-deployments/hub-reqs.pdf.

3.3.6.2.1. Create a DB user for the reporting

Before connecting an external Reporting Tools to the Database, a user with read-only permission should be created. For doing that, it is possible to use `uyuni-setup-reportdb-user`.

```
usage: uyuni-setup-reportdb-user [options]

options:
  --help
            show this help message and exit
  --non-interactive
            Switches to non-interactive mode
  --dbuser=DBUSER
            Report DB User
  --dbpassword=DBPASSWORD
            Report DB Password
  --add
            Add the new user
  --delete
            Delete the user
  --modify
            Set a new password
```

3.3.6.3. Database Schema

The schema exports the most important tables from the main Uyuni Database as a de-normalized variant containing only data which are relevant for a report.

Ready-to-use reports are provided as views, aggregating data over multiple tables.

Every table gets an extra id column (`mgm_id`) specifying the Uyuni server which provided the data. On a single Uyuni Server this column has the standard value `1` which represent `localhost`. On the Uyuni Hub it is replaced with the real server id the managed server has in the hub database.

Another common additional field is `synced_date`, which represents the time when the data were exported from the main Uyuni Server database.

Navigate to **Help › Report Database Schema** to find the schema documentation.

3.3.6.4. Data Generation and Update

Uyuni uses taskomatic jobs to generate the data for the reporting database and to get the data from the peripheral servers to the hub.

To generate and update the data on a peripheral server, the responsible schedule is called `update-`

`reporting-default`. It is executed by default daily at midnight.

On the Uyuni Hub there is a second schedule which is important. To fetch the reporting data from all registered peripheral servers, the task with the name `update-reporting-hub-default` is executed daily at 1:30 AM.

All times are in the local timezone of the server. If the peripheral servers are in different timezones, it is recommended to align all the schedules. Make sure that all reporting data are gathered at a specific point in time, and `update-reporting-hub-default` is running when all peripheral servers have actually finished their local jobs.

3.3.6.4.1. Tuning Reporting Jobs

3.3.6.4.2. `report_db_batch_size`

Description	The maximum number of rows fetched and written from one database to the other in one shot.
Tune when	Out of memory errors or on processing speed problems.
Value default	2000
Value recommendation	500 - 5000
Location	`/etc/rhn/rhn.conf`
Example	`report_db_batch_size = 4000`
After changing	Check memory usage. Monitor memory usage closely before and after the change.

3.3.6.4.3. `report_db_hub_workers`

Description	The maximum number of workers requesting data from peripheral servers on a hub at the same point in time.
Tune when	The number of peripheral servers increases significantly (more than 100), or a faster synchronization is required.
Value default	2
Value recommendation	2 - 10
Location	`/etc/rhn/rhn.conf`
Example	`report_db_hub_workers = 5`

After changing	Check memory usage. Monitor memory and cpu usage of the hub closely before and after the change. Also monitor the load, cpu and memory usage of the reporting database of the hub.
Notes	All the data collected from the peripheral server must be written into the hub reporting database. Tuning that database could increase the performance as well.

3.3.7. Hub Online Synchronization

3.3.7.1. Introduction

Hub online synchronization reuses the existing repository synchronization and synchronizes channels in the peripheral servers from the repositories on the hub server.

When the connection between hub and peripheral server is established, the hub server becomes the main source of data for the peripheral server. In case of vendor channels, hub server is effectively replacing SUSE Customer Center. In case of custom channels, when they are synchronized, the peripheral server will fetch the packages from the hub and not from the original location of the custom channel defined on the hub.

The main characteristics of this feature are:

- There can only be one hub server per connection, with one or more peripheral servers.
- Each peripheral server can only have one hub server.
- Content can be synchronized on regular basis, or on demand.

3.3.7.2. Registration of the hub and peripheral servers

Hub online synchronization is configured from menu **Admin › Hub Configuration**.

Configuration process uses token which uniquely identifies peripheral server's connection to the hub.

There are two ways to register a peripheral server to the hub server:

1. by using a combination of token creation on the peripheral, and subsequent registration on the hub server. This method uses Procedure: Generating token on the peripheral server and Procedure: Registering to the hub server with the token.
2. by direct registration from the hub, without any user interactions with the peripheral server. This method is described in Procedure: Direct registering from the hub server.

3.3.7.2.1. Registration from peripheral server by token generation

Before being registered to the hub server, a token needs to be generated on the peripheral server and

passed to the administrator of the hub server.

Procedure: Generating token on the peripheral server

1. On the peripheral server, go to **Admin › Hub Configuration › Access Tokens**.
2. Click button Add token and select option `Issue new token`.
3. In the field `Server FQDN` on the form that opens type the FQDN of the hub server that will be using this token.
4. Click Issue.
5. A new form with the successfully generated token appears and button Copy.

The only time token is displayed is at the time of its creation. Save it in a safe place until it is later needed.

6. Once generated, the token appears on the screen `Access Tokens`.

The generated token needs to be transferred to the hub server before it can be used.

Procedure: Registering to the hub server with the token

1. On the hub server, go to **Hub Configuration › Peripherals Configuration**.
2. Click button Add peripheral. A new form `Register a new peripheral server` opens.
3. In the field `Peripheral Server FQDN` enter the name of the peripheral server.
4. In the field `Registration mode` select option `Existing token`.
5. In the field `Token` paste the token that was created on the peripheral server.
6. In the field `Root CA certificate` specify the certificate using one of the options:
    - Use option `Not needed` if both hub and peripheral servers have the same certificate authority.
    - Use option `Upload a file` if the servers have different certificate authorities to upload a certificate file.
    - Use option `Paste a PEM certificate` to paste a certificate.
7. Click button Register. A newly registered peripheral server will appear on screen `Peripherals Configuration`.

3.3.7.2.2. Registration from the hub server directly

It is possible to initiate the registration of a peripheral server from hub server, without any interaction with the peripheral server.

Procedure: Direct registering from the hub server

1. On the hub server, go to **Hub Configuration › Peripherals Configuration**.
2. Click button Add peripheral. A new form `Register a new peripheral server` opens.

3. In the field `Peripheral Server FQDN` enter the name of the peripheral server.
4. In the field `Registration mode` select option `Administrator User/Password`.
5. In the fields `Username` and `Password` enter the credentials for the peripheral server.

The credentials must be those of `SUSE Manager Administrator` of the peripheral server.

6. In the field `Root CA certificate` specify the certificate using one of the options:
   - Use option `Not needed` if both hub and peripheral servers have the same certificate authority.
   - Use option `Upload a file` if the servers have different certificate authorities to upload a certificate file.
   - Use option `Paste a PEM certificate` in cases when PEM certificate is used.
7. Click button `Register`.
8. The newly registered peripheral server will be shown in the **Systems › System List** with the value `Foreign` in the column `System Type`.
9. To access its details, click on the peripheral server's name and select tab **Details › Peripheral Server**.

Peripheral server uses hub to access the vendor channels and does not connect to the SUSE Customer Center directly. Therefore, if you open configured peripheral server's page **Admin › Setup Wizard › Organization Credentials**, **Admin › Setup Wizard › Products** or **Admin › Setup Wizard › PAYG Connections**, you will see a notification that this is peripheral server and its connections are managed via hub.

3.3.7.2.3. Access tokens

All existing tokens are shown in **Hub Configuration › Access Tokens**.

A token can viewed as `Consumed` and `Issued`, both from the perspective of the peripheral and the hub server.

- From the perspective of the peripheral server:

  Consumed

  The `Consumed`token is generated on the peripheral server and received by the hub server to be used.

  Issued

  The `Issued` token is issued by the hub server to be used by the peripheral server.

- From the perspective of the hub server:

Consumed

The `Consumed`token is generated on the hub server and received by the peripheral server to be used.

Issued

The `Issued` token is issued by the peripheral server to be used by the hub server.

Token operations

A token can be invalidated, or deleted.

Be careful when using option Invalidate as it no longer grants access to the other server. This operation ensures that no communication will happen until a new token is generated if the existing one is compromised, or until the current token is reactivated. Invalidated token can be made valid again at any time.

It is possible to delete a token. Deleting is only possible when the server associated with the token is not registered as hub or peripheral. This operation cannot be undone.

3.3.7.2.4. Access hub server details from the peripheral server

Every peripheral server stores the information about its hub server.

A peripheral server can only have one hub server configured.

Procedure: Accessing hub server details

1. On the peripheral server, go to **Hub Configuration › Hub Details**.
2. On the screen `Hub Details` find the information about the hub server.
    a. Field `Server FQDN` shows the hub server's FQDN.
    b. Field `Registration date` shows the time when the peripheral server was registered to the hub server.
    c. Field `Last modified` shows the time of the last saved configuration change.
    d. Field `Root Certificate Authority` shows certificate details. To download, edit or delete the root certificate, clicking Download, Edit or Delete respectively. Deleting the certificate will break the connection between servers.
    e. Field `GPG Public Key` shows whether the GPG key has been configured for the hub server. For more information about GPG keys between hub and peripheral servers, see GPG key usage with hub online synhronization.
    f. Field `Mirror credentials` is the username the peripheral server uses when connecting to the hub server to synchronize vendor channels. This username is generated automatically on the hub server, and then transmitted to the peripheral server during the registration phase.

GPG key usage with hub online synhronization

When the metadata on the hub server are signed with a GPG key, the public key is automatically transmitted from hub to peripheral server.

By default, Uyuni is not signing metadata. Therefore, when the peripheral server is downloading data from the hub server there is no way of checking if the downloaded metadata have a valid signature, unless the customer has created their own GPG key.

To enable checking of the data integrity, the GPG key needs to be created on the hub. When the peripheral server is configured to communicate with the hub, the public GPG key will then automatically be transferred to it.

When the GPG key is created on the hub, field `GPG Public Key` will be set to show that this server is using the GPG key. For more information about setting up own GPG key, see **Administration › Repo-metadata**.

3.3.7.2.5. Deregister peripheral server

Deregistration can happen from both sides, from the hub or from the peripheral server.

Procedure: Deregistering from the peripheral server

1. Go to **Hub Configuration › Hub Details**.
2. Click Deregister.
3. Confirm the operation by clicking Deregister on the pop-up window.
4. Page **Hub Configuration › Hub Details** is now empty.

Procedure: Deregistering from the hub server

1. Go to **Hub Configuration › Peripheral Configuration**.
2. Find the perpheral server on the list.
3. Click Deregister next to the peripheral server's name.
4. The peripheral server is no longer shown on the list.

3.3.7.3. Synchronize channels from hub to peripheral server

Synchronizing vendor channels for the configured hub and server is done via dedicated user interface.

Procedure: Synchronizing channels from hub to peripheral server

1. Go to **Admin › Hub Configuration › Peripherals Configuration**.
2. In the field `Synchronized channels` click on Edit channels.
3. Page `Sync Channels from Hub to Peripheral` opens.
4. Select the channels you want to synchronize.
5. For Custom Channels also select the target organization on the peripheral from the dropdown.

The drop-down list only exists on custom channels which do not yet exist on the peripheral server. If the channel exists, the organization will stay unchanged.

6. Click Apply Changes to view the summary of your changes.
7. A pop-up window with the summary of your selections will open.
8. Click Confirm to confirm the selection.

Now channels will be created on the peripheral server and everything will be set up to mirror the channels with the next regular repository synchronization task.

+

The repository synchronization will not start immediately after clicking the confirmation button.

3.4. Managing Large Scale Deployments in a Retail Environment

Uyuni for Retail 2025.05 is an open source infrastructure management solution, optimized and tailored specifically for the retail industry. It uses the same technology as SUSE Multi-Linux Manager, but is customized to address the needs of retail organizations.

Uyuni for Retail is designed for use in retail situations where customers can use point-of-service terminals to purchase or exchange goods, take part in promotions, or collect loyalty points. In addition to retail installations, it can also be used for novel purposes, such as maintaining student computers in an educational environment, or self-service kiosks in banks or hospitals.

Uyuni for Retail is intended for use in installations that include servers, workstations, point-of-service terminals, and other devices. It allows administrators to install, configure, and update the software on their servers, and manage the deployment and provisioning of point-of-service machines.

Point-of-Service (POS) terminals can come in many different formats, such as point-of-sale terminals, kiosks, digital scales, self-service systems, and reverse-vending systems. Every terminal, however, is provided by a vendor, who set basic information about the device in the firmware. Uyuni for Retail accesses this vendor information to determine how best to work with the terminal in use.

In most cases, different terminals will require a different operating system (OS) image to ensure they work correctly. For example, an information kiosk has a high-resolution touchscreen, where a cashier terminal might only have a very basic display. While both of these terminals require similar processing and network functionality, they will require different OS images. The OS images ensure that the different display mechanisms work correctly.

For more information about setting up and using Uyuni for Retail, see **Retail › Uyuni-retail-overview**.

3.5. Tuning Large Scale Deployments

Uyuni is designed by default to work on small and medium scale installations. For installations with more than 1000 clients per Uyuni Server, adequate hardware sizing and parameter tuning must be performed.

The instructions in this section can have severe and catastrophic performance impacts when improperly used. In some cases, they can cause Uyuni to completely cease functioning. Always test changes before implementing them in a production environment. During implementation, take care when changing parameters. Monitor performance before and after each change, and revert any steps that do not produce the expected result.

Tuning is not required on installations of fewer than 1000 clients. Do not perform these instructions on small or medium scale installations.

3.5.1. The Tuning Process

Any Uyuni installation is subject to a number of design and infrastructure constraints that, for the purposes of tuning, we call environmental variables. Environmental variables can include the total number of clients, the number of different operating systems under management, and the number of software channels.

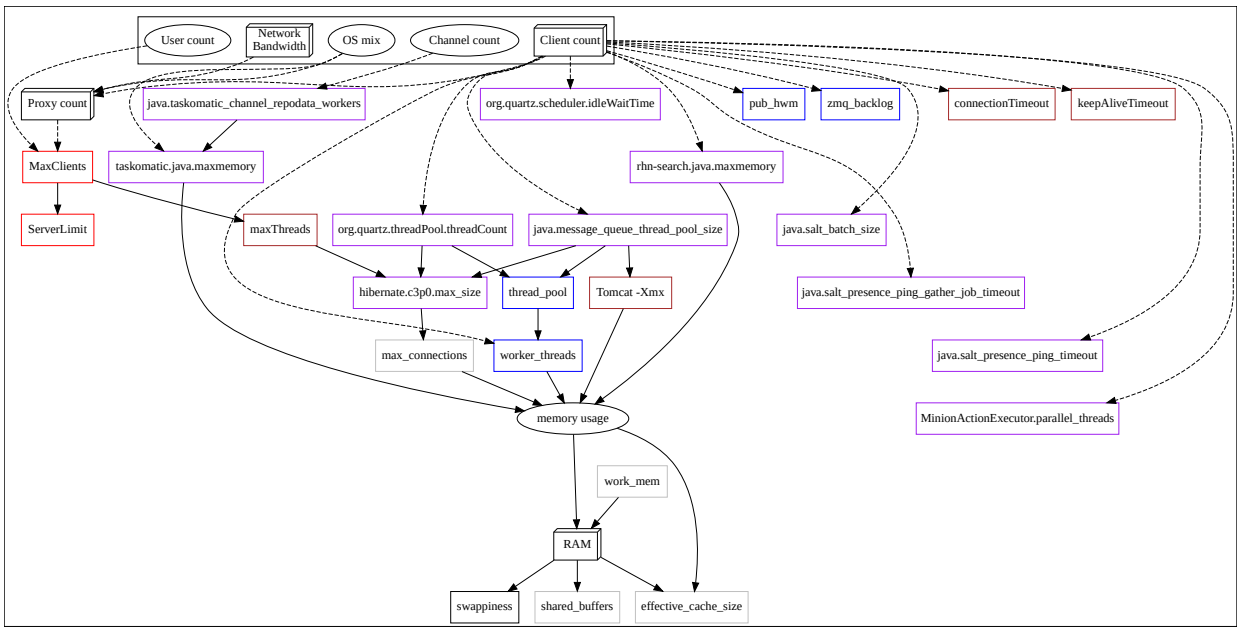
Environmental variables influence, either directly or indirectly, the value of most configuration parameters. During the tuning process, the configuration parameters are manipulated to improve system performance.

Before you begin tuning, you will need to estimate the best setting for each environment variable, and adjust the configuration parameters to suit.

To help you with the estimation process, we have provided you with a dependency graph. Locate the environmental variables on the dependency graph to determine how they will influence other variables and parameters.

Environmental variables are represented by graph nodes in a rectangle at the top of the dependency graph. Each node is connected to the relevant parameters that might need tuning. Consult the relevant sections in this document for more information about recommended values.

Tuning one parameter might require tuning other parameters, or changing hardware, or the infrastructure. When you change a parameter, follow the arrows from that node on the graph to determine what other parameters might need adjustment. Continue through each parameter until you have visited all nodes on the graph.



Key to the Dependency Graph

- 3D boxes are hardware design variables or constraints
- Oval-shaped boxes are software or system design variables or constraints
- Rectangle-shaped boxes are configurable parameters, color-coded by configuration file:
  - Red: Apache `httpd` configuration files
  - Blue: Salt configuration files
  - Brown: Tomcat configuration files
  - Grey: PostgreSQL configuration files
  - Purple: `/etc/rhn/rhn.conf`
- Dashed connecting lines indicate a variable or constraint that might require a change to another parameter
- Solid connecting lines indicate that changing a configuration parameter requires checking another one to prevent issues

After the initial tuning has been completed, you will need to consider tuning again in these cases:

- If your tuning inputs change significantly
- If special conditions arise that require a certain parameter to be changed. For example, if specific warnings appear in a log file.
- If performance is not satisfactory

To re-tune your installation, you will need to use the dependency graph again. Start from the node where significant change has happened.

3.5.2. Environmental Variables

This section contains information about environmental variables (inputs to the tuning process).

Network Bandwidth

A measure of the typically available egress bandwith from the Uyuni Server host to the clients or Uyuni Proxy hosts. This should take into account network hardware and topology as well as possible capacity limits on switches, routers, and other network equipment between the server and clients.

Channel count

The number of expected channels to manage. Includes any vendor-provided, third-party, and cloned or staged channels.

Client count

The total number of actual or expected clients. It is important to tune any parameters in advance of a client count increase, whenever possible.

OS mix

The number of distinct operating system versions that managed clients have installed. This is ordered by family (SUSE Linux Enterprise, openSUSE, Red Hat Enterprise Linux, or Ubuntu based). Storage and computing requirements are different in each case.

User count

The expected maximum amount of concurrent users interacting with the Web UI plus the number of programs simultaneously using the XMLRPC API. Includes `spacecmd`, `spacewalk-clone-by-date`, and similar.

3.5.3. Parameters

This section contains information about the available parameters.

3.5.3.1. `MaxClients`

Description	The maximum number of HTTP requests served simultaneously by Apache httpd. Proxies, Web UI, and XMLRPC API clients each consume one. Requests exceeding the parameter will be queued and might result in timeouts.
Tune when	User count and proxy count increase significantly and this line appears in `/var/log/apache2/error_log`: `[…] [mpm_prefork:error] [pid …] AH00161: server reached MaxRequestWorkers setting, consider raising the MaxRequestWorkers setting`.

Value default	150
Value recommendation	150-500
Location	`/etc/apache2/server-tuning.conf`, in the `prefork.c` section
Example	`MaxClients = 200`
After changing	Immediately change `ServerLimit` and check `maxThreads` for possible adjustment.
Notes	This parameter was renamed to `MaxRequestWorkers`, both names are valid.
More information	https://httpd.apache.org/docs/2.4/en/mod/mpm_common.html#maxrequestworkers

3.5.3.2. `ServerLimit`

Description	The number of Apache httpd processes serving HTTP requests simultaneously. The number must equal `MaxClients`.
Tune when	`MaxClients` changes
Value default	150
Value recommendation	The same value as `MaxClients`
Location	`/etc/apache2/server-tuning.conf`, in the `prefork.c` section
Example	`ServerLimit = 200`
More information	https://httpd.apache.org/docs/2.4/en/mod/mpm_common.html#serverlimit

3.5.3.3. `maxThreads`

Description	The number of Tomcat threads dedicated to serving HTTP requests
Tune when	`MaxClients` changes. `maxThreads` must always be equal or greater than `MaxClients`
Value default	150
Value recommendation	The same value as `MaxClients`

Location	`/etc/tomcat/server.xml`
Example	`<Connector port="8009" protocol="AJP/1.3" redirectPort="8443" URIEncoding="UTF-8" address="127.0.0.1" maxThreads="200" connectionTimeout="20000"/>`
More information	https://tomcat.apache.org/tomcat-9.0-doc/config/http.html

3.5.3.4. `connectionTimeout`

Description	The number of milliseconds before a non-responding AJP connection is forcibly closed.
Tune when	Client count increases significantly and `AH00992`, `AH00877`, and `AH01030` errors appear in Apache error logs during a load peak.
Value default	900000
Value recommendation	20000-3600000
Location	`/etc/tomcat/server.xml`
Example	`<Connector port="8009" protocol="AJP/1.3" redirectPort="8443" URIEncoding="UTF-8" address="127.0.0.1" maxThreads="200" connectionTimeout="1000000" keepAliveTimeout="300000"/>`
More information	https://tomcat.apache.org/tomcat-9.0-doc/config/http.html

3.5.3.5. `keepAliveTimeout`

Description	The number of milliseconds without data exchange from the JVM before a non-responding AJP connection is forcibly closed.

Tune when	Client count increases significantly and `AH00992`, `AH00877`, and `AH01030` errors appear in Apache error logs during a load peak.
Value default	300000
Value recommendation	20000-600000
Location	`/etc/tomcat/server.xml`
Example	`<Connector port="8009" protocol="AJP/1.3" redirectPort="8443" URIEncoding="UTF-8" address="127.0.0.1" maxThreads="200" connectionTimeout="1000000" keepAliveTimeout="400000"/>`
More information	https://tomcat.apache.org/tomcat-9.0-doc/config/http.html

3.5.3.6. Tomcat's `-Xmx`

Description	The maximum amount of memory Tomcat can use
Tune when	`java.message_queue_thread_pool_size` is increased or `OutOfMemoryException` errors appear in `/var/log/rhn/rhn_web_ui.log`
Value default	1 GiB
Value recommendation	4-8 GiB
Location	`/etc/tomcat/conf.d/tomcat_java_opts.conf`
Example	`JAVA_OPTS="⋯ -Xmx8G ⋯"`
After changing	Check memory usage
More information	https://docs.oracle.com/javase/8/docs/technotes/tools/windows/java.html

3.5.3.7. `java.disable_list_update_status`

Description	Disable displaying the update status for clients of a system group

Tune when	displaying the update status causes timeouts
Value default	`false`
Value recommendation	
Location	`/etc/rhn/rhn.conf`
Example	`java.disable_list_update_status = true`
After changing	?
Notes	
More information	`man rhn.conf`

3.5.3.8. `java.message_queue_thread_pool_size`

Description	The maximum number of threads in Tomcat dedicated to asynchronous operations
Tune when	Client count increases significantly
Value default	5
Value recommendation	50 - 150
Location	`/etc/rhn/rhn.conf`
Example	`java.message_queue_thread_pool_size = 50`
After changing	Check `hibernate.c3p0.max_size`, as each thread consumes a PostgreSQL connection, starvation might happen if the allocated connection pool is insufficient. Check `thread_pool`, as each thread might perform Salt API calls, starvation might happen if the allocated Salt thread pool is insufficient. Check Tomcat's `-Xmx`, as each thread consumes memory, `OutOfMemoryException` might be raised if insufficient.
Notes	Incoming Salt events are handled in separate thread pool, see `java.salt_event_thread_pool_size`
More information	`man rhn.conf`

3.5.3.9. `java.salt_batch_size`

Description	The maximum number of minions concurrently executing a scheduled action.
Tune when	Client count reaches several thousands and actions are not executed quickly enough.
Value default	200
Value recommendation	200-500
Location	`/etc/rhn/rhn.conf`
Example	`java.salt_batch_size = 300`
After changing	Check memory usage. Monitor memory usage closely before and after the change.
More information	**Specialized-guides › Salt**

3.5.3.10. `java.salt_event_thread_pool_size`

Description	The maximum number of threads in Tomcat dedicated to handling of incoming Salt events.
Tune when	The number of queued Salt events grows. Typically, this can happen during onboarding of large number of minions with higher value of `java.salt_presence_ping_timeout`. The number of events can be queried by `echo "select count(*) from susesaltevent;" | spacewalk-sql --select-mode-direct -`
Value default	8
Value recommendation	20-100
Location	`/etc/rhn/rhn.conf`
Example	`java.salt_event_thread_pool_size = 50`

After changing	Check the length of Salt event queue. Check `hibernate.c3p0.max_size`, as each thread consumes a PostgreSQL connection, starvation might happen if the allocated connection pool is insufficient. Check `thread_pool`, as each thread might perform Salt API calls, starvation might happen if the allocated Salt thread pool is insufficient. Check Tomcat's `-Xmx`, as each thread consumes memory, `OutOfMemoryException` might be raised if insufficient.
More information	`man rhn.conf`

3.5.3.11. `java.salt_presence_ping_timeout`

Description	Before any action is executed on a client, a presence ping is executed to make sure the client is reachable. This parameter sets the amount of time before a second command (in most cases `state.apply` or any other Salt function) is sent to the client to verify its presence. Having many clients typically means some will respond faster than others, so this timeout could be raised to accommodate for the slower ones.
Tune when	Client count increases significantly, or some clients are responding correctly but too slowly, and Uyuni excludes them from calls. This line appears in `/var/log/rhn/rhn_web_ui.log`: `"Got no result for <COMMAND> on minion <MINION_ID> (minion did not respond in time)"`
Value default	4 seconds
Value recommendation	4-20 seconds
Location	`/etc/rhn/rhn.conf`
Example	`java.salt_presence_ping_timeout = 10`
After changing	Large `java.salt_presence_ping_timeout` value can reduce overall throughput. This can be compensated by increasing `java.salt_event_thread_pool_size`
More information	**Specialized-guides › Salt**

3.5.3.12. java.salt_presence_ping_gather_job_timeout

Description	Before any action is executed on a client, a presence ping is executed to make sure the client is reachable. After `java.salt_presence_ping_timeout` seconds have elapsed without a response, a second command (in most cases `state.apply` or any other Salt function) is sent to the client and if there is no response from the client for the amount of seconds specified with this parameter one more call (`saltutil.find_job`) is sent for a final check. This parameter sets the number of seconds after the second command after which the client is definitely considered timeout. Having many clients typically means some will respond faster than others, so this timeout could be raised to accommodate for the slower ones.
Tune when	Client count increases significantly, or some clients are responding correctly but too slowly, and Uyuni excludes them from calls. This line appears in `/var/log/rhn/rhn_web_ui.log`: `"Got no result for <COMMAND> on minion <MINION_ID> (minion did not respond in time)"`
Value default	1 second
Value recommendation	1-50 seconds
Location	`/etc/rhn/rhn.conf`
Example	`java.salt_presence_ping_gather_job_timeout = 20`
More information	**Specialized-guides › Salt**

3.5.3.13. java.taskomatic_channel_repodata_workers

Description	Whenever content is changed in a software channel, its metadata needs to be recomputed before clients can use it. Channel-altering operations include the addition of a patch, the removal of a package or a repository synchronization run. This parameter specifies the maximum number of Taskomatic threads that Uyuni will use to recompute the channel metadata. Channel metadata computation is both CPU-bound and memory-heavy, so raising this parameter and operating on many channels simultaneously could cause Taskomatic to consume significant resources, but channels will be available to clients sooner.
Tune when	Channel count becomes larger than 50, or more concurrent operations on channels are expected.
Value default	2
Value recommendation	2-10
Location	`/etc/rhn/rhn.conf`
Example	`java.taskomatic_channel_repodata_workers = 4`
After changing	Check `taskomatic.java.maxmemory` for adjustment, as every new thread will consume memory
More information	`man rhn.conf`

3.5.3.14. `taskomatic.java.maxmemory`

Description	The maximum amount of memory Taskomatic can use. Generation of metadata, especially for some OSs, can be memory-intensive, so this parameter might need raising depending on the managed OS mix.
Tune when	`java.taskomatic_channel_repodata_workers` increases, OSs are added to Uyuni (particularly Red Hat Enterprise Linux or Ubuntu), or `OutOfMemoryException` errors appear in `/var/log/rhn/rhn_taskomatic_daemon.log`.
Value default	4096 MiB

Value recommendation	4096-16384 MiB
Location	`/etc/rhn/rhn.conf`
Example	`taskomatic.java.maxmemory = 8192`
After changing	Check memory usage.
More information	`man rhn.conf`

3.5.3.15. `org.quartz.threadPool.threadCount`

Description	The number of Taskomatic worker threads. Increasing this value allows Taskomatic to serve more clients in parallel.
Tune when	Client count increases significantly
Value default	20
Value recommendation	20-200
Location	`/etc/rhn/rhn.conf`
Example	`org.quartz.threadPool.threadCount = 100`
After changing	Check `hibernate.c3p0.max_size` and `thread_pool` for adjustment
More information	http://www.quartz-scheduler.org/documentation/2.4.0-SNAPSHOT/configuration.html

3.5.3.16. `org.quartz.scheduler.idleWaitTime`

Description	Cycle time for Taskomatic. Decreasing this value lowers the latency of Taskomatic.
Tune when	Client count is in the thousands.
Value default	5000 ms
Value recommendation	1000-5000 ms
Location	`/etc/rhn/rhn.conf`
Example	`org.quartz.scheduler.idleWaitTime = 1000`

More information	http://www.quartz-scheduler.org/documentation/2.4.0-SNAPSHOT/configuration.html

3.5.3.17. `MinionActionExecutor.parallel_threads`

Description	Number of Taskomatic threads dedicated to sending commands to Salt clients as a result of actions being executed.
Tune when	Client count is in the thousands.
Value default	1
Value recommendation	1-10
Location	`/etc/rhn/rhn.conf`
Example	`taskomatic.minion_action_executor.parallel_threads = 10`

3.5.3.18. `SSHMinionActionExecutor.parallel_threads`

Description	Number of Taskomatic threads dedicated to sending commands to Salt SSH clients as a result of actions being executed.
Tune when	Client count is in the hundreds.
Value default	20
Value recommendation	20-100
Location	`/etc/rhn/rhn.conf`
Example	`taskomatic.sshminion_action_executor.parallel_threads = 40`

3.5.3.19. `hibernate.c3p0.max_size`

Description	Maximum number of PostgreSQL connections simultaneously available to both Tomcat and Taskomatic. If any of those components requires more concurrent connections, their requests will be queued.

Tune when	`java.message_queue_thread_pool_size` or `maxThreads` increase significantly, or when `org.quartz.threadPool.threadCount` has changed significantly. Each thread consumes one connection in Taskomatic and Tomcat, having more threads than connections might result in starving.
Value default	20
Value recommendation	100 to 200, higher than the maximum of `java.message_queue_thread_pool_size` + `maxThreads` and `org.quartz.threadPool.threadCount`
Location	`/etc/rhn/rhn.conf`
Example	`hibernate.c3p0.max_size = 100`
After changing	Check `max_connections` for adjustment.
More information	https://www.mchange.com/projects/c3p0/#maxPoolSize

3.5.3.20. `rhn-search.java.maxmemory`

Description	The maximum amount of memory that the `rhn-search` service can use.
Tune when	Client count increases significantly, and `OutOfMemoryException` errors appear in `journalctl -u rhn-search`.
Value default	512 MiB
Value recommendation	512-4096 MiB
Location	`/etc/rhn/rhn.conf`
Example	`rhn-search.java.maxmemory = 4096`
After changing	Check memory usage.

3.5.3.21. `shared_buffers`

Description	The amount of memory reserved for PostgreSQL shared buffers, which contain caches of database tables and index data.

Tune when	RAM changes
Value default	25% of total RAM
Value recommendation	25-40% of total RAM
Location	`/var/lib/pgsql/data/postgresql.conf`
Example	`shared_buffers = 8192MB`
After changing	Check memory usage.
More information	https://www.postgresql.org/docs/15/runtime-config-resource.html#GUC-SHARED-BUFFERS

3.5.3.22. `max_connections`

Description	Maximum number of PostgreSQL connections available to applications. More connections allow for more concurrent threads/workers in various components (in particular Tomcat and Taskomatic), which generally improves performance. However, each connection consumes resources, in particular `work_mem` megabytes per sort operation per connection.
Tune when	`hibernate.c3p0.max_size` changes significantly, as that parameter determines the maximum number of connections available to Tomcat and Taskomatic
Value default	400
Value recommendation	Depends on other settings, use `/usr/lib/susemanager/bin/susemanager-connection-check` to obtain a recommendation.
Location	`/var/lib/pgsql/data/postgresql.conf`
Example	`max_connections = 250`
After changing	Check memory usage. Monitor memory usage closely before and after the change.
More information	https://www.postgresql.org/docs/15/runtime-config-connection.html#GUC-MAX-CONNECTIONS

3.5.3.23. `work_mem`

Description	The amount of memory allocated by PostgreSQL every time a connection needs to do a sort or hash operation. Every connection (as specified by `max_connections`) might make use of an amount of memory equal to a multiple of `work_mem`.
Tune when	Database operations are slow because of excessive temporary file disk I/O. To test if that is happening, add `log_temp_files = 5120` to `/var/lib/pgsql/data/postgresql.conf`, restart PostgreSQL, and monitor the PostgreSQL log files. If you see lines containing `LOG: temporary file:` try raising this parameter's value to help reduce disk I/O and speed up database operations.
Value recommendation	2-20 MB
Location	`/var/lib/pgsql/data/postgresql.conf`
Example	`work_mem = 10MB`
After changing	check if the Uyuni Server might need additional RAM.
More information	https://www.postgresql.org/docs/15/runtime-config-resource.html#GUC-WORK-MEM

3.5.3.24. `effective_cache_size`

Description	Estimation of the total memory available to PostgreSQL for caching. It is the explicitly reserved memory (`shared_buffers`) plus any memory used by the kernel as cache/buffer.
Tune when	Hardware RAM or memory usage increase significantly
Value recommendation	Start with 75% of total RAM. For finer settings, use `shared_buffers` + free memory + buffer/cache memory. Free and buffer/cache can be determined via the `free -m` command (`free` and `buff/cache` in the output respectively)
Location	`/var/lib/pgsql/data/postgresql.conf`

Example	`effective_cache_size = 24GB`
After changing	Check memory usage
Notes	This is an estimation for the query planner, not an allocation.
More information	https://www.postgresql.org/docs/15/runtime-config-query.html#GUC-EFFECTIVE-CACHE-SIZE

3.5.3.25. `thread_pool`

Description	The number of worker threads serving Salt API HTTP requests. A higher number can improve parallelism of Uyuni Server-initiated Salt operations, but will consume more memory.
Tune when	`java.message_queue_thread_pool_size` or `org.quartz.threadPool.threadCount` are changed. Starvation can occur when there are more Tomcat or Taskomatic threads making simultaneous Salt API calls than there are Salt API worker threads.
Value default	100
Value recommendation	100-500, but should be higher than the sum of `java.message_queue_thread_pool_size` and `org.quartz.threadPool.threadCount`
Location	`/etc/salt/master.d/susemanager.conf`, in the `rest_cherrypy` section.
Example	`thread_pool: 100`
After changing	Check `worker_threads` for adjustment.
More information	https://docs.saltproject.io/en/latest/ref/netapi/all/salt.netapi.rest_cherrypy.html#performance-tuning

3.5.3.26. `worker_threads`

Description	The number of `salt-master` worker threads that process commands and replies from minions and the Salt API. Increasing this value, assuming sufficient resources are available, allows Salt to process more data in parallel from minions without timing out, but will consume significantly more RAM (typically about 70 MiB per thread). Setting this value to very high values could cause opposite effect as the workers will compete to each other for the CPU resources and the performance could be dropped significantly.
Tune when	Client count increases significantly, `thread_pool` increases significantly, or `SaltReqTimeoutError` or `Message timed out` errors appear in `/var/log/salt/master` could be a sign of too low or too high value of this parameter.
Value default	8
Value recommendation	8-32, depending on the number of the CPU cores available for the server, it is recommended to keep the value slightly less than the number of CPU cores.
Location	`/etc/salt/master.d/tuning.conf`
Example	`worker_threads: 16`
After changing	Check memory usage. Monitor memory usage closely before and after the change. It makes sense to monitor the `salt-master` stats event by enabling `master_stats` and adjusting `master_stats_event_iter` to fine tune the value of this parameter.
More information	https://docs.saltproject.io/en/latest/ref/configuration/master.html#worker-threads

3.5.3.27. `auth_events`

Description	Determines whether the master will fire authentication events. Authentication events are fired when a minion performs an authentication check with the master. It helps to reduce the number of events published with the Salt Master Event Publisher and reduce the workload on Event Publisher subscribers.
Tune when	Large amount of `salt/auth` events published in the Salt event bus, which in most cases are useless for the subscribers.
Value default	True
Value recommendation	False
Location	`/etc/salt/master.d/tuning.conf`
Example	`auth_events: False`
More information	https://docs.saltproject.io/en/latest/ref/configuration/master.html#auth-events

3.5.3.28. `minion_data_cache_events`

Description	Determines whether the master will fire minion data cache events (`minion/refresh/*`). Minion data cache events are fired when a minion requests a minion data cache refresh. It helps to reduce the number of events published with the Salt Master Event Publisher and reduce the workload on Event Publisher subscribers.
Tune when	Large amount of `minion/refresh/*` events published in the Salt event bus, which in most cases are useless for the subscribers.
Value default	True
Value recommendation	False
Location	`/etc/salt/master.d/tuning.conf`
Example	`minion_data_cache_events: False`
More information	https://docs.saltproject.io/en/latest/ref/configuration/master.html#minion-data-cache-events

3.5.3.29. pub_hwm

Description	The maximum number of outstanding messages sent by `salt-master`. If more than this number of messages need to be sent concurrently, communication with clients slows down, potentially resulting in timeout errors during load peaks.
Tune when	Client count increases significantly and `Salt request timed out. The master is not responding.` errors appear when pinging minions during a load peak.
Value default	1000
Value recommendation	10000-100000
Location	`/etc/salt/master.d/tuning.conf`
Example	`pub_hwm: 10000`
More information	https://docs.saltproject.io/en/latest/ref/configuration/master.html#pub-hwm, https://zeromq.org/socket-api/#high-water-mark

3.5.3.30. zmq_backlog

Description	The maximum number of allowed client connections that have started but not concluded the opening process. If more than this number of clients connects in a very short time frame, connections are dropped and clients experience a delay re-connecting.
Tune when	Client count increases significantly and very many clients reconnect in a short time frame, TCP connections to the `salt-master` process get dropped by the kernel.
Value default	1000
Value recommendation	1000-5000
Location	`/etc/salt/master.d/tuning.conf`
Example	`zmq_backlog: 2000`

More information	https://docs.saltproject.io/en/latest/ref/configuration/master.html#zmq-backlog, http://api.zeromq.org/3-0:zmq-getsockopt (`ZMQ_BACKLOG`)

3.5.3.31. `swappiness`

Description	How aggressively the kernel moves unused data from memory to the swap partition. Setting a lower parameter typically reduces swap usage and results in better performance, especially when RAM memory is abundant.
Tune when	RAM increases, or swap is used when RAM memory is sufficient.
Value default	60
Value recommendation	1-60. For 128 GB of RAM, 10 is expected to give good results.
Location	`/etc/sysctl.conf`
Example	`vm.swappiness = 20`
More information	https://documentation.suse.com/sles/15-SP6/html/SLES-all/cha-tuning-memory.html#cha-tuning-memory-vm

3.5.3.32. `wait_for_backend`

Description	Determines whether the `salt-broker` service should wait for backend sockets to be connected before opening the sockets for listening for connections from `salt-minions`. When enabled, it helps to prevent collecting ZeroMQ messages with the internal buffers of the sockets and pushing them to the `salt-master` once connection is restored.
Tune when	Unstable connectivity between the Uyuni Proxy and the Uyuni Server.
Value default	False
Value recommendation	True
Location	`/etc/salt/broker`

Example	`wait_for_backend: True`
More information	Proxies Connectivity

3.5.3.33. `tcp_keepalive`

Description	The tcp keepalive interval to set on TCP ports. This setting can be used to tune Salt connectivity issues in messy network environments with misbehaving firewalls.
Tune when	Unstable connectivity between managed clients and the Uyuni Proxy or the Uyuni Server.
Value default	True
Value recommendation	True
Location	`/etc/venv-salt-minon/minion.d/tuning.conf` or `/etc/salt/minion.d/tuning.conf`, depending on the minion type.
Example	`tcp_keepalive: True`
After changing	Check Minions Connectivity for more details to fine tune extra keepalive parameters.
More information	https://docs.saltproject.io/en/latest/ref/configuration/minion.html#tcp-keepalive, Minions Connectivity

3.5.4. Memory Usage

Adjusting some of the parameters listed in this section can result in a higher amount of RAM being used by various components. It is important that the amount of hardware RAM is adequate after any significant change.

To determine how RAM is being used, you will need to check each process that consumes it.

Operating system

Stop all Uyuni services and inspect the output of `free -h`.

Java-based components

This includes Taskomatic, Tomcat, and `rhn-search`. These services support a configurable memory cap.

The Uyuni Server

Depends on many factors and can only be estimated. Measure PostgreSQL reserved memory by checking `shared_buffers`, permanently. You can also multiply `work_mem` and `max_connections`, and multiply by three for a worst case estimate of per-query RAM. You will also need to check the operating system buffers and caches, which are used by PostgreSQL to host copies of database data. These often automatically occupy any available RAM.

It is important that the Uyuni Server has sufficient RAM to accommodate all of these processes, especially OS buffers and caches, to have reasonable PostgreSQL performance. We recommend you keep several gigabytes available at all times, and add more as the database size on disk increases.

Whenever the expected amount of memory available for OS buffers and caches changes, update the `effective_cache_size` parameter to have PostgreSQL use it correctly. You can calculate the total available by finding the total RAM available, less the expected memory usage.

To get a live breakdown of the memory used by services on the Uyuni Server, use this command:

```
pidstat -p ALL -r --human 1 60 | tee pidstat-memory.log
```

This command will save a copy of displayed data in the `pidstat-memory.log` file for later analysis.

3.6. Monitoring Large Scale Deployments

You can monitor your Uyuni environment using Prometheus and Grafana. Uyuni Server and Proxy are able to provide self-health metrics. You can also install and manage a number of Prometheus exporters on clients.

Prometheus and Grafana packages are included in the Uyuni Client Tools for SUSE Linux Enterprise 12, SUSE Linux Enterprise 15, CentOS 7, CentOS 8 and openSUSE 15.x.

You need to install Prometheus and Grafana on a machine separate from the Uyuni Server. We recommend you use a managed client as your monitoring server.

It is recommended to monitor the Salt event bus in the large scale deployments with Saline to identify possible bottlenecks.

For more information on monitoring, see **Administration › Monitoring**.

Chapter 4. Quick Start: SAP Overview

This guide shows you how to use Uyuni to install and configure an SAP cluster. It guides you through setting up a single Uyuni Server, preparing your client systems, and configuring the cluster using formulas.

- For more information about SAP, see the SAP documentation at https://documentation.suse.com/sles-sap.
- For more information about Uyuni, see the Uyuni documentation at https://documentation.suse.com/MLM.

4.1. Prepare Server

Before you start you need to deploy the Uyuni Server. The method for deploying the Uyuni Server varies depending on your hardware and environment.

Uyuni is deployed using the `mgradm` command. During the deployment process, when you are prompted for which product to install, select Uyuni Server. For more information about deploying the Uyuni Server, see **Installation-and-upgrade › Container-deployment**.

You need to do some configuration to set up the Uyuni Web UI. In your browser, navigate to the URL of the server, and configure your administration access to the Web UI.

Now you can use the Web UI to prepare software channels and activation keys for your clients.

On the Uyuni Server, add the appropriate SAP channels: From the Web UI, add `SUSE Linux Enterprise Server 15 for SAP`.

Synchronize the Uyuni Server with the SUSE Customer Center. You can do this using the Web UI. Add the new channel to your activation key.

To check if a channel has finished synchronizing navigate to **Admin › Setup Wizard** and select the `Products` tab. This dialog displays a completion bar for each product when they are being synchronized.

Software channels can be very large. The initial channel synchronization can sometimes take up to several hours.

When the initial synchronization is complete, we recommended you clone the channel before you work with it. This gives you a backup of the original synchronization data.

4.2. Preparing Clients

Your SAP cluster requires several client systems. Prepare your clients on physical or virtual hardware, and ensure you have SUSE Linux Enterprise Server 15 for SAP installation media ready. You cannot create an SAP cluster without the SUSE Linux Enterprise Server SAP extension, as it provides tooling specific to SAP.

One of the key features of SAP is high availability of the cluster. Every component within an SAP cluster has redundancy and failover protection. When you are preparing your clients, ensure you have enough hardware and infrastructure to allow for this. For more information about hardware requirements, see https://documentation.suse.com/sles-sap/15-SP4/html/SLES-SAP-installation/cha-plan.html#sec-hardware

For more information about the clients you need to set up for an SAP cluster, see https://documentation.suse.com/sbp/all.

4.2.1. Register Clients to the SUSE Customer Center

Each client within your SAP cluster must be registered with the SUSE Customer Center. To obtain your registration code, navigate to https://scc.suse.com/login in your web browser. Log in to your SCC account, or follow the prompts to create a new account. Click the Subscriptions tab to see the registration code. When you install SUSE Linux Enterprise Server 15 for SAP the Unified Installer prompts you for the code.

For more information about registering Uyuni with SUSE Customer Center, see **Installation-and-upgrade › General-requirements**.

4.2.2. Configure the Clients for Clustering

Every client system must have all the other client systems listed in their `/etc/hosts` file. Open the `/etc/hosts` file on each client, and add the hostname for each of the other clients.

4.2.3. Create a Shared Storage Device

Each of the clients needs to be able to access a shared disk. The shared disk can be physical hardware connected by ethernet, or you can set up a virtual disk and access it with iSCSI.

If you use a virtual disk, consider hosting it on a separate system. Do not use a client machine to host the shared storage disk.

4.2.4. Download the SAP Installation Software

Download the SAP installation media and save a copy on each client. The software that you require differs depending on your environment. For example, if you are using HANA, you need the SAP HANA platform. If you are using Netweaver, you need different packages. These software packages are provided by SAP, not by SUSE.

Ensure you have saved the installation software in the same file system location on each client. Alternatively, save it to a shared NFS drive.

4.2.5. Configure Clients to Use Latest `module.run`

Each client needs to be configured to use the latest version of `module.run`. On each of the client machines, open the `/etc/salt/minion` configuration file and add or edit this line:

```
use_superseded:
  - module.run
```

Restart the `salt-minion` process to enable the changes:

```
systemctl restart salt-minion
```

4.2.6. Install Additional Disks for HANA

For the clients that are going to run the HANA database, you require an additional storage device. This device is used to store files required by HANA, which are located in the `/hana/` directory.

We recommend that this storage device be at least 20 GB. For some installations, you might require more, and it is possible to use multiple disks to provide this storage. For comprehensive hardware requirements, see https://documentation.suse.com/sbp/all.

4.2.7. Register Clients to the Server

First of all, make sure you have an activation key that is associated with the `SLE-Product-SLES_SAP15` base channel. For more information about activation keys, see **Client-configuration › Activation-keys**.

In the Uyuni Web UI, navigate to **Systems › Bootstrapping**. Fill in the appropriate details, and make sure you check the `Manage System Completely via SSH` checkbox. In the `Activation Key` field, select the SLES for SAP activation key.

For more information about registering, see **Client-configuration › Registration-webui**.

4.3. Configure Clients

Uyuni uses formulas with forms to configure your SAP clients. There are two formulas that you need to use:

- `Hana` to configure the HANA database
- `Cluster` to configure the clients into a cluster

The formulas are provided by packages that you can download with your package manager. You need to install the formulas on the Uyuni Server. When you have installed the package, you can use the Uyuni Web UI to enable and configure the formulas. As you go through the formula configuration process, provide details of the clients that contain your SAP cluster, to set them up appropriately.

To install the formulas on the Uyuni Server, use your package manager to install these packages:

- `saphanabootstrap-formula`

- `sapnwbootstrap-formula`
- `drbd-formula`
- `habootstrap-formula`
- `salt-shaptools`

The order that you enable and configure the formulas is important. You must enable, configure, and apply the HANA formula first. Then you can enable, configure, and apply the cluster formula. If you perform these steps in the wrong order, your SAP installation fails.

4.3.1. Enable and Configure the HANA Formula

In the Uyuni Web UI, navigate to **Systems › System List** and click the client to use as the primary client in the cluster.

Navigate to the `Formulas` tab, locate the `Sap Hana Deployment` heading, and check the `Saphanabootstrap` formula in the list. Click `Save` and apply the highstate to activate the formula.

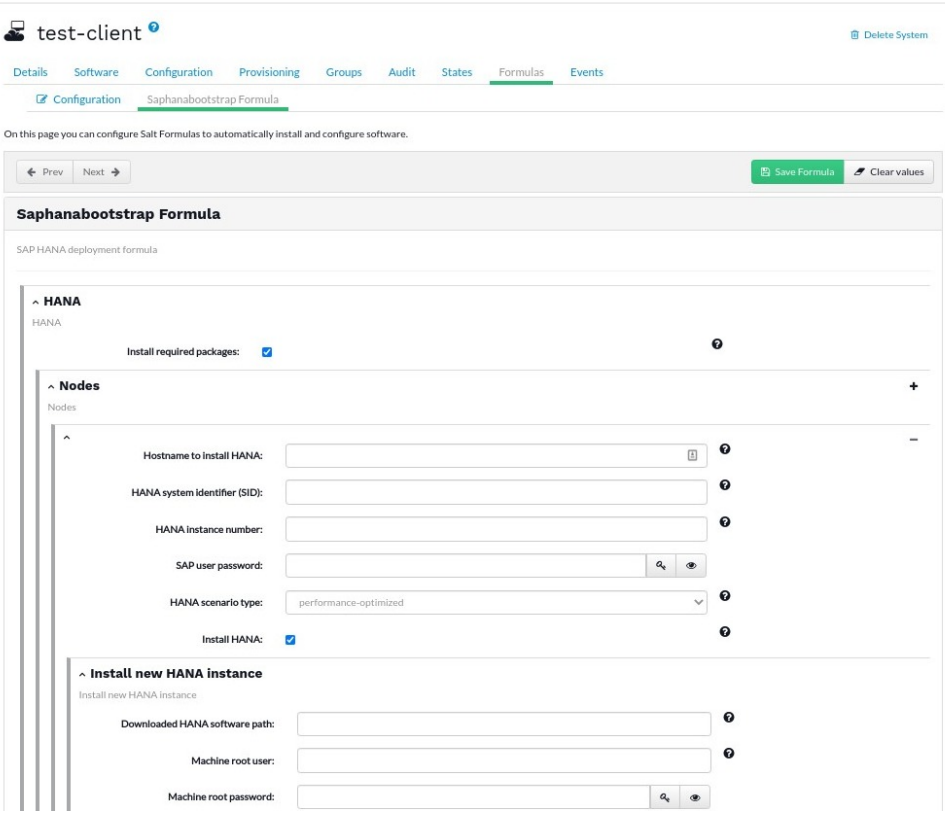
When the formula is activated, navigate to the **Formulas › Hana** tab, and complete the details in the form.

Make sure you check `Install required packages` to install everything you need on the client. In the `Nodes` sections, type the short hostname of the client to install the HANA database or the hostname you can retrieve on the command line with:

```
salt '<client-name>' grains.item host
```

Provide further details for the installation.

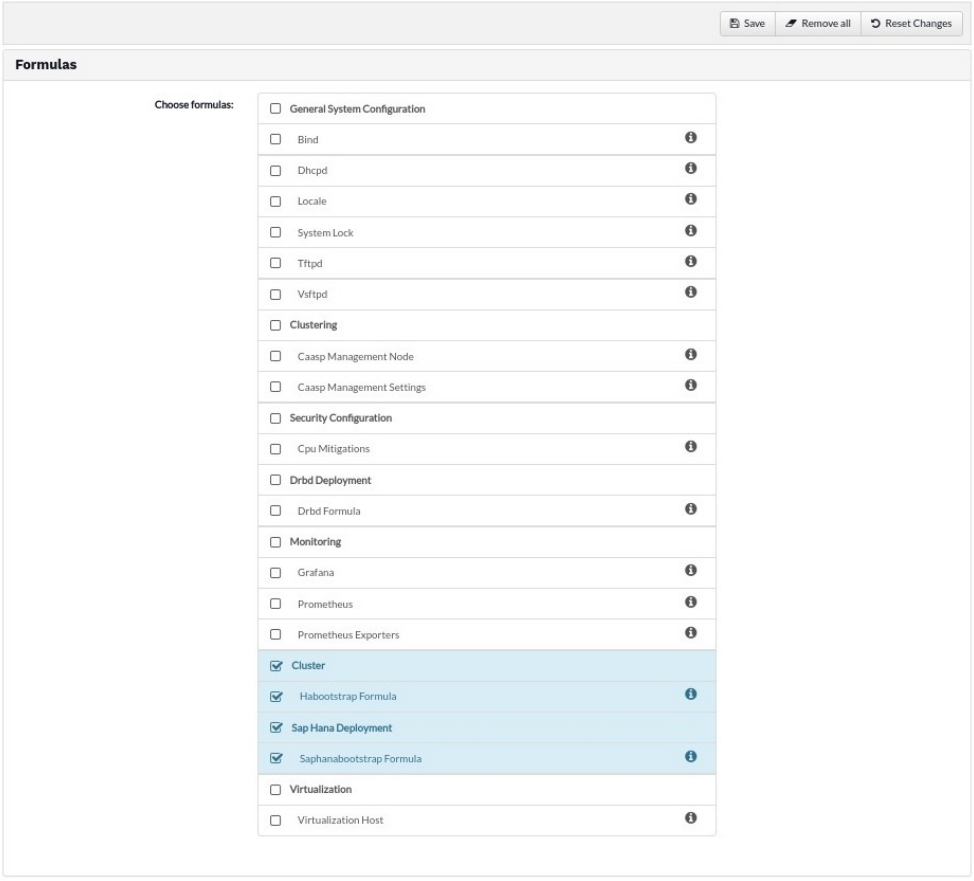
Complete the remaining details according to your environment, click `Save`, and apply the highstate. When the highstate is complete, you can go on to apply the cluster formula.



4.3.2. Enable and Configure the Cluster Formula

In the Uyuni Web UI, navigate to **Systems › System List** and click the client to use as the primary client in the cluster.

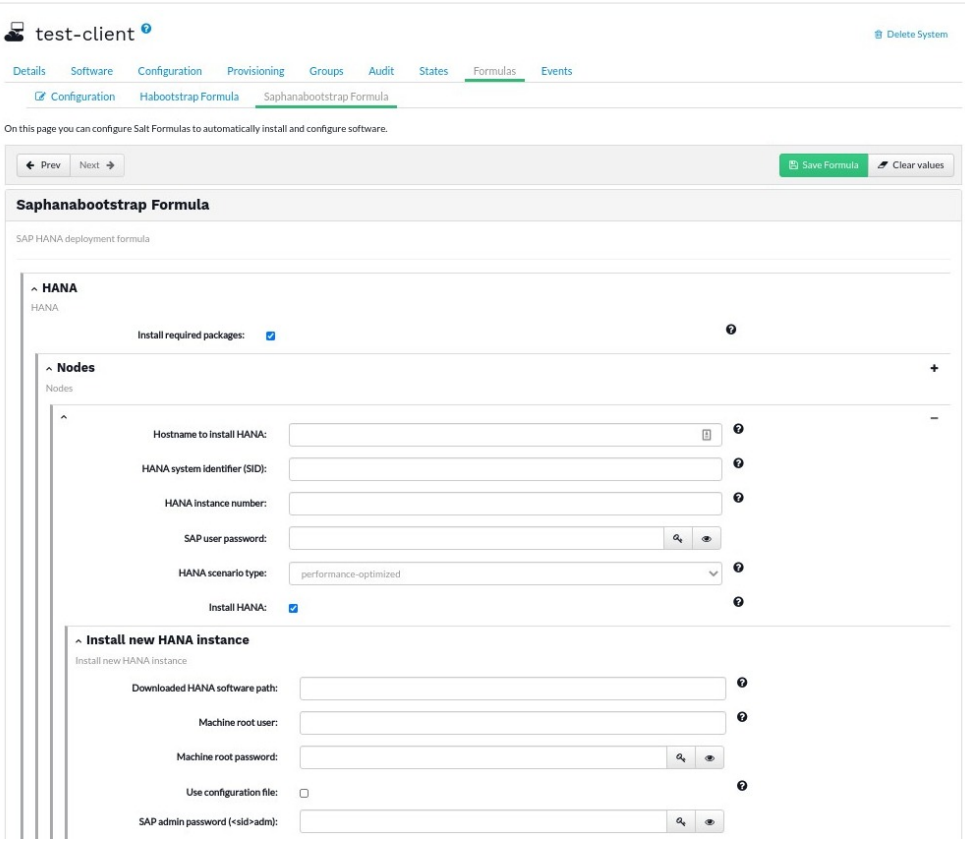
Navigate to the `Formulas` tab, locate the `Cluster` heading, and check the `Habootstrap` formula in the list. Click Save and apply the highstate to activate the formula.



When the formula is activated, navigate to the **Formulas › Cluster** tab, and complete the details in the form.

Make sure you check `Install required packages` to install everything you need on the client. Give your cluster a name, and specify the hostname of the primary client in the cluster.

Complete the remaining details according to your environment, click Save, and apply the highstate.


test-client
Delete System
Details
Software
Configuration
Provisioning
Groups
Audit
States
Formulas
Events
Configuration
Habootstrap Formula
Saphanabootstrap Formula
On this page you can configure Salt Formulas to automatically install and configure software.
Prev
Next
Save Formula
Clear values
Saphanabootstrap Formula
SAP HANA deployment formula
HANA
HANA
Install required packages:
Nodes
Nodes
Hostname to install HANA:
HANA system identifier (SID):
HANA instance number:
SAP user password:
HANA scenario type:
performance-optimized
Install HANA:
Install new HANA instance
Install new HANA instance
Downloaded HANA software path:
Machine root user:
Machine root password:
Use configuration file:
SAP admin password (<sid>adm):

Chapter 5. GNU Free Documentation License

0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document "free" in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondarily, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of "copyleft", which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The "Document", below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A "Modified Version" of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A "Secondary Section" is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document’s overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections

then there are none.

The "Cover Texts" are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A "Transparent" copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not "Transparent" is called "Opaque".

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The "Title Page" means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, "Title Page" means the text near the most prominent appearance of the work’s title, preceding the beginning of the body of the text.

A section "Entitled XYZ" means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as "Acknowledgements", "Dedications", "Endorsements", or "History".) To "Preserve the Title" of such a section when you modify the Document means that it remains a section "Entitled XYZ" according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.

B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.

C. State on the Title page the name of the publisher of the Modified Version, as the publisher.

D. Preserve all the copyright notices of the Document.

E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.

F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.

G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document’s license notice.

H. Include an unaltered copy of this License.

I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.

J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.

K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.

L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.

M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.

N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.

O. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version’s license notice. These titles must be distinct from any other section titles.

You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements".

6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an "aggregate" if the copyright resulting from the compilation is not used to limit the legal rights of the compilation's users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document's Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled "Acknowledgements", "Dedications", or "History", the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See http://www.gnu.org/copyleft/.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation.

ADDENDUM: How to use this License for your documents

```
Copyright (c) YEAR YOUR NAME.
   Permission is granted to copy, distribute and/or modify this document
   under the terms of the GNU Free Documentation License, Version 1.2
   or any later version published by the Free Software Foundation;
   with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts.
   A copy of the license is included in the section entitled "GNU
   Free Documentation License".
```