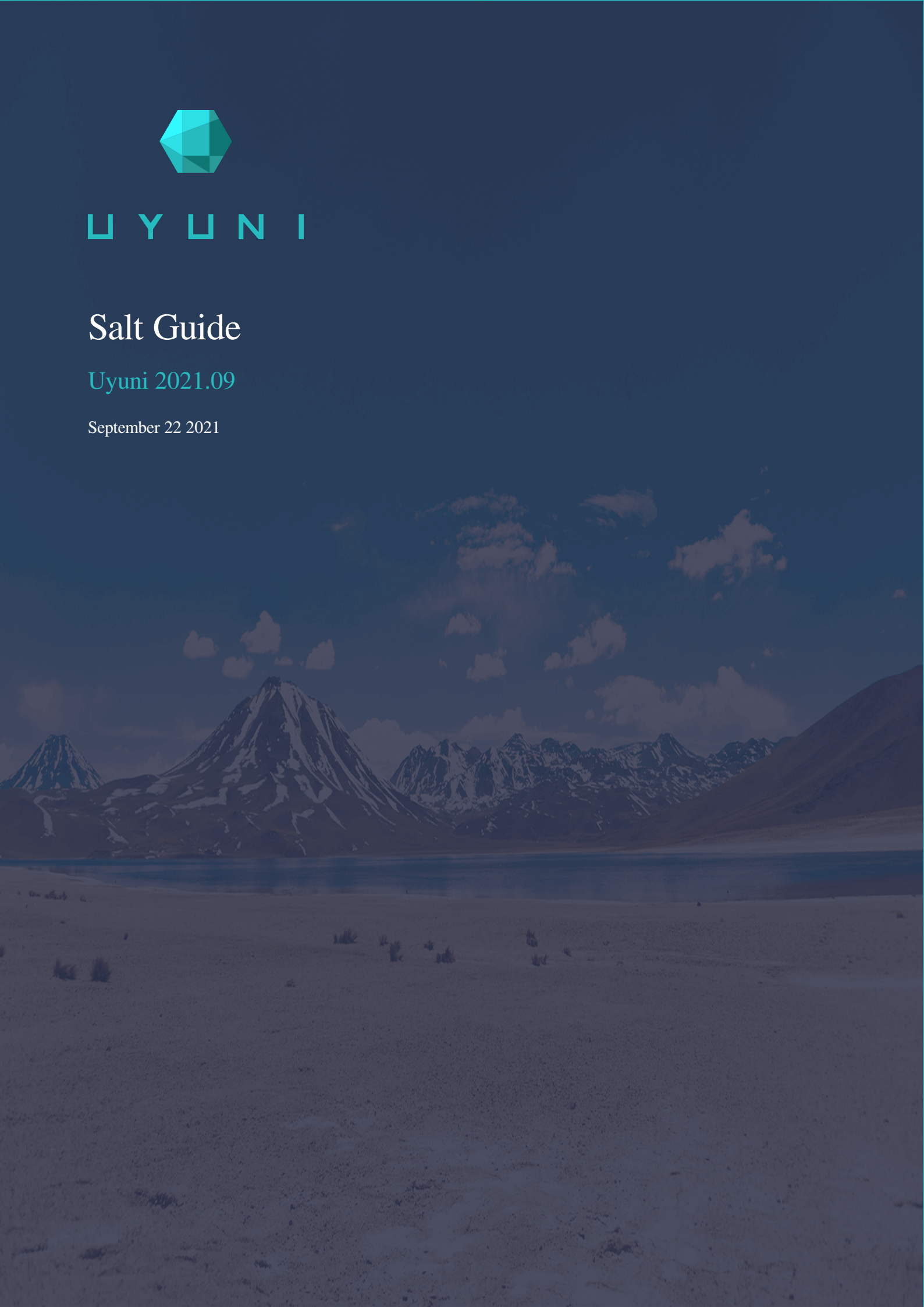

Salt Guide

Uyuni 2021.09

September 22 2021

Table of Contents

Salt Guide Overview

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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.saltstack.com/en/latest/contents.html.

The current version of Salt in Uyuni is 3002.

Throughout the Uyuni documentation, we use the term `Salt clients` to refer to Salt machines that are connected to and controlled by the Salt master on the Uyuni Server. This is to clearly differentiate them from traditional clients. In other documentation, and in some internal references, Salt clients are sometimes referred to as Salt `minions` instead. This is a difference in terminology only.

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.saltstack.com/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.saltstack.com/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 **[Salt › Formulas-intro ›]**.

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. Salt modules are stored on clients and the Uyuni Server within the `/usr/lib/python*/site-packages/salt/` directory.

For more information on grains, see https://docs.saltstack.com/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 referred to as Salt clients, in order to clearly differentiate them from traditional clients. This is a difference in terminology only.

Modules

Functions within Salt are stored in modules. There are many types of Salt modules, including state and execution modules. For a complete list of available Salt modules, see https://docs.saltstack.com/en/latest/ref/index.html. Alternatively, you can write your own Salt modules using Python.

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.saltstack.com/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.saltstack.com/en/latest/topics/tutorials/starting_states.html.

For more Salt terminology, see https://docs.saltstack.com/en/latest/glossary.html.

The 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.

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.saltstack.com/en/latest/topics/targeting/.

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.saltstack.com/en/latest/ref/modules/all/index.html.

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"}'
```

Often Used Salt Commands

This section contains the most commonly used Salt commands. For a complete list of available Salt commands, see https://docs.saltstack.com/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
```

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 **[Salt › Custom-states ›]**.

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
```

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.

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/.

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 %}
```

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.

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 btn:`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.

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
```

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 SUSE public keys are also 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.

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
```

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 salt-gitfs.pdf.

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.saltstack.com/en/latest/topics/tutorials/gitfs.html
- https://docs.saltstack.com/en/latest/ref/configuration/master.html

Install with 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.

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 **[Salt › Formula-yomi ›]**

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 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.

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 `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
```

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 **[Salt › Formula-yomi ›]**.

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

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.

Configuration Modules

This feature is a technology preview.

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 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 **[Large-deployments › Multi-server ›]**.

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.saltstack.com/en/latest/topics/tutorials/modules.html.

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

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/`.

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 **[Salt › Formulas-custom ›]**.

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 **[Salt › Formulas-custom ›]**.

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>
```

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.

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 resolve saltboot 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`.

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.

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.

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 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 Manager Web UI.

Procedure: Setting Up a Branch Server with a Dedicated LAN

1. In the SUSE 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.

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 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 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 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.

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 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 ›]**.

DHCPd Formula

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

Procedure: Configuring DHCP

1. In the SUSE 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.

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 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`.

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** ›].

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.
   - In the `Default admin user` field, type the name of the default Grafana user.
   - In the `Default admin password` field, enter a password for the default user. Alternatively, click **[Generate new password]** to generate a password and fill the field.
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.

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 ›]**.

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.

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 ›]**.

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

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

PXE Formula

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

Procedure: Configuring PXE Booting

1. In the SUSE 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.

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.

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.

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.

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.

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.

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.

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.

For more information on troubleshooting problems with the Saltboot formula, see **[Administration › Tshoot-saltboot ›]**.

TFTPD Formula

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

Procedure: Configuring TFTP

1. In the SUSE 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.

VsFTPd Formula

The VsFTPd formula is used to configure the FTP service on the branch server.

Procedure: Configuring VsFTPd

1. In the SUSE Manager Web UI, open the details page for the branch server, and navigate to the `Formulas` tab.
2. Select the `Vsftpd` formula, and click **`[Save]`**.
3. Navigate to the **Formulas › Vsftpd** tab, and set these parameters:
   - In the `FTP server directory` field, enter `/srv/saltboot`.
   - In the `Internal Network Address` field, enter the IP address of the branch server (for example: `192.168.1.5`).
   - All other fields can retain their default values.
4. Click **`[Save Formula]`** to save your configuration.
5. Apply the highstate.

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 **[Salt › Yomi ›]**.

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 **[Salt › Yomi ›]**.

Custom Salt Formulas

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

For information about the formulas provided by Uyuni, see **[Salt › Formulas-suma ›]**.

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/salt-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 directoy also contains an optional `metadata.yml` file that contains additional information about a 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.

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

  yet_another_group:
    $type: group

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

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}"
```

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:

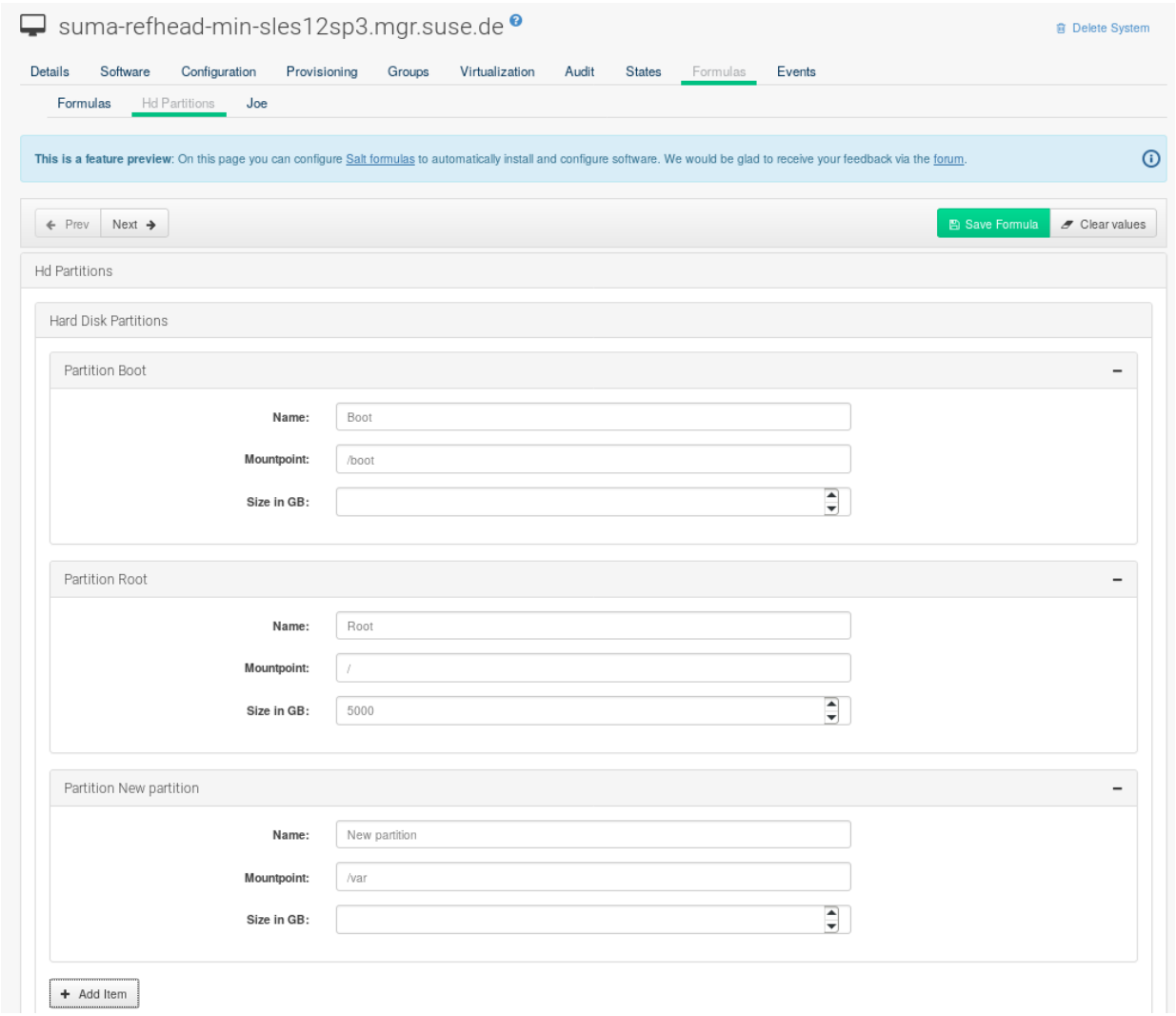
```
some_group:
  $type: group

  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"
```

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 }}
```

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.saltstack.com/en/latest/topics/development/conventions/formulas.html.

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/suma_minion.py
```

The process is executed like this:

1. The `suma_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 (`suma_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`.

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.saltstack.com/en/latest/topics/ssh/.

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.

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 by generating a temporary roster file for each Salt SSH call. The location of the temporary roster file is supplied to `salt-ssh` using the `--roster-file= option`.

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. 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.

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
```

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://suma-server:1233/repourl...
```

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

```
127.0.0.1       localhost    suma-server
```

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

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

This means that the package manager will actually connect to `localhost:1233`, which is then forwarded to `suma-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.

Call Sequence

Salt SSH calls run in this sequence:

1. Prepare the Salt roster 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
3. Execute a synchronous `salt-ssh` call using the API
4. Remove the temporary roster file

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`

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 generate the roster using the Salt API, with this command:

```
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

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

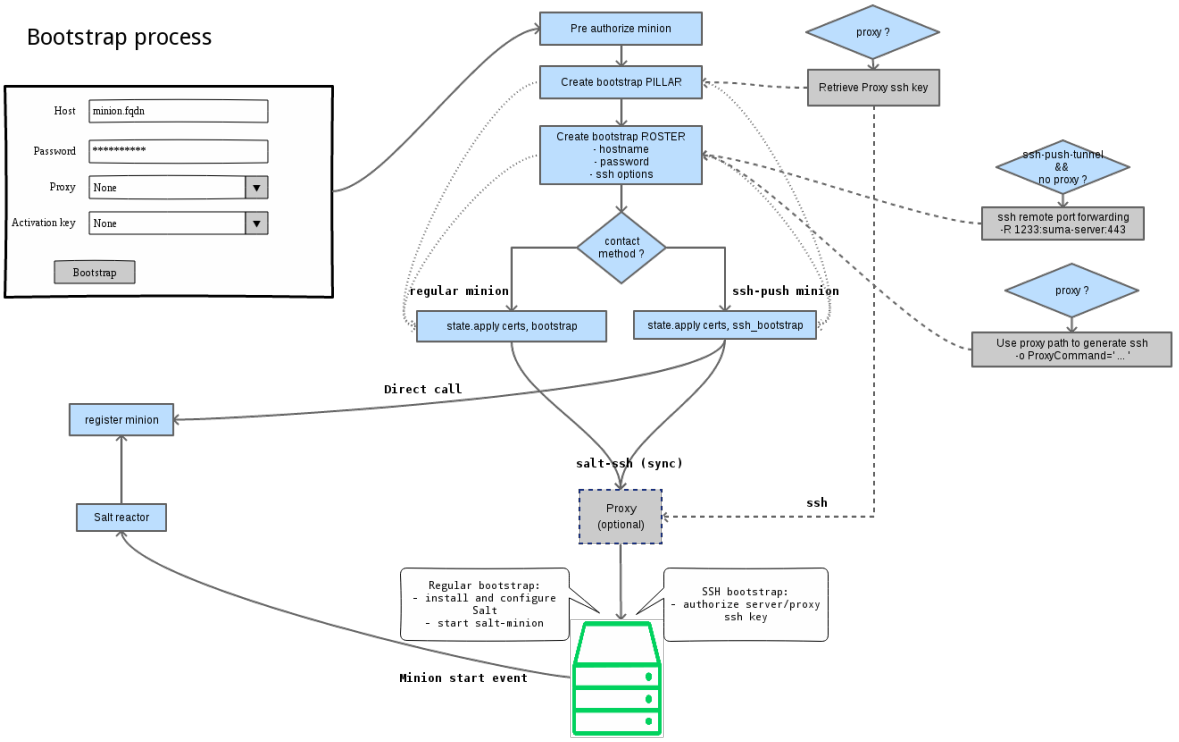
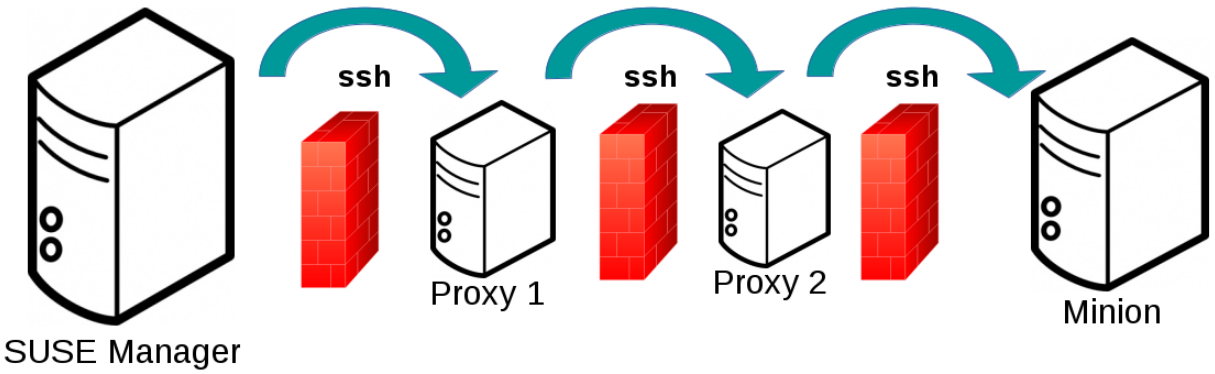


Figure 1. Salt SSH Bootstrap Process

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.

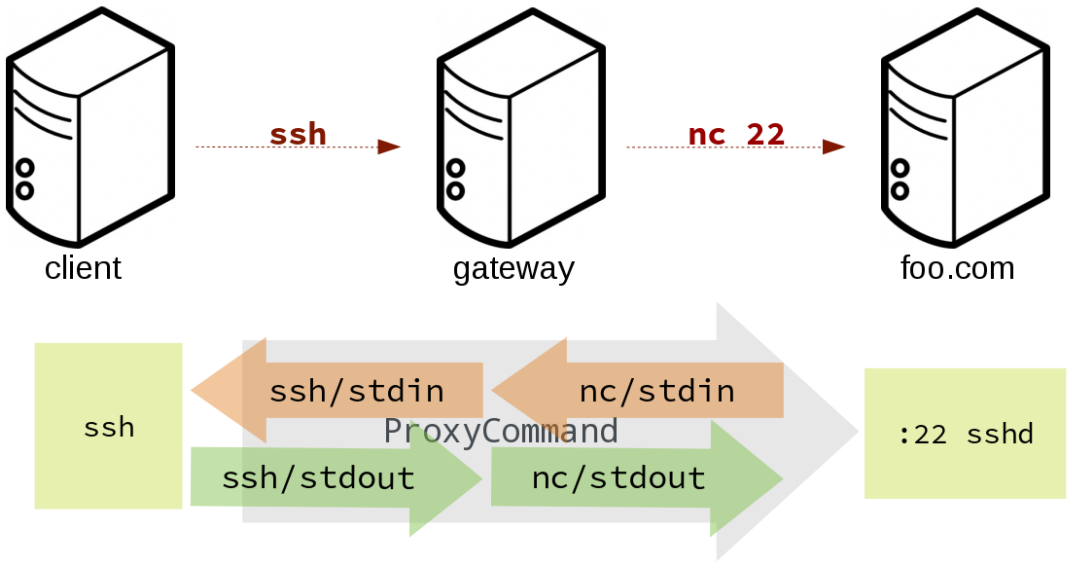


Uyuni uses `ProxyCommand` to redirect SSH connections through proxies. This options invokes an arbitrary command that is expected to connect to the SSH port on the target host. The SSH process uses standard input and output of the command to communicate with the remote SSH daemon.

`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
```



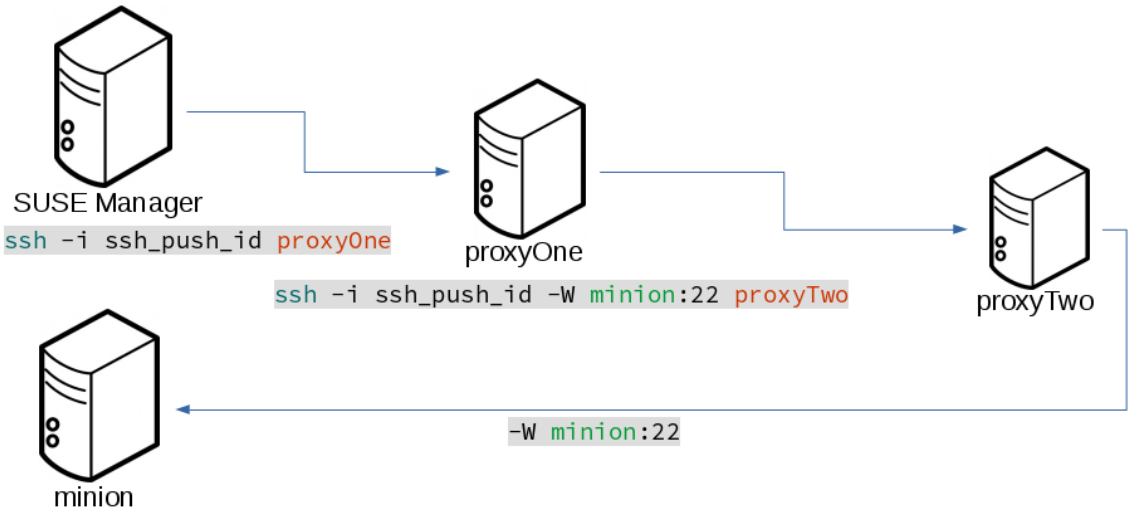
The Salt SSH calls run in this sequence when a proxy is in use:

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:

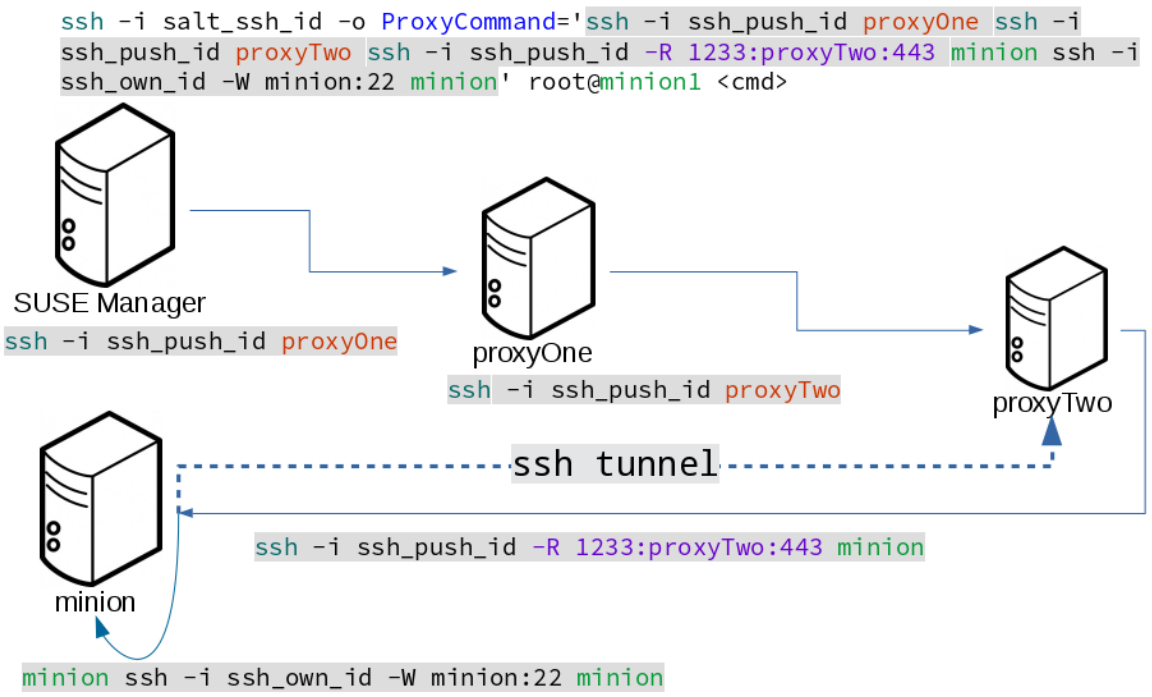
```
# Connect the server to the first proxy:
/usr/bin/ssh -i /srv/susemanager/salt/salt_ssh/mgr_ssh_id -o StrictHostKeyChecking=no -o
User=mgrsshtunnel  proxy1

# 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
```

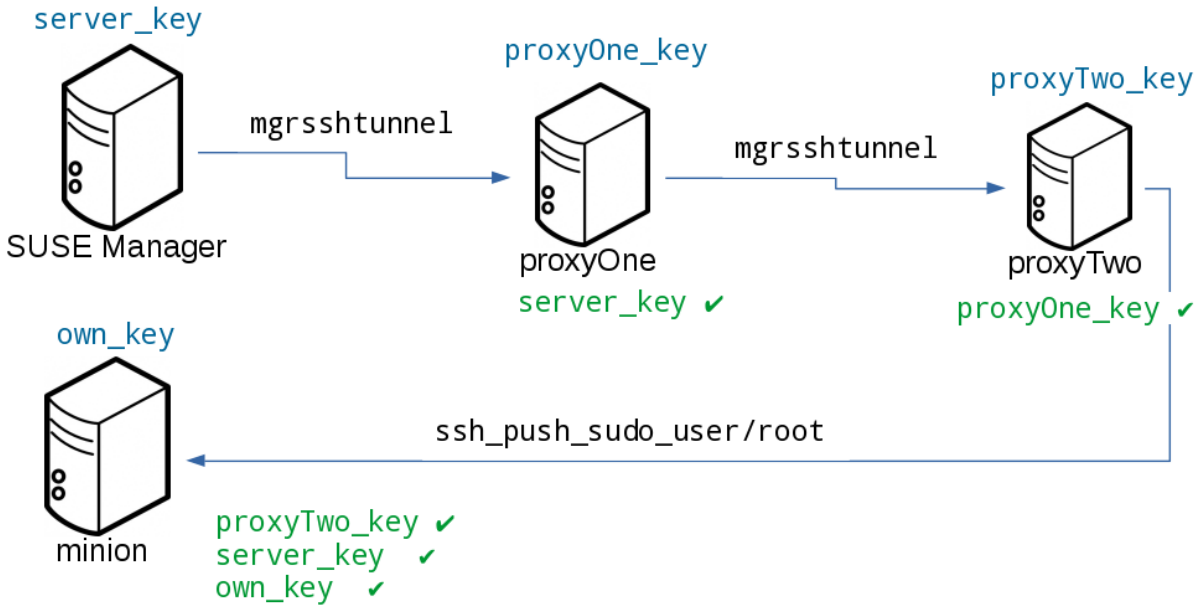


Users and SSH Key Management

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.

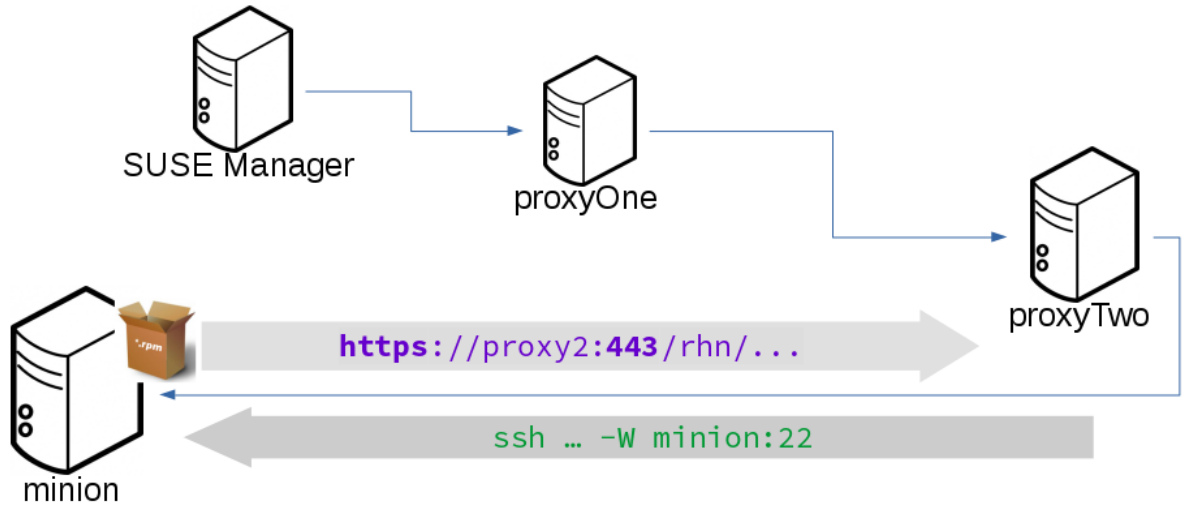


Repository Access with a Proxy

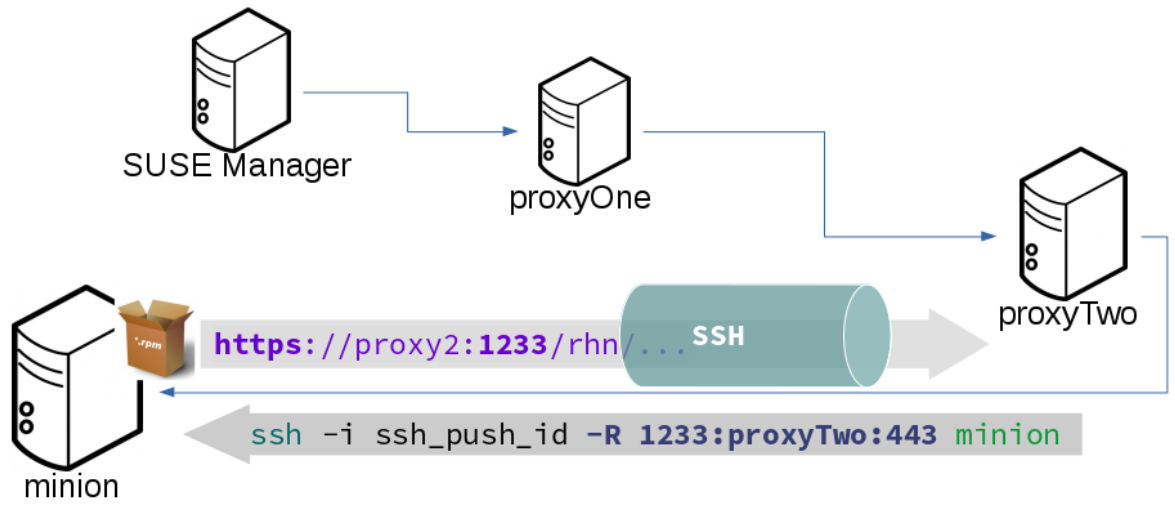
When Uyuni connects to a repository using a proxy, it can use either `ssh-push` or `ssh-push-tunnel`.

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.



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.

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.

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.

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`.

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 **[Large-deployments › Large-deployments-overview ›]**.

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