



# Salt Guide

SUSE Manager 4.0

August 29, 2019



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# Introduction

Salt is a configuration management system used by SUSE Manager to manage clients.

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

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

For more information about Salt, see the Salt documentation at <https://docs.saltstack.com/en/latest/contents.html>.

The current version of Salt in SUSE Manager is 2019.2.0.



Throughout the SUSE Manager documentation, we use the term **Salt clients** to refer to Salt machines that are connected to and controlled by the Salt master on the SUSE Manager 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

## 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 SUSE Manager Server within the `/usr/lib/python2.7/site-packages/salt/` directory.

List all available grains with the `grains.ls` function:

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

You can also use `grains.ls` to list collected grain system data:

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

For more information on grains, see <https://docs.saltstack.com/en/latest/topics/grains/>.

## 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 written, and then applied to the target systems. This automates the process of bringing a large number of systems into a known state, and then maintaining them.

For more information on states, see [https://docs.saltstack.com/en/latest/topics/tutorials/starting\\_states.html](https://docs.saltstack.com/en/latest/topics/tutorials/starting_states.html).



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

## Pillar

Pillars are created on the SUSE Manager 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>.

---

## Beacons

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 Salt 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>.

## Environments

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

## Salt Calls

Salt calls 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 Call Targets

Salt call 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 Call Functions

When you have specified a target, provide the function to call on the target.

Find which functions can be called on the target:

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

For a full list of callable functions, see <https://docs.saltstack.com/en/latest/ref/modules/all/index.html>.

## Salt Call 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"}'
```

---

# Salt Commands

This section contains the most 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 SUSE Manager 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
```

## **salt-key -A**

Accept all pending keys:

```
salt-key -A
```



# Salt 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. 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 SUSE Manager in the form of package and custom states.

For more information on states, see [https://docs.saltstack.com/en/latest/topics/tutorials/starting\\_states.html](https://docs.saltstack.com/en/latest/topics/tutorials/starting_states.html).

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)

Custom user-created states can be made with SUSE Manager. All user-created Salt state (SLS) files are saved on the SUSE Manager Server, in the `/srv/susemanager/salt/` directory. Within that directory, each organization has a sub-directory.

*Listing 1. Example: SLS File Directory Structure*

```
├── manager_org_DEVEL
│   ├── 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 ...
```

## Salt Pillars

SUSE Manager exposes a small amount of internal data as pillars which can be used with custom states. Pillars are created on the SUSE Manager Server, and contain information about a client or group of clients. Pillars are useful for sensitive data, configuration of clients, variables, and any arbitrary data.

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

For more information on pillars, see <https://docs.saltstack.com/en/latest/topics/tutorials/pillar.html>.

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
```

## 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
```

In these examples we will 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
```

By default, SUSE Manager assumes that the download endpoint to use is the FQDN of the SUSE Manager 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 SUSE Manager Server (or Proxy, if in use). \* `pkg_download_point_port`, defaults to `443`.

If you do not adjust these pillars directly, SUSE Manager 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 %}
```

# Salt File Locations and Structure

This diagram shows the Salt file structure, as it is used by the SUSE Manager Server. The files are listed in the `/etc/salt/master.d/susemanager.conf` configuration file.

```
# Configure different file roots

file_roots:
  base:
    - /usr/share/susemanager/salt      #Should not be touched by a user
    - /srv/susemanager/salt           #Should not be touched by a user
    - /srv/salt                       #Your custom states go here

# Configure different pillar roots

pillar_roots:
  base:
    - /usr/share/susemanager/pillar   #Should not be touched by a user
    - /srv/pillar                     #Custom pillars go here

# Extension modules path

extension_modules: /usr/share/susemanager/modules

# Master top configuration

master_tops:
  mgr_master_tops: True
```

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 SUSE Manager Server reads Salt state data from three root directories:

## `/usr/share/susemanager/salt`

This directory is shipped and updated with SUSE Manager 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.

## `/srv/susemanager/salt`

This directory is generated by SUSE Manager, 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 SUSE Manager database.



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

## `/srv/salt`

This directory is used for custom state data, modules, and related data. SUSE Manager 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 SUSE Manager. Use this directory for custom Salt data.

The SUSE Manager Server reads Salt pillar data from two root directories:

### **/usr/share/susemanager/pillar**

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



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

### **/srv/pillar**

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

## Formulas

Formulas are collections of Salt States that have been pre-written by other Salt users and contain generic parameter fields. Formulas allow for reliable reproduction of a specific configuration. Formulas can be installed from RPM packages or an external git repository.

Formulas work best for large, non-trivial, configurations. For trivial tasks, use a state rather than a formula.

Formula data can be managed using the XMLRPC API.

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.

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>.

You can use the SUSE Manager Web UI to apply pre-existing SUSE Manager formulas. For more information on the standard formulas available, see [ **Salt** > **Salt-formulas-standard** > ].

Alternatively, you can write your own custom formulas. For more information on custom formulas, see [ **Salt** > **Salt-formulas-custom** > ].

## Standard Salt Formulas

You can see the currently available installed formulas in the SUSE Manager Web UI. Navigate to **Salt** > **Formula Catalog**.

Apply a formula by selecting the system or system group, and navigating to the **System Details** > **Formulas** tab. Select the formulas you want to apply, and click [ **Save** ]. An additional tab will become available in the top menu to edit the configuration of the formula.

When you have finished customizing your formula, you must apply the highstate for them to take effect. Applying the highstate executes the state associated with the formula and configures targeted systems. Click [ **Apply Highstate** ] on any formula page.

When a change to any of your values is required or you need to re-apply the formula state because of a failure or bug, change values located on your formula pages and re-apply the highstate. Salt will ensure that only modified values are adjusted and restart or reinstall services only when necessary.

For more information about Salt formulas, see <https://docs.saltstack.com/en/latest/topics/development/conventions/formulas.html>

For information about using Salt formulas in a SUSE Manager for Retail environment, see [ **Retail** > **Retail-formulas-intro** > ].

This section contains information on each of the standard, pre-installed formulas.

## Locale

The locale formula allows setting `Timezone`` and `[guimenu]Keyboard and Language``.

## Domain Name System (Bind)

With the bind formula you set up and configure a Domain Name System (DNS) server. For technical information about the bind formula and low-level pillar data, see the [README.rst](#) file on the SUSE Manager server: `/usr/share/salt-formulas/metadata/bind/README.rst`.

DNS is needed to resolve the domain names and host names into IP addresses. For more information about DNS, see the SLES Administration Guide, Services, The Domain Name System.

Figure 1. Bind Formula

In the `Config` group you can set arbitrary options such as `directory` where are the zone data files (usually `/var/lib/named/`) or `forwarders`. Click **Add Item** to provide more Key/Value fields for configuration.

Check `Include Forwarders` if you want to rely on an external DNS server if your DNS is down (or is otherwise not able to resolve an address).

At least, you will configure one zone. In `Configured Zones` define your zone; for example,



[example.com](#). Then in **Available Zones** configure this zone: as **Name** enter your zone (in this case [example.com](#)) and the **File** to which this configuration should be written ([example.com.txt](#)). Enter the mandatory **SOA** record (start of authority), and the A, NS, and CNAME **Records** you need.

On the other hand, if no **records** entry exists, the zone file is not generated by this state rather than taken from [salt://zones](#). For how to overwrite this URL, see [pillar.example](#).

← Prev   Next →   **Save Formula**   Clear values

### Configured Zones

Zone 1

**Name:**  ?

**Type:**

**Notify:** ☐

+ Add Item

### Available Zones

Zone 1

**Name:**  ?

**File:**

**SOA**

**NS:**

**Contact:**

Figure 2. *bind-02-zones*

← Prev

Next →

Save FormulaClear values

Available Zones

Zone 1

Name:

File:

SOA

NS:

ns@zone

Contact:

admin@domain

Serial:

auto

Class:

IN

Refresh:

8600

Retry:

900

Expiry:

86000

NXDOMAIN:

500

TTL:

8600

Figure 3. bind-03-records

Figure 4. *bind-03-records2*

In **Generate Reverse**, and define reverse mapping and for which zones:

Figure 5. *bind-04-reverse*

When saved, data is written to `/srv/susemanager/formula_data/pillar/<salt-client.example.com>_bind.json`.

If you apply the highstate (**System Details** > **States** > **Highstate**), it first ensures that **bind** and all required packages will get installed. Then it will start the DNS service (**named**).

## Dhcpd

With the `dhcpd` formula you set up and configure a DHCP server (Dynamic Host Configuration Protocol). For technical information about the `dhcpd` formula and low-level pillar data, see the Pillar example file `/usr/share/susemanager/formulas/metadata/dhcpd/pillar.example`.

DHCP is needed to define network settings centrally (on a server) and let clients retrieve and use this information for local host configuration. For more information about DHCP, see the SLES Administration Guide, Services, DHCP.

Figure 6. `dhcpd` formula

Domain Name.

**Domain Name Servers.** One or more Domain Name Service (DNS) servers.

On which interface(s) the DHCP server should listen (**Listen interfaces**). Set option for this interface: Authoritative: Max Lease Time: Default Lease Time:

Next is at least one network in the **Network configuration (subnet)** group (with IP address, netmask, etc.). You define every network with **Dynamic IP range**, **Routers**, and **Hosts with static IP addresses (with defaults from subnet)** (optionally).

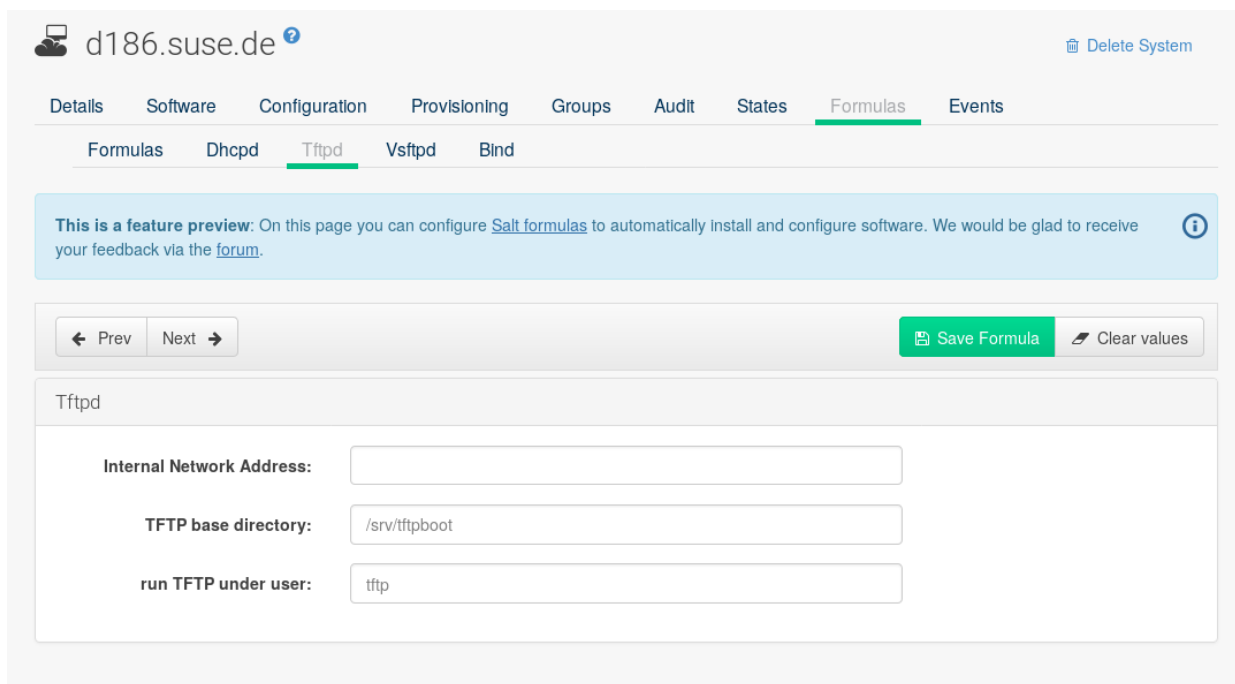
And finally **Hosts with static IP addresses (with global defaults)**.

If you apply the highstate (**System Details** > **States** > **Highstate**), it first ensures that **dhcp-server** and all required packages will get installed. Then it will start the DHCP service (**dhcpd**).

## Tftpd

With the tftpd formula you set up and configure a TFTP server (Trivial File Transfer Protocol). A TFTP server is a component that provides infrastructure for booting with PXE.

For more information about setting up TFTP, see the SLES Deployment Guide, Preparing Network Boot Environment, Setting Up a TFTP Server.



The screenshot shows the Salt Formula configuration interface for the Tftpd formula. At the top, there's a header with the system name 'd186.suse.de' and a 'Delete System' button. Below the header is a navigation bar with tabs: Details, Software, Configuration, Provisioning, Groups, Audit, States, Formulas (selected), and Events. Under the 'Formulas' tab, there are sub-tabs: Formulas, Dhcpcd, Tftpd (selected), Vsftpd, and Bind. A blue banner message states: 'This is a feature preview: On this page you can configure Salt formulas to automatically install and configure software. We would be glad to receive your feedback via the forum.' Below the banner, there are navigation buttons 'Prev' and 'Next', and two action buttons: 'Save Formula' and 'Clear values'. The main configuration area is titled 'Tftpd' and contains three input fields: 'Internal Network Address:' (empty), 'TFTP base directory:' (default: /srv/tftpboot), and 'run TFTP under user:' (default: tftp).

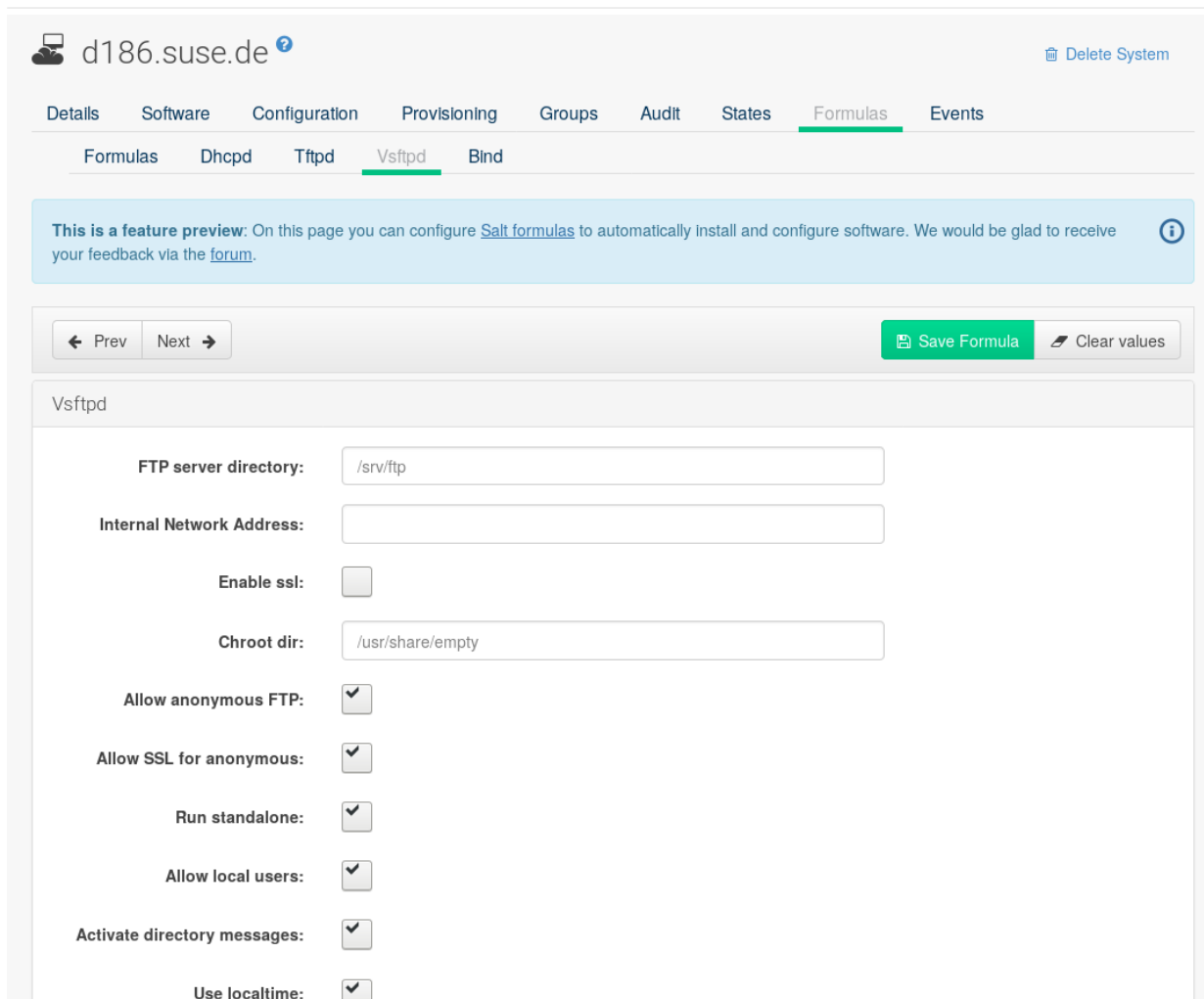
Figure 7. tftpd formula

For setting up a TFTP server, specify the **Internal Network Address**, **TFTP base directory** (default: **/srv/tftpboot**), and **run TFTP under user** (default: **sftp**).

If you apply the highstate (**System Details** > **States** > **Highstate**), it first ensures that **atftp** and all required packages will get installed. Then it will start TFTP (**atftpd**).

## Vsftpd

With the vsftpd formula you set up and configure Vsftpd. Vsftpd is an FTP server or daemon, written with security in mind. "vs" in its name stands for "Very Secure".



d186.suse.de [?](#) [Delete System](#)

Details Software Configuration Provisioning Groups Audit States **Formulas** Events

Formulas Dhcpcd Tftpd **Vsftpd** Bind

**This is a feature preview:** On this page you can configure [Salt formulas](#) to automatically install and configure software. We would be glad to receive your feedback via the [forum](#).

← Prev Next → [Save Formula](#) [Clear values](#)

Vsftpd

FTP server directory:

Internal Network Address:

Enable ssl: ☐

Chroot dir:

Allow anonymous FTP: ☒

Allow SSL for anonymous: ☒

Run standalone: ☒

Allow local users: ☒

Activate directory messages: ☒

Use localtime: ☒

Figure 8. vsftpd formula

For configuring a VSFTP server, specify the settings and options in the Vsftpd formula. There are settings such as **FTP server directory**, **Internal Network Address**, **Enable ssl**, etc.

If you apply the highstate (**System Details** > **States** > **Highstate**), it first ensures that **vsftpd** and all required packages will get installed. Then it will start the VSFTP service (**vsftpd**).

For more information about setting up and tuning Vsftpd, see the documentation coming with the **vsftpd** package (**/usr/share/doc/packages/vsftpd/** when the package is installed).

## CPU Mitigation Formula

CPU mitigations have been introduced to improve security on CPUs affected by vulnerabilities such as Meltdown and Spectre. The mitigations are available in SUSE Linux Enterprise 12 SP3 and later.

The CPU Mitigation formula allows you to control which mitigations are enabled.



By disabling the CPU mitigations, you are removing your protection from these vulnerabilities. Do not disable CPU mitigations unless you are aware of the risks of doing so.

There are four possible options within the CPU Mitigation formula:

### Auto

If a vulnerable CPU type is detected, all mitigations are enabled. If any other CPU type is detected, all mitigations are disabled.

### Auto + No SMT

This option works in the same way as **Auto**, but it leaves the symmetric multi-threading (SMT) mitigation disabled at all times. This can be useful if you experience an L1 terminal fault side-channel problem.

### Off

All mitigations are disabled. This setting gives the highest performance, but compromises your security. Do not use this setting where untrusted code might be used.

### Manual

Allows you to control mitigations directly on the client, instead of using the formula. For more information about CPU mitigations in the kernel, see <https://www.suse.com/documentation/suse-best-practices/singlehtml/SBP-Spectre-Meltdown-L1TF/SBP-Spectre-Meltdown-L1TF.html>

## Custom Salt Formulas

Some formulas are provided by default with SUSE Manager. Other official formulas can be installed as RPM packages. You can also write your own, custom, formulas, and make them available to your systems in the SUSE Manager Web UI.

This section contains information about installing official formulas, and writing custom formulas.

### Install Official Salt Formulas

SUSE releases formulas as RPM packages. Available formulas can be located within the **SUSE-Manager-Server-VERSION-Pool** channel.



- If a Salt 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 Salt Formulas from an RPM*

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

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

2. Get more information about a formula:

```
zypper info locale-formula
```

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

```
zypper in locale-formula
```

## 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/
```

The metadata directory contains a **form.yml** file which defines the forms for SUSE Manager. It 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 SUSE Manager 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 Data

SUSE Manager requires a file called `form.yml`, to describe how formula data should look within the Web UI. The `form.yml` file is used by SUSE Manager to generate the desired form, 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 SUSE Manager 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:

```
# This file is part of locale-formula.
#
# Foobar is free software: you can redistribute it and/or modify
# it under the terms of the GNU General Public License as published by
# the Free Software Foundation, either version 3 of the License, or
# (at your option) any later version.
#
# Foobar is distributed in the hope that it will be useful,
# but WITHOUT ANY WARRANTY; without even the implied warranty of
# MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the
# GNU General Public License for more details.
#
# You should have received a copy of the GNU General Public License
# along with Foobar. If not, see <http://www.gnu.org/licenses/>.

timezone:
  $type: group

name:
  $type: select
  $values: ["CET",
            "CST6CDT",
            "EET",
            "EST",
            "EST5EDT",
            "GMT",
            "GMT+0",
            "GMT-0",
            "GMT0",
            "Greenwich",
            "HST",
            "MET",
            "MST",
            "MST7MDT",
            "NZ",
            "NZ-CHAT",
```

```

    "Navajo",
    "PST8PDT",
    "UCT",
    "UTC",
    "Universal",
    "W-SU",
    "WET",
    "Zulu",
    "Etc/GMT+1",
    "Etc/GMT+2",
    "Etc/GMT+3",
    "Etc/GMT+4",
    "Etc/GMT+5",
    "Etc/GMT+6",
    "Etc/GMT+7",
    "Etc/GMT+8",
    "Etc/GMT+9",
    "Etc/GMT+10",
    "Etc/GMT+11",
    "Etc/GMT+12",
    "Etc/GMT-1",
    "Etc/GMT-2",
    "Etc/GMT-3",
    "Etc/GMT-4",
    "Etc/GMT-5",
    "Etc/GMT-6",
    "Etc/GMT-7",
    "Etc/GMT-8",
    "Etc/GMT-9",
    "Etc/GMT-10",
    "Etc/GMT-11",
    "Etc/GMT-12",
    "Etc/GMT-13",
    "Etc/GMT-14",
    "Etc/GMT",
    "Etc/GMT+0",
    "Etc/GMT-0",
    "Etc/GMT0",
    "Etc/Greenwich",
    "Etc/UCT",
    "Etc/UTC",
    "Etc/Universal",
    "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

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
```


### Listing 2. 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.

 suma-refhead-min-sles12sp3.mgr.suse.de 





Details Software Configuration Provisioning Groups Virtualization Audit States **Formulas** Events

Formulas **Hd Partitions** Joe

This is a feature preview: On this page you can configure [Salt formulas](#) to automatically install and configure software. We would be glad to receive your feedback via the [forum](#). 

← Prev Next →

Hd Partitions

Hard Disk Partitions

Partition Boot

Name:

Boot

Mountpoint:

/boot

Size in GB:

Partition Root

Name:

Root

Mountpoint:

/

Size in GB:

5000

Partition New partition

Name:

New partition

Mountpoint:

/var

Size in GB:

+ Add Item

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 3. 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 SUSE Manager 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 a SUSE Manager installation. 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 (SUSE Manager) located at `/etc/salt/master.d/susemanager.conf`.

## Install the Example Formula

This section provides guidance on installing and using SUSE-provided Salt formulas.

### *Procedure: Installing the Locale Formula*

1. Install the locale formula with:

```
zypper install locale-formula
```



This installs the package contents to `/usr/share/susemanager/formulas/{metadata,states}`

2. After installing the RPM, log in to the SUSE Manager Web UI.
3. Browse to the **Main Menu** > **System Details** page of any client you would like to apply the formula to.
4. On the **Main Menu** > **System Details** page you will see a new **[Formulas]** tab. Select it to view a list of installed formulas.
5. From the **[Formulas]** list select **Formulas** > **Locale** and click **[Save]**.
6. A new tab will appear next to the **Formula** > **Locale** subtab. Select the new **Formulas** > **Locale** tab.
7. The **Formulas** > **Locale** tab contains options for setting the language, keyboard layout, timezone, and whether hardware clock is set to UTC. Select the desired options and click **[Save]**.
8. Run the following command to verify pillar settings. The output has been truncated.

```
salt '$your_client' pillar.items
```

```
...
  keyboard_and_language:
    -----
    keyboard_layout:
      English (US)
    language:
      English (US)
  machine_password:
    foobar
  mgr_server:
    manager_server
  org_id:alt '$your_client_here'
    1
  timezone:
    -----
    hardware_clock_set_to_utc:
      True
    name:
      CET
  ...
```

9. Apply this state to your client by applying the highstate from the command line with:

```
salt '$your_client' state.highstate
```



You can also apply the highstate from the previous formula tab from the SUSE Manager Web UI by selecting **System Details** > **States** and clicking **[Apply Highstate]**.

## 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 SUSE Manager 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, SUSE Manager 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. { SUSE Manager 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. SUSE Manager 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's `~/.ssh/authorized_keys` file. Subsequent calls no longer require a password.

## User Account

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

If the value of `ssh_push_sudo_user` is not root, then the `--sudo` options of `salt-ssh` are used.

## 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`

For more information, see <https://github.com/SUSE/spacewalk/blob/Manager/java/code/src/com/suse/manager/webui/services/impl/SaltSSHService.java>

## Bootstrap Sequence

Salt SSH is used to bootstrap Salt clients. This happens for both regular and SSH clients.

The bootstrap sequence differs slightly from other Salt SSH calls.

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.
4. If contact method is `ssh-push-tunnel`, fill the remote port forwarding option.
5. If the client connects through a proxy, compute the `ProxyCommand` option. This depends on the path used to connect to the proxy. For example, server to proxy1 to proxy2 to client.
6. Generate the roster for bootstrapping into a temporary file.
7. Execute this command using the Salt API:

```
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.

Pillar data contains:

- `mgr_server`: The hostname of the SUSE Manager 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.

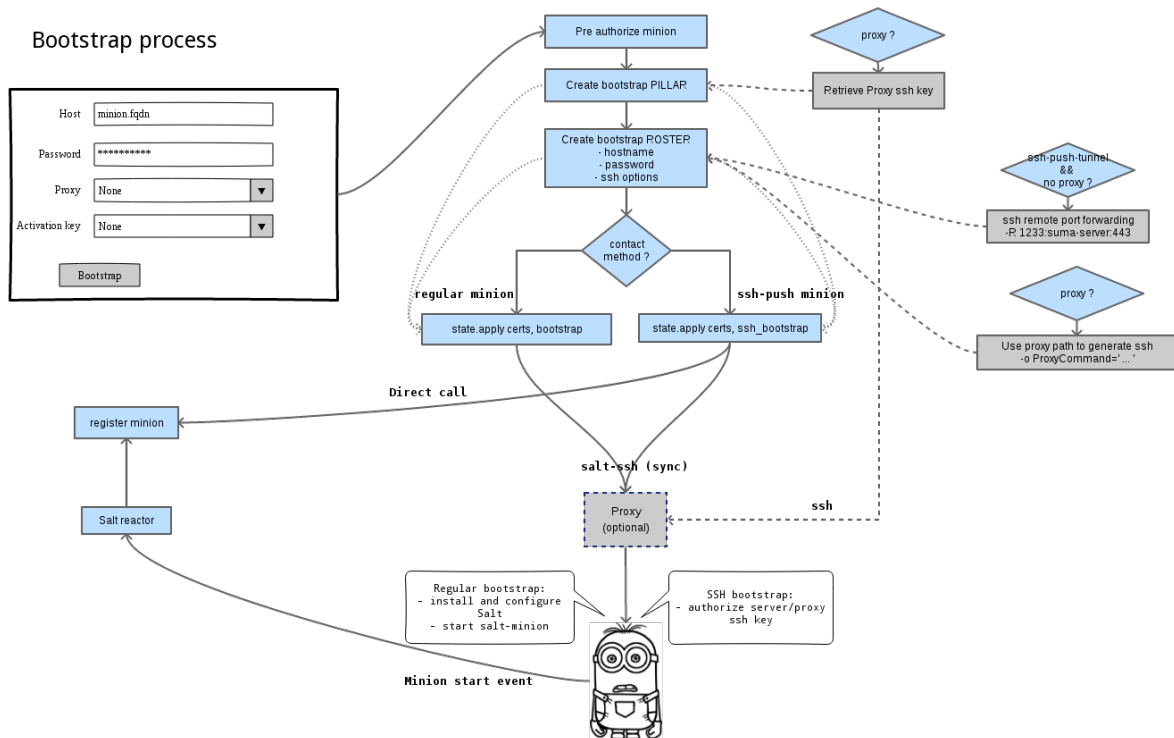


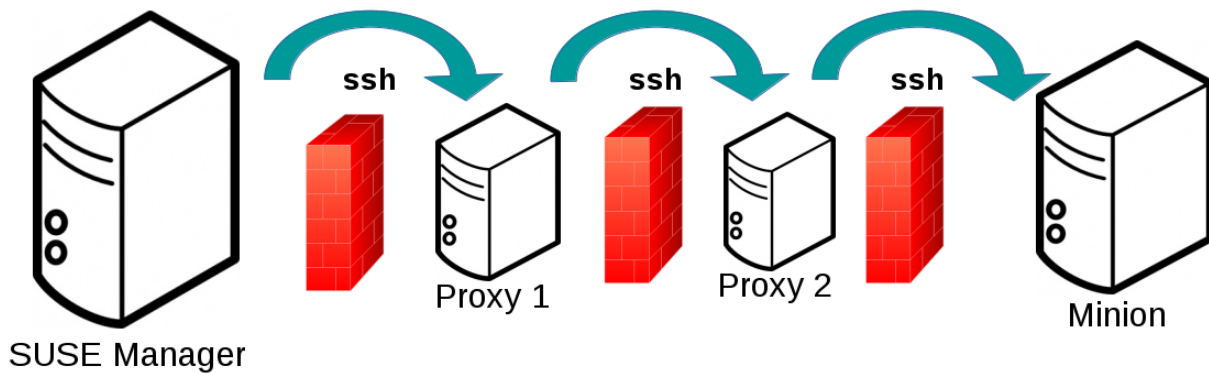
Figure 9. Salt SSH Bootstrap Process

For more information see these code snippets:

- <https://github.com/SUSE/spacewalk/blob/Manager/java/code/src/com/suse/manager/webui/controllers/Utils/RegularMinionBootstrapper.java>
- <https://github.com/SUSE/spacewalk/blob/Manager/java/code/src/com/suse/manager/webui/controllers/Utils/SSHMinionBootstrapper.java>
- <https://github.com/SUSE/spacewalk/blob/Manager/susemanager-utils/susemanager-sls/salt/bootstrap/init.sls>
- [https://github.com/SUSE/spacewalk/blob/Manager/susemanager-utils/susemanager-sls/salt/ssh\\_bootstrap/init.sls](https://github.com/SUSE/spacewalk/blob/Manager/susemanager-utils/susemanager-sls/salt/ssh_bootstrap/init.sls)

## Proxy Support

Salt SSH works with SUSE Manager 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.

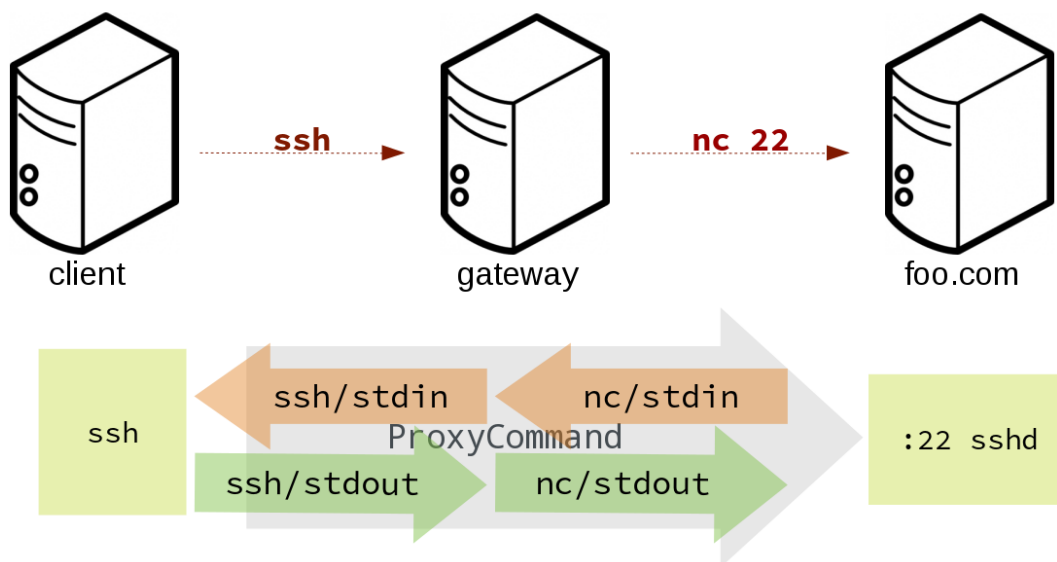


SUSE Manager uses **ProxyCommand** to redirect SSH connections through proxies. This option invokes an arbitrary command that is expected to connect to the SSH port on the target host. The SSH process uses standard input and output of the command to communicate with the remote SSH daemon.

**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:

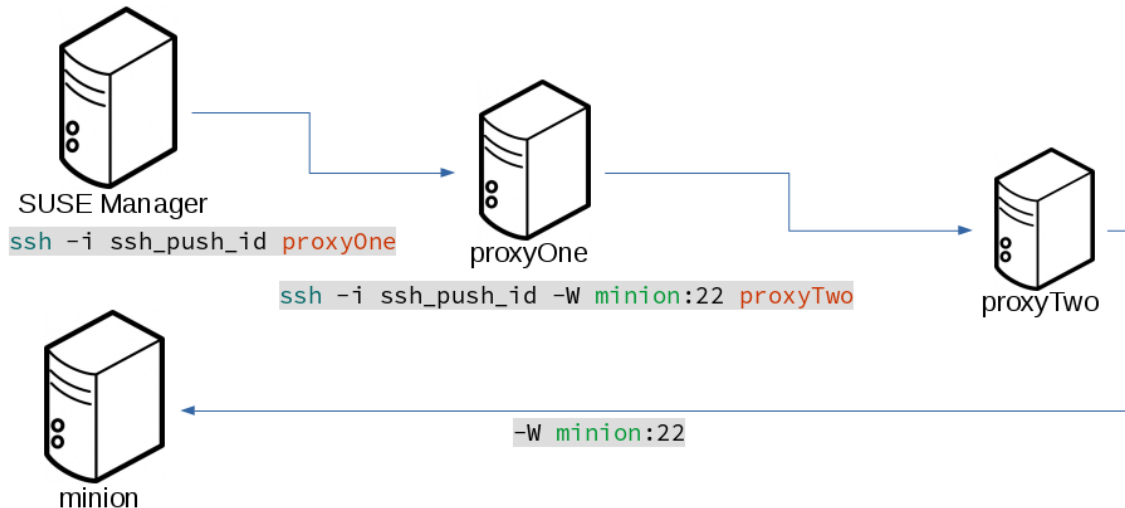
1. SUSE Manager initiates the SSH connection.
2. **ProxyCommand** uses SSH to create a connection from the server to the client through the proxies.

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=mgrshtunnel 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/mgrshtunnel/.ssh/id_susemanager_ssh_push -o
StrictHostKeyChecking=no -o User=mgrshtunnel -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>
```



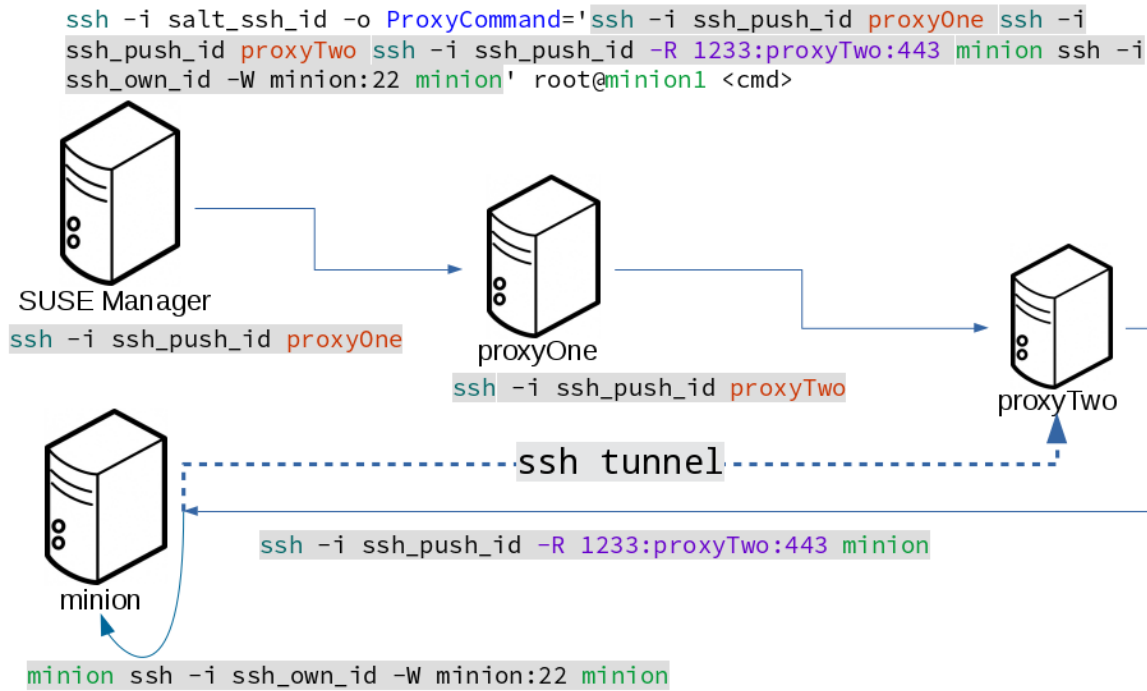
This example uses **ProxyCommand** with two proxies and the **ssh-push-tunnel** method:

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

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



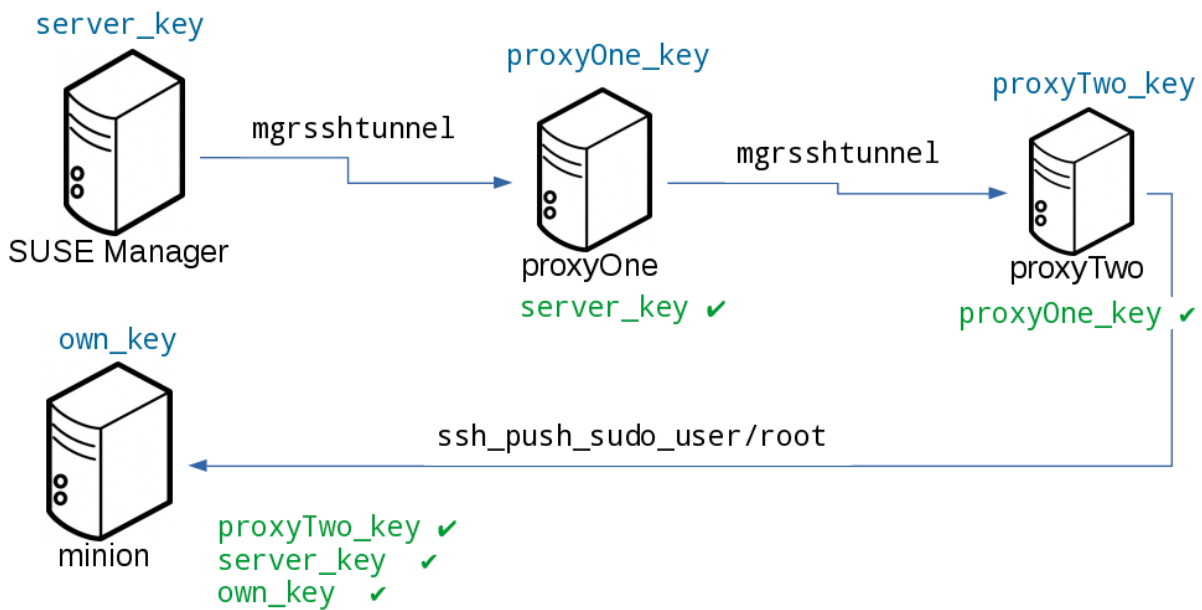
For more information, see <https://github.com/SUSE/spacewalk/blob/Manager/java/code/src/com/suse/manager/webui/services/impl/SaltSSHService.java>.

## Users and SSH Key Management

To connect to a proxy, the parent server or proxy uses a specific user called `mgrshtunnel`. When `mgrshtunnel` 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/mgrshtunnel/.ssh/id_susemanager_ssh_push`.
3. Each proxy authorizes the key of the parent proxy or server.
4. The client authorizes its own key.



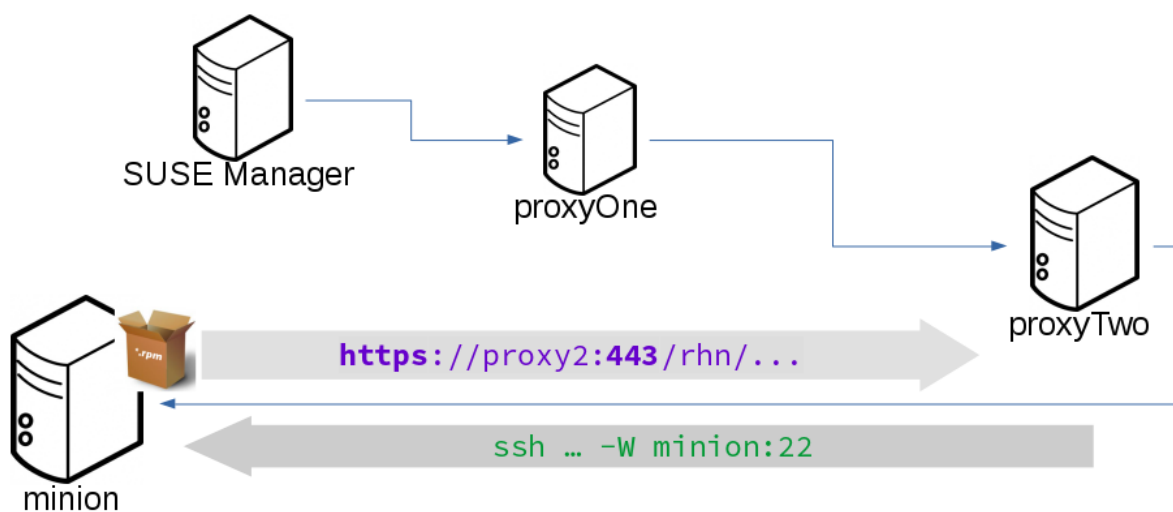
For more information, see <https://github.com/SUSE/spacewalk/blob/Manager/proxy/proxy/mgr-proxy-ssh-force-cmd>.

## Repository Access with a Proxy

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

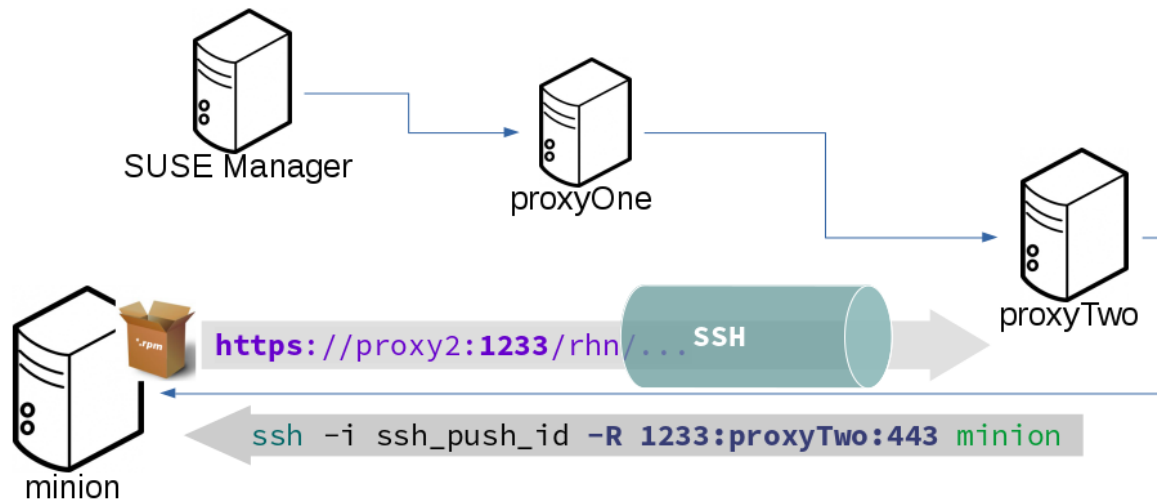
In both methods the client connects to the proxy to retrieve package and repository information.

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 HTTP 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 generated 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.

---

For more information, see these code snippets:

- <https://github.com/SUSE/spacewalk/blob/Manager/java/code/src/com/suse/manager/webui/controllers/SaltSSHController.java>
- <https://github.com/SUSE/spacewalk/blob/Manager/susemanager-utils/susemanager-sls/modules/runners/mgrutil.py>
- <https://github.com/SUSE/spacewalk/blob/Manager/proxy/proxy/mgr-proxy-ssh-push-init>
- <https://github.com/SUSE/spacewalk/blob/Manager/proxy/proxy/spacewalk-proxy.spec>



# Salt timeouts

## General Salt timeouts

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

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

- A salt command or job is executed:

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

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

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

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

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

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

## Presence Ping Timeouts

Before Actions are executed on Salt clients, whether they scheduled via the Web UI or the API, SUSE

Manager performs a "presence ping" command to ensure the respective `salt-minion` processes are active and able to respond. Then, a ping gather job runs on the Salt master to handle the incoming pings from the clients. Actual commands will begin only after all clients have either responded to the ping, or timed out.

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

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

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

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

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

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

## Salt SSH Clients (SSH Push)

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

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

```
# salt_ssh_connect_timeout = 180
```

## 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 SUSE Manager 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 100.

Increasing the delay increases the chance that multiple clients will have completed before the next action is issued, resulting in fewer overall commands, and reducing load.

The batch delay parameter sets the amount of time, in seconds, to wait after a command 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, SUSE Manager 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 SUSE Manager 3.2, the Salt mine is no longer required. Instead, the SUSE Manager 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

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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

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

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



Large installations require standard Salt clients. These instructions cannot be used in environments using traditional clients or Salt SSH minions.

## Hardware and Infrastructure

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

The minimum requirements for the SUSE Manager Server are:

- Eight or more recent x86\_64 CPU cores.
- 32 GiB RAM. For installations with thousands of clients, use 64 GB or more.
- Fast I/O storage devices, such as locally-attached SSDs. For PostgreSQL data directories, we recommend locally-attached RAID-0 SSDs.

If the SUSE Manager Server is virtualized, enable the `elevator=noop` kernel command line option, for the best input/output performance. You can check the current status with `cat /sys/block/<DEVICE>/queue/scheduler`. This command will display a list of available schedulers with the currently active one in brackets. To change the scheduler before a reboot, use `echo noop > /sys/block/<DEVICE>/queue/scheduler`.

The minimum requirements for the SUSE Manager Proxy are:

- One SUSE Manager Proxy per 500-1000 clients, depending on available network bandwidth.
- Two or more recent x86\_64 CPU cores.
- 16 GB RAM, and sufficient storage for caching.

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

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

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

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

$$\text{Size of updates} * \text{Number of clients} / \text{Theoretical download speed} / 60$$

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

$$400 \text{ MB} * 3000 / 119 \text{ MB/s} / 60 = 169 \text{ min}$$

## Operation Recommendations

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



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

### Salt Client Onboarding Rate

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

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

### Salt Clients and the RNG

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

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

### Clients Running with Unaccepted Salt Keys

Clients which have not been onboarded, that is clients running with unaccepted Salt keys, consume more resources than clients that have been onboarded. Generally, this consumes about an extra 2.5 Kb/s of

inbound network bandwidth per client. For example, 1000 idle clients will consume about 2.5 Mb/s extra. This consumption will reduce almost to zero when onboarding has been completed for all clients. Limit the number of non-onboarded clients for optimal performance.

## Disabling the Salt Mine

In older versions, SUSE Manager 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 SUSE Manager 3.2, the Salt mine is no longer required. Instead, the SUSE Manager 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`.

## Disable Unnecessary Taskomatic jobs

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

You can see the list of Taskomatic jobs in the SUSE Manager Web UI, at **Admin > Task Schedules**.

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

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

We recommend disabling these jobs:

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

- Daily gatherer and subscription matcher: `gatherer-matcher-default`

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

## Swap and Monitoring

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

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

You can also consider tuning the Server to consume less memory. For more information on tuning, see [ [Salt > Large-scale\\_tuning >](#)  ].

## Tuning Large Scale Deployments

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



The instructions in this section can have severe and catastrophic performance impacts when improperly used. In some cases, they can cause SUSE Manager to completely cease functioning. Always test changes before implementing them in a production environment. During implementation, take care when changing parameters. Monitor performance before and after each change, and revert any steps that do not produce the expected result.



We strongly recommend that you contact SUSE Consulting for assistance with tuning.

SUSE will not provide support for catastrophic failure when these advanced parameters are modified without consultation.



Tuning is not required on installations of fewer than 1000 clients. Do not perform these instructions on small or medium scale installations.

## The Tuning Process

Any SUSE Manager installation is subject to a number of design and infrastructure constraints that, for the purposes of tuning, we call environmental variables. Environmental variables can include the total number of clients, the number of different operating systems under management, and the number of software channels.

Environmental variables influence, either directly or indirectly, the value of most configuration



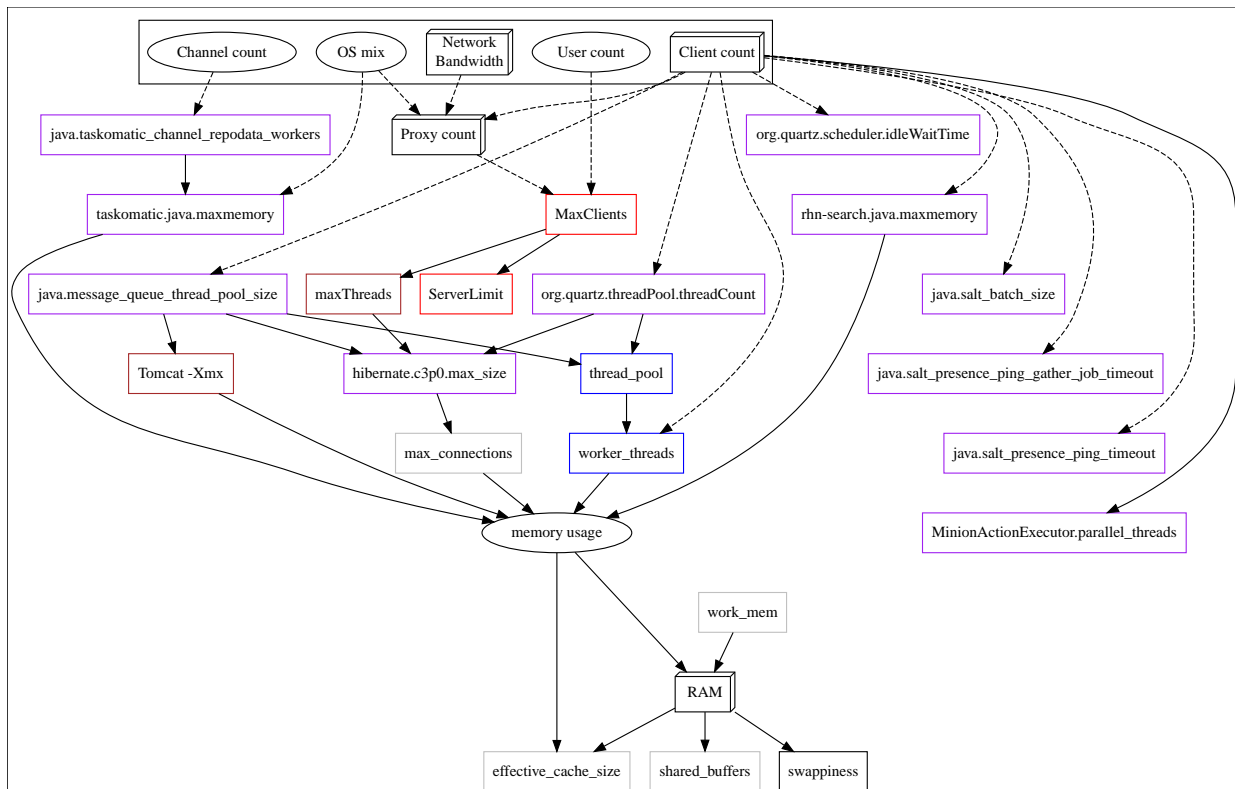
parameters. During the tuning process, the configuration parameters are manipulated to improve system performance.

Before you begin tuning, you will need to estimate the best setting for each environment variable, and adjust the configuration parameters to suit.

To help you with the estimation process, we have provided you with a dependency graph. Locate the environmental variables on the dependency graph to determine how they will influence other variables and parameters.

Environmental variables are represented by graph nodes in a rectangle at the top of the dependency graph. Each node is connected to the relevant parameters that might need tuning. Consult the relevant sections in this document for more information about recommended values.

Tuning one parameter might require tuning other parameters, or changing hardware, or the infrastructure. When you change a parameter, follow the arrows from that node on the graph to determine what other parameters might need adjustment. Continue through each parameter until you have visited all nodes on the graph.



#### Key to the Dependency Graph

- 3D boxes are hardware design variables or constraints
- Oval-shaped boxes are software or system design variables or constraints
- Rectangle-shaped boxes are configurable parameters, color-coded by configuration file:
  - Red: Apache [httpd](#) configuration files
  - Blue: Salt configuration files

- Brown: Tomcat configuration files
- Grey: PostgreSQL configuration files
- Purple: `/etc/rhn/rhn.conf`
- Dashed connecting lines indicate a variable or constraint that might require a change to another parameter
- Solid connecting lines indicate that changing a configuration parameter requires checking another one to prevent issues

After the initial tuning has been completed, you will need to consider tuning again in these cases:

- If your tuning inputs change significantly
- If special conditions arise that require a certain parameter to be changed. For example, if specific warnings appear in a log file.
- If performance is not satisfactory

To re-tune your installation, you will need to use the dependency graph again. Start from the node where significant change has happened.

## Environmental Variables

This section contains information about environmental variables (inputs to the tuning process).

### Network Bandwidth

A measure of the typically available egress bandwidth from the SUSE Manager Server host to the clients or SUSE Manager Proxy hosts. This should take into account network hardware and topology as well as possible capacity limits on switches, routers, and other network equipment between the server and clients.

### Channel count

The number of expected channels to manage. Includes any vendor-provided, third-party, and cloned or staged channels.

### Client count

The total number of actual or expected clients. It is important to tune any parameters in advance of a client count increase, whenever possible.

### OS mix

The number of distinct operating system versions that managed clients have installed. This is ordered by family (SUSE Linux Enterprise, openSUSE, Red Hat Enterprise Linux, or Ubuntu based). Storage and computing requirements are different in each case.

### User count

The expected maximum amount of concurrent users interacting with the Web UI plus the number of programs simultaneously using the XMLRPC API. Includes `spacecmd`, `spacewalk-clone-by-`

`date`, and similar.

## Parameters

This section contains information about the available parameters.

### MaxClients

Description	The maximum number of HTTP requests served simultaneously by Apache httpd. Proxies, Web UI, and XMLRPC API clients each consume one. Requests exceeding the parameter will be queued and might result in timeouts.
Tune when	<code>User count</code> and proxy count increase significantly and this line appears in <pre>/var/log/apache2/error_log: [...] [mpm_prefork:error] [pid ...] AH00161: server reached MaxRequestWorkers setting, consider raising the MaxRequestWorkers setting.</pre>
Value default	150
Value recommendation	150-500
Location	<code>/etc/apache2/server-tuning.conf</code> , in the <code>prefork.c</code> section
Example	<code>MaxClients = 200</code>
After changing	Immediately change <code>ServerLimit</code> and check <code>maxThreads</code> for possible adjustment.
Notes	This parameter was renamed to <code>MaxRequestWorkers</code> , both names are valid.
More information	<a href="https://httpd.apache.org/docs/2.4/en/mod/mpm_common.html#maxrequestworkers">https://httpd.apache.org/docs/2.4/en/mod/mpm_common.html#maxrequestworkers</a>

### ServerLimit

Description	The number of Apache httpd processes serving HTTP requests simultaneously. The number must equal <code>MaxClients</code> .
Tune when	<code>MaxClients</code> changes
Value default	150

Value recommendation	The same value as <code>MaxClients</code>
Location	<code>/etc/apache2/server-tuning.conf</code> , in the <code>prefork.c</code> section
Example	<code>ServerLimit = 200</code>
More information	<a href="https://httpd.apache.org/docs/2.4/en/mod/mpm_common.html#serverlimit">https://httpd.apache.org/docs/2.4/en/mod/mpm_common.html#serverlimit</a>

## maxThreads

Description	The number of Tomcat threads dedicated to serving HTTP requests
Tune when	<code>MaxClients</code> changes. <code>maxThreads</code> must always be equal or greater than <code>MaxClients</code>
Value default	150
Value recommendation	The same value as <code>MaxClients</code>
Location	<code>/etc/tomcat/server.xml</code>
Example	<pre>&lt;Connector port="8009" protocol="AJP/1.3" redirectPort="8443" URIEncoding="UTF-8" address="127.0.0.1" maxThreads="200" connectionTimeout="20000"/&gt;</pre>
More information	<a href="https://tomcat.apache.org/tomcat-9.0-doc/config/http.html">https://tomcat.apache.org/tomcat-9.0-doc/config/http.html</a>

## Tomcat's -Xmx

Description	The maximum amount of memory Tomcat can use
Tune when	<code>java.message_queue_thread_pool_size</code> is increased or <code>OutOfMemoryException</code> errors appear in <code>/var/log/rhn/rhn_web_ui.log</code>
Value default	1 GiB
Value recommendation	4-8 GiB
Location	<code>/etc/sysconfig/tomcat</code>
Example	<code>JAVA_OPTS="... -Xmx8G ..."</code>
After changing	Check <a href="#">memory usage</a>
More information	<a href="https://docs.oracle.com/javase/8/docs/technotes/tools/windows/java.html">https://docs.oracle.com/javase/8/docs/technotes/tools/windows/java.html</a>

## java.message\_queue\_thread\_pool\_size

Description	The maximum number of threads in Tomcat dedicated to asynchronous operations, including handling of incoming Salt events
Tune when	<a href="#">Client count</a> increases significantly
Value default	5
Value recommendation	50 - 150
Location	<a href="#">/etc/rhn/rhn.conf</a>
Example	<code>java.message_queue_thread_pool_size = 50</code>
After changing	Check <a href="#">hibernate.c3p0.max_size</a> , as each thread consumes a PostgreSQL connection, starvation might happen if the allocated connection pool is insufficient. Check <a href="#">thread_pool</a> , as each thread might perform Salt API calls, starvation might happen if the allocated Salt thread pool is insufficient. Check <a href="#">Tomcat's -Xmx</a> , as each thread consumes memory, <a href="#">OutOfMemoryException</a> might be raised if insufficient.
More information	<a href="#">man rhn.conf</a>

## java.salt\_batch\_size

Description	The maximum number of minions concurrently executing a scheduled action.
Tune when	<a href="#">Client count</a> reaches several thousands and actions are not executed quickly enough.
Value default	200
Value recommendation	200-500
Location	<a href="#">/etc/rhn/rhn.conf</a>
Example	<code>java.salt_batch_size = 300</code>
After changing	Check <a href="#">memory usage</a> . Monitor memory usage closely before and after the change.
More information	<a href="#">Salt Rate Limiting</a>

## java.salt\_presence\_ping\_timeout

Description	Before any action is executed on a client, a presence ping is executed to make sure the client is reachable. This parameter sets the amount of time before a second command ( <code>find_job</code> ) is sent to the client to verify its presence. Having many clients typically means some will respond faster than others, so this timeout could be raised to accommodate for the slower ones.
Tune when	<code>Client count</code> increases significantly, or some clients are responding correctly but too slowly, and SUSE Manager excludes them from calls. This line appears in <code>/var/log/rhn/rhn_web_ui.log</code> : "Got no result for <COMMAND> on minion <MINION_ID> (minion did not respond in time)"
Value default	4 seconds
Value recommendation	4-400 seconds
Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>java.salt_presence_ping_timeout = 40</code>
More information	<a href="#">Salt Timeouts</a>

## `java.salt_presence_ping_gather_job_timeout`

Description	Before any action is executed on a client, a presence ping is executed to make sure the client is reachable. After <code>java.salt_presence_ping_timeout</code> seconds have elapsed without a response, a second command ( <code>find_job</code> ) is sent to the client for a final check. This parameter sets the number of seconds after the second command after which the client is definitely considered offline. Having many clients typically means some will respond faster than others, so this timeout could be raised to accommodate for the slower ones.
Tune when	<code>Client count</code> increases significantly, or some clients are responding correctly but too slowly, and SUSE Manager excludes them from calls. This line appears in <code>/var/log/rhn/rhn_web_ui.log</code> : "Got no result for <COMMAND> on minion <MINION_ID> (minion did not respond in time)"

Value default	1 second
Value recommendation	1-100 seconds
Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>java.salt_presence_ping_gather_job_timeout = 10</code>
More information	<a href="#">Salt Timeouts</a>

## `java.taskomatic_channel_repodata_workers`

Description	Whenever content is changed in a software channel, its metadata needs to be recomputed before clients can use it. Channel-altering operations include the addition of a patch, the removal of a package or a repository synchronization run. This parameter specifies the maximum number of Taskomatic threads that SUSE Manager will use to recompute the channel metadata. Channel metadata computation is both CPU-bound and memory-heavy, so raising this parameter and operating on many channels simultaneously could cause Taskomatic to consume significant resources, but channels will be available to clients sooner.
Tune when	<a href="#">Channel count</a> increases significantly (more than 50), or more concurrent operations on channels are expected.
Value default	2
Value recommendation	2-10
Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>java.taskomatic_channel_repodata_workers = 4</code>
After changing	Check <code>taskomatic.java.maxmemory</code> for adjustment, as every new thread will consume memory
More information	<code>man rhn.conf</code>

## `taskomatic.java.maxmemory`

Description	The maximum amount of memory Taskomatic can use. Generation of metadata, especially for some OSs, can be memory-intensive, so this parameter might need raising depending on the managed <a href="#">OS mix</a> .
Tune when	<code>java.taskomatic_channel_repodata_workers</code> increases, OSs are added to SUSE Manager (particularly Red Hat Enterprise Linux or Ubuntu), or <code>OutOfMemoryException</code> errors appear in <code>/var/log/rhn/rhn_taskomatic_daemon.log</code> .
Value default	2048 MiB
Value recommendation	2048-16384 MiB
Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>taskomatic.java.maxmemory = 8192</code>
After changing	Check <a href="#">memory usage</a> .
More information	<code>man rhn.conf</code>

### `org.quartz.threadPool.threadCount`

Description	The number of Taskomatic worker threads. Increasing this value allows Taskomatic to serve more clients in parallel.
Tune when	<a href="#">Client count</a> increases significantly
Value default	20
Value recommendation	20-200
Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>org.quartz.threadPool.threadCount = 100</code>
After changing	Check <code>hibernate.c3p0.max_size</code> and <code>thread_pool</code> for adjustment
More information	<a href="http://www.quartz-scheduler.org/documentation/2.4.0-SNAPSHOT/configuration.html">http://www.quartz-scheduler.org/documentation/2.4.0-SNAPSHOT/configuration.html</a>

### `org.quartz.scheduler.idleWaitTime`

Description	Cycle time for Taskomatic. Decreasing this value lowers the latency of Taskomatic.
Tune when	<a href="#">Client count</a> is in the thousands.



Value default	5000 ms
Value recommendation	1000-5000 ms
Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>org.quartz.scheduler.idleWaitTime = 1000</code>
More information	<a href="http://www.quartz-scheduler.org/documentation/2.4.0-SNAPSHOT/configuration.html">http://www.quartz-scheduler.org/documentation/2.4.0-SNAPSHOT/configuration.html</a>

### `MinionActionExecutor.parallel_threads`

Description	Number of Taskomatic threads dedicated to sending commands to Salt clients as a result of actions being executed.
Tune when	<code>Client count</code> is in the thousands.
Value default	1
Value recommendation	1-10
Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>taskomatic.com.redhat.rhn.taskomatic.task.MinionActionExecutor.parallel_threads = 10</code>

### `hibernate.c3p0.max_size`

Description	Maximum number of PostgreSQL connections simultaneously available to both Tomcat and Taskomatic. If any of those components requires more concurrent connections, their requests will be queued.
Tune when	<code>java.message_queue_thread_pool_size</code> or <code>maxThreads</code> increase significantly, or when <code>org.quartz.threadPool.threadCount</code> has changed significantly. Each thread consumes one connection in Taskomatic and Tomcat, having more threads than connections might result in starving.
Value default	20
Value recommendation	100 to 200, higher than the maximum of <code>java.message_queue_thread_pool_size</code> + <code>maxThreads</code> and <code>org.quartz.threadPool.threadCount</code>

Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>hibernate.c3p0.max_size = 100</code>
After changing	Check <code>max_connections</code> for adjustment.
More information	<a href="https://www.mchange.com/projects/c3p0/#maxPoolSize">https://www.mchange.com/projects/c3p0/#maxPoolSize</a>

### `rhn-search.java.maxmemory`

Description	The maximum amount of memory that the <code>rhn-search</code> service can use.
Tune when	<code>Client count</code> increases significantly, and <code>OutOfMemoryException</code> errors appear in <code>journalctl -u rhn-search</code> .
Value default	512 MiB
Value recommendation	512-4096 MiB
Location	<code>/etc/rhn/rhn.conf</code>
Example	<code>rhn-search.java.maxmemory = 4096</code>
After changing	Check <code>memory usage</code> .

### `shared_buffers`

Description	The amount of memory reserved for PostgreSQL shared buffers, which contain caches of database tables and index data.
Tune when	RAM changes
Value default	25% of total RAM
Value recommendation	25-40% of total RAM
Location	<code>/var/lib/pgsql/data/postgresql.conf</code>
Example	<code>shared_buffers = 8192MB</code>
After changing	Check <code>memory usage</code> .
More information	<a href="https://www.postgresql.org/docs/10/runtime-config-resource.html#GUC-SHARED-BUFFERS">https://www.postgresql.org/docs/10/runtime-config-resource.html#GUC-SHARED-BUFFERS</a>

### `max_connections`

Description	Maximum number of PostgreSQL connections available to applications. More connections allow for more concurrent threads/workers in various components (in particular Tomcat and Taskomatic), which generally improves performance. However, each connection consumes resources, in particular <code>work_mem</code> megabytes per sort operation per connection.
Tune when	<code>hibernate.c3p0.max_size</code> changes significantly, as that parameter determines the maximum number of connections available to Tomcat and Taskomatic
Value default	400
Value recommendation	$2 * \text{hibernate.c3p0.max\_size} + 50$ , if less than 1000
Location	<code>/var/lib/pgsql/data/postgresql.conf</code>
Example	<code>max_connections = 250</code>
After changing	Check <code>memory usage</code> . Monitor memory usage closely before and after the change.
More information	<a href="https://www.postgresql.org/docs/10/runtime-config-connection.html#GUC-MAX-CONNECTIONS">https://www.postgresql.org/docs/10/runtime-config-connection.html#GUC-MAX-CONNECTIONS</a>

## work\_mem

Description	The amount of memory allocated by PostgreSQL every time a connection needs to do a sort or hash operation. Every connection (as specified by <code>max_connections</code> ) might make use of an amount of memory equal to a multiple of <code>work_mem</code> .
Tune when	Individual query operations are too slow, and value is below 5 MB
Value recommendation	2-20 MB
Location	<code>/var/lib/pgsql/data/postgresql.conf</code>
Example	<code>work_mem = 10MB</code>
After changing	check if the SUSE Manager Server might need additional RAM.
More information	<a href="https://www.postgresql.org/docs/10/runtime-config-resource.html#GUC-WORK-MEM">https://www.postgresql.org/docs/10/runtime-config-resource.html#GUC-WORK-MEM</a>

## effective\_cache\_size

Description	Estimation of the total memory available to PostgreSQL for caching. It is the explicitly reserved memory ( <code>shared_buffers</code> ) plus any memory used by the kernel as cache/buffer.
Tune when	Hardware RAM or memory usage increase significantly
Value recommendation	Start with 75% of total RAM. For finer settings, use <code>shared_buffers</code> + free memory + buffer/cache memory. Free and buffer/cache can be determined via the <code>free -m</code> command ( <code>free</code> and <code>buff/cache</code> in the output respectively)
Location	<code>/var/lib/pgsql/data/postgresql.conf</code>
Example	<code>effective_cache_size = 24GB</code>
After changing	Check <a href="#">memory usage</a>
Notes	This is an estimation for the query planner, not an allocation.
More information	<a href="https://www.postgresql.org/docs/10/runtime-config-query.html#GUC-EFFECTIVE-CACHE-SIZE">https://www.postgresql.org/docs/10/runtime-config-query.html#GUC-EFFECTIVE-CACHE-SIZE</a>

## thread\_pool

Description	The number of worker threads serving Salt API HTTP requests. A higher number can improve parallelism of SUSE Manager Server-initiated Salt operations, but will consume more memory.
Tune when	<code>java.message_queue_thread_pool_size</code> or <code>org.quartz.threadPool.threadCount</code> are changed. Starvation can occur when there are more Tomcat or Taskomatic threads making simultaneous Salt API calls than there are Salt API worker threads.
Value default	100
Value recommendation	100-500, but should be higher than the sum of <code>java.message_queue_thread_pool_size</code> and <code>org.quartz.threadPool.threadCount</code>
Location	<code>/etc/salt/master.d/susemanager.conf</code> , in the <code>rest_cherrypy</code> section.
Example	<code>thread_pool: 100</code>

After changing	Check <code>worker_threads</code> for adjustment.
More information	<a href="https://docs.saltstack.com/en/latest/ref/netapi/all/salt.netapi.rest_cherry.py.html#performance-tuning">https://docs.saltstack.com/en/latest/ref/netapi/all/salt.netapi.rest_cherry.py.html#performance-tuning</a>

## worker\_threads

Description	The number of <code>salt-master</code> worker threads that process commands and replies from minions and the Salt API. Increasing this value, assuming sufficient resources are available, allows Salt to process more data in parallel from minions without timing out, but will consume significantly more RAM (typically about 70 MiB per thread).
Tune when	<code>Client count</code> increases significantly, <code>thread_pool</code> increases significantly, or <code>SaltReqTimeoutError</code> or <code>Message timed out</code> errors appear in <code>/var/log/salt/master</code> .
Value default	8
Value recommendation	8-200
Location	<code>/etc/salt/master.d/tuning.conf</code>
Example	<code>worker_threads: 50</code>
After changing	Check <code>memory usage</code> . Monitor memory usage closely before and after the change.
More information	<a href="https://docs.saltstack.com/en/latest/ref/configuration/master.html#worker-threads">https://docs.saltstack.com/en/latest/ref/configuration/master.html#worker-threads</a>

## swappiness

Description	How aggressively the kernel moves unused data from memory to the swap partition. Setting a lower parameter typically reduces swap usage and results in better performance, especially when RAM memory is abundant.
Tune when	RAM increases, or swap is used when RAM memory is sufficient.
Value default	60
Value recommendation	1-60. For 128 GB of RAM, 10 is expected to give good results.
Location	<code>/etc/sysctl.conf</code>
Example	<code>vm.swappiness = 20</code>

More information	<a href="https://www.suse.com/documentation/sles-15/book_sle_tuning/data/cha_tuning_memory_vm.html">https://www.suse.com/documentation/sles-15/book_sle_tuning/data/cha_tuning_memory_vm.html</a>
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## Memory Usage

Adjusting some of the parameters listed in this section can result in a higher amount of RAM being used by various components. It is important that the amount of hardware RAM is adequate after any significant change.

To determine how RAM is being used, you will need to check each process that consumes it.

## Operating system

Stop all SUSE Manager services and inspect the output of `free -h`.

## Java-based components

This includes Taskomatic, Tomcat, and `rhn-search`. These services support a configurable memory cap.

## The SUSE Manager Server

Depends on many factors and can only be estimated. Measure PostgreSQL reserved memory by checking `shared_buffers`, permanently. You can also multiply `work_mem` and `max_connections`, and multiply by three for a worst case estimate of per-query RAM. You will also need to check the operating system buffers and caches, which are used by PostgreSQL to host copies of database data. These often automatically occupy any available RAM.

It is important that the SUSE Manager Server has sufficient RAM to accommodate all of these processes, especially OS buffers and caches, to have reasonable PostgreSQL performance. We recommend you keep several gigabytes available at all times, and add more as the database size on disk increases.

Whenever the expected amount of memory available for OS buffers and caches changes, update the `effective_cache_size` parameter to have PostgreSQL use it correctly. You can calculate the total available by finding the total RAM available, less the expected memory usage.

To get a live breakdown of the memory used by services on the SUSE Manager Server, use this command:

```
pidstat -p ALL -r --human 1 60 | tee pidstat-memory.log
```

This command will save a copy of displayed data in the `pidstat-memory.log` file for later analysis.

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