



U Y U N I

Uyuni 2022.10

Retail Guide

September 30 2022



# Table of Contents

|                                                                                      |    |
|--------------------------------------------------------------------------------------|----|
| Retail Guide Overview                                                                | 1  |
| 1. Components                                                                        | 2  |
| 1.1. The Uyuni Server.....                                                           | 2  |
| 1.2. Build Hosts.....                                                                | 2  |
| 1.3. Branch Servers.....                                                             | 2  |
| 1.4. Point-of-Service Terminals.....                                                 | 2  |
| 1.5. Fitting It All Together.....                                                    | 3  |
| 1.5.1. Hardware Types .....                                                          | 3  |
| 1.5.2. Branch System Groups.....                                                     | 3  |
| 1.5.3. Salt Formulas .....                                                           | 3  |
| 1.5.4. Saltboot .....                                                                | 3  |
| 2. Retail Installation                                                               | 5  |
| 2.1. Retail Requirements .....                                                       | 5  |
| 2.1.1. Server Requirements.....                                                      | 5  |
| 2.1.2. Branch Server Requirements .....                                              | 5  |
| 2.1.3. Build Host Requirements .....                                                 | 6  |
| 2.1.4. Network Requirements .....                                                    | 6  |
| 2.1.5. POS Terminal Requirements .....                                               | 6  |
| 2.2. Install Uyuni Retail Server with openSUSE .....                                 | 6  |
| 2.2.1. Install Uyuni on openSUSE Leap.....                                           | 7  |
| 2.3. Retail Uyuni Server Setup .....                                                 | 8  |
| 2.3.1. Set up Uyuni with YaST.....                                                   | 8  |
| 2.3.2. Create the Main Administration Account .....                                  | 9  |
| 2.4. Retail Uyuni Branch Server .....                                                | 9  |
| 2.4.1. Add Software Channels .....                                                   | 10 |
| 2.4.2. Check Synchronization Status .....                                            | 10 |
| 2.4.3. Trust GPG Keys on Clients .....                                               | 11 |
| 2.4.4. Create Activation Key for a Branch Server and the Retail Terminal Images..... | 11 |
| 2.4.5. Register the Branch Server and Terminals as Clients .....                     | 12 |
| 2.5. Network Architecture .....                                                      | 13 |
| 2.5.1. Branch Server Network Configuration .....                                     | 13 |
| 2.6. Set Up the Uyuni for Retail Environment .....                                   | 15 |
| 2.6.1. Prepare and Build Terminal Images .....                                       | 15 |
| 2.6.2. Configure Services on the Branch Server .....                                 | 16 |
| 2.6.3. Synchronize Images to the Branch Server .....                                 | 19 |
| 3. Deploying Terminals                                                               | 20 |
| 3.1. Deploy Terminals .....                                                          | 20 |
| 3.1.1. Create A Hardware Type Group.....                                             | 20 |
| 3.1.2. Assign and Configure the Saltboot Formula for Each Hardware Type Group.....   | 21 |
| 3.1.3. Synchronize Images to the Branch Server .....                                 | 21 |
| 3.1.4. Deploy Images to the Terminals .....                                          | 22 |
| 3.1.5. Re-Deploy Images to the Terminals .....                                       | 23 |
| 3.1.6. Customize the Terminal Image Download Process.....                            | 23 |
| 3.2. Deploy Terminals - Other Methods .....                                          | 24 |
| 3.2.1. Deploy Terminals with a Removable USB Device .....                            | 24 |
| 3.2.2. Deploy Terminals over a Wireless Network .....                                | 25 |

|                                                                    |    |
|--------------------------------------------------------------------|----|
| 3.3. Deploy Terminals and Auto-Accept Keys . . . . .               | 28 |
| 3.3.1. Configure Saltboot to Send Auto-Signed Grain Once . . . . . | 29 |
| 3.3.2. Configure Saltboot to Keep Auto-Signed Grains . . . . .     | 29 |
| 3.3.3. Configure Saltboot to Auto-Sign During PXE Boot . . . . .   | 30 |
| 3.3.4. Configure the Server to Auto-Accept . . . . .               | 30 |
| 3.4. Terminal Boot Process (Saltboot Diagram) . . . . .            | 31 |
| 3.5. Terminal Names . . . . .                                      | 33 |
| 3.5.1. Naming by <b>HWT</b> ype . . . . .                          | 33 |
| 3.5.2. Naming by <b>Hostname</b> . . . . .                         | 33 |
| 3.5.3. Naming by <b>FQDN</b> . . . . .                             | 34 |
| 3.5.4. Assign Hostnames to Terminals . . . . .                     | 34 |
| 3.6. Offline Use . . . . .                                         | 36 |
| 3.6.1. Offline Terminal Reboot . . . . .                           | 36 |
| 3.6.2. Cached Terminal Updates . . . . .                           | 36 |
| 3.7. Rate Limiting Terminals . . . . .                             | 37 |
| 3.7.1. Troubleshooting . . . . .                                   | 37 |
| 4. Introduction to Retail Formulas . . . . .                       | 38 |
| 4.1. Branch Server Formulas . . . . .                              | 38 |
| 4.2. Partitioning and Image Deployment Formula . . . . .           | 39 |
| 5. Administration . . . . .                                        | 40 |
| 5.1. Mass Configuration . . . . .                                  | 40 |
| 5.1.1. Branch Server Mass Configuration . . . . .                  | 40 |
| 5.1.2. Terminal Mass Configuration . . . . .                       | 41 |
| 5.1.3. Export Configuration to Mass Configuration File . . . . .   | 42 |
| 5.2. Example YAML File for Mass Configuration . . . . .            | 42 |
| 5.3. Delta Images . . . . .                                        | 44 |
| 5.3.1. Building Delta Images . . . . .                             | 44 |
| 5.3.2. Tuning Delta Generation . . . . .                           | 44 |
| 5.3.3. Image Synchronizing to the Branch Server . . . . .          | 44 |
| 5.4. Network Administration . . . . .                              | 45 |
| 6. Retail Migration . . . . .                                      | 46 |
| 6.1. Upgrade Uyuni for Retail Branch Server . . . . .              | 46 |
| 7. What Next? . . . . .                                            | 47 |
| 7.1. More Documentation . . . . .                                  | 47 |
| 7.2. Support . . . . .                                             | 47 |
| 8. GNU Free Documentation License . . . . .                        | 48 |

# Retail Guide Overview

**Updated:** 2022-09-30

Uyuni for Retail 2022.10 is an open source infrastructure management solution, optimized and tailored specifically for the retail industry. It uses the same technology as Uyuni, but is customized to address the needs of retail organizations.

Uyuni for Retail is designed for use in retail situations where customers can use point-of-service terminals to purchase or exchange goods, take part in promotions, or collect loyalty points. In addition to retail installations, it can also be used for novel purposes, such as maintaining student computers in an educational environment, or self-service kiosks in banks or hospitals.

Uyuni for Retail is intended for use in installations that include servers, workstations, point-of-service terminals, and other devices. It allows administrators to install, configure, and update the software on their servers, and manage the deployment and provisioning of point-of-service machines.

This guide provides an overview of Uyuni for Retail, and its initial installation and setup.

It should be read in conjunction with the Uyuni documentation suite, available from <https://www.uyuni-project.org/uyuni-docs>.

For more information about managing your Uyuni for Retail environment, or to find out where to get help, see **Retail > Retail-next**.

# Chapter 1. Components

Uyuni for Retail is made up of various components. For more on how these components work together, see [retail-network-arch.pdf](#).

## 1.1. The Uyuni Server

The Uyuni server contains information about infrastructure, network topology, and everything required to automate image deployment and perform day-to-day operations on branches and terminals. This can include database entries of registered systems, Salt pillar data for images, image assignments, partitioning, network setup, network services, and more.

## 1.2. Build Hosts

Build hosts can be arbitrary servers or virtual machines. They are used to securely build operating system images.

For more information on build hosts, see [Administration > Image-management](#).

## 1.3. Branch Servers

Branch servers should be physically located close to point-of-service terminals, such as in an individual store or branch office. Branch servers provide services for PXE boot, and act as an image cache, Salt broker, and proxy for software components (RPM packages). The branch server can also manage local networking, and provide DHCP and DNS services.

## 1.4. Point-of-Service Terminals

Point-of-Service (POS) terminals can come in many different formats, such as point-of-sale terminals, kiosks, digital scales, self-service systems, and reverse-vending systems. Every terminal, however, is provided by a vendor, who set basic information about the device in the firmware. Uyuni for Retail accesses this vendor information to determine how best to work with the terminal in use.

In most cases, different terminals will require a different operating system (OS) image to ensure they work correctly. For example, an information kiosk has a high-resolution touchscreen, where a cashier terminal might only have a very basic display. While both of these terminals require similar processing and network functionality, they will require different OS images. The OS images ensure that the different display mechanisms work correctly.

Uyuni for Retail supports POS terminals that boot using both BIOS and UEFI. For UEFI booting terminals, you will need to configure the EFI partition in the Saltboot formula. For more information on EFI in the Saltboot formula, see [Specialized-guides > Salt](#).

## 1.5. Fitting It All Together

Uyuni for Retail uses the same technology as Uyuni, but is customized to address the needs of retail organizations.

### 1.5.1. Hardware Types

Because every environment is different, and can contain many different configurations of many different terminals, Uyuni for Retail uses hardware types to simplify device management.

Hardware types allow you to group devices according to manufacturer and device name. Then all devices of a particular type can be managed as one.

### 1.5.2. Branch System Groups

Uyuni for Retail uses system groups to organize the various devices in your environment.

Each branch requires a system group, containing a single branch server, and the POS terminals associated with that server. Each system group is identified with a Branch ID. The Branch ID is used in formulas and scripts to automatically update the entire group.

### 1.5.3. Salt Formulas

Uyuni for Retail uses Salt formulas to help simplify configuration. Formulas are pre-written Salt states, that are used to configure your installation.

You can use formulas to apply configuration patterns to your hardware groups. Uyuni for Retail uses the Saltboot formula, which defines partitioning and OS images for terminals.

You can use default settings for formulas, or edit them to make them more specific to your environment.

For more information about formulas, see [Retail > Retail-formulas-intro](#).

### 1.5.4. Saltboot

Saltboot is a collection of tools and processes that are used to bootstrap, deploy and validate Uyuni for Retail terminals.

Saltboot consists of:

- Initialization:

The saltboot **initrd** is created during image building and is required for bootstrapping terminals.

- Saltboot state:

The Salt state that contains the logic for the entire saltboot process.

- 
- Partitioning pillars:

The Salt pillar structure that describes how terminals are partitioned and what image is deployed on each terminal.

- Images and boot images pillars:

When the image building feature in Uyuni successfully builds an image that contains the saltboot **initrd**, the image and boot image Salt pillars are created.

The saltboot process involves the Uyuni Server, a terminal running the saltboot **initrd**, and the branch server providing the saltboot services to the terminal.

For a detailed diagram explaining how the saltboot boot process works, see [Retail > Retail-saltboot-diagram](#).

# Chapter 2. Retail Installation

Uyuni Retail Server and Uyuni Retail Branch Server are installed on top of openSUSE Leap.

## 2.1. Retail Requirements

Before you install Uyuni for Retail, ensure your environment meets the minimum requirements. This section lists the requirements for the Uyuni for Retail installation. These requirements are in addition to the Uyuni requirements listed at **Installation-and-upgrade > General-requirements**.



Uyuni for Retail is tested on x86-64 architecture.

### 2.1.1. Server Requirements

*Table 1. Hardware Requirements for Uyuni Server*

| Hardware    | Recommended                                                                  |
|-------------|------------------------------------------------------------------------------|
| CPU         | Minimum 4 dedicated 64-bit CPU cores                                         |
| RAM:        | <i>Test Server</i> Minimum 8 GB                                              |
|             | <i>Base Installation</i> Minimum 16 GB                                       |
|             | <i>Production Server</i> Minimum 32 GB                                       |
| Disk Space: | / (root) 24 GB                                                               |
|             | /var/lib/pgsql Minimum 50 GB                                                 |
|             | /srv Minimum 50 GB                                                           |
|             | /var/spacewalk Minimum 50 GB per SUSE product and 360 GB per Red Hat product |

### 2.1.2. Branch Server Requirements

*Table 2. Hardware Requirements for Branch Server*

| Hardware    | Recommended                           |
|-------------|---------------------------------------|
| CPU         | Minimum 2 dedicated 64-bit CPU cores  |
| RAM:        | <i>Test Server</i> Minimum 2 GB       |
|             | <i>Production Server</i> Minimum 8 GB |
| Disk Space: | / (root) Minimum 24 GB                |
|             | /srv Minimum 100 GB                   |

| Hardware | Recommended               |
|----------|---------------------------|
|          | /var/cache Minimum 100 GB |

### 2.1.3. Build Host Requirements

Table 3. Hardware Requirements for Build Host

| Hardware    | Recommended                           |
|-------------|---------------------------------------|
| CPU         | Multi-core 64-bit CPU                 |
| RAM:        | <i>Test Server</i> Minimum 2 GB       |
|             | <i>Production Server</i> Minimum 4 GB |
| Disk Space: | / (root) Minimum 24 GB                |
|             | /var/lib/Kiwi Minimum 10 GB           |

### 2.1.4. Network Requirements

- The Uyuni Server requires a reliable and fast WAN connection.
- The branch server requires a reliable WAN connection, to reach the Uyuni Server.
- If you are using a dedicated network, the branch server requires at least two network interfaces: one connected to the WAN with a reachable Uyuni Server, and one connected to the internal branch LAN.
- Terminals require a LAN connection to the branch server network.

### 2.1.5. POS Terminal Requirements

Table 4. Hardware Requirements for Terminals

| Hardware    | Recommended                                                                           |
|-------------|---------------------------------------------------------------------------------------|
| RAM:        | Minimum 1 GB for hosts that need to run OS images built with Kiwi (PXE booted or not) |
| Disk Space: | Disk space depends on size of the OS image                                            |

For more information on Uyuni for Retail POS terminals, see documentation on Uyuni Salt clients ([Client-configuration > Client-config-overview](#)).

## 2.2. Install Uyuni Retail Server with openSUSE

Uyuni for Retail Server can be installed on openSUSE.

For general requirements, see **Installation-and-upgrade > Uyuni-install-requirements**.



For more information about the latest version and updates of openSUSE Leap, see <https://doc.opensuse.org/release-notes/>.

### 2.2.1. Install Uyuni on openSUSE Leap

You install Uyuni as an add-on to openSUSE Leap.

*Procedure: Installing Uyuni on openSUSE Leap*

1. As the base system, install openSUSE Leap with all available service packs and package updates applied.
2. Configure a resolvable fully qualified domain name (FQDN) with **yast > System > Network Settings > Hostname/DNS**.
3. Set variables to use to create repository:

```
repo=repositories/systemsmanagement:/  
repo=${repo}Uyuni:/Stable/images/repo/Uyuni-Server-POOL-x86_64-Media1/
```

4. Add the repository for installing the Uyuni Server software as **root**:

```
zypper ar https://download.opensuse.org/$repo uyuni-server-stable
```

5. Refresh metadata from the repositories as **root**, and confirm the import of new GPG key into the keyring:

```
zypper ref
```

6. Install the pattern for the Uyuni Server as **root**:

```
zypper in patterns-uyuni_server
```

7. Install the pattern for the Uyuni for Retail product as **root**:

```
zypper in patterns-uyuni_retail
```

8. Reboot the Uyuni for Retail Server.

Continue with the server setup as described in **Installation-and-upgrade > Uyuni-server-setup**.

## 2.3. Retail Uyuni Server Setup

This section covers Uyuni for Retail Server setup, using these procedures:

- Set up Uyuni with YaST
- Create the main administration account
- Add Software Channels
- Check Synchronization Status
- Trust GPG Keys on Clients
- Register the Branch Server and Terminals as Clients

### 2.3.1. Set up Uyuni with YaST

This section guides you through Uyuni setup procedures.

*Procedure: Uyuni Setup*

1. On the Uyuni Server, at the command prompt, as root, start YaST:

```
yast2
```

2. Navigate to **Network Services > Uyuni Setup** to begin set up.
3. From the introduction screen, select **Uyuni Setup > Set up Uyuni from scratch** and click **[Next]** to continue.
4. Type an email address to receive status notifications and click **[Next]** to continue. Uyuni can sometimes send a large volume of notification emails. You can disable email notifications in the Web UI after setup, if you need to.
5. Type your certificate information and provide a password. Passwords must be at least seven characters in length, and must not contain spaces, single or double quotation marks (' or "'), exclamation marks (!), or dollar signs (\$). Always store your passwords in a secure location. You must have the certificate password to set up the Uyuni Proxy.

Click btn:[Next] to continue.

6. Navigate to **Uyuni Setup > Database Settings** screen, type a database username and password, and click **[Next]** to continue. Passwords must be at least seven characters in length, and must not contain spaces, single or double quotation marks (' or "'), exclamation marks (!), or dollar signs (\$). Always store your passwords in a secure location.

Click btn:[Next] to continue.

7. Click [**Yes**] to begin the setup process.
8. When setup is complete, click [**Next**] to continue. Take note of the address to access the Uyuni Web UI.
9. Click [**Finish**] to complete Uyuni setup.

### 2.3.2. Create the Main Administration Account

This section covers how to create your organization's main administration account for Uyuni.



The main administration account has the highest authority within Uyuni. Ensure you keep access information for this account secure. We recommend that you create lower level administration accounts for organizations and groups. Do not share the main administration access details.

*Procedure: Setting Up the Main Administration Account*

1. In your web browser, enter the address for the Uyuni Web UI. This address was provided after you completed setup. For more information, see [retail:retail-uyuni-server-setup.pdf](#).
2. Sign in to the Web UI, navigate to the **Create Organization > Organization Name** field, and enter your organization name.
3. In the **Create Organization > Desired Login** and **Create Organization > Desired Password** fields, enter your username and password.
4. Complete the **Account Information** fields, including an email for system notifications.
5. Click [**Create Organization**] to finish creating your administration account.

When you have completed the Uyuni Web UI setup, you are taken to the **Home > Overview** page.

## 2.4. Retail Uyuni Branch Server

This section covers Uyuni for Retail Branch Server installation and setup, using these procedures:

- Add Software Channels
- Check Synchronization Status
- Trust GPG Keys on Clients
- Register the Branch Server and Terminals as Clients

The Uyuni for Retail Branch Server is a Uyuni Proxy with additional Retail features. For proxy installation procedures, see **Installation-and-upgrade > Install-proxy-uyuni** and **Installation-and-upgrade > Uyuni-proxy-setup**.

Then continue with the following sections.

## 2.4.1. Add Software Channels

Before you register Uyuni branch servers and terminals to your Uyuni Server, check that you have the openSUSE product enabled, and the required channels are fully synchronized.

The products you need for this procedure are:

*Table 5. OpenSUSE Channels - CLI*

| OS Version         | Base Channel       | Client Channel                  | Updates Channel            | Non-OSS Channel            | Non-OSS Updates Channel            | Backports Updates Channel            | SLE Updates Channel            |
|--------------------|--------------------|---------------------------------|----------------------------|----------------------------|------------------------------------|--------------------------------------|--------------------------------|
| openSUSE Leap 15.4 | opensuse_1 eap15_4 | opensuse_1 eap15_4-uyuni-client | opensuse_1 eap15_4-updates | opensuse_1 eap15_4-non-oss | opensuse_1 eap15_4-non-oss-updates | opensuse_1 eap15_4-backports-updates | opensuse_1 eap15_4-sle-updates |

*Procedure: Adding Software Channels at the Command Prompt*

- At the command prompt on the Uyuni Server, as root, use the `spacewalk-common-channels` command to add the appropriate channels:

```
spacewalk-common-channels \
<base_channel_name> \
<child_channel_name_1> \
<child_channel_name_2> \
... <child_channel_name_n>
```

- Synchronize the channels:

```
mgr-sync refresh --refresh-channels
```

## 2.4.2. Check Synchronization Status

*Procedure: Checking Synchronization Progress*

- In the Uyuni Web UI, navigate to **Software > Manage > Channels**, then click the channel associated to the repository.
- Navigate to the **Repositories** tab, then click **Sync** and check **Sync Status**.

*Procedure: Checking Synchronization Progress from the Command Prompt*

- At the command prompt on the Uyuni Server, as root, use the `tail` command to check the synchronization log file:

```
tail -f /var/log/rhn/reposync/<channel-label>.log
```

- Each child channel generates its own log during the synchronization progress. You will need to check all the base and child channel log files to be sure that the synchronization is complete.



openSUSE channels can be very large. Synchronization can sometimes take several hours.

### 2.4.3. Trust GPG Keys on Clients

By default, some operating systems do not trust the GPG key for the Uyuni client tools. The clients can be successfully bootstrapped without the GPG key being trusted. However, you will not be able to install new client tool packages or update them until the keys are trusted.

*Procedure: Trusting GPG Keys on Clients*

- On the Uyuni Server, at the command prompt, check the contents of the `/srv/www/htdocs/pub/` directory. This directory contains all available public keys. Take a note of the key that applies to the client you are registering.
- Open the relevant bootstrap script, locate the `ORG_GPG_KEY=` parameter and add the required key. For example:

```
uyuni-gpg-pubkey-0d20833e.key
```

You do not need to delete any previously stored keys.  
 If you are bootstrapping clients from the {productname} {webui}, you will need to use a Salt state to trust the key.  
 Create the Salt state and assign it to the organization.  
 You can then use an activation key and configuration channels to deploy the key to the clients.

### 2.4.4. Create Activation Key for a Branch Server and the Retail Terminal Images

The branch server is based on the Uyuni Proxy. Its activation key must contain these child channels:

- openSUSE Leap 15.4 Updates (x86\_64)
- Uyuni Client Tools for openSUSE Leap 15.4 (x86\_64)
- Uyuni Proxy Stable for openSUSE Leap 15.4 (x86\_64)

The activation key for retail terminal images based on openSUSE Leap 15.4 must contain these child channels:

- openSUSE Leap 15.4 Updates (x86\_64)
- Uyuni Client Tools for openSUSE Leap 15.4 (x86\_64)

For more information about creating activation keys, see [Client-configuration > Activation-keys](#).

## 2.4.5. Register the Branch Server and Terminals as Clients

You register both the branch server and the terminals as openSUSE clients. To register your openSUSE clients, you need a bootstrap repository. By default, bootstrap repositories are automatically created, and regenerated daily for all synchronized products. You can manually create the bootstrap repository from the command prompt, using this command:

```
mgr-create-bootstrap-repo --with-custom-channels
```

For more information on registering your clients, see [Client-configuration > Registration-overview](#).

### 2.4.5.1. Register the Branch Server

A retail branch server is registered as an openSUSE proxy. The proxy can be bootstrapped using the Web UI, or at the command prompt. Ensure you use the activation key you created for the proxy.

For more information about proxies, see [Installation-and-upgrade > Uyuni-proxy-registration](#). For more information about activation keys, see [Client-configuration > Activation-keys](#).

*Procedure: Setting Up the Uyuni Proxy*

1. Check that the [Uyuni Proxy Stable for openSUSE Leap 15.4 \(x86\\_64\)](#) channel is assigned to the proxy on the system profile page.
2. At the command prompt on the proxy, as root, install the proxy pattern:

```
zypper in -t pattern uyuni_proxy
```

3. Finalize the proxy setup:

```
configure-proxy.sh
```

[command]``configure-proxy.sh`` is an interactive script.  
For more information about the proxy setup script, see [xref:installation-and-upgrade:uyuni-proxy-setup.adoc#uyuni-proxy-setup-confproxy\[\]](#).

4. OPTIONAL: If you want to use the same system also as a build host, navigate to the client's system profile and check [OS Image Build Host](#) as a [Add-On System Types](#).
5. Configure the proxy to become a branch server. On the Uyuni for Retail Server, for example, run:

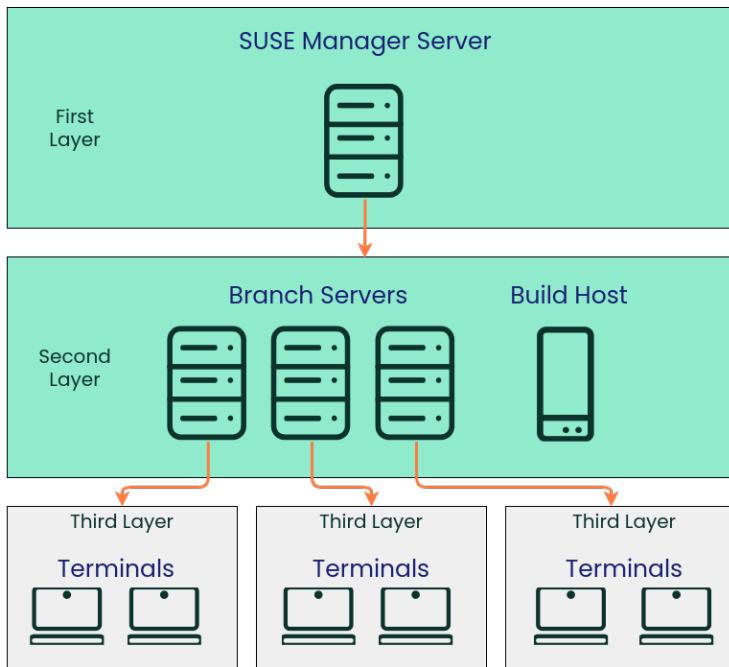
```
retail_branch_init <branch_server_minion_id> --dedicated-nic eth1 \
--branch-ip 192.168.7.5 \
--netmask 255.255.255.0 \
--dyn-range 192.168.7.100 192.168.7.200 \
--server-domain branch.example.org \
--branch-prefix uyuni
```

For additional options, use the [command]`'retail\_branch\_init --help`` command.

## 2.5. Network Architecture

Uyuni for Retail uses a layered architecture:

- The first layer contains the Uyuni Server.
- The second layer contains one or more branch servers to provide local network and boot services. It also contains one or more build hosts.
- The final layer contains any number of deployed point-of-service terminals.



Branch servers should be physically located close to point-of-service terminals, such as in an individual store or branch office. We recommend you have a fast network connection between the branch server and its terminals. Branch servers provide services for PXE boot, and act as an image cache, Salt broker, and proxy for software components (RPM packages). The branch servers can also manage local networking, and provide DHCP and DNS services.

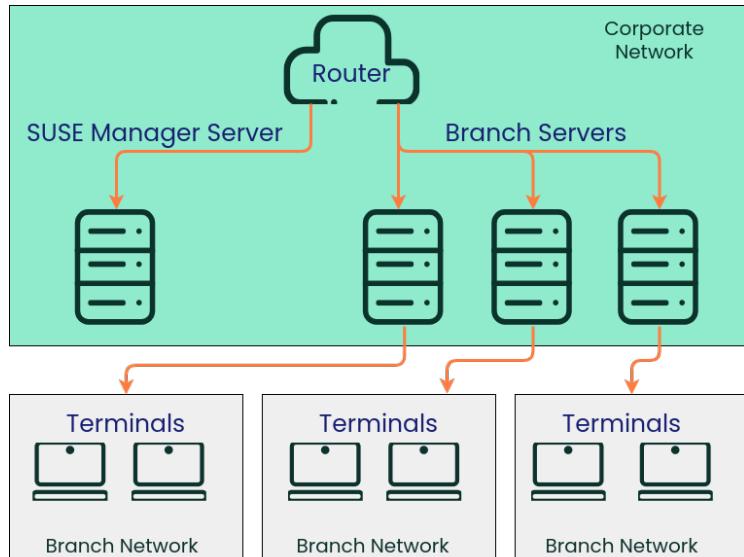
Uyuni for Retail Branch Servers are implemented as enhanced Uyuni Proxies. For technical background information on Uyuni Proxies, see [Installation-and-upgrade > Install-proxy-uyuni](#).

### 2.5.1. Branch Server Network Configuration

You can use branch servers in different network configurations, depending on your installation requirements.

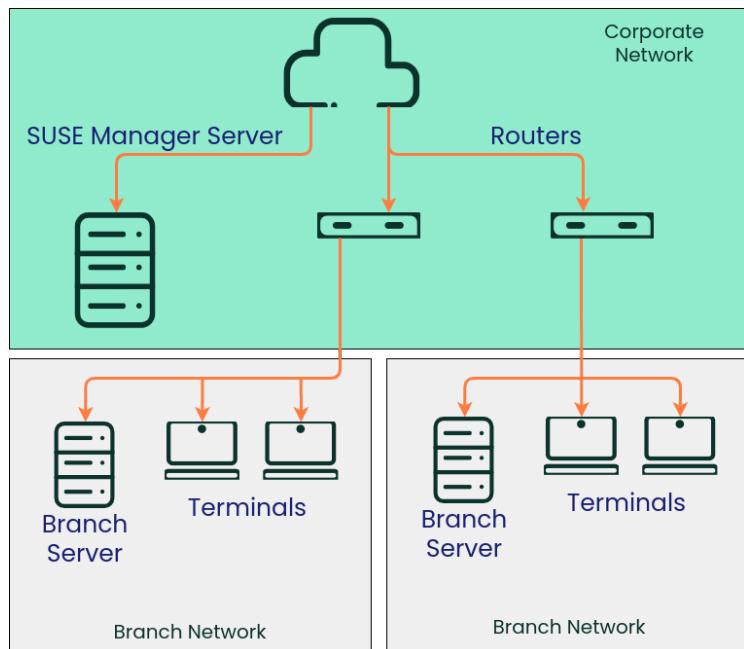
## Dedicated Network Architecture

The branch servers are in the same network as the Uyuni Server, and terminals use an isolated branch network. In this configuration, the branch servers are in the corporate network, and provide all DHCP, DNS, PXE, FTP, and TFTP services to the terminals in the branch networks.



## External Network Architecture

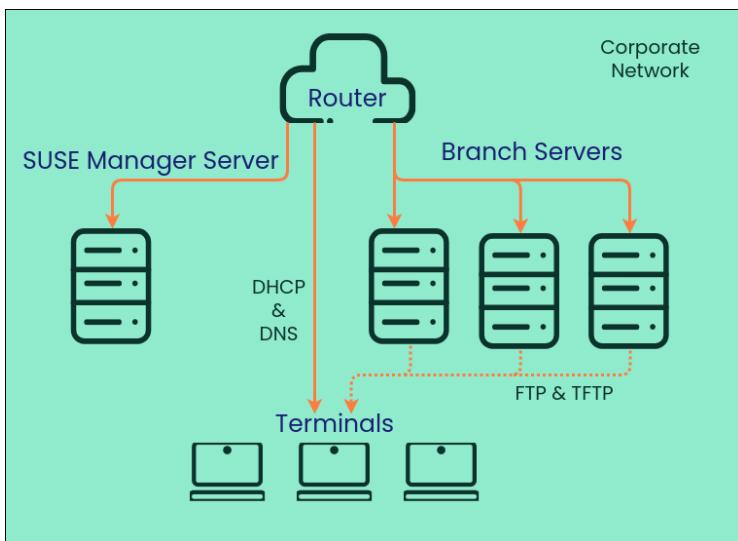
The branch servers are in separate branch networks, along with the terminals they manage. In this configuration, external routers provide DHCP and DNS services to the branch servers and the terminals, and the branch server provides PXE, FTP, and TFTP services to the terminals in their branch network.



## Shared Network Architecture

The branch server and the terminals are connected to the same network as the Uyuni Server. In this configuration, external routers provide DHCP and DNS services to the branch servers and the

terminals, and the branch server provides PXE, FTP, and TFTP services to the terminals in their branch network.



For more information about network administration on Uyuni for Retail, see [Retail > Retail-admin-network](#).

## 2.6. Set Up the Uyuni for Retail Environment

To set up the Uyuni for Retail environment, you will need to have already installed and configured Uyuni Server, have one or more Uyuni for Retail branch server, and one or more Uyuni build host.

This section covers how to configure your Uyuni for Retail environment, including:

- \* Prepare POS images
- \* Configure services on the branch server
- \* Synchronize POS images to the branch servers

The very first time you set up the Uyuni for Retail environment, you will need to perform all three steps. You will need to revisit some of these steps later on as you are working with Uyuni for Retail.

For example, the first time you configure the branch server, you will need to have images prepared for synchronization. If you are configuring more than one branch server, you can use the same images across different branch servers.

If you have an existing environment, and need to build new images, you do not need to re-initialize the branches. You will need to synchronize the images, and can skip setting up the services on the branch server.

Usually, POS images are rebuilt when updated packages are available, and synchronized to the branch servers before the update window opens.

### 2.6.1. Prepare and Build Terminal Images

For information about Uyuni image building, see [Administration > Image-management](#).

Uyuni for Retail POS images are images specifically tailored for Uyuni for Retail environment and

designed to be deployed using PXE booting mechanism.

### 2.6.1.1. POS Image Templates

As starting point, SUSE provides basic templates at <https://github.com/SUSE/manager-build-profiles/tree/master/OSImage>. These templates need to be adapted for specific usecases, for example by including specific applications, configuration settings, and users.



By default, POS templates do not include a system user. You will not be able to login as a user to a system that has been installed with a SUSE provided template. However you can use Salt to manage clients without a system user. You can use Salt to install a system user after the terminal has been deployed.

### 2.6.1.2. SLES 11 SP 3 Terminals

POS Terminals based on SUSE Linux Enterprise Server 11 SP 3 can be deployed in much the same way as other terminals, with a few differences.

- You must use the SLES 11 template
- SLES 11 images need to be activated with the **SLES11 SP3 i586** and **SLEPOS 11 SP3 i586** channels



Ensure that SLES 11 images are built on the SLES 11 build host. Building on the incorrect build host will cause your build to fail.



If you are building images for SLES 11 using profiles from an HTTPS git repository that uses TLS 1.0 or greater, it will fail. SLES 11 does not support later versions of TLS. You will need to clone the repository locally to use it for building.

### 2.6.2. Configure Services on the Branch Server

Before you configure the branch server, ensure you have decided on networking topology, and know the minion ID of the branch server. For the information about the possible network topologies, see **Retail > Retail-network-arch**.



In case you plan to use the branch server as a monitoring server with Prometheus, be aware that Prometheus demands additional hardware resources. For more information about installing Prometheus, see **Administration > Monitoring**.



In case you plan to use the branch server with Ansible software, be aware that Ansible demands additional hardware resources. For more information about installing Ansible, see **Administration > Ansible-integration**.

Configure branch server services from the Uyuni Server. The configuration is then applied to the selected branch server using Salt states. Uyuni Formulas with Forms functionality is used to configure branch server services. However, there are multiple ways to configure these services:

- Uyuni for Retail provided command line tool `retail_branch_init`
- Uyuni for Retail provided mass import command line tool `retail_yaml`
- Uyuni web UI and configuring formulas manually (for advanced users)

The branch server can be configured automatically using the `retail_branch_init` command, as shown in this section. If you prefer to manually configure the branch server, you can do so using formulas. For more information about formulas, see [Retail > Retail-formulas-intro](#).

*Procedure: Configuring Branch Server Formulas With a Helper Script*

1. Branch server configuration is performed using the `retail_branch_init` command:

```
retail_branch_init <branch_server_minion_id>
```

This command will configure branch server formulas with default values and for shared networking topology. For dedicated network topology run this command:

```
retail_branch_init <branch_server_minion_id> --dedicated-nic <network_device>
```

You can customize network information as well, together with custom `branch_prefix`. For example:

```
retail_branch_init <branch_server_minion_id> --dedicated-nic eth1 \
--branch-prefix B001 \
--server-domain <branch_server_subdomain> \
--branch-ip 192.168.86.1 \
--netmask 255.255.255.0
```

You can use the `retail_branch_init --help` command for additional options.

2. Verify that your changes have been configured correctly by checking the Uyuni Web UI branch server system formulas.
3. Apply highstate on the branch server. You can do this through the Web UI, or by running this command:

```
salt <branch_server_minion_id> state.apply
```

Similar results can be achieved by using mass import command line tool.

*Procedure: Configuring Branch Server Formulas With a Mass Import Tool*

## 1. Prepare branch specific YAML file:

For example, create branch.yaml file with content:

```
branches:
  <branch_server_minion_id>:
    branch_prefix: branch1
    server_name: branchserver1
    server_domain: example.com
    nic: eth1
    dedicated_nic: true
    configure_firewall: true
    branch_ip: 192.168.2.1
    netmask: 255.255.255.0
    dyn_range:
      - 192.168.2.10
      - 192.168.2.250
```

For more information about mass import tool, see [Retail > Retail-mass-config](#).

## 2. Import branch information from YAML file to Uyuni

```
retail_yaml --from-yaml branch.yaml
```

3. Verify that your changes have been configured correctly by checking the Uyuni Web UI branch server system formulas.
4. Apply highstate on the branch server.



Both `retail_branch_init` and `retail_yaml` commands override existing configuration settings of the specified branch server.

After the initial configuration done by command line tools, branch server configuration can be further adjusted in Uyuni Web UI through branch server formulas.

### 2.6.2.1. Required System Groups

Uyuni for Retail requires system groups for terminals and servers. Manually create these system groups during installation:

- TERMINALS
- SERVERS

Additionally, you will need to create a system group for each branch server, and each terminal hardware type in your environment. For more information about hardware type groups, see [Retail > Retail-deploy-terminals](#).

Branch server groups are named after branch server prefixes, for example group name `B0001` for branch server prefix `B001`.

You can create system groups using the Uyuni Web UI. Navigate to **Systems > System Groups** and click [**Create System Group**].

For more information about system groups, see **Reference > Systems**.



Uyuni for Retail command line tools create required system groups and branch group automatically.

### 2.6.3. Synchronize Images to the Branch Server

The OS image you use on the Uyuni server must be synchronized for use to the branch server. You can do this with the Salt **image-sync** state, part of the **Image Synchronization Formula**.

*Procedure: Synchronizing Images to the Branch Server*

1. On the Uyuni server, run this command:

```
salt <branch_server_minion_id> state.apply image-sync
```

2. The image details will be transferred to **/srv/saltboot** on the branch server.

You can also set synchronization to run automatically on the branch server. Configure the image synchronization formula to apply the highstate regularly. For more information about **Image Synchronization Formula**, see **Specialized-guides > Salt**.

# Chapter 3. Deploying Terminals

This section covers how to integrate terminals into your Uyuni for Retail environment. You can prepare the Uyuni for Retail installation for image deployment. Finally, you can deploy terminals using network boot and other methods.

## 3.1. Deploy Terminals

When you have the Uyuni Server and Branch Server set up, you are ready to deploy point-of-service terminals by following these steps:

1. Create hardware type groups
2. Assign and configure the Saltboot formula for each hardware type group
3. Synchronize images to the branch server
4. Deploy images to the terminals

Each procedure is detailed in this section.

For other methods of booting terminals, including using a USB device, or booting over a wireless network, see [Retail > Retail-deploy-terminals-other](#).

For Uyuni 4.2 and later, terminals can be either x86-64 or ARM64 architecture. For earlier versions, terminals must be x86 architecture only.

If you have many terminals, you can handle them with a script. For more information, see [Retail > Retail-mass-config](#).

Before terminals can be deployed, ensure you have prepared a Saltboot-based operating system image. For more information about building OS images, see [Administration > Image-management](#).



After you have registered new terminals, always check the Uyuni Web UI to ensure your terminals have connected successfully to the branch server. The terminals must not have directly connected to the Uyuni Server by mistake.

### 3.1.1. Create A Hardware Type Group

Each terminal requires a specific hardware type, which contains information about the product name and terminal manufacturer. However, at the beginning, the Uyuni database does not have this information. To tell Uyuni what image to deploy on each terminal, you can set hardware type groups. After you have created a new hardware type group, you can apply the Saltboot formula to the group and configure it for your environment.

Hardware types allow you to group devices according to manufacturer and device name. Then, all devices of a particular type can be managed as one.

Empty profiles can be assigned to a hardware type group either before or after registration. If an empty profile is not assigned to a hardware type group before registration, it will be assigned to group that best matches the product information available to it.

For this procedure, you will require the system manufacturer name and product name for your terminal.

*Procedure: Creating a Hardware Type Group*

1. Determine the hardware type group name. Prefix the name with **HWTYPE:**, followed by the system manufacturer name and product name, separated by a hyphen. For example:

```
HWTYPE:POSVendor-Terminal1
```

2. In the Uyuni Web UI, navigate to **Systems > System Groups**, and click the **[Create Group]** button.
3. In the **Create System Group** dialog, create a new system group, using the hardware type group name you determined in step one of this procedure.



Only use colons, hyphens, or underscores in hardware type group names. Spaces and other non-alphanumeric characters will be removed when the name is processed.

### 3.1.2. Assign and Configure the Saltboot Formula for Each Hardware Type Group

Each hardware type group must have the Saltboot formula applied.

*Procedure: Assigning the Saltboot Formula*

1. Open the details page for your new hardware type group, and navigate to the **Formulas** tab.
2. Select the Saltboot formula and click **[Save]**.
3. Navigate to the **Formulas > Saltboot** tab.
4. Configure the Saltboot formula. For more information about the Saltboot formula, see **Specialized-guides > Salt**.

### 3.1.3. Synchronize Images to the Branch Server

*Procedure: Synchronizing Images to the Branch Server*

1. On the Uyuni server, run this command:

```
salt <branch_server_salt_id> state.apply image-sync
```

#### 3.1.3.1. Using a SUSE Linux Enterprise Server11 SP3 32-bit based images

If you have 32-bit machines included in your branch, then you must use a 32-bit boot image as a default

boot image.



- If a 32-bit boot image is not used as a default boot image, 32-bit terminals will be unable to boot and operate properly.

Check the available boot images and their architecture from the command line:

```
salt <branch_server_salt_id> pillar.item boot_images
```

Output:

```
POS_Image_JeOS6-6.0.0:
-----
arch:
  x86_64
...
legacy-6.0.0:
-----
arch:
  i686
```

In this example, the **legacy-6.0.0** boot image is 32-bit.

You can set the default boot image in the **Image Synchronization** formula on the branch server, by adding the chosen boot image name to the **Default boot image** field. For more information about **Image Synchronization** formula, see **Specialized-guides > Salt**.

The screenshot shows the SUSE Manager web interface. On the left, there's a sidebar with navigation links like Home, Systems, Overview, System Groups, System Set Manager, Bootstrapping, Visualization, Advanced Search, Activation Keys, Stored Profiles, Custom System Info, Autoinstallation, Software Crashes, and Virtual Host Managers. The main content area has a header 'proxy.tf.local'. Below the header, there are tabs: Details, Software, Configuration, Provisioning, Groups, Audit, Status, **Image Synchronization**, Locale, Pxe, Tftpd, Vtftpd, and Bind. Under the 'Image Synchronization' tab, there's a sub-section titled 'Image Synchronization' with a note: 'On this page you can configure Salt Formulas to automatically install and configure software'. It includes fields for 'Include Image Synchronization in Highstate' (with a checked checkbox), 'Synchronize only the listed images' (with a dropdown menu), and a 'Default boot image' input field containing 'POS\_Image\_JeOS6\_SLE11-6.0.0'. At the bottom right of the sub-section, there are 'Save Formula' and 'Clear values' buttons.

### 3.1.4. Deploy Images to the Terminals

When you have your bootstrap image ready, you can deploy the image to the terminals.

#### *Procedure: Deploying Images to the Terminals*

1. Power on your POS terminals.
2. The branch server will bootstrap the terminals according to the data you have provided.

### 3.1.5. Re-Deploy Images to the Terminals

You can instruct terminals to download and deploy images when they are restarted. This is achieved using a Salt state.

*Procedure: Forcing a Terminal to Re-Deploy Images*

1. On the Uyuni Server, at the command prompt, as root, apply this Salt state:

```
salt $terminal_minion_id state.apply saltboot.force_redeploy
```

2. Restart the terminal to pick up the changes.

If your terminal encounters a problem with the file system or the partition table, you might need to remove the partition table and reformat the terminal.



- Re-partitioning a terminal removes all data stored on the terminal hard disk, including any persistent partitions.

*Procedure: Forcing a Terminal to Re-partition the Hard Disk*

1. On the Uyuni Server, at the command prompt, as root, apply this Salt state:

```
salt $terminal_minion_id state.apply saltboot.force_repartition
```

2. Restart the terminal to pick up the changes.

### 3.1.6. Customize the Terminal Image Download Process

You can change the terminal boot process using Salt pillars. Two Salt pillars allow you to change the protocol and server used to download the image.

- The `saltboot_download_protocol` pillar specifies which protocol should be used to download the image to the terminal. This overrides the default protocol specified in the image pillar. Allowed values are `http`, `https`, `ftp`, or `tftp`.
- The `saltboot_download_server` pillar specifies which server to use to download the image. This overrides the default hostname specified in the image pillar.

*Example: Changing the Saltboot Image Download Protocol*

This example changes the protocol used for all terminals.

Edit the `/srv/pillar/top.sls` file:

```
base:
  '*':
    - saltboot_proto
```

Edit the `/srv/pillar/saltboot_proto.sls` file:

```
saltboot_download_protocol: http
# can be http, https, ftp, tftp
```

*Example: Changing the Saltboot Image Download Location*

This example changes the download location for all terminals on a specified branch server.

Edit the `/srv/pillar/top.sls` file:

```
base:
'minion_id_prefix:$branch_prefix':
  - match: grain
  - $branch_prefix
```

Edit the `/srv/pillar/$branch_prefix.sls` file:

```
saltboot_download_server: $download_server_fqdn
```



In this example, the download server must be prepared by the `image_sync` state before you begin.

## 3.2. Deploy Terminals - Other Methods

If you are not able to boot terminals from the network, you can create a live USB image and deploy terminals using a removable USB storage device. You can also bootstrap terminals across a wireless network.



Hardware type groups must be created and images must be synchronized before continuing. For more information, see **Retail > Retail-deploy-terminals**.



After you have registered new terminals, always check the Uyuni Web UI to ensure your terminals have connected successfully to the branch server, and not directly to the Uyuni Server by mistake.

### 3.2.1. Deploy Terminals with a Removable USB Device

If you do not want to boot terminals from the network, you can create a live USB image and deploy terminals using a removable USB storage device. This is useful if you cannot boot your terminals from the network, or if you do not have a local Uyuni for Retail branch server providing network services.

You can prepare a bootable USB device with the image and tools required to deploy a POS terminal using a remote Uyuni for Retail branch server. You can create the bootable USB device on the branch server

directly, or on the Uyuni for Retail Server.



POS devices booted using the USB device are assigned to the Uyuni for Retail branch server that created the USB device.

*Procedure: Creating a Bootable USB Device*

1. On the Uyuni for Retail branch server, at the command prompt, as root, create the POS image.

You need to specify the size of the image, in megabytes.

Ensure you allow at least 300 MB:

```
salt-call image_sync_usb.create <usb image name> <size in MB>
```

2. Insert the USB device into the Uyuni for Retail branch server machine, and copy the image to the new location:

```
dd bs=1M if=<usb image name> of=<path to usb device>
```

When you have the image on the USB drive, check that the terminals you want to deploy allow local booting. You can check this by editing the Saltboot formula in the Uyuni for Retail Web UI. For more information about the Saltboot formula, see **Specialized-guides > Salt**.

*Procedure: Deploying Images to the Terminals using USB*

1. Insert the USB device into the terminal.
2. Power on the POS terminal.
3. Boot from the USB device to begin bootstrapping.

### 3.2.2. Deploy Terminals over a Wireless Network

For terminals that cannot be connected directly to the physical network, you can deploy them over a wireless network. Wireless networks do not support PXE booting, so you must perform the initial booting and initialization of the wireless connection on the terminal using a USB device.

For more information about using USB devices to boot, see **Retail > Retail-deploy-terminals-other**.



Bootstrapping across a wireless network could expose a security risk if you are using encrypted OS images. The boot **initrd** image and the partition that contains **/etc/salt** must be stored unencrypted on the terminal. This allows Uyuni for Retail to set up the wireless network. If this breaches your security requirements, you will need to use a separate production network, with network credentials managed by Salt, so that credentials are not stored on the terminal unencrypted.

Before you begin, you need to have created a bootable USB device. Ensure that the OS image you use to create the USB device has the **dracut-wireless** package included. For more information about using USB devices to boot, see **Retail > Retail-deploy-terminals-other**.

When you have created the USB device, you need to provide the wireless credentials to the terminal. You can do this in a number of ways:

- Directly during image build.
- Add it to the **initrd** file on the branch server.
- During terminal booting, using the kernel command line.

*Procedure: Providing Wireless Credentials During Image Build*

1. Ensure that the **dracut-wireless** package is included in the image template.
2. Set the wireless credentials by creating or editing the **etc/sysconfig/network/ifcfg-wlan0** file to the image template, with these details:

```
# ALLOW_UPDATE_FROM_INITRD
WIRELESS_ESSID=<wireless network name>
WIRELESS_WPA_PSK=<wireless network password>
```

If you want to use different credentials for bootstrapping to what is used during normal operation, you can remove the **ALLOW\_UPDATE\_FROM\_INITRD** line.

3. Build the image.
4. Prepare a USB device using this image, and boot the terminal. For more information about using USB devices to boot, see **Retail > Retail-deploy-terminals-other**.

*Procedure: Providing Wireless Credentials with initrd*

1. Set the wireless credentials by creating or editing the **etc/sysconfig/network/ifcfg-wlan0** file, with these details:

```
# ALLOW_UPDATE_FROM_INITRD
WIRELESS_ESSID=<wireless network name>
WIRELESS_WPA_PSK=<wireless network password>
```

2. Copy the file to **initrd** on the branch server:

```
echo ./etc/sysconfig/network/ifcfg-wlan0 | cpio -H newc -o | gzip >>
/srv/saltboot/boot/initrd.gz
```

3. Check that the terminals you want to deploy allow local booting. You can check this by editing the Saltboot formula in the Uyuni for Retail Web UI. For more information about the Saltboot formula, see **Specialized-guides > Salt**.

**Procedure: Providing Wireless Credentials During Terminal Boot**

1. Mount the USB device on the terminal, and boot from it.
2. Append these commands to the kernel boot parameters:

```
WIRELESS_ESSID=<wireless_network_name>
WIRELESS_WPA_PSK=<wireless_network_password>
```

**3.2.2.1. Change Wireless Credentials**

After you have set the wireless credentials, you can change them as needed. The way to do this is different if you use one company-wide network, or if you have each branch server on its own separate network.

**Procedure: Changing Wireless Credentials for Single Network**

1. Rebuild the boot image with updated credentials.
2. Recreate the bootable USB device based on the new boot image.
3. Boot terminal from new USB device.

**Procedure: Changing Wireless Credentials for Multiple Networks**

1. In the `/srv/salt/` directory, create a salt state called `update-terminal-credentials.sls`, and enter the new wireless network credentials:

```
/etc/sysconfig/network/ifcfg-wlan0
file.managed:
  - contents: |
    WIRELESS_ESSID=<wireless_network_name>
    WIRELESS_WPA_PSK=<wireless_network_password>
# regenerate initrd
cmd.run:
  - name: 'mkinitrd'
```

2. Apply the Salt state to the terminal:

```
salt <terminal_salt_name> state.apply update-terminal-credentials
```



If you are using a separate network for the boot phase, the managed file might need to be renamed, or extended to `/etc/sysconfig/network/initrd-ifcfg-wlan0`.

**3.2.2.2. Use Multiple Wireless Networks**

You can configure terminals to use a different set of wireless credentials during the boot process, to what they use during normal operation.

If you provide wireless credentials using `initrd` files, you can create two different files, one for use during boot called `initrd-ifcfg-wlan0`, and the other for use during normal operation, called `ifcfg-wlan0`.

Alternatively, you can use custom Salt states to manage wireless credentials with `saltboot-hook`.

First of all, you need to set the wireless details for normal operation. This will become the default settings. Then you can specify a second Salt state with the wireless details for use during the boot procedure.

*Procedure: Using Different Wireless Credentials for Production Network*

1. Write a custom Salt state named `/srv/salt/saltboot_hook.sls` containing the wireless details for normal operation. This Salt state is applied by Saltboot after the system image is deployed.

```
%{ set root = salt['environ.get']('NEWROOT') %}
{{ root }}/etc/sysconfig/network/ifcfg-wlan0:
file.managed:
- contents: |
    WIRELESS_ESSID=<wireless_network_name>
    WIRELESS_WPA_PSK=<wireless_network_password>
- require:
  - saltboot: saltboot_fstab
- require_in:
  - saltboot: boot_system
```



The boot phase supports only WPA2 PSK wireless configuration. Salt-managed production configuration supports all features supported by all major operating systems.

### 3.3. Deploy Terminals and Auto-Accept Keys

You can configure Uyuni to automatically accept the keys of newly deployed terminals. This is achieved using Salt grains.



Automatically accepting keys is less secure than manually checking and accepting keys. Only use this method on trusted networks.

There are three different ways you can configure auto-signed grains:

- Configure Saltboot to send automatically signed grains once and then delete them. To do this, append the Saltboot configuration to an existing `initrd`. For more information, see [retail-deploy-terminals-auto.pdf](#).
- Choose to keep the automatically signed grains on the Salt client. To do this, include the configuration file in the image source before the client image is built. After booting, the auto-signed grain is stored on the client as a regular Salt grain. For more information, see [retail-deploy-terminals-auto.pdf](#).
- Configure Saltboot during PXE boot using kernel parameters. For more information, see [retail-](#)

## [deploy-terminals-auto.pdf](#)

When you have configured Saltboot using one of these methods, you need to configure the Uyuni Server to accept them. For more information, see [retail-deploy-terminals-auto.pdf](#).

### 3.3.1. Configure Saltboot to Send Auto-Signed Grain Once

*Procedure: Configuring Saltboot to Send Auto-Signed Grain Once*

1. On the branch server, create a configuration file called `/etc/salt/minion.d/autosign-grains-onetime.conf`.
2. Edit the new configuration file with these details. You can use any value you like as the auto-sign key:

```
# create the grain
grains:
    autosign_key: <AUTOSIGN_KEY>

# send the grain as part of auth request
autosign_grains:
    - autosign_key
```

3. At the command prompt, add the new configuration file to the existing `initrd`:

```
echo ./etc/salt/minion.d/autosign-grains-onetime.conf | /
cpio -H newc -o | gzip >> /srv/saltboot/boot/initrd.gz
```

### 3.3.2. Configure Saltboot to Keep Auto-Signed Grains

Use different procedure for SLE 15 and SLE 11/12.

*Procedure: Configuring Saltboot to Keep Auto-Signed Grains (SLE 15)*

1. In the location where the image source is built, such as a build host or source repository, create a configuration file called `etc/salt/minion.d/autosign-grains.conf`.
2. Edit the new configuration file with these details. You can use any value you like as the auto-sign key:

```
# create the grain
grains:
    autosign_key: <AUTOSIGN_KEY>

# send the grain as part of auth request
autosign_grains:
    - autosign_key
```

*Procedure: Configuring Saltboot to Keep Auto-Signed Grains (SLE 11 and SLE 12)*

1. In the location where the image source is built, such as a build host or source repository, create a

configuration file called `etc/salt/minion.d/autosign-grains.conf`. This must be outside of the `root` directory provided by the template. This way you prevent the inclusion of unwanted files in the `initrd`.

2. Edit the new configuration file with these details. You can use any value you like as the auto-sign key:

```
# create the grain
grains:
    autosign_key: <AUTOSIGN_KEY>

# send the grain as part of auth request
autosign_grains:
    - autosign_key
```

3. Create a tarball of this directory:

```
tar -czf autosign-grains.tgz etc
```

4. Edit the `config.xml` template file. In the `<packages type="image">` element, add:

```
<archive name="autosign.tgz" bootinclude="true"/>
```

5. Save the file and rebuild the image.

### 3.3.3. Configure Saltboot to Auto-Sign During PXE Boot

*Procedure: Configuring Saltboot to Auto-Sign During PXE Boot*

1. Configure the PXE formula to specify these kernel parameters during booting:

```
SALT_AUTOSIGN_GRAINS=autosign_key:<AUTOSIGN_KEY>
```

2. PXE boot the Salt client. The formula creates the `./etc/salt/minion.d/autosign-grains-onetime.conf` configuration file and passes it to `initrd`.

### 3.3.4. Configure the Server to Auto-Accept

When you have configured Saltboot using one of these methods, you need to configure the server to accept them. The server stores the autosign keys in a file within the `/etc/salt/master.d/` directory. You can enable auto-signing by creating an auto-sign file that contains the key you created when you configured Saltboot.

*Procedure: Configuring the Server to Auto-Accept*

1. On the Uyuni Server, open the master configuration file in the `/etc/salt/master.d/` directory, and add or edit this line:

```
autosign_grains_dir: /etc/salt/autosign_grains
```

2. Create a file at **/etc/salt/autosign\_grains/autosign\_key**, that contains the auto-sign key you specified with Saltboot:

```
<AUTOSIGN_KEY>
```

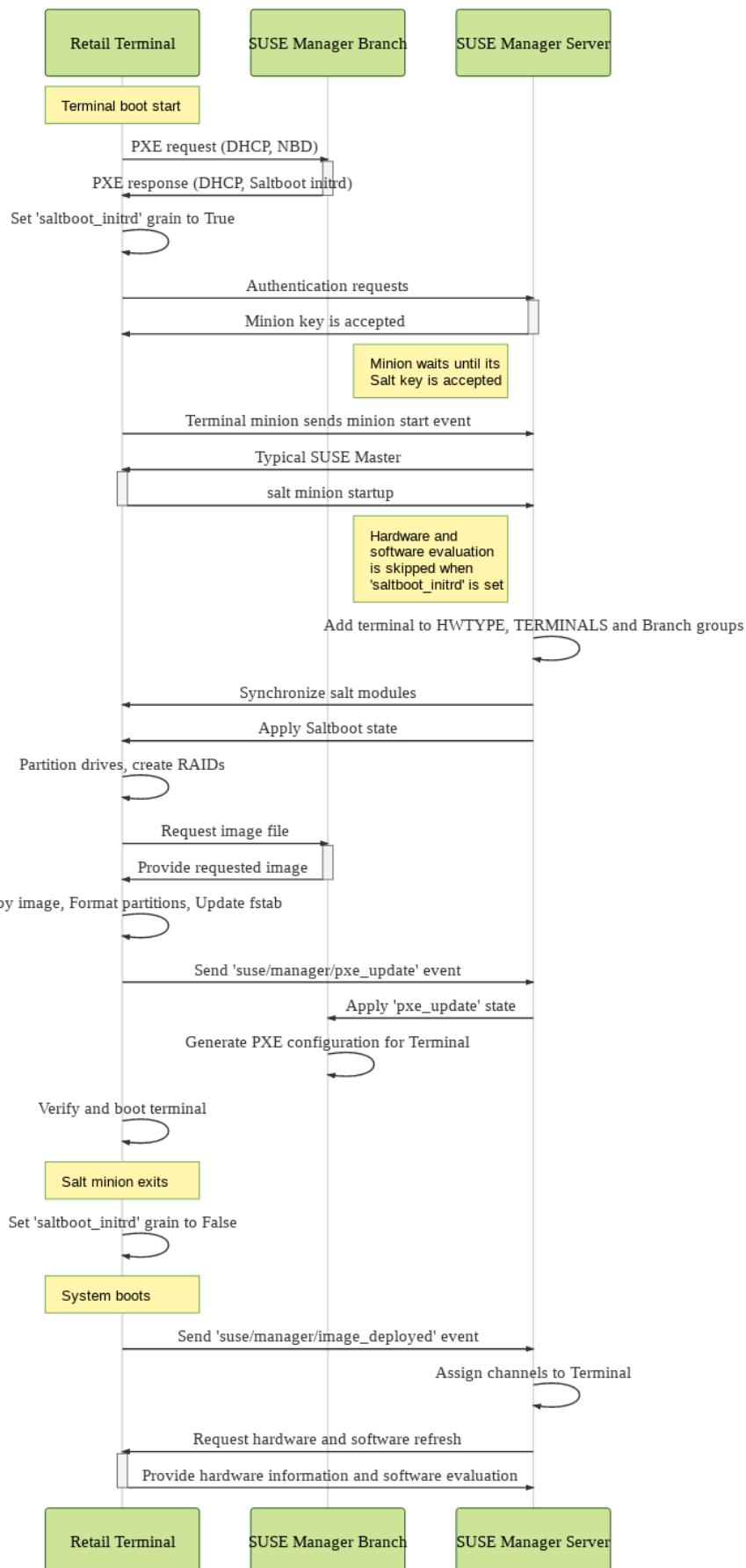
For multiple keys, put each one on a new line.

For more information about configuring the server to automatically accept grains, see [https://docs.saltstack.com/en/latest/topics/tutorials/autoaccept\\_grains.html](https://docs.saltstack.com/en/latest/topics/tutorials/autoaccept_grains.html).

## 3.4. Terminal Boot Process (Saltboot Diagram)

The saltboot process involves the Uyuni Server, a terminal running the saltboot **initrd**, and the branch server providing the saltboot services to the terminal.

This sequence diagram explains how the three components interact with each other to boot a terminal.



## 3.5. Terminal Names

Terminals can be named according to certain parameters, which can make it easier to match the physical device with its record in the Uyuni Web UI.

Naming schemes available are **Hostname**, **FQDN**, and **HWTyPe**. Naming scheme can be selected in the **Branch Network** formula. For more information, see **Specialized-guides > Salt**.

By default, terminals are named according to the **Hostname** naming scheme with the **HWTyPe** scheme as a fallback.

### 3.5.1. Naming by HWTyPe

Terminal names that are derived from the hardware type use this format:

```
BranchID.Manufacturer-ProductName-SerialNumber-UniqueID
```

For example:

```
B002.TOSHIBA-6140100-41BA03X-c643
```

The **BranchID** is the unique identifier for the branch server that the terminal is connected to. You can configure this value in the **Specialized-guides > Salt** settings for the branch server. You can disable this prefix by toggling the **Do not prefix salt client ID with Branch ID** checkbox in the **Specialized-guides > Salt**.

The **Manufacturer**, **ProductName**, and **SerialNumber** are provided by the terminal hardware BIOS. If the terminal does not provide a serial number, it will be omitted from the terminal name.

The **UniqueID** is the first four characters of a generated machine identification number. Added unique ID is a requirement for successful terminal deployment. Without unique ID, subsequent terminal registration will fail.

### 3.5.2. Naming by Hostname

Terminal names that are derived from the hostname use this format:

```
BranchID.Hostname-UniqueID
```

For example:

```
B002.terminal-c643
```

The **BranchID** is the unique identifier for the branch server that the terminal is connected to. You can configure this value in the **Specialized-guides > Salt** settings for the branch server. You can disable this prefix by toggling the **Do not prefix salt client ID with Branch ID** checkbox in the **Specialized-guides > Salt**.

The **Hostname** is the plain hostname (without domain part) of the terminal.

The **UniqueID** is the first four characters of a generated machine identification number. You can disable this behavior by toggling the **Do not append unique suffix to the salt client ID** checkbox in the **Specialized-guides > Salt**.

### 3.5.3. Naming by FQDN

Terminal names that are derived from the Fully Qualified Domain Names (FQDN) use this format:

BranchID.FQDN-UniqueID

For example:

B002.terminal.example.com-c643

The **BranchID** is the unique identifier for the branch server that the terminal is connected to. You can configure this value in the **Specialized-guides > Salt** settings for the branch server. You can disable this prefix by toggling the **Do not prefix salt client ID with Branch ID** checkbox in the **Specialized-guides > Salt**.

The **FQDN** is the fully qualified domain name of the terminal.

The **UniqueID** is the first four characters of a generated machine identification number. You can disable this behavior by toggling the **Do not append unique suffix to the salt client ID** checkbox in the **Specialized-guides > Salt**.

### 3.5.4. Assign Hostnames to Terminals

If you want terminal names to be derived from the hostname, you will need to ensure your terminals have a static hostname. This requires a static IP address to be able to resolve the static hostname.

There are a number of different ways to assign hostnames to terminals. This section describes how to do this when DNS and DHCP services are managed by the branch server.

#### *Procedure: Assigning IP Address and Hostname with Formulas*

1. In the DHCP formula settings, navigate to **Hosts with Static IP Address** and click **[Add Item]**. For more information on the DHCP formula, see **Specialized-guides > Salt**.
2. In the **Hostname** field, type the hostname of the branch server.

3. In the **IP Address** field, type the static IP address for the terminal. Ensure the IP address is within the range used by the branch server.
4. In the **Hardware Type and Address** field, type the hardware type and address in this format:

```
ethernet <terminal_MAC_address>
```

5. OPTIONAL: For multiple terminals, click **[Add Item]** and fill in the details for each terminal.
6. Click **[Save Formula]** to save the changes.
7. In the Bind formula settings, navigate to the A records of the appropriate non-reverse zone, and click **[Add Item]**. For more information on the bind formula, see **Specialized-guides > Salt**.
8. In the **Hostname** field, type the hostname of the branch server.
9. In the **IP Address** field, type the static IP address you assigned to the terminal in the DHCP formula settings.
10. OPTIONAL: For multiple terminals, click **[Add Item]** and fill in the details for each terminal.
11. Click **[Save Formula]** to save the changes.
12. Apply the highstate on the branch server to apply the changes.



If the terminal was previously registered using a name based on the hardware type instead of the hostname, you will need to delete the previous registration. When you re-register the terminal, use the new terminal name.

#### *Procedure: Assigning IP Address and Hostname with YAML*

1. At the command prompt on the branch server, export a YAML configuration file:

```
retail_yaml --to-yaml retail.yaml
```

2. Open the YAML file and navigate to the end of the branch server section. Add a new **terminals** section if it does not already exist.
3. Add the IP address, MAC address, and hardware type for the terminal, using this format:

```
$hostname:
  IP: <IP_Address>
  hwAddress: <MAC_Address>
  hwtype: <HWTYPENAME_Group_name_without_HWTYPENAME_prefix>
```

4. Import the modified YAML file:

```
retail_yaml --from-yaml retail.yaml
```

5. Apply the highstate on the branch server to apply the changes.



If the terminal was previously registered using a name based on the hardware type instead of the hostname, you will need to delete the previous registration. When you re-register the terminal, use the new terminal name.

For more information about using YAML configuration files, see [Retail > Retail-mass-config](#).

## 3.6. Offline Use

If the Uyuni Server is offline, you can still perform some operations on the terminals. This is useful if the connection between the branch server and the Uyuni Server is unstable or has low bandwidth. This feature uses caching to perform updates.

### 3.6.1. Offline Terminal Reboot

If the Uyuni Server is offline, and a terminal is rebooted, it will fall back to a previously installed image.

This will occur in these situations:

- If the Saltboot formula has not started within a specified time (default value is 60 seconds).
- If the terminal does not acknowledge that the Saltboot formula has started.
- If the root partition is specified on the kernel command line (handled by the PXE formula), is mountable (and is not encrypted), and contains `/etc/ImageVersion` (which is created by Kiwi).

You can adjust the timeout value by changing the `SALT_TIMEOUT` kernel parameter. The parameter is measured in seconds, and defaults to `60`.

```
SALT_TIMEOUT = 60
```

For more about kernel parameters, see [Specialized-guides > Salt](#).

### 3.6.2. Cached Terminal Updates

If the bandwidth between the branch server and the terminal is low, or for optimization of the terminal update process, POS images can be cached in advance on the terminal. The upgrade can then be performed on the terminals when suitable.

This functionality requires the terminal to have a dedicated service partition. A service partition is a partition mounted as `/srv/saltboot`. This partition must be created before the system partition and large enough to store a POS image. To ensure that terminals will always have such a partition, use the Saltboot formula for terminal hardware type to specify the partition details. For more information, see [Specialized-guides > Salt](#).

When the service partition is set up on the terminal, a POS image can be downloaded in advance by

applying the `saltboot.cache_image` state:

```
salt $TERMINALID state.apply saltboot.cache_image
```

This can be done regularly to ensure that terminals always have an up-to-date POS image downloaded.

When the terminal is rebooted and an up-to-date POS image is found in the service partition, the terminal will automatically use this cached image for system redeployment.

## 3.7. Rate Limiting Terminals

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

For more information about rate limiting on terminals, see [Specialized-guides > Salt](#).

### 3.7.1. Troubleshooting

Sometimes when attempting to reboot a terminal after attempting to apply the Saltboot formula, the terminal will hang at the boot screen. This can be caused by a presence ping timeout value being set at a value that is too low. You can adjust the presence ping timeout value to fix this problem.

For more information about rate limiting on terminals, see [Specialized-guides > Salt](#).

# Chapter 4. Introduction to Retail Formulas

Formulas are pre-written Salt states, that are used to configure your Uyuni for Retail installation.

You can use the Uyuni Web UI to apply common Uyuni formulas. For the most commonly used formulas, see [Specialized-guides > Salt](#).

All formulas must be accurately configured for your Uyuni for Retail installation to function correctly. If you are unsure of the correct formula configuration details, run the `retail_branch_init` command before you begin to create the recommended formula configuration. You can then manually edit the formulas as required.

## 4.1. Branch Server Formulas

Branch servers are configured using formulas. Formulas can be configured using Uyuni Web UI, or the Uyuni XMLRPC API. To fully configure Uyuni for Retail, these formulas need to be enabled and configured on the branch server:

- Branch network formula, see [Specialized-guides > Salt](#)
- Bind formula, see [Specialized-guides > Salt](#)
- DHCPD formula, see [Specialized-guides > Salt](#)
- PXE formula, see [Specialized-guides > Salt](#)
- TFTP formula, see [Specialized-guides > Salt](#)
- VSFTP formula, see [Specialized-guides > Salt](#)

Optionally, you can also enable the image synchronization formula. For more information, see [Specialized-guides > Salt](#).



Badly configured formulas can result in the branch server failing to work as expected. Due to the generic nature of formulas it is difficult to do overall validation. We recommend that you configure the branch server using the Uyuni for Retail command line utilities, and use individual formula settings for further tuning if required. For more information, see [Retail > Retail-install-setup](#).



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

When you have made changes to your formula, ensure you apply the highstate. The highstate propagates your changes to the appropriate services.

## 4.2. Partitioning and Image Deployment Formula

Use the Saltboot formula to specify disk partitioning, and to select which image should be deployed. For more information about the Saltboot formula, see [Specialized-guides > Salt](#).

# Chapter 5. Administration

This sections contains notes on administering your Uyuni for Retail installation. For general administration tasks, see the Uyuni documentation at <https://documentation.suse.com/suma/>.

## 5.1. Mass Configuration

Mass configuration is possible with branch servers and terminals.

### 5.1.1. Branch Server Mass Configuration

Branch servers are configured individually using formulas. If you are working in an environment with many branch servers, it often helps to configure branch servers automatically with a pre-defined configuration file, rather than configuring each one individually.



Before working with the mass configuration tool, back up the existing branch servers configuration.

The mass configuration tool overwrites the existing configuration with data specified in the provided YAML file.

The mass configuration tool does not support all possible formula configurations. Always make sure on a small sample that the mass configuration tool can configure systems as expected.

#### 5.1.1.1. Configure Multiple Branch Servers

Configuring multiple branch servers requires the `python-susemanager-retail` package, which is provided with Uyuni for Retail. Install the `python-susemanager-retail` package on the Uyuni server.

*Procedure: Configuring Multiple Branch Servers*

1. Create a YAML file describing the infrastructure you intend to install. For an example YAML file, see [retail-mass-config-yaml.pdf](#).
2. On a clean Uyuni for Retail installation, import the YAML file you have created:

```
retail_yaml --from-yaml filename.yaml
```

See the `retail_yaml --help` output for additional options.

3. In the Uyuni Web UI, check that your systems are listed correctly. Also check that the formulas you require are available.
4. Create activation keys for each of your branch servers, register them using bootstrap, and configure them as proxy servers. For more information, see **Retail > Retail-install-unified**.

5. In the **States** tab, click **[Apply Highstate]** to deploy your configuration changes for each branch server.

If you need to change your configuration, you can edit the YAML file at any time, and use the `retail_yaml --from-yaml` command to upload the new configuration.

Use empty profiles together with activation keys to onboard all the systems of your infrastructure. Use an activation key to assign the channels listed in **Retail > Retail-install-setup**.

### 5.1.2. Terminal Mass Configuration

If you are working in an environment with many terminals, it often helps to configure terminals automatically with a pre-defined configuration file, rather than configuring each one individually.

You will need to have your infrastructure planned out ahead of time, including the IP addresses, hostnames, and domain names of branch servers and terminals. You will also require the hardware (MAC) addresses of each terminal.



The settings specified in the configuration file cannot always be successfully applied. In cases where there is a conflict, Uyuni will ignore the request in the file. This is especially important when designating hostnames. You should always check that the details have been applied as expected after using this configuration method.

#### 5.1.2.1. Configure Multiple Terminals

*Procedure: Configuring Multiple Terminals*

1. Create a YAML file describing the infrastructure you intend to install, specifying the hardware address for each terminal. For an example YAML file, see [retail-mass-config-yaml.pdf](#).
2. On a clean Uyuni installation, import the YAML file you have created:

```
retail_yaml --from-yaml filename.yaml
```

See the `retail_yaml --help` output for additional options.

3. In the Uyuni Web UI, check that your systems are listed and displaying correctly, and the formulas you require are available.
4. Create activation keys for each of your branch servers, connect them using bootstrap, and configure them as proxy servers. For more information, see **Retail > Retail-install-unified**.
5. In the **States** tab, click **[Apply Highstate]** to deploy your configuration changes for each branch server.
6. Connect your terminals according to your infrastructure plan.

If you need to change your configuration, you can edit the YAML file at any time, and use the

`retail_yaml --from-yaml` command to upload the new configuration.

### 5.1.3. Export Configuration to Mass Configuration File

If you already have a configuration that you would like to export to a YAML file, use:

```
retail_yaml --to-yaml filename.yaml
```

This can be a good way to create a basic mass configuration file. However, it is important to check the file before using it, because some mandatory configuration entries may be missing.



When you are designing your configuration and creating the YAML file, ensure the branch server ID matches the fully qualified hostname, and the Salt ID. If these do not match, the bootstrap script could fail.

## 5.2. Example YAML File for Mass Configuration

You can use the `retail_yaml` command to import configuration parameters from a manually prepared YAML file. This section contains a YAML example file with comments.

*Listing 1. Example: YAML Mass Terminal Configuration File*

```
branches:
# there are 2 possible setups: with / without dedicated NIC
#
# with dedicated NIC
branchserver1.branch1.cz:      # salt ID of branch server
    branch_prefix: branch1      # optional, default guessed from salt id
    server_name: branchserver1  # optional, default guessed from salt id
    server_domain: branch1.cz   # optional, default guessed from salt id
    nic: eth1                  # nic used for connecting terminals, default taken from hw
info in SUMA
    dedicated_nic: true        # set to true if the terminals are on separate network
    salt_cname: branchserver1.branch1.cz  # hostname of salt master / broker for
terminals, mandatory
    configure_firewall: true   # modify firewall configuration
    branch_ip: 192.168.2.1     # default for dedicated NIC: 192.168.1.1
    netmask: 255.255.255.0     # default for dedicated NIC: 255.255.255.0
    dyn_range:
        - 192.168.2.10
        - 192.168.2.250
#
# without dedicated NIC
# the DHCP formula is not used, DHCP is typically provided by a router
# the network parameters can be autodetected if the machine is already connected to SUSE
Manager
branchserver2.branch2.cz:      # salt ID of branch server
    branch_prefix: branch2      # optional, default guessed from salt id
    server_name: branchserver2  # optional, default guessed from salt id
    server_domain: branch2.cz   # optional, default guessed from salt id
    salt_cname: branchserver2.branch1.cz  # FQDN of salt master / broker for terminals,
mandatory
    branch_ip: 192.168.2.1     # optional, default taken from SUMA data if the machine is
registered
    netmask: 255.255.255.0     # optional, default taken from SUMA data if the machine is
registered
    exclude_formulas:         # optional, do not configure listed formulas
```

```

- dhcp          # without dedicated NIC the dhcp service is typically
provided by a router
  hwAddress: 11:22:33:44:55:66 # optional, required to connect pre-configured entry with
particular machine
  terminals:      # during onboarding
    hostname1:      # configuration of static terminal entries
      hwAddress: aa:aa:aa:bb:bb:bb # required as unique id of a terminal
      IP: 192.168.2.50        # required for static dhcp and dns entry
      saltboot:           # optional, alternative 1: configure terminal-specific
pillar data
    partitioning:      # partitioning pillar as described in saltboot
documentation
      disk1:
        device: /dev/sda
        disklabel: msdos
        partitions:
          p1:
            flags: swap
            format: swap
            size_MiB: 2000.0
          p2:
            image: POS_Image_JeOS6
            mountpoint: /
            type: DISK
      hostname2:      # hostname
        hwAddress: aa:aa:aa:bb:bb:cc # required as unique id of a terminal
        IP: 192.168.2.51        # required for static dhcp and dns entry
        hwtype: IBMCORPORATION-4838910 # optional, alternative 2: assign the terminal to
hwtype group
        # if neither of hwtype nor saltboot is specified, a group is assigned according to
hwtype
        # reported by bios on the first boot
  hwtypes:
    IBMCORPORATION-4838910:      # HWTYPE string (manufacturer-model) as returned by bios
    description: 4838-910        # freetext description
    saltboot:
      partitioning:      # partitioning pillar as described in saltboot documentation
        disk1:
          device: /dev/sda
          disklabel: msdos
          partitions:
            p1:
              flags: swap
              format: swap
              size_MiB: 1000.0
            p2:
              image: POS_Image_JeOS6
              mountpoint: /
              type: DISK
    TOSHIBA-6140100:
      description: HWTYPE:TOSHIBA-6140100
      saltboot:
        partitioning:
          disk1:
            device: /dev/sda
            disklabel: msdos
            partitions:
              p1:
                flags: swap
                format: swap
                size_MiB: 1000.0
              p2:
                image: POS_Image_JeOS6
                mountpoint: /
                type: DISK

```

## 5.3. Delta Images

If you have very large images that you need to synchronize to the branch server, you can use delta images to save network bandwidth.

A delta image contains only the differences between two regular images. If there are only a few changes between two images, the delta image can be very small. Synchronizing a delta image to the branch consumes less network bandwidth but it requires some extra hardware resources on the branch server to rebuild the installable image.

### 5.3.1. Building Delta Images

The `retail_create_delta` tool creates a delta image on the Uyuni server. The tool uses `xdelta3` internally.

Use the name and the version strings of the target and the source image as parameters to the command. The format of the parameters must be `<NAME>-<VERSION>` and they must correspond to the image names and versions available in the pillar. For example, if the pillar contains:

```
images:
  POS_Image_JeOS6:
    6.0.0:
      ...
    6.0.1:
      ...
  POS_Image_Graphical6:
    6.0.0:
      ...
```

Then the `retail_create_delta` command is:

```
retail_create_delta POS_Image_JeOS6-6.0.1 POS_Image_JeOS6-6.0.0
```

This command will generate the delta image between version 6.0.0 and version 6.0.1. The resulting delta file is saved in `/srv/www/os-images` and the corresponding pillar file in `/srv/susemanager/pillar_data/images/`.

### 5.3.2. Tuning Delta Generation

Performance tuning is possible with the `-B <VALUE>` option, which is passed to `xdelta3`. With higher values you achieve smaller deltas at the cost of higher memory requirements. For more information, see the `xdelta3` documentation ([man xdelta3](#)).

### 5.3.3. Image Synchronizing to the Branch Server

When an image is synchronized to the branch server, the `image-sync-formula` first checks whether the source image is available on the branch server. Only if the source image is available, the delta will be

downloaded to save network bandwidth.

## 5.4. Network Administration

If you are intending to set up either an external or a shared network architecture, you need to ensure that the server providing DHCP services has PXE support enabled.

For example:

```
next-server: <branch server IP>
if option arch = 00:07 {
    filename "boot/shim.efi";
} else {
    filename "boot/pxelinux.0";
}
```

Configure your DNS servers to resolve **salt** and **ftp** as CNAMEs to the correct branch server FQDN.

If using a CNAME is not possible, there are several workarounds:

- For **salt**, set this kernel parameter when the terminal boots:

```
MASTER=<branch_server_fqdn>
```

You can configure this using the PXE formula. For more information, see [Specialized-guides > Salt](#).

- For **ftp**, you can use an A record that resolves to an IP address instead of a CNAME. Alternatively, you can change the terminal boot process using Salt pillars. For more information, see [retail-deploy-terminals.pdf](#).

For a description of the different networking architectures, see [Retail > Retail-network-arch](#).

# Chapter 6. Retail Migration

For migrating Uyuni for Retail to the latest version, see the Uyuni upgrade instructions.

## 6.1. Upgrade Uyuni for Retail Branch Server

This section describes upgrading the Uyuni for Retail Branch Server to the next SP (service pack).

The Uyuni for Retail Branch Server is a client system similar to the Uyuni Proxy, with additional Uyuni for Retail features.



Upgrade the Uyuni Server before starting the Uyuni for Retail upgrade.

*Procedure: Upgrading the Uyuni for Retail Branch Server*

1. For general information about upgrading a proxy client, see [Installation-and-upgrade > Proxy-intro](#).
2. After the proxy upgrade is complete, apply the highstate on the Uyuni for Retail Branch Server. When applying the highstate, the retail functionality will also be updated.

# Chapter 7. What Next?

This document covers only a sub-section of information about your Uyuni for Retail installation. If you need further information or support, try one of these options.

## 7.1. More Documentation

For Uyuni documentation, visit <https://documentation.suse.com/suma/4.3/>.

For legacy SUSE Linux Enterprise Point of Service documentation, see <https://documentation.suse.com/sle-pos/11-SP3/>. For legacy Uyuni for Retail documentation, see <https://documentation.suse.com/suma-retail/4.1/>. Note, however, that Uyuni for Retail documentation supersedes this information.

## 7.2. Support

For personalized support, log in to your SUSE Customer Center account at <https://scc.suse.com/login>.

For assistance with planning and installing your Uyuni for Retail environment, contact the SUSE Consulting team.

# Chapter 8. GNU Free Documentation License

Copyright © 2000, 2001, 2002 Free Software Foundation, Inc. 51 Franklin St, Fifth Floor, Boston, MA 02110-1301 USA. Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

## 0. PREAMBLE

The purpose of this License is to make a manual, textbook, or other functional and useful document "free" in the sense of freedom: to assure everyone the effective freedom to copy and redistribute it, with or without modifying it, either commercially or noncommercially. Secondarily, this License preserves for the author and publisher a way to get credit for their work, while not being considered responsible for modifications made by others.

This License is a kind of "copyleft", which means that derivative works of the document must themselves be free in the same sense. It complements the GNU General Public License, which is a copyleft license designed for free software.

We have designed this License in order to use it for manuals for free software, because free software needs free documentation: a free program should come with manuals providing the same freedoms that the software does. But this License is not limited to software manuals; it can be used for any textual work, regardless of subject matter or whether it is published as a printed book. We recommend this License principally for works whose purpose is instruction or reference.

## 1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a worldwide, royalty-free license, unlimited in duration, to use that work under the conditions stated herein. The "Document", below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

A "Modified Version" of the Document means any work containing the Document or a portion of it, either copied verbatim, or with modifications and/or translated into another language.

A "Secondary Section" is a named appendix or a front-matter section of the Document that deals exclusively with the relationship of the publishers or authors of the Document to the Document's overall subject (or to related matters) and contains nothing that could fall directly within that overall subject. (Thus, if the Document is in part a textbook of mathematics, a Secondary Section may not explain any mathematics.) The relationship could be a matter of historical connection with the subject or with related matters, or of legal, commercial, philosophical, ethical or political position regarding them.

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections

---

then there are none.

The "Cover Texts" are certain short passages of text that are listed, as Front-Cover Texts or Back-Cover Texts, in the notice that says that the Document is released under this License. A Front-Cover Text may be at most 5 words, and a Back-Cover Text may be at most 25 words.

A "Transparent" copy of the Document means a machine-readable copy, represented in a format whose specification is available to the general public, that is suitable for revising the document straightforwardly with generic text editors or (for images composed of pixels) generic paint programs or (for drawings) some widely available drawing editor, and that is suitable for input to text formatters or for automatic translation to a variety of formats suitable for input to text formatters. A copy made in an otherwise Transparent file format whose markup, or absence of markup, has been arranged to thwart or discourage subsequent modification by readers is not Transparent. An image format is not Transparent if used for any substantial amount of text. A copy that is not "Transparent" is called "Opaque".

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

The "Title Page" means, for a printed book, the title page itself, plus such following pages as are needed to hold, legibly, the material this License requires to appear in the title page. For works in formats which do not have any title page as such, "Title Page" means the text near the most prominent appearance of the work's title, preceding the beginning of the body of the text.

A section "Entitled XYZ" means a named subunit of the Document whose title either is precisely XYZ or contains XYZ in parentheses following text that translates XYZ in another language. (Here XYZ stands for a specific section name mentioned below, such as "Acknowledgements", "Dedications", "Endorsements", or "History".) To "Preserve the Title" of such a section when you modify the Document means that it remains a section "Entitled XYZ" according to this definition.

The Document may include Warranty Disclaimers next to the notice which states that this License applies to the Document. These Warranty Disclaimers are considered to be included by reference in this License, but only as regards disclaiming warranties: any other implication that these Warranty Disclaimers may have is void and has no effect on the meaning of this License.

## 2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License. You may not use technical measures to obstruct or control the reading or further copying of the copies you make or distribute. However, you may accept compensation in exchange for copies. If you distribute a large enough number of copies you must also follow the conditions in section 3.

---

You may also lend copies, under the same conditions stated above, and you may publicly display copies.

### 3. COPYING IN QUANTITY

If you publish printed copies (or copies in media that commonly have printed covers) of the Document, numbering more than 100, and the Document's license notice requires Cover Texts, you must enclose the copies in covers that carry, clearly and legibly, all these Cover Texts: Front-Cover Texts on the front cover, and Back-Cover Texts on the back cover. Both covers must also clearly and legibly identify you as the publisher of these copies. The front cover must present the full title with all words of the title equally prominent and visible. You may add other material on the covers in addition. Copying with changes limited to the covers, as long as they preserve the title of the Document and satisfy these conditions, can be treated as verbatim copying in other respects.

If the required texts for either cover are too voluminous to fit legibly, you should put the first ones listed (as many as fit reasonably) on the actual cover, and continue the rest onto adjacent pages.

If you publish or distribute Opaque copies of the Document numbering more than 100, you must either include a machine-readable Transparent copy along with each Opaque copy, or state in or with each Opaque copy a computer-network location from which the general network-using public has access to download using public-standard network protocols a complete Transparent copy of the Document, free of added material. If you use the latter option, you must take reasonably prudent steps, when you begin distribution of Opaque copies in quantity, to ensure that this Transparent copy will remain thus accessible at the stated location until at least one year after the last time you distribute an Opaque copy (directly or through your agents or retailers) of that edition to the public.

It is requested, but not required, that you contact the authors of the Document well before redistributing any large number of copies, to give them a chance to provide you with an updated version of the Document.

### 4. MODIFICATIONS

You may copy and distribute a Modified Version of the Document under the conditions of sections 2 and 3 above, provided that you release the Modified Version under precisely this License, with the Modified Version filling the role of the Document, thus licensing distribution and modification of the Modified Version to whoever possesses a copy of it. In addition, you must do these things in the Modified Version:

- A. Use in the Title Page (and on the covers, if any) a title distinct from that of the Document, and from those of previous versions (which should, if there were any, be listed in the History section of the Document). You may use the same title as a previous version if the original publisher of that version gives permission.
- B. List on the Title Page, as authors, one or more persons or entities responsible for authorship of the modifications in the Modified Version, together with at least five of the principal authors of the Document (all of its principal authors, if it has fewer than five), unless they release you from this requirement.
- C. State on the Title page the name of the publisher of the Modified Version, as the publisher.

- 
- D. Preserve all the copyright notices of the Document.
  - E. Add an appropriate copyright notice for your modifications adjacent to the other copyright notices.
  - F. Include, immediately after the copyright notices, a license notice giving the public permission to use the Modified Version under the terms of this License, in the form shown in the Addendum below.
  - G. Preserve in that license notice the full lists of Invariant Sections and required Cover Texts given in the Document's license notice.
  - H. Include an unaltered copy of this License.
  - I. Preserve the section Entitled "History", Preserve its Title, and add to it an item stating at least the title, year, new authors, and publisher of the Modified Version as given on the Title Page. If there is no section Entitled "History" in the Document, create one stating the title, year, authors, and publisher of the Document as given on its Title Page, then add an item describing the Modified Version as stated in the previous sentence.
  - J. Preserve the network location, if any, given in the Document for public access to a Transparent copy of the Document, and likewise the network locations given in the Document for previous versions it was based on. These may be placed in the "History" section. You may omit a network location for a work that was published at least four years before the Document itself, or if the original publisher of the version it refers to gives permission.
  - K. For any section Entitled "Acknowledgements" or "Dedications", Preserve the Title of the section, and preserve in the section all the substance and tone of each of the contributor acknowledgements and/or dedications given therein.
  - L. Preserve all the Invariant Sections of the Document, unaltered in their text and in their titles. Section numbers or the equivalent are not considered part of the section titles.
  - M. Delete any section Entitled "Endorsements". Such a section may not be included in the Modified Version.
  - N. Do not retitle any existing section to be Entitled "Endorsements" or to conflict in title with any Invariant Section.
  - O. Preserve any Warranty Disclaimers.

If the Modified Version includes new front-matter sections or appendices that qualify as Secondary Sections and contain no material copied from the Document, you may at your option designate some or all of these sections as invariant. To do this, add their titles to the list of Invariant Sections in the Modified Version's license notice. These titles must be distinct from any other section titles.

You may add a section Entitled "Endorsements", provided it contains nothing but endorsements of your Modified Version by various parties—for example, statements of peer review or that the text has been approved by an organization as the authoritative definition of a standard.

You may add a passage of up to five words as a Front-Cover Text, and a passage of up to 25 words as a Back-Cover Text, to the end of the list of Cover Texts in the Modified Version. Only one passage of Front-Cover Text and one of Back-Cover Text may be added by (or through arrangements made by) any one entity. If the Document already includes a cover text for the same cover, previously added by you or by arrangement made by the same entity you are acting on behalf of, you may not add another; but you may replace the old one, on explicit permission from the previous publisher that added the old one.

---

The author(s) and publisher(s) of the Document do not by this License give permission to use their names for publicity for or to assert or imply endorsement of any Modified Version.

## 5. COMBINING DOCUMENTS

You may combine the Document with other documents released under this License, under the terms defined in section 4 above for modified versions, provided that you include in the combination all of the Invariant Sections of all of the original documents, unmodified, and list them all as Invariant Sections of your combined work in its license notice, and that you preserve all their Warranty Disclaimers.

The combined work need only contain one copy of this License, and multiple identical Invariant Sections may be replaced with a single copy. If there are multiple Invariant Sections with the same name but different contents, make the title of each such section unique by adding at the end of it, in parentheses, the name of the original author or publisher of that section if known, or else a unique number. Make the same adjustment to the section titles in the list of Invariant Sections in the license notice of the combined work.

In the combination, you must combine any sections Entitled "History" in the various original documents, forming one section Entitled "History"; likewise combine any sections Entitled "Acknowledgements", and any sections Entitled "Dedications". You must delete all sections Entitled "Endorsements".

## 6. COLLECTIONS OF DOCUMENTS

You may make a collection consisting of the Document and other documents released under this License, and replace the individual copies of this License in the various documents with a single copy that is included in the collection, provided that you follow the rules of this License for verbatim copying of each of the documents in all other respects.

You may extract a single document from such a collection, and distribute it individually under this License, provided you insert a copy of this License into the extracted document, and follow this License in all other respects regarding verbatim copying of that document.

## 7. AGGREGATION WITH INDEPENDENT WORKS

A compilation of the Document or its derivatives with other separate and independent documents or works, in or on a volume of a storage or distribution medium, is called an "aggregate" if the copyright resulting from the compilation is not used to limit the legal rights of the compilation's users beyond what the individual works permit. When the Document is included in an aggregate, this License does not apply to the other works in the aggregate which are not themselves derivative works of the Document.

If the Cover Text requirement of section 3 is applicable to these copies of the Document, then if the Document is less than one half of the entire aggregate, the Document's Cover Texts may be placed on covers that bracket the Document within the aggregate, or the electronic equivalent of covers if the Document is in electronic form. Otherwise they must appear on printed covers that bracket the whole aggregate.

## 8. TRANSLATION

Translation is considered a kind of modification, so you may distribute translations of the Document under the terms of section 4. Replacing Invariant Sections with translations requires special permission from their copyright holders, but you may include translations of some or all Invariant Sections in addition to the original versions of these Invariant Sections. You may include a translation of this License, and all the license notices in the Document, and any Warranty Disclaimers, provided that you also include the original English version of this License and the original versions of those notices and disclaimers. In case of a disagreement between the translation and the original version of this License or a notice or disclaimer, the original version will prevail.

If a section in the Document is Entitled "Acknowledgements", "Dedications", or "History", the requirement (section 4) to Preserve its Title (section 1) will typically require changing the actual title.

## 9. TERMINATION

You may not copy, modify, sublicense, or distribute the Document except as expressly provided for under this License. Any other attempt to copy, modify, sublicense or distribute the Document is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

## 10. FUTURE REVISIONS OF THIS LICENSE

The Free Software Foundation may publish new, revised versions of the GNU Free Documentation License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns. See <http://www.gnu.org/copyleft/>.

Each version of the License is given a distinguishing version number. If the Document specifies that a particular numbered version of this License "or any later version" applies to it, you have the option of following the terms and conditions either of that specified version or of any later version that has been published (not as a draft) by the Free Software Foundation. If the Document does not specify a version number of this License, you may choose any version ever published (not as a draft) by the Free Software Foundation.

## ADDENDUM: How to use this License for your documents

Copyright (c) YEAR YOUR NAME.

Permission is granted to copy, distribute and/or modify this document  
under the terms of the GNU Free Documentation License, Version 1.2  
or any later version published by the Free Software Foundation;  
with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts.  
A copy of the license is included in the section entitled{ldquo}GNU  
Free Documentation License{rdquo}.

If you have Invariant Sections, Front-Cover Texts and Back-Cover Texts, replace the " with...Texts." line with this:

with the Invariant Sections being LIST THEIR TITLES, with the Front-Cover Texts being LIST, and with the Back-Cover Texts being LIST.

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

If your document contains nontrivial examples of program code, we recommend releasing these examples in parallel under your choice of free software license, such as the GNU General Public License, to permit their use in free software.