

Administering SUSE Linux Enterprise Server for SAP applications Using Cockpit

WHAT?

From basic system overview, over storage management to keeping your system up to date, Cockpit enables you to perform a number of administration tasks in a convenient way.

WHY?

This article is intended to provide a complete overview of tasks that can be performed from the Cockpit Web interface.

EFFORT

The average reading time of this article is approximately 40 minutes.

GOAL

You will be able to administer your system using Cockpit.

REQUIREMENTS

To fully administer the system using Cockpit, you must have sudo privileges.

Publication Date: 12 Mar 2026

Contents

- 1 About Cockpit 3

2	Cockpit installation	3
3	Accessing Cockpit	4
4	Configuring servers using Cockpit	10
5	Filtering Cockpit logs	12
6	Managing storage using Cockpit	15
7	Managing networking using Cockpit	22
8	Working with containers	30
9	User administration using Cockpit	36
10	Managing services using Cockpit	38
11	Managing Subscriptions using Cockpit	40
12	SELinux mode and policy	42
13	Legal Notice	45
A	GNU Free Documentation License	46

1 About Cockpit

Cockpit is a Web-based graphical interface that enables you to manage most administration tasks from one place. You do not need to create credentials for Cockpit as, by default, Cockpit uses the same credentials that you use to log in to your server. Cockpit uses APIs that already exist on the system without adding a layer to the system.

Cockpit enables you to perform the following tasks:

- download container images and run containers
- manage the server storage
- inspect and change network settings
- manage user accounts
- view system logs
- inspect and interact with `systemd` services
- switch between SELinux modes
- use a terminal on a remote server in your Web browser

2 Cockpit installation

2.1 Installing Cockpit

If Cockpit is not present on your system, you can install it by following the procedure below:

1. If the Cockpit instance is intended to serve as a primary one, you need to enable the Cockpit socket in `systemd` by running:

```
> sudo systemctl enable --now cockpit.socket
```

After running the command, the server exposes the default 9090 port and `systemd` starts the `cockpit-ws` service that listens on the 9090 port.

2. In case you have enabled the firewall, proceed as follows:
 - a. Open the firewall for Cockpit

```
> sudo firewall-cmd --add-service=cockpit --permanent && sudo firewall-cmd --reload
```

b. Restart `cockpit.socket` by running:

```
> sudo zypper in -f cockpit-selinux-policies && sudo systemctl restart cockpit.socket
```

3. Now you can access the Cockpit Web interface by opening the following address in your Web browser:

```
https://IP_ADDRESS_OF_MACHINE:9090
```

2.2 Cockpit plug-ins

Cockpit uses plug-ins to administer the system. The plug-ins are included in the installation pattern. However, depending on the technologies installed on your system, some plug-ins may not be visible to you. For example, if NFS is not present, the corresponding NFS panel is not visible.

3 Accessing Cockpit

Cockpit enables you to log in directly to each machine that can expose the 9090 port. This machine is sometimes referred to as the primary server. It is the primary server that runs the `cockpit-ws` through which connections to additional servers are established. By default, Cockpit listens on both HTTP and HTTPS connections. However, most of the HTTP connections are redirected to HTTPS, with exceptions like local host access.

If the port cannot be accessed on the particular machine, you can still use Cockpit to administer the machine by using it as a secondary server. For the procedure of adding a server as secondary, refer to *Procedure 2, "Adding a server as secondary"*.



Note: A limited number of secondary servers

The number of secondary servers that you can administer from one primary server is limited to 20. If you need to administer more servers, add other primary servers or use another tool for cluster administration.

3.1 TLS certificates

By default, Cockpit loads `.cert` or `.crt` certificates from the directory `/etc/cockpit/ws-certs.d`. The corresponding private key must be a separate file with the same file name but with the `.key` suffix. Make sure the key is not encrypted.

If no certificate is found in the directory, Cockpit generates a self-signed certificate (`0-self-signed.cert`) to establish a secure connection.

To check which certificate Cockpit uses, run the command:

```
> sudo /usr/libexec/cockpit-certificate-ensure --check
```

3.2 Authentication

You do not need separate credentials to log in to Cockpit. Use the same credentials that you use to log in to SUSE Linux Enterprise Server for SAP applications. However, on new installations, login using `root` is not allowed by default. Either enable `root` login with a password as described in [Section 3.2.2, “Enabling root to log in using a password”](#), or create an unprivileged user to access Cockpit. On instances upgraded from a previous release, `root` login is still allowed. In all cases, we recommend enhancing the security by adding 2FA as described in [Section 3.2.1, “Enabling 2FA authorization”](#).

At first, you log in to Cockpit with limited access. To perform administrative tasks, click *Limited access* in the upper-right menu and unlock the administrative mode by entering your password.

3.2.1 Enabling 2FA authorization

To set up 2FA on SUSE Linux Enterprise Server for SAP applications, you need an available TOTP application of your choice. Then run a command to configure the authorization. The following sections provide details on how to proceed with the configuration of 2FA and also give instructions in situations when your 2FA fails.

3.2.1.1 Applications providing TOTP 2FA

The following applications providing 2FA are supported on SUSE Linux Enterprise Server for SAP applications.

Using cloud storage

- PSONO (<https://psono.com/>) - available for Firefox, Chrome, Docker, iOS, Android
- Google Authenticator - available on Android, iOS and Wear OS
- Okta Verify (<https://help.okta.com/en-us/content/topics/mobile/okta-verify-overview.htm>) - available on Android, iOS, macOS and Windows

Using only local storage

- Yubico Authenticator (<https://www.yubico.com/products/yubico-authenticator/>) - with a hardware key
- KeePassXC (<https://keepassxc.org/>) - available on Linux desktops, Windows and macOS
- KeePassDX (<https://www.keeppassdx.com/>) - available on Android
- FreeOTP Plus (<https://github.com/helloworld1/FreeOTPlus>) - for Android
- FreeOTP (<https://github.com/freeotp/freeotp-ios>) - for iOS

3.2.1.2 Setting up 2FA

Each user can configure their own 2FA, or `root` can configure it for any regular user on the system. To set up 2FA for a user from a running system, proceed as follows.

1. Run the command:

```
> sudo /sbin/jeos-config otp
```

2. Scan the code to any TOTP application mentioned above.
3. Confirm the process by entering an OTP code.

3.2.1.3 Recovering access

Setting up 2FA is optional. However, once set, the second factor is mandatory to log in to Cockpit. If the second factor becomes unavailable, you can change it or disable it. Even without the second factor, you can still log in to the machine using SSH or directly from a console. After login, you can use the following two options:

Change the second factor

Run the command either as root or with your user name using sudo:

```
> sudo /sbin/jeos-config otp
```

Disable the 2FA

Remove the file .pam_oath_usersfile from the affected user's home directory.

3.2.2 Enabling root to log in using a password



Warning: root login with a password is not secure

We strongly discourage you from enabling root login with a password for security reasons.

In new SLES for SAP installations, root login using a password is disabled by default due to security reasons. To allow root login with password, proceed as follows:

1. Open the /etc/cockpit/disallowed-users file.
2. Remove root from the file.

3.3 Logging in to the primary server directly

Whenever you have direct network access to the 9090 port, you can directly log in to the server using your credentials. To do so, follow *Procedure 1, "Logging in to the primary server"*.



Note: No dedicated credentials for Cockpit needed

By default, access is controlled by a Cockpit-specific PAM stack located at `/usr/lib/pam.d/cockpit`. The default configuration allows logging in with the same user names and passwords that are used for any local account on the system.

PROCEDURE 1: LOGGING IN TO THE PRIMARY SERVER

1. Go to the Cockpit login page by opening the following address in a browser:

```
https://IP_ADDRESS_OF_MACHINE:9090
```

2. Enter the credentials.

3.4 Logging in to secondary servers

If your machine does not have direct access to the 9090 port, you can use this machine as a secondary server. Ensure that Cockpit is installed on the machine.

There are two ways of logging in to a secondary server: you can log in to a secondary server directly or you can use the primary server.

3.4.1 Logging in to secondary servers directly

You can log in to any secondary server without logging in to the primary server first. This solution can be useful when you do not have credentials for the primary server. The primary server will be used as a bridge, and you will be connected to the secondary server using SSH.

To connect to the secondary server, proceed as follows:

1. Go to the Cockpit login page by opening the following address in a browser:

```
https://IP_ADDRESS_OF_MACHINE:9090
```

2. Fill in the credentials for the secondary server.
3. Expand *Other options* on the login screen.
4. Fill in the IP address of the secondary server.
5. Proceed by clicking *Login*.

6. If you are trying to log in for the first time, you are asked to verify the fingerprint. After this, click *Accept and connect*.

3.4.2 Accessing secondary servers from the primary server

If you have credentials for the primary server, you can access secondary servers from the primary one. You must add the secondary servers first, as described in [Procedure 2, “Adding a server as secondary”](#).

PROCEDURE 2: ADDING A SERVER AS SECONDARY

1. Log in to the primary server using the account with the *system administrator* role.
2. Click the `USERNAME@HOSTNAME` in the upper-left corner.
3. Click *Add new host*.
4. Fill in the host identification and optionally user name that will be used to log in to the server. You can assign a color to the machine. When the details are complete, click *Add*.
5. Verify the fingerprint on the server you want to add. If the fingerprint matches or if you have not set up the SSH connection, click *Trust and add host* to proceed.
6. Fill in the password and, if needed, check *Automatic login*. Cockpit will generate a new SSH key for the user, and next time you will be logged in automatically.

3.5 Switching to the administration mode

By default, a regular user can log in to Cockpit with limited access that does not enable the user to perform administration tasks like managing user accounts, updating the system, and so on.

To switch to administrative access, proceed as follows:

1. Click the *Limited access* button.
2. Fill in the `root` password.
3. Click *Authenticate* to confirm.

To turn off administrative mode, proceed as follows:

1. Click *Administrative access*.
2. To confirm, click *Limit access*.

4 Configuring servers using Cockpit

Using the Cockpit *Overview* part, you can perform changes to the default server configuration or the configuration you provided during the manual installation. In this part, you can change the host name or change the system date or time zone.

4.1 Viewing system health

To view the system health, click *Overview* on the left pane. You can view the following details in the *Health* section.

If a service fails, you can click the *1 service failed* to view the details of the service failure.

Click *View login history* to view your login history. You can modify the user credentials in the user page.

4.2 Viewing metrics and history

You can view the PCP metrics and usage history under the *Usage* section in the *Overview* page.

- Click *Overview* on the left pane.

The following details appear in the *Metrics and History* page.

- *CPU*: The number of CPUs, the CPU load and a list of services that use the CPU.
- *Memory*: The RAM and Swap memory usage, and the related services.
Cockpit reads memory usage data from the `virtio-balloon` driver inside the VM to estimate the memory VM uses. The specific value `currentMemory` shows how much memory the host has currently assigned to that VM. This number can change dynamically when the balloon inflates or deflates. If the VM does not use `virtio-balloon`, then Cockpit does not know the actual memory being used inside the VM. Hence the memory displayed could be different. The memory displayed is an approximation and not the actual memory usage inside the VM.
- *Disks*: A list of used disks and partitions. Click *View per-disk throughput* to display a table showing the data transfer rates for each disk.

- *Network* - Displays the list of networks.
- *Metrics history*: When present, Cockpit integrates with the Performance Co-Pilot (PCP) framework to collect and manage system performance metrics. These metrics are used to render historical data visualizations on the *Metrics and History* interface. Cockpit can also use the archive logging subsystem of PCP to retrieve and display time-shifted historical data. In environments where PCP is not installed, Cockpit falls back to its own metrics collection mechanism; however, this mode does not support data archival or retrieval of historical metrics.

Archival of metrics depends on whether the `pmlogger.service` systemd unit is running or not. You can enable the `Collect metrics` option to enable and start the service.

4.3 Changing the server host name

To change the host name, proceed as follows:

PROCEDURE 3: CHANGING THE HOST NAME

1. Navigate to the *Overview* page.
2. In the *Configuration* section, click *edit* under *Hostname*.
3. Fill in the following:
 - *Pretty host name*—a user-defined free-form host name
 - *Real host name*—the name of the device in the network

4.4 Changing the system time or time zone

To change the system time or time zone, proceed as follows:

PROCEDURE 4: CHANGING SYSTEM TIME OR TIME ZONE

1. Navigate to the *Overview* page.
2. In the *Configuration* section, click the current time value under *System time*.

3. In the pop-up window you can change the following:

- *Time zone*—the value set during the manual installation or, in case of raw images, set to UTC.
- *Set time*—by default, NTP is used for time synchronization. You can set the time manually or, if you defined alternative NTP servers, you can use those NTP servers for time synchronization.
- Click *Change*.

5 Filtering Cockpit logs

Click *Logs* on the left navigation pane and select the required filters. You can filter the logs according to the following criteria:

- *Time*. For details, refer to [Section 5.1, “Filtering according to time”](#).
- *Priority*. For details, refer to [Section 5.2, “Filtering according to priority”](#).
- *Identifier*. You can filter logs for a particular service, daemon or process. Available identifiers are parsed from the logs currently displayed according to the set filters.
- *Free-form filters*. For details, refer to [Section 5.3, “Logs filters”](#).



Note: The filter criteria are combined

When changing any of the time, priority or identifier criteria, the others are still applied. For example, if you change the time criterion to *Last 24 hours*, the priority and identifier criteria remain the same.

5.1 Filtering according to time

To filter the logs according to a specific time, you can choose from the following values:

Current boot

Displays logs for the current boot only. The *Resume* button enables continuous refreshing of currently displayed logs.

Previous boot

Displays logs relevant to the previous boot.

Last 24 hours

Displays logs that were recorded within the last 24 hours.

Last 7 days

Displays logs that were recorded within the last 7 days.

5.2 Filtering according to priority

The standard **syslog** severity levels are used (sorted from most to least severe):

Only emergency

The system is unusable. This is a panic condition.

Alert and above

This log requires your immediate action.

Critical and above

Failures in the primary systems. You should correct the problem immediately.

Error and above

Not an urgent error, but should be handled within a specific time.

Warning and above

Not an error, but indicates that an error might occur if no action is taken.

Notice and above

Unusual events that are not errors. No immediate action is required.

Info and above

Normal operational messages that serve as a confirmation that the system works properly.

Debug and above

These messages are used just for debugging the system.

5.3 Logs filters

You can refine the logs view here according to the following criteria:

Since

Logs for the specified date or newer will be displayed. You can specify the time in the following way:

- using the absolute date in the format *YYYY-MM-DD*
- using any of the terms: yesterday, today, tomorrow and now
- using relative time by prefixing the value with - or + and specifying units. You can use the following units: seconds or s, minutes or min, hours or h, days or d, weeks or w, months or m, and years or y.

Until

Logs for the specified date or older will be displayed. You can specify the time in the following way:

- using the absolute date in the format *YYYY-MM-DD*
- using any of the terms: yesterday, today, tomorrow and now
- using relative time by prefixing the value with - or + and specifying units. You can use the following units: seconds or s, minutes or min, hours or h, days or d, weeks or w, months or m, and years or y.

Boot

Enter an integer: 0 means the current boot, -1 is for the previous boot, 1 for the first boot, 2 for the second, etc.

Unit

Specify the systemd unit for which you want to display logs. Use one of the formats:

- __SYSTEMD_UNIT=NAME.service
- COREDUMP_UNIT=NAME.service
- UNIT=NAME.service

Free-form search

Enter the string that you want to find in the log messages. You can also use [PERL-compatible regular expressions](https://www.freedesktop.org/software/systemd/man/journalctl.html#-g) (<https://www.freedesktop.org/software/systemd/man/journalctl.html#-g>). Alternatively, you can filter messages according to message log fields in the format `FIELD=VALUE`. For example, `CODE_LINE=349` displays logs with this value.

6 Managing storage using Cockpit

The *Storage* page enables you to monitor traffic on your drives, repartition your system, manage NFS mounts, view storage logs, and create RAIDs or LVM.

6.1 Monitoring data flow on disks

The graphs on the *Storage* page display reading and writing data flow to devices. Each device in the graph has a different color. Hover over the displayed data flow peak to identify the device name.

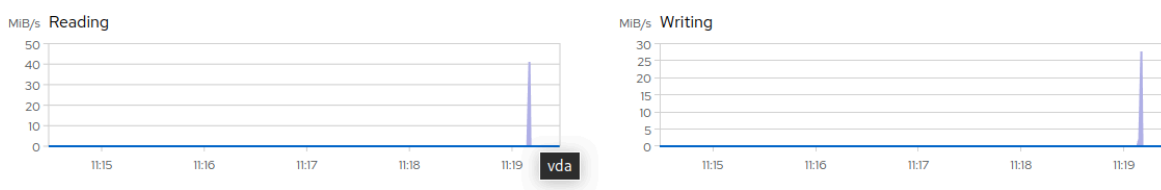


FIGURE 1: DATA FLOW VIEW

6.2 Managing file systems

The *Filesystems* view enables you to create a partition table and to format or mount file systems. You can sort the mounted partition according to *Name* or *Mount point*.

6.2.1 Formatting partitions using Cockpit

To format the partition, proceed as follows:

PROCEDURE 5: FORMATTING PARTITIONS

1. Navigate to the *Storage* page.

2. In the *Filesystem* view, click the partition you want to format.
3. Click *Format* next to the particular partition description to open the format window.
4. Enter a unique name for the partition.
5. In the *Mount point*, specify the directory to which the partition will be mounted. The *Mount point* field is mandatory.
6. In *Type*, select the file system type. Btrfs is mandatory for the `/` partition.
7. If needed, configure the encryption:

Passphrase and Confirm

Enter a passphrase to unlock the encrypted partition.

Store passphrase

The passphrase is stored in `/etc/luks - keys` and you are not asked for the passphrase on next boot.

Encryption options

You can pass a list of options described in [supported encrypted options \(https://www.man7.org/linux/man-pages/man5/crypttab.5.html#SUPPORTED_OPTIONS\)](https://www.man7.org/linux/man-pages/man5/crypttab.5.html#SUPPORTED_OPTIONS).

8. Select the *Mount options*. In the *Custom mount options* text field, you can enter a comma-separated list of options. For common options, refer to [File system Independent Mount Options \(https://linux.die.net/man/8/mount\)](https://linux.die.net/man/8/mount). These options are used in the `options` part of the `/etc/fstab` file.

6.2.2 Mounting partitions using Cockpit



Note: The partition must be formatted

Before you try to mount a partition or disk, you need to format the device first. For details, refer to [Procedure 5, "Formatting partitions"](#).

To mount a partition, proceed as follows:

1. Navigate to the *Storage* page.

2. In the *Filesystems* view, click the device to mount.
3. Click *Mount* to open the *Mount filesystem* window.
4. Specify the *Mount point*.
5. To select mount options in the *Custom mount options* text field, you can enter a comma-separated list of options. For common options, refer to [File system Independent Mount Options \(https://linux.die.net/man/8/mount\)](https://linux.die.net/man/8/mount). These options are used in the options part of the /etc/fstab file.
6. Select at which booting stage the partition must be mounted.
7. Click *Mount* to proceed.

6.3 Managing NFS mount points

The *NFS mounts* view under the *Storage* page enables you to add, edit or delete NFS mounts.

6.3.1 Adding an NFS mount point

To add an NFS mount point, proceed as follows:

1. Navigate to the *Storage* page.
2. From the three-line menu, select *New NFS mounts* view.
3. Specify the following values:

Server address

Provide the IP address or name of the NFS server.

Path on server

Select the available path on the NFS server that can be mounted.

Local mount point

Specify a directory on the local system where the path will be mounted.

Mount options

Check any of the options:

- *Mount at boot* – to mount the path automatically after each start or restart of the system.
- *Mount read only* – you will not be able to perform changes to the data on the NFS path.
- *Custom mount options* is a comma-separated list of the **mount** command options.

6.3.2 Editing existing NFS mount points

To edit an NFS mount, proceed as follows:

1. Navigate to the *Storage* page.
2. In the *NFS mounts* view, click on the particular NFS mount.
3. On the next screen, click *Edit* and specify the details described in *NFS mount details*.

6.4 Managing RAID using Cockpit

Using Cockpit, you can create or modify software RAID of different levels.

6.4.1 Creating RAID using Cockpit



Note: Sufficient number of disks

Make sure that you have enough disks available according to the RAID level.

To create a software RAID, proceed as follows:

PROCEDURE 6: CREATING A RAID

1. Navigate to the *Storage* page.

2. Select the *Create RAID device* option in the three-line menu in the *Devices* view.
3. Enter the following parameters of the RAID:

Name

Enter a unique name for the RAID.

RAID level

Select one of the RAID levels.

Chunk size

The size of chunks in KBs. A chunk is the minimum amount of data read or written to each data disk in the array during a single read/write operation.

Disks

Select the disks that should be included in the RAID. The required number of disks depends on the selected RAID level.

4. Confirm the parameters by clicking *Create*. The RAID then appears in the *Devices* part.

6.4.2 Modifying RAID

Using the *Storage* plug-in of Cockpit, you can stop or delete a RAID. Here you can also remove or add disks to the array.

To modify an existing RAID, proceed as follows:

1. Navigate to the *Storage* page.
2. Click the RAID in *Devices* to open the RAID details view.
3. In the detailed view, you can stop or delete the RAID, add or remove disks and format the device.

With certain RAID levels, you can switch on the *Bitmap* option that enables you to synchronize only the changes after a disk is temporarily disconnected. If the *Bitmap* is off, all data on the disk will be synchronized.



Note: Removing or adding disks

After any change in the disk number of the array, the system undergoes resynchronization that may take some time. Keep in mind that each RAID level requires a minimum number of disks. Therefore, Cockpit does not allow removing the disks that are required by the particular RAID level.

6.5 Managing volume groups and LVM

6.5.1 Creating volume groups

To create a volume group of disks, proceed as follows:

1. Click *Storage*.
2. Under the three-line menu in *Devices*, select *Create LVM2 volume group*.
3. Enter the volume group name.
4. Select the disks that will be part of the volume group.
5. Confirm the data with *Create*. The volume group appears in the *Devices* view.

6.5.2 Creating logical block volumes

If you have a volume group, you can create a logical block volume from it. To do so, proceed as follows:

1. Navigate to the *Storage* page.
2. In the *Devices*, click the volume group you want to use.
3. Click *Create new logical volume*
4. Specify a logical volume name. Select a block device and choose the size to use.
5. Select the *Block device for filesystems*.
6. Select the size to use.

7. Click *Create* to confirm the details.
8. Format the block volume by clicking *Format* and filling the details as described in [Step 4](#).

6.5.3 Creating a thin logical volume

If you have a volume group, you can create a thin logical volume as described below:

PROCEDURE 7: CREATING A THIN LOGICAL VOLUME

1. Navigate to the *Storage* page.
2. Click the volume group in *Devices*.
3. In the volume group details, click *Create new logical volume*.
4. Specify a logical volume name.
5. Select a pool of thinly provisioned volumes.
6. Select the size to use.
7. Click *Create* to confirm the details.
8. Create a thin volume by clicking *Create thin volume*.
9. Enter a unique name.
10. Select the size of the volume.
11. Click *Create* to confirm the thin volume.
12. You can create several volumes of the particular volume group by clicking *Create thin volume* again and repeating the steps above.
13. Format the volumes by clicking *Format* and filling the details as described in [Step 4](#).

6.5.4 Managing logical volumes

To perform any administration task on an existing logical volume, perform the following steps:

1. Navigate to the *Storage* page.
2. In the *Filesystems* view, click the logical volume.

3. Here you can perform the following actions with existing logical volumes:

Deactivate/Activate

In the three-dot menu, select *Deactivate* or *Activate*.

Mount

By clicking *Mount* and filling in the mount point and options, the volume will be mounted.

Shrink/Grow

The shrink/grow function is not available for all file systems.

In the expanded details about the volume, click *Shrink* or *Grow*.

Delete

In the three-dot menu, select *Delete*.

7 Managing networking using Cockpit

After clicking *Networking*, you can view traffic on your system, manage the firewall, manage network interfaces, or view network logs.

7.1 Managing firewall rules and zones

Cockpit enables you to create new zones or update the existing ones. In the firewall settings, you can add services to a zone or allow access to ports.



Note: Cockpit service is mandatory

Do not remove the Cockpit service from the default firewall zone as the Cockpit service may get blocked, and you may get disconnected from the server.

7.1.1 Adding firewall zones

The *public zone* is the default firewall zone. To add a new zone, proceed as follows:

PROCEDURE 8: ADDING NEW FIREWALL ZONES

1. Navigate to the *Networking* page.

2. Click *Edit rules and zones*.
3. Click *Add new zone*.
4. Select *Trust level*. Each trust level of network connections has a predefined set of included services (the Cockpit service is included in all trust levels). The description for each trust level appears in the *Description* section.
5. Define allowed addresses within the zone. Select one of the values:
 - *Entire subnet* to allow all addresses in the subnet.
 - *Range*—a comma-separated list of IP addresses with the routing prefix, for example, 192.0.2.0/24, 2001:db8::/32.
6. Click *Add zone*.

7.1.2 Adding allowed services and ports to a zone

You can add services to an existing firewall zone as described below:

PROCEDURE 9: ADDING SERVICES TO A FIREWALL ZONE

1. Navigate to the *Networking* page.
2. Click *Edit rules and zones*.
3. Click *Add services*.
4. To add a service, select *Services* and choose the services from the list.
5. To allow custom ports, select *Custom ports* and specify the port value for UDP and/or TCP. You can assign an identifier to this port.
6. To confirm the changes, click *Add services* or *Add ports*, respectively.

7.2 About network bonds

A bond interface is a combination of several network interfaces into one bond. Depending on the *Mode* (described further), network bonding can improve performance by increasing the network throughput and bandwidth. Network bonding can also increase fault tolerance by keeping overall connectivity even if some of the bonded interfaces stopped working.

7.2.1 Managing bonds

7.2.1.1 Adding bonds



Warning: Using DHCP when creating bonds may cause disconnection from Cockpit

When you try to create a network bond, you will be disconnected from Cockpit as its IP address changes if the following conditions are met:

- DHCP is used on the server running Cockpit
- the currently used network interface is added to the new network bond

To add a bond, proceed as follows:

1. Navigate to the *Networking* page.
2. Click *Add bond*.
3. Specify the following parameters of the bond interface:

Name

Enter a unique name for the interface.

Interfaces

Select which network interfaces should be grouped in the bond.

MAC

You can either select a specific MAC address of the underlying interface, or you can use any of the following options:

Permanent

Use the permanent hardware address if the device has a MAC address.

Preserve

During the bond activation, the MAC address is not changed.

Random

A random MAC address is created on each connection attempt.

Stable

Creates a hashed MAC address.

Mode

Keep the default mode or select any of the following modes:

Round Robin

Transfers packets from the first available interface to the last. The mode offers fault tolerance and load balancing.

Active Backup

Only one interface in the bonding is active. If the active interface fails, the backup will be activated.

XOR

Balancing using a transmit hash policy. The default is a modulo device count. To select a different policy, specify the `xmit_hash_policy` option in the *Option* field.

Broadcast

Everything is transmitted on all interfaces.

Adaptive Transmit Load Balancing

Channel bonding that does not require any special switch support. The outgoing traffic is distributed according to the current load on each interface.

Adaptive Load Balancing

Includes adaptive transmit load balancing and receive load balancing; no special switch support is required.

Primary

This selection is available only in the *Active Backup* mode. You can select a particular interface that will be used as primary, while other interfaces in the bond are used as secondary.

Link monitoring

Select the type of link monitoring.

Monitoring interval

Specifies the intervals at which the particular link monitor performs checks. The value is in ms.

Link up delay

Define the time in ms for how long the bond is disabled after a link has been activated. The value should be a multiple of the *Monitoring interval* value. Otherwise, it will be rounded to the nearest value. Available only for the MII link monitor.

Link down delay

Define the time in ms for how long the bond is disabled if a link failure has been detected. The value should be a multiple of the *Monitoring interval* value. Otherwise, it will be rounded to the nearest value. Available only for the MII link monitor.

Monitoring targets

Specify the list of host IP addresses that you want to monitor. Available only for the ARP link monitor.

4. Click *Apply*.

7.2.1.2 Modifying bonds

To modify a bond, proceed as follows:

1. Navigate to the *Networking* page.
2. Click on the particular bond name to open the details.
3. You can modify the following bond parameters:

Bond

Click the bond name and the bond details appear. Modify the details and click *Save*.

Connect automatically

The bond connects automatically by default. Clear the box to disable the automatic connection.

IPv4 and IPv6

After clicking *edit*, you can set an IP address and configure a specific DNS, DNS search domain and routes.

MTU

By default, *Automatic* is selected. After clicking *edit*, you can specify a particular value of the maximum transmission unit in bytes or select *Automatic*.

Bond

After clicking *edit*, you can edit the same parameters as when you were creating the bond interface.

7.3 Managing network bridges

A network bridge is a device that creates a single aggregated network from multiple networks.

7.3.1 Creating network bridges



Warning: Using DHCP when creating network bridges may cause disconnection from Cockpit

When you try to create a network bridge, you will be disconnected from Cockpit as its IP address changes if the following conditions are met:

- DHCP is used on the server running Cockpit
- the currently used network interface is added to the new network bridge

To create a network bridge, proceed as follows:

1. Navigate to the *Networking* page.
2. In the *Interfaces* view, click *Add bridge*.
3. Specify the following:

Name

Specify a unique name for the bridge.

Ports

Select the interfaces to be included in the bridge.

Spanning Tree Protocol (STP)

STP is a network protocol used for Ethernet networks that prevents bridge loops by setting a preferred link whenever network switches are connected with several links. This preferred link is used for all Ethernet traffic unless it fails. In that case, a redundant link is used instead. For details regarding STP, see [STP \(https://en.wikipedia.org/wiki/Spanning_Tree_Protocol\)](https://en.wikipedia.org/wiki/Spanning_Tree_Protocol).

If you enable the STP protocol, you can edit the following settings:

STP priority

The lower the priority, the higher the probability of the switch becoming the root switch.

STP forward delay

Specify the time spent in the listening and learning state (in seconds). The default value is 15 s, but you can use any value between 4 and 30 s.

STP hello time

Specify the time between each bridge protocol data unit (BPDU) that is sent on a port (in seconds). The default value is 2 s, but the recommended range is 1 to 10 s.

STP maximum message age

Specify the maximum length of time that passes before a bridge port saves its configuration BPDU information.

4. Click *Add*

7.3.2 Modifying or deleting existing bridges

To modify or delete a bridge, proceed as follows:

1. Navigate to the *Networking* page.
2. In the *Interfaces* view, click the bridge name to open the details.
3. To delete the bridge, click *Delete*.

To modify, change any of the following details and click *Save*.

General

The bridge connects automatically by default. To disable the automatic connection, uncheck the option.

IPv4 and IPv6

After clicking *edit*, you can set the IP address and configure a specific DNS, DNS search domain and routes.

Bridge

By clicking *edit*, you can edit all parameters of the bridge.

7.4 Managing VLANs using Cockpit

A virtual local area network is a logical subnetwork that groups devices from different physical LANs.

7.4.1 Creating a virtual local area network

To add a VLAN, proceed as follows:

1. Navigate to the *Networking* page.
2. In the *Interfaces* view, click *Add VLAN*.
3. Fill in the VLAN details:

Parent

Select the parent network interface.

VLAN ID

Specify an ID in the range 1–4094.

Name

Enter the name of the VLAN.

4. Click *Add VLAN*.

7.4.2 Modifying or deleting existing VLANs

To modify or delete an existing VLAN, proceed as follows:

1. Navigate to the *Networking* page.
2. In the *Interface* view, click the VLAN name.
3. To delete the VLAN, click *Delete* or modify any of the following details and click *Save*.

Parent

Select the parent network interface.

VLAN ID

Specify an ID in the range 1–4094.

Name

Enter the name of the VLAN.

8 Working with containers

After the first login to Cockpit, you need to start Podman. Keep the default check box selected to start Podman automatically on each boot.

The *Podman containers* page enables you to pull images from registries and manage your containers. You can also filter the view by entering a filter criterion into the filter field.

8.1 Managing container images



Note: openSUSE registry and Docker Hub not enabled by default

The openSUSE registry and Docker Hub are not configured in the default installation. To download container images from those registries, you need to add the registries to the `/etc/containers/registries.conf` file as follows:

```
unqualified-search-registries = ["registry.suse.com", "registry.opensuse.org",  
"docker.io"]
```

In the *Images* view, you can download, update or delete already pulled images. Each function is available through the three-dot menu. After clicking the menu, there are the following options:

- *Download new image*: How to proceed with downloading an image is described in *Procedure 10, "Downloading a new image"*.
- *Pull all images*: Cockpit pulls new versions of the container images you already downloaded.
- *Prune all unused images*: All images that are not used by any container will be removed.

PROCEDURE 10: DOWNLOADING A NEW IMAGE

1. In the *Podman containers* > *Images* view, open the three-dot menu and select *Download new image*.
2. Select the *Owner* to define who can see the downloaded image. The *System* restricts the image visibility to users with administrative access. The image downloaded under the *User* owner is visible to the regular user and also to all other users with administrative access.
3. Choose a preferred image registry or proceed with All registries.
4. Define the *Tag*. The default value is latest.
5. Fill in the image name or description in the *Search for* field to start the search. Cockpit suggests possible images according to the entered name, registry and tag.
6. Select the desired image and click *Download*.

8.2 Managing containers using Cockpit

8.2.1 Running new containers from images



Note: Image required to run a container

To run a container, you need a container image. The image can be pulled using Podman or Cockpit. When using Cockpit, you can pull an image in advance as described in *Procedure 10, "Downloading a new image"*, or you can pull the image directly from the *Create container* form as described below.

To run a new container, proceed as follows:

1. Navigate to the *Podman containers* page.
2. If you pulled an image in advance:
 - a. In the *Images* view, click *Show images*.
 - b. Click *Create container* next to the image you want to use.
3. If you do not have the image, click *Create container* in the *Containers* view.
4. In the *Create container* window, enter the container details as described below. Note that some options are available only for system administrators.

In the *Details* tab, enter the following details:

Owner

Select whether the container will be visible only for users with **sudo** privileges by selecting *system*. The *user* defines that the container is visible to privileged users and regular users.

Name

Specify a unique name for the container.

Image

This field is enabled if you do not have an image. After you start typing the image name, Cockpit makes suggestions of images in the configured registries.

Pull the latest image

The checkbox is available if you are creating the container from an already downloaded image. If selected, the latest image version is pulled before the container is started.

Command

You can specify a command to run in the container.

With terminal

Select the option to gain access to the container using a terminal. If not selected, the container will be in the detached state.

Memory limit

You can limit the maximum memory consumption of the container by checking the box and specifying the limit.

CPU shares

Specify the weight of the container to use CPU time. The default weight is 1024. The weight applies only if containers are under high load. If the tasks in one container are idle, other containers may use its CPU time.

If you have four containers, two of them have CPU shares of 512 and the other two have 1024. Thus, under high load, the containers with lower CPU shares get only 16,5% of CPU time, while those with 1024 CPU shares get 33% of CPU time.

In the *Integration* tab, you can enter the following parameters:

Port mapping

After you click the *Add port mapping* button, specify the host IP address, the host port to map the container port onto, the container port and select the protocol. If you do not set the host IP address or set the value to 0.0.0.0, the port is bound to ALL host IP addresses. If you omit the host port, a random one is used for the mapping.

Volumes

This field maps a path in a container onto a path on the host machine. Fill in the host path, the container path and select the SELinux label.

The SELinux label *private* defines that the volume is accessible only from the particular container. The *shared* label means that all containers can access the volume.

Environment variables

To define environment variables in the container, click *Add variable* and fill in *Key* and *Value*. You can enter multiple variables by adding more lines.

In the *Health check* tab, you can set the interval for triggering commands to check the container's status. Fill in the following parameters:

Command

Specify the command that is triggered to check the container status.

Interval

Specify the interval of checks in seconds.

Timeout

The maximum time in seconds to wait before the interval is considered failed.

Start period

The time interval after the container is started when the health check is not performed.

Retries

Specify how many times the check can be performed before the status is considered unhealthy.

When unhealthy

Select the action to take after a container is considered unhealthy.

5. To create the container, click *Create* or *Create and run* to create and start the container.

8.2.2 Further actions with running containers

Under the three-dot menu, you can perform the following actions:

- delete the container
- pause the container
- commit changes performed to the container, for example, installing packages to the container
- checkpoint the container—write the state of the container to disk and stop the container
- restart the container either by regular *Restart*, where processes running inside the container are stopped, or by *Force restart*, where the processes are killed, and you may lose data
- stop the container, either by regular *Stop*, *Force stop* or *Checkpoint*. When using *Checkpoint*, the state of all processes in the container is written to the disk, and after the next start, the container is restored to the same point before stopping.

By expanding the container details, you can access the container's terminal in the *Console* tab and view its information in other tabs.

8.3 Pods management

8.3.1 Creating pods

Cockpit enables you to create pods in which you can then create containers. To create a pod, follow the steps:

1. Navigate to the *Podman containers* page.
2. Click *Create pod*.
3. Fill in the pod details:

Name

Enter a unique name for the pod.

Owner

Specify whether the pod will be visible only under root privileges or also to regular users.

Port mapping

After clicking *Add port mapping*, you can map a pod port onto a host port. Specify the container's port, assign the desired host port and IP address. If the host IP address is not set or is set to 0.0.0.0, the port is bonded to all host IP addresses. If you omit the host port number, a random port number is assigned to the mapping.

Volumes

After clicking *Add volume*, you can map a directory on the host onto the container's volume. Select the host path, enter the path in containers and select the SELinux labeling.

4. Click *Create* to confirm the pod creation.

8.3.2 Creating containers in pods



Important: Existing containers cannot be added to pods

During the planning, note that only new containers can be run in a pod. You cannot add an already created container that has not been run under a pod to any pod.

To create containers in a pod, follow the steps:

1. Navigate to the *Podman containers* page.
2. In the desired pod group, click *Create container in pod*.
3. Fill in the container details as described in [Section 8.2.1, “Running new containers from images”](#). Remember that the owner of new containers is the same as the owner of the particular pod.

9 User administration using Cockpit

The Cockpit *Accounts* screen enables you to administer user accounts and groups. You can search and view the users, manage the user access and delete users.



Note: User administration only for server administrators

Only users with *Administrative access* can edit other users.

Using the *Accounts* Cockpit screen, you can perform the following tasks:

- Creating new users of the system as described in [Section 9.2, “Creating user accounts using Cockpit”](#)
- Assigning **sudo** privileges to user accounts as described in [Section 9.1, “Modifying existing user accounts”](#)
- Forcing a change of a user's password as described in [Section 9.1, “Modifying existing user accounts”](#)
- Locking a particular user account as described in [Section 9.1, “Modifying existing user accounts”](#)

9.1 Modifying existing user accounts

To modify a user account, proceed as follows:

1. Navigate to the *Accounts* page.
2. Click the account you want to modify.
3. In the user details view, you can perform the following actions:

Delete the user

Click *Delete* to remove the user from the system.

Terminate user's session

By clicking *Terminate session*, you can log a particular user out of the system.

Manage access to the account

You can set a date for when the account will expire. The default is to never expire.

You can disallow the user to use their password to log in. The user then must use a different method of authentication.

Manage the user's password

Click *Set password* to set a new password for the account.

By clicking *Force change*, the user will have to change the password on the next login.

Click *edit* to set whether and when the password expires.

Add SSH key

You can add an SSH key for passwordless authentication via SSH. Click *Add key*, paste the contents of the public SSH key and confirm it by clicking *Add*.

Change shell

Click the shell name and select the shell from the list.

View login history

You can view the login history of the user.

9.2 Creating user accounts using Cockpit

To add a new user to the system, proceed as follows:

1. Navigate to the *Accounts* page.

2. Click *Create new account* to open the window that enables you to add a new user.
3. Fill in the user account details. You can assign a different home directory to the user in the *Home directory* text box. If you do not specify a directory, the standard `/home/USERNAME` path is used.
If you select *Disallow password authentication*, the user will have to use an authentication method other than filling in a password, for example, an SSH login.
4. Click *Create* to confirm the account.
5. To add an SSH key to the account, you need to modify the account as described in [Section 9.1, "Modifying existing user accounts"](#).

9.3 Creating user groups

The topic covers the creation of user groups.

To create a user group, proceed as follows:

1. Navigate to the *Accounts* page.
2. Click *Create new group*.
3. Enter a unique name for the group and specify or leave the default ID.



Note

The already existing group ID cannot be overwritten. Group IDs under 1000 are usually reserved for system accounts, services, and so on. If you create a group with an ID less than 1000, the group cannot be later deleted using Cockpit.

10 Managing services using Cockpit

The following sections describe how to start, stop and restart a service, target, socket, timer or path.

10.1 Managing systemd units

To manage a systemd unit, proceed as follows:

1. Click the *Services* page.
2. Select the appropriate tab (*System services*, *Targets*, *Sockets*, *Timers* or *Paths*).
3. Click the unit you want to administer.
4. In the unit details, you can view relations to other systemd units, the status of the unit, or you can perform the following actions that can be found in the three-dot menu:
 - *Start* if the unit is not running
 - *Restart* the running unit
 - *Stop* the running unit
 - *Disallow running*—that will stop the service permanently, including all its dependencies. Keep in mind that the dependent service can be used by other units, and disallowing the unit may cause serious trouble for the system.

10.2 Creating new timers

systemd timers help you in automating recurring tasks. A systemd timer can control the triggering of systemd services and the handling of events.



Note: Overriding existing timers

The default set of systemd timers is stored in `/usr/lib/systemd`. If you create a timer with already existing names, the default unit file is not overwritten, but a new one is created in `/etc/systemd/system/` that overrides the default unit file. To restore the timer to the default one, delete the timer unit file in `/etc/systemd/system/`.

If you try to create a timer that already exists in the `/etc/systemd/system/` directory, the unit file will be overwritten, and the previous changes are lost.

To create a systemd timer using Cockpit, proceed as follows:

1. Navigate to *Services*.

2. In the *Timers* tab, click *Create timer*.

3. Fill in the details:

Name

The name of the timer that will be used in the unit name and in the service unit name as well. For example, specifying the name *example* will create the following unit files: `/etc/systemd/system/example.timer` and `/etc/systemd/system/example.service`.

Description

You can provide a short description of the timer.

Command

The command to be invoked when the timer is triggered.

Trigger

The timer can be triggered each time you reboot your machine or at a specific time. For the *After system boot* option, you can define the delay of the service invocation. For the *At specific time* option, specify when the service should be invoked.

4. Click *Save*.

11 Managing Subscriptions using Cockpit

Cockpit enables you to register new subscriptions, view the list of registered and available subscriptions and also deregister subscriptions.

11.1 Register new subscription

To register a new subscription, you must have a registration code and an e-mail address.

1. Navigate to the *Subscriptions* section.

2. In the *Register a new subscription* section, enter the details as described below.

Registration code

Specify the registration code.

Email

Specify the e-mail address.

3. Click *Register*.

11.2 Edit subscription settings

You can edit the subscription settings.

1. Navigate to the *Subscriptions* section.
2. Click *Edit Settings*.
3. Specify the proxy URI.
4. To allow insecure proxy addresses, select the *Allow insecure Proxies* check box.
5. Select the language code in *Language*.
6. Click *Save*.

11.3 Register available extension

Extensions that you can use are listed under *Available Extensions*. To register an extension, proceed as follows:

1. Navigate to the *Subscriptions* section.
2. In the *Available Extensions* section, click *Register* corresponding to the extension you want to register.

11.4 Deregistering subscriptions or extensions

You can deregister subscriptions or extensions using Cockpit.

1. Navigate to the *Subscriptions* section.
2. In the *Registered Subscriptions* section, click *De-register* corresponding to the subscription or extension you want to deregister.

12 SELinux mode and policy

The SELinux tool enables you to switch between SELinux modes and view current modifications of the SELinux policy.

Important: Missing SELinux module

The SELinux Cockpit module is visible only if SELinux is enabled on the system. If you cannot access the module, SELinux is probably disabled. To check that SELinux is enabled, run:

```
> sestatus
```

On SUSE Linux Enterprise Server for SAP applications, SELinux is in the enforcing mode by default. To temporarily switch to the permissive mode, click the button with the [Enforcing](#) label. Note that the change persists only until the next boot. If you need to perform a persistent change of the mode, edit the configuration file [/etc/selinux/config](#).

The *System modifications* lists all modifications performed on the default SELinux policy. If you want to export the modifications and reuse them on different servers, click [View automation script](#). In the new window, you can copy a shell script or an Ansible configuration file that can be applied on other servers.

12.1 Updating SLES for SAP using Cockpit

To update your system, proceed as follows:

1. Navigate to the *Software updates* page.
2. Click the *Check for Updates* icon to get a list of new package updates and patches available for your system. We recommend installing the patches marked as important as soon as possible.
3. Now you can update your system either with immediate reboot, or the reboot might be postponed:
 - a. Click *Install all updates* to install all updates. By default, all available updates are selected.

To install specific updates, select *Unselect all* and then select the required updates and click *Install selected updates*.

After the installation is complete, you can reboot your system or click *Ignore* to postpone the reboot.



Note

When the Web Console is restarted, you will no longer see progress information. However, the update process will continue in the background. Reconnect to continue watching the update process.

- b. To reboot the system after installation, enable the *Reboot after completion* toggle button. By default, the *Reboot after completion* toggle button is disabled. You must reboot the system to activate the snapshot with updates. If you perform further changes without rebooting the system beforehand, a new snapshot will be created from the same point as the snapshots with updates. Therefore, the new snapshot will not include the updates.
 - c. To view the installed package information, click *Package information*.
 - d. In the *Reboot* window, enter the message for the logged-in users and select the time delay for the reboot.
 - e. Click *Reboot*.
4. You can view the update history in the *Update history* section.

12.2 Managing Software Repositories using Cockpit

Cockpit enables you to view, add, edit, and delete software repositories.

12.2.1 Adding new repository

To add a new repository, you must have the repository URL.

1. Navigate to the *Software Repositories* section.
2. Click *Add repo*.

3. In the *Add repo* window, enter the repository details as described below.

Alias

Specify the repository alias.

Name

Specify a unique name for the repository.

Priority

Specify the priority number. The default priority is set to 99.

You can set the priority within the range 1 to 99. Where 99 denotes lowest priority and 1 the highest.

Enabled

The check box is enabled by default. To disable the repository, clear the check box.

Autorefresh

The check box is enabled by default. To disable auto-refresh for the repository, clear the check box.

GPG Check

The check box is enabled by default. To disable the GPG Check, clear the check box.

Uri

Specify the repository URI.

4. Click *Save*.

12.2.2 Refreshing repositories

You can refresh repositories manually.

1. Navigate to the *Software Repositories* section.

2. Click *Refresh repositories*.

The repositories are refreshed, and a window appears stating that the repos refresh is successful.

3. Click *Ok*

12.2.3 Editing repositories

You can edit repositories. You cannot edit the repository URI using Cockpit.

1. Navigate to the *Software Repositories* section.
2. Click the three-dot menu and click *Edit*.
3. Modify the required details and click *Save*.

12.2.4 Deleting repositories

You can delete repositories using Cockpit.

1. Navigate to the *Software Repositories* section.
2. Click the three-dot menu and click *Delete*.
3. Click *Delete* to confirm deletion.

12.3 Solving SELinux access issues

In the *SELinux* page, you can view access denial messages from the audit log. On top of that, Cockpit provides possible ways of solving the access denial. To do so, follow the steps:

1. Navigate to the *SELinux* page.
2. In *SELinux access control errors*, expand the details regarding access denial.
3. To view the audit log record, click *Audit log*.
4. To view possible solutions, click *Solutions*. Some solutions may be applied directly through Cockpit by clicking *Apply this solution*.

13 Legal Notice

Copyright© 2006–2026 SUSE LLC and contributors. All rights reserved.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or (at your option) version 1.3; with the Invariant Section being this copyright notice and license. A copy of the license version 1.2 is included in the section entitled “GNU Free Documentation License”.

For SUSE trademarks, see <https://www.suse.com/company/legal/>. All other third-party trademarks are the property of their respective owners. Trademark symbols (®, ™ etc.) denote trademarks of SUSE and its affiliates. Asterisks (*) denote third-party trademarks.

All information found in this book has been compiled with utmost attention to detail. However, this does not guarantee complete accuracy. Neither SUSE LLC, its affiliates, the authors, nor the translators shall be held liable for possible errors or the consequences thereof.

A GNU Free Documentation License

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

1. APPLICABILITY AND DEFINITIONS

This License applies to any manual or other work, in any medium, that contains a notice placed by the copyright holder saying it can be distributed under the terms of this License. Such a notice grants a world-wide, royalty-free license, unlimited in duration, to use that work under

the conditions stated herein. The "Document", below, refers to any such manual or work. Any member of the public is a licensee, and is addressed as "you". You accept the license if you copy, modify or distribute the work in a way requiring permission under copyright law.

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

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

The "Invariant Sections" are certain Secondary Sections whose titles are designated, as being those of Invariant Sections, in the notice that says that the Document is released under this License. If a section does not fit the above definition of Secondary then it is not allowed to be designated as Invariant. The Document may contain zero Invariant Sections. If the Document does not identify any Invariant Sections then there are none.

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

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

Examples of suitable formats for Transparent copies include plain ASCII without markup, Texinfo input format, LaTeX input format, SGML or XML using a publicly available DTD, and standard-conforming simple HTML, PostScript or PDF designed for human modification. Examples of transparent image formats include PNG, XCF and JPG. Opaque formats include proprietary

formats that can be read and edited only by proprietary word processors, SGML or XML for which the DTD and/or processing tools are not generally available, and the machine-generated HTML, PostScript or PDF produced by some word processors for output purposes only.

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

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

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

2. VERBATIM COPYING

You may copy and distribute the Document in any medium, either commercially or non-commercially, 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 <https://www.gnu.org/copyleft/>.

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

ADDENDUM: How to use this License for your documents

```
Copyright (c) YEAR YOUR NAME.  
Permission is granted to copy, distribute and/or modify this document  
under the terms of the GNU Free Documentation License, Version 1.2  
or any later version published by the Free Software Foundation;  
with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts.  
A copy of the license is included in the section entitled "GNU  
Free Documentation License".
```

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.