



# Release Notes

SUSE Linux Enterprise Server is a modern, modular operating system for both multimodal and traditional IT. This document provides a high-level overview of features, capabilities, and limitations of SUSE Linux Enterprise Server 15 SP6 (prerelease) and highlights important product updates.

*This product will be released in June 2024.* The latest version of these release notes is always available at <https://www.suse.com/releasenotes> . Drafts of the general documentation can be found at <https://susedoc.github.io/doc-sle/main> .

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# 1 About the release notes

These Release Notes are identical across all architectures, and the most recent version is always available online at <https://www.suse.com/releasenotes> .

Entries are only listed once but they can be referenced in several places if they are important and belong to more than one section.

Release notes usually only list changes that happened between two subsequent releases. Certain important entries from the release notes of previous product versions are repeated. To make these entries easier to identify, they contain a note to that effect.

However, repeated entries are provided as a courtesy only. Therefore, if you are skipping one or more service packs, check the release notes of the skipped service packs as well. If you are only reading the release notes of the current release, you could miss important changes.

## 2 SUSE Linux Enterprise Server

SUSE Linux Enterprise Server 15 SP6 (prerelease) is a multimodal operating system that paves the way for IT transformation in the software-defined era. It is a modern and modular OS that helps simplify multimodal IT, makes traditional IT infrastructure efficient and provides an engaging platform for developers. As a result, you can easily deploy and transition business-critical workloads across on-premises and public cloud environments.

SUSE Linux Enterprise Server 15 SP6 (prerelease), with its multimodal design, helps organizations transform their IT landscape by bridging traditional and software-defined infrastructure.

### 2.1 Interoperability and hardware support

Designed for interoperability, SUSE Linux Enterprise Server integrates into classical Unix and Windows environments, supports open standard interfaces for systems management, and has been certified for IPv6 compatibility.

This modular, general-purpose operating system runs on four processor architectures and is available with optional extensions that provide advanced capabilities for tasks such as real-time computing and high-availability clustering.

SUSE Linux Enterprise Server is optimized to run as a high-performance guest on leading hypervisors. This makes SUSE Linux Enterprise Server the perfect guest operating system for virtual computing.

## 2.2 What is new?

### 2.2.1 General changes in SLE 15

SUSE Linux Enterprise Server 15 introduces many innovative changes compared to SUSE Linux Enterprise Server 12. The most important changes are listed below.

#### Migration from openSUSE Leap to SUSE Linux Enterprise Server

SLE 15 SP2 and later support migrating from openSUSE Leap 15 to SUSE Linux Enterprise Server 15. Even if you decide to start out with the free community distribution, you can later easily upgrade to a distribution with enterprise-class support. For more information, see the *Upgrade Guide* at <https://documentation.suse.com/sles/15-SP6/html/SLES-all/cha-upgrade-online.html#sec-upgrade-online-opensuse-to-sle>.

#### Extended package search

Use the new Zypper command `zypper search-packages` to search across all SUSE repositories available for your product, even if they are not yet enabled. For more information see [Section 5.8.1, "Searching packages across all SLE modules"](#).

#### Software Development Kit

In SLE 15, packages formerly shipped as part of the Software Development Kit are now integrated into the products. Development packages are packaged alongside other packages. In addition, the *Development Tools* module contains tools for development.

#### RMT replaces SMT

SMT (Subscription Management Tool) has been removed. Instead, RMT (Repository Mirroring Tool) now allows mirroring SUSE repositories and custom repositories. You can then register systems directly with RMT. In environments with tightened security, RMT can also proxy other RMT servers. If you are planning to migrate SLE 12 clients to version 15, RMT is the supported product to handle such migrations. If you still need to use SMT for these migrations, beware that the migrated clients will have *all* installation modules enabled. For more information see [Section 4.2.3, "SMT has been replaced by RMT"](#).

## Media changes

The *Unified Installer* and *Packages* media known from SUSE Linux Enterprise Server 15 SP1 have been replaced by the following media:

- **Online Installation Medium:** Allows installing all SUSE Linux Enterprise 15 products. Packages are fetched from online repositories. This type of installation requires a registration key. Available SLE modules are listed in [Section 3.1, “Modules in the SLE 15 SP6 \(prerelease\) product line”](#).
- **Full Installation Medium:** Allows installing all SUSE Linux Enterprise Server 15 products without a network connection. This medium contains all packages from all SLE modules. SLE modules need to be enabled manually during installation. RMT (Repository Mirroring Tool) and SUSE Manager provide additional options for disconnected or managed installations.

## MAJOR UPDATES TO THE SOFTWARE SELECTION:

### Salt

SLE 15 SP6 (prerelease) can be managed via Salt, making it integrate better with modern management solutions such as SUSE Manager.

### Python 3

As the first enterprise distribution, SLE 15 offers full support for Python 3 development in addition to Python 2.

### Directory Server

389 Directory Server replaces OpenLDAP as the LDAP directory service.

## 2.2.2 Changes in 15 SP6 (prerelease)

SUSE Linux Enterprise Server 15 SP6 (prerelease) introduces changes compared to SUSE Linux Enterprise Server 15 SP5. The most important changes are listed below:

### 2.2.3 Package and module changes in 15 SP6 (prerelease)

The full list of changed packages compared to 15 SP5 can be seen at this URL:

- [https://documentation.suse.com/package-lists/sle/15-SP6/package-changes\\_SLE-15-SP5-GA\\_SLE-15-SP6-GA.txt](https://documentation.suse.com/package-lists/sle/15-SP6/package-changes_SLE-15-SP5-GA_SLE-15-SP6-GA.txt) ↗

The full list of changed modules compared to 15 SP5 can be seen at this URL:

- [https://documentation.suse.com/package-lists/sle/15-SP6/module-changes\\_SLE-15-SP5-GA\\_SLE-15-SP6-GA.txt](https://documentation.suse.com/package-lists/sle/15-SP6/module-changes_SLE-15-SP5-GA_SLE-15-SP6-GA.txt) ↗

## 2.3 Important sections of this document

If you are upgrading from a previous SUSE Linux Enterprise Server release, you should review at least the following sections:

- *Section 2.7, “Support statement for SUSE Linux Enterprise Server”*
- *Section 4.2, “Upgrade-related notes”*
- *Section 5, “Changes affecting all architectures”*

## 2.4 Security, standards, and certification

SUSE Linux Enterprise Server 15 SP6 (prerelease) will not be submitted for certification to either Common Criteria or NIST FIPS 140-3. As a practice, SUSE only submits even-numbered Service Packs (for example: SLES 15, SP2, SP4, etc.) for certification.

For more information about certification, see <https://www.suse.com/support/security/certifications/> ↗.

## 2.5 Documentation and other information


### 2.5.1 Available on the product media

- Read the READMEs on the media.
- Get the detailed change log information about a particular package from the RPM (where *FILENAME.rpm* is the name of the RPM):

```
rpm --changelog -qp FILENAME.rpm
```

- Check the ChangeLog file in the top level of the installation medium for a chronological log of all changes made to the updated packages.
- Find more information in the docu directory of the installation medium of SUSE Linux Enterprise Server 15 SP6 (prerelease). This directory includes PDF versions of the SUSE Linux Enterprise Server 15 SP6 (prerelease) Installation Quick Start Guide.

### 2.5.2 Online documentation

- For the most up-to-date version of the documentation for SUSE Linux Enterprise Server 15 SP6 (prerelease), see <https://susedoc.github.io/doc-sle/main>  (draft version).

## 2.6 Support and life cycle

SUSE Linux Enterprise Server is backed by award-winning support from SUSE, an established technology leader with a proven history of delivering enterprise-quality support services.

SUSE Linux Enterprise Server 15 has a 13-year life cycle, with 10 years of General Support and three years of Extended Support. The current version (SP6) will be fully maintained and supported until six months after the release of SUSE Linux Enterprise Server 15 SP7.

If you need additional time to design, validate and test your upgrade plans, Long Term Service Pack Support can extend the support duration. You can buy an additional 12 to 36 months in twelve month increments. This means that you receive a total of three to five years of support per Service Pack.

For more information, see the pages [Support Policy \(https://www.suse.com/support/policy.html\)](https://www.suse.com/support/policy.html) and [Long Term Service Pack Support \(https://www.suse.com/support/programs/long-term-service-pack-support.html\)](https://www.suse.com/support/programs/long-term-service-pack-support.html).

## 2.7 Support statement for SUSE Linux Enterprise Server

To receive support, you need an appropriate subscription with SUSE. For more information, see [https://www.suse.com/support/?id=SUSE\\_Linux\\_Enterprise\\_Server](https://www.suse.com/support/?id=SUSE_Linux_Enterprise_Server).

The following definitions apply:

### L1

Problem determination, which means technical support designed to provide compatibility information, usage support, ongoing maintenance, information gathering, and basic troubleshooting using the documentation.

### L2

Problem isolation, which means technical support designed to analyze data, reproduce customer problems, isolate the problem area, and provide a resolution for problems not resolved by Level 1 or prepare for Level 3.

### L3

Problem resolution, which means technical support designed to resolve problems by engaging engineering to resolve product defects which have been identified by Level 2 Support.

For contracted customers and partners, SUSE Linux Enterprise Server is delivered with L3 support for all packages, except for the following:

- Technology Previews, see [Section 2.8, “Technology previews”](#)
- Sound, graphics, fonts and artwork
- Packages that require an additional customer contract, see [Section 2.7.2, “Software requiring specific contracts”](#)
- Some packages shipped as part of the module *Workstation Extension* are L2-supported only
- Packages with names ending in `-devel` (containing header files and similar developer resources) will only be supported together with their main packages.



SUSE will only support the usage of original packages. That is, packages that are unchanged and not recompiled.

### 2.7.1 General support

To learn about supported features and limitations, refer to the following sections in this document:

- *Section 5.3, “Kernel”*
- *Section 5.6, “Storage and file systems”*
- *Section 5.9, “Virtualization”*
- *Section 7, “Removed and deprecated features and packages”*

### 2.7.2 Software requiring specific contracts

Certain software delivered as part of SUSE Linux Enterprise Server may require an external contract. Check the support status of individual packages using the RPM metadata that can be viewed with `rpm`, `zypper`, or YaST.

Major packages and groups of packages affected by this are:

- PostgreSQL (all versions, including all subpackages)

### 2.7.3 Software under GNU AGPL

SUSE Linux Enterprise Server 15 SP6 (prerelease) (and the SUSE Linux Enterprise modules) includes the following software that is shipped *only* under a GNU AGPL software license:

- Ghostscript (including subpackages)

SUSE Linux Enterprise Server 15 SP6 (prerelease) (and the SUSE Linux Enterprise modules) includes the following software that is shipped under multiple licenses that include a GNU AGPL software license:

- MySpell dictionaries and LightProof
- ArgyllCMS

## 2.8 Technology previews

Technology previews are packages, stacks, or features delivered by SUSE to provide glimpses into upcoming innovations. Technology previews are included for your convenience to give you a chance to test new technologies within your environment. We would appreciate your feedback! If you test a technology preview, contact your SUSE representative and let them know about your experience and use cases. Your input is helpful for future development.

Technology previews come with the following limitations:

- Technology previews are still in development. Therefore, they may be functionally incomplete, unstable, or in other ways not suitable for production use.
- Technology previews are **not** supported.
- Technology previews may only be available for specific hardware architectures. Details and functionality of technology previews are subject to change. As a result, upgrading to subsequent releases of a technology preview may be impossible and require a fresh installation.
- Technology previews can be removed from a product at any time. This may be the case, for example, if SUSE discovers that a preview does not meet the customer or market needs, or does not comply with enterprise standards.

### 2.8.1 Technology previews for Arm 64-Bit (AArch64)

#### 2.8.1.1 64K page size kernel flavor is available

SUSE Linux Enterprise Server for Arm 12 SP2 and later kernels have used a page size of 4K. This offers the widest compatibility also for small systems with little RAM, allowing to use Transparent Huge Pages (THP) where large pages make sense.

As a technology preview, SUSE Linux Enterprise Server for Arm 15 SP5 added a kernel flavor `64kb`, offering a page size of 64 KiB and physical/virtual address size of 52 bits. Same as the `default` kernel flavor, it does not use preemption.

Main purpose at this time is to allow for side-by-side benchmarking for High Performance Computing, Machine Learning and other Big Data use cases. Contact your SUSE representative if you notice performance gains for your specific workloads.



## Note: Default file system no longer needs to be changed

SUSE Linux Enterprise Server for Arm 15 SP5 and later allow the use of Btrfs based file systems with 4 KiB block size also with 64 KiB page size kernels.



## Important: Swap needs to be re-initialized

After booting the 64K kernel, any swap partitions need to be re-initialized to be usable. To do this, run the `swapon` command with the `--fixpgsz` parameter on the swap partition. Note that this process deletes data present in the swap partition (for example, suspend data). In this example, the swap partition is on `/dev/sdc1`:

```
swapon --fixpgsz /dev/sdc1
```



## Warning: RAID 5 uses page size as stripe size

It is currently possible to configure stripe size by setting the following kernel parameter:

```
echo 16384 > /sys/block/md1/md/stripe_size
```

Keep in mind that `stripe_size` must be in multiples of 4KB and not bigger than `PAGE_SIZE`. Also, it is only supported on systems where `PAGE_SIZE` is not 4096, such as arm64.

Avoid RAID 5 volumes when benchmarking 64K vs. 4K page size kernels.

See the *Storage Guide* for more information on software RAID.



## Note: Cross-architecture compatibility considerations

The SUSE Linux Enterprise Server 15 SP6 (prerelease) kernels on x86-64 use 4K page size.

The SUSE Linux Enterprise Server for POWER 15 SP6 (prerelease) kernel uses 64K page size.

### 2.8.1.2 Driver enablement for NVIDIA BlueField-2 DPU as host platform

SUSE Linux Enterprise Server for Arm 15 SP1 and later kernels include drivers for installing on NVIDIA\* BlueField\* Data Processing Unit (DPU) based server platforms and SmartNIC (Network Interface Controller) cards.

As a technology preview, the SUSE Linux Enterprise Server for Arm 15 SP5 and SP6 kernels include drivers for running on NVIDIA BlueField-2 DPU.

Should you wish to use SUSE Linux Enterprise Server for Arm on NVIDIA BlueField-2 or BlueField-2X (or BlueField-3) in production, contact your SUSE representative.



#### Note: Host drivers and tools for NVIDIA BlueField-2 SmartNICs

This Technology Preview status applies only to installing SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease) **on** NVIDIA BlueField-2 DPUs.

For an NVIDIA BlueField-2 DPU PCIe card inserted as **SmartNIC** into a SUSE Linux Enterprise Server 15 SP6 (prerelease) or SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease) based server, check [Section 2.8, “Technology previews”](#) and [Section 5.3, “Kernel”](#) for support status or known limitations of NVIDIA ConnectX\* network drivers for BlueField-2 DPUs (`mlx5_core` and others).

The `rshim` tool is available from SUSE Package Hub ([Section 5.7, “SUSE Package Hub”](#)).

### 2.8.1.3 etnaviv drivers for Vivante GPUs are available

The NXP\* Layerscape\* LS1028A/LS1018A System-on-Chip (SoC) contains a Vivante GC7000UL Graphics Processor Unit (GPU), and the NXP i.MX 8M SoC contains a Vivante GC7000L GPU.

As a technology preview, the SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease) kernel includes `etnaviv`, a Display Rendering Infrastructure (DRI) driver for Vivante GPUs, and the `Mesa-dri` package contains a matching `etnaviv_dri` graphics driver library. Together they can avoid the need for third-party drivers and libraries.



#### Note

To use them, the Device Tree passed by the bootloader to the kernel needs to include a description of the Vivante GPU for the kernel driver to get loaded. You may need to contact your hardware vendor for a bootloader firmware upgrade.

#### 2.8.1.4 **lima driver for Arm Mali Utgard GPUs available**

The Xilinx\* Zynq\* UltraScale\* + MPSoC contains an Arm\* Mali\*-400 Graphics Processor Unit (GPU).

Prior to SUSE Linux Enterprise Server for Arm 15 SP2, this GPU needed third-party drivers and libraries from your hardware vendor.

As a technology preview, the SUSE Linux Enterprise Server for Arm 15 SP2 kernel added lima, a Display Rendering Infrastructure (DRI) driver for Mali *Utgard* microarchitecture GPUs, such as Mali-400, and the Mesa-dri package contains a matching lima\_dri graphics driver library.



#### Note

To use them, the Device Tree passed by the bootloader to the kernel needs to include a description of the Mali GPU for the kernel driver to get loaded. You may need to contact your hardware vendor for a bootloader firmware upgrade.



#### Note

The panfrost driver for Mali *Midgard* microarchitecture GPUs is supported since SUSE Linux Enterprise Server for Arm 15 SP2.

#### 2.8.1.5 **mali-dp driver for Arm Mali Display Processors available**

The NXP\* Layerscape\* LS1028A/LS1018 System-on-Chip contains an Arm\* Mali\*-DP500 Display Processor.

As a technology preview, the SUSE Linux Enterprise Server for Arm 15 SP2 kernel added mali-dp, a Display Rendering Manager (DRM) driver for Mali Display Processors. It has undergone only limited testing because it requires an accompanying physical-layer driver for DisplayPort\* output (see [Section 6.3.2, “No DisplayPort graphics output on NXP LS1028A and LS1018A”](#)).

#### 2.8.1.6 **Btrfs file system is enabled in U-Boot bootloader**

For Raspberry Pi\* devices, SUSE Linux Enterprise Server for Arm 12 SP3 and later include *Das U-Boot* as bootloader, in order to align the boot process with other platforms. By default, it loads GRUB as UEFI application from a FAT-formatted partition, and GRUB then loads Linux kernel and ramdisk from a file system such as Btrfs.

As a technology preview, SUSE Linux Enterprise Server for Arm 15 SP2 added a Btrfs driver to U-Boot for the Raspberry Pi (package `u-boot-rpiarm64`). This allows its commands `ls` and `load` to access files on Btrfs-formatted partitions on supported boot media, such as microSD and USB. The U-Boot command `btrfs subvol` lists Btrfs subvolumes.

## 2.8.2 Technology previews for Intel 64/AMD64 (x86-64)

### 2.8.2.1 Support for AMD Wheat Nas GPU

SLES 15 SP6 (prerelease) includes the kernel driver support for AMD Wheat Nas GPU (Navi32 dGPU). However because the corresponding firmware is still not publicly released yet, this feature is considered a technology preview.

## 3 Modules, extensions, and related products

This section comprises information about modules and extensions for SUSE Linux Enterprise Server 15 SP6 (prerelease). Modules and extensions add functionality to the system.



### Note: Package and module changes in 15 SP6 (prerelease)

For more information about all package and module changes since the last version, see [Section 2.2.3, “Package and module changes in 15 SP6 \(prerelease\)”](#).

## 3.1 Modules in the SLE 15 SP6 (prerelease) product line

The SLE 15 SP6 (prerelease) product line is made up of modules that contain software packages. Each module has a clearly defined scope. Modules differ in their life cycles and update timelines. The modules available within the product line based on SUSE Linux Enterprise 15 SP6 (prerelease) at the release of SUSE Linux Enterprise Server 15 SP6 (prerelease) are listed in the *Modules and Extensions Quick Start* at <https://susedoc.github.io/doc-sle/main/html/SLES-modules/> [↗](#) (draft version).

Not all SLE modules are available with a subscription for SUSE Linux Enterprise Server 15 SP6 (prerelease) itself (see the column *Available for*).

For information about the availability of individual packages within modules, see <https://scc.suse.com/packages>.

## 3.2 SLE extensions

SLE Extensions add extra functionality to the system and require their own registration key, usually at additional cost. Most extensions have their own release notes documents that are available from <https://www.suse.com/releasesnotes>.

The following extensions are available for SUSE Linux Enterprise Server 15 SP6 (prerelease):

- SUSE Linux Enterprise Live Patching: <https://www.suse.com/products/live-patching>
- SUSE Linux Enterprise High Availability Extension: <https://www.suse.com/products/highavailability>
- SUSE Linux Enterprise Workstation Extension: <https://www.suse.com/products/workstation-extension>

The following extension is not covered by SUSE support agreements, available at no additional cost and without an extra registration key:

- SUSE Package Hub: <https://packagehub.suse.com/> (see *Section 5.7, “SUSE Package Hub”*)

## 3.3 Derived and related products

This sections lists derived and related products. Usually, these products have their own release notes documents that are available from <https://www.suse.com/releasesnotes>.

- SUSE Linux Enterprise JeOS: <https://www.suse.com/products/server/jeos> (see *Section 4.3, “Minimal-VM and Minimal-Image”*)
- SUSE Linux Enterprise Desktop: <https://www.suse.com/products/desktop>
- SUSE Linux Enterprise Server for SAP Applications: <https://www.suse.com/products/sles-for-sap>
- SUSE Linux Enterprise for High-Performance Computing: <https://www.suse.com/products/server/hpc>

- SUSE Linux Enterprise Real Time: <https://www.suse.com/products/realtime> ↗
- SUSE Manager: <https://www.suse.com/products/suse-manager> ↗

## 4 Installation and upgrade

SUSE Linux Enterprise Server can be deployed in several ways:

- Physical machine
- Virtual host
- Virtual machine
- System containers
- Application containers

### 4.1 Installation

This section includes information related to the initial installation of SUSE Linux Enterprise Server 15 SP6 (prerelease).



#### Important: Installation documentation

The following release notes contain additional notes regarding the installation of SUSE Linux Enterprise Server. However, they do not document the installation procedure itself. For installation documentation, see the *Deployment Guide* at <https://susedoc.github.io/docsle/main/html/SLES-deployment/> ↗ (draft version).



### 4.1.1 New media layout

The set of media has changed with 15 SP2. There still are two different installation media, but the way they can be used has changed:

- You can install with registration using either the online-installation medium (as with SUSE Linux Enterprise Server 15 SP1) or the full medium.
- You can install without registration using the full medium. The installer has been added to the full medium and the full medium can now be used universally for all types of installations.
- You can install without registration using the online-installation medium. Point the installer at the required SLE repositories, combining the `install=` and `instsys=` boot parameters:
  - With the `install=` parameter, select a path that contains either just the product repository or the full content of the media.
  - With the `inst-sys=` parameter, point at the installer itself, that is, `/boot/ARCHITECTURE/root` on the medium.

For more information about the parameters, see [https://en.opensuse.org/SDB:Linuxrc#p\\_install](https://en.opensuse.org/SDB:Linuxrc#p_install).

## 4.2 Upgrade-related notes

This section includes upgrade-related information for SUSE Linux Enterprise Server 15 SP6 (prerelease).



### Important: Upgrade documentation

The following release notes contain additional notes regarding the upgrade of SUSE Linux Enterprise Server. However, they do not document the upgrade procedure itself.

For upgrade documentation, see the *Upgrade Guide* at <https://susedoc.github.io/doc-sle/main/html/SLES-upgrade/> (draft version).

#### 4.2.1 Make sure the current system is up-to-date before upgrading

Upgrading the system is only supported from the most recent patch level. Make sure the latest system updates are installed by either running `zypper patch` or by starting the YaST module *Online Update*. An upgrade on a system that is not fully patched may fail.

#### 4.2.2 Skipping service packs requires LTSS

Skipping service packs during an upgrade is only supported if you have a Long Term Service Pack Support contract. Otherwise, you need to first upgrade to SLE 15 SP5 before upgrading to SLE 15 SP6 (prerelease).

#### 4.2.3 SMT has been replaced by RMT

*SLE 12 is the last codestream that SMT (Subscription Management Tool) is available for.*

When upgrading your OS installation to SLE 15, we recommend also upgrading from SMT to its replacement RMT (Repository Mirroring Tool). RMT provides the following functionality:

- Mirroring of SUSE-originated repositories for the SLE 12-based and SLE 15-based products your organization has valid subscriptions for.
- Synchronization of subscriptions from SUSE Customer Center using your organization's mirroring credentials. (These credentials can be found in SCC under *Select Organization, Organization, Organization Credentials*)
- Selecting repositories to be mirrored locally via `rmt-cli` tool.
- Registering systems directly to RMT to get required updates.
- Adding custom repositories from external sources and distributing them via RMT to target systems.
- Improved security with proxying: If you have strict security requirements, an RMT instance with direct Internet access can proxy to another RMT instance without direct Internet access.
- Nginx as Web server: The default Web server of RMT is Nginx which has a smaller memory footprint and comparable performance than that used for SMT.

Note that unlike SMT, RMT does not support installations of SLE 11 and earlier.

For more feature comparison between RMT and SMT, see [https://github.com/SUSE/rmt/blob/master/docs/smt\\_and\\_rmt.md](https://github.com/SUSE/rmt/blob/master/docs/smt_and_rmt.md).

For more information about RMT, also see the new RMT Guide at <https://documentation.suse.com/sles/15-SP3/html/SLES-all/book-rmt.html>.

## 4.3 Minimal-VM and Minimal-Image

SUSE Linux Enterprise Server Minimal-VM and Minimal-Image is a slimmed-down form factor of SUSE Linux Enterprise Server that is ready to run in virtualization environments and the cloud. With SUSE Linux Enterprise Server Minimal-VM and Minimal-Image, you can choose the right-sized SUSE Linux Enterprise Server option to fit your needs.

SUSE provides virtual disk images for Minimal-VM and Minimal-Image in the file formats `.qcow2`, `.vhd`, and `.vmdk`, compatible with KVM, Xen, OpenStack, Hyper-V, and VMware environments. All Minimal-VM and Minimal-Image images set up the same disk size (24 GB) for the system. Due to the properties of different file formats, the size of Minimal-VM and Minimal-Image image downloads differs between formats.

## 4.4 JeOS renamed Minimal-VM and Minimal-Image

We have received feedback from users confused by the name JeOS, as a matter of fact the acronym JeOS, which meant Just enough Operating System, was not well understood and could be confused with other images provided by SUSE or openSUSE.

We have decided to go with simplicity and rename JeOS by "Minimal-VM" for all our Virtual Machine Images and "Minimal-Image" for the Raspberry Pi Image. We have also removed a few other characters, in the full images name to make it more simple and clear:

- [`SLES15-SP4-Minimal-VM.x86\_64-kvm-and-xen-GM.qcow2`](#)
- [`SLES15-SP4-Minimal-VM.x86\_64-OpenStack-Cloud-GM.qcow2`](#)
- [`SLES15-SP4-Minimal-VM.x86\_64-MS-HyperV-GM.vhdx.xz`](#)
- [`SLES15-SP4-Minimal-VM.x86\_64-VMware-GM.vmdk.xz`](#)
- [`SLES15-SP4-Minimal-VM.aarch64-kvm-GM.qcow2`](#)
- [`SLES15-SP4-Minimal-Image.aarch64-RaspberryPi-GM.raw.xz`](#)

## 4.5 For more information

For more information, see *Section 5, “Changes affecting all architectures”* and the sections relating to your respective hardware architecture.

# 5 Changes affecting all architectures

Information in this section applies to all architectures supported by SUSE Linux Enterprise Server 15 SP6 (prerelease).

## 5.1 Containers

### 5.1.1 `suse/sle15` container uses NDB as the database back-end for RPM

Starting with SUSE Linux Enterprise 15 SP3, the `rpm` package in the `suse/sle15` container image no longer supports the BDB back-end (based on Berkeley DB) and switches to the NDB back-end. Tools for scanning, diffing, and building container image using the `rpm` binary of the host for introspection can fail or return incorrect results if the host’s version of `rpm` does not recognize the NDB format.

To use such tools, make sure that the host supports reading NDB databases, such as hosts with SUSE Linux Enterprise 15 SP2 and later.

## 5.2 Development

### 5.2.1 Supported Java versions

The following Java implementations are available in SUSE Linux Enterprise Server 15 SP6 (prerelease):

| Name (Package Name)                         | Version | Module      | Support                    |
|---|---------|-------------|----------------------------|
| OpenJDK<br>( <code>java-11-openjdk</code> ) | 11      | Base System | SUSE, L3, until 2026-12-31 |

| Name (Package Name)                               | Version | Module      | Support                    |
|---|---------|-------------|----------------------------|
| OpenJDK<br>( <a href="#">java-17-openjdk</a> )    | 17      | Base System | SUSE, L3, until 2028-06-30 |
| OpenJDK<br>( <a href="#">java-1_8_0-openjdk</a> ) | 1.8.0   | Legacy      | SUSE, L3, until 2026-12-31 |
| IBM Java<br>( <a href="#">java-1_8_0-ibm</a> )    | 1.8.0   | Legacy      | External, until 2025-04-30 |

## 5.3 Kernel

### 5.3.1 Kernel limits

This table summarizes the various limits which exist in our recent kernels and utilities (if related) for SUSE Linux Enterprise Server 15 SP6 (prerelease).

| SLES 15 SP6 (prerelease)<br>(Linux 5.14.21)      | AMD64/Intel<br>64 (x86_64) | IBM Z<br>(s390x)   | POWER<br>(ppc64le)              | ARMv8<br>(AArch64)  |
|--|----------------------------|--------------------|---------------------------------|---------------------|
| CPU bits   | 64                         | 64                 | 64                              | 64                  |
| Maximum number of logical CPUs                   | 8192                       | 256                | 2048                            | 768                 |
| Maximum amount of RAM<br>(theoretical/certified) | > 1 PiB/<br>64 TiB         | 10 TiB/<br>256 GiB | 1 PiB/64 TiB                    | 256 TiB/n.a.        |
| Maximum amount of user<br>space/kernel space     | 128 TiB/<br>128 TiB        | n.a.               | 512 TiB <sup>1</sup> /<br>2 EiB | 256 TiB/<br>256 TiB |
| Maximum amount of swap<br>space                  | Up to 29 *<br>64 GB        | Up to 30 * 64 GB   |                                 |                     |
| Maximum number of<br>processes                   | 1,048,576                  |                    |                                 |                     |

| SLES 15 SP6 (prerelease)<br>(Linux 5.14.21) | AMD64/Intel<br>64 (x86_64)  | IBM Z<br>(s390x) | POWER<br>(ppc64le) | ARMv8<br>(AArch64) |
|---|---|------------------|--------------------|--------------------|
| Maximum number of threads per process       | Upper limit depends on memory and other parameters (tested with more than 120,000) <sup>2</sup> . |                  |                    |                    |
| Maximum size per block device               | Up to 8 EiB on all 64-bit architectures   |                  |                    |                    |
| FD_SETSIZE                                  | 1024  |                  |                    |                    |

<sup>1</sup> By default, the user space memory limit on the POWER architecture is 128 TiB. However, you can explicitly request mmaps up to 512 TiB.

<sup>2</sup> The total number of all processes and all threads on a system may not be higher than the "maximum number of processes".

### 5.3.2 Restoring default Btrfs file compression

Previously in kernel 5.14, it was possible to disable compression by passing an empty string instead of explicitly mentioning `none` or `no`.

In SLES 15 SP6 (prerelease), this behavior is changed to the more expected one. From kernel 5.14 onwards, empty string will reset the default setting instead of disabling compression.

## 5.4 Networking

### 5.4.1 Samba

The version of Samba shipped with SUSE Linux Enterprise Server 15 SP6 (prerelease) delivers integration with Windows Active Directory domains. In addition, we provide the clustered version of Samba as part of SUSE Linux Enterprise High Availability Extension 15 SP6 (prerelease).

## 5.4.2 NFS

### 5.4.2.1 NFSv4

NFSv4 with IPv6 is only supported for the client side. An NFSv4 server with IPv6 is not supported.

## 5.5 Security

### 5.5.1 TLS 1.1 and 1.0 are no longer recommended for use

The TLS 1.0 and 1.1 standards have been superseded by TLS 1.2 and TLS 1.3. TLS 1.2 has been available for considerable time now.

SUSE Linux Enterprise Server packages using OpenSSL, GnuTLS, or Mozilla NSS already support TLS 1.3. We recommend no longer using TLS 1.0 and TLS 1.1, as SUSE plans to disable these protocols in a future service pack. However, not all packages, for example, Python, are TLS 1.3-enabled yet as this is an ongoing process.

## 5.6 Storage and file systems

### 5.6.1 Comparison of supported file systems

SUSE Linux Enterprise was the first enterprise Linux distribution to support journaling file systems and logical volume managers in 2000. Later, we introduced XFS to Linux, which allows for reliable large-scale file systems, systems with heavy load, and multiple parallel reading and writing operations. With SUSE Linux Enterprise 12, we started using the copy-on-write file system Btrfs as the default for the operating system, to support system snapshots and rollback.

The following table lists the file systems supported by SUSE Linux Enterprise.

*Support status:* + supported / – unsupported

| Feature              | Btrfs | XFS | Ext4 | OCFS 2 <sup>1</sup> |
|----------------------|-------|-----|------|---------------------|
| Supported in product | SLE   | SLE | SLE  | SLE HA              |

| Feature                           | Btrfs              | XFS      | Ext4         | OCFS 2 <sup>1</sup> |
|-----------------------------------|--------------------|----------|--------------|---------------------|
| Data/metadata journaling          | N/A <sup>2</sup>   | – / +    | + / +        | – / +               |
| Journal internal/external         | N/A <sup>2</sup>   | + / +    | + / +        | + / –               |
| Journal checksumming              | N/A <sup>2</sup>   | +        | +            | +                   |
| Subvolumes                        | +                  | –        | –            | –                   |
| Offline extend/shrink             | + / +              | – / –    | + / +        | + / – <sup>3</sup>  |
| Inode allocation map              | B-tree             | B+ -tree | Table        | B-tree              |
| Sparse files                      | +                  | +        | +            | +                   |
| Tail packing                      | –                  | –        | –            | –                   |
| Small files stored inline         | + (in metadata)    | –        | + (in inode) | + (in inode)        |
| Defragmentation                   | +                  | +        | +            | –                   |
| Extended file attributes/<br>ACLs | + / +              | + / +    | + / +        | + / +               |
| User/group quotas                 | – / –              | + / +    | + / +        | + / +               |
| Project quotas                    | –                  | +        | +            | –                   |
| Subvolume quotas                  | +                  | N/A      | N/A          | N/A                 |
| Data dump/restore                 | –                  | +        | –            | –                   |
| Block size default                | 4 KiB <sup>4</sup> |          |              |                     |
| Maximum file system size          | 16 EiB             | 8 EiB    | 1 EiB        | 4 PiB               |
| Maximum file size                 | 16 EiB             | 8 EiB    | 1 EiB        | 4 PiB               |

<sup>1</sup> OCFS 2 is fully supported as part of the SUSE Linux Enterprise High Availability Extension.



<sup>2</sup> Btrfs is a copy-on-write file system. Instead of journaling changes before writing them in-place, it writes them to a new location and then links the new location in. Until the last write, the changes are not "committed". Because of the nature of the file system, quotas are implemented based on subvolumes (qgroups).

<sup>3</sup> To extend an OCFS 2 file system, the cluster must be online but the file system itself must be unmounted.

<sup>4</sup> The block size default varies with different host architectures. 64 KiB is used on POWER, 4 KiB on other systems. The actual size used can be checked with the command `getconf PAGE_SIZE`.

### **Additional notes**

Maximum file size above can be larger than the file system's actual size because of the use of sparse blocks. All standard file systems on SUSE Linux Enterprise Server have LFS, which gives a maximum file size of  $2^{63}$  bytes in theory.

The numbers in the table above assume that the file systems are using a 4 KiB block size which is the most common standard. When using different block sizes, the results are different.

In this document:

- 1024 Bytes = 1 KiB
- 1024 KiB = 1 MiB;
- 1024 MiB = 1 GiB
- 1024 GiB = 1 TiB
- 1024 TiB = 1 PiB
- 1024 PiB = 1 EiB.

See also <http://physics.nist.gov/cuu/Units/binary.html>.

Some file system features are available in SUSE Linux Enterprise Server 15 SP6 (prerelease) but are not supported by SUSE. By default, the file system drivers in SUSE Linux Enterprise Server 15 SP6 (prerelease) will refuse mounting file systems that use unsupported features (in particular, in read-write mode). To enable unsupported features, set the module parameter `allow_unsupported=1` in `/etc/modprobe.d` or write the value `1` to `/sys/module/MODULE_NAME/parameters/allow_unsupported`. However, note that setting this option will render your kernel and thus your system unsupported.

## 5.6.2 Supported Btrfs features

The following table lists supported and unsupported Btrfs features across multiple SLES versions.

*Support status:* + supported / – unsupported

| Feature                                     | SLES<br>11 SP4 | SLES<br>12 SP5 | SLES<br>15 GA | SLES<br>15 SP1 | SLES<br>15 SP2 | SLES<br>15 SP3 |
|---|----------------|----------------|---------------|----------------|----------------|----------------|
| Copy on write                               | +              | +              | +             | +              | +              | +              |
| Free space tree<br>(Free Space Cache<br>v2) | –              | –              | –             | +              | +              | +              |
| Snapshots/<br>subvolumes                    | +              | +              | +             | +              | +              | +              |
| Swap files                                  | –              | –              | –             | +              | +              | +              |
| Metadata integrity                          | +              | +              | +             | +              | +              | +              |
| Data integrity                              | +              | +              | +             | +              | +              | +              |
| Online metadata<br>scrubbing                | +              | +              | +             | +              | +              | +              |
| Automatic<br>defragmentation                | –              | –              | –             | –              | –              | –              |
| Manual<br>defragmentation                   | +              | +              | +             | +              | +              | +              |
| In-band<br>deduplication                    | –              | –              | –             | –              | –              | –              |
| Out-of-band<br>deduplication                | +              | +              | +             | +              | +              | +              |
| Quota groups                                | +              | +              | +             | +              | +              | +              |

| Feature                | SLES<br>11 SP4 | SLES<br>12 SP5 | SLES<br>15 GA | SLES<br>15 SP1 | SLES<br>15 SP2 | SLES<br>15 SP3 |
|------------------------|----------------|----------------|---------------|----------------|----------------|----------------|
| Metadata duplication   | +              | +              | +             | +              | +              | +              |
| Changing metadata UUID | –              | –              | –             | +              | +              | +              |
| Multiple devices       | –              | +              | +             | +              | +              | +              |
| RAID 0                 | –              | +              | +             | +              | +              | +              |
| RAID 1                 | –              | +              | +             | +              | +              | +              |
| RAID 5                 | –              | –              | –             | –              | –              | –              |
| RAID 6                 | –              | –              | –             | –              | –              | –              |
| RAID 10                | –              | +              | +             | +              | +              | +              |
| Hot add/remove         | –              | +              | +             | +              | +              | +              |
| Device replace         | –              | –              | –             | –              | –              | –              |
| Seeding devices        | –              | –              | –             | –              | –              | –              |
| Compression            | –              | +              | +             | +              | +              | +              |
| Big metadata blocks    | –              | +              | +             | +              | +              | +              |
| Skinny metadata        | –              | +              | +             | +              | +              | +              |
| Send without file data | –              | +              | +             | +              | +              | +              |
| Send/receive           | –              | +              | +             | +              | +              | +              |
| Inode cache            | –              | –              | –             | –              | –              | –              |

| Feature                      | SLES<br>11 SP4 | SLES<br>12 SP5 | SLES<br>15 GA | SLES<br>15 SP1 | SLES<br>15 SP2 | SLES<br>15 SP3 |
|------------------------------|----------------|----------------|---------------|----------------|----------------|----------------|
| Fallocate with<br>hole punch | –              | +              | +             | +              | +              | +              |

## 5.7 SUSE Package Hub

SUSE Package Hub brings open-source software packages from openSUSE to SUSE Linux Enterprise Server and SUSE Linux Enterprise Desktop.

Usage of software from SUSE Package Hub is not covered by SUSE support agreements. At the same time, usage of software from SUSE Package Hub does not affect the support status of your SUSE Linux Enterprise systems. SUSE Package Hub is available at no additional cost and without an extra registration key.

## 5.8 System management

### 5.8.1 Searching packages across all SLE modules

In SLE 15 SP6 (prerelease) you can search for packages both within and outside of currently enabled SLE modules using the following command:

```
zypper search-packages -d SEARCH_TERM
```

This command contacts the SCC and searches all modules for matching packages. This functionality makes it easier for administrators and system architects to find the software packages needed.

## 5.9 Virtualization

For more information about acronyms used below, see <https://documentation.suse.com/sles/15-SP6/html/SLES-all/book-virtualization.html> .



## Important: Virtualization limits and supported hosts/guests

These release notes only document changes in virtualization support compared to the immediate previous service pack of SUSE Linux Enterprise Server. Full information regarding virtualization limits for KVM and Xen as well as supported guest and host systems is now available as part of the SUSE Linux Enterprise Server documentation.

See the *Virtualization Guide* at <https://susedoc.github.io/doc-sle/main/html/SLES-virtualization/cha-virt-support.html>  (draft version).

## 6 Arm 64-bit-specific changes (AArch64)

Information in this section applies to SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease).

### 6.1 System-on-Chip driver enablement

SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease) includes driver enablement for the following System-on-Chip (SoC) chipsets:

- AMD\* Opteron\* A1100
- Ampere\* X-Gene\*, eMAG\*, Altra\*, *Altra Max*, **AmpereOne\***
- AWS\* Graviton, Graviton2, Graviton3
- Broadcom\* BCM2837/BCM2710, BCM2711
- Fujitsu\* A64FX
- Huawei\* Kunpeng\* 916, Kunpeng 920
- Marvell\* ThunderX\*, ThunderX2\*; OCTEON TX\*; Armada\* 7040, Armada 8040
- NVIDIA\* Tegra\* X1, Tegra X2, Xavier\*, **Orin**; BlueField\*, *BlueField-2*
- NXP\* i.MX 8M, 8M Mini; Layerscape\* LS1012A, LS1027A/LS1017A, LS1028A/LS1018A, LS1043A, LS1046A, LS1088A, LS2080A/LS2040A, LS2088A, LX2160A
- Qualcomm\* Centriq\* 2400
- Rockchip RK3399

- Socionext\* SynQuacer\* SC2A11
- Xilinx\* Zynq\* UltraScale\* + MPSoC



## Note

Driver enablement is done as far as available and requested. Refer to the following sections for any known limitations.

Some systems might need additional drivers for external chips, such as a Power Management Integrated Chip (PMIC), which may differ between systems with the same SoC chipset.

For booting, systems need to fulfill either the Server Base Boot Requirements (SBBR) or the Embedded Base Boot Requirements (EBBR), that is, the Unified Extensible Firmware Interface (UEFI) either implementing the Advanced Configuration and Power Interface (ACPI) or providing a Flat Device Tree (FDT) table. If both are implemented, the kernel will default to the Device Tree; the kernel command line argument `acpi=force` can override this default behavior.

Check for SUSE *YES!* certified systems, which have undergone compatibility testing.

## 6.2 New features

### 6.2.1 Driver enablement for NVIDIA Orin

SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease) adds initial enablement for the NVIDIA Orin\* SoC (T234), which is found on Jetson\* AGX Orin, Jetson Orin NX and Jetson Orin Nano System-on-Modules (SoM).

Drivers for the integrated, NVIDIA *Ampere* microarchitecture-based Graphics Processor Unit (GPU) are not included (*Section 6.3.1, “No graphics drivers on NVIDIA Jetson”*).

## 6.3 Known limitations

### 6.3.1 No graphics drivers on NVIDIA Jetson

The NVIDIA\* Tegra\* System-on-Chip chipsets include an integrated Graphics Processor Unit (GPU).

SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease) does not include graphics drivers for any of the NVIDIA Jetson\*, NVIDIA IGX or NVIDIA DRIVE\* platforms.

Contact the chip vendor NVIDIA for whether third-party graphics drivers are available for SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease).

### 6.3.2 No DisplayPort graphics output on NXP LS1028A and LS1018A

The NXP\* Layerscape\* LS1028A/LS1018A System-on-Chip contains an Arm\* Mali\*-DP500 Display Processor, whose output is connected to a DisplayPort\* TX Controller (HDP-TX) based on Cadence\* High Definition (HD) Display Intellectual Property (IP).

A Display Rendering Manager (DRM) driver for the Arm Mali-DP500 Display Processor is available as technology preview ([Section 2.8.1.5, “mali-dp driver for Arm Mali Display Processors available”](#)).

However, there was no HDP-TX physical-layer (PHY) controller driver ready yet. Therefore no graphics output will be available, for example, on the DisplayPort\* connector of the NXP LS1028A Reference Design Board (RDB).

Contact the chip vendor NXP for whether third-party graphics drivers are available for SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease).

Alternatively, contact your hardware vendor for whether a bootloader update is available that implements graphics output, allowing to instead use `efi fb` framebuffer graphics in SUSE Linux Enterprise Server for Arm 15 SP6 (prerelease).



#### Note

The Vivante GC7000UL GPU driver (`etnaviv`) is available as a technology preview ([Section 2.8.1.3, “etnaviv drivers for Vivante GPUs are available”](#)).

## 7 Removed and deprecated features and packages

This section lists features and packages that were removed from SUSE Linux Enterprise Server or will be removed in upcoming versions.



### Note: Package and module changes in 15 SP6 (prerelease)

For more information about all package and module changes since the last version, see [Section 2.2.3, “Package and module changes in 15 SP6 \(prerelease\)”](#).

## 7.1 Removed features and packages

The following features and packages have been removed in this release.

### 7.1.1 Public Cloud module removals

The following packages in the Public Cloud module have been removed:

- [azure-cli-acr](#)
- [azure-cli-acs](#)
- [azure-cli-advisor](#)
- [azure-cli-ams](#)
- [azure-cli-appservice](#)
- [azure-cli-backup](#)
- [azure-cli-batch](#)
- [azure-cli-batchai](#)
- [azure-cli-billing](#)
- [azure-cli-cdn](#)
- [azure-cli-cloud](#)
- [azure-cli-cognitiveservices](#)



- [azure-cli-component](#)
- [azure-cli-configure](#)
- [azure-cli-consumption](#)
- [azure-cli-container](#)
- [azure-cli-cosmosdb](#)
- [azure-cli-dla](#)
- [azure-cli-dls](#)
- [azure-cli-dms](#)
- [azure-cli-eventgrid](#)
- [azure-cli-eventhubs](#)
- [azure-cli-extension](#)
- [azure-cli-feedback](#)
- [azure-cli-find](#)
- [azure-cli-interactive](#)
- [azure-cli-iot](#)
- [azure-cli-keyvault](#)
- [azure-cli-lab](#)
- [azure-cli-monitor](#)
- [azure-cli-network](#)
- [azure-cli-profile](#)
- [azure-cli-rdbms](#)
- [azure-cli-redis](#)
- [azure-cli-reservations](#)
- [azure-cli-resource](#)
- [azure-cli-role](#)

- [azure-cli-search](#)
- [azure-cli-servicebus](#)
- [azure-cli-servicefabric](#)
- [azure-cli-sql](#)
- [azure-cli-storage](#)
- [azure-cli-taskhelp](#)
- [azure-cli-vm](#)
- [blue-horizon-config-deploy-cap-eks](#)
- [cfn-lint](#)
- [gcimagebundle](#)
- [google-cloud-sdk](#)
- [google-compute-engine](#)
- [google-daemon](#)
- [google-startup-scripts](#)
- [python-azure-storage](#)
- [python-ravello-sdk](#)
- [python-vsts-cd-manager](#)
- [python-vsts](#)
- [regionServiceClientConfigHP](#)
- [regionServiceClientConfigSAPAzure](#)
- [regionServiceClientConfigSAPEC2](#)
- [regionServiceClientConfigSAPGCE](#)
- [terraform-provider-aws](#)
- [terraform-provider-azurerm](#)
- [terraform-provider-external](#)

- [terraform-provider-google](#)
- [terraform-provider-helm](#)
- [terraform-provider-kubernetes](#)
- [terraform-provider-local](#)
- [terraform-provider-null](#)
- [terraform-provider-openstack](#)
- [terraform-provider-random](#)
- [terraform-provider-susepubliccloud](#)
- [terraform-provider-template](#)
- [terraform-provider-tls](#)
- [WALinuxAgent](#)

### 7.1.2 Miscellaneous


- [openmpi2](#) and [openmpi3](#) have been removed.


## 7.2 Deprecated features and packages

The following features and packages are deprecated and will be removed in a future version of SUSE Linux Enterprise Server.

- [sev-tool](#) has been deprecated. Use [sevctl](#) instead.
- [gnote](#) has been deprecated. Use [bijiben](#) instead.

## 8 Obtaining source code


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## A Changelog for 15 SP6 (prerelease)

### A.1 2023-10-19

- Initial SP6 release

#### A.1.1 New

- *Section 7.1.1, “Public Cloud module removals”* (Jira (<https://jira.suse.com/browse/PED-3806>) )

## B Kernel parameter changes



### Warning

This list of changes may not be exhaustive.

### B.1 Changes from SP5 to SP6

These Linux kernel parameters have been changed since SLES 15 SP5.