Virtualization with KVM

This manual offers an introduction to setting up and managing virtualization with KVM (Kernel-based Virtual Machine) on SUSE Linux Enterprise Server. The first part introduces KVM by describing it's requirements and SUSE's support status. The second part deals with managing KVM with libvirt, while the last part covers management with QEMU.

Many chapters in this manual contain links to additional documentation resources. This includes additional documentation that is available on the system as well as documentation available on the Internet.

For an overview of the documentation available for your product and the latest documentation updates, refer to <http://www.suse.com/doc>.

**Available Documentation**[**#**](https://www.suse.com/documentation/sles11/book_kvm/data/book_kvm.html)

We provide HTML and PDF versions of our books in different languages. The following manuals for users and administrators are available for this product:

[Deployment Guide, (↑Deployment Guide)](https://www.suse.com/documentation/sles11/book_sle_deployment/data/book_sle_deployment.html#book_sle_deployment)

Shows how to install single or multiple systems and how to exploit the product inherent capabilities for a deployment infrastructure. Choose from various approaches, ranging from a local installation or a network installation server to a mass deployment using a remote-controlled, highly-customized, and automated installation technique.

[Administration Guide, (↑Administration Guide)](https://www.suse.com/documentation/sles11/book_sle_admin/data/book_sle_admin.html#book_sle_admin)

Covers system administration tasks like maintaining, monitoring, and customizing an initially installed system.

[Security Guide, (↑Security Guide)](https://www.suse.com/documentation/sles11/book_security/data/book_security.html#book_security)

Introduces basic concepts of system security, covering both local and network security aspects. Shows how to make use of the product inherent security software like AppArmor (which lets you specify per program which files the program may read, write, and execute), and the auditing system that reliably collects information about any security-relevant events.

[Security and Hardening Guide, (↑Security and Hardening Guide)](https://www.suse.com/documentation/sles11/book_hardening/data/book_hardening.html#book_hardening)

Deals with the particulars of installing and setting up a secure SUSE Linux Enterprise Server, and additional post-installation processes required to further secure and harden that installation. Supports the administrator with security-related choices and decisions.

[System Analysis and Tuning Guide, (↑System Analysis and Tuning Guide)](https://www.suse.com/documentation/sles11/book_sle_tuning/data/book_sle_tuning.html#book_sle_tuning)

An administrator's guide for problem detection, resolution and optimization. Find how to inspect and optimize your system by means of monitoring tools and how to efficiently manage resources. Also contains an overview of common problems and solutions, and of additional help and documentation resources.

[Virtualization with Xen, (↑Virtualization with Xen)](https://www.suse.com/documentation/sles11/book_xen/data/book_xen.html#book_xen)

Offers an introduction to virtualization technology of your product. It features an overview of the various fields of application and installation types of each of the platforms supported by SUSE Linux Enterprise Server as well as a short description of the installation procedure.

[Virtualization with KVM](https://www.suse.com/documentation/sles11/book_kvm/data/book_kvm.html)

Offers an introduction to setting up and managing virtualization with KVM (Kernel-based Virtual Machine) on SUSE Linux Enterprise Server. Learn how to manage KVM with libvirt or QEMU. The guide also contains detailed information about requirements, limitations, and support status.

[AutoYaST, (↑AutoYaST)](https://www.suse.com/documentation/sles11/book_autoyast/data/book_autoyast.html#book_autoyast)

AutoYaST is a system for installing one or more SUSE Linux Enterprise systems automatically and without user intervention, using an AutoYaST profile that contains installation and configuration data. The manual guides you through the basic steps of auto-installation: preparation, installation, and configuration.

[Storage Administration Guide, (↑Storage Administration Guide)](https://www.suse.com/documentation/sles11/stor_admin/data/bookinfo.html#bookinfo)

Provides information about how to manage storage devices on a SUSE Linux Enterprise Server.

In addition to the comprehensive manuals, several quick start guides are available:

[Installation Quick Start, (↑Quick Start Manuals)](https://www.suse.com/documentation/sles11/book_quickstarts/data/art_sles_installquick.html#art_sles_installquick)

Lists the system requirements and guides you step-by-step through the installation of SUSE Linux Enterprise Server from DVD, or from an ISO image.

Linux Audit Quick Start

Gives a short overview how to enable and configure the auditing system and how to execute key tasks such as setting up audit rules, generating reports, and analyzing the log files.

AppArmor Quick Start

Helps you understand the main concepts behind AppArmor®.

[Virtualization with Linux Containers (LXC), (↑Quick Start Manuals)](https://www.suse.com/documentation/sles11/book_quickstarts/data/art_lxcquick.html#art_lxcquick)

Gives a short introduction to LXC (a lightweight virtualization method) and shows how to set up an LXC host and LXC containers.

Find HTML versions of most product manuals in your installed system under /usr/share/doc/manual or in the help centers of your desktop. Find the latest documentation updates at <http://www.suse.com/doc> where you can download PDF or HTML versions of the manuals for your product.

**Feedback**[**#**](https://www.suse.com/documentation/sles11/book_kvm/data/book_kvm.html)

Several feedback channels are available:

Bugs and Enhancement Requests

For services and support options available for your product, refer to <http://www.suse.com/support/>.

To report bugs for a product component, log in to the Novell Customer Center from <http://www.suse.com/support/> and select My Support > Service Request.

User Comments

We want to hear your comments about and suggestions for this manual and the other documentation included with this product. Use the User Comments feature at the bottom of each page in the online documentation or go to <http://www.suse.com/doc/feedback.html> and enter your comments there.

Mail

For feedback on the documentation of this product, you can also send a mail to doc-team@suse.de. Make sure to include the document title, the product version, and the publication date of the documentation. To report errors or suggest enhancements, provide a concise description of the problem and refer to the respective section number and page (or URL).

**Documentation Conventions**[**#**](https://www.suse.com/documentation/sles11/book_kvm/data/book_kvm.html)

The following typographical conventions are used in this manual:

* /etc/passwd: directory names and filenames
* placeholder: replace placeholder with the actual value
* PATH: the environment variable PATH
* ls, --help: commands, options, and parameters
* user: users or groups
* Alt, Alt+F1: a key to press or a key combination; keys are shown in uppercase as on a keyboard
* File, File > Save As: menu items, buttons
* This paragraph is only relevant for the architectures amd64, em64t, and ipf. The arrows mark the beginning and the end of the text block.
* Dancing Penguins (Chapter Penguins, ↑Another Manual): This is a reference to a chapter in another manual.

# 1.0 KVM Installation and Requirements

KVM is a full virtualization solution for x86 processors supporting hardware virtualization (Intel VT or AMD-V). It consists of two main components: A set of Kernel modules (kvm.ko, kvm-intel.ko, and kvm-amd.ko) providing the core virtualization infrastructure and processor specific drivers and a userspace program (qemu-kvm) that provides emulation for virtual devices and control mechanisms to manage VM Guests (virtual machines). The term KVM more properly refers to the Kernel level virtualization functionality, but is in practice more commonly used to reference the userspace component.

VM Guests (virtual machines), virtual storage and networks can be managed with libvirt-based and QEMU tools. libvirt is a library that provides an API to manage VM Guests based on different virtualization solutions, among them KVM and Xen. It offers a graphical user interface as well as a command line program. The QEMU tools are KVM/QEMU specific and are only available for the command line.

1.1 Hardware Requirements

Currently, SUSE only supports KVM full virtualization on x86\_64 hosts. KVM is designed around hardware virtualization features included in AMD (AMD-V) and Intel (VT-x) CPUs. It supports virtualization features of chipsets, and PCI devices, such as an I/O Memory Mapping Unit (IOMMU) and Single Root I/O Virtualization (SR-IOV)).

You can test whether your CPU supports hardware virtualization with the following command:

egrep '(vmx|svm)' /proc/cpuinfo

If this command returns no output, your processor either does not support hardware virtualization, or this feature has been disabled in the BIOS.

The following Web site identifies processors which support hardware virtualization: <http://ark.intel.com/Products/VirtualizationTechnology>(for Intel CPUs), and <http://products.amd.com/> (for AMD CPUs).

*NOTE:* The KVM Kernel modules will not load if the CPU does not support hardware virtualization or if this feature is not enabled in the BIOS.

The general minimum hardware requirements for the VM Host Server are the same as outlined in [Section 2.2, System Requirements for Operating Linux, (↑Deployment Guide)](https://www.suse.com/documentation/sles11/book_sle_deployment/data/sec_x86_sysreqs.html#sec_x86_sysreqs). However, additional RAM for each virtualized guest is needed. It should at least be the same amount that is needed for a physical installation. It is also strongly recommended to have at least one processor core or hyper-thread for each running guest.

1.2 Supported Guest Operating Systems

The following table lists guest operating systems tested and their support status offered by SUSE. All guest operating systems are supported both fully virtualized and paravirtualized, with the exception of Windows guests, which are only supported fully virtualized and OES and Netware guests, which are supported only paravirtualized. All operating systems except Netware (32-bit only) are supported in both 32 and 64-bit x86 versions.

Para-virtualized drivers (PV drivers) are listed where available.

Para-virtualized drivers for KVM

* virtio-net: Virtual network driver.
* virtio-blk: Virtual block device driver for paravirtualized block devices.
* virtio-balloon: Memory driver for dynamic memory allocation. Allows to dynamically change the amount of memory allocated to a guest.
* virtio-scsi: Storage interface that supports advanced SCSI hardware.
* kvm-clock: Clock synchronization driver.

*Table 1-1*Supported Guest Operating Systems on KVM with SUSE Linux Enterprise Server

|  |  |  |
| --- | --- | --- |
| SLES 12 | | |
|  | PV drivers: | kvm-clock, virtio-net, virtio-blk, virtio-balloon, virtio-console, virtio-rng, virtio-scsi |
|  | Support Status: | Fully supported (L3) |
| SLES 11 SP3 / SP4 | | |
|  | PV drivers: | kvm-clock, virtio-net, virtio-blk, virtio-balloon, virtio-console, virtio-rng, virtio-scsi (SP3 and SP4 only) |
|  | Support Status: | Fully supported (L3) |
| SLES 10 SP4 | | |
|  | PV drivers: | kvm-clock, virtio-net, virtio-blk, virtio-balloon, virtio-console |
|  | Support Status: | Fully supported (L3) |
| SLES 9 SP4 | | |
|  | PV drivers: | n/a |
|  | Support Status: | Fully supported (L3) |
|  | Mandatory boot parameters: | * 32 bit kernel: clock=pmtmr * 64 bit kernel: ignore\_lost\_ticks |
| SLED 11 SP4 | | |
|  | PV drivers: | kvm-clock, virtio-net, virtio-blk, virtio-balloon, virtio-console, virtio-rng |
|  | Support Status: | Technology Preview (L2) |
| RedHat Enterprise Linux 5.11+ / RHEL 6.6+ / RHEL 7.0+ | | |
|  | PV drivers: | See <http://www.redhat.com/> |
|  | Support Status: | Best Effort (L2) |
|  | Note: | Refer to the RHEL Virtualization guide for more information. |
| Windows 2003 SP2+ / 2008 SP2+ / 2008 R2 SP1+ / 2012+ / 2012 R2+ | | |
|  | PV drivers: | virtio-net, virtio-blk, virtio-balloon; drivers from the Virtual Machine Driver Pack (<http://www.suse.com/products/vmdriverpack/>) are preferred |
|  | Support Status: | Fully supported (L3) |
|  | Note: | Host processor must have constant\_tsc CPU feature (check with the following command: grep "constant\_tsc" /proc/cpuinfo). |
| Windows XP SP3+ / Vista SP2+ / 7 SP1+ / 8+ / 8.1+ | | |
|  | PV drivers: | virtio-net, virtio-blk, virtio-balloon; drivers from the Virtual Machine Driver Pack (<http://www.suse.com/products/vmdriverpack/>) are preferred |
|  | Support Status: | Best effort (L2) |
| OES 11 SPx | | |
|  | PV drivers: |  |
|  | Support Status: | Fully supported (L3) |
| Netware 6.5 SP8 (32b only) | | |
|  | PV drivers: |  |
|  | Support Status: | Fully supported (L3) |

*IMPORTANT:* Guest images created under SUSE Linux Enterprise Server 11 SP1 and newer are supported, but guest images created under a previous SUSE Linux Enterprise version are not supported.

**1.2.1 Availability of Paravirtualized Drivers**[**#**](https://www.suse.com/documentation/sles11/book_kvm/data/sec_kvm_requires_guests.html#sec_kvm_requires_guests_virt_drivers)

To improve the performance of the guest operating system, paravirtualized drivers are provided when available. Although they are not required, it is strongly recommended to use them. The paravirtualized drivers are available as follows:

SUSE Linux Enterprise Server 11 SP1 / SP2 / SP3

included in Kernel

SUSE Linux Enterprise Server 10 SP4

included in Kernel

SUSE Linux Enterprise Server 9 SP4

not available

RedHat

available in RedHat Enterprise Linux 5.4 and newer

Windows

SUSE has developed virtio based drivers for Windows, which are available in the Virtual Machine Driver Pack (VMDP). See<http://www.suse.com/products/vmdriverpack/> for more information.

# 1.3 The kvm package

The kvm package provides qemu-kvm, the program that performs the I/O emulation for the VM Guest. In addition to the qemu-kvm program, the kvm package also comes with a debug level monitoring utility (kvm\_stat), firmware components, key-mapping files, and scripts. The deprecated Windows drivers (win-virtio-drivers.iso) are no longer provided. For more information, see [Deprecated features](https://www.suse.com/documentation/sles11/book_kvm/data/app_kvm_qemu-commands.html#kvm_deprecated_features).

Originally, the kvm package also provided the KVM Kernel modules. Now, these modules are included with the Kernel and only userspace components are included in the current kvm package.

Using the libvirt-based tools is the recommended way of managing VM Guests. Interoperability with other virtualization tools has been tested and is an essential part of SUSE's support stance. All tools are provided by packages carrying the tool's name.

* libvirt: A toolkit that provides management of VM Guests, virtual networks, and storage. libvirt provides an API, a daemon, and a shell (virsh).
* virt-manager (Virtual Machine Manager): A graphical management tool for VM Guests.
* vm-install: Define a VM Guest and install its operating system.
* virt-viewer: An X viewer client for VM Guests which supports TLS/SSL encryption of x509 certificate authentication and SASL authentication.

Support for creating and manipulating file-based virtual disk images is provided by qemu-img. qemu-img is provided by the package virt-utils.

# 1.4 Installing KVM

KVM is not installed by default. To install KVM and all virtualization tools, proceed as follows:

1. Start YaST and choose Virtualization > Installing Hypervisor and Tools.
2. Select KVM and confirm with Accept.
3. Confirm the list of packages that is to be installed with Install.
4. Agree to set up a network bridge by clicking Yes. It is recommended using a bridge on a VM Host Server (virtual machine host). If you prefer to manually configure a different network setup, you can safely skip this step by clicking No.
5. After the setup has been finished, reboot the machine as YaST suggests. Alternatively load the required kernel modules manually and start libvirtd to avoid a reboot:
6. modprobe kvm-intel # on Intel machines only
7. modprobe kvm-amd # on AMD machines only
8. modprobe vhost-net

rclibvirtd start

NOTE: The vhost-net Kernel Module

The vhost-net kernel module allows for a more efficient network transport to the guest. It is automatically used by libvirt if loaded, or when using the qemu-kvm command line, by adding ,vhost=on to the networking option.

# 2.0 KVM Limitations

Although virtualized machines behave almost like physical machines, some limitations apply. These affect both, the VM Guest as well as the VM Host Server system.

2.1 General Limitations

The following general restrictions apply when using KVM:

Overcommits

KVM allows for both memory and disk space overcommit. It is up to the user to understand the implications of doing so. However, hard errors resulting from exceeding available resources will result in guest failures. CPU overcommit is also supported but carries performance implications.

Time Synchronization

Most guests require some additional support for accurate time keeping. Where available, kvm-clock is to be used. NTP or similar network based time keeping protocols are also highly recommended (for VM Host Server and VM Guest) to help maintain a stable time. Running NTP inside the guest is not recommended when using the kvm-clock . Refer to [Section 10.8, Clock Settings](https://www.suse.com/documentation/sles11/book_kvm/data/sec_kvm_managing_clock.html) for details.

MAC addresses

If no MAC address is specified for a NIC, a default MAC address will be assigned. This may result in network problems when more than one NIC receives the same MAC address. It is recommended to always assure a unique MAC address has been assigned for each NIC.

Live Migration

Live Migration is only possible between VM Host Servers with the same CPU features. The only supported CPU model for migration is -cpu qemu64 (default) with no additional features specified. No physical devices can be passed from host to guest. Guest storage has to be accessible from both VM Host Servers and guest definitions need to be compatible. VM Host Server and VM Guests need to have proper timekeeping installed. The use of the AHCI interface, the virtfs feature, and the -mem-path command-line option are not compatible with migration. Migration from SP3 to SP2 or SP1 hosted guests is not supported.

User Permissions

The management tools (Virtual Machine Manager, virsh, vm-install) need to authenticate with libvirt—see [Section 8.0, Connecting and Authorizing](https://www.suse.com/documentation/sles11/book_kvm/data/cha_libvirt_connect.html) for details. In order to invoke qemu-kvm from the command line, a user has to be a member of the group kvm.

Suspending/Hibernating the VM Host Server

Suspending or hibernating the VM Host Server system while guests are running is not supported.