Oracle VM VirtualBox®

User Manual

Version 4.1.0_BETA1

http://www.virtualbox.org

Contents

1 First steps

Welcome to Oracle VM VirtualBox!

VirtualBox is a cross-platform virtualization application. What does that mean? For one thing, it installs on your existing Intel or AMD-based computers, whether they are running Windows, Mac, Linux or Solaris operating systems. Secondly, it extends the capabilities of your existing computer so that it can run multiple operating systems (inside multiple virtual machines) at the same time. So, for example, you can run Windows and Linux on your Mac, run Windows Server 2008 on your Linux server, run Linux on your Windows PC, and so on, all alongside your existing applications. You can install and run as many virtual machines as you like – the only practical limits are disk space and memory.

VirtualBox is deceptively simple yet also very powerful. It can run everywhere from small embedded systems or desktop class machines all the way up to datacenter deployments and even Cloud environments.

The following screenshot shows you how VirtualBox, installed on a Mac computer, is running Windows 7 in a virtual machine window:

In this User Manual, we'll begin simply with a quick introduction to virtualization and how to get your first virtual machine running with the easy-to-use VirtualBox graphical user interface. Subsequent chapters will go into much more detail covering more powerful tools and features, but fortunately, it is not necessary to read the entire User Manual before you can use VirtualBox.

You can find a summary of VirtualBox's capabilities in chapter 1.3, *Features overview*, page 11. For existing VirtualBox users who just want to see what's new in this release, there is a detailed list in chapter 15, *Change log*, page 187.

1.1 Why is virtualization useful?

The techniques and features that VirtualBox provides are useful for several scenarios:

- **Running multiple operating systems simultaneously.** VirtualBox allows you to run more than one operating system at a time. This way, you can run software written for one operating system on another (for example, Windows software on Linux or a Mac) without having to reboot to use it. Since you can configure what kinds of "virtual" hardware should be presented to each such operating system, you can install an old operating system such as DOS or OS/2 even if your real computer's hardware is no longer supported by that operating system.

- **Easier software installations.** Software vendors can use virtual machines to ship entire software configurations. For example, installing a complete mail server solution on a real machine can be a tedious task. With VirtualBox, such a complex setup (then often called an "appliance") can be packed into a virtual machine. Installing and running a mail server becomes as easy as importing such an appliance into VirtualBox.

- **Testing and disaster recovery.** Once installed, a virtual machine and its virtual hard disks can be considered a "container" that can be arbitrarily frozen, woken up, copied, backed up, and transported between hosts.

  On top of that, with the use of another VirtualBox feature called "snapshots", one can save a particular state of a virtual machine and revert back to that state, if necessary. This way, one can freely experiment with a computing environment. If something goes wrong (e.g. after installing misbehaving software or infecting the guest with a virus), one can easily switch back to a previous snapshot and avoid the need of frequent backups and restores.

  Any number of snapshots can be created, allowing you to travel back and forward in virtual machine time. You can delete snapshots while a VM is running to reclaim disk space.

- **Infrastructure consolidation.** Virtualization can significantly reduce hardware and electricity costs. Most of the time, computers today only use a fraction of their potential power and run with low average system loads. A lot of hardware resources as well as electricity is thereby wasted. So, instead of running many such physical computers that are only partially used, one can pack many virtual machines onto a few powerful hosts and balance the loads between them.

1.2 Some terminology

When dealing with virtualization (and also for understanding the following chapters of this documentation), it helps to acquaint oneself with a bit of crucial terminology, especially the following terms:

Host operating system (host OS). This is the operating system of the physical computer on which VirtualBox was installed. There are versions of VirtualBox for Windows, Mac OS X, Linux and Solaris hosts; for details, please see chapter 1.4, *Supported host operating systems*, page 13.

Most of the time, this User Manual discusses all VirtualBox versions together. There may be platform-specific differences which we will point out where appropriate.

Guest operating system (guest OS). This is the operating system that is running inside the virtual machine. Theoretically, VirtualBox can run any x86 operating system (DOS, Windows, OS/2, FreeBSD, OpenBSD), but to achieve near-native performance of the guest code on your machine, we had to go through a lot of optimizations that are specific to certain operating systems. So while your favorite operating system *may* run as a guest, we

officially support and optimize for a select few (which, however, include the most common ones).

See chapter 3.1, *Supported guest operating systems*, page 39 for details.

Virtual machine (VM). This is the special environment that VirtualBox creates for your guest operating system while it is running. In other words, you run your guest operating system "in" a VM. Normally, a VM will be shown as a window on your computer's desktop, but depending on which of the various frontends of VirtualBox you use, it can be displayed in full-screen mode or remotely on another computer.

In a more abstract way, internally, VirtualBox thinks of a VM as a set of parameters that determine its behavior. They include hardware settings (how much memory the VM should have, what hard disks VirtualBox should virtualize through which container files, what CDs are mounted etc.) as well as state information (whether the VM is currently running, saved, its snapshots etc.). These settings are mirrored in the VirtualBox Manager window as well as the `VBoxManage` command line program; see chapter 8, *VBoxManage*, page 100. In other words, a VM is also what you can see in its settings dialog.

Guest Additions. This refers to special software packages which are shipped with VirtualBox but designed to be installed *inside* a VM to improve performance of the guest OS and to add extra features. This is described in detail in chapter 4, *Guest Additions*, page 53.

1.3 Features overview

Here's a brief outline of VirtualBox's main features:

- **Portability.** VirtualBox runs on a large number of 32-bit and 64-bit host operating systems (again, see chapter 1.4, *Supported host operating systems*, page 13 for details).

  VirtualBox is a so-called "hosted" hypervisor (sometimes referred to as a "type 2" hypervisor). Whereas a "bare-metal" or "type 1" hypervisor would run directly on the hardware, VirtualBox requires an existing operating system to be installed. It can thus run alongside existing applications on that host.

  To a very large degree, VirtualBox is functionally identical on all of the host platforms, and the same file and image formats are used. This allows you to run virtual machines created on one host on another host with a different host operating system; for example, you can create a virtual machine on Windows and then run it under Linux.

  In addition, virtual machines can easily be imported and exported using the Open Virtualization Format (OVF, see chapter 1.12, *Importing and exporting virtual machines*, page 26), an industry standard created for this purpose. You can even import OVFs that were created with a different virtualization software.

- **No hardware virtualization required.** For many scenarios, VirtualBox does not require the processor features built into newer hardware like Intel VT-x or AMD-V. As opposed to many other virtualization solutions, you can therefore use VirtualBox even on older hardware where these features are not present. The technical details are explained in chapter 10.3, *Hardware vs. software virtualization*, page 161.

- **Guest Additions: shared folders, seamless windows, 3D virtualization.** The VirtualBox Guest Additions are software packages which can be installed *inside* of supported guest systems to improve their performance and to provide additional integration and communication with the host system. After installing the Guest Additions, a virtual machine will support automatic adjustment of video resolutions, seamless windows, accelerated 3D graphics and more. The Guest Additions are described in detail in chapter 4, *Guest Additions*, page 53.

In particular, Guest Additions provide for "shared folders", which let you access files from the host system from within a guest machine. Shared folders are described in chapter 4.3, *Shared folders*, page 62.

- **Great hardware support.** Among others, VirtualBox supports:
  - **Guest multiprocessing (SMP).** VirtualBox can present up to 32 virtual CPUs to each virtual machine, irrespective of how many CPU cores are physically present on your host.
  - **USB device support.** VirtualBox implements a virtual USB controller and allows you to connect arbitrary USB devices to your virtual machines without having to install device-specific drivers on the host. USB support is not limited to certain device categories. For details, see chapter 3.10.1, *USB settings*, page 50.
  - **Hardware compatibility.** VirtualBox virtualizes a vast array of virtual devices, among them many devices that are typically provided by other virtualization platforms. That includes IDE, SCSI and SATA hard disk controllers, several virtual network cards and sound cards, virtual serial and parallel ports and an Input/Output Advanced Programmable Interrupt Controller (I/O APIC), which is found in many modern PC systems. This eases cloning of PC images from real machines and importing of third-party virtual machines into VirtualBox.
  - **Full ACPI support.** The Advanced Configuration and Power Interface (ACPI) is fully supported by VirtualBox. This eases cloning of PC images from real machines or third-party virtual machines into VirtualBox. With its unique **ACPI power status support,** VirtualBox can even report to ACPI-aware guest operating systems the power status of the host. For mobile systems running on battery, the guest can thus enable energy saving and notify the user of the remaining power (e.g. in fullscreen modes).
  - **Multiscreen resolutions.** VirtualBox virtual machines support screen resolutions many times that of a physical screen, allowing them to be spread over a large number of screens attached to the host system.
  - **Built-in iSCSI support.** This unique feature allows you to connect a virtual machine directly to an iSCSI storage server without going through the host system. The VM accesses the iSCSI target directly without the extra overhead that is required for virtualizing hard disks in container files. For details, see chapter 5.10, *iSCSI servers*, page 82.
  - **PXE Network boot.** The integrated virtual network cards of VirtualBox fully support remote booting via the Preboot Execution Environment (PXE).

- **Multigeneration branched snapshots.** VirtualBox can save arbitrary snapshots of the state of the virtual machine. You can go back in time and revert the virtual machine to any such snapshot and start an alternative VM configuration from there, effectively creating a whole snapshot tree. For details, see chapter 1.9, *Snapshots*, page 23. You can create and delete snapshots while the virtual machine is running.

- **Clean architecture; unprecedented modularity.** VirtualBox has an extremely modular design with well-defined internal programming interfaces and a clean separation of client and server code. This makes it easy to control it from several interfaces at once: for example, you can start a VM simply by clicking on a button in the VirtualBox graphical user interface and then control that machine from the command line, or even remotely. See chapter 1.13, *Alternative front-ends*, page 28 for details.

  Due to its modular architecture, VirtualBox can also expose its full functionality and configurability through a comprehensive **software development kit (SDK),** which allows for integrating every aspect of VirtualBox with other software systems. Please see chapter 11, *VirtualBox programming interfaces*, page 167 for details.

- **Remote machine display.** The VirtualBox Remote Desktop Extension (VRDE) allows for high-performance remote access to any running virtual machine. This extension supports the Remote Desktop Protocol (RDP) originally built into Microsoft Windows, with special additions for full client USB support.

  The VRDE does not rely on the RDP server that is built into Microsoft Windows; instead, it is plugged directly into the virtualization layer. As a result, it works with guest operating systems other than Windows (even in text mode) and does not require application support in the virtual machine either. The VRDE is described in detail in chapter 7.1, *Remote display (VRDP support)*, page 91.

  On top of this special capacity, VirtualBox offers you more unique features:

  - **Extensible RDP authentication.** VirtualBox already supports Winlogon on Windows and PAM on Linux for RDP authentication. In addition, it includes an easy-to-use SDK which allows you to create arbitrary interfaces for other methods of authentication; see chapter 7.1.5, *RDP authentication*, page 95 for details.
  - **USB over RDP.** Via RDP virtual channel support, VirtualBox also allows you to connect arbitrary USB devices locally to a virtual machine which is running remotely on a VirtualBox RDP server; see chapter 7.1.4, *Remote USB*, page 94 for details.

1.4 Supported host operating systems

Currently, VirtualBox runs on the following host operating systems:

- **Windows** hosts:
  - Windows XP, all service packs (32-bit)
  - Windows Server 2003 (32-bit)
  - Windows Vista (32-bit and 64-bit[1]).
  - Windows Server 2008 (32-bit and 64-bit)
  - Windows 7 (32-bit and 64-bit)
- **Mac OS X** hosts:[2]
  - 10.5 (Leopard, 32-bit)
  - 10.6 (Snow Leopard, 32-bit and 64-bit)

  Intel hardware is required; please see chapter 14, *Known limitations*, page 185 also.
- **Linux** hosts (32-bit and 64-bit[3]). Among others, this includes:
  - Ubuntu 6.06 (“Dapper Drake”), 6.10 (“Edgy Eft”), 7.04 (“Feisty Fawn”), 7.10 (“Gutsy Gibbon”), 8.04 (“Hardy Heron”), 8.10 (“Intrepid Ibex”), 9.04 (“Jaunty Jackalope”), 9.10 (“Karmic Koala”), 10.04 (“Lucid Lynx”), 10.10 (“Maverick Meerkat).
  - Debian GNU/Linux 3.1 (“sarge”), 4.0 (“etch”), 5.0 (“lenny”) and 6.0 (“squeeze”)
  - Oracle Enterprise Linux 4 and 5, Oracle Linux 6
  - Redhat Enterprise Linux 4, 5 and 6
  - Fedora Core 4 to 14
  - Gentoo Linux
  - SUSE Linux 9, 10 and 11, openSUSE 10.3, 11.0, 11.1, 11.2, 11.3
  - Mandriva 2007.1, 2008.0, 2009.1, 2010.0 and 2010.1

[1] Support for 64-bit Windows was added with VirtualBox 1.5.
[2] Preliminary Mac OS X support (beta stage) was added with VirtualBox 1.4, full support with 1.6. Mac OS X 10.4 (Tiger) support was removed with VirtualBox 3.1.
[3] Support for 64-bit Linux was added with VirtualBox 1.4.

It should be possible to use VirtualBox on most systems based on Linux kernel 2.6 using either the VirtualBox installer or by doing a manual installation; see chapter 2.3, *Installing on Linux hosts*, page 31. However, the formally tested and supported Linux distributions are those for which we offer a dedicated package.

Note that starting with VirtualBox 2.1, Linux 2.4-based host operating systems are no longer supported.

- **Solaris** hosts (32-bit and 64-bit) are supported with the restrictions listed in chapter 14, *Known limitations*, page 185:
  - Solaris 11 Express (Nevada build 86 and higher, OpenSolaris 2008.05 and higher)
  - Solaris 10 (u8 and higher)

1.5 Installing VirtualBox and extension packs

VirtualBox comes in many different packages, and installation depends on your host operating system. If you have installed software before, installation should be straightforward: on each host platform, VirtualBox uses the installation method that is most common and easy to use. If you run into trouble or have special requirements, please refer to chapter 2, *Installation details*, page 29 for details about the various installation methods.

Starting with version 4.0, VirtualBox is split into several components.

1. The base package consists of all open-source components and is licensed under the GNU General Public License V2.

2. Additional extension packs can be downloaded which extend the functionality of the VirtualBox base package. Currently, Oracle provides the one extension pack, which can be found at `http://www.virtualbox.org` and provides the following added functionality:

   a) The virtual USB 2.0 (EHCI) device; see chapter 3.10.1, *USB settings*, page 50.

   b) VirtualBox Remote Desktop Protocol (VRDP) support; see chapter 7.1, *Remote display (VRDP support)*, page 91.

   c) Intel PXE boot ROM with support for the E1000 network card.

   VirtualBox extension packages have a `.vbox-extpack` file name extension. To install an extension, simply double-click on the package file, and the VirtualBox Manager will guide you through the required steps.

   To view the extension packs that are currently installed, please start the VirtualBox Manager (see the next section). From the "File" menu, please select "Preferences". In the window that shows up, go to the "Extensions" category which shows you the extensions which are currently installed and allows you to remove a package or add a new one.

   Alternatively you can use VBoxManage on the command line: see chapter 8.34, *VBoxManage extpack*, page 135 for details.

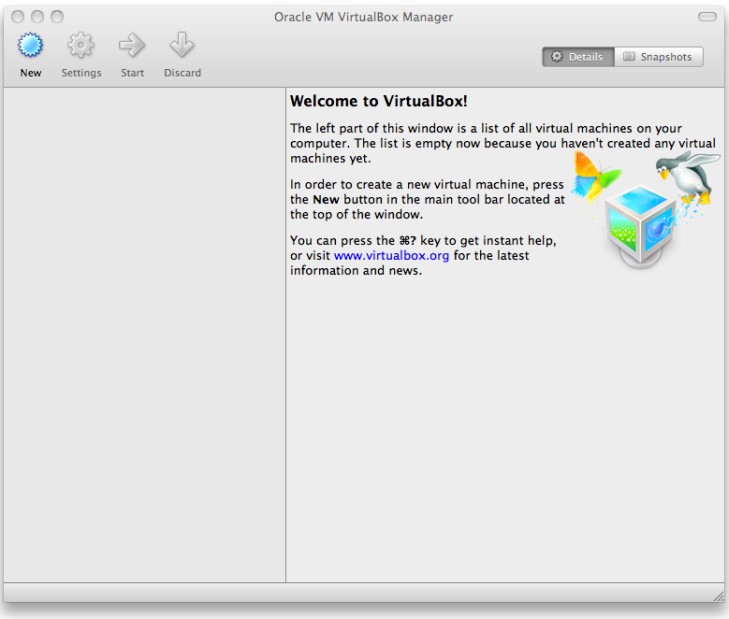
1.6 Starting VirtualBox

After installation, you can start VirtualBox as follows:

- On a Windows host, in the standard "Programs" menu, click on the item in the "VirtualBox" group. On Vista or Windows 7, you can also type "VirtualBox" in the search box of the "Start" menu.

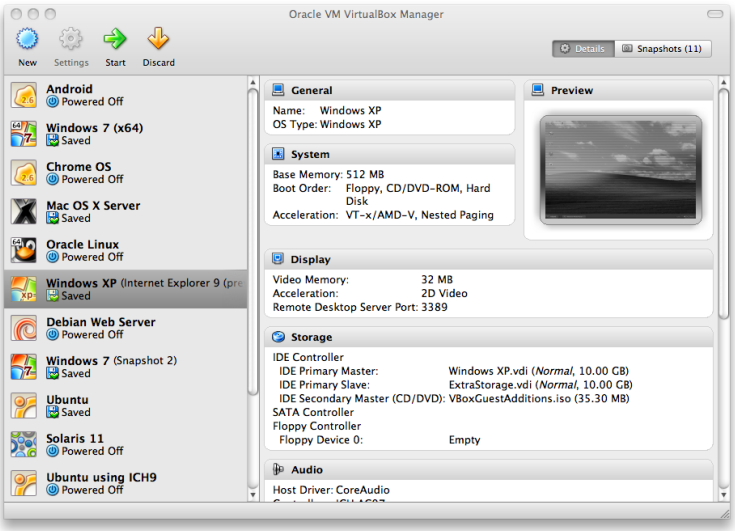
- On a Mac OS X host, in the Finder, double-click on the "VirtualBox" item in the "Applications" folder. (You may want to drag this item onto your Dock.)
- On a Linux or Solaris host, depending on your desktop environment, a "VirtualBox" item may have been placed in either the "System" or "System Tools" group of your "Applications" menu. Alternatively, you can type `VirtualBox` in a terminal.

When you start VirtualBox for the first time, a window like the following should come up:



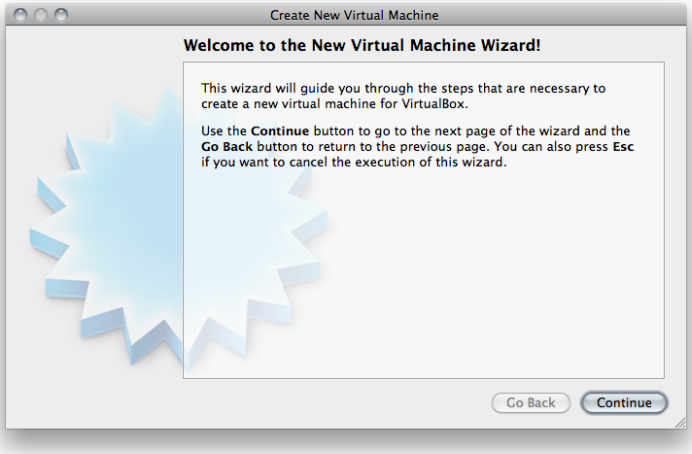
This window is called the **"VirtualBox Manager".** On the left, you can see a pane that will later list all your virtual machines. Since you have not created any, the list is empty. A row of buttons above it allows you to create new VMs and work on existing VMs, once you have some. The pane on the right displays the properties of the virtual machine currently selected, if any. Again, since you don't have any machines yet, the pane displays a welcome message.

To give you an idea what VirtualBox might look like later, after you have created many machines, here's another example:



1.7 Creating your first virtual machine

Click on the "New" button at the top of the VirtualBox Manager window. A wizard will pop up to guide you through setting up a new virtual machine (VM):



On the following pages, the wizard will ask you for the bare minimum of information that is needed to create a VM, in particular:

1. The **VM name** will later be shown in the VM list of the VirtualBox Manager window, and it will be used for the VM's files on disk. Even though any name could be used, keep in mind that once you have created a few VMs, you will appreciate if you have given your VMs rather informative names; "My VM" would thus be less useful than "Windows XP SP2 with OpenOffice".

2. For **"Operating System Type"**, select the operating system that you want to install later. The supported operating systems are grouped; if you want to install something very unusual that is not listed, select "Other". Depending on your selection, VirtualBox will enable or disable certain VM settings that your guest operating system may require. This is particularly important for 64-bit guests (see chapter 3.1.2, *64-bit guests*, page 40). It is therefore recommended to always set it to the correct value.

3. On the next page, select the **memory (RAM)** that VirtualBox should allocate every time the virtual machine is started. The amount of memory given here will be taken away from your host machine and presented to the guest operating system, which will report this size as the (virtual) computer's installed RAM.

   Note: Choose this setting carefully! The memory you give to the VM will not be available to your host OS while the VM is running, so do not specify more than you can spare. For example, if your host machine has 1 GB of RAM and you enter 512 MB as the amount of RAM for a particular virtual machine, while that VM is running, you will only have 512 MB left for all the other software on your host. If you run two VMs at the same time, even more memory will be allocated for the second VM (which may not even be able to start if that memory is not available). On the other hand, you should specify as much as your guest OS (and your applications) will require to run properly.

   A Windows XP guest will require at least a few hundred MB RAM to run properly, and Windows Vista will even refuse to install with less than 512 MB. Of course, if you want to run graphics-intensive applications in your VM, you may require even more RAM.

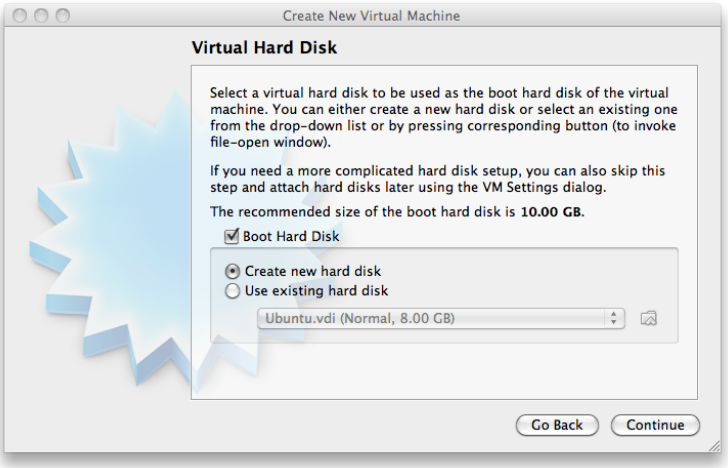
So, as a rule of thumb, if you have 1 GB of RAM or more in your host computer, it is usually safe to allocate 512 MB to each VM. But, in any case, make sure you always have at least 256 to 512 MB of RAM left on your host operating system. Otherwise you may cause your host OS to excessively swap out memory to your hard disk, effectively bringing your host system to a standstill.

As with the other settings, you can change this setting later, after you have created the VM.

4. Next, you must specify a **virtual hard disk** for your VM.

   There are many and potentially complicated ways in which VirtualBox can provide hard disk space to a VM (see chapter 5, *Virtual storage*, page 71 for details), but the most common way is to use a large image file on your "real" hard disk, whose contents VirtualBox presents to your VM as if it were a complete hard disk. This file represents an entire hard disk then, so you can even copy it to another host and use it with another VirtualBox installation.

   The wizard shows you the following window:



   Here you have the following options:

   - To create a new, empty virtual hard disk, press the **"New"** button.
   - You can pick an **existing** disk image file.

     The **drop-down list** presented in the window contains all disk images which are currently remembered by VirtualBox, probably because they are currently attached to a virtual machine (or have been in the past).

     Alternatively, you can click on the small **folder button** next to the drop-down list to bring up a standard file dialog, which allows you to pick any disk image file on your host disk.

   Most probably, if you are using VirtualBox for the first time, you will want to create a new disk image. Hence, press the "New" button.

   This brings up another window, the **"Create New Virtual Disk Wizard",** which helps you create a new disk image file in the new virtual machine's folder.

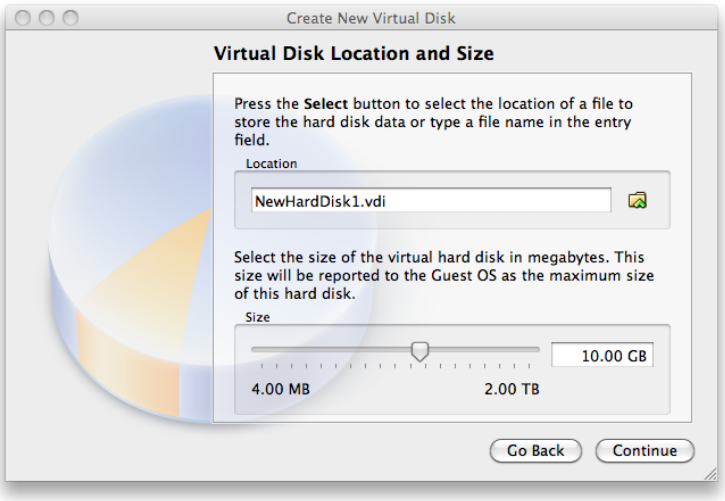
   VirtualBox supports two types of image files:

   - A **dynamically expanding file** will only grow in size when the guest actually stores data on its virtual hard disk. It will therefore initially be small on the host hard drive and only later grow to the size specified as it is filled with data.

- A **fixed-size file** will immediately occupy the file specified, even if only a fraction of the virtual hard disk space is actually in use. While occupying much more space, a fixed-size file incurs less overhead and is therefore slightly faster than a dynamically expanding file.

For details about the differences, please refer to chapter 5.2, *Disk image files (VDI, VMDK, VHD, HDD)*, page 73.

To prevent your physical hard disk from running full, VirtualBox limits the size of the image file. Still, it needs to be large enough to hold the contents of your operating system and the applications you want to install – for a modern Windows or Linux guest, you will probably need several gigabytes for any serious use:



After having selected or created your image file, again press **"Next"** to go to the next page.

5. After clicking on **"Finish"**, your new virtual machine will be created. You will then see it in the list on the left side of the Manager window, with the name you entered initially.

1.8 Running your virtual machine

To start a virtual machine, you have several options:

- Double-click on its entry in the list within the Manager window or
- select its entry in the list in the Manager window it and press the "Start" button at the top or
- for virtual machines created with VirtualBox 4.0 or later, navigate to the "VirtualBox VMs" folder in your system user's home directory, find the subdirectory of the machine you want to start and double-click on the machine settings file (with a `.vbox` file extension).

This opens up a new window, and the virtual machine which you selected will boot up. Everything which would normally be seen on the virtual system's monitor is shown in the window, as can be seen with the image in chapter 1.2, *Some terminology*, page 10.

In general, you can use the virtual machine much like you would use a real computer. There are couple of points worth mentioning however.

1.8.1 Starting a new VM for the first time

When a VM gets started for the first time, another wizard – the **"First Start Wizard"** – will pop up to help you select an **installation medium**. Since the VM is created empty, it would otherwise behave just like a real computer with no operating system installed: it will do nothing and display an error message that no bootable operating system was found.

For this reason, the wizard helps you select a medium to install an operating system from.

- If you have physical CD or DVD media from which you want to install your guest operating system (e.g. in the case of a Windows installation CD or DVD), put the media into your host's CD or DVD drive.

  Then, in the wizard's drop-down list of installation media, select **"Host drive"** with the correct drive letter (or, in the case of a Linux host, device file). This will allow your VM to access the media in your host drive, and you can proceed to install from there.

- If you have downloaded installation media from the Internet in the form of an ISO image file (most probably in the case of a Linux distribution), you would normally burn this file to an empty CD or DVD and proceed as just described. With VirtualBox however, you can skip this step and mount the ISO file directly. VirtualBox will then present this file as a CD or DVD-ROM drive to the virtual machine, much like it does with virtual hard disk images.

  For this case, the wizard's drop-down list contains a list of installation media that were previously used with VirtualBox.

  If your medium is not in the list (especially if you are using VirtualBox for the first time), select the small folder icon next to the drop-down list to bring up a standard file dialog, with which you can pick the image file on your host disks.

In both cases, after making the choices in the wizard, you will be able to install your operating system.

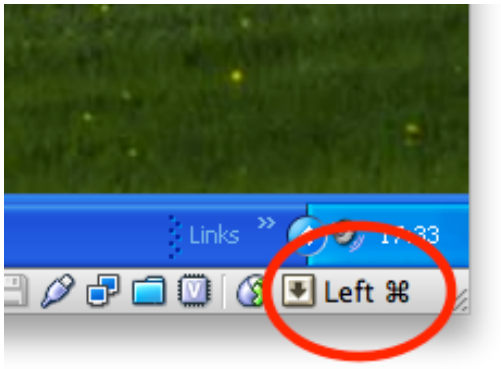
1.8.2 Capturing and releasing keyboard and mouse

As of version 3.2, VirtualBox provides a virtual USB tablet device to new virtual machines through which mouse events are communicated to the guest operating system. As a result, if you are running a modern guest operating system that can handle such devices, mouse support may work out of the box without the mouse being "captured" as described below; see chapter 3.4.1, *"Motherboard" tab*, page 43 for more information.

Otherwise, if the virtual machine only sees standard PS/2 mouse and keyboard devices, since the operating system in the virtual machine does not "know" that it is not running on a real computer, it expects to have exclusive control over your keyboard and mouse. This is, however, not the case since, unless you are running the VM in full-screen mode, your VM needs to share keyboard and mouse with other applications and possibly other VMs on your host.

As a result, initially after installing a guest operating system and before you install the Guest Additions (we will explain this in a minute), only one of the two – your VM or the rest of your computer – can "own" the keyboard and the mouse. You will see a *second* mouse pointer which will always be confined to the limits of the VM window. Basically, you activate the VM by clicking inside it.

To return ownership of keyboard and mouse to your host operating system, VirtualBox reserves a special key on your keyboard for itself: the **"host key".** By default, this is the *right Control key* on your keyboard; on a Mac host, the default host key is the left Command key. You can change this default in the VirtualBox Global Settings. In any case, the current setting for the host key is always displayed *at the bottom right of your VM window,* should you have forgotten about it:



In detail, all this translates into the following:

- Your **keyboard** is owned by the VM if the VM window on your host desktop has the keyboard focus (and then, if you have many windows open in your guest operating system as well, the window that has the focus in your VM). This means that if you want to type within your VM, click on the title bar of your VM window first.

  To release keyboard ownership, press the Host key (as explained above, typically the right Control key).

  Note that while the VM owns the keyboard, some key sequences (like Alt-Tab for example) will no longer be seen by the host, but will go to the guest instead. After you press the host key to re-enable the host keyboard, all key presses will go through the host again, so that sequences like Alt-Tab will no longer reach the guest.

- Your **mouse** is owned by the VM only after you have clicked in the VM window. The host mouse pointer will disappear, and your mouse will drive the guest's pointer instead of your normal mouse pointer.

  Note that mouse ownership is independent of that of the keyboard: even after you have clicked on a titlebar to be able to type into the VM window, your mouse is not necessarily owned by the VM yet.

  To release ownership of your mouse by the VM, also press the Host key.

As this behavior can be inconvenient, VirtualBox provides a set of tools and device drivers for guest systems called the "VirtualBox Guest Additions" which make VM keyboard and mouse operation a lot more seamless. Most importantly, the Additions will get rid of the second "guest" mouse pointer and make your host mouse pointer work directly in the guest.

This will be described later in chapter 4, *Guest Additions*, page 53.

1.8.3 Typing special characters

Operating systems expect certain key combinations to initiate certain procedures. Some of these key combinations may be difficult to enter into a virtual machine, as there are three candidates as to who receives keyboard input: the host operating system, VirtualBox, or the guest operating system. Who of these three receives keypresses depends on a number of factors, including the key itself.

- Host operating systems reserve certain key combinations for themselves. For example, it is impossible to enter the **Ctrl+Alt+Delete** combination if you want to reboot the guest operating system in your virtual machine, because this key combination is usually hardwired into the host OS (both Windows and Linux intercept this), and pressing this key combination will therefore reboot your *host*.

Also, on Linux and Solaris hosts, which use the X Window System, the key combination **Ctrl+Alt+Backspace** normally resets the X server (to restart the entire graphical user interface in case it got stuck). As the X server intercepts this combination, pressing it will usually restart your *host* graphical user interface (and kill all running programs, including VirtualBox, in the process).

Third, on Linux hosts supporting virtual terminals, the key combination **Ctrl+Alt+Fx** (where Fx is one of the function keys from F1 to F12) normally allows to switch between virtual terminals. As with Ctrl+Alt+Delete, these combinations are intercepted by the host operating system and therefore always switch terminals on the *host*.

If, instead, you want to send these key combinations to the *guest* operating system in the virtual machine, you will need to use one of the following methods:

- Use the items in the "Machine" menu of the virtual machine window. There you will find "Insert Ctrl+Alt+Delete" and "Ctrl+Alt+Backspace"; the latter will only have an effect with Linux or Solaris guests, however.
- Press special key combinations with the Host key (normally the right Control key), which VirtualBox will then translate for the virtual machine:
  - **Host key + Del** to send Ctrl+Alt+Del (to reboot the guest);
  - **Host key + Backspace** to send Ctrl+Alt+Backspace (to restart the graphical user interface of a Linux or Solaris guest);
  - **Host key + F1** (or other function keys) to simulate Ctrl+Alt+F1 (or other function keys, i.e. to switch between virtual terminals in a Linux guest).

- For some other keyboard combinations such as **Alt-Tab** (to switch between open windows), VirtualBox allows you to configure whether these combinations will affect the host or the guest, if a virtual machine currently has the focus. This is a global setting for all virtual machines and can be found under "File" -> "Preferences" -> "Input" -> "Auto-capture keyboard".

1.8.4 Changing removable media

While a virtual machine is running, you can change removable media in the "Devices" menu of the VM's window. Here you can select in detail what VirtualBox presents to your VM as a CD, DVD, or floppy.

The settings are the same as would be available for the VM in the "Settings" dialog of the VirtualBox main window, but since that dialog is disabled while the VM is in the "running" or "saved" state, this extra menu saves you from having to shut down and restart the VM every time you want to change media.

Hence, in the "Devices" menu, VirtualBox allows you to attach the host drive to the guest or select a floppy or DVD image using the Disk Image Manager, all as described in chapter 1.10, *Virtual machine configuration*, page 26.

1.8.5 Resizing the machine's window

You can resize the virtual machine's window when it is running. In that case, one of three things will happen:

1. If you have **"scale mode"** enabled, then the virtual machine's screen will be scaled to the size of the window. This can be useful if you have many machines running and want to have a look at one of them while it is running in the background. Alternatively, it might be useful to enlarge a window if the VM's output screen is very small, for example because you are running an old operating system in it.

   To enable scale mode, press the **host key + C**, or select "Scale mode" from the "Machine" menu in the VM window. To leave scale mode, press the host key + C again.

Please see chapter 14, *Known limitations*, page 185 for additional remarks.

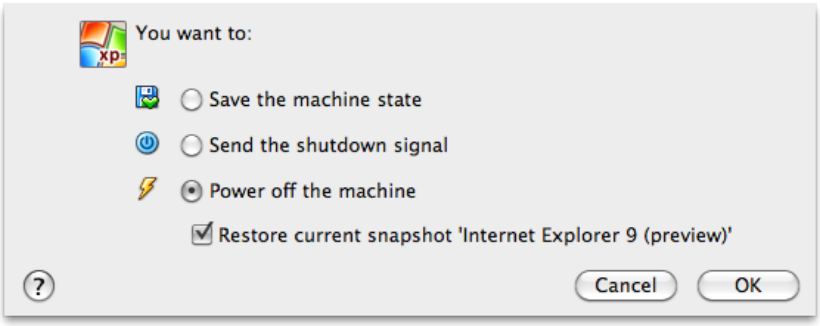
2. If you have the Guest Additions installed and they support automatic **resizing**, the Guest Additions will automatically adjust the screen resolution of the guest operating system. For example, if you are running a Windows guest with a resolution of 1024x768 pixels and you then resize the VM window to make it 100 pixels wider, the Guest Additions will change the Windows display resolution to 1124x768.

   Please see chapter 4, *Guest Additions*, page 53 for more information about the Guest Additions.

3. Otherwise, if the window is bigger than the VM's screen, the screen will be centered. If it is smaller, then scroll bars will be added to the machine window.

1.8.6 Saving the state of the machine

When you click on the "Close" button of your virtual machine window (at the top right of the window, just like you would close any other window on your system), VirtualBox asks you whether you want to "save" or "power off" the VM. (As a shortcut, you can also press the Host key together with "Q".)



The difference between these three options is crucial. They mean:

- **Save the machine state:** With this option, VirtualBox "freezes" the virtual machine by completely saving its state to your local disk.

  When you start the VM again later, you will find that the VM continues exactly where it was left off. All your programs will still be open, and your computer resumes operation. Saving the state of a virtual machine is thus in some ways similar to suspending a laptop computer (e.g. by closing its lid).

- **Send the shutdown signal.** This will send an ACPI shutdown signal to the virtual machine, which has the same effect as if you had pressed the power button on a real computer. So long as the VM is running a fairly modern operating system, this should trigger a proper shutdown mechanism from within the VM.

- **Power off the machine:** With this option, VirtualBox also stops running the virtual machine, but *without* saving its state.

> **Warning:** This is equivalent to pulling the power plug on a real computer without shutting it down properly. If you start the machine again after powering it off, your operating system will have to reboot completely and may begin a lengthy check of its (virtual) system disks. As a result, this should not normally be done, since it can potentially cause data loss or an inconsistent state of the guest system on disk.

As an exception, if your virtual machine has any snapshots (see the next chapter), you can use this option to quickly **restore the current snapshot** of the virtual machine. In that case, powering off the machine will not disrupt its state, but any changes made since that snapshot was taken will be lost.

The **"Discard"** button in the VirtualBox Manager window discards a virtual machine's saved state. This has the same effect as powering it off, and the same warnings apply.

1.9 Snapshots

With snapshots, you can save a particular state of a virtual machine for later use. At any later time, you can revert to that state, even though you may have changed the VM considerably since then. A snapshot of a virtual machine is thus similar to a machine in "saved" state, as described above, but there can be many of them, and these saved states are preserved.

You can see the snapshots of a virtual machine by first selecting a machine in the VirtualBox Manager and then clicking on the "Snapshots" button at the top right. Until you take a snapshot of the machine, the list of snapshots will be empty except for the "Current state" item, which represents the "Now" point in the lifetime of the virtual machine.

1.9.1 Taking, restoring and deleting snapshots

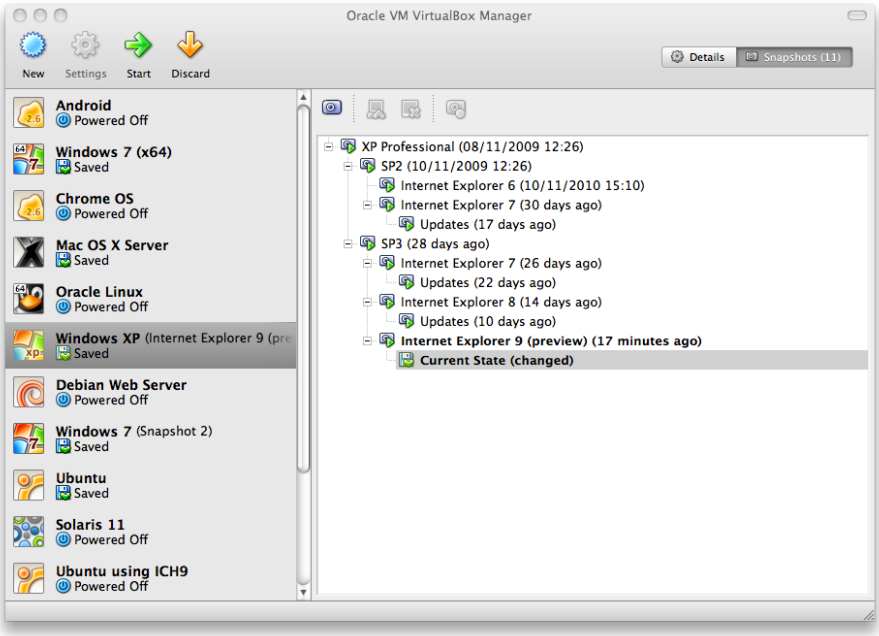
There are three operations related to snapshots:

1. You can **take a snapshot**. This makes a copy of the machine's current state, to which you can go back at any given time later.

   - If your VM is currently running, select "Take snapshot" from the "Machine" pull-down menu of the VM window.
   - If your VM is currently in either the "saved" or the "powered off" state (as displayed next to the VM in the VirtualBox main window), click on the "Snapshots" tab on the top right of the main window, and then
     - either on the small camera icon (for "Take snapshot") or
     - right-click on the "Current State" item in the list and select "Take snapshot" from the menu.

   In any case, a window will pop up and ask you for a snapshot name. This name is purely for reference purposes to help you remember the state of the snapshot. For example, a useful name would be "Fresh installation from scratch, no Guest Additions", or "Service Pack 3 just installed". You can also add a longer text in the "Description" field if you want.

   Your new snapshot will then appear in the snapshots list. Underneath your new snapshot, you will see an item called "Current state", signifying that the current state of your VM is a variation based on the snapshot you took earlier. If you later take another snapshot, you will see that they will be displayed in sequence, and each subsequent snapshot is derived from an earlier one:



VirtualBox imposes no limits on the number of snapshots you can take. The only practical limitation is disk space on your host: each snapshot stores the state of the virtual machine and thus occupies some disk space. (See the next section for details on what exactly is stored in a snapshot.)

2. You can **restore a snapshot** by right-clicking on any snapshot you have taken in the list of snapshots. By restoring a snapshot, you go back (or forward) in time: the current state of the machine is lost, and the machine is restored to the exact state it was in when the snapshot was taken.[4]

> **Note:** Restoring a snapshot will affect the virtual hard drives that are connected to your VM, as the entire state of the virtual hard drive will be reverted as well. This means also that all files that have been created since the snapshot and all other file changes *will be lost*. In order to prevent such data loss while still making use of the snapshot feature, it is possible to add a second hard drive in "write-through" mode using the `VBoxManage` interface and use it to store your data. As write-through hard drives are *not* included in snapshots, they remain unaltered when a machine is reverted. See chapter 5.4, *Special image write modes*, page 76 for details.

To avoid losing the current state when restoring a snapshot, you can create a new snapshot before the restore.

By restoring an earlier snapshot and taking more snapshots from there, it is even possible to create a kind of alternate reality and to switch between these different histories of the virtual machine. This can result in a whole tree of virtual machine snapshots, as shown in the screenshot above.

3. You can also **delete a snapshot**, which will not affect the state of the virtual machine, but only release the files on disk that VirtualBox used to store the snapshot data, thus freeing

[4] Both the terminology and the functionality of restoring snapshots has changed with VirtualBox 3.1. Before that version, it was only possible to go back to the very last snapshot taken – not earlier ones, and the operation was called "Discard current state" instead of "Restore last snapshot". The limitation has been lifted with version 3.1. It is now possible to restore *any* snapshot, going backward and forward in time.

disk space. To delete a snapshot, right-click on it in the snapshots tree and select "Delete". As of VirtualBox 3.2, snapshots can be deleted even while a machine is running.

Note: Whereas taking and restoring snapshots are fairly quick operations, deleting a snapshot can take a considerable amount of time since large amounts of data may need to be copied between several disk image files. Temporary disk files may also need large amounts of disk space while the operation is in progress.

There are some situations which cannot be handled while a VM is running, and you will get an appropriate message that you need to perform this snapshot deletion when the VM is shut down.

1.9.2 Snapshot contents

Think of a snapshot as a point in time that you have preserved. More formally, a snapshot consists of three things:

- It contains a complete copy of the VM settings, including the hardware configuration, so that when you restore a snapshot, the VM settings are restored as well. (For example, if you changed the hard disk configuration or the VM's system settings, that change is undone when you restore the snapshot.)

  The copy of the settings is stored in the machine configuration, an XML text file, and thus occupies very little space.

- The complete state of all the virtual disks attached to the machine is preserved. Going back to a snapshot means that all changes that had been made to the machine's disks – file by file, bit by bit – will be undone as well. Files that were since created will disappear, files that were deleted will be restored, changes to files will be reverted.

  (Strictly speaking, this is only true for virtual hard disks in "normal" mode. As mentioned above, you can configure disks to behave differently with snapshots; see chapter 5.4, *Special image write modes*, page 76. Even more formally and technically correct, it is not the virtual disk itself that is restored when a snapshot is restored. Instead, when a snapshot is taken, VirtualBox creates differencing images which contain only the changes since the snapshot were taken, and when the snapshot is restored, VirtualBox throws away that differencing image, thus going back to the previous state. This is both faster and uses less disk space. For the details, which can be complex, please see chapter 5.5, *Differencing images*, page 77.)

  Creating the differencing image as such does not occupy much space on the host disk initially, since the differencing image will initially be empty (and grow dynamically later with each write operation to the disk). The longer you use the machine after having created the snapshot, however, the more the differencing image will grow in size.

- Finally, if you took a snapshot while the machine was running, the memory state of the machine is also saved in the snapshot (the same way the memory can be saved when you close the VM window). When you restore such a snapshot, execution resumes at exactly the point when the snapshot was taken.

  The memory state file can be as large as the memory size of the virtual machine and will therefore occupy quite some disk space as well.

1.10 Virtual machine configuration

When you select a virtual machine from the list in the Manager window, you will see a summary of that machine's settings on the right.

Clicking on the "Settings" button in the toolbar at the top brings up a detailed window where you can configure many of the properties of the selected VM. But be careful: even though it is possible to change all VM settings after installing a guest operating system, certain changes might prevent a guest operating system from functioning correctly if done after installation.

> **Note:** The "Settings" button is disabled while a VM is either in the "running" or "saved" state. This is simply because the settings dialog allows you to change fundamental characteristics of the virtual computer that is created for your guest operating system, and this operating system may not take it well when, for example, half of its memory is taken away from under its feet. As a result, if the "Settings" button is disabled, shut down the current VM first.

VirtualBox provides a plethora of parameters that can be changed for a virtual machine. The various settings that can be changed in the "Settings" window are described in detail in chapter 3, *Configuring virtual machines*, page 39. Even more parameters are available with the VirtualBox command line interface; see chapter 8, *VBoxManage*, page 100.

1.11 Removing virtual machines

To remove a virtual machine which you no longer need, right-click on it in the Manager's VM list select "Remove" from the context menu that comes up.

A confirmation window will come up that allows you to select whether the machine should only be removed from the list of machines or whether the files associated with it should also be deleted.

The "Remove" menu item is disabled while a machine is running.

1.12 Importing and exporting virtual machines

VirtualBox can import and export virtual machines in the industry-standard Open Virtualization Format (OVF).[5]

OVF is a cross-platform standard supported by many virtualization products which allows for creating ready-made virtual machines that can then be imported into a virtualizer such as VirtualBox. VirtualBox makes OVF import and export easy to access and supports it from the Manager window as well as its command-line interface. This allows for packaging so-called **virtual appliances**: disk images together with configuration settings that can be distributed easily. This way one can offer complete ready-to-use software packages (operating systems with applications) that need no configuration or installation except for importing into VirtualBox.

> **Note:** The OVF standard is complex, and support in VirtualBox is an ongoing process. In particular, no guarantee is made that VirtualBox supports all appliances created by other virtualization software. For a list of known limitations, please see chapter 14, *Known limitations*, page 185.

Appliances in OVF format can appear in two variants:

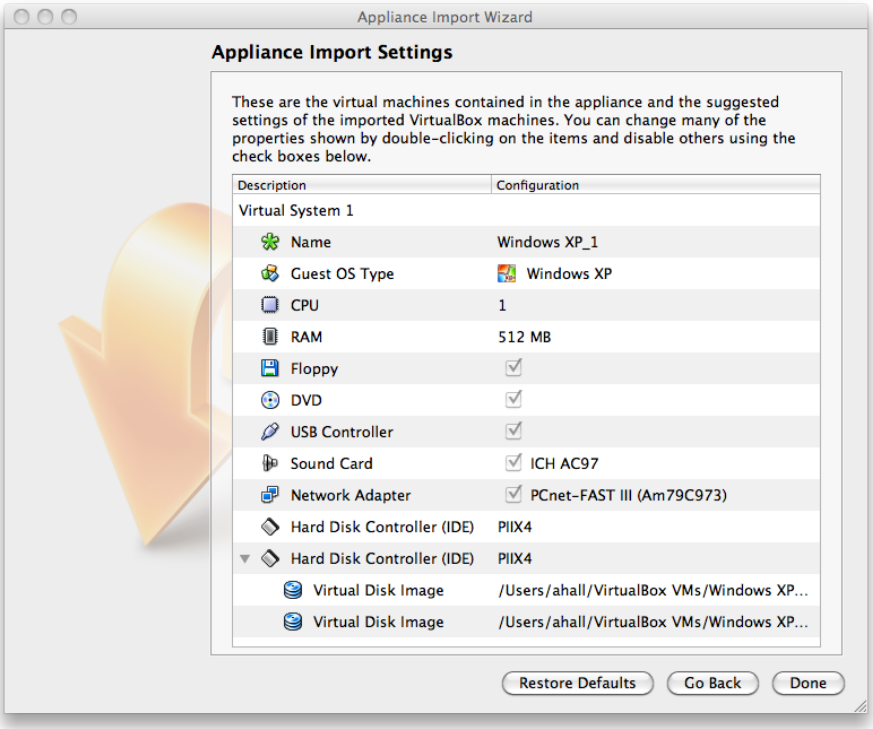
[5] OVF support was originally introduced with VirtualBox 2.2 and has seen major improvements with every version since.

1. They can come in several files, as one or several disk images, typically in the widely-used VMDK format (see chapter 5.2, *Disk image files (VDI, VMDK, VHD, HDD)*, page 73) and a textual description file in an XML dialect with an `.ovf` extension. These files must then reside in the same directory for VirtualBox to be able to import them.

2. Alternatively, the above files can be packed together into a single archive file, typically with an `.ova` extension. (Such archive files use a variant of the TAR archive format and can therefore be unpacked outside of VirtualBox with any utility that can unpack standard TAR files.)

To **import** an appliance in one of the above formats, simply double-click on the OVF/OVA file.[6] Alternatively, select "File" -> "Import appliance" from the Manager window. In the file dialog that comes up, navigate to the file with either the `.ovf` or the `.ova` file extension.

If VirtualBox can handle the file, a dialog similar to the following will appear:



This presents the virtual machines described in the OVF file and allows you to change the virtual machine settings by double-clicking on the description items. Once you click on **"Import"**, VirtualBox will copy the disk images and create local virtual machines with the settings described in the dialog. These will then show up in the Manager's list of virtual machines.

Note that since disk images tend to be big, and VMDK images that come with virtual appliances are typically shipped in a special compressed format that is unsuitable for being used by virtual machines directly, the images will need to be unpacked and copied first, which can take a few minutes.

For how to import an image at the command line, please see chapter 8.8, *VBoxManage import*, page 116.

Conversely, to **export** virtual machines that you already have in VirtualBox, select "File" -> "Export appliance". A different dialog window shows up that allows you to combine several virtual machines into an OVF appliance. Then, select the target location where the target files should be stored, and the conversion process begins. This can again take a while.

[6] Starting with version 4.0, VirtualBox creates file type associations for OVF and OVA files on your host operating system.

For how to export an image at the command line, please see chapter 8.9, *VBoxManage export*, page 117.

Note: OVF cannot describe snapshots that were taken for a virtual machine. As a result, when you export a virtual machine that has snapshots, only the current state of the machine will be exported, and the disk images in the export will have a "flattened" state identical to the current state of the virtual machine.

1.13 Alternative front-ends

As briefly mentioned in chapter 1.3, *Features overview*, page 11, VirtualBox has a very flexible internal design that allows for using multiple interfaces to control the same virtual machines. To illustrate, you can, for example, start a virtual machine with the VirtualBox Manager window and then stop it from the command line. With VirtualBox's support for the Remote Desktop Protocol (RDP), you can even run virtual machines remotely on a headless server and have all the graphical output redirected over the network.

In detail, the following front-ends are shipped in the standard VirtualBox package:

1. `VirtualBox` is the VirtualBox Manager. This graphical user interface uses the Qt toolkit; most of this User Manual is dedicated to describing it. While this is the easiest to use, some of the more advanced VirtualBox features are kept away from it to keep it simple.

2. `VBoxManage` is our command-line interface for automated and very detailed control of every aspect of VirtualBox. It is described in chapter 8, *VBoxManage*, page 100.

3. `VBoxSDL` is an alternative, simple graphical front-end with an intentionally limited feature set, designed to only display virtual machines that are controlled in detail with `VBoxManage`. This is interesting for business environments where displaying all the bells and whistles of the full GUI is not feasible. `VBoxSDL` is described in chapter 9.1, *VBoxSDL, the simplified VM displayer*, page 136.

4. Finally, `VBoxHeadless` is yet another front-end that produces no visible output on the host at all, but merely acts as a RDP server if the VirtualBox Remote Desktop Extension (VRDE) is installed. As opposed to the other graphical interfaces, the headless front-end requires no graphics support. This is useful, for example, if you want to host your virtual machines on a headless Linux server that has no X Window system installed. For details, see chapter 7.1.2, *VBoxHeadless, the remote desktop server*, page 92.

If the above front-ends still do not satisfy your particular needs, it is possible to create yet another front-end to the complex virtualization engine that is the core of VirtualBox, as the VirtualBox core neatly exposes all of its features in a clean API; please refer to chapter 11, *VirtualBox programming interfaces*, page 167.

2 Installation details

As installation of VirtualBox varies depending on your host operating system, we provide installation instructions in four separate chapters for Windows, Mac OS X, Linux and Solaris, respectively.

2.1 Installing on Windows hosts

2.1.1 Prerequisites

For the various versions of Windows that we support as host operating systems, please refer to chapter 1.4, *Supported host operating systems*, page 13.

In addition, Windows Installer 1.1 or higher must be present on your system. This should be the case if you have all recent Windows updates installed.

2.1.2 Performing the installation

The VirtualBox installation can be started

- either by double-clicking on its executable file (contains both 32- and 64-bit architectures)
- or by entering

  ```
  VirtualBox.exe -extract
  ```

  on the command line. This will extract both installers into a temporary directory in which you'll then find the usual .MSI files. Then you can do a

  ```
  msiexec /i VirtualBox-<version>-MultiArch_<x86|amd64>.msi
  ```

  to perform the installation.

In either case, this will display the installation welcome dialog and allow you to choose where to install VirtualBox to and which components to install. In addition to the VirtualBox application, the following components are available:

USB support This package contains special drivers for your Windows host that VirtualBox requires to fully support USB devices inside your virtual machines.

Networking This package contains extra networking drivers for your Windows host that VirtualBox needs to support Bridged Networking (to make your VM's virtual network cards accessible from other machines on your physical network).

Python Support This package contains Python scripting support for the VirtualBox API (see chapter 11, *VirtualBox programming interfaces*, page 167). For this to work, an already working Windows Python installation on the system is required.[1]

Depending on your Windows configuration, you may see warnings about "unsigned drivers" or similar. Please select "Continue" on these warnings as otherwise VirtualBox might not function correctly after installation.

[1] See, for example, http://www.python.org/download/windows/.

The installer will create a "VirtualBox" group in the Windows "Start" menu which allows you to launch the application and access its documentation.

With standard settings, VirtualBox will be installed for all users on the local system. In case this is not wanted, you have to invoke the installer by first extracting it by using

```
VirtualBox.exe -extract
```

and then do as follows:

```
VirtualBox.exe -msiparams ALLUSERS=2
```

or

```
msiexec /i VirtualBox-<version>-MultiArch_<x86|amd64>.msi ALLUSERS=2
```

on the extracted .MSI files. This will install VirtualBox only for the current user.

If you do not want to install all features of VirtualBox, you can set the optional `ADDLOCAL` parameter to explicitly name the features to be installed. The following features are available:

VBoxApplication Main binaries of VirtualBox.

> **Note:** This feature must not be absent since it contains the minimum set of files to have working VirtualBox installation.

VBoxUSB USB support.

VBoxNetwork All networking support; includes the VBoxNetworkFlt and VBoxNetworkAdp features (see below).

VBoxNetworkFlt Bridged networking support.

VBoxNetworkAdp Host-only networking support.

VBoxPython Python support.

For example, to only install USB support along with the main binaries, do a:

```
VirtualBox.exe -msiparams ADDLOCAL=VBoxApplication,VBoxUSB
```

or

```
msiexec /i VirtualBox-<version>-MultiArch_<x86|amd64>.msi ADDLOCAL=VBoxApplication,VBoxUSB
```

2.1.3 Uninstallation

As VirtualBox uses the standard Microsoft Windows installer, VirtualBox can be safely uninstalled at any time by choosing the program entry in the "Add/Remove Programs" applet in the Windows Control Panel.

2.1.4 Unattended installation

Unattended installations can be performed using the standard MSI support.

2.2 Installing on Mac OS X hosts

2.2.1 Performing the installation

For Mac OS X hosts, VirtualBox ships in a disk image (`dmg`) file. Perform the following steps:

1. Double-click on that file to have its contents mounted.
2. A window will open telling you to double click on the `VirtualBox.mpkg` installer file displayed in that window.
3. This will start the installer, which will allow you to select where to install VirtualBox to.

After installation, you can find a VirtualBox icon in the "Applications" folder in the Finder.

2.2.2 Uninstallation

To uninstall VirtualBox, open the disk image (dmg) file again and double-click on the uninstall icon contained therein.

2.2.3 Unattended installation

To perform a non-interactive installation of VirtualBox you can use the command line version of the installer application.

Mount the disk image (dmg) file as described in the normal installation. Then open a terminal session and execute:

```
sudo installer -pkg /Volumes/VirtualBox/VirtualBox.mpkg \
      -target /Volumes/Macintosh\ HD
```

2.3 Installing on Linux hosts

2.3.1 Prerequisites

For the various versions of Linux that we support as host operating systems, please refer to chapter 1.4, *Supported host operating systems*, page 13.

You will need to install the following packages on your Linux system before starting the installation (some systems will do this for you automatically when you install VirtualBox):

- Qt 4.4.0 or higher;
- SDL 1.2.7 or higher (this graphics library is typically called `libsdl` or similar).

Note: To be precise, these packages are only required if you want to run the VirtualBox graphical user interfaces. In particular, `VirtualBox`, the graphical VirtualBox manager, requires both Qt and SDL; `VBoxSDL`, our simplified GUI, requires only SDL. By contrast, if you only want to run `VBoxHeadless`, neither Qt nor SDL are required.

2.3.2 The VirtualBox kernel module

VirtualBox uses a special kernel module called `vboxdrv` to perform physical memory allocation and to gain control of the processor for guest system execution. Without this kernel module, you can still use the VirtualBox manager to configure virtual machines, but they will not start. In addition, there are the network kernel modules `vboxnetflt` and `vboxnetadp` which are required for the more advanced networking features of VirtualBox.

The VirtualBox kernel module is automatically installed on your system when you install VirtualBox. To maintain it with future kernel updates, for most Linux distributions – for example Fedora Core 11 and later, Ubuntu 8.04 (Hardy) and later and Mandriva 2009.1 and later –, generally we recommend installing Dynamic Kernel Module Support (DKMS)[2]. This framework helps with building and upgrading kernel modules.

If DKMS is not already installed, execute one of the following:

- On an Ubuntu system:

  ```
  sudo apt-get install dkms
  ```

- On a Fedora system:

  ```
  yum install dkms
  ```

- On a Mandriva system:

  ```
  urpmi dkms
  ```

If DKMS is available and installed, the VirtualBox kernel module should always work automatically, and it will be automatically rebuilt if your host kernel is updated.

Otherwise, there are only two situations in which you will need to worry about the kernel module:

1. The original installation fails. This probably means that your Linux system is not prepared for building external kernel modules.

   Most Linux distributions can be set up simply by installing the right packages - normally, these will be the GNU compiler (GCC), GNU Make (make) and packages containing header files for your kernel - and making sure that all system updates are installed and that the system is running the most up-to-date kernel included in the distribution. *The version numbers of the header file packages must be the same as that of the kernel you are using.*

   - With Debian and Ubuntu releases, you must install the right version of the `linux-headers` and if it exists the `linux-kbuild` package. Current Ubuntu releases should have the right packages installed by default.
   - In even older Debian and Ubuntu releases, you must install the right version of the `kernel-headers` package.
   - On Fedora and Redhat systems, the package is `kernel-devel`.
   - On SUSE and openSUSE Linux, you must install the right versions of the `kernel-source` and `kernel-syms` packages.
   - If you have built your own kernel, you will need to make sure that you also installed all the required header and other files for building external modules to the right locations. The details of how to do this will depend on how you built your kernel, and if you are unsure you should consult the documentation which you followed to do so.

2. The kernel of your Linux host was updated and DKMS is not installed. In that case, the kernel module will need to be reinstalled by executing (as root):

   ```
   /etc/init.d/vboxdrv setup
   ```

[2] See http://en.wikipedia.org/wiki/Dynamic_Kernel_Module_Support for an introduction.

2.3.3 Performing the installation

VirtualBox is available in a number of package formats native to various common Linux distributions (see chapter 1.4, *Supported host operating systems*, page 13 for details). In addition, there is an alternative generic installer (.run) which should work on most Linux distributions.

2.3.3.1 Installing VirtualBox from a Debian/Ubuntu package

First, download the appropriate package for your distribution. The following examples assume that you are installing to a 32-bit Ubuntu Karmic system. Use `dpkg` to install the Debian package:

```
sudo dpkg -i VirtualBox-3.2_4.1.0_BETA1_Ubuntu_karmic_i386.deb
```

You will be asked to accept the VirtualBox Personal Use and Evaluation License. Unless you answer "yes" here, the installation will be aborted.

The installer will also search for a VirtualBox kernel module suitable for your kernel. The package includes pre-compiled modules for the most common kernel configurations. If no suitable kernel module is found, the installation script tries to build a module itself. If the build process is not successful you will be shown a warning and the package will be left unconfigured. Please have a look at `/var/log/vbox-install.log` to find out why the compilation failed. You may have to install the appropriate Linux kernel headers (see chapter 2.3.2, *The VirtualBox kernel module*, page 32). After correcting any problems, do

```
sudo /etc/init.d/vboxdrv setup
```

This will start a second attempt to build the module.

If a suitable kernel module was found in the package or the module was successfully built, the installation script will attempt to load that module. If this fails, please see chapter 12.6.1, *Linux kernel module refuses to load*, page 178 for further information.

Once VirtualBox has been successfully installed and configured, you can start it by selecting "VirtualBox" in your start menu or from the command line (see chapter 2.3.5, *Starting VirtualBox on Linux*, page 36).

2.3.3.2 Using the alternative installer (VirtualBox.run)

The alternative installer performs the following steps:

- It unpacks the application files to the target directory,

  `/opt/VirtualBox/`

  which cannot be changed.
- It builds the VirtualBox kernel modules (`vboxdrv`, `vboxnetflt` and `vboxnetadp`) and installs them.
- It creates `/etc/init.d/vboxdrv`, an init script to start the VirtualBox kernel module.
- It creates a new system group called `vboxusers`.
- It creates symbolic links in `/usr/bin` to the a shell script (`/opt/VirtualBox/VBox`) which does some sanity checks and dispatches to the actual executables, `VirtualBox`, `VBoxSDL`, `VBoxVRDP`, `VBoxHeadless` and `VBoxManage`
- It creates `/etc/udev/rules.d/10-vboxdrv.rules`, a description file for udev, if that is present, which makes the USB devices accessible to all users in the `vboxusers` group.
- It writes the installation directory to `/etc/vbox/vbox.cfg`.

The installer must be executed as root with either `install` or `uninstall` as the first parameter.

```
sudo ./VirtualBox.run install
```

Or if you do not have the "sudo" command available, run the following as root instead:

```
./VirtualBox.run install
```

After that you need to put every user which should be able to access USB devices from VirtualBox guests in the group `vboxusers`, either through the GUI user management tools or by running the following command as root:

```
sudo usermod -a -G vboxusers username
```

> **Note:** The `usermod` command of some older Linux distributions does not support the `-a` option (which adds the user to the given group without affecting membership of other groups). In this case, find out the current group memberships with the `groups` command and add all these groups in a comma-separated list to the command line after the `-G` option, e.g. like this: `usermod -G group1,group2,vboxusers username`.

2.3.3.3 Performing a manual installation

If, for any reason, you cannot use the shell script installer described previously, you can also perform a manual installation. Invoke the installer like this:

```
./VirtualBox.run --keep --noexec
```

This will unpack all the files needed for installation in the directory `install` under the current directory. The VirtualBox application files are contained in `VirtualBox.tar.bz2` which you can unpack to any directory on your system. For example:

```
sudo mkdir /opt/VirtualBox
sudo tar jxf ./install/VirtualBox.tar.bz2 -C /opt/VirtualBox
```

or as root:

```
mkdir /opt/VirtualBox
tar jxf ./install/VirtualBox.tar.bz2 -C /opt/VirtualBox
```

The sources for VirtualBox's kernel module are provided in the `src` directory. To build the module, change to the directory and issue

```
make
```

If everything builds correctly, issue the following command to install the module to the appropriate module directory:

```
sudo make install
```

In case you do not have sudo, switch the user account to root and perform

```
make install
```

The VirtualBox kernel module needs a device node to operate. The above make command will tell you how to create the device node, depending on your Linux system. The procedure is slightly different for a classical Linux setup with a `/dev` directory, a system with the now deprecated `devfs` and a modern Linux system with `udev`.

On certain Linux distributions, you might experience difficulties building the module. You will have to analyze the error messages from the build system to diagnose the cause of the problems. In general, make sure that the correct Linux kernel sources are used for the build process.

Note that the `/dev/vboxdrv` kernel module device node must be owned by root:root and must be read/writable only for the user.

Next, you will have to install the system initialization script for the kernel module:

```
cp /opt/VirtualBox/vboxdrv.sh /etc/init.d/vboxdrv
```

(assuming you installed VirtualBox to the `/opt/VirtualBox` directory) and activate the initialization script using the right method for your distribution. You should create VirtualBox's configuration file:

```
mkdir /etc/vbox
echo INSTALL_DIR=/opt/VirtualBox > /etc/vbox/vbox.cfg
```

and, for convenience, create the following symbolic links:

```
ln -sf /opt/VirtualBox/VBox.sh /usr/bin/VirtualBox
ln -sf /opt/VirtualBox/VBox.sh /usr/bin/VBoxManage
ln -sf /opt/VirtualBox/VBox.sh /usr/bin/VBoxHeadless
ln -sf /opt/VirtualBox/VBox.sh /usr/bin/VBoxSDL
```

2.3.3.4 Updating and uninstalling VirtualBox

Before updating or uninstalling VirtualBox, you must terminate any virtual machines which are currently running and exit the VirtualBox or VBoxSVC applications. To update VirtualBox, simply run the installer of the updated version. To uninstall VirtualBox, invoke the installer like this:

```
sudo ./VirtualBox.run uninstall
```

or as root

```
./VirtualBox.run uninstall
```

. Starting with version 2.2.2, you can uninstall the .run package by invoking

```
/opt/VirtualBox/uninstall.sh
```

To manually uninstall VirtualBox, simply undo the steps in the manual installation in reverse order.

2.3.3.5 Automatic installation of Debian packages

The Debian packages will request some user feedback when installed for the first time. The debconf system is used to perform this task. To prevent any user interaction during installation, default values can be defined. A file `vboxconf` can contain the following debconf settings:

```
virtualbox virtualbox/module-compilation-allowed boolean true
virtualbox virtualbox/delete-old-modules boolean true
```

The first line allows compilation of the vboxdrv kernel module if no module was found for the current kernel. The second line allows the package to delete any old vboxdrv kernel modules compiled by previous installations.

These default settings can be applied with

```
debconf-set-selections vboxconf
```

prior to the installation of the VirtualBox Debian package.

In addition there are some common configuration options that can be set prior to the installation, described in chapter 2.3.3.7, *Automatic installation options*, page 36.

2.3.3.6 Automatic installation of .rpm packages

The .rpm format does not provide a configuration system comparable to the debconf system. See chapter 2.3.3.7, *Automatic installation options*, page 36 for how to set some common installation options provided by VirtualBox.

2.3.3.7 Automatic installation options

To configure the installation process of our .deb and .rpm packages, you can create a response file named `/etc/default/virtualbox`. The automatic generation of the udev rule can be prevented by the following setting:

```
INSTALL_NO_UDEV=1
```

The creation of the group vboxusers can be prevented by

```
INSTALL_NO_GROUP=1
```

If the line

```
INSTALL_NO_VBOXDRV=1
```

is specified, the package installer will not try to build the `vboxdrv` kernel module if no module fitting the current kernel was found.

2.3.4 The vboxusers group

The Linux installers create the system user group `vboxusers` during installation. Any system user who is going to use USB devices from VirtualBox guests must be member of that group. A user can be made member of the group `vboxusers` through the GUI user/group management or at the command line with

```
sudo usermod -a -G vboxusers username
```

Note that adding an active user to that group will require that user to log out and back in again. This should be done manually after successful installation of the package.

2.3.5 Starting VirtualBox on Linux

The easiest way to start a VirtualBox program is by running the program of your choice (`VirtualBox`, `VBoxManage`, `VBoxSDL` or `VBoxHeadless`) from a terminal. These are symbolic links to `VBox.sh` that start the required program for you.

The following detailed instructions should only be of interest if you wish to execute VirtualBox without installing it first. You should start by compiling the `vboxdrv` kernel module (see above) and inserting it into the Linux kernel. VirtualBox consists of a service daemon (`VBoxSVC`) and several application programs. The daemon is automatically started if necessary. All VirtualBox applications will communicate with the daemon through Unix local domain sockets. There can be multiple daemon instances under different user accounts and applications can only communicate with the daemon running under the user account as the application. The local domain socket resides in a subdirectory of your system's directory for temporary files called `.vbox-<username>-ipc`. In case of communication problems or server startup problems, you may try to remove this directory.

All VirtualBox applications (`VirtualBox`, `VBoxSDL`, `VBoxManage` and `VBoxHeadless`) require the VirtualBox directory to be in the library path:

```
LD_LIBRARY_PATH=. ./VBoxManage showvminfo "Windows XP"
```

2.4 Installing on Solaris hosts

For the specific versions of Solaris that we support as host operating systems, please refer to chapter 1.4, *Supported host operating systems*, page 13.

If you have a previously installed instance of VirtualBox on your Solaris host, please uninstall it first before installing a new instance. Refer to chapter 2.4.3, *Uninstallation*, page 37 for uninstall instructions.

2.4.1 Performing the installation

VirtualBox is available as a standard Solaris package. Download the VirtualBox SunOS package which includes both the 32-bit and 64-bit versions of VirtualBox. *The installation must be performed as root and from the global zone* as the VirtualBox installer loads kernel drivers which cannot be done from non-global zones. To verify which zone you are currently in, execute the `zonename` command. Execute the following commands:

```
gunzip -cd VirtualBox-4.1.0_BETA1-SunOS.tar.gz | tar xvf -
```

Starting with VirtualBox 3.1 the VirtualBox kernel package is no longer a separate package and has been integrated into the main package. Install the VirtualBox package using:

```
pkgadd -d VirtualBox-4.1.0_BETA1-SunOS.pkg
```

Note: If you are using Solaris Zones, to install VirtualBox only into the current zone and not into any other zone, use `pkgadd -G`. For more information refer to the `pkgadd` manual; see also chapter 2.4.5, *Configuring a zone for running VirtualBox*, page 38.

The installer will then prompt you to enter the package you wish to install. Choose "1" or "all" and proceed. Next the installer will ask you if you want to allow the postinstall script to be executed. Choose "y" and proceed as it is essential to execute this script which installs the VirtualBox kernel module. Following this confirmation the installer will install VirtualBox and execute the postinstall setup script.

Once the postinstall script has been executed your installation is now complete. You may now safely delete the uncompressed package and `autoresponse` files from your system. VirtualBox would be installed in `/opt/VirtualBox`.

2.4.2 Starting VirtualBox on Solaris

The easiest way to start a VirtualBox program is by running the program of your choice (`VirtualBox`, `VBoxManage`, `VBoxSDL` or `VBoxHeadless`) from a terminal. These are symbolic links to `VBox.sh` that start the required program for you.

Alternatively, you can directly invoke the required programs from `/opt/VirtualBox`. Using the links provided is easier as you do not have to type the full path.

You can configure some elements of the `VirtualBox` Qt GUI such as fonts and colours by executing `VBoxQtconfig` from the terminal.

2.4.3 Uninstallation

Uninstallation of VirtualBox on Solaris requires root permissions. To perform the uninstallation, start a root terminal session and execute:

```
pkgrm SUNWvbox
```

After confirmation, this will remove VirtualBox from your system.

If you are uninstalling VirtualBox version 3.0 or lower, you need to remove the VirtualBox kernel interface package, execute:

```
pkgrm SUNWvboxkern
```

2.4.4 Unattended installation

To perform a non-interactive installation of VirtualBox we have provided a response file named `autoresponse` that the installer will use for responses to inputs rather than ask them from you.

Extract the tar.gz package as described in the normal installation. Then open a root terminal session and execute:

```
pkgadd -d VirtualBox-4.1.0_BETA1-SunOS-x86 -n -a autoresponse SUNWvbox
```

To perform a non-interactive uninstallation, open a root terminal session and execute:

```
pkgrm -n -a /opt/VirtualBox/autoresponse SUNWvbox
```

2.4.5 Configuring a zone for running VirtualBox

Starting with VirtualBox 1.6 it is possible to run VirtualBox from within Solaris zones. For an introduction of Solaris zones, please refer to http://www.sun.com/bigadmin/features/articles/solaris_zones.jsp.

Assuming that VirtualBox has already been installed into your zone, you need to give the zone access to VirtualBox's device node. This is done by performing the following steps. Start a root terminal and execute:

```
zonecfg -z vboxzone
```

Inside the `zonecfg` prompt add the `device` resource and `match` properties to the zone. Here's how it can be done:

```
zonecfg:vboxzone>add device
zonecfg:vboxzone:device>set match=/dev/vboxdrv
zonecfg:vboxzone:device>end
zonecfg:vboxzone>verify
zonecfg:vboxzone>exit
```

If you are running VirtualBox 2.2.0 or above on Solaris 11 or Nevada hosts, you should add a device for `/dev/vboxusbmon` too, similar to what was shown above. This does not apply to Solaris 10 hosts due to lack of USB support.

Replace "vboxzone" with the name of the zone in which you intend to run VirtualBox. Next reboot the zone using `zoneadm` and you should be able to run VirtualBox from within the configured zone.

3 Configuring virtual machines

Whereas chapter 1, *First steps*, page 9 gave you a quick introduction to VirtualBox and how to get your first virtual machine running, the following chapter describes in detail how to configure virtual machines.

You have considerable latitude in deciding what virtual hardware will be provided to the guest. The virtual hardware can be used for communicating with the host system or with other guests. For instance, if you provide VirtualBox with the image of a CD-ROM in an ISO file, VirtualBox can present this image to a guest system as if it were a physical CD-ROM. Similarly, you can give a guest system access to the real network via its virtual network card, and, if you so choose, give the host system, other guests, or computers on the Internet access to the guest system.

3.1 Supported guest operating systems

Since VirtualBox is designed to provide a generic virtualization environment for x86 systems, it may run operating systems of any kind, even those not listed here. However, the focus is to optimize VirtualBox for the following guest systems:

Windows NT 4.0 All versions, editions and service packs are fully supported; however, there are some issues with older service packs. We recommend to install service pack 6a. Guest Additions are available with a limited feature set.

Windows 2000 / XP / Server 2003 / Vista / Server 2008 / Windows 7 All versions, editions and service packs are fully supported (including 64-bit versions, under the preconditions listed below). Guest Additions are available.

DOS / Windows 3.x / 95 / 98 / ME Limited testing has been performed. Use beyond legacy installation mechanisms not recommended. No Guest Additions available.

Linux 2.4 Limited support.

Linux 2.6 All versions/editions are fully supported (32 bits and 64 bits). Guest Additions are available.

We strongly recommend using a Linux kernel version 2.6.13 or higher for better performance.

> **Note:** Certain Linux kernel releases have bugs that prevent them from executing in a virtual environment; please see chapter 12.4.3, *Buggy Linux 2.6 kernel versions*, page 176 for details.

Solaris 10, OpenSolaris Fully supported (32 bits and 64 bits). Guest Additions are available.

FreeBSD Requires hardware virtualization to be enabled. Limited support. Guest Additions are not available yet.

OpenBSD Requires hardware virtualization to be enabled. Versions 3.7 and later are supported. Guest Additions are not available yet.

OS/2 Warp 4.5 Requires hardware virtualization to be enabled. We officially support MCP2 only; other OS/2 versions may or may not work. Guest Additions are available with a limited feature set.[1]

Mac OS X Server VirtualBox 3.2 added experimental support for Mac OS X Server guests, but this comes with restrictions. Please see the following section as well as chapter 14, *Known limitations*, page 185.

3.1.1 Mac OS X Server guests

Starting with version 3.2, VirtualBox has experimental support for Mac OS X Server guests. This allows you to install and execute unmodified versions of Mac OS X Server on supported host hardware.

Whereas competing solutions perform modifications to the Mac OS X Server install DVDs (e.g. different boot loader and replaced files), VirtualBox is the first product to provide the modern PC architecture expected by OS X without requiring any "hacks".

You should be aware of a number of **important issues** before attempting to install a Mac OS X Server guest:

1. Mac OS X is commercial, licensed software and contains **both license and technical restrictions** that limit its use to certain hardware and usage scenarios. It is important that you understand and obey these restrictions.

   In particular, for most versions of Mac OS X Server, Apple prohibits installing them on non-Apple hardware. Also, only the server versions of Mac OS X are designed to be used in a virtual environment; as a result, VirtualBox does not support client versions of Mac OS X as a guest.

   These license restrictions are also enforced on a technical level. Mac OS X Server verifies whether it is running on Apple hardware, and most DVDs that that come with Apple hardware even check for an exact model. These restrictions are *not* circumvented by VirtualBox and continue to apply.

2. Only **CPUs** known and tested by Apple are supported. As a result, if your Intel CPU is newer than the build of Mac OS X Server, or if you have a non-Intel CPU, it will most likely panic during bootup with an "Unsupported CPU" exception. It is generally best to use the Mac OS X Server DVD that came with your Apple hardware.

3. The Mac OS X Server installer expects the harddisk to be **partitioned** so when it does not offer a selection, you have to launch the Disk Utility from the "Tools" menu and partition the hard disk. Then close the Disk Utility and proceed with the installation.

4. In addition, as Mac OS X Server support in VirtualBox is currently still experimental, please refer also to chapter 14, *Known limitations*, page 185.

3.1.2 64-bit guests

VirtualBox supports 64-bit guest operating systems, even on 32-bit host operating systems,[2] provided that the following conditions are met:

1. You need a 64-bit processor with hardware virtualization support (see chapter 10.3, *Hardware vs. software virtualization*, page 161).

[1] See chapter 14, *Known limitations*, page 185.

[2] 64-bit guest support was added with VirtualBox 2.0; support for 64-bit guests on 32-bit hosts was added with VirtualBox 2.1.

2. You must enable hardware virtualization for the particular VM for which you want 64-bit support; software virtualization is not supported for 64-bit VMs.

3. If you want to use 64-bit guest support on a 32-bit host operating system, you must also select a 64-bit operating system for the particular VM. Since supporting 64 bits on 32-bit hosts incurs additional overhead, VirtualBox only enables this support upon explicit request.

   On 64-bit hosts (which typically come with hardware virtualization support), 64-bit guest operating systems are always supported regardless of settings, so you can simply install a 64-bit operating system in the guest.

Warning: On any host, you should enable the **I/O APIC** for virtual machines that you intend to use in 64-bit mode. This is especially true for 64-bit Windows VMs. See chapter 3.3.2, *"Advanced" tab*, page 42. In addition, for 64-bit Windows guests, you should make sure that the VM uses the **Intel networking device**, since there is no 64-bit driver support for the AMD PCNet card; see chapter 6.1, *Virtual networking hardware*, page 83.

If you use the "Create VM" wizard of the VirtualBox graphical user interface (see chapter 1.7, *Creating your first virtual machine*, page 16), VirtualBox will automatically use the correct settings for each selected 64-bit operating system type.

3.2 Emulated hardware

VirtualBox virtualizes nearly all hardware of the host. Depending on a VM's configuration, the guest will see the following virtual hardware:

- **Input devices.** By default, VirtualBox emulates a standard PS/2 keyboard and mouse. These devices are supported by almost all past and present operating systems.

  In addition, VirtualBox can provide virtual USB input devices to avoid having to capture mouse and keyboard, as described in chapter 1.8.2, *Capturing and releasing keyboard and mouse*, page 19.

- **Graphics.** The VirtualBox graphics device (sometimes referred to as VGA device) is, unlike nearly all other emulated devices, not based on any physical counterpart. It is a simple, synthetic device which provides compatibility with standard VGA and several extended registers used by the VESA BIOS Extensions (VBE).

- **Storage.** VirtualBox currently emulates the standard ATA interface found on Intel PIIX3/PIIX4 chips, the SATA (AHCI) interface, and two SCSI adapters (LSI Logic and BusLogic); see chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71 for details. Whereas providing one of these would be enough for VirtualBox by itself, this multitude of storage adapters is required for compatibility with other hypervisors. Windows is particularly picky about its boot devices, and migrating VMs between hypervisors is very difficult or impossible if the storage controllers are different.

- **Networking.** See chapter 6.1, *Virtual networking hardware*, page 83.

- **USB.** VirtualBox emulates two USB host controllers, EHCI and OHCI. There is a need for two host controllers because OHCI only handles USB low- and full-speed devices (both USB 1.x and 2.0), while EHCI only handles high-speed devices (USB 2.0 only). The emulated USB controllers do not communicate directly with devices on the host but rather with a virtual USB layer which abstracts the USB protocol and allows the use of remote USB devices.

- **Audio.** See chapter 3.7, *Audio settings*, page 48.

3.3 General settings

In the Settings window, under "General", you can configure the most fundamental aspects of the virtual machine such as memory and essential hardware. There are three tabs, "Basic", "Advanced" and "Description".

3.3.1 "Basic" tab

Under the "Basic" tab of the "General" settings category, you can find these settings:

Name The name under which the VM is shown in the list of VMs in the main window. Under this name, VirtualBox also saves the VM's configuration files. By changing the name, VirtualBox renames these files as well. As a result, you can only use characters which are allowed in your host operating system's file names.

Note that internally, VirtualBox uses unique identifiers (UUIDs) to identify virtual machines. You can display these with `VBoxManage`.

Operating system / version The type of the guest operating system that is (or will be) installed in the VM. This is the same setting that was specified in the "New Virtual Machine" wizard, as described in chapter 1.7, *Creating your first virtual machine*, page 16.

Whereas the default settings of a newly created VM depend on the selected operating system type, changing the type later has no effect on VM settings; this value is then purely informational and decorative.

3.3.2 "Advanced" tab

Snapshot folder By default, VirtualBox saves snapshot data together with your other VirtualBox configuration data; see chapter 10.1, *Where VirtualBox stores its files*, page 157. With this setting, you can specify any other folder for each VM.

Shared clipboard You can select here whether the clipboard of the guest operating system should be shared with that of your host. If you select "Bidirectional", then VirtualBox will always make sure that both clipboards contain the same data. If you select "Host to guest" or "Guest to host", then VirtualBox will only ever copy clipboard data in one direction.

Clipboard sharing requires that the VirtualBox Guest Additions be installed. As a result, this setting has no effect otherwise; see chapter 4, *Guest Additions*, page 53 for details.

Removable media: remember runtime changes If this is checked, VirtualBox will save the state of what media has been mounted between several runs of a virtual machine.

Mini toolbar In full screen or seamless mode, VirtualBox can display a small toolbar that contains some of the items that are normally available from the virtual machine's menu bar. This toolbar reduces itself to a small gray line unless you move the mouse over it. With the toolbar, you can return from full screen or seamless mode, control machine execution or enable certain devices. If you don't want to see the toolbar, disable this setting.

3.3.3 "Description" tab

Here you can enter any description for your virtual machine, if you want. This has no effect on the functionality of the machine, but you may find this space useful to note down things like the configuration of a virtual machine and the software that has been installed into it.

3.4 System settings

The "System" category groups various settings that are related to the basic hardware that is presented to the virtual machine.

> **Note:** As the activation mechanism of Microsoft Windows is sensitive to hardware changes, if you are changing hardware settings for a Windows guest, some of these changes may trigger a request for another activation with Microsoft.

3.4.1 "Motherboard" tab

On the "Motherboard" tab, you can influence virtual hardware that would normally be on the motherboard of a real computer.

Base memory This sets the amount of RAM that is allocated and given to the VM when it is running. The specified amount of memory will be requested from the host operating system, so it must be available or made available as free memory on the host when attempting to start the VM and will not be available to the host while the VM is running. This is the same setting that was specified in the "New Virtual Machine" wizard, as described with guidelines under chapter 1.7, *Creating your first virtual machine*, page 16 above.

Generally, it is possible to change the memory size after installing the guest operating system (provided you do not reduce the memory to an amount where the operating system would no longer boot).

Boot order This setting determines the order in which the guest operating system will attempt to boot from the various virtual boot devices. Analogous to a real PC's BIOS setting, VirtualBox can tell a guest OS to start from the virtual floppy, the virtual CD/DVD drive, the virtual hard drive (each of these as defined by the other VM settings), the network, or none of these.

If you select "Network", the VM will attempt to boot from a network via the PXE mechanism. This needs to be configured in detail on the command line; please see chapter 8.7, *VBoxManage modifyvm*, page 110.

Chipset Here you can select which chipset will be presented to the virtual machine. Before VirtualBox 4.0, PIIX3 was the only available option here. For modern guest operating systems such as Mac OS X server, that old chipset is no longer well supported. As a result, VirtualBox 4.0 introduced an emulation of the more modern ICH9 chipset, which supports PCI express, three PCI buses, PCI-to-PCI bridges and Message Signalled Interrupts (MSI). This allows modern operating systems to address more PCI devices and no longer requires IRQ sharing.

Enable I/O APIC Advanced Programmable Interrupt Controllers (APICs) are a newer x86 hardware feature that have replaced old-style Programmable Interrupt Controllers (PICs) in recent years. With an I/O APIC, operating systems can use more than 16 interrupt requests (IRQs) and therefore avoid IRQ sharing for improved reliability.

> **Note:** Enabling the I/O APIC is *required* for 64-bit guest operating systems, especially Windows Vista; it is also required if you want to use more than one virtual CPU in a virtual machine.

However, software support for I/O APICs has been unreliable with some operating systems other than Windows. Also, the use of an I/O APIC slightly increases the overhead of virtualization and therefore slows down the guest OS a little.

Warning: All Windows operating systems starting with Windows 2000 install different kernels depending on whether an I/O APIC is available. As with ACPI, the I/O APIC therefore *must not be turned off after installation* of a Windows guest OS. Turning it on after installation will have no effect however.

Enable EFI This enables Extensible Firmware Interface (EFI), which replaces the legacy BIOS and may be useful for certain advanced use cases. Please refer to chapter 3.12, *Alternative firmware (EFI)*, page 52 for details.

Hardware clock in UTC time If checked, VirtualBox will report the system time in UTC format to the guest instead of local (host) time. This affects how the virtual real-time clock (RTC) operates and may be useful for Unix-like guest operating systems, which typically expect the hardware clock to be set to UTC.

Enable absolute pointing device If enabled, VirtualBox reports to the virtual machine that a USB tablet device is present and communicates mouse events to the virtual machine through this device. If disabled, mouse events are communicated through a traditional PS/2 virtual mouse device.

Using the virtual USB tablet has the advantage that movements are reported in absolute coordinates (instead of as relative position changes), which allows VirtualBox to translate mouse events over the VM window into tablet events without having to "capture" the mouse in the guest as described in chapter 1.8.2, *Capturing and releasing keyboard and mouse*, page 19. This makes using the VM less tedious even if Guest Additions are not installed.[3]

In addition, you can turn off the **Advanced Configuration and Power Interface (ACPI)** which VirtualBox presents to the guest operating system by default. ACPI is the current industry standard to allow operating systems to recognize hardware, configure motherboards and other devices and manage power. As all modern PCs contain this feature and Windows and Linux have been supporting it for years, it is also enabled by default in VirtualBox. It can only be turned off on the command line; see chapter 8.7, *VBoxManage modifyvm*, page 110.

Warning: All Windows operating systems starting with Windows 2000 install different kernels depending on whether ACPI is available, so ACPI *must not be turned off* after installation of a Windows guest OS. Turning it on after installation will have no effect however.

3.4.2 "Processor" tab

On the "Processor" tab, you can set how many virtual **CPU cores** the guest operating systems should see. Starting with version 3.0, VirtualBox supports symmetrical multiprocessing (SMP) and can present up to 32 virtual CPU cores to each virtual machine.

You should not, however, configure virtual machines to use more CPU cores than you have available physically.

[3] The virtual USB tablet was added with VirtualBox 3.2. Depending on the guest operating system selected, this is now enabled by default for new virtual machines.

In addition, the **"Enable PAE/NX"** setting determines whether the PAE and NX capabilities of the host CPU will be exposed to the virtual machine. PAE stands for "Physical Address Extension". Normally, if enabled and supported by the operating system, then even a 32-bit x86 CPU can access more than 4 GB of RAM. This is made possible by adding another 4 bits to memory addresses, so that with 36 bits, up to 64 GB can be addressed. Some operating systems (such as Ubuntu Server) require PAE support from the CPU and cannot be run in a virtual machine without it.

With virtual machines running modern server operating systems, VirtualBox also supports CPU hot-plugging. For details about this, please refer to chapter 9.5, *CPU hot-plugging*, page 142.

3.4.3 "Acceleration" tab

On this page, you can determine whether and how VirtualBox should use hardware virtualization extensions that your host CPU may support. This is the case with most CPUs built after 2006.

You can select for each virtual machine individually whether VirtualBox should use software or hardware virtualization.[4]

In most cases, the default settings will be fine; VirtualBox will have picked sensible defaults depending on the operating system that you selected when you created the virtual machine. In certain situations, however, you may want to change these preconfigured defaults.

Advanced users may be interested in technical details about software vs. hardware virtualization; please see chapter 10.3, *Hardware vs. software virtualization*, page 161.

If your host's CPU supports the **nested paging** (AMD-V) or **EPT** (Intel VT-x) features, then you can expect a significant performance increase by enabling nested paging in addition to hardware virtualization. For technical details, see chapter 10.6, *Nested paging and VPIDs*, page 165.

3.5 Display settings

Video memory size This sets the size of the memory provided by the virtual graphics card available to the guest, in MB. As with the main memory, the specified amount will be allocated from the host's resident memory. Based on the amount of video memory, higher resolutions and color depths may be available.

Monitor count With this setting VirtualBox can provide more than one virtual monitor to a virtual machine. If a guest operating system (such as Windows) supports multiple attached monitors, VirtualBox can pretend that multiple virtual monitors are present.[5] Up to 8 such virtual monitors are supported.

The output of the multiple monitors will be displayed on the host in multiple VM windows which are running side by side.

However, in fullscreen and seamless mode, they will use the available physical monitors attached to the host. As a result, for fullscreen and seamless modes to work with multiple monitors, you will need at least as many physical monitors as you have virtual monitors configured, or VirtualBox will report an error. You can configure the relationship between guest and host monitors using the view menu by pressing Host key + Home when you are in fullscreen or seamless mode.

Please see chapter 14, *Known limitations*, page 185 also.

Enable 3D acceleration If a virtual machine has Guest Additions installed, you can select here whether the guest should support accelerated 3D graphics. Please refer to chapter 4.4.1, *Hardware 3D acceleration (OpenGL and Direct3D 8/9)*, page 64 for details.

[4] Prior to VirtualBox version 2.2, software virtualization was the default; starting with version 2.2, VirtualBox will enable hardware virtualization by default for new virtual machines that you create. (Existing virtual machines are not automatically changed for compatibility reasons, and the default can of course be changed for each virtual machine.)

[5] Multiple monitor support was added with VirtualBox 3.2.

Enable 2D video acceleration If a virtual machine with Microsoft Windows has Guest Additions installed, you can select here whether the guest should support accelerated 2D video graphics. Please refer to chapter 4.4.2, *Hardware 2D video acceleration for Windows guests*, page 65 for details.

Remote display Under the "Remote display" tab, if the VirtualBox Remote Display Extension (VRDE) is installed, you can enable the VRDP server that is built into VirtualBox. This allows you to connect to the console of the virtual machine remotely with any standard RDP viewer, such as `mstsc.exe` that comes with Microsoft Windows. On Linux and Solaris systems you can use the standard open-source `rdesktop` program. These features are described in detail in chapter 7.1, *Remote display (VRDP support)*, page 91.

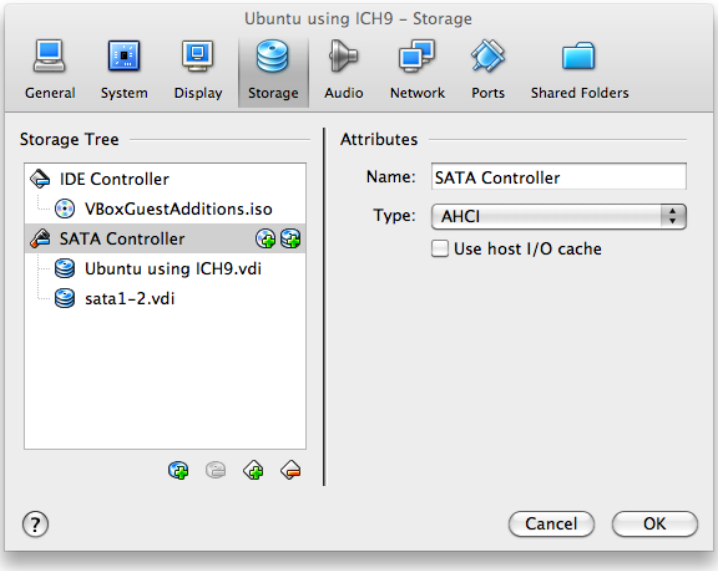
3.6 Storage settings

The "Storage" category in the VM settings allows you to connect virtual hard disk, CD/DVD and floppy images and drives to your virtual machine.

In a real PC, so-called "storage controllers" connect physical disk drives to the rest of the computer. Similarly, VirtualBox presents virtual storage controllers to a virtual machine. Under each controller, the virtual devices (hard disks, CD/DVD or floppy drives) attached to the controller are shown.

> **Note:** This section can only give you a quick introduction to the VirtualBox storage settings. Since VirtualBox gives you an enormous wealth of options in this area, we have dedicated an entire chapter of this User Manual to explaining all the details: please see chapter 5, *Virtual storage*, page 71.

If you have used the "Create VM" wizard to create a machine, you will normally see something like the following:



Depending on the guest operating system type that you selected when you created the VM, the typical layout of storage devices in a new VM is as follows:

- You will see an **IDE controller,** to which a virtual CD/DVD drive has been attached (to the "secondary master" port of the IDE controller).

- You will also see a **SATA controller,** which is a more modern type of storage controller for higher hard disk data throughput, to which the virtual hard disks are attached. Initially you will normally have one such virtual disk, but as you can see in the above screenshot, you can have more than one, each represented by a disk image file (VDI files, in this case).

If you created your VM with an older version of VirtualBox, the default storage layout may differ. You might then only have an IDE controller to which both the CD/DVD drive and the hard disks have been attached. This might also apply if you selected an older operating system type when you created the VM. Since older operating systems do not support SATA without additional drivers, VirtualBox will make sure that no such devices are present initially. Please see chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71 for additional information.

VirtualBox also provides a **floppy controller**, which is special: you cannot add devices other than floppy drives to it. Virtual floppy drives, like virtual CD/DVD drives, can be connected to either a host floppy drive (if you have one) or a disk image, which in this case must be in RAW format.

You can modify these media attachments freely. For example, if you wish to copy some files from another virtual disk that you created, you can connect that disk as a second hard disk, as in the above screenshot. You could also add a second virtual CD/DVD drive, or change where these items are attached. The following options are available:

- To **add another virtual hard disk, or a CD/DVD or floppy drive,** select the storage controller to which it should be added (IDE, SATA, SCSI, SAS, floppy controller) and then click on the "add disk" button below the tree. You can then either select "Add CD/DVD device" or "Add Hard Disk". (If you clicked on a floppy controller, you can add a floppy drive instead.) Alternatively, right-click on the storage controller and select a menu item there.

  On the right part of the window, you can then set the following:

  1. You can then select to which **device slot** of the controller the virtual disk should be connected to. IDE controllers have four slots which have traditionally been called "primary master", "primary slave", "secondary master" and "secondary slave". By contrast, SATA and SCSI controllers offer you up to 30 slots to which virtual devices can be attached.
  2. You can select which **image file** to use.
     - For virtual hard disks, a button with a drop-down list appears on the right, offering you to either select a **virtual hard disk file** using a standard file dialog or to **create a new hard disk** (image file), which will bring up the "Create new disk" wizard, which was described in chapter 1.7, *Creating your first virtual machine*, page 16.
       For details on the image file types that are supported, please see chapter 5.2, *Disk image files (VDI, VMDK, VHD, HDD)*, page 73.
     - For virtual CD/DVD drives, the image files will typically be in the standard ISO format instead. Most commonly, you will select this option when installing an operating system from an ISO file that you have obtained from the Internet. For example, most Linux distributions are available in this way.
       For virtual CD/DVD drives, the following additional options are available:
       * If you select **"Host drive"** from the list, then the physical device of the host computer is connected to the VM, so that the guest operating system can read from and write to your physical device. This is, for instance, useful if you want to install Windows from a real installation CD. In this case, select your host drive from the drop-down list presented.
         If you want to write (burn) CDs or DVDs using the host drive, you need to also enable the **"Passthrough"** option; see chapter 5.9, *CD/DVD support*, page 81.
       * If you select **"Remove disk from virtual drive",** VirtualBox will present an empty CD/DVD drive to the guest into which no media has been inserted.

- To **remove an attachment,** select it and click on the "remove" icon at the bottom (or right-click on it and select the menu item).

Removable media (CD/DVDs and floppies) can be changed while the guest is running. Since the "Settings" dialog is not available at that time, you can also access these settings from the "Devices" menu of your virtual machine window.

3.7 Audio settings

The "Audio" section in a virtual machine's Settings window determines whether the VM will see a sound card connected, and whether the audio output should be heard on the host system.

If audio is enabled for a guest, you can choose between the emulation of an Intel AC'97 controller, an Intel HD Audio controller[6] or a SoundBlaster 16 card. In any case, you can select what audio driver VirtualBox will use on the host.

On a Linux host, depending on your host configuration, you can also select between the OSS, ALSA or the PulseAudio subsystem. On newer Linux distributions (Fedora 8 and above, Ubuntu 8.04 and above) the PulseAudio subsystem should be preferred.

3.8 Network settings

The "Network" section in a virtual machine's Settings window allows you to configure how VirtualBox presents virtual network cards to your VM, and how they operate.

When you first create a virtual machine, VirtualBox by default enables one virtual network card and selects the "Network Address Translation" (NAT) mode for it. This way the guest can connect to the outside world using the host's networking and the outside world can connect to services on the guest which you choose to make visible outside of the virtual machine.

This default setup is good for probably 95% of VirtualBox users. However, VirtualBox is extremely flexible in how it can virtualize networking. It supports many virtual network cards per virtual machine, the first four of which can be configured in detail in the Manager window. Additional network cards can be configured on the command line with VBoxManage.

Because of the vast array of options available, we have dedicated an entire chapter of this manual to discussing networking configuration; please see chapter 6, *Virtual networking*, page 83.

3.9 Serial ports

VirtualBox fully supports virtual serial ports in a virtual machine in an easy-to-use manner.[7]

Ever since the original IBM PC, personal computers have been equipped with one or two serial ports (also called COM ports by DOS and Windows). Serial ports were commonly used with modems, and some computer mice used to be connected to serial ports before USB became commonplace.

While serial ports are no longer as ubiquitous as they used to be, there are still some important uses left for them. For example, serial ports can be used to set up a primitive network over a null-modem cable, in case Ethernet is not available. Also, serial ports are indispensable for system programmers needing to do kernel debugging, since kernel debugging software usually interacts with developers over a serial port. With virtual serial ports, system programmers can do kernel debugging on a virtual machine instead of needing a real computer to connect to.

[6] Intel HD Audio support was added with VirtualBox 4.0 because Windows 7 (32-bit and 64-bit versions) as well as 64-bit Windows Vista do not support the Intel AC'97 controller.

[7] Serial port support was added with VirtualBox 1.5.

If a virtual serial port is enabled, the guest operating system sees a standard 16550A compatible UART device. Both receiving and transmitting data is supported. How this virtual serial port is then connected to the host is configurable, and the details depend on your host operating system.

You can use either the graphical user interface or the command-line `VBoxManage` tool to set up virtual serial ports. For the latter, please refer to chapter 8.7, *VBoxManage modifyvm*, page 110; in that section, look for the `--uart` and `--uartmode` options.

In either case, you can configure up to two virtual serial ports per virtual machine. For each such device, you will need to determine

1. what kind of serial port the virtual machine should see by selecting an I/O base address and interrupt (IRQ). For these, we recommend to use the traditional values[8], which are:
   a) COM1: I/O base 0x3F8, IRQ 4
   b) COM2: I/O base 0x2F8, IRQ 3
   c) COM3: I/O base 0x3E8, IRQ 4
   d) COM4: I/O base 0x2E8, IRQ 3

2. Then, you will need to determine what this virtual port should be connected to. For each virtual serial port, you have the following options:

   - You can elect to have the virtual serial port "disconnected", which means that the guest will see the device, but it will behave as if no cable had been connected to it.
   - You can connect the virtual serial port to a physical serial port on your host. (On a Windows host, this will be a name like `COM1`; on Linux or Solaris hosts, it will be a device node like `/dev/ttyS0`). VirtualBox will then simply redirect all data received from and sent to the virtual serial port to the physical device.
   - You can tell VirtualBox to connect the virtual serial port to a software pipe on the host. This depends on your host operating system:
     – On a Windows host, data will be sent and received through a named pipe. The pipe name must be in the format `\\.\pipe\<name>` where `<name>` should identify the virtual machine but may be freely chosen.
     For forwarding serial traffic, you can use a helper program called VMware Serial Line Gateway, available for download at `http://www.l4ka.org/91.php`. This tool provides a fixed server mode named pipe at `\\.\pipe\vmwaredebug` and connects incoming TCP connections on port 567 with the named pipe.
     – On a Mac, Linux or Solaris host, a local domain socket is used instead. The socket filename must be chosen such that the user running VirtualBox has sufficient privileges to create and write to it. The `/tmp` directory is often a good candidate. On Linux there are various tools which can connect to a local domain socket or create one in server mode. The most flexible tool is `socat` and is available as part of many distributions.

     In this case, you can configure whether VirtualBox should create the named pipe (or, on non-Windows hosts, the local domain socket) itself or whether VirtualBox should assume that the pipe (or socket) exists already. With the `VBoxManage` command-line options, this is referred to as "server" or "client" mode, respectively.

     For a direct connection between two virtual machines (corresponding to a null-modem cable), simply configure one VM to create a pipe/socket and another to attach to it.
   - You can send the virtual serial port output to a file. This option is very useful for capturing diagnostic output from a guest. Any file may be used for this purpose, as long as the user running VirtualBox has sufficient privileges to create and write to the file.

[8] See, for example, `http://en.wikipedia.org/wiki/COM_(hardware_interface)`.

Up to two serial ports can be configured per virtual machine, but you can pick any port numbers out of the above. However, serial ports cannot reliably share interrupts; if both ports are to be used at the same time, they must use different interrupt levels, for example COM1 and COM2, but not COM1 and COM3.

3.10 USB support

3.10.1 USB settings

The "USB" section in a virtual machine's Settings window allows you to configure VirtualBox's sophisticated USB support.

VirtualBox can allow virtual machines to access the USB devices on your host directly. To achieve this, VirtualBox presents the guest operating system with a virtual USB controller. As soon as the guest system starts using a USB device, it will appear as unavailable on the host.

Note:

1. Be careful with USB devices that are currently in use on the host! For example, if you allow your guest to connect to your USB hard disk that is currently mounted on the host, when the guest is activated, it will be disconnected from the host without a proper shutdown. This may cause data loss.
2. Solaris hosts have a few known limitations regarding USB support; please see chapter 14, *Known limitations*, page 185.

In addition to allowing a guest access to your local USB devices, VirtualBox even allows your guests to connect to remote USB devices by use of the VirtualBox Remote Desktop Extension (VRDE). For details about this, see chapter 7.1.4, *Remote USB*, page 94.

In the Settings dialog, you can first configure whether USB is available in the guest at all, and in addition also optionally enable the USB 2.0 (EHCI) controller for the guest. If so, you can determine in detail which devices are available. For this, you must create so-called "filters" by specifying certain properties of the USB device.

Note: The EHCI controller is shipped as a VirtualBox extension package, which must be installed separately. See chapter 1.5, *Installing VirtualBox and extension packs*, page 14 for more information.

Clicking on the "+" button to the right of the "USB Device Filters" window creates a **new filter.** You can give the filter a name (for referencing it later) and specify the filter criteria. The more criteria you specify, the more precisely devices will be selected. For instance, if you specify only a vendor ID of 046d, all devices produced by Logitech will be available to the guest. If you fill in all fields, on the other hand, the filter will only apply to a particular device model from a particular vendor, and not even to other devices of the same type with a different revision and serial number.

In detail, the following criteria are available:

1. **Vendor and product ID.** With USB, each vendor of USB products carries an identification number that is unique world-wide, the "vendor ID". Similarly, each line of products is assigned a "product ID" number. Both numbers are commonly written in hexadecimal (that is, they are composed of the numbers 0-9 and the letters A-F), and a colon separates the vendor from the product ID. For example, `046d:c016` stands for Logitech as a vendor, and the "M-UV69a Optical Wheel Mouse" product.

Alternatively, you can also specify **"Manufacturer"** and **"Product"** by name.

To list all the USB devices that are connected to your host machine with their respective vendor and product IDs, you can use the following command (see chapter 8, *VBoxManage*, page 100):

```
VBoxManage list usbhost
```

On Windows, you can also see all USB devices that are attached to your system in the Device Manager. On Linux, you can use the `lsusb` command.

2. **Serial number.** While vendor and product ID are already quite specific to identify USB devices, if you have two identical devices of the same brand and product line, you will also need their serial numbers to filter them out correctly.

3. **Remote.** This setting specifies whether the device will be local only, or remote only (over VRDP), or either.

On a Windows host, you will need to unplug and reconnect a USB device to use it after creating a filter for it.

As an example, you could create a new USB filter and specify a vendor ID of 046d (Logitech, Inc), a manufacturer index of 1, and "not remote". Then any USB devices on the host system produced by Logitech, Inc with a manufacturer index of 1 will be visible to the guest system.

Several filters can select a single device – for example, a filter which selects all Logitech devices, and one which selects a particular webcam.

You can **deactivate** filters without deleting them by clicking in the checkbox next to the filter name.

3.10.2 Implementation notes for Windows and Linux hosts

On Windows hosts, a kernel mode device driver provides USB proxy support. It implements both a USB monitor, which allows VirtualBox to capture devices when they are plugged in, and a USB device driver to claim USB devices for a particular virtual machine. As opposed to VirtualBox versions before 1.4.0, system reboots are no longer necessary after installing the driver. Also, you no longer need to replug devices for VirtualBox to claim them.

On newer Linux hosts, VirtualBox accesses USB devices through special files in the file system. When VirtualBox is installed, these are made available to all users in the `vboxusers` system group. In order to be able to access USB from guest systems, make sure that you are a member of this group.

On older Linux hosts, USB devices are accessed using the `usbfs` file system. Therefore, the user executing VirtualBox needs read and write permission to the USB file system. Most distributions provide a group (e.g. `usbusers`) which the VirtualBox user needs to be added to. Also, VirtualBox can only proxy to virtual machines USB devices which are not claimed by a Linux host USB driver. The `Driver=` entry in `/proc/bus/usb/devices` will show you which devices are currently claimed. Please refer to chapter 12.6.7, *USB not working*, page 180 also for details about `usbfs`.

3.11 Shared folders

Shared folders allow you to easily exchange data between a virtual machine and your host. This feature requires that the VirtualBox Guest Additions be installed in a virtual machine and is described in detail in chapter 4.3, *Shared folders*, page 62.

3.12 Alternative firmware (EFI)

Starting with release 3.1, VirtualBox includes experimental support for the Extensible Firmware Interface (EFI), which is a new industry standard intended to eventually replace the legacy BIOS as the primary interface for bootstrapping computers and certain system services later.

By default, VirtualBox uses the BIOS firmware for virtual machines. To use EFI for a given virtual machine, you can enable EFI in the machine's "Settings" dialog (see chapter 3.4.1, *"Motherboard" tab*, page 43). Alternatively, use the `VBoxManage` command line interface like this:

```
VBoxManage modifyvm "VM name" --firmware efi
```

To switch back to using the BIOS, use:

```
VBoxManage modifyvm "VM name" --firmware bios
```

One notable user of EFI is Apple's Mac OS X, but recent Linuxes (such as Fedora 11) and Windows (starting with Vista) offer special versions that can be booted using EFI as well.

Another possible use of EFI in VirtualBox is development and testing of EFI applications, without booting any OS.

Note that the VirtualBox EFI support is experimental and will be enhanced as EFI matures and becomes more widespread. While Mac OS X and Linux guests are known to work fine, Windows guests are currently unable to boot with the VirtualBox EFI implementation.

3.12.1 Video modes in EFI

EFI provides two distinct video interfaces: GOP (Graphics Output Protocol) and UGA (Universal Graphics Adapter). Mac OS X uses GOP, while Linux tends to use UGA. VirtualBox provides a configuration option to control the framebuffer size for both interfaces.

To control GOP, use the following `VBoxManage` command:

```
VBoxManage setextradata "VM name" VBoxInternal2/EfiGopMode N
```

Where N can be one of 0,1,2,3,4 referring to the 640x480, 800x600, 1024x768, 1280x1024, 1440x900 screen resolution respectively.

To change the UGA resolution:

```
VBoxManage setextradata "VM name" VBoxInternal2/UgaHorizontalResolution 1440
VBoxManage setextradata "VM name" VBoxInternal2/UgaVerticalResolution    900
```

The video mode for both GOP and UGA can only be changed when the VM is powered off and remains persistent until changed.

4 Guest Additions

The previous chapter covered getting started with VirtualBox and installing operating systems in a virtual machine. For any serious and interactive use, the VirtualBox Guest Additions will make your life much easier by providing closer integration between host and guest and improving the interactive performance of guest systems. This chapter describes the Guest Additions in detail.

4.1 Introduction

As mentioned in chapter 1.2, *Some terminology*, page 10, the Guest Additions are designed to be installed *inside* a virtual machine after the guest operating system has been installed. They consist of device drivers and system applications that optimize the guest operating system for better performance and usability. Please see chapter 3.1, *Supported guest operating systems*, page 39 for details on what guest operating systems are fully supported with Guest Additions by VirtualBox.

The VirtualBox Guest Additions for all supported guest operating systems are provided as a single CD-ROM image file which is called `VBoxGuestAdditions.iso`. This image file is located in the installation directory of VirtualBox. To install the Guest Additions for a particular VM, you mount this ISO file in your VM as a virtual CD-ROM and install from there.

The Guest Additions offer the following features:

Mouse pointer integration To overcome the limitations for mouse support that were described in chapter 1.8.2, *Capturing and releasing keyboard and mouse*, page 19, this provides you with seamless mouse support. You will only have one mouse pointer and pressing the Host key is no longer required to "free" the mouse from being captured by the guest OS. To make this work, a special mouse driver is installed in the guest that communicates with the "real" mouse driver on your host and moves the guest mouse pointer accordingly.

Shared folders These provide an easy way to exchange files between the host and the guest. Much like ordinary Windows network shares, you can tell VirtualBox to treat a certain host directory as a shared folder, and VirtualBox will make it available to the guest operating system as a network share, irrespective of whether guest actually has a network. For details, please refer to chapter 4.3, *Shared folders*, page 62.

Better video support While the virtual graphics card which VirtualBox emulates for any guest operating system provides all the basic features, the custom video drivers that are installed with the Guest Additions provide you with extra high and non-standard video modes as well as accelerated video performance.

In addition, with Windows, Linux and Solaris guests, you can resize the virtual machine's window if the Guest Additions are installed. The video resolution in the guest will be automatically adjusted (as if you had manually entered an arbitrary resolution in the guest's display settings). Please see chapter 1.8.5, *Resizing the machine's window*, page 21 also.

Finally, if the Guest Additions are installed, 3D graphics and 2D video for guest applications can be accelerated; see chapter 4.4, *Hardware-accelerated graphics*, page 64.

Seamless windows With this feature, the individual windows that are displayed on the desktop of the virtual machine can be mapped on the host's desktop, as if the underlying application was actually running on the host. See chapter 4.5, *Seamless windows*, page 66 for details.

Generic host/guest communication channels The Guest Additions enable you to control and monitor guest execution in ways other than those mentioned above. The so-called "guest properties" provide a generic string-based mechanism to exchange data bits between a guest and a host, some of which have special meanings for controlling and monitoring the guest; see chapter 4.6, *Guest properties*, page 66 for details.

Additionally, applications can be started in a guest from the host; see chapter 4.7, *Guest control*, page 68.

Time synchronization With the Guest Additions installed, VirtualBox can ensure that the guest's system time is better synchronized with that of the host.

For various reasons, the time in the guest might run at a slightly different rate than the time on the host. The host could be receiving updates via NTP and its own time might not run linearly. A VM could also be paused, which stops the flow of time in the guest for a shorter or longer period of time. When the wall clock time between the guest and host only differs slightly, the time synchronization service attempts to gradually and smoothly adjust the guest time in small increments to either "catch up" or "lose" time. When the difference is too great (e.g., a VM paused for hours or restored from saved state), the guest time is changed immediately, without a gradual adjustment.

The Guest Additions will re-synchronize the time regularly. See chapter 9.13.3, *Tuning the Guest Additions time synchronization parameters*, page 153 for how to configure the parameters of the time synchronization mechanism.

Shared clipboard With the Guest Additions installed, the clipboard of the guest operating system can optionally be shared with your host operating system; see chapter 3.3, *General settings*, page 42.

Automated logons (credentials passing) For details, please see chapter 9.2, *Automated guest logons*, page 138.

Each version of VirtualBox, even minor releases, ship with their own version of the Guest Additions. While the interfaces through which the VirtualBox core communicates with the Guest Additions are kept stable so that Guest Additions already installed in a VM should continue to work when VirtualBox is upgraded on the host, for best results, it is recommended to keep the Guest Additions at the same version.

Starting with VirtualBox 3.1, the Windows and Linux Guest Additions therefore check automatically whether they have to be updated. If the host is running a newer VirtualBox version than the Guest Additions, a notification with further instructions is displayed in the guest.

To disable this update check for the Guest Additions of a given virtual machine, set the value of its `/VirtualBox/GuestAdd/CheckHostVersion` guest property to `0`; see chapter 4.6, *Guest properties*, page 66 for details.

4.2 Installing and Maintaining Guest Additions

Guest Additions are available for virtual machines running Windows, Linux, Solaris or OS/2. The following sections describe the specifics of each variant in detail.

4.2.1 Guest Additions for Windows

The VirtualBox Windows Guest Additions are designed to be installed in a virtual machine running a Windows operating system. The following versions of Windows guests are supported:

- Microsoft Windows NT 4.0 (any service pack)
- Microsoft Windows 2000 (any service pack)

- Microsoft Windows XP (any service pack)
- Microsoft Windows Server 2003 (any service pack)
- Microsoft Windows Server 2008
- Microsoft Windows Vista (all editions)
- Microsoft Windows 7 (all editions)

4.2.1.1 Installation

In the "Devices" menu in the virtual machine's menu bar, VirtualBox has a handy menu item named "Install guest additions", which mounts the Guest Additions ISO file inside your virtual machine. A Windows guest should then automatically start the Guest Additions installer, which installs the Guest Additions into your Windows guest.

> **Note:** For Direct 3D acceleration to work in a Windows Guest, you must install the Guest Additions in "Safe Mode"; see chapter 14, *Known limitations*, page 185 for details.

If you prefer to mount the additions manually, you can perform the following steps:

1. Start the virtual machine in which you have installed Windows.
2. Select "Mount CD/DVD-ROM" from the "Devices" menu in the virtual machine's menu bar and then "CD/DVD-ROM image". This brings up the Virtual Media Manager described in chapter 5.3, *The Virtual Media Manager*, page 74.
3. In the Virtual Media Manager, press the "Add" button and browse your host file system for the `VBoxGuestAdditions.iso` file:
   - On a Windows host, you can find this file in the VirtualBox installation directory (usually under `C:\Program files\Oracle\VirtualBox`).
   - On Mac OS X hosts, you can find this file in the application bundle of VirtualBox. (Right click on the VirtualBox icon in Finder and choose *Show Package Contents*. There it is located in the `Contents/MacOS` folder.)
   - On a Linux host, you can find this file in the `additions` folder under where you installed VirtualBox (normally `/opt/VirtualBox/`).
   - On Solaris hosts, you can find this file in the `additions` folder under where you installed VirtualBox (normally `/opt/VirtualBox`).
4. Back in the Virtual Media Manager, select that ISO file and press the "Select" button. This will mount the ISO file and present it to your Windows guest as a CD-ROM.

Unless you have the Autostart feature disabled in your Windows guest, Windows will now autostart the VirtualBox Guest Additions installation program from the Additions ISO. If the Autostart feature has been turned off, choose `VBoxWindowsAdditions.exe` from the CD/DVD drive inside the guest to start the installer.

The installer will add several device drivers to the Windows driver database and then invoke the hardware detection wizard.

Depending on your configuration, it might display warnings that the drivers are not digitally signed. You must confirm these in order to continue the installation and properly install the Additions.

After installation, reboot your guest operating system to activate the Additions.

4.2.1.2 Updating the Windows Guest Additions

Windows Guest Additions can be updated by running the installation program again, as previously described. This will then replace the previous Additions drivers with updated versions.

Alternatively, you may also open the Windows Device Manager and select "Update driver..." for two devices:

1. the VirtualBox Graphics Adapter and
2. the VirtualBox System Device.

For each, choose to provide your own driver and use "Have Disk" to point the wizard to the CD-ROM drive with the Guest Additions.

4.2.1.3 Unattended Installation

In order to allow for completely unattended guest installations, you can specify a command line parameter to the install launcher:

```
VBoxWindowsAdditions.exe /S
```

This automatically installs the right files and drivers for the corresponding platform (32- or 64-bit).

> **Note:** Because of the drivers are not yet WHQL certified, you still might get some driver installation popups, depending on the Windows guest version.

For more options regarding unattended guest installations, consult the command line help by using the command:

```
VBoxWindowsAdditions.exe /?
```

4.2.1.4 Manual file extraction

If you would like to install the files and drivers manually, you can extract the files from the Windows Guest Additions setup by typing:

```
VBoxWindowsAdditions.exe /extract
```

To explicitly extract the Windows Guest Additions for another platform than the current running one (e.g. 64-bit files on a 32-bit system), you have to execute the appropriate platform installer (`VBoxWindowsAdditions-x86.exe` or `VBoxWindowsAdditions-amd64.exe`) with the `/extract` parameter.

4.2.2 Guest Additions for Linux

Like the Windows Guest Additions, the VirtualBox Guest Additions for Linux are a set of device drivers and system applications which may be installed in the guest operating system.

The following Linux distributions are officially supported:

- Fedora as of Fedora Core 4;
- Redhat Enterprise Linux as of version 3;
- SUSE and openSUSE Linux as of version 9;
- Ubuntu as of version 5.10.

Many other distributions are known to work with the Guest Additions.

The version of the Linux kernel supplied by default in SUSE and openSUSE 10.2, Ubuntu 6.10 (all versions) and Ubuntu 6.06 (server edition) contains a bug which can cause it to crash during startup when it is run in a virtual machine. The Guest Additions work in those distributions.

Note that some Linux distributions already come with all or part of the VirtualBox Guest Additions. You may choose to keep the distribution's version of the Guest Additions but these are often not up to date and limited in functionality, so we recommend replacing them with the Guest Additions that come with VirtualBox. The VirtualBox Linux Guest Additions installer tries to detect existing installation and replace them but depending on how the distribution integrates the Guest Additions, this may require some manual interaction. It is highly recommended to take a snapshot of the virtual machine before replacing pre-installed Guest Additions.

4.2.2.1 Installing the Linux Guest Additions

The VirtualBox Guest Additions for Linux are provided on the same virtual CD-ROM file as the Guest Additions for Windows described above. They also come with an installation program guiding you through the setup process, although, due to the significant differences between Linux distributions, installation may be slightly more complex.

Installation generally involves the following steps:

1. Before installing the Guest Additions, you will have to prepare your guest system for building external kernel modules. This works similarly as described in chapter 2.3.2, *The VirtualBox kernel module*, page 32, except that this step must now be performed in your Linux *guest* instead of on a Linux host system, as described there.

   Again, as with Linux hosts, we recommend using DKMS if it is available for the guest system. If it is not installed, use this command for Ubuntu/Debian systems:

   ```
   sudo apt-get install dkms
   ```

   or for Fedora systems:

   ```
   yum install dkms
   ```

   Be sure to install DKMS *before* installing the Linux Guest Additions. If DKMS is not available or not installed, the guest kernel modules will need to be recreated manually whenever the guest kernel is updated using the command

   ```
   /etc/init.d/vboxadd setup
   ```

   as root.

2. Insert the `VBoxGuestAdditions.iso` CD file into your Linux guest's virtual CD-ROM drive, exactly the same way as described for a Windows guest in chapter 4.2.1.1, *Installation*, page 55.

3. Change to the directory where your CD-ROM drive is mounted and execute as root:

   ```
   sh ./VBoxLinuxAdditions.run
   ```

For your convenience, we provide the following step-by-step instructions for freshly installed copies of recent versions of the most popular Linux distributions. After these preparational steps, you can execute the VirtualBox Guest Additions installer as described above.

Ubuntu

1. In order to fully update your guest system, open a terminal and run

   ```
   apt-get update
   ```

   as root followed by

```
apt-get upgrade
```

2. Install DKMS using

   ```
   apt-get install dkms
   ```

3. Reboot your guest system in order to activate the updates and then proceed as described above.

Fedora

1. In order to fully update your guest system, open a terminal and run

   ```
   yum update
   ```

   as root.

2. Install DKMS and the GNU C compiler using

   ```
   yum install dkms
   ```

   followed by

   ```
   yum install gcc
   ```

3. Reboot your guest system in order to activate the updates and then proceed as described above.

openSUSE

1. In order to fully update your guest system, open a terminal and run

   ```
   zypper update
   ```

   as root.

2. Install the make tool and the GNU C compiler using

   ```
   zypper install make gcc
   ```

3. Reboot your guest system in order to activate the updates.

4. Find out which kernel you are running using

   ```
   uname -a
   ```

   An example would be `2.6.31.12-0.2-default` which refers to the "default" kernel. Then install the correct kernel development package. In the above example this would be

   ```
   zypper install kernel-default-devel
   ```

5. Make sure that your running kernel (`uname -a`) and the kernel packages you have installed (`rpm -qa kernel\*`) have the exact same version number. Proceed with the installation as described above.

SuSE Linux Enterprise Desktop (SLED)

1. In order to fully update your guest system, open a terminal and run

   ```
   zypper update
   ```

   as root.

2. Install the GNU C compiler using

   ```
   zypper install gcc
   ```

3. Reboot your guest system in order to activate the updates.

4. Find out which kernel you are running using

   ```
   uname -a
   ```

   An example would be `2.6.27.19-5.1-default` which refers to the "default" kernel. Then install the correct kernel development package. In the above example this would be

   ```
   zypper install kernel-syms kernel-source
   ```

5. Make sure that your running kernel (`uname -a`) and the kernel packages you have installed (`rpm -qa kernel\*`) have the exact same version number. Proceed with the installation as described above.

Mandrake

1. Mandrake ships with the VirtualBox Guest Additions which will be replaced if you follow these steps.

2. In order to fully update your guest system, open a terminal and run

   ```
   urpmi --auto-update
   ```

   as root.

3. Reboot your system in order to activate the updates.

4. Install DKMS using

   ```
   urpmi dkms
   ```

   and make sure to choose the correct kernel-devel package when asked by the installer (use `uname -a` to compare).

CentOS, Red Hat Enterprise Linux and Oracle Enterprise Linux

1. For versions prior to 6, add `divider=10` to the kernel boot options in `/etc/grub.conf` to reduce the idle CPU load.

2. In order to fully update your guest system, open a terminal and run

   ```
   yum update
   ```

   as root.

3. Install the GNU C compiler and the kernel development packages using

   ```
   yum install gcc
   ```

   followed by

   ```
   yum install kernel-devel
   ```

4. Reboot your guest system in order to activate the updates and then proceed as described above.

5. In case Oracle Enterprise Linux does not find the required packages, you either have to install them from a different source (e.g. DVD) or use Oracle's public Yum server located at http://public-yum.oracle.com.

Debian

1. In order to fully update your guest system, open a terminal and run

   ```
   apt-get update
   ```

   as root followed by

   ```
   apt-get upgrade
   ```

2. Install the make tool and the GNU C compiler using

   ```
   apt-get install make gcc
   ```

3. Reboot your guest system in order to activate the updates.

4. Determine the exact version of your kernel using `uname -a` and install the correct version of the linux-headers package, e.g. using

   ```
   apt-get install linux-headers-2.6.26-2-686
   ```

4.2.2.2 Graphics and mouse integration

In Linux and Solaris guests, VirtualBox graphics and mouse integration goes through the X Window System. VirtualBox can use the X.Org variant of the system (or XFree86 version 4.3 which is identical to the first X.Org release). During the installation process, the X.Org display server will be set up to use the graphics and mouse drivers which come with the Guest Additions.

After installing the Guest Additions into a fresh installation of a supported Linux distribution or Solaris system (many unsupported systems will work correctly too), the guest's graphics mode will change to fit the size of the VirtualBox window on the host when it is resized. You can also ask the guest system to switch to a particular resolution by sending a "video mode hint" using the `VBoxManage` tool.

Multiple guest monitors are supported in guests using the X.Org server version 1.3 (which is part of release 7.3 of the X Window System version 11) or a later version. The layout of the guest screens can be adjusted as needed using the tools which come with the guest operating system.

If you want to understand more about the details of how the X.Org drivers are set up (in particular if you wish to use them in a setting which our installer doesn't handle correctly), you should read chapter 9.4.2, *Guest graphics and mouse driver setup in depth*, page 141.

4.2.2.3 Updating the Linux Guest Additions

The Guest Additions can simply be updated by going through the installation procedure again with an updated CD-ROM image. This will replace the drivers with updated versions. You should reboot after updating the Guest Additions.

4.2.2.4 Uninstalling the Linux Guest Additions

If you have a version of the Guest Additions installed on your virtual machine and wish to remove it without installing new ones, you can do so by inserting the Guest Additions CD image into the virtual CD-ROM drive as described above and running the installer for the current Guest Additions with the "uninstall" parameter from the path that the CD image is mounted on in the guest:

```
sh ./VBoxLinuxAdditions.run uninstall
```

While this will normally work without issues, you may need to do some manual cleanup of the guest (particularly of the XFree86Config or xorg.conf file) in some cases, particularly if the Additions version installed or the guest operating system were very old, or if you made your own changes to the Guest Additions setup after you installed them.

Starting with version 3.1.0, you can uninstall the Additions by invoking

```
/opt/VBoxGuestAdditions-4.1.0_BETA1/uninstall.sh
```

Please replace `/opt/VBoxGuestAdditions-4.1.0_BETA1` with the correct Guest Additions installation directory.

4.2.3 Guest Additions for Solaris

Like the Windows Guest Additions, the VirtualBox Guest Additions for Solaris take the form of a set of device drivers and system applications which may be installed in the guest operating system.

The following Solaris distributions are officially supported:

- Solaris 11 Express;
- Solaris 10 (u5 and higher);
- Solaris Nevada/SXDE/SXCE (build 82 and higher);
- OpenSolaris (Developer Preview 2 and higher; this includes OpenSolaris 2008.05, 2008.11 and 2009.06);

Other distributions may work if they are based on comparable software releases.

4.2.3.1 Installing the Solaris Guest Additions

The VirtualBox Guest Additions for Solaris are provided on the same ISO CD-ROM as the Additions for Windows and Linux described above. They also come with an installation program guiding you through the setup process.

Installation involves the following steps:

1. Mount the `VBoxGuestAdditions.iso` file as your Solaris guest's virtual CD-ROM drive, exactly the same way as described for a Windows guest in chapter 4.2.1.1, *Installation*, page 55.

   If in case the CD-ROM drive on the guest doesn't get mounted (observed on some versions of Solaris 10), execute as root:

   ```
   svcadm restart volfs
   ```

2. Change to the directory where your CD-ROM drive is mounted and execute as root:

   ```
   pkgadd -G -d ./VBoxSolarisAdditions.pkg
   ```

3. Choose "1" and confirm installation of the Guest Additions package. After the installation is complete, re-login to X server on your guest to activate the X11 Guest Additions.

4.2.3.2 Uninstalling the Solaris Guest Additions

The Solaris Guest Additions can be safely removed by removing the package from the guest. Open a root terminal session and execute:

```
pkgrm SUNWvboxguest
```

4.2.3.3 Updating the Solaris Guest Additions

The Guest Additions should be updated by first uninstalling the existing Guest Additions and then installing the new ones. Attempting to install new Guest Additions without removing the existing ones is not possible.

4.2.4 Guest Additions for OS/2

VirtualBox also ships with a set of drivers that improve running OS/2 in a virtual machine. Due to restrictions of OS/2 itself, this variant of the Guest Additions has a limited feature set; see chapter 14, *Known limitations*, page 185 for details.

The OS/2 Guest Additions are provided on the same ISO CD-ROM as those for the other platforms. As a result, mount the ISO in OS/2 as described previously. The OS/2 Guest Additions are located in the directory `\32bit\OS2`.

As we do not provide an automatic installer at this time, please refer to the `readme.txt` file in that directory, which describes how to install the OS/2 Guest Additions manually.

4.3 Shared folders

With the "shared folders" feature of VirtualBox, you can access files of your host system from within the guest system. This is similar how you would use network shares in Windows networks – except that shared folders do not need require networking, only the Guest Additions. Shared Folders are supported with Windows (2000 or newer), Linux and Solaris guests.

Shared folders must physically reside on the *host* and are then shared with the guest, which uses a special file system driver in the Guest Addition to talk to the host. For Windows guests, shared folders are implemented as a pseudo-network redirector; for Linux and Solaris guests, the Guest Additions provide a virtual file system.

To share a host folder with a virtual machine in VirtualBox, you must specify the path of that folder and choose for it a "share name" that the guest can use to access it. Hence, first create the shared folder on the host; then, within the guest, connect to it.

There are several ways in which shared folders can be set up for a particular virtual machine:

- In the window of a running VM, you can select "Shared folders" from the "Devices" menu, or click on the folder icon on the status bar in the bottom right corner.
- If a VM is not currently running, you can configure shared folders in each virtual machine's "Settings" dialog.
- From the command line, you can create shared folders using VBoxManage, as follows:

  ```
  VBoxManage sharedfolder add "VM name" --name "sharename" --hostpath "C:\test"
  ```

  See chapter 8.27, *VBoxManage sharedfolder add/remove*, page 128 for details.

There are two types of shares:

1. VM shares which are only available to the VM for which they have been defined;
2. transient VM shares, which can be added and removed at runtime and do not persist after a VM has stopped; for these, add the `--transient` option to the above command line.

Shared folders have read/write access to the files at the host path by default. To restrict the guest to have read-only access, create a read-only shared folder. This can either be achieved using the GUI or by appending the parameter `--readonly` when creating the shared folder with VBoxManage.

Starting with version 4.0, VirtualBox shared folders also support symbolic links (**symlinks**), under the following conditions:

1. The host operating system must support symlinks (i.e. a Mac, Linux or Solaris host is required).
2. Currently only Linux Guest Additions support symlinks.

4.3.1 Manual mounting

You can mount the shared folder from inside a VM the same way as you would mount an ordinary network share:

- In a Windows guest, shared folders are browseable and therefore visible in Windows Explorer. So, to attach the host's shared folder to your Windows guest, open Windows Explorer and look for it under "My Networking Places" -> "Entire Network" -> "VirtualBox Shared Folders". By right-clicking on a shared folder and selecting "Map network drive" from the menu that pops up, you can assign a drive letter to that shared folder.

  Alternatively, on the Windows command line, use the following:

  ```
  net use x: \\vboxsvr\sharename
  ```

  While `vboxsvr` is a fixed name (note that `vboxsrv` would also work), replace "x:" with the drive letter that you want to use for the share, and `sharename` with the share name specified with `VBoxManage`.

- In a Linux guest, use the following command:

  ```
  mount -t vboxsf [-o OPTIONS] sharename mountpoint
  ```

  To mount a shared folder during boot, add the following entry to /etc/fstab:

  ```
  sharename   mountpoint   vboxsf   defaults  0   0
  ```

- In a Solaris guest, use the following command:

  ```
  mount -F vboxfs [-o OPTIONS] sharename mountpoint
  ```

  Replace `sharename` (use lowercase) with the share name specified with `VBoxManage` or the GUI, and `mountpoint` with the path where you want the share to be mounted on the guest (e.g. `/mnt/share`). The usual mount rules apply, that is, create this directory first if it does not exist yet.

  Here is an example of mounting the shared folder for the user "jack" on Solaris:

  ```
  $ id
  uid=5000(jack) gid=1(other)
  $ mkdir /export/home/jack/mount
  $ pfexec mount -F vboxfs -o uid=5000,gid=1 jackshare /export/home/jack/mount
  $ cd ~/mount
  $ ls
  sharedfile1.mp3 sharedfile2.txt
  $
  ```

  Beyond the standard options supplied by the `mount` command, the following are available:

  ```
  iocharset CHARSET
  ```

  to set the character set used for I/O operations (utf8 by default) and

  ```
  convertcp CHARSET
  ```

  to specify the character set used for the shared folder name (utf8 by default).

  The generic mount options (documented in the mount manual page) apply also. Especially useful are the options `uid`, `gid` and `mode`, as they allow access by normal users (in read/write mode, depending on the settings) even if root has mounted the filesystem.

4.3.2 Automatic mounting

Starting with version 4.0, VirtualBox can mount shared folders automatically, at your option. If automatic mounting is enabled for a specific shared folder, the Guest Additions will automatically mount that folder as soon as a user logs into the guest OS. The details depend on the guest OS type:

- With **Windows guests,** any auto-mounted shared folder will receive its own drive letter (e.g. `E:`) depending on the free drive letters remaining in the guest.

  If there no free drive letters left, auto-mounting will fail; as a result, the number of auto-mounted shared folders is typically limited to 22 or less with Windows guests.

- With **Linux guests,** auto-mounted shared folders are mounted into the `/media` directory, along with the prefix `sf_`. For example, the shared folder `myfiles` would be mounted to `/media/sf_myfiles` on Linux and `/mnt/sf_myfiles` on Solaris.

  The guest property `/VirtualBox/GuestAdd/SharedFolders/MountPrefix` determines the prefix that is used. Change that guest property to a value other than "sf" to change that prefix; see chapter 4.6, *Guest properties*, page 66 for details.

  Note: Access to auto-mounted shared folders is only granted to the user group `vboxsf`, which is created by the VirtualBox Guest Additions installer. Hence guest users have to be member of that group to have read/write access or to have read-only access in case the folder is not mapped writable.

  To change the mount directory to something other than `/media`, you can set the guest property `/VirtualBox/GuestAdd/SharedFolders/MountDir`.

- **Solaris guests** behave like Linux guests except that `/mnt` is used as the default mount directory instead of `/media`.

To have any changes to auto-mounted shared folders applied while a VM is running, the guest OS needs to be rebooted. (This applies only to auto-mounted shared folders, not the ones which are mounted manually.)

4.4 Hardware-accelerated graphics

4.4.1 Hardware 3D acceleration (OpenGL and Direct3D 8/9)

The VirtualBox Guest Additions contain experimental hardware 3D support for Windows, Linux and Solaris guests.[1]

With this feature, if an application inside your virtual machine uses 3D features through the OpenGL or Direct3D 8/9 programming interfaces, instead of emulating them in software (which would be slow), VirtualBox will attempt to use your host's 3D hardware. This works for all supported host platforms (Windows, Mac, Linux, Solaris), provided that your host operating system can make use of your accelerated 3D hardware in the first place.

The 3D acceleration currently has the following preconditions:

1. It is only available for certain Windows, Linux and Solaris guests. In particular:

[1] OpenGL support for Windows guests was added with VirtualBox 2.1; support for Linux and Solaris followed with VirtualBox 2.2. With VirtualBox 3.0, Direct3D 8/9 support was added for Windows guests. OpenGL 2.0 is now supported as well.

- 3D acceleration with Windows guests requires Windows 2000, Windows XP, Vista or Windows 7. Both OpenGL and Direct3D 8/9 (not with Windows 2000) are supported (experimental).
- OpenGL on Linux requires kernel 2.6.27 and higher as well as X.org server version 1.5 and higher. Ubuntu 10.10 and Fedora 14 have been tested and confirmed as working.
- OpenGL on Solaris guests requires X.org server version 1.5 and higher.

2. The Guest Additions must be installed.

> **Note:** For Direct 3D acceleration to work in a Windows Guest, VirtualBox needs to replace Windows system files in the virtual machine. As a result, the Guest Additions installation program offers Direct 3D acceleration as an option that must be explicitly enabled. Also, you must install the Guest Additions in "Safe Mode"; see chapter 14, *Known limitations*, page 185 for details.

3. Because 3D support is still experimental at this time, it is disabled by default and must be **manually enabled** in the VM settings (see chapter 3.3, *General settings*, page 42).

> **Note:** Enabling 3D acceleration may expose security holes to malicious software running in the guest. The third-party code that VirtualBox uses for this purpose (Chromium) is not hardened enough to prevent every risky 3D operation on the host.

Technically, VirtualBox implements this by installing an additional hardware 3D driver inside your guest when the Guest Additions are installed. This driver acts as a hardware 3D driver and reports to the guest operating system that the (virtual) hardware is capable of 3D hardware acceleration. When an application in the guest then requests hardware acceleration through the OpenGL or Direct3D programming interfaces, these are sent to the host through a special communication tunnel implemented by VirtualBox, and then the *host* performs the requested 3D operation via the host's programming interfaces.

4.4.2 Hardware 2D video acceleration for Windows guests

Starting with version 3.1, the VirtualBox Guest Additions contain experimental hardware 2D video acceleration support for Windows guests.

With this feature, if an application (e.g. a video player) inside your Windows VM uses 2D video overlays to play a movie clip, then VirtualBox will attempt to use your host's video acceleration hardware instead of performing overlay stretching and color conversion in software (which would be slow). This currently works for Windows, Linux and Mac host platforms, provided that your host operating system can make use of 2D video acceleration in the first place.

The 2D video acceleration currently has the following preconditions:

1. It is only available for Windows guests (XP or later).
2. The Guest Additions must be installed.
3. Because 2D support is still experimental at this time, it is disabled by default and must be **manually enabled** in the VM settings (see chapter 3.3, *General settings*, page 42).

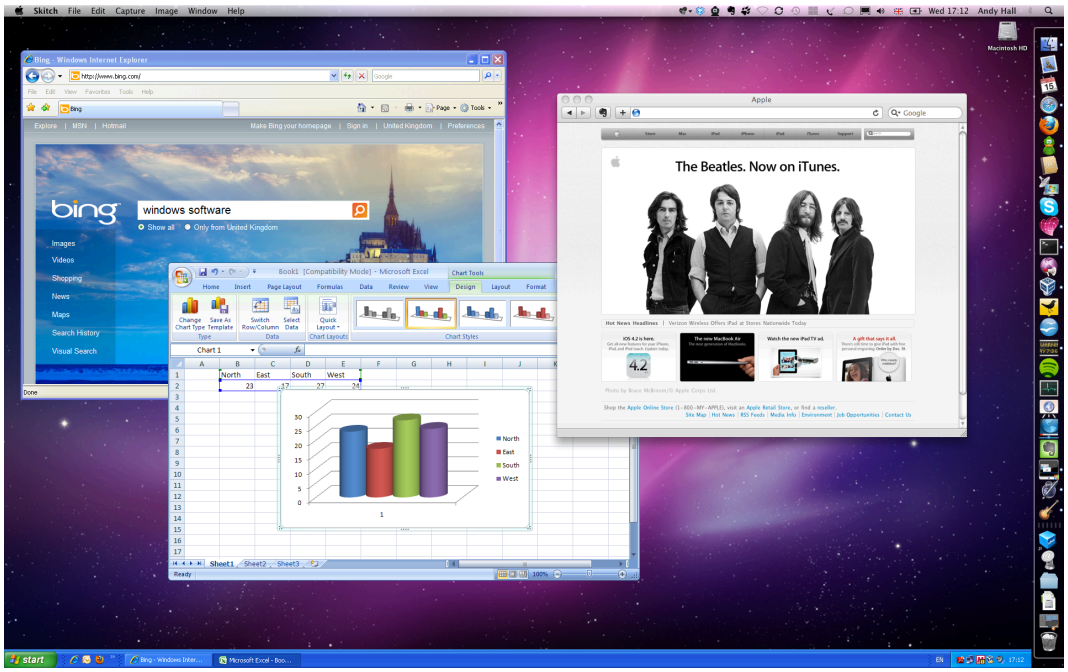
Technically, VirtualBox implements this by exposing video overlay DirectDraw capabilities in the Guest Additions video driver. The driver sends all overlay commands to the host through a special communication tunnel implemented by VirtualBox. On the host side, OpenGL is then used to implement color space transformation and scaling

4.5 Seamless windows

With the “seamless windows” feature of VirtualBox, you can have the windows that are displayed within a virtual machine appear side by side next to the windows of your host. This feature is supported for the following guest operating systems (provided that the Guest Additions are installed):

- Windows guests (support added with VirtualBox 1.5);
- Supported Linux or Solaris guests running the X Window System (added with VirtualBox 1.6).

After seamless windows are enabled (see below), VirtualBox suppresses the display of the Desktop background of your guest, allowing you to run the windows of your guest operating system seamlessly next to the windows of your host:



To enable seamless mode, after starting the virtual machine, press the Host key (normally the right control key) together with “L”. This will enlarge the size of the VM’s display to the size of your host screen and mask out the guest operating system’s background. To go back to the “normal” VM display (i.e. to disable seamless windows), press the Host key and “L” again.

4.6 Guest properties

Starting with version 2.1, VirtualBox allows for requesting certain properties from a running guest, provided that the VirtualBox Guest Additions are installed and the VM is running. This is good for two things:

1. A number of predefined VM characteristics are automatically maintained by VirtualBox and can be retrieved on the host, e.g. to monitor VM performance and statistics.
2. In addition, arbitrary string data can be exchanged between guest and host. This works in both directions.

To accomplish this, VirtualBox establishes a private communication channel between the VirtualBox Guest Additions and the host, and software on both sides can use this channel to exchange string data for arbitrary purposes. Guest properties are simply string keys to which a value is attached. They can be set (written to) by either the host and the guest, and they can also be read from both sides.

In addition to establishing the general mechanism of reading and writing values, a set of predefined guest properties is automatically maintained by the VirtualBox Guest Additions to allow for retrieving interesting guest data such as the guest's exact operating system and service pack level, the installed version of the Guest Additions, users that are currently logged into the guest OS, network statistics and more. These predefined properties are all prefixed with `/VirtualBox/` and organized into a hierarchical tree of keys.

Some of this runtime information is shown when you select "Session Information Dialog" from a virtual machine's "Machine" menu.

A more flexible way to use this channel is via the `VBoxManage guestproperty` command set; see chapter 8.28, *VBoxManage guestproperty*, page 128 for details. For example, to have *all* the available guest properties for a given running VM listed with their respective values, use this:

```
$ VBoxManage guestproperty enumerate "Windows Vista III"
VirtualBox Command Line Management Interface Version 4.1.0
(C) 2005-2011 Oracle Corporation
All rights reserved.

Name: /VirtualBox/GuestInfo/OS/Product, value: Windows Vista Business Edition,
    timestamp: 1229098278843087000, flags:
Name: /VirtualBox/GuestInfo/OS/Release, value: 6.0.6001,
    timestamp: 1229098278950553000, flags:
Name: /VirtualBox/GuestInfo/OS/ServicePack, value: 1,
    timestamp: 1229098279122627000, flags:
Name: /VirtualBox/GuestAdd/InstallDir,
    value: C:/Program Files/Oracle/VirtualBox
    Guest Additions, timestamp: 1229098279269739000, flags:
Name: /VirtualBox/GuestAdd/Revision, value: 40720,
    timestamp: 1229098279345664000, flags:
Name: /VirtualBox/GuestAdd/Version, value: 4.1.0,
    timestamp: 1229098279479515000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxControl.exe, value: 4.1.0r40720,
    timestamp: 1229098279651731000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxHook.dll, value: 4.1.0r40720,
    timestamp: 1229098279804835000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxDisp.dll, value: 4.1.0r40720,
    timestamp: 1229098279880611000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxMRXNP.dll, value: 4.1.0r40720,
    timestamp: 1229098279882618000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxService.exe, value: 4.1.0r40720,
    timestamp: 1229098279883195000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxTray.exe, value: 4.1.0r40720,
    timestamp: 1229098279885027000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxGuest.sys, value: 4.1.0r40720,
    timestamp: 1229098279886838000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxMouse.sys, value: 4.1.0r40720,
    timestamp: 1229098279890600000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxSF.sys, value: 4.1.0r40720,
    timestamp: 1229098279893056000, flags:
Name: /VirtualBox/GuestAdd/Components/VBoxVideo.sys, value: 4.1.0r40720,
    timestamp: 1229098279895767000, flags:
Name: /VirtualBox/GuestInfo/OS/LoggedInUsers, value: 1,
    timestamp: 1229099826317660000, flags:
Name: /VirtualBox/GuestInfo/OS/NoLoggedInUsers, value: false,
    timestamp: 1229098455580553000, flags:
Name: /VirtualBox/GuestInfo/Net/Count, value: 1,
    timestamp: 1229099826299785000, flags:
Name: /VirtualBox/HostInfo/GUI/LanguageID, value: C,
    timestamp: 1229098151272771000, flags:
Name: /VirtualBox/GuestInfo/Net/0/V4/IP, value: 192.168.2.102,
```

```
    timestamp: 1229099826300088000, flags:
Name: /VirtualBox/GuestInfo/Net/0/V4/Broadcast, value: 255.255.255.255,
    timestamp: 1229099826300220000, flags:
Name: /VirtualBox/GuestInfo/Net/0/V4/Netmask, value: 255.255.255.0,
    timestamp: 1229099826300350000, flags:
Name: /VirtualBox/GuestInfo/Net/0/Status, value: Up,
    timestamp: 1229099826300524000, flags:
Name: /VirtualBox/GuestInfo/OS/LoggedInUsersList, value: username,
    timestamp: 1229099826317386000, flags:
```

To query the value of a single property, use the "get" subcommand like this:

```
$ VBoxManage guestproperty get "Windows Vista III"
         "/VirtualBox/GuestInfo/OS/Product"
VirtualBox Command Line Management Interface Version 4.1.0
(C) 2005-2011 Oracle Corporation
All rights reserved.

Value: Windows Vista Business Edition
```

To add or change guest properties from the guest, use the tool `VBoxControl`. This tool is included in the Guest Additions of VirtualBox 2.2 or later. When started from a Linux guest, this tool requires root privileges for security reasons:

```
$ sudo VBoxControl guestproperty enumerate
VirtualBox Guest Additions Command Line Management Interface Version 4.1.0
(C) 2009-2011 Oracle Corporation
All rights reserved.

Name: /VirtualBox/GuestInfo/OS/Release, value: 2.6.28-18-generic,
    timestamp: 1265813265835667000, flags: <NULL>
Name: /VirtualBox/GuestInfo/OS/Version, value: #59-Ubuntu SMP Thu Jan 28 01:23:03 UTC 2010,
    timestamp: 1265813265836305000, flags: <NULL>
      ...
```

For more complex needs, you can use the VirtualBox programming interfaces; see chapter 11, *VirtualBox programming interfaces*, page 167.

4.7 Guest control

Starting with version 3.2, the Guest Additions of VirtualBox allow starting applications inside a VM from the host system.

For this to work, the application needs to be installed inside the guest; no additional software needs to be installed on the host. Additionally, text mode output (to stdout and stderr) can be shown on the host for further processing along with options to specify user credentials and a timeout value (in milliseconds) to limit time the application is able to run.

This feature can be used to automate deployment of software within the guest.

Starting with version 4.0, the Guest Additions for Windows allow for automatic updating (only already installed Guest Additions 4.0 or later). Also, copying files from host to the guest as well as remotely creating guest directories is available.

To use these features, use the VirtualBox command line, see chapter 8.29, *VBoxManage guestcontrol*, page 129.

4.8 Memory overcommitment

In server environments with many VMs; the Guest Additions can be used to share physical host memory between several VMs, reducing the total amount of memory in use by the VMs. If memory usage is the limiting factor and CPU resources are still available, this can help with packing more VMs on each host.

4.8.1 Memory ballooning

Starting with version 3.2, the Guest Additions of VirtualBox can change the amount of host memory that a VM uses while the machine is running. Because of how this is implemented, this feature is called "memory ballooning".

> **Note:** VirtualBox supports memory ballooning only on 64-bit hosts, and it is not supported on Mac OS X hosts.

Normally, to change the amount of memory allocated to a virtual machine, one has to shut down the virtual machine entirely and modify its settings. With memory ballooning, memory that was allocated for a virtual machine can be given to another virtual machine without having to shut the machine down.

When memory ballooning is requested, the VirtualBox Guest Additions (which run inside the guest) allocate physical memory from the guest operating system on the kernel level and lock this memory down in the guest. This ensures that the guest will not use that memory any longer: no guest applications can allocate it, and the guest kernel will not use it either. VirtualBox can then re-use this memory and give it to another virtual machine.

The memory made available through the ballooning mechanism is only available for re-use by VirtualBox. It is *not* returned as free memory to the host. Requesting balloon memory from a running guest will therefore not increase the amount of free, unallocated memory on the host. Effectively, memory ballooning is therefore a memory overcommitment mechanism for multiple virtual machines while they are running. This can be useful to temporarily start another machine, or in more complicated environments, for sophisticated memory management of many virtual machines that may be running in parallel depending on how memory is used by the guests.

At this time, memory ballooning is only supported through VBoxManage. Use the following command to increase or decrease the size of the memory balloon within a running virtual machine that has Guest Additions installed:

```
VBoxManage controlvm "VM name" guestmemoryballoon <n>
```

where `"VM name"` is the name or UUID of the virtual machine in question and `<n>` is the amount of memory to allocate from the guest in megabytes. See chapter 8.11, *VBoxManage controlvm*, page 118 for more information.

You can also set a default balloon that will automatically be requested from the VM every time after it has started up with the following command:

```
VBoxManage modifyvm "VM name" --guestmemoryballoon <n>
```

By default, no balloon memory is allocated. This is a VM setting, like other `modifyvm` settings, and therefore can only be set while the machine is shut down; see chapter 8.7, *VBoxManage modifyvm*, page 110.

4.8.2 Page Fusion

Whereas memory ballooning simply reduces the amount of RAM that is available to a VM, Page Fusion works differently: it avoids memory duplication between several similar running VMs.

In a server environment running several similar VMs (e.g. with identical operating systems) on the same host, lots of memory pages are identical. VirtualBox's Page Fusion technology, introduced with VirtualBox 3.2, is a novel technique to efficiently identify these identical memory pages and share them between multiple VMs.

> **Note:** VirtualBox supports Page Fusion only on 64-bit hosts, and it is not supported on Mac OS X hosts. Page Fusion currently works only with Windows guests (2000 and later).

The more similar the VMs on a given host are, the more efficiently Page Fusion can reduce the amount of host memory that is in use. It therefore works best if all VMs on a host run identical operating systems (e.g. Windows XP Service Pack 2). Instead of having a complete copy of each operating system in each VM, Page Fusion identifies the identical memory pages in use by these operating systems and eliminates the duplicates, sharing host memory between several machines ("deduplication"). If a VM tries to modify a page that has been shared with other VMs, a new page is allocated again for that VM with a copy of the shared page ("copy on write"). All this is fully transparent to the virtual machine.

You may be familiar with this kind of memory overcommitment from other hypervisor products, which call this feature "page sharing" or "same page merging". However, Page Fusion differs significantly from those other solutions, whose approaches have several drawbacks:

1. Traditional hypervisors scan *all* guest memory and compute checksums (hashes) for every single memory page. Then, they look for pages with identical hashes and compare the entire content of those pages; if two pages produce the same hash, it is very likely that the pages are identical in content. This, of course, can take rather long, especially if the system is not idling. As a result, the additional memory only becomes available after a significant amount of time (this can be hours or even days!). Even worse, this kind of page sharing algorithm generally consumes significant CPU resources and increases the virtualization overhead by 10-20%.

   Page Fusion in VirtualBox uses logic in the VirtualBox Guest Additions to quickly identify memory cells that are most likely identical across VMs. It can therefore achieve most of the possible savings of page sharing almost immediately and with almost no overhead.

2. Page Fusion is also much less likely to be confused by identical memory that it will eliminate just to learn seconds later that the memory will now change and having to perform a highly expensive and often service-disrupting reallocation.

At this time, Page Fusion can only be controlled with VBoxManage, and only while a VM is shut down. To enable Page Fusion for a VM, use the following command:

```
VBoxManage modifyvm "VM name" --pagefusion on
```

You can observe Page Fusion operation using some metrics. `RAM/VMM/Shared` shows the total amount of fused pages, whereas the per-VM metric `Guest/RAM/Usage/Shared` will return the amount of fused memory for a given VM. Please refer to chapter 8.31, *VBoxManage metrics*, page 133 for information on how to query metrics.

5 Virtual storage

As the virtual machine will most probably expect to see a hard disk built into its virtual computer, VirtualBox must be able to present "real" storage to the guest as a virtual hard disk. There are presently three methods in which to achieve this:

1. Most commonly, VirtualBox will use large image files on a real hard disk and present them to a guest as a virtual hard disk. This is described in chapter 5.2, *Disk image files (VDI, VMDK, VHD, HDD)*, page 73.

2. Alternatively, if you have iSCSI storage servers, you can attach such a server to VirtualBox as well; this is described in chapter 5.10, *iSCSI servers*, page 82.

3. Finally, as an experimental feature, you can allow a virtual machine to access one of your host disks directly; this advanced feature is described in chapter 9.8.1, *Using a raw host hard disk from a guest*, page 145.

Each such virtual storage device (image file, iSCSI target or physical hard disk) will need to be connected to the virtual hard disk controller that VirtualBox presents to a virtual machine. This is explained in the next section.

5.1 Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS

In a real PC, hard disks and CD/DVD drives are connected to a device called hard disk controller which drives hard disk operation and data transfers. VirtualBox can emulate the four most common types of hard disk controllers typically found in today's PCs: IDE, SATA (AHCI), SCSI and SAS.[1]

- **IDE (ATA)** controllers have been in use since the 1980s. Initially, this type of interface worked only with hard disks, but was later extended to also support CD-ROM drives and other types of removable media. In physical PCs, this standard uses flat ribbon parallel cables with 40 or 80 wires. Each such cable can connect two devices to a controller, which have traditionally been called "master" and "slave". Typical hard disk controllers have two connectors for such cables; as a result, most PCs support up to four devices.

  In VirtualBox, each virtual machine has one IDE controller enabled by default, which gives you up to four virtual storage devices that you can attach to the machine. (By default, one of these four – the secondary master – is preconfigured to be the machine's virtual CD/DVD drive, but this can be changed.[2])

  So even if your guest operating system has no support for SCSI or SATA devices, it should always be able to see the default IDE controller that is enabled by default.

  You can also select which exact type of IDE controller hardware VirtualBox should present to the virtual machine (PIIX3, PIIX4 or ICH6). This makes no difference in terms of performance, but if you import a virtual machine from another virtualization product, the

[1] SATA support was added with VirtualBox 1.6; experimental SCSI support was added with 2.1 and fully implemented with 2.2. Generally, storage attachments were made much more flexible with VirtualBox 3.1; see below. Support for the LSI Logic SAS controller was added with VirtualBox 3.2.

[2] The assignment of the machine's CD/DVD drive to the secondary master was fixed before VirtualBox 3.1; it is now changeable, and the drive can be at other slots of the IDE controller, and there can be more than one such drive.

operating system in that machine may expect a particular controller and crash if it isn't found.

After you have created a new virtual machine with the "New Virtual Machine" wizard of the graphical user interface, you will typically see one IDE controller in the machine's "Storage" settings where the virtual CD/DVD drive will be attached to one of the four ports of this controller.

- **Serial ATA (SATA)** is a newer standard introduced in 2003. Compared to IDE, it supports both much higher speeds and more devices per hard disk controller. Also, with physical hardware, devices can be added and removed while the system is running. The standard interface for SATA controllers is called Advanced Host Controller Interface (**AHCI**).

  For compatibility reasons, AHCI controllers by default operate the disks attached to it in a so-called "IDE compatibility mode", unless SATA support is explicitly requested. "IDE compatibility mode" only means that the drives can be seen and operated by the computer's BIOS. Still, disks assigned to those slots will operate in full-speed AHCI mode once the guest operating system has loaded its AHCI device driver.

  Like a real SATA controller, VirtualBox's virtual SATA controller operates faster and also consumes less CPU resources than the virtual IDE controller. Also, this allows you to connect up to 30 virtual hard disks to one machine instead of just three, as with the VirtualBox IDE controller (with the DVD drive already attached). Of these, the first four (numbered 0-3 in the graphical user interface) are operated in IDE compatibility mode by default.

  For this reason, starting with version 3.2 and depending on the selected guest operating system, VirtualBox uses SATA as the default for newly created virtual machines. One virtual SATA controller is created by default, and the default disk that is created with a new VM is attached to this controller.

  Warning: The entire SATA controller and the virtual disks attached to it (including those in IDE compatibility mode) will not be seen by operating systems that do not have device support for AHCI. In particular, **there is no support for AHCI in Windows before Windows Vista**, so Windows XP (even SP2) will not see such disks unless you install additional drivers. It is possible to switch from IDE to SATA after installation by installing the SATA drivers and changing the controller type in the VM settings dialog.[a]

  [a] VirtualBox recommends the Intel Matrix Storage drivers which can be downloaded from http://downloadcenter.intel.com/Product_Filter.aspx?ProductID=2101.

  To add a SATA controller to a machine for which it has not been enabled by default (either because it was created by an earlier version of VirtualBox, or because SATA is not supported by default by the selected guest operating system), go to the "Storage" page of the machine's settings dialog, click on the "Add Controller" button under the "Storage Tree" box and then select "Add SATA Controller". After this, the additional controller will appear as a separate PCI device in the virtual machine, and you can add virtual disks to it.

  To change the IDE compatibility mode settings for the SATA controller, please see chapter 8.17, *VBoxManage storagectl*, page 123.

- **SCSI** is another established industry standard, standing for "Small Computer System Interface". SCSI was standardized as early as 1986 as a generic interface for data transfer between all kinds of devices, including storage devices. Today SCSI is still used for connecting hard disks and tape devices, but it has mostly been displaced in commodity hardware. It is still in common use in high-performance workstations and servers.

  Primarily for compatibility with other virtualization software, VirtualBox optionally supports LSI Logic and BusLogic SCSI controllers, to each of which up to 15 virtual hard disks can be attached.

To enable a SCSI controller, on the "Storage" page of a virtual machine's settings dialog, click on the "Add Controller" button under the "Storage Tree" box and then select "Add SCSI Controller". After this, the additional controller will appear as a separate PCI device in the virtual machine.

Warning: As with the other controller types, a SCSI controller will only be seen by operating systems with device support for it. Windows 2003 and later ships with drivers for the LSI Logic controller, while Windows NT 4.0 and Windows 2000 ships with drivers for the BusLogic controller. Windows XP ships with drivers for neither.

- **Serial Attached SCSI (SAS)** is another bus standard which uses the SCSI command set. As opposed to SCSI, however, with physical devices, serial cables are used instead of parallel ones, which simplifies physical device connections. In some ways, therefore, SAS is to SCSI what SATA is to IDE: it allows for more reliable and faster connections.

  To support high-end guests which require SAS controllers, VirtualBox emulates a LSI Logic SAS controller, which can be enabled much the same way as a SCSI controller. At this time, up to eight devices can be connected to the SAS controller.

Warning: As with SATA, the SAS controller will only be seen by operating systems with device support for it. In particular, **there is no support for SAS in Windows before Windows Vista**, so Windows XP (even SP2) will not see such disks unless you install additional drivers.

In summary, VirtualBox gives you the following categories of virtual storage slots:

1. four slots attached to the traditional IDE controller, which are always present (one of which typically is a virtual CD/DVD drive);
2. 30 slots attached to the SATA controller, if enabled and provided that your guest operating system can see it; these slots can either be
   a) in IDE compatibility mode (by default, slots 0-3) or
   b) in SATA mode;
3. 15 slots attached to the SCSI controller, if enabled and supported by the guest operating system;
4. eight slots attached to the SAS controller, if enabled and supported by the guest operating system.

Given this large choice of storage controllers, you may ask yourself which one to choose. In general, you should avoid IDE unless it is the only controller supported by your guest. Whether you use SATA, SCSI or SAS does not make any real difference. The variety of controllers is only supplied for VirtualBox for compatibility with existing hardware and other hypervisors.

5.2 Disk image files (VDI, VMDK, VHD, HDD)

Disk image files reside on the host system and are seen by the guest systems as hard disks of a certain geometry. When a guest operating system reads from or writes to a hard disk, VirtualBox redirects the request to the image file.

Like a physical disk, a virtual disk has a size (capacity), which must be specified when the image file is created. As opposed to a physical disk however, VirtualBox allows you to expand an image file after creation, even if it has data already; see chapter 8.21, *VBoxManage modifyhd*, page 125 for details.[3]

VirtualBox supports four variants of disk image files:

- Normally, VirtualBox uses its own container format for guest hard disks – Virtual Disk Image (VDI) files. In particular, this format will be used when you create a new virtual machine with a new disk.
- VirtualBox also fully supports the popular and open VMDK container format that is used by many other virtualization products, in particular, by VMware.[4]
- VirtualBox also fully supports the VHD format used by Microsoft.
- Image files of Parallels version 2 (HDD format) are also supported.[5] For lack of documentation of the format, newer formats (3 and 4) are not supported. You can however convert such image files to version 2 format using tools provided by Parallels.

Irrespective of the disk capacity and format, as briefly mentioned in chapter 1.7, *Creating your first virtual machine*, page 16, there are two options of how to create a disk image: fixed-size or dynamically expanding.

- If you create a **fixed-size image**, an image file will be created on your host system which has roughly the same size as the virtual disk's capacity. So, for a 10G disk, you will have a 10G file. Note that the creation of a fixed-size image can take a long time depending on the size of the image and the write performance of your hard disk.
- For more flexible storage management, use a **dynamically expanding image**. This will initially be very small and not occupy any space for unused virtual disk sectors, but the image file will grow every time a disk sector is written to for the first time. While this format takes less space initially, the fact that VirtualBox needs to constantly expand the image file consumes additional computing resources, so until the disk has fully expanded, write operations are slower than with fixed size disks. However, after a dynamic disk has fully expanded, the performance penalty for read and write operations is negligible.

5.3 The Virtual Media Manager

VirtualBox keeps track of all the hard disk, CD/DVD-ROM and floppy disk images which are in use by virtual machines. These are often referred to as "known media" and come from two sources:

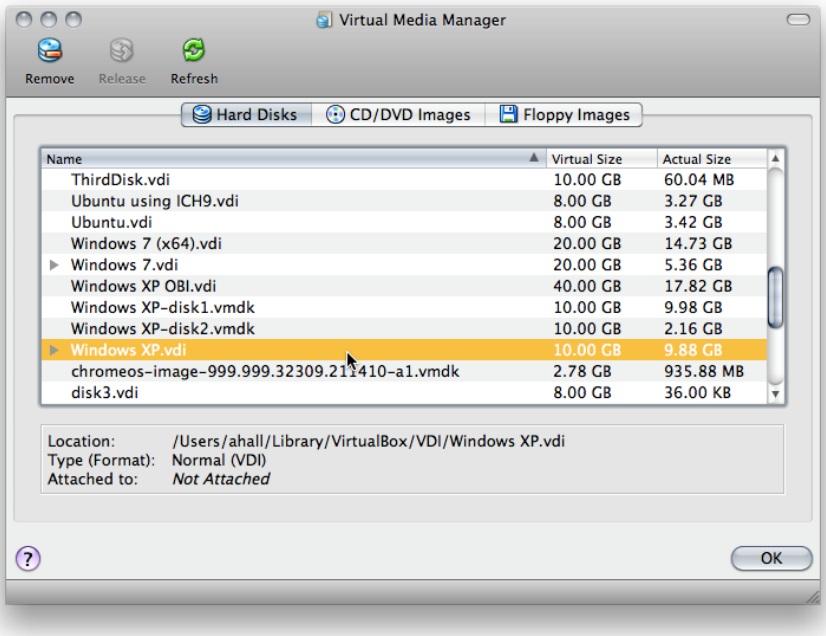
- all media currently attached to virtual machines;
- "registered" media for compatibility with VirtualBox versions older than version 4.0. For details about how media registration has changed with version 4.0, please refer to chapter 10.1, *Where VirtualBox stores its files*, page 157.

The known media can be viewed and changed in the **Virtual Media Manager**, which you can access from the "File" menu in the VirtualBox main window:

[3] Image resizing was added with VirtualBox 4.0.

[4] Initial support for VMDK was added with VirtualBox 1.4; since version 2.1, VirtualBox supports VMDK fully, meaning that you can create snapshots and use all the other advanced features described above for VDI images with VMDK also.

[5] Support was added with VirtualBox 3.1.



The known media are conveniently grouped in three tabs for the three possible formats. These formats are:

- Hard disk images, either in VirtualBox's own Virtual Disk Image (VDI) format or in the third-party formats listed in the previous chapter;
- CD/DVD images in standard ISO format;
- floppy images in standard RAW format.

As you can see in the screenshot above, for each image, the Virtual Media Manager shows you the full path of the image file and other information, such as the virtual machine the image is currently attached to, if any.

The Virtual Media Manager allows you to

- **remove** an image from the registry (and optionally delete the image file when doing so);
- **"release"** an image, that is, detach it from a virtual machine if it is currently attached to one as a virtual hard disk.

Starting with version 4.0, to **create new disk images,** please use the "Storage" page in a virtual machine's settings dialog because disk images are now by default stored in each machine's own folder.

Hard disk image files can be copied onto other host systems and imported into virtual machines there, although certain guest systems (notably Windows 2000 and XP) will require that the new virtual machine be set up in a similar way to the old one.

Note: Do not simply make copies of virtual disk images. If you import such a second copy into a virtual machine, VirtualBox will complain with an error, since VirtualBox assigns a unique identifier (UUID) to each disk image to make sure it is only used once. See chapter 5.6, *Cloning disk images*, page 79 for instructions on this matter. Also, if you want to copy a virtual machine to another system, VirtualBox has an import/export facility that might be better suited for your needs; see chapter 1.12, *Importing and exporting virtual machines*, page 26.

5.4 Special image write modes

For each virtual disk image supported by VirtualBox, you can determine separately how it should be affected by write operations from a virtual machine and snapshot operations. This applies to all of the aforementioned image formats (VDI, VMDK, VHD or HDD) and irrespective of whether an image is fixed-size or dynamically expanding.

By default, images are in "normal" mode. To mark an existing image with one of the non-standard modes listed below, use `VBoxManage modifyhd`; see chapter 8.21, *VBoxManage modifyhd*, page 125. Alternatively, use VBoxManage to attach the image to a VM and use the `--mtype` argument; see chapter 8.16, *VBoxManage storageattach*, page 121.

1. With **normal images** (the default setting), there are no restrictions on how guests can read from and write to the disk.

   When you take a snapshot of your virtual machine as described in chapter 1.9, *Snapshots*, page 23, the state of such a "normal hard disk" will be recorded together with the snapshot, and when reverting to the snapshot, its state will be fully reset.

   (Technically, strictly speaking, the image file itself is not "reset". Instead, when a snapshot is taken, VirtualBox "freezes" the image file and no longer writes to it. For the write operations from the VM, a second, "differencing" image file is created which receives only the changes to the original image; see the next section for details.)

   While you can attach the same "normal" image to more than one virtual machine, only one of these virtual machines attached to the same image file can be executed simultaneously, as otherwise there would be conflicts if several machines write to the same image file.[6]

2. By contrast, **write-through hard disks** are completely unaffected by snapshots: their state is *not* saved when a snapshot is taken, and not restored when a snapshot is restored.

3. **Shareable hard disks** are a variant of write-through hard disks. In principle they behave exactly the same, i.e. their state is *not* saved when a snapshot is taken, and not restored when a snapshot is restored. The difference only shows if you attach such disks to several VMs. Shareable VMs may be attached to several VMs which may run concurrently. This makes them suitable for use by cluster filesystems between VMs and similar applications which are explicitly prepared to access a disk concurrently. Only fixed size images can be used in this way, and dynamically growing images are rejected.

   Warning: This is an expert feature, and misuse can lead to data loss – regular filesystems are not prepared to handle simultaneous changes by several parties.

4. Next, **immutable images** only remember write accesses temporarily while the virtual machine is running; all changes are lost when the virtual machine is powered on the next time. As a result, as opposed to "normal" images, the same immutable image can be used with several virtual machines without restrictions.

   Creating an immutable image makes little sense since it would be initially empty and lose its contents with every machine restart (unless you really want to have a disk that is always unformatted when the machine starts up). As a result, normally, you would first create a "normal" image and then, when you deem its contents useful, later mark it immutable.

   If you take a snapshot of a machine with immutable images, then on every machine power-up, those images are reset to the state of the last (current) snapshot (instead of the state of the original immutable image).

[6] This restriction is more lenient now than it was before VirtualBox 2.2. Previously, each "normal" disk image could only be *attached* to one single machine. Now it can be attached to more than one machine so long as only one of these machines is running.

Note: As a special exception, immutable images are *not* reset if they are attached to a machine whose last snapshot was taken while the machine was running (a so-called "online" snapshot). As a result, if the machine's current snapshot is such an "online" snapshot, its immutable images behave exactly like the "normal" images described previously. To re-enable the automatic resetting of such images, delete the current snapshot of the machine.

Again, technically, VirtualBox never writes to an immutable image directly at all. All write operations from the machine will be directed to a differencing image; the next time the VM is powered on, the differencing image is reset so that every time the VM starts, its immutable images have exactly the same content.[7] The differencing image is only reset when the machine is powered on from within VirtualBox, not when you reboot by requesting a reboot from within the machine. This is also why immutable images behave as described above when snapshots are also present, which use differencing images as well.

If the automatic discarding of the differencing image on VM startup does not fit your needs, you can turn it off using the `autoreset` parameter of `VBoxManage modifyhd`; see chapter 8.21, *VBoxManage modifyhd*, page 125 for details.

5. An image in **multiattach mode** can be attached to more than one virtual machine at the same time, even if these machines are running simultaneously. For each virtual machine to which such an image is attached, a differencing image is created. As a result, data that is written to such a virtual disk by one machine is not seen by the other machines to which the image is attached; each machine creates its own write history of the multiattach image.

   Technically, a "multiattach" image behaves identically to an "immutable" image except the differencing image is not reset every time the machine starts.

6. Finally, the **read-only image** is used automatically for CD/DVD images, since CDs/DVDs can never be written to.

To illustrate the differences between the various types with respect to snapshots: Assume you have installed your guest operating system in your VM, and you have taken a snapshot. Imagine you have accidentally infected your VM with a virus and would like to go back to the snapshot. With a normal hard disk image, you simply restore the snapshot, and the earlier state of your hard disk image will be restored as well (and your virus infection will be undone). With an immutable hard disk, all it takes is to shut down and power on your VM, and the virus infection will be discarded. With a write-through image however, you cannot easily undo the virus infection by means of virtualization, but will have to disinfect your virtual machine like a real computer.

Still, you might find write-through images useful if you want to preserve critical data irrespective of snapshots, and since you can attach more than one image to a VM, you may want to have one immutable for the operating system and one write-through for your data files.

5.5 Differencing images

The previous section hinted at differencing images and how they are used with snapshots, immutable images and multiple disk attachments. For the inquisitive VirtualBox user, this section describes in more detail how they work.

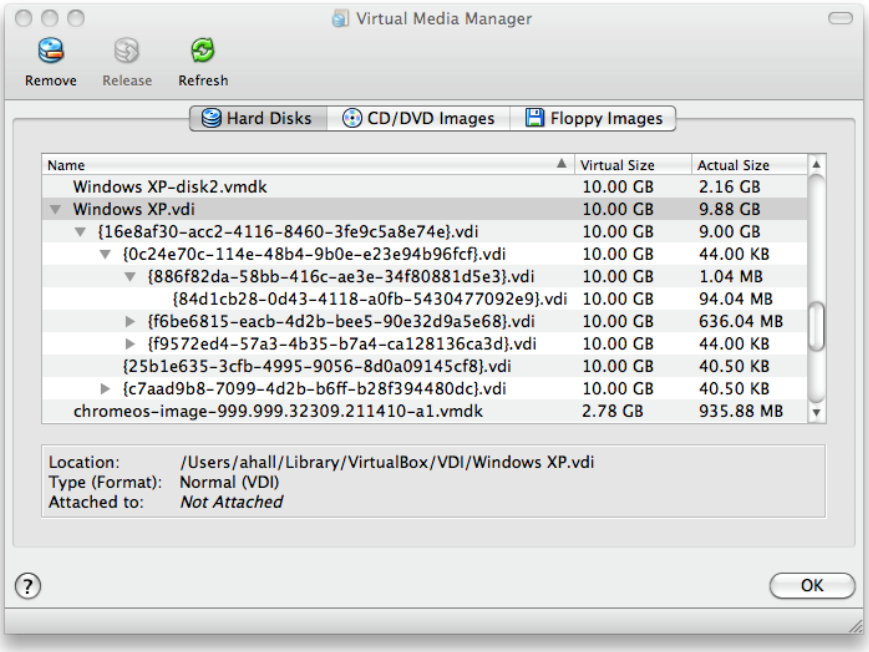
A differencing image is a special disk image that only holds the differences to another image. A differencing image by itself is useless, it must always refer to another image. The differencing image is then typically referred to as a "child", which holds the differences to its "parent".

[7] This behavior also changed with VirtualBox 2.2. Previously, the differencing images were discarded when the machine session *ended*; now they are discarded every time the machine is powered on.

When a differencing image is active, it receives all write operations from the virtual machine instead of its parent. The differencing image only contains the sectors of the virtual hard disk that have changed since the differencing image was created. When the machine reads a sector from such a virtual hard disk, it looks into the differencing image first. If the sector is present, it is returned from there; if not, VirtualBox looks into the parent. In other words, the parent becomes "read-only"; it is never written to again, but it is read from if a sector has not changed.

Differencing images can be chained. If another differencing image is created for a virtual disk that already has a differencing image, then it becomes a "grandchild" of the original parent. The first differencing image then becomes read-only as well, and write operations only go to the second-level differencing image. When reading from the virtual disk, VirtualBox needs to look into the second differencing image first, then into the first if the sector was not found, and then into the original image.

There can be an unlimited number of differencing images, and each image can have more than one child. As a result, the differencing images can form a complex tree with parents, "siblings" and children, depending on how complex your machine configuration is. Write operations always go to the one "active" differencing image that is attached to the machine, and for read operations, VirtualBox may need to look up all the parents in the chain until the sector in question is found. You can look at such a tree in the Virtual Media Manager:



In all of these situations, from the point of view of the virtual machine, the virtual hard disk behaves like any other disk. While the virtual machine is running, there is a slight run-time I/O overhead because VirtualBox might need to look up sectors several times. This is not noticeable however since the tables with sector information are always kept in memory and can be looked up quickly.

Differencing images are used in the following situations:

1. **Snapshots.** When you create a snapshot, as explained in the previous section, VirtualBox "freezes" the images attached to the virtual machine and creates differencing images for each of them (to be precise: one for each image that is not in "write-through" mode). From the point of view of the virtual machine, the virtual disks continue to operate before, but all write operations go into the differencing images. Each time you create another snapshot, for each hard disk attachment, another differencing image is created and attached, forming a chain or tree.

In the above screenshot, you see that the original disk image is now attached to a snapshot, representing the state of the disk when the snapshot was taken.

If you now **restore** a snapshot – that is, if you want to go back to the exact machine state that was stored in the snapshot –, the following happens:

a) VirtualBox copies the virtual machine settings that were copied into the snapshot back to the virtual machine. As a result, if you have made changes to the machine configuration since taking the snapshot, they are undone.

b) If the snapshot was taken while the machine was running, it contains a saved machine state, and that state is restored as well; after restoring the snapshot, the machine will then be in "Saved" state and resume execution from there when it is next started. Otherwise the machine will be in "Powered Off" state and do a full boot.

c) For each disk image attached to the machine, the differencing image holding all the write operations since the current snapshot was taken is thrown away, and the original parent image is made active again. (If you restored the "root" snapshot, then this will be the root disk image for each attachment; otherwise, some other differencing image descended from it.) This effectively restores the old machine state.

If you later **delete** a snapshot in order to free disk space, for each disk attachment, one of the differencing images becomes obsolete. In this case, the differencing image of the disk attachment cannot simply be deleted. Instead, VirtualBox needs to look at each sector of the differencing image and needs to copy it back into its parent; this is called "merging" images and can be a potentially lengthy process, depending on how large the differencing image is. It can also temporarily need a considerable amount of extra disk space, before the differencing image obsoleted by the merge operation is deleted.

2. **Immutable images.** When an image is switched to "immutable" mode, a differencing image is created as well. As with snapshots, the parent image then becomes read-only, and the differencing image receives all the write operations. Every time the virtual machine is started, all the immutable images which are attached to it have their respective differencing image thrown away, effectively resetting the virtual machine's virtual disk with every restart.

5.6 Cloning disk images

You can duplicate hard disk image files on the same host to quickly produce a second virtual machine with the same operating system setup. However, you should *only* make copies of virtual disk images using the utility supplied with VirtualBox; see chapter 8.22, *VBoxManage clonehd*, page 126. This is because VirtualBox assigns a unique identity number (UUID) to each disk image, which is also stored inside the image, and VirtualBox will refuse to work with two images that use the same number. If you do accidentally try to reimport a disk image which you copied normally, you can make a second copy using VirtualBox's utility and import that instead.

Note that newer Linux distributions identify the boot hard disk from the ID of the drive. The ID VirtualBox reports for a drive is determined from the UUID of the virtual disk image. So if you clone a disk image and try to boot the copied image the guest might not be able to determine its own boot disk as the UUID changed. In this case you have to adapt the disk ID in your boot loader script (for example `/boot/grub/menu.lst`). The disk ID looks like this:

```
scsi-SATA_VBOX_HARDDISK_VB5cfdb1e2-c251e503
```

The ID for the copied image can be determined with

```
hdparm -i /dev/sda
```

5.7 Host I/O caching

Starting with version 3.2, VirtualBox can optionally disable the I/O caching that the host operating system would otherwise perform on disk image files.

Traditionally, VirtualBox has opened disk image files as normal files, which results in them being cached by the host operating system like any other file. The main advantage of this is speed: when the guest OS writes to disk and the host OS cache uses delayed writing, the write operation can be reported as completed to the guest OS quickly while the host OS can perform the operation asynchronously. Also, when you start a VM a second time and have enough memory available for the OS to use for caching, large parts of the virtual disk may be in system memory, and the VM can access the data much faster.

Note that this applies only to image files; buffering never occurred for virtual disks residing on remote iSCSI storage, which is the more common scenario in enterprise-class setups (see chapter 5.10, *iSCSI servers*, page 82).

While buffering is a useful default setting for virtualizating a few machines on a desktop computer, there are some disadvantages to this approach:

1. Delayed writing through the host OS cache is less secure. When the guest OS writes data, it considers the data written even though it has not yet arrived on a physical disk. If for some reason the write does not happen (power failure, host crash), the likelihood of data loss increases.

2. Disk image files tend to be very large. Caching them can therefore quickly use up the entire host OS cache. Depending on the efficiency of the host OS caching, this may slow down the host immensely, especially if several VMs run at the same time. For example, on Linux hosts, host caching may result in Linux delaying all writes until the host cache is nearly full and then writing out all these changes at once, possibly stalling VM execution for minutes. This can result in I/O errors in the guest as I/O requests time out there.

3. Physical memory is often wasted as guest operating systems typically have their own I/O caches, which may result in the data being cached twice (in both the guest and the host caches) for little effect.

If you decide to disable host I/O caching for the above reasons, VirtualBox uses its own small cache to buffer writes, but no read caching since this is typically already performed by the guest OS. In addition, VirtualBox fully supports asynchronous I/O for its virtual SATA, SCSI and SAS controllers through multiple I/O threads.

Since asynchronous I/O is not supported by IDE controllers, for performance reasons, you may want to leave host caching enabled for your VM's virtual IDE controllers.

For this reason, VirtualBox allows you to configure whether the host I/O cache is used for each I/O controller separately. Either uncheck the "Use host I/O cache" box in the "Storage" settings for a given virtual storage controller, or use the following VBoxManage command to disable the host I/O cache for a virtual storage controller:

```
VBoxManage storagectl <vm> --name <controllername> --hostiocache off
```

See chapter 8.17, *VBoxManage storagectl*, page 123 for details.

For the above reasons also, VirtualBox now uses SATA controllers by default for new virtual machines.

5.8 Limiting bandwidth for disk images

Starting with version 4.0, VirtualBox allows for limiting the maximum bandwidth used for asynchronous I/O. Additionally it supports sharing limits through bandwidth groups for several images. It is possible to have more than one such limit.

Limits are configured through `VBoxManage`. The example below creates a bandwidth group named “Limit”, sets the limit to 20 MB/s and assigns the group to the attached disks of the VM:

```
VBoxManage bandwidthctl "VM name" --name Limit --add disk --limit 20
VBoxManage storageattach "VM name" --controller "SATA" --port 0 --device 0 --type hdd
                                   --medium disk1.vdi --bandwidthgroup Limit
VBoxManage storageattach "VM name" --controller "SATA" --port 1 --device 0 --type hdd
                                   --medium disk2.vdi --bandwidthgroup Limit
```

All disks in a group share the bandwidth limit, meaning that in the example above the bandwidth of both images combined can never exceed 20 MB/s. However if one disk doesn’t require bandwidth the other can use the remaining bandwidth of its group.

The limits for each group can be changed while the VM is running, with changes being picked up immediately. The example below changes the limit for the group created in the example above to 10 MB/s:

```
VBoxManage bandwidthctl "VM name" --name Limit --limit 10
```

5.9 CD/DVD support

The virtual CD/DVD drive(s) by default support only reading. The medium configuration is changeable at runtime. You can select between three options to provide the medium data:

- **Host Drive** defines that the guest can read from the medium in the host drive.
- **Image file** (typically an ISO file) gives the guest read-only access to the data in the image.
- **Empty** stands for a drive without an inserted medium.

Changing between the above, or changing a medium in the host drive that is accessed by a machine, or changing an image file will signal a medium change to the guest operating system, which can then react to the change (e.g. by starting an installation program).

Medium changes can be prevented by the guest, and VirtualBox reflects that by locking the host drive if appropriate. You can force a medium removal in such situations via the VirtualBox GUI or the VBoxManage command line tool. Effectively this is the equivalent of the emergency eject which many CD/DVD drives provide, with all associated side effects: the guest OS can issue error messages, just like on real hardware, and guest applications may misbehave. Use this with caution.

> **Note:** The identification string of the drive provided to the guest (which, in the guest, would be displayed by configuration tools such as the Windows Device Manager) is always “VBOX CD-ROM”, irrespective of the current configuration of the virtual drive. This is to prevent hardware detection from being triggered in the guest operating system every time the configuration is changed.

The standard CD/DVD emulation allows for reading standard data CD and DVD formats only. As an experimental feature, for additional capabilities, it is possible to give the guest direct access to the CD/DVD host drive by enabling “passthrough” mode. Depending on the host hardware, this may enable three things to work, potentially:

- CD/DVD writing from within the guest, if the host DVD drive is a CD/DVD writer;
- playing audio CDs;
- playing encrypted DVDs.

There is a “Passthrough” checkbox in the GUI dialog for configuring the media attached to a storage controller, or you can use the `--passthrough` option with `VBoxManage storageattach`; see chapter 8.16, *VBoxManage storageattach*, page 121 for details.

Even if pass-through is enabled, unsafe commands, such as updating the drive firmware, will be blocked. Video CD formats are never supported, not even in passthrough mode, and cannot be played from a virtual machine.

On Solaris hosts, pass-through requires running VirtualBox with real root permissions due to security measures enforced by the host.

5.10 iSCSI servers

iSCSI stands for “Internet SCSI” and is a standard that allows for using the SCSI protocol over Internet (TCP/IP) connections. Especially with the advent of Gigabit Ethernet, it has become affordable to attach iSCSI storage servers simply as remote hard disks to a computer network. In iSCSI terminology, the server providing storage resources is called an “iSCSI target”, while the client connecting to the server and accessing its resources is called “iSCSI initiator”.

VirtualBox can transparently present iSCSI remote storage to a virtual machine as a virtual hard disk. The guest operating system will not see any difference between a virtual disk image (VDI file) and an iSCSI target. To achieve this, VirtualBox has an integrated iSCSI initiator.

VirtualBox’s iSCSI support has been developed according to the iSCSI standard and should work with all standard-conforming iSCSI targets. To use an iSCSI target with VirtualBox, you must use the command line; see chapter 8.16, *VBoxManage storageattach*, page 121.

6 Virtual networking

As briefly mentioned in chapter 3.8, *Network settings*, page 48, VirtualBox provides up to eight virtual PCI Ethernet cards for each virtual machine. For each such card, you can individually select

1. the hardware that will be virtualized as well as
2. the virtualization mode that the virtual card will be operating in with respect to your physical networking hardware on the host.

Four of the network cards can be configured in the "Network" section of the settings dialog in the graphical user interface of VirtualBox. You can configure all eight network cards on the command line via VBoxManage modifyvm; see chapter 8.7, *VBoxManage modifyvm*, page 110.

This chapter explains the various networking settings in more detail.

6.1 Virtual networking hardware

For each card, you can individually select what kind of *hardware* will be presented to the virtual machine. VirtualBox can virtualize the following six types of networking hardware:

- AMD PCNet PCI II (Am79C970A);
- AMD PCNet FAST III (Am79C973, the default);
- Intel PRO/1000 MT Desktop (82540EM);
- Intel PRO/1000 T Server (82543GC);
- Intel PRO/1000 MT Server (82545EM);
- Paravirtualized network adapter (virtio-net).

The PCNet FAST III is the default because it is supported by nearly all operating systems out of the box, as well as the GNU GRUB boot manager. As an exception, the Intel PRO/1000 family adapters are chosen for some guest operating system types that no longer ship with drivers for the PCNet card, such as Windows Vista.

The Intel PRO/1000 MT Desktop type works with Windows Vista and later versions. The T Server variant of the Intel PRO/1000 card is recognized by Windows XP guests without additional driver installation. The MT Server variant facilitates OVF imports from other platforms.

The **"Paravirtualized network adapter (virtio-net)"** is special. If you select this, then VirtualBox does *not* virtualize common networking hardware (that is supported by common guest operating systems out of the box). Instead, VirtualBox then expects a special software interface for virtualized environments to be provided by the guest, thus avoiding the complexity of emulating networking hardware and improving network performance. Starting with version 3.1, VirtualBox provides support for the industry-standard "virtio" networking drivers, which are part of the open-source KVM project.

The "virtio" networking drivers are available for the following guest operating systems:

- Linux kernels version 2.6.25 or later can be configured to provide virtio support; some distributions also back-ported virtio to older kernels.

- For Windows 2000, XP and Vista, virtio drivers can be downloaded and installed from the KVM project web page.[1]

VirtualBox also has limited support for so-called **jumbo frames**, i.e. networking packets with more than 1500 bytes of data, provided that you use the Intel card virtualization and bridged networking. In other words, jumbo frames are not supported with the AMD networking devices; in those cases, jumbo packets will silently be dropped for both the transmit and the receive direction. Guest operating systems trying to use this feature will observe this as a packet loss, which may lead to unexpected application behavior in the guest. This does not cause problems with guest operating systems in their default configuration, as jumbo frames need to be explicitly enabled.

6.2 Introduction to networking modes

Each of the eight networking adapters can be separately configured to operate in one of the following modes:

Not attached In this mode, VirtualBox reports to the guest that a network card is present, but that there is no connection – as if no Ethernet cable was plugged into the card. This way it is possible to "pull" the virtual Ethernet cable and disrupt the connection, which can be useful to inform a guest operating system that no network connection is available and enforce a reconfiguration.

Network Address Translation (NAT) If all you want is to browse the Web, download files and view e-mail inside the guest, then this default mode should be sufficient for you, and you can safely skip the rest of this section. Please note that there are certain limitations when using Windows file sharing (see chapter 6.3.3, *NAT limitations*, page 86 for details).

Bridged networking This is for more advanced networking needs such as network simulations and running servers in a guest. When enabled, VirtualBox connects to one of your installed network cards and exchanges network packets directly, circumventing your host operating system's network stack.

Internal networking This can be used to create a different kind of software-based network which is visible to selected virtual machines, but not to applications running on the host or to the outside world.

Host-only networking This can be used to create a network containing the host and a set of virtual machines, without the need for the host's physical network interface. Instead, a virtual network interface (similar to a loopback interface) is created on the host, providing connectivity among virtual machines and the host.

Generic networking Rarely used modes share the same generic network interface, by allowing the user to select a driver which can be included with VirtualBox or be distributed in an extension pack.

At the moment there are potentially two available sub-modes:

UDP Tunnel This can be used to interconnect virtual machines running on different hosts directly, easily and transparently, over existing network infrastructure.

VDE (Virtual Distributed Ethernet) networking This option can be used to connect to a Virtual Distributed Ethernet switch on a Linux or a FreeBSD host. At the moment this needs compiling VirtualBox from sources, as the Oracle packages do not include it.

The following sections describe the available network modes in more detail.

[1] http://www.linux-kvm.org/page/WindowsGuestDrivers.

6.3 Network Address Translation (NAT)

Network Address Translation (NAT) is the simplest way of accessing an external network from a virtual machine. Usually, it does not require any configuration on the host network and guest system. For this reason, it is the default networking mode in VirtualBox.

A virtual machine with NAT enabled acts much like a real computer that connects to the Internet through a router. The "router", in this case, is the VirtualBox networking engine, which maps traffic from and to the virtual machine transparently. The disadvantage of NAT mode is that, much like a private network behind a router, the virtual machine is invisible and unreachable from the outside internet; you cannot run a server this way unless you set up port forwarding (described below).

The network frames sent out by the guest operating system are received by VirtualBox's NAT engine, which extracts the TCP/IP data and resends it using the host operating system. To an application on the host, or to another computer on the same network as the host, it looks like the data was sent by the VirtualBox application on the host, using an IP address belonging to the host. VirtualBox listens for replies to the packages sent, and repacks and resends them to the guest machine on its private network.

The virtual machine receives its network address and configuration on the private network from a DHCP server integrated into VirtualBox. The IP address thus assigned to the virtual machine is usually on a completely different network than the host. As more than one card of a virtual machine can be set up to use NAT, the first card is connected to the private network 10.0.2.0, the second card to the network 10.0.3.0 and so on. If you need to change the guest-assigned IP range for some reason, please refer to chapter 9.11, *Fine-tuning the VirtualBox NAT engine*, page 149.

6.3.1 Configuring port forwarding with NAT

As the virtual machine is connected to a private network internal to VirtualBox and invisible to the host, network services on the guest are not accessible to the host machine or to other computers on the same network. However, like a physical router, VirtualBox can make selected services available to the world outside the guest through **port forwarding.** This means that VirtualBox listens to certain ports on the host and resends all packets which arrive there to the guest, on the same or a different port.

To an application on the host or other physical (or virtual) machines on the network, it looks as though the service being proxied is actually running on the host. This also means that you cannot run the same service on the same ports on the host. However, you still gain the advantages of running the service in a virtual machine – for example, services on the host machine or on other virtual machines cannot be compromised or crashed by a vulnerability or a bug in the service, and the service can run in a different operating system than the host system.

You can set up a guest service which you wish to proxy using the command line tool `VBoxManage`; for details, please refer to chapter 8.7, *VBoxManage modifyvm*, page 110.

You will need to know which ports on the guest the service uses and to decide which ports to use on the host (often but not always you will want to use the same ports on the guest and on the host). You can use any ports on the host which are not already in use by a service. For example, to set up incoming NAT connections to an `ssh` server in the guest, use the following command:

```
VBoxManage modifyvm "VM name" --natpf1 "guestssh,tcp,,2222,,22"
```

With the above example, all TCP traffic arriving on port 2222 on any host interface will be forwarded to port 22 in the guest. The protocol name `tcp` is a mandatory attribute defining which protocol should be used for forwarding (`udp` could also be used). The name `guestssh` is purely descriptive and will be auto-generated if omitted. The number after `--natpf` denotes the network card, like in other parts of VBoxManage.

To remove this forwarding rule again, use the following command:

```
VBoxManage modifyvm "VM name" --natpf1 delete "guestssh"
```

If for some reason the guest uses a static assigned IP address not leased from the built-in DHCP server, it is required to specify the guest IP when registering the forwarding rule:

```
VBoxManage modifyvm "VM name" --natpf1 "guestssh,tcp,,2222,10.0.2.19,22"
```

This example is identical to the previous one, except that the NAT engine is being told that the guest can be found at the 10.0.2.19 address.

To forward *all* incoming traffic from a specific host interface to the guest, specify the IP of that host interface like this:

```
VBoxManage modifyvm "VM name" --natpf1 "guestssh,tcp,127.0.0.1,2222,,22"
```

This forwards all TCP traffic arriving on the localhost interface (127.0.0.1) via port 2222 to port 22 in the guest.

It is not possible to configure incoming NAT connections while the VM is running. However, you can change the settings for a VM which is currently saved (or powered off at a snapshot).

6.3.2 PXE booting with NAT

PXE booting is now supported in NAT mode. The NAT DHCP server provides a boot file name of the form `vmname.pxe` if the directory `TFTP` exists in the directory where the user's `VirtualBox.xml` file is kept. It is the responsibility of the user to provide `vmname.pxe`.

6.3.3 NAT limitations

There are four **limitations** of NAT mode which users should be aware of:

ICMP protocol limitations: Some frequently used network debugging tools (e.g. `ping` or tracerouting) rely on the ICMP protocol for sending/receiving messages. While ICMP support has been improved with VirtualBox 2.1 (`ping` should now work), some other tools may not work reliably.

Receiving of UDP broadcasts is not reliable: The guest does not reliably receive broadcasts, since, in order to save resources, it only listens for a certain amount of time after the guest has sent UDP data on a particular port. As a consequence, NetBios name resolution based on broadcasts does not always work (but WINS always works). As a workaround, you can use the numeric IP of the desired server in the `\\server\share` notation.

Protocols such as GRE are unsupported: Protocols other than TCP and UDP are not supported. This means some VPN products (e.g. PPTP from Microsoft) cannot be used. There are other VPN products which use simply TCP and UDP.

Forwarding host ports < 1024 impossible: On Unix-based hosts (e.g. Linux, Solaris, Mac OS X) it is not possible to bind to ports below 1024 from applications that are not run by `root`. As a result, if you try to configure such a port forwarding, the VM will refuse to start.

These limitations normally don't affect standard network use. But the presence of NAT has also subtle effects that may interfere with protocols that are normally working. One example is NFS, where the server is often configured to refuse connections from non-privileged ports (i.e. ports not below 1024).

6.4 Bridged networking

With bridged networking, VirtualBox uses a device driver on your *host* system that filters data from your physical network adapter. This driver is therefore called a "net filter" driver. This allows VirtualBox to intercept data from the physical network and inject data into it, effectively creating a new network interface in software. When a guest is using such a new software interface, it looks to the host system as though the guest were physically connected to the interface using a network cable: the host can send data to the guest through that interface and receive data from it. This means that you can set up routing or bridging between the guest and the rest of your network.

For this to work, VirtualBox needs a device driver on your host system. The way bridged networking works has been completely rewritten with VirtualBox 2.0 and 2.1, depending on the host operating system. From the user perspective, the main difference is that complex configuration is no longer necessary on any of the supported host operating systems.[2]

Note: Even though TAP is no longer necessary on Linux with bridged networking, you *can* still use TAP interfaces for certain advanced setups, since you can connect a VM to any host interface – which could also be a TAP interface.

To enable bridged networking, all you need to do is to open the Settings dialog of a virtual machine, go to the "Network" page and select "Bridged network" in the drop down list for the "Attached to" field. Finally, select desired host interface from the list at the bottom of the page, which contains the physical network interfaces of your systems. On a typical MacBook, for example, this will allow you to select between "en1: AirPort" (which is the wireless interface) and "en0: Ethernet", which represents the interface with a network cable.

Depending on your host operating system, the following limitations should be kept in mind:

- On **Macintosh** hosts, functionality is limited when using AirPort (the Mac's wireless networking) for bridged networking. Currently, VirtualBox supports only IPv4 over AirPort. For other protocols such as IPv6 and IPX, you must choose a wired interface.
- On **Linux** hosts, functionality is limited when using wireless interfaces for bridged networking. Currently, VirtualBox supports only IPv4 over wireless. For other protocols such as IPv6 and IPX, you must choose a wired interface.

  Also, setting the MTU to less than 1500 bytes on wired interfaces provided by the sky2 driver on the Marvell Yukon II EC Ultra Ethernet NIC is known to cause packet losses under certain conditions.
- On **Solaris** hosts, there is no support for using wireless interfaces. Filtering guest traffic using IPFilter is also not completely supported due to technical restrictions of the Solaris networking subsystem. These issues would be addressed in a future release of Solaris 11.

  With VirtualBox 2.0.4 and above, it is possible to use Crossbow Virtual Network Interfaces (VNICs) with bridged networking, but with the following caveats:

  – A VNIC cannot be shared between multiple guest network interfaces, i.e. each guest network interface must have its own, exclusive VNIC.
  – The VNIC and the guest network interface that uses the VNIC must be assigned identical MAC addresses.

[2] For Mac OS X and Solaris hosts, net filter drivers were already added in VirtualBox 2.0 (as initial support for Host Interface Networking on these platforms). With VirtualBox 2.1, net filter drivers were also added for the Windows and Linux hosts, replacing the mechanisms previously present in VirtualBox for those platforms; especially on Linux, the earlier method required creating TAP interfaces and bridges, which was complex and varied from one distribution to the next. None of this is necessary anymore. Bridged network was formerly called "Host Interface Networking" and has been renamed with version 2.2 without any change in functionality.

When using VLAN interfaces with VirtualBox, they must be named according to the PPA-hack naming scheme (e.g. “e1000g513001”), as otherwise the guest may receive packets in an unexpected format.

6.5 Internal networking

Internal Networking is similar to bridged networking in that the VM can directly communicate with the outside world. However, the “outside world” is limited to other VMs on the same host which connect to the same internal network.

Even though technically, everything that can be done using internal networking can also be done using bridged networking, there are security advantages with internal networking. In bridged networking mode, all traffic goes through a physical interface of the host system. It is therefore possible to attach a packet sniffer (such as Wireshark) to the host interface and log all traffic that goes over it. If, for any reason, you prefer two or more VMs on the same machine to communicate privately, hiding their data from both the host system and the user, bridged networking therefore is not an option.

Internal networks are created automatically as needed, i.e. there is no central configuration. Every internal network is identified simply by its name. Once there is more than one active virtual network card with the same internal network ID, the VirtualBox support driver will automatically “wire” the cards and act as a network switch. The VirtualBox support driver implements a complete Ethernet switch and supports both broadcast/multicast frames and promiscuous mode.

In order to attach a VM’s network card to an internal network, set its networking mode to “internal networking”. There are two ways to accomplish this:

- You can use a VM’s “Settings” dialog in the VirtualBox graphical user interface. In the “Networking” category of the settings dialog, select “Internal Networking” from the drop-down list of networking modes. Now select the name of an existing internal network from the drop-down below or enter a new name into the entry field.

- You can use

  ```
  VBoxManage modifyvm "VM name" --nic<x> intnet
  ```

  Optionally, you can specify a network name with the command

  ```
  VBoxManage modifyvm "VM name" --intnet<x> "network name"
  ```

  If you do not specify a network name, the network card will be attached to the network `intnet` by default.

Unless you configure the (virtual) network cards in the guest operating systems that are participating in the internal network to use static IP addresses, you may want to use the DHCP server that is built into VirtualBox to manage IP addresses for the internal network. Please see chapter 8.33, *VBoxManage dhcpserver*, page 134 for details.

As a security measure, the Linux implementation of internal networking only allows VMs running under the same user ID to establish an internal network.

6.6 Host-only networking

Host-only networking is another networking mode that was added with version 2.2 of VirtualBox. It can be thought of as a hybrid between the bridged and internal networking modes: as with bridged networking, the virtual machines can talk to each other and the host as if they were connected through a physical ethernet switch. Similarly, as with internal networking however, a physical networking interface need not be present, and the virtual machines cannot talk to the world outside the host since they are not connected to a physical networking interface.

Instead, when host-only networking is used, VirtualBox creates a new software interface on the host which then appears next to your existing network interfaces. In other words, whereas with bridged networking an existing physical interface is used to attach virtual machines to, with host-only networking a new "loopback" interface is created on the host. And whereas with internal networking, the traffic between the virtual machines cannot be seen, the traffic on the "loopback" interface on the host can be intercepted.

Host-only networking is particularly useful for preconfigured virtual appliances, where multiple virtual machines are shipped together and designed to cooperate. For example, one virtual machine may contain a web server and a second one a database, and since they are intended to talk to each other, the appliance can instruct VirtualBox to set up a host-only network for the two. A second (bridged) network would then connect the web server to the outside world to serve data to, but the outside world cannot connect to the database.

To change a virtual machine's virtual network interface to "host only" mode:

- either go to the "Network" page in the virtual machine's settings notebook in the graphical user interface and select "Host-only networking", or
- on the command line, type `VBoxManage modifyvm "VM name" --nic<x> hostonly`; see chapter 8.7, *VBoxManage modifyvm*, page 110 for details.

For host-only networking, like with internal networking, you may find the DHCP server useful that is built into VirtualBox. This can be enabled to then manage the IP addresses in the host-only network since otherwise you would need to configure all IP addresses statically.

- In the VirtualBox graphical user interface, you can configure all these items in the global settings via "File" -> "Settings" -> "Network", which lists all host-only networks which are presently in use. Click on the network name and then on the "Edit" button to the right, and you can modify the adapter and DHCP settings.
- Alternatively, you can use `VBoxManage dhcpserver` on the command line; please see chapter 8.33, *VBoxManage dhcpserver*, page 134 for details.

6.7 UDP Tunnel networking

This networking mode allows to interconnect virtual machines running on different hosts.

Technically this is done by encapsulating Ethernet frames sent or received by the guest network card into UDP/IP datagrams, and sending them over any network available to the host.

UDP Tunnel mode has three parameters:

Source UDP port The port on which the host listens. Datagrams arriving on this port from any source address will be forwarded to the receiving part of the guest network card.

Destination address IP address of the target host of the transmitted data.

Destination UDP port Port number to which the transmitted data is sent.

When interconnecting two virtual machines on two different hosts, their IP addresses must be swapped. On single host, source and destination UDP ports must be swapped.

In the following example host 1 uses the IP address 10.0.0.1 and host 2 uses IP address 10.0.0.2. Configuration via command-line:

```
VBoxManage modifyvm "VM 01 on host 1" --nic<x> generic
VBoxManage modifyvm "VM 01 on host 1" --nicgenericdrv<x> UDPTunnel
VBoxManage modifyvm "VM 01 on host 1" --nicproperty<x> dest=10.0.0.2
VBoxManage modifyvm "VM 01 on host 1" --nicproperty<x> sport=10001
VBoxManage modifyvm "VM 01 on host 1" --nicproperty<x> dport=10002
```

and

```
VBoxManage modifyvm "VM 02 on host 2" --nic<y> generic
VBoxManage modifyvm "VM 02 on host 2" --nicgenericdrv<y> UDPTunnel
VBoxManage modifyvm "VM 02 on host 2" --nicproperty<y> dest=10.0.0.1
VBoxManage modifyvm "VM 02 on host 2" --nicproperty<y> sport=10002
VBoxManage modifyvm "VM 02 on host 2" --nicproperty<y> dport=10001
```

Of course, you can always interconnect two virtual machines on the same host, by setting the destination address parameter to 127.0.0.1 on both. It will act similarly to "Internal network" in this case, however the host can see the network traffic which it could not in the normal Internal network case.

> **Note:** On Unix-based hosts (e.g. Linux, Solaris, Mac OS X) it is not possible to bind to ports below 1024 from applications that are not run by `root`. As a result, if you try to configure such a source UDP port, the VM will refuse to start.

6.8 VDE networking

Virtual Distributed Ethernet (VDE[3]) is a flexible, virtual network infrastructure system, spanning across multiple hosts in a secure way. It allows for L2/L3 switching, including spanning-tree protocol, VLANs, and WAN emulation. It is an optional part of VirtualBox which is only included in the source code.

The basic building blocks of the infrastructure are VDE switches, VDE plugs and VDE wires which inter-connect the switches.

The VirtualBox VDE driver has one parameter:

VDE network The name of the VDE network switch socket to which the VM will be connected.

The following basic example shows how to connect a virtual machine to a VDE switch:

1. Create a VDE switch:

   ```
   vde_switch -s /tmp/switch1
   ```

2. Configuration via command-line:

   ```
   VBoxManage modifyvm "VM name" --nic<x> generic
   ```

   ```
   VBoxManage modifyvm "VM name" --nicgenericdrv<x> VDE
   ```

   To connect to automatically allocated switch port, use:

   ```
   VBoxManage modifyvm "VM name" --nicproperty<x> network=/tmp/switch1
   ```

   To connect to specific switch port <n>, use:

   ```
   VBoxManage modifyvm "VM name" --nicproperty<x> network=/tmp/switch1[<n>]
   ```

   The latter option can be useful for VLANs.

3. Optionally map between VDE switch port and VLAN: (from switch CLI)

   ```
   vde$ vlan/create <VLAN>
   ```

   ```
   vde$ port/setvlan <port> <VLAN>
   ```

VDE is available on Linux and FreeBSD hosts only. It is only available if the VDE software and the VDE plugin library from the VirtualSquare project are installed on the host system. For more information on setting up VDE networks, please see the documentation accompanying the software.[4]

[3] VDE is a project developed by Renzo Davoli, Associate Professor at the University of Bologna, Italy.
[4] http://wiki.virtualsquare.org/wiki/index.php/VDE_Basic_Networking.

7 Remote virtual machines

7.1 Remote display (VRDP support)

VirtualBox can display virtual machines remotely, meaning that a virtual machine can execute on one machine even though the machine will be displayed on a second computer, and the machine will be controlled from there as well, as if the virtual machine was running on that second computer.

For maximum flexibility, starting with VirtualBox 4.0, VirtualBox implements remote machine display through a generic extension interface, the VirtualBox Remote Desktop Extension (VRDE). The base open-source VirtualBox package only provides this interface, while implementations can be supplied by third parties with VirtualBox extension packages, which must be installed separately from the base package. See chapter 1.5, *Installing VirtualBox and extension packs*, page 14 for more information.

Oracle provides support for the **VirtualBox Remote Display Protocol (VRDP)** in such a VirtualBox extension package. When this package is installed, VirtualBox versions 4.0 and later support VRDP the same way as binary (non-open-source) versions of VirtualBox before 4.0 did.

VRDP is a backwards-compatible extension to Microsoft's Remote Desktop Protocol (RDP). Typically graphics updates and audio are sent from the remote machine to the client, while keyboard and mouse events are sent back. As a result, you can use any standard RDP client to control the remote VM.

Even when the extension is installed, the VRDP server is disabled by default. It can easily be enabled on a per-VM basis either in the VirtualBox Manager in the "Display" settings (see chapter 3.5, *Display settings*, page 45) or with `VBoxManage`:

```
VBoxManage modifyvm "VM name" --vrde on
```

If you use `VBoxHeadless` (described further below), VRDP support will be automatically enabled since VBoxHeadless has no other means of output.

7.1.1 Common third-party RDP viewers

Since VRDP is backwards-compatible to RDP, you can use any standard RDP viewer to connect to such a remote virtual machine (examples follow below). For this to work, you must specify the **IP address** of your *host* system (not of the virtual machine!) as the server address to connect to, as well as the **port number** that the RDP server is using.

By default, VRDP uses TCP port `3389`. You will need to change the default port if you run more than one VRDP server, since the port can only be used by one server at a time; you might also need to change it on Windows hosts since the default port might already be used by the RDP server that is built into Windows itself. Ports 5000 through 5050 are typically not used and might be a good choice.

The port can be changed either in the "Display" settings of the graphical user interface or with `--vrdeport` option of the `VBoxManage modifyvm` command. You can specify a comma-separated list of ports or ranges of ports. Use a dash between two port numbers to specify a range. The VRDP server will bind to **one** of available ports from the specified list. For example, `VBoxManage modifyvm "VM name" --vrdeport 5000,5010-5012` will configure the server to bind to one of the ports 5000, 5010, 5011 or 5012. See chapter 8.7, *VBoxManage modifyvm*, page 110 for details.

The actual port used by a running VM can be either queried with `VBoxManage showvminfo` command or seen in the GUI on the "Runtime" tab of the "Session Information Dialog", which is accessible via the "Machine" menu of the VM window.

Here follow examples for the most common RDP viewers:

- On Windows, you can use the Microsoft Terminal Services Connector (`mstsc.exe`) that ships with Windows. You can start it by bringing up the "Run" dialog (press the Windows key and "R") and typing "mstsc". You can also find it under "Start" -> "All Programs" -> "Accessories" -> "Remote Desktop Connection". If you use the "Run" dialog, you can type in options directly:

  ```
  mstsc 1.2.3.4[:3389]
  ```

  Replace "1.2.3.4" with the host IP address, and 3389 with a different port if necessary.

  Note: When connecting to localhost in order to test the connection, the addresses `localhost` and `127.0.0.1` might not work using `mstsc.exe`. Instead, the address `127.0.0.2[:3389]` has to be used.

- On other systems, you can use the standard open-source `rdesktop` program. This ships with most Linux distributions, but VirtualBox also comes with a modified variant of rdesktop for remote USB support (see chapter 7.1.4, *Remote USB*, page 94 below).

  With rdesktop, use a command line such as the following:

  ```
  rdesktop -a 16 -N 1.2.3.4:3389
  ```

  As said for the Microsoft viewer above, replace "1.2.3.4" with the host IP address, and 3389 with a different port if necessary. The `-a 16` option requests a color depth of 16 bits per pixel, which we recommend. (For best performance, after installation of the guest operating system, you should set its display color depth to the same value). The `-N` option enables use of the NumPad keys.

- If you run the KDE desktop, you might prefer `krdc`, the KDE RDP viewer. The command line would look like this:

  ```
  krdc --window --high-quality rdp:/1.2.3.4[:3389]
  ```

  Again, replace "1.2.3.4" with the host IP address, and 3389 with a different port if necessary. The "rdp:/" bit is required with krdc to switch it into RDP mode.

- With Sun Ray thin clients you can use `uttsc`, which is part of the Sun Ray Windows Connector package. See the corresponding documentation for details.

7.1.2 VBoxHeadless, the remote desktop server

While any VM started from the VirtualBox Manager is capable of running virtual machines remotely, it is not convenient to have to run the full-fledged GUI if you never want to have VMs displayed locally in the first place. In particular, if you are running server hardware whose only purpose is to host VMs, and all your VMs are supposed to run remotely over VRDP, then it is pointless to have a graphical user interface on the server at all – especially since, on a Linux or Solaris host, the VirtualBox manager comes with dependencies on the Qt and SDL libraries. This is inconvenient if you would rather not have the X Window system on your server at all.

VirtualBox therefore comes with yet another front-end called `VBoxHeadless`, which produces no visible output on the host at all, but instead only delivers VRDP data. This front-end has no dependencies on the X Window system on Linux and Solaris hosts.[1]

To start a virtual machine with `VBoxHeadless`, you have two options:

[1] Before VirtualBox 1.6, the headless server was called `VBoxVRDP`. For the sake of backwards compatibility, the VirtualBox installation still installs an executable with that name as well.

- You can use

  ```
  VBoxManage startvm "VM name" --type headless
  ```

  The extra `--type` option causes VirtualBox to use `VBoxHeadless` as the front-end to the internal virtualization engine instead of the Qt front-end.

- The alternative is to use `VBoxHeadless` directly, as follows:

  ```
  VBoxHeadless --startvm <uuid|name>
  ```

  This way of starting the VM is preferred because you can see more detailed error messages, especially for early failures before the VM execution is started. If you have trouble with `VBoxManage startvm`, it can help greatly to start `VBoxHeadless` directly to diagnose the problem cause.

Note that when you use `VBoxHeadless` to start a VM, since the headless server has no other means of output, the VRDP server will *always* be enabled, regardless of whether you had enabled the VRDP server in the VM's settings. If this is undesirable (for example because you want to access the VM via `ssh` only), start the VM like this:

```
VBoxHeadless --startvm <uuid|name> --vrde=off
```

To have the VRDP server enabled depending on the VM configuration, as the other front-ends would, use this:

```
VBoxHeadless --startvm <uuid|name> --vrde=config
```

7.1.3 Step by step: creating a virtual machine on a headless server

The following instructions may give you an idea how to create a virtual machine on a headless server over a network connection. We will create a virtual machine, establish an RDP connection and install a guest operating system – all without having to touch the headless server. All you need is the following:

1. VirtualBox on a server machine with a supported host operating system. The VirtualBox extension pack for the VRDP server must be installed (see the previous section). For the following example, we will assume a Linux server.

2. An ISO file accessible from the server, containing the installation data for the guest operating system to install (we will assume Windows XP in the following example).

3. A terminal connection to that host through which you can access a command line (e.g. via `ssh`).

4. An RDP viewer on the remote client; see chapter 7.1.1, *Common third-party RDP viewers*, page 91 above for examples.

Note again that on the server machine, since we will only use the headless server, neither Qt nor SDL nor the X Window system will be needed.

1. On the headless server, create a new virtual machine:

   ```
   VBoxManage createvm --name "Windows XP" --ostype WindowsXP --register
   ```

   Note that if you do not specify `--register`, you will have to manually use the `registervm` command later.

   Note further that you do not need to specify `--ostype`, but doing so selects some sane default values for certain VM parameters, for example the RAM size and the type of the virtual network device. To get a complete list of supported operating systems you can use

```
VBoxManage list ostypes
```

2. Make sure the settings for this VM are appropriate for the guest operating system that we will install. For example:

   ```
   VBoxManage modifyvm "Windows XP" --memory 256 --acpi on --boot1 dvd --nic1 nat
   ```

3. Create a virtual hard disk for the VM (in this case, 10GB in size):

   ```
   VBoxManage createhd --filename "WinXP.vdi" --size 10000
   ```

4. Add an IDE Controller to the new VM:

   ```
   VBoxManage storagectl "Windows XP" --name "IDE Controller"
         --add ide --controller PIIX4
   ```

5. Set the VDI file created above as the first virtual hard disk of the new VM:

   ```
   VBoxManage storageattach "Windows XP" --storagectl "IDE Controller"
         --port 0 --device 0 --type hdd --medium "WinXP.vdi"
   ```

6. Attach the ISO file that contains the operating system installation that you want to install later to the virtual machine, so the machine can boot from it:

   ```
   VBoxManage storageattach "Windows XP" --storagectl "IDE Controller"
         --port 0 --device 1 --type dvddrive --medium /full/path/to/iso.iso
   ```

7. Start the virtual machine using VBoxHeadless:

   ```
   VBoxHeadless --startvm "Windows XP"
   ```

   If everything worked, you should see a copyright notice. If, instead, you are returned to the command line, then something went wrong.

8. On the client machine, fire up the RDP viewer and try to connect to the server (see chapter 7.1.1, *Common third-party RDP viewers*, page 91 above for how to use various common RDP viewers).

   You should now be seeing the installation routine of your guest operating system remotely in the RDP viewer.

7.1.4 Remote USB

As a special feature on top of the VRDP support, VirtualBox supports remote USB devices over the wire as well. That is, the VirtualBox guest that runs on one computer can access the USB devices of the remote computer on which the VRDP data is being displayed the same way as USB devices that are connected to the actual host. This allows for running virtual machines on a VirtualBox host that acts as a server, where a client can connect from elsewhere that needs only a network adapter and a display capable of running an RDP viewer. When USB devices are plugged into the client, the remote VirtualBox server can access them.

For these remote USB devices, the same filter rules apply as for other USB devices, as described with chapter 3.10.1, *USB settings*, page 50. All you have to do is specify “Remote” (or “Any”) when setting up these rules.

Accessing remote USB devices is only possible if the RDP client supports this extension. On Linux and Solaris hosts, the VirtualBox installation provides a suitable VRDP client called `rdesktop-vrdp`. Recent versions of `uttsc`, a client tailored for the use with Sun Ray thin clients, also support accessing remote USB devices. RDP clients for other platforms will be provided in future VirtualBox versions.

To make a remote USB device available to a VM, `rdesktop-vrdp` should be started as follows:

```
rdesktop-vrdp -r usb -a 16 -N my.host.address
```

Note that `rdesktop-vrdp` can access USB devices only through `/proc/bus/usb`. Please refer to chapter 12.6.7, *USB not working*, page 180 for further details on how to properly set up the permissions. Furthermore it is advisable to disable automatic loading of any host driver on the remote host which might work on USB devices to ensure that the devices are accessible by the RDP client. If the setup was properly done on the remote host, plug/unplug events are visible on the VBox.log file of the VM.

7.1.5 RDP authentication

For each virtual machine that is remotely accessible via RDP, you can individually determine if and how client connections are authenticated. For this, use `VBoxManage modifyvm` command with the `--vrdeauthtype` option; see chapter 8.7, *VBoxManage modifyvm*, page 110 for a general introduction. Three methods of authentication are available:

- The "null" method means that there is no authentication at all; any client can connect to the VRDP server and thus the virtual machine. This is, of course, very insecure and only to be recommended for private networks.
- The "external" method provides external authentication through a special authentication library. VirtualBox ships with two such authentication libraries:
  1. The default authentication library, `VBoxAuth`, authenticates against user credentials of the hosts. Depending on the host platform, this means:
     - On Linux hosts, `VBoxAuth.so` authenticates users against the host's PAM system.
     - On Windows hosts, `VBoxAuth.dll` authenticates users against the host's WinLogon system.
     - On Mac OS X hosts, `VBoxAuth.dylib` authenticates users against the host's directory service.[2]

     In other words, the "external" method per default performs authentication with the user accounts that exist on the host system. Any user with valid authentication credentials is accepted, i.e. the username does not have to correspond to the user running the VM.
  2. An additional library called `VBoxAuthSimple` performs authentication against credentials configured in the "extradata" section of a virtual machine's XML settings file. This is probably the simplest way to get authentication that does not depend on a running and supported guest (see below). The following steps are required:
     a) Enable `VBoxAuthSimple` with the following command:
     ```
     VBoxManage setproperty vrdeauthlibrary "VBoxAuthSimple"
     ```
     b) To enable the library for a particular VM, you must then switch authentication to external:
     ```
     VBoxManage modifyvm <vm> --vrdeauthtype external
     ```
     Replace `<vm>` with the VM name or UUID.
     c) You will then need to configure users and passwords by writing items into the machine's extradata. Since the XML machine settings file, into whose "extradata" section the password needs to be written, is a plain text file, VirtualBox uses hashes to encrypt passwords. The following command must be used:
     ```
     VBoxManage setextradata <vm> "VBoxAuthSimple/users/<user>" <hash>
     ```
     Replace `<vm>` with the VM name or UUID, `<user>` with the user name who should be allowed to log in and `<hash>` with the encrypted password. As an example, to obtain the hash value for the password "secret", you can use the following command:
     ```
     VBoxManage internalcommands passwordhash "secret"
     ```
     This will print

[2] Support for Mac OS X was added in version 3.2.

```
2bb80d537b1da3e38bd30361aa855686bde0eacd7162fef6a25fe97bf527a25b
```

You can then use VBoxManage setextradata to store this value in the machine's "extradata" section.

As example, combined together, to set the password for the user "john" and the machine "My VM" to "secret", use this command:

```
VBoxManage setextradata "My VM" "VBoxAuthSimple/users/john"
    2bb80d537b1da3e38bd30361aa855686bde0eacd7162fef6a25fe97bf527a25b
```

- Finally, the "guest" authentication method performs authentication with a special component that comes with the Guest Additions; as a result, authentication is not performed on the host, but with the *guest* user accounts.

  This method is currently still in testing and not yet supported.

In addition to the methods described above, you can replace the default "external" authentication module with any other module. For this, VirtualBox provides a well-defined interface that allows you to write your own authentication module. This is described in detail in the VirtualBox Software Development Kit (SDK) reference; please see chapter 11, *VirtualBox programming interfaces*, page 167 for details.

7.1.6 RDP encryption

RDP features data stream encryption, which is based on the RC4 symmetric cipher (with keys up to 128bit). The RC4 keys are being replaced in regular intervals (every 4096 packets).

RDP provides different authentication methods:

1. Historically, RDP4 authentication was used, with which the RDP client does not perform any checks in order to verify the identity of the server it connects to. Since user credentials can be obtained using a "man in the middle" (MITM) attack, RDP4 authentication is insecure and should generally not be used.

2. RDP5.1 authentication employs a server certificate for which the client possesses the public key. This way it is guaranteed that the server possess the corresponding private key. However, as this hard-coded private key became public some years ago, RDP5.1 authentication is also insecure.

As the client that connects to the server determines what type of encryption will be used, with rdesktop, the Linux RDP viewer, use the `-4` or `-5` options.

7.1.7 Multiple connections to the VRDP server

The VRDP server of VirtualBox supports multiple simultaneous connections to the same running VM from different clients. All connected clients see the same screen output and share a mouse pointer and keyboard focus. This is similar to several people using the same computer at the same time, taking turns at the keyboard.

The following command enables multiple connection mode:

```
VBoxManage modifyvm "VM name" --vrdemulticon on
```

7.1.8 Multiple remote monitors

To access two or more remote VM displays you have to enable the VRDP multiconnection mode (see chapter 7.1.7, *Multiple connections to the VRDP server*, page 96).

The RDP client can select the virtual monitor number to connect to using the `domain` logon parameter (`-d`). If the parameter ends with `@` followed by a number, VirtualBox interprets this

number as the screen index. The primary guest screen is selected with `@1`, the first secondary screen is `@2`, etc.

The Microsoft RDP6 client does not let you specify a separate domain name. Instead, use `domain\username` in the `Username:` field – for example, `@2\name`. `name` must be supplied, and must be the name used to log in if the VRDP server is set up to require credentials. If it is not, you may use any text as the username.

7.1.9 VRDP video redirection

Starting with VirtualBox 3.2, the VRDP server can redirect video streams from the guest to the RDP client. Video frames are compressed using the JPEG algorithm allowing a higher compression ratio than standard RDP bitmap compression methods. It is possible to increase the compression ratio by lowering the video quality.

The VRDP server automatically detects video streams in a guest as frequently updated rectangular areas. As a result, this method works with any guest operating system without having to install additional software in the guest; in particular, the Guest Additions are not required.

On the client side, however, currently only the Windows 7 Remote Desktop Connection client supports this feature. If a client does not support video redirection, the VRDP server falls back to regular bitmap updates.

The following command enables video redirection:

```
VBoxManage modifyvm "VM name" --vrdevideochannel on
```

The quality of the video is defined as a value from 10 to 100 percent, representing a JPEG compression level (where lower numbers mean lower quality but higher compression). The quality can be changed using the following command:

```
VBoxManage modifyvm "VM name" --vrdevideochannelquality 75
```

7.1.10 VRDP customization

With VirtualBox 4.0 it is possible to disable display output, mouse and keyboard input, audio, remote USB or clipboard individually in the VRDP server.

The following commands change corresponding server settings:

```
VBoxManage modifyvm "VM name" --vrdeproperty Client/DisableDisplay=1
VBoxManage modifyvm "VM name" --vrdeproperty Client/DisableInput=1
VBoxManage modifyvm "VM name" --vrdeproperty Client/DisableUSB=1
VBoxManage modifyvm "VM name" --vrdeproperty Client/DisableAudio=1
VBoxManage modifyvm "VM name" --vrdeproperty Client/DisableClipboard=1
VBoxManage modifyvm "VM name" --vrdeproperty Client/DisableUpstreamAudio=1
```

To reenable a feature use a similar command without the trailing 1. For example:

```
VBoxManage modifyvm "VM name" --vrdeproperty Client/DisableDisplay=
```

These properties were introduced with VirtualBox 3.2.10. However, in the 3.2.x series, it was necessary to use the following commands to alter these settings instead:

```
VBoxManage setextradata "VM name" "VRDP/Feature/Client/DisableDisplay" 1
VBoxManage setextradata "VM name" "VRDP/Feature/Client/DisableInput" 1
VBoxManage setextradata "VM name" "VRDP/Feature/Client/DisableUSB" 1
VBoxManage setextradata "VM name" "VRDP/Feature/Client/DisableAudio" 1
VBoxManage setextradata "VM name" "VRDP/Feature/Client/DisableClipboard" 1
```

To reenable a feature use a similar command without the trailing 1. For example:

```
VBoxManage setextradata "VM name" "VRDP/Feature/Client/DisableDisplay"
```

7.2 Teleporting

Starting with version 3.1, VirtualBox supports "teleporting" – that is, moving a virtual machine over a network from one VirtualBox host to another, while the virtual machine is running. This works regardless of the host operating system that is running on the hosts: you can teleport virtual machines between Solaris and Mac hosts, for example.

Teleporting requires that a machine be currently running on one host, which is then called the **"source"**. The host to which the virtual machine will be teleported will then be called the **"target"**; the machine on the target is then configured to wait for the source to contact the target. The machine's running state will then be transferred from the source to the target with minimal downtime.

Teleporting happens over any TCP/IP network; the source and the target only need to agree on a TCP/IP port which is specified in the teleporting settings.

At this time, there are a few prerequisites for this to work, however:

1. On the target host, you must configure a virtual machine in VirtualBox with exactly the same hardware settings as the machine on the source that you want to teleport. This does not apply to settings which are merely descriptive, such as the VM name, but obviously for teleporting to work, the target machine must have the same amount of memory and other hardware settings. Otherwise teleporting will fail with an error message.

2. The two virtual machines on the source and the target must share the same storage (hard disks as well as floppy and CD/DVD images). This means that they either use the same iSCSI targets or that the storage resides somewhere on the network and both hosts have access to it via NFS or SMB/CIFS.

   This also means that neither the source nor the target machine can have any snapshots.

Then perform the following steps:

1. On the *target* host, configure the virtual machine to wait for a teleport request to arrive when it is started, instead of actually attempting to start the machine. This is done with the following VBoxManage command:

   ```
   VBoxManage modifyvm <targetvmname> --teleporter on --teleporterport <port>
   ```

   where `<targetvmname>` is the name of the virtual machine on the target host and `<port>` is a TCP/IP port number to be used on both the source and the target hosts. For example, use 6000. For details, see chapter 8.7.5, *Teleporting settings*, page 116.

2. Start the VM on the target host. You will see that instead of actually running, it will show a progress dialog. indicating that it is waiting for a teleport request to arrive.

3. Start the machine on the *source* host as usual. When it is running and you want it to be teleported, issue the following command on the source host:

   ```
   VBoxManage controlvm <sourcevmname> teleport --host <targethost> --port <port>
   ```

   where `<sourcevmname>` is the name of the virtual machine on the source host (the machine that is currently running), `<targethost>` is the host or IP name of the target host on which the machine is waiting for the teleport request, and `<port>` must be the same number as specified in the command on the target host. For details, see chapter 8.11, *VBoxManage controlvm*, page 118.

For testing, you can also teleport machines on the same host; in that case, use "localhost" as the hostname on both the source and the target host.

Note: In rare cases, if the CPUs of the source and the target are very different, teleporting can fail with an error message, or the target may hang. This may happen especially if the VM is running application software that is highly optimized to run on a particular CPU without correctly checking that certain CPU features are actually present. VirtualBox filters what CPU capabilities are presented to the guest operating system. Advanced users can attempt to restrict these virtual CPU capabilities with the `VBoxManage --modifyvm --cpuid` command; see chapter 8.7.5, *Teleporting settings*, page 116.

8 VBoxManage

8.1 Introduction

As briefly mentioned in chapter 1.13, *Alternative front-ends*, page 28, VBoxManage is the command-line interface to VirtualBox. With it, you can completely control VirtualBox from the command line of your host operating system. VBoxManage supports all the features that the graphical user interface gives you access to, but it supports a lot more than that. It exposes really all the features of the virtualization engine, even those that cannot (yet) be accessed from the GUI.

You will need to use the command line if you want to

- use a different user interface than the main GUI (for example, VBoxSDL or the VBoxHeadless server);
- control some of the more advanced and experimental configuration settings for a VM.

There are two main things to keep in mind when using `VBoxManage`: First, `VBoxManage` must always be used with a specific "subcommand", such as "list" or "createvm" or "startvm". All the subcommands that `VBoxManage` supports are described in detail in chapter 8, *VBoxManage*, page 100.

Second, most of these subcommands require that you specify a particular virtual machine after the subcommand. There are two ways you can do this:

- You can specify the VM name, as it is shown in the VirtualBox GUI. Note that if that name contains spaces, then you must enclose the entire name in double quotes (as it is always required with command line arguments that contain spaces).

  For example:

  ```
  VBoxManage startvm "Windows XP"
  ```

- You can specify the UUID, which is the internal unique identifier that VirtualBox uses to refer to the virtual machine. Assuming that the aforementioned VM called "Windows XP" has the UUID shown below, the following command has the same effect as the previous:

  ```
  VBoxManage startvm 670e746d-abea-4ba6-ad02-2a3b043810a5
  ```

You can type `VBoxManage list vms` to have all currently registered VMs listed with all their settings, including their respective names and UUIDs.

Some typical examples of how to control VirtualBox from the command line are listed below:

- To create a new virtual machine from the command line and immediately register it with VirtualBox, use `VBoxManage createvm` with the `--register` option,[1] like this:

  ```
  $ VBoxManage createvm --name "SUSE 10.2" --register
  VirtualBox Command Line Management Interface Version 4.1.0
  (C) 2005-2011 Oracle Corporation
  All rights reserved.

  Virtual machine 'SUSE 10.2' is created.
  UUID: c89fc351-8ec6-4f02-a048-57f4d25288e5
  Settings file: '/home/username/.VirtualBox/Machines/SUSE 10.2/SUSE 10.2.xml'
  ```

[1] For details, see chapter 8.6, *VBoxManage createvm*, page 110.

As can be seen from the above output, a new virtual machine has been created with a new UUID and a new XML settings file.

- To show the configuration of a particular VM, use `VBoxManage showvminfo`; see chapter 8.4, *VBoxManage showvminfo*, page 109 for details and an example.
- To change settings while a VM is powered off, use `VBoxManage modifyvm`, e.g. as follows:

  ```
  VBoxManage modifyvm "Windows XP" --memory "512MB"
  ```

  For details, see chapter 8.7, *VBoxManage modifyvm*, page 110.
- To change the storage configuration (e.g. to add a storage controller and then a virtual disk), use `VBoxManage storagectl` and `VBoxManage storageattach`; see chapter 8.17, *VBoxManage storagectl*, page 123 and chapter 8.16, *VBoxManage storageattach*, page 121 for details.
- To control VM operation, use one of the following:
  - To start a VM that is currently powered off, use `VBoxManage startvm`; see chapter 8.10, *VBoxManage startvm*, page 118 for details.
  - To pause or save a VM that is currently running or change some of its settings, use `VBoxManage controlvm`; see chapter 8.11, *VBoxManage controlvm*, page 118 for details.

8.2 Commands overview

When running VBoxManage without parameters or when supplying an invalid command line, the below syntax diagram will be shown. Note that the output will be slightly different depending on the host platform; when in doubt, check the output of `VBoxManage` for the commands available on your particular host.

```
Usage:

VBoxManage [-v|--version]    print version number and exit
VBoxManage [-q|--nologo] ... suppress the logo

VBoxManage list [--long|-l] vms|runningvms|ostypes|hostdvds|hostfloppies|
                            bridgedifs|hostonlyifs|dhcpservers|hostinfo|
                            hostcpuids|hddbackends|hdds|dvds|floppies|
                            usbhost|usbfilters|systemproperties|extpacks

VBoxManage showvminfo       <uuid>|<name> [--details]
                            [--machinereadable]
VBoxManage showvminfo       <uuid>|<name> --log <idx>

VBoxManage registervm       <filename>

VBoxManage unregistervm     <uuid>|<name> [--delete]

VBoxManage createvm         --name <name>
                            [--ostype <ostype>]
                            [--register]
                            [--basefolder <path>]
                            [--uuid <uuid>]

VBoxManage modifyvm         <uuid|name>
                            [--name <name>]
                            [--ostype <ostype>]
                            [--memory <memorysize in MB>]
                            [--pagefusion on|off]
```

```
[--vram <vramsize in MB>]
[--acpi on|off]
[--attachpci 03:04.0]
[--attachpci 03:04.0@02:01.0]
[--detachpci 03:04.0]
[--ioapic on|off]
[--pae on|off]
[--hpet on|off]
[--hwvirtex on|off]
[--hwvirtexexcl on|off]
[--nestedpaging on|off]
[--largepages on|off]
[--vtxvpid on|off]
[--synthcpu on|off]
[--cpuidset <leaf> <eax> <ebx> <ecx> <edx>]
[--cpuidremove <leaf>]
[--cpuidremoveall]
[--hardwareuuid <uuid>]
[--cpus <number>]
[--cpuhotplug on|off]
[--plugcpu <id>]
[--unplugcpu <id>]
[--cpuexecutioncap <1-100>]
[--rtcuseutc on|off]
[--monitorcount <number>]
[--accelerate3d on|off]
[--accelerate2dvideo on|off]
[--firmware bios|efi|efi32|efi64]
[--chipset ich9|piix3]
[--bioslogofadein on|off]
[--bioslogofadeout on|off]
[--bioslogodisplaytime <msec>]
[--bioslogoimagepath <imagepath>]
[--biosbootmenu disabled|menuonly|messageandmenu]
[--biossystemtimeoffset <msec>]
[--biospxedebug on|off]
[--boot<1-4> none|floppy|dvd|disk|net>]
[--nic<1-N> none|null|nat|bridged|intnet|hostonly|
           generic]
[--nictype<1-N> Am79C970A|Am79C973|
                82540EM|82543GC|82545EM|
                virtio]
[--cableconnected<1-N> on|off]
[--nictrace<1-N> on|off]
[--nictracefile<1-N> <filename>]
[--nicproperty<1-N> name=[value]]
[--nicspeed<1-N> <kbps>]
[--nicbootprio<1-N> <priority>]
[--nicpromisc<1-N> deny|allow-vms|allow-all]
[--nicbandwidthgroup<1-N> none|<name>]
[--bridgeadapter<1-N> none|<devicename>]
[--hostonlyadapter<1-N> none|<devicename>]
[--intnet<1-N> <network name>]
[--natnet<1-N> <network>|default]
[--nicgenericdrv<1-N> <driver>
[--natsettings<1-N> [<mtu>],[<socksnd>],
                    [<sockrcv>],[<tcpsnd>],
                    [<tcprcv>]]
[--natpf<1-N> [<rulename>],tcp|udp,[<hostip>],
              <hostport>,[<guestip>],<guestport>]
[--natpf<1-N> delete <rulename>]
[--nattftpprefix<1-N> <prefix>]
[--nattftpfile<1-N> <file>]
[--nattftpserver<1-N> <ip>]
[--natbindip<1-N> <ip>
[--natdnspassdomain<1-N> on|off]
[--natdnsproxy<1-N> on|off]
```

```
                        [--natdnshostresolver<1-N> on|off]
                        [--nataliasmode<1-N> default|[log],[proxyonly],
                                             [sameports]]
                        [--macaddress<1-N> auto|<mac>]
                        [--mouse ps2|usb|usbtablet
                        [--keyboard ps2|usb
                        [--uart<1-N> off|<I/O base> <IRQ>]
                        [--uartmode<1-N> disconnected|
                                         server <pipe>|
                                         client <pipe>|
                                         file <file>|
                                         <devicename>]
                        [--guestmemoryballoon <balloonsize in MB>]
                        [--gueststatisticsinterval <seconds>]
                        [--audio none|null|dsound|solaudio|oss|alsa|pulse|
                                 oss|pulse|coreaudio]
                        [--audiocontroller ac97|hda|sb16]
                        [--clipboard disabled|hosttoguest|guesttohost|
                                     bidirectional]
                        [--vrde on|off]
                        [--vrdeextpack default|<name>
                        [--vrdeproperty <name=[value]>]
                        [--vrdeport <hostport>]
                        [--vrdeaddress <hostip>]
                        [--vrdeauthtype null|external|guest]
                        [--vrdeauthlibrary default|<name>
                        [--vrdemulticon on|off]
                        [--vrdereusecon on|off]
                        [--vrdevideochannel on|off]
                        [--vrdevideochannelquality <percent>]
                        [--usb on|off]
                        [--usbehci on|off]
                        [--snapshotfolder default|<path>]
                        [--teleporter on|off]
                        [--teleporterport <port>]
                        [--teleporteraddress <address|empty>
                        [--teleporterpassword <password>]

VBoxManage clonevm      <uuid>|<name>
                        [--snapshot <uuid>|<name>]
                        [--mode machine|machineandchilds|all]
                        [--options keepallmacs|keepnatmacs]
                        [--name <name>]
                        [--basefolder <basefolder>]
                        [--uuid <uuid>]
                        [--register]

VBoxManage import       <ovf/ova> [--dry-run|-n] [more options]
                        (run with -n to have options displayed
                         for a particular OVF)

VBoxManage export       <machines> --output|-o <ovf/ova>
                        [--legacy09]
                        [--manifest]
                        [--vsys <number of virtual system>]
                                [--product <product name>]
                                [--producturl <product url>]
                                [--vendor <vendor name>]
                                [--vendorurl <vendor url>]
                                [--version <version info>]
                                [--eula <license text>]
                                [--eulafile <filename>]

VBoxManage startvm      <uuid>|<name>
                        [--type gui|sdl|headless]

VBoxManage controlvm    <uuid>|<name>
```

```
                          pause|resume|reset|poweroff|savestate|
                          acpipowerbutton|acpisleepbutton|
                          keyboardputscancode <hex> [<hex> ...]|
                          setlinkstate<1-N> on|off |
                          nic<1-N> null|nat|bridged|intnet|hostonly|generic
                                   [<devicename>] |
                          nictrace<1-N> on|off
                          nictracefile<1-N> <filename>
                          nicproperty<1-N> name=[value]
                          natpf<1-N> [<rulename>],tcp|udp,[<hostip>],
                                       <hostport>,[<guestip>],<guestport>
                          natpf<1-N> delete <rulename>
                          guestmemoryballoon <balloonsize in MB>]
                          gueststatisticsinterval <seconds>]
                          usbattach <uuid>|<address> |
                          usbdetach <uuid>|<address> |
                          vrde on|off |
                          vrdeport <port> |
                          vrdeproperty <name=[value]> |
                          vrdevideochannelquality <percent>
                          setvideomodehint <xres> <yres> <bpp> [display] |
                          screenshotpng <file> [display] |
                          setcredentials <username> <password> <domain>
                                        [--allowlocallogon <yes|no>] |
                          teleport --host <name> --port <port>
                                 [--maxdowntime <msec>] [--password password]
                          plugcpu <id>
                          unplugcpu <id>
                          cpuexecutioncap <1-100>

VBoxManage discardstate   <uuid>|<name>

VBoxManage adoptstate     <uuid>|<name> <state_file>

VBoxManage snapshot       <uuid>|<name>
                          take <name> [--description <desc>] [--pause] |
                          delete <uuid>|<name> |
                          restore <uuid>|<name> |
                          restorecurrent |
                          edit <uuid>|<name>|--current
                               [--name <name>]
                               [--description <desc>] |
                          showvminfo <uuid>|<name>

VBoxManage closemedium    disk|dvd|floppy <uuid>|<filename>
                          [--delete]

VBoxManage storageattach  <uuid|vmname>
                          --storagectl <name>
                          --port <number>
                          --device <number>
                          [--type dvddrive|hdd|fdd]
                          [--medium none|emptydrive|
                                    <uuid>|<filename>|host:<drive>|iscsi]
                          [--mtype normal|writethrough|immutable|shareable|
                                   readonly|multiattach]
                          [--comment <text>]
                          [--setuuid <uuid>]
                          [--setparentuuid <uuid>]
                          [--passthrough on|off]
                          [--tempeject on|off]
                          [--bandwidthgroup <name>]
                          [--forceunmount]
                          [--server <name>|<ip>]
                          [--target <target>]
                          [--port <port>]
                          [--lun <lun>]
```

```
                            [--encodedlun <lun>]
                            [--username <username>]
                            [--password <password>]
                            [--intnet]

VBoxManage storagectl       <uuid|vmname>
                            --name <name>
                            [--add ide|sata|scsi|floppy|sas]
                            [--controller LSILogic|LSILogicSAS|BusLogic|
                                          IntelAHCI|PIIX3|PIIX4|ICH6|I82078]
                            [--sataideemulation<1-4> <1-30>]
                            [--sataportcount <1-30>]
                            [--hostiocache on|off]
                            [--bootable on|off]
                            [--remove]

VBoxManage bandwidthctl     <uuid|vmname>
                            --name <name>
                            [--add disk|network]
                            [--limit <megabytes per second>
                            [--delete]

VBoxManage showhdinfo       <uuid>|<filename>

VBoxManage createhd         --filename <filename>
                            --size <megabytes>|--sizebyte <bytes>
                            [--format VDI|VMDK|VHD] (default: VDI)
                            [--variant Standard,Fixed,Split2G,Stream,ESX]

VBoxManage modifyhd         <uuid>|<filename>
                            [--type normal|writethrough|immutable|shareable|
                                    readonly|multiattach]
                            [--autoreset on|off]
                            [--compact]
                            [--resize <megabytes>|--resizebyte <bytes>]

VBoxManage clonehd          <uuid>|<filename> <uuid>|<outputfile>
                            [--format VDI|VMDK|VHD|RAW|<other>]
                            [--variant Standard,Fixed,Split2G,Stream,ESX]
                            [--existing]

VBoxManage convertfromraw   <filename> <outputfile>
                            [--format VDI|VMDK|VHD]
                            [--variant Standard,Fixed,Split2G,Stream,ESX]
VBoxManage convertfromraw   stdin <outputfile> <bytes>
                            [--format VDI|VMDK|VHD]
                            [--variant Standard,Fixed,Split2G,Stream,ESX]

VBoxManage getextradata     global|<uuid>|<name>
                            <key>|enumerate

VBoxManage setextradata     global|<uuid>|<name>
                            <key>
                            [<value>] (no value deletes key)

VBoxManage setproperty      machinefolder default|<folder> |
                            vrdeauthlibrary default|<library> |
                            websrvauthlibrary default|null|<library> |
                            vrdeextpack null|<library> |
                            loghistorycount <value>

VBoxManage usbfilter        add <index,0-N>
                            --target <uuid>|<name>|global
                            --name <string>
                            --action ignore|hold (global filters only)
                            [--active yes|no] (yes)
                            [--vendorid <XXXX>] (null)
```

```
                            [--productid <XXXX>] (null)
                            [--revision <IIFF>] (null)
                            [--manufacturer <string>] (null)
                            [--product <string>] (null)
                            [--remote yes|no] (null, VM filters only)
                            [--serialnumber <string>] (null)
                            [--maskedinterfaces <XXXXXXXX>]

VBoxManage usbfilter        modify <index,0-N>
                            --target <uuid>|<name>|global
                            [--name <string>]
                            [--action ignore|hold] (global filters only)
                            [--active yes|no]
                            [--vendorid <XXXX>|""]
                            [--productid <XXXX>|""]
                            [--revision <IIFF>|""]
                            [--manufacturer <string>|""]
                            [--product <string>|""]
                            [--remote yes|no] (null, VM filters only)
                            [--serialnumber <string>|""]
                            [--maskedinterfaces <XXXXXXXX>]

VBoxManage usbfilter        remove <index,0-N>
                            --target <uuid>|<name>|global

VBoxManage sharedfolder     add <vmname>|<uuid>
                            --name <name> --hostpath <hostpath>
                            [--transient] [--readonly] [--automount]

VBoxManage sharedfolder     remove <vmname>|<uuid>
                            --name <name> [--transient]

VBoxManage guestproperty    get <vmname>|<uuid>
                            <property> [--verbose]

VBoxManage guestproperty    set <vmname>|<uuid>
                            <property> [<value> [--flags <flags>]]

VBoxManage guestproperty    enumerate <vmname>|<uuid>
                            [--patterns <patterns>]

VBoxManage guestproperty    wait <vmname>|<uuid> <patterns>
                            [--timeout <msec>] [--fail-on-timeout]

VBoxManage guestcontrol     <vmname>|<uuid>
                            exec[ute]
                            --image <path to program>
                            --username <name> --password <password>
                            [--dos2unix]
                            [--environment "<NAME>=<VALUE> [<NAME>=<VALUE>]"]
                            [--timeout <msec>] [--unix2dos] [--verbose]
                            [--wait-exit] [--wait-stdout] [--wait-stdout]
                            [--output-type=<binary>|<text>]
                            [-- [<argument1>] ... [<argumentN>]

                            copyto|cp
                            <source on host> <destination on guest>
                            --username <name> --password <password>
                            [--dryrun] [--follow] [--recursive] [--verbose]

                            createdir[ectory]|mkdir|md
                            <directory to create on guest>
                            --username <name> --password <password>
                            [--parents] [--mode <mode>] [--verbose]

                            updateadditions
                            [--source <guest additions .ISO>] [--verbose]
```

```
VBoxManage debugvm          <uuid>|<name>
                            dumpguestcore --filename <name> |
                            info <item> [args] |
                            injectnmi |
                            osdetect |
                            osinfo |
                            getregisters [--cpu <id>] <reg>|all ... |
                            setregisters [--cpu <id>] <reg>=<value> ... |
                            statistics [--reset] [--pattern <pattern>]
                            [--descriptions]

VBoxManage metrics          list [*|host|<vmname> [<metric_list>]]
                                                (comma-separated)

VBoxManage metrics          setup
                            [--period <seconds>] (default: 1)
                            [--samples <count>] (default: 1)
                            [--list]
                            [*|host|<vmname> [<metric_list>]]

VBoxManage metrics          query [*|host|<vmname> [<metric_list>]]

VBoxManage metrics          enable
                            [--list]
                            [*|host|<vmname> [<metric_list>]]

VBoxManage metrics          disable
                            [--list]
                            [*|host|<vmname> [<metric_list>]]

VBoxManage metrics          collect
                            [--period <seconds>] (default: 1)
                            [--samples <count>] (default: 1)
                            [--list]
                            [--detach]
                            [*|host|<vmname> [<metric_list>]]

VBoxManage hostonlyif       ipconfig <name>
                            [--dhcp |
                            --ip<ipv4> [--netmask<ipv4> (def: 255.255.255.0)] |
                            --ipv6<ipv6> [--netmasklengthv6<length> (def: 64)]]
                            create |
                            remove <name>

VBoxManage dhcpserver       add|modify --netname <network_name> |
                                       --ifname <hostonly_if_name>
                            [--ip <ip_address>
                            --netmask <network_mask>
                            --lowerip <lower_ip>
                            --upperip <upper_ip>]
                            [--enable | --disable]

VBoxManage dhcpserver       remove --netname <network_name> |
                                   --ifname <hostonly_if_name>

VBoxManage extpack          install <tarball> |
                            uninstall [--force] <name> |
                            cleanup
```

Each time VBoxManage is invoked, only one command can be executed. However, a command might support several subcommands which then can be invoked in one single call. The following sections provide detailed reference information on the different commands.

8.3 VBoxManage list

The `list` command gives relevant information about your system and information about VirtualBox's current settings.

The following subcommands are available with `VBoxManage list`:

- `vms` lists all virtual machines currently registered with VirtualBox. By default this displays a compact list with each VM's name and UUID; if you also specify `--long` or `-l`, this will be a detailed list as with the `showvminfo` command (see below).
- `runningvms` lists all currently running virtual machines by their unique identifiers (UUIDs) in the same format as with `vms`.
- `ostypes` lists all guest operating systems presently known to VirtualBox, along with the identifiers used to refer to them with the `modifyvm` command.
- `hostdvds`, `hostfloppies`, respectively, list DVD, floppy, bridged networking and host-only networking interfaces on the host, along with the name used to access them from within VirtualBox.
- `bridgedifs`, `hostonlyifs` and `dhcpservers`, respectively, list bridged network interfaces, host-only network interfaces and DHCP servers currently available on the host. Please see chapter 6, *Virtual networking*, page 83 for details on these.
- `hostinfo` displays information about the host system, such as CPUs, memory size and operating system version.
- `hostcpuids` dumps the CPUID parameters for the host CPUs. This can be used for a more fine grained analyis of the host's virtualization capabilities.
- `hddbackends` lists all known virtual disk back-ends of VirtualBox. For each such format (such as VDI, VMDK or RAW), this lists the back-end's capabilities and configuration.
- `hdds`, `dvds` and `floppies` all give you information about virtual disk images currently in use by VirtualBox, including all their settings, the unique identifiers (UUIDs) associated with them by VirtualBox and all files associated with them. This is the command-line equivalent of the Virtual Media Manager; see chapter 5.3, *The Virtual Media Manager*, page 74.
- `usbhost` supplies information about USB devices attached to the host, notably information useful for constructing USB filters and whether they are currently in use by the host.
- `usbfilters` lists all global USB filters registered with VirtualBox – that is, filters for devices which are accessible to all virtual machines – and displays the filter parameters.
- `systemproperties` displays some global VirtualBox settings, such as minimum and maximum guest RAM and virtual hard disk size, folder settings and the current authentication library in use.
- `extpacks` displays all VirtualBox extension packs currently installed; see chapter 1.5, *Installing VirtualBox and extension packs*, page 14 and chapter 8.34, *VBoxManage extpack*, page 135 for more information.

8.4 VBoxManage showvminfo

The `showvminfo` command shows information about a particular virtual machine. This is the same information as `VBoxManage list vms --long` would show for all virtual machines.

You will get information similar to the following:

```
$ VBoxManage showvminfo "Windows XP"
VirtualBox Command Line Management Interface Version 4.1.0
(C) 2005-2011 Oracle Corporation
All rights reserved.

Name:            Windows XP
Guest OS:        Other/Unknown
UUID:            1bf3464d-57c6-4d49-92a9-a5cc3816b7e7
Config file:     /home/username/.VirtualBox/Machines/Windows XP/Windows XP.xml
Memory size:     512MB
VRAM size:       12MB
Number of CPUs:  2
Synthetic Cpu:   off
Boot menu mode:  message and menu
Boot Device (1): DVD
Boot Device (2): HardDisk
Boot Device (3): Not Assigned
Boot Device (4): Not Assigned
ACPI:            on
IOAPIC:          on
PAE:             on
Time offset:     0 ms
Hardw. virt.ext: on
Hardw. virt.ext exclusive: on
Nested Paging:   on
VT-x VPID:       off
State:           powered off (since 2009-10-20T14:52:19.000000000)
Monitor count:   1
3D Acceleration: off
2D Video Acceleration: off
Teleporter Enabled: off
Teleporter Port: 0
Teleporter Address:
Teleporter Password:
Storage Controller      (0): IDE Controller
Storage Controller Type (0): PIIX4
Storage Controller      (1): Floppy Controller 1
Storage Controller Type (1): I82078
IDE Controller (0, 0): /home/user/windows.vdi (UUID: 46f6e53a-4557-460a-9b95-68b0f17d744b)
IDE Controller (0, 1): /home/user/openbsd-cd46.iso (UUID: 4335e162-59d3-4512-91d5-b63e94eebe0b)
Floppy Controller 1 (0, 0): /home/user/floppy.img (UUID: 62ac6ccb-df36-42f2-972e-22f836368137)
NIC 1:           disabled
NIC 2:           disabled
NIC 3:           disabled
NIC 4:           disabled
NIC 5:           disabled
NIC 6:           disabled
NIC 7:           disabled
NIC 8:           disabled
UART 1:          disabled
UART 2:          disabled
Audio:           disabled (Driver: Unknown)
Clipboard Mode:  Bidirectional
VRDE:            disabled
USB:             disabled

USB Device Filters:
<none>

Shared folders:
<none>
```

```
Statistics update:  disabled
```

8.5 VBoxManage registervm / unregistervm

The `registervm` command allows you to import a virtual machine definition in an XML file into VirtualBox. The machine must not conflict with one already registered in VirtualBox and it may not have any hard or removable disks attached. It is advisable to place the definition file in the machines folder before registering it.

> **Note:** When creating a new virtual machine with `VBoxManage createvm` (see below), you can directly specify the `--register` option to avoid having to register it separately.

The `unregistervm` command unregisters a virtual machine. If `--delete` is also specified, the following files will automatically be deleted as well:

1. all hard disk image files, including differencing files, which are used by the machine and not shared with other machines;
2. saved state files that the machine created, if any (one if the machine was in "saved" state and one for each online snapshot);
3. the machine XML file and its backups;
4. the machine log files, if any;
5. the machine directory, if it is empty after having deleted all the above.

8.6 VBoxManage createvm

This command creates a new XML virtual machine definition file.

The `--name <name>` parameter is required and must specify the name of the machine. Since this name is used by default as the file name of the settings file (with the extension `.xml`) and the machine folder (a subfolder of the `.VirtualBox/Machines` folder), it must conform to your host operating system's requirements for file name specifications. If the VM is later renamed, the file and folder names will change automatically.

However, if the `--basefolder <path>` option is used, the machine folder will be named `<path>`. In this case, the names of the file and the folder will not change if the virtual machine is renamed.

By default, this command only creates the XML file without automatically registering the VM with your VirtualBox installation. To register the VM instantly, use the optional `--register` option, or run `VBoxManage registervm` separately afterwards.

8.7 VBoxManage modifyvm

This command changes the properties of a registered virtual machine which is not running. Most of the properties that this command makes available correspond to the VM settings that VirtualBox graphical user interface displays in each VM's "Settings" dialog; these were described in chapter 3, *Configuring virtual machines*, page 39. Some of the more advanced settings, however, are only available through the `VBoxManage` interface.

These commands require that the machine is powered off (neither running nor in "saved" state). Some machine settings can also be changed while a machine is running; those settings

will then have a corresponding subcommand with the `VBoxManage controlvm` subcommand (see chapter 8.11, *VBoxManage controlvm*, page 118).

8.7.1 General settings

The following general settings are available through `VBoxManage modifyvm`:

- `--name <name>`: This changes the VM's name and possibly renames the internal virtual machine files, as described with `VBoxManage createvm` above.
- `--ostype <ostype>`: This specifies what guest operating system is supposed to run in the VM. To learn about the various identifiers that can be used here, use `VBoxManage list ostypes`.
- `--memory <memorysize>`: This sets the amount of RAM, in MB, that the virtual machine should allocate for itself from the host. See the remarks in chapter 1.7, *Creating your first virtual machine*, page 16 for more information.
- `--vram <vramsize>`: This sets the amount of RAM that the virtual graphics card should have. See chapter 3.5, *Display settings*, page 45 for details.
- `--acpi on|off`; `--ioapic on|off`: These two determine whether the VM should have ACPI and I/O APIC support, respectively; see chapter 3.4.1, *"Motherboard" tab*, page 43 for details.
- `--hardwareuuid <uuid>`: The UUID presented to the guest via memory tables (DMI/SMBIOS), hardware and guest properties. By default this is the same as the VM uuid. Useful when cloning a VM. Teleporting takes care of this automatically.
- `--cpus <cpucount>`: This sets the number of virtual CPUs for the virtual machine (see chapter 3.4.2, *"Processor" tab*, page 44). If CPU hot-plugging is enabled (see below), this then sets the *maximum* number of virtual CPUs that can be plugged into the virtual machines.
- `--rtcuseutc on|off`: This option lets the real-time clock (RTC) operate in UTC time (see chapter 3.4.1, *"Motherboard" tab*, page 43).
- `--cpuhotplug on|off`: This enables CPU hot-plugging. When enabled, virtual CPUs can be added to and removed from a virtual machine while it is running. See chapter 9.5, *CPU hot-plugging*, page 142 for more information.
- `--plugcpu|unplugcpu <id>`: If CPU hot-plugging is enabled (see above), this adds a virtual CPU to the virtual machines (or removes one). `<id>` specifies the index of the virtual CPU to be added or removed and must be a number from 0 to the maximum no. of CPUs configured with the `--cpus` option. CPU 0 can never be removed.
- `--cpuexecutioncap <1-100>`: This setting controls how much cpu time a virtual CPU can use. A value of 50 implies a single virtual CPU can use up to 50% of a single host CPU.
- `--synthcpu on|off`: This setting determines whether VirtualBox will expose a synthetic CPU to the guest to allow live migration between host systems that differ significantly.
- `--pae on|off`: This enables/disables PAE (see chapter 3.4.2, *"Processor" tab*, page 44).
- `--hpet on|off`: This enables/disables a High Precision Event Timer (HPET) which can replace the legacy system timers. This is turned off by default. Note that Windows supports a HPET only from Vista onwards.

- `--hwvirtex on|off`: This enables or disables the use of hardware virtualization extensions (Intel VT-x or AMD-V) in the processor of your host system; see chapter 10.3, *Hardware vs. software virtualization*, page 161.

- `--hwvirtexexcl on|off`: This specifies whether VirtualBox will make exclusive use of the hardware virtualization extensions (Intel VT-x or AMD-V) in the processor of your host system; see chapter 10.3, *Hardware vs. software virtualization*, page 161. If you wish to simultaneously share these extensions with other hypervisors, then you must disable this setting. Doing so has negative performance implications.

- `--nestedpaging on|off`: If hardware virtualization is enabled, this additional setting enables or disables the use of the nested paging feature in the processor of your host system; see chapter 10.3, *Hardware vs. software virtualization*, page 161.

- `--largepages on|off`: If hardware virtualization *and* nested paging are enabled, for Intel VT-x only, an additional performance improvement of up to 5% can be obtained by enabling this setting. This causes the hypervisor to use large pages to reduce TLB use and overhead.

- `--vtxvpid on|off`: If hardware virtualization is enabled, for Intel VT-x only, this additional setting enables or disables the use of the tagged TLB (VPID) feature in the processor of your host system; see chapter 10.3, *Hardware vs. software virtualization*, page 161.

- `--accelerate3d on|off`: This enables, if the Guest Additions are installed, whether hardware 3D acceleration should be available; see chapter 4.4.1, *Hardware 3D acceleration (OpenGL and Direct3D 8/9)*, page 64.

- You can influence the BIOS logo that is displayed when a virtual machine starts up with a number of settings. Per default, a VirtualBox logo is displayed.

  With `--bioslogofadein on|off` and `--bioslogofadeout on|off`, you can determine whether the logo should fade in and out, respectively.

  With `--bioslogodisplaytime <msec>` you can set how long the logo should be visible, in milliseconds.

  With `--bioslogoimagepath <imagepath>` you can, if you are so inclined, replace the image that is shown, with your own logo. The image must be an uncompressed 256 color BMP file.

- `--biosbootmenu disabled|menuonly|messageandmenu`: This specifies whether the BIOS allows the user to select a temporary boot device. `menuonly` suppresses the message, but the user can still press F12 to select a temporary boot device.

- `--boot<1-4> none|floppy|dvd|disk|net`: This specifies the boot order for the virtual machine. There are four "slots", which the VM will try to access from 1 to 4, and for each of which you can set a device that the VM should attempt to boot from.

- `--snapshotfolder default|<path>`: This allows you to specify the folder in which snapshots will be kept for a virtual machine.

- `--firmware efi|bios`: Specifies which firmware is used to boot particular virtual machine: EFI or BIOS. Use EFI only if your fully understand what you're doing.

- `--guestmemoryballoon <size>` sets the default size of the guest memory balloon, that is, memory allocated by the VirtualBox Guest Additions from the guest operating system and returned to the hypervisor for re-use by other virtual machines. <size> must be specified in megabytes. The default size is 0 megabytes. For details, see chapter 4.8.1, *Memory ballooning*, page 69.

8.7.2 Networking settings

The following networking settings are available through `VBoxManage modifyvm`. With all these settings, the decimal number directly following the option name ("1-N" in the list below) specifies the virtual network adapter whose settings should be changed.

- `--nic<1-N> none|null|nat|bridged|intnet|hostonly|generic` : With this, you can set, for each of the VM's virtual network cards, what type of networking should be available. They can be not present (`none`), not connected to the host (`null`), use network address translation (`nat`), bridged networking (`bridged`) or communicate with other virtual machines using internal networking (`intnet`), host-only networking (`hostonly`), or access rarely used sub-modes (`generic`). These options correspond to the modes which are described in detail in chapter 6.2, *Introduction to networking modes*, page 84.

- `--nictype<1-N> Am79C970A|Am79C973|82540EM|82543GC|82545EM|virtio`: This allows you, for each of the VM's virtual network cards, to specify which networking hardware VirtualBox presents to the guest; see chapter 6.1, *Virtual networking hardware*, page 83.

- `--cableconnected<1-N> on|off`: This allows you to temporarily disconnect a virtual network interface, as if a network cable had been pulled from a real network card. This might be useful for resetting certain software components in the VM.

- With the "nictrace" options, you can optionally trace network traffic by dumping it to a file, for debugging purposes.

  With `--nictrace<1-N> on|off`, you can enable network tracing for a particular virtual network card.

  If enabled, you must specify with `--nictracefile<1-N> <filename>` what file the trace should be logged to.

- `--bridgeadapter<1-N> none|<devicename>`: If bridged networking has been enabled for a virtual network card (see the `--nic` option above; otherwise this setting has no effect), use this option to specify which host interface the given virtual network interface will use. For details, please see chapter 6.4, *Bridged networking*, page 87.

- `--hostonlyadapter<1-N> none|<devicename>`: If host-only networking has been enabled for a virtual network card (see the –nic option above; otherwise this setting has no effect), use this option to specify which host-only networking interface the given virtual network interface will use. For details, please see chapter 6.6, *Host-only networking*, page 88.

- `--intnet<1-N> network`: If internal networking has been enabled for a virtual network card (see the `--nic` option above; otherwise this setting has no effect), use this option to specify the name of the internal network (see chapter 6.5, *Internal networking*, page 88).

- `--macaddress<1-N> auto|<mac>`: With this option you can set the MAC address of the virtual network card. Normally, each virtual network card is assigned a random address by VirtualBox at VM creation.

- `--nicgenericdrv<1-N> <backend driver>`: If generic networking has been enabled for a virtual network card (see the `--nic` option above; otherwise this setting has no effect), this mode allows you to access rarely used networking sub-modes, such as VDE network or UDP Tunnel.

- `--nicproperty<1-N> <paramname>="paramvalue"`: This option, in combination with "nicgenericdrv" allows you to pass parameters to rarely-used network backends.

  Those parameters are backend engine-specific, and are different between UDP Tunnel and the VDE backend drivers. For example, please see chapter 6.7, *UDP Tunnel networking*, page 89.

8.7.2.1 NAT Networking settings.

The following NAT networking settings are available through `VBoxManage modifyvm`. With all these settings, the decimal number directly following the option name ("1-N" in the list below) specifies the virtual network adapter whose settings should be changed.

- `--natpf<1-N> [<name>],tcp|udp,[<hostip>],<hostport>,[<guestip>], <guestport>`: This option defines a NAT port-forwarding rule (please see chapter 6.3.1, *Configuring port forwarding with NAT*, page 85 for details).
- `--natpf<1-N> delete <name>`: This option deletes a NAT port-forwarding rule (please see chapter 6.3.1, *Configuring port forwarding with NAT*, page 85 for details).
- `--nattftpprefix<1-N> <prefix>`: This option defines a prefix for the built-in TFTP server, i.e. where the boot file is located (please see chapter 6.3.2, *PXE booting with NAT*, page 86 and chapter 9.11.2, *Configuring the boot server (next server) of a NAT network interface*, page 150 for details).
- `--nattftpfile<1-N> <bootfile>`: This option defines the TFT boot file (please see chapter 9.11.2, *Configuring the boot server (next server) of a NAT network interface*, page 150 for details).
- `--nattftpserver<1-N> <tftpserver>`: This option defines the TFTP server address to boot from (please see chapter 9.11.2, *Configuring the boot server (next server) of a NAT network interface*, page 150 for details).
- `--natdnspassdomain<1-N> on|off`: This option specifies whether the built-in DHCP server passes the domain name for network name resolution.
- `--natdnsproxy<1-N> on|off`: This option makes the NAT engine proxy all guest DNS requests to the host's DNS servers (please see chapter 9.11.5, *Enabling DNS proxy in NAT mode*, page 150 for details).
- `--natdnshostresolver<1-N> on|off`: This option makes the NAT engine use the host's resolver mechanisms to handle DNS requests (please see chapter 9.11.5, *Enabling DNS proxy in NAT mode*, page 150 for details).
- `--natnatsettings<1-N> [<mtu>],[<socksnd>],[<sockrcv>],[<tcpsnd>], [<tcprcv>]`: This option controls several NAT settings (please see chapter 9.11.3, *Tuning TCP/IP buffers for NAT*, page 150 for details).
- `--nataliasmode<1-N> default|[log],[proxyonly],[sameports]`: This option defines behaviour of NAT engine core: log - enables logging, proxyonly - switches of aliasing mode makes NAT transparent, sameports enforces NAT engine to send packets via the same port as they originated on, default - disable all mentioned modes above . (please see chapter 9.11.7, *Configuring aliasing of the NAT engine*, page 151 for details).

8.7.3 Serial port, audio, clipboard, remote desktop and USB settings

The following other hardware settings are available through `VBoxManage modifyvm`:

- `--uart<1-N> off|<I/O base> <IRQ>`: With this option you can configure virtual serial ports for the VM; see chapter 3.9, *Serial ports*, page 48 for an introduction.
- `--uartmode<1-N> <arg>`: This setting controls how VirtualBox connects a given virtual serial port (previously configured with the `--uartX` setting, see above) to the host on which the virtual machine is running. As described in detail in chapter 3.9, *Serial ports*, page 48, for each such port, you can specify `<arg>` as one of the following options:

  - `disconnected`: Even though the serial port is shown to the guest, it has no "other end" – like a real COM port without a cable.
  - `server <pipename>`: On a Windows host, this tells VirtualBox to create a named pipe on the host named `<pipename>` and connect the virtual serial device to it. Note that Windows requires that the name of a named pipe begin with `\\.\pipe\`.

    On a Linux host, instead of a named pipe, a local domain socket is used.
  - `client <pipename>`: This operates just like `server ...`, except that the pipe (or local domain socket) is not created by VirtualBox, but assumed to exist already.
  - `<devicename>`: If, instead of the above, the device name of a physical hardware serial port of the host is specified, the virtual serial port is connected to that hardware port. On a Windows host, the device name will be a COM port such as `COM1`; on a Linux host, the device name will look like `/dev/ttyS0`. This allows you to "wire" a real serial port to a virtual machine.

- `--audio none|null|oss`: With this option, you can set whether the VM should have audio support.

- `--clipboard disabled|hosttoguest|guesttohost|bidirectional`: With this setting, you can select whether the guest operating system's clipboard should be shared with the host; see chapter 3.3, *General settings*, page 42. This requires that the Guest Additions be installed in the virtual machine.

- `--monitorcount <count>`: This enables multi-monitor support; see chapter 3.5, *Display settings*, page 45.

- `--usb on|off`: This option enables or disables the VM's virtual USB controller; see chapter 3.10.1, *USB settings*, page 50 for details.

- `--usbehci on|off`: This option enables or disables the VM's virtual USB 2.0 controller; see chapter 3.10.1, *USB settings*, page 50 for details.

8.7.4 Remote machine settings

The following settings that affect remote machine behavior are available through `VBoxManage modifyvm`:

- `--vrde on|off`: With the VirtualBox graphical user interface, this enables or disables the VirtualBox remote desktop extension (VRDE) server. Note that if you are using `VBoxHeadless` (see chapter 7.1.2, *VBoxHeadless, the remote desktop server*, page 92), VRDE is enabled by default.

- `--vrdeport default|<ports>`: A port or a range of ports the VRDE server can bind to; "default" or "0" means port 3389, the standard port for RDP. You can specify a comma-separated list of ports or ranges of ports. Use a dash between two port numbers to specify a range. The VRDE server will bind to **one** of available ports from the specified list. Only one machine can use a given port at a time. For example, the option `--vrdeport 5000,5010-5012` will tell the server to bind to one of following ports: 5000, 5010, 5011 or 5012.

- `--vrdeaddress <IP address>`: The IP address of the host network interface the VRDE server will bind to. If specified, the server will accept connections only on the specified host network interface.

- `--vrdeauthtype null|external|guest`: This allows you to choose whether and how authorization will be performed; see chapter 7.1.5, *RDP authentication*, page 95 for details.

- `--vrdemulticon on|off`: This enables multiple connections to the same VRDE server, if the server supports this feature; see chapter 7.1.7, *Multiple connections to the VRDP server*, page 96.
- `--vrdereusecon on|off`: This specifies the VRDE server behavior when multiple connections are disabled. When this option is enabled, the server will allow a new client to connect and will drop the existing connection. When this option is disabled (this is the default setting), a new connection will not be accepted if there is already a client connected to the server.
- `--vrdevideochannel on|off`: This enables video redirection, if it is supported by the VRDE server; see chapter 7.1.9, *VRDP video redirection*, page 97.
- `--vrdevideochannelquality <percent>`: Sets the image quality for video redirection; see chapter 7.1.9, *VRDP video redirection*, page 97.

8.7.5 Teleporting settings

With the following commands for `VBoxManage modifyvm` you can configure a machine to be a target for teleporting. See chapter 7.2, *Teleporting*, page 98 for an introduction.

- `--teleporter on|off`: With this setting you turn on or off whether a machine waits for a teleporting request to come in on the network when it is started. If "on", when the machine is started, it does not boot the virtual machine as it would normally; instead, it then waits for a teleporting request to come in on the port and address listed with the next two parameters.
- `--teleporterport <port>`, `--teleporteraddress <address>`: these must be used with –teleporter and tell the virtual machine on which port and address it should listen for a teleporting request from another virtual machine. `<port>` can be any free TCP/IP port number (e.g. 6000); `<address>` can be any IP address or hostname and specifies the TCP/IP socket to bind to. The default is "0.0.0.0", which means any address.
- `--teleporterpassword <password>`: if this optional argument is given, then the teleporting request will only succeed if the source machine specifies the same password as the one given with this command.

> **Note:** Currently, the password is stored without encryption (i.e. in clear text) in the XML machine configuration file.

- `--cpuid <leaf> <eax> <ebx> <ecx> <edx>`: Advanced users can use this command before a teleporting operation to restrict the virtual CPU capabilities that VirtualBox presents to the guest operating system. This must be run on both the source and the target machines involved in the teleporting and will then modify what the guest sees when it executes the `CPUID` machine instruction. This might help with misbehaving applications that wrongly assume that certain CPU capabilities are present. The meaning of the parameters is hardware dependent; please refer to the AMD or Intel processor manuals.

8.8 VBoxManage import

This command imports a virtual appliance in OVF format by copying the virtual disk images and creating virtual machines in VirtualBox. See chapter 1.12, *Importing and exporting virtual machines*, page 26 for an introduction to appliances.

The `import` subcommand takes at least the path name of an OVF file as input and expects the disk images, if needed, in the same directory as the OVF file. A lot of additional command-line options are supported to control in detail what is being imported and modify the import parameters, but the details depend on the content of the OVF file.

It is therefore recommended to first run the import subcommand with the `--dry-run` or `-n` option. This will then print a description of the appliance's contents to the screen how it would be imported into VirtualBox, together with the optional command-line options to influence the import behavior.

As an example, here is the screen output with a sample appliance containing a Windows XP guest:

```
VBoxManage import WindowsXp.ovf --dry-run
Interpreting WindowsXp.ovf...
OK.
Virtual system 0:
 0: Suggested OS type: "WindowsXP"
    (change with "--vsys 0 --ostype <type>"; use "list ostypes" to list all)
 1: Suggested VM name "Windows XP Professional_1"
    (change with "--vsys 0 --vmname <name>")
 3: Number of CPUs: 1
    (change with "--vsys 0 --cpus <n>")
 4: Guest memory: 956 MB (change with "--vsys 0 --memory <MB>")
 5: Sound card (appliance expects "ensoniq1371", can change on import)
    (disable with "--vsys 0 --unit 5 --ignore")
 6: USB controller
    (disable with "--vsys 0 --unit 6 --ignore")
 7: Network adapter: orig bridged, config 2, extra type=bridged
 8: Floppy
    (disable with "--vsys 0 --unit 8 --ignore")
 9: SCSI controller, type BusLogic
    (change with "--vsys 0 --unit 9 --scsitype {BusLogic|LsiLogic}";
    disable with "--vsys 0 --unit 9 --ignore")
10: IDE controller, type PIIX4
    (disable with "--vsys 0 --unit 10 --ignore")
11: Hard disk image: source image=WindowsXp.vmdk,
      target path=/home/user/disks/WindowsXp.vmdk, controller=9;channel=0
    (change controller with "--vsys 0 --unit 11 --controller <id>";
    disable with "--vsys 0 --unit 11 --ignore")
```

As you can see, the individual configuration items are numbered, and depending on their type support different command-line options. The import subcommand can be directed to ignore many such items with a `--vsys X --unit Y --ignore` option, where X is the number of the virtual system (zero unless there are several virtual system descriptions in the appliance) and Y the item number, as printed on the screen.

In the above example, Item #1 specifies the name of the target machine in VirtualBox. Items #9 and #10 specify hard disk controllers, respectively. Item #11 describes a hard disk image; in this case, the additional `--controller` option indicates which item the disk image should be connected to, with the default coming from the OVF file.

You can combine several items for the same virtual system behind the same `--vsys` option. For example, to import a machine as described in the OVF, but without the sound card and without the USB controller, and with the disk image connected to the IDE controller instead of the SCSI controller, use this:

```
VBoxManage import WindowsXp.ovf
      --vsys 0 --unit 5 --ignore --unit 6 --ignore --unit 11 --controller 10
```

8.9 VBoxManage export

This command exports one or more virtual machines from VirtualBox into a virtual appliance in OVF format, including copying their virtual disk images to compressed VMDK. See chapter 1.12, *Importing and exporting virtual machines*, page 26 for an introduction to appliances.

The `export` command is simple to use: list the machine (or the machines) that you would like to export to the same OVF file and specify the target OVF file after an additional `--output` or `-o` option. Note that the directory of the target OVF file will also receive the exported disk images in the compressed VMDK format (regardless of the original format) and should have enough disk space left for them.

Beside a simple export of a given virtual machine, you can append several product information to the appliance file. Use `--product`, `--producturl`, `--vendor`, `--vendorurl` and `--version` to specify this additional information. For legal reasons you may add a license text or the content of a license file by using the `--eula` and `--eulafile` option respectively. As with OVF import, you must use the `--vsys X` option to direct the previously mentioned options to the correct virtual machine.

For virtualization products which aren't fully compatible with the OVF standard 1.0 you can enable a OVF 0.9 legacy mode with the `--legacy09` option.

8.10 VBoxManage startvm

This command starts a virtual machine that is currently in the "Powered off" or "Saved" states.

> **Note:** This is provided for backwards compatibility only. We recommend to start virtual machines directly by running the respective front-end, as you might otherwise miss important error and state information that VirtualBox may display on the console. This is especially important for front-ends other than `VirtualBox`, our graphical user interface, because those cannot display error messages in a popup window. See chapter 7.1.2, *VBoxHeadless, the remote desktop server*, page 92 for more information.

The optional `--type` specifier determines whether the machine will be started in a window (GUI mode, which is the default) or whether the output should go through `VBoxHeadless`, with VRDE enabled or not; see chapter 7.1.2, *VBoxHeadless, the remote desktop server*, page 92 for more information. The list of types is subject to change, and it's not guaranteed that all types are accepted by any product variant.

The following values are allowed:

gui Starts a VM showing a GUI window. This is the default.

headless Starts a VM without a window for remote display only.

8.11 VBoxManage controlvm

The `controlvm` subcommand allows you to change the state of a virtual machine that is currently running. The following can be specified:

- `VBoxManage controlvm <vm> pause` temporarily puts a virtual machine on hold, without changing its state for good. The VM window will be painted in gray to indicate that the VM is currently paused. (This is equivalent to selecting the "Pause" item in the "Machine" menu of the GUI.)
- Use `VBoxManage controlvm <vm> resume` to undo a previous `pause` command. (This is equivalent to selecting the "Resume" item in the "Machine" menu of the GUI.)
- `VBoxManage controlvm <vm> reset` has the same effect on a virtual machine as pressing the "Reset" button on a real computer: a cold reboot of the virtual machine, which will restart and boot the guest operating system again immediately. The state of the VM is not saved beforehand, and data may be lost. (This is equivalent to selecting the "Reset" item in the "Machine" menu of the GUI.)

- `VBoxManage controlvm <vm> poweroff` has the same effect on a virtual machine as pulling the power cable on a real computer. Again, the state of the VM is not saved beforehand, and data may be lost. (This is equivalent to selecting the "Close" item in the "Machine" menu of the GUI or pressing the window's close button, and then selecting "Power off the machine" in the dialog.)

  After this, the VM's state will be "Powered off". From there, it can be started again; see chapter 8.10, *VBoxManage startvm*, page 118.

- `VBoxManage controlvm <vm> savestate` will save the current state of the VM to disk and then stop the VM. (This is equivalent to selecting the "Close" item in the "Machine" menu of the GUI or pressing the window's close button, and then selecting "Save the machine state" in the dialog.)

  After this, the VM's state will be "Saved". From there, it can be started again; see chapter 8.10, *VBoxManage startvm*, page 118.

- `VBoxManage controlvm <vm> teleport --hostname <name> --port <port> [--password <password>]` makes the machine the source of a teleporting operation and initiates a teleport to the given target. See chapter 7.2, *Teleporting*, page 98 for an introduction. If the optional password is specified, it must match the password that was given to the `modifyvm` command for the target machine; see chapter 8.7.5, *Teleporting settings*, page 116 for details.

A few extra options are available with `controlvm` that do not directly affect the VM's running state:

- The `setlinkstate<1-N>` operation connects or disconnects virtual network cables from their network interfaces.

- `nic<1-N> null|nat|bridged|intnet|hostonly|generic`: With this, you can set, for each of the VM's virtual network cards, what type of networking should be available. They can be not connected to the host (`null`), use network address translation (`nat`), bridged networking (`bridged`) or communicate with other virtual machines using internal networking (`intnet`) or host-only networking (`hostonly`) or access to rarely used sub-modes (`generic`). These options correspond to the modes which are described in detail in chapter 6.2, *Introduction to networking modes*, page 84.

- `usbattach` and `usbdettach` make host USB devices visible to the virtual machine on the fly, without the need for creating filters first. The USB devices can be specified by UUID (unique identifier) or by address on the host system.

  You can use `VBoxManage list usbhost` to locate this information.

- `vrde on|off` lets you enable or disable the VRDE server, if it is installed.

- `vrdeport default|<ports>` changes the port or a range of ports that the VRDE server can bind to; "default" or "0" means port 3389, the standard port for RDP. For details, see the description for the `--vrdeport` option in chapter 8.7.3, *Serial port, audio, clipboard, remote desktop and USB settings*, page 114.

- `setvideomodehint` requests that the guest system change to a particular video mode. This requires that the Guest Additions be installed, and will not work for all guest systems.

- `screenshotpng` takes a screenshot of the guest display and saves it in PNG format.

- The `setcredentials` operation is used for remote logons in Windows guests. For details, please refer to chapter 9.2, *Automated guest logons*, page 138.

- The `guestmemoryballoon` operation changes the size of the guest memory balloon, that is, memory allocated by the VirtualBox Guest Additions from the guest operating system and returned to the hypervisor for re-use by other virtual machines. This must be specified in megabytes. For details, see chapter 4.8.1, *Memory ballooning*, page 69.

- The `cpuexecutioncap <1-100>`: This operation controls how much cpu time a virtual CPU can use. A value of 50 implies a single virtual CPU can use up to 50% of a single host CPU.

8.12 VBoxManage discardstate

This command discards the saved state of a virtual machine which is not currently running, which will cause its operating system to restart next time you start it. This is the equivalent of pulling out the power cable on a physical machine, and should be avoided if possible.

8.13 VBoxManage adoptstate

If you have a saved state file (`.sav`) that is seperate from the VM configuration, you can use this command to "adopt" the file. This will change the VM to saved state and when you start it, VirtualBox will attempt to restore it from the saved state file you indicated. This command should only be used in special setups.

8.14 VBoxManage snapshot

This command is used to control snapshots from the command line. A snapshot consists of a complete copy of the virtual machine settings, copied at the time when the snapshot was taken, and optionally a virtual machine saved state file if the snapshot was taken while the machine was running. After a snapshot has been taken, VirtualBox creates differencing hard disk for each normal hard disk associated with the machine so that when a snapshot is restored, the contents of the virtual machine's virtual hard disks can be quickly reset by simply dropping the pre-existing differencing files.

The `take` operation takes a snapshot of the current state of the virtual machine. You must supply a name for the snapshot and can optionally supply a description. The new snapshot is inserted into the snapshots tree as a child of the current snapshot and then becomes the new current snapshot.

The `delete` operation deletes a snapshot (specified by name or by UUID). This can take a while to finish since the differencing images associated with the snapshot might need to be merged with their child differencing images.

The `restore` operation will restore the given snapshot (specified by name or by UUID) by resetting the virtual machine's settings and current state to that of the snapshot. The previous current state of the machine will be lost. After this, the given snapshot becomes the new "current" snapshot so that subsequent snapshots are inserted under the snapshot from which was restored.

The `restorecurrent` operation is a shortcut to restore the current snapshot (i.e. the snapshot from which the current state is derived). This subcommand is equivalent to using the "restore" subcommand with the name or UUID of the current snapshot, except that it avoids the extra step of determining that name or UUID.

With the `edit` operation, you can change the name or description of an existing snapshot.

With the `showvminfo` operation, you can view the virtual machine settings that were stored with an existing snapshot.

8.15 VBoxManage closemedium

This commands removes a hard disk, DVD or floppy image from a VirtualBox media registry.[2]

Optionally, you can request that the image be deleted. You will get appropriate diagnostics that the deletion failed, however the image will become unregistered in any case.

8.16 VBoxManage storageattach

This command attaches/modifies/removes a storage medium connected to a storage controller that was previously added with the `storagectl` command (see the previous section). The syntax is as follows:

```
VBoxManage storageattach    <uuid|vmname>
                            --storagectl <name>
                            --port <number>
                            --device <number>
                            [--type dvddrive|hdd|fdd]
                            [--medium none|emptydrive|
                                      <uuid>|<filename>|host:<drive>|iscsi]
                            [--mtype normal|writethrough|immutable|shareable]
                            [--comment <text>]
                            [--setuuid <uuid>]
                            [--setparentuuid <uuid>]
                            [--passthrough on|off]
                            [--tempeject on|off]
                            [--bandwidthgroup name|none]
                            [--forceunmount]
                            [--server <name>|<ip>]
                            [--target <target>]
                            [--port <port>]
                            [--lun <lun>]
                            [--encodedlun <lun>]
                            [--username <username>]
                            [--password <password>]
                            [--intnet]
```

A number of parameters are commonly required; the ones at the end of the list are required only for iSCSI targets (see below).

The common parameters are:

uuid|vmname The VM UUID or VM Name. Mandatory.

storagectl Name of the storage controller. Mandatory. The list of the storage controllers currently attached to a VM can be obtained with `VBoxManage showvminfo`; see chapter 8.4, *VBoxManage showvminfo*, page 109.

port The number of the storage controller's port which is to be modified. Mandatory.

device The number of the port's device which is to be modified. Mandatory.

type Define the type of the drive to which the medium is being attached/detached/modified. This argument can only be omitted if the type of medium can be determined from either the medium given with the `--medium` argument or from a previous medium attachment.

medium Specifies what is to be attached. The following values are supported:

[2] Before VirtualBox 4.0, it was necessary to call VBoxManage openmedium before a medium could be attached to a virtual machine; that call "registered" the medium with the global VirtualBox media registry. With VirtualBox 4.0 this is no longer necessary; media are added to media registries automatically. The "closemedium" call has been retained, however, to allow for explicitly removing a medium from a registry.

- "none": Any existing device should be removed from the given slot.
- "emptydrive": For a virtual DVD or floppy drive only, this makes the device slot behaves like a removeable drive into which no media has been inserted.
- If a UUID is specified, it must be the UUID of a storage medium that is already known to VirtualBox (e.g. because it has been attached to another virtual machine). See chapter 8.3, *VBoxManage list*, page 108 for how to list known media. This medium is then attached to the given device slot.
- If a filename is specified, it must be the full path of an existing disk image (ISO, RAW, VDI, VMDK or other), which is then attached to the given device slot.
- "host:<drive>": For a virtual DVD or floppy drive only, this connects the given device slot to the specified DVD or floppy drive on the host computer.
- "iscsi": For virtual hard disks only, this allows for specifying an iSCSI target. In this case, more parameters must be given; see below.

Some of the above changes, in particular for removeable media (floppies and CDs/DVDs), can be effected while a VM is running. Others (device changes or changes in hard disk device slots) require the VM to be powered off.

mtype Defines how this medium behaves with respect to snapshots and write operations. See chapter 5.4, *Special image write modes*, page 76 for details.

comment Any description that you want to have stored with this medium (optional; for example, for an iSCSI target, "Big storage server downstairs"). This is purely descriptive and not needed for the medium to function correctly.

setuuid, setparentuuid Modifies the UUID or parent UUID of a medium before attaching it to a VM. This is an expert option. Inappropriate use can make the medium unusable or lead to broken VM configurations if any other VM is referring to the same media already. The most frequently used variant is `--setuuid ""`, which assigns a new (random) UUID to an image. This is useful to resolve the duplicate UUID errors if one duplicated an image using file copy utilities.

passthrough For a virtual DVD drive only, you can enable DVD writing support (currently experimental; see chapter 5.9, *CD/DVD support*, page 81).

tempeject For a virtual DVD drive only, you can configure the behavior for guest-triggered medium eject. If this is set to "on", the eject has only temporary effects. If the VM is powered off and restarted the originally configured medium will be still in the drive.

bandwidthgroup Sets the bandwidth group to use for the given device; see chapter 5.8, *Limiting bandwidth for disk images*, page 80.

forceunmount For a virtual DVD or floppy drive only, this forcibly unmounts the DVD/CD/Floppy or mounts a new DVD/CD/Floppy even if the previous one is locked down by the guest for reading. Again, see chapter 5.9, *CD/DVD support*, page 81 for details.

When "iscsi" is used with the `--medium` parameter for iSCSI support – see chapter 5.10, *iSCSI servers*, page 82 –, additional parameters must or can be used:

server The host name or IP address of the iSCSI target; required.

target Target name string. This is determined by the iSCSI target and used to identify the storage resource; required.

port TCP/IP port number of the iSCSI service on the target (optional).

lun Logical Unit Number of the target resource (optional). Often, this value is zero.

username, password Username and password for target authentication, if required (optional).

> **Note:** Currently, username and password are stored without encryption (i.e. in clear text) in the XML machine configuration file.

intnet If specified, connect to the iSCSI target via Internal Networking. This needs further configuration which is described in chapter 9.8.3, *Access iSCSI targets via Internal Networking*, page 148.

8.17 VBoxManage storagectl

This command attaches/modifies/removes a storage controller. After this, virtual media can be attached to the controller with the `storageattach` command (see the next section).

The syntax is as follows:

```
VBoxManage storagectl       <uuid|vmname>
                            --name <name>
                            [--add <ide/sata/scsi/floppy>]
                            [--controller <LsiLogic|LSILogicSAS|BusLogic|
                                           IntelAhci|PIIX3|PIIX4|ICH6|I82078>]
                            [--sataideemulation<1-4> <1-30>]
                            [--sataportcount <1-30>]
                            [--hostiocache on|off]
                            [--bootable on|off]
                            [--remove]
```

where the parameters mean:

uuid|vmname The VM UUID or VM Name. Mandatory.

name Name of the storage controller. Mandatory.

add Define the type of the system bus to which the storage controller must be connected.

controller Allows to choose the type of chipset being emulated for the given storage controller.

sataideemulation This specifies which SATA ports should operate in IDE emulation mode. As explained in chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71, by default, this is the case for SATA ports 1-4; with this command, you can map four IDE channels to any of the 30 supported SATA ports.

sataportcount This determines how many ports the SATA controller should support.

hostiocache Configures the use of the host I/O cache for all disk images attached to this storage controller. For details, please see chapter 5.7, *Host I/O caching*, page 80.

bootable Selects whether this controller is bootable.

remove Removes the storage controller from the VM config.

8.18 VBoxManage bandwidthctl

This command creates/deletes/modifies bandwidth groups of the given virtual machine:

```
VBoxManage bandwidthctl    <uuid|vmname>
                           --name <name>
                           [--add disk
                           [--delete]
                           [--limit MB/s]
```

See chapter 5.8, *Limiting bandwidth for disk images*, page 80 for an introduction to bandwidth limits. The parameters mean:

uuid|vmname The VM UUID or VM Name. Mandatory.

name Name of the bandwidth group. Mandatory.

add Creates a new bandwdith group with the given type.

delete Deletes a bandwdith group if it isn't used anymore.

limit Sets the limit for the given group to the specified amount. Can be changed while the VM is running.

8.19 VBoxManage showhdinfo

This command shows information about a virtual hard disk image, notably its size, its size on disk, its type and the virtual machines which use it.

Note: For compatibility with earlier versions of VirtualBox, the "showvdiinfo" command is also supported and mapped internally to the "showhdinfo" command.

The disk image must be specified either by its UUID (if the medium is registered) or by its filename. Registered images can be listed by `VBoxManage list hdds` (see chapter 8.3, *VBoxManage list*, page 108 for more information). A filename must be specified as valid path, either as an absolute path or as a relative path starting from the current directory.

8.20 VBoxManage createhd

This command creates a new virtual hard disk image. The syntax is as follows:

```
VBoxManage createhd        --filename <filename>
                           --size <megabytes>
                           [--format VDI|VMDK|VHD] (default: VDI)
                           [--variant Standard,Fixed,Split2G,Stream,ESX]
```

where the parameters mean:

filename Allows to choose a file name. Mandatory.

size Allows to define the image capacity, in 1 MiB units. Mandatory.

format Allows to choose a file format for the output file different from the file format of the input file.

variant Allows to choose a file format variant for the output file. It is a comma-separated list of variant flags. Not all combinations are supported, and specifying inconsistent flags will result in an error message.

Note: For compatibility with earlier versions of VirtualBox, the "createvdi" command is also supported and mapped internally to the "createhd" command.

8.21 VBoxManage modifyhd

With the `modifyhd` command, you can change the characteristics of a disk image after it has been created:

```
VBoxManage modifyhd         <uuid>|<filename>
                            [--type normal|writethrough|immutable|shareable|
                                    readonly|multiattach]
                            [--autoreset on|off]
                            [--compact]
                            [--resize <megabytes>|--resizebyte <bytes>]
```

Note: Despite the "hd" in the subcommand name, the command works with all disk images, not only hard disks. For compatibility with earlier versions of VirtualBox, the "modifyvdi" command is also supported and mapped internally to the "modifyhd" command.

The disk image to modify must be specified either by its UUID (if the medium is registered) or by its filename. Registered images can be listed by `VBoxManage list hdds` (see chapter 8.3, *VBoxManage list*, page 108 for more information). A filename must be specified as valid path, either as an absolute path or as a relative path starting from the current directory.

The following options are available:

- With the `--type` argument, you can change the type of an existing image between the normal, immutable, write-through and other modes; see chapter 5.4, *Special image write modes*, page 76 for details.
- For immutable (differencing) hard disks only, the `--autoreset on|off` option determines whether the disk is automatically reset on every VM startup (again, see chapter 5.4, *Special image write modes*, page 76). The default is "on".
- With the `--compact` option, can be used to compact disk images, i.e. remove blocks that only contains zeroes. This will shrink a dynamically expanding image again; it will reduce the *physical* size of the image without affecting the logical size of the virtual disk. Compaction works both for base images and for diff images created as part of a snapshot.

  For this operation to be effective, it is required that free space in the guest system first be zeroed out using a suitable software tool. For Windows guests, you can use the `sdelete` tool provided by Microsoft. Execute `sdelete -c` in the guest to zero the free disk space before compressing the virtual disk image. For Linux, use the `zerofree` utility which supports ext2/ext3 filesystems.

  Please note that compacting is currently only available for VDI images. A similar effect can be achieved by zeroing out free blocks and then cloning the disk to any other dynamically expanding format. You can use this workaround until compacting is also supported for disk formats other than VDI.
- The `--resize` option allows you to change the capacity of an existing image; this adjusts the *logical* size of a virtual disk without affecting the physical size much.[3] This currently

[3] Image resizing was added with VirtualBox 4.0.

works only for expanding the capacity of VDI and VHD formats, and only for the dynamically expanding variants. For example, if you originally created a 10G disk which is now full, you can use the `--resize 15360` command to add 5 GByte more space to the virtual disk without having to create a new image and copy all data from within a virtual machine.

8.22 VBoxManage clonehd

This command duplicates a registered virtual hard disk image to a new image file with a new unique identifier (UUID). The new image can be transferred to another host system or imported into VirtualBox again using the Virtual Media Manager; see chapter 5.3, *The Virtual Media Manager*, page 74 and chapter 5.6, *Cloning disk images*, page 79. The syntax is as follows:

```
VBoxManage clonehd          <uuid>|<filename> <outputfile>
                            [--format VDI|VMDK|VHD|RAW|<other>]
                            [--variant Standard,Fixed,Split2G,Stream,ESX]
                            [--existing]
```

The disk image to clone as well as the target image must be described either by its UUIDs (if the mediums are registered) or by its filename. Registered images can be listed by `VBoxManage list hdds` (see chapter 8.3, *VBoxManage list*, page 108 for more information). A filename must be specified as valid path, either as an absolute path or as a relative path starting from the current directory.

The following options are available:

format Allow to choose a file format for the output file different from the file format of the input file.

variant Allow to choose a file format variant for the output file. It is a comma-separated list of variant flags. Not all combinations are supported, and specifying inconsistent flags will result in an error message.

existing Perform the clone operation to an already existing destination medium. Only the portion of the source medium which fits into the destination medium is copied. This means if the destination medium is smaller than the source only a part of it is copied, and if the destination medium is larger than the source the remaining part of the destination medium is unchanged.

Note: For compatibility with earlier versions of VirtualBox, the “clonevdi” command is also supported and mapped internally to the “clonehd” command.

8.23 VBoxManage convertfromraw

This command converts a raw disk image to a VirtualBox Disk Image (VDI) file. The syntax is as follows:

```
VBoxManage convertfromraw   <filename> <outputfile>
                            [--format VDI|VMDK|VHD]
                            [--variant Standard,Fixed,Split2G,Stream,ESX]
VBoxManage convertfromraw   stdin <outputfile> <bytes>
                            [--format VDI|VMDK|VHD]
                            [--variant Standard,Fixed,Split2G,Stream,ESX]
```

where the parameters mean:

format Select the disk image format to create. Default is VDI.

variant Allow to choose a file format variant for the output file. It is a comma-separated list of variant flags. Not all combinations are supported, and specifying inconsistent flags will result in an error message.

The second form forces VBoxManage to read the content for the disk image from standard input (useful for using that command in a pipe).

> **Note:** For compatibility with earlier versions of VirtualBox, the "convertdd" command is also supported and mapped internally to the "convertfromraw" command.

8.24 VBoxManage getextradata/setextradata

These commands let you attach and retrieve string data to a virtual machine or to a VirtualBox configuration (by specifying `global` instead of a virtual machine name). You must specify a key (as a text string) to associate the data with, which you can later use to retrieve it. For example:

```
VBoxManage setextradata Fedora5 installdate 2006.01.01
VBoxManage setextradata SUSE10 installdate 2006.02.02
```

would associate the string "2006.01.01" with the key installdate for the virtual machine Fedora5, and "2006.02.02" on the machine SUSE10. You could retrieve the information as follows:

```
VBoxManage getextradata Fedora5 installdate
```

which would return

```
VirtualBox Command Line Management Interface Version 4.1.0
(C) 2005-2011 Oracle Corporation
All rights reserved.

Value: 2006.01.01
```

8.25 VBoxManage setproperty

This command is used to change global settings which affect the entire VirtualBox installation. Some of these correspond to the settings in the "Global settings" dialog in the graphical user interface. The following properties are available:

machinefolder This specifies the default folder in which virtual machine definitions are kept; see chapter 10.1, *Where VirtualBox stores its files*, page 157 for details.

vrdeauthlibrary This specifies which library to use when "external" authentication has been selected for a particular virtual machine; see chapter 7.1.5, *RDP authentication*, page 95 for details.

websrvauthlibrary This specifies which library the web service uses to authenticate users. For details about the VirtualBox web service, please refer to the separate VirtualBox SDK reference (see chapter 11, *VirtualBox programming interfaces*, page 167).

vrdelibrary This specifies which library implements the VirtualBox Remote Desktop Extension.

hwvirtexenabled This selects whether or not hardware virtualization support is enabled by default.

8.26 VBoxManage usbfilter add/modify/remove

The `usbfilter` commands are used for working with USB filters in virtual machines, or global filters which affect the whole VirtualBox setup. Global filters are applied before machine-specific filters, and may be used to prevent devices from being captured by any virtual machine. Global filters are always applied in a particular order, and only the first filter which fits a device is applied. So for example, if the first global filter says to hold (make available) a particular Kingston memory stick device and the second to ignore all Kingston devices, that memory stick will be available to any machine with an appropriate filter, but no other Kingston device will.

When creating a USB filter using `usbfilter add`, you must supply three or four mandatory parameters. The index specifies the position in the list at which the filter should be placed. If there is already a filter at that position, then it and the following ones will be shifted back one place. Otherwise the new filter will be added onto the end of the list. The `target` parameter selects the virtual machine that the filter should be attached to or use "global" to apply it to all virtual machines. `name` is a name for the new filter and for global filters, `action` says whether to allow machines access to devices that fit the filter description ("hold") or not to give them access ("ignore"). In addition, you should specify parameters to filter by. You can find the parameters for devices attached to your system using `VBoxManage list usbhost`. Finally, you can specify whether the filter should be active, and for local filters, whether they are for local devices, remote (over an RDP connection) or either.

When you modify a USB filter using `usbfilter modify`, you must specify the filter by index (see the output of `VBoxManage list usbfilters` to find global filter indexes and that of `VBoxManage showvminfo` to find indexes for individual machines) and by target, which is either a virtual machine or "global". The properties which can be changed are the same as for `usbfilter add`. To remove a filter, use `usbfilter remove` and specify the index and the target.

8.27 VBoxManage sharedfolder add/remove

This command allows you to share folders on the host computer with guest operating systems. For this, the guest systems must have a version of the VirtualBox Guest Additions installed which supports this functionality.

Shared folders are described in detail in chapter 4.3, *Shared folders*, page 62.

8.28 VBoxManage guestproperty

The "guestproperty" commands allow you to get or set properties of a running virtual machine. Please see chapter 4.6, *Guest properties*, page 66 for an introduction. As explained there, guest properties are arbitrary key/value string pairs which can be written to and read from by either the guest or the host, so they can be used as a low-volume communication channel for strings, provided that a guest is running and has the Guest Additions installed. In addition, a number of values whose keys begin with "/VirtualBox/" are automatically set and maintained by the Guest Additions.

The following subcommands are available (where `<vm>`, in each case, can either be a VM name or a VM UUID, as with the other VBoxManage commands):

- `enumerate <vm> [--patterns <pattern>]`: This lists all the guest properties that are available for the given VM, including the value. This list will be very limited if the guest's service process cannot be contacted, e.g. because the VM is not running or the Guest Additions are not installed.

  If `--patterns <pattern>` is specified, it acts as a filter to only list properties that match the given pattern. The pattern can contain the following wildcard characters:

  - * (asterisk): represents any number of characters; for example, "/VirtualBox*" would match all properties beginning with "/VirtualBox".
  - ? (question mark): represents a single arbitrary character; for example, "fo?" would match both "foo" and "for".
  - | (pipe symbol): can be used to specify multiple alternative patterns; for example, "s*|t*" would match anything starting with either "s" or "t".

- get <vm>: This retrieves the value of a single property only. If the property cannot be found (e.g. because the guest is not running), this will print

  ```
  No value set!
  ```

- set <vm> <property> [<value> [--flags <flags>]]: This allows you to set a guest property by specifying the key and value. If <value> is omitted, the property is deleted. With --flags you can optionally specify additional behavior (you can combine several by separating them with commas):

  - TRANSIENT: the value will not be stored with the VM data when the VM exits;
  - TRANSRESET: the value will be deleted as soon as the VM restarts and/or exits;
  - RDONLYGUEST: the value can only be changed by the host, but the guest can only read it;
  - RDONLYHOST: reversely, the value can only be changed by the guest, but the host can only read it;
  - READONLY: a combination of the two, the value cannot be changed at all.

- wait <vm> <pattern> --timeout <timeout>: This waits for a particular value described by "pattern" to change or to be deleted or created. The pattern rules are the same as for the "enumerate" subcommand above.

8.29 VBoxManage guestcontrol

The "guestcontrol" commands allow you to control certain things inside a guest from the host. Please see chapter 4.7, *Guest control*, page 68 for an introduction.

Generally, the syntax is as follows:

```
VBoxManage guestcontrol <command>
```

The following subcommands are available (where <vm>, in each case, can either be a VM name or a VM UUID, as with the other VBoxManage commands):

- execute, which allows for executing a program/script (process) which is already installed and runnable on the guest. This command only works while a VM is up and running and has the following syntax:

  ```
  VBoxManage guestcontrol <vmname>|<uuid> exec[ute]
              <path to program>
              --username <name> --password <password>
              [--arguments "<arguments>"]
              [--environment "<NAME>=<VALUE> [<NAME>=<VALUE>]"]
              [--flags <flags>] [--timeout <msec>]
              [--verbose] [--wait-for exit,stdout,stderr||]
  ```

  where the parameters mean:

  uuid|vmname The VM UUID or VM name. Mandatory.

  path to program Absolute path and process name of process to execute in the guest, e.g. C:\Windows\System32\calc.exe

–arguments "<arguments>" One or more arguments to pass to the process being executed.

Arguments containing spaces must be enclosed in quotation marks. More than one `--arguments` at a time can be specified to keep the command line tidy.

–environment "<NAME>=<VALUE>" One or more environment variables to be set or unset.

By default, the new process in the guest will be created with the standard environment of the guest OS. This option allows for modifying that environment. To set/modify a variable, a pair of `NAME=VALUE` must be specified; to unset a certain variable, the name with no value must set, e.g. `NAME=`.

Arguments containing spaces must be enclosed in quotation marks. More than one `--environment` at a time can be specified to keep the command line tidy.

–flags <flags> Additional flags to set. This is not used at the moment.

–timeout <msec> Value (in milliseconds) that specifies the time how long the started process is allowed to run and how long VBoxManage waits for getting output from that process. If no timeout is specified, VBoxManage will wait forever until the started process ends or an error occured.

–username <name> Name of the user the process should run under. This user must exist on the guest OS.

–password <password> Password of the user account specified with `--username`. If not given, an empty password is assumed.

–verbose Tells VBoxManage to be more verbose.

–wait-for <action> Tells VBoxManage to wait for a certain action to happen and react to it. The following actions are available:

exit Waits until the process ends and outputs its exit code along with the exit reason/flags.

stdout or stderr Waits until the process ends and outputs its exit code along with the exit reason/flags. After that VBoxManage retrieves the output collected from the guest process's stdout and stderr.

Note: On Windows there are certain limitations for graphical applications; please see chapter 14, *Known limitations*, page 185 for more information.

Examples:

```
VBoxManage --nologo guestcontrol execute "My VM" "/bin/ls" --arguments "-l /usr"
          --username foo --password bar --wait-for stdout

VBoxManage --nologo guestcontrol execute "My VM" "c:\\windows\\system32\\ipconfig.exe"
          --username foo --password bar --wait-for stdout
```

Note that the double backslashes in the second example are only required on Unix hosts.

- `copyto`, which allows copying files from the host to the guest (only with installed Guest Additions 4.0 and later).

```
VBoxManage guestcontrol <vmname>|<uuid> copyto|cp
            <source on host> <destination on guest>
            --username <name> --password <password>
            [--dryrun] [--follow] [--recursive] [--verbose]
```

where the parameters mean:

uuid|vmname The VM UUID or VM name. Mandatory.

source on host Absolute path of source file(s) on host to copy over to the guest, e.g. `C:\Windows\System32\calc.exe`. This also can be a wildcard expression, e.g. `C:\Windows\System32\*.dll`

destination on guest Absolute destination path on the guest, e.g. `C:\Temp`

–username <name> Name of the user the copy process should run under. This user must exist on the guest OS.

–password <password> Password of the user account specified with `--username`. If not given, an empty password is assumed.

–dryrun Tells VBoxManage to only perform a dry run instead of really copying files to the guest.

–follow Enables following symlinks on the host's source.

–recursive Recursively copies files/directories of the specified source.

–verbose Tells VBoxManage to be more verbose.

–flags <flags> Additional flags to set. This is not used at the moment.

- `createdirectory`, which allows copying files from the host to the guest (only with installed Guest Additions 4.0 and later).

```
VBoxManage guestcontrol <vmname>|<uuid> createdir[ectory]|mkdir|md
           <directory to create on guest>
           [--username "<name>"] [--password "<password>"]
           [--parents] [--mode <mode>] [--verbose]
```

where the parameters mean:

uuid|vmname The VM UUID or VM name. Mandatory.

directory to create on guest Absolute path of directory/directories to create on guest, e.g. `D:\Foo\Bar`. Parent directories need to exist (e.g. in this example `D:\Foo`) when switch `--parents` is omitted. The specified user must have appropriate rights to create the specified directory.

–username <name> Name of the user the copy process should run under. This user must exist on the guest OS.

–password <password> Password of the user account specified with `--username`. If not given, an empty password is assumed.

–parents Also creates not yet existing parent directories of the specified directory, e.g. if the directory `D:\Foo` of `D:\Foo\Bar` does not exist yet it will be created. Without specifying `--parent` the action would have failed.

–mode <mode> Sets the permission mode of the specified directory. Only octal modes (e.g. `0755`) are supported right now.

–verbose Tells VBoxManage to be more verbose.

- `updateadditions`, which allows for updating an already installed Guest Additions version on the guest (only already installed Guest Additions 4.0 and later).

```
VBoxManage guestcontrol updateadditions <vmname>|<uuid>
           [--source "<guest additions .ISO file to use>"] [--verbose]
```

where the parameters mean:

uuid|vmname The VM UUID or VM name. Mandatory.

–source "<guest additions .ISO file to use>" Full path to an alternative VirtualBox Guest Additions .ISO file to use for the Guest Additions update.

–verbose Tells VBoxManage to be more verbose.

8.30 VBoxManage debugvm

The "debugvm" commands are for experts who want to tinker with the exact details of virtual machine execution. Like the VM debugger described in chapter 12.1.3, *The built-in VM debugger*, page 169, these commands are only useful if you are very familiar with the details of the PC architecture and how to debug software.

The subcommands of "debugvm" all operate on a running virtual machine. The following are available:

- With `dumpguestcore --filename <name>`, you can create a system dump of the running VM, which will be written into the given file. This file will have the standard ELF core format (with custom sections); see chapter 12.1.4, *VM core format*, page 171.

  This corresponds to the `writecore` command in the debugger.

- The `info` command is used to display info items relating to the VMM, device emulations and associated drivers. This command takes one or two arguments: the name of the info item, optionally followed by a string containing arguments specific to the info item. The `help` info item provides a listning of the available items and hints about any optional arguments.

  This corresponds to the `info` command in the debugger.

- The `injectnmi` command causes a non-maskable interrupt (NMI) in the guest, which might be useful for certain debugging scenarios. What happens exactly is dependent on the guest operating system, but an NMI can crash the whole guest operating system. Do not use unless you know what you're doing.

- The `osdetect` command makes the VMM's debugger facility (re-)detection the guest operation system.

  This corresponds to the `detect` command in the debugger.

- The `osinfo` command is used to display info about the operating system (OS) detected by the VMM's debugger facility.

- The `getregisters` command is used to display CPU and device registers. The command takes a list of registers, each having one of the following forms:

  - `register-set.register-name.sub-field`
  - `register-set.register-name`
  - `cpu-register-name.sub-field`
  - `cpu-register-name`
  - `all`

  The `all` form will cause all registers to be shown (no sub-fields). The registers names are case-insensitive. When requesting a CPU register the register set can be omitted, it will be selected using the value of the `--cpu` option (defaulting to 0).

- The `setregisters` command is used to change CPU and device registers. The command takes a list of register assignments, each having one of the following forms:

  - `register-set.register-name.sub-field=value`
  - `register-set.register-name=value`
  - `cpu-register-name.sub-field=value`
  - `cpu-register-name=value`

The value format should be in the same style as what `getregisters` displays, with the exception that both octal and decimal can be used instead of hexadecimal. The register naming and the default CPU register set are handled the same way as with the `getregisters` command.

- The `statistics` command can be used to display VMM statistics on the command line. The `--reset` option will reset statistics. The affected statistics can be filtered with the `--pattern` option, which accepts DOS/NT-style wildcards (`?` and `*`).

8.31 VBoxManage metrics

This command supports monitoring the usage of system resources. Resources are represented by various metrics associated with the host system or a particular VM. For example, the host system has a `CPU/Load/User` metric that shows the percentage of time CPUs spend executing in user mode over a specific sampling period.

Metric data is collected and retained internally; it may be retrieved at any time with the `VBoxManage metrics query` subcommand. The data is available as long as the background `VBoxSVC` process is alive. That process terminates shortly after all VMs and frontends have been closed.

By default no metrics are collected at all. Metrics collection does not start until `VBoxManage metrics setup` is invoked with a proper sampling interval and the number of metrics to be retained. The interval is measured in seconds. For example, to enable collecting the host processor and memory usage metrics every second and keeping the 5 most current samples, the following command can be used:

```
VBoxManage metrics setup --period 1 --samples 5 host CPU/Load,RAM/Usage
```

Metric collection can only be enabled for started VMs. Collected data and collection settings for a particular VM will disappear as soon as it shuts down. Use `VBoxManage metrics list` subcommand to see which metrics are currently available. You can also use `--list` option with any subcommand that modifies metric settings to find out which metrics were affected.

Note that the `VBoxManage metrics setup` subcommand discards all samples that may have been previously collected for the specified set of objects and metrics.

To enable or disable metrics collection without discarding the data `VBoxManage metrics enable` and `VBoxManage metrics disable` subcommands can be used. Note that these subcommands expect metrics, not submetrics, like `CPU/Load` or `RAM/Usage` as parameters. In other words enabling `CPU/Load/User` while disabling `CPU/Load/Kernel` is not supported.

The host and VMs have different sets of associated metrics. Available metrics can be listed with `VBoxManage metrics list` subcommand.

A complete metric name may include an aggregate function. The name has the following form: `Category/Metric[/SubMetric][:aggregate]`. For example, `RAM/Usage/Free:min` stands for the minimum amount of available memory over all retained data if applied to the host object.

Subcommands may apply to all objects and metrics or can be limited to one object or/and a list of metrics. If no objects or metrics are given in the parameters, the subcommands will apply to all available metrics of all objects. You may use an asterisk ("*") to explicitly specify that the command should be applied to all objects or metrics. Use "host" as the object name to limit the scope of the command to host-related metrics. To limit the scope to a subset of metrics, use a metric list with names separated by commas.

For example, to query metric data on the CPU time spent in user and kernel modes by the virtual machine named "test", you can use the following command:

```
VBoxManage metrics query test CPU/Load/User,CPU/Load/Kernel
```

The following list summarizes the available subcommands:

list This subcommand shows the parameters of the currently existing metrics. Note that VM-specific metrics are only available when a particular VM is running.

setup This subcommand sets the interval between taking two samples of metric data and the number of samples retained internally. The retained data is available for displaying with the `query` subcommand. The `--list` option shows which metrics have been modified as the result of the command execution.

enable This subcommand "resumes" data collection after it has been stopped with `disable` subcommand. Note that specifying submetrics as parameters will not enable underlying metrics. Use `--list` to find out if the command did what was expected.

disable This subcommand "suspends" data collection without affecting collection parameters or collected data. Note that specifying submetrics as parameters will not disable underlying metrics. Use `--list` to find out if the command did what was expected.

query This subcommand retrieves and displays the currently retained metric data.

> **Note:** The `query` subcommand does not remove or "flush" retained data. If you query often enough you will see how old samples are gradually being "phased out" by new samples.

collect This subcommand sets the interval between taking two samples of metric data and the number of samples retained internally. The collected data is displayed periodically until Ctrl-C is pressed unless the `--detach` option is specified. With the `--detach` option, this subcommand operates the same way as `setup` does. The `--list` option shows which metrics match the specified filter.

8.32 VBoxManage hostonlyif

With "hostonlyif" you can change the IP configuration of a host-only network interface. For a description of host-only networking, please refer to chapter 6.6, *Host-only networking*, page 88. Each host-only interface is identified by a name and can either use the internal DHCP server or a manual IP configuration (both IP4 and IP6).

8.33 VBoxManage dhcpserver

The "dhcpserver" commands allow you to control the DHCP server that is built into VirtualBox. You may find this useful when using internal or host-only networking. (Theoretically, you can enable it for a bridged network as well, but that will likely cause conflicts with other DHCP servers in your physical network.)

Use the following command line options:

- If you use internal networking for a virtual network adapter of a virtual machine, use `VBoxManage dhcpserver add --netname <network_name>`, where `<network_name>` is the same network name you used with `VBoxManage modifyvm <vmname> --intnet<X> <network_name>`.
- If you use host-only networking for a virtual network adapter of a virtual machine, use `VBoxManage dhcpserver add --ifname <hostonly_if_name>` instead, where `<hostonly_if_name>` is the same host-only interface name you used with `VBoxManage modifyvm <vmname> --hostonlyadapter<X> <hostonly_if_name>`.

Alternatively, you can also use the –netname option as with internal networks if you know the host-only network's name; you can see the names with `VBoxManage list hostonlyifs` (see chapter 8.3, *VBoxManage list*, page 108 above).

The following additional parameters are required when first adding a DHCP server:

- With `--ip`, specify the IP address of the DHCP server itself.
- With `--netmask`, specify the netmask of the network.
- With `--lowerip` and `--upperip`, you can specify the lowest and highest IP address, respectively, that the DHCP server will hand out to clients.

Finally, you must specify `--enable` or the DHCP server will be created in the disabled state, doing nothing.

After this, VirtualBox will automatically start the DHCP server for given internal or host-only network as soon as the first virtual machine which uses that network is started.

Reversely, use `VBoxManage dhcpserver remove` with the given `--netname <network_name>` or `--ifname <hostonly_if_name>` to remove the DHCP server again for the given internal or host-only network.

To modify the settings of a DHCP server created earlier with `VBoxManage dhcpserver add`, you can use `VBoxManage dhcpserver modify` for a given network or host-only interface name.

8.34 VBoxManage extpack

The "extpack" command allows you to add or remove VirtualBox extension packs, as described in chapter 1.5, *Installing VirtualBox and extension packs*, page 14.

- To add a new extension pack, use `VBoxManage extpack install <tarball>`.
- To remove a previously installed extension pack, use `VBoxManage extpack uninstall <name>`. You can use `VBoxManage list extpacks` to show the names of the extension packs which are currently installed; please see chapter 8.3, *VBoxManage list*, page 108 also. The optional `--force` parameter can be used to override the refusal of an extension pack to be uninstalled.
- The `VBoxManage extpack cleanup` command can be used to remove temporary files and directories that may have been left behind if a previous install or uninstall command failed.

9 Advanced topics

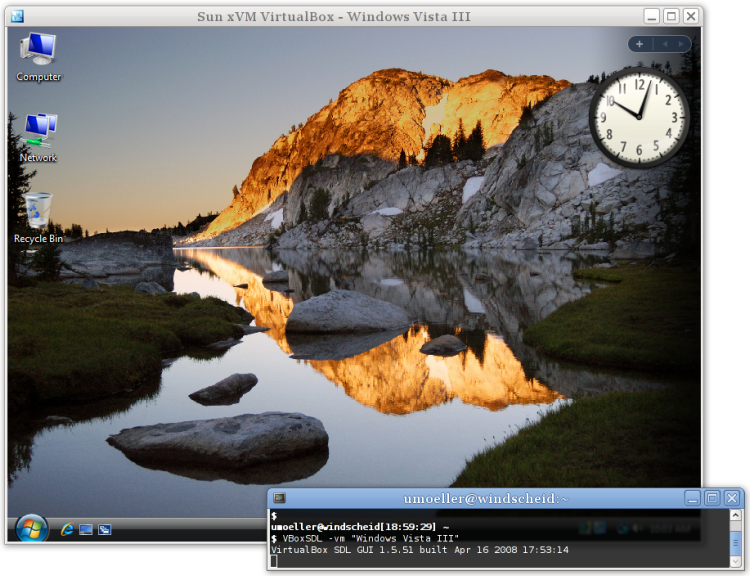
9.1 VBoxSDL, the simplified VM displayer

9.1.1 Introduction

VBoxSDL is a simple graphical user interface (GUI) that lacks the nice point-and-click support which VirtualBox, our main GUI, provides. VBoxSDL is currently primarily used internally for debugging VirtualBox and therefore not officially supported. Still, you may find it useful for environments where the virtual machines are not necessarily controlled by the same person that uses the virtual machine.

Note: VBoxSDL is not available on the Mac OS X host platform.

As you can see in the following screenshot, VBoxSDL does indeed only provide a simple window that contains only the "pure" virtual machine, without menus or other controls to click upon and no additional indicators of virtual machine activity:



To start a virtual machine with VBoxSDL instead of the VirtualBox GUI, enter the following on a command line:

```
VBoxSDL --startvm <vm>
```

where `<vm>` is, as usual with VirtualBox command line parameters, the name or UUID of an existing virtual machine.

9.1.2 Secure labeling with VBoxSDL

When running guest operating systems in fullscreen mode, the guest operating system usually has control over the whole screen. This could present a security risk as the guest operating

system might fool the user into thinking that it is either a different system (which might have a higher security level) or it might present messages on the screen that appear to stem from the host operating system.

In order to protect the user against the above mentioned security risks, the secure labeling feature has been developed. Secure labeling is currently available only for VBoxSDL. When enabled, a portion of the display area is reserved for a label in which a user defined message is displayed. The label height in set to 20 pixels in VBoxSDL. The label font color and background color can be optionally set as hexadecimal RGB color values. The following syntax is used to enable secure labeling:

```
VBoxSDL --startvm "VM name"
      --securelabel --seclabelfnt ~/fonts/arial.ttf
      --seclabelsiz 14 --seclabelfgcol 00FF00 --seclabelbgcol 00FFFF
```

In addition to enabling secure labeling, a TrueType font has to be supplied. To use another font size than 12 point use the parameter `--seclabelsiz`.

The label text can be set with

```
VBoxManage setextradata "VM name" "VBoxSDL/SecureLabel" "The Label"
```

Changing this label will take effect immediately.

Typically, full screen resolutions are limited to certain “standard” geometries such as 1024 x 768. Increasing this by twenty lines is not usually feasible, so in most cases, VBoxSDL will chose the next higher resolution, e.g. 1280 x 1024 and the guest’s screen will not cover the whole display surface. If VBoxSDL is unable to choose a higher resolution, the secure label will be painted on top of the guest’s screen surface. In order to address the problem of the bottom part of the guest screen being hidden, VBoxSDL can provide custom video modes to the guest that are reduced by the height of the label. For Windows guests and recent Solaris and Linux guests, the VirtualBox Guest Additions automatically provide the reduced video modes. Additionally, the VESA BIOS has been adjusted to duplicate its standard mode table with adjusted resolutions. The adjusted mode IDs can be calculated using the following formula:

```
reduced_modeid = modeid + 0x30
```

For example, in order to start Linux with 1024 x 748 x 16, the standard mode 0x117 (1024 x 768 x 16) is used as a base. The Linux video mode kernel parameter can then be calculated using:

```
vga = 0x200 | 0x117 + 0x30
vga = 839
```

The reason for duplicating the standard modes instead of only supplying the adjusted modes is that most guest operating systems require the standard VESA modes to be fixed and refuse to start with different modes.

When using the X.org VESA driver, custom modelines have to be calculated and added to the configuration (usually in /etc/X11/xorg.conf. A handy tool to determine modeline entries can be found at http://www.tkk.fi/Misc/Electronics/faq/vga2rgb/calc.html.)

9.1.3 Releasing modifiers with VBoxSDL on Linux

When switching from a X virtual terminal (VT) to another VT using Ctrl-Alt-Fx while the VBoxSDL window has the input focus, the guest will receive Ctrl and Alt keypress events without receiving the corresponding key release events. This is an architectural limitation of Linux. In order to reset the modifier keys, it is possible to send `SIGUSR1` to the VBoxSDL main thread (first entry in the `ps` list). For example, when switching away to another VT and saving the virtual machine from this terminal, the following sequence can be used to make sure the VM is not saved with stuck modifiers:

```
kill -usr1 <pid>
VBoxManage controlvm "Windows 2000" savestate
```

9.2 Automated guest logons

VirtualBox provides Guest Addition modules for Windows, Linux and Solaris to enable automated logons on the guest.

When a guest operating system is running in a virtual machine, it might be desirable to perform coordinated and automated logons using credentials from a master logon system. (With "credentials", we are referring to logon information consisting of user name, password and domain name, where each value might be empty.)

9.2.1 Automated Windows guest logons

Since Windows NT, Windows has provided a modular system logon subsystem ("Winlogon") which can be customized and extended by means of so-called GINA modules (Graphical Identification and Authentication). With Windows Vista and Windows 7, the GINA modules were replaced with a new mechanism called "credential providers". The VirtualBox Guest Additions for Windows come with both, a GINA and a credential provider module, and therefore enable any Windows guest to perform automated logons.

To activate the VirtualBox GINA or credential provider module, install the Guest Additions with using the command line switch `/with_autologon`. All the following manual steps required for installing these modules will be then done by the installer.

To manually install the VirtualBox GINA module, extract the Guest Additions (see chapter 4.2.1.4, *Manual file extraction*, page 56) and copy the file `VBoxGINA.dll` to the Windows `SYSTEM32` directory. Then, in the registry, create the following key:

```
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion\Winlogon\GinaDLL
```

with a value of `VBoxGINA.dll`.

> **Note:** The VirtualBox GINA module is implemented as a wrapper around the standard Windows GINA module (`MSGINA.DLL`). As a result, it will most likely not work correctly with 3rd party GINA modules.

To manually install the VirtualBox credential provider module, extract the Guest Additions (see chapter 4.2.1.4, *Manual file extraction*, page 56) and copy the file `VBoxCredProv.dll` to the Windows `SYSTEM32` directory. Then, in the registry, create the following keys:

```
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\
          Authentication\Credential Providers\{275D3BCC-22BB-4948-A7F6-3A3054EBA92B}

HKEY_CLASSES_ROOT\CLSID\{275D3BCC-22BB-4948-A7F6-3A3054EBA92B}

HKEY_CLASSES_ROOT\CLSID\{275D3BCC-22BB-4948-A7F6-3A3054EBA92B}\InprocServer32
```

with all default values (the key named `(Default)` in each key) set to `VBoxCredProv`. After that a new string named

```
HKEY_CLASSES_ROOT\CLSID\{275D3BCC-22BB-4948-A7F6-3A3054EBA92B}\InprocServer32\ThreadingModel
```

with a value of `Apartment` has to be created.

To set credentials, use the following command on a *running* VM:

```
VBoxManage controlvm "Windows XP" setcredentials "John Doe" "secretpassword" "DOMTEST"
```

While the VM is running, the credentials can be queried by the VirtualBox logon modules (GINA or credential provider) using the VirtualBox Guest Additions device driver. When Windows is in "logged out" mode, the logon modules will constantly poll for credentials and if they

are present, a logon will be attempted. After retrieving the credentials, the logon modules will erase them so that the above command will have to be repeated for subsequent logons.

For security reasons, credentials are not stored in any persistent manner and will be lost when the VM is reset. Also, the credentials are "write-only", i.e. there is no way to retrieve the credentials from the host side. Credentials can be reset from the host side by setting empty values.

Depending on the particular variant of the Windows guest, the following restrictions apply:

1. For **Windows XP guests,** the logon subsystem needs to be configured to use the classic logon dialog as the VirtualBox GINA module does not support the XP-style welcome dialog.

2. For **Windows Vista and Windows 7 guests,** the logon subsystem does not support the so-called Secure Attention Sequence (`CTRL+ALT+DEL`). As a result, the guest's group policy settings need to be changed to not use the Secure Attention Sequence. Also, the user name given is only compared to the true user name, not the user friendly name. This means that when you rename a user, you still have to supply the original user name (internally, Windows never renames user accounts).

3. Auto-logon handling of the built-in Windows Remote Desktop Service (formerly known as Terminal Services) is disabled by default. To enable it, create the registry key

   `HKEY_LOCAL_MACHINE\SOFTWARE\Oracle\VirtualBox Guest Additions\AutoLogon`

   with a `DWORD` value of `1`.

The following command forces VirtualBox to keep the credentials after they were read by the guest and on VM reset:

```
VBoxManage setextradata "Windows XP" VBoxInternal/Devices/VMMDev/0/Config/KeepCredentials 1
```

Note that this is a potential security risk as a malicious application running on the guest could request this information using the proper interface.

9.2.2 Automated Linux/Unix guest logons

Starting with version 3.2, VirtualBox provides a custom PAM module (Pluggable Authentication Module) which can be used to perform automated guest logons on platforms which support this framework. Virtually all modern Linux/Unix distributions rely on PAM.

The `pam_vbox.so` module itself **does not** do an actual verification of the credentials passed to the guest OS; instead it relies on other modules such as `pam_unix.so` or `pam_unix2.so` down in the PAM stack to do the actual validation using the credentials retrieved by `pam_vbox.so`. Therefore `pam_vbox.so` has to be on top of the authentication PAM service list.

> **Note:** The `pam_vbox.so` only supports the `auth` primitive. Other primitives such as `account`, `session` or `password` are not supported.

The `pam_vbox.so` module is shipped as part of the Guest Additions but it is not installed and/or activated on the guest OS by default. In order to install it, it has to be copied from `/opt/VBoxGuestAdditions-<version>/lib/VBoxGuestAdditions/` to the security modules directory, usually `/lib/security/` on 32-bit guest Linuxes or `/lib64/security/` on 64-bit ones. Please refer to your guest OS documentation for the correct PAM module directory.

For example, to use `pam_vbox.so` with a Ubuntu Linux guest OS and GDM (the GNOME Desktop Manager) to logon users automatically with the credentials passed by the host, the guest OS has to be configured like the following:

1. The `pam_vbox.so` module has to be copied to the security modules directory, in this case it is `/lib/security`.

2. Edit the PAM configuration file for GDM found at `/etc/pam.d/gdm`, adding the line `auth requisite pam_vbox.so` at the top. Additionaly, in most Linux distributions there is a file called `/etc/pam.d/common-auth`. This file is included in many other services (like the GDM file mentioned above). There you also have to add the line `auth requisite pam_vbox.so`.
3. If authentication against the shadow database using `pam_unix.so` or `pam_unix2.so` is desired, the argument `try_first_pass` for `pam_unix.so` or `use_first_pass` for `pam_unix2.so` is needed in order to pass the credentials from the VirtualBox module to the shadow database authentication module. For Ubuntu, this needs to be added to `/etc/pam.d/common-auth`, to the end of the line referencing `pam_unix.so`. This argument tells the PAM module to use credentials already present in the stack, i.e. the ones provided by the VirtualBox PAM module.

Warning: An incorrectly configured PAM stack can effectively prevent you from logging into your guest system!

To make deployment easier, you can pass the argument `debug` right after the `pam_vbox.so` statement. Debug log output will then be recorded using syslog.

Warning: At present, the GDM display manager only retrieves credentials at startup so unless the credentials have been supplied to the guest before GDM starts, automatic logon will not work. This limitation needs to be addressed by the GDM developers or another display manager must be used.

9.3 Advanced configuration for Windows guests

9.3.1 Automated Windows system preparation

Beginning with Windows NT 4.0, Microsoft offers a "system preparation" tool (in short: Sysprep) to prepare a Windows system for deployment or redistribution. Whereas Windows 2000 and XP ship with Sysprep on the installation medium, the tool also is available for download on the Microsoft web site. In a standard installation of Windows Vista and 7, Sysprep is already included. Sysprep mainly consists of an executable called `sysprep.exe` which is invoked by the user to put the Windows installation into preparation mode.

Starting with VirtualBox 3.2.2, the Guest Additions offer a way to launch a system preparation on the guest operating system in an automated way, controlled from the host system. To achieve that, see chapter 4.7, *Guest control*, page 68 for using the feature with the special identifier `sysprep` as the program to execute, along with the user name `sysprep` and password `sysprep` for the credentials. Sysprep then gets launched with the required system rights.

Note: Specifying the location of "sysprep.exe" is **not possible** – instead the following paths are used (based on the operating system):

- `C:\sysprep\sysprep.exe` for Windows NT 4.0, 2000 and XP
- `%WINDIR%\System32\Sysprep\sysprep.exe` for Windows Vista, 2008 Server and 7

The Guest Additions will automatically use the appropriate path to execute the system preparation tool.

9.4 Advanced configuration for Linux and Solaris guests

9.4.1 Manual setup of selected guest services on Linux

The VirtualBox Guest Additions contain several different drivers. If for any reason you do not wish to set them all up, you can install the Guest Additions using the following command:

```
sh ./VBoxLinuxAdditions.run no_setup
```

After this, you will need to at least compile the kernel modules by running the command

```
/usr/lib/VBoxGuestAdditions/vboxadd setup
```

as root (you will need to replace *lib* by *lib64* on some 64bit guests), and on older guests without the udev service you will need to add the *vboxadd* service to the default runlevel to ensure that the modules get loaded.

To setup the time synchronization service, run the command

```
/usr/lib/VBoxGuestAdditions/vboxadd-service setup
```

and add the service vboxadd-service to the default runlevel. To set up the X11 and OpenGL part of the Guest Additions, run the command

```
/usr/lib/VBoxGuestAdditions/vboxadd-x11 setup
```

(you do not need to enable any services for this).

To recompile the guest kernel modules, use this command:

```
/usr/lib/VBoxGuestAdditions/vboxadd setup
```

After compilation you should reboot your guest to ensure that the new modules are actually used.

9.4.2 Guest graphics and mouse driver setup in depth

This section assumes that you are familiar with configuring the X.Org server using xorg.conf and optionally the newer mechanisms using hal or udev and xorg.conf.d. If not you can learn about them by studying the documentation which comes with X.Org.

The VirtualBox Guest Additions come with drivers for X.Org versions

- X11R6.8/X11R6.9 and XFree86 version 4.3 (vboxvideo_drv_68.o and vboxmouse_drv_68.o)
- X11R7.0 (vboxvideo_drv_70.so and vboxmouse_drv_70.so)
- X11R7.1 (vboxvideo_drv_71.so and vboxmouse_drv_71.so)
- X.Org Server versions 1.3 and later (vboxvideo_drv_13.so and vboxmouse_drv_13.so and so on).

By default these drivers can be found in the directory
`/opt/VBoxGuestAdditions-<version>/lib/VBoxGuestAdditions`
and the correct versions for the X server are symbolically linked into the X.Org driver directories.

For graphics integration to work correctly, the X server must load the vboxvideo driver (many recent X server versions look for it automatically if they see that they are running in VirtualBox) and for an optimal user experience the guest kernel drivers must be loaded and the Guest Additions tool VBoxClient must be running as a client in the X session. For mouse integration to work correctly, the guest kernel drivers must be loaded and in addition, in X servers from X.Org X11R6.8 to X11R7.1 and in XFree86 version 4.3 the right vboxmouse driver must be loaded

and associated with /dev/mouse or /dev/psaux; in X.Org server 1.3 or later a driver for a PS/2 mouse must be loaded and the right vboxmouse driver must be associated with /dev/vboxguest.

The VirtualBox guest graphics driver can use any graphics configuration for which the virtual resolution fits into the virtual video memory allocated to the virtual machine (minus a small amount used by the guest driver) as described in chapter 3.5, *Display settings*, page 45. The driver will offer a range of standard modes at least up to the default guest resolution for all active guest monitors. In X.Org Server 1.3 and later the default mode can be changed by setting the output property VBOX_MODE to "<width>x<height>" for any guest monitor. When VBoxClient and the kernel drivers are active this is done automatically when the host requests a mode change. The driver for older versions can only receive new modes by querying the host for requests at regular intervals.

With pre-1.3 X Servers you can also add your own modes to the X server configuration file. You simply need to add them to the "Modes" list in the "Display" subsection of the "Screen" section. For example, the section shown here has a custom 2048x800 resolution mode added:

```
Section "Screen"
        Identifier    "Default Screen"
        Device        "VirtualBox graphics card"
        Monitor       "Generic Monitor"
        DefaultDepth  24
        SubSection "Display"
                Depth         24
                Modes         "2048x800" "800x600" "640x480"
        EndSubSection
EndSection
```

9.5 CPU hot-plugging

With virtual machines running modern server operating systems, VirtualBox supports CPU hot-plugging.[1] Whereas on a physical computer this would mean that a CPU can be added or removed while the machine is running, VirtualBox supports adding and removing virtual CPUs while a virtual machine is running.

CPU hot-plugging works only with guest operating systems that support it. So far this applies only to Linux and Windows Server 2008 x64 Data Center Edition. Windows supports only hot-add while Linux supports hot-add and hot-remove but to use this feature with more than 8 CPUs a 64bit Linux guest is required.

At this time, CPU hot-plugging requires using the VBoxManage command-line interface. First, hot-plugging needs to be enabled for a virtual machine:

```
VBoxManage modifyvm "VM name" --cpuhotplug on
```

After that, the –cpus option specifies the maximum number of CPUs that the virtual machine can have:

```
VBoxManage modifyvm "VM name" --cpus 8
```

When the VM is off, you can then add and remove virtual CPUs with the modifyvm –plugcpu and –unplugcpu subcommands, which take the number of the virtual CPU as a parameter, like this:

```
VBoxManage modifyvm "VM name" --plugcpu 3
VBoxManage modifyvm "VM name" --unplugcpu 3
```

Note that CPU 0 can never be removed.

While the VM is running, CPUs can be added with the `controlvm plugcpu/unplugcpu` commands instead:

[1] Support for CPU hot-plugging was introduced with VirtualBox 3.2.

```
VBoxManage controlvm "VM name" plugcpu 3
VBoxManage controlvm "VM name" unplugcpu 3
```

See chapter 8.7, *VBoxManage modifyvm*, page 110 and chapter 8.11, *VBoxManage controlvm*, page 118 for details.

With Linux guests, the following applies: To prevent ejection while the CPU is still used it has to be ejected from within the guest before. The Linux Guest Additions contain a service which receives hot-remove events and ejects the CPU. Also, after a CPU is added to the VM it is not automatically used by Linux. The Linux Guest Additions service will take care of that if installed. If not a CPU can be started with the following command:

```
echo 1 > /sys/devices/system/cpu/cpu<id>/online
```

9.6 PCI passthrough

When running on Linux hosts, with recent enough kernel (at least version `2.6.31`) experimental host PCI devices passthrough is available.[2] Essentially this feature allows to use physical PCI devices on host directly by the guest, even if host doesn't have drivers for this particular device. Both regular PCI and some PCI Express cards are supported. AGP and certain PCI Express cards are not supported at the moment, if they rely on GART (Graphics Address Remapping Table) unit programming for texture management, as it does rather nontrivial operations with pages remapping interfering with IOMMU. This limitation may be lifted in future releases.

To be fully functional, PCI passthrough support in VirtualBox depends upon IOMMU hardware unit, which is not yet too widely available. To be exact, if device uses bus mastering (i.e. performs DMA to the OS memory on its own), then IOMMU hardware is needed (otherwise such DMA transactions may override wrong physical memory address, as device DMA engine is programmed using device-specific protocol to perform memory transactions). IOMMU functions as translation unit, mapping physical memory access requests from the device, using knowledge of guest physical address to host physical addresses translation rules.

Intel's solution for IOMMU is marketed as "Intel Virtualization Technology for Directed I/O" (VT-d), and AMD's one is called AMD-Vi. So please check if your motherboard datasheet has appropriate technology. Even if your hardware doesn't have IOMMU, certain PCI cards may work (such as serial PCI adapters), but guest will show warning on boot, and VM execution will terminate, if guest driver will attempt to enable card bus mastering.

It's not uncommon, that BIOS/OS disables IOMMU by default, so before any attempt to use it, please make sure that

1. Your motherboard has IOMMU unit.
2. Your CPU supports IOMMU.
3. IOMMU is enabled in the BIOS.
4. Your Linux kernel was compiled with IOMMU support (including DMA remapping, see `CONFIG_DMAR` kernel compilation option). The PCI stub driver (`CONFIG_PCI_STUB`) is required as well.
5. Your Linux kernel recognizes and uses IOMMU unit (`intel_iommu=on` boot option could be needed). Search for DMAR and PCI-DMA in kernel boot log.

Once you made sure that host kernel supports IOMMU, next step is to select PCI card, and attach it to the guest. To figure out list of available PCI devices, use `lspci` command. Output will look like this

[2] Experimental support for PCI passthrough was introduced with VirtualBox 4.1.

```
01:00.0 VGA compatible controller: ATI Technologies Inc Cedar PRO [Radeon HD 5450]
01:00.1 Audio device: ATI Technologies Inc Manhattan HDMI Audio [Mobility Radeon HD 5000 Series]
02:00.0 Ethernet controller: Realtek Semiconductor Co., Ltd. RTL8111/8168B PCI Express Gigabit Ethernet contr
03:00.0 SATA controller: JMicron Technology Corp. JMB362/JMB363 Serial ATA Controller (rev 03)
03:00.1 IDE interface: JMicron Technology Corp. JMB362/JMB363 Serial ATA Controller (rev 03)
06:00.0 VGA compatible controller: nVidia Corporation G86 [GeForce 8500 GT] (rev a1)
```

First column here is a PCI address (in format `bus:device.function`). This address could be used to identify device for further operations. For example, to attach PCI network controller on system listed above, to second PCI bus in the guest, as device 5, function 0, use the following command:

```
VBoxManage modifyvm "VM name" --attachpci 02:00.0@01:05.0
```

To detach same device, use

```
VBoxManage modifyvm "VM name" --detachpci 02:00.0
```

Please note, that both host and guest could freely assign different PCI address to card attached during runtime, so those addresses only apply to address of card at the moment of attachment (host), and during BIOS PCI init (guest).

If virtual machine has PCI device attached, certain limitations apply.

1. Only PCI cards with non-shared interrupts (such as using MSI on host) can be supported at the moment.
2. No guest state can be reliably saved/restored (as PCI card internal state could not be retrieved).
3. Teleportation (live migration) doesn't work (for the same reason).
4. No lazy physical memory allocation, host preallocates whole RAM on startup (as we cannot catch physical hardware access to physical memory).

9.7 Advanced display configuration

9.7.1 Custom VESA resolutions

Apart from the standard VESA resolutions, the VirtualBox VESA BIOS allows you to add up to 16 custom video modes which will be reported to the guest operating system. When using Windows guests with the VirtualBox Guest Additions, a custom graphics driver will be used instead of the fallback VESA solution so this information does not apply.

Additional video modes can be configured for each VM using the extra data facility. The extra data key is called CustomVideoMode<x> with x being a number from 1 to 16. Please note that modes will be read from 1 until either the following number is not defined or 16 is reached. The following example adds a video mode that corresponds to the native display resolution of many notebook computers:

```
VBoxManage setextradata "VM name" "CustomVideoMode1" "1400x1050x16"
```

The VESA mode IDs for custom video modes start at 0x160. In order to use the above defined custom video mode, the following command line has be supplied to Linux:

```
vga = 0x200 | 0x160
vga = 864
```

For guest operating systems with VirtualBox Guest Additions, a custom video mode can be set using the video mode hint feature.

9.7.2 Configuring the maximum resolution of guests when using the graphical frontend

When guest systems with the Guest Additions installed are started using the graphical frontend (the normal VirtualBox application), they will not be allowed to use screen resolutions greater than the host's screen size unless the user manually resizes them by dragging the window, switching to fullscreen or seamless mode or sending a video mode hint using VBoxManage. This behavior is what most users will want, but if you have different needs, it is possible to change it by issuing one of the following commands from the command line:

```
VBoxManage setextradata global GUI/MaxGuestResolution any
```

will remove all limits on guest resolutions.

```
VBoxManage setextradata global GUI/MaxGuestResolution >width,height<
```

manually specifies a maximum resolution.

```
VBoxManage setextradata global GUI/MaxGuestResolution auto
```

restores the default settings. Note that these settings apply globally to all guest systems, not just to a single machine.

9.8 Advanced storage configuration

9.8.1 Using a raw host hard disk from a guest

Starting with version 1.4, as an alternative to using virtual disk images (as described in detail in chapter 5, *Virtual storage*, page 71), VirtualBox can also present either entire physical hard disks or selected partitions thereof as virtual disks to virtual machines.

With VirtualBox, this type of access is called "raw hard disk access"; it allows a guest operating system to access its virtual hard disk without going through the host OS file system. The actual performance difference for image files vs. raw disk varies greatly depending on the overhead of the host file system, whether dynamically growing images are used and on host OS caching strategies. The caching indirectly also affects other aspects such as failure behavior, i.e. whether the virtual disk contains all data written before a host OS crash. Consult your host OS documentation for details on this.

> **Warning:** Raw hard disk access is for expert users only. Incorrect use or use of an outdated configuration can lead to **total loss of data** on the physical disk. Most importantly, *do not* attempt to boot the partition with the currently running host operating system in a guest. This will lead to severe data corruption.

Raw hard disk access – both for entire disks and individual partitions – is implemented as part of the VMDK image format support. As a result, you will need to create a special VMDK image file which defines where the data will be stored. After creating such a special VMDK image, you can use it like a regular virtual disk image. For example, you can use the Virtual Media Manager (chapter 5.3, *The Virtual Media Manager*, page 74) or `VBoxManage` to assign the image to a virtual machine.

9.8.1.1 Access to entire physical hard disk

While this variant is the simplest to set up, you must be aware that this will give a guest operating system direct and full access to an *entire physical disk*. If your *host* operating system is also booted from this disk, please take special care to not access the partition from the guest at all. On the positive side, the physical disk can be repartitioned in arbitrary ways without having to recreate the image file that gives access to the raw disk.

To create an image that represents an entire physical hard disk (which will not contain any actual data, as this will all be stored on the physical disk), on a Linux host, use the command

```
VBoxManage internalcommands createrawvmdk -filename /path/to/file.vmdk
      -rawdisk /dev/sda
```

This creates the image `/path/to/file.vmdk` (must be absolute), and all data will be read and written from `/dev/sda`.

On a Windows host, instead of the above device specification, use e.g. `\\.\PhysicalDrive0`. On a Mac OS X host, instead of the above device specification use e.g. `/dev/disk1`. Note that on OS X you can only get access to an entire disk if no volume is mounted from it.

Creating the image requires read/write access for the given device. Read/write access is also later needed when using the image from a virtual machine.

Just like with regular disk images, this does not automatically attach the newly created image to a virtual machine. This can be done with e.g.

```
VBoxManage storageattach WindowsXP --storagectl "IDE Controller"
      --port 0 --device 0 --type hdd --medium /path/to/file.vmdk
```

When this is done the selected virtual machine will boot from the specified physical disk.

9.8.1.2 Access to individual physical hard disk partitions

This "raw partition support" is quite similar to the "full hard disk" access described above. However, in this case, any partitioning information will be stored inside the VMDK image, so you can e.g. install a different boot loader in the virtual hard disk without affecting the host's partitioning information. While the guest will be able to *see* all partitions that exist on the physical disk, access will be filtered in that reading from partitions for which no access is allowed the partitions will only yield zeroes, and all writes to them are ignored.

To create a special image for raw partition support (which will contain a small amount of data, as already mentioned), on a Linux host, use the command

```
VBoxManage internalcommands createrawvmdk -filename /path/to/file.vmdk
      -rawdisk /dev/sda -partitions 1,5
```

As you can see, the command is identical to the one for "full hard disk" access, except for the additional `-partitions` parameter. This example would create the image `/path/to/file.vmdk` (which, again, must be absolute), and partitions 1 and 5 of `/dev/sda` would be made accessible to the guest.

VirtualBox uses the same partition numbering as your Linux host. As a result, the numbers given in the above example would refer to the first primary partition and the first logical drive in the extended partition, respectively.

On a Windows host, instead of the above device specification, use e.g. `\\.\PhysicalDrive0`. On a Mac OS X host, instead of the above device specification use e.g. `/dev/disk1`. Note that on OS X you can only use partitions which are not mounted (eject the respective volume first). Partition numbers are the same on Linux, Windows and Mac OS X hosts.

The numbers for the list of partitions can be taken from the output of

```
VBoxManage internalcommands listpartitions -rawdisk /dev/sda
```

The output lists the partition types and sizes to give the user enough information to identify the partitions necessary for the guest.

Images which give access to individual partitions are specific to a particular host disk setup. You cannot transfer these images to another host; also, whenever the host partitioning changes, the image *must be recreated*.

Creating the image requires read/write access for the given device. Read/write access is also later needed when using the image from a virtual machine. If this is not feasible, there is a special variant for raw partition access (currently only available on Linux hosts) that avoids having to give the current user access to the entire disk. To set up such an image, use

```
VBoxManage internalcommands createrawvmdk -filename /path/to/file.vmdk
      -rawdisk /dev/sda -partitions 1,5 -relative
```

When used from a virtual machine, the image will then refer not to the entire disk, but only to the individual partitions (in the example `/dev/sda1` and `/dev/sda5`). As a consequence, read/write access is only required for the affected partitions, not for the entire disk. During creation however, read-only access to the entire disk is required to obtain the partitioning information.

In some configurations it may be necessary to change the MBR code of the created image, e.g. to replace the Linux boot loader that is used on the host by another boot loader. This allows e.g. the guest to boot directly to Windows, while the host boots Linux from the "same" disk. For this purpose the `-mbr` parameter is provided. It specifies a file name from which to take the MBR code. The partition table is not modified at all, so a MBR file from a system with totally different partitioning can be used. An example of this is

```
VBoxManage internalcommands createrawvmdk -filename /path/to/file.vmdk
      -rawdisk /dev/sda -partitions 1,5 -mbr winxp.mbr
```

The modified MBR will be stored inside the image, not on the host disk.

The created image can be attached to a storage controller in a VM configuration as usual.

9.8.2 Configuring the hard disk vendor product data (VPD)

VirtualBox reports vendor product data for its virtual hard disks which consist of hard disk serial number, firmware revision and model number. These can be changed using the following commands:

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/ahci/0/Config/Port0/SerialNumber" "serial"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/ahci/0/Config/Port0/FirmwareRevision" "firmware"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/ahci/0/Config/Port0/ModelNumber" "model"
```

The serial number is a 20 byte alphanumeric string, the firmware revision an 8 byte alphanumeric string and the model number a 40 byte alphanumeric string. Instead of "Port0" (referring to the first port), specify the desired SATA hard disk port.

The above commands apply to virtual machines with an AHCI (SATA) controller. The commands for virtual machines with an IDE controller are:

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/piix3ide/0/Config/PrimaryMaster/SerialNumber" "serial"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/piix3ide/0/Config/PrimaryMaster/FirmwareRevision" "firmware"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/piix3ide/0/Config/PrimaryMaster/ModelNumber" "model"
```

For hard disks it's also possible (experimental!) to mark the drive as having a non-rotational medium with:

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/ahci/0/Config/Port0/NonRotational" "1"
```

Additional three parameters are needed for CD/DVD drives to report the vendor product data:

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/ahci/0/Config/Port0/ATAPIVendorId" "vendor"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/ahci/0/Config/Port0/ATAPIProductId" "product"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/ahci/0/Config/Port0/ATAPIRevision" "revision"
```

The vendor id is an 8 byte alphanumeric string, the product id an 16 byte alphanumeric string and the revision a 4 byte alphanumeric string. Instead of "Port0" (referring to the first port), specify the desired SATA hard disk port.

9.8.3 Access iSCSI targets via Internal Networking

As an experimental feature, VirtualBox allows for accessing an iSCSI target running in a virtual machine which is configured for using Internal Networking mode. Please see chapter 5.10, *iSCSI servers*, page 82; chapter 6.5, *Internal networking*, page 88; and chapter 8.16, *VBoxManage storageattach*, page 121 for additional information.

The IP stack accessing Internal Networking must be configured in the virtual machine which accesses the iSCSI target. A free static IP and a MAC address not used by other virtual machines must be chosen. In the example below, adapt the name of the virtual machine, the MAC address, the IP configuration and the Internal Networking name ("MyIntNet") according to your needs. The following seven commands must first be issued:

```
VBoxManage setextradata "VM name" VBoxInternal/Devices/IntNetIP/0/Trusted 1
VBoxManage setextradata "VM name" VBoxInternal/Devices/IntNetIP/0/Config/MAC 08:00:27:01:02:0f
VBoxManage setextradata "VM name" VBoxInternal/Devices/IntNetIP/0/Config/IP 10.0.9.1
VBoxManage setextradata "VM name" VBoxInternal/Devices/IntNetIP/0/Config/Netmask 255.255.255.0
VBoxManage setextradata "VM name" VBoxInternal/Devices/IntNetIP/0/LUN#0/Driver IntNet
VBoxManage setextradata "VM name" VBoxInternal/Devices/IntNetIP/0/LUN#0/Config/Network MyIntNet
VBoxManage setextradata "VM name" VBoxInternal/Devices/IntNetIP/0/LUN#0/Config/IsService 1
```

Finally the iSCSI disk must be attached with the `--intnet` option to tell the iSCSI initiator to use internal networking:

```
VBoxManage storageattach ... --medium iscsi
         --server 10.0.9.30 --target iqn.2008-12.com.sun:sampletarget --intnet
```

Compared to a "regular" iSCSI setup, IP address of the target *must* be specified as a numeric IP address, as there is no DNS resolver for internal networking.

The virtual machine with the iSCSI target should be started before the VM using it is powered on. If a virtual machine using an iSCSI disk is started without having the iSCSI target powered up, it can take up to 200 seconds to detect this situation. The VM will fail to power up.

9.9 Launching more than 120 VMs on Solaris hosts

Solaris hosts have a fixed number of IPC semaphores IDs per process preventing users from starting more than 120 VMs. While trying to launch more VMs you would be shown a "Cannot create IPC semaphore" error.

In order to run more VMs, you will need to bump the semaphore ID limit of the VBoxSVC process. Execute as root the `prctl` command as shown below. The process ID of VBoxSVC can be obtained using the `ps` list command.

```
prctl -r -n project.max-sem-ids -v 2048 <pid-of-VBoxSVC>
```

9.10 Legacy commands for using serial ports

Starting with version 1.4, VirtualBox provided support for virtual serial ports, which, at the time, was rather complicated to set up with a sequence of `VBoxManage setextradata` statements. Since version 1.5, that way of setting up serial ports is no longer necessary and *deprecated*. To set up virtual serial ports, use the methods now described in chapter 3.9, *Serial ports*, page 48.

> **Note:** For backwards compatibility, the old `setextradata` statements, whose description is retained below from the old version of the manual, take *precedence* over the new way of configuring serial ports. As a result, if configuring serial ports the new way doesn't work, make sure the VM in question does not have old configuration data such as below still active.

The old sequence of configuring a serial port used the following 6 commands:

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/serial/0/Config/IRQ" 4
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/serial/0/Config/IOBase" 0x3f8
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/serial/0/LUN#0/Driver" Char
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/serial/0/LUN#0/AttachedDriver/Driver" NamedPipe
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/serial/0/LUN#0/AttachedDriver/Config/Location" "\\.\pipe\vboxCOM1"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/serial/0/LUN#0/AttachedDriver/Config/IsServer" 1
```

This sets up a serial port in the guest with the default settings for COM1 (IRQ 4, I/O address 0x3f8) and the `Location` setting assumes that this configuration is used on a Windows host, because the Windows named pipe syntax is used. Keep in mind that on Windows hosts a named pipe must always start with `\\.\pipe\`. On Linux the same config settings apply, except that the path name for the `Location` can be chosen more freely. Local domain sockets can be placed anywhere, provided the user running VirtualBox has the permission to create a new file in the directory. The final command above defines that VirtualBox acts as a server, i.e. it creates the named pipe itself instead of connecting to an already existing one.

9.11 Fine-tuning the VirtualBox NAT engine

9.11.1 Configuring the address of a NAT network interface

In NAT mode, the guest network interface is assigned to the IPv4 range `10.0.x.0/24` by default where `x` corresponds to the instance of the NAT interface +2. So `x` is 2 when there is only one NAT instance active. In that case the guest is assigned to the address `10.0.2.15`, the gateway is set to `10.0.2.2` and the name server can be found at `10.0.2.3`.

If, for any reason, the NAT network needs to be changed, this can be achieved with the following command:

```
VBoxManage modifyvm "VM name" --natnet1 "192.168/16"
```

This command would reserve the network addresses from `192.168.0.0` to `192.168.254.254` for the first NAT network instance of "VM name". The guest IP would be assigned to `192.168.0.15` and the default gateway could be found at `192.168.0.2`.

9.11.2 Configuring the boot server (next server) of a NAT network interface

For network booting in NAT mode, by default VirtualBox uses a built-in TFTP server at the IP address 10.0.2.3. This default behavior should work fine for typical remote-booting scenarios. However, it is possible to change the boot server IP and the location of the boot image with the following commands:

```
VBoxManage modifyvm "VM name" --nattftpserver1 10.0.2.2
VBoxManage modifyvm "VM name" --nattftpfile1 /srv/tftp/boot/MyPXEBoot.pxe
```

9.11.3 Tuning TCP/IP buffers for NAT

The VirtualBox NAT stack performance is often determined by its interaction with the host's TCP/IP stack and the size of several buffers (`SO_RCVBUF` and `SO_SNDBUF`). For certain setups users might want to adjust the buffer size for a better performance. This can by achieved using the following commands (values are in kilobytes and can range from 8 to 1024):

```
VBoxManage modifyvm "VM name" --natsettings1 16000,128,128,0,0
```

This example illustrates tuning the NAT settings. The first parameter is the MTU, then the size of the socket's send buffer and the size of the socket's receive buffer, the initial size of the TCP send window, and lastly the initial size of the TCP receive window. Note that specifying zero means fallback to the default value.

Each of these buffers has a default size of 64KB and default MTU is 1500.

9.11.4 Binding NAT sockets to a specific interface

By default, VirtualBox's NAT engine will route TCP/IP packets through the default interface assigned by the host's TCP/IP stack. (The technical reason for this is that the NAT engine uses sockets for communication.) If, for some reason, you want to change this behavior, you can tell the NAT engine to bind to a particular IP address instead. Use the following command:

```
VBoxManage modifyvm "VM name" --natbindip1 "10.45.0.2"
```

After this, all outgoing traffic will be sent through the interface with the IP address 10.45.0.2. Please make sure that this interface is up and running prior to this assignment.

9.11.5 Enabling DNS proxy in NAT mode

The NAT engine by default offers the same DNS servers to the guest that are configured on the host. In some scenarios, it can be desirable to hide the DNS server IPs from the guest, for example when this information can change on the host due to expiring DHCP leases. In this case, you can tell the NAT engine to act as DNS proxy using the following command:

```
VBoxManage modifyvm "VM name" --natdnsproxy1 on
```

9.11.6 Using the host's resolver as a DNS proxy in NAT mode

For resolving network names, the DHCP server of the NAT engine offers a list of registered DNS servers of the host. If for some reason you need to hide this DNS server list and use the host's resolver settings, thereby forcing the VirtualBox NAT engine to intercept DNS requests and forward them to host's resolver, use the following command:

```
VBoxManage modifyvm "VM name" --natdnshostresolver1 on
```

Note that this setting is similar to the DNS proxy mode, however whereas the proxy mode just forwards DNS requests to the appropriate servers, the resolver mode will interpret the DNS requests and use the host's DNS API to query the information and return it to the guest.

9.11.7 Configuring aliasing of the NAT engine

By default, the NAT core uses aliasing and uses random ports when generating an alias for a connection. This works well for the most protocols like SSH, FTP and so on. Though some protocols might need a more transparent behavior or may depend on the real port number the packet was sent from. It is possible to change the NAT mode via the VBoxManage frontend with the following commands:

```
VBoxManage modifyvm "VM name" --nataliasmode proxyonly
```

and

```
VBoxManage modifyvm "Linux Guest" --nataliasmode sameports
```

The first example disables aliasing and switches NAT into transparent mode, the second example enforces preserving of port values. These modes can be combined if necessary.

9.12 Configuring the BIOS DMI information

The DMI data VirtualBox provides to guests can be changed for a specific VM. Use the following commands to configure the DMI BIOS information:

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiBIOSVendor"        "BIOS Vendor"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiBIOSVersion"       "BIOS Version"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiBIOSReleaseDate"   "BIOS Release Date"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiBIOSReleaseMajor"  1
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiBIOSReleaseMinor"  2
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiBIOSFirmwareMajor" 3
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiBIOSFirmwareMinor" 4
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiSystemVendor"      "System Vendor"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiSystemProduct"     "System Product"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiSystemVersion"     "System Version"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiSystemSerial"      "System Serial"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiSystemSKU"         "System SKU"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiSystemFamily"      "System Family"
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiSystemUuid"
                                          "9852bf98-b83c-49db-a8de-182c42c7226b"
```

If a DMI string is not set, the default value of VirtualBox is used. To set an empty string use `"<EMPTY>"`.

Note that in the above list, all quoted parameters (DmiBIOSVendor, DmiBIOSVersion but not DmiBIOSReleaseMajor) are expected to be strings. If such a string is a valid number, the parameter is treated as number and the VM will most probably refuse to start with an `VERR_CFGM_NOT_STRING` error. In that case, use `"string:<value>"`, for instance

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/pcbios/0/Config/DmiSystemSerial"      "string:1234"
```

Changing this information can be necessary to provide the DMI information of the host to the guest to prevent Windows from asking for a new product key. On Linux hosts the DMI BIOS information can be obtained with

```
dmidecode -t0
```

and the DMI system information can be obtained with

```
dmidecode -t1
```

9.13 Fine-tuning timers and time synchronization

9.13.1 Configuring the guest time stamp counter (TSC) to reflect guest execution

By default, VirtualBox keeps all sources of time visible to the guest synchronized to a single time source, the monotonic host time. This reflects the assumptions of many guest operating systems, which expect all time sources to reflect "wall clock" time. In special circumstances it may be useful however to make the TSC (time stamp counter) in the guest reflect the time actually spent executing the guest.

This special TSC handling mode can be enabled on a per-VM basis, and for best results must be used only in combination with hardware virtualization. To enable this mode use the following command:

```
VBoxManage setextradata "VM name" "VBoxInternal/TM/TSCTiedToExecution" 1
```

To revert to the default TSC handling mode use:

```
VBoxManage setextradata "VM name" "VBoxInternal/TM/TSCTiedToExecution"
```

Note that if you use the special TSC handling mode with a guest operating system which is very strict about the consistency of time sources you may get a warning or error message about the timing inconsistency. It may also cause clocks to become unreliable with some guest operating systems depending on they use the TSC.

9.13.2 Accelerate or slow down the guest clock

For certain purposes it can be useful to accelerate or to slow down the (virtual) guest clock. This can be achieved as follows:

```
VBoxManage setextradata "VM name" "VBoxInternal/TM/WarpDrivePercentage" 200
```

The above example will double the speed of the guest clock while

```
VBoxManage setextradata "VM name" "VBoxInternal/TM/WarpDrivePercentage" 50
```

will halve the speed of the guest clock. Note that changing the rate of the virtual clock can confuse the guest and can even lead to abnormal guest behavior. For instance, a higher clock rate means shorter timeouts for virtual devices with the result that a slightly increased response time of a virtual device due to an increased host load can cause guest failures. Note further that any time synchronization mechanism will frequently try to resynchronize the guest clock with the reference clock (which is the host clock if the VirtualBox Guest Additions are active). Therefore any time synchronization should be disabled if the rate of the guest clock is changed as described above (see chapter 9.13.3, *Tuning the Guest Additions time synchronization parameters*, page 153).

9.13.3 Tuning the Guest Additions time synchronization parameters

The VirtualBox Guest Additions ensure that the guest's system time is synchronized with the host time. There are several parameters which can be tuned. The parameters can be set for a specific VM using the following command:

```
VBoxManage guestproperty set VM_NAME "/VirtualBox/GuestAdd/VBoxService/PARAMETER" VALUE
```

where PARAMETER is one of the following:

--timesync-interval Specifies the interval at which to synchronize the time with the host. The default is 10000 ms (10 seconds).

--timesync-min-adjust The minimum absolute drift value measured in milliseconds to make adjustments for. The default is 1000 ms on OS/2 and 100 ms elsewhere.

--timesync-latency-factor The factor to multiply the time query latency with to calculate the dynamic minimum adjust time. The default is 8 times, that means in detail: Measure the time it takes to determine the host time (the guest has to contact the VM host service which may take some time), multiply this value by 8 and do an adjustment only if the time difference between host and guest is bigger than this value. Don't do any time adjustment otherwise.

--timesync-max-latency The max host timer query latency to accept. The default is 250 ms.

--timesync-set-threshold The absolute drift threshold, given as milliseconds where to start setting the time instead of trying to smoothly adjust it. The default is 20 minutes.

--timesync-set-start Set the time when starting the time sync service.

--timesync-set-on-restore 0|1 Set the time after the VM was restored from a saved state when passing 1 as parameter (default). Disable by passing 0. In the latter case, the time will be adjusted smoothly which can take a long time.

All these parameters can be specified as command line parameters to VBoxService as well.

9.14 Configuring multiple host-only network interfaces on Solaris hosts

By default VirtualBox provides you with one host-only network interface. Adding more host-only network interfaces on Solaris hosts requires manual configuration. Here's how to add two more host-only network interfaces.

You first need to stop all running VMs and unplumb all existing "vboxnet" interfaces. Execute the following commands as root:

```
ifconfig vboxnet0 unplumb
```

Once you make sure all vboxnet interfaces are unplumbed, remove the driver using:

```
rem_drv vboxnet
```

then edit the file `/platform/i86pc/kernel/drv/vboxnet.conf` and add a line for the new interfaces:

```
name="vboxnet" parent="pseudo" instance=1;
name="vboxnet" parent="pseudo" instance=2;
```

Add as many of these lines as required and make sure "instance" number is uniquely incremented. Next reload the vboxnet driver using:

```
add_drv vboxnet
```

Now plumb all the interfaces using `ifconfig vboxnetX plumb` (where X can be 0, 1 or 2 in this case) and once plumbed you can then configure the interface like any other network interface.

To make your newly added interfaces' settings persistent across reboots you will need to edit the files `/etc/netmasks`, and if you are using NWAM `/etc/nwam/llp` and add the appropriate entries to set the netmask and static IP for each of those interfaces. The VirtualBox installer only updates these configuration files for the one "vboxnet0" interface it creates by default.

9.15 Configuring the VirtualBox CoreDumper on Solaris hosts

VirtualBox is capable of producing its own core files when things go wrong and for more extensive debugging. Currently this is only available on Solaris hosts.

The VirtualBox CoreDumper can be enabled using the following command:

```
VBoxManage setextradata "VM name" VBoxInternal2/CoreDumpEnabled 1
```

You can specify which directory to use for core dumps with this command:

```
VBoxManage setextradata "VM name" VBoxInternal2/CoreDumpDir <path-to-directory>
```

Make sure the directory you specify is on a volume with sufficient free space and that the VirtualBox process has sufficient permissions to write files to this directory. If you skip this command and don't specify any core dump directory, the current directory of the VirtualBox executable will be used (which would most likely fail when writing cores as they are protected with root permissions). It is recommended you explicity set a core dump directory.

You must specify when the VirtualBox CoreDumper should be triggered. This is done using the following commands:

```
VBoxManage setextradata "VM name" VBoxInternal2/CoreDumpReplaceSystemDump 1
VBoxManage setextradata "VM name" VBoxInternal2/CoreDumpLive 1
```

At least one of the above two commands will have to be provided if you have enabled the VirtualBox CoreDumper.

Setting `CoreDumpReplaceSystemDump` sets up the VM to override the host's core dumping mechanism and in the event of any crash only the VirtualBox CoreDumper would produce the core file.

Setting `CoreDumpLive` sets up the VM to produce cores whenever the VM receives a `SIGUSR2` signal. After producing the core file, the VM will not be terminated and will continue to run. You can then take cores of the VM process using:

```
kill -s SIGUSR2 <VM-process-id>
```

Core files produced by the VirtualBox CoreDumper are of the form `core.vb.<ProcessName>.<ProcessID>`, e.g.`core.vb.VBoxHeadless.11321`.

9.16 Locking down the VirtualBox manager GUI

There are several advanced customization settings for locking down the VirtualBox manager, that is, removing some features that the user should not see.

```
VBoxManage setextradata global GUI/Customizations OPTION[,OPTION...]
```

where `OPTION` is one of the following keywords:

noSelector Don't allow to start the VirtualBox manager. Trying to do so will show a window containing a proper error message.

noMenuBar VM windows will not contain a menu bar.

noStatusBar VM windows will not contain a status bar.

To disable any GUI customization do

```
VBoxManage setextradata global GUI/Customizations
```

To disable all host key combinations, open the preferences and change the host key to *None*. This might be useful when using VirtualBox in a kiosk mode.

Furthermore, you can disallow certain actions when terminating a VM. To disallow specific actions, type:

```
VBoxManage setextradata "VM name" GUI/RestrictedCloseActions OPTION[,OPTION...]
```

where `OPTION` is one of the following keywords:

SaveState Don't allow the user to save the VM state when terminating the VM.

Shutdown Don't allow the user to shutdown the VM by sending the ACPI power-off event to the guest.

PowerOff Don't allow the user to power off the VM.

Restore Don't allow the user to return to the last snapshot when powering off the VM.

Any combination of the above is allowed. If all options are specified, the VM cannot be shut down at all.

9.17 Starting the VirtualBox web service automatically

The VirtualBox web service (`vboxwebsrv`) is used for controlling VirtualBox remotely. It is documented in detail in the VirtualBox Software Development Kit (SDK); please see chapter 11, *VirtualBox programming interfaces*, page 167. As the client base using this interface is growing, we added start scripts for the various operation systems we support. The following describes how to use them.

- On Mac OS X, launchd is used. An example configuration file can be found in `$HOME/Library/LaunchAgents/org.virtualbox.vboxwebsrv.plist`. It can be enabled by changing the `Disabled` key from `true` to `false`. To manually start the service use the following command:

  ```
  launchctl load ~/Library/LaunchAgents/org.virtualbox.vboxwebsrv.plist
  ```

  For additional information on how launchd services could be configured see http://developer.apple.com/mac/library/documentation/MacOSX/Conceptual/BPSystemStartup/BPSystemStartup.html.

9.18 Memory Ballooning Service

Starting with VirtualBox 4.0.8 a new host executable called `VBoxBalloonCtrl` is available to automatically take care of a VM's configured memory balloon (see chapter 4.8.1, *Memory ballooning*, page 69 for an introduction to memory ballooning). This is especially useful for server environments where VMs may dynamically require more or less memory during runtime.

VBoxBalloonCtrl periodically checks a VM's current memory balloon and its free guest RAM and automatically adjusts the current memory balloon by inflating or deflating it accordingly. This handling only applies to running VMs having recent Guest Additions installed.

To set up VBoxBalloonCtrl and adjust the maximum ballooning size a VM can reach the following parameters will be checked in the following order:

- specified via VBoxBalloonCtrl command line parameter `--balloon-max`
- per-VM parameter using

  ```
  VBoxManage setextradata "VM-Name" VBoxInternal/Guest/BalloonSizeMax <Size in MB>
  ```

- global parameter for all VMs using

  ```
  VBoxManage setextradata global VBoxInternal/Guest/BalloonSizeMax <Size in MB>
  ```

Note: If no maximum ballooning size is specified by at least one of the parameters above, no ballooning will be performed at all.

For more options and parameters check the built-in command line help accessible with `--help`.

10 Technical background

The contents of this chapter are not required to use VirtualBox successfully. The following is provided as additional information for readers who are more familiar with computer architecture and technology and wish to find out more about how VirtualBox works "under the hood".

10.1 Where VirtualBox stores its files

In VirtualBox, a virtual machine and its settings are described in a virtual machine settings file in XML format. In addition, most virtual machine have one or more virtual hard disks, which are typically represented by disk images (e.g. in VDI format). Where all these files are stored depends on which version of VirtualBox created the machine.

10.1.1 Machines created by VirtualBox version 4.0 or later

Starting with version 4.0, by default, each virtual machine has one directory on your host computer where all the files of that machine are stored – the XML settings file (with a `.vbox` file extension) and its disk images.

By default, this "machine folder" is placed in a common folder called "VirtualBox VMs", which VirtualBox creates in the current system user's home directory. The location of this home directory depends on the conventions of the host operating system:

- On Windows, this is `%HOMEDRIVE%%HOMEPATH%`; typically something like `C:\Documents and Settings\Username\`.
- On Mac OS X, this is `/Users/username`.
- On Linux and Solaris, this is `/home/username`.

For simplicity, we will abbreviate this as `$HOME` below. Using that convention, the common folder for all virtual machines is `$HOME/VirtualBox VMs`.

As an example, when you create a virtual machine called "Example VM", you will find that VirtualBox creates

1. the folder `$HOME/VirtualBox VMs/Example VM/` and, in that folder,
2. the settings file `Example VM.vbox` and
3. the virtual disk image `Example VM.vdi`.

This is the default layout if you use the "Create new virtual machine" wizard as described in chapter 1.7, *Creating your first virtual machine*, page 16. Once you start working with the VM, additional files will show up: you will find log files in a subfolder called `Logs`, and once you have taken snapshots, they will appear in a `Snapshots` subfolder. For each VM, you can change the location of its snapsnots folder in the VM settings.

You can change the default machine folder by selecting "Preferences" from the "File" menu in the VirtualBox main window. Then, in the window that pops up, click on the "General" tab. Alternatively, use `VBoxManage setproperty machinefolder`; see chapter 8.25, *VBoxManage setproperty*, page 127.

10.1.2 Machines created by VirtualBox versions before 4.0

If you have upgraded to VirtualBox 4.0 from an earlier version of VirtualBox, you probably have settings files and disks in the earlier file system layout.

Before version 4.0, VirtualBox separated the machine settings files from virtual disk images. The machine settings files had an `.xml` file extension and resided in a folder called "Machines" under the global VirtualBox configuration directory (see the next section). So, for example, on Linux, this was the hidden `$HOME/.VirtualBox/Machines` directory. The default hard disks folder was called "HardDisks" and resided in the `.VirtualBox` folder as well. Both locations could be changed by the user in the global preferences. (The concept of a "default hard disk folder" has been abandoned with VirtualBox 4.0, since disk images now reside in each machine's folder by default.)

The old layout had several severe disadvantages.

1. It was very difficult to move a virtual machine from one host to another because the files involved did not reside in the same folder. In addition, the virtual media of all machines were registered with a global registry in the central VirtualBox settings file (`$HOME/.VirtualBox/VirtualBox.xml`).

   To move a machine to another host, it was therefore not enough to move the XML settings file and the disk images (which were in different locations), but the hard disk entries from the global media registry XML had to be meticulously copied as well, which was close to impossible if the machine had snapshots and therefore differencing images.

2. Storing virtual disk images, which can grow very large, under the hidden `.VirtualBox` directory (at least on Linux and Solaris hosts) made many users wonder where their disk space had gone.

Whereas new VMs created with VirtualBox 4.0 or later will conform to the new layout, for maximum compatibility, old VMs are *not* converted to the new layout. Otherwise machine settings would be irrevocably broken if a user downgraded from 4.0 back to an older version of VirtualBox.

10.1.3 Global configuration data

In addition to the files of the virtual machines, VirtualBox maintains global configuration data. On Windows, Linux and Solaris, this is in `$HOME/.VirtualBox` (which makes it hidden on Linux and Solaris), whereas on a Mac this resides in `$HOME/Library/VirtualBox`.

VirtualBox creates this configuration directory automatically if necessary. Optionally, you can supply an alternate configuration directory by setting the `VBOX_USER_HOME` environment variable. (Since the global `VirtualBox.xml` settings file points to all other configuration files, this allows for switching between several VirtualBox configurations entirely.)

Most importantly, in this directory, VirtualBox stores its global settings file, another XML file called `VirtualBox.xml`. This includes global configuration options and the list of registered virtual machines with pointers to their XML settings files. (Neither the location of this file nor its directory has changed with VirtualBox 4.0.)

Before VirtualBox 4.0, all virtual media (disk image files) were also contained in a global registry in this settings file. For compatibility, this media registry still exists if you upgrade VirtualBox and there are media from machines which were created with a version before 4.0. If you have no such machines, then there will be no global media registry; with VirtualBox 4.0, each machine XML file has its own media registry.

Also before VirtualBox 4.0, the default "Machines" folder and the default "HardDisks" folder resided under the VirtualBox configuration directory (e.g. `$HOME/.VirtualBox/Machines` on Linux). If you are upgrading from a VirtualBox version before 4.0, files in these directories are not automatically moved in order not to break backwards compatibility.

10.1.4 Summary of 4.0 configuration changes

	Before 4.0	4.0 or above
Default machines folder	`$HOME/.VirtualBox/Machines`	`$HOME/VirtualBox VMs`
Default disk image location	`$HOME/.VirtualBox/HardDisks`	In each machine's folder
Machine settings file extension	`.xml`	`.vbox`
Media registry	Global `VirtualBox.xml` file	Each machine settings file
Media registration	Explicit open/close required	Automatic on attach

10.1.5 VirtualBox XML files

VirtualBox uses XML for both the machine settings files and the global configuration file, `VirtualBox.xml`.

All VirtualBox XML files are versioned. When a new settings file is created (e.g. because a new virtual machine is created), VirtualBox automatically uses the settings format of the current VirtualBox version. These files may not be readable if you downgrade to an earlier version of VirtualBox. However, when VirtualBox encounters a settings file from an earlier version (e.g. after upgrading VirtualBox), it attempts to preserve the settings format as much as possible. It will only silently upgrade the settings format if the current settings cannot be expressed in the old format, for example because you enabled a feature that was not present in an earlier version of VirtualBox.[1] In such cases, VirtualBox backs up the old settings file in the virtual machine's configuration directory. If you need to go back to the earlier version of VirtualBox, then you will need to manually copy these backup files back.

We intentionally do not document the specifications of the VirtualBox XML files, as we must reserve the right to modify them in the future. We therefore strongly suggest that you do not edit these files manually. VirtualBox provides complete access to its configuration data through its the `VBoxManage` command line tool (see chapter 8, *VBoxManage*, page 100) and its API (see chapter 11, *VirtualBox programming interfaces*, page 167).

10.2 VirtualBox executables and components

VirtualBox was designed to be modular and flexible. When the VirtualBox graphical user interface (GUI) is opened and a VM is started, at least three processes are running:

1. `VBoxSVC`, the VirtualBox service process which always runs in the background. This process is started automatically by the first VirtualBox client process (the GUI, `VBoxManage`, `VBoxHeadless`, the web service or others) and exits a short time after the last client exits. The service is responsible for bookkeeping, maintaining the state of all VMs, and for providing communication between VirtualBox components. This communication is implemented via COM/XPCOM.

> **Note:** When we refer to "clients" here, we mean the local clients of a particular `VBoxSVC` server process, not clients in a network. VirtualBox employs its own client/server design to allow its processes to cooperate, but all these processes run under the same user account on the host operating system, and this is totally transparent to the user.

[1] As an example, before VirtualBox 3.1, it was only possible to enable or disable a single DVD drive in a virtual machine. If it was enabled, then it would always be visible as the secondary master of the IDE controller. With VirtualBox 3.1, DVD drives can be attached to arbitrary slots of arbitrary controllers, so they could be the secondary slave of an IDE controller or in a SATA slot. If you have a machine settings file from an earlier version and upgrade VirtualBox to 3.1 and then move the DVD drive from its default position, this cannot be expressed in the old settings format; the XML machine file would get written in the new format, and a backup file of the old format would be kept.

2. The GUI process, `VirtualBox`, a client application based on the cross-platform Qt library. When started without the `--startvm` option, this application acts as the VirtualBox manager, displaying the VMs and their settings. It then communicates settings and state changes to `VBoxSVC` and also reflects changes effected through other means, e.g., `VBoxManage`.

3. If the `VirtualBox` client application is started with the `--startvm` argument, it loads the VMM library which includes the actual hypervisor and then runs a virtual machine and provides the input and output for the guest.

Any VirtualBox front-end (client) will communicate with the service process and can both control and reflect the current state. For example, either the VM selector or the VM window or VBoxManage can be used to pause the running VM, and other components will always reflect the changed state.

The VirtualBox GUI application is only one of several available front ends (clients). The complete list shipped with VirtualBox is:

1. `VirtualBox`, the Qt front end implementing the manager and running VMs;

2. `VBoxManage`, a less user-friendly but more powerful alternative, described in chapter 8, *VBoxManage*, page 100.

3. `VBoxSDL`, a simple graphical front end based on the SDL library; see chapter 9.1, *VBoxSDL, the simplified VM displayer*, page 136.

4. `VBoxHeadless`, a VM front end which does not directly provide any video output and keyboard/mouse input, but allows redirection via VirtualBox Remote Desktop Extension; see chapter 7.1.2, *VBoxHeadless, the remote desktop server*, page 92.

5. `vboxwebsrv`, the VirtualBox web service process which allows for controlling a VirtualBox host remotely. This is described in detail in the VirtualBox Software Development Kit (SDK) reference; please see chapter 11, *VirtualBox programming interfaces*, page 167 for details.

6. The VirtualBox Python shell, a Python alternative to VBoxManage. This is also described in the SDK reference.

Internally, VirtualBox consists of many more or less separate components. You may encounter these when analyzing VirtualBox internal error messages or log files. These include:

- IPRT, a portable runtime library which abstracts file access, threading, string manipulation, etc. Whenever VirtualBox accesses host operating features, it does so through this library for cross-platform portability.

- VMM (Virtual Machine Monitor), the heart of the hypervisor.

- EM (Execution Manager), controls execution of guest code.

- REM (Recompiled Execution Monitor), provides software emulation of CPU instructions.

- TRPM (Trap Manager), intercepts and processes guest traps and exceptions.

- HWACCM (Hardware Acceleration Manager), provides support for VT-x and AMD-V.

- PDM (Pluggable Device Manager), an abstract interface between the VMM and emulated devices which separates device implementations from VMM internals and makes it easy to add new emulated devices. Through PDM, third-party developers can add new virtual devices to VirtualBox without having to change VirtualBox itself.

- PGM (Page Manager), a component controlling guest paging.

- PATM (Patch Manager), patches guest code to improve and speed up software virtualization.
- TM (Time Manager), handles timers and all aspects of time inside guests.
- CFGM (Configuration Manager), provides a tree structure which holds configuration settings for the VM and all emulated devices.
- SSM (Saved State Manager), saves and loads VM state.
- VUSB (Virtual USB), a USB layer which separates emulated USB controllers from the controllers on the host and from USB devices; this also enables remote USB.
- DBGF (Debug Facility), a built-in VM debuger.
- VirtualBox emulates a number of devices to provide the hardware environment that various guests need. Most of these are standard devices found in many PC compatible machines and widely supported by guest operating systems. For network and storage devices in particular, there are several options for the emulated devices to access the underlying hardware. These devices are managed by PDM.
- Guest Additions for various guest operating systems. This is code that is installed from within a virtual machine; see chapter 4, *Guest Additions*, page 53.
- The "Main" component is special: it ties all the above bits together and is the only public API that VirtualBox provides. All the client processes listed above use only this API and never access the hypervisor components directly. As a result, third-party applications that use the VirtualBox Main API can rely on the fact that it is always well-tested and that all capabilities of VirtualBox are fully exposed. It is this API that is described in the VirtualBox SDK mentioned above (again, see chapter 11, *VirtualBox programming interfaces*, page 167).

10.3 Hardware vs. software virtualization

VirtualBox allows software in the virtual machine to run directly on the processor of the host, but an array of complex techniques is employed to intercept operations that would interfere with your host. Whenever the guest attempts to do something that could be harmful to your computer and its data, VirtualBox steps in and takes action. In particular, for lots of hardware that the guest believes to be accessing, VirtualBox simulates a certain "virtual" environment according to how you have configured a virtual machine. For example, when the guest attempts to access a hard disk, VirtualBox redirects these requests to whatever you have configured to be the virtual machine's virtual hard disk – normally, an image file on your host.

Unfortunately, the x86 platform was never designed to be virtualized. Detecting situations in which VirtualBox needs to take control over the guest code that is executing, as described above, is difficult. There are two ways in which to achive this:

- Since 2006, Intel and AMD processors have had support for so-called **"hardware virtualization"**. This means that these processors can help VirtualBox to intercept potentially dangerous operations that a guest operating system may be attempting and also makes it easier to present virtual hardware to a virtual machine.

  These hardware features differ between Intel and AMD processors. Intel named its technology **VT-x**; AMD calls theirs **AMD-V**. The Intel and AMD support for virtualization is very different in detail, but not very different in principle.

> **Note:** On many systems, the hardware virtualization features first need to be enabled in the BIOS before VirtualBox can use them.

- As opposed to other virtualization software, for many usage scenarios, VirtualBox does not *require* hardware virtualization features to be present. Through sophisticated techniques, VirtualBox virtualizes many guest operating systems entirely in **software**. This means that you can run virtual machines even on older processors which do not support hardware virtualization.

Even though VirtualBox does not always require hardware virtualization, enabling it is *required* in the following scenarios:

- Certain rare guest operating systems like OS/2 make use of very esoteric processor instructions that are not supported with our software virtualization. For virtual machines that are configured to contain such an operating system, hardware virtualization is enabled automatically.
- VirtualBox's 64-bit guest support (added with version 2.0) and multiprocessing (SMP, added with version 3.0) both require hardware virtualization to be enabled. (This is not much of a limitation since the vast majority of today's 64-bit and multicore CPUs ship with hardware virtualization anyway; the exceptions to this rule are e.g. older Intel Celeron and AMD Opteron CPUs.)

Warning: Do not run other hypervisors (open-source or commercial virtualization products) together with VirtualBox! While several hypervisors can normally be *installed* in parallel, do not attempt to *run* several virtual machines from competing hypervisors at the same time. VirtualBox cannot track what another hypervisor is currently attempting to do on the same host, and especially if several products attempt to use hardware virtualization features such as VT-x, this can crash the entire host. Also, within VirtualBox, you can mix software and hardware virtualization when running multiple VMs. In certain cases a small performance penalty will be unavoidable when mixing VT-x and software virtualization VMs. We recommend not mixing virtualization modes if maximum performance and low overhead are essential. This does *not* apply to AMD-V.

10.4 Details about software virtualization

Implementing virtualization on x86 CPUs with no hardware virtualization support is an extraordinarily complex task because the CPU architecture was not designed to be virtualized. The problems can usually be solved, but at the cost of reduced performance. Thus, there is a constant clash between virtualization performance and accuracy.

The x86 instruction set was originally designed in the 1970s and underwent significant changes with the addition of protected mode in the 1980s with the 286 CPU architecture and then again with the Intel 386 and its 32-bit architecture. Whereas the 386 did have limited virtualization support for real mode operation (V86 mode, as used by the "DOS Box" of Windows 3.x and OS/2 2.x), no support was provided for virtualizing the entire architecture.

In theory, software virtualization is not overly complex. In addition to the four privilege levels ("rings") provided by the hardware (of which typically only two are used: ring 0 for kernel mode and ring 3 for user mode), one needs to differentiate between "host context" and "guest context".

In "host context", everything is as if no hypervisor was active. This might be the active mode if another application on your host has been scheduled CPU time; in that case, there is a host ring 3 mode and a host ring 0 mode. The hypervisor is not involved.

In "guest context", however, a virtual machine is active. So long as the guest code is running in ring 3, this is not much of a problem since a hypervisor can set up the page tables properly

and run that code natively on the processor. The problems mostly lie in how to intercept what the guest's kernel does.

There are several possible solutions to these problems. One approach is full software emulation, usually involving recompilation. That is, all code to be run by the guest is analyzed, transformed into a form which will not allow the guest to either modify or see the true state of the CPU, and only then executed. This process is obviously highly complex and costly in terms of performance. (VirtualBox contains a recompiler based on QEMU which can be used for pure software emulation, but the recompiler is only activated in special situations, described below.)

Another possible solution is paravirtualization, in which only specially modified guest OSes are allowed to run. This way, most of the hardware access is abstracted and any functions which would normally access the hardware or privileged CPU state are passed on to the hypervisor instead. Paravirtualization can achieve good functionality and performance on standard x86 CPUs, but it can only work if the guest OS can actually be modified, which is obviously not always the case.

VirtualBox chooses a different approach. When starting a virtual machine, through its ring-0 support kernel driver, VirtualBox has set up the host system so that it can run most of the guest code natively, but it has inserted itself at the "bottom" of the picture. It can then assume control when needed – if a privileged instruction is executed, the guest traps (in particular because an I/O register was accessed and a device needs to be virtualized) or external interrupts occur. VirtualBox may then handle this and either route a request to a virtual device or possibly delegate handling such things to the guest or host OS. In guest context, VirtualBox can therefore be in one of three states:

- Guest ring 3 code is run unmodified, at full speed, as much as possible. The number of faults will generally be low (unless the guest allows port I/O from ring 3, something we cannot do as we don't want the guest to be able to access real ports). This is also referred to as "raw mode", as the guest ring-3 code runs unmodified.

- For guest code in ring 0, VirtualBox employs a nasty trick: it actually reconfigures the guest so that its ring-0 code is run in ring 1 instead (which is normally not used in x86 operating systems). As a result, when guest ring-0 code (actually running in ring 1) such as a guest device driver attempts to write to an I/O register or execute a privileged instruction, the VirtualBox hypervisor in "real" ring 0 can take over.

- The hypervisor (VMM) can be active. Every time a fault occurs, VirtualBox looks at the offending instruction and can relegate it to a virtual device or the host OS or the guest OS or run it in the recompiler.

  In particular, the recompiler is used when guest code disables interrupts and VirtualBox cannot figure out when they will be switched back on (in these situations, VirtualBox actually analyzes the guest code using its own disassembler). Also, certain privileged instructions such as LIDT need to be handled specially. Finally, any real-mode or protected-mode code (e.g. BIOS code, a DOS guest, or any operating system startup) is run in the recompiler entirely.

Unfortunately this only works to a degree. Among others, the following situations require special handling:

1. Running ring 0 code in ring 1 causes a lot of additional instruction faults, as ring 1 is not allowed to execute any privileged instructions (of which guest's ring-0 contains plenty). With each of these faults, the VMM must step in and emulate the code to achieve the desired behavior. While this works, emulating thousands of these faults is very expensive and severely hurts the performance of the virtualized guest.

2. There are certain flaws in the implementation of ring 1 in the x86 architecture that were never fixed. Certain instructions that *should* trap in ring 1 don't. This affect for example the

LGDT/SGDT, LIDT/SIDT, or POPF/PUSHF instruction pairs. Whereas the "load" operation is privileged and can therefore be trapped, the "store" instruction always succeed. If the guest is allowed to execute these, it will see the true state of the CPU, not the virtualized state. The CPUID instruction also has the same problem.

3. A hypervisor typically needs to reserve some portion of the guest's address space (both linear address space and selectors) for its own use. This is not entirely transparent to the guest OS and may cause clashes.

4. The SYSENTER instruction (used for system calls) executed by an application running in a guest OS always transitions to ring 0. But that is where the hypervisor runs, not the guest OS. In this case, the hypervisor must trap and emulate the instruction even when it is not desirable.

5. The CPU segment registers contain a "hidden" descriptor cache which is not software-accessible. The hypervisor cannot read, save, or restore this state, but the guest OS may use it.

6. Some resources must (and can) be trapped by the hypervisor, but the access is so frequent that this creates a significant performance overhead. An example is the TPR (Task Priority) register in 32-bit mode. Accesses to this register must be trapped by the hypervisor, but certain guest operating systems (notably Windows and Solaris) write this register very often, which adversely affects virtualization performance.

To fix these performance and security issues, VirtualBox contains a Code Scanning and Analysis Manager (CSAM), which disassembles guest code, and the Patch Manager (PATM), which can replace it at runtime.

Before executing ring 0 code, CSAM scans it recursively to discover problematic instructions. PATM then performs *in-situ* patching, i.e. it replaces the instruction with a jump to hypervisor memory where an integrated code generator has placed a more suitable implementation. In reality, this is a very complex task as there are lots of odd situations to be discovered and handled correctly. So, with its current complexity, one could argue that PATM is an advanced *in-situ* recompiler.

In addition, every time a fault occurs, VirtualBox analyzes the offending code to determine if it is possible to patch it in order to prevent it from causing more faults in the future. This approach works well in practice and dramatically improves software virtualization performance.

10.5 Details about hardware virtualization

With Intel VT-x, there are two distinct modes of CPU operation: VMX root mode and non-root mode.

- In root mode, the CPU operates much like older generations of processors without VT-x support. There are four privilege levels ("rings"), and the same instruction set is supported, with the addition of several virtualization specific instruction. Root mode is what a host operating system without virtualization uses, and it is also used by a hypervisor when virtualization is active.

- In non-root mode, CPU operation is significantly different. There are still four privilege rings and the same instruction set, but a new structure called VMCS (Virtual Machine Control Structure) now controls the CPU operation and determines how certain instructions behave. Non-root mode is where guest systems run.

Switching from root mode to non-root mode is called "VM entry", the switch back is "VM exit". The VMCS includes a guest and host state area which is saved/restored at VM entry and exit. Most importantly, the VMCS controls which guest operations will cause VM exits.

The VMCS provides fairly fine-grained control over what the guests can and can't do. For example, a hypervisor can allow a guest to write certain bits in shadowed control registers, but not others. This enables efficient virtualization in cases where guests can be allowed to write control bits without disrupting the hypervisor, while preventing them from altering control bits over which the hypervisor needs to retain full control. The VMCS also provides control over interrupt delivery and exceptions.

Whenever an instruction or event causes a VM exit, the VMCS contains information about the exit reason, often with accompanying detail. For example, if a write to the CR0 register causes an exit, the offending instruction is recorded, along with the fact that a write access to a control register caused the exit, and information about source and destination register. Thus the hypervisor can efficiently handle the condition without needing advanced techniques such as CSAM and PATM described above.

VT-x inherently avoids several of the problems which software virtualization faces. The guest has its own completely separate address space not shared with the hypervisor, which eliminates potential clashes. Additionally, guest OS kernel code runs at privilege ring 0 in VMX non-root mode, obviating the problems by running ring 0 code at less privileged levels. For example the SYSENTER instruction can transition to ring 0 without causing problems. Naturally, even at ring 0 in VMX non-root mode, any I/O access by guest code still causes a VM exit, allowing for device emulation.

The biggest difference between VT-x and AMD-V is that AMD-V provides a more complete virtualization environment. VT-x requires the VMX non-root code to run with paging enabled, which precludes hardware virtualization of real-mode code and non-paged protected-mode software. This typically only includes firmware and OS loaders, but nevertheless complicates VT-x hypervisor implementation. AMD-V does not have this restriction.

Of course hardware virtualization is not perfect. Compared to software virtualization, the overhead of VM exits is relatively high. This causes problems for devices whose emulation requires high number of traps. One example is the VGA device in 16-color modes, where not only every I/O port access but also every access to the framebuffer memory must be trapped.

10.6 Nested paging and VPIDs

In addition to "plain" hardware virtualization, your processor may also support additional sophisticated techniques:[2]

- A newer feature called **"nested paging"** implements some memory management in hardware, which can greatly accelerate hardware virtualization since these tasks no longer need to be performed by the virtualization software.

  With nested paging, the hardware provides another level of indirection when translating linear to physical addresses. Page tables function as before, but linear addresses are now translated to "guest physical" addresses first and not physical addresses directly. A new set of paging registers now exists under the traditional paging mechanism and translates from guest physical addresses to host physical addresses, which are used to access memory.

  Nested paging eliminates the overhead caused by VM exits and page table accesses. In essence, with nested page tables the guest can handle paging without intervention from the hypervisor. Nested paging thus significantly improves virtualization performance.

  On AMD processors, nested paging has been available starting with the Barcelona (K10) architecture – they call it now "rapid virtualization indexing" (RVI). Intel added support for nested paging, which they call "extended page tables" (EPT), with their Core i7 (Nehalem) processors.

  If nested paging is enabled, the VirtualBox hypervisor can also use **large pages** to reduce TLB usage and overhead. This can yield a performance improvement of up to 5%. To

[2] VirtualBox 2.0 added support for AMD's nested paging; support for Intel's EPT and VPIDs was added with version 2.1.

enable this feature for a VM, you need to use the `VBoxManage modifyvm --largepages` command; see chapter 8.7, *VBoxManage modifyvm*, page 110.

- On Intel CPUs, another hardware feature called **"Virtual Processor Identifiers" (VPIDs)** can greatly accelerate context switching by reducing the need for expensive flushing of the processor's Translation Lookaside Buffers (TLBs).

  To enable these features for a VM, you need to use the `VBoxManage modifyvm --vtxvpid` and `--largepages` commands; see chapter 8.7, *VBoxManage modifyvm*, page 110.

11 VirtualBox programming interfaces

VirtualBox comes with comprehensive support for third-party developers. The so-called "Main API" of VirtualBox exposes the entire feature set of the virtualization engine. It is completely documented and available to anyone who wishes to control VirtualBox programmatically.

The Main API is made available to C++ clients through COM (on Windows hosts) or XPCOM (on other hosts). Bridges also exist for SOAP, Java and Python.

All programming information (documentation, reference information, header and other interface files as well as samples) have been split out to a separate **Software Development Kit (SDK),** which is available for download from http://www.virtualbox.org. In particular, the SDK comes with a "Programming Guide and Reference" in PDF format, which contains, among other things, the information that was previously in this chapter of the User Manual.

12 Troubleshooting

This chapter provides answers to commonly asked questions. In order to improve your user experience with VirtualBox, it is recommended to read this section to learn more about common pitfalls and get recommendations on how to use the product.

12.1 Procedures and tools

12.1.1 Categorizing and isolating problems

More often than not, a virtualized guest behaves like a physical system. Any problems that a physical machine would encounter, a virtual machine will encounter as well. If, for example, Internet connectivity is lost due to external issues, virtual machines will be affected just as much as physical ones.

If a true VirtualBox problem is encountered, it helps to categorize and isolate the problem first. Here are some of the questions that should be answered before reporting a problem:

1. Is the problem specific to a certain guest OS? Specific release of a guest OS? Especially with Linux guest related problems, the issue may be specific to a certain distribution and version of Linux.

2. Is the problem specific to a certain host OS? Problems are usually not host OS specific (because most of the VirtualBox code base is shared across all supported platforms), but especially in the areas of networking and USB support, there are significant differences between host platforms. Some GUI related issues are also host specific.

3. Is the problem specific to certain host hardware? This category of issues is typically related to the host CPU. Because of significant differences between VT-x and AMD-V, problems may be specific to one or the other technology. The exact CPU model may also make a difference (even for software virtualization) because different CPUs support different features, which may affect certain aspects of guest CPU operation.

4. Is the problem specific to a certain virtualization mode? Some problems may only occur in software virtualization mode, others may be specific to hardware virtualization.

5. Is the problem specific to guest SMP? That is, is it related to the number of virtual CPUs (VCPUs) in the guest? Using more than one CPU usually significantly affects the internal operation of a guest OS.

6. Is the problem specific to the Guest Additions? In some cases, this is a given (e.g., a shared folders problem), in other cases it may be less obvious (for example, display problems). And if the problem is Guest Additions specific, is it also specific to a certain version of the Additions?

7. Is the problem specific to a certain environment? Some problems are related to a particular environment external to the VM; this usually involves network setup. Certain configurations of external servers such as DHCP or PXE may expose problems which do not occur with other, similar servers.

8. Is the problem a regression? Knowing that an issue is a regression usually makes it significantly easier to find the solution. In this case, it is crucial to know which version is affected and which is not.

12.1.2 Collecting debugging information

For problem determination, it is often important to collect debugging information which can be analyzed by VirtualBox support. This section contains information about what kind of information can be obtained.

Every time VirtualBox starts up a VM, a so-called **"release log file"** is created containing lots of information about the VM configuration and runtime events. The log file is called `VBox.log` and resides in the VM log file folder. Typically this will be a directory like this:

```
$HOME/VirtualBox VMs/{machinename}/Logs
```

When starting a VM, the configuration file of the last run will be renamed to `.1`, up to `.3`. Sometimes when there is a problem, it is useful to have a look at the logs. Also when requesting support for VirtualBox, supplying the corresponding log file is mandatory.

For convenience, for each virtual machine, the VirtualBox main window can show these logs in a window. To access it, select a virtual machine from the list on the left and select "Show logs..." from the "Machine" window.

The release log file (VBox.log) contains a wealth of diagnostic information, such as Host OS type and version, VirtualBox version and build (32-bit or 64-bit), a complete dump of the guest's configuration (CFGM), detailed information about the host CPU type and supported features, whether hardware virtualization is enabled, information about VT-x/AMD-V setup, state transitions (creating, running, paused, stopping, etc.), guest BIOS messages, Guest Additions messages, device-specific log entries and, at the end of execution, final guest state and condensed statistics.

In case of crashes, it is very important to collect **crash dumps**. This is true for both host and guest crashes. For information about enabling core dumps on Linux, Solaris, and OS X systems, refer to the core dump article on the VirtualBox website.[1]

You can also use `VBoxManage debugvm` to create a dump of a complete virtual machine; see chapter 8.30, *VBoxManage debugvm*, page 132.

For network related problems, it is often helpful to capture a trace of network traffic. If the traffic is routed through an adapter on the host, it is possible to use Wireshark or a similar tool to capture the traffic there. However, this often also includes a lot of traffic unrelated to the VM.

VirtualBox provides an ability to capture network traffic only on a specific VM's network adapter. Refer to the network tracing article on the VirtualBox website[2] for information on enabling this capture. The trace files created by VirtualBox are in `.pcap` format and can be easily analyzed with Wireshark.

12.1.3 The built-in VM debugger

VirtualBox includes a built-in VM debugger, which advanced users may find useful. This debugger allows for examining and, to some extent, controlling the VM state.

> **Warning:** Use the VM debugger at your own risk. There is no support for it, and the following documentation is only made available for advanced users with a very high level of familiarity with the x86/AMD64 machine instruction set, as well as detailed knowledge of the PC architecture. A degree of familiarity with the internals of the guest OS in question may also be very helpful.

The VM debugger is available in all regular production versions of VirtualBox, but it is disabled by default because the average user will have little use for it. There are two ways to access the debugger:

[1] http://www.virtualbox.org/wiki/Core_dump.
[2] http://www.virtualbox.org/wiki/Network_tips.

- A debugger console window displayed alongside the VM
- Via the `telnet` protocol at port 5000

The debugger can be enabled in three ways:

- Start the VM directly using `VirtualBox --startvm`, with an additional `--dbg`, `--debug`, or `--debug-command-line` argument. See the VirtualBox usage help for details.
- Set the `VBOX_GUI_DBG_ENABLED` or `VBOX_GUI_DBG_AUTO_SHOW` environment variable to `true` before launching the VirtualBox process. Setting these variables (only their presence is checked) is effective even when the first VirtualBox process is the VM selector window. VMs subsequently launched from the selector will have the debugger enabled.
- Set the `GUI/Dbg/Enabled` extra data item to `true` before launching the VM. This can be set globally or on a per VM basis.

A new 'Debug' menu entry will be added to the VirtualBox application. This menu allows the user to open the debugger console.

The VM debugger command syntax is loosely modeled on Microsoft and IBM debuggers used on DOS, OS/2 and Windows. Users familiar with symdeb, CodeView, or the OS/2 kernel debugger will find the VirtualBox VM debugger familiar.

The most important command is `help`. This will print brief usage help for all debugger commands. The set of commands supported by the VM debugger changes frequently and the `help` command is always up-to-date.

A brief summary of frequently used commands follows:

- `stop` – stops the VM execution and enables single stepping
- `g` – continue VM execution
- `t` – single step an instruction
- `rg/rh/r` – print the guest/hypervisor/current registers
- `kg/kh/k` – print the guest/hypervisor/current call stack
- `da/db/dw/dd/dq` – print memory contents as ASCII/bytes/words/dwords/qwords
- `u` – unassemble memory
- `dg` – print the guest's GDT
- `di` – print the guest's IDT
- `dl` – print the guest's LDT
- `dt` – print the guest's TSS
- `dp*` – print the guest's page table structures
- `bp/br` – set a normal/recompiler breakpoint
- `bl` – list breakpoints
- `bc` – clear a breakpoint
- `writecore` – writes a VM core file to disk, refer chapter 12.1.4, *VM core format*, page 171

See the built-in `help` for other available commands.

The VM debugger supports symbolic debugging, although symbols for guest code are often not available. For Solaris guests, the `detect` command automatically determines the guest OS version and locates kernel symbols in guest's memory. Symbolic debugging is then available. For Linux guests, the `detect` commands also determines the guest OS version, but there are no symbols in the guest's memory. Kernel symbols are available in the file `/proc/kallsyms` on Linux guests. This file must be copied to the host, for example using `scp`. The `loadmap` debugger command can be used to make the symbol information available to the VM debugger. Note that the `kallsyms` file contains the symbols for the currently loaded modules; if the guest's configuration changes, the symbols will change as well and must be updated.

For all guests, a simple way to verify that the correct symbols are loaded is the `k` command. The guest is normally idling and it should be clear from the symbolic information that the guest operating system's idle loop is being executed.

Another group of debugger commands is the set of `info` commands. Running `info help` provides complete usage information. The information commands provide ad-hoc data pertinent to various emulated devices and aspects of the VMM. There is no general guideline for using the `info` commands, the right command to use depends entirely on the problem being investigated. Some of the info commands are:

- `cfgm` – print a branch of the configuration tree
- `cpuid` – display the guest CPUID leaves
- `ioport` – print registered I/O port ranges
- `mmio` – print registered MMIO ranges
- `mode` – print the current paging mode
- `pit` – print the i8254 PIT state
- `pic` – print the i8259A PIC state
- `ohci/ehci` – print a subset of the OHCI/EHCI USB controller state
- `pcnet0` – print the PCnet state
- `vgatext` – print the contents of the VGA framebuffer formatted as standard text mode
- `timers` – print all VM timers

The output of the `info` commands generally requires in-depth knowledge of the emulated device and/or VirtualBox VMM internals. However, when used properly, the information provided can be invaluable.

12.1.4 VM core format

VirtualBox uses the 64-bit ELF format for its VM core files created by `VBoxManage debugvm`; see chapter 8.30, *VBoxManage debugvm*, page 132. The VM core file contain the memory and CPU dumps of the VM and can be useful for debugging your guest OS. The 64-bit ELF object format specficiation can be obtained here: `http://downloads.openwatcom.org/ftp/devel/docs/elf-64-gen.pdf`.

The overall layout of the VM core format is as follows:

```
[ ELF 64 Header]
[ Program Header, type PT_NOTE ]
  -> offset to COREDESCRIPTOR
[ Program Header, type PT_LOAD ] - one for each contiguous physical memory range
  -> Memory offset of range
```

```
  -> File offset
[ Note Header, type NT_VBOXCORE ]
[ COREDESCRIPTOR ]
  -> Magic
  -> VM core file version
  -> VBox version
  -> Number of vCPUs etc.
[ Note Header, type NT_VBOXCPU ] - one for each vCPU
[ vCPU 1 Note Header ]
  [ CPUMCTX - vCPU 1 dump ]
[ Additional Notes + Data ] - currently unused
[ Memory dump ]
```

The memory descriptors contain physical addresses relative to the guest and not virtual addresses. Regions of memory such as MMIO regions are not included in the core file.

The relevant data structures and definitions can be found in the VirtualBox sources under the following header files: `include/VBox/dbgfcorefmt.h`, `include/VBox/cpumctx.h` and `src/VBox/Runtime/include/internal/ldrELFCommon.h`.

The VM core file can be inspected using `elfdump` and GNU `readelf` or other similar utilities.

12.2 General

12.2.1 Guest shows IDE/SATA errors for file-based images on slow host file system

Occasionally, some host file systems provide very poor writing performance and as a consequence cause the guest to time out IDE/SATA commands. This is normal behavior and should normally cause no real problems, as the guest should repeat commands that have timed out. However some guests (e.g. some Linux versions) have severe problems if a write to an image file takes longer than about 15 seconds. Some file systems however require more than a minute to complete a single write, if the host cache contains a large amount of data that needs to be written.

The symptom for this problem is that the guest can no longer access its files during large write or copying operations, usually leading to an immediate hang of the guest.

In order to work around this problem (the true fix is to use a faster file system that doesn't exhibit such unacceptable write performance), it is possible to flush the image file after a certain amount of data has been written. This interval is normally infinite, but can be configured individually for each disk of a VM.

For IDE disks use the following command:

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/piix3ide/0/LUN#[x]/Config/FlushInterval" [b]
```

For SATA disks use the following command:

```
VBoxManage setextradata "VM name"
      "VBoxInternal/Devices/ahci/0/LUN#[x]/Config/FlushInterval" [b]
```

The value [x] that selects the disk for IDE is 0 for the master device on the first channel, 1 for the slave device on the first channel, 2 for the master device on the second channel or 3 for the master device on the second channel. For SATA use values between 0 and 29. Only disks support this configuration option; it must not be set for CD/DVD drives.

The unit of the interval [b] is the number of bytes written since the last flush. The value for it must be selected so that the occasional long write delays do not occur. Since the proper flush interval depends on the performance of the host and the host filesystem, finding the optimal value that makes the problem disappear requires some experimentation. Values between 1000000 and 10000000 (1 to 10 megabytes) are a good starting point. Decreasing the interval both decreases the probability of the problem and the write performance of the guest. Setting the value unnecessarily low will cost performance without providing any benefits. An interval of 1 will cause a

flush for each write operation and should solve the problem in any case, but has a severe write performance penalty.

Providing a value of 0 for [b] is treated as an infinite flush interval, effectively disabling this workaround. Removing the extra data key by specifying no value for [b] has the same effect.

12.2.2 Responding to guest IDE/SATA flush requests

If desired, the virtual disk images can be flushed when the guest issues the IDE FLUSH CACHE command. Normally these requests are ignored for improved performance. The parameters below are only accepted for disk drives. They must not be set for DVD drives.

To enable flushing for IDE disks, issue the following command:

```
VBoxManage setextradata "VM name" "VBoxInternal/Devices/piix3ide/0/LUN#[x]/Config/IgnoreFlush" 0
```

The value [x] that selects the disk is 0 for the master device on the first channel, 1 for the slave device on the first channel, 2 for the master device on the second channel or 3 for the master device on the second channel.

To enable flushing for SATA disks, issue the following command:

```
VBoxManage setextradata "VM name" "VBoxInternal/Devices/ahci/0/LUN#[x]/Config/IgnoreFlush" 0
```

The value [x] that selects the disk can be a value between 0 and 29.

Note that this doesn't affect the flushes performed according to the configuration described in chapter 12.2.1, *Guest shows IDE/SATA errors for file-based images on slow host file system*, page 172. Restoring the default of ignoring flush commands is possible by setting the value to 1 or by removing the key.

12.2.3 Poor performance caused by host power management

On some hardware platforms and operating systems, virtualization peformance is negatively affected by host CPU power management. The symptoms may be choppy audio in the guest or erratic guest clock behavior.

Some of the problems may be caused by firmware and/or host operating system bugs. Therefore, updating the firmware and applying operating systems fixes is recommended.

For optimal virtualization performance, the C1E power state support in the system's BIOS should be disabled, if such a setting is available (not all systems support the C1E power state). Disabling other power management settings may also improve performance. However, a balance between performance and power consumption must always be considered.

12.2.4 GUI: 2D Video Acceleration option is grayed out

To use 2D Video Acceleration within VirtualBox, your host's video card should support certain OpenGL extensions. On startup, VirtualBox checks for those extensions, and, if the test fails, this option is silently grayed out.

To find out why it has failed, you can manually execute the following command:

```
VBoxTestOGL --log "log_file_name" --test 2D
```

It will list the required OpenGL extensions one by one and will show you which one failed the test. This usually means that you are running an outdated or misconfigured OpenGL driver on your host. It can also mean that your video chip is lacking required functionality.

12.3 Windows guests

12.3.1 Windows bluescreens after changing VM configuration

Changing certain virtual machine settings can cause Windows guests to fail during start up with a bluescreen. This may happen if you change VM settings after installing Windows, or if you copy a disk image with an already installed Windows to a newly created VM which has settings that differ from the original machine.

This applies in particular to the following settings:

- The ACPI and I/O APIC settings should never be changed after installing Windows. Depending on the presence of these hardware features, the Windows installation program chooses special kernel and device driver versions and will fail to startup should these hardware features be removed. (Enabling them for a Windows VM which was installed without them does not cause any harm. However, Windows will not use these features in this case.)
- Changing the storage controller hardware will cause bootup failures as well. This might also apply to you if you copy a disk image from an older version of VirtualBox to a virtual machine created with a newer VirtualBox version; the default subtype of IDE controller hardware was changed from PIIX3 to PIIX4 with VirtualBox 2.2. Make sure these settings are identical.

12.3.2 Windows 0x101 bluescreens with SMP enabled (IPI timeout)

If a VM is configured to have more than one processor (symmetrical multiprocessing, SMP), some configurations of Windows guests crash with an 0x101 error message, indicating a timeout for inter-processor interrupts (IPIs). These interrupts synchronize memory management between processors.

According to Microsoft, this is due to a race condition in Windows. A hotfix is available.[3] If this does not help, please reduce the number of virtual processors to 1.

12.3.3 Windows 2000 installation failures

When installing Windows 2000 guests, you might run into one of the following issues:

- Installation reboots, usually during component registration.
- Installation fills the whole hard disk with empty log files.
- Installation complains about a failure installing msgina.dll.

These problems are all caused by a bug in the hard disk driver of Windows 2000. After issuing a hard disk request, there is a race condition in the Windows driver code which leads to corruption if the operation completes too fast, i.e. the hardware interrupt from the IDE controller arrives too soon. With physical hardware, there is a guaranteed delay in most systems so the problem is usually hidden there (however it should be possible to reproduce it on physical hardware as well). In a virtual environment, it is possible for the operation to be done immediately (especially on very fast systems with multiple CPUs) and the interrupt is signaled sooner than on a physical system. The solution is to introduce an artificial delay before delivering such interrupts. This delay can be configured for a VM using the following command:

```
VBoxManage setextradata "VM name" "VBoxInternal/Devices/piix3ide/0/Config/IRQDelay" 1
```

This sets the delay to one millisecond. In case this doesn't help, increase it to a value between 1 and 5 milliseconds. Please note that this slows down disk performance. After installation, you should be able to remove the key (or set it to 0).

[3] See http://support.microsoft.com/kb/955076.

12.3.4 How to record bluescreen information from Windows guests

When Windows guests run into a kernel crash, they display the infamous bluescreen. Depending on how Windows is configured, the information will remain on the screen until the machine is restarted or it will reboot automatically. During installation, Windows is usually configured to reboot automatically. With automatic reboots, there is no chance to record the bluescreen information which might be important for problem determination.

VirtualBox provides a method of halting a guest when it wants to perform a reset. In order to enable this feature, issue the following command:

```
VBoxManage setextradata "VM name" "VBoxInternal/PDM/HaltOnReset" 1
```

12.3.5 No networking in Windows Vista guests

With Windows Vista, Microsoft dropped support for the AMD PCNet card that VirtualBox used to provide as the default virtual network card before version 1.6.0. For Windows Vista guests, VirtualBox now uses an Intel E1000 card by default.

If, for some reason, you still want to use the AMD card, you need to download the PCNet driver from the AMD website (available for 32-bit Windows only). You can transfer it into the virtual machine using a shared folder, see (see chapter 4.3, *Shared folders*, page 62).

12.3.6 Windows guests may cause a high CPU load

Several background applications of Windows guests, especially virus scanners, are known to increases the CPU load notably even if the guest appears to be idle. We recommend to deactivate virus scanners within virtualized guests if possible.

12.3.7 Long delays when accessing shared folders

The performance for accesses to shared folders from a Windows guest might be decreased due to delays during the resolution of the VirtualBox shared folders name service. To fix these delays, add the following entries to the file `\windows\system32\drivers\etc\lmhosts` of the Windows guest:

```
255.255.255.255        VBOXSVR #PRE
255.255.255.255        VBOXSRV #PRE
```

After doing this change, a reboot of the guest is required.

12.4 Linux and X11 guests

12.4.1 Linux guests may cause a high CPU load

Some Linux guests may cause a high CPU load even if the guest system appears to be idle. This can be caused by a high timer frequency of the guest kernel. Some Linux distributions, for example Fedora, ship a Linux kernel configured for a timer frequency of **1000Hz**. We recommend to recompile the guest kernel and to select a timer frequency of 100Hz.

Linux kernels shipped with Red Hat Enterprise Linux (RHEL) as of release 4.7 and 5.1 as well as kernels of related Linux distributions (for instance CentOS and Oracle Enterprise Linux) support a kernel parameter *divider=N*. Hence, such kernels support a lower timer frequency without recompilation. We suggest to add the kernel parameter *divider=10* to select a guest kernel timer frequency of 100Hz.

12.4.2 AMD Barcelona CPUs

Most Linux-based guests will fail with AMD Phenoms or Barcelona-level Opterons due to a bug in the Linux kernel. Enable the I/O-APIC to work around the problem (see chapter 3.4, *System settings*, page 43).

12.4.3 Buggy Linux 2.6 kernel versions

The following bugs in Linux kernels prevent them from executing correctly in VirtualBox, causing VM boot crashes:

- The Linux kernel version 2.6.18 (and some 2.6.17 versions) introduced a race condition that can cause boot crashes in VirtualBox. Please use a kernel version 2.6.19 or later.
- With hardware virtualization and the I/O APIC enabled, kernels before 2.6.24-rc6 may panic on boot with the following message:

  ```
  Kernel panic - not syncing: IO-APIC + timer doesn't work!  Boot with
  apic=debug and send a report.  Then try booting with the 'noapic' option
  ```

  If you see this message, either disable hardware virtualization or the I/O APIC (see chapter 3.4, *System settings*, page 43), or upgrade the guest to a newer kernel.[4]

12.4.4 Shared clipboard, auto-resizing and seamless desktop in X11 guests

Guest desktop services in guests running the X11 window system (Solaris, Linux and others) are provided by a guest service called `VBoxClient`, which runs under the ID of the user who started the desktop session and is automatically started using the following command lines

```
VBoxClient --clipboard
VBoxClient --display
VBoxClient --seamless
```

when your X11 user session is started if you are using a common desktop environment (Gnome, KDE and others). If a particular desktop service is not working correctly, it is worth checking whether the process which should provide it is running.

The `VBoxClient` processes create files in the user's home directory with names of the form `.vboxclient-*.pid` when they are running in order to prevent a given service from being started twice. It can happen due to misconfiguration that these files are created owned by root and not deleted when the services are stopped, which will prevent them from being started in future sessions. If the services cannot be started, you may wish to check whether these files still exist.

12.5 Windows hosts

12.5.1 VBoxSVC out-of-process COM server issues

VirtualBox makes use of the Microsoft Component Object Model (COM) for inter- and intra-process communication. This allows VirtualBox to share a common configuration among different virtual machine processes and provide several user interface options based on a common architecture. All global status information and configuration is maintained by the process `VBoxSVC.exe`, which is an out-of-process COM server. Whenever a VirtualBox process is started,

[4] See http://www.mail-archive.com/git-commits-head@vger.kernel.org/msg30813.html for details about the kernel fix.

it requests access to the COM server and Windows automatically starts the process. Note that it should never be started by the end user.

When the last process disconnects from the COM server, it will terminate itself after some seconds. The VirtualBox configuration (XML files) is maintained and owned by the COM server and the files are locked whenever the server runs.

In some cases - such as when a virtual machine is terminated unexpectedly - the COM server will not notice that the client is disconnected and stay active for a longer period (10 minutes or so) keeping the configuration files locked. In other rare cases the COM server might experience an internal error and subsequently other processes fail to initialize it. In these situations, it is recommended to use the Windows task manager to kill the process `VBoxSVC.exe`.

12.5.2 CD/DVD changes not recognized

In case you have assigned a physical CD/DVD drive to a guest and the guest does not notice when the medium changes, make sure that the Windows media change notification (MCN) feature is not turned off. This is represented by the following key in the Windows registry:

```
HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\Cdrom\Autorun
```

Certain applications may disable this key against Microsoft's advice. If it is set to 0, change it to 1 and reboot your system. VirtualBox relies on Windows notifying it of media changes.

12.5.3 Sluggish response when using Microsoft RDP client

If connecting to a Virtual Machine via the Microsoft RDP client (called Remote Desktop Connection), there can be large delays between input (moving the mouse over a menu is the most obvious situation) and output. This is because this RDP client collects input for a certain time before sending it to the RDP server.

The interval can be decreased by setting a Windows registry key to smaller values than the default of 100. The key does not exist initially and must be of type DWORD. The unit for its values is milliseconds. Values around 20 are suitable for low-bandwidth connections between the RDP client and server. Values around 4 can be used for a gigabit Ethernet connection. Generally values below 10 achieve a performance that is very close to that of the local input devices and screen of the host on which the Virtual Machine is running.

Depending whether the setting should be changed for an individual user or for the system, either

```
HKEY_CURRENT_USER\Software\Microsoft\Terminal Server Client\Min Send Interval
```

or

```
HKEY_LOCAL_MACHINE\Software\Microsoft\Terminal Server Client\Min Send Interval
```

can be set appropriately.

12.5.4 Running an iSCSI initiator and target on a single system

Deadlocks can occur on a Windows host when attempting to access an iSCSI target running in a guest virtual machine with an iSCSI initiator (e.g. Microsoft iSCSI Initiator) that is running on the host. This is caused by a flaw in the Windows cache manager component, and causes sluggish host system response for several minutes, followed by a "Delayed Write Failed" error message in the system tray or in a separate message window. The guest is blocked during that period and may show error messages or become unstable.

Setting the environment variable `VBOX_DISABLE_HOST_DISK_CACHE` to 1 will enable a workaround for this problem until Microsoft addresses the issue. For example, open a command prompt window and start VirtualBox like this:

```
set VBOX_DISABLE_HOST_DISK_CACHE=1
VirtualBox
```

While this will decrease guest disk performance (especially writes), it does not affect the performance of other applications running on the host.

12.5.5 Bridged networking adapters missing

If no bridged adapters show up in the "Networking" section of the VM settings, this typically means that the bridged networking driver was not installed properly on your host. This could be due to the following reasons:

- The maximum allowed filter count was reached on the host. In this case, the MSI log would mention the `0x8004a029` error code returned on NetFlt network component install:

  ```
  VBoxNetCfgWinInstallComponent: Install failed, hr (0x8004a029)
  ```

  You can try to increase the maximum filter count in the Windows registry at the following key:

  ```
  HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Network\MaxNumFilters
  ```

  The maximum number allowed is 14. After a reboot, try to re-install VirtualBox.

- The INF cache is corrupt. In this case, the install log (`%windir%\inf\setupapi.log` on XP or `%windir%\inf\setupapi.dev.log` on Vista or later) would typically mention the failure to find a suitable driver package for either the `sun_VBoxNetFlt` or `sun_VBoxNetFltmp` components. The solution then is to uninstall VirtualBox, remove the INF cache (`%windir%\inf\INFCACHE.1`), reboot and try to re-install VirtualBox

12.5.6 Host-only networking adapters cannot be created

If host-only adapter cannot be created (either via the Manager or VBoxManage), then the INF cache is probably corrupt. In this case, the install log (`%windir%\inf\setupapi.log` on XP or `%windir%\inf\setupapi.dev.log` on Vista or later) would typically mention the failure to find a suitable driver package for the `sun_VBoxNetAdp` component. Again, as with the bridged networking problem described above, the solution is to uninstall VirtualBox, remove the INF cache (`%windir%\inf\INFCACHE.1`), reboot and try to re-install VirtualBox.

12.6 Linux hosts

12.6.1 Linux kernel module refuses to load

If the VirtualBox kernel module (`vboxdrv`) refuses to load, i.e. you get an "Error inserting vboxdrv: Invalid argument", check (as root) the output of the `dmesg` command to find out why the load failed. Most probably the kernel disagrees with the version of the gcc used to compile the module. Make sure that you use the same compiler as used to build the kernel.

12.6.2 Linux host CD/DVD drive not found

If you have configured a virtual machine to use the host's CD/DVD drive, but this does not appear to work, make sure that the current user has permission to access the corresponding Linux device file (`/dev/hdc` or `/dev/scd0` or `/dev/cdrom` or similar). On most distributions, the user must be added to a corresponding group (usually called `cdrom` or `cdrw`).

12.6.3 Linux host CD/DVD drive not found (older distributions)

On older Linux distributions, if your CD/DVD device has a different name, VirtualBox may be unable to find it. On older Linux hosts, VirtualBox performs the following steps to locate your CD/DVD drives:

1. VirtualBox examines if the environment variable `VBOX_CDROM` is defined (see below). If so, VirtualBox omits all the following checks.
2. VirtualBox tests if `/dev/cdrom` works.
3. In addition, VirtualBox checks if any CD/DVD drives are currently mounted by checking `/etc/mtab`.
4. In addition, VirtualBox checks if any of the entries in `/etc/fstab` point to CD/DVD devices.

In other words, you can try to set VBOX_CDROM to contain a list of your CD/DVD devices, separated by colons, for example as follows:

```
export VBOX_CDROM='/dev/cdrom0:/dev/cdrom1'
```

On modern Linux distributions, VirtualBox uses the hardware abstraction layer (hal) to locate CD and DVD hardware.

12.6.4 Linux host floppy not found

The previous instructions (for CD and DVD drives) apply accordingly to floppy disks, except that on older distributions VirtualBox tests for `/dev/fd*` devices by default, and this can be overridden with the `VBOX_FLOPPY` environment variable.

12.6.5 Strange guest IDE error messages when writing to CD/DVD

If the experimental CD/DVD writer support is enabled with an incorrect VirtualBox, host or guest configuration, it is possible that any attempt to access the CD/DVD writer fails and simply results in guest kernel error messages (for Linux guests) or application error messages (for Windows guests). VirtualBox performs the usual consistency checks when a VM is powered up (in particular it aborts with an error message if the device for the CD/DVD writer is not writable by the user starting the VM), but it cannot detect all misconfigurations. The necessary host and guest OS configuration is not specific for VirtualBox, but a few frequent problems are listed here which occurred in connection with VirtualBox.

Special care must be taken to use the correct device. The configured host CD/DVD device file name (in most cases /dev/cdrom) must point to the device that allows writing to the CD/DVD unit. For CD/DVD writer units connected to a SCSI controller or to a IDE controller that interfaces to the Linux SCSI subsystem (common for some SATA controllers), this must refer to the SCSI device node (e.g. /dev/scd0). Even for IDE CD/DVD writer units this must refer to the appropriate SCSI CD-ROM device node (e.g. /dev/scd0) if the ide-scsi kernel module is loaded. This module is required for CD/DVD writer support with all Linux 2.4 kernels and some early 2.6 kernels. Many Linux distributions load this module whenever a CD/DVD writer is detected in the system, even if the kernel would support CD/DVD writers without the module. VirtualBox supports the use of IDE device files (e.g. /dev/hdc), provided the kernel supports this and the ide-scsi module is not loaded.

Similar rules (except that within the guest the CD/DVD writer is always an IDE device) apply to the guest configuration. Since this setup is very common, it is likely that the default configuration of the guest works as expected.

12.6.6 VBoxSVC IPC issues

On Linux, VirtualBox makes use of a custom version of Mozilla XPCOM (cross platform component object model) for inter- and intra-process communication (IPC). The process `VBoxSVC` serves as a communication hub between different VirtualBox processes and maintains the global configuration, i.e. the XML database. When starting a VirtualBox component, the processes `VBoxSVC` and `VirtualBoxXPCOMIPCD` are started automatically. They are only accessible from the user account they are running under. `VBoxSVC` owns the VirtualBox configuration database which normally resides in `~/.VirtualBox`. While it is running, the configuration files are locked. Communication between the various VirtualBox components and `VBoxSVC` is performed through a local domain socket residing in `/tmp/.vbox-<username>-ipc`. In case there are communication problems (i.e. a VirtualBox application cannot communicate with `VBoxSVC`), terminate the daemons and remove the local domain socket directory.

12.6.7 USB not working

If USB is not working on your Linux host, make sure that the current user is a member of the `vboxusers` group. On older hosts, you need to make sure that the user has permission to access the USB filesystem (`usbfs`), which VirtualBox relies on to retrieve valid information about your host's USB devices. The rest of this section only applies to those older systems.

As `usbfs` is a virtual filesystem, a `chmod` on `/proc/bus/usb` has no effect. The permissions for `usbfs` can therefore *only* be changed by editing the `/etc/fstab` file.

For example, most Linux distributions have a user group called `usb` or similar, of which the current user must be a member. To give all users of that group access to usbfs, make sure the following line is present:

```
# 85 is the USB group
none     /proc/bus/usb     usbfs      devgid=85,devmode=664    0    0
```

Replace 85 with the group ID that matches your system (search `/etc/group` for "usb" or similar). Alternatively, if you don't mind the security hole, give all users access to USB by changing "664" to "666".

The various distributions are very creative from which script the `usbfs` filesystem is mounted. Sometimes the command is hidden in unexpected places. For SuSE 10.0 the mount command is part of the udev configuration file `/etc/udev/rules.d/50-udev.rules`. As this distribution has no user group called `usb`, you may e.g. use the `vboxusers` group which was created by the VirtualBox installer. Since group numbers are allocated dynamically, the following example uses 85 as a placeholder. Modify the line containing (a linebreak has been inserted to improve readability)

```
DEVPATH="/module/usbcore", ACTION=="add",
    RUN+="/bin/mount -t usbfs usbfs /proc/bus/usb"
```

and add the necessary options (make sure that everything is in a single line):

```
DEVPATH="/module/usbcore", ACTION=="add",
    RUN+="/bin/mount -t usbfs usbfs /proc/bus/usb -o devgid=85,devmode=664"
```

Debian Etch has the mount command in `/etc/init.d/mountkernfs.sh`. Since that distribution has no group `usb`, it is also the easiest solution to allow all members of the group `vboxusers` to access the USB subsystem. Modify the line

```
domount usbfs usbdevfs /proc/bus/usb -onoexec,nosuid,nodev
```

so that it contains

```
domount usbfs usbdevfs /proc/bus/usb -onoexec,nosuid,nodev,devgid=85,devmode=664
```

As usual, replace the 85 with the actual group number which should get access to USB devices. Other distributions do similar operations in scripts stored in the `/etc/init.d` directory.

12.6.8 PAX/grsec kernels

Linux kernels including the grsec patch (see http://www.grsecurity.net/) and derivates have to disable PAX_MPROTECT for the VBox binaries to be able to start a VM. The reason is that VBox has to create executable code on anonymous memory.

12.6.9 Linux kernel vmalloc pool exhausted

When running a large number of VMs with a lot of RAM on a Linux system (say 20 VMs with 1GB of RAM each), additional VMs might fail to start with a kernel error saying that the vmalloc pool is exhausted and should be extended. The error message also tells you to specify `vmalloc=256MB` in your kernel parameter list. If adding this parameter to your GRUB or LILO configuration makes the kernel fail to boot (with a weird error message such as "failed to mount the root partition"), then you have probably run into a memory conflict of your kernel and initial RAM disk. This can be solved by adding the following parameter to your GRUB configuration:

```
uppermem 524288
```

12.7 Solaris hosts

12.7.1 Cannot start VM, not enough contiguous memory

The ZFS file system is known to use all available RAM as cache if the default system settings are not changed. This may lead to a heavy fragmentation of the host memory preventing VirtualBox VMs from being started. We recommend to limit the ZFS cache by adding a line

```
set zfs:zfs_arc_max = xxxx
```

to /etc/system where xxxx bytes is the amount of memory usable for the ZFS cache.

12.7.2 VM aborts with out of memory errors on Solaris 10 hosts

32-bit Solaris 10 hosts (bug 1225025) require swap space equal to, or greater than the host's physical memory size. For example, 8 GB physical memory would require at least 8 GB swap. This can be configured during a Solaris 10 install by choosing a 'custom install' and changing the default partitions.

> **Note:** This restriction applies only to 32-bit Solaris hosts, 64-bit hosts are not affected!

For existing Solaris 10 installs, an additional swap image needs to be mounted and used as swap. Hence if you have 1 GB swap and 8 GB of physical memory, you require to add 7 GB more swap. This can be done as follows:

For ZFS (as root user):

```
zfs create -V 8gb /_<ZFS volume>_/swap
swap -a /dev/zvol/dsk/_<ZFS volume>_/swap
```

To mount if after reboot, add the following line to /etc/vfstab:

```
/dev/zvol/dsk/_<ZFS volume>_/swap - - swap - no -
```

Alternatively, you could grow the existing swap using:

```
zfs set volsize=8G rpool/swap
```

And reboot the system for the changes to take effect.
For UFS (as root user):

```
mkfile 7g /path/to/swapfile.img
swap -a /path/to/swapfile.img
```

To mount it after reboot, add the following line to /etc/vfstab:

```
/path/to/swap.img - - swap - no -
```

13 Security considerations

13.1 Potentially insecure operations

The following features of VirtualBox can present security problems:

- Enabling 3D graphics via the Guest Additions exposes the host to additional security risks; see chapter 4.4.1, *Hardware 3D acceleration (OpenGL and Direct3D 8/9)*, page 64.
- When teleporting a machine, the data stream through which the machine's memory contents are transferred from one host to another is not encrypted. A third party with access to the network through which the data is transferred could therefore intercept that data.
- When using the VirtualBox web service to control a VirtualBox host remotely, connections to the web service (through which the API calls are transferred via SOAP XML) are not encrypted, but use plain HTTP. This is a potential security risk! For details about the web service, please see chapter 11, *VirtualBox programming interfaces*, page 167.
- All traffic sent over an UDP Tunnel network attachment is not encrypted. You can either encrypt it on the host network level (with IPsec), or use encrypted protocols in the guest network (such as SSH). The security properties are similar to bridged Ethernet.

13.2 Authentication

The following components of VirtualBox can use passwords for authentication:

- When using the VirtualBox extension pack provided by Oracle for VRDP remote desktop support, you can optionally use various methods to configure RDP authentication. The "null" method is very insecure and should be avoided in a public network. See chapter 7.1.5, *RDP authentication*, page 95 for details.
- When using teleporting, passwords can optionally be used to protect a machine waiting to be teleported from unauthorized access. Note however that these passwords are stored **unencrypted** in the machine configuration XML and therefore potentially readable on the host. See chapter 7.2, *Teleporting*, page 98 and chapter 8.7.5, *Teleporting settings*, page 116.
- When using remote iSCSI storage and the storage server requires authentication, a password can optionally be supplied with the `VBoxManage storageattach` command. Note however that this is stored **unencrypted** in the machine configuration and is therefore potentially readable on the host. See chapter 5.10, *iSCSI servers*, page 82 and chapter 8.16, *VBoxManage storageattach*, page 121.
- When using the VirtualBox web service to control a VirtualBox host remotely, connections to the web service are authenticated in various ways. This is described in detail in the VirtualBox Software Development Kit (SDK) reference; please see chapter 11, *VirtualBox programming interfaces*, page 167.

13.3 Encryption

The following components of VirtualBox use encryption to protect sensitive data:

- When using the VirtualBox extension pack provided by Oracle for VRDP remote desktop support, RDP data can optionally be encrypted. See chapter 7.1.6, *RDP encryption*, page 96 for details.

14 Known limitations

This sections describes known problems with VirtualBox 4.1.0_BETA1. Unless marked otherwise, these issues are planned to be fixed in later releases.

- The following **Guest SMP (multiprocessor) limitations** exist:
  - **Poor performance** with 32-bit guests on AMD CPUs. This affects mainly Windows and Solaris guests, but possibly also some Linux kernel revisions. Partially solved in 3.0.6 for 32 bits Windows NT, 2000, XP and 2003 guests. Requires 3.0.6 or higher Guest Additions to be installed.
  - **Poor performance** with 32-bit guests on certain Intel CPU models that do not include virtual APIC hardware optimization support. This affects mainly Windows and Solaris guests, but possibly also some Linux kernel revisions. Partially solved in 3.0.12 for 32 bits Windows NT, 2000, XP and 2003 guests. Requires 3.0.12 or higher Guest Additions to be installed.
- **64-bit guests on some 32-bit host systems with VT-x** can cause instabilities to your system. If you experience this, do not attempt to execute 64-bit guests. Refer to the VirtualBox user forum for additional information.
- For **Direct3D support in Windows guests** to work, the Guest Additions must be installed in Windows "safe mode". Press F8 when the Windows guest is booting and select "Safe mode", then install the Guest Additions. Otherwise Windows' file protection mechanism will interfere with the replacement DLLs installed by VirtualBox and keep restoring the original Windows system DLLs.
- **Guest control.** On Windows guests, a process lauched via the guest control execute support will not be able to display a graphical user interface *unless* the user account under which it is running is currently logged in and has a desktop session.

  Also, to use accounts without or with an empty password, the guest's group policy must be changed. To do so, open the group policy editor on the command line by typing `gpedit.msc`, open the key *Computer Configuration\Windows Settings\Security Settings\Local Policies\Security Options* and change the value of *Accounts: Limit local account use of blank passwords to console logon only* to *Disabled*.
- **Compacting virtual disk images is limited to VDI files.** The `VBoxManage modifyhd --compact` command is currently only implemented for VDI files. At the moment the only way to optimize the size of a virtual disk images in other formats (VMDK, VHD) is to clone the image and then use the cloned image in the VM configuration.
- **OVF import/export:**
  - OVF localization (multiple languages in one OVF file) is not yet supported.
  - Some OVF sections like StartupSection, DeploymentOptionSection and InstallSection are ignored.
  - OVF environment documents, including their property sections and appliance configuration with ISO images, are not yet supported.
  - Remote files via HTTP or other mechanisms are not yet supported.
- Neither **scale mode** nor **seamless mode** work correctly with guests using OpenGL 3D features (such as with compiz-enabled window managers).

- On **Mac OS X hosts,** the following features are not yet implemented:
  - Numlock emulation
  - CPU frequency metric
  - Memory ballooning
- **Mac OS X Server guests:**
  - Mac OS X Server guests can only run on a certain host hardware. For details about license and host hardware limitations, please see chapter 3.1.1, *Mac OS X Server guests*, page 40.
  - VirtualBox does not provide Guest Additions for Mac OS X Server at this time.
  - The graphics resolution currently defaults to 1024x768 as Mac OS X Server falls back to the built-in EFI display support. See chapter 3.12.1, *Video modes in EFI*, page 52 for more information on how to change EFI video modes.
  - Even when idle, Mac OS X Server guests currently burn 100% CPU. This is a power management issue that will be addressed in a future release.
  - Mac OS X Server guests only work with one CPU assigned to the VM. Support for SMP will be provided in a future release.
  - Depending on your system and version of Mac OS X Server, you might experience guest hangs after some time. This can be fixed by turning off energy saving (set timeout to "Never") in the system preferences.
  - By default, the VirtualBox EFI enables debug output of the Mac OS X Server kernel to help you diagnose boot problems. Note that there is a lot of output and not all errors are fatal (they would also show on your physical Mac). You can turn off these messages by issuing this command:

    ```
    VBoxManage setextradata "VM name" "VBoxInternal2/EfiBootArgs" "  "
    ```

    To revert to the previous behavior, use:

    ```
    VBoxManage setextradata "VM name" "VBoxInternal2/EfiBootArgs" ""
    ```
- **Solaris hosts:**
  - There is no support for USB devices connected to Solaris 10 hosts.
  - USB support on Solaris hosts requires kernel version snv_124 or higher. Webcams and other isochronous devices are known to have poor performance.
  - No ACPI information (battery status, power source) is reported to the guest.
  - No support for using wireless adapters with bridged networking.
- **Guest Additions for OS/2.** Shared folders are not yet supported with OS/2 guests. In addition, seamless windows and automatic guest resizing will probably never be implemented due to inherent limitations of the OS/2 graphics system.

15 Change log

This section summarizes the changes between VirtualBox versions. Note that this change log is not exhaustive; not all changes are listed.

VirtualBox version numbers consist of three numbers separated by dots where the first and second number represent the major version and the 3rd number the minor version. Minor version numbers of official releases are always even. An odd minor version number represents an internal development or test build. In addition, each build contains a revision number.

15.1 Version 4.1.0 Beta 1 (2011-06-30)

This version is a major update. The following major new features were added:

- Support for cloning of VMs (bug #5853)
- GUI: enhanced wizard for creating new virtual disks
- GUI: new wizard for copying virtual disks
- VMM: raised the memory limit for 64-bit hosts to 1TB
- Windows guests: Experimental WDDM graphics driver
- Guest Additions: modules and features now are represented as facilities to have a common interface for frontends.
- New Networking Mode: *UDP Tunnel*. Allows to interconnect VMs running on different hosts easily and transparently, see chapter 6.2, *Introduction to networking modes*, page 84

In addition, the following items were fixed and/or added:

- VMM: more SMP timer fixes
- VMM: fixed sporadic recompiler crashes with SMP guests
- VMM: many small fixes
- GUI: when reverting to a snapshot, ask for taking a snapshot of the current state
- GUI: added *View* menu
- GUI: added setting for the promiscuous mode policy for internal networks, bridged networks and host-only networks
- GUI: the VM description is editable during the runtime of a VM
- GUI: added proxy settings (bug #2870)
- VBoxManage: changed syntax of the *guestcontrol* command group, fixed various bugs
- VBoxBalloonCtrl: new service for automatic dynamic adjustment of the balloon size for running VMs
- Settings: machine names and snapshot names are not allowed to be a valid UUID

- Storage: virtual CD/DVD images will be detached if the guest ejects the medium
- Floppy: several bugs have been fixed
- BIOS: disk-related structures are now checksummed correctly
- USB: many fixes for the Windows USB host driver
- NAT: reduced memory footprint
- Serial: announce the serial devices in the ACPI tables to make Windows guests find the virtual hardware (bug #7411)
- VRDP: support for TLS connections
- VRDP: support for multimonitor client configurations with MS RDP client
- 3D support: fixed GL_VERSION string for different locales (bug #8916)
- Windows hosts: fixed copy'n'paste in the GUI and for the VM window (bug #4491)
- Guest Additions: improved driver installation on Windows guests
- Guest Additions: fixed high CPU usage while executing guest programs from the host

15.2 Version 4.0.10 (2011-06-22)

This is a maintenance release. The following items were fixed and/or added:

- GUI: fixed disappearing settings widgets on KDE hosts (bug #6809)
- Storage: fixed hang under rare circumstances with flat VMDK images
- Storage: a saved VM could not be restored under certain circumstances after the host kernel was updated (bug #8983)
- Storage: refuse to create a medium with an invalid variant (for example Split2G with VDI; bug #7227)
- iSCSI: pause the VM if a request times out
- Snapshots: none of the hard disk attachments must be attached to another VM in normal mode when creating a snapshot
- USB: fixed occasional VM hangs with SMP guests (bug #4580)
- USB: proper device detection on RHEL/OEL/CentOS 5 guests (partial fix for bug #8978)
- ACPI: force the ACPI timer to return monotonic values for improve behavior with SMP Linux guests (bug #8511 and others)
- VRDP: fixed screen corruption under rare circumstances (bug #8977)
- rdesktop-vrdp: updated to version 1.7.0
- OVF: under rare circumstances some data at the end of a VMDK file was not written during export
- Mac OS X hosts: Lion fixes
- Mac OS X hosts: GNOME 3 fix

- Linux hosts: fixed VT-x detection on Linux 3.0 hosts (bug #9071)
- Linux hosts: fixed Python 2.7 bindings in the universal Linux binaries
- Windows hosts: fixed leak of thread and process handles
- Windows Additions: fixed bug when determining the extended version of the Guest Additions (4.0.8 regression; bug #8948)
- Solaris Additions: fixed installation to 64-bit Solaris 10u9 guests (4.0.8 regression)
- Linux Additions: RHEL6.1/OL6.1 compile fix
- Linux Additions: fixed a memory leak during `VBoxManage guestcontrol execute` (bug #9068)

15.3 Version 4.0.8 (2011-05-16)

This is a maintenance release. The following items were fixed and/or added:

- Mac OS X hosts: fixed incompatibility with recent Mac OS X versions in 64-bit mode (bug #8474)
- Mac OS X hosts: fixed incompatibility with hosts with more than 16 cores (bug #8389)
- Mac OS X hosts: fixed painting corruptions on a second monitor in 64-bit mode (bug #7606)
- GUI: restored functionality to set an empty host key to disallow any host key combination (4.0.6 regression; bug #8793)
- GUI: more expressive error messages for USB proxy permission problems (mainly Linux hosts; bug #8823)
- VBoxManage: added `controlvm screenshotpng` subcommand for saving the screenshot of a running VM in PNG format
- VBoxHeadless: fixed potential crash during shutdown (Windows hosts only)
- NAT: built-in services use the correct Ethernet addresses in Ethernet header and in ARP requests
- Host-only networking: fixed adapter reference counting
- E1000: fixed rare guest crashes with Linux SMP guests (bug #8755)
- SATA: fixed guest disk corruption under rare circumstances (only relevant for guests with more than 2GB RAM; bug #8826)
- Storage: fixed data corruption after a snapshot was taken with asynchronous I/O enabled (bug #8498)
- Floppy: several improvement
- HPET: another fix for time jumps (bug #8707)
- USB: use correct permissions when creating /dev/vboxusb (Linux hosts only)
- USB: removed assumption that string descriptors are null-terminated (Windows hosts only)
- 3D support: fixed a potential crash when resizing the guest window

- 3D support: fixed GNOME 3 rendering under Ubuntu 11.04 and Fedora 15
- Snapshots: fixed another bug which could lose entries in the media registry when restoring a snapshot (bug #8363)
- Shared Folders: don't stop mounting the other valid folders if one host folder is inaccessible (4.0.6 regression)
- Linux Additions: check whether gcc and make are installed before building kernel modules (bug #8795)
- Solaris Additions: added support for X.Org Server 1.10
- Guest Additions: fixed inappropriate Guest Additions update notification when using vendor-specific version suffixes (bug #8844)

15.4 Version 4.0.6 (2011-04-21)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed incorrect handling of ballooned pages when restoring a VMM from a saved state
- VMM: don't crash on hosts with more than 64 cores / hyperthreads; implemented support for up to 256 host cores (except Windows hosts; bug #8489)
- VMM: fixed guru meditation for PAE guests running on hosts without PAE (bug #8006)
- VMM: fixed slow Linux guests with raw mode and recent guest kernels (bug #8726)
- GUI: support host key combinations (bug #979)
- GUI: fixed progress indicator (bug #7814)
- GUI: show the mouse pointer while the VM is paused if the USB tablet mouse emulation is used (bug #6799)
- GUI: adapt the snapshot folder as well when renaming a VM (bug #8469)
- GUI: persistently remember the last folders of the disk/DVD/floppy selectors
- GUI: never allow to start a VM with USB-2.0 activated if the proper extension pack is missing (bug #8182)
- GUI: fixed hang/crash when opening a file dialog in an non-existing folder (bug #8673)
- Snapshots: fixed a bug which could lose entries in the media registry when restoring a snapshot (bug #8363)
- Snapshots: allow snapshots to be stored in the VM directory
- 3D support: fixed a crash if a VM was forced to terminate (Windows hosts only; bug #7133)
- Storage: fixed memory leak (4.0 regression; bug #7966)
- Storage: fixed access to iSCSI targets over internal network
- Storage: fixed reading from disks with more than one snapshot for VHD and VMDK images with disabled host cache (bug #8408)

- Storage: fixed a possible hang during VM suspend after an I/O error occurred
- Storage: fixed a possible hang during VM suspend / reset (bug #8276, #8294)
- Storage: automatically create a diff image when attaching a streamOptimized VMDK image to a VM
- ATA/SATA: fixed automounting of virtual CD/DVD mediums with recent Linux distributions by correctly reporting the current profile as 'none' if no medium is present
- Buslogic: fixed emulation for certain guests (e.g. jRockit VE)
- Host-Only Networking: fixed interface creation failure on Windows hosts (4.0.4 regression; bug #8362)
- Host-Only & Bridged & Internal Networking: fix for processing promiscuous mode requests by VMs, defaulting to switch behaviour
- Host-Only Networking: fixed connectivity issue after resuming the host from sleep (bug #3625)
- Bridged Networking: support for interface bonding on Mac OS X hosts (bug #8731)
- NAT: fixed processing of ARP announcements for guests with static assigned IPs (bug #8609)
- VRDP: backward compatibility with VRDPAuth external authentication library (bug #8063)
- Shared Folders: don't fail to start a VM if a path is not absolute, for example when importing an OVF from a different host (bug #7941)
- Audio: fixed crash under certain conditions (bug #8527)
- USB: fixed a crash when plugging certain USB devices (bug #8699)
- HPET: fixed time jumps when reading the counter (bug #8707)
- OVF/OVA: automatically adjust disk paths if the VM name is changed on import
- OVF/OVA: fix export to slow medias
- OVF/OVA: automatically repair inconsistent appliances with multiple disks (bug #8253)
- rdesktop-vrdp: fixed an assertion triggered under certain conditions (bug #8593)
- Windows hosts: fixed occasional hangs during VM shutdown because sometimes COM was not properly uninitialized
- Mac OS X hosts: prevent the mouse from leaving the VM window while captured
- Mac OS X hosts: keep aspect ratio while resizing in scale mode (shift for old behaviour) (part of bug #7822)
- X11 hosts: fixed Yen key support (bug #8438)
- X11 hosts: fixed a regression which caused Host+F1 to pop up help instead of sending Ctrl+Alt+F1
- Linux hosts / Linux Additions: mangle IPRT symbols to allow installing VirtualBox inside a VM while the Guest Additions are active (bug #5686)

- Linux hosts / Linux guests: workaround for a bug in GLIBC older than version 1.11 leading to crashes under certain conditions (signed/unsigned problem with memchr on 64-bit machines)
- Solaris hosts: fixed a deadlock in event semaphores that could lead to unkillable VM processes
- Windows Additions: fixed Sysprep parameter handling
- Windows Additions: fixed spontaneous guest reboots under certain circumstances (4.0.2 regression; bugs #8406, #8429)
- Windows Additions: added auto logon support for locked workstations on legacy Windows versions
- Windows Additions: fixed driver bugcheck error when handling PnP messages (4.0 regression; bug #8367)
- Windows Additions: fixed memory leak in VBoxVideo
- X11 Additions: added support for X.Org Server 1.10 final
- Linux Additions: Linux kernel 2.6.39-rc1 fixes
- Linux Additions: improved auto-run support (bug #5509)
- Linux Additions: fix mouse support on SUSE 11 SP 1 guests (bug #7946)
- Solaris Additions: added support for X.Org Server 1.9
- Guest Additions: various bugfixes for guest control execution
- Webservice: use own log file, with log rotation to limit size

15.5 Version 4.0.4 (2011-02-17)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed recompiler crashes under certain conditions (bugs #8255, #8319 and further)
- VMM: fixed running 64-bit guests on 32-bit host with nested paging enabled on AMD CPUs (4.0 regression; bug #7938)
- VMM: fixed timing issues / hangs for certain guests using the programmable interval timer (bugs #8033 and #8062)
- VMM: large page and monitoring fixes for live snapshots (bugs #7910, #8059, #8125)
- GUI: fixed error message when trying to exceed the maximum number of host network interfaces
- GUI: fixed saving of changes to the metadata of an existing snapshot (bug #8145)
- GUI: fixed rare crash on X11 hosts (bug #8131)
- GUI: when selecting a shared folder, start the file dialog in the users home directory (bug #8017)
- ExtPack: enforce the correct permissions which might be restricted by umask when creating directories (non-Windows hosts only; bug #7878)

- VBoxSDL: fixed crash when starting by specifying the VM UUID (4.0 regression; bug #8342)
- VBoxManage: allow savestate even if the VM is already paused
- VBoxManage: fixed *modifyvm –synthcpu* (bug #6577)
- VBoxManage: fixed hang when doing *guestcontrol execute –wait-for exit* and displaying process status on exit (bug #8235)
- VBoxManage: decreased CPU load during *guestcontrol execute –wait-for exit/stdout* while waiting for the guest process to terminate (bug #7872)
- VBoxManage: fixed *list hostdvds/hostfloppies*
- VBoxManage: fixed *storageattach* for host DVD drives and host floppy drives
- Metrics: introduced *RAM/VMM* base metric.
- Main: improved sanity check when taking a VM screen shot (bug #7966)
- Main: fixed a crash under rare circumstances if a VM failed to start
- Main: fixed attaching of immutable disk images (bug #8105)
- Main: fixed a crash at VM shutdown (bug #6443)
- Main: fixed incorrect handling of cross-referenced medium attachments (bug #8129)
- Settings: fixed truncating of big integer values (4.0 regression)
- Settings: properly store the ICH9 chipset type (bug #8123)
- Host-Only & Bridged Networking: fixed VBox DHCP server startup issue for Windows hosts (4.0 regression; bug #7905)
- Host-Only Networking: re-create vboxnetX interfaces after vboxnetadp.ko module reload on Linux and Darwin (bugs #5934, #6341)
- NAT: fixed an mbuf leak under rare circumstances (bug #7459)
- ACPI: don't allow the guest to enter S4 by default and don't announce S1 and S4 in the ACPI tables if disabled (bug #8008)
- Graphics card: made re-enabling disabled screens work correctly to prevent problems when X11 guests enter screen saving mode (bug #8122)
- Storage: fixed write errors with snapshots if the host cache is disabled (4.0 regression; bug #8221)
- ATA/SATA: fixed reset handling after ACPI suspend/resume
- BusLogic: fixed hang with SMP VMs
- Serial: another attempt to prevent lost characters during transmission (bug #1548)
- Linux hosts/guests: Linux 2.6.38-rc1 compile fixes
- Mac OS X hosts: fixed VBoxSVC crash when listing host interfaces without default gateway (64-bit hosts only; bug #7955)
- Solaris/Darwin hosts: fixed VM CPU execution cap

- X.Org guests: fixed a crash on X server restart (bug #8231)
- X.Org guests: support X.Org Server 1.10 pre-release and Ubuntu 11.04 Alpha.
- X.Org guests: Add EDID emulation in the graphics driver to prevent GNOME settings daemon changing the mode on login.
- X.Org guests: never send graphics modes to the host that older VirtualBox versions can't handle.
- Linux Additions: fixed a memory leak in the shared folders code if a host link is not readable (bug #8185)
- Windows Additions: fixed handling of Security Attention Sequence (SAS) with VBoxGINA

15.6 Version 4.0.2 (2011-01-18)

This is a maintenance release. The following items were fixed and/or added:

- GUI: don't crash if a removable host drive referenced from the VM settings vanished
- GUI: fixed a crash when using the KDE4 Oxygen theme and clicked on the settings button (4.0 regression; bug #7875)
- GUI: properly warn if the machine folder cannot be created (bug #8031)
- GUI: several fixes for multimonitor X11 guests
- ExtPack: don't make the installer helper application suid root (Linux .deb/.rpm packages only)
- ExtPack: improved user experience on Vista / Windows 7 when installing an extension pack
- ExtPack: fixed issue with non-ascii characters in the path name during installing an extension pack (bug #9717)
- ExtPack: fixed SELinux issues on 32-bit Linux hosts
- VBoxManage: Host-only interface creation and removal is now supported for all platforms except Solaris (bug #7741)
- VBoxManage: fixed segmentation fault when removing non-existent host-only interface
- Storage: fixed possible crashes with VMDK/VHD images with snapshots and asynchronous I/O (4.0 regression)
- Storage: don't eject the physical medium if a DVD/CDROM/floppy drive is detached from a VM (bug #5825)
- Storage: be more robust when a faulty guest sends ATA commands to an ATAPI device (bug #6597)
- Parallels: fixed deletion of the image during suspend, pause or power off (4.0 regression)
- Bridged networking: fixed host kernel panic when bridging to devices with no TX queue (4.0 regression; Linux hosts only; bug #7908)
- NAT: port-forwarding rule registration respects protocol parameter (bug #8094)
- E1000: fixed PXE boot issues with WDS (bug #6330)

- Virtio-net: fixed the issue with TX performance in some Linux guests
- ICH9: fixed VM crash (software virtualization only; bug #7885)
- VGA: fixed VESA screen issue (4.0 regression; bug #7986)
- Shared Folders: fixed parameter parsing when creating symbolic links, fixes 32-bit/64-bit bitness issue (bug #818)
- Main: fixed crash under rare circumstances due to an invalid logging string (4.0 regression)
- Main: improve error information propagation for errors preventing a VM start
- Main: fixed problems with snapshots and non-ASCII characters in machine paths (bug #8024)
- Webservice: now listens to localhost by default as documented (bug #6067)
- Settings: do not fail loading machine settings if removeable drive attachment (host drive or image) cannot be found; with 4.0 this is much more likely when machines are moved from one host to another
- Settings: fixed issue that changing a snapshot name or description was not saved to machine XML
- OVF/OVA: fixed import of files created by other OVF tools (bug #7983)
- rdesktop-vrdp: fix a crash during USB device enumeration (bug #7981)
- Linux hosts: fixed a crash during USB device enumeration.
- Linux hosts: try a bit harder to allocate memory (bug #8035; 4.0 regression)
- Guest Additions: fixed parsing of parameters for guest control in VBoxService (4.0 regression; bug #8010)
- Windows Guest Additions: automatic logon on Windows Vista/Windows 7 now supports unlocking previously locked workstations

15.7 Version 4.0.0 (2010-12-22)

This version is a major update. The following major new features were added:

- Reorganization of VirtualBox into a base package and Extension Packs; see chapter 1.5, *Installing VirtualBox and extension packs*, page 14
- New settings/disk file layout for VM portability; see chapter 10.1, *Where VirtualBox stores its files*, page 157
- Major rework of the GUI (now called "VirtualBox Manager"):
  - Redesigned user interface with guest window preview (also for screenshots)
  - New "scale" display mode with scaled guest display; see chapter 1.8.5, *Resizing the machine's window*, page 21
  - Support for creating and starting `.vbox` desktop shortcuts (bug #1889)
  - The VM list is now sortable
  - Machines can now be deleted easily without a trace including snapshots and saved states, and optionally including attached disk images (bug #5511; also, `VBoxManage unregistervm --delete` can do the same now)

  - Built-in creation of desktop file shortcuts to start VMs on double click (bug #2322)

- VMM: support more than 1.5/2 GB guest RAM on 32-bit hosts
- New virtual hardware:
  - Intel ICH9 chipset with three PCI buses, PCI Express and Message Signaled Interrupts (MSI); see chapter 3.4.1, *"Motherboard" tab*, page 43
  - Intel HD Audio, for better support of modern guest operating systems (e.g. 64-bit Windows; bug #2785)
- Improvements to OVF support (see chapter 1.12, *Importing and exporting virtual machines*, page 26):
  - Open Virtualization Format Archive (OVA) support
  - Significant performance improvements during export and import
  - Creation of the manifest file on export is optional now
  - Imported disks can have formats other than VMDK
- Resource control: added support for limiting a VM's CPU time and IO bandwidth; see chapter 5.8, *Limiting bandwidth for disk images*, page 80
- Storage: support asynchronous I/O for iSCSI, VMDK, VHD and Parallels images
- Storage: support for resizing VDI and VHD images; see chapter 8.21, *VBoxManage modifyhd*, page 125.
- Guest Additions: support for multiple virtual screens in Linux and Solaris guests using X.Org server 1.3 and later
- Language bindings: uniform Java bindings for both local (COM/XPCOM) and remote (SOAP) invocation APIs

In addition, the following items were fixed and/or added:

- VMM: Enable large page support by default on 64-bit hosts (applies to nested paging only)
- VMM: fixed guru meditation when running Minix (VT-x only; bug #6557)
- VMM: fixed crash under certain circumstances (Linux hosts only, non VT-x/AMD-V mode only; bugs #4529 and #7819)
- GUI: add configuration dialog for port forwarding in NAT mode (bug #1657)
- GUI: show the guest window content on save and restore
- GUI: certain GUI warnings don't stop the VM output anymore
- GUI: fixed black fullscreen minitoolbar on KDE4 hosts (Linux hosts only; bug #5449)
- BIOS: implemented multi-sector reading to speed up booting of certain guests (e.g. Solaris)
- Bridged networking: improved throughput by filtering out outgoing packets intended for the host before they reach the physical network (Linux hosts only; bug #7792)
- 3D support: allow use of *CR_SYSTEM_GL_PATH* again (bug #6864)
- 3D support: fixed various clipping/visibility issues (bugs #5659, #5794, #5848, #6018, #6187, #6570)
- 3D support: guest application stack corruption when using glGetVertexAttrib[ifd]v (bug #7395)

- 3D support: fixed OpenGL support for libMesa 7.9
- 3D support: fixed Unity/Compiz crashes on natty
- 2D Video acceleration: multimonitor support
- VRDP: fixed rare crash in multimonitor configuration
- VRDP: support for upstream audio
- Display: fixed occasional guest resize crash
- NAT: port forwarding rules can be applied at runtime
- SATA: allow to attach CD/DVD-ROM drives including passthrough (bug #7058)
- Floppy: support readonly image files, taking this as the criteria for making the medium readonly (bug #5651)
- Audio: fixed memory corruption during playback under rare circumstances
- Audio: the DirectSound backend now allows VMs to be audible when another DirectSound application is active, including another VM (bug #5578)
- EFI: support for SATA disks and CDROMs
- BIOS: reduce the stack usage of the VESA BIOS function *#4F01* (Quake fix)
- OVF/OVA: fixed export of VMs with iSCSI disks
- Storage: Apple DMG image support for the virtual CD/DVD (bug #6760)
- Linux host USB support: introduced a less invasive way of accessing raw USB devices (bugs #1093, #5345, #7759)
- Linux hosts: support recent Linux kernels with *CONFIG_DEBUG_SET_MODULE_RONX* set
- Guest Additions: Shared Folders now can be marked as being auto-mounted on Windows, Linux and Solaris guests
- Linux Additions: Shared Folders now support symbolic links (bug #818)
- Linux Additions: combined 32-bit and 64-bit additions into one file
- Windows Additions: automatic logon on Windows Vista/Windows 7 is now able to handle renamed user accounts; added various bugfixes

15.8 Version 3.2.12 (2010-11-30)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed rare host crash when running 64-bit guests on 32-bit hosts (bug #7577)
- VMM: fixed host reboots under rare circumstances due to NMIs triggered by active performance counters (Linux hosts in non-VT-x/AMD-V mode only; bug #4529)
- VMM: fixed out of memory guru meditation for large memory guests (bug #7586)
- VMM: fixed a guru meditation related to large pages
- VMM: use new VT-x feature to keep the guest from hogging the CPU

- Snapshots: implemented deleting the last remaining snapshot while the VM is running
- GUI: perform the checks for exceeding the size limit of the host file system and for broken asynchronous I/O on older Linux kernels with ext4 / xfs file systems not only when starting the VM from scratch but also when starting from a saved state
- NAT: fixed memory leak (3.2.0 regression; bugs #6918, #7353)
- NAT: fixed Linux NFS root issue (bugs #7299)
- Networking: fixed VM reset handling in e1000
- VRDP: fixed rare crash in multimonitor configuration
- Display: fixed occasional guest resize crash
- Mouse: don't send relative mouse events together with absolute mouse events (3.2.10 regression; bug #7571)
- Keyboard: fixes for the USB keyboard emulation; fixes for Korean keyboards
- Serial: don't hang if the host device would block during open (bugs #5756, #5380)
- Serial: fixed modem status lines (Linux hosts only; bug #812)
- Graphics: Horizontal resolutions are no longer restricted to a multiple of 8 pixels (bug #2047; requires Guest Additions update).
- USB: fixed a crash with older Linux kernels and non-ASCII characters in device strings (Linux hosts only; bug #6983, #7158, #7733; version 3.2.8 contained an incomplete fix)
- USB: fixed a crash under rare circumstances (bug #7409; Windows hosts only)
- "iSCSI: respond to NOP-In requests from the target immediately to avoid being disconnected if the guest is idle
- 3D support: fixed a crash under certain circumstances (bug #7659)
- 3D support: fixed crashes for GLUT based apps (bug #6848)
- 3D support: added missing GLX 1.3 functionality (bugs #7652, #7195)
- 2D Video acceleration: fixed potential deadlock when saving the VM state (bug #4124)
- Windows hosts: another fix for BSODs under certain circumstances in VBoxNetFlt.sys (bug #7601)
- Solaris hosts: fixed host USB DVD drive detection
- Mac OS X hosts: fixed swapped keys for certain ISO keyboard types (bug #2996)
- Linux hosts: added link state handling for TAP devices needed for proper operation with bridged networking on kernels 2.6.36 and above (bug #7649)
- Linux hosts/guests: Linux 2.6.37 fixes
- Linux Additions: properly compile the vboxvideo module if DKMS is not installed (bug #7572)
- Linux Additions: fixed a memory leak when accessing non-existing files on a Shared Folders (bug #7705)
- Windows Additions: skip none-mapped user accounts when enumerating user accounts for VM information

15.9 Version 3.2.10 (2010-10-08)

This is a maintenance release. The following items were fixed and/or added:

- VMM: V8086 mode fix for legacy DOS/Windows guests with EMM386 (3.2.8 regression)
- VMM: stability fix (bug #7342)
- VMM: fixed a Guru meditation related to large pages (bug #7300)
- VMM: fixed support for large pages on Linux hosts
- VMM: fixed a Guru meditation for large memory 64-bit guests on 32-bit hosts with nested paging (bug #7544)
- VMM: performance improvements for VMs with more than 2GB RAM (bug #6928)
- GUI: fixed host key handling if the host key is set to Left Alt (Linux/Solaris hosts only; 3.2.0 regression; bug #6758)
- GUI: the VM can be minimized from the mini toolbar (bug #4952)
- GUI: handle Ctrl+Break properly on X11 hosts (3.2.0 regression; bug #6122)
- GUI: fixed the case where the user aborted the media selector for selecting the boot hard disk from the VM wizard
- GUI: added a check for Linux kernels 2.6.36 or later which are known to have the asynchronous I/O bug on ext4 / xfs file systems fixed (Linux hosts only)
- OpenSolaris guests: use SATA controller by default
- Storage: fixed I/O errors in the guest after compacting VDI images (3.2.6 regression; bug #7294)
- Storage: automatically repair base disk images with non-zero parent UUID which made them inaccessible (bug #7289)
- Storage: fixed corrupted images if a merge operation was canceled
- IDE: added ATAPI passthrough support for audio CDs
- SATA: fixed a potential hang during boot of recent Solaris guests
- SATA: handle out of disk space and similar conditions better
- iSCSI: fixed sporadic hangs when closing the connection
- VGA: fixed missing redraw with multiple screens under certain circumstances (bug #7291)
- VGA: serveral small fixes for legacy VGA graphics modes
- Bridged networking: fixed occasional host freeze during VM shutdown (Linux hosts only)
- NAT: don't check for the existence of the TFTP prefix when delivering a file via bootp (bug #7384)
- NAT: fixed resolving of names at the host resolver (bug #7138)
- NAT: under rare conditions the NAT engine consumed 100% CPU load (non-Windows hosts only)
- VRDP: fixed memory leak under certain circumstances (bug #5966)

- VRDP: fixed missing redraws with Windows guests under certain circumstances
- USB: properly discard blocking outstanding bulk URBs, fixes some printers
- USB: Blackberry fix (bug #6465)
- VBoxHeadless: fixed event queue processing problems which led to hangs if the VM could not be started successfully
- VBoxManage: don't crash if parameters with invalid characters are passed (bug #7388)
- VBoxManage: `clonehd`: fixed a bug where the command aborted with an error message under rare circumstances
- VBoxManage `metrics`: made it work for directly started VMs again (3.2.8 regression; bug #7482)
- 3D support: report *GLX_ARB_get_proc_address* as supported extension
- 3D support: guest application stack corruption when using *glGetVertexAttrib[ifd]v* (bug #7395)
- 3D support: fixed broken 3D support when switching to fullscreen/seamless modes (bug #7314)
- 3D support: fixed 32bit OpenGL apps under 64bit Windows XP/Vista (bug #7066)
- OVF: fixed bug when exporting a VM with multiple attached disks (bug #7366)
- OVF: fixed slow export for certain filesystems (bug #3719)
- OVF: disabled manifest (.mf file) support; manifests are no longer verified on import nor written on export
- Shared clipboard/Windows: improved the reliability of the shared clipboard on Windows hosts and guest (partial fix to bug #5266)
- Shared Folders: don't show an empty directory if filenames with an invalid encoding exist on the host (bug #7349)
- Shared Folders: return the proper error code when trying to list files for a non-existing wildcard (bug #7004)
- Audio: fixed guest memory corruption when capturing from the NULL audio backend (bug #6911)
- Audio: improved playback quality (less choppy)
- Web service: avoid unnecessary creation of idle threads
- Additions: fixed bug in the guest execution feature when passing more than one environment variable
- Additions: refresh all guest properties written by VBoxService after the VM was restored from a saved state
- Additions: fixed a *division by zero* crash of VBoxService under certain circumstances
- Additions: immediately resynchronize the guest time with the host time after the VM was restored from a saved state (bug #4018)
- Additions/Windows: fixed *LsaEnumerate* error when enumerating logged in users

- Additions/X.Org: support X.Org Server 1.9 (bug #7306)
- Additions/X.Org: don't crash VBoxClient during reboot
- Solaris hosts: fixed host DVD drive enumeration on Solaris 10
- Solaris hosts: added a custom core dumper to procure more data in the event of a VM crash
- Solaris guests: fixed user idle detection
- Solaris guests: fixed a possible panic in Shared Folders when using the wrong user or group IDs (bug #7295)
- Solaris guests: fixed Shared Folders from truncating files to 2GB on 32-bit guests (bug #7324)
- Windows hosts: fixed a BSOD under certain circumstances in VBoxNetFlt.sys (bug #7448)
- Linux hosts/guests: Linux 2.6.36 fixes
- Linux hosts/guests: DKMS fixes (bug #5817)
- Mac OS X hosts: fixed missing dock menu entries (bug #7392)

15.10 Version 3.2.8 (2010-08-05)

This is a maintenance release. The following items were fixed and/or added:

- VMM: properly terminate the VM with an error if the guest is trying to switch to the PAE mode but PAE is disabled in the VM settings
- GUI: switch to native file dialogs (Windows hosts only; bug #5459)
- GUI: don't use native file dialogs on KDE hosts (Linux hosts only; bug #6809)
- 3D support: fixed *GL_EXT_texture_sRGB* support
- PXE: fixed ZENworks PXE boot regression
- OVF: fixed slower export and larger images under certain circumstances (3.2.6 regression; bug #7073)
- USB: properly signal an interrupt if the port suspend status changes
- USB: respect the remote-only filter
- USB: avoid VM hang when changing the configuration of certain devices (Windows hosts only)
- USB: fix a crash with older Linux kernels and non-ASCII characters in device strings (Linux hosts only; bug #6983)
- PageFusion: fixed conflict with the guest execution feature
- PageFusion: fixed stability issues with a large number of VMs
- PageFusion: fixed host crashes with guest SMP and Win64 guests
- Memory ballooning: fixed problems restoring VMs with pre-allocation enabled
- Bridged networking: fixed performance issue with GRO enabled on bridged device (bug #7059)

- Hostonly networking: fixed performance issue (3.2.6 regression; bug #7081)
- Hard disks: fix auto-reset of immutable disk at VM startup (bug #6832)
- BusLogic: several fixes for Windows NT/2000 and SCO OpenServer guests
- LsiLogic: fixed I/O errors under rare circumstances
- Sharing disks: support for attaching one disk to several VMs without external tools and tricks
- Shared Folders: several fixes and performance enhancements for Solaris guests (bugs #4154 and #6512)
- Solaris Installer: added support for remote installations
- Guest Properties API: correctly support enumerating the properties of a running VM with an empty "patterns" field (bug #7171)
- Guest properties: properly delete transient properties on shutdown
- VRDP video redirection performance improvements and stability fixes
- Settings: silently fix host audio driver when reading machine XML settings files or OVF written by VirtualBox on a different host OS, for example convert DirectSound to PulseAudio (bug #7209)
- Settings: properly store the NAT network setting in XML settings file version 1.10 and later (bug #6176)
- VBoxManage: handle differencing images with parent UUID correctly in subcommand *openmedium disk* (bug #6751)
- Web service: enabled HTTP keepalive for much better performance
- Web service: added timestamps to logging output
- Web service: treat 8-bit strings as UTF-8 not ASCII
- X11 Additions: fix for Xorg 6.8 guests (e.g. RHEL4)

15.11 Version 3.2.6 (2010-06-25)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed host crash when running 64-bit guests on 32-bit hosts with certain Intel CPUs (VT-x only; bug #6166)
- VMM: allow 64-bit SMP guests on 32-bit hosts (VT-x and AMD-V only; does not apply to Mac OS X, which already supports it)
- VMM: fixed Guru mediation if guests with more than 2GB are booted with VT-x/AMD-V disabled (bug #5740)
- VMM: fixed TR limit trashing (VT-x and 64-bit host only; bug #7052)
- Page Fusion: several bug fixes for SMP guests (including bug #6964)
- Teleportation: several fixes and improvements
- Mac OS X server guests: compatibility fix

- EFI: fixed memory detection for guests with 2GB or more RAM assigned
- GUI: added a workaround for a Linux kernel bug which affecting asynchronous I/O on ext4 / xfs file systems (Linux hosts only)
- GUI: added setting for multiple VRDP connections; useful if multiple screens are enabled
- GUI: another fix for the keyboard capturing bug under metacity (bug #6727)
- GUI: fixed quit dialog when used in seamless or fullscreen mode (Mac OS X hosts only; bug #6938)
- GUI: handle the extra key on the Brazilian keyboard on X11 hosts again (bug #7022).
- 2D Video acceleration: fixed crashes when leaving the fullscreen mode (bug #6768)
- VBoxManage: fixed *storageattach* error handling (bug #6927)
- VBoxManage: fixed *dhcpserver add* (3.2.0 regression; bug #7031)
- Storage: fixed hang with images located on filesystems which don't support asynchronous I/O (bug #6905)
- Storage: fixed raw disks on Windows hosts (3.2.0 regression; bug #6987)
- LsiLogic: fixed hang with older Linux guests
- BusLogic: fixed hang during I/O
- SATA: set initial number of ports to 1 as some guests can't handle 30 ports (e.g. CentOS 4 and FreeBSD; bug #6984)
- SATA: performance improvement
- SCSI: fixed error when using the full format option during Windows installation (bug #5101)
- iSCSI: fixed authentication (bug #4031)
- Host-only/bridged networking: fixed excessive host kernel warnings under certain circumstances (Linux hosts only; 3.2.0 regression; bug #6872)
- NAT: fixed potential memory leaks
- NAT: increased the size of the memory pool for 16K Jumbo frames (performance tweak)
- NAT: allow to link/unlink the network cable even if the VM is currently paused
- E1000: disconnect cable was not properly handled if the NIC was not yet initialized by the guest
- OVF: export performance optimization
- OVF: upgraded OS type definitions to CIM 2.25.0 so that Windows 7 and other OSes are now tagged correctly on export
- Settings: the setting for disabling the host I/O cache was sometimes not properly saved
- Settings: save machine state into XML correctly even when snapshot folder has been changed to a non-default location (bug #5656)
- USB: allow the guest to disable an EHCI port

- USB: find a valid language ID before querying strings (bug #7034)
- POSIX hosts: fixed several memory leaks (3.2.0 regression)
- Solaris hosts: fixed VDI access problem under certain circumstances (IDE/SATA; 3.2.0 regression)
- Solaris hosts: fixed VM fails to start on 32-bit hosts (3.2.0 regression; bug #6899)
- Windows hosts (32-bit): increase guest RAM limit if the host kernel allows for more virtual address space
- Linux Additions: re-read a directory after a file was removed (bug #5251)
- Linux Additions: install the DRI driver in the right location on ArchLinux guests (bug #6937)
- X11 Additions: fixed spurious mouse movement events (bug #4260)
- Solaris Additions: fixed guest execution feature
- Windows Additions: automatic logon on Windows Vista/Windows 7 is now able to handle renamed and principal user accounts; added various bugfixes
- Windows Additions: improved command line parsing of the installer
- Windows Additions: fixed driver verifier bugcheck in VBoxMouse (bug #6453)
- 3D support: fixed OpenGL support for 32bit applications under 64bit Windows guests

15.12 Version 3.2.4 (2010-06-07)

This is a maintenance release. The following items were fixed and/or added:

- GUI: fixed superfluous resize-event on powering-on VM for X11 (improvement for the 3.2.2 fix)
- GUI: fixed keyboard capturing bug under metacity (bug #6727)
- Host-only/bridged networking: fixed guest-to-guest communication over wireless (3.2.0 regression; bug #6855)
- Storage: fixed a potential guest disk corruption with growing images (3.2.0 regression)
- Page Fusion: fixed shared module detection for Win64 guests
- 3D support: allow use of *CR_SYSTEM_GL_PATH* again (bug #6864)
- 3D support: fixed a host assertion for some multi-threaded guest applications (bug #5236)
- 3D support: fixed host crashes with nVIDIA drivers on WDDM startup
- OVF: fixed import of OVFs with a VM description (annotation) (3.2.2 regression; bug #6914)
- VRDP: fixed issues with secondary monitors (bug #6759)

15.13 Version 3.2.2 (2010-06-02)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed rare invalid guest state guru meditation (VT-x only)
- VMM: fixed poor performance with nested paging and unrestricted guest execution (VT-x only; bug #6716)
- VMM: fixed occasional guru meditation during Windows 7 bootup (bug #6728)
- GUI: keep the status for remote control in sync with the actual state
- GUI: don't exit after a successful refresh of an invalid VM configuration
- GUI: fixed keyboard capturing bug under metacity (bug #6727)
- GUI: fixed crash during VM termination if a modal dialog is open
- GUI: default controllers names of New VM Wizard are synchronized with VM settings
- GUI: fixed superfluous resize-event on powering-on VM for X11
- GUI: fixed regression - missed USB item's tool-tip of USB devices menu
- GUI: Activate VM window on mouse-hovering for multi-monitor VMs
- VBoxSDL/Linux hosts: automated keyboard type detection (bug #5764)
- SATA: fixed crash during VM suspend under rare circumstances
- SATA: fixed crash during VM reset after a snapshot was taken
- Storage: fixed sporadic hang of SMP guests using SATA or LSI Logic SCSI and asynchronous I/O
- Virtio-net: fix for guests with more than about 4GB RAM (bug #6784)
- Page Fusion: fixed VBoxService crash with enabled Page Fusion on Win64 guests
- Page Fusion: added kernel module sharing
- HGCM: fixed memory leak which showed up if the Guest Additions were accessing a non-existing HGCM service
- Teleportation: several fixes
- Floppy: don't disable the host I/O cache by default
- USB: fixed 3.1 regression with certain devices (e.g. iPhone); Windows host only
- Serial: updated the guest device emulation to 16550A and reduced the probability for losing bytes during transmission (bug #1548)
- NAT: re-fetch the name server parameters from the host on guest DHCP requests to handle host network switches more gracefully (bug #3847)
- NAT: fixed parsing of IPv4 addresses in CIDR notation (bug #6797)
- NAT: limit the number of name servers passed to the guest to four (non-Windows hosts only; bug #4098)
- NAT: fixed DNS transaction ID mismatch (bug #6833)

- VDE: fixed changing the attachment during runtime
- Bridged networking: fixed memory leak in the Bridged Networking driver for Windows hosts (bug #6824)
- Windows Additions: fix for NT4 guests (bug #6748)
- Windows Additions: re-introduced system preparation feature
- Linux guests: enable PAE for RedHat guests by default
- Linux guests: fix support for disabling mouse integration (bug #6714)
- Webservice: fixed a rare crash when calling IGuest methods from the webservice
- OVF: fixed wrong hard disk UUIDs on export (bug #6802)
- OVF: fixed 3.2.0 regression importing legacy OVF 0.9 files
- 3D support: fixed OpenGL support for 64bit applications on windows guests
- 3D support: fixed various host crashes (bugs #2954, #5713, #6443)

15.14 Version 3.2.0 (2010-05-18)

This version is a major update. The following major new features were added:

- Following the acquisition of Sun Microsystems by Oracle Corporation, the product is now called "Oracle VM VirtualBox" and all references were changed without impacting compatibility
- Experimental support for Mac OS X Server guests (see chapter 3.1.1, *Mac OS X Server guests*, page 40)
- Memory ballooning to dynamically in- or decrease the amount of RAM used by a VM (64-bit hosts only) (see chapter 4.8.1, *Memory ballooning*, page 69)
- Page Fusion automatically de-duplicates RAM when running similar VMs thereby increasing capacity. Currently supported for Windows guests on 64-bit hosts (see chapter 4.8.2, *Page Fusion*, page 69)
- CPU hot-plugging for Linux (hot-add and hot-remove) and certain Windows guests (hot-add only) (see chapter 9.5, *CPU hot-plugging*, page 142)
- New Hypervisor features: with both VT-x/AMD-V on 64-bit hosts, using large pages can improve performance (see chapter 10.6, *Nested paging and VPIDs*, page 165); also, on VT-x, unrestricted guest execution is now supported (if nested paging is enabled with VT-x, real mode and protected mode without paging code runs faster, which mainly speeds up guest OS booting)
- Support for deleting snapshots while the VM is running
- Support for multi-monitor guest setups in the GUI for Windows guests (see chapter 3.5, *Display settings*, page 45)
- USB tablet/keyboard emulation for improved user experience if no Guest Additions are available (see chapter 3.4.1, *"Motherboard" tab*, page 43)
- LsiLogic SAS controller emulation (see chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71)

- VRDP video acceleration (see chapter 7.1.9, *VRDP video redirection*, page 97)
- NAT engine configuration via API and VBoxManage
- Use of host I/O cache is now configurable (see chapter 5.7, *Host I/O caching*, page 80)
- Guest Additions: added support for executing guest applications from the host system (replaces the automatic system preparation feature; see chapter 4.7, *Guest control*, page 68)
- OVF: enhanced OVF support with custom namespace to preserve settings that are not part of the base OVF standard

In addition, the following items were fixed and/or added:

- VMM: fixed Windows 2000 guest crash when configured with a large amount of RAM (bug #5800)
- Linux/Solaris guests: PAM module for automatic logons added
- GUI: guess the OS type from the OS name when creating a new VM
- GUI: added VM setting for passing the time in UTC instead of passing the local host time to the guest (bug #1310)
- GUI: fixed seamless mode on secondary monitors (bugs #1322 and #1669)
- GUI: offer to download the user manual in the OSE version (bug #6442)
- GUI: allow to set an empty host key to disallow any host key combination (bug #684)
- GUI: allow to restrict the possible actions when shutting down the VM from the GUI
- Main: allow to start a VM even if a virtual DVD or floppy medium is not accessible
- Settings: be more robust when saving the XML settings files
- Mac OS X: rewrite of the CoreAudio driver and added support for audio input (bug #5869)
- Mac OS X: external VRDP authentication module support (bug #3106)
- Mac OS X: moved the realtime dock preview settings to the VM settings (no global option anymore). Use the dock menu to configure it
- Mac OS X: added the VM menu to the dock menu
- 3D support: fixed corrupted surface rendering (bug #5695)
- 3D support: fixed VM crashes when using *ARB_IMAGING* (bug #6014)
- 3D support: fixed assertion when guest applications uses several windows with single OpenGL context (bug #4598)
- 3D support: added GL_ARB_pixel_buffer_object support
- 3D support: added OpenGL 2.1 support
- 3D support: fixed Final frame of Compiz animation not updated to the screen (Mac OS X only) (bug #4653)
- 3D support: fixed blank screen after loading snapshot of VM with enabled Compiz

- Added support for *Virtual Distributed Ethernet* (VDE) (Linux hosts only; see chapter 6.2, *Introduction to networking modes*, page 84)
- Added support for virtual high precision event timer (HPET)
- OVF: fixed mapping between two IDE channels in OVF and the one IDE controller in VirtualBox
- OVF: fix VMDK format string identifiers and sort XML elements from rasd: namespace alphabetically as prescribed by standard
- VBoxShell: interactive Python shell extended to be fully functional TUI for VirtualBox
- Linux Additions: support Fedora 13 (bug #6370)
- VBoxManage: fixed overly strict checks when creating a raw partition VMDK (bugs #688, #4438)

15.15 Version 3.1.8 (2010-05-10)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed crash with the OpenSUSE 11.3 milestone kernel during early boot (software virtualization only)
- VMM: fixed invalid state during teleportation
- VMM: fixed OS/2 guest crash with nested paging enabled
- VMM: fixed massive display performance loss (AMD-V with nested paging only)
- GUI: fixed off-by-one bug when passing absolute mouse coordinates to the guest (3.1.6 regression)
- GUI: show the real version of the Guest Additions, not the interface version
- GUI: when adding a DVD or floppy slot in the VM mass storage settings dialog, don't attach a random medium but just leave the slot empty
- GUI: added `--seamless` and `--fullscreen` command line switches (bug #4220)
- GUI: fixed a SEGFAULT under rare circumstances
- 2D Video acceleration: fixed display issues when working with non 32-bit modes (bugs #6094 & #6208)
- LsiLogic: fixed detection of hard disks attached to port 0 when using the drivers from LSI
- ATA: fixed sporadic crash with Linux guests when having a hard disk and DVD drive on the same channel (bug #6079)
- Network: allow to start a VM even if not all network adapters are attached
- Network: promiscuous mode support for e1000 and paravirtualized adapters (bug #6519)
- NAT: fixed ICMP latency (non-Windows hosts only; bug #6427)
- SCSI: fixed guest crashes under certain circumstances when booting from SCSI devices
- VBoxManage: fixed several bugs in cloning of images (one of them is bug #6408)

- VBoxManage: fixed *modifyvm –natnet default*
- Solaris hosts: fixed a kernel panic when bridged networking might fail to initialize
- Solaris hosts: fixed priority tagged VLAN packets in bridged networking
- Shared Folders: fixed issue with copying read-only files (Linux guests only; bug #4890)
- Shared Folders: renamed the guest kernel module from *vboxvfs* to *vboxsf* to make it load on demand by the Linux kernel. Fixes mounting from /etc/fstab in Ubuntu 10.04
- Shared Folders: fixed setuid file permissions (Solaris guests only)
- Shared Folders: fixed deleting directories recursively (Solaris guests only; bug #6513)
- Guest Additions: support seamless and dynamic resizing on certain older X11 guests (bug #5840)
- Solaris Additions: fixed OpenGL library dependencies (bug #6435)
- Keyboard/Mouse emulation: fixed handling of simultaneous mouse/keyboard events under certain circumstances (bug #5375)
- Mouse emulation: never switch straight back from Explorer to IntelliMouse mode as it confuses the FreeBSD mouse driver (bug #6488)
- SDK: fixed memory leak in *IDisplay::takeScreenShotSlow()* (bug #6549)
- 3D support: fixed Final frame of Compiz animation not updated to the screen (Mac OS X only) (bug #4653)
- VRDP: allow to bind to localhost only on Mac OS X (bug #5227)
- Linux hosts: add host USB support for Ubuntu 10.04 and other hosts without the hal daemon or usbfs (bug #6343)
- webservice: more structs and array fixes in PHP bindings
- Windows hosts: make the bridged networking driver notify dll be correctly unregistred on uninstall (bug #5780)

15.16 Version 3.1.6 (2010-03-25)

This is a maintenance release. The following items were fixed and/or added:

- Linux hosts: fixed timing issue on hosts with Linux kernels 2.6.31 or later with certain CPUs (asynchronous timer mode; bug #6250)
- Linux hosts: properly handle host suspend/resume events on Linux kernels 2.6.30 or later (bug #5562)
- Mac OS X hosts: fixed VBoxSVC crash while enumerating the host network interfaces under certain circumstances
- Snapshots: fixed image corruption after snapshot merge under certain circumstances (bug #6023)
- Snapshots: fixed crash with VBoxHeadless / OSE
- VMM: fixed reference counting guru meditation (bug #4940)

- VMM: improved guest SMP stability
- VMM: fixed VT-x hardware debug issues (bugs #477 & #5792)
- VMM: fixed *PGMDynMapHCPage* guru meditation (Mac OS X; VT-x only; bug #6095)
- VMM: fixed *pgmPoolTrackFlushGCPhysPTInt* guru meditations (Mac OS X; VT-x only; bugs #6095 & #6125)
- VMM: fixed host crash when running PAE guests in VT-X mode (Mac OS X only; bug #5771)
- GUI: fix displaying of error message (bug #4345)
- GUI: fix inability to enter seamless mode (bugs #6185, #6188)
- 3D support: fixed assertion and flickering when guest application uses several windows with a single OpenGL context (bug #4598)
- 3D support: fixed host crashes when using *GL_EXT_compiled_vertex_array* and array element calls (bug #6165)
- 3D support: fixed runtime linker errors with OpenGL guest libs (bug #5297)
- 3D support: fixed OpenGL extension viewer crash on startup (bug #4962)
- NAT: fixed a 3.1.4 regression on Windows hosts where graceful connection termination was broken (bug #6237)
- NAT: alternative network setting was not stored persistent (bug #6176)
- NAT: fixed memory corruption during ICMP traffic under certain circumstances
- Network: allow to switch the host interface or the internal network while a VM is running (bug #5781)
- VHD: fix for images with a block size different than 2MB
- USB: fixed filtered device attach regression (bug #6251)
- USB: fixed crash in OHCI under rare circumstances (bug #3571)
- VRDP: fixed hang under rare circumstances when attaching USB devices
- ACPI: prevent guest freezes when accessing /proc/acpi for determining the state of the host battery and the AC adapter (Linux hosts only; bug #2836)
- PulseAudio: fixed guest freezes under certain conditions (3.1.4 regression; bug #6224)
- BIOS: increased space for DMI strings
- BIOS: fixed interrupt routing problem for certain configurations (I/O-APIC enabled, ACPI not used; bug #6098)
- iSCSI: be more robust when handling the *INQUIRY* response
- iSCSI: be more robust when handling sense data
- BusLogic: fixed FreeBSD guests
- webservice: vboxwebsrv is now multithreaded
- webservice: fixed handling of structs and arrays in PHP bindings

- Solaris Installer: fixed netmask to stay persistent across reboots for Host-only interface (bug #4590)
- Linux installer: removed external dependency to libpng12.so (bug #6243)
- Solaris Additions: fixed superfluous kernel logging (bug #6181)
- Linux Additions: fixed hang when starting the X server in Fedora12 guests and in guests with Linux 2.6.33 or later (bug #6198)
- Linux Additions: support Mandriva speedboot runlevel (bug #5484)
- Linux Additions: fixed SELinux security context of mount.vboxsf (bug #6362)
- Linux Additions: support Ubuntu 10.04 (bug #5737)
- Web service: update PHP bindings to fix problems with enums and collections

15.17 Version 3.1.4 (2010-02-12)

This is a maintenance release. The following items were fixed and/or added:

- VMM: SMP stability fixes
- VMM: fixed guru meditation in certain rare cases (bug #5968)
- VMM: activate NXE for PAE enabled guests (VT-x and AMD-V on 32 bits hosts only; bug #3578)
- VMM: added workaround for broken BIOSes that make VirtualBox think AMD-V is in use (for details see bug #5639)
- VMM: fixed rare host reboot when restoring a saved state (bug #3945)
- VMM: fixed incompatibility with 2.6.32 Linux kernels (software virtualization only; bug #6100)
- VMM: turn on nested paging by default for new VMs (if available; VT-x and AMD-V only)
- VMM: turn on VPID by default for new VMs (if available; VT-x only)
- VMM: perform strict CPUID compatibility checks when teleporting; to get the old behavior set “VBoxInternal/CPUM/StrictCpuIdChecks” to 0
- VMM: fixed VM crash with certain 16 bits Windows applications (software virtualization only; bug #5399)
- Snapshots: fixed a 3.1 regression that broke deletion of snapshots when a machine had immutable or writethrough storage attached (bug #5727)
- Saved state: fixed *VERR_SSM_LOADED_TOO_MUCH* error when loading *DisplayScreenshot*(bug #6162)
- VBoxManage: add *restorecurrent* operation to snapshots command
- VBoxManage: fixed broken snapshot lookup by name (bug #6070
- GUI: fixed the broken “Reload” button that reloads the machine XML when a machine is inaccessible
- GUI: fixed guest fullscreen mode after reboot (bug #5372)

- GUI: handle Ctrl+Break properly on X11 hosts (bug #6122)
- GUI: fixed status LEDs for storage devices
- GUI: workaround for disabling the seamless mode on KDE hosts (KWin bug)
- 3D support: fixed SELinux warning saying VBoxOGL.so requires text relocation (bug #5690)
- 3D support: fixed Corrupted surface rendering (bug #5695)
- 3D support: free textures on guest application termination (bug #5206)
- 3D support: fixed *ubigraph_server* crashes (bug #4674)
- 3D support: fixes for 64-bit Solaris guests
- Seamless: disable seamless mode when guest changes screen resolution (bug #5655)
- NAT: fixed high CPU load under certain circumstances (Windows hosts only; bug #5787)
- NAT: fixed handling of the *broadcast* flag in DHCP requests
- NAT: fixed rare crash due to an assertion in the ICMP code (bug #3217)
- Virtio-net: don't crash when ports accessed beyond the valid range (bug #5923)
- LsiLogic: fix for Windows 7 guests
- ATA: fix for guru meditation when installing Solaris 8 guests (bug #5972)
- VHD: fixed an incompatibility with Virtual PC (bug #5990)
- VHD: update the footer backup after setting a new UUID (bug #5004)
- Host DVD: really fixed loading "passthrough" setting from configuration file (bug #5681)
- Shared Folders: fixed resolving of symlink target on Linux (3.1.2 regression)
- VRDP: fixed *VERR_NET_ADDRESS_IN_USE* error when restarting a VM (3.1 regression; bug #5902)
- VRDP: fixed crash on Mac OS X when 3D is enabled (3.1 regression)
- PulseAudio: fixed recording (bug #4302)
- USB: fixed a shutdown blue screen (Windows hosts only; bug #5885)
- BIOS: fixed attribute during text scroll (bug #3407)
- OVF: fix strange error messages on disk import errors
- OVF: do not require write access to the .ovf file during import (3.1 regression; bug #5762)
- iSCSI: fix taking snapshots of a running VM (bug #5849)
- Solaris hosts: several USB fixes (including support for Apple iPod; bug #5873)
- Solaris installer: fixed USB module removal and Solaris 10 "id" binary incompatibility
- Guest Additions: fixed wrong guest time adjustment if the guest clock is ahead (3.1 regression; non-Windows guests only)
- Linux Additions: fixed shared folders for Linux 2.6.32 guests (bug #5891)

- Linux Additions: make the mouse driver work on Debian 5.0.3 guests again (3.1.2 regression, bug #5832)
- Windows Additions: fixed malfunctioning VBoxService that broke time-sync (bug #5872)
- Windows Additions: fixed uninstallation issues on 64-bit guests
- Windows Additions: fixed some sysprep execution issues
- X.Org Additions: never reject the saved video mode as invalid (bug #5731)
- XFree86 Additions: accept video mode hints for the initial mode again

15.18 Version 3.1.2 (2009-12-17)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed SMP stability regression
- USB: fixed USB related host crashes on 64 bits Windows hosts (bug #5237)
- Main: wrong default HWVirtExExclusive value for new VMs (bug #5664)
- Main: DVD passthrough setting was lost (bug #5681)
- VBoxManage: iSCSI disks do not support adding a comment (bug #4460)
- VBoxManage: added missing *–cpus* and *–memory* options to OVF *–import*
- GUI: fixed VBox URL in update dialog for German and Dutch languages
- GUI: NLS updates
- OVF: fixed export of non standard storage controller names (bug #5643)
- Solaris hosts: several USB fixes (including support for Apple iPhone)
- Mac OS X hosts: several fixes for the 3D support
- Mac OS X hosts: re-enabled CMD+Key combinations, even if the Host-Key isn't CMD (bug #5684)
- Mac OS X hosts: fixed to fast scrolling if the mouse wheel is used inside the guest (bug #5672)
- Mac OS X hosts: dock & menubar don't disappear in fullscreen when the VM is not running on the primary display (bug #1762)
- Mac OS X hosts: added an option for enabling "Auto show Dock & Menubar in fullscreen" (bug #5636)
- Windows host installer: fixed starting VBox with wrong privileges right after installation (bug #4162)
- Host interface and host-only networking: prevent driver from unloading while a VM is still active (Windows host only)
- Host-only networking: fixed host-only interface creation (Windows host only) (bug #5708)
- Virtio-net: don't crash without an attached network
- Virtio-net: fixed the issue with intermittent network in VM with several virtual CPU cores

- NAT: fixed port-forwarding regressions (bug #5666)
- NAT: fixed crash under certain conditions (bug #5427)
- NAT: fixed resolving of names containing a slash or underscore when using the host resolver DNS proxy (bug #5698)
- ATA: fixed sporadic crash when resuming after a VM was forcefully paused (e.g. due to iSCSI target being unavailable)
- SATA: fixed raw vmdk disks (bug #5724)
- Linux guests: increased the default memory for Redhat and Fedora guests
- Linux Guest Additions: fixed installation on RHEL 3.9 guests and on some 64bit guests
- Linux Guest Additions: prevent SELinux warnings concerning text relocations in VBoxOGL.so (bug #5690)
- X11 guests: fixed mouse support for some Xorg 1.4 guests (openSUSE 11.0)
- X11 guests: fixed xorg.conf modification for some older Xorg releases (openSUSE 11.1)
- Windows guests: fixed some VBoxService shutdown issues
- Windows guests: fixed VBoxVideo spinlock issues on NT4
- Windows Guest Additions: fixed uninstallation issues of NT4
- Shared Folders: fixed resolving of symlink target (bug #5631)
- 2D Video acceleration: delay loading of OpenGL dlls for Windows hosts to avoid GUI crashes on misconfigured systems
- 2D Video acceleration: fixed issues with video picture not displayed on playback

15.19 Version 3.1.0 (2009-11-30)

This version is a major update. The following major new features were added:

- Teleportation (aka live migration); migrate a live VM session from one host to another (see chapter 7.2, *Teleporting*, page 98)
- VM states can now be restored from arbitrary snapshots instead of only the last one, and new snapshots can be taken from other snapshots as well ("branched snapshots"; see chapter 1.9, *Snapshots*, page 23)
- 2D video acceleration for Windows guests; use the host video hardware for overlay stretching and color conversion (see chapter 4.4.2, *Hardware 2D video acceleration for Windows guests*, page 65)
- More flexible storage attachments: CD/DVD drives can be attached to arbitrary storage controllers, and there can be more than one such drive (chapter 5, *Virtual storage*, page 71)
- The network attachment type can be changed while a VM is running
- Complete rewrite of experimental USB support for OpenSolaris hosts making use of the latest USB enhancements in Solaris Nevada 124 and higher

- Significant performance improvements for PAE and AMD64 guests (VT-x and AMD-V only; normal (non-nested) paging)
- Experimental support for EFI (Extensible Firmware Interface; see chapter 3.12, *Alternative firmware (EFI)*, page 52)
- Support for paravirtualized network adapters (virtio-net; see chapter 6.1, *Virtual networking hardware*, page 83)

In addition, the following items were fixed and/or added:

- VMM: guest SMP fixes for certain rare cases
- GUI: snapshots include a screenshot
- GUI: locked storage media can be unmounted by force
- GUI: the log window grabbed all key events from other GUI windows (bug #5291)
- GUI: allow to disable USB filters (bug #5426)
- GUI: improved memory slider in the VM settings
- 3D support: major performance improvement in VBO processing
- 3D support: added *GL_EXT_framebuffer_object*, *GL_EXT_compiled_vertex_array* support
- 3D support: fixed crashes in FarCry, SecondLife, Call of Duty, Unreal Tournament, Eve Online (bugs #2801, #2791)
- 3D support: fixed graphics corruption in World of Warcraft (bug #2816)
- 3D support: fixed Final frame of Compiz animation not updated to the screen (bug #4653)
- 3D support: fixed incorrect rendering of non ARGB textures under compiz
- iSCSI: support iSCSI targets with more than 2TiB capacity
- VRDP: fixed occasional VRDP server crash (bug #5424)
- Network: fixed the E1000 emulation for QNX (and probably other) guests (bug #3206)
- NAT: added host resolver DNS proxy (see chapter 9.11.6, *Using the host's resolver as a DNS proxy in NAT mode*, page 150)
- VMDK: fixed incorrectly rejected big images split into 2G pieces (bug #5523, #2787)
- VMDK: fixed compatibility issue with fixed or raw disk VMDK files (bug #2723)
- VHD: fixed incompatibility with Hyper-V
- Support for Parallels version 2 disk image (HDD) files; see chapter 5.2, *Disk image files (VDI, VMDK, VHD, HDD)*, page 73
- OVF: create manifest files on export and verify the content of an optional manifest file on import
- OVF: fixed memory setting during import (bug #4188)
- Mouse device: now five buttons are passed to the guest (bug #3773)
- VBoxHeadless: fixed loss of saved state when VM fails to start

- VBoxSDL: fixed crash during shutdown (Windows hosts only)
- X11 based hosts: allow the user to specify their own scan code layout (bug #2302)
- Mac OS X hosts: don't auto show the menu and dock in fullscreen (bug #4866)
- Mac OS X hosts (64 bit): don't interpret mouse wheel events as left click (bug #5049)
- Mac OS X hosts: fixed a VM abort during shutdown under certain conditions
- Solaris hosts: combined the kernel interface package into the VirtualBox main package
- Solaris hosts: support for OpenSolaris Boomer architecture (with OSS audio backend)
- Shared Folders: VBOXSVR is visible in Network folder (Windows guests, bug #4842)
- Shared Folders: performance improvements (Windows guests, bug #1728)
- Windows, Linux and Solaris Additions: added balloon tip notifier if VirtualBox host version was updated and Additions are out of date
- Solaris guests: fixed keyboard emulation (bug #1589)
- Solaris Additions: fixed *as_pagelock()* failed errors affecting guest properties (bug #5337)
- Windows Additions: added automatic logon support for Windows Vista and Windows 7
- Windows Additions: improved file version lookup for guest OS information
- Windows Additions: fixed runtime OS detection on Windows 7 for session information
- Windows Additions: fixed crash in seamless mode (contributed by Huihong Luo)
- Linux Additions: added support for uninstalling the Linux Guest Additions (bug #4039)
- Linux guest shared folders: allow mounting a shared folder if a file of the same name as the folder exists in the current directory (bug #928)
- SDK: added object-oriented web service bindings for PHP5

15.20 Version 3.0.12 (2009-11-10)

This is a maintenance release. The following items were fixed and/or added:

- VMM: reduced IO-APIC overhead for 32 bits Windows NT/2000/XP/2003 guests; requires 64 bits support (VT-x only; bug #4392)
- VMM: fixed double timer interrupt delivery on old Linux kernels using IO-APIC (caused guest time to run at double speed; bug #3135)
- VMM: re-initizalize VT-x and AMD-V after host suspend or hibernate; some BIOSes forget this (Windows hosts only; bug #5421)
- VMM: fixed loading of saved state when RAM preallocation is enabled
- BIOS: ignore unknown shutdown codes instead of causing a guru meditation (bug #5389)
- GUI: never start a VM on a single click into the selector window (bug #2676)
- Serial: reduce the probability of lost bytes if the host end is connected to a raw file
- VMDK: fixed handling of split image variants and fix a 3.0.10 regression (bug #5355)

- VRDP: fixed occasional VRDP server crash
- Network: even if the virtual network cable was disconnected, some guests were able to send / receive packets (E1000; bug #5366)
- Network: even if the virtual network cable was disconnected, the PCNet card received some spurious packets which might confuse the guest (bug #4496)
- Shared Folders: fixed changing case of file names (bug #2520)
- Windows Additions: fixed crash in seamless mode (contributed by Huihong Luo)
- Linux Additions: fixed writing to files opened in *O_APPEND* mode (bug #3805)
- Solaris Additions: fixed regression in Guest Additions driver which among other things caused lost guest property updates and periodic error messages being written to the system log

15.21 Version 3.0.10 (2009-10-29)

This is a maintenance release. The following items were fixed and/or added:

- VMM: guest SMP stability fixes
- VMM: fixed guru meditation with nested paging and SMP guests (bug #5222)
- VMM: changed VT-x/AMD-V usage to detect other active hypervisors; necessary for e.g. Windows 7 XP compatibility mode (Windows & Mac OS X hosts only; bug #4239)
- VMM: guru meditation during SCO OpenServer installation and reboot (VT-x only; bug #5164)
- VMM: fixed accessed bit handling in certain cases (bug #5248)
- VMM: fixed VPID flushing (VT-x only)
- VMM: fixed broken nested paging for 64 bits guests on 32 bits hosts (AMD-V only; bug #5285)
- VMM: fixed loading of old saved states/snapshots (bug #3984)
- Mac OS X hosts: fixed memory leaks (bug #5084)
- Mac OS X hosts (Snow Leopard): fixed redraw problem in a dual screen setup (bug #4942)
- Windows hosts: installer updates for Windows 7
- Solaris hosts: out of memory handled incorrectly (bug #5241)
- Solaris hosts: the previous fix for #5077 broke the DVD host support on Solaris 10 (VBox 3.0.8 regression)
- Linux hosts: fixed module compilation against Linux 2.6.32rc4 and later
- Guest Additions: fixed possible guest OS kernel memory exhaustion
- Guest Additions: fixed stability issues with SMP guests
- Windows Additions: fixed color depth issue with low resolution hosts, netbooks, etc. (bug #4935)

- Windows Additions: fixed NO_MORE_FILES error when saving to shared folders (bug #4106)
- Windows Additions: fixed subdirectory creation on shared folders (bug #4299)
- Linux Additions: *sendfile()* returned *-EOVERFLOW* when executed on a shared folder (bug #2921)
- Linux Additions: fixed incorrect disk usage value (non-Windows hosts only)
- Linux installer: register the module sources at DKMS even if the package provides proper modules for the current running kernel
- 3D support: removed invalid OpenGL assertion (bug #5158)
- Network: fixed the Am79C973 PCNet emulation for QNX (and probably other) guests (bug #3206)
- VMDK: fix handling of split image variants
- VHD: do not delay updating the footer when expanding the image to prevent image inconsistency
- USB: stability fix for some USB 2.0 devices
- GUI: added a search index to the .chm help file
- GUI/Windows hosts: fixed CapsLock handling on French keyboards (bug #2025)
- Shared clipboard/X11 hosts: fixed a crash when clipboard initialisation failed (bug #4987)

15.22 Version 3.0.8 (2009-10-02)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed 64 bits guest on 32 bits host regression in 3.0.6 (VT-x only; bug #4947)
- VMM: fixed a recompiler triple fault guru meditation (VT-x & AMD-V only; bug #5058)
- VMM: fixed hang after guest state restore (AMD-V, 32 bits Windows guest and IO-APIC enabled only; bug #5059)
- VMM: fixed paging issue with OS/2 guests
- VMM: fixed guru meditation in rare cases (2.0 regression; software virtualization only)
- VMM: fixed release assertion during state restore when using the Sound Blaster 16 emulation (bug #5042)
- Security: fixed vulnerability that allowed to execute commands with root privileges
- Linux hosts: fixed runtime assertion in semaphore implementation which was triggered under certain conditions (bug #616)
- Linux hosts: change the default USB access mode on certain distributions (bugs #3394 and #4291)
- Linux hosts: on hardened Gentoo, the VBoxSVC daemon crashed by opening the VM network settings (bug #3732)

- Linux hosts, Solaris hosts: pass the XAUTHORITY variable along the DISPLAY variable when starting a VM from VBoxManage or from the VM selector (bug #5063)
- Linux hosts: use sysfs to enumerate host drives if hal is not available
- Solaris hosts: fixed a bug which would hang the host sporadically as interrupts were not re-enabled every time
- Solaris hosts: fixed a kernel panic with bridged and host-only networking (bug #4775)
- Solaris hosts: fixed incorrectly persistent CD/DVD-ROMs when changing them (bug #5077)
- X11-based hosts: support additional function keys on Sun keyboards (bug #4907)
- Mac OS X hosts (Snow Leopard): fixed problem starting headless VMs without a graphical session (bug #5002)
- Mac OS X hosts: fixed problem listing host-only adapter names with trailing garbage (attached VMs won't start)
- Windows Additions: now work with Vista 64-bit Home editions (bug #3865)
- Windows Additions: fixed screen corruption with ZoomText Magnifier
- Windows Additions: fixed NPGetUniversalName failure (bug #4853)
- Windows Additions: fixed Windows NT regression (bug #4946)
- Windows Additions: fixed VBoxService not running if no Shared Folders are installed
- Linux Additions: implemented *ftrunctate* (bug #4771)
- VRDP: start VM even if configured VRDP port is in use
- Networking: the PCnet network device stopped receiving under rare conditions (bug #4870)
- VBoxManage: implemented `controlvm vrdpport` command
- iSCSI: fixed issue with NetApp targets (bug #5072)
- SCSI: add support for virtual disks larger than 2TB
- USB: fixed potential crash when unplugging USB2 devices (bug #5089)
- NAT: IPSEC did not properly work with Linux guests (bug #4801)

15.23 Version 3.0.6 (2009-09-09)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed IO-APIC overhead for 32 bits Windows NT, 2000, XP and 2003 guests (AMD-V only; bug #4392)
- VMM: fixed a Guru meditation under certain circumstances when enabling a disabled device (bug #4510)
- VMM: fixed a Guru meditation when booting certain Arch Linux guests (software virtualization only; bug #2149)

- VMM: fixed hangs with 64 bits Solaris & OpenSolaris guests (bug #2258)
- VMM: fixed decreasing *rdtsc* values (AMD-V & VT-x only; bug #2869)
- VMM: small Solaris/OpenSolaris performance improvements (VT-x only)
- VMM: *cpuid* change to correct reported virtual CPU ID in Linux
- VMM: NetBSD 5.0.1 CD hangs during boot (VT-x only; bug #3947)
- Solaris hosts: worked around an issue that caused the host to hang (bug #4486)
- Solaris hosts: fixed a rare host system deadlock when using bridged networking
- Solaris hosts: fixed a potential host system deadlock when CPUs were onlined or offlined
- Solaris hosts installer: added missing dependency for UTF-8 package (bug #4899)
- Linux hosts: don't crash on Linux PAE kernels < 2.6.11 (in particular RHEL/CentOS 4); disable VT-x on Linux kernels < 2.6.13 (bug #1842)
- Linux/Solaris hosts: correctly detect keyboards with fewer keys than usual (bug #4799)
- Mac OS X hosts: prevent password dialogs in 32 bits Snow Leopard
- Python WS: fixed issue with certain enumerations constants having wrong values in Python webservices bindings
- Python API: several threading and platform issues fixed
- Python shell: added *exportVM* command
- Python shell: various improvements and bugfixes
- Python shell: corrected detection of home directory in remote case
- OVF: fixed XML comment handling that could lead to parser errors
- Main: fixed a rare parsing problem with port numbers of USB device filters in machine settings XML
- Main: restrict guest RAM size to 1.5 GB (32 bits Windows hosts only)
- Main: fixed possible hang during guest reboot (bug #3792)
- GUI: fixed rare crash when removing the last disk from the media manager (bug #4795)
- VBoxManage: fixed `guestproperty` for Mac OS X hosts (bug #3806)
- VBoxManage: fixed setting guest properties with *–flags* or *-flags*
- Webservice: fixed a severe memory leak, at least on platforms using XPCOM
- Serial: fixed host mode (Solaris, Linux and Mac OS X hosts; bug #4672)
- VRDP: Remote USB Protocol version 3
- SATA: fixed hangs and BSODs introduced with 3.0.4 (bugs #4695, #4739, #4710)
- SATA: fixed a bug which prevented Windows 7 from detecting more than one hard disk
- SATA/SCSI: fixed rare random guest crashes and hangs
- SCSI: fixed problem with Fedora 11 refusing to boot after kernel update

- iSCSI: fix logging out when the target has dropped the connection, fix negotiation of parameters, fix command resend when the connection was dropped, fix processing SCSI status for targets which do not use phase collapse
- BIOS: fixed a bug that caused the OS/2 boot manager to fail (2.1.0 regression, bug #3911)
- PulseAudio: don't hang during VM termination if the connection to the server was unexpectedly terminated (bug #3100)
- Mouse: fixed weird mouse behaviour with SMP (Solaris) guests (bug #4538)
- HostOnly Network: fixed failure in *CreateHostOnlyNetworkInterface()* on Linux (no GUID)
- HostOnly Network: fixed wrong DHCP server startup while hostonly interface bringup on Linux
- HostOnly Network: fixed incorrect factory and default MAC address on Solaris
- HostOnly Network: fixed the problem with listing host-only interfaces on Mac OS X when all physical interfaces are down (bugs #4698, #4790)
- DHCP: fixed a bug in the DHCP server where it allocated one IP address less than the configured range
- E1000: fixed receiving of multicast packets
- E1000: fixed up/down link notification after resuming a VM
- NAT: fixed Ethernet address corruptions (bug #4839)
- NAT: fixed hangs, dropped packets and retransmission problems (bug #4343)
- Bridged networking: fixed packet queue issue which might cause DRIVER_POWER_STATE_FAILURE BSOD for Windows hosts (bug #4821)
- Windows Additions: fixed a bug in VBoxGINA which prevented selecting the right domain when logging in the first time
- Windows host installer: should now also work on unicode systems (like Korean, bug #3707)
- Windows host installer: check for sufficient disk space
- Shared clipboard: do not send zero-terminated text to X11 guests and hosts (bug #4712)
- Shared clipboard: use a less CPU intensive way of checking for new data on X11 guests and hosts (bug #4092)
- Guest Additions: do not hide the host mouse cursor when restoring a saved state (bug #4700)
- Windows guests: fixed issues with the display of the mouse cursor image (bugs #2603, #2660 and #4817)
- SUSE 11 guests: fixed Guest Additions installation (bug #4506)
- Guest Additions: support Fedora 12 Alpha guests (bugs #4731, #4733 and #4734)

15.24 Version 3.0.4 (2009-08-04)

This is a maintenance release. The following items were fixed and/or added:

- VMM: 64 bits guest stability fixes (AMD-V only; bugs #3923 & #3666)
- VMM: SMP stability fixes (AMD-V only)
- VMM: SMP performance improvement (esp. for Solaris guests)
- VMM: eliminated several bugs which could lead to a host reboot
- VMM: fixed OS/2 ACP2 boot floppy hang (VT-x only)
- VMM: small performance improvement for OpenSolaris guests (AMD-V only)
- VMM: fixed CentOS/Xen reboot (software virtualization only; bug #4509)
- SATA: fixed hangs / BSOD during Windows XP installation (bug #4342)
- SATA: mark the ports as non hotpluggable (bug #3920)
- 3D support: fix deadlocks and context/window tracking for multithreaded applications (bug #3922)
- 3D support: fix memory leaks when terminating OpenGL guest applications
- 3D support: fix crash in Call of Duty
- NAT: using two or more NAT adapters in one VM was broken (3.0.0 regression)
- NAT: fixed network communication corruptions (bugs #4499, #4540, #4591, #4604)
- NAT: fixed passive ftp access to host server (bug #4427)
- iSCSI: fixed cloning to/from iSCSI disks
- GUI: fixed path separator handling for the OVF export on Windows (bug #4354)
- GUI: the mini toolbar was only shown on the first host display (bug #4654)
- GUI: added a VM option to display the mini toolbar on top
- GUI: don't crash when adding plus configuring host-only network interfaces
- Shared Folders: fixed selection of a drive root directory as a shared folder host path in VirtualBox (Windows host only)
- USB: fixed a bug that may have rendered USB device filter settings inactive (3.0.2 regression, bug #4668)
- Guest Additions: report the Guest Additions version to the guest properties (bug #3415)
- Mac OS X hosts: fix creation of VMDK files giving raw partition access (bug #1461)
- Mac OS X hosts: improved support for Snow Leopard
- Linux hosts: fixed problems leading to wrong colors or transparency in host windows with some graphics drivers (bug #3095)
- Linux hosts: hardware detection fallbacks if the hal service fails to find any DVD drives
- Linux and Solaris hosts: Work around color handling problems in Qt (bug #4353)

- Solaris hosts: fixed memory leaks in host-only networking
- Solaris Installer: fixed incorrect netmask for Host-only interface (bug #4590)
- Solaris Installer: added package dependency for Python and Python-devel (bug #4570)
- X11 guests: prevent windows from being skipped in seamless mode KDE guests (bugs #1681 and #3574)
- X11 guests: fixed screen corruption in X11 guests when large amounts of video RAM were allocated (bug #4430)
- X11 guests: some fixes when switching between host and guest-drawn mouse pointers
- X11 guests: fixed an issue which caused seamless mode to stop working as it should (the main issue listed in bug #2238)

15.25 Version 3.0.2 (2009-07-10)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed network regressions (guest hangs during network IO) (bug #4343)
- VMM: guest SMP performance improvements
- VMM: fixed hangs and poor performance with Kaspersky Internet Security (VT-x/AMD-V only; bug #1778)
- VMM: fixed crashes when executing certain Linux guests (software virtualization only; bugs #2696 & #3868)
- ACPI: fixed Windows 2000 kernel hangs with IO-APIC enabled (bug #4348)
- APIC: fixed high idle load for certain Linux guests (3.0 regression)
- BIOS: properly handle Ctrl-Alt-Del in real mode
- iSCSI: fixed configuration parsing (bug #4236)
- OVF: fix potential confusion when exporting networks
- OVF: compatibility fix (bug #4452)
- OVF: accept ovf:/disk/ specifiers with a single slash in addition to ovf://disk/ (bug #4452)
- NAT: fixed crashes under certain circumstances (bug #4330)
- 3D support: fixed dynamic linking on Solaris/OpenSolaris guests (bug #4399)
- 3D support: fixed incorrect context/window tracking for multithreaded apps
- Shared Folders: fixed loading from saved state (bug #1595)
- Shared Folders: host file permissions set to 0400 with Windows guest (bug #4381)
- X11 host and guest clipboard: fixed a number of issues, including bug #4380 and #4344
- X11 Additions: fixed some issues with seamless windows in X11 guests (bug #3727)
- Windows Additions: added VBoxServiceNT for NT4 guests (for time synchronization and guest properties)

- Windows Additions: fixed version lookup
- Linux Installer: support Pardus Linux
- Linux hosts: workaround for buggy graphics drivers showing a black VM window on recent distributions (bug #4335)
- Linux hosts: fixed typo in kernel module startup script (bug #4388)
- Solaris hosts: several installer fixes
- Solaris hosts: fixed a preemption issue causing VMs to never start on Solaris 10 (bug #4328)
- Solaris guests: fixed mouse integration for OpenSolaris 2009.06 (bug #4365)
- Windows hosts: fixed high CPU usage after resuming the host (bug #2978)
- Fixed a settings file conversion bug which sometimes caused hardware acceleration to be enabled for virtual machines that had no explicit configuration in the XML

15.26 Version 3.0.0 (2009-06-30)

This version is a major update. The following major new features were added:

- Guest SMP with up to 32 virtual CPUs (VT-x and AMD-V only; see chapter 3.4.2, *"Processor" tab*, page 44)
- Windows guests: ability to use Direct3D 8/9 applications / games (experimental; see chapter 4.4.1, *Hardware 3D acceleration (OpenGL and Direct3D 8/9)*, page 64)
- Support for OpenGL 2.0 for Windows, Linux and Solaris guests

In addition, the following items were fixed and/or added:

- Solaris hosts: allow suspend/resume on the host when a VM is running (bug #3826)
- Solaris hosts: loosen the restriction for contiguous physical memory under certain conditions
- Mac OS X hosts: fixed guest PAE
- Linux hosts: kernel module compile fixes for 2.6.31 (bug #4264)
- VMM: fixed occasional guru meditation when loading a saved state (VT-x only)
- VMM: eliminated IO-APIC overhead with 32 bits guests (VT-x only, some Intel CPUs don't support this feature (most do); bug #638)
- VMM: fixed 64 bits CentOS guest hangs during early boot (AMD-V only; bug #3927)
- VMM: performance improvements for certain PAE guests (e.g. Linux 2.6.29+ kernels)
- VMM: some Windows guests detected a completely wrong CPU frequency (bug #2227)
- VMM: fixed hanging and unkillable VM processes (bug #4040)
- VMM: fixed random infrequent guest crashes due XMM state corruption (Win64 hosts only)
- VMM: performance improvements for network I/O (VT-x/AMD-V only)

- GUI: added mini toolbar for fullscreen and seamless mode (Thanks to Huihong Luo)
- GUI: redesigned settings dialogs
- GUI: allow to create/remove more than one host-only network adapters (non Windows hosts)
- GUI: display estimated time for long running operations (e.g. OVF import/export)
- GUI: fixed rare hangs when open the OVF import/export wizards (bug #4157)
- 3D support: fixed VM crashes for client applications using incorrect OpenGL states
- 3D support: fixed memory corruption when querying for supported texture compression formats
- 3D support: fixed incorrect rendering of glDrawRangeElements
- 3D support: fixed memory leak when using VBOs
- 3D support: fixed glew library detection
- 3D support: fixed random textures corruption
- VRDP: support Windows 7 RDP client
- Networking: fixed another problem with TX checksum offloading with Linux kernels up to version 2.6.18
- NAT: fixed “open ports on virtual router 10.0.2.2 - 513, 514” (forum)
- NAT: allow to configure socket and internal parameters
- NAT: allow to bind sockets to specific interface
- PXE boot: significant performance increase (VT-x/AMD-V only)
- VHD: properly write empty sectors when cloning of VHD images (bug #4080)
- VHD: fixed crash when discarding snapshots of a VHD image
- VHD: fixed access beyond the block bitmap which could lead to arbitrary crashes
- VBoxManage: fixed incorrect partition table processing when creating VMDK files giving raw partition access (bug #3510)
- VBoxManage: support cloning to existing image file
- OVF: several OVF 1.0 compatibility fixes
- OVF: fixed exporting of disk images when multiple virtual machines are exported at once
- Virtual mouse device: eliminated micro-movements of the virtual mouse which were confusing some applications (bug #3782)
- Shared Folders: sometimes a file was created using the wrong permissions (2.2.0 regression; bug #3785)
- Shared Folders: allow to change file attributes from Linux guests and use the correct file mode when creating files
- Shared Folders: some content was incorrectly written under certain conditions (bug #1187)

- Shared Folders: fixed incorrect file timestamps, when using Windows guest on a Linux host (bug #3404)
- X11 clipboard: fix duplicate end of lines (bug #4270)
- X11 guests: a number of shared clipboard fixes
- Linux guests: Guest Additions support for SUSE Linux Enterprise Desktop 11
- Linux guests: new daemon vboxadd-service to handle time synchronization and guest property lookup
- Linux guests: implemented guest properties (OS info, logged in users, basic network information)
- Windows host installer: VirtualBox Python API can now be installed automatically (requires Python and Win32 Extensions installed)
- USB: Support for high-speed isochronous endpoints has been added. In addition, read-ahead buffering is performed for input endpoints (currently Linux hosts only). This should allow additional devices to work, notably webcams (bug #242)
- USB: fixed error handling for some USB dongles
- Web service: fixed inability to handle NULL pointers for object arguments, which are valid values for a lot of APIs, in both the raw and the object-oriented web service
- Web service: object-oriented bindings for JAX-WS did not exhibit interface inheritance correctly, fixed
- Web service: added support for IDisplay and IGuest interfaces, which were previously unavailable
- Registration dialog uses Sun Online accounts now

15.27 Version 2.2.4 (2009-05-29)

This is a maintenance release. The following items were fixed and/or added:

- Windows Installer: fixed a potential hang during installation
- Windows Installer: fixed several problems (bug #3892)
- Solaris hosts: make it work with Solaris build 114 or later (bug #3981)
- Solaris hosts: fixed a bug serial port character handling found during loopback (bug #3120)
- Linux hosts: adapted vboxdrv.sh to the latest changes in `VBoxManage list runningvms` (bug #4034)
- Windows hosts: fixed a crash caused by host-only/bridged networking
- Mac OS X hosts: fixed access to host DVD with passthrough disabled (bug #4077)
- Guest Additions: fixed problems with KDE 4 not recognizing mouse clicks
- Windows Additions: fixed incorrect 8-bit guest color depth in Windows 7 guests
- GUI: warn if VT-x/AMD-V could not be enabled for guests that require this setting (bug #4055)

- VMM: fixed occasional crash due to insufficient memory
- VMM: fixed hanging 64 bits Solaris guests
- VMM: restore from a saved state occasionally failed (bugs #3984 and #2742)
- Clipboard: fixed a deadlock while shutting down the shared clipboard on X11 hosts (bug #4020)
- OVF: fixed potential hang during import
- OVF: fixed potential crashes during import/export on Win64 hosts
- VBoxManage `modifyhd --compact`: fixed bug which could lead to crashes and image corruption (bug #3864)
- VBoxManage `metrics collect`: now flushes the output stream
- VHD: made `VBoxManage internalcommands sethduuid` work for .vhd files (bug #3443)
- VHD: some .vhd files could not be cloned (bug #4080)
- NAT: improvement of TCP connection establishment (bug #2987)
- NAT: fixed order of DNS servers in DHCP lease (bug #4091)
- NAT: fixed DHCP lease for multiple name servers (bug #3692)
- NAT: fixed a potential segfault if the host lost its connectivity (bug #3964)
- Shared Folders: deny access to parent directories on Windows hosts (bug #4090)
- Shared Folders: make rm/rmdir work with Solaris guests on Windows hosts
- Networking: fixed the problem with blocked receiving thread when a broadcast packet arrives too early to be handled by uninitialized e1000 adapter
- Networking: fixed the problem that caused host freezes/crashes when using bridged mode with host's interface having RX checksum offloading on (bug #3926 and related). Fixes problems with TX offloading as well (bug #3870)
- PXE boot: Added support for PRO/1000 MT Server adapter
- Python bindings: fixed keyword conflict
- SCSI: fixed occasional crashes on Win64
- Serial: allow to redirect the serial port to a raw file (bug #1023)
- VRDP: fixed a rare incorrect screen update
- VMDK: fixed creating snapshots

15.28 Version 2.2.2 (2009-04-27)

This is a maintenance release. The following items were fixed and/or added:

- Host and guest clipboard: fixed a number of issues affecting hosts and guests running the X window system
- Guest Additions: make sure the virtual mouse autodetection works on first reboot after installing the Additions on X.Org server 1.5 and later
- Guest Additions: properly report process identity number of running services
- Guest Additions: clean up properly if the X Window server terminates
- Linux Additions: fixed installation path for OpenGL libraries in some 64-bit guests (bug #3693)
- Solaris Additions: fixed installation to work when X.Org is not installed on the guest
- Solaris Additions: fixed a bug that could panic the guest when unmounting a busy shared folder
- Windows Additions: fixed mouse pointer integration of some Windows guests (2.2.0 regression, bug #3734)
- Windows Additions: fixed installation on Windows Server 2008 Core (bug #2628)
- Main: do not try to use older versions of D-Bus (Linux hosts only, bug #3732)
- VMM: fixed out-of-memory conditions on Windows hosts (bug #3657)
- VMM: fixed occasional hangs when attaching USB devices during VM startup (2.2.0 regression; bugs #3787)
- VMM: fixed guru meditation related to memory management (software virtualization only)
- Virtual disks: fix possible data corruption when writing to diff images, incorrect detection of redundant writes
- GUI: reworked network settings dialog
- GUI: properly show the detailed settings dialog of NAT networks (bug #3702)
- GUI: HostKey could not be changed (2.2.0 regression, bug #3689)
- GUI: fixed memory textfield size (Windows hosts only; bug #3679)
- GUI: fixed crash when selecting a shared folder path (Windows hosts only; bugs #3694, #3751, #3756)
- VBoxManage `modifyhd --compact`: implemented again for VDI files, and now supports relative paths (bug #2180, #2833)
- VBoxManage `snapshot discard`: made it work again (2.1.0 regression; bug #3714)
- NAT: on some Windows hosts, the guest didn't receive a DHCP lease (bug #3655)
- NAT: fixed release assertion during *poll()* (bug #3667)
- Networking: fixed a deadlock caused by the PCnet network device emulation (2.2.0 regression, bug #3676)

- Clipboard: fixed random crashes (X11 hosts only, bug #3723)
- Shared Folders: fixed incorrect permissions for Solaris guests
- Shared Folders: fixed wrong file sizes with Solaris guests
- CBindings: fixed possible memory leak while releasing the IVirtualBox and ISession Objects
- Solaris hosts: fixed host-only network interface incompatibility with nwam/dhcpagent (bug #3754)
- Windows installer: fixed several install and uninstall issues (bugs #3659, #3686, #1730, #3711, #3373, #3382, #3701, #3685, #3710)
- Mac OS X hosts: preliminary support for Snow Leopard

15.29 Version 2.2.0 (2009-04-08)

This version is a major update. The following major new features were added:

- OVF (Open Virtualization Format) appliance import and export (see chapter 1.12, *Importing and exporting virtual machines*, page 26)
- Host-only networking mode (see chapter 6.6, *Host-only networking*, page 88)
- Hypervisor optimizations with significant performance gains for high context switching rates
- Raised the memory limit for VMs on 64-bit hosts to 16GB
- VT-x/AMD-V are enabled by default for newly created virtual machines
- USB (OHCI & EHCI) is enabled by default for newly created virtual machines (Qt GUI only)
- Experimental USB support for OpenSolaris hosts
- Shared Folders for Solaris and OpenSolaris guests
- OpenGL 3D acceleration for Linux and Solaris guests (see chapter 4.4.1, *Hardware 3D acceleration (OpenGL and Direct3D 8/9)*, page 64)
- Added C API in addition to C++, Java, Python and Web Services

In addition, the following items were fixed and/or added:

- VMM: FreeBSD guest related fix for V86 flags (bug #2342)
- VMM: fixed guru meditation when booting an AsteriskNow Linux VM (bug #2342)
- VMM: fixed PGMPOOLKIND_FREE guru meditation (bugs #3356, #3431)
- VMM: fixed Windows XP boot hang (guest PAE + nested paging only)
- VMM: allow mixing of VT-x/AMD-V and software virtualization
- VMM: fixed extremely slow safe mode booting in e.g. Windows 2008 (VT-x/AMD-V only)
- VMM: significant speedup of certain GRUB boot loaders (e.g. Solaris) (VT-x/AMD-V only)
- VMM: real-mode IOPL fix for DOS guests (VT-x only)

- VMM: fixed VT-x detection with certain BIOSes that enable VT-x, but don't set the lock bit in MSR_IA32_FEATURE_CONTROL
- VMM: fixed hibernation issues on Windows XP hosts (VT-x only; bug #1794)
- VMM: properly emulate *RDMSR* from the TSC MSR, should fix some NetBSD guests
- VMM: emulate *RDPMC*; fixes Windows guests crashes when using the Kaspersky virus scanner (bug #1778)
- NAT: fixed truncated downloads (FTP) (bug #3257)
- NAT: blocked UDP packets caused a crash (bug #3426)
- NAT: allow to configure the *next server* and the *boot file* via VBoxManage (bug #2759)
- IDE: fixed hard disk upgrade from XML-1.2 settings (bug #1518)
- Hard disk: support more VMDK file variants (including fixed-size ESX server images)
- Hard disks: refuse to start the VM if a disk image is not writable
- USB: further reduced host CPU utilization for OHCI and EHCI; the "VBoxInternal/Devices/usb-ohci/0/Config/FrameRate" CFG key is no longer necessary and no longer supported
- USB: fixed BSOD on the host with certain USB devices (Windows hosts only; bug #1654)
- E1000: properly handle cable disconnects (bug #3421)
- VRDP: fixed hangs when VRDP server is enabled or disabled in runtime
- Shared Folders: respect umask settings on Linux, OSX and Solaris hosts when creating files
- X11 guests: prevented setting the locale in vboxmouse, as this caused problems with Turkish locales (bug #3563)
- X11 guests: show the guest mouse pointer at the right position if the virtual desktop is larger than the guest resolution (bug #2306)
- Linux Additions: fixed typo when detecting Xorg 1.6 (bug #3555)
- Solaris guests: added xpg4/xcu4 dependency to the Guest Additions installer (bug #3524)
- Windows guests: bind the VBoxMouse.sys filter driver to the correct guest pointing device (bug #1324)
- Windows hosts: fixed BSOD when starting a VM with enabled host interface (bug #3414)
- Linux hosts: do proper reference counting to prevent unloading the vboxnetflt module as long as this code is in use (bug #3104)
- Linux hosts: do not leave zombies of VBoxSysInfo.sh (bug #3586)
- Linux installers: fixes for Slackware, Arch Linux and Linux from Scratch systems
- Windows installers: combined installer executable which contains both (32- and 64-bit) architectures
- VBoxManage: less cryptic command-line error messages
- VBoxManage `list vms` commands now default to compact format
- VBoxManage `controlvm dvdattach` did not work if the image was attached before

- VBoxManage: allow creation of all supported disk image variants
- VBoxManage `showvminfo`: don't spam the release log if the Guest Additions don't support statistics information (bug #3457)
- VBoxManage: big command line processing cleanup, the legacy single-dash options are deprecated and will be removed in the next major release, so switch to the new options now
- Hard disks: improved immutable disk support to auto-reset diff file at VM startup (related to bug #2772)
- GUI: enable the audio adapter by default for new VMs
- GUI: warn if VT-x/AMD-V is not operational when starting a 64-bit guest
- GUI: deactivate 64-bit guest support when the host CPU does not support VT-x/AMD-V
- GUI: removed floppy icon from the status bar
- GUI: show build revision in about dialog
- GUI: fixed sticky status bar text
- GUI: improved error dialogs
- GUI: fail with an appropriate error message when trying to boot a read-only disk image (bug #1745)
- GUI/Mac OS X: fixed disabled close button
- GUI/Windows: re-enabled support for copy and paste (Windows hosts 2.0 regression; bug #2065)
- 3D support: added OpenGL select/feedback support (bug #2920)
- 3D support: close OpenGL subsystem for terminated guest applications (bug #3243)
- 3D support: fixed VM hangs when starting guests with 3D acceleration enabled (bug #3437)
- PXE: fixed boot hangs when hardware virtualization is used (bug #2536)
- LsiLogic: fixed problems with Solaris guests
- Main API: close machine settings XML file when unregistering machine (bug #3548)

15.30 Version 2.1.4 (2009-02-16)

This is a maintenance release. The following items were fixed and/or added:

- Windows hosts: fixed host crashes/hangs on certain 32 bits Windows systems when running Linux guests (bugs #1606, #2269, #2763)
- Windows hosts: fixed network component BSOD issue (bugs #3168, #2916)
- Windows hosts: fixed installation issues (bugs #2517, #1730, #3130)
- Linux hosts: fixed occasional kernel oopses (bug #2556)
- Linux hosts: fixed module dependency for shipped modules (bug #3115)

- Linux hosts: moved the udev rules for USB forward so that they don't override existing system rules (bug #3143)
- Linux hosts: fixed the issue with guest not being able to communicate with each other when attached via TAP interfaces (bug #3215)
- Linux hosts: give up probing for USB gracefully if DBus or hal are not available (bug #3136)
- Linux hosts: fixed warnings in installer when SELinux was disabled (bug #3098)
- Linux hosts: VirtualBox sometimes failed to start if it had been started using sudo previously (bug #3270)
- Solaris hosts: fixed high CPU load while running many guests in parallel
- Solaris hosts: fixed inability to start more than 128 VMs
- VMM: fixed performance regression for Windows guests (bug #3172)
- VMM: ignore CPU stepping when restoring a saved state/snapshot
- REM: fixed inability to use gdb to debug programs in Linux guests with software virtualization (bug #3245)
- GUI: fixed dead key handling on Solaris hosts (bug #3256)
- GUI: in the shutdown dialog, disable the action *send the shutdown signal* if the guest is currently not using ACPI
- GUI: suppress additional key release events sent by X11 hosts when keys are auto-repeated (bug #1296)
- API: restore case insensitive OS type name lookup (bug #3087)
- VBoxHeadless: really don't start X11 services (clipboard service, 3D acceleration; Solaris & Darwin hosts only; bug #3199)
- NAT: fixed occasional crashes when the guest is doing traceroute (non-Windows hosts; bug #3200)
- NAT: fixed crashes under high load (bug #3110)
- NAT: fixed truncated downloads (Windows hosts only, bug #3257)
- NAT: don't intercept TFTP packages with a destination address different from the builtin TFTP server (bug #3112)
- USB: several fixes for USB passthrough on Linux hosts
- USB: reduced host CPU utilization if EHCI is active
- VRDP: fixed VRDP server black screen after a client reconnect (bug #1989)
- VRDP: modified rdesktop client (rdesktop-vrdp) now uses NumLock state synchronization (bug #3253)
- LsiLogic: make FreeBSD guests work (bug #3174)
- ATA: fixed deadlock when pausing VM due to problems with the virtual disk (e.g. disk full, iSCSI target unavailable)
- iSCSI: fixed possible crash when pausing the VM

- 3D support: added missing GL_MAX_TEXTURE_COORDS_ARB (bug #3246)
- Windows Additions: fixed *ERROR (e0000101)* error during installation (bug #1923)
- Windows Additions: fixed Windows Explorer hang when browsing shared folders with 64 bit guests (bug #2225)
- Windows Additions: fixed guest screen distortions during a video mode change
- Windows Additions: fixed the *Network drive not connected* message for mapped shared folders drives after the guest startup (bug #3157)
- Linux Additions: fixed occasional file corruption when writing files in *O_APPEND* mode to a shared folder (bug #2844)
- Linux Additions: the mouse driver was not properly set up on X.Org release candidates (bug #3212)
- Linux Additions: fixed installer to work with openSUSE 11.1 (bug #3213)
- Linux Additions: disable dynamic resizing if the X server is configured for fixed resolutions
- Linux/Solaris Additions: handle virtual resolutions properly which are larger than the actual guest resolution (bug #3096)

15.31 Version 2.1.2 (2009-01-21)

This is a maintenance release. The following items were fixed and/or added:

- USB: Linux host support fixes (bug #3136)
- VMM: fixed guru meditation for PAE guests on non-PAE hosts (AMD-V)
- VMM: fixed guru meditation on Mac OS X hosts when using VT-x
- VMM: allow running up to 1023 VMs on 64-bit hosts (used to be 127)
- VMM: several FreeBSD guest related fixes (bugs #2342, #2341, #2761)
- VMM: fixed guru meditation when installing Suse Enterprise Server 10U2 (VT-x only; bug #3039)
- VMM: fixed guru meditation when booting Novell Netware 4.11 (VT-x only; bug #2898)
- VMM: fixed VERR_ADDRESS_TOO_BIG error on some Mac OS X systems when starting a VM
- VMM: clear MSR_K6_EFER_SVME after probing for AMD-V (bug #3058)
- VMM: fixed guru meditation during Windows 7 boot with more than 2 GB guest RAM (VT-x, nested paging only)
- VMM: fixed hang during OS/2 MCP2 boot (AMD-V and VT-x only)
- VMM: fixed loop during OpenBSD 4.0 boot (VT-x only)
- VMM: fixed random crashes related to FPU/XMM with 64 bits guests on 32 bits hosts
- VMM: fixed occasional XMM state corruption with 64 bits guests
- GUI: raised the RAM limit for new VMs to 75% of the host memory

- GUI: added Windows 7 as operating system type
- VBoxSDL: fixed `-fixed fixedmode` parameter (bug #3067)
- Clipboard: stability fixes (Linux and Solaris hosts only, bug #2675 and #3003)
- 3D support: fixed VM crashes for certain guest applications (bugs #2781, #2797, #2972, #3089)
- LsiLogic: improved support for Windows guests (still experimental)
- VGA: fixed a 2.1.0 regression where guest screen resize events were not properly handled (bug #2783)
- VGA: significant performance improvements when using VT-x/AMD-V on Mac OS X hosts
- VGA: better handling for VRAM offset changes (fixes GRUB2 and Dos DOOM display issues)
- VGA: custom VESA modes with invalid widths are now rounded up to correct ones (bug #2895)
- IDE: fixed ATAPI passthrough support (Linux hosts only; bug #2795)
- Networking: fixed kernel panics due to NULL pointer dereference in Linux kernels < 2.6.20 (Linux hosts only; bug #2827)
- Networking: fixed intermittent BSODs when using the new host interface (Windows hosts only; bugs #2832, #2937, #2929)
- Networking: fixed several issues with displaying hostif NICs in the GUI (Windows hosts only; bugs 2814, #2842)
- Networking: fixed the issue with displaying hostif NICs without assigned IP addresses (Linux hosts only; bug #2780)
- Networking: fixed the issue with sent packets coming back to internal network when using hostif (Linux hosts only; bug #3056).
- NAT: fixed port forwarding (Windows hosts only; bug #2808)
- NAT: fixed booting from the builtin TFTP server (bug #1959)
- NAT: fixed occasional crashes (bug #2709)
- SATA: vendor product data (VPD) is now configurable
- SATA: raw disk partitions were not recognized (2.1.0 regression, Windows host only, bug #2778)
- SATA: fixed timeouts in the guest when using raw VMDK files (Linux host only, bug #2796)
- SATA: huge speed up during certain I/O operations like formatting a drive
- SATA/IDE: fixed possible crash/errors during VM shutdown
- VRDP: fixed loading of `libpam.so.1` from the host (Solaris hosts only)
- VRDP: fixed RDP client disconnects
- VRDP: fixed VRDP server misbehavior after a broken client connection
- VBoxManage `showvminfo`: fixed assertion for running VMs (bug #2773)

- VBoxManage `convertfromraw`: added parameter checking and made it default to creating VDI files; fixed and documented format parameter (bug #2776)
- VBoxManage `clonehd`: fixed garbled output image when creating VDI files (bug #2813)
- VBoxManage `guestproperty`: fixed property enumeration (incorrect parameters/exception)
- VHD: fixed error when attaching certain container files (bug #2768)
- Solaris hosts: added support for serial ports (bug #1849)
- Solaris hosts: fix for Japanese keyboards (bug #2847)
- Solaris hosts: 32-bit and 64-bit versions now available as a single, unified package
- Linux hosts: don't depend on `libcap1` anymore (bug #2859)
- Linux hosts: kernel module compile fixes for 2.6.29-rc1
- Linux hosts: don't drop any capability if the VM was started by root (2.1.0 regression)
- Mac OS X hosts: save the state of running or paused VMs when the host machine's battery reaches critical level
- Mac OS X hosts: improved window resizing of the VM window
- Mac OS X hosts: added GUI option to disable the dock icon realtime preview in the GUI to decrease the host CPU load when the guest is doing 3D
- Mac OS X hosts: polished realtime preview dock icon
- Windows Additions: fixed guest property and logging OS type detection for Windows 2008 and Windows 7 Beta
- Windows Additions: added support for Windows 7 Beta (bugs #2995, #3015)
- Windows Additions: fixed Windows 2000 guest freeze when accessing files on shared folders (bug #2764)
- Windows Additions: fixed CTRL-ALT-DEL handling when using VBoxGINA
- Windows Additions Installer: added /extract switch to only extract (not install) the files to a directory (can be specified with /D=path)
- Linux installer and Additions: added support for the Linux From Scratch distribution (bug #1587) and recent Gentoo versions (bug #2938)
- Additions: added experimental support for X.Org Server 1.6 RC on Linux guests
- Linux Additions: fixed bug which prevented to properly set `fmode` on mapped shared folders (bug #1776)
- Linux Additions: fixed appending of files on shared folders (bug #1612)
- Linux Additions: ignore `noauto` option when mounting a shared folder (bug #2498)
- Linux Additions: fixed a driver issue preventing X11 from compiling keymaps (bug #2793 and #2905)
- X11 Additions: workaround in the mouse driver for a server crash when the driver is loaded manually (bug #2397)

15.32 Version 2.1.0 (2008-12-17)

This version is a major update. The following major new features were added:

- Support for hardware virtualization (VT-x and AMD-V) on Mac OS X hosts
- Support for 64-bit guests on 32-bit host operating systems (experimental; see chapter 3.1.2, *64-bit guests*, page 40)
- Added support for Intel Nehalem virtualization enhancements (EPT and VPID; see chapter 10.3, *Hardware vs. software virtualization*, page 161)
- Experimental 3D acceleration via OpenGL (see chapter 4.4.1, *Hardware 3D acceleration (OpenGL and Direct3D 8/9)*, page 64)
- Experimental LsiLogic and BusLogic SCSI controllers (see chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71)
- Full VMDK/VHD support including snapshots (see chapter 5.2, *Disk image files (VDI, VMDK, VHD, HDD)*, page 73)
- New NAT engine with significantly better performance, reliability and ICMP echo (ping) support (bugs #1046, #2438, #2223, #1247)
- New Host Interface Networking implementations for Windows and Linux hosts with easier setup (replaces TUN/TAP on Linux and manual bridging on Windows)

In addition, the following items were fixed and/or added:

- VMM: significant performance improvements for VT-x (real mode execution)
- VMM: support for hardware breakpoints (VT-x and AMD-V only; bug #477)
- VMM: VGA performance improvements for VT-x and AMD-V
- VMM: Solaris and OpenSolaris guest performance improvements for AMD-V (Barcelona family CPUs only)
- VMM: fixed guru meditation while running the Dr. Web virus scanner (software virtualization only; bug #1439)
- VMM: deactivate VT-x and AMD-V when the host machine goes into suspend mode; reactivate when the host machine resumes (Windows, Mac OS X & Linux hosts; bug #1660)
- VMM: fixed guest hangs when restoring VT-x or AMD-V saved states/snapshots
- VMM: fixed guru meditation when executing a one byte debug instruction (VT-x only; bug #2617)
- VMM: fixed guru meditation for PAE guests on non-PAE hosts (VT-x)
- VMM: disallow mixing of software and hardware virtualization execution in general (bug #2404)
- VMM: fixed black screen when booting OS/2 1.x (AMD-V only)
- GUI: pause running VMs when the host machine goes into suspend mode (Windows & Mac OS X hosts)
- GUI: resume previously paused VMs when the host machine resumes after suspend (Windows & Mac OS X hosts)

- GUI: save the state of running or paused VMs when the host machine's battery reaches critical level (Windows hosts)
- GUI: properly restore the position of the selector window when running on the compiz window manager
- GUI: properly restore the VM in seamless mode (2.0 regression)
- GUI: warn user about non optimal memory settings
- GUI: structure operating system list according to family and version for improved usability
- GUI: predefined settings for QNX guests
- IDE: improved ATAPI passthrough support
- Networking: added support for up to 8 Ethernet adapters per VM
- Networking: fixed issue where a VM could lose connectivity after a reboot
- iSCSI: allow snapshot/diff creation using local VDI file
- iSCSI: improved interoperability with iSCSI targets
- Graphics: fixed handling of a guest video memory which is not a power of two (bug #2724)
- VBoxManage: fixed bug which prevented setting up the serial port for direct device access
- VBoxManage: added support for VMDK and VHD image creation
- VBoxManage: added support for image conversion (VDI/VMDK/VHD/RAW)
- Solaris hosts: added IPv6 support between host and guest when using host interface networking
- Mac OS X hosts: added ACPI host power status reporting
- API: redesigned storage model with better generalization
- API: allow attaching a hard disk to more than one VM at a time
- API: added methods to return network configuration information of the host system
- Shared Folders: performance and stability fixes for Windows guests (Microsoft Office Applications)

15.33 Version 2.0.8 (2009-03-10)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed guest hangs when restoring VT-x or AMD-V saved states/snapshots
- VMM: fixed memory allocation issues which can cause VM start failures with VERR_PGM_MAPPING_CONFLICT error
- VMM: fixed host crashes/hangs on certain 32 bits Windows systems when running Linux guests (bugs #1606, #2269, #2763)
- XPCOM/Main: fixed synchronization bug caused by SYSV semaphore key collisions
- ATA: fixed deadlock when pausing VM due to problems with the virtual disk (e.g. disk full, iSCSI target unavailable)

- iSCSI: fixed possible crash when pausing the VM
- iSCSI: fix PDU validity checking and detect final PDU reliably
- VBoxHeadless: really don't start X11 services (clipboard service, 3D acceleration; Solaris & Darwin hosts only; bug #3199)
- Networking: fixed issue where a VM could lose connectivity after a reboot
- Linux hosts: fixed occasional kernel oopses (bug #2556)
- Solaris hosts: fixed high CPU load while running many guests in parallel
- Solaris hosts: fixed inability to start more than 128 VMs
- Solaris/Web services: fixed SMF script to set home directory correctly
- Linux Additions: fixed occasional file corruption when writing files in *O_APPEND* mode to a shared folder (bug #2844)

15.34 Version 2.0.6 (2008-11-21)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed Guru meditation when running 64 bits Windows guests (bug #2220)
- VMM: fixed Solaris 10U6 boot hangs (VT-x and AMD-V) bug #2565)
- VMM: fixed Solaris 10U6 reboot hangs (AMD-V only; bug #2565)
- GUI: the host key was sometimes not properly displayed (Windows hosts only, bug #1996)
- GUI: the keyboard focus was lost after minimizing and restoring the VM window via the Windows taskbar (bugs #784)
- VBoxManage: properly show SATA disks when showing the VM information (bug #2624)
- SATA: fixed access if the buffer size is not sector-aligned (bug #2024)
- SATA: improved performance
- SATA: fixed snapshot function with ports>1 (bug #2510)
- E1000: fixed crash under rare circumstances
- USB: fixed support for iPhone and Nokia devices (Linux host: bugs #470 & #491)
- Windows host installer: added proper handling of open VirtualBox applications when updating the installation
- Windows host installer: fixed default installation directory on 64-bit on new installations (bug #2501)
- Linux/Solaris/Darwin hosts: verify permissions in `/tmp/vbox-$USER-ipc`
- Linux hosts: fixed assertion on high network load (AMD64 hosts, fix for Linux distributions with glibc 2.6 and newer (bug #616)
- Linux hosts: don't crash during shutdown with serial ports connected to a host device
- Solaris hosts: fixed incompatibility between IPSEC and host interface networking

- Solaris hosts: fixed a rare race condition while powering off VMs with host interface networking
- Solaris hosts: fixed VBoxSDL on Solaris 10 by shipping the required SDL library (bug #2475)
- Windows Additions: fixed logged in users reporting via guest properties when using native RDP connections
- Windows Additions: fixed Vista crashes when accessing shared folders under certain circumstances (bug #2461)
- Windows Additions: fixed shared folders access with MS-Office (bug #2591)
- Linux Additions: fixed compilation of vboxvfs.ko for 64-bit guests (bug #2550)
- SDK: added JAX-WS port caching to speedup connections

15.35 Version 2.0.4 (2008-10-24)

This is a maintenance release. The following items were fixed and/or added:

- VMM: better error reporting for VT-x failures
- VMM: don't overflow the release log with PATM messages (bug #1775)
- VMM: fixed save state restore in real mode (software virtualization only)
- GUI: work around a Qt bug on Mac OS X (bug #2321)
- GUI: properly install the Qt4 accessible plugin (bug #629)
- SATA: error message when starting a VM with a VMDK connected to a SATA port (bug #2182)
- SATA: fixed Guru mediation when booting OpenSolaris/64; most likely applies to other guests as well (bug #2292)
- Network: don't crash when changing the adapter link state if no host driver is attached (bug #2333)
- VHD: fixed bug which prevents booting from VHD images bigger than 4GB (bug #2085)
- VRDP: fixed a repaint problem when the guest resolution was not equal to the client resolution
- Clipboard: don't crash when host service initialization takes longer than expected (Linux hosts only; bug #2001)
- Windows hosts: VBoxSVC.exe crash (bug #2212)
- Windows hosts: VBoxSVC.exe memory leak due to a Windows WMI memory leak (Vista only) (bug #2242)
- Windows hosts: VBoxSVC.exe delays GUI startup
- Linux hosts: handle jiffies counter overflow (VM stuck after 300 seconds of host uptime; bug #2247)
- Solaris hosts: fixed host or guest side networking going stale while using host interface networking (bug #2474)

- Solaris hosts: added support for using unplumbed network interfaces and Crossbow Virtual Network Interfaces (VNICs) with host interface networking
- Solaris hosts: reworked threading model improves performance for host interface networking
- Windows Additions: fixed crash when accessing deep directory structures in a shared folder
- Windows Additions: improved shared folder name resolving (bug #1728)
- Windows Additions: fixed Windows 2000 shutdown crash (bug #2254)
- Windows Additions: fixed error code for `MoveFile()` if the target exists (bug #2350)
- Linux Additions: fixed `seek()` for files bigger than 2GB (bug #2379)
- Linux Additions: support Ubuntu 8.10
- Linux Additions: clipboard fixes (bug #2015)
- Web services: improved documentation and fixed example (bug #1642)

15.36 Version 2.0.2 (2008-09-12)

This is a maintenance release. The following items were fixed and/or added:

- VMM: fixed inability to run more than one VM in parallel (AMD-V on CPUs with erratum 170 only; bug #2167)
- VMM: VT-x stability fixes (bug #2179 and others)
- VMM: fixed Linux 2.6.26+ kernel crashes (used by Ubuntu 8.10 Alpha, Fedora 10 Alpha; bug #1875)
- VMM: fixed 64 bits Linux 2.6.26 kernel crashes (Debian)
- VMM: fixed Vista (32 bits) guest crash during boot when PAE and NX are enabled (applied to 64 bits hosts with VT-x enabled only)
- VMM: fixed OS/2 guest crashes during boot (AMD-V; bug #2132)
- GUI: fixed crash when trying to release an inaccessible image in the virtual disk manager
- GUI: fixed invalid error message for a changed snapshot path even if that path wasn't changed (bug #2064)
- GUI: fixed crash when creating a new hard disk image (bug #2060)
- GUI: fixed crash when adding a hard disk in the VM settings (bug #2081)
- GUI: fixed a bug where VirtualBox isn't working with the new QGtkStyle plugin (bug #2066)
- GUI: fixed VM close dialog in seamless mode (Mac OS X hosts only; bug #2067)
- GUI: fixed standard menu entries for NLS versions (Mac OS X hosts only)
- GUI: disable the VT-x/AMD-V setting when it's not supported by the CPU (or on Mac OS X hosts)
- VBoxManage: fixed crash during `internalcommands createrawvmdk` (bug #2184)

- VBoxManage: fixed output of `snapshot showvminfo` (bug #698)
- Guest properties: added information about guest network interfaces (Windows guests only)
- Shared Folders: fixed regression that caused Windows guest crashes
- API: fixed number of installed CPUs (Solaris hosts only)
- VRDP: allow a client to reconnect to an existing session on the VRDP server by dropping the existing connection (configurable and disabled by default; only relevant when multi-connection mode is disabled)
- VRDP: fixed an image repaint problem
- Linux hosts: fixed bug in vboxdrv.ko that could corrupt kernel memory and panic the kernel (bug #2078)
- Linux hosts: compile fixes for kernel module on Linux 2.6.27
- Mac OS X hosts: added Python support
- Additions: fixed a possible hang in HGCM communication after a VM reboot
- Windows Additions: added support for Windows XP 64 bits (bug #2117)
- Linux Additions: deactivate dynamic resizing on Linux guests with buggy X servers
- Linux Additions: support Ubuntu 8.10 guests and Fedora 9 guests (dynamic resizing disabled for the latter)
- Linux Additions: added installer check for the system architecture
- Linux Additions: fixed Xorg modules path for some Linux distributions (bug #2128)
- VMDK: be more liberal with ambiguous parts of the format specification and accept more format variants (bug #2062)
- VHD: fixed a bug in the VHD backend which resulted in reading the wrong data (bug #2085)
- Solaris hosts: fixed kernel panic on certain machines when starting VMs with host interface networking (bug #2183)
- Solaris hosts: fixed inability to access NFS shares on the host when host interface networking was enabled
- Solaris hosts: installer now detects and reports when installing under the wrong architecture
- Solaris hosts: fixed security hardening that prevented starting VMs from non-global zones even as root (bug #1948)
- Solaris Additions: combined the 32 bit and 64 bit Additions installer into a single package
- Mac OS X hosts: experimental support for attaching a real serial port to the guest

15.37 Version 2.0.0 (2008-09-04)

This version is a major update. The following major new features were added:

- 64 bits guest support (64 bits host only)
- New native Leopard user interface on Mac OS X hosts
- The GUI was converted from Qt3 to Qt4 with many visual improvements
- New-version notifier
- Guest property information interface
- Host Interface Networking on Mac OS X hosts
- New Host Interface Networking on Solaris hosts
- Support for Nested Paging on modern AMD CPUs (major performance gain)
- Framework for collecting performance and resource usage data (metrics)
- Added SATA asynchronous IO (NCQ: Native Command Queuing) when accessing raw disks/partitions (major performance gain)
- Clipboard integration for OS/2 Guests
- Created separate SDK component featuring a new Python programming interface on Linux and Solaris hosts
- Support for VHD disk images

In addition, the following items were fixed and/or added:

- VMM: VT-x fixes
- AHCI: improved performance
- GUI: keyboard fixes
- Linux installer: properly uninstall the package even if unregistering the DKMS module fails
- Linux Additions: the guest screen resolution is properly restored
- Network: added support for jumbo frames (> 1536 bytes)
- Shared Folders: fixed guest crash with Windows Media Player 11
- Mac OS X: Ctrl+Left mouse click doesn't simulate a right mouse click in the guest anymore. Use Hostkey+Left for a right mouse click emulation. (bug #1766)

With VirtualBox 3.2, changelog information for versions before 2.0 was removed in order to save space. To access this information, please consult the User Manual of VirtualBox version 3.1 or earlier.

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The IJG distribution formerly included code to read and write GIF files. To avoid entanglement with the Unisys LZW patent, GIF reading support has been removed altogether, and the GIF writer has been simplified to produce "uncompressed GIFs". This technique does not use the LZW algorithm; the resulting GIF files are larger than usual, but are readable by all standard GIF decoders.

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x86 SIMD extension for IJG JPEG library - version 1.02

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17 VirtualBox privacy policy

Policy version 4, Apr 22, 2010

This privacy policy sets out how Oracle Corporation ("Oracle") treats personal information related to the virtualbox.org website and the VirtualBox application.

§ 1 virtualbox.org. The "virtualbox.org" website logs anonymous usage information such as your IP address, geographical location, browser type, referral source, length of visit and number of page views while you visit (collectively, "anonymous data"). In addition, but only if you choose to register, the website's bug tracking and forum services store the data you choose to reveal upon registration, such as your user name and contact information.

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§ 3 VirtualBox registration process. The VirtualBox application may ask that the user optionally register with Oracle. in der If you choose to register, your name, e-mail address, country and company will be submitted to Oracle and stored together with the IP address of the submitter as well as product version and platform being used. The standard Oracle Privacy Policies as posted on http://www.oracle.com/html/privacy.html apply to this data.

§ 4 Update notifications. The VirtualBox application may contact Oracle to find out whether a new version of VirtualBox has been released and notify the user if that is the case. In the process, anonymous data such as your IP address and a non-identifying counter, together with the product version and the platform being used, is sent so that the server can find out whether an update is available. By default, this check is performed once a day. You change this interval or disable these checks altogether in the VirtualBox preferences.

§ 5 Usage of personal information. Oracle may use anonymous and personal data collected by the means above for statistical purposes as well as to automatically inform you about new notices related to your posts on the bug tracker and forum services, to administer the website and to contact you due to technical issues. Oracle may also inform you about new product releases related to VirtualBox.

In no event will personal data without your express consent be provided to any third parties, unless Oracle may be required to do so by law or in connection with legal proceedings.

§ 6 Updates. Oracle may update this privacy policy by posting a new version on the virtualbox.org website. You should check this page occasionally to ensure you are happy with any changes.

Glossary

A

ACPI Advanced Configuration and Power Interface, an industry specification for BIOS and hardware extensions to configure PC hardware and perform power management. Windows 2000 and higher as well as Linux 2.4 and higher support ACPI. Windows can only enable or disable ACPI support at installation time.

AHCI Advanced Host Controller Interface, the interface that supports SATA devices such as hard disks. See chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71.

AMD-V The hardware virtualization features built into modern AMD processors. See chapter 10.3, *Hardware vs. software virtualization*, page 161.

API Application Programming Interface.

APIC Advanced Programmable Interrupt Controller, a newer version of the original PC PIC (programmable interrupt controller). Most modern CPUs contain an on-chip APIC ("local APIC"). Many systems also contain an I/O APIC (input output APIC) as a separate chip which provides more than 16 IRQs. Windows 2000 and higher use a different kernel if they detect an I/O APIC during installation. Therefore an I/O APIC must not be removed after installation.

ATA Advanced Technology Attachment, an industry standard for hard disk interfaces (synonymous with IDE). See chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71.

B

BIOS Basic Input/Output System, the firmware built into most personal computers which is responsible of initializing the hardware after the computer has been turned on and then booting an operating system. VirtualBox ships with its own virtual BIOS that runs when a virtual machine is started.

C

COM Microsoft Component Object Model, a programming infrastructure for modular software. COM allows applications to provide application programming interfaces which can be accessed from various other programming languages and applications. VirtualBox makes use of COM both internally and externally to provide a comprehensive API to 3rd party developers.

D

DHCP Dynamic Host Configuration Protocol. This allows a networking device in a network to acquire its IP address (and other networking details) automatically, in order to avoid having to configure all devices in a network with fixed IP addresses. VirtualBox has a built-in DHCP server that delivers an IP addresses to a virtual machine when networking is configured to NAT; see chapter 6, *Virtual networking*, page 83.

DKMS Dynamic Kernel Module Support. A framework that simplifies installing and updating external kernel modules on Linux machines; see chapter 2.3.2, *The VirtualBox kernel module*, page 32.

E

EFI Extensible Firmware Interface, a firmware built into computers which is designed to replace the aging BIOS. Originally designed by Intel, most modern operating systems can now boot on computers which have EFI instead of a BIOS built into them; see chapter 3.12, *Alternative firmware (EFI)*, page 52.

EHCI Enhanced Host Controller Interface, the interface that implements the USB 2.0 standard.

G

GUI Graphical User Interface. Commonly used as an antonym to a "command line interface", in the context of VirtualBox, we sometimes refer to the main graphical `VirtualBox` program as the "GUI", to differentiate it from the `VBoxManage` interface.

GUID See UUID.

I

IDE Integrated Drive Electronics, an industry standard for hard disk interfaces. See chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71.

I/O APIC See APIC.

iSCSI Internet SCSI; see chapter 5.10, *iSCSI servers*, page 82.

M

MAC Media Access Control, a part of an Ethernet network card. A MAC address is a 6-byte number which identifies a network card. It is typically written in hexadecimal notation where the bytes are separated by colons, such as `00:17:3A:5E:CB:08`.

MSI Message Signalled Interrupts, as supported by modern chipsets such as the ICH9; see chapter 3.4.1, *"Motherboard" tab*, page 43. As opposed to traditional pin-based interrupts, with MSI, a small amount of data can accompany the actual interrupt message. This reduces the amount of hardware pins required, allows for more interrupts and better performance.

N

NAT Network Address Translation. A technique to share networking interfaces by which an interface modifies the source and/or target IP addresses of network packets according to specific rules. Commonly employed by routers and firewalls to shield an internal network from the Internet, VirtualBox can use NAT to easily share a host's physical networking hardware with its virtual machines. See chapter 6.3, *Network Address Translation (NAT)*, page 85.

O

OVF Open Virtualization Format, a cross-platform industry standard to exchange virtual appliances between virtualization products; see chapter 1.12, *Importing and exporting virtual machines*, page 26.

P

PAE Physical Address Extension. This allows accessing more than 4 GB of RAM even in 32-bit environments; see chapter 3.3.2, *"Advanced" tab*, page 42.

PIC See APIC.

PXE Preboot Execution Environment, an industry standard for booting PC systems from remote network locations. It includes DHCP for IP configuration and TFTP for file transfer. Using UNDI, a hardware independent driver stack for accessing the network card from bootstrap code is available.

R

RDP Remote Desktop Protocol, a protocol developed by Microsoft as an extension to the ITU T.128 and T.124 video conferencing protocol. With RDP, a PC system can be controlled from a remote location using a network connection over which data is transferred in both directions. Typically graphics updates and audio are sent from the remote machine and keyboard and mouse input events are sent from the client. A VirtualBox extension package by Oracle provides VRDP, an enhanced implementation of the relevant standards which is largely compatible with Microsoft's RDP implementation. See chapter 7.1, *Remote display (VRDP support)*, page 91 for details.

S

SAS Serial Attached SCSI, an industry standard for hard disk interfaces. See chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71.

SATA Serial ATA, an industry standard for hard disk interfaces. See chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71.

SCSI Small Computer System Interface. An industry standard for data transfer between devices, especially for storage. See chapter 5.1, *Hard disk controllers: IDE, SATA (AHCI), SCSI, SAS*, page 71.

SMP Symmetrical Multiprocessing, meaning that the resources of a computer are shared between several processors. These can either be several processor chips or, as is more common with modern hardware, multiple CPU cores in one processor.

T

TAR A widely used file format for archiving. Originally, this stood for "Tape ARchive" and was already supported by very early Unix versions for backing up data on tape. The file format is still widely used today, for example, with OVF archives (with an `.ova` file extension); see chapter 1.12, *Importing and exporting virtual machines*, page 26.

U

UUID A Universally Unique Identifier – often also called GUID (Globally Unique Identifier) – is a string of numbers and letters which can be computed dynamically and is guaranteed to be unique. Generally, it is used as a global handle to identify entities. VirtualBox makes use of UUIDs to identify VMs, Virtual Disk Images (VDI files) and other entities.

V

VM Virtual Machine – a virtual computer that VirtualBox allows you to run on top of your actual hardware. See chapter 1.2, *Some terminology*, page 10 for details.

VMM Virtual Machine Manager – the component of VirtualBox that controls VM execution. See chapter 10.2, *VirtualBox executables and components*, page 159 for a list of VirtualBox components.

VRDE VirtualBox Remote Desktop Extension. This interface is built into VirtualBox to allow VirtualBox extension packages to supply remote access to virtual machines. A VirtualBox extension package by Oracle provides VRDP support; see chapter 7.1, *Remote display (VRDP support)*, page 91 for details.

VRDP See RDP.

VT-x The hardware virtualization features built into modern Intel processors. See chapter 10.3, *Hardware vs. software virtualization*, page 161.

X

XML The eXtensible Markup Language, a metastandard for all kinds of textual information. XML only specifies how data in the document is organized generally and does not prescribe how to semantically organize content.

XPCOM Mozilla Cross Platform Component Object Model, a programming infrastructure developed by the Mozilla browser project which is similar to Microsoft COM and allows applications to provide a modular programming interface. VirtualBox makes use of XPCOM on Linux both internally and externally to provide a comprehensive API to third-party developers.