Virtualization Tools

September 1, 2015

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VIRTUALIZATION BRIEF HISTORY

What is Virtualization?

Key concept: Virtualization is the creation of a virtual (rather than actual) version of something, such as an operating system, a server, a storage device or network resources.

The Beginning

Virtualization Brief History

Virtualization Brief History

Virtualization Brief History

Virtualization was first implemented in the 60-ies of XX century by IBM as a way to logically partition mainframe computers into separate virtual machines. These partitions allowed mainframes to “multitask”: run multiple applications and processes at the same time. Since mainframes were expensive resources at the time, they were designed for partitioning as a way to fully leverage the investment.

IBM M44\44X was the first computer system that used the “virtual machine” concept . It was based on IBM 7044 mainframe.

Virtualization Brief History

In 1999, VMware introduced virtualization to x86 systems to address many of these challenges and transform x86 systems into a general purpose, shared hardware infrastructure that offers full isolation, mobility and operating system choice for application environments.

VMware delivered its first product, VMware Workstation, in May 1999 and entered the server market in 2001 with VMware GSX Server (hosted) and VMware ESX Server (hostless).

TYPES OF VIRTUALIZATION

Hosts and Guests

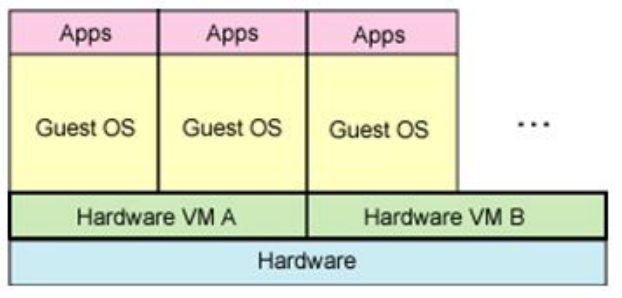
Types of virtualization

Hardware virtualization

Software virtualization

Types of virtualization

Hardware virtualization



In computing, hardware virtualization is a virtualization of computers or operating systems. It hides the physical characteristics of a computing platform from users, instead showing another abstract computing platform.

Hardware virtualizations splits in different types:

- Full (Hypervisor) Virtualization
- Paravirtualization
- Partial Virtualization

Types of virtualization

Hardware Virtualization is not the same as Hardware-assisted Virtualization

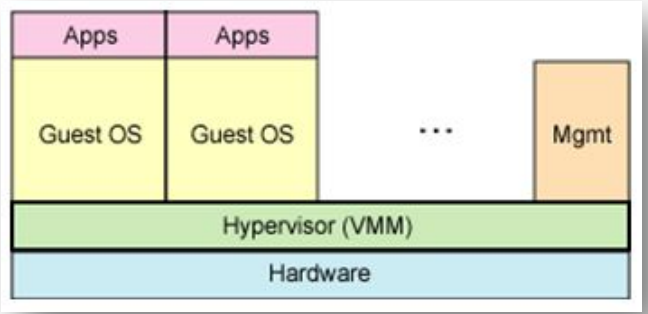
In hardware-assisted virtualization, the hardware provides architectural support that facilitates building a virtual machine monitor and allows guest OSes to be run in isolation.

The most famous technologies are:

- AMD virtualization (AMD-V)
- Intel virtualization (VT-x)

Types of virtualization

Full (Hypervisor) virtualization



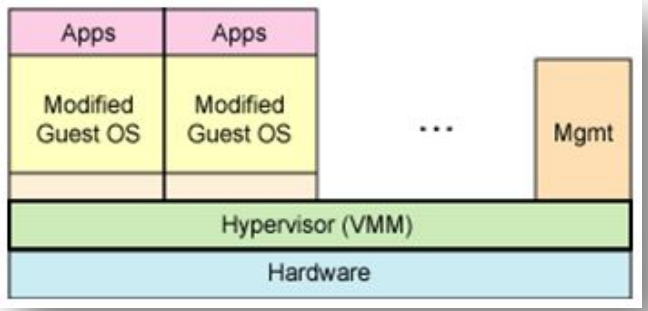
This model uses a virtual machine monitor (hypervisor) that mediates between the guest operating systems and the native hardware.

The biggest advantage of full virtualization is that an operating system can run unmodified.

VirtualBox, Vmware Workstation

Types of virtualization

Paravirtualization



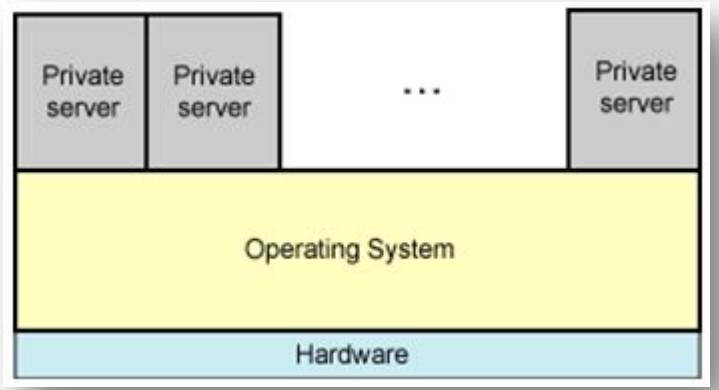
This method uses a hypervisor for shared access to the underlying hardware but integrates virtualization-aware code into the operating system itself.

Paravirtualization offers performance near that of an unvirtualized system.

XEN, VirtualBox

Types of virtualization

Software virtualization
Operating system-level virtualization



This technique virtualizes servers on top of the operating system itself. This method supports a single operating system and simply isolates the independent servers from one another.
OSL virtualization requires changes to the operating system kernel, but the advantage is native performance.
Virtuozzo, OpenVZ, Jail (FreeBSD)

ADVANTAGES OF VIRTUALIZATION

Advantages of Virtualization

Advantages of Virtualization

1. More efficient use of computer processing power
2. Less energy consumption
   (a) Run ONE physical server instead of several
   (b) Less air conditioning usage to keep the environment intact
   (c) Less power backup resources required
3. End of endless hardware purchases and upgrades
   (a) All the hardware is virtualized so no need to purchase controllers
   (b) Hardware upgrades are on software level (memory, processor, or any controller)
   (c) No need to physically install hardware
4. Safer, faster backups and restore
   (a) Ability to take live snapshots while OS is running
   (b) You can schedule snapshots of OS
   (c) Less time to recover the whole OS
5. Reduced IT overhead.
6. Simplified IT Management from a remote location (from anywhere in the world using an Internet connection).
7. Ability to use Thin Clients (low-cost centrally managed computers devoid of diskette drives, CD players and expansion slots, and which require no hardware maintenance).
8. Ability to use existing computers for remote desktop connection to virtual machines located on the main server.
9. Faster server/client connection speed through a virtual switch.

Advantages of Virtualization

Advantages of Virtualization for testers

1. Virtualization tools allow software testers to quickly and easily set up and maintain testing environments, and to rapidly restore testing environments to their original state when required.
2. Ease of application deployment
3. It's good for testing a virtual network. This would allow you to test out networking protocols.
4. Configuration testing, installation testing (different sets of OS's and applications)
5. Experiment with potentially incompatible applications.
6. Perform testing with different user profiles.
7. Access / security / vulnerability / etc. testing with no effect to the normal working environment.
8. When finding a bug, a tester can simply save a system state, where the bug appears, to a snapshot and continue testing of the system. If it is necessary to reproduce the bug, the virtual machine can be given to a developer who can work with it without fear to damage tester's environment. Besides, resources become available for further testing: the tester can continue working and not wait till the developer finishes with the test environment.

Advantages of Virtualization

Disadvantages of the Virtualization Technology

1. Impossibility of emulation of all devices. At the current moment, all main devices of hardware platforms are supported by vendors of virtualization systems. But if some controllers or devices, which are not supported, are used, we have to refuse the virtualization of such environment.
2. Virtualization requires additional hardware resources. Existing virtualization technologies make it possible to bring performance of virtual machines to real. But to start some definite configuration with a number of machines, we need a physical host to allow this.
3. Equipment conflict. Drivers used by a virtualization system can conflict with drivers of tested equipment.
4. In case of low disk space on the hard disk of the virtual machine, we cannot increase it if the virtual machine contains snapshots.
5. We should perform final testing of the developed software on real machines because no virtual environment can completely replace the real one.
6. There are training costs on work with virtual machines.
7. When a virus is detected on one of snapshots, it is hard to define on which stage it appeared. We have to check all snapshots because the antivirus that can detect and delete viruses on all snapshots of the virtual machine isn’t developed yet.
8. Single destruction point. If a virtualization system fails, it is impossible to start virtual machines till the reason of failure is found and system is recovered.

VIRTUALIZATION TOOLS

Virtualization tools

Magic Quadrant for x86 Server Virtualization Infrastructure (Gartner, 14 July 2015)
http://www.gartner.com/technology/reprints.do?id=1-2JFZ1KP&ct=150715&st=sb

Leaders:

1. VMware: Player, Workstation, ESX
2. Microsoft: Hyper-V, VirtualPC

Niche players:

1. Oracle: Server, VirtualBox
2. Odin (Parallels): Virtuozzo, Parallels Desktop
3. Red Hat: KVM
4. Citrix: XenServer
5. Huawei: FusionSphere, FusionCloud

ORACLE

VM

VirtualBox

VirtualBox

Oracle VM VirtualBox is an virtualization software package, originally created by software company innotek GmbH (initial release January 15, 2007), purchased by Sun Microsystems, and now developed by Oracle Corporation as part of its family of virtualization products. It is installed on an existing host operating system; within this application, additional guest operating systems, each known as a Guest OS, can be loaded and run, each with its own virtual environment.

Latest versions of VirtualBox:
https://www.virtualbox.org/wiki/Downloads

VirtualBox Oracle VM VirtualBox Extension Pack - support for USB devices, VirtualBox RDP and PXE boot for Intel cards.
(Please install the extension pack with the same version as your installed version of VirtualBox!)

VirtualBox

Changelog for VirtualBox 5.0

The following major new features were added (the most important):

- Paravirtualization support for Windows and Linux guests to improve time-keeping accuracy and performance (see the manual for more information)
- xHCI Controller to support USB 3 devices (see the manual for more information)
- Drag and drop support (bidirectional) for Windows, Linux and Solaris guests
- Disk image encryption (see the manual for more information)
- VMs can now be started in separate mode. The VM process is started headless while the frontend runs as a separate process which can be terminated without stopping the VM.
- GUI: New User Interface settings page for customizing status-bar, menu-bar and guest-content scaling
- GUI: New Encryption settings tab for customizing encryption options for disk images

VirtualBox

1. Windows
2. Mac OS X
3. Linux
4. Solaris

VirtualBox

Supported guest operating systems:

- Windows
- Linux
- DragonFlyBSD
- FreeBSD
- OpenBSD
- OS/2 Warp
- Solaris & OpenSolaris
- Haiku
- Syllable
- ReactOS, and SkyOS
- MacOS X (limited, since 3.2)

VirtualBox

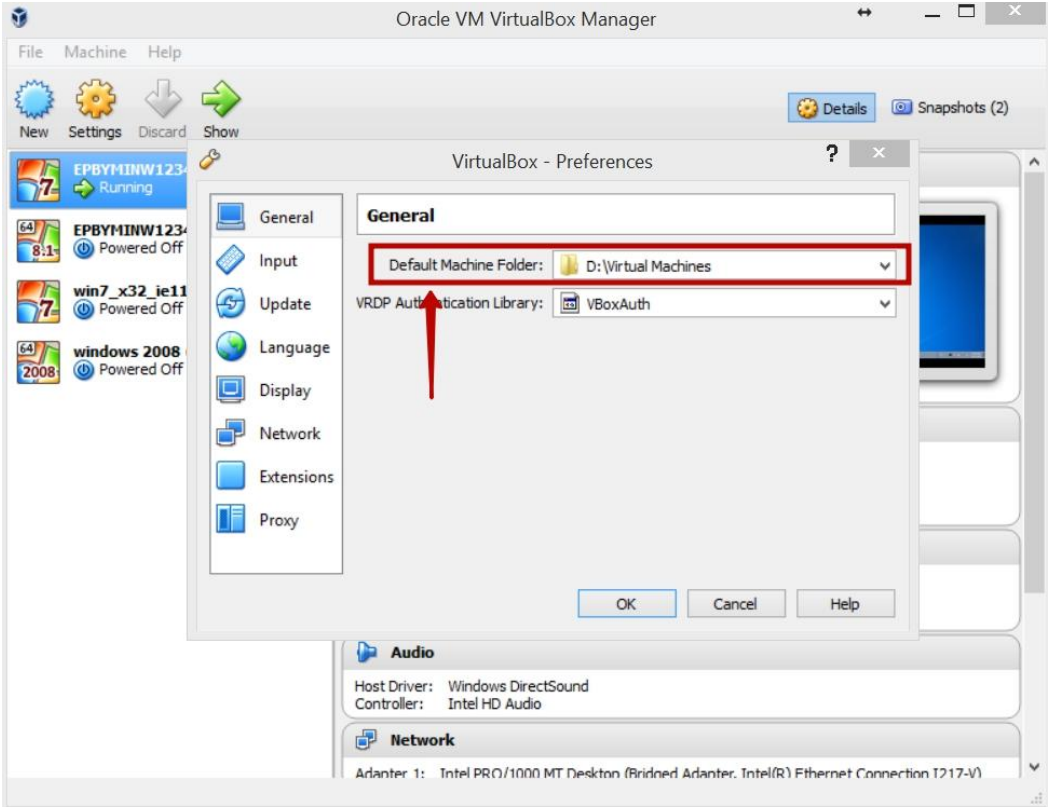
Features:

- 64-bit guests (64-bit hosts with CPU virtualization extensions)
- Snapshots
- Clone
- Seamless mode
- Clipboard
- Shared folders
- Special drivers and utilities to facilitate switching between systems
- Command line interaction (in addition to the GUI)
- Nested paging for AMD-V and Intel VT (only for Intel Nehalem processors and up)
- Raw hard disk access – allows physical hard disk partitions on the host system to appear in the guest system
- VMware Virtual Machine Disk (VMDK) format support – allows VirtualBox to exchange disk images with VMware
- Microsoft VHD support
- QEMU qed and qcow disks
- HDD format disks (only version 2; version 3 and 4 are not supported) used by Parallels (Odin) virtualization products
- 3D virtualization (Limited support for OpenGL was added to v2.1, more support was added to v2.2, OpenGL 2.0 and Direct3D support was added in VirtualBox 3.0)
- Teleportation (aka Live Migration), since version 3.1
- 2D video acceleration, since version 3.1

VirtualBox

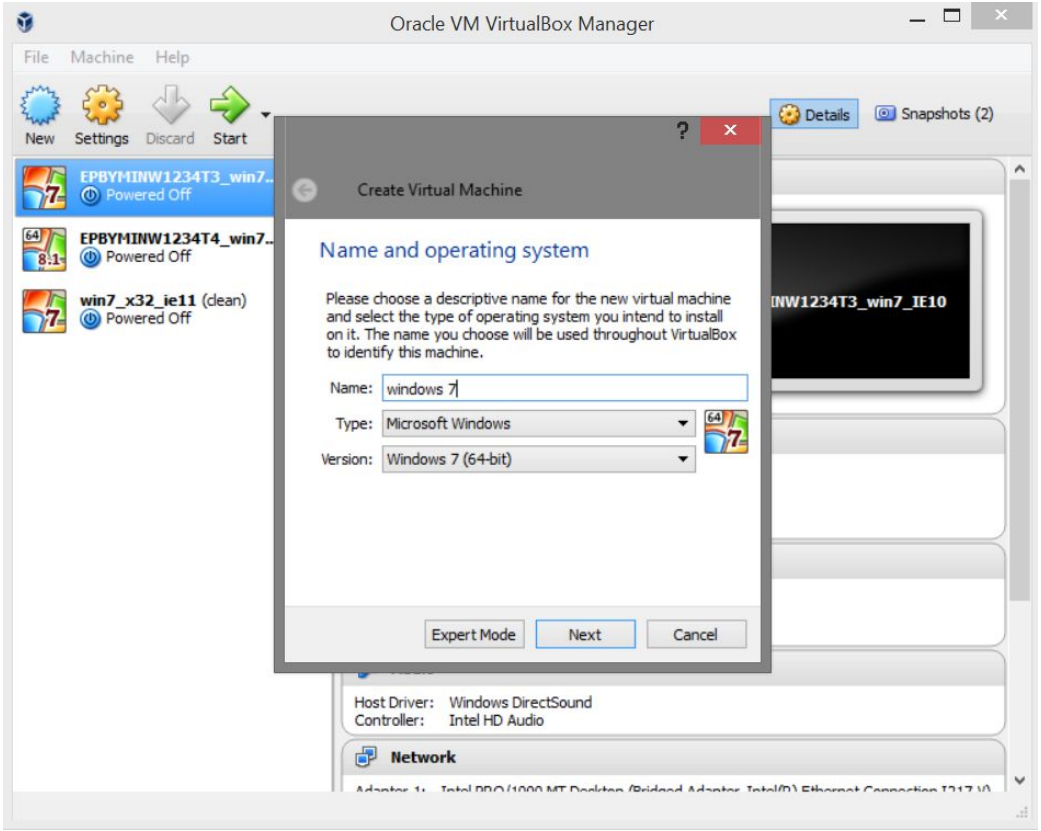
Recommendation:

Change the default machine folder to use drive with big size



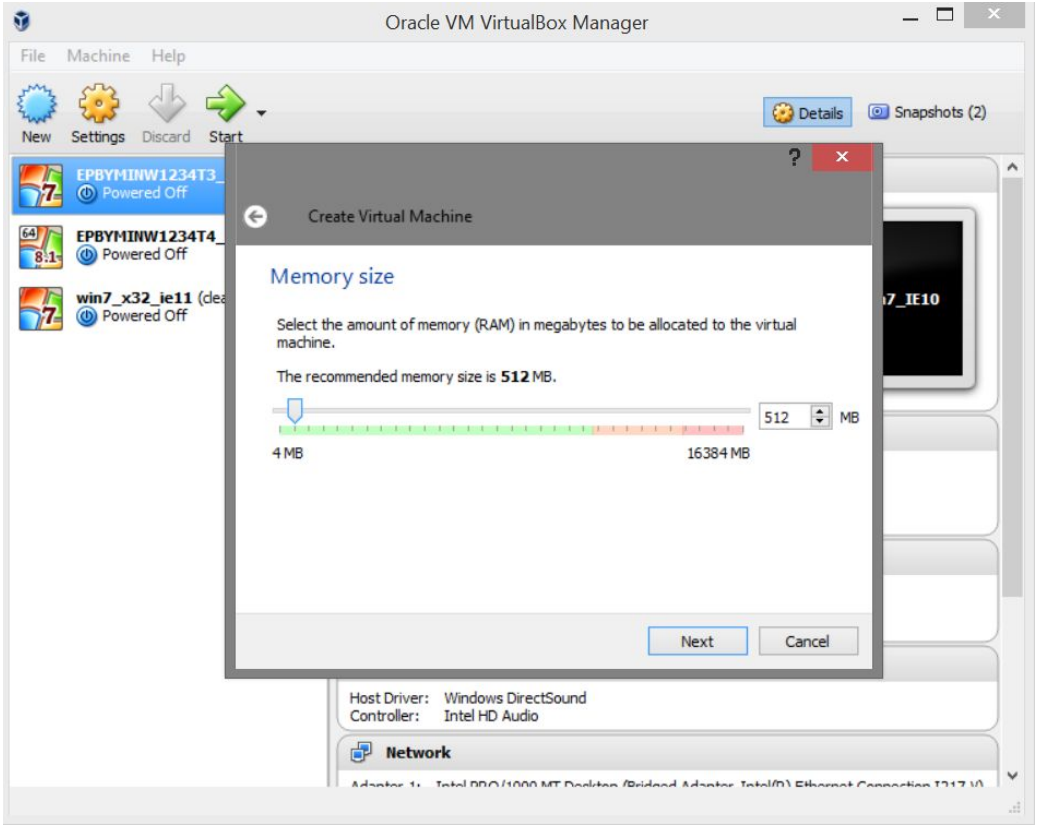
Virtual Machines: Create VMs in Virtual Box

1. Name
2. Type
3. Version



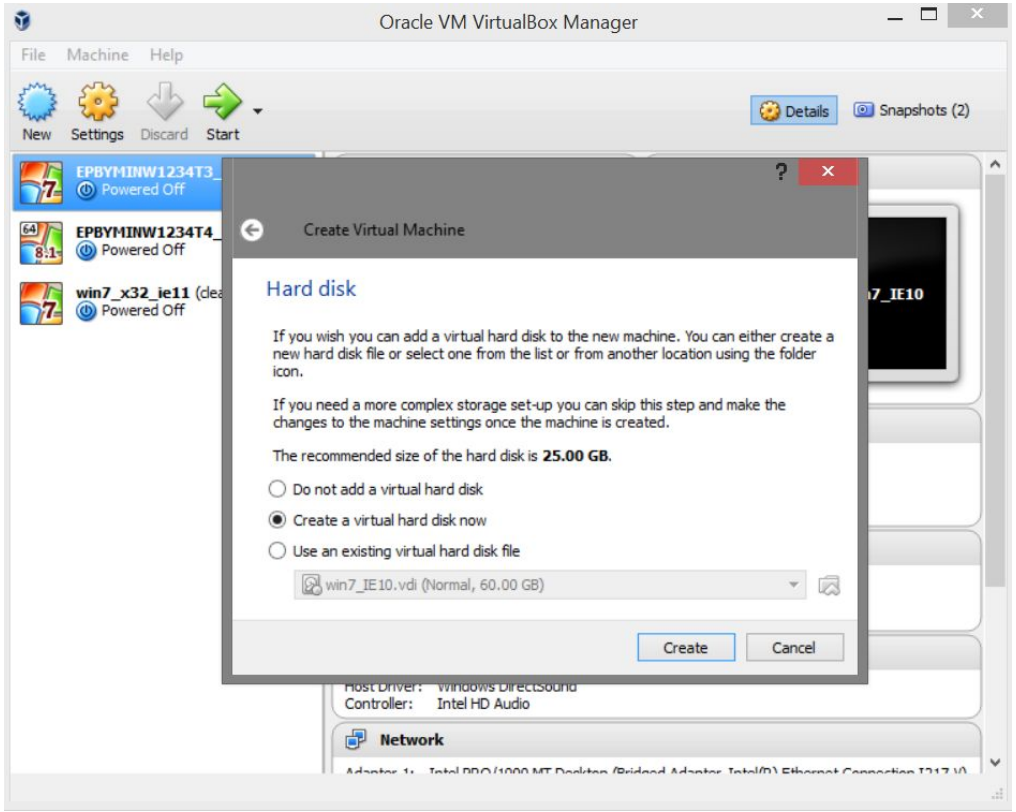
Virtual Machines: Create VMs in Virtual Box

1. Memory size



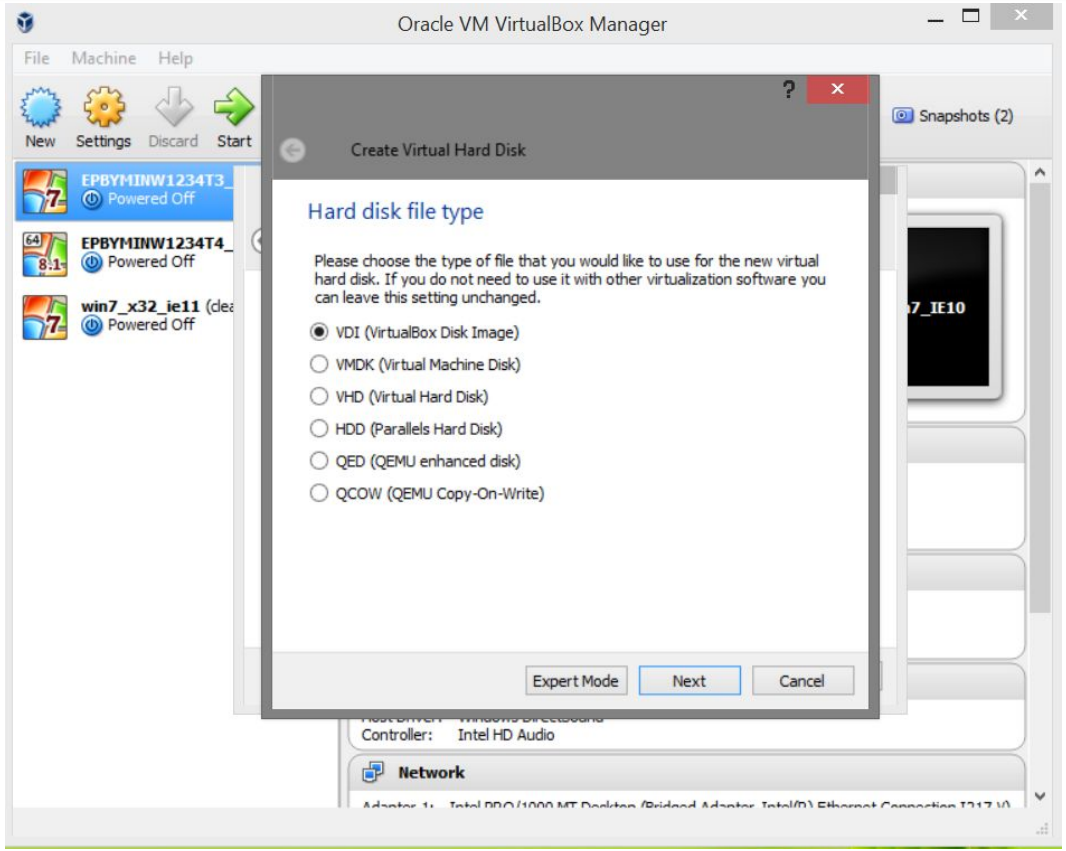
Virtual Machines: Create VMs in Virtual Box

1. Without disk
2. Create disk
3. Use an existing disk



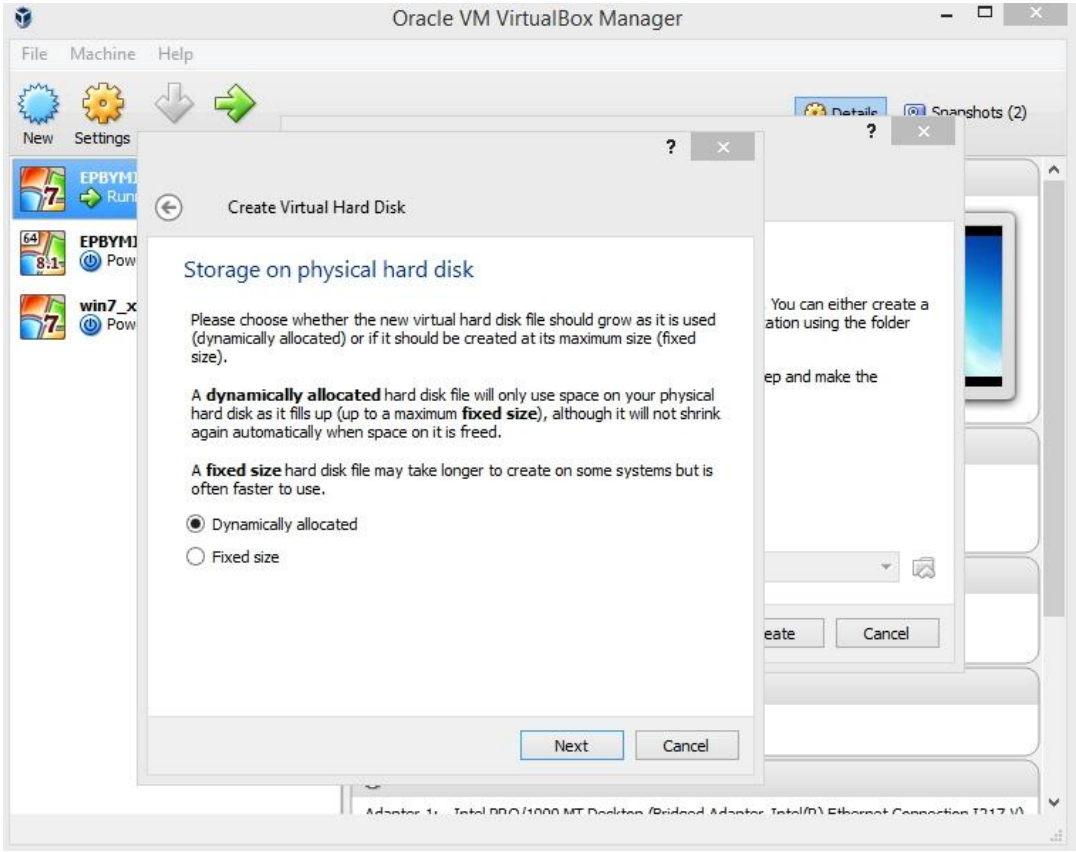
Virtual Machines: Create VMs in Virtual Box

1. Select hard disk type



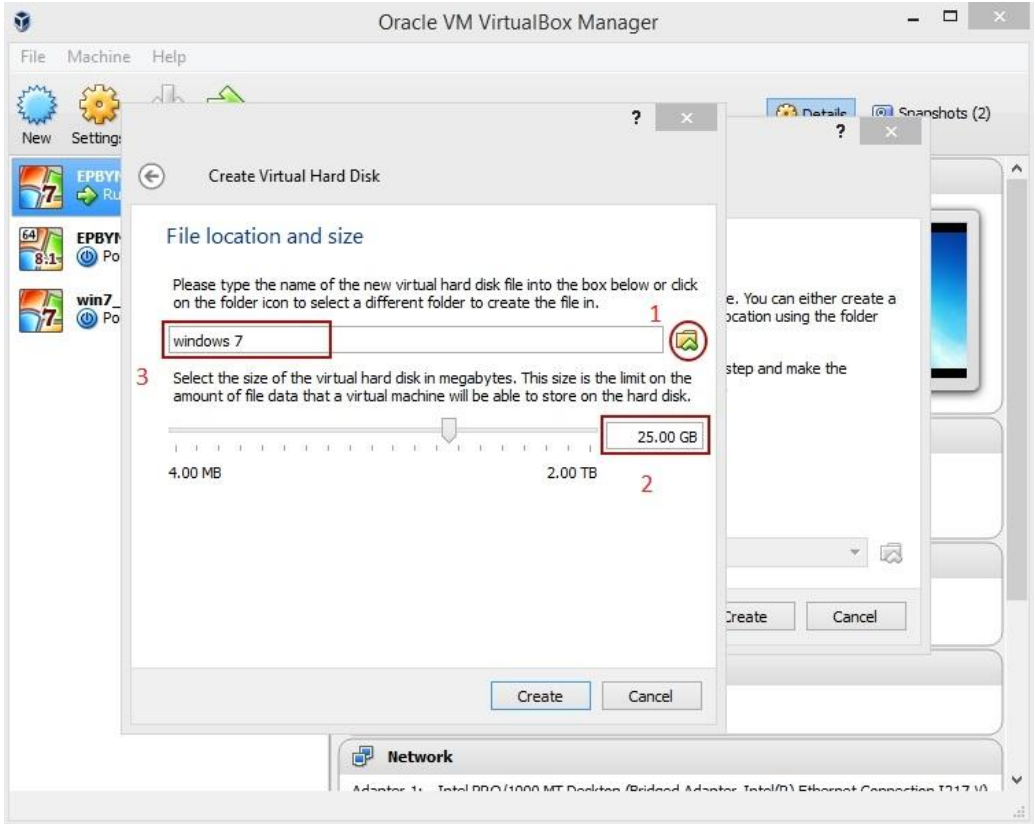
Virtual Machines: Create VMs in Virtual Box

1. Dynamically allocated
2. Fixed size



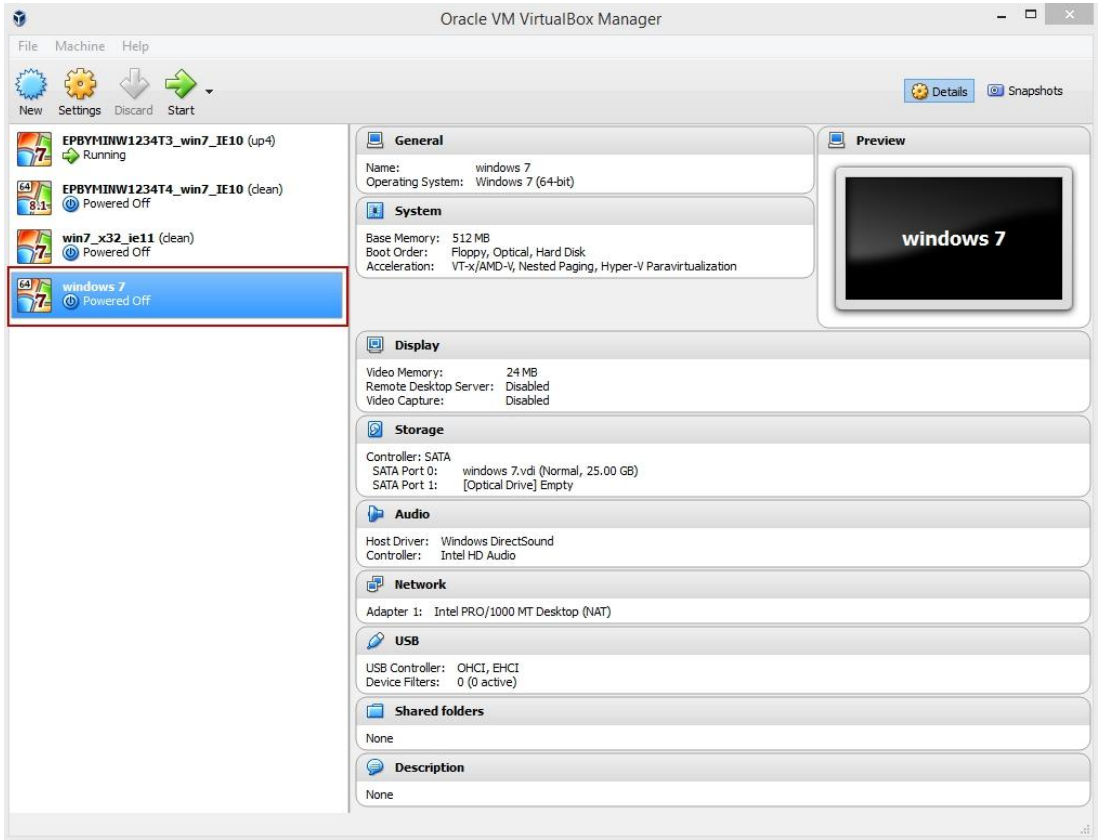
Virtual Machines: Create VMs in Virtual Box

1. Select a folder
2. Select the size
3. Type the name



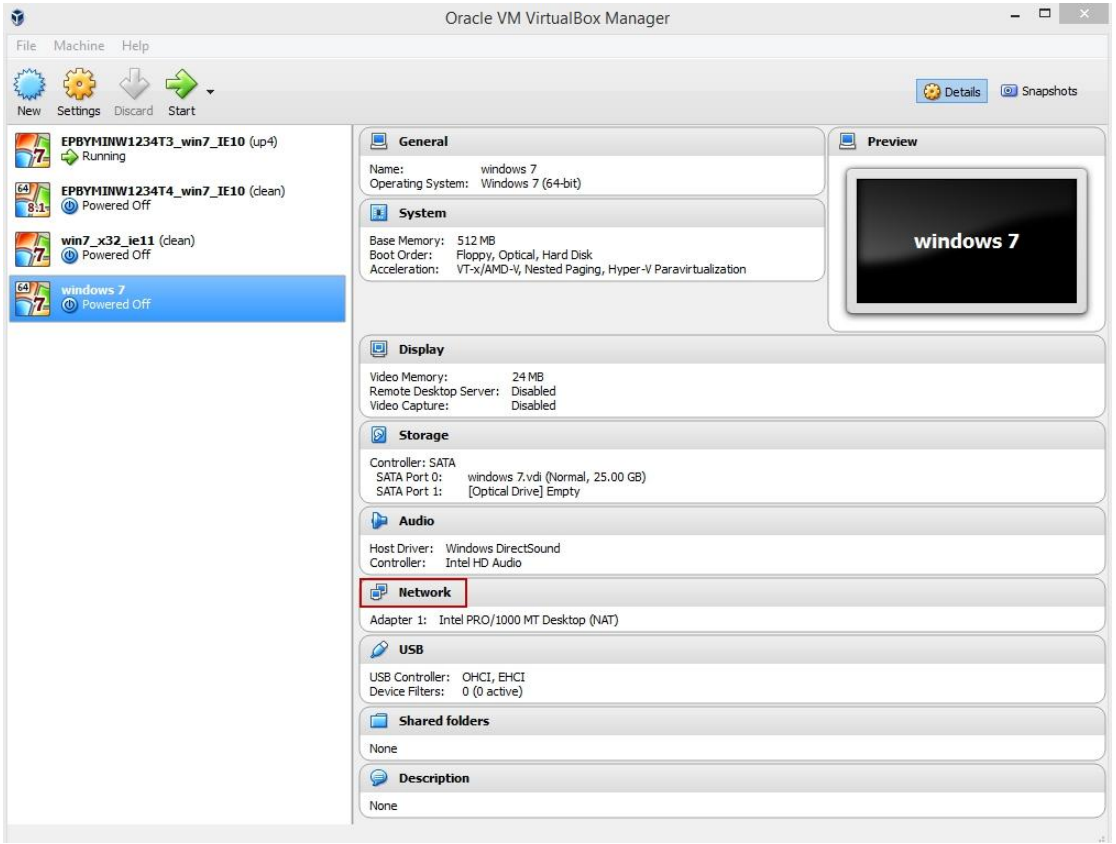
Virtual Machines: Create VMs in Virtual Box

1 Summary



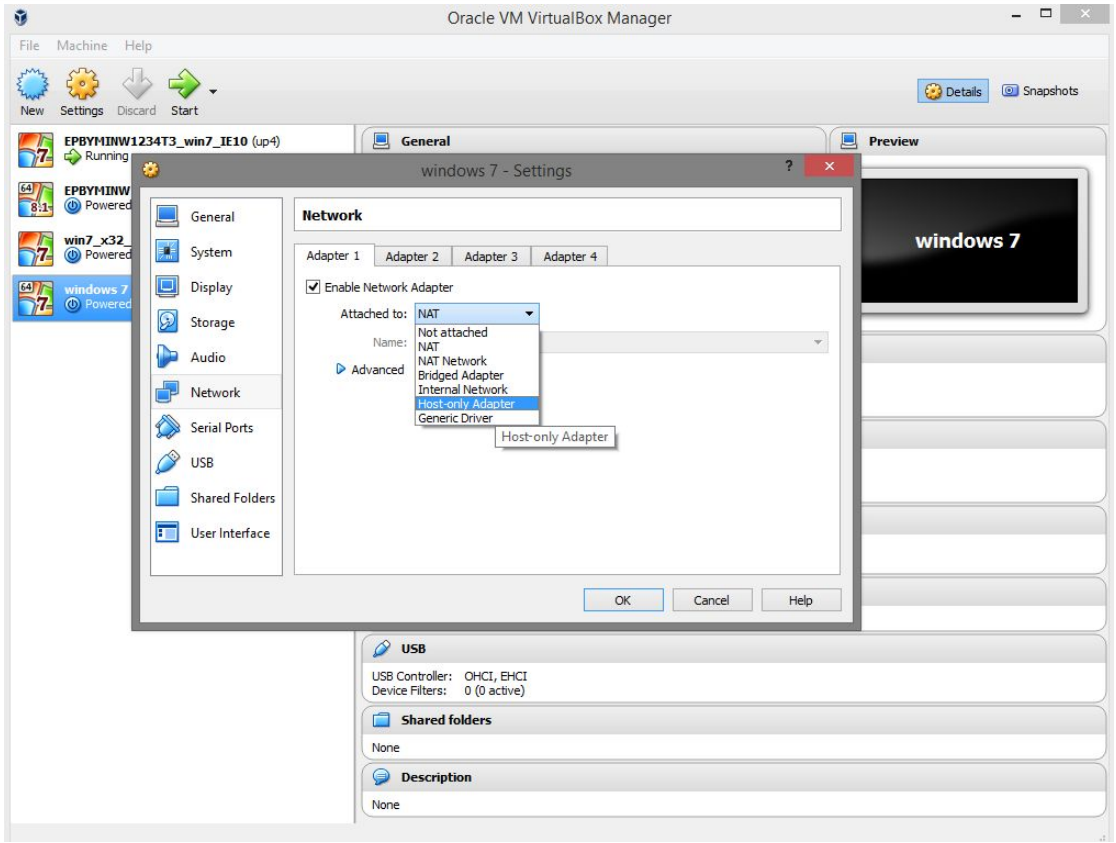
Virtual Machines: Create VMs in Virtual Box

1 Click on Network



Virtual Machines: Create VMs in Virtual Box

1. **Not attached**
   No network cable connected
2. **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.
3. **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.
4. **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.
5. **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.

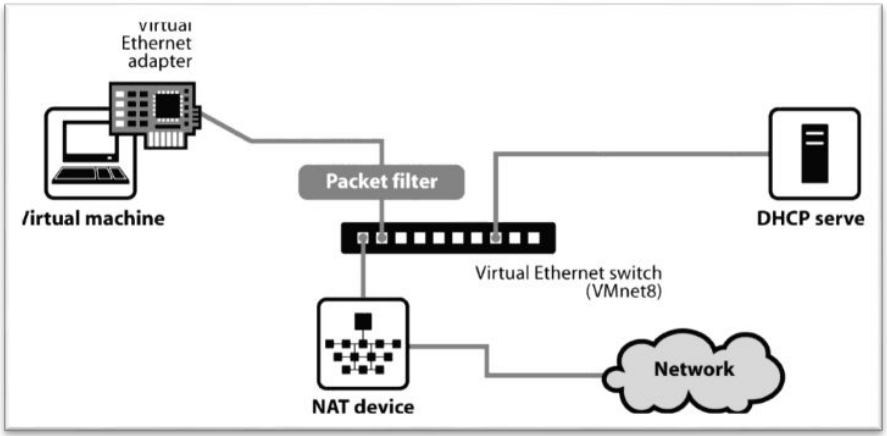


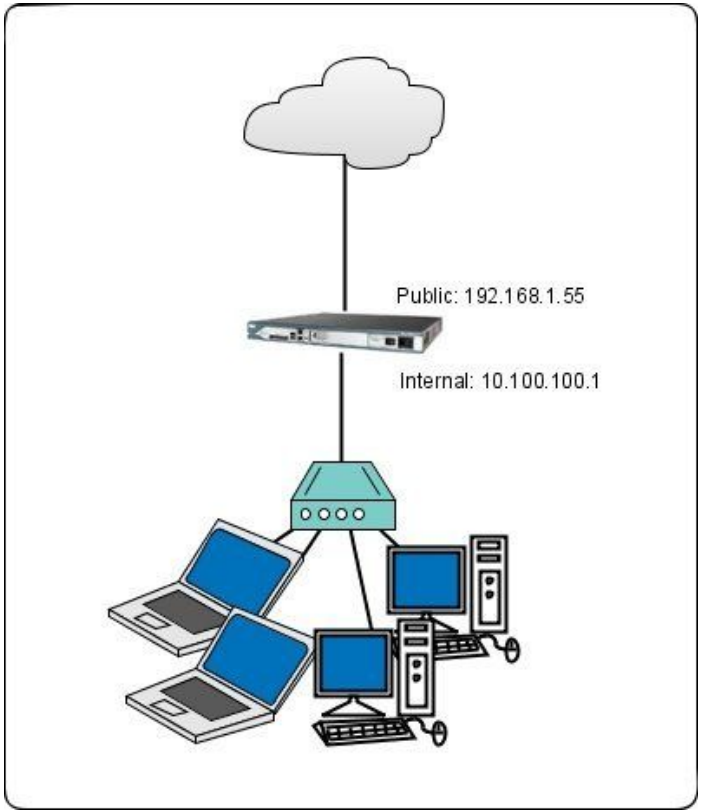
Virtual Machines: Create VMs in Virtual Box

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.

In computer networking, network address translation (NAT) is the process of modifying network address information in datagram (IP) packet headers while in transit across a traffic routing device for the purpose of remapping one IP address space into another.



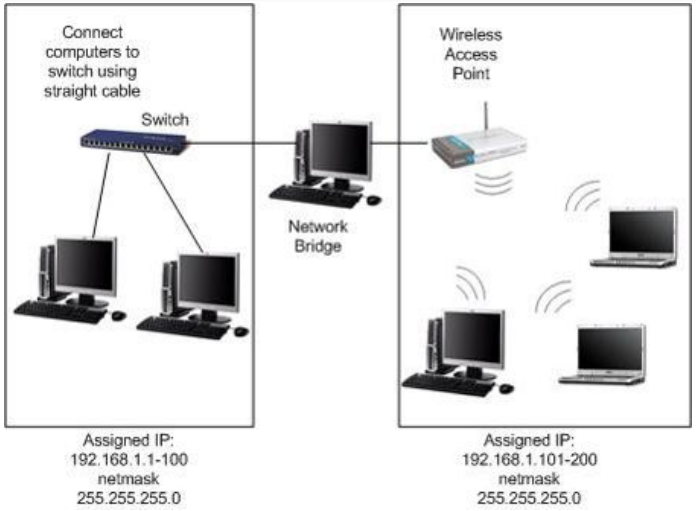


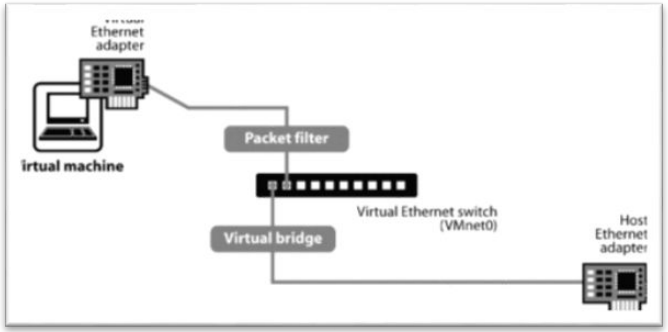
Virtual Machines: Create VMs in Virtual Box

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.

Bridging is a forwarding technique used in packet-switched computer networks. Unlike routing, bridging makes no assumptions about where in a network a particular address is located. Instead, it depends on flooding and examination of source addresses in received packet headers to locate unknown devices. Once a device has been located, its location is recorded in a table where the MAC address is stored so as to preclude the need for further broadcasting. The utility of bridging is limited by its dependence on flooding, and is thus only used in local area networks.





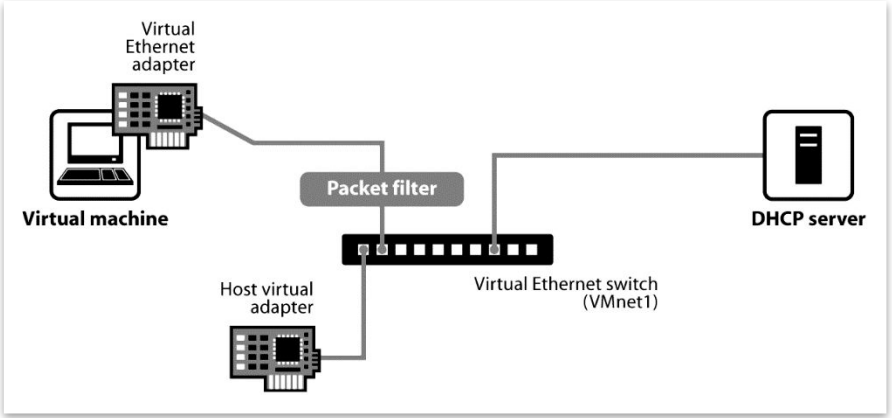
Virtual Machines: Create VMs in Virtual Box

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.

Host-only networking provides a network connection between the virtual machine and the host computer, using a virtual Ethernet adapter that is visible to the host operating system. This approach can be useful if you need to set up an isolated virtual network.

If you use host-only networking, your virtual machine and the host virtual adapter are connected to a private TCP/IP network. Addresses on this network are provided by the product's DHCP server.



Virtual Machines: Create VMs in Virtual Box

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);

•Intel PRO/1000 MT Desktop (82540OEM);

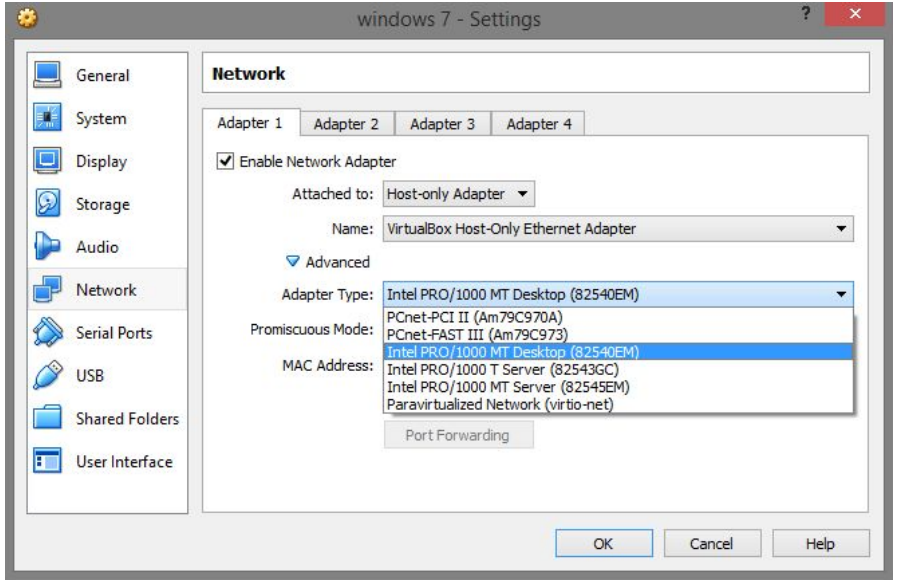
•Intel PRO/1000 T Server (82543GC);

•Intel PRO/1000 MT Server (82545EM);

•Paravirtualized network adapter (virtio-net)

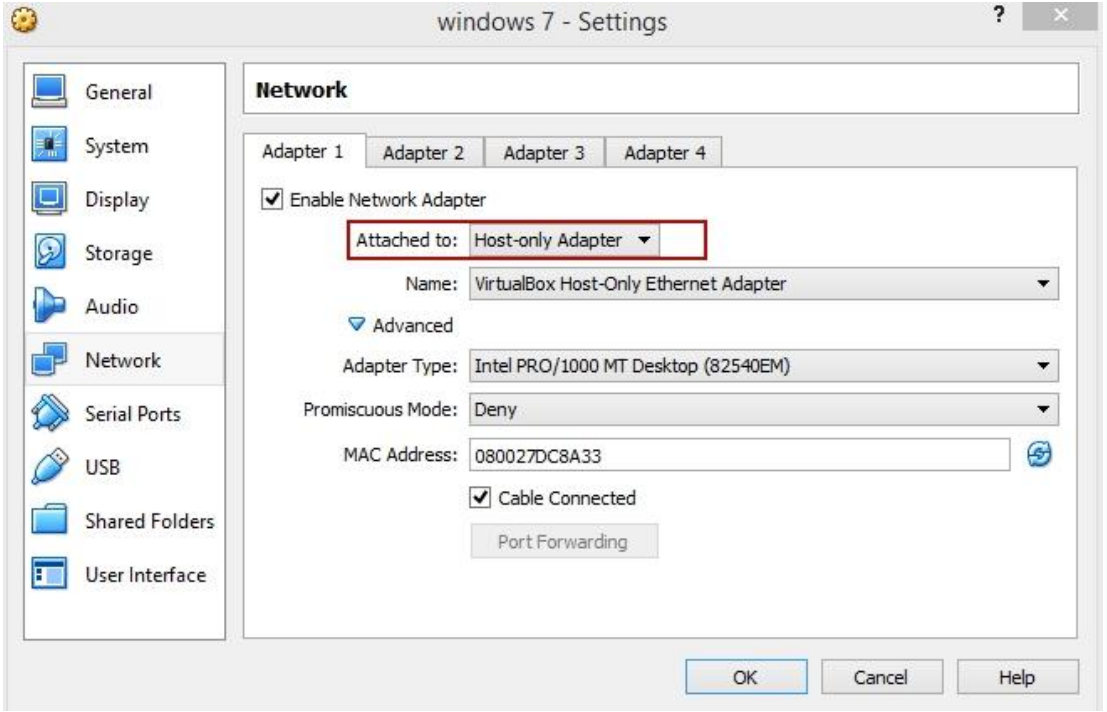
The Intel PRO/1000 MT Desktop type works with **Windows Vista and later versions**. The T Server variant of the Intel PRO/1000 card is recognized by Windows XP guests without additional driver installation. The MT Server variant facilitates OVF imports from other platforms.

The 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.



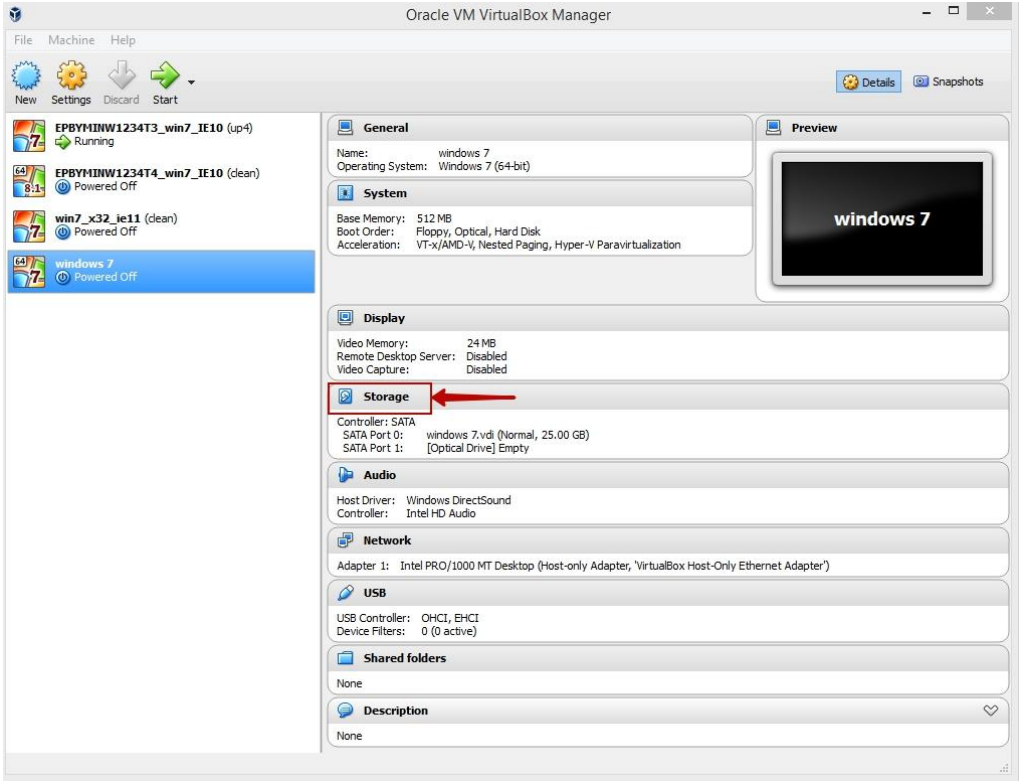
Virtual Machines: Create VMs in Virtual Box

1. Select Host-only adapter. Leave other settings by default



Virtual Machines: Create VMs in Virtual Box

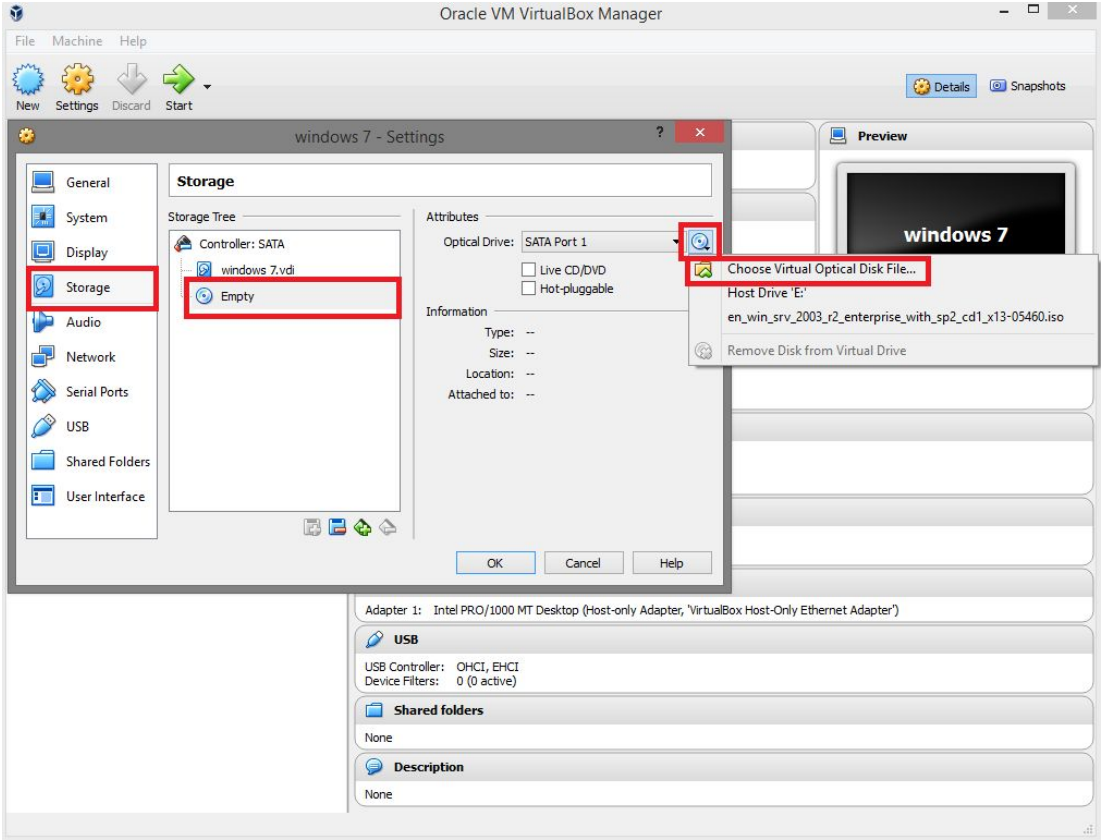
1 Click on Storage



Virtual Machines: Create VMs in Virtual Box

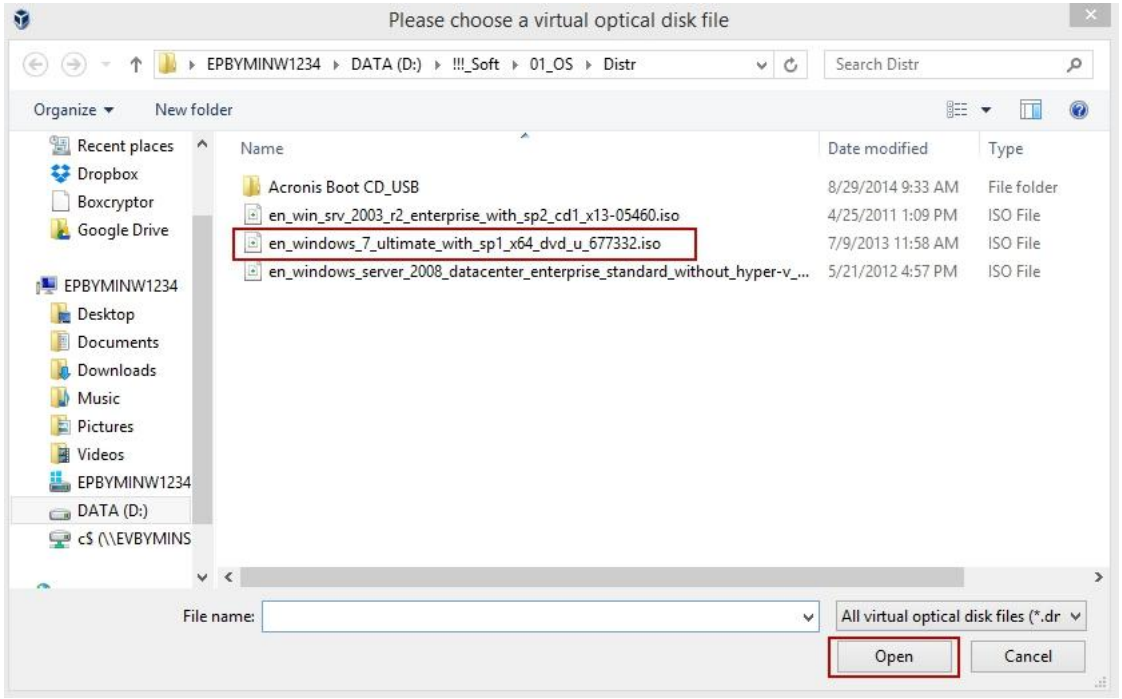
1. Select ‘Empty’ disk

2. Choose Virtual Optical Disk File



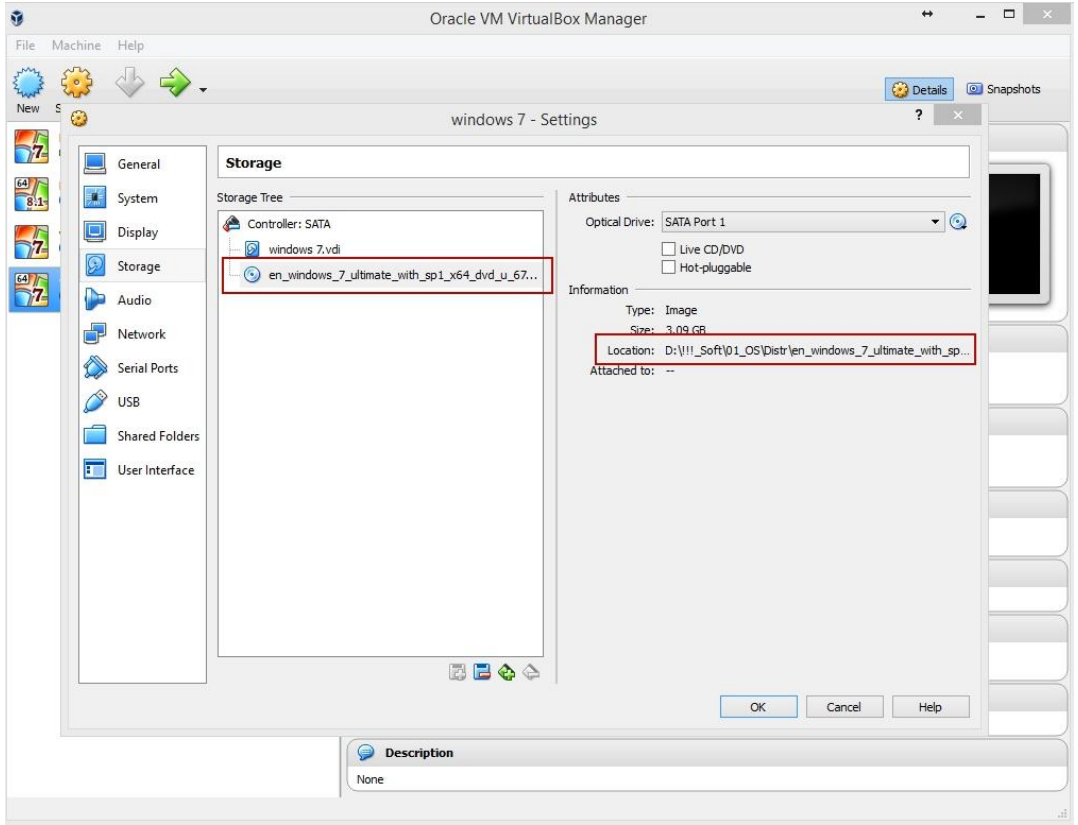
Virtual Machines: Create VMs in Virtual Box

1. Select and open .iso file



Virtual Machines: Create VMs in Virtual Box

1. Optical drive is ready to install OS.



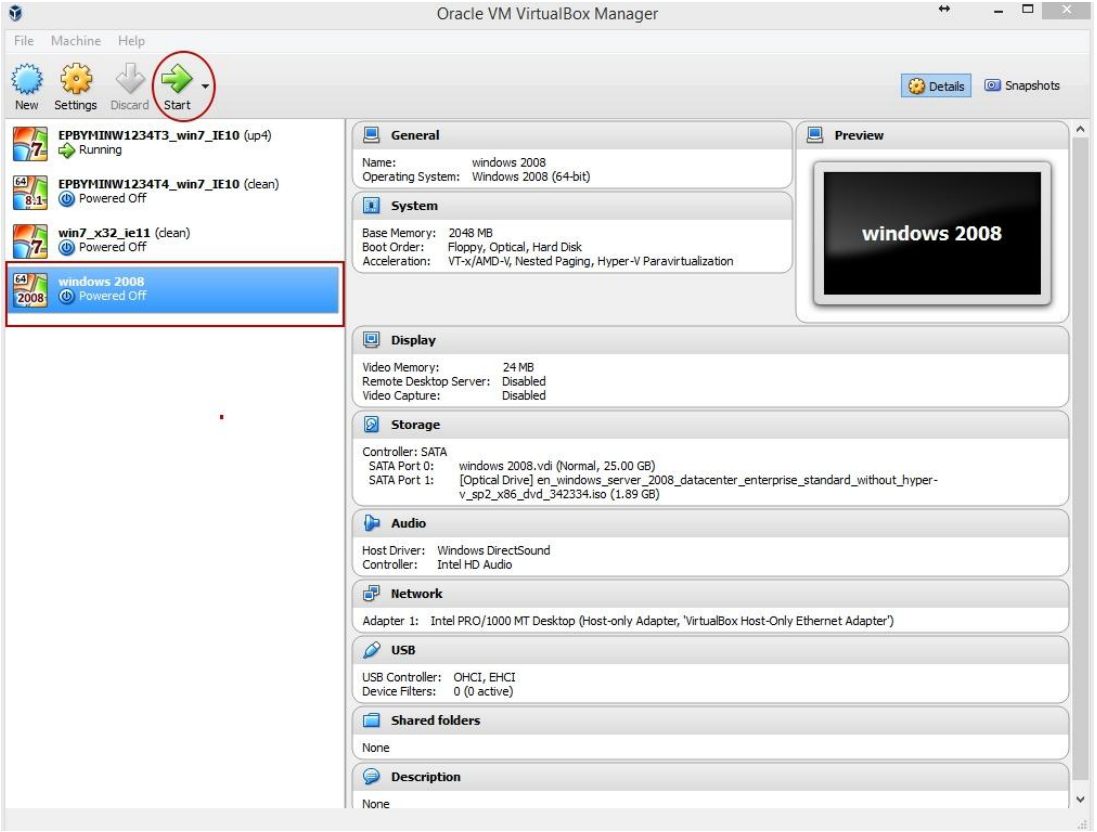
Virtual Machines: Create VMs in Virtual Box

Before you continue…

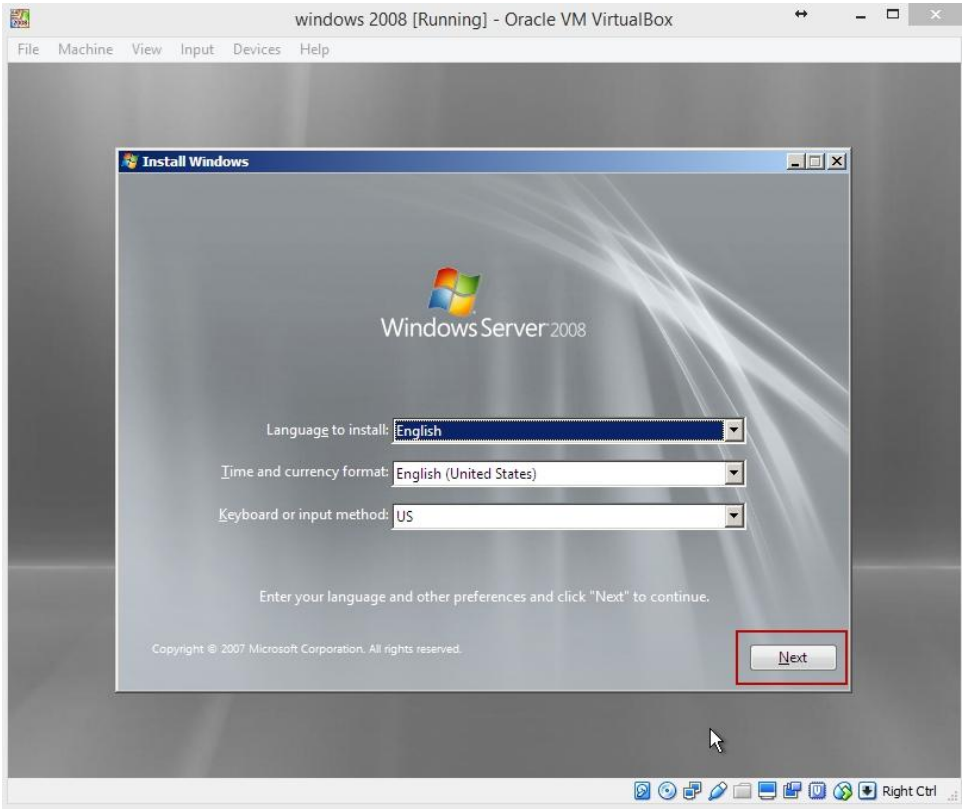
Remember, until your Virtual Machine in VirtualBox doesn't have Guest Additions installed, your mouse will be captured by a Virtual Machine's screen. It means you are not able to use the mouse in a host and the VM simultaneously. You can release your mouse by clicking Right Control on a keyboard.

Virtual Machines: Create VMs in Virtual Box

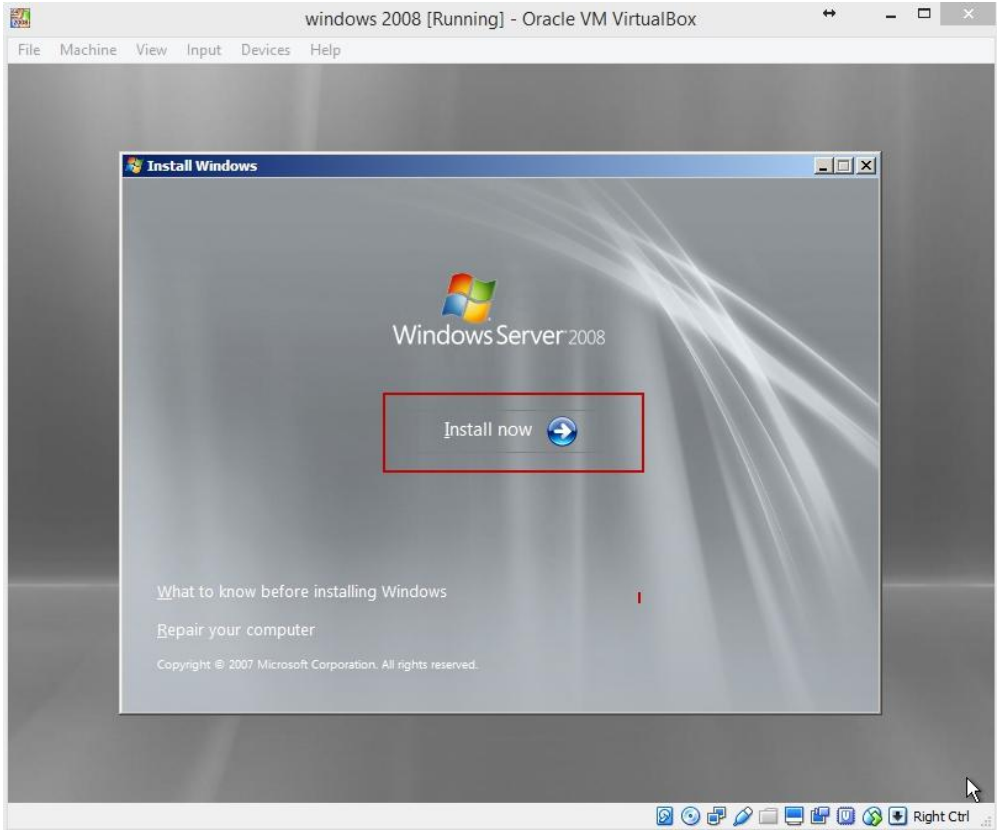
1. Start new VM



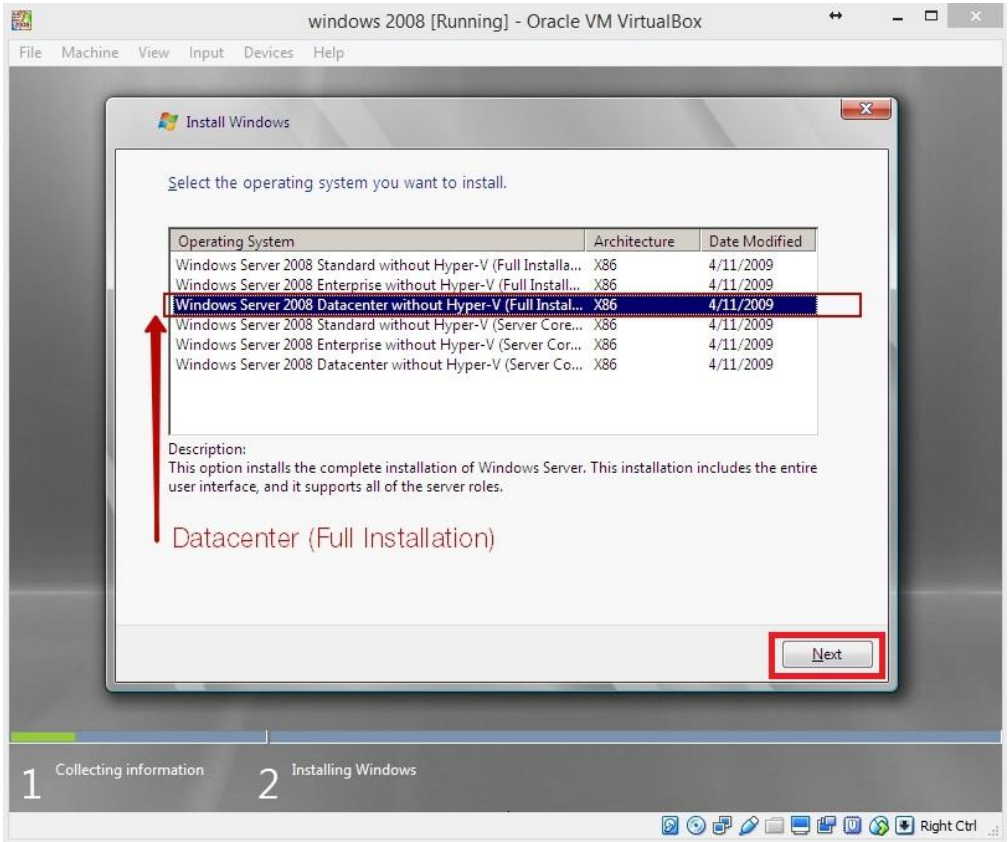
Virtual Machines: Create VMs in Virtual Box



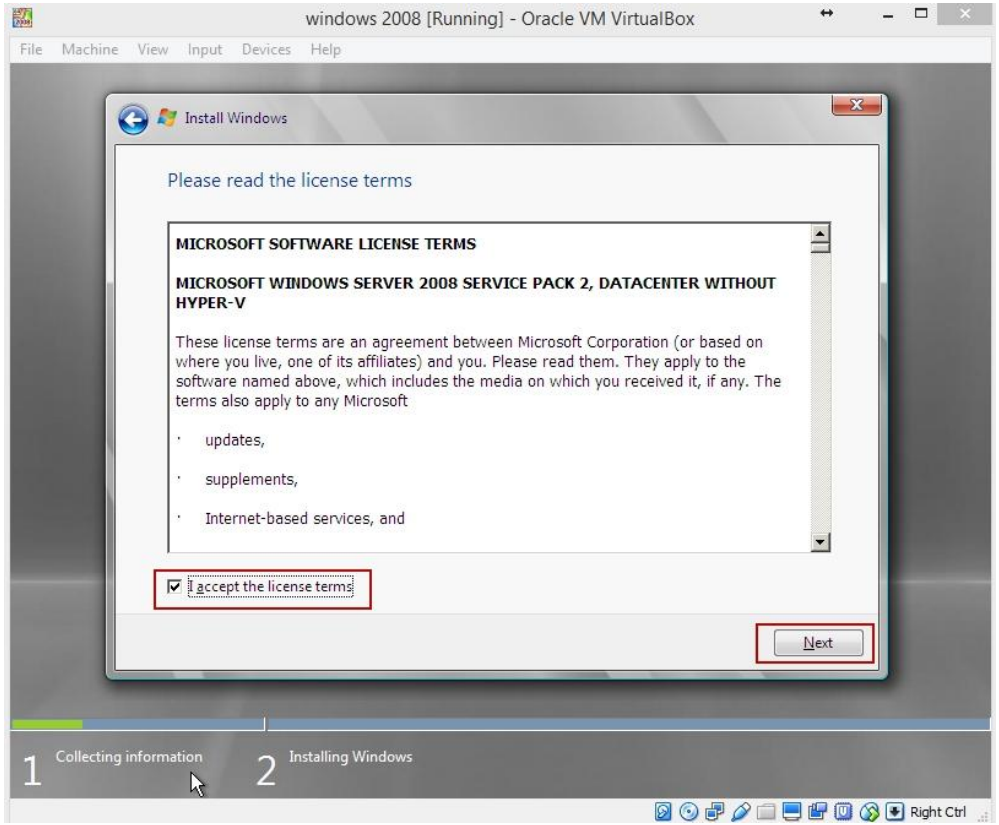
Virtual Machines: Create VMs in Virtual Box



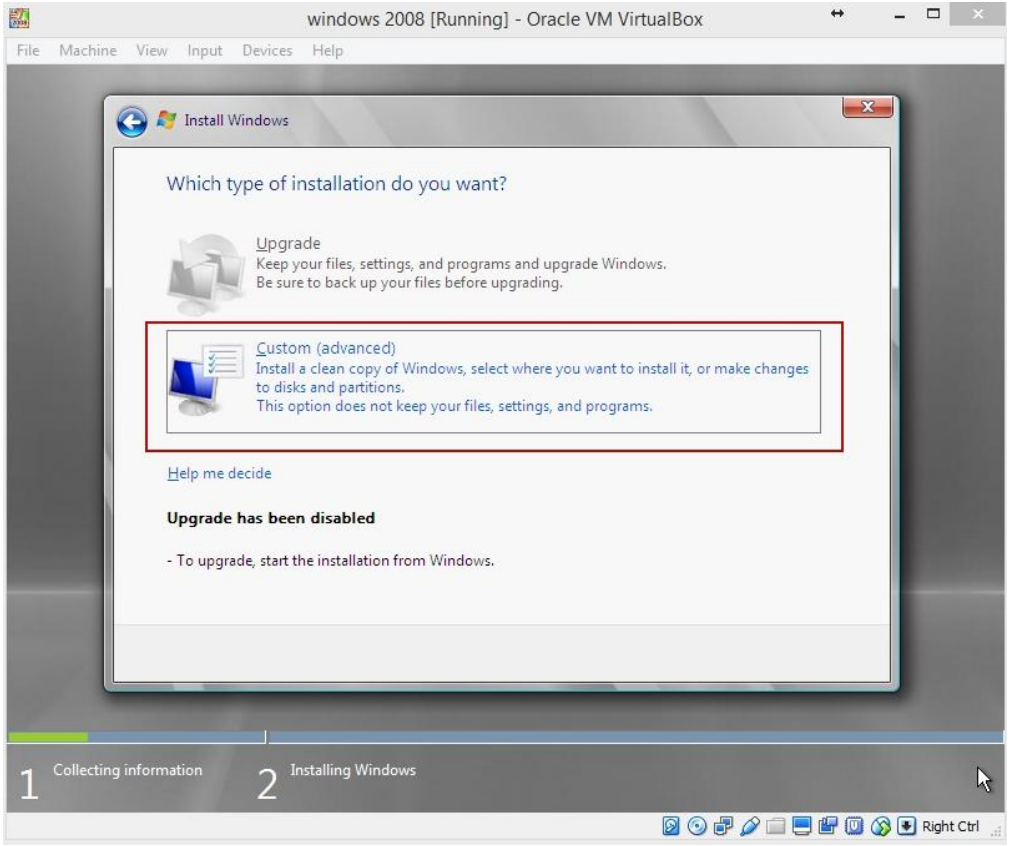
Virtual Machines: Create VMs in Virtual Box



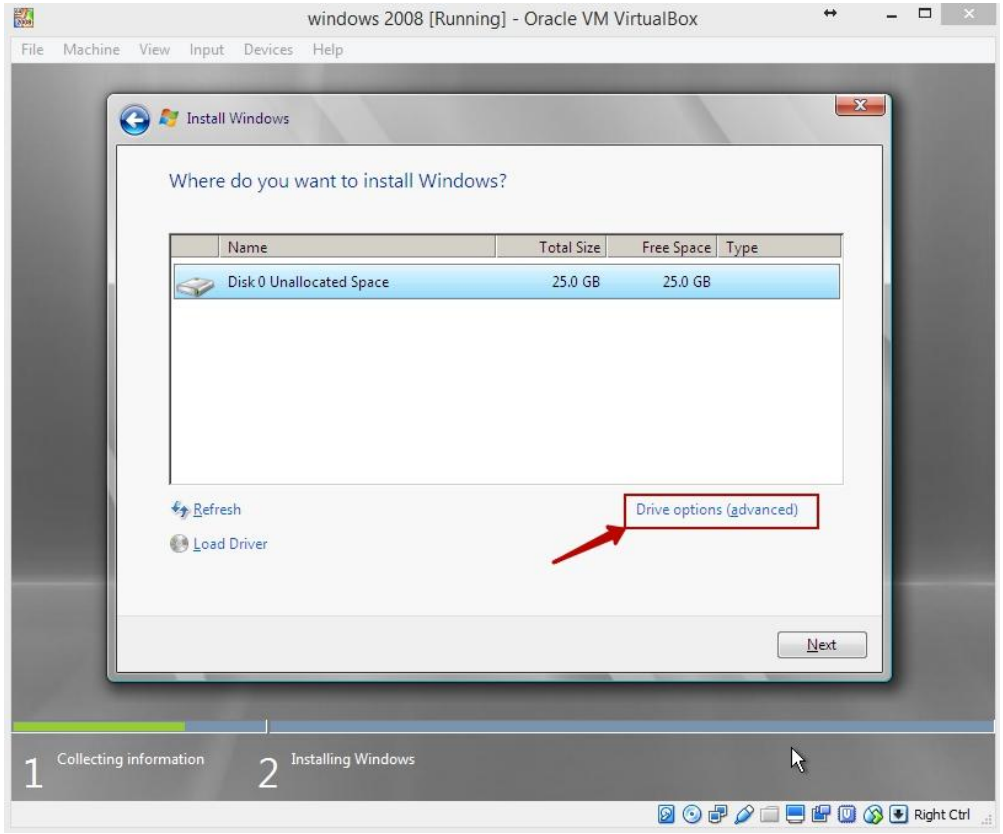
Virtual Machines: Create VMs in Virtual Box



Virtual Machines: Create VMs in Virtual Box



Virtual Machines: Create VMs in Virtual Box



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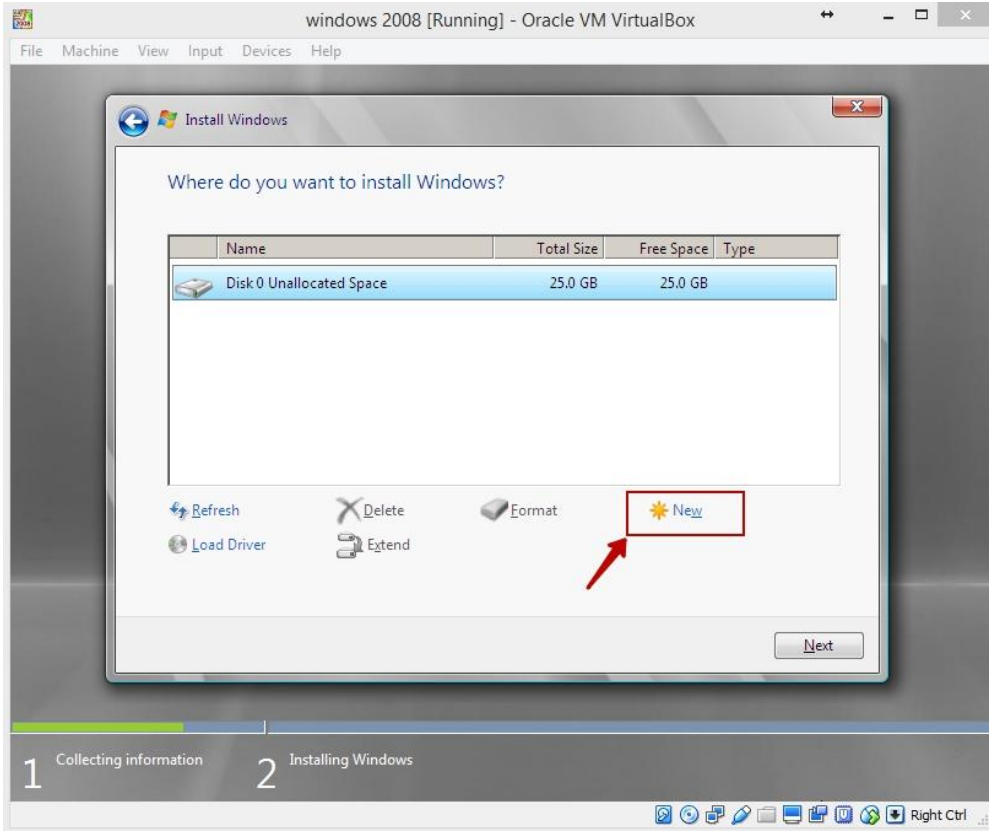
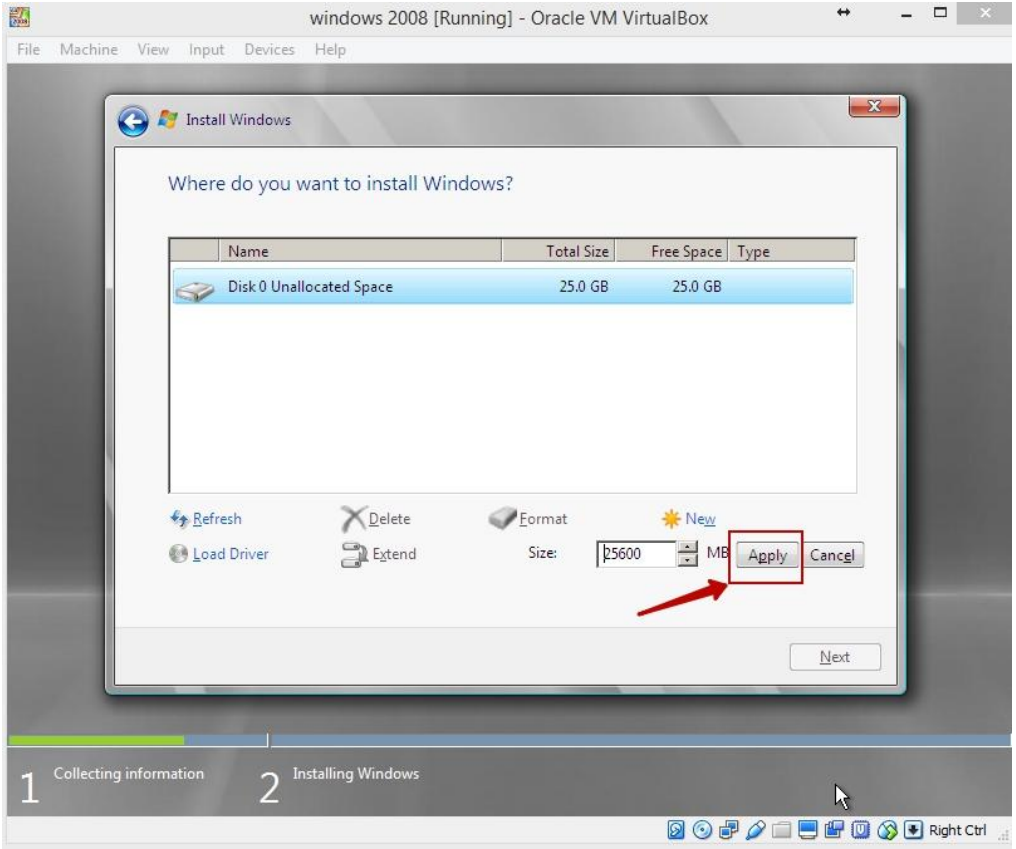
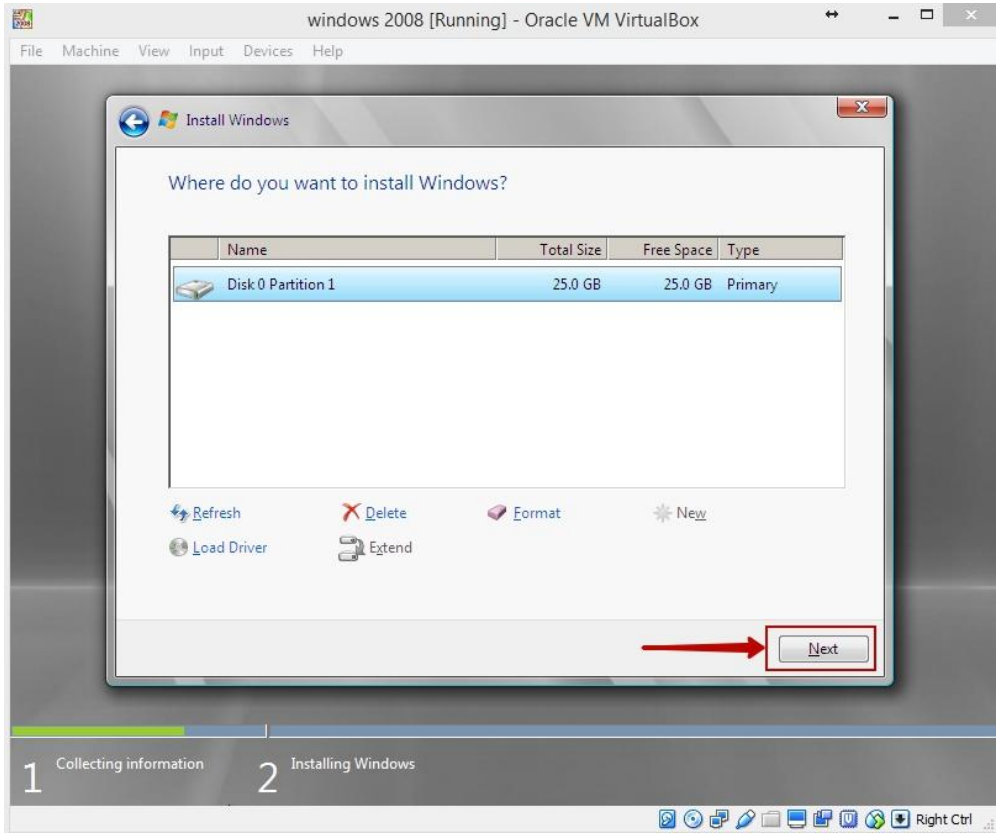


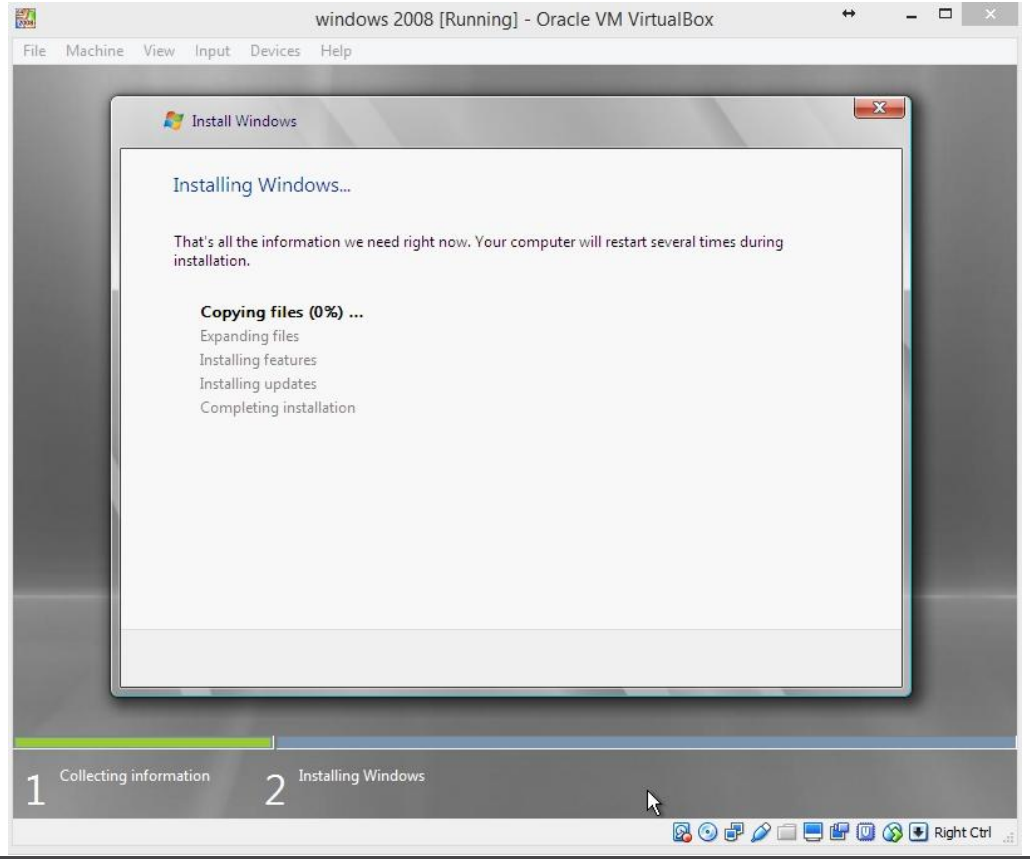
Virtual Machines: Create VMs in Virtual Box



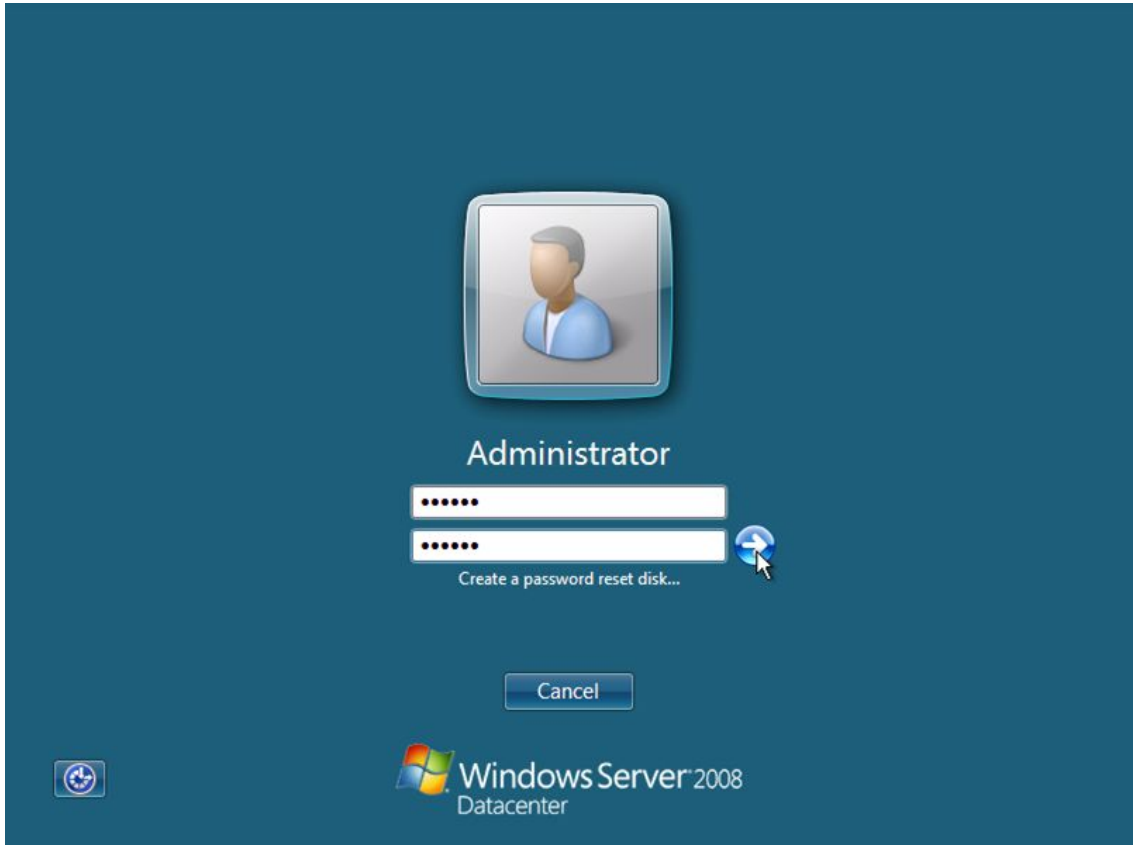
Virtual Machines: Create VMs in Virtual Box



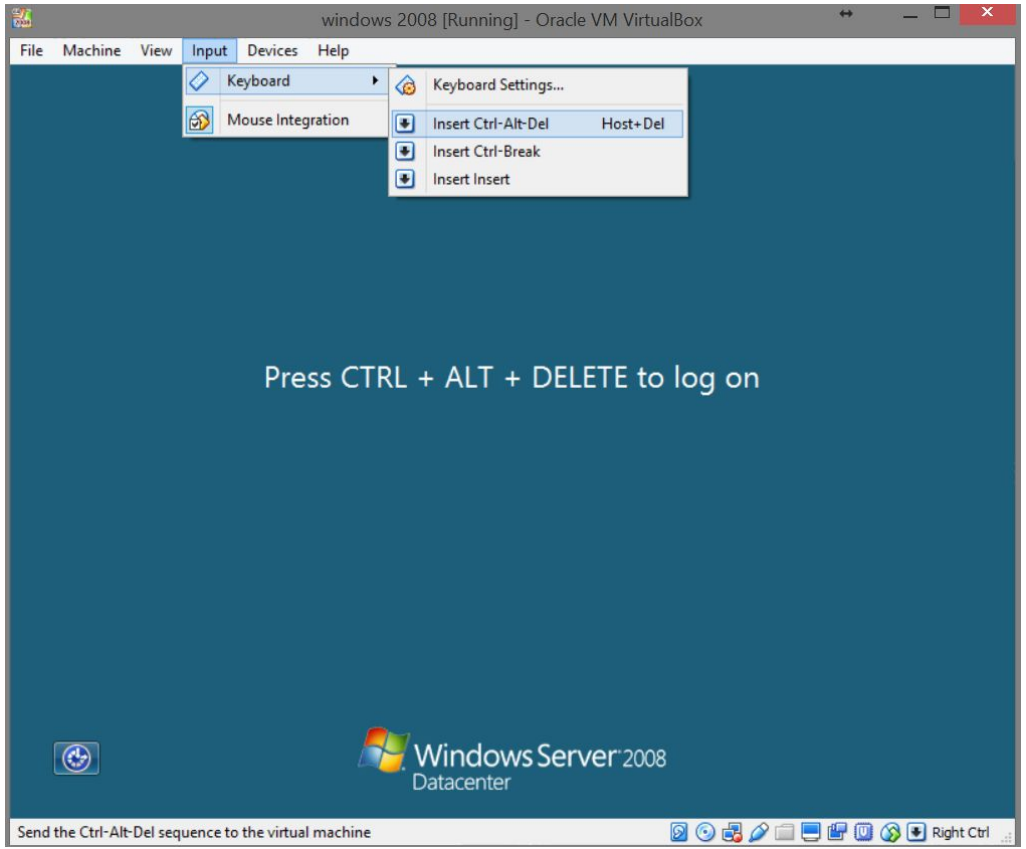
Virtual Machines: Create VMs in Virtual Box



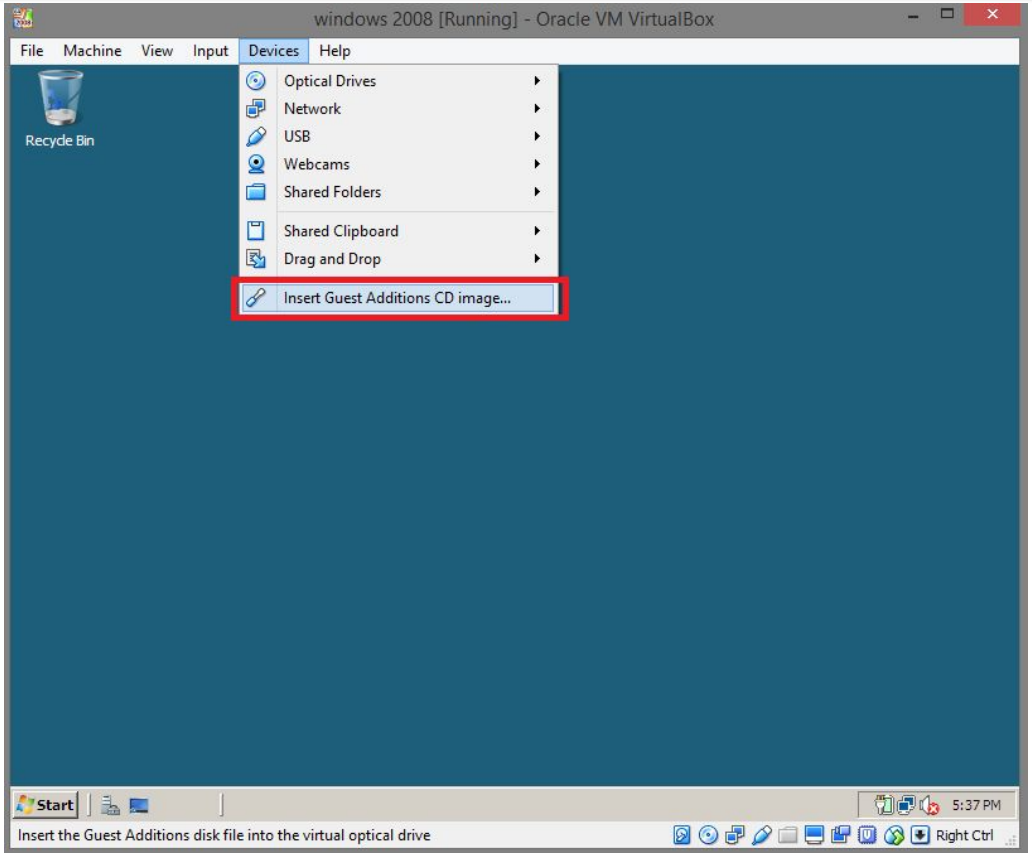
Virtual Machines: Create VMs in Virtual Box



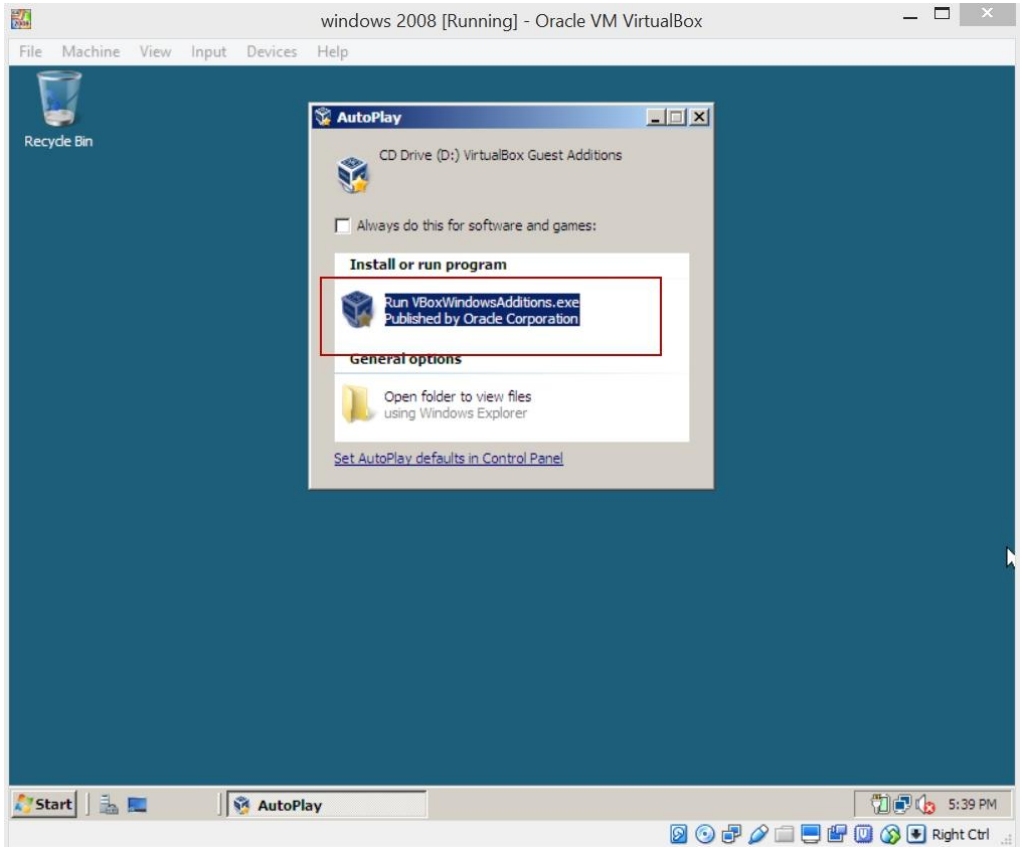
Virtual Machines: Create VMs in Virtual Box



Virtual Machines: Create VMs in Virtual Box

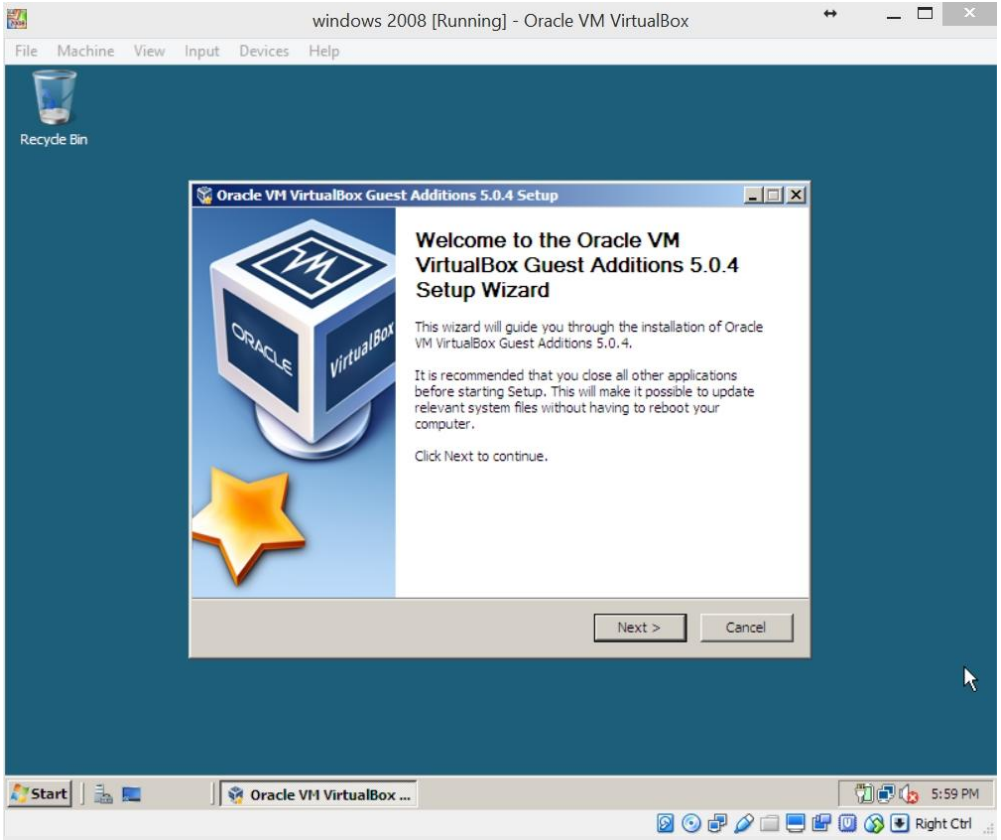


Virtual Machines: Create VMs in Virtual Box

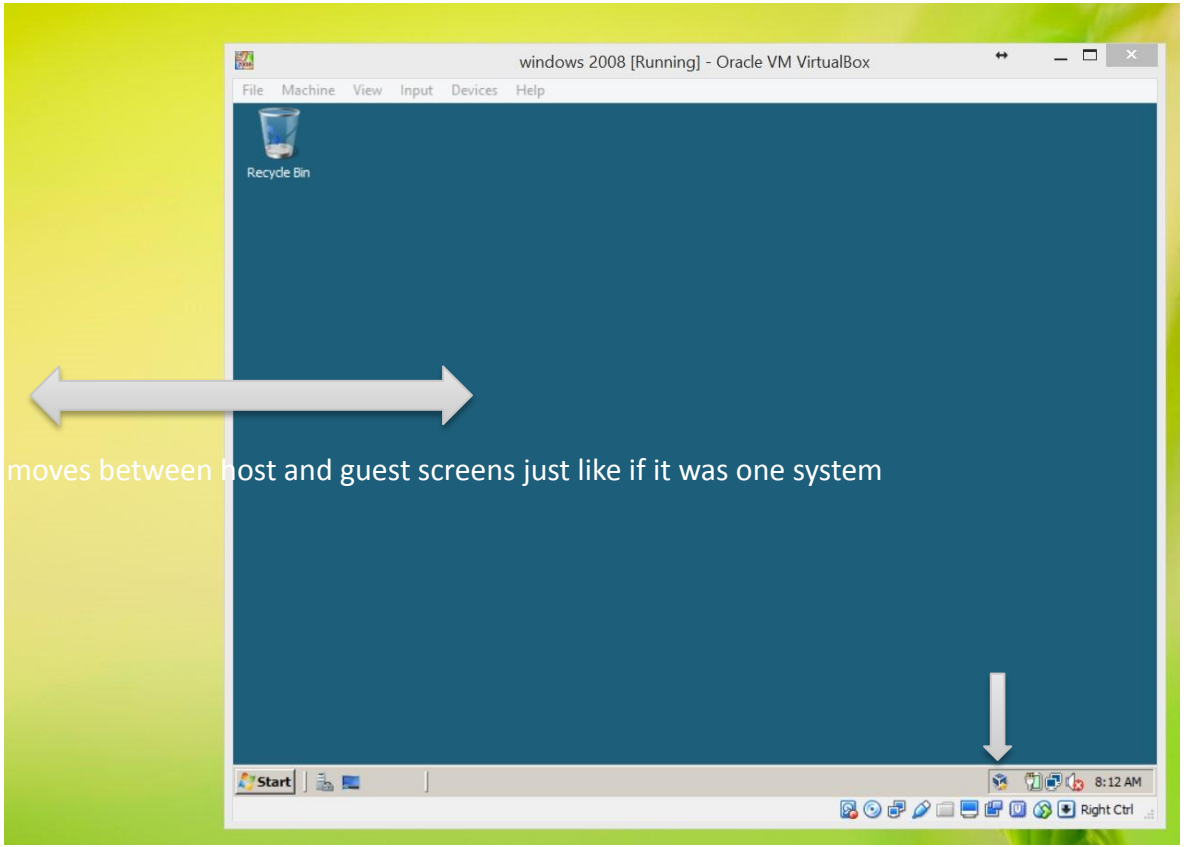


Virtual Machines: Create VMs in Virtual Box

1. Install additions with default settings
2. Install all drivers with additions
3. Reboot



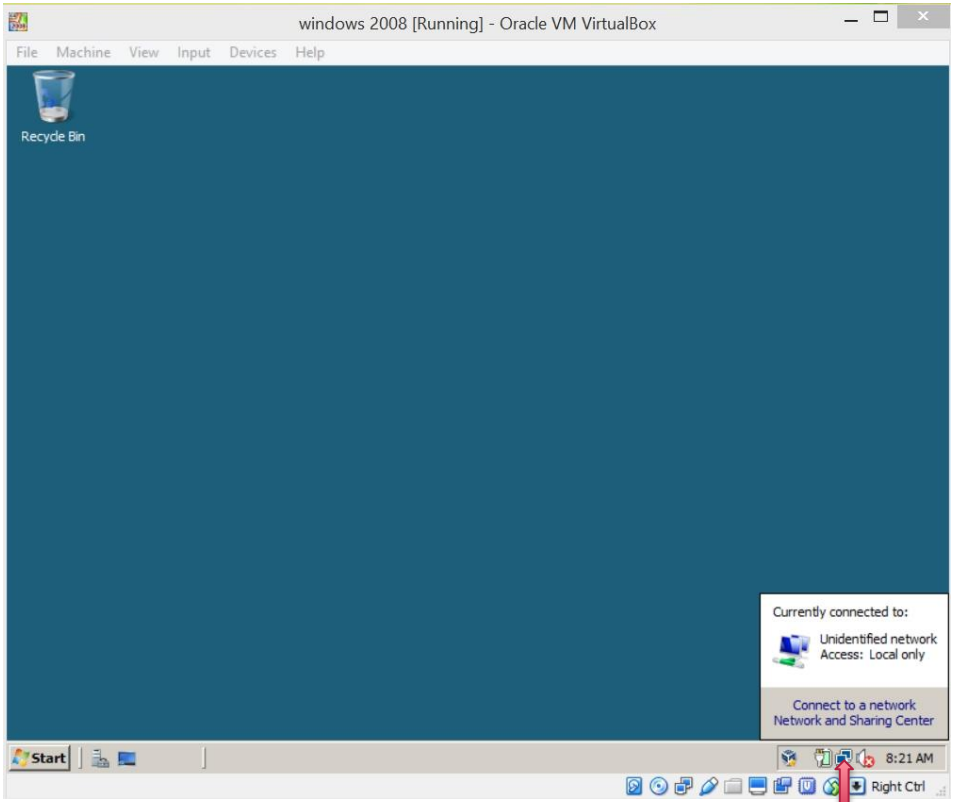
Virtual Machines: Create VMs in Virtual Box



Now your mouse moves between host and guest screens just like if it was one system

After Guest Additions are installed, you will see this icon in the system tray

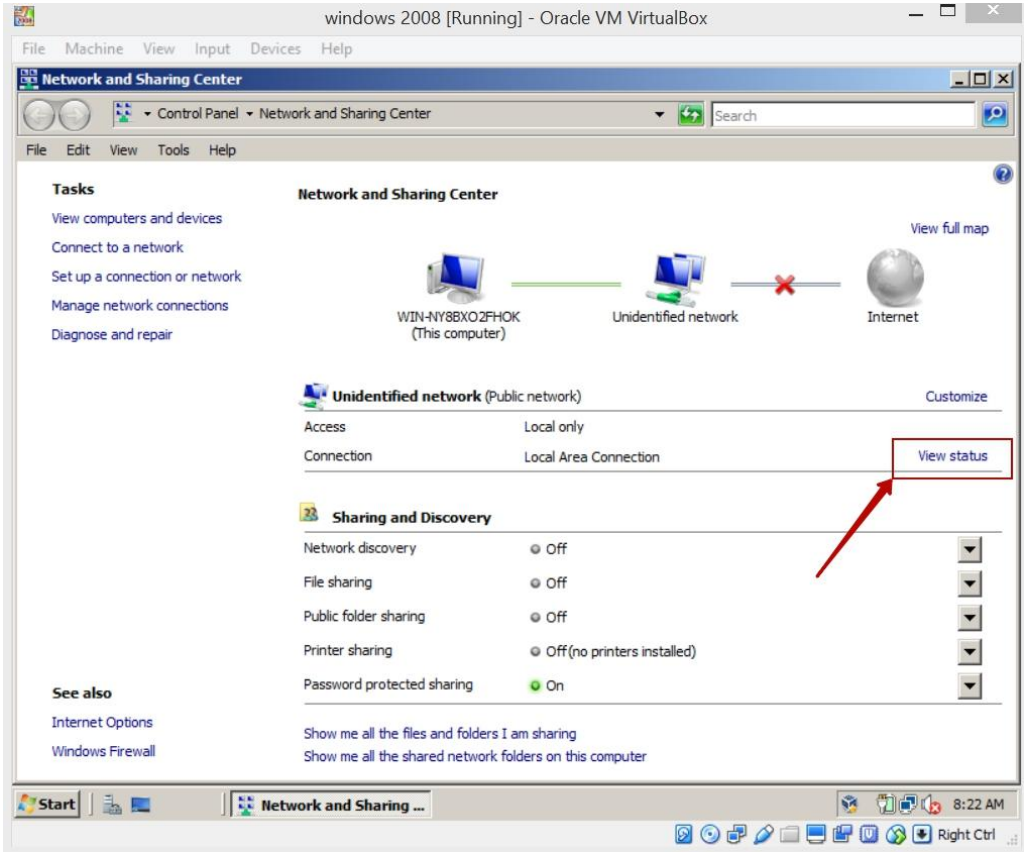
Virtual Machines: Create VMs in Virtual Box



Right-click Network icon and choose ‘Network and Sharing Center’

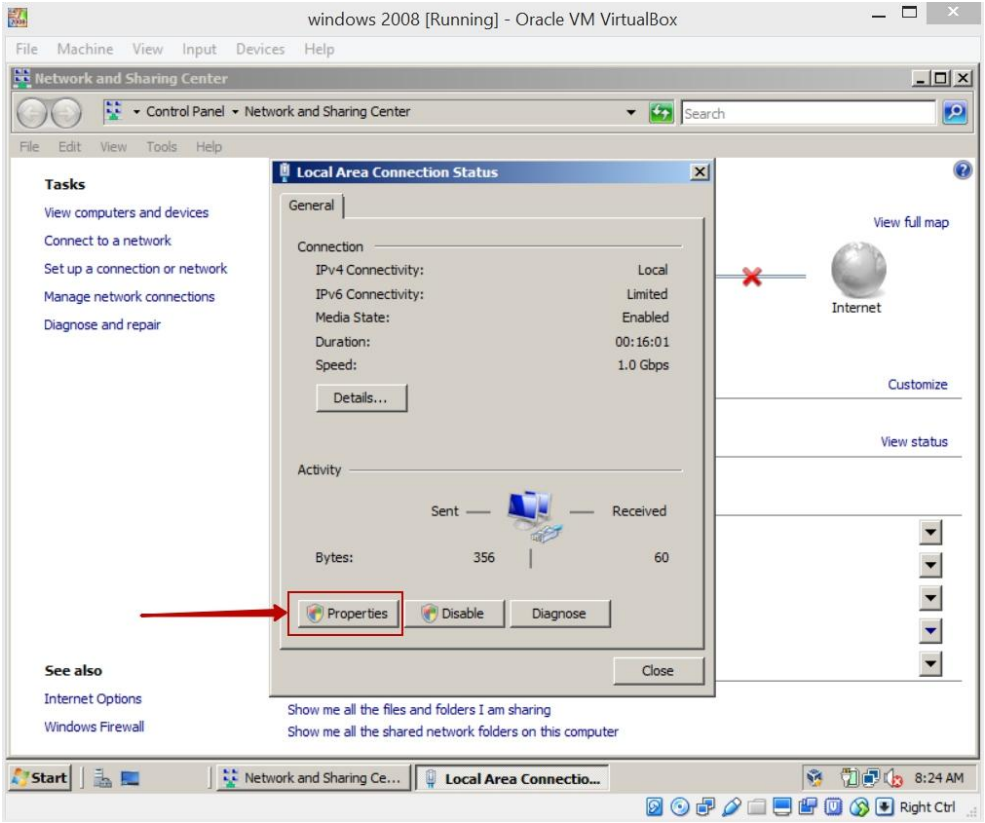
Virtual Machines: Create VMs in Virtual Box

1. Click on ‘View status’



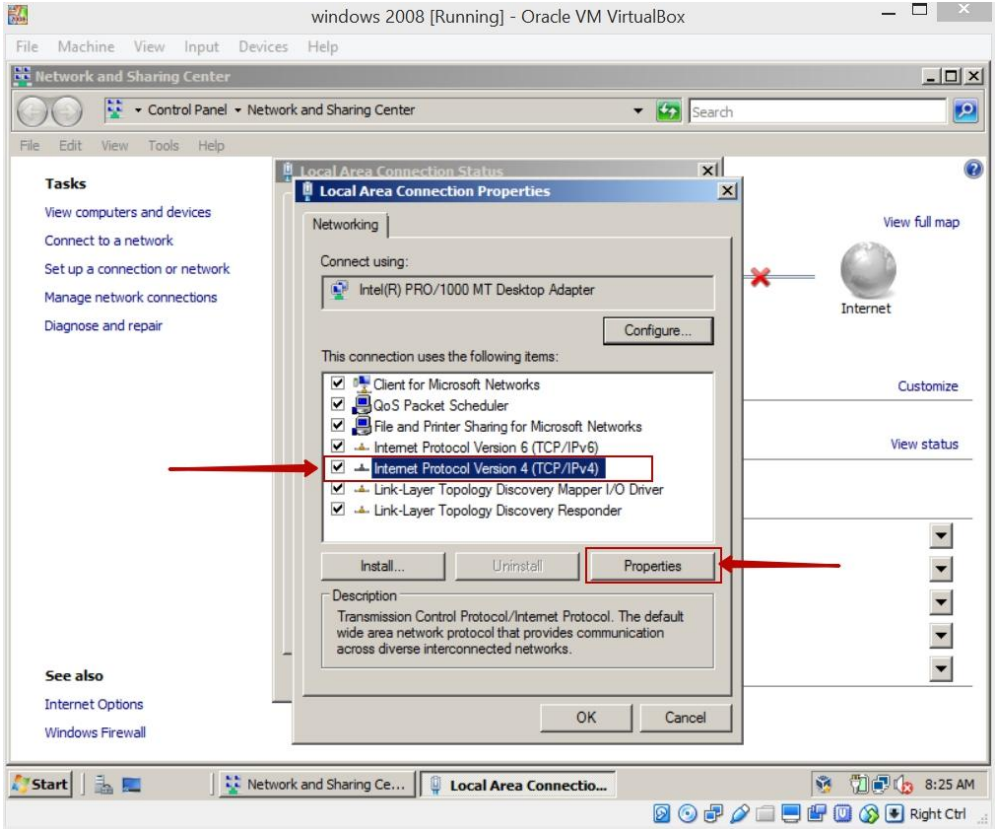
Virtual Machines: Create VMs in Virtual Box

1 Properties



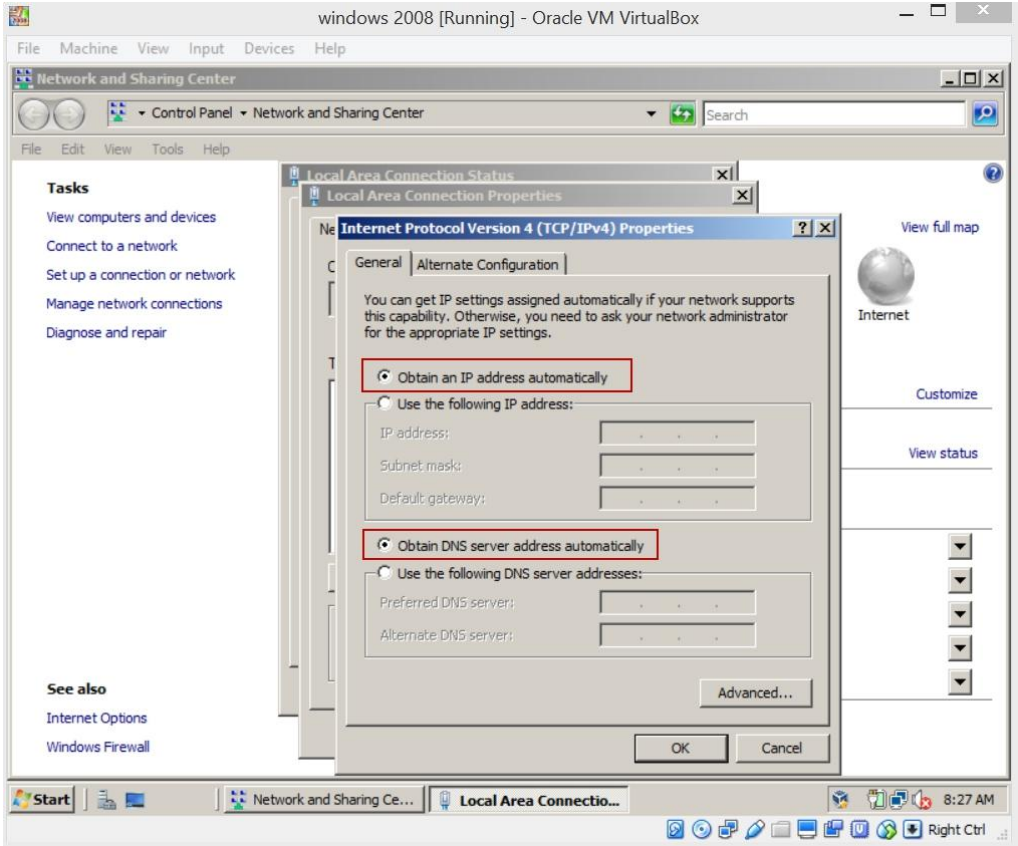
Virtual Machines: Create VMs in Virtual Box

1. Select Internet Protocol Version 4
2. Properties



Virtual Machines: Create VMs in Virtual Box

1. Obtain an IP address automatically
2. Obtain DNS server address automatically



Virtual Machines: Create VMs in Virtual Box

Now your Virtual Machine is almost ready for a long and courageous journey, but you must do one more thing before venturing forth…

VirtualBox: Snapshot

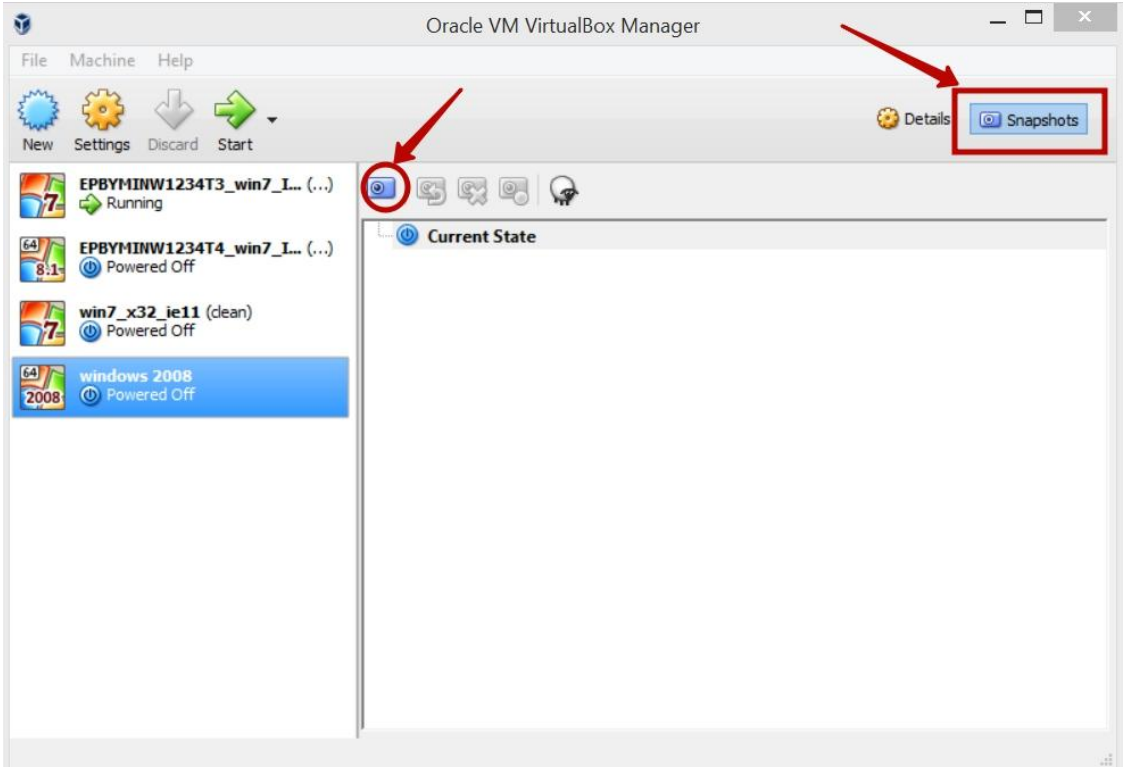
A snapshot

VirtualBox: Snapshot

A snapshot is a “point in time image” of a virtual guest operating system (VM). That snapshot contains an image of the VMs disk, RAM, and devices at the time the snapshot was taken. With the snapshot, you can return the VM to that point in time, whenever you choose. All changes made after the snapshot was taken may be based on that snapshot information (incremental changes). You can take snapshots of your VMs, no matter what guest OS you have and the snapshot functionality can be used for features like performing image level backups of the VMs without ever shutting them down.

VirtualBox: Snapshot

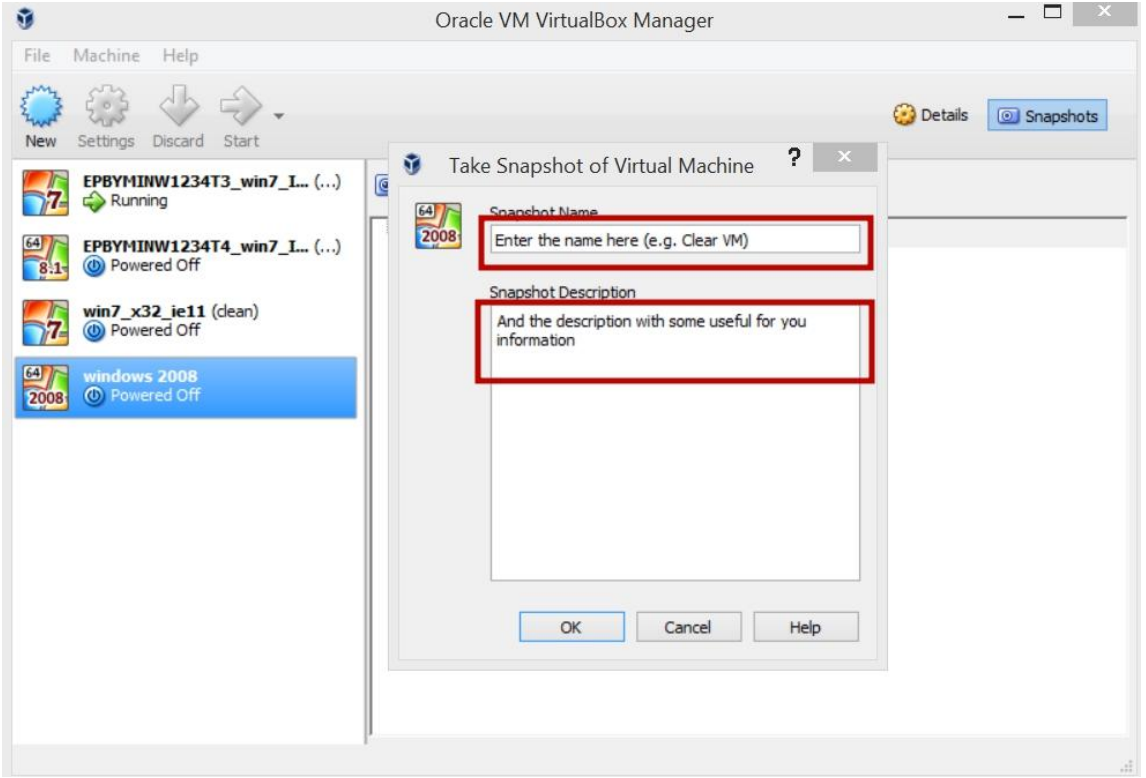
1. Open tab ‘Snapshots’
2. Click on icon ‘Take a snapshot’



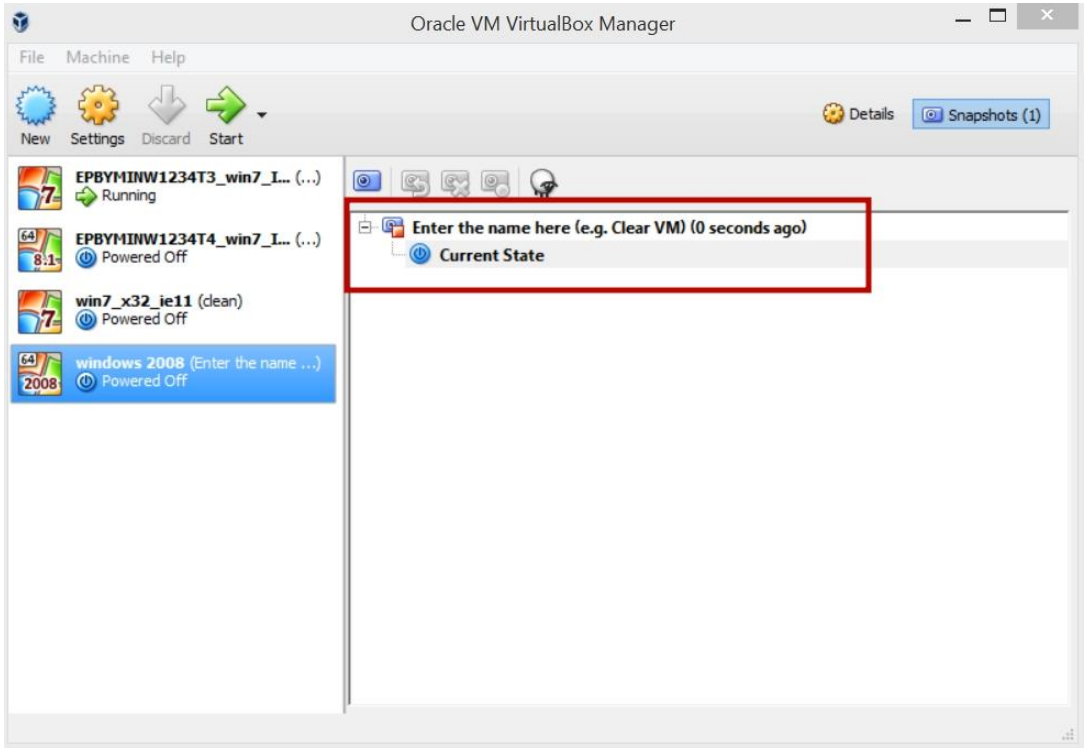
VirtualBox: Snapshot

1. Enter the name

2. Enter the description (optional)



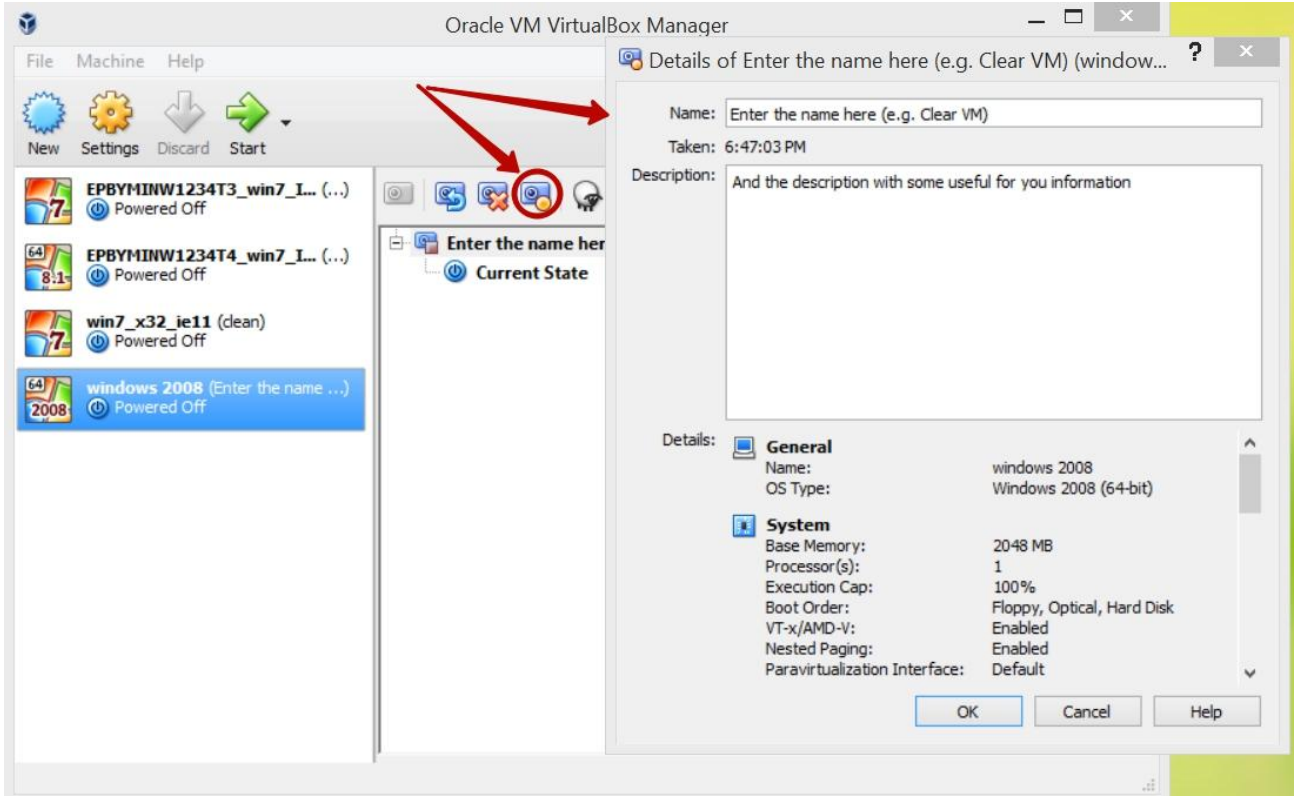
VirtualBox: Snapshot



This is your first snapshot, it's useful to take it every time before major changes you plan to do to your Virtual Machine

VirtualBox: Snapshot

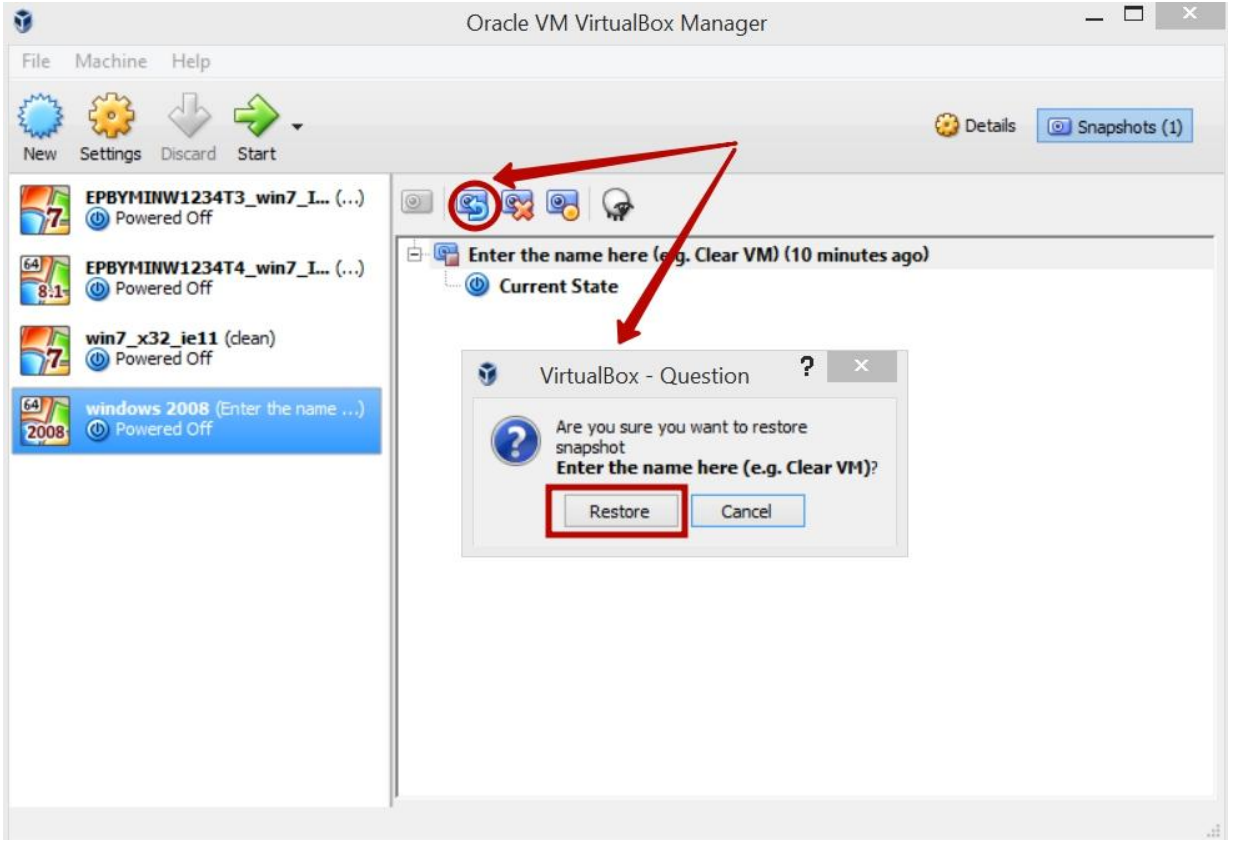
1. Snapshot details



VirtualBox: Snapshot

To restore machine's certain state:

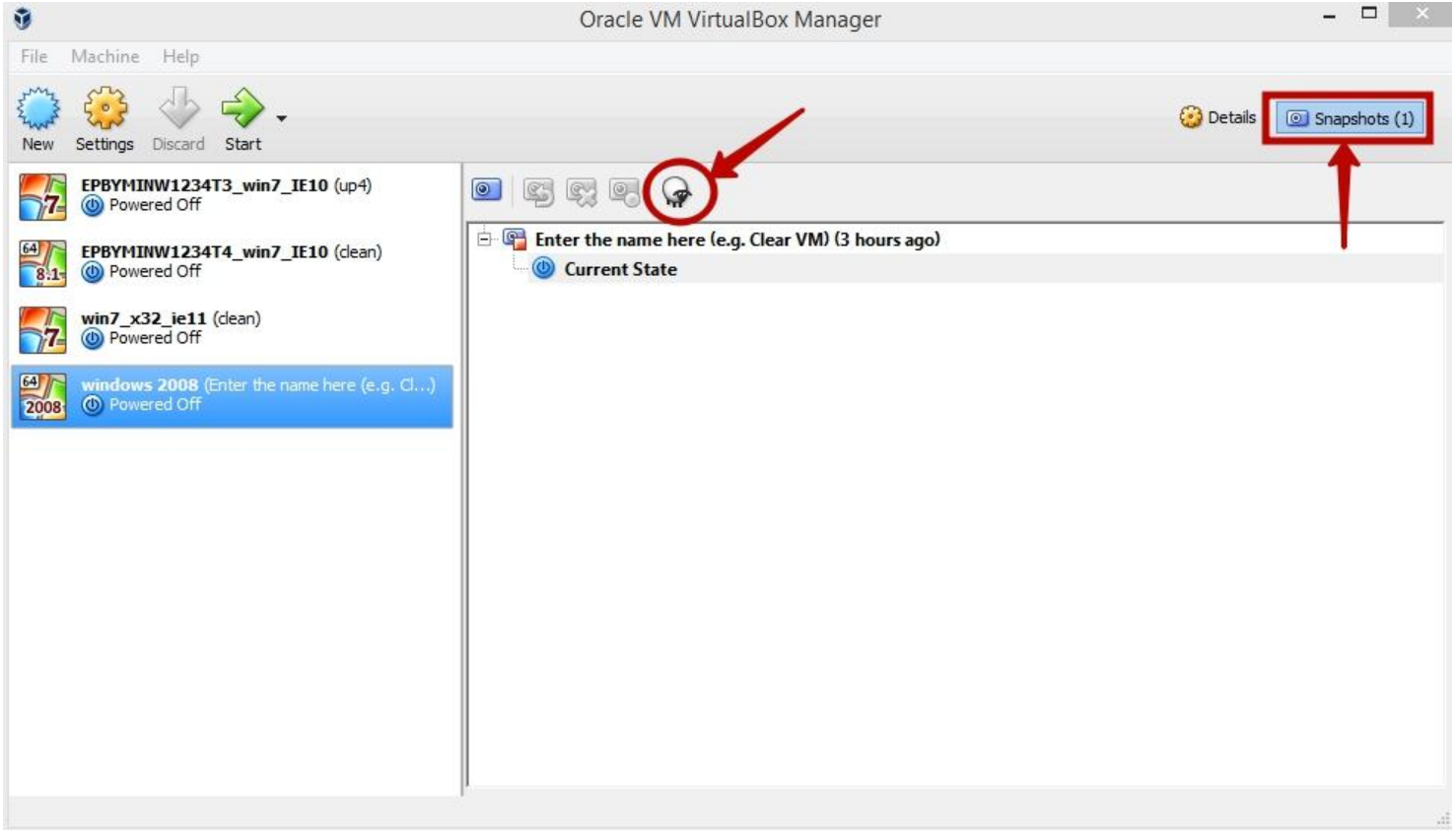
1. Power it down
2. Choose the snapshot
3. Click on the icon 'Restore…', restore and start VM



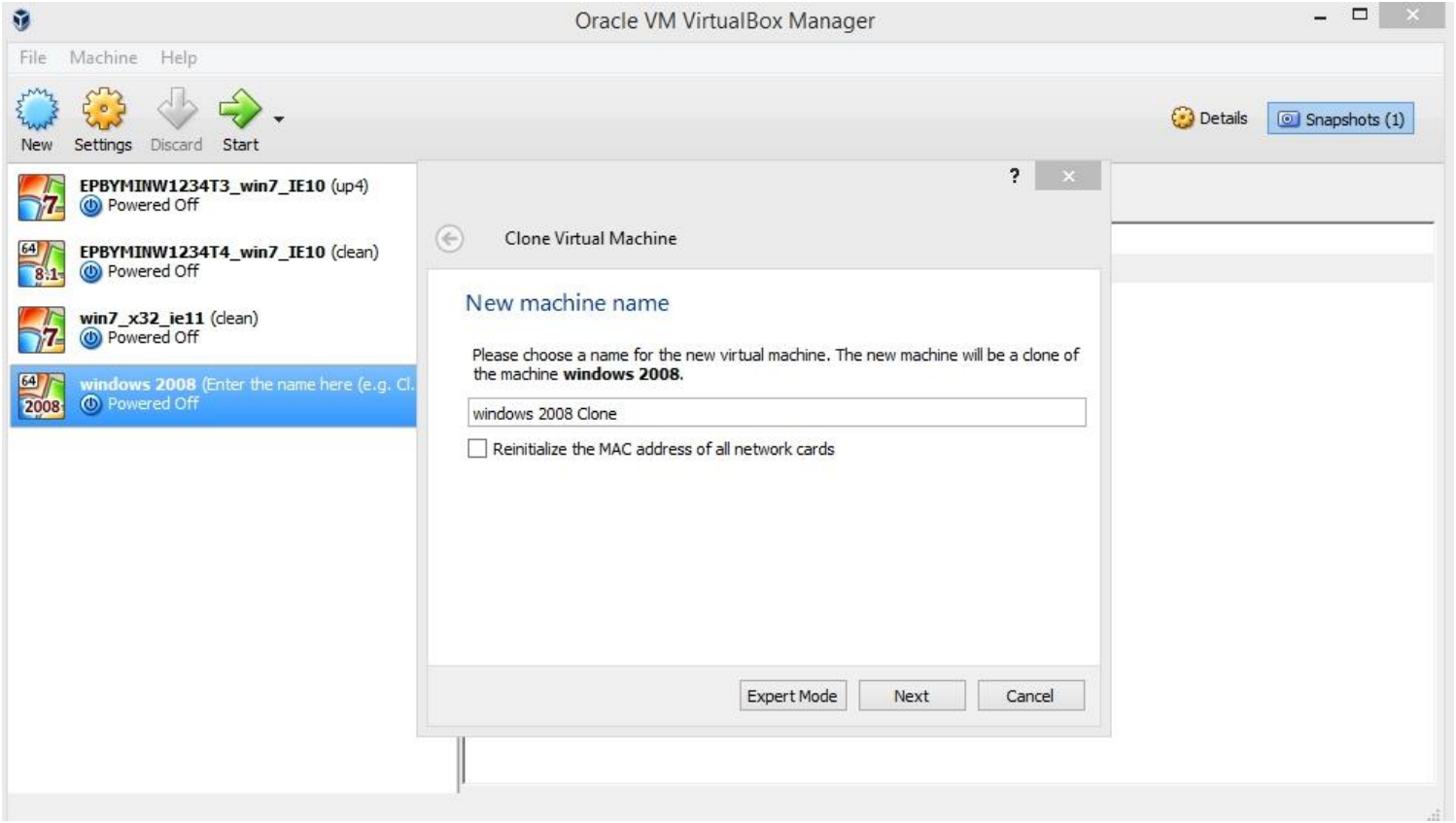
VirtualBox: Clone

A clone

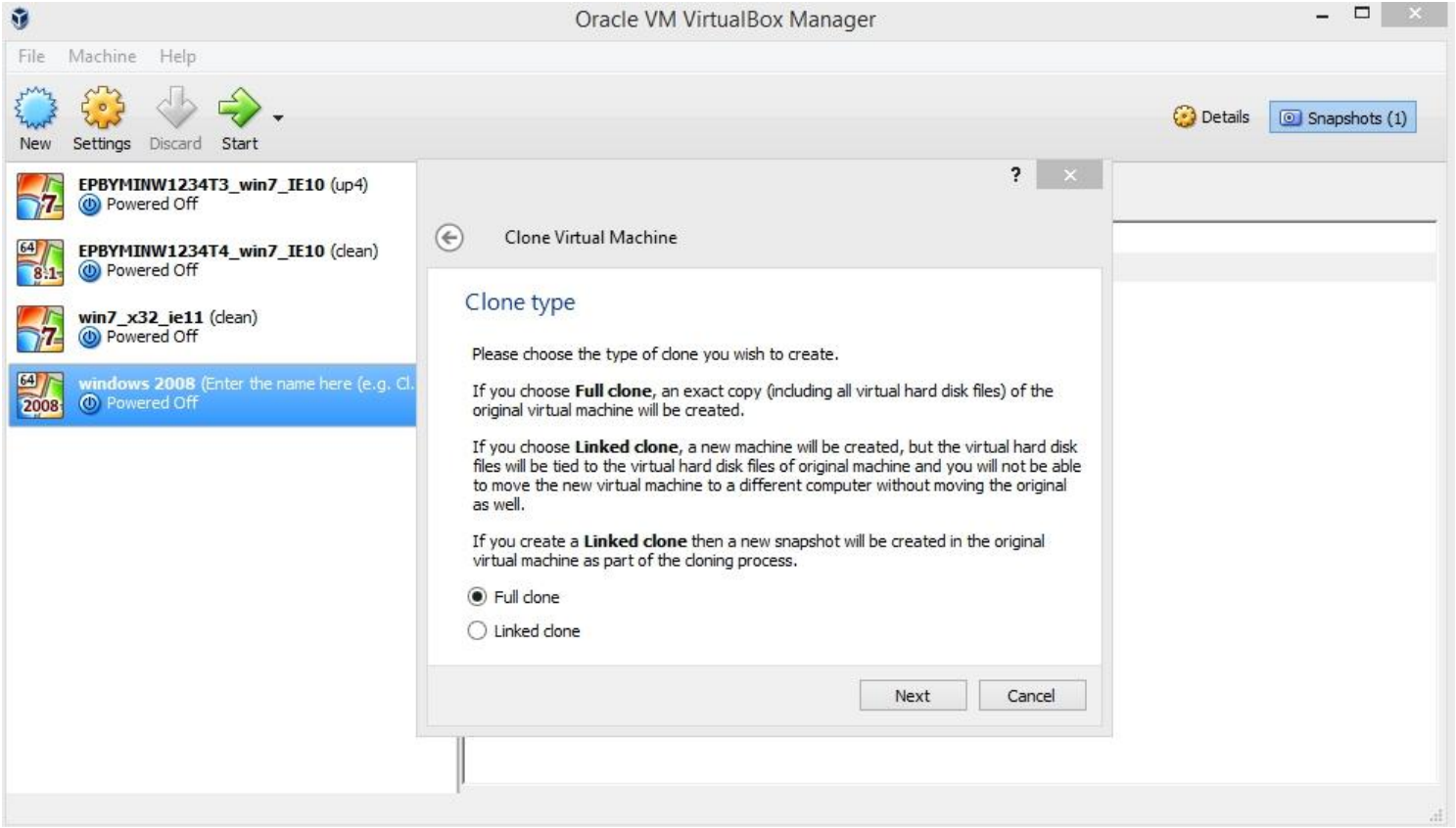
VirtualBox: Clone



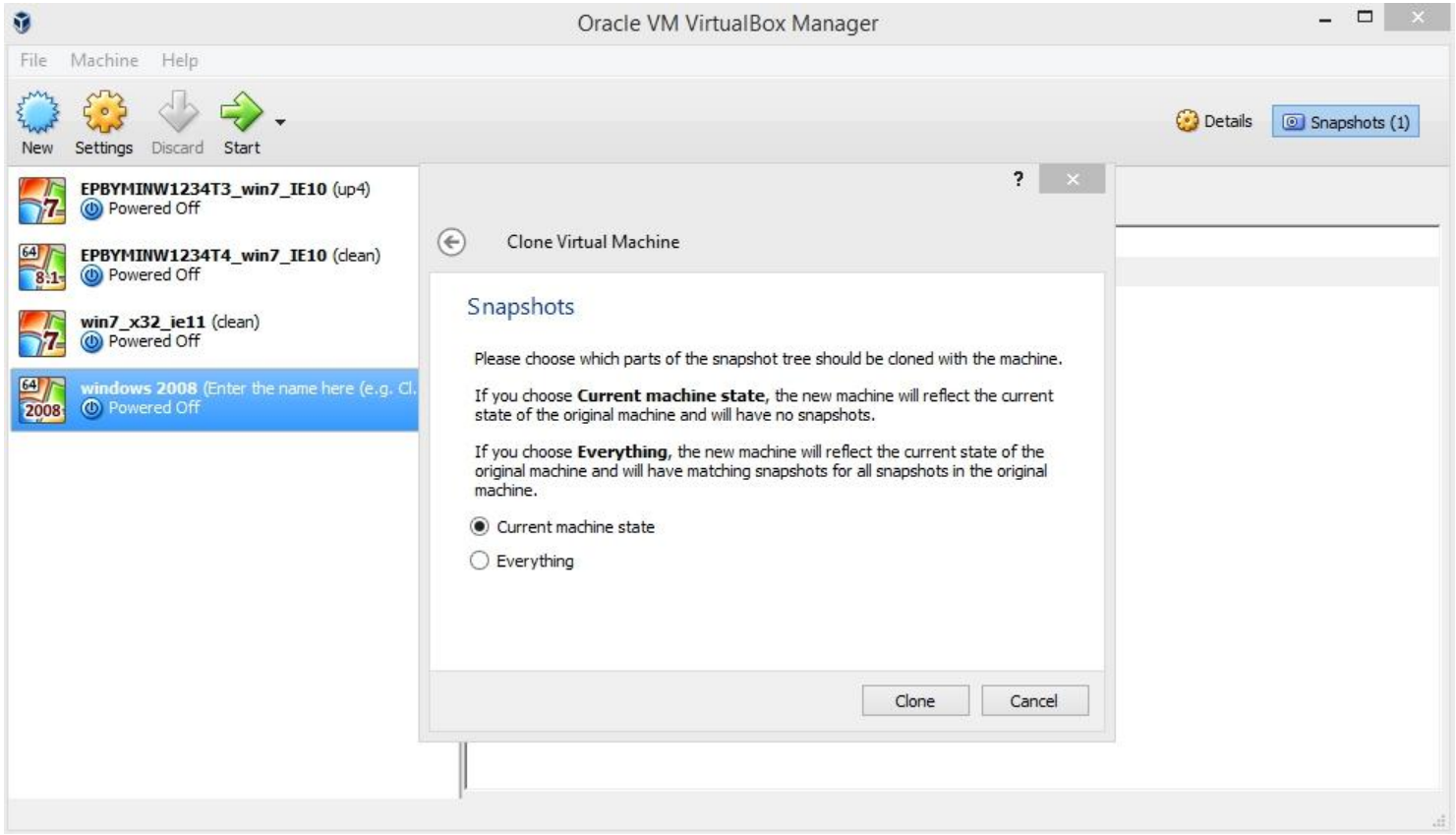
VirtualBox: Clone



VirtualBox: Clone



VirtualBox: Clone



Cool features

VirtualBox: Cool features

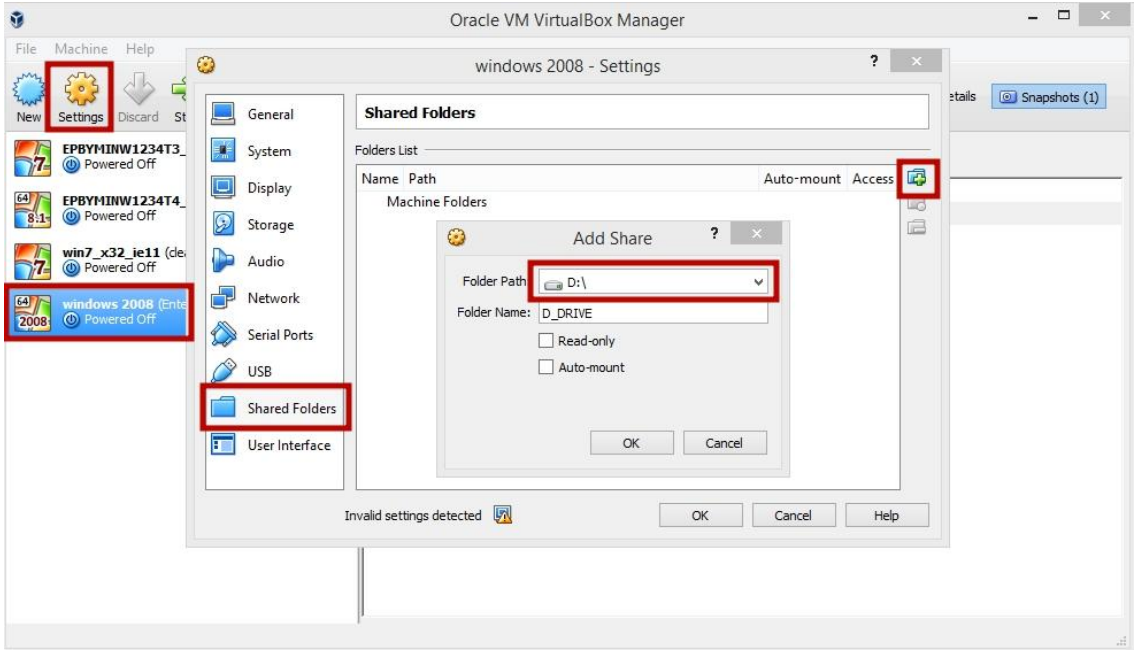
VirtualBox offers a set of useful features for user's convenience and work experience, all of them are available after guest tools installation:

1. Shared Folders
2. Seamless mode
3. Fullscreen mode
4. Encryption
5. Drag'n'Drop
6. External USB devices
7. Video Capture
8. Customization of User Interface

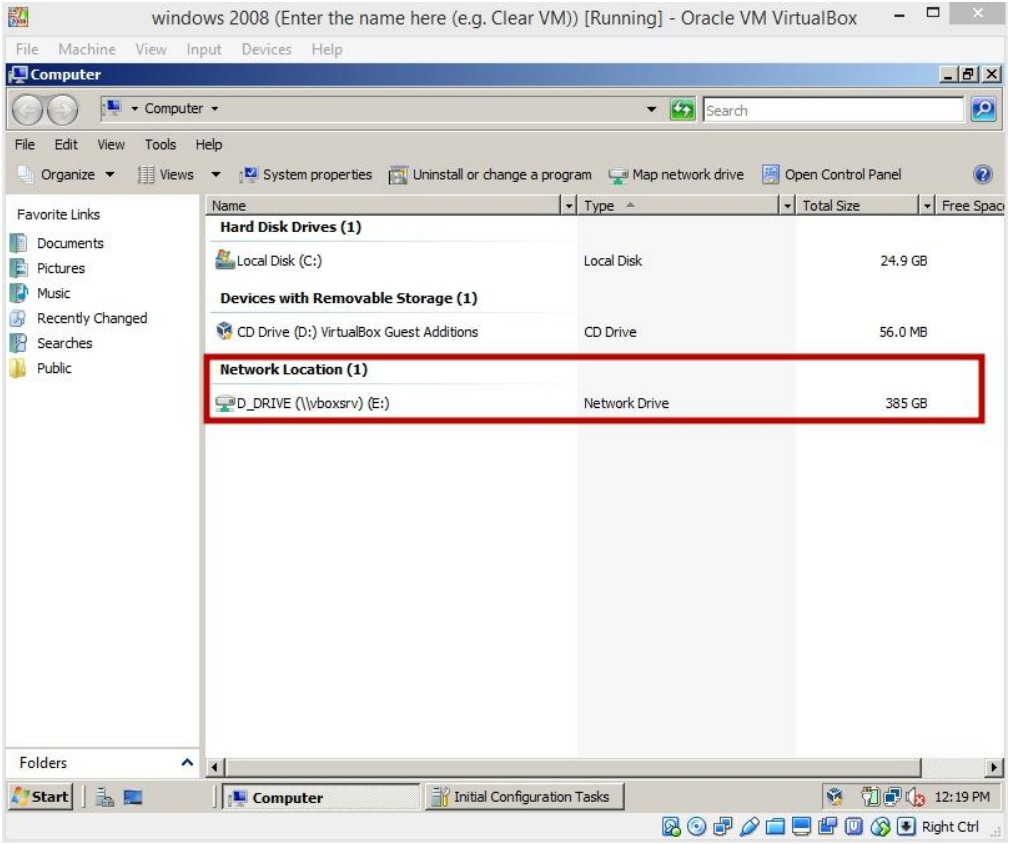
VirtualBox: Cool features

Shared folders

1. click Devices > Shared Folders (if VM is running)
   click Settings > Shared Folders (if VM is stopped)
2. Click on ‘+’ button
3. Choose the path or drive



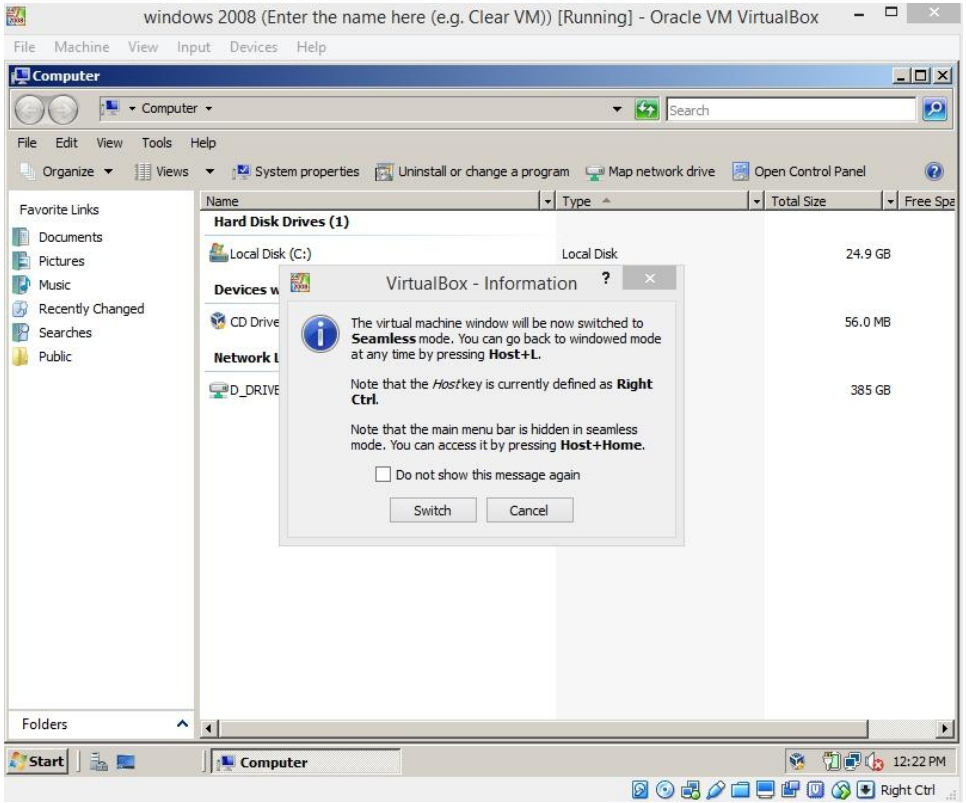
VirtualBox: Cool features



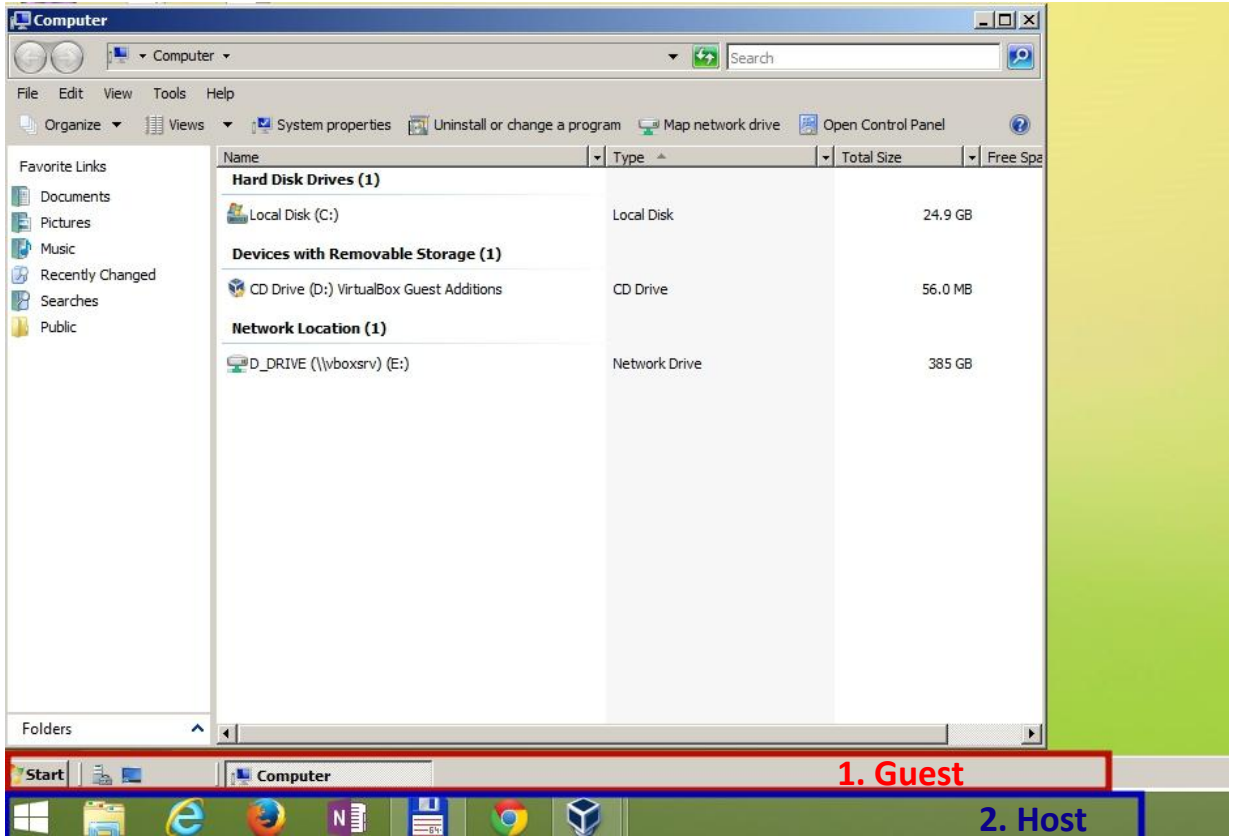
VirtualBox: Cool features

Seamless mode is a graphical mode which merges host's and guest's desktops together for more convenient work

Toggle Seamless – RightCtrl+L

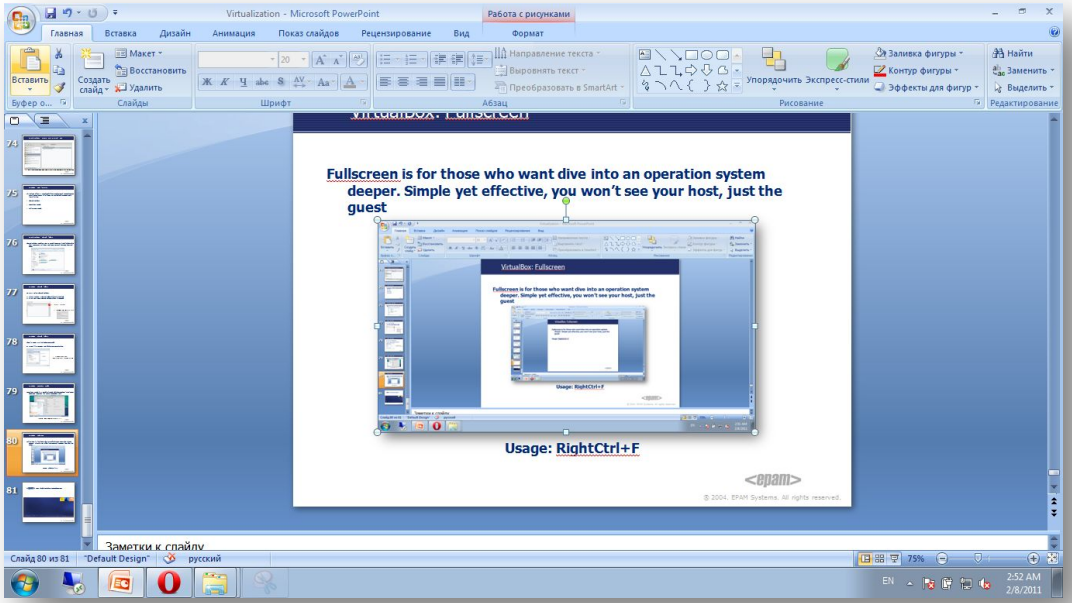


VirtualBox: Cool features



VirtualBox: Cool features

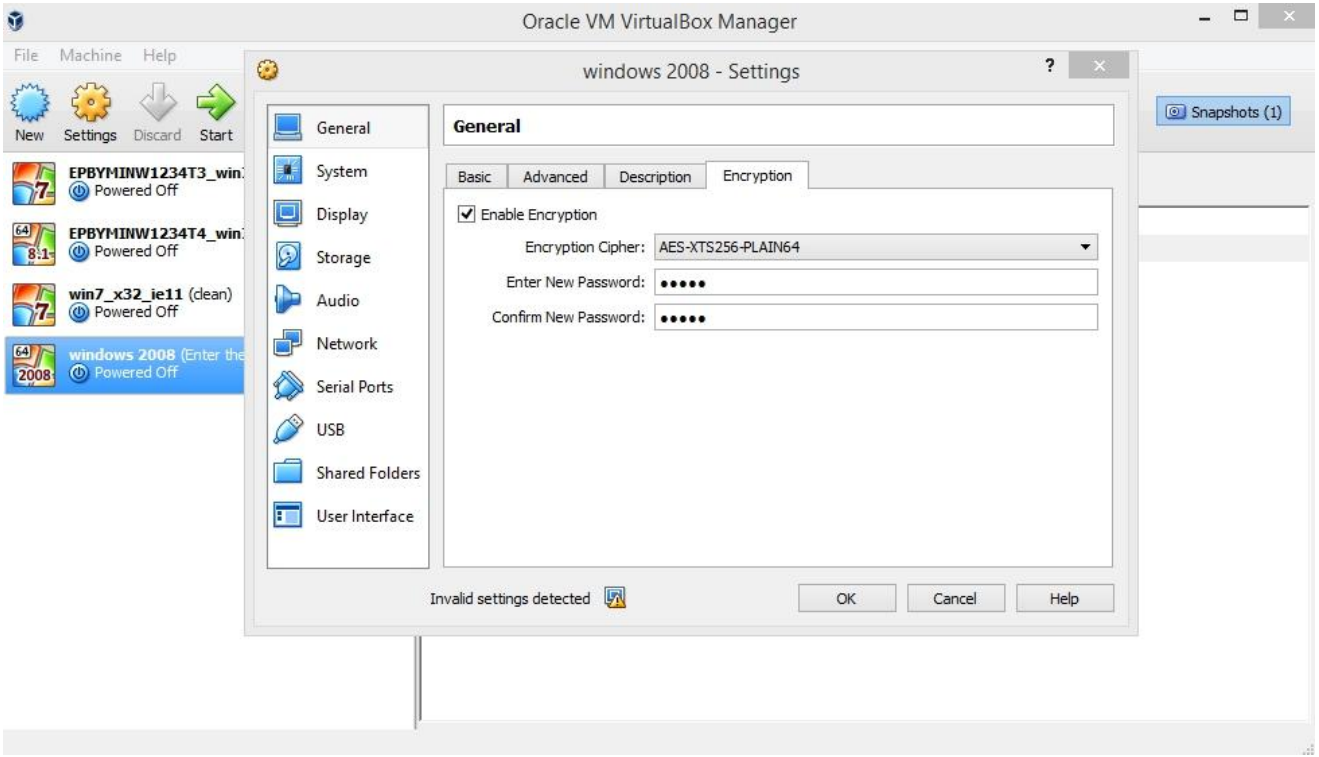
Fullscreen is for those who want dive into an operation system deeper. Simple yet effective, you won't see your host, just the guest



Usage: RightCtrl+F

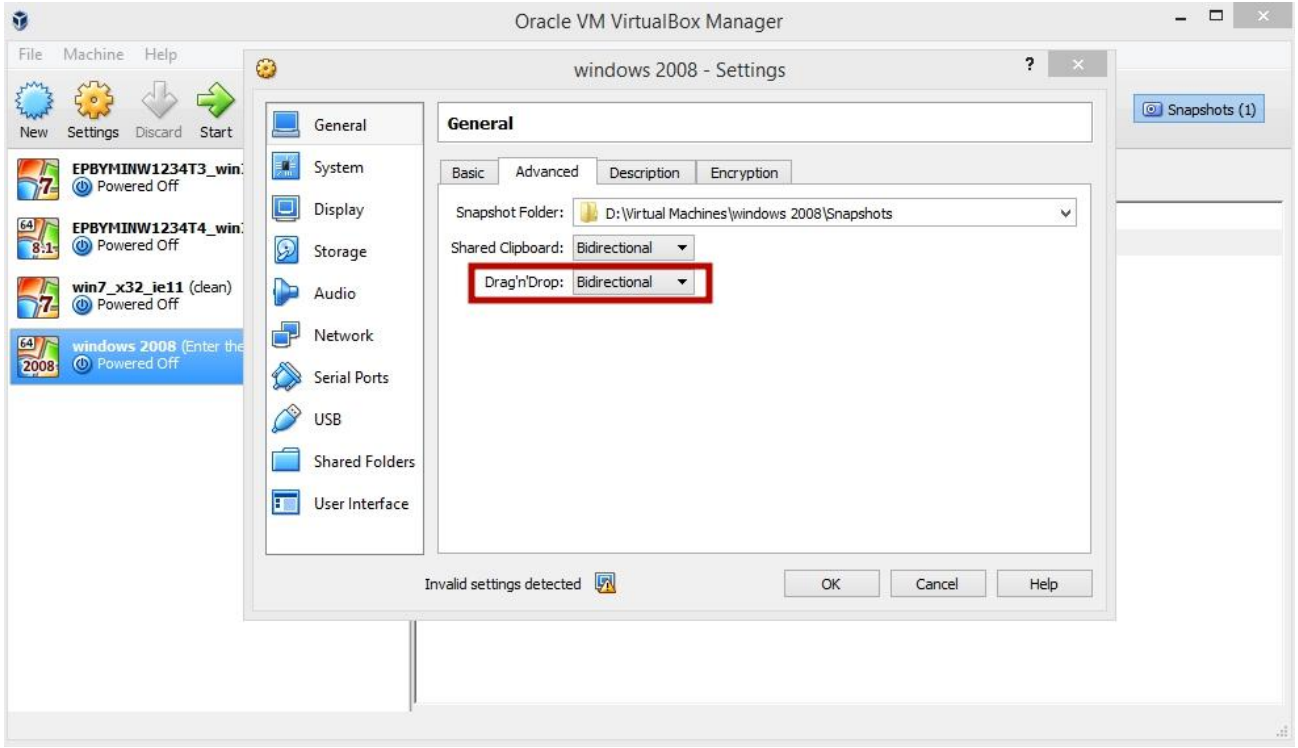
VirtualBox: Cool features

Encryption



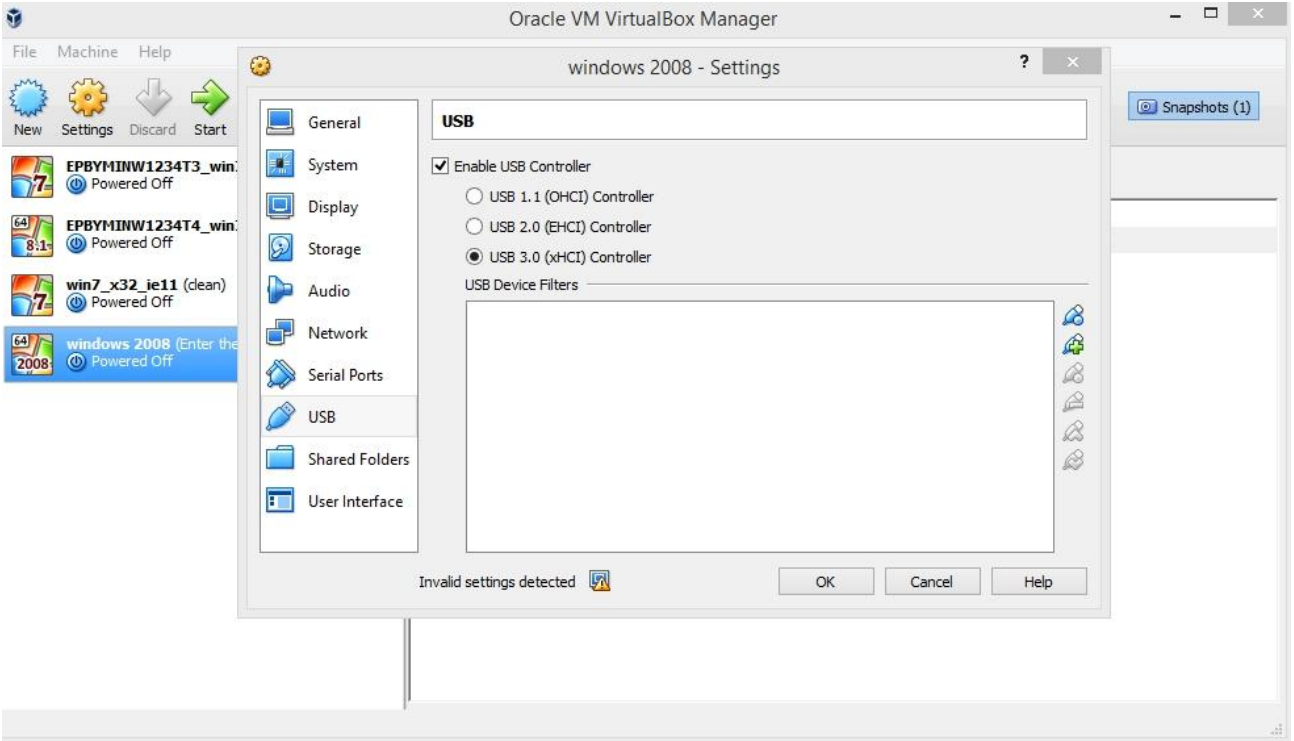
VirtualBox: Cool features

Drag'n'Drop



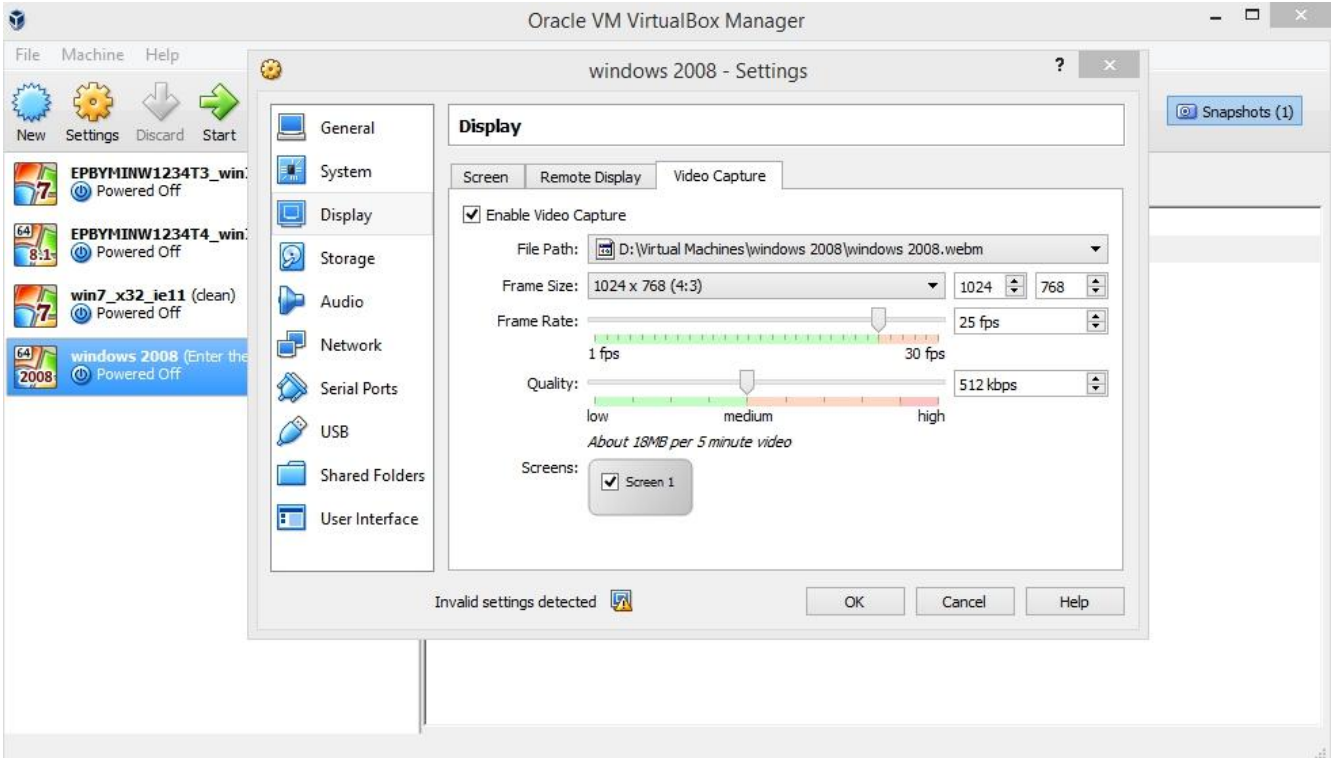
VirtualBox: Cool features

External USB devices



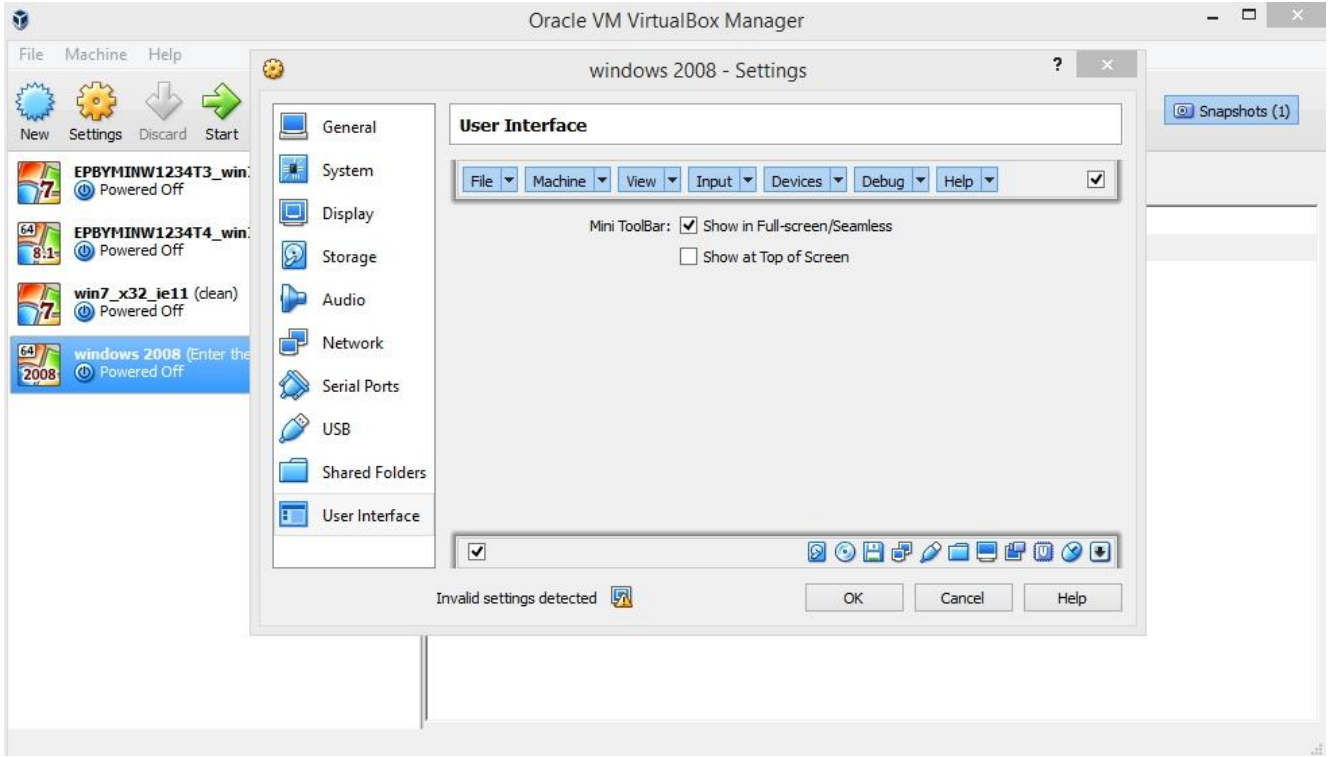
VirtualBox: Cool features

Video Capture



VirtualBox: Cool features

Customization of User Interface



EPAM deploy

Described here: \\epam.com\sam\SoftArchive\EPAM_Images\EPM-GESS_Deploying_SI_to_VM.docx

1. By default you can install only workstation-class OS (Win7, Win8, Win10). To have server OS in VM you need to receive MSDN subscription to be on safe side from licensing point of view.
2. Oracle Virtual Box added as virtualization tool.
3. You cannot run a procedure in EPAM office that do not have server farm installed (London, Zurich, Boston, etc).
4. You cannot run the procedure from outside of office LAN (VPN will not help here).
5. Procedure is automated and simple enough.
6. You installed licensed copy of OS and software.
7. Virtual machine is properly configured and managed, i.e. security updates installed, antivirus running.

Useful Links

Virtualization links:
http://www.vmgu.ru/articles
http://en.wikipedia.org/wiki/Hardware_virtualization
http://en.wikipedia.org/wiki/Full_virtualization
http://en.wikipedia.org/wiki/Paravirtualization
http://en.wikipedia.org/wiki/Operating_system-level_virtualization
http://en.wikipedia.org/wiki/Hypervisor
http://en.wikipedia.org/wiki/Virtual_machine
http://en.wikipedia.org/wiki/Comparison_of_platform_virtual_machines
http://en.wikipedia.org/wiki/Hardware_emulation
http://www.google.com

VirtualBox related links:
http://www.virtualbox.org/wiki/User_HOWTOS
http://www.virtualbox.org/manual/ch12.html
http://www.virtualbox.org/manual/UserManual.html
http://www.virtualbox.org/wiki/Downloads

Interesting:
http://www.vmgu.ru/articles/red-pill-virtualization-security
http://en.wikipedia.org/wiki/Blue_Pill_%28malware%29
http://qubes-os.org/Architecture.html

Thank you for attention!