How to create and configure a virtual machine using Oracle VM VirtualBox?

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Introduction

The worksheet is designed in different activities which will help you in creating and configuring your virtual machine using Oracle VM VirtualBox. The term virtualization is the core functionality running behind cloud computing which is a cost-effective technique. The Oracle VM VirtualBox is a type II hypervisor (Hosted Hypervisor) which allows you to create virtual machines on the host operating system (OS).

The activities are divided into

1. Enable Virtualization
2. Identify OS images compatible for virtualization
3. Virtual Machine(VM) Creation
4. VM Setting Configuration
5. Types of Hardware Controllers
6. Storage Configuration
7. Network Configuration
8. External I/O Configuration
9. Shared Folder
10. Network Virtualization

All the defined activities will be covering the basics of using Oracle VM VirtualBox.

Enable Virtualization

Before moving towards the creation of a virtual machine, the first thing is to check if the flag is enabled or not in your system i.e. for running a machine in virtual mode you need to enable Intel-VT/ AMD-V based on your system by entering into BIOS or UEFI Firmware settings.

To enter into boot mode for changing the BIOS setting every system has different keys which are splashed on the screen while starting the PC.

For enabling virtualization using UEFI, go to Settings ➜ Update and Security ➜ Recovery ➜ Restart Now while restarting your system you will be asked to Troubleshoot, select it and then move to Advanced Options ➜ UEFI Settings ➜ Restart, and now you can turn on the flag.

The Intel-VT/AMD-V can also be enabled on guest OS in Oracle VM VirtualBox under System Settings where Hardware Virtualization dialogue box consisting of two check boxes defining intel-vt and amd-v as well as nested virtualization can be found.

Identify OS images compatible for virtualization

An iso file is an optical disc image which comprises all required files for distributing an operating system in a compressed single file format. The image can be in GB's which is used for installing the operating system. Oracle VM VirtualBox provides a set of Linux/Unix operating systems in an vdi format i.e. virtual disk image which can be directly used for installation. This hypervisor supports all kinds of operating systems such as Microsoft Windows, Linux, MacOS etc.

To directly download the vdi images of Linux/Unix distributions, you can check this link https://www.osboxes.org/virtualbox-images/.

The iso images of different OSes can be directly downloaded from their original websites itself which may or may not be free (can require you to purchase product key). All open source GNU(GPL) Oses provide both 32 -bit and 64-bit iso images for all the currently active versions.

Example : Ubuntu - https://ubuntu.com/download/desktop

Raspbian - https://www.raspberrypi.org/software/operating-systems/

Virtual Disk Image is one of the types of disk image file formation which creates its own container with a new disk and new VM. There are other formats too such as Virtual Machine Disk(VMDK), Virtual Hard Disk(VHD) and HDD which are supported by VMware, Microsoft as well as Parallel versions of image files can also reside. The guest OS treats these formats as a hard disk which is saved in the host OS. In addition, by using VBoxManage modify medium command the size of images can be easily modified if they are not dynamically allocated.

A disk image file can be created either by fixed size or dynamic allocation. In case of fixed size, the allocated disk remains unutilized if it is not used which restricts the flexibility of the disk. However, in case of dynamic allocation the size grows when the resource is required. The demonstration of vdi creation is illustrated in the VM creation part.

Virtual Machine(VM) Creation

One of the significance of creating virtual machines is that any damage occurred at the time of configuration and installation of OS cannot affect the physical hardware which is why this technique is also utilized in creating virtual environments for testing production sites.

Oracle VM VirtualBox supports almost every kind of system running with Microsoft Windows, Linux Distributions, Solaris, MacOS etc.
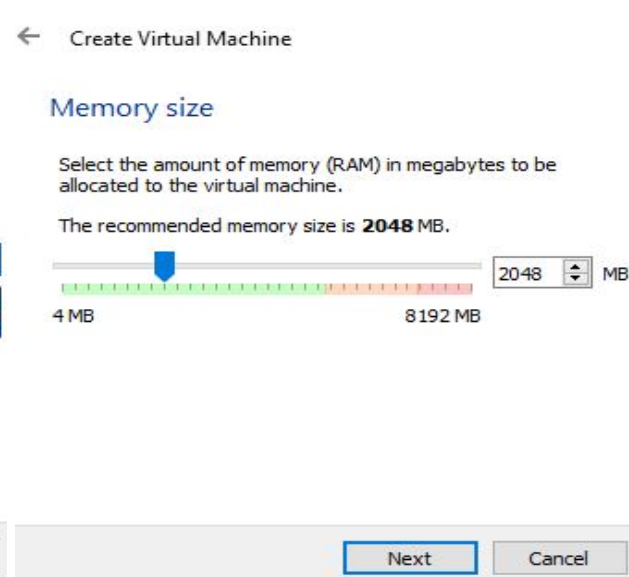
You can download the VirtualBox according to your system requirements from this link https://www.oracle.com/in/virtualization/technologies/vm/downloads/virtualbox-downloads.html.

Note: RAM of the Host OS running system should be at least 4GB for a better performance.

1. Click on New icon for creating the VM where you need to provide the OS name, type and version. After filling the details click Next button where you have to provide the memory information i.e. total bytes of RAM which you want to allocate to the system.
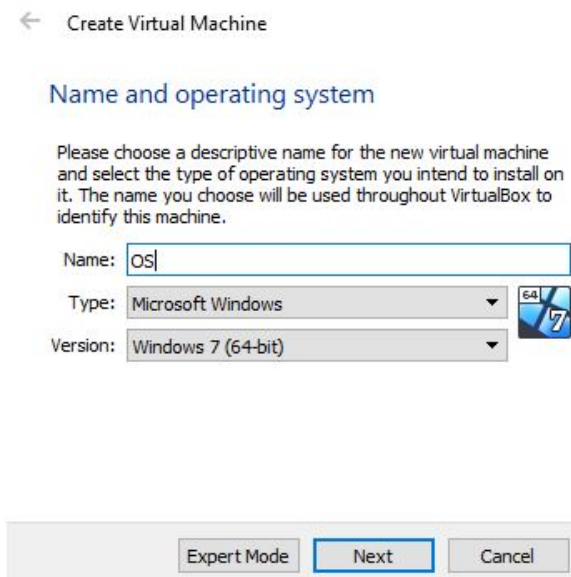
Fig 1. Name and Operating System   **Fig 2. Memory Size**

2. In the next step, you need to select the hard disk type where any of the three given options can be chosen based on the virtual hard disk you want.
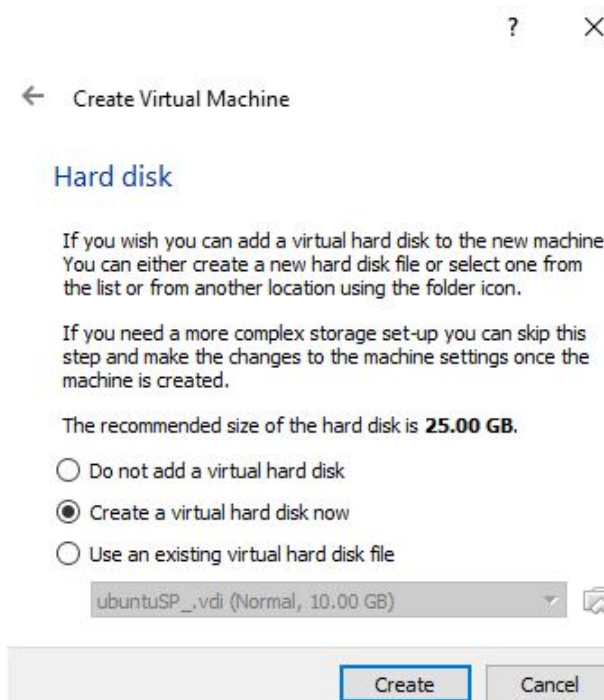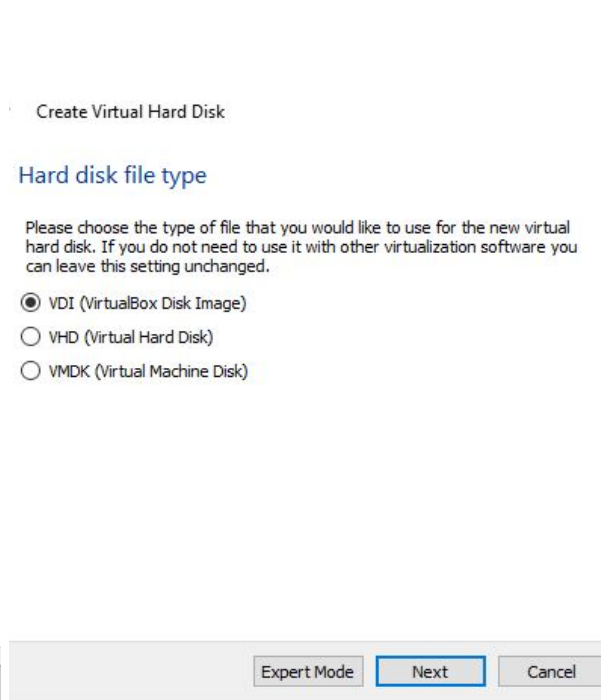
Fig 3. Hard disk   **Fig 4. Hard disk file type**

Since we want to build things from scratch we are not selecting the existing virtual hard disk and therefore, we want to create a new virtual hard disk now.

The hard disk type is where you need to choose whether you want vdi/vmdk/vhd as defined in the earlier section. On selecting the appropriate option, a virtual hard disk or image is created in the path.

3. Now, you will be asked to define the type of allocation i.e. fixed or dynamic and in most of the cases to avoid wastage of disk and to improve flexibility, the dynamic allocation option is widely implemented. The file size grows with the increase in data when the guest OS saves data on the virtual hard drive.

Fig 5. Storage on Physical hard disk

4. Once the allocation of virtual hard disk size is completed, enter the file path or if you want a new location where the file should be stored then browse it from the option. Now, select the size from the overall hard disk size available to you.

5. Click on the create button and start the virtual machine. On starting the virtual machine you will be notified that there is no optical disk selected and it will ask you to select one.
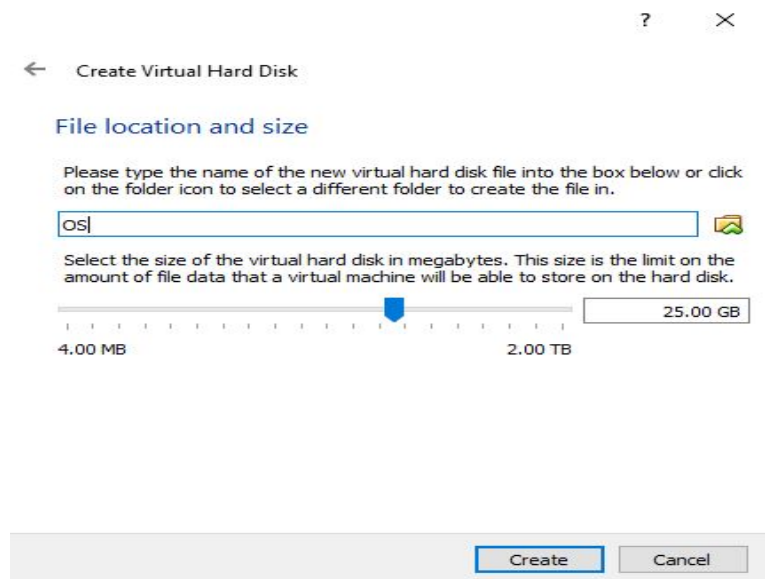

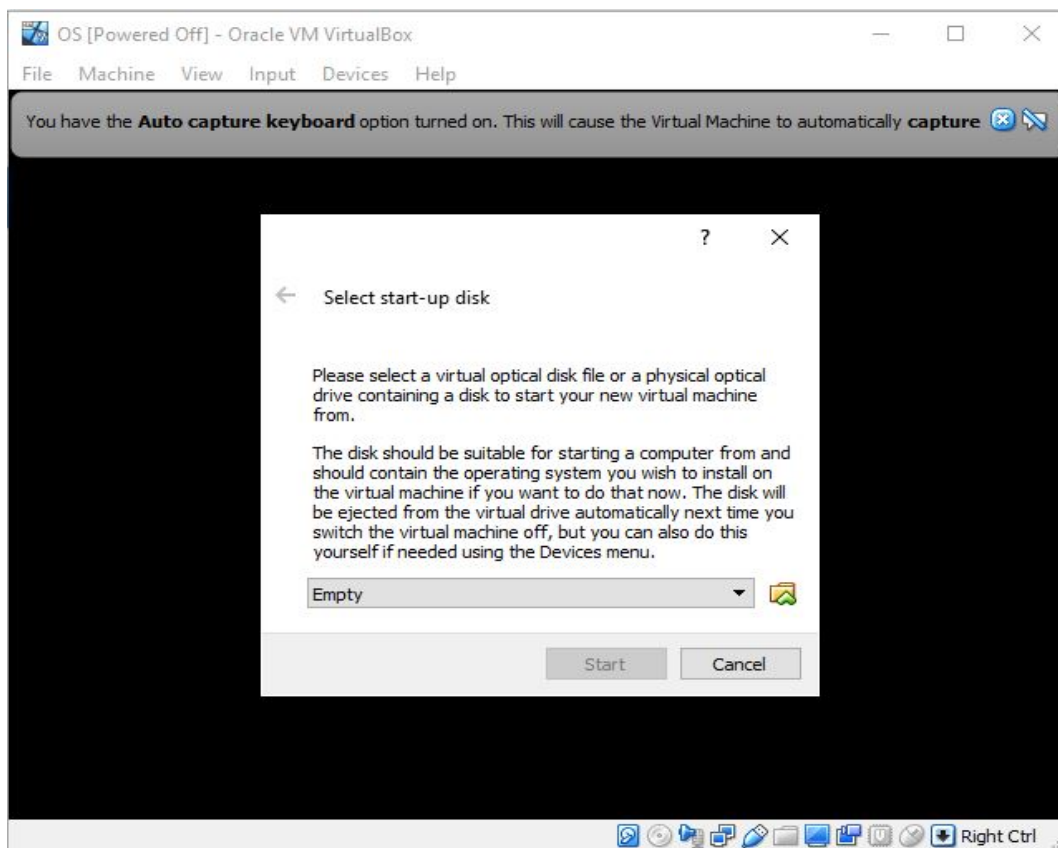**Fig 6. File Location and size**

Fig 7. Start-up disk empty

VM Setting Configuration

The VM settings of the created machine can be found by right clicking the VM or in the toolbar. It comprises all necessary configurations such as system, display, storage, audio, network, serial port, usb, shared folder and user interface settings.

1. In general settings, you need to provide the path where you want the clicked snapshot in your VM to be saved. It also asks you the clipboard sharing and drag and drop preferences from guest to host, host to guest or both.
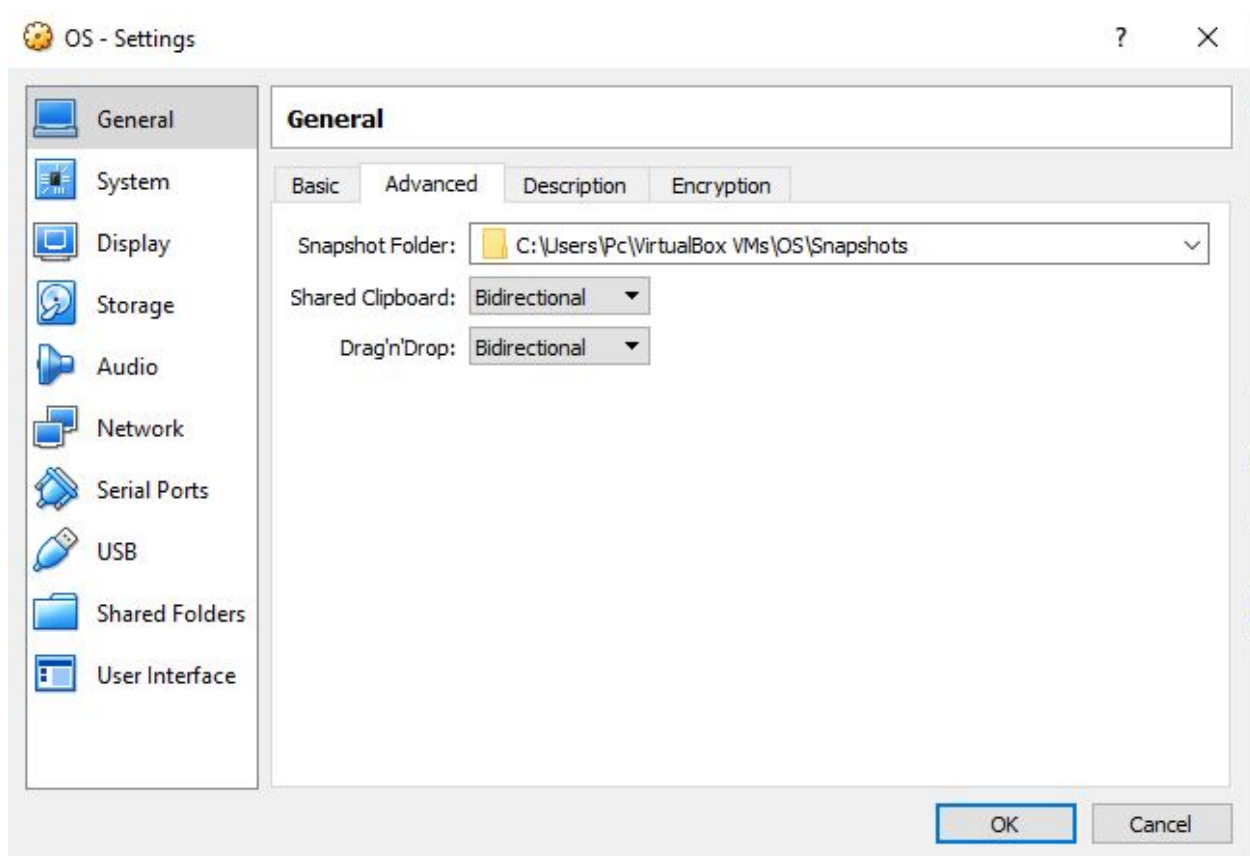
Fig 8. General Settings

2. There are three system components which need to be configured i.e. motherboard, processor and acceleration. In tab motherboard, the base memory is the RAM size which you have provided while creating the VM followed by the booting order and extended features which you can leave as it is until and unless you want to manipulate them.
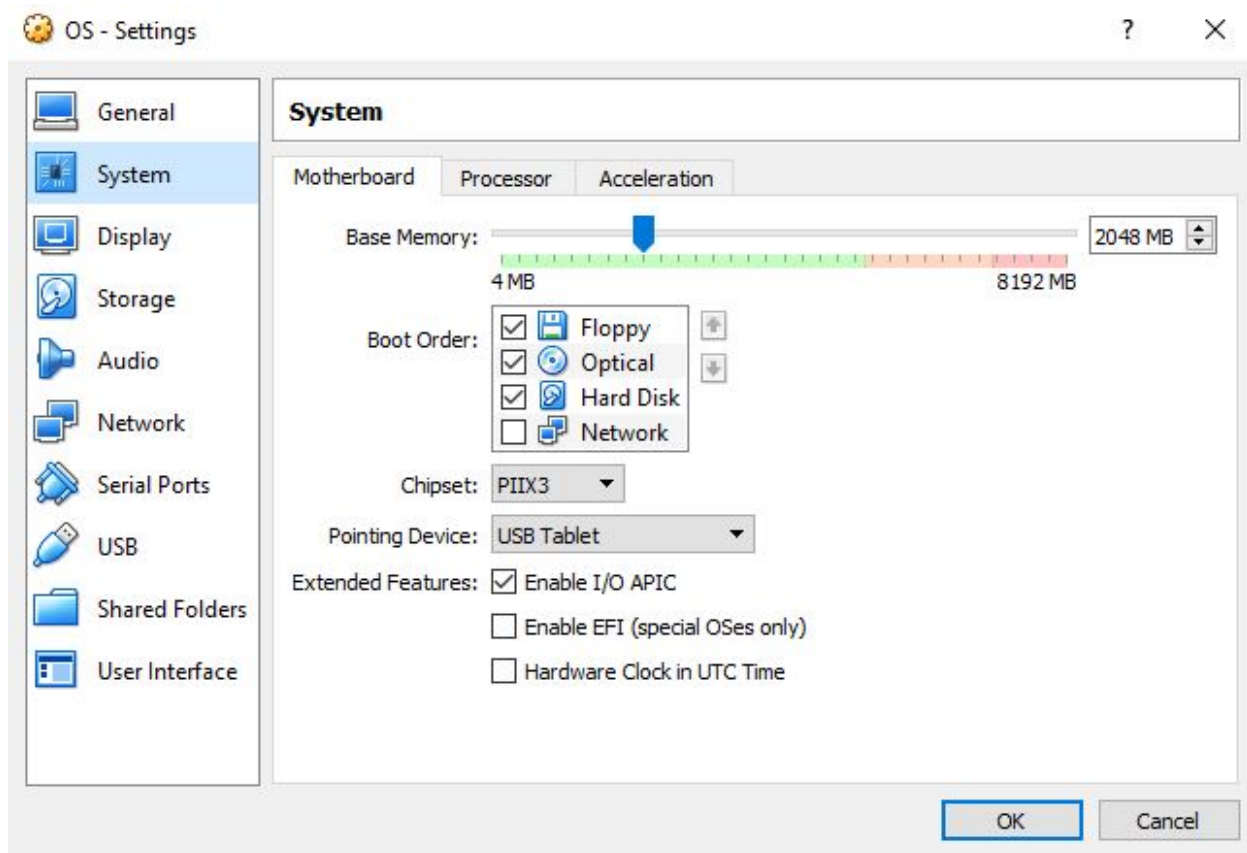
Fig 9. Motherboard settings

The next component is processor where you can select the number of processors which you want to allocate to your VM. These virtual CPU cores are only visible to the guest OS. Oracle VM VirtualBox can enable upto 32 cores to one VM and supports multiprocessing.

Note: Do not include virtual cores more than the available physical cores.

The execution cap is by default set to 100% which means host CPUs are fully involved in emulating Virtual CPU for the installed VM, you can change the percentage of execution cap according to the system performance. Another extended feature of enabling PAE (Physical Address Extension) states about assigning the PAE capability to virtual CPU from host CPU. For more information on PAE/NX you can visit this page https://www.virtualbox.org/manual/ch03.html#settings-processor .
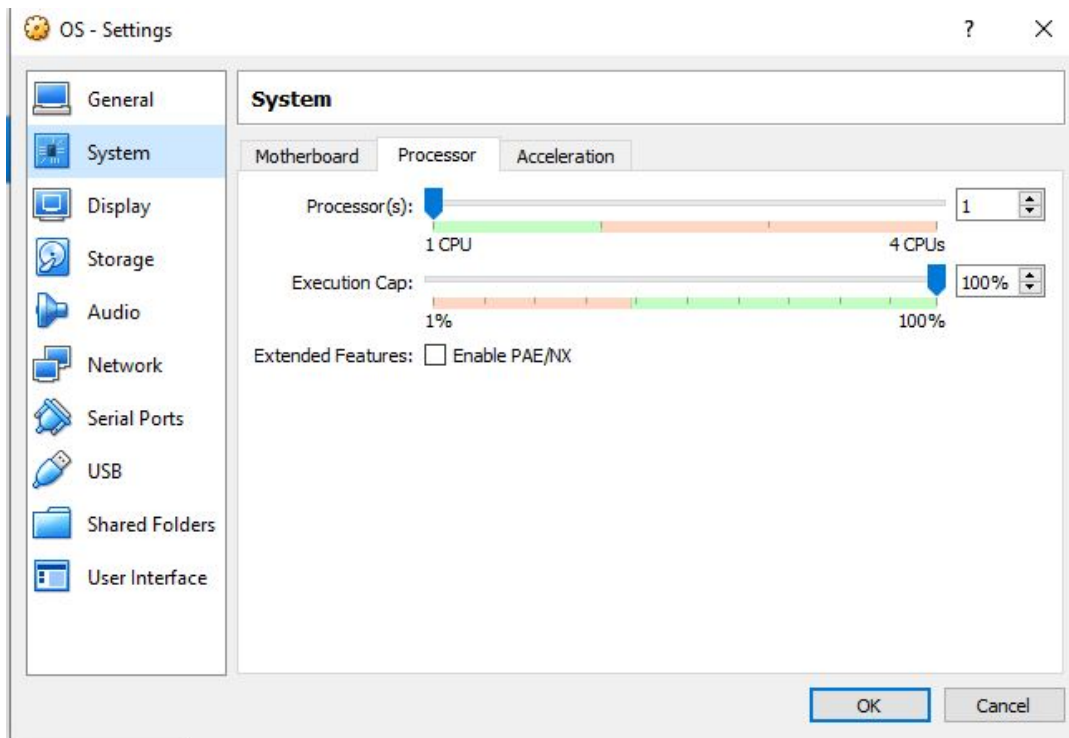
Fig 10. Processor Settings
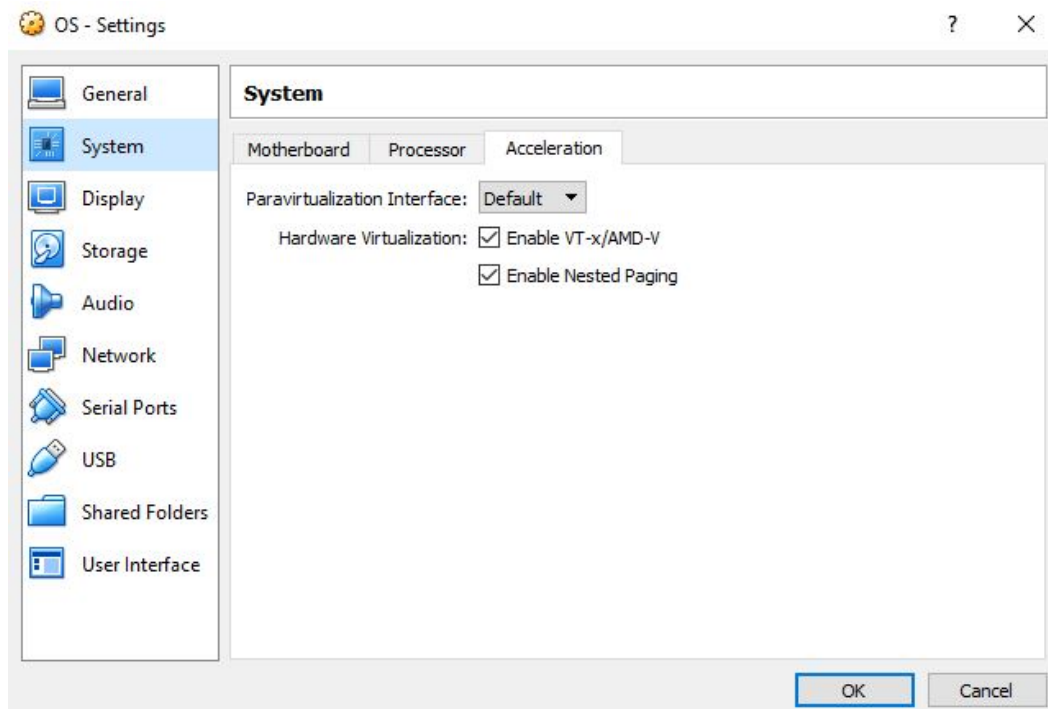
Fig 11. Acceleration Settings

The acceleration tab as shown in Fig 11. is where you initialize hardware virtualization capability to your VM. It comes with paravirtualization and hardware virtualization. The former is enabled when you want your guest OS performance to be efficient. However, the latter one is similar to enabling virtualization in your host OS system. Here, you can enable Intel virtualization or AMD virtualization based on the supported hardware types as well as there is another option for nested virtualization which enhances the system performance by using nested paging.

Display settings can be left unchanged if you do not want to manipulate the default settings of screen, remote and video capture. For this worksheet demonstration, the display settings are kept unchanged. Further, if you want to explore about the display configuration, check this link https://www.virtualbox.org/manual/ch03.html#settings-display.

Types of Hardware Controllers

Before moving on to the storage configuration we first need to understand about the different types of hardware controllers available in Oracle VM VirtualBox. As we know, hard disk or optical drives are connected to hardware controllers such as SATA, IDE, USB-based, SCSI etc. for performing data transfers and various other operations. Here, IDE also known as ATA is a backward compatible disk controller which when attached to a VM provides four virtual storage where 0th disk storage is by default set to CD/DVD ROM. The IDE controller in Oracle VM VirtualBox is always present for the new VM which may or may not support SATA or SCSI. The CD/DVD ROM is virtually attached to the available IDE ports while configuring the storage settings. Another hardware controller SATA is an advanced standard than IDE with higher speed support, less processor consumption and allows disk removal even when it is in running mode. The difference between IDE and SATA of Oracle VM VirtualBox is that IDE allows 3 virtual hard disks to be connected to a VM whereas SATA allows 30 virtual hard disks in a VM.

One of the industry standard interfaces, Small Computer System Interface(SCSI) is removed from the commodity hardware but is still practiced in servers and high performance systems whereas USB-based mass storage means connecting external devices to the system which is being supported by almost all OSes. You can learn more about other hardware controllers supported by Oracle VM VirtualBox https://www.virtualbox.org/manual/ch05.html#harddiskcontrollers .
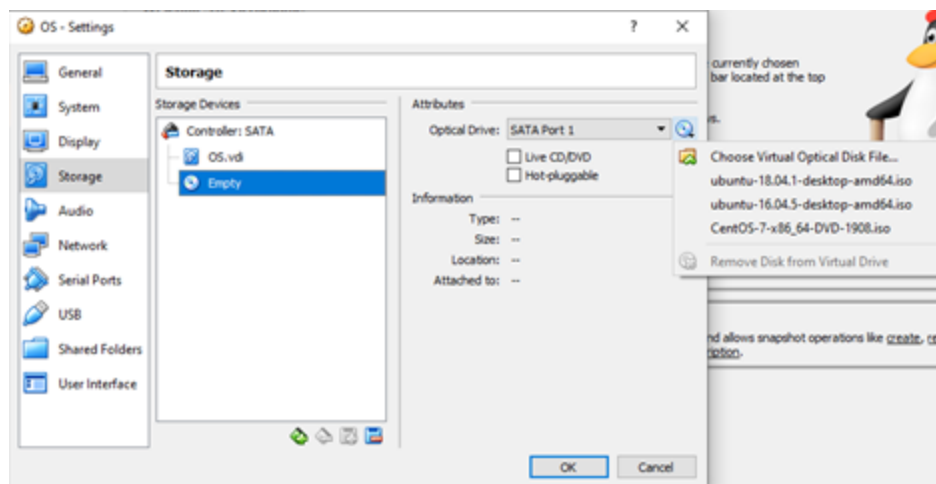
Storage Configuration

Storage configuration is an important part while creating the VM otherwise you won't be able to start-up the system due to unavailability of virtual disk. For configuring the storage, first you need to select the vdi image which you have created in the starting of VM creation.
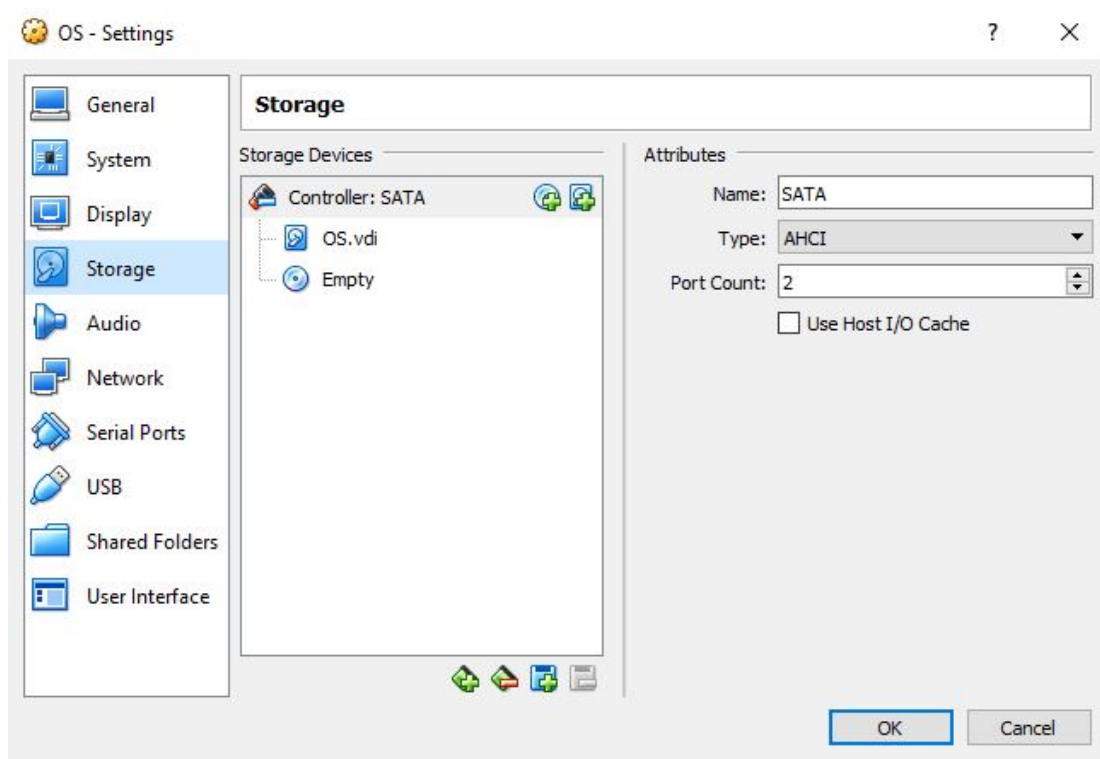
Fig 12. SATA Controller configuration

Once the appropriate vdi image is selected, browse the optical drive from where you want to add the iso image of the operating system such as Fig 13 where under the attribute section on browsing optical drives different available iso images are available for installation.

Fig 13. Virtual Optical Disk Files available for installation
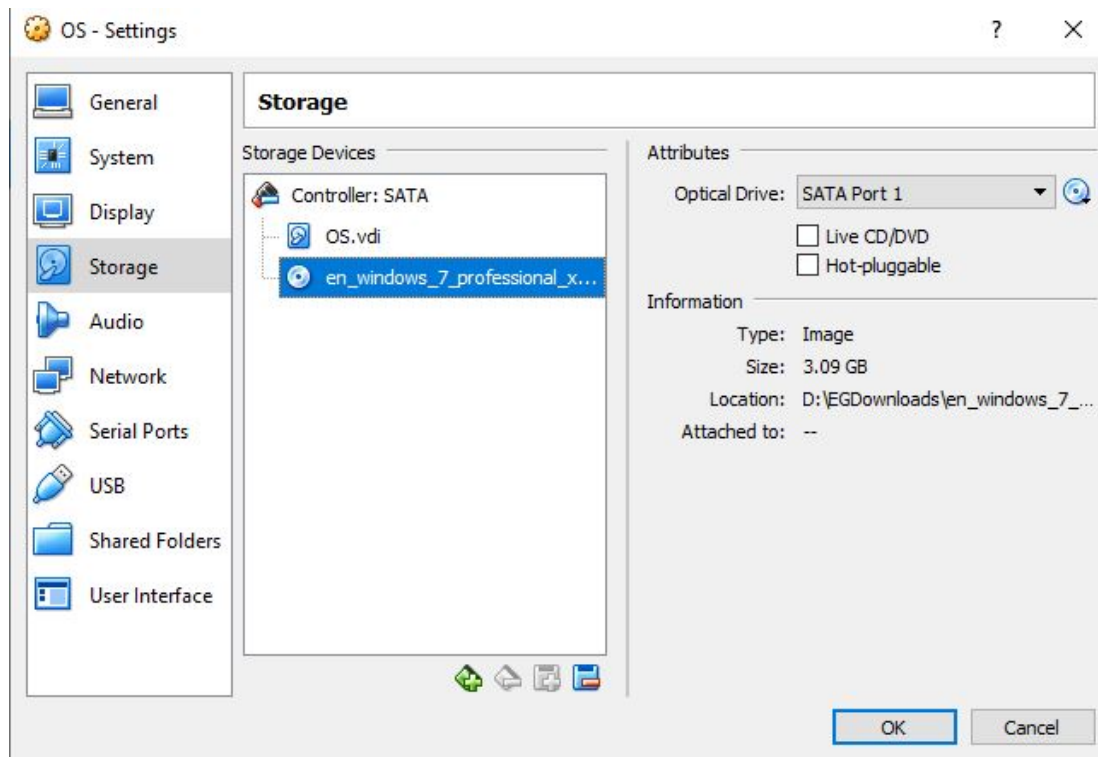
Fig 14. Storage Configuration

After iso image selection, the information of the selected file can be seen as given in above figure. Here, Microsoft Windows 7 professional iso file is chosen to be installed which is of 3.09GB size.

Network Configuration

The network configurations are by default set to NAT (Network Address Translation) when you install the virtual machine. The NAT configuration lets the user use the host's networking for interacting publically and allows connection of services.

Oracle VM VirtualBox supports multiple network cards per machine from which 4 cards can be configured easily from the GUI interface and all 8 PCI Ethernet cards can be configured by *VBoxManage modifyvm*.

Network card available for virtualization are as follows:

● *AMD PCNet PCI II (Am79C970A)*

● *AMD PCNet FAST III (Am79C973), supports all OS, GNU GRUB boot manager and is default setting.*

● *Intel PRO/1000 MT Desktop (82540EM)- Windows Vista and later versions.*

- *Intel PRO/1000 T Server (82543GC)- Windows XP*

- *Intel PRO/1000 MT Server (82545EM) – OVF imports*

- *Paravirtualized network adapter (virtio-net) – Disables Emulation of Network Hardware, requires software interface by guest and improves performance.*

Oracle VM VirtualBox network settings gives four network adapters which can be configured based on the network interfaces you want to add for your VM. As already mentioned above, NAT is the default setting due to the easy external network.
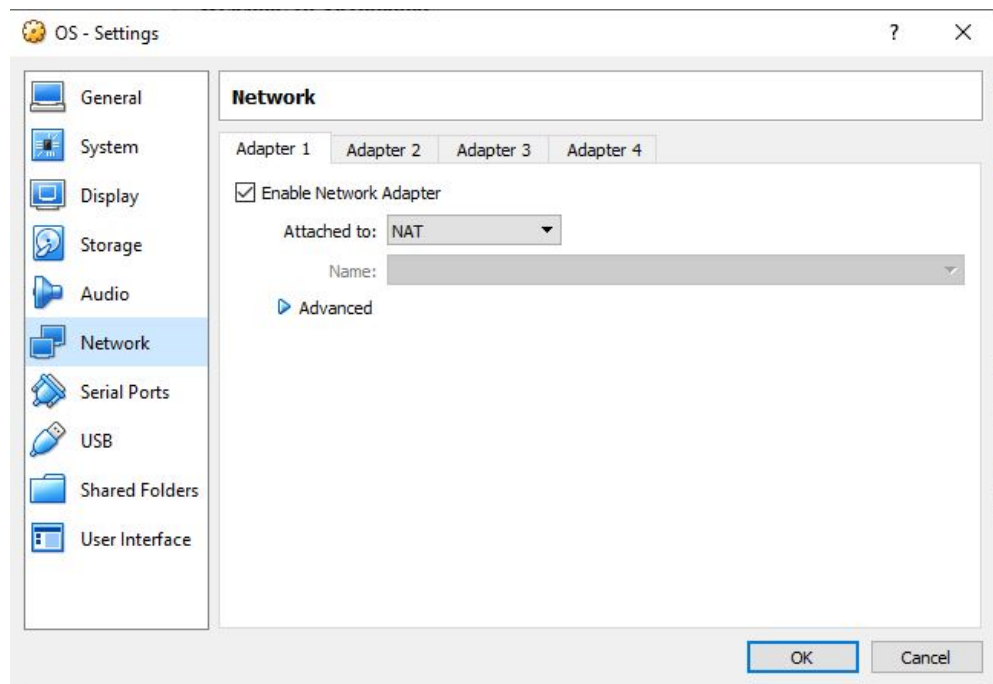
Fig 15. Network Adapter Settings

Since NAT configuration in Oracle VM VirtualBox does not require any configuration on host and/or guest OS, it is the best choice if you just want to explore the internet or file downloading work. Enabling NAT utilizes the networking engine as a router between VM and the host and behaves like a physical system for accessing internet via router. There are seven network interface card attachments, where if you want to detach the virtual ethernet card then you can directly change the attached to option to Not Attached where no network connection is available as no available card is attached. The functionality of other adapters are defined below:

- **NAT Network.** It is an internal network for allowing outbound connections.

- **Bridged networking.** Used for network simulations and servers running inside the guest OS. It creates a bridge for network connection directly with the installed card.

- **Internal networking.** It is a software-based networking which connects only VM's and is not visible to host OS applications.

- **Host-only networking.** A virtual network interface card is utilized rather than a physical card to provide connectivity between host and VM's.

- **Generic networking.** Rarely used modes which share the same generic network interface, by allowing the user to select a driver which can be included with Oracle VM VirtualBox or be distributed in an extension pack.

The below given figures depicts the various options available on selecting a particular network adapter. Here, Fig 16. shows the above explained adapter types provided by Oracle VM VirtualBox and Fig 17. displays the available cards name available for attachment.
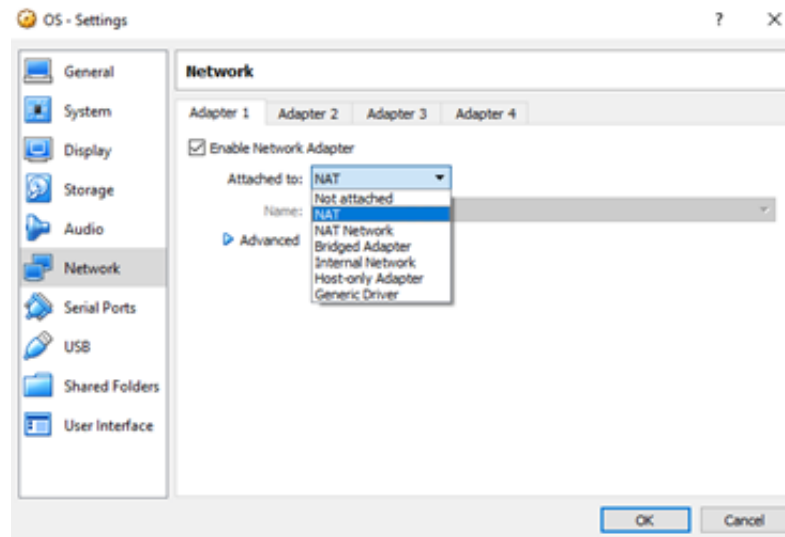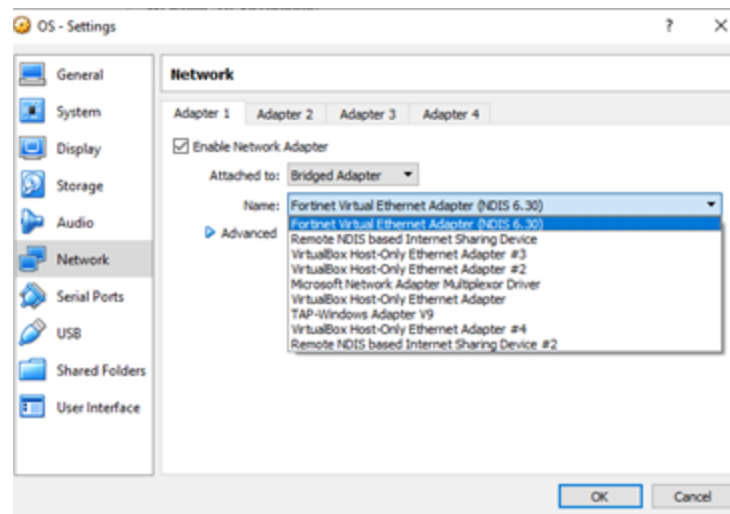

Fig 16. Network Adapter Modes

Fig 17. Available Network Attachments

For understanding the concepts of these networking modes in depth, yo can visit https://www.virtualbox.org/manual/ch03.html#settings-network.

Another concept in VM settings is Serial Port configuration where virtual serial ports are allocated to the machines for accessing modems or UART devices. When serial port configuration is turned on, the COM port works as a UART pin and allows the compatible connections.

VBoxManage   modifyvm command can be used to explore   types   of   UART configurations.   The   port number,   port   mode   and path/address are kept as it is for this worksheet.

These   are   few   of   the   Port number which you can check while creating your own VM COM1: I/O base 0x3F8, IRQ 4, COM2: I/O base 0x2F8, IRQ 3, COM3: I/O base 0x3E8, IRQ 4, COM4: I/O base 0x2E8, IRQ 3.
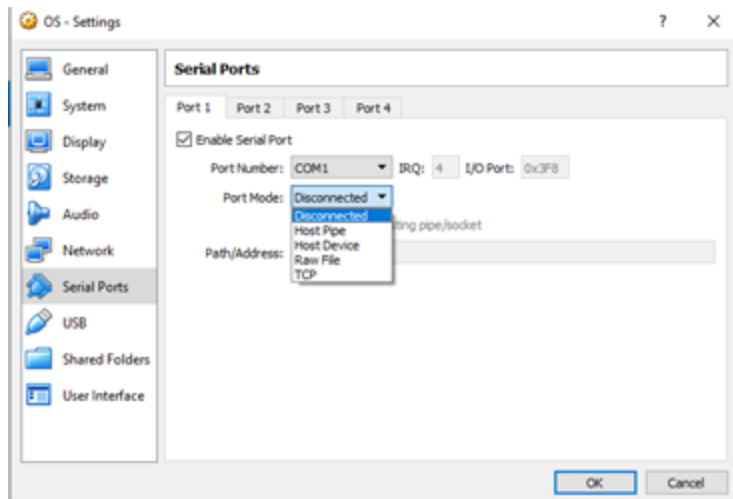
Fig 18. Serial Port Configuration

The IRQ refers to the interrupt code for each defined COM port. Additionally, you can create your own COM port i.e. user-defined serial port. And the various port modes can then be made use of https://www.virtualbox.org/manual/ch03.html#serialports.

External I/O Configuration

External I/O configuration is where you allow external devices to interact with your VM like an original or physical machine. For accessing USB devices, Oracle VM VirtualBox comes with Virtual USB Controller. The USB connected to the guest cannot be accessed by the host at the same time as the guest is in active mode. Further, to use the USB device on the host, first disconnect the USB from the guest OS.

Additionally, the guest OS can also access remote USB devices by using VirtualBox Remote Desktop Extension.

To enable USB for a VM, select the Enable USB Controller check box. The following settings are available:

- OHCI for USB 1.1

- EHCI for USB 2.0. This also enables OHCI (Part of Extension Pack).

- xHCI for USB 3.0. This supports all USB speeds (Part of Extension Pack)

Fig. shows the selected USB
controller which can get access
to the VM. Since the USB
drive/Flash drive which is used
in this work is USB 2.0 (EHCI).
Therefore, when you click on
add USB device, you will get all
available USB 2.0 devices such
as SanDisk Cruzer Blade (0100).

Oracle VM VirtualBox also
provides USB Device Filters
from where you can create filters
to directly fetch your required
preferences.
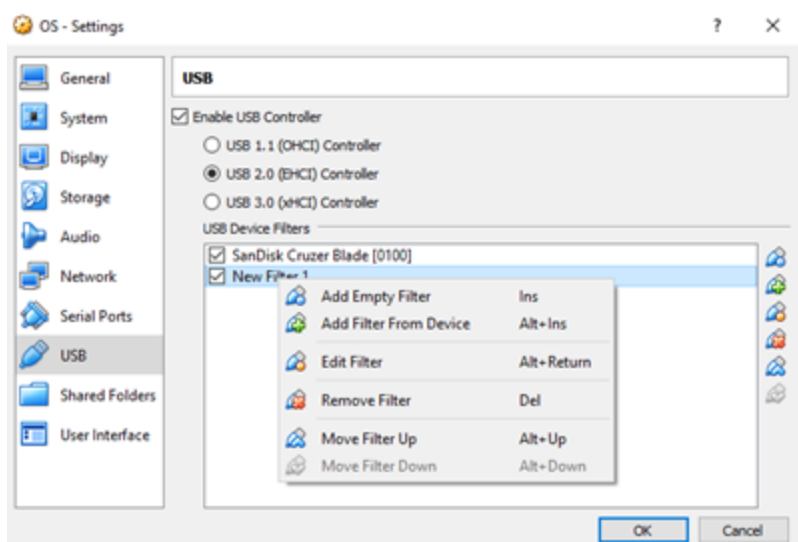
Fig 19. USB Controller Configuration

The filter can be created through vendor ID and product ID which can be listed through the
command VBoxManage list usbhost, this command will return the information about all the
connected USB devices with their vendor ID, product ID and serial number.

An external device can also be accessed remotely by VirtualBox Remote Display Protocol(VRDP)
extension pack. To utilize VRDP protocol you can go through the link
https://www.virtualbox.org/manual/ch03.html#usb-support.

Shared Folder

As the name suggests,
it allows sharing of
folders from host OS to
guest OS. The shared
folder is mounted on
VM by the given path
and originally the folder
remains in host. To
access the folder on
guest OS we just need
to use the given share
name.
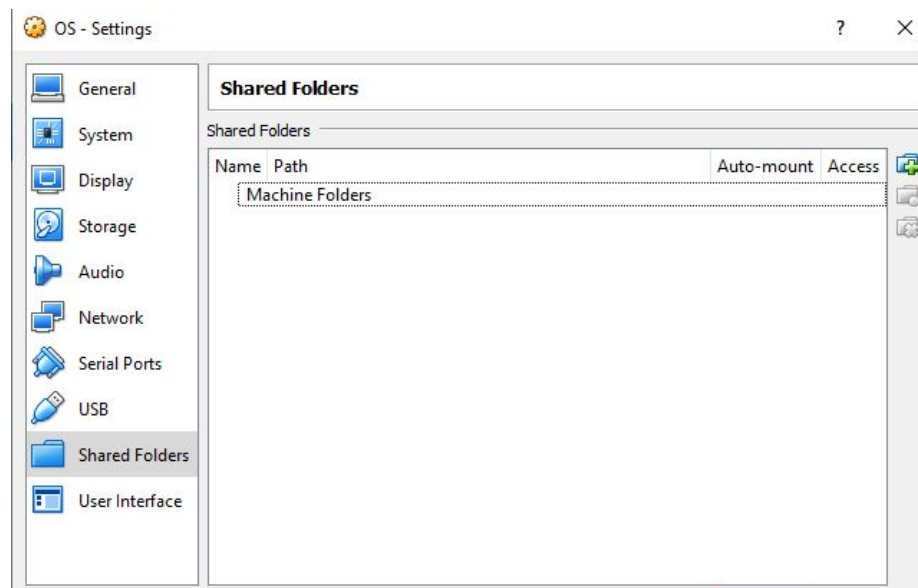
Fig 19. Shared Folders

To add more shared folders through the command line, you can use the VBoxManage sharedfolder command. In Fig 20 the path of the folder which needs to be shared is entered i.e. "C:\Users\Pc\PyCharmCE2018.3", which is a PyCharm project folder from the host OS. The option auto-mount is selected so as to automatically mount the folder in VM and it can be accessed with the folder name ".PyCharmCE2018.3".
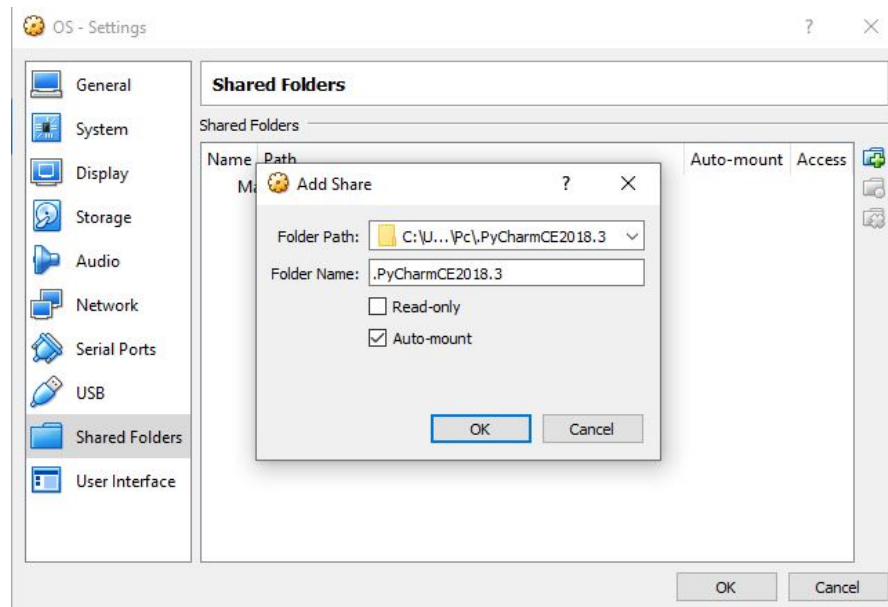

Fig 20. Adding folder path for sharing it to the Guest OS.
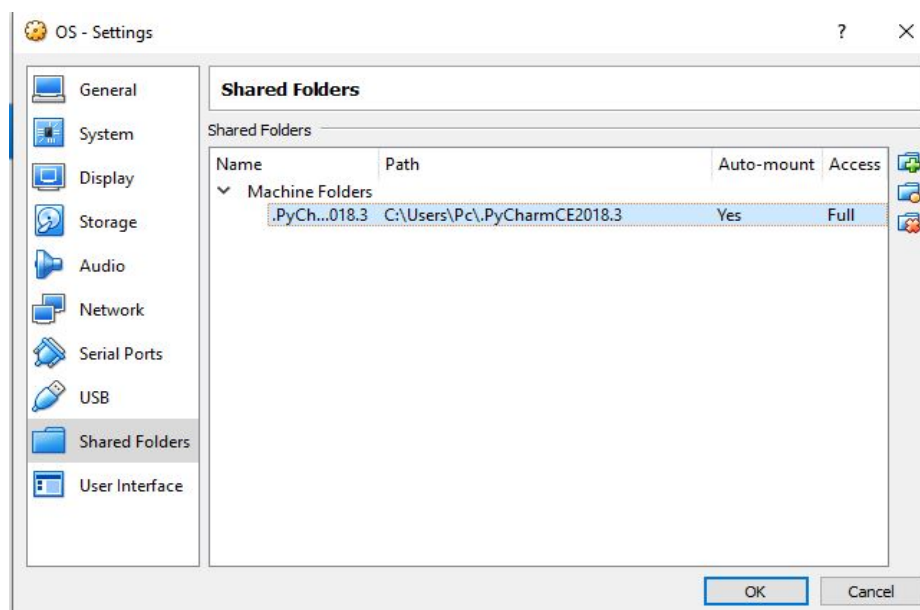
Fig 21. Shared Folder

On successful addition of the host folder in the shared folder of the created VM, you can see the name and folder path with access permissions in the shared folder list. The Fig 21 displays the added shared folder which can also be removed from the list by clicking on the remove icon given at the right side of the window.

For better user experience, you can change the user-interface settings where you can manage files, devices, various debugging options, input devices, different viewing options etc. For this worksheet the user interface settings are kept the same as default.
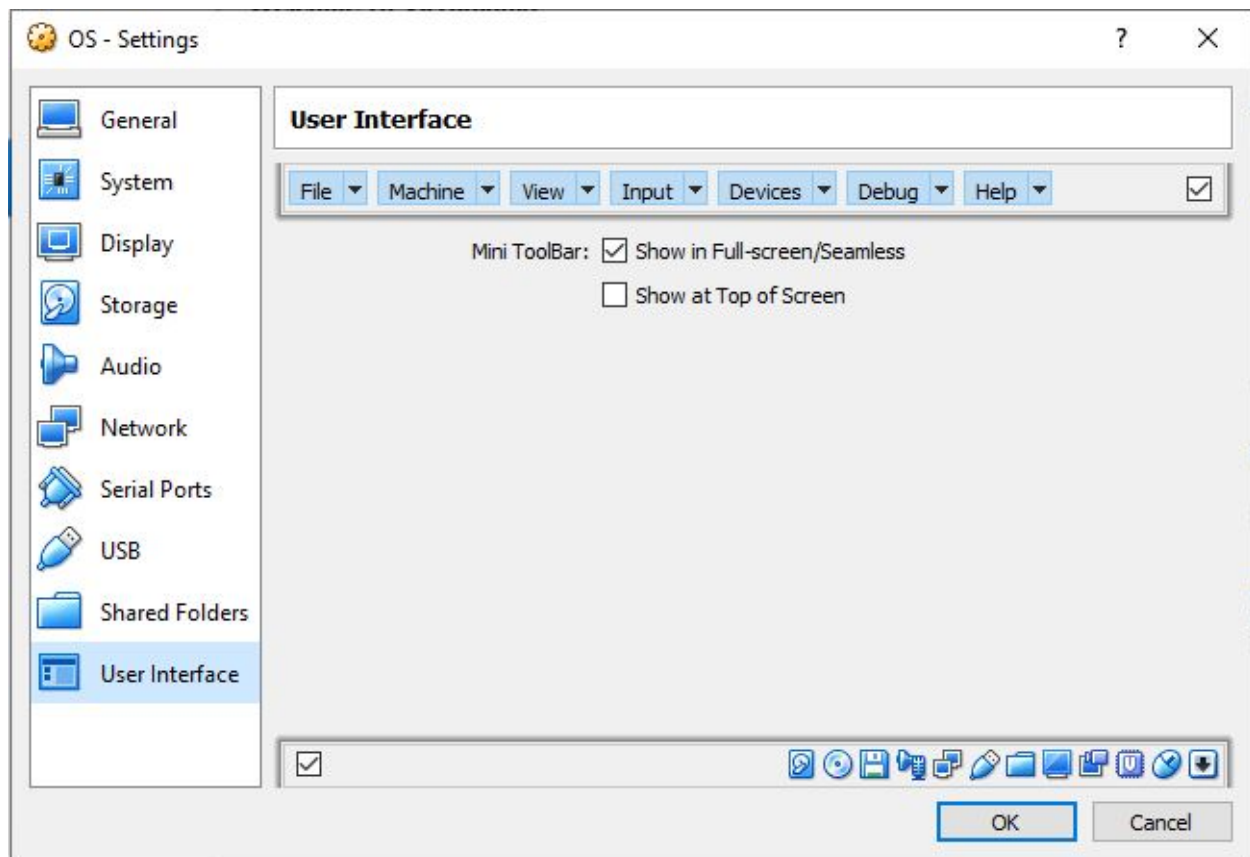
Fig 22. User Interface Settings

You can now launch the created VM by clicking on the start icon or you can just right click on the created VM. On starting the VM, the selected OS will ask you for installation the way we do on a physical system. The below given figures are the installation screenshots of Microsoft Windows 7 professional on Oracle VM VirtualBox. After succesful installation, the Virtual Machine Manager allows us three ways of machine termination i.e. save the machine state, or power off the

17

machine or send the shutdown signal. Here, the Fig illustrates the power off termination.
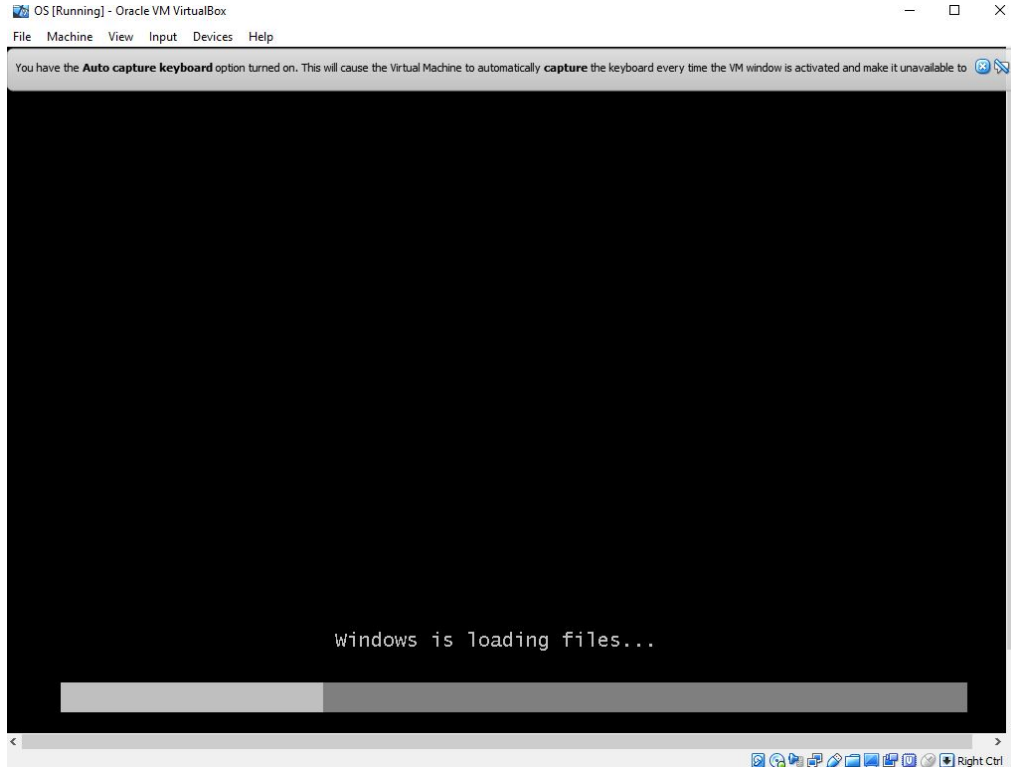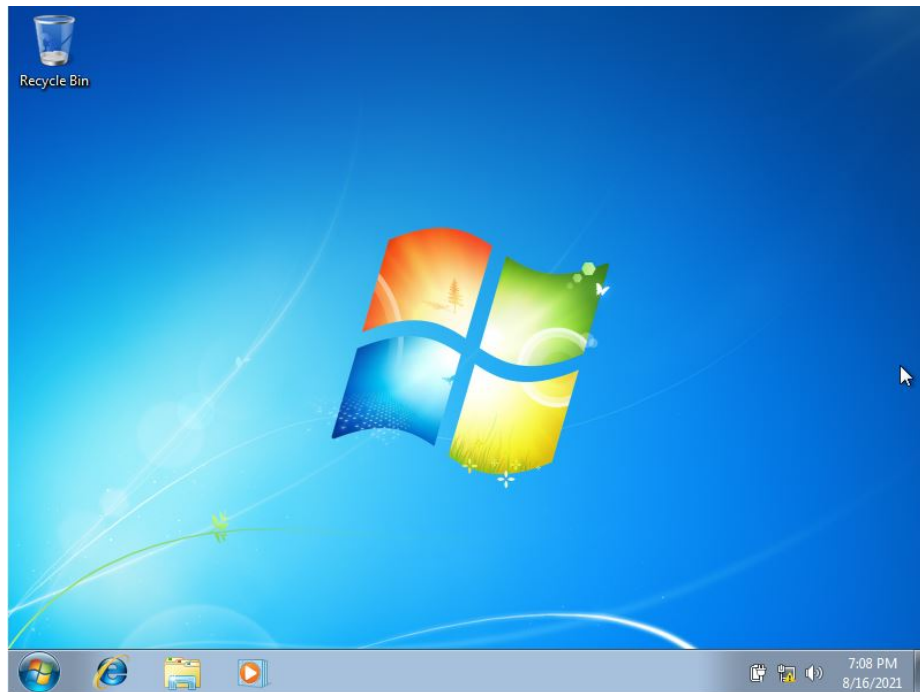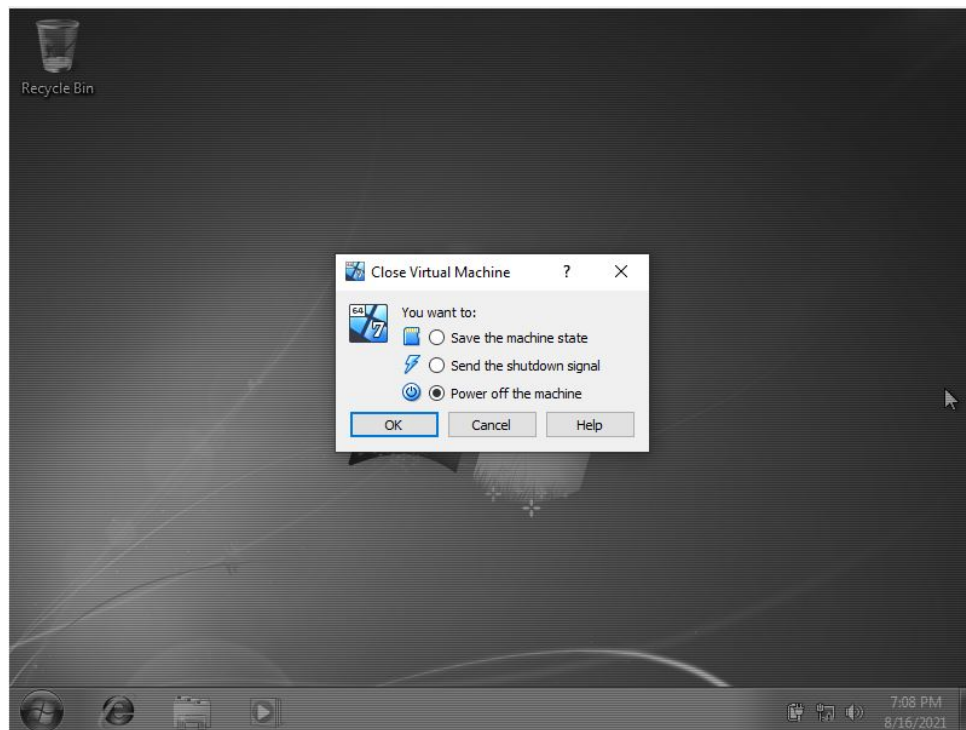

Fig 23. Starting the Virtual Machine

Fig 24. Installing Windows 7 Professional

Fig 25. Installed OS

Fig 26. Closing Virtual Machine

Network Virtualization

In network virtualization, the main network mode which will be focused is Host-Only Networking which can be considered as a hybrid network between two modes bridged networking and internal networking. In case of bridged networking, all the virtual machines and host can interact with eachother whereas in internal networking the virtual machines are not allowed to interact with external network due to the absence of physical networking interface.

The host-only networking mode is the one where a software network interface is created by clicking global tools where you can find Host Network Manager. This interface is similar to the physical interfaces which is a loopback interface. This mode also restricts the traffic as part of internal networking mode. Since host-only networking mode provides both the feaures through virtual ethernet interface, it helps in easy network virtualization.

Fig 27. Virtual Ethernet Adapter Configuration

You can create and remove the virtual host only ethernet adapter from the toolbar as given in Fig 27. Another important concept with software interface is to configure it i.e. you can either configure the adapter manually or can enable DHCP settings.

Fig 28. DHCP Server configuration for Virtual Ethernet Adapter

The above given illustrates the DHCP settings for the created virtual interface where all the necessary details of address, server mask, lower and upper address bounds are automatically assigned.

In this way, network virtualization can be created and for further details you can always refer to https://www.virtualbox.org/manual/ch06.html.