

Using GNS3 and VirtualBox

Virtualize Network Test-Labs

Tashi Wangchuk

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*Dedicated to students
and
my small family*

Acknowledgement

Firstly I would like to sincerely thank all my past and present students of both Computer Hardware and Networking as well as Computer System and Network of Jigme Namgyel Engineering College (Royal University of Bhutan). It was with you all that I have learned so much and I am writing now.

I don't want to forget my colleagues for being one of the encouraging factors to go on with the idea of coming up with a book and of course my small family for bearing with my share of problems and hassles too.

My immense gratitude goes out to Kezang Wangmo for being very supportive in my endeavor of writing and also for designing this Book's cover in a very special way, the way I liked and wished for.

Finally to all the students who have bought a copy of this book and I look forward to getting valuable feedback and suggestions for improving the future editions.

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Chapter 1

Install and Configure GNS3

The best way to practice and learn Network Services Administration without having to buy any hardware is by building a Virtual Lab. An open source software, GNS3 can be used for building a Virtual Lab which we can download and use for free. Today, GNS3 is used by thousands of network engineers worldwide to emulate, configure, test and troubleshoot networks. It allows running a small topology consisting of a few devices on your laptop or desktop. In this chapter, we will learn to install and configure the GNS3, and also add the IOS images.

Emulation and Simulation

The GNS3 emulates the hardware of a device and run the actual images on the virtual device. We can use the IOS of a real, physical Cisco router and run that on a virtual, emulated Cisco router in GNS3 and simulate the features and functionality of a device such as a router.

Downloading GNS3

The GNS3 software can be obtained from the official website of the GNS3. However, before we get to download, we have to signup if we don't have an account or login if we already have an account created. Follow the link <https://www.gns3.com/> and download the software appropriate for your Operating System.

At the time of this writing, GNS3 Version 2.1.5 (for Windows) was released, however, it appeared to be behaving in an unexplainable way and instead Version 2.0.0a3 is used in this book. You can continue to use the latest GNS3 Version or the one used in this book as most of the basic features and functionalities remain similar.

The following screen would be shown for downloading in the GNS3 official download page. The download is available for Mac and Linux

as well but in this book, the platform used is Windows. However, you can choose to use either Linux, Mac or Windows, depending on the convenience.

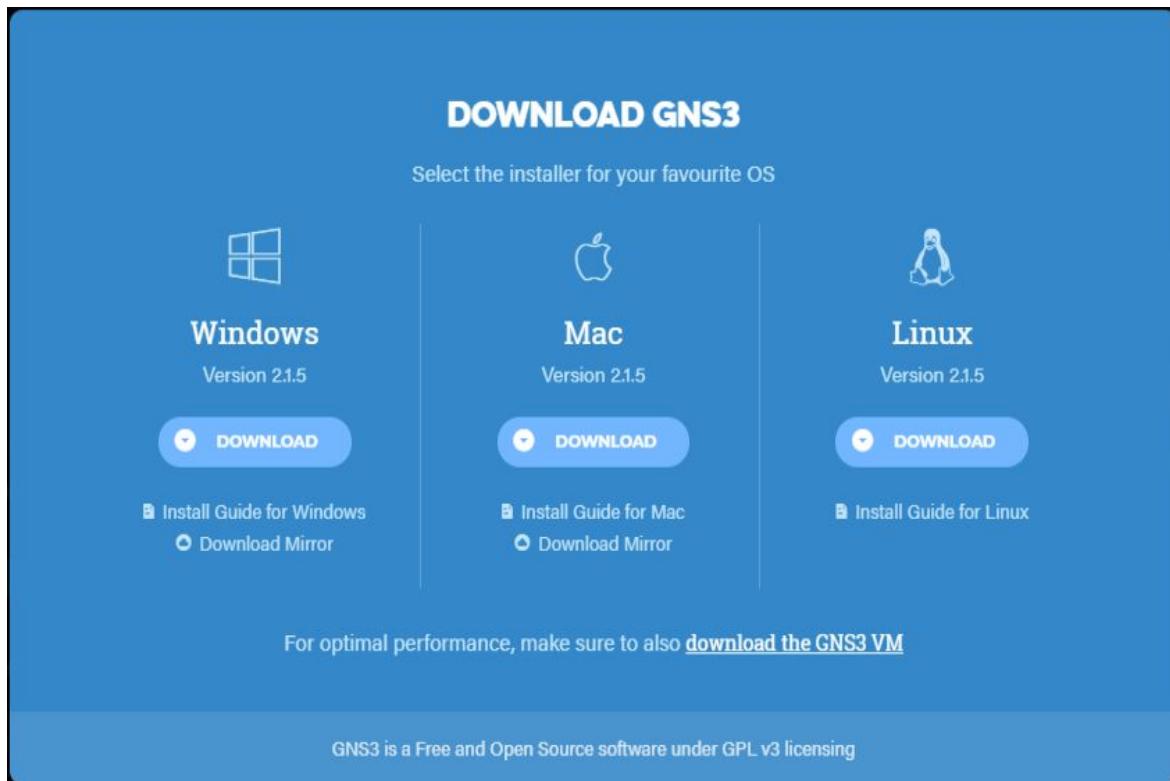


Figure 1.1: GNS3 Download Options

Installing the GNS3

After the download is complete, run the software as administrator and then the GNS3 setup will begin. Click the “Next” button.



Figure 1.2: GNS3 Setup Welcome Screen

In the next screen, choose “I Agree” for the License agreement to proceed with the installation.

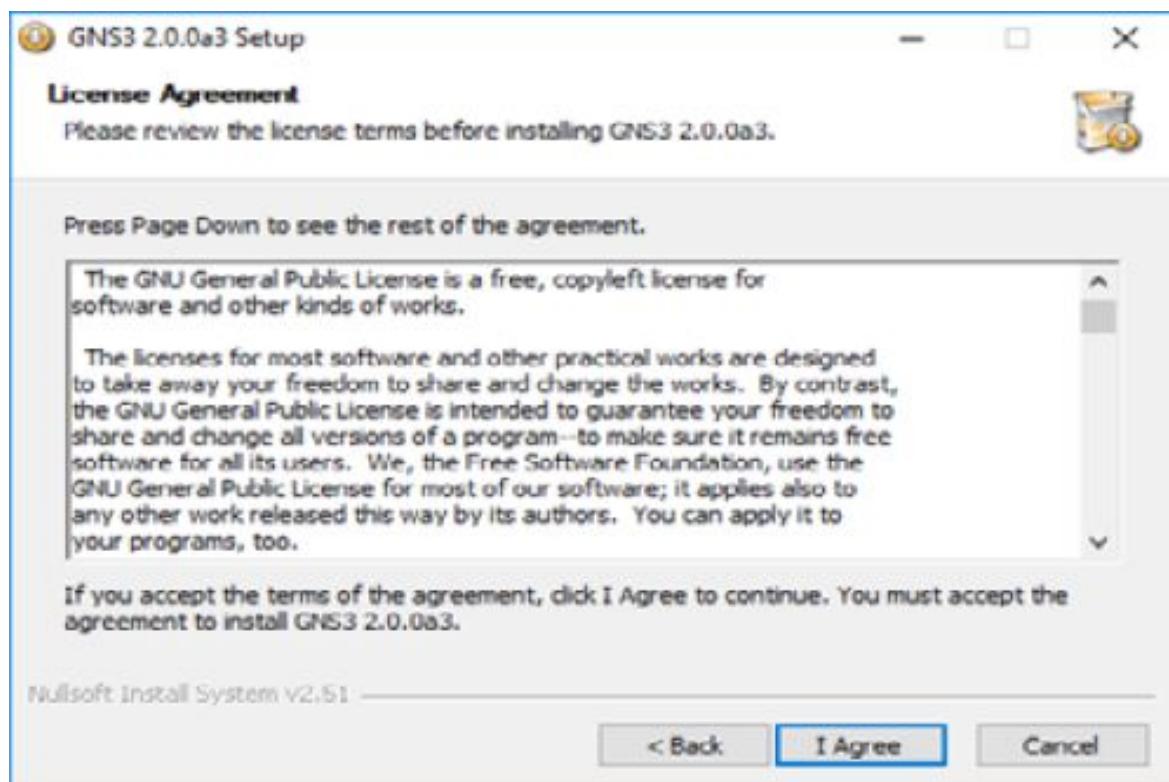


Figure 1.3: License Agreement Screen

Allow GNS3 to create a “Start Menu” folder with the default name GNS3 by clicking the “Next” button.

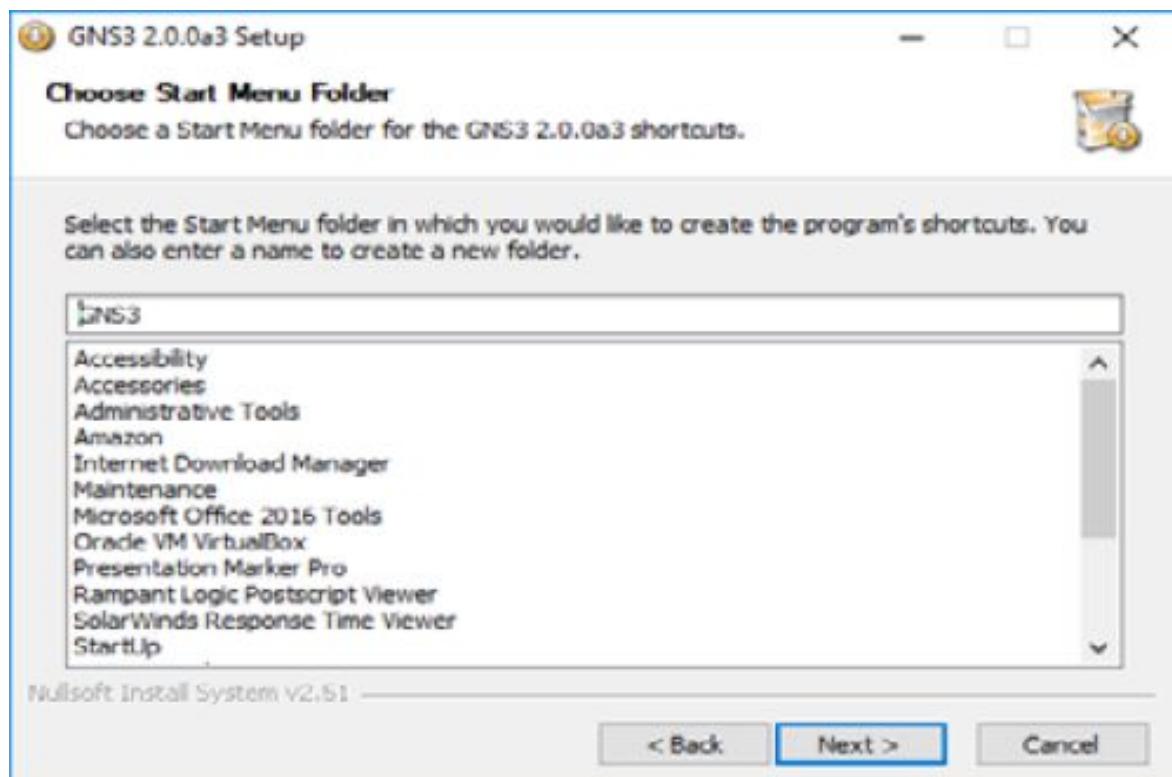


Figure 1.4: Startup Menu Folder Selection

The GNS3 software depends on several other programs to function. These dependencies along with GNS3 are all chosen by default for installation, if not choose all and click the “Next” button to continue.

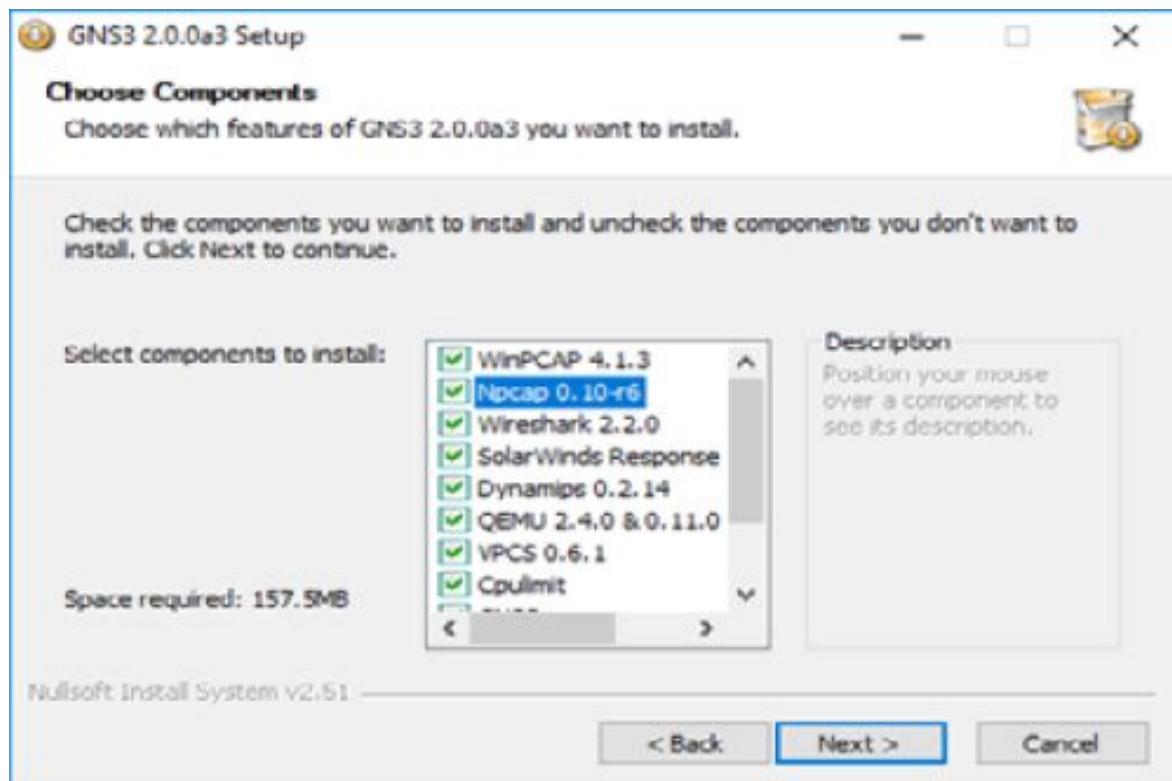


Figure 1.5: GNS3 Component selection for installation

A default location is chosen for GNS3. Click the “Install” button to accept the default location and to begin the actual installation of files.

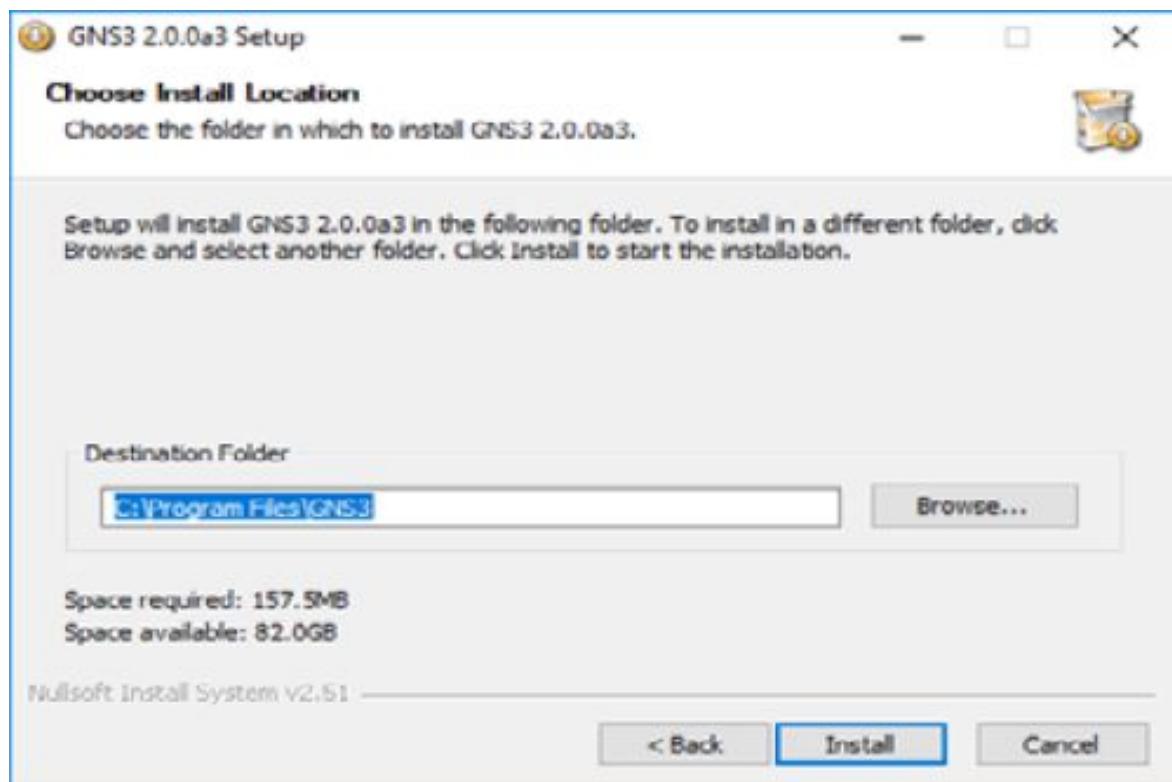


Figure 1.6: Choosing the installation location

Click “Next” to proceed with the installation and then the installation would be complete.

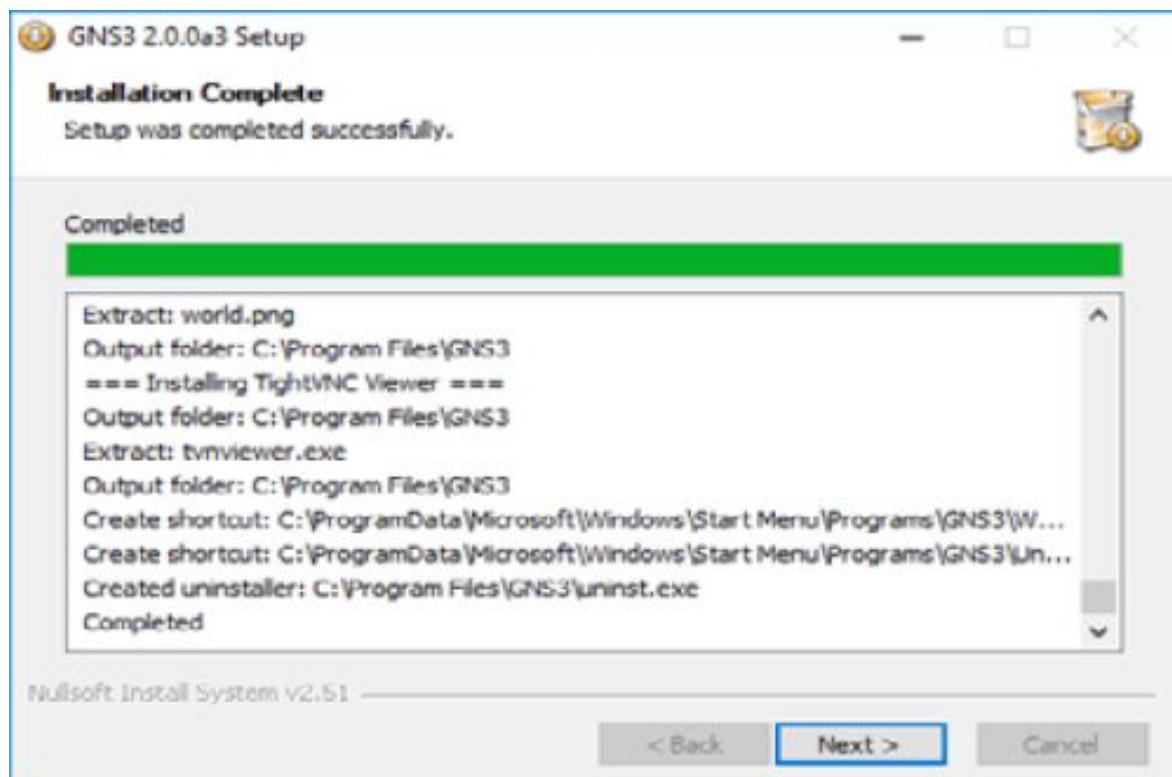


Figure 1.7: Installation Complete Screen

Choose “No” and then click “Next”.

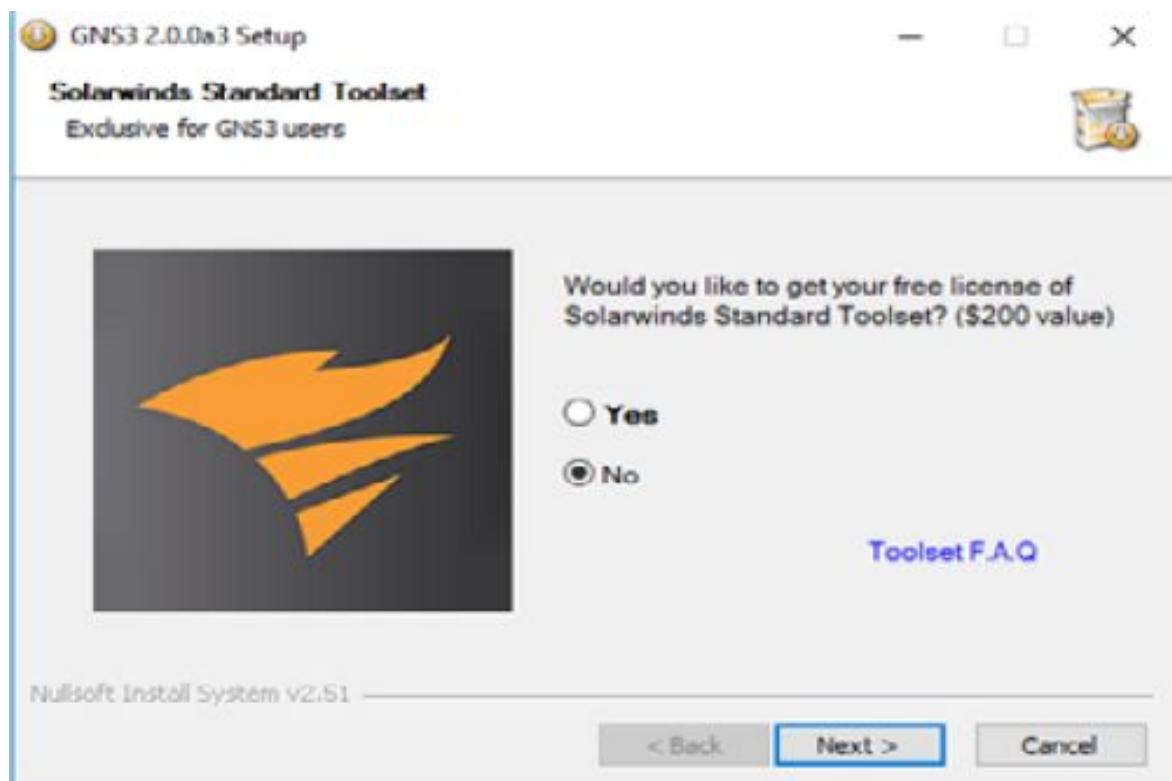


Figure 1.8: Solarwinds Standard Toolset Option

Click “Finish” and complete the GNS3 installation.

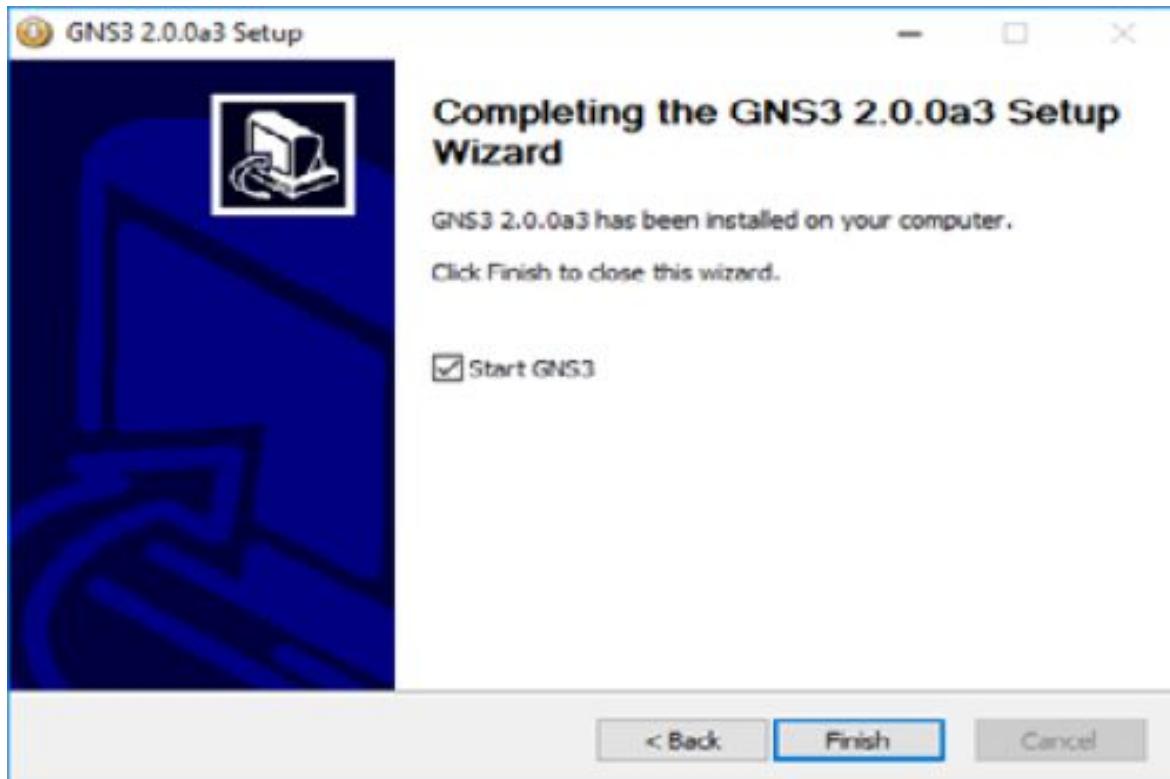


Figure 1.9: GNS3 setup Complete Screen

Configuring GNS3

Immediately after the installation is complete, you will be shown the following screen. Choose “Run only legacy IOS on my computer” and then click “Next”.

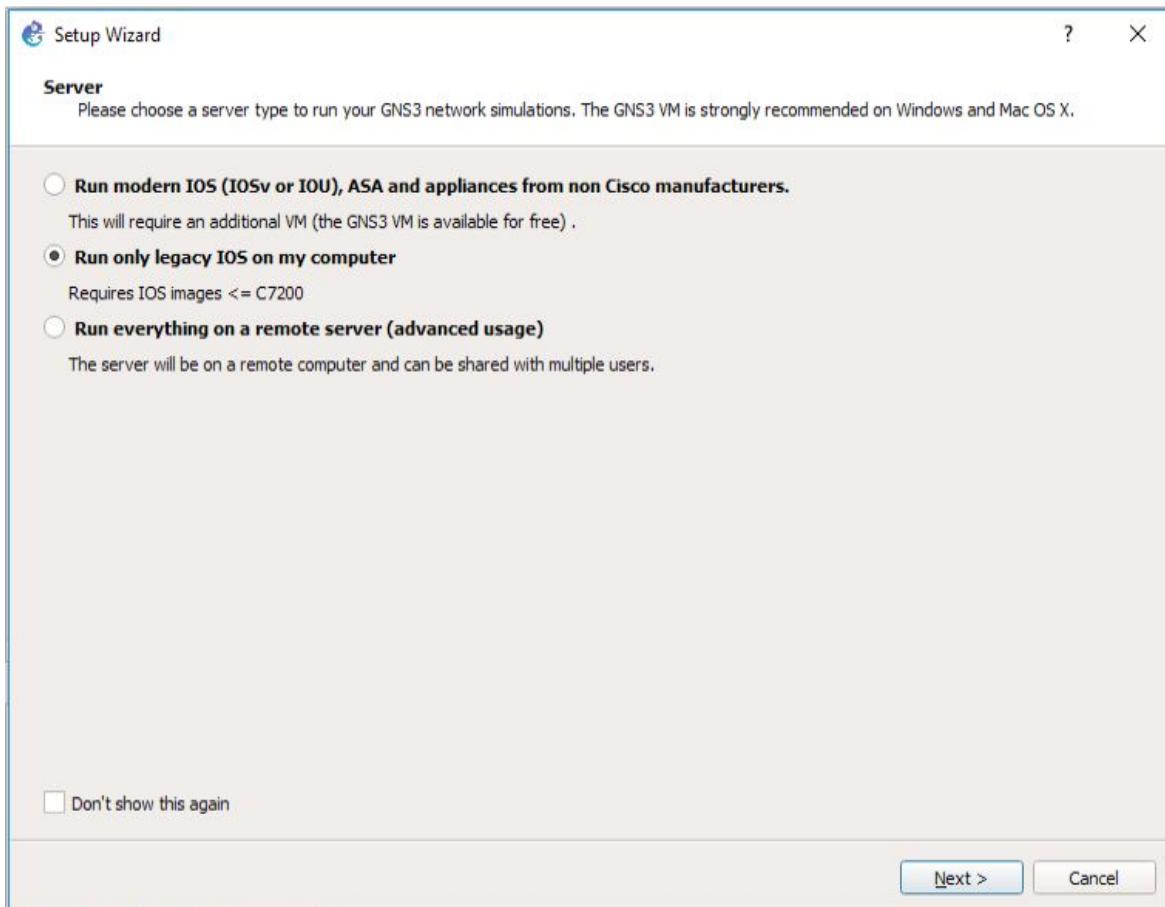


Figure 1.10: Choosing GNS3 Server Type

In the options shown, keep the “Server path” and “Port” to defaults, set the “Host binding” to 127.0.0.1 in case if it is set to something different. Click “Next” and proceed with the configuration.

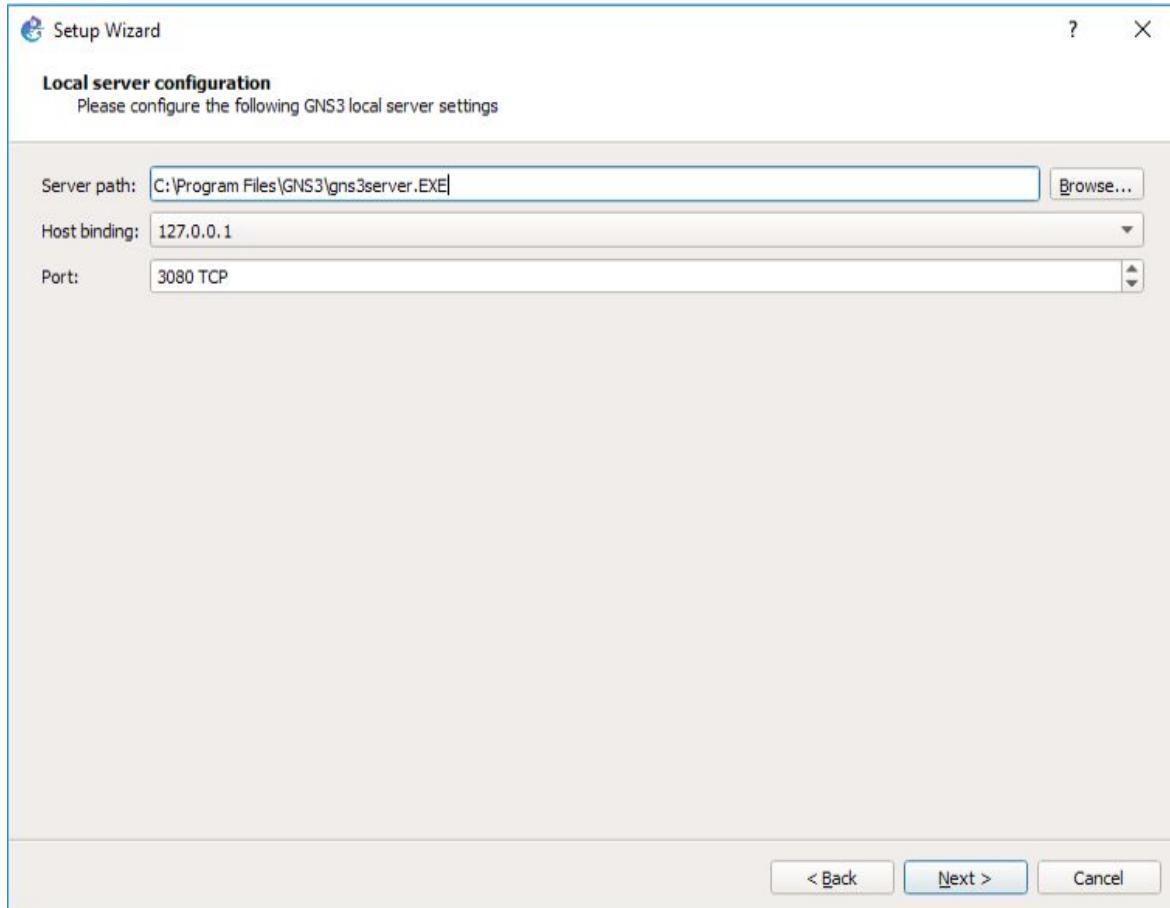


Figure 1.11: Local GNS3 Server setting

Upon the successful configuration validation and connection to the server, click “Next”.

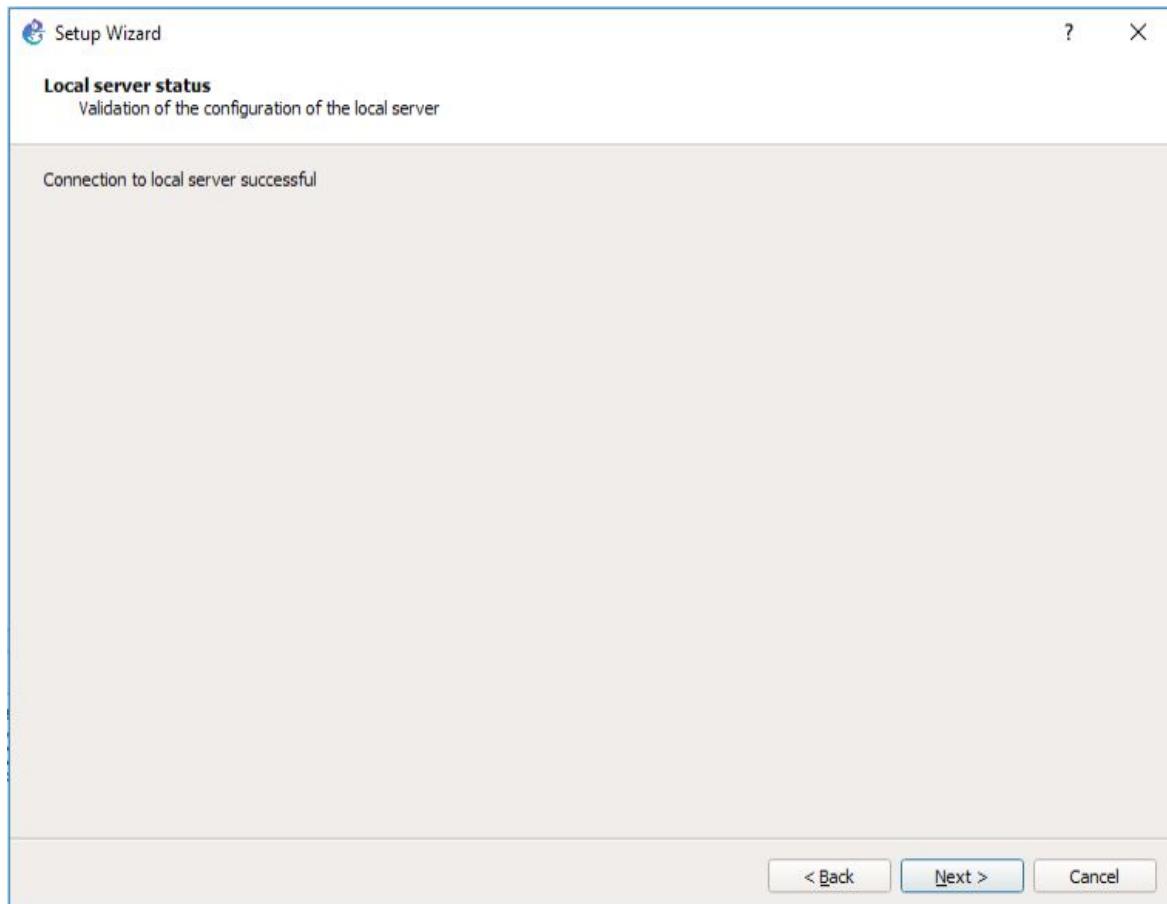


Figure 1.12: Local Server Validation Status

On the summary screen of the configuration, click “Finish”.

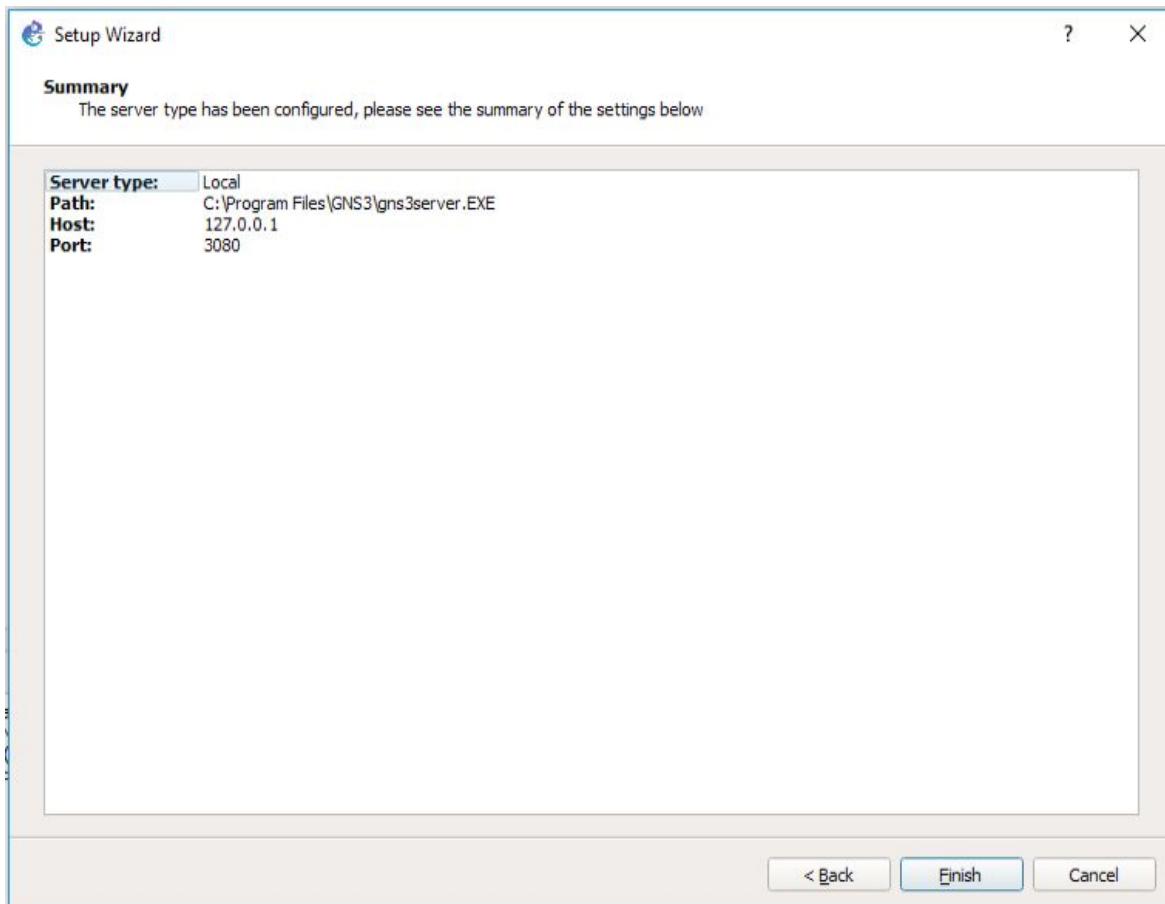


Figure 1.13: Local Server Configuration Summary

Adding IOS Image for the Router

The following template takes us through the adding of router's IOS to be used with the GNS3. Choose “Add an IOS router using a real IOS image (supported by Dynamips)” and click “OK” to continue.

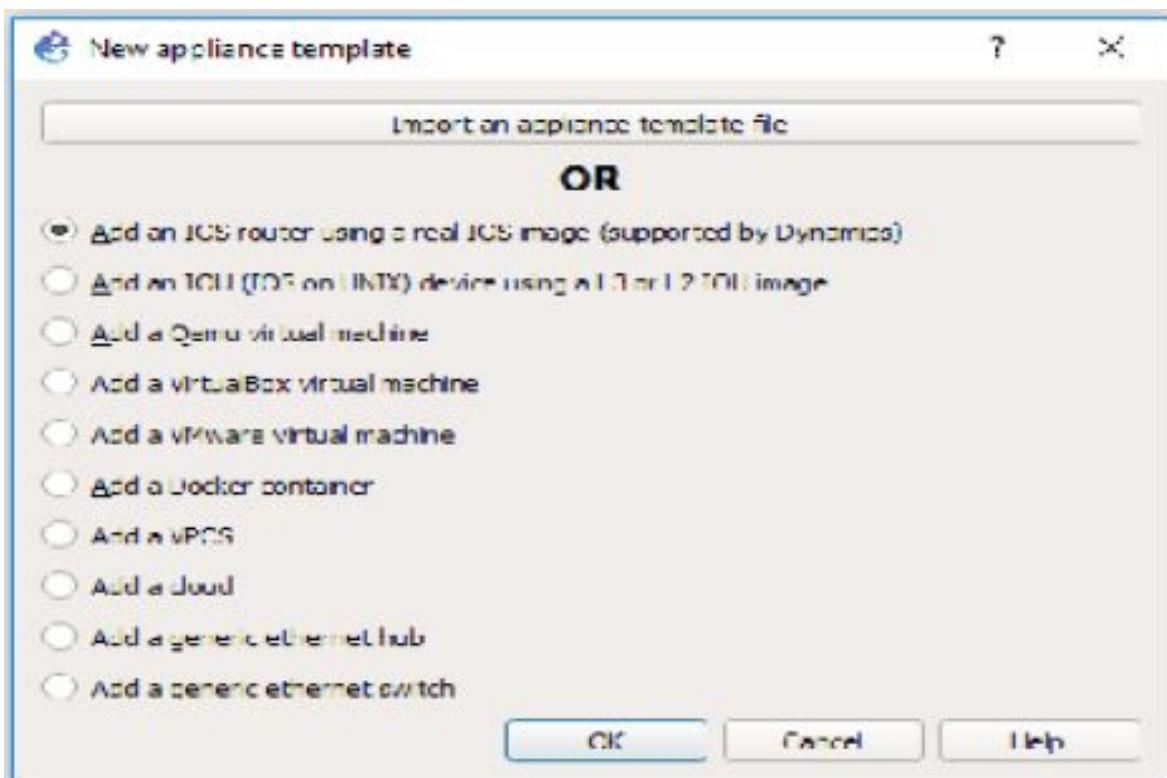


Figure 1.14: IOS Importing Options

In this step, we have to browse to a location where your router's IOS is stored and select the IOS image to be used.

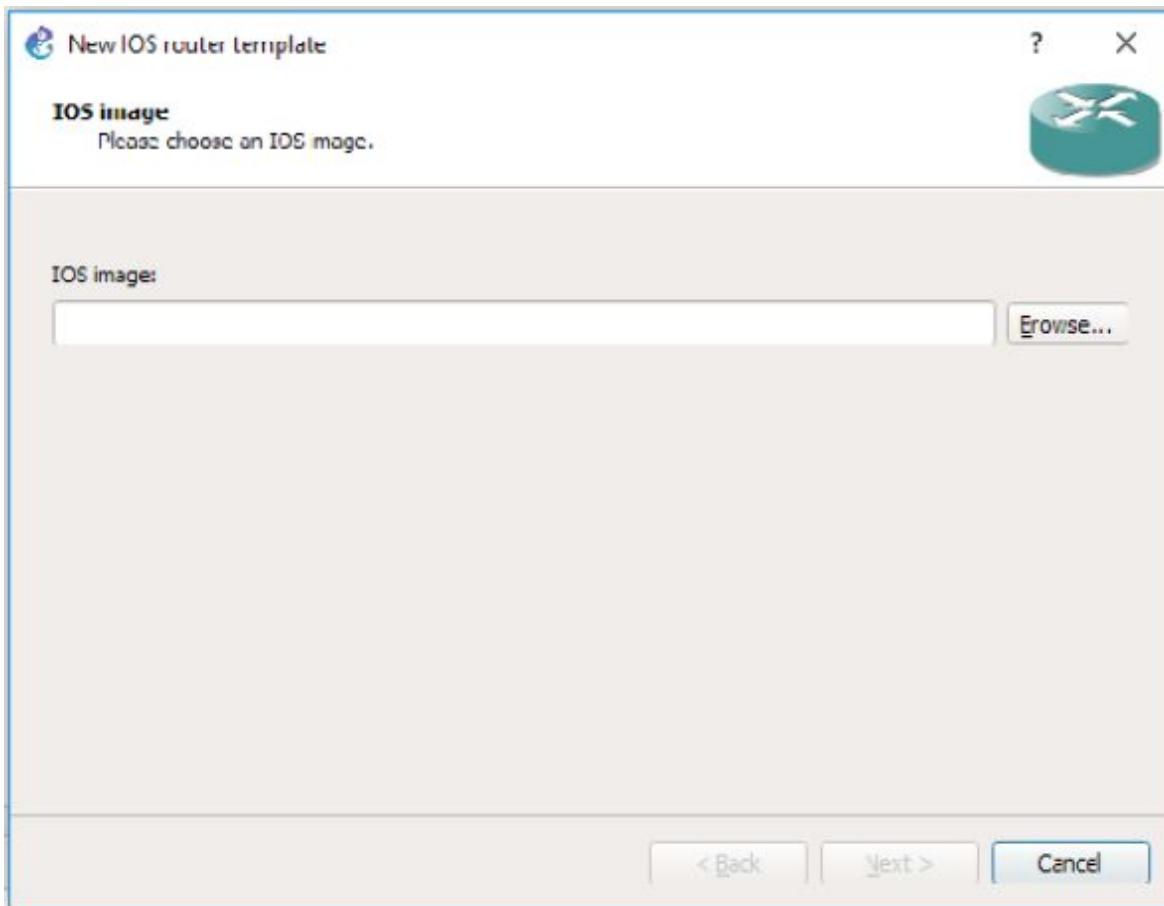


Figure 1.15: Browsing to the IOS Image location

Once the IOS is chosen and loaded, click “Yes” button to start decompressing the IOS image.

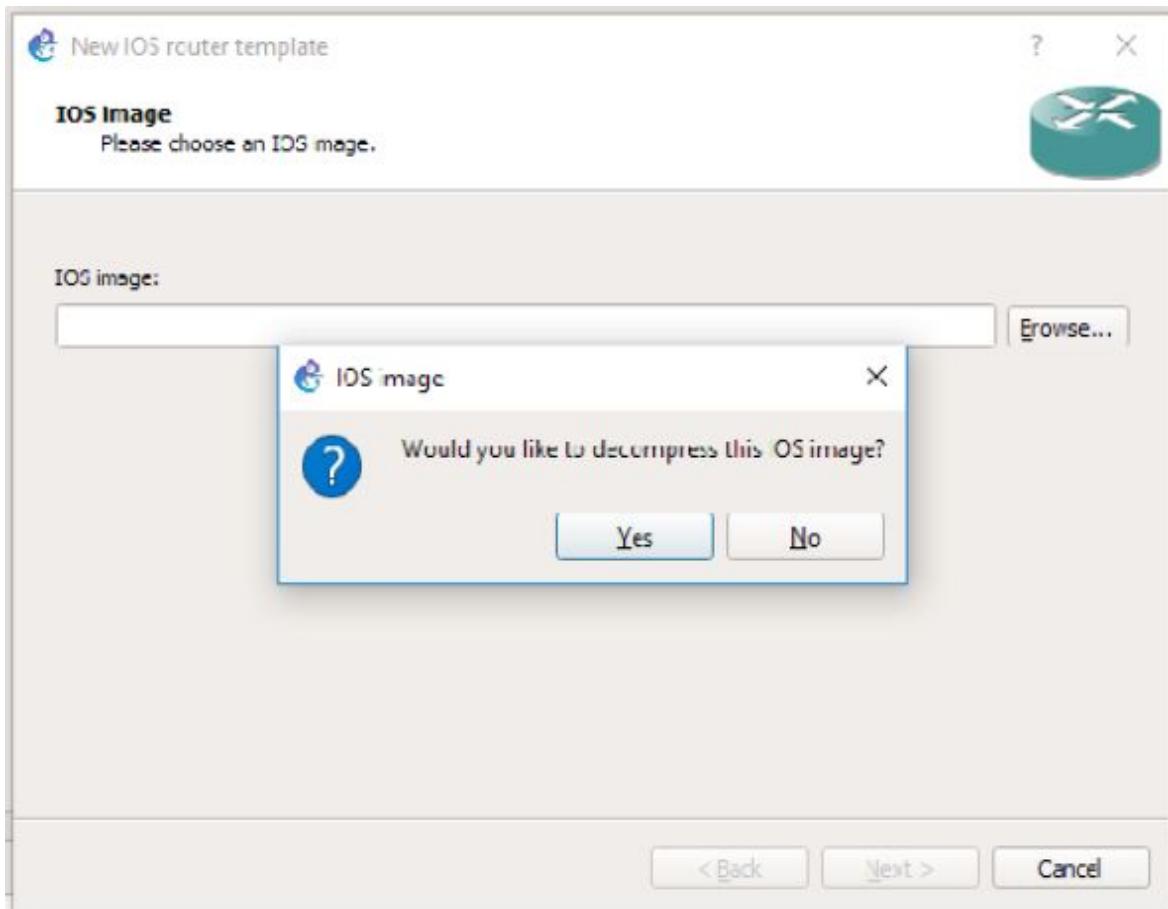


Figure 1.16: Decompressing the loaded IOS image

Once the image decompression is completed, click “Next” to continue.

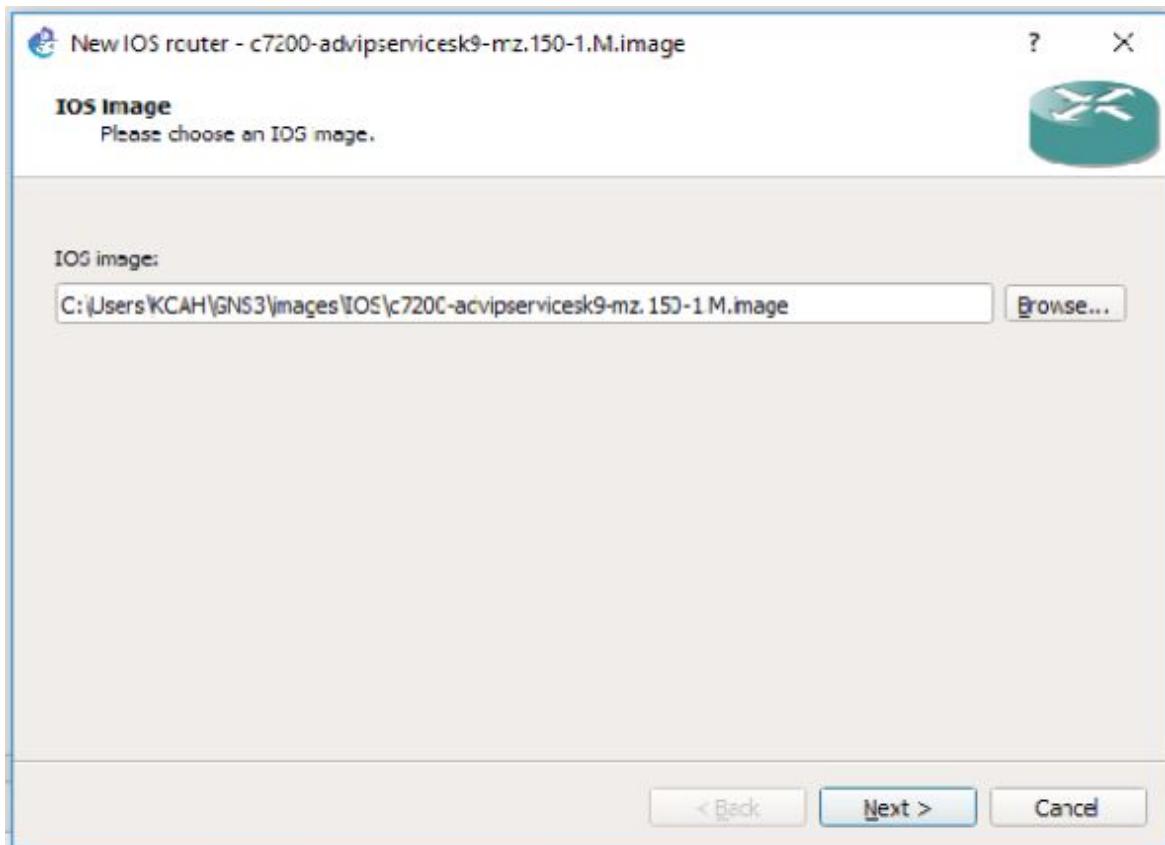


Figure 1.17: Path to the loaded IOS image

In the “Name” and “Platform” options, leave to the defaults and continue by clicking “Next” button.

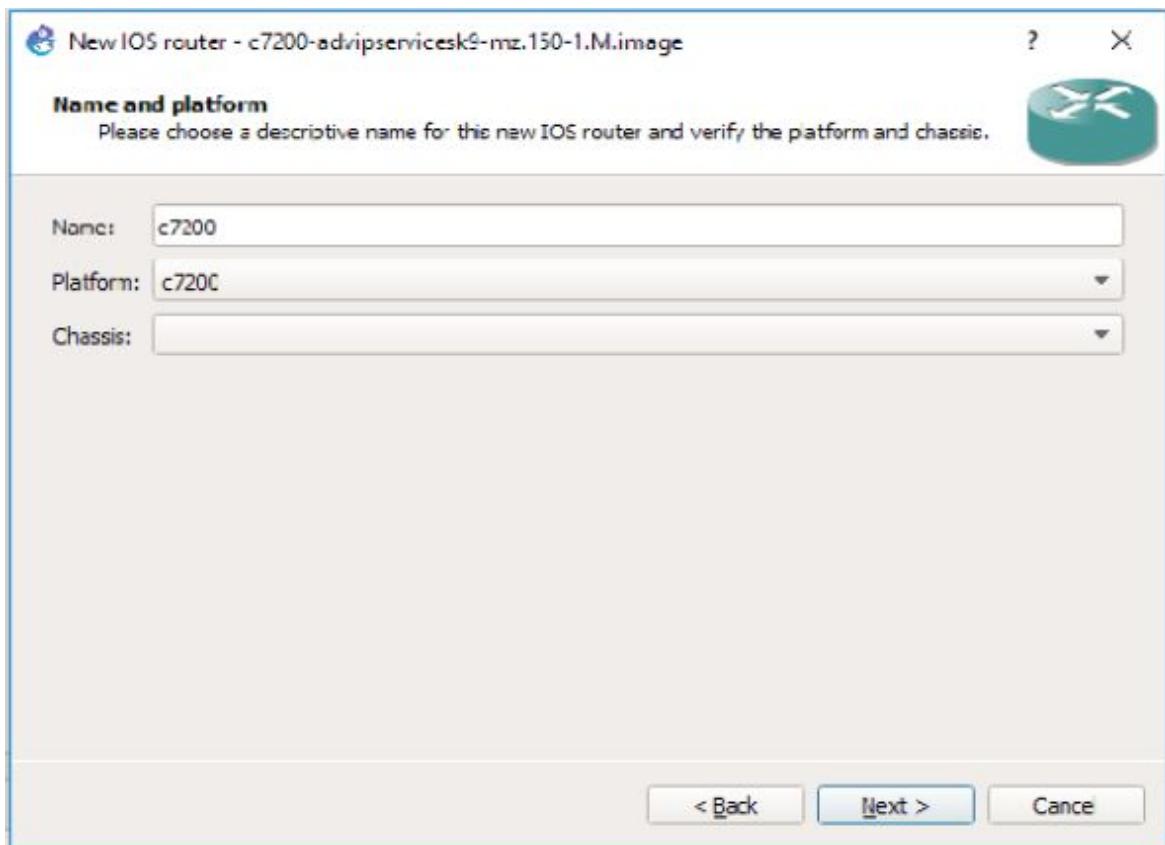


Figure 1.18: IOS router name and platform details

In this step, you have to allocate the amount of RAM size for the IOS and it is recommended to keep it to the default or allocate a bit higher. Allocating too much or too less would cause issues in the router startup. Assign the required amount of RAM as per the requirement and then click “Next” button.

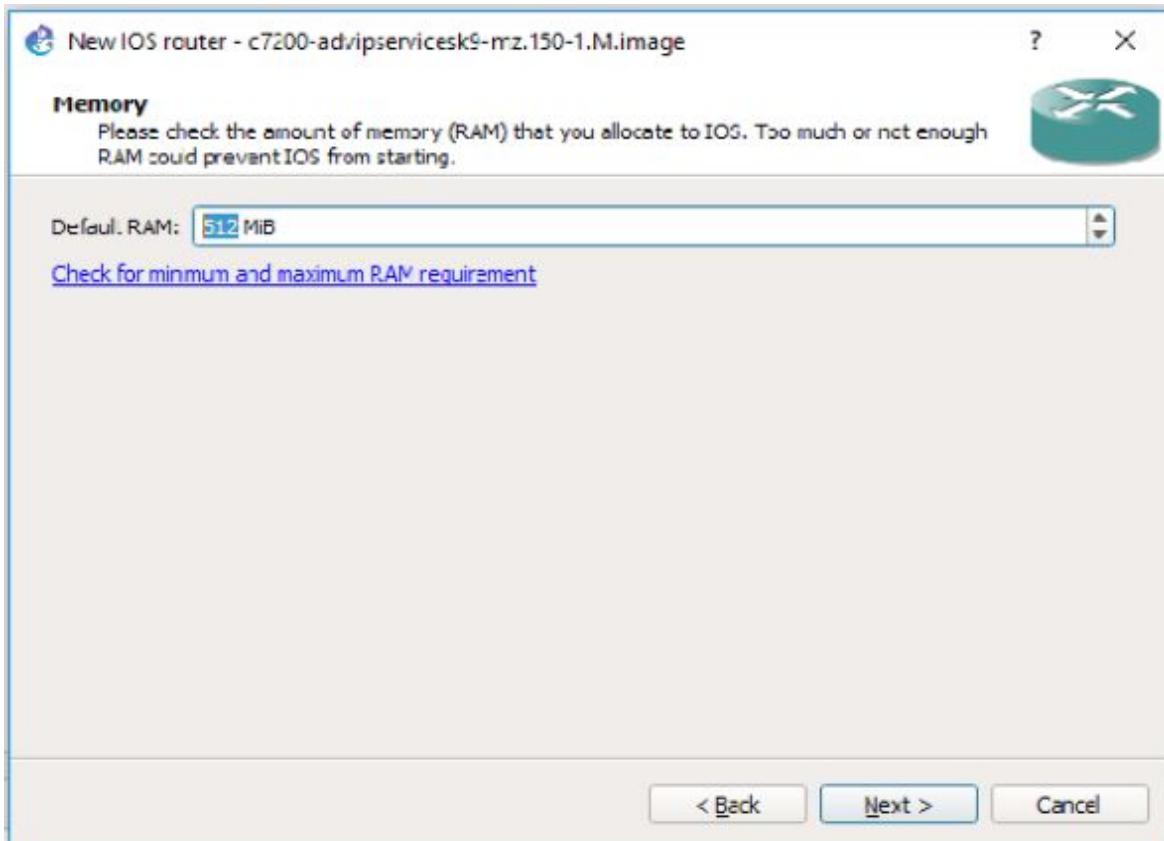


Figure 1.19: Memory allocation for the IOS

Here, we can specify the type and the number of interfaces to be created whenever new router instances are initiated. In the following, two fast ethernet interfaces (C7200-IO-2FE) are specified to be created for a router in every instance. Once it is specified correctly as per the need, click “Next” to proceed.

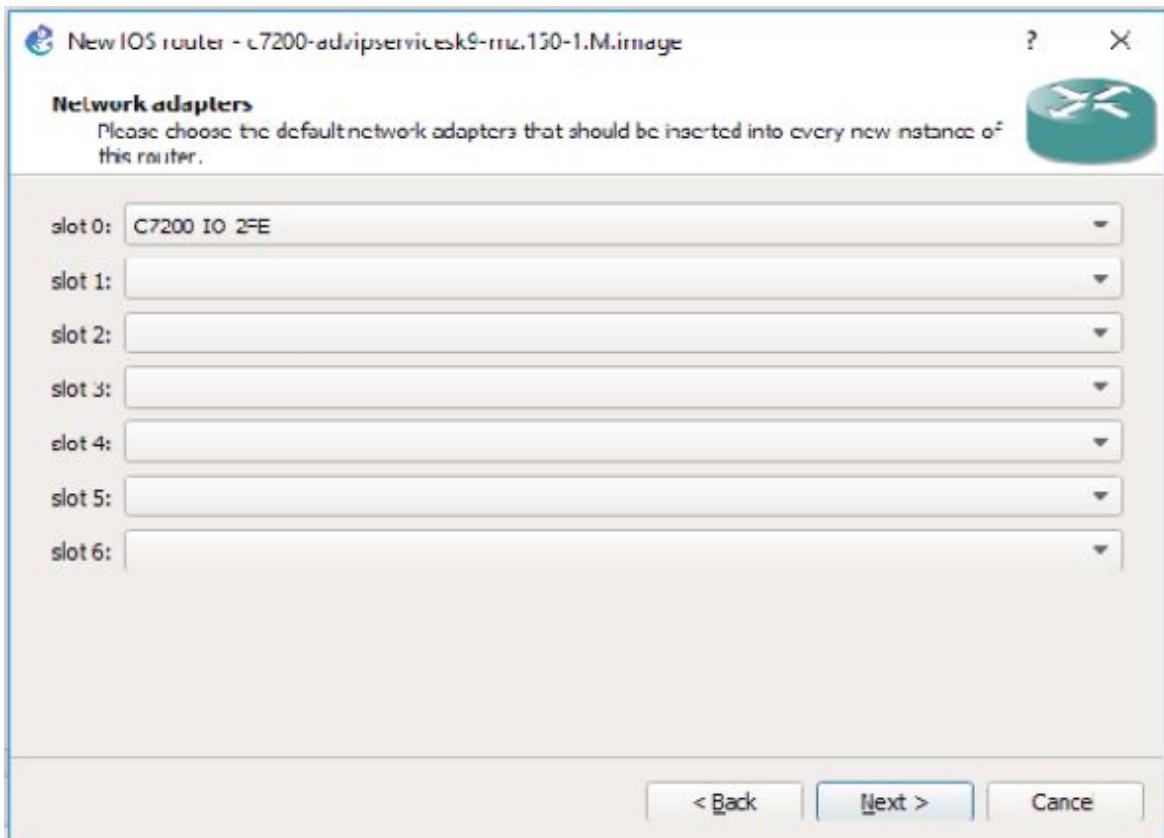


Figure 1.20: Default Network Adaptor specification

The Idle-PC value helps in reducing the percentage of CPU usage whenever we have to run multiple instances of routers at the same time. So, click on the “Idle-PC finder” button and wait for the system to find the suitable value for the IOS image. Once the Idle-PC value is found, accept the value by clicking “OK” and then click “Finish”.

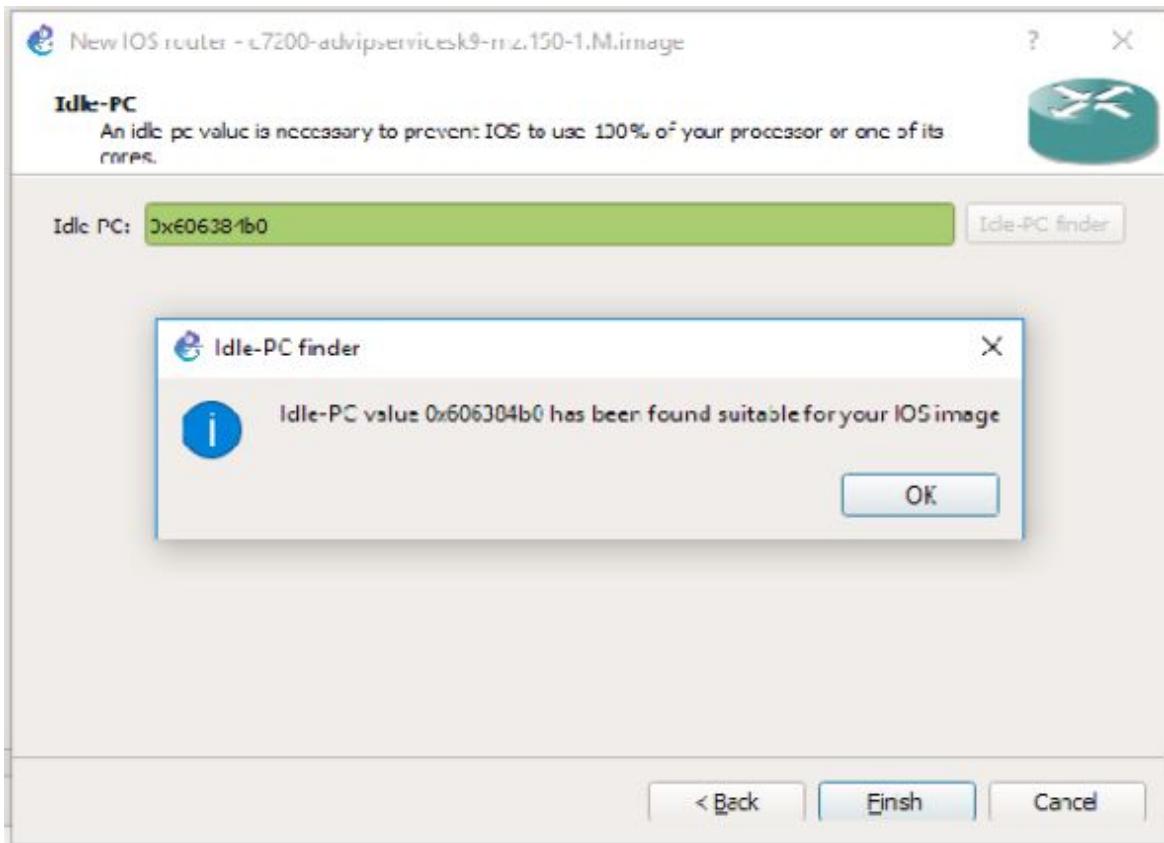


Figure 1.21: Finding Idle-PC Value for the IOS

When the process is complete, your IOS must be listed in the IOS routers list. Further, to accept the changes to take effect, click “Apply” and then “OK”.

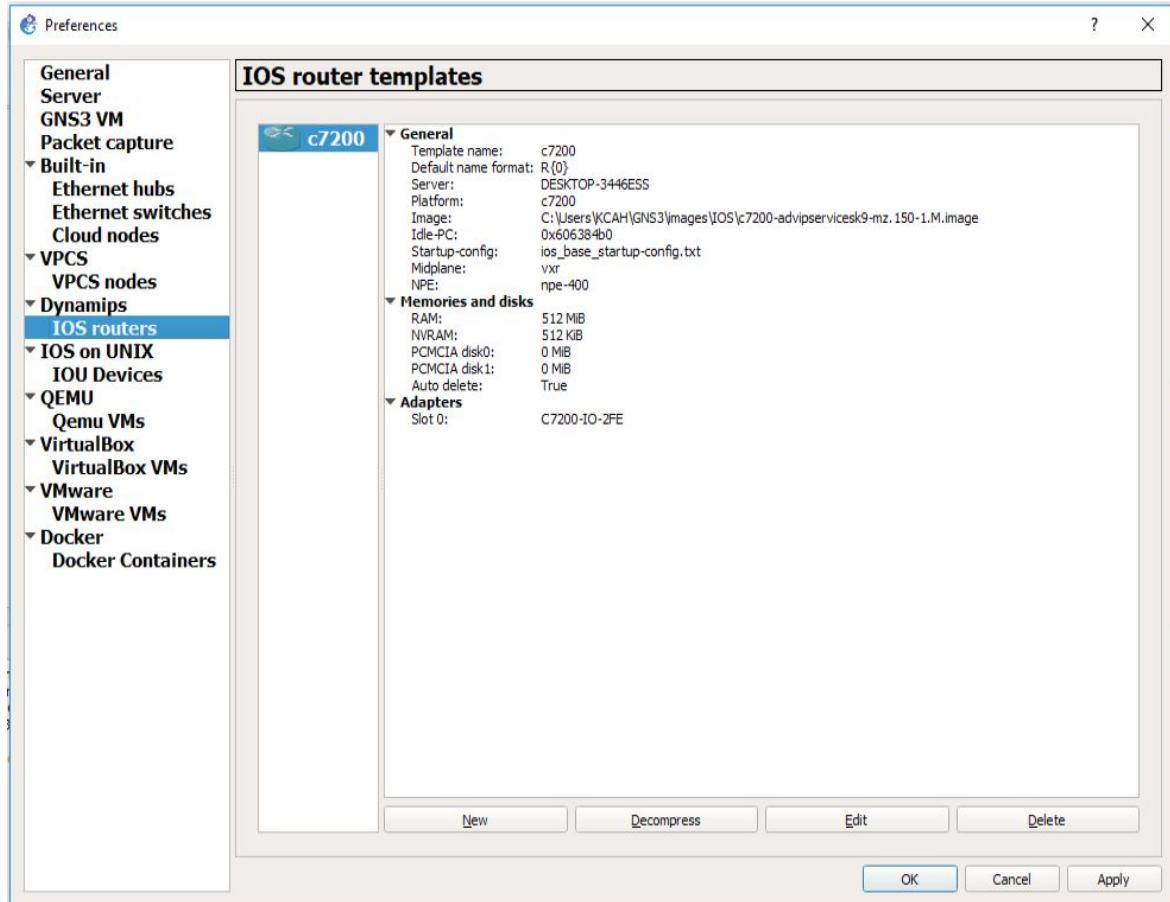


Figure 1.22: Imported Router IOS List

When the IOS adding is completed, GNS3 takes directly to the creation of the project. It shows a dialog box where we can specify the name of the project and the default location of the project to be saved is shown. At this point, click the “Cancel” and abort the project creation step.

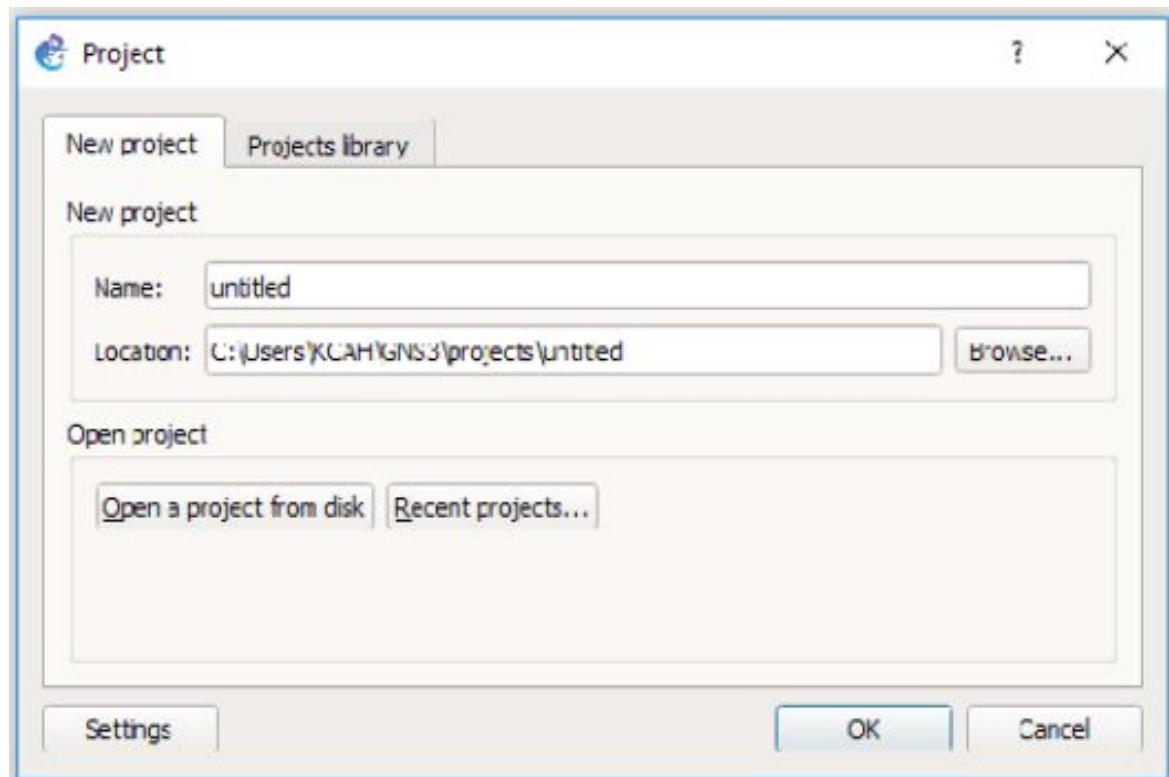


Figure 1.23: New project dialog box

Adding IOS for the EtherSwitch Router

In the previous step, you have added an IOS image to be used as the router. Now, in the following steps, we will try to add an IOS image of a router to be used as an EtherSwitch Router. After the launching of the GNS3 application, go to Edit --> Preferences --> Choose “IOS routers”. Here, we get options either to add new, decompress, edit or delete the IOS routers. For now, in order to add new click on the “New” button.

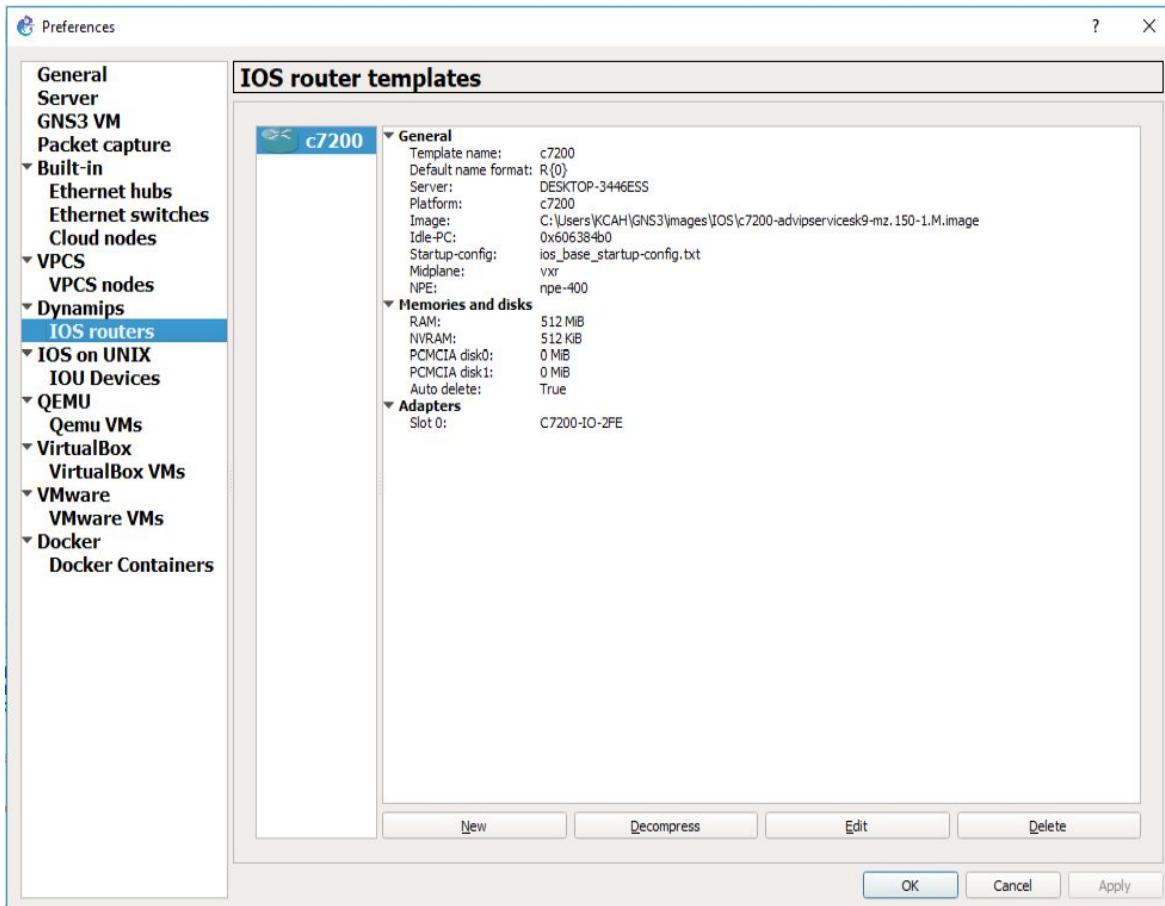


Figure 1.24: Adding more IOS Images

Choose “New Image” option, browse to the location where you have stored the IOS of the router, choose to decompress the image and then click “Next” to proceed.

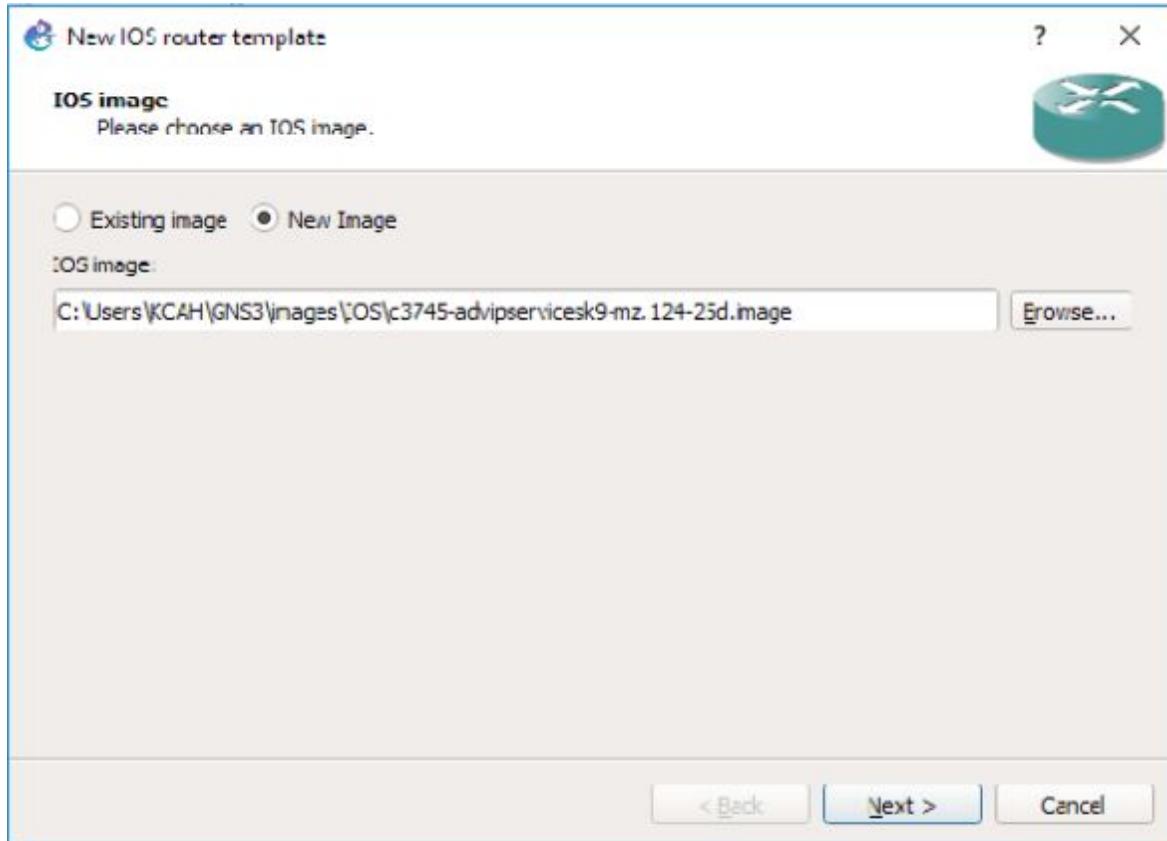


Figure 1.25: Choosing New IOS Image

Here, we have to provide a descriptive name, platform and select “This is an EtherSwitch router” option for our router and then click “Next”.

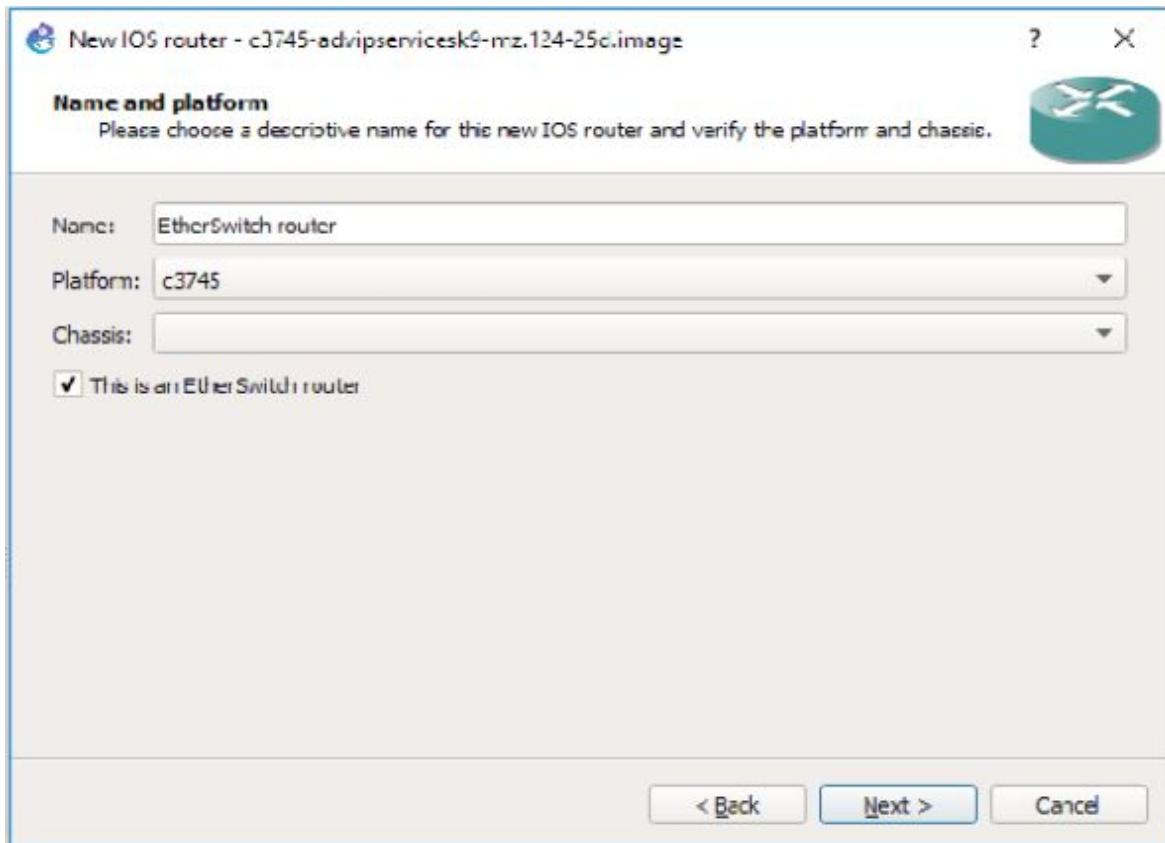


Figure 1.26: Router IOS to EtherSwitch Option

Allocate the required amount of RAM size for the IOS and click "Next" to continue.

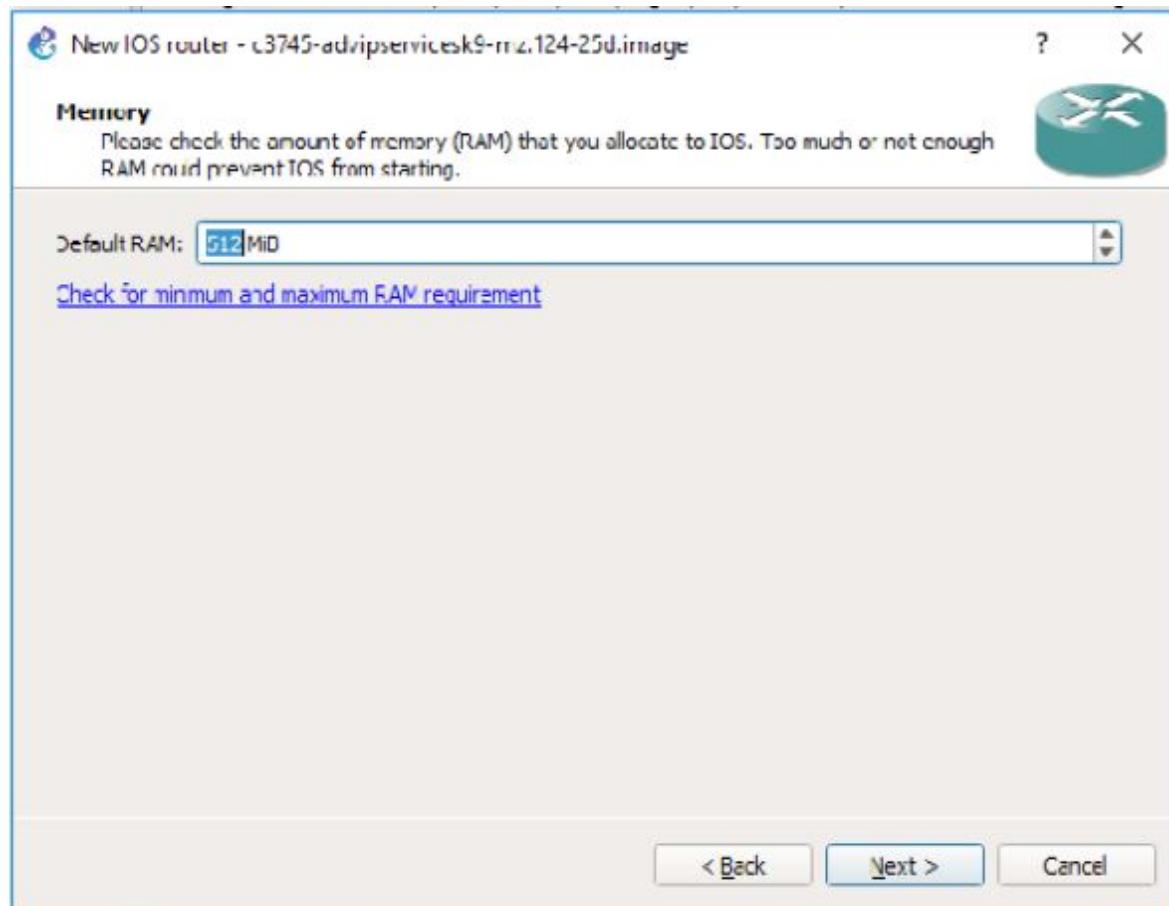


Figure 1.27: Memory allocation for the EtherSwitch Router

In this step, don't forget to add a module with 16 interfaces, since our intention is to use it as a switch. So, selecting NM-16ESW is recommended in this step and continue by clicking "Next".

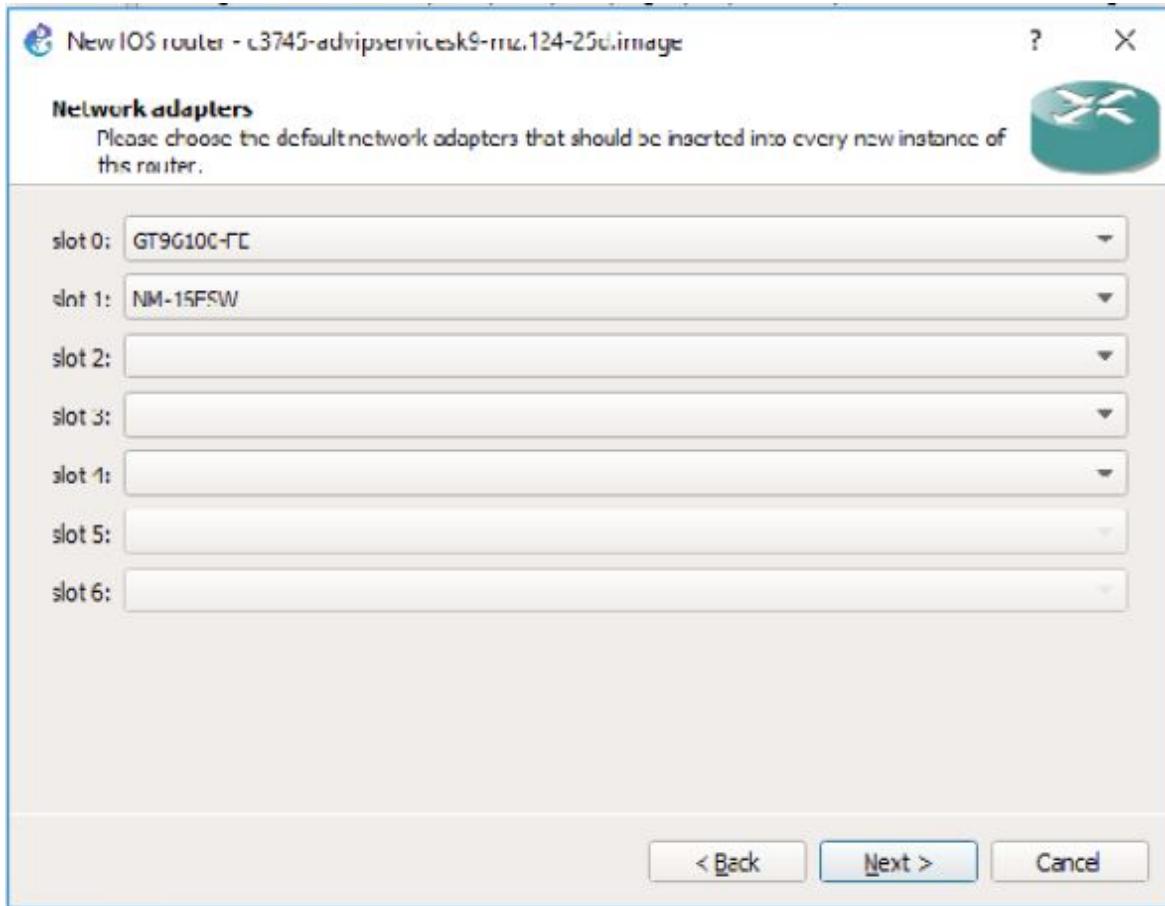


Figure 1.28: Specifying Default Ethernet Adaptors

Click “Next” to proceed with the setting.

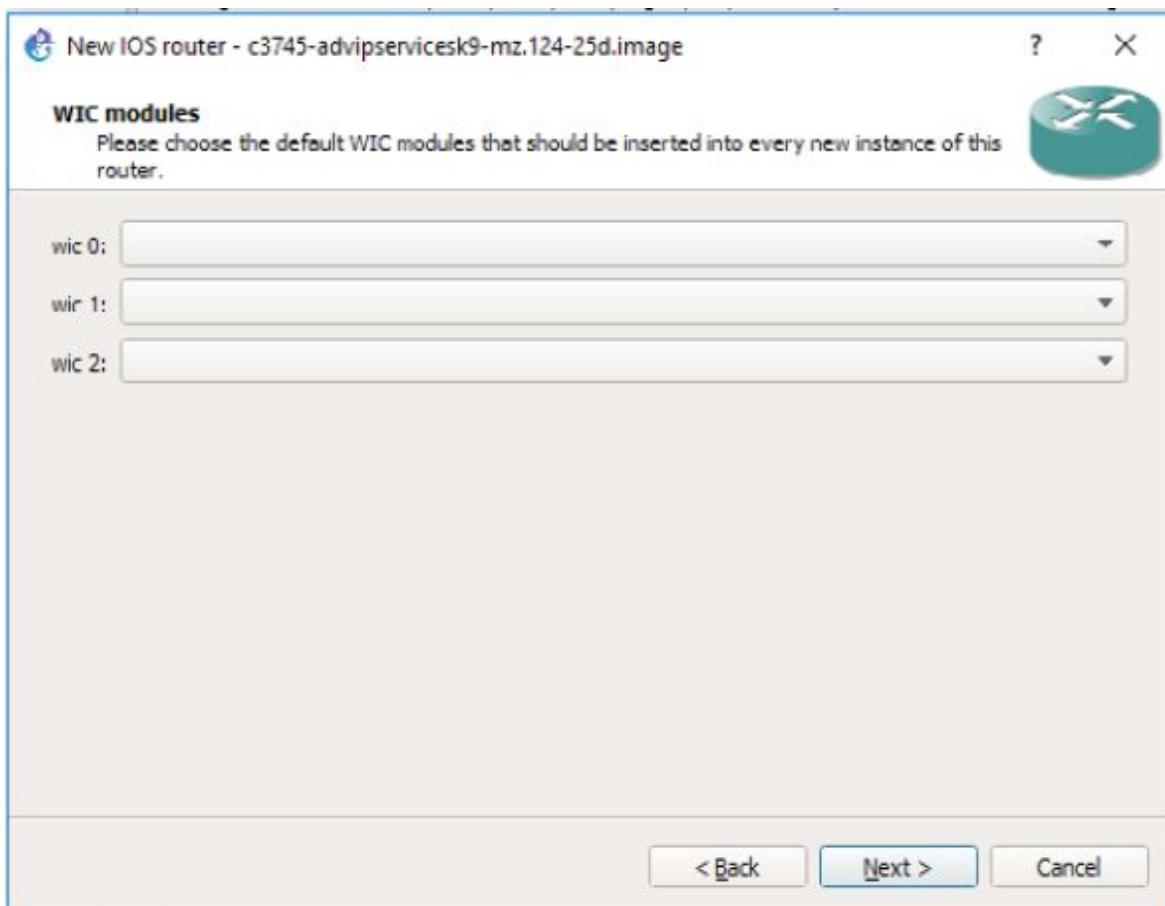


Figure 1.29: Specifying WIC module options

Look for the Idle-PC value and click “Finish”. Even if the Idle-PC value is not found by the system, you can continue by clicking “Finish”.

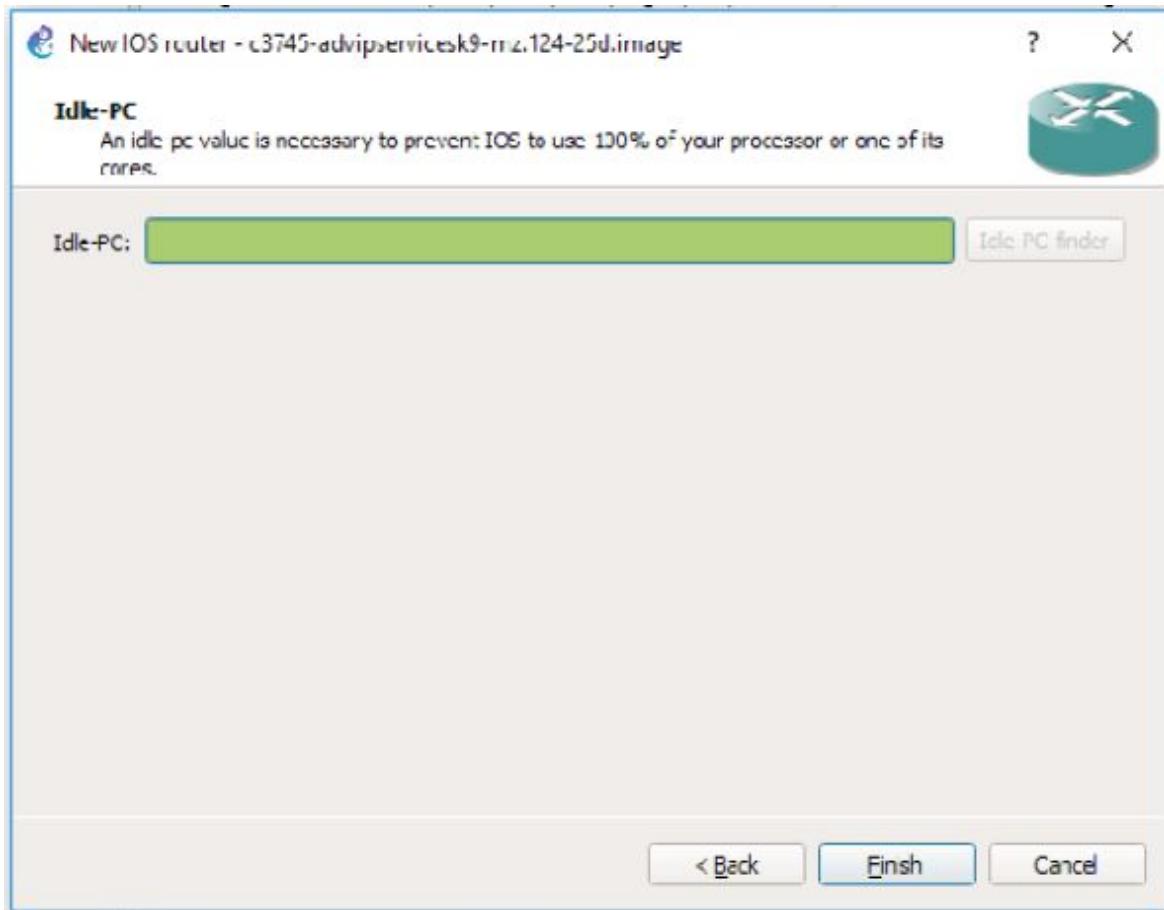


Figure 1.30: *Idle-PC Value for EtherSwitch Router*

Once the setting is complete, we have to accept by clicking “Apply” and then “OK”.

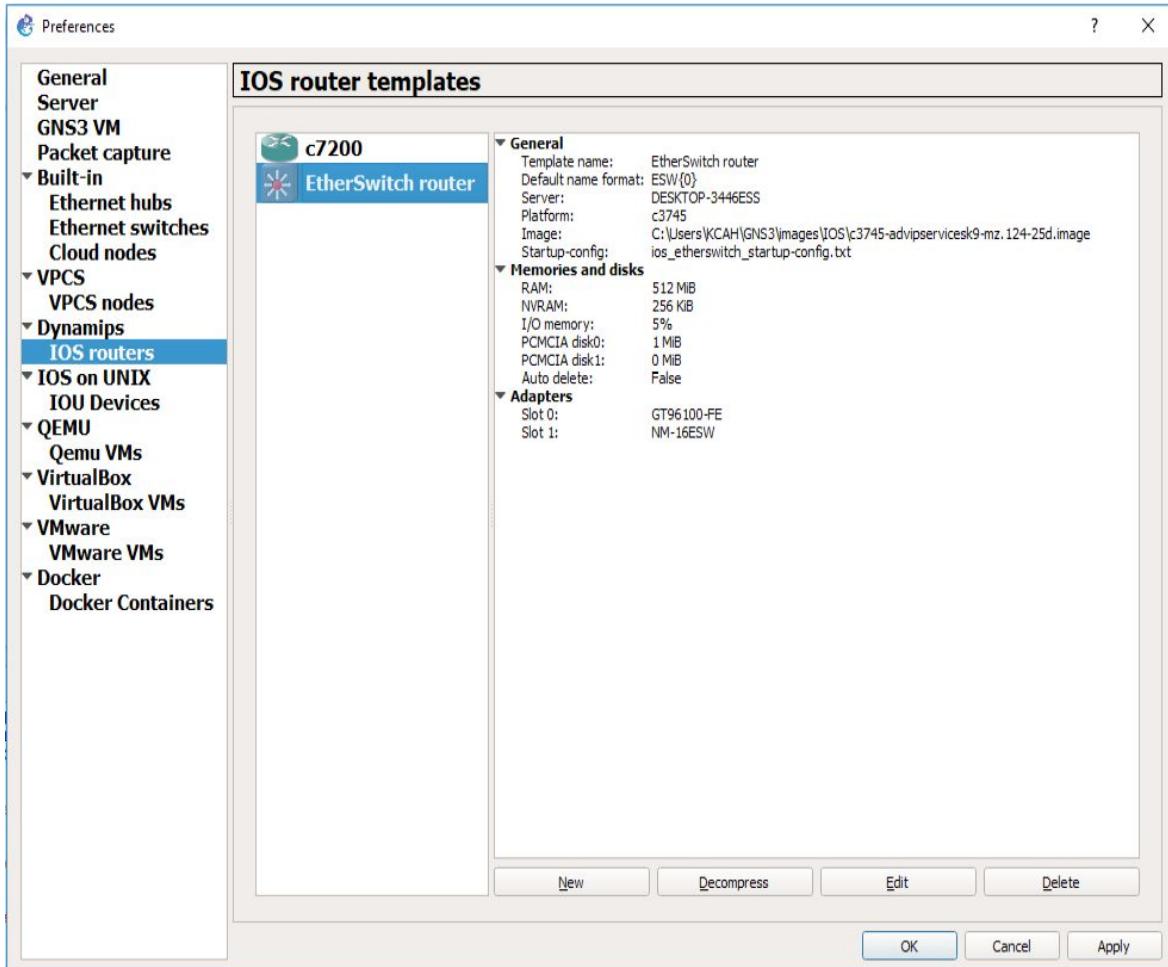


Figure 1.31: Imported IOS Image List

This completes the adding of IOS images to be used while working with GNS3. In case, a number of IOS images are required, the same procedure can be followed and added. Here, c7200 will be used as a router while EtherSwitch router is going to be used as a switch.

Further Reading

Cisco IOS images for Dynamips. (n.d.). Retrieved April 06, 2018, from <https://docs.gns3.com/1-kBrTpIBtp9P3P-AigoMzIDo-ISyL1h3bYpOl5Q8mQ/>

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GNS3 Labs | CCNP | CCNA Labs. (n.d.). Retrieved April 05, 2018, from

<http://commonerrors.blogspot.com/2014/10/add-router-ios-in-gns3-10-beta2.html>

How to Add Router IOS Image in GNS3. (2016, July 16). Retrieved April 06, 2018, from <https://protechgurus.com/how-to-add-router-ios-image-in-gns3/>

Introduction. (n.d.). Retrieved April 05, 2018, from https://docs.gns3.com/1PvtRW5eAb8RJZ11maEYD9_aLY8kkdhgaMB0wPCz8a38/index.html

Chapter 2

Install and Configure VirtualBox

The Oracle VM VirtualBox Manager is an open source virtualization software developed by the Oracle. It allows running a wide range of guest operating systems including Windows, MAC, Solaris, and Linux. In this chapter, we will install the Oracle VM VirtualBox Manager and also learn to install CentOS 7 as the Guest Operating System.

Download and Install VirtualBox

The VirtualBox is available for download for Linux, Windows and Mac. At the time of writing this book, the latest version available for the Windows platform was 5.2.8. To download the latest version of the VirtualBox for the appropriate platform follow the URL <https://www.virtualbox.org/wiki/Downloads> which is the official download link.

When the download is complete, you can install it on the host which could be running any operating system.

Creating Virtual Machine in the VirtualBox

Once the installation of the VirtualBox is completed, launch the Oracle VM VirtualBox Manager and click on the “New” to create a new Virtual Machine. Here we will create a Virtual Machine for installing the CentOS 7 Operating System.

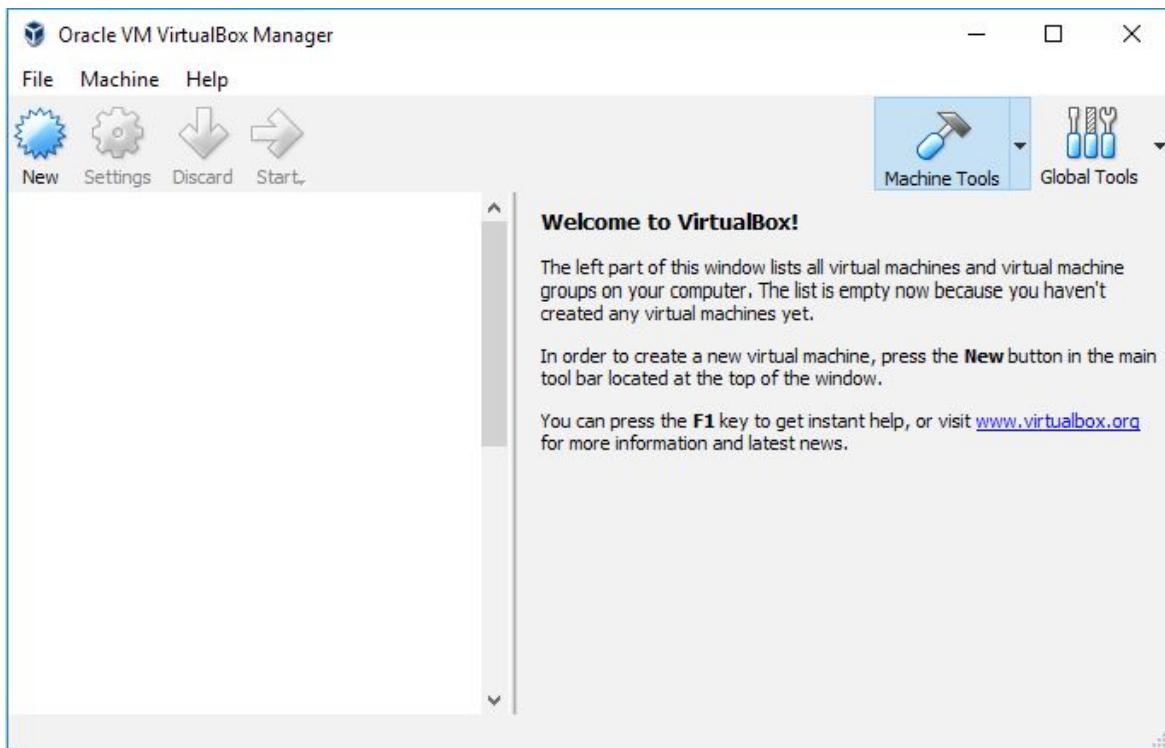


Figure 2.1: Oracle VM VirtualBox Manager's interface

In the following, we have to specify the name of the Virtual Machine, type of the Operating System and the version. As we are intending to install CentOS 7, the type is going to be Linux and then the version as Red Hat (64-bit), since CentOS is a Red Hat family. Click “Next” to continue.

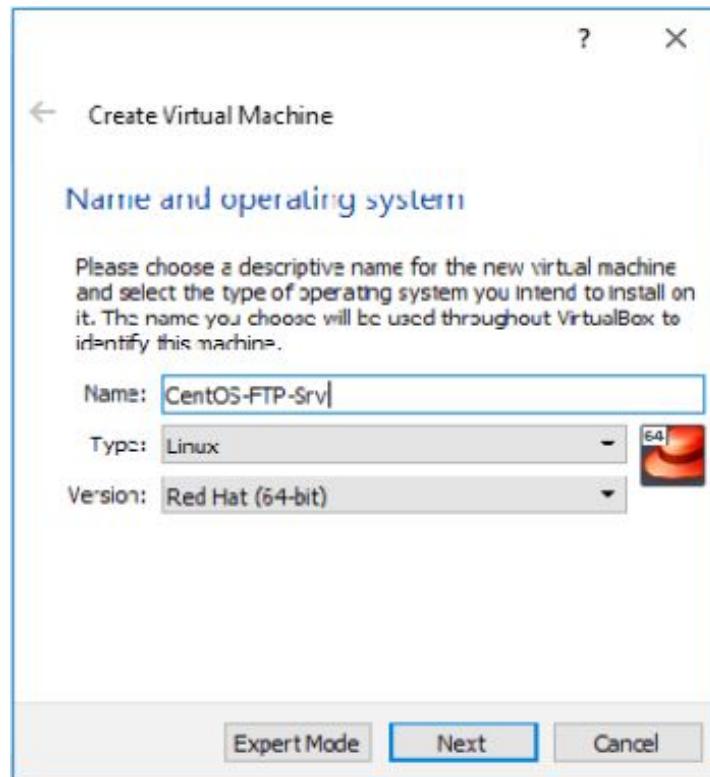


Figure 2.2: Assigning name and type of OS

In the following, VirtualBox automatically assigns memory size to the virtual Machine but if there is more memory to be spared, you can increase as per the need and availability. However, assigning lower than the recommended would pose issues. Click “Next” to continue.

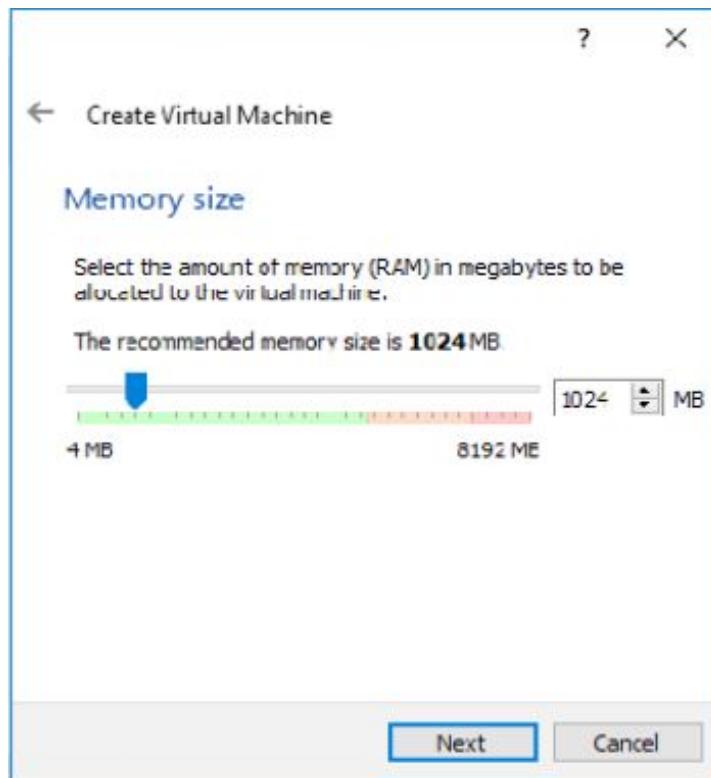


Figure 2.3: Allocating memory size for the VM

In this screen, if we already have a pre-configured Virtual Hard Disk (VHD) file, select the “Use an existing virtual hard disk file” and select the VHD that you want to use. If you want to create a new virtual hard disk, select “Create a virtual hard disk now” and click the “Create” button.

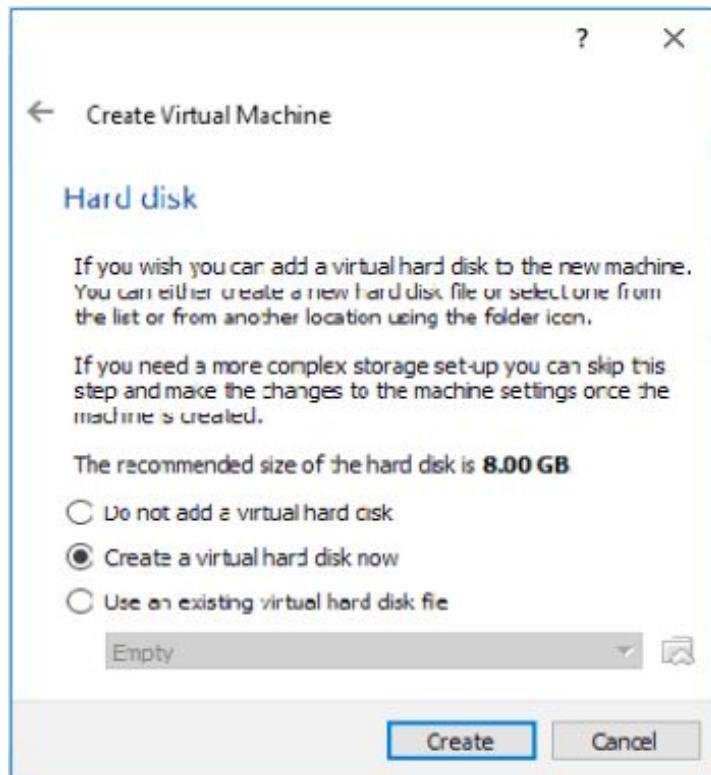


Figure 2.4: Virtual hard disk option

For the Hard disk file type, you can select any of the VHD disk types depending on your choice. By default, the disk type selected is VDI. Let's keep it to "VMDK (Virtual Machine Disk)" and click "Next".

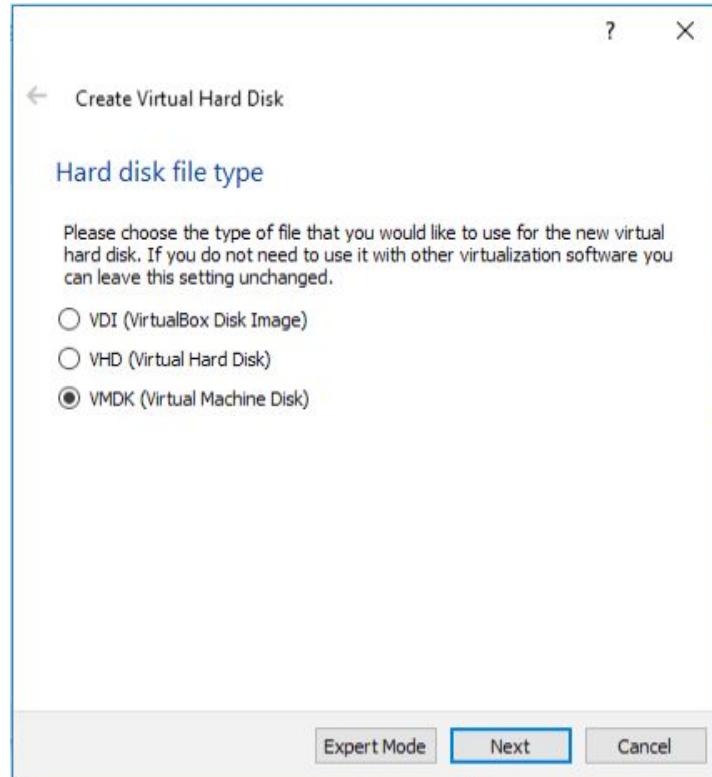


Figure 2.5: Virtual hard disk file type

In the following, choose “Dynamically allocated” and click “Next”. If you select dynamically allocated option, VirtualBox will use the disk space from the hard disk only when the virtual machine’s data increase. This option is suitable for the disk optimization.

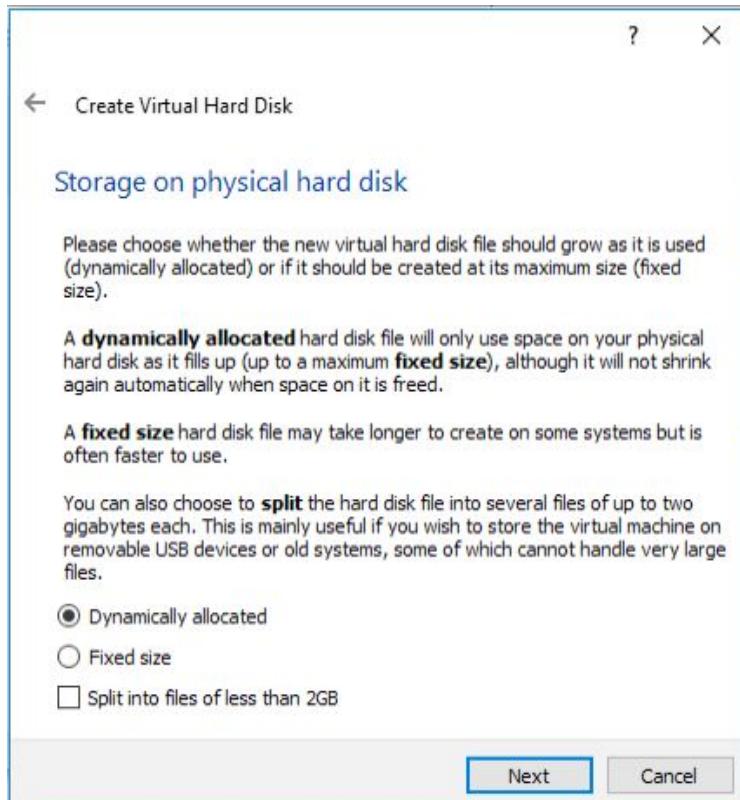


Figure 2.6: Choosing Dynamically allocated storage

Type the disk file name and select the location where you want to save it. Specify the size of the hard disk as well. Else, we can keep it to the defaults and click “Create”.

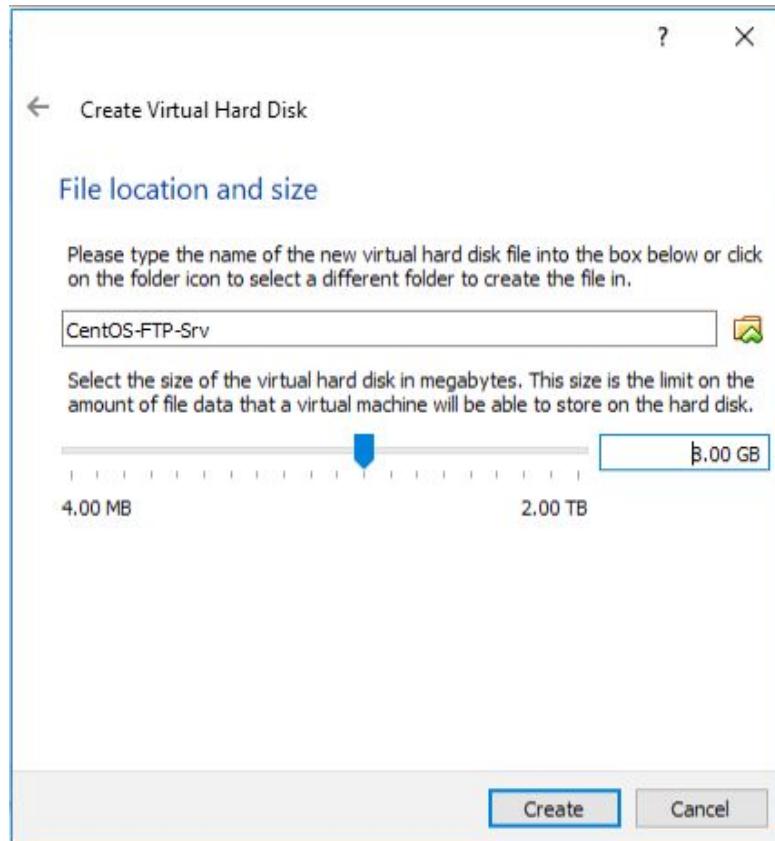


Figure 2.7: Virtual hard disk file location and size

We have completed creating a new virtual machine in VirtualBox for installing CentOS 7. The virtual machine will get listed as shown in the following figure.

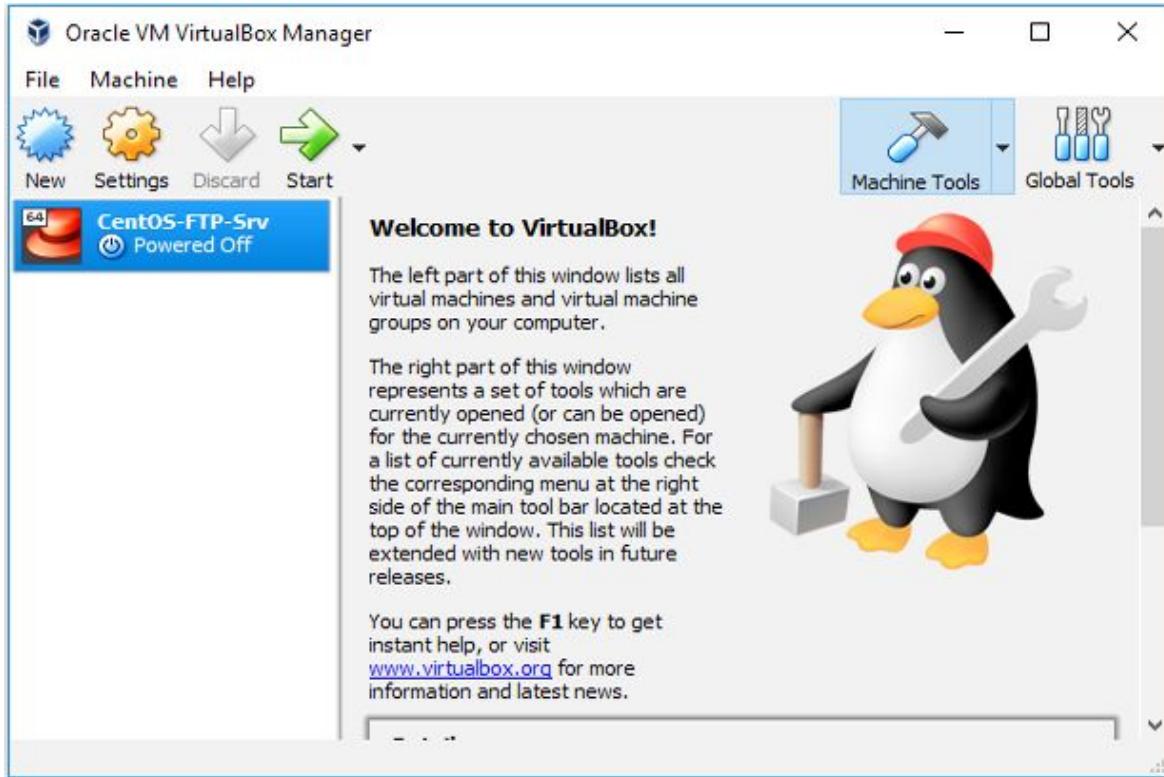


Figure 2.8: Created virtual machine listed

Virtual Machine Settings

In order for the virtual machine to function the way we expect it to, we have to perform some of the required changes in the settings under various sections. So, to change the settings for the particular virtual machine, we can Right-click and choose settings. This will launch the settings screen for the particular virtual machine.

General Settings

The first section of the setting window is “General”, which has four tabs. The “Basic” tab allows us to specify the virtual machine name, operating system type, and the version of guest OS.

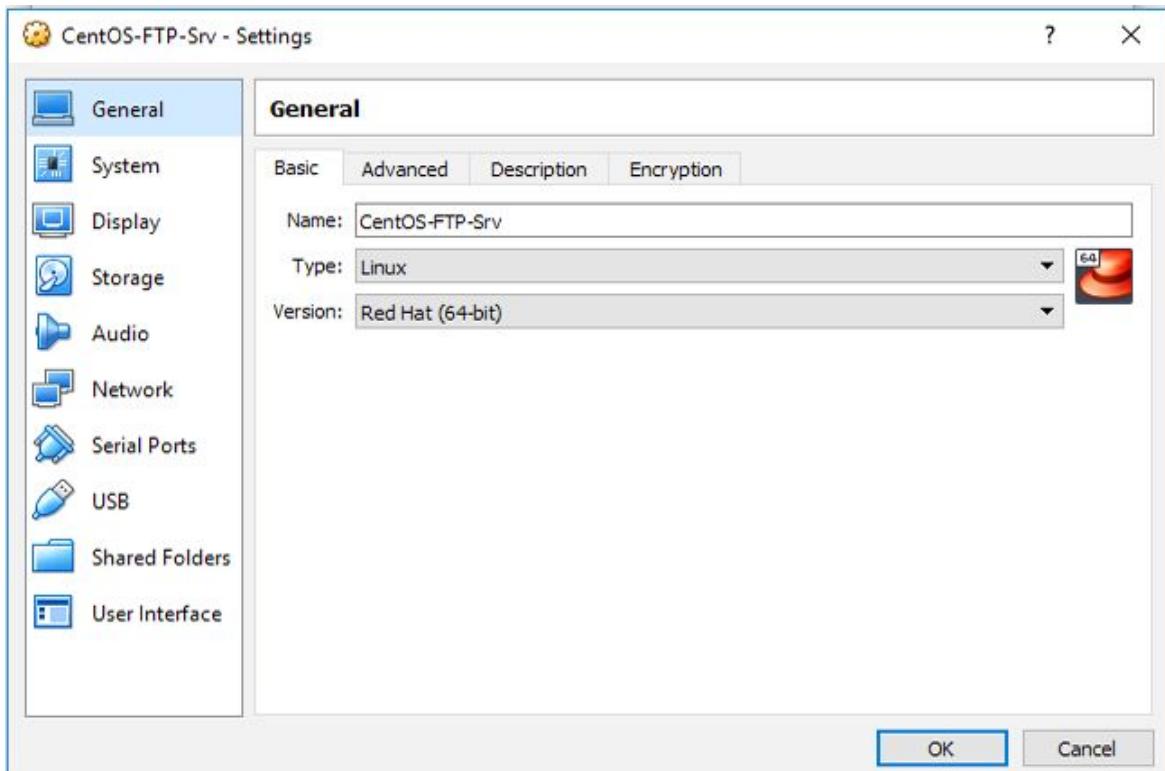


Figure 2.9: VM's general settings (Basic)

The “Advanced” tab allows specifying the snapshot folder location and drag-and-drop option between the host and guest machines. So, here the snapshot location is set to default, the “Shared Clipboard” and “Drag’n’Drop” are set to Bidirectional. Click OK to save the changes.

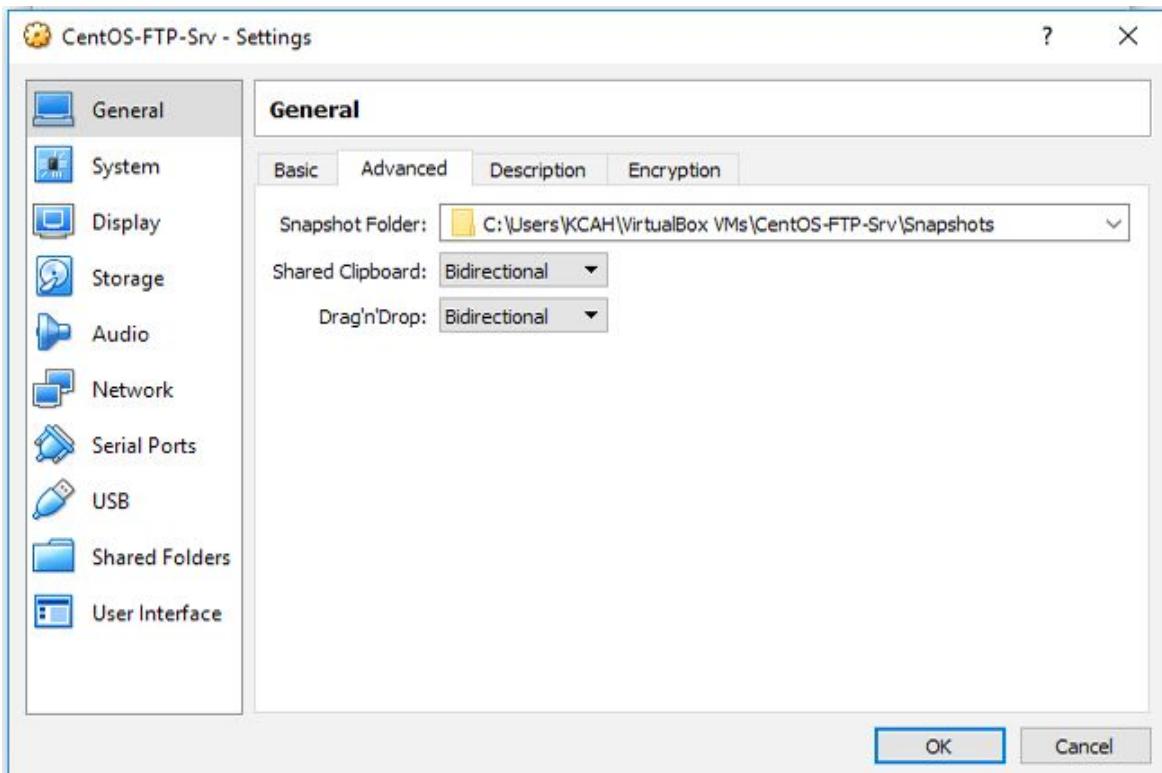


Figure 2.10: VM's general settings (Advanced)

System Settings

The “System” section of the setting has three tabs. In the “Motherboard” tab, we can adjust the allocated size of the memory and the order of bootable media to install the guest operating system. So, it becomes important for us to select and set the boot order based on our requirement. Here, the “Optical” is selected and is taken to the first.

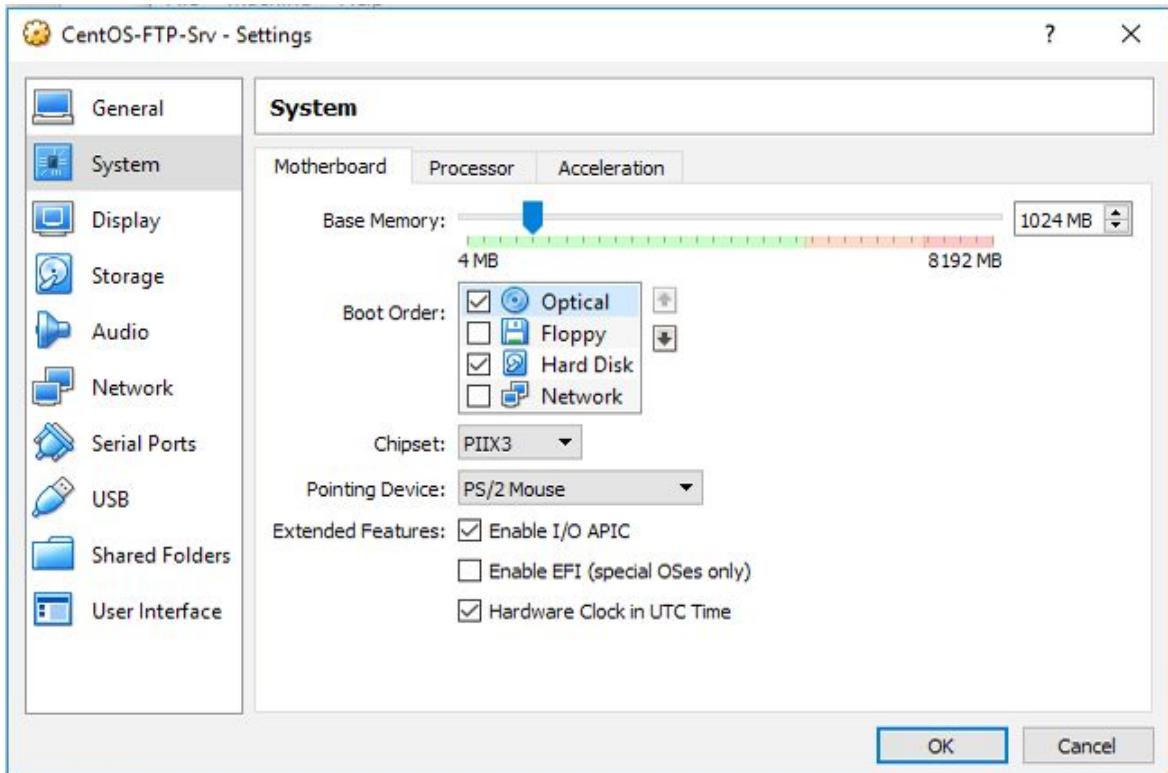


Figure 2.11: VM’s system settings

In the Processor and Acceleration tabs, leave the settings to the default at this time. We will make changes to those settings whenever required.

Display Settings

In the “Display” section, we can leave the settings of all the tabs to the defaults for the time being.

Storage Settings

Under the “Storage” section, we can customize the settings related to the storage devices such as HDD, VHD, and CD/DVD. More

importantly, since we are going to install the CentOS 7 as the Guest Operating System, we have to browse to a location where we have stored the ISO file of the CentOS 7.

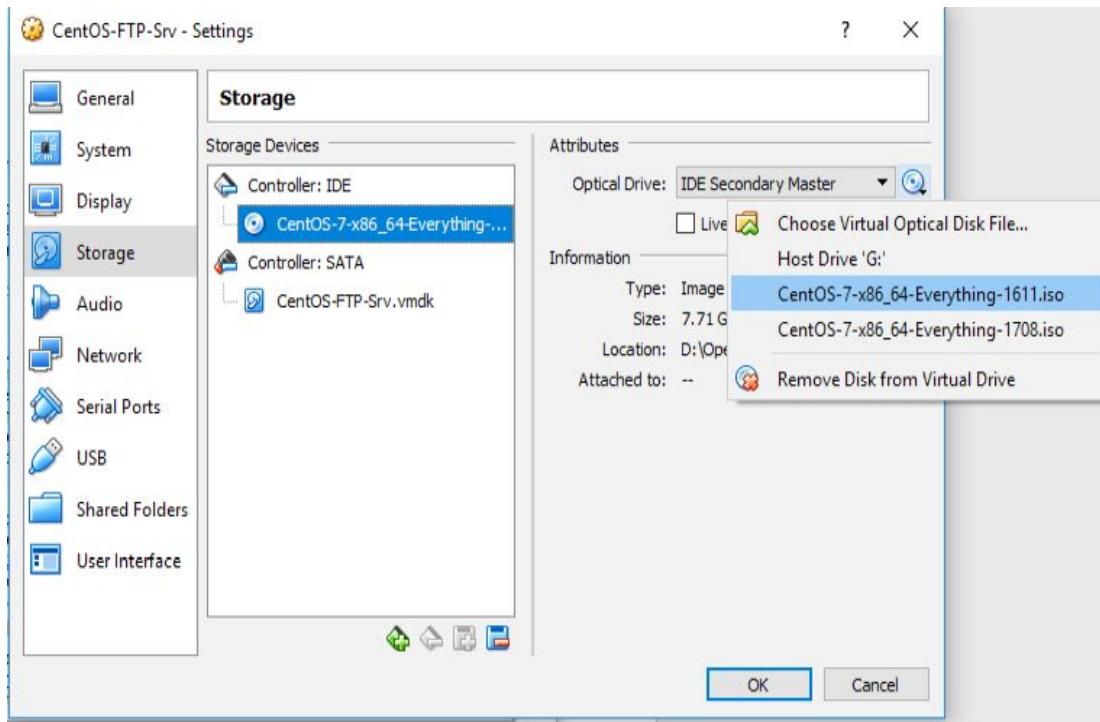


Figure 2.12: VM's storage settings

Network Settings

This section allows attaching the virtual machine to the desired network. Choose the network type that fulfills your requirement. As of now, we will leave it to the defaults and click “OK”.

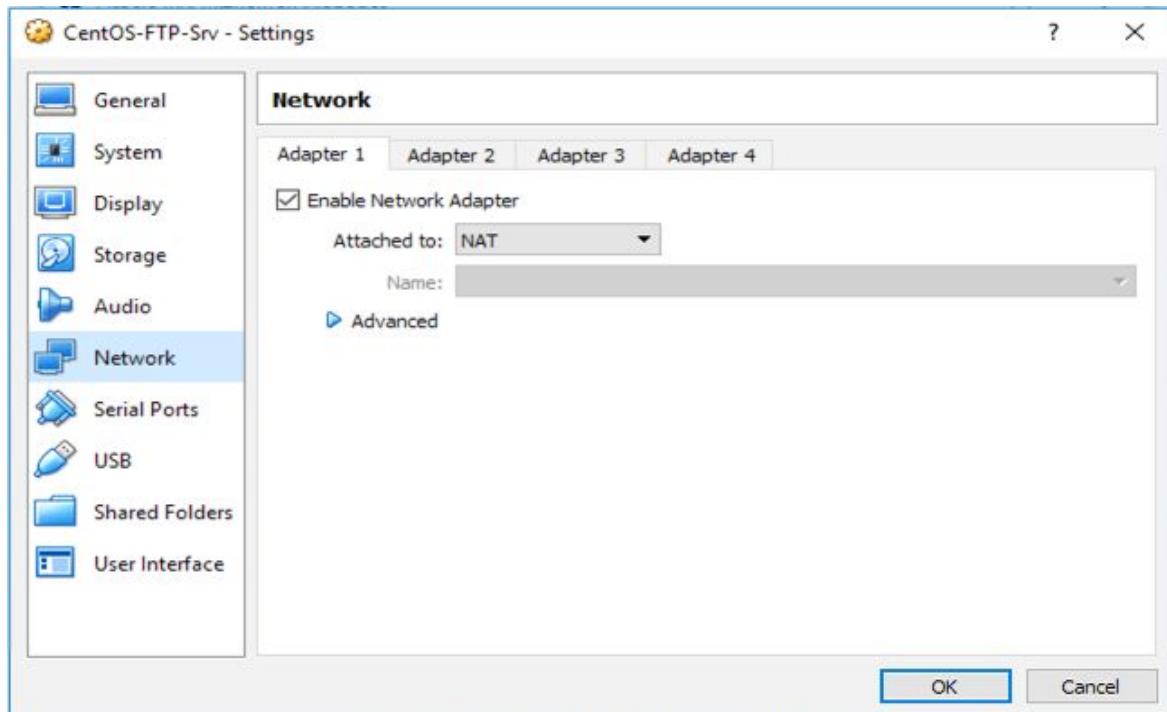


Figure 2.13: VM’s network settings

Installing Operating System on the VM

In the previous steps, we have installed Oracle VM VirtualBox Manager, created a Virtual Machine and the configuration settings for the Virtual Machine was completed.

In this section, we will try to install the CentOS 7 as the operating system on the Virtual Machine (CentOS-FTP-Srv). Installing the CentOS 7 on the Virtual Machine is almost similar to installing on a host machine. Follow the steps indicated below to install on the Virtual Machine:

Before we start, we need to have in place, the installation media (DVD or ISO) of the guest operating system which we are intending to install. In our case, we need to have CentOS 7 DVD or the ISO file.

If you have more than one virtual machine, make sure that you select the particular virtual machine and click the “Start” button.

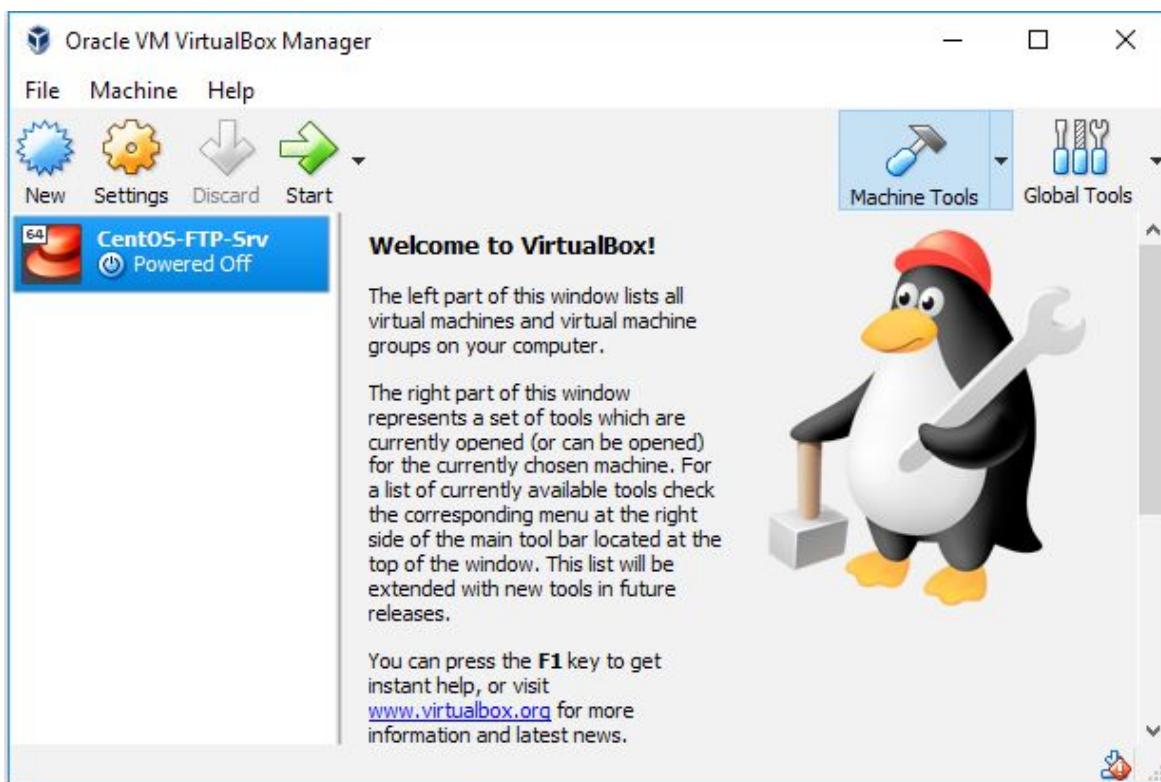


Figure 2.14: Selecting a VM to start

To use an ISO image file for CentOS 7 as an installation media, click “Devices”, choose “Optical Drives” and then “Choose disk image” option. Browse and select the desired ISO image of CentOS 7 that you want to use as an installation source. This step is required only if you have not done the image selection in the previous steps.

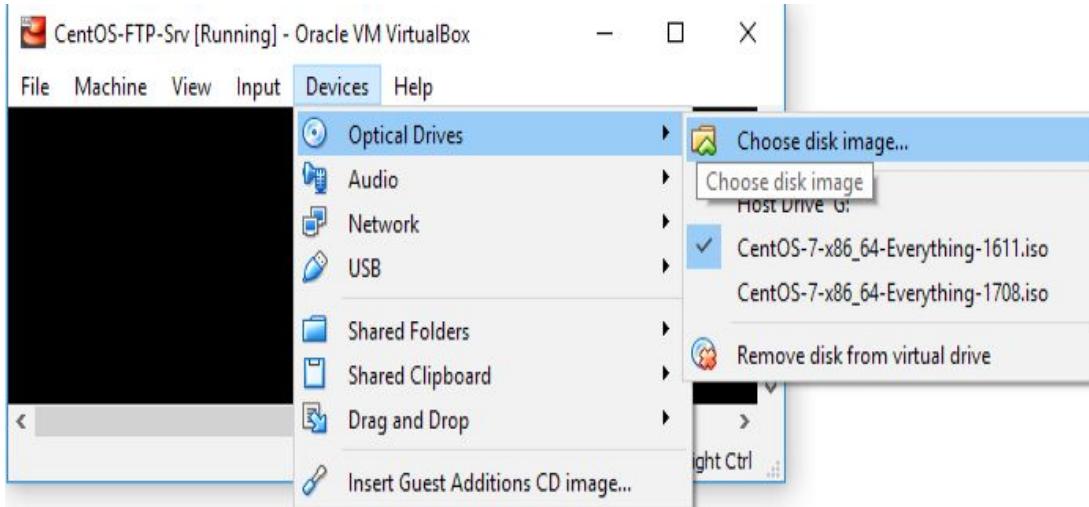


Figure 2.15: Selecting an ISO file for installation

You may consider resetting the virtual machine to restart it if the booting failed message appears. To reset the virtual machine, go to “Machines” and then click the “Reset”.

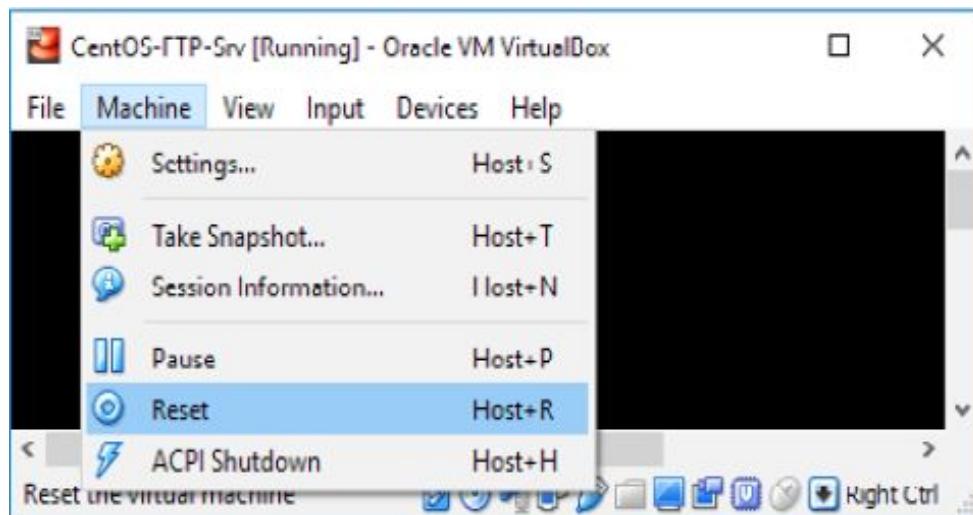


Figure 2.16: Resetting VM

Once the reset command is given, the reset confirmation dialog box would appear. Click “Reset” to confirm the reset action and then proceed with the installation.

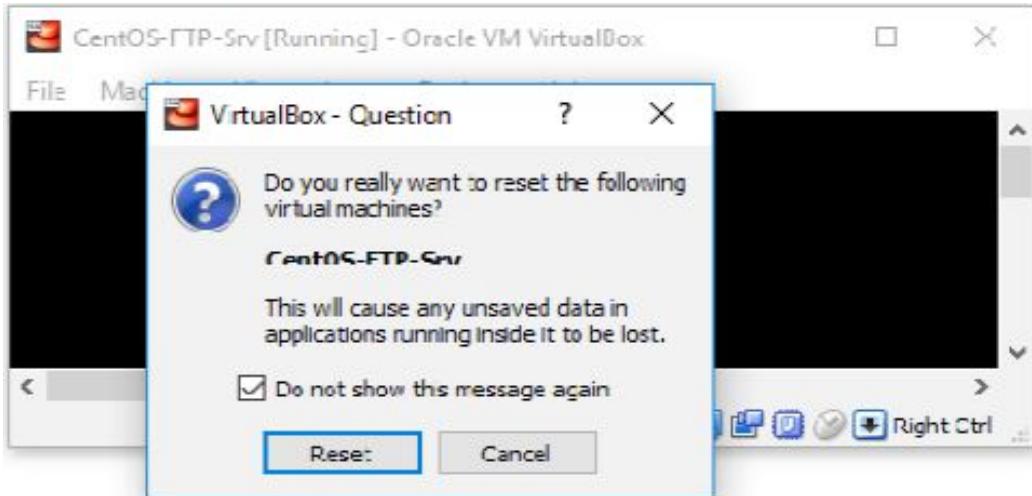


Figure 2.17: Resetting confirmation

From this point onwards, the procedure is similar to installing CentOS 7 as a host Operating System on a real hardware. For this virtual machine, the CentOS 7 minimal install is only required to be carried out.

If you require the virtual machine to fit the whole display screen use Ctrl (right) + F key combination, or if you want the virtual machine to be viewed in a scaled mode use Right Ctrl + C key combination. Also, in case if your mouse cursor gets caught up inside the Virtual Machine's window, use Ctrl (right) key to let you move and click out of the Virtual Machine's window.

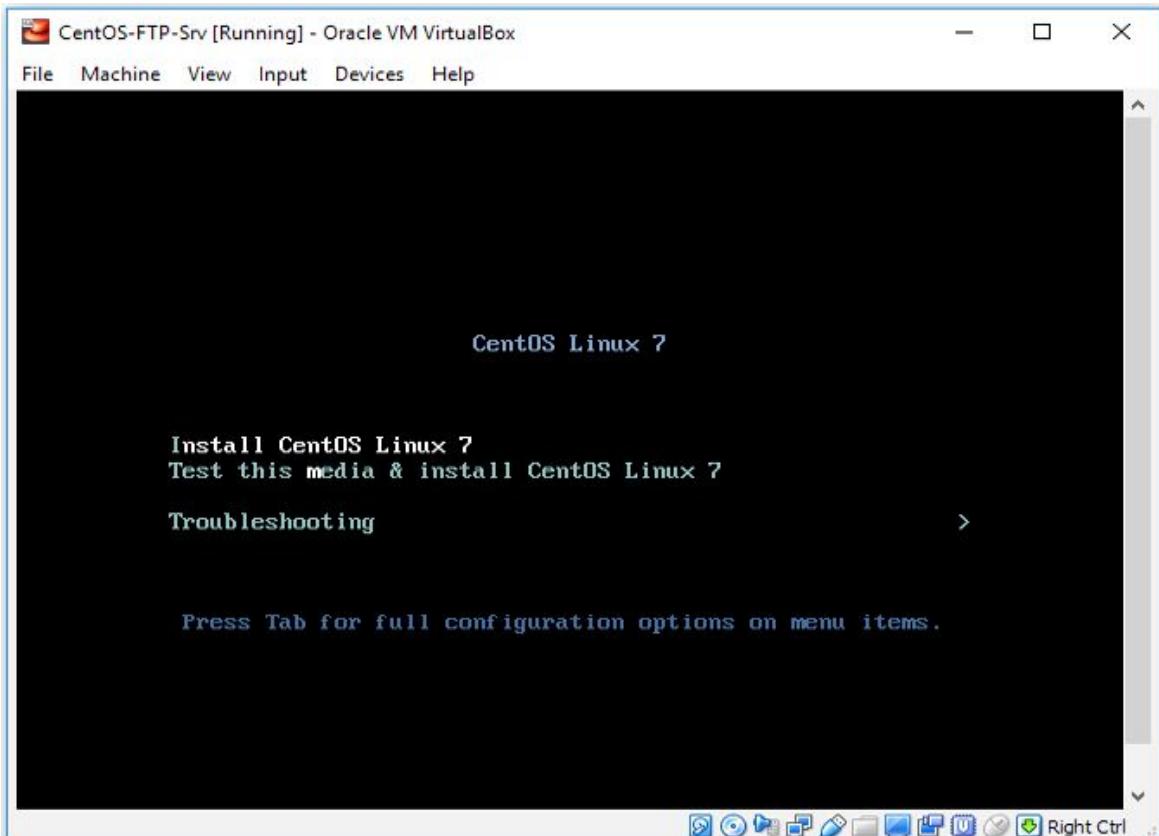


Figure 2.18: Installation process (started)

Once the installation is complete, you can start using the Virtual Machine by clicking “Reboot”.

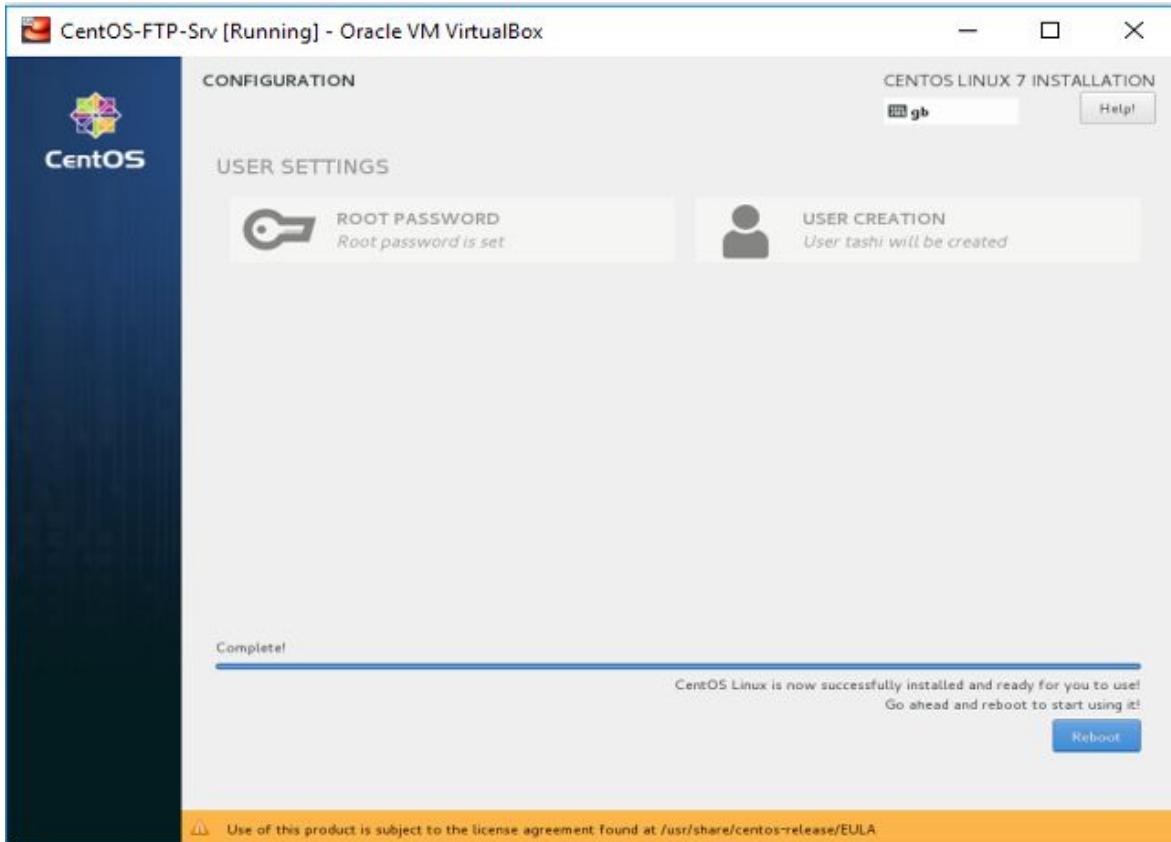


Figure 2.19: Installation process (completed)

*The installation process is shown here as fast forward steps. The rest of the steps are skipped assuming that the learner is equipped with the basics of Linux Operating System installation. In case you are a beginner, get a copy of the book *Linux System Administration (A Hands-on Guide)*.*

Once the booting completes, the similar login screen would be displayed for the CentOS 7 minimal install.

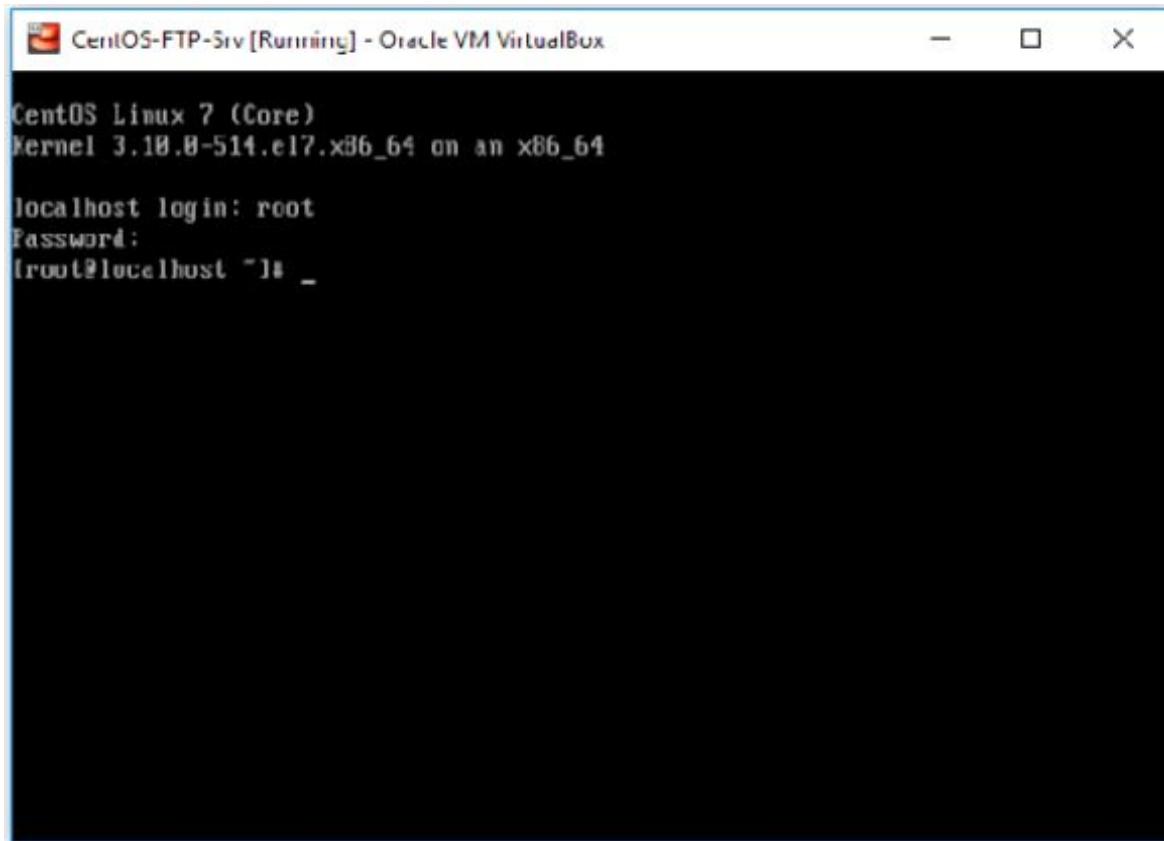


Figure 2.20: Login prompt of the VM

When you are done with the use of the Virtual Machine, you can close the Virtual Machine by choosing one of the options shown when you click to close the Virtual Machine window. Choosing the first option would save the current state of the virtual machine and when you start the machine next time, you would be able to continue from where you left the previous time. If you wanted to shutdown properly, the second option is used, while choosing the third option equates to switching off the system using the power off button on a real system. So, to shut down, choose the second option and click "OK".

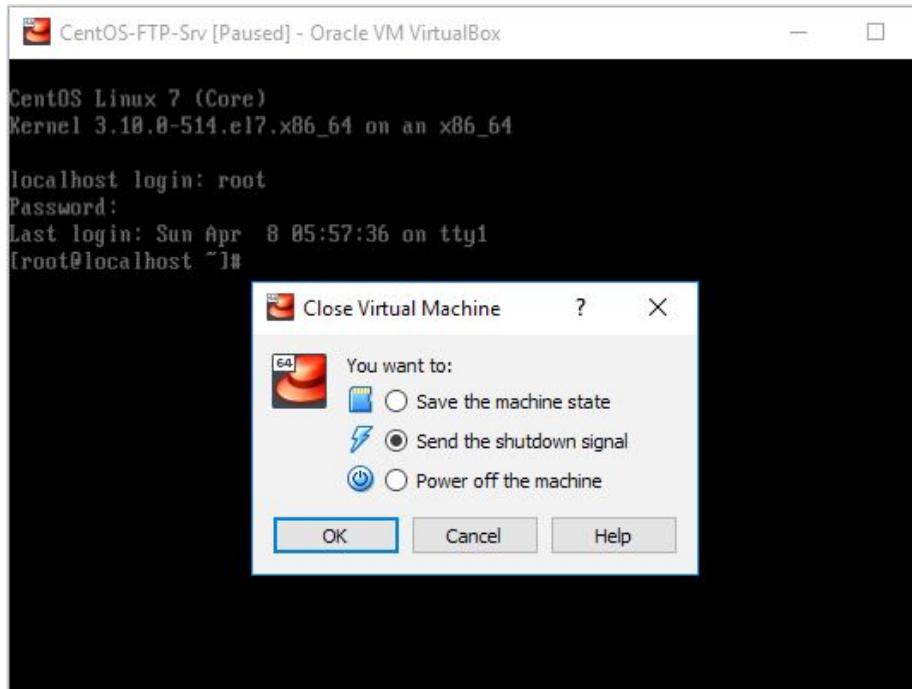


Figure 2.21: Shutting down the Virtual machine

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Chapter 3

Creating Adaptors and Cloning VMs

Oracle VM VirtualBox Manager has made working with it very easy. We have to install a particular Guest Operating System on a Virtual Machine in VirtualBox only once; then it allows to clone the virtual machine saving our time and efforts. Also, if multiple VMs are to be used, we can also create virtual adaptors. In this chapter, we will look into creating VirtualBox Host-only Ethernet Adaptors and the clones of a VM.

Host-Only Networking

In Host-Only Adaptor the Host machine and the Guest VMs are on a private network, where the Host can provide DHCP services to the Guest VMs. In order to configure the Host-Only networking, we have to create a required number of VirtualBox Host-only Ethernet Adapter(s). The requirement of the VirtualBox Host-Only Ethernet Adaptors actually depends on the number of the guest VMs to be used for the networking.

By default, one VirtualBox Host-Only Ethernet Adaptor is created when the Oracle VM VirtualBox Manager application is installed. The VirtualBox Host-Only Ethernet Adaptor will be listed under the “Host-only Adaptor” as shown in the following figure.

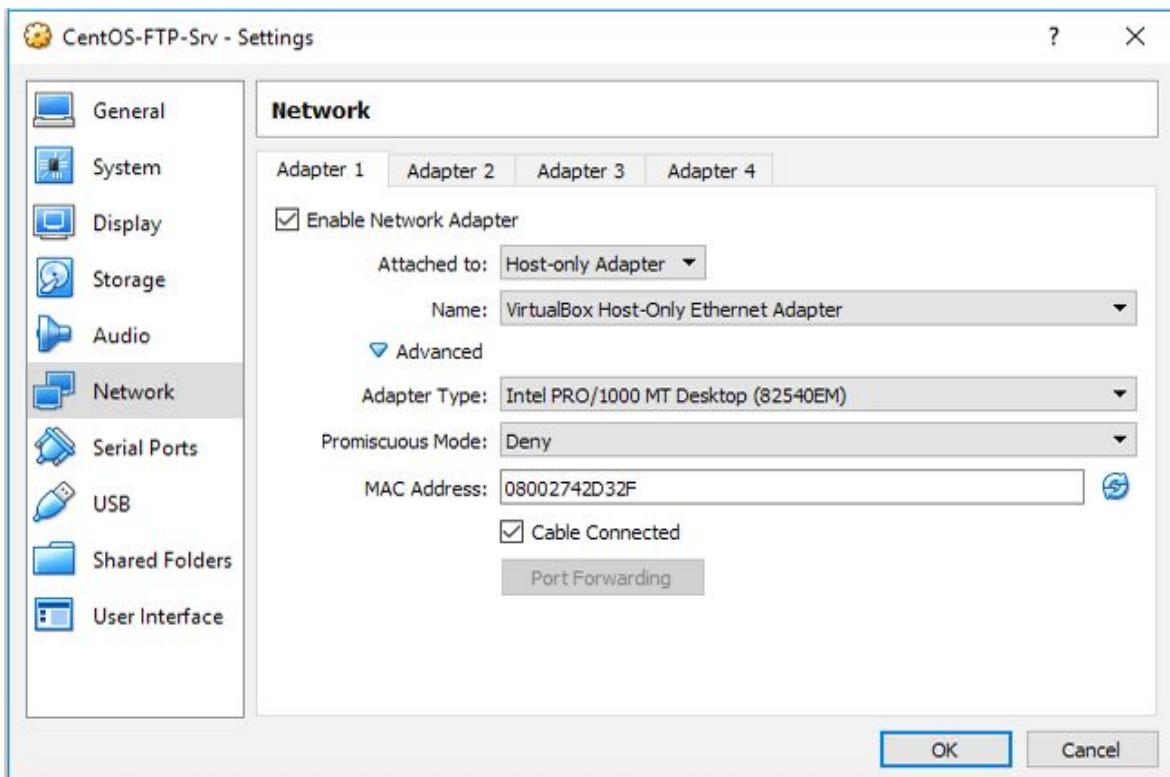


Figure 3.1: Default VirtualBox Host-Only Ethernet Adaptor

If more adaptors are required as per the networking plan, accordingly we have to create the required numbers. Assuming that we require seven VirtualBox Host-Only Ethernet Adaptors excluding the first adaptor, we will go onto the creation of the adaptors.

Creating VirtualBox Host-Only Ethernet Adaptors

To create the VirtualBox Host-Only Ethernet Adapters, in the VirtualBox Manager Window (Figure 3.2), click on the “Global Tools”.

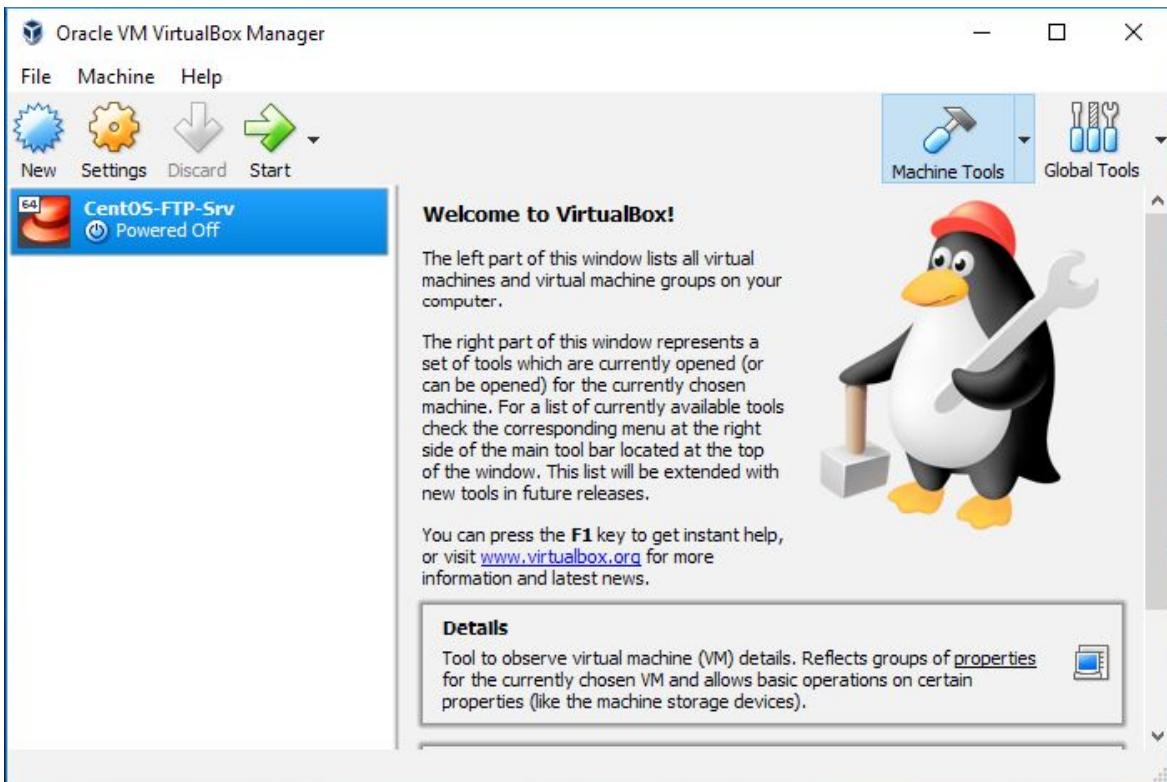


Figure 3.2: Oracle VM VirtualBox Manager window

The following screen (Figure 3.3) would be displayed. By default, “Host network Manager” tab would be selected and the “Create”, “Remove” and “Properties” buttons would be featured. This would enable us to create new adaptors, remove the existing ones and check their properties accordingly. In Figure 4.3, the first adaptor, VirtualBox Host-Only Adaptor is listed and now we can click the “Create” button to create the second adaptor and add to the list.

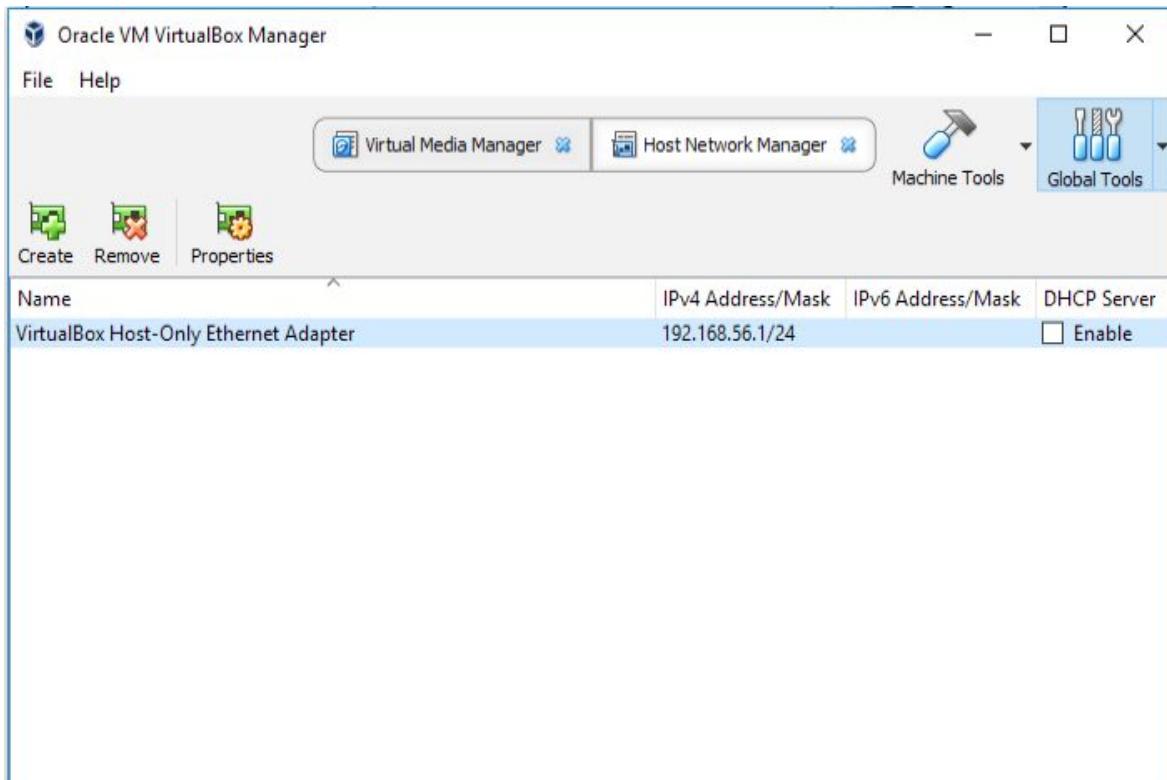


Figure 3.3: Host Network Manager window

After clicking the “Create” button, the second adaptor would be created and added to the list. The second adaptor would be indicated by “VirtualBox Host-Only Ethernet Adaptor #2”. The following figure (Figure 3.4) shows two VirtualBox Host-Only Ethernet Adaptors, the first and the second respectively. However, unlike the second adaptor, the first doesn’t have any number indication.

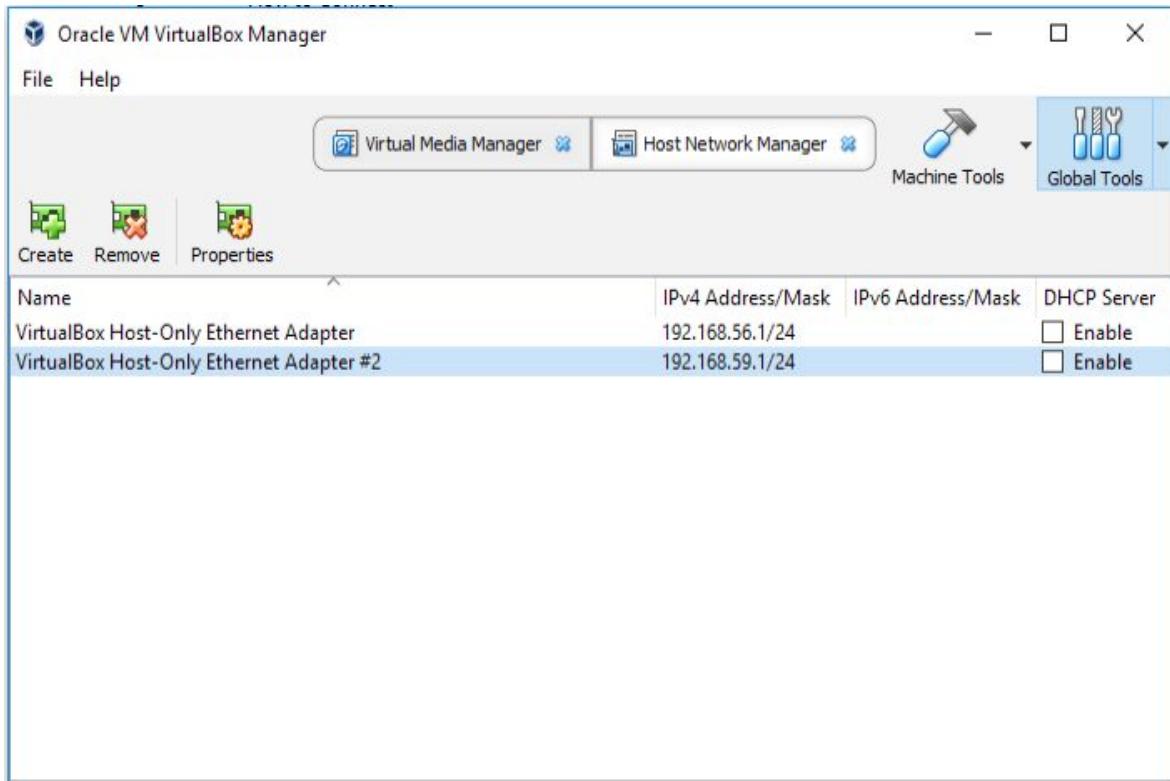


Figure 3.4: VirtualBox Host-Only Ethernet Adaptors

Following the same steps, create the remaining five adaptors by clicking the “Create” button consecutively. Finally, you would be having seven adaptors as shown in the figure below:

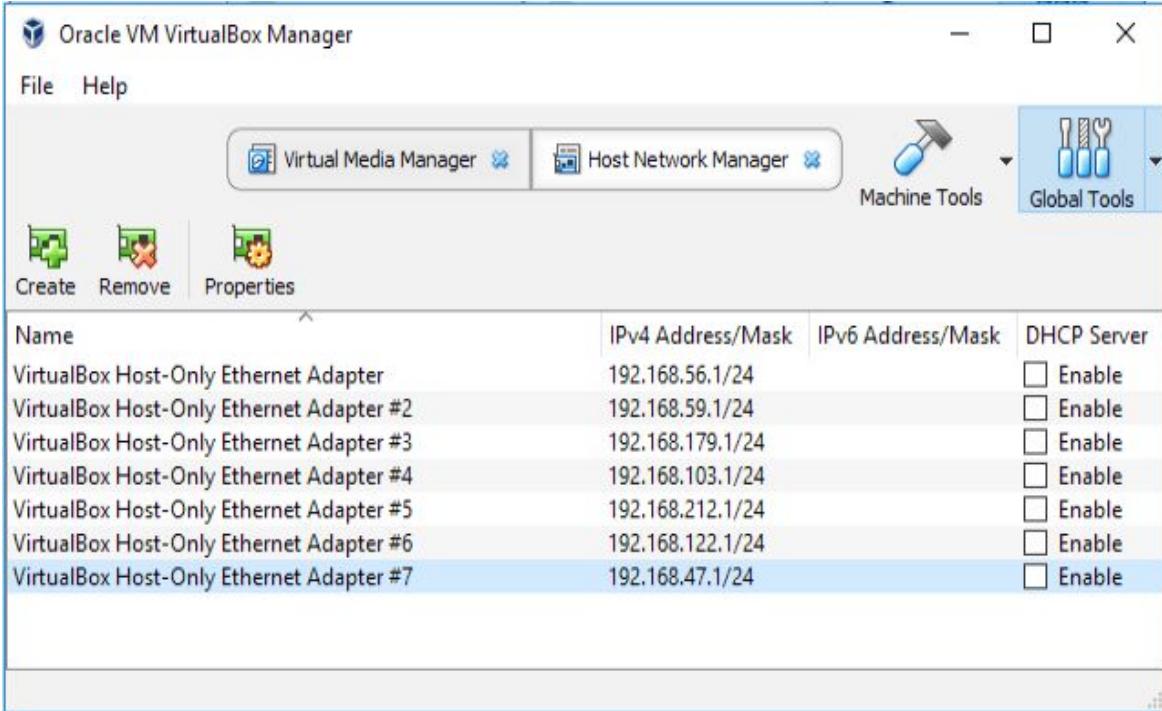


Figure 3.5: All the VirtualBox Host-Only Ethernet Adaptors listed

Removing VirtualBox Host-Only Ethernet Adaptors

In case, we have more than the required number of adaptors, we can delete the excess adaptors by selecting the adaptors and clicking the “Remove” button. Any time creating new adaptors or deleting the extra can be done from this window.

Viewing Properties of the Adaptors

Selecting an adaptor and clicking the “Properties” button gives options either to “Configure Adaptor Automatically” or to “Configure Adaptor manually”. Selecting either one requires some network setting details as per the existing network or the planned network. In the following, VirtualBox Host-Only Ethernet Adaptor #7 is chosen and the properties are displayed:

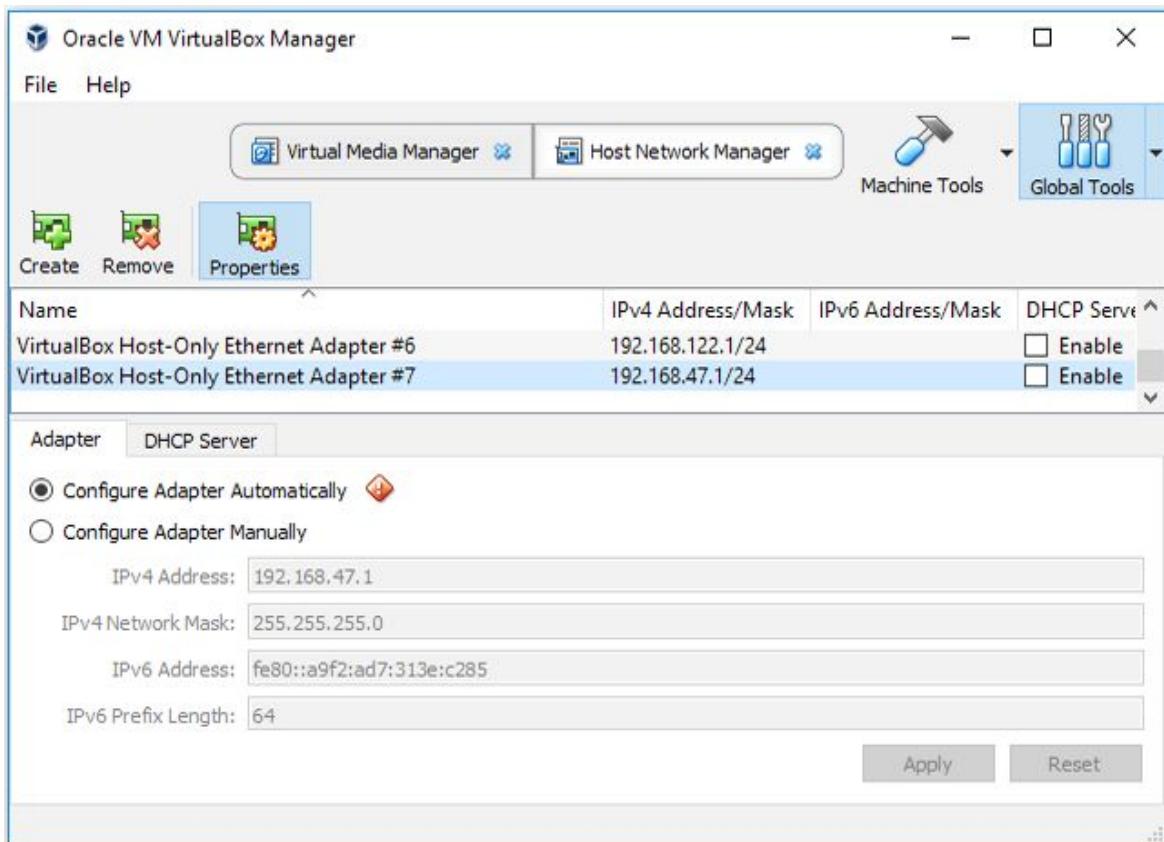


Figure 3.6: Configuring Host-Only Ethernet Adaptor automatically

Choosing “Configure Adaptor Automatically” and enabling DHCP Server would allow the VirtualBox to assign IP addresses and on the other hand, if we wanted to configure adaptor automatically using the DHCP Server other than the in-built VirtualBox’s DHCP Server, then it is recommended to choose “Configure Adaptor Automatically” and leave the “Enable Server” option unchecked in the DHCP Server tab as shown below:

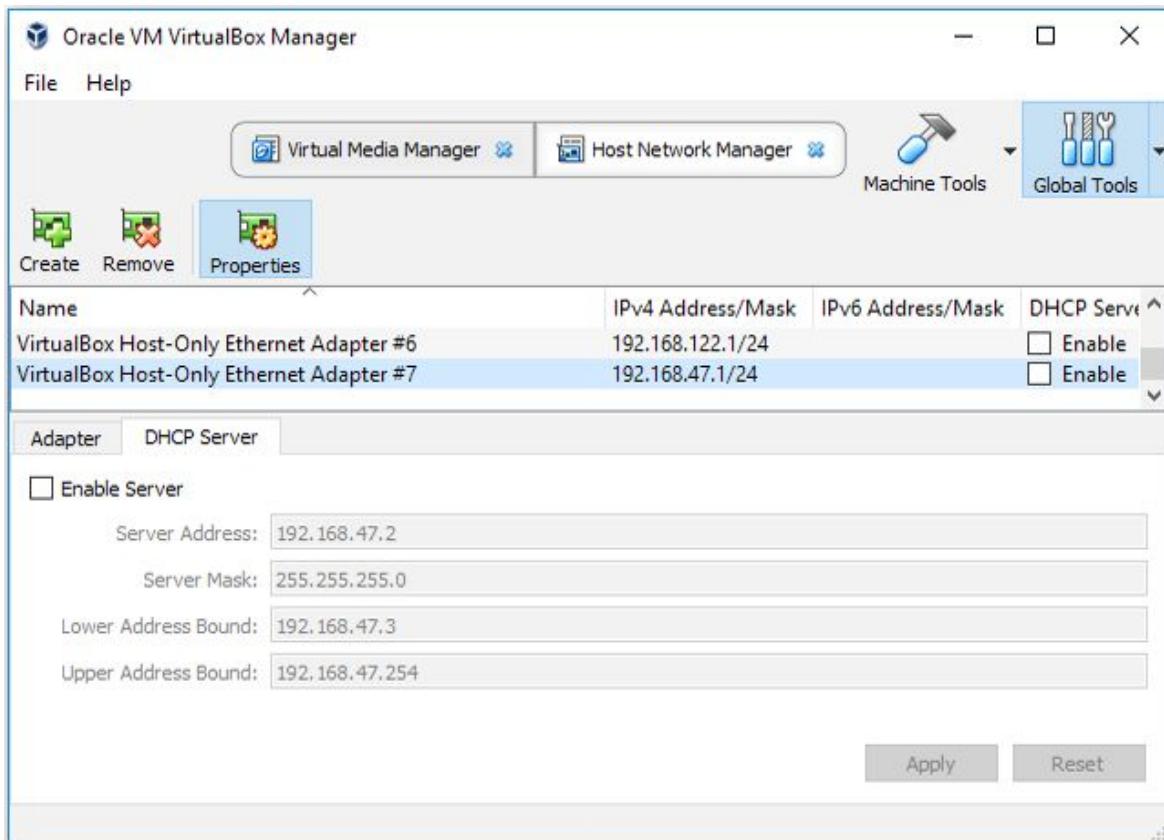


Figure 3.7: Disabling VirtualBox’s in-built DHCP Server

The VirtualBox Host-Only Ethernet Adapters can be set to “Configure Adaptor Automatically” without enabling the VirtualBox’s in-built DHCP Server, so that we can use our own DHCP Server to assign the IP addresses without the interference of the VirtualBox’s in-built DHCP Server.

Virtual Machine (VM) States

When the attempt is made by the users to close the running Virtual Machine in the VirtualBox by either clicking the close button or by pressing the Host and the Q key combination, the VirtualBox would prompt the user with the options as shown in the following figure (Figure 3.8):

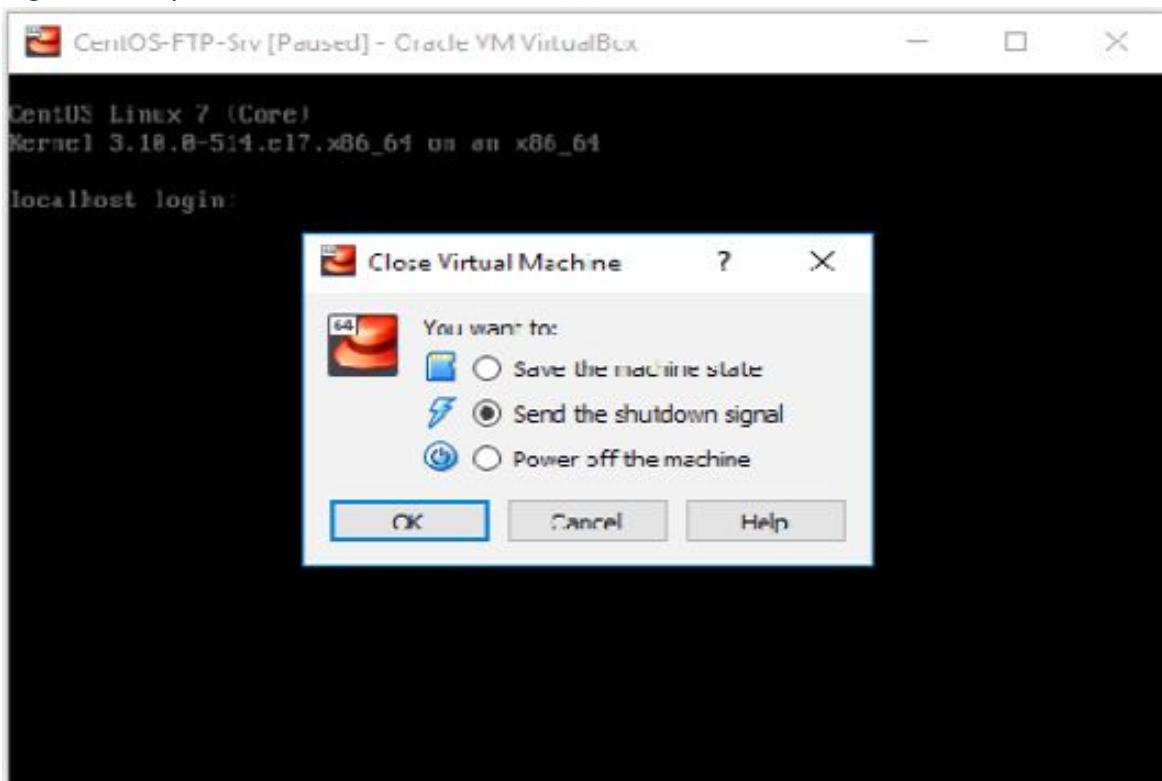


Figure 3.8: Options for closing Virtual Machine

Depending on your need, choose one of these options and choose OK. The description of each of these states are explained below:

- **Save the machine state:** The virtual machine will be stopped from running and VirtualBox completely saves the VM's state to the user's local disk. The virtual machine will resume operation and the programs will be available from the point where you left, when you start it again. The user's computer will resume operation and the programs will still be available.
- **Send the shutdown signal:** This option will send the ACPI

shutdown signal to the Virtual Machine, which is similar to pressing the power button on a real computer.

- ***Power off the machine:*** This option also permits the virtual machine to stop running but it does not save the state of the VM. This option is similar to pulling the power cord from the real computer hardware which would cause potential loss of information. In the next start, the system will have to go through an extensive inspection of the virtual disks. The same results as powering off the machine will be achieved when pressing the “Discard” button in the main window of VirtualBox.

Saving and Discarding VM's State

While working with the VirtualBox, it pays to save the machine state sometimes and start the VM whenever we need. This saves the time taken for not having to start the VM all over again every time we require to work. So, to save the machine state, choose the VM which you wanted to save its state and click on the close button. Upon clicking the close button, the options as shown in the following figure would be displayed; choose “Save the machine state” and click “OK”.

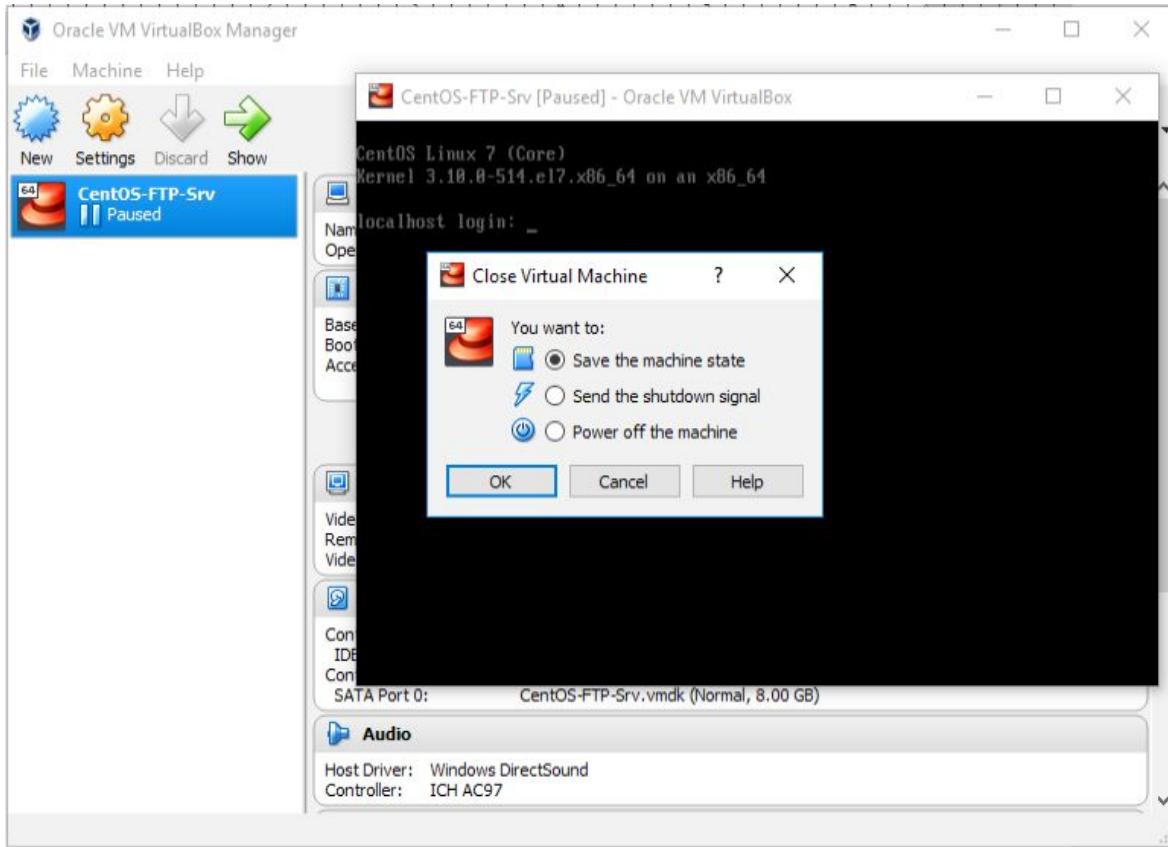


Figure 3.9: Saving the virtual machine state

Once the machine state is saved, the corresponding VM state would appear as saved in the VirtualBox VM list as shown in the following figure (Figure 3.10):

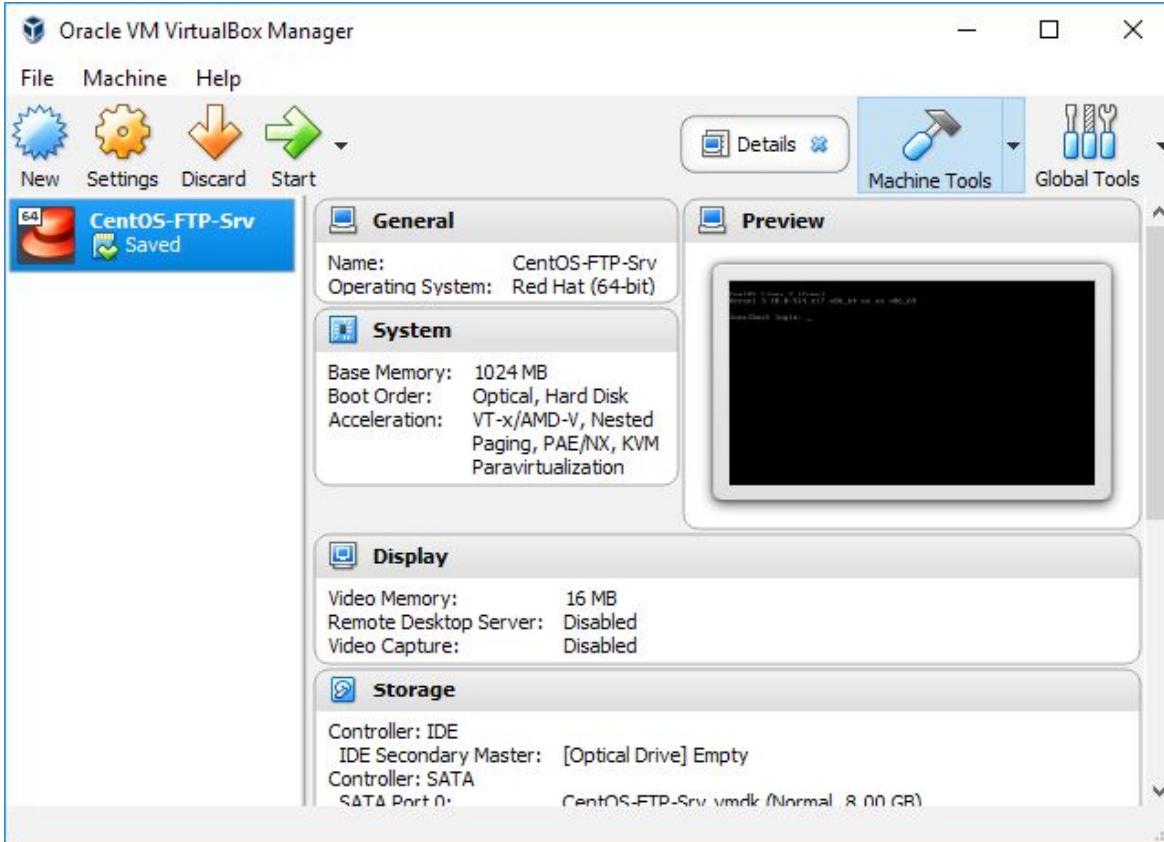


Figure 3.10: Saved machine state

If the machine state had been saved successfully, we will find the “Discard” button enabled in the display menu. So, if you wish to discard the saved machine state, simply clicking the “Discard” button would remove the saved details of the VM and the next time when we require to work with the VM, we won’t be able to continue from the point where we left earlier.

Cloning VMs

Cloning a Virtual Machine will result in the creation of an exact copy of the selected virtual machine in the VirtualBox. Cloning saves the time that otherwise would be spent in creating a virtual machine with similar features and settings. Cloning a virtual machine is useful in a number of ways. For example, if you wanted to do some experiments with a virtual machine configuration or want to test the different guest operating systems or want to take the backup a VM, creating a clone of a virtual machine would be a wise decision. In this section, we will learn to make clones of the virtual machines. Assuming that the CentOS on the virtual machine (CentOS-FTP-Srv) is required to be cloned, we will proceed with the cloning of the virtual machine.

Launch the Oracle VM VirtualBox Manager and select the desired virtual machine from the list to be cloned, if in case you have multiple virtual machines created. In the figure 3.11, CentOS-FTP-Srv is going to be cloned. Since it is only the virtual machine, by default it gets selected.

Before you start to clone, make sure that the selected virtual machine is not in the “Saved” state. If it is in the saved state, we have to discard the saved state and then only start to clone.

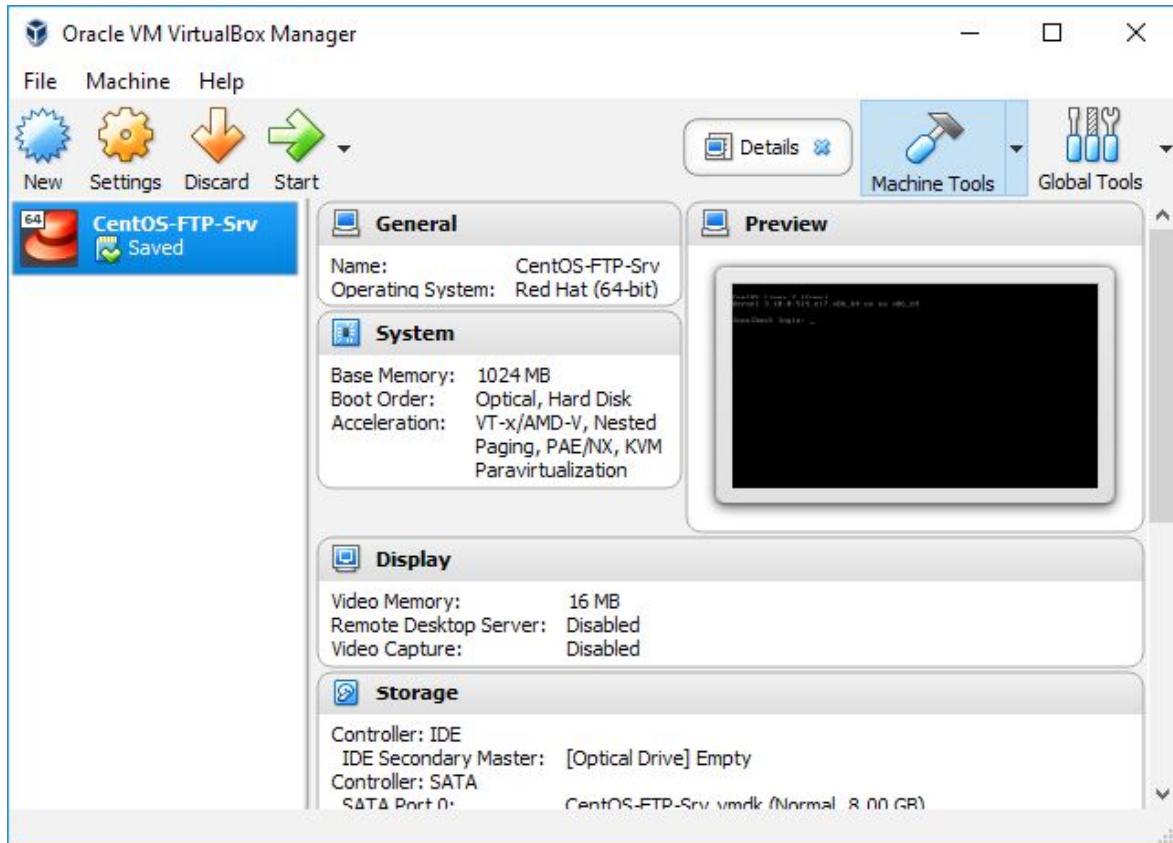


Figure 3.11: Selected Virtual Machine in the list

To create a clone, after selecting, right-click and click Clone in the options provided as shown in the figure 3.12:

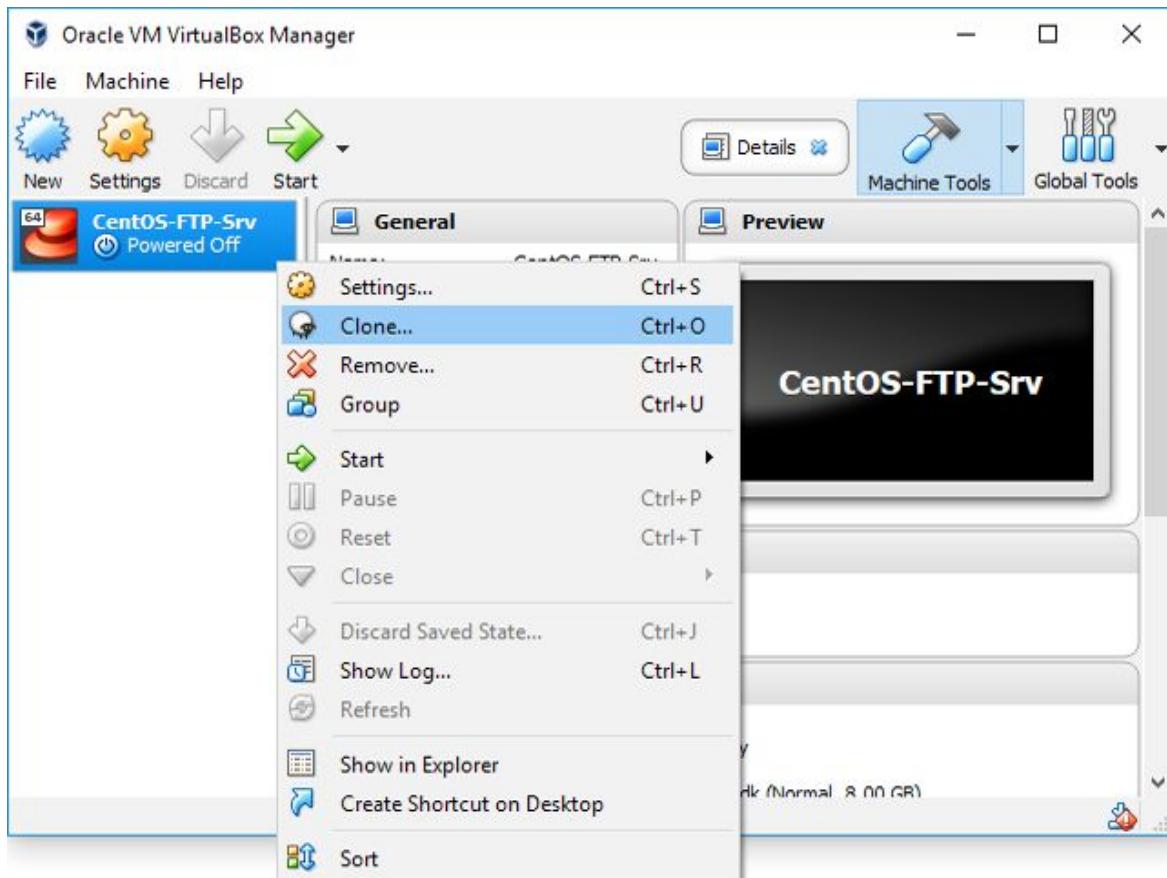


Figure 3.12: Showing the clone option

You will be prompted to choose a name for the clone and asked whether you want to reinitialize the MAC of the network card(s) included with the machine. In the virtual machine name field, you can set to something different from the machine (base) where you are cloning from and must choose the “Reinitialize the MAC address of all network cards” option. Here, the name is set to CentOS-DHCP-Srv and the option is chosen to reinitialize the MAC addresses of the network cards as shown in the figure 3.13. Click “Next” to continue.

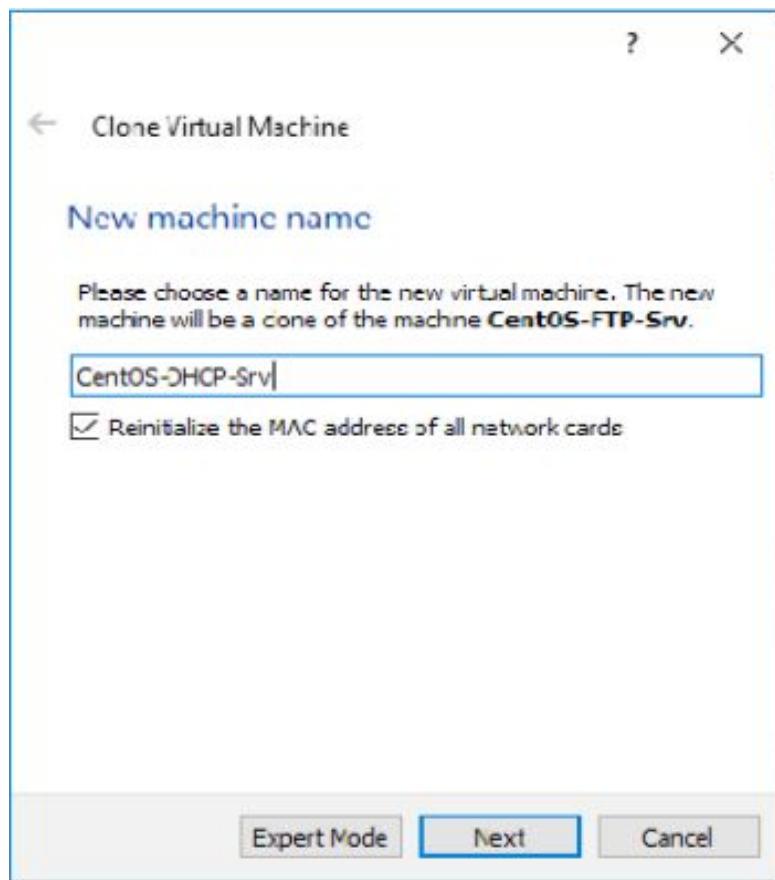


Figure 3.13: Naming the clone and reinitializing network cards

We have the option to either choose the “Full clone” or the “Linked clone”. Choosing the “Full clone” would create independent disks for the cloned virtual machine which will enable us to move resources easily around. So, choose the “Full clone” option and click the “Clone” button to proceed.

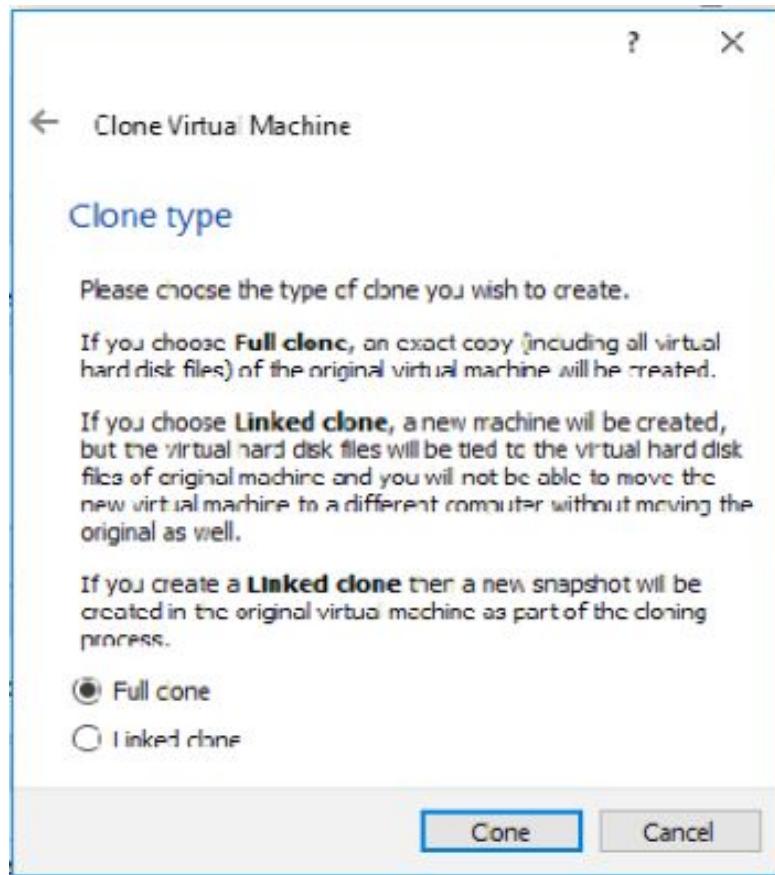


Figure 3.14: Choosing the Clone Type

Upon the completion of the cloning process, the cloned virtual machine will appear in the virtual machine list with the name which we have specified to change.

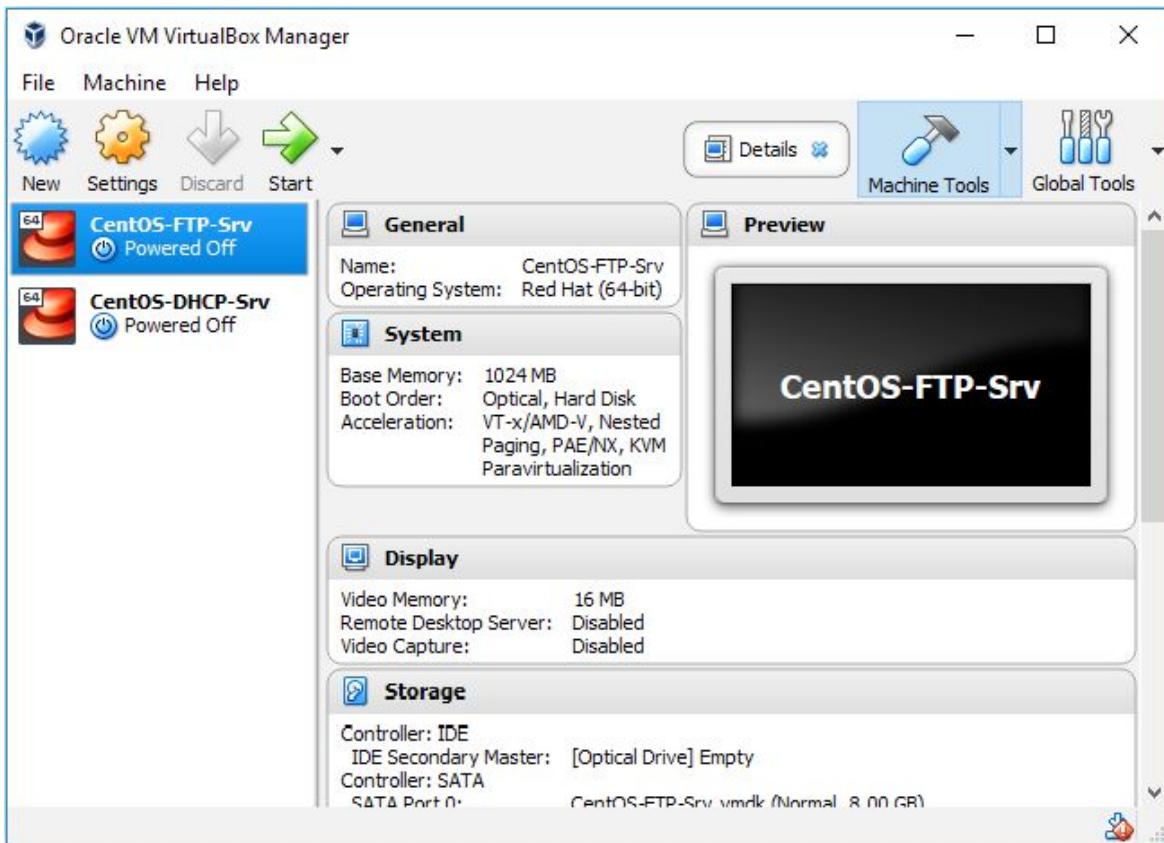


Figure 3.15: Showing the Cloned VM in the list

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Chapter 4

Exporting and Importing Appliances

In the situations, where you will have to copy the virtual machine files from one system to another system, exporting and importing the virtual machines as a virtual appliance (VA) is a good way. A virtual appliance is a virtual machine file which consists of a pre-configured operating system (OS) environment as a single application. Exporting the virtual machines as appliances is one of the easiest and most reliable ways to move VMs from one host to another host. In this section, we will learn to export the virtual machines as a virtual appliance and import it to another system.

Exporting as Virtual Machine as Appliance

To export the virtual machine as an open virtual appliance (OVA), launch the Oracle VM VirtualBox Manager, go to the “File” menu and then to the “Export Appliance” as in figure 4.1:

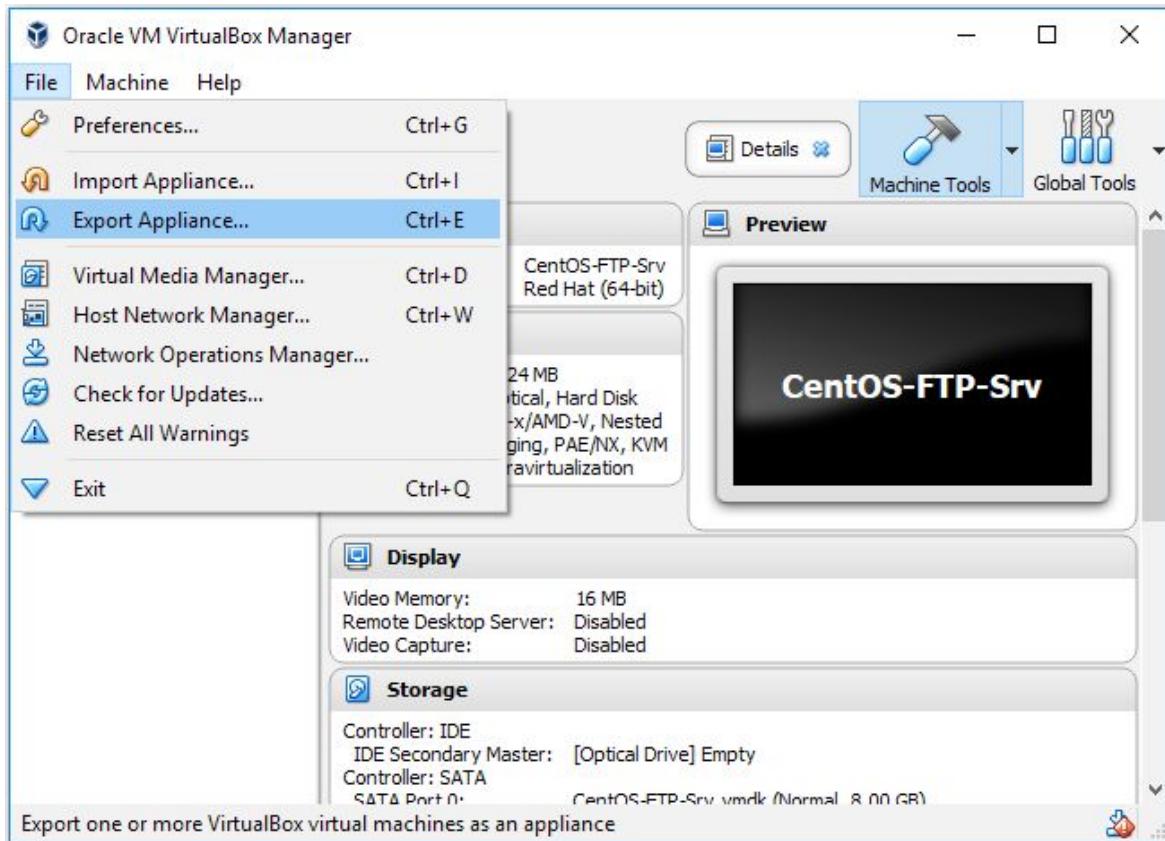


Figure 4.1: Exporting Appliance menu

In order to be able to export as an appliance, your selected virtual machine should not be running. In case if it is running, it must be powered-off. Even if the virtual machine is in the saved state, the exporting will not be allowed unless the saved state is discarded.

In the window presented after choosing “Export Appliance”, locate and select the Virtual Machine to be exported and click Next (Figure 4.2).

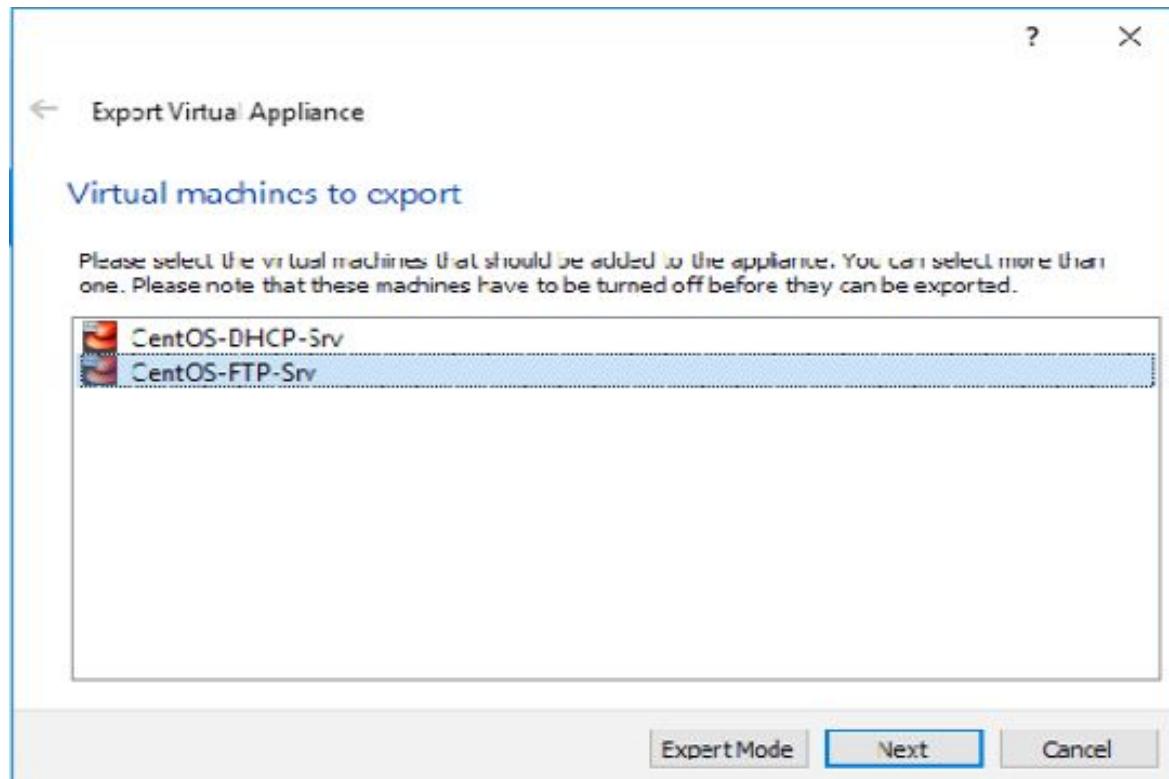


Figure 4.2: Virtual Machine selection for exporting as an appliance

In the next, we are supposed to give a name for the exported appliance file with an extension and browse to the location to save the exported appliance file (Figure 4.3).

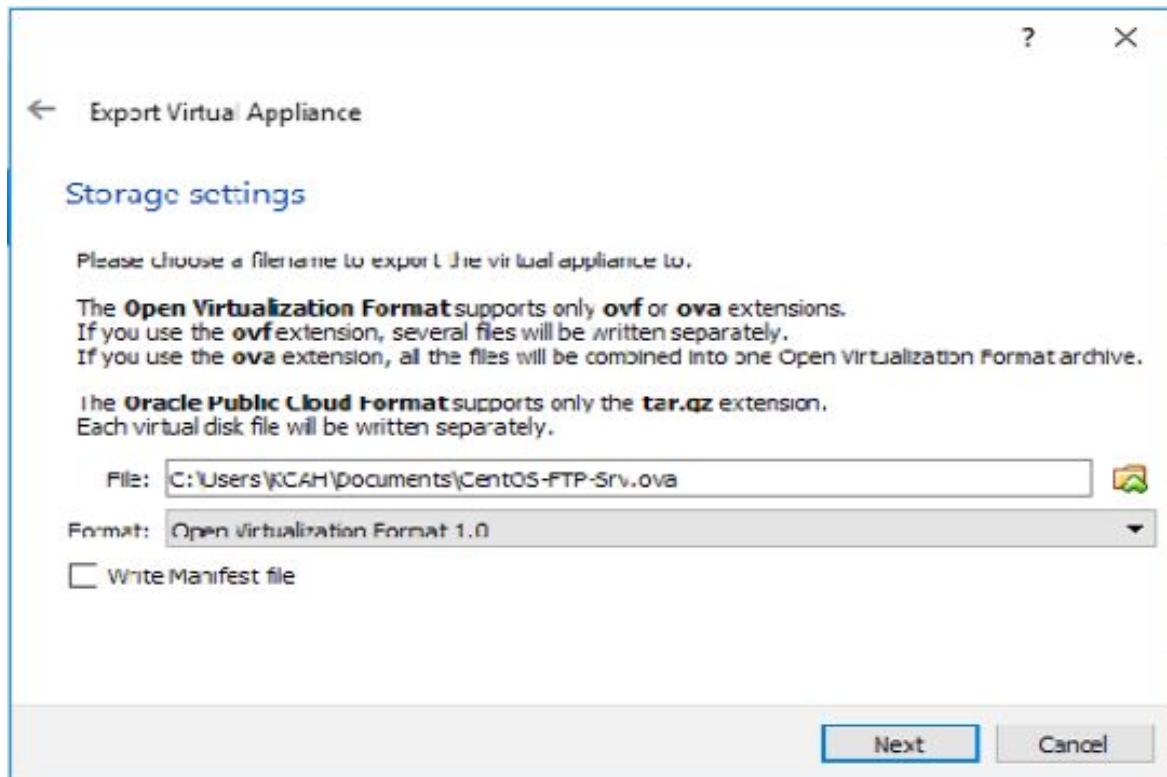


Figure 4.3: Exported Appliance Settings

By default, the exported file will be saved with ova extension in the default location. If the extension is ova, the appliance is going to be in a single file whereas if ovf extension is chosen, several files are going to constitute the exported appliance. Just keeping to the defaults should be working fine.

In the appliance settings, leaving the information, click the “Export” button to start the exporting process.

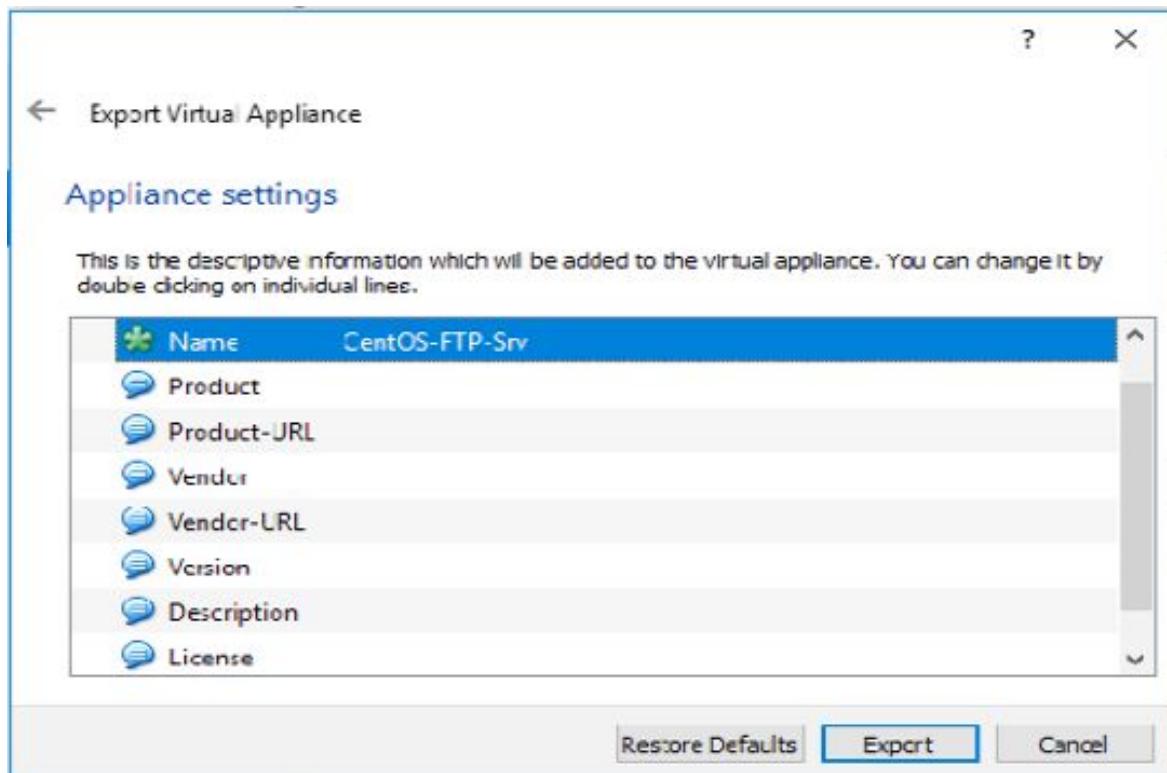


Figure 4.4: Appliance settings

The exporting process would take few minutes to complete and once the process gets completed, the exported appliance with an ova extension is expected to be in the location you have selected for saving. Copying it and saving it to the other safe locations will not have any problem with the exported file.

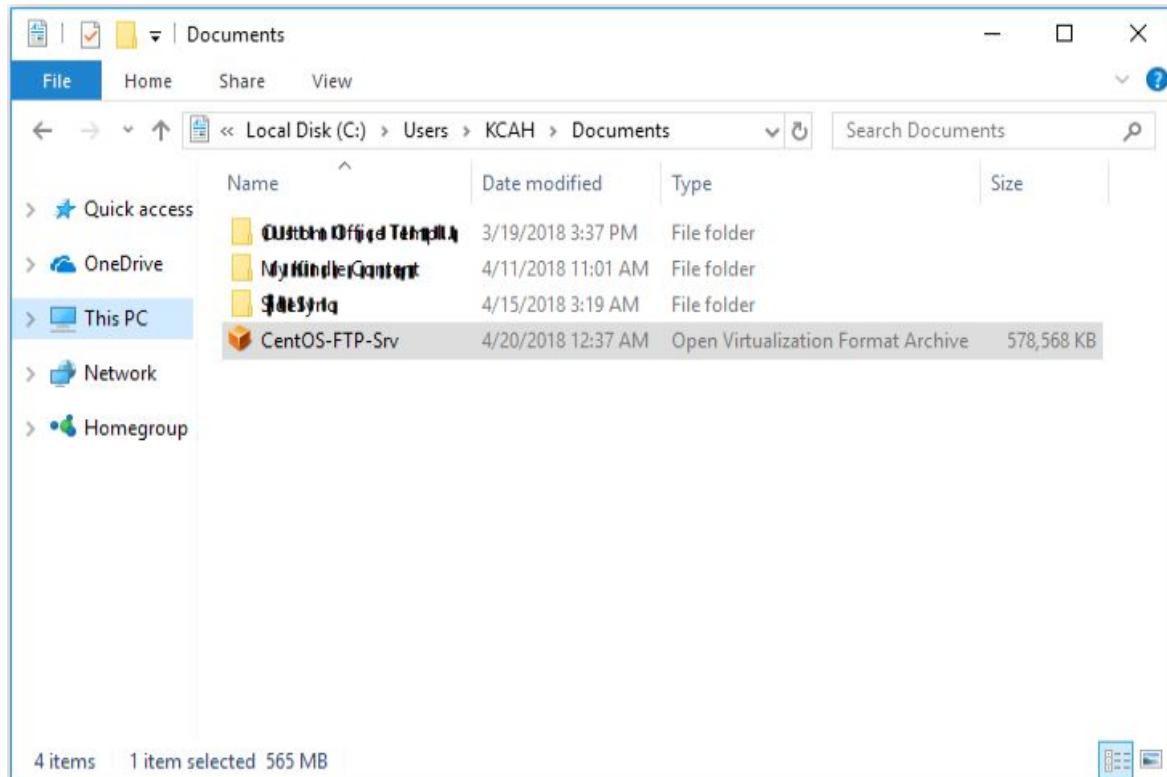


Figure 4.5: Exported Virtual Machine as an appliance

Importing Virtual Machines as Appliance

In the previous part, we have learned how to export a virtual machine as an appliance, in which the exporting process bundled all of the virtual machine resources into a single file with an ova extension. Now, to import the virtual machine, go to “File” menu and then choose “Import Appliance” as in Figure 4.6:

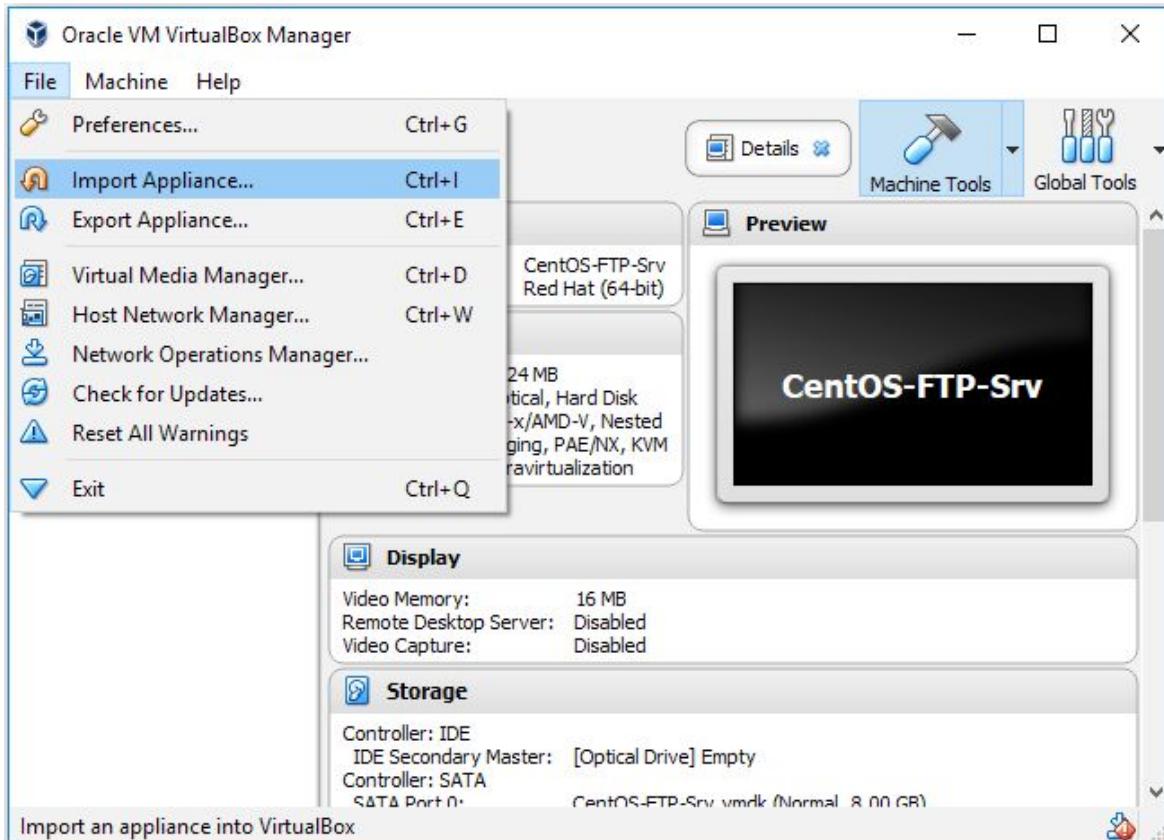


Figure 4.6: Import Appliance option

In the next, you will then be prompted to browse your system to look for the file with an ova extension as shown in Figure 4.7 and then click “Next”.

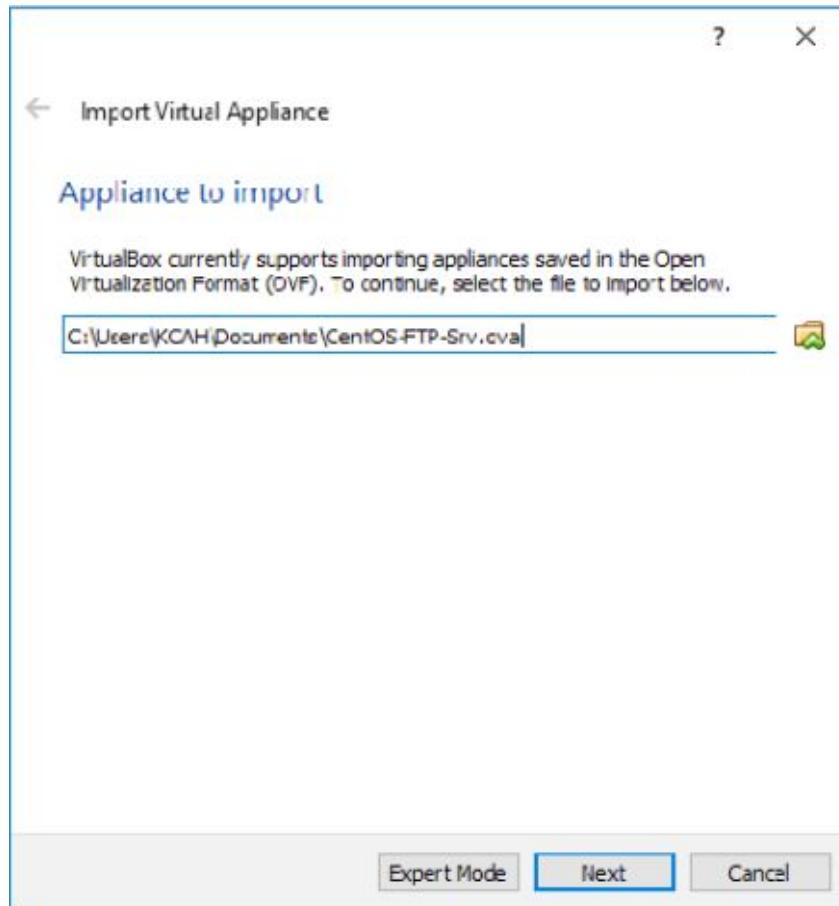


Figure 4.7: Browsing to the file location for importing

In the appliance settings information, the name must not be same as the already existing virtual machine. If the virtual machine with the same name exists, then change the name to something different by double-clicking. In figure 4.8, the name of the virtual machine is changed to CentOS-Web-Srv, leaving the rests of the settings as it is and the “Reinitialize the MAC address of all network cards” option is checked. To proceed, click the “Import” button.

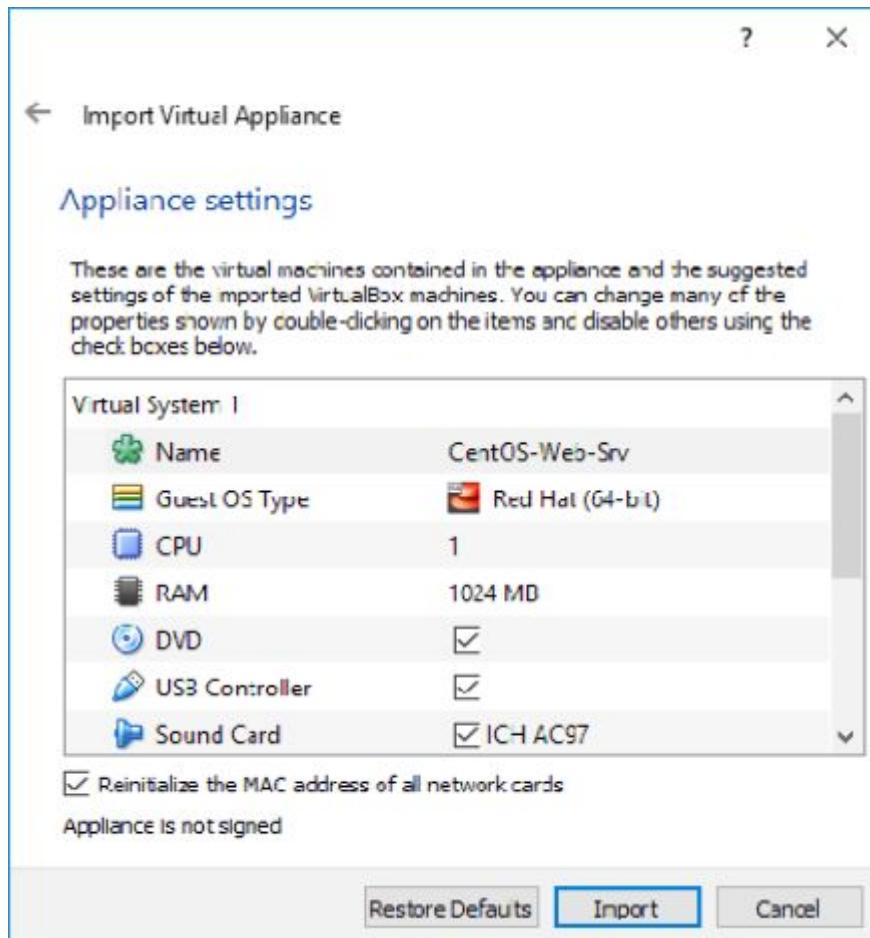


Figure 4.8: Import Appliance settings

During the process of importing, the appliance and storage settings of the virtual machine would be shown as they were set originally when it was first created. You can edit those settings and information by double clicking on the corresponding textbox and enter the desired value.

Importing of the virtual machine would take few minutes to complete and will result in creating a virtual machine with the name specified in the appliance settings. In figure 4.9, CentOS-Web-Srv is the imported appliance from the file.

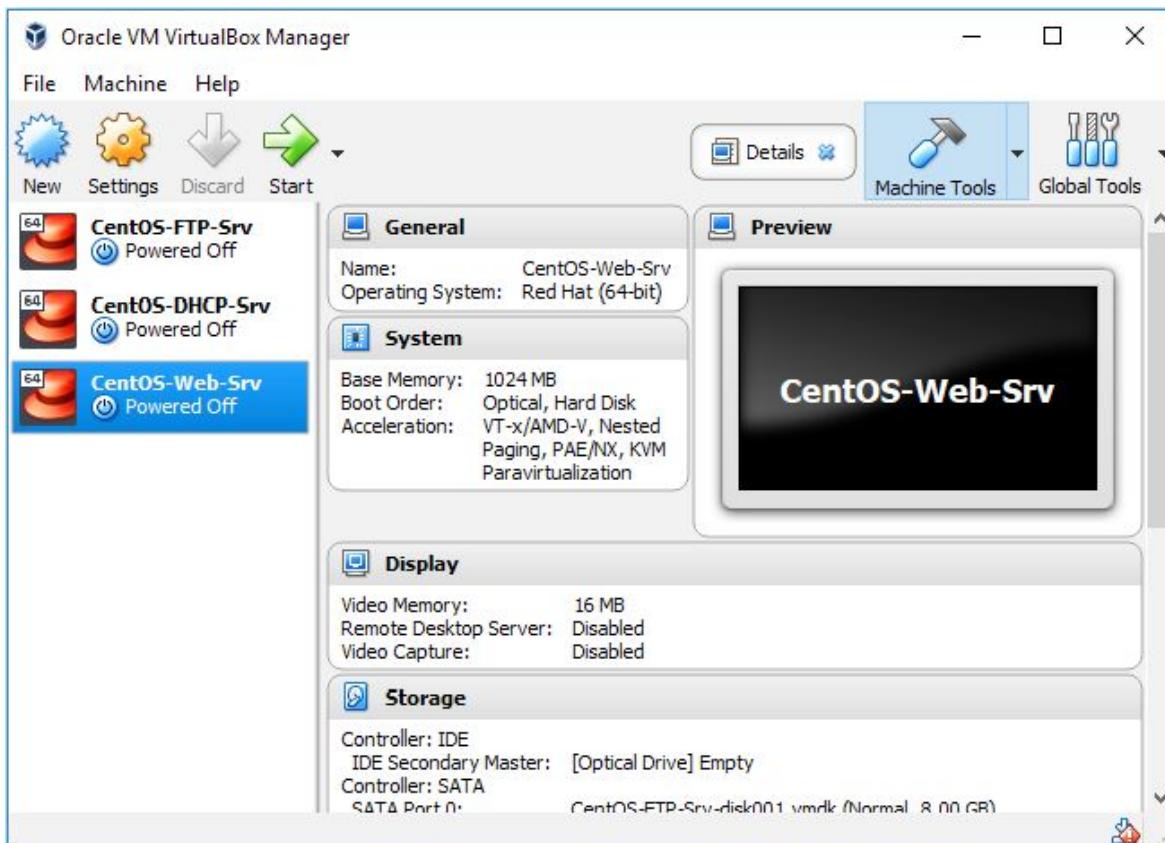


Figure 4.9: List of Virtual Machines

Removing Virtual Machines

It so happens that some of the virtual machines which we have used for testing the configurations can serve no purpose; keeping those virtual machines would just occupy space and the list become long. It is a good idea to delete one or more of such virtual machines which serves no good purpose.

To delete the intended virtual machine from the list, select and right click on the virtual machine in the list as shown in the figure 4.10 and choose “Remove”.

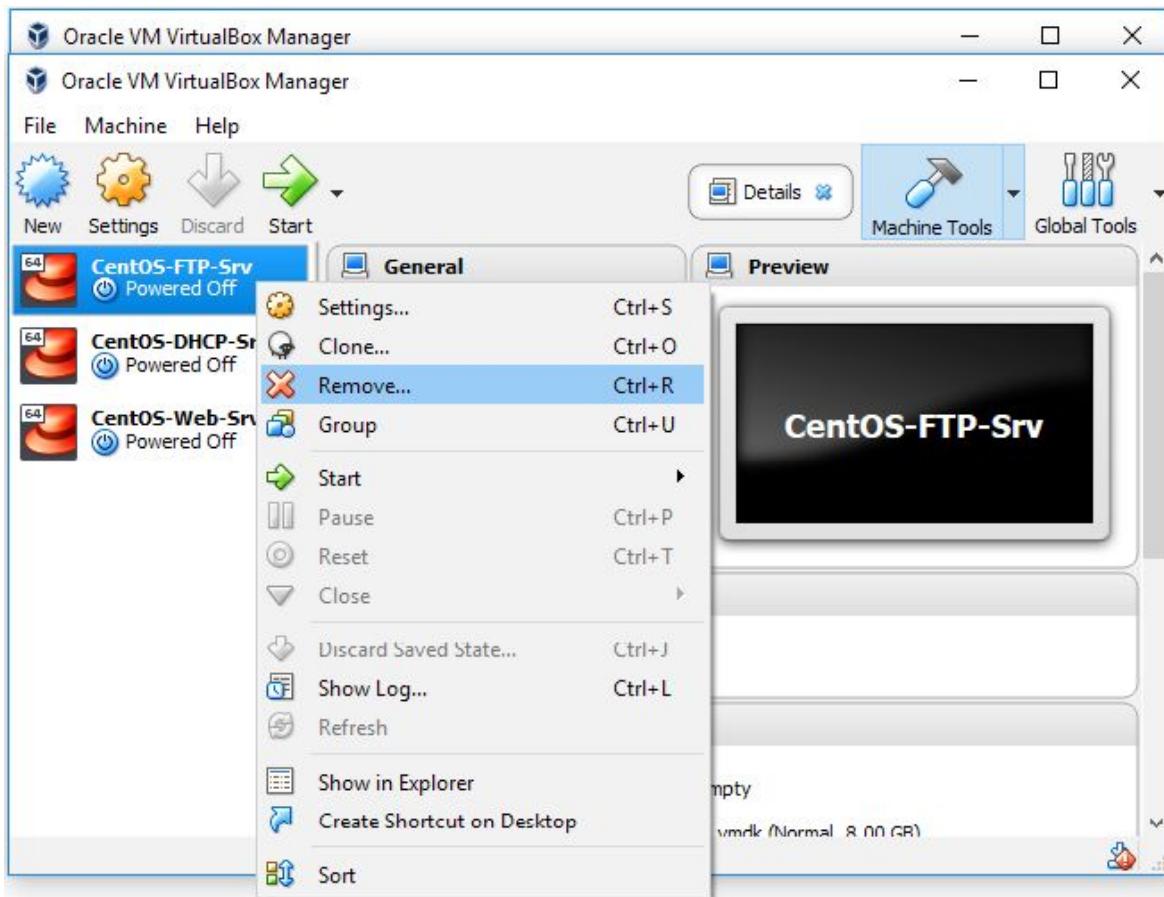


Figure 4.10: Removing Virtual Machine option

We will not be allowed to remove a running virtual machine. For this we have to power off the virtual machine and then only remove it from the list.

In the next screen, we are prompted to choose one of the options. To remove the virtual machine along with its virtual hard disks, click “Delete all files” button as in the figure 4.11.

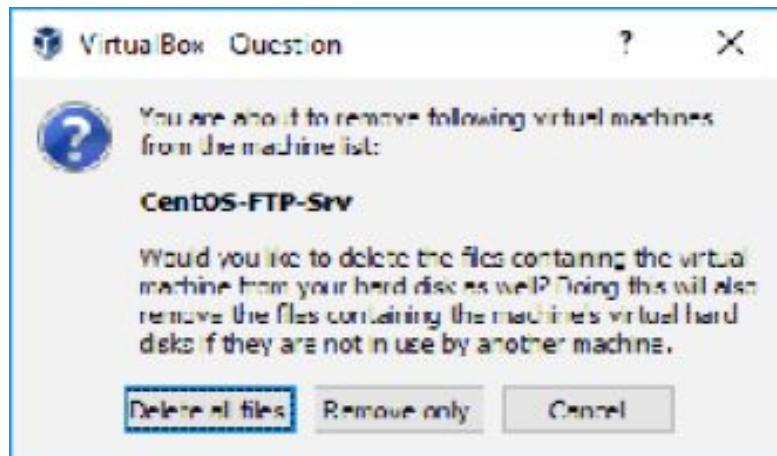


Figure 4.11: Removing virtual machine

Self Activity:

Applying the concept of creating the virtual machines, installing the operating system and cloning; create at least 6 virtual machines with CentOS operating system and then also create one virtual machine for installing Windows (Windows XP, Windows 7, Windows 8 or Windows 10).

In the Figure 4.12, CentOS-DHCP-Srv, CentOS-Web-Srv, CentOS-DNS-Srv, CentOS-Mail-Srv, CentOS-Yum-Srv are clones made from CentOS-FTP-Srv (Base) and Windows 7 a new virtual machine created with Windows 7 as the operating system.

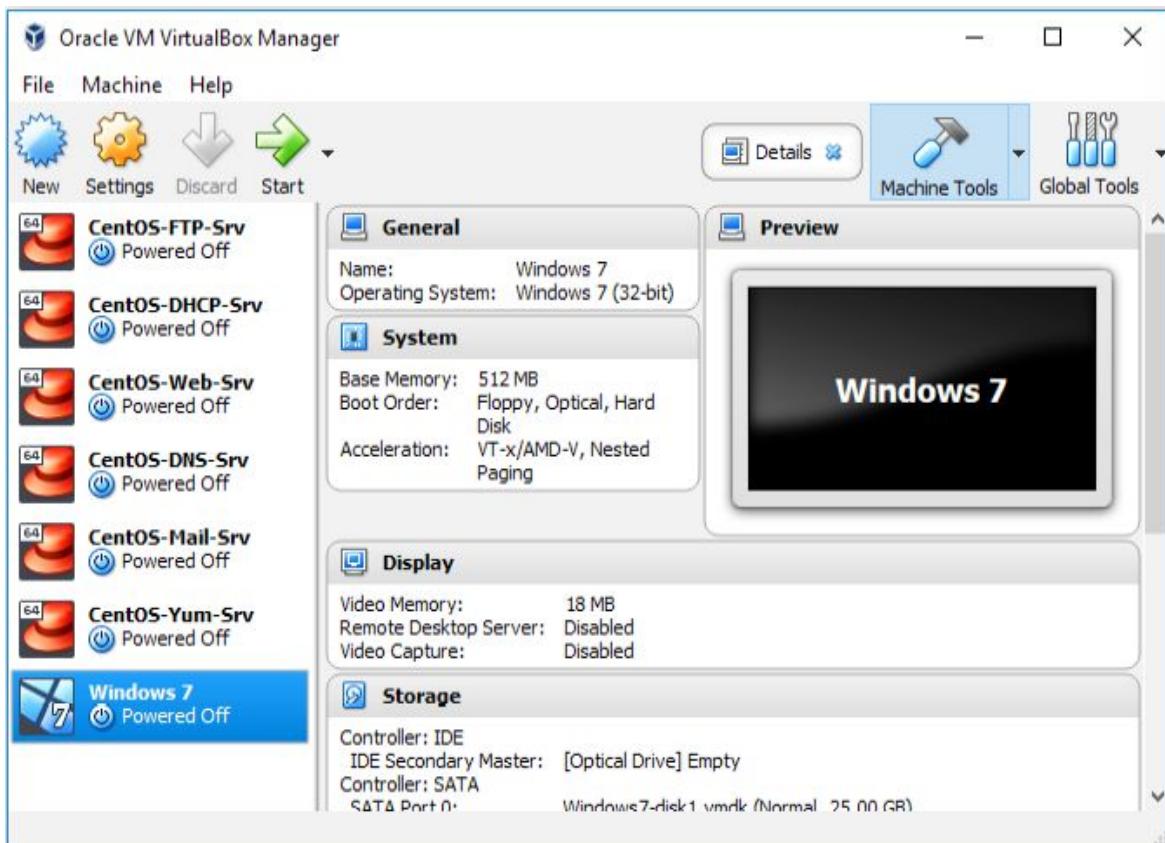


Figure 4.12: Cloned and new Virtual Machines created

Further Reading

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Chapter 5

Integrating VMs with GNS3

Till this point, we have created virtual machines and the clones of it in the Oracle VM VirtualBox Manager for CentOS and Windows 7. In order for us to be able to use the virtual machines inside the GNS3 virtualized network, we have to link virtual machines existing in the Oracle VM VirtualBox to the GNS3 so that those VMs would be available for use in the GNS3 topologies. In this section we will learn to add the existing VMs to the GNS3.

Adding VMs

Launch the GNS3 application, close the Project dialog box if it appears as shown in figure 5.1.

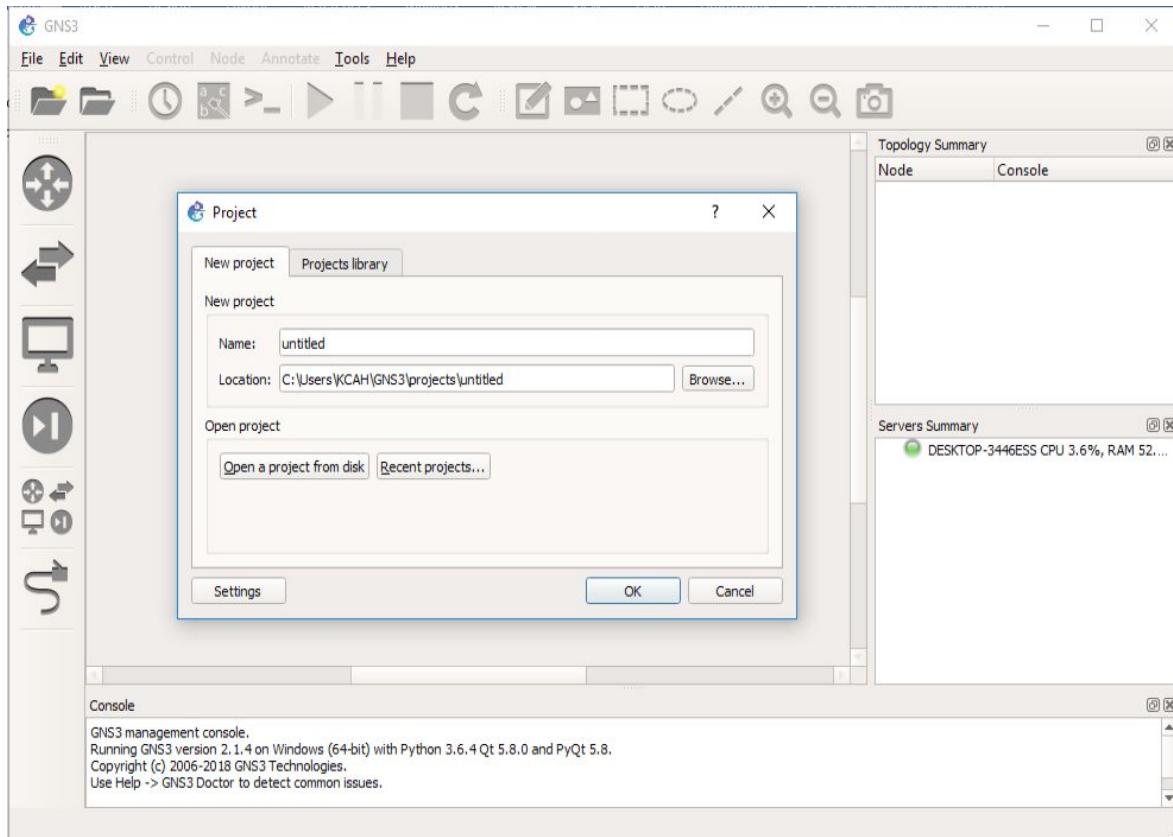


Figure 5.1: Launching the GNS3 application

Then go to the “Edit” menu and then click “Preferences” button. The following screen would be displayed and from the list, select the “VirtualBox VMs” using the mouse and then click “New” button to start adding the VMs to the GNS3.

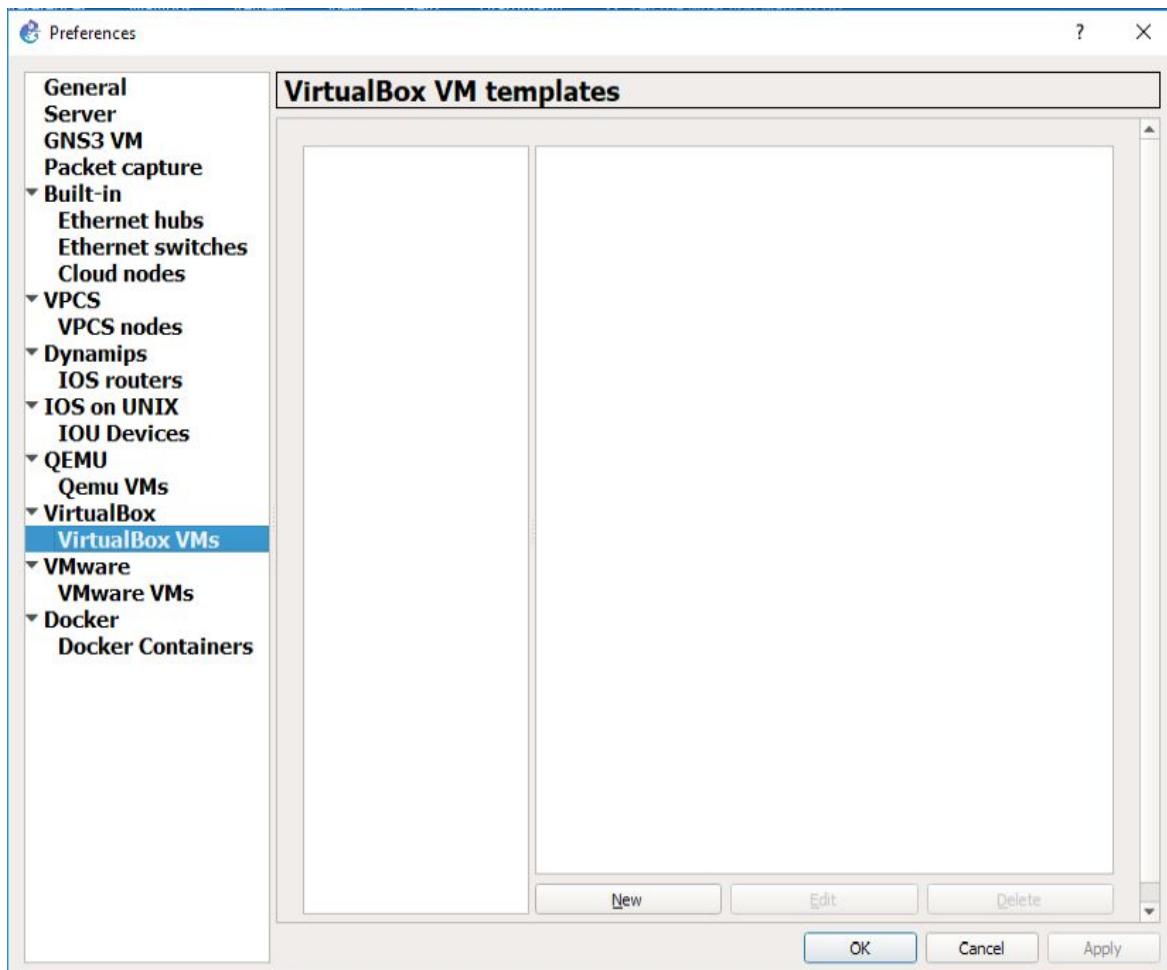


Figure 5.2: VirtualBox VM templates

The GNS3 and the VirtualBox are interconnected, and the GNS3 has the knowledge of where to find VMs. When the “New” button is clicked, GNS3 would take a moment to populate the list of VMs available in the VirtualBox and it will list in the VM list dropdown list. From the populated dropdown list, select whichever VM is desired to be available in the GNS3 network topologies and click “Finish” button. As in figure 6.3, I want CentOS-FTP-Srv to be available in the GNS3 topology, so I choose it from the list and click “Finish”.

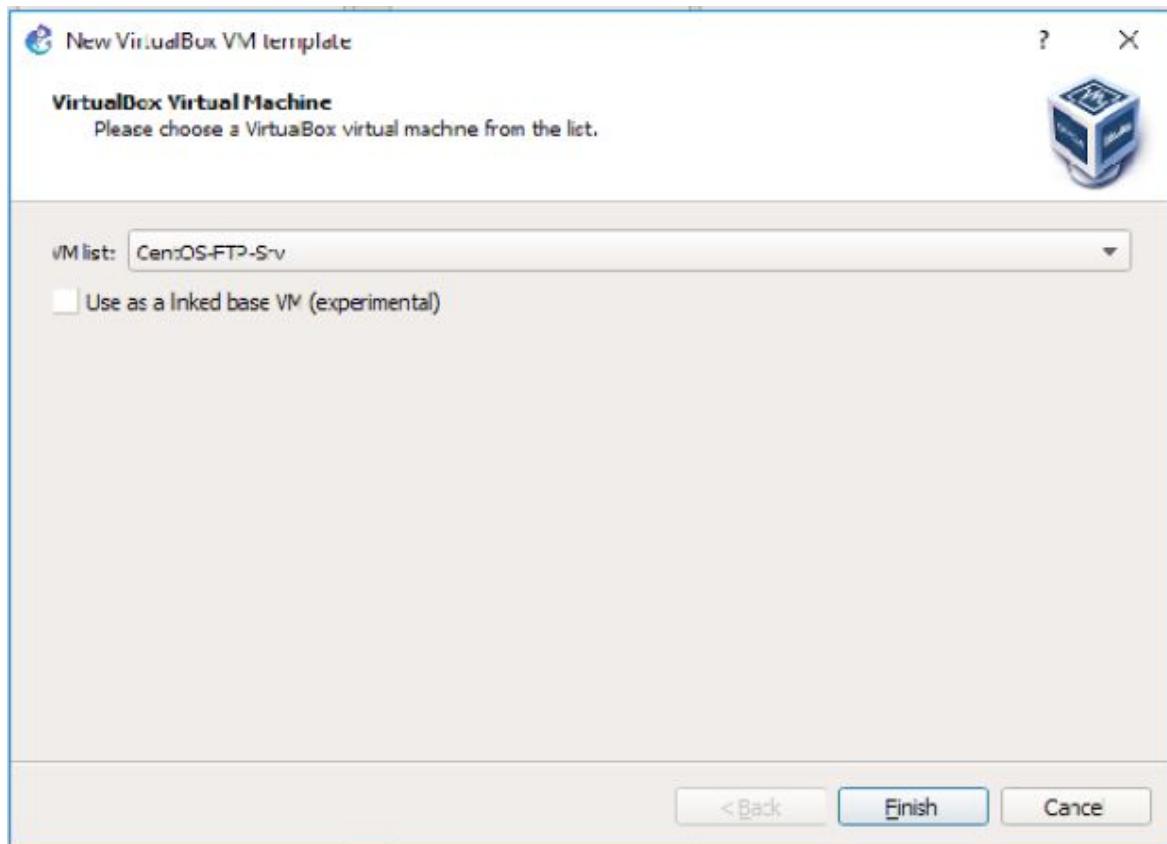


Figure 5.3: Choosing from the populated VM list

Immediately after the “Finish” button is clicked, the VM will be listed in the VirtualBox VM templates list with other details. Click the “Apply” button and if other VMs are desired to be available in the GNS3 topology as well, click the “New” button and follow the same procedure.

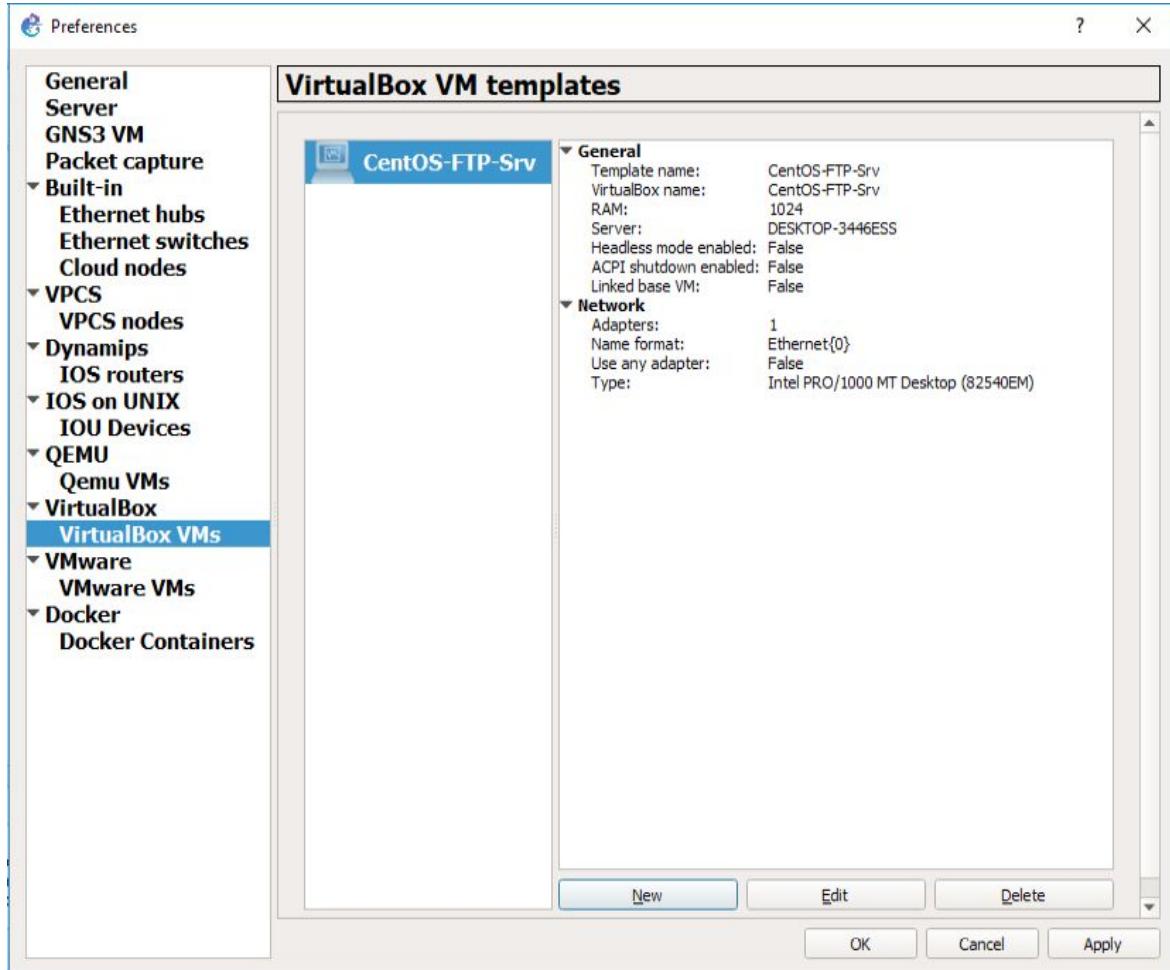


Figure 5.4: Linking the selected VM to GNS3

Finally, when all the VMs are linked and listed, click “OK” to apply the changes. In figure 5.5, all the VMs that I wish to be available for use in the GNS3 topology are listed in the VirtualBox VM template, including the Windows 7 VM. Now click “OK” to apply the changes and the VMs should be available for use.

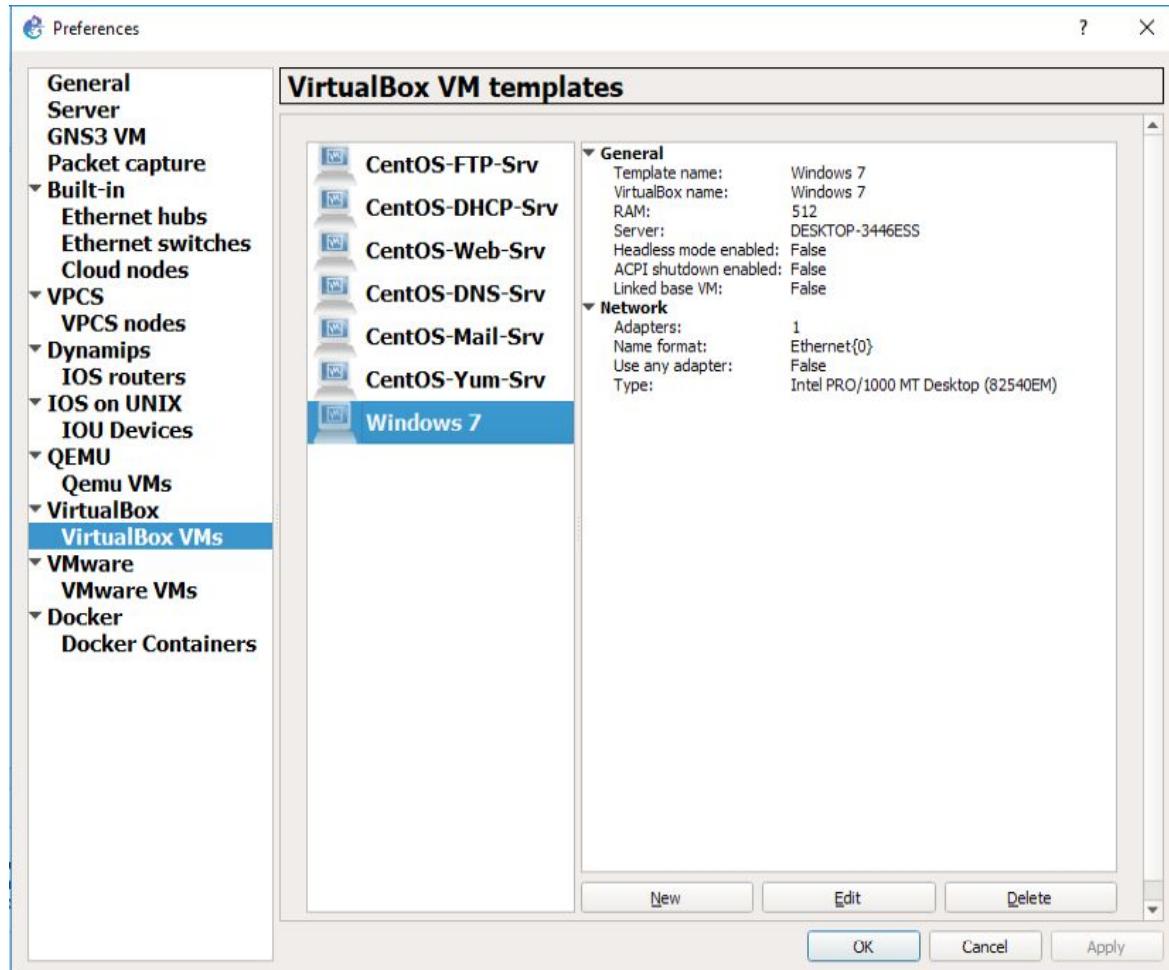


Figure 5.5: All the VMs listed

Browsing End Devices

After that, if we go to “Browse End Devices” (circled) in figure 5.6, then choosing the “Installed category” of the End devices, all the VMs which we have linked would appear in the list. In case, any of the devices are not listed, follow the steps required for adding the VMs and continue.

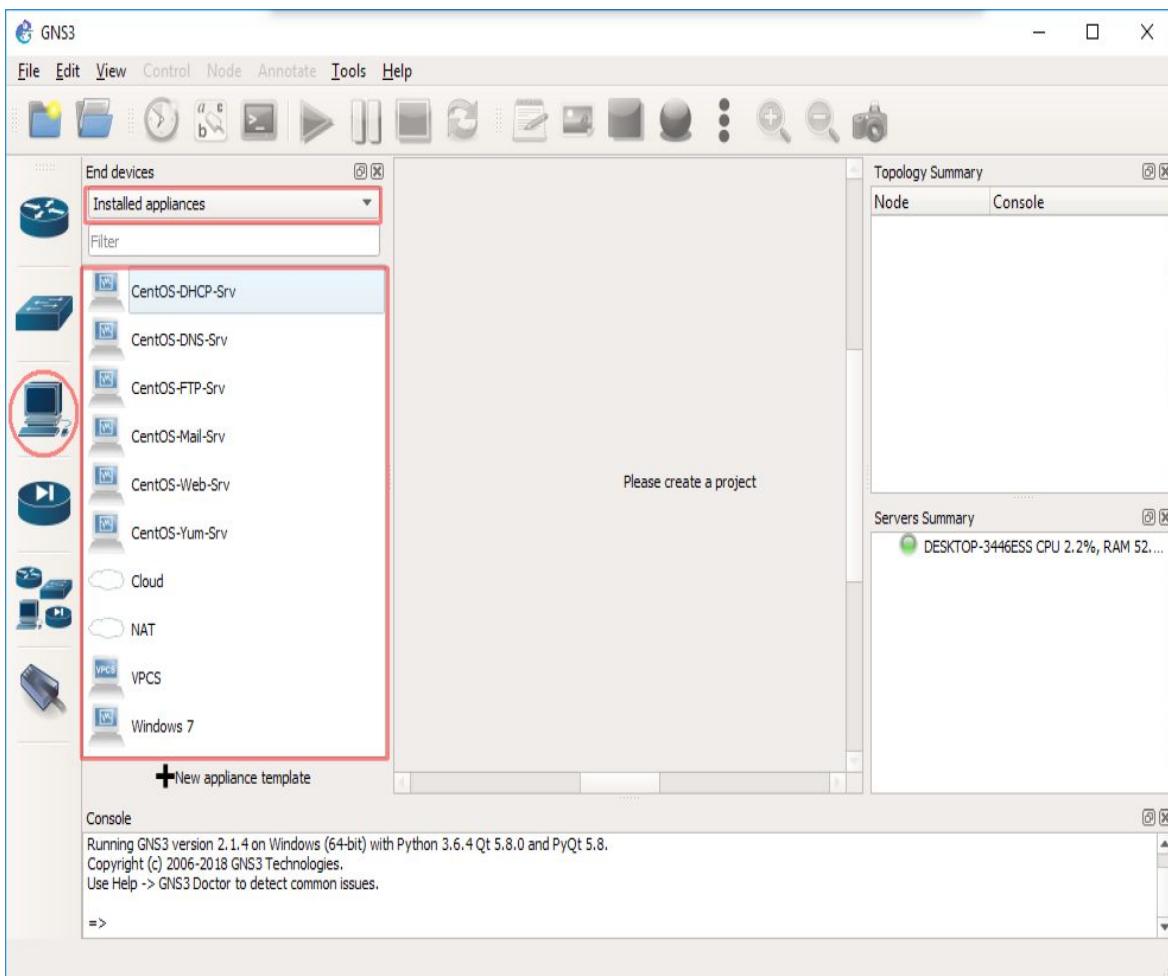


Figure 5.6: Browsing for the End Devices

Further Reading

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Chapter 6

Creating a GNS3 Network Topology

We have looked into the installation and the configuration of the required applications for building a virtualized network. To continue, it is presumed that all the required applications are installed and configuration is being made accordingly by following the previous chapters. As we go on, you would be getting familiarized with the toolbars and the interface slowly. To begin with, we will create a small network as a test bed for learning purpose.

Creating and Saving Projects

Launch the GNS3 application, click on the New Blank Project button indicated with an arrow in figure 6.1. Give a name of the project and click “OK” button to create a project keeping the location to the default.

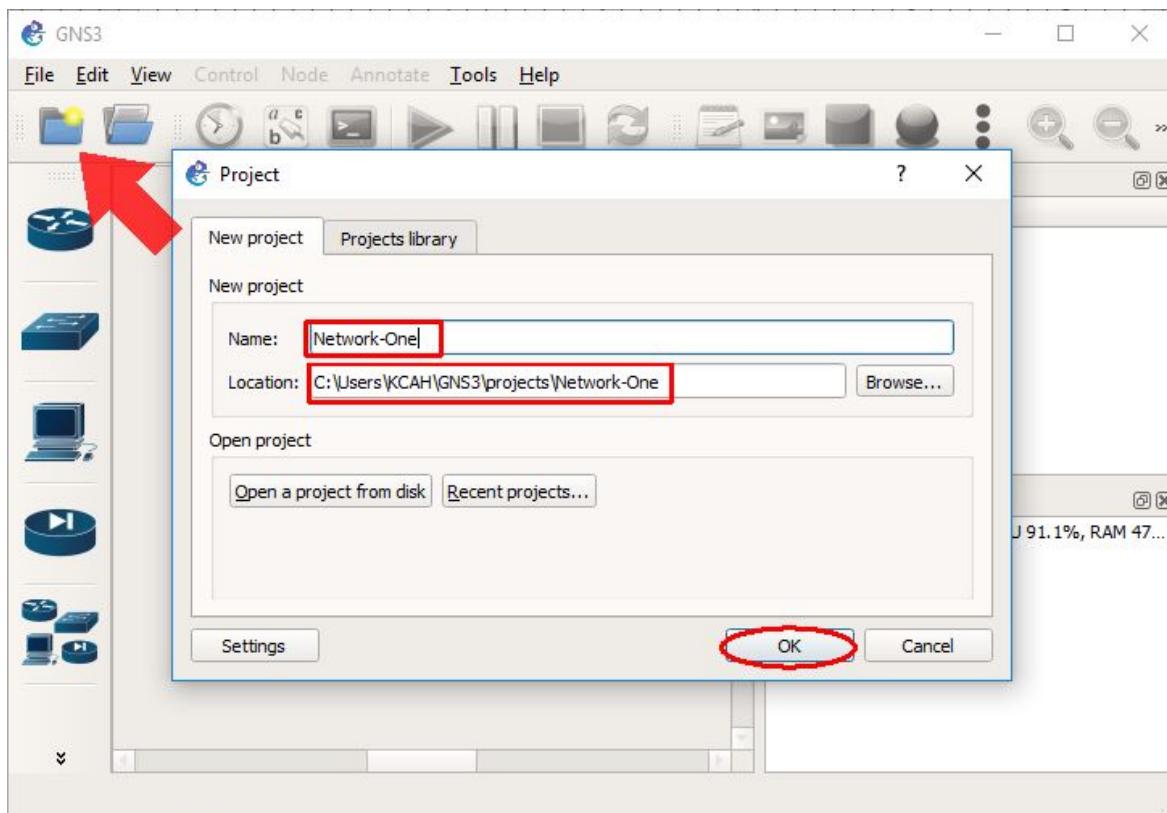


Figure 6.1: Creating a new project

After the project is being created, you would be able to drag and drop the devices to the workspace. First, we will drag and drop a cloud to represent an Internet in our project (Network-One). For this, you can click on the Browse End Devices (1) and the list of end devices would be displayed. Choose the Cloud (2), drag and drop to a location as desired (3) in the workspace. The cloud should appear in the workspace as shown in figure 6.2.

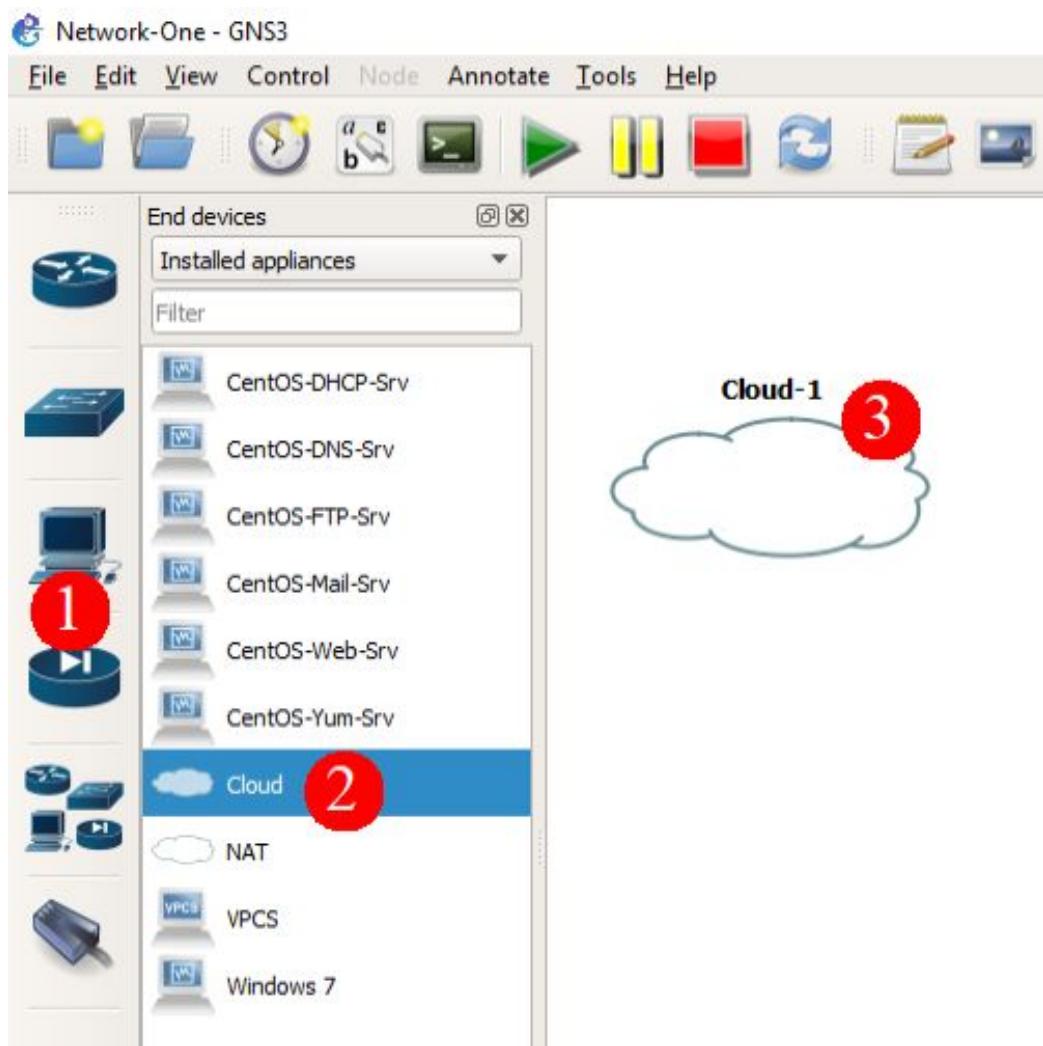


Figure 6.2: Creating a Cloud to represent the Internet

After adding a cloud, we will bring a router to the workspace by clicking on the Browse Routers (1), and then choose the available router (2). Drag and drop the desired router to a location in the workspace as shown in figure 6.3.

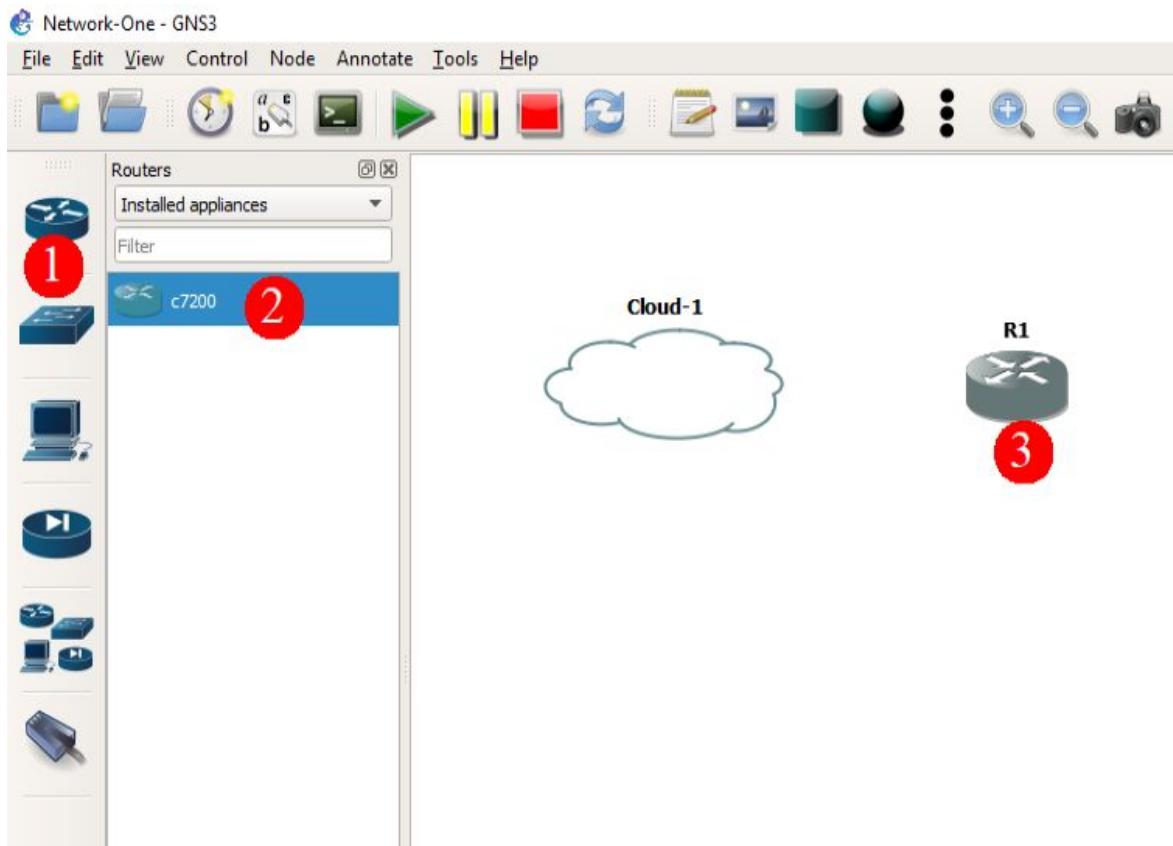


Figure 6.3: Creating a router

In the next, we will drop the Ethernet switch into the workspace. In order to create an ethernet switch, click on the Browse switches (1), choose Ethernet switch (2) and then drag and drop it into the workspace as shown in figure 6.4.

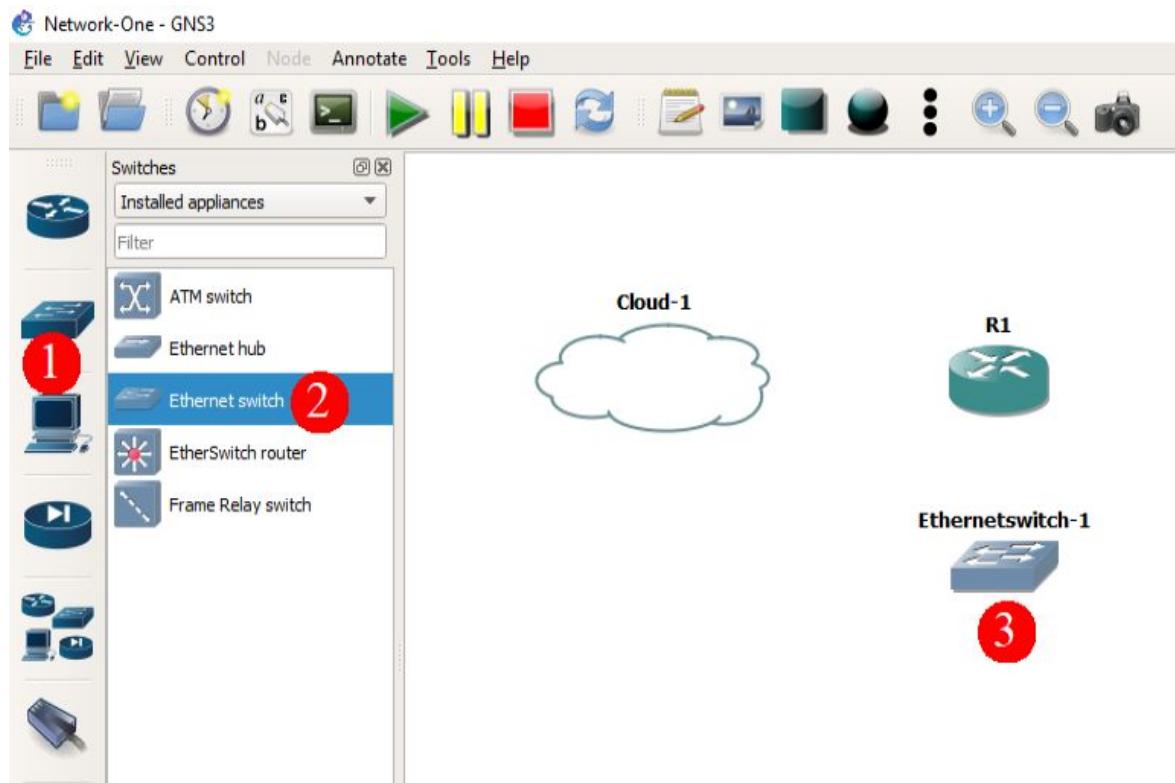


Figure 6.4: Creating an Ethernet switch

In a similar way, we will add one appliance (Windows 7) into the workspace by clicking on the Browse End Devices (1), choosing Windows 7 (2) and dragging and dropping into the workspace as shown in figure 6.5.

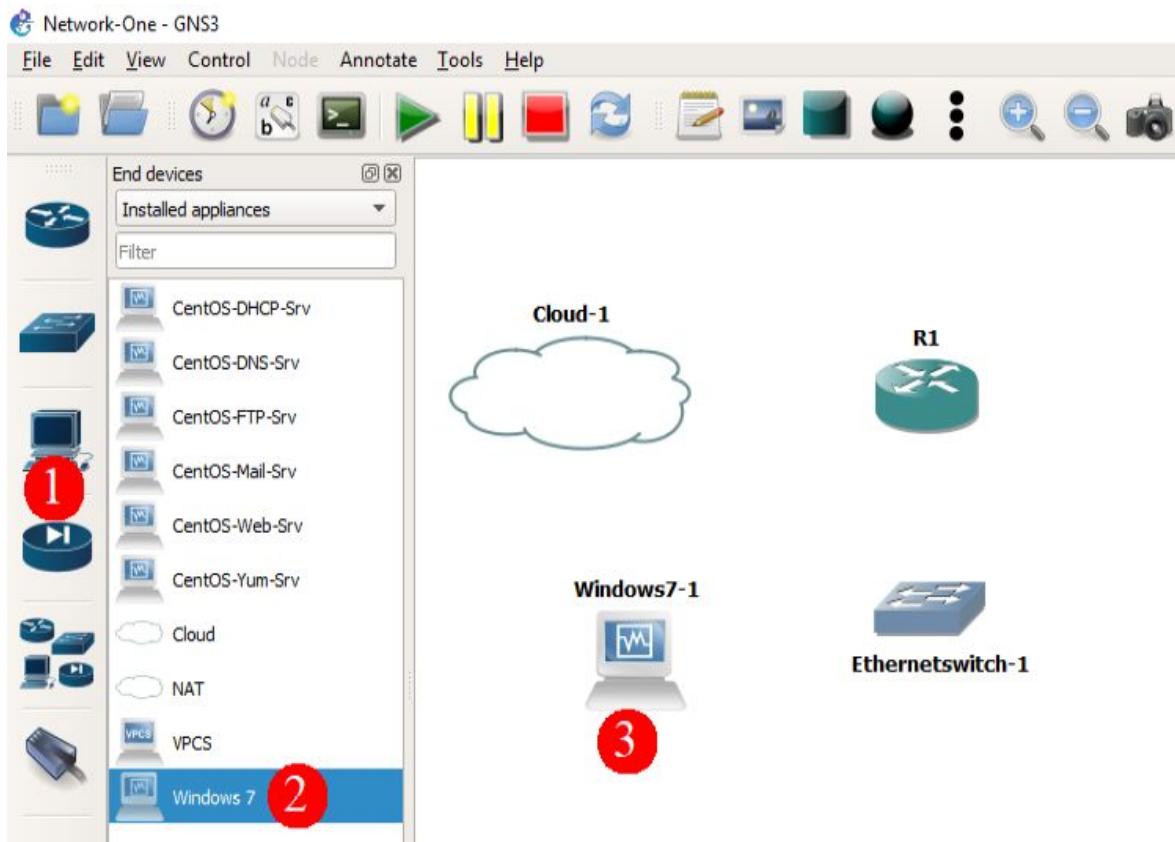


Figure 6.5: Creating Windows 7 (end device)

Configuring the Windows 7 (End device)

Before we give connections to the devices, we need to configure the appliance to allow the GNS3 to use any configured VirtualBox Adaptor. For this, right-click on the Windows 7 placed in the workspace and click on the Configure as indicated in figure 6.6.

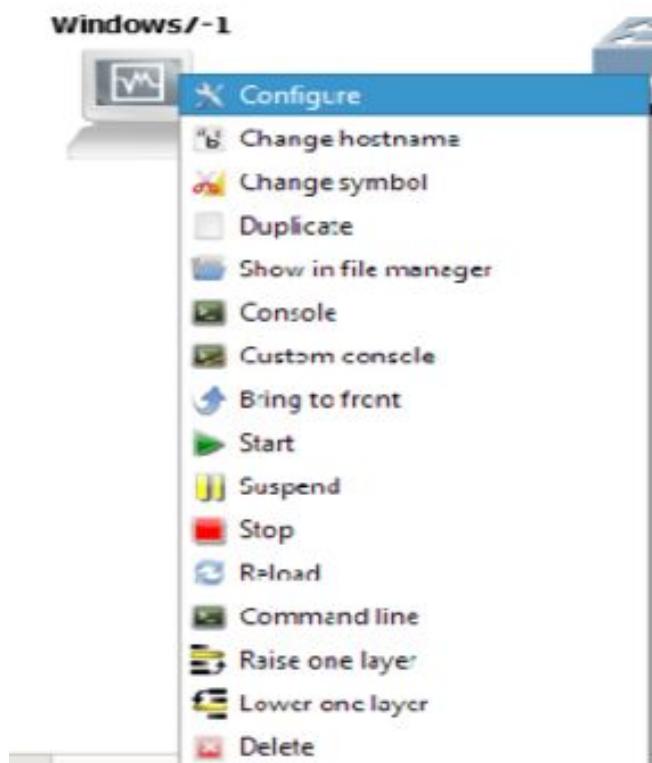


Figure 6.6: Configuring Windows 7

Upon clicking the configure option, the following window would be displayed. Choose the Network Tab (1), tick “Allow GNS3 to use any configured VirtualBox adaptor” (2), apply the setting and click “OK”.

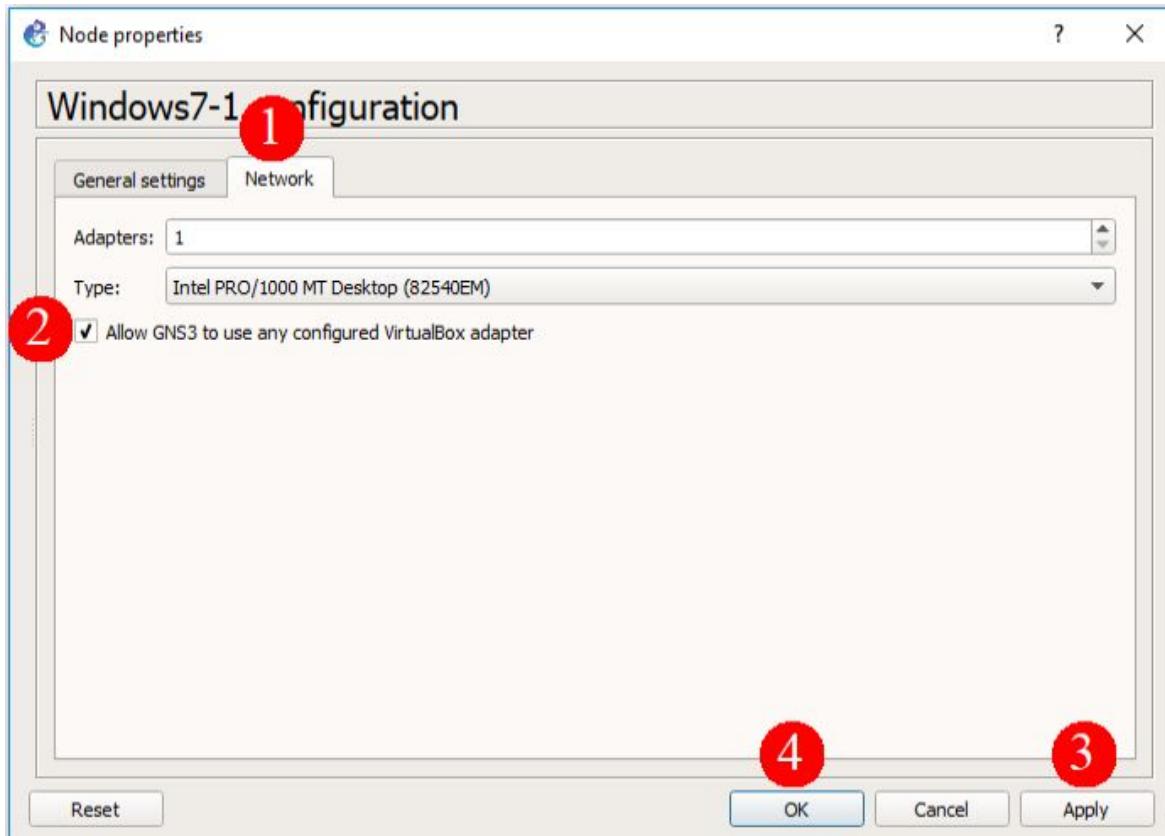


Figure 6.7: Allow GNS3 to use any configured VirtualBox adaptor

Creating Links Between the Devices

In order to create the links between the devices, click on the “Add a Link” button and take the mouse to the workspace where the devices are placed. The mouse cursor would change to a plus like sign (+), with that left-click on the Cloud-1 and the “Ethernet” option would appear. Click on the “Ethernet” option and then take your cursor to the router (R1) and left-click. Two interfaces as options would appear to choose from in order to connect the Cloud-1 (1) and the router (R1). Just to follow, choose FastEthernet0/0 and the connection between the Cloud-1 and the router (R1) would be complete with that.

To connect the router (R1) and the Ethernetswitch-1, click on the router and choose the other interface which is not in use (fastEthernet0/1) and then when you click on the Ethernetswitch-1, you would be shown a number of interfaces to choose. Just to follow choose Ethernet0. This completes the connection between the router (R1) and the Ethernetswitch-1.

Finally, to complete the connection between the Ethernetswitch-1 and the Windows 7-1, after clicking Ethernetswitch-1, choose Ethernet1 from the options and then choose Ethernet0 from Windows 7-1.

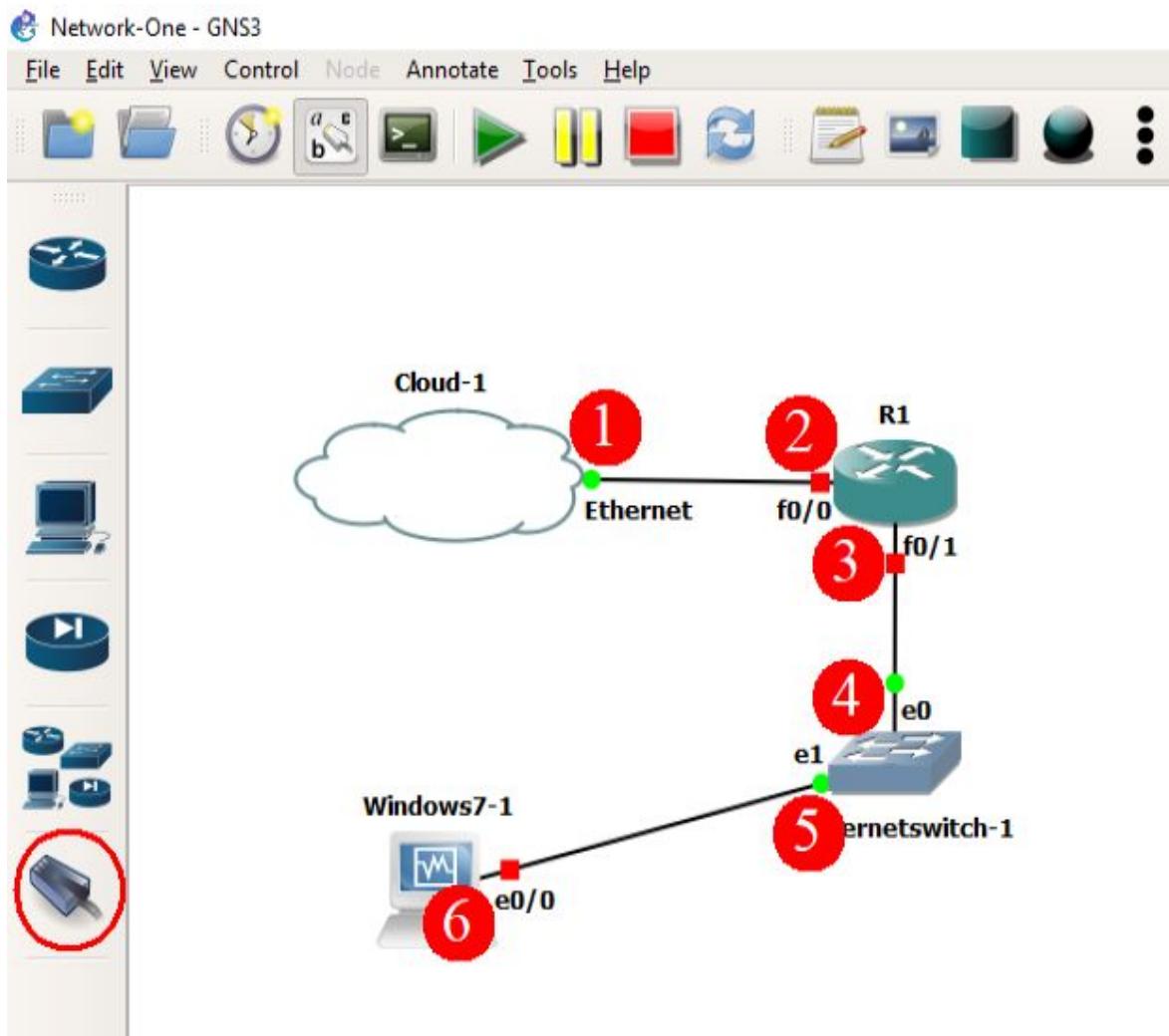


Figure 6.8: Complete links between the devices

Once the adding of the links is completed, press the Esc key on the keyboard to enable you to carry out other tasks. At this point your cursor must be changed to the normal one.

Status of the Devices and Nodes

In the GNS3 workspace, the Cloud and the generic Ethernet Switches are always on (started) by default. The links of connections on these devices and nodes are shown by green circular points indicating that the devices are started or kept on.

On the other hand, the routers and appliances are not started by default. The red square points on the connection links indicate that the devices and nodes are powered-off or not yet started. Once these devices are started, the red square points would change to green circular points. In the following figure 6.9, the router (R1) and Windows 7-1 are off, which is why the links bear red square points.

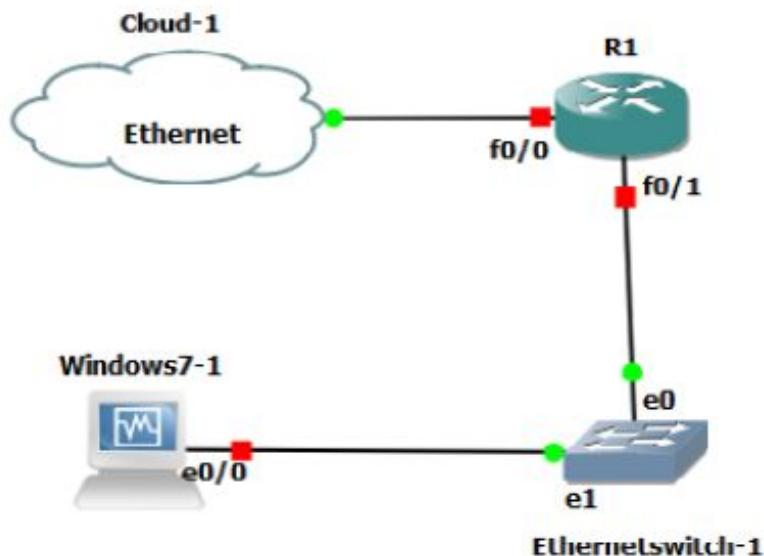


Figure 6.9: Status of the devices and nodes

Verifying the Network Adaptors

To start using the devices placed in the workspace, we have to start the devices whichever are required, but before that it is important to verify the network adaptors assigned to the appliances. A single network adaptor must not be assigned to more than one appliance.

To verify, launch the Oracle VM VirtualBox Manager, choose the appliance for which the adaptor is to be verified, right-click on the selected appliance which is used in the GNS3 workspace and choose the Settings.

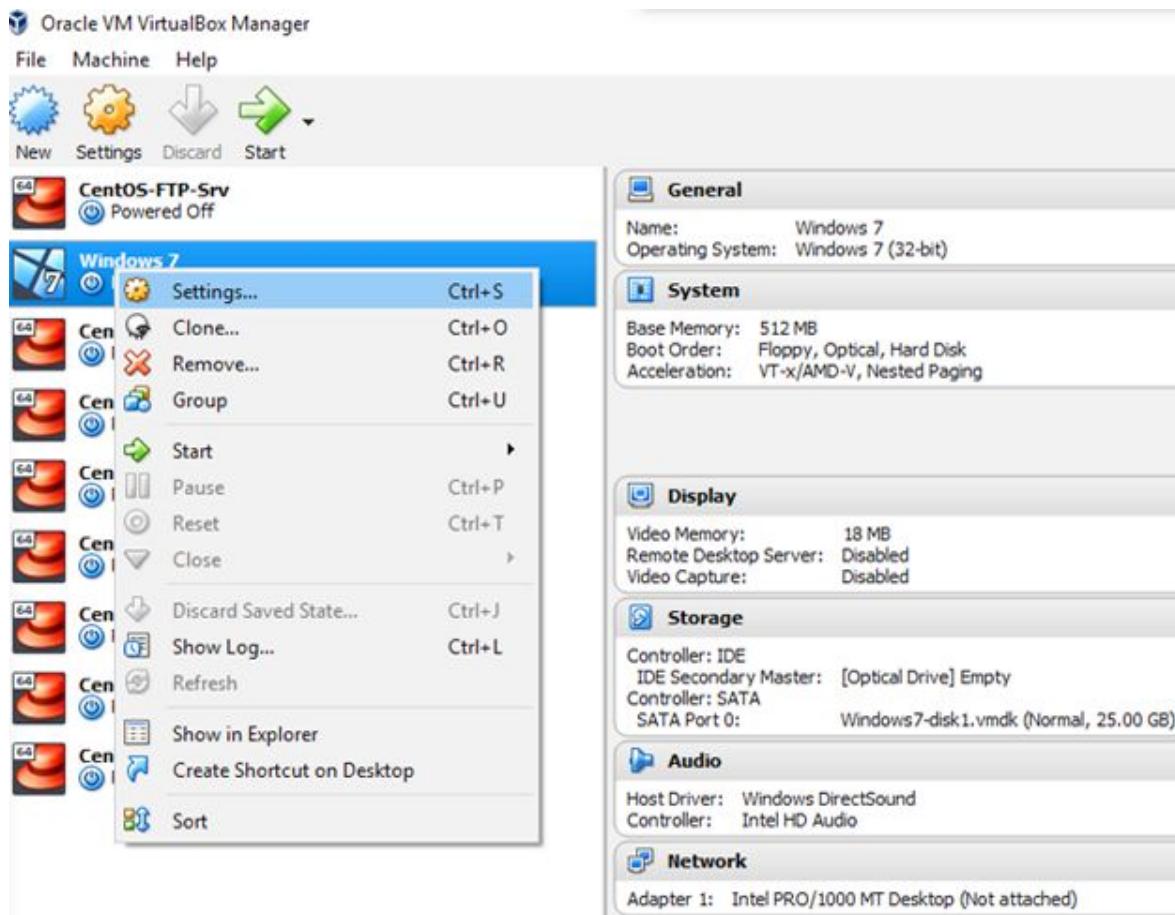


Figure 6.10: Settings option

In the Settings window, select Network (1) and then on the Adaptor 1 tab, choose “Host-only Adaptor”. In the next, choose the VirtualBox Host-only Ethernet Adaptor whichever is not assigned to other appliances. Check the “Cable connected” option and click “OK” button.

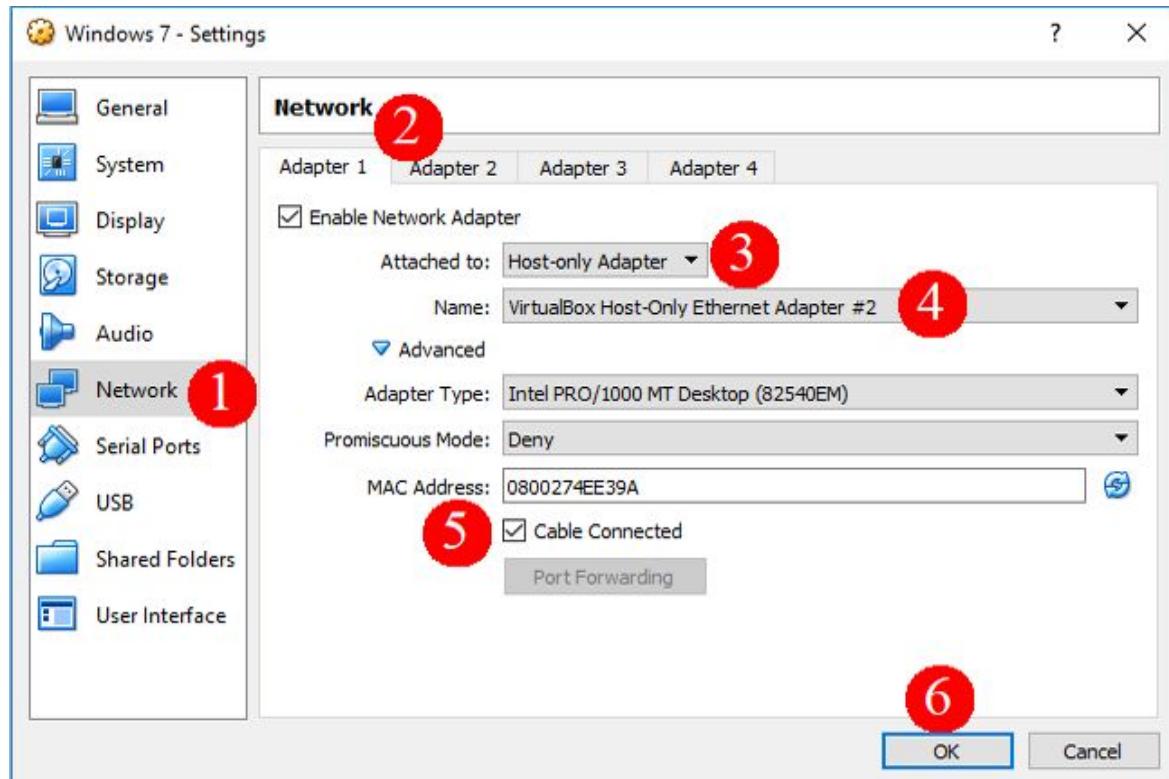


Figure 6.11: Settings window

In the above figure 6.11, the VirtualBox Host-only Adaptor #2 must not be assigned to any other appliances since it is assigned to Windows 7. If you have multiple appliances used on the GNS3 network, the adaptor must be verified for any possible double assignment to avoid problems.

Starting the Devices

To be able to make use of the devices, we have to start the devices. The devices can be started all at a time or one by one. To start the devices all at a time, the play-like button (Start/resume all nodes) must be clicked. This will start or resume all the suspended or stopped nodes placed in the GNS3 network.

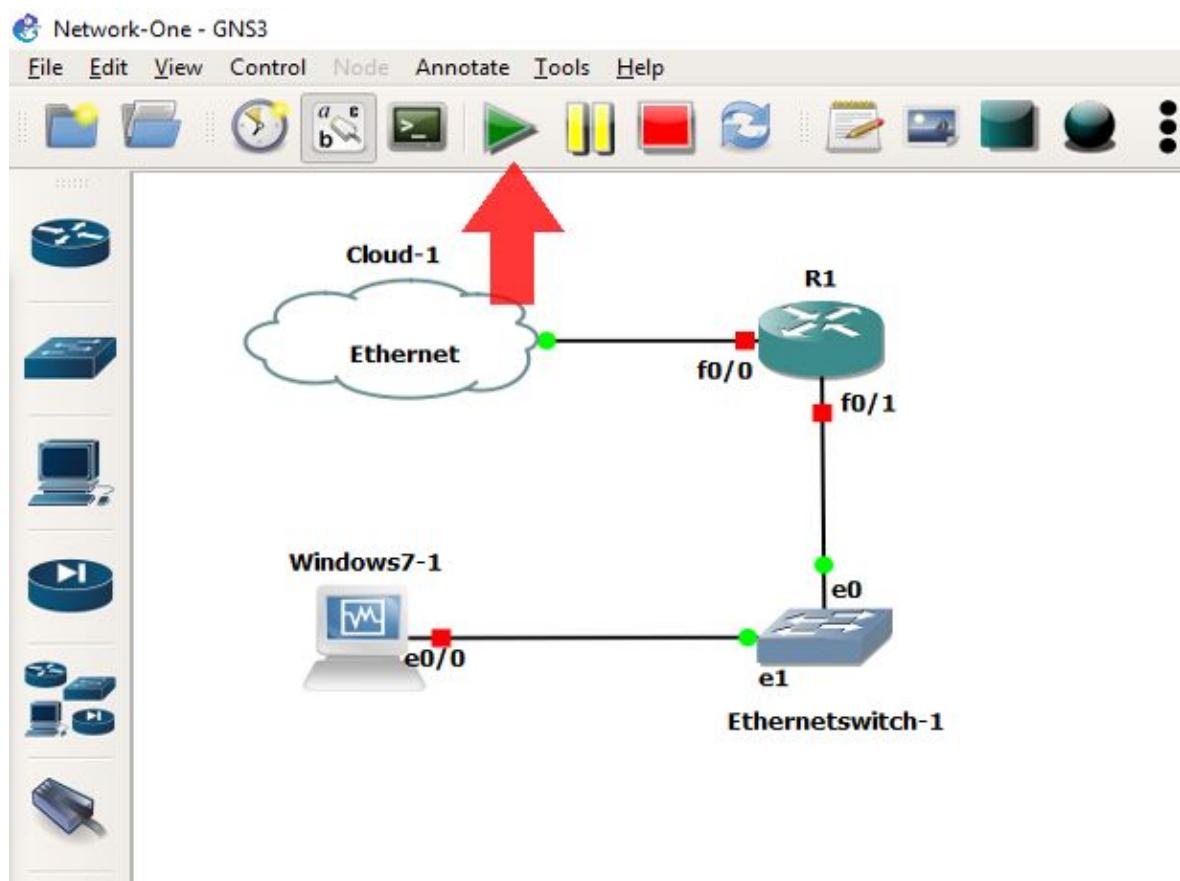


Figure 6.12: Starting or resuming all the nodes

If we want to start the nodes individually, we have to right-click the node to be started and choose the “Start” option as indicated in the figure below.

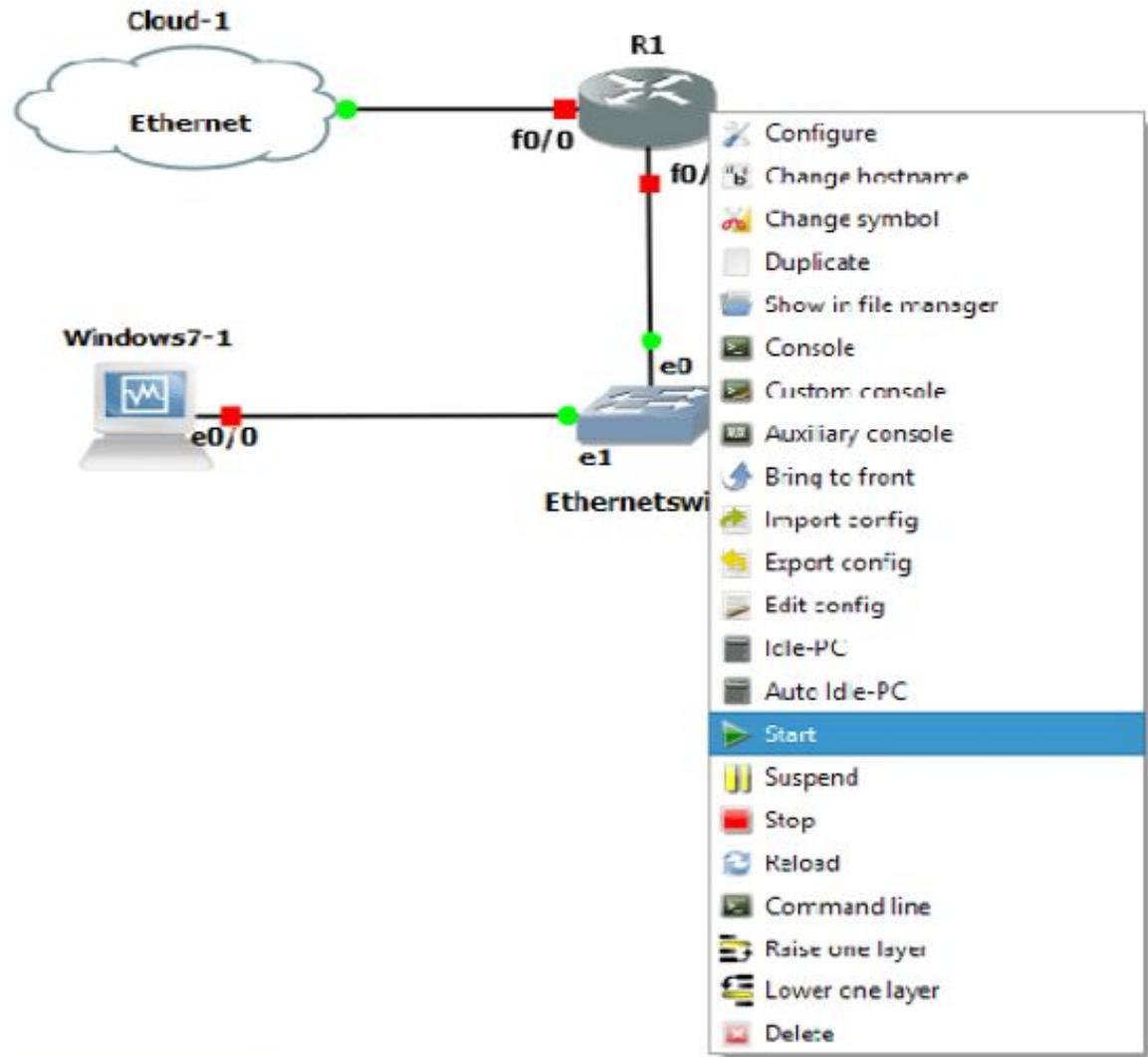


Figure 6.13: Starting the selected node individually

Finally, if we have started all the required nodes, the points on the connection links would appear as green circular points as in the following figure.

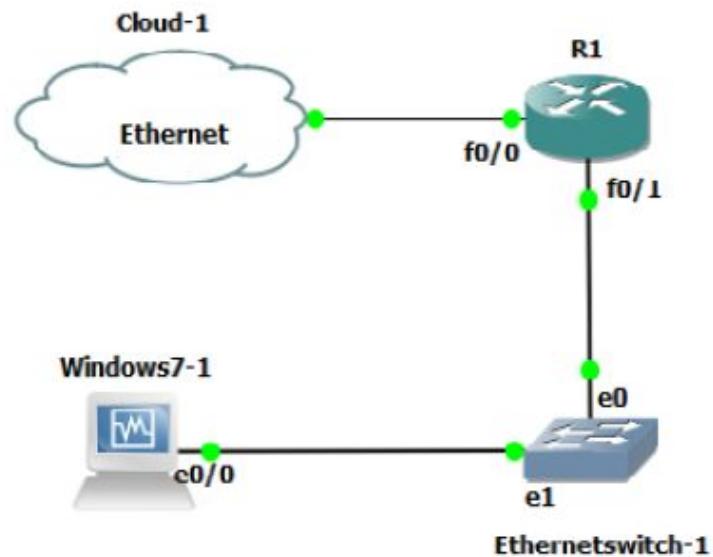


Figure 6.14: All the nodes started

Since the Oracle VM VirtualBox Manager and the GNS3 are linked, when the individual virtual machines are started from the GNS3 network, the virtual machines' operating systems would start to boot and appear as shown in the figure below.

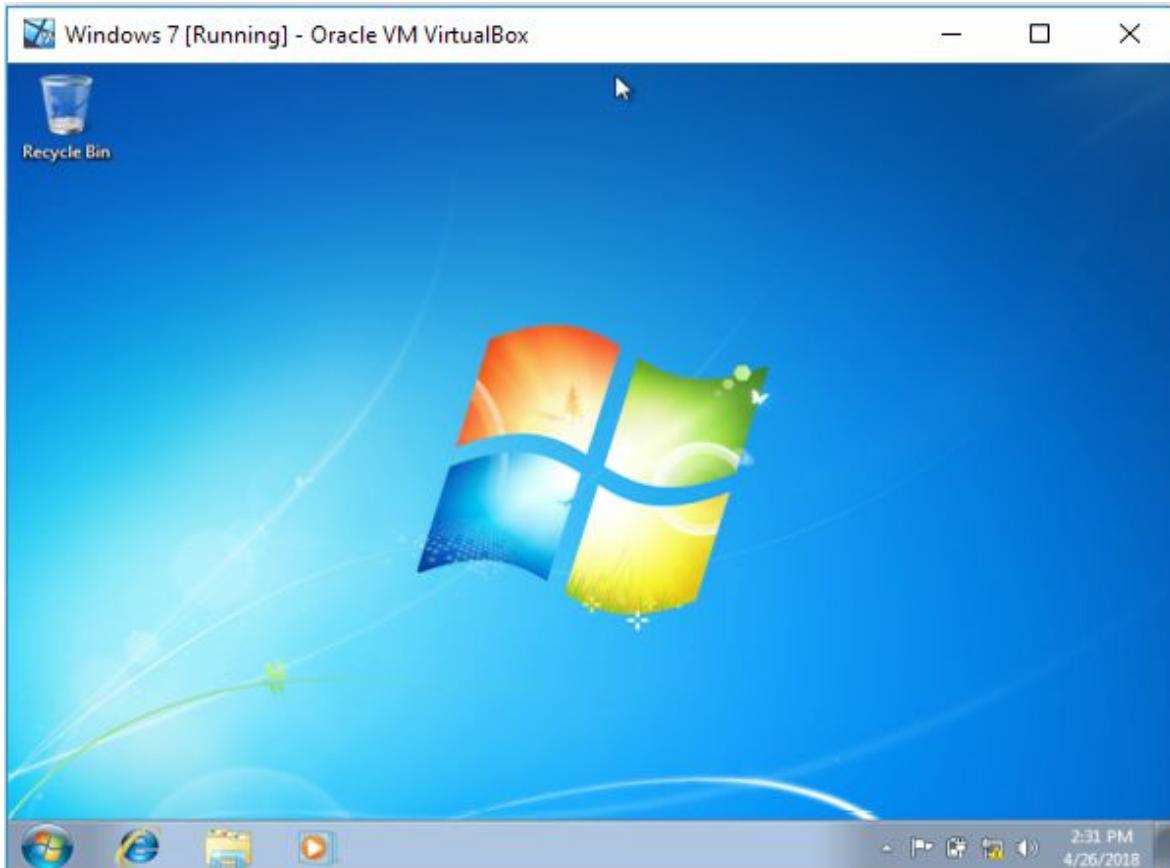


Figure 6.15: Started Virtual Machine linked to the GNS3

Further Reading

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Chapter 7

Configure and Test Network

Once the creation of the network topology in the GNS3 is completed, it is time for us to be able to access the nodes and start configuring. In this chapter, based on the network topology created in the previous chapter, we will access the nodes and configure, so that the virtual network becomes functional. Finally, the configured network created in the GNS3 will be tested for the functionality.

Network Scenario

Before we go onto accessing and configuring the nodes, let us consider the following network scenario to get a clear picture of the sample network. In this network, the cloud which is connected to the ethernet adaptor of the host computer is treated as a connection to the internet. On the interface 0/1 of the router (R1) the IP address assigned is 172.168.30.1/24 and the other consideration is, the Windows 7 device would be assigned the IP address dynamically from the DHCP service configured on the router (R1), where NAT is also configured on the same router.

Finally, when the configurations are completed, the Windows 7 device should be able to browse and access the web services hosted outside of this network.

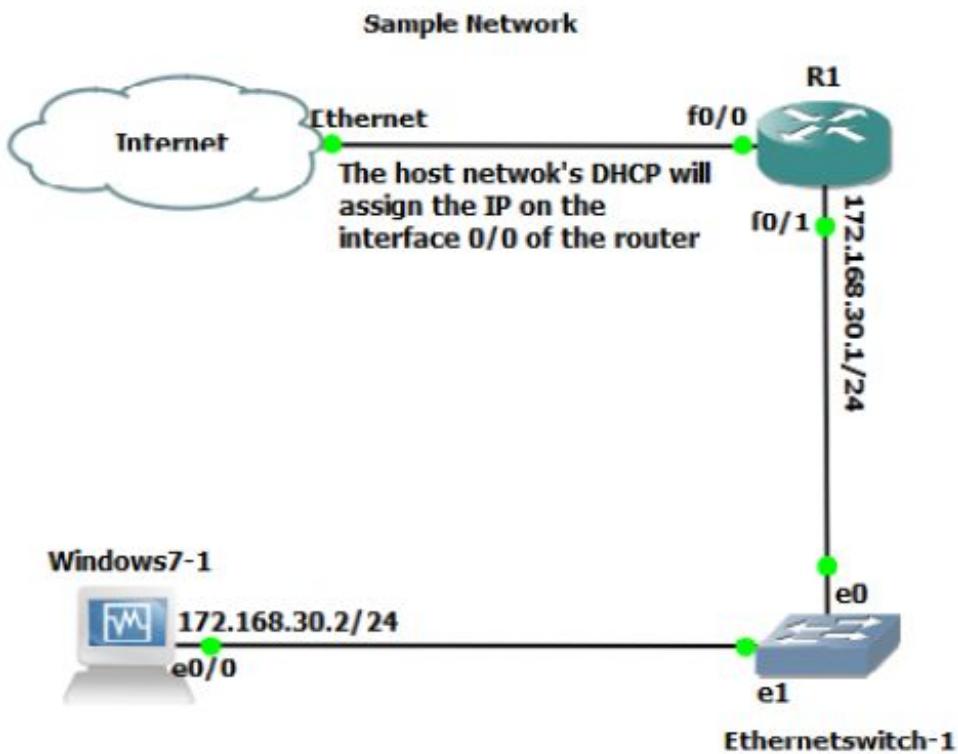


Figure 7.1: Network scenario

Accessing and Configuring Router

Once the router is being started, to configure it we have access to it. Unlike the virtual machines, the routers when started doesn't show up for access immediately. We can have access to the router's console by right-clicking the router and choosing the "Console" option.

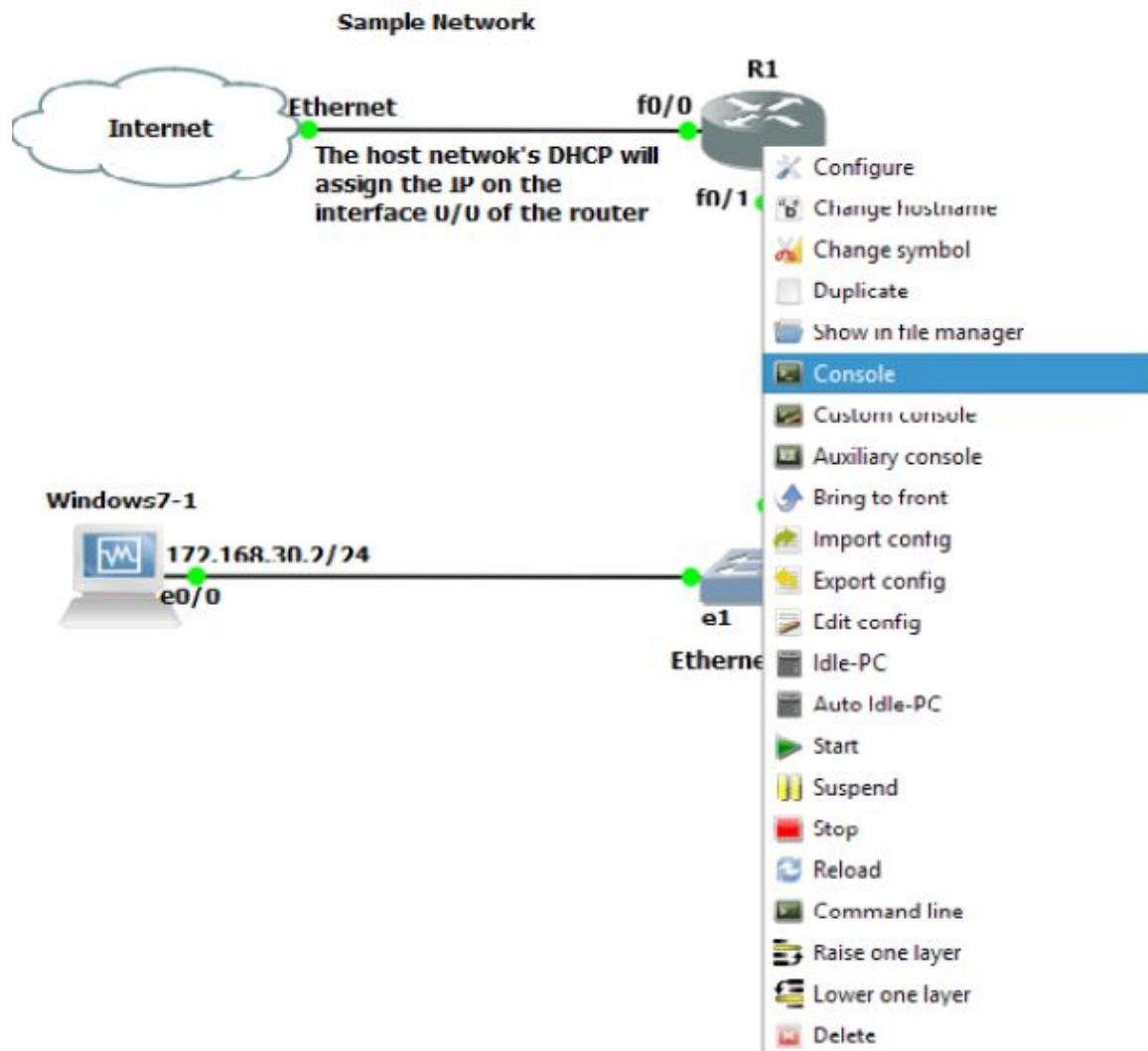
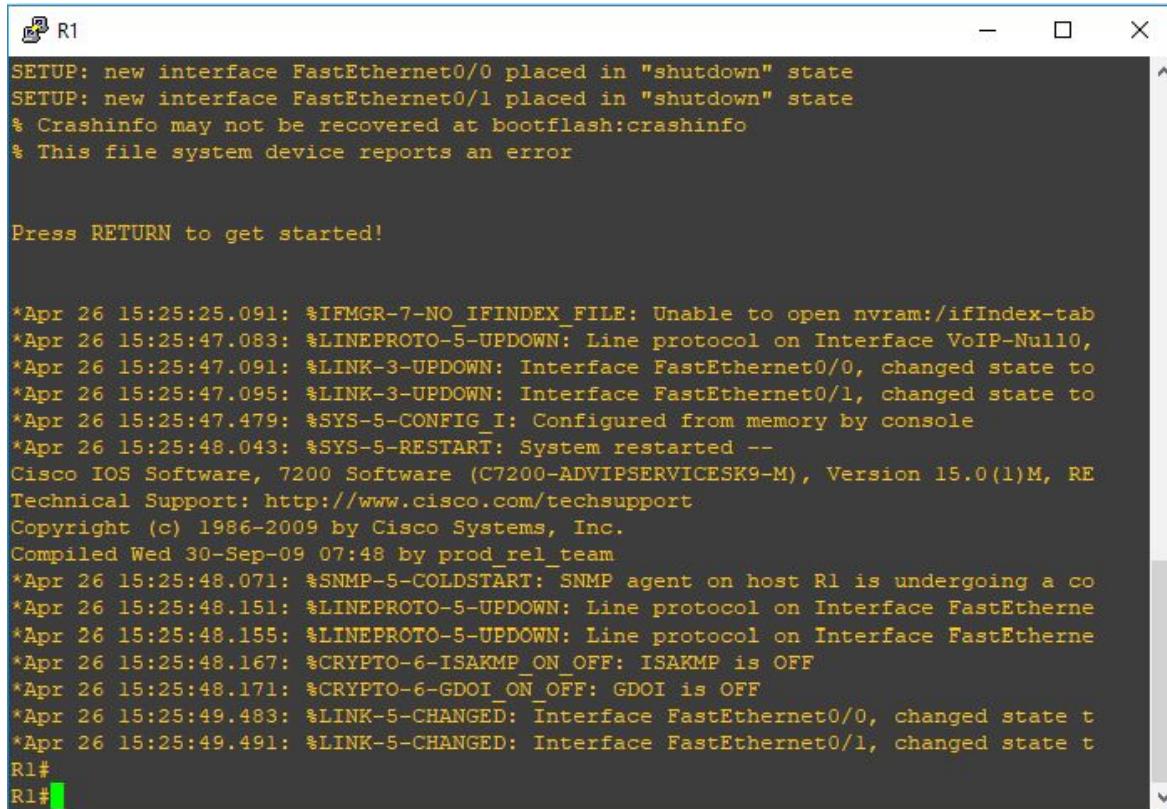


Figure 7.2: Opening the router's console for access

By clicking on the console option, the selected router's console would be opened for making configuration changes to the particular router. If the configurations have to be made, we can make it using the console.



The screenshot shows a terminal window titled "R1". The window displays the boot logs of a Cisco router. The logs include messages about new interfaces being placed in "shutdown" state, crashinfo recovery, and various system and link status changes. It also shows the router's software version, copyright information, and compilation details. The log concludes with a message to press RETURN to get started. At the bottom of the window, there is a command-line prompt "R1#".

```
SETUP: new interface FastEthernet0/0 placed in "shutdown" state
SETUP: new interface FastEthernet0/1 placed in "shutdown" state
% Crashinfo may not be recovered at bootflash:crashinfo
% This file system device reports an error

Press RETURN to get started!

*Apr 26 15:25:25.091: %IFMGR-7-NO_IFINDEX_FILE: Unable to open nvram:/ifIndex-tab
*Apr 26 15:25:47.083: %LINEPROTO-5-UPDOWN: Line protocol on Interface VoIP-Null0,
*Apr 26 15:25:47.091: %LINK-3-UPDOWN: Interface FastEthernet0/0, changed state to
*Apr 26 15:25:47.095: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to
*Apr 26 15:25:47.479: %SYS-5-CONFIG_I: Configured from memory by console
*Apr 26 15:25:48.043: %SYS-5-RESTART: System restarted --
Cisco IOS Software, 7200 Software (C7200-ADVIPSERVICESK9-M), Version 15.0(1)M, RE
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2009 by Cisco Systems, Inc.
Compiled Wed 30-Sep-09 07:48 by prod_rel_team
*Apr 26 15:25:48.071: %SNMP-5-COLDSTART: SNMP agent on host R1 is undergoing a co
*Apr 26 15:25:48.151: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEtherne
*Apr 26 15:25:48.155: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEtherne
*Apr 26 15:25:48.167: %CRYPTO-6-ISAKMP_ON OFF: ISAKMP is OFF
*Apr 26 15:25:48.171: %CRYPTO-6-GDOI_ON OFF: GDOI is OFF
*Apr 26 15:25:49.483: %LINK-5-CHANGED: Interface FastEthernet0/0, changed state t
*Apr 26 15:25:49.491: %LINK-5-CHANGED: Interface FastEthernet0/1, changed state t
R1#
R1#
```

Figure 7.3: The router's console

The other way to access the router is by using the “Console connect to all nodes” button. However, when we use this button, the consoles of all the nodes would be opened up for us.

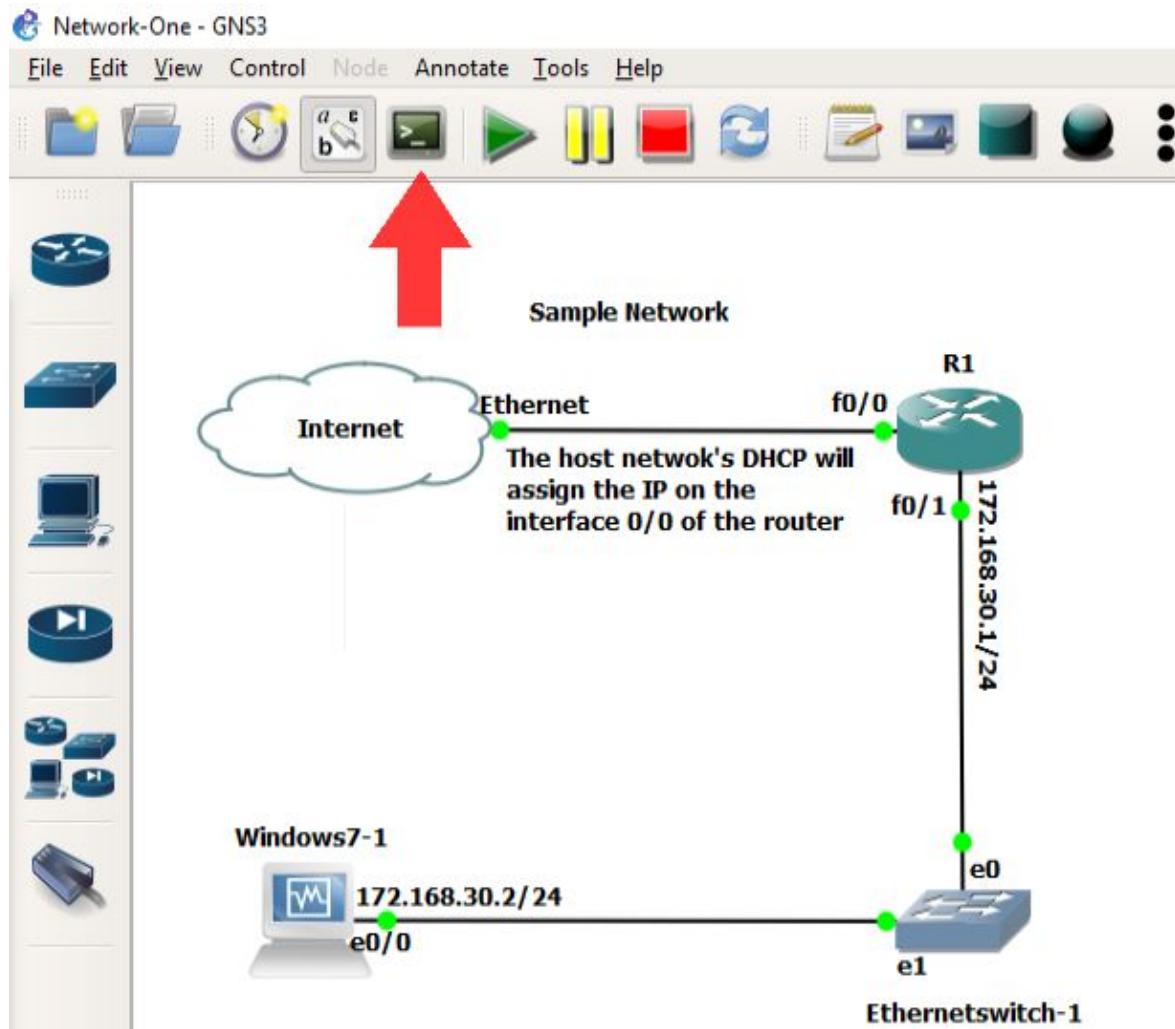


Figure 7.4: The “Console connect to all nodes” button

Configuring Router’s Interface 0/0

To configure the router’s interfaces, we will use the console and the following commands can be used for configuring the first interface to get an IP address assigned from the host network’s DHCP. Although, technically, assigning IP address to a router is not recommended for a production environment, we are doing here since we are not having access to the real ISP. The host network is assumed as an ISP for our virtual network.

```
R1# conf t
```

```
R1(config)# interface fastEthernet 0/0
R1(config-if)# ip address dhcp
R1(config-if)# no shutdown
R1(config-if)# end
R1# wr
R1# show ip interface brief
```

Configuring Router's Interface 0/1

As per the scenario we have, assign 172.168.30.1/24 on to the router R1's interface f0/1 which is connected to the switch.

```
R1#conf t  
R1(config)#interface fastEthernet 0/1  
R1(config-if)#ip address 172.168.30.1 255.255.255.0  
R1(config-if)#no shutdown  
R1(config-if)#end  
R1#wr
```

Configuring DHCP Service

For the devices used in the workspace to receive the IP addresses from the router, the following commands can be used to configure the DHCP service on the router.

```
R1#conf t  
R1(config)#ip dhcp pool internal-clients  
R1(dhcp-config)#network 172.168.30.0 255.255.255.0  
R1(dhcp-config)#default-router 172.168.30.1  
R1(dhcp-config)#dns-server aaa.bbb.ccc.ddd  
R1(dhcp-config)#end  
R1#wr
```

In the above, in the place of aaa.bbb.ccc.ddd, you are expected to use the DNS server's IP address of your network.

Configuring NAT

The following commands can be used for configuring the NAT on the router so that the devices which are assigned IP addresses by the DHCP service configured on the router would be able to make a request to the computers on the internet.

```
R1#conf t  
R1(config)#access-list 1 permit 172.168.30.0 0.0.0.255  
R1(config)#ip nat inside source list 1 interface fastEthernet 0/0 overload  
R1(config)#interface fastEthernet 0/1  
R1(config-if)#ip nat inside  
R1(config-if)#exit  
R1(config)#interface fastEthernet 0/0  
R1(config-if)#ip nat outside
```

R1(config-if)#end

R1#wr

Testing the Network

The basic configuration required is completed and the client device (Windows 7) in the GNS3 network should be able to get the IP address assigned dynamically and also should be able to browse the internet.

For the verification, use the ipconfig command in the Windows 7 virtual machine's command prompt. The details of the IP address assigned would be shown in the output section of the command prompt as shown below.

```
C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.1.7600]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\Windows7Lab>ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection:
  Connection-specific DNS Suffix . . .
  Link-local IPv6 Address . . . . . fe80::f0e6:cd4d:cb04:6274%11
  IPv4 Address . . . . . 172.168.30.2
  Subnet Mask . . . . . 255.255.255.0
  Default Gateway . . . . . 172.168.30.1

Tunnel adapter isatap.<779D567D-3973-4838-99C9-1B06049A2522>:
  Media State . . . . . Media disconnected
  Connection-specific DNS Suffix . . .

Tunnel adapter Local Area Connection* 9:
  Media State . . . . . Media disconnected
  Connection-specific DNS Suffix . . .

Tunnel adapter 6T04 Adapter:
  Connection-specific DNS Suffix . . .
  IPv6 Address . . . . . 2002:aca8:1e02::aca8:1e02
  Default Gateway . . . . .

C:\Users\Windows7Lab>
```

Figure 7.5: Assigned IP details on the Windows 7 device

The same concept of creating a network topology in GNS3, configuring and testing the network can be applied to other networks of similar nature.

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