Network Design and Management (IT3010)

3rd Year 1st Semester

Individual Assignment - 1

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LAB 01

Initial Setup and Network Adapter Identification

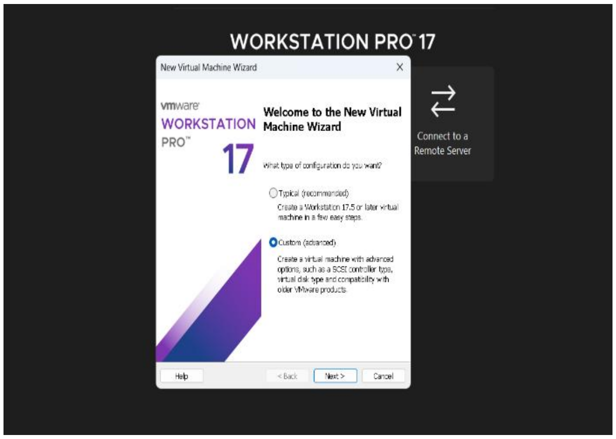
With the help of the virtualization program VMware Workstation Pro 17, users may build, operate, and maintain numerous virtual machines (VMs) on a single computer. System management, testing, and software development all make extensive use of it.
For professionals who must effectively work with several operating systems, VMware Workstation Pro 17 is a potent tool.

Client and Server Setup

Both NDM Client and NDM Server are configured with the following specifications:

- Operating System : Fedora and CentOS
- RAM : 1.5GB
- Processor : 1 CPU core
- Hard Disk : 15GB
- Network Adapter : NAT and VMnet2

1.Select Custom



New Virtual Machine Wizard

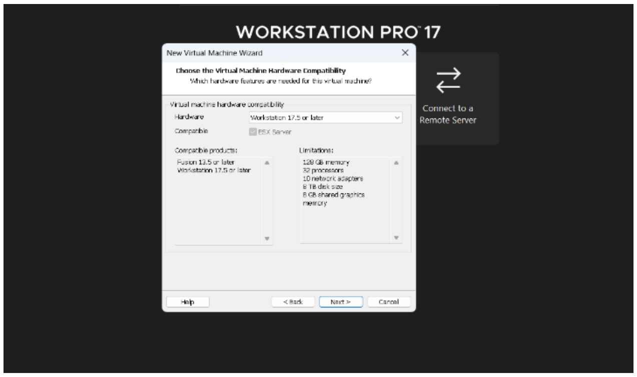
Welcome to the New Virtual Machine Wizard

What type of configuration do you want?

○ Typical (recommended)
Create a Workstation 17.5 or later virtual machine in a few easy steps.

● Custom (advanced)
Create a virtual machine with advanced options, such as a SCSI controller type, virtual disk type and compatibility with older VMware products.

2.Click on next



New Virtual Machine Wizard

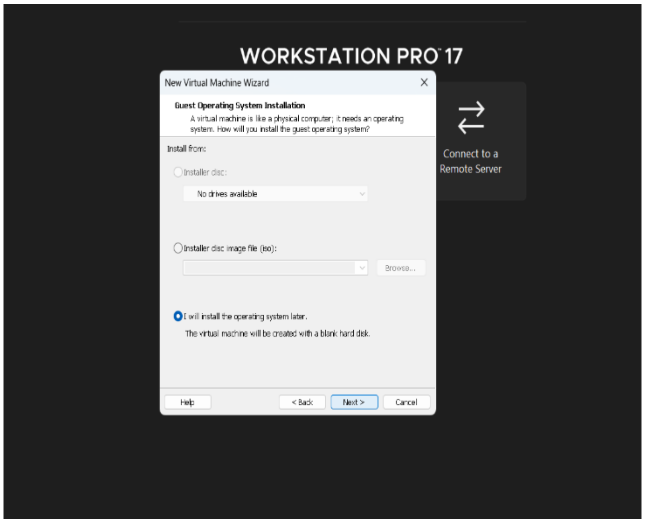
Choose the Virtual Machine Hardware Compatibility
Which hardware features are needed for this virtual machine?

Virtual machine hardware compatibility
Hardware: Workstation 17.5 or later
Compatible: ☑ ESX Server

Compatible products:
Fusion 13.5 or later
Workstation 17.5 or later

Limitations:
128 GB memory
32 processors
10 network adapters
8 TB disk size
8 GB shared graphics memory

3.Select last option & enter next



Guest Operating System Installation
A virtual machine is like a physical computer; it needs an operating system. How will you install the guest operating system?

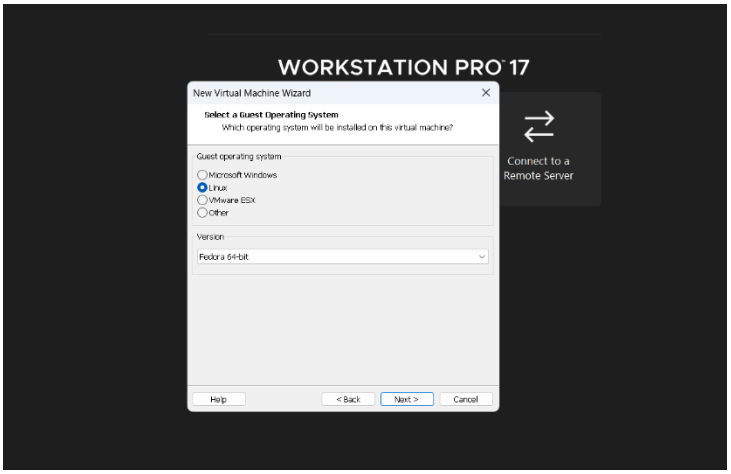
Install from:

○ Installer disc:
No drives available

○ Installer disc image file (iso):

● I will install the operating system later.
The virtual machine will be created with a blank hard disk.

4.Linux Linux & Fedora 64 bits as version

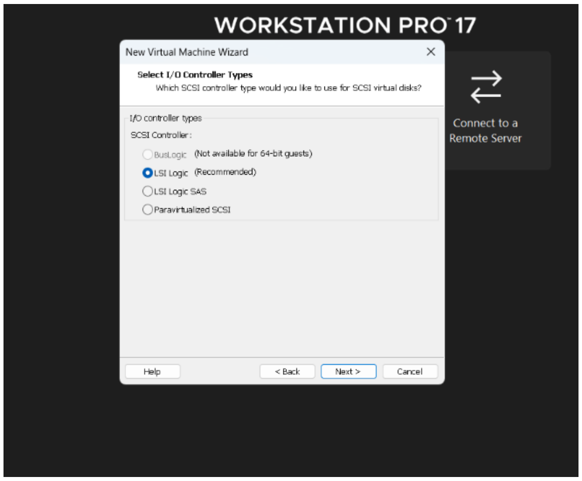


Select a Guest Operating System
Which operating system will be installed on this virtual machine?

Guest operating system
○ Microsoft Windows
● Linux
○ VMware ESX
○ Other

Version
Fedora 64-bit

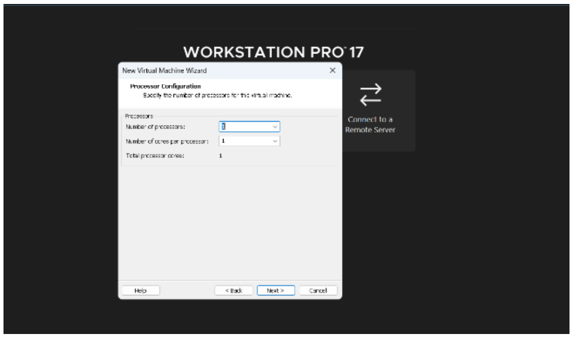
5.Select LSI Logic (Recommended)



Select I/O Controller Types
Which SCSI controller type would you like to use for SCSI virtual disks?

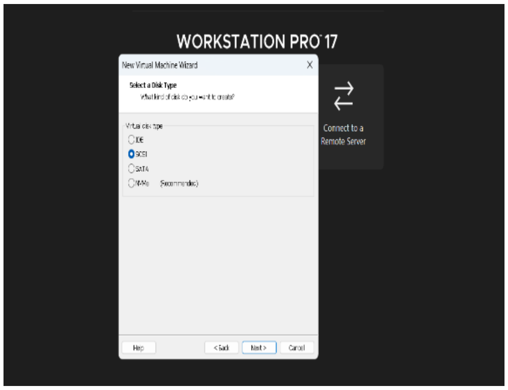
I/O controller types
SCSI Controller:
○ BusLogic (Not available for 64-bit guests)
● LSI Logic (Recommended)
○ LSI Logic SAS
○ Paravirtualized SCSI

6.Add one processor only



Processor Configuration
Specify the number of processors for this virtual machine.

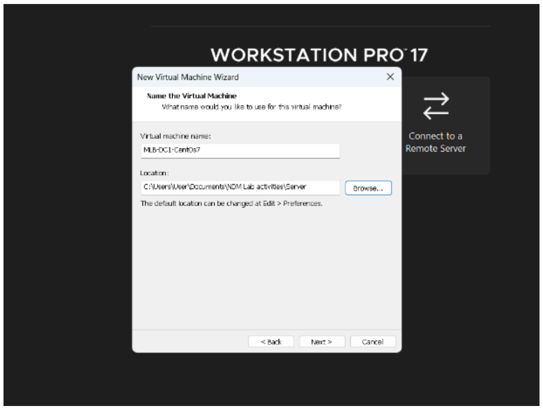
Processors
Number of processors: 1
Number of cores per processor: 1
Total processor cores: 1



Select a Disk Type
What kind of disk do you want to create?

Virtual disk type
○ IDE
● SCSI
○ SATA
○ NVMe (Recommended)

7.Rename Virtual machine name

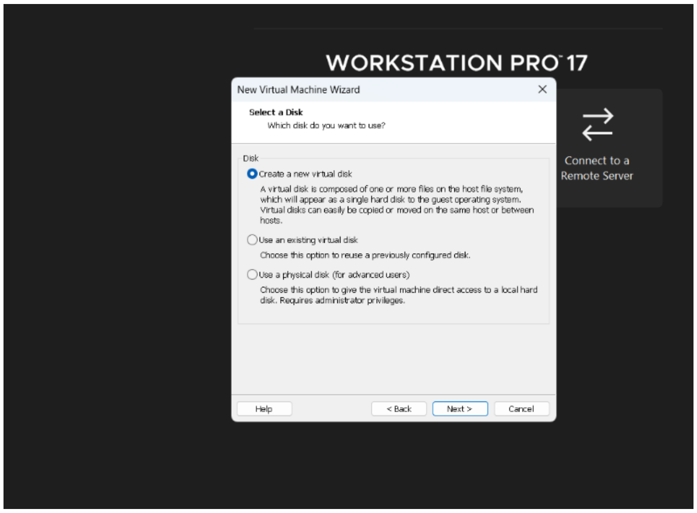


Name the Virtual Machine
What name would you like to use for this virtual machine?

Virtual machine name:
MLB-DC1-CentOs7

Location:
C:\Users\User\Documents\NDM Lab activities\Server

The default location can be changed at Edit > Preferences.



Select a Disk

Which disk do you want to use?

Disk

● Create a new virtual disk

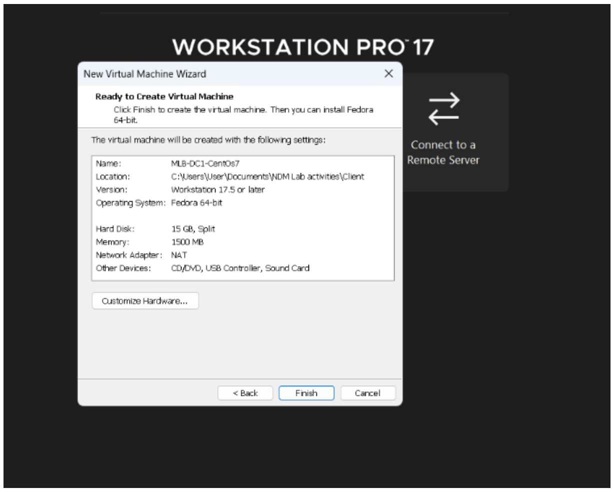
A virtual disk is composed of one or more files on the host file system, which will appear as a single hard disk to the guest operating system. Virtual disks can easily be copied or moved on the same host or between hosts.

○ Use an existing virtual disk

Choose this option to reuse a previously configured disk.

○ Use a physical disk (for advanced users)

Choose this option to give the virtual machine direct access to a local hard disk. Requires administrator privileges.



Ready to Create Virtual Machine

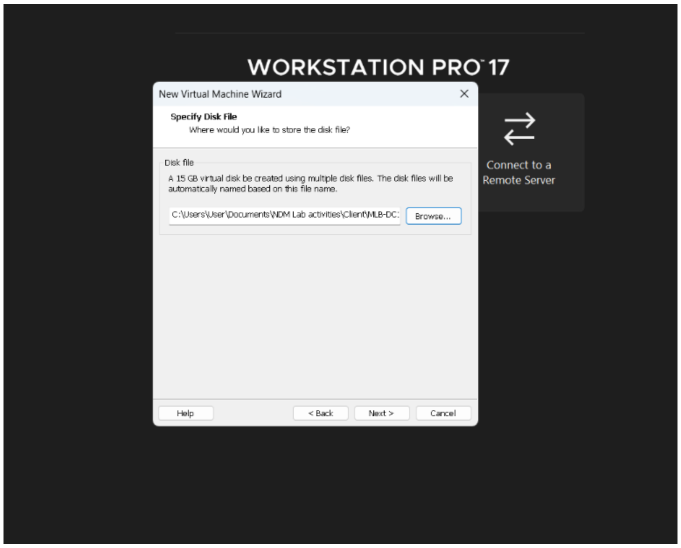
Click Finish to create the virtual machine. Then you can install Fedora 64-bit.

The virtual machine will be created with the following settings:

Name: MLB-DC1-CentOs7
Location: C:\Users\User\Documents\NDM Lab activities\Client
Version: Workstation 17.5 or later
Operating System: Fedora 64-bit

Hard Disk: 15 GB, Split
Memory: 1500 MB
Network Adapter: NAT
Other Devices: CD/DVD, USB Controller, Sound Card

Select client file



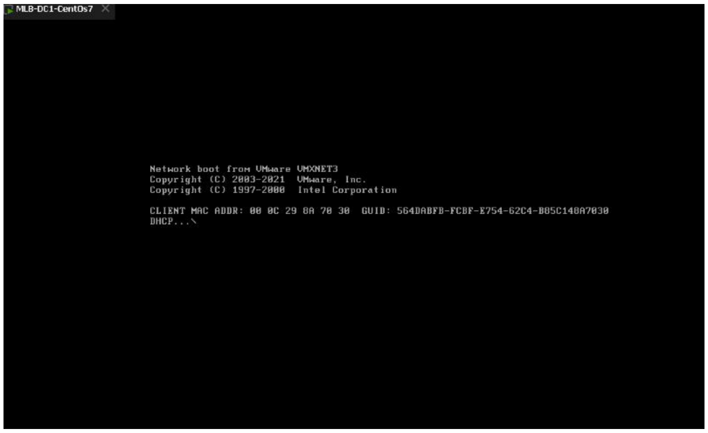
Specify Disk File

Where would you like to store the disk file?

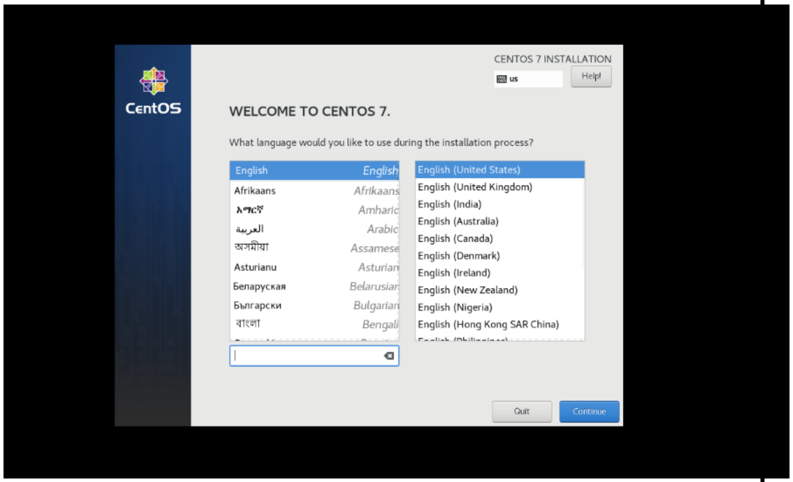
Disk file

A 15 GB virtual disk be created using multiple disk files. The disk files will be automatically named based on this file name.

C:\Users\User\Documents\NDM Lab activities\Client\MLB-DC:



```
Network boot from VMware VMXNET3
Copyright (C) 2003-2021  VMware, Inc.
Copyright (C) 1997-2000  Intel Corporation

CLIENT MAC ADDR: 00 0C 29 8A 70 30  GUID: 564DABFB-FCBF-E754-62C4-B85C148A7030
DHCP...\
```

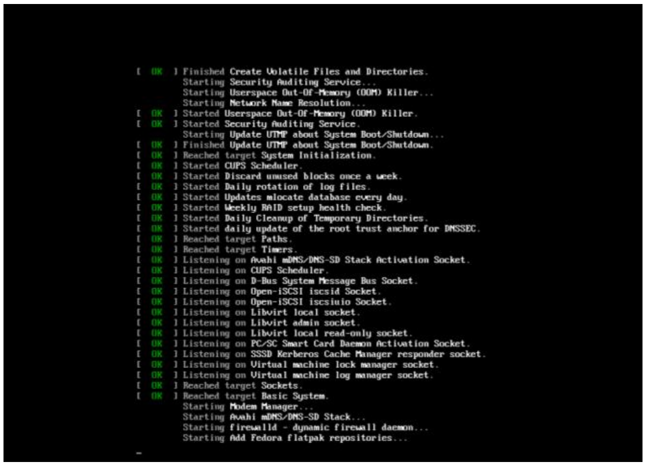


WELCOME TO CENTOS 7.

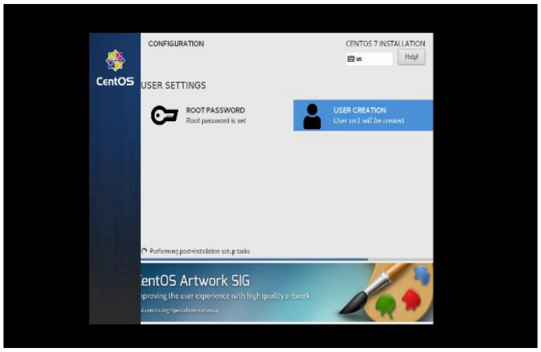
What language would you like to use during the installation process?

English	English
Afrikaans	Afrikaans
አማርኛ	Amharic
العربية	Arabic
অসমীয়া	Assamese
Asturianu	Asturian
Беларуская	Belarusian
Български	Bulgarian
বাংলা	Bengali

English (United States)
English (United Kingdom)
English (India)
English (Australia)
English (Canada)
English (Denmark)
English (Ireland)
English (New Zealand)
English (Nigeria)
English (Hong Kong SAR China)



```
[  OK  ] Finished Create Volatile Files and Directories.
         Starting Security Auditing Service...
         Starting Userspace Out-Of-Memory (OOM) Killer...
         Starting Network Name Resolution...
[  OK  ] Started Userspace Out-Of-Memory (OOM) Killer.
[  OK  ] Started Security Auditing Service.
         Starting Update UTMP about System Boot/Shutdown...
[  OK  ] Finished Update UTMP about System Boot/Shutdown.
[  OK  ] Reached target System Initialization.
[  OK  ] Started CUPS Scheduler.
[  OK  ] Started Discard unused blocks once a week.
[  OK  ] Started Daily rotation of log files.
[  OK  ] Started Updates mlocate database every day.
[  OK  ] Started Weekly RAID setup health check.
[  OK  ] Started Daily Cleanup of Temporary Directories.
[  OK  ] Started daily update of the root trust anchor for DNSSEC.
[  OK  ] Reached target Paths.
[  OK  ] Reached target Timers.
[  OK  ] Listening on Avahi mDNS/DNS-SD Stack Activation Socket.
[  OK  ] Listening on CUPS Scheduler.
[  OK  ] Listening on D-Bus System Message Bus Socket.
[  OK  ] Listening on Open-iSCSI iscsid Socket.
[  OK  ] Listening on Open-iSCSI iscsiuio Socket.
[  OK  ] Listening on Libvirt local socket.
[  OK  ] Listening on Libvirt admin socket.
[  OK  ] Listening on Libvirt local read-only socket.
[  OK  ] Listening on PC/SC Smart Card Daemon Activation Socket.
[  OK  ] Listening on SSSD Kerberos Cache Manager responder socket.
[  OK  ] Listening on Virtual machine lock manager socket.
[  OK  ] Listening on Virtual machine log manager socket.
[  OK  ] Reached target Sockets.
[  OK  ] Reached target Basic System.
         Starting Modem Manager...
         Starting Avahi mDNS/DNS-SD Stack...
         Starting firewalld - dynamic firewall daemon...
         Starting Add Fedora flatpak repositories...
_
```



CONFIGURATION

CENTOS 7 INSTALLATION

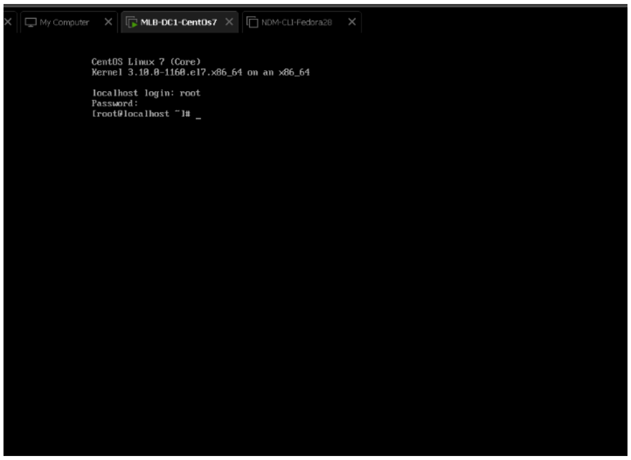
USER SETTINGS

ROOT PASSWORD
Root password is set

USER CREATION
User sw1 will be created

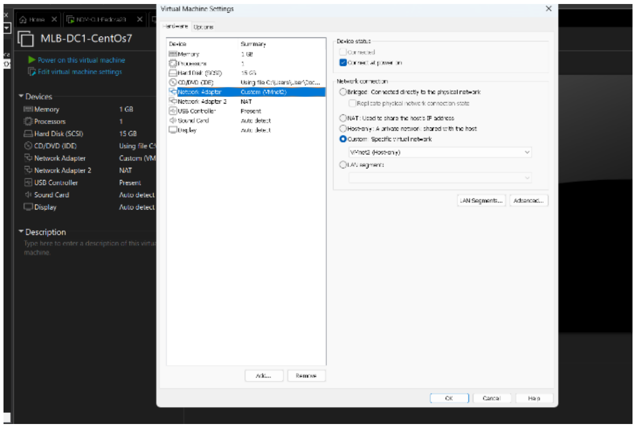
Performing post-installation setup tasks

Give root as login name & password



```
CentOS Linux 7 (Core)
Kernel 3.10.0-1160.el7.x86_64 on an x86_64

localhost login: root
Password:
[root@localhost ~]# _
```

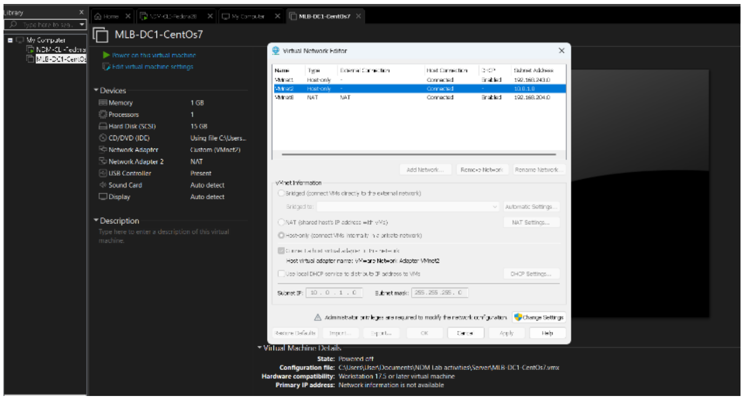
Network Configurations



Device	Summary
Memory	1 GB
Processors	1
Hard Disk (SCSI)	15 GB
CD/DVD (IDE)	Using file C:\Users\User\Doc...
Network Adapter	Custom (VMnet2)
Network Adapter 2	NAT
USB Controller	Present
Sound Card	Auto detect
Display	Auto detect

Device status
- ☐ Connected
- ☑ Connect at power on

Network connection
- ○ Bridged: Connected directly to the physical network
  - ☐ Replicate physical network connection state
- ○ NAT: Used to share the host's IP address
- ○ Host-only: A private network shared with the host
- ● Custom: Specific virtual network
  - VMnet2 (Host-only)
- ○ LAN segment:



Devices

Memory	1 GB
Processors	1
Hard Disk (SCSI)	15 GB
CD/DVD (IDE)	Using file C:\Users...
Network Adapter	Custom (VMnet2)
Network Adapter 2	NAT
USB Controller	Present
Sound Card	Auto detect
Display	Auto detect

Name	Type	External Connection	Host Connection	DHCP	Subnet Address
VMnet1	Host-only	-	Connected	Enabled	192.168.243.0
VMnet2	Host-only	-	Connected	-	10.0.1.0
VMnet8	NAT	NAT	Connected	Enabled	192.168.204.0

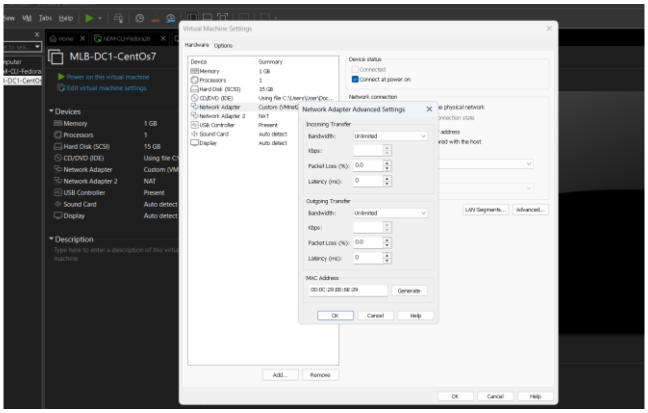
VMnet Information
- ○ Bridged (connect VMs directly to the external network)
  - Bridged to:
- ○ NAT (shared host's IP address with VMs)
- ● Host-only (connect VMs internally in a private network)
- ☑ Connect a host virtual adapter to this network
  - Host virtual adapter name: VMware Network Adapter VMnet2
- ☐ Use local DHCP service to distribute IP address to VMs

Subnet IP: 10 . 0 . 1 . 0 Subnet mask: 255 . 255 . 255 . 0

Administrator privileges are required to modify the network configuration.

Virtual Machine Details

State: Powered off
Configuration file: C:\Users\User\Documents\NDM Lab activities\Server\MLB-DC1-CentOs7.vmx
Hardware compatibility: Workstation 17.5 or later virtual machine
Primary IP address: Network information is not available



MLB-DC1-CentOs7

Virtual Machine Settings

Device	Summary
Memory	1 GB
Processors	1
Hard Disk (SCSI)	15 GB
CD/DVD (IDE)	Using file C:\Users\User\Doc...
Network Adapter	Custom (VMnet2
Network Adapter 2	NAT
USB Controller	Present
Sound Card	Auto detect
Display	Auto detect

Device status

□ Connected

☑ Connect at power on

Network Adapter Advanced Settings

Incoming Transfer

- Bandwidth: Unlimited
- Kbps:
- Packet Loss (%): 0.0
- Latency (ms): 0

Outgoing Transfer

- Bandwidth: Unlimited
- Kbps:
- Packet Loss (%): 0.0
- Latency (ms): 0

MAC Address: 00:0C:29:EE:6E:29

Server Configurations

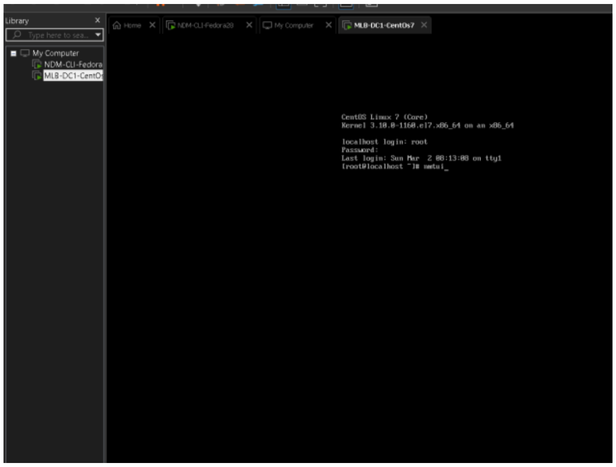
Opened nmtui and selected "Edit a Connection"

Chose VMnet2 adapter and set IPv4 Configuration to Manual Entered:

- • IP Address: 10.0.1.2/24

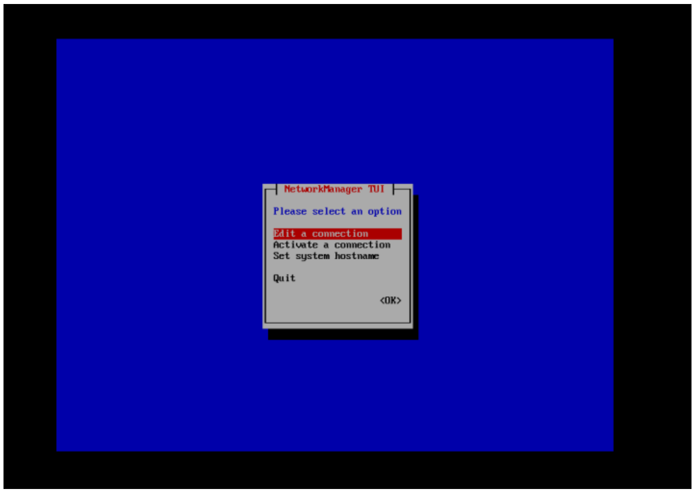
• Gateway: 10.0.1.1 Saved and activated the connection

1.Enter nmtui in terminal

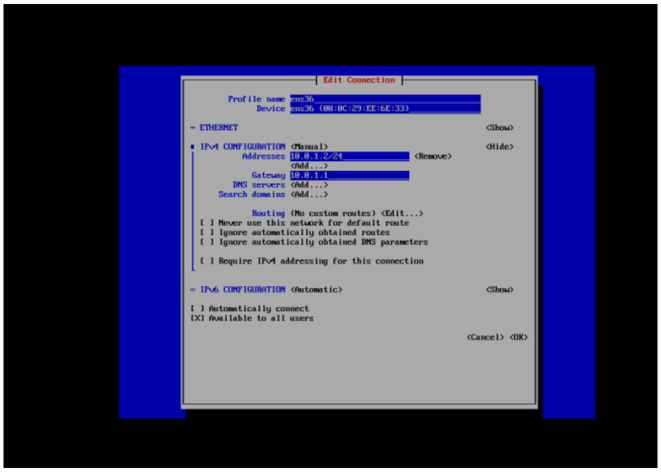


```
CentOS Linux 7 (Core)
Kernel 3.10.0-1160.el7.x86_64 on an x86_64

localhost login: root
Password:
Last login: Sun Mar  2 08:13:08 on tty1
[root@localhost ~]# nmtui_
```

2.Select edit a connection & check

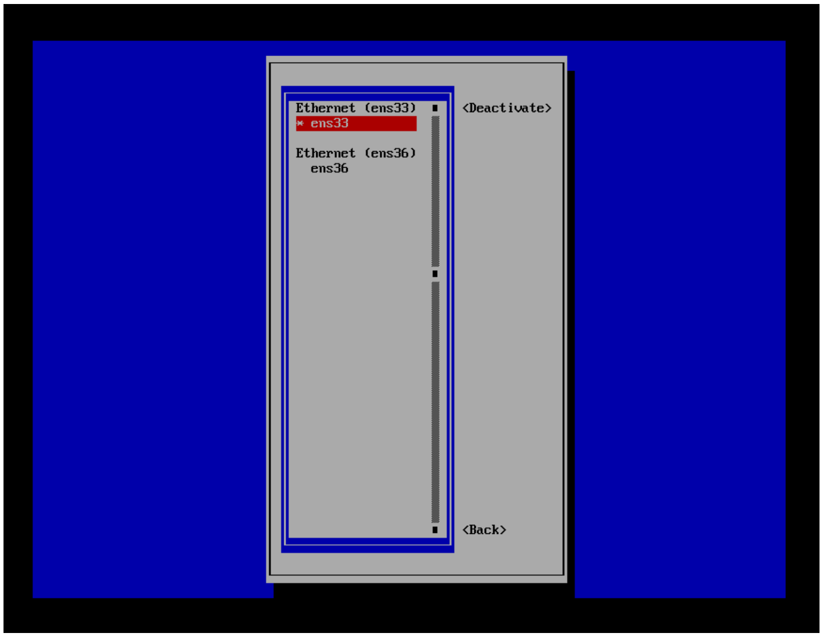


```
NetworkManager TUI

Please select an option

Edit a connection
Activate a connection
Set system hostname

Quit
                 <OK>
```



```
                    ┤ Edit Connection ├

      Profile name ens36
            Device ens36 (00:0C:29:EE:6E:33)

═ ETHERNET                                                  <Show>

╤ IPv4 CONFIGURATION <Manual>                               <Hide>
│          Addresses 10.0.1.2/24          <Remove>
│                    <Add...>
│            Gateway 10.0.1.1
│        DNS servers <Add...>
│     Search domains <Add...>
│
│            Routing (No custom routes) <Edit...>
│ [ ] Never use this network for default route
│ [ ] Ignore automatically obtained routes
│ [ ] Ignore automatically obtained DNS parameters
│
│ [ ] Require IPv4 addressing for this connection
└

═ IPv6 CONFIGURATION <Automatic>                            <Show>

[ ] Automatically connect
[X] Available to all users

                                                     <Cancel> <OK>
```

3.Then click ok option .After select active connection & enter twice on ens33



```
Ethernet (ens33)    <Deactivate>
* ens33

Ethernet (ens36)
  ens36






                    <Back>
```

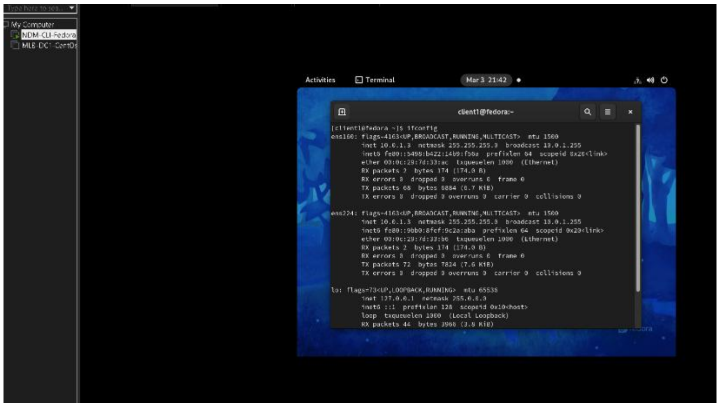
Client Configuration (Using GUI)

Opened Network Settings

Selected VMnet2 adapter

Configured IPv4 settings manually:

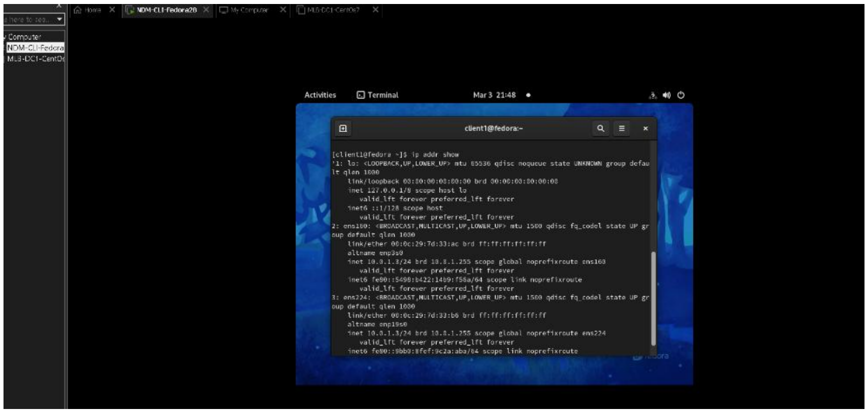
- IP Address: 10.0.1.3/24
- Gateway: 10.0.1.1 Saved and activated the connection



```
[client1@fedora ~]$ ifconfig
ens160: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.1.3  netmask 255.255.255.0  broadcast 10.0.1.255
        inet6 fe80::5498:b422:14b9:f56a  prefixlen 64  scopeid 0x20<link>
        ether 00:0c:29:7d:33:ac  txqueuelen 1000  (Ethernet)
        RX packets 2  bytes 174 (174.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 68  bytes 6884 (6.7 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

ens224: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.1.3  netmask 255.255.255.0  broadcast 10.0.1.255
        inet6 fe80::9bb0:8fef:9c2a:aba  prefixlen 64  scopeid 0x20<link>
        ether 00:0c:29:7d:33:b6  txqueuelen 1000  (Ethernet)
        RX packets 2  bytes 174 (174.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 72  bytes 7824 (7.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 44  bytes 3960 (3.8 KiB)
```

02) Configuring the Network settings on Fedora Client by only using CLI commands.

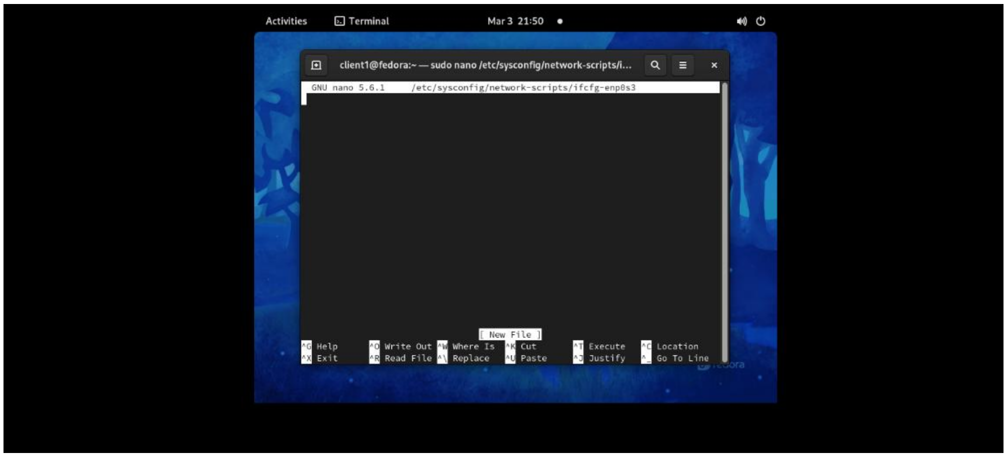
1. Open a new terminal in NDM-CLI-Fedora28 & check available network interfaces



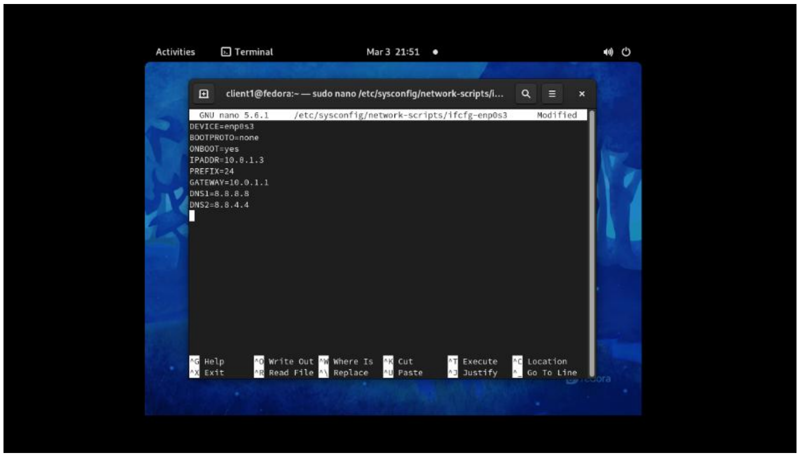
```
[client1@fedora ~]$ ip addr show
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group defau
lt qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: ens160: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP gr
oup default qlen 1000
    link/ether 00:0c:29:7d:33:ac brd ff:ff:ff:ff:ff:ff
    altname enp3s0
    inet 10.0.1.3/24 brd 10.0.1.255 scope global noprefixroute ens160
       valid_lft forever preferred_lft forever
    inet6 fe80::5498:b422:14b9:f56a/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
3: ens224: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP gr
oup default qlen 1000
    link/ether 00:0c:29:7d:33:b6 brd ff:ff:ff:ff:ff:ff
    altname enp19s0
    inet 10.0.1.3/24 brd 10.0.1.255 scope global noprefixroute ens224
       valid_lft forever preferred_lft forever
    inet6 fe80::9bb0:8fef:9c2a:aba/64 scope link noprefixroute
```

3. Configure the Network Interface

3.1. Edit the network configuration file:

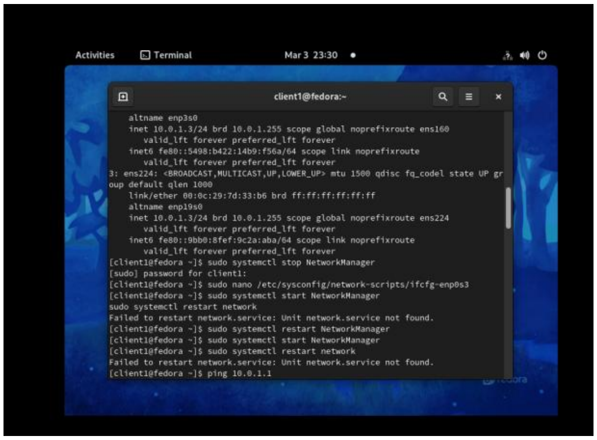

Activities
Terminal
Mar 3 21:50
client1@fedora:~ — sudo nano /etc/sysconfig/network-scripts/i...

```
  GNU nano 5.6.1      /etc/sysconfig/network-scripts/ifcfg-enp0s3

                                 [ New File ]
^G Help       ^O Write Out ^W Where Is  ^K Cut       ^T Execute   ^C Location
^X Exit       ^R Read File ^\ Replace   ^U Paste     ^J Justify   ^_ Go To Line
```


Activities
Terminal
Mar 3 21:51
client1@fedora:~ — sudo nano /etc/sysconfig/network-scripts/i...

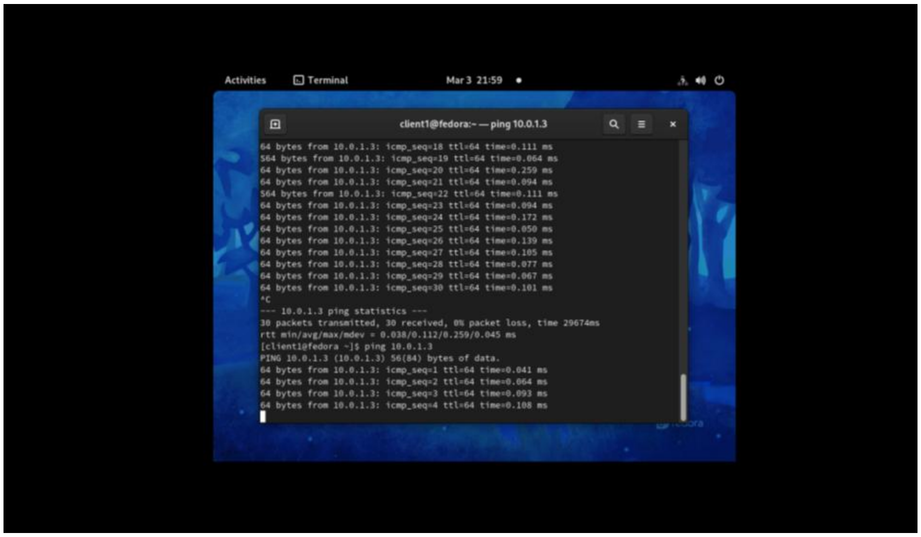
```
  GNU nano 5.6.1      /etc/sysconfig/network-scripts/ifcfg-enp0s3       Modified
DEVICE=enp0s3
BOOTPROTO=none
ONBOOT=yes
IPADDR=10.0.1.3
PREFIX=24
GATEWAY=10.0.1.1
DNS1=8.8.8.8
DNS2=8.8.4.4

^G Help       ^O Write Out ^W Where Is  ^K Cut       ^T Execute   ^C Location
^X Exit       ^R Read File ^\ Replace   ^U Paste     ^J Justify   ^_ Go To Line
```

4. Restart the Network Service and Verify the Network Configuration



```
    altname enp3s0
    inet 10.0.1.3/24 brd 10.0.1.255 scope global noprefixroute ens160
       valid_lft forever preferred_lft forever
    inet6 fe80::5498:b422:14b9:f56a/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
3: ens224: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP gr
oup default qlen 1000
    link/ether 00:0c:29:7d:33:b6 brd ff:ff:ff:ff:ff:ff
    altname enp19s0
    inet 10.0.1.3/24 brd 10.0.1.255 scope global noprefixroute ens224
       valid_lft forever preferred_lft forever
    inet6 fe80::9bb0:8fef:9c2a:aba/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
[client1@fedora ~]$ sudo systemctl stop NetworkManager
[sudo] password for client1:
[client1@fedora ~]$ sudo nano /etc/sysconfig/network-scripts/ifcfg-enp0s3
[client1@fedora ~]$ sudo systemctl start NetworkManager
sudo systemctl restart network
Failed to restart network.service: Unit network.service not found.
[client1@fedora ~]$ sudo systemctl restart NetworkManager
[client1@fedora ~]$ sudo systemctl start NetworkManager
[client1@fedora ~]$ sudo systemctl restart network
Failed to restart network.service: Unit network.service not found.
[client1@fedora ~]$ ping 10.0.1.1
```

5. Test Connectivity



```
64 bytes from 10.0.1.3: icmp_seq=18 ttl=64 time=0.111 ms
564 bytes from 10.0.1.3: icmp_seq=19 ttl=64 time=0.064 ms
64 bytes from 10.0.1.3: icmp_seq=20 ttl=64 time=0.259 ms
64 bytes from 10.0.1.3: icmp_seq=21 ttl=64 time=0.094 ms
564 bytes from 10.0.1.3: icmp_seq=22 ttl=64 time=0.111 ms
64 bytes from 10.0.1.3: icmp_seq=23 ttl=64 time=0.094 ms
64 bytes from 10.0.1.3: icmp_seq=24 ttl=64 time=0.172 ms
64 bytes from 10.0.1.3: icmp_seq=25 ttl=64 time=0.050 ms
64 bytes from 10.0.1.3: icmp_seq=26 ttl=64 time=0.139 ms
64 bytes from 10.0.1.3: icmp_seq=27 ttl=64 time=0.105 ms
64 bytes from 10.0.1.3: icmp_seq=28 ttl=64 time=0.077 ms
64 bytes from 10.0.1.3: icmp_seq=29 ttl=64 time=0.067 ms
64 bytes from 10.0.1.3: icmp_seq=30 ttl=64 time=0.101 ms
^C
--- 10.0.1.3 ping statistics ---
30 packets transmitted, 30 received, 0% packet loss, time 29674ms
rtt min/avg/max/mdev = 0.038/0.112/0.259/0.045 ms
[client1@fedora ~]$ ping 10.0.1.3
PING 10.0.1.3 (10.0.1.3) 56(84) bytes of data.
64 bytes from 10.0.1.3: icmp_seq=1 ttl=64 time=0.041 ms
64 bytes from 10.0.1.3: icmp_seq=2 ttl=64 time=0.064 ms
64 bytes from 10.0.1.3: icmp_seq=3 ttl=64 time=0.093 ms
64 bytes from 10.0.1.3: icmp_seq=4 ttl=64 time=0.108 ms
```

PRACTICAL 1

1. **Select three Virtualization providers**
    - VMware Workstation
    - Microsoft Hyper-V
    - Oracle VirtualBox

2.Three Virtualization Providers and Their Virtual Network Interface Cards

1)VMware

- Virtual NIC Type: VMXNET3
    - A paravirtualized network adapter optimized for high performance in VMware environments.
    - Features: Supports advanced functionalities like TCP/IP offloading, jumbo frames, and low-latency communication. Ideal for high-throughput workloads.

2)Microsoft Hyper-V

- Virtual NIC Type: Synthetic Network Adapter
    - Uses the Hyper-V VMBus for direct communication between the guest OS and hypervisor.
    - Features: Enhanced performance over emulated adapters, supports VLAN tagging, and integrates with Windows Server environments.

3)Oracle VirtualBox

- Virtual NIC Type: Intel PRO/1000 MT Desktop
    - An emulated network adapter for broad compatibility across guest operating systems.
    - Features: Simulates physical hardware, suitable for testing and development environments.

3. Comparison of Virtual Network Interface Cards

Feature	**VMware VMXNET3**	**Hyper-V Synthetic Adapter**	**VirtualBox Intel PRO/1000 MT**
Performance	High (paravirtualized)	High (VMBus optimized)	Moderate (emulated)
Driver Requirements	Requires VMware Tools	Requires Hyper-V Integration Services	Uses generic drivers
Use Case	Enterprise workloads, cloud environments	Windows Server virtualization	Cross-platform testing/development
Advanced Features	Jumbo frames, RSS support	VLAN tagging, SR-IOV (optional)	Basic network emulation

4. Practical Usage Scenarios

Scenario 1: VMware VMXNET3

- **Use Case**: Hosting a high-traffic web server cluster.
  - VMXNET3's low latency and high throughput ensure efficient handling of concurrent HTTP requests.
  - Example: Deploying a Kubernetes node with multiple pods requiring rapid inter-VM communication.

Scenario 2: Hyper-V Synthetic Network Adapter

- **Use Case**: Enterprise Active Directory Domain Services.
  - The Synthetic Adapter's integration with Windows Server ensures seamless authentication and directory replication across Hyper-V VMs.
  - Example: Running a Windows Server 2022 VM managing domain-joined workstations.

Scenario 3: VirtualBox Intel PRO/1000 MT

- **Use Case**: Cross-platform software testing.
  - The emulated NIC allows Linux, Windows, and macOS VMs to share a network for testing application compatibility.
  - Example: Validating a Python script's network behavior across different OS environments.