Ex No: 1 STUDY AND PERFORM THE CONFIGURATION OF A NETWORK IN LINUX

Date:

AIM:
To study and perform the configuration of a network interface in Linux Operating System.
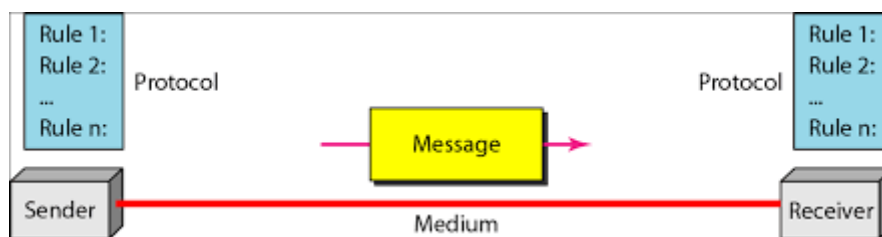### DESCRIPTION:

NETWORKING OVERVIEW:

COMPUTER NETWORK
Computer network is defined as the interconnection of nodes (computers and other devices) connected by a communication channel (wired or wireless) that facilitates communication among users and allows them to share resources.
Components *of data communication*

- **Sender:** It is the transmitter of data. Some examples are Terminal, Computer, and Mainframe.
- **Medium:** The communication stream through which the data is being transmitted. Some examples are: Cabling, Microwave, Fiber optics, Radio Frequencies (RF), Infrared Wireless
- **Receiver:** The receiver of the data transmitted. Some examples are Printer, Terminal, Mainframe, and Computer.
- **Message:** It is the data that is being transmitted from the Source/Sender to the Destination/Receiver.
- **Protocol:** It is the set of rules and regulations (resides in the form of software and hardware) that are to be followed for communication. If protocol is not present it implies the nodes are connected but they can't communicate.

CATEGORIES OF NETWORK:
The three primary categories of network are Local Area Network (LAN), Metropolitan Area Network (MAN), and Wide Area Network (WAN). The category into which a network fall is determined by its size, ownership, the distance it covers and its physical architecture.

LAN
- A LAN is usually privately owned and links the devices in a single office, building or campus.
- A LAN can be as simple as two PCs or it can extend throughout a company. LAN size is limited to a few kilometers.
- The most widely used LAN technology is the Ethernet technology developed by the Xerox Corporation.
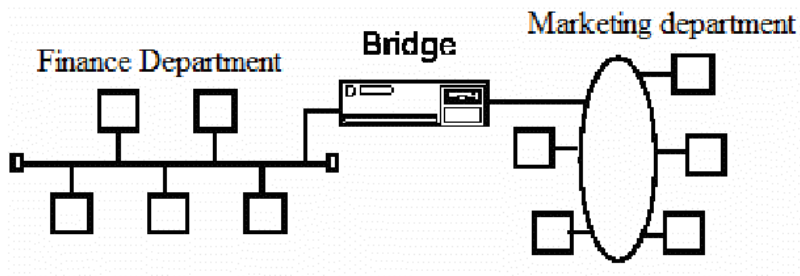
Figure 1.8: Local Area Network

MAN

- A MAN is designed to extend over an entire city.
- It could be a single network such as cable TV network or connect a number of LANs into a larger network.
- A MAN can be owned by a private company or it may be a service provided by a public company, such as local telephone company.
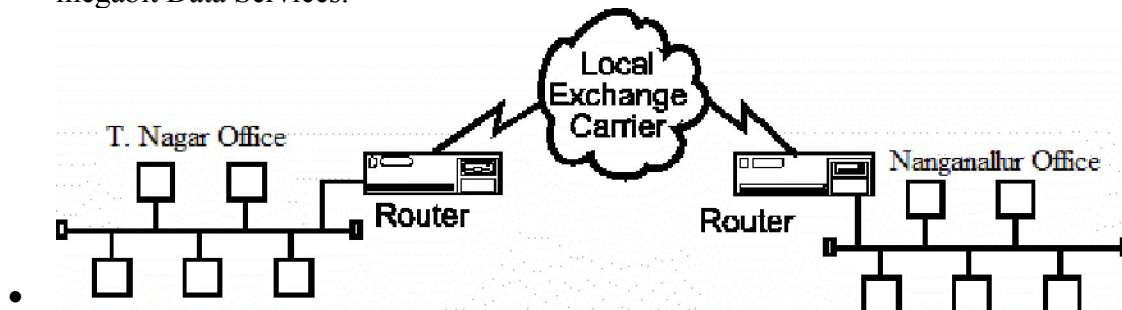- Telephone companies provide a popular MAN service called (SMDS) Switched Multi-megabit Data Services.

-

Figure: Metropolitan Area Network

WAN

- A WAN provides long distance transmission of data, voice, image and video information over large geographic areas.
- WAN utilize public, leased, or private communication equipment usually in combinations and therefore span an unlimited number of miles.
- A WAN that is wholly owned and used by a single company is referred to as an Enterprise Network.
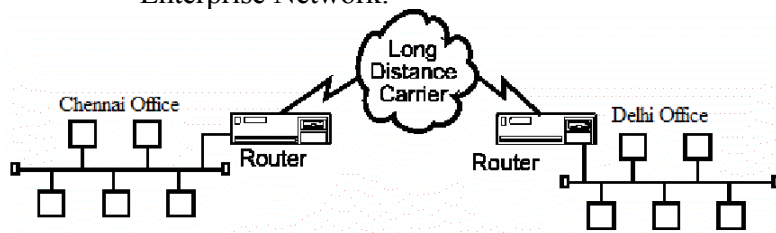

Figure 1.10: Wide Area Network

ADDRESSING IN A NETWORK:

- Every network device has two types of addresses,

  1. **Logical address** -- in most cases this is the IP address- IP address is a number assigned to a connection of a device in a network. It is 32 bit length for IPv4 and 128 bit length for IPv6.

  2. **Physical address** -- also known as the MAC address-A MAC address is a

number assigned to the NIC card by the manufacturer. It length is 48 bits represented in hexadecimal (6 bytes).

- A **network address** is also known as the numerical network part of an IP address. This is used to identify a network that has its own hosts and addresses. For example, in the IP address 192.168.1.1, the network address part is 192.168.1 and the network address of this IP connection is 192.168.1.0.
- A subnetwork or subnet is a logical subdivision of an IP network. The practice of dividing a network into two or more networks is called subnetting.
- **Subnet masks** are expressed in dot-decimal notation like an address. For example, 255.255.255.0 is the subnet mask for the prefix 198.51.100.0/24.

GATEWAY:

- A gateway is a hardware device that acts as a "gate" between two networks. It may be a router, firewall, server, or other device that enables traffic to flow in and out of the network. While a gateway protects the nodes within network, it also a node itself.

DNS:

- DNS. (Domain Name System) The Internet's system for converting alphabetic names into numeric IP addresses. For example, when a Web address (URL) is typed into a browser, DNS servers return the IP address of the Web server associated with that name.

INTRODUCTION TO NETWORKING IN LINUX:

Connecting your Linux computer to a network is pretty straightforward. Linux easily manages multiple network interface adapters.

LINUX FILE SYSTEM:

In a LINUX file system, everything is a file. In order to manage all those files in an orderly fashion, man likes to think of them in an ordered
tree-like structure on the hard disk.
A Linux system, just like UNIX, makes no difference between a file and a directory, since a directory is just a file containing names of other files. Programs, services, texts, images, and so forth, are all files. Input and output devices, and generally all devices, are considered to be files, according to the system.
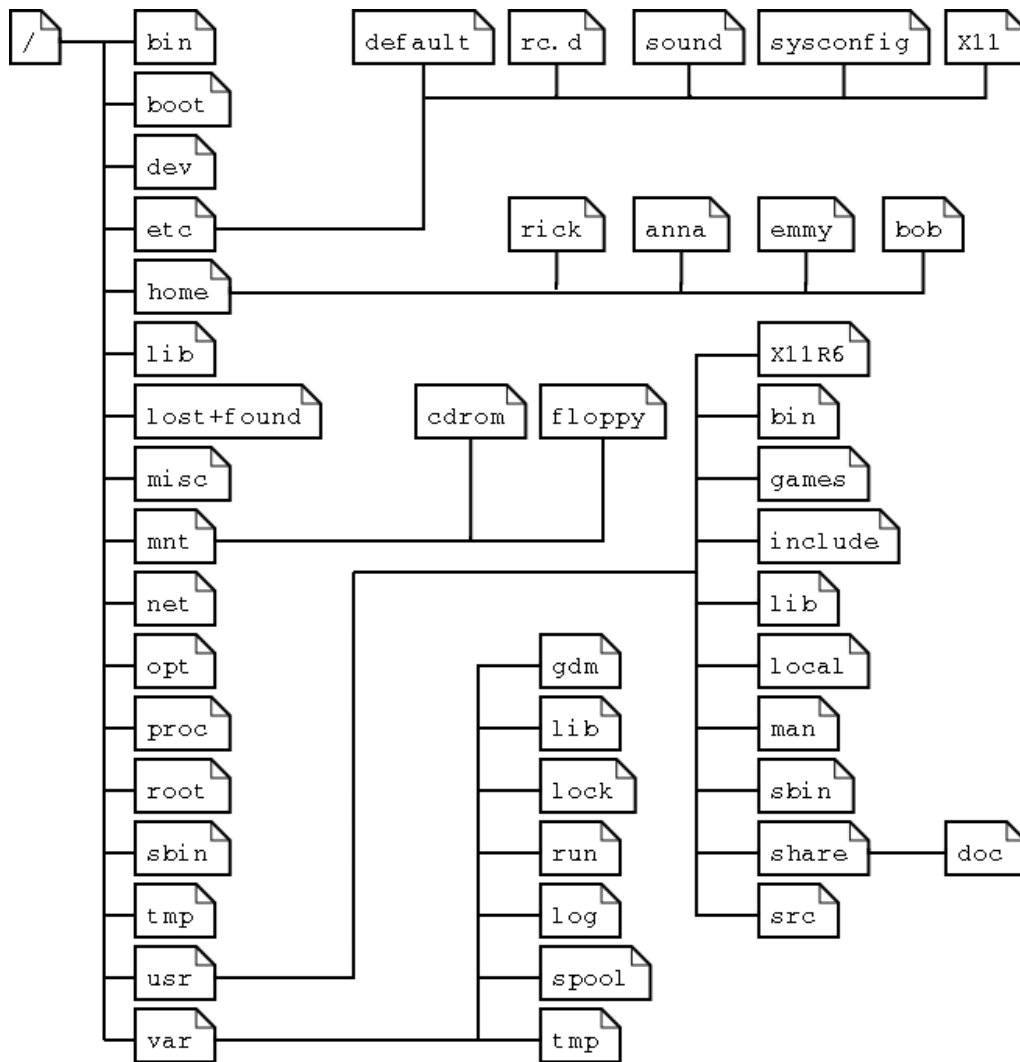
The tree of the file system starts at the trunk or slash, indicated by a forward slash (/). This directory, containing all underlying directories and files, is also called the root directory or "the root" of the file system.

Directories that are only one level below the root directory are often preceded by a slash, to indicate their position and prevent confusion with other directories that could have the same name. When starting with a new system, it is always a good idea to take a look in the root directory. Let's see what you could run into:

In the above set of directories, /etc directory contains most important system configuration files, this directory contains data similar to those in the Control Panel in Windows

CONFIGURING A NETWORK INTERFACE:

/etc directory:
1. This is the nerve center of the Linux file system; it contains all **system related configuration files** in it or in its sub-directories.
2. A "configuration file" is defined as a local file used to control the operation of a program; it must be static and cannot be an executable binary.

/etc/sysconfig/ sub-directory:

1. This directory contains configuration files for mouse, keyboard, network, desktop, system clock, power management etc. Its subdirectories contain setup of system configuration specifics, like 'clock', which sets the time zone, or 'keyboard' which controls the keyboard map.
2. The contents may vary drastically depending on which distribution and what utilities you have installed.
3. The sub directory for network configuration is **etc/sysconfig/network-scripts.**

Ethernet Interfaces files:
1. Every network interface has its own configuration file in the */etc/sysconfig/network-scripts* directory.
2. This file starts the interface on boot, assigns it a static IP address, defines a domain and network gateway, specifies two DNS servers.
3. **It does not allow non-root users to start and stop the interface.**
4. The network interface file **/etc/sysconfig/network-scripts/ifcfg-eth0 (eth0-name of the interface card)** controls the first Ethernet *network interface card* or NIC in the system.
5. The system reads this network interface files during the boot process to determine which interfaces to bring up and how to configure them.
6. In a system with multiple NICs, there are multiple ifcfg-eth*X* files (where *X* is a unique number corresponding to a specific interface). Because each device has its own configuration file, an administrator can control how each interface functions individually.
7. Sample ifcfg-eth0 file for an interface using a **fixed IP address consists of the following configuration parameters set.**:

- TYPE=Ethernet
- BOOTPROTO=none
- DEFROUTE=yes
-

  IPV4_FAILURE_FATAL=no
- IPV6INIT=yes
- IPV6_AUTOCONF=yes
- IPV6_DEFROUTE=yes
-

  IPV4_FAILURE_FATAL=no
- NAME=eth0
- UUID=...

- ONBOOT=yes
-

  HWADDR=0e:a5:1a:b6:fc:86
- **IPADDR0=172.31.24.10**
- **PREFIX0=23**
- **GATEWAY0=172.31.24.1**
- **DNS1=192.168.154.3**
- **DNS2=10.216.106.3**
- DOMAIN=example.com
- IPV6_PEERDNS=yes
- IPV6_PEERROUTES=yes

Configuration Parameters Description:
A description of some of these configuration parameters follows:

Configuration Parameters	Description
TYPE	The type of network interface device
BOOTPROTO	**Protocol is one of the following:** none: No boot-time protocol is used (static)

	bootp: Use BOOTP (bootstrap protocol) dhcp: Use DHCP (Dynamic Host Configuration Protocol).
DEFROUTE|IPV6_DEFROUTE	**Answer is one of the following:** yes: This interface is set as the default route for IPv4|IPv6 traffic. no: This interface is not set as the default route.
IPV6INIT	**Answer is one of the following:** Enable IPv6 on this interface. If IPV6INIT=yes, the following parameters could also be set in this file: IPV6ADDR=IPv6 address IPV6_DEFAULTGW=The default route through the specified gateway no: Disable IPv6 on this interface.
IPV4_FAILURE_FATAL| IPV6_FAILURE_FATAL	**Answer is one of the following:** yes: This interface is disabled if IPv4 or IPv6 configuration fails. no: This interface is not disabled if configuration fails.
ONBOOT	**Answer is one of the following:** yes: This interface is activated at boot time. no: This interface is not activated at boot time
HWADDR	The hardware address of the Ethernet device
IPADDRN	The IPv4 address assigned to the interface
PREFIXN	Length of the IPv4 netmask value
GATEWAYN	The IPv4 gateway address assigned to the interface. Because an interface can be associated with several combinations of IP address, network mask prefix length, and gateway address, these are numbered starting from 0.
DNSN	The address of the Domain Name Servers (DNS)
DOMAIN	The DNS search domain
USERCTL	**Answer is one of the following:** yes: Non-root users are allowed to control this device. no : Non-root users are not allowed to control this device.
NAME	Interface Device name

BASIC NETWORKING COMMANDS IN LINUX:

IFCONFIG COMMAND:
ifconfig (interface configurator) command is used to,
1. View IP Address and Hardware / MAC address assigned to interface , gateway, DNS Server ,MTU (Maximum transmission unit) size and many other network configuration parameters.
   [root@localhost ~]# ifconfig

   eth0   Link encap:Ethernet HWaddr 00:0C:29:28:FD:4C

inet addr:192.168.50.2 Bcast:192.168.50.255 Mask:255.255.255.0
inet6 addr: fe80::20c:29ff:fe28:fd4c/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:6093 errors:0 dropped:0 overruns:0 frame:0
TX packets:4824 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:6125302 (5.8 MiB) TX bytes:536966 (524.3 KiB)
Interrupt:18 Base address:0x2000

lo   Link encap:Local Loopback
inet addr:127.0.0.1 Mask:255.0.0.0
inet6 addr: ::1/128 Scope:Host
UP LOOPBACK RUNNING MTU:16436 Metric:1
RX packets:8 errors:0 dropped:0 overruns:0 frame:0
TX packets:8 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:0
RX bytes:480 (480.0 b) TX bytes:480 (480.0 b)

2. Assign IP Address to interface
[root@localhost ~]#ifconfig eth0 192.168.50.5 netmask 255.255.255.0
[root@localhost ~]#ifconfig eth0
eth0 Link encap:Ethernet HWaddr 00:0C:29:28:FD:4C
inet addr:192.168.50.5 Bcast:192.168.50.255 Mask:255.255.255.0
inet6 addr: fe80::20c:29ff:fe28:fd4c/64 Scope:Link
UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
RX packets:6119 errors:0 dropped:0 overruns:0 frame:0
TX packets:4841 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:6127464 (5.8 MiB) TX bytes:539648 (527.0 KiB)
Interrupt:18 Base address:0x2000

3. Enable or disable intrface on demand.
[root@localhost ~]#ifdown eth0 – disables an interface named eth0
[root@localhost ~]#ifup eth0 – Enables an interface named eth0

PING COMMAND:

1. PING (Packet INternet Groper) command is the best way to test connectivity between two nodes.
2. Both in Local Area Network (LAN) or Wide Area Network (WAN).
3.   Ping use ICMP (Internet Control Message Protocol) to communicate to other devices.
4. #ping hostname(ping localhost)
5. #ping ip address (ping 4.2.2.2)
6. #ping fully qualified domain name(ping www.facebook.com)

[root@localhost ~]#ping 4.2.2.2
PING 4.2.2.2 (4.2.2.2) 56(84) bytes of data.
64 bytes from 4.2.2.2: icmp_seq=1 ttl=44 time=203 ms
64 bytes from 4.2.2.2: icmp_seq=2 ttl=44 time=201 ms
64 bytes from 4.2.2.2: icmp_seq=3 ttl=44 time=201 ms

HOSTNAME COMMAND:

This command displays the network name of the host machine.

    [root@localhost network-scripts]# hostname
    localhost.localdomain
    [root@localhost network-scripts]#

TRACEROUTE COMMAND:

Traceroute is a command which can shows the path a packet takes from the computer to one specified as destination. It will list all the routers it passes through until it reaches its destination, or fails to and is discarded. In addition to this, it will tell how long each 'hop' from router to router takes.

[root@localhost network-scripts]# traceroute www.google.com
        traceroute to www.google.com (172.217.163.132), 30 hops max, 60 byte packets
        1 gateway (172.16.8.1) 0.165 ms 0.131 ms 0.119 ms
        2 220.225.219.38 (220.225.219.38) 7.131 ms 7.133 ms 7.472 ms
        3 * * *
        4 220.227.42.241 (220.227.42.241) 6.951 ms 7.100 ms 7.323 ms
        5 80.81.65.93 (80.81.65.93) 6.869 ms 6.826 ms 6.962 ms
        6 ae10.0.cjr01.sin001.flagtel.com (62.216.128.233) 39.441 ms 221.191 ms 40.260 ms
        7 80.77.1.254 (80.77.1.254) 40.248 ms 38.916 ms 38.304 ms
        8 108.170.240.164 (108.170.240.164) 39.610 ms 108.170.240.242
        (108.170.240.242) 38.963 ms 108.170.240.172 (108.170.240.172) 38.860 ms
        9 72.14.235.152 (72.14.235.152) 39.912 ms * 72.14.234.96 (72.14.234.96) 38.783 ms
        10 216.239.48.226 (216.239.48.226) 122.220 ms 72.14.233.122 (72.14.233.122)
         121.132 ms 216.239.48.226 (216.239.48.226) 124.187 ms
        11 74.125.242.145 (74.125.242.145) 121.041 ms 74.125.242.129 (74.125.242.129)
         121.181 ms 127.865 ms
        12 216.239.42.245 (216.239.42.245) 127.057 ms 216.239.43.77 (216.239.43.77)
         125.901 ms *
        13 maa05s04-in-f4.1e100.net (172.217.163.132) 27.956 ms * *
        [root@localhost network-scripts]#

ROUTE COMMAND:

Route command is used to show/manipulate the IP routing table. It is primarily used to setup static routes to specific host or networks via an interface.

    [root@localhost network-scripts]# route
    Kernel IP routing table
    Destination Gateway   Genmask   Flags Metric Ref   Use Iface
    default   gateway   0.0.0.0 UG   100   0   0 enp3s0
    172.16.8.0   0.0.0.0   255.255.252.0   U   100   0   0 enp3s0

[root@localhost network-scripts]#

NETSTAT COMMAND:

Netstat (network statistics) is a command line tool for monitoring network connections both incoming and outgoing as well as viewing routing tables, interface statistics etc.

```
[root@localhost network-scripts]# netstat -r
Kernel IP routing table
Destination   Gateway        Genmask         Flags  MSS Window  irtt Iface
default       gateway        0.0.0.0         UG      0 0        0 enp3s0
172.16.8.0    0.0.0.0        255.255.252.0   U       0 0        0 enp3s0
[root@localhost network-scripts]#
```

NSLOOKUP COMMAND:

nslookup command. nslookup (name server lookup) is a tool used to perform DNS lookups inLinux. It is used to display DNS details, such as the IP address of a particular computer, the MX records for a domain or the NS servers of a domain. nslookup can operate in two modes: interactive and non-interactive.

```
[root@localhost network-scripts]# nslookup www.google.com
Server:       172.16.8.1
Address:      172.16.8.1
Non-authoritative answer:
Name:  www.google.com
Address: 172.217.163.132
Name:  www.google.com
Address: 2404:6800:4007:80e::2004
[root@localhost network-scripts]#
```

ARP COMMAND:
Arp command is used to display the arp cache table

```
[root@localhost network-scripts]# arp
Address             HWtype  HWaddress          Flags Mask        Iface
172.16.9.82           ether  ec:a8:6b:69:d3:e1  C               enp3s0
172.16.10.118         ether  00:11:5b:ff:cc:a5  C               enp3s0
gateway             ether  08:35:71:f2:b4:a1  C               enp3s0
172.16.10.91          ether  00:e0:4c:b2:5b:06  C               enp3s0
172.16.10.124         ether  00:0f:ea:93:f4:55  C               enp3s0
172.16.8.51           ether  00:1a:4d:a6:98:30  C               enp3s0
[root@localhost network-scripts]# ^C
```

WHOIS COMMAND:

It's queries an official Internet database to determine the current owner of a network domain name or host name

[root@localhost network-scripts]# whois google.com
[Querying whois.verisign-grs.com]
[Redirected to whois.markmonitor.com]
[Querying whois.markmonitor.com]
[whois.markmonitor.com]
Domain Name: google.com
Registry Domain ID: 2138514_DOMAIN_COM-VRSN
Registrar WHOIS Server: whois.markmonitor.com
Registrar URL: http://www.markmonitor.com
Updated Date: 2018-02-21T10:45:07-0800
Creation Date: 1997-09-15T00:00:00-0700

EXERCISES:

NETWORK CONFIGURATION IN LINUX

1. **Open the network interface configuration file of your computer and write the values of the following configuration parameters**

   Output:

a)	IPADDR	:	172.16.8.138
b)	HWADDR	:	00:27:0e:13:ea:6a
c)	PREFIX/SUBNET MASK	:	23
d)	GATEWAY	:	172.16.8.1
e)	DNS	:	172.16.8.1
f)	NAME	:	New 302-3-ethernet connection
g)	TYPE	:	Ethernet

2. **Display the network configuration details of your network interface.**

   Output:

   ```
   ETHTOOL_OPTS = "autonig on"
   TYPE = Ethernet
   PROXY_METHOD=none
   BROWSER_ONLY=no
   BOOTPROTO= "static"
   IPADDR=172.16.8.13
   PREFIX=23
   GATEWAY=172.16.8.1
   DNS=172.16.8.1
   DEFROUTE=yes
   IPV4_FAILURE_FATAL=yes
   ```

```
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=Stable_privacy
NAME= New 302-3-ethernet connection
UUID=C7628055-dbb6-470f-a68-c71dafdefa
ONBOOT=yes
```

3. **Assign the following IP address to your device 172.16.8.127 and display the change in IP address.**

   Output:

   To change the IP address:
   [root@localhost network-scripts]#ifconfig eth0 **172.16.8.127** netmask 255.255.255.0

   To verify the Change:
   [root@localhost network-scripts]# ifconfig
   ```
           eth0   Link encap:Ethernet  HWaddr 00:0C:29:28:FD:4C
                  inet addr:192.168.50.5  Bcast:172.16.8.127  Mask:255.255.255.0
                  inet6 addr: fe80::20c:29ff:fe28:fd4c/64 Scope:Link
                  UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
                  RX packets:6119 errors:0 dropped:0 overruns:0 frame:0
                  TX packets:4841 errors:0 dropped:0 overruns:0 carrier:0
                  collisions:0 txqueuelen:1000
                  RX bytes:6127464 (5.8 MiB)  TX bytes:539648 (527.0 KiB)
                  Interrupt:18 Base address:0x2000
   ```

4. **Disconnect the network interface and check the dis-connectivity through a command and display the results. Finally activate the interface.**

   Output:

   To Disconnect the Interface:
   [root@localhost network-scripts]#ifdown enp3so
   Device 'enp3so' successfully disconnected.
   (Check for a internet connectivity. It will not happen)

   To connect to the Interface:
   [root@localhost network-scripts]#ifup enp3so
   Connection successfully activated.

5. **Check whether the following hosts are reachable from your device and explain the response.**

   Output:

   a) 172.16.8.2
       [root@localhost network-scripts]#ping 172.16.8.2

64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.14ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=2.12ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.44ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=1.14ms
172.16.8.2 is reachable.

b)DNS Server
[root@localhost network-scripts]#ping 172.16.8.1
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.14ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=2.12ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.44ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=1.14ms
DNS is reachable.

c) GATEWAY
[root@localhost network-scripts]#ping 172.16.8.1
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.14ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=2.12ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.44ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=1.14ms
GATEWAY is reachable.
d)127.0.0.1
[root@localhost network-scripts]#ping 127.0.0.1
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.14ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=2.12ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.44ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=1.14ms

Since the Interface is active. We are reachable to all the specified Destinations

6. **Disconnect the network interface and Check whether the following hosts are reachable from your device and explain the response.**

Output:

[root@localhost network-scripts]#ifdown enp3so
Device 'enp3so' successfully disconnected.
a)127.0.0.1
[root@localhost network-scripts]#ping 127.0.01
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.14ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=2.12ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=3.44ms
64 bytes from 172.16.8.2:icmp_seq=1 ttl=64 time=1.14ms
127.0.0.1 is reachable because it is loopback address.
b)GATEWAY
[root@localhost network-scripts]#ping 172.16.8.1
GATEWAY is unreachable.

7. **Find the IPv4 and IPv6 addresses of the following URLs.**

   Output:
   a)www.google.com
   nslookup www.google.com
   IPV4 172.217.163.68
   IPV6 2404:6800:4007:80c::2004
   b)www.facebook.com
   nslookup www.facebook.com
   IPV4 157.240.24.35
   IPV6 2a03:2880:f139:83:face:booc:0:25de
   c)www.rajalakshmi.org
   nslookup www.rajalakshmi.org
   IPV4 220.227.30.5

8. **Display the ARP table of your machine.**

   Output:

   [root@localhost network-scripts]#arp
   Address   HWType   HWaddress   FlagsMark   Iface
   172.16.8.1   ether   00:27:0e:13:ea:6a   c   enp3so
   172.16.8.2   ether   00:27:0e:13:ea:6a   c   enp3so

9. **Display the kernel routing table of your machine.**

   Output:

   [root@localhost network-scripts]#route
     Kernel IP routing table
     Destination   Gateway   Genmask   Flags   metric   Ref   Iface
     Default   gateway   0.0.0.0   ua   100   0   U enp3s0
     172.16.0.0   0.0.0.0   255.255.0.0   U   100   0   O enp3s0

10. **List out the hops(IP addresses of the intermediate nodes) taken by a packet to reach its destination.**

    Output:

    [root@localhost network-scripts]#traceroute www.google.com
    Traceroute to www.google.com (172.217.163.68) 30 hops.60 byte packets.