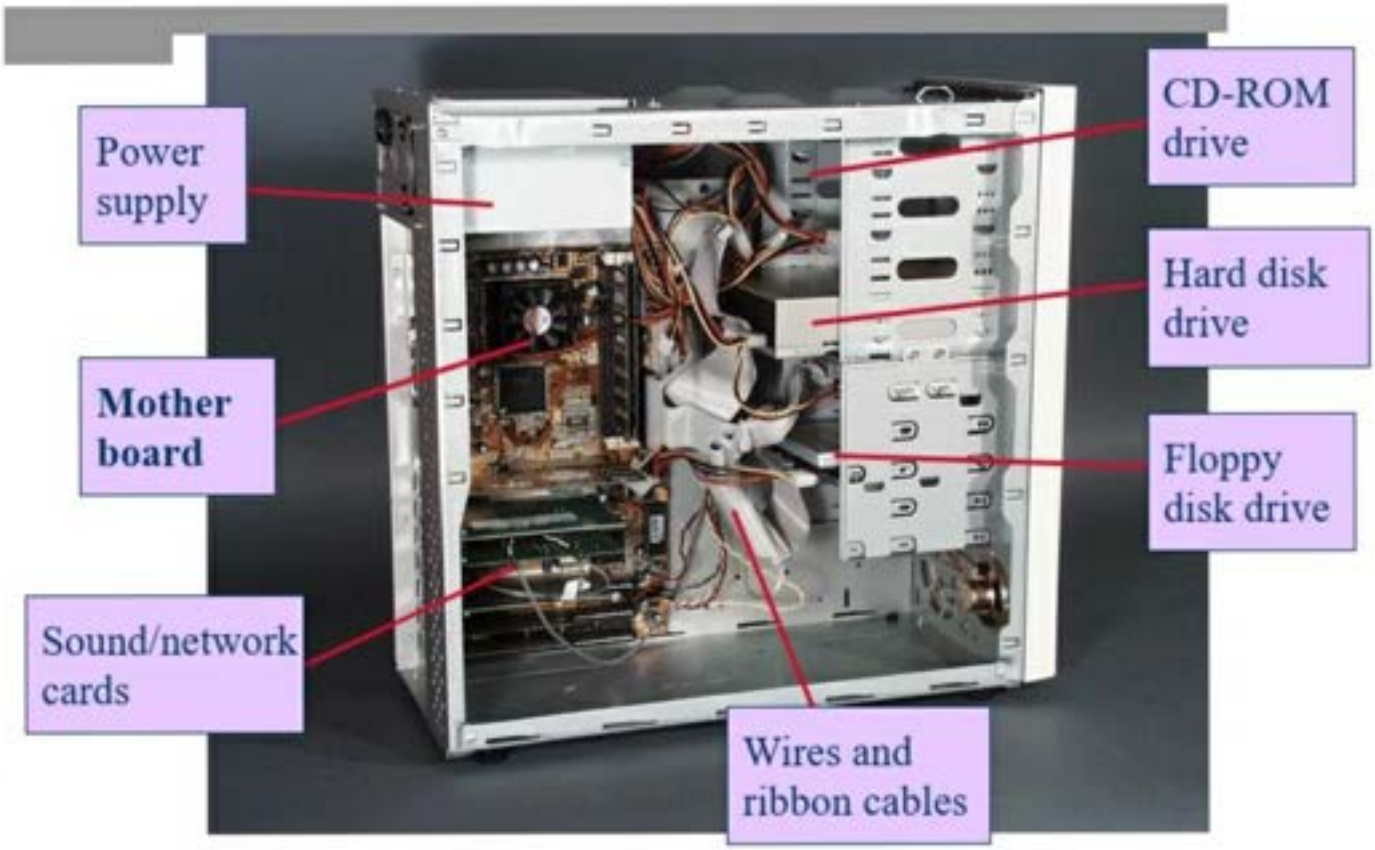
Inside a PC - components:



(i) The Motherboard:

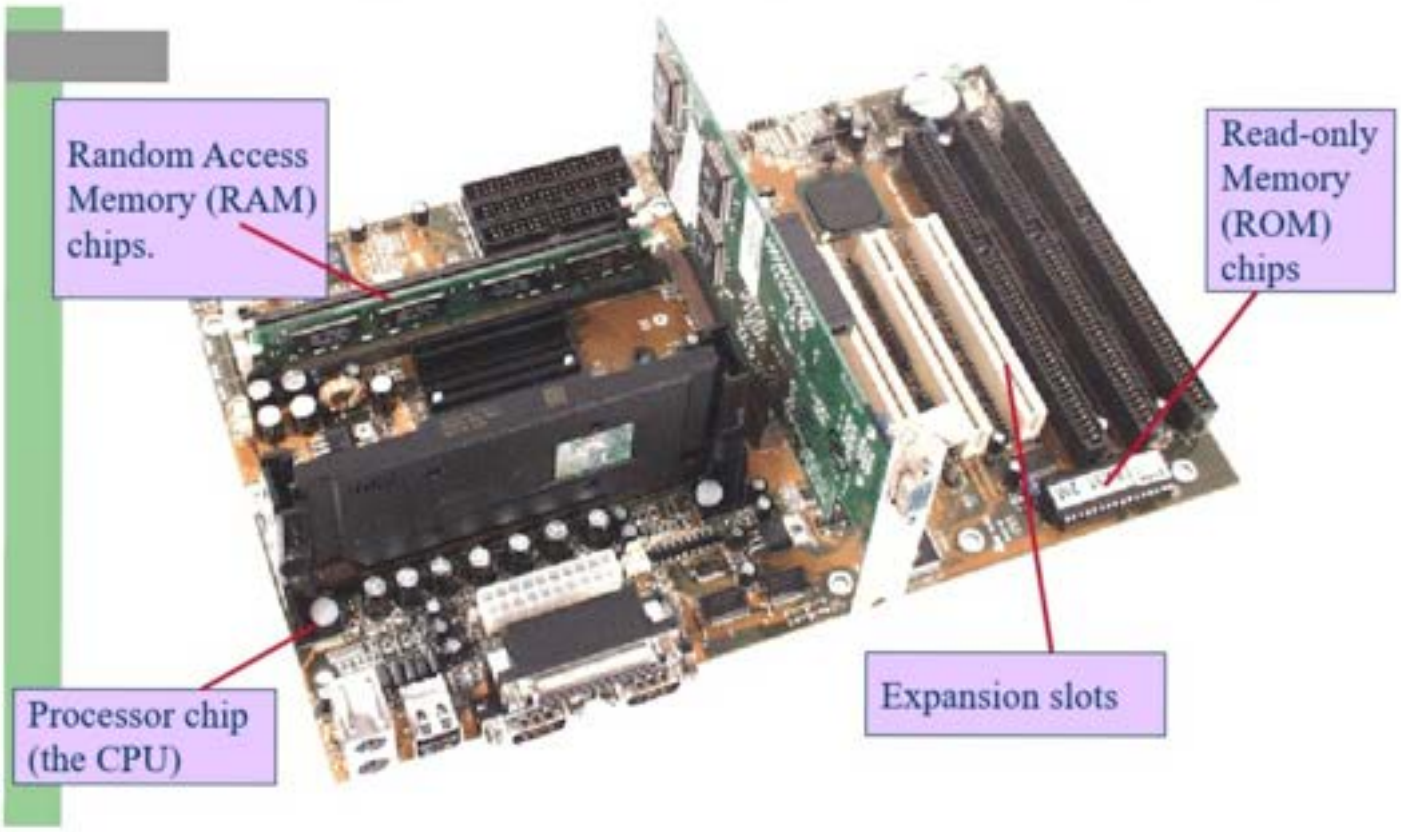
- The most important part of PC
- Also called backbone of computer
- It connects all parts of a computer together

Features:

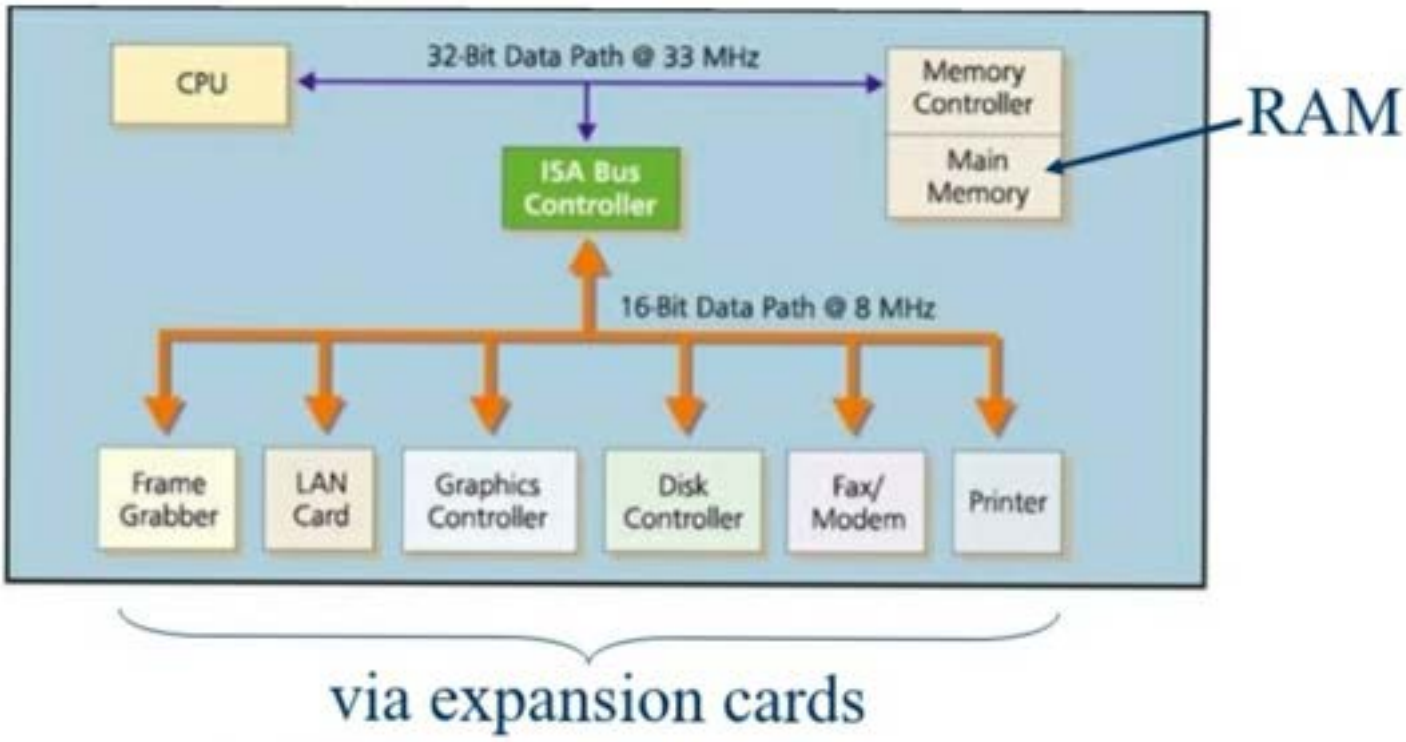
- Varies greatly in supporting various types of components
- Supports single type of CPU and few types of memories
- Video cards, Hard drives, Sound cards have to be compatible with motherboard to function properly.
- Motherboard, Cases, and power supplies must be compatible to work properly together.

Components of Motherboard:

- RAM slots (Random Access Memory): Also called as main memory, it is primary storage device for storage of huge bytes of data
- CPU Fan and Heat Sink: To cool down CPU by absorbing heat while system is running
- North bridge: Also called as host bridge, It is connected directly to CPU via front-side bus and is thus responsible for tasks with highest performance
- South bridge: Controls Input and Output functions
- Capacitors & Resistors : Data Storage
- CMOS battery (Complementary Metal Oxide Semiconductor): To provide backup power
- PCI slots (Peripheral Component Interconnect): to connect peripherals
- SATA cables (Serial Advanced Technology Attachment): Data transfer
- BIOS (Basic Input Output System): controls basic input-output functions
- Processor: main component for data processing
- AGP (Accelerated Graphics Port): To display graphics on the screen
- IDE (Integrated Drive Electronics): Used for data transfer
- Processor socket: To insert or remove processor
- Integrated Circuits (IC): for storage & data processing



- Data bus (data path): connects parts of motherboard



(ii) RAM (Random Access Memory):

- It is one of the parts of Main memory and can be accessed in any (random) order

Features:

- volatile in nature, which means, data is lost when device is switched off.
- Also known as Primary memory of computer
- Expensive since memory can be accessed directly
- Fastest memory, therefore, it's internal memory for computer
- Speed of computer depends on RAM. If computer has less RAM, it will take more time to load & computer slows down

Types of RAM:

- SRAM (static Random Access Memory): It provides direct interface with CPU at higher speeds
- DRAM (Dynamic Random Access Memory): It is used for program code by computer processor in order to function. It is used in PCs.

RAM Storage:

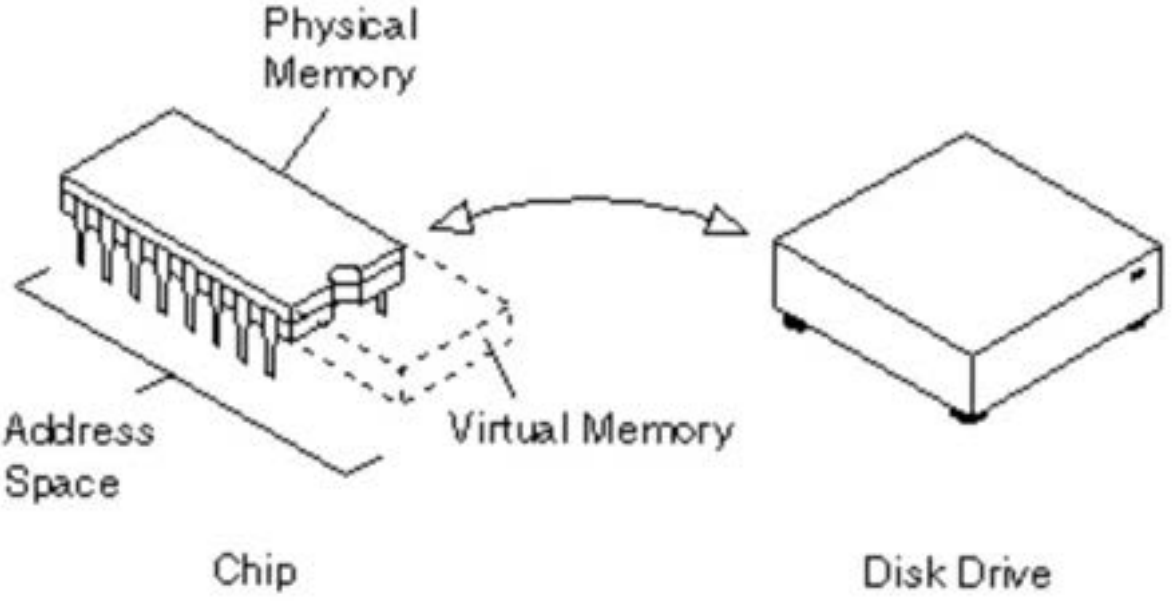
- Typically, computers have 64 and 512 Megabytes of RAM.
- RAM access speeds can be fast a 8 nano seconds
- RAM depends on software you are using
- You can install extra RAM (virtual memory)

RAM STORAGE

RAM

Extra RAM (Virtual Memory):

- It uses part of hard disk to simulate more memory than actually exists.
- It allows computer to run more programs at sametime.
- It is slower than RAM
- It doesn't have direct access to CPU
- It uses paging. Paging allows cumulative total of virtual address spaces to exceed physical main memory.



(iii) ROM (Read-Only Memory):

- Also primary memory unit of computer system

Features:

- It is a non-volatile memory
- Information stored in ROM is permanent.
- Information and programs stored on it, we can only read
- Information and programs are stored on ROM in binary format
- It is used in start-up process of computer to store instructions, called firmware.

Types of ROM:

- MROM (Masked read-only memory)
- PROM (Programmable read-only memory)
- EPROM (Erasable programmable read-only memory)

EEPROM (Electrically erasable programmable read-only memory)

Advantages:

- cheaper and more reliable than RAM
- Circuit is simple when compared to RAM
- It doesn't need refreshing time because it's static
- It's easy to test

Disadvantages:

- It is read-only memory, so it can't be modified
- It is slower as compared to RAM

MOS6502/Wikimedia Commons/Public Domain

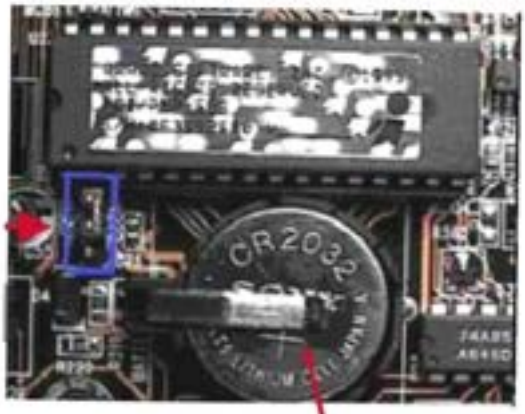
(iv) CMOS Memory: (Complementary Metal Oxide Semiconductor Memory)

- It stores start-up data in semi-permanent way

  Eg: the current time, the no. of hard disks. This data may need to be updated / changed

- It requires very little power to retain its contents. Thus, it is supplied by a battery on motherboard.

- It stores the Basic Input/Output System (BIOS) settings.



(v) The CPU: (Central Processing Unit)

- Also known as processor (or) microprocessor
- Brain of the computer
- It has 3 major units, which are:
  1. Memory or Storage unit
  2. Control unit
  3. ALU (Arithmetic Logic unit)

1. Memory (or) Storage unit:

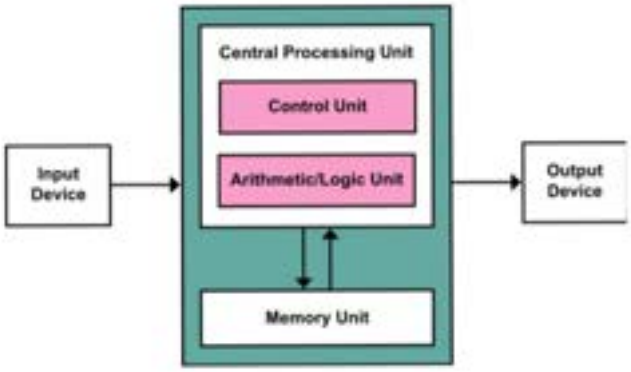
Data, instructions, intermediate results and final results of processing are stored.

2. Control unit:

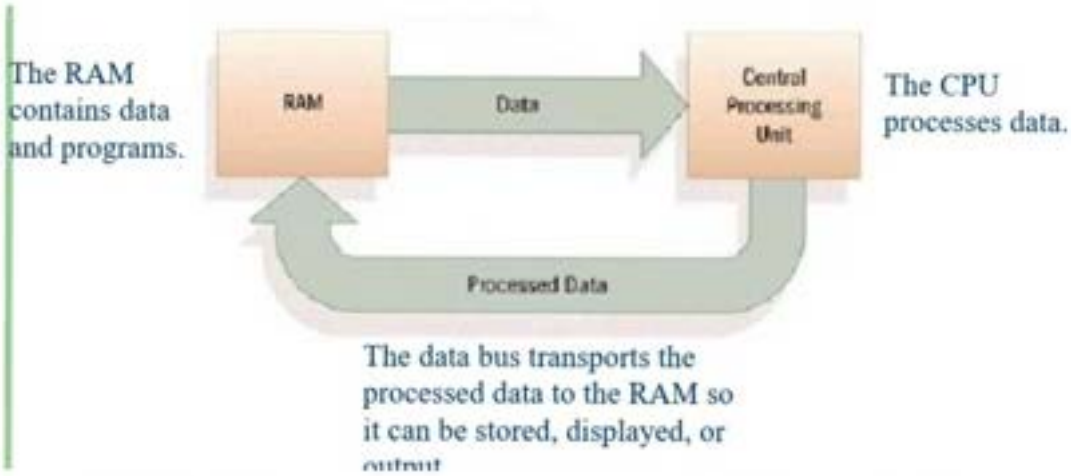
Obtains the instructions which is input from the memory unit, interprets them, and directs operation of computer according to that. It has instruction pointer to store location of next program instruction to be executed.

3. ALU:

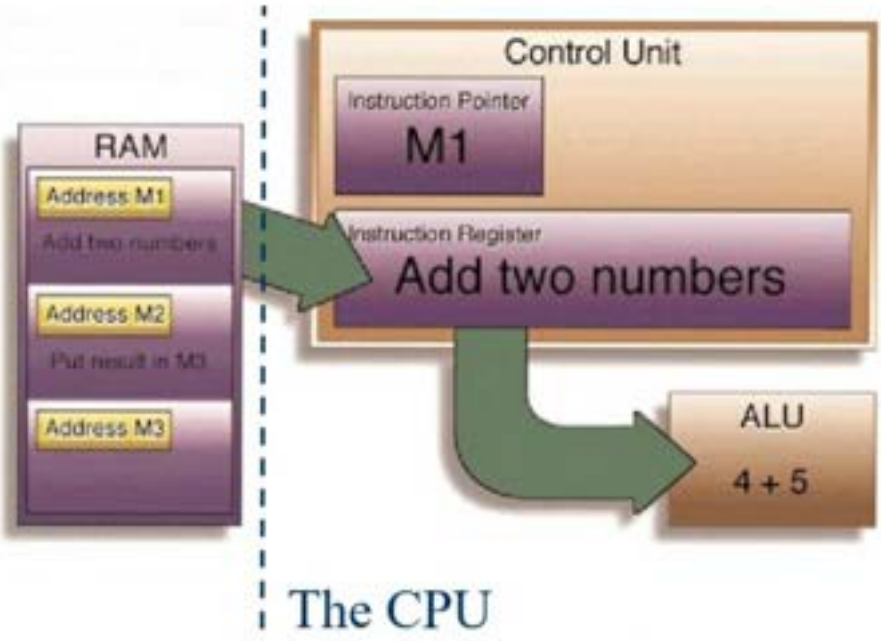
All the operations or functions like selecting, comparing, matching and merging data, are performed.



CPU & RAM:



CPU in Action:



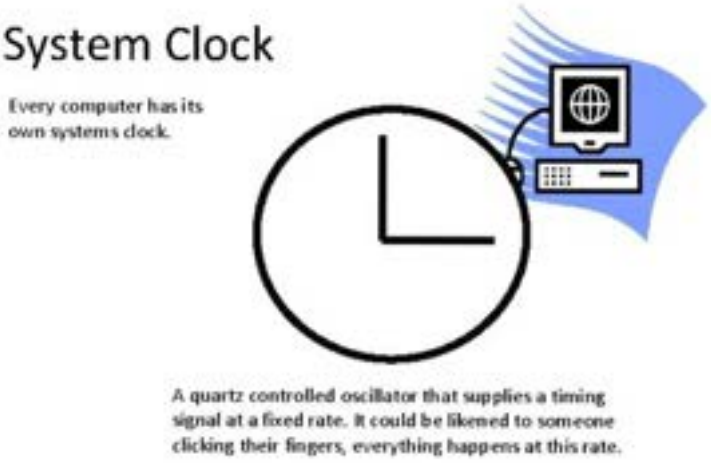
- The instruction pointer in CPU's control unit stores the location of next program instruction to be executed
- The instruction is loaded into instruction register to be carried out.
- ALU executes the instruction
- The register, accumulator stores the result, then stored back in RAM (or) used in other CPU operations.

CPU Instruction cycle:

- The speed of instruction cycle is controlled by CPU's clock
- The system clock sends out 'ticks' to control timing of all motherboard tasks.

  Eg: It controls speed of data bus and instruction cycle
- The time taken to complete an instruction cycle is measured in megahertz (MHz)

  1 MHz = one million cycles per second



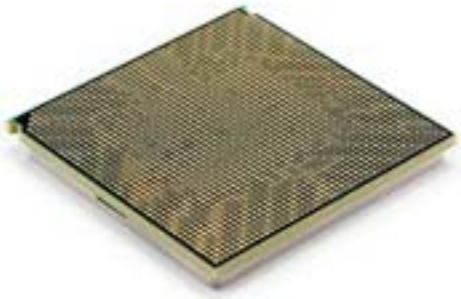
Two Measures of CPU Size:

Word size: the number of bytes CPU can process at once.
- depends on number of registers in CPU
- depends on size of data bus

Cache size: Cache is high-speed memory on CPU that stores data which is needed often.

Some Processors (CPUs):

Intel quad core processor



IBM's Power 9 processor

Intel pentium D processor

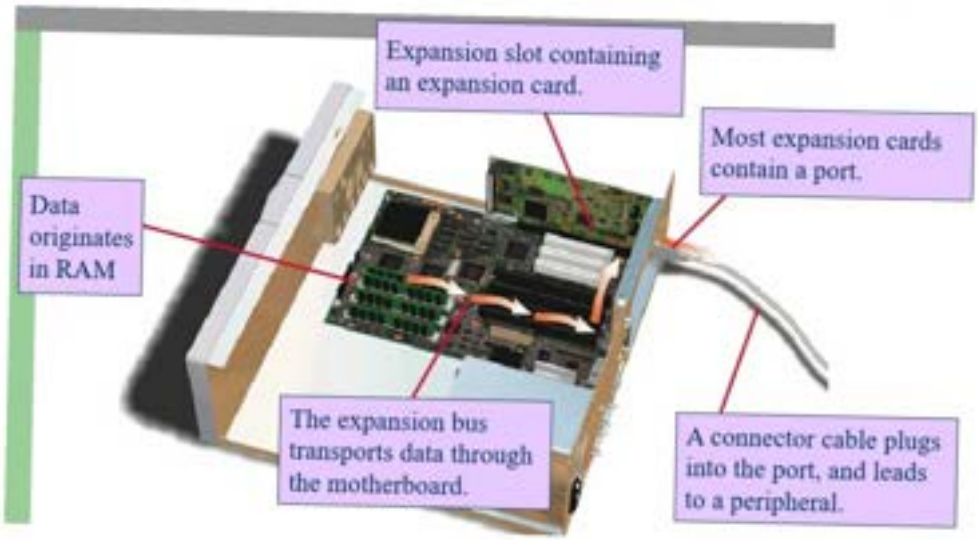
- Intel quad core processor is a chip with four independent units called cores that run multiple instructions at same time, increasing overall speed for programs compatible with parallel processing.

- IBM's POWER9 chip has enhanced core and chip architecture for next generation workloads. It provides premier platform for accelerated computing with maximized bandwidth.

- Intel Pentium D processor 820 had two cores with 64-bit instruction set. It doesn't include Hyper-Threading. It has two execution cores to provide two completely parallel processing streams

(vi) Expansion slots:

- It is a socket on motherboard that is used to insert an expansion card, to provide additional features to a computer such as video, sound, advanced graphics, etc.
- Most PC's offer 4-8 expansion slots.



Some common expansion cards:

- Graphics card:
  - Also called GPU (or) video card (Graphics processing unit)
  - It is a specialized electronic circuit that accelerates creation and rendering of images, video and animations for connecting to a monitor.
  - It performs fast math calculations while freeing CPU to perform other tasks

Network card:

- It allows wired and wireless communications
- It allows communications between computers connected via Local Area network as well as communications over large-scale network through Internet protocol.

Sound card:

- Also known as audio card
- It provides input and output of audio signals to and from a computer under control of computer programs.
- It is used for connecting to microphone and speakers

Expansion Slot Types:

ISA:

- Industry Standard Architecture
- Older technology
- It was used for modems and devices with requirement of less speed performance

PCI:

- Peripheral Component Interconnect
- It is used for graphics, sound, videos, etc
- It is used in modems and network cards

AGP:

- Accelerated Graphics port
- It is used in graphics cards

Connector Cables :

Connector : Serial DB-9

Description : Connects to serial port, which sends data over a single data line one bit at a time at speed of 56 Kbps

Devices : Mouse (or) Modem

Connector : Parallel DB-25M

Description : Connects to parallel port, which sends data simultaneously over eight data lines at speed of 12,000 Kbps

Devices : Printer, external CD-ROM drive, Zip drive, external hard disk drive, tape backup device

Connector: USB

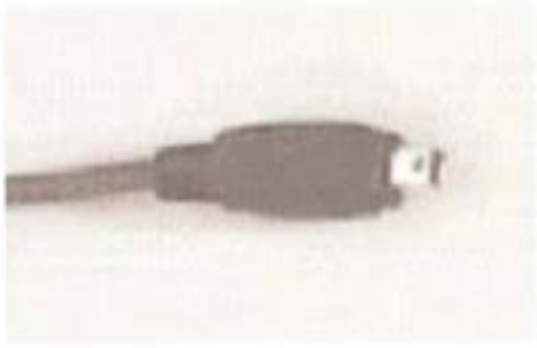
Description: Connects to Universal Serial bus, which sends data over a single data line at speed of 12,000 Kbps; supports upto 127 devices

Devices: Modem, Keyboards, joystick, scanner, mouse

Connector: SCSI C-50F

Description: Connects to SCSI ("scuzzy") port, which sends data simultaneously over 8 to 16 data lines at speeds between 5 MBps and 80 MBps; supports upto 16 devices

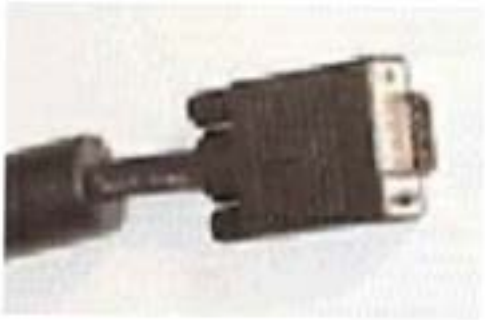
Devices: Hard disk drive, Scanner, CD-ROM drive, tape backup device



Connector : IEEE 1394

Description : connects to the "FireWire" port, which sends data at 400,000 Kbps

Devices : Video camera, DVD drive



Connector : VGA DB-15

Description : connects to video port

Device : Monitor

(Vii) Booting a Computer:

- It is sequence of computer operations from power-up until system is ready for use.
- This includes hardware testing, and loading OS
- The computer also checks CMOS memory
- The computer loads configuration settings from Config.sys or the Windows Registry

Two types of Booting:

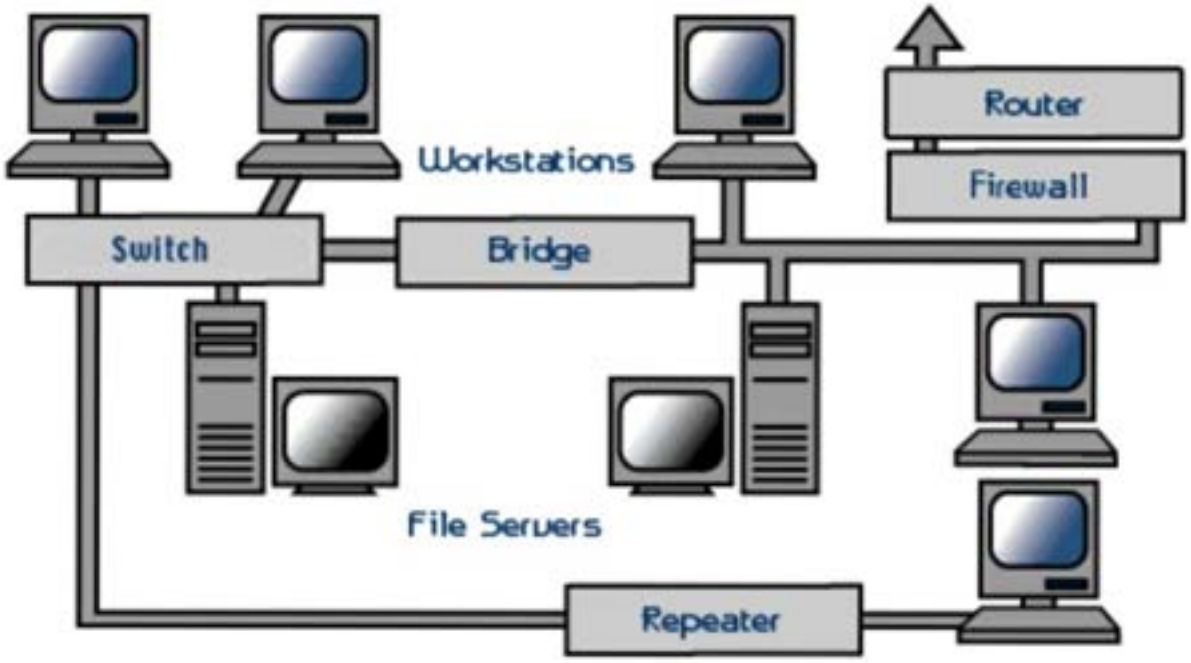
Warm Booting:

- When system starts from initial state
- It reads all instructions from ROM and OS and will automatically get loaded into System

Cold Booting:

- When system is running
- Eg: Due to light fluctuation, the system will automatically restart so that chances of damaging of system are less and system will not be started from its initial state. So, some files may be damaged as they aren't properly stored into system

Networking Hardware



Network Adapters:

- Also called network interface cards (NICs)
- Hardware that acts as interface for computer to a network.
- In modern network devices, network adapters contain data transceiver
- Typically, its built on printed circuit board with jumpers that connect it with computer's motherboard
- For wired networks, it has RJ-45 port that uses cable for network connectivity.
- Wireless adapters connect with network through a built-in or externally connected antenna.
- Wired and wireless adapters support LAN protocols, including TCP/IP

- For a desktop, network adapter is likely to be a type of expansion board (connect to system board through expansion slots)

Network Adapter

Types of Network Adapters:

PCMCIA:

- Personal Computer Memory Card Internal Association
- Developed in early 1990s to provide standard interface for connecting any type of device to a portable computer
- Also called PC cards

PCI:

- Peripheral component interconnect
- Offer cardless convenience and good speeds
- Add-in card that can fit within desktop computer

USB port:

- Universal Serial Bus port
- Standard external bus that can be used to connect multiple types of peripherals
- Also supply electric power across USB cable to devices that require
- USB ports allow USB devices to connect with each other and transfer digit data over USB cables

A parallel port network adapter:

- Sends multiple bits of data at once (parallel communication)
- It uses 25-pin connector and used to connect devices that need relatively high bandwidth

Wireless network adapters:

- Hardware device that is attached to computer
- Allows to connect to wireless network
- Two main types based on network type they help you connect to:

  WiFi adapters: help to connect to WiFi networks

  Cellular/mobile broadband adapters: help to connect to 3G/4G cellular networks

Variety of Ethernet network adapters:

- Support Ethernet standard for high-speed network connections using cable connections
- It is a card that plugs into a slot on motherboard and enables a computer to access an Ethernet network (LAN)

Repeaters :

- Network devices operating at physical layer of OSI Model
- They amplify or regenerate an incoming signal before retransmitting it. Also known as, signal boosters
- They are incorporated in networks to expand coverage area.

Types of Repeaters :

Based on type of signals they regenerate:

Analog Repeaters : Amplify analog signal

Digital Repeaters : Reconstruct distorted signal

Based on type of networks that they connect :

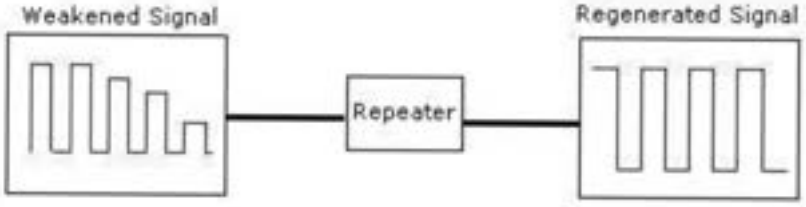
Wired Repeaters : Used in wired LANs

Wireless Repeaters : Used in wireless LANs and cellular networks

Based on domain of LANs they connect :

Local Repeaters : Connect LAN segments seperated by small distance

Remote Repeaters : Connect LANs that are far from each other



Advantages:

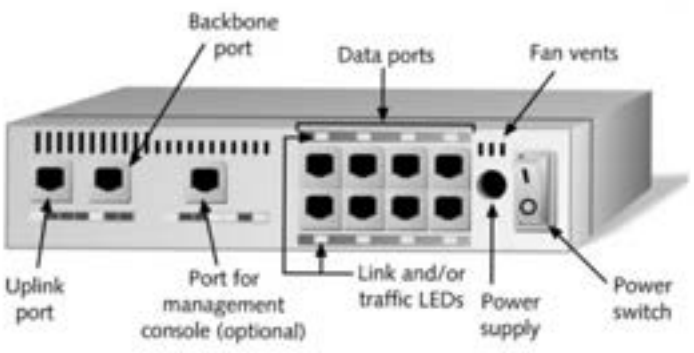
- Simple to install and can easily extend coverage area of networks
- Cost effective
- Don't require processing overhead. The only time they need to be investigated is in case of degradation of performance
- Can connect signals using different types of cables

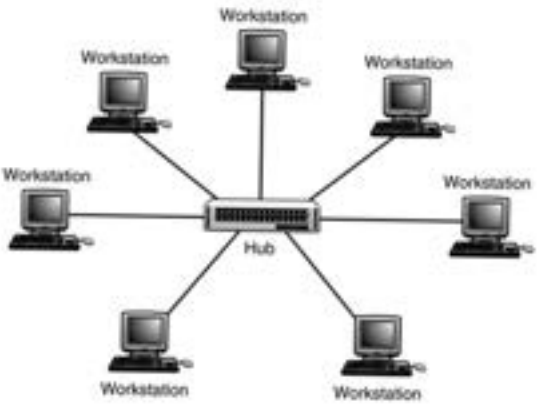
Disadvantages:

- Can't connect dissimilar networks
- Can't differentiate between actual signal and noise
- Can't reduce work network traffic (or) congestion
- Most networks have limitations upon number of repeaters that can be deployed

Hubs:

- Centralized server
- Multiport repeater containing multiple ports to interconnect multiple devices





Types of Hubs:

Passive Hubs:

- Only repeats signal, doesn't amplify
- Cheaper than active Hubs
- Doesn't require power supply
- Only used to share physical medium

Active Hubs:

- It houses electronic components used to amplify or regenerate signals between nodes
- It helps in extending distance between two nodes
- It amplifies noise in addition to desired signals
- Very expensive compared to passive hub
- It requires power supply

Active Hub

Passive Hub

Intelligent Hubs:

- Active hubs providing additional network management facilities.
- Can perform variety of functions of more intelligent network devices like network management, switching, provide flexible data rates, etc

Standalone Hubs:

- Hubs that serve a group of computers that are isolated from rest of the network
- Least expensive type of Hub
- Best suitable to small, independent departments, home offices, or test lab environments
- Disadvantage of using single hub for many connection ports is that it introduces a single point of failure on network

Stackable Hubs:

- physically designed to be linked with other hubs in a single telecommunications closet
- Ideal hubs to start with minimal investment, but realising LAN can grow

Choosing the Right Hub:

Factors to consider when selecting right hub for your network:

- Performance
- Cost
- Size & growth
- Security
- Management benefits
- Reliability

Switches:

- Subdivide a network into smaller logical pieces
- It operate in layer 2 i.e data link layer of OSI model
- It uses MAC addresses to send data packets to selected destination ports
- It uses packet switching technique to receive and forward data packets from source to destination device
- Transmission mode is full-duplex
- It performs error checking before forwarding data to destination.

Switching Modes:

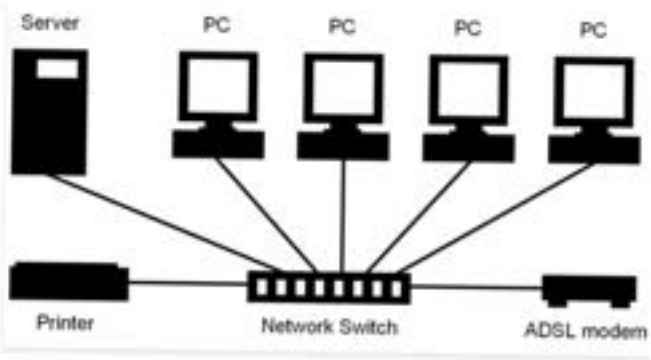
Store-and-forward mode:

- Switches receive and store entire frame before making any operational decision
- It keeps integrity and validity of frames but creates additional network latency

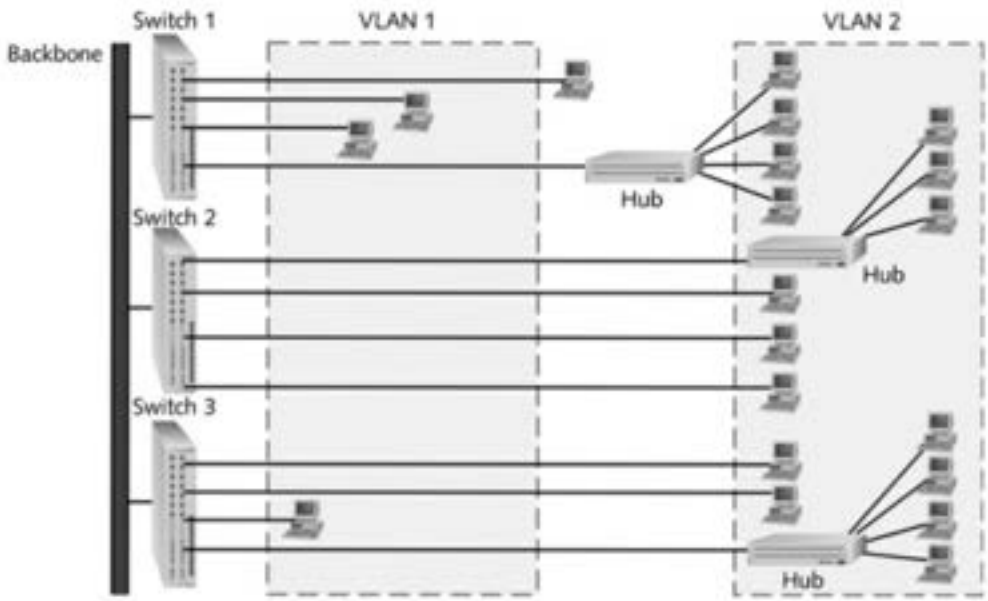
Cut-through switching mode:

- Switch receives only a fraction of frame and immediately starts making forwarding decision
- Lower network latency than with the store-and-forward mode.
- Switches don't drop invalid frames but forward them to next node
- Can detect runts (or) packet fragments

Switch



Using Switches to create VLANs :



A simple VLAN design

VLANs (Virtual local area networks) : Network within a network that is logically defined by grouping its devices switch ports in same broadcast domain

Broadcast domain: Combination of ports that make up a Layer 2 segment & must be connected by a Layer 3 device

Types of Switches :

Higher-Layer Switches :

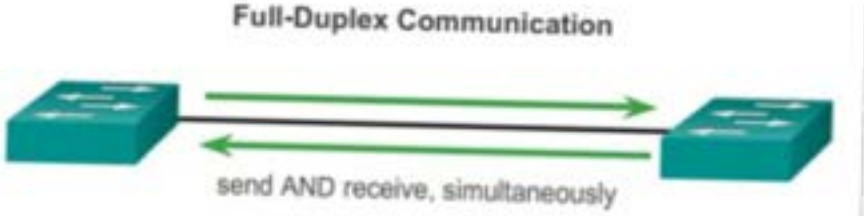
- Also called routing switches (or) application switches.

Switch capable of interpreting Layer 3 data is called Layer 3 switch

Switch capable of interpreting Layer 4 data is called Layer 4 switch

Full Duplex Switches :

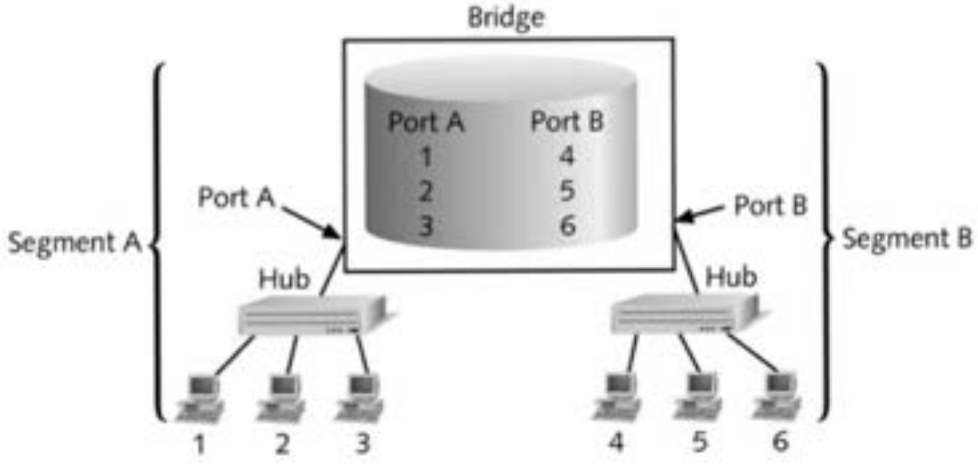
- Allows for simultaneous transmission and reception of data to and from a workstation
- Helps to eliminate collisions
- To support full duplex connection to a switch, two sets of wires are necessary - one for receive operation & one for transmit operation



Bridges :

- Data link layer device that can connect to different networks
- Is a repeater, with add on functionality of filtering content by reading MAC addresses of source and destination
- Also used for interconnecting two LANs working on same protocol
- It has single input and single output port, thus making it a 2port device.
- Filters database
  - The collection of data created and used by bridge that correlates MAC addresses of connected workstations with their locations

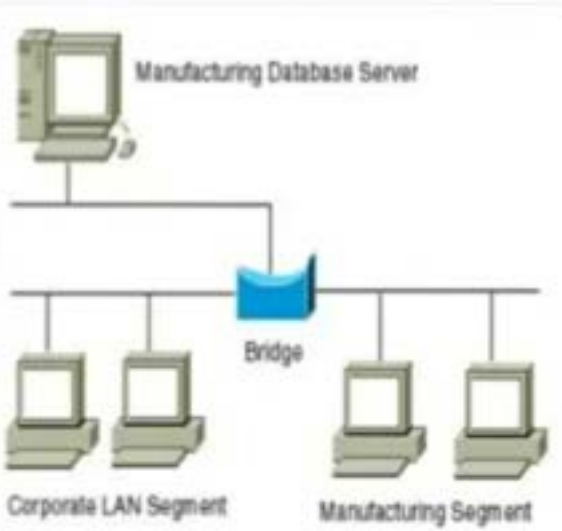
- Also called as forwarding table



- The bridge examines destination address in a frame and either forwards this frame onto next LAN or doesn't

- The bridge examines source address in a frame and places this address in a routing table, to be used for future routing decisions.

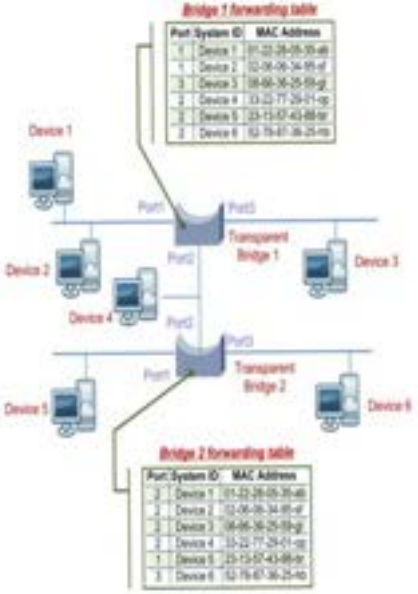
Bridge



Types Of Bridges:

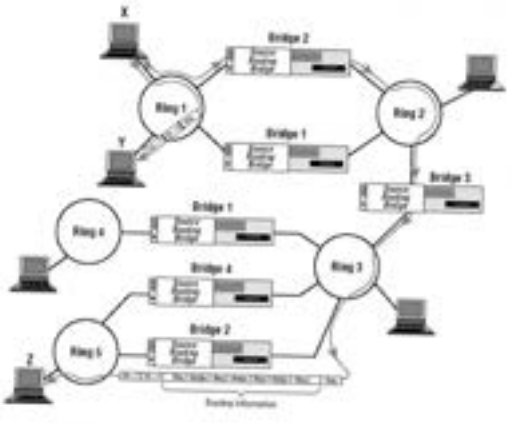
Transparent Bridge:

- It doesn't need programming but observes all traffic and builds routing tables from this observation
- This observation is called backward learning
- Each bridge has two ports and there is a routing table associated with each port.
- A bridge observes each frame that arrives at a port, extracts source address from frame, and places that address in port's routing table.
- It is found with CSMA/CD LANs
- It can also convert one frame format to another
- Some people/manufacturers call a bridge such as a gateway or sometimes a router
- The bridge removes headers and trailers from one frame format and inserts (encapsulates) the headers and trailers for second frame format.
- Transparent bridge mechanism consists of three mechanisms:
    - Frame forwarding
    - Address Learning
    - Loop Resolution
- Easy to use, install bridge and no software changes are needed in hosts.



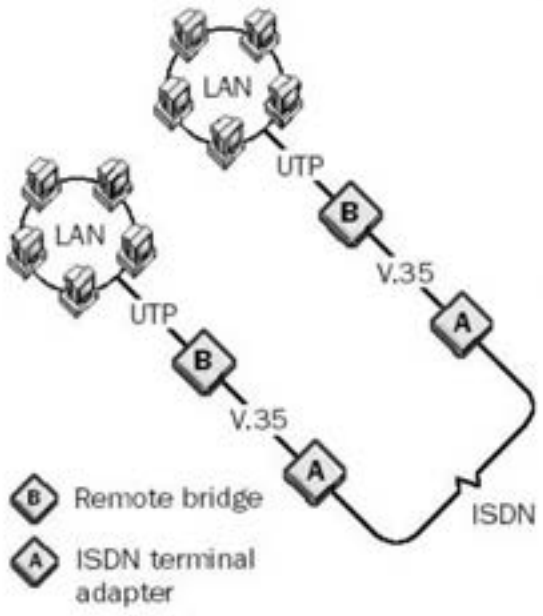
Source-routing Bridge:

- Found with token ring networks & connection oriented
- When workstation wants to send a frame, it must know exact path of network/bridge..
- If workstation doesn't know exact path, it sends out discovery frame.
- The discovery frame makes its way to final destination, then as it returns, it records path.
- It uses MAC address of a frame to direct it by source routing algorithm
- Load sharing is possible by judicious choice of routes
- The frame processing delay is less



Remote Bridge:

- Capable of passing data frame from one local area network to another when two LANs are seperated by a long distance and there is a wide area network connecting two LANs
- It takes frame before it leaves first LAN and encapsulates WAN headers and trailers
- When packet arrives at destination remote bridge, that bridge removes WAN headers and trailers leaving original frame.
- The bridge might have both synchronous and asynchronous serial ports
- It can also be enabled for Simple Network Management Protocol (SNMP) and have other diagnostic and support features such as out-of-band management (OBM) support



Remote Bridge

Routers:

- Networking device that forwards data packets between computer network based on IP address
- It has multiple ports
- Can integrate LANs and WANs running at different transmission speeds and using a variety of protocols
- Operate at Network layer (Layer 3) of OSI Model
- It divide broadcast domains of hosts connected through it

Router

Modular router

Modular router: Router with multiple slots that can hold different interface cards or other devices

Functions of Router:

1. Forwarding:

Router receives packets from its input ports, checks it headers, performs some basic functions like checking checksum and then looks upto routing table to find appropriate output port to dump packets onto, and forwards the packets onto that output port.

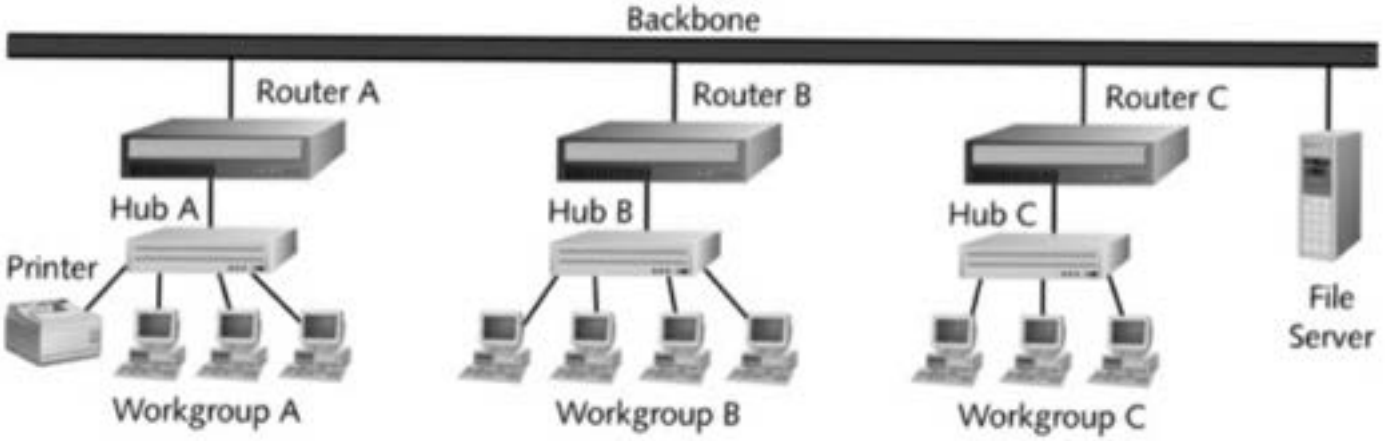
2. Routing:

It is process by which router ascertains what is best path for packet to reach the destination. It maintains routing table which is made using different algorithms by routers.

Features of Router:

- Filter out broadcast transmission to alleviate network congestion
- Prevent certain types of traffic from getting to a network
- support simultaneous local ande remote activity
- Provide high network fault tolerance through redundant components

- Monitor network traffic and report statistics to a MIB
- Diagnose internal or other connectivity problems and trigger alarms
- Routers often incorporate firewall functions
- It accepts an outgoing packet, removes any LAN headers and trailers, and encapsulates necessary WAN headers and trailers
- Because a router has to make WAN routing decisions, router has to dig down into network layer of packet to retrieve network destination address.



Types of Routing:

1. Static Routing:

- Process in which we have to manually add routes in routing table
- No routing overhead for router CPU which means a cheaper router can be used to do routing
- It adds security because only administrator can allow routing to particular networks only
- No bandwidth usage between routers
- Technique in which network administrator programs to use specified paths

Disadvantages:

- For large network, it's a hectic task for administrator to manually add each route for network in routing table on each router
- The administrator should have good knowledge of topology. If new administrator comes, then he has to manually add each route so he should have very good knowledge of routes of topology

2. Default Routing:

- Method where router is configured to send all packets towards a single router (next hop)
- It forwards packet out to router which is configured for default routing

3. Dynamic Routing :

- Automatically calculates best path between nodes and accumulates this information in routing table
- It uses protocols to discover network destinations and routes to reach it
- Easy to configure
- More effective at selecting best route to a destination remote network and also for discovering remote network

Disadvantages :

- Consumes more bandwidth for communicating with other neighbours
- Less secure than static routing

Hop :

- To describe each trip that data takes from one connectivity device to another
- Example, In TCP/IP internetworking, the number of hops between two hosts would be number of routers that an IP packet would have to pass through in order to reach its destination

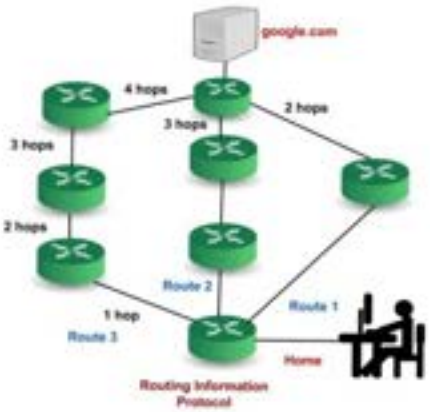
Routing Protocols:

- To determine best path, routers communicate with each other through routing protocols
- Routing protocol can be characterized according to its convergence time and bandwidth overhead.

  Convergence time: Time taken by router to recognize a best path in event of a change or outage

  Bandwidth overhead: Burden placed on an underlying network to support routing protocol

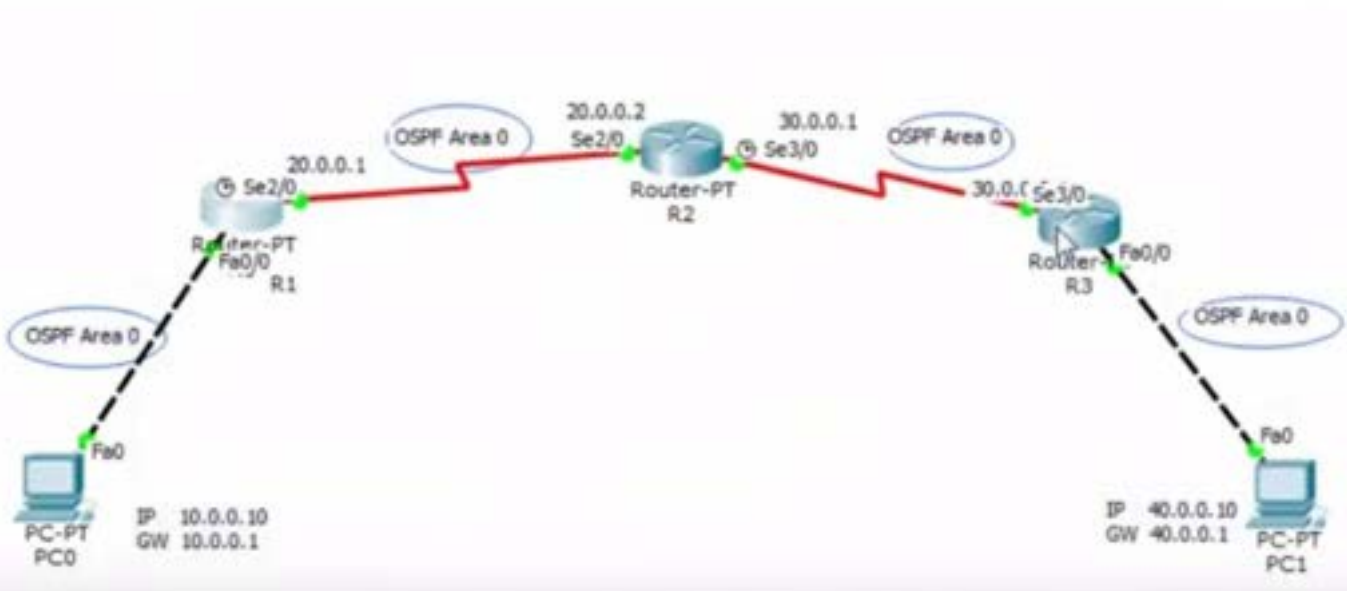
- Routing protocols don't move information from source to destination but only update routing table that contains information.
- Four most common routing protocols:
  - RIP (Routing Information Protocol) for IP & IPX



    - It is distance-vector routing protocol
    - Routers running distance-vector protocol send all or portion of routing tables in routing-update messages to their neighbours
    - It helps to configure hosts as part of RIP network
    - Prevents routing loops by implementing limit on number of hops allowed in path

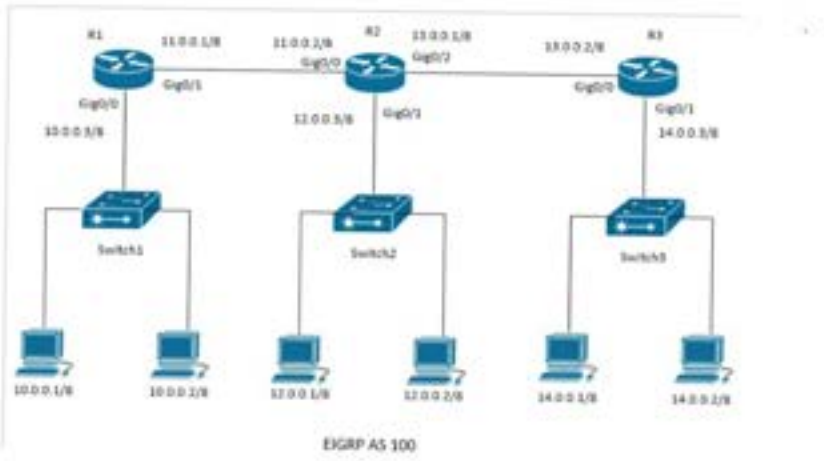
- OSPF (Open Shortest Path First) for IP:

  - It uses link state routing algorithm and falls into group of interior gateway protocols, operating within single autonomous system
  - More suitable for serving large, heterogeneous internetworks
  - It can recalculate routes in short amount of time when network topology changes
  - It provides equal-cost multipath routing.
  - With OSPF, you can divide Autonomous system into areas and keep area topologies seperate to decrease OSPF routing traffic and size of link-state database of each area.



- EIGRP (Enhanced Interior Gateway Routing protocol) for IP, IPX, and AppleTalk:

  - It is advanced distance-vector routing protocol that is used on computer network
  - It automates routing decisions and configuration
  - To find best path between any two (layer-3) devices to deliver packet
  - It uses protocol number 88.
  - It uses metrics to find out best path



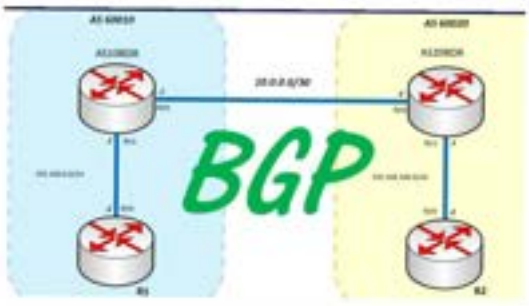
- BGP (Border Gateway Protocol) for IP:
  - To exchange routing information for internet
  - It is the protocol used between ISP which are different Autonomous Systems
  - It constructs an autonomous systems graph based on information exchanged between BGP routers

Characteristics of BGP:

- Inter-Autonomous System configuration
- Supports Next-Hop Paradigm
- Coordination among multiple BGP speakers within Autonomous system
- Path information
- Policy support
- Runs over TCP
- Conserves network bandwidth
- Supports security

Functions of BGP:

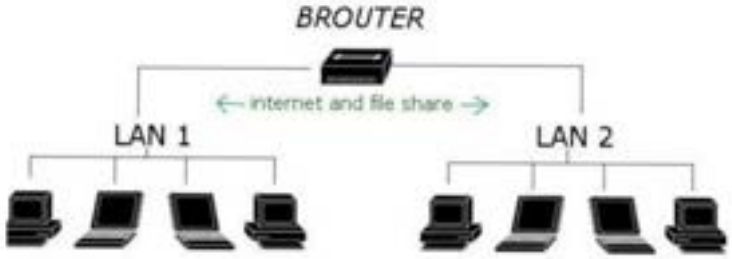
1. Initial peer acquisition and authentication. Both peers establish TCP connection and perform message exchange that guarantees, both sides have agreed to communicate
2. Sends negative or positive reach-ability information
3. Verifies that peers and network connection between them are functioning correctly



Brouters :

- Also called Bridge routers
- Combination of bridge and router
- It operates either at datalink layer or Network layer
- It stores routing table when it is configured as router and stores MAC address when configured as bridge
- Forwarding decisions are taken based on IP address when it is configured as router, or it takes forwarding decisions based on MAC address when configured as bridge
- It transmits data in form of packets when configured as router and transmits data in form of frames when configured as a bridge
- It works on more than one broadcast domain when configured as router and works on single broadcast domain when configured as bridge
- It is full duplex when configured as router and half duplex when configured as bridge

Brouter



Routing Switch:

- Performs many tasks of router and switch
- It operates in Layer 3

Gateways:

- Combination of networking hardware and software that connects two dissimilar kinds of networks
- Optimize data for search engines, applications, and servers by implanting better readability to content
- Make data more secure if modifications to gateway could be done
- Make transmission more feasible as it queues up all data and divide into packets than sending in bulk
- Create structural temporary storeroom for data transmitted by server and data requests made by users

Limitations of Gateways:

- Device-specific and need for sink
- Doesn't perform data handling
- Doesn't validate sources of data request and user
- Extra memory requirement
- Special attention for maintenance
- Not learners, only task-specific

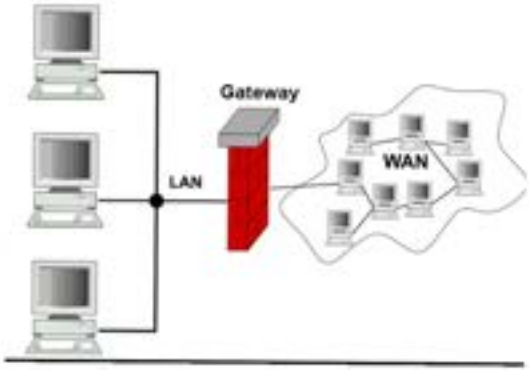
Overcoming Limitations:

- Programming gateways
- Securing gateways by cyber-attacks
- Need for sink
- Making gateways learn

Popular gateways:

- E-mail gateway: protects organizations/users internal email servers
- IBM host gateway: serves entry & exit point for network
- Internet gateway: to provide target in VPC tables for internet-routable traffic
- LAN gateway: serves entry & exit point for LAN

Gateway



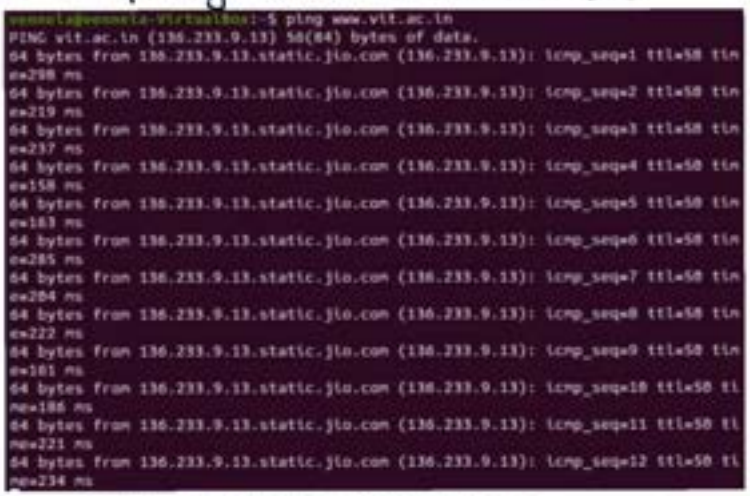
LINUX commands

1. ping

Syntax : ping ipAddress or hostname

Description : The ping command sends echo requests to host specified on command line, and lists the responses received

Example : ping www.vit.ac.in



- ping sends an ICMP ECHO_REQUEST packet to the specified host. If host responds, an ICMP packet is received.
- One can "ping" an IP address to see if machine is alive
- It provides very quick way to see if a machine is up and connected to the network

2. netstat

Syntax : netstat or netstat -a

Description: It works with LINUX Network Subsystem, it will tell us what the status of ports are i.e. open, closed, waiting connections. It displays TCP/IP network protocol statistics and information

Example : netstat

netstat -a

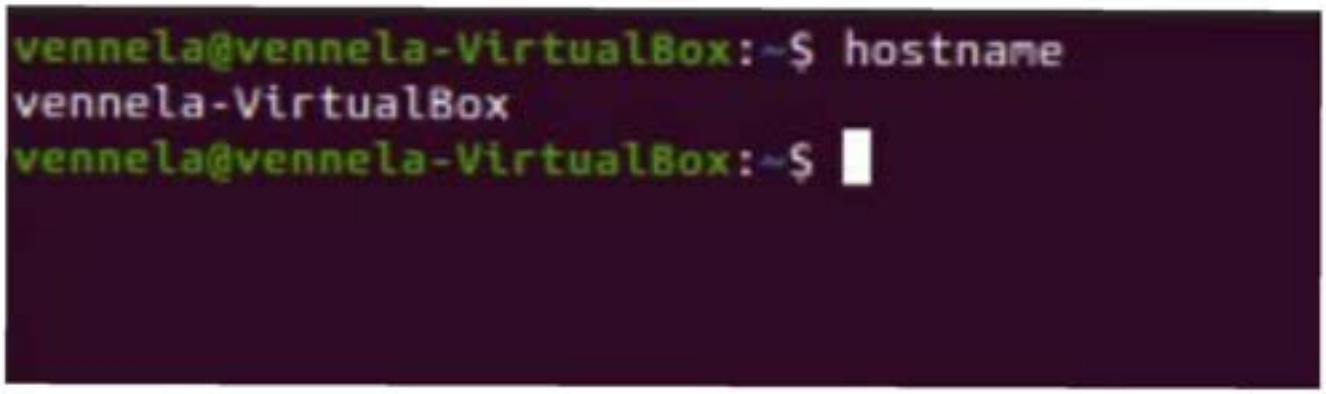
```
vennela@vennela-VirtualBox:~$ netstat
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
udp        0      0 vennela-VirtualB:bootpc _gateway:bootps         ESTABLISHED
Active UNIX domain sockets (w/o servers)
Proto RefCnt Flags       Type       State         I-Node   Path
unix  2      [ ]         DGRAM                    31107    /run/user/1000/syste
md/notify
unix  3      [ ]         DGRAM                    15336    /run/systemd/notify
unix  2      [ ]         DGRAM                    15350    /run/systemd/journal
/syslog
unix  17     [ ]         DGRAM                    15360    /run/systemd/journal
/dev-log
unix  8      [ ]         DGRAM                    17412    /run/systemd/journal
/socket
unix  3      [ ]         STREAM     CONNECTED     35065    /run/systemd/journal
/stdout
unix  3      [ ]         STREAM     CONNECTED     33660
unix  2      [ ]         DGRAM                    31795
unix  3      [ ]         STREAM     CONNECTED     35340    /run/user/1000/bus
unix  3      [ ]         STREAM     CONNECTED     40104
unix  2      [ ]         DGRAM                    23886
unix  3      [ ]         STREAM     CONNECTED     23006    /run/dbus/system_bus
_socket
unix  3      [ ]         STREAM     CONNECTED     34011
unix  3      [ ]         STREAM     CONNECTED     27246
unix  3      [ ]         STREAM     CONNECTED     36808
```

3. hostname

Syntax : hostname

Description: Tells the user i.e the host name of the computer they are logged into

Example : hostname



4. traceroute

Syntax : traceroute hostname or ipAddress

Description : Traceroute will show route of a packet. It attempts to list series of hosts through which our packets travel on their way to a given destination

Example : traceroute www.vit.ac.in

```
vennela@vennela-VirtualBox:~$ traceroute www.vit.ac.in
traceroute to www.vit.ac.in (136.233.9.13), 30 hops max, 60 byte packets
 1  _gateway (10.0.2.2)  0.375 ms  0.312 ms  0.285 ms
```

Each host will be displayed, along with response times at each host.

5. finger

Syntax : finger username

Description : Retrieves information about the specified user

Example : finger vennela

```
vennela@vennela-VirtualBox:~$ finger vennela
Login: vennela                          Name: Vennela
Directory: /home/vennela                Shell: /bin/bash
On since Sun Aug 22 22:46 (IST) on :0 from :0 (messages off)
No mail.
No Plan.
vennela@vennela-VirtualBox:~$
```

6. nslookup

Syntax : nslookup hostname

Description: nslookup returns ipaddress of given hostname and vice versa

Example : nslookup www.vit.ac.in

```
vennela@vennela-VirtualBox:~$ nslookup www.vit.acin
Server:         127.0.0.53
Address:        127.0.0.53#53

** server can't find www.vit.acin: NXDOMAIN

vennela@vennela-VirtualBox:~$ nslookup www.google.com
Server:         127.0.0.53
Address:        127.0.0.53#53

Non-authoritative answer:
Name:   www.google.com
Address: 142.250.195.228
Name:   www.google.com
Address: 2404:6800:4007:804::2004
```

7. dig

Syntax : dig hostname

Description: The "domain information groper" tool. If a hostname is given as an argument, it outputs information about host, including it's IP address, hostname and various other information.

Example : dig vitlinux

```
vennela@vennela-VirtualBox:~$ dig vitlinux

; <<>> DiG 9.16.1-Ubuntu <<>> vitlinux
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: SERVFAIL, id: 44166
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 65494
;; QUESTION SECTION:
;vitlinux.                      IN      A

;; Query time: 0 msec
;; SERVER: 127.0.0.53#53(127.0.0.53)
;; WHEN: Sun Aug 22 23:26:55 IST 2021
;; MSG SIZE  rcvd: 37
```

8. ifconfig

Syntax : ifconfig

Description: This command is used to configure network interfaces, or to display their current configuration

Example : /sbin/ifconfig

/sbin/ifconfig -a

```
vennela@vennela-VirtualBox:~$ /sbin/ifconfig
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.2.15  netmask 255.255.255.0  broadcast 10.0.2.255
        inet6 fe80::af58:6584:8295:88ac  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:09:d8:cd  txqueuelen 1000  (Ethernet)
        RX packets 915  bytes 771916 (771.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 742  bytes 74593 (74.5 KB)
        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 285  bytes 25602 (25.6 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 285  bytes 25602 (25.6 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

vennela@vennela-VirtualBox:~$
```

```
vennela@vennela-VirtualBox:~$ /sbin/ifconfig -a
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 10.0.2.15  netmask 255.255.255.0  broadcast 10.0.2.255
        inet6 fe80::af58:6584:8295:88ac  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:09:d8:cd  txqueuelen 1000  (Ethernet)
        RX packets 916  bytes 772006 (772.0 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 743  bytes 74683 (74.6 KB)
        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 285  bytes 25602 (25.6 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 285  bytes 25602 (25.6 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

9. route

Syntax : route

Description : route command also shows and manipulate ip routing table.

Example : route

```
vennela@vennela-VirtualBox:~$ route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
default         _gateway        0.0.0.0         UG    100    0        0 enp0s3
10.0.2.0        0.0.0.0         255.255.255.0   U     100    0        0 enp0s3
link-local      0.0.0.0         255.255.0.0     U     1000   0        0 enp0s3
```

10. ARP

Syntax : arp

Description : ARP (Address Resolution Protocol) is used to view/add contents of kernel's ARP tables

Example : arp -e

```
vennela@vennela-VirtualBox:~$ arp -e
Address                  HWtype  HWaddress           Flags Mask            Ifac
e
_gateway                 ether   52:54:00:12:35:02   C                     enp0
s3
vennela@vennela-VirtualBox:~$ ethtool eth0
```

11. IWCONFIG

Syntax : iwconfig

Description : iwconfig command is used to configure a wireless network interface. You can see and set basic Wi-Fi details like SSID channel and encryption

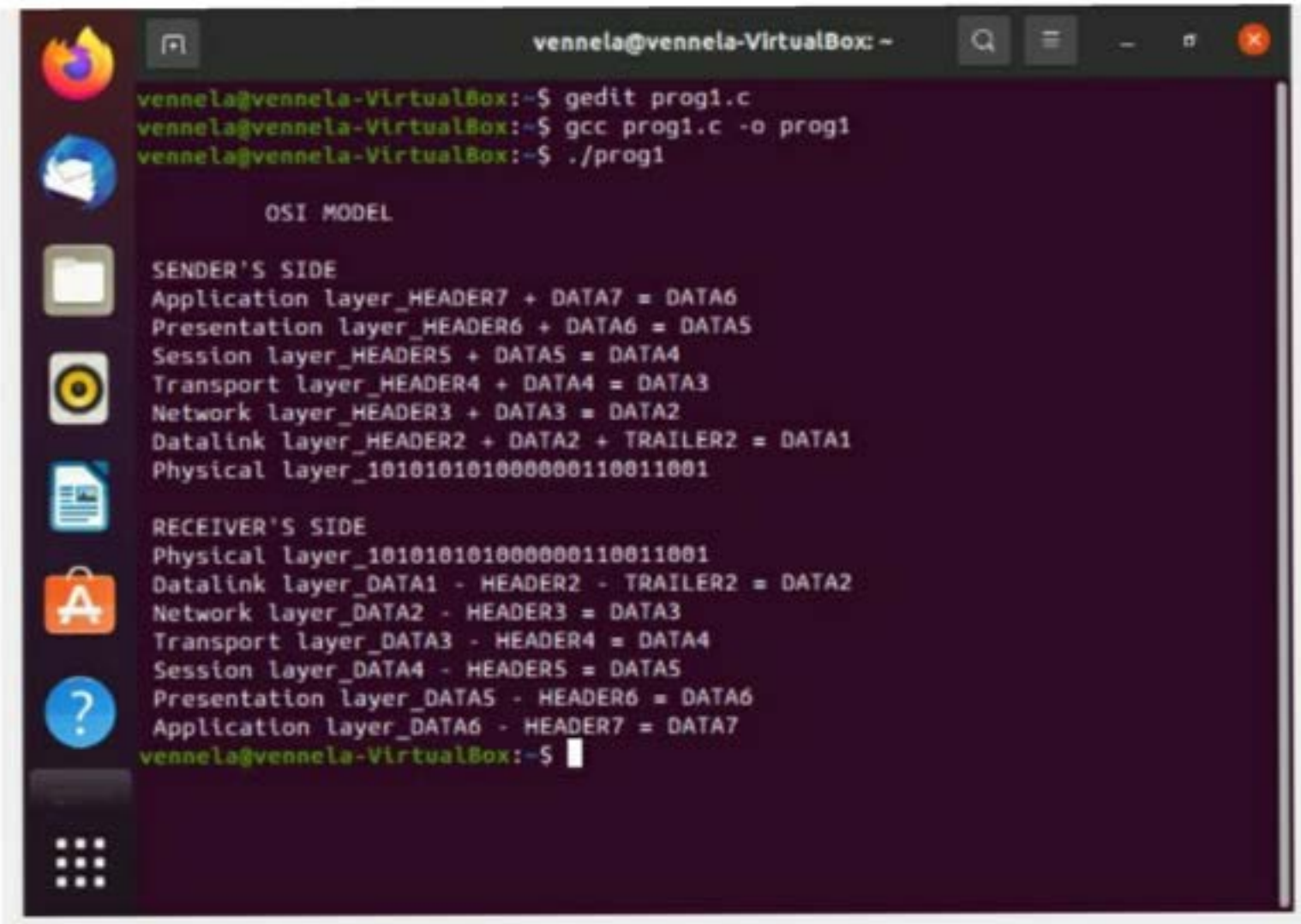
Example : iwconfig

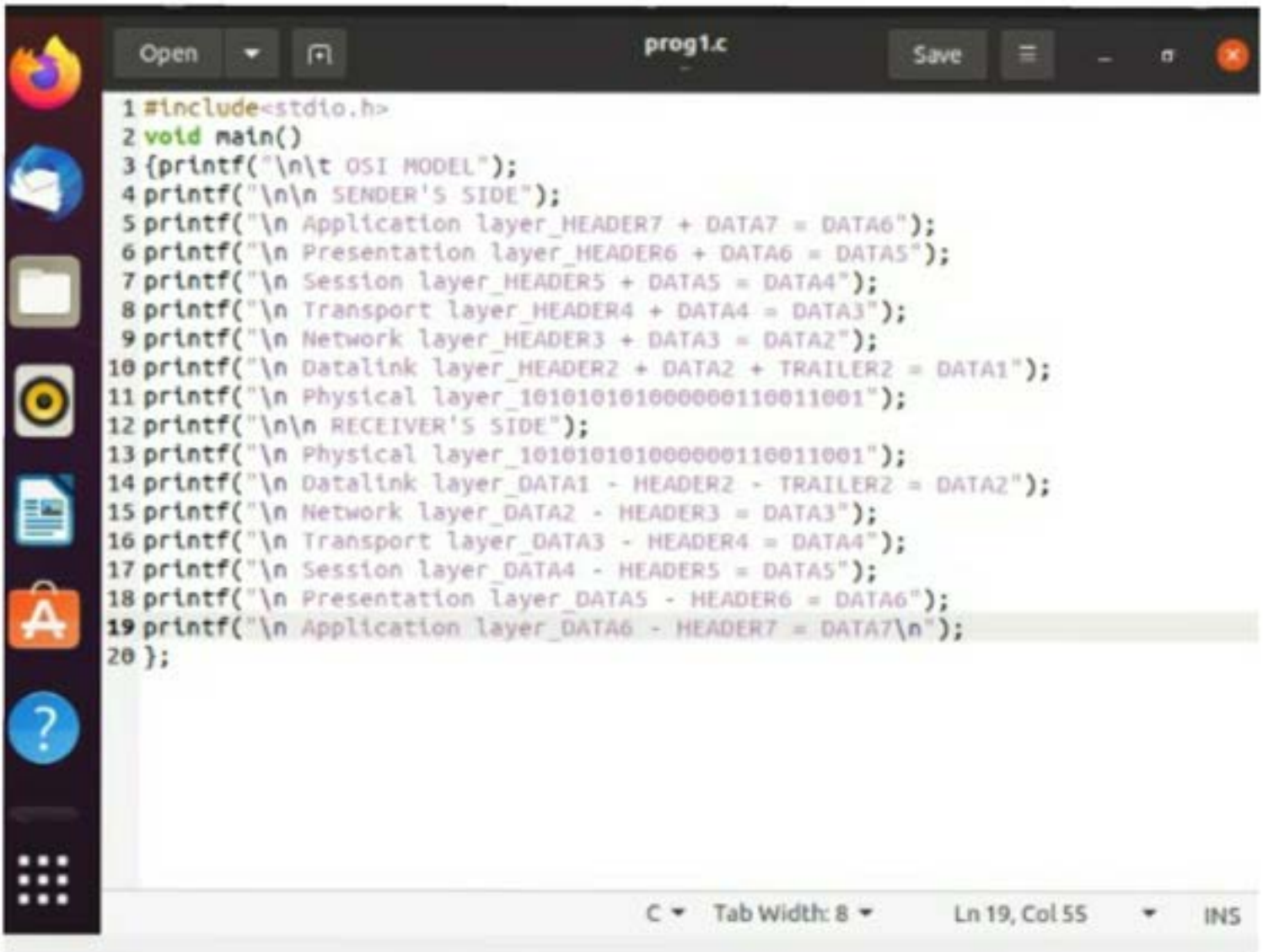
```
vennela@vennela-VirtualBox:~$ iwconfig
lo        no wireless extensions.

enp0s3    no wireless extensions.
```

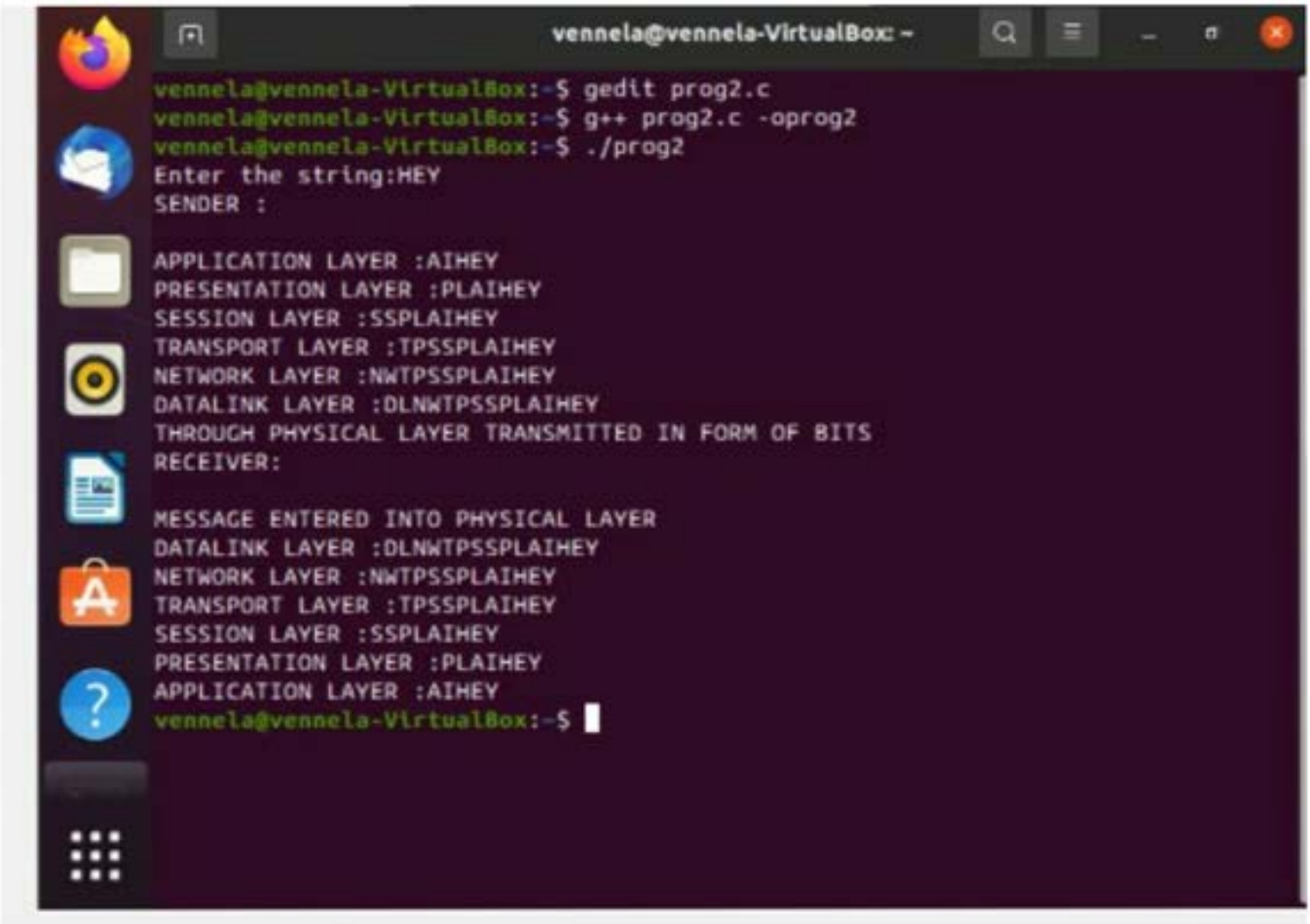
C-PROGRAMS

(i) OSI Model Implementation Program - Simple display of information in each layer




Open
prog1.c
Save
#include<stdio.h>
void main()
{printf("\n\t OSI MODEL");
printf("\n\n SENDER'S SIDE");
printf("\n Application layer_HEADER7 + DATA7 = DATA6");
printf("\n Presentation layer_HEADER6 + DATA6 = DATA5");
printf("\n Session layer_HEADER5 + DATA5 = DATA4");
printf("\n Transport layer_HEADER4 + DATA4 = DATA3");
printf("\n Network layer_HEADER3 + DATA3 = DATA2");
printf("\n Datalink layer_HEADER2 + DATA2 + TRAILER2 = DATA1");
printf("\n Physical layer_10101010100000011001");
printf("\n\n RECEIVER'S SIDE");
printf("\n Physical layer_10101010100000011001");
printf("\n Datalink layer_DATA1 - HEADER2 - TRAILER2 = DATA2");
printf("\n Network layer_DATA2 - HEADER3 = DATA3");
printf("\n Transport layer_DATA3 - HEADER4 = DATA4");
printf("\n Session layer_DATA4 - HEADER5 = DATA5");
printf("\n Presentation layer_DATA5 - HEADER6 = DATA6");
printf("\n Application layer_DATA6 - HEADER7 = DATA7\n");
};
C
Tab Width: 8
Ln 19, Col 55
INS

(ii) OSI Model Implementation Program – Using String Manipulation



Open prog2.c Save

```
#include <iostream>
#include<string.h>
#include<stdio.h>
using namespace std;
void remove1(string &str)
{
 str=str.erase(0,2);
 cout<< str<<"\n";
}
int main()
{
 string str;
 cout<<"Enter the string:";
 getline(cin, str);
 cout<<"SENDER : \n\n";
cout<<"APPLICATION LAYER :";
str="AI"+str;
cout<<str <<"\n";
cout<<"PRESENTATION LAYER :";
str="PL"+str;
cout<<str <<"\n";
cout<<"SESSION LAYER :";
str="SS"+str;
cout<<str<<"\n";
cout<<"TRANSPORT LAYER :";
str="TP"+str;
cout<<str<<"\n";
```

C Tab Width: 8 Ln 13, Col 26 INS

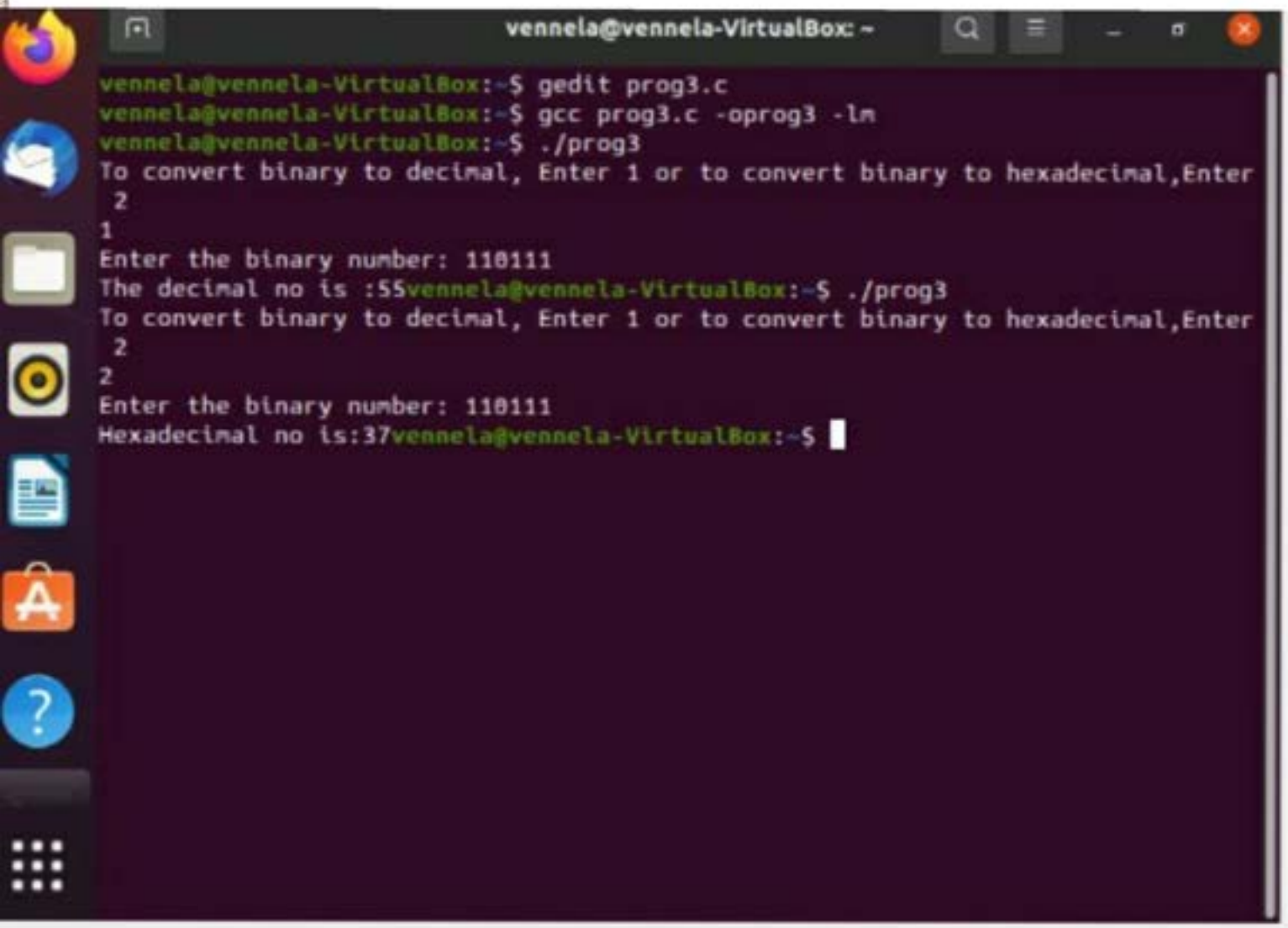
Open prog2.c Save

```
str="SS"+str;
cout<<str<<"\n";
cout<<"TRANSPORT LAYER :";
str="TP"+str;
cout<<str<<"\n";
cout<<"NETWORK LAYER :";
str="NW"+str;
cout<<str<<"\n";
cout<<"DATALINK LAYER :";
str="DL"+str;
cout<<str<<"\n";
cout<<"THROUGH PHYSICAL LAYER TRANSMITTED IN FORM OF BITS"<<"\n";
cout<< "RECEIVER:"<<"\n\n";
cout<<"MESSAGE ENTERED INTO PHYSICAL LAYER"<<"\n";
cout<<"DATALINK LAYER :";
cout<<str<<"\n";
cout<<"NETWORK LAYER :";
remove1(str);
cout<<"TRANSPORT LAYER :";
remove1(str);
cout<<"SESSION LAYER :";
remove1(str);
cout<<"PRESENTATION LAYER :";
remove1(str);
cout<<"APPLICATION LAYER :";
remove1(str);
}

```

C Tab Width: 8 Ln 13, Col 26 INS

(iii) Conversion from Binary to Decimal and Hexa



Open prog3.c Save

```c
#include <stdio.h>
#include <math.h>
#include<string.h>


void hexadecimal_conv(long long int a){
int hexConstant[] = {0, 1, 10, 11, 100, 101, 110, 111, 1000,
                     1001, 1010, 1011, 1100, 1101, 1110, 1111};

    long long tempBinary;
    char hex[20];
    int index, i, digit;

    tempBinary = a;
    index = 0;


    while(tempBinary!=0)
    {

        digit = tempBinary % 10000;


        for(i=0; i<16; i++)
        {
            if(hexConstant[i] == digit)
            {
                if(i<10)
```

Open prog3.c Save

```c
            {
                if(i<10)
                {
                    /* 0-9 integer constant */
                    hex[index] = (char)(i + 48);
                }
                else
                {
                    /* A-F character constant */
                    hex[index] = (char)((i-10) + 65);
                }

                index++;
                break;
            }
        }


        tempBinary /= 10000;
    }
    hex[index] = '\0';


    char *strrev(char *hex)
    {
      char *p1, *p2;

      if (! hex || ! *hex)
```

Open prog3.c Save

```
53
54        if (! hex || ! *hex)
55              return hex;
56        for (p1 = hex, p2 = hex + strlen(hex) - 1; p2 > p1; ++p1, --p2)
57        {
58              *p1 ^= *p2;
59              *p2 ^= *p1;
60              *p1 ^= *p2;
61        }
62        return hex;
63
64 }
65 strrev(hex);
66 printf("Hexadecimal no is:%s",hex);
67
68 }
69
70  long long int decimal_conv(long long int b){
71  long long int dec = 0, j = 0, rem;
72  while (b != 0) {
73          rem = b % 10;
74          b /= 10;
75          dec += rem * pow(2, j);
76          ++j;
77      }
78
79
80   return dec;}
```

Open prog3.c Save

```
74          b /= 10;
75          dec += rem * pow(2, j);
76          ++j;
77      }
78
79
80   return dec;}
81
82
83 int main()
84 {int k; long long int binaryval;long long int binaryval1;
85 printf("To convert binary to decimal, Enter 1 or to convert binary to
     hexadecimal,Enter 2\n");
86 scanf("%d",&k);
87 switch(k)
88 {
89  case 1:printf("Enter the binary number: ");
90          scanf("%lld", &binaryval1);
91
92          printf("The decimal no is :%lld",   decimal_conv(binaryval1));
93          break;
94  case 2:printf("Enter the binary number: ");
95          scanf("%lld", &binaryval);
96
97          hexadecimal_conv(binaryval);
98
99 }
100 return 0;}
```

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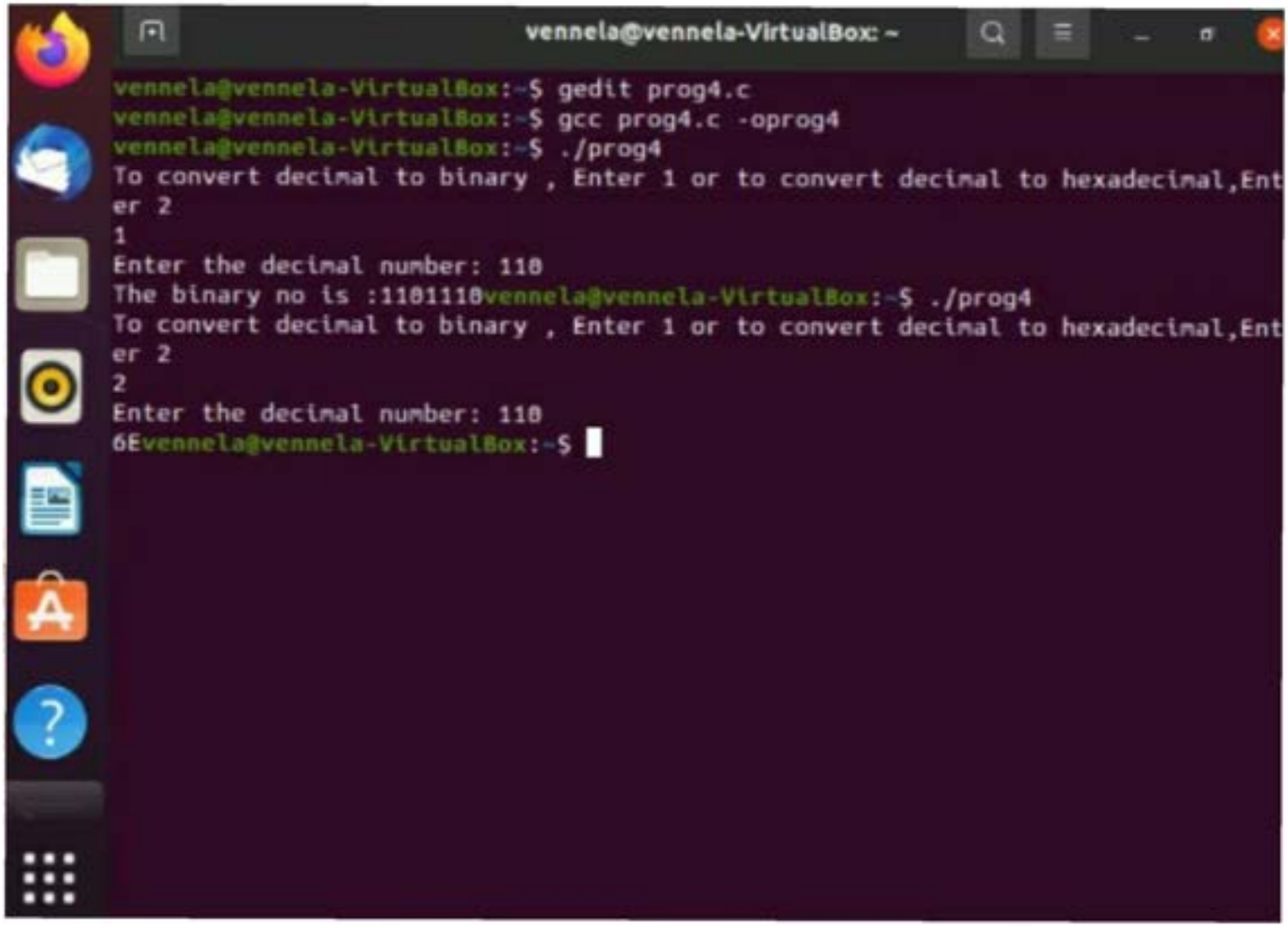
(iv) Conversion from Decimal to Binary and Hexa




Open
prog4.c
Save
#include <stdio.h>
void hexadecimal_conv(long long int a){
long quotient, remainder;
int i, j = 0;
char hexadecimalnum[100];
quotient = a;
while (quotient != 0)
{
remainder = quotient % 16;
if (remainder < 10)
hexadecimalnum[j++] = 48 + remainder;
else
hexadecimalnum[j++] = 55 + remainder;
quotient = quotient / 16;
}
// display integer into character
for (i = j; i >=0; i--)
printf("%c", hexadecimalnum[i-1]);
}
long long int binary_conv(long long int b){
long long bin = 0;
int rem, i = 1, step = 1;
while (b != 0) {
rem = b % 2;
b /= 2;
bin += rem * i;
i *= 10;
}
return bin;
}
int main()
{int k; long long int decimalval;long long int decimalval1;
printf("To convert decimal to binary , Enter 1 or to convert decimal to hexadecimal,Enter 2\n");
scanf("%d",&k);
switch(k)
{
case 1:printf("Enter the decimal number: ");
scanf("%lld", &decimalval1);
printf("The binary no is :%lld", binary_conv(decimalval1));
break;
case 2:printf("Enter the decimal number: ");
scanf("%lld", &decimalval);
hexadecimal_conv(decimalval);
}
return 0;}
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