Introduction to Networking

Definition of Networking:

Networking can be defined in various ways. As per my view Network can be defined as collection of devices tied together so that they can communicate each other. The devices are Routers, Switches, Hubs or PC's.

The medium which ties these devices are cables. Cables vary depend up on the environment, e.g. for LAN we can prefer an Ethernet or Fiber optic cables, for WAN we can prefer a serial cable or T1/E1 cables.

Why we need a network?

Think you have an office in India, with people working on project who are seated in various floor, if you modified a file for a project and that file needs to be transferred to team by floppy disk or cd, in earlier days. Think that file needs to be frequently modified based on business requirements, so it's a painful task. To address this issue, we can tie all the PC's in all floors with a cable using a switched environment (LAN) and share that file on a common folder so that everyone can access at the same time and do their modifications, saving huge amount of time.

Think you started one more office in USA, if those people want to access the same file in India, how to do that? Yes, then we need to rely on WAN connections. WAN is used to interconnect the LAN's in INDIA and USA with help of ISP's. ISP's are major people in WAN. They tie these LAN segments, so that file can be modified from USA, but keep in mind ISP have different SLA's for the type of connectivity, may be frame-relay, ATM or Leased line.

Do we need to consider cables before setting up a network?

Yes, cables play a major role in networking industry. While setting up a network we need to know the cable types, this section will briefly explain the cable type.

Ethernet cables: RJ45 or Cat5 cable is most commonly used for LAN's. i.e. to connect PC to Switches or Switches to Switches or Switches to a Router. See Fig. 1.1 below.
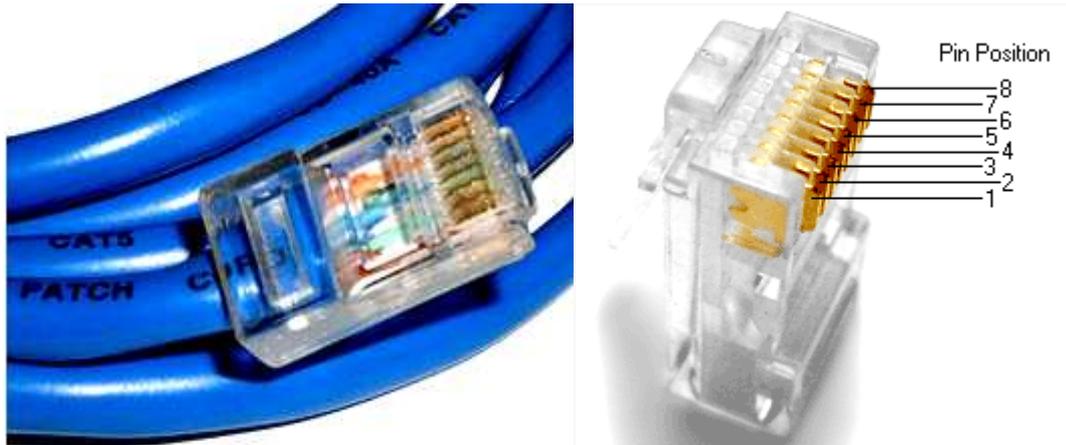
Fig: 1.1 RJ45 CABLE

If the users on the network increase, we need to rely on more switch ports/switches.
To address these, we need to interconnect switches in the LAN using an Ethernet cable or Fiber optic cable.
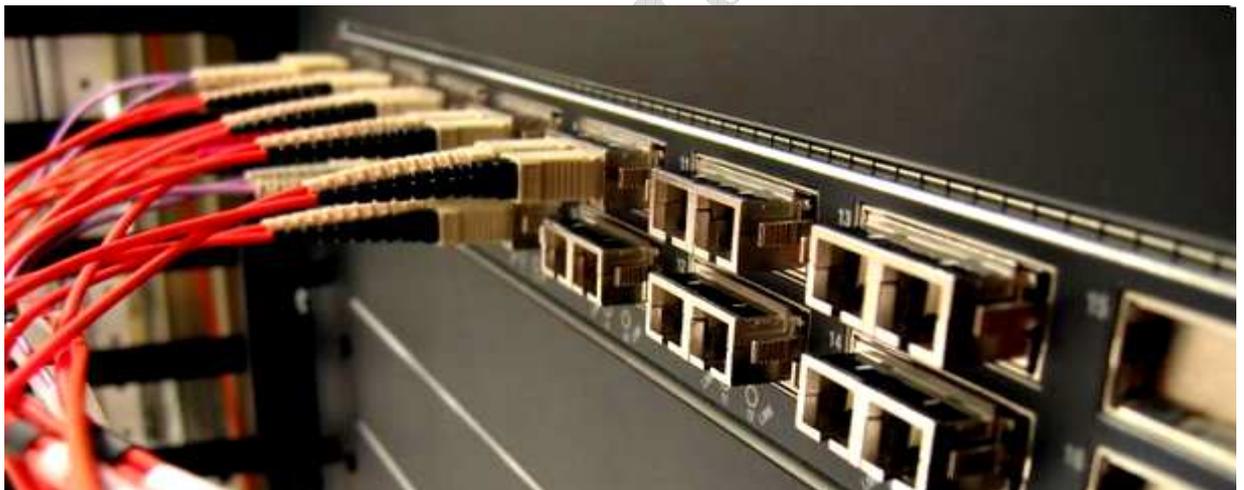See Fig: 1.2 below

Fig: 1.2 FIBER OPTIC CABLE

If there is a requirement for extend your LAN crossing geographic locations, typically WAN comes in to picture, For wan you need a serial cable or T1/E1 connectivity.
See Fig: 1.3 & 1.4 below:

Fig: 1.3 SERIAL CABLE   Fig: 1.4 T1/E1 CABLE

Difference between LAN and WAN

LAN – means Local – It makes your local devices to
communicate together. Example: If you have two PC's want
to transfer a file, normally what we can do is take a
cross over cable connect it directly between two PC's NIC
card (Network Interface Card – Visible on back side of
your PC). But if the size of pc count increases for 2 to
5 then we need to go for a Switch/Bridge/Hub, which ties
your PC's together so that it can communicate each other.

WAN – Ties Remote LAN or connect LAN to Internet.
Think you have two offices (2 LANS – One in INDIA and
other in USA) physically separated by geographic
boundaries. To make communication between two LAN we need
to rely on WAN connectivity or if you have a LAN and
users in that LAN needs internet access, in that case
also we need to rely on WAN connections.

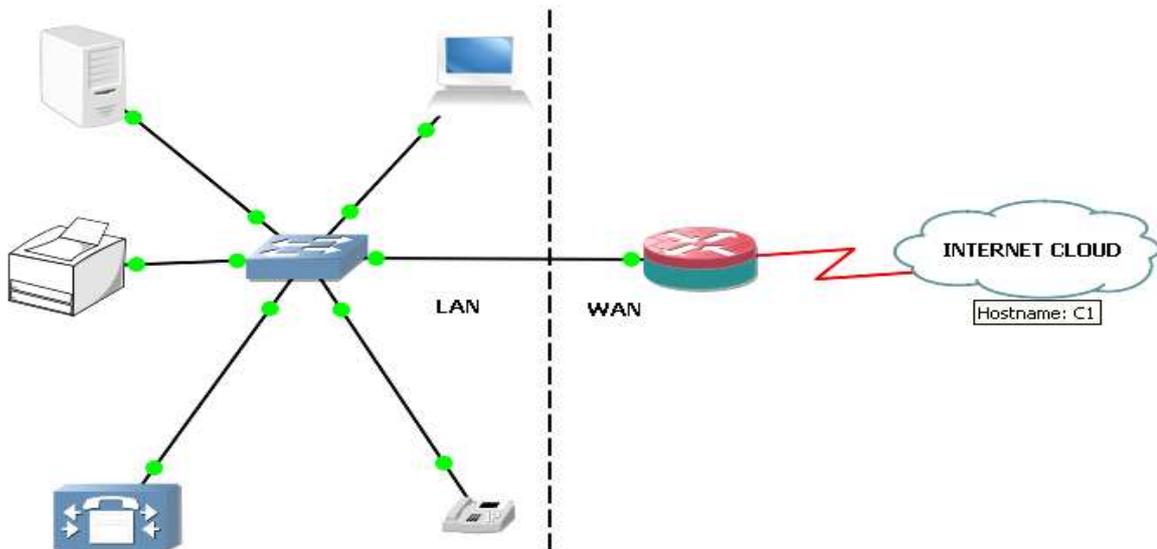Logical view of a typical LAN and WAN environment

Fig: 1.5 TYPICAL LAN & WAN ENVIRONMENT

From fig: 1.5 LAN ties all your local devices together by means of a switch, switch switches packet with in the network.
If any of the LAN pieces want to communicate outside, with the help of Router it reaches the internet/WAN cloud. Router routes packet around the networks.

Do you ever think why companies spending lot of money in buying equipments?

As the applications increases, need for bandwidth increase and when in turn requires better equipments with better processing power to route / switch packets around the network

Applications used in Industry:

The common applications run on the network are
- Email.
- Database.
- Web browser.
- File Transfer – FTP.
- Online Gaming.

When the applications increase, speed of our network also needs to be considered.

Speed calculation basics:

In computer industry, speed can be classified in to one of the below flavors.
- Bit
- Byte
- Kilobyte
- Megabyte
- Gigabyte
- Terabyte and the list go...

Bit:
    Bit is the basic of network communication, 1 and 0's are used to transfer data on the wire.

Byte:
    Eight bits form a byte, remember back in the windows days if you type a character e.g. X it take 1 byte of memory.

Kilobyte:
    1024 bytes form one Kilobyte.

Megabyte:

1024 Kilobyte form one Megabyte.

<h2>Gigabyte:</h2>

1024 Megabyte form one Gigabyte.

When it comes to networking, speed is always calculated in bits/sec not bytes/sec.

E.g. Ethernet can operate on speed of 10Mbps or 100Mbps or 1000Mbps. T1 can operate at a speed of 1.544Mbps. SONET support a speed of 51.84Mbps.

<h2>Designing a Network:</h2>

Think you have X amount of PC's, Routers, Switches etc, on which model you will design?
So we need to consider the topology type. Most common topologies are given below.
- BUS Topology.
- STAR Topology.
- RING Topology.

<h2>BUS Topology:</h2>

This is most commonly used topology when cable modem connections came out.
The long pipe denote a thicknet cable and pc's connected to that pipe using thinnet cables to access the broadband network.
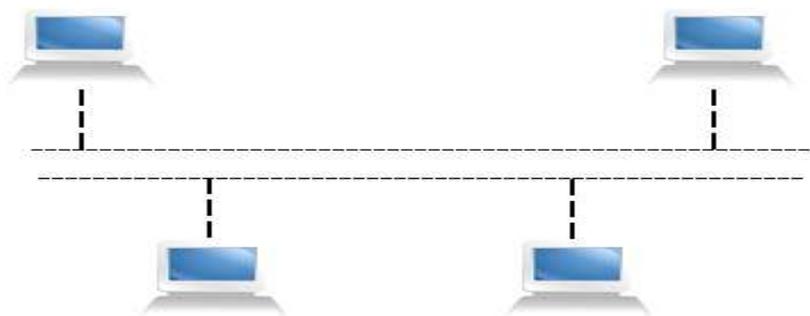See fig: 1.6

Fig: 1.6 BUS TOPOLOGY

<h2>STAR Topology:</h2>

These kind of topology found in today's networks where all our PC's are tied together to a switch.
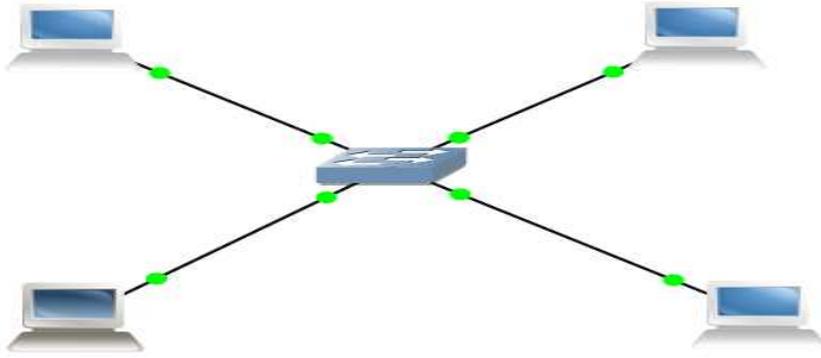See fig: 1.7

Fig: 1.7 STAR TOPOLOGY

RING TOPOLOGY:

Now a days ring topologies are rarely found, they came
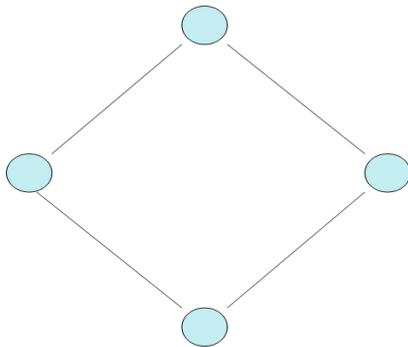out earlier with token ring technology.
See fig: 1.8

Fig: 1.8 RING TOPOLOGY

Network of Today's world:

Today the networks are build using a combination of BUS
and STAR topologies. For connecting PC's to switch it
will be designed as STAR & for interconnecting switches
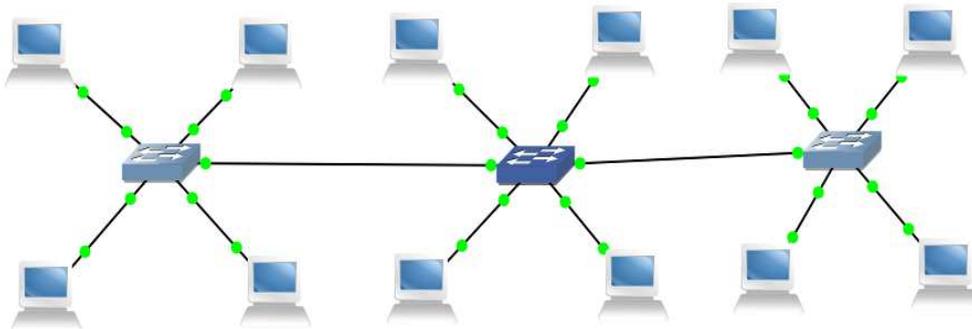it will be designed as BUS topology.
See fig: 1.9

Fig: 1.9 BUS & STAR TOPOLOGY – TODAYS NETWORK

So you have created a network and if some problem arise in the network how will you troubleshoot? You need to follow layer by layer approach to find the fault on which layer it actually resides.

OSI Model – Layer by Layer Approach

OSI model helps to define break it up network in multiple layers like,
- Physical layer
- Datalink layer
- Network layer
- Transport layer
- Session layer
- Presentation layer
- Application layer

To remember the above you can memorize the below,

"Please Do Not Throw Sausage Pizza Away"
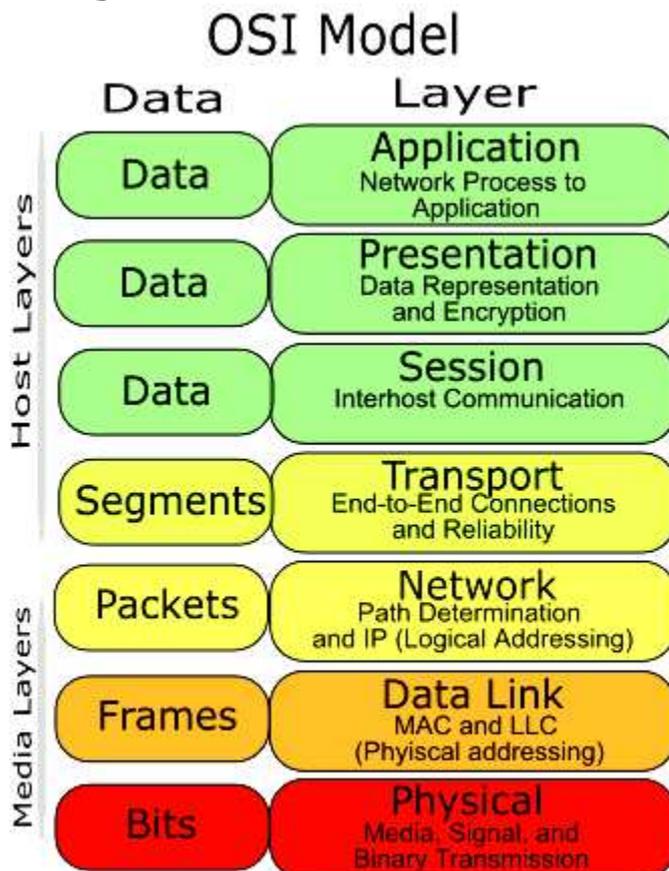See fig: 1.10 below

Fig: 1.10 OSI LAYER – BREAK UP NETWORK IN TO LAYERS
International Organization for Standardization came up with layer by layer approach called OSI model.

Physical Layer:

It defines the physical and electrical standard for the device. It deals with transportation of signals (binary 1's and 0's) over wire.
Physical layer data is treated as bits. The physical layer standards are EIA/TIA-232, SONET/SDH, IEEE802.3, PON, DSL, POTS, USB, or BLUETOOTH.

Datalink Layer:

This layer provides physical addressing and error free data transport. Data in this layer is treated as Frame in this layer. The physical addressing is related to MAC address/layer 2 address. MAC address/Hardware address is a burned in address on NIC card (PC's Ethernet interface). Datalink layer standards are Frame-relay, ATM, HDLC, PPP, ARP or X.25.

Network Layer:

This layer provides logical addressing and route date across the network. Data in this layer is treated as Packet. Logical address means an IP address/Layer3 address. Network layer standards are IP, IPX, IPSec, ICMP or IGMP.

Transport Layer:

How a data can be send on the network? Reliable communication or Unreliable communication. Depending up on the application, it decide,
Reliable – TCP; Unreliable – UDP
TCP is a connection oriented communication and UDP is a connectionless communication. Connection oriented means if you send a data on the network after the receiver receives the data, it sends out an acknowledgement. If it's a connectionless service, the sender won't expect an acknowledgement from the receiver. Data in this layer is treated as segments. Transport layer standards are TCP, UDP or SCTP.

Session Layer:

This layer helps to maintain end to end sessions for different applications. Think you have initiated a telnet session from your machine, it's a session but if you initiate another telnet session, now you formed two separate sessions from your machine. This functionality

is done at the session layer. Data in this layer is treated as data only! Session layer standards are l2tp, pptp, or NetBIOS.

Presentation Layer:

This layer deals with data encryption decryption related stuffs, Think you are emailing a letter, it may contain images texts videos etc, so that need to be converted to some form so that it can be handled by mailbox server (POP3 or SMTP). Data in this layer is treated as data only! Presentation layer standards are SSL or MIME.

Application Layer:

This layer can is considered a end user layer, in which applications run. E.g. Web browser, Telnet, DNS, Email Clients or FTP client/server. Data in this layer is treated as Data only!

Fig: 1.11 summarizes the functions of the above mentioned layers.

OSI MODEL			
	DATA UNIT	LAYER	FUNCTION
HOST LAYERS		Application	Network process to application
	Data	Presentation	Data representation, encryption,decryption, Convert machine dependent data in to machine independent data
		Session	Inter host communication
	Segments	Transport	End to End connection and reliability, Flow control
MEDIA LAYERS	Packet	Network	Path determination and logical addressing
	Frame	Data link	Physical addressing
	Bit	Physical	Media, Signal and Binary transmission

Fig: 1.11 OSI LAYER FUNCTIONS