COMPUTER NETWORKS

Network: A network is a group of systems that are connected to allow sharing of resources such as files or printers or sharing of services such as an Internet connection.

Setting up network: There are two aspects of setting up a network, the hardware used to connect the computer systems together and the software installed on the computers to allow them to communicate. The network hardware is made up of two basic components, the entities that want to share the information or resources, such as servers and workstations, and the medium that enables the entities to communicate, which is a cable or a wireless medium.

Workstation or client: A typical network involves having users sit at workstations, running such applications as word processors or spreadsheet programs. The workstation also is known as a client, which is just a basic computer running a client operating system such as Windows XP or Linux. These users typically store their files on a central server so that they can share the files with other users on the network.

Client's responsibilities: The client is responsible for.

i. Handle the user interface.
ii. Translate the user's request into the desired protocol.
iii. Send the request to server.
iv. Wait for server's response.
v. Translate the response into the human readable format.
vi. Present the result to the user.

Server: The server is a special computer that contains more disk space and memory than are found on client workstations. The server has special software installed that allows it to function as a server. This special software can provide file and print services (to allow sharing of files and printers), provide web pages to clients, or provide e-mail functionality to the company.

Server's responsibilities: The server is responsible for.

i. Listen to the client's query (request).
ii. Process that query.
iii. Return the results back to the client.

How client/server interaction happens: Client and server work as follows.

i. User runs client software on client to generate query.
ii. Client connects to the server.
iii. Client sends query to the server.
iv. Server analyzes the query.
v. Server computes the result of the query.
vi. Server sends the results to the client.
vii. Client presents the results to the user.
viii. The process is repeated when required.

Host: The term *host* refers to any computer or device that is connected to a network and sends or receives information on that network. A host can be a server, a workstation, a printer with its own network card, or a device such as a router. We can summarize by saying that any system or device that is connected to the network is known as a host.

Requirement of a network: Four components are required to set up a computer network

1. Sending device.
2. Receiving device.
3. Communication device.
4. Transmission medium.
5. Software that support network communication.

Sending device: A computer or any other device on a network that sends data.

Receiving device: A computer or any other device that receive data.

Communication device: All devices on network that sends and receive data are called communication devices. For example Dialup Modems, Network cards (NIC), routers, hubs, switches etc.

Dialup Modem: modems can be used to communicate with other systems across the public switched telephone network (PSTN). They are used to convert digital data from the PC to analog transmission so that the information can be transmitted over the analog phone lines. The modem on the receiving end is designed to convert the analog signal to a digital format readable by the system.

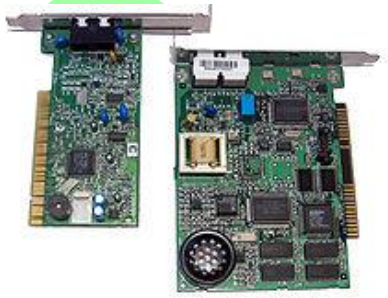
Types of Modems: External modem, Internal modem, Wireless modem.

External Modem:

This modem attached with the computer externally using USB or serial port of computer. This modem gets the power from a wall outlet. It has some light indicator on it.

Internal Modem:

This modem plugs into the PCI or ISA slot of the computer motherboard. No indication lights are provided on that. It gets the power from inside of the computer.
A PCI modem (on the left) next to a traditional ISA modem (on the right).



Wireless Modem:

A **wireless modem** is a type of modem which connects to a wireless network instead of a telephone system. When a mobile Internet user connects using a wireless modem, they're attached directly to the wireless ISP (Internet Service Provider) and can then access the Internet.

USB wireless modem

PC card modem

Desktop wireless modem

Networking Cards (NIC):

A **network interface controller** (also known as a **network interface card**, **network adapter**, **LAN adapter** and by similar terms) is a computer hardware component that connects a computer to a computer network. The NIC provides a physical connection between the networking cable and the computer's internal bus. NICs come in three basic varieties 8-bit, 16-bit, and 32-bit. The larger the number of bits that can be transferred to the NIC, the faster the NIC can transfer data to the network cable.

Network interface controller card which connects to the motherboard via the now-obsolete ISA bus. This combination card features both a (now obsolete) bayonet cap BNC connector (left) for use in coaxial-based networks and an RJ-45 connector (right) for use in twisted pair-based networks. Common manufacturers are Novell, Intel, Realtek.

Transmission medium: It is the element that allows the data to flow among the computers and other devices. It is of two types.

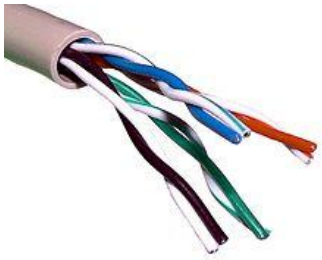
i. Guided medium
ii. Unguided medium

Guided medium: Such a medium that follow a specific path to transfer the data from one place to another, as wires (Coaxial cable, Twisted pair, Fiber optics).

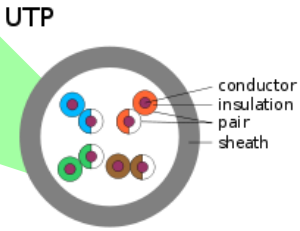
Twisted pair cable: **Twisted pair** cabling is a type of wiring in which two conductors (the forward and return conductors of a single circuit) are twisted together for the purposes of canceling out electromagnetic interference (EMI) from external sources; for instance, electromagnetic radiation from unshielded twisted pair (UTP) cables, and crosstalk between neighboring pairs. It was invented by Alexander Graham Bell. Twisted pair is of two types.

i- UTP (Unshielded Twisted Pair)
ii- STP (Shielded Twisted Pair)

UTP: UTP cable is also the most common cable used in computer networking. Modern Ethernet, the most common data networking standard, utilizes UTP cables. Twisted pair cabling is often used in data networks for short and medium length connections because of its relatively lower costs compared to optical fiber and coaxial cable. The UTP cable has four pairs of wires inside the jacket. Each pair is twisted with a different number of twists per inch to help eliminate interference.



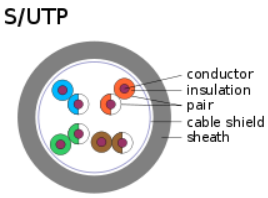
Unshielded twisted pair cable with different twist rates



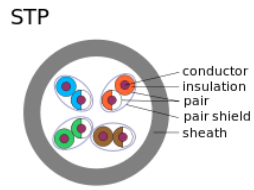
Unshielded twisted pair cross section

STP: Twisted pair cables are often shielded in an attempt to prevent electromagnetic interference. Because the shielding is made of metal, it may also serve as a ground. However, usually a shielded or a screened twisted pair cable has a special grounding wire added called a drain wire. This shielding can be applied to individual pairs, or to the collection of pairs. When shielding is applied to the collection of pairs, this is referred to as screening. The shielding must be grounded for the shielding to work, and is improved by grounding the drain wire along with the shield.

STP also known as FTP

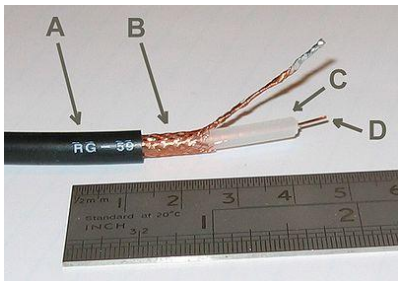


STP cross section

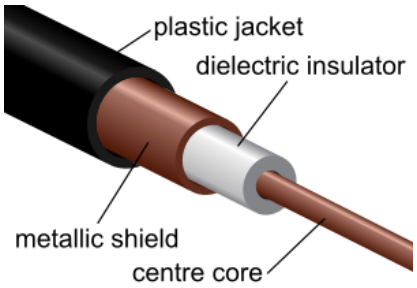


Another STP cross section

Coaxial cable: **Coaxial cable**, or **coax**, is an electrical cable with an inner conductor surrounded by a flexible, tubular insulating layer, surrounded by a tubular conducting shield. The term coaxial comes from the inner conductor and the outer shield sharing the same geometric axis. Coaxial cable was invented by English engineer and mathematician Oliver Heaviside. Coaxial cable is used as a transmission line for radio frequency signals, computer network (Internet) connections, and distributing cable television signals.



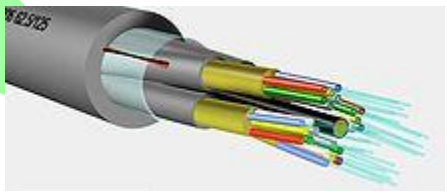
RG-59 flexible coaxial cable composed of
A: outer plastic sheath
B: woven copper shield
C: inner dielectric insulator
D: copper core



Fiber optic cable: An **optical fiber cable** is a cable containing one or more optical fibers. The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable will be deployed. In practical fibers, the cladding is usually coated with a tough resin buffer layer, which may be further surrounded by a jacket layer, usually plastic. These cables are designed for high speed and very long network communications. Fiber optics carry communication signals using pulses of light. These are expensive and have much greater capacity to transfer data.

A TOSLINK optical fiber cable with a clear jacket. These plastic-fiber cables are used mainly for digital audio connections between devices.

A multi-fiber cable



An optical fiber breakout cable

Unguided medium: Such a medium that in which information or data spreads in space in all directions, as electromagnetic waves, satellite waves

Network supporting software: It is the operating system software that allows the computers to communicate in the network. It is of two types.

i. Client program
ii. Server program

Types of computer networks: We categorize the computer networks on the basis of geographical area and their structure. On the basis of geographical are the computer networks mainly are of three types.

i. LAN
ii. WAN
iii. MAN

LAN (Local Area Network): A *local area network (LAN)* typically is confined to a single building, such as an office building, your home network, or a college campus. LAN can be set up using guided or unguided media.

Characteristics of LAN:

i. Higher data transfer rate.
ii. Smaller geographical area.
iii. Leased telecommunication lines mostly not required.
iv. Every computer can communicate with other in the network.
v. High chances of interconnection between the computers.
vi. Easy to make a physical connection of computers within a network.
vii. It is an inexpensive medium of data transmission.

Advantage of LAN:

i. The reliability of network is high because the network is situated in small area and less complicated. The length of wires used for networking is short.
ii. It is very easy to add or discard any computer from the network.

iii. High data transfer rate.
iv. Peripherals can be shared.

Disadvantage of LAN: The big disadvantage of LAN is that the communication over long distances is not possible.

Usage of LAN: The LAN is used for

i. File transfer and access.
ii. Word processing.
iii. Email handling.
iv. Remote database access.
v. Personal computing.
vi. Digital voice transmission and storage.

WAN (Wide area network): A *wide area network (WAN)* spans multiple geographic locations and is typically made up of multiple LANs. For example, I have a company with an office in Gujranwala that has 100 computers all connected together. This would be considered a LAN. Now if we expand the company and create an office in Karachi, the network in Karachi also would be considered a LAN. If we want to allow the two offices to share information with one another, we would connect the two LANs together, creating a WAN. The examples of WAN are Ethernet, ARPA net.

Characteristics of WAN: The major characteristics of WAN are

i. **Communication facility:** Communication can be possible among the employees of a big company spanning over different parts of the country. Video conferencing can be possible through WAN.
ii. **Remote data entry:** Sitting at one place we can enter, update data and query other information to any computer attached to the WAN but located in the other cities.
iii. **Centralized information:** If the organization is spread over many cities, they keep their important business data at a single place. As a data is generated at different sites, WAN permits collection of this data from different sites and save at a single site.

LAN Vs. WAN:

	LAN	WAN
Definition	A *local area network (LAN)* typically is confined to a single building, such as an office building, your home network, or a college campus. LAN can be set up using guided or unguided media.	A *wide area network (WAN)* spans multiple geographic locations and is typically made up of multiple LANs.
Example	Network in a building of a school	The Internet
Ownership	It is owned by the boss of an organization, like a principle of a school.	It is not owned by any one person.
Technology	Ethernet, Token ring	Frame relay, X.25
Data transfer rate	High	Low
Geographical spread	Small geographical range, a building or an office so don't require leased lines.	Large geographical range spreading across cities and countries so require leased lines.
Setup cost	Low	High

MAN: The term *metropolitan area network (MAN)* is not used often anymore it refers to a network that exists within a single city or metropolitan area. If we had two different buildings within a city that were connected together, it would be considered a MAN. It is much larger than LAN but not as large as WAN.

Cellular communications: Cellular communication is one of the famous types of wireless communications. The name 'cellular' is derived from the word cell. In cellular technology the cell is a basic geographic unit of a complete cellular system. Each cell size varies depending on the landscape and density of population. In cellular communication, each cell has its own short range transmitter to communicate with its subscriber (users).

The cellular technology is mostly used by the cellular phone service providers. They divide the geographic area into number of small cells and install a transmitter in each cell to provide communication link to the mobile subscribers.

Satellite communication: The satellite communication is another famous type of wireless communication. A communication satellite also known as COMSAT is an artificial satellite stationed in the space for the purpose of telecommunications. A satellite provides coverage for a large geographical area. TV phone and radio signals are sent up to the satellite by a large dish. The signals are amplified (strengthened) by the satellite, then sent to the receiving station. High speed internet access was introduced using satellite technology for customers in hard to reach geographic places.

Global Positioning System: The Global Positioning System (GPS) is a space-based global navigation satellite system (GNSS) that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible by anyone with a GPS receiver.

The GPS project was developed in 1973 to overcome the limitations of previous navigation systems integrating ideas from several predecessors, including a number of classified engineering design studies from the 1960s. GPS was

created and realized by the U.S. Department of Defense (USDOD) and was originally run with 24 satellites. It became fully operational in 1994.

Bluetooth: Bluetooth is a name for a short range radio frequency (RF) technology. This technology allows many electronic devices to connect and communicate with each other wirelessly. Bluetooth was introduced to get rid of wires. Normally the effective range of Bluetooth devices is 32 feet. It operates at 2.4 GHz and is capable of transmitting voice and data. For example the cell phones can be paired with wireless Bluetooth headsets. We can leave our cell phone in our pocket and perform most of our phone's functions using our in-ear Bluetooth headset. In addition to the cell phones Bluetooth technology is also compatible with personal computers, laptops, printers, GPS receivers, digital cameras, video game consoles and more.