Course Contents

Unit-05: Computer Networks and Internet Services (10 Hrs.)

- Introduction; Importance of Networking; Data Transmission Media (Twisted pair, coaxial cable, Optical fiber, RF transmission, microwave transmission, satellite transmission);
- Data Transmission across Media;
- Data Transmission and Data Networking;
- Network Types; Network Topology; Communication Protocol; Network Devices; Wireless Networking

Course Contents

- Internet: History of Internet; Internetworking Protocol; The Internet Architecture; Managing the Internet; Internet Connections; Internet Address; WWW, Domain Name System, Internet Services; E-mail and its working principle; E-commerce and E-governance,Web2.0; Internet of Things(IoT); Wearable computing; Cloud computing;
- Smart City; Case Study: ISP in Nepal and their services

Computer Networks and Internet Services

Unit-05:Computer Networks and Internet Services: Part-1

- Introduction
- Importance of Networking
- Data Transmission Media (Twisted pair, coaxial cable, Optical fiber, RF transmission, microwave transmission, satellite transmission)
- Data Transmission across Media
- Data Transmission and Data Networking
- Computer Network (Multiplexing, Switching)
- Network Types
- Network Topology
- Communication Protocol
- Network Devices
- Wireless Networking

Computer Networks and Internet Services

Unit-05:Computer Networks and Internet Services: Part-1

- Introduction
- Importance of networking
  - Resource sharing, information sharing, as a communication medium, back-up and support
- Data transmission media
  - Twisted pair, coaxial cable, optical fiber, RF transmission, microwave transmission, satellite transmission
- Data transmission across media
  - Transmission modes - Simplex, half duplex, full-duplex
  - Transmission speed - Bandwidth, throughput, attenuation, distortion
  - Fundamentals of transmission - Electromagnetic waves, signals
    - Analog and digital signals
    - Modulation and demodulation - Amplitude, frequency, phase shift
    - Multiplexing - FDM, WDM
    - Asynchronous and synchronous transmission

Computer Networks and Internet Services

- **Data transmission and data networking**
  - Switching - Circuit switching, message switching, packet switching
- **Computer network**
  - Network types - LAN, MAN, WAN
  - Network topologies - Bus, ring, star
  - Communication protocol - The seven layers of OSI model
  - Network devices - NIC, repeater, bridge, hub, switch, router, gateway
- **Wireless networking** - Bluetooth technology, wireless LAN, wireless WAN

Computer Networks and Internet Services

Objectives of this Chapter:

- Computer networks facilitate exchange of information
- To connect the computers, need a data transmission media and understand how data gets transmitted across the media.
- Can create Computer network across a room, building, city, state or the world to communicate.
- Introduce to the data communication and the computer network.

Computer Networks and Internet Services

Introduction

- What is communication ? What involves in communication?
- What are different types of communication media?
- What is computer network?
- Explain the importance of networking.

Data transmission media:

- What do you mean by guided and unguided transmission media?
- What are the features of a twisted pair cable?
- What are the features of a coaxial cable?
- What are the features of an optical fiber?
- List the advantages and disadvantages of optical wire over a copper wire.
- Describe the following unguided transmission media—(i) RF transmission, (2) Microwave transmission, and (iii) Satellite transmission.

Data transmission across media

- Define a signal.
- Which is better to use for data transmission—analog signal or digital signal? Why.

Computer Networks and Internet Services

Data transmission across media

- What is a carrier wave?
- Why is modulation needed?
- Explain modulation and demodulation.
- What is the purpose of a modem?
- Name the three kinds of modulation.
- Define multiplexing and demultiplexing.
- What is the difference between the FDM and WDM multiplexing techniques?
- Define synchronous and asynchronous transmission.

Data transmission and data networking

- Name the three kinds of switching techniques.
- Describe briefly the circuit switching and message switching techniques.
- Define a packet.
- Which switching technique is most commonly used in computer networks? Why?
- Explain the working of the packet switching technique.
- Difference between Broadband vs Baseband technology

Computer Networks and Internet Services

Computer network

- Define computer network.
- Name the three types of networks classified on the basis of their size.
- What do you mean by transmission technology?
- What do you mean by network topology?
- Describe briefly the LAN, MAN, and WAN transmission technologies.
- Name three LAN topologies.
- List the features of the following LAN topologies—(i) Bus, (ii) Star, and (iii) Ring.
- Name the protocol(s) used to implement bus, ring and star technologies.
- List the advantages and disadvantages of each of the LAN technology–Bus, Star, and Ring.
- What is the need of communication protocol?
- List the seven layers of the OSI model protocol, in order.
- How does the OSI seven layer protocol work?
- Describe briefly the function of each layer of the OSI model.

Computer Networks and Internet Services

Computer network

- Define a concentrator.
- Name three network connecting devices.
- What is the purpose of the Network Interface Card?
- Describe the features of (i) repeater, (ii) hub, (iii) switch, (iv) bridge, (v) router, and (vi) gateway.
- What is the purpose of a gateway?
- Name a connecting device, each, that works at (i) physical layer, (ii) data link layer, and (iii) network layer.

Computer Networks and Internet Services

Introduction:

What is communication ? What does it involves?

- Communication is simply the act of transferring information/data from one place, person or group to another. Every communication involves (at least) one sender, a message, a recipient and medium used to establish the communication.
- The communication process involves - sender information, receiver information, language used for communication, and medium used to establish the communication.
- Communication between computers also follows a similar process.

Computer Networks and Internet Services

Introduction:

- Data communication discusses the media used for transmission of data, how data can be transferred across the communication media and the relationship between data transmission and data networking.
- Computer network discusses different network types, network topologies, communication protocol and network communicating devices and of wireless networks.

What is Computer network?

- A computer network is a group of computer systems and other computing hardware devices that are linked together through communication channels/media to facilitate communication and resource-sharing among a wide range of users.

Computer Networks and Internet Services

Importance of Networking:

Networking of computer provides a communication link between the users, and provides access to information.

Can you list the some importance of networking of computer?

1. Resource Sharing
2. Information Sharing
3. As a communication medium
4. For Backup and support
5. Centralized administration and support

Computer Networks and Internet Services

Importance of Networking:

1. Resource Sharing:

- Resources such as printers, fax machines and scanners are generally not required by each person at all times in an organization. Moreover, for small organizations it may not be feasible to provide such resources to each individual. Such resources can be made available to different users of the organization on the network.
- It results in availability of the resource to different users regardless of the physical location of the resource or the user, enhances optimal use of the resource, leads to easy maintenance, and saves cost too

Computer Networks and Internet Services

Importance of Networking:

2. Information Sharing

Networking facilitates sharing of information. Information stored on networked computers located at same or different physical locations, becomes accessible to the computers connected to the network.

3. As a communication medium:

Networking helps in sending and receiving of electronic-mail (email) messages from anywhere in the world. Data in the form of text, audio, video and pictures can be sent via e-mail. This allows the users to communicate online in a faster and cost effective manner. Video conferencing is another form of communication made possible via networking. People in distant locations can hold a meeting, and they can hear and see each other simultaneously.

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Importance of Networking:

4. For Backup and support

Networked computers can be used to take back-up of critical data. In situations where there is a requirement of always-on computer, another computer on the network can take over in case of failure of one computer.

5. Centralized administration and support

Can perform administration tasks from a central location. All computers and other components of a network can be managed by central support system. Any rules, security measures etc. which are necessary in the network are implemented through server to all attached computers in the networks by transferring to all clients. So networking simplifies administration and support task from just a single location.

Computer Networks and Internet Services

Question session:

Introduction

- What is communication ? What involves in communication?
- What are different types of communication media?
- What is computer network?
- Explain the importance of networking.

Communication and Computer Network

What is Data Transmission Media?

- Transmission media are the physical pathways that connect computers, other devices, and people on a network- the highways and byways that comprise the information superhighway.
- Each transmission medium requires specialized network hardware that has to be compatible with that medium.
  - The transmission medium is the physical path by which a message travels from sender to receiver.
  - Computers and telecommunication devices use signals to represent data.

Communication and Computer Network

Types of Data Transmission Media?

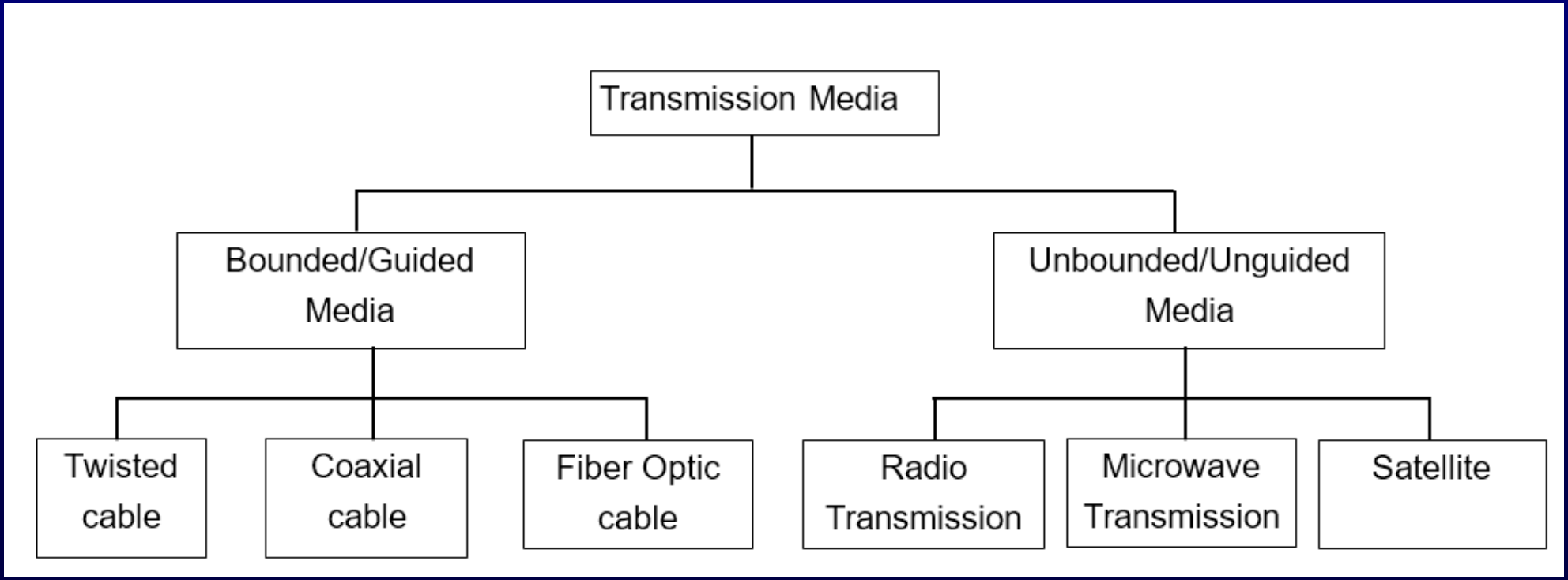
The transmission media can be grouped into.

- Conducted/wired or guided media: use a conductor such as a wire or a fiber optic cable to move the signal from sender to receiver. Examples are twisted pair wires, coaxial cables and optical fiber.
- Wireless or unguided media: use radio waves of different frequencies and do not need a wire or cable conductor to transmit signals. Examples are terrestrial microwave, satellite microwave, broadcast radio and infrared

Computer Networks and Internet Services

Data Transmission Media;

The transmission media can be grouped into.



Computer Networks and Internet Services

Twisted Pair (TP):

- A twisted pair cable consists of four pairs of copper wires coated with an insulating material like plastic or Teflon, twisted together. Twisting reduces electromagnetic interference.
- 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(???).
- TP is of two kinds—Shielded Twisted Pair (STP), and Unshielded Twisted Pair (UTP).
- STP cable has an extra layer of metal foil between the twisted pair of copper wires and the outer covering. The metal foil covering provides additional protection from external disturbances. However, the covering increases the resistance to the signal and thus decreases the length of the cable. STP is costly and is generally used in networks where cables pass closer to devices that cause external disturbances.
- UTP is the most commonly used medium for transmission over short distances up to 100m. Out of the four pairs of wires in a UTP cable, only two pairs are used for communication.
- UTP cables are defined in different categories. The commonly used UTP cable is the Cat-5(?) cable which is used with fast Ethernet.

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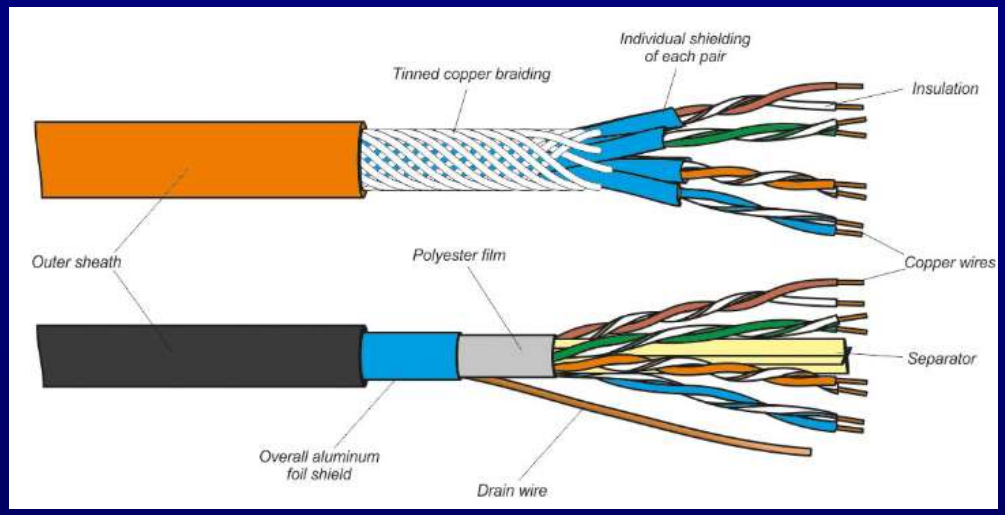
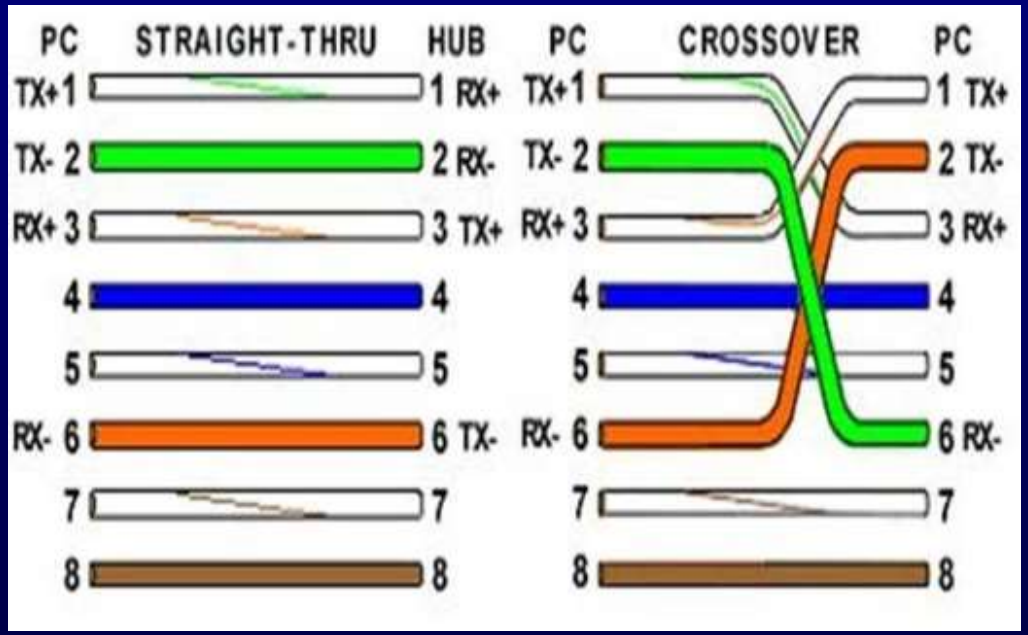
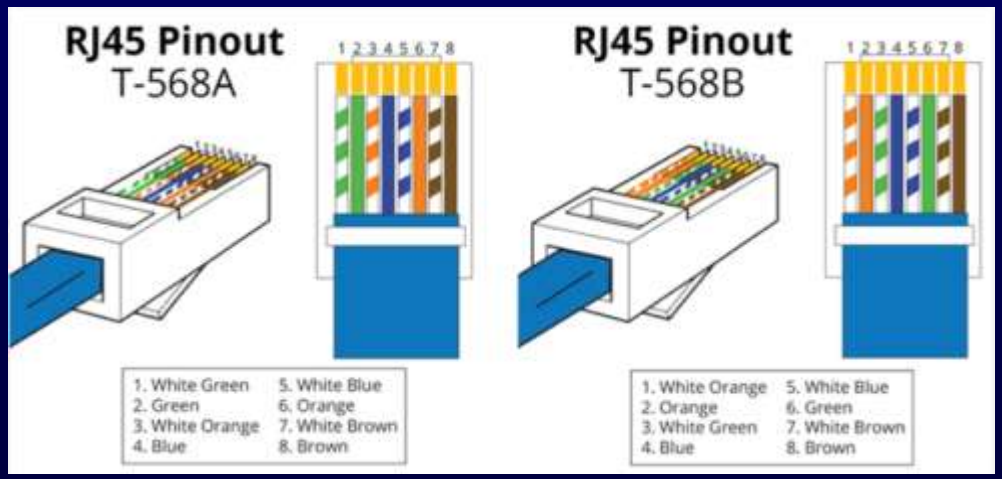
Twisted Pair:







Twisted cable Connection details

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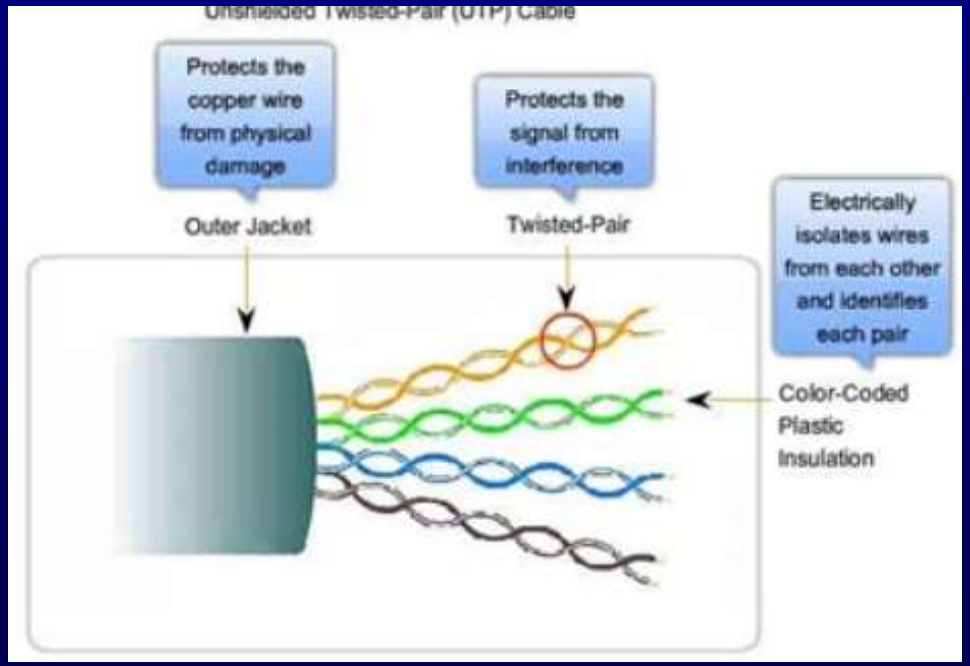
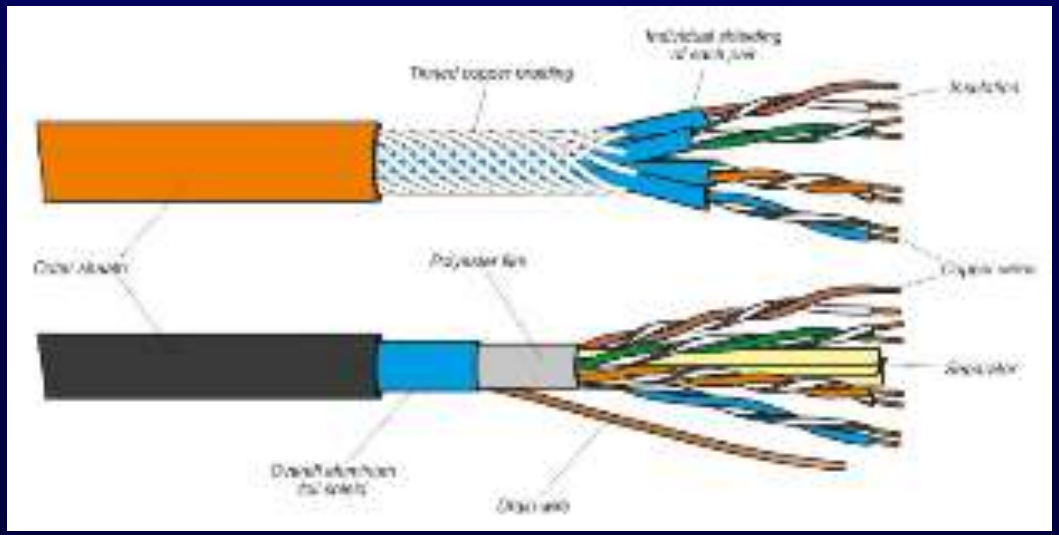
Guided and the unguided data transmission media:

Twisted Pair:





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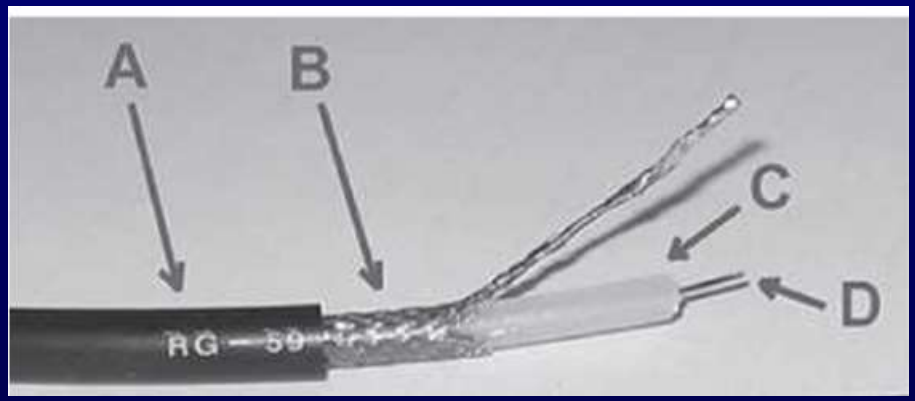
Coaxial Cable:

- A coaxial cable has a single inner conductor that transmits electric signals; the outer conductor acts as a ground. The two conductors are separated by insulation. The inner conductor, insulator, and the outer conductor are wrapped in a sheath of Teflon or PVC.



Coaxial cable (A: outer plastic sheath, B: woven copper shield, C: inner dielectric insulator, D: copper core

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Coaxial Cable:

- The copper wire is used for both inner and outer conductor. The signal is transmitted over the surface of the inner conductor.
- In an ideal coaxial cable the electromagnetic field carrying the signal exists only in the space between the inner and outer conductors. This allows coaxial cable runs to be installed next to metal objects such as gutters without the power losses that occur in other transmission lines, and provides protection of the signal from external electromagnetic interference.
- A thicker coaxial cable can transmit more data than a thinner one.
- The commonly used coaxial cable is 10base2 that transmits over a distance of 185 m, and 10base5 that transmits over a distance of 500 m

Check 10Base2, 10Base5, 100Base-Tx mean ???

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Optical Fiber:

- Optical fibers are being used for transmission of information over large distances more cost effectively than the copper wire connection. Communication systems are now unthinkable without fiber optics.
- Optical fiber transmits data as light signals instead of electric signals.
- An optical fiber cable consists of
  1) Core - optical fiber conductor (glass) that transmits light,
  2) Cladding - an optical material that surrounds the core to prevent any light from escaping the core, and
  3) Jacket - outer covering made of plastic to protect the fiber from damage.

Computer Networks and Internet Services

Optical Fiber:

- Modern optical fiber cables can contain up to a thousand fibers in a single cable, so the performance of optical networks easily accommodate large demands for bandwidth on a point-to-point basis.
- Optical fibers come in two types:

  1) Single-mode fibers, and
  2) Multi-mode fibers

  - Single-mode fibers have small cores (about 3.5×10^{-4} inches or 9 microns in diameter) and transmit infrared laser light (wavelength = 1,300 to 1,550 nanometers).
  - Multi-mode fibers have larger cores (about 2.5×10^{-3} inches or 62.5 microns in diameter) and transmit infrared light (wavelength⁉ 850 to 1,300 nm) from Light Emitting Diodes (LEDs).

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Optical Fiber: The Advantages of Optical Fibers over wires are:

- Optical fibers do not cause electrical interference in other cables, since they use light signals.
- Due to much lower attenuation and interference, optical fiber has large advantages over existing copper wire in long-distance and high-demand applications.
- A fiber can carry a pulse of light much farther than a copper wire carrying a signal.
- Optical fiber can carry more information than a wire (light can encode more information than electrical signal).
- A single optical fiber is required for light to travel from one computer to another (two wires are required for electric connection).
- Because signals in optical fibers degrade less, lower-power transmitters can be used instead of the high-voltage electrical transmitters needed for copper wires.
- No amplification of the optical signal is needed over distances of hundreds of kilometers. This has greatly reduced the cost of optical networking, particularly over undersea spans where the cost reliability of amplifiers is one of the key factors determining the performance of the whole cable system.
- Optical fibers are ideally suited for carrying digital information, which is especially useful in computer networks.
- They are highly secure as they cannot be tapped and for lack of signal radiation.

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Optical Fiber: The Disadvantages of Optical Fiber are:

- Installing an optical fiber requires special equipment.
- If a fiber breaks, finding the broken location is difficult.
- Repairing a broken optical fiber is difficult and requires special equipment.
- Due to its high installation costs, they are economical when the bandwidth utilization is high.

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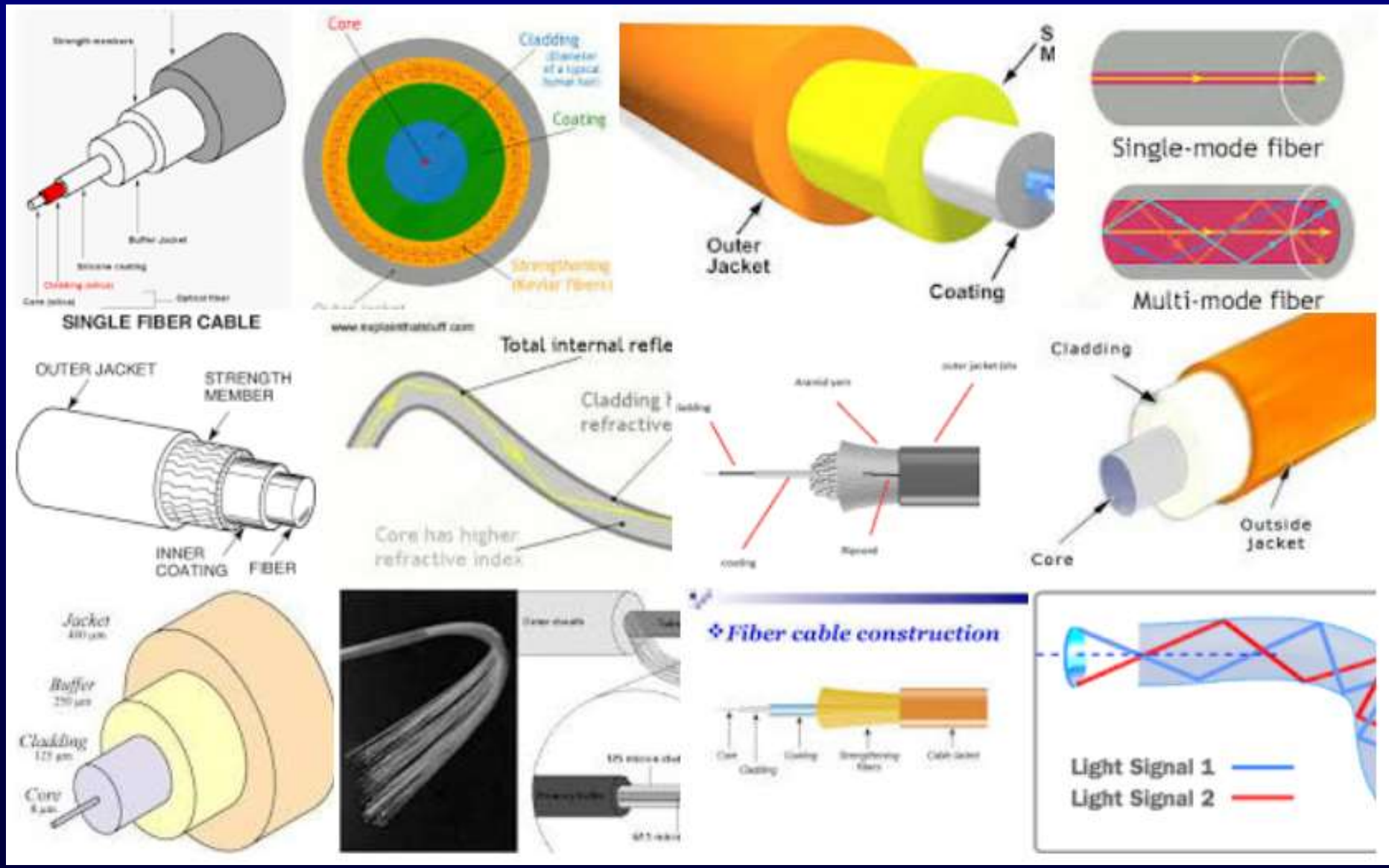
Optical Fiber:



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Guided and the unguided data transmission media:

Radio Transmission:

- The electromagnetic radio waves that operate at the radio frequency are also used to transmit computer data. This transmission is also known as Radio Frequency RF) transmission. The computers using RF transmission do not require a direct physical connection like wires or cable. Each computer attaches to an antenna hat can both send and receive radio transmission.

Computer Networks and Internet Services

Guided and the unguided data transmission media:

Microwave Transmission:

- Microwave transmission refers to the technique of transmitting information over a microwave link.
- Microwaves have a higher frequency than radio waves.
- Microwave transmission can be aimed at a single direction, instead of broadcasting in all directions (like in radio waves). Microwaves can carry more information than radio waves but cannot penetrate metals.
- Microwaves are used where there is a clear path between the transmitter and the receiver.

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Guided and the unguided data transmission media:

Microwave Transmission:

- Microwave transmission has the advantage of not requiring access to all contiguous land along the path of the system, since it does not need cables.
- They suffer from the disadvantages: a) needing expensive towers and repeaters, and b) are subject to interference from passing airplanes and rain.
- Because microwave systems are line-of-sight media, radio towers must be spaced approximately every 42 km along the route.

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Guided and the unguided data transmission media:

Satellite Transmission:

- The communication across longer distances can be provided by combining radio frequency transmission with satellites. Geosynchronous satellites are placed in an orbit synchronized with the rotation of the earth at a distance of 36,000 km above the surface of the earth.
- Geosynchronous satellites appear to be stationary when viewed from the earth.
- The satellite consists of transponder that can receive RF signals and transmit them back to the ground at a different angle. A ground station on one side of the ocean transmits signal to the satellite which in turn sends the signal to the ground station on the other side of the ocean

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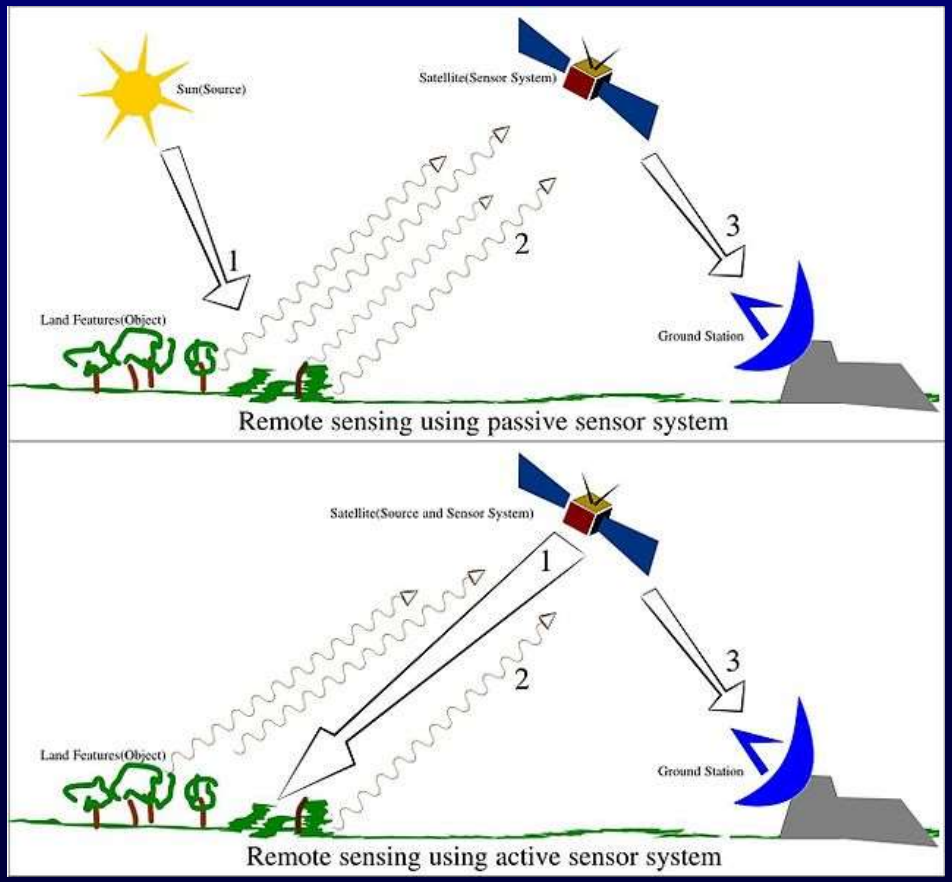
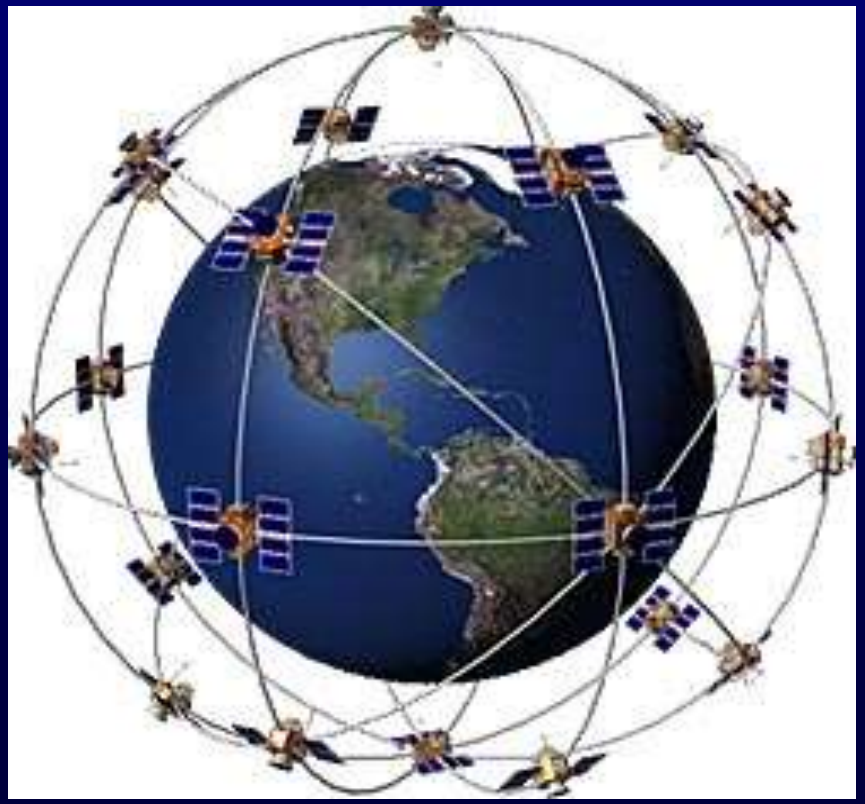
Guided and the unguided data transmission media:

Satellite Transmission:





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Guided and the unguided data transmission media:

Bluetooth:

- Bluetooth networking transmits data via low-power radio waves. It communicates on a frequency of 2.45 gigahertz (between 2.400 GHz and 2.483.5 GHz)
- This frequency band has been set aside by international agreement for the use of industrial, scientific and medical devices (ISM).
- A number of devices that you may already use take advantage of this same radio-frequency band.
- Baby monitors, garage-door openers and the newest generation of cordless phones all make use of frequencies in the ISM band. Making sure that Bluetooth and these other devices don't interfere with one another has been a crucial part of the design process.
- Bluetooth can handle many devices simultaneously of 10-meter radius.

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Q&A session

Data transmission media:

- What do you mean by guided and unguided transmission media?
- What are the features of a twisted pair cable?
- What are the features of a coaxial cable?
- What are the features of an optical fiber?
- List the advantages and disadvantages of optical wire over a copper wire.
- Describe the following unguided transmission media—(i) RF transmission, (2) Microwave transmission, and (iii) Satellite transmission.

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Data Transmission across Media:

- Transmission modes - simplex, half-duplex, full-duplex
- Transmission speed - Bandwidth, throughput, attenuation, distortion
- Fundamentals of transmission - Electromagnetic waves, signals
  - Analog and digital signals
  - Modulation and demodulation - Amplitude, frequency, phase shift
  - Multiplexing - FDM, WDM
  - Asynchronous and synchronous transmission

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Data Transmission across Media:

Transmission modes:

The direction in which data can be transmitted between any two linked devices is of three types

(1) Simplex,
(2) Half-duplex, and
(3) Full-duplex, or duplex.

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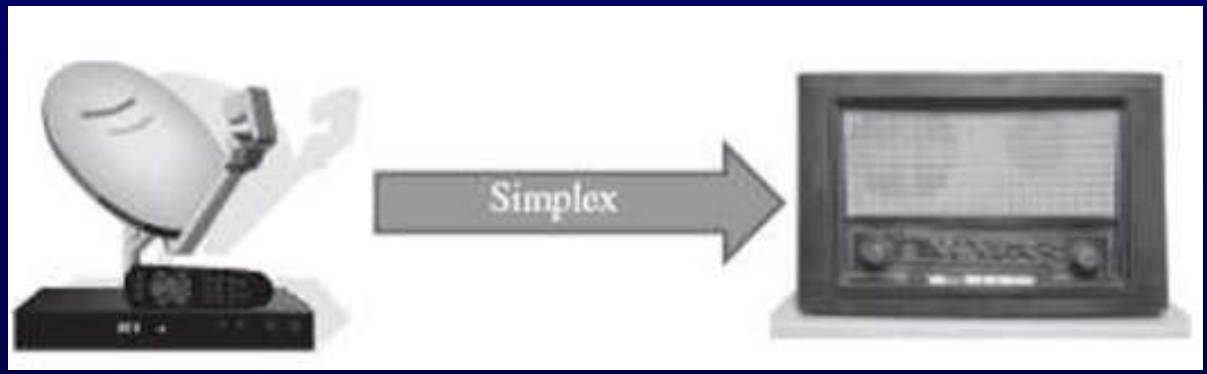
Data Transmission across Media:

Transmission modes:

(1) Simplex,

Simplex transmission is unidirectional data transmission. Of the two linked devices, only one of them can send data and the other one can only receive data.



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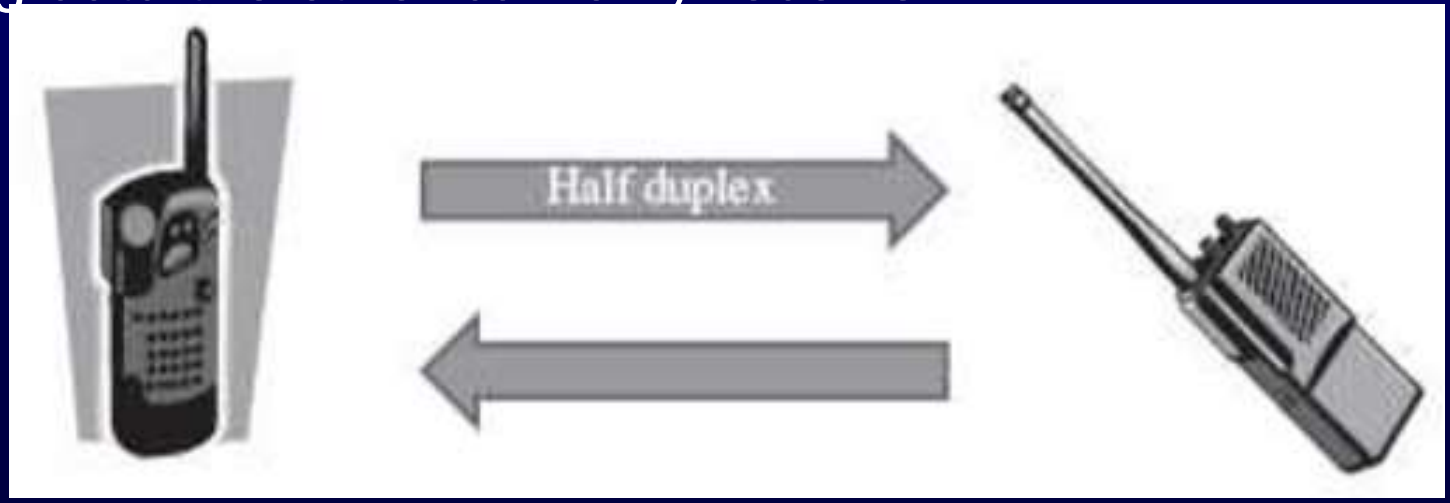
Data Transmission across Media:

Transmission modes:

2. Half-duplex

Half–duplex transmission is bi-directional data transmission, but the linked devices cannot send and receive at the same time. When one device is sending data the other can only receive.



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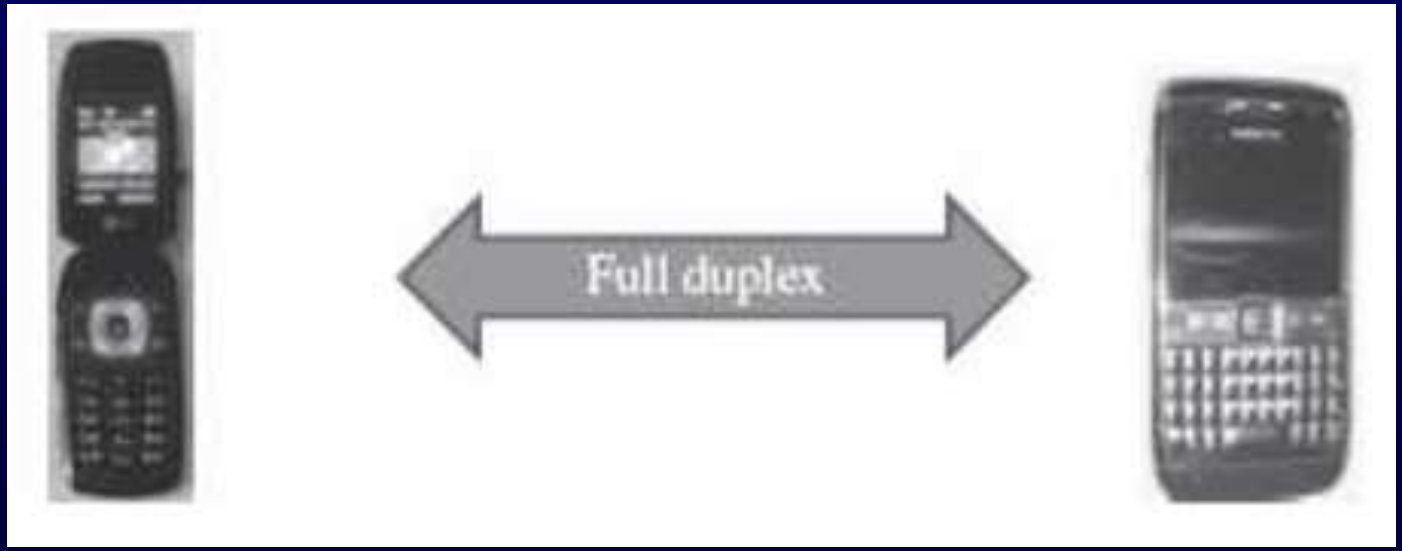
Data Transmission across Media:

Transmission modes:

2. Full-duplex

Full-duplex transmission is bi-directional and the linked devices can send and receive data simultaneously. The linked devices can send data and at the same time receive data.



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Transmission Speed:

- When the signals are transmitted between two computers, two factors need to be considered - (1) Bandwidth, and (2) Distance.
- Bandwidth is the amount of data that can be transferred through the underlying hardware i.e. the communication medium, in a fixed amount of time. Bandwidth is measured in cycles per second (cps) or Hertz (Hz). The bandwidth of the transmission medium determines the data transfer rate.
- Throughput is the amount of data that is actually transmitted between the two computers. Throughput is specified in bits per second (bps). The throughput capability of the communication medium is also called bandwidth. The bandwidth of the communication medium is the upper bound on the throughput, because data cannot be sent at a rate more than the throughput of the communication medium.
- Higher throughput is achieved by using a large part of the electromagnetic spectrum (large bandwidth). Technology that uses large part of the electromagnetic spectrum to achieve higher throughput is known as broadband technology. The technology that uses small part of the electromagnetic spectrum is known as baseband technology.

Computer Networks and Internet Services

Transmission Speed:

- Throughput is affected by the distance between the connected computers or devices. Even if a transmission medium is designed for a specific bandwidth, the throughput is affected by the distance of communication.
- The bandwidth of transmission medium is limited by the distance over which the medium needs to transmit the signal. The bandwidth decreases with the increase in the distance between the connected devices. When a signal has to travel long distance, the signal strength decreases; the signal strength is utilized to overcome the resistance offered by the connecting medium (cable or wire). The gradual deterioration of signal strength across long distances is called attenuation.
- Moreover, with increasing distance the external disturbance increases, which causes the signal to deteriorate and results in less amount of data to be transferred. The degradation of signal due to internal or external disturbances is called distortion.
- The bandwidth and distance of the transmission medium is selected so that it offers minimum attenuation and minimum distortion.
- The cat-5 UTP cable has a throughput of 100 Mbps over a distance of 100m. The 10base2 coaxial cable has a throughput up to 10Mbps over a distance of 185 m. The 10base5 coaxial cable has a throughput up to 10Mbps over a distance of 500 m.

Note : Attenuation (wave shape same) Vs Distortion (Wave shape distort)?

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Transmission Speed: Bandwidth

- All signals that are transmitted consist of multiple frequencies. The range of frequencies a signal occupies is called the bandwidth of the signal. The bandwidth is measured in terms of Hertz (Hz).
- The bandwidth of a signal depends on the amount of information contained in it and the quality of it. The range of frequencies necessary for an analogue voice signal, with a fixed telephone line quality (recognizable speaker), is 300 - 3400 Hz. This means that the bandwidth of the signal is 3,100 Hz. A human voice contains much higher frequencies, but this bandwidth gives a good compromise between the quality of the signal and the bandwidth. To transmit audio, a much wider bandwidth of about 20 kHz is needed. The bandwidth of a television signal is in the order of 5,000,000 Hz or 5 MHz
- Bandwidth, together with noise, is the major factor that determines the information-carrying capacity of a telecommunications channel. The term bandwidth is often used instead of data rate or bit rate to express the capacity of a digital channel. Although they are closely related, they are not the same.

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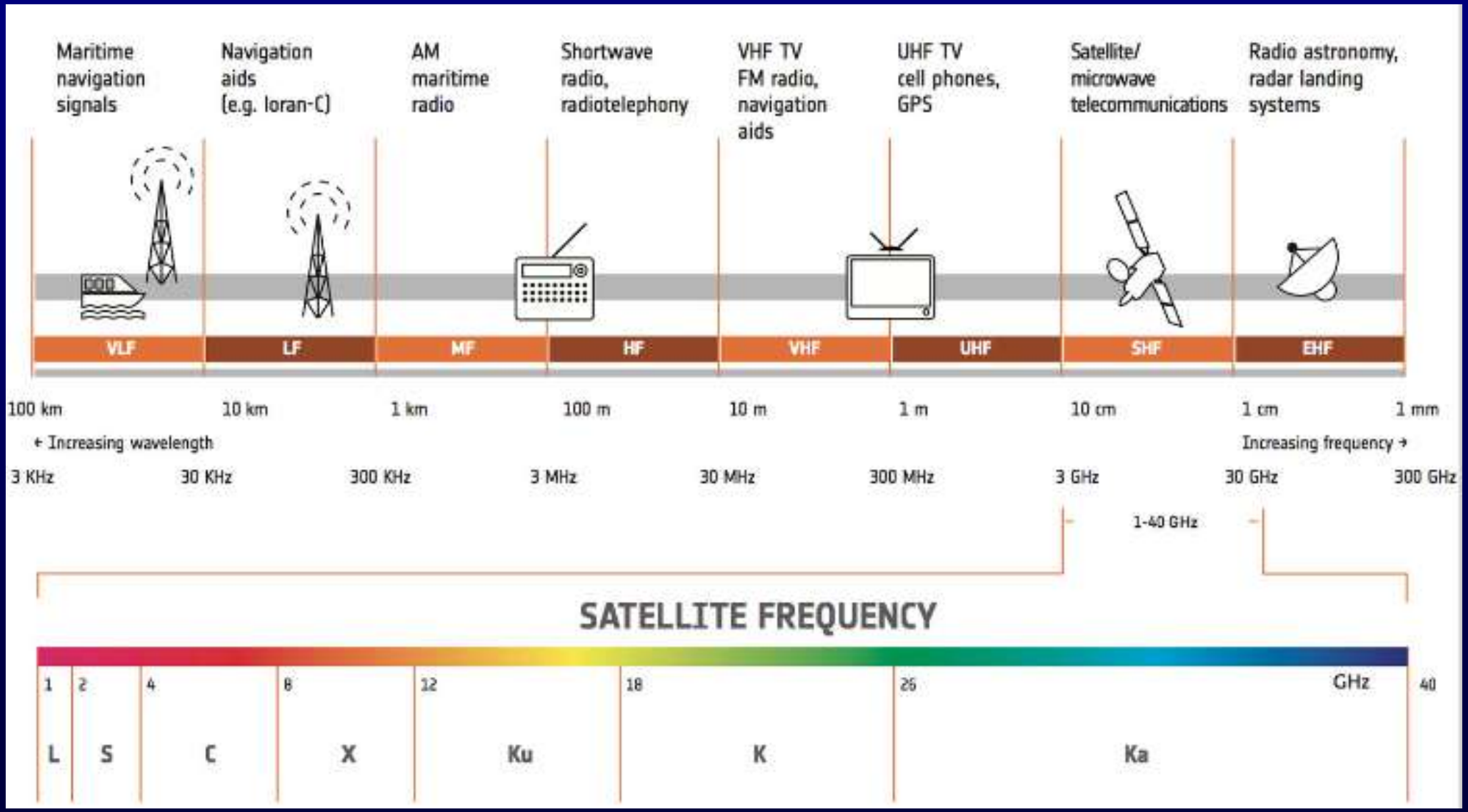
Transmission Speed: Bandwidth



Computer Networks and Internet Services

Fundamentals of Transmission:

- Telecommunication systems use electromagnetic waves to transfer information. Electromagnetic waves can travel through transmission media like copper wires, fiber optics or as radio waves. They can also travel in vacuum. Wireless communication uses electromagnetic waves for transmission of information. The transmission media through which the waves propagate are not perfect. As a result, the waves propagated via the transmission media get attenuated and distorted.
- The information to be transmitted does not always exist in a form that is compatible with the transmission medium. Waves that are compatible with the transmission medium must be generated to carry information. A signal is a wave that is suitable for carrying information over a transmission medium.
- Signals can be electric signals, light signals, electromagnetic signals or radio signals. Electric signals are used to carry information through copper wires, light signals for fiber optic cables, and radio signals for carrying information in free space. Electrical signals have limited bandwidth and cannot be used in long distance communication. They need to be amplified or regenerated. Light signals have a high bandwidth and are suited for long distance communication.

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Analog and Digital Signals:

- Information carrying signals are of two types :

  (a) analog signal, and (b) digital signal

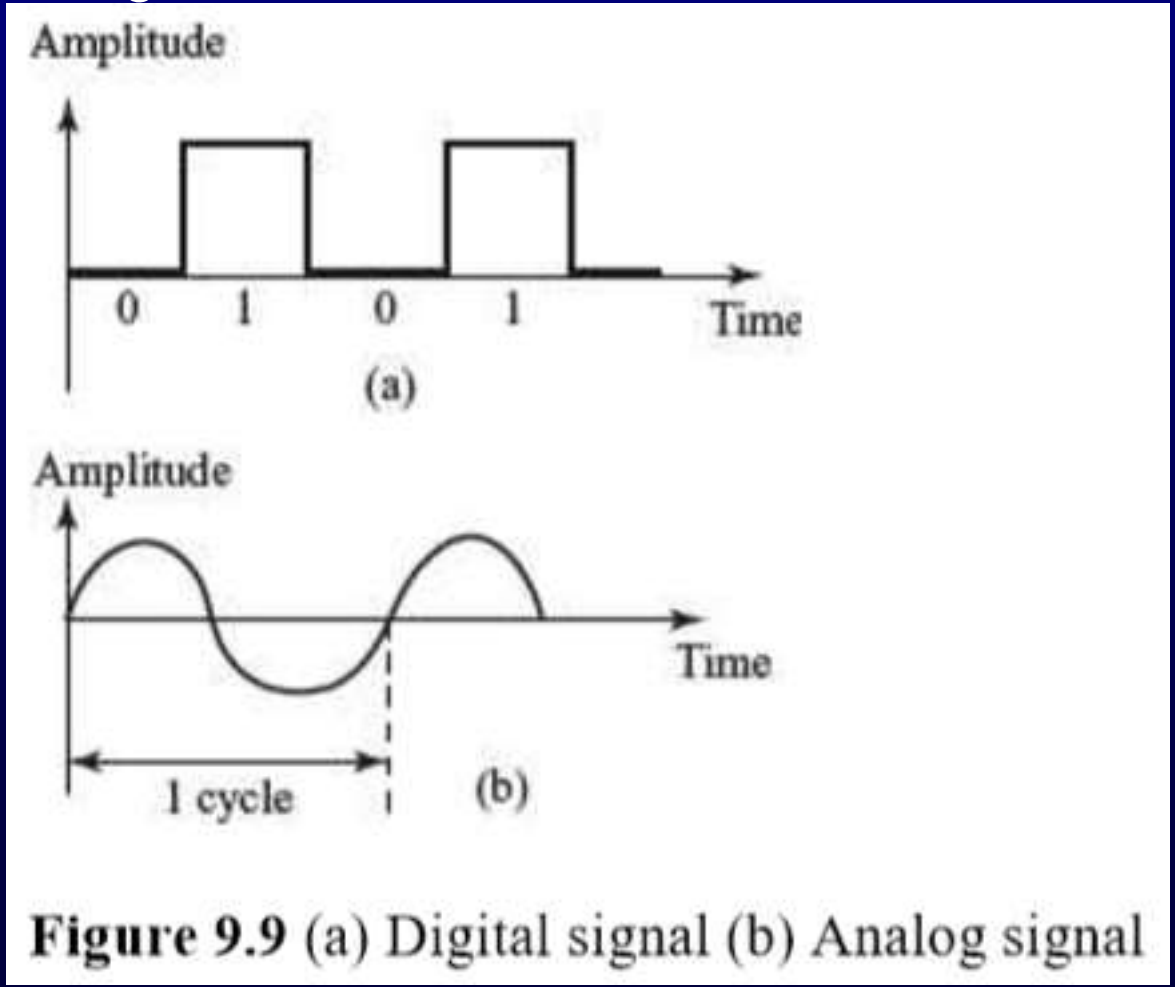

Figure 9.9 (a) Digital signal (b) Analog signal

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Analog and Digital Signals:

- Analog Signal: An analog signal is a wave that continuously changes its information carrying properties over time. The wave may vary in amplitude or frequency in response to changes in sound, light, heat, position, or pressure etc. For example a telephone voice signal is analog. The intensity of the voice causes electric current variations. At the receiving end, the signal is reproduced in the same proportion.
- Digital Signal: A digital signal is a wave that takes limited number of values at discrete intervals of time. Digital signals are non-continuous, they change in individual steps. They consist of pulses or digits with discrete levels or values. The value of each pulse is constant, but there is an abrupt change from one digit to the next. Digital signals have two amplitude levels called nodes. The value of which are specified as one of two possibilities such as 1 or 0, HIGH or LOW, TRUE or FALSE, and so on.
- Analog and digital signals are compared on the basis of—(1) impact of noise, (2) loss of information, and (3) introduction of error.

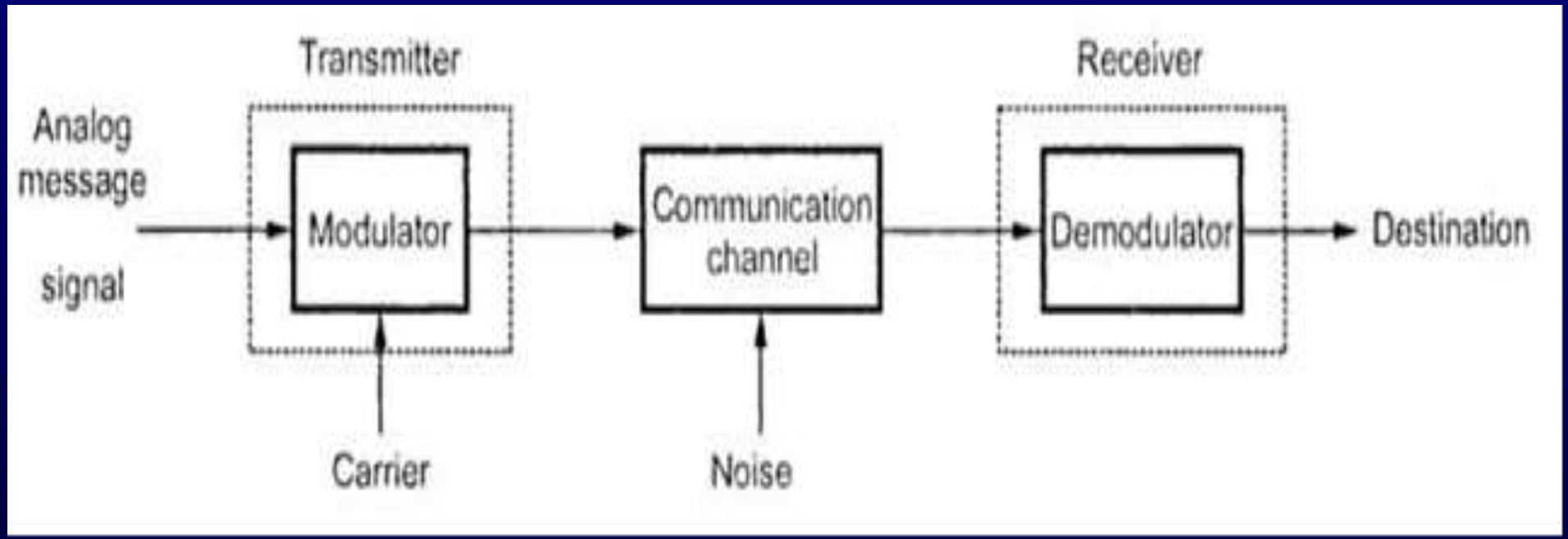
Computer Networks and Internet Services

Analog and Digital Signals:

- Analog signal has the potential for an infinite amount of signal resolution with A/D converter. Another advantage with analog signals is that they can be processed more easily than their digital equivalent. The primary disadvantage of the analog signals is the noise. The effects of noise create signal loss and distortion, which is impossible to recover, since amplifying the signal to recover attenuated parts of the signal, also amplifies the noise. Even if the resolution of an analog signal is higher than a comparable digital signal, the difference can be overshadowed by the noise in the signal. In digital systems, degradation can not only be detected, but corrected as well.
- Amplifier is any device or a circuit that changes, usually increases, the amplitude of an analog signal.
- Repeater is an electronic device that receives a signal and retransmits it at a higher level and/or higher power, so that the signal can cover longer distances. With physical media like Ethernet or Wi-Fi, data transmissions can only span a limited distance before the quality of the signal degrades. Repeaters attempt to preserve signal integrity and extend the distance over which data can safely travel. Actual network devices that serve as repeaters usually have some other name. Active hubs, for example, are repeaters. Active hubs are sometimes also called “multiport repeaters,” but more commonly they are just “hubs.”

Computer Networks and Internet Services

Basic Analog communication system block diagram



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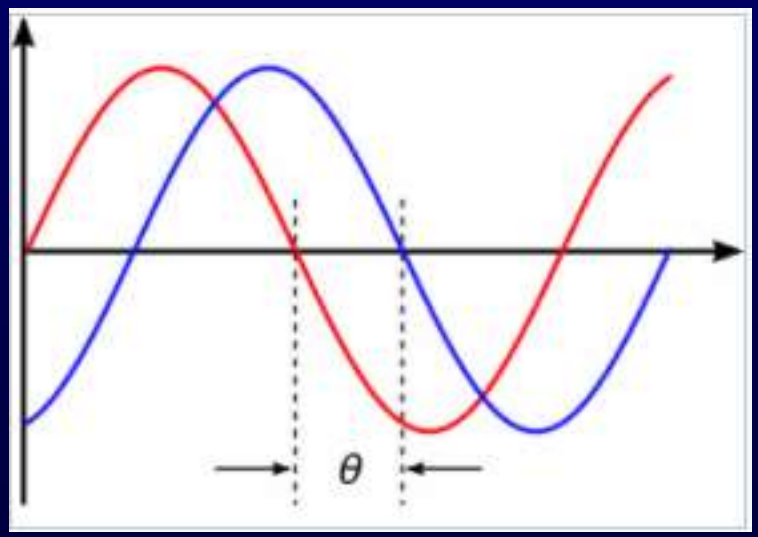
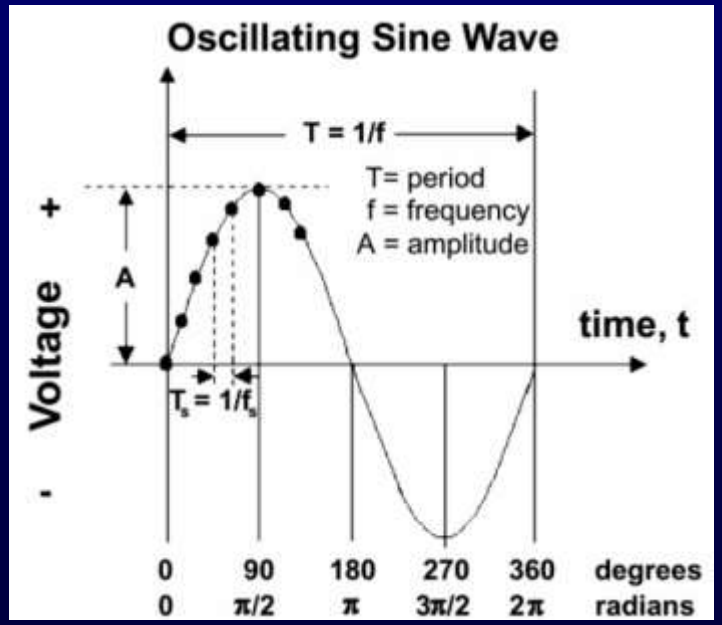
Analog Signal Characteristics

- Amplitude, Frequency and Phase





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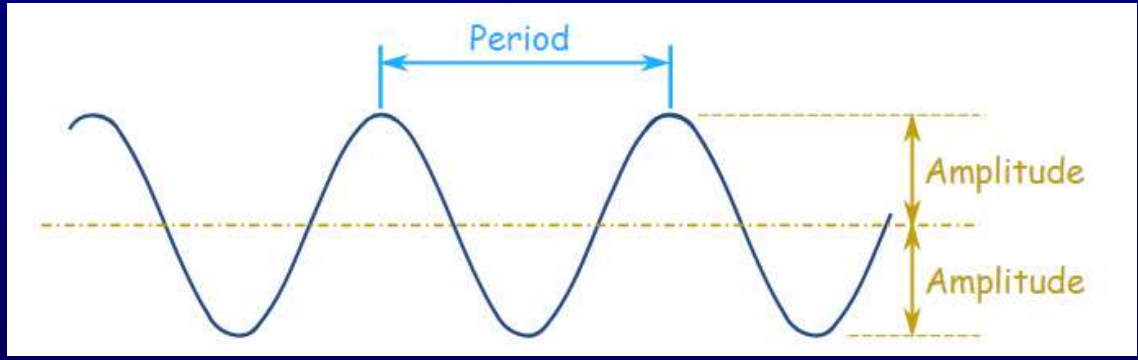
Period:

Some functions (like Sine wave) repeat forever and are called Periodic Functions.



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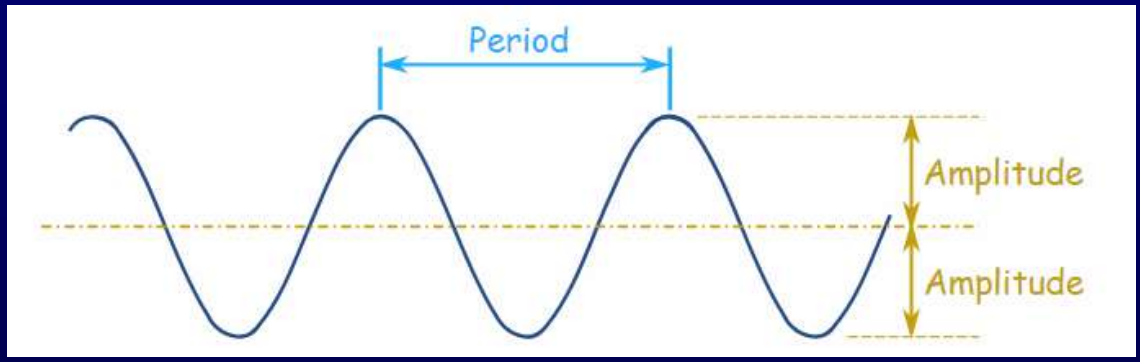
Amplitude:

The Amplitude is the height from the center line to the peak Or we can measure the height from highest to lowest points and divide that by 2.



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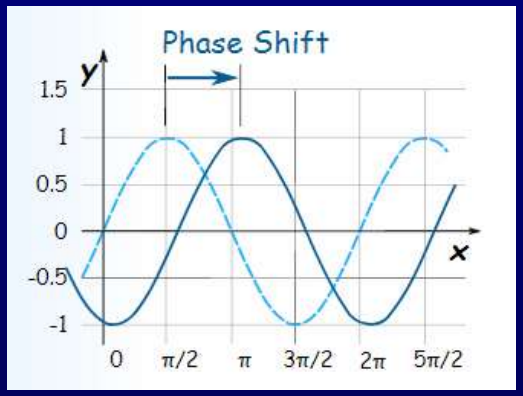
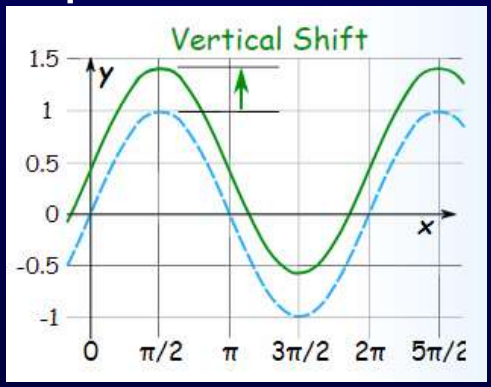
Phase:

The Phase Shift is how far the function is horizontally to the right of the usual position.



The Vertical Shift is how far the function is vertically up from the usual position.



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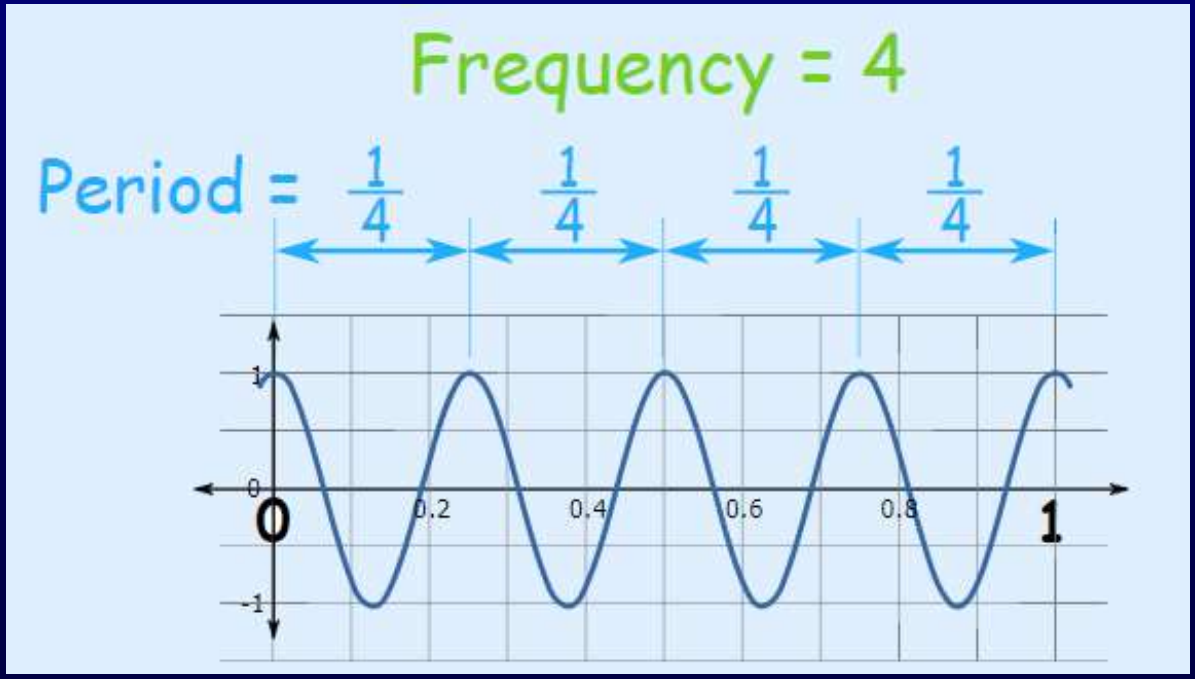
Frequency:

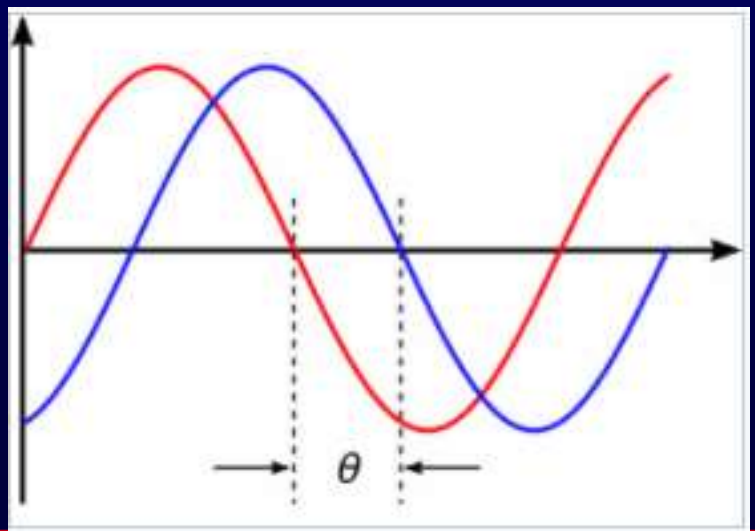
Frequency is how often something happens per unit of time (per "1").

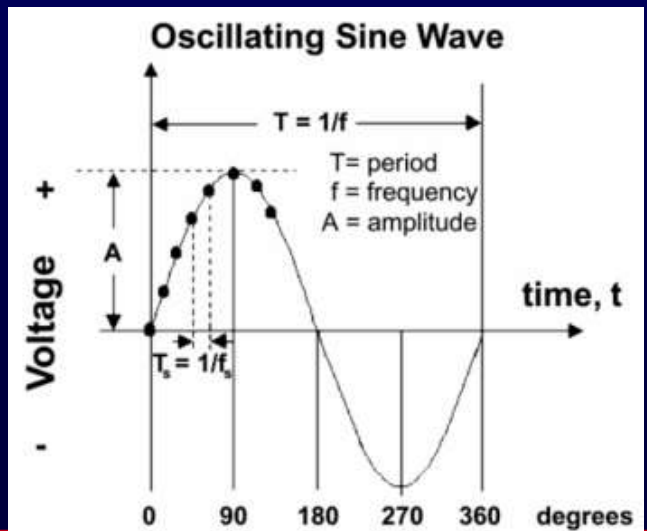


Communication and Computer Network

Modulation and Demodulation

- The process of changing some characteristics (Amplitude, Frequency or Phase) of a carrier wave in accordance with the intensity of the signal is known as modulation. The resultant wave is called the modulated wave or radio wave. For transmission purposes, a high frequency carrier wave is used to carry the audio signals.
- The process of segregating the data signal and the carrier signal from the modulated carrier wave is called demodulation. At the receiving end, the carrier wave is discarded after the data signal has been reconstructed.





Communication and Computer Network

Types of Modulation

There are 3 types of analog modulation

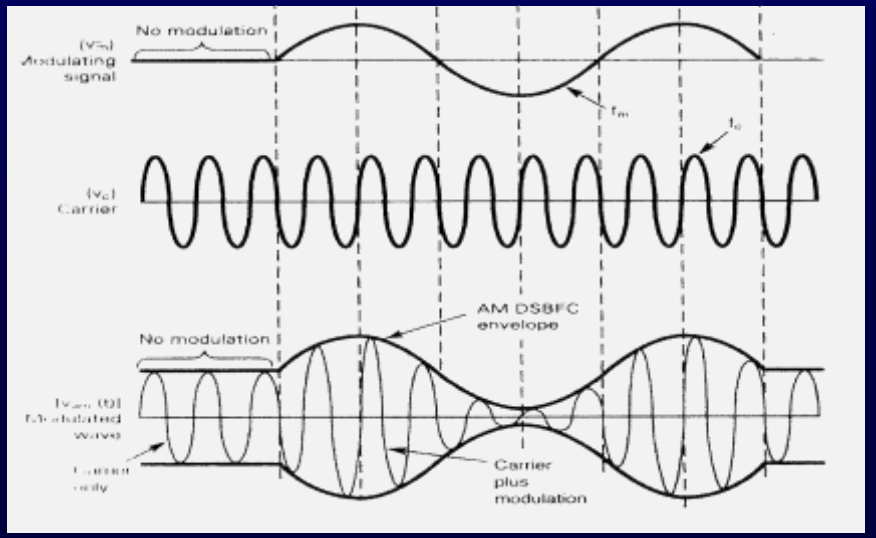
1. **Amplitude Modulation (AM)**
2. **Frequency Modulation (FM)**
3. **Phase Modulation (PM)**

Communication and Computer Network

Types of Modulation

There are 3 types of analog modulation

1. **Amplitude Modulation (AM):** When the amplitude of the high frequency carrier wave is changed in accordance with the intensity of the signal, it is called amplitude modulation. In amplitude modulation only the amplitude of the carrier wave is changed while the frequency of the modulated wave remains the same.

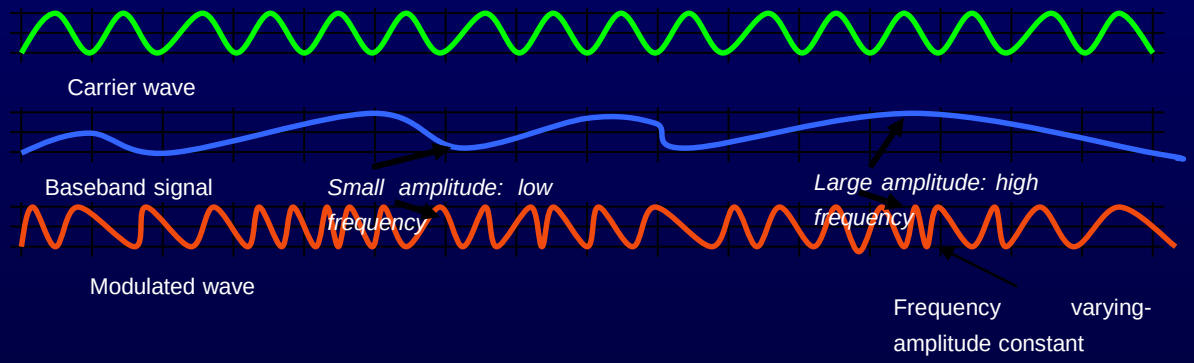


Communication and Computer Network

Types of Modulation

There are 3 types of analog modulation

2. **Frequency Modulation (FM):** When the frequency of the carrier wave is changed in accordance with the intensity of the signal it is called frequency modulation. In FM, only the frequency of the carrier is changed while the amplitude of the modulated wave remains the same.

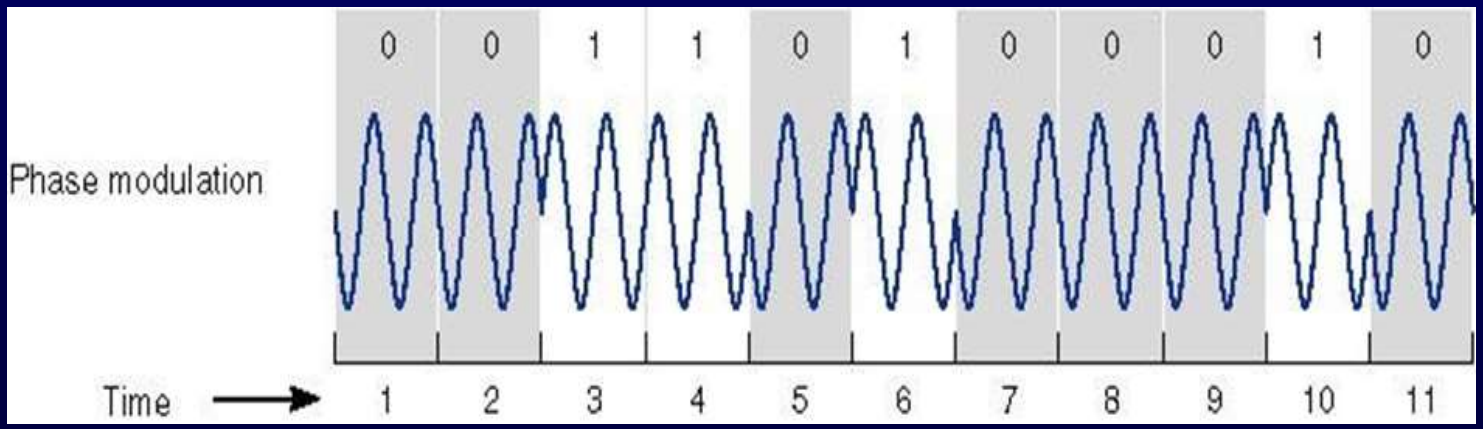


Communication and Computer Network

Types of Modulation

There are 3 types of analog modulation

3. **Phase Modulation (PM):** Phase modulation is a change in the carrier phase angle, which can not change without affecting a change in frequency. Therefore PM is in a second form of frequnecy modulation (FM).



Communication and Computer Network

Types of Modulations

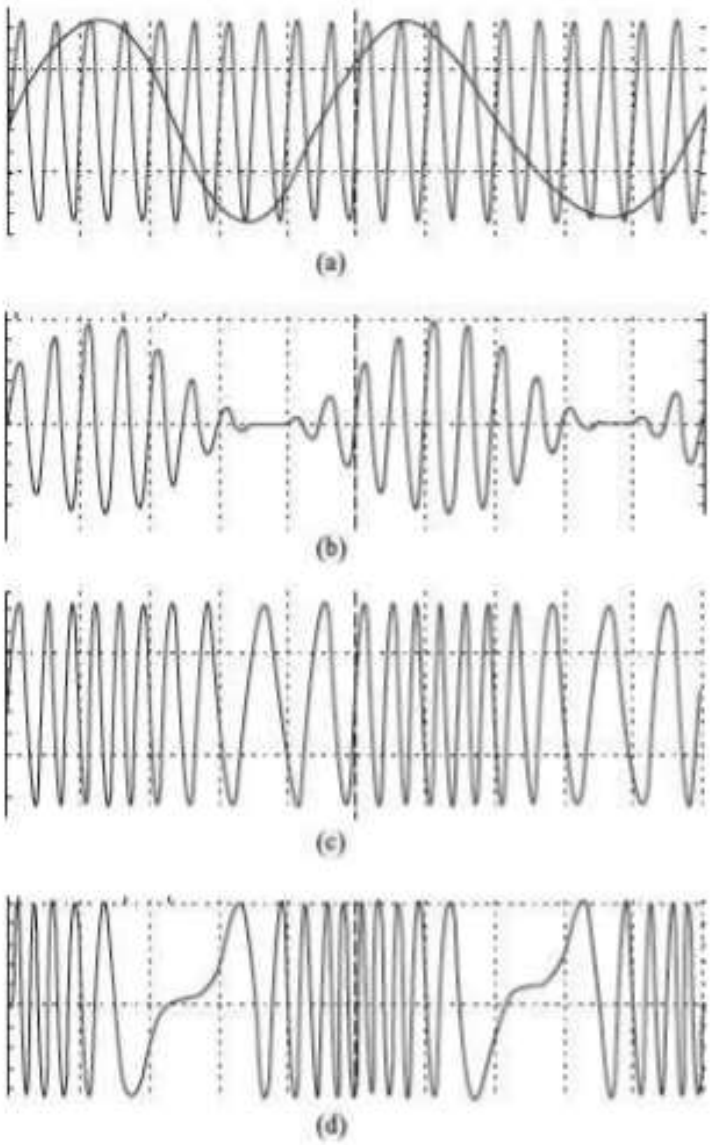


Figure 9.10 (a) Carrier wave with signal (b) Amplitude modulation (c) Frequency modulation (d) Wavelength modulation

Communication and Computer Network

Modems

- Modem is a device that has both a modulator and a demodulator. Modulator accepts data signals from the computer and modulates the carrier wave accordingly. Demodulator accepts modulated carrier wave and regenerates the original data signal from it.
- During data communication, modem is attached to the computer, both at the sender and the receiver side. Modems are used with all transmission media like RF modem for RF transmission and optical modem for transmission through fiber optics.

Communication and Computer Network

Multiplexing:

- Transmission medium have varying data carrying capacities. To utilize the full capacity of the transmission medium, computer networks use separate channels that allow sharing of a single physical connection for multiple communication. Multiple carrier signals are transmitted over the same medium at the same time and without interference from each other.
- The combining of multiple signals into a form that can be transmitted over a single link of a communication medium is called multiplexing.
- De-multiplexing is a technique of separating the merged signals and sending them to the corresponding receivers.
- The two basic multiplexing techniques are
  - Frequency Division Multiplexing (FDM) and
  - Wavelength Division Multiplexing (WDM).

Communication and Computer Network

Multiplexing:

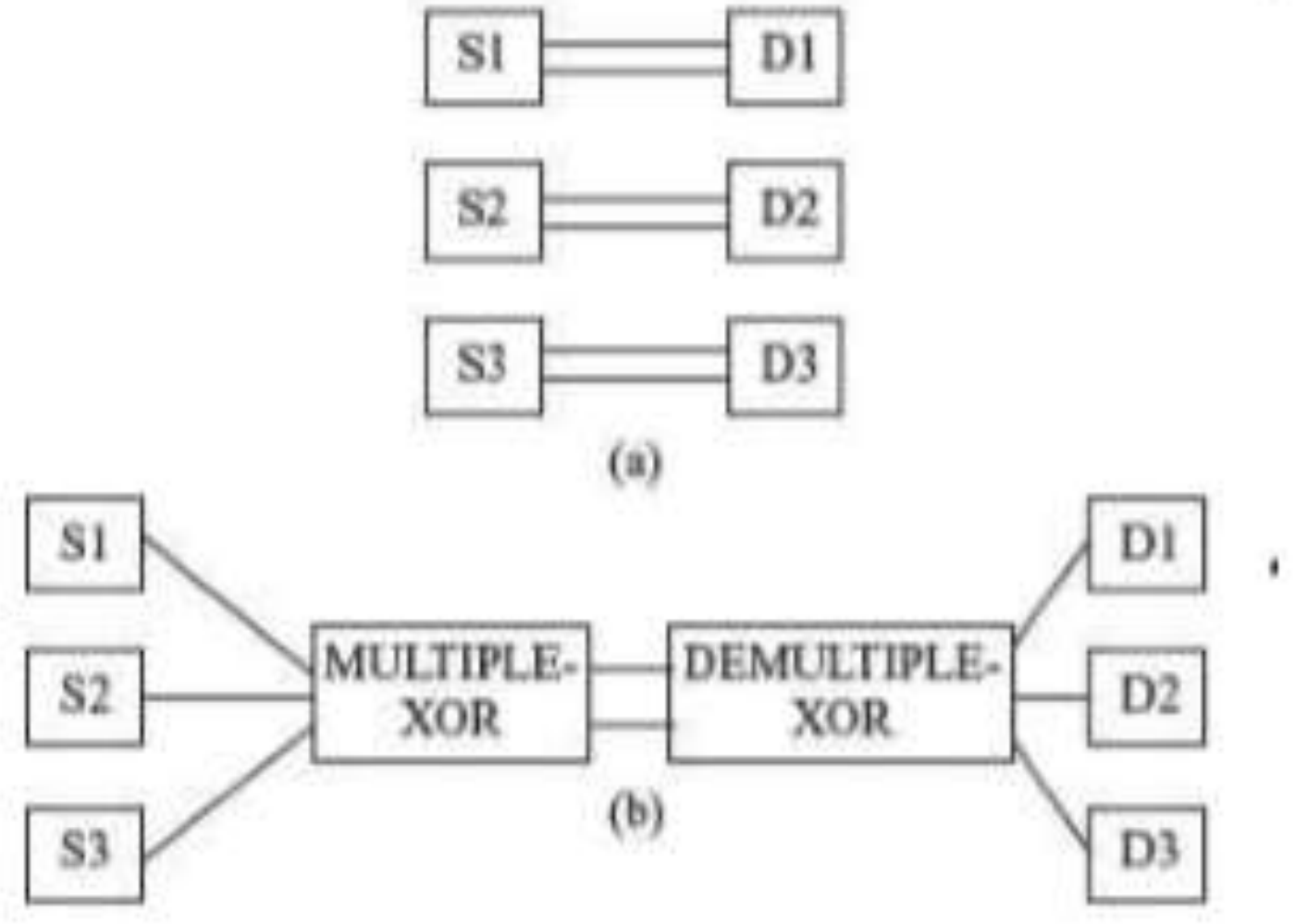
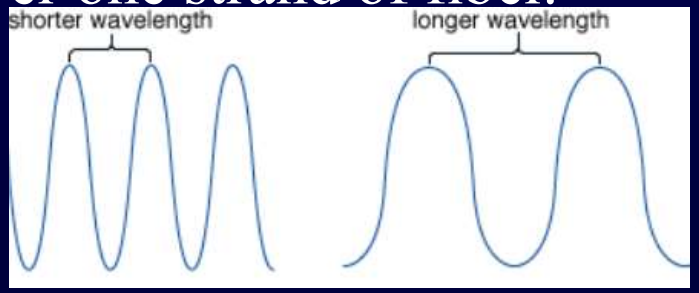


Figure 9.12 (a) No multiplexing (b) Multiplexing

Communication and Computer Network

Multiplexing:

- FDM combines different carrier frequencies signals into a single signal of higher bandwidth. The bandwidth of the communication medium link carrying the combined signal is greater than the sum of the bandwidth of the individual signals that are combined.
- FDM is used for high band - width analog transmission systems like broadband technology.
- WDM is similar to FDM except that FDM involves electromagnetic spectrum below light and WDM involves light signals. WDM uses very high frequencies. WDM combines different light signals coming from different sources into a larger band light signal across a single optical fiber. It also enables bi-directional communications over one strand of fiber.



Communication and Computer Network

Asynchronous and Synchronous Transmission:

- One major difficulty in data transmission is that of synchronizing the receiver with the sender. Whenever an electronic device transmits digital (and sometimes analog) data to another electronic device, there must be a certain rhythm established between the two devices, i.e., the receiving device must have some way of knowing, within the context of the fluctuating signal that it is receiving, where each unit of data begins, and ends. The signal must be synchronized in a way that the receiver can distinguish the bits and bytes as the transmitter intends them to be distinguished.
- Two approaches exist to address the problem of synchronization.
  - synchronous transmission, and
  - asynchronous transmission.

Communication and Computer Network

Asynchronous and Synchronous Transmission:

- Synchronous communication is the characteristic of a communication system in which the sender must coordinate (i.e. synchronize) with the receiver before sending data. The network is designed to move the data at the precise rate, which is not affected by the increase or decrease in network traffic. Voice system network use the synchronous transmission.
- Asynchronous communication is a characteristic of a communication system in which the sender and receiver do not coordinate before the transmission of data. The receiver must be prepared to accept data at any time. The sender can wait when no data is available and send when data is available for sending. Most of the data networks use asynchronous transmission.

Computer Networks and Internet Services

Data transmission across media

- What is a carrier wave?
- Why is modulation needed?
- Explain modulation and demodulation.
- What is the purpose of a modem?
- Name the three kinds of modulation.
- Define multiplexing and demultiplexing.
- What is the difference between the FDM and WDM multiplexing techniques?
- Define synchronous and asynchronous transmission.
- Difference between Broadband vs Baseband technology

Data transmission and data networking

- Name the three kinds of switching techniques.
- Describe briefly the circuit switching and message switching techniques.
- Define a packet.
- Which switching technique is most commonly used in computer networks? Why?
- Explain the working of the packet switching technique.

Communication and Computer Network

Data Transmission and Data Networking:

Two devices(computers) can communicate using two methods

1. Point to Point communication
2. Share communication facility (a network of nodes)

- Two devices directly linked via a communication medium (point to point communication) can send and receive data, to and from each other respectively.
- For long distance communication, instead of point to point connection, a network of nodes is used as a communication medium. The different computers attached to the network share the communication facility.
- The computer network provides a convenient interface that handles sending of multiple bytes of data across the network instead of handling data transmission at physical level.

Communication and Computer Network

Data Transmission and Data Networking:

Two devices(computers) can communicate using two methods

1. Point to Point communication
2. Share communication facility (a network of nodes)

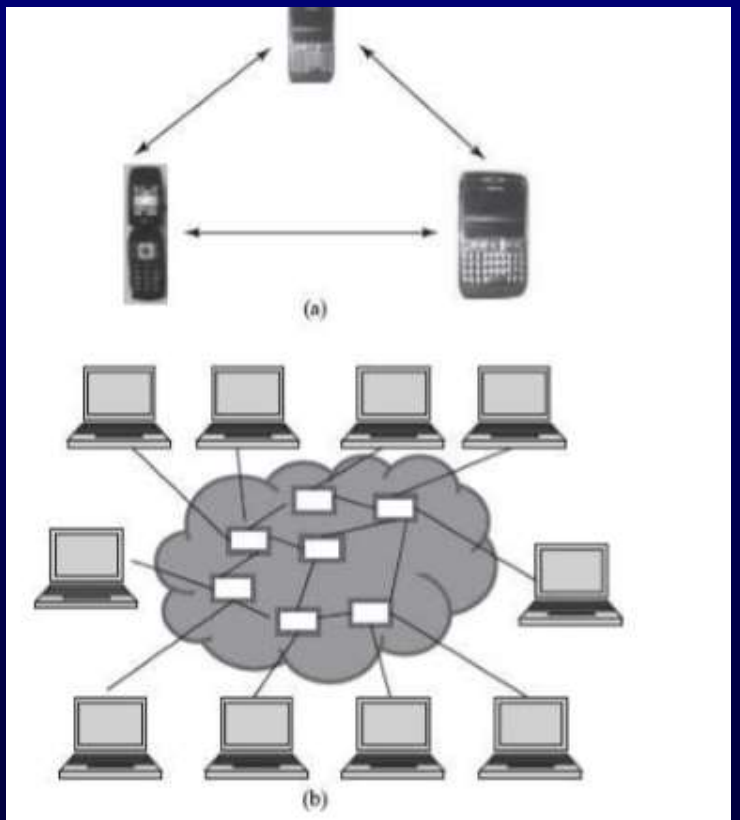


Figure 9.15 (a) Point-to-point communication (b) Switching

Communication and Computer Network

Switching:

- A network cannot allow or deny access to a shared communication facility. All computers attached to the network can use it to send and receive data.
- Networks allow sharing of communication medium using switching.
- Switching routes the traffic (data traffic) on the network. It sets up temporary connections between the network nodes to facilitate sending of data. Switching allows different users, fair access to the shared communication medium.

There are three kinds of switching techniques:

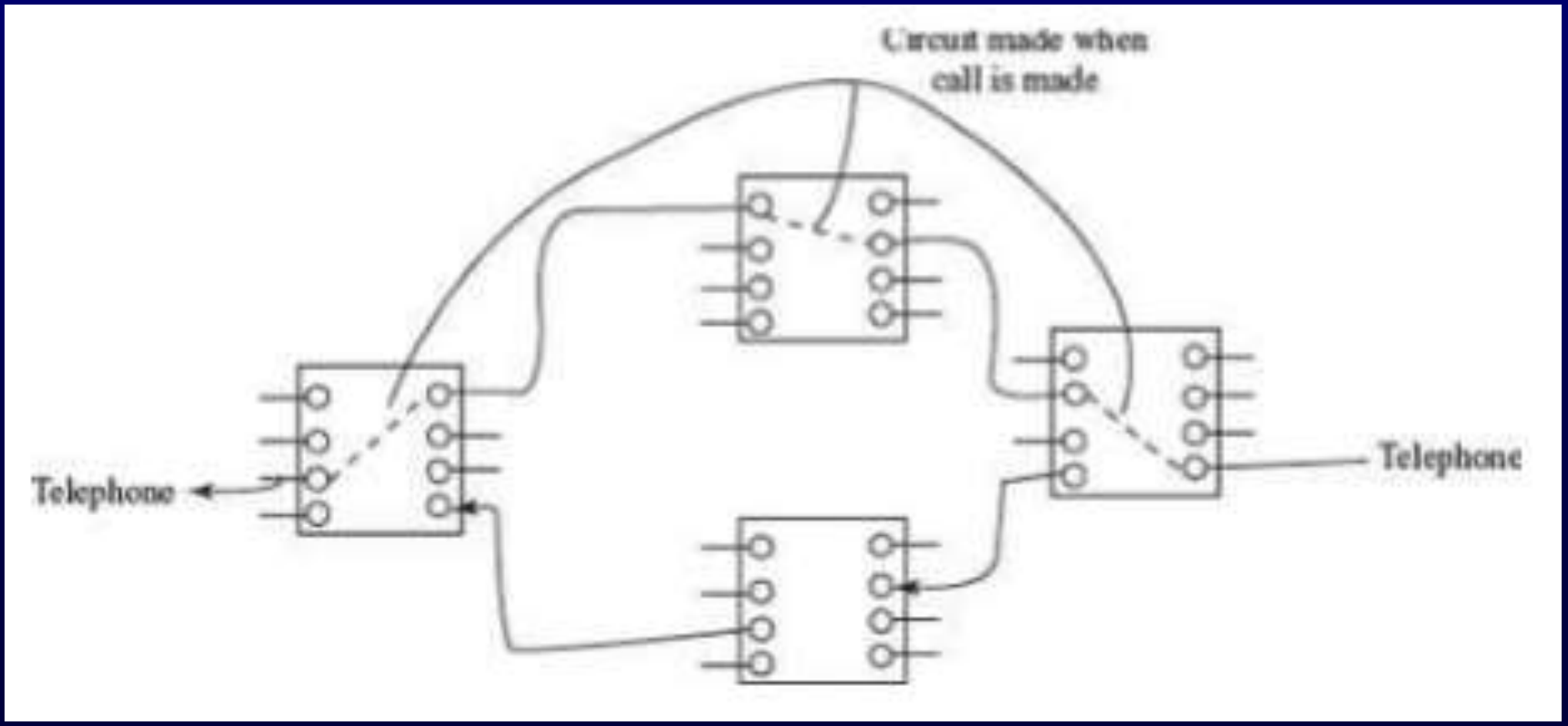
1) Circuit switching
2) Message switching
3) Packet switching

Computer networks generally use packet switching, occasionally use circuit switching but do not use message switching.

Communication and Computer Network

Circuit Switching:

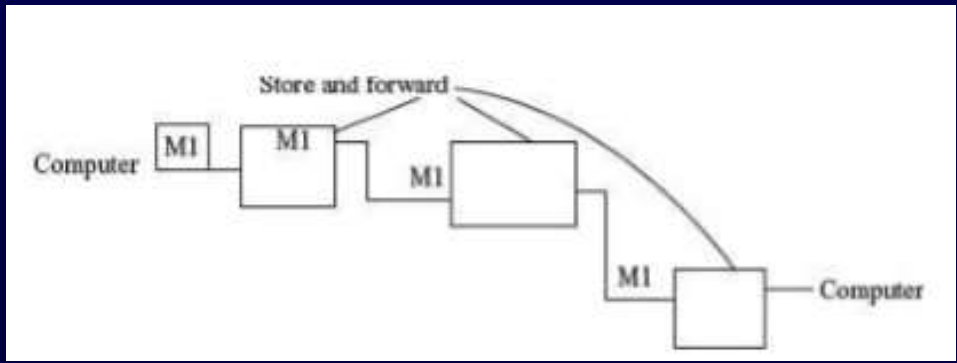
- Circuit switching sets up end-to-end communication path between the source and the destination, before the data can be sent. The path gets reserved during the duration of the connection. Circuit switching is commonly used in the telephone communication network.



Communication and Computer Network

Message Switching:

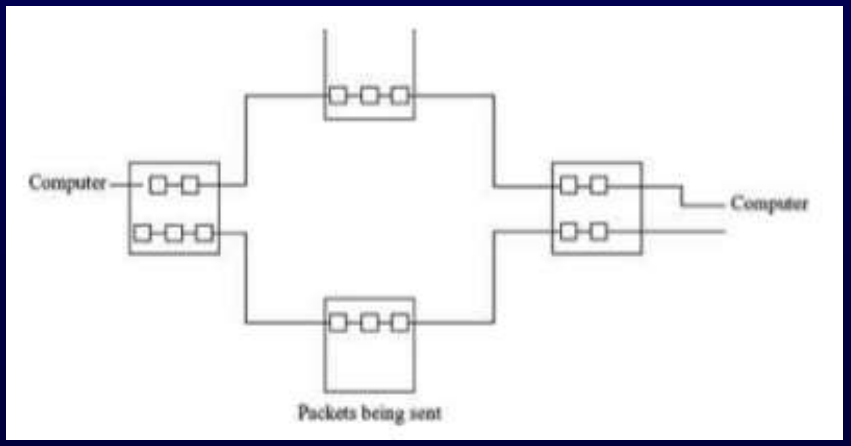
- Message switching does not establish a physical path in advance between the sender and the receiver. It uses the 'store and forward' mechanism.
- In this mechanism, the network nodes have large memory storage. The message is received from the sender and stored in the network node, and when it finds a free route, it forwards the message to the next node till it reaches the destination.
- Message switching requires large data storage capacity and incurs delay in storing and forwarding of message. Message switching may block the network nodes for a long time. They are thus not suitable for interactive communication. Message switching is no more used in computer networks.



Communication and Computer Network

Packet Switching:

- Like message switching, packet switching does not establish a physical path between the sender and the receiver, in advance.
- Packet switching also uses the 'store and forward' mechanism. However, instead of a complete message, packets are sent over the network. Packet switching splits a message into small "packets" of defined size to be sent over the network. Each packet is numbered.
- A packet is a self-contained part of data that can be sent over the network. A packet contains the data to be transmitted and a header that contains information about the packet, like the source and destination addresses, size of packet, error checking bytes etc.



Communication and Computer Network

Packet Switching:

- Since the path through which the packets travel is not reserved, the packets may travel through different paths in the network and may not reach the destination in order. At the destination, the received packets are reassembled (according to the packet number), and the complete message is constructed.
- Packet switching is suited for interactive traffic. Packet switching limits the size of the packet and does not block a network node for a long time. Moreover, a node can transmit a packet before the arrival of another full packet, thus reducing the delay.
- Packet switching does not require dedicated communication link, and shares the underlying resources.
- Packet switching is commonly used for computer networks, including the Internet.

Computer Networks and Internet Services

Q&A session

Data transmission and data networking

- Name the three kinds of switching techniques.
- Describe briefly the circuit switching and message switching techniques.
- Define a packet.
- Which switching technique is most commonly used in computer networks? Why?
- Explain the working of the packet switching technique.

Data Communication and Computer Network

Computer Network:

- A computer network is an interconnection of two or more computers that are able to exchange information.
- The computers may be connected via any data communication link, like copper wires, optical fibers, communication satellites, or radio links.
- The computers connected to the network may be personal computers or large main frames.
- The computers in a network may be located in a room, building, city, country, or anywhere in the world.

Data Communication and Computer Network

Network Types:

- The different network types are distinguished from each other based on the following characteristics:
  1) Size of the network
  2) Transmission Technology
  3) Networking Topology

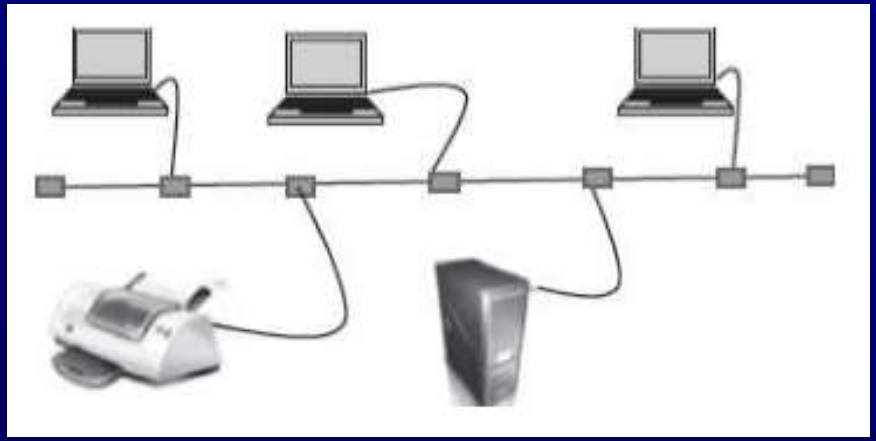
1. The size of the network refers to the area over which the network is spread.
2. Transmission technology refers to the transmission media used to connect computers on the network and the transmission protocols used for connecting.
3. Network topology refers to the arrangement of computers on the network or the shape of the network.

- Computer network based on size is broadly classified into three types
  1) Local Area Network (LAN),
  2) Metropolitan Area Network (MAN), and
  3) Wide Area Network (WAN).

Data Communication and Computer Network

Network Types (Size of the network):

1. Local Area Network:



What is LAN ?

What protocol does it use?

What topology does LAN use ?

Types of LAN ?

Data Communication and Computer Network

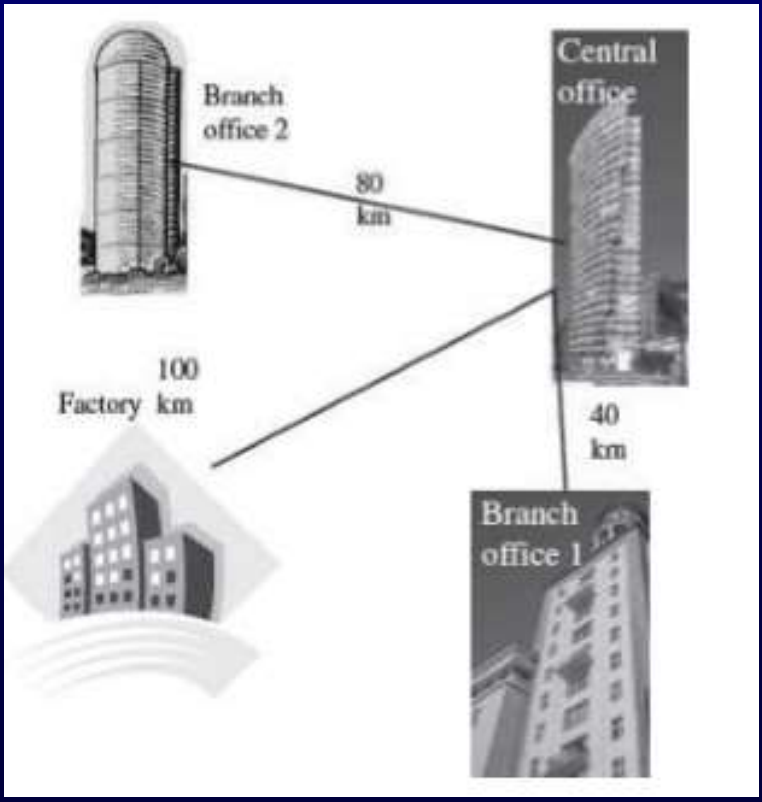
Network Types (Size of the network): 1. Local Area Network:

- LAN is a computer network widely used for local communication. LAN connects computers in a small area like a room, building, office or a campus spread up to a few kilometers. They are privately owned networks, with a purpose to share resources and to exchange information.
- The computers in a LAN are generally connected using cables. LAN is different from other types of network since they share the network. The different computers connected to a LAN take turns to send data packets over the cables connecting them. This requires coordination of the use of the network.
- Some of the transmission protocols used in LAN are Ethernet, Token bus, and FDDI (Fiber Distributed Data Interface) ring.
- Star, Bus, and Ring are some of the common LAN networking topologies. LAN runs at a speed of 10 Mbps to 100 Mbps(?) and has low delays. A LAN based on WiFi wireless network technology is called Wireless Local Area Network (WLAN).

Data Communication and Computer Network

Network Types (Size of the network):2. Metropolitan Area Network

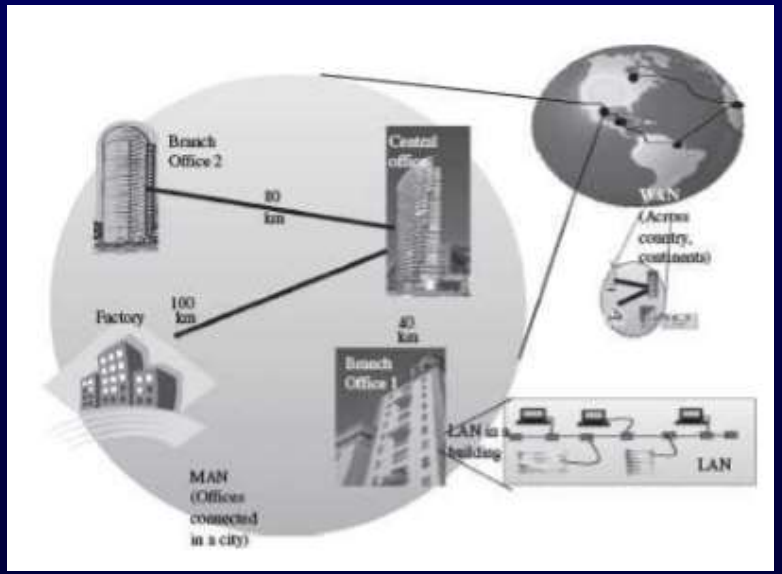
MAN is a computer network spread over a city. Cable television network is an example of MAN. The computers in a MAN are connected using coaxial cables or fiber optic cables. MAN also connects several LAN spread over a city.



Data Communication and Computer Network

Network Types (Size of the network): 2. Wide Area Network

WAN is a network that connects computers over long distances like cities, countries, continents, or worldwide. WAN uses public, leased, or private communication links to spread over long distances. WAN uses telephone lines, satellite link, and radio link to connect. The need to be able to connect any number of computers at any number of sites, results in WAN technologies to be different from the LAN technologies. WAN network must be able to grow itself. Internet is a common example of WAN.



Data Communication and Computer Network

Network Topology:

There are different types of network topologies that are used in a network. The network topologies in the structure or the layout of the different devices and computers connected to the network. The topologies commonly used in LAN are

1) Bus topology,
2) Star topology, and
3) Ring topology.

In some book, Network topologies are classified as

1. BUS
2. RING
3. STAR
4. MESH
5. TREE
6. HYBRID

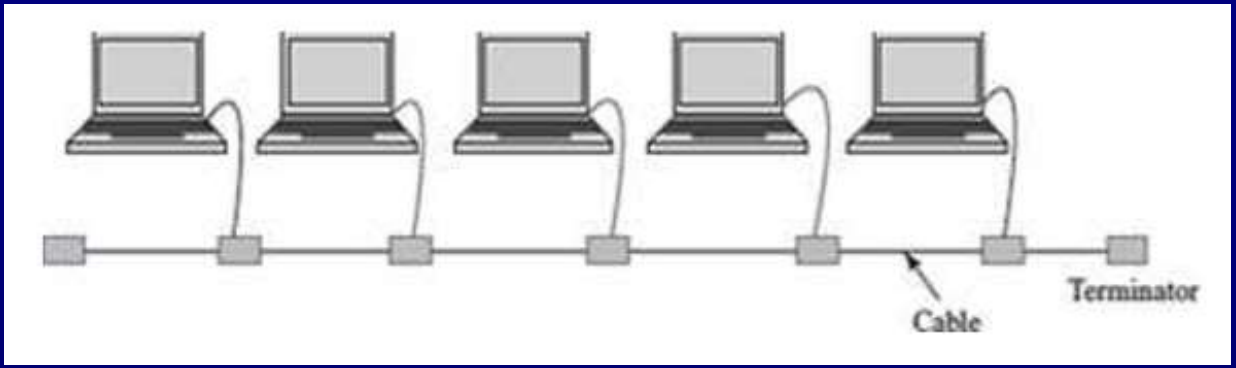
Data Communication and Computer Network

Bus Topology:

- All devices on the network are connected through a central cable called a Bus.
- The data signal is available to all computers connected to the bus .
- The data signal carries the address of the destination computer.
- Each computer on the network checks the destination address as the data signal travels through the bus. The computer whose address matches makes a copy of the signal and converts it into data. The data signal on the bus does not get destroyed and still transmits along the bus, and is finally absorbed by the terminator attached to the end of the network.
- It is good for connecting 15–20 computers.
- A single coaxial cable is generally used in bus topology, to which the computers or devices are connected.
- Ethernet is a commonly used protocol in networks connected by bus topology.

Data Communication and Computer Network

Bus Topology:



Advantages of Bus Topology

- It is cost effective.
- Cable required is least compared to other network topology.
- Used in small network
- It is easy to understand
- Easy to expand joining two cables together.

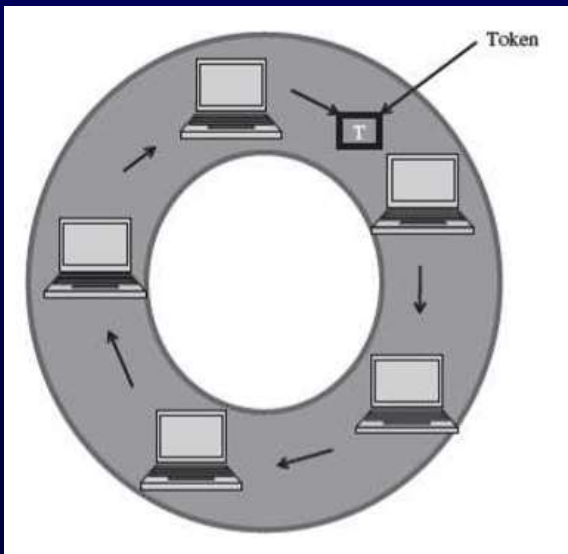
Disadvantages of Bus Topology

- Cable fails then whole network fails
- If network traffic is heavy or nodes are more the performance of the network decreases
- Cable has a limited length
- It is slower than the ring topology

Data Communication and Computer Network

Ring Topology:

- All devices in the network are connected in the form of a ring.
- Each device has a receiver and transmitter to receive the data signals and to send them to the next computer, respectively.
- Ring network does not have terminated ends, thus data signals travel in a circle. Ring topology uses token passing method to provide access to the devices in the network.
- The computers or devices are connected to the ring using twisted pair cables, coaxial cables or optic fibers.
- The protocols used to implement ring topology are Token Ring and Fiber Distributed Data Interface (FDDI).



Data Communication and Computer Network

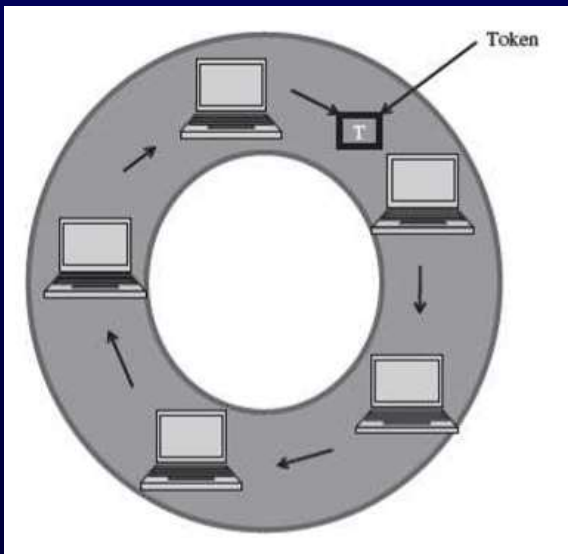
Ring Topology:

Advantages of Ring Topology

- Transmitting networks is not affected by high traffic or by adding more nodes as only the nodes having tokens can transmit data.
- Cheap to install and expand

Disadvantages of Ring Topology

- Trouble shooting is difficult in ring topology
- Adding or deleting the computers disturbs the network activity
- Failure of one computer disturbs the whole network.



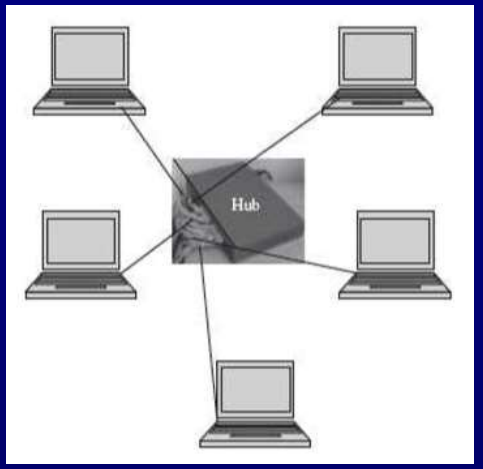
Data Communication and Computer Network

Star Topology:

- All devices are connected through a central link forming a star-like structure.
- The central link is a hub or switch. The computers are connected to the hub or switch using twisted pair cables, coaxial cables or optic fibers.
- Star topology is the most popular topology to connect computer and devices in network.
- The data signal is transmitted from the source computer to the destination computer via the hub or switch.
- The common protocols used in star topology are Ethernet, Token Ring, and LocalTalk.
- In addition to the bus, ring, and star topologies, there are complex topologies like the tree topology, and the mesh topology used for networking in LAN.

Data Communication and Computer Network

Star Topology:



Advantages of Start Topology

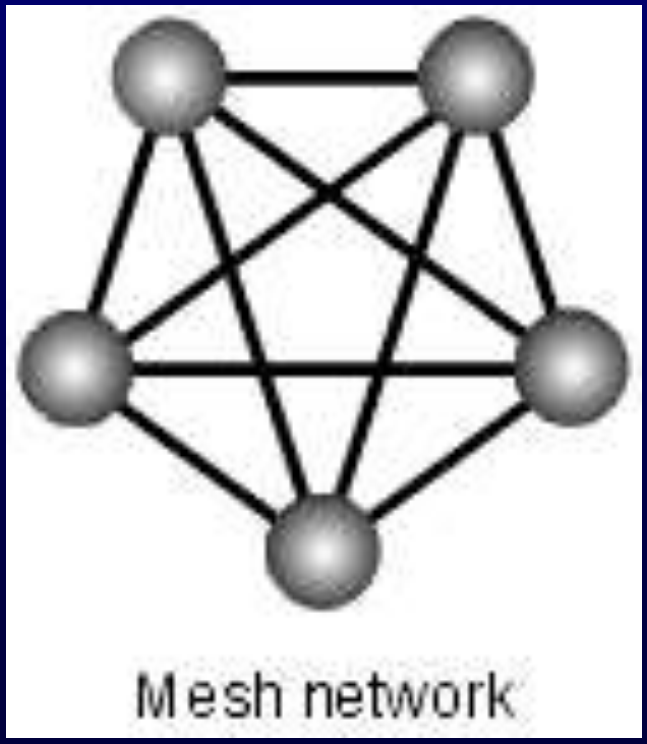
- Fast performance with few nodes and low network traffic
- Hub can be upgraded easily
- Easy to troubleshoot
- Easy to set up and modify
- Only that nodes is affected which has failed and rest of the nodes can work smoothly.

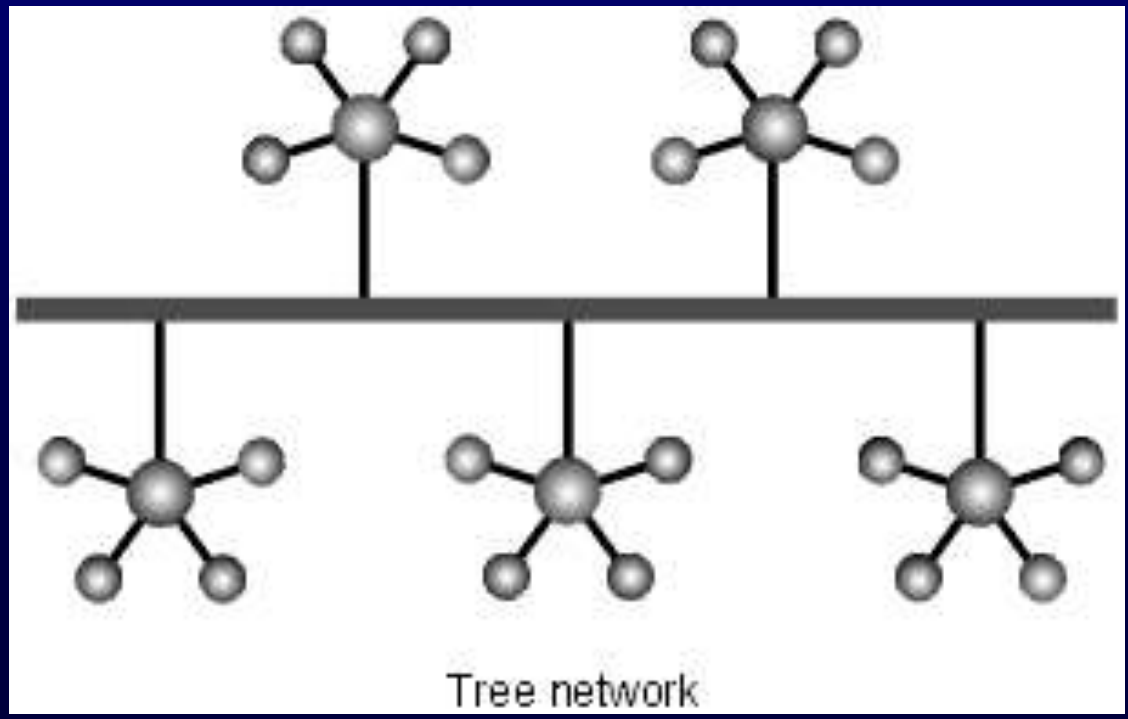
Advantages of Start Topology

- Cost of installation is high
- Expensive to use
- If the hub effected then the whole network is stopped because all the nodes depend on the hub
- Performance is based on the hub that is it depends upon its capacity.

Data Communication and Computer Network

- In addition to the bus, ring, and star topologies, there are complex topologies like the tree topology, and the mesh topology used for networking in LAN.
- Table lists the advantages and disadvantages of the different LAN network topologies.

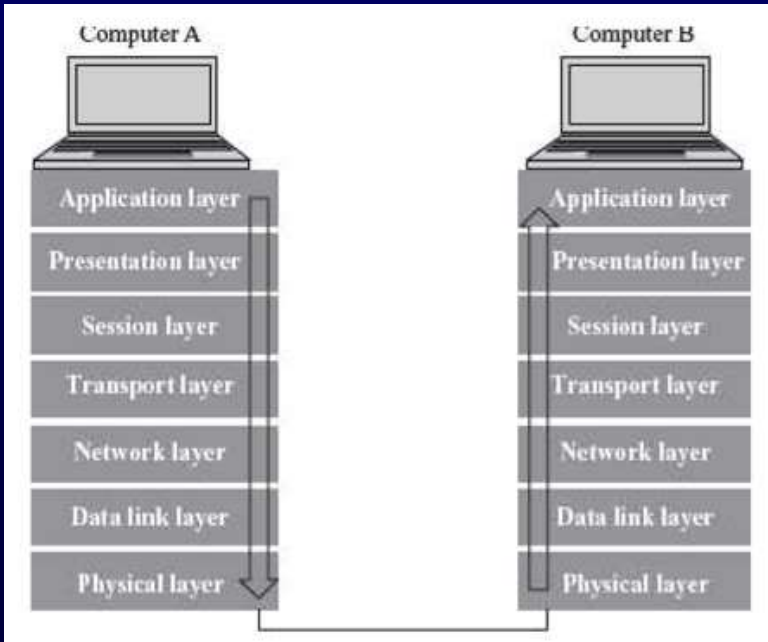




Data Communication and Computer Network

Communication Protocol:

- All computers in the network use the protocol software. The network communication protocol is organized as a stack of layers with one layer built upon the other. Each layer has a specific function and interacts with the layers above and below it. The outgoing data from a computer connected to the network passes down through each layer and the incoming data passes up through each layer. The corresponding layers on the different machines are called **peers**. The peers interact with each other using the protocol.



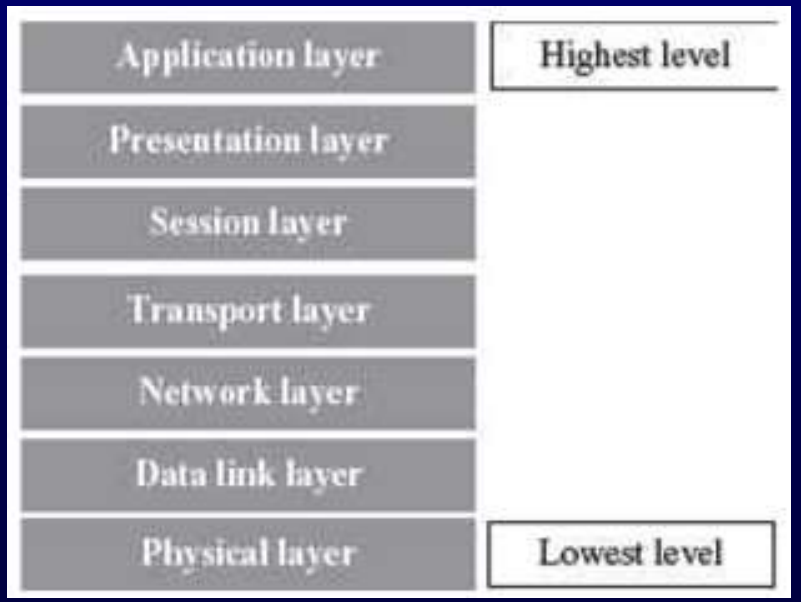
Data Communication and Computer Network

Communication Protocol: OSI Reference Model

The International Standards Organization (ISO) has developed a seven-layer reference model for data networks, known as Open System Interconnection (OSI) model. The OSI model specifies the functions of each layer. It does not specify how the protocol needs to be implemented. It is independent of the underlying architecture of the system and is thus an open system.

The seven layers of the OSI model are

(1) Physical layer,
(2) Data link layer,
(3) Network layer,
(4) Transport layer,
(5) Session layer,
(6) Presentation layer, and
(7) Application layer.



The functions of the different layers are as follows:

Data Communication and Computer Network

Communication Protocol:

- Physical Layer: This layer specifies the basic network hardware. Some of the characteristics defined in the specification are - interface between transmission media and device, encoding of bits, bit rate, error detection parameters, network topology, and the mode of transmission (duplex, half-duplex or simplex).

  Layer 1 is anything that carries 1's and 0's between two nodes.

- Data Link Layer: This layer specifies the functions required for node-to-node transmission without errors. It specifies the organization of data into frames, error detection in frames during transmission, and how to transmit frames over a network.

  Data Link layer is to deliver packets from one NIC to another. Layer 2 uses MAC addresses and is responsible for packet delivery from hop to hop.

- Network Layer: The network layer specifies the assignment of addresses (address structure, length of address etc.) to the packets and forwarding of packets to the destination i.e. routing.

  Layer 3 uses IP addresses and is responsible for packet delivery from end to end.

Data Communication and Computer Network

Communication Protocol:

- Transport Layer: It specifies the details to handle reliable transfer of data. It handles end-to-end error control and flow control, breaking up data into frames and reassembling the frames.

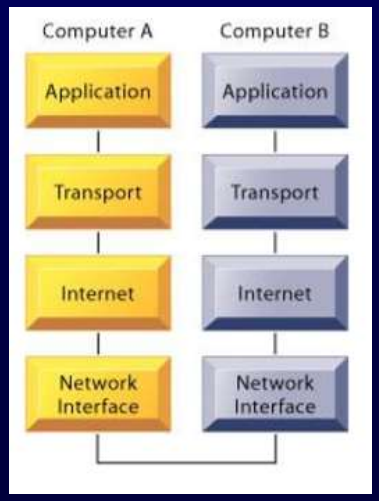
  Layer 4 is responsible for service to service delivery

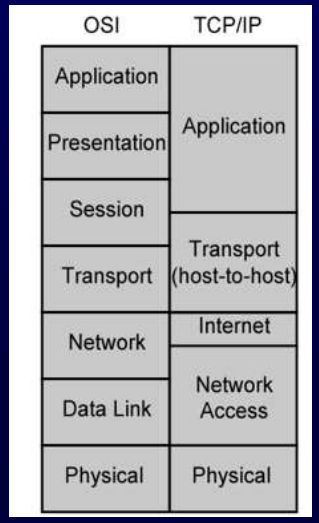
- Session Layer: The session layer maintains a session between the communicating devices. It includes specifications for password and authentication, and maintaining synchronization between the sender and the receiver.
- Presentation Layer: This layer specifies the presentation and representation of data. Its functions include translation of the representation of the data into an identifiable format at the receiver end, encryption, and decryption of data etc.
- Application Layer: This layer specifies how an application uses a network. It deals with the services attached to the data. It contains the protocols used by users like HTTP, protocol for file transfer and electronic mail

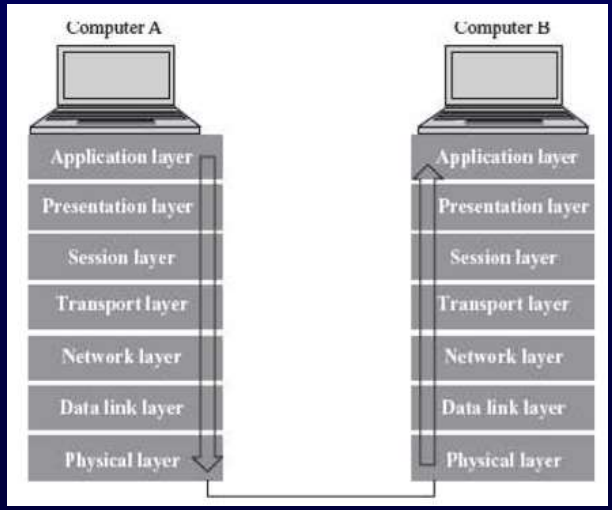
Data Communication and Computer Network

Communication Protocol:

- Each layer at the sender's side transforms the data according to the function it handles. For this it attaches headers to the data. At the receiver's side, the corresponding layer applies the inverse of the transformation that has been applied at the source.
- As an example, if the Data link layer at the sender's side adds an error detection code to the frame, then at the receiver's side, the Data link layer verifies the error detection code and removes it from the frame before passing it to the next higher level, i.e. the Network layer.

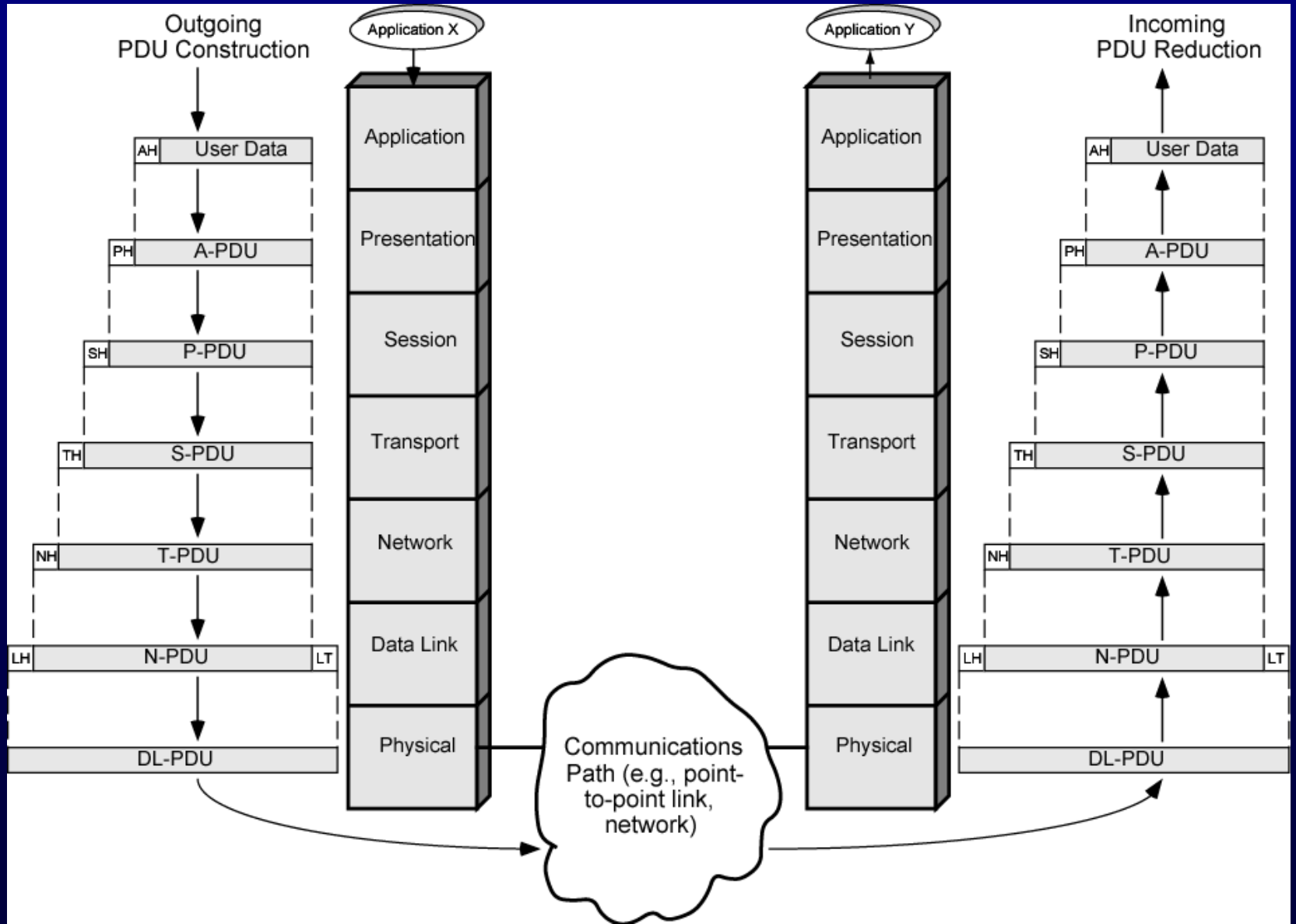






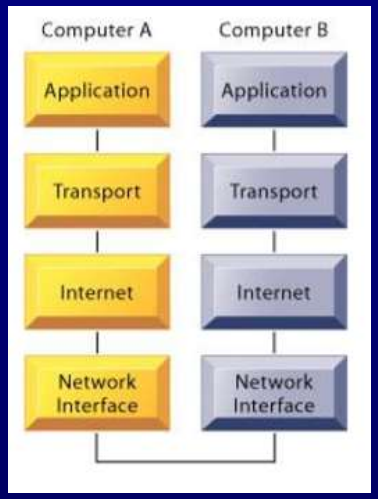
Data Communication and Computer Network

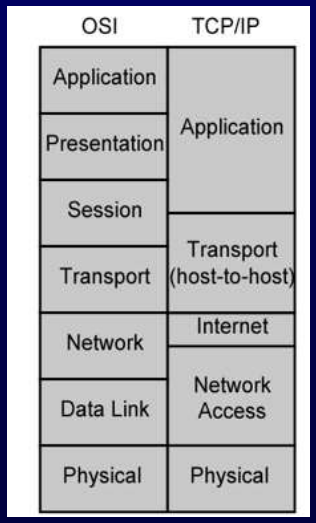
Communication Protocol:

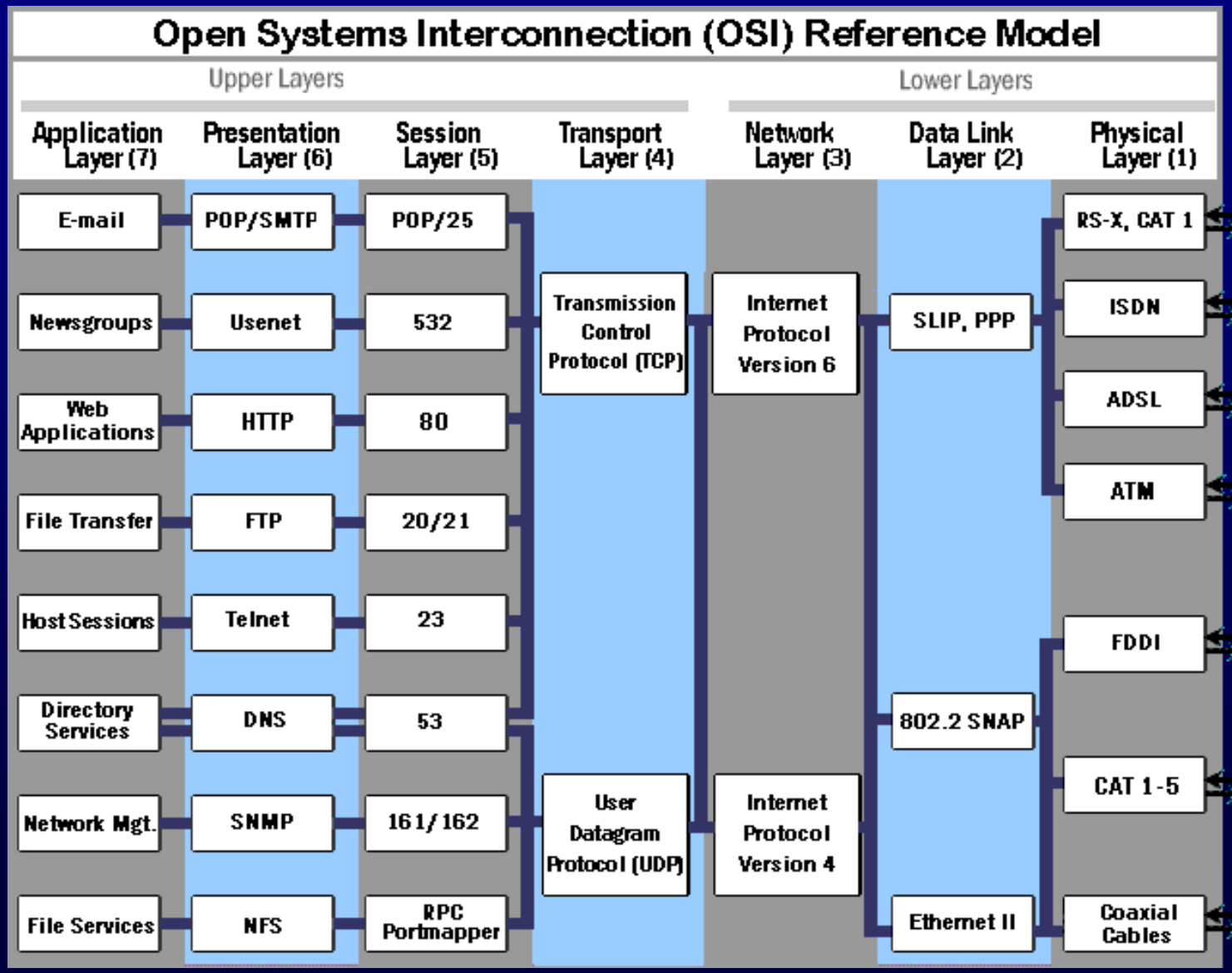


Data Communication and Computer Network

Communication Protocol:







Data Communication and Computer Network

Communication Protocol:

- The 7-layer ISO reference model forms a framework for communication between the devices attached to the network. For different networks, the number of layers and their functions may vary.
- For example, the TCP/IP Internet protocol is organized into five layers.
- The X.25 Wide Area Network protocol (the first public data network) provides connectivity to Public Switched Telephone Network (PSTN) network and has three layers.

Data Communication and Computer Network

Communication Protocol:

- Protocol in a network is a set of rules used by a network for communication.
- Data networks are a combination of software and hardware components. The hardware includes transmission media, devices, and transmission equipments. The software allows the hardware to interact with one another and provide access to the network.
- The application programs that use the network do not interact with the hardware directly. The application programs interact with the protocol software, which follows the rules of the protocol while communicating.

Data Communication and Computer Network

Network Devices:

- The cables are used to transmit data in the form of signals from one computer to another. But cables cannot transmit signals beyond a particular distance.
- There is a need to connect multiple computers and devices.
- A concentrator is a device having two or more ports to which the computers and other devices can be connected.
- A concentrator has two main functions—(1) it amplifies the signal and (2) it provides an interface to connect multiple computers and devices in a network.
- Repeater, hub, switch, bridge, and gateway are examples of network connecting devices.
- Two or more LANs using different protocols may not be able to communicate with the computers attached to their network.
- For example, a LAN connected using Ethernet may not be able to communicate with a LAN connected using Token Ring.
- Bridge, Router, and Gateway are devices used to interconnect LANs.

Data Communication and Computer Network

Network Devices:

1. Network Interface Card
2. Repeater
3. Bridge
4. Hub
5. Switch
6. Router
7. Gateway

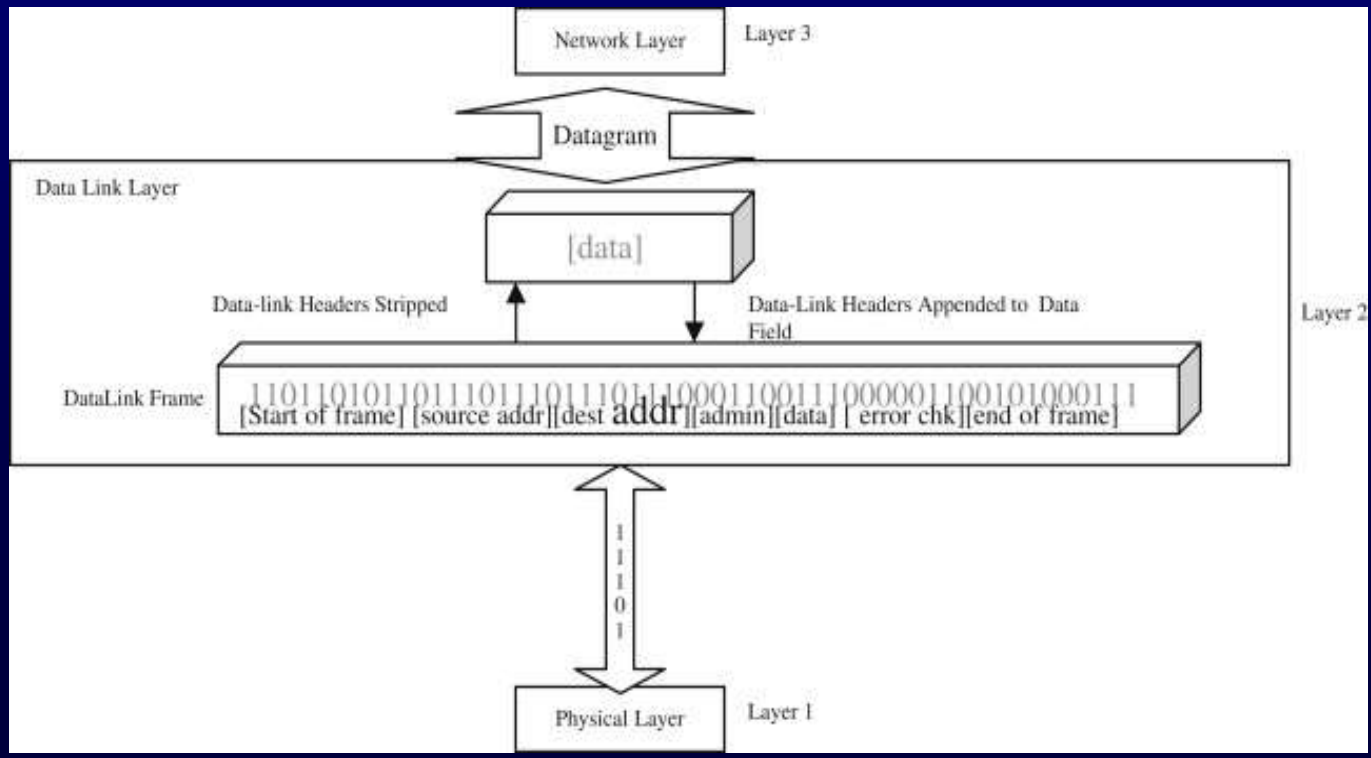
Data Communication and Computer Network

Network Devices: Network Interface Card

- A Network Interface Card (NIC) is a hardware device through which the computer connects to a network.
- NIC is an expansion card or can be on-board integrated on a chipset. NIC has an appropriate connector to connect the cable to it. NIC for different LAN are different (NIC for token ring is different from NIC for Ethernet).
- NIC work at both the data link layer and physical layer of the OSI reference model.
- At the physical layer, it converts the data into signals and transmits it across the communication medium. At the data link layer, NIC converts the data packets into data frames, adds the Media Access address (MAC address) to data frames. The MAC address is a globally unique hardware number present on the NIC and is specified by the NIC manufacturer.
- NIC depends upon the configuration of the computer, unlike hub or switches that perform independently.

Data Communication and Computer Network

Network Devices: Network Interface Card



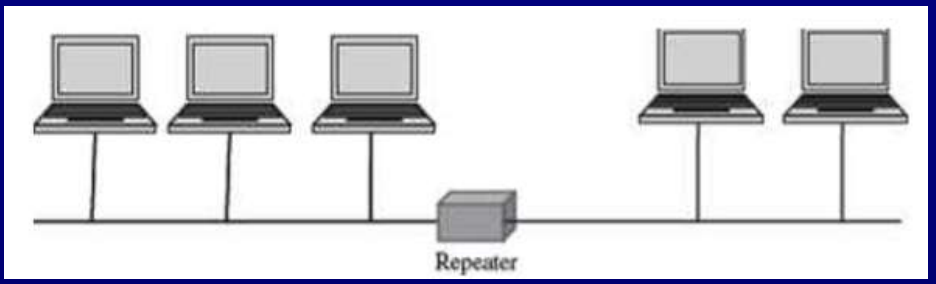
Data Communication and Computer Network

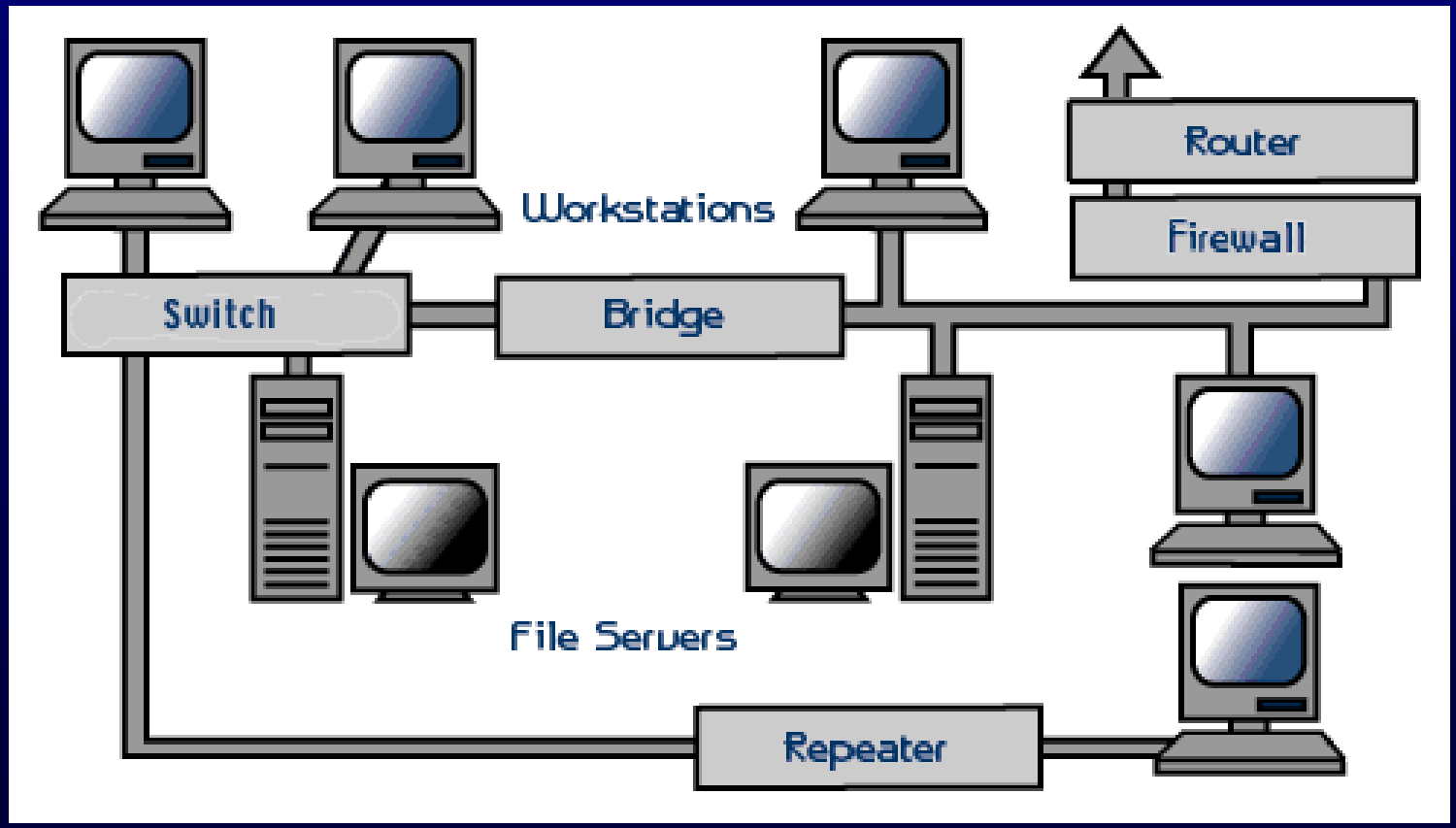
Network Devices: Repeater

- Repeaters are used to extend LAN. It has only two ports and can connect only two segments of a network. Multiple repeaters can be used to connect more segments. (Segment is a logical section of the same network).
- Repeaters operate at the Physical layer of OSI reference model.
- They are useful when computers in a network are located far away from each other.
- Repeaters amplify the signal so that the signal is as strong as the original signal. They can thus extend the reach of a network.
- Repeaters cannot be used if multiple computers need to be interconnected.
- Repeaters cannot identify complete frames. Thus, in addition to the valid transmissions from one segment to another, repeater also propagates any electrical interference occurring on a segment to other segment.

Data Communication and Computer Network

Network Devices: Repeater





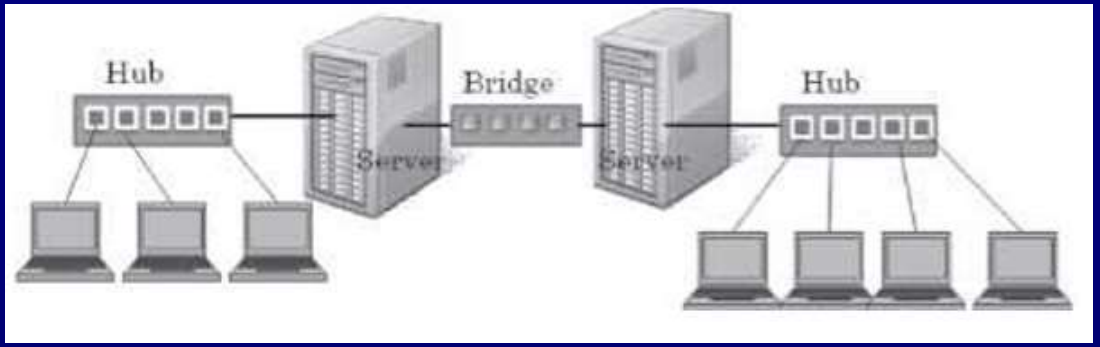
Data Communication and Computer Network

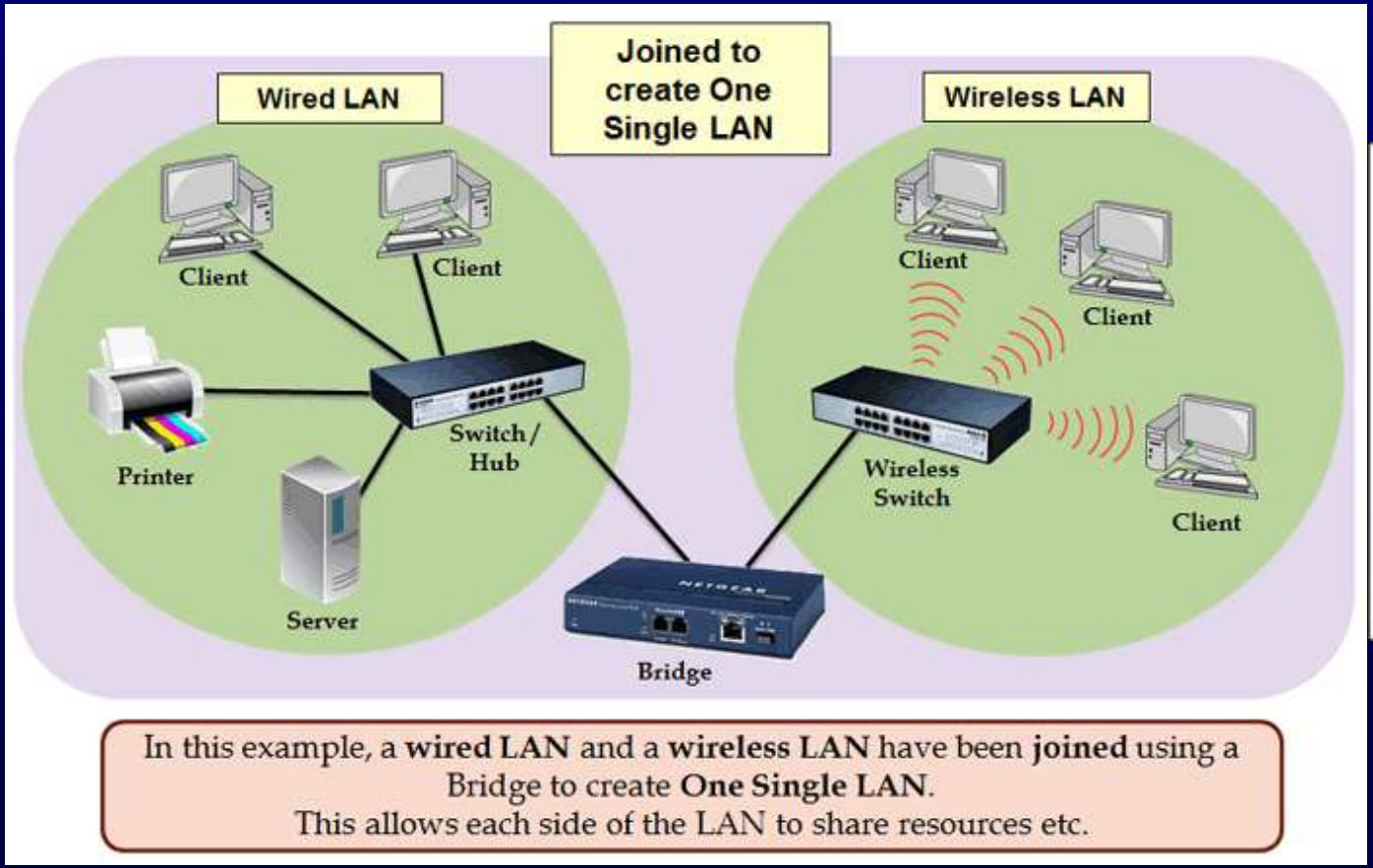
Network Devices: Bridge

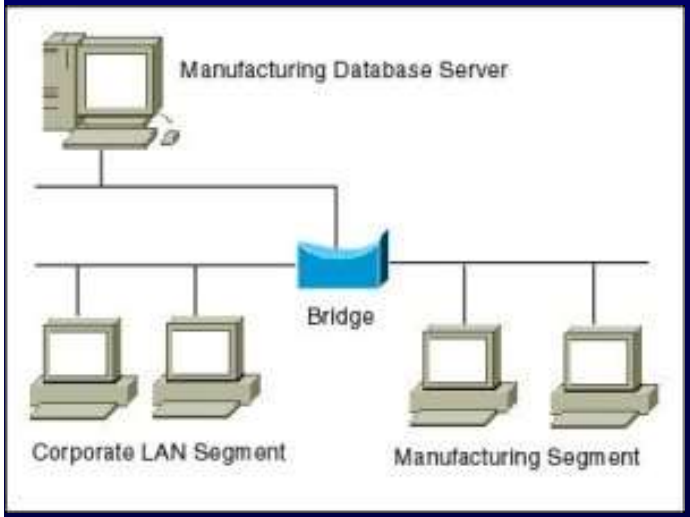
- Bridge is used to connect two LAN segments like a repeater; it forwards complete and correct frames to the other segment. It does not forward any electrical interference signals to the other segment.
- Bridge connects networks that use different protocol at the Data Link Layer. The frame format of data in the two networks is different. The bridge converts the frame format before transmitting data from one network to another, with translation software included in the bridge.
- Bridge forwards a copy of the frame to the other segment, only if necessary. If a frame is meant for a computer on the same segment, then bridge does not forward a copy of the frame to other segment.
- A bridge is also used to divide a network into separate broadcast domains to reduce network traffic while maintaining connectivity between the computers.

Data Communication and Computer Network

Network Devices: Bridge







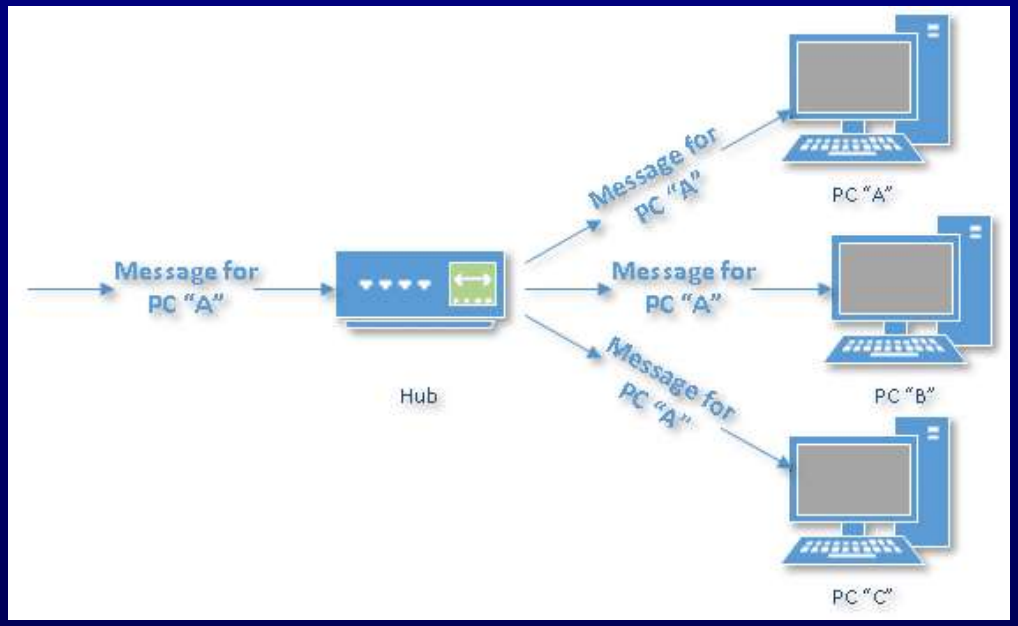
Data Communication and Computer Network

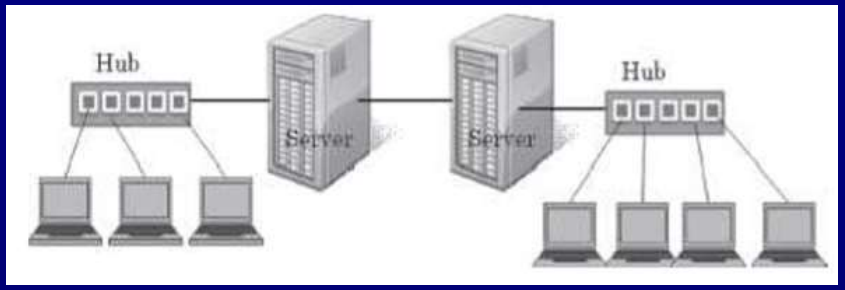
Network Devices: Hub

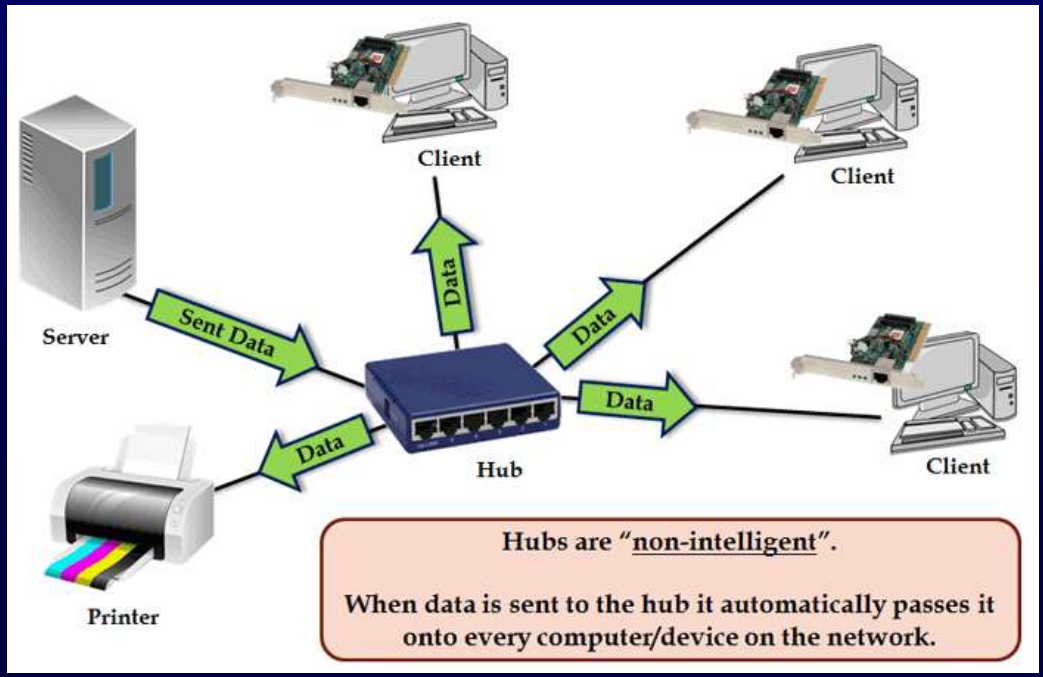
- It is like a repeater with multiple ports. But, hub does not amplify the incoming signal.
- Hub operates at the Physical layer of OSI reference model, hence treats data as a signal.
- Hubs are used to connect multiple segments of the same network.
- Hubs are also used to connect computers to network that use Star topology.
- The port on the hubs can also be used to connect another hub, switch, bridge or router.
- Hubs increase the network traffic because they broadcast data to all the device connected all the ports of the hub.
- It is preferable to use a hub in a small LAN having about 8–10 computers connected to it.

Data Communication and Computer Network

Network Devices: Hub







Data Communication and Computer Network

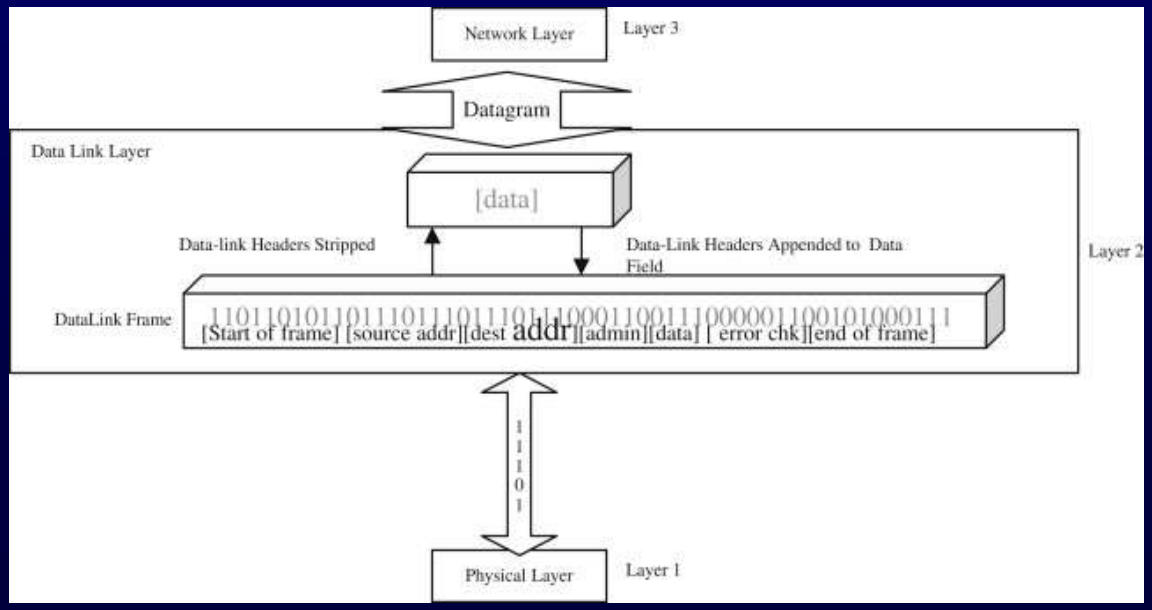
Network Devices: Switch

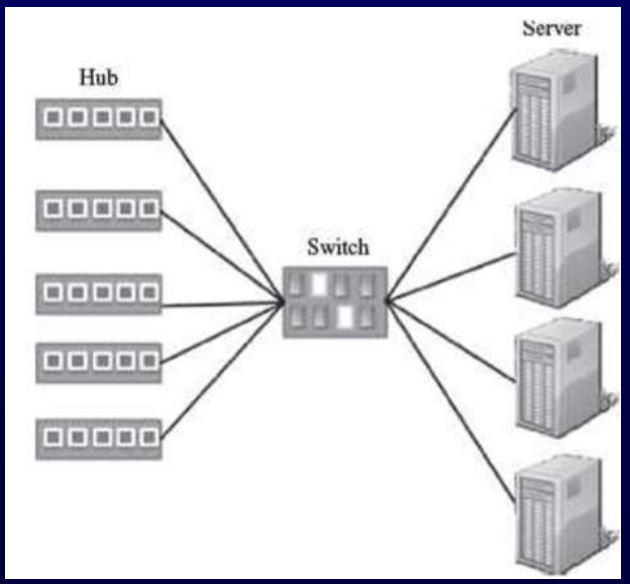
- Like hub, switch also connects multiple computers in a network or different segments of the same network. A hub simulates a single segment that is shared by all computers attached to it (hub transmits the data to all computers attached to it). In a hub, at most two computers can interact with each other at a given point of time. However, in a switch each computer attached to a switch has a simulated LAN segment.
- Switches work at the Data Link Layer of the OSI reference model. Hence, switches consider data as frames and not as signals.
- A data frame contains the MAC address of the destination computer. A switch receives a signal as a data frame from a source computer on a port, checks the MAC address of the frame, forwards the frame to the port connected to the destination computer having the same MAC addresses, reconverts the frame back into signal and sends to the destination computer. (Switching is a technique that reads the MAC address of the data frame and forwards the data to the appropriate port). Switches, thus, regenerate the signals.

Data Communication and Computer Network

Network Devices: Switch

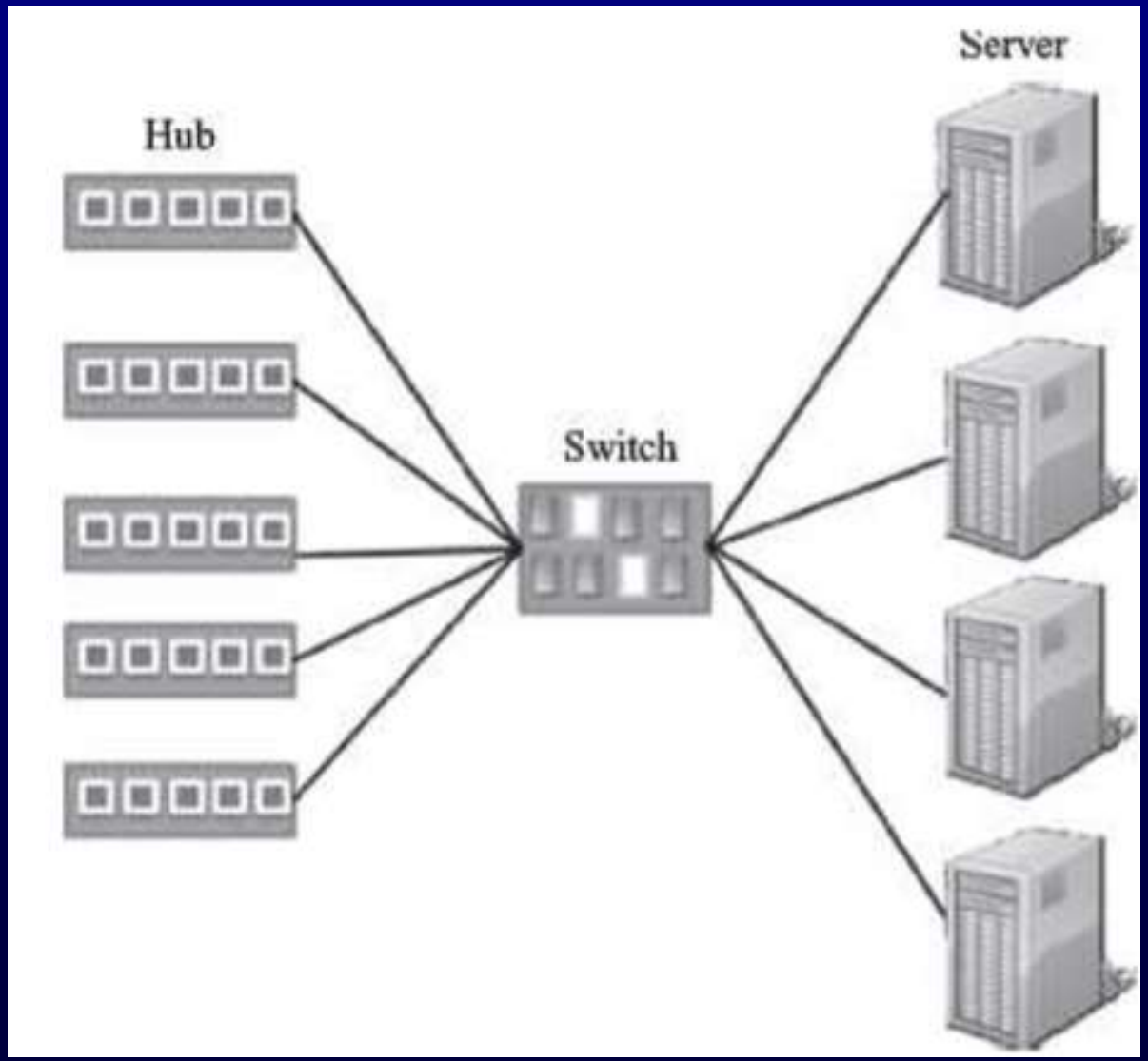
- Since a switch does not broadcast data, but sends the data from the source computer to the destination computer, a half of the computers attached to the switch can send data at the same time.
- Switch is also referred to as a multi-port bridge. In general, bridges are used to extend the distance of the network, and switches are primarily used for their filtering capabilities to create a multiple and smaller virtual LAN (a LAN segment can be connected to each port of the switch) from a single large LAN.





Data Communication and Computer Network

Network Devices: Switch



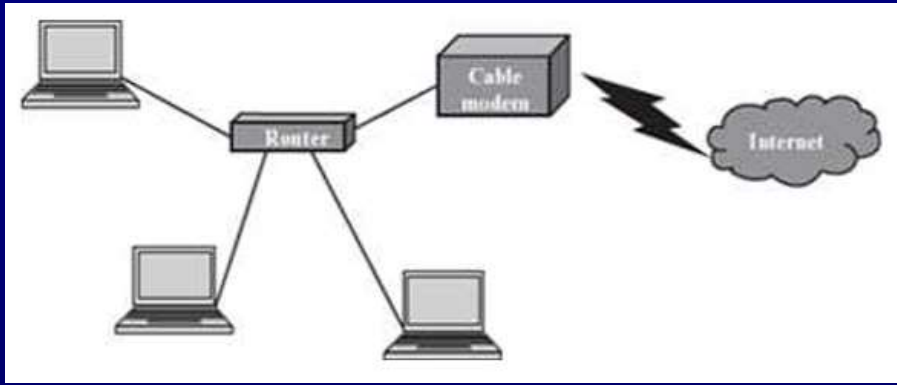
Data Communication and Computer Network

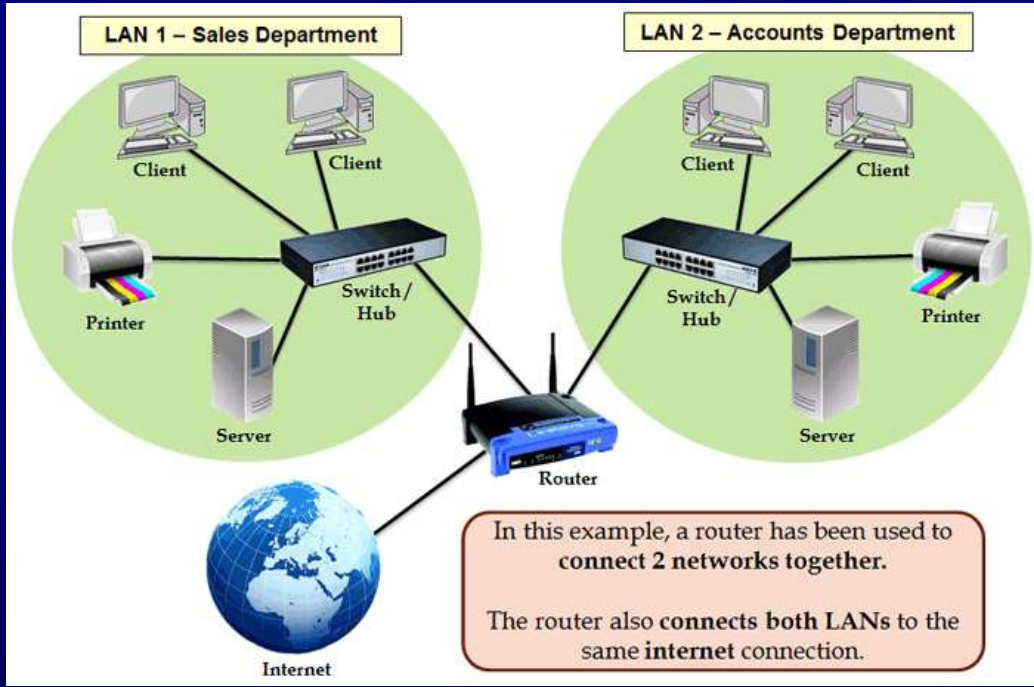
Network Devices: Router

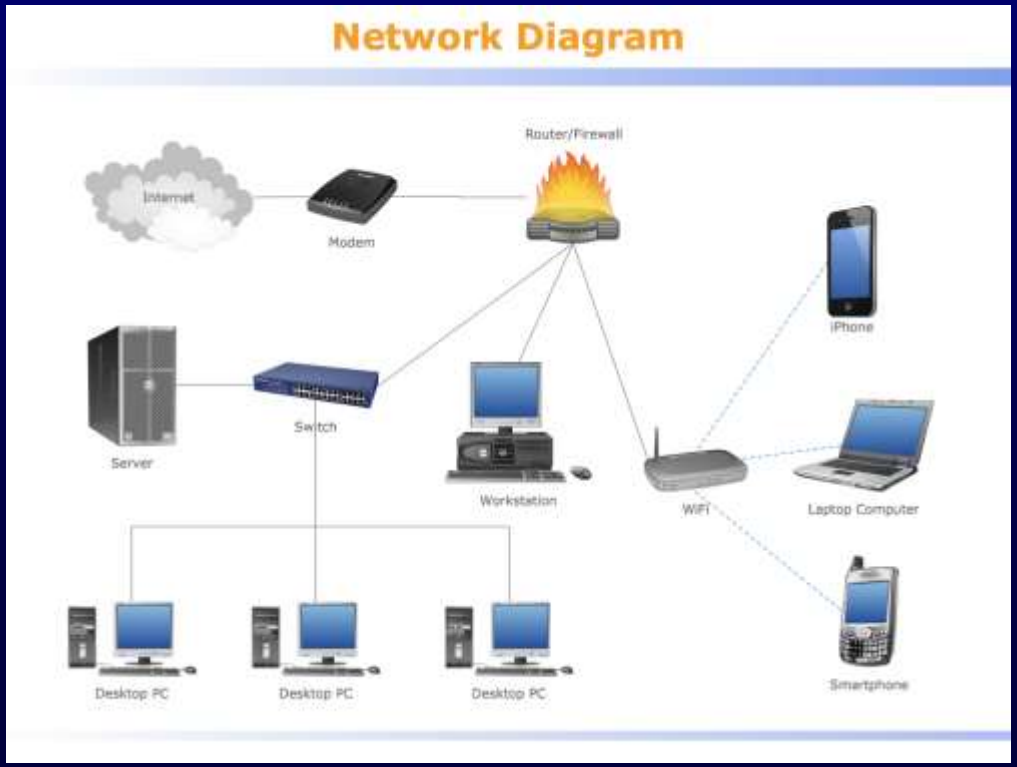
- Router is used to connect heterogeneous networks.
- A router has a processor, memory, and I/O interface for each network to which it connects.
- A router connects networks that use different technologies, different media, and physical addressing schemes or frame formats. A router can connect two LANs, a LAN and a WAN, or two WANs.
- A router is used to interconnect the networks in the Internet.
- Router operates at the Network layer of the OSI model (layer 3).
- Physically, a router resembles a bridge, but is different from a bridge. A router determines which way is the shortest or fastest in a network, and routes packets accordingly. Since it works at the Network layer, it moves packets based on the IP addresses etc. In contrast, a bridge connects two LANs almost permanently.

Data Communication and Computer Network

Network Devices: Router







Data Communication and Computer Network

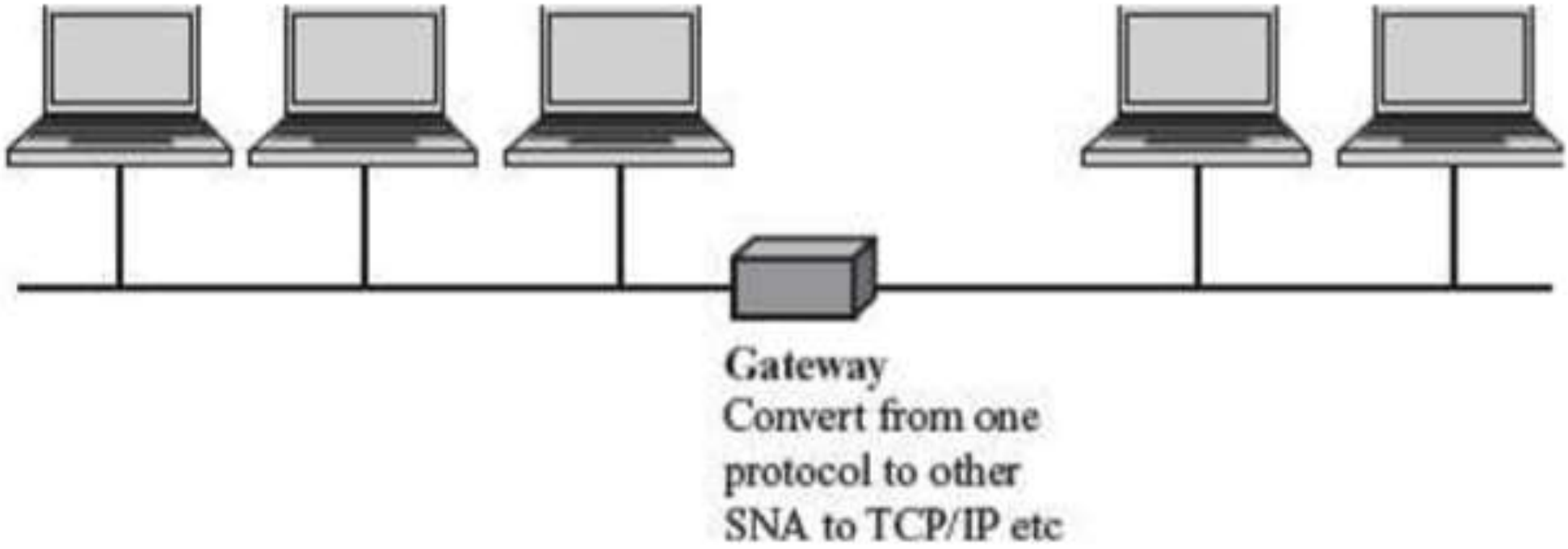
Network Devices: Gateway

- Gateway is a generic term used to represent devices that connect two dissimilar networks.
- A gateway at the transport layer converts protocols among communications networks. It can accept a packet formatted for one protocol and convert it to a packet formatted for another protocol, before forwarding it. An application gateway can translate messages from one format to the other.
- A gateway can be implemented in hardware, software, or in both hardware and software. Generally, gateway is implemented by software installed within a router.

Note: The network connecting devices— repeater and hub operate at the physical layer, bridge and switch operate at the data link layer, and the router operates at the network layer of the OSI model.

Data Communication and Computer Network

Network Devices: Gateway



Data Communication and Computer Network

Wireless Networking:

- Wireless technology is used to establish a wire-free connection or communication between two or more devices.
- Wired technology data is encoded as electric current and signals travel through wires but in wireless technology, data is encoded on electromagnetic waves that travel through air.
- The wireless technology is used for broadcasting in radio and television communication, for communication using mobile phones and pagers, for connecting components of computers using Bluetooth technology, for Internet connection using Wi-Fi, Wireless LAN, PDA, and in remote controls for television etc.

Data Communication and Computer Network

Wireless Networking:

- Wireless network is a computer network connected wirelessly. The communication is done through a wireless media like radio waves, infrared or Bluetooth.
- The wireless networks have two main components
  1. the wireless access points that include the transmitter along with the area it can cover
  2. the wireless clients like mobile handsets, laptops with Ethernet cards etc.
- The access point receives data frames from the computers attached to it wirelessly, checks the frames, and transmits them to their destination. The coverage area of a transmitter depends on the output power of the transmitter, its location, and the frequency used to transmit the data. Higher frequencies require a clear line of sight as compared to lower frequencies.
- The speed of wireless connection is determined by the distance of the wireless client device from the access point, the obstruction-free path (walls, trees etc.), interference, and the number of users using the network at a given time.

Data Communication and Computer Network

Wireless Networking:

- Wireless networks can be divided into three categories based on their use:
  1. Bluetooth technology to connect the different components of the computer in a room, a small office or home.
  2. Wireless LAN is used to connect computers and devices wirelessly in a LAN, for example, different computers or devices in an office or campus.
  3. Wireless WAN is used to connect wide area systems, for example access to Internet via mobile devices like cell phone, PDAs and laptops.

Data Communication and Computer Network

Wireless Networking:

Bluetooth Technology

- The different components of the computer like the keyboard, printer, monitor etc., are connected to the computer case via wires.
- Bluetooth technology is used to connect the different components wirelessly. A printer placed in a room may be connected to a computer placed in a different room using Bluetooth technology.
- Using Bluetooth does away with the wires required to connect the components to the computer and allows portability of components within a small area lying within the Bluetooth range.

Data Communication and Computer Network

Wireless Networking:

Wireless LAN

- Wireless LAN has some benefits over the wired LANs. In wireless LAN, there is flexibility to move the computers and devices within the network. It can connect computers where cabling is not possible. It is easy to expand by using an access point.
- Since no physical medium is required, wireless LANs are easy to install.
- Since data is transmitted using radio or infrared waves, there is no attenuation or distortion of the signal due to electromagnetic interference.
- Wireless LANs are used at home to connect devices on different floors or to set up a home network, to provide connectivity in public places like airports, railway stations, college campus, and hotels etc., where traveling users can access the network.
- Wireless LANs can also be connected to a WAN thus providing access to Internet to the user. IEEE 802.11 is a standard for wireless LAN.

Data Communication and Computer Network

Wireless Networking:

Wireless WAN:

- The radio network used for cellular telephone is an example of wireless WAN. Wireless WANs allow the users to access the Internet via their mobile devices. This provides flexibility to the user to access the Internet from any location where wireless connectivity exists.
- Almost all wireless networks are connected to the wired network at the back-end to provide access to Internet.
- Wireless networks also offer many challenges, like, the compatibility among different standards promoted by different companies, congested networks in case of low bandwidth, the high infrastructure and service cost, data security, battery storage capability of wireless device, and health risk.

Computer Networks and Internet Services

Q&A session

Network Devices:

- Define a concentrator.
- Name all network connecting devices.
- What is the purpose of the Network Interface Card?
- Describe the features of (i) repeater, (ii) hub, (iii) switch, (iv) bridge, (v) router, and (vi) gateway.
- What is the purpose of a gateway?
- Name a connecting device, each, that works at (i) physical layer, (ii) data link layer, and (iii) network layer (iv) transport layer
- Name the network devices that works on Signal and Frame.

Computer Networks and Internet Services

Q&A session

Computer network

- Define computer network.
- Name the three types of networks classified on the basis of their size.
- What do you mean by transmission technology?
- What do you mean by network topology?
- Describe briefly the LAN, MAN, and WAN transmission technologies.
- Name three LAN topologies.
- List the features of the following LAN topologies—(i) Bus, (ii) Star, and (iii) Ring.
- Name the protocol(s) used to implement bus, ring and star technologies.
- List the advantages and disadvantages of each of the LAN technology–Bus, Star, and Ring.
- What is the need of communication protocol?
- List the seven layers of the OSI model protocol, in order.
- How does the OSI seven layer protocol work?
- Describe briefly the function of each layer of the OSI model.

Course Contents

- Internet:
  - History of Internet
  - Internetworking Protocol (TCP/IP)
  - The Internet Architecture
  - Managing the Internet (Various Organization managing Internet)
  - Internet Connections
  - Internet Address; WWW, Domain Name System,
  - Internet Services; E-mail and its working principle
- E-commerce and E-governance
- Web2.0;
- Internet of Things(IoT)
- Wearable computing
- Cloud computing
- Smart City; Case Study: ISP in Nepal and their services

The Internet and Internet Services

INTRODUCTION:

- The computers interconnected by LAN, MAN, and WAN are able to exchange information within their networks. Computer connected to one network is able to exchange information with another computer connected to the same network.
- However, a computer connected to a particular network may need to interact with a computer connected to a different network. Internet is defined as an interconnection of networks. Internet allows computers on different kinds of networks to interact with each other.
- Any two computers, often having different software and hardware, can exchange information over the Internet, as long as they obey the technical rules of Internet communication.
- The exchange of information may be among connected computers located anywhere like military and research institutions, banks, educational institutions, public libraries, commercial sectors etc.

The Internet and Internet Services

HISTORY OF INTERNET:

Growth of Internet can be discussed in three steps, as follows:

1. Internetworking Protocol - Transmission Control Protocol/Internet Protocol (TCP/IP) in 1970s
2. Usenet groups and Electronic mail in 1980s
3. World Wide Web (WWW) in 1990s

The Internet and Internet Services

HISTORY OF INTERNET:

US Department of Defense Advanced Research Projects Agency (DARPA) during 1970's developed the ARPANET as a WAN to connect different computers and later to connect computers on different networks (Internetworking).

Internetworking became the focus of research at ARPA and led to the emergence of Internet.

DARPA goals included:

- the ability to interconnect different types of network
- to connect through alternate paths if some path gets destroyed, and
- to support applications of various types like audio, video, text etc.

The Internet and Internet Services

HISTORY OF INTERNET:

- Based on the design goals, a protocol named Transmission Control Protocol/Internet Protocol (TCP/IP) was developed for computer communication. TCP/IP has become the protocol for Internet.
- In late 1970s, the US National Science Foundation (NSF) designed a successor to ARPANET, called NSFNET, which was open for use to all university research groups, libraries and museums.
- This allowed scientists across the country to share data and interact with each other for their research projects.
- Internet grew exponentially when ARPANET was interconnected with NSFNET.

The Internet and Internet Services

HISTORY OF INTERNET:

- In 1980s, many Internet applications like electronic mail, newsgroups, file transfer facility and remote login were developed. The Electronic mail facility allowed users to compose, send, and receive messages.
- Users having common interests could exchange messages using forums like Newsgroups. The Telnet command allowed users to login to a remote computer. The File Transfer Protocol program was used to copy files from one computer to another on the Internet.

The Internet and Internet Services

HISTORY OF INTERNET:

- In the early 1990s, a new application World Wide Web (WWW) changed the way in which Internet was used.
- WWW is a system of creating, organizing, and linking documents, and was created by British scientist Tim Berners Lee. A protocol based on hypertext was developed that allowed the documents and content on WWW to be connected via hyperlink.
- In 1993, Marc Andreessen at the University of Illinois developed the Mosaic browser. The WWW along with the browser made it possible to set up number of web pages that may consist of text, pictures or sound, and with link to other pages.
- Internet and WWW which are interconnection of networks, and interconnection of documents and resources, respectively, has wired the whole world together.

Course Contents

Internet Protocols:

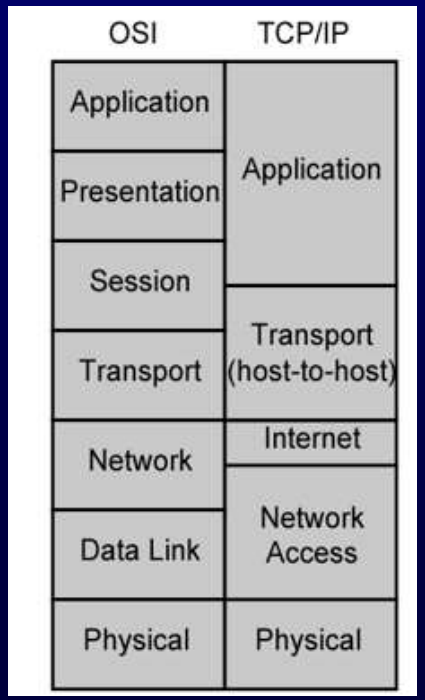
Protocol Layer	Comments
Application Protocols Layer	Protocols specific to applications such as HTML(WWW), FTP, SMTP, POP3,Telnet, Gopher, WAIS etc.
Transmission Control Protocol Layer	TCP directs packets to a specific application on a computer using a port number.
Internet Protocol Layer	IP directs packets to a specific computer using an IP address.
Hardware Layer	Converts binary packet data to network signals and back. Mac Address

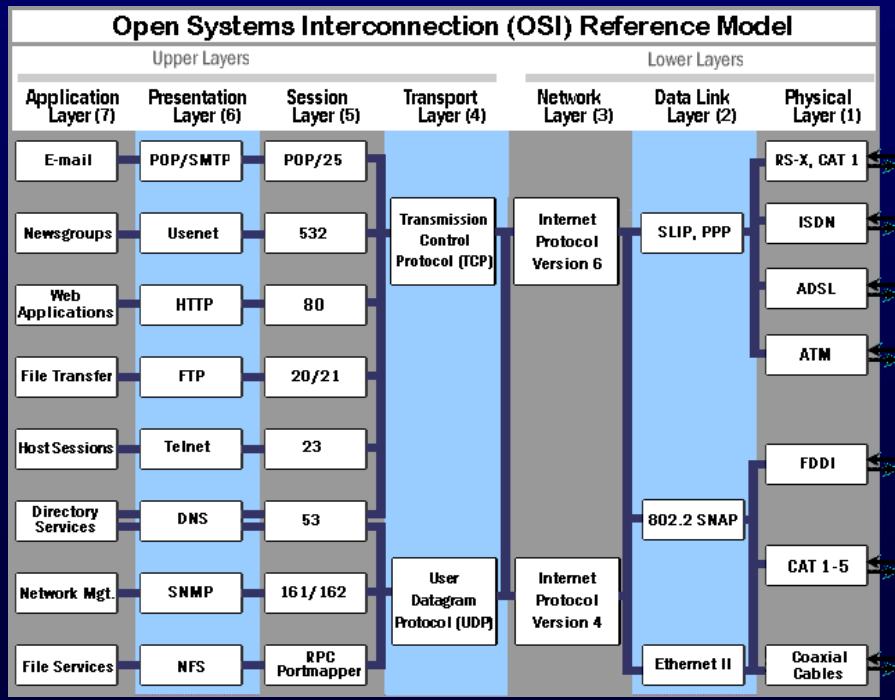
The Internet and Internet Services

Internetworking Protocol:

TCP/IP is the communication protocol for the Internet.

- The TCP/IP protocol has two parts: TCP and IP.
- Transmission Control Protocol (TCP) provides reliable transport service, i.e. it ensures that messages sent from sender to receiver are properly routed and arrive intact at the destination.





The Internet and Internet Services

Internetworking Protocol: TCP

TCP converts messages into a set of packets at the source, which are then reassembled back into messages at the destination. TCP operates with the packet switching technique, which is described as follows:

- The message is divided into small packets.
- Each packet contains address, sequencing information, and error control information.
- The address is used to route the packet to its destination.
- Since multiple users can send or receive information over the same communication line, the packets can arrive out of order at the destination. The sequencing information in the packet is used to reassemble the packets in order, at their destination.
- The error control information is used to check that the packet arrived at the destination is the same as that sent from the source (i.e. has not got corrupted)

The Internet and Internet Services

Internetworking Protocol: IP

- Internet Protocol (IP) allows different computers to communicate by creating a network of networks.
- IP handles the dispatch of packets over the network.
- It handles the addressing of packets, and ensures that a packet reaches its destination traveling through multiple networks with multiple standards.

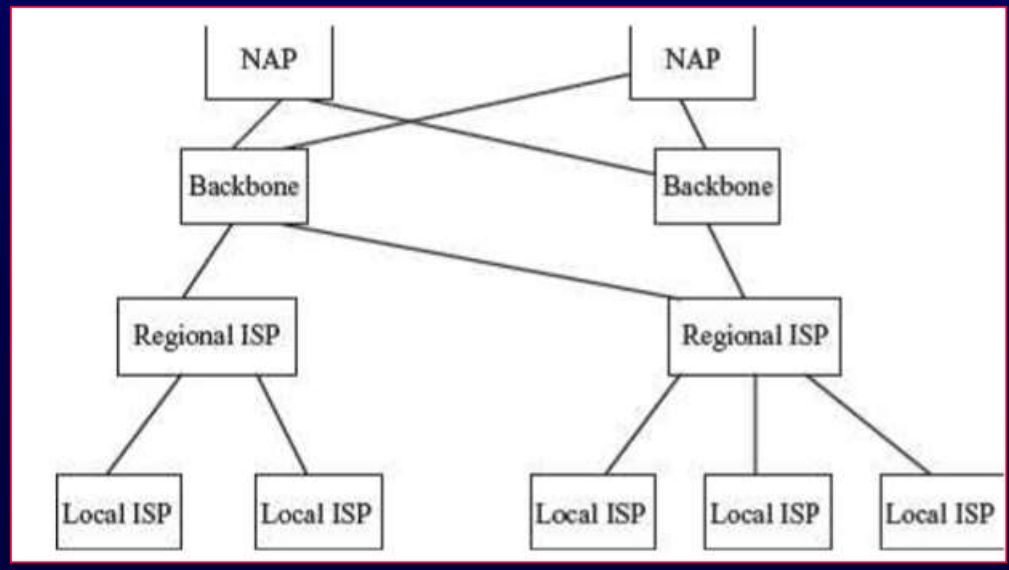
TCP/IP protocol makes it possible for any pair of computers connected to Internet to communicate, despite their hardware differences.

The Internet and Internet Services

THE INTERNET ARCHITECTURE:

Internet is a network of interconnected networks and is designed to operate without a central control. If a portion of the network fails, connection is made through alternative paths available.

- Client
- Local Internet Service Provider (ISP)
- Regional ISP
- Backbone is at top of the hierarchy.
- Network Access Point (NAP)



The Internet and Internet Services

Managing the Internet:

Internet is not controlled by any one person or an organization. A number of organizations manage the Internet. Some of the governing bodies of the Internet and their functions are as

Governing Bodies of Internet	Functions
1. Internet Society (ISOC)	➢ Provides information about Internet ➢ Responsible for development of standards and protocols related to Internet
2. Internet Architecture Board (IAB)	➢ Advisory group of ISOC ➢ Responsible for development of Internet architecture
3. Internet Engineering Task Force (IETF)	➢ Community of network designers, operators, vendors, and researchers ➢ Responsible for evolution of Internet ➢ Open to all individuals

The Internet and Internet Services

Managing the Internet:

Governing Bodies of Internet	Functions
4. Internet Engineering Steering Group (IESG)	➢ Reviews standards developed by IETF
5. Internet Research Task Force (IRTF)	➢ Focuses on research towards the future of Internet (Internet protocol, architecture etc.)
6. Internet Assigned Number Authority (IANA)	➢ Allots IP address to organizations and individuals
7. Internet Network Information Center (InterNIC)	➢ Responsible for domain name registration
8. World Wide Web Consortium (W3C)	➢ Responsible for development of technologies for World Wide Web

The Internet and Internet Services

Connecting to Internet:

To be able to connect your computer to the Internet, we require

(1) a TCP/IP enabled computer

(2) web browser software

(3) an account with an ISP

(4) a telephone line, and

(5) a modem or Network Interface Card (NIC) to connect the telephone line to the computer

A modem is a device that connects a computer to Internet. A Network Interface Card or NIC is a device that is required to connect a computer to Internet via a LAN or high-speed Internet connection like cable modem or Digital Subscriber Line (DSL). A web browser is a software that allows the user to view information on WWW. WWW is a large-scale, on-line repository of information that the users search using the web browser. Internet Explorer and Netscape Navigator are examples of web browser.

The Internet and Internet Services

Internet Connections:

1. Hardwired broadband access
   - Dial-up access
   - Integrated Services Digital Network
   - Leased lines
   - Cable Internet access
   - Digital subscriber line (DSL, ADSL, SDSL, and VDSL)
   - Fiber to the home
2. Wireless broadband access
   - Satellite broadband
   - Mobile broadband
   - WiMAX
   - Wireless ISP

The Internet and Internet Services

Internet Address:

A computer connected to the Internet must have a unique address in order to communicate across the Internet. Internet Protocol (IP) address is assigned uniquely to every computer connected to the Internet.

Course Contents

Define internet address.

- Physical
- Logical address
- Domain Address
- URL

Course Contents

Internet Address:

Every computer or device on the internet has two types of addresses:

1. **Physical address** – Mac(media access control) address
2. Internet address(**Logical address**) – IP Address

A MAC address and an IP address each identify network devices, but they do the job at different levels.

- MAC address identifies a device to other devices on the same local network. The internet address (or IP address) identifies the device globally.
- A network packet needs both addresses to get to its destination.

Course Contents

Internet Address: Physical (Mac) address

- Mac Address works in layer 2 (Data Link layer) of OSI reference model. Most devices are connected physically with Ethernet cables or wirelessly with Wi-Fi and both methods use MAC addresses to identify a device on the network.
- A MAC address consists of 12 hexadecimal digits, usually grouped into six pairs separated by hyphens. MAC addresses are available from 00-00-00-00-00-00 through FF-FF-FF-FF-FF-FF.
- The first half are vendor numbers which is the address of manufacturer (also called the OUI – Organizationally Unique Identifier), and the 2nd half is NIC serial number assigned by the manufacturer to this adapter, or station address.
- Mac number is hardcoded both into Ethernet and Wi-Fi devices during the manufacturing process.

Course Contents

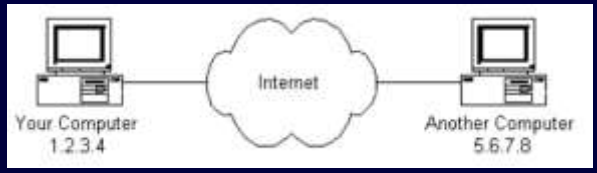
Internet Address: Internet address (Logical address) – IP Address

- IP address works in Layer 3, the network layer, of the OSI reference model. The internet was initially built around IP version 4 (IPv4) and is in transition to IPv6.
- An IP address identifies a device on the global internet.
- An IPv4 address consists of 32 bits, usually written as four decimal numbers, or a dotted quad. Possible decimal values range from 000.000.000.000 through 255.255.255.255, although many possible addresses are disallowed or reserved for specific purposes.
- The address combines network identification and device identification data. The network prefix is anywhere from eight to 31 bits, and the remainder identify the device on the network.
- An IPv6 address consists of 128 bits, with the first 64 reserved for network identification and the second 64 dedicated to identifying a device on the network.
- The address is written as eight sets of four hexadecimal digits separated by colons - for example, FEDC:BA98:7654:3210:0123:4567:89AB:CDEF.

Course Contents

Internet Address: Internet address (Logical address) – IP Address :

- A computer connected to the Internet must have a unique address in order to communicate across the Internet. Internet Protocol (IP) address is assigned uniquely to every computer connected to the Internet.
- An IP address looks like 201.54.122.107. Since IP addresses are numeric, it is difficult to remember everyone's IP address. So, instead of numeric IP address, domain name is used.
- Another difference between a MAC address and IP address is the way the addresses are assigned. An IP address is bound to a network device via software configurations, and it can be changed at any time. Local network switches maintain Address Resolution Protocol (ARP) tables that map IP addresses to MAC addresses. When a router sends the switch a packet with a destination specified by an IP address, it uses the ARP table to know which MAC address to attach to the packet when it forwards the data to the device as Ethernet frames.



Course Contents

Internet Address: IP Address:

Who provide IP Address to computer?

- If we connect to the Internet through an Internet Service Provider (ISP), temporary IP address are assigned for the duration of connection session.
- If we connect to the Internet from a local area network (LAN), computer might have a permanent IP address or it might obtain a temporary one from a DHCP (Dynamic Host Configuration Protocol) server.
- In any case, if you are connected to the Internet, your computer has a unique IP address.

Course Contents

Internet Address: Domain Address:

- Domain name is a text name (string of words) corresponding to the numeric IP address of a computer on the Internet.
- Domain names are used for the convenience of the user. A domain name combines a group of hosts on the Internet (e.g. Yahoo, Google, MSN etc.), and a top level domain.

Some examples of top-level domain are as follows:

com for commercial organizations,

edu for educational institutions,

net for gateways and administrative hosts,

org for non-profit organizations,

co for companies, and

ac for academics

Course Contents

Internet Address: Domain Names and Address Resolution using DNS:

- Domain Name Service(DNS) is a distributed database which keeps track of computer's names and their corresponding IP addresses on the Internet.
- Many computers connected to the Internet host part of the DNS database and the software that allows others to access it. These computers are known as DNS servers.
- No DNS server contains the entire database; they only contain a subset of it. If a DNS server does not contain the domain name requested by another computer, the DNS server re-directs the requesting computer to another DNS server.

Course Contents

Uniform Resource Locator (URL):

- A web page on the Internet is uniquely identified by its address, called URL. URL is the address on the Internet at which the web page resides (Figure 10.10). The user uses this address to get a web page from the Internet. The general form of URL is

  protocol://address/path

where,

- protocol defines the method used to access the web page, e.g., http, ftp, news etc.
- address is the Internet address of the server where the web page resides. It contains the service (e.g. www) and the domain name (e.g.google.com), and
- path is the location of web page on the server.

To access documents on WWW, the HTTP protocol is used.

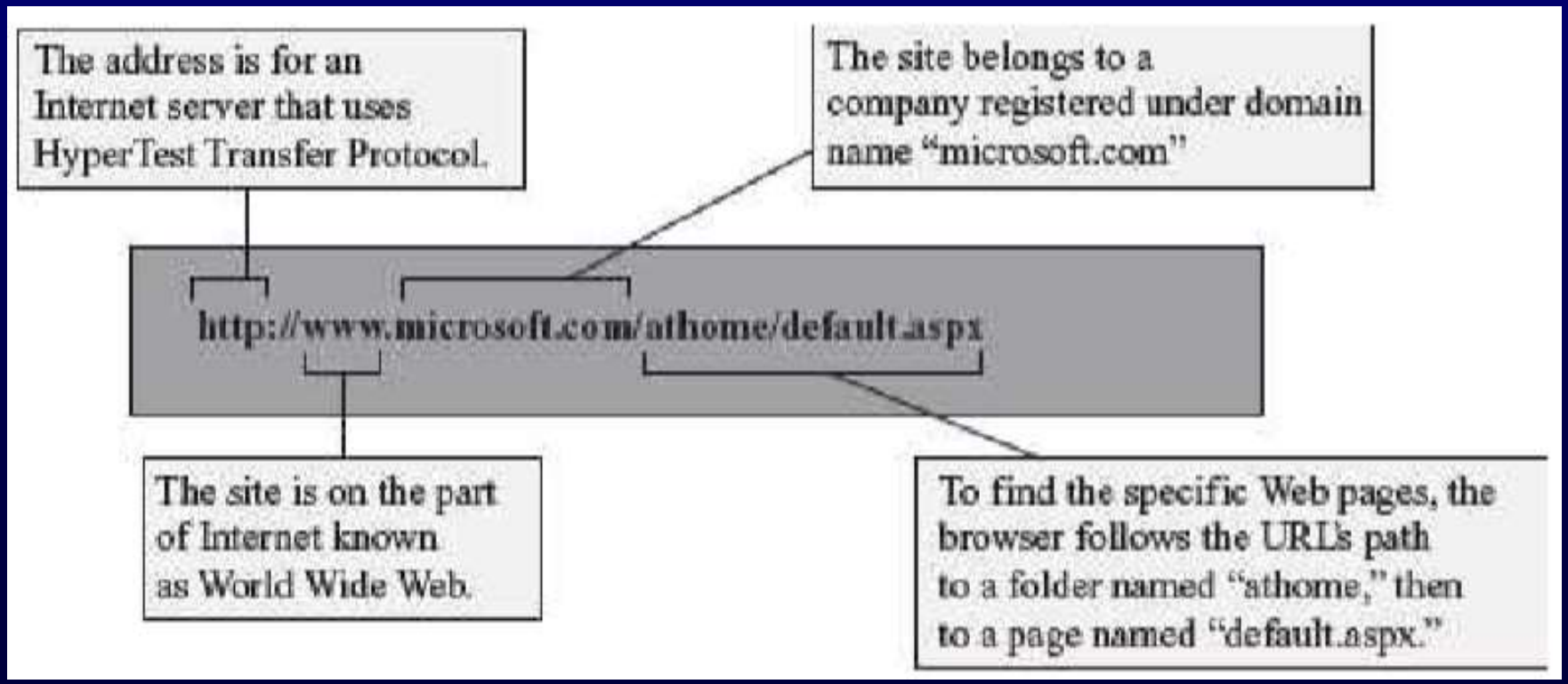
Course Contents

Uniform Resource Locator (URL):

An example of a URL is,

http://www.dsc.com/mainpage

where, http is the protocol, www.dsc.com is the address, and mainpage is the path.



The Internet and Internet Services

Internet Services:

1. World Wide Web (WWW)
2. Electronic Mail
   - E-mail Address
   - E-mail Message Format
   - E-mail Services
   - How E-mail Works
3. File Transfer Protocol (FTP)
   - How FTP Works
4. Terminal Network (Telnet)
5. News
6. Internet Relay Chat (IRC)

The Internet and Internet Services

Internet Services: World Wide Web (WWW)

- WWW (also called as Web) is a large scale, online store of information. It is a system of creating, organizing, and linking of documents.
- Information is stored on WWW as a collection of documents that are interconnected with each other via links.
- The interconnected documents may be located on one or more than one computer, worldwide, thus, the name world wide web.

The features of WWW and terms linked to WWW are given below

Course Contents

World Wide Web (WWW)

- Hypertext format
- HyperText Markup Language (HTML)
- Hyperlink
- HyperText Transfer Protocol (HTTP)
- Web page
- Web site
- Homepage
- Web Server
- Uploading/Downloading
- Web browser
- Uniform Resource Locator (URL)
- web portal

The Internet and Internet Services

Internet Services: World Wide Web (WWW)

The documents on web are created in hypertext format. Hypertext facilitates linking of documents.

- The language used to create a hypertext format document is HyperText Markup Language (HTML). HTML allows the designer of the document to include text, pictures, video, images, sound, graphics, movies etc., and also to link contents on the same document or different documents using a hyperlink.
- The hypertext format document is transferred on the Web using HyperText Transfer Protocol (HTTP).
- A single hypertext document is called a Web page.
- A group of related web pages is called a Web site. A web site displays related information on a specific topic.

The Internet and Internet Services

Internet Services: World Wide Web (WWW)

- The first web page or main page of a website is called Homepage.
- The web pages are stored on the Internet on the Web Server. Web servers are host computers that can store thousands of web pages.
- The process of storing a web page on a web server is called uploading.
- The process of retrieving a web page from a web server onto the user's computer is downloading.
- The web pages stored on web server on the Internet, can be viewed from the user's computer using a tool called Web browser.
- Every web page is identified on Internet by its address, also called Uniform Resource Locator (URL).
- A web portal is a web site that presents information from different sources and makes them available in a unified way. A web portal enables the user to search for any type of information from a single location, i.e. the home page of the web portal. A web portal generally consists of a search engine, e-mail service, news, advertisements, and an extensive list of links to other sites.

Course Contents

Electronic Mail: Electronic mail (E-mail) is an electronic message transmitted over a network from one user to another. E-mail is a text-based mail consisting of lines of text, and can include attachments such as audio messages, pictures and documents. The features of e-mail are as follows:

- E-mail can be sent to one person or more than one person at the same time.
- Communicating via e-mail does not require physical presence of the recipient. The recipient can open the e-mail at his/her convenience.
- Since messages are transmitted electronically, e-mail is a fast way to communicate with the people in your office or to people located in a distant country, as compared to postal system.
- E-mail messages can be sent at any time of the day.
- A copy of e-mail message that the sender has sent is available on the senders computer for later reference.
- In addition to sending messages, e-mail is an ideal method for sending documents already on the computer, as attachments.
- E-mail has features of the regular postal service. The sender of e-mail gets the e-mail address of the recipient, composes the message and sends it. The recipient of e-mail can read the mail, forward it or reply back. The recipient can also store the e-mail or delete it.

Course Contents

E-mail Message Format:

The e-mail message consists of two parts-header and body. The header contains information about the message, such as:

- **From**—Sender's e-mail address.
- **To**—Recipient's e-mail address.
- Date—When the e-mail was sent.
- Subject—The topic of the message.
- Cc—Addresses where carbon copies of the same e-mail will be sent. The recipients of e-mail can see all e-mail addresses to which the copies have been sent.
- Bcc—Addresses where Blind carbon copies (Bcc) of the same e-mail will be sent. The recipients of e-mail do not know that the same e-mail has been sent to other e-mail addresses.
- The **size** of e-mail.

The body contains the text of the message and any attachments to be sent.

Course Contents

How E-mail Works:

- The e-mail works on the client-server model.
- E-mail clients are the users who wish to use the e-mail facility. Both, the sender of e-mail and the recipient of e-mail are e-mail clients.
- E-mail server is a combination of processes running on a server with a large storage capacity- a list of users and rules, and the capability to receive, send, and store emails and attachments. These servers are designed to operate without constant user intervention.
- The e-mail client interacts with the e-mail server to send or receive e-mail. Most email servers provide email services by running two separate processes on the same machine-Post Office Protocol 3 (**POP3**) and Simple Mail Transfer Protocol (**SMTP**). Some e-mail servers also run another process on the machine—Internet Message Access Protocol (IMAP) (Microsoft Exchange Server & Exchange ActiveSync)
- SMTP is used to send e-mail from the client to server and from one server to another server.
- POP3 is used by client for application based e-mail to access mail from the server.
- IMAP is used by client for web-based e-mail to access mail on server.

Course Contents

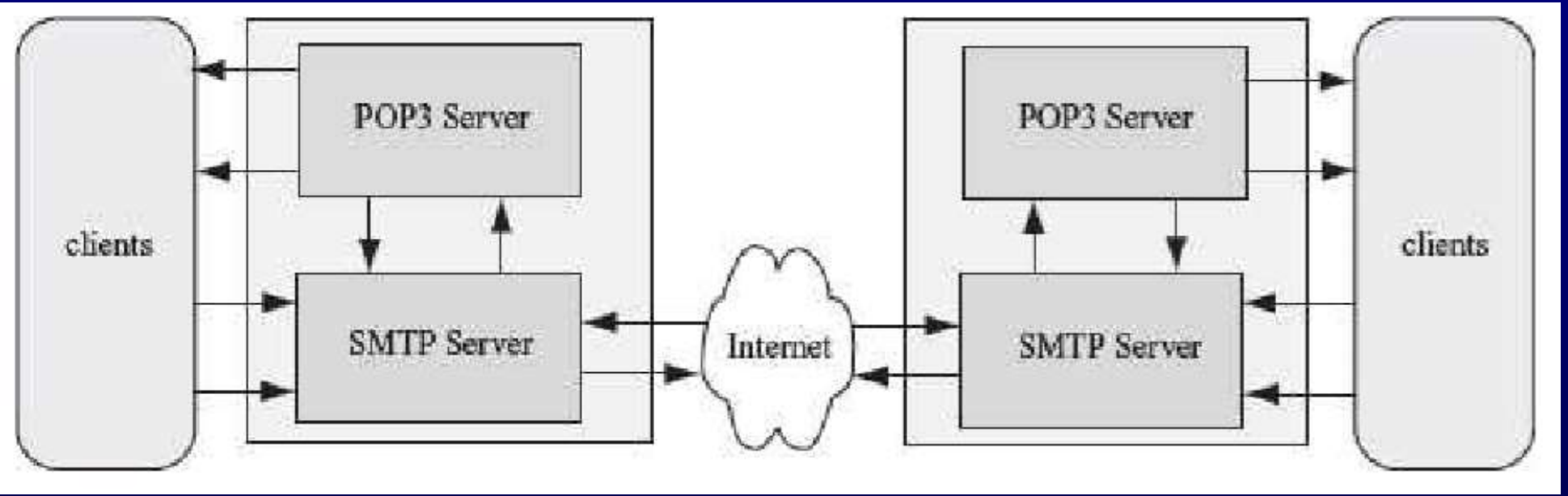
How E-mail Works:

The e-mail client-server work as follows:

- The client connects to e-mail server when the user wants to send, check or receive email. The client connects to the server on two TCP/IP ports—(1) SMTP on port 25, and (2) POP3 on port 110 or IMAP on port 143.
- SMTP server accepts outgoing email from client (sender e-mail client). Next, the SMTP server checks the e-mail address at which e-mail has to be delivered (recipient e-mail client). If the recipient e-mail client resides on the same SMTP server, then the e-mail is sent to the local POP or IMAP server, otherwise, the e-mail is sent to another SMTP server so that it reaches the recipient e-mail client's SMTP server.
- POP3 stores e-mail for a client on a remote server. When the client gets connected to server, the e-mail messages are downloaded from POP3 server to client's computer.
- IMAP also stores e-mails on a remote server. However, the e-mail messages are not downloaded to the client's computer. The user manipulates the e-mail messages directly on the e-mail server.
- The POP3/IMAP and SMTP are linked by an internal mail delivery mechanism that moves mail between the POP3/IMAP and SMTP servers.

Course Contents

How E-mail Works:



Course Contents

File Transfer Protocol (FTP):

FTP is an Internet tool used for copying files from one computer to another. It gives access to directories or folders on remote computers, and allows software, data and text files to be transferred between different kinds of computers. Using a FTP program or a web browser, the user can log onto an FTP host computer over Internet and copy files onto their own computer.

The goals of FTP are as follows:

- FTP promotes sharing of files, articles, and other types of data.
- FTP encourages indirect use of remote computers.
- Heterogeneous systems use different operating systems, character sets, directory structures, file structures and formats. FTP shields users from these variations and transfers data reliably and efficiently.
- Universities and software companies use FTP host computers to provide visitors with access to data.

Course Contents

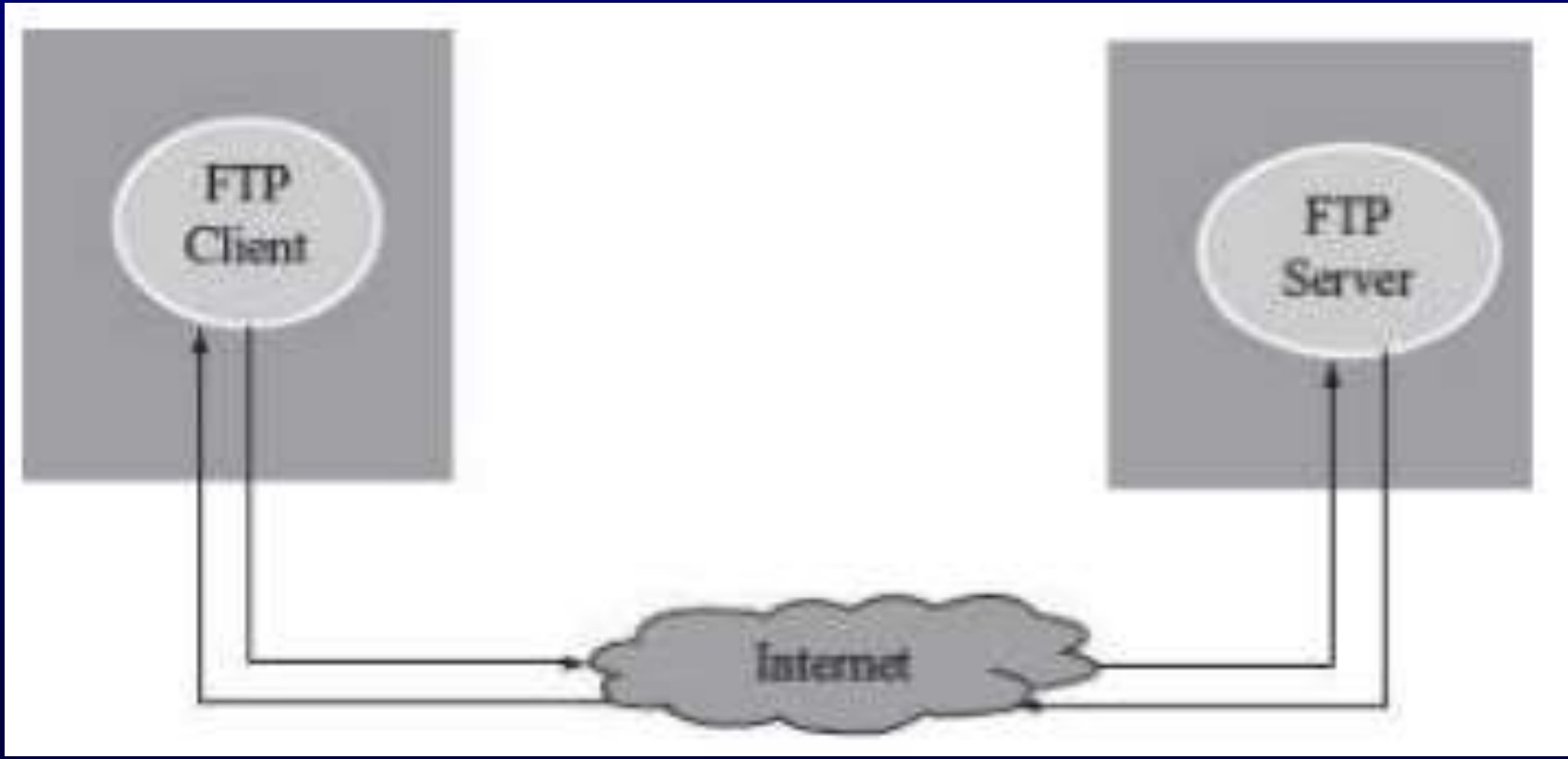
How FTP Works:

FTP works on the client-server model. FTP client is a program running on the user's computer that enables the user to talk to, and get files from remote computers. FTP server is the remote computer or the host computer from which files are accessed by the FTP client. The FTP client-server works as follows:

- The FTP client gives the ftp command with the address of FTP server, using a URL. For example, ftp://ftp.cs.vu.nl
- When the FTP client gets connected to FTP server, the user enters the User Login and password. A user can login to a FTP server even if they don't have an account on the FTP server. For this, the user uses the anonymous login.
- FTP server verifies the User Login and password to allow the FTP client to access its files.
- FTP client looks in the directory for files in the FTP server.
- FTP client gets the requested file(s) and quits.

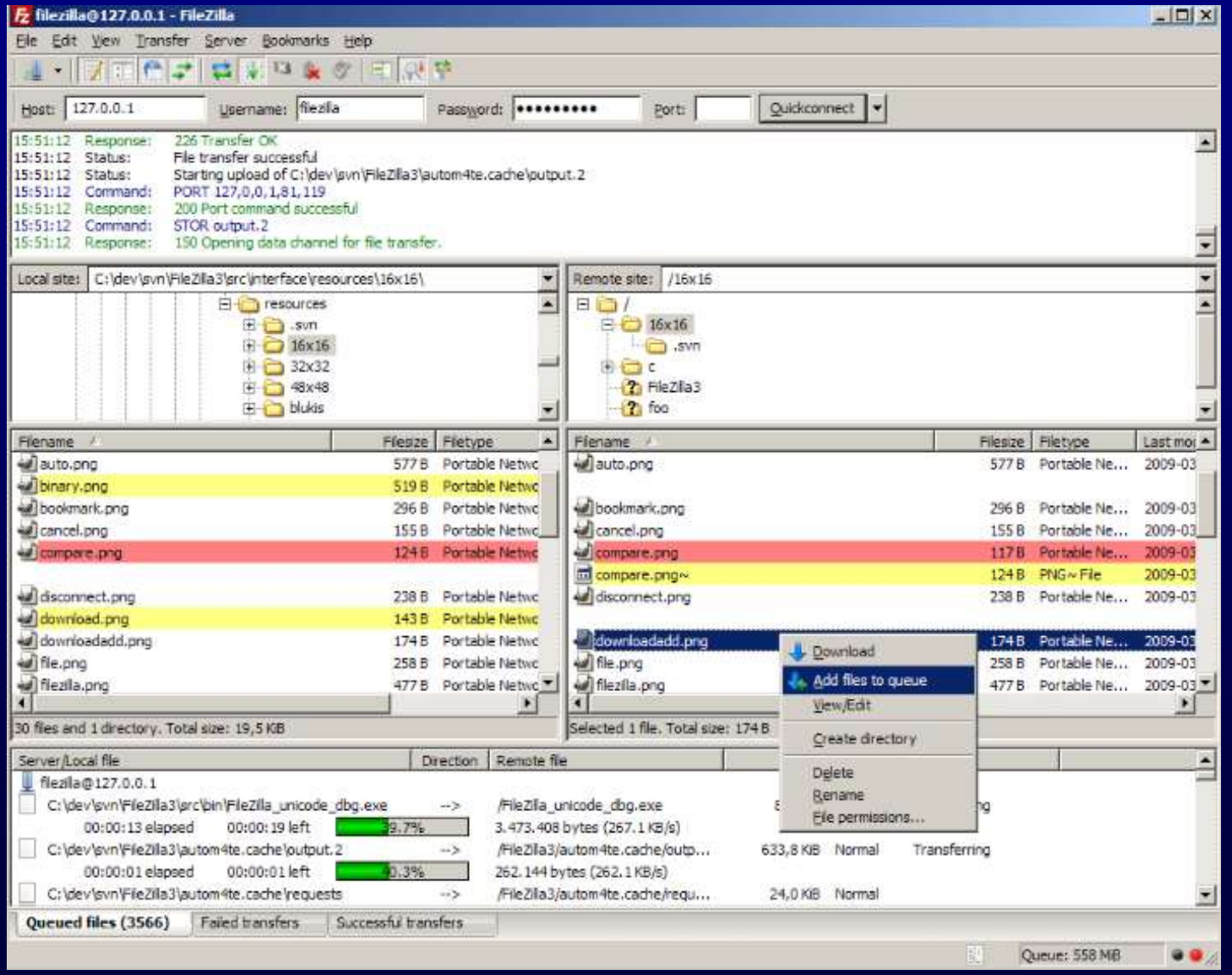
Course Contents

How FTP Works:



Course Contents

How FTP Works:



The Internet and Internet Services

Uses of Internet:

Internet is used for different purposes by different people. Some uses of the Internet are listed below:

- E-Commerce (auction, buying, selling products etc.)
- Research (on-line journals, magazines, information etc.)
- Education (e-learning courses, virtual classroom, distance learning)
- E-Governance (online filing of application (Income Tax), on-line application forms etc.)
- On-line ticket booking (airplane tickets, rail tickets, cinema hall tickets etc.)
- On-line payments (credit card payments etc.)
- Video conferencing
- Exchange of views, music, files, mails, folders, data, information etc.
- Outsourcing jobs (work flow software)
- Social networking (sites like Facebook, LinkedIn, twitter, Orkut
- E-Telephony (sites like skype)

The Internet and Internet Services

Introduction to Internet of Things (IoT):

- Internet of Things (IoT) is the networking of physical objects that contain electronics embedded within their architecture in order to communicate and sense interactions amongst each other or with respect to the external environment.
- In the upcoming years, IoT-based technology will offer advanced levels of services and practically change the way people lead their daily lives.
- Advancements in medicine, power, gene therapies, agriculture, smart cities, and smart homes are just a very few of the categorical examples where IoT is strongly established.

The Internet and Internet Services

Introduction to Internet of Things (IoT):

There are four main components used in IoT:

1. Low-power embedded systems: Less battery consumption, high performance are the inverse factors play a significant role during the design of electronic systems.
2. Cloud computing: Data collected through IoT devices is massive and this data has to be stored on a reliable storage server for cloud computing. The data is processed and learned, giving more room for us to discover where things like electrical faults/errors are within the system.
3. Availability of big data: We know that IoT relies heavily on sensors, especially real-time. As these electronic devices spread throughout every field, their usage is going to trigger a massive flux of big data.
4. Networking connection: In order to communicate, internet connectivity is a must where each physical object is represented by an IP address.

The Internet and Internet Services

Wearable Computing, and Cloud Computing:

- Wearable computing is a term that refers to computer-powered devices or equipment that can be worn by a user, including clothing, watches, glasses, shoes and similar items.
- Wearable computing devices can range from providing very specific, limited features like heart rate monitoring and pedometer capabilities to advanced “smart” functions and features similar to those a smartphone or smartwatch offers.
- These more advanced wearable computing devices can typically enable the wearer to take and view pictures or video, read text messages and emails, respond to voice commands, browse the web and more.
- While wearable computing devices are only just now starting to emerge from the realm of science fiction into reality, rumored devices like Google Glasses and the Apple iWatch may soon bring advanced wearable computing devices into the mainstream.

The Internet and Internet Services

Wearable Computing, and Cloud Computing:

- Cloud computing basically means computing on the Internet. Connecting to the cloud represents connecting to the Internet and is made easier through the advances in wireless technology.
- In cloud services, the data center operates like the Internet and computing resources are accessed and shared as virtual resources in a secure and scalable manner.
- In a simple description, cloud computing refers to taking services (“cloud services”) and moving them outside an organizations firewall on shared systems.
- In the cloud system, applications and services are accessed via the web, instead of a computer hard drive. The services are delivered and used over the Internet where a charge is paid by cloud customer typically on an “as-needed, pay-per-use” business model. The benefit is that the cloud infrastructure is managed by the cloud provider, not the individual cloud customer.

The Internet and Internet Services

Introduction to E-commerce:

E-commerce involves any business transaction executed electronically between parties. It uses Internet and Web for doing the business. It uses services like e-mail, workflow software tools, Intranet, and, the e-payment services.

- E-commerce involves buying and selling of products and services, electronically. Figure 11.13 shows a snapshot of an e-commerce website made by students.
- The parties involved in e-commerce may be of the following kinds:
  - Companies and Companies (B2B). A data processing company handling data services for a company.
  - Companies and Consumers (B2C).
  - Consumers and Consumers (C2C). A customer selling goods to another customer, like in e-bay.com.
  - Business and the public sector, and, consumers and the public sector.
- E-commerce web sites are like on-line market places where you can sell and buy items, and facilitate it by advertising your product, establishing newsgroups and blogs, posting job-oriented resumes etc.
- The on-line shopping is a fast growing segment as consumers are becoming more confident to use it, with the widespread use of the Internet.

The Internet and Internet Services

Introduction to E-commerce:

- Electronic commerce, commonly known as e-commerce or eCommerce, consists of the buying and selling of products or services over electronic systems such as the Internet and other computer networks. Modern electronic commerce typically uses the World Wide Web at least at some point in the transaction's lifecycle, although it can encompass a wider range of technologies such as e-mail as well. Modern electronic commerce typically uses the World Wide Web at least at some point in the transaction's lifecycle, although it can encompass a wider range of technologies such as e-mail as well.
- A small percentage of electronic commerce is conducted entirely electronically for "virtual" items such as access to premium content on a website, but most electronic commerce involves the transportation of physical items in some way.

The Internet and Internet Services

Things to consider for e-commerce business:

There are several issues that you should consider before selling your goods and services via internet.

- Planning for e-commerce
- Choose the right website hosting and ISP provider
- Options for connecting to the Internet
- Best practice in web design
- Create an online shop for sales and marketing
- Accepting online payments
- Develop an e-marketing plan

The Internet and Internet Services

Introduction to E-commerce:

Who is involved in an ecommerce business ?

Depending upon the scale and complexity of the proposed e-commerce system, ranges of specialists required and have experiences of:

- Servers Microsoft, Lynux, Sun etc(File, Communication and database server)
- Firewalls and security
- Graphic design and production
- HTML and XML coding
- Programming languages
- Database technologies

The Internet and Internet Services

E-governance:

- Electronic governance or e-governance or Digital Governance is the application of information and communication technology (ICT) for delivering government services, exchange of information, communication transactions, integration of various stand-alone systems between government to citizen (G2C), government-to-business (G2B), government-to- government (G2G)
- The two main objectives of E-governance is to restore the democracy to its true meaning with the help of improvisation of the participation of the citizen in the governing process by giving feedback and access to information and overall participation of the citizen in the decision making.
- The main objective of e-Governance is delivering or exchanging the information, enhancing the business transactions, giving better services to the citizens and handle the various interactions within and across the government and business organizations.

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E-governance:

- Governance is about how local public bodies and partnerships ensure that they are doing the right things, in the right way, for the right people in a timely inclusive, open, honest and accountable manner.
- It comprises the systems and processes for the direction and control of local authorities through which they account to, engage with and lead their communities”

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Smart City:

A smart city is a designation given to a city that incorporates information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation and utilities in order to reduce resource consumption, wastage and overall costs.

To improve urban living and to optimize their resources, cities are folding internet-connected devices into streetlights, municipal infrastructure, parking meters, and more, composing what could be called the “technological” portion of a smart city. Smart cities are using the Internet of Things (IoT) to improve the quality of life for their citizens.

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GIS: What is GIS ?

GIS = G + IS

Geographic reference + Information system

Data of spatial coordinates on the surface of the earth (Map) – location data

Database of attribute data corresponding to spatial location and procedures to provide information for decision making

GIS = IS with geographically referenced data

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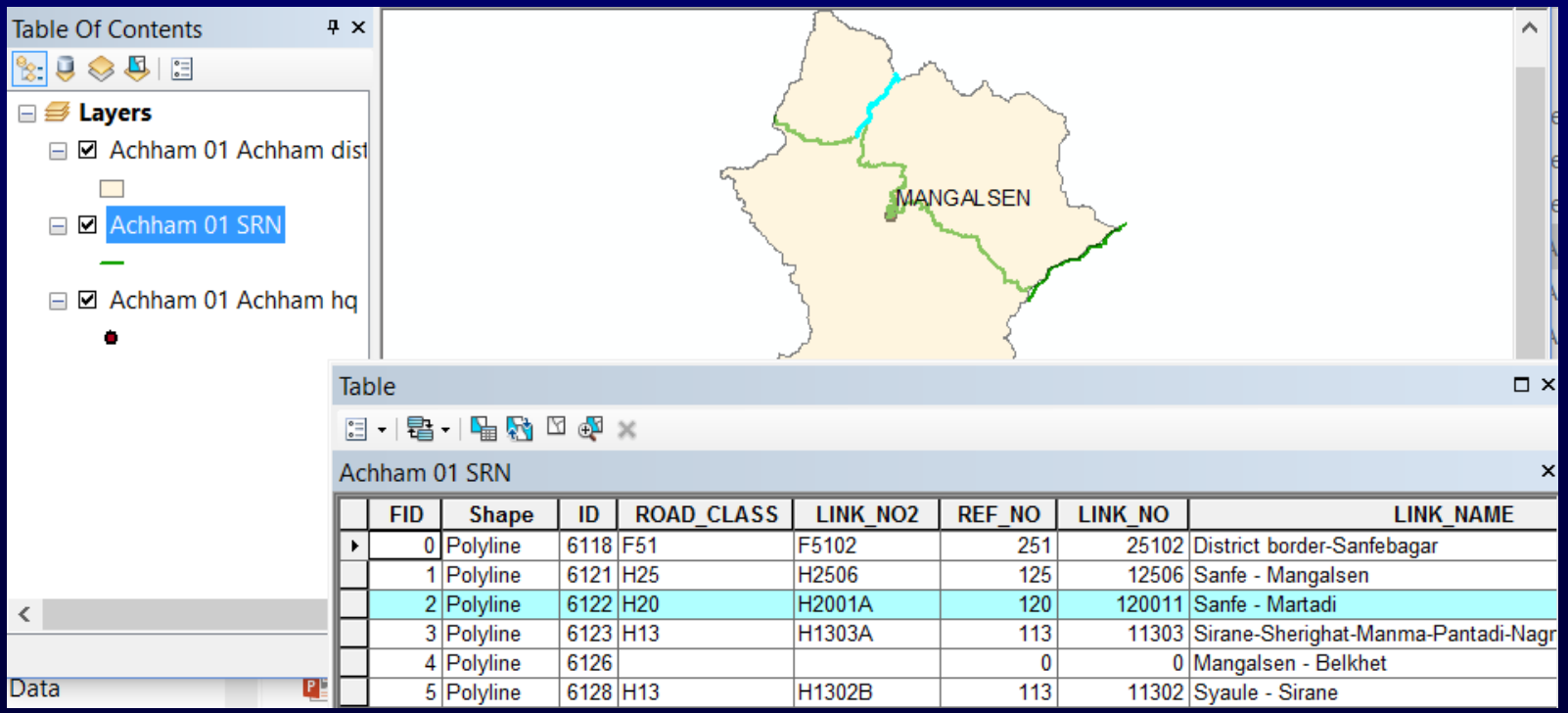
GIS: What is GIS ?

A geographic information system (GIS) is the system that captures, stores, analyzes, manages, and presents data with reference to geographic location data.

GIS is concerned with spatial or geographic data which refers to data that has a location upon the Earth's surface.



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1	Polyline	6121	H25	H2506	125	12506	Sanfe - Mangalsen
2	Polyline	6122	H20	H2001A	120	120011	Sanfe - Martadi
3	Polyline	6123	H13	H1303A	113	11303	Sirane-Sherighat-Manma-Pantadi-Nagr
4	Polyline	6126			0	0	Mangalsen - Belkhet
5	Polyline	6128	H13	H1302B	113	11302	Syaule - Sirane

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GIS: Why use GIS?

A GIS can be used to do the following:

- **Merges** diverse data sources – project specific information, socio-economic, census, statistical and spatial base data such as administrative boundaries, roads, cities, infrastructure, etc.
- **Manage all diverse data sources to prepare map, graph and reports** and to report management for decision making process.
- **Visualizes** and **disseminates** information.
- **Analyses** data, **illustrates** trends, growth, and generates value added outputs.
- Reveals important **spatial** relationships that facilitate understanding.

So GIS provides a platform for project **planning**, **monitoring, reporting and data sharing** for decision making process**.**

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GIS: Basic GIS Function?

- **Data input**
  - Graphic data: digitized, converted from existing data
  - Attribute data: keyed-in, loaded from existing data files
- **Data storage and manipulation**
  - File management, Editing, Geoprocessing (clip, merge, etc), reclassification
- **Data analysis**
  - Database query, Spatial analysis, Modeling
- **Data output or display**
  - Maps, Reports, Tables, Graphs

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GIS: Scope of GIS

- Land registration system
- Utilities such as Water supply, Electricity, Telephone, Irrigation networks
- Topographical database
- Forestry planning management
- Transportation networks
- Land use and land cover planning
- Urban planning
- Natural resource planning
- Disaster management and mitigation
- Environment impact studies

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GIS: Geographical Data

1. **Spatial data**

- Point Object: School, hospital, settlement, bridge, tap stands etc
- Line objects: Roads, Drain, Canal, Electric line, W/S pipe lines, etc
- Polygon Objects: Forest, Lake, Cultivates area etc

2. **Non-spatial (Attribute data) - Like as Excel or Dbase**

- These are the properties of the spatial data. Each component has number of important properties which is presented in tabular form and also called attributes.