

Data Communication

AH1102 Information Technology

What is Information Technology (IT)?

Information Technology (IT)

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graph TD; A["Information Technology (IT)"] --- B["Computer Technology"]; A --- C["Communication Technology"];
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Computer Technology

To collect, store, process, search, retrieve, and present electronic information to meet the needs of various kinds of users, e.g., computer hardware & software, PDAs, printers, groupware, smart cards....

Communication Technology

To deliver, disseminate, exchange, transmit, and receive electronic information in local, regional or global contexts, e.g., networks, fax machines, cell phones, email, satellites, GPS, Internet, telephony,

Data Communication

What is Data?

- Data refers to information presented in whatever form is agreed upon by the parties creating and using the data.
- Signals are electric or electromagnetic representation of data

Data Communication

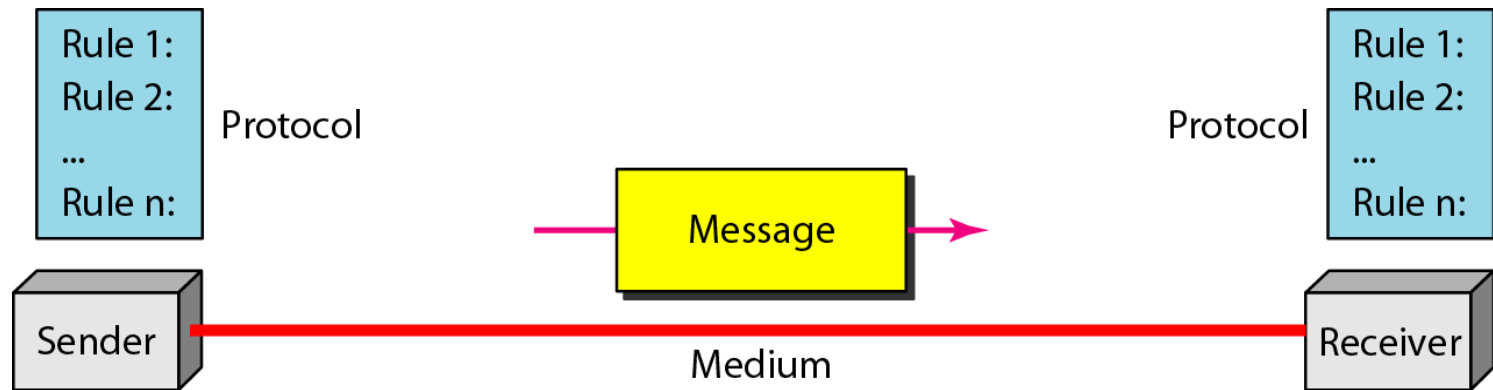
- Refers to the exchange of data between a source and a receiver
- Data formats – analog or digital or both
- Data travels across the medium
 - Wired medium
 - Wireless medium

Fundamental Characteristics of Data Communication

- Delivery
 - Data must be delivered to the correct destination.
- Accuracy
 - Data must be delivered accurately
- Timeliness
 - system must deliver data in a timely manner
- Jitter
 - Refers to the variation in the packet arrival time

Components of a Data Communication System

- Message
- Sender
- Receiver
- Transmission Medium
- Protocol



Components of a Data Communication System

- **Message**
 - Information (data) to be communicated
 - Text, numbers, pictures, audio and video
- **Sender**
 - The device that sends the data message
 - Computer, workstation, telephone handset, video camera
- **Receiver**
 - The device that receives the message
 - Computer, workstation, telephone handset, television
- **Transmission Medium**
 - The physical path which a message travels from sender to receiver
 - Twisted-pair wire, co-axial cable, fiber optic cable and radio waves
- **Protocol**
 - Set of rules that govern data communication.
 - Represents an agreement between communicating devices

Data Transmission Modes

- Simplex
 - Communication is unidirectional
 - Only one of the two devices on a link can transmit; the other can only receive (eg.: keyboard, traditional monitors)
 - Can use the entire capacity of the channel to send data in one direction

Data Transmission Modes

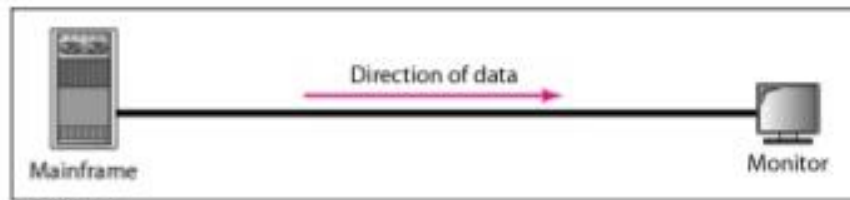
- Half Duplex
 - Each station can both transmit and receive, but not at the same time
 - When one device is sending , the other can only receive
 - The entire capacity of a channel is taken over by whichever of the two devices transmitting at the time (eg.: Walkie-talkies)

Data Transmission Modes

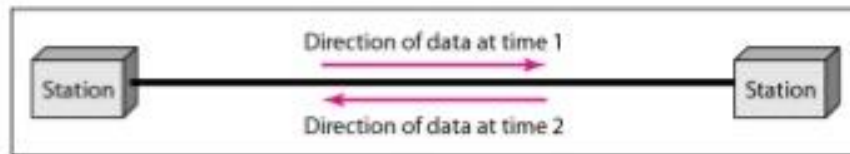
- Full duplex
 - Both stations can transmit and receive simultaneously
 - Signals going in one direction share the capacity of the link with signals going in the other direction
 - This sharing can occur in two ways:
 1. Link must contain two physically separate transmission paths one for sending and the other one for receiving
 2. Capacity of the channel is divided between signals travelling in both directions

Data Transmission Modes

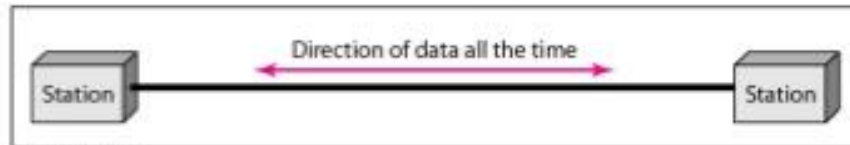
- Simplex, Half-duplex and Full duplex



a. Simplex



b. Half-duplex



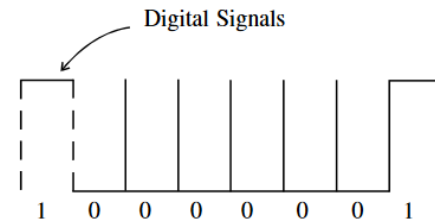
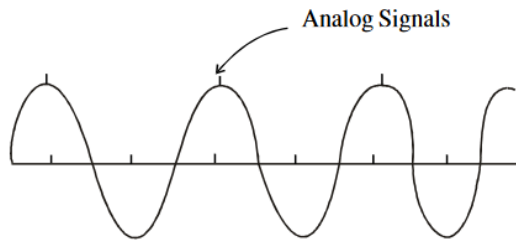
c. Full-duplex

Rate of Data Transmission

- The speed with which data can be transmitted from one device to another.
- Data rates are often measured in megabits (million bits) or megabytes (million bytes) per second. (Mbps and MBps).
- Another term for data transfer rate is **throughput**.

Analog and Digital Transmission

- Data can be analog or digital.
- Analog data refers to continuous (human voice)
- Digital data refers to information that has discrete state (data stored in a computer)



Protocols

- A set of predetermined rules that govern data communication
- Define what is communicated, how it is communicated and when it is communicated
- Key elements of a protocol are syntax, semantics, and timing

Protocols

- Syntax
 - The term refers to the structure or the format of the data, meaning the order in which they are presented
- Symantics
 - Refers to the meaning of each section of bits
 - How is a particular pattern to be interpreted, and what action to be taken based on that?
- Timing
 - When data should be sent and how fast they can be sent

Protocols

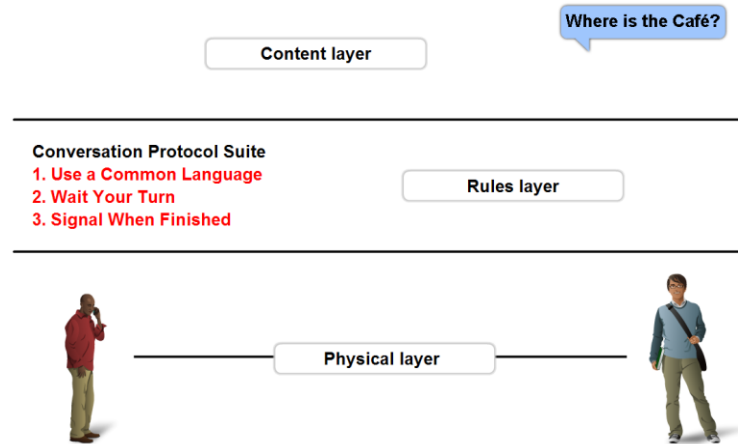
- Protocol Suite

A group of inter-related protocols that are necessary to perform a communication function

- Implemented in software and hardware that is loaded on each host and network device

Function of Network Protocol

- Network protocols are used to allow devices to communicate successfully



A Protocol performs the following functions:

1. **Data sequencing.** It refers to breaking a long message into smaller packets of fixed size. Data sequencing rules define the method of numbering packets to detect loss or duplication of packets, and to correctly identify packets, which belong to same message.

2. **Data routing.** Data routing defines the most efficient path between the source and destination.
3. **Data formatting.** Data formatting rules define which group of bits or characters within packet constitute data, control, addressing, or other information.

4. **Flow control.** A communication protocol also prevents a fast sender from overwhelming a slow receiver. It ensures resource sharing and protection against traffic congestion by regulating the flow of data on communication lines.

5. **Error control.** These rules are designed to detect errors in messages and to ensure transmission of correct messages. The most common method is to retransmit erroneous message block. In such a case, a block having error is discarded by the receiver and is retransmitted by the sender.

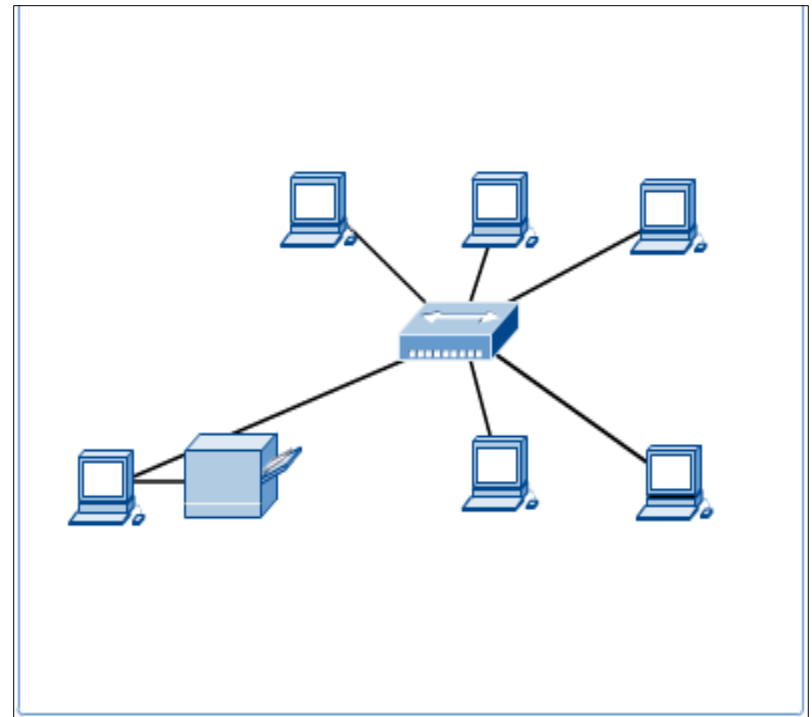
6. **Precedence and order of transmission.** These rules ensure that all the nodes get a chance to use the communication lines and other resources of the network based on the priorities assigned to them.
7. **Connection establishment and termination.** These rules define how connections are established, maintained and terminated when two nodes of a network want to communicate with each other.

8. **Data security.** Providing data security and privacy is also built into most communication software packages. It prevents access of data by unauthorized users.
9. **Log information.** Several communication software are designed to develop log information, which consists of all jobs and data communications tasks that have taken place. Such information may be used for charging the users of the network based on their usage of the network resources.

INTRODUCTION TO COMPUTER NETWORKS

Computer Networks

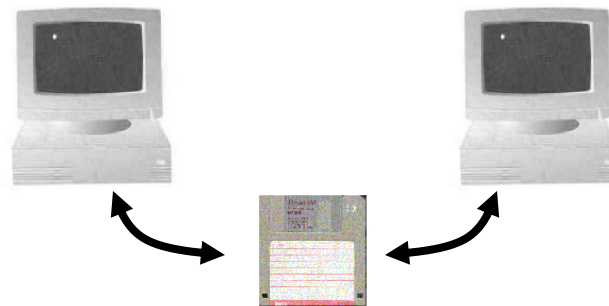
- Two or more computers or communications devices connected by **transmission media and channels** and guided by **a set of rules** for communication purposes that allow users to communicate with each other and share applications and data.



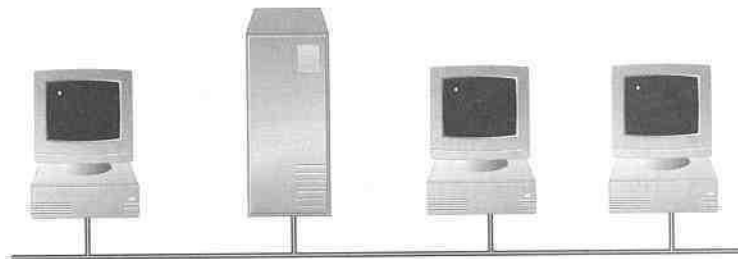
Why Networking?

- **Sharing information — i.e. data communication**

- Do you prefer these?



- Or this?



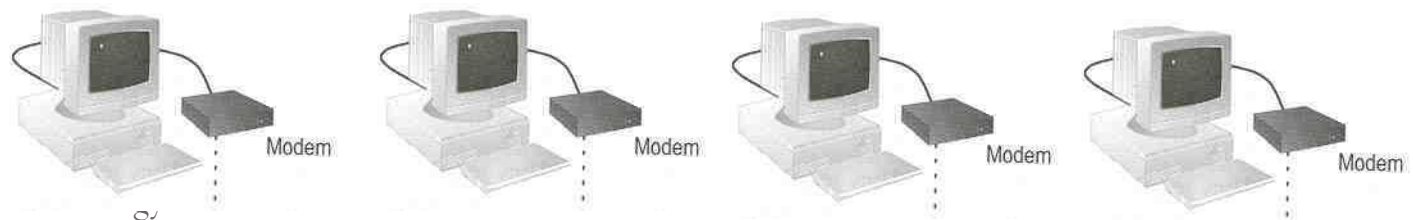
- **Sharing hardware or software**

- E.g. print document



- **Centralize administration and support**

- E.g. Internet-based, so everyone can access the same administrative or support application from their PCs



How many kinds of Networks?

- **Depending on one's perspective, we can classify networks in different ways**
 - Based on transmission media: Wired (UTP, coaxial cables, fiber-optic cables) and Wireless
 - Based on network size: LAN and WAN (and MAN)
 - Based on management method: Peer-to-peer and Client/Server
 - Based on topology (connectivity): Bus, Star, Ring ...

Based on transmission media

- Two main categories:
 - Guided — wires, cables
 - Twisted-Pair cables:
 - Unshielded Twisted-Pair (UTP) cables
 - Shielded Twisted-Pair (STP) cables
 - Coaxial cables
 - Fiber-optic cables
 - Unguided — wireless transmission, e.g. radio, microwave, infrared, sound

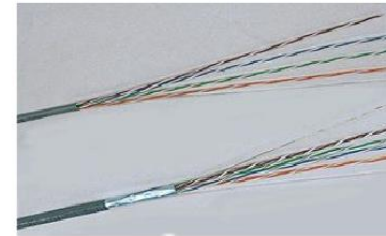
Network Media

- The channel over which a message travels

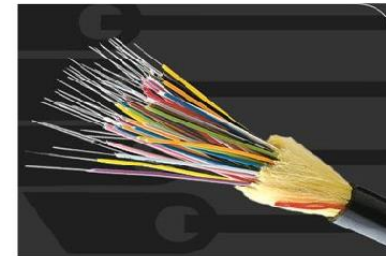
Network Media



Copper



Fiber Optics



Wireless



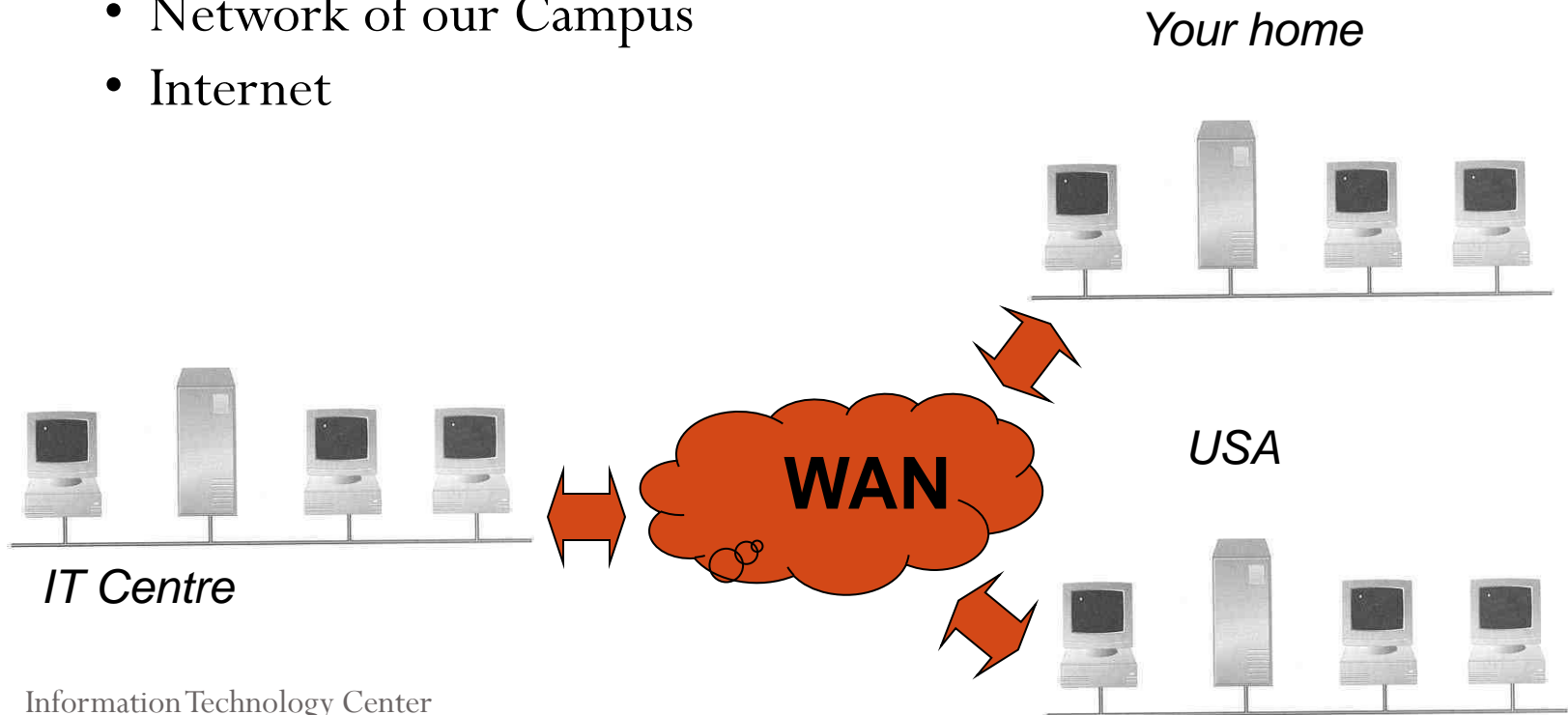
Based on network size

LAN and WAN

- **Local Area Network (LAN)**
 - Small network, short distance
 - A room, a floor, a building
 - Limited by no. of computers and distance covered
 - Usually one kind of technology throughout the LAN
 - Serve a department within an organization
 - Examples:
 - Network inside the Student Computer lab
 - Network inside a small office
 - Network inside your home

Wide Area Network (WAN)

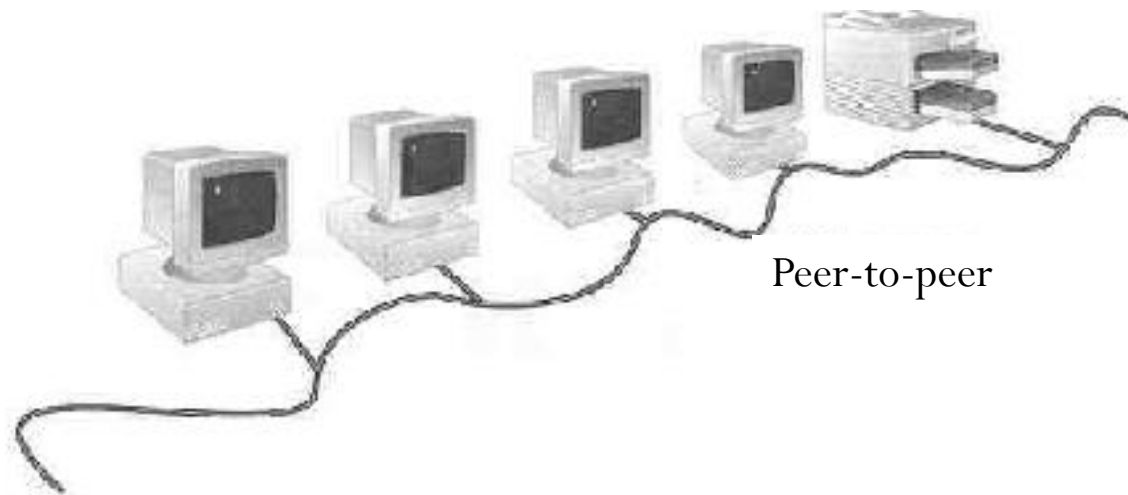
- A network that uses long-range telecommunication links to connect 2 or more LANs/computers housed in different places far apart.
 - Towns, states, countries
- Examples:
 - Network of our Campus
 - Internet



Based on management method

Peer-to-Peer Networks

- Peer-to-peer network is also called workgroup
- No hierarchy among computers \Rightarrow all are equal
- No administrator responsible for the network



- Advantages of peer-to-peer networks:
 - Low cost
 - Simple to configure
 - User has full accessibility of the computer
- Disadvantages of peer-to-peer networks:
 - May have duplication in resources
 - Difficult to uphold security policy
 - Difficult to handle uneven loading
- Where peer-to-peer network is appropriate:
 - 10 or less users
 - No specialized services required
 - Security is not an issue
 - Only limited growth in the foreseeable future

Based on management method

Clients and Servers

- **Network Clients (Workstation)**
 - Computers that request network resources or services
- **Network Servers**
 - Computers that manage and provide network resources and services to clients
 - Usually have more processing power, memory and hard disk space than clients
 - Run Network Operating System that can manage not only data, but also users, groups, security, and applications on the network
 - Servers often have a more stringent requirement on its performance and reliability

- Advantages of client/server networks
 - Facilitate resource sharing – centrally administrate and control
 - Facilitate system backup and improve fault tolerance
 - Enhance security – only administrator can have access to Server
 - Support more users – difficult to achieve with peer-to-peer networks

- Disadvantages of client/server networks
 - High cost for Servers
 - Need expert to configure the network
 - Introduce a single point of failure to the system

Based on topology

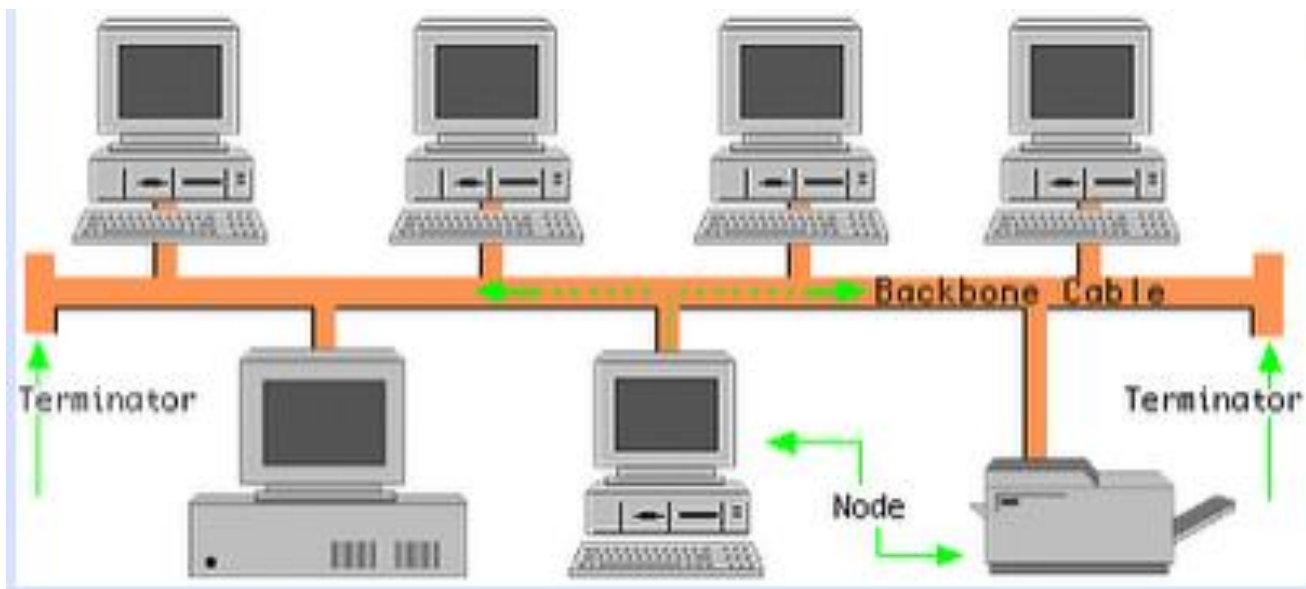
Network Topologies

- **Physical topology** - the physical design of a network including the devices, location and cable installation.
- **Logical topology** - how data is actually transferred in a network as opposed to its physical design

Network Topologies

- Bus Topology
- Ring Topology
- Star Topology
- Mesh Topology

Bus Topology



Bus Topology

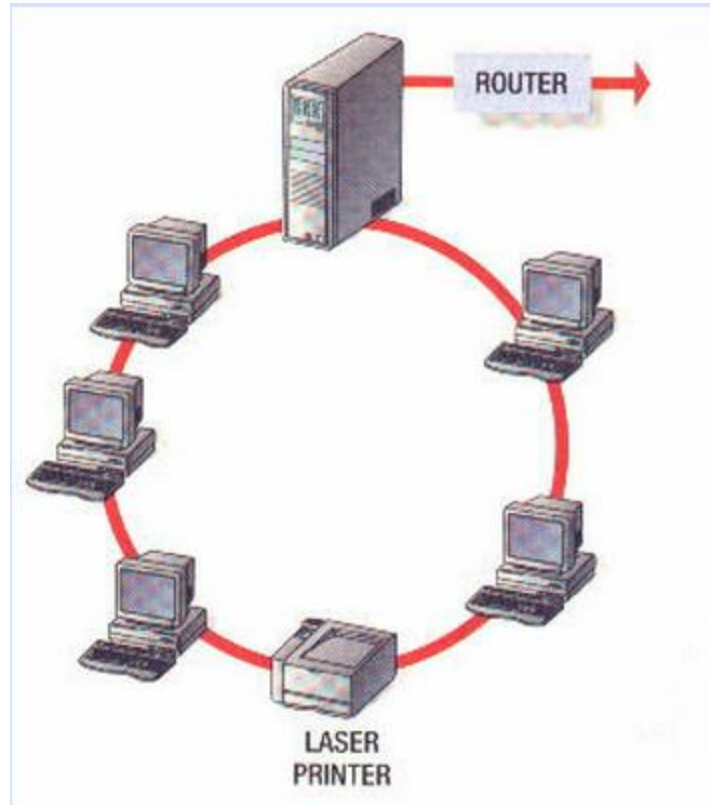
Advantages

- Easy implementation. New devices can be added to the backbone or to the existing nodes.
- Failure of a node doesn't affect the entire LAN.
- No disruptions to the network when connecting or removing devices.
- Network can easily be extended, by adding new devices to the backbone or existing nodes.

Disadvantages

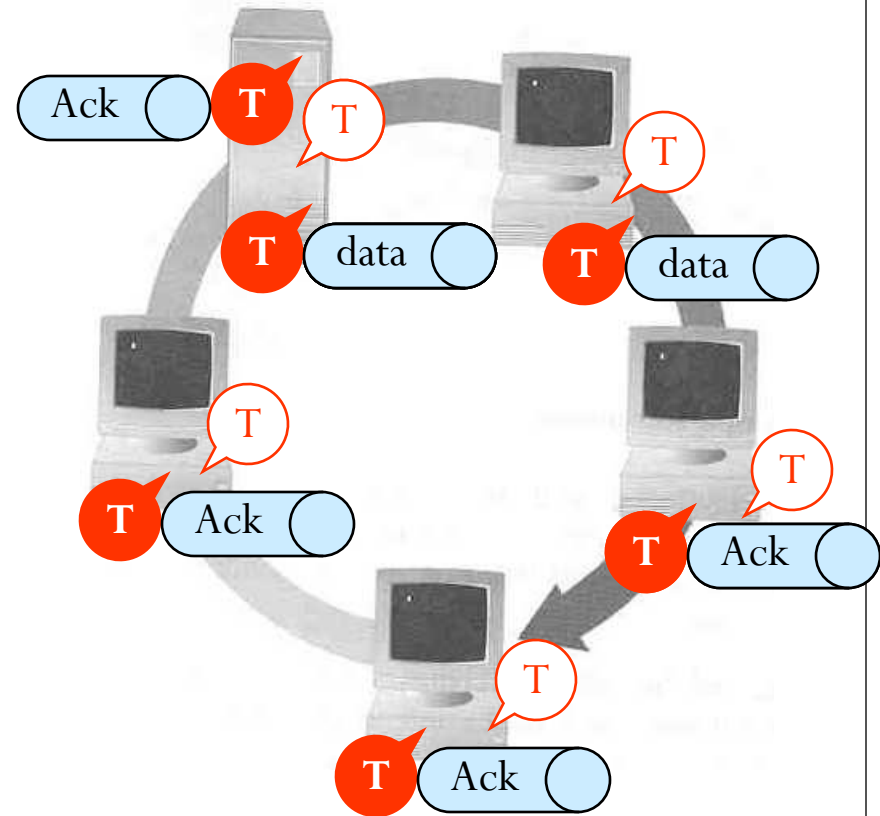
- If the backbone fails, the entire bus network will be affected.
- Network speed decreases when the number of nodes increases.
- Troubleshooting is difficult when one of the nodes fails.

Ring Topology



Ring Topology

- Every computer serves as a repeater to boost signals
- Typical way to send data:
 - Token passing
 - only the computer who gets the token can send data



Ring Topology

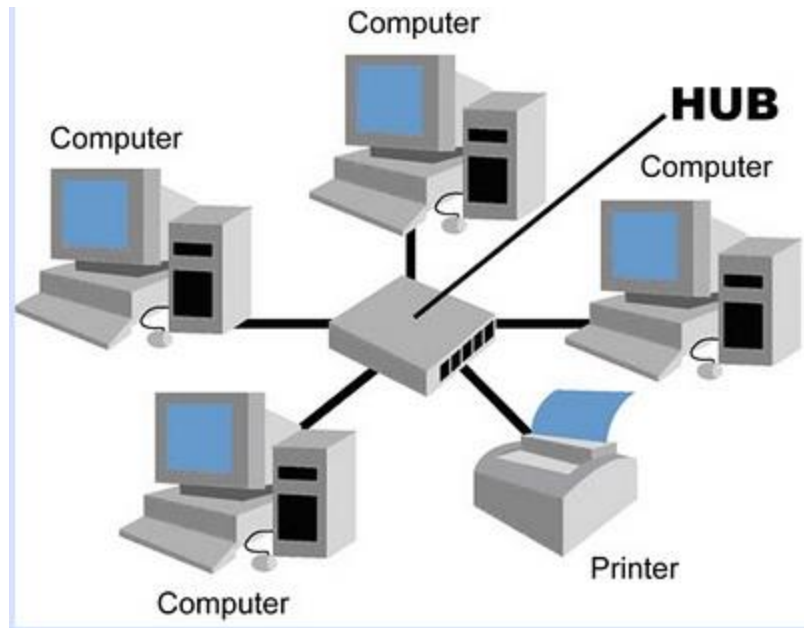
Advantages

- Troubleshooting is easy when one of the nodes fails.
- Repair or remove the failing nodes and the network will continue to function.

Disadvantages

- Implementation is difficult. Network administrator has to terminate the entire network to install a new node between existing nodes.
- A failing node will affect the entire LAN.
- Connecting or removing devices is difficult because network administrator needs to terminate the network in order to do it.
- Network speed decreases when the number of nodes increases.

Star Topology



Star Topology

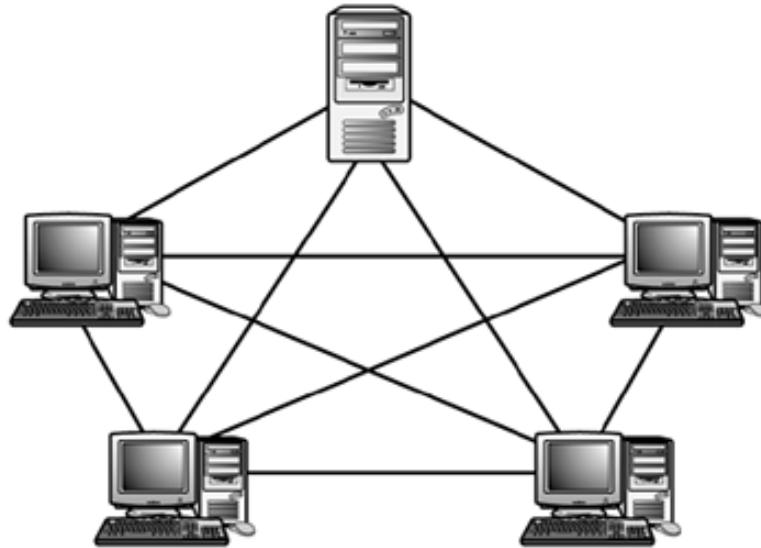
Advantages

- It is easy to implement. You only add nodes to the host.
- The failure of a node does not affect the entire LAN.
- There are no disruptions to the network when connecting or removing devices.
- The network can be extended by adding new devices to the host or nodes.
- Troubleshooting is easy when the host fails. Simply repair or replace the host and the network will continue to function.

Disadvantages

- If the host fails, the entire LAN will be affected.
- Network speed decreases when the number of nodes increases.
- Troubleshooting is difficult when one of the nodes fails.
- A host must be installed to control the network.

Mesh Topology



Mesh Topology

Advantages

- Provides redundant paths between devices
- The network can be expanded without disruption to current users.

Disadvantages

- Requires more cable than the other LAN topologies.
- Complicated implementation.

Network Technologies

Ethernet

- Based on bus topology; but can be used in star topology;
- Higher speed: first Fast Ethernet, then Gigabit Ethernet;
- Most popular: inexpensive, easy to install and maintain.

Token Ring

- Based on a ring topology; but can use a star topology;
- Token-passing scheme to prevent collision of data;
- The second most widely-used protocol after Ethernet.

TCP/IP

- Based on client/server model of network computing;
- Uses packet switching technique for data transmission;
- Commonly used for Internet applications.

WAP

- Uses client/server model of network computing;
- Allows wireless devices to access the Internet and WWW;
- Meets increasing demands for wireless Internet access.

Internet

What is the Internet?

The Internet is a global network of computer networks utilizing a suite of protocols called TCP/IP (Transmission Control Protocol/Internet Protocol) that supports interconnection of a number of different computer networks

What is the Internet?

The Internet covers large, international Wide Area Networks (WAN's) as well as smaller Local Area Networks (LAN's) and individual computers connected to the Internet worldwide

What is the Internet?

The Internet supports communication and sharing of data, and offers vast amount of information through a variety of services and tools

What are the major Internet tools and services?

- Electronic mail (email)
- Newsgroups
- Internet Relay Chat (IRC)
- Telnet
- File Transfer Protocol (FTP)
- World Wide Web (www)

What are the major Internet tools and services?

E-mail

- The most popular use of the Internet
- Available for free on the Web
 - Yahoo Mail, Gmail, Hotmail, Eudoramail
- Valid e-mail address consists of a username and a domain name separated by the @ sign
 - ex. abc@mail.com

What are the major Internet tools and services?

Newsgroups

- Service dedicated to discussions on a particular topic through posted articles
- Accessible through newsreaders
- Names signify to users the topic of discussion
 - ex.
 - www.nurse-enter.com/studentnurse/ngroup.html
 - <http://www.vetclick.com>

What are the major Internet tools and services?

IRC (Internet Relay Chat)

- Allows real-time text based communication through the Internet
- Organized by topic of interest into “channels”
- Discussion occurs in “chatrooms”
- Some Websites have built-in chatrooms

What are the major Internet tools and services?

Telnet

- Service that allows one computer to access another computer
- Enables the user to exchange data and issue commands on the other computer, the Telnet host
- Mainly used by libraries to allow access to information stored in their computers

What are the major Internet tools and services?

FTP (File Transfer Protocol)

- Allows the transfer or copying of files from one computer to another
- Ideal for procuring or sending files to a remote computer
- FTP Programs available freely
- Modern browsers have built in FTP capabilities

What are the major Internet tools and services?

World Wide Web (www)

- Invented in 1991 by Tim Berners-Lee, the web is the fastest-growing Internet service.
- Based on HTML (Hyper Text Markup Language) allowing users to access data in multimedia format
- Simplest unit is the Webpage, primarily a document encoded in HTML format that can be accessed by using a browser
- HTML links contents of a Webpage to each other as well as to other Web pages through a hyperlink
- Each page has an address, a Uniform Resource Locator (URL)

What is the Internet's history?

- The Internet grew from ARPANET the first computer network designed for the Advanced Research Projects Agency (ARPA) of the U.S Department of Defense
- ARPA sponsored research on interconnecting geographically remote computers to allow communication and sharing of data and resources
- The goal was to create a communications network that could exist even if parts of it was incapacitated

What is the Internet's history?

- One of the early developments that proved significant to the success of ARPANET (which later on becomes the Internet) were “packet switching” and “TCP/IP”
- Packet switching involves digital systems that transmit data in small packets that use the best current path to their destination
- TCP/IP is the core Internet protocol that allows computers to communicate with each other

What is the Internet's history?

- Realizing the value of interconnected computers the academic community started with its own research network
- The NSFNet, created and named for the National Science Foundation, linked academic networks that connected universities and research organizations around North America.
- Networks from Europe and other countries were connected to NSFNet making it the backbone of the Internet.

What is the Internet's history?

- ARPANET was decommissioned and the management of the Internet was passed on to the NSFNET
- Restriction on commercial use was lifted
- The emergence of World Wide Web, and Mosaic brought an unprecedented growth to the Internet
- NSFNET reverts back to a research project, leaving the Internet in commercial hands and its management to independent organizations

How does the Internet work?

- Protocols – standardized rules that define how computers communicate and exchange data
- IP address – unique number used to identify computers on the Internet
- Domain name – structured naming system to locate computers on the Internet
- URL – uniform naming scheme that specifies unique addresses of Internet resources
- Client and server – computing architecture used by most Internet services

How does the Internet work?

TCP/IP (Transmission Control Protocol / Internet Protocol)

- The Internet is a packet-switching network that uses TCP/IP as its core protocol
- TCP/IP is a suite of protocols that govern network addresses and the organization and packaging of the information to be sent over the Internet
 - TCP – flow control and recovery of packets
 - IP – addressing and forwarding of individual packets

How does the Internet work?

Internet Protocols

- HTTP (Hypertext Transfer Protocol Protocol) - for accessing and transmitting World Wide Web documents
- FTP (File Transfer Protocol Protocol) - for transferring files from one computer to another
- Telnet Protocol - allows users to logon to a remote computer
- SMTP (Simple Mail Transfer Protocol) for sending and managing electronic mails (e-mail)

How does the Internet work?

IP address

- IP address is a unique address assigned to each computer connected to the Internet
- It is used by TCP/IP to route packets of information from a sender to a location on the Internet
- IP address consist of four sets of numbers ranging from 0 to 255 Ex. 249.7.13.53

How does the Internet work?

IP address

- 192.168.213.4
- The first two number sets designate the network
- The third number set identifies the local network
- The fourth number set identifies the particular machine

How to find the IP Address of your Computer?

- ipconfig

```
C:\WINDOWS\system32\cmd.exe
C:\>ipconfig

Windows IP Configuration

Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix  . : ceit.pdn.ac.lk
    IP Address. . . . .               : 192.168.213.215
    Subnet Mask . . . . .             : 255.255.255.0
    IP Address. . . . .               : fe80::211:85ff:febb:a2ea%4
    Default Gateway . . . . .         : 192.168.213.254

Tunnel adapter Teredo Tunneling Pseudo-Interface:

    Connection-specific DNS Suffix  . :
    IP Address. . . . .               : fe80::ffff:ffff:fffd%5
    Default Gateway . . . . .         :

Tunnel adapter Automatic Tunneling Pseudo-Interface:

    Connection-specific DNS Suffix  . : ceit.pdn.ac.lk
    IP Address. . . . .               : fe80::5efe:192.168.213.215%2
    Default Gateway . . . . .         :

C:\>
```

How to check the Network Connectivity?

- ping

```
C:\>ping 192.168.213.222

Pinging 192.168.213.222 with 32 bytes of data:

Reply from 192.168.213.222: bytes=32 time<1ms TTL=63
Reply from 192.168.213.222: bytes=32 time<1ms TTL=64
Reply from 192.168.213.222: bytes=32 time<1ms TTL=64
Reply from 192.168.213.222: bytes=32 time<1ms TTL=64

Ping statistics for 192.168.213.222:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>
```

ping

```
C:\>ping 192.168.213.222
```

```
Pinging 192.168.213.222 with 32 bytes of data:
```

```
Destination host unreachable.  
Destination host unreachable.  
Destination host unreachable.  
Destination host unreachable.
```

```
Ping statistics for 192.168.213.222:
```

```
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

```
C:\>
```


nslookup

```
C:\WINDOWS\system32\cmd.exe

C:\>nslookup
Default Server:  s1.ns.slt.lk
Address:  203.115.0.18

> www.ceit.pdn.ac.lk
Server:  s1.ns.slt.lk
Address:  203.115.0.18

Non-authoritative answer:
Name:    www.ceit.pdn.ac.lk
Address:  203.94.81.83

> www.dailynews.lk
Server:  s1.ns.slt.lk
Address:  203.115.0.18

Non-authoritative answer:
Name:    origin.dailynews.lk
Address:  203.143.20.39
Aliases:  www.dailynews.lk

> 192.248.40.17
Server:  s1.ns.slt.lk
Address:  203.115.0.18

Name:    www.ee.pdn.ac.lk
Address:  192.248.40.17

> exit
C:\>
```