

FUNDAMENTALS OF NETWORKING

COURSE CODE: ITSE-2121

ACADEMIC YEAR: 2019/20 (SEMESTER II)



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CHAPTER-1 INTRODUCTION TO COMPUTER NETWORKS

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Definition of Computer Network

What is a Network?

- A **network** consists of two or more entities, or objects, sharing resources and information

Human Networks

- **Family Network**
 - Most people belong to a family share their resources and information
 - As the family grows, so does the network
- **Peer Network**
 - Outside the family
- **Contact Network**
 - A list of friends and associates who will help you find the perfect job.
 - The more people you meet and get to know, the better your chances of obtaining job



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Definition of Computer Network

Computer Networks

- A **computer network** consists of two or more computing devices (computers, printers, switches, routers and other equipment) that are connected together in various ways in order to communicate and share available resources (data, software, hardware).
- The generic term **node** or **host** refers to any device on a network.
- Usually, the connections between computers in a network are made using physical **wires** or cables. However, some connections are **wireless**, using radio waves or infrared signals
- The best-known computer network is the **internet**.
 - Network of computer networks

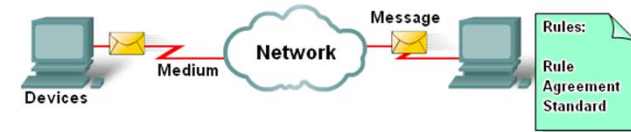
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Definition of Computer Network

- A network is the interconnection of a set of devices that communicate and share information.
- A device can be a
 - Host (or an end system) such as a desktop, laptop, smart phone.
 - Connecting device such as a router, which connects the network to other networks, a switch, which connects devices together, a modem (modulator-demodulator), which changes the form of data, and so on.
 - These devices in a network are connected using wired or wireless transmission media such as cable or air



Elements of a Network



Four elements of a network:

- Rules
- Medium
- Messages
- Devices

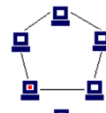
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Types of Network Topology

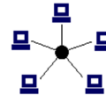
- Bus Topology



- Ring Topology



- Star Topology



- Mesh Topology

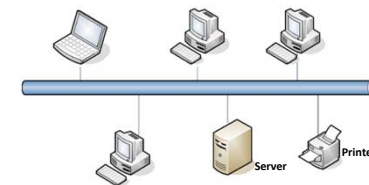


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Types of Network Topology

Bus Topology

- All computers and devices connected to **central cable** or **bus**.
- Each device connected to the bus can send signals along the bus to other connected devices.
- Any device wanting to communicate with another device on the network sends a **broadcast** message onto the bus and only the intended recipient accepts and processes the message.

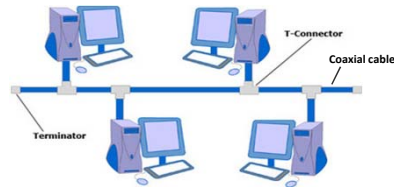


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Types of Network Topology

Bus Topology

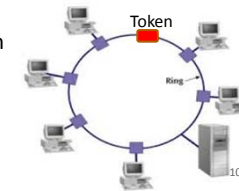
- Messages being sent from many hosts along the same bus can lead to data **collision** on the bus.
- A **terminator** is placed at each end of the cable to absorb any signal that reaches it to stop signals bouncing back and causing errors.
- The bus topology is easy to setup.



Types of Network Topology

Ring Topology

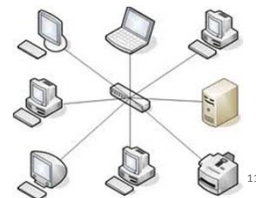
- In a ring topology, devices are connected to each other in a **closed loop (ring)**.
- Data is transmitted using **token**.
 - A **token** travels around the ring and stops at each node in turn.
 - Any node that wishes to transmit data must attach that data to the **token**.
 - The **token** is then passed along by each node until it reaches its intended destination.
- There is no **data collision** since the token travels around the ring in one direction.



Types of Network Topology

Star Topology

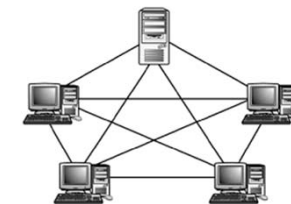
- Each device is connected to the **central device**, hub/switch
- All data transferred from one computer to another passes through the hub.
- If one of the cable connecting a node to the central device fails, this does not affect any other nodes.
- The weakness of a star topology is if the central device fails then the network fails.



Types of Network Topology

Mesh Topology

- In the mesh topology each computer are connected with each other by a separate cable.
 - Creates point to point connection to every device on network.
- If one cable fail data always has alternative path to get to its destination.



Types of Network Topology

Network Topology	Advantages	Disadvantages
Bus	<ul style="list-style-type: none"> • Easy to connect a computer or peripheral to a linear bus. • Requires less cable length than a star topology. • Very easy to extend 	<ul style="list-style-type: none"> • Entire network shuts down if there is a break in the main cable. • There is data collision
Ring	<ul style="list-style-type: none"> • Fault diagnostic and isolation are relatively easy • The transmission of data is relatively simple as packets travel in one direction only. 	<ul style="list-style-type: none"> • Data packets must pass through every computer between the sender and receiver therefore, this makes it slower. • If any of the nodes fail then the ring is broken and data cannot be transmitted successfully. • Network configuration can be technically complicated

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Types of Network Topology

Network Topology	Advantages	Disadvantages
Star	<ul style="list-style-type: none"> • Easy to setup • Easy to detect faults and to remove parts • No disruptions to the network when connecting or removing devices 	<ul style="list-style-type: none"> • Requires more cable length than a linear topology. • If the hub fails, nodes attached are disabled • More expensive than linear bus topologies because of the cost of the hub and the cable
Mesh	<ul style="list-style-type: none"> • Provide redundant path between device • The network can be expanded without disruption 	<ul style="list-style-type: none"> • Require more cable then other topology • Complicated implementations. • Difficulty of cabling so many redundant connections

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Types of Computer Network

- Based on the size and the coverage area, networks are categorized into the following main types:
 - **Local Area Networks (LANs)**
 - **Metropolitan Area Networks (MANs)**
 - **Wide Area Networks (WANs)**

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Types of Computer Networks

Local Area Network (LANs)

- **A local area network (LAN)** is a network that connects computers and devices in a limited geographical area/a relatively small area such as a home, school, single office building, or closely positioned group of buildings.
- LANs are commonly considered the building blocks for creating larger networks.
- LANs are inexpensive to design, install, and troubleshoot.
- Different types of topologies such as star, bus, ring, can be used
- Wired LANs are most likely based on Ethernet technology.

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Types of Computer Networks

Metropolitan Area Networks (MANs)

- When the network spans the distance of a typical metropolitan city, it can be referred to as a **metropolitan area network (MAN)**.
- It is relatively larger than LAN and extends across a city or a metropolitan.
- It is created by connecting two or more LANs located at different locations in a city.

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Types of Computer Networks

Wide Area Networks (WANs)

- A wide area network (WAN) is a computer network that covers a large geographic area such as country, or spans even intercontinental distances.
- A WAN uses different communication channels that combines many types of media, such as telephone lines, satellite links and similar channels.
- A WAN often makes use of transmission facilities provided by common carriers **ISP**, such as telephone companies.
- One of the most prominent examples of the existing WANs is the **Internet**.

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Benefits of Computer Networks

Fast Communication – Information can be exchanged at a very fast speed

- Provide a very rapid method for sharing and transferring files.
- Without a computer network, files are shared by copying them to floppy disks, then carrying or sending the disks from one computer to another ... very time-consuming.
 - **Sneakernet** era, during the late '70s and early '80s, often a PC was used as a **stand-alone computer** and operated independently from other computers
- Computer Networks erase physical location and time constraints
- You can communicate almost instantly to anywhere in the world that is connected to your network

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Benefits of Computer Networks

Information and Resource sharing - Through a computer network, data, software and hardware resources can be shared irrespective of the physical location of the resources and the user.

- E-mail
- Peripherals such as printers
- Software/Applications – sharing of expensive software and databases
 - Software as a services, a third party provider hosts applications and makes them available to customers over the internet
 - Sharing software resources reduces the cost of software installation, saves space on hard disk.
- Storage – storing files/data centrally, not on your own local computer

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Benefits of Computer Networks

Reliability – A file can have its copies on two or more computers of the network.

Reduced Cost – Sharing resources reduces the cost

- The network version of most software programs are available at considerable savings when compared to buying individually licensed copies.

Centralized Software Management

- All of the software or files can be installed/loaded on one computer (the server).
- This eliminates that need to spend time and energy installing updates and tracking files on independent computers.

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Benefits of Computer Networks

Flexible Access

- You can access your files/software anywhere, so you can work cooperatively through the network. Example google Doc, overleaf...

Improved Security

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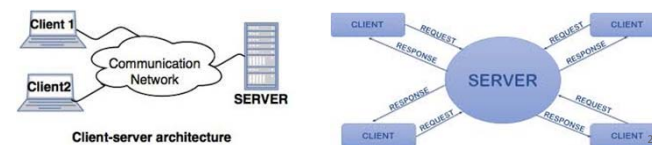
Network Architectures

- The architecture of a network determines how the devices in the network communicate.
- The commonly used architectures for computer networks are:
 - **Client-Server Architecture**
 - **Peer-to-Peer Architecture**

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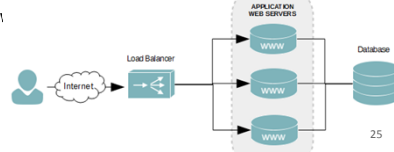
Client-Server Architecture

- A network architecture in which each computer or process on the network is either a **client** or **server**.
 - Certain computers act as **servers** and other act as **clients**
- A **server** is simply a computer with high processing power that provides services to other computers/clients on the network when they request it.
- A **client** is a computer running a program that requests the service from a server to access the resources available on the server



Client-Server Architecture

- **Servers** are computers or processes that manage network resources (such as files, applications, shared devices) and ensure the security of the resources
- Types of servers: *Web server, Mail server, Proxy server, Database server, Telnet server, DNS server, FTP server, etc*
 - **Database server** A computer that process database queries
 - **File server** A computer that stores and manages files for multiple users on a network
 - **Web server** A computer dedicated to responding to requests (from the browser client) for



Client-Server Architecture

- **Clients** are applications that run on computers

Examples

- **E-mail client** an application that enables you to send and receive e-mails, e.g., Microsoft Outlook
- **A web browser** is a software application for accessing information on the World Wide Web.



- **Client-Server** based networks have become the standard models for networking

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Client-Server Architecture

Advantages:

- **Performance**
 - Servers are faster at sharing resources on the network
- **Centralized management**
 - Central file storage which allows all users to work from the same set of data and provides easy backup of critical data
 - Provide strong central security
- **Reliability**:- replicated servers

Disadvantages:

- Requires professional administration – A network administrator
- Requires expensive dedicated hardware and software
- Difficult to setup
- Clients rely on the servers for their operations

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Peer-to-Peer (P2P) Architecture

- In a **P2P** network, every computer plays the role of **client** and **server** at the same time, but no specialized servers exist.
 - All the computers are equal and they are known as **peers**.
- Each computer is responsible for making its own resources available to other computers on the network.
 - The user at each computer determines what data on that computer is shared on the network
- Each computer is responsible for implementing its own security.
- Since each computer functions as both a client and a server, there is **no administrator** responsible for the entire network.

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Peer-to-Peer Architecture

Advantages:

- No extra investment in server hardware or software
- Easy setup and low cost
- Little network administration required
- Ability of users to control resource sharing
- No reliance on other computers

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Peer-to-Peer Architecture

Disadvantages:

- Additional load on computers because of resource sharing
- Inability of peers to handle as many network connections as servers
- Lack of central management
 - No central point of storage for file archiving
 - Weak and intrusive security which makes large peer networks difficult to work with
- Requirement that users administer their own computers

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Transmission Technology

- Computer networks can be broadly categorized into two types based on transmission technologies:
 - **Broadcast Networks**
 - **Point-to-Point Networks**

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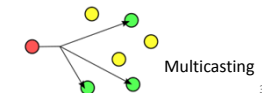
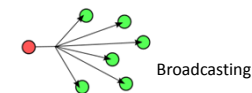
Transmission Technology

Broadcast Networks

- A single communication link is shared by all the machines on that network.
- When a message is transmitted, it can be received and processed by every machine on that network.
 - The **address field** within the message specifies the intended recipient.

Broadcasting:- Addressing the message to all destinations
(All nodes on the network)

Multicasting:- Supports transmission to a sub-set of machines



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Transmission Technology

Point-to-Point Networks

- Consists of many connections / intermediate devices between sender and receiver nodes.
 - The **switching nodes** to provide switching facility until the message reach the destination node
- Multiple routes of different lengths are possible
 - The routing algorithms are used to find a path from the source to destination

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Switching Techniques

- How data is transmitted across networks?
- Switching techniques are used for transmitting data across Networks.
 - Long distance transmission is typically done over a network of switched nodes
 - Data routed by being switched from node to node
- Three types of switching techniques
 - **Circuit Switching**
 - **Message Switching**
 - **Packet Switching**

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Switching Techniques

Circuit Switching

- Circuit switching establishes a dedicated physical connection, called a **circuit** between sender and receiver then the dedicated path will remain to exist during the communication.
- Message generated by the source station are transmitted along dedicated path.
- At each node, incoming message are routed or switched to the appropriate outgoing channel without excessive delay.

Fig: Circuit Switching

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Switching Techniques

Circuit Switching

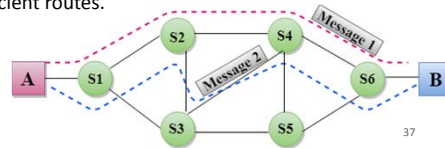
- Circuit switching has 3 phases:
 - **Establish**
 - **Transfer**
 - **Disconnect**
- Used in public telephone network for voice traffic (phone)
- Inefficient
 - A path is dedicated for duration of connection
- Set up (circuit establishment) takes time

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Switching Techniques

Message Switching

- In message switching technique, there is no a dedicated path between the sender and receiver.
 - A message is routed through intermediate nodes and each and every node **stores the message** and then **forward it to the next node....(store and forward network)**
 - The **destination address info** is appended to the message and the message is routed through the intermediate nodes based on the information available in the message.
 - The switching nodes are programmed in such a way so that they can provide the most efficient routes.

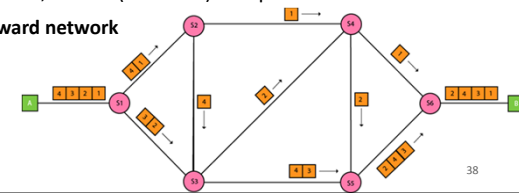


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Switching Techniques

Packet Switching

- Longer messages split into series of **packets**
- Every packet contains **control info (routing info)** in its headers such as **source address, destination address** and **sequence number** in addition to the user data
- Packets will travel across the network, taking **the shortest path** as possible.
- Packets are received, stored (buffered) and past on to the next node
 - **Store and forward network**

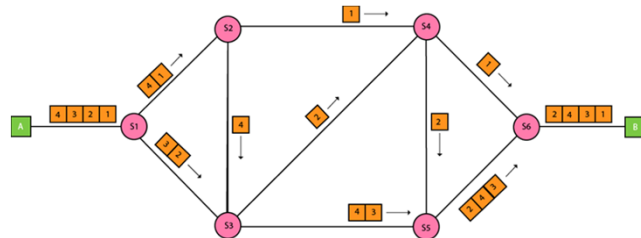


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Switching Techniques

Packet Switching

- All the packets are reassembled at the receiving end in correct order.
- If packet errors occur, the packet is retransmitted.
- If the correct order of the packets is reached, then the acknowledgment message will be sent.



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