DATA COMMUNICATION AND NETWORKING

Software Department – Fourth Class

Fundamentals of Data Communication

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Introduction

Data communications and networking are changing the way we do business and the way we live. Business decisions have to be made ever more quickly, and the decision makers require immediate access to accurate information. Why wait a week for that report from Germany to arrive by mail when it could appear almost instantaneously through computer networks? Businesses today rely on computer networks and internetworks, but before we ask how quickly we can get hooked up, we need to know how networks operate, what types of technologies are available, and which design best fills which set of needs.

Data Communications

When we communicate, we are sharing information. This sharing can be local or remote. Between individuals, local communication usually occurs face to face, while remote communication takes place over a distance. The term telecommunication, which includes telephony, telegraphy, and television, means communication at a distance. The word data refers to information presented in whatever form is agreed upon by the parties creating and using the data. Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable. For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs).

The effectiveness of a data communications system depends on four fundamental characteristics:

- **Delivery**: The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.
- **Accuracy**: The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.
- **Timeliness**: The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.
- **Jitter**: Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packets are sent every 3D ms. If some of the packets arrive with 3D-ms delay and others with 4D-ms delay, an uneven quality of the video is the result.

Components of Data Communication System

Data communication system has five Components: message, sender, receiver, medium and protocol (see Figure 1).

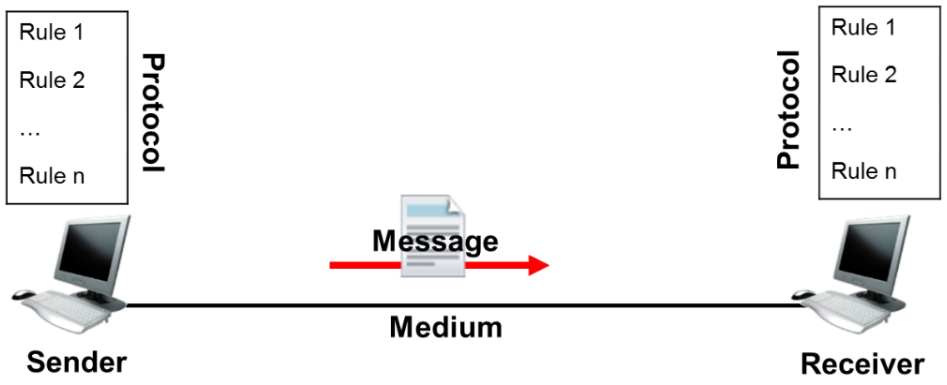

Figure 1. Components of Data Communication System

- **Message**: The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.
- **Sender**: The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

- **Receiver**: The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.
- **Transmission medium**: The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.
- **Protocol**: A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese.

Networks

A network is a set of devices (often referred to as nodes) connected by communication links. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network.

Figure 2. Set of devices represent as a network

Types of Connection

A network is two or more devices connected through links. A link is a communications pathway that transfers data from one device to another. For visualization purposes, it is simplest to imagine any link as a line drawn between two points. For communication to occur, two devices must be connected in some way to the same link at the same time. There are two possible types of connections: point-to-point and multipoint (see Figure 3).

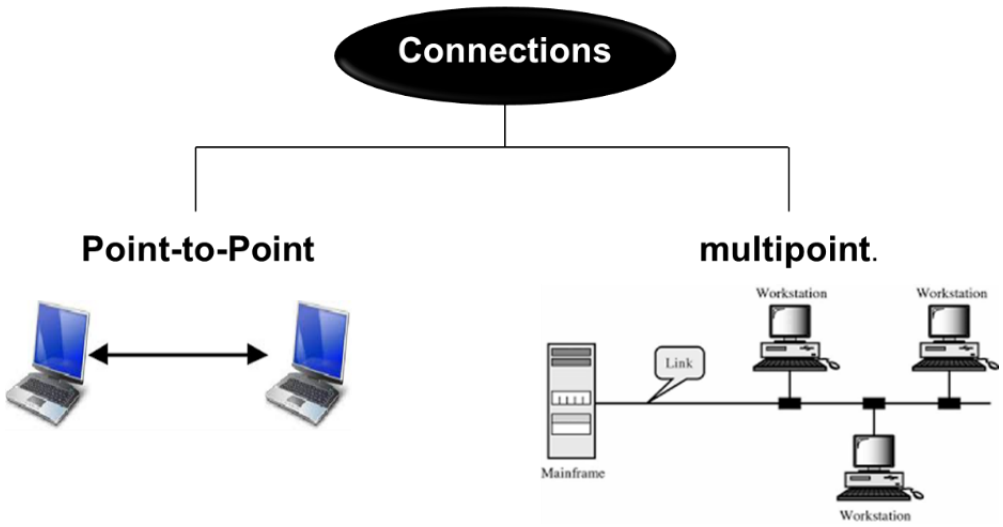

Figure 3. Types of Connections

Point-to-Point (P2P): A P2P connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices. Most P2P connections use an actual length of wire or cable to connect the two ends, but other options, such as microwave or satellite links, are also possible. When you change television channels by infrared remote control, you are establishing a P2P connection between the remote control and the television's control system.

Multipoint: A multipoint connection is one in which more than two specific devices share a single link. In a multipoint environment, the capacity of the channel is shared, either spatially or temporally. If several devices can use the link simultaneously, it is a spatially shared connection. If users must take turns, it is a timeshared connection.

Difference between Point-to-point and Multipoint Connection

Basis for Comparison	**Point-to-Point**	**Multipoint**
Link	There is dedicated link between two devices.	The link is shared between more than two devices.
Channel Capacity	The channel's entire capacity is reserved for the two connected devices.	The channel's capacity is shared temporarily among the devices connected to the link.
Transmitter and Receiver	There is a single transmitter and a single receiver.	There is a single transmitter and multiple receivers.
Example	Frame relay	Ethernet, ATM.

Network Topology

Topology of a network refers to the configuration of cables, computers, and other peripherals. On the other hand, topology should not be confused with logical topology which is the method used to pass information between workstations (computers). The main types of topologies are:

Star Topology: Star topology consists of a central node to which all other nodes are connected (see Figure 4).

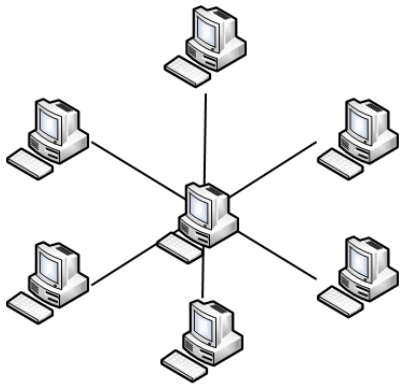

Figure 4. Start Topology

Bus Topology: Bus topology was the basis for most of the original LAN networks. Ideally suited for use with coaxial cable, the bus topology is a single length of transmission medium with nodes connected to it (see figure 5).

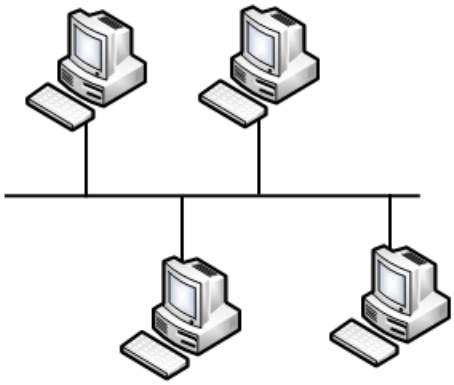

Figure 5. Bus Topology

Ring Topology: Ring topology uses lengths of transmission media to connect the nodes; each node is attached to its neighbor. The transmission signal moves around the ring in one direction and is repeated, instead of just passed, as it moves from node to node. When a station transmits a data message, the transmission is picked up by the next station on the ring, examined, and then retransmitted to the downstream neighbor. This process is continued until the transmitted signal is

returned to the host that started the transmission, which then removes the data from the network (see Figure 6).

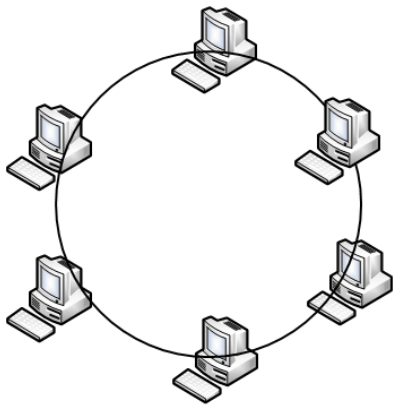

Figure 6. Ring Topology

Tree Topology: A tree topology combines the characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable. Tree topologies allow for the expansion of an existing network (see Figure 7).

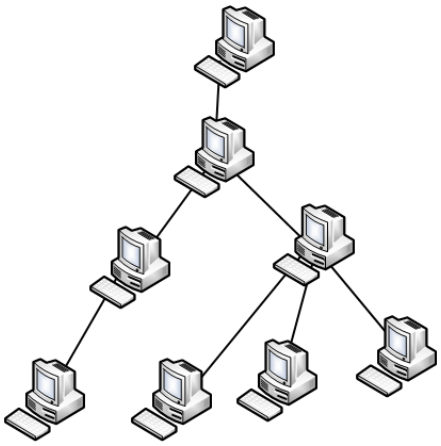

Figure 7. Tree Topology

Table below shown the advantage and disadvantage for each topology.

Topology	Advantage	Disadvantage
Start Topology	• Less damage in case of a single computer failure as it does not affect the entire network. • Easy to connect new nodes or devices. In star topology new nodes can be added easily without affecting rest of the	• More cables are required to be connected because each computer individually connects to the central server. • Single point of failure in case the server get down.

	network. Similarly components can also be removed easily. • Centralized management. It helps in monitoring the network. • Failure of one node or link doesn't affect the rest of network. At the same time its easy to detect the failure and troubleshoot it.	• Too much dependency on central device has its own drawbacks. If it fails whole network goes down. • The use of hub, a router or a switch as central device increases the overall cost of the network. • Performance and as well number of nodes which can be added in such topology is depended on capacity of central device.
Bus Topology	• It is easy to connect a device to the network. • It is cheaper than other network options. • The failure of one station does not affect the rest of the network. • No hubs or switches are required. • Extensions can be made to the network. • Multiple nodes can be installed without difficulty. • Multiple peripherals can be supported through bus topology.	• Additional devices slow the network down. • Size limitations are always present. • Security options are limited with bus topology. • A break in the backbone can cause an entire network to collapse. • The quality of the data is placed at-risk on large bus topology setups.
Ring Topology	• Data is quickly transferred without a 'bottle neck'. (very fast, all data traffic is in the same direction) • The transmission of data is relatively simple as packets travel in one direction only. • Adding additional nodes has very little impact on bandwidth • It prevents network collisions because of the media access method or architecture required.	• Data packets must pass through every computer between the sender and recipient therefore this makes it slower. • If any of the nodes fail then the ring is broken and data cannot be transmitted successfully. • It is difficult to troubleshoot the ring. • Because all stations are wired together, to add a station you must shut down the network temporarily. • In order for all computers to communicate with each other, all computers must be turned on. • Total dependence upon the one cable
Tree Topology	• Tree topology is an extension of Star and bus topologies. • Scalable as leaf nodes can accommodate more nodes in the hierarchical chain. • A point to point wiring to the central hub as each intermediate node of a tree topology represents a node in the bus topology • Other hierarchical networks are not affected if one of them gets damaged • Easier maintenance and fault finding	• Difficult to troubleshoot problem. • If there is a problem with the main cable, the entire network goes down. • This network is not secure, any one can see transmitted data. • As more and more nodes and segments are added, the maintenance becomes difficult.

Categories of Networks

Networks are generally referring to two primary categories: Local-Area Networks (LANs) and Wide-Area Networks (WANs). The category into which a network falls is determined by its size. A LAN normally covers an area less than two miles; a WAN can be worldwide. Networks of a size in between are normally referred to as Metropolitan-Area Networks (MANs) and span tens of miles (see Figure 8).

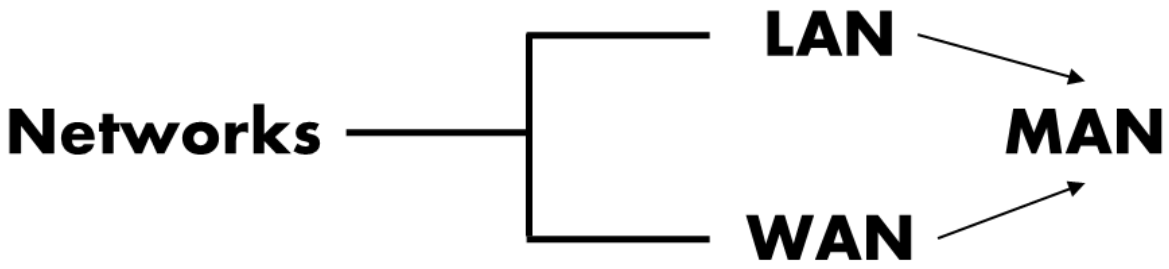

Figure 8. Networks Categories

Local Area Network

A local area network (LAN) is usually privately owned and links the devices in a single office, building, or campus Depending on the needs of an organization and the type of technology used, a LAN can be as simple as two PCs and a printer in someone's home office; or it can extend throughout a company and include audio and video peripherals. Currently, LAN size is limited to a few kilometers. LANs are designed to allow resources to be shared between personal computers or workstations. The resources to be shared can include hardware (e.g., a printer), software (e.g., an application program), or data. A common example of a LAN, found in many business environments, links a workgroup of task-related computers, for example, engineering workstations or accounting PCs. One of the computers may be given a large capacity disk drive and may become a server to clients. Software can be stored on this central server and used as needed by the whole group. In this example, the size of the LAN may be determined by licensing restrictions on the number of users per copy of software, or by restrictions on the number of users licensed to access the operating system. In addition to size, LANs are distinguished from other types of networks by their transmission media and topology. In general, a given LAN will use only one type of transmission medium. The most common LAN topologies are bus, ring, and star.

Wide Area Network

A wide area network (WAN) provides long-distance transmission of data, image, audio, and video information over large geographic areas that may comprise a country, a continent, or even the whole world. A WAN can be as complex as the backbones that connect the Internet or as simple as a dial-up line that connects a home computer to the Internet. We normally refer to the first as a switched WAN and to the second as a point-to-point WAN. The switched WAN connects the end systems, which usually comprise a router (internetworking connecting device) that connects to another LAN or WAN. The point-to-point WAN is normally a line leased from a telephone or cable TV provider that connects a home computer or a small LAN to an Internet Service Provider (lSP). This type of WAN is often used to provide Internet access.

Metropolitan Area Networks

A metropolitan area network (MAN) is a network with a size between a LAN and a WAN. It normally covers the area inside a town or a city. It is designed for customers who need a high-speed connectivity, normally to the Internet, and have endpoints spread over a city or part of city. A good example of a MAN is the part of the telephone company network that can provide a high-speed DSL line to the customer. Another example is the cable TV network that originally was designed for cable TV, but today can also be used for high-speed data connection to the internet.

Good Luck!