Data communications

Lecture No. 1 **Lecturer: M.Sc. Eng. Haider M. Abdulhadi**

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, accuracy, timeliness, and jitter.

1. **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.

2. **Accuracy:** The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.

3. **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.

4. **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 30 ms. If some of the packets arrive with 30-ms delay and others with 40-ms delay, an uneven quality in the video is the result.

Components of data communications system

A data communications system has five components (see Figure below).

1. **Message**: The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.

2. **Sender:** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

3. **Receiver:** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

4. **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.

5. **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.

Data Representation

Information today comes in different forms such as text, numbers, images, audio, and video.

1-Text: In data communications, text is represented as a bit pattern, a sequence of bits (0s or 1s). Different sets of bit patterns have been designed to represent text symbols. Each set is called a code, and the process of representing symbols is called coding.

2-Numbers: Numbers are also represented by bit patterns. However, a code such as ASCII is not used to represent numbers; the number is directly converted to a binary number to simplify mathematical operations.

3-Images: are also represented by bit patterns. In its simplest form, an image is composed of a matrix of pixels (picture elements), where each pixel is a small dot. The size of the pixel depends on the resolution. For example, an image can be divided into 1000 pixels or 10,000 pixels. In the second case, there is a better representation of the image (better resolution), but more memory is needed to store the image.

After an image is divided into pixels, each pixel is assigned a bit pattern. The size and the value of the pattern depend on the image. For an image made of only black-and-white dots (e.g., a chessboard), a 1-bit pattern is enough to represent a pixel. If an image is not made of pure white and pure black pixels, we can increase the size of the bit pattern to include gray scale. For example, to show four levels of gray scale, we can use 2-bit patterns. A black pixel can be represented by 00, a dark gray pixel by 01, a light gray pixel by 10, and a white pixel by 11.

4-Audio: Audio refers to the recording or broadcasting of sound or music. Audio is by nature different from text, numbers, or images. It is continuous, not discrete. Even when we use a microphone to change voice or music to an electric signal, we create a continuous signal.

5-Video: Video refers to the recording or broadcasting of a picture or movie. Video can either be produced as a continuous entity (e.g., by a TV camera), or it can be a combination of images, each a discrete entity, arranged to convey the idea of motion.

Data Flow

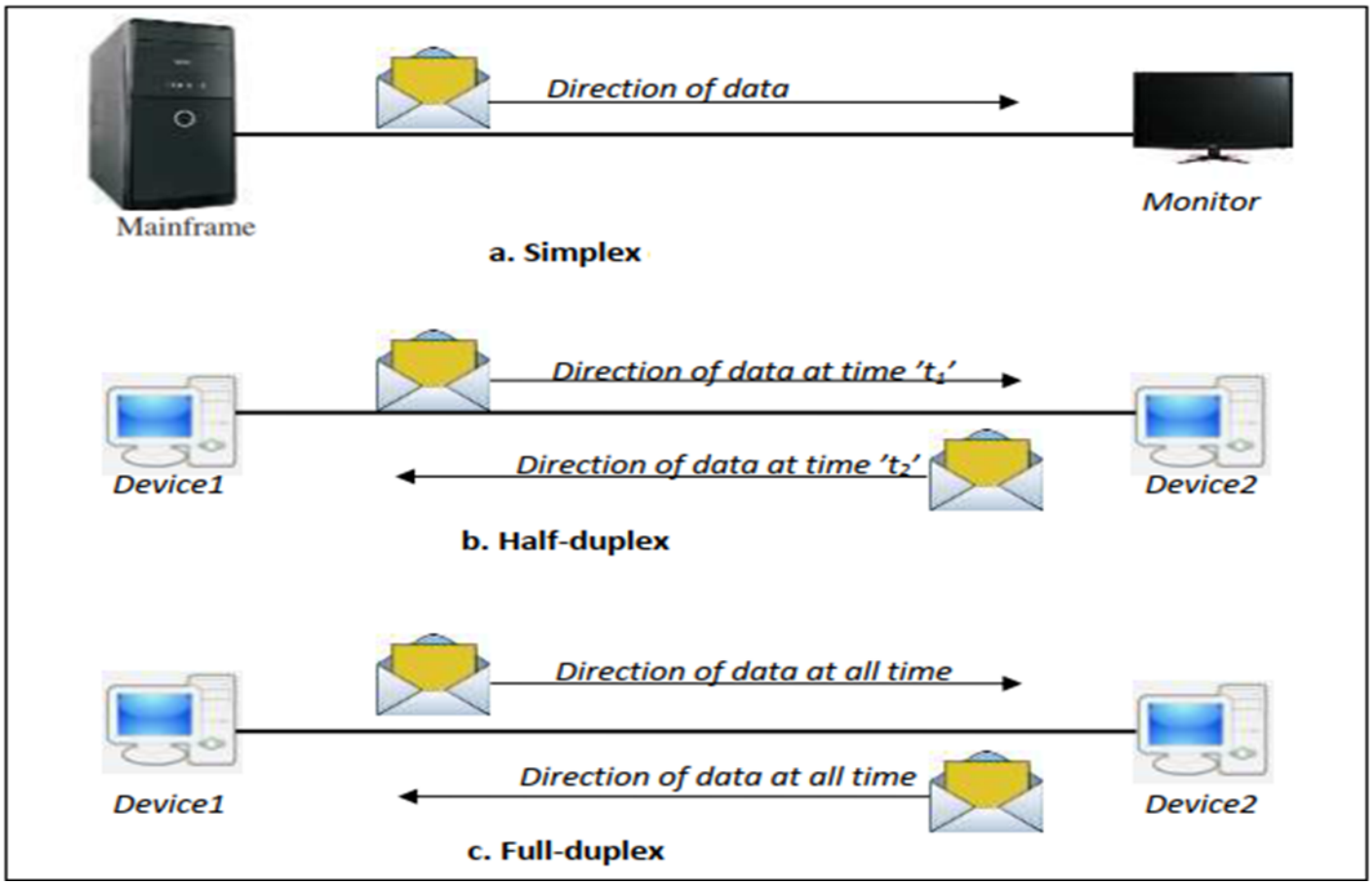
Communication between two devices can be simplex, half-duplex, or full-duplex as shown in Figure below.

1-Simplex

-In simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit; the other can only receive (see Figure below a).

-Keyboards and traditional monitors are examples of simplex devices. The keyboard can only introduce input; the monitor can only accept output.

-The simplex mode can use the entire capacity of the channel to send data in one direction



2-Half-Duplex

-In half-duplex mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive, and vice versa (see Figure b).

-The half-duplex mode is like a one-lane road with traffic allowed in both directions. When cars are traveling in one direction, cars going the other way must wait.

-Walkie-talkies and CB (citizens band) radios are both half-duplex systems.

-Half-duplex transmission, the entire capacity of a channel is taken over by whichever of the two devices is transmitting at the time.

3-Full-Duplex

-In full-duplex mode (also called duplex), both stations can transmit and receive simultaneously (see Figure c).

-The full-duplex mode is like a two-way street with traffic flowing in both directions at the same time.

-One common example of full-duplex communication is the telephone network. When two people are communicating by a telephone line, both can talk and listen at the same time.

-The full-duplex mode is used when communication in both directions is required

all the time. The capacity of the channel, however, must be divided between the two directions.

NETWORKS

-A network is the interconnection of a set of devices capable of communication.

-a device can be a host (or an end system as it is sometimes called) such as a large computer, desktop, laptop, workstation, cellular phone, or security system.

-A device in this definition can also be a 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.

Network Criteria

A network must be able to meet a certain number of criteria. The most important of these are performance, reliability, and security.

1-Performance

-Performance can be measured in many ways, including transit time and response time. Transit time is the amount of time required for a message to travel from one device to another. Response time is the elapsed time between an inquiry and a response.

-The performance of a network depends on a number of factors, including the number of users, the type of transmission medium, the capabilities of the connected hardware, and the efficiency of the software.

-Performance is often evaluated by two networking metrics: throughput and delay. We often need more throughput and less delay.

2-Reliability

In addition to accuracy of delivery, network reliability is measured by the frequency of failure, the time it takes a link to recover from a failure, and the network's robustness in a catastrophe.

3-Security

Network security issues include protecting data from unauthorized access, protecting data from damage and development, and implementing policies and procedures for recovery from breaches and data losses.

Physical Structures

Type 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. There are two possible types of connections: point-to-point and multipoint.

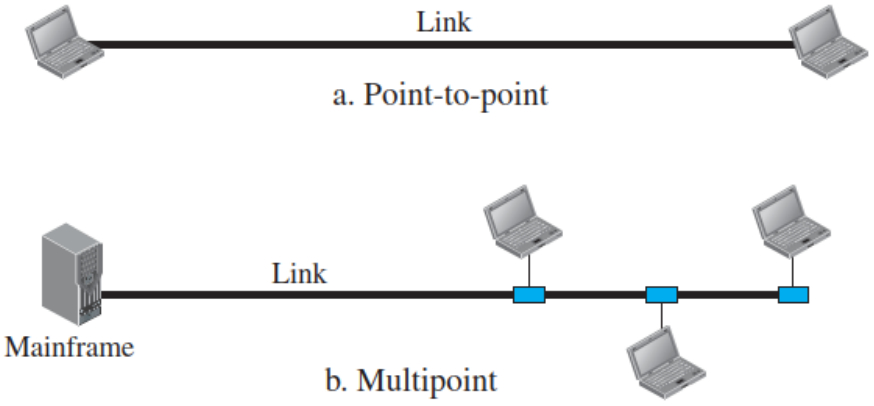
1- Point-to-Point

-A point-to-point connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices.

-When we change television channels by infrared remote control, we are establishing a point-to-point connection

2- Multipoint

A multipoint (also called multidrop) connection is one in which more than two specific devices share a single link (see Figure below b). In a multipoint environment, the capacity of the channel is shared, either spatially or temporally.



Physical Topology

-The term physical topology refers to the way in which a network is laid out physically.

-Two or more devices connect to a link; two or more links form a topology.

-The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another.

-There are four basic topologies possible: mesh, star, bus, and ring.

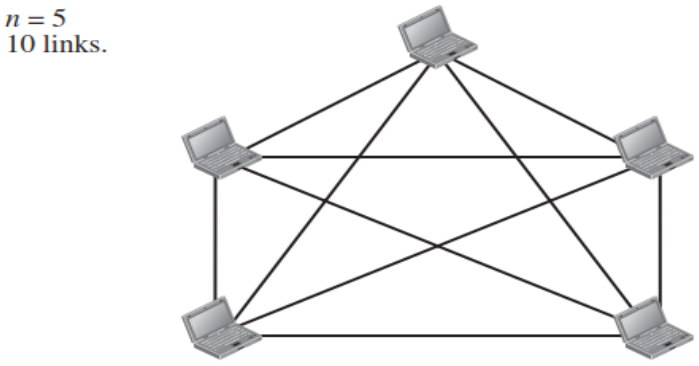
1-Mesh Topology

-In a mesh topology, every device has a dedicated point-to-point link to every other device.

-The term dedicated means that the link carries traffic only between the two devices it connects.

-To find the number of physical links in a fully connected mesh net-work with n nodes, n (n – 1) / 2

- To accommodate that many links, every device on the network must have n – 1 input/output (I/O) ports (see Figure below) to be connected to the other n – 1 stations.



Advantages

1-the use of dedicated links guarantees that each connection can carry its own data load, thus eliminating the traffic problems that can occur when links must be shared by multiple devices.

2-mesh topology is robust. If one link becomes unusable, it does not incapacitate the entire system.

3. Privacy or security. When every message travels along a dedicated line, only the intended recipient sees it.

4. Point-to-point links make fault identification and fault isolation easy.

Disadvantages:

1. Amount of cabling and the number of I/O ports required.

2. Installation and reconnection are difficult.

3. The sheer bulk of the wiring can be greater than the available space (in walls, ceilings, or floors) can accommodate.

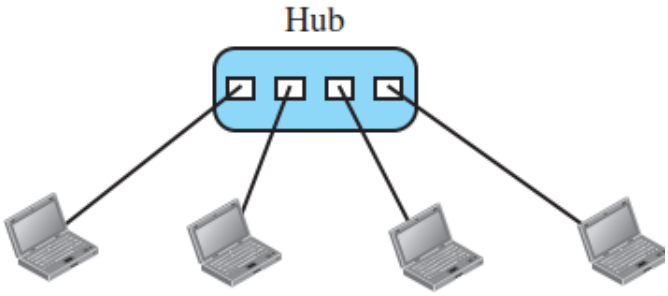
4. The hardware required to connect each link (I/O ports and cable) can be prohibitively expensive.

* For these reasons a mesh topology is usually implemented in a limited fashion,

2-Star Topology

In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub.

-The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device (see Figure below) .



*** The star topology is used in local-area networks (LANs)**

Advantages:

1. Less expensive than a mesh topology.

2. In a star, each device needs only one link and one I/O port to connect it to any number of others. This factor also makes it easy to install and reconfigure.

3. Far less cabling needs to be housed, and additions, moves, and deletions involve only one connection: between that device and the hub.

4. Robustness. If one link fails, only that link is affected. All other links remain active.

5- Easy fault identification and fault isolation.

Disadvantages:

1-If the hub goes down, the whole system is dead.

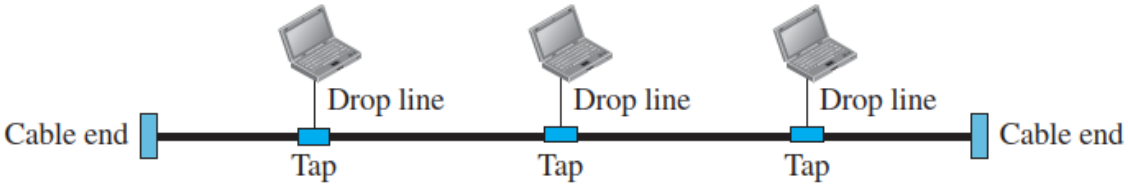
2-more cabling is required in a star than in some other topologies (such as ring or bus).

3- Bus Topology

-A bus topology is multipoint. One long cable acts as a backbone to link all the devices in a network (see Figure below). Nodes are connected to the bus cable by drop lines and taps.

-A drop line is a connection running between the device and the main cable.

- It is a connecter that splices into the main cable to create a contact with the metallic core.



Advantages:

1- Ease of installation.

2-. Uses less cabling than mesh or star topologies.

Disadvantages:

1-difficult reconnection and fault isolation.

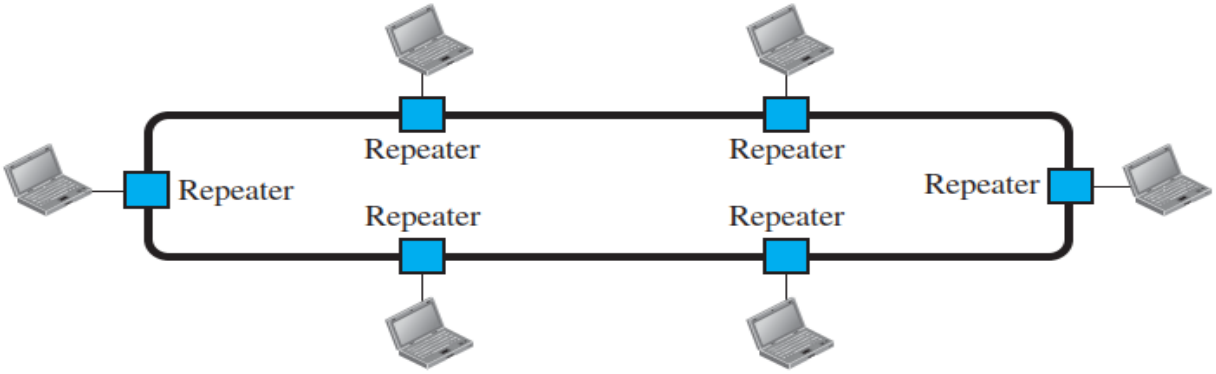
2-difficult to add new devices.

3- Signal reflection at the taps can cause degradation in quality.

4-fault or break in the bus cable stops all transmission, even between devices on the same side of the problem.

4- Ring Topology

In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it reaches its destination. Each device in the ring incorporates a repeater. When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along (see Figure below).



Advantages:

1-Easy to install and reconfigure.

2- Fault isolation is simplified.

Disadvantage

1-Unidirectional traffic

2-In a simple ring, a break in the ring (such as a disabled station) can disable the entire network.

-This weakness can be solved by using a dual ring or a switch capable of closing off the break.

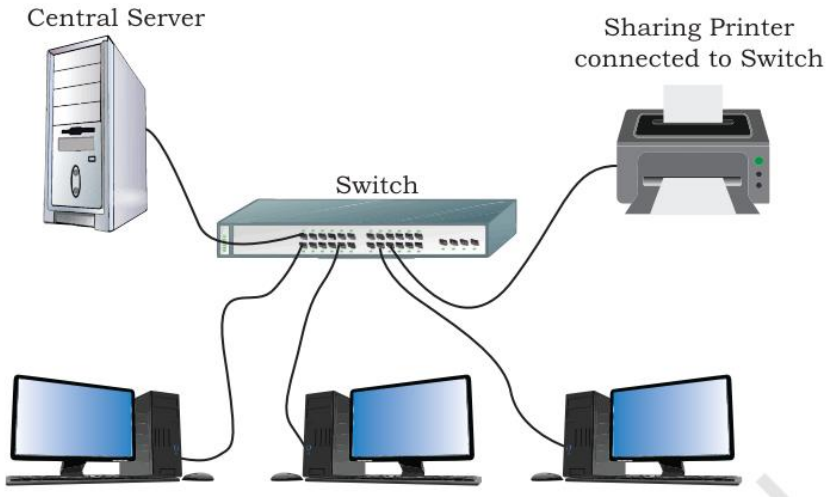
NETWORK TYPES

1-Local Area Network

A local area network (LAN) is a communications network that interconnects a variety of data communications devices within a small geographic area and transmit data at high data transfer rates (see figure below).

* The phrase "within a small geographic area," usually implies that a local area network can be as small as one room, or can extend over multiple rooms, over multiple floors within a building, and even over multiple buildings within a single campus.

*One of the biggest advantages of local area networks is their ability to share resources in an economical and efficient manner. Shared hardware resources can include high-quality printers, plotters, CD, mass storage systems, and other hardware devices. On the software end, local area networks allow the sharing of commercial applications, in house applications, and data sets with one or all user workstations.



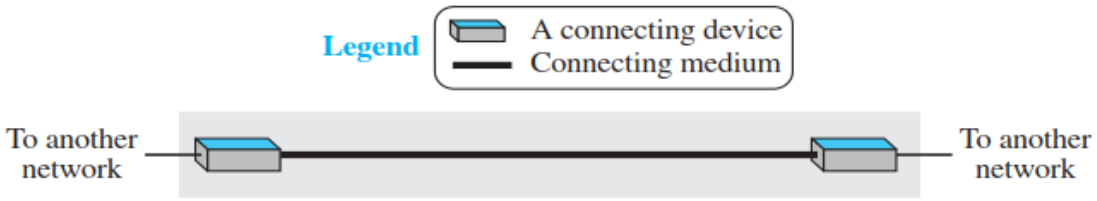
2-Wide Area Network

- (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.

- We see two distinct examples of WANs today: point-to-point WANs and switched WANs.

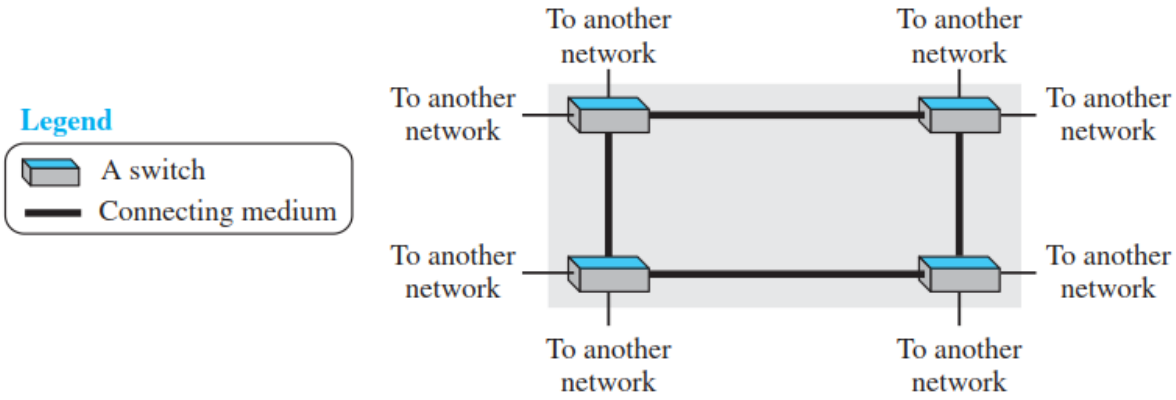
-Point-to-Point WAN

A point-to-point WAN is a network that connects two communicating devices through a transmission media (cable or air).Figure below shows an example of a point-to-point WAN.



-Switched WAN

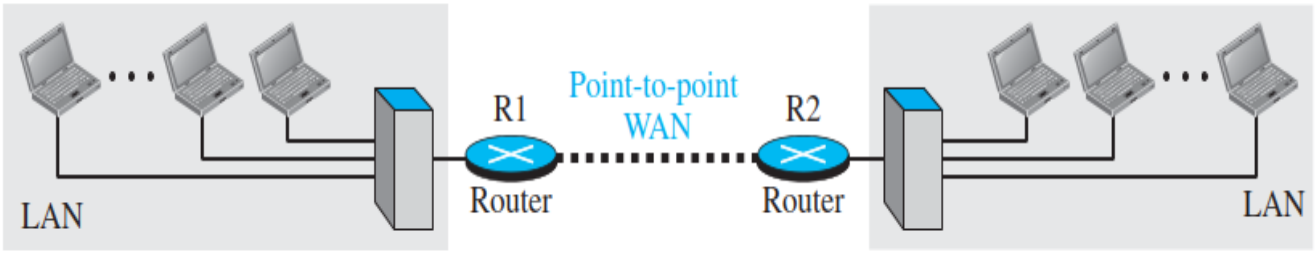
A switched WAN is a network with more than two ends. A switched WAN, as we will see shortly, is used in the backbone of global communication today. We can say that a switched WAN is a combination of several point-to-point WANs that are connected by switches. Figure below shows an example of a switched WAN.



Internetwork

-When two or more networks are connected, they make an **internetwork**, or **internet.**

- As an example, assume that an organization has two offices, one on the east coast and the other on the west coast. Each office has a LAN that allows all employees in the office to communicate with each other. To make the communication between employees at different offices possible, the management leases a point-to-point dedicated WAN from a service provider, such as a telephone company, and connects the two LANs. Now the company has an internetwork, or a private internet (with lowercase i). Communication between offices is now possible. Figure below shows this internet.



Accessing the Internet

1-Using Telephone Networks

This can be done in two ways.

A-Dial-up service

B-DSL Service

2-Using Cable Networks

3-Using Wireless Networks

4-Direct Connection to the Internet