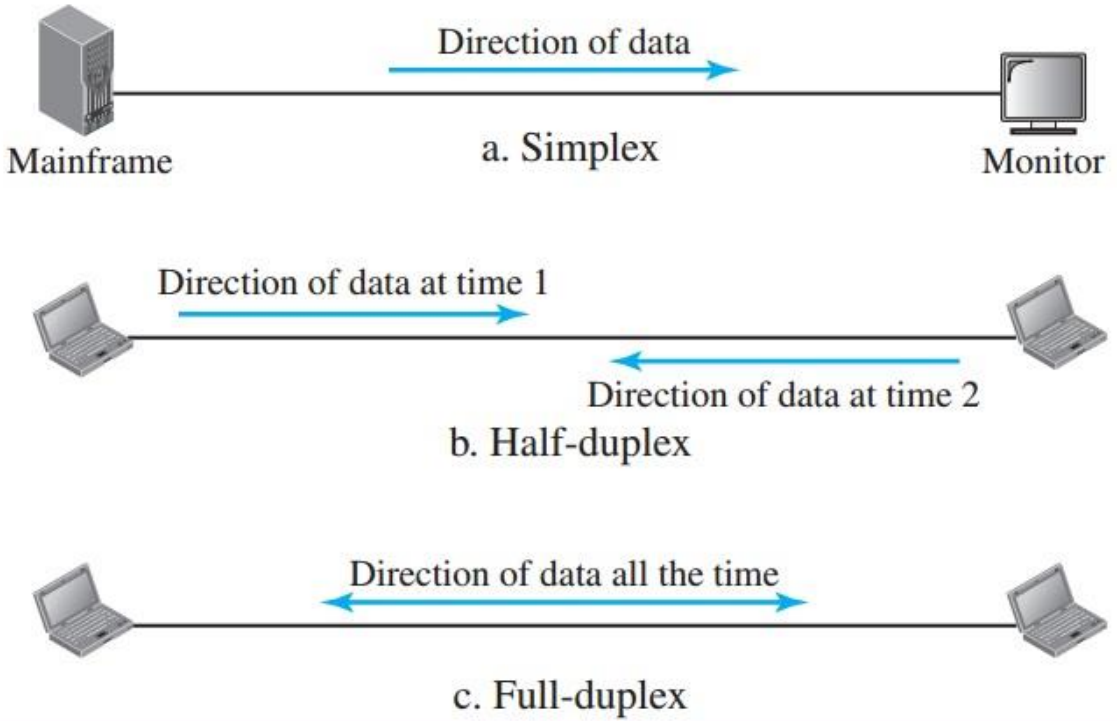

DATA
COMMUNICATIONS
Lecture - 2

Data Flow

Figure *Data flow (simplex, half-duplex, and full-duplex)*



Data Flow

- 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.
- Keyboards and traditional monitors are examples of simplex devices.
- 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.
- The half-duplex mode is like a one-lane road with traffic allowed in both directions.
- Walkie-talkies and CB (citizens band) radios are both half-duplex systems

Data Flow

- In **full-duplex mode** (also called duplex), both stations can transmit and receive simultaneously.
- The full-duplex mode is like a two-way street with traffic flowing in both directions at the same time.
- In full-duplex mode, 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: Either the link must contain two physically separate transmission paths, one for sending and the other for receiving; or the capacity of the channel is divided between signals traveling in both directions.
- One common example of full-duplex communication is the telephone network.

Networks: Network Criteria

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

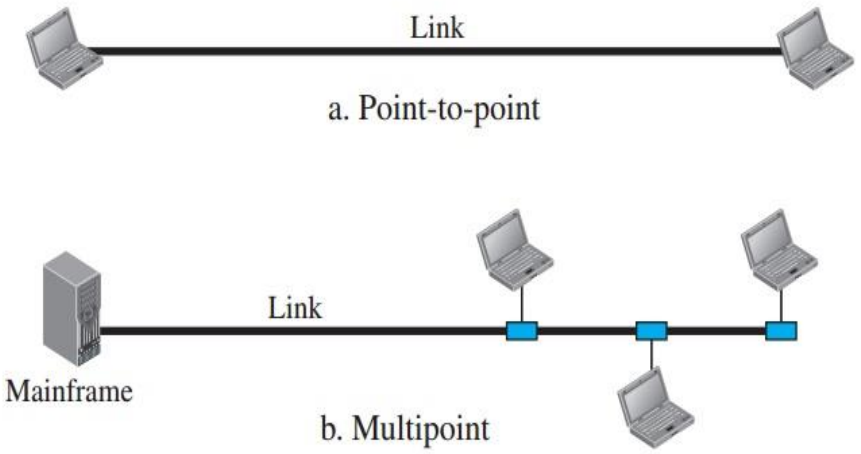
Networks: Network Criteria

- 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.
- 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.

Networks: Physical Structure

- A link is a communications pathway that transfers data from one device to another. 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.

Figure *Types of connections: point-to-point and multipoint*



Networks: Physical Structure

- 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 between the remote control and the television's control system.
- A **multipoint** (also called **multidrop**) **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.

Networks: Network Types (LAN & WAN)

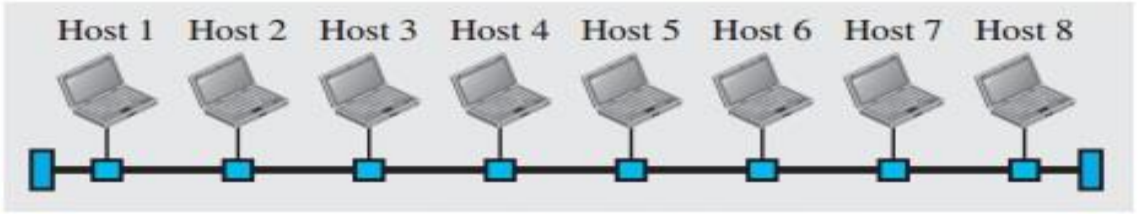
- The criteria of distinguishing one type of network from another is difficult and sometimes confusing.
- Few criteria such as size, geographical coverage, and ownership to make this distinction.
- A **local area network** (**LAN**) is usually privately owned and connects some hosts in a single office, building, or campus.
- Depending on the needs of an organization, 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 devices.
- Each host in a LAN has an identifier, an address, that uniquely defines the host in the LAN. A packet sent by a host to another host carries both the source host's and the destination host's addresses.

Networks: LAN

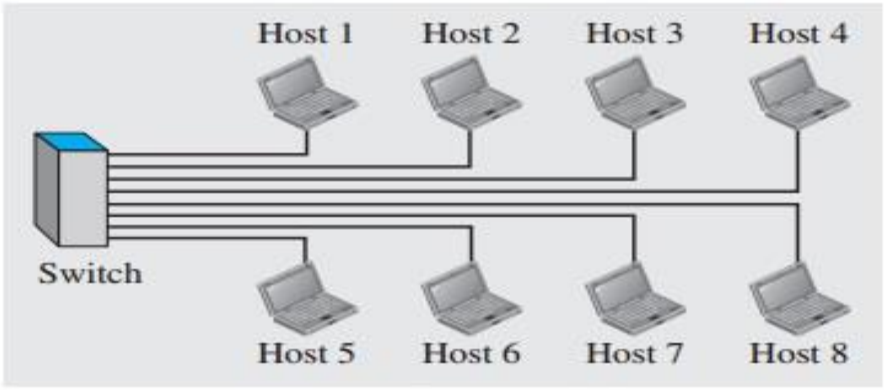
- In the past, all hosts in a network were connected through a common cable, which meant that a packet sent from one host to another was received by all hosts.
- The intended recipient kept the packet; the others dropped the packet.
- Today, most LANs use a smart connecting switch, which is able to recognize the destination address of the packet and guide the packet to its destination without sending it to all other hosts.
- The switch alleviates the traffic in the LAN and allows more than one pair to communicate with each other at the same time if there is no common source and destination among them.

Networks: LAN

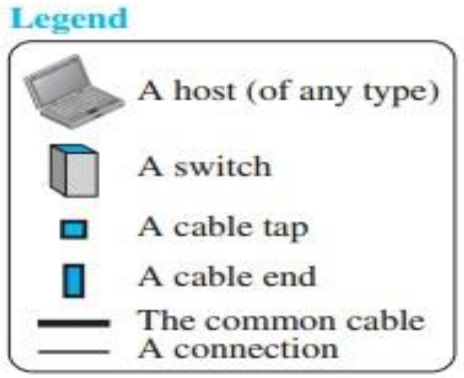
Figure *An isolated LAN in the past and today*



a. LAN with a common cable (past)



b. LAN with a switch (today)



Networks: WAN

- A **wide area network (WAN)** is also an interconnection of devices capable of communication. Two distinct examples of WANs today: point-to-point WANs and switched WANs.

LAN	WAN
1. LAN is normally limited in size, spanning an office, a building, or a campus	1. WAN has a wider geographical span, spanning a town, a state, a country, or even the world.
2. LAN interconnects hosts	2. WAN interconnects connecting devices such as switches, routers, or modems
3. LAN is normally privately owned by the organization that uses it.	3. WAN is normally created and run by communication companies and leased by an organization that uses it

Networks: WAN

- A point-to-point WAN is a network that connects two communicating devices through a transmission media (cable or air).
- A switched WAN is a network with more than two ends. A switched WAN is used in the backbone of global communication today. A switched WAN is a combination of several point-to-point WANs that are connected by switches.

Figure *A point-to-point WAN*

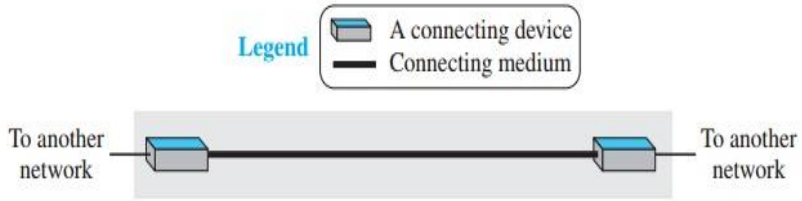
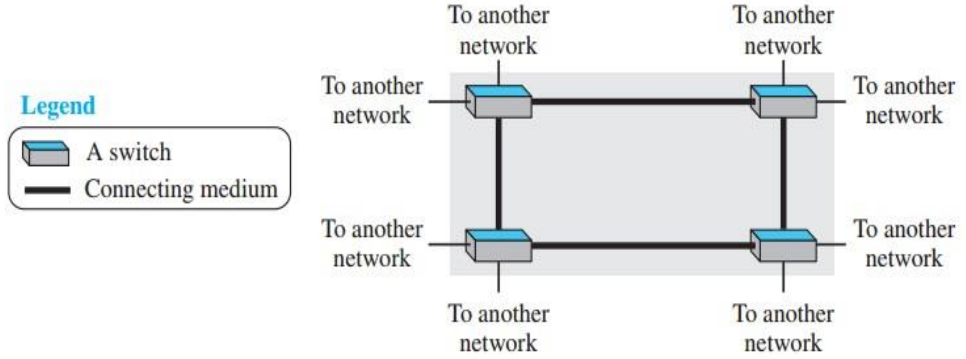


Figure *A switched WAN*



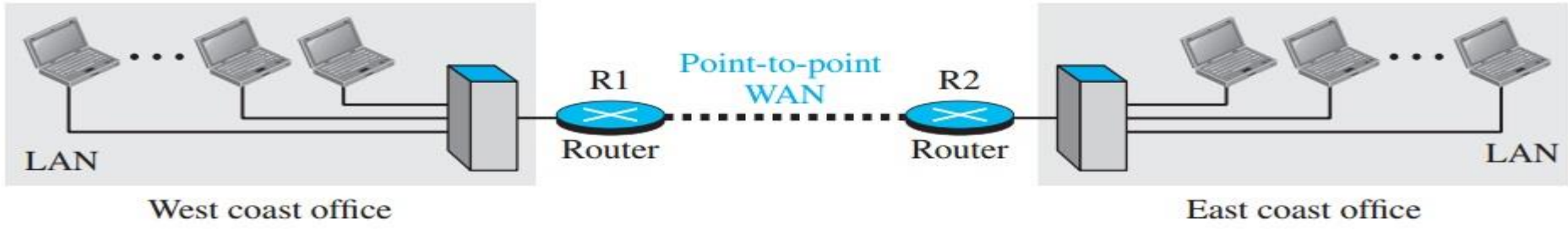
Networks: Internetwork

- 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.

Networks: Internetwork

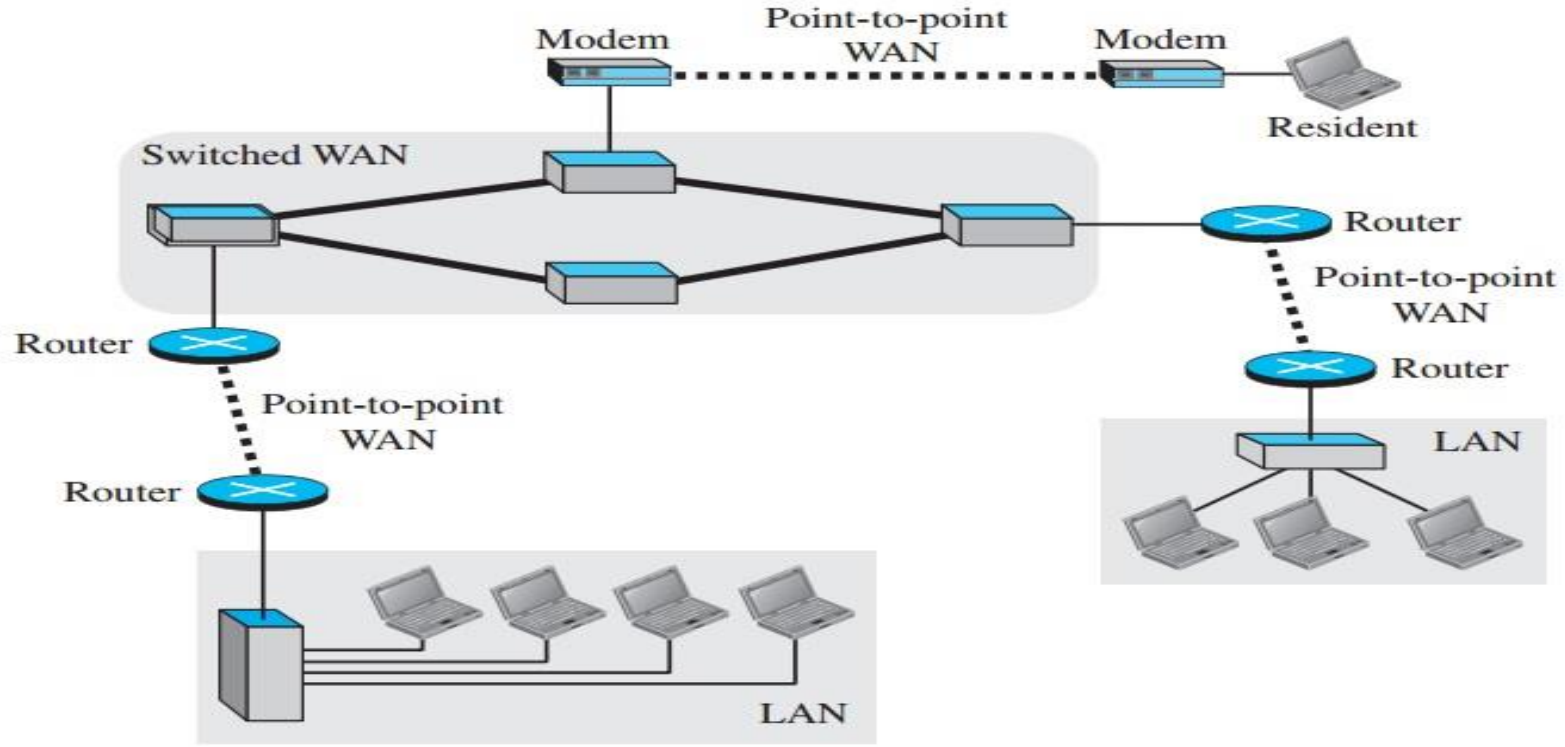
- When a host in the west coast office sends a message to another host in the same office, the router blocks the message, but the switch directs the message to the destination.
- On the other hand, when a host on the west coast sends a message to a host on the east coast, router R1 routes the packet to router R2, and the packet reaches the destination.

Figure *An internetwork made of two LANs and one point-to-point WAN*



Networks: Internetwork

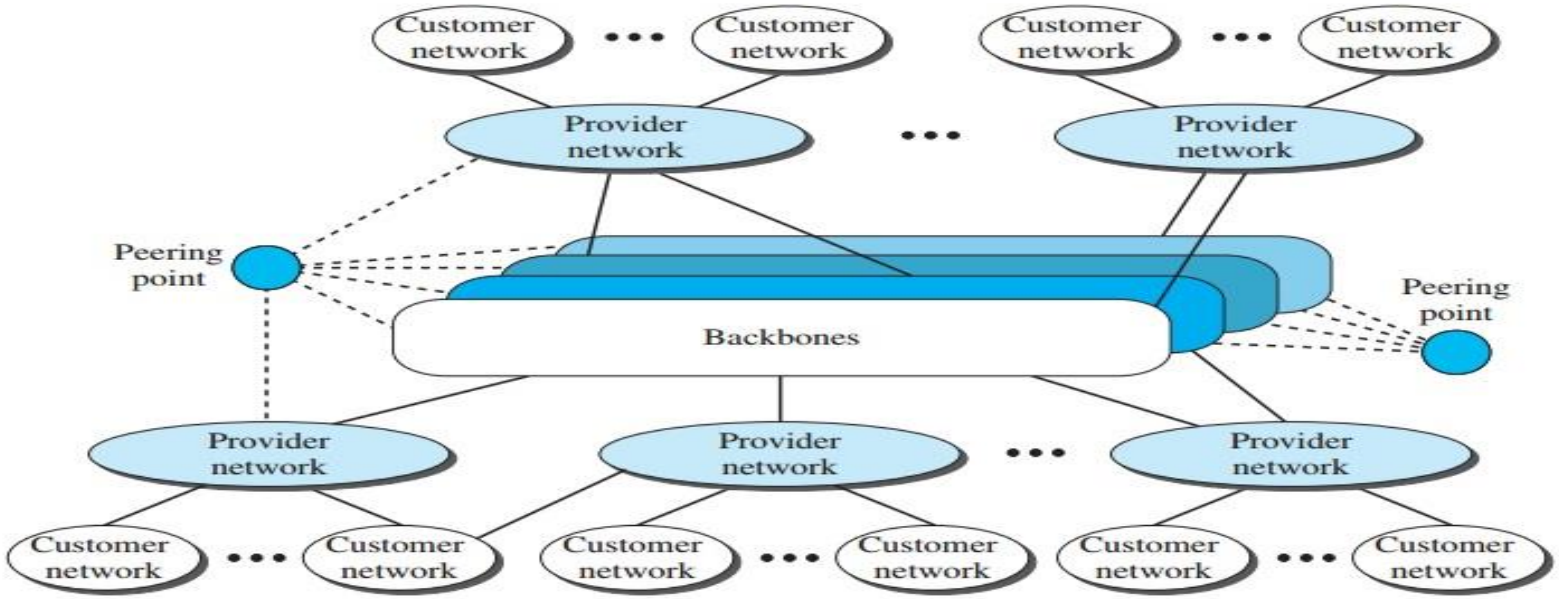
Figure *A heterogeneous network made of four WANs and three LANs*



Networks: The Internet

- An internet (note the lowercase *i*) is two or more networks that can communicate with each other. The most notable internet is called the **Internet** (uppercase *I*), and is composed of thousands of interconnected networks.

Figure *The Internet today*



Networks: Internet

- The figure shows the Internet as several backbones, provider networks, and customer networks.
- At the top level, the *backbones* are large networks owned by some communication companies such as Sprint, Verizon (MCI), AT&T, and NTT.
- The backbone networks are connected through some complex switching systems, called *peering points*.
- At the second level, there are smaller networks, called *provider networks*, that use the services of the backbones for a fee. The provider networks are connected to backbones and sometimes to other provider networks.
- The *customer networks* are networks at the edge of the Internet that actually use the services provided by the Internet. They pay fees to provider networks for receiving services.
- Backbones and provider networks are also called **Internet Service Providers (ISPs).** The backbones are often referred to as *international ISPs;* the provider networks are often referred to as *national* or *regional ISPs*.