Underlying Technologies

Objectives:

The chapter has several objectives:

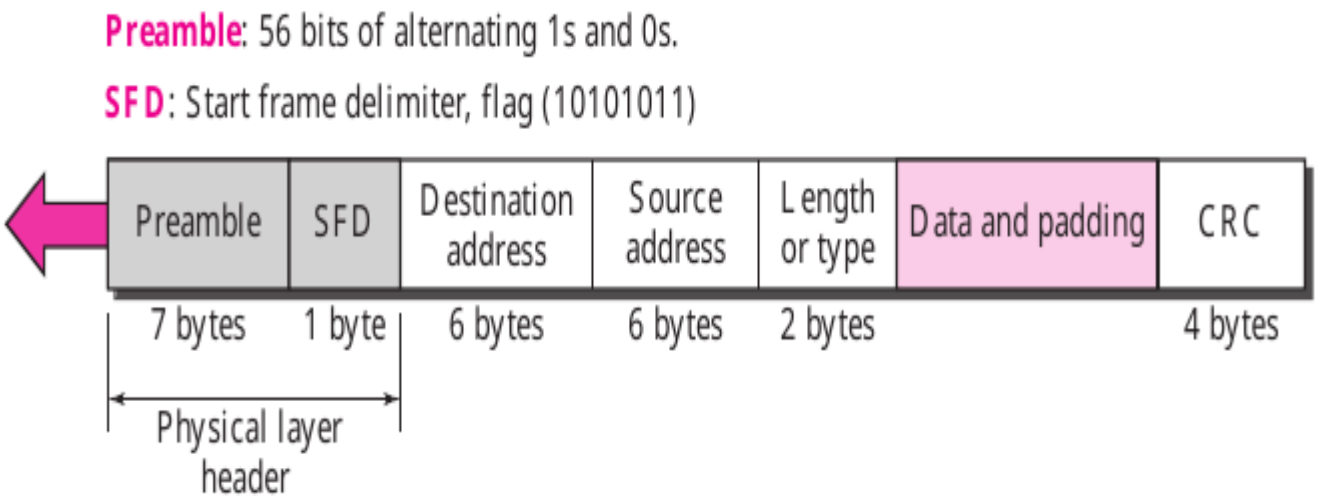
- To briefly discuss the technology of dominant wired LANs, Ethernet, including traditional, fast, gigabit, and ten-gigabit Ethernet.
- To briefly discuss the technology of wireless WANs, including IEEE 802.11 LANs, and Bluetooth 802.15.
- To briefly discuss the technology of point-to-point WANs including 56K modems, DSL, and T-lines.
- To briefly discuss the technology of switched WANs including Frame Relay.
- To discuss the need and use of connecting devices such as repeaters(hubs), bridges (layer-two switches), and routers (layer-three switches).

Wired Local Area Networks

- A local area network (LAN) is a computer network that is designed for a limited geographic area such as a building or a campus.
- A LAN can be used as an isolated network to connect computers in an organization for the sole purpose of sharing resource.
- Most LANs today are also linked to a wide are network (WAN) or the Internet.

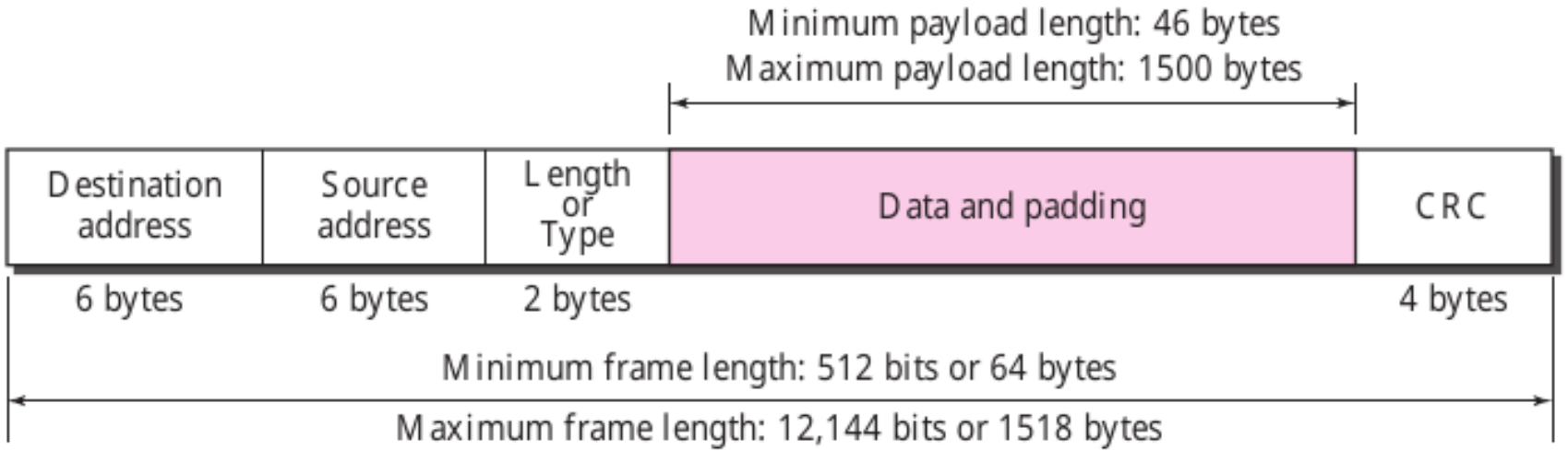
Ethernet Frame Format

- The packet sent in an Ethernet LAN is called a frame.
- The Ethernet frame contains seven fields: Preamble, SFD, DA, SA, length or type of data unit, upper-layer data, and the CRC.



Ethernet Frame Length

- The minimum Ethernet length is 512 bits or 64 bytes.
- The maximum length of a frame is 1518 bytes.



Ethernet Addressing

- Ethernet address is 6 bytes (48 bits), normally written in hexadecimal notation, with colon between the bytes.
- The address normally is referred to as the data link address, physical address, or MAC address.

d: Hexadecimal digit

$$d_1d_2 : d_3d_4 : d_5d_6 : d_7d_8 : d_9d_{10} : d_{11}d_{12}$$

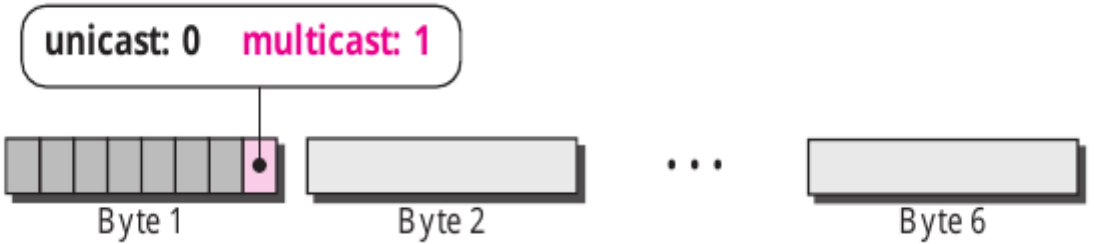
6 bytes = 12 hexadecimal digits = 48 bits

For example, the following shows an Ethernet MAC address:

4A:30:10:21:10:1A

Unicast, Multicast, and Broadcast Ethernet Addresses

- A source address is always a unicast address the frame comes from only one station.
- The destination address, however, can be unicast, multicast, or broadcast.



The least significant bit of the first byte defines the type of address. If the bit is 0, the address is unicast; otherwise, it is multicast.

Cont'd ...

- A unicast destination address defines only one recipient; the relationship between sender and receiver is one-to-one.
- A multicast destination address defines a group of addresses; the relationship between sender and receiver is one-to-group.
- The broadcast address is a special case, the recipient is all the stations on the LAN.

Example of Ethernet Addresses

- **Example**: Define the type of the following destination addresses:

A. 4A:30:10:21:10:1A

B. 47:20:1B:2E:08:EE

C. FF:FF:FF:FF:FF:FF

- **Solution:**

To find the type of address, we need to look at the second hexadecimal digit from the left. If it is even, the address is unicast. If it is odd, the address is multicast. If all digits are F's the address is broadcast. Therefore, we have the following:

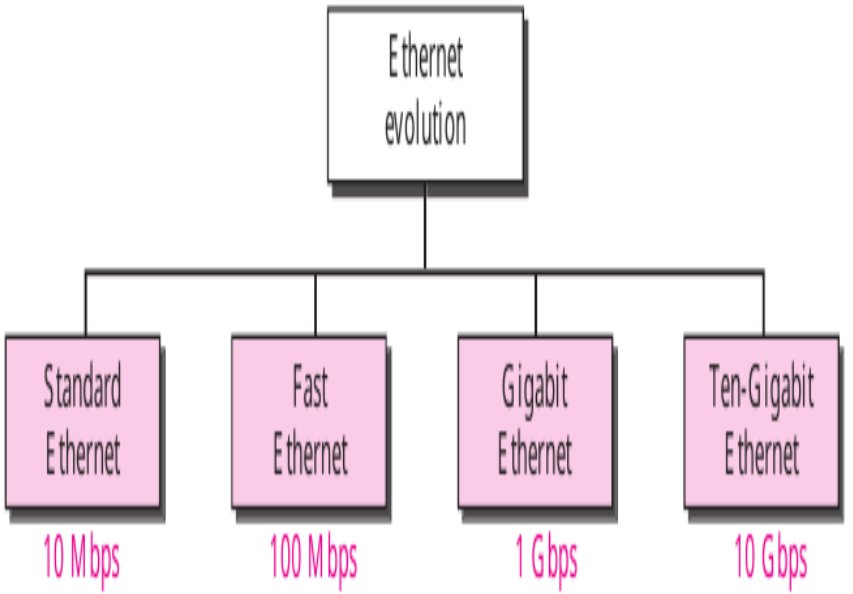
A. This is a unicast address because A in binary is 1010 (even).

B. This is a multicast address because 7 in binary is 0111 (odd).

C. This is a broadcast address because all digits are F's.

Ethernet Evolution

- Ethernet was created in 1976 at Xerox's Palo Alto Research Center (PARC).
  - Standard Ethernet (10 Mbps)
  - Fast Ethernet (100 Mbps)
  - Gigabit Ethernet (1 Gbps)
  - 10 Gigabit Ethernet (10 Gbps)



Wireless LANs

- Wireless communication is one of the fastest-growing technologies.
- Wireless LANs can be found on college campuses, in office buildings, and in many public areas.
- In this section we concentrate on two wireless technologies for LANs: IEEE 802.11 Wireless LANs, and Bluetooth IEEE 802.15.

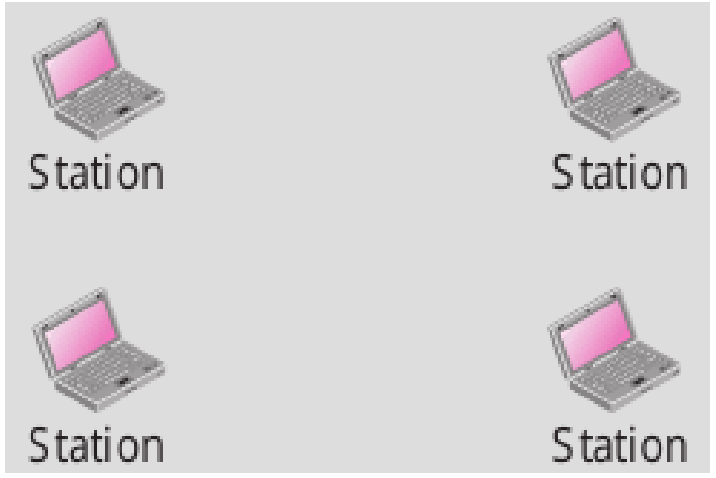
IEEE 802.11 Wireless LAN

- Architecture:
  - The standard defines two kinds of services:
    - Basic service set (BSS) and
    - Extended service set (ESS).

Basic Service Set (BSS)

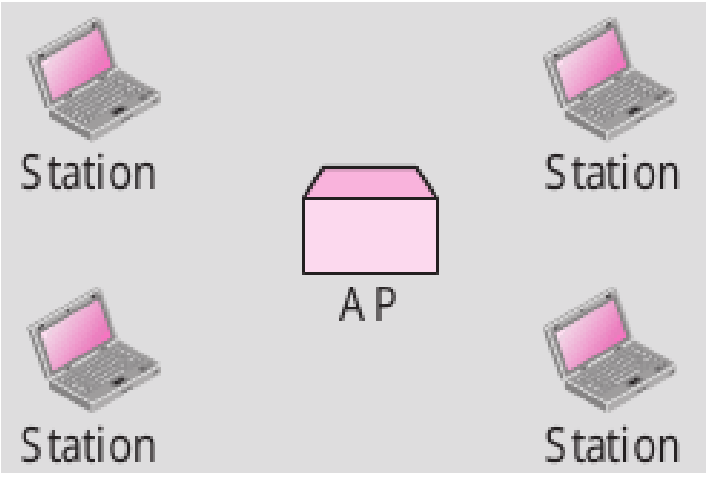
- Basic Service Set (BSS): IEEE 802.11 defines the BSS as the building blocks of wireless LAN.
  - A basic service set is made of stationary or mobile wireless stations and an optional central base station, known as the access point (AP)
  - Ad hoc architecture: In this stations can form a network without the need of an AP.
  - A BBS with an AP is referred to as an infrastructure network.

BSS: Basic service set



Ad hoc network (BSS without an AP)

AP: Access point

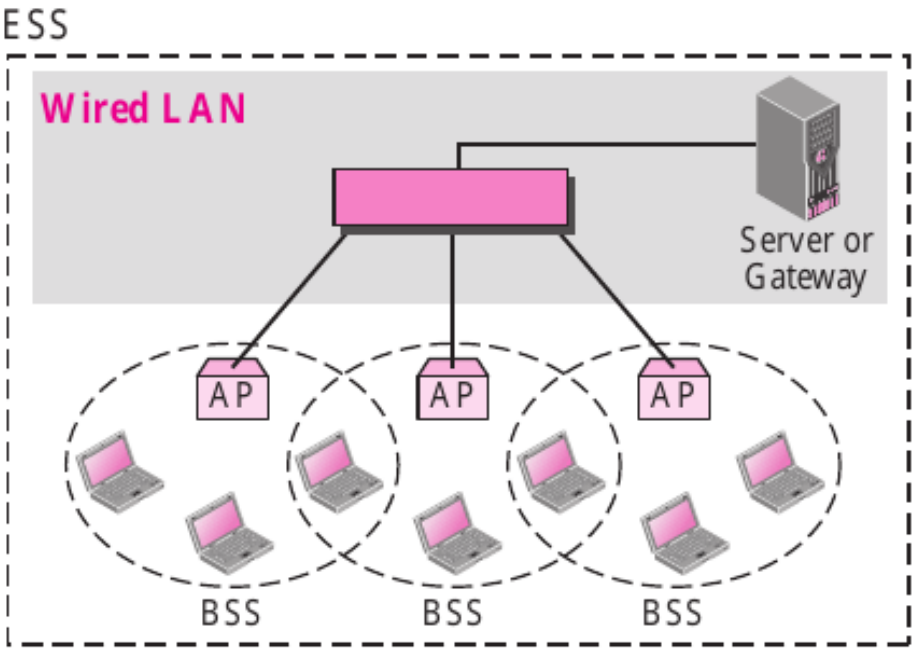


Infrastructure (BSS with an AP)

Extended Service Set (ESS)

- Extended Service Set: is made up of two or more BSSs with APs
- BSSs are connected through a distribution system, which is usually a wired LAN.
- The distribution system connects the APs in the BSSs.

ESS: Extended service set
BSS: Basic service set
AP: Access point



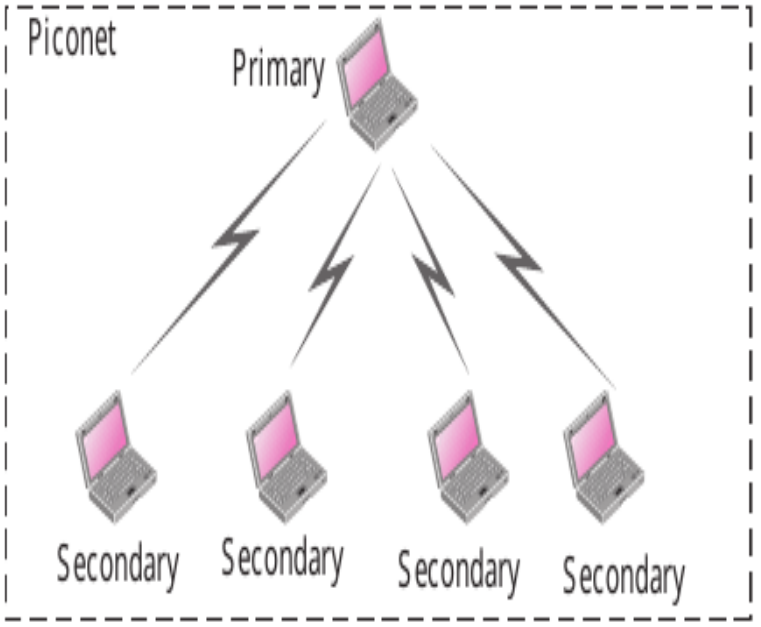
IEEE 802.15 Bluetooth

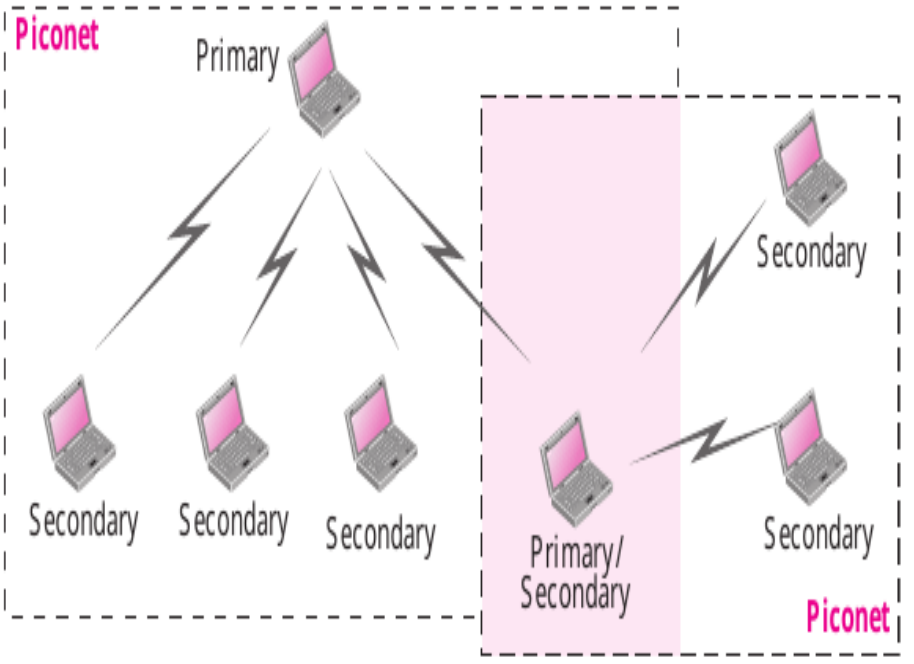
- Bluetooth is a wireless LAN technology designed to connect devices of different functions such telephones, notebooks, computers (desktop, laptop), cameras, printers, coffee makers, and so on.
- A Bluetooth LAN is an ad hoc network, which means that the network is formed spontaneously.
- Bluetooth technology is the implementation of a protocol defined by the IEEE 802.15 standard.

Architecture of Bluetooth

- Bluetooth defines two types of networks: Piconet and Scatternet.
- Piconet: can have up to eight stations, one of which is called the primary; the rest are called secondaries.
- Scatternet: Piconets can be combined to form what is called a scatternet.
  - A secondary station in one piconet can be the primary in another piconet.
  - A station can be a member of two piconets.

Piconet and Scatternet



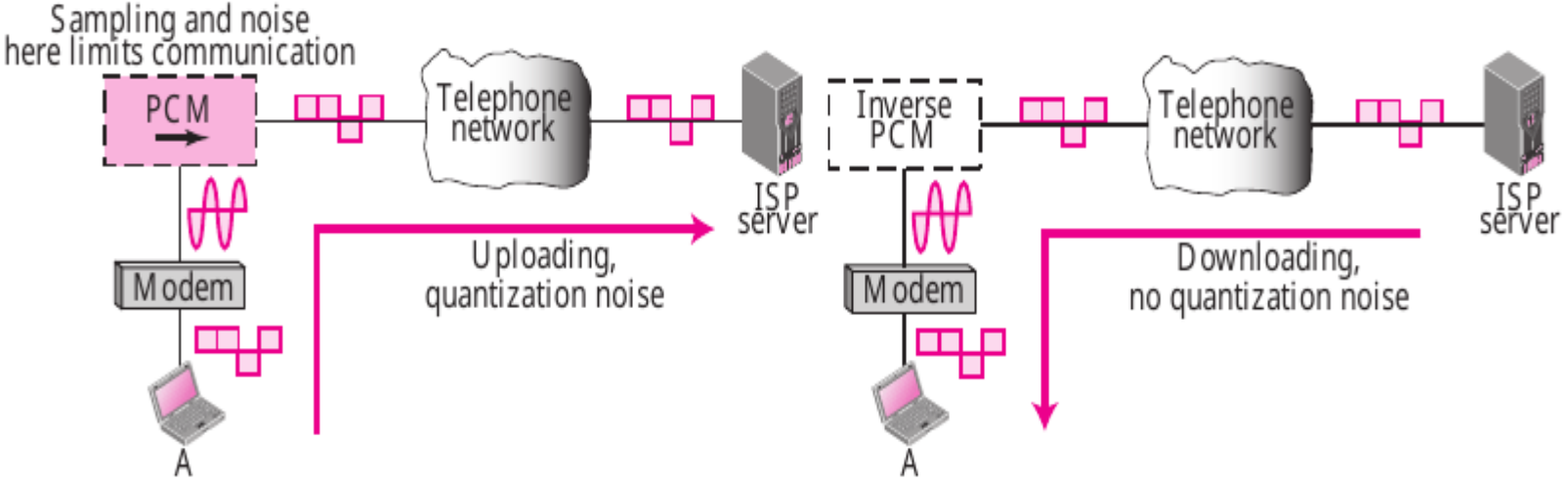


Point-To-Point WANs

- A point-to-point WAN connects two remote devices using a line available from a public network such as a telephone network.
  - Traditional modems technology
  - DSL line
  - T-Lines

56K Modems

- We use traditional modems to upload data to the Internet and download data from the Internet, as shown below.



DSL Technology

- Digital Subscriber Line: DSL technology provides higher-speed access to the Internet.
  - Upstream: 64 Kbps to 1 Mbps
  - Downstream: 500 Kbps to 8 Mbps

T Lines

- T lines are standard digital telephone carriers originally designed to multiplex voice channels (after being digitized).
- T lines can be used to carry data from a residence or an organization to the Internet.

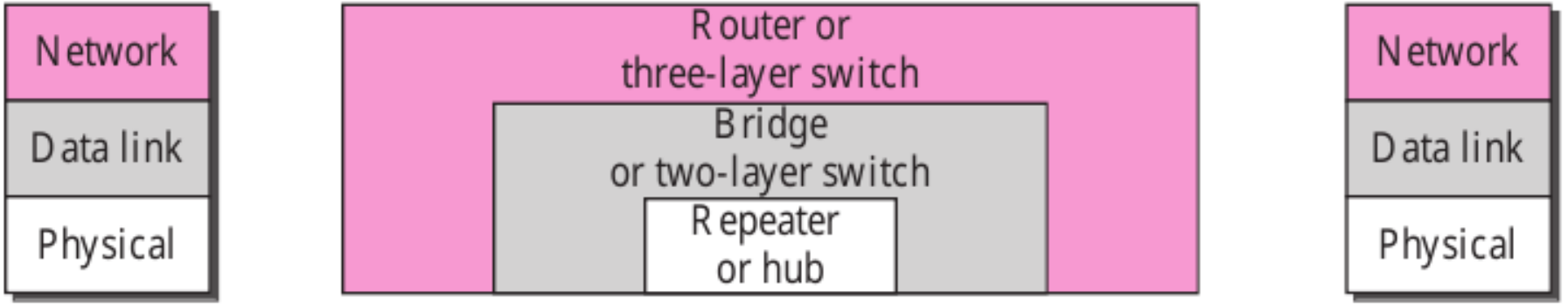
Line	*Rate (Mbps)*
T-1	1.544
T-3	44.736

Switched WAN

- The backbone networks in the Internet can be switched WANs.
- A switched WAN is a wide area network that covers a large area (a state or a country) and provides access at several points to the users.
- **Frame Relay**: FR protocol, a switched technology that provides low-level (physical and data link layers) service.

Connecting Devices

- LANs or WANs do not normally operate in isolation. They are connected to one another or to the Internet.
- Connecting devices can operate in different layers of the Internet model.



Repeaters and Hubs

- Repeaters: is a device that operates only in the physical layer.
- A repeater receives a signal and, before it becomes too weak or corrupted, regenerates and retransmits the original bit pattern.
- A repeater forwards every bit; it has no filtering capability.
- A hub or a repeater is a physical-layer device. They do not have any data-link address and they do not check the data-link address of the received frame.

Bridges and Switches

- A bridge operates in both the physical and the data link layers.
- As a physical-layer device, it regenerates the signal it receives.
- As a data link layer device, the bridge can check the MAC addresses (source and destination) contained in the frame.
- A bridge has a table used in filtering decisions.

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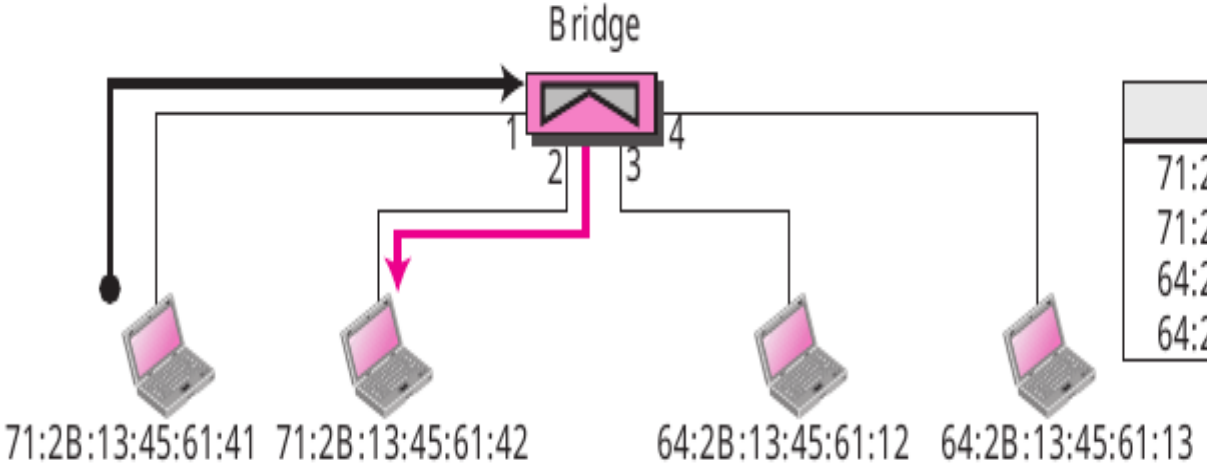
- A bridge does not change the physical (MAC) addresses in a frame.



Bridge table

Address	Port
71:2B:13:45:61:41	1
71:2B:13:45:61:42	2
64:2B:13:45:61:12	3
64:2B:13:45:61:13	4

Routers (Layer Three Device)

- A router: operates in the physical, data link, and network layers.
- A router checks the network layer addresses (addresses in the IP layer).
- A router can connect LANs together; a router can connect WANs together; and a router can connect LANs and WANs together.

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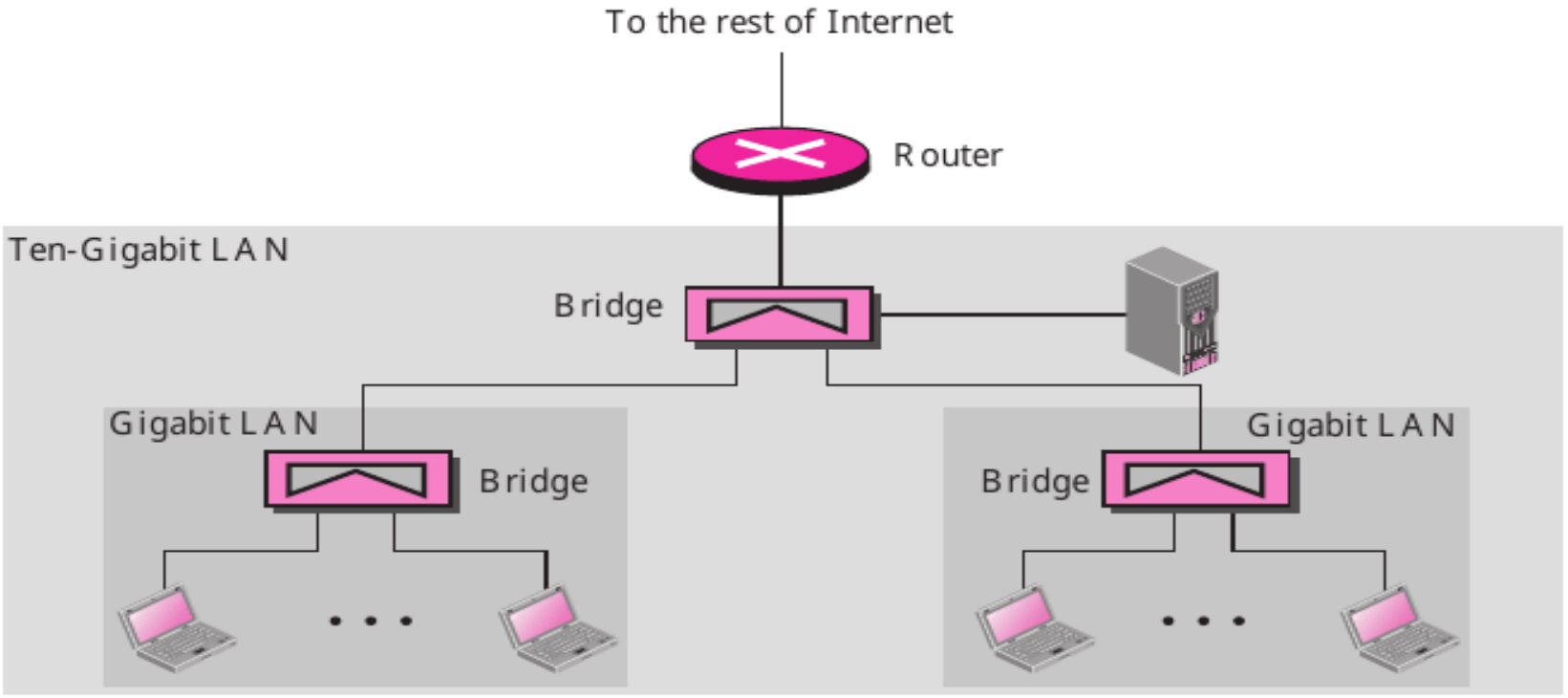
To the rest of Internet
Router
Ten-Gigabit LAN
Bridge
Gigabit LAN
Bridge
Gigabit LAN
Bridge

End of Chapter 3

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