Chapter 6
Connecting Device
Functions of network devices

- Separating (connecting) networks or expanding network
  - e.g. repeaters, hubs, bridges, routers, switches
6.1 Connecting Devices

Five connecting devices
- Repeaters
- Hubs
- Bridges
- Switches
- Routers
Figure 6.1 Five categories of connecting devices

<table>
<thead>
<tr>
<th>Application</th>
<th>Transport</th>
<th>Network</th>
<th>Data link</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gateway</td>
<td>Router or three-layer switch</td>
<td>Bridge or two-layer switch</td>
<td>Repeater or hub</td>
<td>Passive hub</td>
</tr>
<tr>
<td>Application</td>
<td>Transport</td>
<td>Network</td>
<td>Data link</td>
<td>Physical</td>
</tr>
</tbody>
</table>
1) Repeaters

- A **physical layer** device that acts on **bits** not on **frames** or packets.

- When a bit (0,1) arrives, the repeater receives it and **regenerates** it, then transmits it onto all other interfaces.

- Used in LAN to **connect cable segments** and **extend** the maximum cable length ➔ extending the geographical LAN range.

- Repeaters do not implement any **access method**.
  - If any two nodes on any two connected segments transmit at the same time **collision** will happen.
Figure 6.2  A repeater connecting two segments of a LAN
Figure 6.3 Function of a repeater

a. Right-to-left transmission.

b. Left-to-right transmission.
2) Hubs

- Acts on the **physical layer**
- Operate on bits rather than frames
- Used to connect stations adapters in a **physical star topology** but **logically** bus
- Hub receives a bit from an adapter and sends it to **all** the other adapters without implementing any access method.
- does not do **filtering** (forward a frame into a specific destination or drop it) just it copy the received frame onto **all other links**
- Multiple Hubs can be used to **extend** the network length
Hubs

- The entire hub forms **a single collision domain**, and **a single Broadcast domain**
  - **Collision domain**: is that part of the network when two or more nodes transmit at the same time collision will happen.
  - **Broadcast domain**: is that part of the network where each NIC can 'see' other NICs' traffic **broadcast messages**.
Interconnecting with hubs

- **Backbone hub interconnects LAN segments**
- **Advantage:**
  - Extends max distance between nodes
- **Disadvantages**
  - Individual segment collision domains become one large collision domain ➔ **(reduce the performance)**
  - Can’t interconnect different Ethernet technologies because **no buffering** at the hub

Here we have a single collision domain and a single broadcast domain
3) Bridges

- Acts on the **data link** layer (MAC address level)
- Used to **divide** (segment) the LAN into smaller LANs segments, or to **connect** LANs that use identical physical and data link layers protocol
- Each LAN segment is a **separate collision domain**
- Bridge does not send the received frame to all other interfaces like hubs and repeaters, but it performs **filtering** which means:
  - Whether a frame should be **forwarded** to another interface that leads to the destination or **dropped**
- A bridge has a table used in filtering decisions.
Figure 6.5  A bridge connecting two LANs

<table>
<thead>
<tr>
<th>Address</th>
<th>Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>71:2B:13:45:61:41</td>
<td>1</td>
</tr>
<tr>
<td>71:2B:13:45:61:42</td>
<td>1</td>
</tr>
<tr>
<td>64:2B:13:45:61:12</td>
<td>2</td>
</tr>
<tr>
<td>64:2B:13:45:61:13</td>
<td>2</td>
</tr>
</tbody>
</table>
Bridges Vs. Hubs

A Hub sending a packet from F to C.

A bridge sending a packet from F to C.
4) Switches

- Usually used to connect individual computers not LANs like bridge.
- Allows more than one device connected to the switch directly to transmit simultaneously.
- Can operate in Full-duplex mode (can send and receive frames at the same time over the same interface).
- Performs MAC address recognition and frame forwarding in hardware.
Types of Switches

- Switches can use different forwarding techniques—two of these are **store-and-forward** switching and **cut-through** switching.

- In **store-and-forward** switching, an entire frame must be received before it is forwarded.

- **Cut-through switching** allows the switch to begin forwarding the frame when enough of the frame is received to make a forwarding decision. This reduces the latency through the switch.

- Store-and-forward switching gives the switch the opportunity to evaluate the frame for errors before forwarding it.

- Cut-through switching does not offer this advantage, so the switch might forward frames containing errors.
5) Routers

- Operates at network layer = deals with **packets** not **frames**.

- Connect LANs and WANs with similar or different protocols together.

- Switches and bridges **isolate collision domains** but forward broadcast messages to **all LANs** connected to them. Routers **isolate both** collision domains and broadcast domains.

- Acts like normal stations on a network, but have **more than one** network address (an address to each connected network).

- Routers **Communicate with each other** and exchange routing information.

- Determine best route using **routing algorithm** by special software installed on them.
Figure 6.11  *Routers connecting independent LANs and WANs*