Module 2

Internetworking Devices

BECE401L

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Internetworking Devices

- ***Network Connecting Device:*** a device that **connects two or more devices** together that are **present in the same** or **different networks.**
  - Routers, Hubs, Switches, and Bridges are all network connecting devices.
  - All these connecting devices operate in ***some specific layers of the OSI*** (Open System Interconnection) Model.

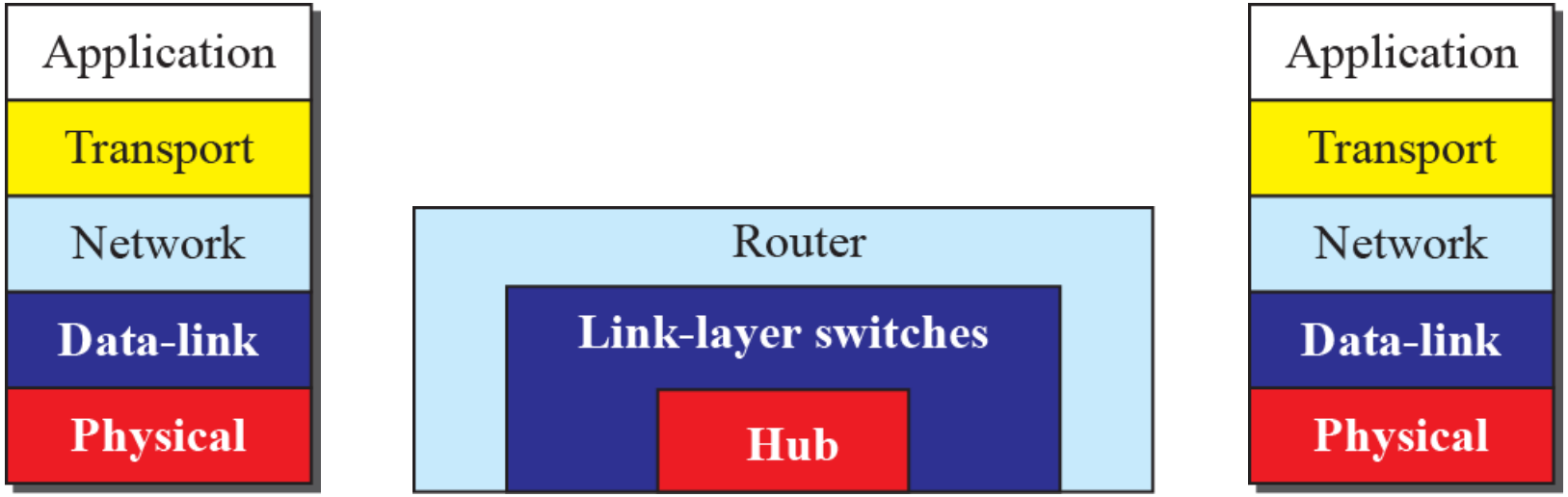
We use connecting devices:

- to **connect hosts** together to make a **network**
- to **connect networks** together to make an **internet**.

Categories of Internetworking Devices

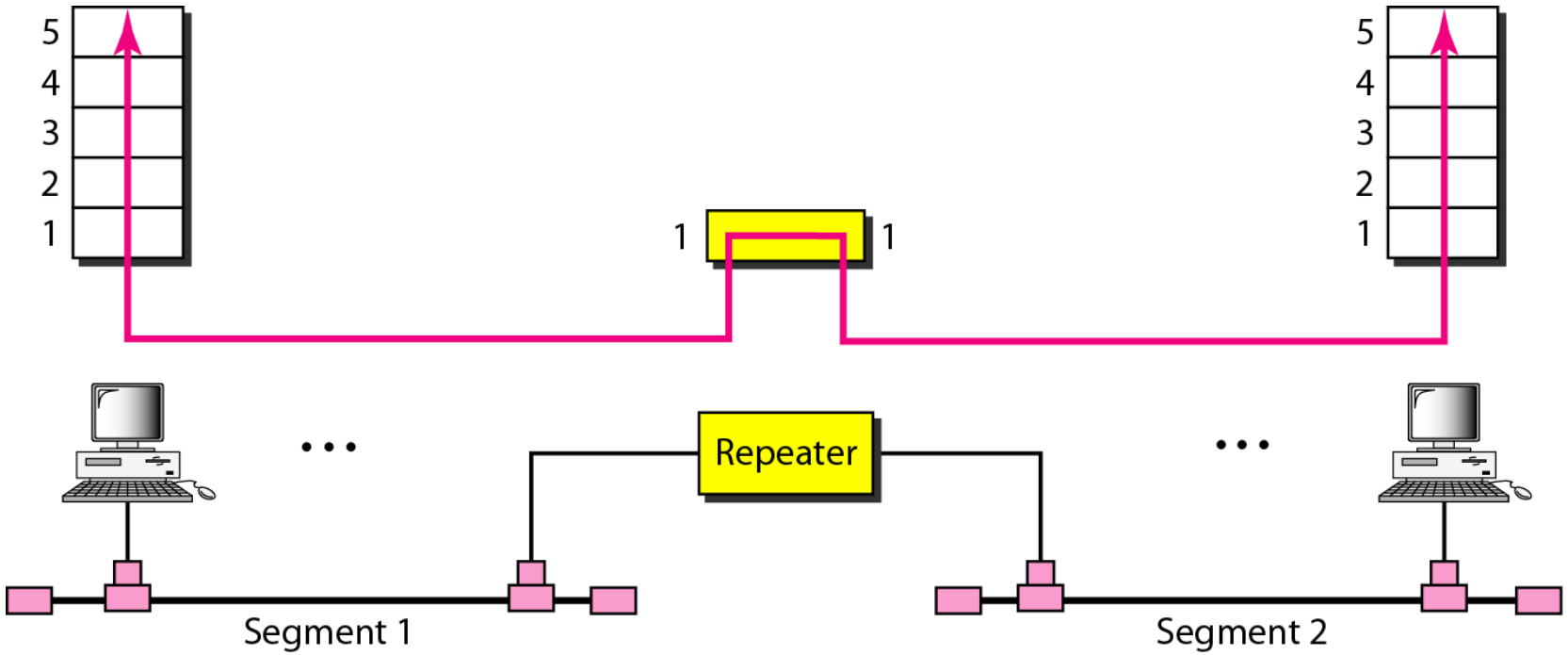
Today, connecting devices can operate in different layers of the Internet model:

- **Hubs:** operate in the **first layer** of the Internet model.
- **Link-layer switches:** operate in the **first two layers.**
- **Routers:** operate in the **first three layers.**



Repeater

- A two-port device that *connect segments of a LAN*
- **Forwards every frame**; it has **no filtering capability**
- A repeater is a **regenerator**, **not an amplifier.**

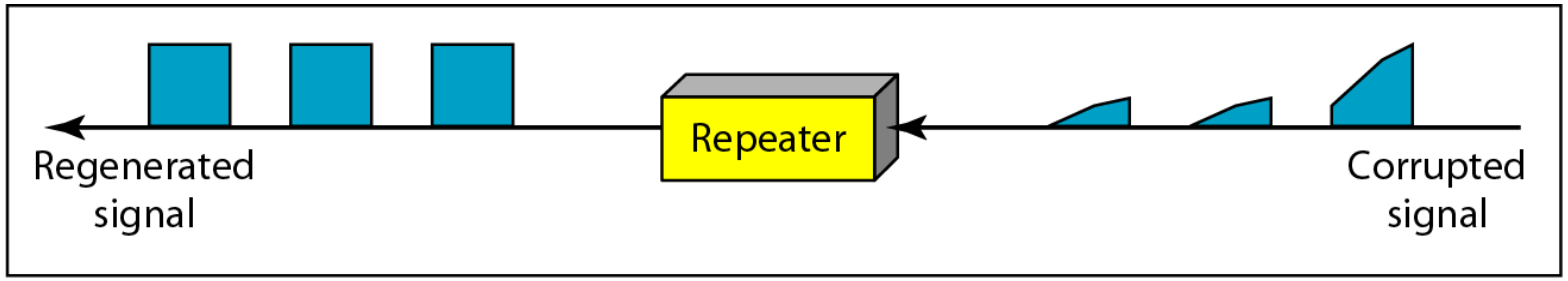


A repeater connecting two segments of a LAN

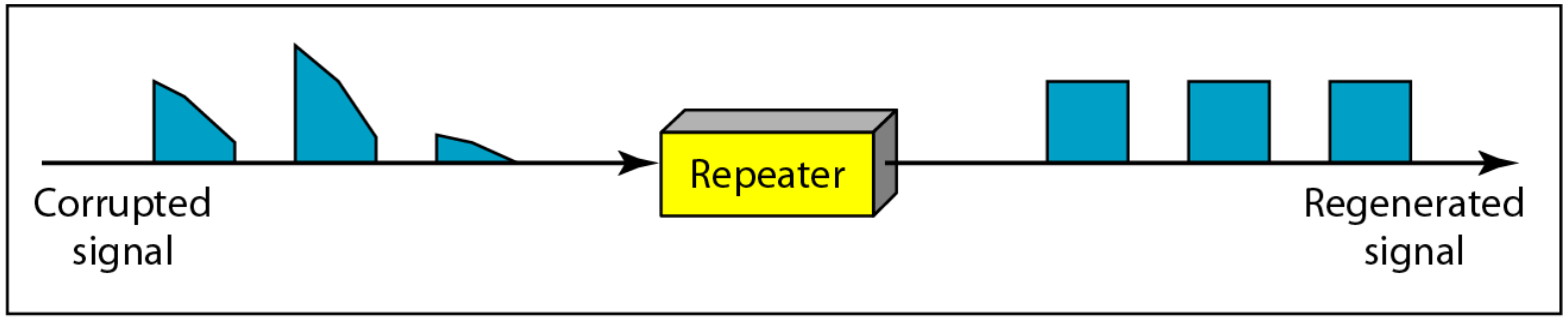
Repeater

- A repeater is a **regenerator**, **not an amplifier**.
  - It is used to **regenerate the signal over the same network** before it **becomes too weak or corrupted**,
  - Allowing the signal to be **transmitted** for a **longer distance over the same network.**

- **When the signal weakens**, repeaters **copy it bit by bit** and **regenerate it at its original strength**.



a. Right-to-left transmission.



b. Left-to-right transmission.

Types of Repeater

- *On the basis of signals that repeaters generate.*
- **Analog Repeaters :**
  - Data is transmitted through ***analog signals to increase its amplitude***.
  - These repeaters are used in **trunk lines** to help **broadcast multiple signals** using **frequency division multiplexing** (FDM).
- **Digital Repeaters :**
  - Data is transmitted in the form of **binary digits** such as 0s and 1s.
  - While transmitting data, **0 and 1 values are generated**, and it is capable of transmitting data over long distances.

- *Based on the types of connected networks.*
- **Wired Repeaters :**
  - These repeaters are commonly used in **wired** Local Area Networks .
- **Wireless Repeaters :**
  - They are commonly used in **wireless** LANs and **cellular** networks .

Repeater

- *Advantages of Repeater*
  - Increase the **overall distance** of a network.
  - Repeaters are **easy to set up** and can easily **increase network length or coverage area**.
  - Repeaters have **no significant impact on network performance**.
  - It is a **cost-effective network** device.
- *Disadvantages of Repeater*
  - Repeaters are **unable to connect disparate networks.**
  - Repeaters **cannot reduce network traffic.**
  - Most repeaters on a **network generate noise on the wire**, increasing the possibility of packet collisions.

Hub

- A **physical-layer device** that acts on individual bits rather than frames.
  - *When a **bit**, representing 0 or 1, arrives from one **interface***
  - *Hub simply **recreates the bit**, **boosts its energy strength**, and **transmits the bit** into **all the other interfaces**.*

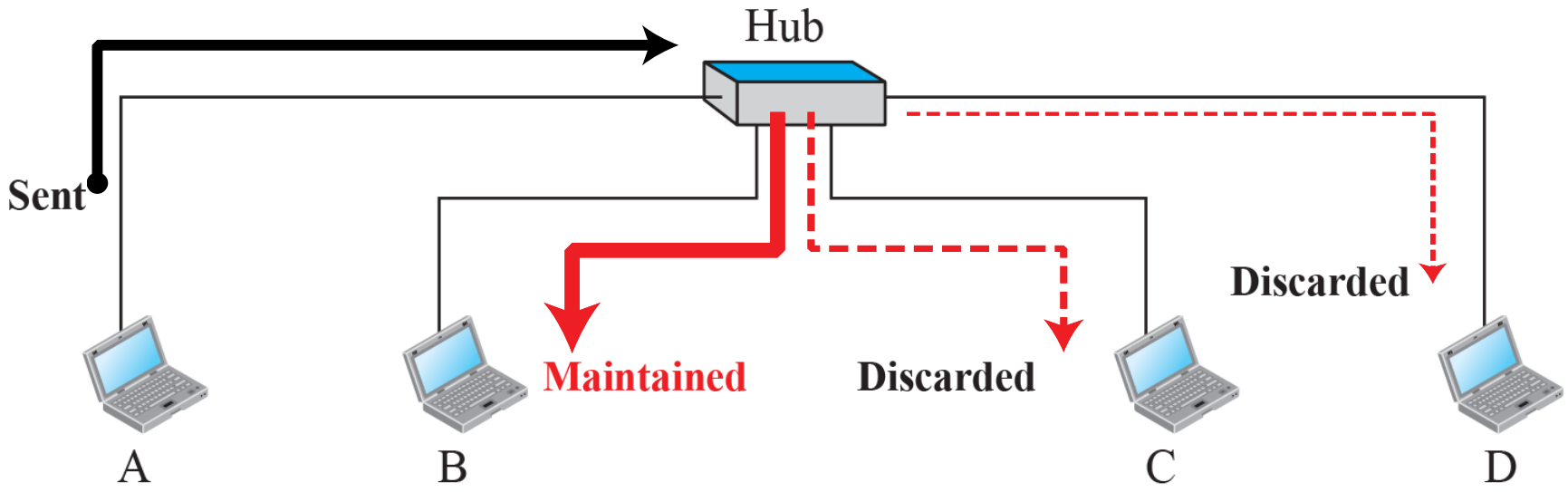
- Whenever **a hub** **receives a bit** from one of its interfaces, it **sends a copy to all other interfaces**.
  - *If a hub receives frames from **two different interfaces at the same time**,*
  - *A **collision occurs**, and the nodes that created the frames must retransmit.*

- A network hub **does not have routing tables** or **intelligence** that are utilized to transfer information and disseminate all network data across all connections.

- **Flooding** is a simple computer network **routing technique** in which a **source** or **node sends packets through every outgoing link**.
  - *The flooding algorithm is easy to implement.*
  - *The hubs use the flooding algorithm to forward data.*

Hub

- When a **packet** from **station A** to **station B** arrives at the hub, the **signal** is **regenerated** to remove any possible corrupting noise.
- Then the **hub forwards** the packet from **all outgoing ports except the sender port**. (broadcast: all station gets it, but only station B keeps it)



Hub

- *Advantages of Hub*
  - Due to its low cost, anyone can utilize it.
  - It supports various types of Network Media.

- *Disadvantages of Hub*
  - It is unable to select the best network path.
  - It has no mechanism for **reducing network traffic**.
  - It is unable to **filter information** because it sends packets to all connected segments.

Link Layer Switches

- A kind of a **two layer device**, that operates at the Data-link & Physical Layer
- A switch has **numerous ports** into which computers can be plugged.

- When a **data frame arrives** at **any network switch port**,
  - *it **evaluates** the **destination address**(destination MAC address),*
  - *Performs the **necessary checks**, and*
  - ***Sends the frame** to the **associated device**.*

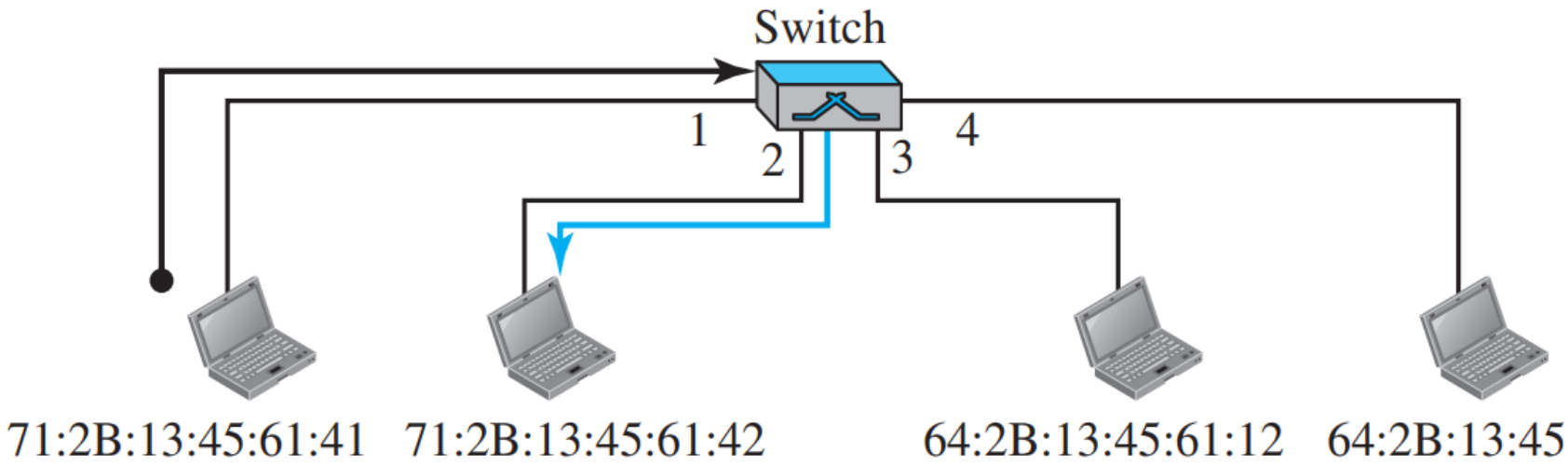
- The switch **performs error checking before forwarding the data**,
  - *Making it very efficient because it **does not forward packets with errors** and*
  - *Only forwards good packets to the correct port.*

- *A **bridge** is also a two layer device that operates at the Data-link & Physical Layer*

- **Difference** in functionality is between a **link-layer switch** and a **hub**.
  - *A link-layer switch **has filtering capability**.*
  - *It **can check** the **destination address of a frame** and can decide from which outgoing port the frame should be sent*

Link Layer Switches

- A **link-layer switch** has a **table** used in **filtering decisions**.
  - **Does not change** the **link-layer (MAC) addresses** in a frame.
- ***Example:***
  - We have a **LAN** with **4 stations** that are connected to **a link-layer switch.**
  - If a frame destined for **station 71:2B:13:45:61:42** arrives at **port 1**,
  - The link-layer switch consults its **table** to find the **departing port**.
  - According to table, **frames for 71:2B:13:45:61:42** should be sent out only **through port 2**;
  - Therefore, there is **no need for forwarding the frame through other ports.**



Switching 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

Transparent Switches

- A switch in which the **stations are completely unaware of the switch's existence**.
- If a switch is **added or deleted** from the system, *reconfiguration of the stations is unnecessary*.
- According to the **IEEE 802.1d specification**, a system equipped with transparent switches must **meet three criteria**:
  - Frames must be **forwarded** from one station to another.
  - The **forwarding table is automatically made** by learning frame movements in the network.
  - **Loops** in the system **must be prevented**.

Transparent Switches

- **Forwarding**
  - A transparent switch must **correctly forward the frames.**

- **Learning**
  - The ***earliest switches*** had ***switching tables*** that ***were static***.
    - The ***system administrator*** would ***manually*** enter ***each table entry*** during switch setup.
    - Although the process was simple, it was not practical.
  - If a station was added or deleted, the table had to be modified manually.
  - The same was true **if a station's MAC address changed**, which is not a rare event.
    - For example, putting in a new network card means a new MAC address.

Transparent Switches

- **Learning Switches**
  - A better solution to the static table is a **dynamic table** that **maps addresses to ports (interfaces) automatically.**
  - To make a table dynamic, **we need a switch** that **gradually learns from the frames' movements**.
  - To do this, the **switch inspects both the destination and the source addresses** in **each frame that passes** through the switch.
    - The **destination address** is used for the **forwarding decision** (table lookup);
    - The **source address** is used for **adding entries to the table** and **for updating purposes.**

Transparent Switches

- **Learning Switches**

Gradual building of table

Address	Port

a. Original

Address	Port
71:2B:13:45:61:41	1

b. After A sends a frame to D

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

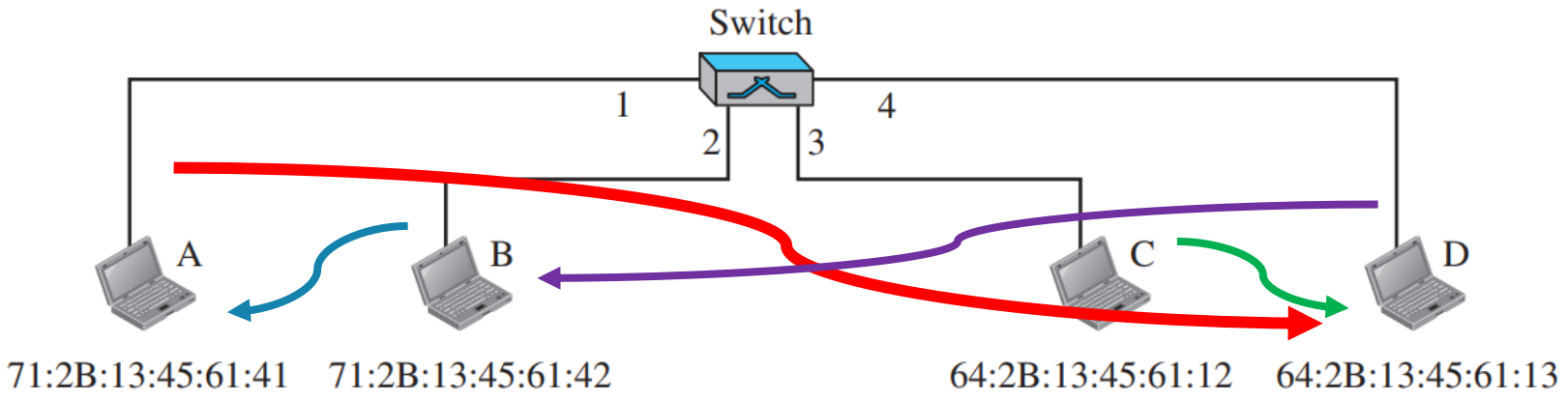
c. After D sends a frame to B

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

d. After B sends a frame to A

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

e. After C sends a frame to D



Transparent Switches

- Learning Switches
- **Step 1**
  - When station A sends a frame to station D, the switch does not have an entry for either D or A.
  - The frame **goes out from all three ports**; the **frame floods the network**.
  - However, **by looking at the source address**, the **switch learns** that **station A** must be **connected to port 1**.
  - This means that frames destined for A, in the future, must be sent out through port 1.
  - The **switch adds this entry to its table**.
  - The table has its first entry now.
- **Step 2**
  - When station D sends a frame to station B, the **switch has no entry for B**, so it **floods the network again**.
  - However, it adds **one more entry** to the table **related to station D**.

Transparent Switches

- **Step 3**
  - The **learning process continues** until the table has information about every port.
  - However, note that the **learning process may take a long time**.
  - For example, if a ***station does not send out a frame*** (a rare situation), the ***station will never have an entry in the table***.