

Interconnecting Devices

Session Objectives

After going through this session you will be able to understand:

- ✓ Networking
- ✓ The devices used in Networking like Router, Switch, Hub, Bridges and Repeaters
- ✓ The network layer at which they operate
- ✓ Working of each device

Introduction

- Network is an **infrastructure** made up of interconnecting devices.
- The most common devices are Hub, Switch, Router and Bridge.
- The devices are used to create LAN, WAN and MAN networks.
- The device make communication possible from one end to another.
- Each device follows a set of rule for data communication.
- The device does the job of signal enhancement, forwarding and routing.



List of Networking Devices



Repeaters



Hubs



Bridges

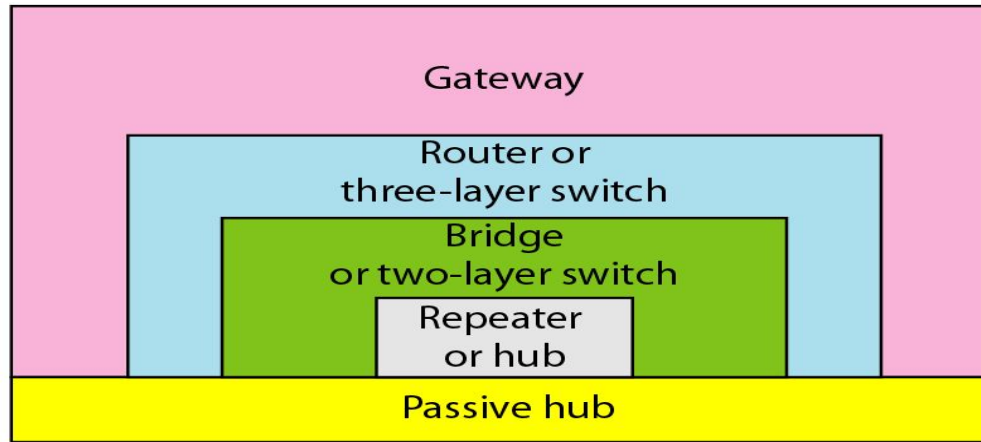


R



Layer Based Working of Connecting Devices

Application
Transport
Network
Data link
Physical



Application
Transport
Network
Data link
Physical

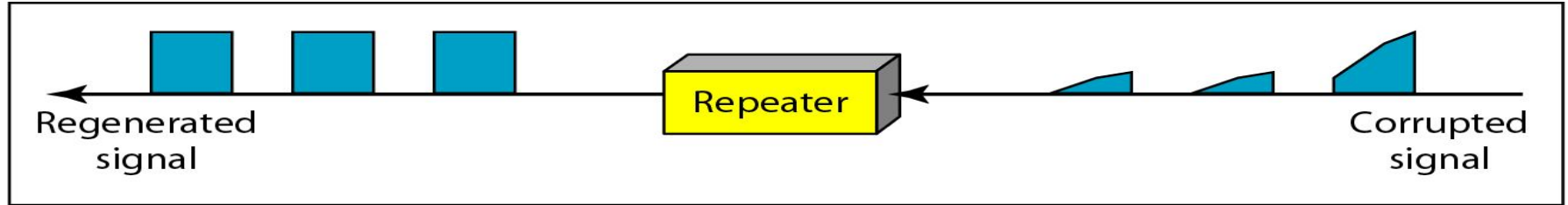


Repeaters

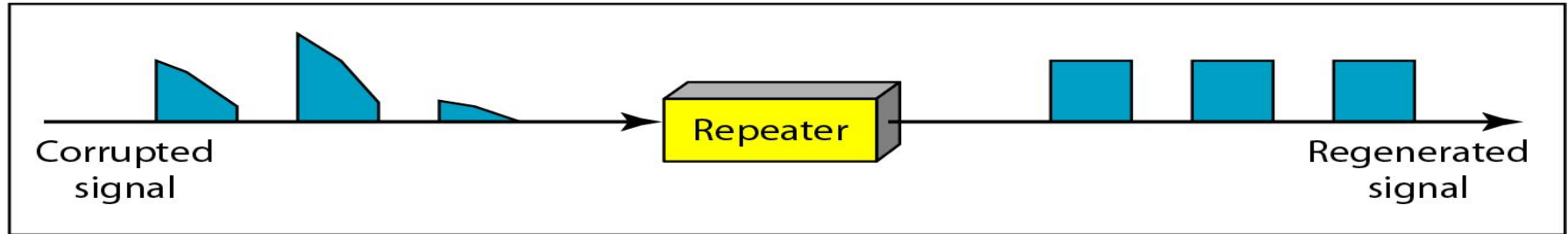
- A **physical layer** device that acts on **bits** not on **frames** or **packets**.
- Can have **two or more** interfaces.
- When a bit (0,1) arrives, the repeater receives it and **regenerates** it, and transmits it onto all other interfaces.
- Used in LAN to **connect cable segments** and **extend the maximum cable length**.
 - Ethernet **10base5** – Max. segment length **500m** – 4 repeaters (5 segments) are used to extend the cable to **2500m**)
 - Ethernet **10Base2**- Max. segment length **185m** - 4 repeaters (5 segments) are used to extend the cable to **925m**
- Repeaters do not implement any **access method** that means if any two nodes on any two connected segments transmit at the same time **collision** will happen.

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Figure 1: *Function of a Repeater*



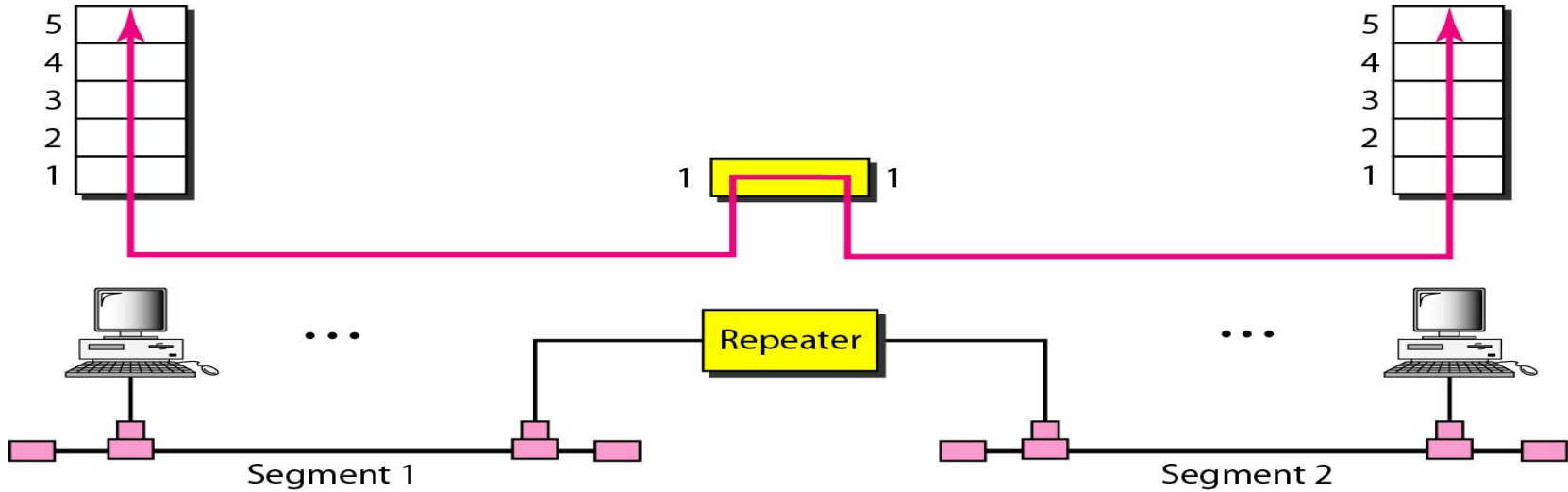
a. Right-to-left transmission.



b. Left-to-right transmission.

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Figure 2: *A repeater connecting two segments of a LAN*



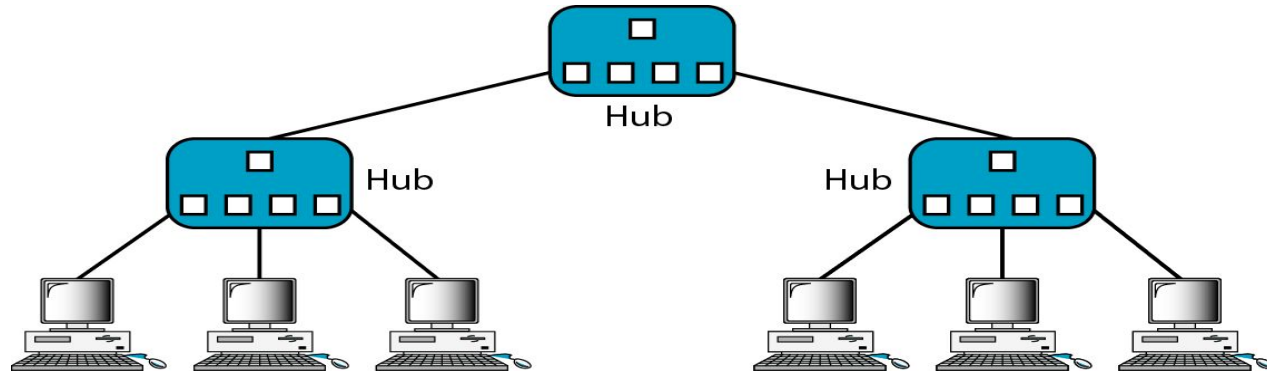
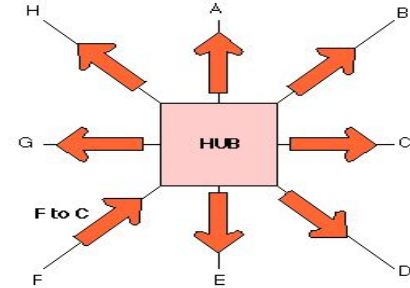
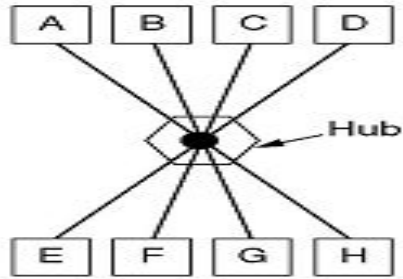


Hubs

- Works on the **physical layer** and is also called **multiport repeater**.
- Operate on **bits** rather than **frames**.
- Used to connect stations adapters in a **physical** star topology but **logically** bus.
- Connection to the hub consists of **two pairs of twisted pair wire** one for **transmission** and the other for **receiving**.
- Follows no **access method** in data transmission.
- Does not do **filtering** it just copy the received frame onto **all other links**
- The entire hub forms **a single collision domain**, and **a single Broadcast domain**
 - **Collision domain:** is that part of the network (set of NICs) when two or more nodes transmit at the same time collision will happen.
 - **Broadcast domain:** is that part of the network (set of NIC) where each NIC can 'see' other NICs' traffic **broadcast messages**.
- Multiple Hubs can be used **to extend** the network length.
 - **No buffering** at the hub.

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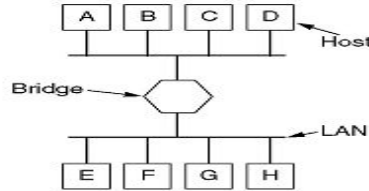
Figure 3: *Hub Interconnection*





Bridges

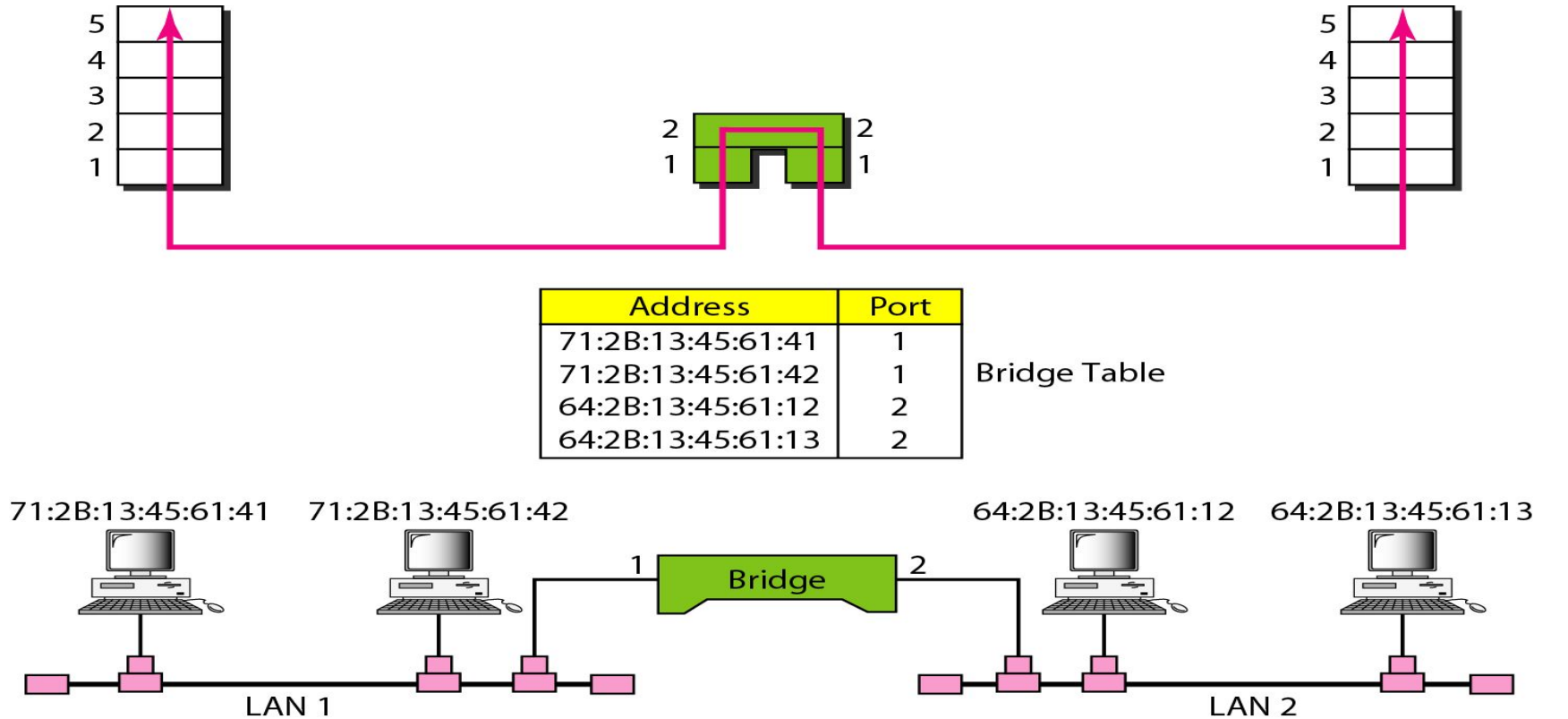
- Acts on the **data link** layer (MAC address level).
- Used to **divide** (segment) the LAN into smaller LANs segments, or to **connect** LANs that use identical physical and data link layers protocol.



- 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**.
- Bridge uses a bridge table (**forwarding table**) that contains entries for the nodes on the LAN for packet forwarding.
- A bridge runs **CSMA/CD before sending a frame** onto the link not like the hub or repeater.

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Figure 4: A bridge connecting two LANs



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Figure 5: *A learning bridge and the process of learning*

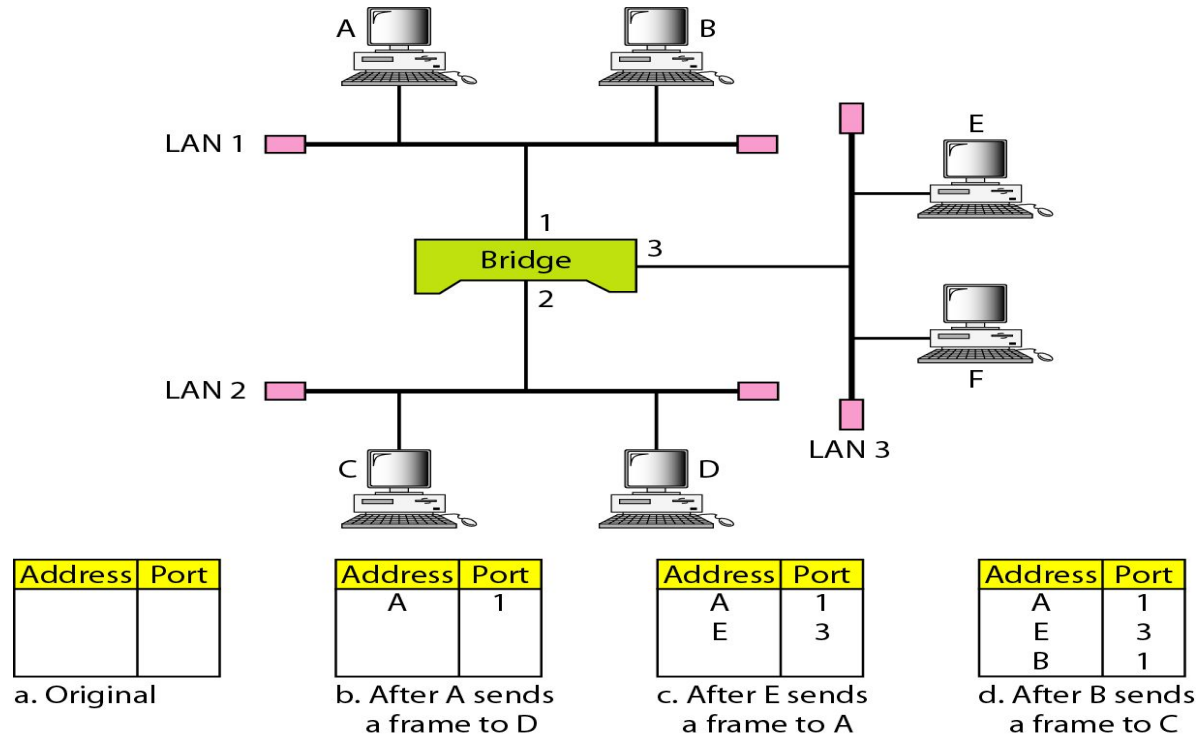


Figure 6: *A learning bridge and the process of learning*

Domain



a. Without bridging

Domain



Domain



Bridge

Domain



Domain



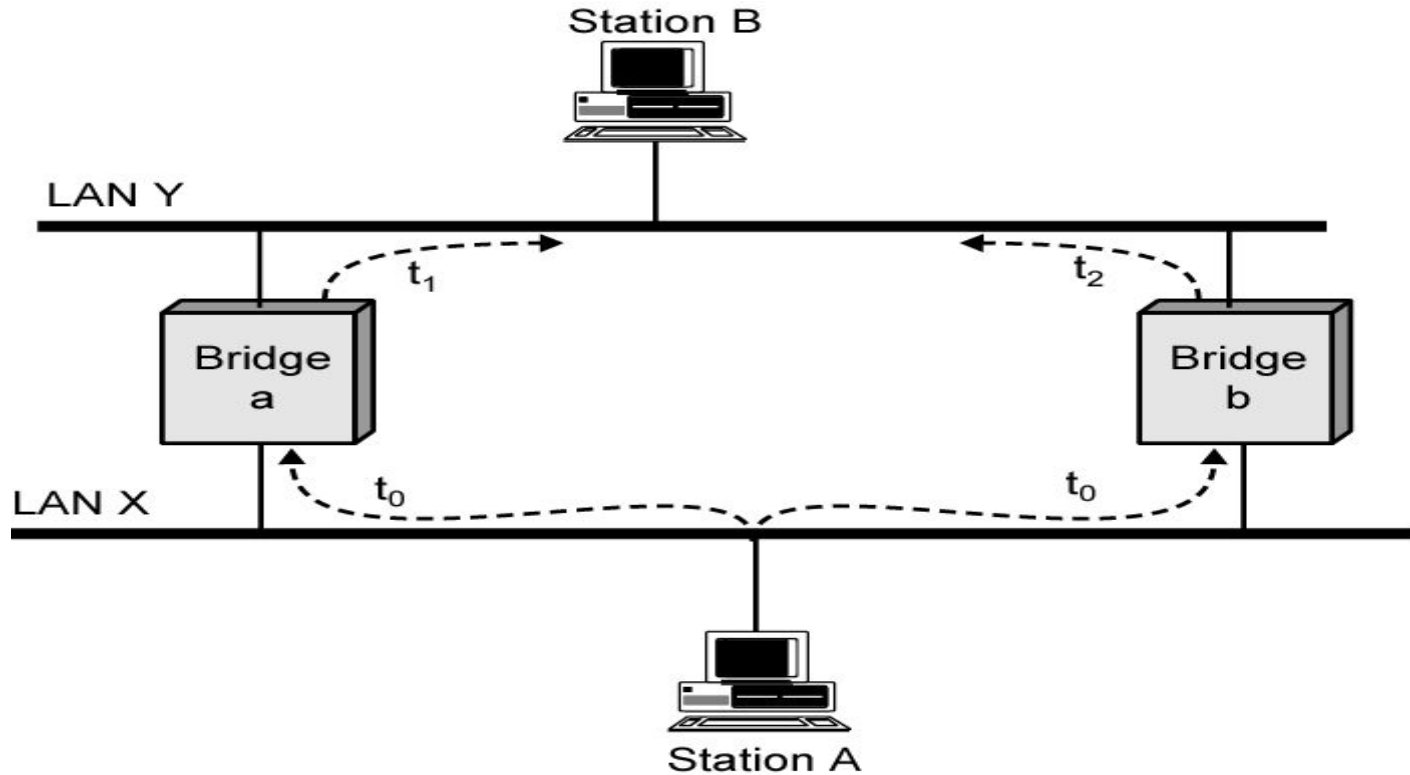
b. With bridging

(a) In heavy load, each station has an average effective theoretical **bandwidth** = $10/12$

(b) Each station has an average effective **bandwidth** equal = $10/3$

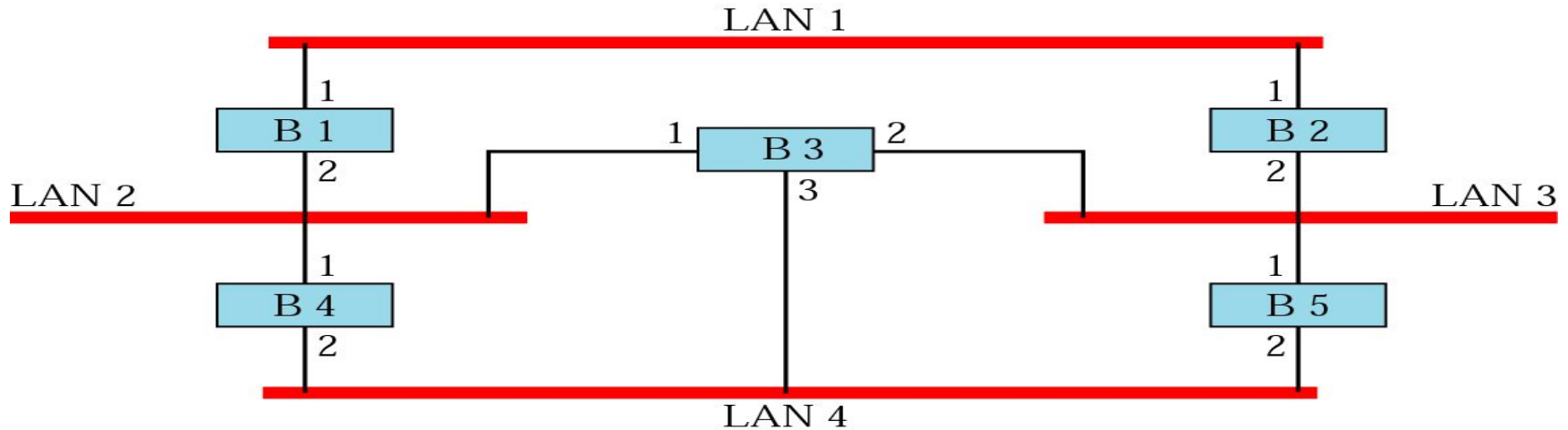
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Figure 7: *Looping problem-1 in Bridge connectivity*



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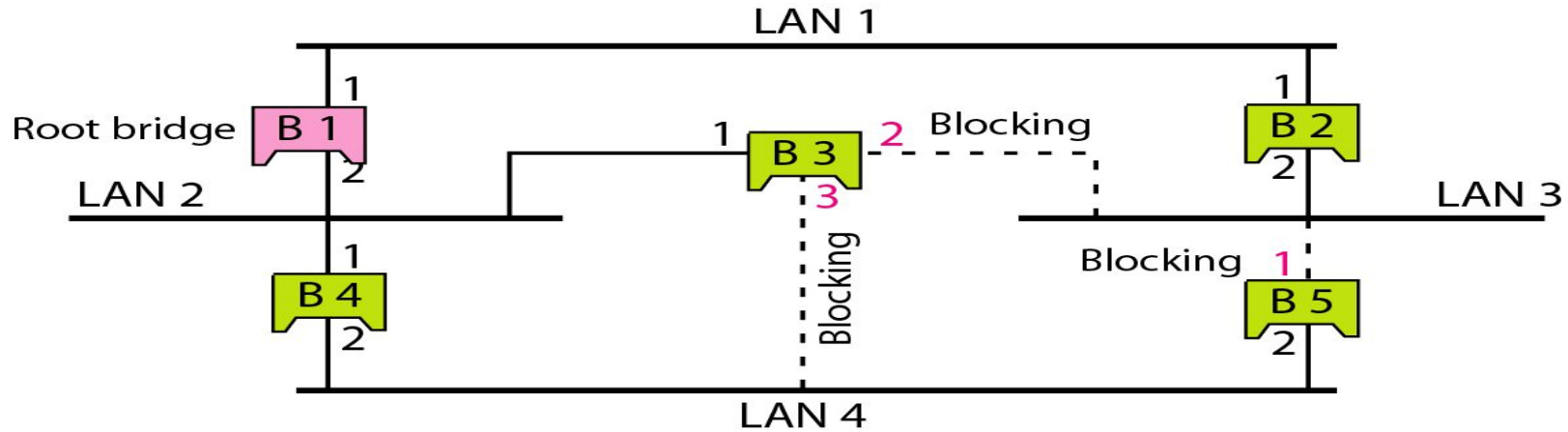
Figure 8: *Looping problem-2 in Bridge connectivity*



- When using switches, the network **should not contain any loop** (there should be exactly one path from any LAN to any other LAN)
- Loops can cause number of frames in the LAN to **increase indefinitely**

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Figure 9: *Looping problem Solution*



Ports 2 and 3 of bridge B3 are blocking ports (no frame is sent out of these ports). Port 1 of bridge B5 is also a blocking port (no frame is sent out of this port).

- Loops are logically disabled by the **minimum spanning tree algorithm**

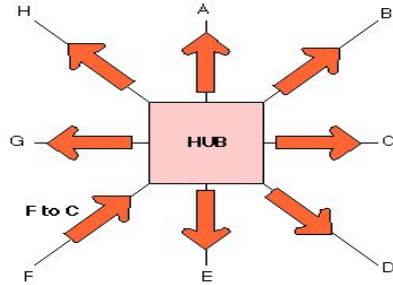


Switch

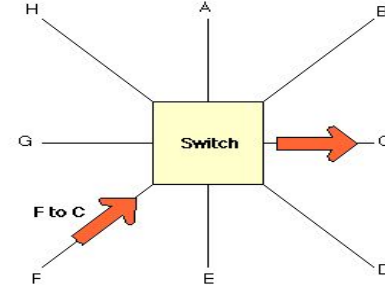
- **N-Port bridge** where N is equal to number of stations
- Usually used to **connect individual computers** not LANs like bridge
- **Allows more than one device** connected to the switch directly to transmit simultaneously
- Can operate in **Full-duplex** mode.
- Performs **MAC address recognition** and frame forwarding in hardware (bridge in software)
- *Two types :*
 - **Store-and-forward**: switch receives the whole *frame* on the input line, buffers it, briefly performs error checking, then routes it to the appropriate output line (similar to bridge).
 - **Cut-through**: based on the destination address the frame is directly sent to the appropriate output line without buffering. Here no error checking is performed

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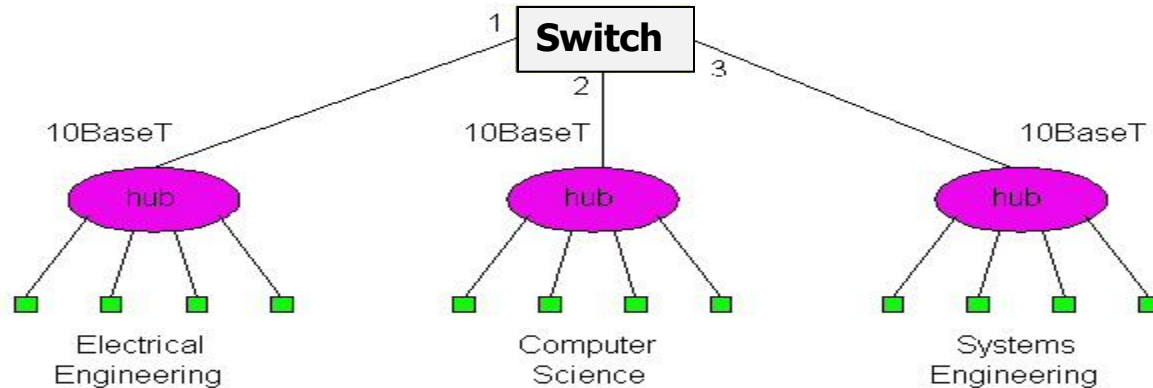
Figure 10: Switch Interconnection -1



A Hub sending a packet form F to C.



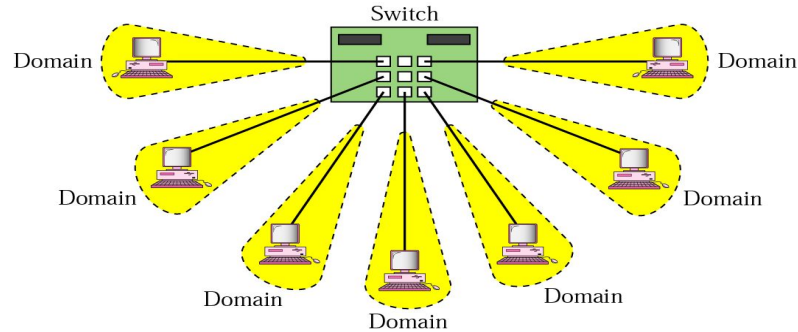
A Switch sending a packet from F to C



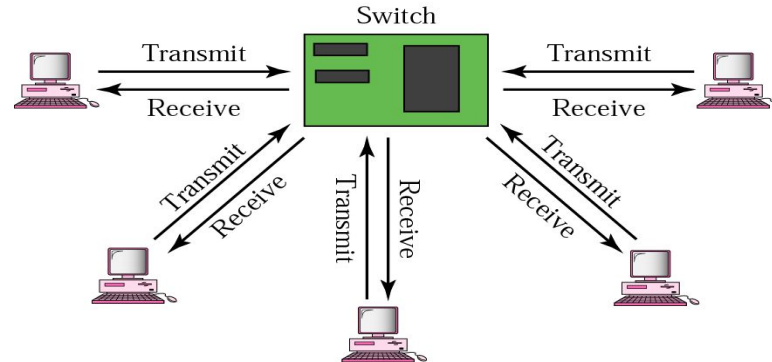
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Figure 11: Switch Interconnection -2

Isolated collision domains



Full-Duplex operation





Router

- ❑ Operates at network layer and deals with **packets** not **frames**.
- ❑ Connect LANs and WANs with similar or different protocols together.
- ❑ 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).
- ❑ Deals with global address (network layer address (IP)) not local address (MAC address).
- ❑ Routers **Communicate with each other** and exchange routing information.
- ❑ Determine best route using **routing algorithm** by special software installed on them.
- ❑ **Forward traffic if information on destination** is available otherwise **discard** it (not like a switch or bridge).

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Figure 12: *Routers connecting independent LANs and WANs*

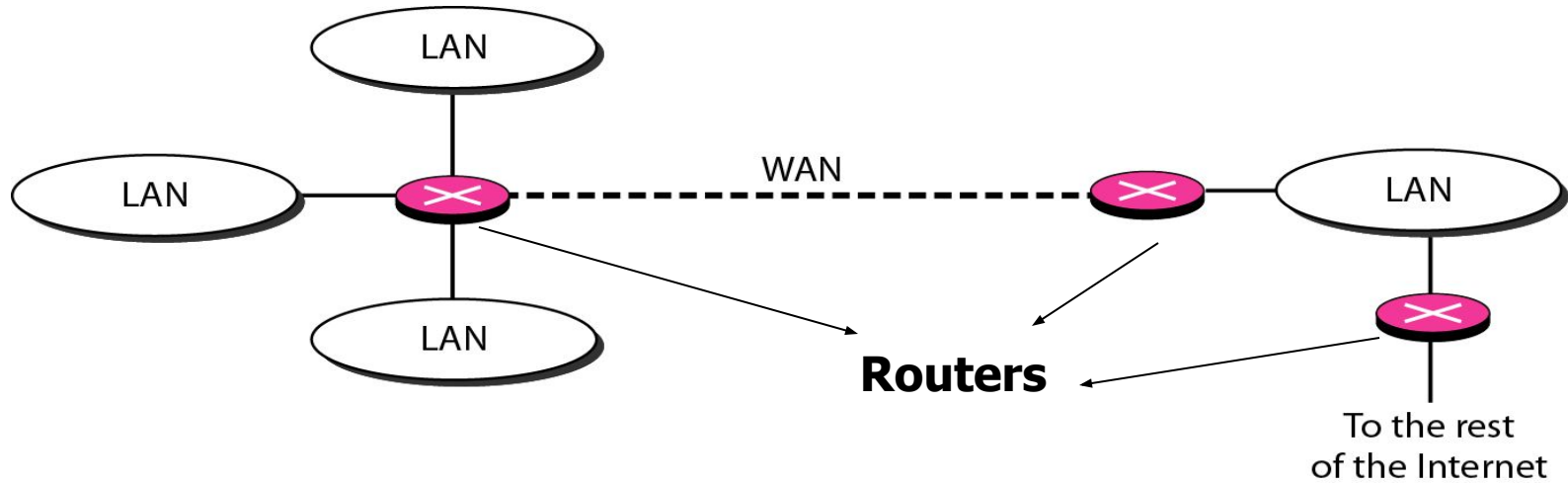
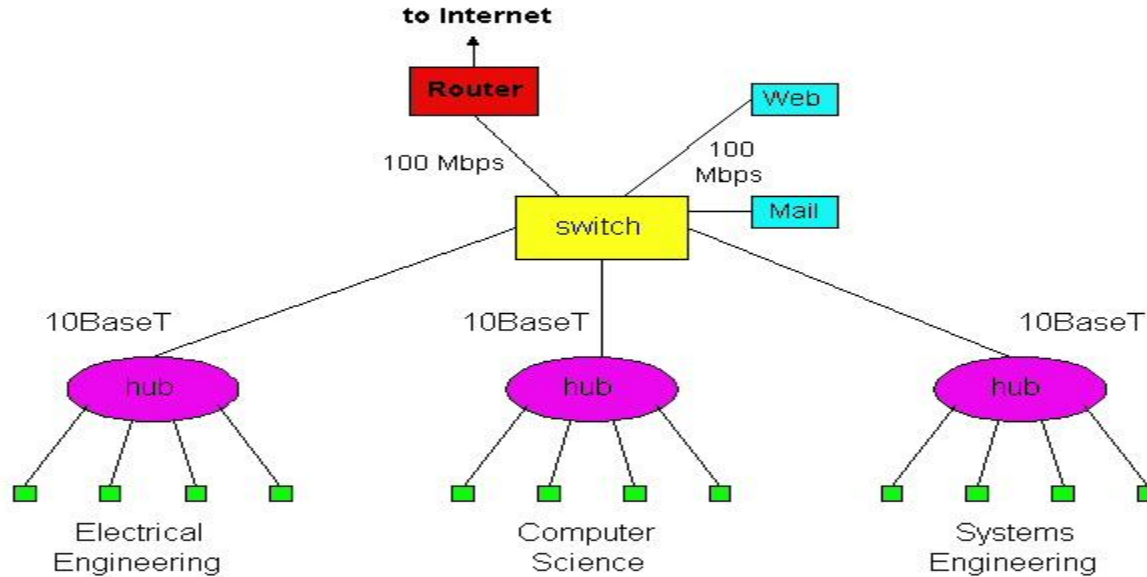


Figure 13: *Interconnecting Router, Switch and Hubs*



Summary

In this section we have discussed the following:

- Interconnecting Devices
- Looping in LAN and eliminating it using Spanning Tree Protocol
- Broadcast and Collision Domains

*Thank
you!*