

## Hub, Switch, Bridge, Router

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### Connecting Devices

- Five connecting devices
  - Repeaters
  - Hubs
  - Bridges
  - Switches
  - Routers

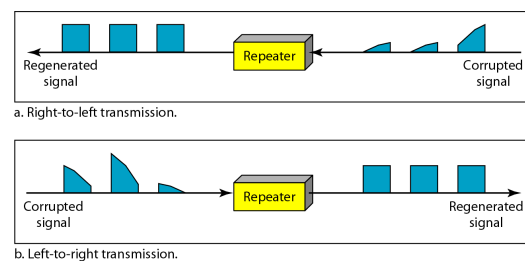
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### Repeaters

- 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, then transmits it onto all other interfaces
- Used in LAN to **connect cable segments** and **extend the maximum cable length**
- Repeaters do not implement any **media access control method**
  - If any two nodes on any two connected segments transmit at the same time **collision** will happen.

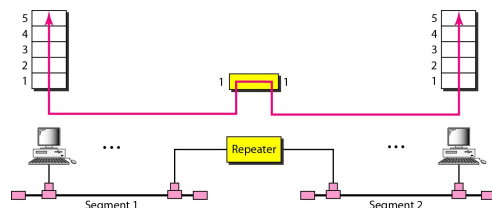
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Figure 1: Function of a repeater



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Figure 2: A repeater connecting two segments of a LAN

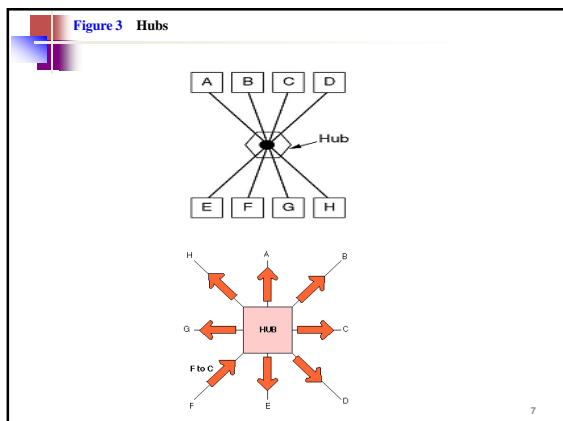


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### Hubs

- Acts on the **physical layer**
- Operate on bits rather than frames
- Also called **multiport repeater**
- Hub receives a bit from an adapter and sends it to **all** the other adapters without implementing any media access control method – it has no CSMA/CD.
- A hub does not do **filtering** (forward a frame into a specific destination or drop it) just it 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

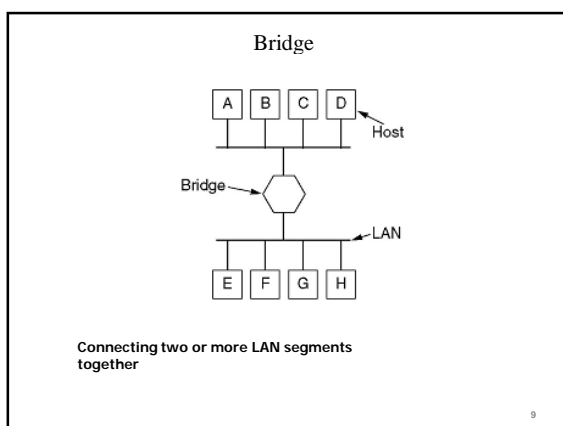
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### Bridge

- 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.
- **Interconnected segments must use the same MAC protocol e.g CSMA/CD or token ring.**
- 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**

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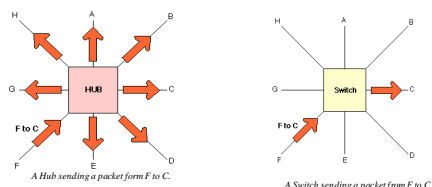


### Switches

- N-Port bridge where N is equal to number of stations
- Switches resemble bridges and can be considered as multiport bridges
- 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 (bridge in software)**.
- For the case of a switch, the interconnected LAN segments may use different MAC protocols

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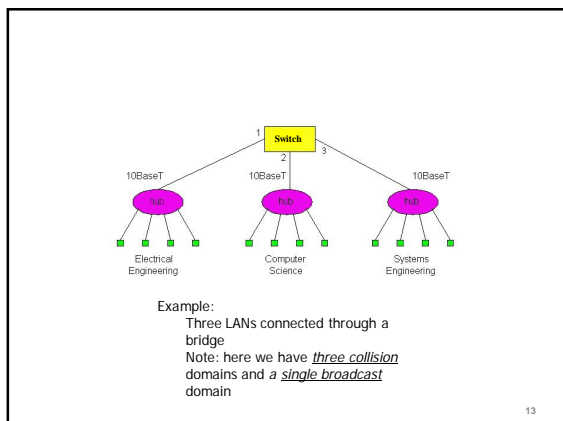
### Bridges (Switches) Vs. Hubs



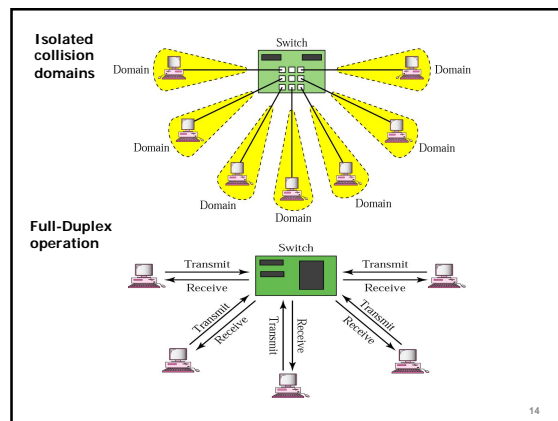
### Bridge/Switch features

- Implements CSMA/CD
- Switches isolate collision domains (each LAN segment is a separate collision domain), **THIS WILL REDUCE THE POSSIBILITY OF COLLISIONS AND result in higher total max throughput**
- Switch forwards a frame with **broadcast address to all devices attached to the whole network (single broadcast domain)**
- **Transparent:** installing or removing a switch does not require the stations networking software to be reconfigured.
- **("plug-and-play"):** no configuration necessary at installation of switch /switch or when a host is removed from one of the LAN segments

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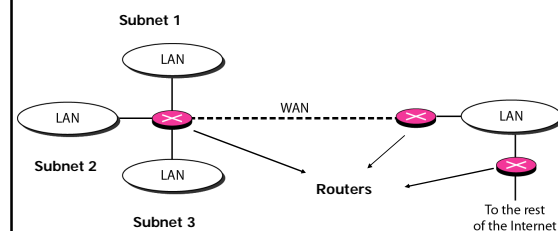
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## Routers

- 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)
- 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)

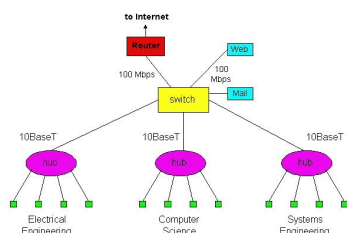
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Figure Routers connecting independent LANs and WANs



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## An Institutional Network Using Hubs, Ethernet Switches, and a Router



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How the OSI and TCP/IP Models Relate in a Networking Environment

OSI Model Layer	OSI Model Name	Pneumonic	Equipment	Equipment Purpose	Data	Protocols	Words to Remember	TCP/IP Model
Layer 7	Application	All	Computer	Regular Computer	Data	Redirector, FTP, Telnet, SMTP, SNMP, Netware Core	Browsers, Common Data Format	Application
Layer 6	Presentation	People	Computer	Regular Computer	Data	NFS, SQL, RPC, XWin	Dialogues and Conversations	Application
Layer 5	Session	Seem	Computer	Regular Computer	Segment	TCP and UDP	Quality of Service, and Reliability	Transport
Layer 4	Transport	To	Computer	Regular Computer	Segment	TCP and UDP	Quality of Service, and Reliability	Transport
Layer 3	Network	Need	Router	Segment Network into Smaller Broadcast Domains	Packet	Routeable Protocols: IP, IPX, AppleTalk	Path Selection, Routing, and Addressing	Internet
Layer 2	Data Link -MAC -LLC	Data	Bridge (2 Ports) or Switch and NIC	Segment Network into Smaller Collision Domains	Frame	NDIS, ODI, MAC Address, Ether Talk	Frames and Media Access Control (MAC)	Network Access
Layer 1	Physical	Processing	Repeater, Hub (Multi-port), Cabling	One Collision AND One Broadcast Domain	Bit	Physical	Signals and Media	Network Access

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