

Module 5

(Connecting Device & VLAN)

(Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD,CDMA/CA; Wired LAN, Wireless LANs, Connecting LANs and Virtual LANs)

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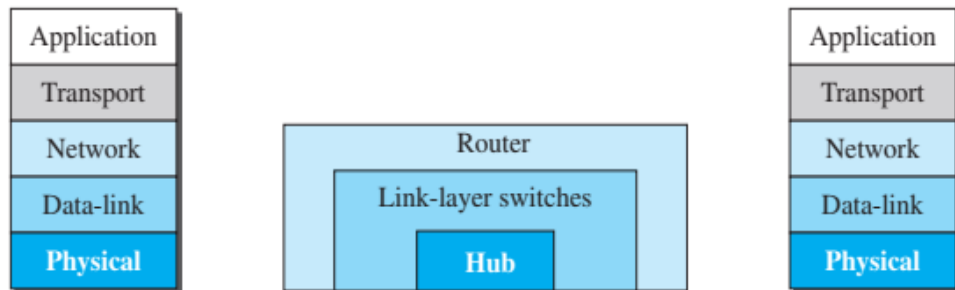
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Connecting Devices

- Connect hosts to make a network
- Connect networks to make an internet
- Operate in different layers of TCP/IP protocol suite
- Three types of devices:
 - Hub/Repeater
 - Link-layer Switch
 - Router

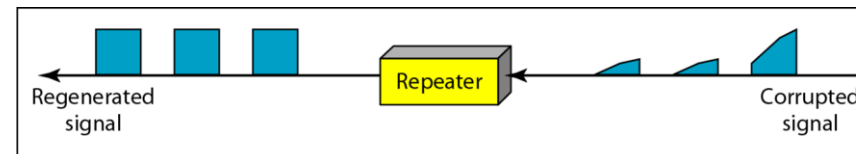


Three Categories of Connecting Devices

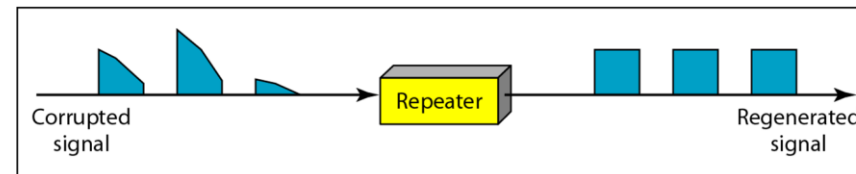
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• Hub/Repeater

- Physical layer device
- Used to connect Ethernet LAN segments (for bus topology LANs)
- Regenerate corrupted bits
- Sends received frame out from every port (except the receiving port)
- No filtering capability

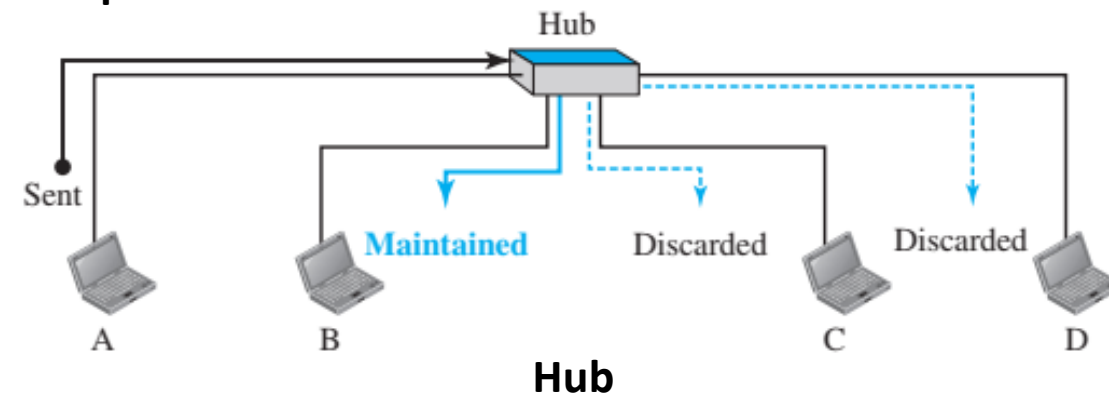


a. Right-to-left transmission.



b. Left-to-right transmission.

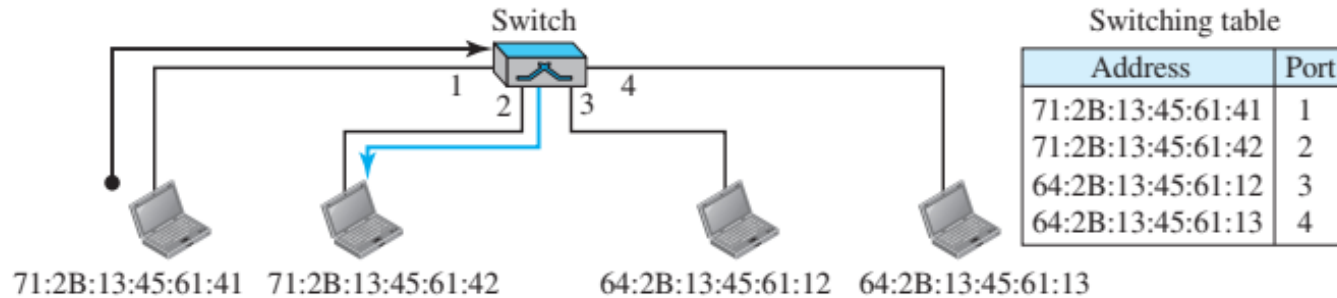
Function of a Repeater



Connecting Devices (Contd...)

• Link-layer Switch/Bridge

- Operates in: **Physical, Data-link** layers
 - Physical layer: **regenerates** received signal
 - Data-link layer: **forwarding based on MAC address**
- Filtering
 - **Does not** send out to **all** outgoing ports
 - Checks **destination** MAC address
 - Outgoing port: refer to **Switching table**

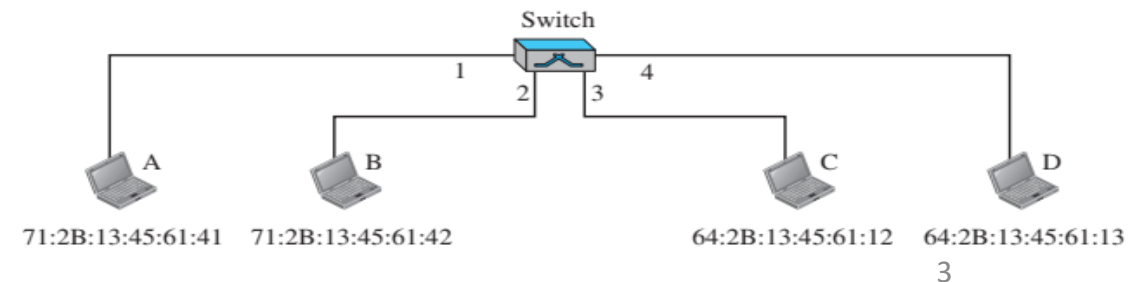
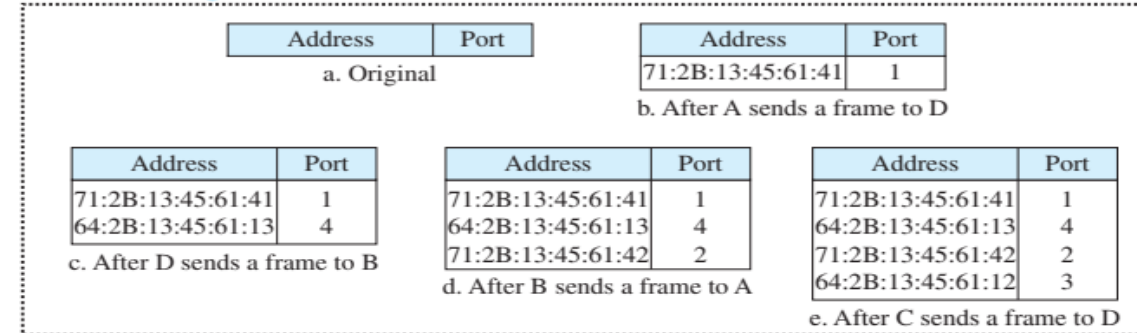


Link-layer Switch

• Learning Switch

- Earlier switches – **static table**
- **Manually** updated: very **inefficient**
- Dynamic table: **maps** addresses to ports (interfaces) automatically
 - Gradually **learns** from the **frames'** movements
- Inspects both **source and destination** addresses
 - Destination address: **used for forwarding decision (table lookup)**
 - Source address: **adding entries and updating**

Gradual building of table



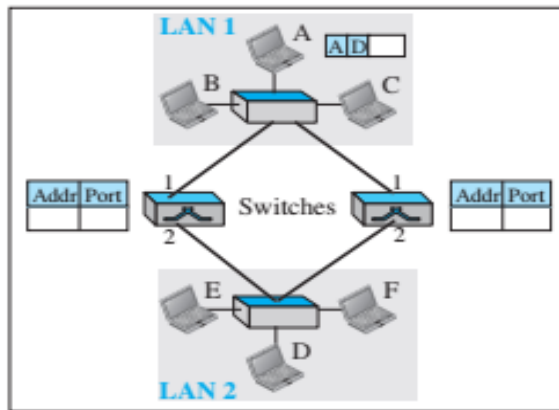
Learning Switch

Connecting Devices (Contd...)

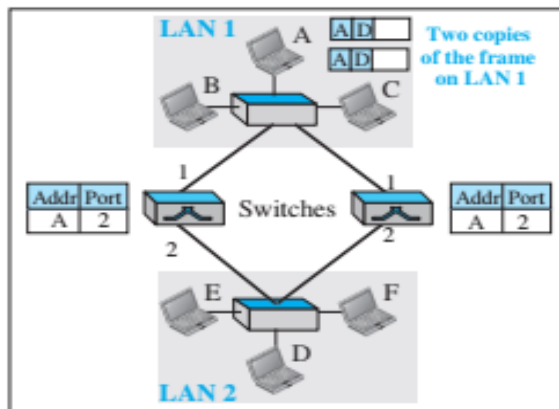
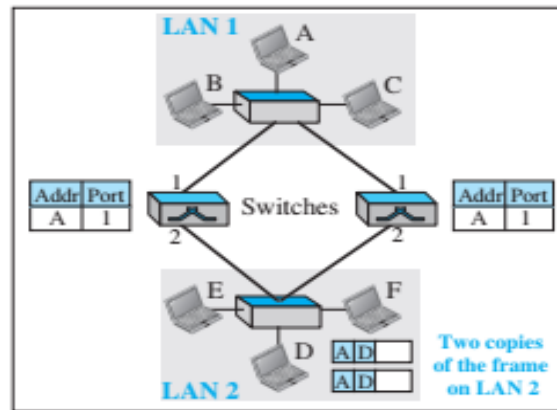
• Loop Problem

- Occurs due to **redundancy** in switches between a **pair of LANs**
 - Redundancy**: makes the system fault tolerant; creates loops in the system
- Loops: created if two or more LANs (using hubs) are connected by more than one switch

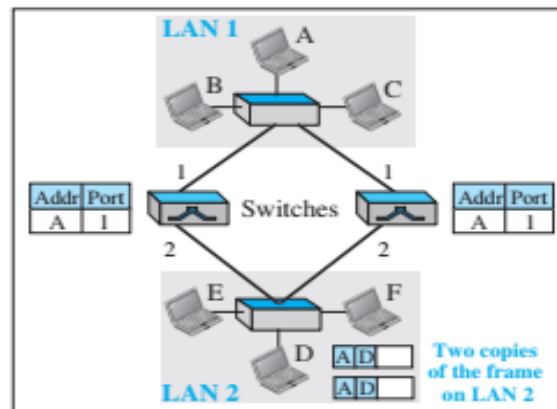
a. Station A sends a frame to station D



b. Both switches forward the frame



c. Both switches forward the frame



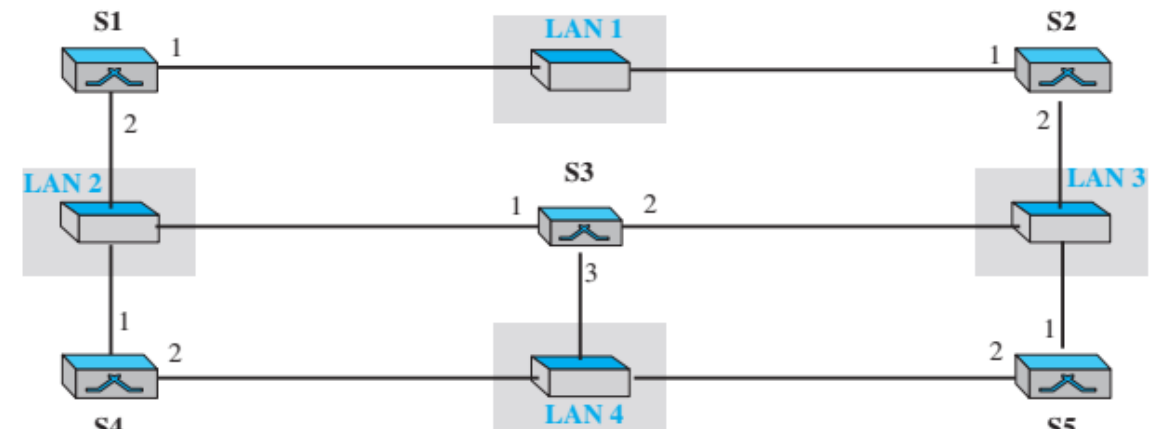
c. Both switches forward the frame

Loop Problem in a Learning Switch

Computer Networks (Module ,

• Spanning Tree Algorithm

- Switches use **spanning tree algorithm** to create **loop-less topology** (IEEE Specs)
 - Spanning tree**: graph with no loops
- Objective: **reach** from **one LAN** to **another** through **one path only** (no loop)
- Logical topology – an **overlay** over the actual physical one



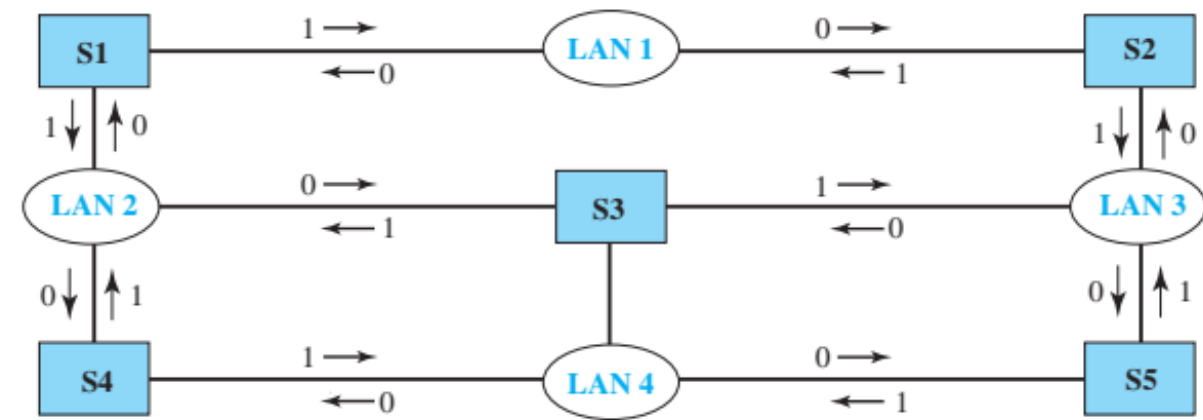
a. Actual system

A System of Connected LANs

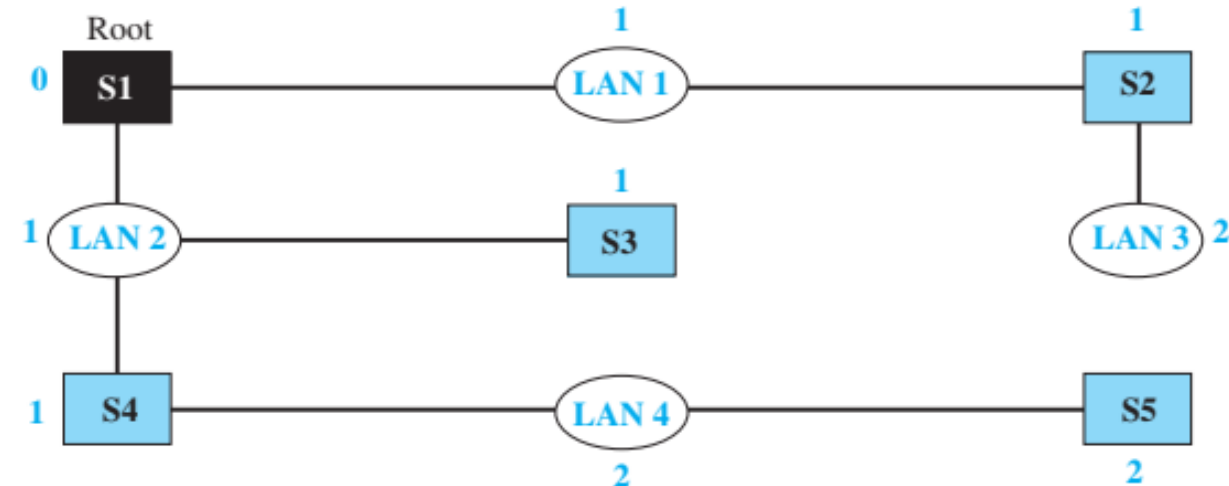
Connecting Devices (Contd...)

• Spanning Tree Algorithm

- Physical topology – modeled by **graph**
- **Nodes** – switches and LANs; edges – connection between them
- Generate **minimal spanning tree** from this graph
- Assign cost (metric) to the edges
 - Potential candidate: **minimum hop count**
 - **Switch-to-LAN: 1; LAN-to-switch:0**
- Three steps to find minimal spanning tree:
 - Find the **root** based on **smallest switch ID**
 - Find the **shortest path** from the root to every other switch or LAN
 - **Combine** the **shortest paths** to create the **minimal spanning tree**
 - Identify **forwarding ports**, **blocking ports**



Graphical Representation with Cost Assigned to each Edge



Minimal Spanning Tree in a System of Switches

• Advantages of Switches

- **Collision elimination** - increases the average bandwidth available to a host in the network
- **Connects heterogeneous devices** – devices that use different protocols at the physical layer (data rates) and different transmission media

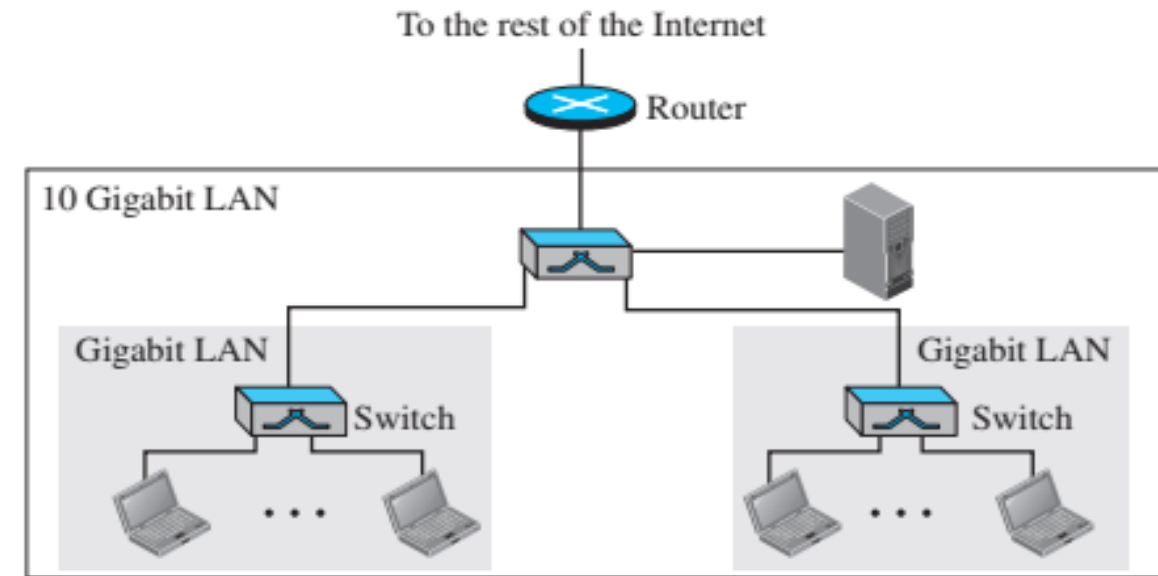
Connecting Devices (Contd...)

• Routers

- Internetworking device – connects **independent networks** to form an **internetwork**
- Operates in: **Physical, Data-link, Network layers**
 - Physical layer: **regenerates received signal**
 - Data-link layer: **checks the physical addresses (source and destination) contained in the packet**
 - Network Layer: **checks the network-layer address**

• Difference between Router and Repeater/Switch

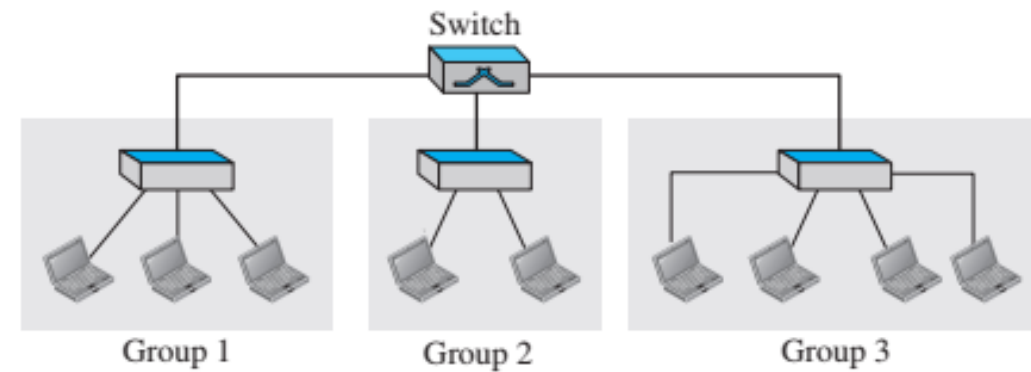
- **Physical & logical** addresses for each **interface**
- Acts only on those packets in which the **link-layer destination address** matches the **address of the interface** at which the packet arrives
- **Changes** the **link-layer address** of the packet (both source and destination) when it **forwards** the packet.



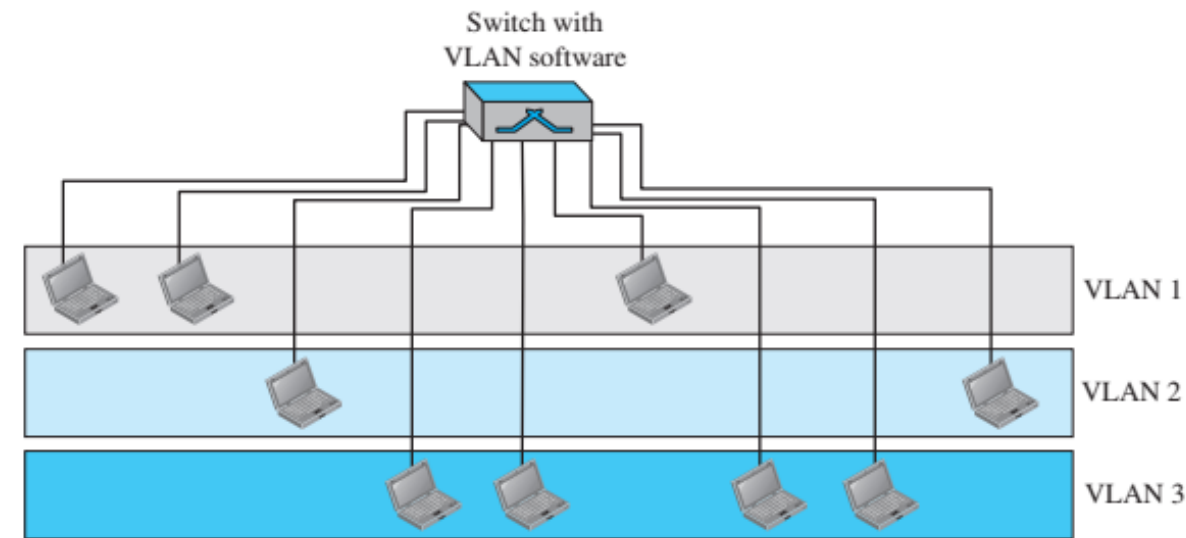
Routing Example

Virtual LAN (VLAN)

- Switched LAN: **changes** in the **work group** - **physical changes** in the **network configuration**
- VLAN: configured by **software** and not by **physical wiring**
- VLAN software:
 - Divides a LAN into several logical LANs – virtual LAN (VLAN)
 - Group membership – defined by software – any station can move across VLANs
 - **All members** belonging to a **VLAN** can receive **broadcast messages** sent to that **particular VLAN**
 - VLAN defines **broadcast domains**
 - Stations belonging to a VLAN communicate with one another similar to be in a same **physical segment**.



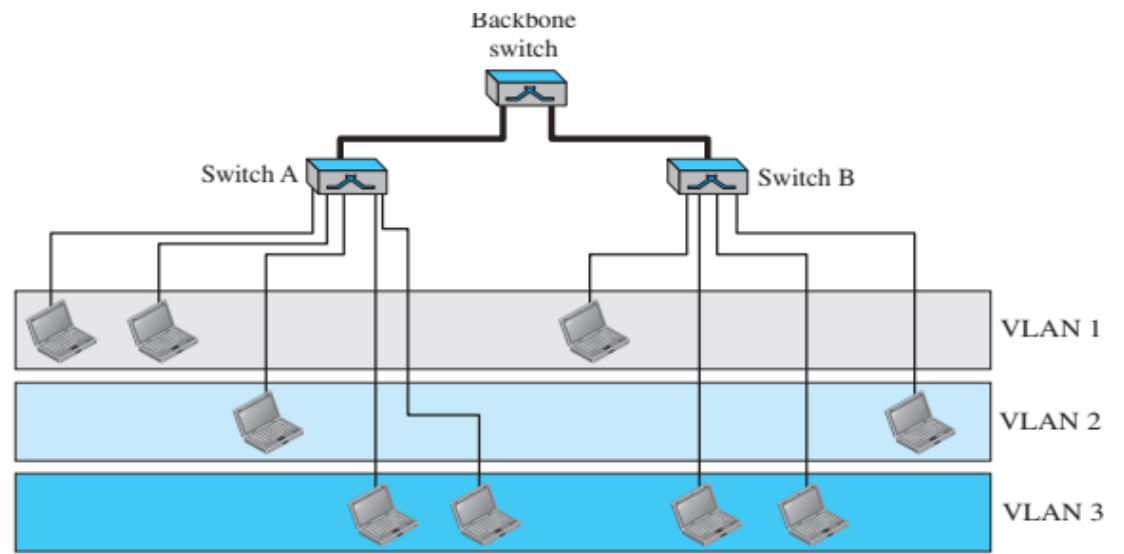
Switched LAN



A Switch using VLAN Software

Virtual LAN (VLAN)

- Membership characteristics in VLAN group
 - Interface number; MAC address; IP address; Multicast IP address
- Configuration
 - **Manual**: VLAN setup, migration of stations across VLANs done manually
 - **Automatic**: stations migrate across VLANs automatically based on predefined criteria
 - **Semi-automatic**: manual initialization; automatic migration
- Advantages
 - **Cost and Time reduction**: reduces migration cost; saves time of physical reconfiguration
 - **Creating Virtual Work Groups**
 - **Security**: broadcast messages within a group – cannot be received by users in other groups



Two Switches in a backbone using VLAN Software

- Communication between Switches: switches need to know the **status of stations (VLAN)** connected to other switches
 - **Table maintenance**: switch creates and shares table after recording membership from broadcast frame
 - **Frame tagging**: extra header added to MAC frame to define destination VLAN
 - **Time Division Multiplexing (TDM)**: the connection divided into time-shared channels equal to number of VLANs.