

Military Institute of Science and Technology
Dept. of Computer Science and Engineering
Engineering

CSE-317

DATA AND TELECOMMUNICATION ENGINEERING

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Week 1

Text Book

Data Communications and
Networking, 4rd Edition, Behrouz A.
Forouzan

TOPICS COVERED-PHASE1

- ◉ Introduction to data comm Forouzan(Ch1)
- ◉ Network model - Forouzan (Ch 2)
- ◉ Tx Basics : Data & signals- Forouzan (Ch 3)
- ◉ Tx Basics : Digital Tx - Forouzan (Ch 4)
- ◉ Tx Basics : Analog Tx- Forouzan (Ch 5)
- ◉ Spread Spectrum - Forouzan (Ch 6 partly)
- ◉ Error Detection & Correction - Forouzan (Ch10)

AREA COVERED

- ◉ Communication Model
- ◉ Data Communication Task
- ◉ Data Presentation
- ◉ Data Flow
- ◉ Networks
- ◉ OSI & TCP/IP Models
- ◉ Standards Organization

DATA COMMUNICATION

- ◎ **Data Communications** are the exchange of data between two devices via some form of transmission.

DATA COMMUNICATION TASKS

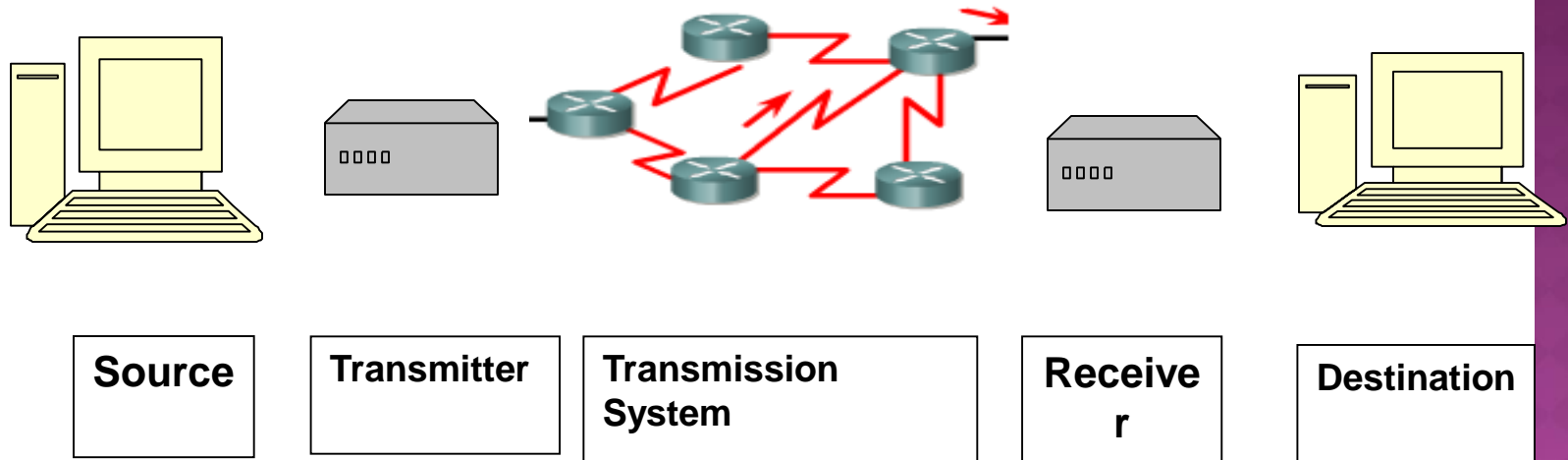
- ◉ Transmission system utilization
- ◉ Interfacing
- ◉ Signal generation
- ◉ Synchronization
- ◉ Exchange management
- ◉ Error detection and correction
- ◉ Flow control
- ◉ Addressing and routing
- ◉ Recovery
- ◉ Message formatting
- ◉ Security and
- ◉ Network management

CONTEMPORARY DATA COMMS

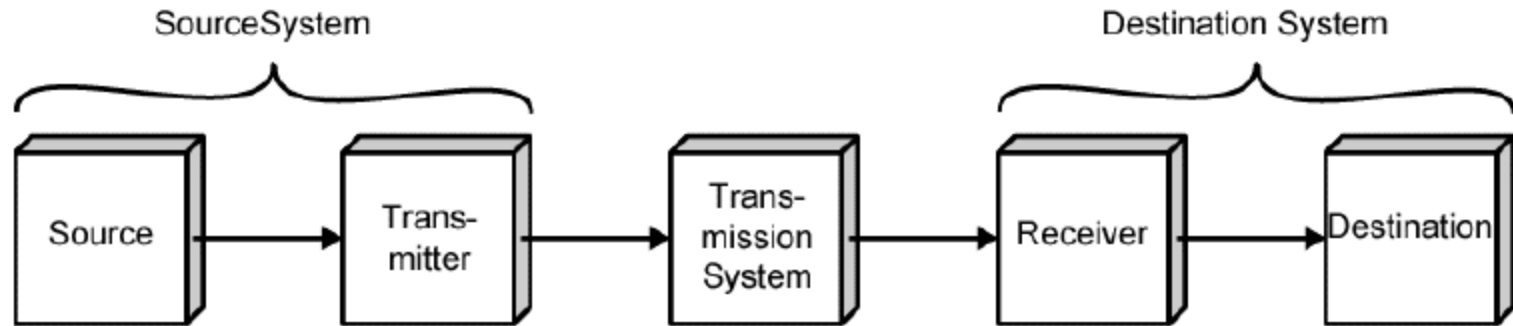
◉ trends

- traffic grow that a high & steady rate
- development of new services
- advances in technology
 - significant change in requirements
- emergence of high-speed LAN s
- corporate WAN needs
- digital electronics

COMMUNICATIONS MODEL



COMMUNICATIONS MODEL

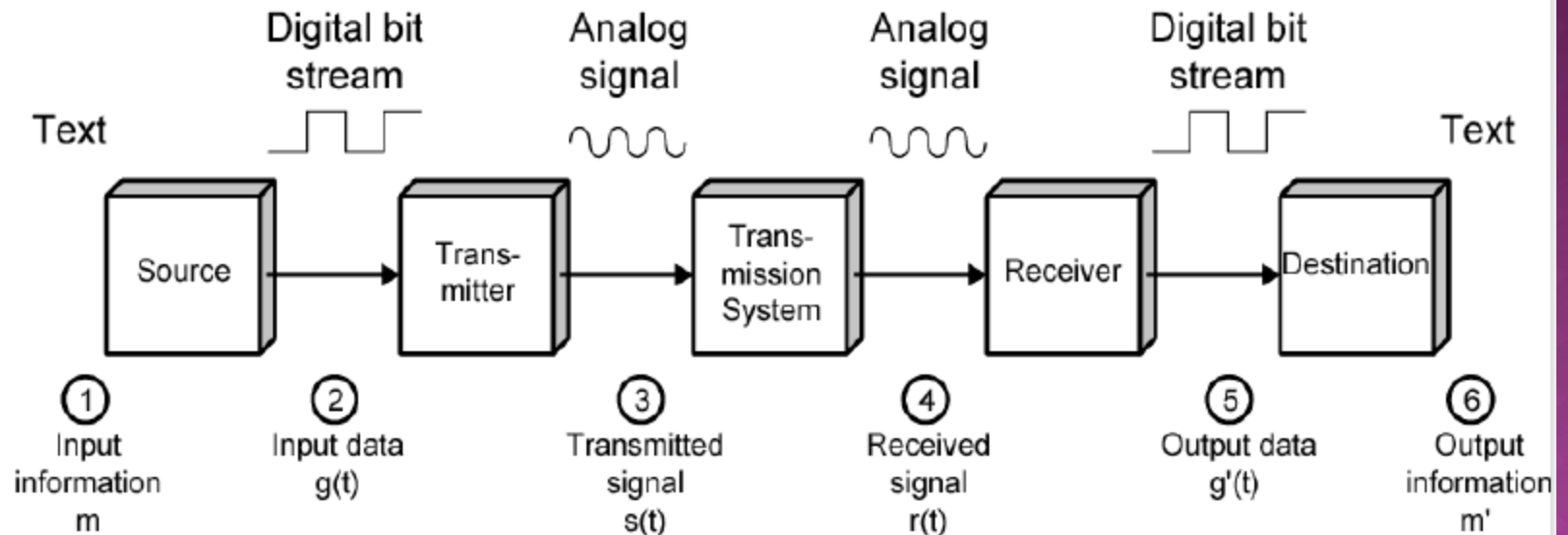


(a) General block diagram

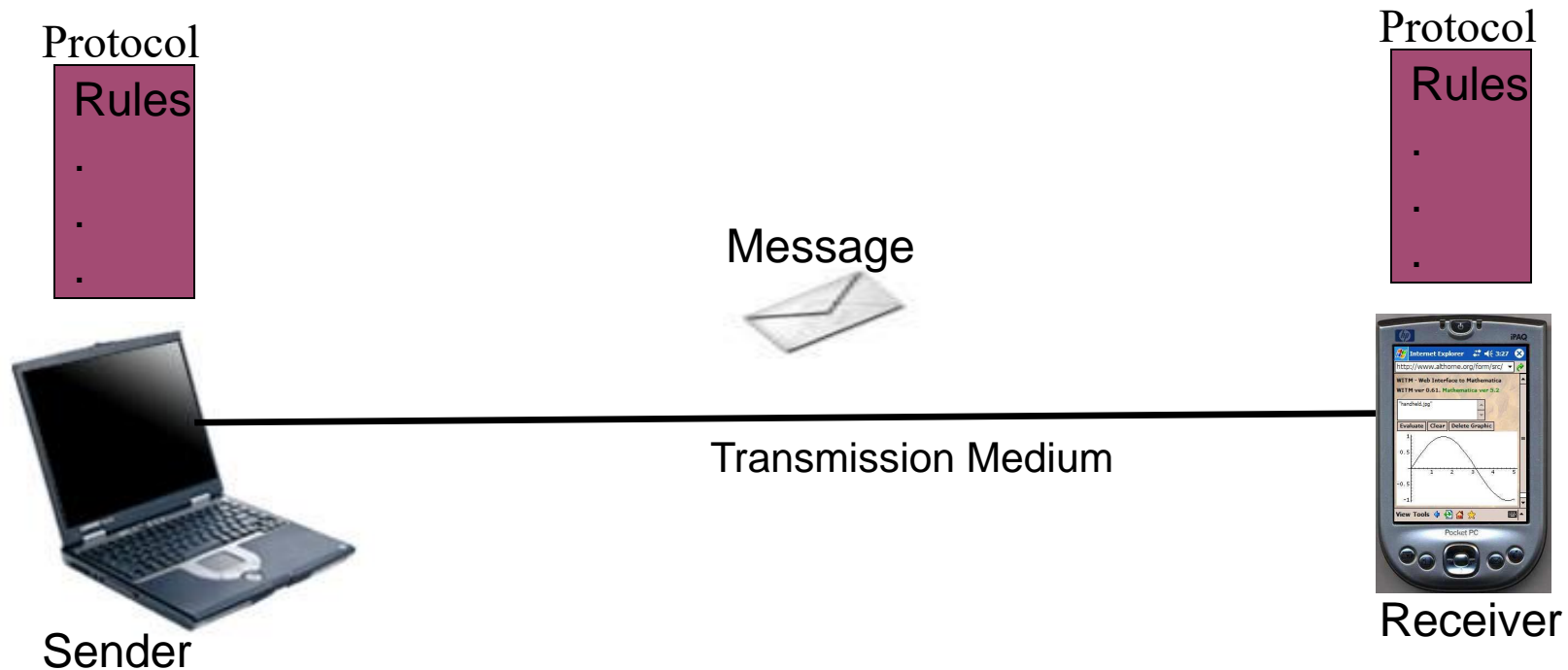


(b) Example

SIMPLIFIED DATA COMMUNICATIONS MODEL



COMPONENTS OF DATA COMMUNICATION



COMPONENTS OF DATA COMMUNICATION CONT.

1. **Message:** data.
2. **Sender:** The device that send the message.
3. **Receiver:** The device that receive the message.
4. **Transmission Medium:** The physical path between sender and receiver, the message travel.
5. **Protocol:** Is a set of rules that governs data communication. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating.

DATA COMMUNICATION CHARACTERISTICS

1. Delivery: The system must deliver data to the correct destination.

2. Accuracy:

- Data delivered accurately.
- Altered data which left uncorrected are unusable.

3. Timelines:

The system must deliver data in timely manner without delay (real-time).

4. Jitter:

Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets.

DATA REPRESENTATION

⦿ Text

- Represented in bits patterns e.g. 0,1
- Different Bit patterns called code.
- Present Coding system: ASCII 7 bit to represent a symbol/Unicode 32 bit to represent a symbol

⦿ Numbers

- Represented in bit patterns
- Converted into binary for calculations

⦿ Images

- Represented into matrix of pixels/bits The size of the pixel depends on the resolution. Black and white (1 bit), Gray Scale (2 bit) color (RGB and YCM) representation of Images.

⦿ Audio/Video

- Continuous data

DATA FLOW

◉ Simplex

- One way traffic only, one device transmits and one receives
e.g. Keyboard->monitor

◉ Half-duplex

- Both stations can transmit and receive but one at time. e.g. Bus topology
- Only one path from source to destination.
- collisions may occur

◉ Full-duplex

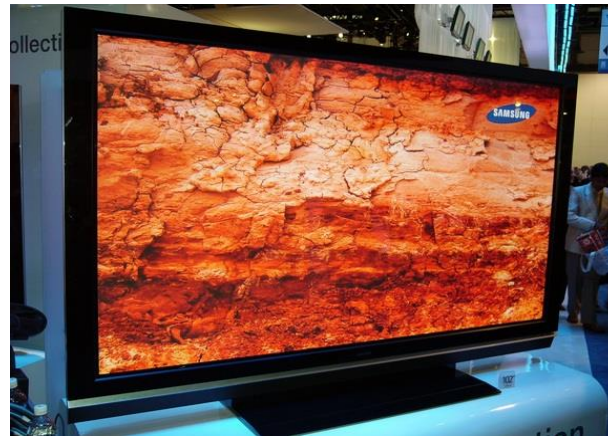
- Both can receive and send at the same time. e.g. Star topology.
- Two separate transmission lines.
- collisions free

DATA FLOW IN COMMUNICATION

- ◉ Simplex: one direction only.



Remote Control



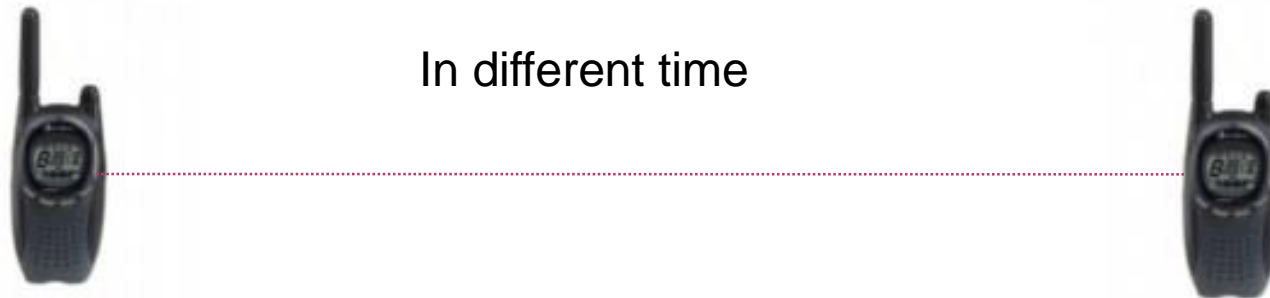
TV

- ◉ Always one side sender and another side receiver.

DATA FLOW IN COMMUNICATION CONT.

- ◉ Half-Duplex: two-way alternate.

Walki-Talki

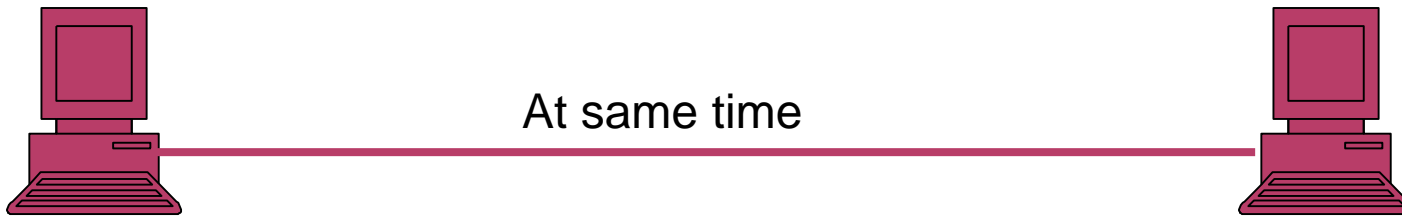


- ◉ Each side maybe sender or receiver but not a same time.

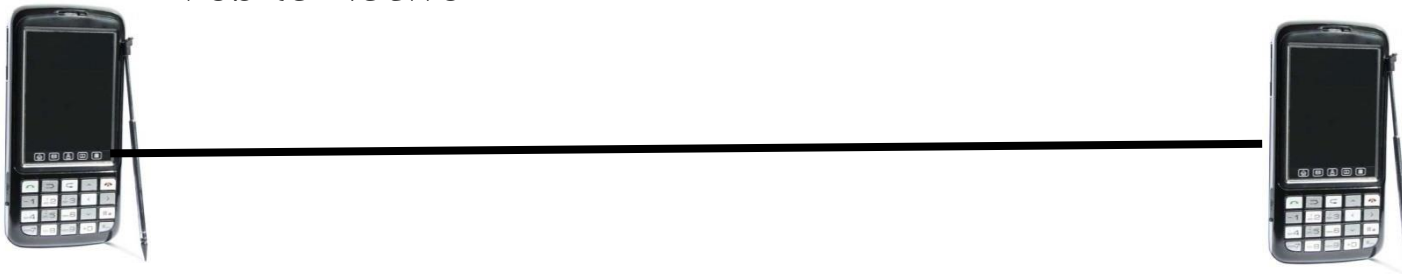
DATA FLOW IN COMMUNICATION CONT.

- ◉ Duplex: two-way concurrent.

Computer network

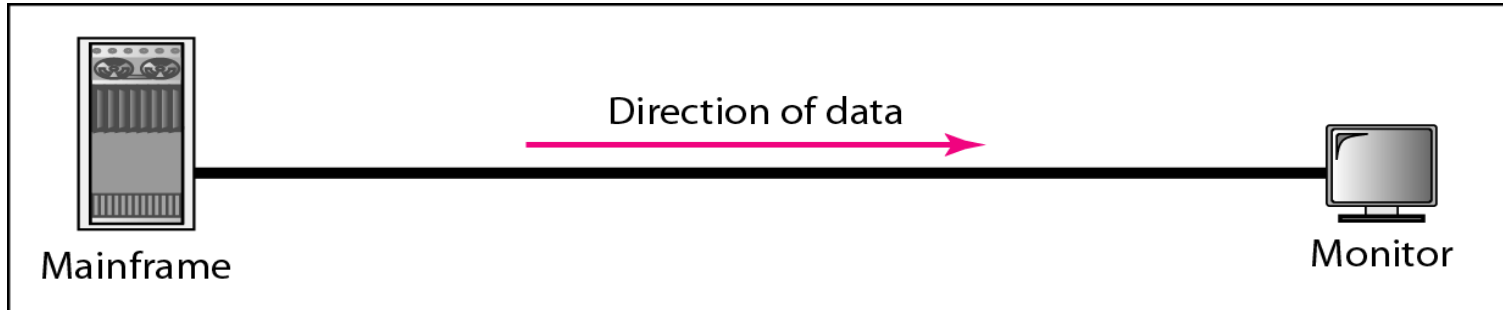


Mobile Network

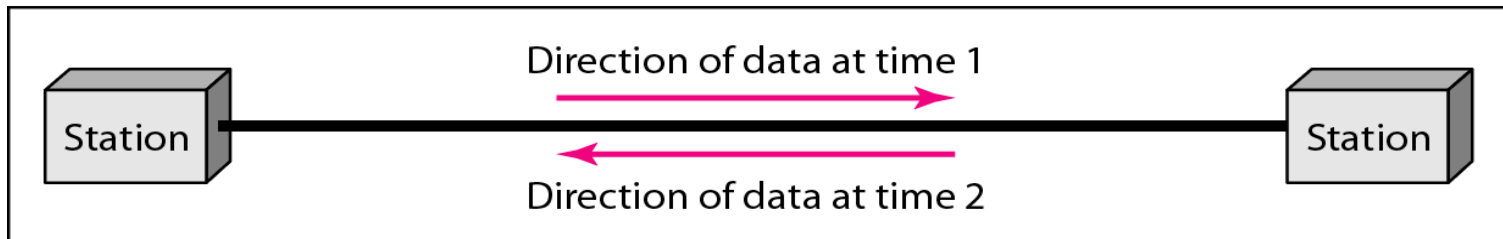


- ◉ Each side sender and receiver at same time.

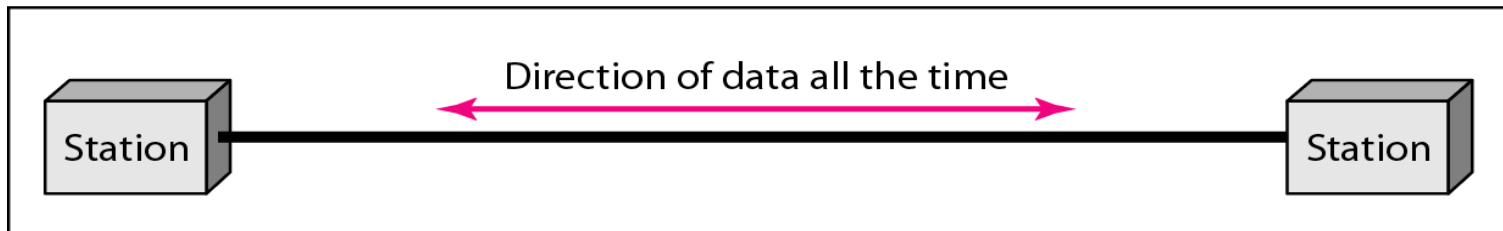
DATA FLOW (CONTD.)



a. Simplex



b. Half-duplex



c. Full-duplex

NETWORK

- ◎ **A Network** is a set of node connect together by communication link to sharing of resources and to transmit information.
- ◎ **Node:** Computer, Printer, Scanner, Software , PD A, etc.
- ◎ **Information:** text, voice, picture, etc.

Why Network ?????

Sharing

Sharing of What ?????

Resources

What Resources ?????

Printer, Scanner, Memory, Information
Network Bandwidth, Internet Services, Data Base,
etc.

NETWORK SERVICES

- ◉ Sharing (file, printer, application).
- ◉ Internet browsing.
- ◉ Fax Service.
- ◉ Telephony.
- ◉ Conferencing.
- ◉ Database.
- ◉ Backup.
- ◉ Etc.....

NETWORK COMPONENTS

- ⦿ Transmission media (wired, wireless).
- ⦿ Network Operating System (NOS).
- ⦿ Network Interface Card (NIC).
- ⦿ Network Hardware:-
 1. Hubs.
 2. Switches.
 3. Routers.
 4. Gateways.
 5. Access Point.
 6. Repeaters.

NETWORK CLASSIFICATION

- ⦿ Upon the transmission medium (type of connection):-

1. Point-to-point:

2. Multipoint:

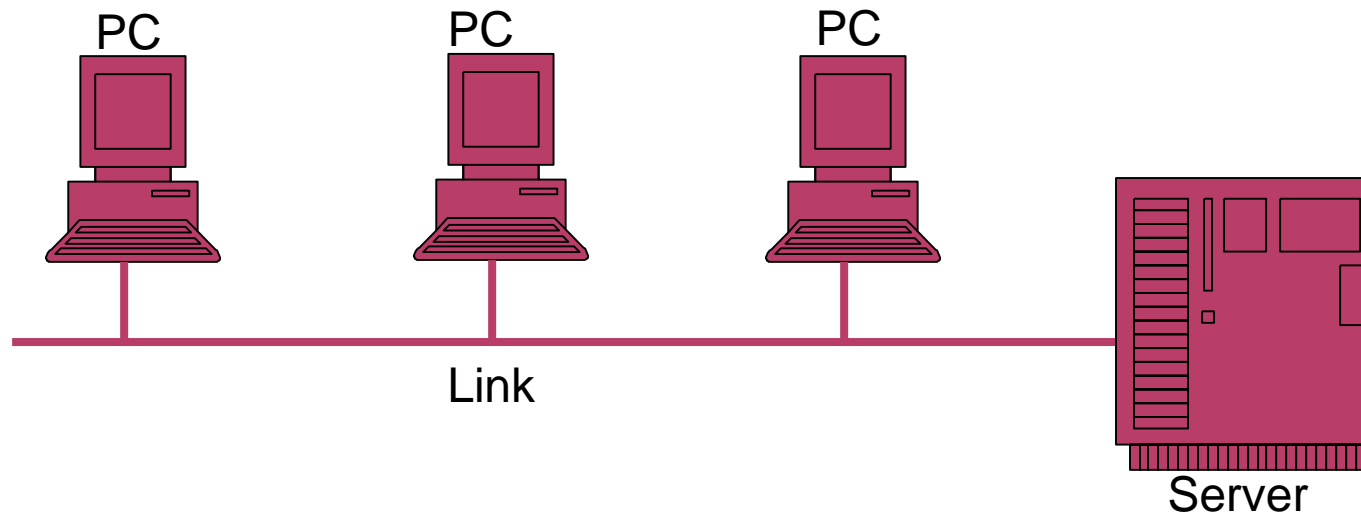
POINT-TO-POINT

- A pair of nodes connected together via dedicated link.



MULTIPOINT

- Number of node connected and share a single link.



NETWORK CLASSIFICATION

Upon the scale (size):-

1. PAN (Personal Area Network).
2. LAN (Local Area Network).
3. CAN (Campus Area Network).
4. MAN (Metropolitan Area Network).
5. WAN (Wide Area Network).

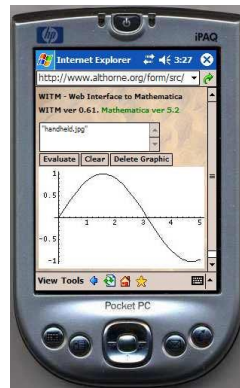
PAN (PERSONAL AREA NETWORK)

- ◉ PAN is a short-distance network design to individual user (person).
- ◉ PAN may contain:- printer, mobile, computer, wireless printers , PDA, etc.
- ◉ components of PAN connected together via Bluetooth , USB cable , IrDA (infrared), etc.

PAN CONT.



Wireless Printer



Bluetooth

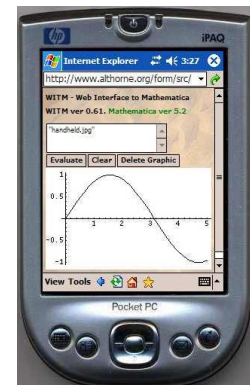


IrDA

USB Cable



Scanner

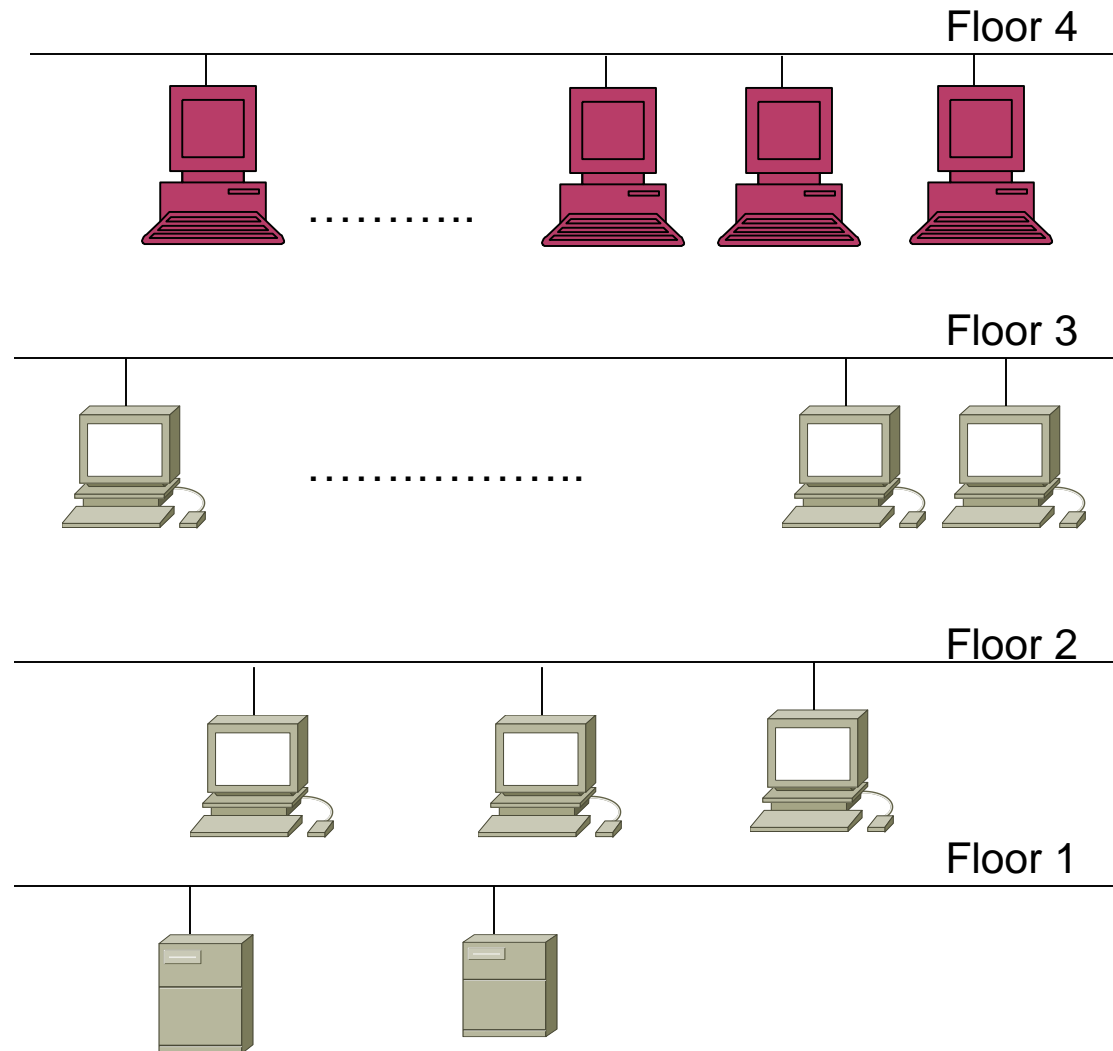
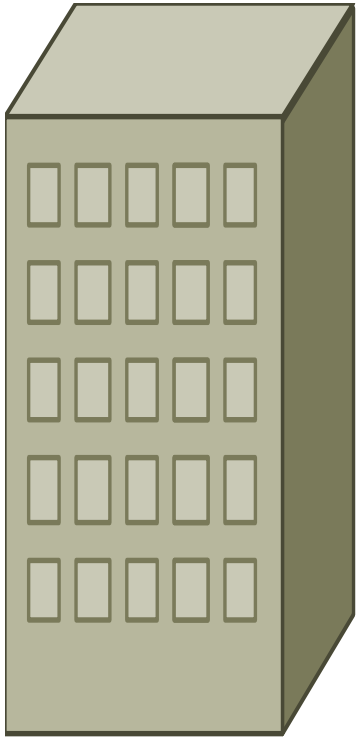


PDA

LAN (LOCAL AREA NETWORK)

- ⦿ A LAN is a group of node connected together in a small specific area.
- ⦿ LAN may be contain workstations, computers, scanner, printers, servers, etc.

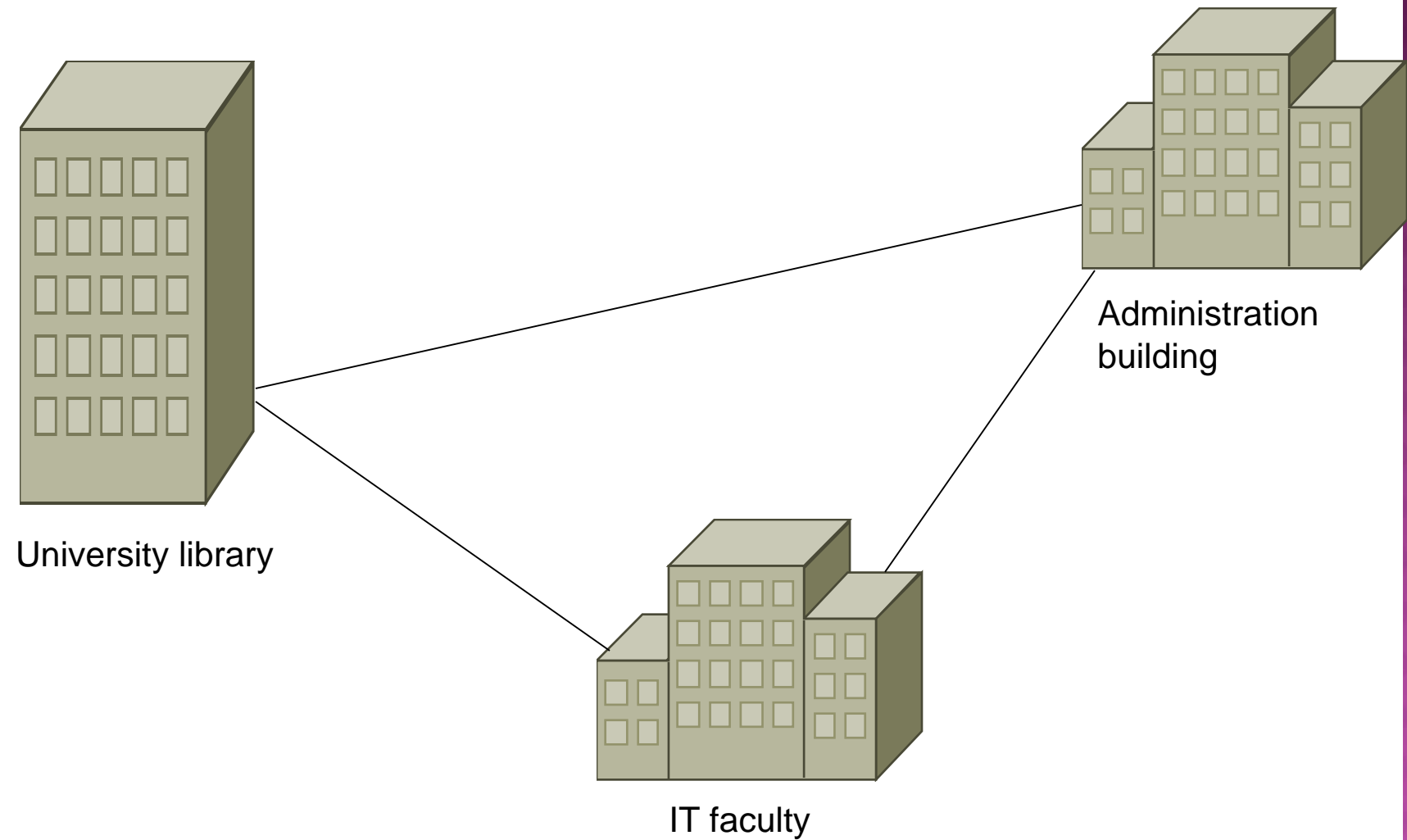
LAN CONT.



CAN (CAMPUS AREA NETWORK)

- ◉ A CAN is a group of interconnection LAN within limited geographical area.
- ◉ A CAN using in school campus, military base, university campus ,etc.

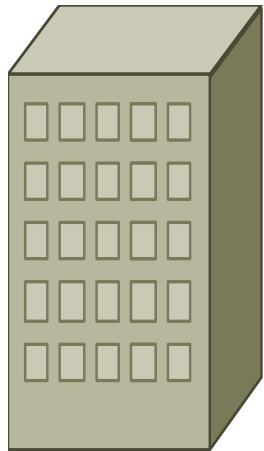
CAN CONT.



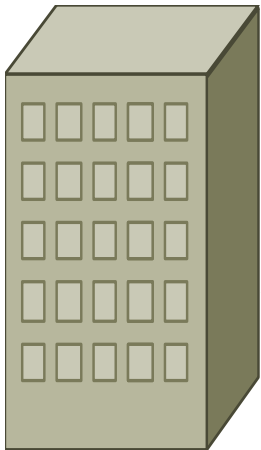
MAN (METROPOLITAN AREA NETWORK)

- A MAN is a large computer network uses to connect between LAN in different location (cities).
- A MAN is a group of node connect together over city.

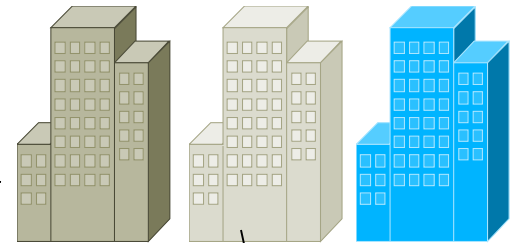
MAN CONT.



LAN 1

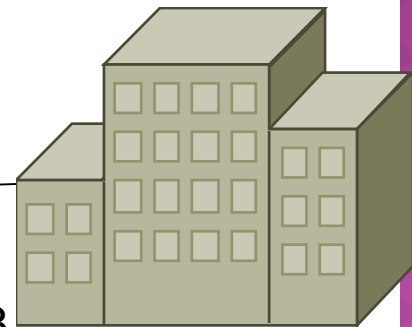


LAN 2



CAN 4

Connect different branch
location in city

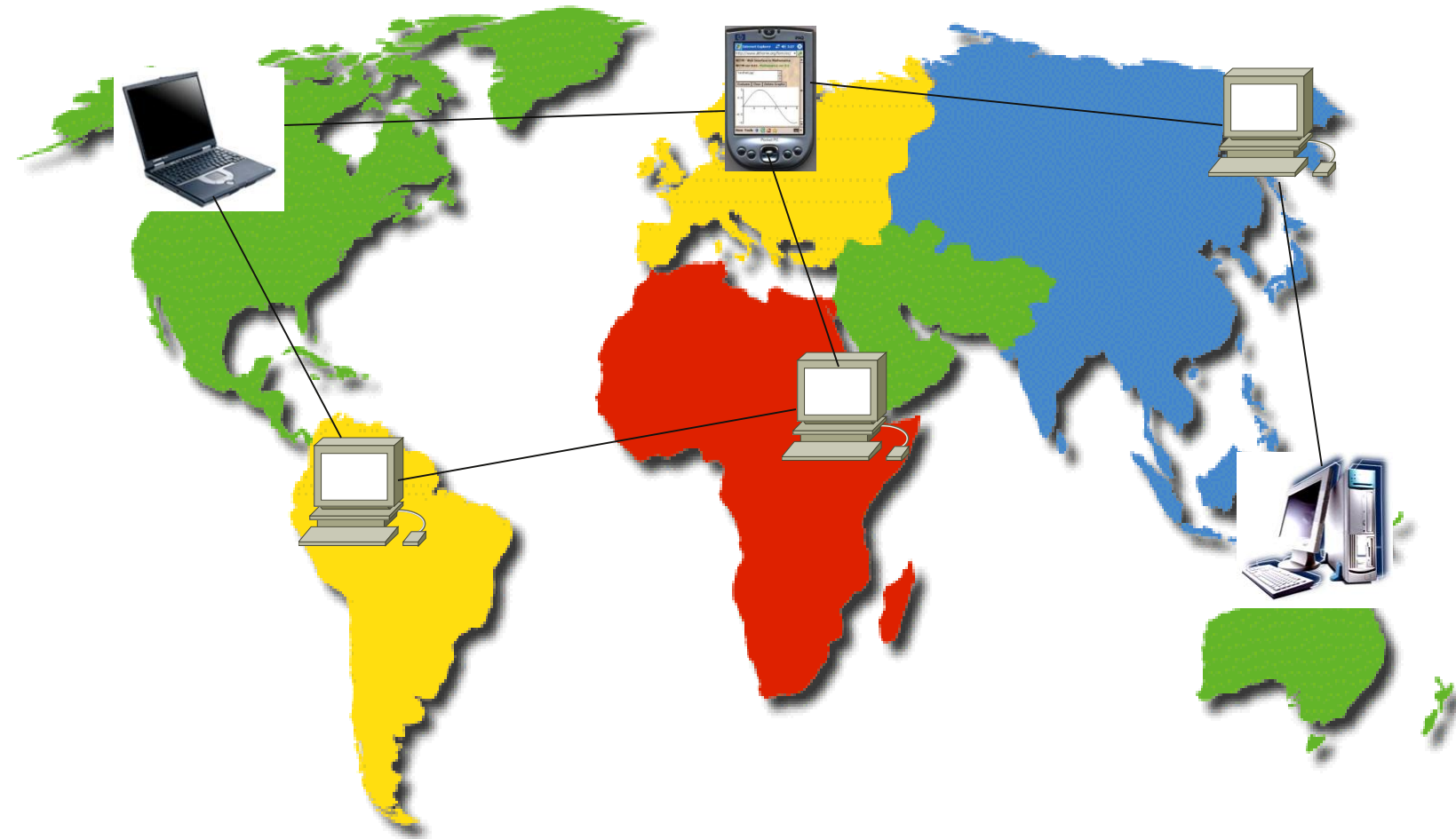


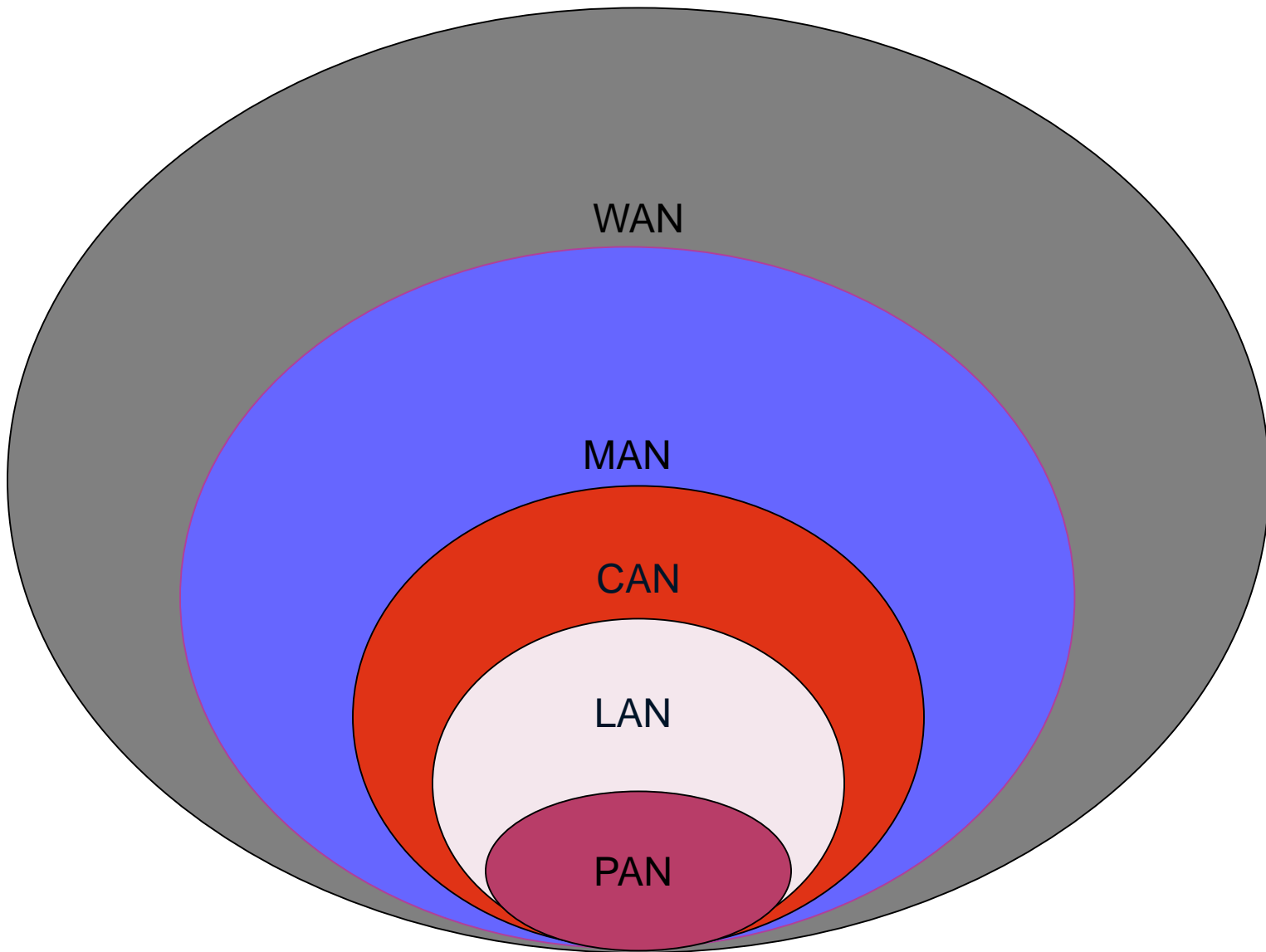
LAN 3

WAN (WIDE AREA NETWORK)

- ⦿ A WAN is a computer network that covers large geographical area.
- ⦿ WANs are used to connect types of networks together.

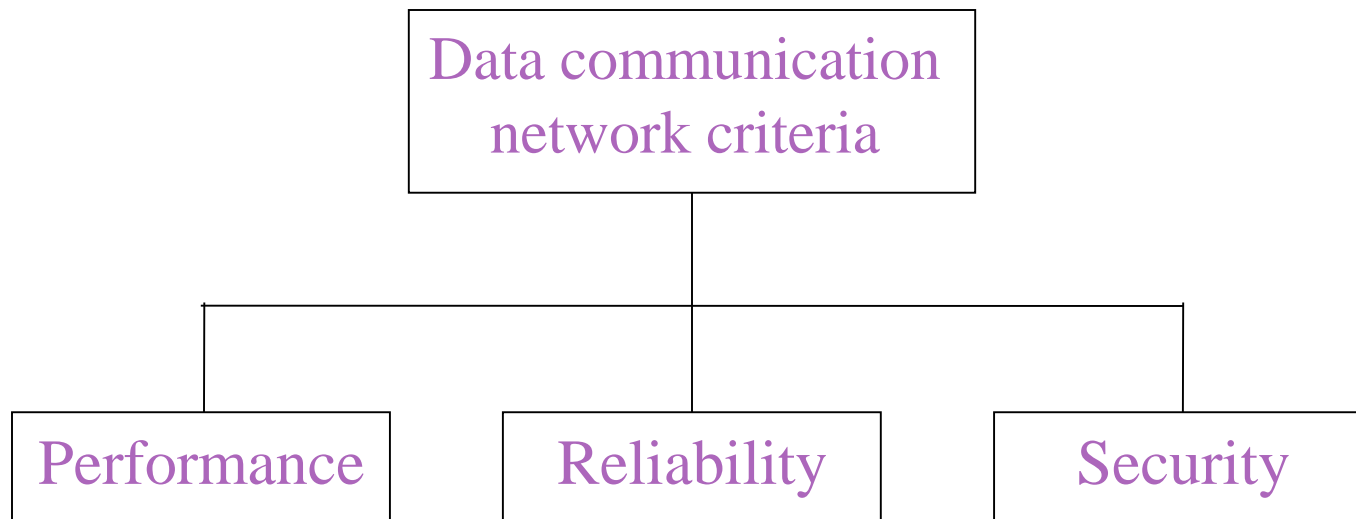
WAN CONT.





NETWORK CRITERIA

A network must be able to meet a certain number of criteria.
The most important of these are Performance, Reliability, and Security



NETWORK CRITERIA

◎ Performance:

- ❖ The performance of network depends on a number of factors:
 - ✓ Number of users
 - ✓ Type of transmission medium
 - ✓ Hardware
 - ✓ Software.
- ❖ The performance is evaluate by two networking metric :
Throughput and Delay.
- ❖ Performance can be measured in many ways, including transit time and response time.
 - **Transit time:** is the amount of time required for a message to travel from one device to anther.
 - **Response time:** is the elapsed time between an inquiry and a response.

NETWORK CRITERIA

Reliability:

The network reliability is measured by the frequency of failure, (the time it takes a link to recover from of failure).

In addition to accuracy of delivery, network reliability is measured by

- Frequency of failure
- Recovery time of a network after a failure
- Catastrophe.

NETWORK CRITERIA CONT.

- ◎ **Security:**

Network security include protecting data from unauthorized access, protecting data from damage, and write policies and implementing it for security issues.

NETWORK MODES

◎ Unicast Mode:

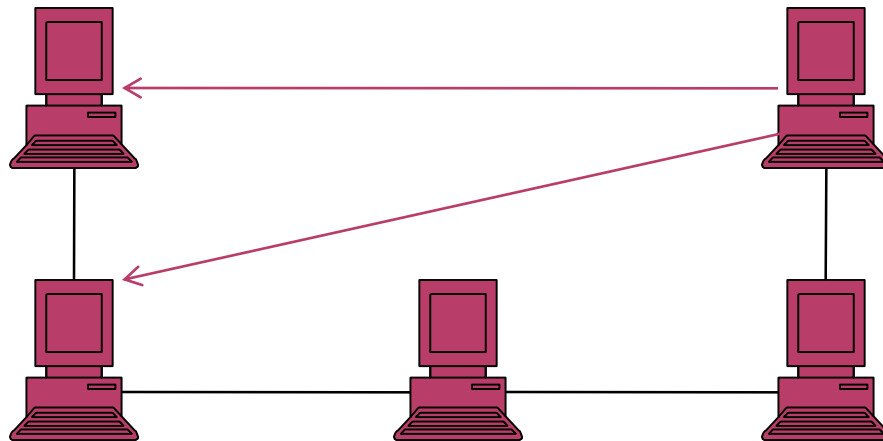
Single source send to single node.



NETWORK MODES CONT.

◉ Multicast Mode :

Single source send to specific nodes (group) that are connected to same Network.

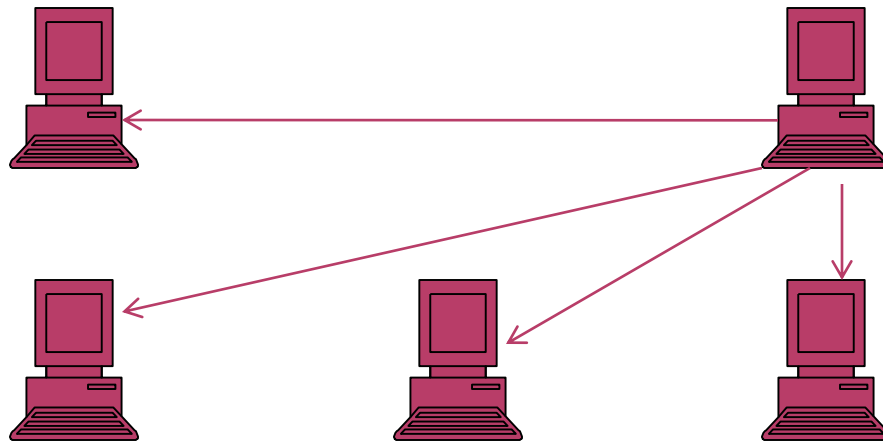


one-to-many

NETWORK MODES CONT.

◎ Broadcast Mode:

Single source send to all others node that are connected to same Network



one-to-all

NETWORK CLASSIFICATION

- Switching technique :

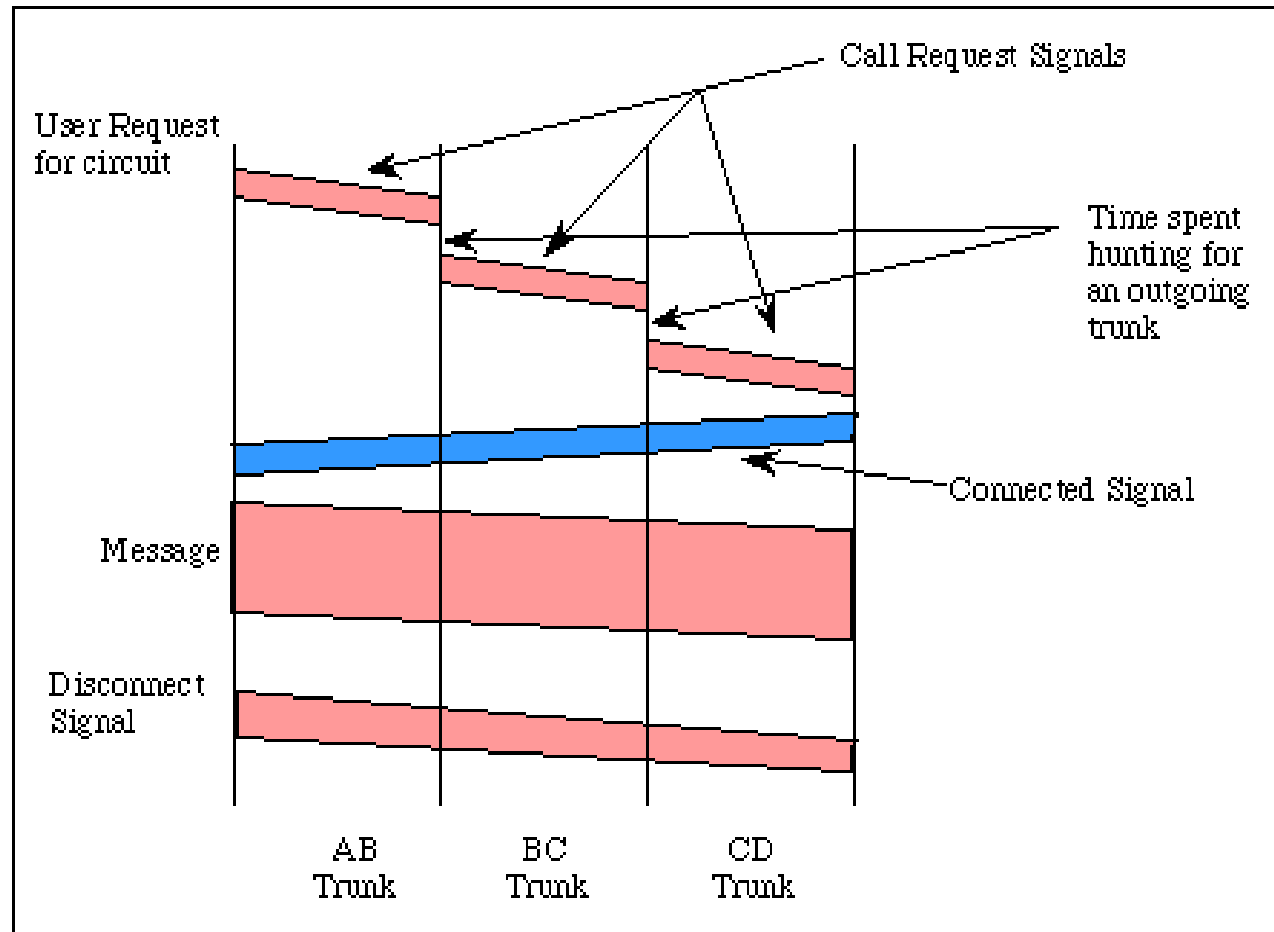
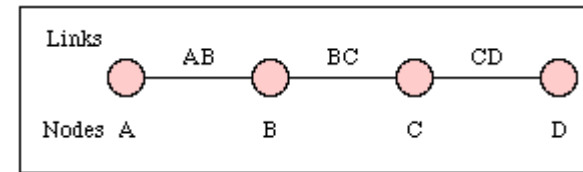
1. Circuit switching
2. Message switching
3. Packet switching

CIRCUIT SWITCHING NETWORK

- ⦿ This allows the communication circuits to be shared among users. e.g. Telephone exchange Switching
- ⦿ It allows equipments and circuits to be shared among users.
- ⦿ Establishes dedicated circuit between users before communication.
- ⦿ When circuit is free other users can use this. e.g. telephone calls.
- ⦿ Telephone exchange is an example of circuit switching.

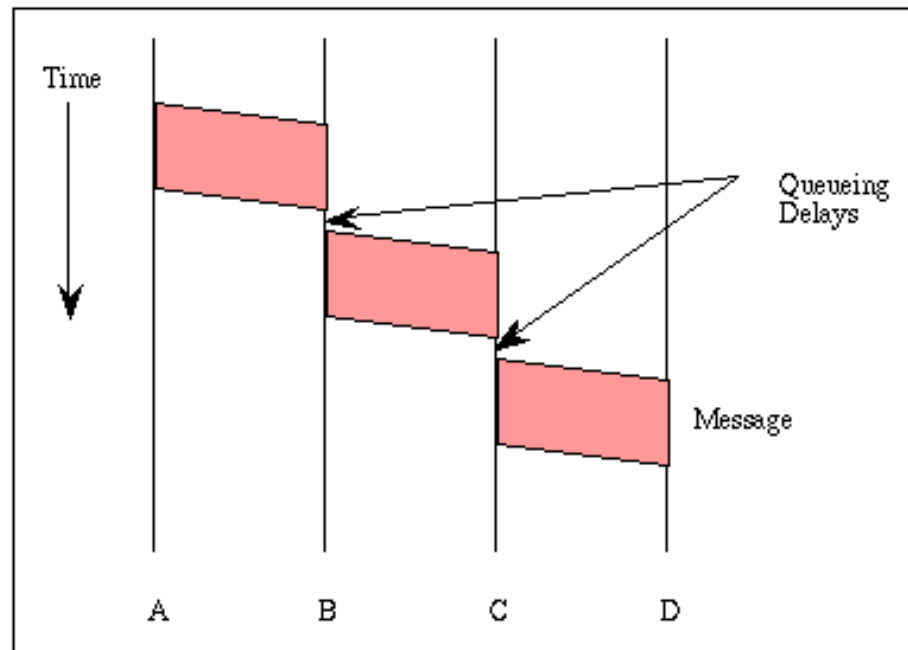
CIRCUIT SWITCHING NETWORK

- Source connects with switching node
- User requests circuit
- Node B receives connection request and identifies path to node D via intermediate node C.



MESSAGE SWITCHING NETWORK

- Circuit setup, store and forward e.g. email, SMS
- Also called stored and forward switching
- Not necessary to establish circuit between A and D.
- When circuit is free it delivers otherwise waits and store message.
- But delays may occur.



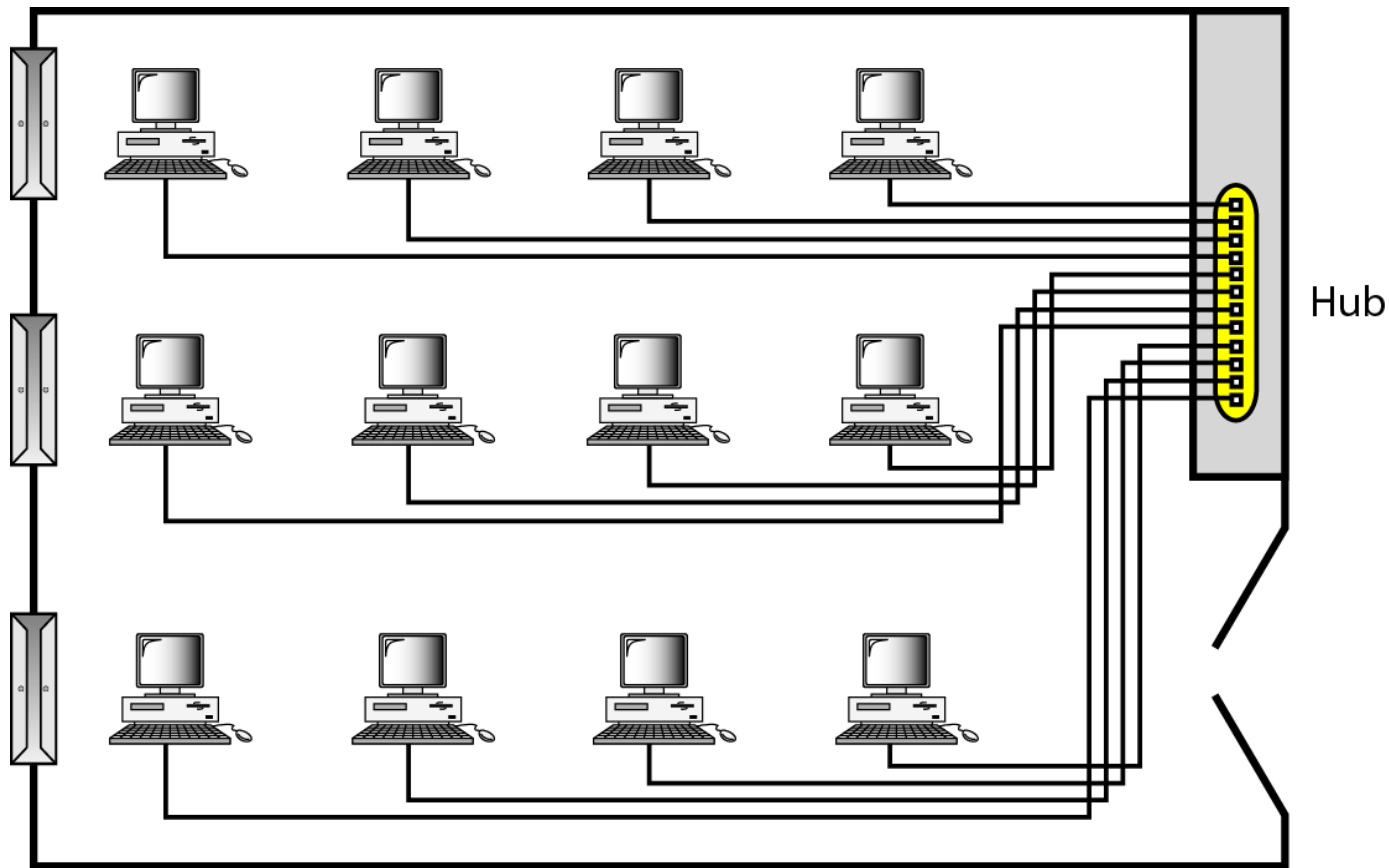
PACKET SWITCHING NETWORK

- ◉ Similar to message switching
- ◉ but divides message into **packets/datagram** packets of equal lengths.
- ◉ Headers are added to each packets.
- ◉ Header contains information about source and destination.
- ◉ No need for dedicated circuit.
- ◉ As length of packet is small so each link is established for small time and then it is available for other messages.
- ◉ Another benefit is pipelining.

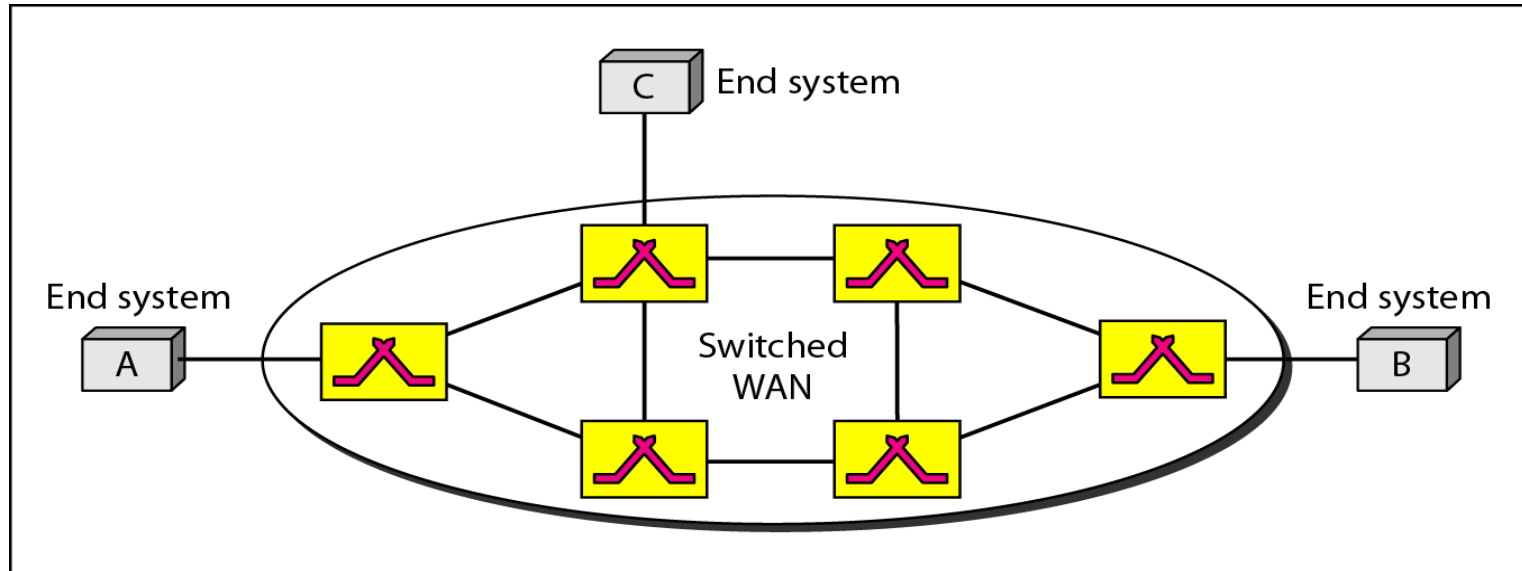
TYPES OF PACKET SWITCHING NETWORK

- ◎ LANs
- ◎ WANS
- ◎ Internet- starts from ARPANET
(Advanced Research Project Agency NET) -
ISPs

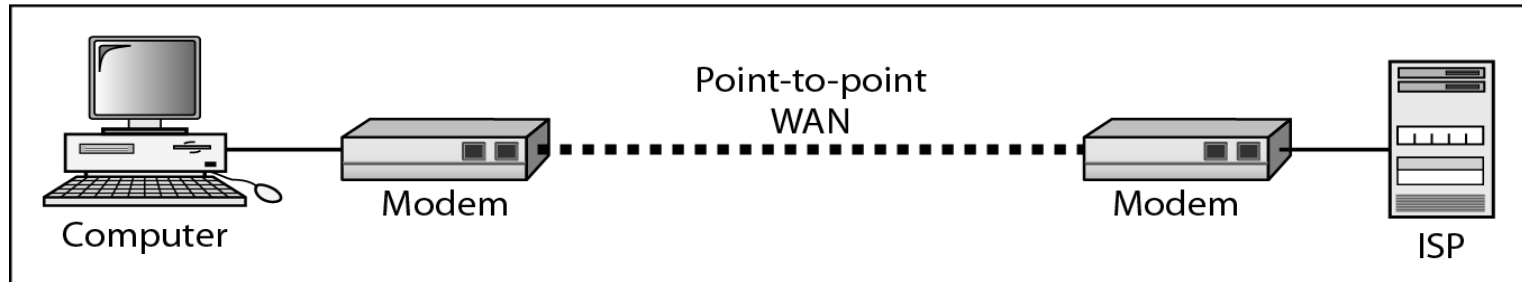
AN ISOLATED LAN CONNECTING 12 COMPUTERS TO A HUB



A SWITCHED WAN AND A POINT-TO-POINT WAN

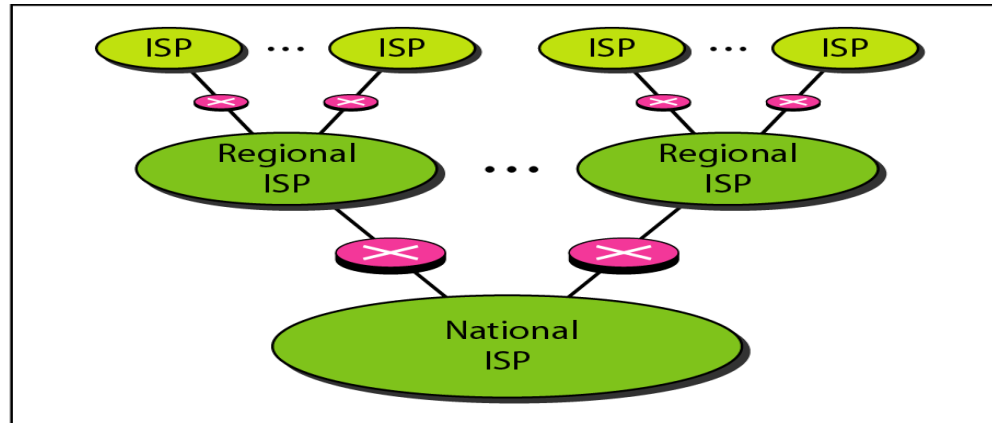


a. Switched WAN

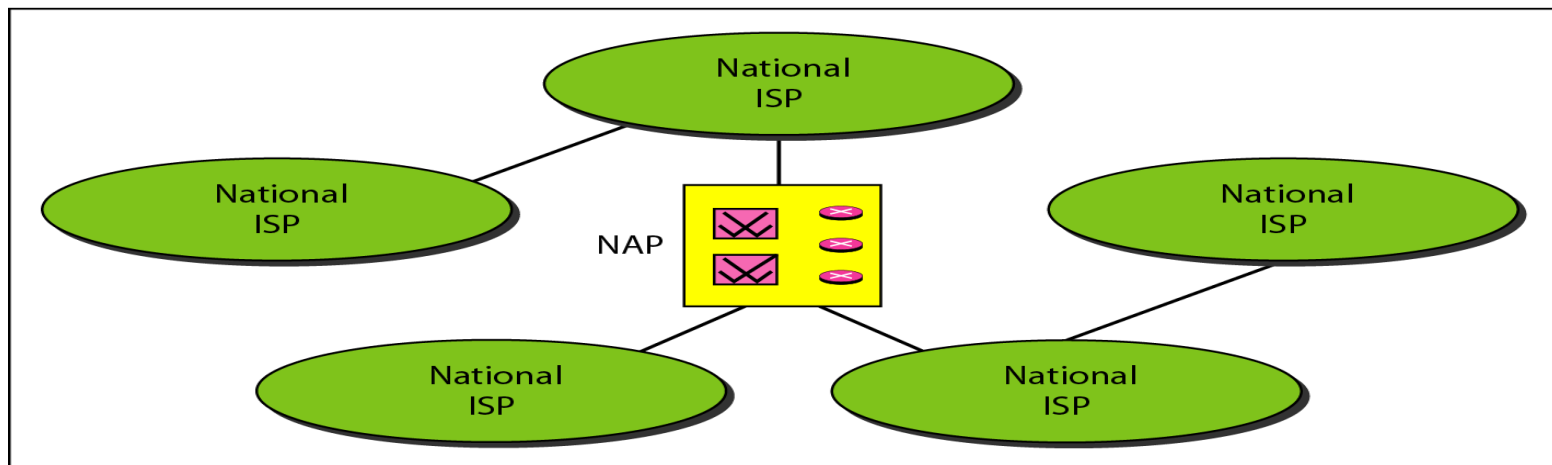


b. Point-to-point WAN

HIERARCHICAL ORGANIZATION OF THE INTERNET



a. Structure of a national ISP



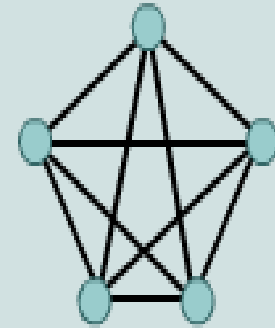
b. Interconnection of national ISPs

PHYSICAL TOPOLOGIES

- ◉ Physical topology: Layout of the wire or media.
- ◉ Physical topology:
 - Mesh
 - Star
 - BUS
 - Ring
 - Tree

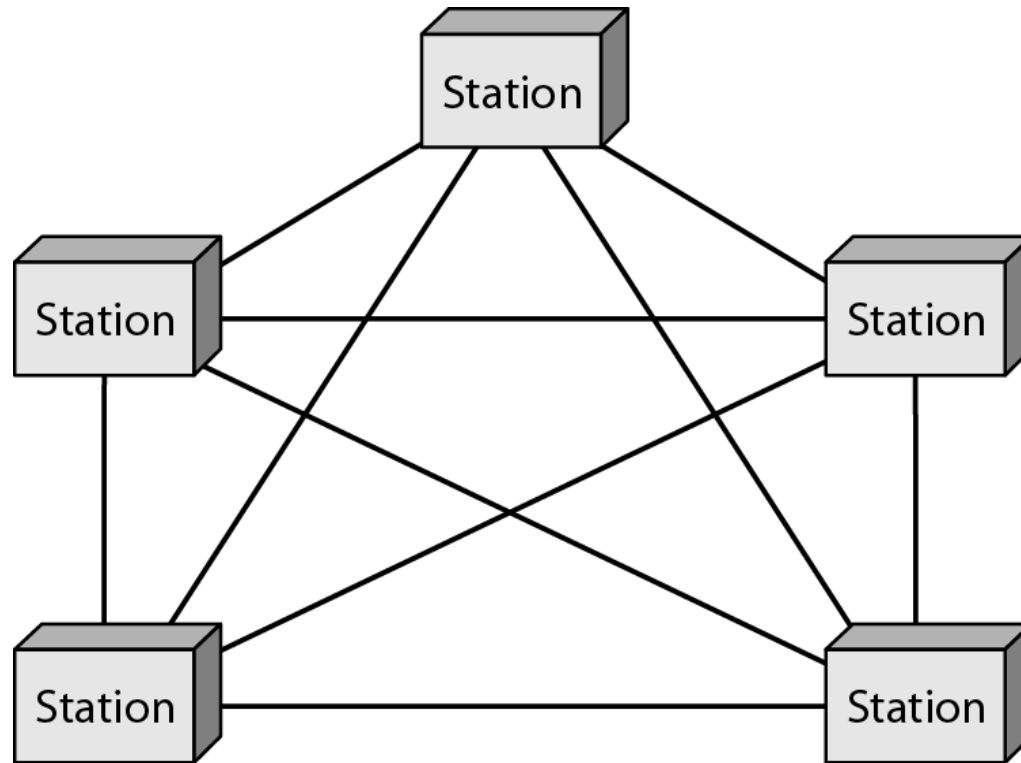
MESH TOPOLOGY

Mesh Topology



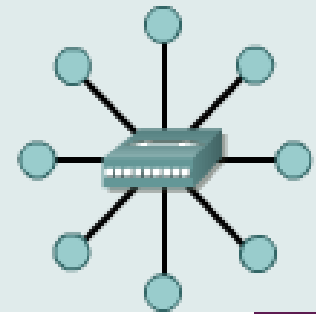
- ⦿ Each host has its dedicated point to point link with every other host.
- ⦿ Link only carries data between *two devices only* (no other can use that link)
- ⦿ If there are n number of nodes in network then we need $n(n-1)$ links.
- ⦿ If link is multi directional or duplex mode then we need $n(n-1)/2$ links.
- ⦿ Each device requires n-1 I/O ports to be connected to each device.
- ⦿ Eliminates traffic problem, Robust, privacy/security of message.
- ⦿ More cabling required, more I/O ports needed, hard to install, expensive.

Figure 1.5 *A fully connected mesh topology (five devices)*



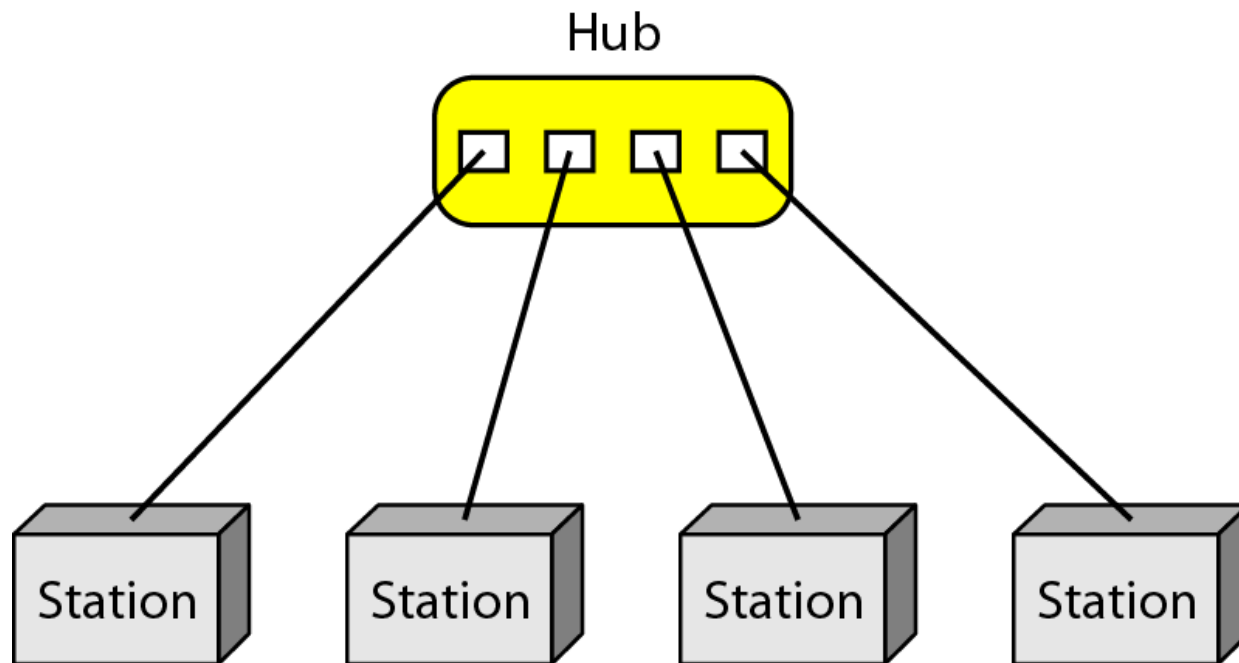
STAR TOPOLOGY

Star Topology



- ◉ Connects all devices with central point.
- ◉ Central point can be hub.
- ◉ Data transmitted reaches to central point, who decides where to send data.
- ◉ Bottleneck occur because all data pass from hub.
- ◉ Less expensive and easy to install, robust if one link is down still remains active.
- ◉ Disadvantage: dependency one central unit.
- ◉ Star is used in LANs

Figure 1.6 *A star topology connecting four stations*



Types of STAR Topology

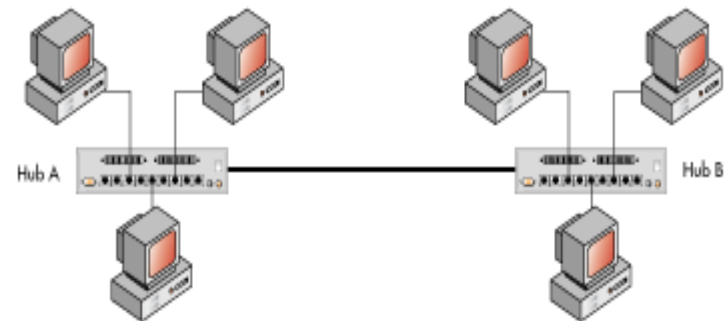
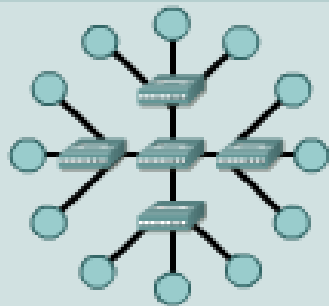
Extended STAR

- Has one or more repeaters from central node to extend maximum transmission distance.
- If repeaters in extended star topology is replaced with hub or switches then it creates *Hybrid topology*.
- Or if backbone as star topology and extended with bus then it also creates *Hybrid topology*.
- Connecting two or more topologies with each other forms hybrid topology.

Distributed STAR

- Individual networks based on star topology
- These networks do not have central or top level connection points.

Extended Star Topology



BUS TOPOLOGY

- Uses **single backbone cable**, All hosts directly connected to this backbone.
- Inexpensive and easy to install
- All nodes receives data
- Ends terminated with a device **terminator**.
- Two types of BUS
 - Linear

All nodes connected to common medium which has only two end points.
 - Distributed

All nodes connected to common medium which has more then two end points.

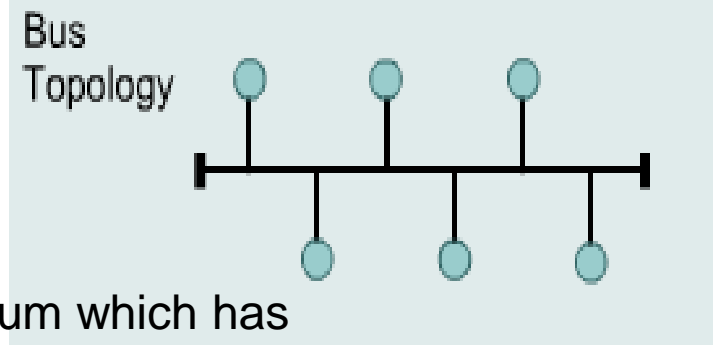
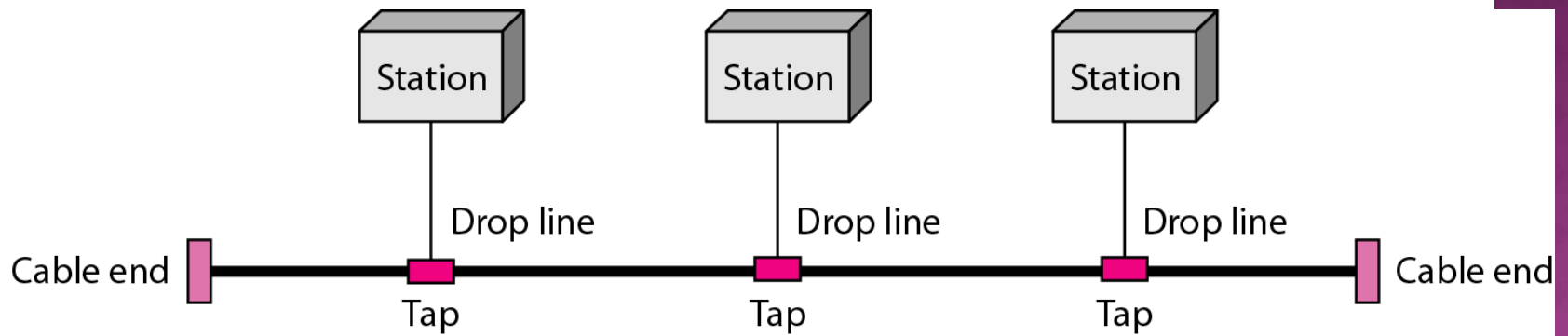


Figure 1.7 *A bus topology connecting three stations*



RING TOPOLOGY

- All nodes connected to one another in form of **closed loop**.
- Expensive and **difficult** to install but offers **high bandwidth**, not robust.
- Point to point connection with only two devices.
- Signal is passed in one direction only, moves until it reaches to its destination.
- Each device connected with a repeater.
- One signal always circulates for fault detection. If device don't receives signal for specified time it generates alarm.

RING TOPOLOGY

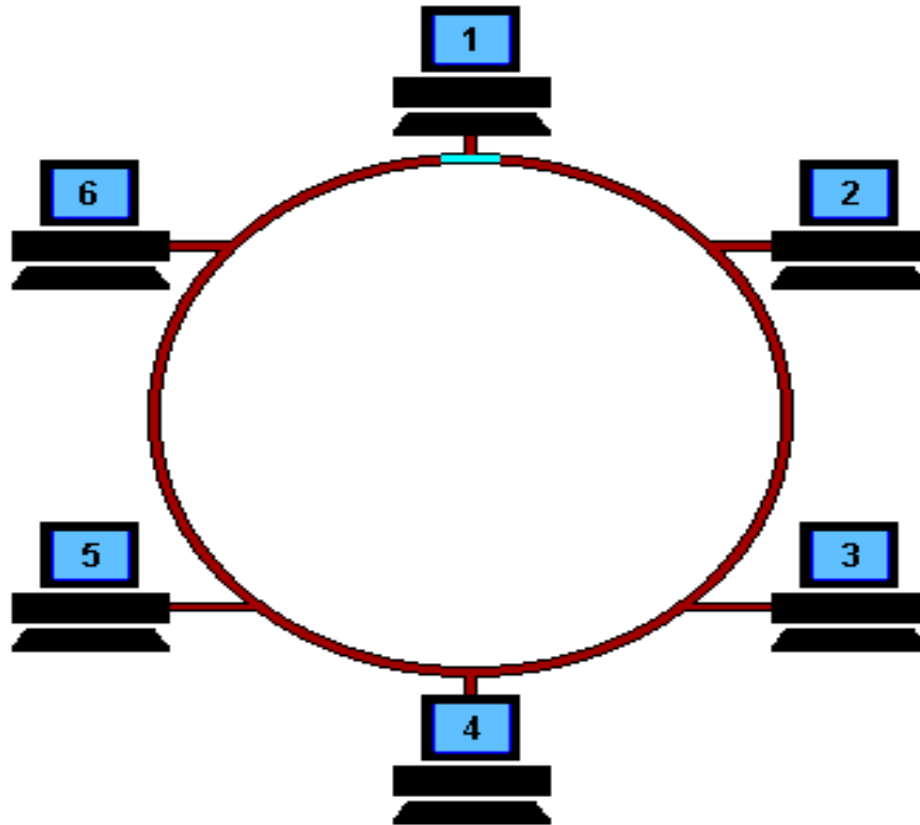


Figure 1.8 *A ring topology connecting six stations*

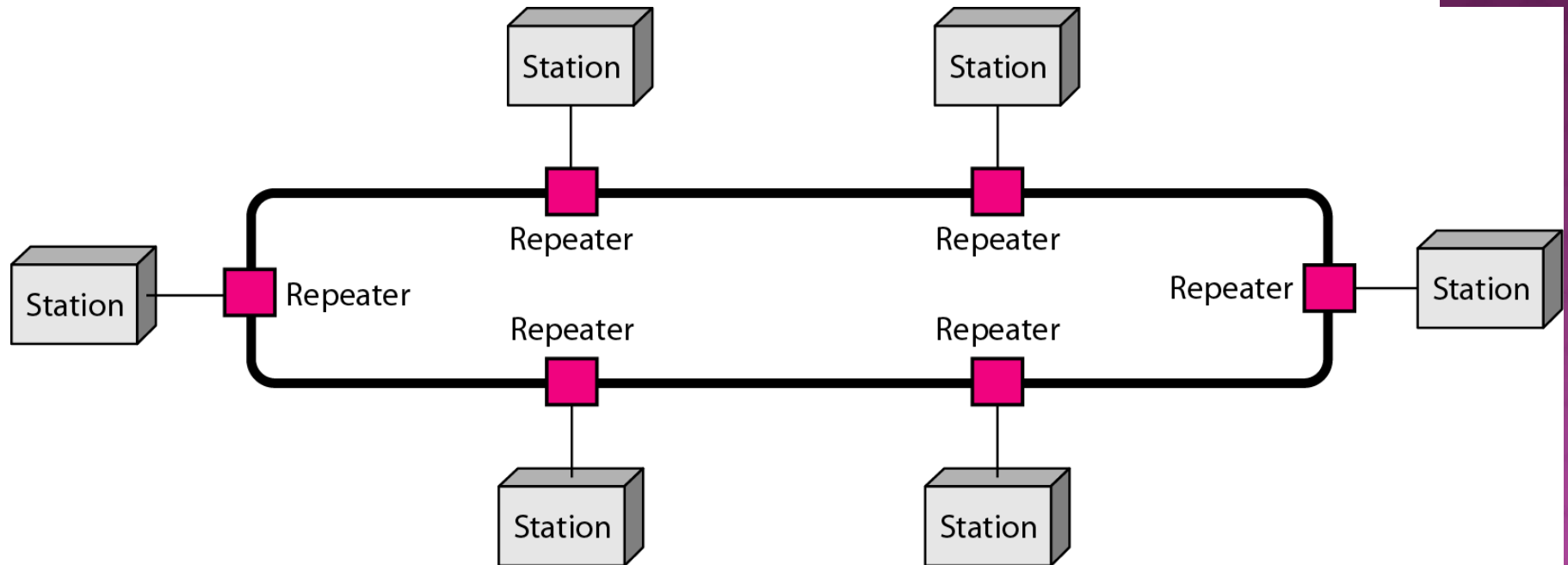
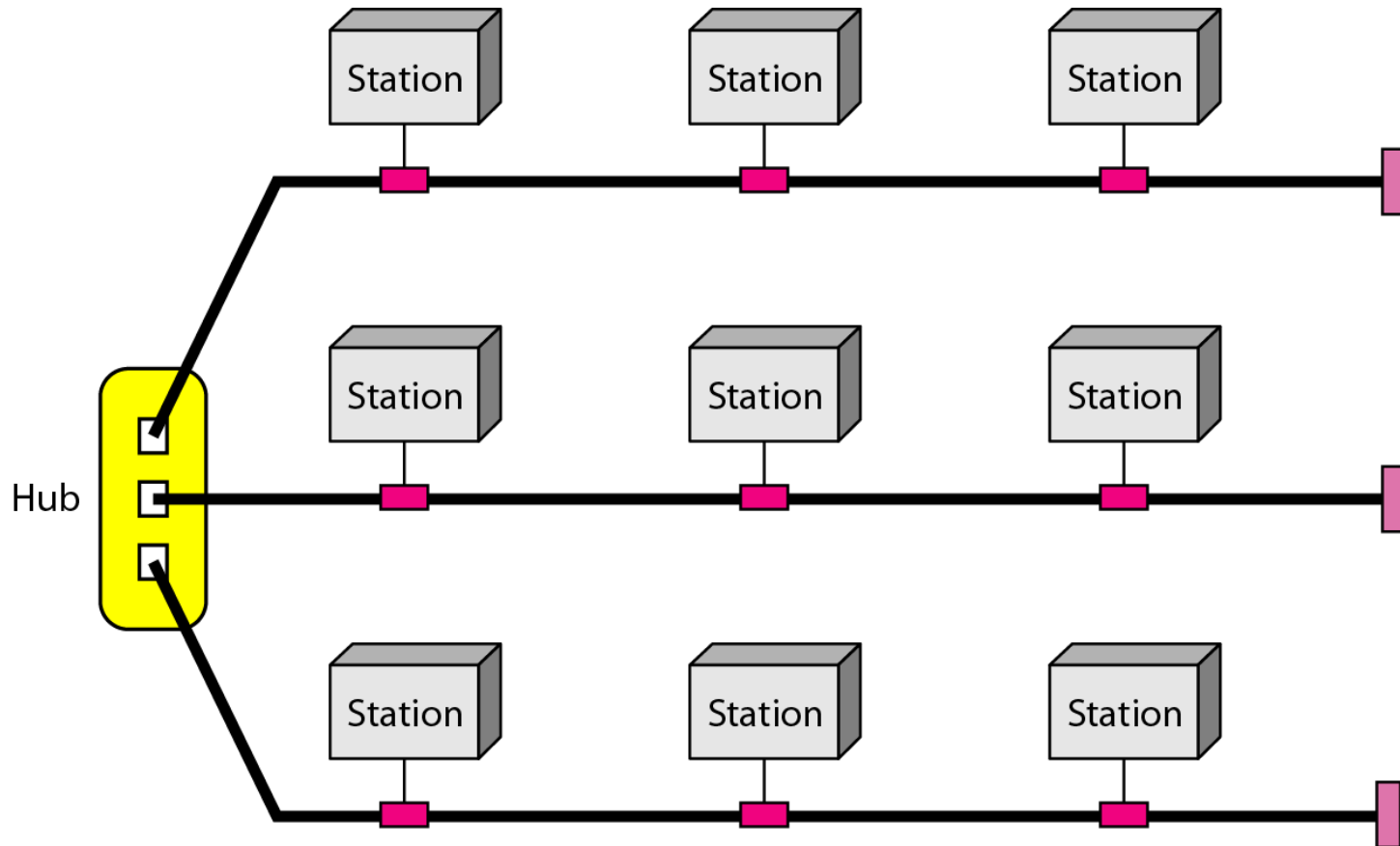


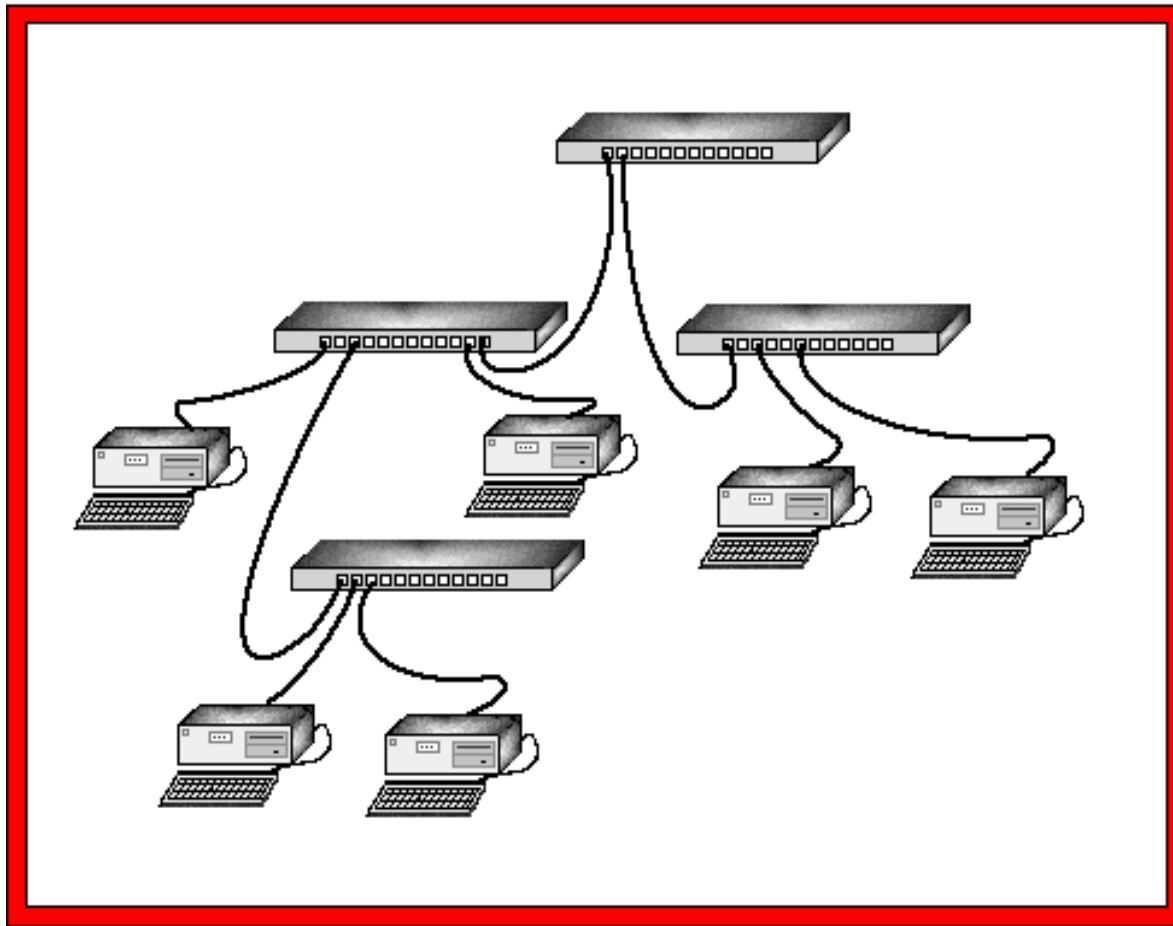
Figure 1.9 *A hybrid topology: a star backbone with three bus networks*



TREE TOPOLOGY

- Central node connected to one or more nodes one level lower in hierarchy.
- Combines characteristics of linear bus and star topology.
- Must have three levels of hierarchy.
- If only two levels then it forms star.
- If branching factor one then linear hierarchy.
- Physical hierarchy will be one less than total number of nodes in network.
- Disadvantage: requires point to point wiring, requires more hardware, dependent on backbone, difficult to configure.

TREE TOPOLOGY



*In this section, we define two widely used terms: **protocols** and **standards**. First, we define protocol, which is synonymous with rule. Then we discuss standards, which are agreed-upon rules.*

Topics discussed in this section:

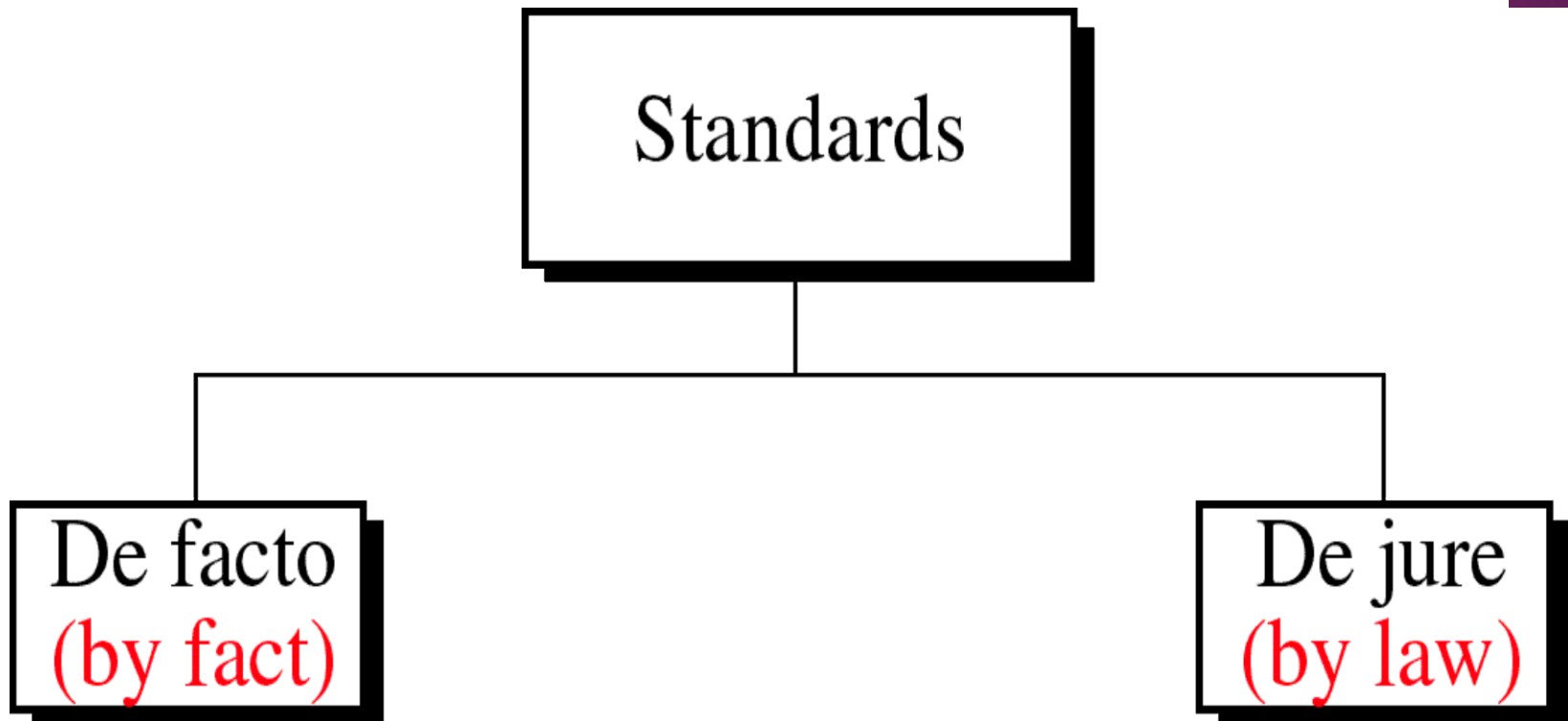
Protocols

Standards

Standards Organizations

Internet Standards

STANDARDS ORGANIZATION



STANDARDS ORGANIZATION

- ◎ Standard creation committees

- ISO
- ITU-CCITT
- ANSI
- IEEE
- EIA

- ◎ Forums

- WiMAX

- ◎ Regulatory agencies

- FCC, BTRC, BERC