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▼ Introduction to Computer Networks

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Sim|**Earn \$2.5 Per Answer****CHAPTER - 1**

# Introduction to Computer Networks

Neso Academy

## Target Audience

- ★ Undergraduate students
- ★ Preparing for GATE
- ★ Preparing for networking interview
- ★ Prerequisite to CCNA international certification course
- ★ Demystify networking technologies and jargons



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- ✓ Networks support the way we learn.
- ✓ Networks support the way we communicate.
- ✓ Networks support the way we work.
- ✓ Networks support the way we play.

## PEDAGOGY

-  Lecture
-  Problem Solving
-  Simulation using Cisco packet tracer

## SYLLABUS

- ★ Chapter 1: Fundamentals
- ★ Chapter 2: Data Link Layer
- ★ Chapter 3: Network Layer
- ★ Chapter 4: Transport Layer
- ★ Chapter 5: Application Layer
- ★ Chapter 6: Network Security

**OUTCOMES**

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- ★ Understand "What is computer network?".
- ★ Identify end devices and intermediary devices.

## DEFINITION – COMPUTER NETWORK

A computer network is a set of nodes connected by communication links.

A node can be a computer, printer or any other device capable of sending/receiving data generated by other nodes in the network.

Example for nodes:	Computer
	Server
	Printer
	Security Camera
	Many more (Switches, Bridges, Routers etc.,)

## DEFINITION – COMPUTER NETWORK

A computer network is a set of nodes connected by communication links.

A communication link can be a wired link or wireless link.

The link carries the information.



## DEFINITION – COMPUTER NETWORK

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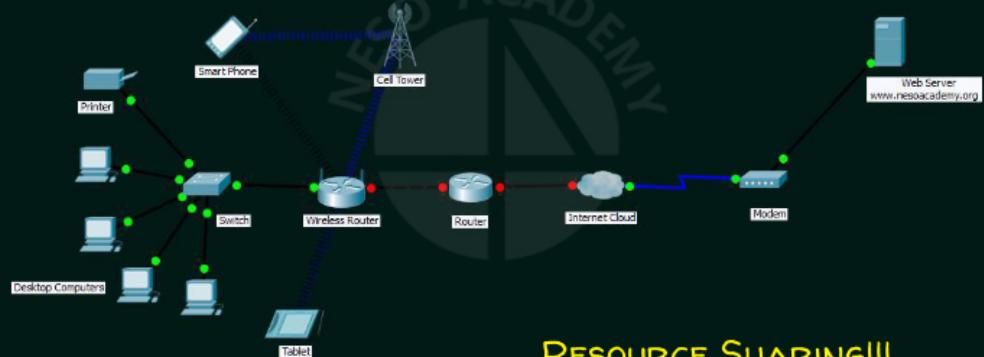
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The link carries the information.

Links (Medium)	<b>Wired: Cable</b>
	<b>Wireless: Air</b>

## AN EXAMPLE COMPUTER NETWORK



## ACTIVITY TIME

Find out the end nodes (end devices) and intermediary nodes depicted in the scenario and place them rightly.

END DEVICES	INTERMEDIARY NODES
PC	Router
Printer	Wireless Router
Server	Cell Tower
Tablet	Modem
Smart Phone	Internet Cloud

## OUTCOMES

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- ★ Understand the need for fault tolerant networks.
- ★ Understand the need for scalable networks.
- ★ Understand Quality of Service (QoS).
- ★ Know the importance of security in computer networks.

## BASIC CHARACTERISTICS OF COMPUTER NETWORK

- ★ Fault Tolerance
- ★ Scalability
- ★ Quality of Service (QoS)
- ★ Security

## FAULT TOLERANCE

The ability to :

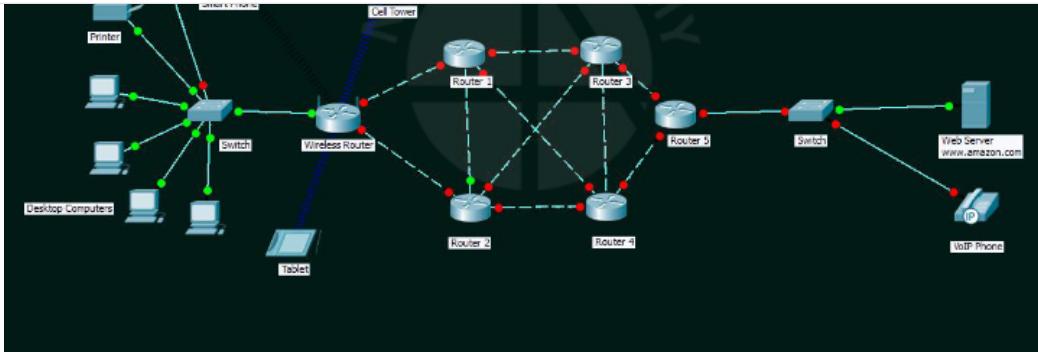
1. Continue working despite failures
2. Ensure no loss of service

## AN EXAMPLE COMPUTER NETWORK

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## SCALABILITY

The ability to :

1. Grow based on the needs
2. Have good performance after growth

## SCALABLE NETWORK – THE INTERNET

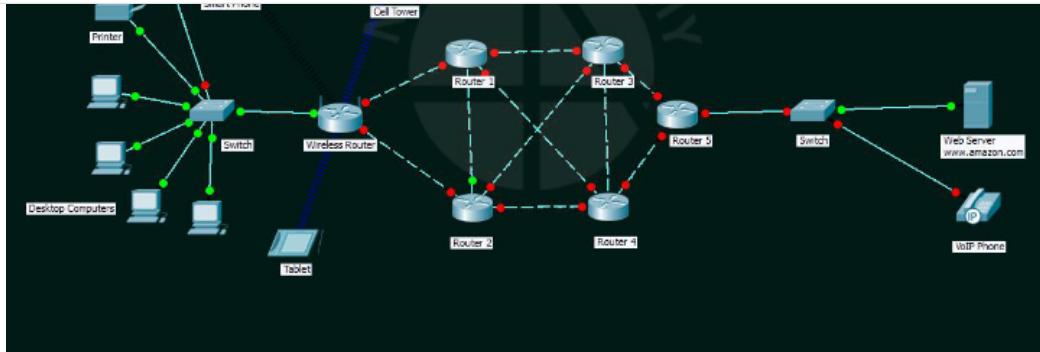


## AN EXAMPLE COMPUTER NETWORK

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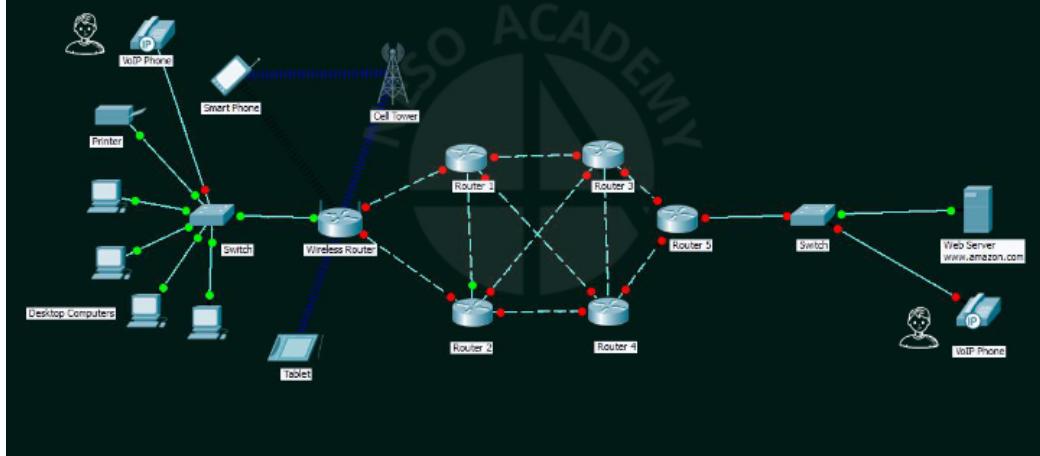


## QUALITY OF SERVICE (QoS)

The ability to :

1. Set Priorities
2. Manage data traffic to reduce data loss, delay etc.,

## AN EXAMPLE COMPUTER NETWORK



## QUALITY OF SERVICE (QoS)

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### 1. SERVICES

2. Manage data traffic to reduce data loss, delay etc.,

## SECURITY

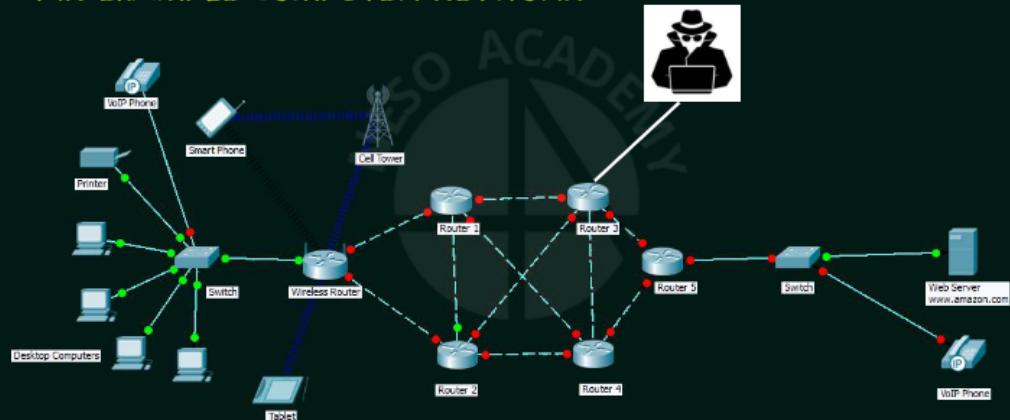
The ability to prevent:

- ★ Unauthorized access
- ★ Misuse
- ★ Forgery

The ability to provide:

- ★ Confidentiality
- ★ Integrity
- ★ Availability

## AN EXAMPLE COMPUTER NETWORK



## SECURITY

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★ Unauthorized access

- ★ Misuse
- ★ Forgery

The ability to provide:

- ★ Confidentiality
- ★ Integrity
- ★ Availability

## BASIC CHARACTERISTICS OF COMPUTER NETWORK

- ★ Fault Tolerance
- ★ Scalability
- ★ Quality of Service (QoS)
- ★ Security

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Know "What is Data Communication?".
- ★ Understand data flow.
- ★ Understand the importance of protocols in computer network.
- ★ Know the elements of protocol.

## DATA COMMUNICATION

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via some form of link (transmission medium) such as a cable.



## DATA FLOW

- ★ Simplex.
- ★ Half Duplex.
- ★ Full Duplex.

### DATA FLOW – SIMPLEX

Communication is always unidirectional.

One device can transmit and the other device will receive.

Example : Keyboards, Traditional monitors.

## DATA FLOW – HALF DUPLEX

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If one device is sending, the other can only receive, and vice versa.

Example : Walkie-Talkies.

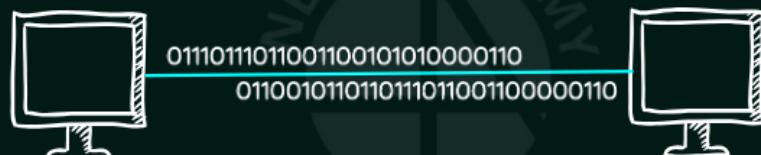
## DATA FLOW – DUPLEX OR FULL DUPLEX

Communication is in both directions simultaneously.

Device can send and receive at the same time.

Example : Telephone line.

## DATA FLOW



## Protocols

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- ★ Source or sender
- ★ Destination or receiver
- ★ Channel or media

Rules or protocols govern all methods of communication.

### IF THERE ARE NO PROTOCOLS...



## PROTOCOLS

Protocol = Rule.

It is a set of rules that govern data communication.

Protocol determines:

- What is communicated?
- How it is communicated?
- When it is communicated?

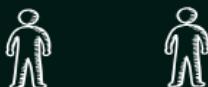
## PROTOCOLS – HUMAN COMMUNICATION

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- ★ An identified sender and receiver
- ★ Common language and grammar
- ★ Speed and timing of delivery
- ★ Confirmation or acknowledgment requirements



## PROTOCOLS – NETWORK COMMUNICATION

Protocols used in network communications also define:

- ★ Message encoding
- ★ Message formatting and encapsulation
- ★ Message timing
- ★ Message size
- ★ Message delivery options



## ELEMENTS OF A PROTOCOL

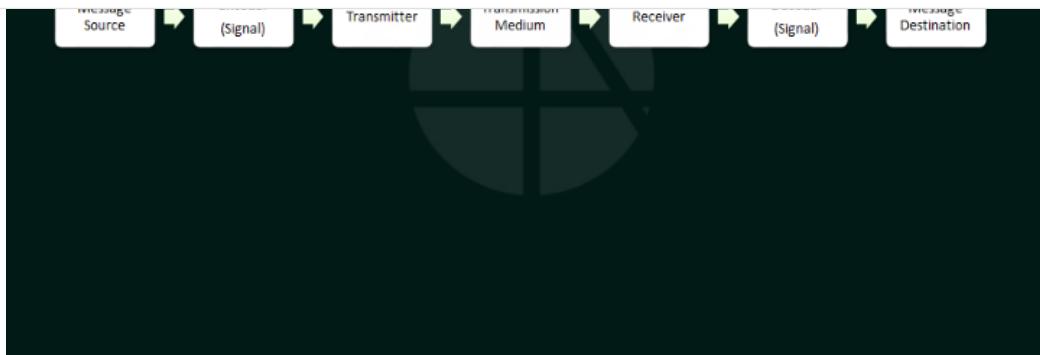
1. Message encoding
2. Message formatting and encapsulation
3. Message timing
4. Message size
5. Message delivery options

## 1. MESSAGE ENCODING

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## 2. MESSAGE FORMATTING AND ENCAPSULATION

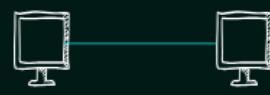
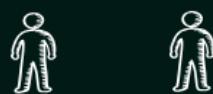
Agreed format.

Encapsulate the information to identify the sender and the receiver rightly.

## 3. MESSAGE SIZE

Humans break long messages into smaller parts or sentences.

Long messages must also be broken into smaller pieces to travel across a network.



## II. MESSAGE TIMING

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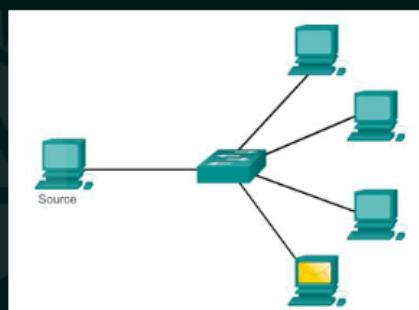
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Response Timeliness



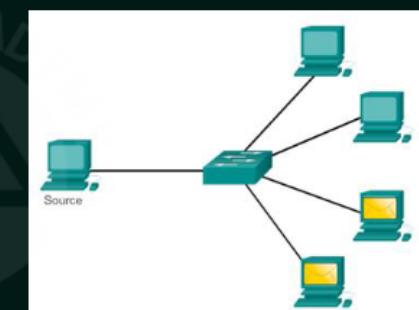
## 5. MESSAGE DELIVERY OPTIONS

- ★ Unicast
- ★ Multicast
- ★ Broadcast



## 5. MESSAGE DELIVERY OPTIONS

- ★ Unicast
- ★ Multicast
- ★ Broadcast



## 5 MESSAGE DELIVERY OPTIONS

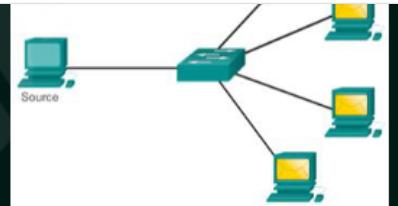
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★ Multicast

★ Broadcast



## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand protocols and its role in computer networks.
- ★ Understand Peer-to-Peer networks and Client-Server networks.

## PROTOCOLS

Protocol = Rule.

It is a set of rules that govern data communication.

Protocol determines:

- What is communicated?
- How it is communicated?
- When it is communicated?

## ELEMENTS OF A PROTOCOL

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### 2. Message formatting and encapsulation

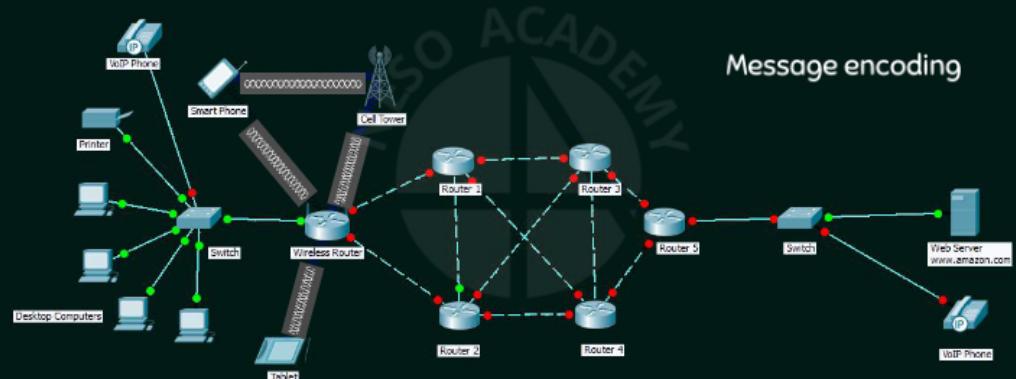
### 3. Message timing

### 4. Message size

### 5. Message delivery options

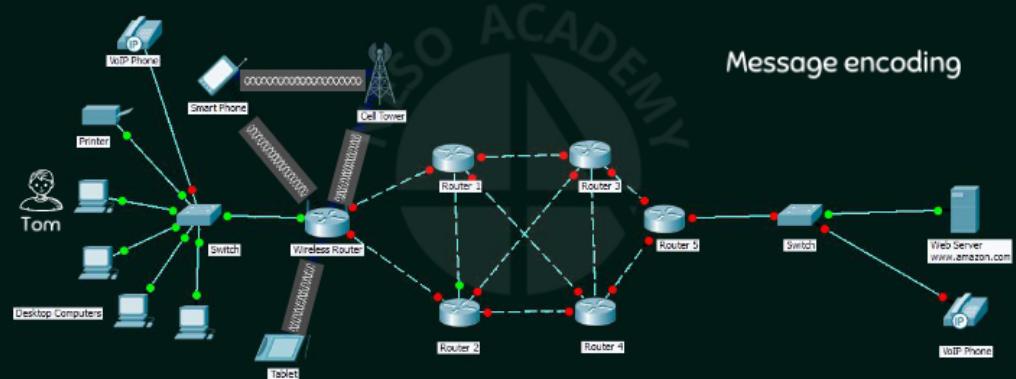
## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

### Message encoding



## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

### Message encoding

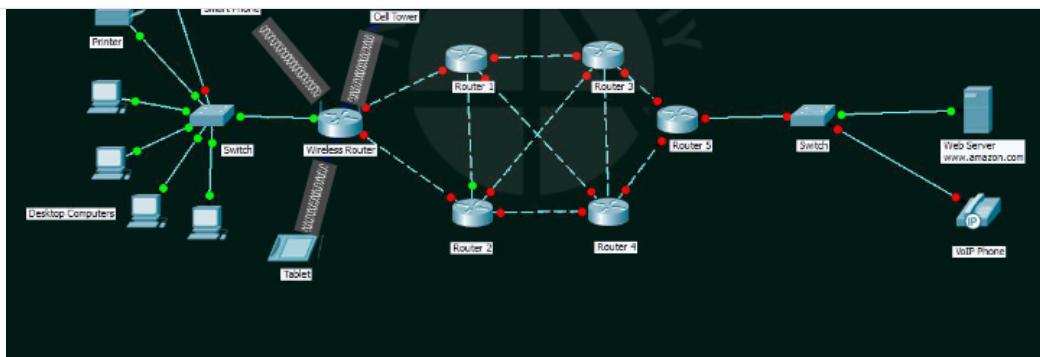


## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

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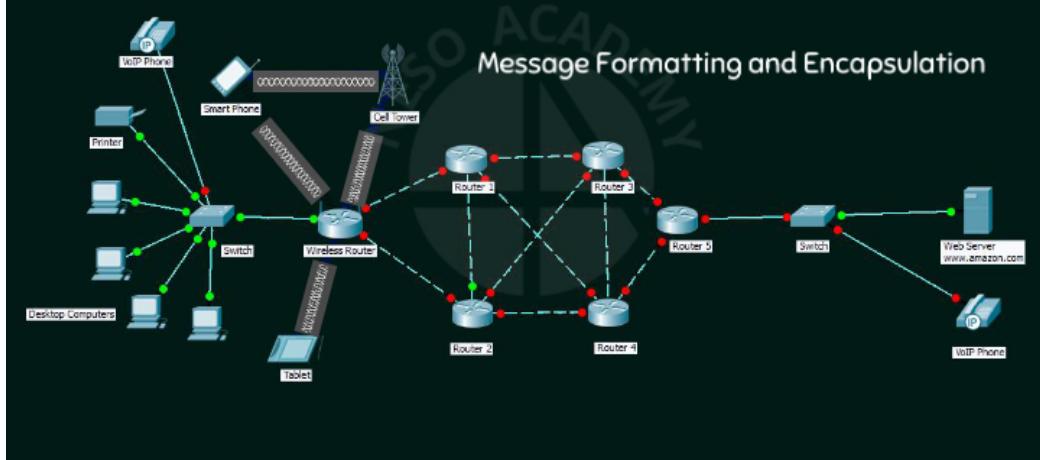
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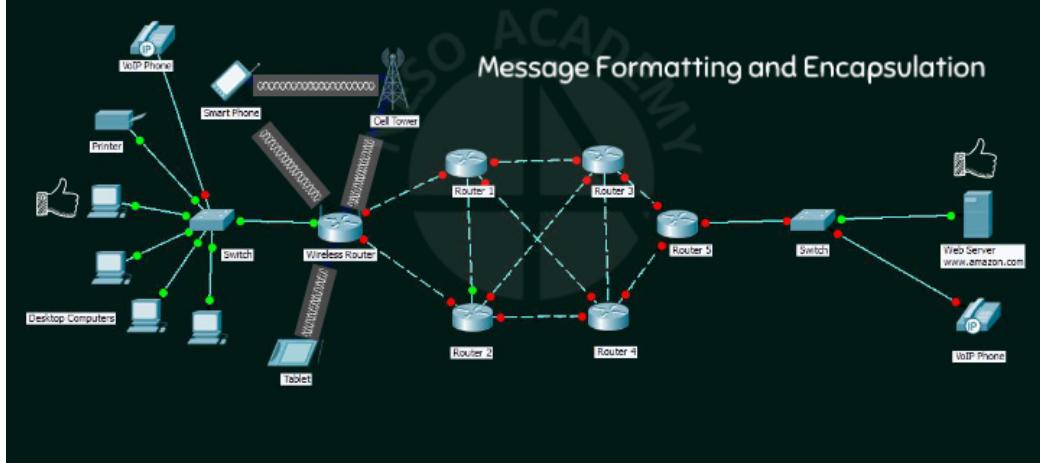
## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

### Message Formatting and Encapsulation



## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

### Message Formatting and Encapsulation

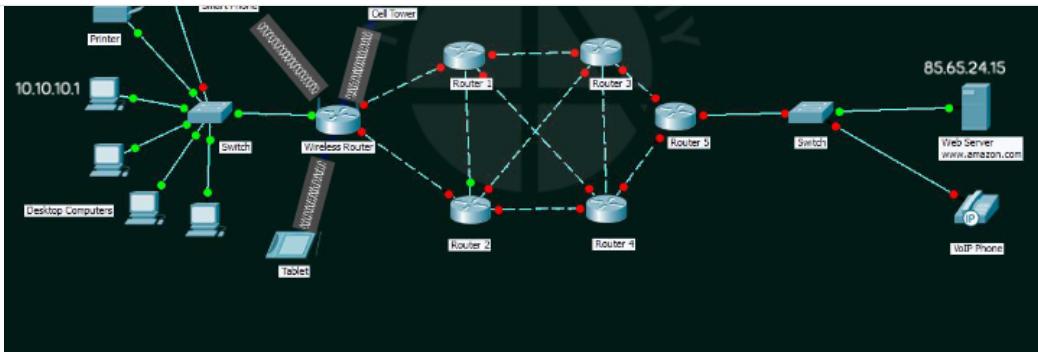


## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

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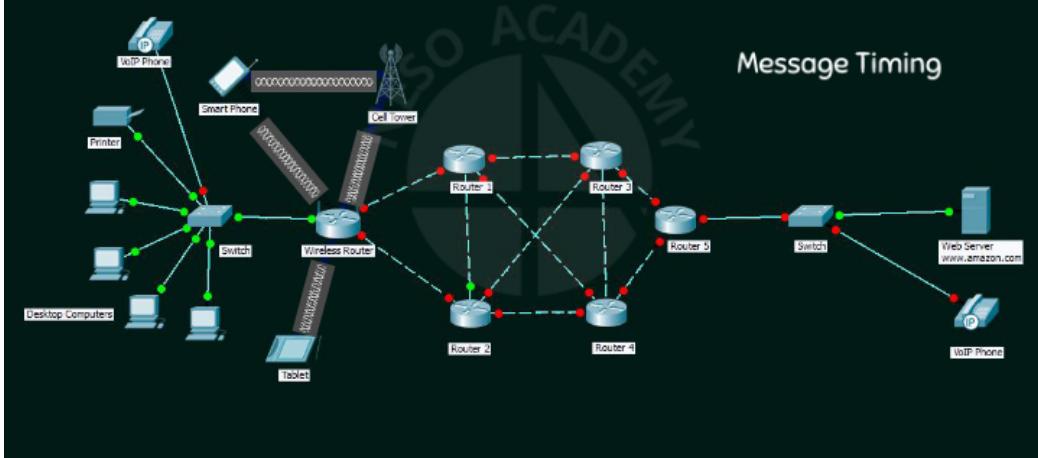
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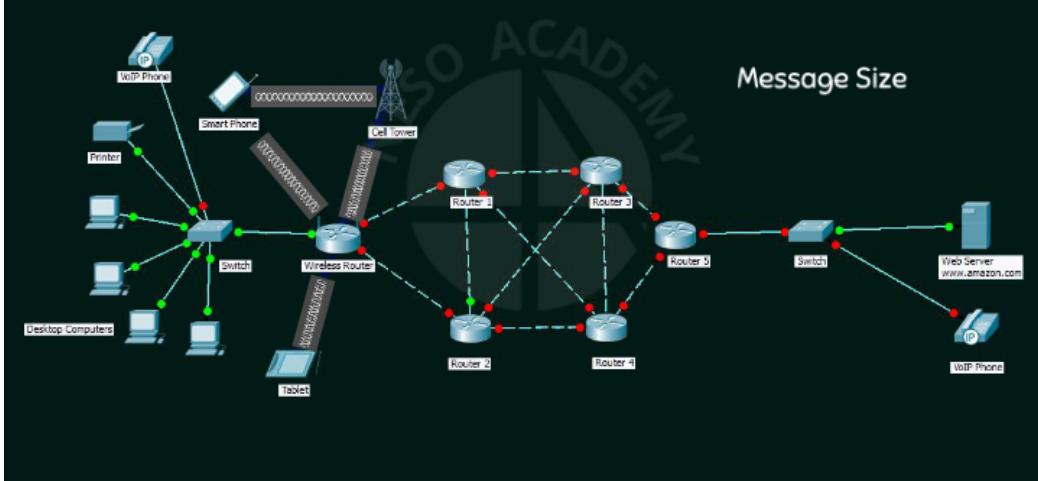
## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

### Message Timing



## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

### Message Size

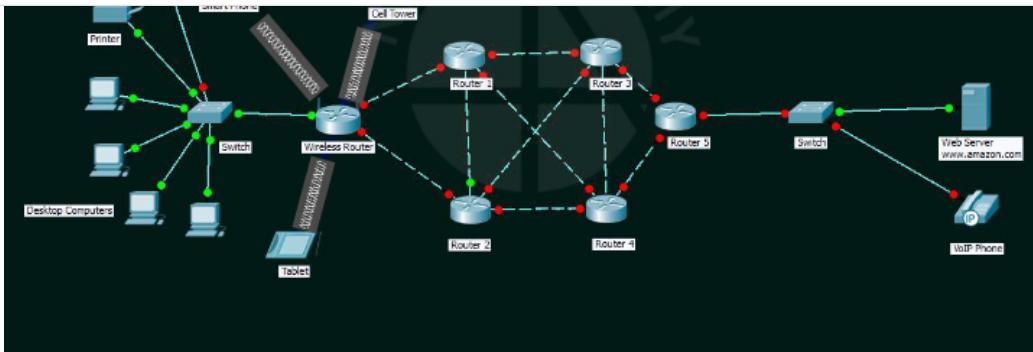


## ELEMENTS OF PROTOCOL IN COMPUTER NETWORK

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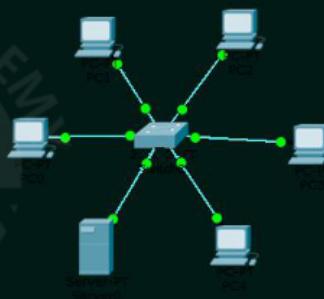
## PEER-TO-PEER NETWORK

- ★ No Centralized administration.
- ★ All peers are equal.
- ★ Simple sharing applications.
- ★ Not scalable.



## CLIENT SERVER NETWORK

- ★ Centralized administration.
- ★ Request-Response model.
- ★ Scalable.
- ★ Server may be overloaded.



## OUTCOMES

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- ★ Understand nodes in computer network.
- ★ Understand different media in computer network.
- ★ Understand various services offered by computer network.

## COMPONENTS OF A COMPUTER NETWORK

1. Nodes
2. Media
3. Services

### 1. NODES

End nodes (End devices).

Intermediary nodes.

## END-NODES (DEVICES)

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VoIP Phones

Telepresence endpoint

Security cameras

Mobile handheld devices (Smart phones, tablets, PDAs, Wireless debit/credit card reader, barcode scanner)

## INTERMEDIARY NODES

Switches

Bridges

Wireless Access Point

Hubs

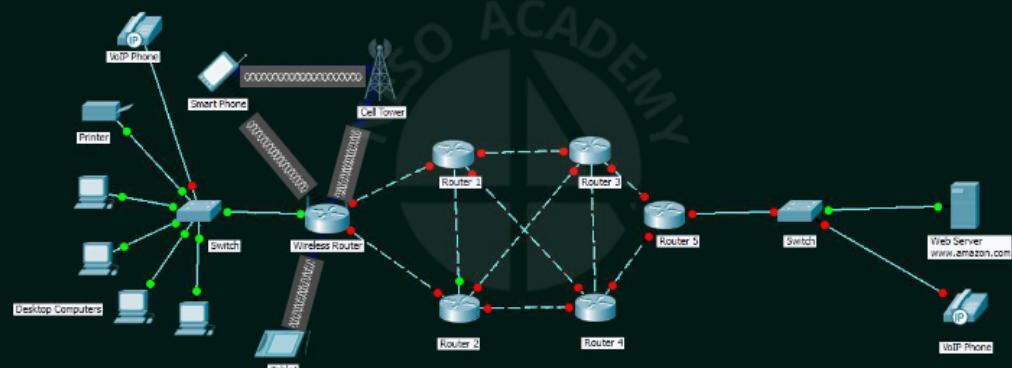
Routers

Repeaters

Security Devices (Firewall)

Cell Tower

## COMPONENTS – NODES, MEDIA AND SERVICES



## 2. MEDIA

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### Wireless Medium (Unguided Medium)

## WIRED MEDIA

Ethernet straight-through cable

Ethernet crossover cable

Fiber Optic cable

Coaxial cable

USB cable

## WIRED MEDIA

Ethernet straight-through cable

Ethernet crossover cable

Fiber Optic cable

Coaxial cable

USB cable



## WIRED MEDIA

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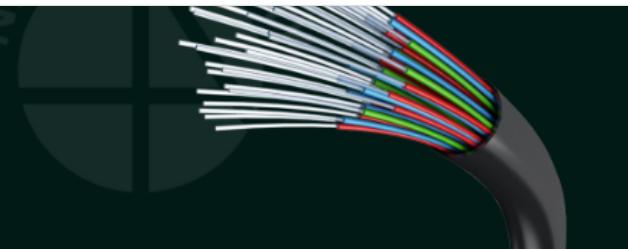
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Fiber Optic cable

Coaxial cable

USB cable



## WIRED MEDIA

Ethernet straight-through cable

Ethernet crossover cable

Fiber Optic cable

Coaxial cable

USB cable



## WIRED MEDIA

Ethernet straight-through cable

Ethernet crossover cable

Fiber Optic cable

Coaxial cable

USB cable



## WIRELESS MEDIA

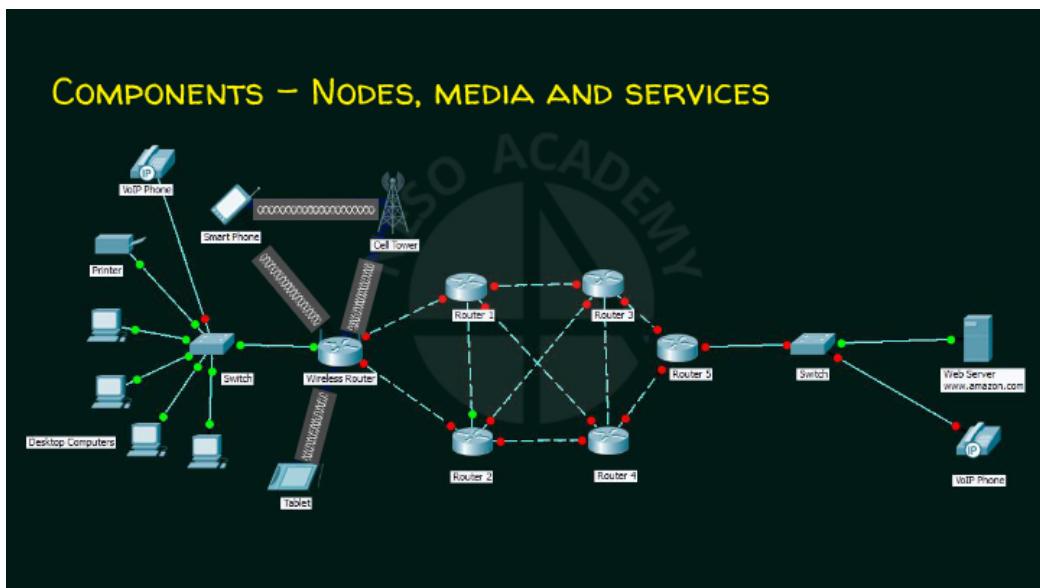
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**Radio (Example: Bluetooth, WiFi)**

**Microwaves (Example: Cellular System)**

**Satellite (Example: Long range communication – GPS)**



### 3. SERVICES

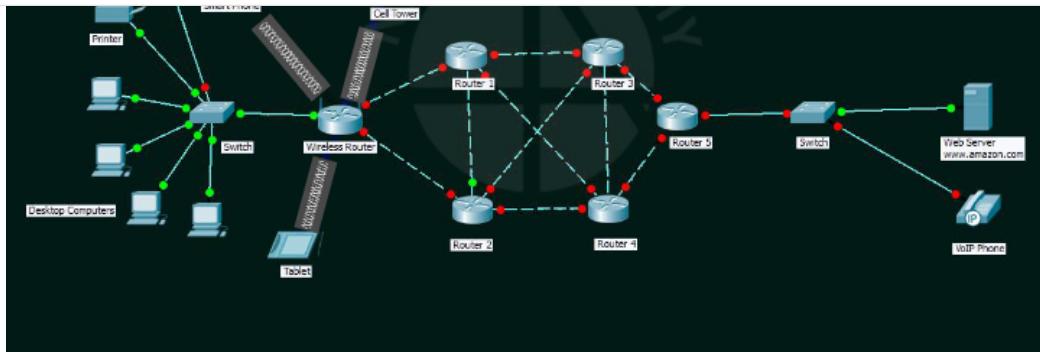
e-Mail	Online game
Storage services	Voice over IP
File sharing	Video telephony
Instant messaging	World Wide Web

## COMPONENTS – NODES, MEDIA AND SERVICES

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## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand LAN, MAN and WAN.
- ★ Know various devices involved in LAN, MAN and WAN.
- ★ Know the new trends in computer networks.

## CLASSIFICATION OF COMPUTER NETWORKS

1. Local Area Network (LAN)
2. Metropolitan Area Network (MAN)
3. Wide Area Network (WAN)

## 1. LOCAL AREA NETWORK (LAN)

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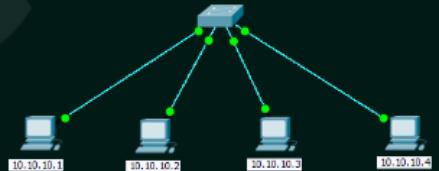
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Office building.

LAN - DEVICES

★ Wired LAN (Example: Ethernet – Hub, Switch)

★ Wireless LAN (Example: Wi-Fi)



## 2. METROPOLITAN AREA NETWORK (MAN)

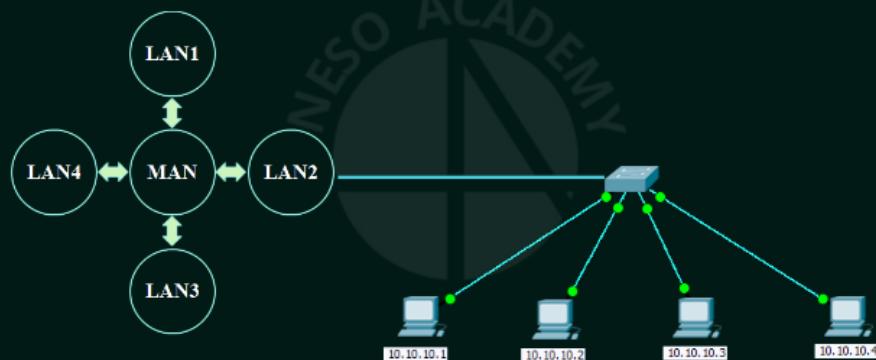
A metropolitan area network (MAN) is a computer network that interconnects users with computer resources in a geographic region of the size of a **metropolitan area (City)**.

MAN - DEVICES

★ Switches/Hub

★ Routers/Bridges

## 2. METROPOLITAN AREA NETWORK (MAN)



### 3. WIDE AREA NETWORK (WAN)

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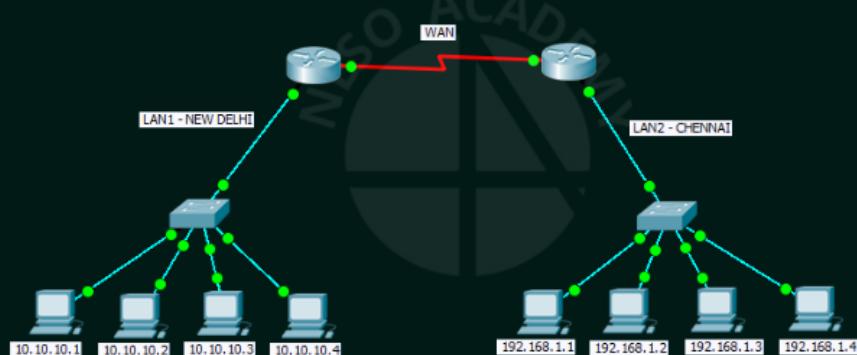
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#### WAN - Devices

End devices and intermediary devices

### 3. WIDE AREA NETWORK (WAN)



### THE INTERNET



**NEW TRENDS**

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**Cloud computing****STORAGE AREA NETWORK (SAN)****Cloud Computing**

It is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user.

**OUTCOMES**

Upon the completion of this session, the learner will be able to

- ★ Understand various network topologies such as bus, star, ring, mesh and hybrid.
- ★ Understand the advantages and disadvantages of each topology.

## NETWORK TOPOLOGY

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Topology = Layout.



## PHYSICAL TOPOLOGY AND LOGICAL TOPOLOGY

Physical Topology – Placement of various nodes.

Logical topology – Direction of data flow in the network.



## NETWORK TOPOLOGY

- ★ Bus
- ★ Ring
- ★ Star
- ★ Mesh
- ★ Hybrid

## BUS TOPOLOGY

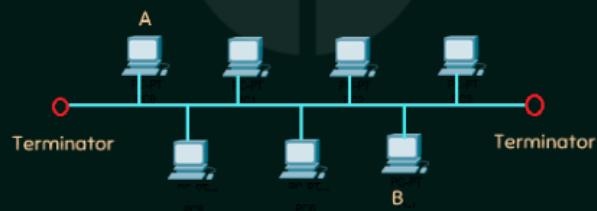
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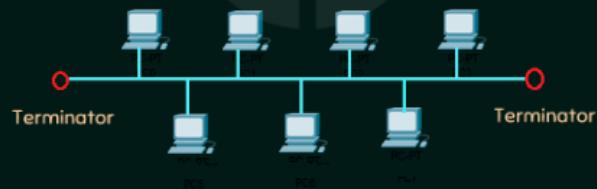
network simultaneously.

- ★ A signal containing the address of the intended receiving machine travels from a source machine in **both directions** to all machines connected to the bus until it finds the intended recipient.



## BUS TOPOLOGY

Advantages	Disadvantages
Only one wire – Less expensive.	Not fault tolerant (No redundancy).
Suited for temporary network.	Limited cable length.
Node failures does not affect others.	No security.



## RING TOPOLOGY

- ★ A ring topology is a bus topology in a closed loop.
- ★ Peer-to-Peer LAN topology.
- ★ Two connections: one to each of its nearest neighbors.
- ★ Unidirectional.
- ★ Sending and receiving data takes place with the help of a **TOKEN**.



## RING TOPOLOGY

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## RING TOPOLOGY

Advantages	Disadvantages
Performance better than Bus topology.	Unidirectional. Single point of failure will affect the whole network.
Can cause bottleneck due to weak links.	↑ in load – ↓ in performance.
All nodes with equal access.	No security.



## STAR TOPOLOGY

- ★ Every node is connected to a central node called a hub or switch.
- ★ Centralized Management.
- ★ All traffic must pass through the hub or switch.



## STAR TOPOLOGY

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Advantages and Disadvantages of Star network.	
Centralized administration.	Bottlenecks due to overloaded switch/Hub.
Scalable.	Increased cost due to switch/hub.



## STAR TOPOLOGY



## EXTENDED STAR TOPOLOGY

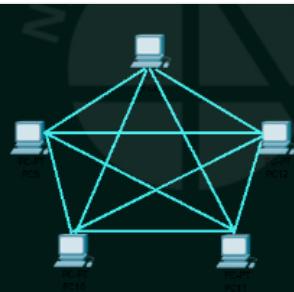


## MESH TOPOLOGY

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## MESH TOPOLOGY

### Advantages

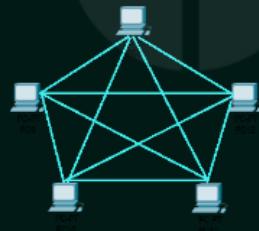
Fault tolerant.

### Disadvantages

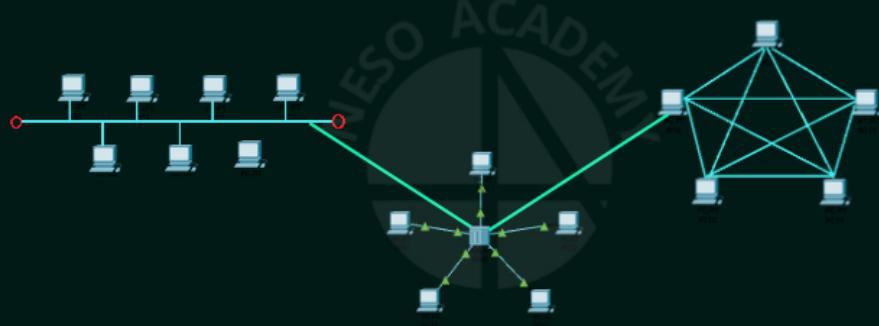
Issues with broadcasting messages.

Reliable.

Expensive and impractical for large networks.



## FIND THE TOPOLOGY??



## Hybrid Topology

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The diagram illustrates a hybrid network topology. On the left, a horizontal bus segment connects five computer nodes. From the middle of this bus, a green line extends to a central switch. This switch is connected to four computer nodes via green lines, forming a star topology. Additionally, the central switch is connected to two other switches on the right, which in turn connect to further computer nodes, creating a mesh-like extension of the network.

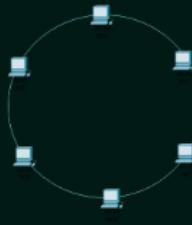
## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Determine the number of links(cables) and ports required for a given topology.

## QUESTION 1

Identify the given topology and determine how many cables and ports are required to have such network?



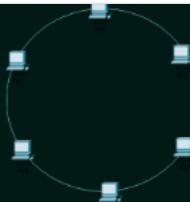
## Ring Topology

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(N)	(=N)	(NOPD)	$(TNOP) = N \times NOPD$
2	2	2	4
3	3	2	6
4	4	2	8
N	N	2	$2 \times N$



### QUESTION 1

Identify the given topology and determine how many cables and ports are required to have such network?

**Solution:** (Here N=6)

**Topology:** Ring Topology

No. of cables = N

No of cables = 6

$TNOP = N \times NOPD$

Here N=6, NOPD=2

$TNOP = 6 \times 2 = 12$



### QUESTION 2

Traffic problem can be minimized using?

- a. Star X
- b. Bus X
- c. Ring X
- d. Mesh



**QUESTION 3**

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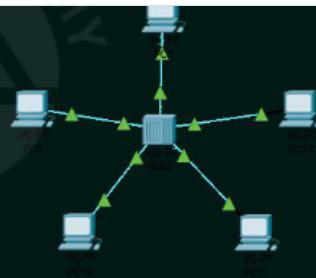
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**Solution:**

No. of cables : N  
No. of cables : 5

$$\begin{aligned}\text{No.of ports} &= 2 \times N \\ \text{No. of ports} &= 2 \times 5 \\ \text{No. of ports} &= 10\end{aligned}$$

**STAR TOPOLOGY**

No. of Nodes (N)	No of Cables (=N)	No of Ports/device (NOPD)	Total No. of ports in the network (TNOP) = 2 X N
2	2	1	4
3	3	1	6
4	4	1	8
N	N	1	2 X N

**HOME WORK**

Assume six devices are arranged in a mesh topology.

- (i) How many cables are needed?
- (ii) How many ports are needed for each device?
- (iii) How many ports are there in the entire network?

## OUTCOMES

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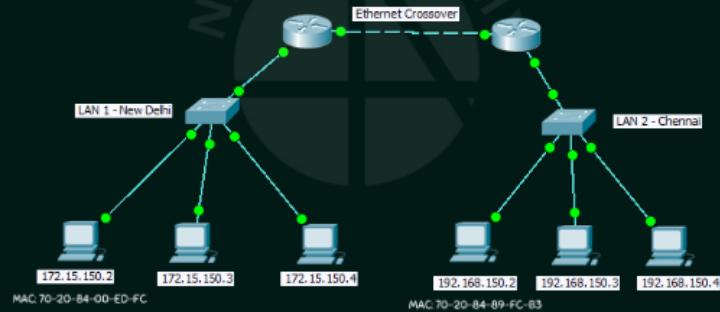
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- ★ Understand the basics of IP addressing.
- ★ Know how to see the IP address in real device.
- ★ Identify valid and invalid IP addresses.

## IP ADDRESS

Every node in the computer network is identified with the help of IP address.



## IP ADDRESS (IPV4)

- ★ Every node in the computer network is identified with the help of IP address.
- ★ Logical address.
- ★ Can change based on the location of the device.
- ★ Assigned by manually or dynamically.
- ★ Represented in decimal and it has 4 octets (x.x.x.x).
- ★ 0.0.0.0 to 255.255.255.255 (32 bits).

**ACTIVITY TIME**

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- a. 24.25.26.8
- b. 10.3.156.256
- c. 0.0.0.0
- d. 255.255.255.255
- e. 100.2.6.345.456
- f. 16.2e.45.67

Valid IP Addresses	Invalid IP Addresses
a, c, d	b, e, f

**OUTCOMES**

Upon the completion of this session, the learner will be able to

- ★ Understand the basics of MAC addressing.
- ★ Understand the difference between IP address and MAC Address.
- ★ See the MAC address in real devices.

**MAC ADDRESS**

MAC stands for Media Access Control.

Every node in the LAN is identified with the help of MAC address.

IP Address = Location of a person.

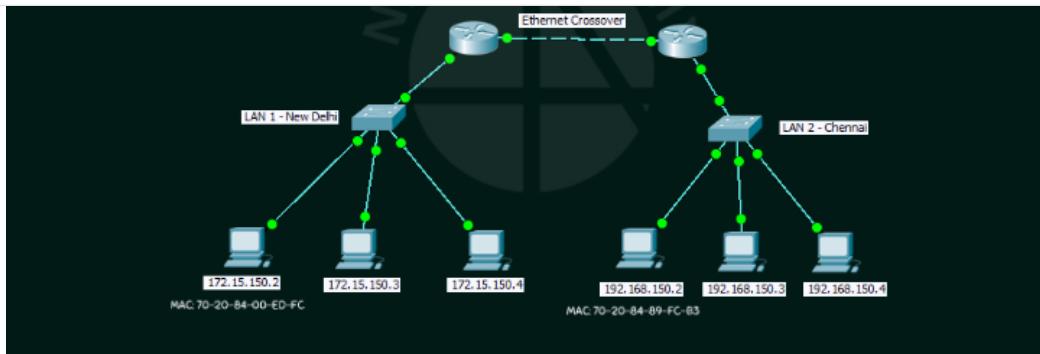
MAC Address = Name of the person.

## MAC ADDRESS

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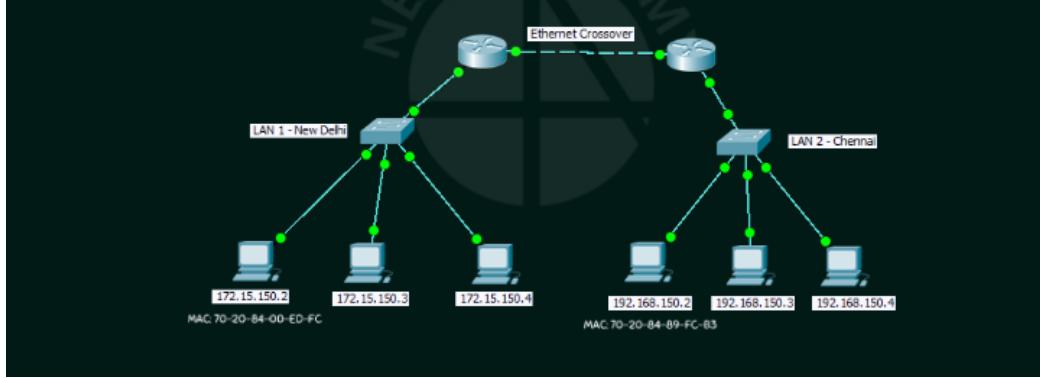


## MAC ADDRESS

- ★ Every node in the LAN is identified with the help of MAC address.
- ★ Physical address or Hardware Address.
- ★ Unique.
- ★ Cannot be changed.
- ★ Assigned by the manufacturer.
- ★ Represented in hexadecimal.
- ★ Example: 70-20-84-00-ED-FC (48 bits).
- ★ Separator: hyphen(-), period(.), and colon(:).

## MAC ADDRESS

- ★ Every node in the LAN is identified with the help of MAC address.



## IP ADDRESS Vs MAC ADDRESS

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Needed for communication.	Needed for communication.
32 bits.	48 bits.
Represented in Decimal.	Represented in hexadecimal.
Router needs IP Address to forward data.	Switch needs MAC address to forward data
Example: 10.10.23.56	Example: 70-20-84-00-ED-FC

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the basics of Port addressing (Port number).
- ★ Know three key points to ponder.
- ★ See port number in real devices.

## ANALOGY



## ANALOGY

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## DERIVATIONS FROM ANALOGY

Reaching our city = Reaching our network. (IP Address)

Reaching our Apartment = Reaching the host. (MAC Address)

Reaching the right person = Reaching the right process. (Port Address)

## PORT ADDRESS OR PORT NUMBER

- ★ In a node, many processes will be running.
- ★ Data which are sent/received must reach the right process.
- ★ Every process in a node is uniquely identified using **port numbers**.
- ★ Port = Communication endpoint.
- ★ Fixed port numbers and dynamic port numbers ( 0 - 65535 )

Example:

Fixed port numbers : 25, 80 etc.,

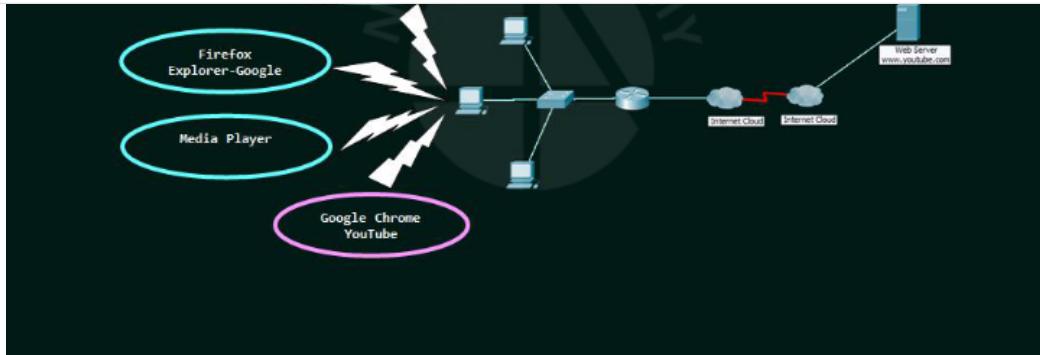
OS assigned dynamic port numbers : 62414.

## PORT ADDRESS OR PORT NUMBERS

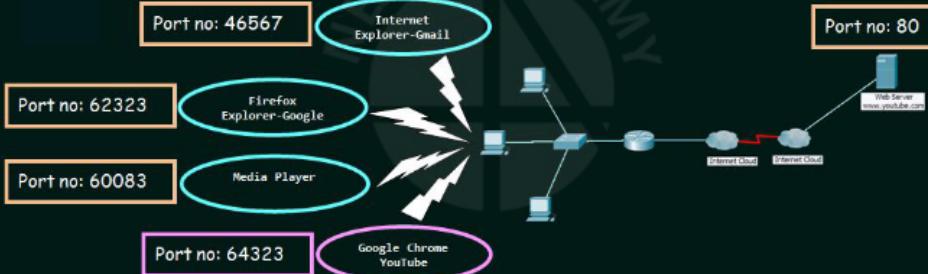
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## PORT ADDRESS OR PORT NUMBERS



## 3 KEY POINTS TO PONDER

Before sending the data, any node must

- ★ Attach source IP address and destination IP address.
- ★ Attach source MAC address and destination MAC address.
- ★ Attach source port number and destination port number.

## OUTCOMES

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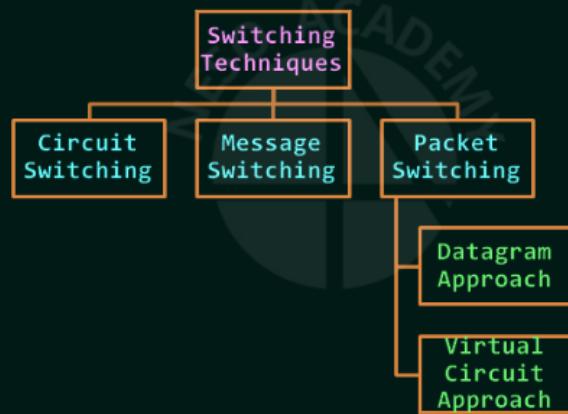
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- ★ Understand switching.
- ★ Understand various switching techniques such as circuit switching, message switching and packet switching.

## SWITCHING

- ★ Switching in computer network helps in deciding the best route for data transmission if there are multiple paths in a larger network.
- ★ One-to-One connection.

## SWITCHING TECHNIQUES



## CIRCUIT SWITCHING

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★ Before data transfer, connection will be established first.

★ Example: Telephone network.

### 3 phases in circuit switching:

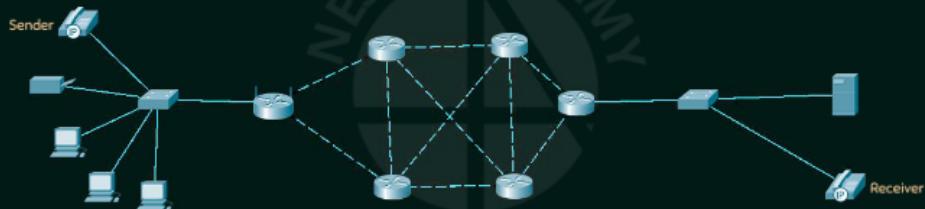
1. Connection establishment.
2. Data transfer
3. Connection Disconnection.

## EXAMPLE FOR CIRCUIT SWITCHING

Phase 1: Connection establishment



## EXAMPLE FOR CIRCUIT SWITCHING

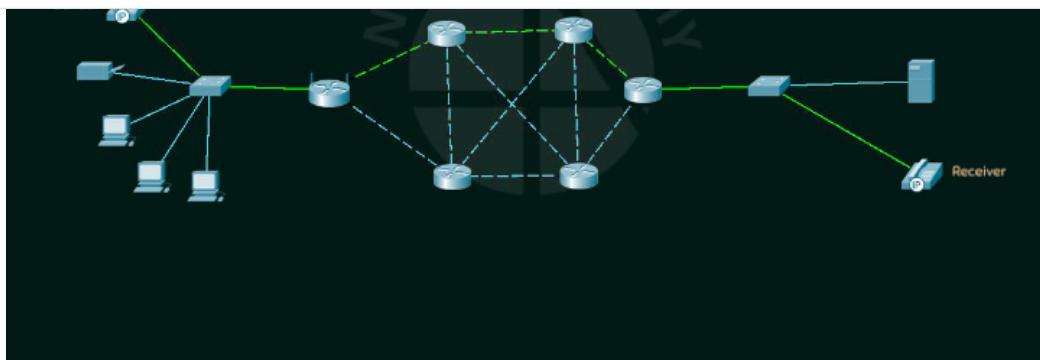


**EXAMPLE FOR CIRCUIT SWITCHING**

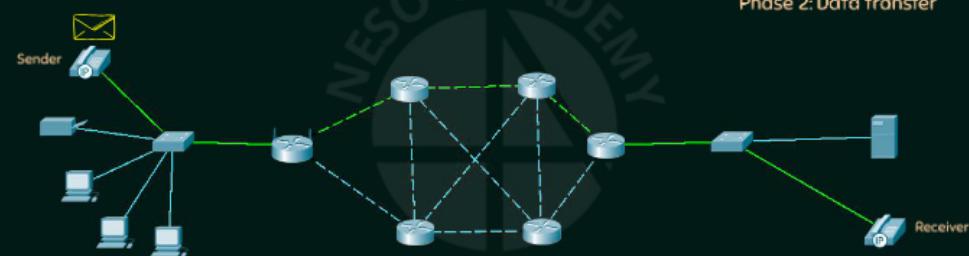
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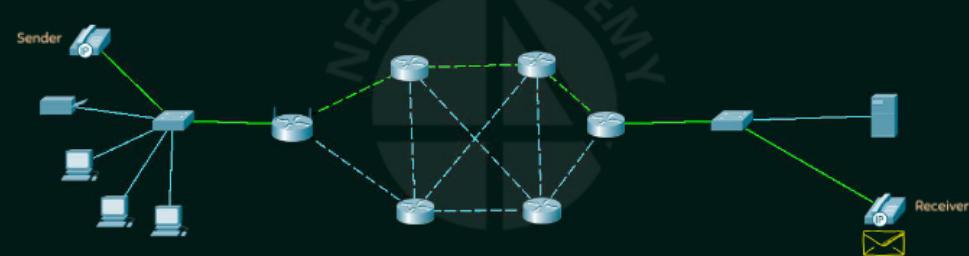
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**EXAMPLE FOR CIRCUIT SWITCHING**

Phase 2: Data transfer

**EXAMPLE FOR CIRCUIT SWITCHING**

Phase 2: Data transfer

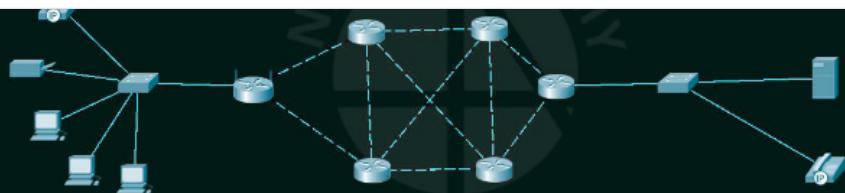


### EXAMPLE FOR CIRCUIT SWITCHING

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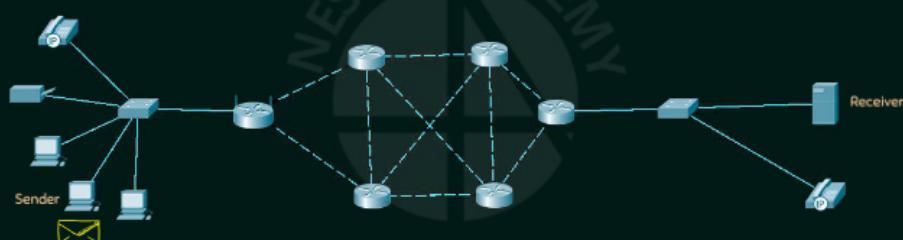
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### MESSAGE SWITCHING

- ★ Store and forward mechanism.
- ★ Message is transferred as a complete unit and forwarded using store and forward mechanism at the intermediary node.
- ★ Not suited for streaming media and real-time applications.

### EXAMPLE FOR MESSAGE SWITCHING

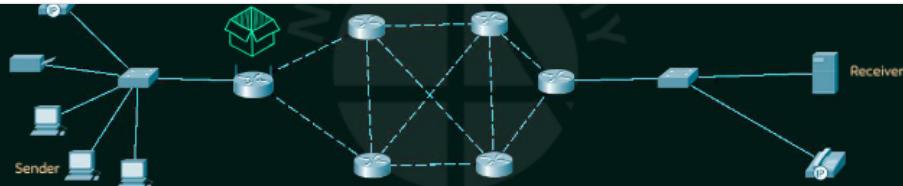
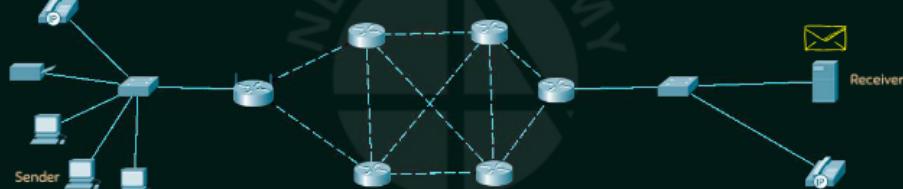


**EXAMPLE FOR PACKET SWITCHING**

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**EXAMPLE FOR MESSAGE SWITCHING****EXAMPLE FOR MESSAGE SWITCHING**

## PACKET SWITCHING

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- ★ Each packet is sent individually.
- ★ Each packet will have source and destination IP address with sequence number.
- ★ Sequence numbers will help the receiver to
  - Reorder the packets.
  - Detect missing packets and
  - Send acknowledgments.

## TWO APPROACHES TO PACKET SWITCHING

1. Datagram Approach.
2. Virtual Circuit Approach.

## PACKET SWITCHING – DATAGRAM APPROACH

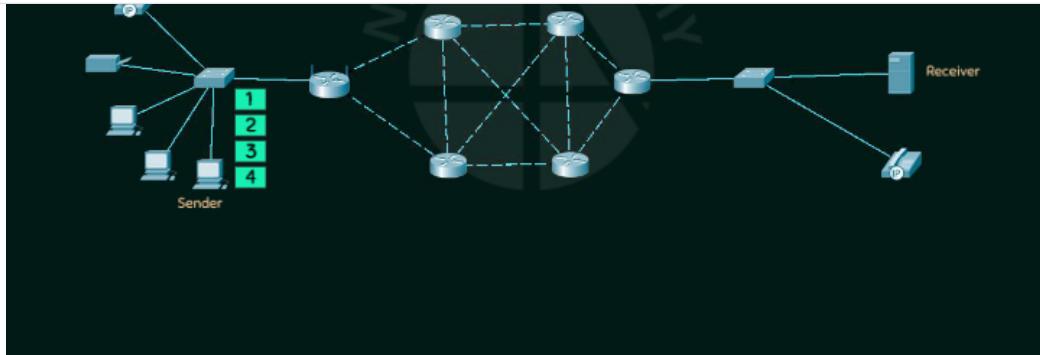
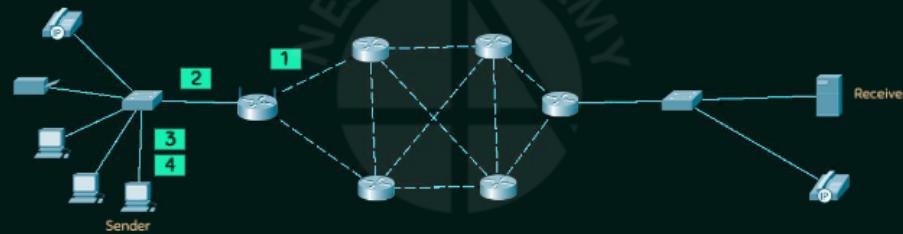
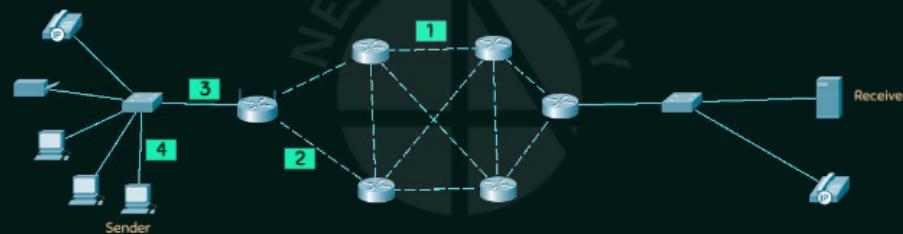
- ★ Datagram Packet Switching is also known as connectionless switching.
- ★ Each independent entity is called as datagram.
- ★ Datagrams contain destination information and the intermediary devices uses this information to forward datagrams to right destination.
- ★ In Datagram Packet Switching approach, the path is not fixed.
- ★ Intermediate nodes take the routing decisions to forward the packets.

**EXAMPLE FOR PACKET SWITCHING – DATAGRAM**

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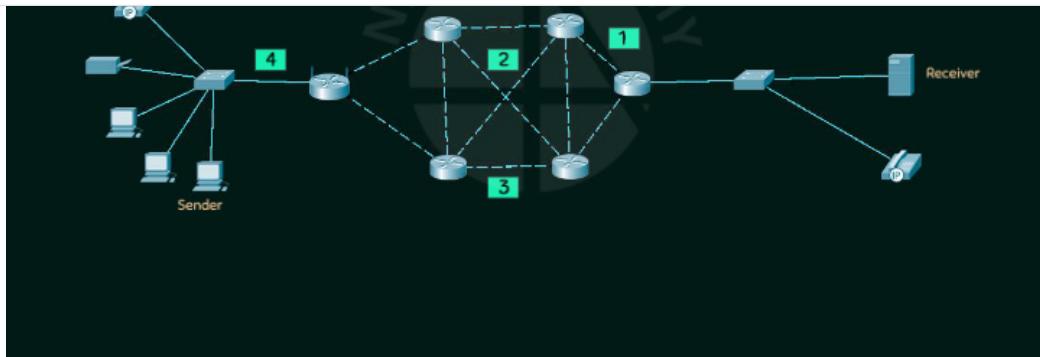
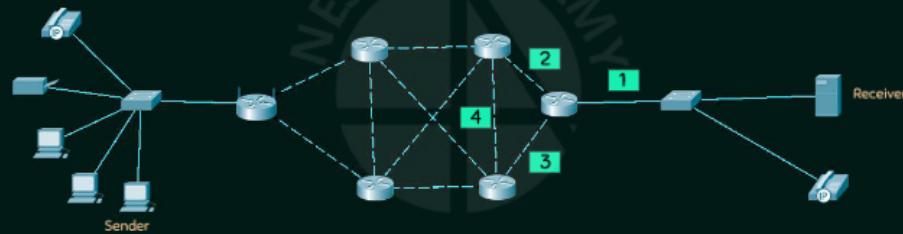
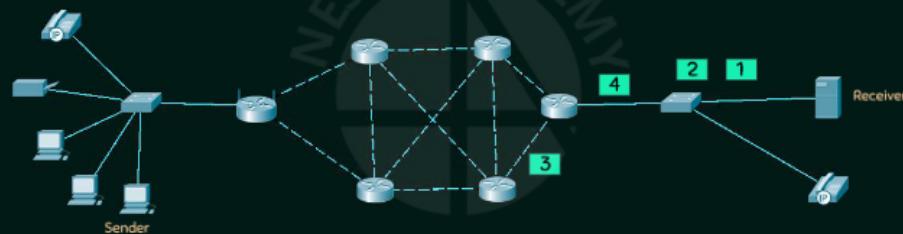
**EXAMPLE FOR PACKET SWITCHING – DATAGRAM****EXAMPLE FOR PACKET SWITCHING – DATAGRAM**

**EXAMPLE FOR PACKET SWITCHING – DATAGRAM**

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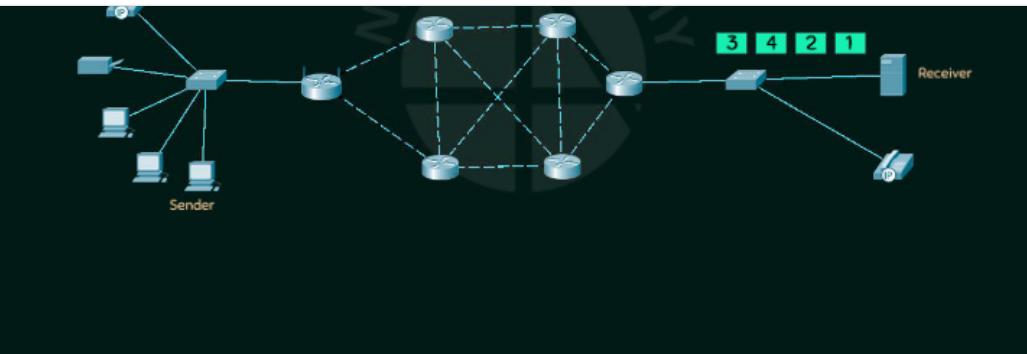
**EXAMPLE FOR PACKET SWITCHING – DATAGRAM****EXAMPLE FOR PACKET SWITCHING – DATAGRAM**

### EXAMPLE FOR PACKET SWITCHING – DATAGRAM

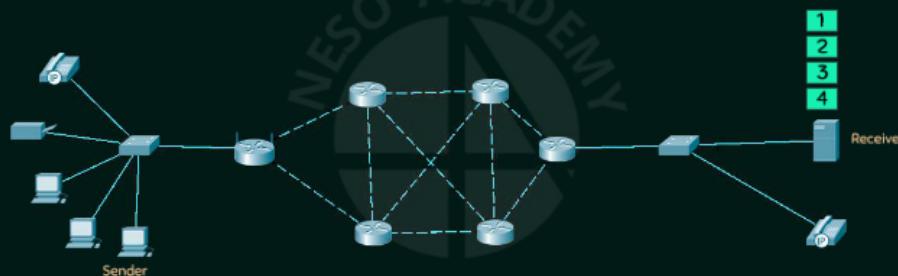
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### EXAMPLE FOR PACKET SWITCHING – DATAGRAM



### PACKET SWITCHING – VIRTUAL CIRCUIT APPROACH

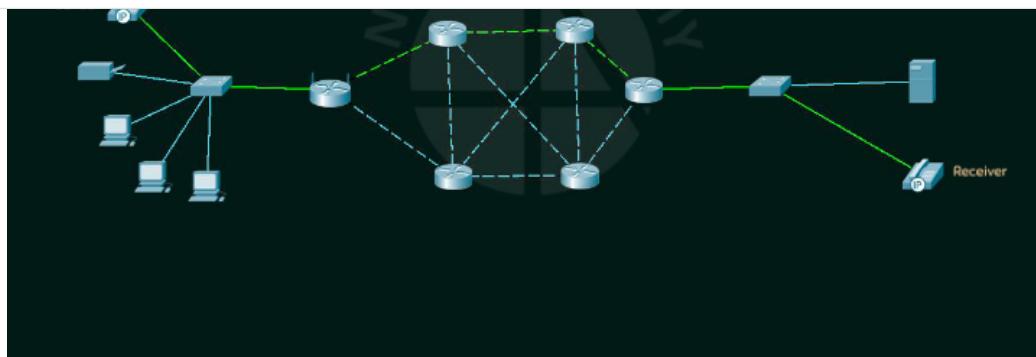
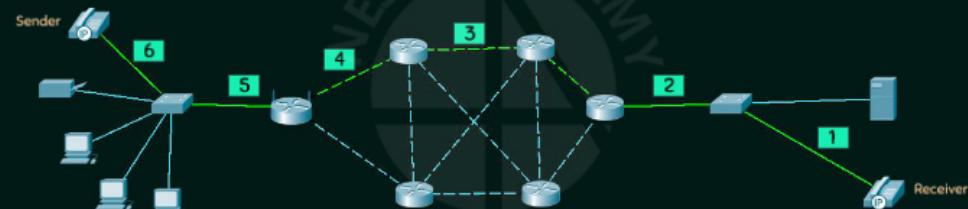
- ★ Virtual Circuit Switching is also known as **connection-oriented switching**.
- ★ In the case of Virtual circuit switching, a preplanned route is established before the messages are sent.
- ★ Call request and call accept packets are used to establish the connection between sender and receiver.
- ★ In this approach, the path is fixed for the duration of a logical connection.

**EXAMPLE FOR PACKET SWITCHING – VIRTUAL CIRCUIT**

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**EXAMPLE FOR PACKET SWITCHING – VIRTUAL CIRCUIT****EXAMPLE FOR PACKET SWITCHING – VIRTUAL CIRCUIT**

## SWITCHING TECHNIQUES

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## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand layering in computer network.
- ★ Understand the benefits of layering.
- ★ Know the introduction of OSI reference model and TCP/IP model.

## LAYERING

Layering means decomposing the problem into more manageable components (Layers).

**Advantages:**

- ★ It provides more modular design.
- ★ Easy to troubleshoot.

## Protocols

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- ★ The protocols in each layer governs the activities of the data communication.

## LAYERED ARCHITECTURES

- ★ The OSI Reference Model.
- ★ The TCP/IP Model.

## THE OSI MODEL

- ★ OSI stands for Open System Interconnection.
- ★ It is a model for understanding and designing a network architecture that is flexible, robust, and interoperable.
- ★ Developed by the International Standards for Organizations (ISO).
- ★ The OSI model is not a protocol.
- ★ It is only a guideline and hence it is referred as OSI reference model.

## THE OSI MODEL

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communication between different systems without requiring changes  
to the logic of the underlying hardware and software.

- ★ The OSI model was never fully implemented.

## THE TCP/IP MODEL

- ★ TCP/IP = Transmission Control Protocol/Internet Protocol.
- ★ The TCP/IP protocol suite was developed prior to the OSI model.
- ★ Therefore, the layers in the TCP/IP protocol suite do not exactly match those in the OSI model.
- ★ **TCP/IP is a hierarchical protocol** made up of interactive modules, each of which provides a specific functionality.

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the OSI reference model.
- ★ List various layers in the OSI reference model.
- ★ Understand how each layers interact with other layers.

## LAYERING – A RECAP

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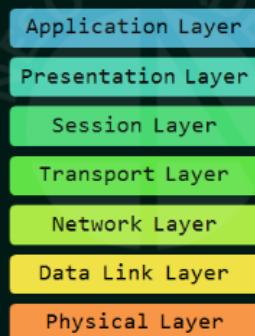
more manageable components (Layers).

- ★ More modular design and easy to troubleshoot.

## THE OSI MODEL

- ★ The purpose of the OSI model is to facilitate communication between different systems without requiring changes to the logic of the underlying hardware and software.

## LAYERS IN THE OSI REFERENCE MODEL

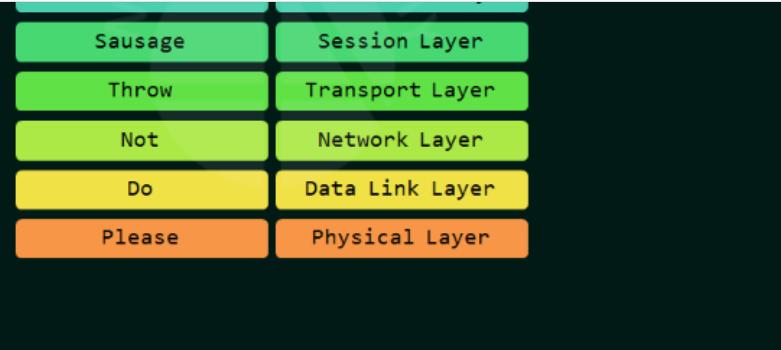


## HOW TO REMEMBER THE LAYERS?

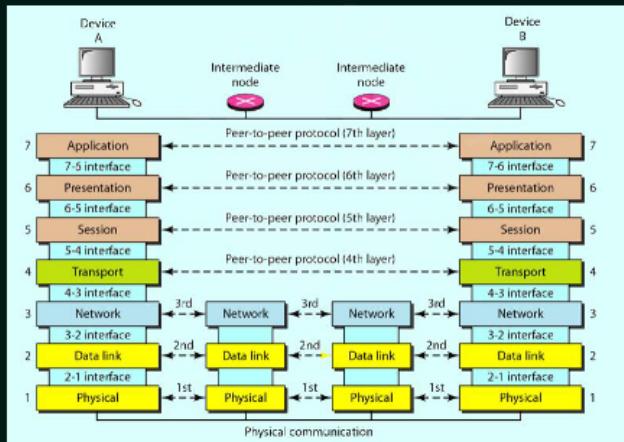
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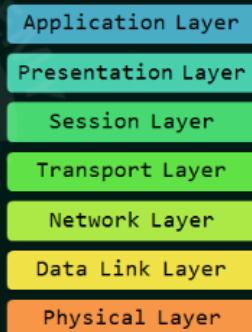


## LAYERS IN THE OSI REFERENCE MODEL



## REVISITING THE SYLLABUS (BOTTOM UP APPROACH)

- ★ Chapter 1: Fundamentals
- ★ Chapter 2: Data Link Layer
- ★ Chapter 3: Network Layer
- ★ Chapter 4: Transport Layer
- ★ Chapter 5: Application Layer
- ★ Chapter 6: Network Security

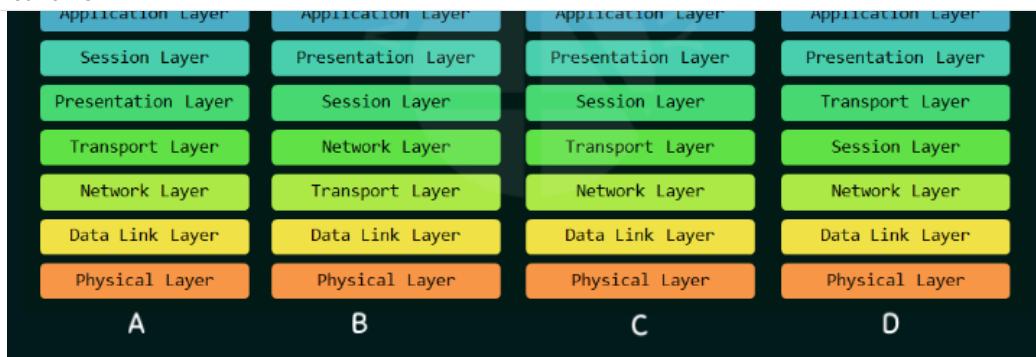


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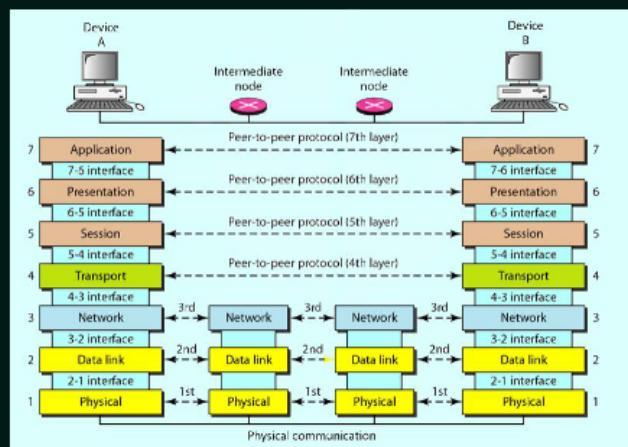
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**OUTCOMES**

Upon the completion of this session, the learner will be able to

- ★ Understand the services offered by Application Layer.
- ★ Understand the services offered by Presentation Layer.
- ★ Understand the services offered by Session Layer.

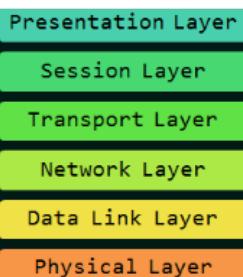
**LAYERS IN THE OSI REFERENCE MODEL – A RECAP**

## LAYERS IN THE OSI REFERENCE MODEL

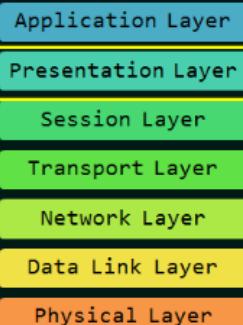
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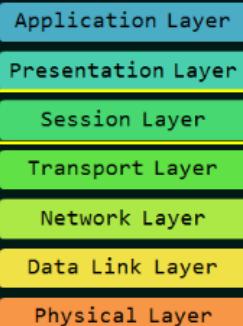
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## LAYERS IN THE OSI REFERENCE MODEL



## LAYERS IN THE OSI REFERENCE MODEL



## LAYERS IN THE OSI REFERENCE MODEL

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## LAYERS IN THE OSI REFERENCE MODEL



## LAYERS IN THE OSI REFERENCE MODEL



## LAYERS IN THE OSI REFERENCE MODEL

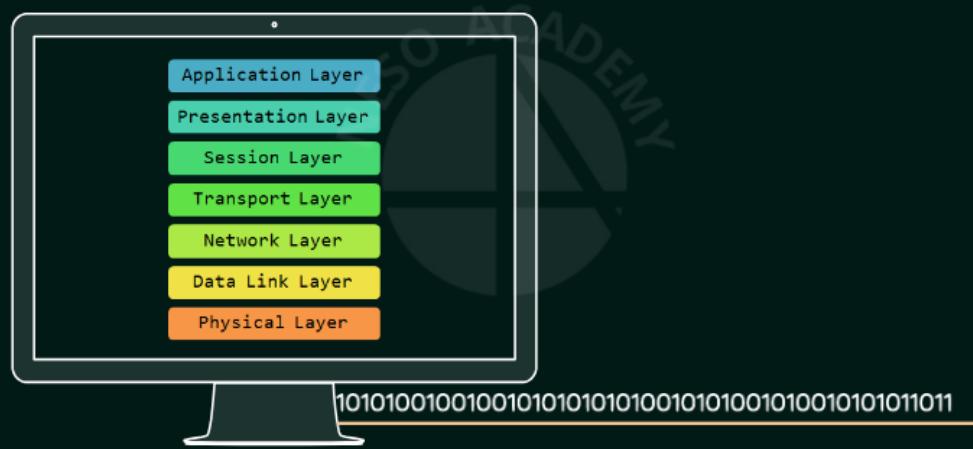
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## LAYERS IN THE OSI REFERENCE MODEL



## LAYERS IN THE OSI REFERENCE MODEL

**Application Layer**

→ It enables the user to access the network resources.

### SERVICES PROVIDED BY APPLICATION LAYER

- ★ File Transfer and Access Management (FTAM).
- ★ Mail Services.
- ★ Directory services.

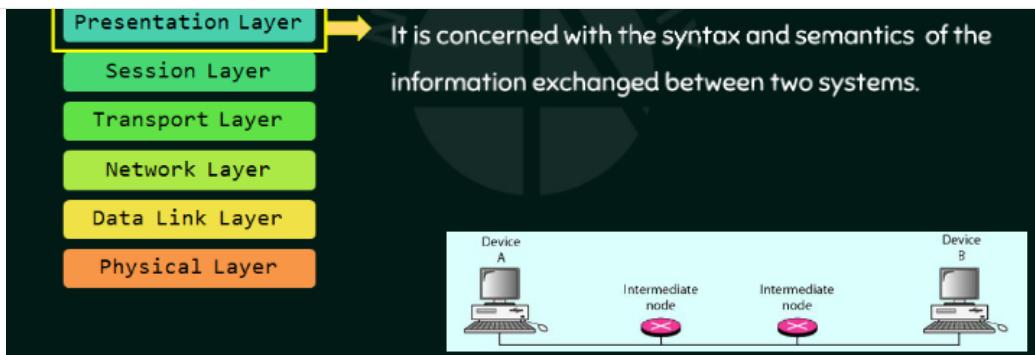


## LAYERS IN THE OSI REFERENCE MODEL

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## LAYERS IN THE OSI REFERENCE MODEL

Application Layer

**Presentation Layer**

Session Layer

Transport Layer

Network Layer

Data Link Layer

Physical Layer

It is concerned with the syntax and semantics of the information exchanged between two systems.

### SERVICES PROVIDED BY PRESENTATION LAYER

- ★ Translation.
- ★ Encryption.
- ★ Compression



## LAYERS IN THE OSI REFERENCE MODEL

Application Layer

Presentation Layer

**Session Layer**

Transport Layer

Network Layer

Data Link Layer

Physical Layer

It establishes, maintains, and synchronizes the interaction among communicating devices

### SERVICES PROVIDED BY SESSION LAYER

- ★ Dialog control.
- ★ Synchronization.

## LAYERS IN THE OSI REFERENCE MODEL

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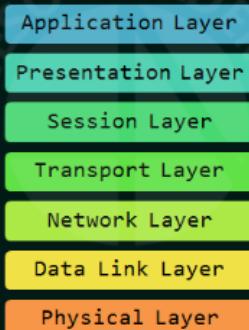


## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the services offered by Transport Layer.
- ★ Understand the services offered by Network Layer.
- ★ Understand the services offered by Data Link Layer.
- ★ Understand the services offered by Physical Layer.

## LAYERS IN THE OSI REFERENCE MODEL – A RECAP



## APPLICATION LAYER – A RECAP

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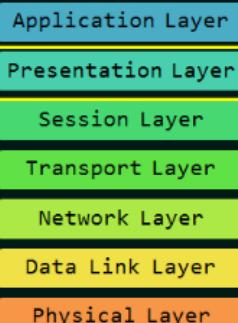


### SERVICES PROVIDED BY APPLICATION LAYER

- ★ File Transfer and Access Management (FTAM).
- ★ Mail Services.
- ★ Directory services.



## PRESENTATION LAYER – A RECAP



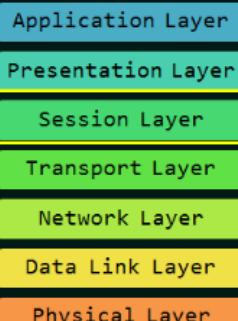
It is concerned with the syntax and semantics of the information exchanged between two systems.

### SERVICES PROVIDED BY PRESENTATION LAYER

- ★ Translation.
- ★ Encryption.
- ★ Compression



## SESSION LAYER – A RECAP



It establishes, maintains, and synchronizes the interaction among communicating devices.

### SERVICES PROVIDED BY SESSION LAYER

- ★ Dialog control.
- ★ Synchronization.



## LAYERS IN THE OSI REFERENCE MODEL

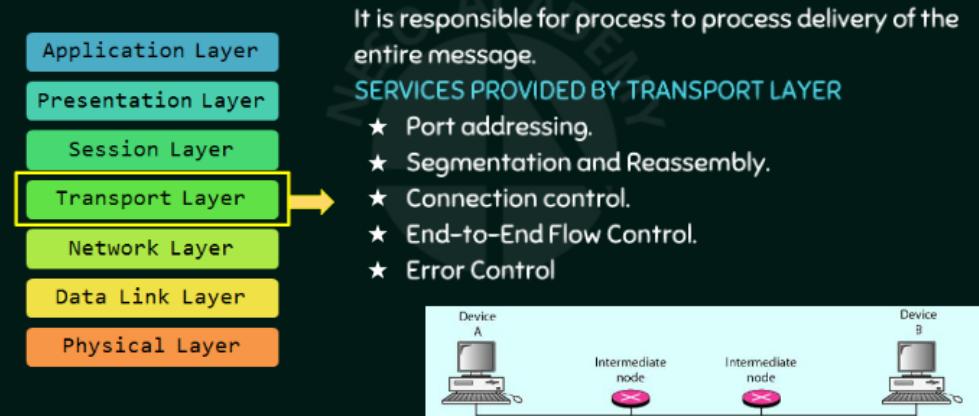
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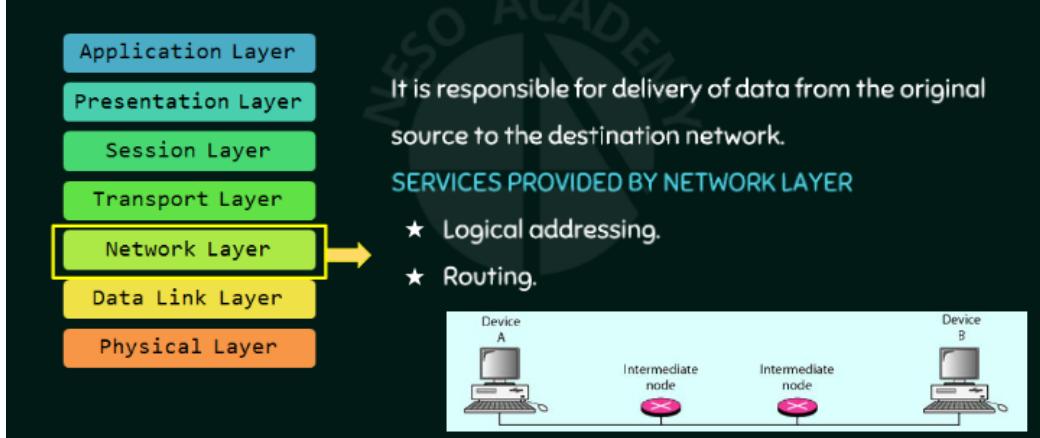
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## LAYERS IN THE OSI REFERENCE MODEL



## LAYERS IN THE OSI REFERENCE MODEL



## LAYERS IN THE OSI REFERENCE MODEL

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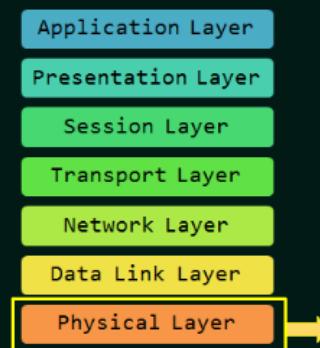
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## LAYERS IN THE OSI REFERENCE MODEL

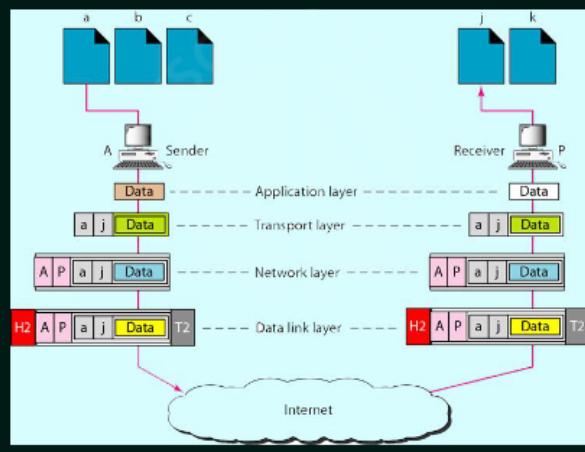
It is responsible for transmitting bits over a medium. It also provides electrical and mechanical specifications.



### SERVICES PROVIDED BY PHYSICAL LAYER

- ★ Physical characteristics of the media.
- ★ Representation of bits.
- ★ Data rate.
- ★ Synchronization of bits.
- ★ Line configuration.
- ★ Physical topology.

## LAYERS IN THE OSI REFERENCE MODEL



## OUTCOMES

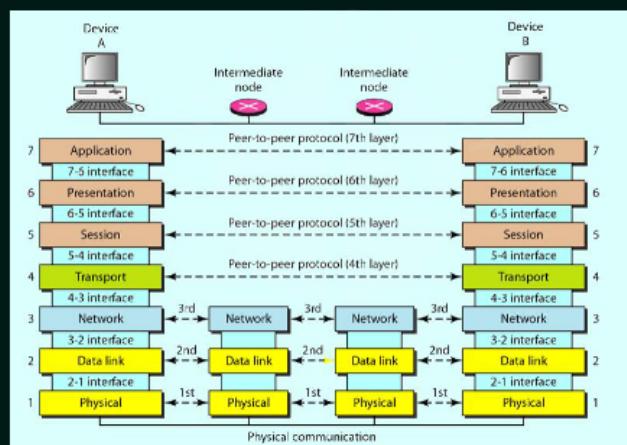
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- ★ Recall the services offered by each layer of the OSI model.
- ★ Understand the working of OSI reference model with an example.

## LAYERS IN THE OSI REFERENCE MODEL – A RECAP



## SERVICES OFFERED BY EACH LAYER

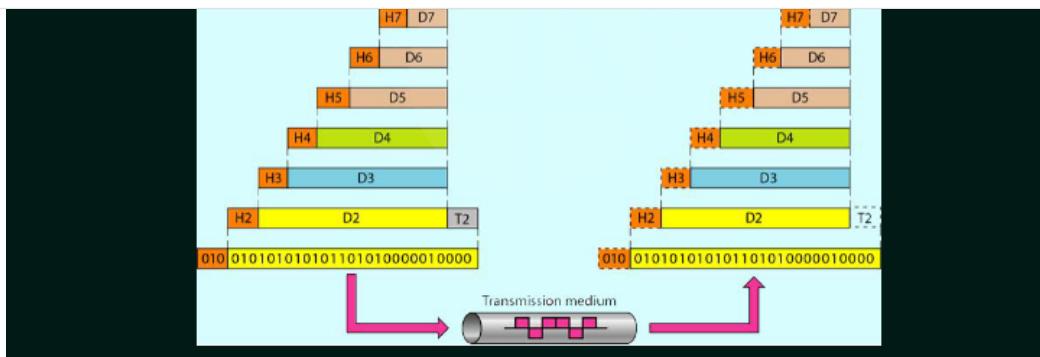
Application Layer	→ FTAM, Mail Services and Directory Services.
Presentation Layer	→ Translation, Encryption and Compression.
Session Layer	→ Dialog control and Synchronization.
Transport Layer	→ Port Addressing, Segmentation and Reassembly, Connection Control, Flow control and Error Control
Network Layer	→ Logical Addressing and Routing.
Data Link Layer	→ Framing, Physical Addressing, Flow Control, Error Control, and Access Control.
Physical Layer	→ Physical characteristics of the media, Representation of bits, Data rate, Synchronization of bits, Line configuration, Physical topology and Transmission mode.

## WORKING OF THE OSI REFERENCE MODEL

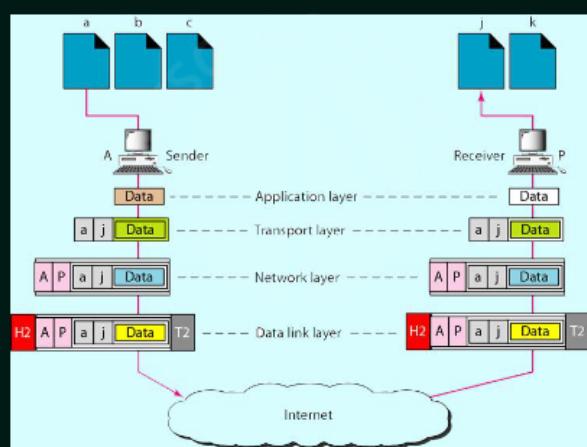
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## WORKING OF THE OSI REFERENCE MODEL



## OUTCOMES

Upon the completion of this session, the learner will be able to

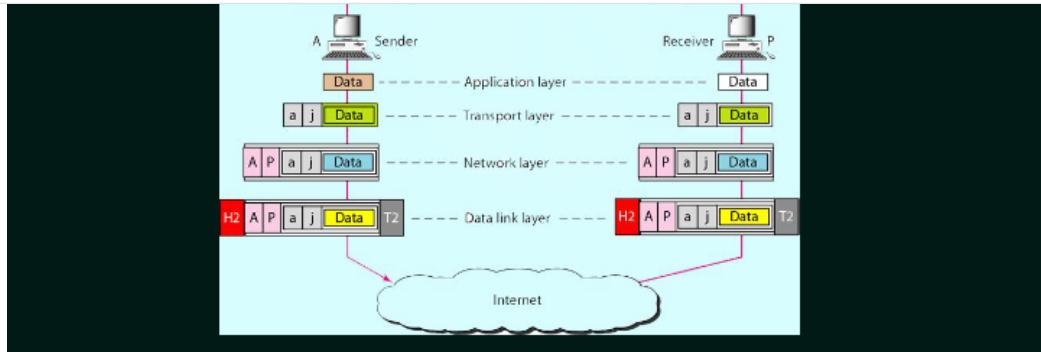
- ★ Understand the role of Port Addressing, IP Addressing and MAC Addressing in Computer Network with examples.

## PORT ADDRESSING AND IP ADDRESSING

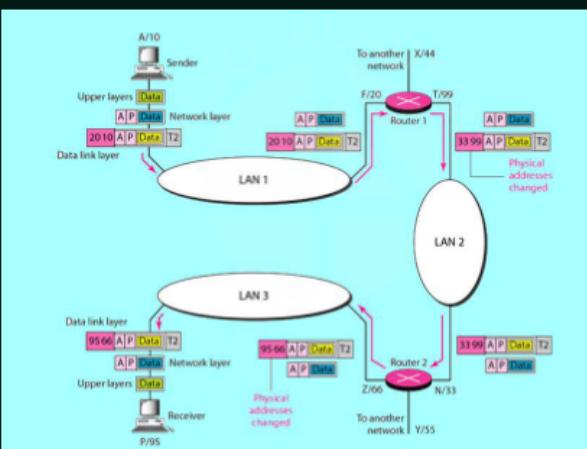
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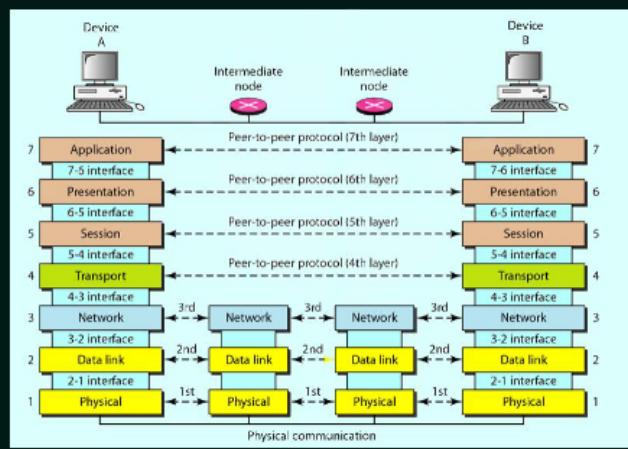
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## IP ADDRESSING AND MAC ADDRESSING



## IP ADDRESSING AND MAC ADDRESSING



**OUTCOMES**

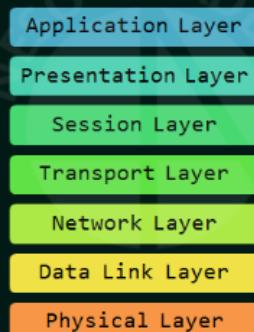
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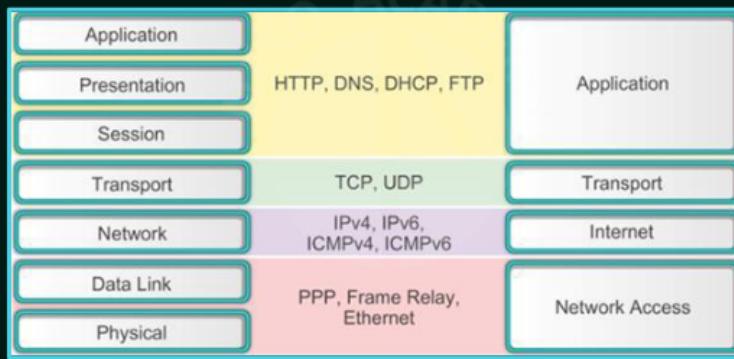
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- ★ Understand the TCP/IP Protocol suite.
- ★ Compare OSI and TCP/IP models.
- ★ Understand the list of protocols in the TCP/IP Protocol suite.
- ★ Know about Protocol Data Unit (PDU).

## THE OSI REFERENCE MODEL



## OSI REFERENCE MODEL Vs TCP/IP MODEL

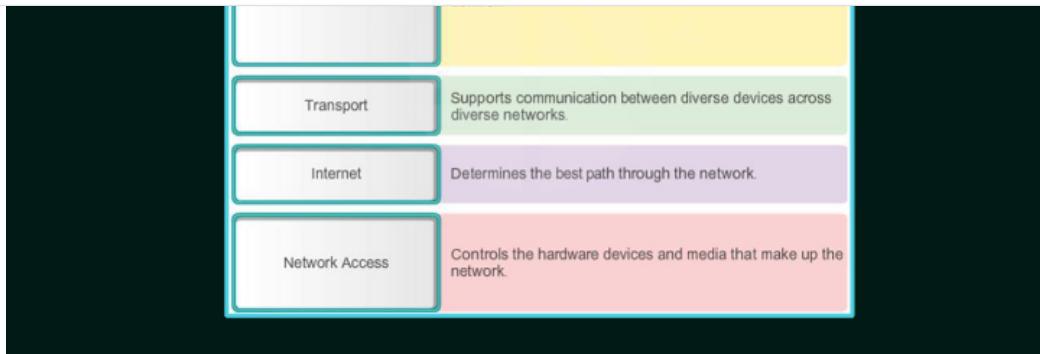


## THE TCP/IP MODEL

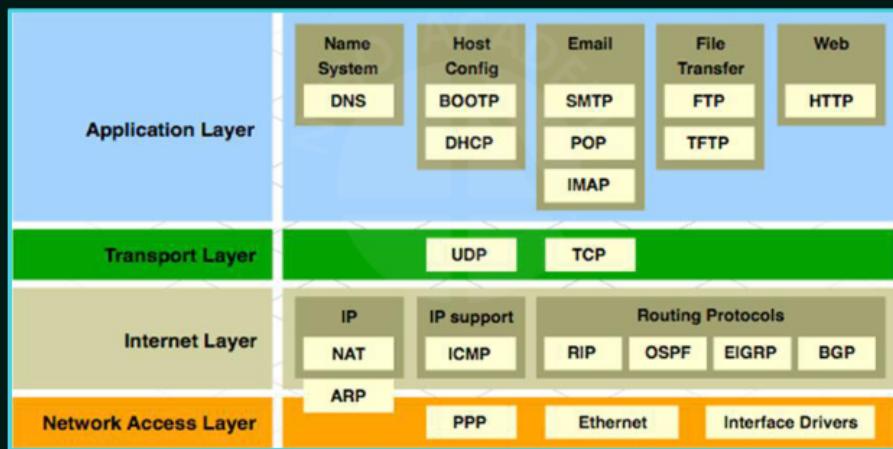
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## THE TCP/IP PROTOCOL SUITE



## PROTOCOL DATA UNIT (PDU)

Protocol Data Units (PDUs) are named according to the protocols of the TCP/IP suite: data, segment, packet, frame, and bits.

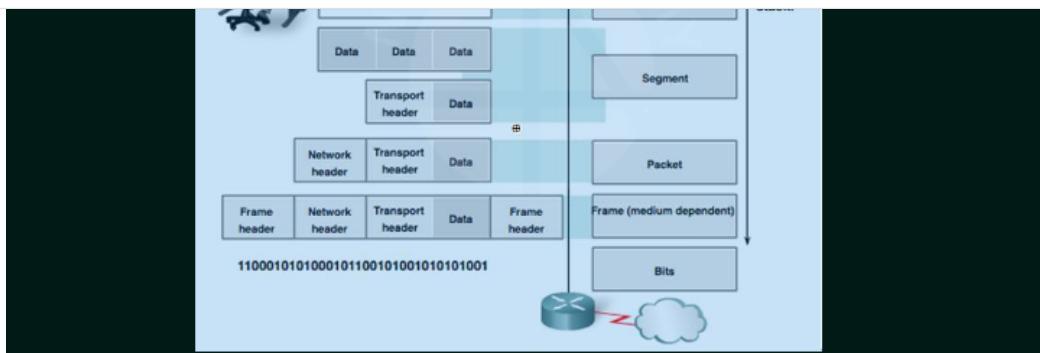
Application Layer – Data
Transport Layer – Segment
Network Layer – Packet
Data Link Layer – Frame
Physical Layer- Bits

## Protocol Data Unit (PDU)

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## ACTIVITY TIME

Identify the correct LAYER-PDU pair in the following.

Application - Data	Application - Data	Application - Data	Application - Data
Transport - Segment	Transport - Frame	Transport - Segment	Transport - Segment
Network - Frame	Network - Packet	Network - Frame	Network - Packet
Data Link - Packet	Data Link - Segment	Data Link - Packet	Data Link - Frame
Physical - Bit	Physical - Bit	Physical - Bit	Physical - Bit
<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Know the basic networking commands such as
  - IPCONFIG
  - IPCONFIG/ALL
  - NSLOOKUP
  - PING
  - TRACERT

## OUTCOMES

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- ★ Download and work with Cisco Packet Tracer (CPT).
- ★ Know the basics of Cisco Packet Tracer.
- ★ Establish an example peer-to-peer network using CPT.

## CISCO PACKET TRACER

- ★ Cisco – The leaders in networking.
- ★ An innovative and powerful networking simulation tool used for practice, discovery and troubleshooting.
- ★ Helps to understand networks practically.

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Know the basics of Cisco Packet Tracer.
- ★ Know about hub.
- ★ Simulate LAN using hub.
- ★ Understand the pros and cons of hub.

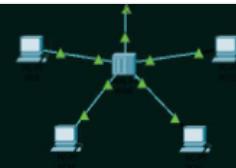
## Hub

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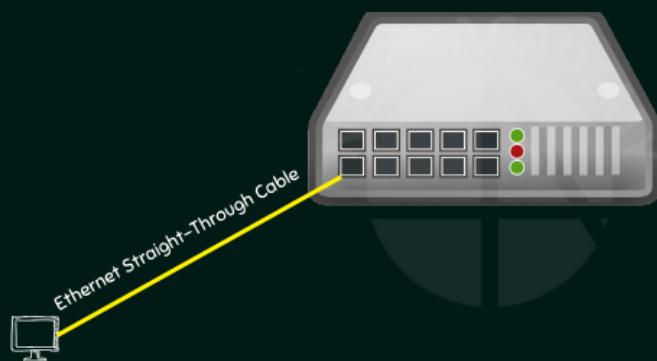
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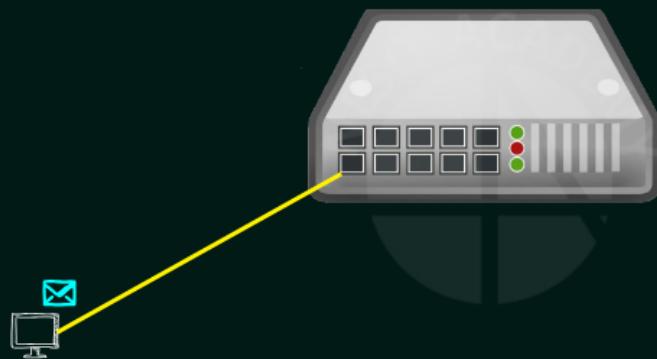
- ★ Hub works at the physical layer of the OSI model.
- ★ Used to set up LAN.
- ★ Has multiple ports.
- ★ Star topology.
- ★ When a packet arrives at one port, it is copied to the other ports so that all segments of the LAN can see all packets.



## WORKING OF HUB



## WORKING OF HUB

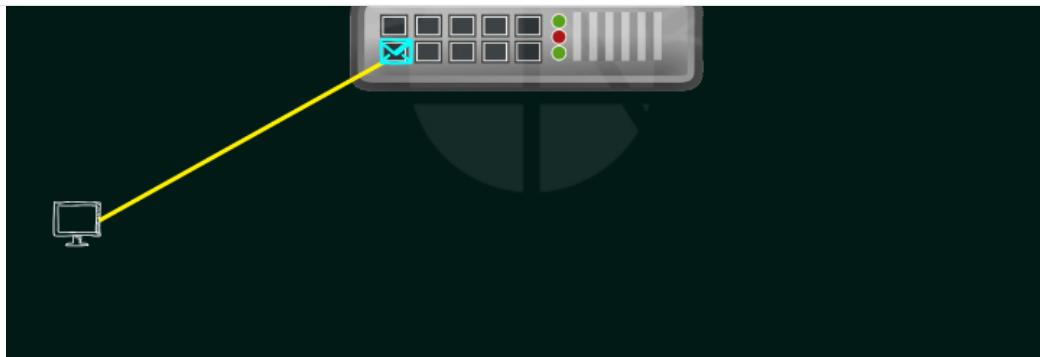


## WORKING OF HUB

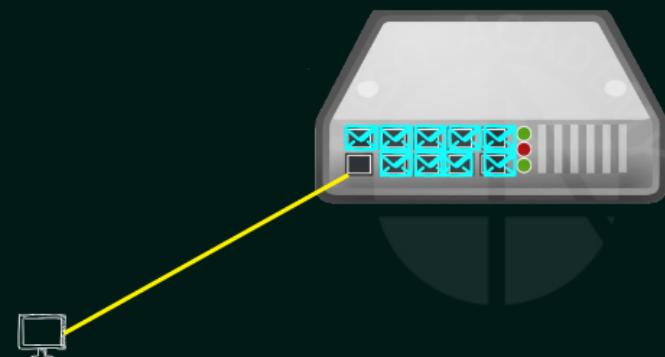
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## WORKING OF HUB



## HUB – PROS AND CONS

### PROS

- ★ Cheaper than switches.
- ★ Works good for smaller network.

### CONS

- ★ Issues with broadcast.
- ★ No memory.
- ★ Normally runs in half duplex mode.

**OUTCOMES**

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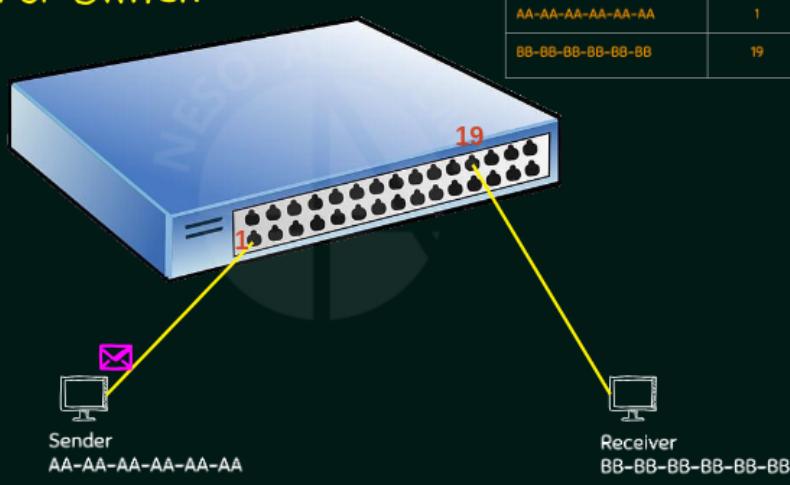
- ★ Learn the Cisco Packet Tracer using switch.
- ★ Simulate LAN using switch.
- ★ Understand the difference between hub and switch.

**SWITCH**

- ★ A switch is a networking hardware that connects devices on a computer network to establish a local area network.
- ★ Unlike hub, switch has memory.
- ★ Stores MAC ADDRESS TABLE.
- ★ Layer 2 Device for setting up LAN.

**WORKING OF SWITCH**

MAC ADDRESS	INTERFACE/ PORT
AA-AA-AA-AA-AA-AA	1
BB-BB-BB-BB-BB-BB	19



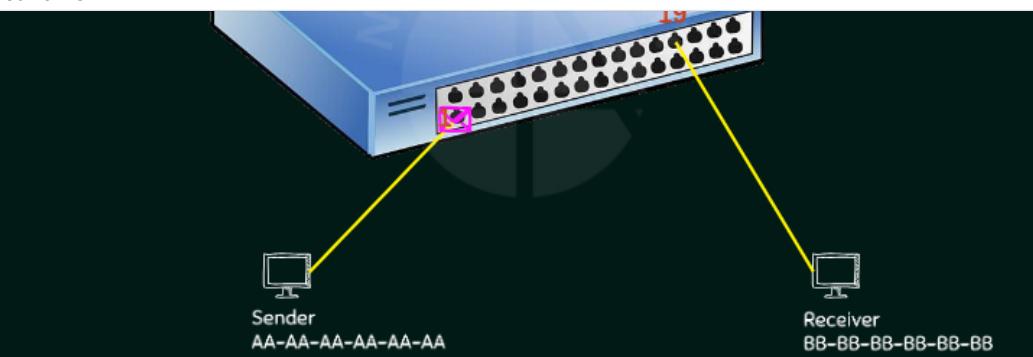
## WORKING OF SWITCH

MAC ADDRESS	INTERFACE/PORT
-------------	----------------

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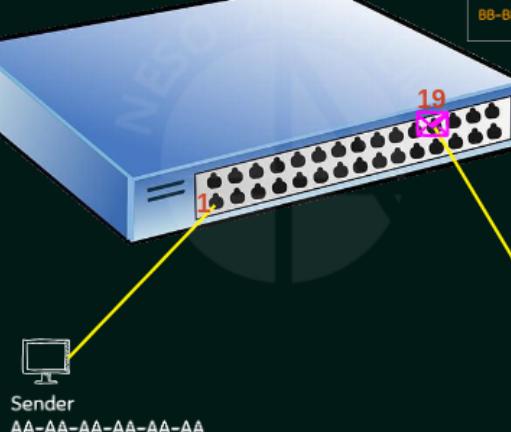
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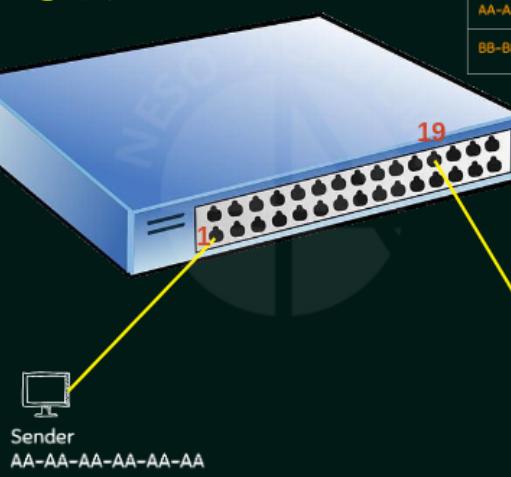
## WORKING OF SWITCH

MAC ADDRESS	INTERFACE/PORT
AA-AA-AA-AA-AA-AA	1
BB-BB-BB-BB-BB-BB	19



## WORKING OF SWITCH

MAC ADDRESS	INTERFACE/PORT
AA-AA-AA-AA-AA-AA	1
BB-BB-BB-BB-BB-BB	19



## HUB VERSUS SWITCH

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WORKS at Physical Layer.	WORKS at Data Link Layer.
Has no memory.	Has memory and stores MAC Address Table.
Not an intelligent device.	Intelligent device.
Floods the network due to broadcasting.	Can do unicasting, multicasting and broadcasting.
Security risks are high.	Security risks are low.
Less efficient.	More efficient.
Half Duplex.	Full Duplex.

## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Know the basics of routers.
- ★ Understand how to connect two different LAN using router theoretically.
- ★ Understand the difference between switch and router.

## ROUTER

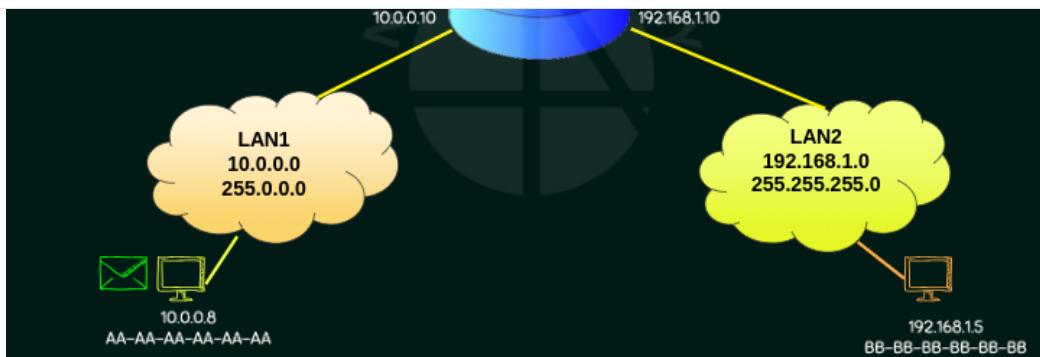
- ★ A router is a networking device that forwards data packets between computer networks.
- ★ A router is connected to at least two networks, commonly two LANs or WANs or a LAN and its ISP's network.
- ★ It is a layer 3 (Network layer) device.
- ★ Stores routing table.

## WORKING OF ROUTER

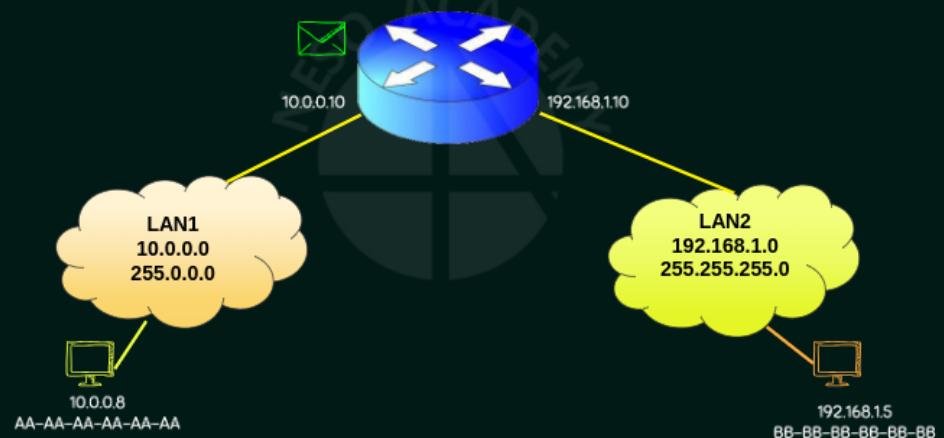
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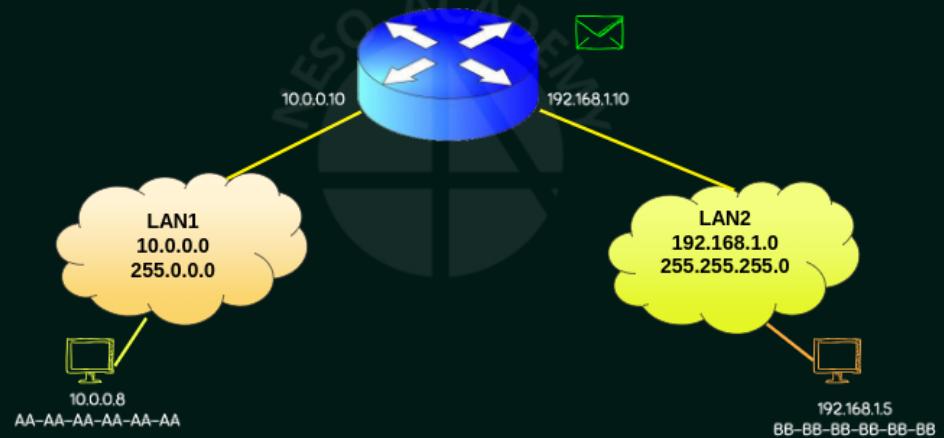
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## WORKING OF ROUTER



## WORKING OF ROUTER

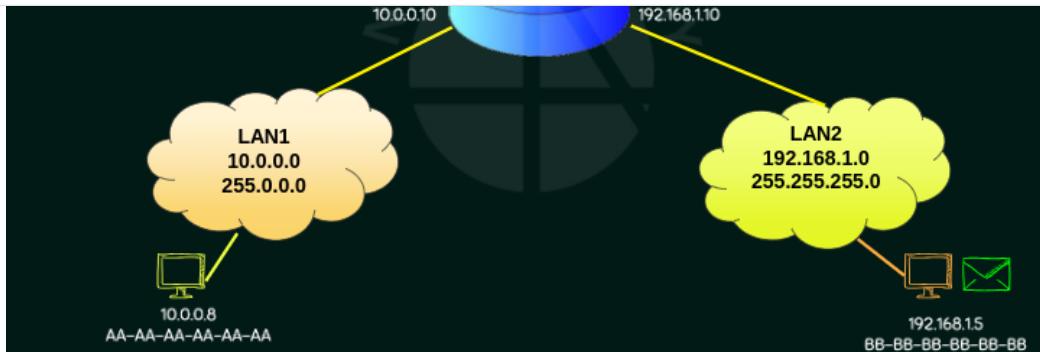


## WORKING OF ROUTER

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## SWITCH VERSUS ROUTER

Switch	Router
A network switch is a computer networking device that is used to connect many devices together on a computer network.	A router is a networking device that connects a local network to other local networks.
Operates at Data Link Layer. (Layer 2 Device)	Operates at network layer. (Layer 3 Device)
Has memory and stores MAC Address Table.	Has memory and stores Routing table.
Decisions are taken based on MAC address.	Decisions are taken based on IP address.
Half/Full Duplex.	Full Duplex.
LAN.	LAN, MAN, and WAN.

## ROUTER – A RECAP

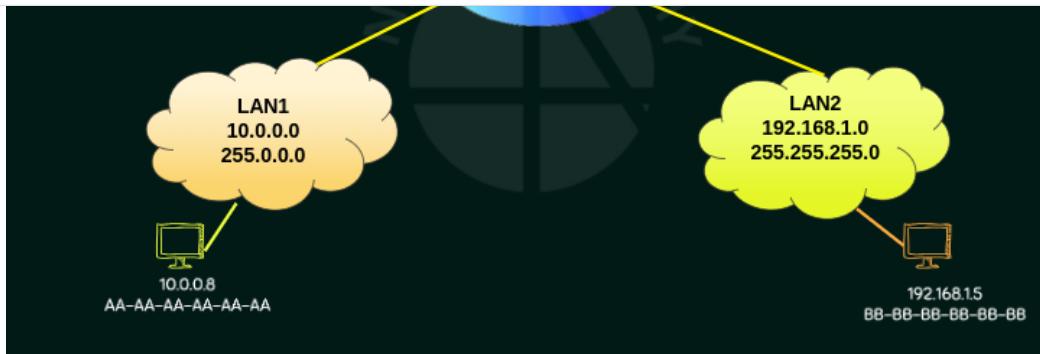
- ★ Connects two or more different LANs.
- ★ It is a layer 3 (Network layer) device.
- ★ Stores routing table.
- ★ Router – Inevitable device in the internet.

## WORKING OF ROUTER

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## OUTCOME

Upon the completion of this session, the learner will be able to

- ★ Understand the basics of repeater.
- ★ Know the working of repeater using CPT.

## REPEATER

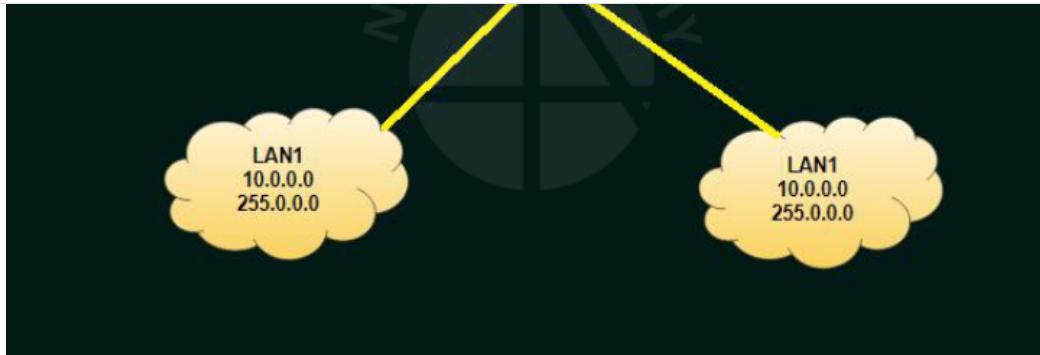
- ★ The data signals generally become too weak or corrupted if they tend travel a long distance.
- ★ Repeater regenerates the signal over the same network.
- ★ It operates at the physical layer.
- ★ They do not amplify the signal.
- ★ It is a 2 port device.

## WORKING OF REPEATER

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## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the basics of bridge.
- ★ Know the types of bridge.
- ★ Understand the working of bridge.
- ★ Understand the difference between router and bridge.

## BRIDGE

- ★ Bridge = Repeater + Functionality of reading MAC address.
- ★ It is a layer 2 device.
- ★ It is also used for interconnecting two LANs on the same protocol.
- ★ It is also a two port device.

## TYPES OF BRIDGES

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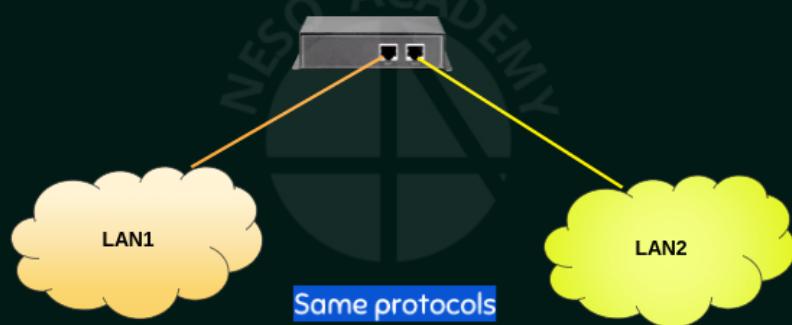
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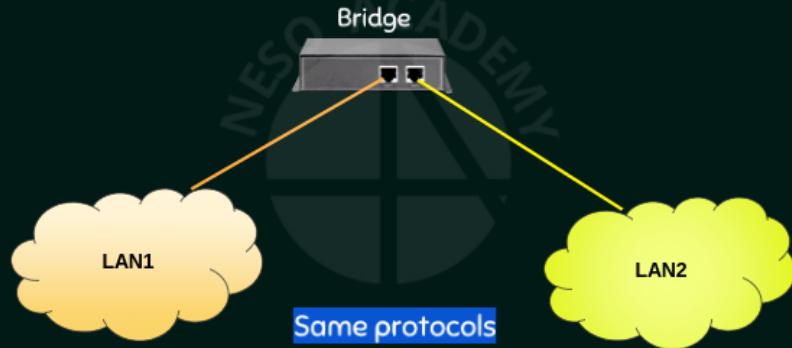
unaware of the bridge's existence.

- ★ Reconfiguration of the stations is unnecessary even if bridge is added or removed from network.
- ★ **Source Routing Bridges.**
  - ★ In these bridges, routing operation is performed by source station and the frame specifies which route to follow.

## WORKING OF BRIDGE



## ROUTER VERSUS BRIDGE

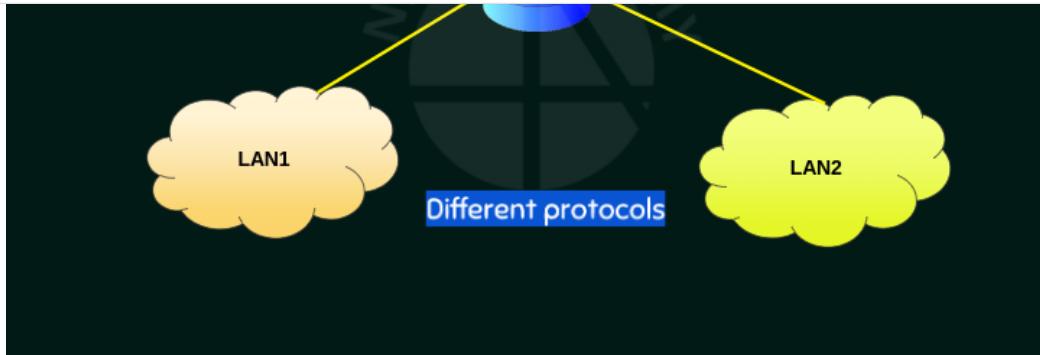


## ROUTER VERSUS BRIDGE

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## OUTCOMES

Upon the completion of this session, the learner will be able to

- ★ Understand the basics of bridge.
- ★ Know the types of bridge.
- ★ Understand the working of bridge.
- ★ Understand the difference between router and bridge.

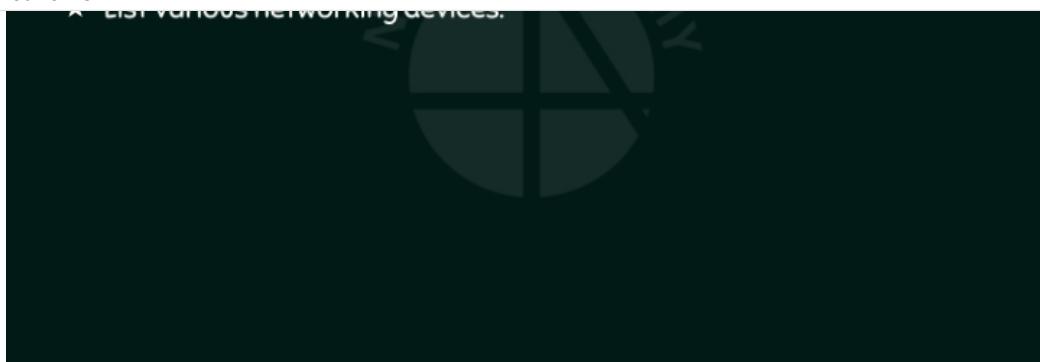
THANK YOU!

**OUTCOME**

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**LIST OF VARIOUS NETWORK DEVICES**

- ★ Repeater
- ★ Hub
- ★ Switch
- ★ Bridge
- ★ Router
- ★ Multi-layer switch (Layer 3 Switch)
- ★ Brouter
- ★ Modem
- ★ Firewall (Security Device)

**QUESTION 1**

Which of the following devices is a component of PC that connects PC to the networking device?

- a. Bridge
- b. Hub
- c. NIC card
- d. Gateway

**QUESTION 2**

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- a. Bridge
- b. Hub
- c. Switch
- d. Modem 

**QUESTION 3**

Which of the following devices take data sent from one network device and broadcasts the same to all the devices regardless of the intended recipient?

- a. Bridge
- b. Hub 
- c. Switch
- d. Modem

**QUESTION 4**

In a network where security is a primary concern, which of the devices can be recommended : Switch or Hub?

Answer

Switch 

**QUESTION 5**

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- Will you recommend to use network?
- a. Switch
  - b. Hub
  - c. Either a or b
  - d. Neither a nor b

**QUESTION 6**

Which of the following network device that connects two lan segments of same protocol?

- a. Hub
- b. Bridge
- c. Repeater
- d. Switch

**QUESTION 7**

Which of the following network devices that can connect any two or more different networks that has two or more different protocols?

- a. Bridge
- b. Router
- c. Repeater
- d. Switch

**QUESTION 8**

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- a. Hub
- b. Bridge
- c. Repeater
- d. Switch

**QUESTION 9**

Which of the following network devices has the functionality of a bridge and router?

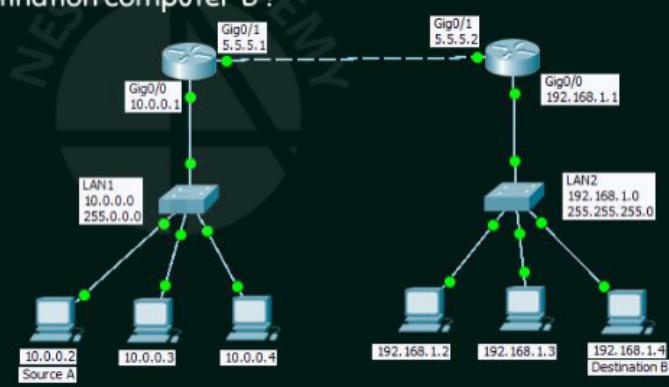
- a. Hub
- b. Bridge
- c. Repeater
- d. Brouter

**QUESTION 10**

In the given network scenario, how many different destination MAC addresses can be noted in the frame in its journey from the source 'A' to the destination computer 'B'?

**Answer**

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