



NETWORK AND TELECOMMUNICATION





ACADEMIC BACKGROUNDS:

- 1987-1993 Georgia University of Technology (Former USSR) **Specialize: Radio Transmitting Device of Satellite Telecommunication Systems** (Master of Science).
- 1997-1998 Advanced course at the Saint-Petersburg State University of Technology in computer simulation of ground stations Modem for Sputnic communication (Russia).

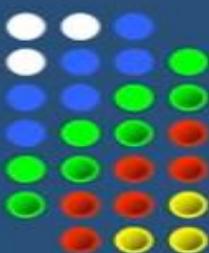
PREVIOUS EMPLOYMENT:

- 2002-2018 The World Bank Cambodia (IT Analyst, Client Services).
- 1999 -2001 Worked as Systems Engineer at VIRTU International Limited.
- 1995 -1997 Worked as assistant manager in operation and technical department at CAMINTEL.
- 1993 – 1995 Worked as engineer in Operations and Technical Department in HUB-station (ex-UNTAC Networks) at Ministry of Post and Telecommunications of Cambodia.

Teaching Experiences:

- 2000 Royal Academy of Cambodia (MSc.IT).
- 2002 Build Bright University (MSc.IT).
- 2019 National Polytechnic Institute of Cambodia (BSc.Telcom).
- 2020 Norton University (BSc.IT)
- 2023 Cambodia Academy of Digital Technology (BSc.Telcom).

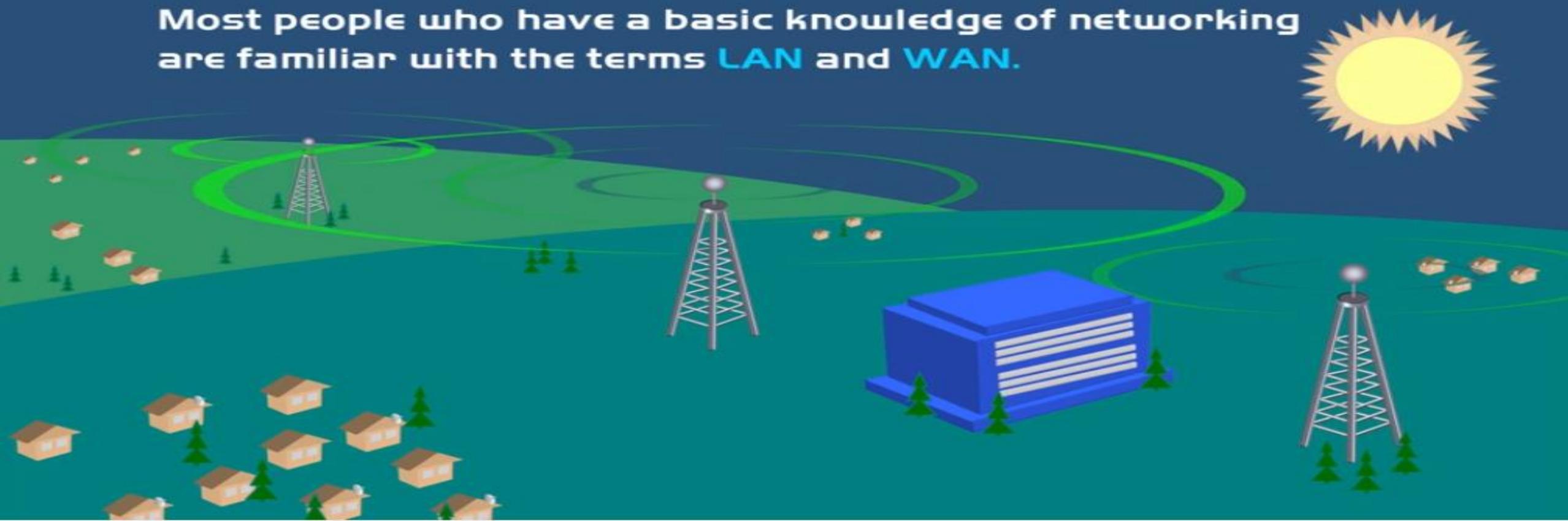




Network TYPES

Network types depend on how large they are and how much of an area they cover geographically.

Most people who have a basic knowledge of networking are familiar with the terms **LAN and **WAN**.**





PAN PERSONAL AREA NETWORK

Network that is used on a personal level.



PANs use wireless technologies such as:

Bluetooth Infrared NFC

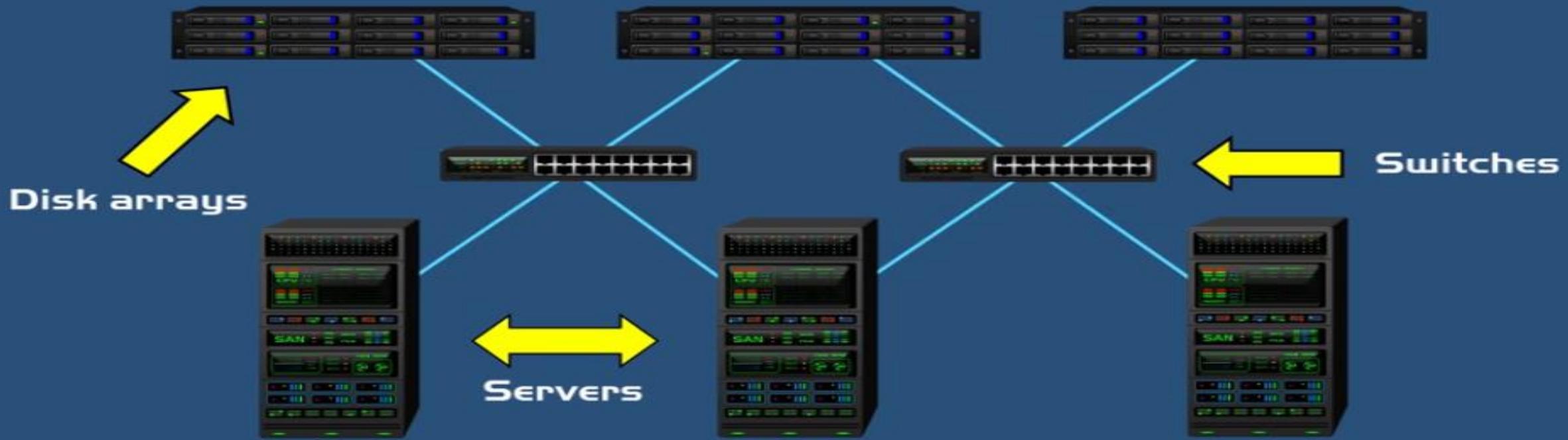
Can also connect by using a USB cable.





SAN

STORAGE AREA NETWORK



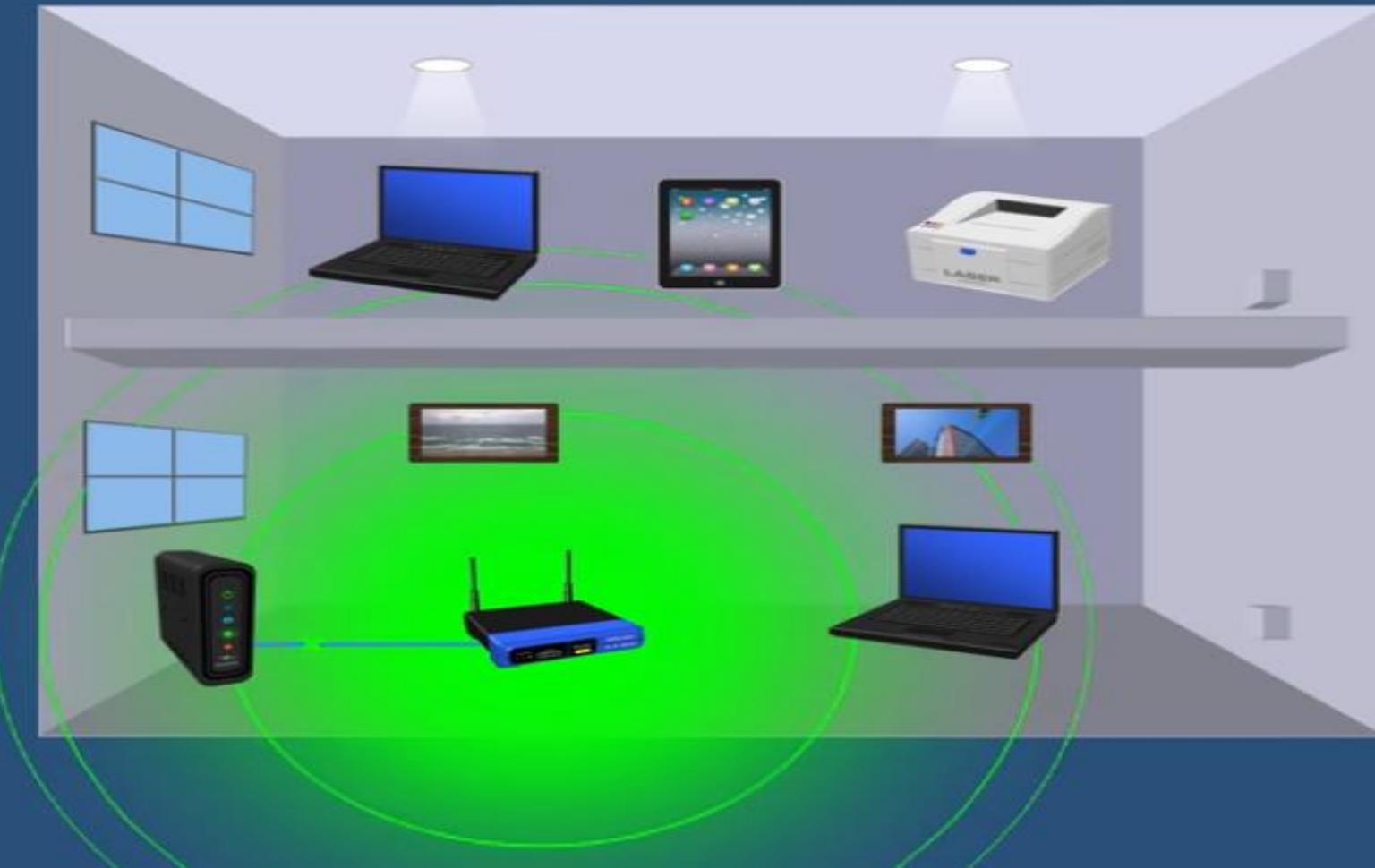
A special high-speed network that stores and provides access to large amounts of data.





WLAN

WIRELESS LOCAL AREA NETWORK



Uses wireless communication instead of wired communication.

A WLAN is a LAN but without using cables.

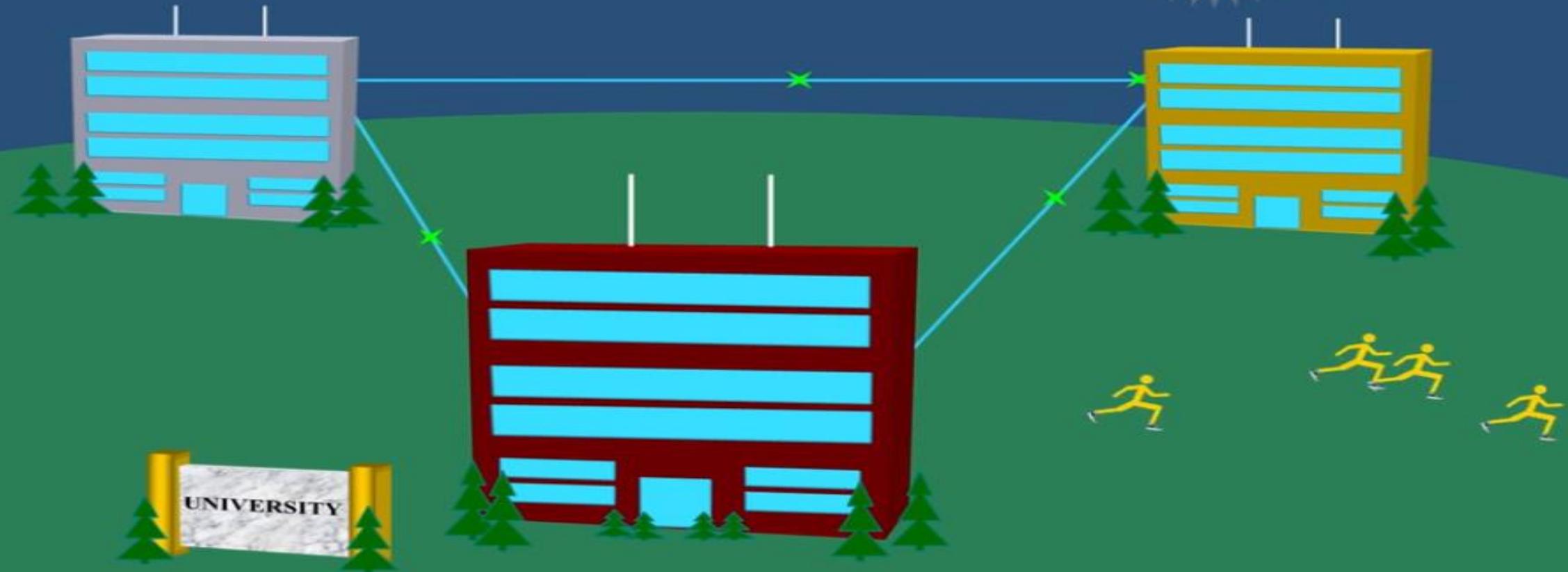


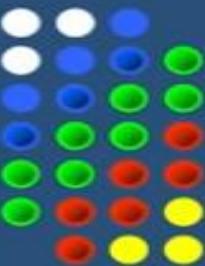


CAN

CAMPUS AREA NETWORK

A network that joins 2 or more LANs together within a limited area.





LAN

LOCAL AREA NETWORK

**A group of devices
(computers, servers,
switches, & printers)
that are located in
the same building.**

**In close proximity to
each other.**

**The most common
type of LAN is an
Ethernet LAN.**

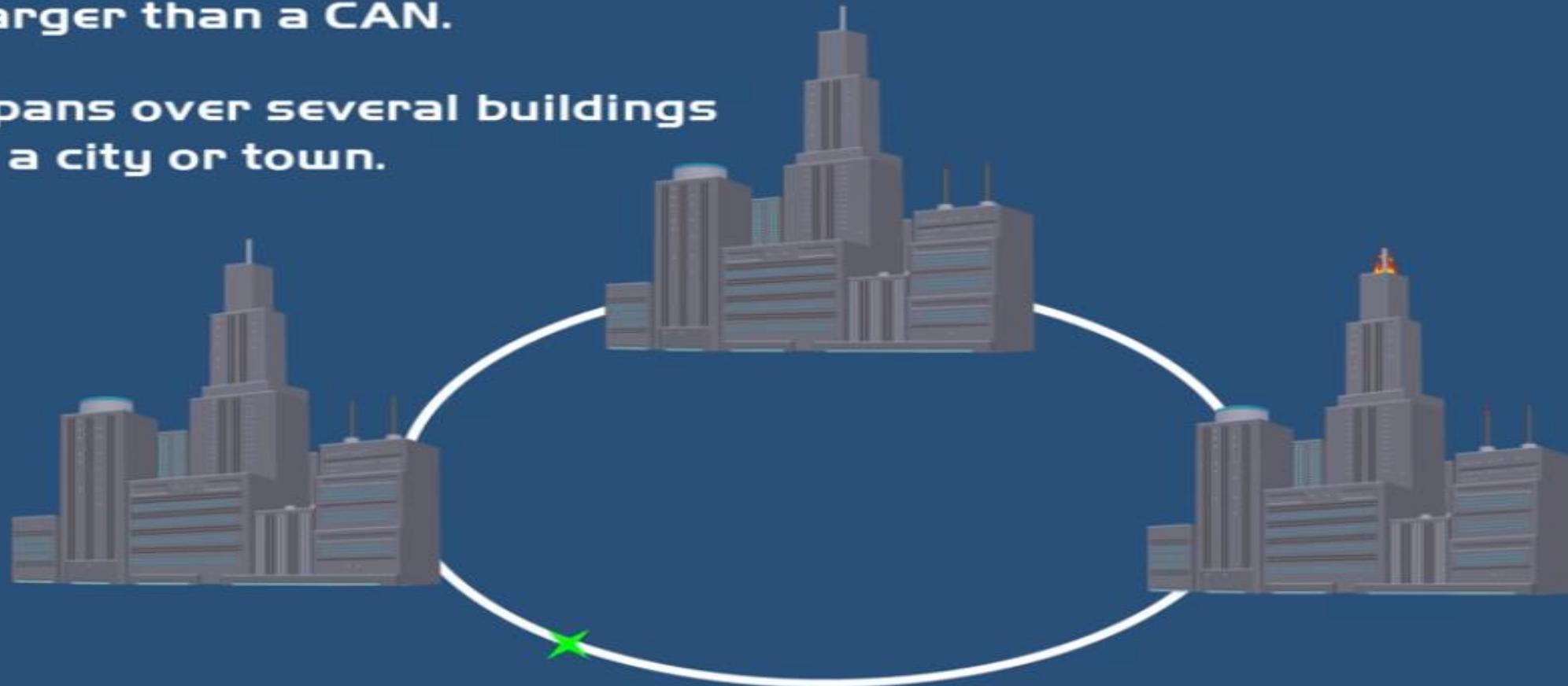




MAN METROPOLITAN AREA NETWORK

Larger than a CAN.

Spans over several buildings
in a city or town.





WAN WIDE AREA NETWORK

Largest type of network.

Spans over a large geographical area.

The **Internet** is an example of a **WAN**.

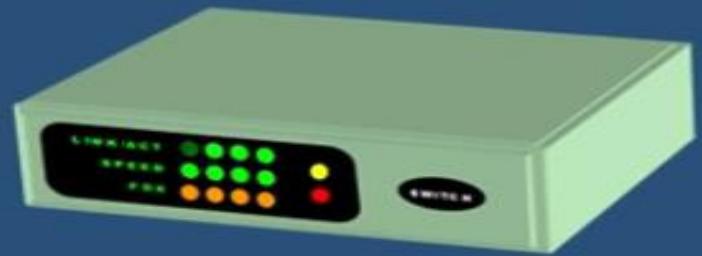




Hub, Switch, & Router



HUB



SWITCH



ROUTER



HUB

HUB IS A SIMPLE AND CHEAP NETWORKING BROADCAST DEVICE WORKS UNDER PHYSICAL LAYER OF OSI MODEL THAT CONNECTS BUNCH OF COMPUTERS TOGETHER IN A NETWORK. BUT, IT DOES LOTS OF WASTAGE OF BANDWIDTH.



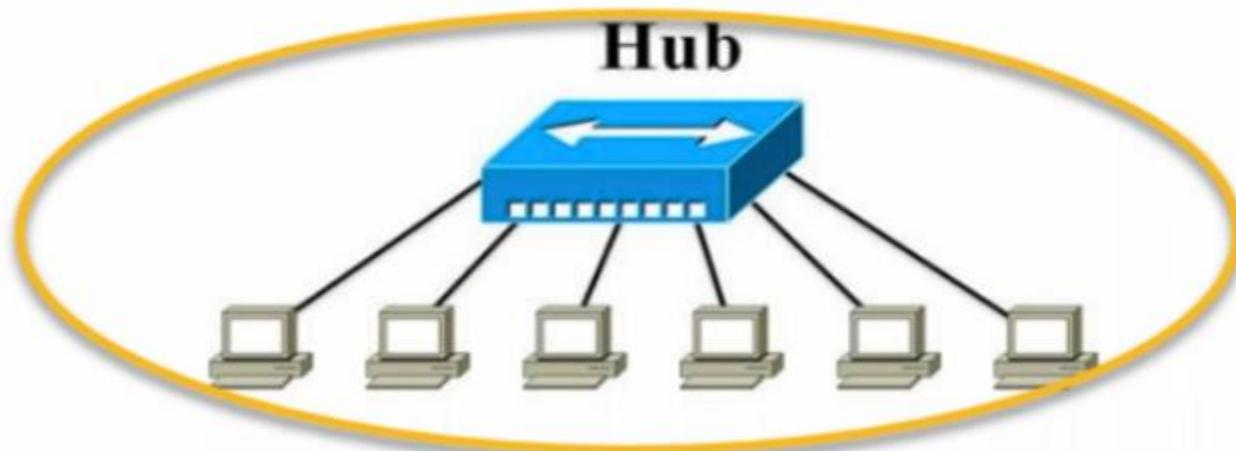
01

Hub

Physical



OSI model



One collision domain
one broadcast domain
All nodes share the bandwidth of
the network



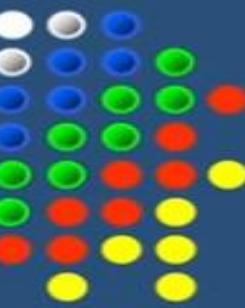


Hub



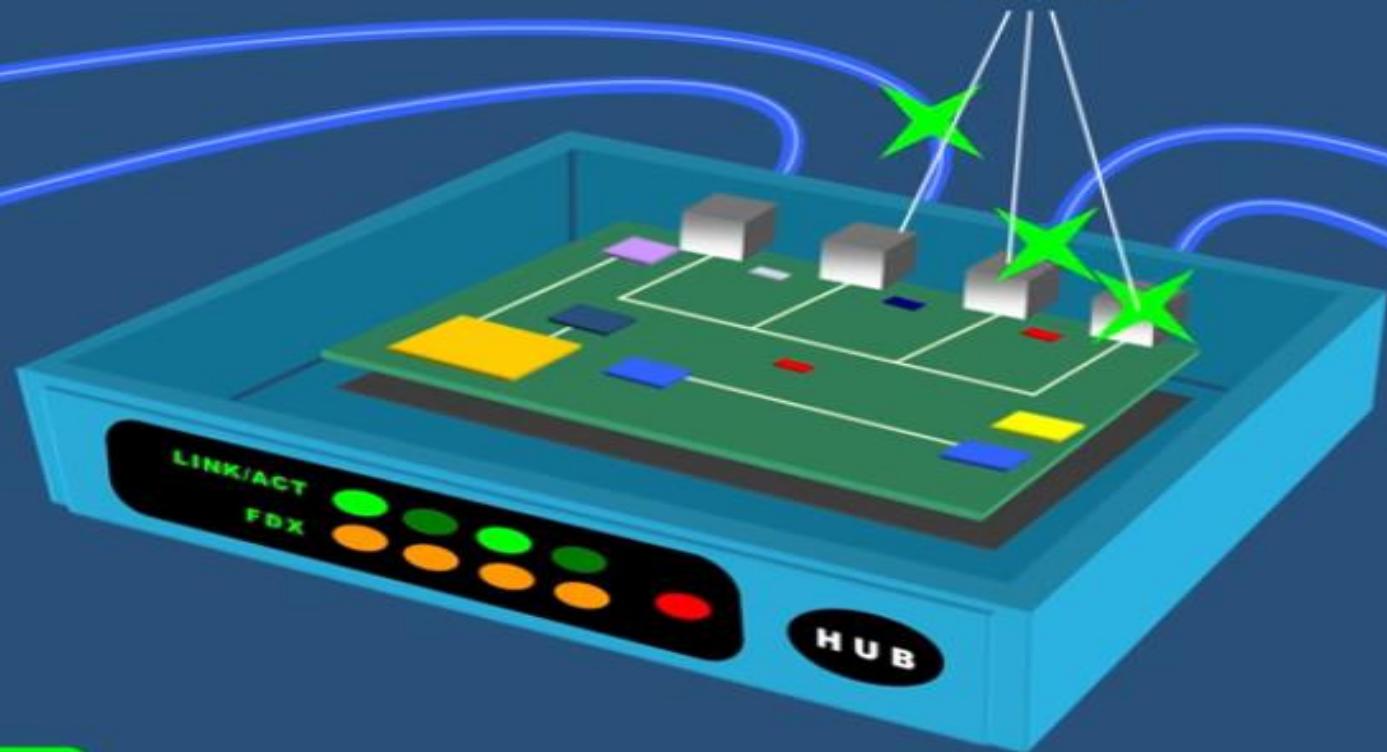
HUB TABLE	
PORT	DEVICE
1	DETECTED
2	DETECTED
3	DETECTED
4	DETECTED





Hub

DATA IS COPIED TO ALL OTHER PORTS

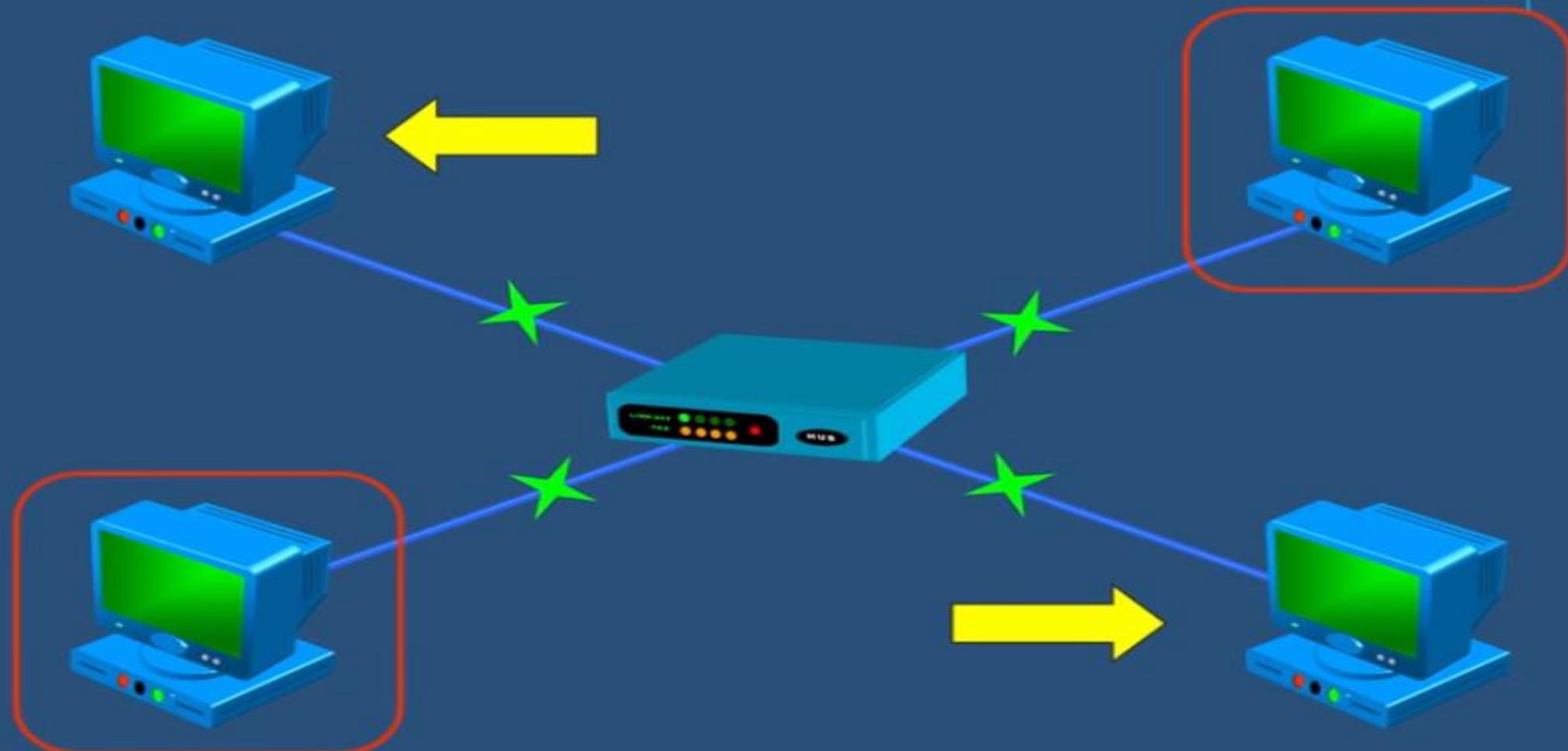


HUB TABLE	
PORT	DEVICE
1	DETECTED
2	DETECTED
3	DETECTED
4	DETECTED





Hub



SWITCH

SWITCH IS A MULTICAST NETWORKING DEVICE WORKS UNDER DATALINK LAYER OF OSI MODEL THAT CONNECTS BUNCH OF COMPUTERS OR DEVICES IN A NETWORK.



WHAT IS BRIDGE

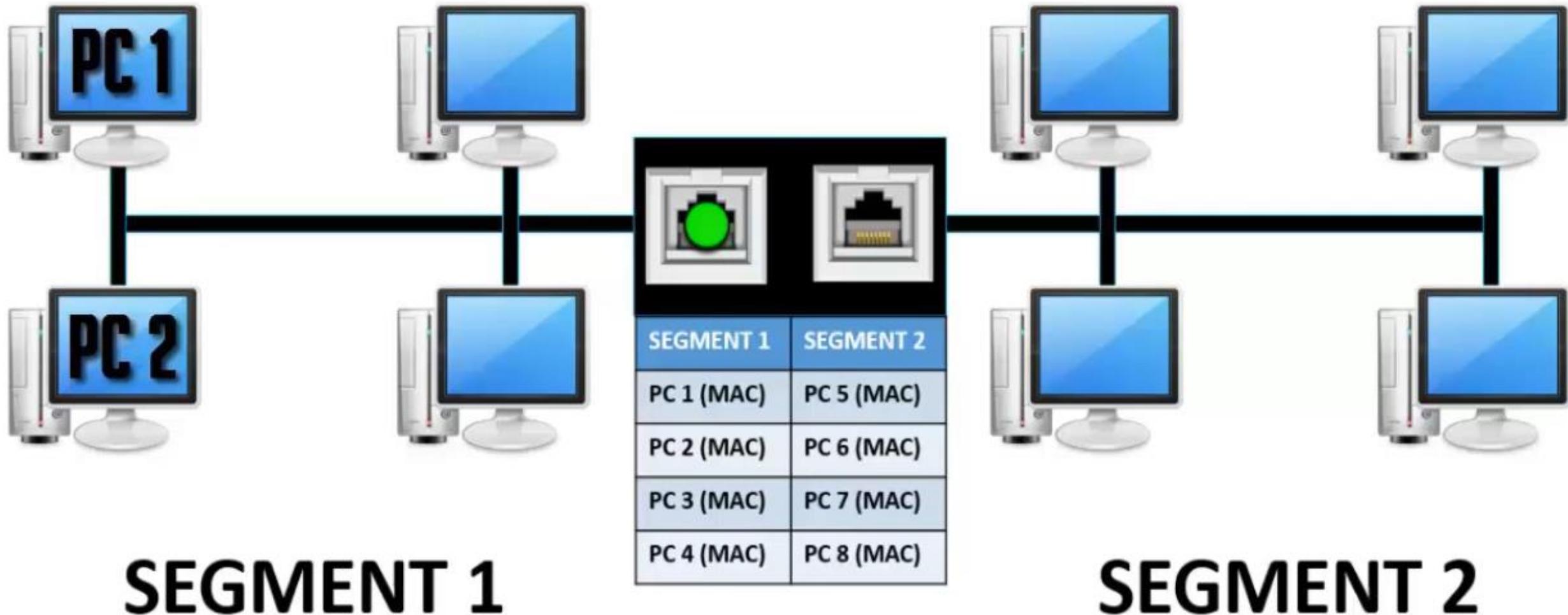
BRIDGE IS A NETWORKING DEVICE WHICH IS USE TO DIVIDE A LAN INTO MULTIPLE SEGMENT.

BRIDGE WORKS UNDER DATA LINK LAYER OF OSI MODEL

BRIDGE STORES THE MAC ADDRESS OF PC AVAILABLE IN A NETWORK.

BRIDGE IS USE TO REDUCE THE TRAFFIC.



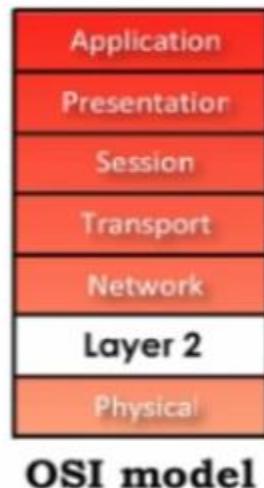


SEGMENT 1

SEGMENT 2



Data Link



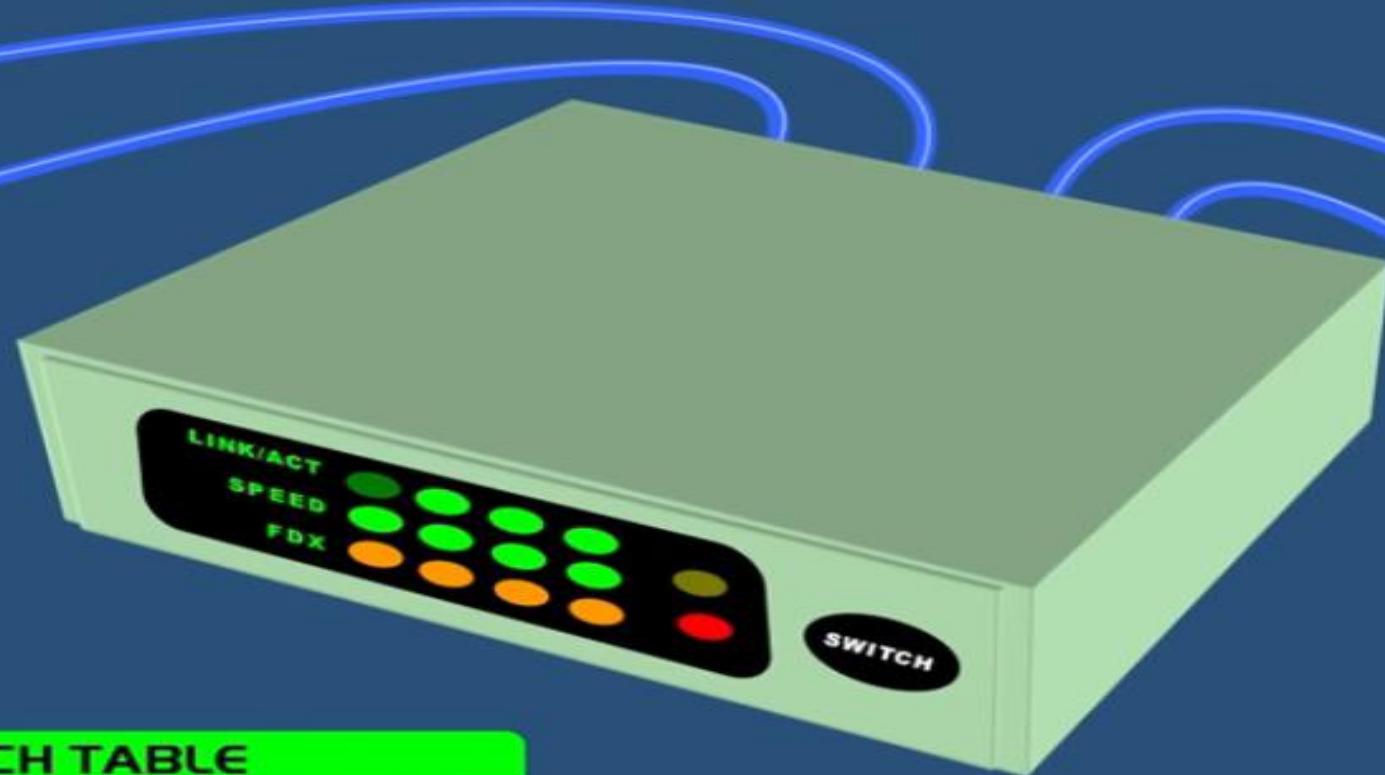
A layer 2 device

- 1) separates collision domains
- 2) creates a broadcast domain
- 3) gives every conversation the full bandwidth of the network





Switch



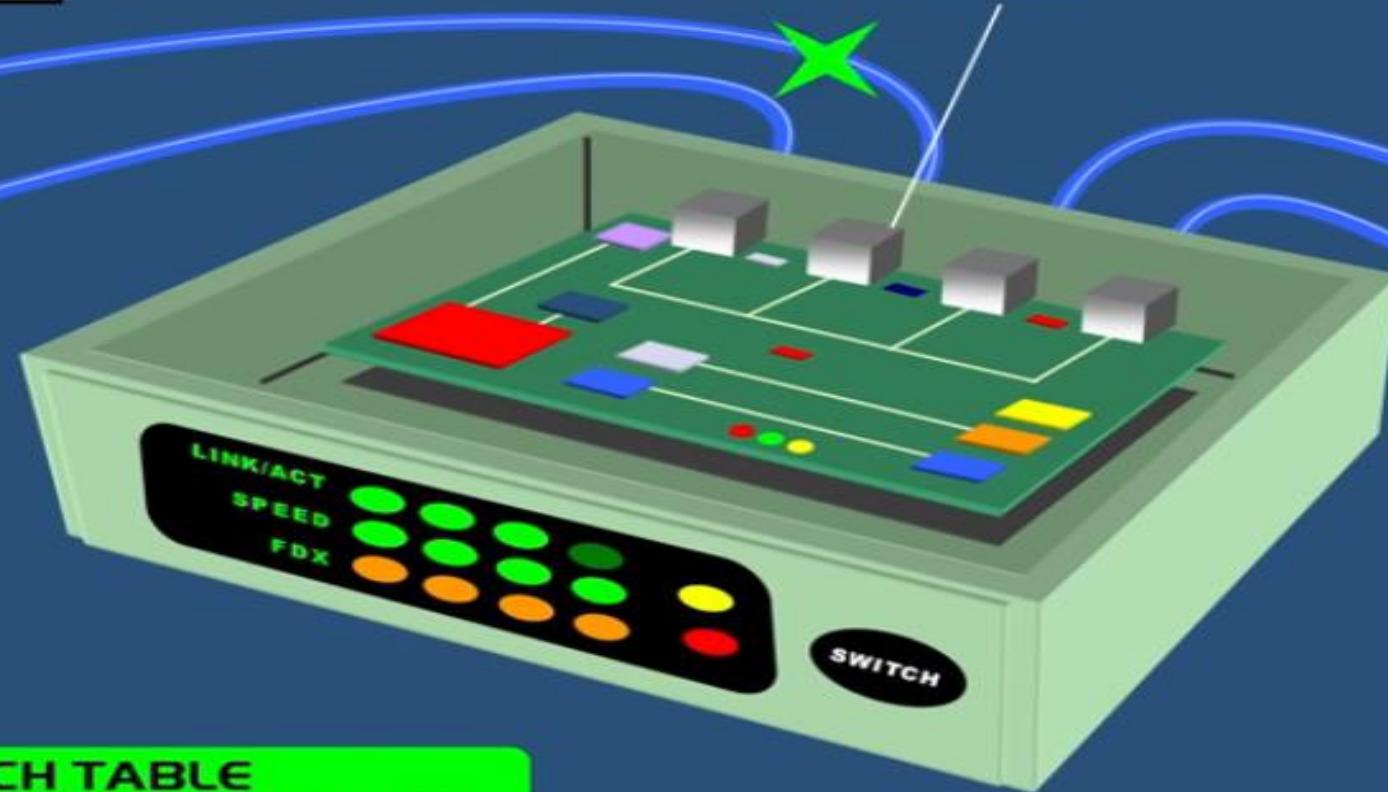
SWITCH TABLE		
PORT	DEVICE	MAC ADDRESS
1	DETECTED	00-04-5A-63-A1-66
2	DETECTED	90-02-7B-C2-C0-67
3	DETECTED	32-07-9A-92-A2-00
4	DETECTED	72-00-FA-63-A9-66





Switch

DATA DIRECTED ONLY TO INTENDED PORT

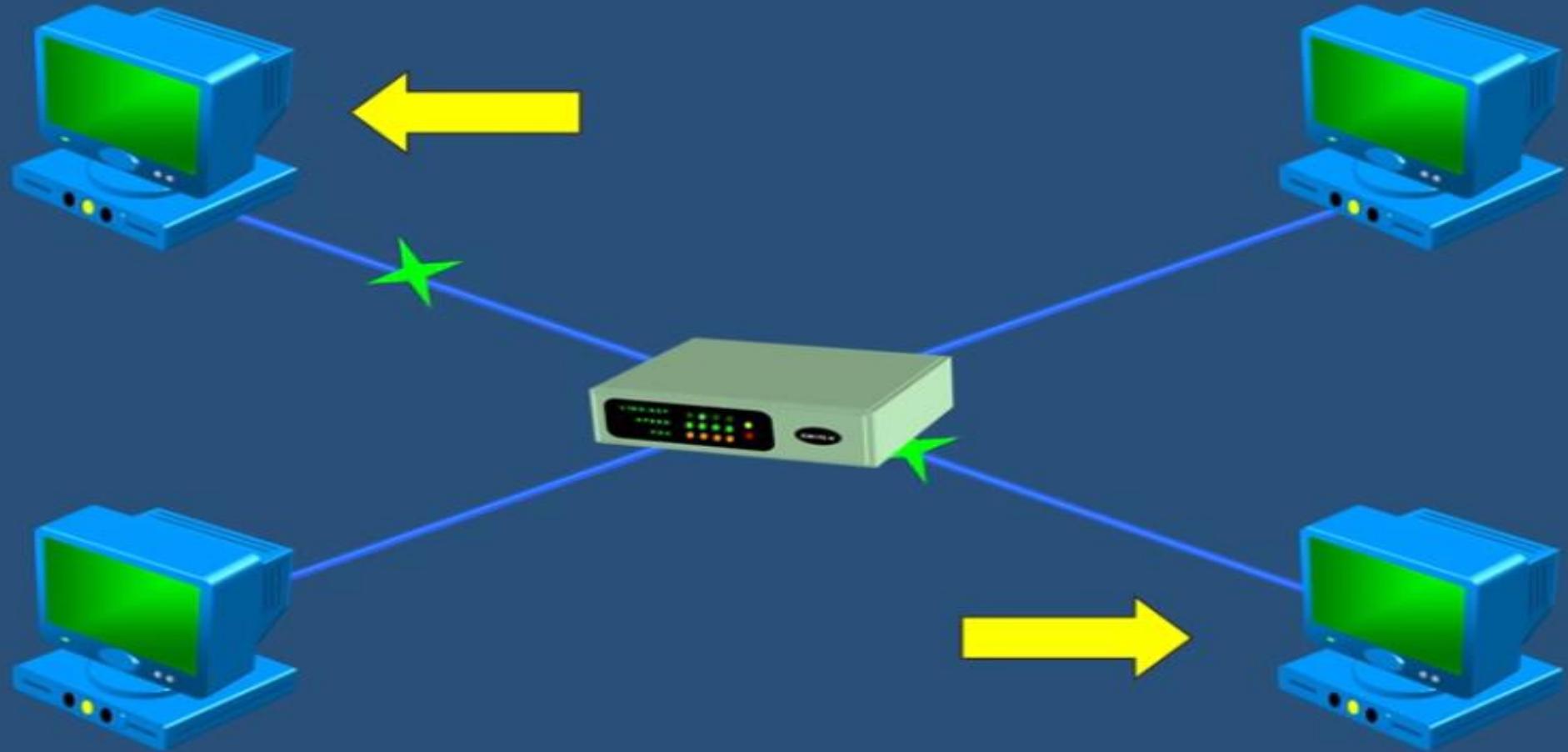


SWITCH TABLE		
PORT	DEVICE	MAC ADDRESS
1	DETECTED	00-04-5A-63-A1-66
2	DETECTED	90-02-7B-C2-C0-67
3	DETECTED	32-07-9A-92-A2-00
4	DETECTED	72-00-FA-63-A9-66





Switch



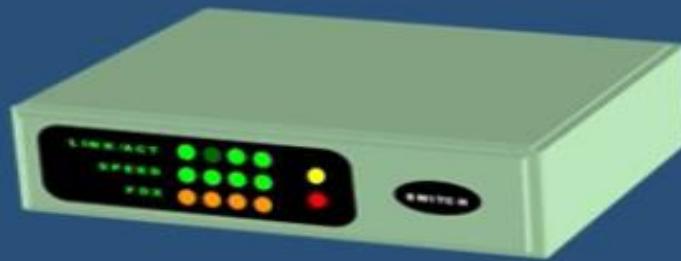


Hub, Switch, & Router



HUB

Only detects that a device is physically connected to it.



SWITCH

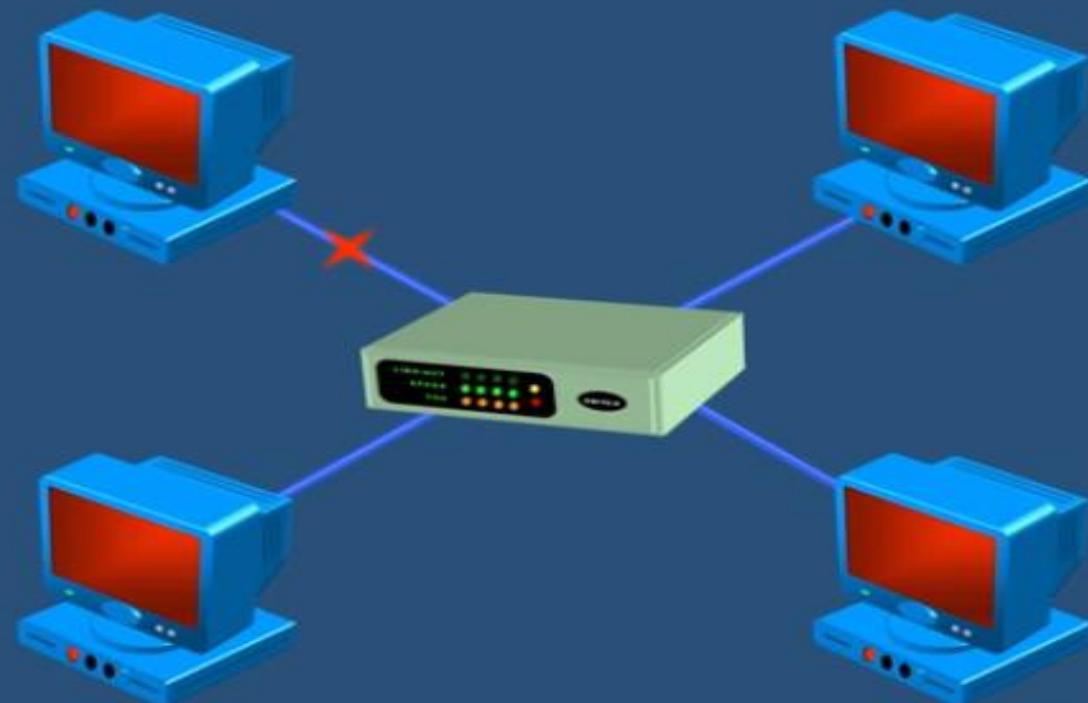
Can detect specific devices that are connected to it.

Keeps a record of the MAC addresses of those devices.





Hub, Switch, & Router



Hubs and **Switches** are used to exchange data within a local area network.

Not used to exchange data outside their own network.

To exchange data outside their own network, a device needs to be able to read I.P. addresses.



SWITCH

NOW THE QUESTION IS HOW SWITCH IS DIFFER FROM HUB ?

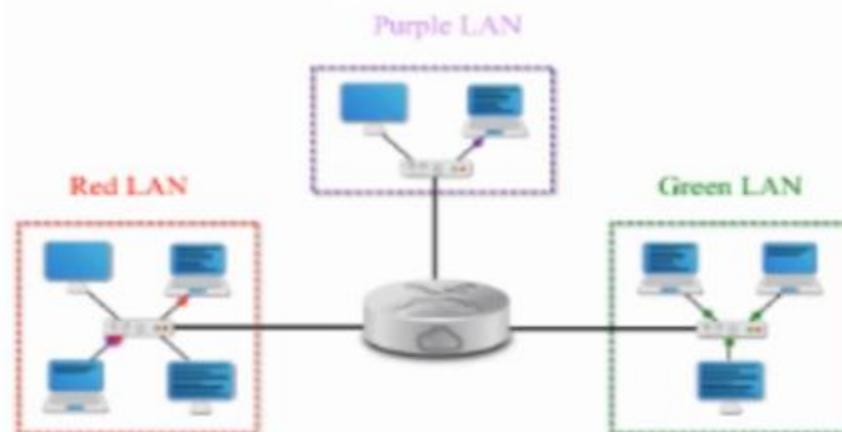
**HUB IS A BROADCAST DEVICE WHICH SENDS DATA FROM ONE PC
TO ALL BUT SWITCH IS A MULTICAST DEVICE WHICH CAN SEND
DATA TO A PARTICULAR PC YOU WANT.**



ROUTER

ROUTER IS A NETWORKING DEVICE WORKS UNDER NETWORK LAYER OF OSI MODEL AND USE TO CONNECT TWO OR MORE DIFFERENT NETWORKS.





OSI model

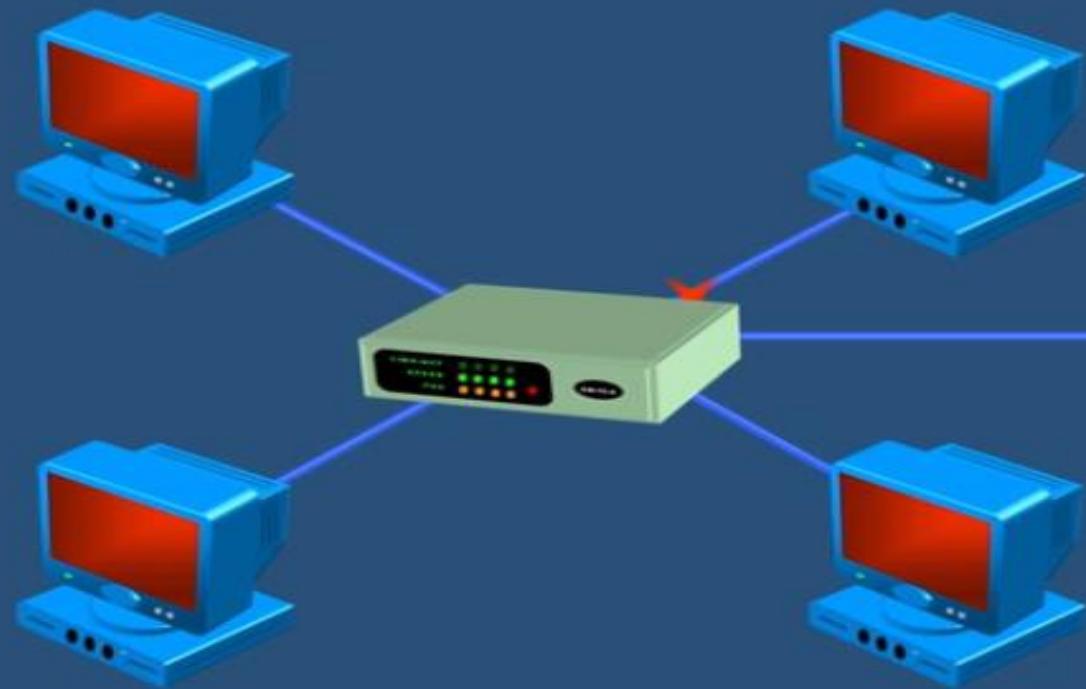
A layer 3 (network) device

- 1) separates collision domains
- 2) separates broadcast domains
- 3) forward IP packets across different networks
- 4) No routers, no Internet





Router



The router is the gateway of a network.

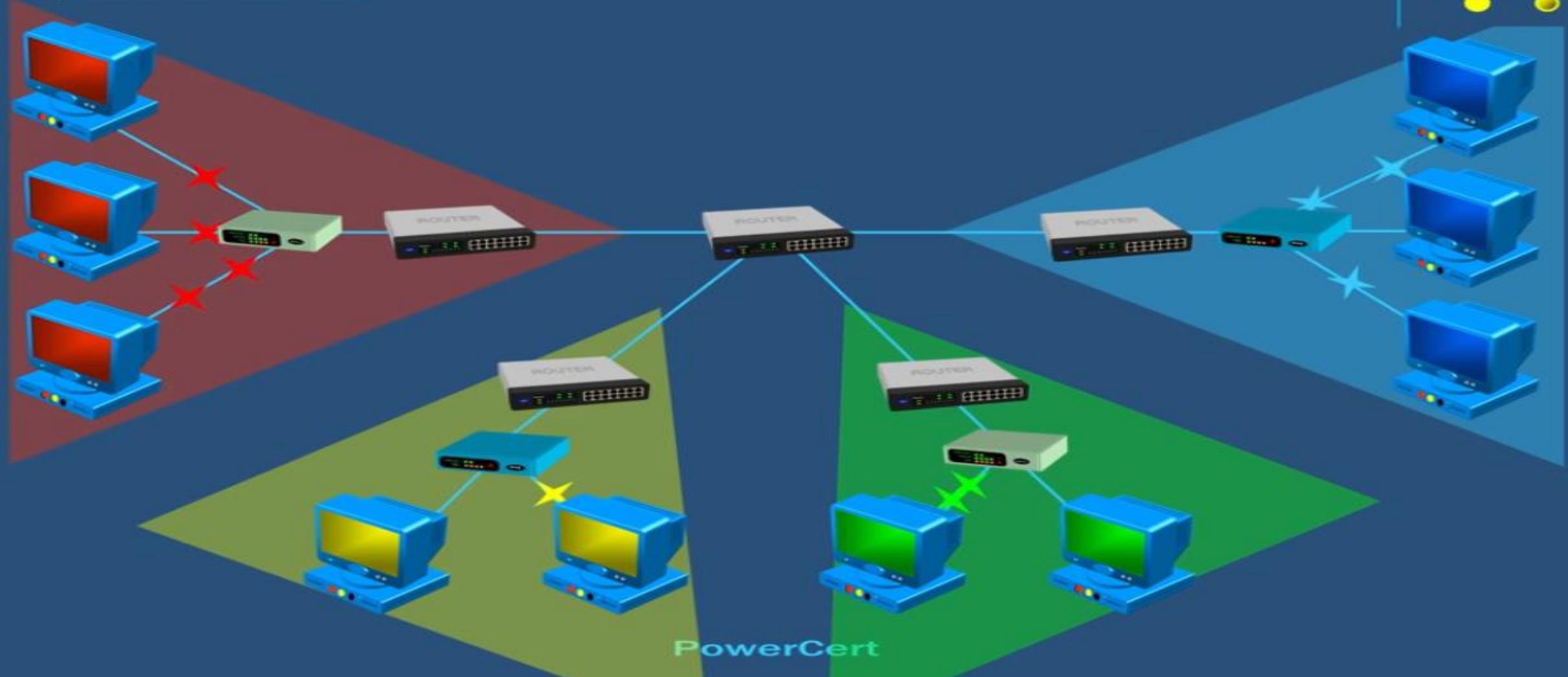


Routes data from one network to another based on their IP address.



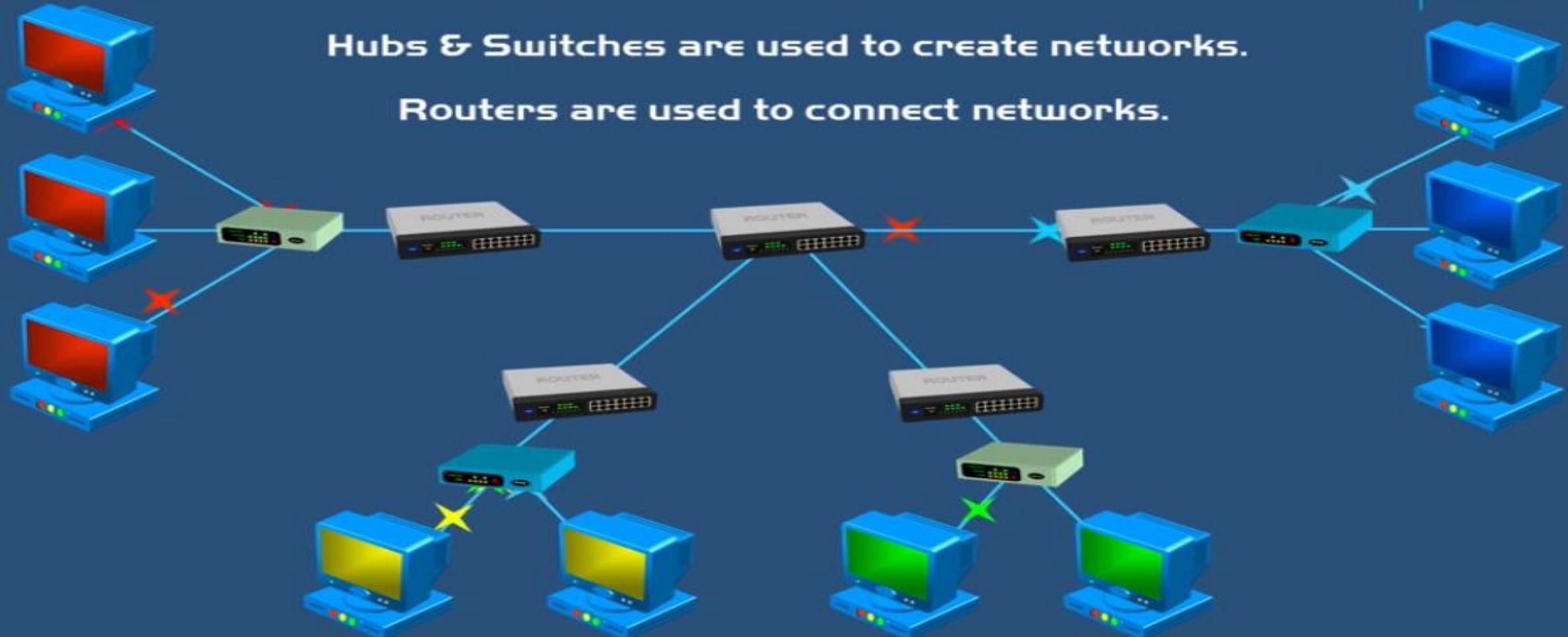


Router





Router



ROUTER

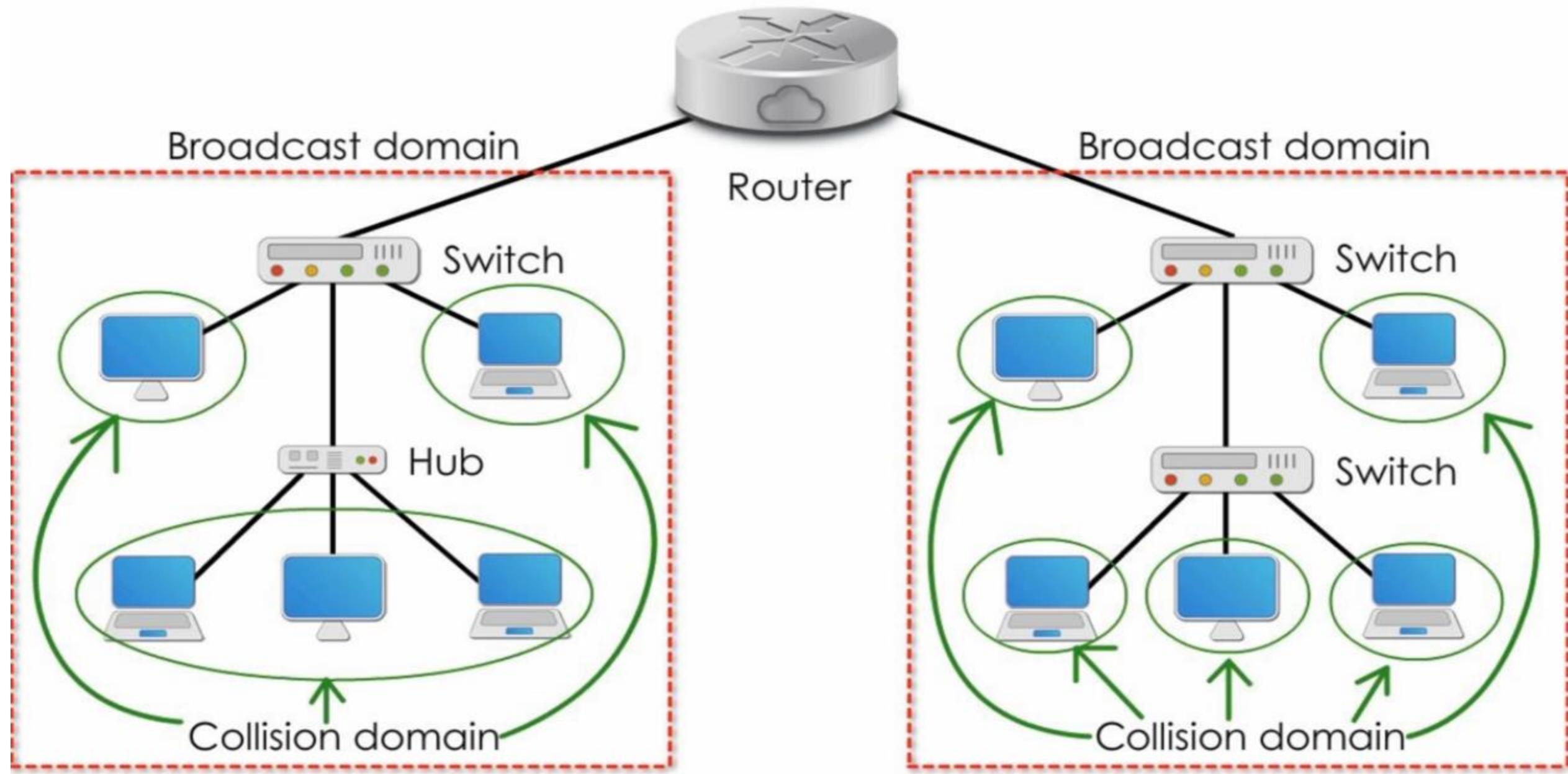
NOW THE QUESTION IS HOW THE ROUTER IS DIFFER FROM SWITCH OR HUB ?

HUB AND SWITCH ARE NETWORKING DEVICE USE TO CONNECT PC OR ANY DEVICES ON THE SAME NETWORK. BUT ROUTER IS A DEVICE USE TO CONNECTS TWO OR MORE DIFFERENT NETWORK.

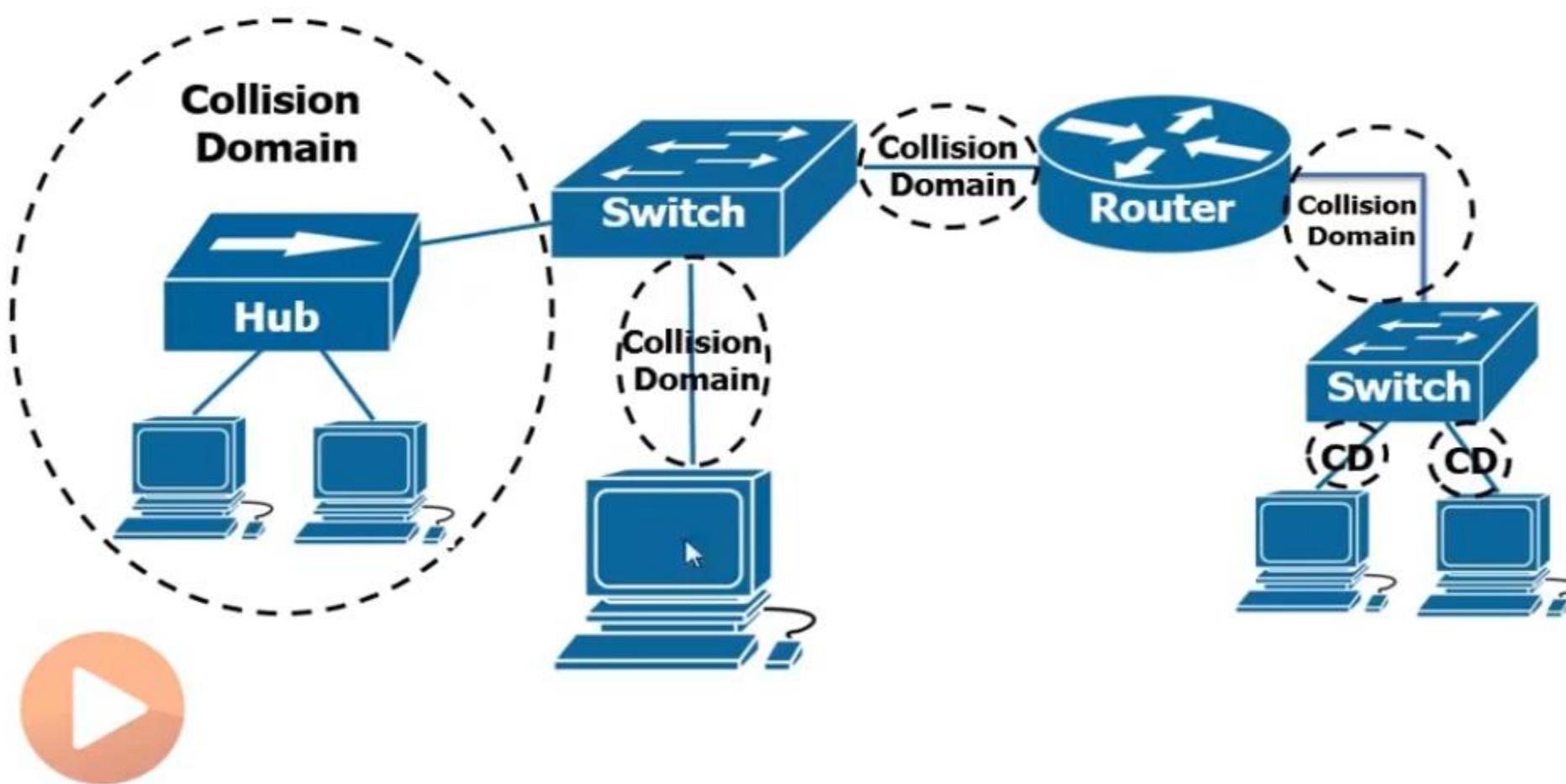


HUB	SWITCH	ROUTER
HUB works in Physical Layer of OSI Model.	SWITCH works in Data Link Layer of OSI Model.	ROUTER works in Network Layer of OSI Model
HUB is a broadcast device	SWITCH is a multicast device	ROUTER is a routing device use to create route for transmitting data packets.
HUB is use to connect devices in the same network.	SWITCH is use to connect devices in the same network	ROUTER is use to connect two or more different network.
HUB sends data in the form of packets.	SWITCH sends data in the form of frames.	ROUTER sends data in the form packets.
HUB only works in half duplex.	SWITCH works in full duplex.	ROUTER works in full duplex.
Only one device can send data at a time.	Multiple devices can send data at the same time.	Multiple devices can send data at the same time.
HUB does not store any mac/IP address to transfer data.	SWITCH stores and uses MAC address of a devices to transfer data.	ROUTER uses IP address to transfer data.

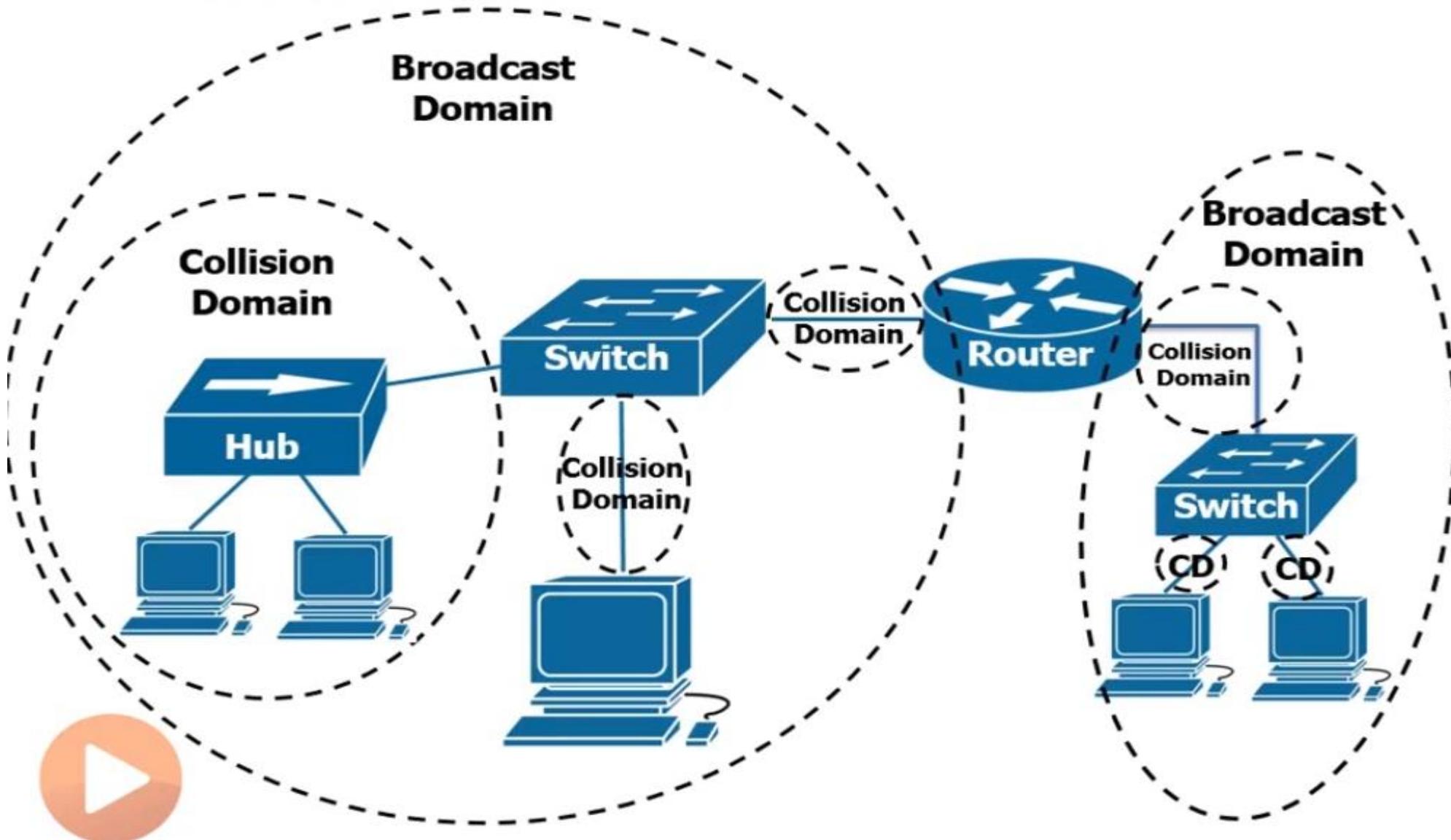




Broadcast Domains



Broadcast Domains

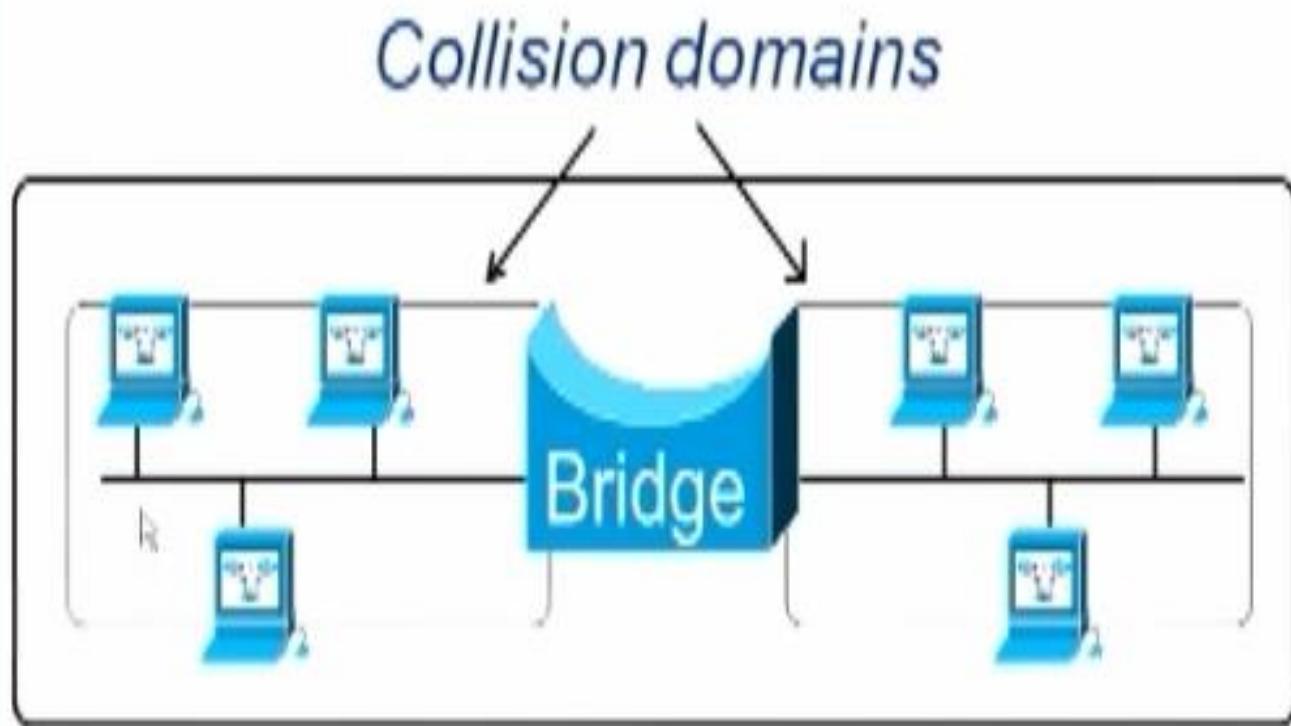


Multi-Port Repeater



*One collision domain
One broadcast domain*

Transparent Bridges



One broadcast domain

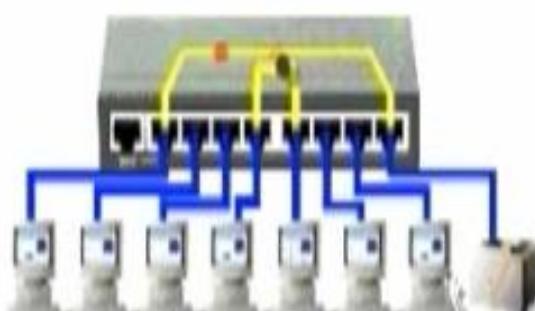
Bridges reduce collisions within a broadcast domain while increasing the number of collision domains



Multi-Port Bridge

Each port is a separate collision domain

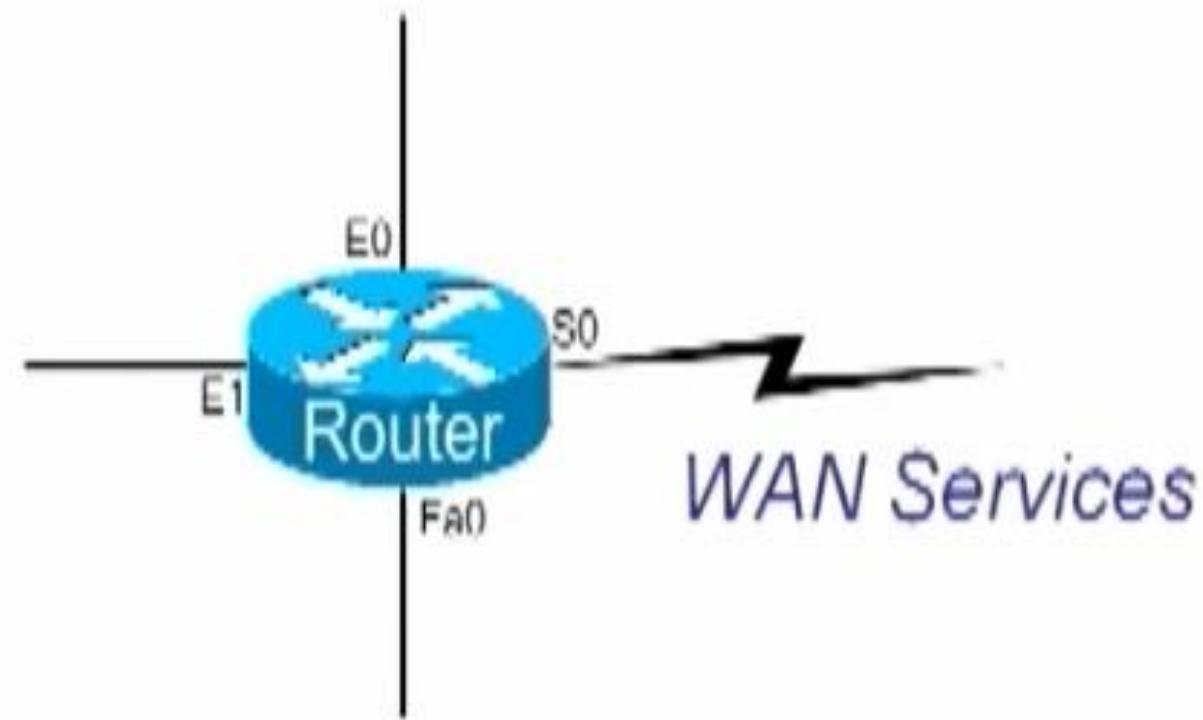
Switch



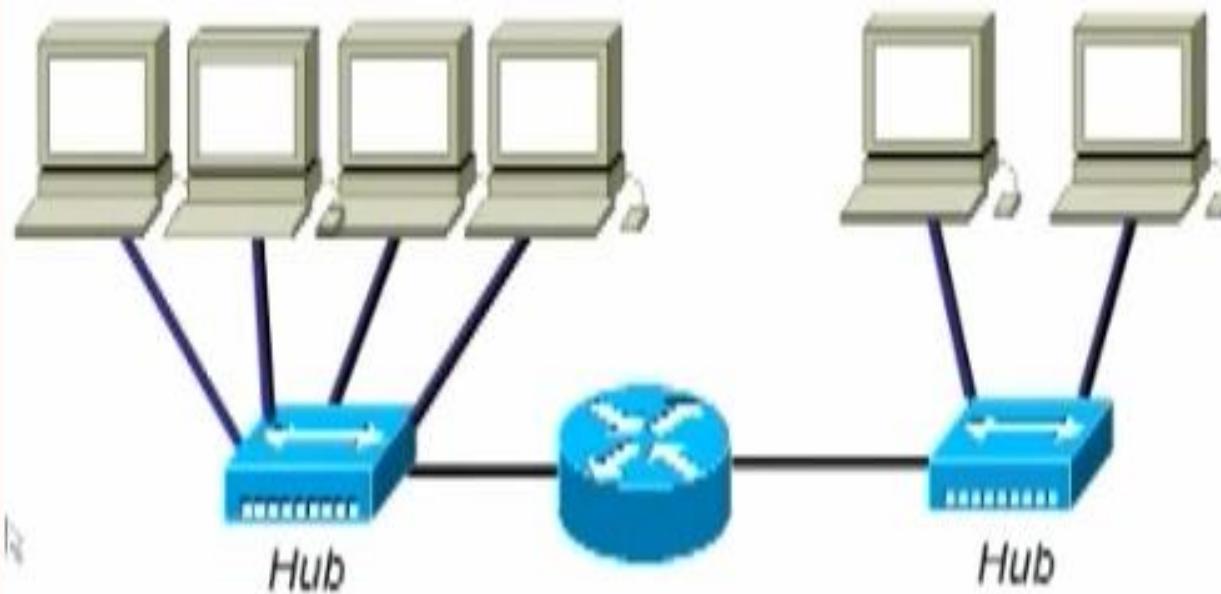
One broadcast domain

Router

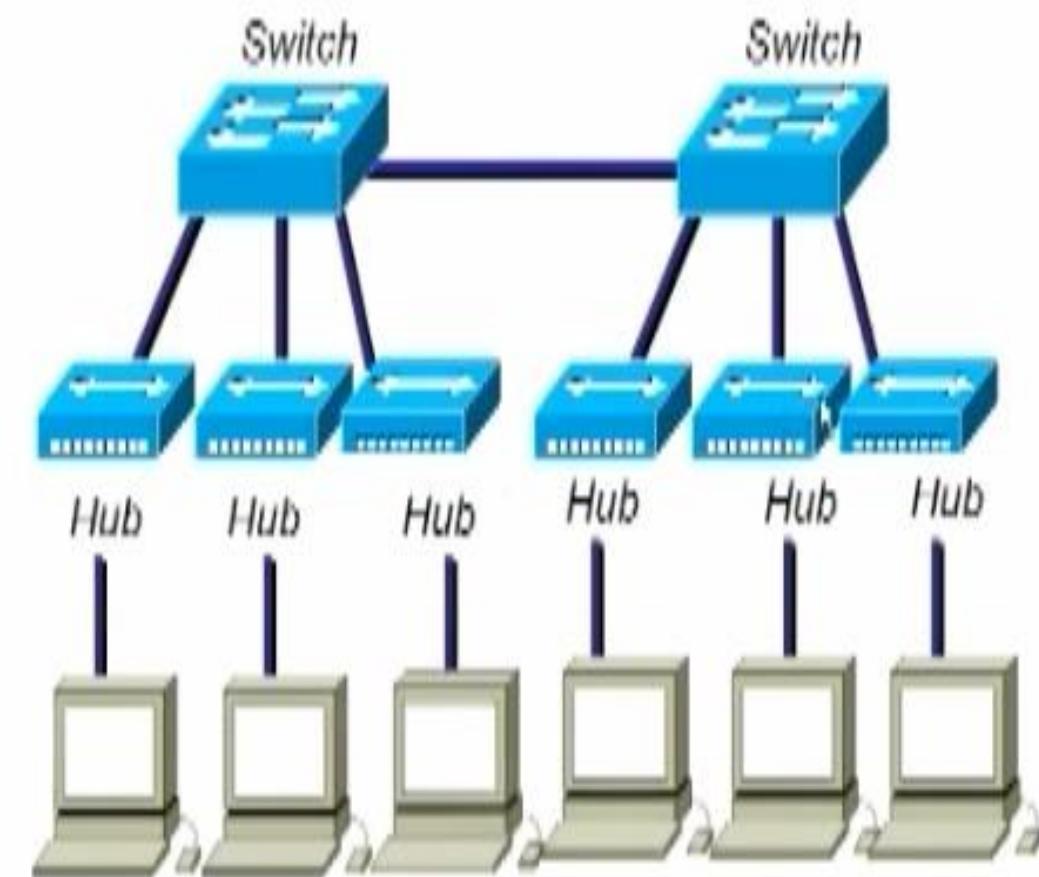
Each interface is a separate collision domain and broadcast domain



How many collision domains are shown? How many broadcast domains are shown?



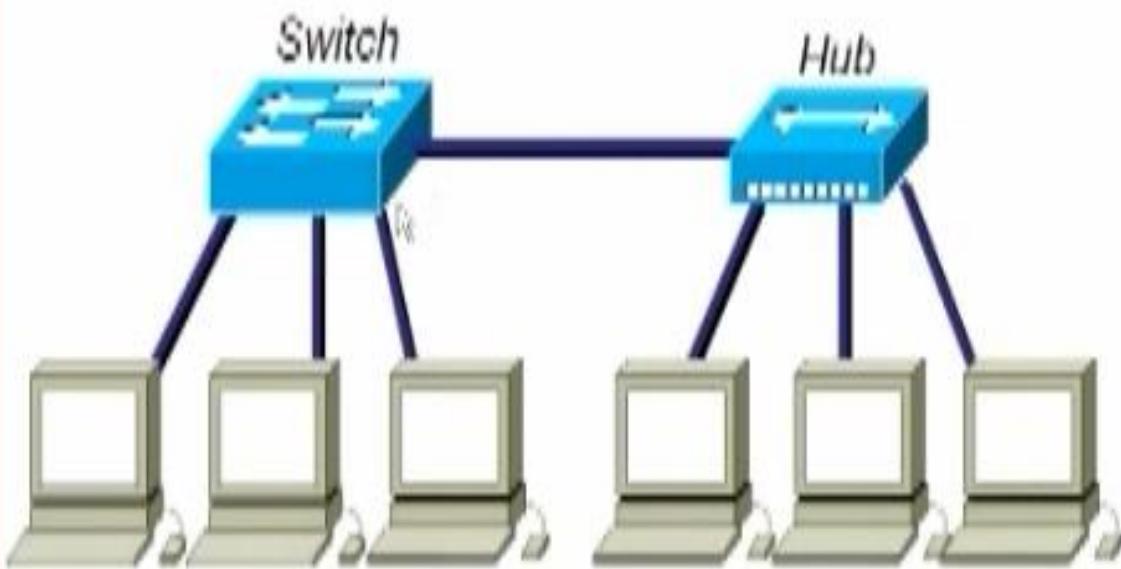
How many broadcast domains are shown?



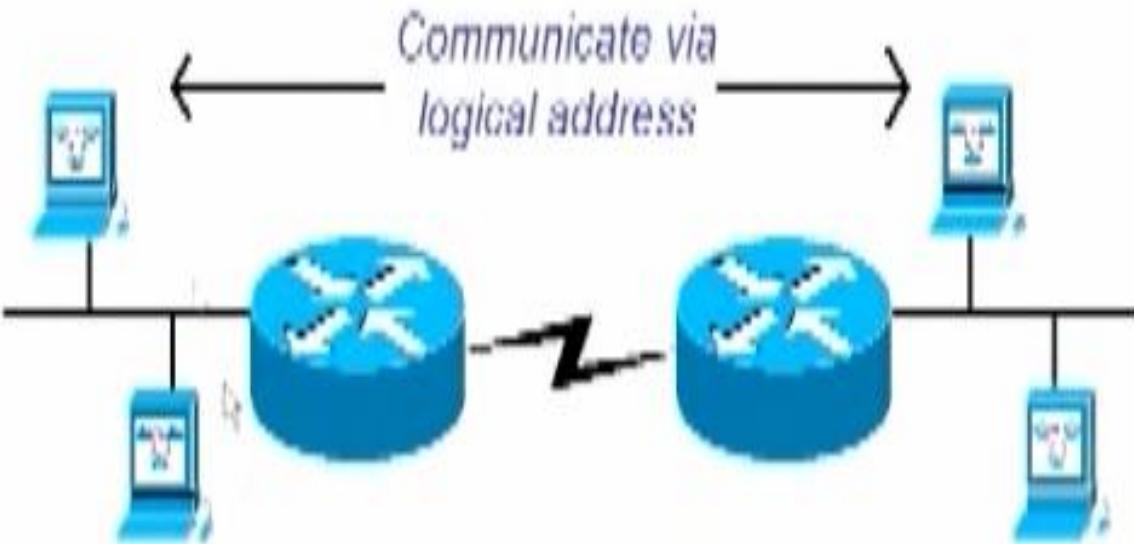
How many collision domains are shown?



Which of the hosts can transmit simultaneously without causing collisions?



Hardware and Logical Addressing



Communicate on LAN
via hardware addresses

Communicate on LAN
via hardware addresses

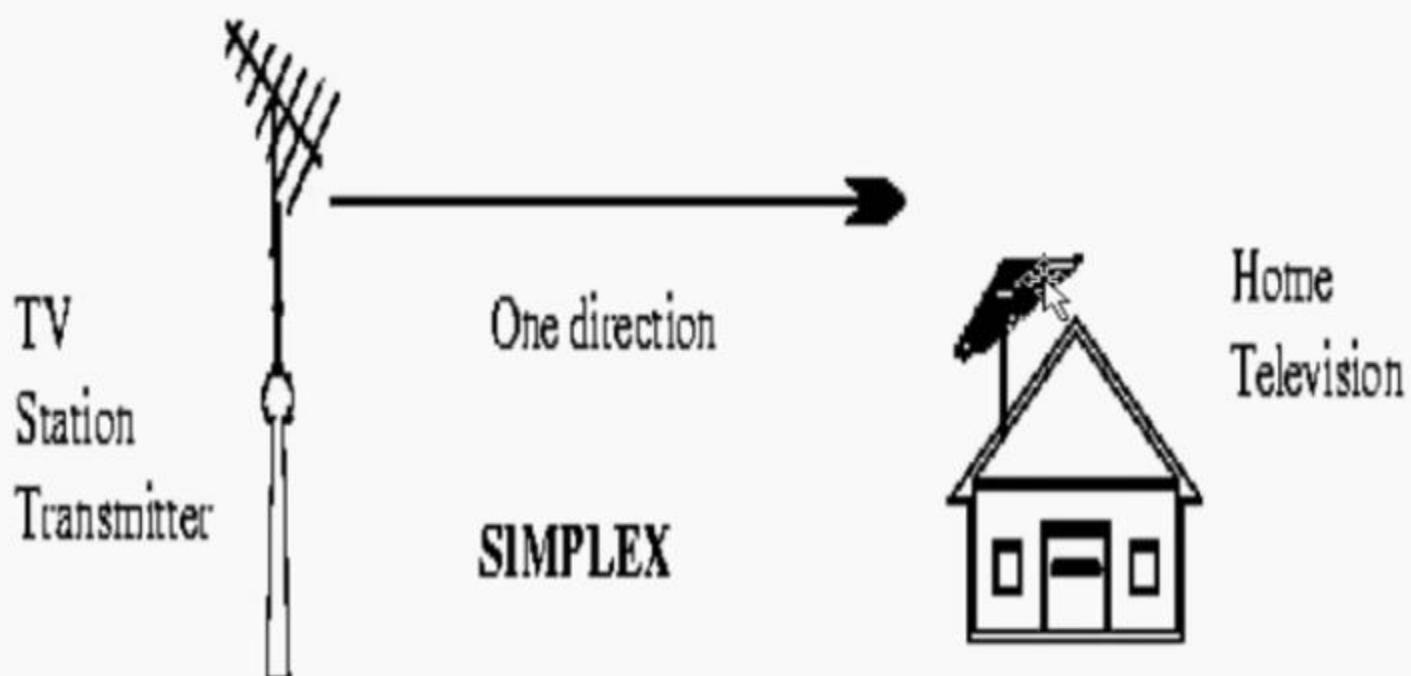
How many collision and broadcast domains are shown?

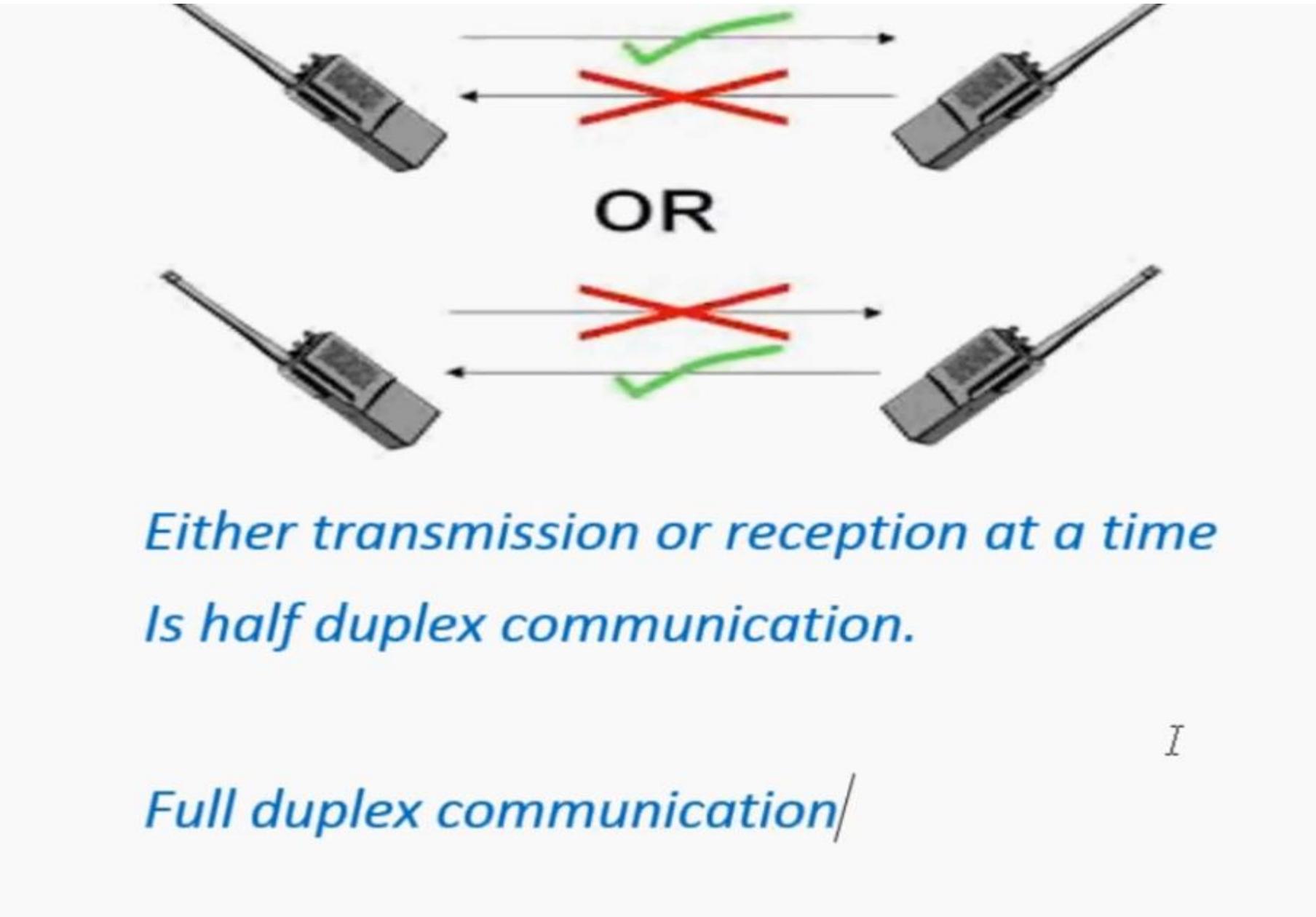


Simplex Half Duplex and Full Duplex

What is simplex??

one way communication is called simplex.

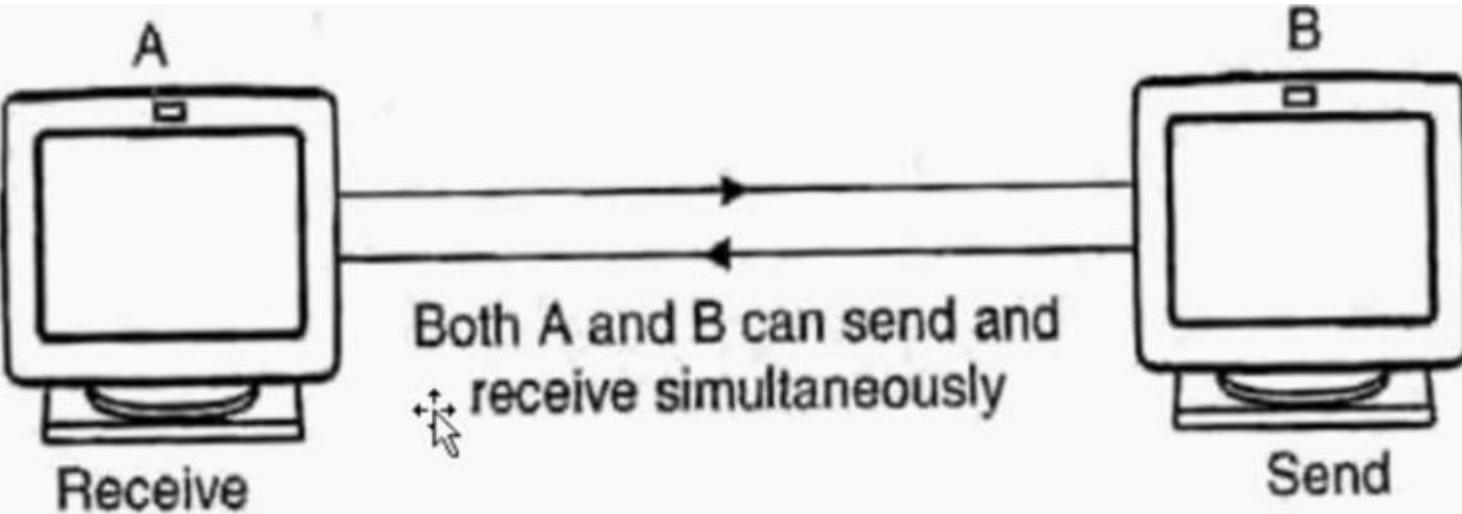




I

Full duplex communication





Full duplex mode

In full duplex both device can transmit and receive simultaneously.

Ex- Mobile phone ,landline./



Transmission Mode

Transmission mode means transferring of data between two devices. It is also called communication mode. These modes direct the direction of flow of information. There are three types of transmission mode.

Simplex

Simplex transmission is a **communication** channel that sends information in one direction only. operates in one direction at a time.

It is also called unidirectional because the signal travels in only one direction.

Examples : Radio, TV Broadcasting System.

Half Duplex

In **Half duplex** transmission data transmission can be take place in both directions, but not at the same time.

This means that only one side can transmit at a time.

Example : walky-talky devices used by security agencies are half-duplex as only one person can talk at one time

Full Duplex

Full Duplex transmission can take place in both directions at the same time.

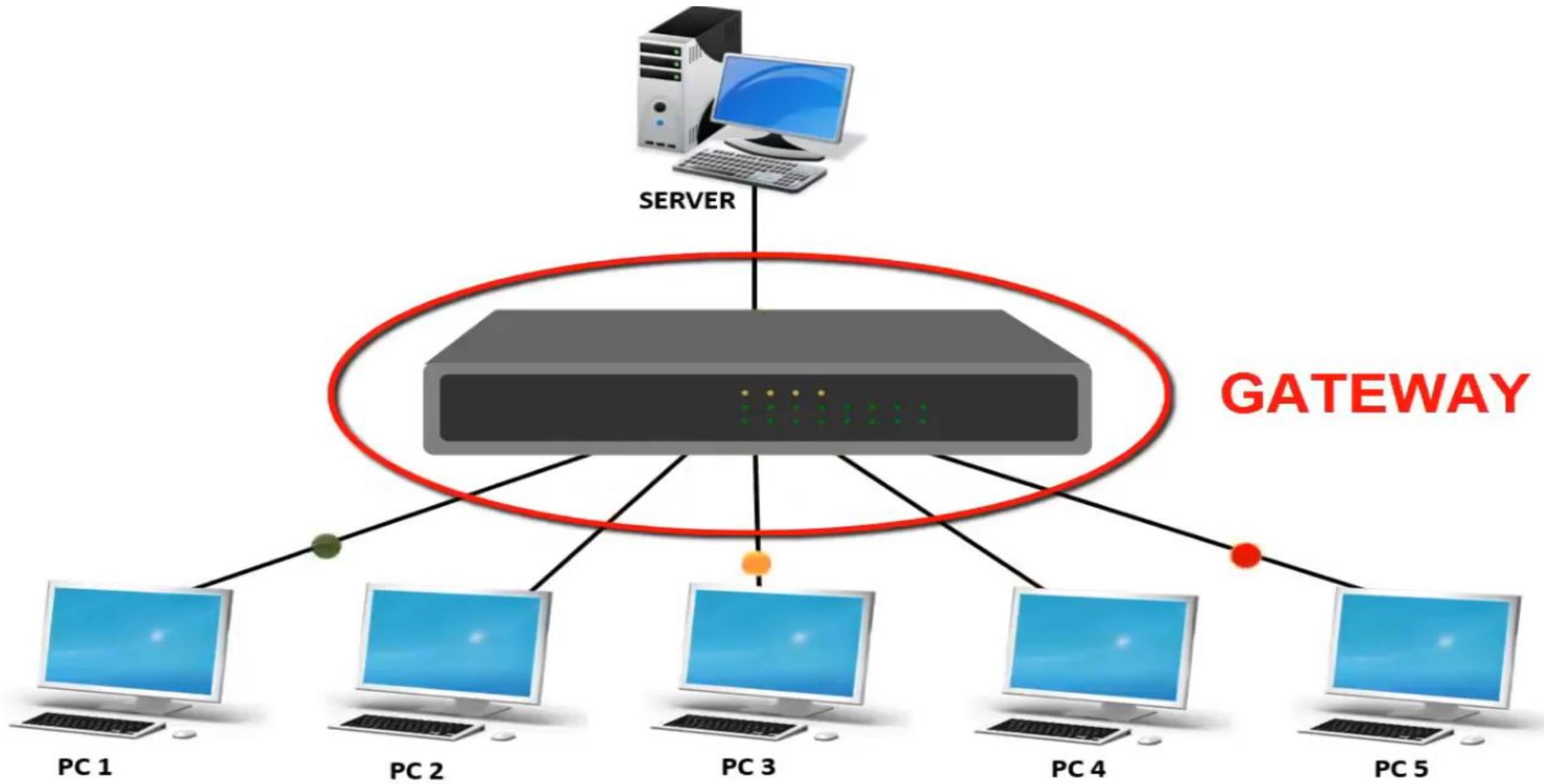
Example : telephone, mobile conversation is an example of full duplex communication, where both sender and receiver can hear each other at the same time.

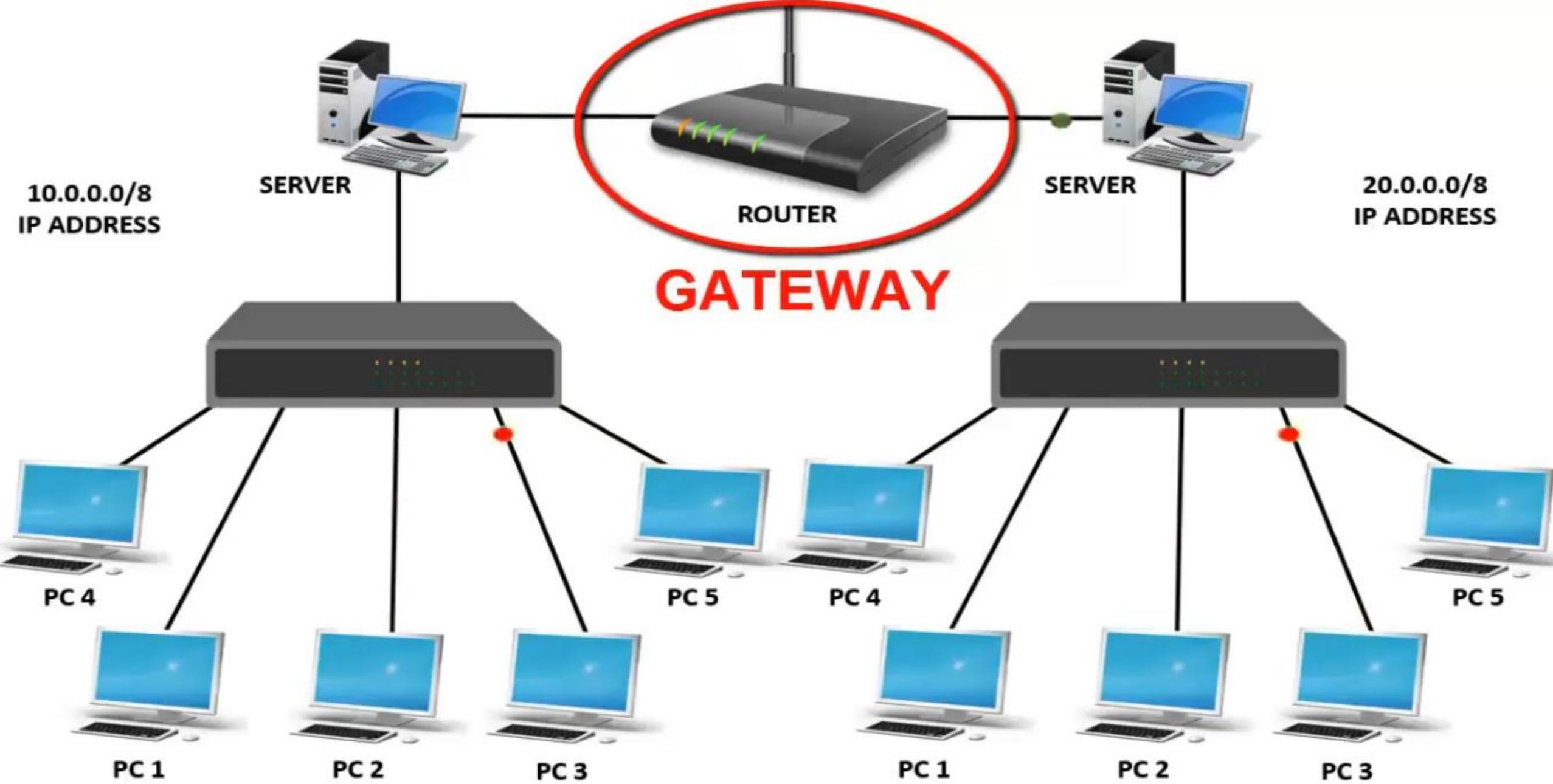


What is Gateway

- **A gateway is a network node that connects two networks using different protocols together.**
- **it also acts as a "gate" between two networks. It may be a router, firewall, server, or other device that enables traffic to flow in and out of the network.**





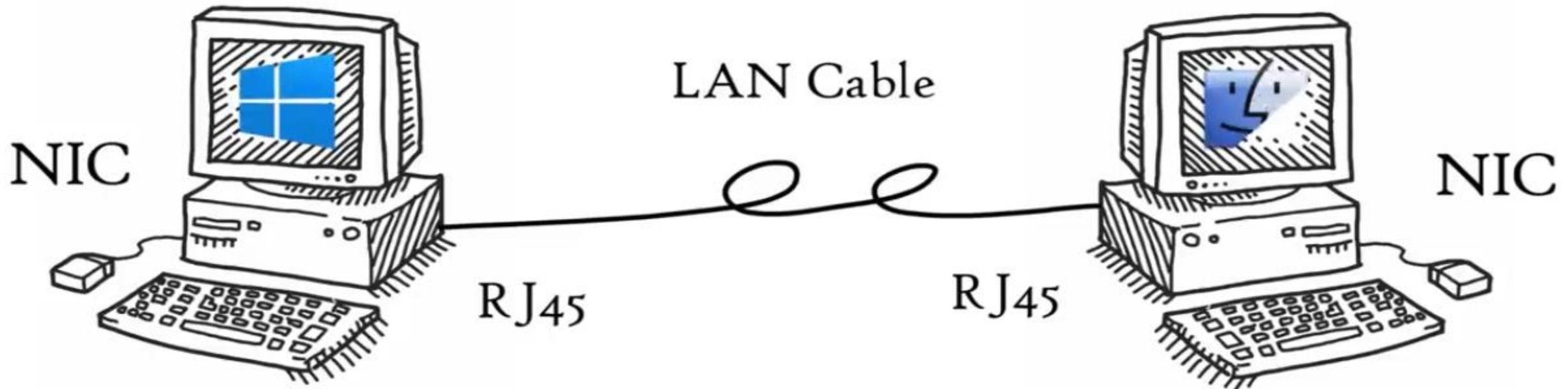


Difference between Router and Gateway

ROUTER	GATEWAY
Network device that forwards packets from one network to another. Based on internal routing tables, routers read each incoming packet and decide how to forward it. Routers work at the network layer (layer 3) of the protocol	Device that converts one protocol or format to another. A network gateway converts packets from one protocol to another. The gateway functions as an entry/exit point to the network.
Route traffic from one network to other.	Translate from one protocol to other
Routers provide additional features like DHCP server, NAT, Static Routing, and Wireless Networking/IPv6 address , Mac address	Protocol conversion like VoIP to PSTN or Network Access Control etc.
Supports dynamic routing	Does not support dynamic routing
Works on Layer 3 and Layer 4 of OSI Model	Works up to Layer 5 of OSI Model

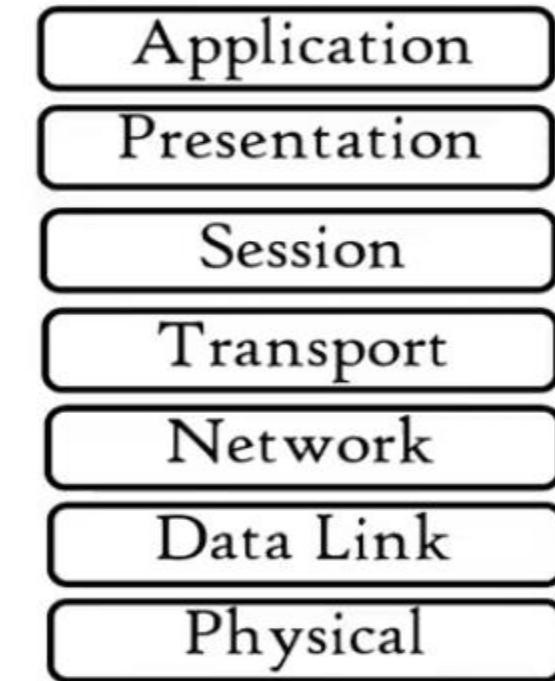


Computer Network



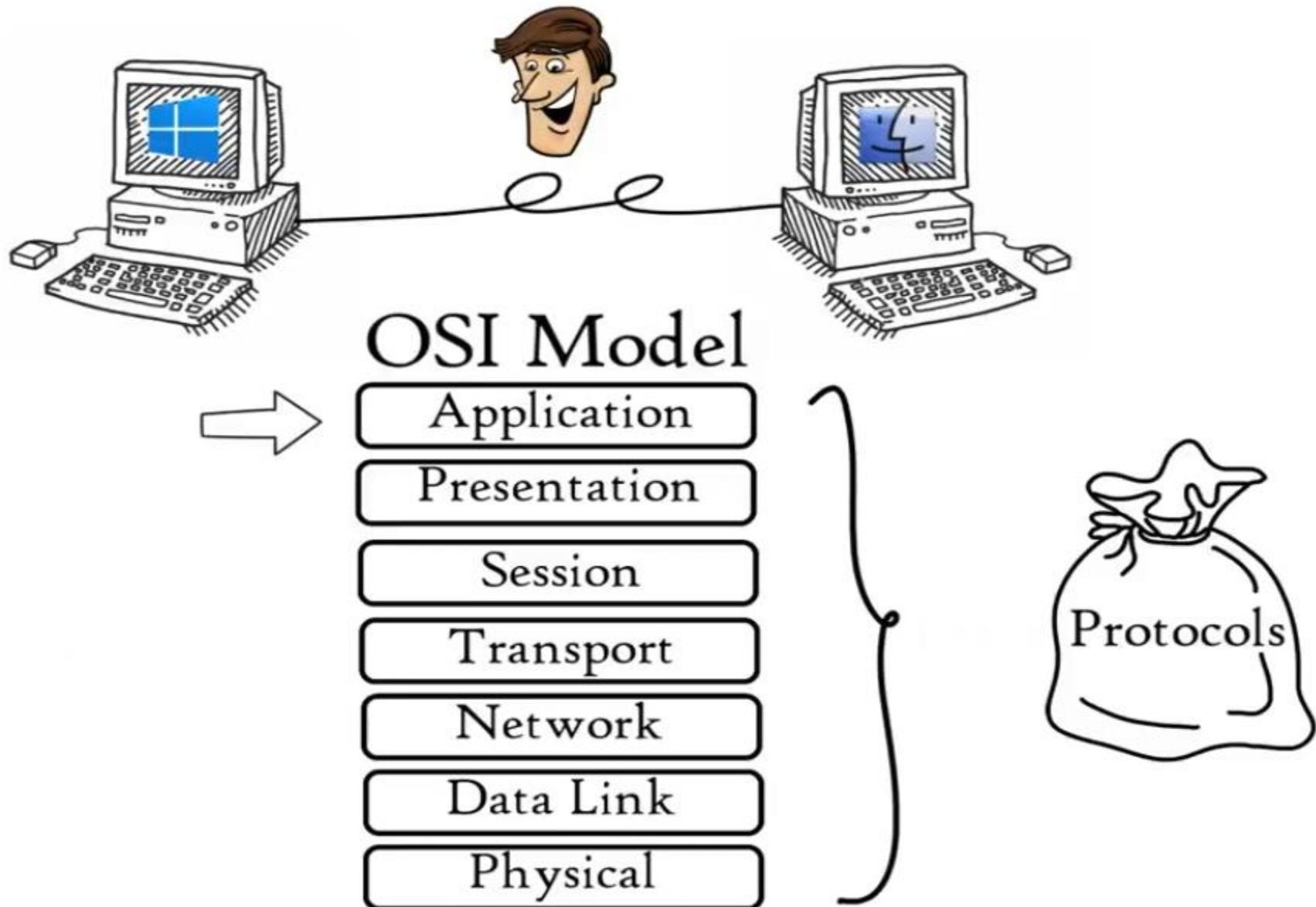


OSI Model

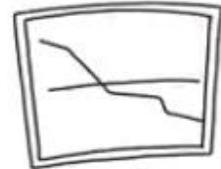


ISO 1984





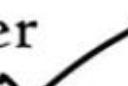
Application Layer: Network Applications



HTTP	HTTPS	FTP
NFS	FMTP	DHCP
SNMP	TELNET	
POP3	IRC	NNTP



File Transfer



Web Surfing



Emails

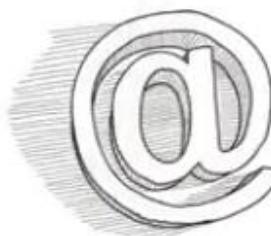
Virtual
Terminals



FTP



HTTP/S

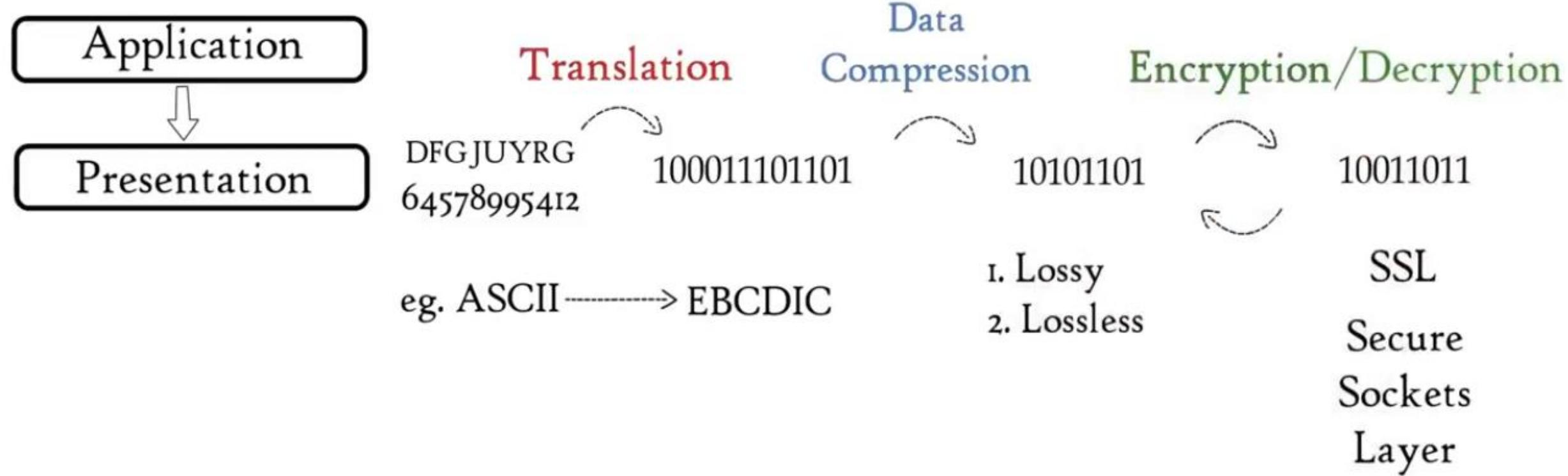


SMTP

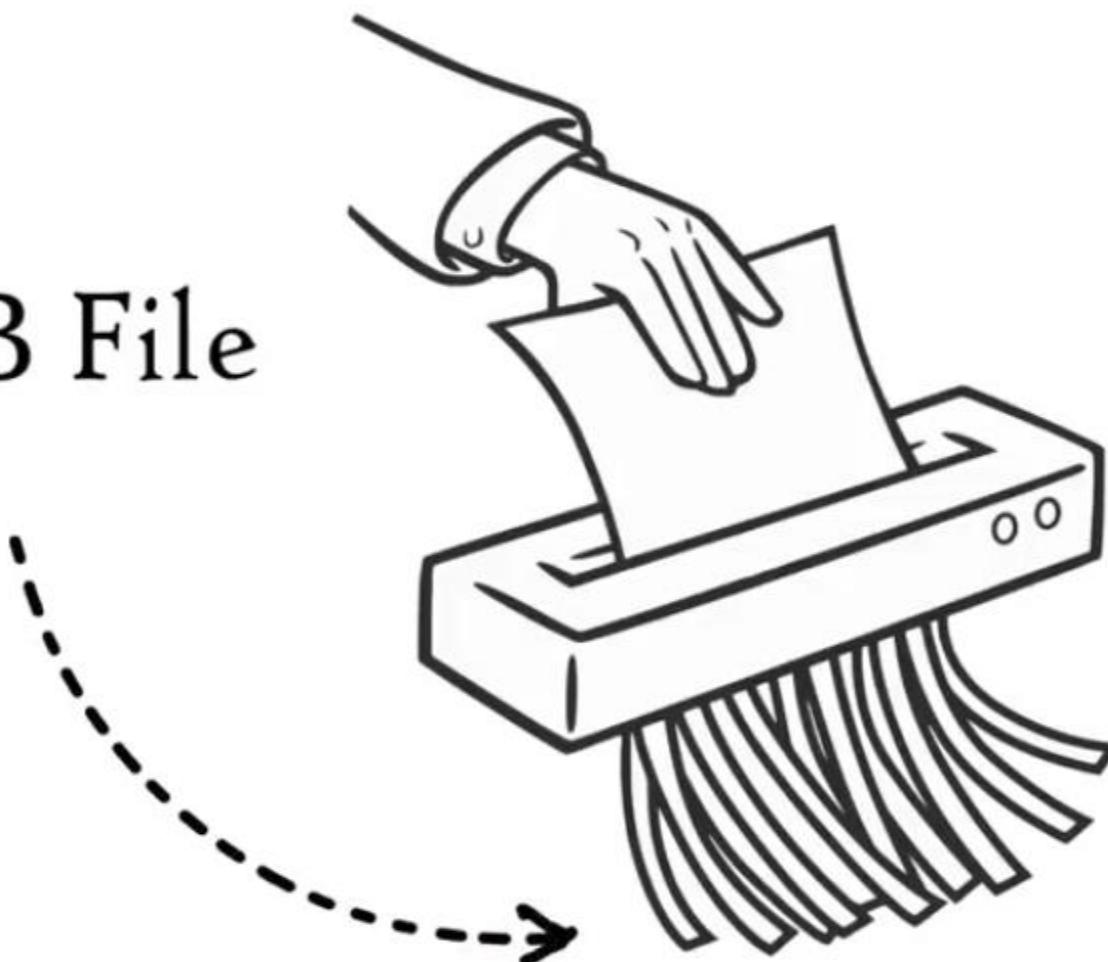
Telnet



Presentation Layer



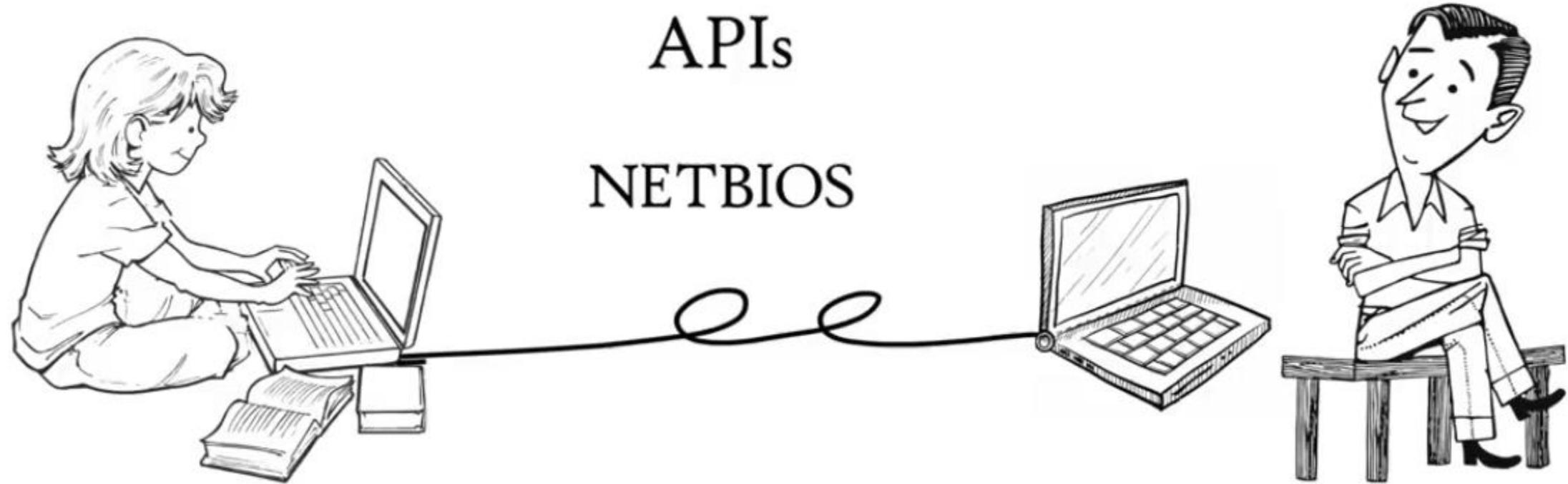
5 MB File

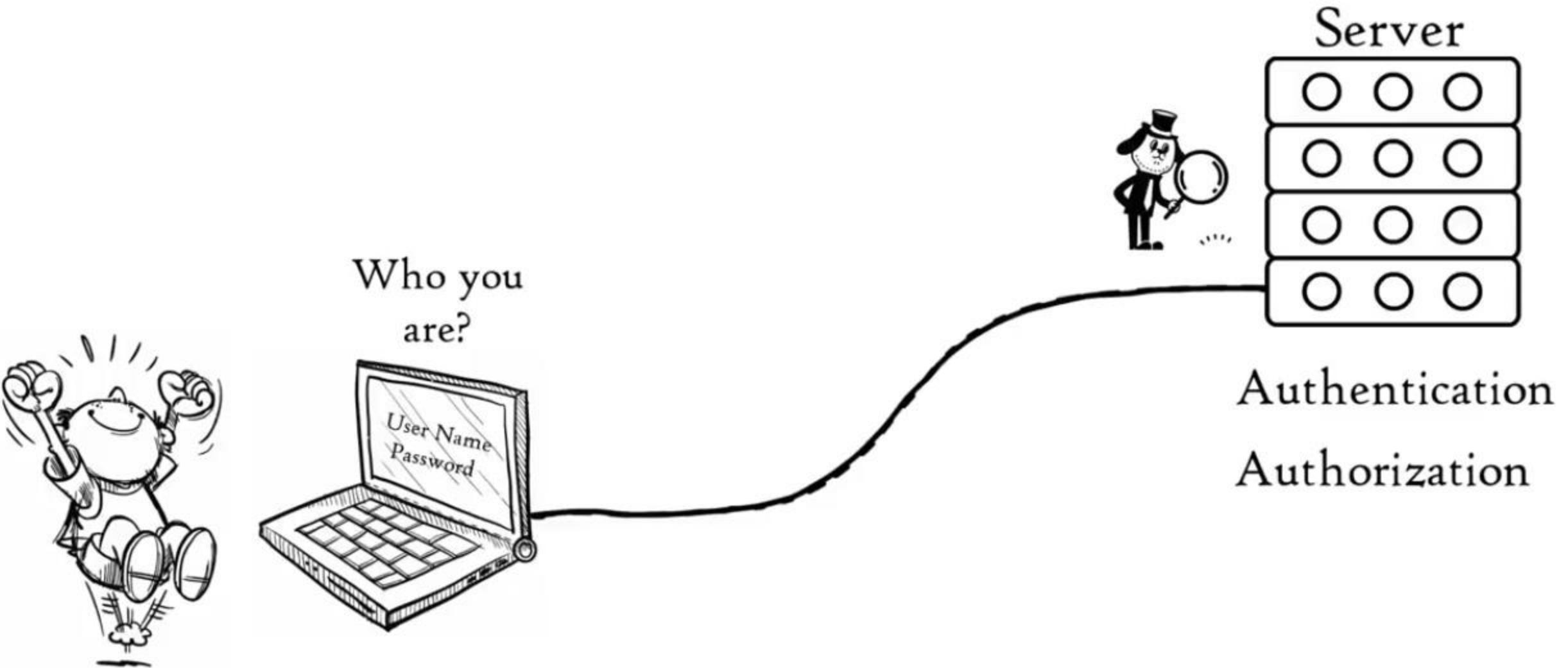


2 MB File



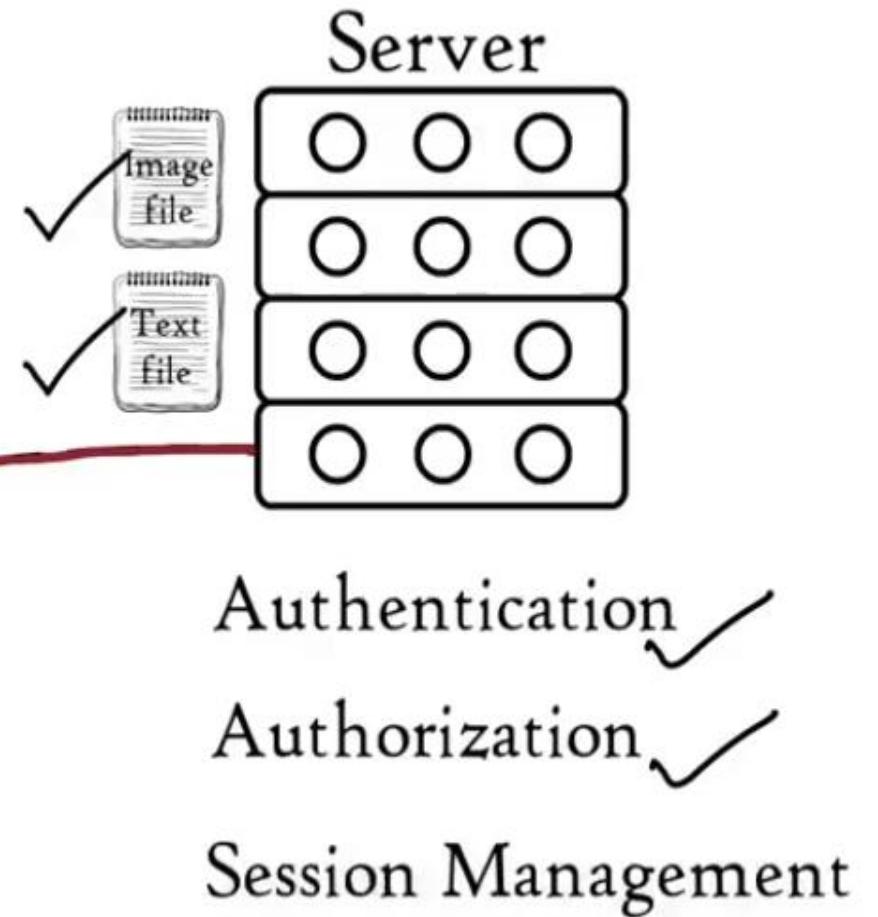
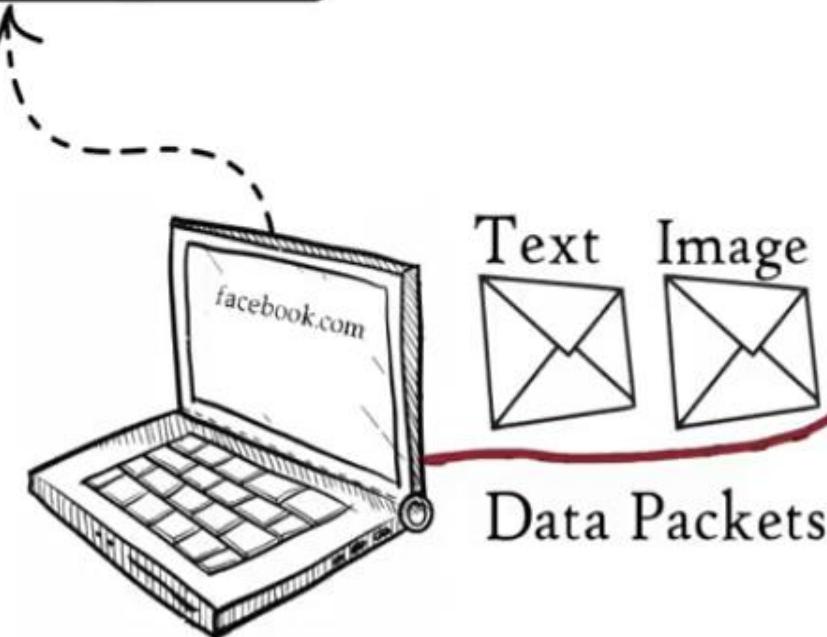
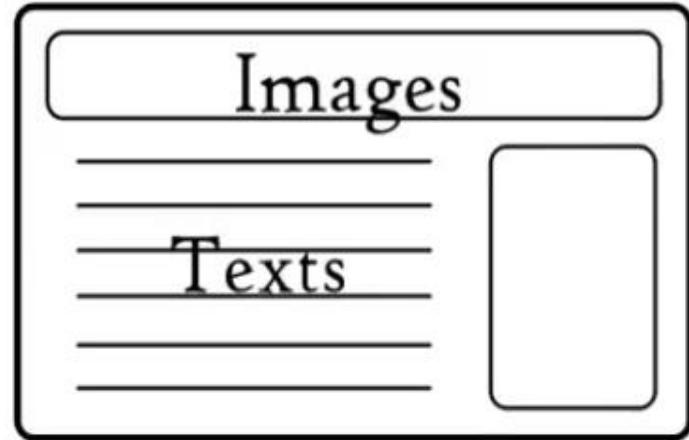
Session Layer



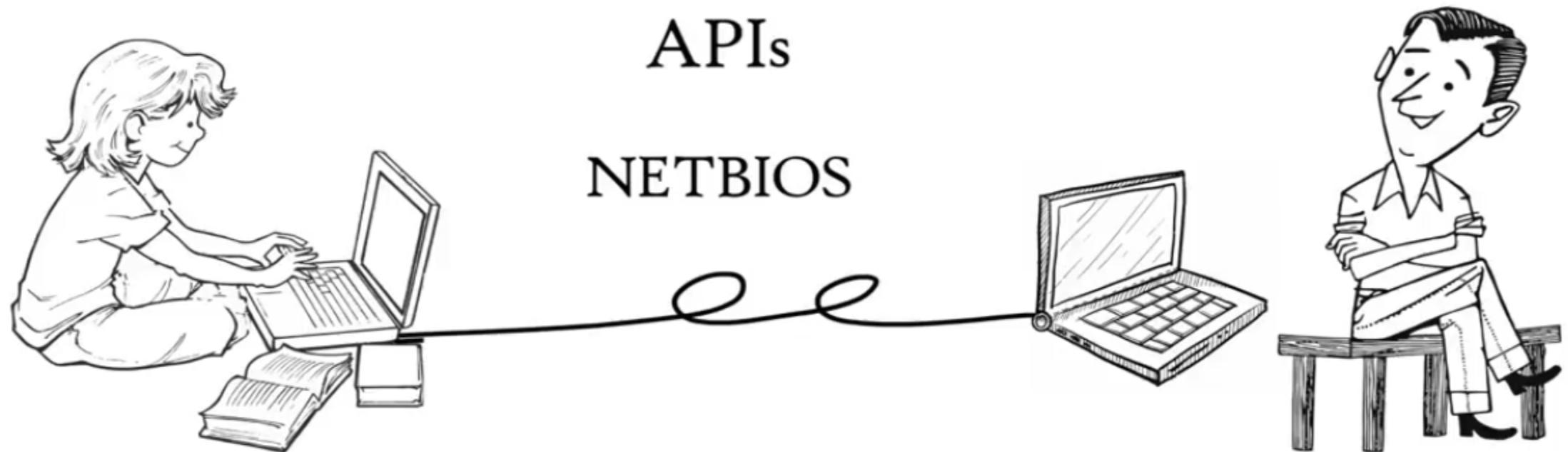




Session Layer

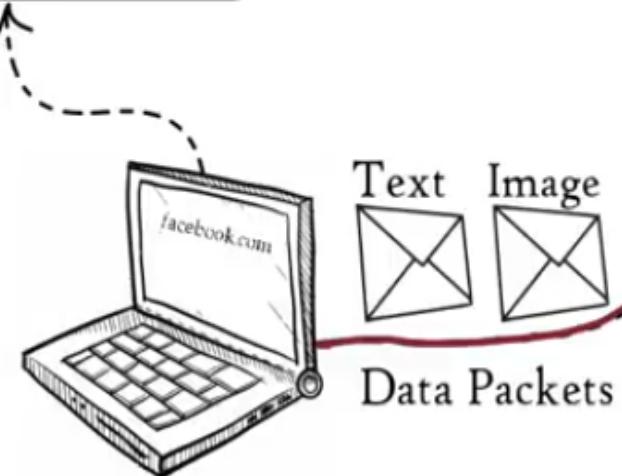
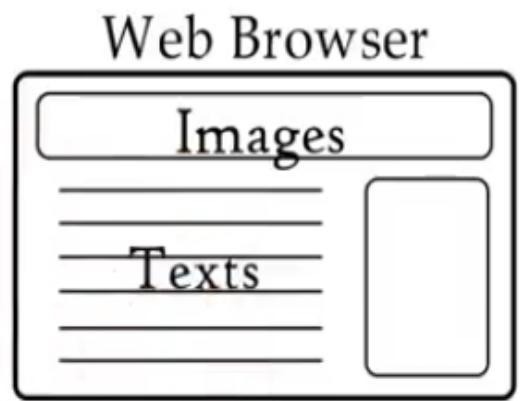
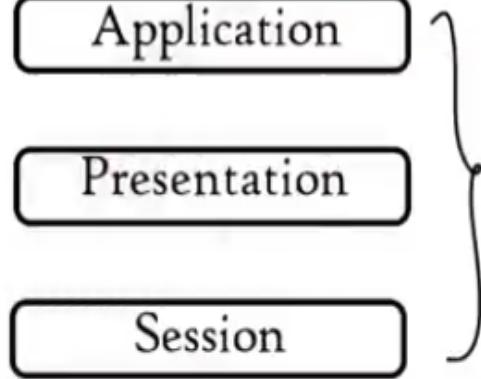


Session Layer

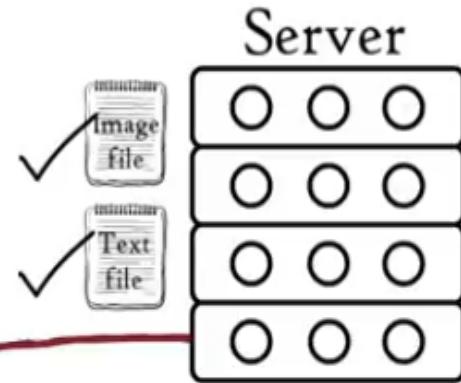


- a. Session management
- b. Authentication
- c. Authorization





Session Layer



- Authentication ✓
- Authorization ✓
- Session Management



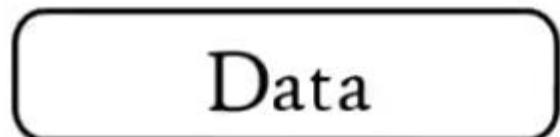
Transport Layer

Segmentation
Flow Control
Error Control

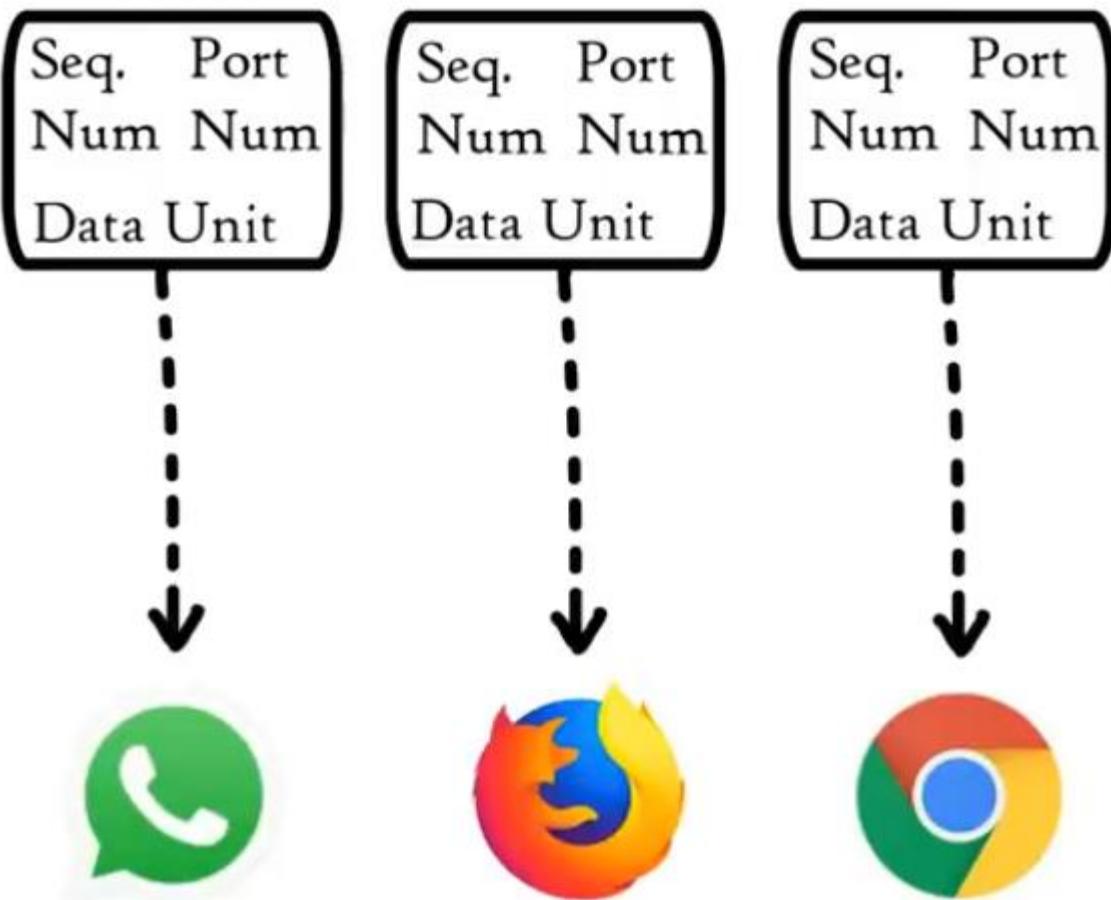
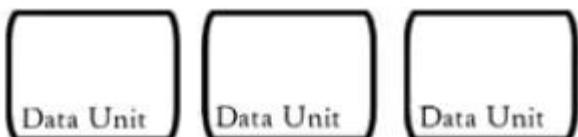


Segments

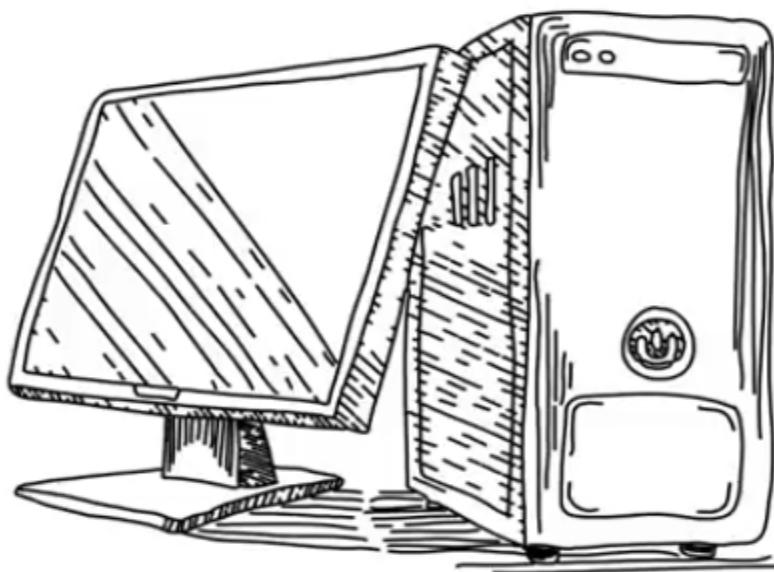
Segmentation:



Segm

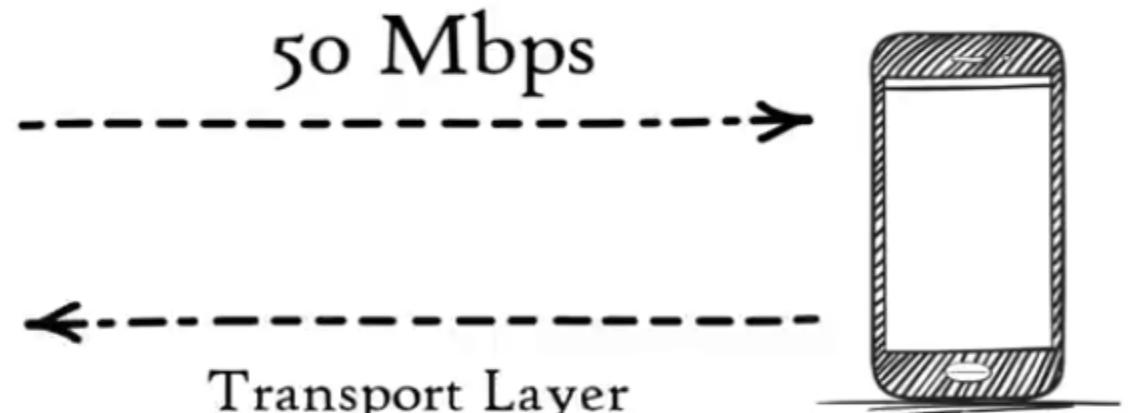


Flow Control:



100 Mbps

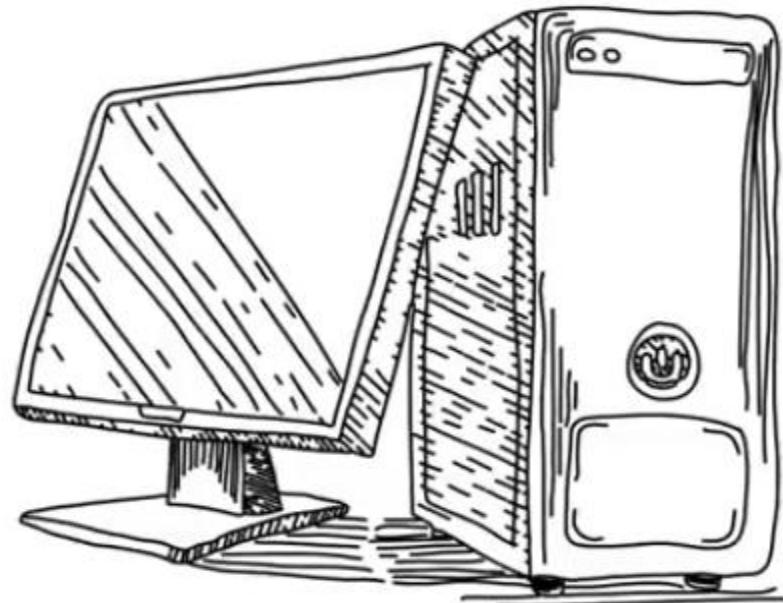
XXXX Mbps



10 Mbps

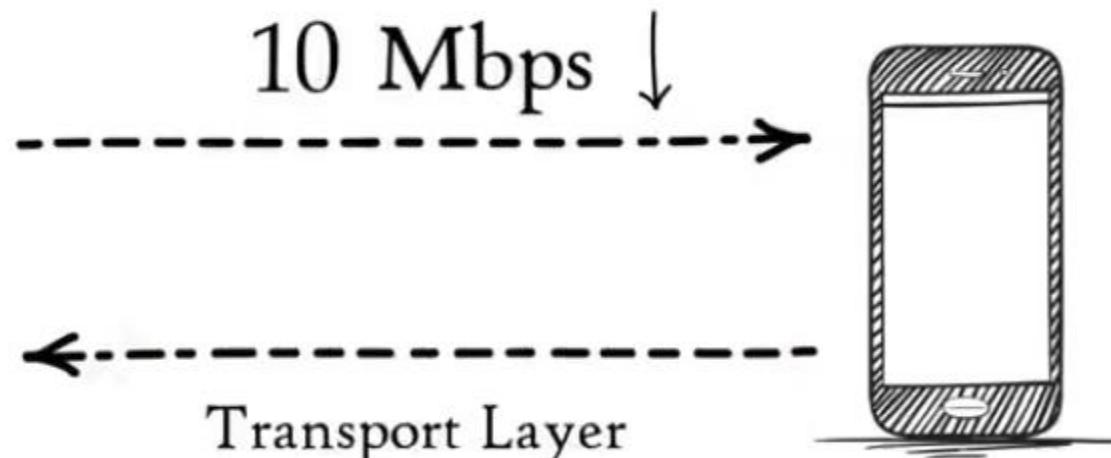


Flow Control:



100 Mbps

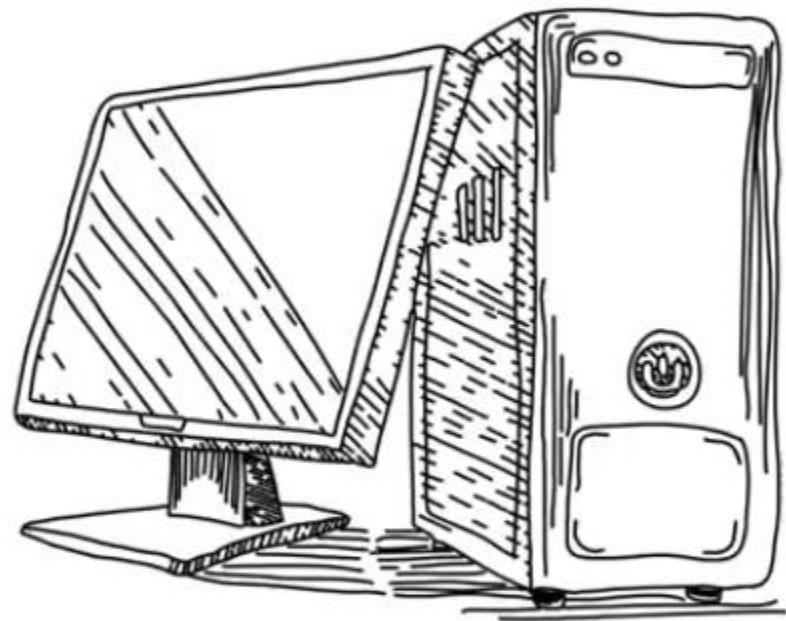
XXXX Mbps



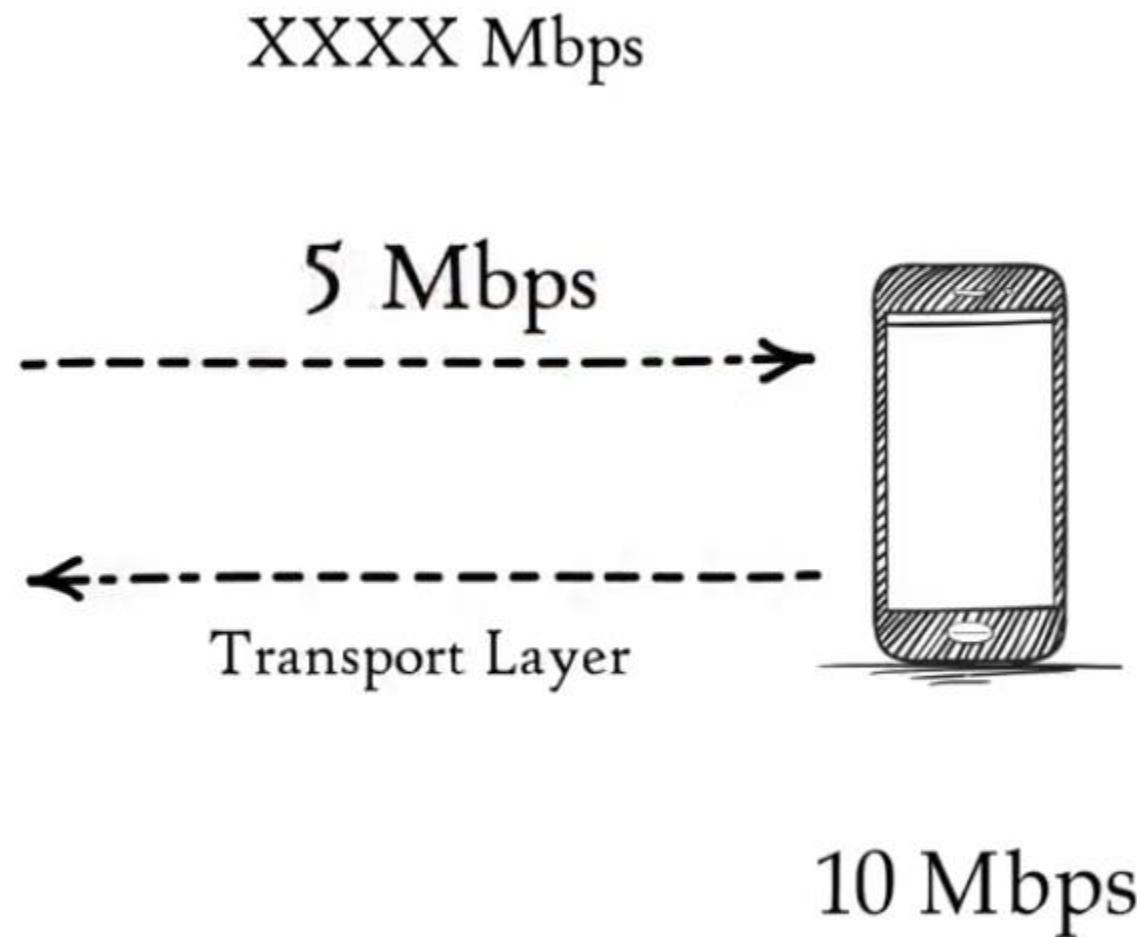
10 Mbps



Flow Control:

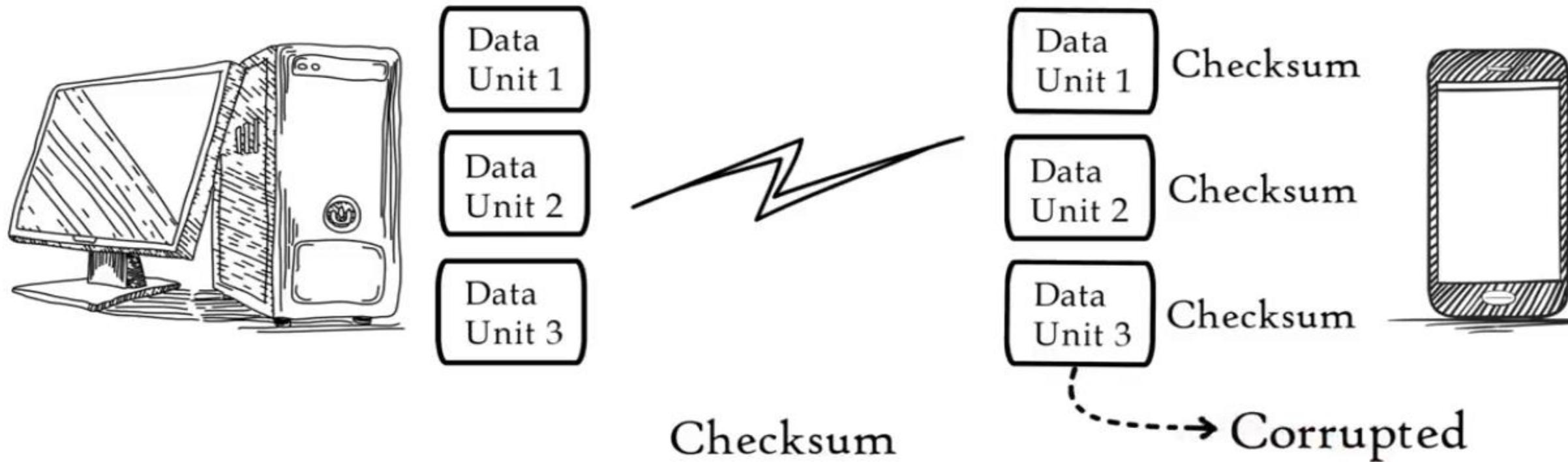


100 Mbps



Error Control:

Automatic Repeat Request



Transport Layer

Services:

- Connection-oriented Transmission
- Connectionless Transmission

Protocols:

- > Transmission Control Protocol (TCP)
- > User Datagram Protocol (UDP)



UDP



VIDEO
GAMES

No feedback

Example:



TFTP DNS

TCP



Feedback



FTP



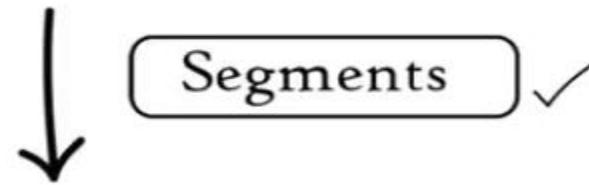
Transport Layer



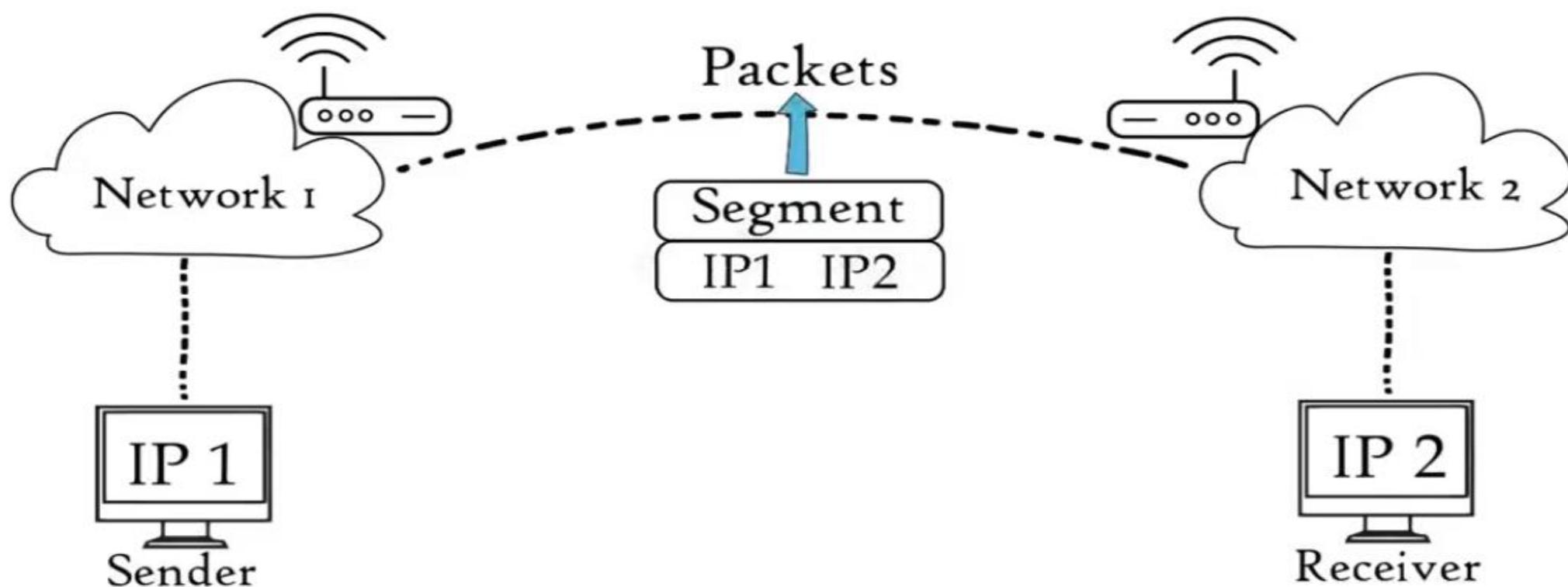
Segmentation
Flow Control
Error Control
Connection and
Connectionless Tx



Transport Layer



Network Layer



Network layer



Logical Addressing

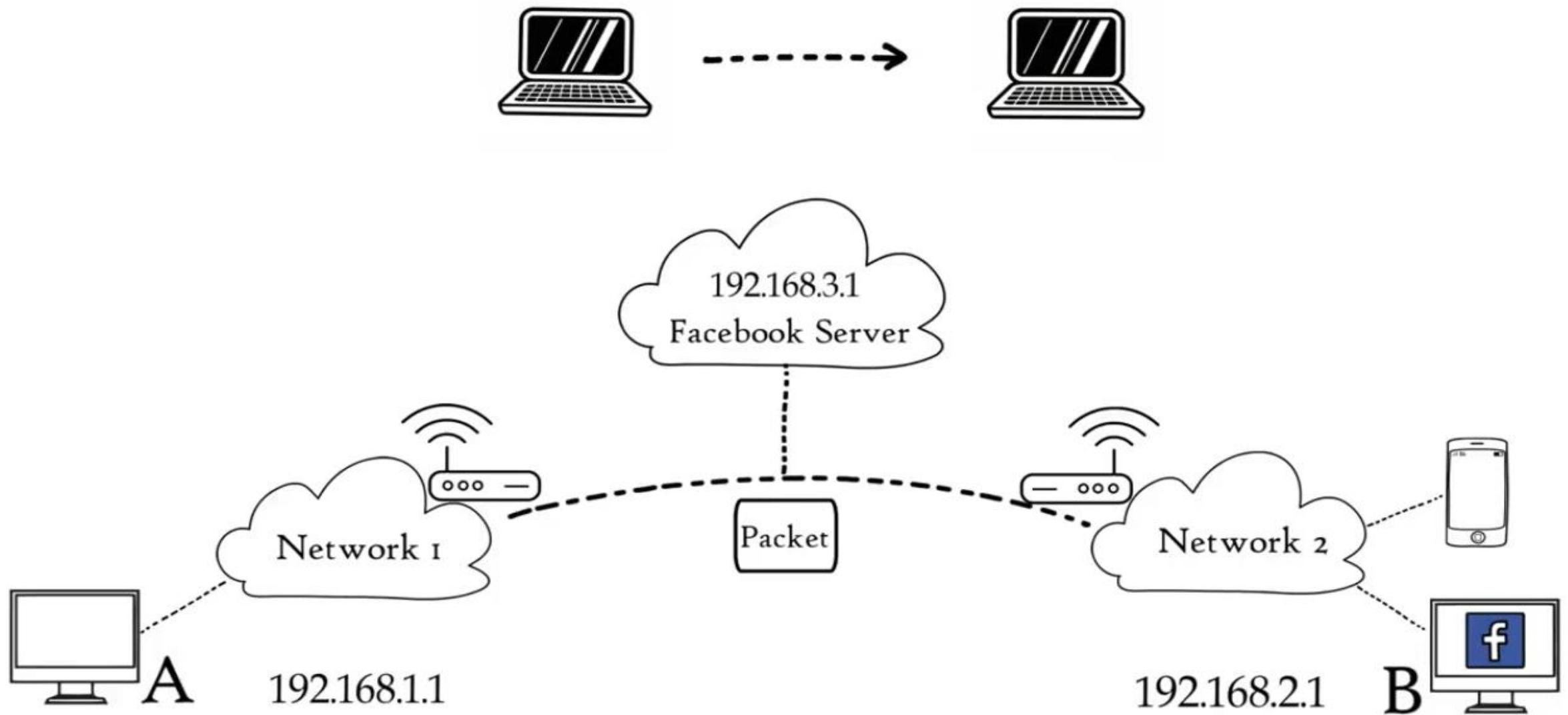


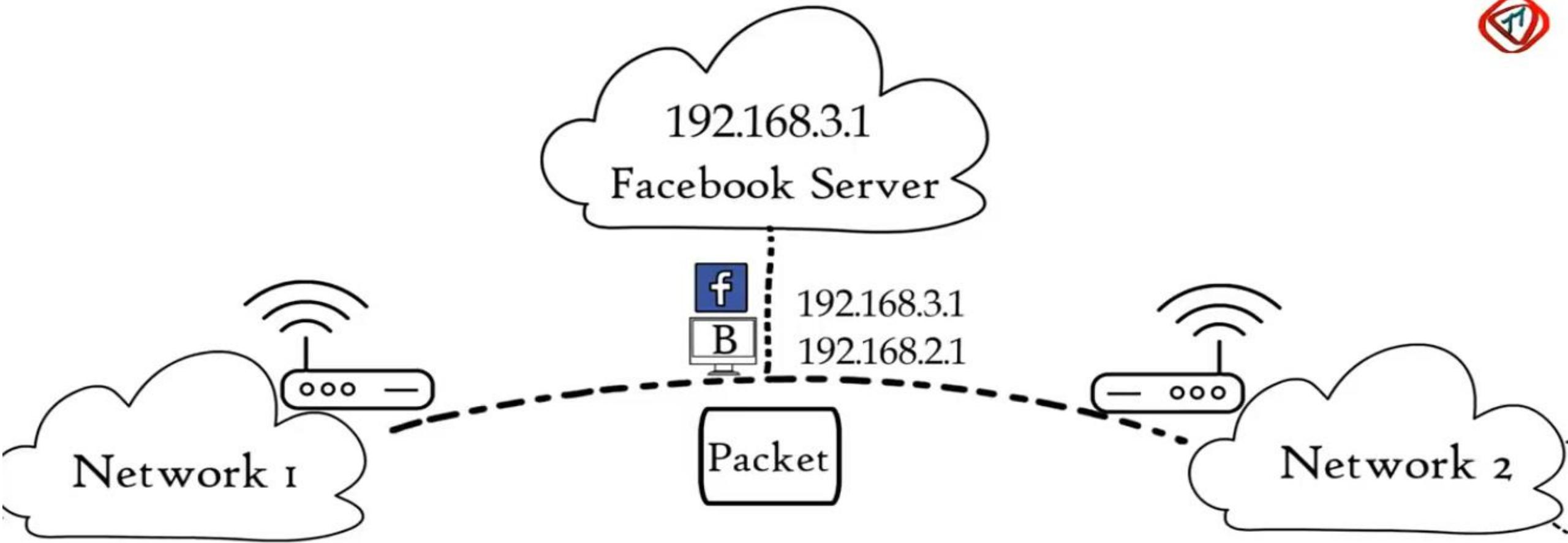
Path determination

Routing



Routing





192.168.1.1

192.168.2.1



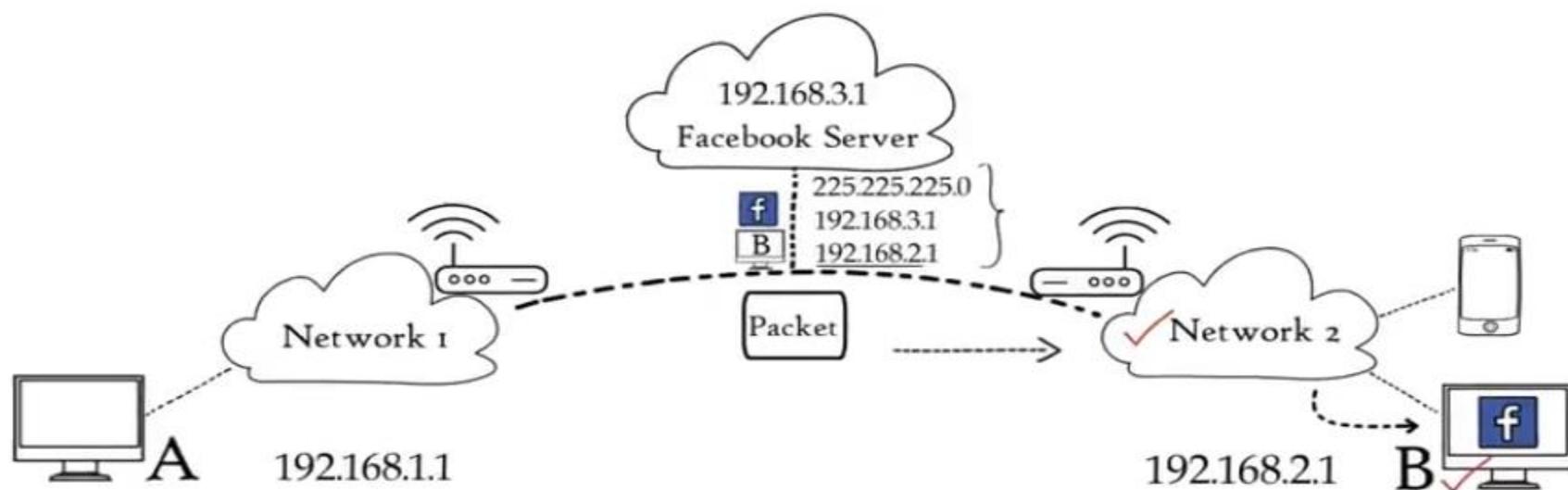
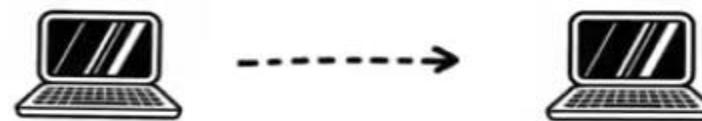
Logical Addressing

IPv4 & IPv6
+
Mask

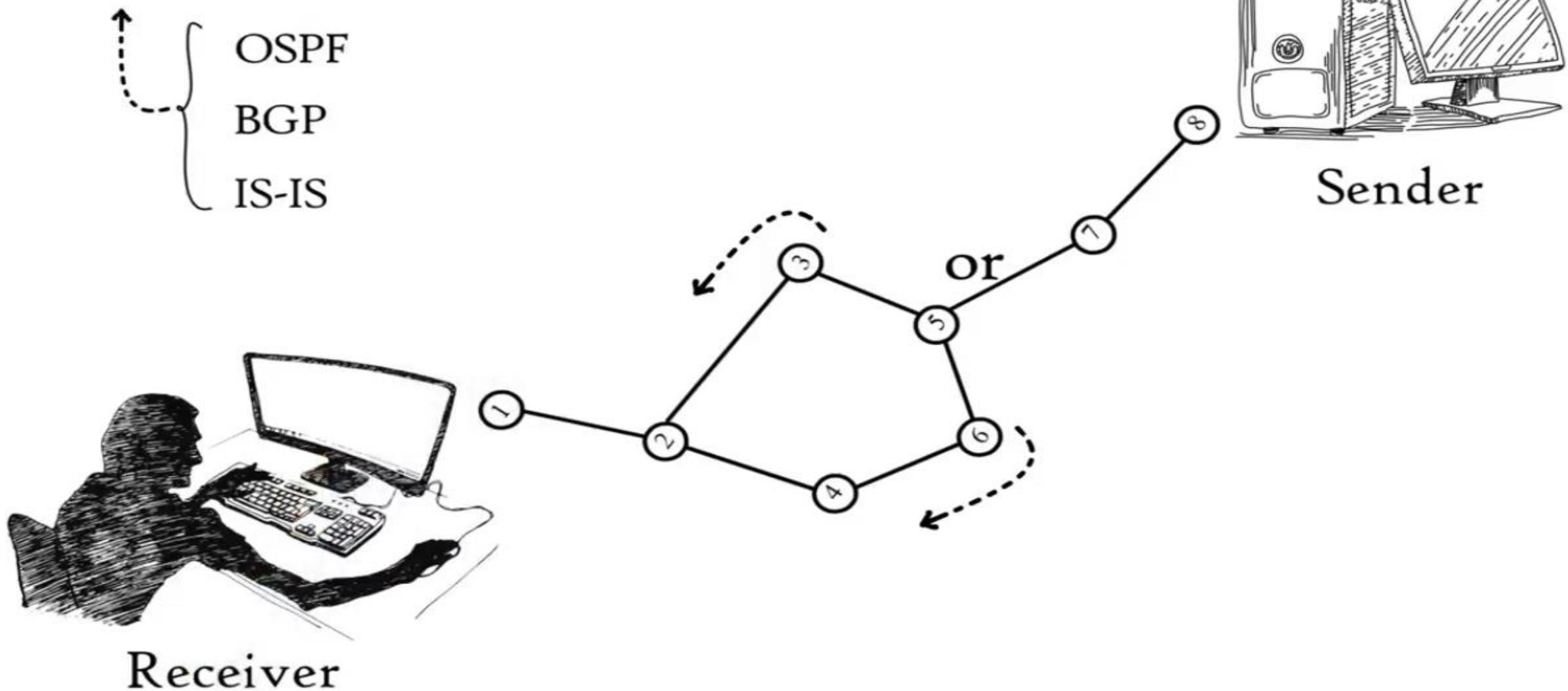


Path determination

Routing



Path determination



Data Packets from
Network Layer



Data Link Layer

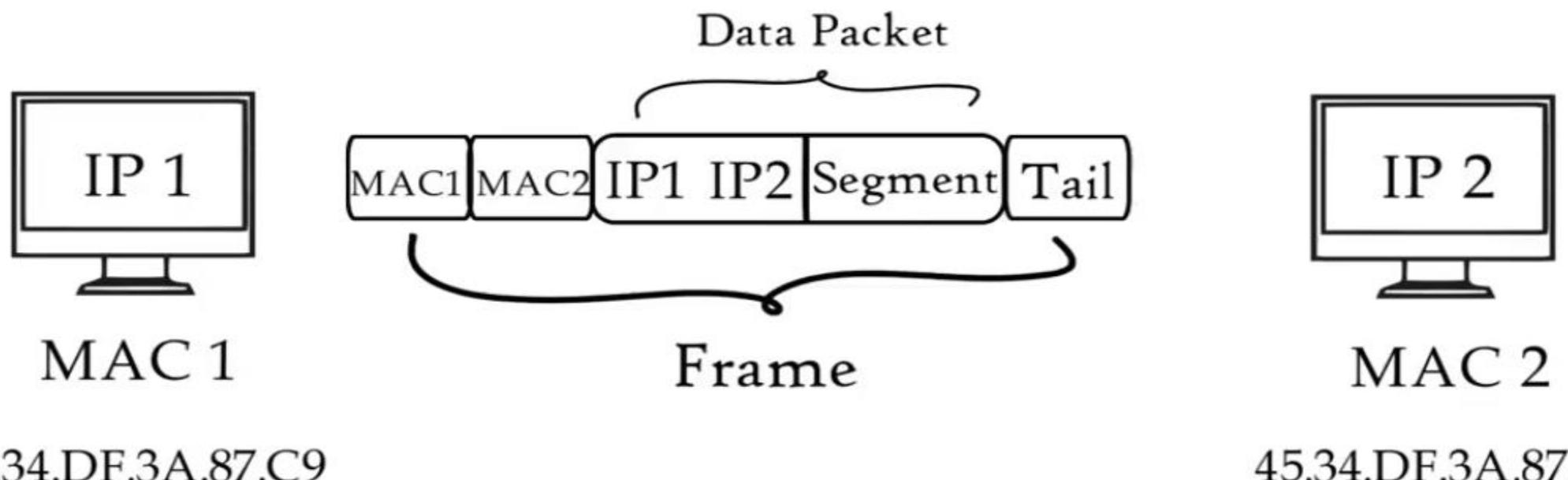
- Logical addressing

- Physical addressi



Data Link Layer

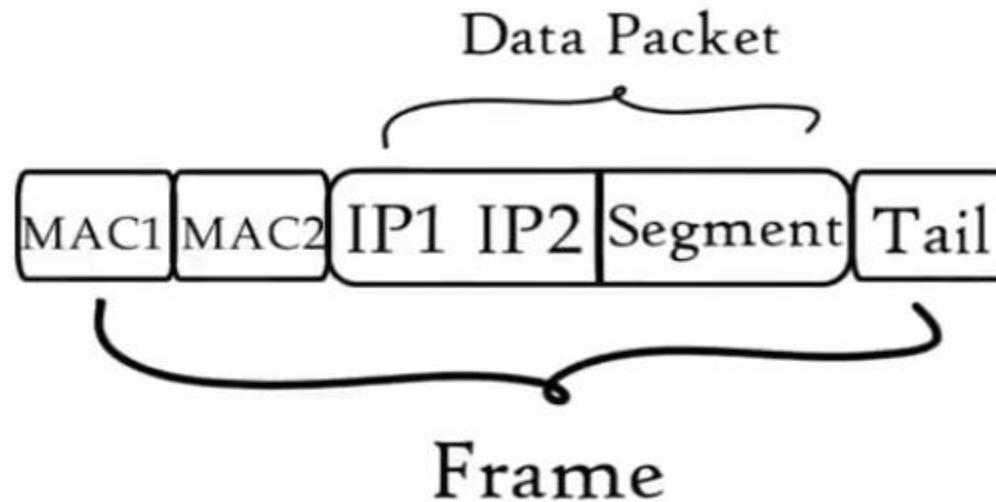
- Logical addressing : Network layer
- Physical addressing : Data Link layer





MAC 1

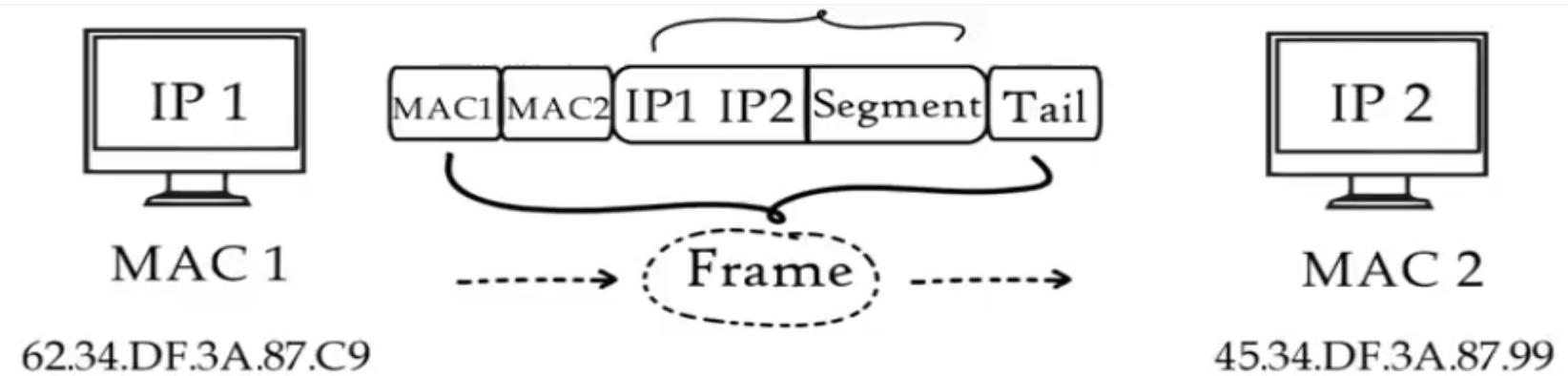
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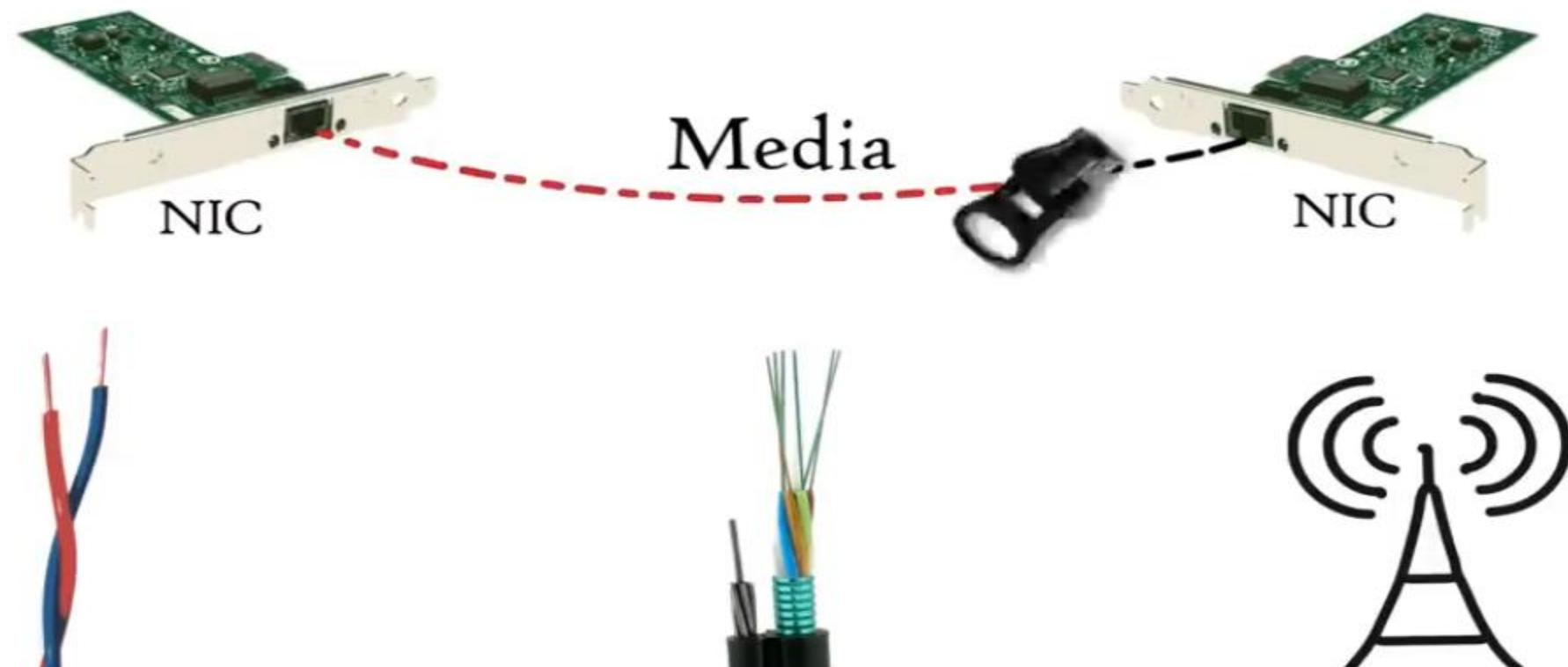
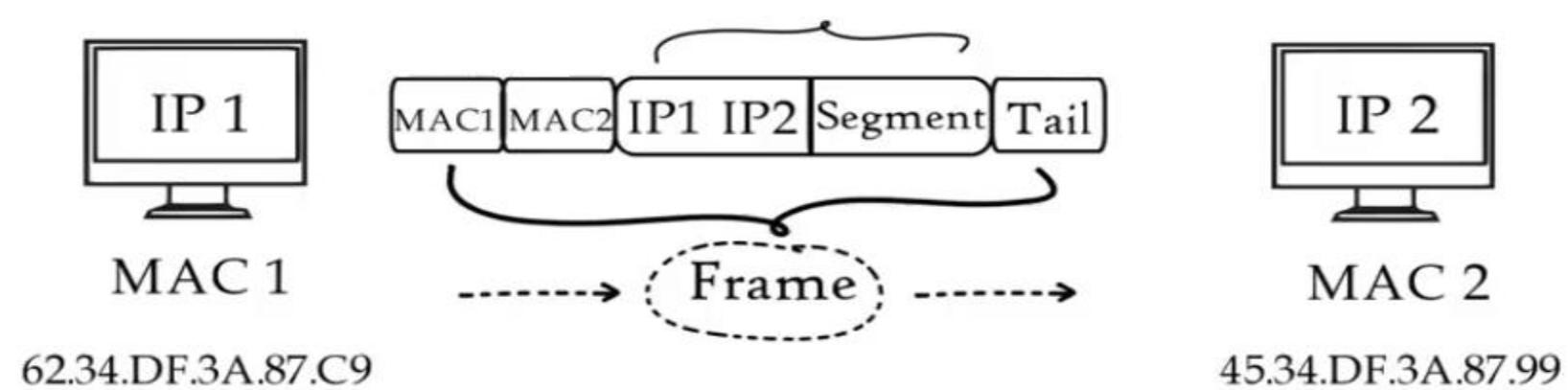


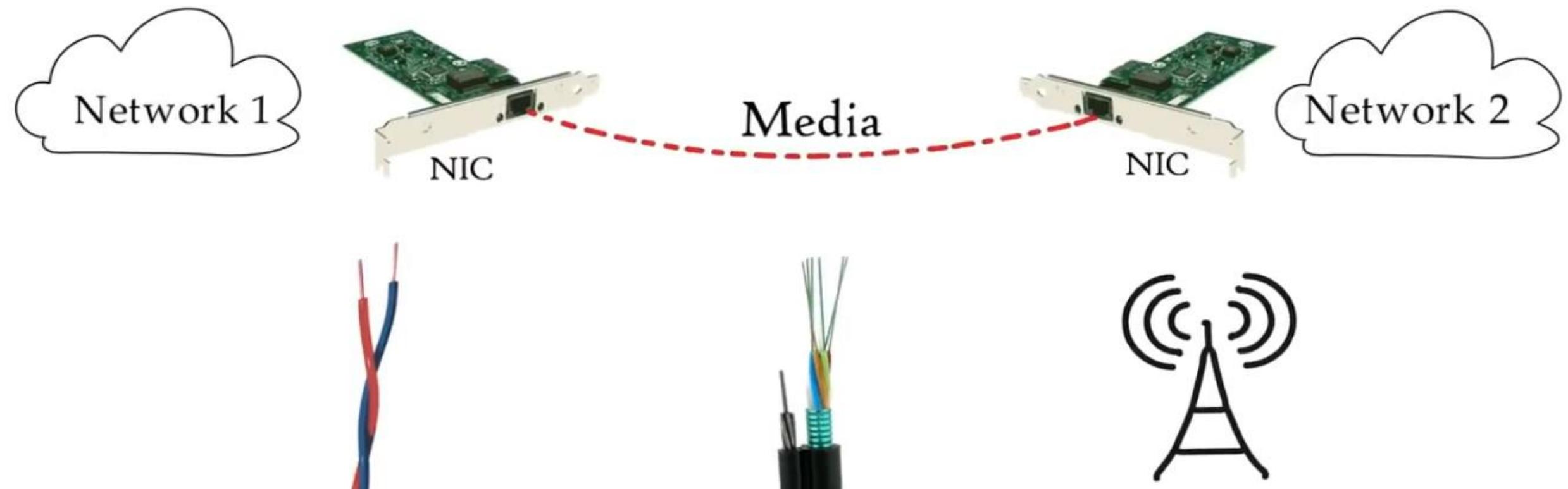
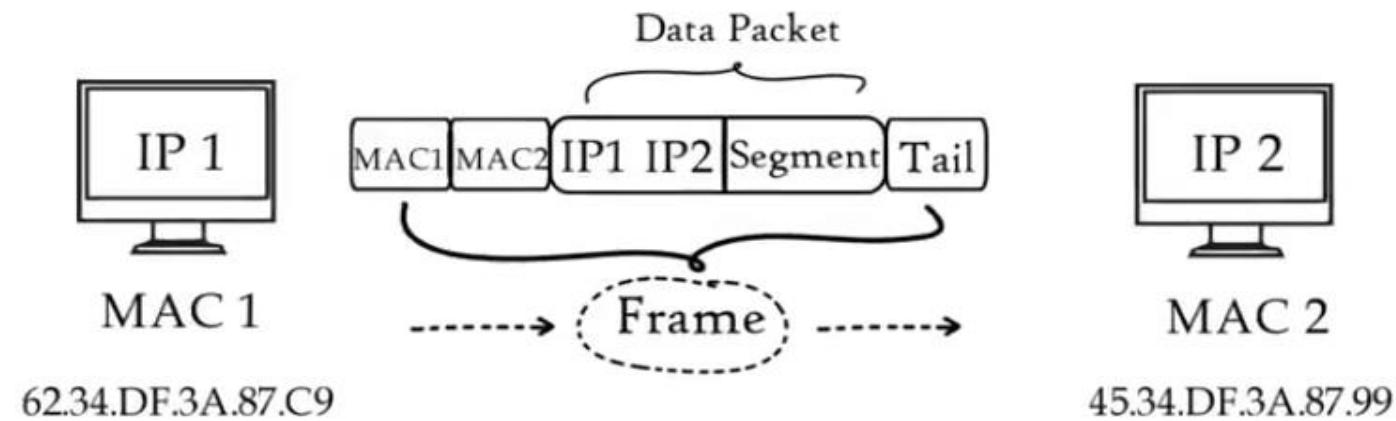
MAC 2

45.34.DF.3A.87.99









Data Link Layer



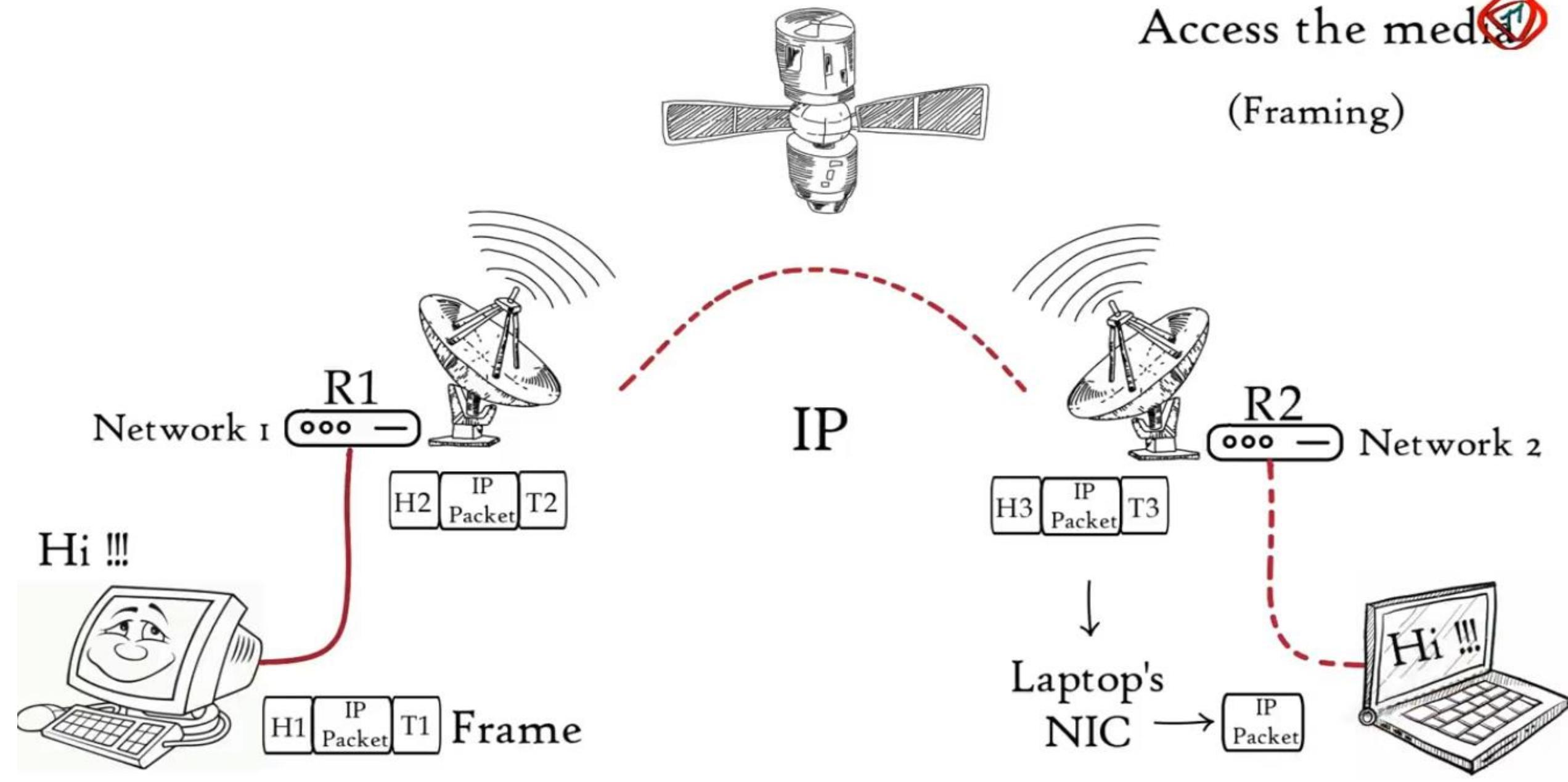
Access the media
(Framing)

Controls how data is placed
and received from the media
(Media Access Control)
(Error Detection)



Access the media 

(Framing)



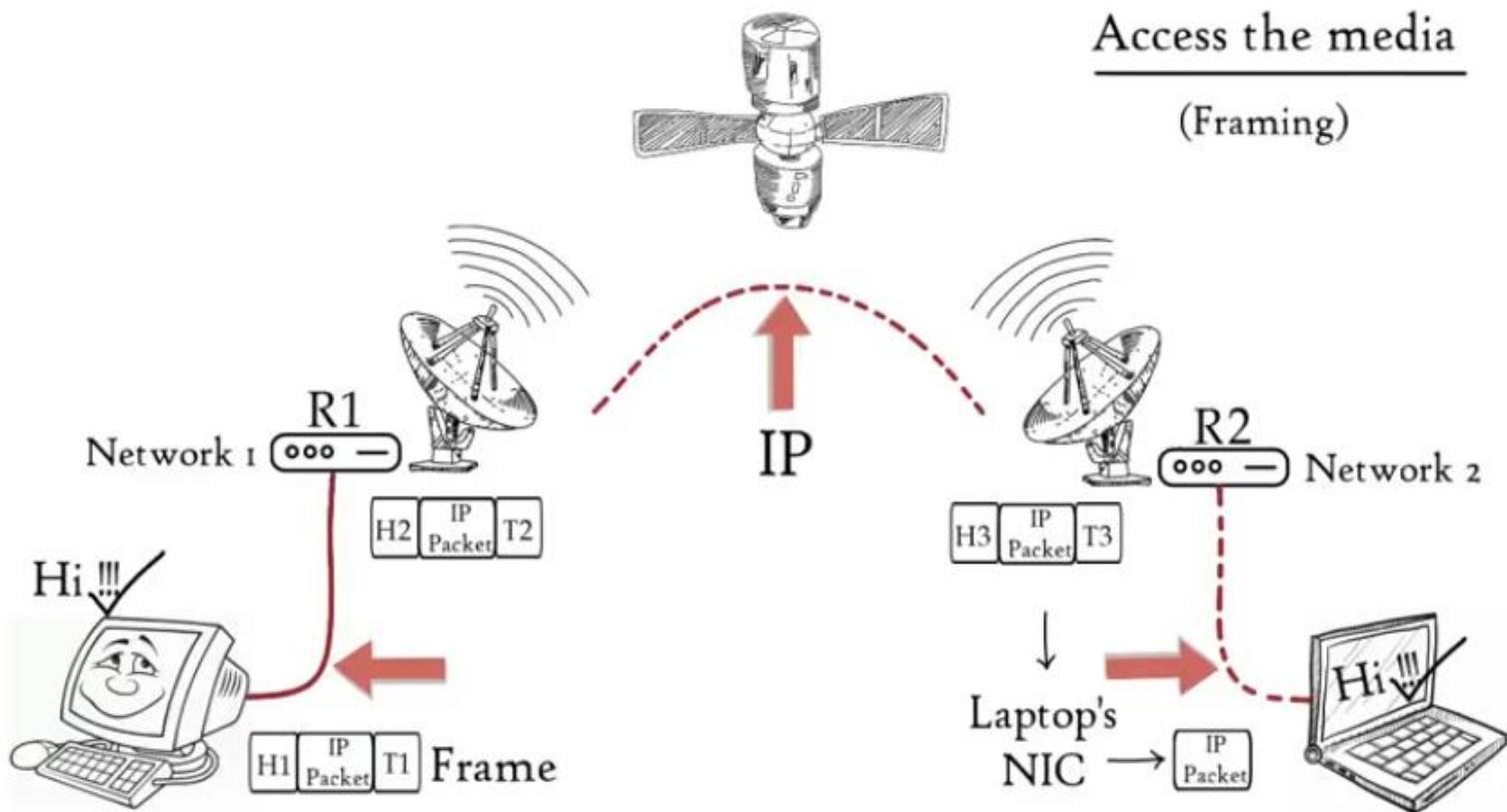


Data Link Layer



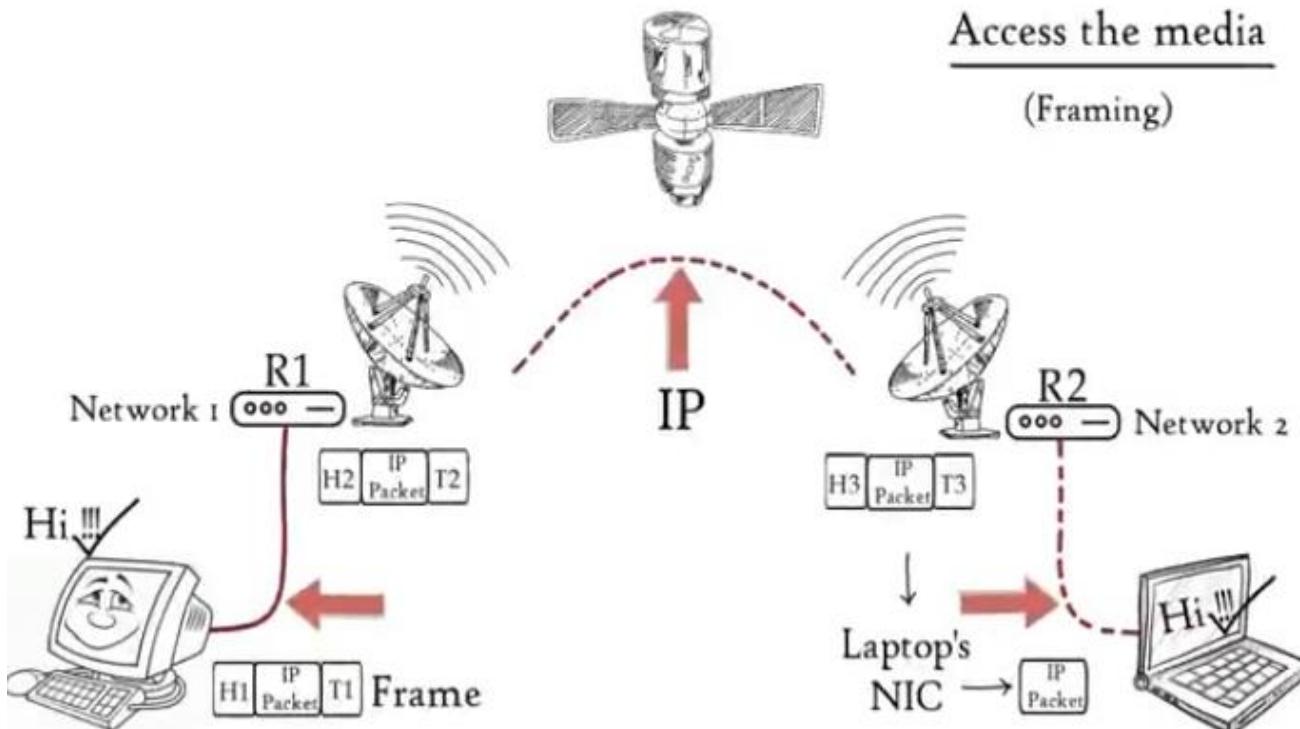
Access the media
(Framing)

Controls how data is placed
and received from the media
(Media Access Control)
(Error Detection)





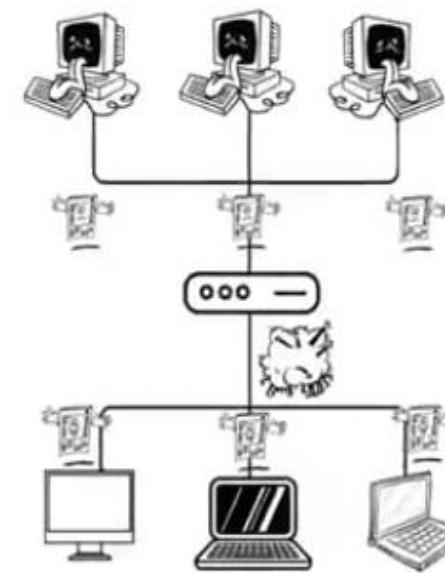
Data Link Layer



Controls how data is placed
and received from the media

→ (Media Access Control)
(Error Detection) ←

DATA LINK LAYER

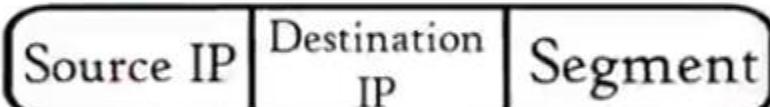


Physical Layer

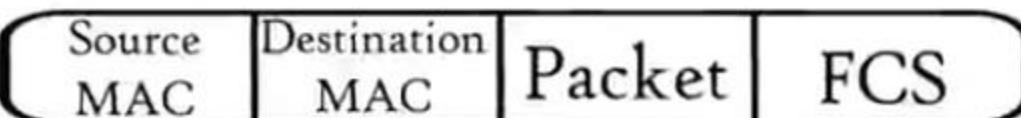


Data (Hi !)

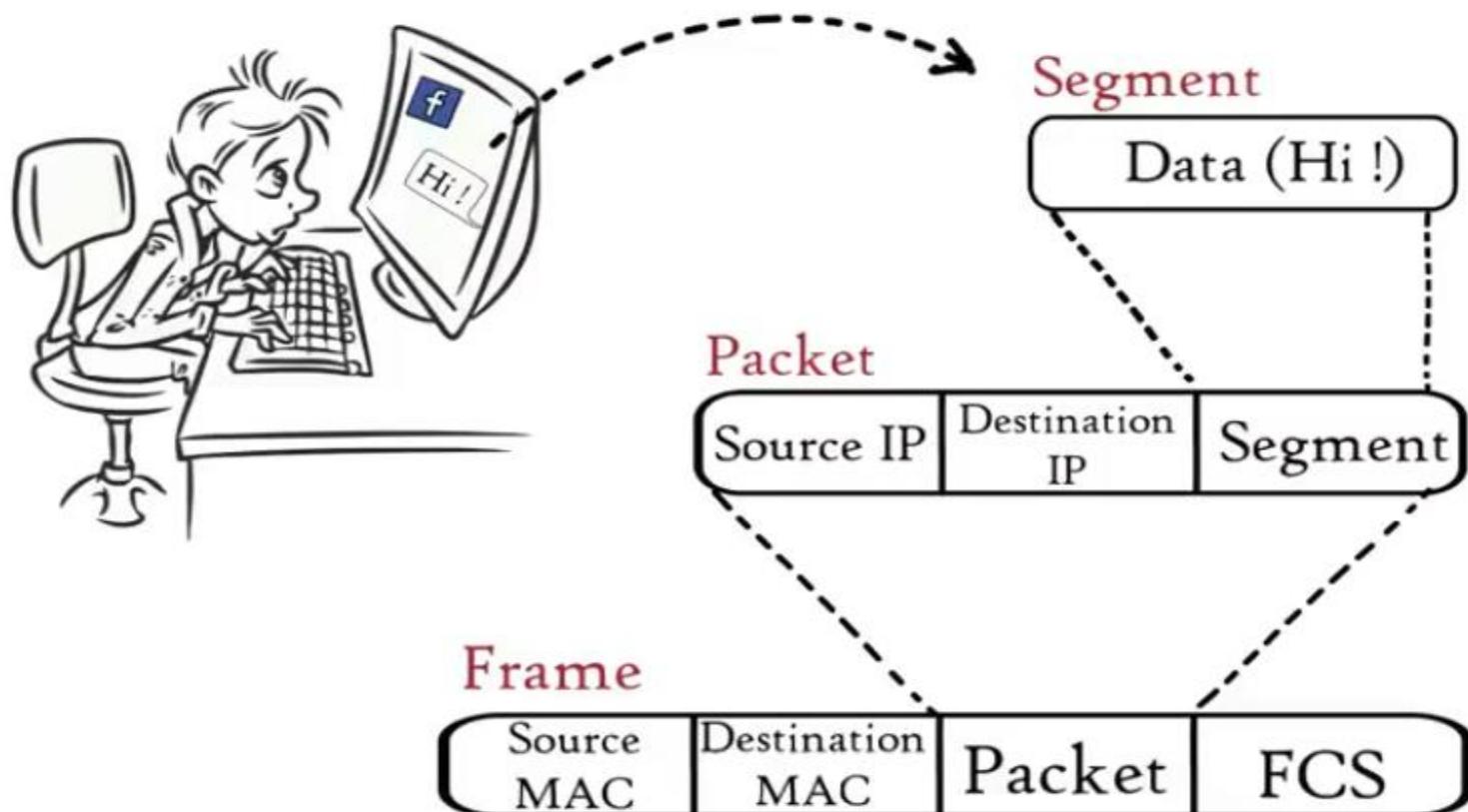
Packet



Frame

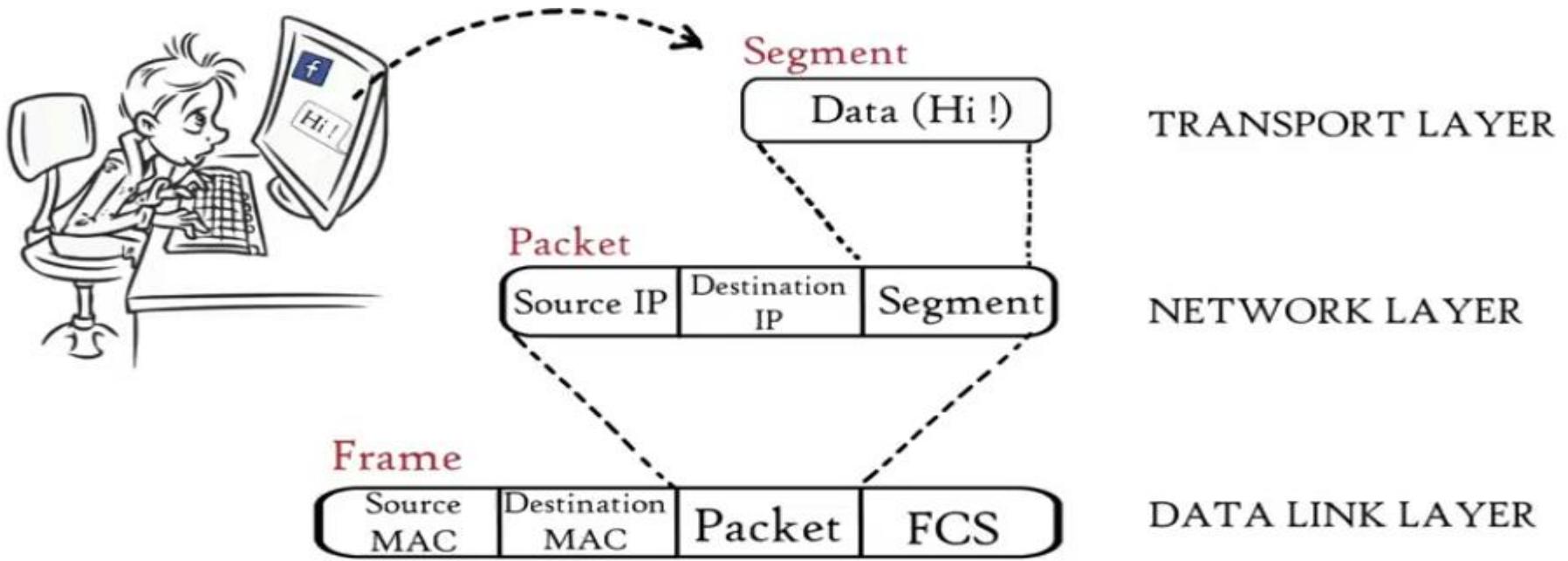


Physical Layer



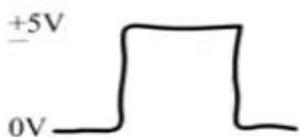
1001011101100101110110111011





1001011101101100101110110111011

BITs



SIGNALS

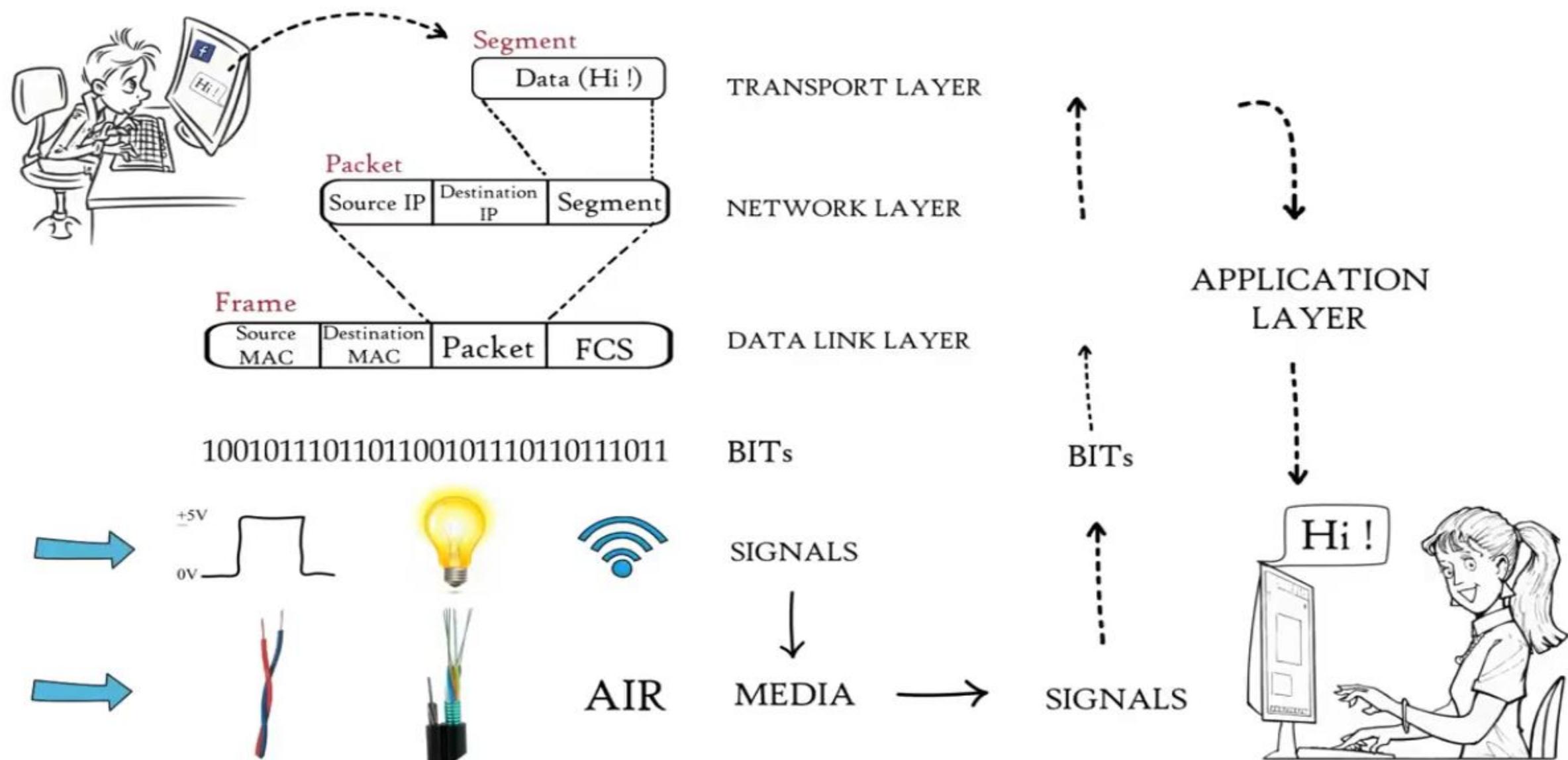


AIR

MEDIA

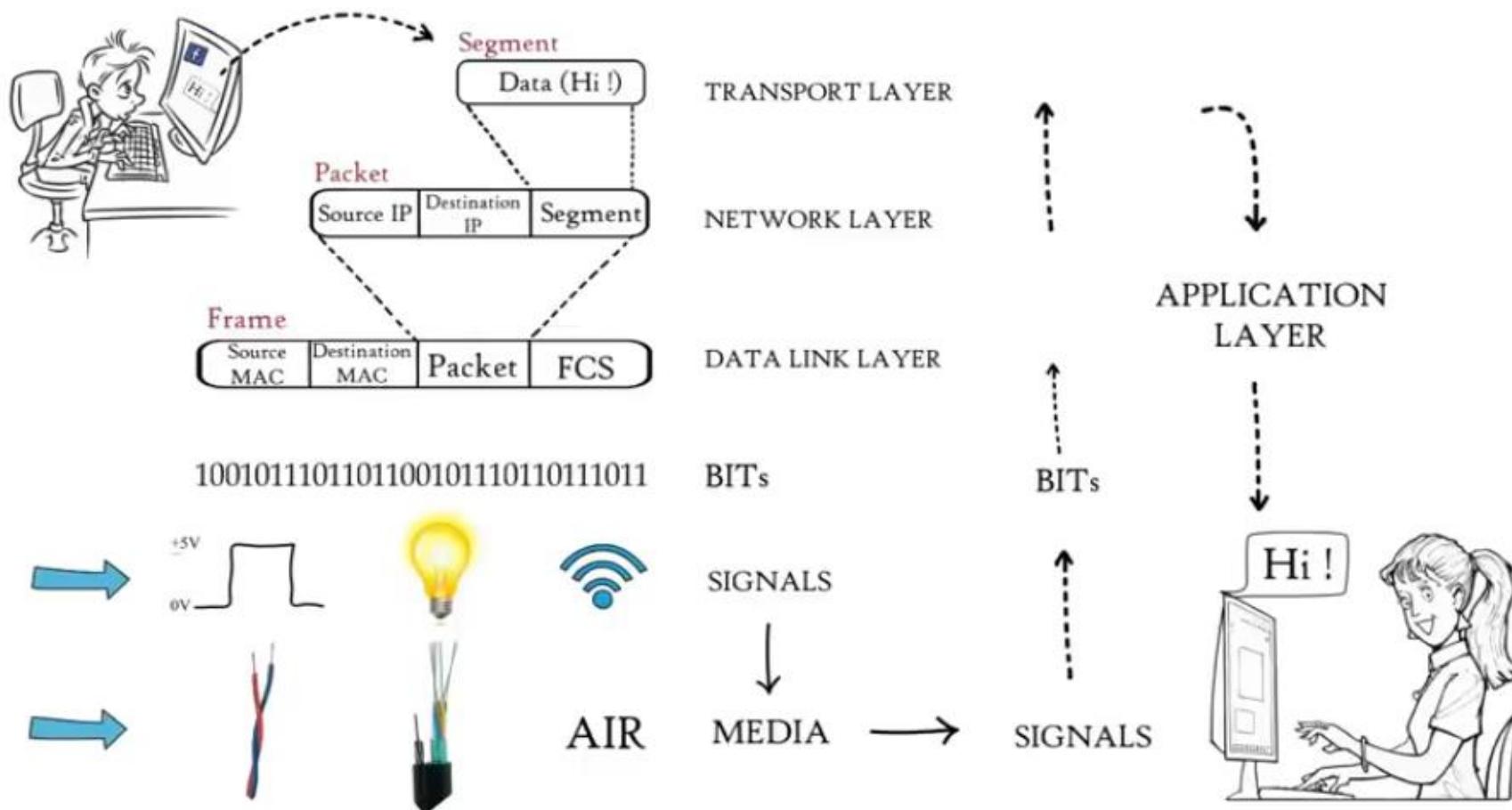


Physical Layer





Physical Layer



Application Layer

Presentation Layer

Session Layer

Transport Layer

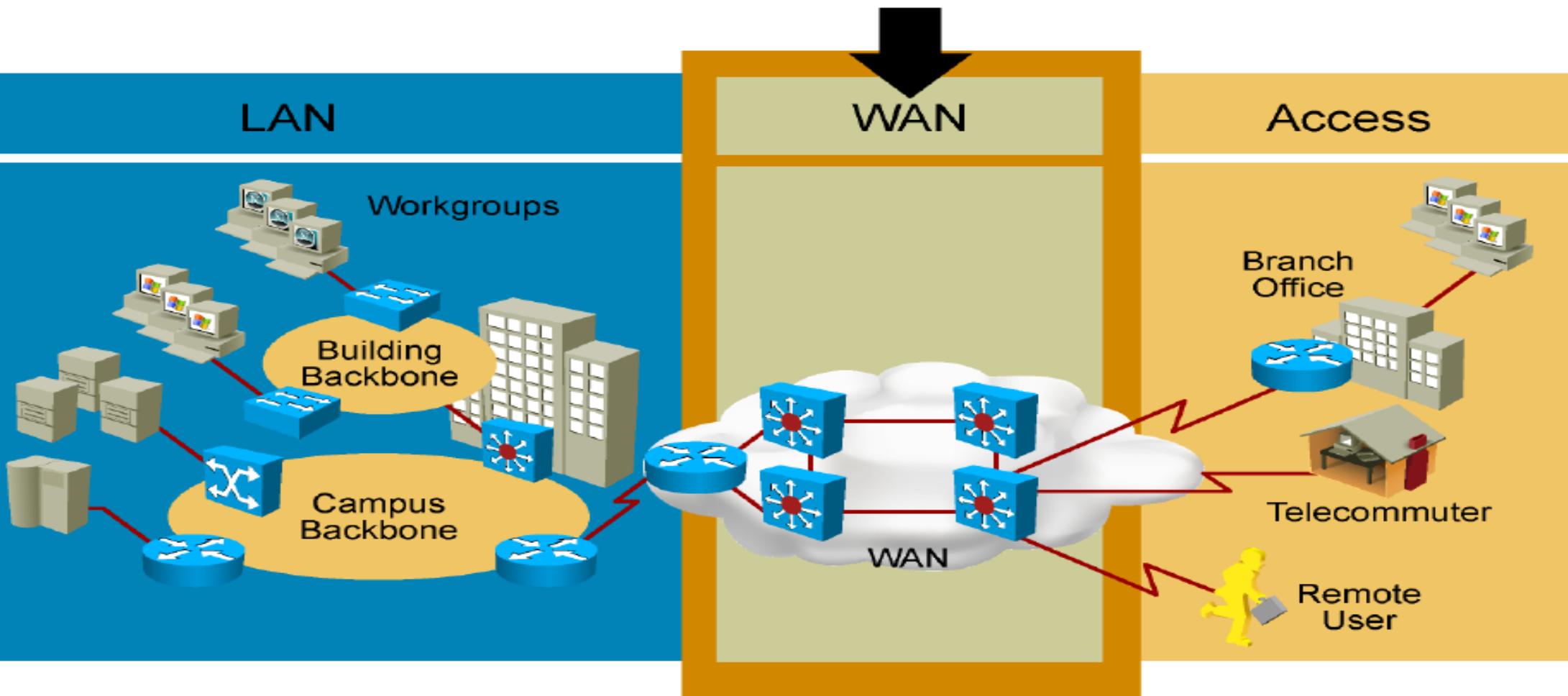
Network Layer

Data Link Layer

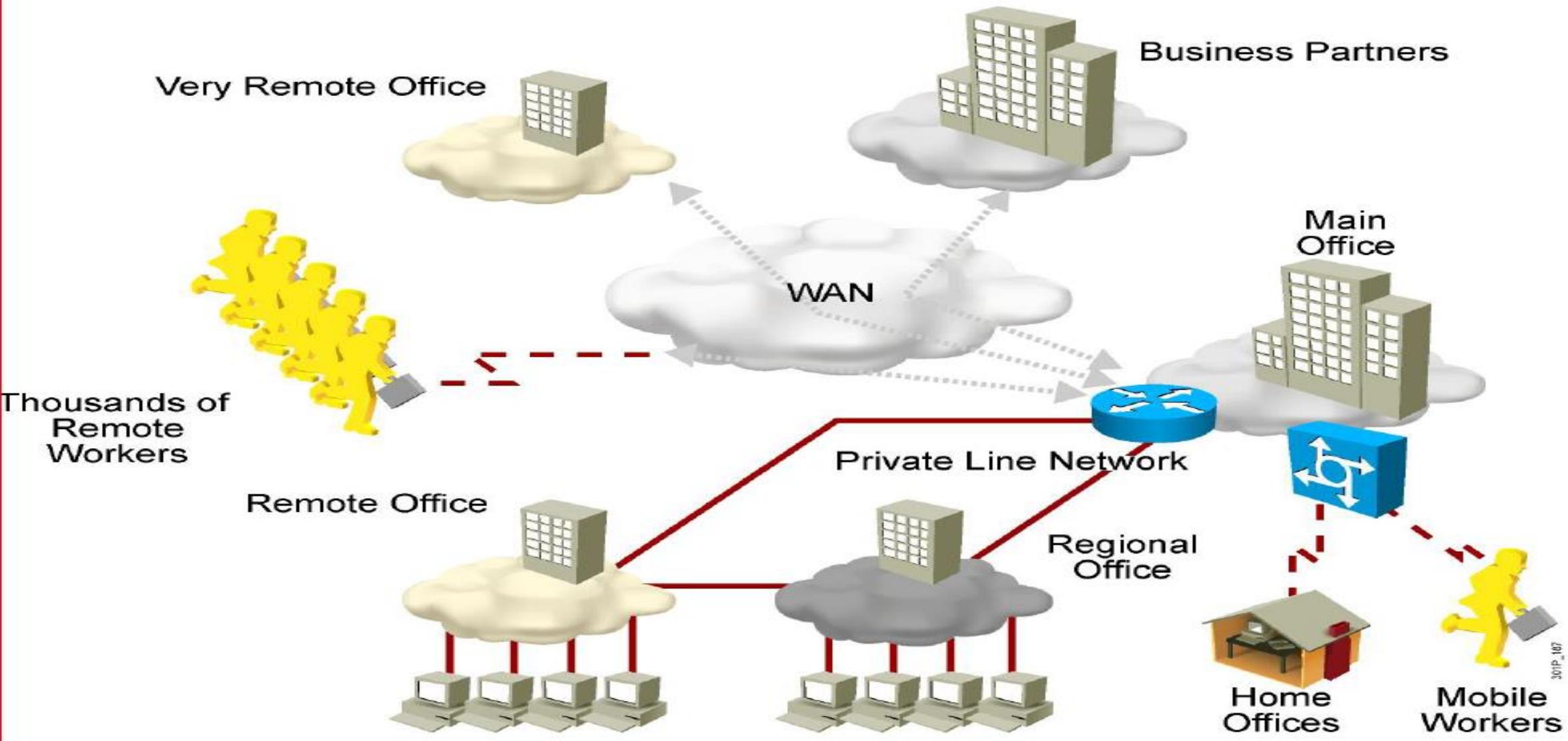
Physical Layer

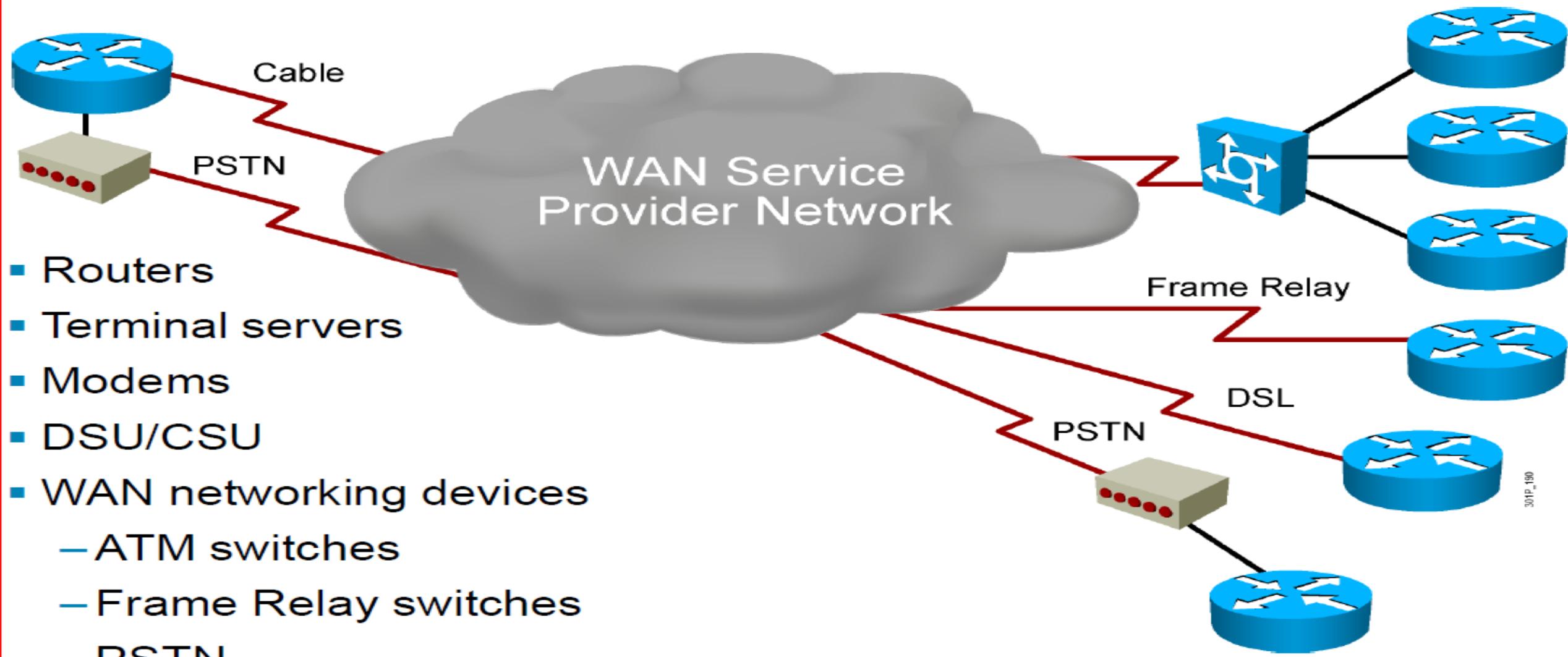


Wide-Area Network

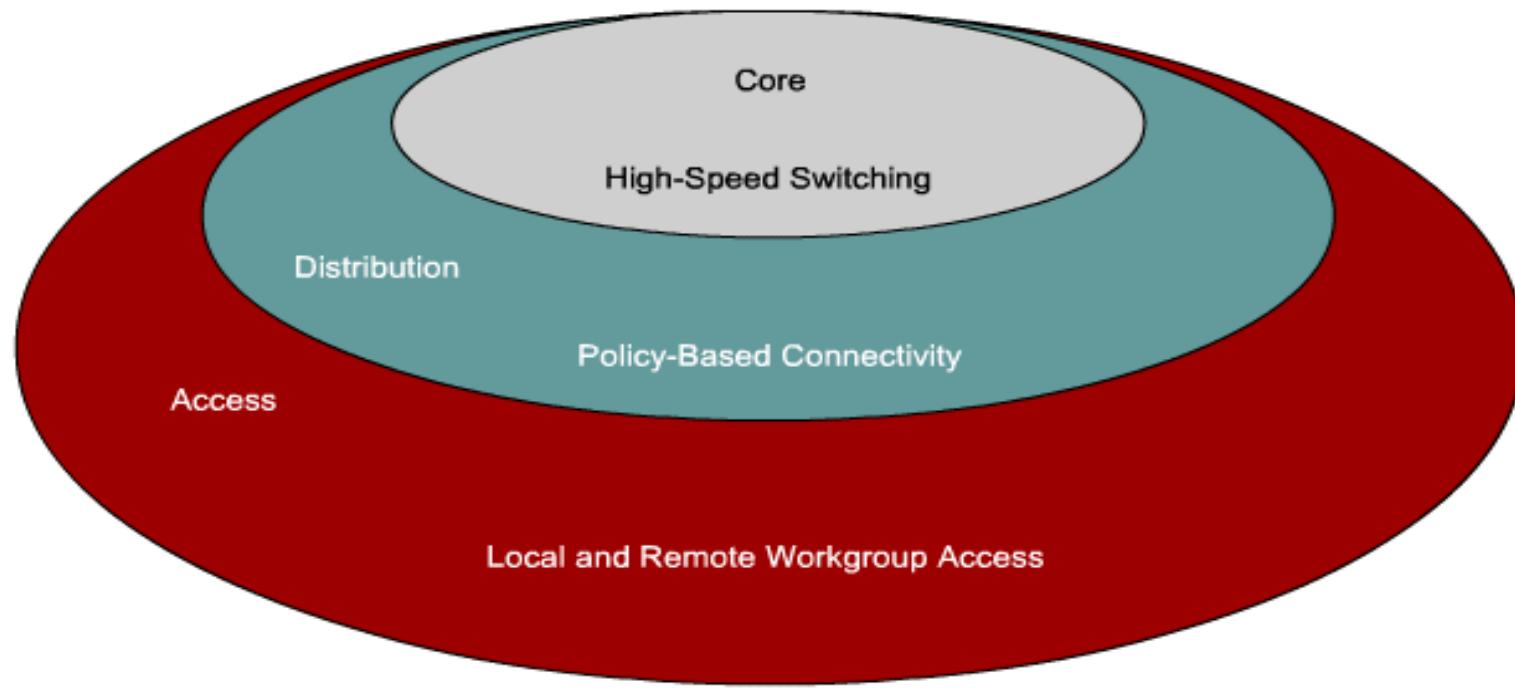


Need for WANs





The Hierarchical Design Model



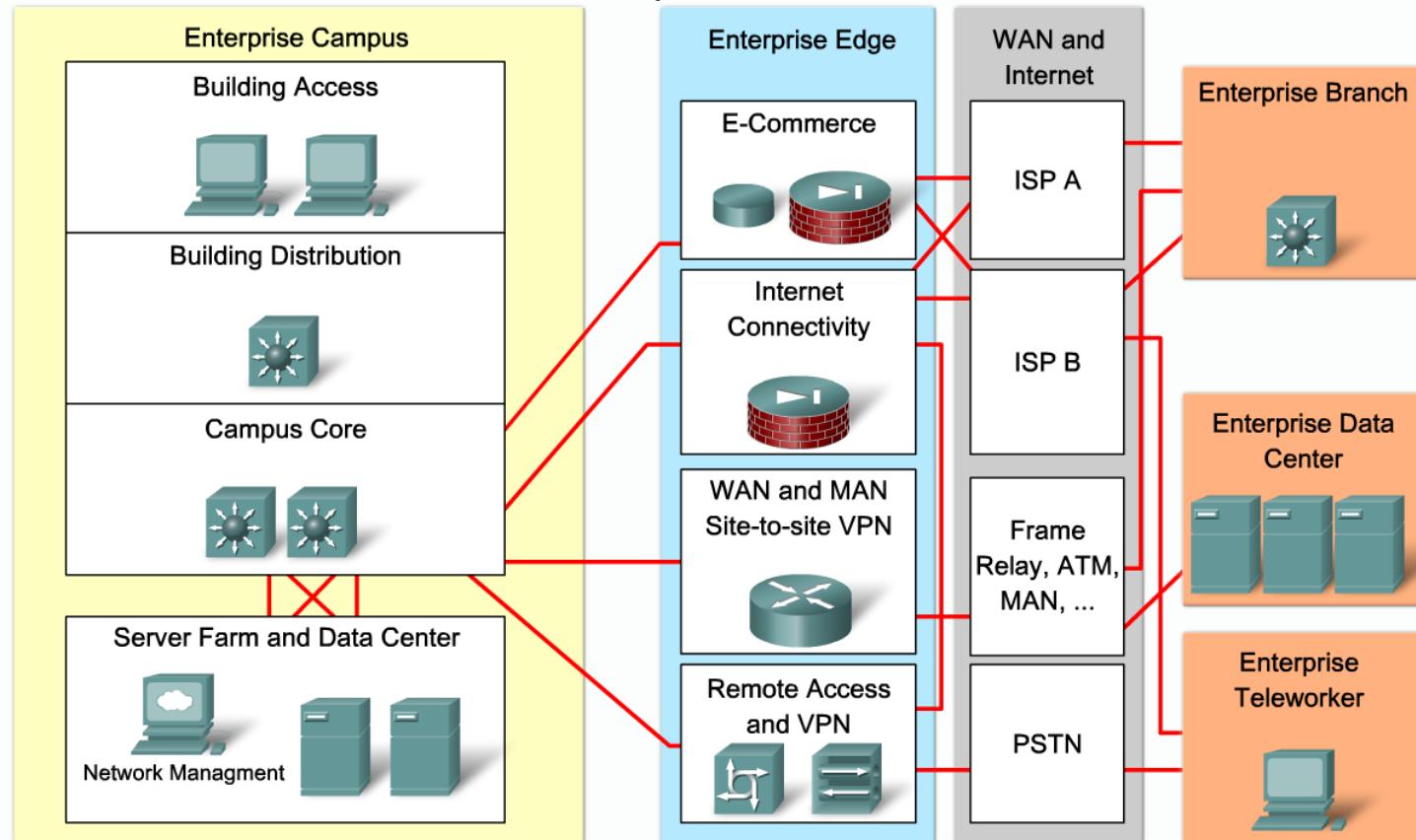
Access layer - Grants user access to network devices.

Distribution layer - aggregates WAN connections at the edge of the campus and provides policy-based connectivity.

Core layer - high-speed backbone that is designed to switch packets as fast as possible.



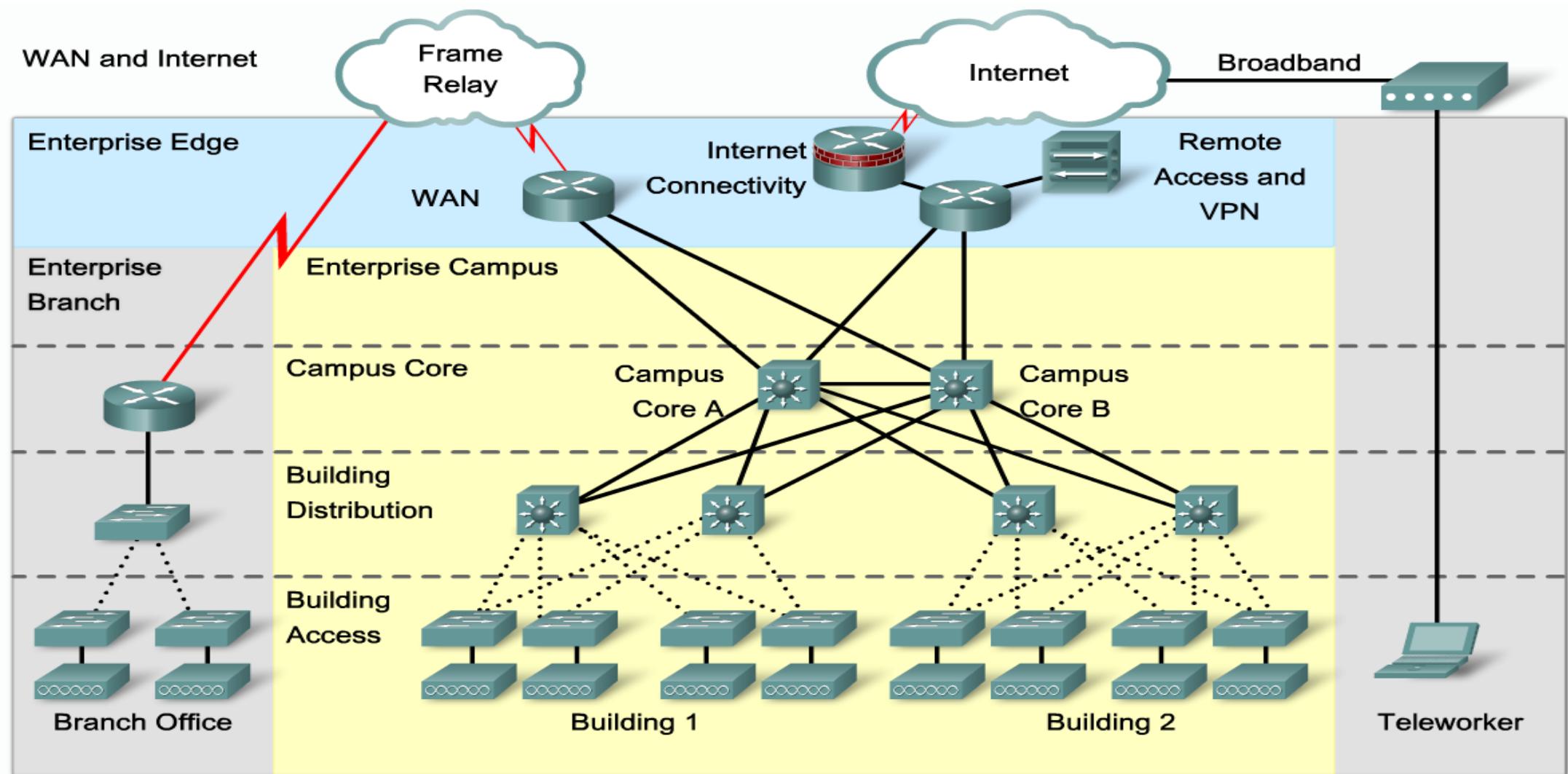
Modules in the Enterprise Architecture



The Cisco Enterprise Architecture consists of modules representing focused views that target each place in the network. Each module has a distinct network infrastructure with services and network applications that extend across the modules.



Example topology



Regional Internet Registries (RIRs)

RIR Name	Geographic Coverage	Link
AfriNIC	Continent of Africa	www.afrinic.net
APNIC (Asia Pacific Network Information Centre)	Asia Pacific region	www.apnic.org
ARIN (American Registry for Internet Numbers)	Canada, the United States, and several islands in the Caribbean Sea and North Atlantic Ocean	www.arin.net
LACNIC (Latin America and Caribbean Internet Addresses Registry)	Central and South America and portions of the Caribbean	www.lacnic.net
RIPE (Réseaux IP Européens)	Europe, the Middle East, and Central Asia	www.ripe.net



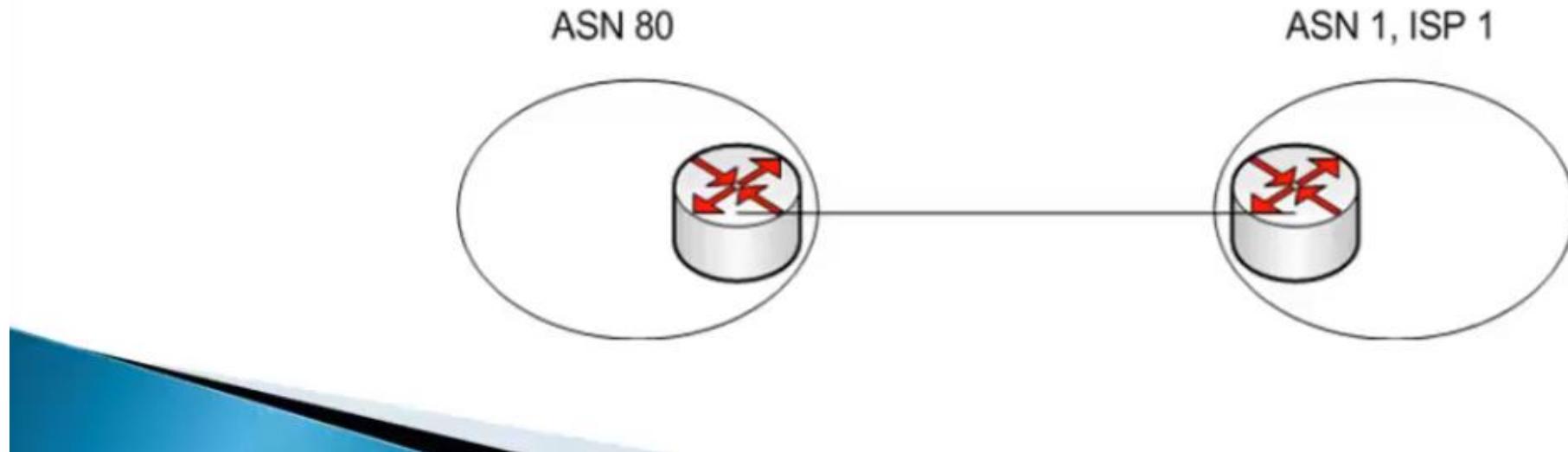
What we Learn

- ▶ *Types of ISP Connections*
 - *Single Homed*
 - *Dual-homed site*
 - *Multi-homing*
 - *Dual Multi-homed*
- ▶ *Connecting to the Internet with BGP*
 - *Default route from provider(s)*
 - *Some routes + default route* –
 - *All routes (full table)* –



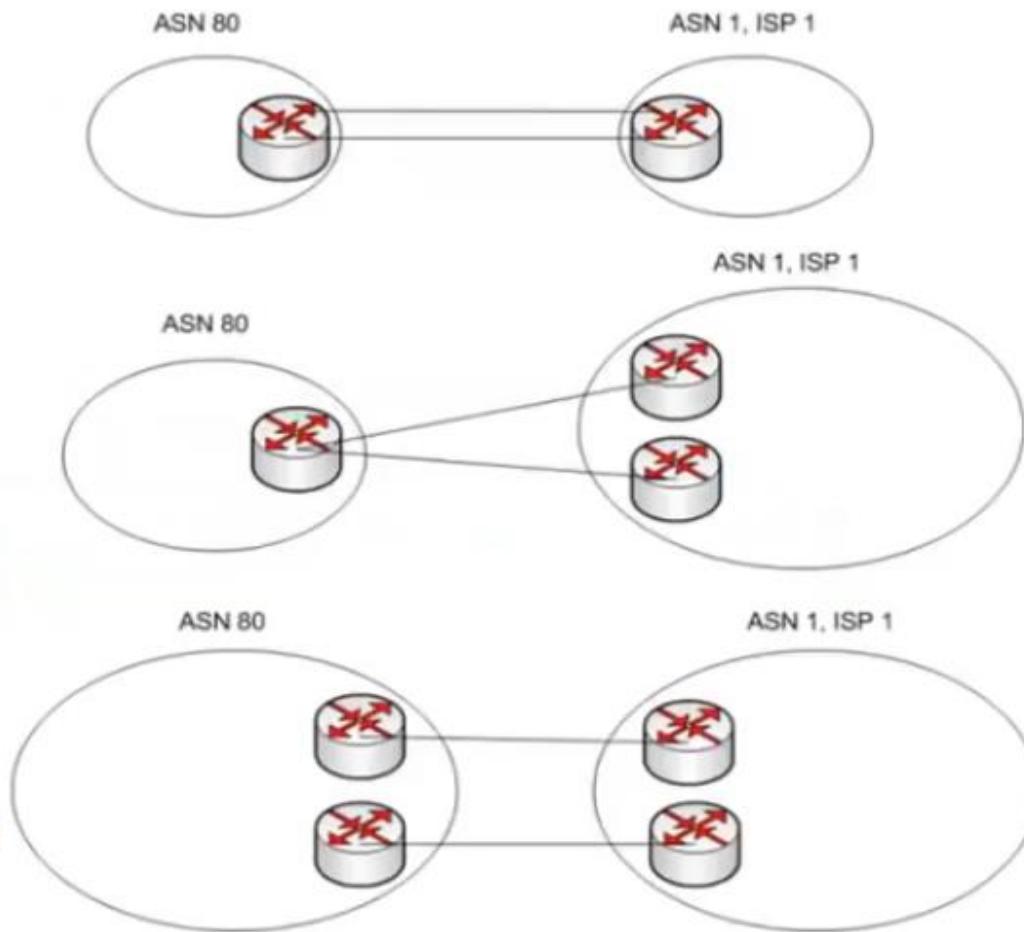
Single homed site

- ▶ A site with a single ISP connection is single-homed.
- ▶ This is fine for a site that does not depend heavily on Internet or WAN connectivity.
- ▶ Either use static routes, or advertise the site routes to the ISP and receive a default route from the ISP.



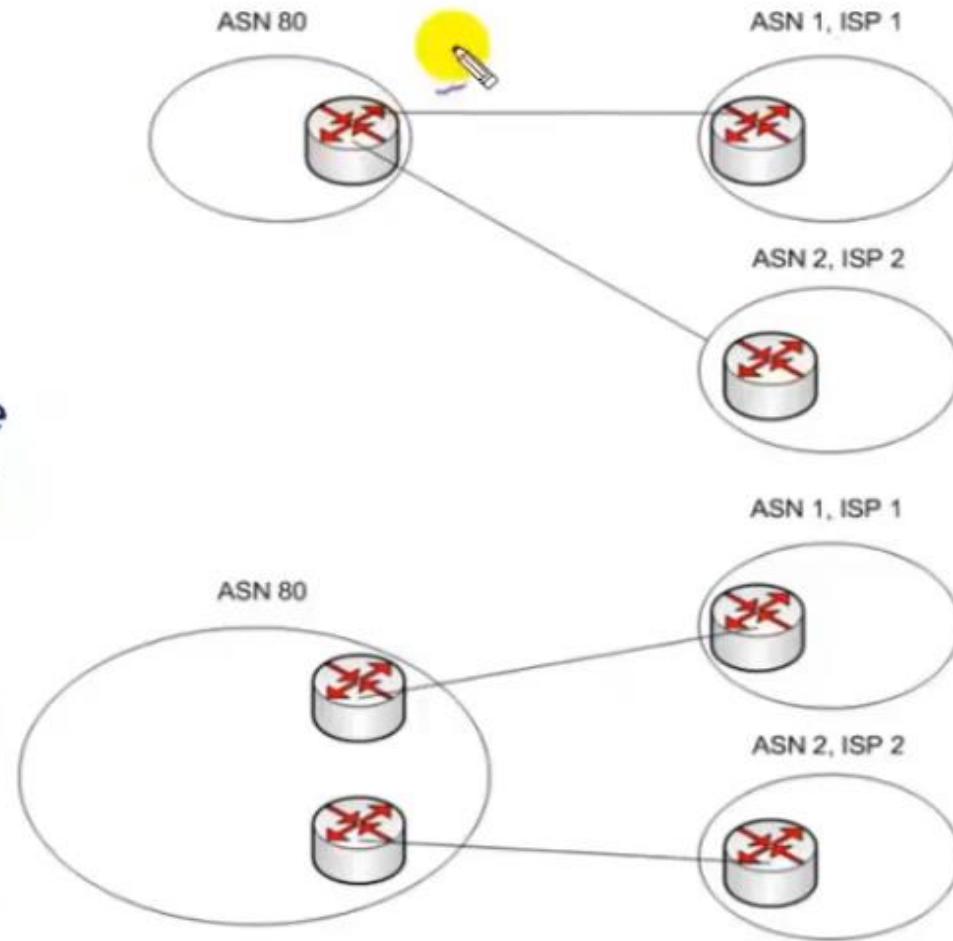
Dual-homed site

- ▶ A dual-homed site has two connections to the same ISP, either from one router or two routers.
- ▶ One link might be primary and the other backup, or the site might load balance over both links.
- ▶ Either static or dynamic routing would work in this case.



Multihoming

- ▶ *Multi-homing means connecting to more than one ISP at the same time.*
- ▶ *It is done for redundancy and backup if one ISP fails and for better performance if one ISP provides a better path to frequently used networks.*
- ▶ *This also gives you an ISP-independent solution.*
- ▶ *BGP is typically used with multihomed connections.*



Dual Multihomed

- ▶ You can take multihoming a step further and be dual-multihomed, with two connections to multiple ISPs.
- ▶ This gives the most redundancy.
- ▶ BGP is used with the ISPs and can be used internally also.

