MINISTRY OF EDUCATION AND SCIENCE OF THE REPUBLIC OF KAZAKHSTAN

NUR-MUBARAK EGYPTIAN UNIVERSITY OF ISLAMIC CULTURE

Chair «GENERAL HUMANITARIAN SUBJECTS»

Course

«Information and communication technologies»

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№

LECTURES

1 The role of ICTs in key sectors of society. ICT Standards.
2 Introduction into computer systems. Architecture of computer systems.
3 Software. OS.
4 Human-computer interaction.
5 Database systems.
6 Data analysis. Data management.
7 **Networks and Telecommunications.**
8 Cyber safety.
9 Internet technologies.
10 Cloud and Mobile technologies.
11 Multimedia technologies
12 Smart technology.
13 E-technology. E-business. E-learning. E-government.
14 Information technology in the professional sphere. Industrial ICT.
15 ICT Development Prospects

LECTURE 7

In general in this lecture you will learn about:

- End devices, communication devices and communication media.
- Network types.
- LANs and WANs.
- Wired and wireless networking technologies.
- Stack protocols: TCP / IP, OSI.
- MAC addressing. IP-addressing.
- The DHCP protocol.
- Connectivity technology to the Internet.
- Telecommunication technologies.

What is a Network?

A network is two or more computers, or other electronic devices, connected together so that they can exchange data.

For example a network allows computers to share files, users to message each other, a whole room of computers to share a single printer, etc.

What is a Network?

What does Computer Network mean?

- A computer network is a group of computer systems and other computing hardware devices that are linked together through communication channels to facilitate communication and resource-sharing among a wide range of users.

Computers in a Network

Computers connected together to create a network fall into two categories: **servers** and **clients** (workstations).

Clients

Client computers, or **workstations**, are the **normal computers** that people sit at to get their **work** done.

Servers

Servers are special, powerful computers that provide '**services**' to the **client** computers on the network.

Networks and Telecommunications.

End devices, communication devices and communication media.

Networking Hardware

Network Interface Card (NIC)

Any computer that is to be connected to a network, needs to have a network interface card (NIC).

Network Cable

To connect together different devices to make up a network, you need cables.

Networking Hardware

Hub

A hub is a device that **connects** a number of computers together to make a **LAN**.

Switch

A switch, like a hub, is a device that **connects** a number of computers together to make a **LAN**.

Router

A router is a network device that **connects** together **two or more networks**.

Bridge

A bridge is a network device that typically **links** together **two different parts of a LAN**.

Whereas a router is usually used to link a LAN to a WAN (such as the Internet), a bridge links independent parts of a LAN so that they act as a single LAN.

Proxy Server

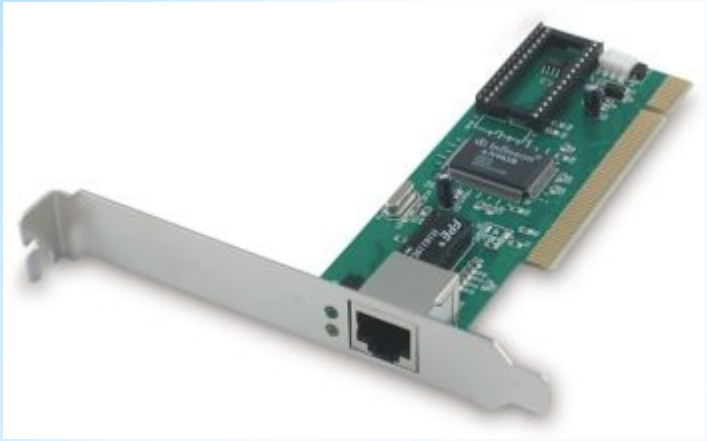
A proxy server is a computer setup to **share a resource**, usually an **Internet connection**.

Firewall

A firewall is a **device**, or a piece of **software** that is placed between your computer and the rest of the network (where the hackers are!)

Modem

Before the days of broadband Internet connections, most computers connected to the Internet via **telephone lines** (**dial-up** connections).



54Mbps
802.11g
Wireless LAN
PCICard
Wireless

Link/Act
10/100
WAN
1
2
3
4

NETGEAR

Network Cabling

- Unshielded Twisted Pair (UTP) Cable

- Shielded Twisted Pair (STP) Cable

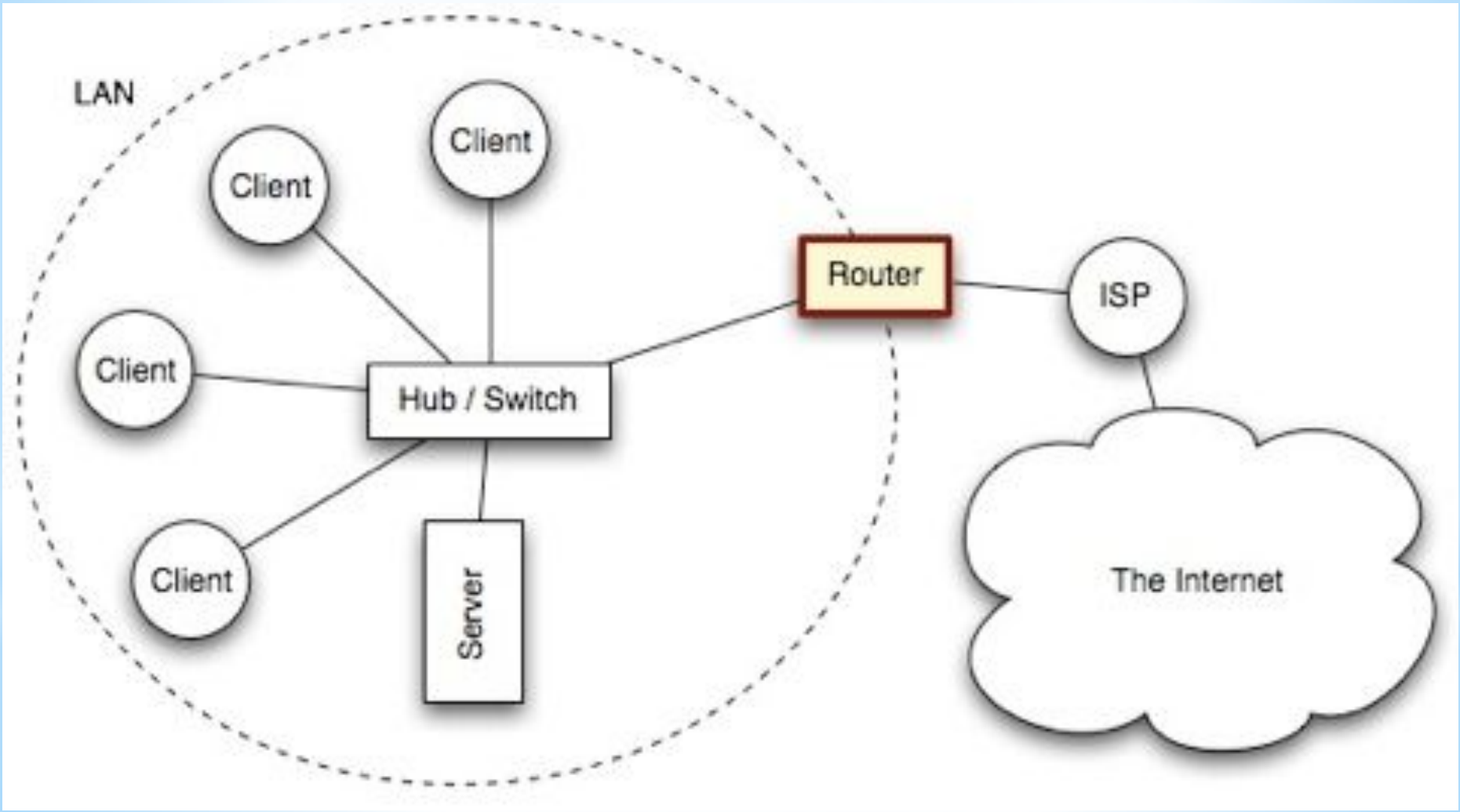
- Coaxial Cable

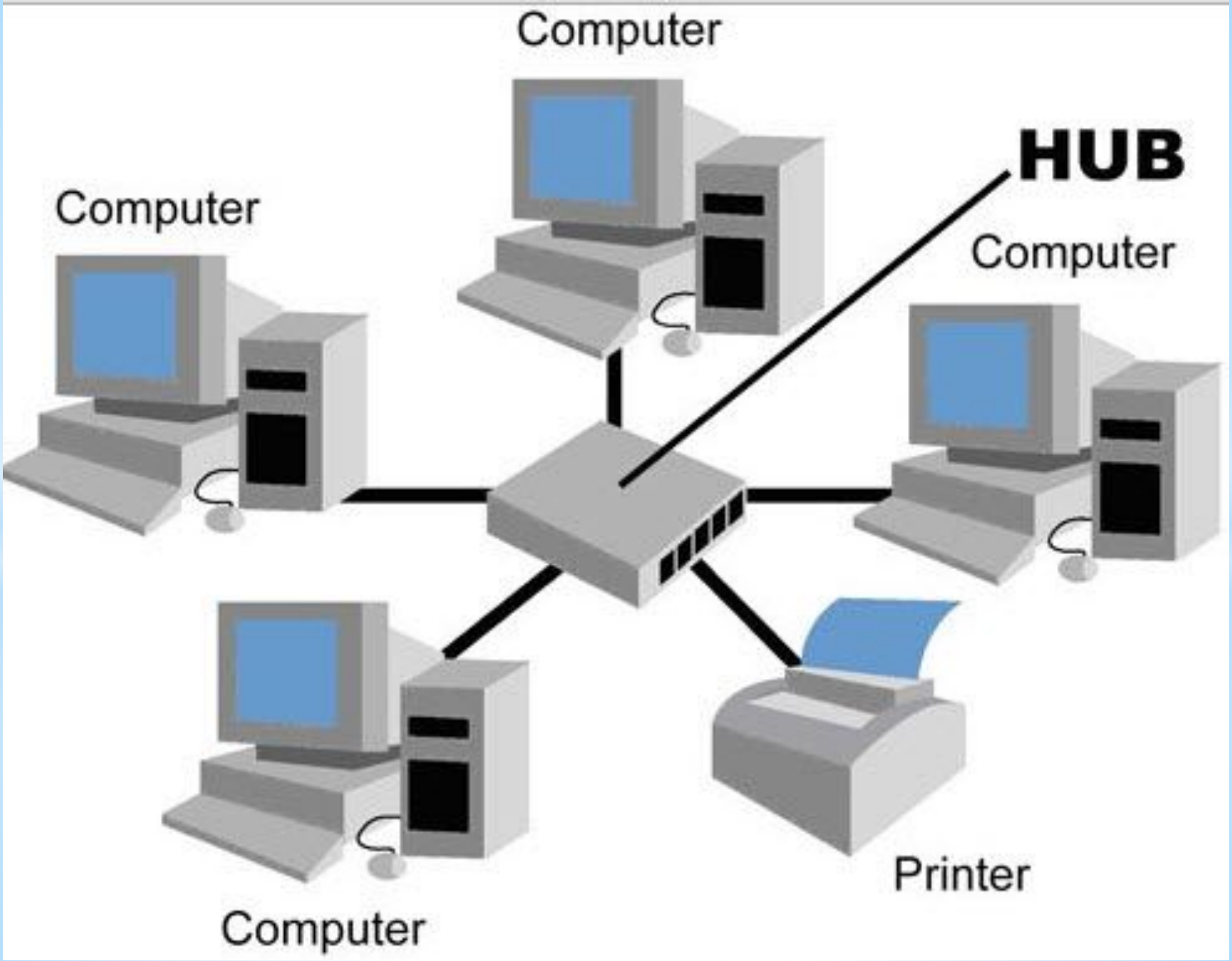
- Coaxial Cable Connectors

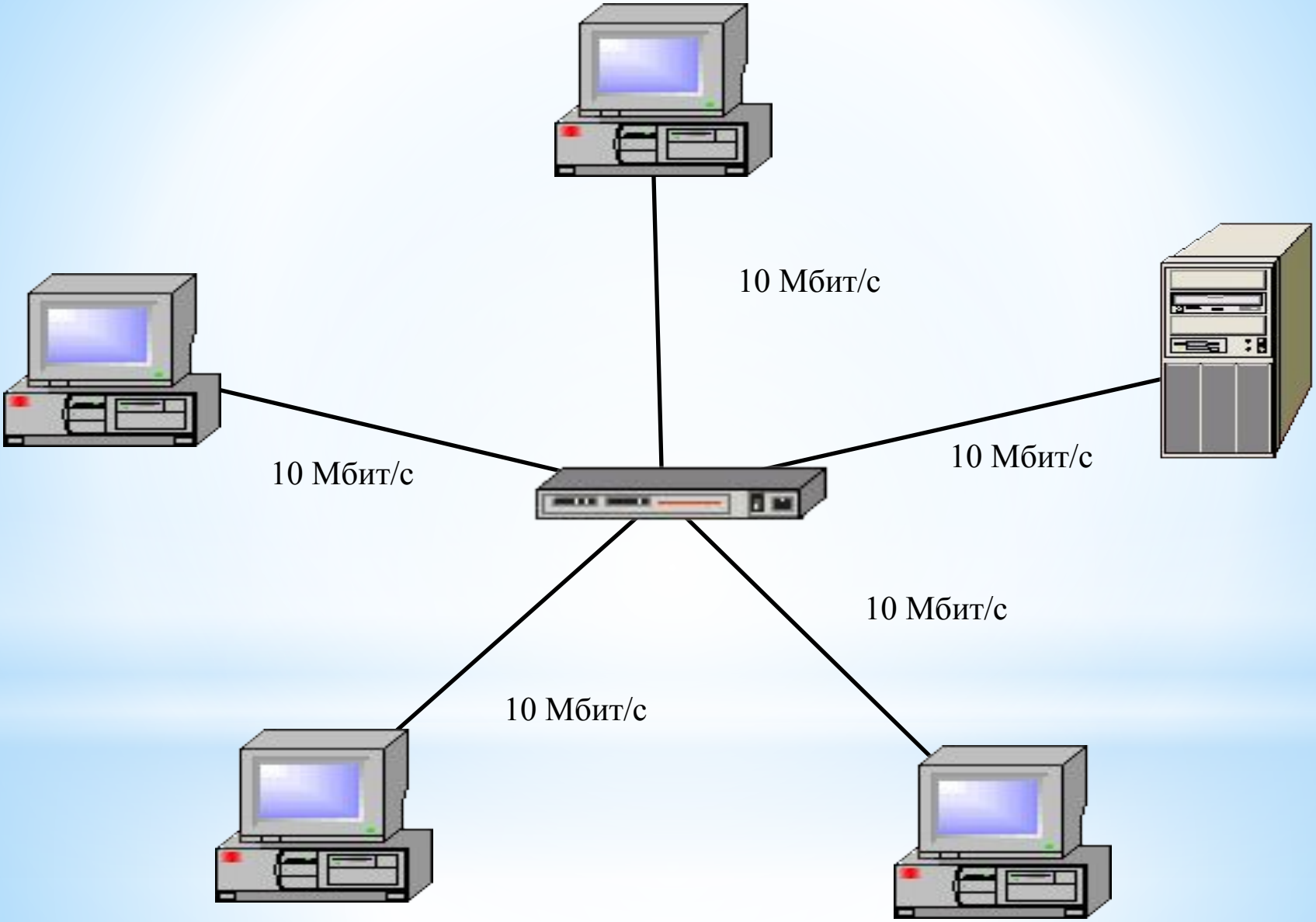
- Fiber Optic Cable

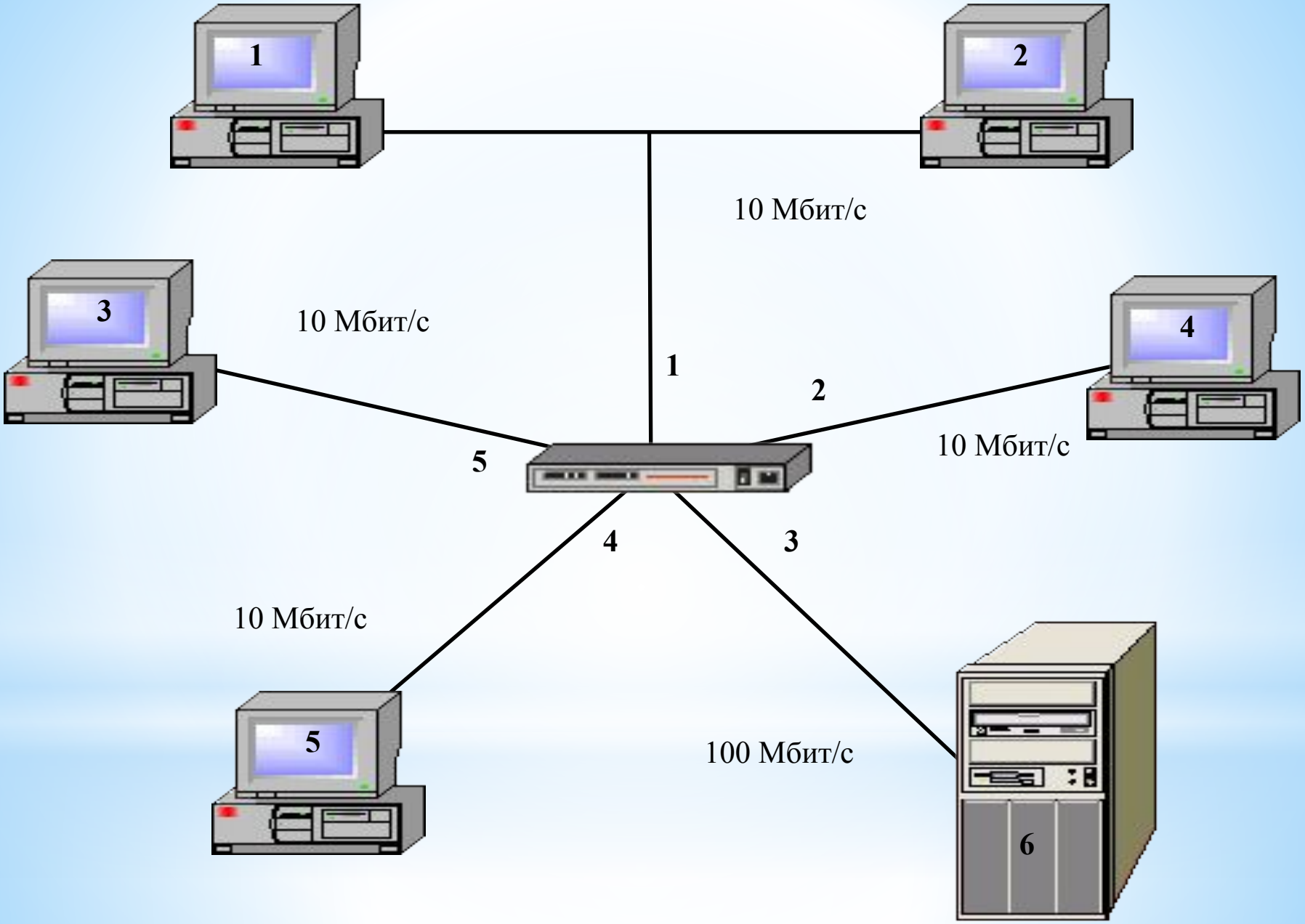
- Wireless LANs

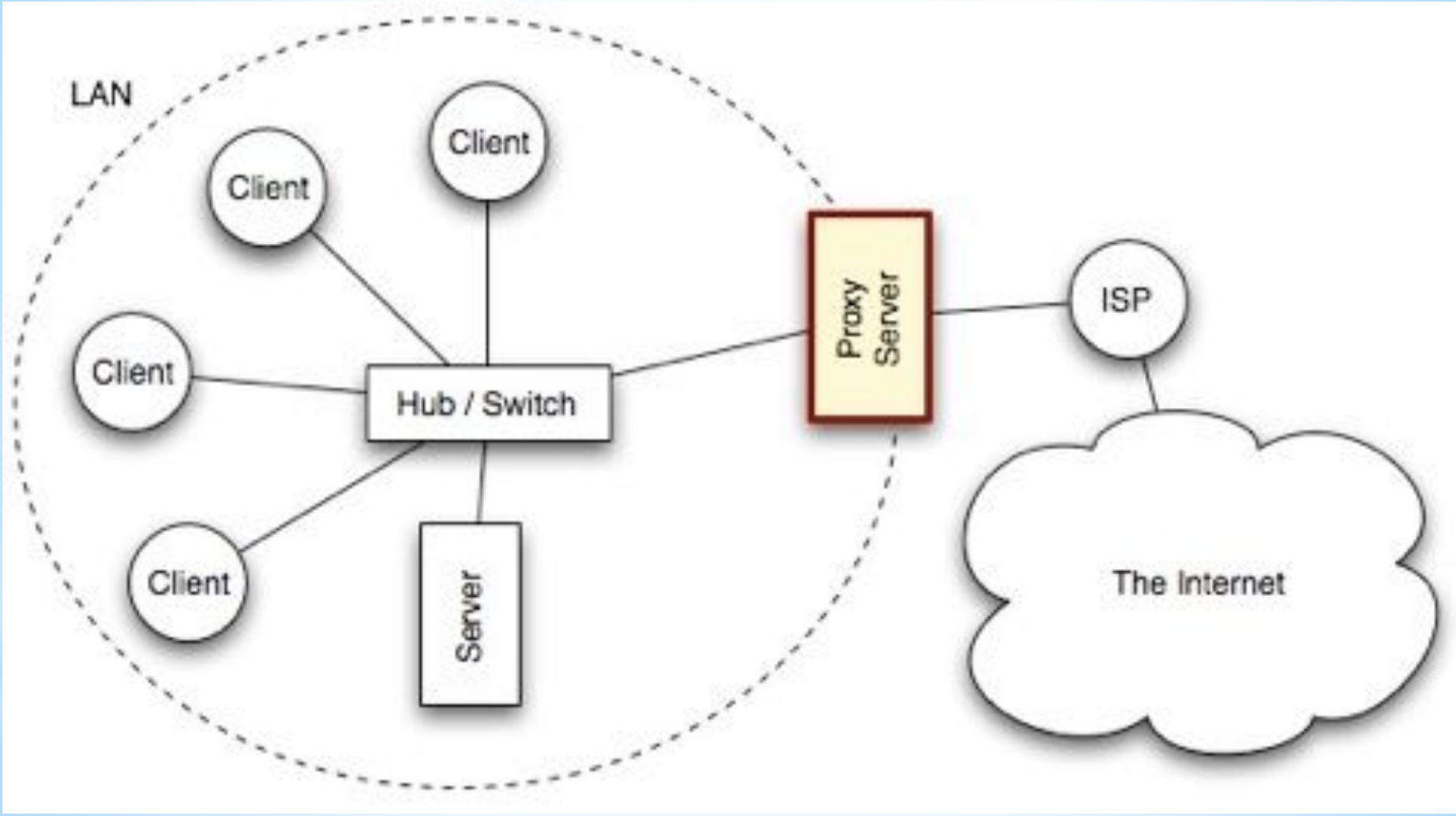
Cable – Twisted Pair

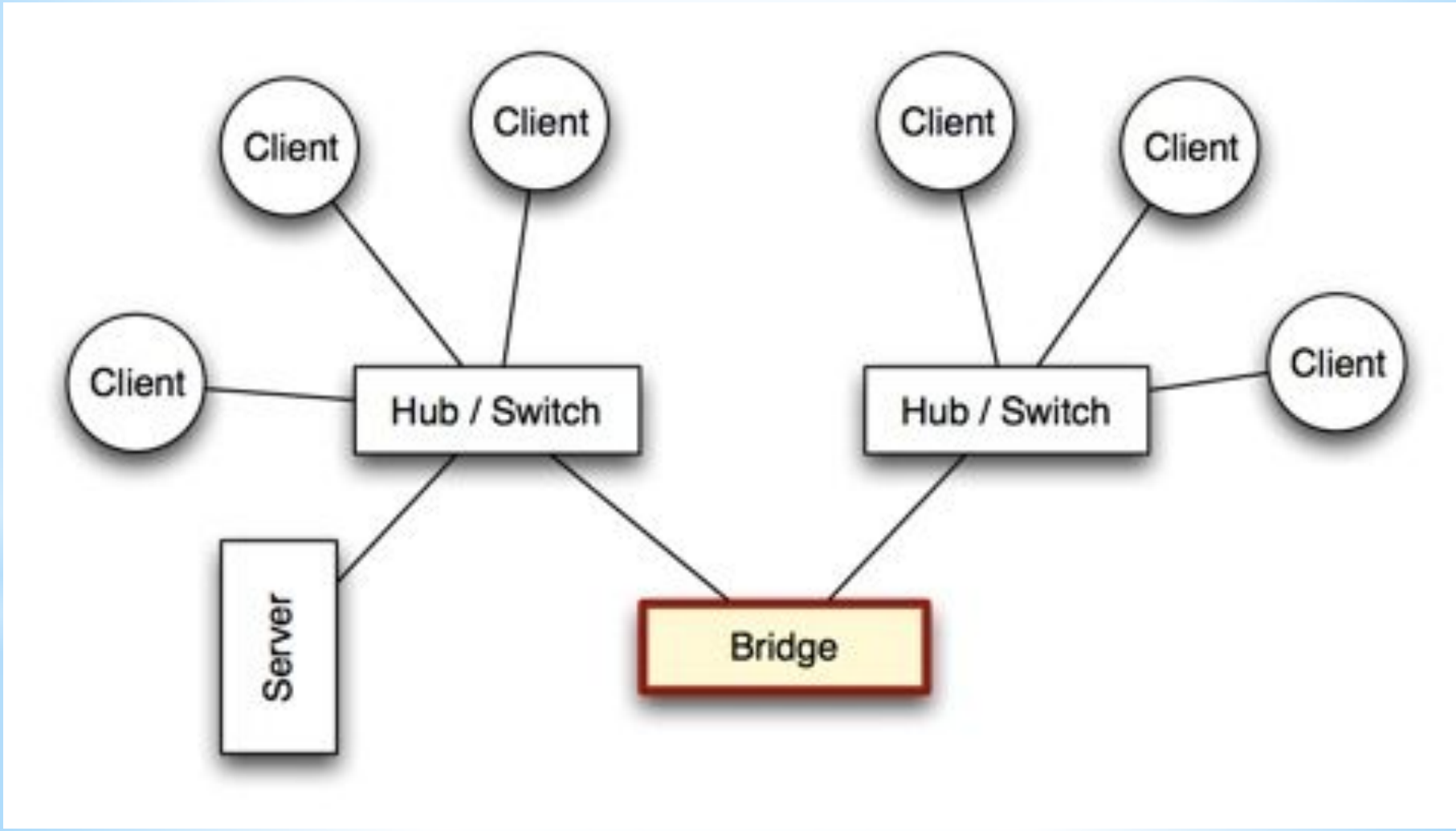

LAN
Client
Client
Client
Client
Client
Hub / Switch
Server
Router
ISP
The Internet

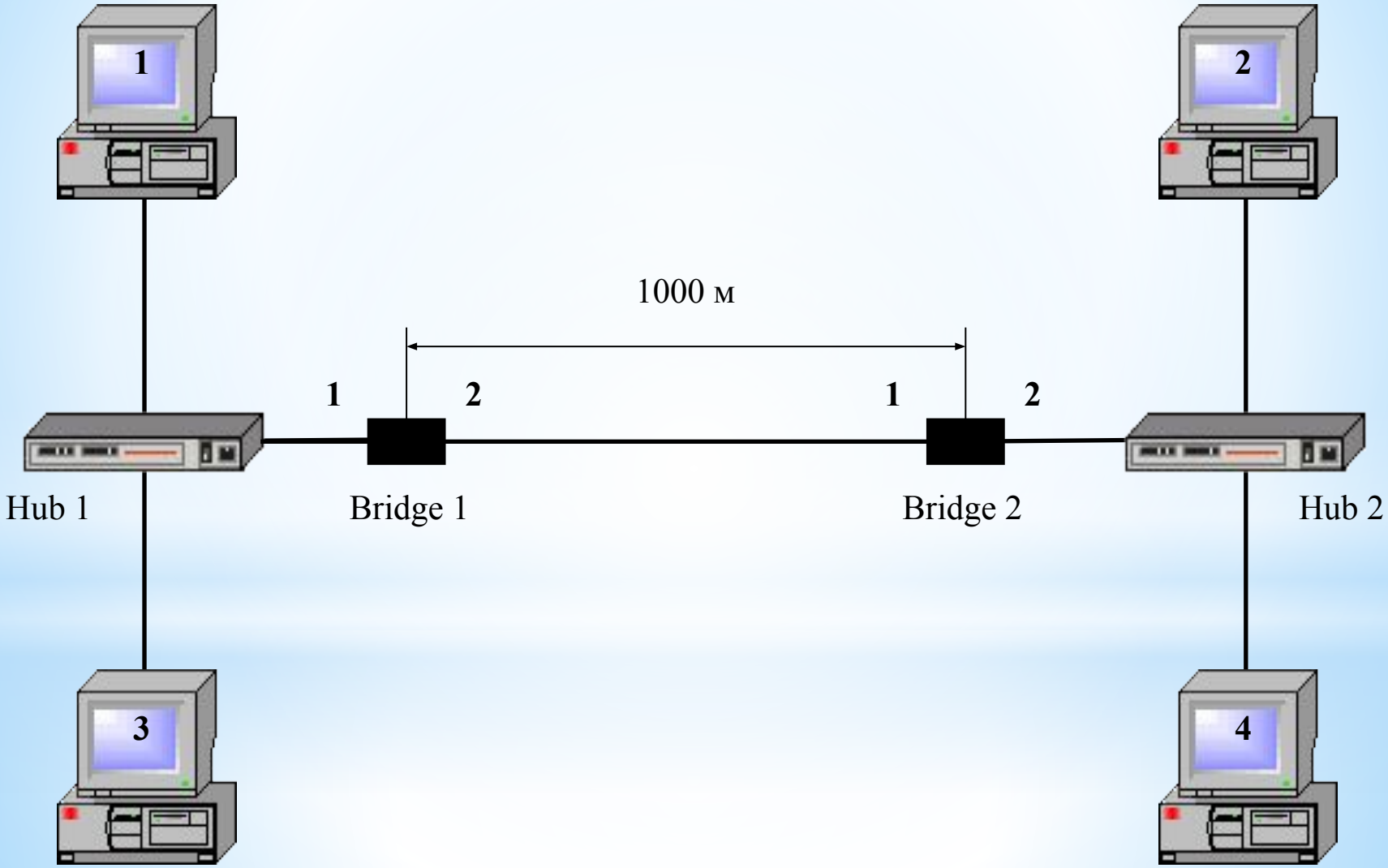

Computer
HUB
Computer
Computer
Computer
Printer
Computer

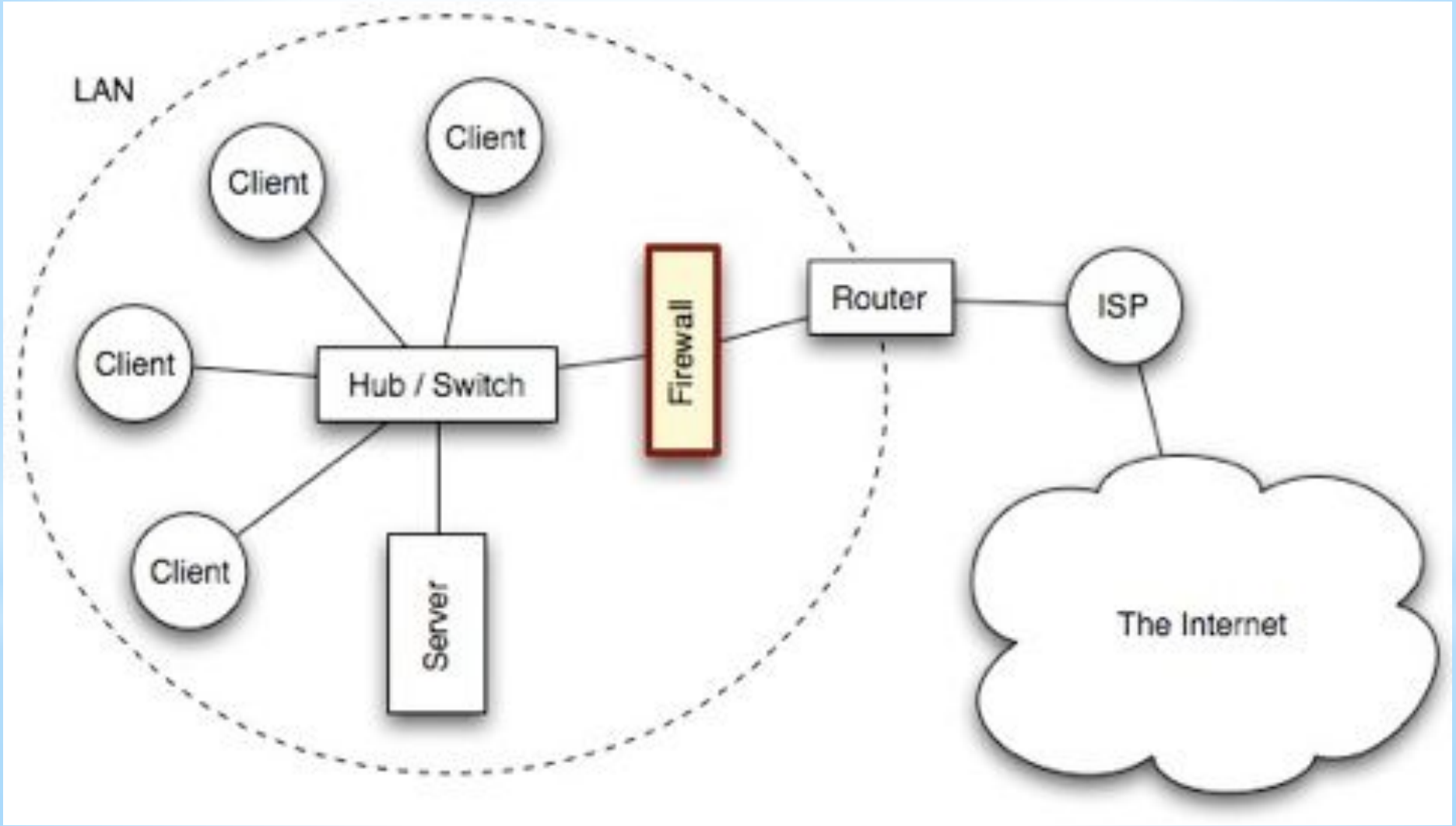

10 Мбит/с
10 Мбит/с
10 Мбит/с
10 Мбит/с
10 Мбит/с

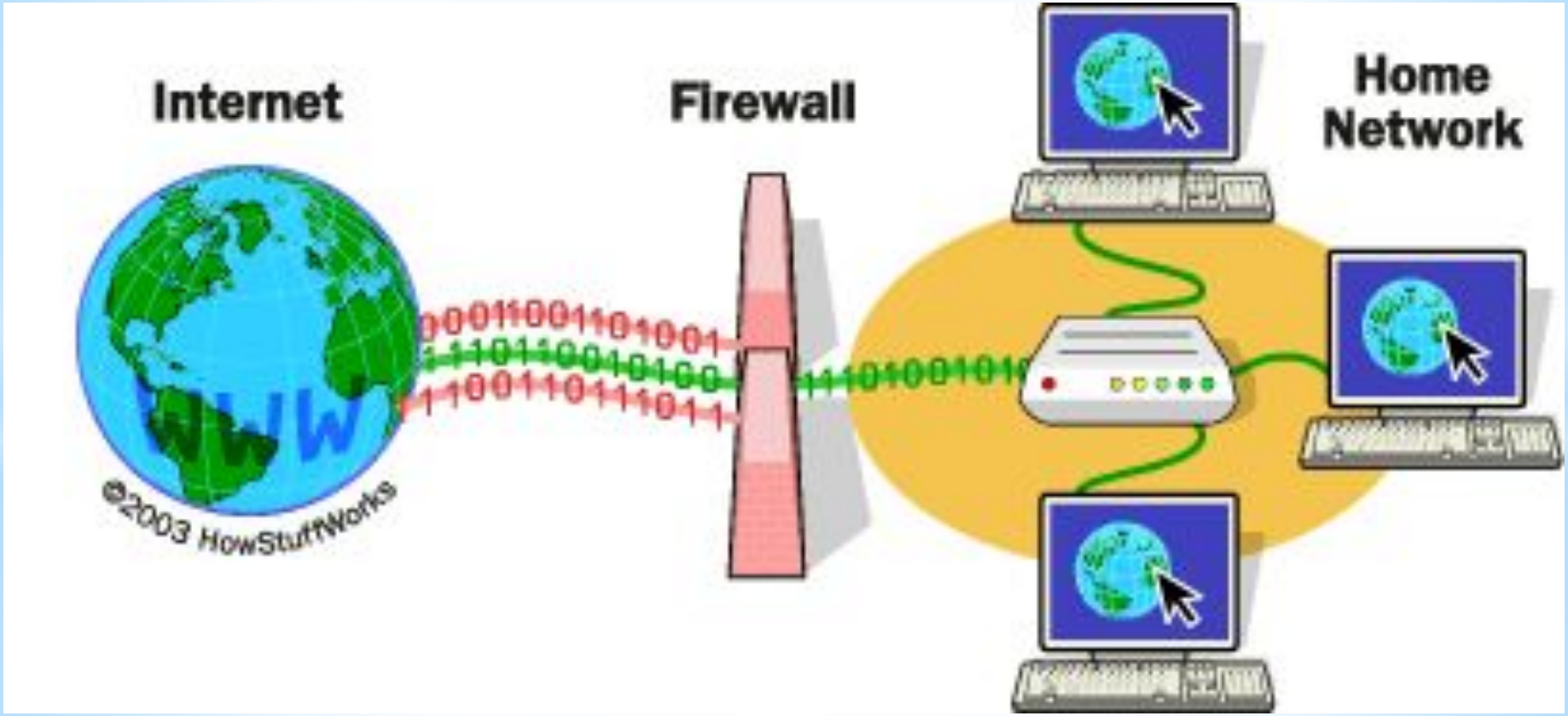

1
2
10 Мбит/с
3
10 Мбит/с
4
1
2
5
10 Мбит/с
4
3
10 Мбит/с
5
100 Мбит/с
6

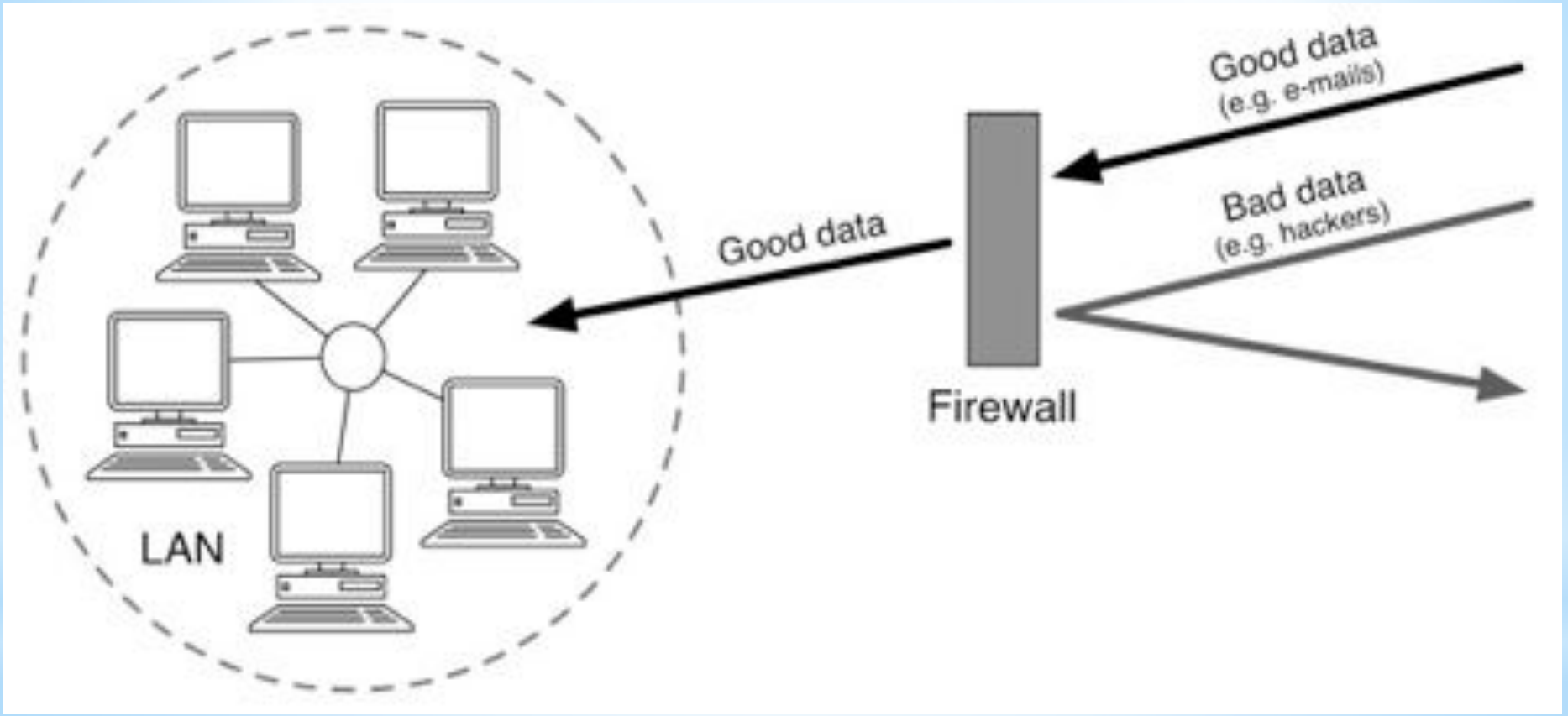

LAN
Client
Client
Client
Client
Client
Hub / Switch
Server
Proxy Server
ISP
The Internet


Client
Client
Client
Client
Client
Client
Client
Hub / Switch
Hub / Switch
Server
Bridge


1
2
1000 м
1
2
1
2
Hub 1
Bridge 1
Bridge 2
Hub 2
3
4


LAN
Client
Client
Client
Client
Client
Hub / Switch
Server
Firewall
Router
ISP
The Internet


Internet
Firewall
Home Network
WWW
©2003 HowStuffWorks


Good data
(e.g. e-mails)
Bad data
(e.g. hackers)
Good data
Firewall
LAN

Networks and Telecommunications.

Wired and wireless networking technologies.

Network connections

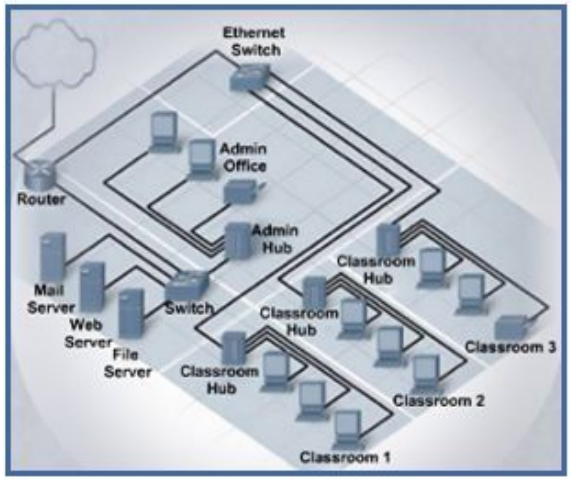
Network connections between computers are typically created using cables (**wires**).

However, connections can be created using radio signals (**wireless / wi-fi**), telephone lines (and modems) or even, for very long distances, via satellite links.

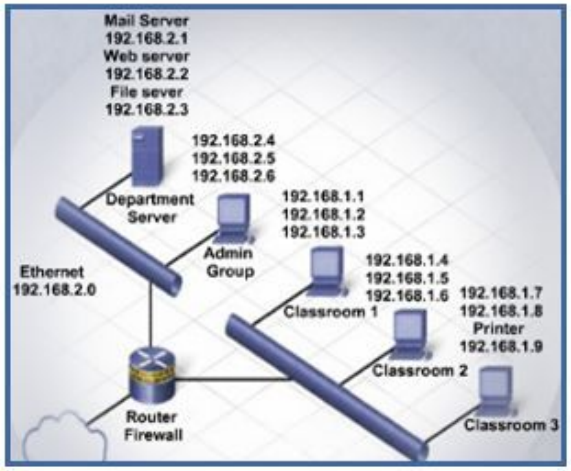
Network topology

- A *topology* is a way of "laying out" the network. Topologies can be either physical or logical.
- *Physical topologies* describe how the cables are run.
- *Logical topologies* describe how the network messages travel

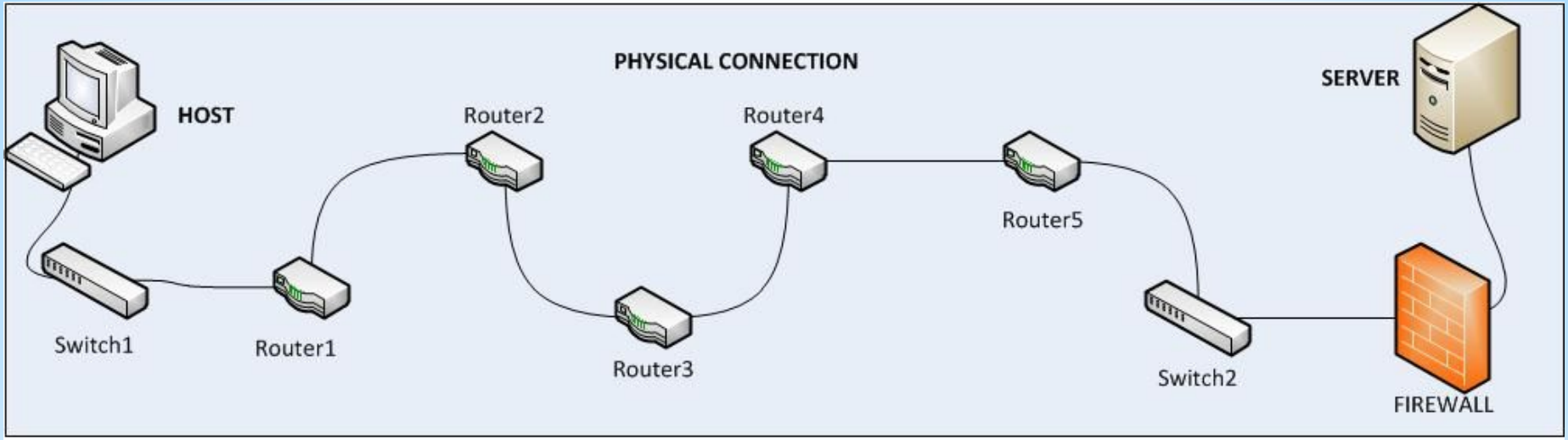
Two Types of LAN Topologies

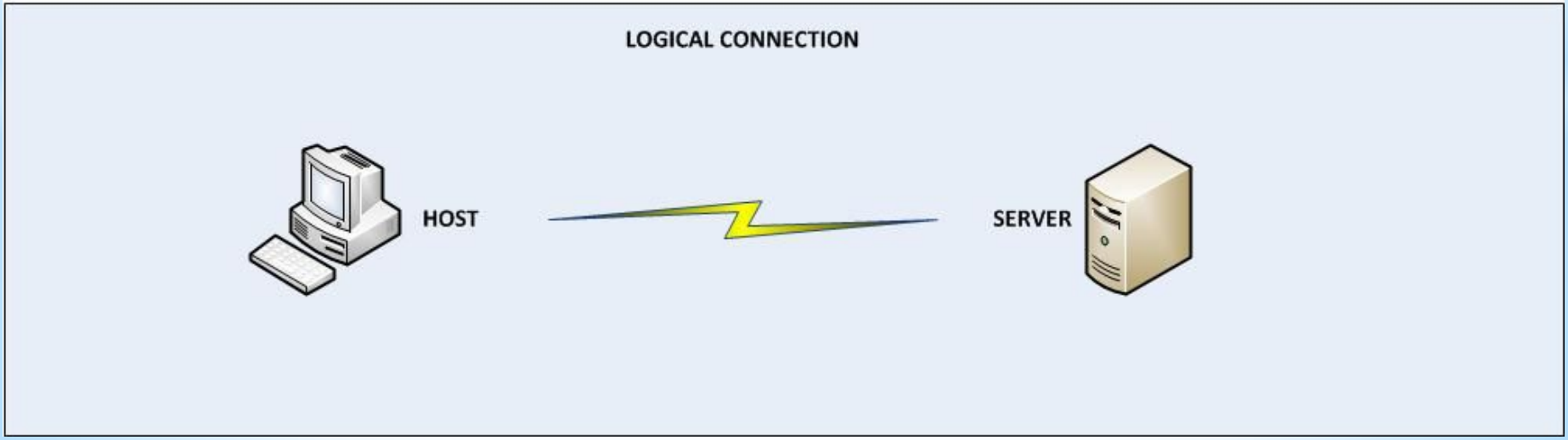


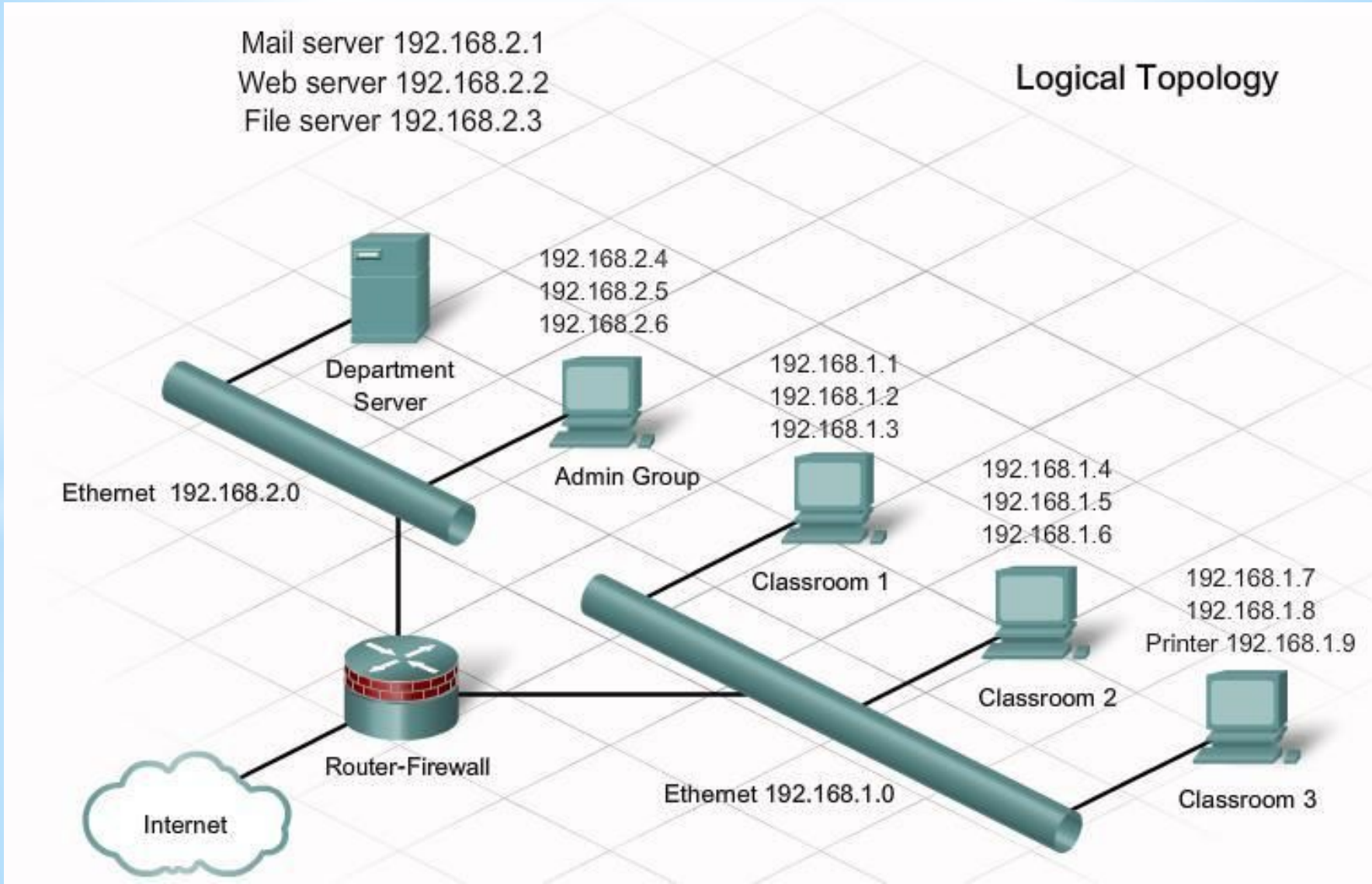
Physical topology is the physical layout of the components on the network.

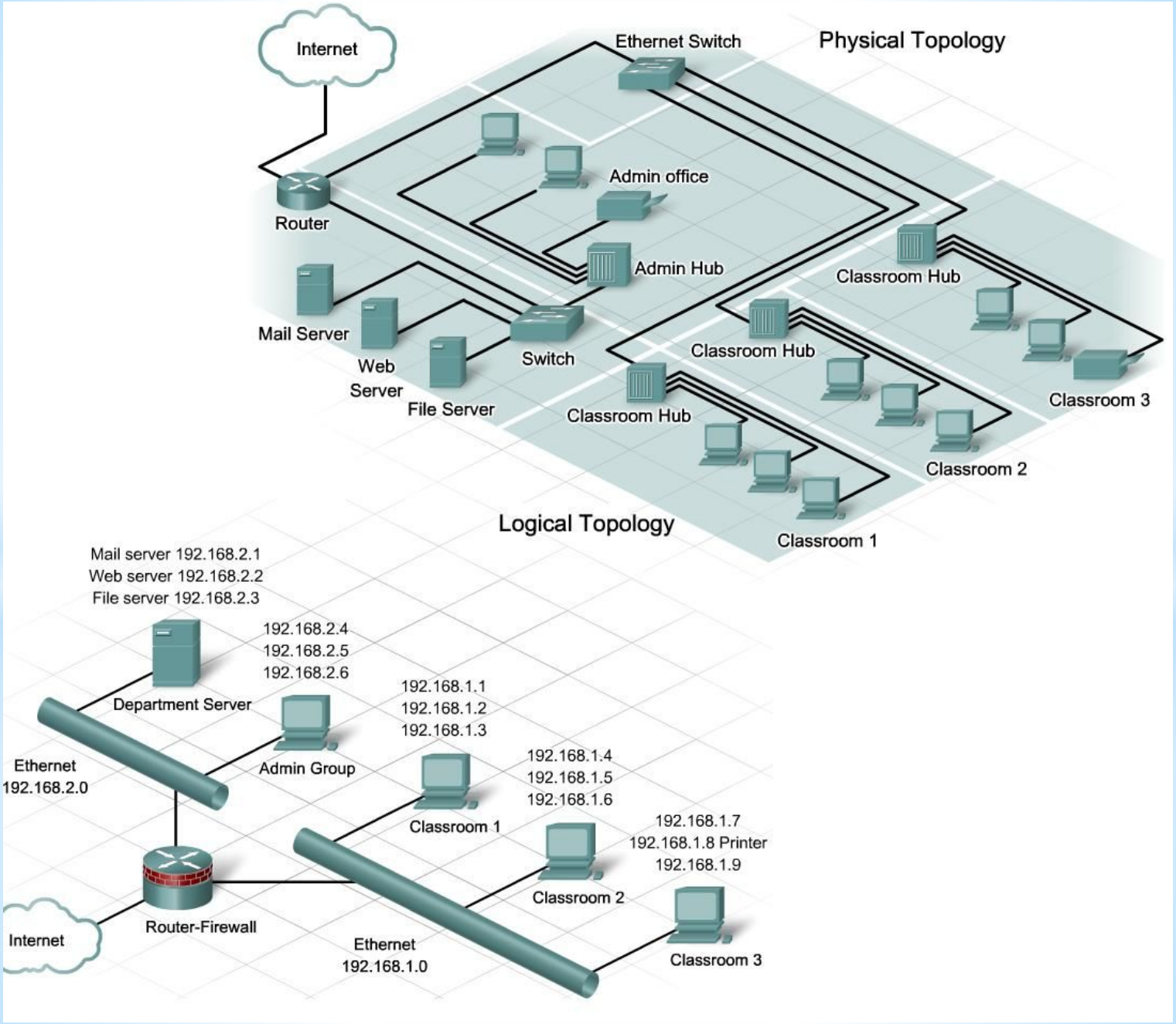


Logical topology determines how the hosts access the medium to communicate across the network.

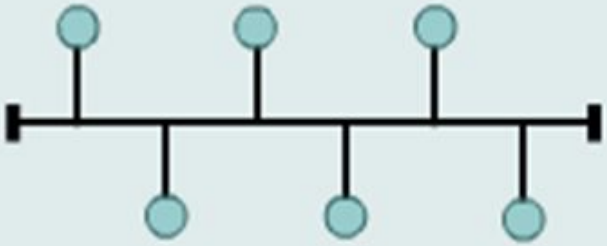

PHYSICAL CONNECTION
HOST
Router2
Router4
SERVER
Router5
Switch1
Router1
Router3
Switch2
FIREWALL


LOGICAL CONNECTION
HOST
SERVER


Mail server 192.168.2.1
Web server 192.168.2.2
File server 192.168.2.3
Logical Topology
192.168.2.4
192.168.2.5
192.168.2.6
Department Server
192.168.1.1
192.168.1.2
192.168.1.3
Admin Group
Ethernet 192.168.2.0
192.168.1.4
192.168.1.5
192.168.1.6
Classroom 1
192.168.1.7
192.168.1.8
Printer 192.168.1.9
Classroom 2
Router-Firewall
Ethernet 192.168.1.0
Classroom 3
Internet

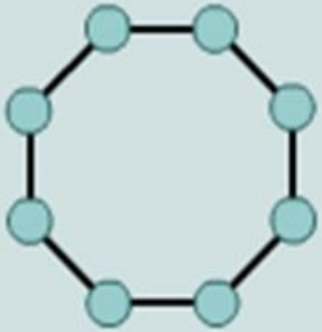

Physical Topology
Internet
Ethernet Switch
Router
Admin office
Admin Hub
Classroom Hub
Mail Server
Web Server
File Server
Switch
Classroom Hub
Classroom 3
Classroom Hub
Classroom 2
Classroom 1
Logical Topology
Mail server 192.168.2.1
Web server 192.168.2.2
File server 192.168.2.3
192.168.2.4
192.168.2.5
192.168.2.6
Department Server
192.168.1.1
192.168.1.2
192.168.1.3
Admin Group
Ethernet
192.168.2.0
192.168.1.4
192.168.1.5
192.168.1.6
Classroom 1
192.168.1.7
192.168.1.8 Printer
192.168.1.9
Classroom 2
Router-Firewall
Internet
Ethernet
192.168.1.0
Classroom 3

Bus Topology

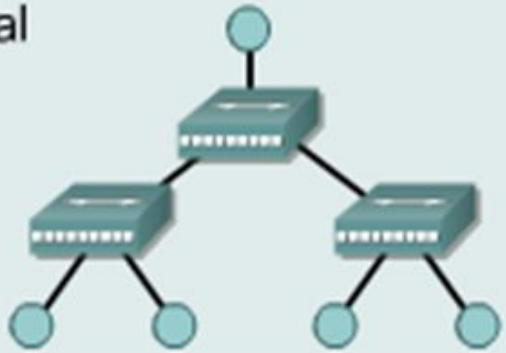


Extended Star Topology

Ring Topology

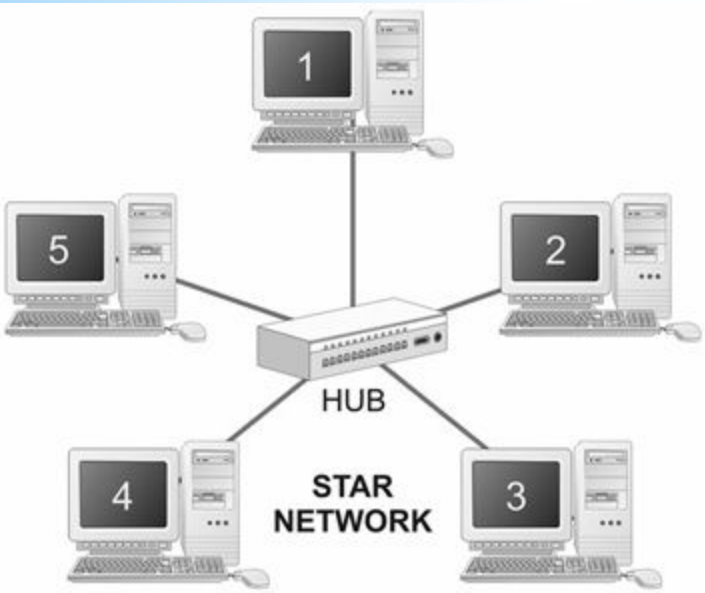


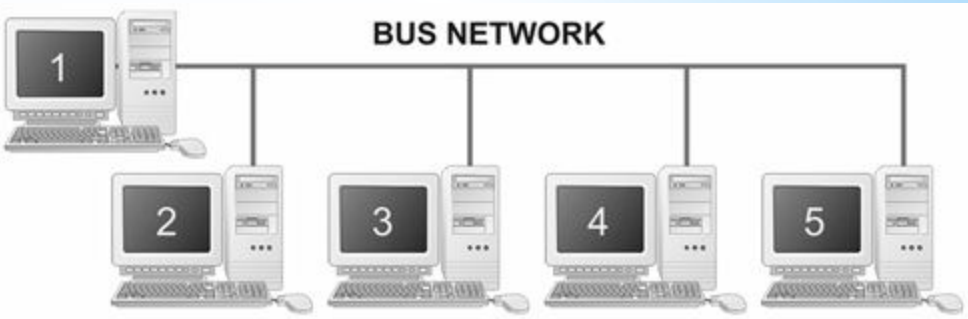
Hierarchical Topology

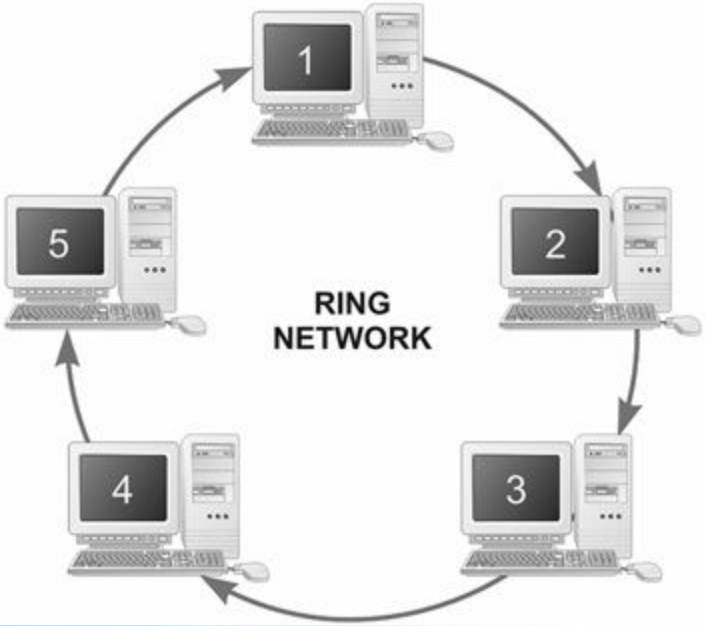


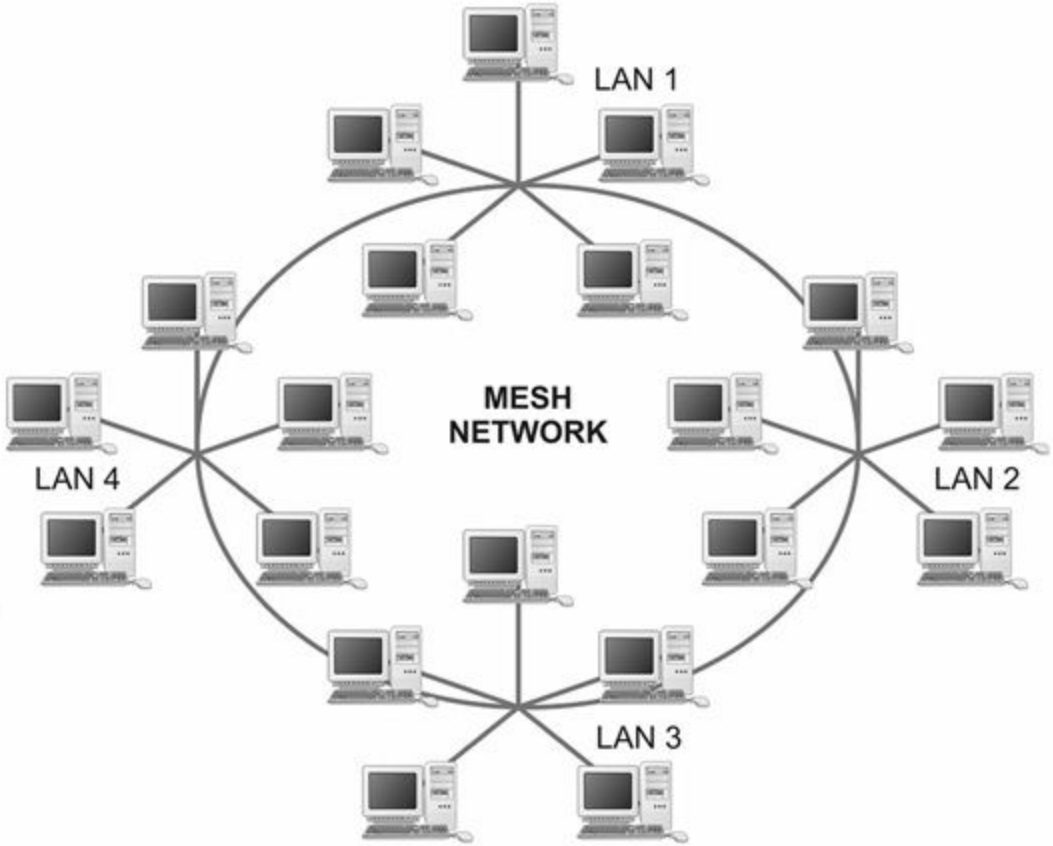
Star Topology

Mesh Topology


1
5
2
HUB
4
3
STAR
NETWORK


BUS NETWORK
1
2
3
4
5

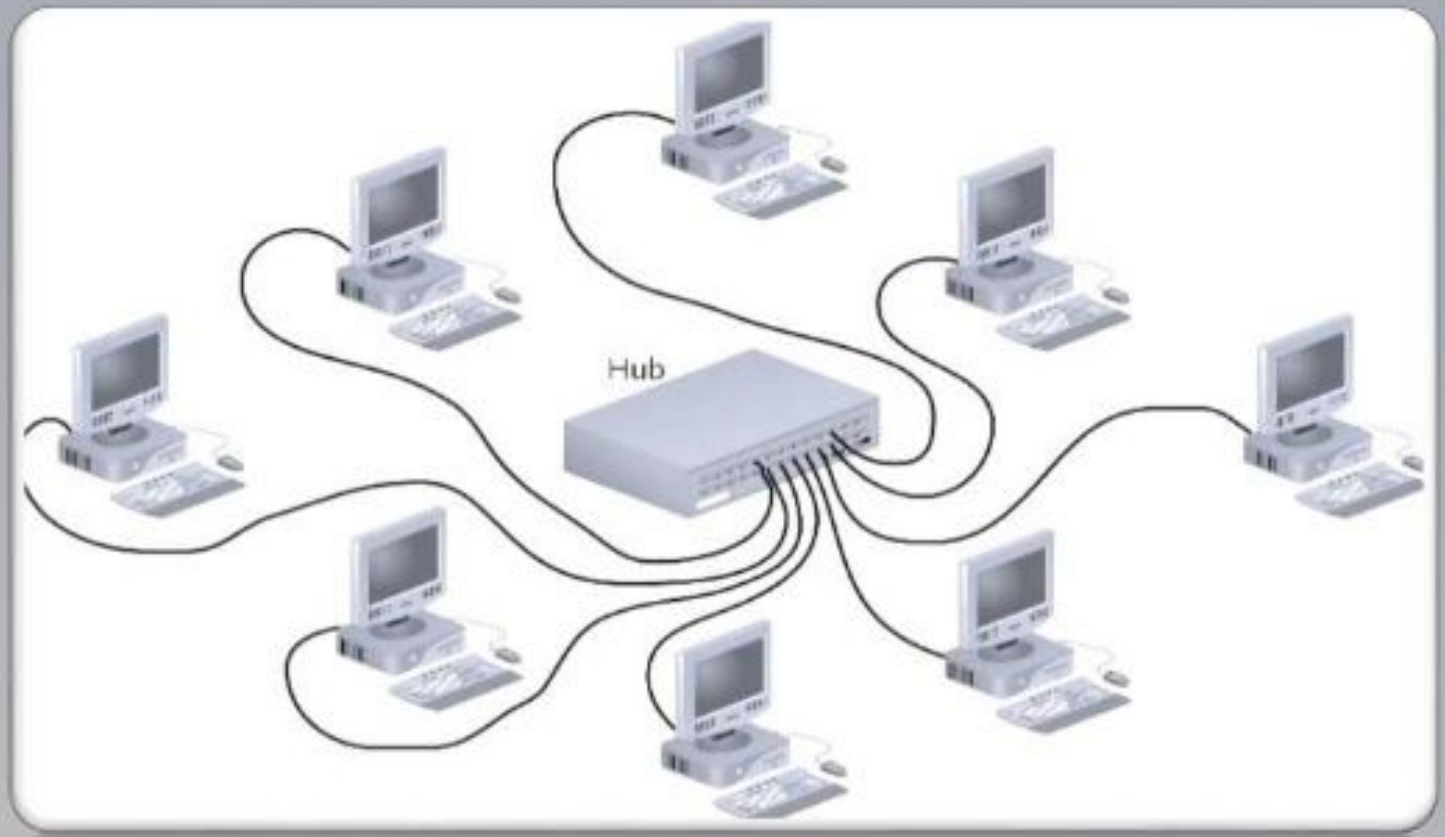

1
5
2
RING
NETWORK
4
3


LAN 1
MESH
NETWORK
LAN 4
LAN 2
LAN 3

Network topology (cont.)

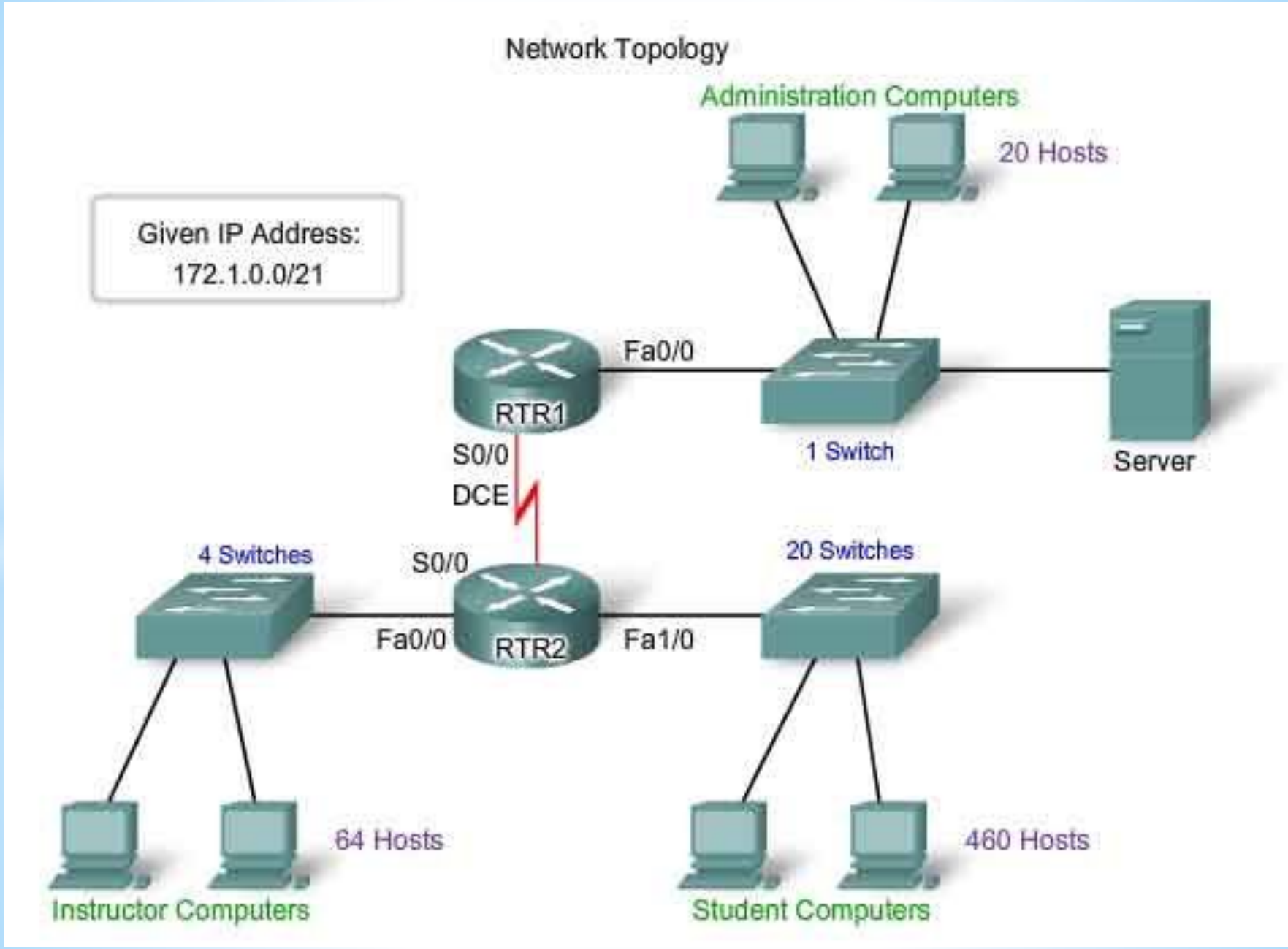
- Advantages and Disadvantages of Network Topologies

Topology	Advantages	Disadvantages
Bus	Cheap. Easy to install.	Difficult to reconfigure. Break in bus disables entire network.
Star	Cheap. Easy to install. Easy to reconfigure. Fault tolerant.	More expensive than bus.
Ring	Efficient. Easy to install.	Reconfiguration difficult. Very expensive.
Mesh	Simplest. Most fault tolerant.	Reconfiguration extremely difficult. Extremely expensive. Very complex.

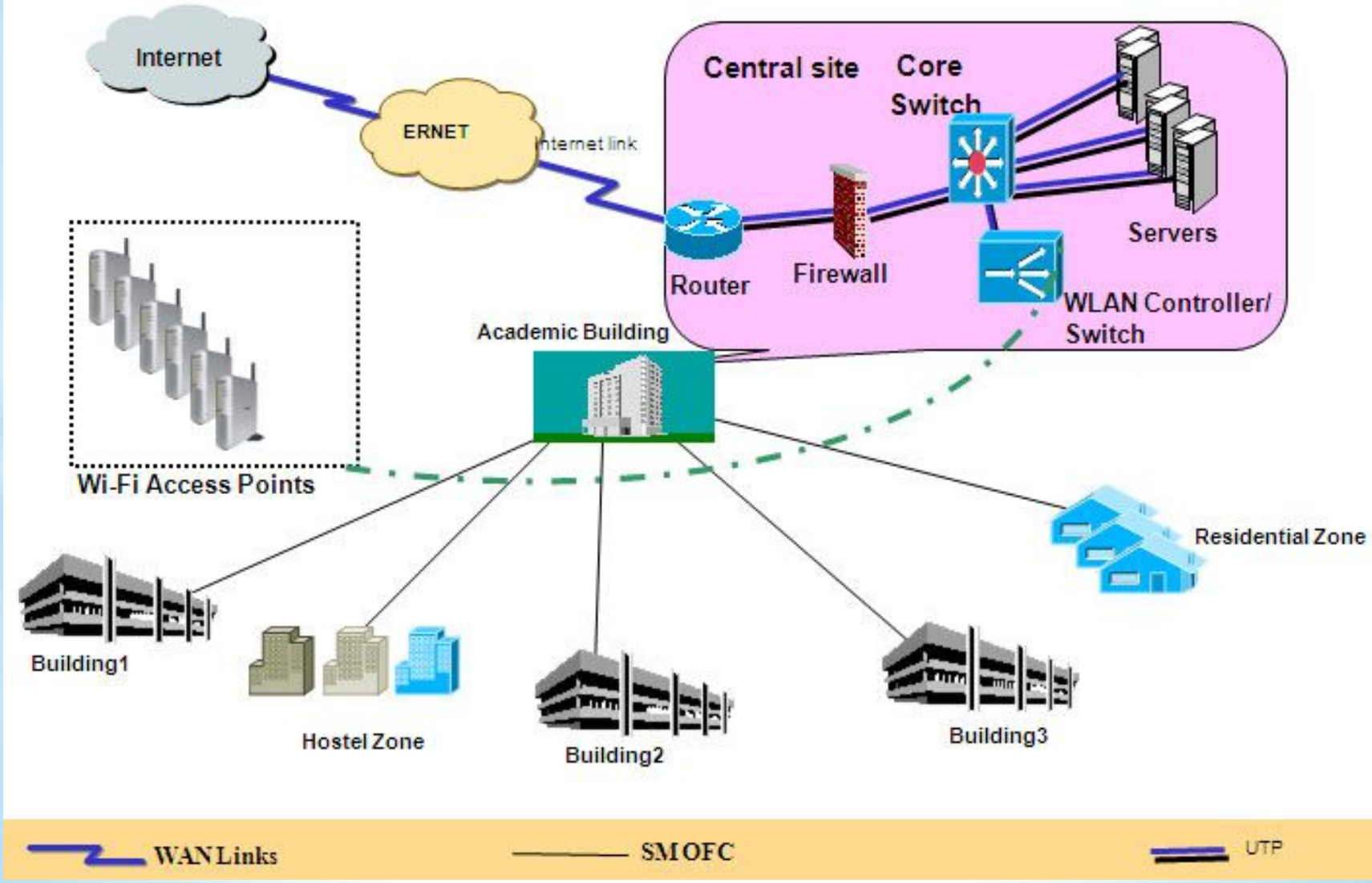


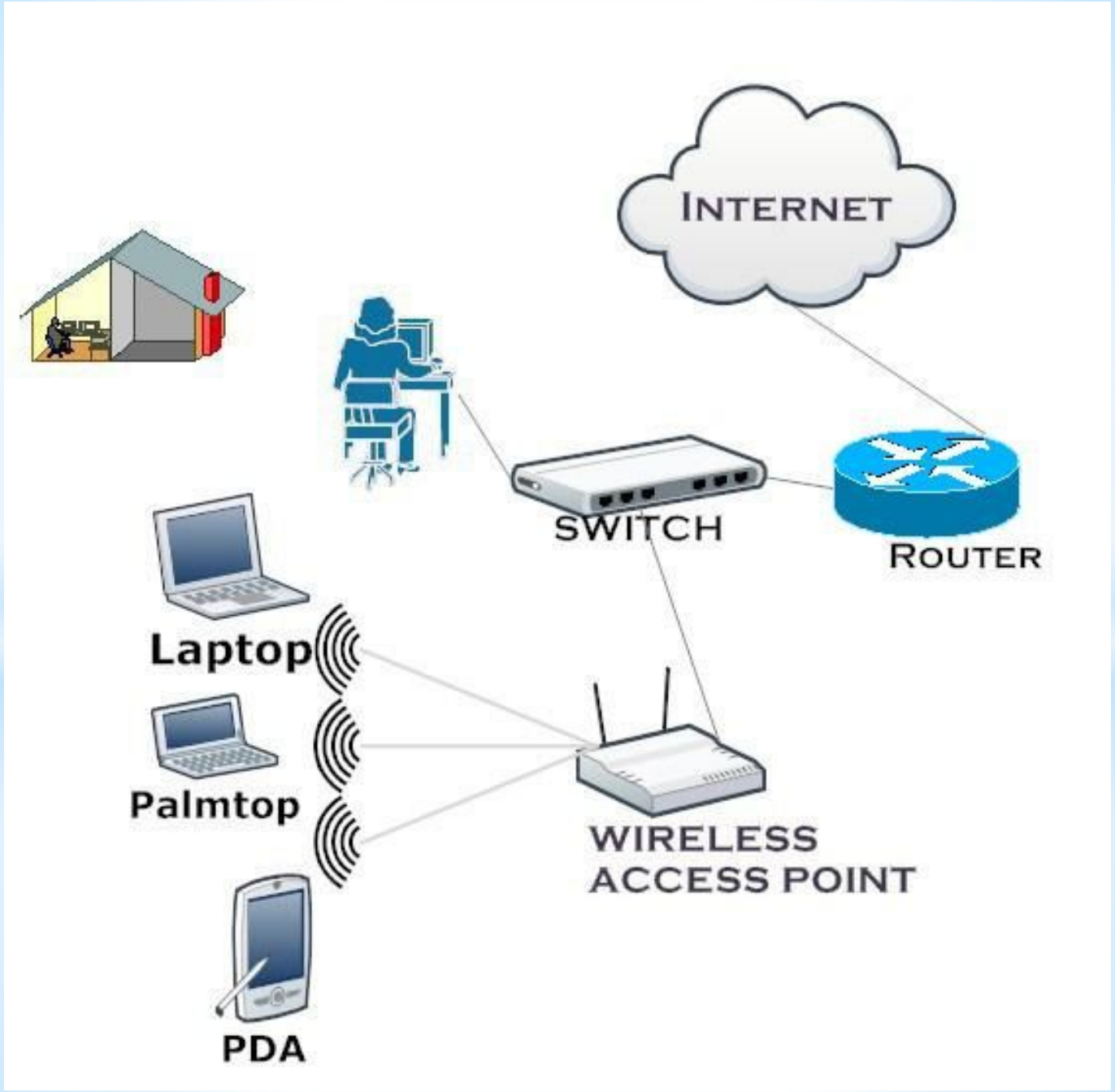
Star Topology

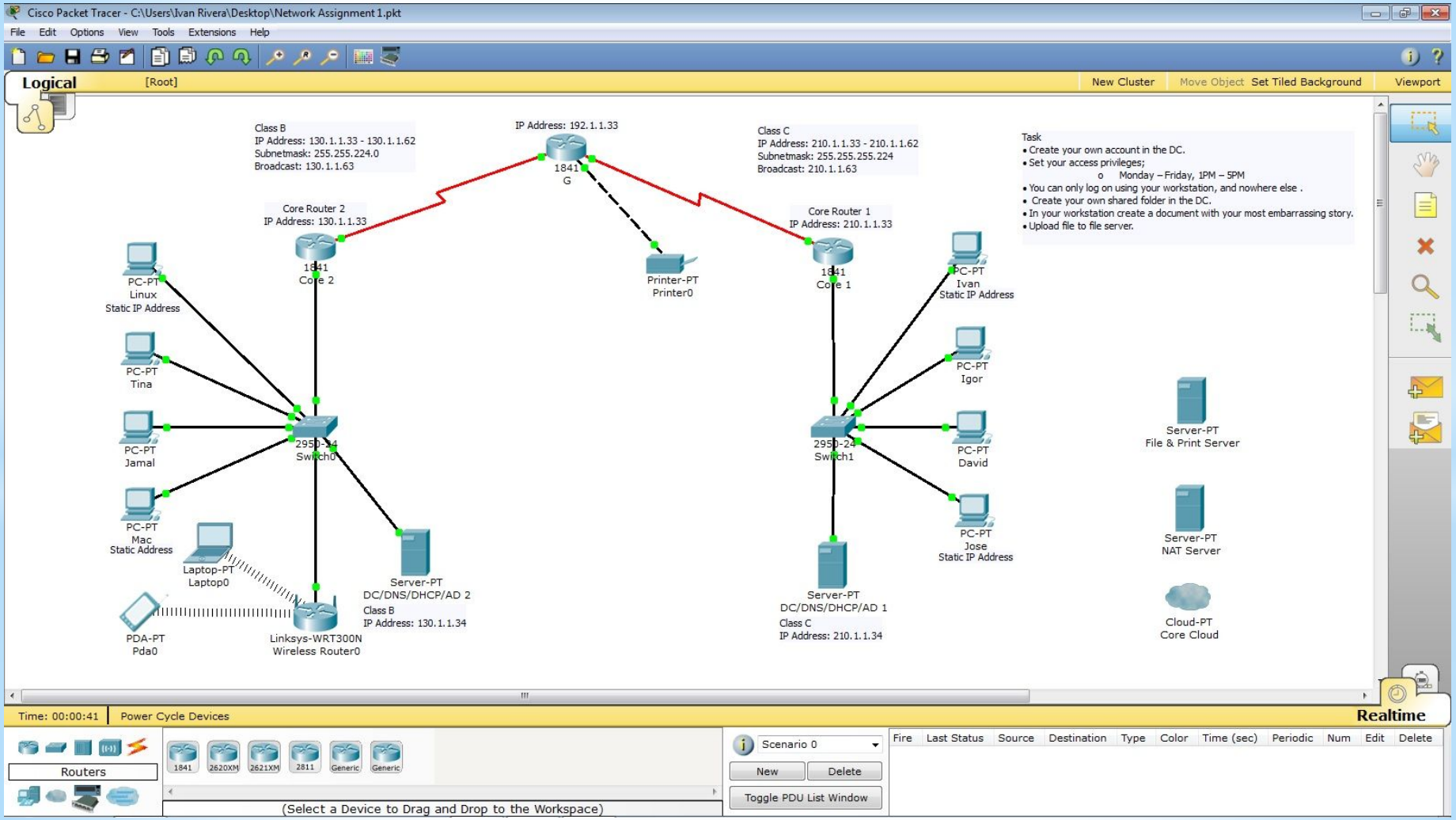
Project Network Topology


Network Topology
Administration Computers
20 Hosts
Given IP Address:
172.1.0.0/21
Fa0/0
RTR1
S0/0
DCE
1 Switch
Server
4 Switches
S0/0
20 Switches
Fa0/0
RTR2
Fa1/0
64 Hosts
460 Hosts
Instructor Computers
Student Computers

A Typical Campus Network Topology




INTERNET
SWITCH
ROUTER
Laptop
Palmtop
PDA
WIRELESS
ACCESS POINT


Cisco Packet Tracer - C:\Users\Ivan Rivera\Desktop\Network Assignment 1.pkt
File Edit Options View Tools Extensions Help
Logical
[Root]
New Cluster
Move Object
Set Tiled Background
Viewport
Class B
IP Address: 130.1.1.33 - 130.1.1.62
Subnetmask: 255.255.224.0
Broadcast: 130.1.1.63
IP Address: 192.1.1.33
1841
G
Class C
IP Address: 210.1.1.33 - 210.1.1.62
Subnetmask: 255.255.255.224
Broadcast: 210.1.1.63
Task
• Create your own account in the DC.
• Set your access privileges;
o Monday – Friday, 1PM – 5PM
• You can only log on using your workstation, and nowhere else .
• Create your own shared folder in the DC.
• In your workstation create a document with your most embarrassing story.
• Upload file to file server.
Core Router 2
IP Address: 130.1.1.33
1841
Core 2
Printer-PT
Printer0
Core Router 1
IP Address: 210.1.1.33
1841
Core 1
PC-PT
Linux
Static IP Address
PC-PT
Tina
PC-PT
Jamal
PC-PT
Mac
Static Address
2950-24
Switch0
Laptop-PT
Laptop0
PDA-PT
Pda0
Linksys-WRT300N
Wireless Router0
Server-PT
DC/DNS/DHCP/AD 2
Class B
IP Address: 130.1.1.34
PC-PT
Ivan
Static IP Address
PC-PT
Igor
PC-PT
David
PC-PT
Jose
Static IP Address
2950-24
Switch1
Server-PT
DC/DNS/DHCP/AD 1
Class C
IP Address: 210.1.1.34
Server-PT
File & Print Server
Server-PT
NAT Server
Cloud-PT
Core Cloud
Time: 00:00:41
Power Cycle Devices
Realtime
Routers
1841
2620XM
2621XM
2811
Generic
Generic
(Select a Device to Drag and Drop to the Workspace)
Scenario 0
New
Delete
Toggle PDU List Window
Fire
Last Status
Source
Destination
Type
Color
Time (sec)
Periodic
Num
Edit
Delete

Networks and Telecommunications.

Network types

LANs and WANs.

Local Area Network (LAN)

A Local Area Network is a network confined to **one building or site**.

Often a LAN is a **private network** belonging to an organization or business.

Wireless Local Area Network (WLAN)

A wireless LAN (WLAN) is a LAN that uses **radio signals** (**WiFi**) to connect computers instead of cables.

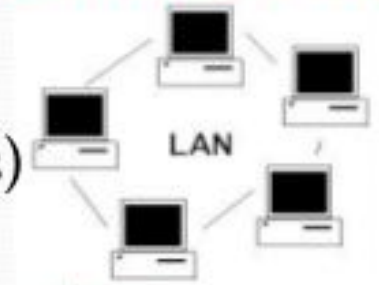
Wide Area Network (WAN)

A Wide Area Network is a network that extends over a **large area**.

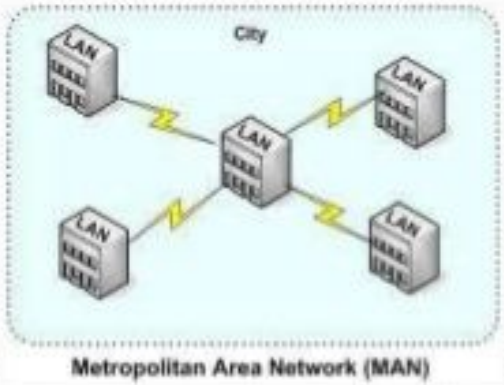
A WAN is often created by **joining several LANs** together, such as when a business that has offices in different countries links the office LANs together.

There are different types of network:

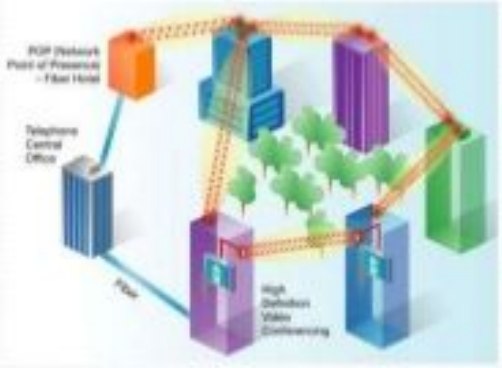
- LAN(Local Area Networking)
- WLAN(Wireless Local Area Networks)
- WAN(Wide Area Networks)
- MAN(Metropolitan Area Networks)
- CAN(Campus Area Networks)



WAN



MAN

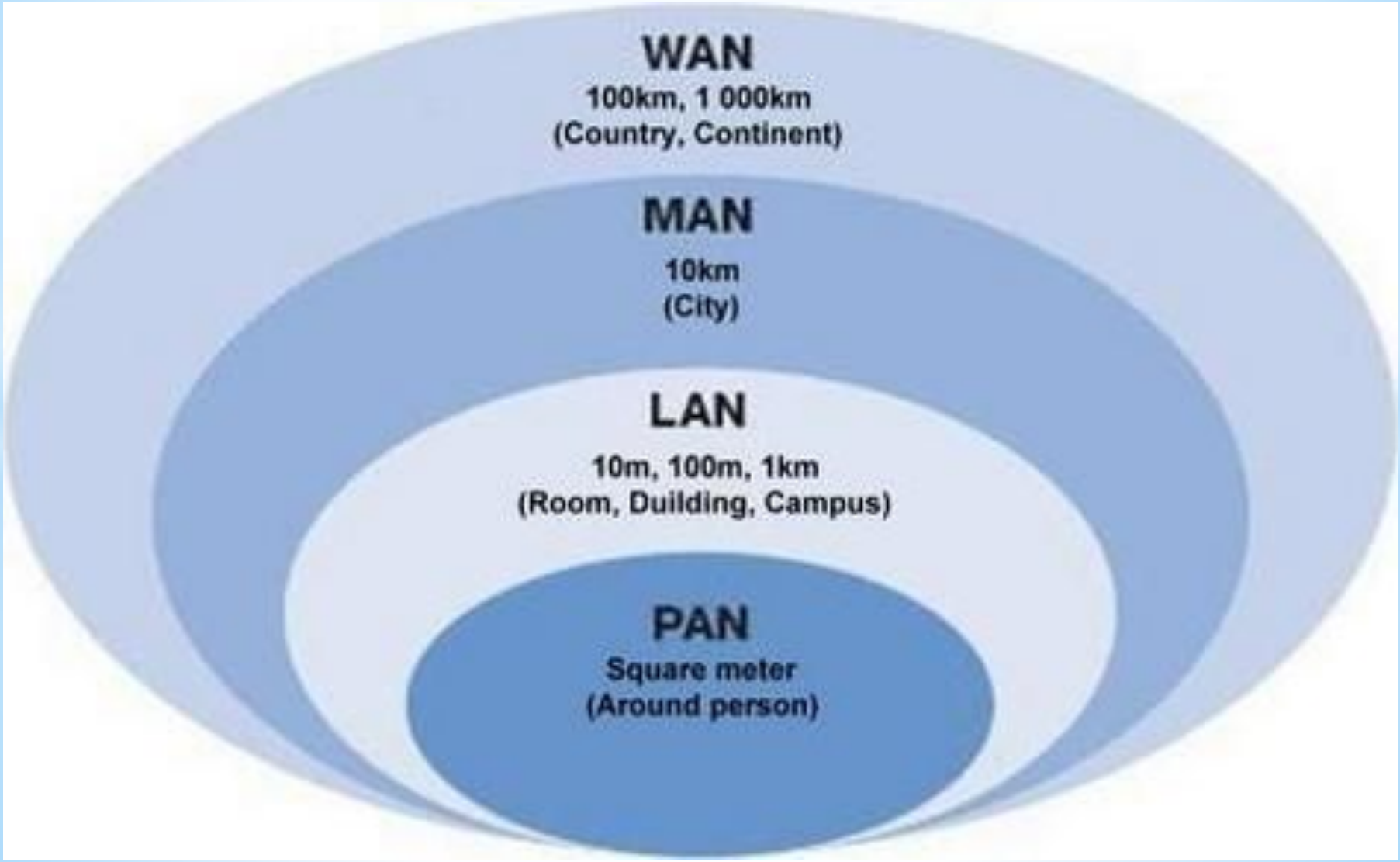


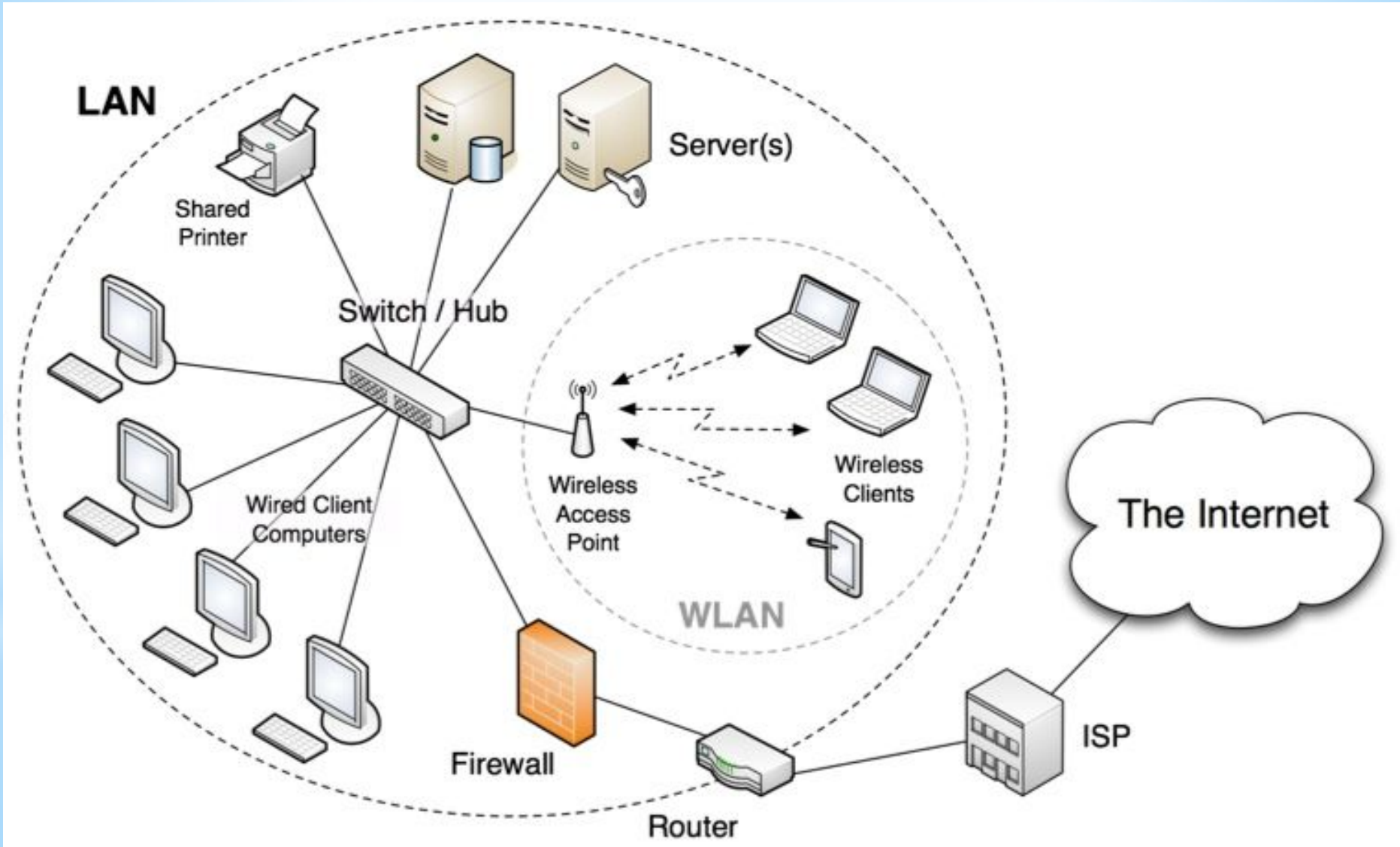
CAN

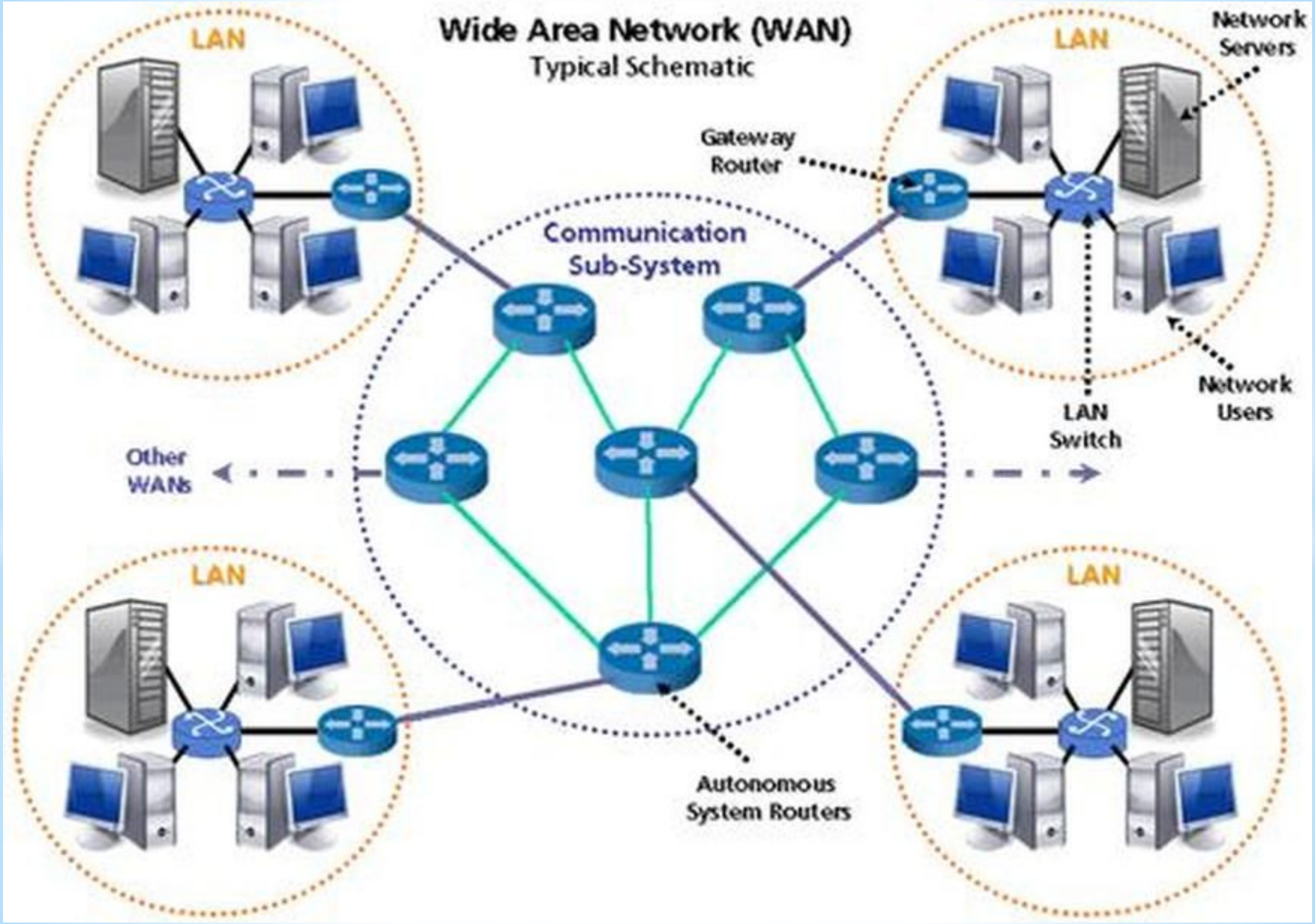
Types of network

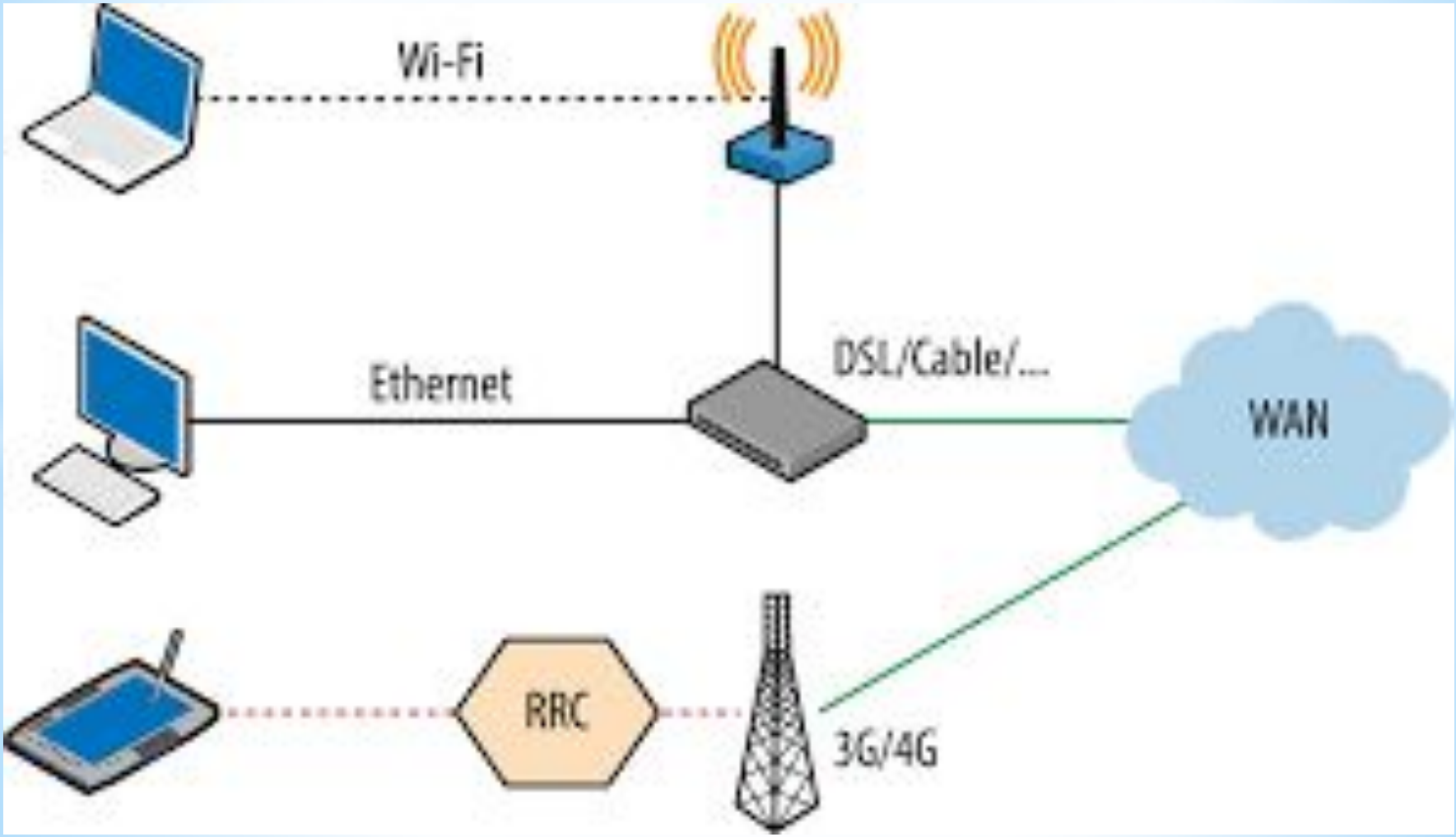
- Local area network (LAN) : connects computers and devices in a limited geographical area such as a home, school or office building
- wide area network (WAN) : covers a large geographic area such as a city, country, or spans
- Metropolitan area network (MAN) : is a large computer network that usually spans a city or a large campus

Types of network




LAN
Server(s)
Shared
Printer
Switch / Hub
Wireless
Clients
Wireless
Access
Point
Wired Client
Computers
WLAN
The Internet
Firewall
ISP
Router


Wide Area Network (WAN)
Typical Schematic
LAN
LAN
LAN
LAN
Network Servers
Gateway Router
Communication Sub-System
Network Users
LAN Switch
Other WANs
Autonomous System Routers


Wi-Fi
Ethernet
DSL/Cable/....
WAN
RRC
3G/4G

Networks and Telecommunications.

Stack protocols: TCP / IP, OSI.

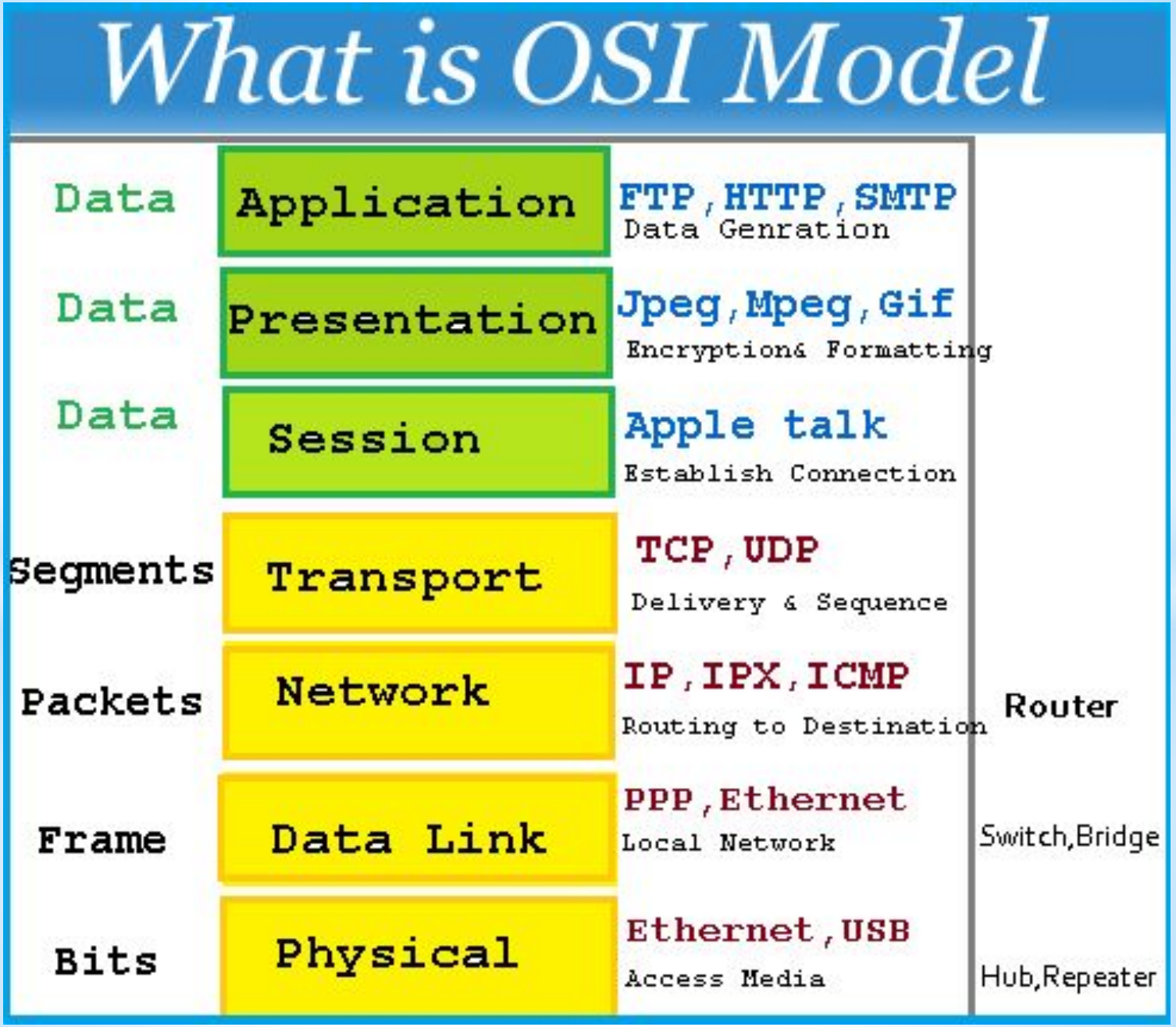
IP-addressing.

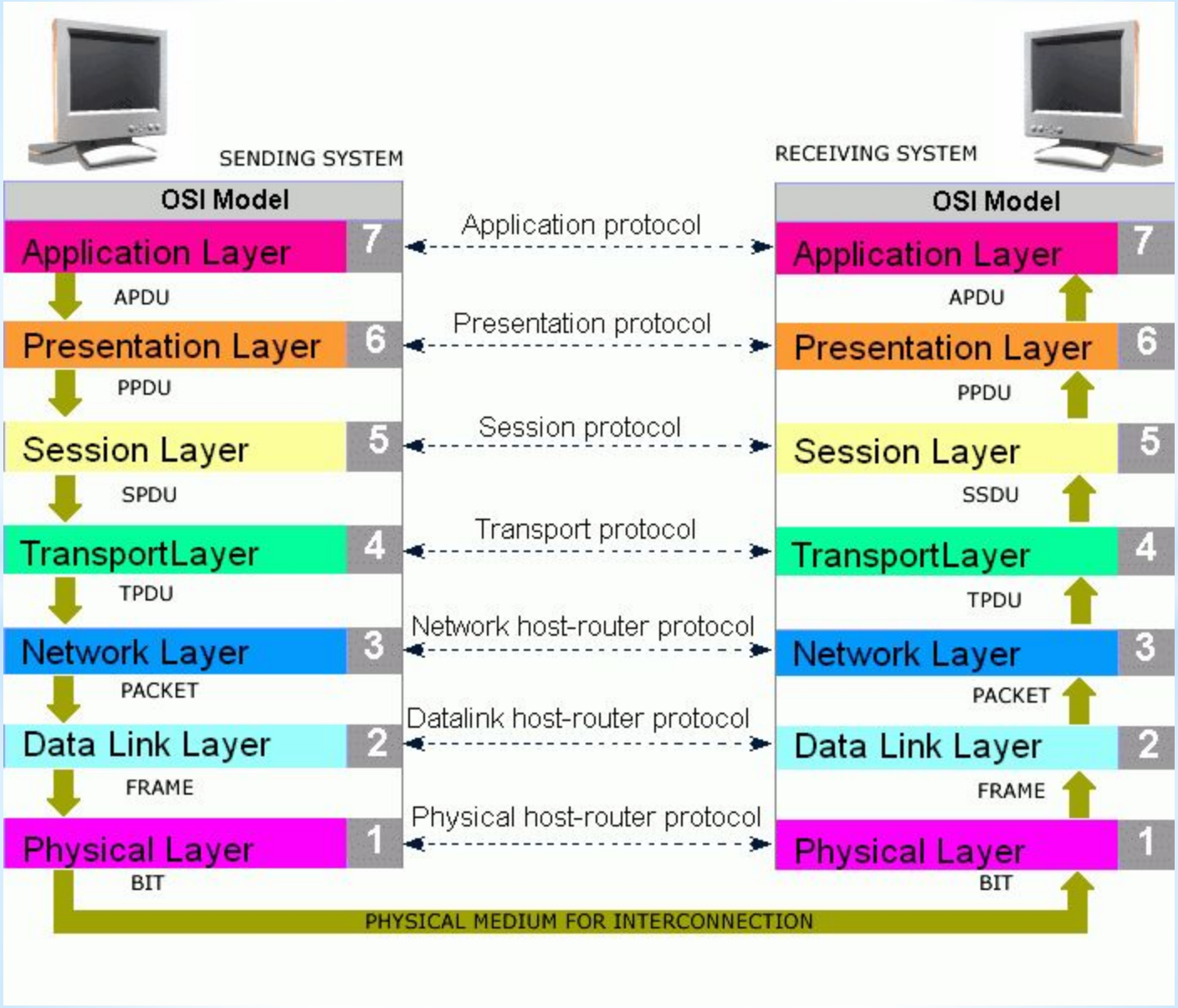
The DHCP protocol.

What is the OSI model ?

- **O**pen **S**ystems **I**nterconnection model is fundamental to all communications between network devices.
- Developed in 1974 by *ISO* after the American Department of Defence began using the TCP/IP suite of protocols.
- Finally adopted in 1977. It is now the *theoretical model* for how communication takes place between network devices.

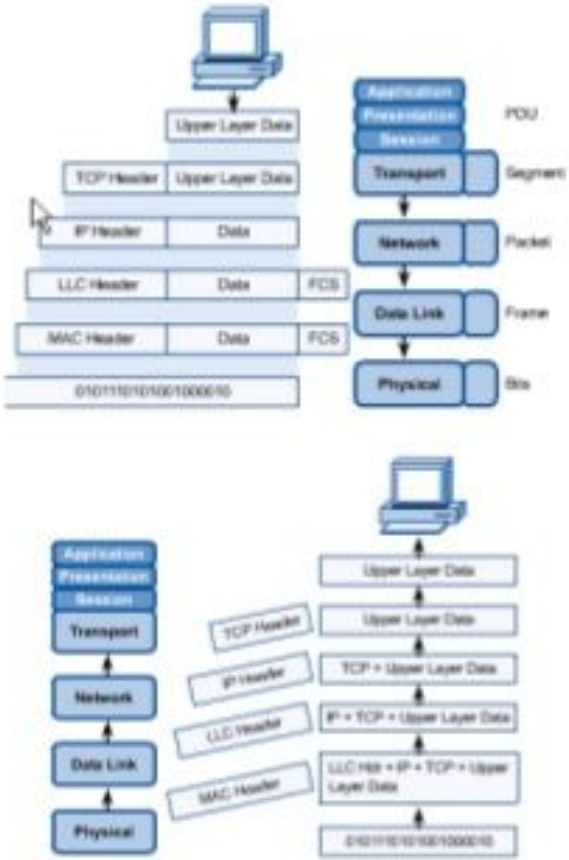
What is OSI Model



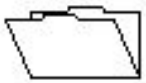
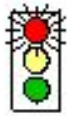

SENDING SYSTEM
RECEIVING SYSTEM
OSI Model
OSI Model
Application Layer 7
Application protocol
Application Layer 7
APDU
APDU
Presentation Layer 6
Presentation protocol
Presentation Layer 6
PPDU
PPDU
Session Layer 5
Session protocol
Session Layer 5
SPDU
SSDU
TransportLayer 4
Transport protocol
TransportLayer 4
TPDU
TPDU
Network Layer 3
Network host-router protocol
Network Layer 3
PACKET
PACKET
Data Link Layer 2
Datalink host-router protocol
Data Link Layer 2
FRAME
FRAME
Physical Layer 1
Physical host-router protocol
Physical Layer 1
BIT
BIT
PHYSICAL MEDIUM FOR INTERCONNECTION

OSI in Action

- A message begins at the top application layer and moves down the OSI layers to the bottom physical layer.
- As the message descends, each successive OSI model layer adds a header to it.
- A header is layer-specific information that basically explains what functions the layer carried out.
- Conversely, at the receiving end, headers are striped from the message as it travels up the corresponding layers.



OSI MODEL

7		**Application Layer** Type of communication: E-mail, file transfer, client/server.	UPPER LAYERS
6		**Presentation Layer** Encryption, data conversion: ASCII to EBCDIC, BCD to binary, etc.	
5		**Session Layer** Starts, stops session. Maintains order.	
4		**Transport Layer** Ensures delivery of entire file or message.	
3		**Network Layer** Routes data to different LANs and WANs based on network address.	LOWER LAYERS
2		**Data Link (MAC) Layer** Transmits packets from node to node based on station address.	
1		**Physical Layer** Electrical signals and cabling.	

OSI Model			
	Data unit	**Layer**	**Function**
Host layers	Data	7. Application	Network process to application
		6. Presentation	Data representation, encryption and decryption, convert machine dependent data to machine independent data
		5. Session	Interhost communication, managing sessions between applications
	Segments	4. Transport	Reliable delivery of segments between points on a network.
Media layers	Packet/Datagram	3. Network	Addressing, routing and (not necessarily reliable) delivery of datagrams between points on a network.
	Bit/Frame	2. Data link	A reliable direct point-to-point data connection.
	Bit	1. Physical	A (not necessarily reliable) direct point-to-point data connection.

Ip address

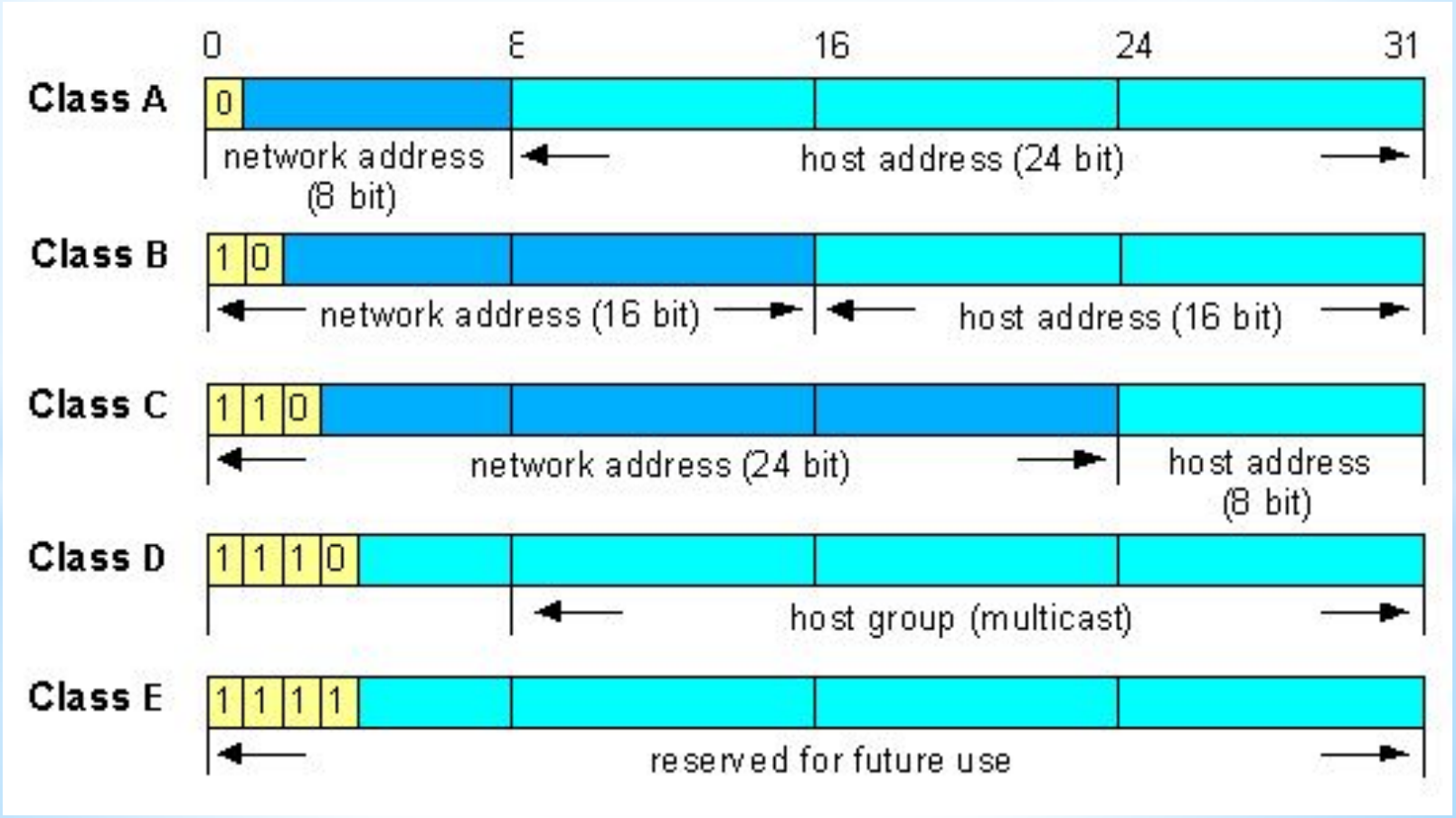
The address granted to computers is divided into two categories

Dynamic ip addresses: Dynamic ip address are assigned to the devices that require temporary connectivity to the network

Dhcp protocol used to assigning ip address to computer on lease time basis

Static ip address: Static ip address are assign to devices on the network whose existence in the network remains a longer duration

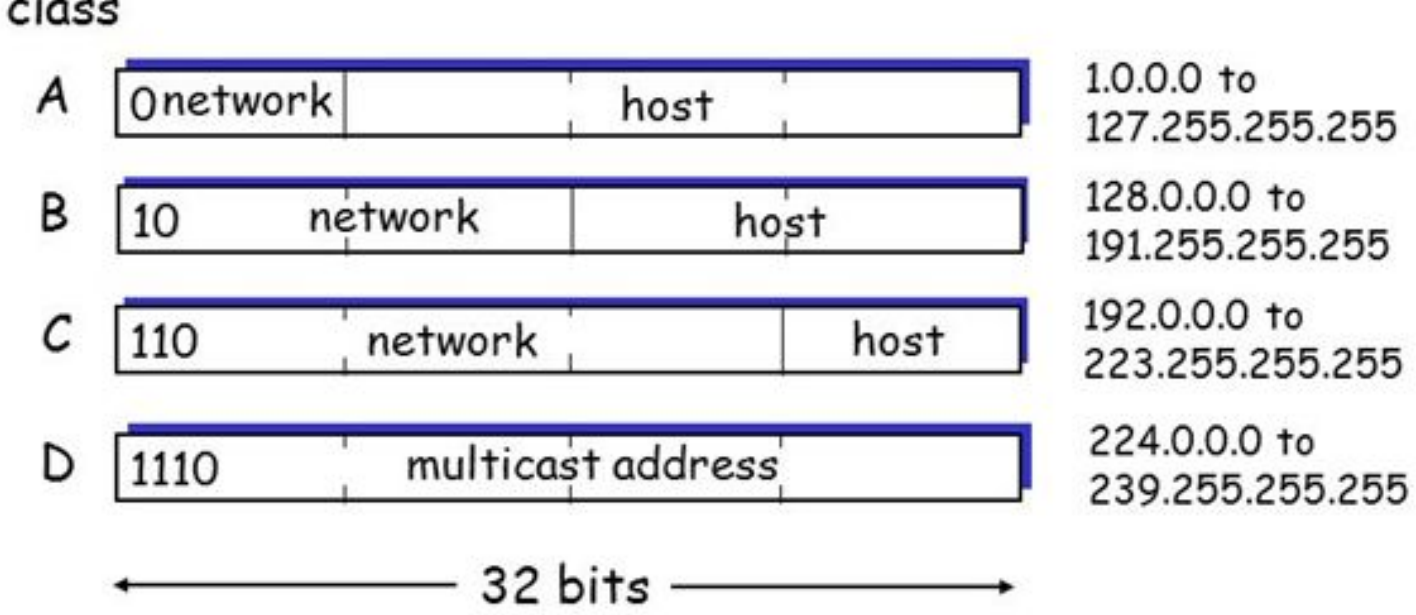
Network address	1st octet								2nd octet								3rd octet								4th octet							
	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
Class A	0	Network address							Computer address																							
Class B	1	0	Network address														Computer address															
Class C	1	1	0	Network address																					Computer address							
Class D	1	1	1	0	Multicast address																											
Class E	1	1	1	1	Undefined format																											

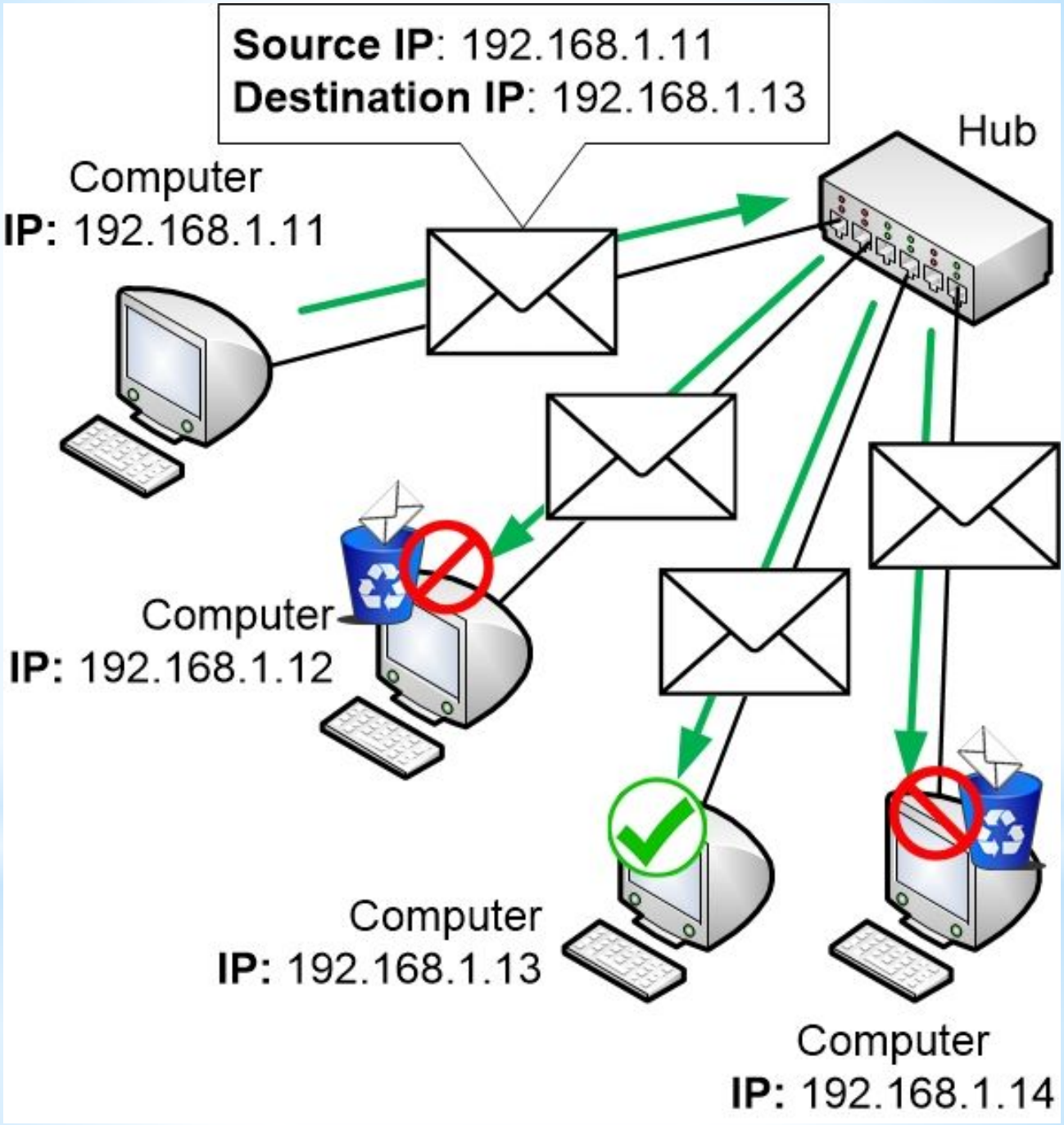


IP Addresses

given notion of "network", let's re-examine IP addresses:

"class-full" addressing: 4 shown, 5th was for future use beginning with 11110




Source IP: 192.168.1.11
Destination IP: 192.168.1.13
Hub
Computer
IP: 192.168.1.11
Computer
IP: 192.168.1.12
Computer
IP: 192.168.1.13
Computer
IP: 192.168.1.14

Internet Protocol (IP) and Media Access Control (MAC)

Each device on the internet is given a unique address known as its **internet protocol (IP) address**. This is a 32-bit number that is usually written in the form: **109.108.158.1**

MAC address is unique number that identifies a device connected to the internet.

Differences between IP addresses and MAC addresses

The IP address gives the *location* of a device on the internet, whereas the MAC address *identifies* the device connected to the internet.

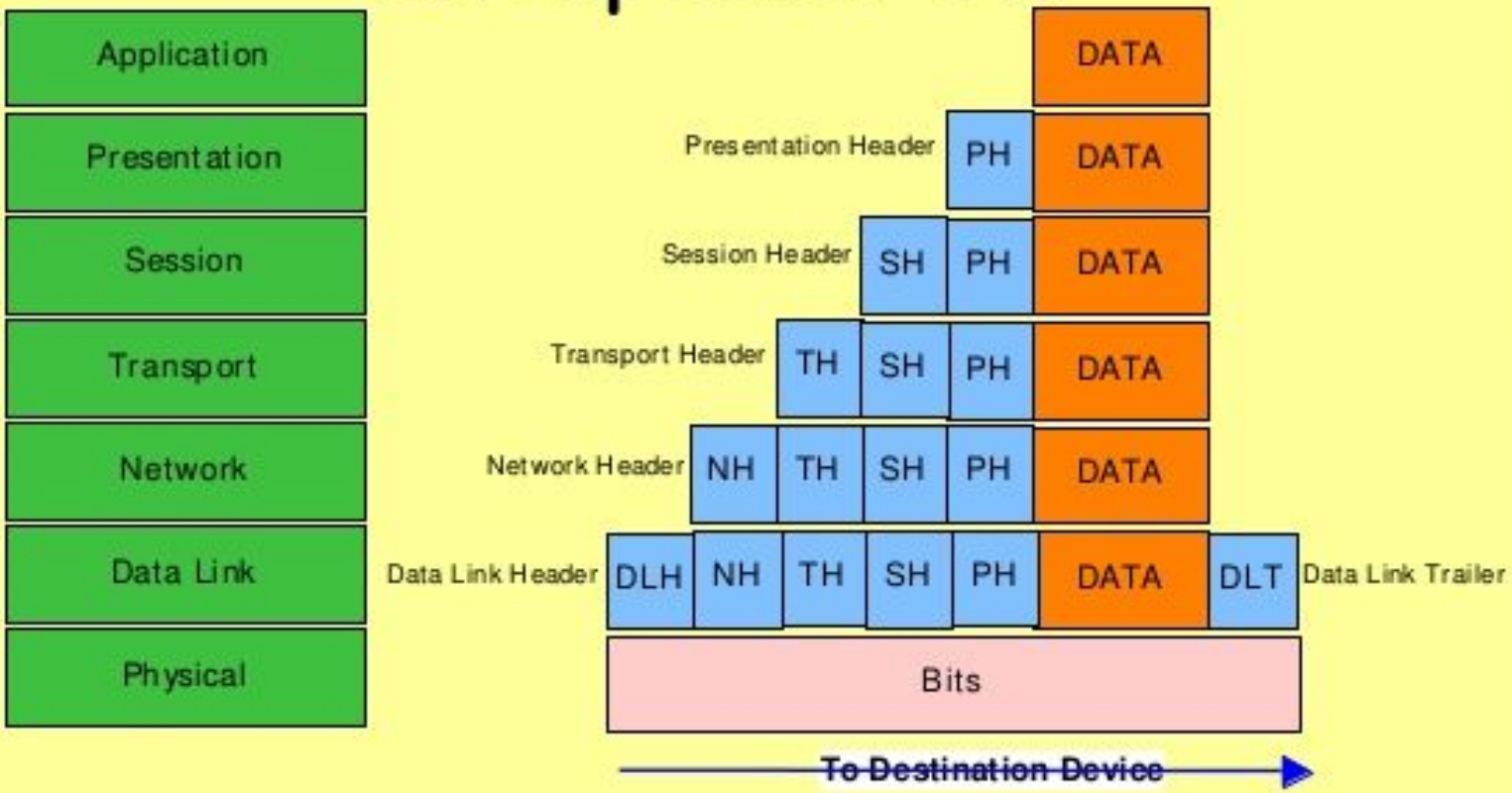
IP-address: 198.162.10.3

Post address: 050036.MAMYR-2.#7.#2

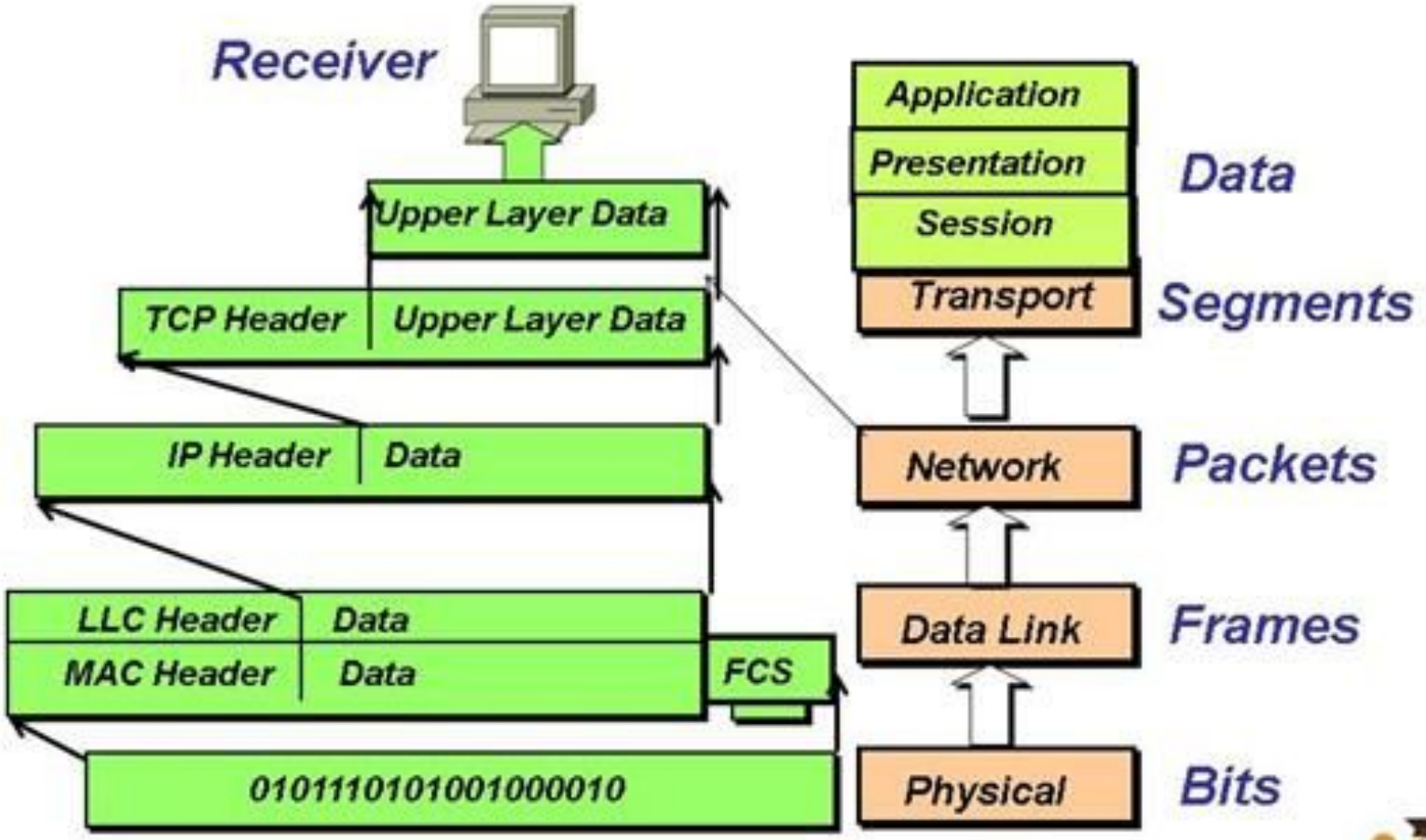
MAC-address: *00:0a:95:9d:68:16.*

IIN/ID: 560601302855/**012601563**

Encapsulation



Data De-Encapsulation



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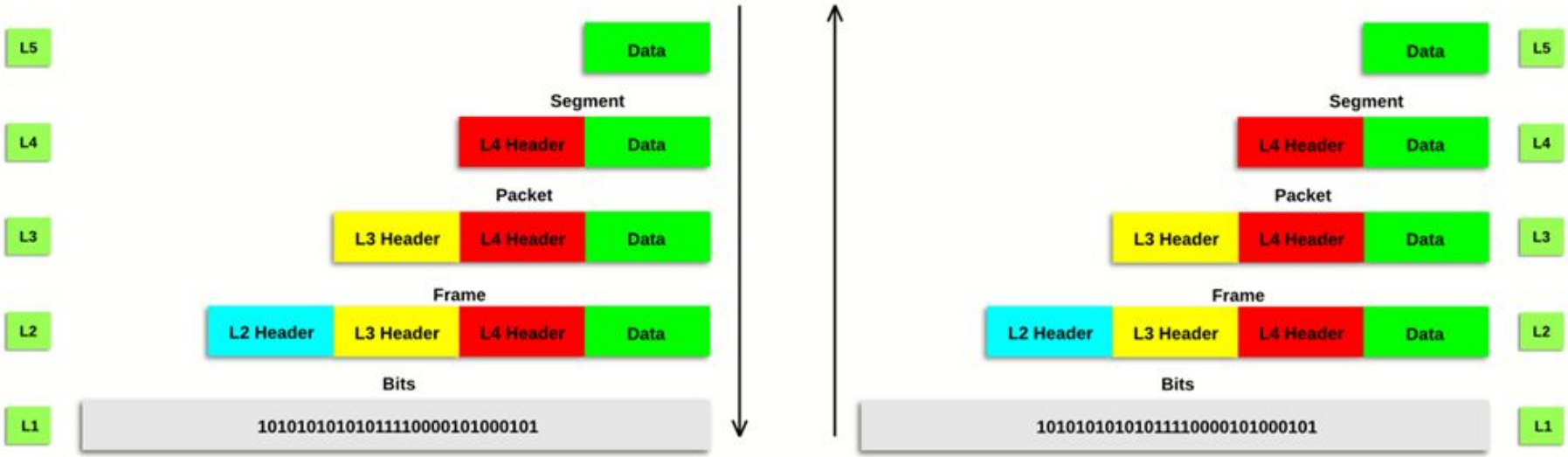
Cisco Is Easy

Encapsulation and De-Encapsulation Process



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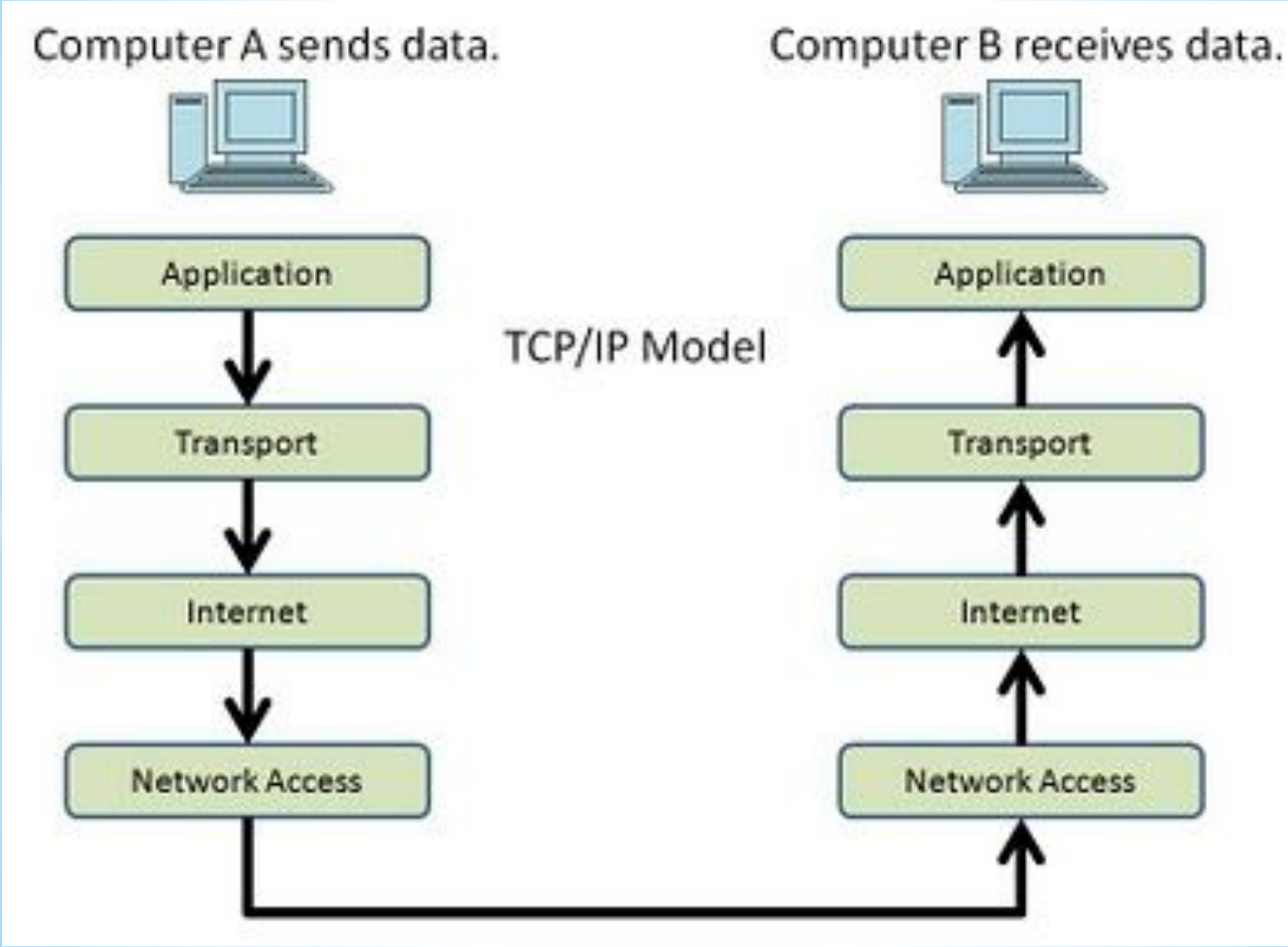
TCP/IP Model – Summary

- Application or Process Layer – concerned with how data at both ends is handled.
- Transport Layer – manages flow of data
- Internet Layer – consists of several protocols, primary protocol is IP (providing hierarchical addressing scheme
- Data Link (or Network Interface) Layer – manages transmission of data within the network
- Physical Layer – not really defined, TCP/IP leaves the physical connection to manage itself

TCP/IP	OSI Model	Protocols
Application Layer	Application Layer	DNS, DHCP, FTP, HTTPS, IMAP, LDAP, NTP, POP3, RTP, RTSP, SSH, SIP, SMTP, SNMP, Telnet, TFTP
	Presentation Layer	JPEG, MIDI, MPEG, PICT, TIFF
	Session Layer	NetBIOS, NFS, PAP, SCP, SQL, ZIP
Transport Layer	Transport Layer	TCP, UDP
Internet Layer	Network Layer	ICMP, IGMP, IPsec, IPv4, IPv6, IPX, RIP
Link Layer	Data Link Layer	ARP, ATM, CDP, FDDI, Frame Relay, HDLC, MPLS, PPP, STP, Token Ring
	Physical Layer	Bluetooth, Ethernet, DSL, ISDN, 802.11 Wi-Fi


Computer A sends data.
Computer B receives data.
Application
Transport
Internet
Network Access
TCP/IP Model
Application
Transport
Internet
Network Access

Application	Description
DHCP	Dynamic Host Configuration Protocol assigns IP addresses
DNS	Domain Name System translates website names to IP addresses
HTTP	Hypertext Transfer Protocol used to transfer web pages
NBNS	NetBIOS Name Service translates local host names to IP addresses
SMTP	Simple Mail Transfer Protocol sends email messages
SNMP	Simple Network Management Protocol manages network devices
SNTP	Simple Network Time Protocol provides time of day
Telnet	Bi-directional text communication via a terminal application
TFTP	Trivial File Transfer Protocol used to transfer small amounts of data

DHCP

- Dynamic Host Configuration Protocol

Dynamic Host Configuration Protocol (DHCP)

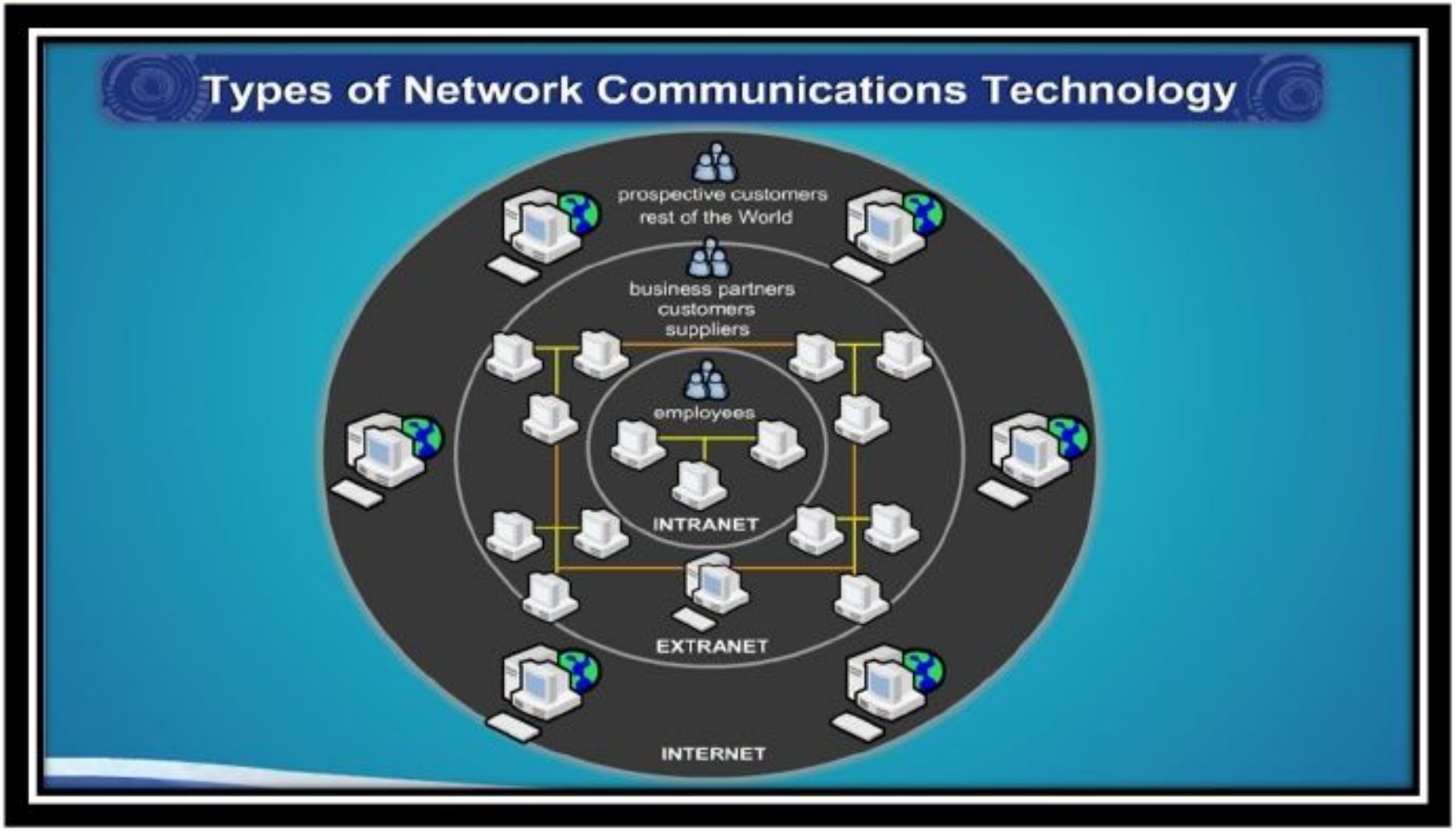
- DHCP is a protocol that allows client computers to automatically receive an IP address and TCP/IP settings from a Server.
- Allows servers to assign or lease IP addresses to computers and other devices that are enabled as DHCP clients on the network.
- All DHCP messages are carried in ***User Datagram Protocol (UDP)*** datagrams using the well-known port numbers 67 (from the server) and 68 (to the client).

Networks and Telecommunications.

Connectivity technology to the Internet.

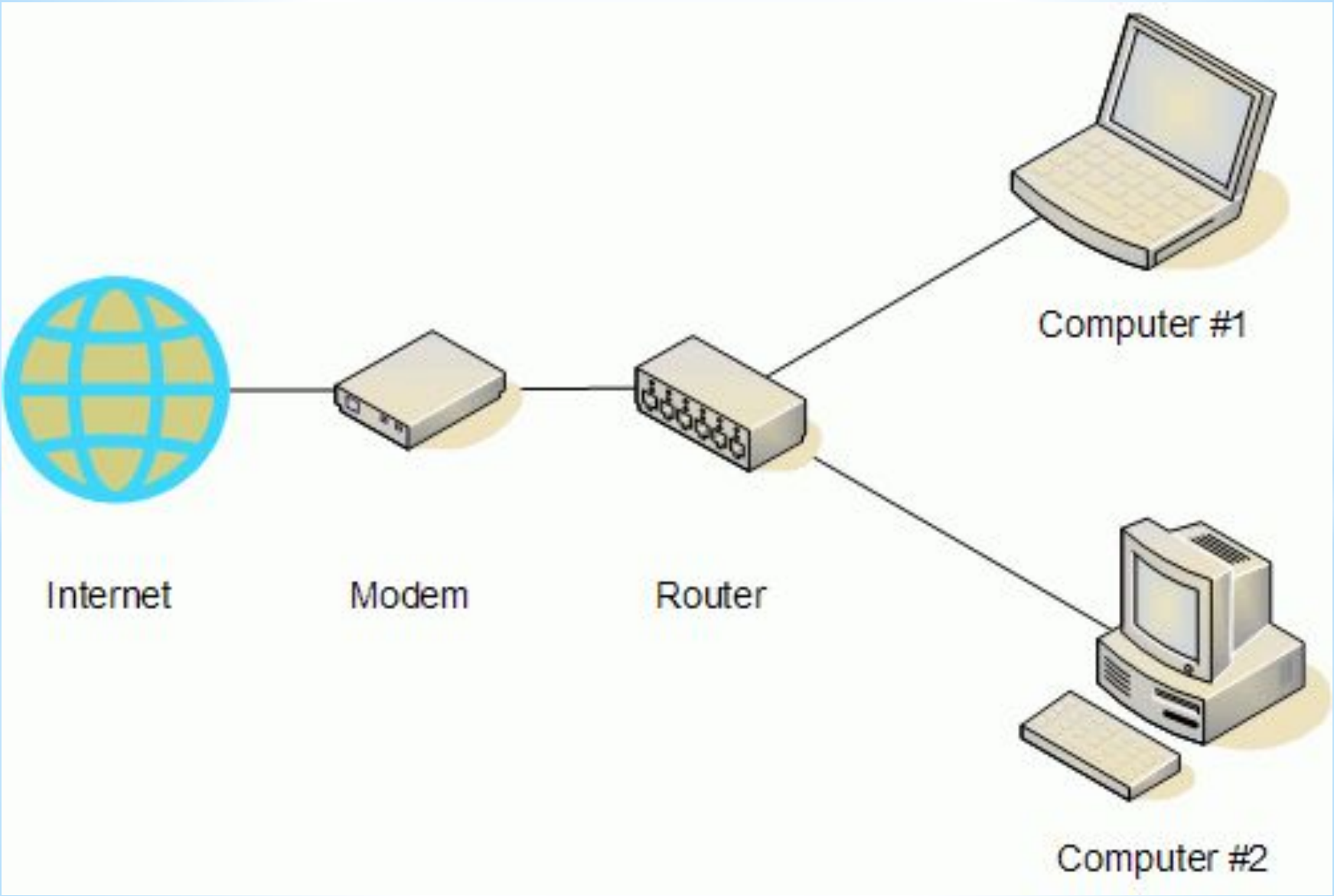
Telecommunication technologies.

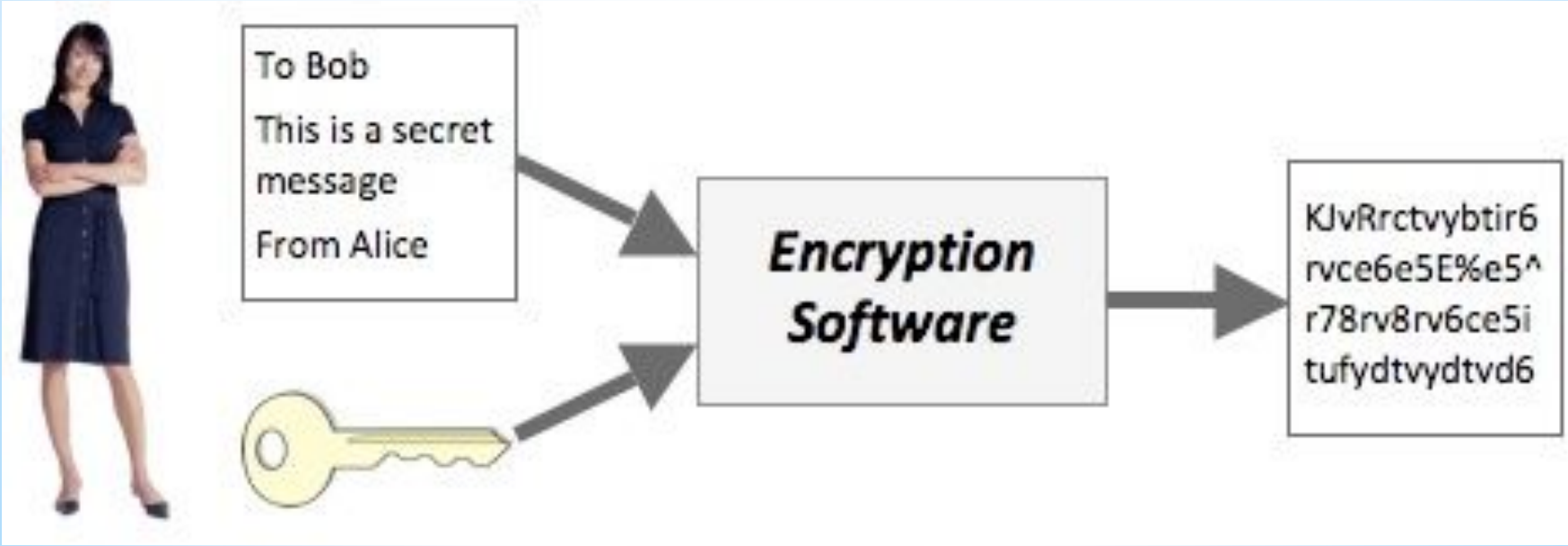
The Types of Network Communication Technology

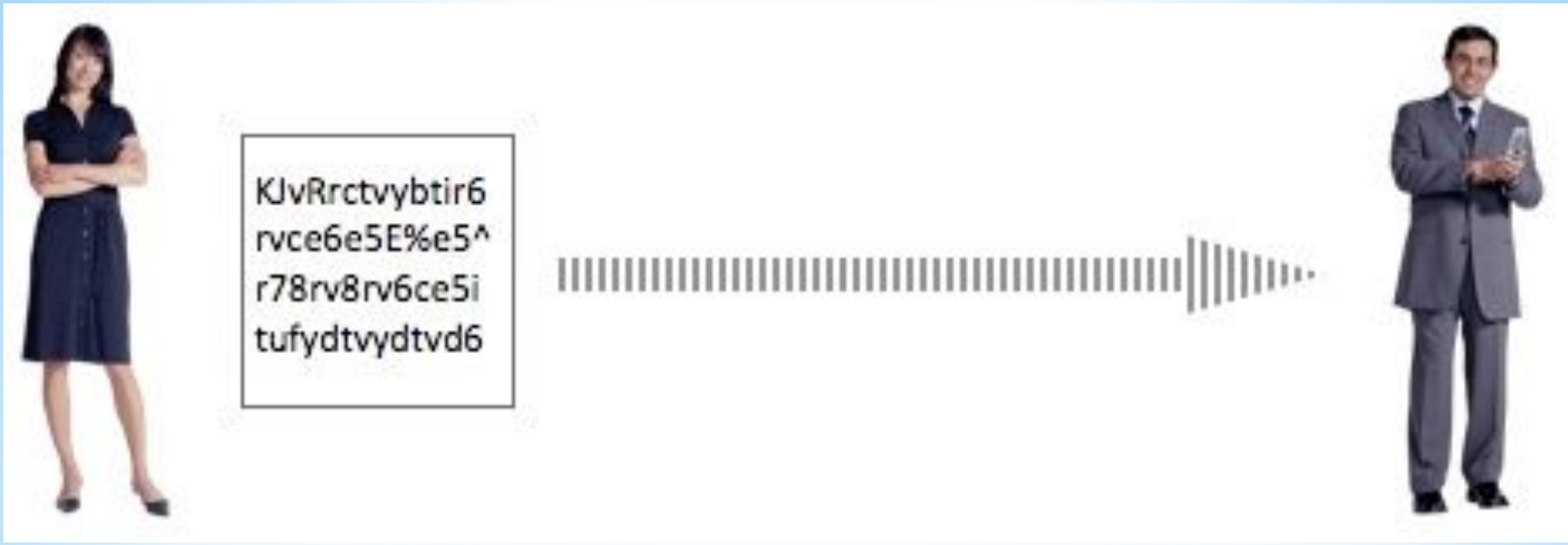


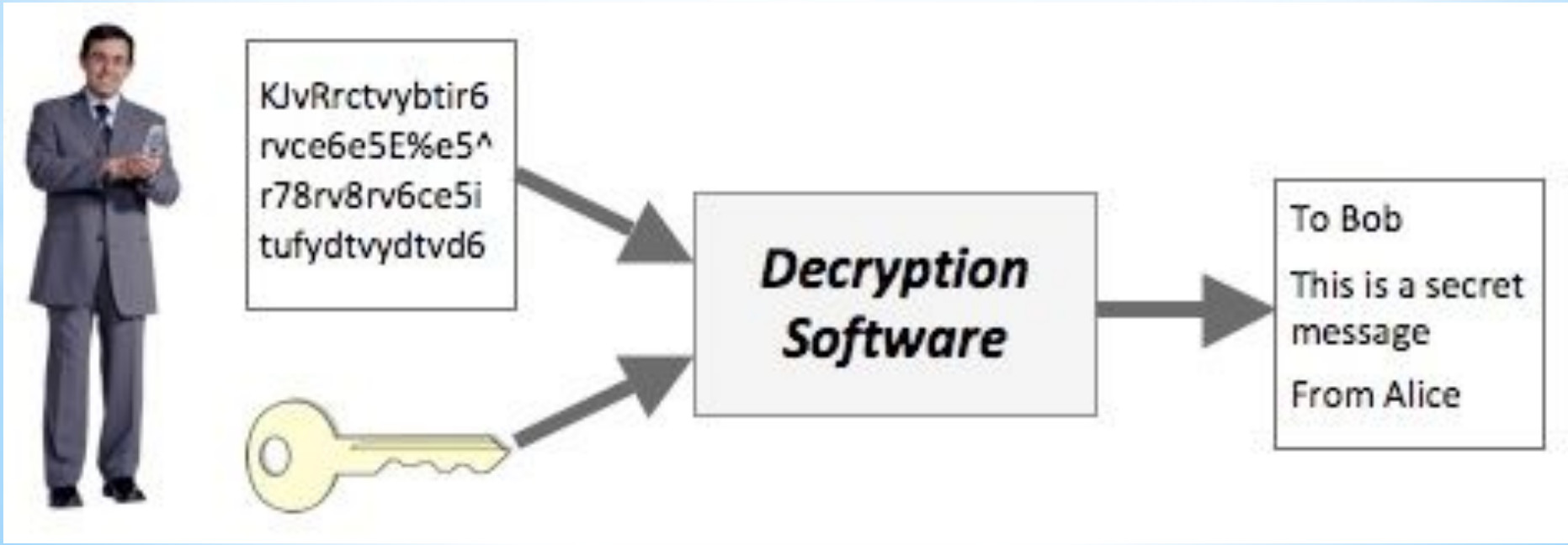
Financial Institutions
Home
Branch Office
Internet Core
Hotel
Data Centre Server Farms
Mobile Wireless
Other Service
VOIP Network
Communication Technologies

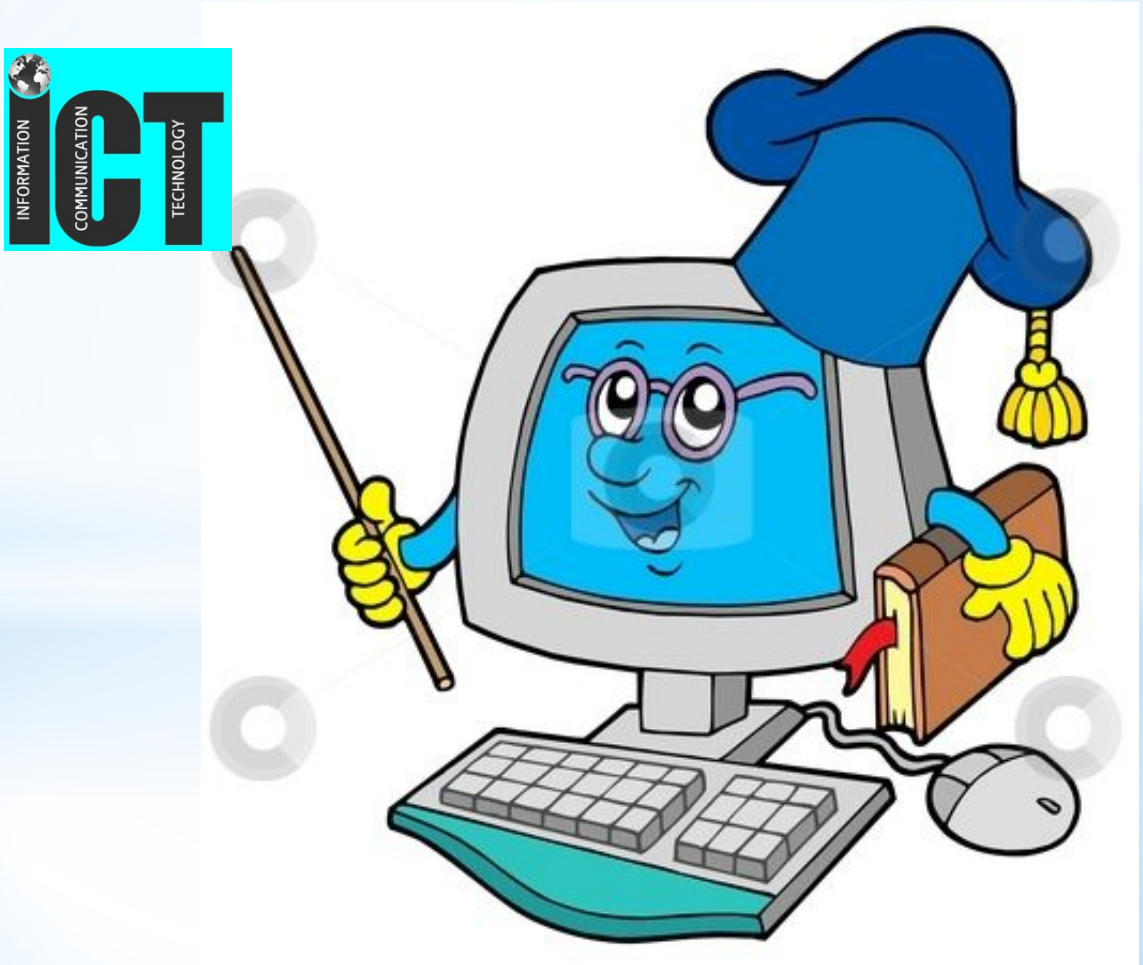
Internet


Computer #1
Internet
Modem
Router
Computer #2


To Bob
This is a secret message
From Alice
Encryption Software
KJvRrctvybtir6
rvce6e5E%e5^
r78rv8rv6ce5i
tufydtvydtvd6


KJvRrctvybtir6
rvce6e5E%e5^
r78rv8rv6ce5i
tufydtvydtvd6


KJvRrctvybtir6
rvce6e5E%e5^
r78rv8rv6ce5i
tufydtvydtvd6
Decryption Software
To Bob
This is a secret message
From Alice

Number	Topic
802.1	Overview and architecture of LANs
802.2 ↓	Logical link control
802.3 *	Ethernet
802.4 ↓	Token bus (was briefly used in manufacturing plants)
802.5	Token ring (IBM's entry into the LAN world)
802.6 ↓	Dual queue dual bus (early metropolitan area network)
802.7 ↓	Technical advisory group on broadband technologies
802.8 †	Technical advisory group on fiber optic technologies
802.9 ↓	Isochronous LANs (for real-time applications)
802.10 ↓	Virtual LANs and security
802.11 *	Wireless LANs
802.12 ↓	Demand priority (Hewlett-Packard's AnyLAN)
802.13	Unlucky number. Nobody wanted it
802.14 ↓	Cable modems (defunct: an industry consortium got there first)
802.15 *	Personal area networks (Bluetooth)
802.16 *	Broadband wireless
802.17	Resilient packet ring

Thank You