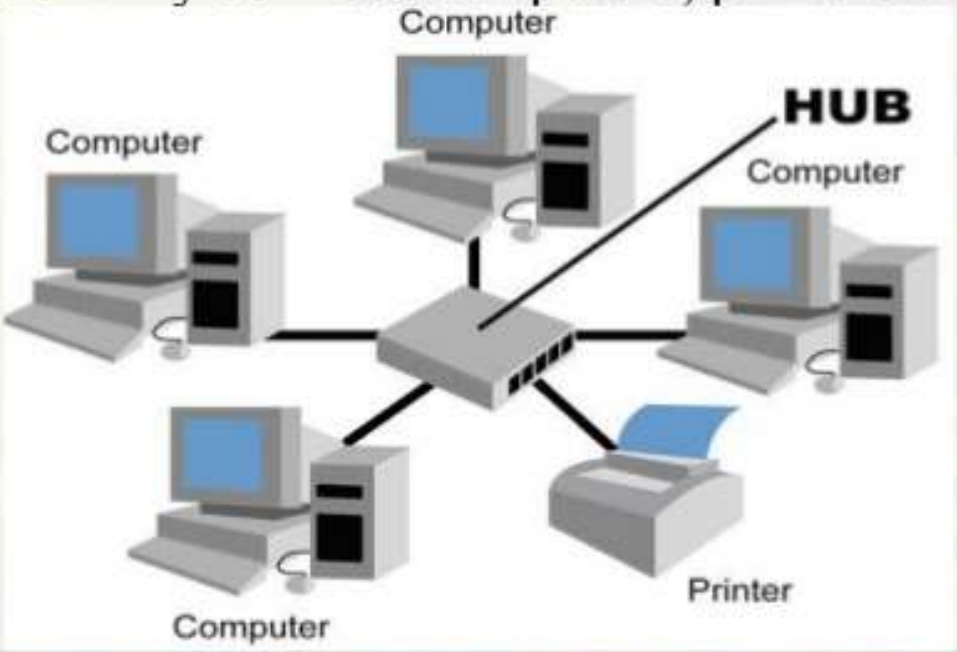
UNIT – I

COMPUTER NETWORK


What Is
A
Computer
Network?
https://www.lootlya.in

Definition of Computer network

- A **Computer network** is a collection of computers and devices Connected together via **communication devices** and **transmission media**. For example it my connect computers, printers and scanners.



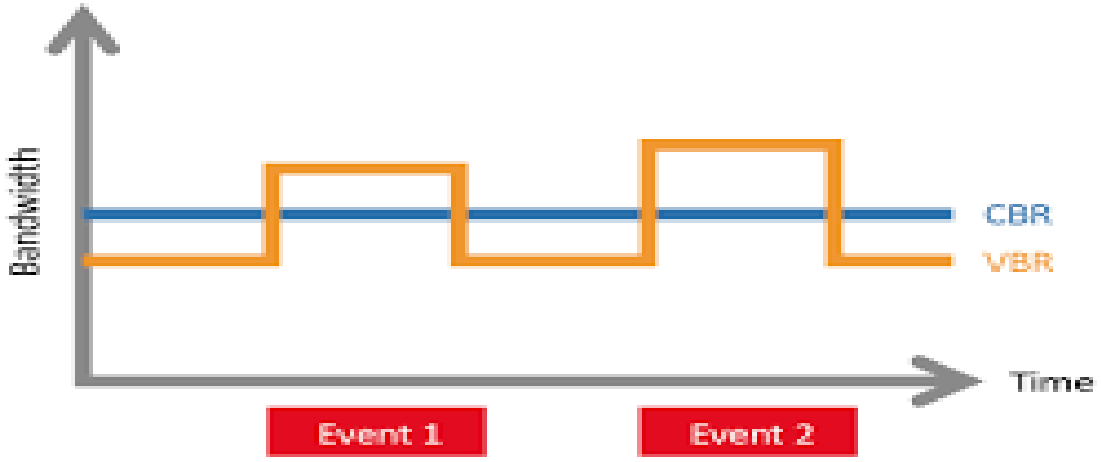
History

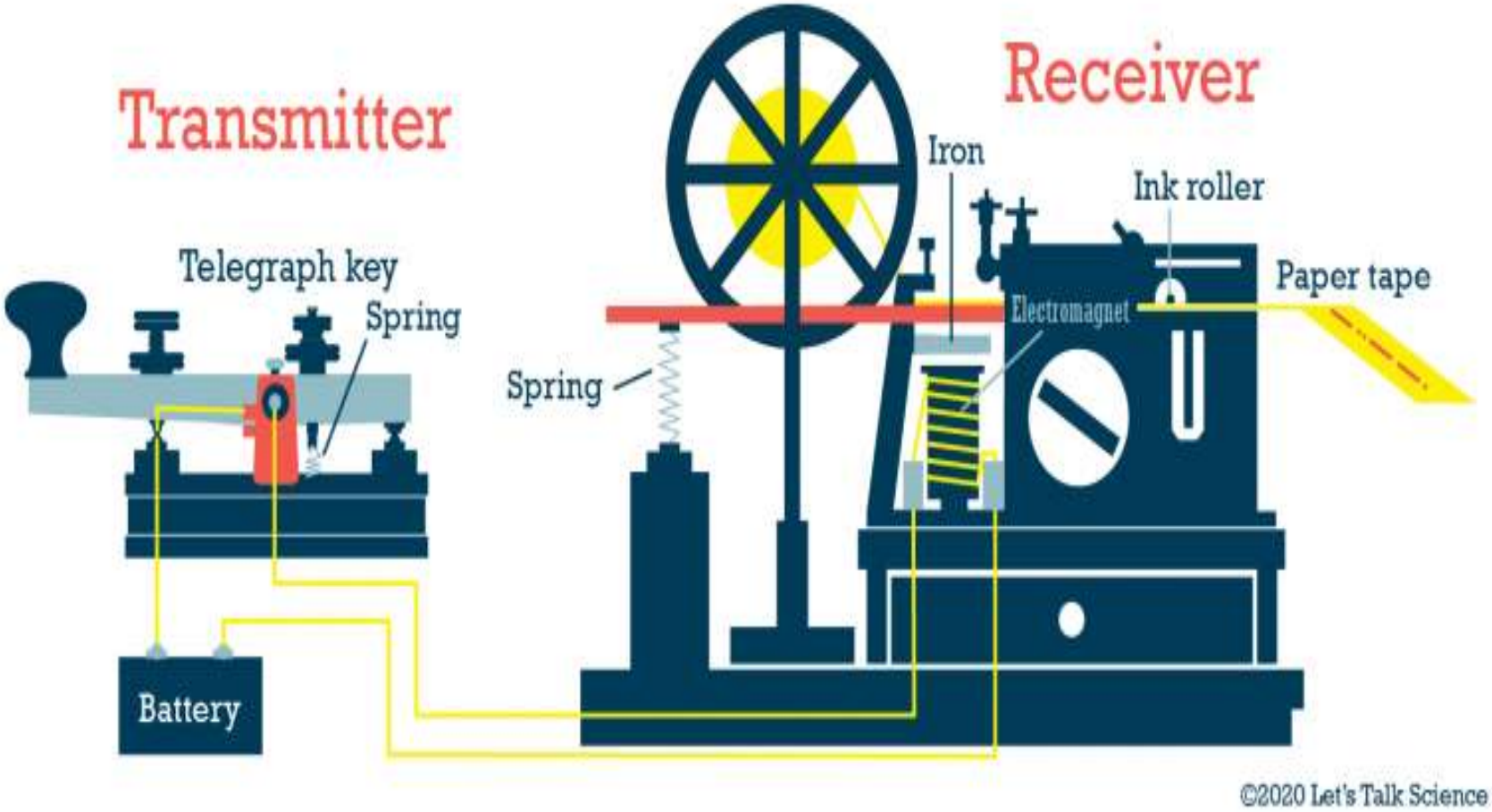
- Before 1960, telegraph and telephone networks.

  - constant-rate communication at that time,

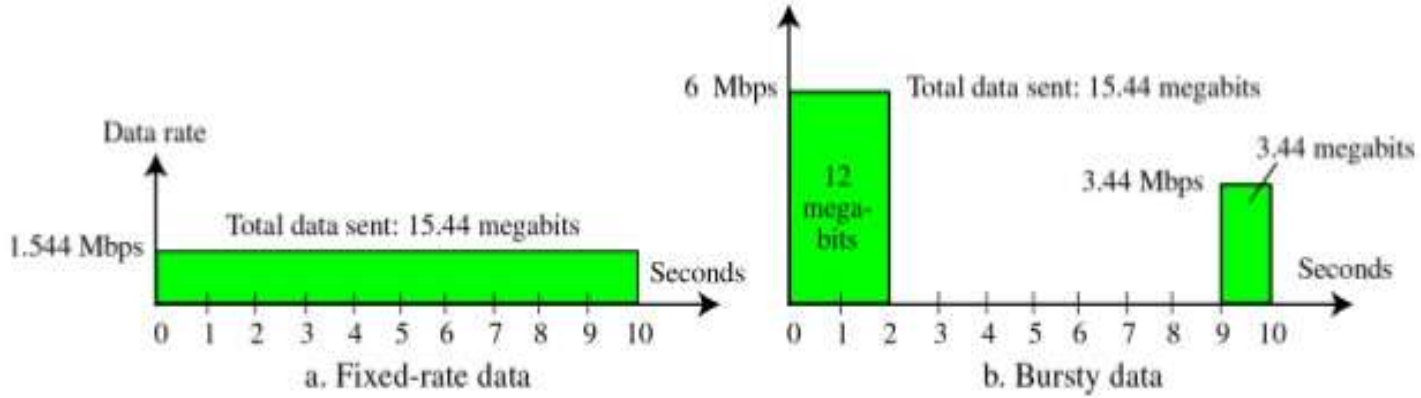
  - encoded message (telegraphy) or voice (telephony)

- A computer network, on the other hand, should be able to handle bursty data, which means data received at variable rates at different times.




Transmitter
Receiver
Telegraph key
Spring
Battery
Spring
Iron
Ink roller
Paper tape
Electromagnet
©2020 Let's Talk Science

Fixed-Rate versus Bursty Data



```
Enter your text to encode:
Python is fun!
Enter how many places to shift:
12
Encoded Message (12 places):
Bkftaz ue rgz!
Enter your text to decode:
Bkftaz ue rgz!
Enter the secret shift number:
12
Decoded Message:
Python is fun!
>>>
```

Rakesh K Gupta. J Pharm Biomed Sci. 2012, December; 25 (25); 218-222
Available at jpbms.info

Research article

The Parameters to be considered before putting the patient on non-invasive positive pressure ventilation (Nippv) in acute respiratory failure

Rakesh K Gupta*

*Assistant Professor, Department of Pulmonology and Critical Care, King Fahd Hospital of University , University of Dammam, Kingdom of Saudi Arabia.

Abstract:

Background: In recent years non-invasive ventilator modalities have been developed to improve alveolar ventilation and oxygenation with-out the need for an artificial airway. It is found to be an effective modality for the treatment of hypercapnic as well as hypoxic respiratory failure. In some patients however noninvasive ventilation is inadequate and invasive ventilation cannot be avoided. Failure of initial trial of NIPPV may lead to a delay in intubation and associated with significant increase in mortality.


wiseGEEK


Your Company

History

- Birth of Packet-Switched Networks

The theory of packet switching for bursty traffic was first presented by Leonard Kleinrock in 1961 at MIT(Massachusetts Institute of Technology). At the same time, two other researchers, Paul Baran at Rand Institute and Donald Davies at National Physical Laboratory in England, published some papers about packet-switched networks.

History

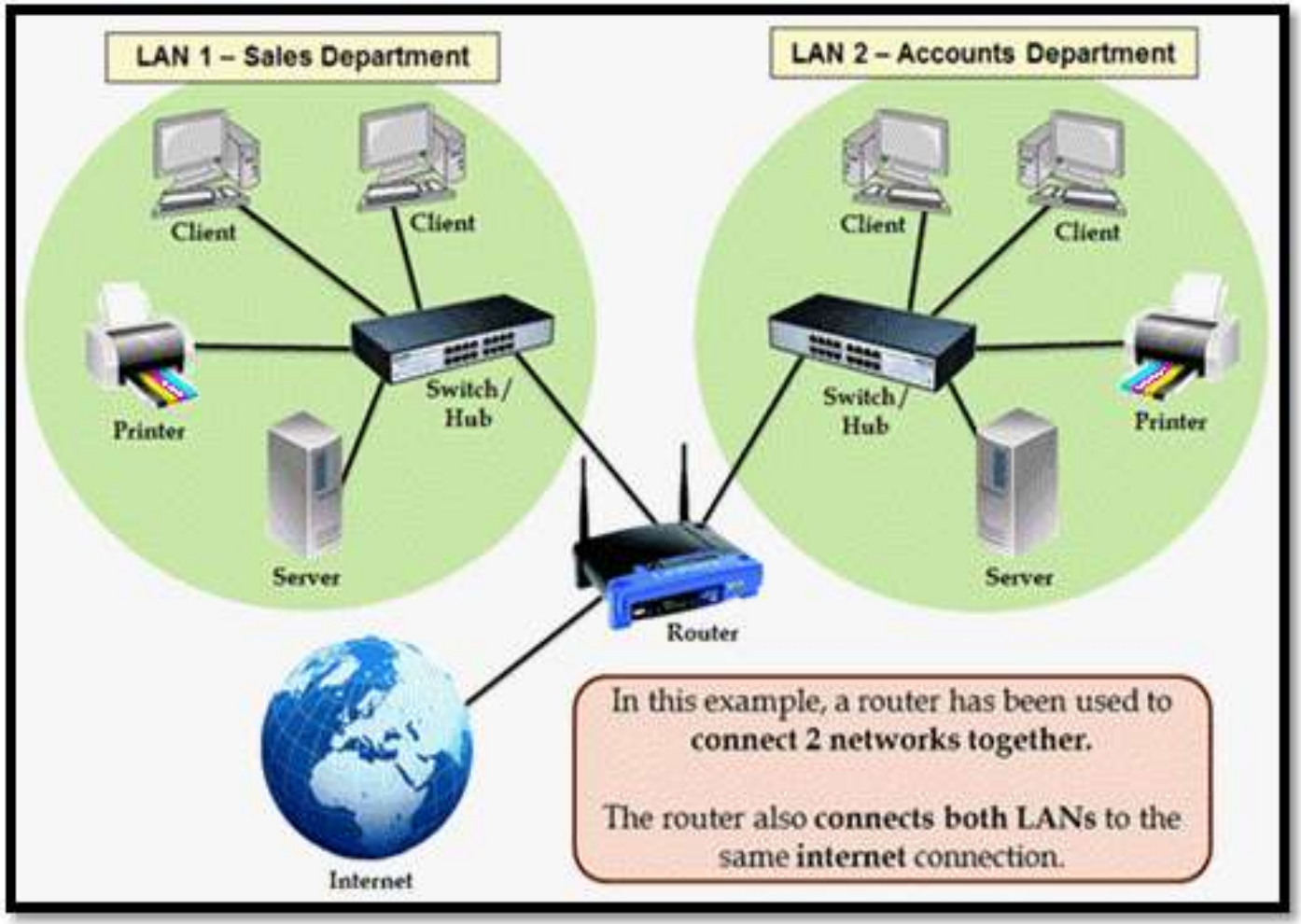
ARPANET

- In the mid-1960s, mainframe computers in research organizations were stand-alone devices. Computers from different manufacturers were unable to communicate with one another.
- The Advanced Research Projects Agency (ARPA) in the Department of Defense (DOD)
- In 1967, at an Association for Computing Machinery (ACM) meeting, ARPA presented its ideas for the Advanced Research Projects Agency Network (ARPANET)
    - interface message processor (IMP).
- By 1969, ARPANET was a reality.
- Four nodes, at the University of California at Los Angeles (UCLA), the University of California at Santa Barbara (UCSB), StanfordResearch Institute (SRI), and the University of Utah, were connected via the IMPs to form a network.
- Software called the Network Control Protocol (NCP) provided communication between the hosts.

History

Birth of the Internet

- In 1972, Vint Cerf and Bob Kahn, both of whom were part of the core ARPANET group, collaborated on what they called the Internetting Project. They wanted to link dissimilar network.
- There were many problems to overcome:
  - diverse packet sizes,
  - diverse interfaces, and
  - diverse transmission rates,
- Cerf and Kahn devised the idea of a device called a gateway(intermediary hardware).


LAN 1 – Sales Department
LAN 2 – Accounts Department
Client
Client
Client
Client
Printer
Switch/
Hub
Switch/
Hub
Printer
Server
Server
Router
Internet
In this example, a router has been used to **connect 2 networks together.**
The router also **connects both LANs** to the same **internet** connection.

History

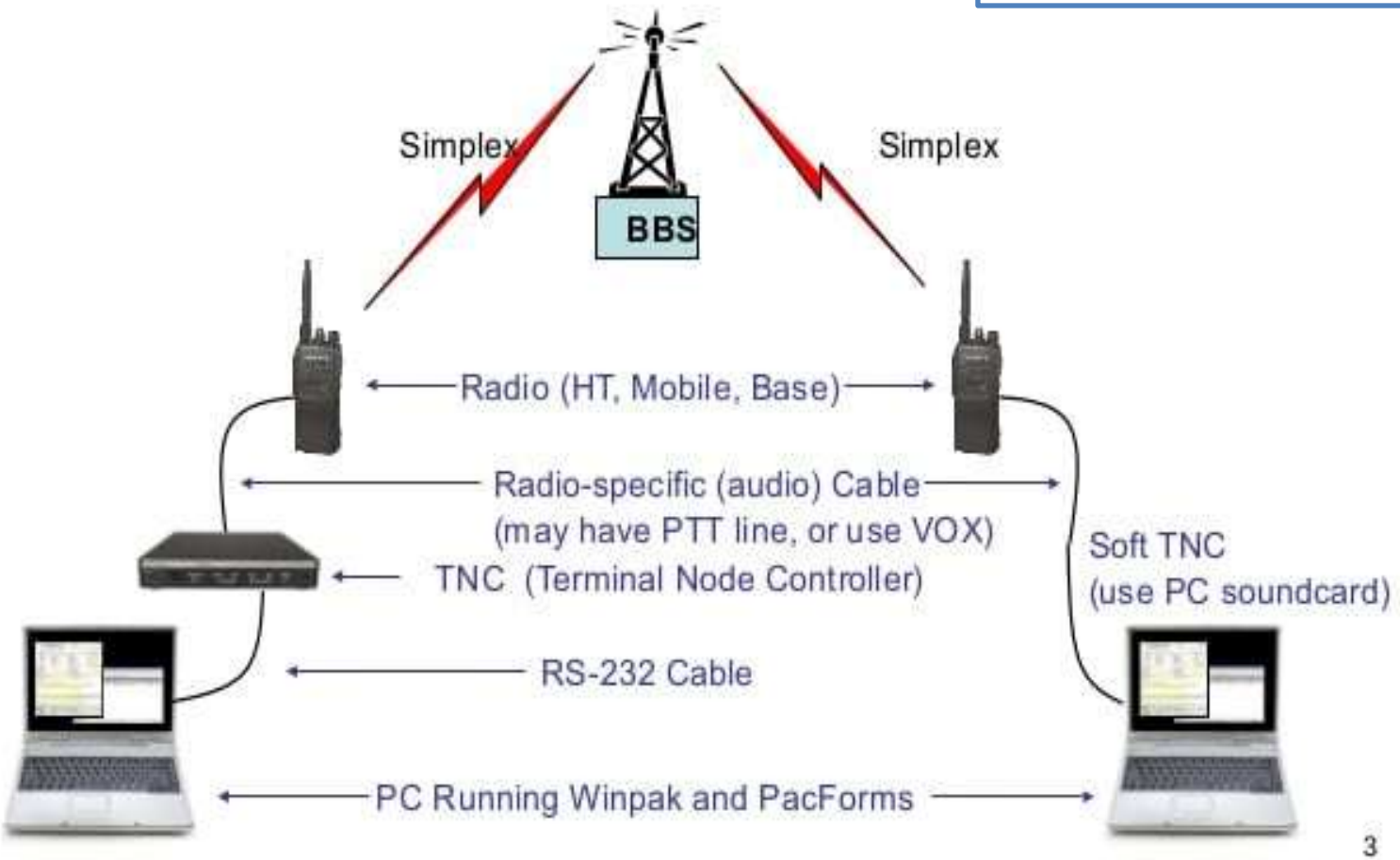
TCP / IP

- Cerf and Kahn's landmark 1973 paper outlined the protocols to achieve end-to-end delivery of data.
- This paper on transmission control protocol (TCP) included concepts such as
  - encapsulation,
  - datagram (Connectionless communication service), and
  - functions of a gateway.
- In October 1977, an internet consisting of three different networks (ARPANET, packet radio, and packet satellite) was successfully demonstrated.

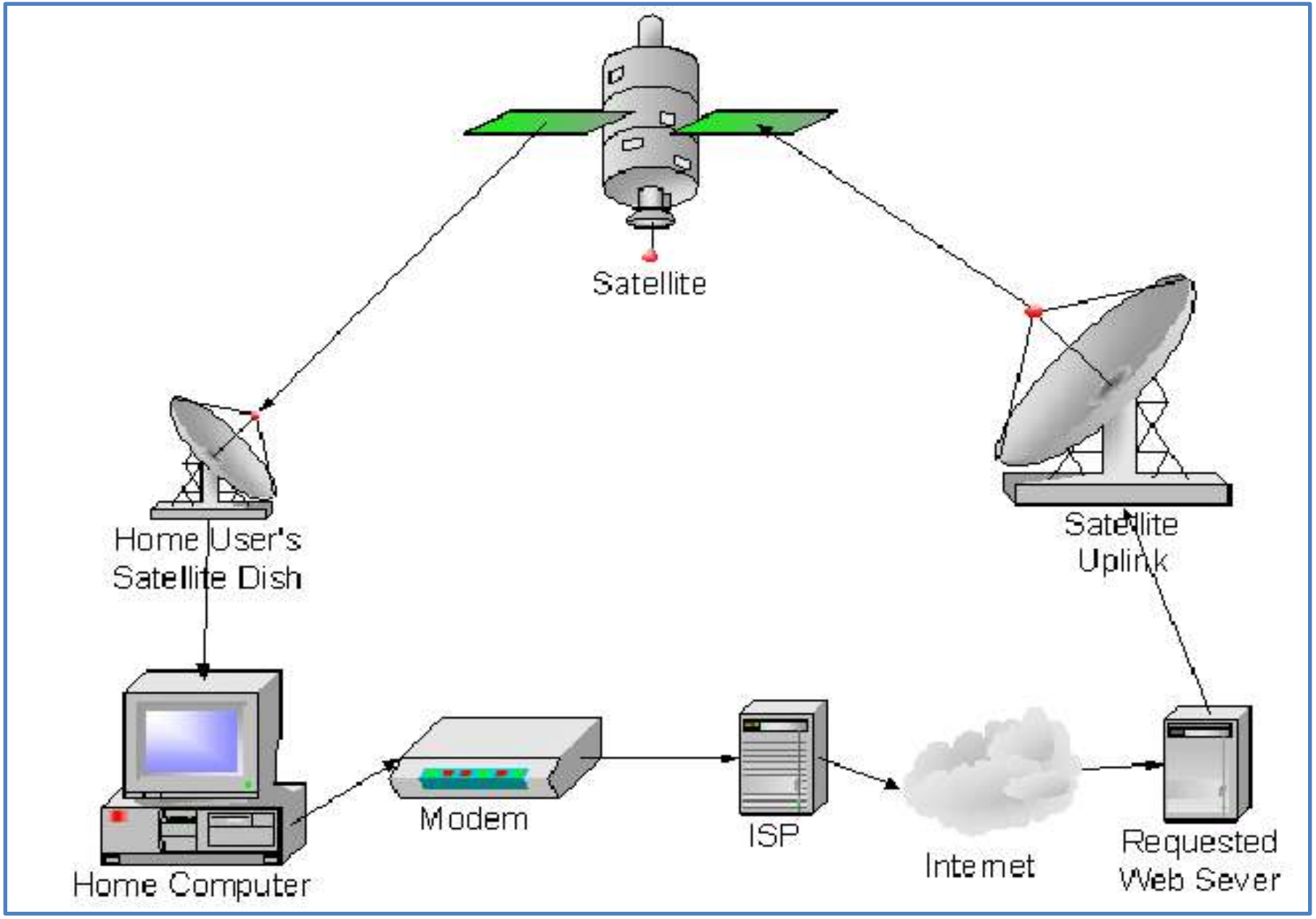
Typical Packet Stations

Push-to-talk (**PTT**)

Voice Activated Transmission (**VOX**)



3


Satellite
Home User's
Satellite Dish
Satellite
Uplink
Home Computer
Modem
ISP
Internet
Requested
Web Sever

History

TCP / IP

- Shortly thereafter, authorities made a decision to split TCP into two protocols:
  1. Transmission Control Protocol (TCP) and
  2. Internet Protocol (IP).
- IP would handle datagram routing
- while TCP would be responsible for higher level functions such as
  - segmentation,
  - reassembly, and
  - error detection
- The new combination became known as TCP/IP.

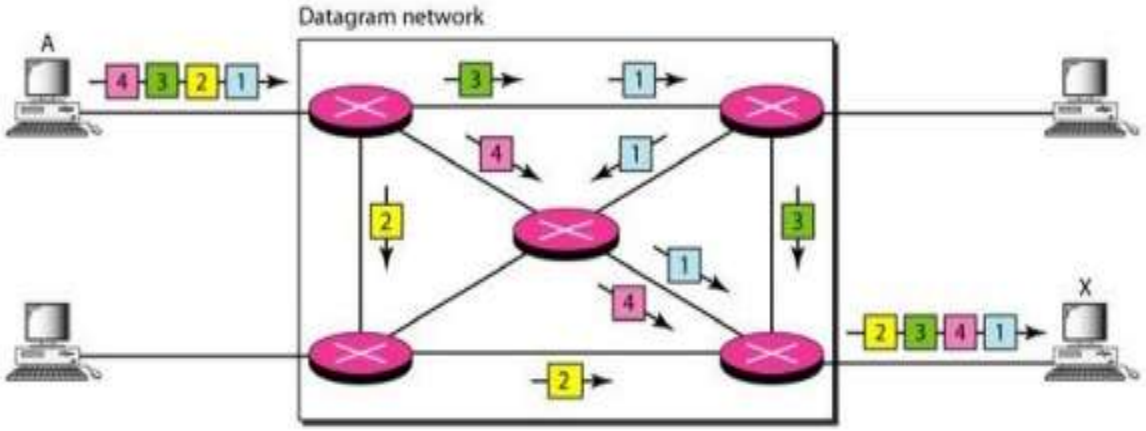


Figure 1.48 A datagram network with four switches

History

TCP / IP

In 1983, authorities abolished the original ARPANET protocols, and TCP/IP became the official protocol for the ARPANET.

Those who wanted to use the Internet to access a computer on a different network had to be running TCP/IP.

MILNET

In 1983, ARPANET split into two networks:

1. Military Network (MILNET) for military users and
2. ARPANET for nonmilitary users.

History

CSNET

- Another milestone in Internet history was the creation of CSNET in 1981. Computer Science Network(CSNET) was a network sponsored by the National Science Foundation (NSF).
- CSNET was a less expensive network;
- By the mid-1980s, most U.S. universities with computer science departments were part of CSNET.

NSFNET

- NSF in 1986 sponsored the National Science Foundation Network(NSFNET),
- In 1990, ARPANET was officially retired and replaced by NSFNET.
- In 1995, NSFNET reverted back to its original concept of a research network.

History

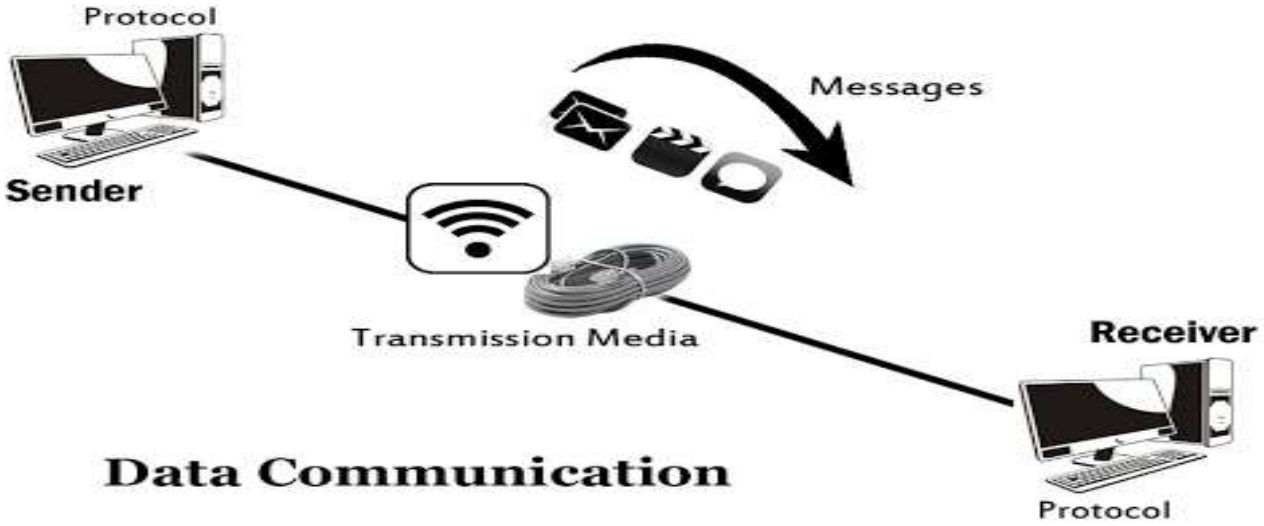
ANSNET

- In 1991, the U.S. government decided that NSFNET was not capable of supporting the rapidly increasing Internet traffic.
- Three companies, IBM, Merit, and Verizon,
- Advanced Network & Services (ANS)to build a new, high-speed Internet backbone called Advanced Network Services Network(ANSNET).

Data Communication

Fundamental characteristics of effectiveness data communication

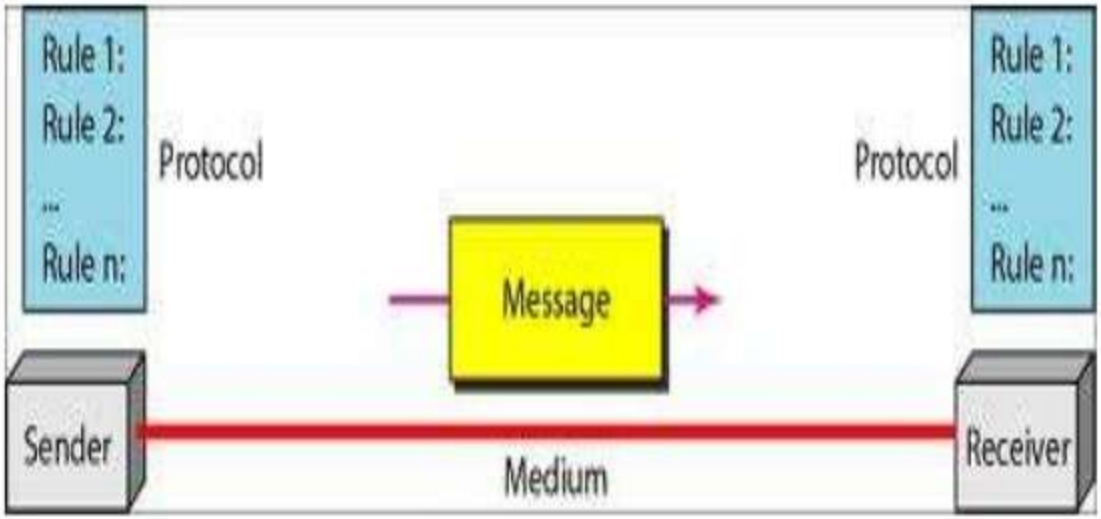
- The effectiveness of a data communication system depends on 4 fundamental characteristics:
  1. Delivery. The system must deliver data to the correct destination
  2. Accuracy. The system must deliver data accurately
  3. Timeliness. The system must deliver data in a timely manner
  4. Jitter. Jitter refers to the variation in the packet arrival time



Data Communication

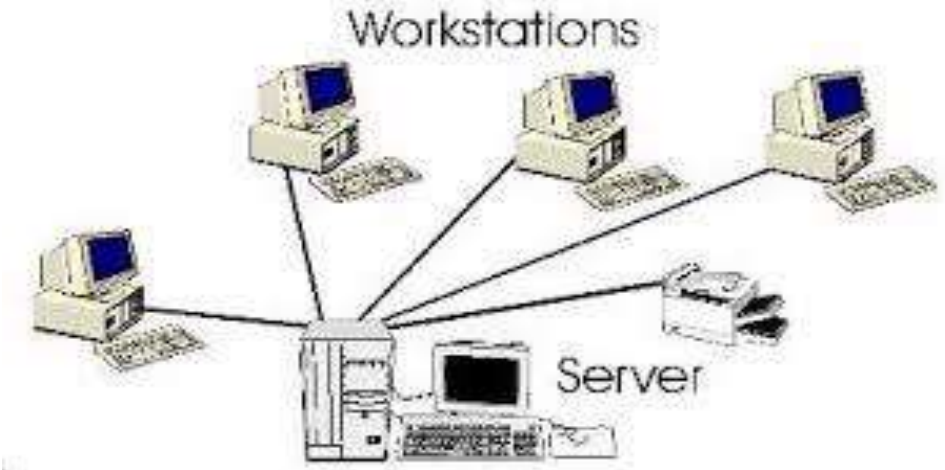
Components of Data Communication:

1.Sender 2.Receiver 3.Message 4.Tramsmission Medium
5. Protocol



The five components of data communication are:

1. **Message** - It is the information to be communicated. Popular forms of information include text, pictures, audio, video etc.
2. **Sender** - It is the device which sends the data messages. It can be a computer, workstation, telephone handset etc.
3. **Receiver** - It is the device which receives the data messages. It can be a computer, workstation, telephone handset etc.
4. **Transmission Medium** - It is the physical path by which a message travels from sender to receiver. Some examples include twisted-pair wire, coaxial cable, radio waves etc.
5. **Protocol** - It is a set of rules that governs the data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating.



KINDS OF NETWORK CABLING:

COAXIAL CABLE

FIBER OPTIC CABLE

SHIELDED TWISTED PAIR (STP) CABLE

UNSHIELDED TWISTED PAIR (UTP) CABLE

Data Representation

- ***Text*** – represented as a bit pattern; codes often used:
  - **ASCII; Extended ASCII; Unicode; ISO**
- **Numbers** – represented by binary equivalent
- **Images** – bit patterns representing pixels
- **Audio** - Audio refers to the recording or broadcasting of sound or music.
- **Video** - Video refers to the recording or broadcasting of a picture or movie.

Converting the text "hope" into binary

Characters:	h	o	p	e
ASCII Values:	104	111	112	101
Binary Values:	01101000	01101111	01110000	01100101
Bits:	8	8	8	8

ComputerHope.com

UNIT	ABBREVIATION	STORAGE
Bit	B	Binary Digit. Single 1 or 0
Nibble	-	4 bits
Byte/Octet	B	8 bits
Kilobyte	KB	1024 bytes
Megabyte	MB	1024 KB
Gigabyte	GB	1024 MB
Terabyte	TB	1024 GB
Petabyte	PB	1024 TB
Exabyte	EB	1024 PB
Zettabyte	ZB	1024 EB
Yottabyte	YB	1024 ZB

Storage units (www.byte-notes.com

The ASCII code

American Standard Code for Information Interchange

ASCII control characters

DEC	HEX	Simbolo ASCII	
00	00h	NULL	(carácter nulo)
01	01h	SOH	(inicio encabezado)
02	02h	STX	(inicio texto)
03	03h	ETX	(fin de texto)
04	04h	EOT	(fin transmisión)
05	05h	ENQ	(enquiry)
06	06h	ACK	(acknowledgement)
07	07h	BEL	(timbre)
08	08h	BS	(retroceso)
09	09h	HT	(tab horizontal)
10	0Ah	LF	(salto de linea)
11	0Bh	VT	(tab vertical)
12	0Ch	FF	(form feed)
13	0Dh	CR	(retorno de carro)
14	0Eh	SO	(shift Out)
15	0Fh	SI	(shift In)
16	10h	DLE	(data link escape)
17	11h	DC1	(device control 1)
18	12h	DC2	(device control 2)
19	13h	DC3	(device control 3)
20	14h	DC4	(device control 4)
21	15h	NAK	(negative acknowle.)
22	16h	SYN	(synchronous idle)
23	17h	ETB	(end of trans. block)
24	18h	CAN	(cancel)
25	19h	EM	(end of medium)
26	1Ah	SUB	(substitute)
27	1Bh	ESC	(escape)
28	1Ch	FS	(file separator)
29	1Dh	GS	(group separator)
30	1Eh	RS	(record separator)
31	1Fh	US	(unit separator)
127	20h	DEL	(delete)

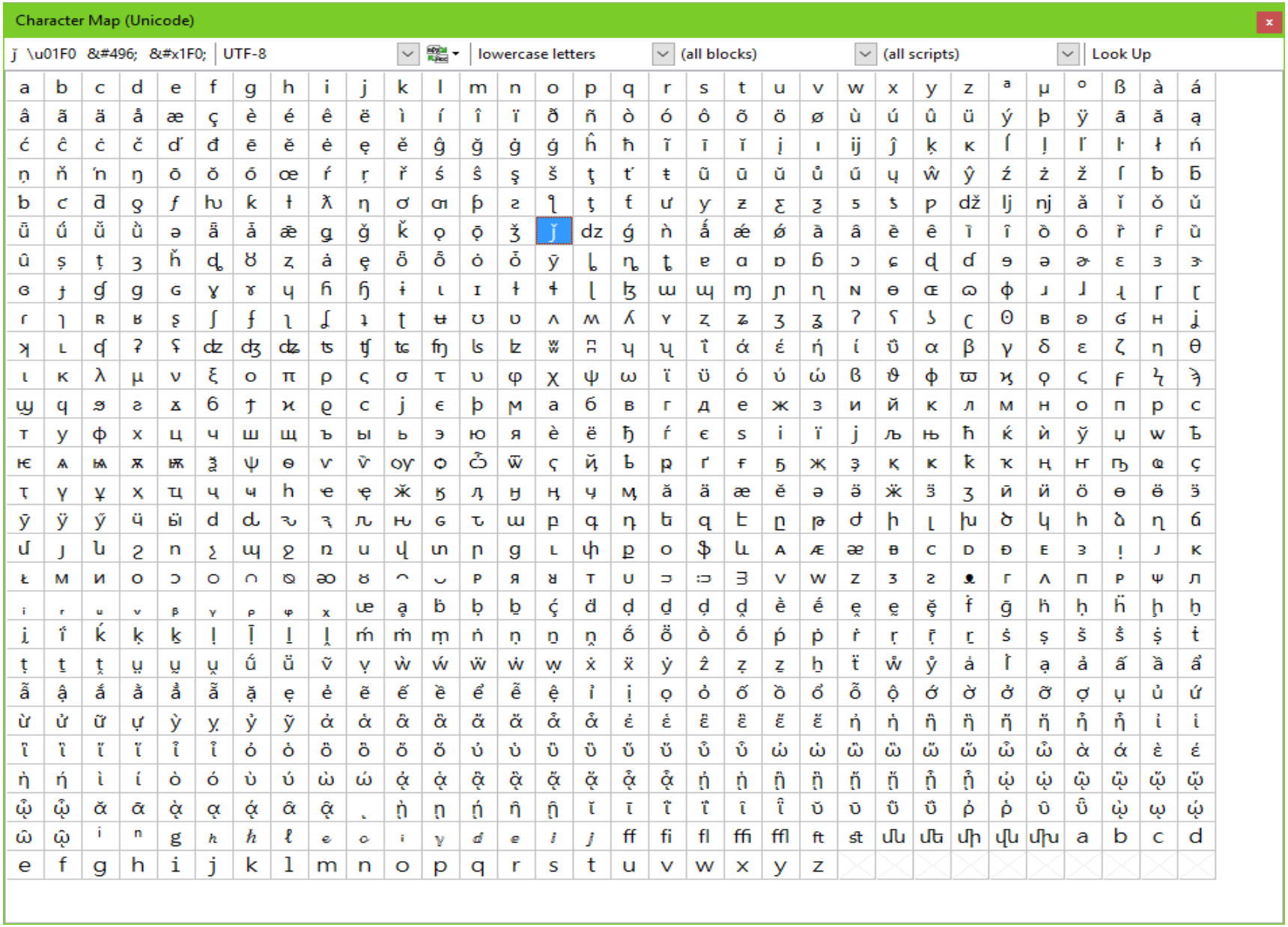
ASCII printable characters

DEC	HEX	Simbolo	DEC	HEX	Simbolo	DEC	HEX	Simbolo
32	20h	espacio	64	40h	@	96	60h	`
33	21h	!	65	41h	A	97	61h	a
34	22h	"	66	42h	B	98	62h	b
35	23h	#	67	43h	C	99	63h	c
36	24h	$	68	44h	D	100	64h	d
37	25h	%	69	45h	E	101	65h	e
38	26h	&	70	46h	F	102	66h	f
39	27h	'	71	47h	G	103	67h	g
40	28h	(	72	48h	H	104	68h	h
41	29h	)	73	49h	I	105	69h	i
42	2Ah	*	74	4Ah	J	106	6Ah	j
43	2Bh	+	75	4Bh	K	107	6Bh	k
44	2Ch	,	76	4Ch	L	108	6Ch	l
45	2Dh	-	77	4Dh	M	109	6Dh	m
46	2Eh	.	78	4Eh	N	110	6Eh	n
47	2Fh	/	79	4Fh	O	111	6Fh	o
48	30h	0	80	50h	P	112	70h	p
49	31h	1	81	51h	Q	113	71h	q
50	32h	2	82	52h	R	114	72h	r
51	33h	3	83	53h	S	115	73h	s
52	34h	4	84	54h	T	116	74h	t
53	35h	5	85	55h	U	117	75h	u
54	36h	6	86	56h	V	118	76h	v
55	37h	7	87	57h	W	119	77h	w
56	38h	8	88	58h	X	120	78h	x
57	39h	9	89	59h	Y	121	79h	y
58	3Ah	:	90	5Ah	Z	122	7Ah	z
59	3Bh	;	91	5Bh	[	123	7Bh	{
60	3Ch	<	92	5Ch	\	124	7Ch	|
61	3Dh	=	93	5Dh	]	125	7Dh	}
62	3Eh	>	94	5Eh	^	126	7Eh	~
63	3Fh	?	95	5Fh	_			

theASCIIcode.com.ar

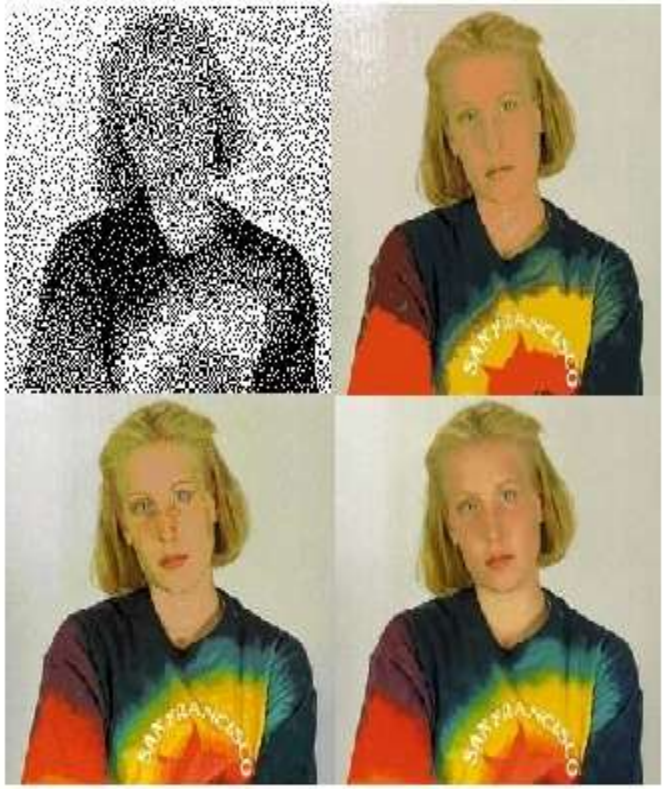
Extended ASCII characters

DEC	HEX	Simbolo	DEC	HEX	Simbolo	DEC	HEX	Simbolo	DEC	HEX	Simbolo
128	80h	Ç	160	A0h	á	192	C0h	└	224	E0h	Ó
129	81h	ü	161	A1h	í	193	C1h	┴	225	E1h	ß
130	82h	é	162	A2h	ó	194	C2h	┬	226	E2h	Ô
131	83h	â	163	A3h	ú	195	C3h	├	227	E3h	Ò
132	84h	ä	164	A4h	ñ	196	C4h	─	228	E4h	õ
133	85h	à	165	A5h	Ñ	197	C5h	┼	229	E5h	Õ
134	86h	å	166	A6h	ª	198	C6h	ã	230	E6h	µ
135	87h	ç	167	A7h	º	199	C7h	Ã	231	E7h	þ
136	88h	ê	168	A8h	¿	200	C8h	╚	232	E8h	Þ
137	89h	ë	169	A9h	®	201	C9h	╔	233	E9h	Ú
138	8Ah	è	170	AAh	¬	202	CAh	╩	234	EAh	Û
139	8Bh	ï	171	ABh	½	203	CBh	╦	235	EBh	Ù
140	8Ch	î	172	ACh	¼	204	CCh	╠	236	ECh	ý
141	8Dh	ì	173	ADh	¡	205	CDh	═	237	EDh	Ý
142	8Eh	Ä	174	AEh	«	206	CEh	╬	238	EEh	¯
143	8Fh	Å	175	AFh	»	207	CFh	¤	239	EFh	´
144	90h	É	176	B0h	░	208	D0h	ð	240	F0h	≡
145	91h	æ	177	B1h	▒	209	D1h	Ð	241	F1h	±
146	92h	Æ	178	B2h	▓	210	D2h	Ê	242	F2h	‗
147	93h	ô	179	B3h	│	211	D3h	Ë	243	F3h	¾
148	94h	ò	180	B4h	┤	212	D4h	È	244	F4h	¶
149	95h	ò	181	B5h	Á	213	D5h	ı	245	F5h	§
150	96h	û	182	B6h	Â	214	D6h	Í	246	F6h	÷
151	97h	ù	183	B7h	À	215	D7h	Î	247	F7h	¸
152	98h	ÿ	184	B8h	©	216	D8h	Ï	248	F8h	°
153	99h	Ö	185	B9h	╣	217	D9h	┘	249	F9h	¨
154	9Ah	Ü	186	BAh	║	218	DAh	┌	250	FAh	·
155	9Bh	ø	187	BBh	╗	219	DBh	▀	251	FBh	¹
156	9Ch	£	188	BCh	╝	220	DCh	▄	252	FCh	³
157	9Dh	Ø	189	BDh	¢	221	DDh	¦	253	FDh	²
158	9Eh	×	190	BEh	¥	222	DEh	Ì	254	FEh	■
159	9Fh	ƒ	191	BFh	┐	223	DFh	▀	255	FFh	


Character Map (Unicode)
ǰ \u01F0 ǰ ǰ UTF-8
lowercase letters
(all blocks)
(all scripts)
Look Up

Examples of Color Depth

1-bit depth



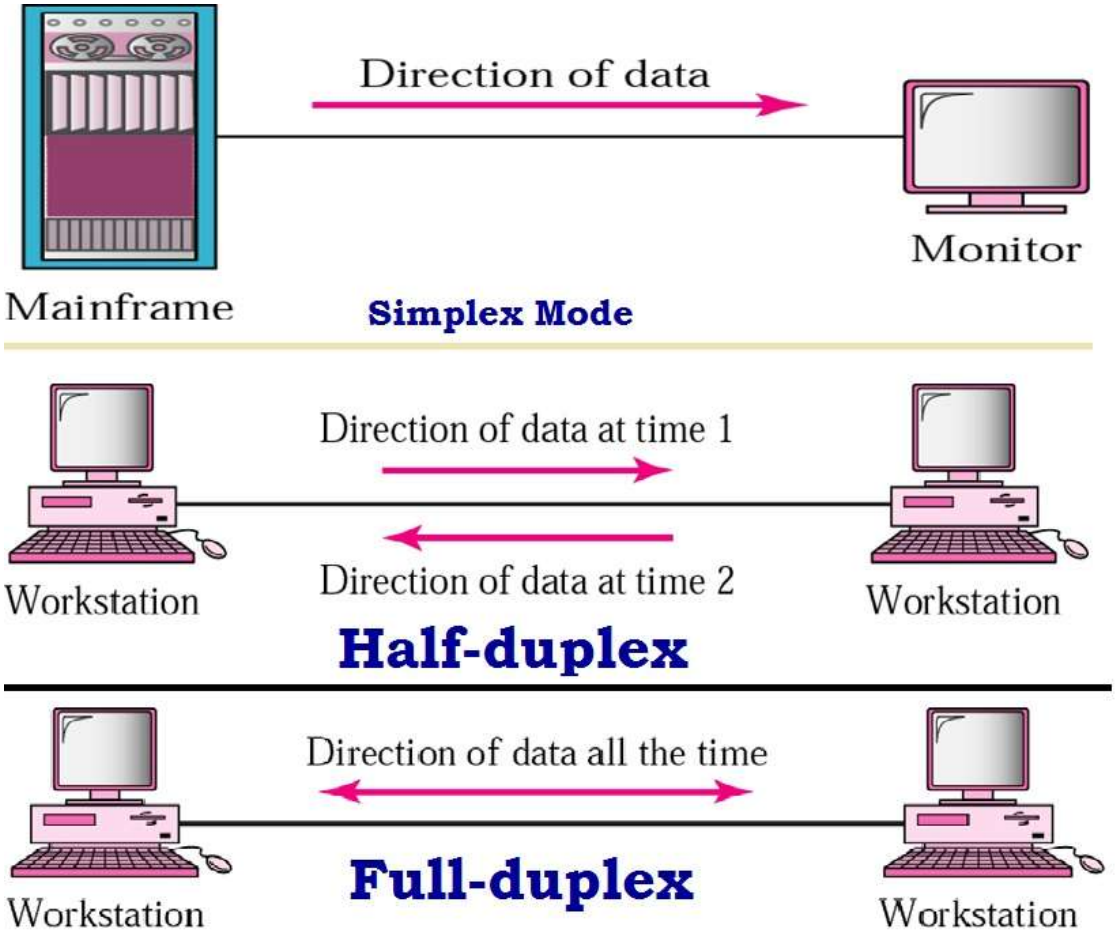
4-bit depth

8-bit depth

16-bit depth

Data Flow

Communication between two devices can be simplex, half-duplex, or full-duplex



Networks

Network criteria

8

1. Performance:

The performance depends on :

- Number of user
- Type of transmission media,
- Capabilities of connected H.W and the efficiency of software.

2. Reliability

Measured by frequency of failure, the time it takes to recover from failure, and network's robustness in a catastrophe.

3. Security:

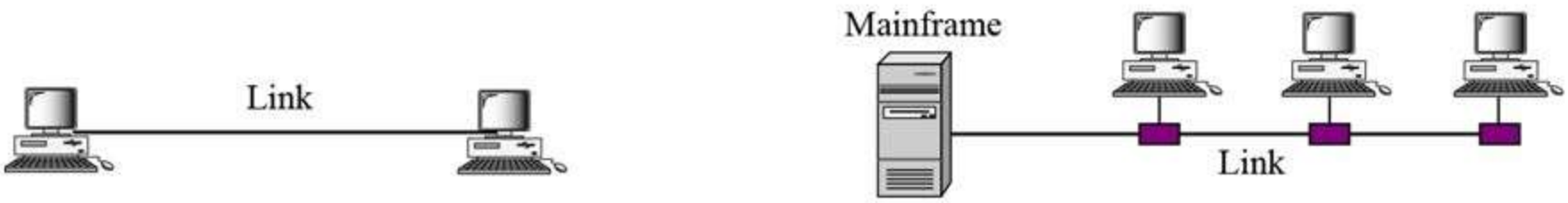
Protecting data from unauthorized access.

Performance is often evaluated by two networking metrics: throughput and delay.

Physical structures

Before discussing networks, we need to define some network attributes.

Types of Connection: A network consists of two or more devices connected through **links**. A link is a communications pathway that transfers data from one device to another. There are two possible types of connections: **point-to-point** and **multipoint**.



a. Point-to-point

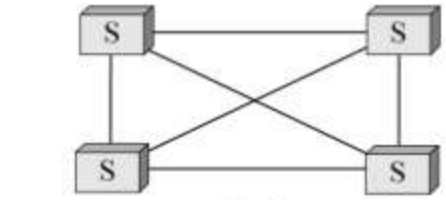
b. Multipoint

Figure 6.1 **Types of connections: point-to-point and multipoint**

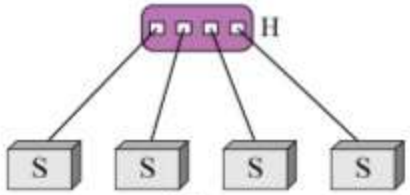
Physical Topology

The term **physical topology** refers to the way in which a network is laid out physically. There are four basic topologies possible: mesh, star, bus and ring.

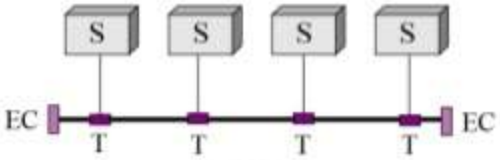
Legend:
S: Station
R: Repeater
H: Hub
T: Tap
EC: End Cable



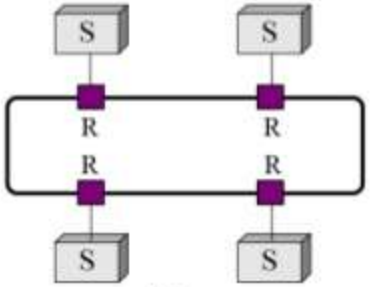
a. Mesh



b. Star



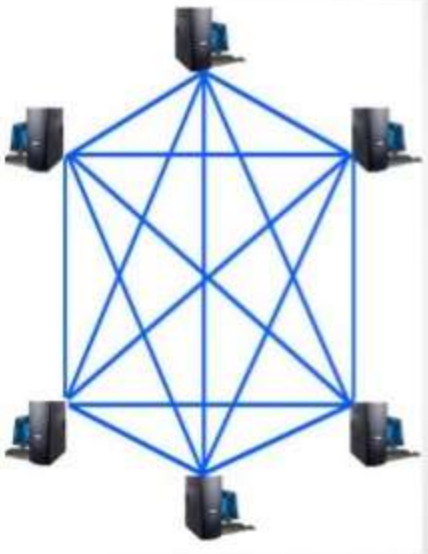
c. Bus



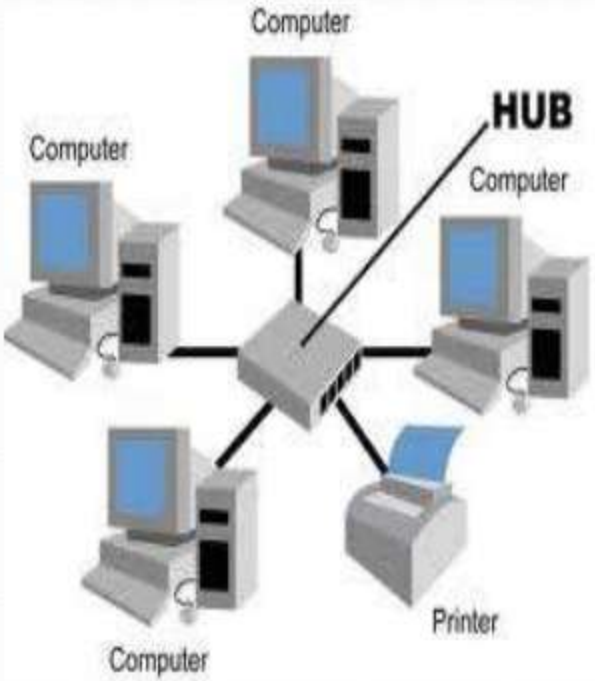
d. Ring

Mesh Topology

- Computers in mesh topologies are connected directly to every other device with cables.
- Create point to point connection to every device on network.
- If one cable fail data always has alternative path to get to its destination.
- This type topology generally use in military area.



STAR TOPOLOGY



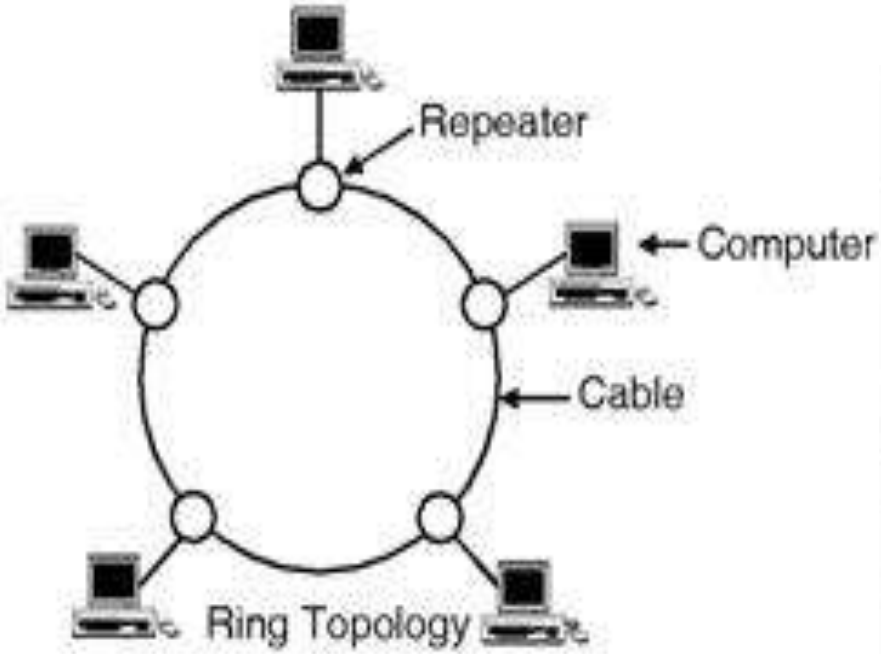
In Star Topology, all the nodes in the network are connected to a central device called Hub or Switch via cables.

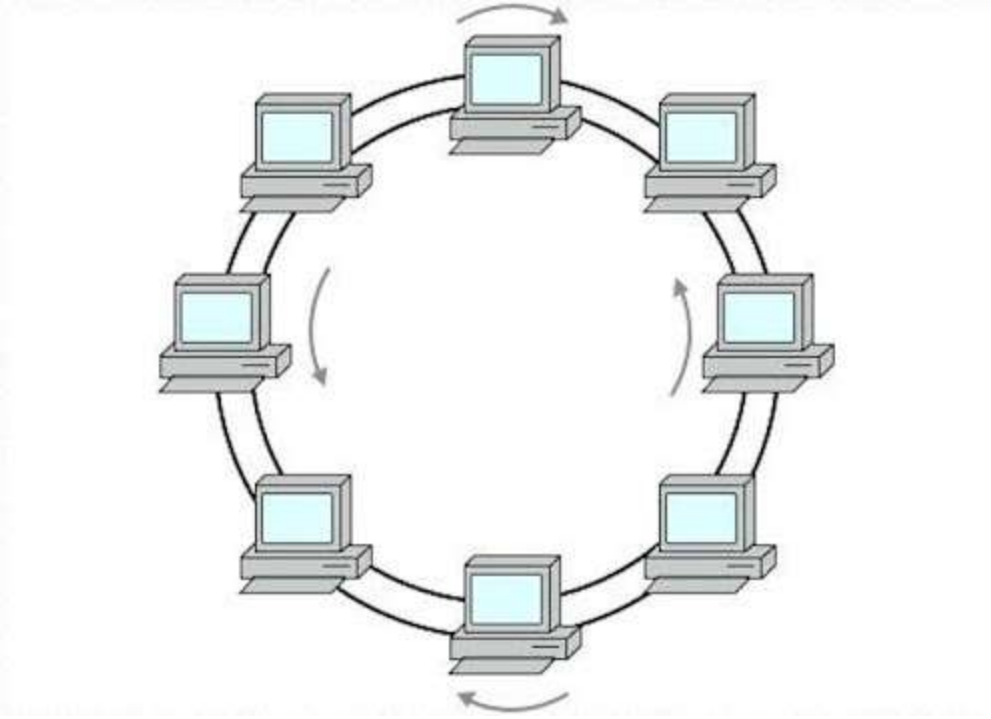
All traffic is controlled by the Hub. Devices transfer the data to each other only through the Hub not directly.

BUS TOPOLOGY

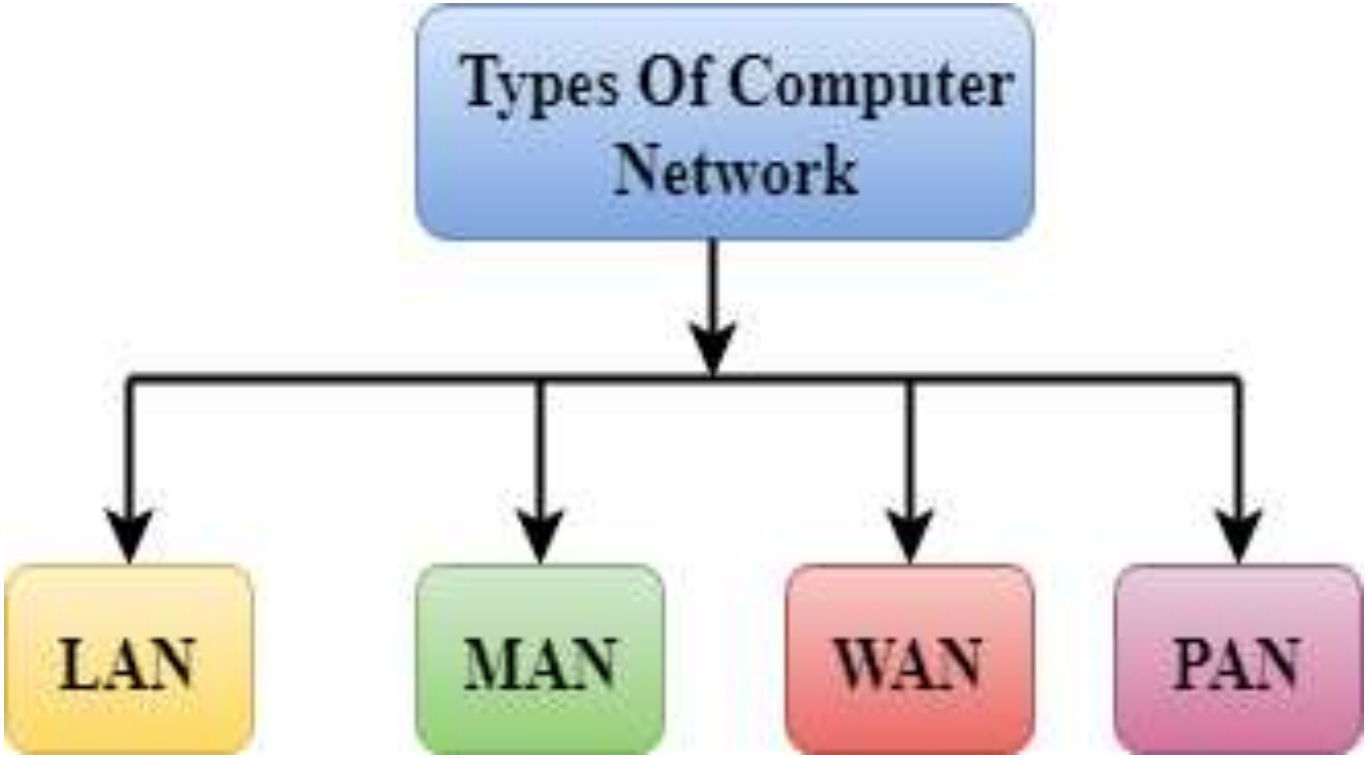
- Multipoint compared to other point to point connections.
- One long cable acts as a **backbone to link all** the devices in a network.
- Nodes are connected to the bus cable by drop lines and taps.

In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it reaches its destination. Each device in the ring incorporates a repeater.

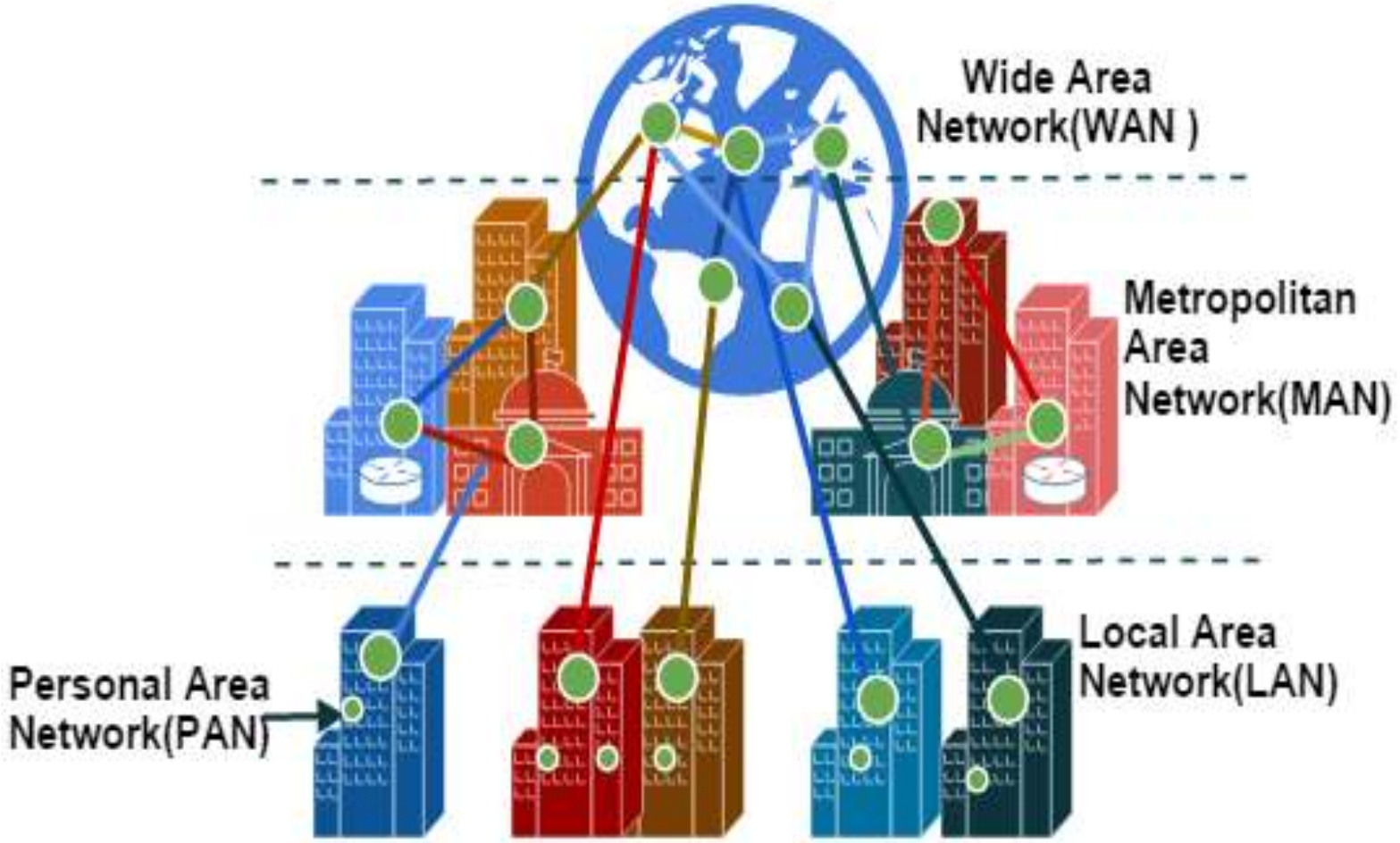


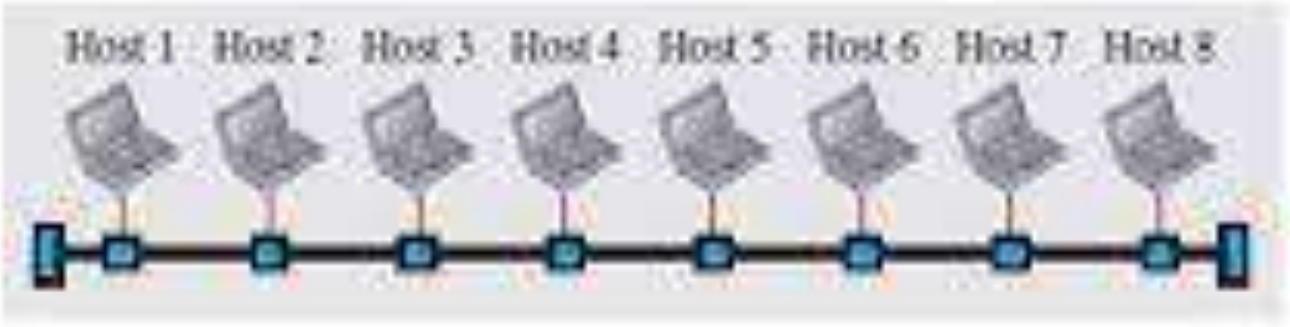


Network Types

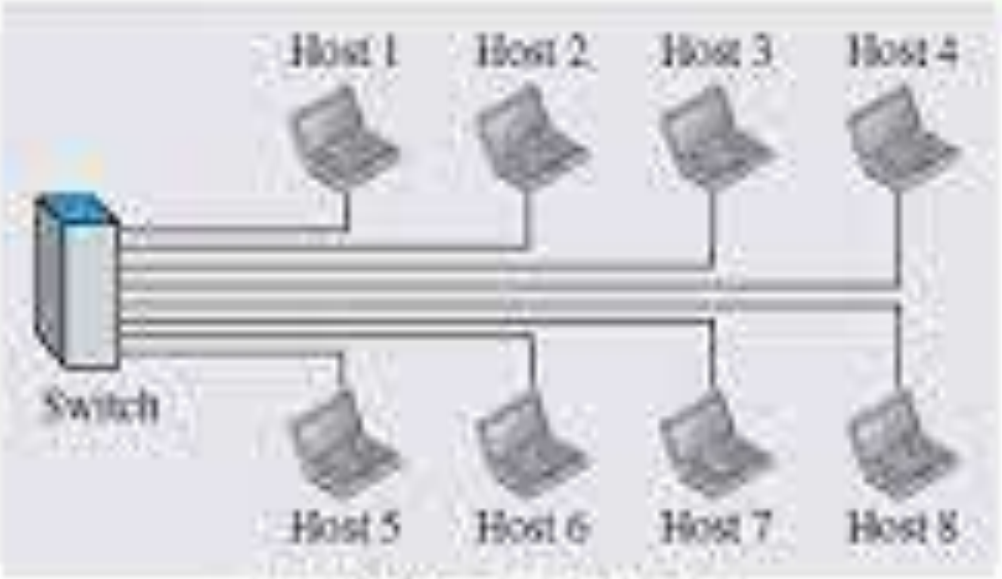


Types of Computer Networks

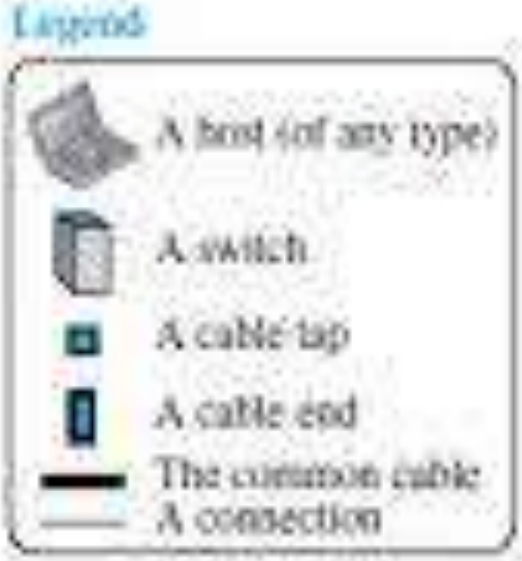


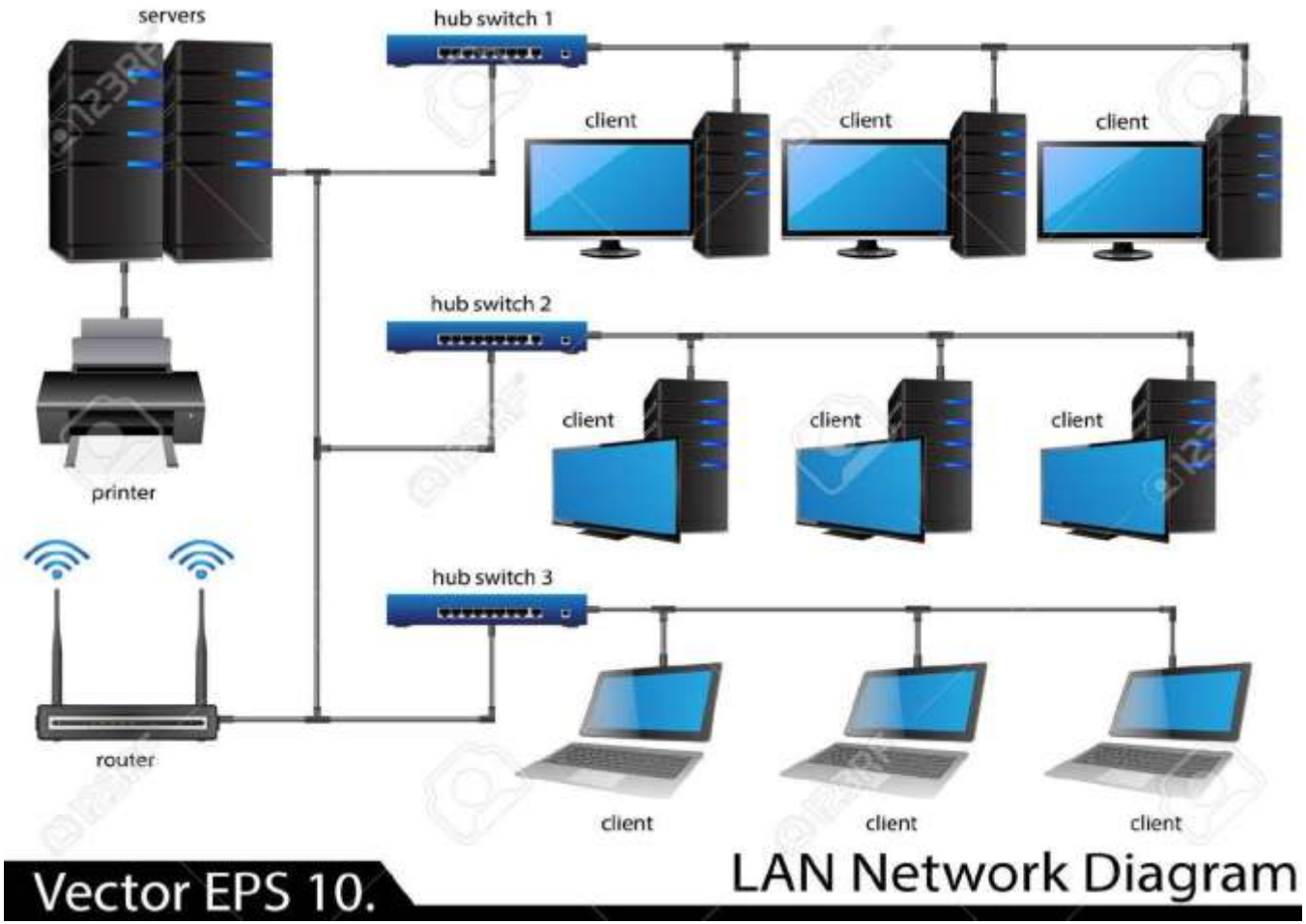


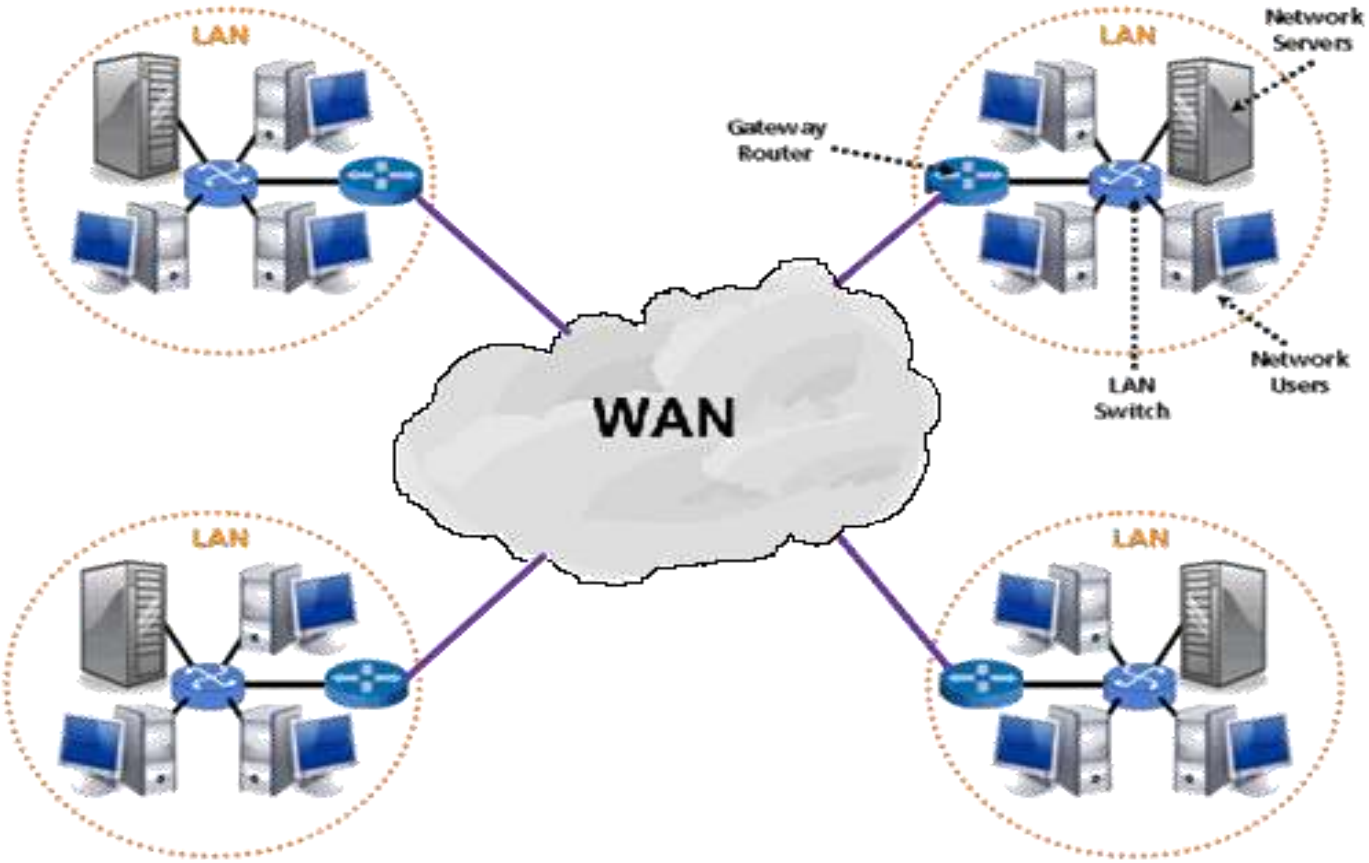
a. LAN with a common cable (past)



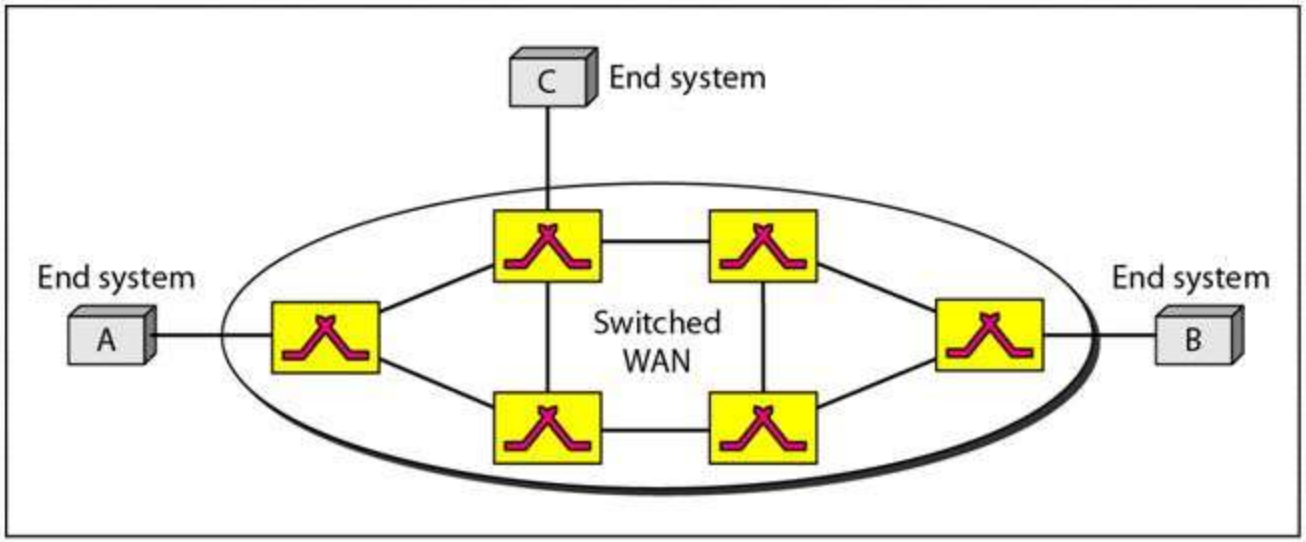
b. LAN with a switch (today)



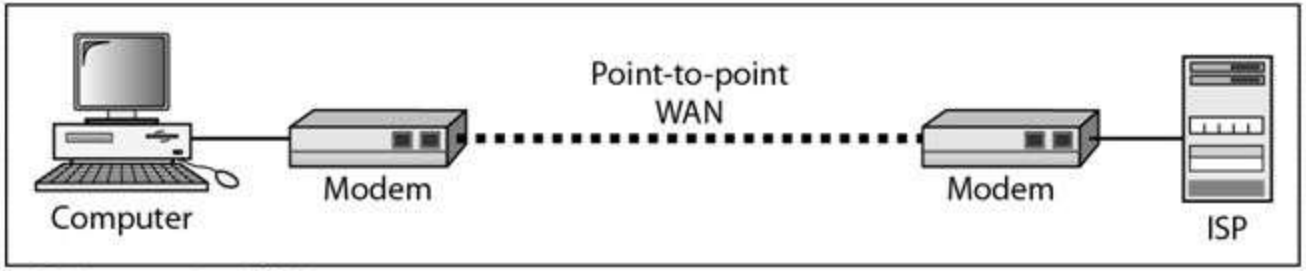

servers
hub switch 1
client
client
client
hub switch 2
client
client
client
printer
hub switch 3
router
client
client
client
Vector EPS 10.
LAN Network Diagram


LAN
LAN
Network
Servers
Gateway
Router
WAN
LAN
Switch
Network
Users
LAN
LAN

WANs: a switched WAN v. a point-to-point WAN



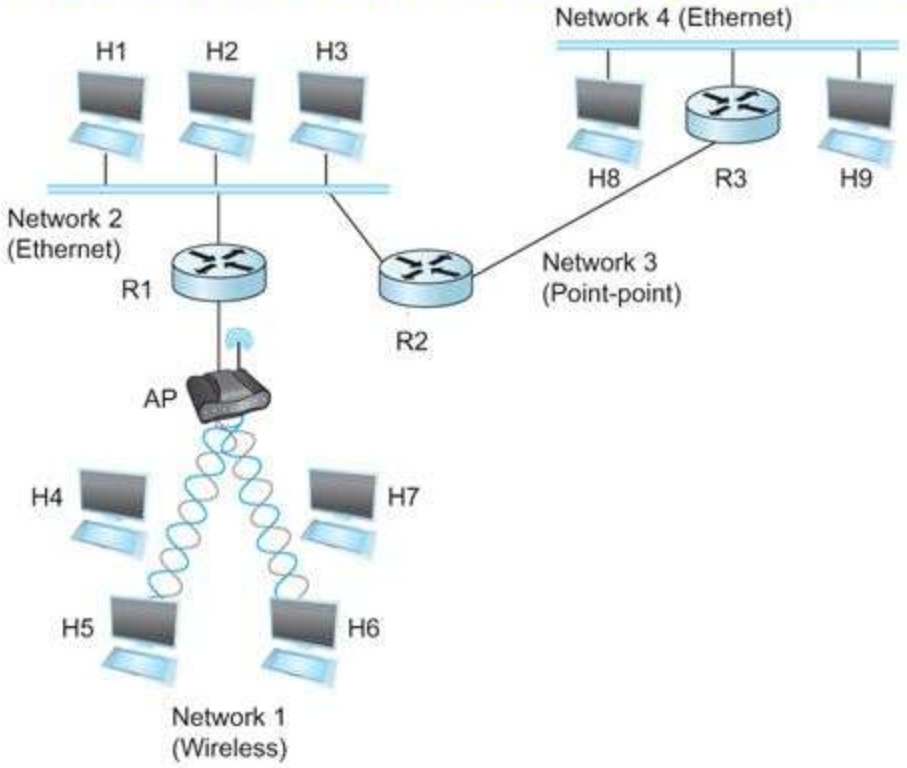
a. Switched WAN



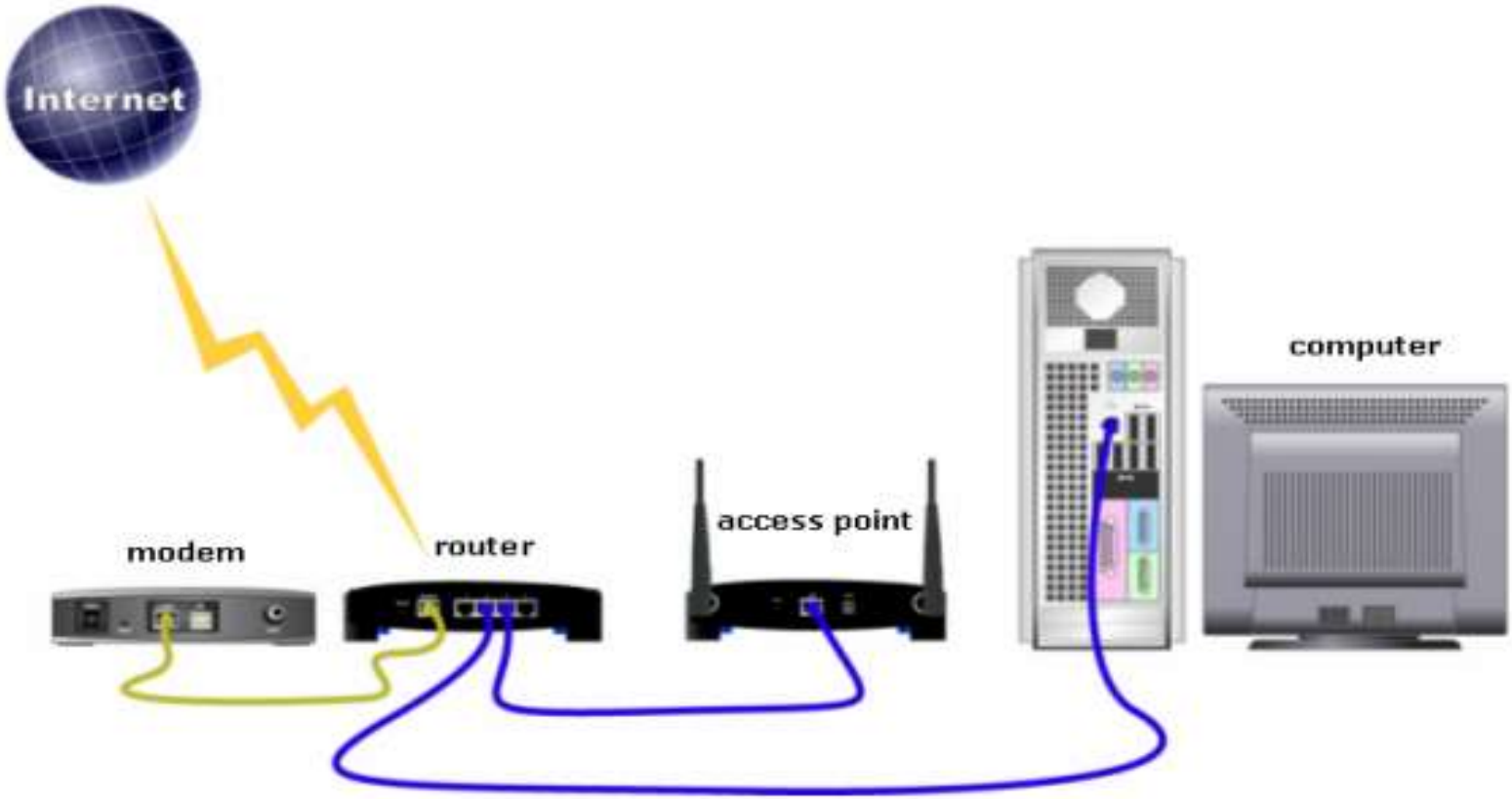
b. Point-to-point WAN

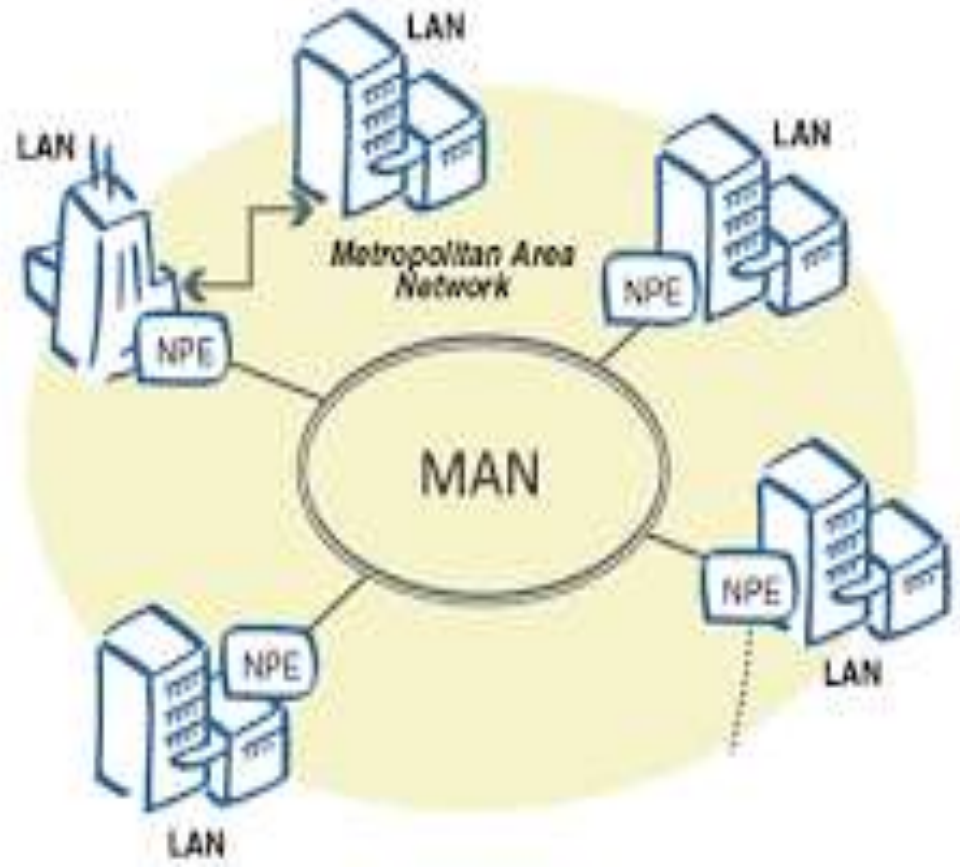
Internetworking

- What is internetwork
  - An arbitrary collection of networks interconnected to provide some sort of host-to-host packet delivery service



A simple internetwork where H represents hosts and R represents routers


Internet
modem
router
access point
computer


LAN
LAN
LAN
Metropolitan Area Network
NPE
NPE
MAN
NPE
NPE
LAN
LAN

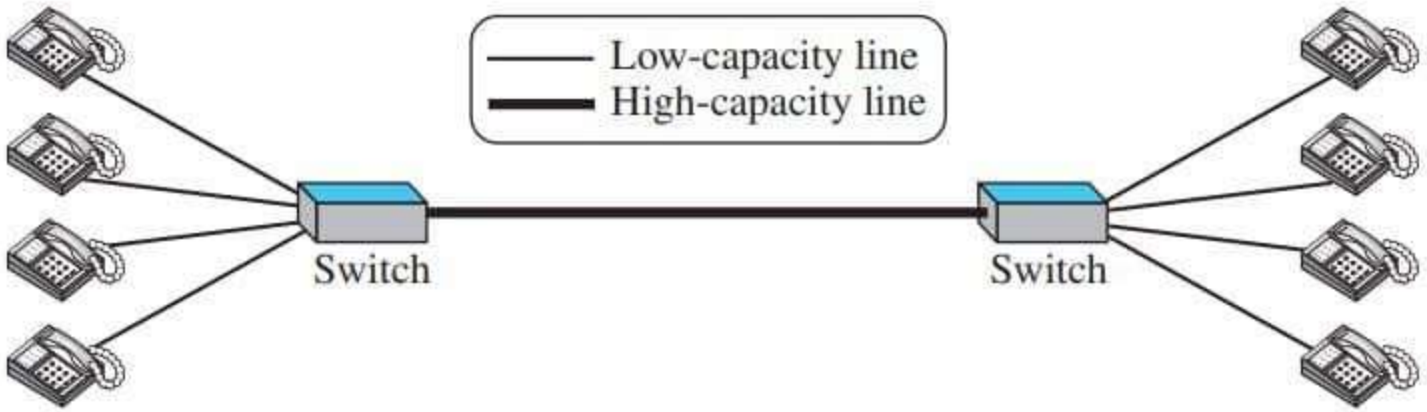
PAN (Personal Area Network):

A PAN is a network of Communicating devices (Computer, Phone, MP3/MP4 Player, Camera etc.) in the proximity of an individual. It can cover an
area of a few meters radius.

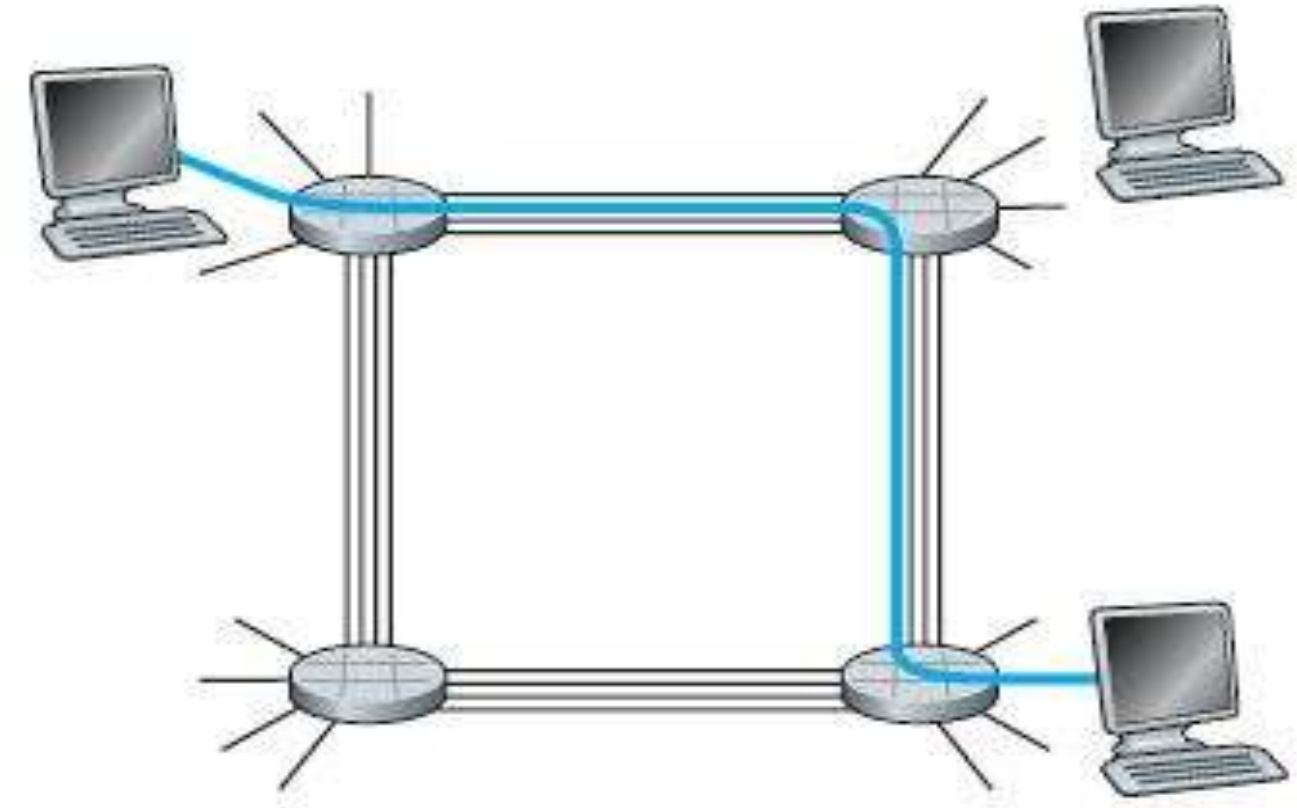
1.3.3 Switching

An internet is a switched network in which a switch connects at least two links together. A switch needs to forward data from a network to another network when required. The two most common types of switched networks are circuit-switched and packet-switched networks. We discuss both next.

A circuit-switched network



Circuit-Switched Network

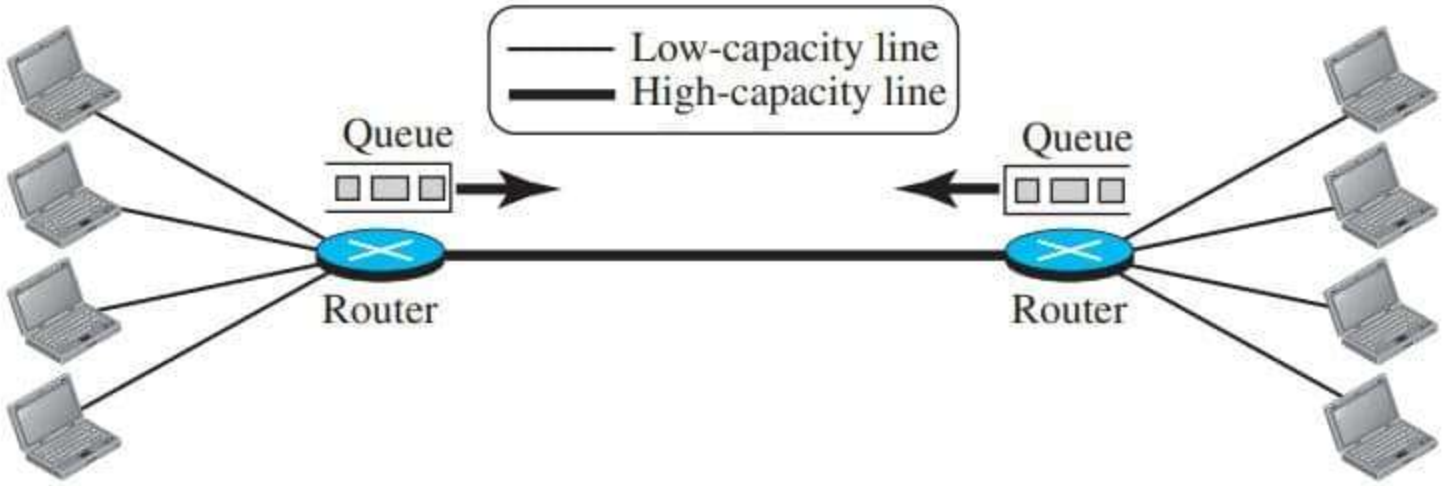


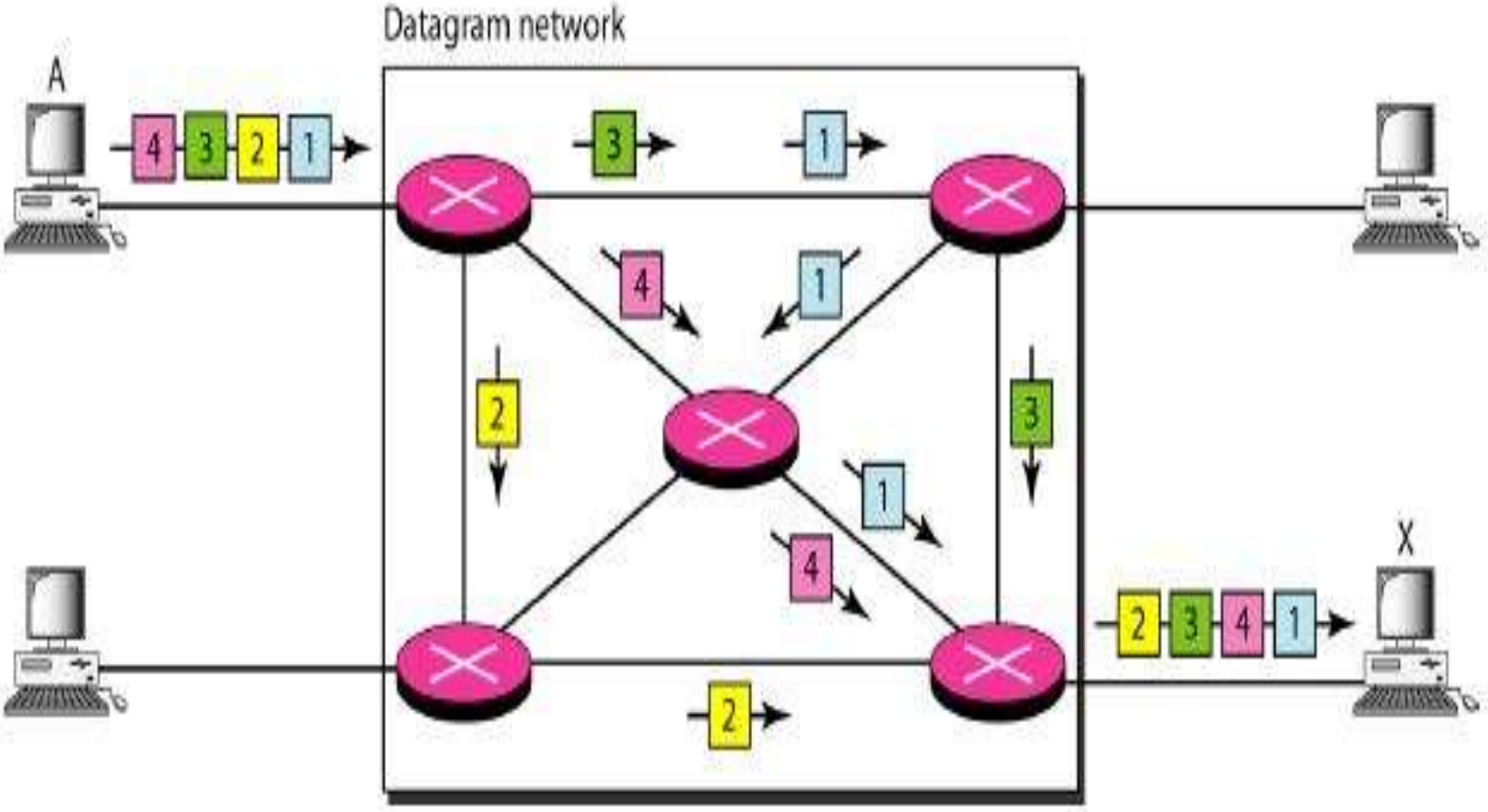
Packet Switched Network

In a computer network, the communication between the two ends is done in blocks of data called packets.

- A router in a packet-switched network has a queue that can store and forward the packet.

1.14 *A packet-switched network*



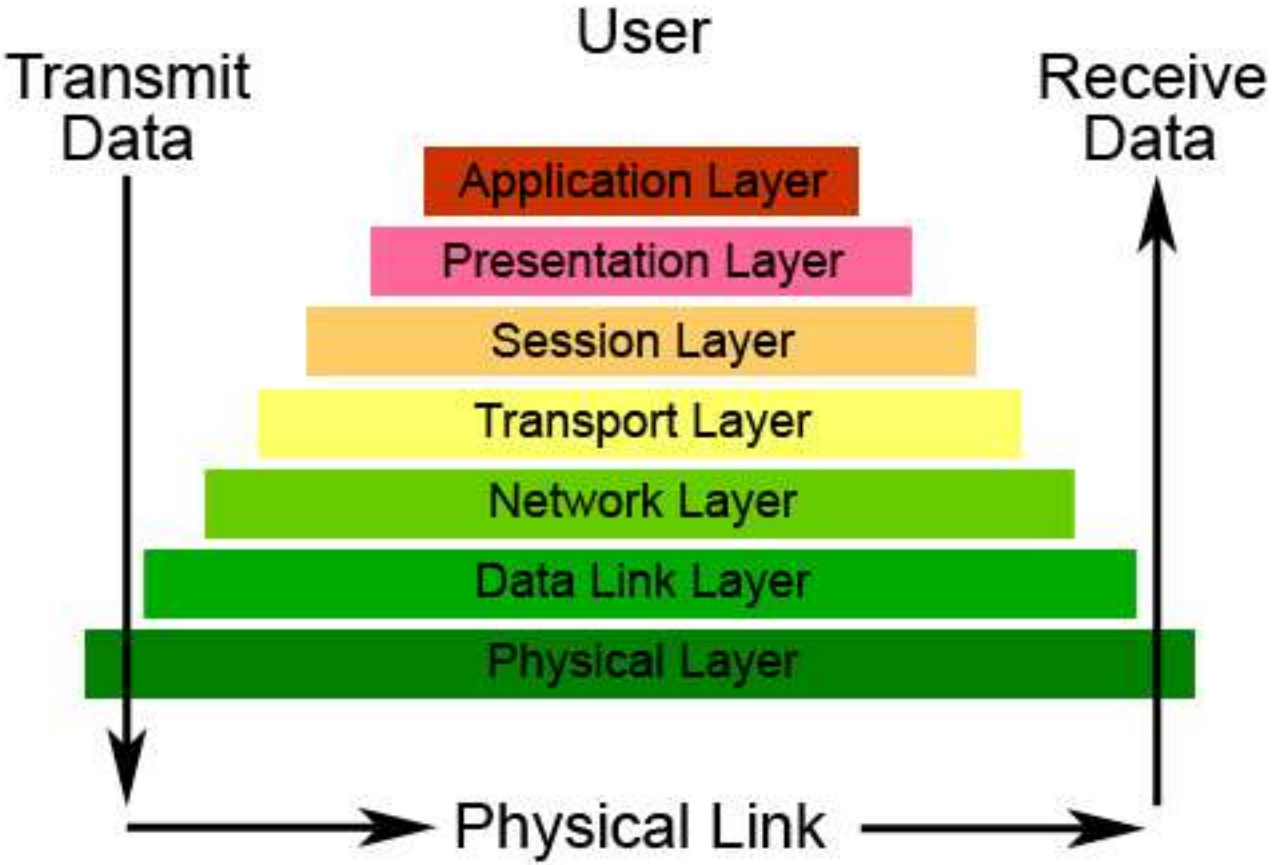

Datagram network
A
X
4
3
2
1

Differences Between Circuit & Packet Switching

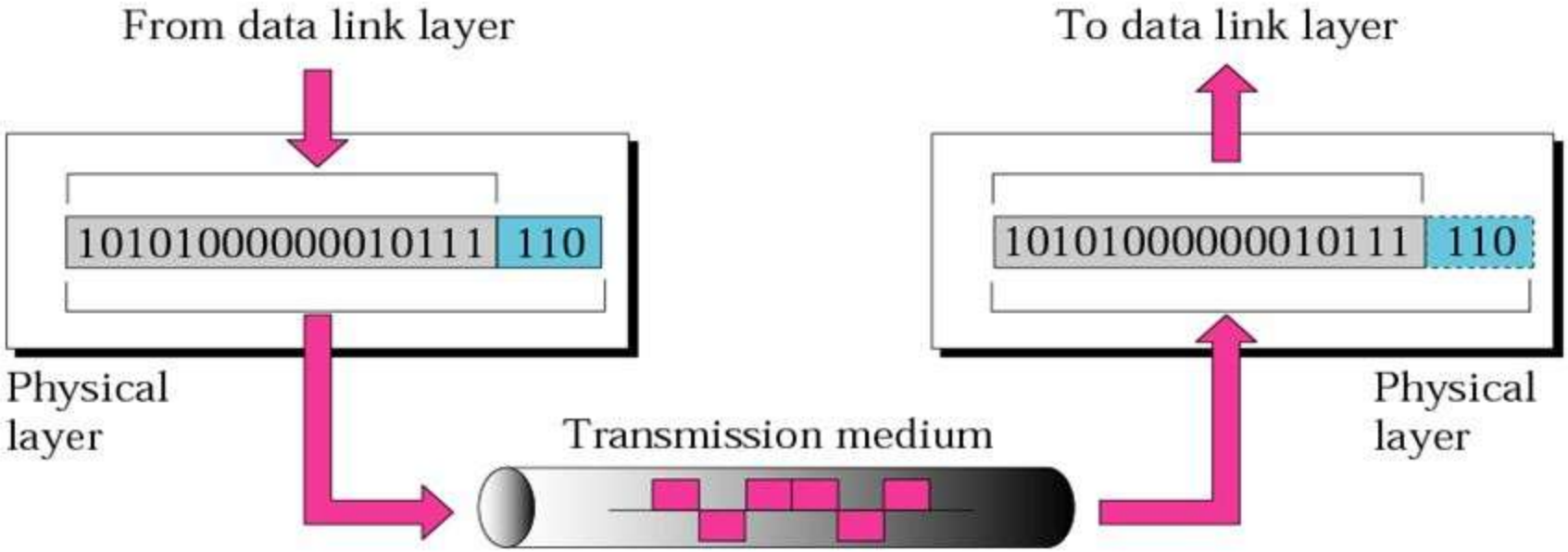
Circuit-switching	**Packet-Switching**
Guaranteed capacity	No guarantees (best effort)
Capacity is wasted if data is bursty	More efficient
Before sending data establishes a path	Send data immediately
All data in a single flow follow one path	Different packets might follow different paths
No reordering; constant delay; no pkt drops	Packets may be reordered, delayed, or dropped


OSI Model
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data link
1 Physical

The Seven Layers of OSI

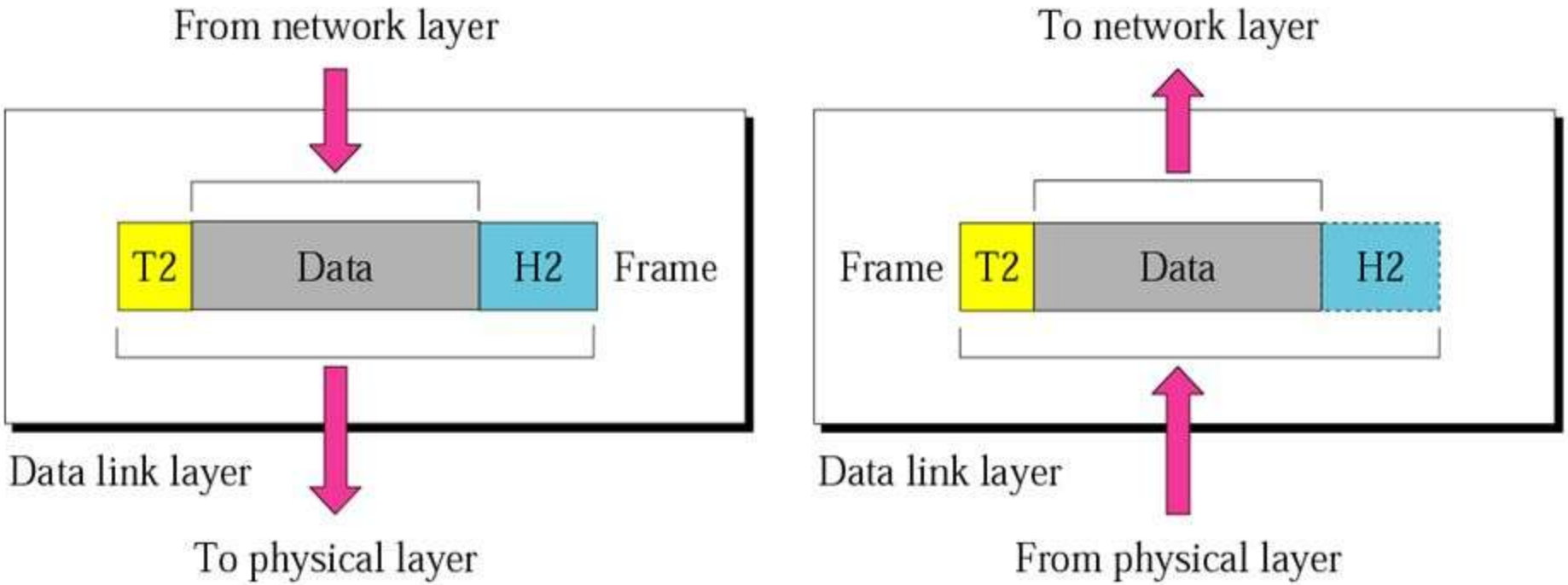


1.Physical Layer



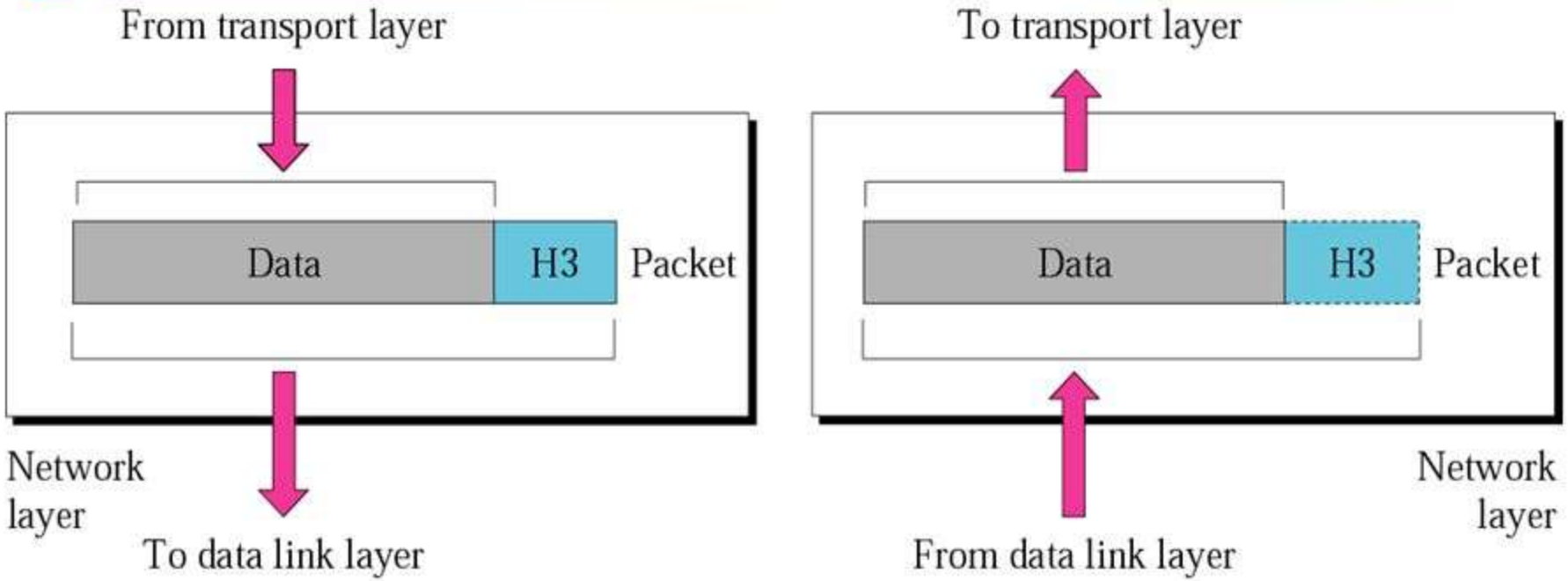
The physical layer is responsible for the movement of individual bits from one hop (node) to the next.

2.Data Link Layer



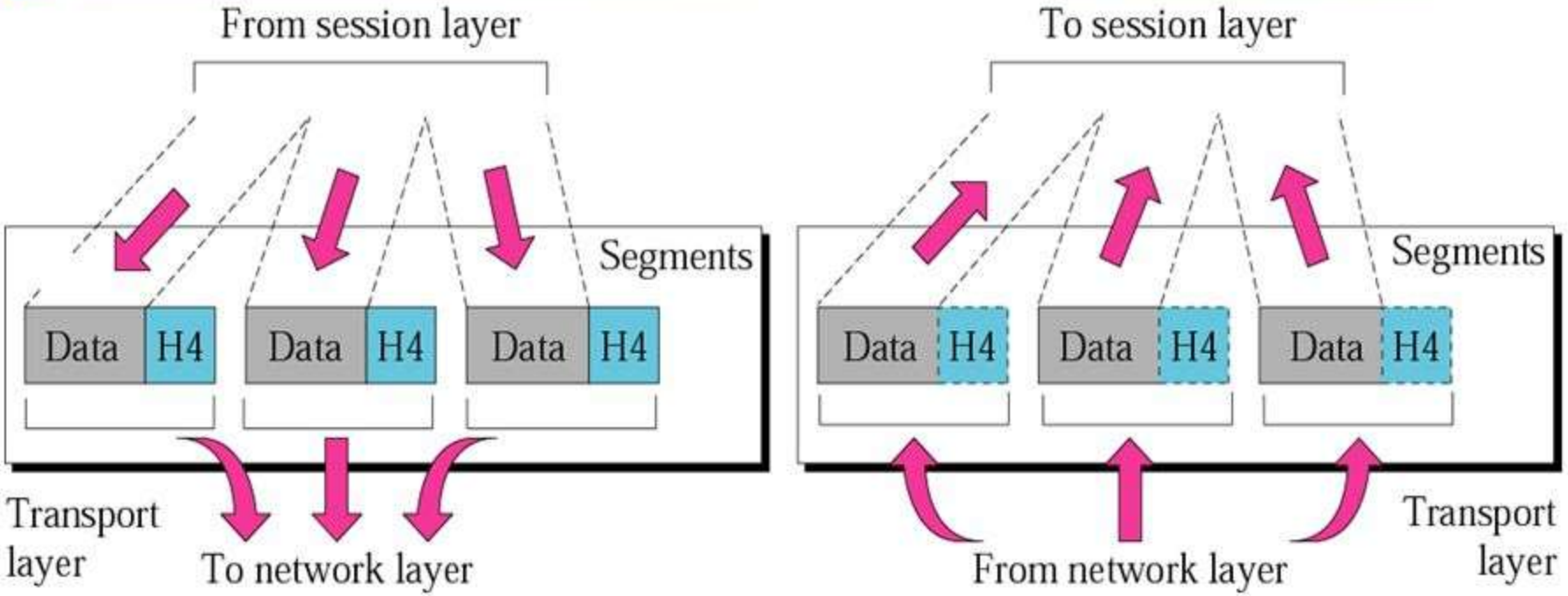
The data link layer is responsible for moving frames from one hop (node) to the next.

3.Network Layer



The network layer is responsible for the delivery of individual packets from the source host to the destination host.

4.Transport Layer

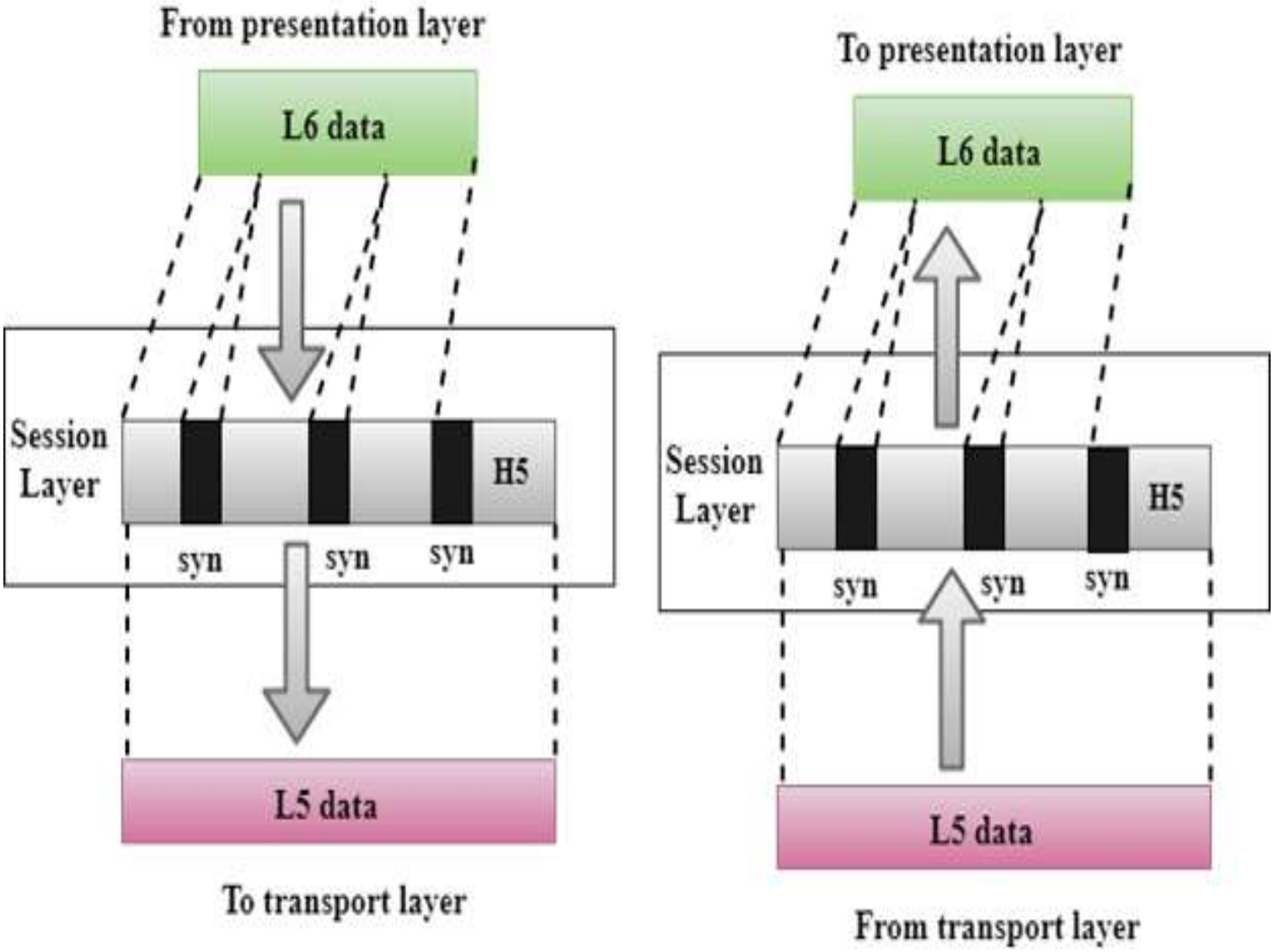


The transport layer is responsible for the delivery of a message from one process to another.

Session Layer

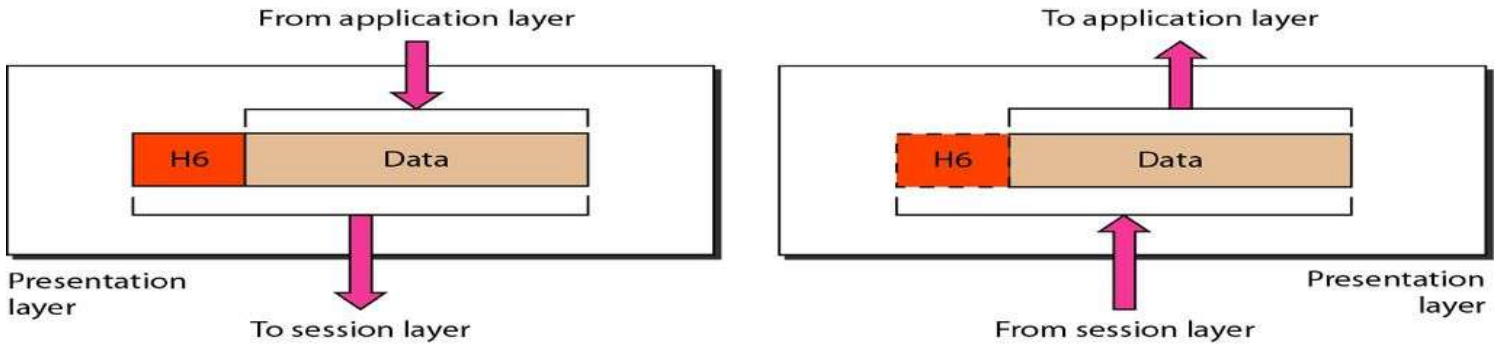
Main functions of this layer are:

- Dialog control – allows two systems to enter into a dialog, keep a track of whose turn it is to transmit
- Synchronization – adds check points (synchronization points) into stream of data.

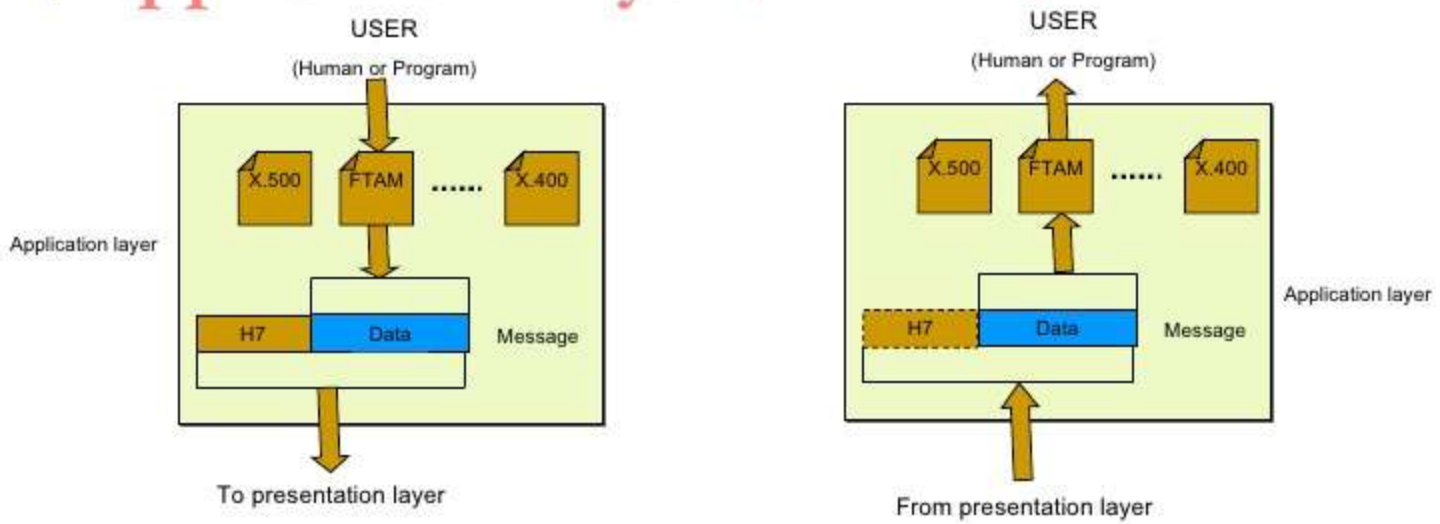

From presentation layer
L6 data
Session Layer
H5
syn
syn
syn
L5 data
To transport layer
To presentation layer
L6 data
Session Layer
H5
syn
syn
syn
L5 data
From transport layer

6. Presentation layer

- The presentation layer is concerned with syntax and semantics of the information exchange between two systems.
- **Specific responsibilities of presentation layer:**
  - ***Translation***
  - ***Encryption***
  - ***Compression***



Application Layer (user level service)



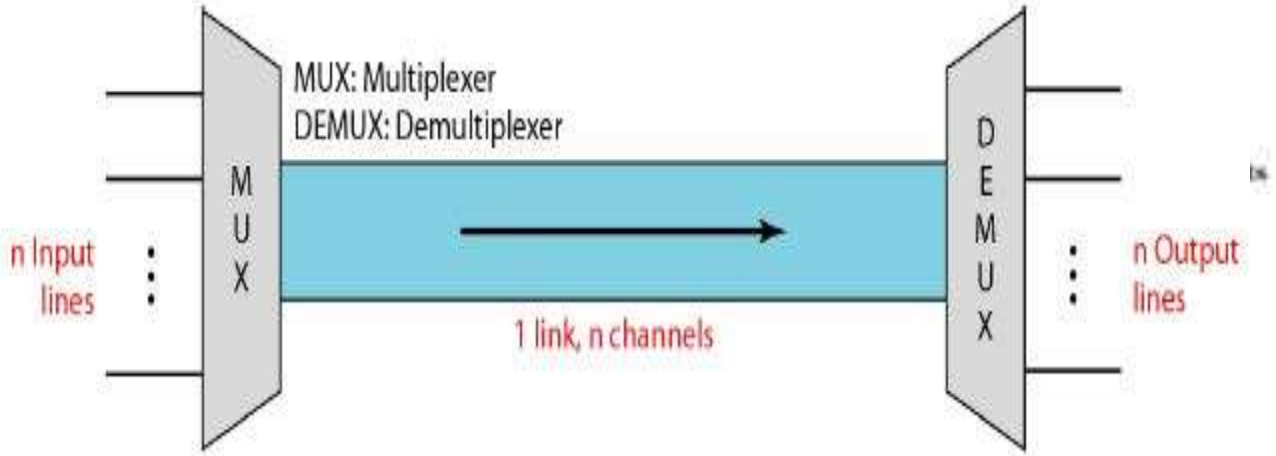
- The application layer is responsible for providing services to the user.
- Concerned:
  - Network virtual terminal (Software)
  - File transfer, access and management
  - Mail services
  - Directory services (access to distributed database sources for global information about various objects and services)

Functions of Application Layer:

- Network Virtual terminal: It allows a user to log on to a remote host.
- File Transfer Access, and Management: This application allows a user to access files in a remote host.
- Mail Services: This application provides various e-mail services.
- Directory Services: This application provides the distributed database sources and access for global information about various objects and services.

Multiplexing

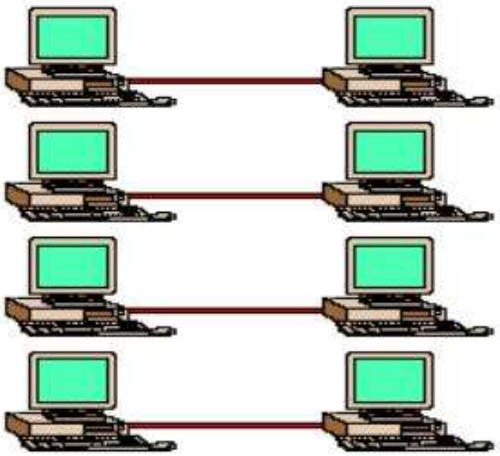
- Sharing the link among multiple users



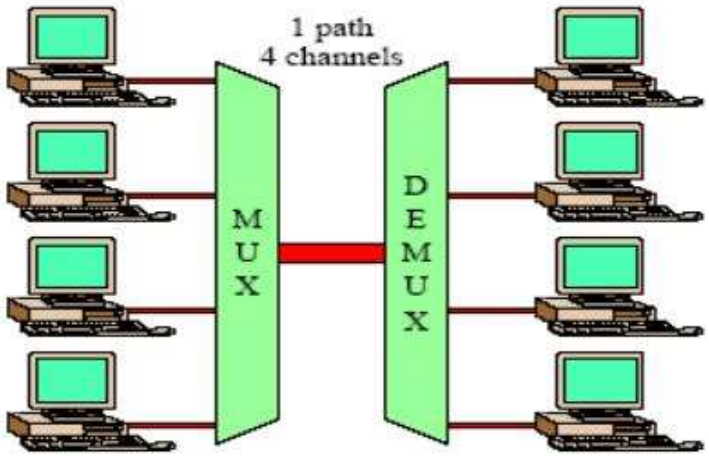
In multiplexing, we combine several channels into one.

Multiplexing

- **Multiplexing:** Combining multiple data (voice) channels for transmission on a common medium. Multiple devices sharing one physical link.
- **Demultiplexing:** Recovering the original separate channels from a multiplexed signal.
- Multiplexing and demultiplexing are performed by a multiplexer.
- The two common forms of multiplexing are frequency-division multiplexing (FDM) and time-division multiplexing (TDM).

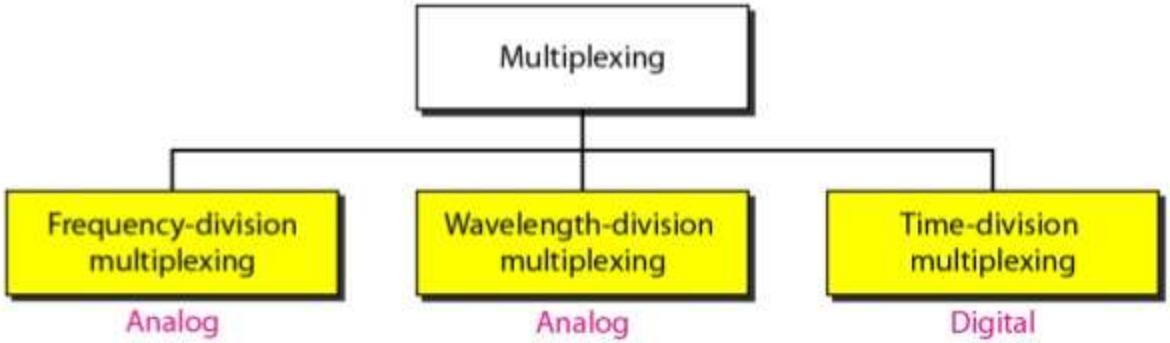


No multiplexing



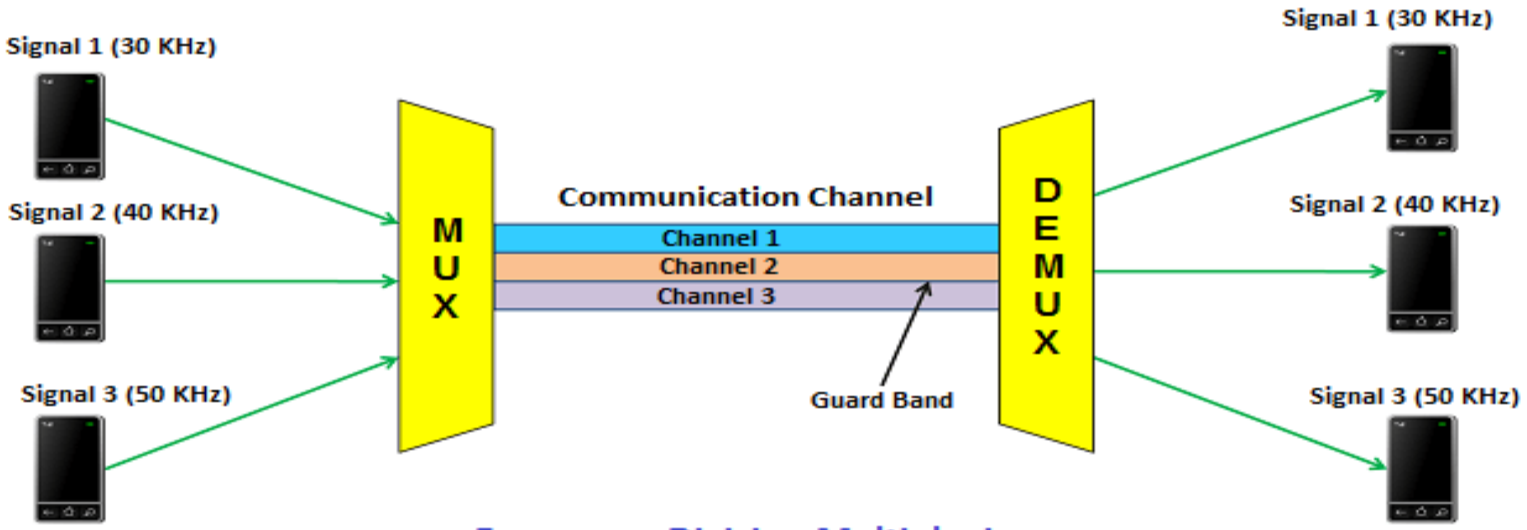
Multiplexing

Figure *Categories of multiplexing*

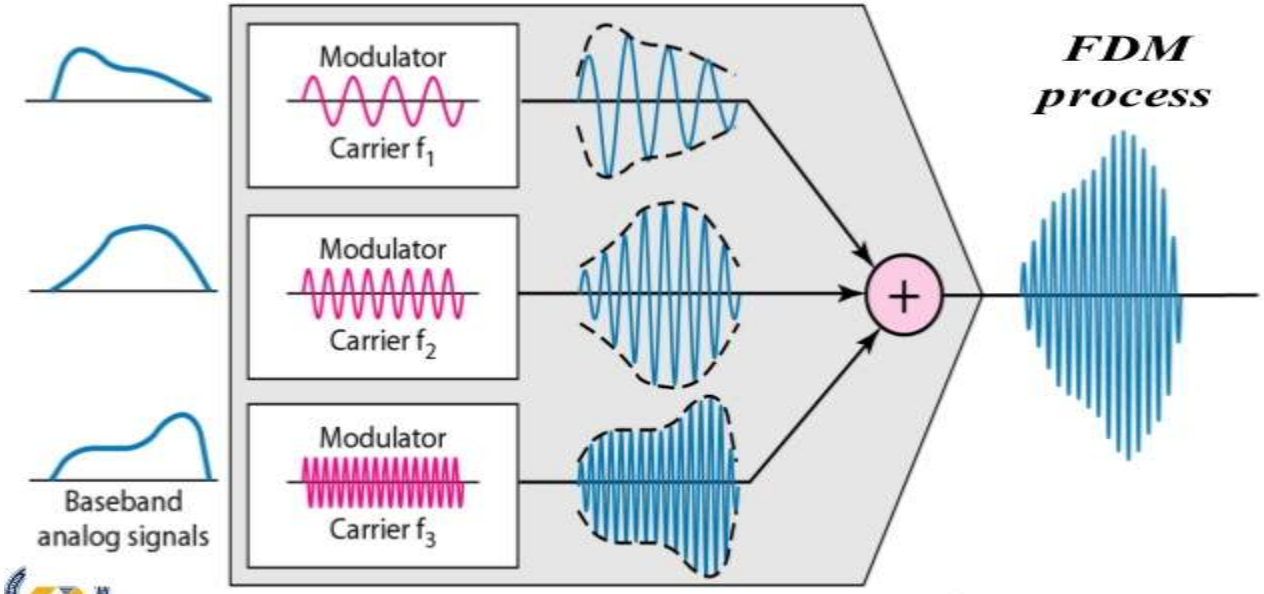


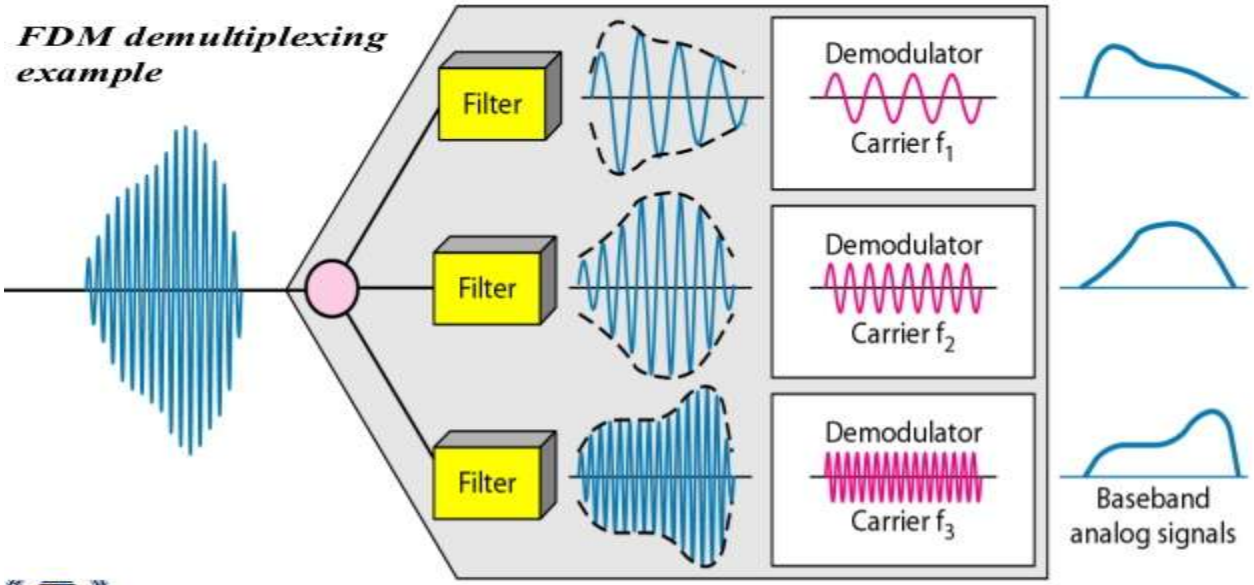
Frequency Division Multiplexing

- A number of signals are carried simultaneously on the same medium.
- Each signal is modulated to a different carrier frequency
- Useful bandwidth of medium should exceed required bandwidth of channels
- Carrier frequencies separated so signals do not overlap (guard bands)
- e.g. FM radio, CATV
- Channel allocated even if no data



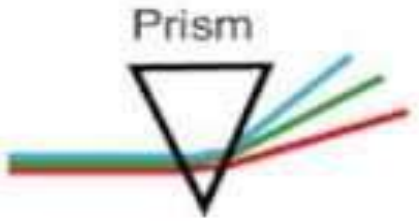
Frequency Division Multiplexing

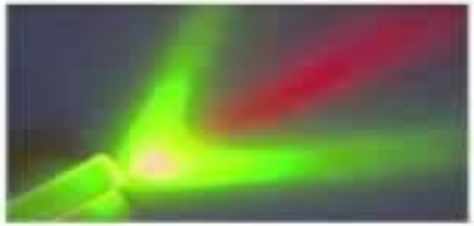

FDM process
Modulator
Carrier f_1
Modulator
Carrier f_2
Modulator
Carrier f_3
+
Baseband analog signals


FDM demultiplexing example
Filter
Filter
Filter
Demodulator
Carrier f_1
Demodulator
Carrier f_2
Demodulator
Carrier f_3
Baseband analog signals

What Is Wavelength Division Multiplexing?

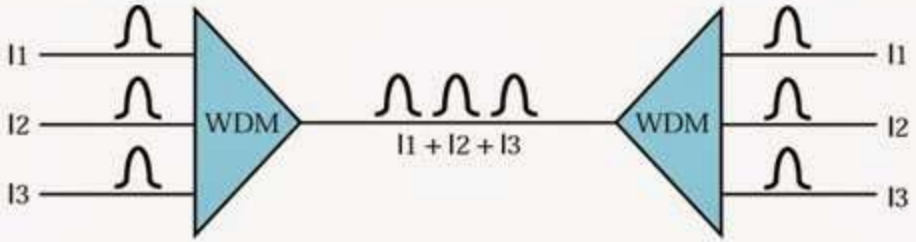
- Light has a property that keeps it from mixing and allows it to be separated into its colors like this by a prism
- WDM uses this property to send signals of different colors down a fiber simultaneously

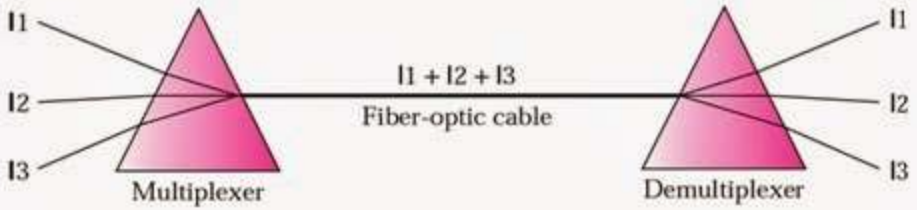




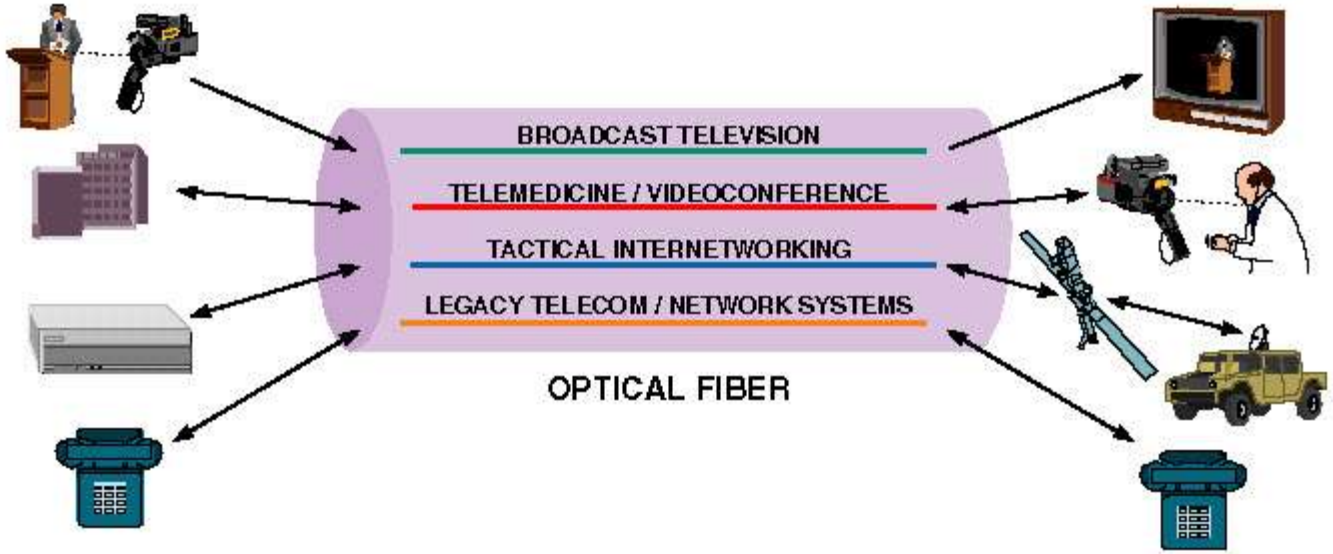
WAVE DIVISION MULTIPLEXING (WDM)

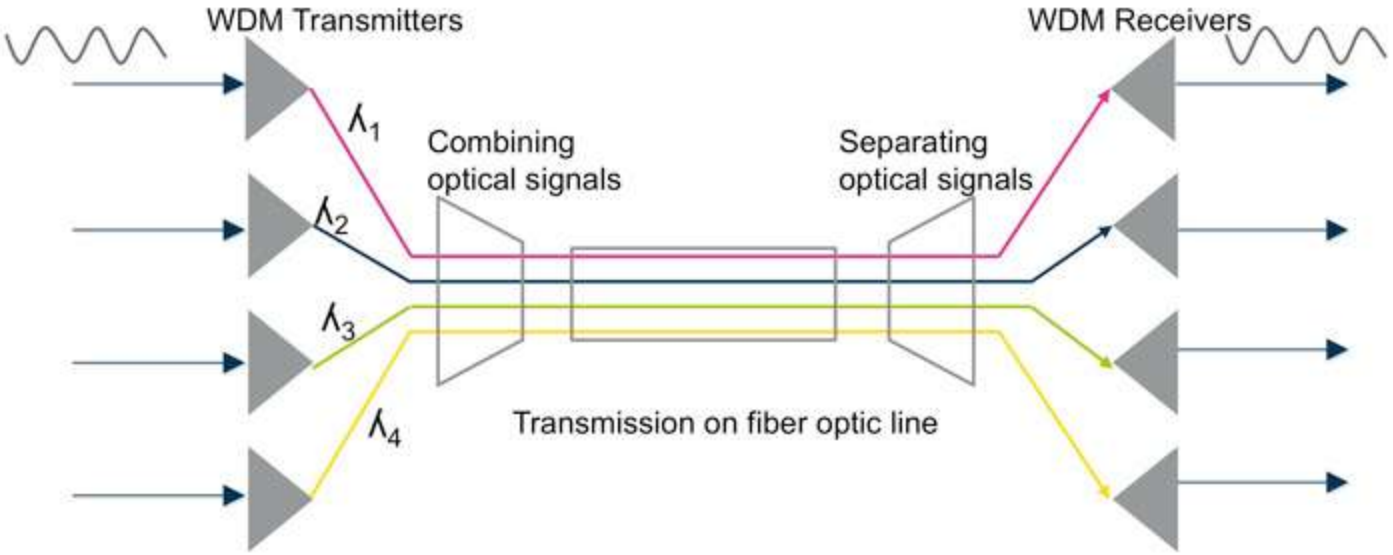
- An analog multiplexing technique to combine optical signals
- Multiple beams of light at different frequency
- Carried by optical fibber
- A form of FDM
- Each color of light (wavelength) carries separate data channel
- Commercial systems of 160 channels of 10 Gbps now available





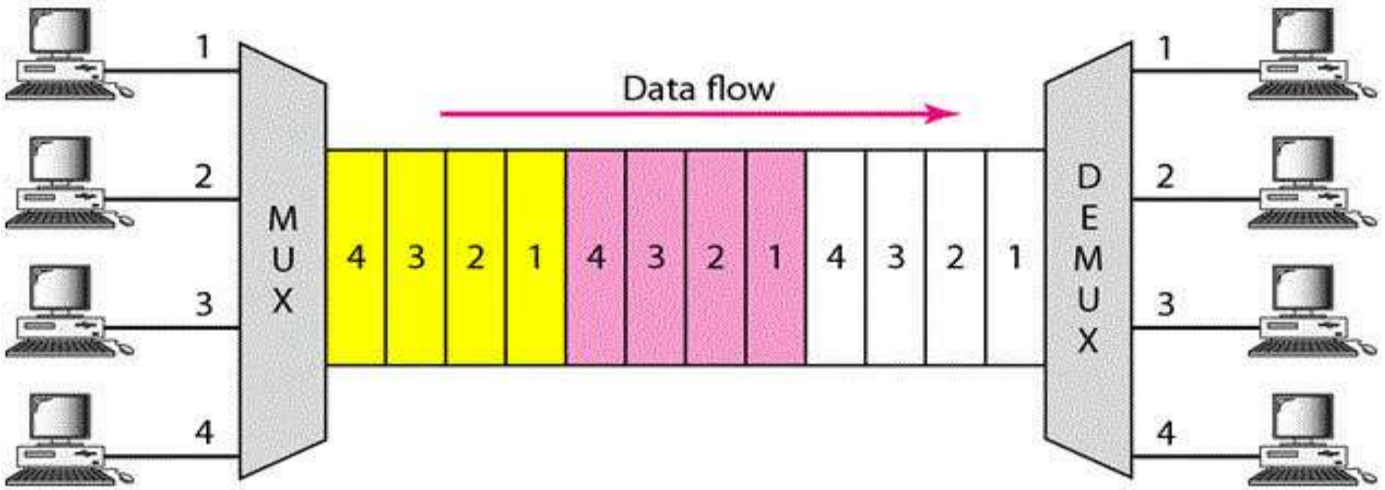
WAVELENGTH DIVISION MULTIPLEXING





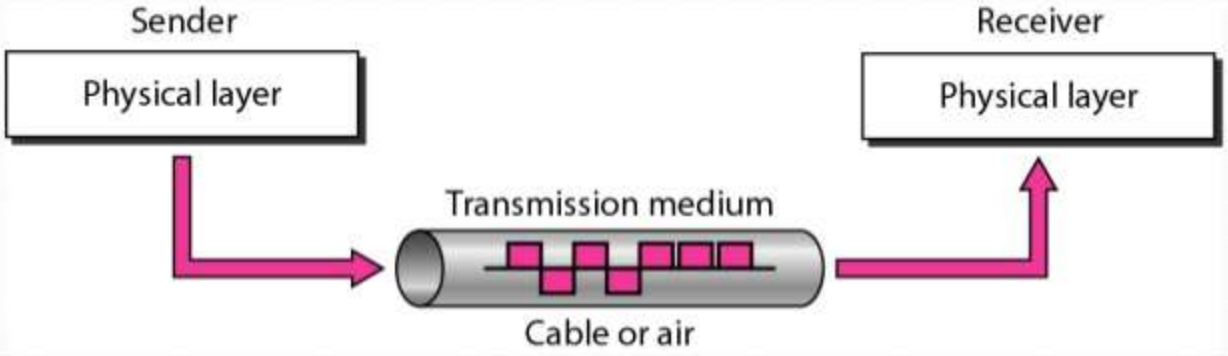
Time Division Multiplexing

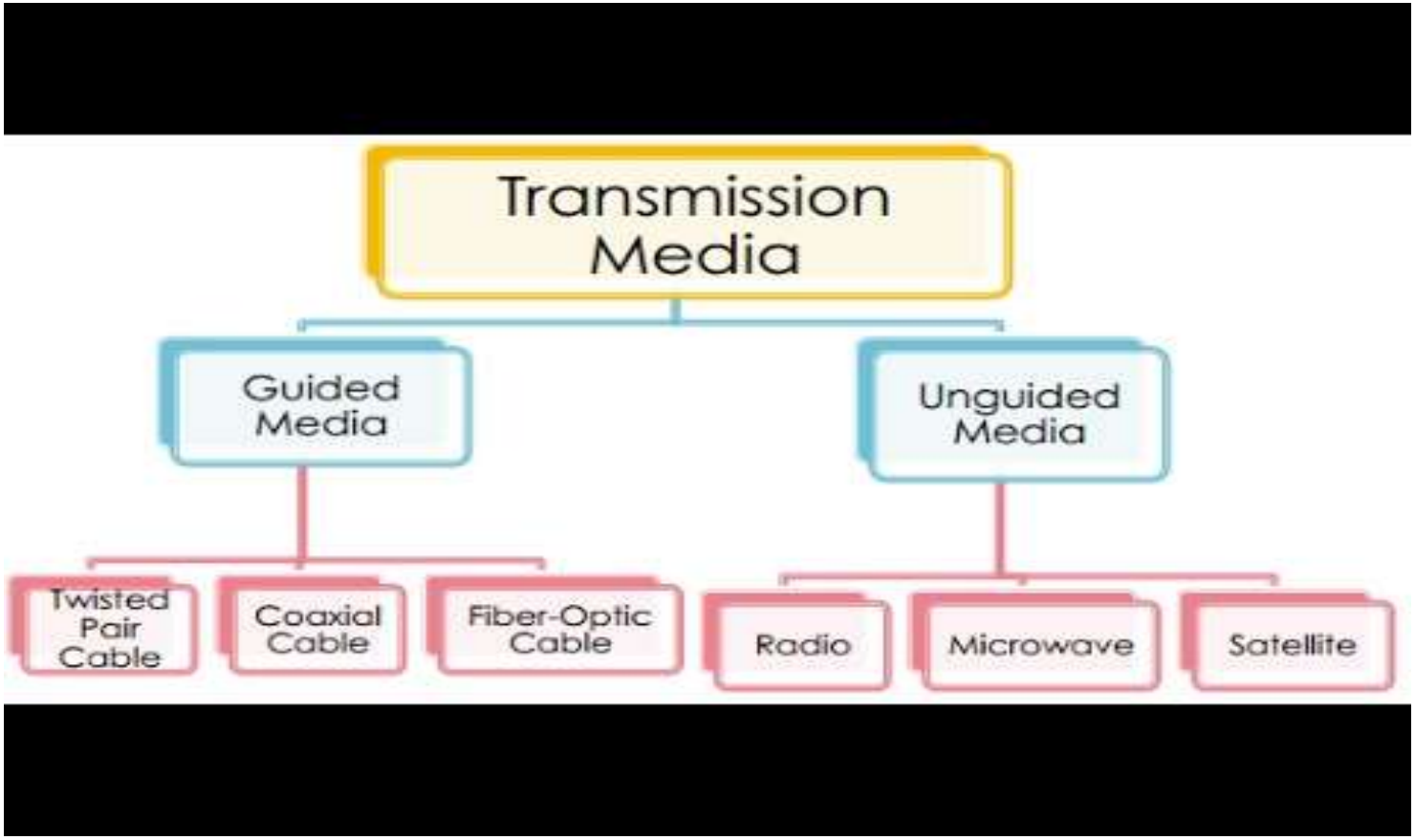
- TDM is a digital process that allows several connections to share the high bandwidth of a link.
- Instead of sharing the portion of the bandwidth as in FDM, time is shared.
- Each connection occupies a portion of time in the link. The link is shown sectioned by time rather than frequency.
- In the figure, portions of signals 1,2,3 and 4 occupy the link sequentially.



Transmission Media

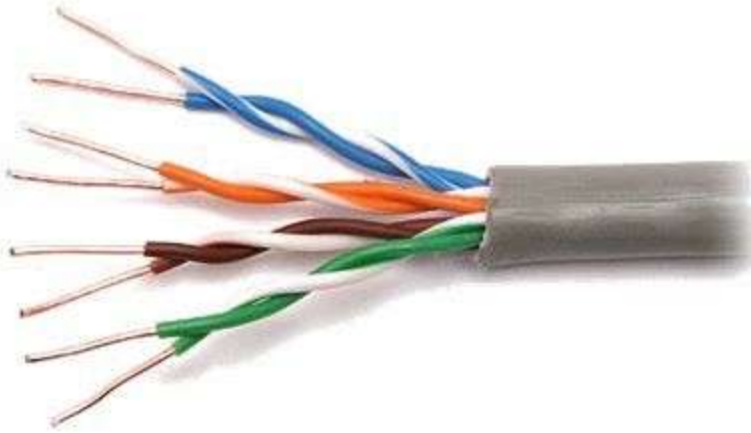
Transmission Media and Physical Layer




Transmission Media
Guided Media
Unguided Media
Twisted Pair Cable
Coaxial Cable
Fiber-Optic Cable
Radio
Microwave
Satellite

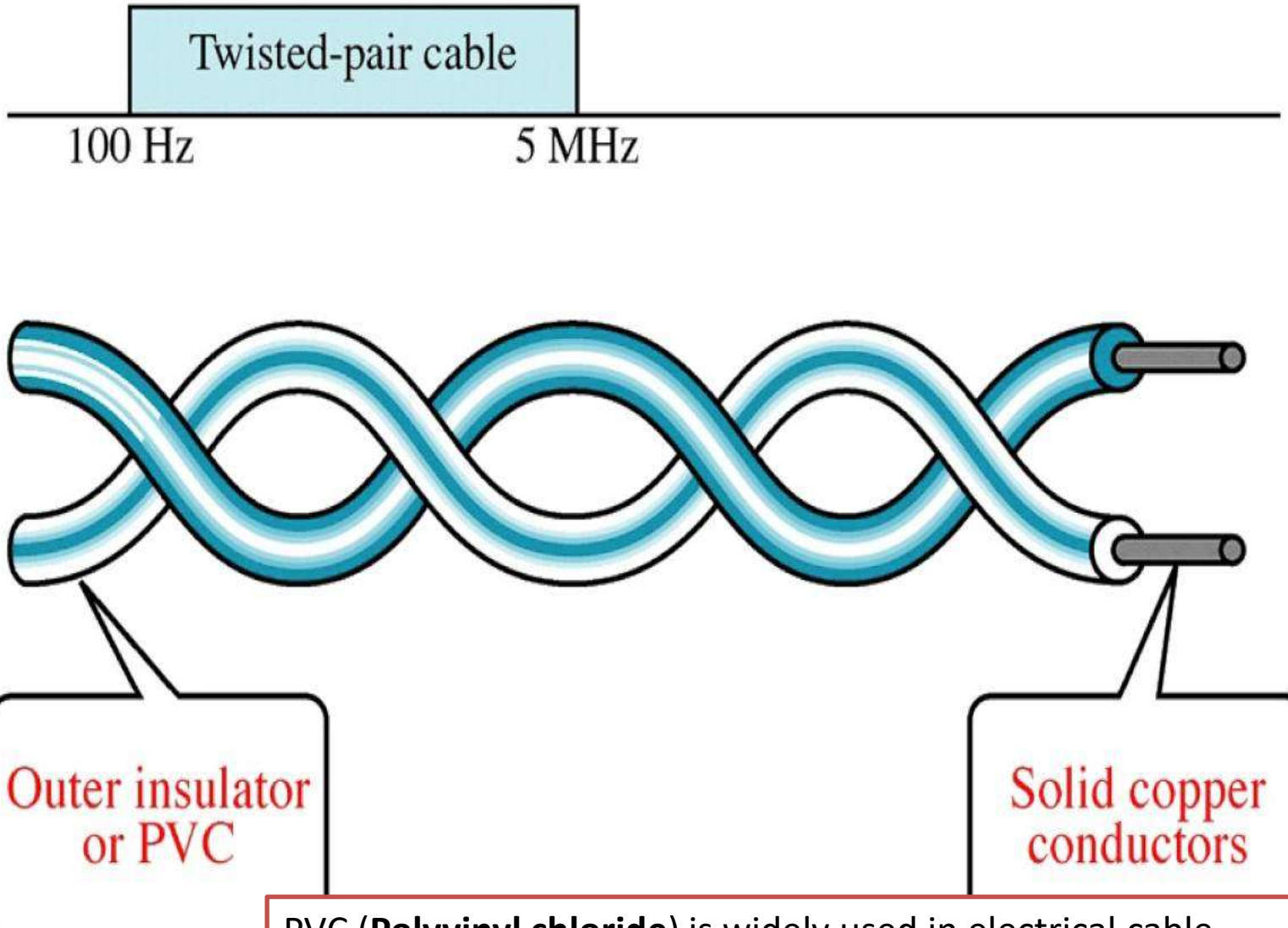
Twisted-Pair cable

- Twisted-pair cable consists of color-coded pairs of insulated copper wires.
- Every two wires are twisted around each other to form pairs, and all the pairs are encased in a plastic sheath.
- The number of pairs in a cable varies, depending on the cable type.
- Modern networks typically use cables that contain four wire pairs, in which one pair is dedicated to sending data and another pair is dedicated to receiving data.
- Twisted-pair cabling is the most common form of cabling found on LAN's today.



All twisted pair cable falls into one of two categories:

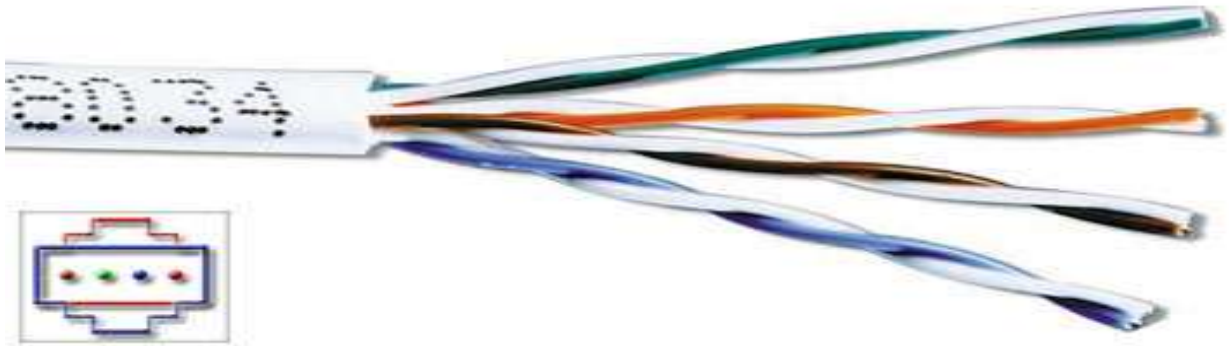
- STP (Shielded Twisted-Pair)
- UTP (Unshielded Twisted-Pair)

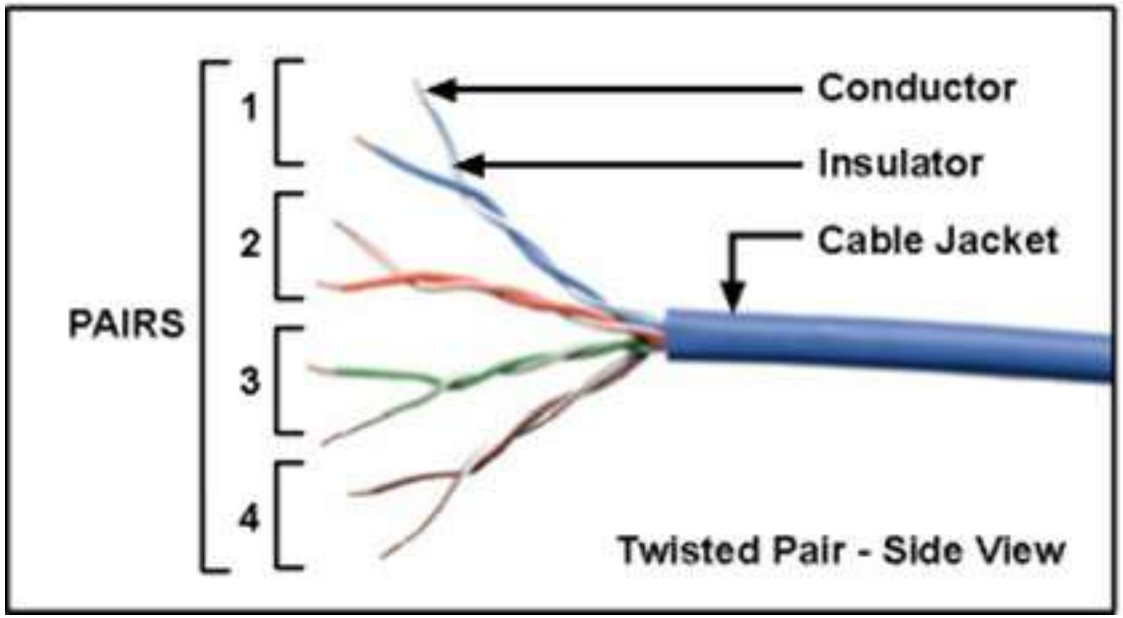


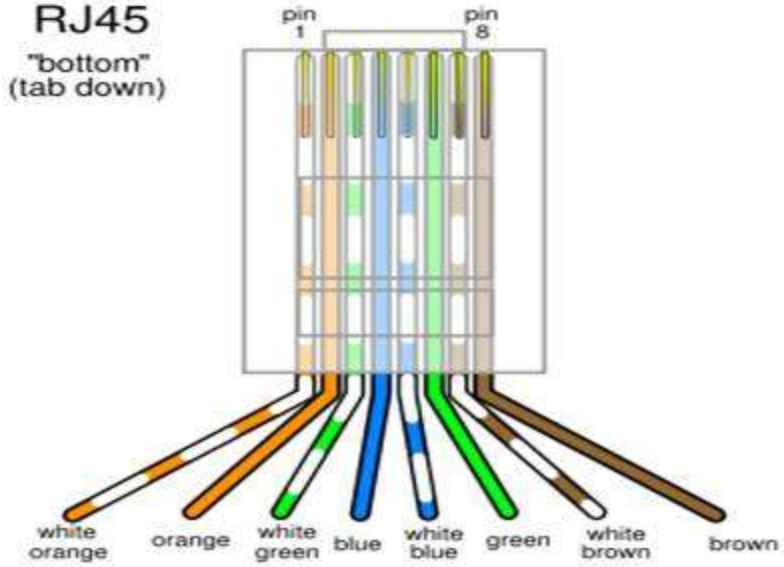
PVC (**Polyvinyl chloride**) is widely used in electrical cable construction for insulation, bedding and sheathing. ...

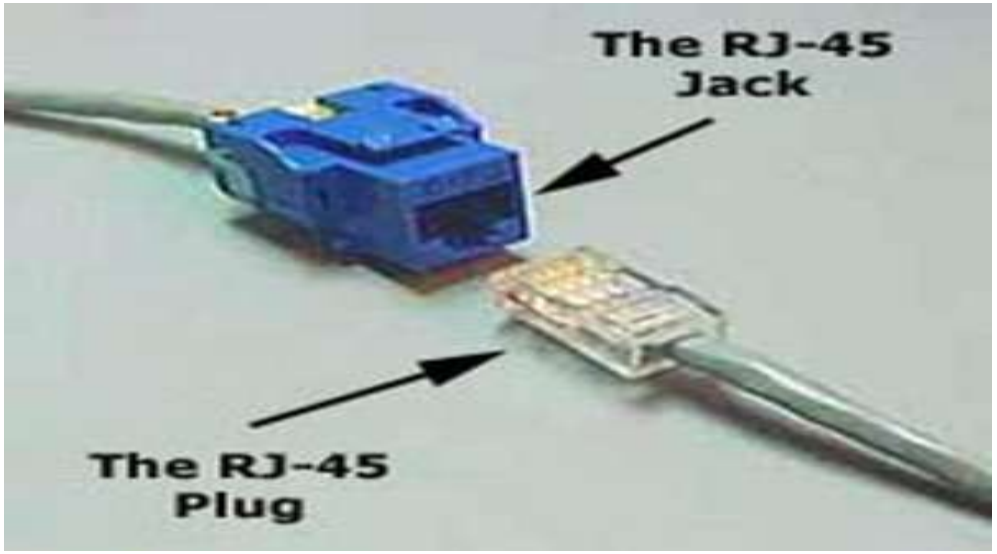
Shielded twisted pair (STP)

Unshielded twisted pair (UTP)



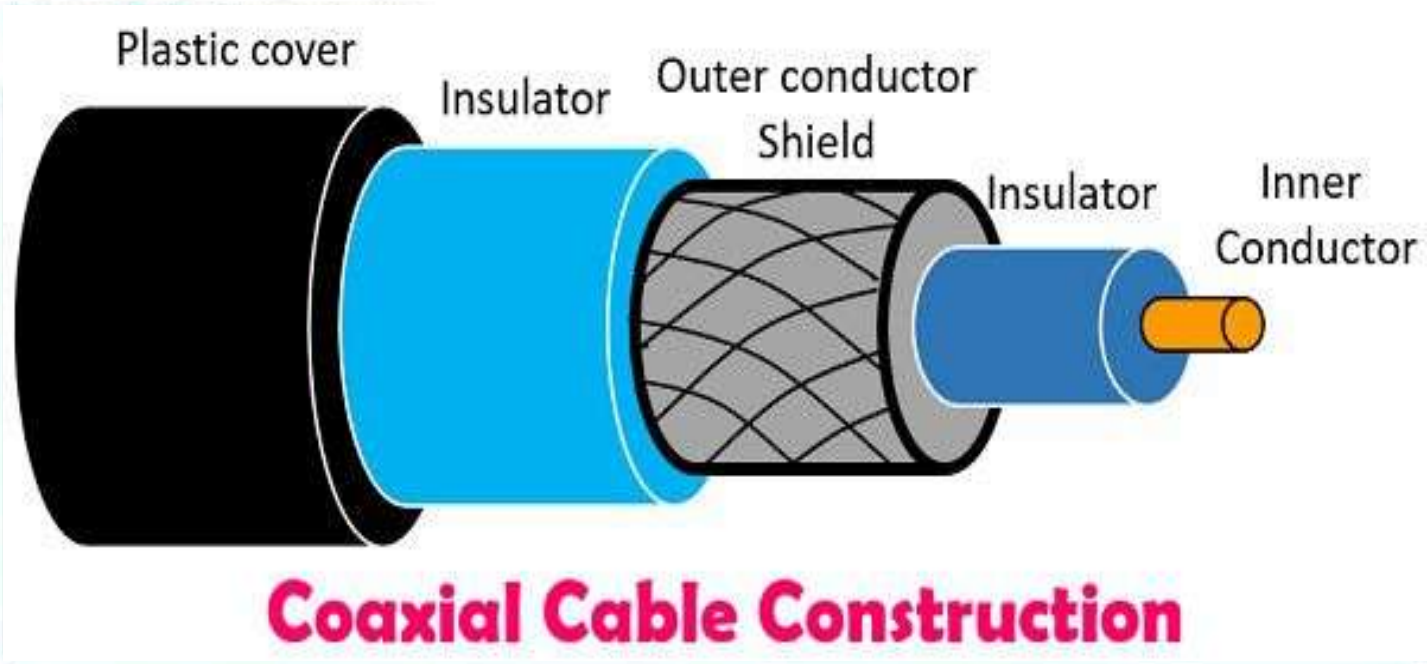


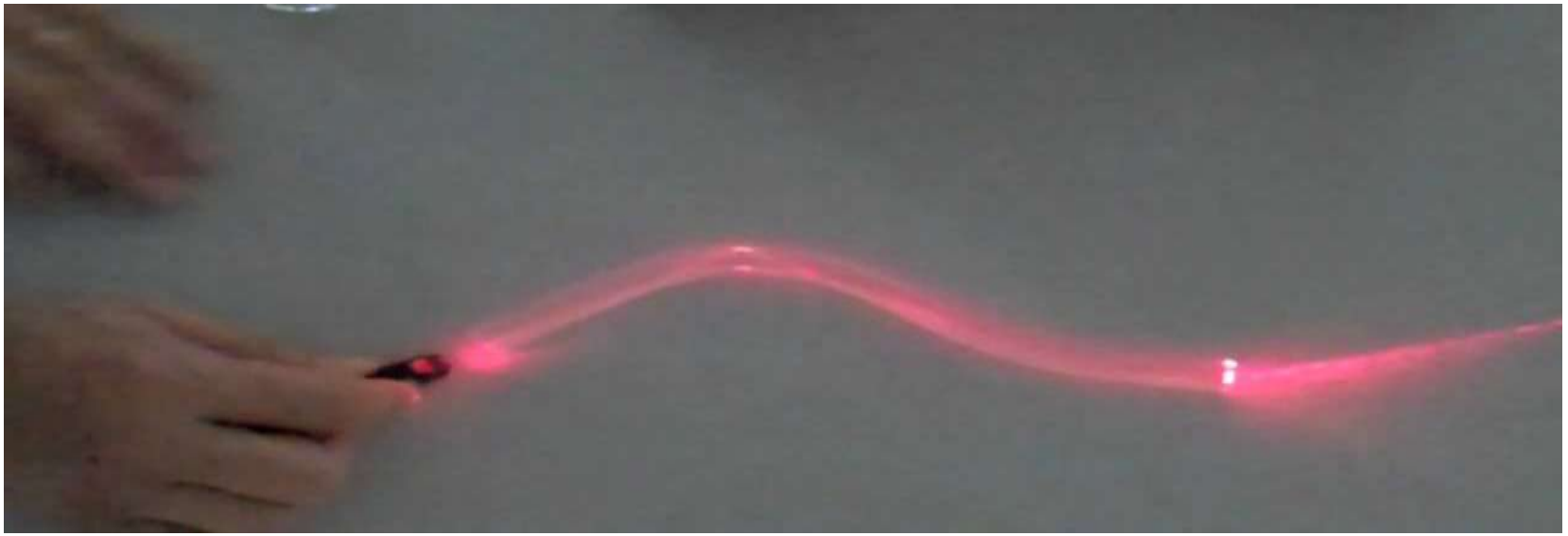

RJ45
"bottom"
(tab down)
pin 1
pin 8
white orange
orange
white green
blue
white blue
green
white brown
brown

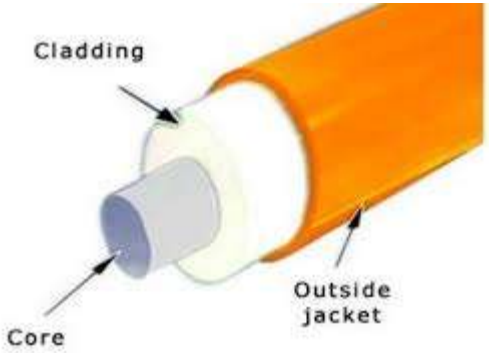

The RJ-45 Jack
The RJ-45 Plug

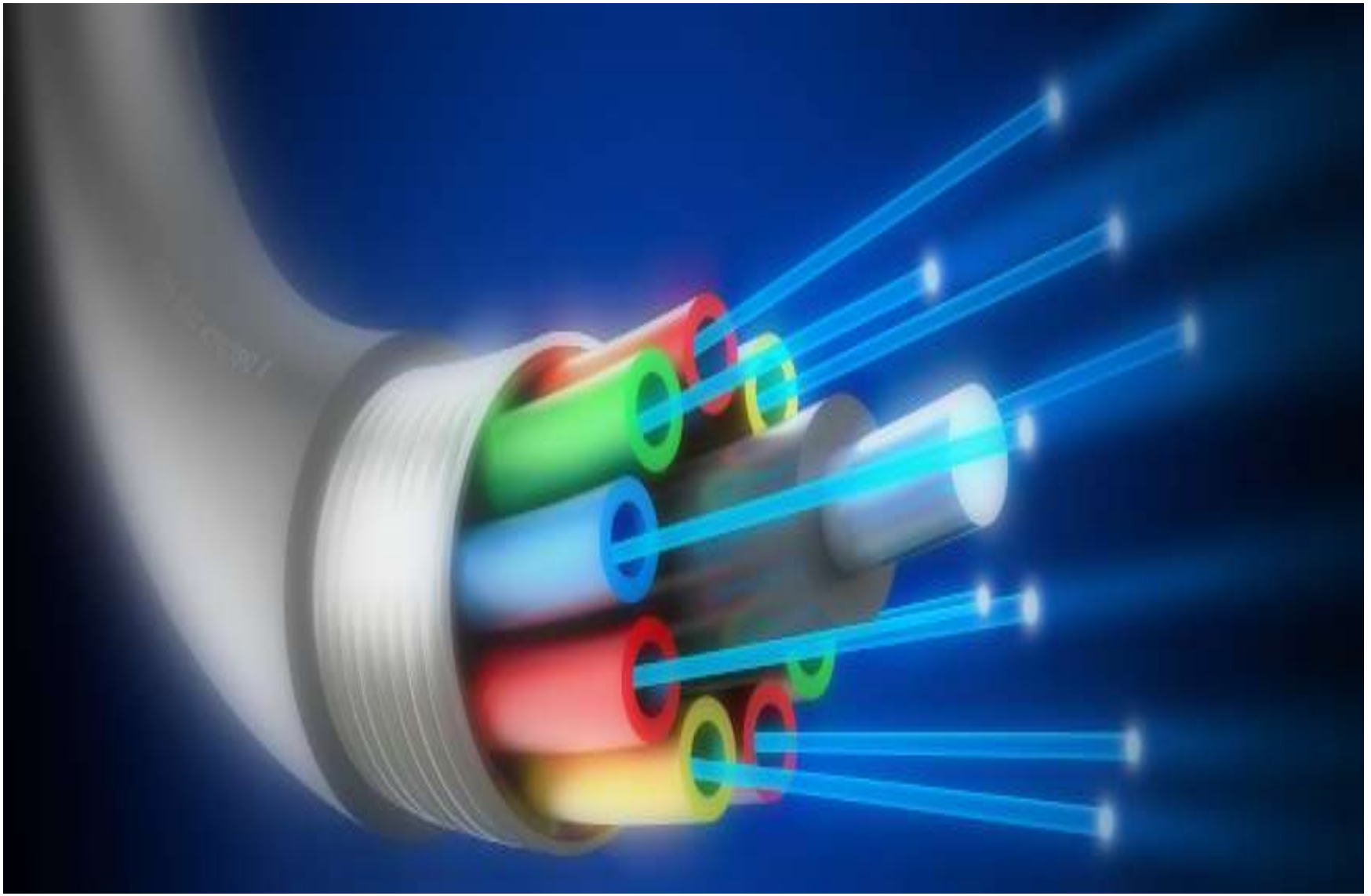
Coaxial Cable

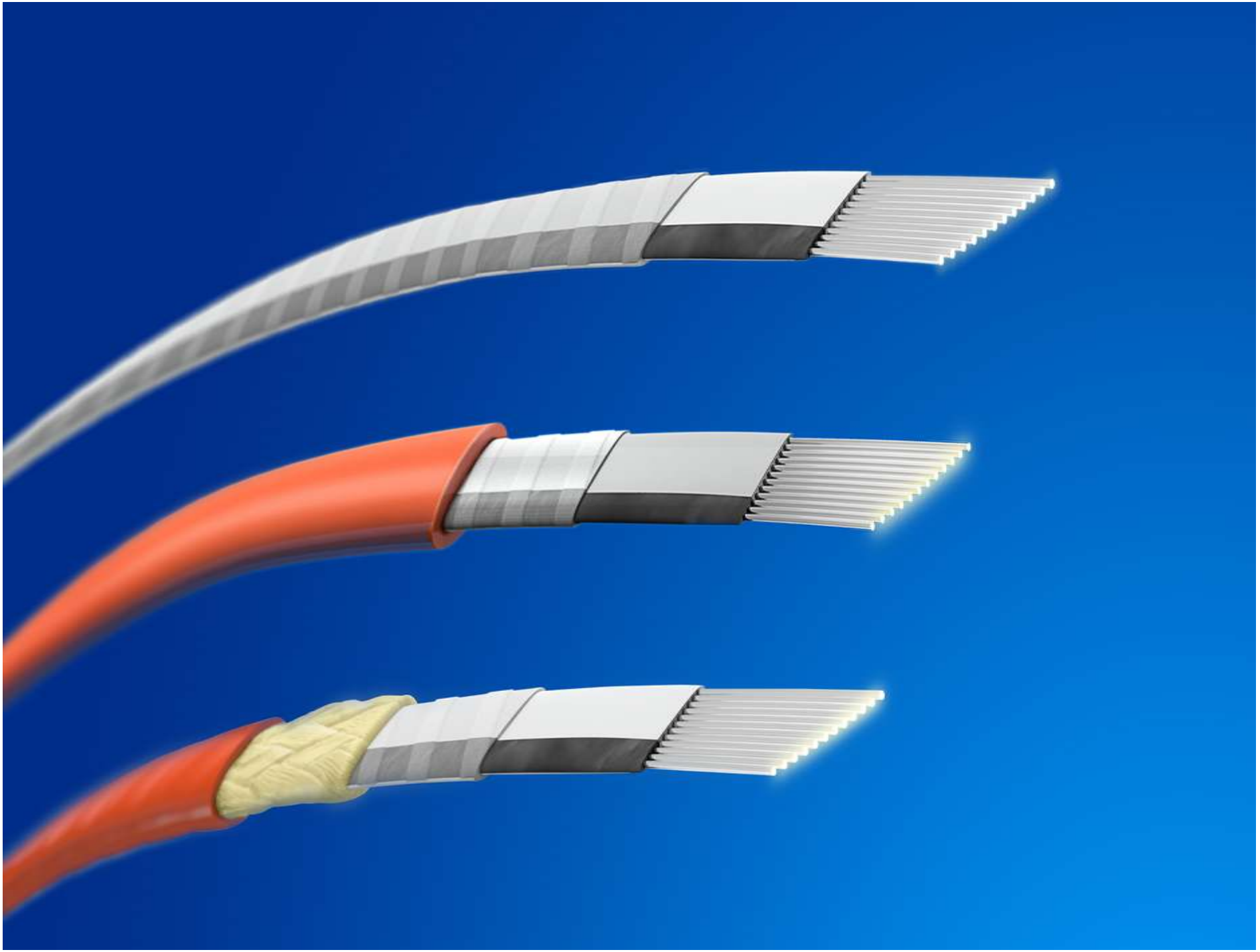
Coaxial cable (or coax) carries signals of higher frequency ranges than those in twisted pair cable, in part because the two media are constructed quite differently. Instead of having two wires, coax has a central core conductor of solid or stranded wire (usually copper)





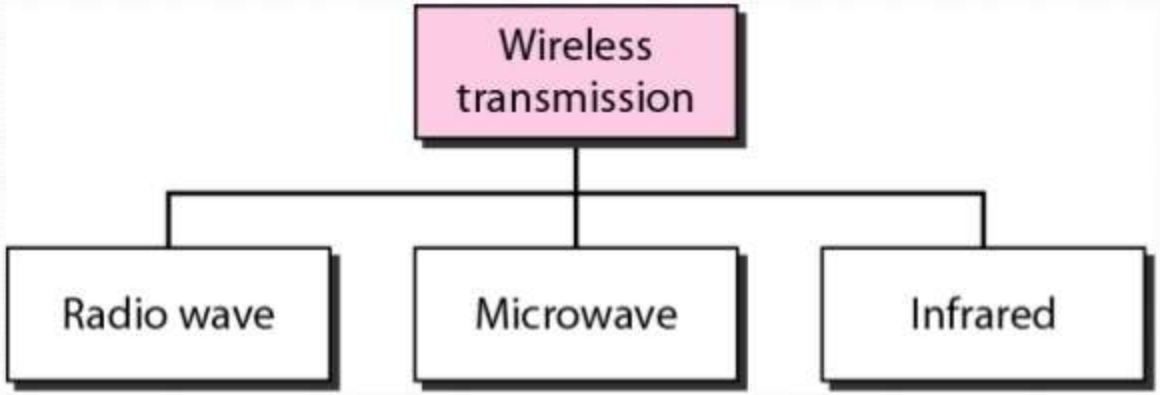

Cladding
Outside
jacket
Core

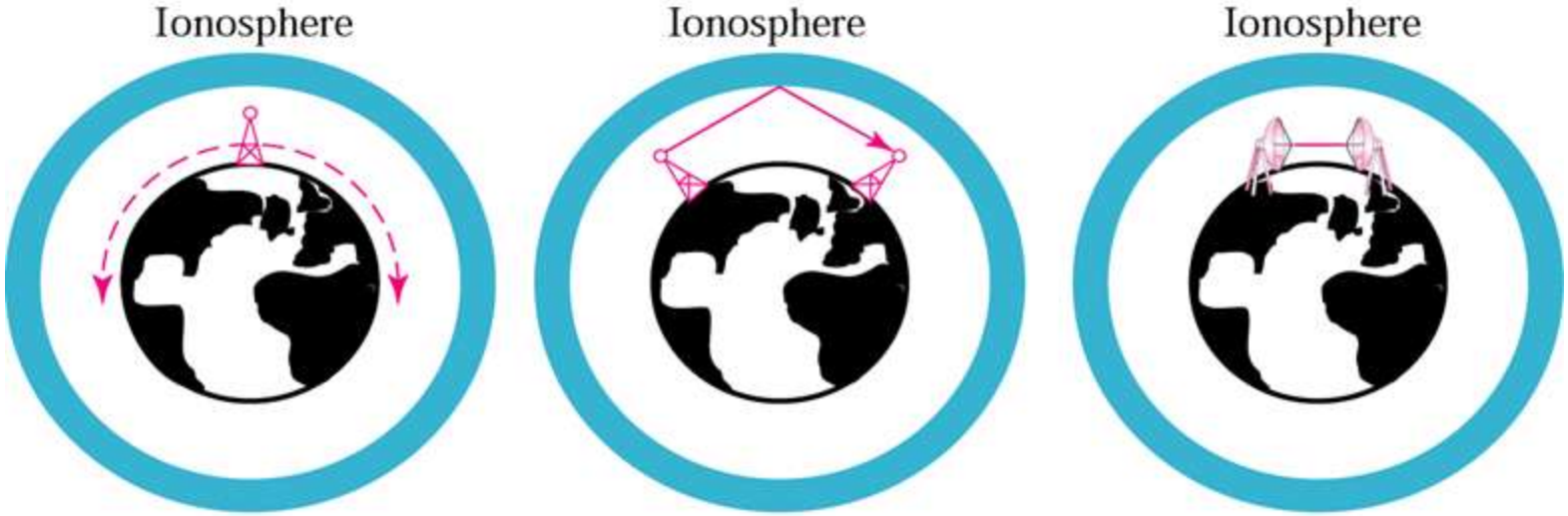




Unguided Media

Wireless transmission waves





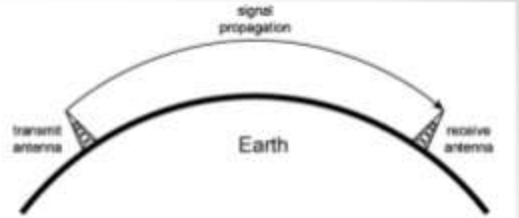
Ground propagation
(below 2 MHz)

Sky propagation
(2 - 30 MHz)

Line-of-sight propagation
(above 30 MHz)

Ground propagation:

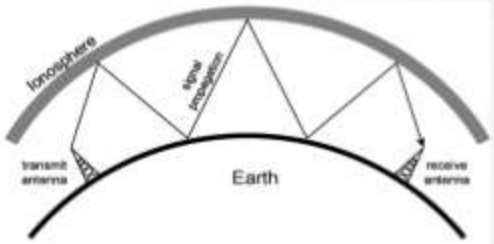
- Radio waves travel through the lowest portion of the atmosphere
- Touching the earth.



(a) Ground-wave propagation (below 2 MHz)

Sky propagation:

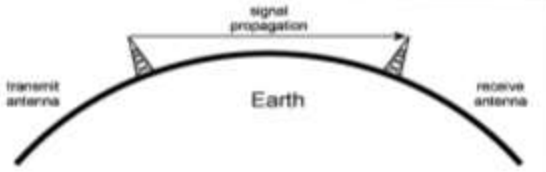
- Radio waves radiate to the ionosphere then they are reflected back to earth.



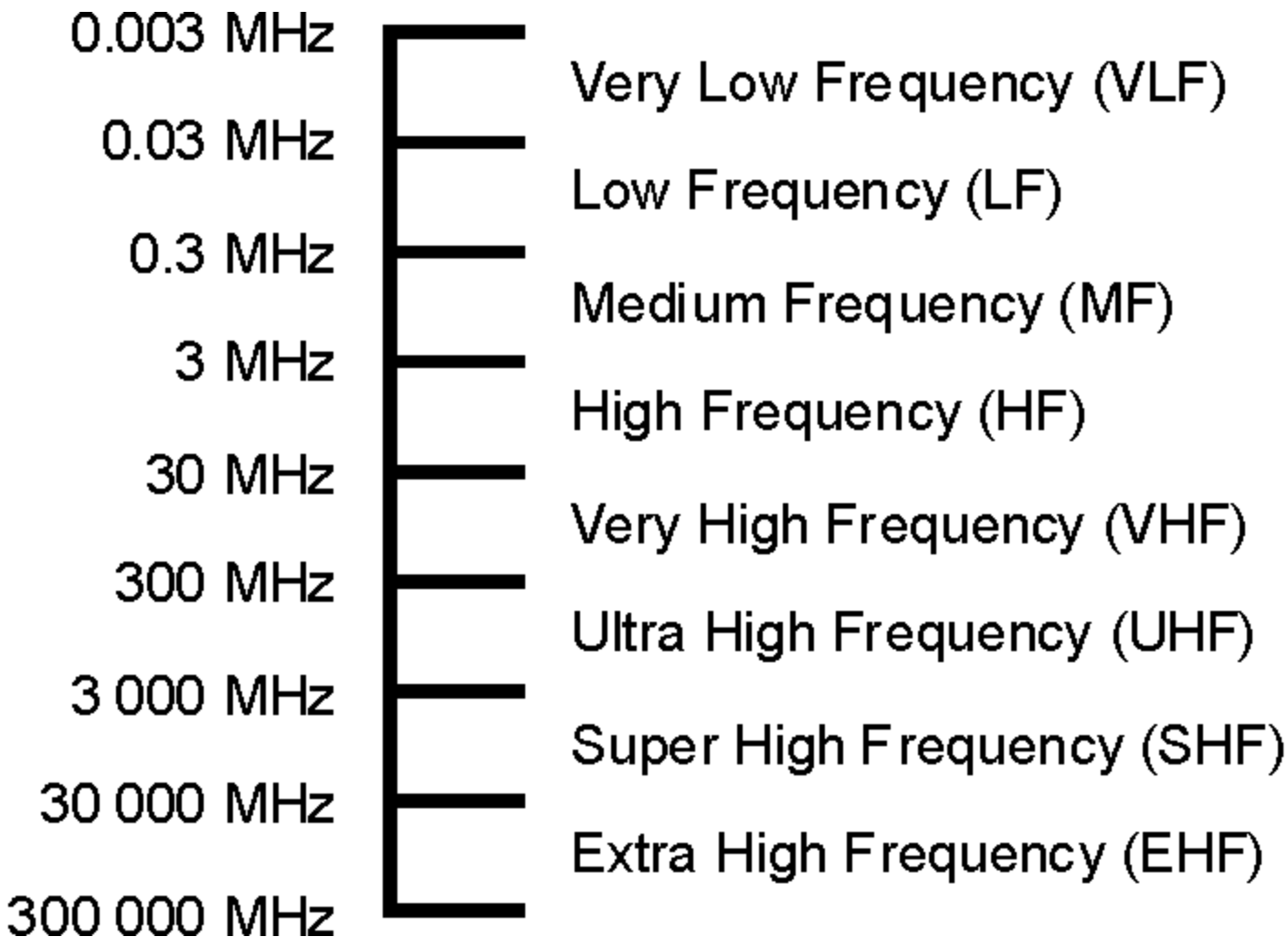
(b) Sky-wave propagation (2 to 30 MHz)

Line-of-Sight Propagation:

- In straight lines directly from antenna to antenna.

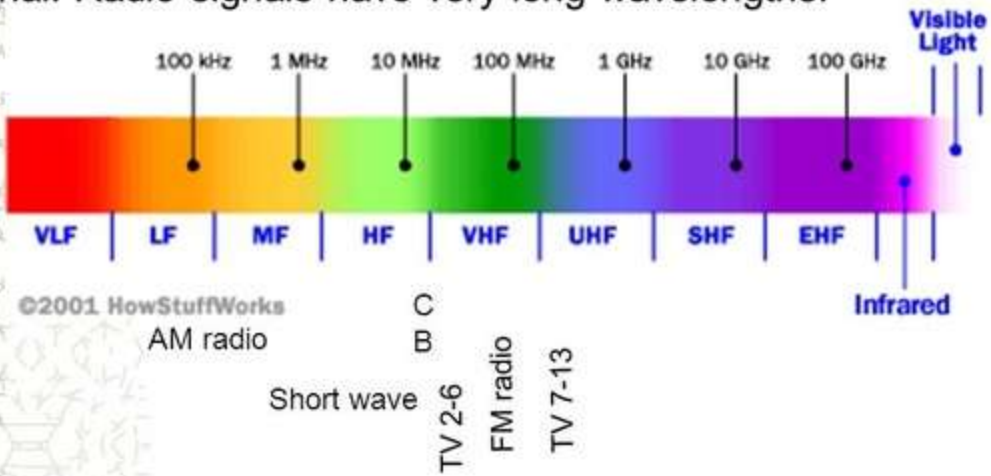


(c) Line-of-sight (LOS) propagation (above 30 MHz)


0.003 MHz
0.03 MHz
0.3 MHz
3 MHz
30 MHz
300 MHz
3 000 MHz
30 000 MHz
300 000 MHz
Very Low Frequency (VLF)
Low Frequency (LF)
Medium Frequency (MF)
High Frequency (HF)
Very High Frequency (VHF)
Ultra High Frequency (UHF)
Super High Frequency (SHF)
Extra High Frequency (EHF)

Radio Waves

A radio wave is an **electromagnetic wave** propagated by an **antenna**. Radio waves have different **frequencies**, and by tuning a radio receiver to a specific frequency you can pick up a specific signal. Radio signals have very long wavelengths.

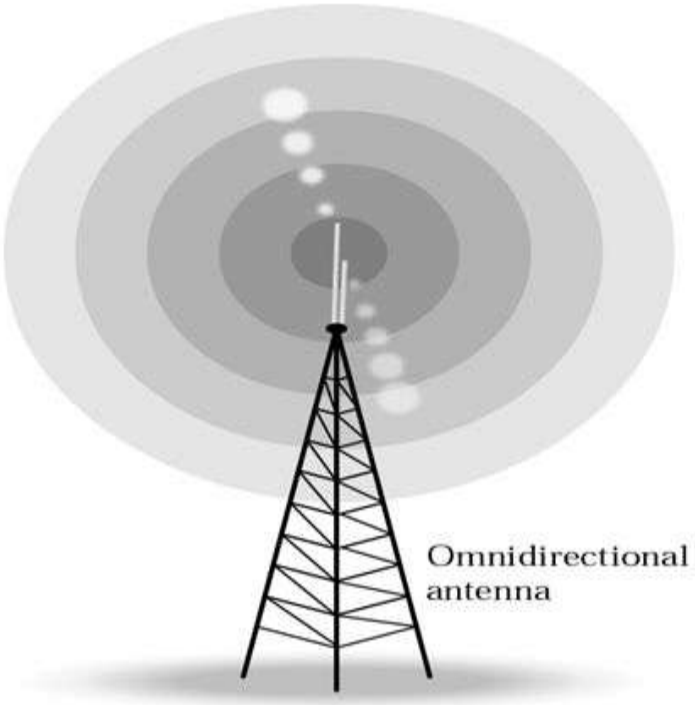


RADIO WAVE

- Electromagnetic waves ranging in frequencies between 3khz and 1Ghz are called Radio wave.

- Radio waves are Omni-directional, they are propagated in all directions.

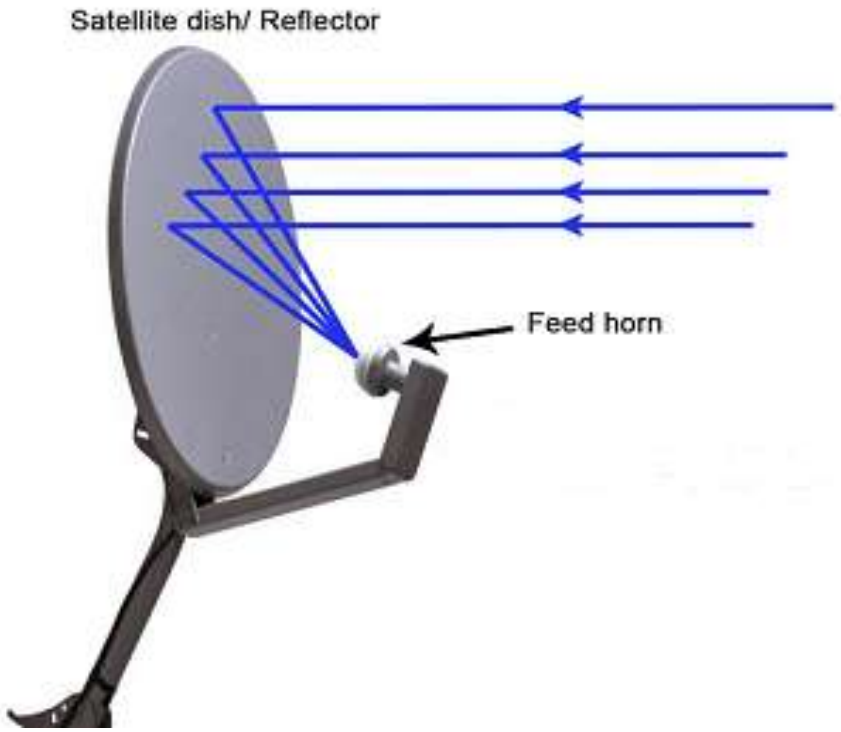
- Radio waves are propagated in sky mode, can travel long distance.



- Electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz are normally called **radio waves**; waves ranging in frequencies between 1 and 300 GHz are called **micro-waves.**

- AM and FM radio, television, cordless phones are examples of multicasting

Microwaves: Electromagnetic waves having frequencies between 1 and 300 GHz are called micro-waves. Microwaves are unidirectional(Microwaves need unidirectional antennas that send out signals in one direction).



Infrared

- Infrared waves, with frequencies from 300 GHz to 400 THz (wavelengths from 1 mm to 770 nm), can be used for **short-range** communication. Infrared waves, having high frequencies, cannot **penetrate** walls.
- keyboards, mice, PCs, and printers.

What is Infrared?

- **Infrared** is a form of light... light that we can not see with our eyes, but that we can sometimes feel on our skin as heat.
- **Infrared** (**IR**) is invisible electromagnetic radiation having a wavelength just greater than that of the red end of the visible light spectrum (rainbow) but less than that of microwaves.