Data Communication Concepts

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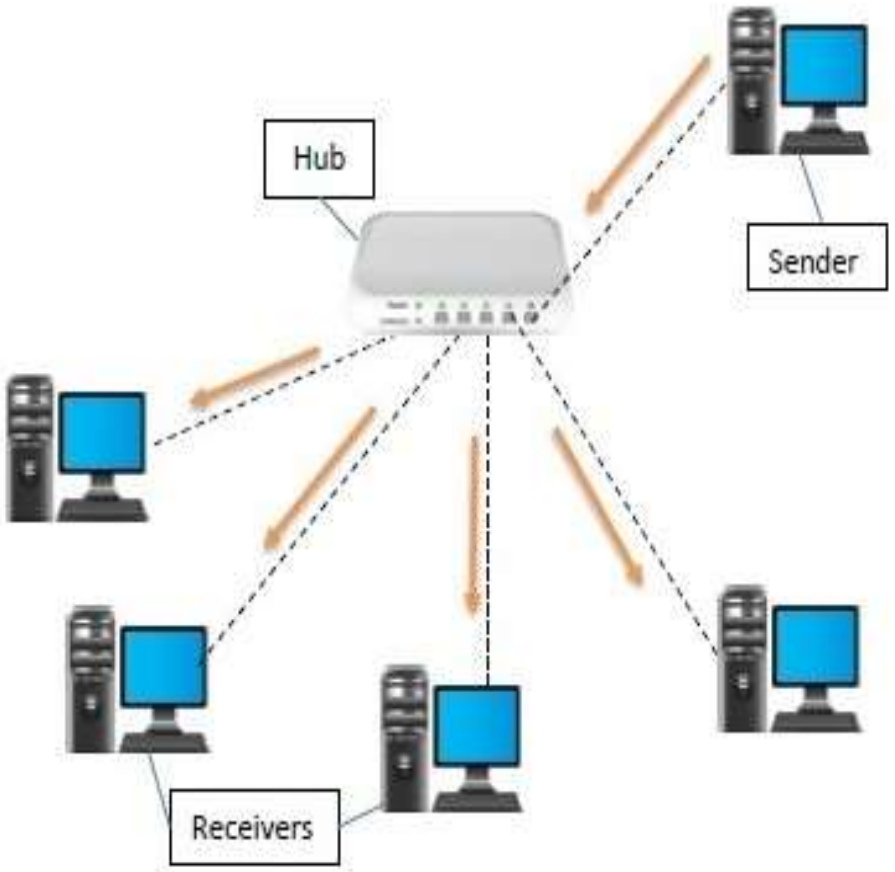
Hubs

A hub is a physical layer networking device which is used to connect multiple devices in a network. They are generally used to connect computers in a LAN.

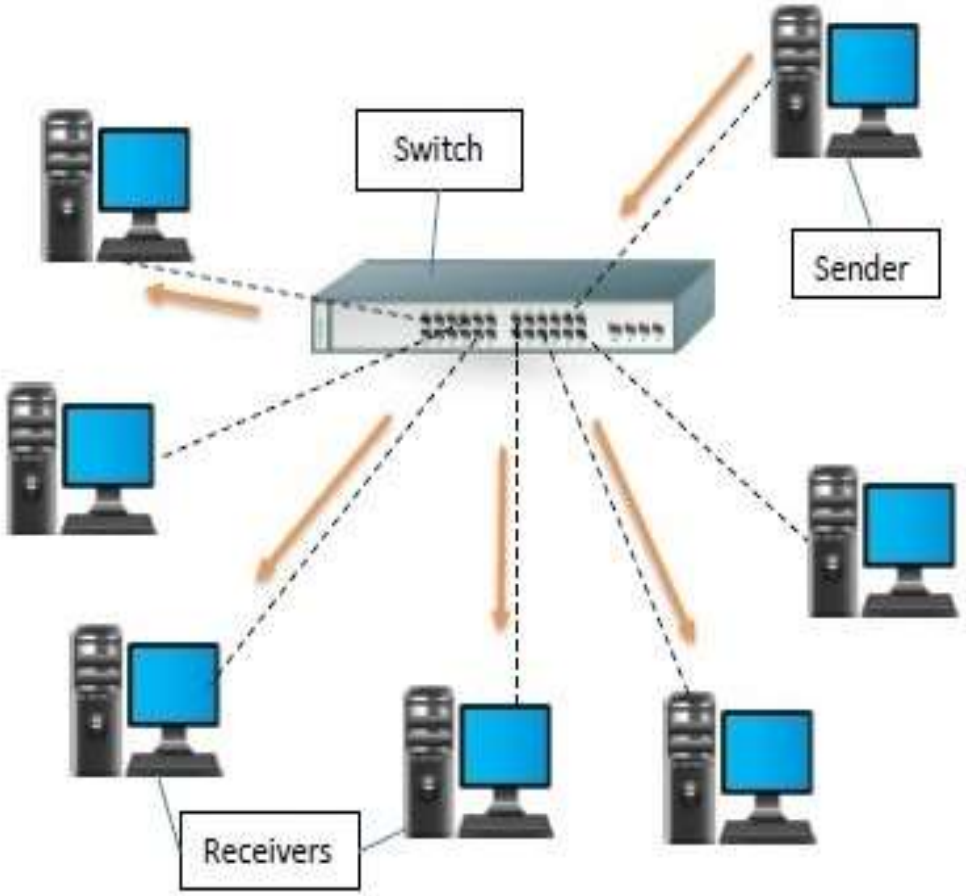
A hub has many ports in it. A computer which intends to be connected to the network is plugged in to one of these ports. When a data frame arrives at a port, it is broadcast to every other port, without considering whether it is destined for a particular destination or not.



Switches

A switch is a data link layer networking device which connects devices in a network and uses packet switching to send and receive data over the network.

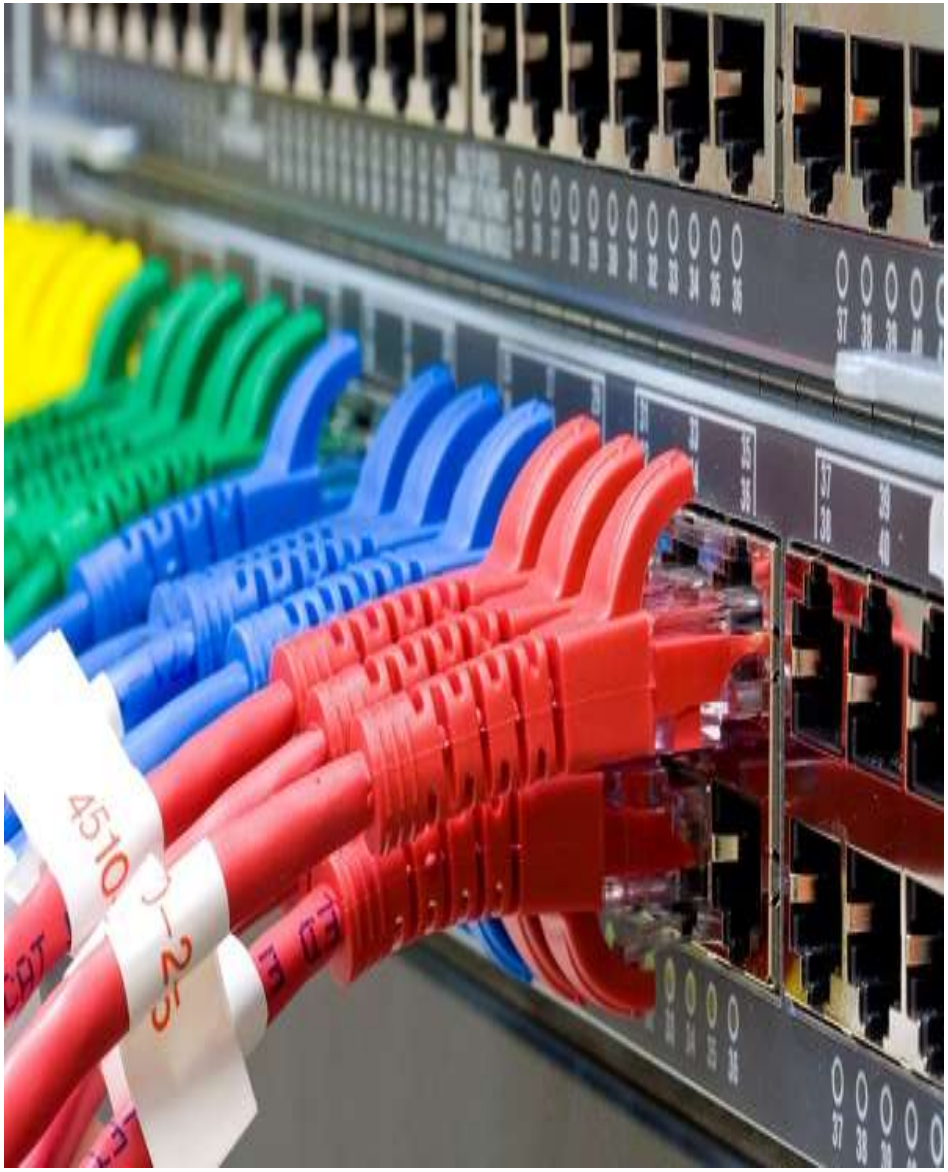
Like a hub, a switch also has many ports, to which computers are plugged in. However, when a data frame arrives at any port of a network switch, it examines the destination address and sends the frame to the corresponding device(s). Thus, it supports both unicast and multicast communications.



Switch is a network device that connects other devices to Ethernet networks through twisted pair cables. It uses packet switching technique to receive, store and forward data packets on the network. The switch maintains a list of network addresses of all the devices connected to it.

On receiving a packet, it checks the destination address and transmits the packet to the correct port. Before forwarding, the packets are checked for collision and other network errors. The data is transmitted in full duplex mode.

Data transmission speed in switches can be double that of other network devices like hubs used for networking. This is because switch shares its maximum speed with all the devices connected to it. This helps in maintaining network speed even during high traffic. In fact, higher data speeds are achieved on networks through use of multiple switches.



Differences between Hub and Switch

Hub	Switch
They operate in the physical layer of the OSI model.	They operate in the data link layer of the OSI model.
It is a non-intelligent network device that sends message to all ports.	It is an intelligent network device that sends message to selected destination ports.
It primarily broadcasts messages.	It is supports unicast, multicast and broadcast.
Transmission mode is half duplex.	Transmission mode is full duplex.
Collisions may occurs during setup of transmission when more than one computers place data simultaneously in the corresponding ports.	Collisions do not occur since the communication is full duplex.
They are passive devices, they don't have any software associated with it.	They are active devices, equipped with network software.
They generally have fewer ports of 4/12.	The number of ports is higher – 24/48.

Router

A router is a network layer hardware device that transmits data from one LAN to another if both networks support the same set of protocols. So a router is typically connected to at least two LANs and the internet service provider (ISP). It receives its data in the form of packets, which are data frames with their destination address added.

Router also strengthens the signals before transmitting them. That is why it is also called repeater.

Gateway

Gateway is a network device used to connect two or more dissimilar networks. In networking parlance, networks that use different protocols are dissimilar networks. A gateway usually is a computer with multiple NICs connected to different networks. A gateway can also be configured completely using software. As networks connect to a different network through gateways, these gateways are usually hosts or end points of the network.

Gateway uses packet switching technique to transmit data from one network to another. In this way it is similar to a router, the only difference being router can transmit data only over networks that use same protocols.

Bridge

A bridge operates at data link layer. A bridge is a repeater, with add on functionality of filtering content by reading the MAC addresses of source and destination. It is also used for interconnecting two LANs working on the same protocol. It has a single input and single output port, thus making it a 2 port device.

Types of Bridges

- Transparent Bridges
- Source Routing Bridges

Transparent Bridges :-

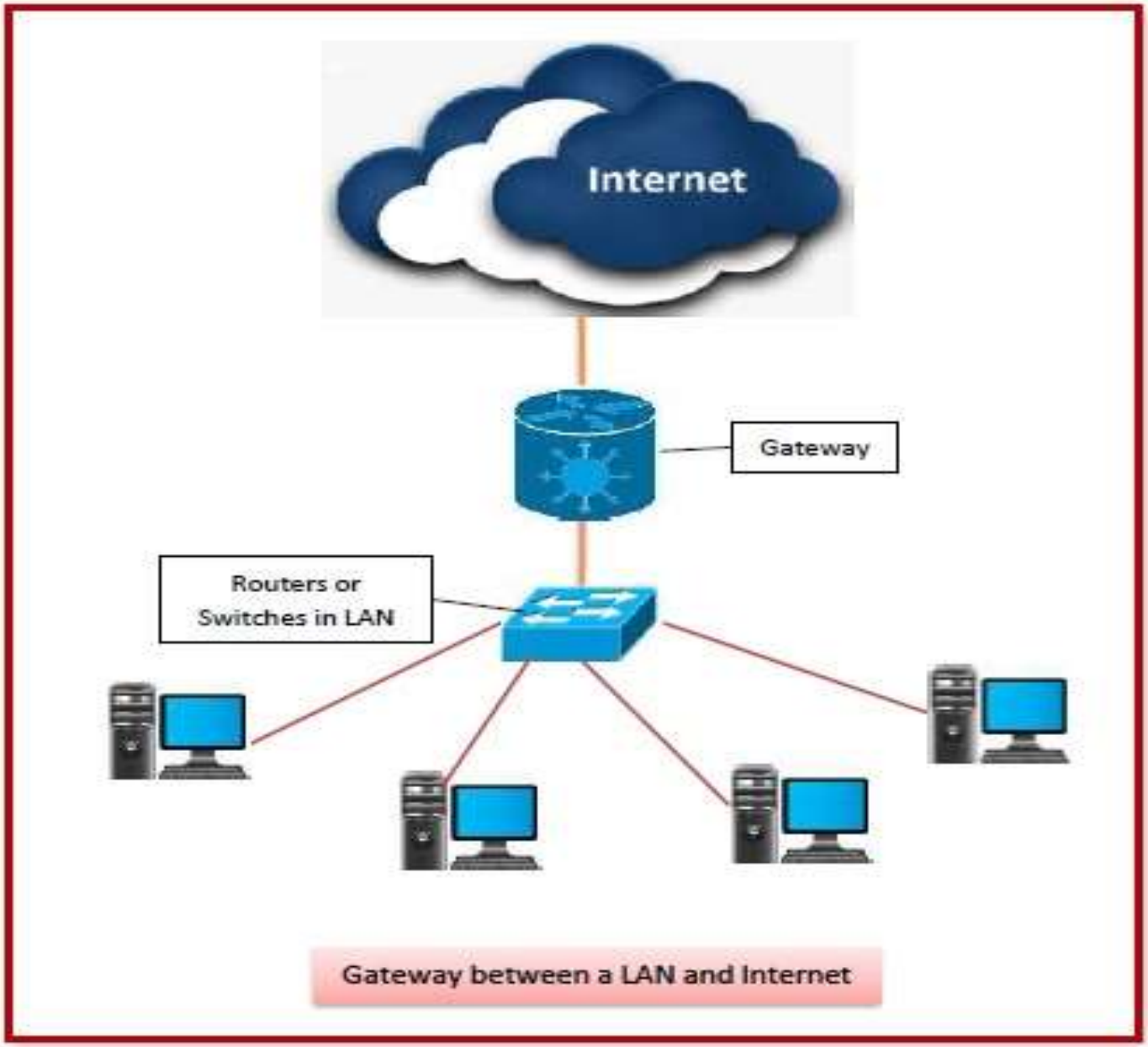
These are the bridge in which the stations are completely unaware of the bridge's existence i.e. whether or not a bridge is added or deleted from the network , reconfiguration of the stations is unnecessary. These bridges makes use of two processes i.e. bridge forwarding and bridge learning.

Source Routing Bridges :-

In these bridges, routing operation is performed by source station and the frame specifies which route to follow. The host can discover frame by sending a special frame called discovery frame, which spreads through the entire network using all possible paths to destination.

Gateways in Computer Network

A gateway is a network node that forms a passage between two networks operating with different transmission protocols. The most common type of gateways, the network gateway operates at layer 3, i.e. network layer of the OSI (open systems interconnection) model. However, depending upon the functionality, a gateway can operate at any of the seven layers of OSI model. It acts as the entry – exit point for a network since all traffic that flows across the networks should pass through the gateway. Only the internal traffic between the nodes of a LAN does not pass through the gateway.



Gateway between a LAN and Internet

Features of Gateways

- Gateway is located at the boundary of a network and manages all data that inflows or outflows from that network.
- It forms a passage between two different networks operating with different transmission protocols.
- A gateway operates as a protocol converter, providing compatibility between the different protocols used in the two different networks.
- The feature that differentiates a gateway from other network devices is that it can operate at any layer of the OSI model.
- It also stores information about the routing paths of the communicating networks.
- When used in enterprise scenario, a gateway node may be supplemented as proxy server or firewall.
- A gateway is generally implemented as a node with multiple NICs (network interface cards) connected to different networks. However, it can also be configured using software.
- It uses packet switching technique to transmit data across the networks.

Types of Gateways

On basis of direction of data flow, gateways are broadly divided into two categories −

- **Unidirectional Gateways** − They allow data to flow in only one direction. Changes made in the source node are replicated in the destination node, but not vice versa. They can be used as archiving tools.
- **Bidirectional Gateways** − They allow data to flow in both directions. They can be used as synchronization tools.

On basis of functionalities, there can be a variety of gateways, the prominent among them are as follows −

- **Network Gateway** − This is the most common type of gateway that provides as interface between two dissimilar networks operating with different protocols. Whenever the term gateway is mentioned without specifying the type, it indicates a network gateway.
- **Cloud Storage Gateway** − It is a network node or server that translates storage requests with different cloud storage service API calls, such as SOAP (Simple Object Access Protocol) or REST (RE presentational State Transfer).It facilitates integration of private cloud storage into applications without necessitating transfer of the applications into any public cloud, thus simplifying data communication.
- **Internet-To-Orbit Gateway (I2O)** − It connects devices on the Internet to satellites and spacecraft orbiting the earth. Two prominent I2O gateways are Project HERMES and Global Educational Network for Satellite Operations (GENSO).
- **IoT Gateway** − IoT gateways assimilates sensor data from IoT (Internet of Things) devices in the field and translates between sensor protocols before sending it to the cloud network. They connect IoT devices, cloud network and user applications.
- **VoiP Trunk Gateway** − It facilitates data transmission between plain old telephone service (POTS) devices like landline phones and fax machines, with VoIP (voice over Internet Protocol) network.

Thank you

Signal Encoding and Decoding Techniques

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Encoding Techniques

Encoding is the process of converting the data or a given sequence of characters, symbols, alphabets etc., into a specified format, for the secured transmission of data.

Decoding is the reverse process of encoding which is to extract the information from the converted format.

Data Encoding

Encoding is the process of using various patterns of voltage or current levels to represent **1's** and **0's** of the digital signals on the transmission link.

The common types of line encoding are Unipolar, Polar, Bipolar, and Manchester.

Encoding Techniques

The data encoding technique is divided into the following types, depending upon the type of data conversion.

- **Analog data to Analog signals** − The modulation techniques such as Amplitude Modulation, Frequency Modulation and Phase Modulation of analog signals, fall under this category.

- **Analog data to Digital signals** − This process can be termed as digitization, which is done by Pulse Code Modulation PCMPCM. Hence, it is nothing but digital modulation.

- **Digital data to Analog signals** − The modulation techniques such as Amplitude Shift Keying ASKASK, Frequency Shift Keying FSKFSK, Phase Shift Keying PSKPSK, etc., fall under this category.

- **Digital data to Digital signals** − There are several ways to map digital data to digital signals.

Principles of Communication - Modulation

A signal can be anything like a sound wave which comes out when we shout. This shout can be heard only up to a certain distance. But for the same wave to travel over a long distance, we'll need a technique which adds strength to this signal, without disturbing the parameters of the original signal.

Signals in the Modulation Process

Following are the three types of signals in the modulation process.

Message or Modulating Signal

The signal which contains a message to be transmitted, is called as a message signal. It is a baseband signal, which has to undergo the process of modulation, to get transmitted. Hence, it is also called as the modulating signal.

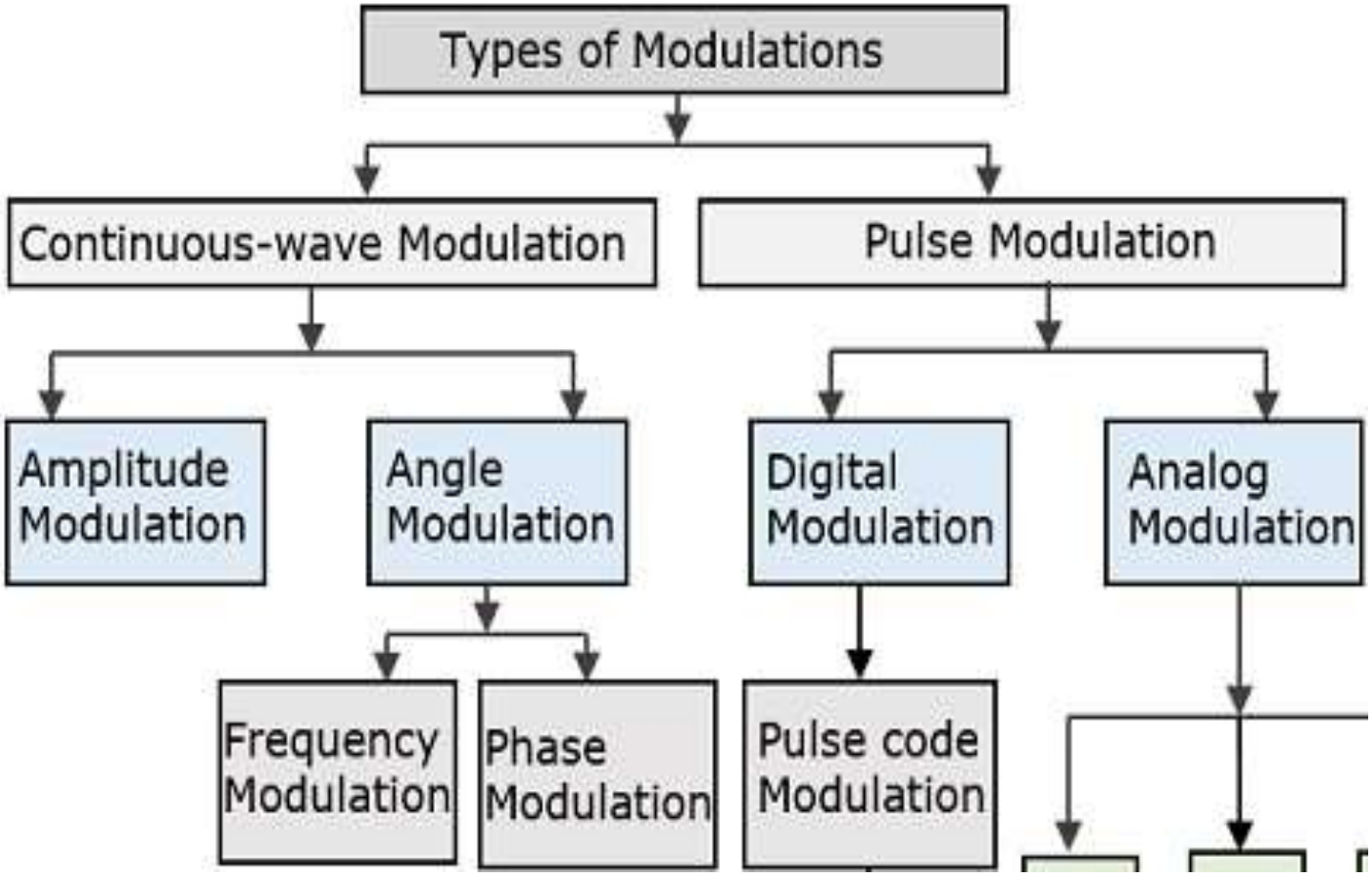
Carrier Signal

The high frequency signal which has a certain phase, frequency, and amplitude but contains no information, is called a carrier signal. It is an empty signal. It is just used to carry the signal to the receiver after modulation.

Modulated Signal

The resultant signal after the process of modulation, is called as the modulated signal. This signal is a combination of the modulating signal and the carrier signal.

Types of Modulation



What is Signal Modulation?

A message carrying signal has to get transmitted over a distance and for it to establish a reliable communication, it needs to take the help of a high frequency signal which should not affect the original characteristics of the message signal.

The characteristics of the message signal, if changed, the message contained in it also alters. Hence it is a must to take care of the message signal. A high frequency signal can travel up to a longer distance, without getting affected by external disturbances. High frequency signal which is called as a carrier signal to transmit message signal. Process is called as Modulation.

Modulation is the process of changing the parameters of the carrier signal, in accordance with the instantaneous values of the modulating signal.

Need for Modulation

The baseband signals are incompatible for direct transmission. For such a signal, to travel longer distances, its strength has to be increased by modulating with a high frequency carrier wave, which doesn’t affect the parameters of the modulating signal.

Advantages of Modulation

The antenna used for transmission, had to be very large, if modulation was not introduced. The range of communication gets limited as the wave cannot travel to a distance without getting distorted.

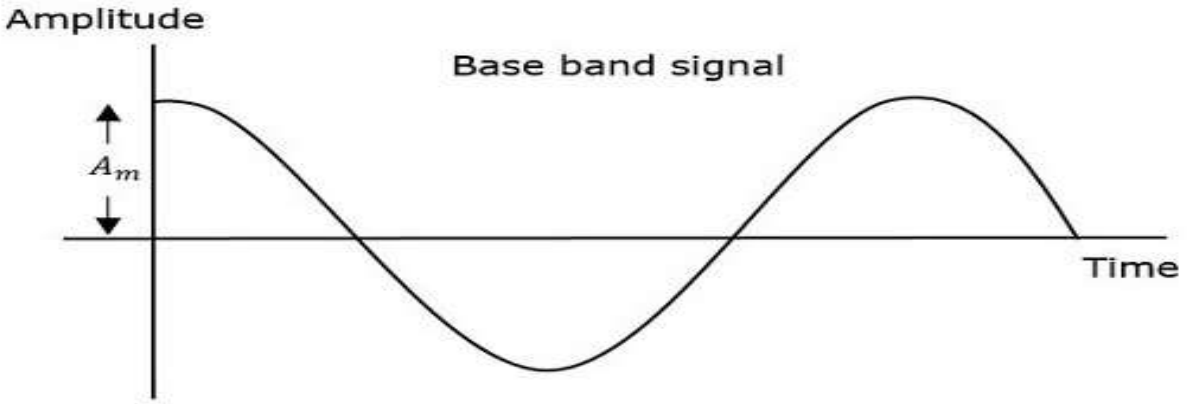
Following are some of the advantages for implementing modulation in the communication systems.

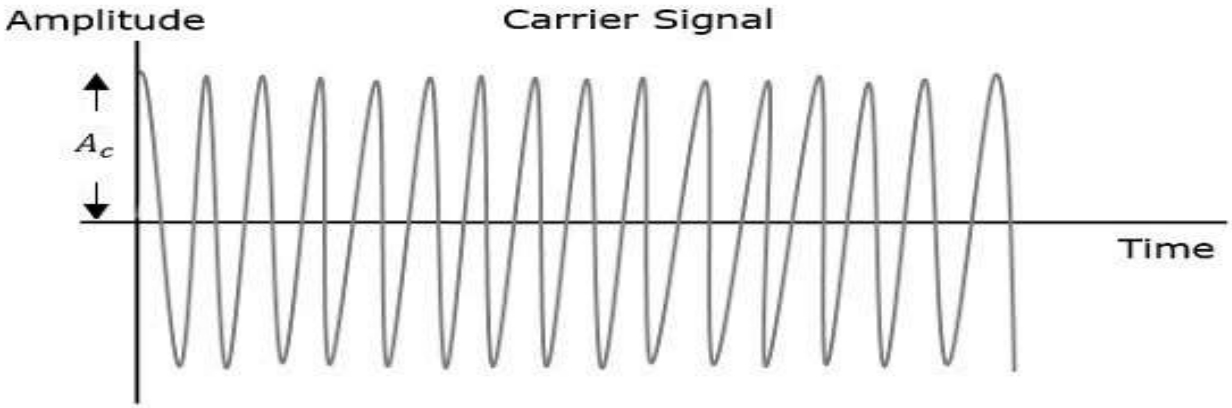
- Antenna size gets reduced.
- No signal mixing occurs.
- Communication range increases.
- Multiplexing of signals occur.
- Adjustments in the bandwidth is allowed.
- Reception quality improves.

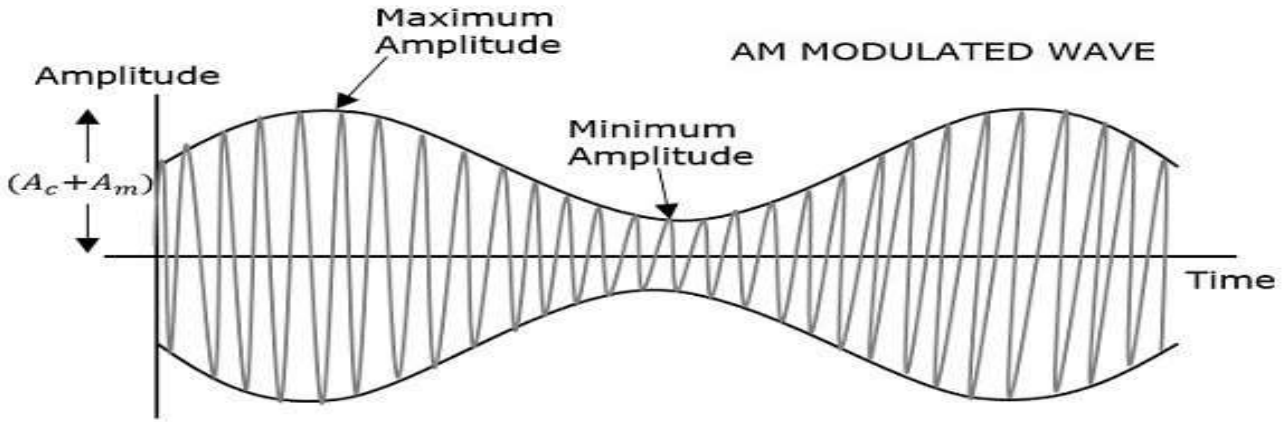
Amplitude Modulation

A continuous-wave goes on continuously without any intervals and it is the **baseband** message signal, which contains the information. This wave has to be modulated.

According to the standard definition, “The amplitude of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal.” Which means, the amplitude of the carrier signal containing no information varies as per the amplitude of the signal containing information, at each instant.


Amplitude
Base band signal
A_m
Time

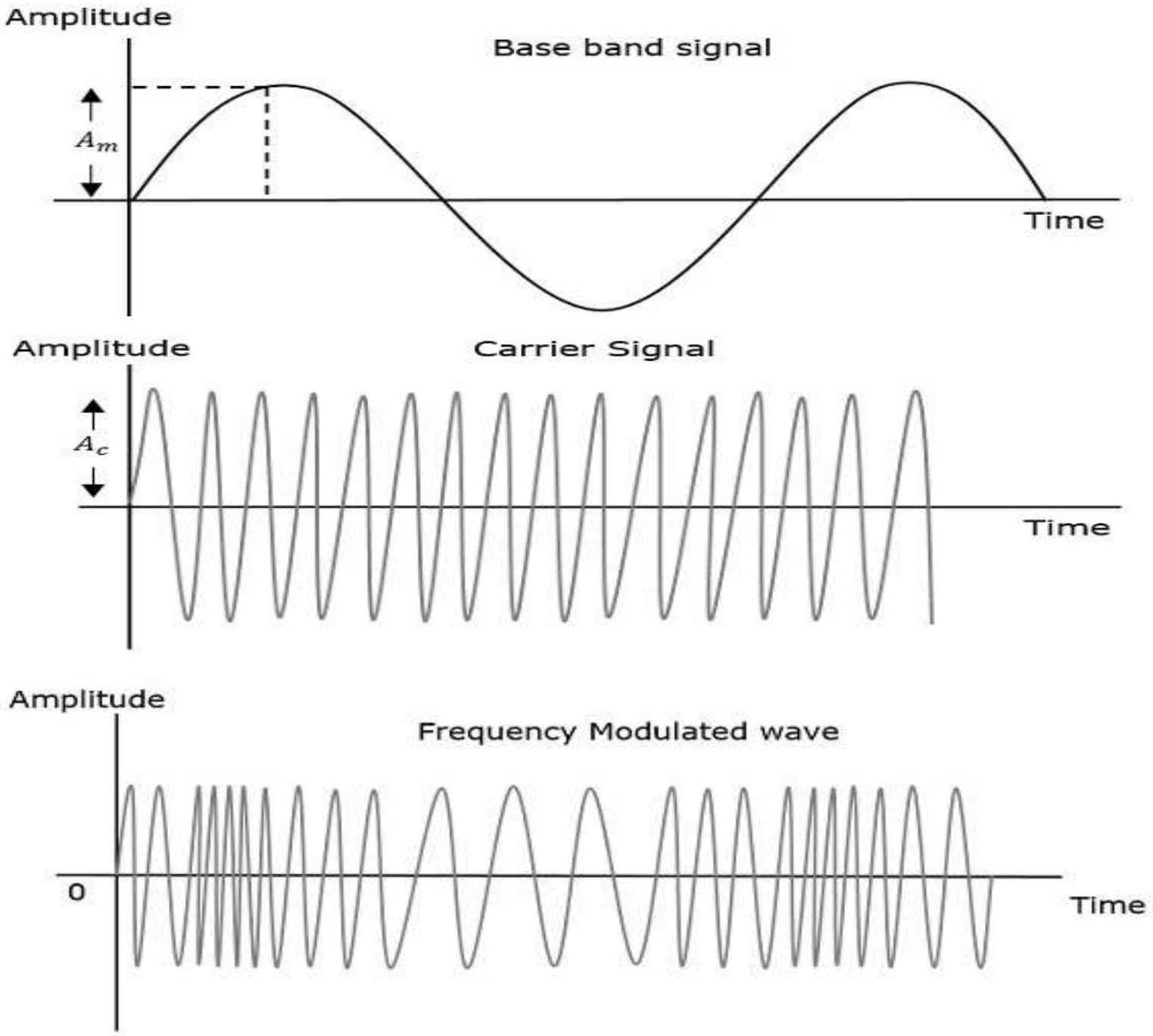

Amplitude
Carrier Signal
A_c
Time


Maximum
Amplitude
AM MODULATED WAVE
Amplitude
Minimum
Amplitude
(A_c+A_m)
Time

Frequency Modulation

In amplitude modulation, the amplitude of the carrier signal varies. Whereas, in Frequency Modulation (FM), the frequency of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal.

Hence, in frequency modulation, the amplitude and the phase of the carrier signal remains constant. This can be better understood by observing the figures on next page.

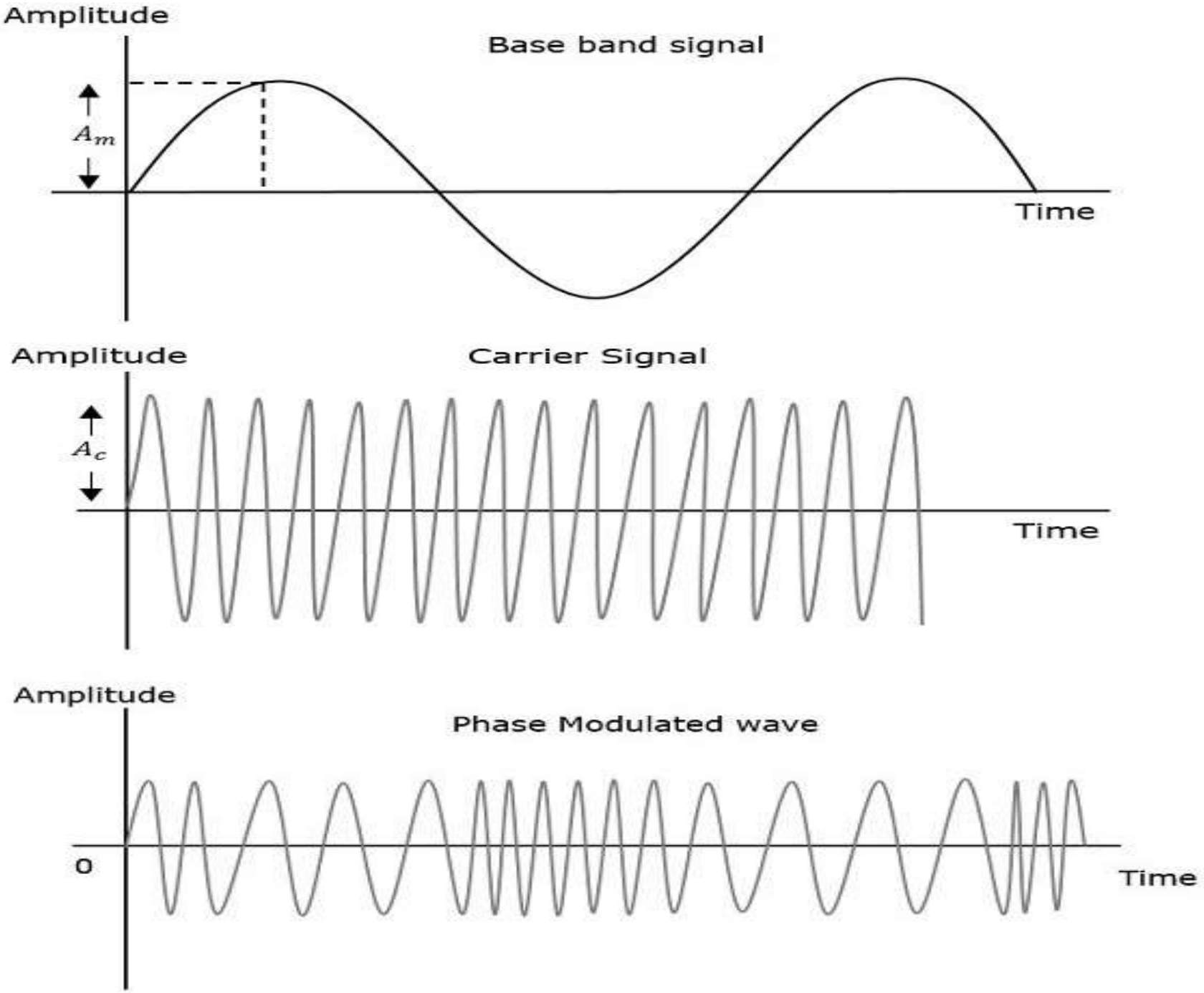

Amplitude
Base band signal
A_m
Time
Amplitude
Carrier Signal
A_c
Time
Amplitude
Frequency Modulated wave
0
Time

The frequency of the modulated wave increases, when the amplitude of the modulating or message signal increases. Similarly, the frequency of the modulated wave decreases, when the amplitude of the modulating signal decreases. Note that, the frequency of the modulated wave remains constant and it is equal to the frequency of the carrier signal, when the amplitude of the modulating signal is zero.

Phase Modulation

In frequency modulation, the frequency of the carrier varies. Whereas, in Phase Modulation (PM), the phase of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal.

So, in phase modulation, the amplitude and the frequency of the carrier signal remains constant. This can be better understood by observing the following figures.


Amplitude
Base band signal
A_m
Time
Amplitude
Carrier Signal
A_c
Time
Amplitude
Phase Modulated wave
0
Time

The phase of the modulated wave has got infinite points, where the phase shift in a wave can take place. The instantaneous amplitude of the modulating signal changes the phase of the carrier signal. When the amplitude is positive, the phase changes in one direction and if the amplitude is negative, the phase changes in the opposite direction.

Signal bandwidth requirements

Bandwidth is the difference between the upper and lower frequencies in a continuous band of frequencies. Passband bandwidth is the difference between the upper and lower cut-off frequencies of, for example, a band-pass filter, a communication channel, or a signal spectrum.

In terms of **analog signal**, bandwidth of the channel is the **range of frequencies** that the channel can carry. In terms of **digital signal**, bandwidth of the channel is the **maximum bit rate** supported by the channel. i.e. number of bits per second that the channel can carry.

IEEE Ethernet standards

Ethernet is defined in a number of IEEE (Institute of Electrical and Electronics Engineers) 802.3 standards. These standards define the physical and data-link layer specifications for Ethernet. The most important 802.3 standards are:

10Base-T (IEEE 802.3) – 10 Mbps with category 3 unshielded twisted pair (UTP) wiring, up to 100 meters long.

100Base-TX (IEEE 802.3u) – known as Fast Ethernet, uses category 5, 5E, or 6 UTP wiring, up to 100 meters long.

100Base-FX (IEEE 802.3u) – a version of Fast Ethernet that uses multi-mode optical fiber. Up to 412 meters long.

1000Base-CX (IEEE 802.3z) – uses copper twisted-pair cabling. Up to 25 meters long.

1000Base-T (IEEE 802.3ab) – Gigabit Ethernet that uses Category 5 UTP wiring. Up to 100 meters long.

1000Base-SX (IEEE 802.3z) – 1 Gigabit Ethernet running over multimode fibre-optic cable.

1000Base-LX (IEEE 802.3z) – 1 Gigabit Ethernet running over single-mode fibre.

10GBase-T (802.3.an) – 10 Gbps connections over category 5e, 6, and 7 UTP cables.

First number in the name of the standard represents the speed of the network in megabits per second. The word base refers to baseband, meaning that the signals are transmitted without modulation. The last part of the standard name refers to the cabling used to carry signals. For example, 1000Base-T means that the speed of the network is up to 1000 Mbps, baseband signaling is used, and the twisted-pair cabling will be used (T stands for twisted-pair).

Thank You