

1. Communications Basics

Q.1 Define data communication. Explain its components.

~~What is data communication? Explain its components.~~

Data communication :-

Data communication are the exchange of data between two devices via some form of transmission medium such as a wire or cable.

(any) components involved in data communication -
Message :-

This is most useful asset of a data communication system.

- The message simply refers to data or piece of information which is to be communicated.

- A message could be in many form, it may be in form of a text file, an audio file, a video file etc.

2] Sender :-

To transfer message from source to destination,

someone must be there who will play role of a source.

- sender plays part of a source in data communication system.

- It is simple a device that sends data message.

- The device could be in form of a computer,

mobile, telephone, laptop, video camera, or a workstation etc.

3] Receiver :-

- It is destination where finally message sent by source has arrived.

- It is a device that receives message.

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the same as sender, receiver can also be in form of computer, telephone, mobile, workstation etc.

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4) Transmission medium :-

It is physical path by which data or message travels from sender to receiver.

- Transmission medium could be guided (with wires) or unguided (Without wires). for example, Twisted pair cable, fiber optic cable, radio waves, microwaves etc.

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5) Protocol :-

The protocol is a set of rules that govern data communication.

- If two different devices are connected but there is no protocol among them, there would

not be any kind of communication between those two devices.

- Thus the protocol is necessary for data communication to take place.

Q.2 Define data flow? Explain its types.

→ Data flow :- means two devices communicate

Data flow means two devices communicate with each other by sending or receiving data.

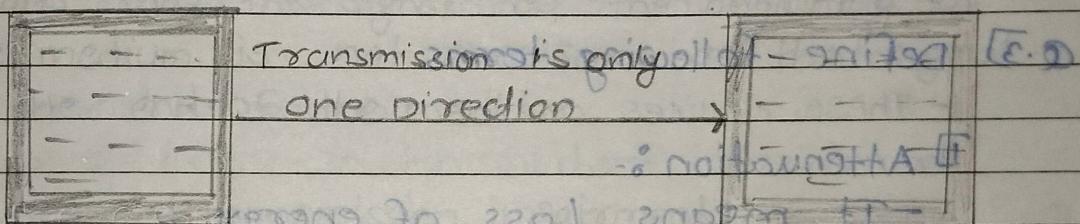
Q.3 Explain the difference between unidirectional and bidirectional data flow.

• In unidirectional data flow, data can only flow in one direction.

Types of Data flow :-

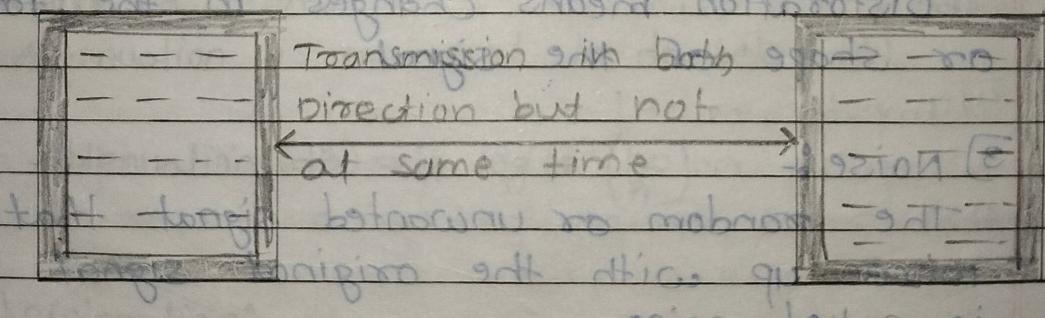
1] Simplex :-

- In simplex, communication is unidirectional only one device sends data and other receives it.
- Example :- CPU to monitor.



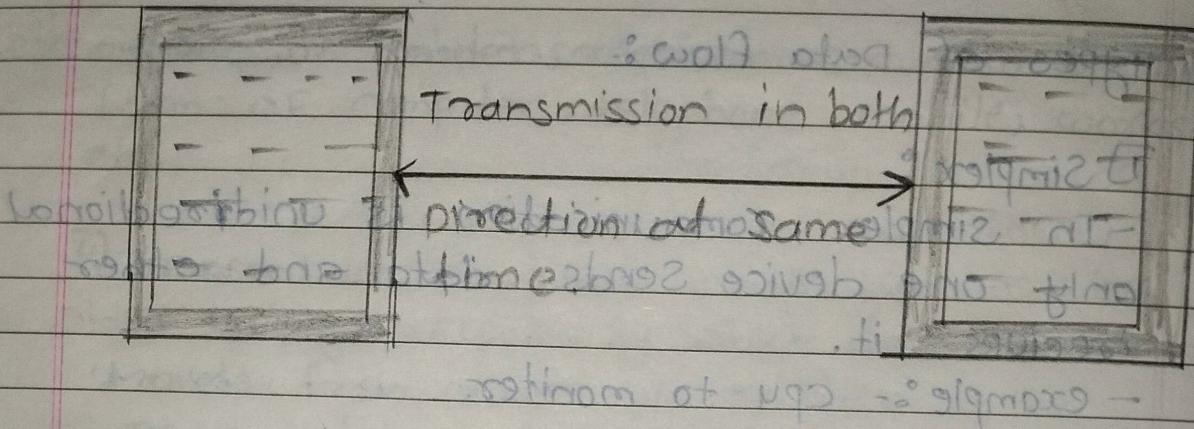
2] Half-duplex :-

- In half duplex, both stations can send and receive data but not at same time.
- Example :- Walkie-talkie.



3] Full-duplex :-

- In full duplex both stations can send and receive data at same time.
- Example :- mobile phones.



a. Define following terms

1) Attenuation :-

- It means loss of energy.
- The strength of signal decreases with increasing distance which causes loss of energy in overcoming resistance of medium. This is also known as attenuated signal.

2) Distortion :-

Distortion means changes in the form or shape of the signal.

3) Noise :-

The random or unwanted signal that mixes up with the original signal is called noise.

4) Analog signals :-

An analog signal has infinitely many levels of intensity over a period of time.

Q.4) Illustrate transmission impairments and Explain its causes - ~~with longish derivations~~ ~~in short~~
 → ~~Transmission~~ ~~Derivations~~ ~~in~~ ~~longish~~ ~~length~~

⇒ Transmission Impairment :- ~~in~~ ~~longish~~ ~~length~~
 - In communication system, analog signals travel through transmission media, which tends to deteriorate the quality of analog signal, which means that the signal at the beginning of the medium is not the same as the signal at the end of the medium.

Causes of transmission impairments :-

1) Attenuation :- ~~in~~ ~~longish~~ ~~length~~

- It means loss of energy.
 - The strength of signal decreases with increasing distance which causes loss of energy in ~~over~~ coming resistance of medium. This is also known as attenuated signal.
 - Attenuation is measured in decibels (dB).

$$\text{Equation for Attenuation (dB)} = 10 \log_{10} \left(\frac{P_2}{P_1} \right)$$

2) Distortion:-

- It means changes in the form or shape of the signal.
- Each frequency component has its own propagation speed travelling through a medium.
- They have different phase at receiver end from what they had at sender's end.

3) Noise :-

- The random or unwanted signal that mixes up with the original signal is called noise.

- There are several types of noise such as induced noise, cross talk noise, thermal noise etc.

1) Induced noise :-

- Induced noise comes from sources such as long motors and appliances.

- These devices act as sending antenna and transmission medium act as receiving antenna.

2) Thermal noise :-

- Thermal noise is movement of electrons in wire which creates an extra signal.

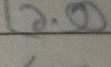
3) Crosstalk noise :-

- Crosstalk noise is when one wire affects the other wire.

4) Impulse noise :-

- Impulse noise is a signal with high energy that comes from lightning or power lines.

Q.5 Define Protocol and standards.



Protocol :-

- In computer networks, communication occurs between entities in different systems.

* - A protocol ~~def~~ is a set of rules that govern data communications.

- A Protocol defines What is communicated, how it is communicated and when it is communicated.

- The key elements of a Protocol :-

1] Syntax

2] Semantics

3] timing.

Standards :-

- Standards are essential in creating and maintaining an open and competitive market for equipment manufacturers and in guaranteeing national and international interoperability of data and telecommunications technology and processes.

- Data communication standards fall into two categories :-

1] de facto (meaning "by fact" or "by convention")

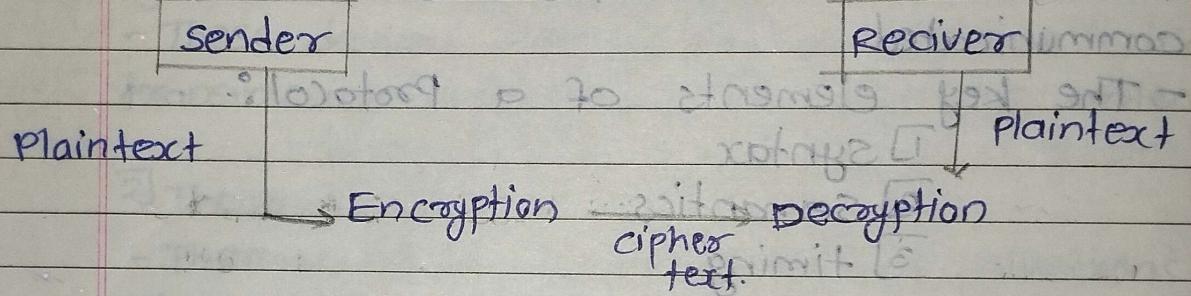
2] de jure (meaning "by law" or "by regulation")

Q.6] State cryptography? Explain its categories.



Cryptography :-

Cryptography is a method of protecting information and communications through the use of codes so that only those for whom the information is intended can read it.

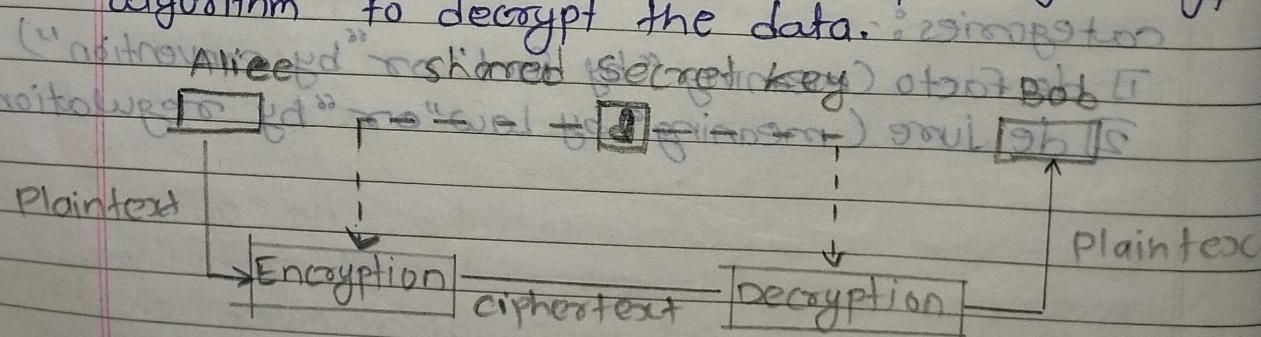


Cryptography categories:-

1] Symmetric - key Cryptography :-

- In symmetric - key cryptography, the same key is used by both parties.

- The sender uses this key and an encryption algorithm to encrypt data; the receiver uses the same key and the corresponding decryption algorithm to decrypt the data.



2] Asymmetric-key cryptography :-

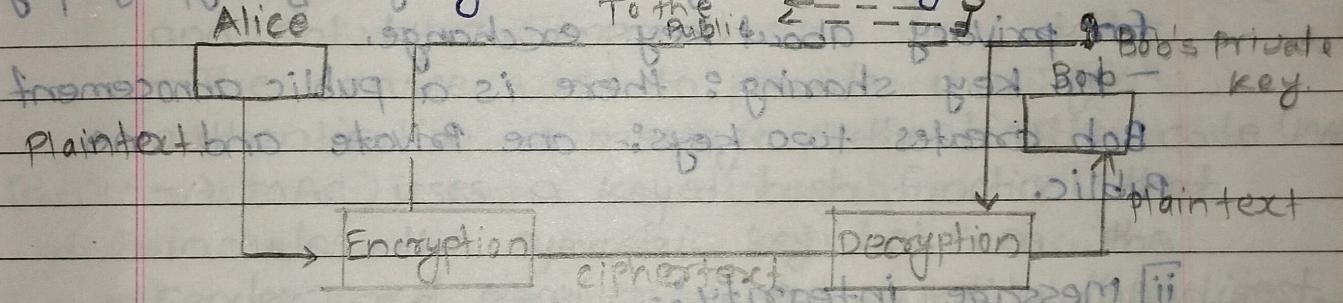
- In asymmetric or Public-key cryptography, there are two keys : a private key and a public key.

- The private key is kept by the receiver.

- The public key is announced to the public.

- In public-key encryption/decryption, the Public key that is used for encryption is different from the private key that is used for decryption.

- The public key is available to the public; the private key is available only to an individual.



Q.7] Describe i] message confidentiality.

ii] message Integrity.

⇒ i] message confidentiality :-

- It means that the content of a message when transmitted across a network must remain confidential; i.e. only the intended receiver and no one else should be able to read the message.

- Confidentiality with symmetric-key cryptography
- To be able to use symmetric-key cryptography we need to find a solution to the key sharing.

This can be done using a session key.

A session key is one that is used only for the duration of one session.

The session key itself is exchanged using asymmetric key cryptography.

- Confidentiality with Asymmetric-key cryptography

The problem is Symmetric-key cryptography for privacy about key exchange.

No key sharing: there is a public announcement Bob creates two keys: one private and one public.

ii] Message integrity:-

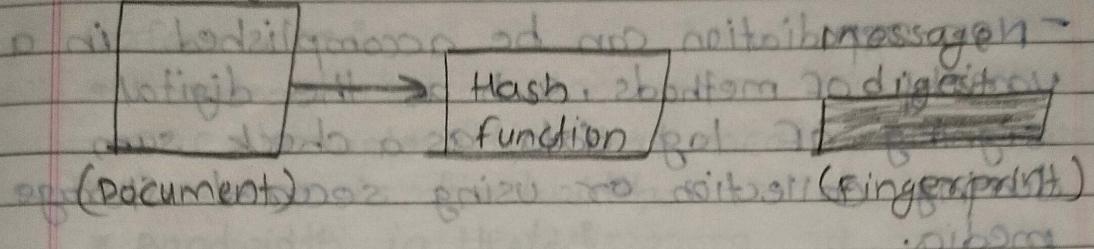
Message integrity describes the concept of ensuring that data has not been modified in transit.

Message integrity means that a message has not been tampered with or altered.

The most common approach is to use a hash function that combines all the bytes in the message with a secret key and produces a message digest that is difficult to reverse.

To preserve the integrity of a document, both the document and the fingerprint are needed.

message



- c.8] Describe i) Message Authentication ii) message nonrepudiation



i) **Message Authentication**: - message authentication ensures that the message has been sent by a genuine identity and not by an imposter.

- The service used to provide message authentication is message Authentication code (mac)
- A MAC uses a keyed hash function that includes the symmetric key between the sender and receiver when creating the digest.

ii) **message nonrepudiation** :-

- Non-repudiation ensures that no party can deny that it sent or received a message via encryption and/or digital signatures or approved some information.
- It also cannot deny the authenticity of its signature on a document.
- Non-repudiation uses cryptography, similar to digital signatures and comprises authentication auditing and logging services.

- Non-repudiation can be accomplished in a variety of methods, such as the digital signing of log data as a check sum during collection, or using secured storage media.

Q.9) summarize data rate limits and performance.
 →

Data rate Limits:-

- A very important consideration in data communication is how fast we can send data, in bits per second, over a channel.

- Data rate depends on three factors:-

1) The bandwidth available

2) The level of the signals

3) The quality of the channel (the level of noise)

- Two theoretical formulas were developed to calculate the data rate; one by Nyquist for a noiseless channel, another by Shannon for a noisy channel.

• Noiseless channel : Nyquist Bit Rate

$$\text{Bit Rate} = 2 \times \text{bandwidth} \times \log_2 L$$

• Noisy channel : Shannon capacity.

$$\text{Capacity} = \text{bandwidth} \times \log_2 (1 + \text{SNR})$$

Performance :-

• Bandwidth :-

- One characteristic that measures network performance is bandwidth.

* Bandwidth in Hertz :-

- Bandwidth in hertz is the range of frequencies contained in a composite signal or the range of frequencies a channel can pass.

* Bandwidth in Bits Per seconds :-

- Bandwidth in bits per second refers to the speed of bit transmission in a channel or link.

• Throughput :-

- The throughput is a measure of how fast we can actually send data through a network.

• Latency (delay) :-

- The latency or delay defines how long it takes for an entire message to completely arrive at destination from the time the first bit is sent out from the source.

• Transmission time :-

- The first bit may take a time equal to the propagation time to reach its destination; the last bit also may take the same amount of time.

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medium of travel and most

• Queuing time :-

- The third component in latency is the queuing time, the time needed for each intermediate or end device to hold the message before it can be processed.

• Jitter :-

- The time delay between two packets is called Jitter.

Q16) Define following terms of QoS layer :-

1) Latency :-

The Latency or delay defines how long it takes for an entire message to completely arrive at the destination from the time the first bit is sent out from the source.

$\text{Latency} = \text{Propagation time} + \text{Transmission time}$
 $+ \text{Queuing time} + \text{Processing delay}$

2) Propagation Time :-

Propagation time measures the time required for a bit to travel from the source to the destination.

3) Propagation speed :-

Propagation speed is the amount of time it takes for one particular signal to get from one point to another.

4] Composite signal :-

A composite signal is a combination of simple sine waves with different frequencies, amplitude, and phases.

Q.11 Define following terms

1] Digital signals :-

Digital signals can have only limited number of defined values.

2] Throughput :-

The throughput is a measure of how fast we can actually send data through a network.

3] Signal to noise ratio :-

Signal to noise ratio is a measure of the strength of the desired signal relative to background noise.

$$SNR = \text{Avg signal Power} / \text{Avg noise power}$$

4] Protocol :-

A Protocol is a set of rules that govern data communications.

- A protocol defines what is communicated, how it is communicated and when it is communicated.

5) Bandwidth :-

The maximum amount of data transmitted over an internet connection in a given amount of time.

Mbps

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