

National Academy of Science and Technology
Affiliated to Pokhara University

Assignment of Data
Communication



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Q) What are standard? Explain its types. Also explain the standard organization in data communication.

Standard are a set of rule that define how data is transmitted and received between device.

Its type are

① De facto standard

They are established by the market and are not backed by an formal organization

② De jure standard

They established by formal organization and are legally binding.

The standard organization in data communication are as follows

③ International Standard Organization (ISO)

It is an organization that is related to worldwide agreement on international standard in a variety of field such as education, communication broadcasting, food production and so on.

④ ITU-T (International Telecommunication Union - Telecommunication)

It is also international standard organization related to the united state that develops the standard for telecommunication such as frequencies, bandwidth different telecommunication equipment, etc.

④ IEEE (Institution of Electrical and Electronic Engineering)

It is the largest national professional group involve in developing standard for the telecommunication computation, electronic and electric engineering and all related branch of engineering

⑤ American National Standard Institution (ANSI)

It is a non-profit organization in the united state which only standardized education sector and related field. It is completely private organization

⑥ Nepal Telecommunication Authority (NTA)

It is an authority of Nepal government which is responsible for frequency distribution to the different service provider. It regularly maintain the services provided and if unauthorized activities are transmitted as shared. Under NTA different telecommunication service such as NTC, Ncell, smart cell and different FM station and so on.

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b. Define bit rate and baud rate? Explain with the scenario to show bit rate is not always equal to baud rate with suitable diagram and calculation

Bit rate is the number of bits transmitted per unit time.
Baud rate is the number of signal units transmitted per unit time.

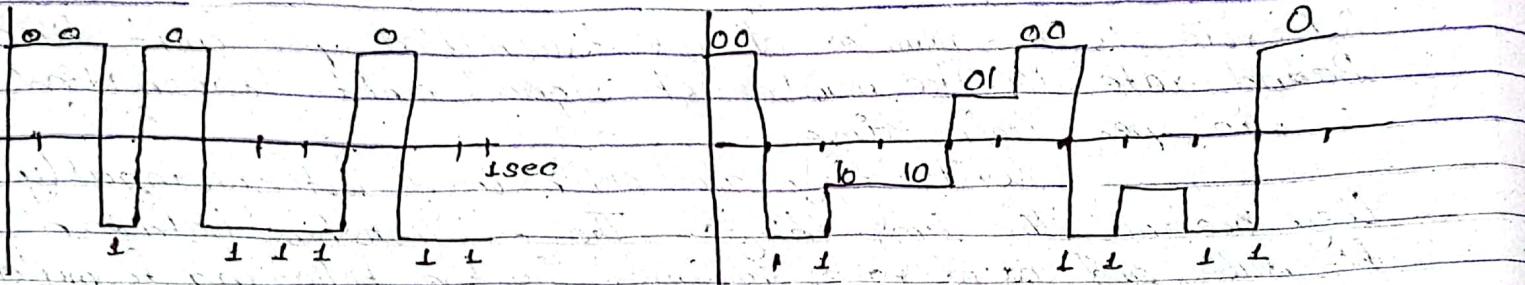
While they are often used interchangeably, they are not the same things. The relationship between bit rate and baud rate is given by the following formula:

Bit rate = Baud rate × No. of bits per signal unit
The number of bits per signal unit depend on the modulation scheme used. For example, in a binary scheme, each signal unit represent one bit. In QAM scheme, each signal unit represent two or more bits.

However in practice, the bit rate is often less than Nyquist rate. This is because the presence of noise and other impairment in the channel. The bit rate is limited by the Shannon capacity which is the maximum bit rate that can be transmitted over a noisy channel without error.

The bit rate is not always equal to the baud rate. In fact, the bit rate can be much less than baud rate if the number of bits per signal unit is greater than one. This is because the bit rate is limited by the bandwidth.

of the channel and presence of noise and other impairment.



Baud = 10

Bit rate = 10 bps

Baud = 101

Bit rate = 20 bps

For example, we have 1G QAM system with a baud rate of 1000 symbol per second and each symbol represent 4 bits.

$$\begin{aligned}\text{Bit rate} &= 4 \times 1000 \\ &= 4000 \text{ bit per second}\end{aligned}$$

In show that, the bit rate is four time the baud rate.

This scenario illustrate that the relationship between bit rate and baud rate depends on the modulation scheme and they are not always equal.

2a) Define Time Invariant System. Explain the following properties of system a) causality b) linearity c) stability d) memory

A system is said to be time invariant if the input and output characteristics does not vary with time.

c) Causality

A system is said to be causal if the output at any time depends only on the value of input at the present and past time

A system is said to be non-causal if the output at any time does not depend on the value of the input at the present and past time but also on the value of future time

b) linearity

A system is said to be linear if superposition principle applies to that system i.e. a linear system may be defined as a system whose response to the sum of weighted input is same as the sum of weighted output

Eg: filter, communication channel, etc

For non-linear system, the principle of superposition does not satisfy in time.

② Stability

A signal having finite magnitude value called as bounded signal like $|g(t)| \leq m$.

A system is called stable if different bounded input result in Bounded output (BIBO) then the output of such system does not divert or does not grow unnecessarily large.

For a bounded input if the output is unbounded in the system then it is said to be unstable.

③ Memory

A system is said to be a memory if its o/p at any time depend upon the i/p at the same time and i/p has previous or past time.

A system is said to be memory less if its o/p at a given time depends only on the i/p at the same time.

2.b) i) Explain deterministic and random signal with example. Justify whether unit step signal is energy signal or power signal

The deterministic signal is one whose future value can be predicated from the knowledge of present and past value. A signal said to be deterministic if it can be describe with out any uncertainty.

Example : Sine wave, music signal, square wave

The random signal is a signal that has uncertainty with respect to its value at any instant of time. It is defined in probabilistic terms as there is no define value.

Example : Noise, thermal fluctuation, ECG signal

The unit step signal is power signal since when we calculate its power it comes to $1/2$ (i.e. Finite value) and when we calculate its energy, it comes out to infinity. If a signal has energy as infinite and power as a finite non-zero value then its power signal.

Mathematically

$$\text{Unit step signal, } u(t) = \begin{cases} 1 & \text{for } t \geq 0 \\ 0 & \text{for } t < 0 \end{cases}$$

$$\text{Energy} = \lim_{T \rightarrow \infty} \int_{-T}^T x^2(t) dt$$

$$= \int_0^T 1 dt$$

$$= \lim_{T \rightarrow \infty} [t]_0^T$$

$$= \lim_{T \rightarrow \infty} T$$

$$= \infty$$

$$\text{Power} = \lim_{T \rightarrow \infty} \frac{1}{2T} \int_0^T x^2(t) dt$$

$$= \lim_{T \rightarrow \infty} \frac{1}{2T} \times \infty$$

$$= \frac{1}{2\infty} \times \infty$$

$$= \frac{1}{2}$$

By this the unit step signal is a power signal

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3b. Compare and Contrast Frame relay, X-25 and ATM

X-25

- An older, low-capacity WAN technology with a maximum speed of 48 kbps. Typically used in dialup mode with point of sale card readers to validate transaction on a central computer.
- For these application, the low bandwidth and high latency are not concern and low cost makes X-25 affordable.
- Frame Relay has replaced X-25 at many service provider location.

Frame relay

- A layer 2 WAN protocol that typically offers data rate of 4 Mbps or higher.
- It provide permanent, shared, medium - bandwidth connectivity using virtual circuit that can carry both voice and data traffic.
- VCs are uniquely identified by a DICI, which ensure bidirectional communication from one DTE device to another.

ATM

- It is based on a cell-based architecture rather than a frame based architecture using fixed length cell of 53 byte.
- These small, fixed length cell are well suited for carrying delay-sensitive voice and video traffic.

Q. Why optical fiber is considered advantageous over other copper media? Explain. Also explain about different propagation techniques.

Optical fiber is considered advantageous over other copper media for following reason:

- Higher bandwidth: Fiber-optic cable can support dramatically higher bandwidth than other cable
- Less signal attenuation: Fiber optic transmission distance is greater than that of other guided media
- Immunity to electromagnetic interference: Electromagnetic noise cannot affect fiber-optic cables
- Resistance to corrosive material: Glass is more resistant to corrosive materials than copper
- Light weight: Fiber optic cable are much lighter than copper cables
- Greater immunity to tapping: Fiber optic cables are more immune to tapping than copper cable.

The different types of propagation techniques

① Groundwave propagation

When the radiowave from the transmitting antenna propagate along the surface of the earth so as to reach the receiving the antenna, the wave

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propagation is called ground wave propagation.

② Sky-wave propagation

It is a type of propagation in which the radiowave reflected or refracted back towards earth from the ionosphere frequency from 2 to 30 MHz can be propagated.

③ Line of Sight propagation

It is a type of propagation in which waves travel in a direct path from the source to the receiver. The frequency above 30 MHz can be propagated.

4(b) A bit stream is 10011101 is transmitted using the standard CRC method. The generator polynomial is $x^3 + 1$. Derive the actual bits string transmitted. Show that the error is detected if any one bit in the received bit stream is inverted.

Given

$$M = 10011101$$

$$\text{Generator polynomial} = x^3 + 1 = x^3 + 0 \cdot x^2 + 0 \cdot x^1 + 1 \cdot x^0$$

$$= 1001$$

$$\begin{array}{r}
 & 10001100 \\
 1001 \overline{)10011101001} \\
 \oplus 1001 \\
 \hline
 0001 \\
 \oplus 0000 \\
 \hline
 0011 \\
 \oplus 0000 \\
 \hline
 00110 \\
 \oplus 0000 \\
 \hline
 1101 \\
 \oplus 1001 \\
 \hline
 01000 \\
 \oplus 1001 \\
 \hline
 0001 \\
 \oplus 0000 \\
 \hline
 00100 \\
 \oplus 0000 \\
 \hline
 100
 \end{array}$$

Now $M = 100011101100$

$$\begin{array}{r} 1000011101100 \\ \hline 1001 | 10011101100 \\ \underline{1001} \\ 00001 \\ \underline{0000} \\ 0011 \\ \underline{0000} \\ 0110 \\ \underline{0000} \\ 1101 \\ \underline{1001} \\ 01001 \\ \underline{1001} \\ 00000 \\ \underline{0000} \\ 0000 \end{array}$$

Thus the actual bit string is transmitted.

If one bit in the received bit stream is inverted then

$$M = 11011101$$

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$$\begin{array}{r} \underline{101000101} \\ 1001 | \underline{11011101000} \\ \underline{1001} \\ 01001 \\ \underline{10001} \\ 00001 \\ \underline{0000} \\ 0010 \\ \underline{0000} \\ 0101 \\ \underline{0000} \\ 1010 \\ \underline{1001} \\ 00110 \\ \underline{00000} \\ 1100 \\ \underline{1001} \\ 0101 \end{array}$$

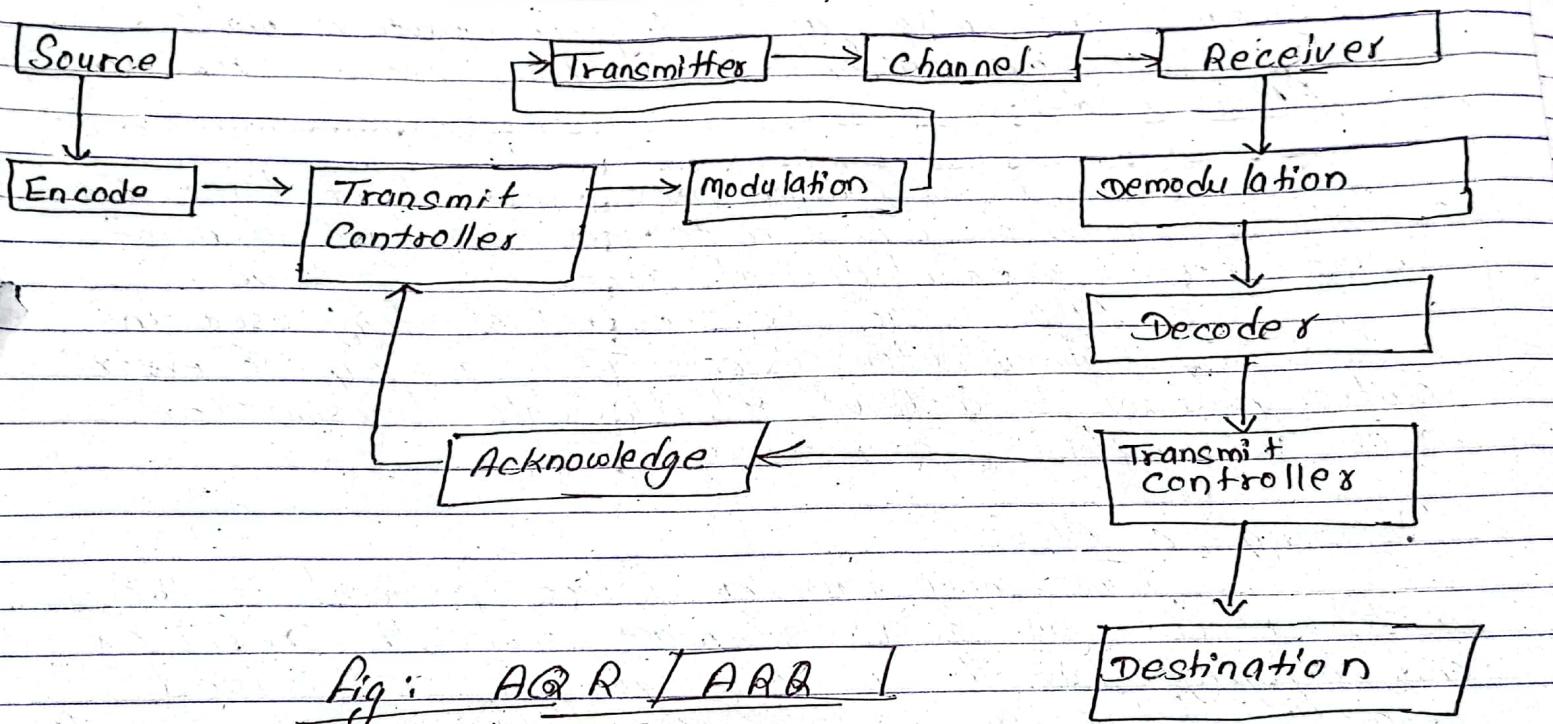
5a) Define Flow control as a layered protocol model.
Explain the mechanism of a Flow control for an ARQ model.

Flow control is a set of procedures that tells the sender how much data it can transmit before it must wait for an acknowledgment from the receiver.

ARQ is an error control strategy used in a two way communication system. It is a group of error control protocol to achieve reliable data transmission over an unreliable source or service.

Working of ARQ

The main function of these protocol is the sender receives an acknowledgment from the receiver end implying that the frame or packet is received correctly before a timeout occurs. Timeout is a specific time period within which the acknowledgment has to sent by the receiver to the sender. If a timeout occurs; the sender does not receive the acknowledgment before the specific time, it is implied that the frame or packet has been corrupt or lost during the transmission. According the sender retransmit the packet and these protocol ensure that the process is repeated until the correct packet is transmitted.



5.b) Compare and Contrast between Virtual Circuit Network and Datagram network.

Criteria	Virtual Circuit Network	Datagram network
Connection Establishment	Prior to data transmission a connection is established between sender and receiver.	No connection setup is required.
Routing	Routing decision are made once during connection setup and remain fixed throughout the duration of connection	Routing decision are made independently for each packet and can vary based on network condition
Flow control	Uses explicit flow control where sender adjusts its rate of transmission based on feedback from receiver	Uses implicit flow control, where sender assume a certain level of available bandwidth and sends packet accordingly
Congestion Control	Uses end to end congestion control where the sender adjust its rate of transmission based on feedback from network	Uses network assisted congestion control where router monitors network condition and may drop packet or send congestion signal to the sender

Error Control	Provide reliable delivery of packet by detecting and retransmitting lost or corrupted signal	Provide unreliable delivery of packet and does not guarantee delivery or correctness.
Overhead	Required less overhead per packet because connection setup and state maintenance are done only once	Requires more overhead per packet because each packet contains information about its destination address and other routing information
Example	ATM, Frame Relay	IP (Internet Protocol)

Q) Differentiate between encoding and modulation?
Explain differential PSK with an example

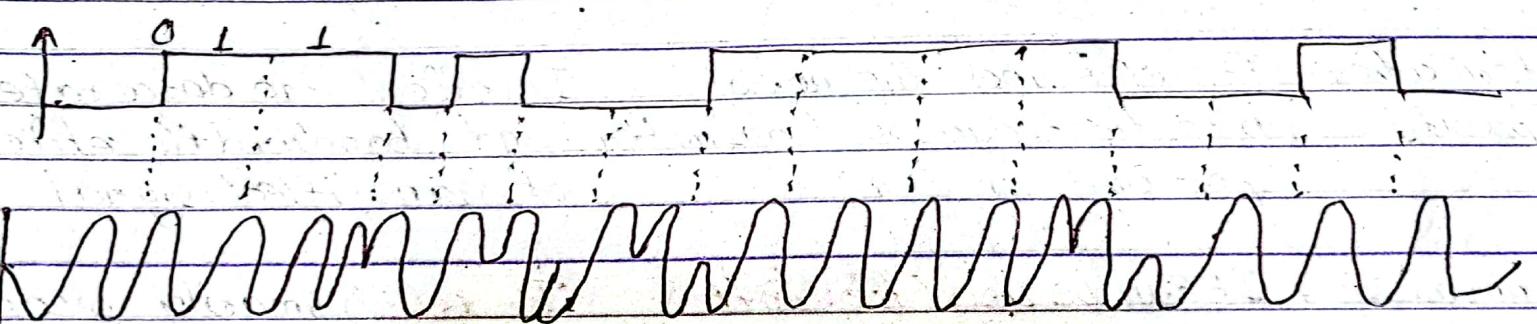
Attribute	Encoding	Modulation
Definition	The process of converting information into a specific format for transmission or storage	The process of modifying a carrier signal to encode information for transmission
Types	Unipolar, Polar, Bipolar, Manchester, Differential Manchester, etc	Amplitude Modulation Frequency Modulation Phase Modulation
Signal Representation	Represent information as digital or analog signal	It represent information by varying characteristics of carrier signal
Information Capacity	It determines the no. of bits that can be transmitted per unit of time	It affect the data rate and bandwidth efficiency of transmitted signal
Transmission Medium	It can be used for both wired and wireless communication	It is primarily used for wireless communication
Error Detection & Correction	Encoding technique can include error detection and correction.	Modulation technique cannot include error detection and correction

It is the type of phase shift keying digital modulation an alternative form of two-level PSK is differential PSK.

In this schema a binary '0' is represented by sending a signal burst of the same phase as the previous signal burst sent.

In differential PSK, the phase of the carrier is varied to represent two or more different signal elements. Both peak amplitude and frequency remain constant as the phase change.

In DPSK, the bits are not represented by a certain phase but by a change of phase. When a binary one is sent the phase is unchanged from the previous bits and binary zero is represented by a change of phase.



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b) How modulation help to reduce the size of antenna illustrate in brief. Explain about amplitude, frequency and phase modulation

⇒ We know that the height of antenna is equal to the quarter of wavelength of the frequency used

$$\text{i.e. } H = \frac{1}{4} = \frac{1}{4} \frac{c}{f}$$

Let us consider a voice signal 2 kHz is used to transmit for this the height of antenna is given by -

$$H = \frac{1}{4} \frac{c}{f} = \frac{1}{4} \times \frac{3 \times 10^8}{2 \times 10^3 \text{ Hz}} = 37500 \text{ m}$$

$$= 37.5 \text{ km (not in practice)}$$

Using modulation technique i.e. adding carrier signal of 5 MHz with voice signal, the height become

$$f = 2 \text{ kHz} + 5 \text{ MHz} \\ = 5.002 \text{ MHz}$$

Now,

$$H = \frac{1}{4} \times \frac{3 \times 10^8}{5.002 \times 10^6} = 14.99 \approx 15 \text{ m}$$

(which is practical)

In this way modulation help to reduce the size of antenna.

① Amplitude modulation

When the amplitude of high frequency carrier wave is changed in accordance with the intensity of signal it is known as amplitude modulation. In AM the amplitude of carrier wave is changed but frequency and phase remain constant.

② Frequency Modulation

When the frequency of the carrier wave is changed in accordance with the intensity of the signal it is known as frequency modulation. In FM, frequency of carrier wave is changed in accordance with modulating signal. However amplitude and phase remain same of the carrier signal.

③ Phase Modulation

When the phase of the carrier wave is changed in accordance with the intensity of the signal it is called phase modulation. In this case amplitude and frequency remain constant.

F. Write Short notes

(a) Synchronous and asynchronous Communication

Synchronous Communication

In this communication, data is sent in form of block or frame

They are fast

They are costly

The time interval of transmission is constant

present

There is no gap[^] between the data

Efficient use of transmission lines is done in synchronous communication

Example : Chat Room

Telephonic Conversation

Video conferencing

Asynchronous Communication

In this communication, data is sent in form of bytes or character

They are slow

They are economical

The time interval of transmission is not constant it is random

There is gap present before data

In this communication, the transmission line remains empty during a gap in character transmission.

Example Email

Formus

Letters

② TCP /IP vs OSI Model

OSI Model	TCP/IP
OSI stand for Open System Interconnection	TCP/IP stand for Transmission Control Protocol / Internet Protocol
It has 7 layer	It has 4 layer
It is less in usage	It is mostly used
It is vertically approach	It is horizontally approach
Delivery of the package is guaranteed in OSI model	Delivery of the package is not guaranteed in TCP/IP model
Replacement of tool and change can easily be done in this model	Replacing the tool is not easy as it is in OSI model
It is less reliable than TCP/IP model	It is more reliable than OSI model