

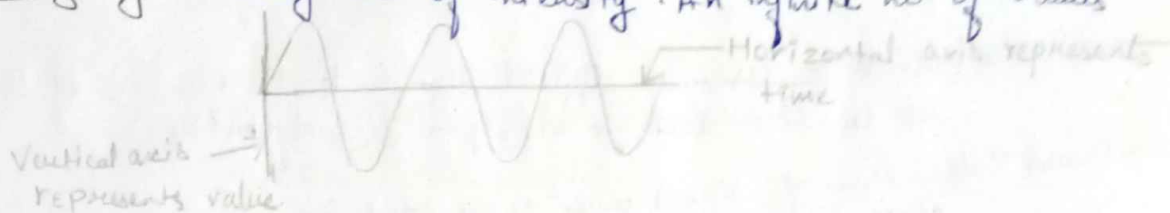
CH-2:- DATA COMMUNICATION

Analog Data Vs Digital data :-

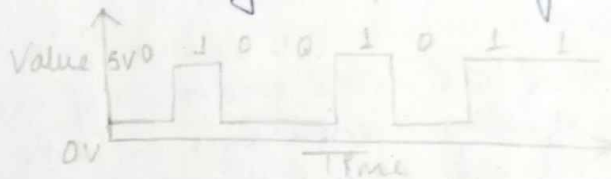
Analog Data:- Info. that is continuous. ex:- a wall clock

Digital Data:- take on discrete values. ex:- a digital clock

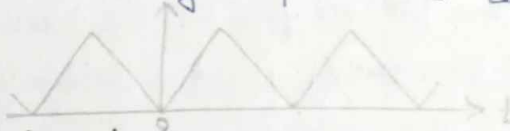
⇒ Analog Signal:- Many level of intensity. An infinite no. of values



⇒ Digital Signal:- limited no. of defined values. Although each value can be any no., it is often as simple as 1 & 0.



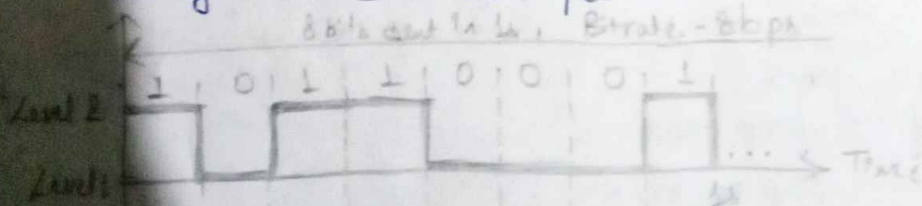
⇒ Periodic Signal:- Completes a pattern & repeats that pattern over subsequent identical periods. The completion of one full cycle pattern is called a cycle.



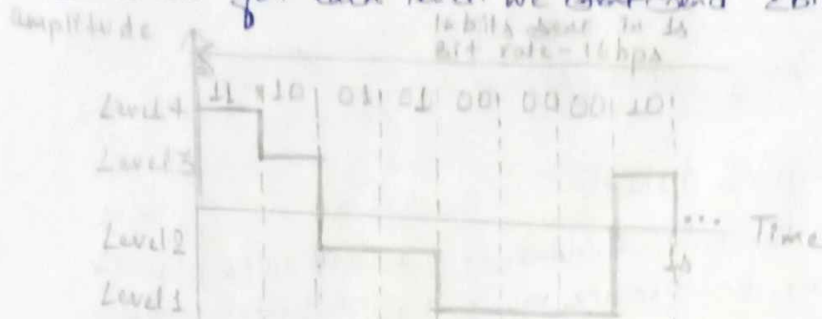
⇒ Non-Periodic Signal:- Changes without exhibiting a pattern. Any continuous-time signal which is not periodic is called a non-periodic.



Digital Signals:- 1 can be encoded as a +ve voltage & 0 as zero voltage. We send 1 bit per level.



It can have more than 2 levels. In this case we can send more than 1 bit for each level. We don't send 2 bit per level.



→ Bit rate: Used to describe digital signals. It is the no. of bits sent in 1s, expressed in bits per second (bps).

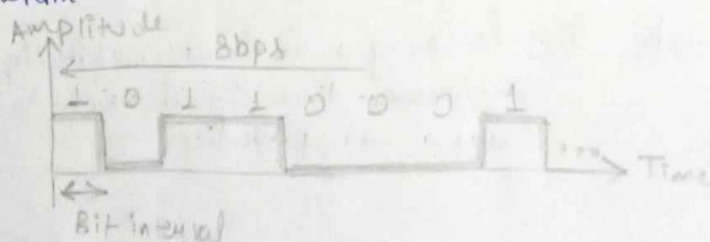
→ Baud Rate: No. of signal unit transmitted per second. Thus, Baud Rate is always less than or equal to bit rate. It is no. of symbols per second.

Bit Rate	Baud Rate
<ul style="list-style-type: none"> Per second travel no. of bits. emphasize on comp. efficiency. Not used to decide the requirement of bandwidth for transmission of signal. 	<ul style="list-style-type: none"> Per second no. of changes in signal emphasizes on data transmission Used to decide the requirements of bandwidth for transmission of signal

→ Bit length: Dist. one bit occupies on the transmission medium.

Bit length = Propagation speed \times bit duration
or Bit width

→ Bit interval:



Transmission Mode:-

• Mechanism of transferring of data b/w 2 devices connected over a network. Also called Comm'n Mode.

• These modes ~~direct~~ direct the direction of flow of info.

1) Simplex Mode

2) Half-Duplex Mode

3) Full-Duplex Mode

i) Simplex Mode:- Data can be sent only in one direction. Unidirectional
We cannot send the message back to the sender

Example:- Keyboard \rightarrow CPU \rightarrow Monitor

Comp. to Printer or Radio & TV transmission

ii) Half-Duplex Mode:- Data can be transmitted in both directions on a signal carrier, but not at the same time.

E.g:- Walkie-talkie

direction of data 1
Direction of data 2

iii) Full-Duplex Mode:- We can send data in both the direction as it is ~~bidirectional~~ bidirectional at the same time.

E.g:- telephone network

Performance Metrics:-

Network performance can be affected by several different factors. It is imp. for companies to know which network

Performance metrics are imp. to examine

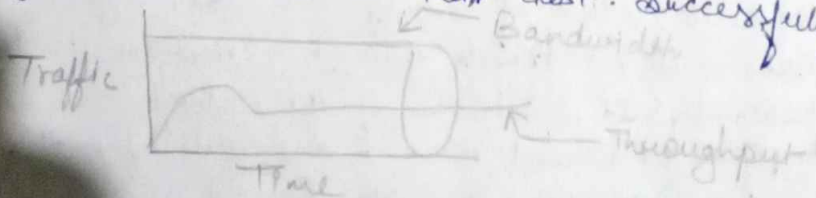
However, depending on the specific issues that plague your network, not every metric is going to be imp. for you to look at

Despite this, there are some metrics that are essential for any business to consider.

⇒ 7 Essential Network Performance Metrics:-

i) Bandwidth Usage:- How much capacity of the network we are using. It could be inbound bandwidth or outbound bandwidth. Larger the bandwidth, the more transmission of data.

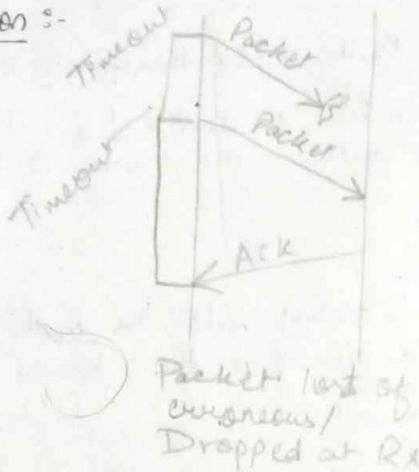
ii) Throughput:- How much data can be transferred from source to dest. within a given timeframe. It measures how many packets arrive at their dest. successfully



iii) Latency:- How long it takes to send data from one point on it to another.
The lower a network's latency, the faster it is. It is measured in milliseconds

iv) Packet Loss :- Fail to reach their dest. It is either caused by errors in data transmission, typically across wireless N/w or N/w congestion. Lessen the packet loss, the better is the n/w

v) Retransmission :-



When a packet gets transmitted as response for the packet which is Ack has to reach within a stipulated time period. If the response doesn't arrive within that time period. The packet is treated to be lost & is retransmitted.

vi) N/w Availability :- The uptime for the n/w. For a accurate & efficient n/w, the n/w availability should be high

$$\text{n/w availability} = \frac{\text{Uptime}}{\text{Total time (Uptime + downtime)}}$$

vii) Connectivity :- The connected n/w is the only the n/w which is useful.

Transmission Impairments :-

Signals travel through transmission media which are not perfect.

The imperfection causes signal impairment. This means that the signal at the beginning of the medium is not the same as " " " " end " " " " . What is sent is not what is received.

Reasons for Impairments :-

i) Attenuation :- loss of energy \rightarrow weaker signal.

When a signal travels through a medium it loses energy overcoming the resistance of the medium.

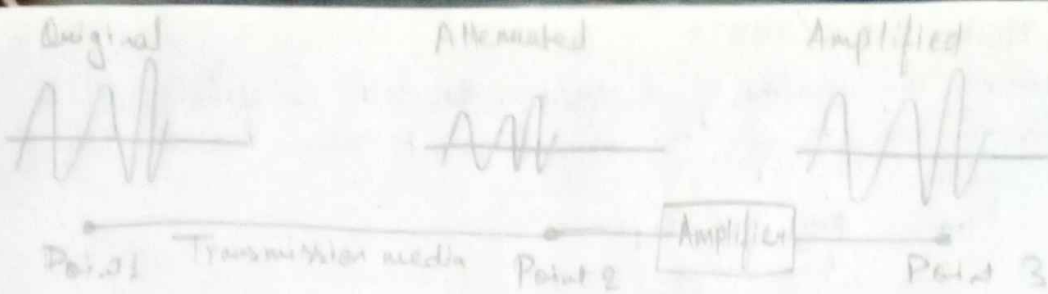
Amplifiers are used to compensate for this loss of energy by amplifying the signal.

To measure the loss or gain of energy the unit "decibel" is used.

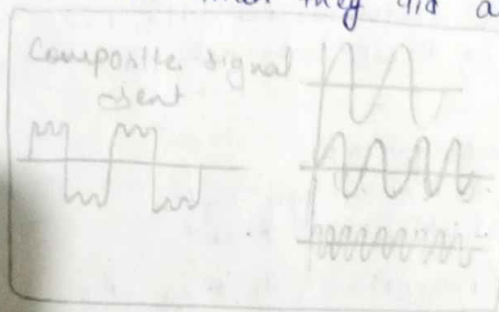
$$dB = 10 \log_{10} \frac{P_2}{P_1}$$

where, P_1 - input signal

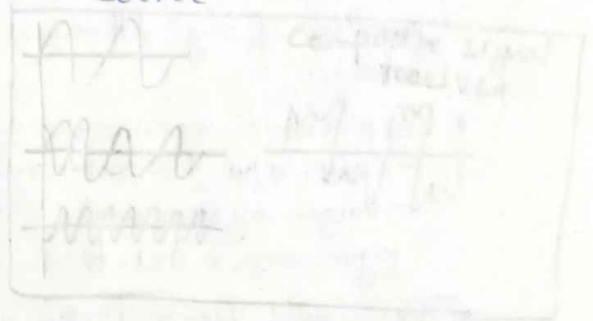
P_2 - output signal



ii) Distortion:- Signal changes its form or shape. It occurs in composite signals. Each frequency component has its own propagation speed travelling through a medium. The diff. components therefore arrive with diff. delays at the receiver. That means that the signals have diff. phases at the receiver than they did at the source.



At the sender



At the receiver

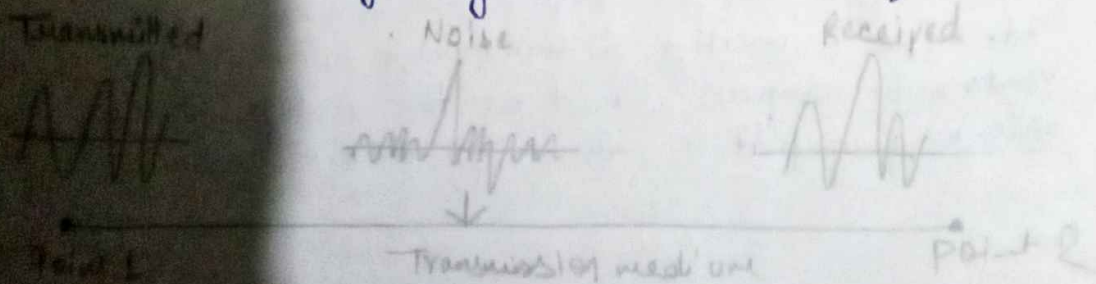
iii) Noise:-

Thermal noise:- random motion of e^- in a wire which creates an extra signal not originally sent by the transmitter.

Induced noise:- comes from sources such as motors & appliances. These devices act as a sending antenna, & the transmission medium acts as the receiving antenna.

Cross talk:- is the effect of one wire on the other. One wire acts as a sending antenna & the other as the receiving antenna.

Impulse noise:- is a spike (a signal with high energy in a very short time) that comes from power lines, lightning etc.



Signal to Noise Ratio (SNR):-

- To measure the quality of a system the SNR is often used. It indicates the strength of the signal w.r.t the noise power in the system.

$$\text{SNR} = \frac{\text{Avg. signal power}}{\text{Avg. noise power}}$$

- It is usually given in dB & referred to as SNR_{dB}
- A high SNR means the signal is less corrupted by noise

Protocols:-

- An established set of rules that determine how data is transmitted b/w diff. devices in the same n/w.
- It allows connected devices to communicate with each other, regardless of any differences in their internal processes, structure or design.
- Cooperative action is necessary.
 - Comp. n/w is not only to exchange bytes.
 - huge system with several utilities & funcn.
 - e.g:- error detection ; encryption ; Routing etc
- There must be mutually acceptable conventions & rules about the content, timing & underlying mechanisms.
Those conventions & associated roles are referred as "PROTOCOLS".

⇒ Protocol Architecture:-

- Task of data transfer is broken up into some modules.
 - Why?
 - How do these modules interact?

Ex:- File transfer could use three modules:-

- File transfer applⁿ
- Commⁿ service module
- N/w access module.

⇒ Network Std.:-

Define the rule for data commⁿ that are needed for interoperability of networking technologies & processes.

Std. helps in creating & maintaining open markets & allow diff. vendors to compete based on the quality of their products while being compatible with existing market products.

Types:-

i) De facto:- followed without any formula plan or approval by any org. They have come into existence due to traditions or facts.
e.g:- HTTP

ii) De jure:- Have been adopted through legislation by any officially recognized std. org.
Most of the comm/n std. that are used today are de jure std.
e.g:- OSI Model

→ Std. Org.:-

- International Std Standards Organization (ISO)
- " Telecommunication Union (ITU)
- Institute of Electronics and Electrical Engineers (IEEE)
- American National Standards Institute (ANSI)
- International Research Task Force (IRTF)
- Electronic Industries Association (EIA)
- World Wide Web Consortium (W3C)

i) ISO:- an international std.- setting body composed of representatives from various national std. org.

- Founded on Feb 23, 1947, the org. promulgates worldwide Proprietary Industrial & commercial std. It has it's headquarters in Geneva, Switzerland.
- It is a non-governmental org., its ability to set std. that often-become law, either through treaties or national std., makes it more powerful than most non-governmental org.
- It acts as a consortium with strong links to govt.
- Main products are the International Std.
- Also publishes Technical reports, Technical Specification, Publicly Available Specification, Technical Corrigenda & Guides.

ii) ITU:- Specialized agency of the UN which is responsible for info & comm/n technologies.

- Coordinates the shared global use of the radio spectrum, promotes international cooperation in assigning satellite orbits, works to improve telecomm/n infrastructure in the developing world & establishes worldwide std.
- Also organizes worldwide & regional exhibitions & forums, such as ITU TELECOM WORLD, bringing together representatives of govt. & the telecomm/n & ICT industry to exchange ideas, knowledge & tech tech.

- It is active in areas including broadband Internet, latest-generation wireless tech., aeronautical & maritime navigation, radio astronomy, satellite-based meteorology, convergence in fixed-mobile phone, Internet access, data, voice, TV broadcasting, & next-generation n/w.

iii) IEEE :- It's constitution defines the purpose of the org. as "scientific & educational, directed towards the advancement of the theory & practice of electrical, electronics, communⁿ & comp. engineering as well as computing science, the allied branches of engineering and the related arts & sciences."

- Not-for-Profit Corporation. Formed in 1963 by the merger of the Institute of Radio Engineers (IRE, founded 1912) & the American Institute of Electrical Engineers (AIEE, founded in 1884). It has more than 400,000 members in more than 160 countries, 45% outside the USA.
- Also a leading developer of industrial std. having developed over 900 active industry std. in a broad range of disciplines, including electric power, biomedical tech. & health care, info. tech., info. assurance, telecommunⁿ, consumer electronics, transportation, aerospace & nanotech.
- Develops & participates in educational activities such as accreditation of electrical engineering programs in institutes of higher learning. It serves as a major publisher of scientific journals & a conference organizer.
- One of the leading std.-making org. in the world. It performs its std. making & maintaining funcⁿ through the IEEE Std. Association (IEEE-SA).
- One of the more notable IEEE std. is the IEEE 802 LAN/MAN group of std. which includes the IEEE 802.3 Ethernet std. & the IEEE 802.11 wireless Networking std.

iv) ANSI :- Formed in 1918, when 5 engineering societies & 3 govt. agencies founded American Engineering Standards Committee (AESC).
 1928, the AESC became American Std. Association (ASA). In 1966, it was reorganized & became US of America Std. Institute (USASI).
 The present name was adopted in 1969.

- Also designates specific std. as American National Std. or ANSI, when the Institute determines that the std. were developed in an environment that is equitable, accessible & responsive to the requirements of various stakeholders.
- ANSI process involves:-
 - consensus by a group that is open to representatives from all interested parties
 - broad-based public review & comment on draft std.
 - consideration of & response to comment.

- Incorporation of submitted changes that meet the same consensus requirements into a draft std.
- availability of an appeal by a participant alleging that these principles were not respected during the std. - development process.

- v) IRTF:- promotes research of importance to the evolution of the Internet by creating focused, long-term research groups working on topics related to Internet protocols, appln, architecture & techn.
- It is composed of a no. of focused & long-term research groups.
 - Research groups have the stable long-term membership needed to promote the development of research collaboration & teamwork in exploring research issues.
 - Participation is by individual contributors, rather than by representatives of org.
 - It is managed by the IRTF Chair in consultation with the Internet Research Steering Group (IRSG).
 - IRSG membership includes the IRTF chair, the chairs of the various research groups & other individuals "membership-at-large" from the research community selected by the IRTF Chair.

- vi) W3C:- Main international std. org. for WWW
- Founded & headed by Tim Berners-Lee, the consortium is made up of member org. which maintain full-time staff for the purpose of working together in the development of std. for the WWW
 - Also engages in education & outreach, develops s/w & servers as an open forum for discussion about the web
 - W3C was created to ensure compatibility & agreement among industry members in the adoption of new std.
 - Prior to its creation, incompatible versions of HTML were offered by diff. vendors, increasing the potential for inconsistency b/w web pages.
 - The consortium was created to get all those vendors to agree on a set of core principles & components which would be supported by everyone.

In Parallel transmission, we can send data by grouping n bits at a time instead of a single bit.

Data rate is how fast we can send data in bps, over a channel.

Why is digital data not easily affected by noise?

Cannot easily change binary 1 to 0.

What is the no. of error bits that occur for a given no. of bits transmission called? Bit error rate.