

DATA COMMUNICATION

Channel and Noise

So, it means that for sending, Data, we need to know the type of the signal to be used, and its mode and technique through which it will be transferred



Pretty Much ... But there is one more thing. We already know that what type of data forms are available, and which modes and techniques can be used to send it from a receiver to transmitter. However no matter what type of data or technique is being used, it will need to encounter or pass through from some channel or medium

HOWEVER, limited data can be sent through a particular channel, or a particular data rate can be transmitted through a particular channel

Two Formulas help us to determine the data that can be used to calculate the channel capacity

1. Nyquist for noiseless channel
2. Shannon for a noisy channel.

Noiseless channel: Nyquist Bit Rate

For a noiseless channel, the Nyquist bit rate formula defines the theoretical maximum bit rate.

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

Where, Bandwidth is the bandwidth of channel

L is the number of signal levels used to represent data, and Bit Rate is the bit rate in bits per second.

Noisy channel: Shannon capacity

In practical, we cannot have a noiseless channel, the channel is always noisy. For a noisy channel, Claude Shannon introduced a formula, called the Shannon capacity, to determine the theoretical highest data rate for a noisy channel.

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

Where, Bandwidth is the bandwidth of the channel, SNR is the signal-to-noise ratio, and capacity is the capacity of the channel in bits per second. The signal to noise ratio is the statistical ratio of the power of the signal to the power of the noise. This formula defines characteristics of the channel, not the method of transmission.

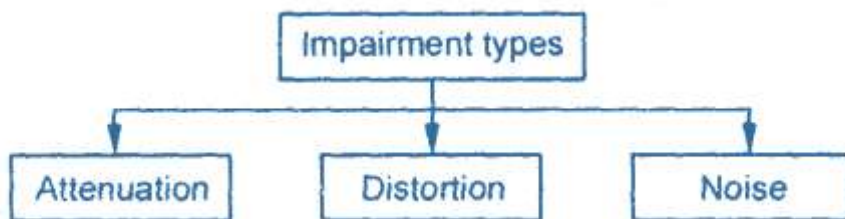


What Factors does effect a signal , while it is travelling through a channel

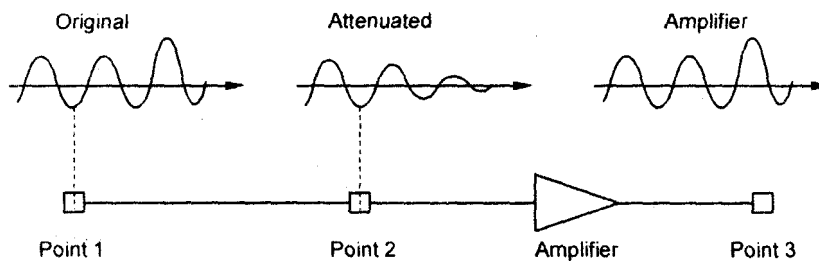
As soon as signals Leaves the transmitter, it becomes part of channel. While the data travels through channel, it faces different impairments

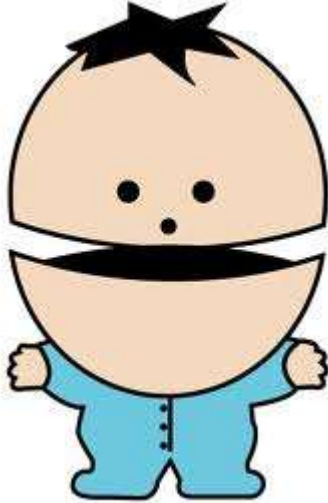
So, when transmission takes place between media, which is not perfect. The imperfections cause impairment in the signal. This means that the signal at the beginning and end of the medium are not the same. There are chances for the data that we have sent and we have received. There are three types of impairment usually occur

1. Attenuation
2. Distortion
3. Noise



1. Attenuation: Attenuation means loss of energy when a signal travels through the mediums, it loses some of its energy so that it can overcome the resistance of the medium. That is why a wire carrying electrical signals gets warm to compensate for this loss, amplifiers are used to amplify the signal.

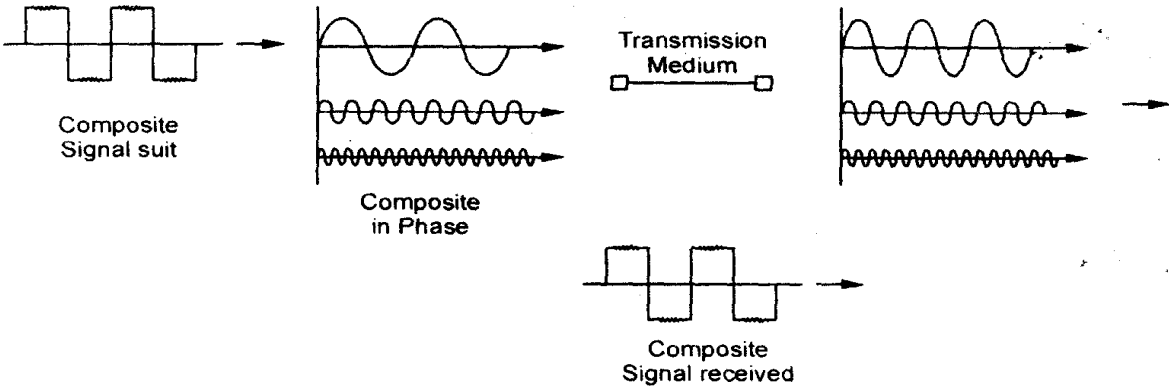




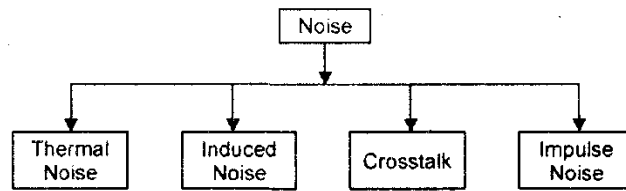
So it means Amplifier can be used, to overcome Attenuation

Ans : Most of the time, however there is a problem with using amplifier , that when it amplifies a weak signal containing data, it also amplifies the , noise added in signal

2. Distortion: Distortion means that the signal changes its forms or shape. Distortion occurs because a signal is made up of made of different frequencies. Each signal component has its own propagation speed through medium and therefore its own delay is arriving at the final destination. Fig. Shows the effect of distortion on composite signal.



Noise: Noise also causes problem in the transmission process. Several types of noise such as thermal noise, induced noise crosstalk and impulse noise may corrupt the signal.

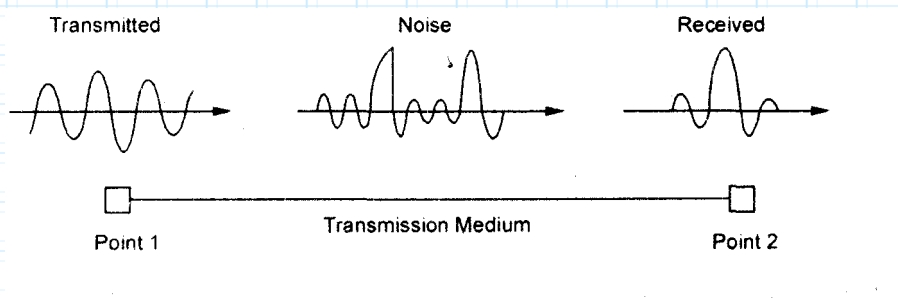


Thermal noise is the random motion of electrons in a wire which creates an extra signal not originally sent by the transmitter.

Induced noise causes from sources such as motors and appliances. These devices out as a sending antenna and the transmission medium acts as the receiving antenna.

Crosstalk is the effect of one wire on the other. One wire act as sending antenna and other as the receiving antenna.

Impulse noise is a spike for a very short period of time that comes from power lines, lightning and so On.



QUICK---RECAP

Difference between analog and digital data transmission? And which is the best way of transmission?

Ans. As a technology analog is the process of taking an audio or video signal (the human voice) and translating it into electronic pulses. Digital on the other hand is breaking the signal into a binary format where the audio or video data is persecuted by a series of "1" and "0".

Digital	Analog
1. Digital signal transfer is assumed to be error free.	1. While analog signals are always subject to some sort of degradation in signal quality and information loss.
2. Digital systems have cheap electronic circuits.	2. On the other hand, analog system have high budget to implement.
3. Easier to calibrate and adjust.	3. It is little bit typical to calibrate and adjust.
4. Digital communication has resistance to noise.	4. It does not have resistance to noise. Noise effects more in analog communication or transmission system.
5. Digital transmission is the faster way of communication.	5. Analog transmission is slower than that of digital transmission.

In conclusion, the strength of using a digital system over analog is clear. Digital signals are easier to transmit and offer less room for error to occur. This leads to accurate data transmission that in turn leads to faster transmission rates and better productivity.

Analog Signal. The transfer of data in the form of electrical signals or continuous waves is called analog signal or analog data transmission. An analog signal is measured in volts and its frequency is in hertz (Hz).

Advantages of Analog Signaling

Allows multiple transmissions across the cable.

Suffers less from attenuation.

Disadvantages of Analog Signaling

Suffers from EMI.

Can only be transmitted in one direction without sophisticated equipment.

Digital Signal

The transfer of data in the form of digit is called digital signal or digital data transmission. Digital signals consist of binary digits 0 & 1. Electrical pulses are used to represent binary digits. Data transmission between computers is in the form of digital signals.

Advantages of Digital Signaling

Equipment is cheaper and simpler than analog equipment.

Signals can be transmitted on a cable bidirectional.

Digital signals suffer less from EMI.

Disadvantages Digital Signaling

Digital signals suffer from attenuation