Tramsmission Impairments-16.01.2006

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With any communication systems,the signal thta is received may differ from the signal that is transmitted due to various transmission impairments.For analog signals,these impairments may degrade the signal quality.For digital signals,bit errors may be introduced. These Impairments can be classified into three main categories as given below:

1. Delay Distortion
2. Attenuation
3. Noise

Error Classification

Delay Distortion
It's caused beacause the signals of varying frequencies travel at different speeds along the medium.We know that any complex signal can be decomposed into different sinusoidal signals of different frequencies resulting in a frequency bandwidth for every signal.One property of signal propagation is that speed of travel of the frequency is the highest at the center of this bandwidth,and lower at both ends. Therefore,at the receiving end,signals with different frequencies wil arrive at different times..If the signals recived are measured at a specific time,they will not measure up to original signal resulting in its misinterpretation.

Attenuation
Attenuation is another form of distortion.In this case,as a signal travels through any medium,its strength decreases.Attenaution increases with distance.This is because some of the signal energy is absorbed by the medium.Attenuation is also higher at higher frequencies.In order to reduce Attenuation,one can use amplifiers to boost the signals,but amplifiers also boost noise.

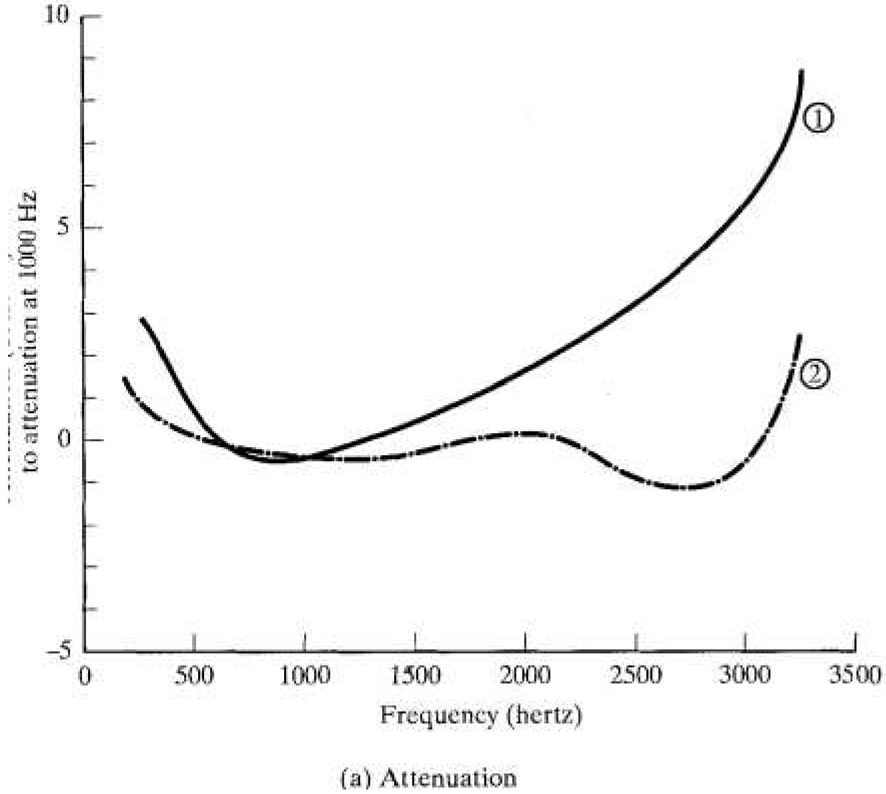

Figure 1: Attenuation curve for voice channels

The figuare shows attenuation as a function of frequency for a typical leased line. In the figure, attenuation is measured relative to the attenuation at 1000 Hz. Positive values on the y axis represent attenuation greater than that at 1000 Hz. A 1000-Hz tone of a given power level is applied to the input, and the power, P1000, is measured at the output. For any other frequency f, the procedure is repeated and the relative attenuation in decibels is

$$N_f = -10log_{10}(P_f/P_{1000}), \tag{1}$$

The solid line in Figure shows attenuation without equalization. As can be seen, frequency components at the upper end of the voice band are attenuated much more than those at lower frequencies. It should be clear that this will result in a distortion of the received speech signal. The dashed line shows the effect of equalization. The flattened response curve improves the quality of voice signals.

Noise

It's yet another component that poses a problem in receiving the signal accurately.Electomagnetic energy that gets inserted somewhere during transmission is called noise. Noise may be divided into four categories:

1. Thermal Noise
   Thermal noise is due to thermal agitation of electrons in a conductor. It is present in all electronic devices and transmission media and is a function of temperature. Thermal noise is uniformly distributed across the frequency spectrum and hence is often referred to as white noise; it cannot be eliminated and therefore places an upper bound on communications system performance.

2. Intermodulation Noise
   When signals at different frequencies share the same transmission medium, the result may be intermodulation noise. The effect of intermodulation noise is to produce signals at a frequency that is the sum or difference of the two original frequencies, or multiples of those frequencies. For example, the mixing of signals at frequencies fi and fi might produce energy at the frequency fi + f2. This derived signal could interfere with an intended signal at the frequency fi + f2.Intermodulation noise is produced when there is some nonlinearity in the transmitter, receiver, or intervening transmission system.

3. Crosstalk
   Crosstalk can occur by electrical coupling between nearby twisted pair

or, rarely, coax cable lines carrying multiple signals. Crosstalk can also occur when unwanted signals are picked up by microwave antennas.

4. Impulse noise
   Impulse noise is generally only a minor annoyance for analog data. For example, voice transmission may be corrupted by short clicks and crackles with no loss of intelligibility. However, impulse noise is the primary source of error in digital data communication.