

Transmission Impairments




Transmission Impairments

- › Signal received may be different from signal transmitted causing:
 -) Analog: degradation of signal quality
 -) Digital: bit errors
- › Most significant impairments:
 1. Attenuation and attenuation distortion
 2. Delay distortion
 3. Noise

Attenuation

- › Signal strength reduces as a function of distance
- › Designing a transmission system:
 1. Received signal has sufficient strength to be interpreted by receiver electronics
 2. Received signal is significantly higher than received noise to avoid errors
- Attenuation is different at different frequencies
- Apply equalization to overcome

Delay Distortion

- › Component signals with different frequencies have different propagation delay through cable
 - › Some signal components representing a bit interfere with neighbour bits: intersymbol interference
 - › Apply equalization to overcome
- 

Noise

Thermal Noise

- › Due to thermal agitation of electrons
- › Present in all transmission devices and media
- › Function of temperature:

$$N = kTB$$

where k = Boltzmann's constant = 1.38×10^{-23} J/K,
 B is bandwidth and T is temperature in kelvins

Intermodulation Noise

- › Caused when signals of different frequencies share the same medium

Noise

Crosstalk

- › Unwanted coupling of different signals

Impulse Noise

- › Short peak of noise, e.g. lightning, electrical disturbances, flaws in communications system

Effect of Noise on a Digital Signal

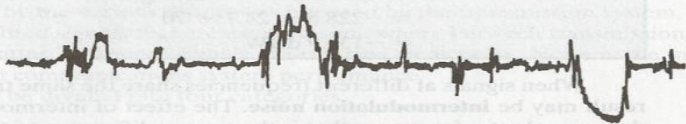
Data transmitted:

1 0 1 0 0 1 1 0 0 1 1 0 1 0 1

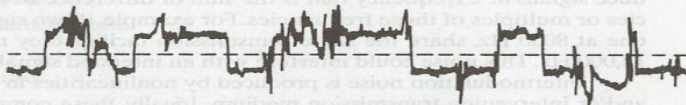
Signal:



Noise:



Signal plus noise:



Sampling times:



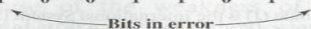
Data received:

1 0 1 0 0 1 0 0 0 1 1 0 1 1 1

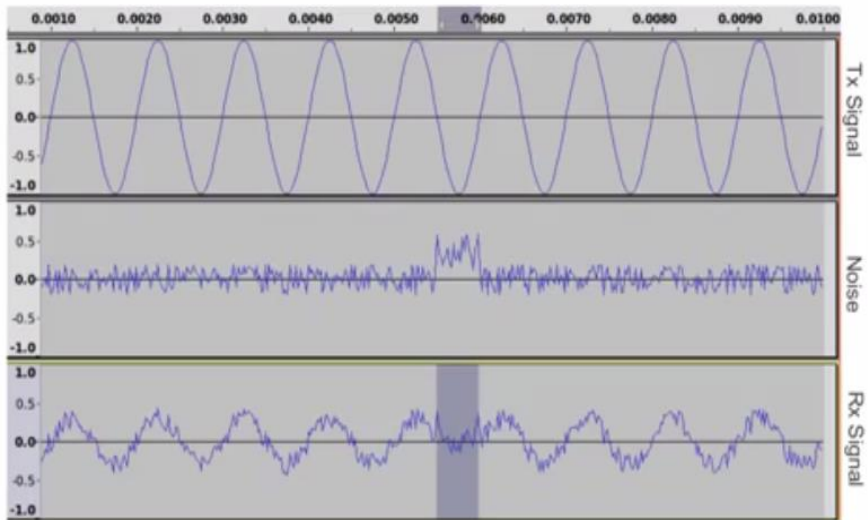
Original data:

1 0 1 0 0 1 1 0 0 1 1 0 1 0 1

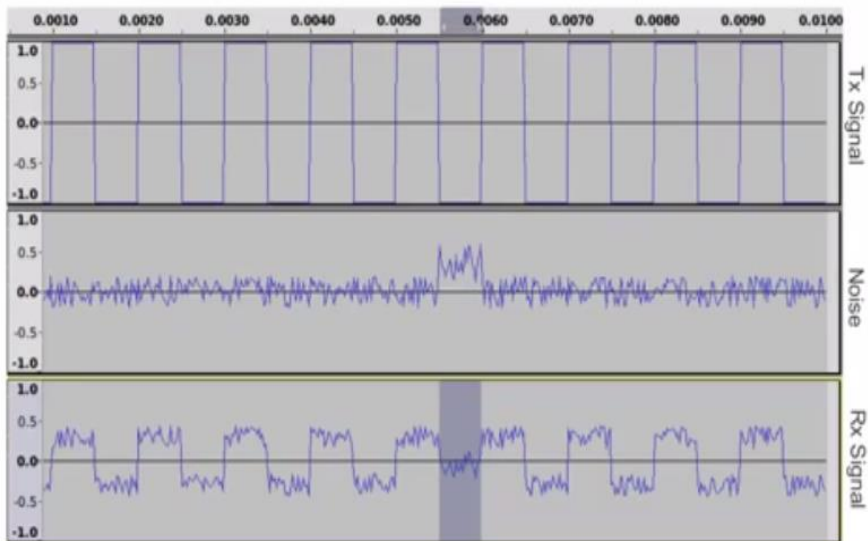
Bits in error



Tx Signal: 1000 Hz **sine** wave; Attenuation; Random noise with 0.5ms spike

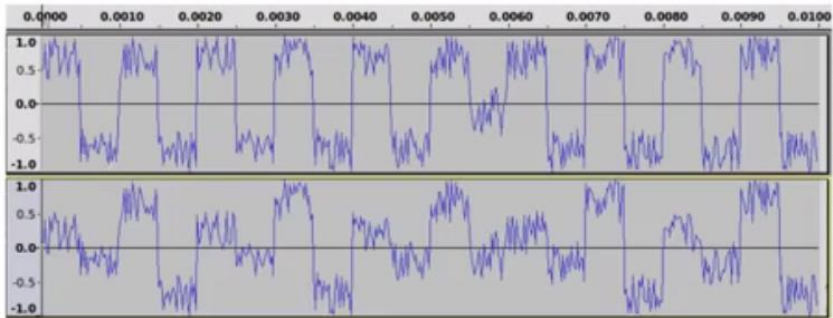


Tx Signal: 1000 Hz **square** wave; Attenuation; Random noise with 0.5ms spike



What about a signal with 2 levels vs a signal with 4 levels: which one will have more bit errors for some given noise?





Rx (2 levels)

Rx (4 levels)