NOISE IN COMMUNICATION SYSTEMS

NOISE

- Noise is random in nature and interferes with the desired signal.
- If the level of noise is much larger than the signal, reception becomes unreliable, reception may be totally marred by noise.
- Noise can be such as:
  - crackles and hiss heard when an FM radio is not tuned to any station
  - Snow like appearance on TV screen or video when signal is weak.

Sources of noise

- Noise can be categories in two:
  i. Correlated: noise that exists only when the signal is present
  ii. Uncorrelated: noise that is ever present regardless of signal presence or not.
- Uncorrected noise can be natural or man-made. Thus sources are external to the receiving system. It can also be generated internally in the system.

Uncorrelated noise

- Can be classified as external or internal noise.
  - external noise:
    - atmospheric noise: due to static noise, electrical disturbances e.g. lightning. It mostly affects receptions of frequencies less than 30MHz
    - extraterrestrial noise: natural noise from sources in space.
      - Solar noise: from the sun's radiation in the communication frequency.
      - Cosmic noise: stars generate radiation. It affects communication at f=15MHz to 150MHz
    - Industrial noise: manmade: produced by automotive ignition systems, switching of equipment ON and OFF, fluorescence lights.

- Internal noise: are low level noise generated by resistors, diodes, transistors e.t.c inside electronic comm. Sys.
- Internal noise obey certain laws, therefore design of systems to minimize this noise can be done.
- Temperature and noise power developed across a resistor are directly proportional.
- Therefore large resistors may cause low RF signals (several milliVolts) to be total lost in the noise.

- Noise appear across a wide range of random frequencies.
- Most of these noise can be rejected by passing the signal through band-pass filter. But cannot completely eliminated.
- Noise is dependent on and increases with:
  - Bandwidth: noise will impact high frequency signals more
  - Amount current in the circuit
  - gain of circuit
  - resistance of circuit.
- Keeping temperature, narrow bandwidth, low current, low gain and low resistance helps to minimizes noise. Repositioning the antenna also helps since the input of the receiver is an entry point to noise in the system.
- Has has tremendous amount of harmonics (frequency multiples) and varying amplitudes.

- Internal noise maybe classified into:

i. Thermal agitation noise
ii. Shot noise
iii. Partition noise
iv. Low frequency or flicker noise
v. High frequency or transit time noise

i) Thermal agitation or Johnson noise

- Small fluctuation in electrons energy (temperature of conductor) are sufficient to produce small noise voltages in conductor.
- These agitation of electrons produce random fluctuations of electrons energy and generate Johnson noise.
- The equation relating average noise power to temperature and bandwidth is:

Average noise power, $P_n = kTBw \qquad watts$

Where: T = Temperature of the conductor (resistor) in Kelvin

B_w = bandwidth of spectrum

K = Boltzmann's constant = 1.33×10^{-23} joule/kelvin

- The **power spectrum density** is the average noise power per hertz of bandwidth.

  Power spectrum density, $S_n = \frac{P_n}{B_w} = kT \quad in\, \frac{W}{Hz}$

- Determine the average noise power at 290 Kelvins if the bandwidth is 1MHz.

  Power spectrum density, $S_n = kT = 1.38x10^{-23}x290$

  $=4x10^{-21} \quad in\, W/Hz$

  average noise power, $P_n = \mathrm{B}S_n = 4x10^{-21}x10^{6} = 4X10^{-15}\ W$