Frequency and Period:

$f = \frac{1}{T}$ (Hz)

$T = \frac{1}{f}$ (S)

Signal Bandwidth = Biggest (Hz) − Smallest (Hz)

Amplitude unit is (Volts)

Number of bits per level = $\log_2$(Level) "Must be Power of 2"

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Bit rate = عليه ذهنية (bPS)

Amplification (Gain of Power) and

Attinuation (Loss of Power) of a signal traveled throw transmission medium:

$10 \log_{10}\left(\frac{P_2 \text{ (signal after)}}{P_1 \text{ (Signal before travel)}}\right)$ (dB) "signal strength", "Used because can be added or subtracted > 2 times"

$SNR = \frac{P_{signal}\ (W)}{P_{noise}\ (W)}$ (No unit), $10^{\frac{SNR_{dB}}{10}}$

If noiseless channel SNR and dB = ∞

$SNR_{dB} = 10 \log_{10}(SNR)$ (dB)

$\log_b(x) = y \Rightarrow x = b^y$

Nyquist theorem:

$$\text{Bit rate} = 2 \times \underbrace{\text{Bandwidth}}_{(Hz)} \times \log_2(\underbrace{\text{Levels}}_{\text{Must be pow 2}}) \quad (bps)$$

$$\log_2(\text{Levels}) = \frac{\text{Bit rate}}{2 \times \text{Bandwidth}} \Rightarrow \text{Levels} = 2^{\frac{\text{Bit rate}}{2 \times \text{Bandwidth}}}$$

Shannon Capacity:

$$\text{Capacity or theoritical highest bit rate} = \underbrace{\text{Bandwidth}}_{(Hz)} \times \log_2(1 + SNR) \quad (bps)$$

$$\text{Simplified capacity} = \text{Bandwidth} \times \frac{SNR_{dB}}{3}$$

$$\text{Throughput} = \underbrace{\text{frames}}_{(\text{per seconds})} \times \underbrace{\text{bits}}_{(bps)}$$

$$\text{Propagation time / delay } (D) = \frac{\text{Distance (m)}}{\underbrace{\text{Propagation speed or signal speed}}_{(m/s)}} \quad (s)$$

If one higher the other ignored

$$\text{Transmission time / delay } (\tfrac{M}{R}) = \frac{\text{Message size (bit)}}{\underbrace{\text{Bandwidth or rate}}_{(bps)}} \quad (s)$$

$$\text{Latency / Total delay} = \text{Propagation time} + \text{Transmission time} \text{ or } \frac{M}{R} + D \quad (s)$$

$$\text{Wave length} = \underbrace{\text{Propagation speed}}_{(m/s)} \times \underbrace{\text{Period}}_{s} \text{ or } \frac{\text{Propagation speed}}{\text{frequency}} \quad (m)$$

Mesh topology calculations:

$\#Links = \frac{n(n-1)}{2}$ n is # devices

$\#Links\ per\ device = n-1$

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Bandwidth-delay product = Bandwidth (bps) * delay (s) (bits)

$$\text{Utilization \%} = \frac{\text{Bits in length}}{\text{Bandwidth-delay product}} \times 100$$

$$T_p = \frac{\text{Distance (m)}}{\text{Signal propagation (m/s)}} \quad (ms)$$

R = Number from $0 \rightarrow 2^k - 1$

$T_B = R + T_p$ or $R + T_{fr}$ (ms)

$$T_{fr} = \frac{\text{frames transmission (bits)}}{\text{Channel (bps)}} \quad (ms), = 2 * T_p \quad (s)$$

Vulnerable = $2 * T_{fr}$ (ms)

Min frame size = Bandwidth * T_{fr} (bits)

Slot time = round-trip time + jam sqr time, $= \frac{\text{frame size (bits)}}{\text{data rate (bps)}}$ (s)

Max ethernet length = Propagation speed * $\left(\frac{\text{slot time}}{2}\right)$ (m)