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Data Communication CS601 Lecture No 11

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Both Formulas are used to measure Data Rate Limits. Shannon's formula gives us the upper limit while the Nyquist formula gives us the signal levels.

Data Rate Limits

- Data Rate Limits mean how much data can be transfer over transmission medium or channel. It can be depend on three factors:
  - Band Width Availability
  - Level of Signals
  - Level of Noise (Quality of Channel)
- The Data Rate Limits can be calculate by two methods:

1. One is provided by Nyquist (Noise = 0)

Formula: Bit Rate = 2 x Bandwidth x Log_2 L

Example: A Noiseless channel with a bandwidth of 3,000 Hz transmitting a signal with four signal levels. What is the maximum bit rate of the said channel?

Bit Rate = 2 x 3,000 x Log_2 4

= 6,000 x Log_2 4

= 6,000 x 2

Bit Rate = 12,000 bps

- **Second is provided by Shanon (Noise > 0)**

Formula: Capacity = Bandwidth x Log_2 (1 + SNR)

Example: Theoretical highest bit rate of a Telephone line Bandwidth of 3000 Hz assigned for data communication. SNR is usually 3162. What is capacity?

Capacity = Bandwidth x Log_2 (1 + SNR)

= 3,000 x Log_2 (1+3162)

= 3,000 x Log_2 (3,163)

Capacity = 34,881 bps

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Network Performance

The network performance is based on three factors. Which includes:

- **Bandwidth**

Bandwidth can be measure in two Terms:

1. Bandwidth in Herts (Range of Frequencies in a Composite Signals)
2. Bandwidth in Bits Per Second (No. of Bits Transmits on Channel or Network)

- **Throughput**

The throughput is how fast we can actually send data through a network.

1. Throughput T bps is always less than Bandwidth B.

- **Latency - Delay**

The time period to sent a signal from source to destination. Its depend on

Propagation Time + Transmission Time + Queuing Time + Processing Time

$$\frac{\text{Distance}}{\text{Propagation Speed}} \quad \frac{\text{Message Size}}{\text{Bandwidth}} \quad \text{Message Time Hold}$$



Throughput Example

A network with bandwidth of 8 Mbps can pass only an average of 10,000 frames per minute with each frame carrying an average of 8,000 bits. What is the throughput of this network?

Formula: No. of Frames in per Minute x No. of Bits per Second

Throughput = 10,000 x 8,000

= 80,000,000 / 60

= 1,333,333.33 bit per second

Throughput = 1.33 Mbps

Bandwidth = 8 Mbps

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Example Propagation Time

What is the propagation time if the distance between the two points is 12,000 km? Assume the propagation speed to be 2.4×10^8 m/s in cable.

SOLUTION

Propagation Time + Transmission Time + Queuing Time + Processing Time

$$\frac{\text{Distance}}{\text{Propagation Speed}} \quad \frac{\text{Message Size}}{\text{Bandwidth}} \quad \text{Message Time Hold}$$

Propagation Time = Distance / Propagation Speed

$= 12{,}000 \times 10{,}000 / 2.4 \times 10^8$

$= 120{,}000{,}000 / 2.4 \times 100{,}000{,}000$

$= 120{,}000{,}000 / 240{,}000{,}000$

$= 0.5$

= 50 m/s

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Exercise

Question No. 1:

A network with bandwidth of 15 Mbps can pass only an average of 20,000 frames per minute with each frame carrying an average of 14,000 bits. What is the throughput of this network?

Question No. 2:

What is the propagation time if the distance between the two points is 15,000 km? Assume the propagation speed to be 3.4×10^{10} m/s in cable.