EE450 Discussion #7

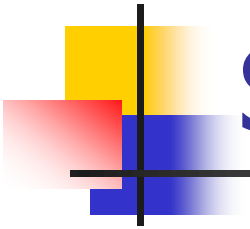
- Multiplexing

Statistical TDM Parameters

- I = Number of Input Sources
- R = Data rate of each source (bps)
- α (Alpha) = mean fraction of time each source is transmitting
- M = Effective capacity of multiplexed line
- K = M / (I x R) = Ratio of multiplexed line capacity to total input rate
- λ (lambda) = α x I x R = Average Arrival time
- T_s = 1 / M = Service time in seconds

ρ : Line Utilization

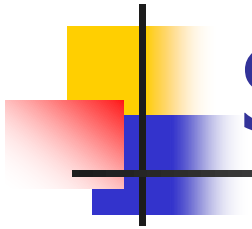
- ρ = Fraction of total link capacity being used
- Many different forms to express line utilization
  - $\rho = \lambda T_s$
  - $\rho = (\alpha \times I \times R) / M$
  - $\rho = \alpha / K$
  - $\rho = \lambda / M$



Sample Problem #5

- Ten 9600 bps lines are multiplexed using TDM. Ignoring overhead bits what is the total capacity required for Synchronous TDM?
  - Simple: 10 X 9600 = 96 kbps (96,000)

Sample Problem #6



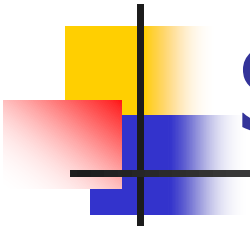
- Ten 9600 bps lines are multiplexed using TDM. Assuming that we limit line utilization to 0.8 and each line is busy 50 % of the time. What is the capacity required for Statistical TDM?
  - What do we know?
    - Line utilization – $\rho = .8$
    - Fraction of time transmitting - $\alpha = .5$
    - R Data Rate of each input source = 9600 bps
    - I number of Input Sources = 10

Continued

- The Equation:
- $\rho = \alpha \times I \times R \times /M$
  - Where M is the capacity of the multiplexed line
- Rearrange for M
  - $M = \alpha \times I \times R / \rho$
- Plug in the given parameters
  - $M = 0.5 \times 10 \times 9600 / 0.8$
  - M = 60 kbps

Sample Problem #7

- Calculate the capacity of a Multiplexed carrier?
  - 24 voice channels multiplexed
  - 8000 samples per second
    - Each frame lasts 1/8000 = 125 μ sec
  - Uses 8 bit encoding per sample
  - Capacity
    - 24 X 8000 samples/second X 8 bits/sample
    - 1,536,000 bits/second
  - T-1 Adds an extra bit per frame (for synchronization) which makes it 1.544 Mbps



Sample Problem #8

- What is the percent overhead on a T-1 Carrier?
  - T-1 Carrier bandwidth of 1.544 Mbps
    - Every 192 bits one more bit is added for framing.
  - What is the overhead?

Continued

- Overhead in a T-1 Line
  - Every frame consists of 193 bits
  - 24 X 8 = 192 bits
  - 193-192 = 1 overhead bit
  - 1/193 = .5%