CS 4390: HW 3

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1 Data Rate Problem

It is desired to send a sequence of computer screen images over optical fiber. The screen is 3840×2160 pixels, each pixel being 24 bits. There are 60 screen images per second. What data rate is needed?

 $Data Rate = \frac{Number of bits}{Bits per second}$

There are 24 bits \cdot (3840 \times 2160) = 199,065,600 bits per image. Transmitting 60 images per second gives a data rate of data rate is 60 \cdot 199,065,600 = $\underline{1.194 \cdot 10^{10}}$ bits per second.

2 FDM Multiplexing Problem

Ten signals, each requiring 4000 Hz, are multiplexed onto a single channel using FDM. What is the minimum bandwidth required for the multiplexed channel? Assume that the guard bands are 400 Hz wide.

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The minimum bandwidth required is $[10 \cdot 4000 \text{Hz}] + [(9) \cdot 400 \text{Hz}] = 43,600 \text{ Hz}.$

3 Analog Sampling Data Rate Problem

A 3-kHz (analog) signal is sampled every 1 msec. What is the (minimum) data rate of a digital channel required to carry this signal? Assume that the quantization uses 256 levels.

The minimum data rate is $2 \times (3 \cdot 10^3) \times \log_2(256)$ = 48,000 bits per second.

4 Network Topology Problem

Three packet-switching networks each contain n nodes. The first network has a star topology with a central switch, the second is a (bidirectional) ring, and the third is fully interconnected, with a wire from every node to every other node. What are the best-, average-, and worst-case transmission paths in hops?

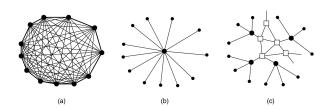


Figure 2-29. (a) Fully interconnected network. (b) Centralized switch. (c) Two-level hierarchy.

The best-, average-, and worst-case for star topology with central switch is 2 hops (e.g., the hop from source to central switch, then from central switch to the destination).

The best-, average-, and worst-case for fully-interconnected network is 1 hop (e.g., the hop from source to destination).

The best-, average-, and worst-case di-directional ring is 1, n/2, and n-1 hops, respectively (e.g., the source and destination nodes are adjacent, the average of 1 hop and n-1 hops is n/2, and at worst the message must travel across all n-1 nodes, respectively).

Minimum Data Rate = $2 \times \text{Bandwidth} \times \log_2(\# \text{ of Q-Levels})$