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?

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

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

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 $[10 \cdot 4000\text{Hz}] + [(9) \cdot 400\text{Hz}] = \underline{43{,}600 \text{ Hz.}}$

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.

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

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

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?

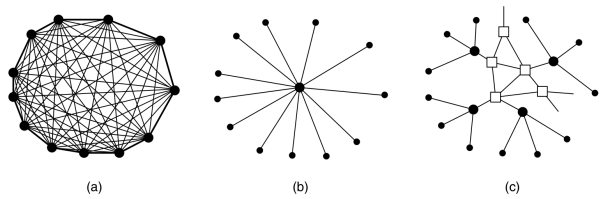

Figure 2-29. (a) Fully interconnected network. (b) Centralized switch. (c) Two-level hierarchy.

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 $\underline{1,\ n/2, \text{ and } n-1 \text{ hops}}$, 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).