

# CS 4390: HW 3

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Draft February 20, 2024

## 1 Data Rate Problem

*It is desired to send a sequence of computer screen images over optical fiber. The screen is  $3840 \times 2160$  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  $60 \cdot 199,065,600 = \underline{1.194 \cdot 10^{10}}$  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  $[10 \cdot 4000\text{Hz}] + [(9) \cdot 400\text{Hz}] = \underline{43,600 \text{ Hz}}$ .

## 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?*

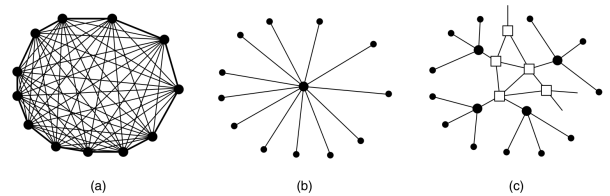


Figure 2-29. (a) Fully interconnected network. (b) Centralized switch. (c) Two-level hierarchy.

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).