

Data Communications I

Homework 1 Solution

Problem 3

- a) A circuit-switched network would be well suited to the application, because the application involves long sessions with predictable smooth bandwidth requirements. Since the transmission rate is known and not bursty, bandwidth can be reserved for each application session without significant waste. In addition, the overhead costs of setting up and tearing down connections are amortized over the lengthy duration of a typical application session.
- b) In the worst case, all the applications simultaneously transmit over one or more network links. However, since each link has sufficient bandwidth to handle the sum of all of the applications' data rates, no congestion (very little queuing) will occur. Given such generous link capacities, the network does not need congestion control mechanisms.

Problem 5

Tollbooths are 75 km apart, and the cars propagate at 100km/hr. A tollbooth services a car at a rate of one car every 12 seconds.

- a) There are ten cars. It takes 120 seconds, or 2 minutes, for the first tollbooth to service the 10 cars. Each of these cars has a propagation delay of 45 minutes (travel 75 km) before arriving at the second tollbooth. Thus, all the cars are lined up before the second tollbooth after 47 minutes. The whole process repeats itself for traveling between the second and third tollbooths. It also takes 2 minutes for the third tollbooth to service the 10 cars. Thus the total delay is 96 minutes.
- b) Delay between tollbooths is 8×12 seconds plus 45 minutes, i.e., 46 minutes and 36 seconds. The total delay is twice this amount plus 8×12 seconds, i.e., 94 minutes and 48 seconds.

Problem 6

- a) $d_{prop} = m / s$ seconds.
- b) $d_{trans} = L / R$ seconds.
- c) $d_{end-to-end} = (m / s + L / R)$ seconds.
- d) The bit is just leaving Host A.
- e) The first bit is in the link and has not reached Host B.
- f) The first bit has reached Host B.
- g) Want

$$m = \frac{L}{R} s = \frac{120}{56 \times 10^3} (2.5 \times 10^8) = 536 \text{ km.}$$

Problem 7

Consider the first bit in a packet. Before this bit can be transmitted, all of the bits in the packet must be generated. This requires

$$\frac{56 \cdot 8}{64 \times 10^3} \text{ sec} = 7 \text{ msec.}$$

The time required to transmit the packet is

$$\frac{56 \cdot 8}{2 \times 10^6} \text{ sec} = 224 \mu \text{ sec.}$$

Propagation delay = 10 msec.

The delay until decoding is

$$7 \text{ msec} + 224 \mu \text{ sec} + 10 \text{ msec} = 17.224 \text{ msec}$$

A similar analysis shows that all bits experience a delay of 17.224 msec.

Problem 24

40 terabytes = $40 \times 10^{12} \times 8$ bits. So, if using the dedicated link, it will take $40 \times 10^{12} \times 8 / (100 \times 10^6)$ = 3200000 seconds = 37 days. But with FedEx overnight delivery, you can guarantee the data arrives in one day, and it should cost less than \$100.

Problem 25

- a) 160,000 bits
- b) 160,000 bits
- c) The bandwidth-delay product of a link is the maximum number of bits that can be in the link.
- d) the width of a bit = length of link / bandwidth-delay product, so 1 bit is 125 meters long, which is longer than a football field
- e) s/R