Home Page: http://www.public.asu.edu/~bhao2

Homework 1

Problems:

3, 5, 7, 14, 24, 25

Question: 3

Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions, briefly justifying your answer:

a. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?

b. Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?

Answer:

a. The circuit-switched network would be more appropriate for this application, because this application requires relatively long period of time for communication, fixed transmission rate. Thus, the bandwidth could be reserved for this connection without waste.
b. No congestion control needed, since the sum of the application data rates is less than the capacities of each and every link. For the worst case, the bandwidth is still enough for all applications transmitting data in the same time over one or more network links, thus congestion is not needed.

Question: 5

Review the car-caravan analogy in Section 1.4. Assume a propagation speed of 100 km/hour.

a. Suppose the caravan travels 150 km, beginning in front of one tollbooth, passing through a second tollbooth, and finishing just after a third tollbooth. What is the end-to-end delay?

b. Repeat (a), now assuming that there are eight cars in the caravan instead of ten.

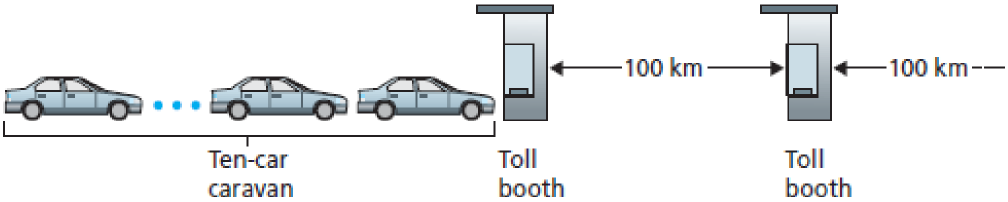


Figure 1.17 ♦ Caravan analogy

Answer:

a. We know the propagation speed is 100km/hr, travelling distance is 150 km and each tollbooth services a car at a rate of one car per 12 seconds. In additional, there are 10 cares.

   The time taken by a car to travel 150km is 150km/100km/hr = 1.5 hr = 90 min
   The overall tollbooths service time for 10 cars is 12*3*10 = 360 seconds = 6 min
   Finally, the end to end time delay for 10 cars is 90 min + 6 min = 96 min

b. For 8 cars, the overall tollbooths service time should be 12*3*8= 288 seconds = 4.8 min
   Finally, the end to end time delay for 8 cars is 90 min + 4.8 min = 94.8 min

Question: 7

In this problem, we consider sending real-time voice from Host A to Host B over a packet-switched network (VoIP). Host A converts analog voice to a digital 64 kbps bit stream on the fly. Host A then groups the bits into 56-byte packets. There is one link between Hosts A and B; its transmission rate is 2 Mbps and its propagation delay is 10 msec. As soon as Host A gathers a packet, it sends it to Host B. As soon as Host B receives an entire packet, it converts the packet's bits to an analog signal. How much time elapses from the time a bit is created (from the original analog signal at Host A) until the bit is decoded (as part of the analog signal at Host B)?

Answer:

Since this is a packet switched network, the data will be transmitted packet by packet. A packet is 56 byte and the analog to digital conversation rate is 64 kbps, thus the preparing time Tp for a packet is (56*8)/(64*1000)= 0.007 s = 7 ms.

The transition time Dtrans for a packet is (56*8)/(2*1000*1000) =0.000224 s = 0.224ms.

Tprop = 10ms

Finally, the total time elapses from the time a bit is create until the bit is decoded is Tp+Dtrans+Tprop= 7+0.224+10 = 17.224 ms

Question: 14

Consider the queuing delay in a router buffer. Let I denote traffic intensity; that is, I = La/R. Suppose that the queuing delay takes the form IL/R (1 – I) for I < 1.

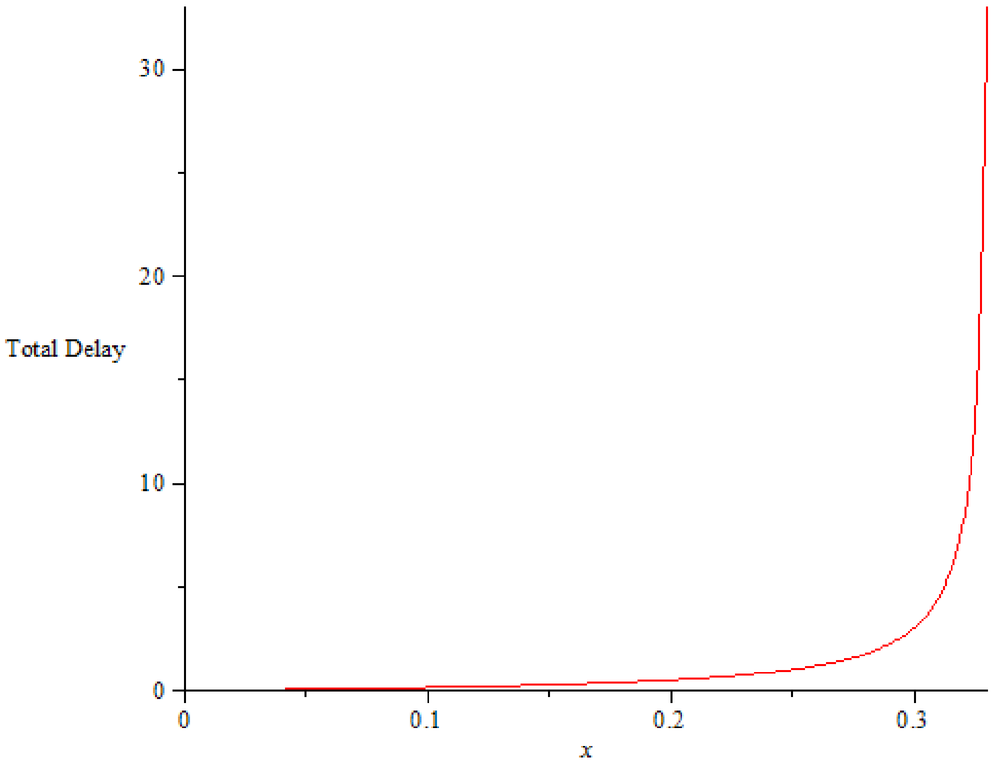
a. Provide a formula for the total delay, that is, the queuing delay plus the transmission delay.

b. Plot the total delay as a function of L/R.

Answer:

a. Since all packets consist of L bits, thus the transmission delay is L/R. The total delay is queuing delay + transmission delay = $\frac{IL}{R(1-I)}+\frac{L}{R}=\frac{IL+L(1-I)}{R(1-I)}=\frac{L}{R(1-I)}$

b. Let $\frac{L}{R}$ be x, thus the total delay is $\frac{x}{1-xa}$, Let a be 3:



Question: 24

Suppose you would like to urgently deliver 40 terabytes data from Boston to Los Angeles. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain.

Answer:

40 TB = 40*1024*1014*8 = $3.32267520\ 10^8$ Mbps, it will take $\left(\frac{(40*1024*1014*8)}{100}\right)$

= $3.322675200\ 10^6$ seconds = 38.45688889 days.

If we copy those data into a removable disk, FedEx overnight could deliver it within one day. Thus I prefer to transmit the data using FedEx overnight delivery.

Question: 25

Suppose two hosts, A and B, are separated by 20,000 kilometers and are connected by a direct link of R = 2 Mbps. Suppose the propagation speed over the link is 2.5 10^8 meters/sec.*

a. Calculate the bandwidth-delay product, R D prop.*

b. Consider sending a file of 800,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?

c. Provide an interpretation of the bandwidth-delay product.

d. What is the width (in meters) of a bit in the link? Is it longer than a football field?

e. Derive a general expression for the width of a bit in terms of the propagation speed s, the transmission rate R, and the length of the link m.

Answer:

a. $d_{prop} = \frac{20000*1000}{2.5*10^8} = 0.08s$

   Therefore, $R*\mathrm{d}_{prop} = 2*1024*1024*0.08 = 167772 bits$

b. **The bandwidth-delay product is the maximum number of bits that can be in the link** and 167772 bits < 800000 bits, thus the maximum number of bits in the link at any a given time is 167772 bits.

c. The bandwidth-delay product is the maximum number of bits that can be in the link at a given time

d. The width of a bit in the link = $\frac{20000*1000}{167772} = 119.209m$, it is longer than a football field if the football field is 91.44m.

e. Width of a bit is $\frac{m}{R*d_{prop}} = \frac{m}{R*\frac{m}{s}} = \frac{m*s}{R*m} = \frac{s}{R}$