COMPUTER NETWORKING
A Top-Down Approach

Chapter 01

Question and answer:

R11. *Suppose there is exactly one packet switch between a sending host and a receiving host. The transmission rates between the sending host and the switch and between the switch and the receiving host are R_1 and R_2, respectively. Assuming that the switch uses store-and-forward packet switching, what is the total end-to-end delay to send a packet of length L? (Ignore queuing, propagation delay, and processing delay.*

Answer: end-to-end delay = L/R1 + L/R2

Explanation: At time t_0 the sending host begins to transmit. At time $t_1 = L/R_1$, the sending host completes transmission and the entire packet is received at the router (no propagation delay). Because the router has the entire packet at time t_1, it can begin to transmit the packet to the receiving host at time t_1. At time $t_2 = t_1 + L/R_2$, the router completes transmission and the entire packet is received at the receiving host (again, no propagation delay).

R19. Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates R_1 = 500 kbps, R_2 = 2 Mbps, and R_3 = 1 Mbps.
a. Assuming no other traffic in the network, what is the throughput for the file transfer?
b. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?
c. Repeat (a) and (b), but now with R_2 reduced to 100 kbps.

Answer:

a) The minimum throughput available is 500 kbps.
b) File Size / Throughput = $4 \times 10^6 \times 8 / (500 \times 10^3)$ = 64s.
c) The min throughput now is 100 kbps, File Size / Throughput = $4 \times 10^6 \times 8 / (100 \times 10^3)$ = 320 seconds

P5. 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 10.

Answer: Propagation Delay or d_{prop} = distance travelled / propagation speed

d_{prop} = 75km / 100 kph (where 75 km is distance between 2 tollbooths of half of total distance i.e 150km and 100 kph is car speed immediately after each tollbooth)

d_{prop} = 0.75 hours (45 minutes) between each toll booth or 1.5 hours (90 minutes) from first booth to last booth.

D_{trans} at toll = 12 * 10 = 120 seconds or 2 minutes.

Therefore total end to end delay = d_{prop} + d_{trans}

= 90 minutes + (time at each toll booth)(2min + 2 min + 2 min) = 96minutes.

B) Assuming 8 cars instead of 10 cars

$d_{trans} =$ 12 × 8 = 96 seconds = 1.6 minutes. For one booth.

So, end to end delay = 90 minutes + 1.6minutes × 3 booths = 90 + 4.8 = 94.8 minutes.

P6. This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate *R* bps. Suppose that the two hosts are separated by *m* meters, and suppose the propagation speed along the link is *s* meters/sec. Host A is to send a packet of size *L* bits to Host B.

a) Express the propagation delay, d_{prop}, in terms of *m* and *s*.
Answer: d_{prop} = m{in meters} / s{in meters/seconds} = m / s seconds.

b) Determine the transmission time of the packet, d_{trans}, in terms of *L* and *R*.
Answer: D_{trans} = L / R seconds

c) Ignoring processing and queuing delays, obtain an expression for the end-to-end delay
Answer: $D_{end\text{-}to\text{-}end}$ = m/s + L/R

d) Host A begins to transmit the packet at time *t* = 0. At time *t* = d_{trans}, where is the last bit of the packet?
Answer: The bit is just leaving host A.

e) Suppose d_{prop} is greater than d_{trans}. At time *t* = d_{trans}, where is the first bit of the packet?

Answer: The first bit is in the link and has not reached Host B.

f) Suppose d_{prop} is less than d_{trans}. At time *t* = d_{trans}, where is the first bit of the packet?

Answer: The First bit has just reached Host B.

g) Suppose $s = 2.5 \cdot 10^8$, L = 120 bits, and R = 56 kbps. Find the distance *m* so that d_{prop} equals d_{trans}.

Answer: As d_{prop} and d_{trans} is equal, so $\frac{m}{S} = \frac{L}{R}$; m = $\frac{L}{R} \times S = \frac{120}{56 \times 1000}(2.5 \times 10^3)$ = 535.71km

P10. Consider a packet of length *L* which begins at end system A and travels over three links to a destination end system. These three links are connected by two packet switches. Let d_i, s_i, and R_i denote the length, propagation speed, and the transmission rate of link i, for i = 1, 2, 3. The packet switch delays each packet by d_{proc}. Assuming no queuing delays, in terms of d_i, s_i, R_i, (i = 1,2,3), and L, what is the total end-to-end delay for the packet? Suppose now the packet is 1,500 bytes, the propagation speed on all three links is $2.5 \cdot 10^8$ m/s, the transmission rates of all three links are 2 Mbps, the packet switch processing delay is 3 msec, the length of the first link is 5,000 km, the length of the second link is 4,000 km, and the length of the last link is 1,000 km. For these values, what is the end-to-end delay?

Answer:

Here, L = 1500 bytes = 1500×8 = 12000 bits

$s1 = s2 = s3 = 2.5 \times 10^8\ ms^{-1}$

$R1=R2=R3=2Mbs^{-1} = 2 \times 10^6\ bits^{-1}$

Nodal processing delay d_{proc} = 3ms

$d1 = 5000km = 5\times10^6\ m$, $d2 = 4000km = 4\times10^6\ m$, $d3 = 1000km = 1\times10^6\ m$

So, end-to-end delay is = $L/R1 + L/R2 + L/R3 + d1/S + d2/S + d3/S + d_{proc1}+d_{proc2}$

$L/R1 = 12000/2 \times10^6 = 6\times10^{-3}$ secs = 6 msec

$d1/s = 5 \times10^6 /(2.5 \times10^8\ ms^{-1}) = 5\times4\times10^{-3}$secs = 20 msec

$d2/s = 4 \times 4 \times 10^{-3}$ =16 msec

$d3/s = 1\times4 \times 10^{-3}$ =4msec

put the values in to the equation = 6 + 6 + 6 + 20 + 16 + 4 + 3 + 3 (2 switch so 2 processing delay) = 64 msec.