Chapter 1

- **K&R, #R17 - Question does NOT ask for the perfect or first combo that works. I did not try all the answers presented by students.**
  Book answer is:
  a) 1000 km, 1 Mbps, 100 bytes b) 100 km, 1 Mbps, 100 bytes

- **K&R, #R18 - Looking for just 'propagation'.** ***Book makes a distinction between putting packet on the link and then the time to transmit. Thus, for propagation it is just d/s.***
  10msec; d/s; no; no

- **K&R, #R25**
  Routers process network, link and physical layers (layers 1 through 3). (This is a little bit of a white lie, as modern routers sometimes act as firewalls or caching components, and process Transport layer as well.) Link layer switches process link and physical layers (layers 1 through2). Hosts process all five layers.

- **K&R, #P5**

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.

- **K&R, #P6 - Check out the K&R video**
  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

$m = Ls = 120\ (2.5\times10^8) = 536$km.$R$ 56×10^3

- **K&R, #P12**

  Interesting answer follows. *His answer seems to look at the packet in transmission as NOT in the queue. If you count that packet as in the queue, then the equation might be: (nL - x)/R where x is the number of bits transmitted. The detail is: is the current transmitting packet 'in' or 'out of' the queue...*

  The arriving packet must first wait for the link to transmit 4.5 *1,500 bytes = 6,750 bytes or 54,000 bits. Since these bits are transmitted at 2 Mbps, the queuing delay is 27 msec. Generally, the queuing delay is $(nL + (L - x))/R$.

- **K&R, #P23**

  Let's call the first packet A and call the second packet B.

  a) If the bottleneck link is the first link, then packet B is queued at the first link waiting for the transmission of packet A. So the packet inter-arrival time at the destination is simply L/R_s.

  b) If the second link is the bottleneck link and both packets are sent back to back, it must be true that the second packet arrives at the input queue of the second link before the second link finishes the transmission of the first packet. That is,

  $L/R_s + L/R_s + d_{prop} < L/R_s + d_{prop} + L/R_c$

  The left hand side of the above inequality represents the time needed by the second packet to *arrive at* the input queue of the second link (the second link has not started transmitting the second packet yet). The right hand side represents the time needed by the first packet to finish its transmission onto the second link. If we send the second packet T seconds later, we will ensure that there is no queuing delay for the second packet at the second link if we have:

  $L/R_s + L/R_s + d_{prop} + T >= L/R_s + d_{prop} + L/R_c$ Thus, the minimum value of T is $L/R_c - L/R_s$.

- **K&R, #P24**

  40 terabytes = 40 * 10^{12} * 8 bits. So, if using the dedicated link, it will take 40 * 10^{12} * 8 / (100 *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.

- **K&R, #P33**

There are *F*/*S* packets. Each packet is S=80 bits. Time at which the last packet is received at the first router is *S* + 80 × *F* sec. At this time, the first F/S-2 packets are at the
RS
destination, and the F/S-1 packet is at the second router. The last packet must then be transmitted by the first router and the second router, with each transmission taking
S* + 80 sec. Thus delay in sending the whole file is *delay* = *S* + 80 × (*F* + 2)*RRS
To calculate the value of S which leads to the minimum delay,
d delay*=0⇒*S*= 40*F