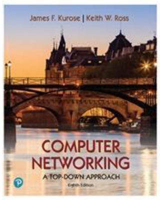
EECS3020 Introduction to Computer Networks
Chapter 1
Sample Solutions



Computer Networking: A Top-Down Approach
8th edition

Problems (starting from page 69): 2, 3, 4, 7, 8, 16, 22, 24, 25, 29, 31, and 33.

2. **N(L/R) + (P-1)(L/R)**
   (Hint: N(L/R) for the first packet and (P-1)(L/R) for the remaining packets)

3.
(a) **circuited-switched**
   (Hint: Since the transmission rate is known and steady, bandwidth can be reserved for each application session without significant waste. Moreover, the setting up and tearing down overhead can be amortized over the lengthy duration of a typical application session.)
(b) **no need for congestion control**
   (Hint: Since each link has sufficient bandwidth to deal with the sum of all of the applications' data rates, the network does not need congestion control.)

4. (one color for one connection)
(a)
   Number of connections between each switch = 4
   Number of links in the circuit-switched network = 4
   4 * 4 = **16**
(b)
   Number of connections between switches A and C = 4
   Number of connections between switches C and A = 4
   4 + 4 = **8**
(c) **Yes**
   2 connections between A and C + 2 connections between C and A = 4
   2 connections between B and D + 2 connections between D and B = 4

7.
   Grouping into packet: 56 bytes / 64 kbps = (56*8)/(64*1000) = 0.007s
   Transmission delay: 56 bytes / 10 Mbps = (56*8)/(10*1000000) = 0.0000448s
   propagation delay: 10ms = 0.01s
   total delay: 0.007+0.0000448+0.01 = **0.0170448s**

8.
(a) 10,000 / 200 = **50 users**
(b) **0.1**

(c) $\boldsymbol{C_n^{120}} * \mathbf{0.1^n} * \mathbf{0.9^{(120 - n)}}$

(d) P(n >= 51) = 1 - P(N < 51) = 1 - P(N <= 50) = 1 - $\sum_{i=0}^{50} C_i^{120} * 0.1^i * 0.9^{120-i}$

(Hint: binomial distribution = $p^n * (1-p)^{(\text{total users - n})}$)

16.

Transmission delay = 1 / 100 = 0.01 (s)

d = Total delay = 0.01(Transmission delay) + 0.02(Queuing delay) = 0.03 (s)

The total number of packets in the system includes those in the buffer and the packet that is being transmitted. So, N = total packets = 100 + 1 = 101.

N = 101 = a * 0.03, a = average packet arrival rate = **10,100 / 3**

(Hint: You should first calculate the transmission delay of the packet)

22.

P(successfully receive by receiver) = $(1-p)^n$

Average retransmit times = **[1 / $(1-p)^n$] – 1**

24.

50TB / 100Mbps = 50 * 1000 * 1000 * 8 / 100 = 4,000,000 (s)

4000000 (s) / 86400 (seconds per day)= **46.2…… days**

Fedex will be better

(Hint: Fedex guaranteed the data arrive in one day if you pay enough)

25.

(a) R * d_{prop} = 20000 km / 2.5 * 10^8 (m/sec) * 5Mbps = **400,000 bits**

(Hint: distance / propagation speed * bandwidth)

(b) **400,000 bits**

(Hint: bandwidth-delay product is the maximum number of bits in the link

(c) **Bandwidth delay product is a measurement of how many bits can fill up a network link**

(d) **1 bit is 50m, which is less than a football field** (90m)

(Hint: the width of a bit = length of link / bandwidth-delay product)

(e) width of a bit = propagation speed / transmission rate = **s/R**

29.

(a) propagation delay

= distance / propagation speed = 36,000 km / 2.4 * 10^8 **(**m/sec) = **150 (s)**

(Hint: geostationary satellite is 36,000 kilometers away from the earth's surface

(b) bandwidth-delay product = R * d_{prop} = 10 Mbps * 150 s = **1,500,000 bits**

(c) 10Mbps * 60s **= 600,000,000 bits**

(Hint: The frequency of transmitting the digital photo by the satellite is equal to 1 per minute or per 60 seconds. So, the interval between each photo is 60 seconds.)

31.

(a) **0.2s, 0.6s**

(Hint: To first switch: 10^6 / 5 Mbps)

(b) **2ms, 4ms**

(Hint: First packet to the first switch: 10^4 / 5 Mbps)

(c) sending with message segmentation:

6ms (the first packet reach the destination, meanwhile the second packet reach the second switch) + 99*2ms (the remaining packets cost 2ms to reach destination from the second switch) = **204ms**
sending without message segmentation: 0.6s = **600ms**
Sending a message with message segmentation costs less time than sending it without message segmentation.

(d)

(1) Without message segmentation, bit errors are not tolerated. If a bit error occurs, the whole message needs to be retransmitted.
(2) Without message segmentation, routers have to store the whole huge packet, and small packets have to queue behind enormous packets and suffer unfair delays.

(e)

(1) Packets need to be received in sequence at the destination
(2) Message segmentation results in many smaller packets. Since header size is usually the same for all packets regardless of their size, with message segmentation the total amount of header bytes is more.

33. **S = √40F**
There are F /S packets.
The time at which the last packet is received at the first router is (S + 80) / R * (F / S) sec.
So It takes (S + 80) / R * (F / S + 2) seconds to transmit the whole file.
To get the minimum delay, differentiate S: d / dS = 0, **S = √40F**