Solutions to Practice Problems

ECE 465/565
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Chapter 1

Problem 14

a) 40,000 bits (1 Mbps * 10,000/2.5x10^8 ms)
b) 40,000 bits
c) The bandwidth-delay product of a link is the maximum number of bits that can be in the link
d) 1 bit is 250 meters long, which is longer than a football field
e) *s/R*

Problem 18

a) 150 msec
b) 1,500,000 bits
c) 600,000,000 bits (10 Mbps*60 sec)

Problem 20.

a) Time to send message from source host to first packet switch = $\frac{7.5\times10^6}{1.5\times10^6}\text{sec} = 5\text{sec}$. With store-and-forward switching, the total time to move message from source host to destination host = $5\text{sec}\times 3\ hops = 15\text{sec}$
b) Time to send 1st packet from source host to first packet switch = . $\frac{1.5\times10^3}{1.5\times10^6}\text{sec} = 1\ m\text{sec}$. Time at which 2nd packet is received at the first switch = time at which 1st packet is received at the second switch = $2\times1\ m\text{sec} = 2\ m\text{sec}$
c) Time at which 1st packet is received at the destination host = . $1\ m\text{sec}\times 3\ hops = 3\ m\text{sec}$. After this, every 1msec one packet will be received; thus time at which last (5000th) packet is received = $3\ m\text{sec} + 4999*1m\text{sec} = 5.002\text{sec}$. It can be seen that delay in using message segmentation is significantly less (almost 1/3rd).
d) Drawbacks:

i. packets have to be put in sequence at the destination.
ii. 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.

Chapter 2

Problem 6

The total amount of time to get the IP address is

$$RTT_1 + RTT_2 + \cdots + RTT_n .$$

Once the IP address is known, RTT_O elapses to set up the TCP connection and another RTT_O elapses to request and receive the small object. The total response time is

$$2RTT_o + RTT_1 + RTT_2 + \cdots + RTT_n$$

Problem 7

a)

$$\begin{aligned} & RTT_1 + \cdots + RTT_n + 2RTT_o + 3 \cdot 2RTT_o \\ &= 8RTT_o + RTT_1 + \cdots + RTT_n . \end{aligned}$$

b)

$$\begin{aligned} & RTT_1 + \cdots + RTT_n + 2RTT_o + 2RTT_o \\ &= 4RTT_o + RTT_1 + \cdots + RTT_n . \end{aligned}$$

c)

$$\begin{aligned} & RTT_1 + \cdots + RTT_n + 2RTT_o + RTT_o \\ &= 3RTT_o + RTT_1 + \cdots + RTT_n . \end{aligned}$$

Problem 20

Alice sends her query to at most N neighbors. Each of these neighbors forwards the query to at most M = N-1 neighbors. Each of those neighbors forwards the query to at most M neighbors. Thus the maximum number of query messages is

$N + NM + NM^2 + \ldots + NM^{(K-1)}$
$= N(1 + M + M^2 + \ldots + M^{(K-1)})$
$= N(1-M^K)/(1-M)$
$= N[(N-1)^K - 1]/(N-2)$.