Solutions to Midterm Exam I for CSCI470

Problem P26 from Chapter 1

Consider sending a large file of F bits from Host A to Host B. There are two links (and one switch) between A and B, and the links are uncongested (that is, no queuing delays). Host A segments the file into segments of S bits each and adds 40 bits of header to each segment, forming packets of $L = 40 + S$ bits. Each link has a transmission rate of R bps. Find the value of S that minimizes the delay of moving the file from Host A to Host B. Disregard propagation delay.

Solution

Time at which the 1st packet is received at the destination is $\frac{S+40}{R} \times 2$ sec. After this, one packet is received at destination every $\frac{S+40}{R}$ sec. Thus delay in sending the whole file is

$$\text{delay} = \frac{S+40}{R} \times 2 + \left(\frac{F}{S} - 1\right)\left(\frac{S+40}{R}\right) = \left(\frac{S+40}{R}\right)\left(\frac{F}{S} + 1\right)$$

To calculate the value of S which leads to the minimum delay, compute the derivative $\frac{d}{dS}\text{delay} = \frac{F}{R}\left(\frac{1}{S} - \frac{40+S}{S^2}\right) + \frac{1}{R}$. The derivative is 0 for $S = \sqrt{40F}$.

Problem P16 from Chapter 2

Consider distributing a a file of $F = 10$ Gbps to N peers. The server has an upload rate of $u_s = 20$ Mbps, and each peer has a download rate of $d_i = 1$ Mbps and upload rate of u. For $N = 10$, 100, and 1000 and $u = 200$ Kbps, 600 Kbps, and 1 Mbps, prepare a chart giving the minimum distribution time for each of the combinations of N and u for both client-server distribution and P2P distribution.

Solution

For calculating the minimum distribution time for client-server distribution, we use the following formula:

$$D_{cs} = \max\{NF/u_s, F/d_{\min}\}$$

Similarly, for calculating the minimum distribution time for P2P distribution, we use the following formula:

$$D_{P2P} = \max\{F/u_i, F/d_{\min}, NF/\left(u_s + \sum_{i=1}^{N} u_i\right)\}$$

Table 1: Client - Server

	$N = 10$	$N = 100$	$N = 100$
$u = 200$Kbps	10240	51200	512000
$u = 600$Kbps	10240	51200	512000
$u = 1$Mbps	10240	51200	512000

Table 2: Peer to Peer

	$N = 10$	$N = 100$	$N = 100$
$u = 200$Kbps	10240	25904.3	47559.33
$u = 600$Kbps	10240	13029.6	6899.64
$u = 1$Mbps	10240	10240	10240

For $F = 10$ Gbits $= 10 \cdot 1024$ Mbits, $u_s = 20$ Mbps and $d_{\min} = d_i = 1$ Mbps we get the following tables:

Problem P23 from Chapter 2

Consider query flooding as discussed in Section 2.6. Suppose that each peer is connected to at most N neighbors in the overlay network. Also suppose that the node-count field is initially set to K. Suppose Alice makes a query. Find an upper bound on the number of query messages that are sent into the overlay network.

Solution

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

$$\begin{aligned} N + NM + NM^2 + \quad + NM^{K-1} &= N(1 + M + M^2 + \quad + M^{K-1}) \\ &= N\frac{1 - M^K}{1 - M} \\ &= N\frac{(N-1)^K - 1}{N - 2} \end{aligned}$$

Problem P42 from Chapter 3

In this problem we consider the delay introduced by the TCP slow-start phase. Consider a client and a Web server directly connected by one link of rate R. Suppose the client wants to retrieve an object whose size is exactly equal to $15S$, where S is the maximum segment size (MSS). Denote the round-trip time between client and server as RTT (assumed to be constant). Ignoring protocol headers, determine the time to retrieve the object (including TCP connection establishment) when

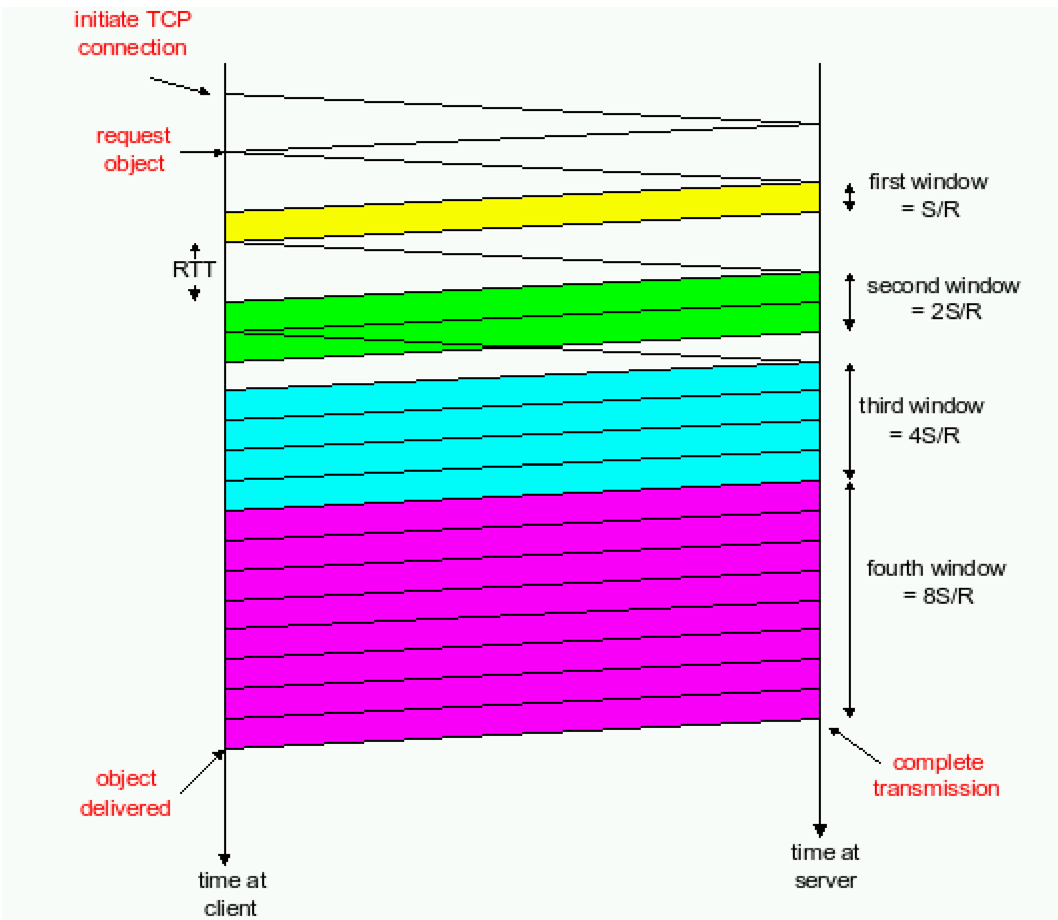
1. $4S/R > S/R + RTT > 2S/R$
2. $8S/R > S/R + RTT > 4S/R$
3. $S/R > RTT$

Solution

This problem concerns the slow-start phase of connection, where the connection speed doubles every round and the threshold is not yet achieved. Hence, there is no any package loss. Note that $15S = 1S + 2S + 4S + 8S$.

1. Referring to the figure below, we see that the total delay is

$$\mathrm{RTT} + \mathrm{RTT} + S/R + \mathrm{RTT} + S/R + \mathrm{RTT} + 12S/R = 4 \cdot \mathrm{RTT} + 14 \cdot S/R$$



2. Similarly, the delay in this case is:

$$\mathrm{RTT} + \mathrm{RTT} + S/R + \mathrm{RTT} + S/R + \mathrm{RTT} + S/R + \mathrm{RTT} + 8S/R = 5 \cdot \mathrm{RTT} + 11 \cdot S/R$$

3. Similarly, the delay in this case is:

$$\mathrm{RTT} + \mathrm{RTT} + S/R + \mathrm{RTT} + 14S/R = 3 \cdot \mathrm{RTT} + 15 \cdot S/R$$

Programming Assignment 4

Check solution at
`http://mcs.uwsuper.edu/sb/470/Exams/Solutions/Ex1_5.php`