King Fahd University of Petroleum and Minerals
College of Computer Sciences and Engineering
Department of Computer Engineering

COE 540 – Computer Networks (T082)

Homework # 03 (*due date: Tuesday 09/06/2009 during class period*)

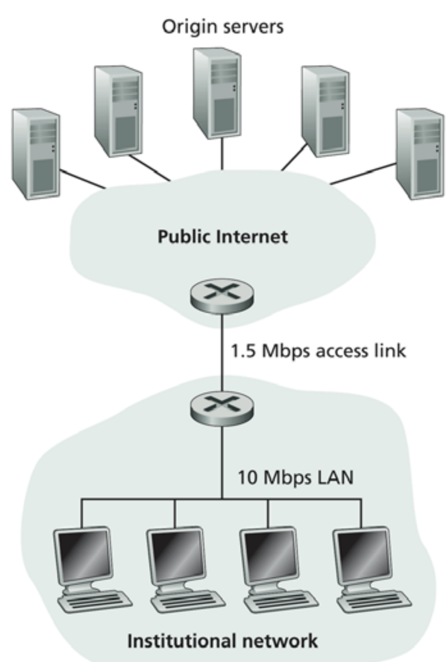
Problem # 1 (50 points):

a. Suppose within your web browser you click on a link to obtain a web page. Suppose that the IP address for the associated URL is not cached in your local host, so that a DNS look-up is necessary to obtain the IP address. Suppose that three (3) DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of RTT_1, RTT_2, and RTT_3. Further suppose that the web page associated with the link contains exactly one object, the base HTML file. Assume that a proxy server is used and the requested web page is not cached by the proxy server. Let RTT_0 denote the RTT between the local host and the proxy server. Likewise, let RTT_0 denote the RTT between the proxy server and the server containing the object. Assuming zero transmission time of the object (i.e. base HTML file), find the amount of time that elapses from when the client clicks on the link until the client receives the object.

b. Suppose the base HTML file of part (a) indexes two (2) objects that reside on a ***different*** server than the server hosting the base HTML file, and the IP address of such a server is not cached in your local host. Assume that the proxy server already have a cached copy of the two indexed objects. Let RTT_0 denote the RTT between the local host and the proxy server. Likewise, let RTT_0 denote the RTT between the proxy server and the server containing the two indexed objects. Assuming the transmission time for each of the two indexed objects is t_{trans}, find the total amount of time that elapses to obtain the two objects, including the time to obtain the base HTML file found in part (a), with:
   i. nonpersistent HTTP with no parallel TCP connections
   ii. nonpersistent HTTP with parallel TCP connections
   iii. persistent HTTP without pipelining
   iv. persistent HTTP with pipelining

Problem # 2 (20 points):

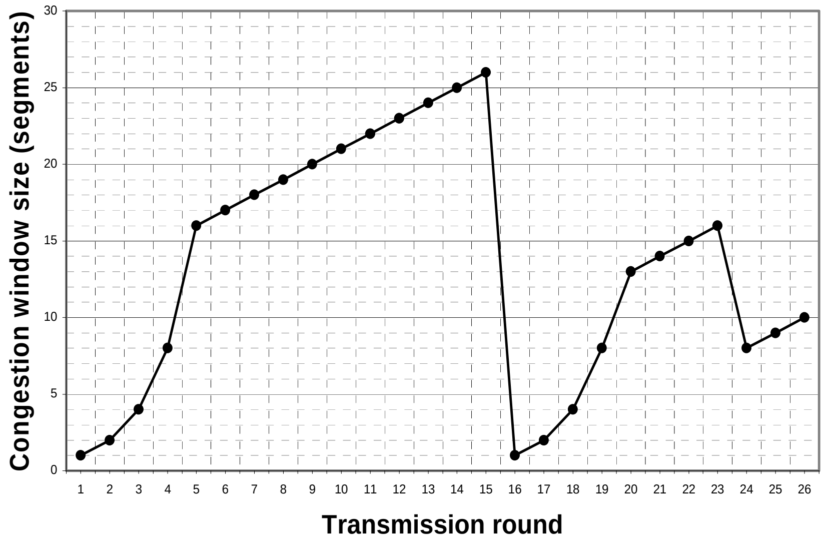
Consider the shown figure, for which there is an institutional network connected to the Internet. Suppose that the average object size is 900,000 bits and that the average request rate from the institution's browsers to the origin servers is 1.5 requests per second. Also suppose that the amount it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is three (3) seconds on average. Model the total average response time as the sum of the average access delay (i.e. the delay from Internet router to institution router), and the average Internet delay. For the average access delay, use $\Delta / (1 - \Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.



a. Find the total average response time.
b. Now suppose a cache is installed in the institutional LAN. Suppose the hit rate is 0.6, and, on a hit, the response time is 10 milliseconds. Find the total response time.

<u>Problem # 3 (30 points):</u>

Consider the following plot of TCP window size as a function of time.



a) Identify the intervals of time when TCP *slow start* is operating.
b) Identify the intervals of time when TCP *congestion avoidance* is operating.
c) After what transmission round(s) is segment loss detected by a triple duplicate ACK?
d) After what transmission round(s) is segment loss detected by a timeout?
e) What is the initial value of `Threshold` at the first transmission round?
f) What is the value of `Threshold` at the 11th transmission round?
g) What is the value of `Threshold` at the 18th transmission round?
h) What is the value of `Threshold` at the 26th transmission round?
i) During what transmission round is the 70th segment sent?
j) Assuming a packet loss is detected after the 26th round by a <u>timeout</u>, what will be the values of the congestion-window size <u>and</u> of the `Threshold`?