Assignment 2

Assignments Instructions:

1- Please briefly justify/explain your approach and/or answers.

2- In addition to your approach, please calculate the final answer when applicable.

3- Use the coversheet provided in the course page.

4- If you decide to team up with another student in an assignment, please recall that you are NOT allowed to team up with one student more than once in this course for all assignments (no matter if required or optional) .

Problem 1 HTTP response time

Consider Figures 2.12 and 2.13, for which there is an institutional network connected to the Internet. However, assume the bandwidth on the access link is 100Mbps and the bandwidth within the institutional LAN is 1000Mbps. Also, suppose that the average object size is 850,000 bits and that the average request rate from the institution's browsers to the origin servers is 16 requests per second. Suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is 3 seconds. Model the total average response time as the sum of the average access delay and the average Internet delay. For the average access delay, use the following formula:

$$\frac{\Delta}{(1 - \Delta \times \beta)}$$

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. Answer the following two questions:

a) Find the total average response time.

b) Now suppose a cache is installed in the institutional LAN. Suppose the miss rate is 0.4. Find the total response time.

Problem 2 (Non)Persistent HTTP Connection

Suppose you use the HTTP protocol to download a Web page that resides on some Web server. The cases of *persistent* and *non-persistent* connections will be considered. Define the response time as the time from when you request the URL of the Web page to the time when the page and its embedded images are displayed.

The assumptions are:

- The base html file has a size of B_f bytes.
- The Web page contains *m* embedded images I_1, I_2, ..., I_m, each image has a size of B_i bytes.
- The *m* images are stored on the same Web server.
- The propagation delay between your host and the Web server is T_p seconds.
- The network path between your host and the Web server has a link capacity of *R* bytes/second.
- The time it takes to transmit a GET message into the link is zero (i.e., the transmission delay is zero for the GET messages).
- Other than propagation and transmission delays, ignore any other types of delays (such as the DNS-related delay).

In terms of *m*, T_p, B_f , B_i, *R* give answers to the following questions:

a) What is the two-way propagation delay between the client and server (denoted T_{tp})?

b) What is the transmission delay (denoted T_{tf}) of the base html file?

c) What is the transmission delay (denoted T_{ti}) of each of the embedded images?

d) What is the required time to conduct the two-step handshaking?

e) Assuming a non-persistent HTTP connection, how long is the response time? Describe and detail the various components that contribute to this delay.

f) Assuming a persistent HTTP connection, how long is the response time? Describe and detail the various components that contribute to this delay.

Problem 3 Parallel download

Assume a wireless link between a client and a web server is 10 meters long, and a sender can transmit at a rate of 200 bps in both directions and packets containing data are 300 Kbits long. Assume that *m* parallel connections each get an equal share of the link bandwidth.

Consider the HTTP protocol, and suppose that each downloaded object is 300 Kbits long and that the initial downloaded object contains 10 referenced objects from the same sender.

a) Would parallel downloads via parallel instances of non-persistent HTPP make sense in this case?

b) Now consider persistent HTTP with no parallel downloads. Do you expect significant gains over the non-persistent case?

Assume t_p is the one way propagation delay between the client and the web server and the size of the control packets is negligible but consider the delays for control packets.

Problem 4 DNS

a) Assume you want to retrieve a web page from *mylab.mie.utoronto.ca*. As your PC or the local DNS server do not have the IP address, then the root, TLD, and authoritative servers should all be visited to resolve the IP address. Now suppose that the round-trip time between your PC and the local DNS server is 2 msec. Further, assume that the subsequent delay between the local DNS server and each of the Root, TLD, and authoritative servers is 10 msec and that each department has its own authoritative name server for its labs. How long would it take for your PC to obtain the IP address of the web server?

b) Now assume that we want to obtain another web page from *mylab.ece.utoronto.ca* immediately after retrieving a web page from *mylab.mie.utoronto.ca*. How long would the DNS resolution take?

Problem 5 File distribution using C/S & P2P

Consider distributing a file of F = 150 Gbits to 1,000,000 peers. The server has an upload rate of u_s = 100 Gbps, and each peer has a download rate of d_i = 2 Mbps and an upload rate of u_i = 500 Kbps. Calculate the minimum distribution time for two cases:

a) If client-server file distribution is used.

b) If a P2P file distribution is used.