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COMP-4320-002
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Homework 2

1) (16 pts) Consider an HTTP client that wants to retrieve a Web document at a given URL. The IP address of the HTTP server is initially unknown. What transport and application-layer protocols besides HTTP are needed in this scenario?

The application-layer protocol that would be used besides HTTP is DNS, because it will be used to translate the user-supplied hostnames to IP addresses. In addition, the transport protocols that will be used are UDP for DNS and TCP for HTTP.

2) (16 pts) Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address. Suppose that k DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of RTT1, ..., RTTk. Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let RTTx denote the RTT between the local host and the server containing the object. Assume that the transmission time of the object is dt. How much time elapses from when the client clicks on the link until the client receives the object.

$2 * RTT_x + d_t + RTT_1 + \cdots + RTT_k$

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3) (16 pts) Referring to Problem 2 above (with the same pre-condition to visit k DNS servers), suppose the HTML file references sixteen very small objects on the same server. Neglecting transmission time, how much time elapses with

a. Non-persistent HTTP with no parallel TCP connections?

b. Non-persistent HTTP with the browser configured for six parallel connections?

c. Persistent HTTP? (Assume that pipelining is used.)

a) $2 * RTT_x + d_t + RTT_1 + \cdots + RTT_k + 16 * 2 * RTT_x =$

$34 * RTT_x + d_t + RTT_1 + \cdots + RTT_k$

b) $2 * RTT_x + d_t + RTT_1 + \cdots + RTT_k + 2 * 3 * RTT_x =$

$8 * RTT_x + d_t + RTT_1 + \cdots + RTT_k$

c) $2 * RTT_x + d_t + RTT_1 + \cdots + RTT_k + RTT_x =$

$3 * RTT_x + d_t + RTT_1 + \cdots + RTT_k$

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4) (16 pts) Consider a short, 50-meter link, over which a sender can transmit at a rate of 1600 bits/sec in both directions. Suppose that packets containing data are 300,000 bits long, and packets containing only control (e.g. ACK or handshaking) are 400 bits long. Assume that k parallel connections each get 1/k of the link bandwidth. Now consider the HTTP protocol, and assume that each downloaded object is 300 Kbit long, and the initial downloaded object contains 8 referenced objects from the same sender. Would parallel download via parallel instances of non-persistent HTTP make sense in this case? Now consider persistent HTTP. Do you expect significant gains over the non-persistent case? Justify and explain your answer.

Considering parallel download via parallel instances of non-persistent HTTP:

$$\left(3 * \left(\frac{300}{1600}\right) + \frac{300000}{1600}\right) + \left(3 * \left(\frac{300}{\frac{1600}{8}}\right) + \left(\frac{300000}{\frac{1600}{8}}\right)\right) = 1692.5625\ sec$$

Considering persistent HTTP:

$$\left(3 * \left(\frac{300}{1600}\right) + \frac{300000}{1600}\right) + \left(8 * \left(\frac{300}{1600}\right) + \frac{300000}{1600}\right) = 377.0625\ sec$$

As a result, persistent HTTP did produce significant gains over the non-persistent case.

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5) (16 pts) Consider the scenario introduced in Question (4) above. Now suppose that the link is shared by James with ten other users. James uses parallel instances of non-persistent HTTP, and the other ten users use non-persistent HTTP without parallel downloads.

a. Do James's parallel connections help him get Web pages more quickly? Why or why not?

b. If all eleven users open parallel instances of non-persistent HTTP, then would James's parallel connections still be beneficial? Why or why not?

a) Yes, since James uses parallel instances of non-persistent HTTP compared to non-persistent HTTP without parallel downloads, his response time to the web pages are quicker.

b) Yes, James parallel connections would still be beneficial because parallel is always quicker compared to non-parallel in reference to non-persistent HTTP.

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6) (20 pts) Consider the following institutional network that is connected to the Internet.

Suppose that the average object size is 320,000 bits and that the average request rate from the institution’s browsers to the origin servers is 46 requests per second. Also suppose that the amount of time it take from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is 2.5 seconds on average (see Section 2.2.5). Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the average access delay, use α/(1- αλ), where α is the average time required to send an object over the access link and λ is the arrival rate of objects to the access link.

a) $\alpha = \frac{320000}{15000000} = 0.0213\ sec$

$\alpha\Delta = 0.0213 * 46 = 0.9798$

average access delay = $\frac{0.0213}{1-0.9798} = 1.0545$

total average response time = $1.0545 + 2.5 = 3.5545$

b) miss rate = $1 - 0.25 = 0.75$

average access delay = $\frac{0.0213}{1-(0.75)(0.9798)} = 0.0803\ sec$

average response time (cache misses) = $0.0803 + 2.5 = 2.5803$

total average response time = $0.75 * 2.5803 = 1.9352$