

COMP 431 — INTERNET SERVICES & PROTOCOLS

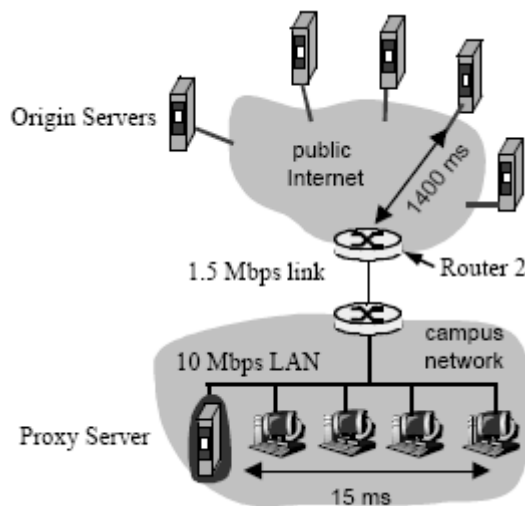
Spring 2009

Homework 7, February 23

Due: 9:30 am, Mar 2

Note: Late solutions for this assignment cannot be accepted.

1. [8+2 = 10 pts] Consider the network configuration for a small corporate campus shown in the figure below. The only traffic on the corporate network is generated by browsers accessing web objects stored by origin servers on the public Internet. A web proxy server with a cache has been installed on the corporate network and all the browsers configured to send HTTP/1.0 requests to the proxy server when the requested object cannot be found in the browser's local cache.



Measurements on this network indicate that the company browsers in aggregate send 75 HTTP requests per second to the proxy server and the mean size of all HTTP responses is 50,000 bits (the size of HTTP requests is negligible relative to the size of the responses).

If the requested object is found in the proxy's cache, the mean request/response latency for accessing the object is 15 milliseconds (including TCP connection overhead). If the requested object is not found in the proxy's cache, the proxy server makes an HTTP/1.0 request to the appropriate origin server and receives the object which is then added to the cache before the response is returned to the browser.

- Assume that the mean HTTP request/response latency between Router 2 and all origin servers is 1,400 milliseconds (including TCP connection delays). Suppose we want to achieve an overall mean request/response latency of 450 milliseconds or less for all requests sent by the browsers to the proxy server. What is the smallest cache hit ratio at the proxy cache that will yield 450 milliseconds of latency for all requests? You may assume queuing and processing delays in routers 1 and 2 and all TCP connection establishment delays are negligible.
- Given the hit ratio obtained in part 1, is the assumption of negligible queuing delays at router 2 valid or invalid? Give a clear and explicit analysis and justification for your answer.

2. [6+6+2 = 14 pts] Consider a web page for a hypothetical company *dog.com*. The HTML file for their main web page, *www.dog.com*, is 20,000 bits and contains the following embedded URLs (*i.e.*, the following URLs are contained in the HTML source for *www.dog.com*):

http://www.dog.com/dog-banner.jpg (15,000 bits)
http://www.cat.com/meow-add.jpg (10,000 bits)
http://www.bird.com/chirp-add.jpg (10,000 bits)
http://www.cat.com/puss-chow-add.jpg (10,000 bits)
http://www.dog.com/dog-chow-add.jpg (10,000 bits)
http://www2.dog.com/cookie.crumb (5,000 bits)

Consider the operation of the HTTP protocol to download the base page (*www.dog.com*) and the embedded objects. Assume:

- i) All network links connecting the browser to each server operate at 100 Mbps.
- ii) The browser has an internal (empty) browser cache and that there is no proxy cache on the network.
- iii) The round trip time from the browser to all servers in the *dog.com* domain is 50 ms, the round trip time from the browser to *www.cat.com* is 10 ms, and the round trip time from the browser to *www.bird.com* is 20 ms.

How long would it take to download the *dog.com* home page and all the embedded objects if the browser used:

- (a) Up to 4 parallel, non-persistent connections.
- (b) Persistent, non-parallel connections.

In answering these questions you should start with the time required for the initial TCP handshake (and assume here that the *transmission* time for the handshake is negligible). You may also ignore the overhead of DNS name resolution, assume there is no queuing or routing delay in the network, and assume that all objects are transferred in one network-layer frame.

- (c) Given that most computers have a single network interface that can only transmit or receive bytes of data from one connection at a time (*i.e.*, there is no true parallel transmission or reception), why are the use of parallel HTTP connections a good idea?

3. [6+4 = 10 pts] Consider a web page for a mythical company *dogmyth.com* that contains the following embedded URLs (*i.e.*, the following URLs are contained in the HTML source for the *dogmyth.com* home page):

http://www.dogmyth.com/logo.gif
http://www.ads.dogmyth.com/dog-banner.jpg
http://www.ads.cat.biz/meow-add.jpg
http://www.ads.bird.biz/chirp-add.jpg
http://www.cat.biz/happy-cat.jpg
http://www.dogmyth.com/happy-dog.jpg
http://www2.dogmyth.com/cookie.crumb

Consider the DNS name resolution that is required for a browser to locate and request all components of this web page beginning with the home page URL *http://www.dogmyth.com*. Assume there is no browser cache of web objects, no web proxy server, and the browser's resolver does not cache any DNS results. In answering the following questions you may assume:

- The cache for the local authoritative DNS server is initially empty and no other resolvers attempt to use that server until all these HTTP requests are completely satisfied.

- The local authoritative DNS server always sends iterated queries.
 - For the domain names in the above URLs, there is a different authoritative DNS server for each unique domain in the name hierarchy. Domain names with a prefix of “www” are all assigned to host machines.
- (a) Show the contents of the cache on the local authoritative DNS server used by a browser accessing the dogmyth.com home page after the page has been entirely fetched. For each entry in the cache, show only the values of the name and type fields for the entry.
- (b) How many DNS query/reply protocol message exchanges with other DNS servers are processed by the local authoritative DNS server during the process of fetching all components of the dogmyth.com home page? Explain how you obtained your answer.
4. [7 pts] Consider sending a large file of F bits from server A to client B . A and B are separated by two (identical) network links with capacity (transmission rate) C and one router. Server A 's transport layer segments the file into S bit segments and adds 40 bits of header to each segment (so an outgoing segment is $S + 40$ bits). Assume the network links are uncongested (*i.e.*, there is no queuing delay in the router) and the propagation delay is negligible. Assume further that the processing time to forward packets inside the router is also negligible.

Derive the value of S (as a function of F) that minimizes the delay of transferring the file from server A to client B .

Appendix: A Reminder on the Honor Code

Students are *encouraged* to work together on this homework assignment. *Acceptable collaboration* includes:

- Discussing the assigned problems to understand their meaning,
- Discussing possible approaches to assigned problems,

In *all* cases you must *explicitly* acknowledge *any and all substantive help received from other individuals* during the course of the preparation of your homework solution. That is, if you collaborate with other individuals then you *must* include an explicit acknowledgment in your homework solution of the persons from whom you received aid. You should include the acknowledgement with your Honor Code pledge. Acknowledging others, if done properly, will not adversely affect your grade.

Unacceptable collaboration on written homework includes:

- Copying (verbatim use) of physical papers or computer files,¹ and
- Submission of solutions that are jointly authored, or authored either wholly or in part by other individuals.

The general rule to be followed is that the strategy and approach of solutions may be developed jointly but *all* actual solutions (*i.e.*, the final solution) must be *constructed* and *written up* individually. Work done jointly should not be done in sufficient detail as to make it a final solution. For example, solutions may *sketched* out jointly, however each student must construct the final form of their solution individually and write-up their own solution. Should questions arise the course of working on a problem please feel free to immediately contact the instructor either by telephone, electronic mail, or by an office visit. In principle, if you work with others in good faith and are honest and generous with your attributions of credit you will have no problems.

¹ This includes computer files that are copied and then edited and/or reformatted.