Assignment # 1, EG-101

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1. Write a comparison (preferably in a tabular format with common attributes, diagrammatic representations if any) between HTTP 2.0, HTTPS and HTTP 3.0. (Note: Answers should NOT exceed 2 pages)

2. Consider two hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by m meters, and suppose the propagation speed along the link is s meters/sec. Host A is to send a packet of size L bits to Host B.
   a. Express the propagation delay, d_{prop}, in terms of m and s.
   b. Determine the transmission time of the packet, d_{trans}, in terms of L and R.
   c. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.
   d. Suppose Host A begins to transmit the packet at time $t = 0$. At time $t = d_{trans}$, where is the last bit of the packet?
   e. Suppose d_{prop} is greater than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?
   f. Suppose d_{prop} is less than d_{trans}. At time $t = d_{trans}$, where is the first bit of the packet?
   g. Suppose $s = 2.5 \times 108$, $L = 120$ bits, and $R = 56$ kbps. Find the distance m so that d_{prop} equals d_{trans}.

3. Suppose users share a 3 Mbps link. Also suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of the time. (See the discussion of packet switching versus circuit switching in the class and Section 1.3 of the book.)
   a. When circuit switching is used, how many users can be supported?
   b. For the remainder of this problem, suppose packet switching is used. Suppose there are N users. Find the probability that at any given time, exactly n users are transmitting simultaneously. (*Hint*: Use the binomial distribution.)
   d. Find the probability that there are 21 or more users transmitting simultaneously.
   e. How do we fix N in this case? Give a step-by-step procedure.

4. Consider the following string of ASCII characters that were captured by Wireshark when the browser sent an HTTP message. The characters *<cr><lf>* are carriage return and line-feed characters (that is, the italized character string *<cr>* in the text below

represents the single carriage-return character that was contained at that point in the HTTP header). Answer the following questions.

```
GET /cs453/index.html HTTP/1.1<cr><lf>Host: gai
a.cs.umass.edu<cr><lf>User-Agent: Mozilla/5.0 (
Windows;U; Windows NT 5.1; en-US; rv:1.7.2) Gec
ko/20040804 Netscape/7.2 (ax) <cr><lf>Accept:ex
t/xml, application/xml, application/xhtml+xml, text
/html;q=0.9, text/plain;q=0.8,image/png,*/*;q=0.5
<cr><lf>Accept-Language: en-us,en;q=0.5<cr><lf>Accept-
Encoding: zip,deflate<cr><lf>Accept-Charset: ISO
-8859-1,utf-8;q=0.7,*;q=0.7<cr><lf>Keep-Alive: 300<cr>
<lf>Connection:keep-alive<cr><lf><cr><lf>
```

a. Is the HTTP message a request or response?
b. What kind of HTTP request is it?
c. What is the URL of the document requested by the browser?
d. What version of HTTP is the browser running?
e. Does the browser request a non-persistent or a persistent connection?
f. What is the IP address of the host on which the browser is running?
g. What type of browser initiates this message? Why is the browser type needed in an HTTP request message?

5. 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 *n* DNS servers are visited before your host receives the IP address from DNS; the successive visits incur an RTT of $RTT_1, \ldots, RTT_n$. Further suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Let RTT_0 denote the RTT between the local host and the server containing the object. Answer the following questions.

   a. Assuming negligible transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?
   b. Suppose the base HTML file references eight very small objects on the same server. How much time elapses with Non-persistent HTTP with no parallel TCP connections?
   c. How much time elapses with Non-persistent HTTP with the browser configured for 5 parallel connections? Clearly state assumptions, if any, made for this calculation.
   d. How much time elapses with Persistent HTTP?

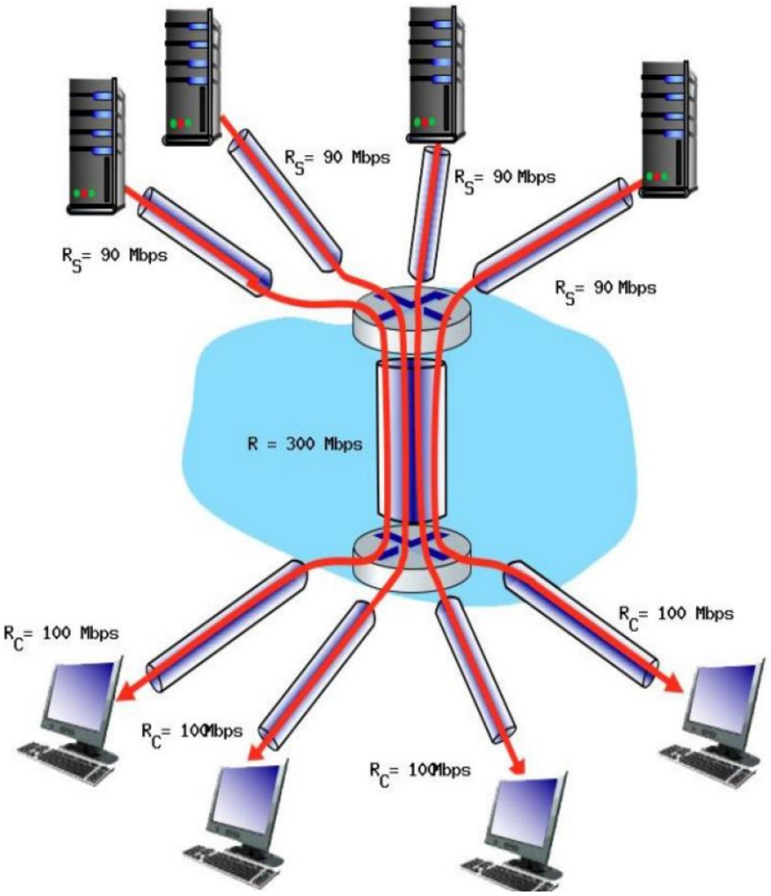
6. Consider a short, 10-meter **single** link, over which a sender can transmit at a rate of 150 bits/sec in both directions. Suppose that packets containing data are 100,000 bits long, and packets containing only control (e.g., ACK or handshaking) are 200 bits long.

Assume that N parallel connections each get $1/N$ of the link bandwidth. Now consider the HTTP protocol, and suppose that each downloaded object is 100 Kbits long, and that the initial downloaded object contains 10 referenced objects from the same sender. Answer the following questions

a) What is the propagation delay d_{prop}? Can we ignore this? Why?
b) Consider non-persistent HTTP 1.0 for the above download. Calculate the total time taken.
c) Consider parallel downloads via parallel instances of non-persistent HTTP 1.0. Is there any gain over b)? Why?
d) Consider the persistent case without and with pipelining? Calculate the total time taken for the download. Is there any gain over b) and c)? Why?
e) Consider this hypothetical scenario now. The link is located 30,000 kms away and the link capacity is 150 Mbits/sec in both directions. Re-compute answers for questions a)-d).

7. Consider the scenario shown below, with four different servers connected to four different clients over four three-hop paths. The four pairs share a common middle hop with a transmission capacity of R = 300 Mbps. The four links from the servers to the shared link have a transmission capacity of RS = 90 Mbps. Each of the four links from the shared middle link to a client has a transmission capacity of RC = 100 Mbps.

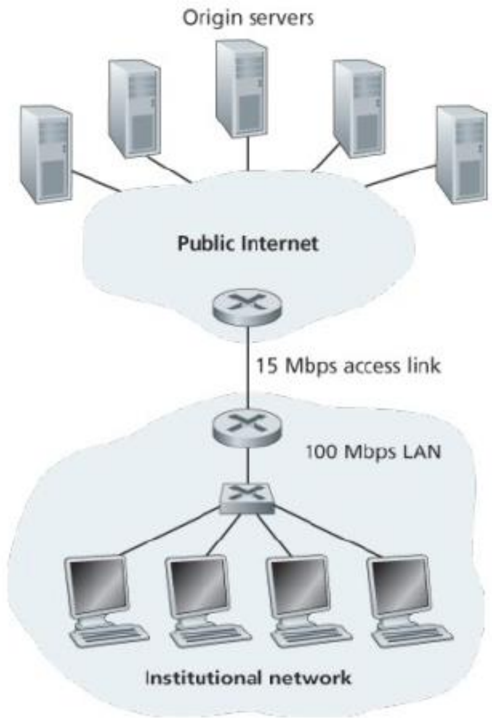
   a) What is the maximum achievable end-end throughput (in Mbps) for each of four client-to server pairs, assuming that the middle link is fairly shared (divides its transmission rate equally)?
   b) Which link is the bottleneck link? Format as Rc, Rs, or R
   c) Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the server links (RS)?
   d) Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the client links (RC)?
   e) Assuming that the servers are sending at the maximum rate possible, what are the link utilizations for the shared link (R)?



8. Consider the figure given below, for which there is an institutional network connected to the Internet. 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. Also 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 three seconds on average (see Section 2.2.5 7th Edition, Computer Networking - A Top Down Approach, Kurose and Ross). 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 $\Delta/(1-\Delta\beta))$ 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 cache hit rate is 0.6. Find the total average response time. You may assume the response time is 0 if the request is satisfied by the cache.


Origin servers
Public Internet
15 Mbps access link
100 Mbps LAN
Institutional network