

P4. Consider the following string of ASCII characters that were captured by Wireshark when the browser sent an HTTP GET message (i.e., this is the actual content of an HTTP GET message). The characters <cr><lf> are carriage return and line-feed characters (that is, the italicized 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, indicating where in the HTTP GET message below you find the answer.

```
GET /cs453/index.html HTTP/1.1<cr><lf>Host: gaia.cs.umass.edu<cr><lf>User-Agent: Mozilla/5.0 (Windows;U; Windows NT 5.1; en-US; rv:1.7.2) Gecko/20040804 Netscape/7.2 (ax) <cr><lf>Accept: text/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. What is the URL of the document requested by the browser?

gaia.cs.umass.edu/cs453/index

b. What version of HTTP is the browser running?

1.1

c. Does the browser request a non-persistent or a persistent connection?

persistent

d. What is the IP address of the host on which the browser is running?

gaia.cs.umass.edu

e. What type of browser initiates this message? Why is the browser type needed in an HTTP request message?

Mozilla. Different browsers interpret web pages differently

P5. The text below shows the reply sent from the server in response to the HTTP GET message in the question above. Answer the following questions, indicating where in the message below you find the answer.

```
HTTP/1.1 200 OK<cr><lf>Date: Tue, 07 Mar 2008
12:39:45GMT<cr><lf>Server: Apache/2.0.52 (Fedora)
<cr><lf>Last-Modified: Sat, 10 Dec2005 18:27:46
GMT<cr><lf>ETag: "526c3-f22-a88a4c80"<cr><lf>Accept-
Ranges: bytes<cr><lf>Content-Length: 3874<cr><lf>
Keep-Alive: timeout=max=100<cr><lf>Connection:
Keep-Alive<cr><lf>Content-Type: text/html; charset=
ISO-8859-1<cr><lf><cr><lf><!doctype html public "-//w3c//dtd html 4.0 transitional//en"><lf><html><lf>
<head><lf> <meta http-equiv="Content-Type"
content="text/html; charset=iso-8859-1"><lf> <meta
name="GENERATOR" content="Mozilla/4.79 [en] (Windows NT
5.0; U) Netscape]"><lf> <title>CMPSCI 453 / 591 /
NTU-ST550A Spring 2005 homepage</title><lf></head><lf>
<much more document text following here (not shown)>
```

a. Was the server able to successfully find the document or not? What time was the document reply provided?

Yes, on Tue, 07 Mar 2008 12:39:45GMT

b. When was the document last modified?

Sat, 10 Dec2005 18:27:46 GMT

c. How many bytes are there in the document being returned?

3874

d. What are the first 5 bytes of the document being returned? Did the server agree to a persistent connection?

CMPSC . Persistent

P7. 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, \dots, 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. Assuming zero transmission time of the object, how much time elapses from when the client clicks on the link until the client receives the object?

$$2RTT[0] + RTT[1] + RTT[2] + \dots + RTT[n] + RTT[obj]$$

P8. Referring to Problem P7, suppose the HTML file references eight very small objects on the same server. Neglecting transmission times, how much time elapses with

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

$$2RTT[0] + RTT[1] + RTT[2] + \dots + RTT[n] + 8RTT[obj]$$

b. Non-persistent HTTP with the browser configured for 5 parallel connections?

$$4RTT[0] + RTT[1] + RTT[2] + \dots + RTT[n]$$

c. Persistent HTTP?

$$2RTT[0] + RTT[1] + RTT[2] + \dots + RTT[n] + RTT[obj]$$

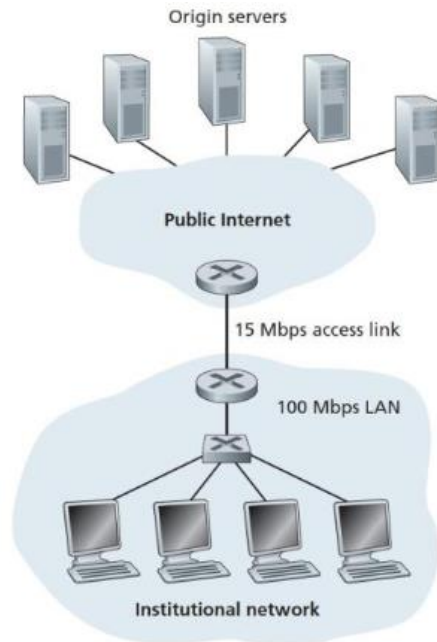


Figure 2.12 ♦ Bottleneck between an institutional network and the Internet

P9. Consider Figure 2.12, 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). 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 $\Delta/(1 - \Delta B)$, where Δ is the average time required to send an object over the access link and B is the arrival rate of objects to the access link.

a. Find the total average response time.

$$\Delta = d[\text{trans}] = L/R = 850,000/15,000,000 = 0.0567 \text{ s}$$

$$\Delta B = \text{Intensity} = \lambda a/R = (850,000 * 16) / 15,000,000 = 0.907$$

$$\Delta/(1 - \Delta B) = 0.0567/(1 - 0.907) = 0.6 \text{ s}$$

$$\text{avg} = 3 + 0.6 = 3.06 \text{ s}$$

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

$$\Delta/(1 - (\text{miss rate} * \Delta B)) = 0.0567/(1 - (0.4 * 0.907)) = 0.089 \text{ s}$$

$$\text{Avg}[\text{LAN}] = 3 + 0.089 = 3.089 \text{ s}$$

$$\text{Avg}[\text{Total}] = (0.6 * 0) + (0.4 * 3.089) = 1.24 \text{ s}$$

P10. Consider a short, 10-meter 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 hand-shaking) 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. Would parallel downloads 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.

Note: assume all the transmissions on the parallel connections are 100% parallel.

$$d = 10 \text{ m}$$

$$R = 150 \text{ bps}$$

$$L[\text{packet}] = 100,000 \text{ b}$$

$$L[\text{control}] = 200 \text{ b}$$

$$N = 10 \text{ conns}$$

$$L[\text{obj}] = 100,000,000 \text{ b}$$

$$R_2 = R/N = 150/10 = 15 \text{ bps}$$

Non-persistent:

$$\begin{aligned} T &= (200/150 + d[\text{prop}]) + (200/150 + d[\text{prop}]) + (200/150 + d[\text{prop}]) + (100000/150 + d[\text{prop}]) + (200/15 \\ &+ d[\text{prop}]) + (200/15 + d[\text{prop}]) + (200/15 + d[\text{prop}]) + (100000/15 + d[\text{prop}]) \\ &= 100,600/150 + 100,600/15 + 8d[\text{prop}] \\ &= 7377 + 8d[\text{prop}] \end{aligned}$$

Persistent:

$$\begin{aligned} T &= (200/150 + d[\text{prop}]) + (200/150 + d[\text{prop}]) + (200/150 + d[\text{prop}]) + (100000/150 + d[\text{prop}]) + \\ &10 * [(200/150 + d[\text{prop}]) + (100000/150 + d[\text{prop}])] \\ &= 100,600/150 + 4d[\text{prop}] + 10 * (100,200/150 + 2d[\text{prop}]) \\ &= 670 + 4d[\text{prop}] + 6680 + 20d[\text{prop}] \\ &= 7350 + 24d[\text{prop}] \end{aligned}$$

Not much significant gain over non-persistent