Chapter 2 Problems

Problem 1

a) F
b) T
c) F
d) F
e) F

Problem 2

Access control commands:
USER, PASS, ACT, CWD, CDUP, SMNT, REIN, QUIT.

Transfer parameter commands:
PORT, PASV, TYPE STRU, MODE.

Service commands:
RETR, STOR, STOU, APPE, ALLO, REST, RNFR, RNTO, ABOR, DELE, RMD, MRD, PWD, LIST, NLST, SITE, SYST, STAT, HELP, NOOP.

Problem 3

Application layer protocols: DNS and HTTP
Transport layer protocols: UDP for DNS; TCP for HTTP

Problem 4

a) The document request was http://gaia.cs.umass.edu/cs453/index.html. The Host : field indicates the server's name and /cs453/index.html indicates the file name.

b) The browser is running HTTP version 1.1, as indicated just before the first <cr><lf> pair.

c) The browser is requesting a persistent connection, as indicated by the Connection: keep-alive.

d) This is a trick question. This information is not contained in an HTTP message anywhere. So there is no way to tell this from looking at the exchange of HTTP messages alone. One would need information from the IP datagrams (that carried the TCP segment that carried the HTTP GET request) to answer this question.

e) Mozilla/5.0. The browser type information is needed by the server to send different versions of the same object to different types of browsers.

Problem 5

a) The status code of 200 and the phrase OK indicate that the server was able to locate the document successfully. The reply was provided on Tuesday, 07 Mar 2008 12:39:45 Greenwich Mean Time.

b) The document index.html was last modified on Saturday 10 Dec 2005 18:27:46 GMT.

c) There are 3874 bytes in the document being returned.

d) The first five bytes of the returned document are : <!doc. The server agreed to a persistent connection, as indicated by the Connection: Keep-Alive field

Problem 7

The total amount of time to get the IP address is
$RTT_1 + RTT_2 + \cdots + RTT_n$.
Once the IP address is known, RTT_O elapses to set up the TCP connection and another RTT_O elapses to request and receive the small object. The total response time is
$2RTT_o + RTT_1 + RTT_2 + \cdots + RTT_n$

Problem 8

a)
$$RTT_1 + \cdots + RTT_n + 2RTT_o + 8 \cdot 2RTT_o$$
$$= 18RTT_o + RTT_1 + \cdots + RTT_n.$$

b)
$$RTT_1 + \cdots + RTT_n + 2RTT_o + 2 \cdot 2RTT_o$$
$$= 6RTT_o + RTT_1 + \cdots + RTT_n$$

c)
$$RTT_1 + \cdots + RTT_n + 2RTT_o + RTT_o$$
$$= 3RTT_o + RTT_1 + \cdots + RTT_n.$$

Problem 11

a) Yes, because Bob has more connections, he can get a larger share of the link bandwidth.
b) Yes, Bob still needs to perform parallel downloads; otherwise he will get less bandwidth than the other four users.

Problem 13

The MAIL FROM: in SMTP is a message from the SMTP client that identifies the sender of the mail message to the SMTP server. The From: on the mail message itself is NOT an SMTP message, but rather is just a line in the body of the mail message.

Problem 22

For calculating the minimum distribution time for client-server distribution, we use the following formula:

$$D_{cs} = max\ \{NF/u_s, F/d_{min}\}$$

Similarly, for calculating the minimum distribution time for P2P distribution, we use the following formula:

$$D_{P2P} = max\{F/u_s, F/d_{min}, NF/(u_s + \sum_{i=1}^{N} u_i)\}$$

Where, F = 15 Gbits = 15 * 1024 Mbits

u_s = 30 Mbps

$d_{min} = d_i$ = 2 Mbps

Note, 300Kbps = 300/1024 Mbps.

Client Server

		N		
		10	**100**	**1000**
	300 Kbps	7680	51200	512000
u	**700 Kbps**	7680	51200	512000
	2 Mbps	7680	51200	512000

Peer to Peer

		N		
		10	**100**	**1000**
	300 Kbps	7680	25904	47559
u	**700 Kbps**	7680	15616	21525
	2 Mbps	7680	7680	7680

Problem 23

a) Consider a distribution scheme in which the server sends the file to each client, in parallel, at a rate of a rate of u_s/N. Note that this rate is less than each of the client's download rate, since by assumption $u_s/N \le d_{\min}$. Thus each client can also receive at rate u_s/N. Since each client receives at rate u_s/N, the time for each client to receive the entire file is $F/(u_s/N) = NF/u_s$. Since all the clients receive the file in NF/u_s, the overall distribution time is also NF/u_s.

b) Consider a distribution scheme in which the server sends the file to each client, in parallel, at a rate of $d_{\min}$. Note that the aggregate rate, $N\, d_{\min}$, is less than the server's link rate u_s, since by assumption $u_s/N \ge d_{\min}$. Since each client receives at rate $d_{\min}$, the time for each client to receive the entire file is $F/d_{\min}$. Since all the clients receive the file in this time, the overall distribution time is also $F/d_{\min}$.

c) From Section 2.6 we know that

$D_{CS} \ge \max\{NF/u_s, F/d_{\min}\}$ (Equation 1)

Suppose that $u_s/N \le d_{\min}$. Then from Equation 1 we have $D_{CS} \ge NF/u_s$. But from (a) we have $D_{CS} \le NF/u_s$. Combining these two gives:

$D_{CS} = NF/u_s$ when $u_s/N \le d_{\min}$. (Equation 2)

We can similarly show that:

$D_{CS} = F/d_{\min}$ when $u_s/N \ge d_{\min}$ (Equation 3).

Combining Equation 2 and Equation 3 gives the desired result.

Problem 24

a) Define u = u1 + u2 + ….. + uN. By assumption

$u_s <= (u_s + u)/N$ Equation 1

Divide the file into N parts, with the i^{th} part having size $(u_i/u)F$. The server transmits the i^{th} part to peer i at rate $r_i = (u_i/u)u_s$. Note that $r_1 + r_2 + \ldots + r_N = u_s$, so that the aggregate server rate does not exceed the link rate of the server. Also have each peer i forward the bits it receives to each of the $N-1$ peers at rate r_i. The aggregate forwarding rate by peer i is $(N-1)r_i$. We have

$$(N-1)r_i = (N-1)(u_s u_i)/u <= u_i,$$

where the last inequality follows from Equation 1. Thus the aggregate forwarding rate of peer i is less than its link rate u_i.

In this distribution scheme, peer i receives bits at an aggregate rate of

$$r_i + \sum_{j<>i} r_j = u_s$$

Thus each peer receives the file in F/u_s.

b) Again define $u = u_1 + u_2 + \ldots.. + u_N$. By assumption

$u_s >= (u_s + u)/N$ Equation 2

Let $r_i = u_i/(N-1)$ and
$r_{N+1} = (u_s - u/(N-1))/N$

In this distribution scheme, the file is broken into $N+1$ parts. The server sends bits from the i^{th} part to the i^{th} peer ($i = 1, \ldots., N$) at rate r_i. Each peer i forwards the bits arriving at rate r_i to each of the other N-1 peers. Additionally, the server sends bits from the $(N+1)^{st}$ part at rate r_{N+1} to each of the N peers. The peers do not forward the bits from the $(N+1)^{st}$ part.

The aggregate send rate of the server is

$r_1 + \ldots. + r_N + N\, r_{N+1} = u/(N-1) + u_s - u/(N-1) = u_s$

Thus, the server's send rate does not exceed its link rate. The aggregate send rate of peer i is

$(N-1)r_i = u_i$

Thus, each peer's send rate does not exceed its link rate.
In this distribution scheme, peer i receives bits at an aggregate rate of

$$r_i + r_{N+1} + \sum_{j<>i} r_j = u/(N-1) + (u_s - u/(N-1))/N = (u_s + u)/N$$

Thus each peer receives the file in $NF/(u_s+u)$.
(For simplicity, we neglected to specify the size of the file part for i = 1, …., N+1. We now provide that here. Let $\Delta = (u_s+u)/N$ be the distribution time. For i = 1, …, N, the i^{th} file part is $F_i = r_i\, \Delta$ bits. The $(N+1)^{st}$ file part is $F_{N+1} = r_{N+1}\, \Delta$ bits. It is straightforward to show that $F_1 + \ldots.. + F_{N+1} = F$.)

c) The solution to this part is similar to that of 17 (c). We know from section 2.6 that

$$D_{P2P} >= max\{F/u_s, NF/(u_s + u)\}$$

Combining this with a) and b) gives the desired result.

Problem 25

There are N nodes in the overlay network. There are $N(N-1)/2$ edges.

Problem 33

Yes, you can configure many browsers to open multiple simultaneous connections to a Web site. The advantage is that you will you potentially download the file faster. The disadvantage is that you may be hogging the bandwidth, thereby significantly slowing down the downloads of other users who are sharing the same physical links