CS 118 - Homework 2

Kuruvilla Cherian, Jahan
UID: 104436427
Section 1A

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1 Problem 1

1a

In a non-persistent HTTP connection we have $time_{total} = 2RTT_0 + t_{transmission}$. Ignoring the transmission time, we notice it takes $2RTT_0$ to fetch the HTML file from the server onto the local device. From there we have to repeat the process 3 times over in order to receive each of the 3 small references. This then concludes the overall time to be:

$$time_{tot} = 2RTT_0 + 3 \cdot (RTT_0) = 8RTT_0$$

1b

Allowing for multiple TCP connections to spawn from the host we can deduce that the time to grab 3 objects from the server will be greatly reduced. We start by noticing that we still need to receive the HTML file, which as mentioned before will take $2RTT_0$ to account for the TCP initialization and the request itself. After this point, the local machine knows it requires 3 separate objects to fetch from the server, and so can spawn 3 TCP "threads" to run in parallel. Thus we will only incur the cost of initialization of TCP 3 times over but in parallel $\rightarrow RTT_0$ and another to get all the objects back in parallel. This then reduces to:

$$time_{total} = 2RTT_0 + RTT_0 + RTT_0 = 4RTT_0$$

1c

Since we are now considering persitent HTTP, we know the we only have to instantiate the TCP connection once. And with pipelining we can receive all the objects from the HTML file at once. Thus we have $2RTT_0$ for the intialization and retrieval of the HTML file, and then just $1RTT_0$ for all the objects pipelined. Thus the overall time boils down to:

$$time_{total} = 2RTT_0 + RTT_0 = 3RTT_0$$

2 Problem 2

2a

We start by analyzing the average access delay $\rightarrow \frac{\Delta}{(1-\Delta\beta)}$ by looking at the average time to send over an object over the access link. We see this basically boils down to

$$\Delta = \frac{size_{object}}{bandwidth_{link}} = \frac{8.5 \cdot 10^5}{15 \cdot 10^6} = 0.057sec$$

. β is the average arrival rate of objects to the access link which is the same as the average request rate from the institutions browsers to the origin servers which is $16reqs/sec$. Thus the traffic intensity at the access link is

$$\Delta\beta = (0.057 \cdot 16) = 0.912$$

. Since the average Internet delay is 1 second we have the total average response rate to be:

$$response = \frac{\Delta}{(1-\Delta\beta)} + 1 = \frac{0.057}{1-0.912} + 1 = 1.648sec$$

2b

When looking at the introduction of a cache we have to consider two possibilities. That is a cache miss (rate of 0.4) and a cache hit (rate of 0.6). Because of the cache, our traffic delay falls down to the amount of times we have a cache miss which is 2/5ths of the time. Thus we now have the average access delay to

$$\frac{0.057}{1 - 0.4 \cdot (0.912)} = 0.09sec$$

. Since on a cache hit, we no longer consider the average Internet delay (as it falls to 0) we have the following average response rate:

$$response = (0.4 \cdot (0.09 + 1) + (0.6 \cdot 0)) = 0.436sec$$

3 Problem 3

3a

Ignoring TCP connection setup and termination we can break down the SMTP client-server communication to the following stages that each require 1 RTT:
1.) Handshake between client and server
2.) Send information about who to send the email to
3.) Send information about who the email is from
4.) Send the data notification
5.) Send the actual data, subject line and the carriage return and line-feed

Thus we see that the minimum number of Round Trip Times required without the inclusion of TCP specific connections, is $5RTT$.

4 Problem 4

To calculate the time distribution for the given file F we use the following formulas:

For Client-Server - $time = \max(NF/u_s, F/\min(d_i))$ for the i different clients.

For P2P - $time = \max(F/u_s, F/\min(d_i), NF/(u_s + \Sigma(u_i)))$

Using these formulas we get the following table Figure 1:

300Kbs	Time for Client-Server (/s)	Time for P2P (/s)
Number of Clients/Peers		
10	7500	7500
100	50000	25000
1000	500000	45455
700Kbs	Time for Client-Server (/s)	Time for P2P (/s)
Number of Clients/Peers		
10	7500	7500
100	50000	15000
1000	500000	20548
2Mbs	Time for Client-Server (/s)	Time for P2P (/s)
Number of Clients/Peers		
10	7500	7500
100	50000	7500
1000	500000	7500

Figure 1: The table of all the values comparing the two methods of file distribution.

We then generate the following three graphs for each of the respective upload speeds of the peers when considering P2P.

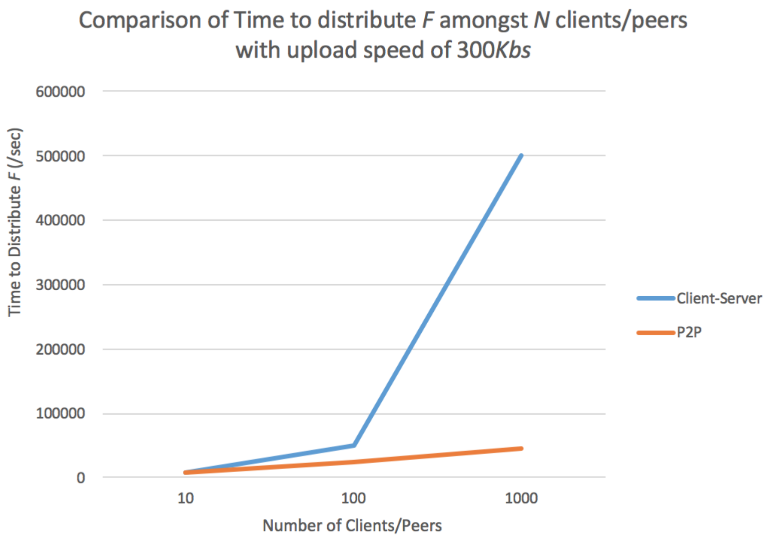

Figure 2: Graph of time vs number of client/peers for upload speeds of 300Kbs.

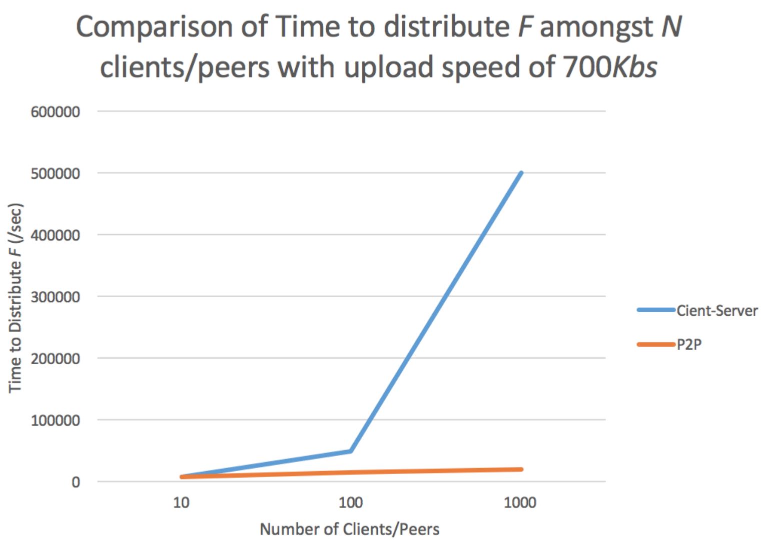

Figure 3: Graph of time vs number of client/peers for upload speeds of 700Kbs.

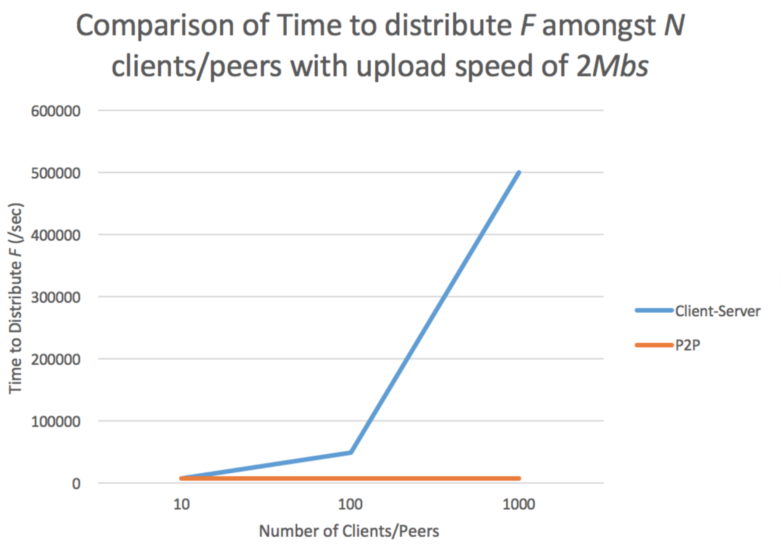

Figure 4: Graph of time vs number of client/peers for upload speeds of 2Mbs.