Matthew Bentz HW2

1. Because the IP of the HTTP server is initially unknown, we would need to use DNS to resolve the given URL. So, at the application layer, we need HTTP and DNS. Because DNS uses UDP for name resolution and HTTP uses TCP to establish a connection with the server, we need both UDP and TCP at the transport layer.

2. Given, N DNS servers need visiting before obtaining the IP address. Total time to resolve the URL is
   $\Rightarrow RTT_1 + RTT_2 + \ldots + RTT_N$
   Assuming the web browser makes a TCP connection, we will need one request for the connection and another for the get request. Total time taken after IP is obtained
   $\Rightarrow 2RTTs$
   Given, the transmission time of the object is T_i.
   Since transmission begins at $0.5RTTs$ after a TCP connection is made, we modify total time after getting IP
   $\Rightarrow 1.5RTTs + T_i$

   In total, $RTT_1 + RTT_2 + \ldots + RTT_N + 1.5RTTs + T_i$

3. a.) Grab IP = $RTT_1 + \ldots + RTT_N$
   Get HTML file = $2RTTs$
   Get 8 objects = $8 * 2RTTs$
   Total = $RTT_1 + \ldots + RTT_N + 18RTTs$
   b.) Grab IP = $RTT_1 + \ldots + RTT_N$
   Get HTML file = $2RTTs$
   Get 6 of 8 Objs = $2RTTs$
   Get 2 of 8 Objs = $2RTTs$
   Total = $RTT_1 + \ldots + RTT_N + 6RTTs$

c.) Grab IP = $RTT_1 + \ldots + RTT_N$
Get HTML file = $2RTT_s$ (connection opened)
Get 8 Objs = RTT_s
Total = $RTT_1 + \ldots + RTT_N + 3RTT_s$

4. Given data:

- link length	90 m
- transmission rate	420 bits/sec
- packet data length	320,000 bits
- control packet data length	240 bits
- N parallel connection bandwidth	$\frac{1}{N}$; assume N=6 so $\frac{420}{6}$ b/sec $\Rightarrow$ 70 b/s
- reference object data	320,000 bits

Non-Persistent HTTP: (6 parallel connections)

$$3\left(\frac{240b}{70b/s}\right) + \left(\frac{320{,}000b}{70b/s}\right) + 3\left(\frac{240b}{420b/s}\right) + \left(\frac{320{,}000b}{420b/s}\right) + 8\left(\frac{90m}{2.2\times10^8 m/s}\right) = 10.286 + 4{,}571.43 + 1.71 + 761.9 + 4\times10^{-7}$$

3 ACK; 6 Objs Referenced; 3 ACK; Initial Obj; 8 propagation delay

$$= \boxed{5{,}345} \text{ seconds total}$$

Persistent HTTP:

$$3\left(\frac{240}{420}\right) + \left(\frac{320{,}000}{420}\right) + 6\left(\frac{240}{420} + \frac{320{,}000}{420}\right)$$

3 ACK; Initial Obj; 6 Request Obj

$$= \boxed{5{,}338.5} \text{ seconds total}$$

Non-persistent HTTP makes sense in this case. No significant gains are realized from using persistent HTTP. Only $\approx$ 6-7 seconds or 0.12% faster.

5. Yes, Tom's parallel connections will help him get web pages more quickly because he will receive more bandwidth compared to the other users since each connection will get $\frac{1}{N}$ speeds. He will also not need to open connections for each reference object.

Yes, Tom's parallel connections would still be beneficial. Regardless of the other users connections, Tom's parallel connections will grant him with the highest proportionate bandwidth available.

6. Given data:

- avg. object size	675,000 bits
- avg. request rate	20 requests/sec
- internet router → response	2 seconds
- Total avg. response time	(avg. access delay + avg. internet delay)

a.) Total average response time = 0.25 + 2 = **2.25 sec**

Avg. Access delay: $\frac{.675\text{Mb}}{15\text{Mbps}} = .045$ seconds avg. time through access link

.045 seconds/request × 20 requests/sec = 0.9 traffic intensity

From the given table, Avg. Access Delay = **0.25 sec**

Internet delay is given at **2.0 sec**

b.) Cached total response time = $\underset{\text{hit}}{\frac{1}{3}(0)} + \underset{\text{miss}}{\frac{2}{3}(2.041)} =$ **1.36 sec**

Miss rate of $\frac{2}{3}$ means traffic intensity gets reduced to 0.6. Associative access delay is .041 seconds, bringing the total delay to 2.041 seconds for 66.6% of requests that don't hit cache.