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Comp 4320 Homework 2
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1. Transport-layer protocols: TCP for HTTP and UDP for DNS
   Application-layer protocols: HTTP and DNS

2. Time elapsed = $2RTT_S + T_i + RTT_1 + RTT_2 + \ldots + RTT_N$

3. a) Time elapsed = $2RTT_S + 8T_i + RTT_1 + RTT_2 + \ldots + RTT_N$
   b) Time elapsed = $2RTT_S + 3T_i + RTT_1 + RTT_2 + \ldots + RTT_N$
   c) Time elapsed = $2RTT_S + T_i + RTT_1 + RTT_2 + \ldots + RTT_N$

4. T_p: propagation delay
   parallel download via parallel instances of nonpersistent HTTP:
   $\left(\frac{240}{420} + T_p + \frac{240}{420} + T_p + \frac{240}{420} + T_p + \frac{320000}{420} + T_p\right) + \left(\frac{240}{420/6} + T_p + \frac{240}{420/6} + T_p + \frac{240}{420/6} + T_p + \frac{320000}{420/6} + T_p\right) \Rightarrow \boxed{8T_p + 5345.33 \text{ seconds}}$

   parallel download via parallel instances of persistent HTTP:
   $\left(\frac{240}{420} + T_p + \frac{240}{420} + T_p + \frac{240}{420} + T_p + \frac{320000}{420} + T_p\right) + 6\left(\frac{240}{420} + T_p + \frac{320000}{420} + T_p\right) \Rightarrow \boxed{16T_p + 5338.50 \text{ seconds}}$

   persistent HTTP does not show significant gains over the nonpersistent case.

5. a) Yes, Tom gains more shares of the bandwidth due to having more connections
   b) Yes so that he keeps more shares of the bandwidth

6. a) L/R: $\frac{675000 \text{ bits}}{15000000 \text{ bits/sec}} = 0.045 \text{ sec}$
   Traffic intensity: 20 requests/sec $(0.045 \text{ sec/requests}) = 0.9$
   average access delay: $\frac{0.05}{1-0.9} = 0.5 \text{ sec}$

   average response time: $2 + 0.5$ seconds = $\boxed{2.5 \text{ seconds}}$

b) average access delay: $\frac{0.045}{1-(0.66)(0.9)} = 0.1123$ seconds

average response time for cache misses: 2.1123 sec

probability of response time for cache = 0 $\Rightarrow$ 0.33

prob. of response time for cache misses $\Rightarrow$ 0.66

average response time: $0(0.33) + 2.1123(0.66) \Rightarrow$ **1.39 sec**