**Chapter 2**

1) Consider a short, 15-meters link, over which a sender can transmit at a rate of 160 bits/sec in both directions. Suppose that packets containing data are 200,000 bits long, and packets containing only control (e.g., ACK or handshaking) are 100 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 200 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 makes sense in this case? Now consider persistent HTTP. Do you expect significant gains over the non-persistent case? Justify and explain your answer.

**Answer:**

Note that each downloaded object can be completely put into one data packet. Let Tp denote the one-way propagation delay between the client and the server.

First consider parallel downloads via non-persistent connections. Parallel download would allow 10 connections share the 160 bits/sec bandwidth, thus each gets just 16 bits/sec. Thus, the total time needed to receive all objects is given by:

(100/160+Tp + 100/160 +Tp + 100/160+Tp + 200,000/160+ Tp )

+ (100/(160/10)+Tp + 100/(160/10) +Tp + 100/(160/10)+Tp + 200,000/(160/10)+ Tp )

= 13771 + 8\*Tp (seconds)

Then consider persistent HTTP connection. The total time needed is give by:

(100/160+Tp + 100/160 +Tp + 100/160+Tp + 200,000/160+ Tp )

+ 10\*(100/160+Tp + 200,000/160+ Tp )

=13758 + 24\*Tp (seconds)

Assume the speed of light is 300\*106 m/sec, then Tp=15/(300\*106)=0.05 microsec. Tp is negligible compared with transmission delay.

Thus, we see that the persistent HTTP does not have significant gain over the non-persistent case with parallel download.

1. Consider the scenario introduced in the previous problem. Now suppose that the link is shared by Bob with four other users. Bob uses parallel instances of non-persistent HTTP, and the other four users use non-persistent HTTP without parallel downloads.
2. Do Bob’s parallel connections help him get Web pages more quickly?

Why or why not?

1. If all five users open five parallel instances of non-persistent HTTP, then would Bob’s parallel connections still be beneficial? Why or why not?

**Answer:**

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