

## Homework 3 (18 points)

Due on 02/27/20 at the beginning of class

### 1. Non-persistent vs. Persistent HTTP (8 points)

Consider a short, 10-meter link between two nodes, where each end can transmit at a rate of 150 bit/sec. Suppose that packets containing data are 100 Kbits long, and packets containing only control (e.g., TCP handshaking and HTTP request) are 200 bits long. Suppose that one end of the link uses the HTTP protocol to download a web page from the other end where the initial downloaded object contains 10 referenced objects from the same node, and each downloaded object is 100 Kbits long (thus each object can be completely put into one data packet). How long does it take to download the web page (1) using non-persistent HTTP with 5 parallel connections (each gets 1/5 of the link bandwidth)? (2) using a persistent HTTP connection? You may assume that the propagation speed for the link is  $3 \cdot 10^8$  meters/sec and 1 Kbits =  $10^3$  bits. (Hint: you should consider both propagation delay and transmission delay, and the latter is different for data packets and control packets.)

### 2. BitTorrent (4 points)

Suppose Bob joins a BitTorrent torrent, but he does not want to upload any data to any other peers (so called free-riding).

- Bob claims that he can receive a complete copy of the file that is shared by the swarm. Is Bob's claim possible? Why or Why not?
- Bob further claims that he can further make his "free riding" more efficient by using a collection of multiple computers (with distinct IP addresses) in the computer lab in his department. How can he do that?

### 3. Client-Server vs. P2P File Sharing (6 points)

Consider a network with four nodes. The upload/download capacities (Mbps) of the four nodes are summarized in the following table:

	Node 1	Node 2	Node 3	Node 4
Upload	3	4	3	5
Download	2	6	4	4

Suppose that node 2 has a file of size 1 MB to be shared with the other three nodes. How long does it take for all the nodes to receive the file using (1) client-server approach and (2) P2P approach.