Network Architectures 3329 **Name:** ____________________

Spring 2018 **Homework 2**

02/09/2018 **Due 02/16/2018**

- **Print** your name.

Problem	Points	Score
1	4	
2	6	
Total:	10	

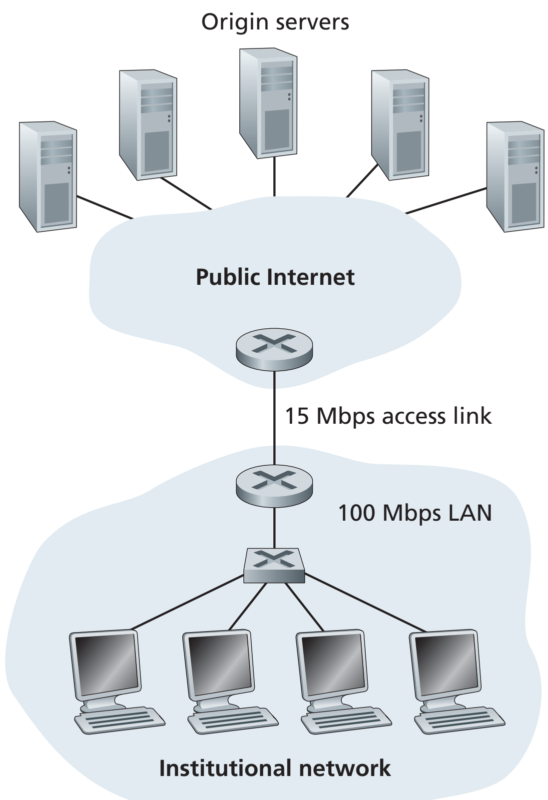

Figure 1: TCP window size as a funtion of time

1. Consider the Figure in the above, for which there is an institutional network connected to the Internet. Suppose that the average object size is 850,000 bits and that the average request rate from the institutions browsers to the origin servers is 16 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the response is 3 seconds on average. Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the average access

delay, use $\Delta/(1-\Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.

(a) (2 points) Find the total average response time.

> **Solution:** The time to transmit an object of size L over a link or rate R is L/R. The average time is the average size of the object divided by R:
> $\Delta = (850,000bits)/(15,000,000bits/sec) = .0567sec.$
> The traffic intensity on the link is given by $\beta\Delta = (16requests/sec)(.0567sec/request) =$ 0.907.
> Thus, the average access delay is $(.0567sec)/(1 - .907).6seconds$. The total average response time is therefore $.6sec + 3sec = 3.6sec$.

(b) (2 points) Now suppose a cache is installed in the institutional LAN. Supposethe the miss rate is 0.4. Find the total response time.

> **Solution:** The traffic intensity on the access link is reduced by 60% since the 60% of the requests are satisfied within the institutional network. Thus the average access delay is $(.0567sec)/[1(.4)(.907)] = .089seconds$.
> The response time is approximately zero if the request is satisfied by the cache (which happens with probability .6); the average response time is $.089sec + 3sec = 3.089sec$ for cache misses (which happens 40% of the time). So the average response time is $(.6)(0sec) + (.4)(3.089sec) = 1.24seconds$.

2. **Written questions (essay, computational)** Consider distributing a file of $F = 15Gbits$ to N peers. The server has an upload rate of $u_s = 30Mbps$, and each peer has a download rate of $d_i = 2Mbps$ and an upload rate of u.

(a) (2 points) For $N = 100$ and $u = 700Kbps$, find the minimum distribution time for client-server distribution.

> **Solution:** 51200 seconds

(b) (2 points) For $N = 100$ and $u = 700Kbps$, find the minimum distribution time for client-server distribution, find the minimum distribution time for P2P distribution

> **Solution:** 15616 seconds

(c) (2 points) Suppose the number of peers increases to $N = 1000$, find the minimum distribution time for both client-server and P2P distribution.

> **Solution:** Client-Server: 512000 seconds
> P2P: 21525 seconds