CSE 550 - Computer Network Design
Spring 2007 (Term 062)

Homework 1

Date: Saturday, March 17th, 2007

Q1. The problem consists of 3 routers A, B, C, and 6 switches, a, b, c, d, e, and f. Assume that the three routers are connected according to a unidirectional ring topology **(A-B-C-A)** and that all links have the same capacity of **2 Mbps**. Assume that the switches are connected as follows: **(a, C), (b, C), (c, A), (d, A), (e, B), (f, B).**

The average packet size has been estimated equal to **2000 bits**. It has also been observed that the traffic generated by the various switches is Poissonian with rates as indicated in the following table showing the **Inter-switches traffic in pps**.

	a	**b**	**c**	**D**	**e**	**f**
a	-	20	50	10	30	20
b	20	-	10	20	40	60
c	50	10	-	80	20	10
d	10	20	80	-	50	50
e	30	40	20	50	-	100
f	20	60	10	50	100	-

a. Find the inter-routers traffic in pps (γ_{jk}, j, k = A, B, C).

b. Find the internal traffic rates on the links AB, BC, and CA, that is, λ_{AB}, λ_{BC}, and λ_{CA}.

c. Which link constitutes the primary bottleneck link?

d. What is the average number of links **ñ** traversed by a packet to go from any source to any destination?

e. Find ***T***, the average delay per packet.

f. Assume that the external traffic from all switches is multiplied by a constant factor **α**. What is largest value α_{max} that will cause the network to saturate?

Q2. Assume that you are faced with the following situation. A company has 6 divisions, each serviced by a 10 Mbps Ethernet workgroup switch, labelled **S_1 to S_6**. The company has acquired three backbone switches **B_1, B_2, and B_3**, each with four interfaces. Two of these interfaces are 10 Mbps Ethernet interfaces, and the two others are 100 Mbps Fast Ethernet interfaces.

Assume that the three backbone switches are interconnected with **full duplex links** according to a **tree topology** with B_1 as the root of the tree, and B_2 and B_3 as the children of B_1. The links are running at **Fast Ethernet** speed.

Suppose that the 6 workgroup switches are assigned as follows: **S_4 and S_6 to B_1, S_1 and S_3 to B_2, and S_2 and S_5 to B_3**. The workgroup switches are connected to the backbone switches with **full duplex links of 10 Mbps speed**. The average packet size has been estimated equal to **1000 bits**. It has also been observed that the traffic (in pps) generated by the various workgroups is Poissonian with rates as indicated in the following table:

	S_1	**S_2**	**S_3**	**S_4**	**S_5**	**S_6**
S_1	-	200	500	100	300	200
S_2	200	-	100	200	400	600
S_3	500	100	-	800	200	100
S_4	100	200	800	-	500	500
S_5	300	400	200	500	-	1000
S_6	200	600	100	500	1000	-

a. Find the internal traffic rates on all the links, that is $\lambda_{Si,Bj}$, and $\lambda_{Bj,Si}$, i = 1, …, 6, j = 1, 2, 3, where S_i is connected to B_j, and $\lambda_{Bi,Bj}$, i, j = 1, 2, 3, $i \neq j$ and the link between B_i and B_j exists.

b. Find the utilizations of all the links, that is $\rho_{Si,Bj}$, and $\rho_{Bj,Si}$, i = 1, …, 6, j = 1, 2, 3, where S_i is connected to B_j, and $\rho_{Bi,Bj}$, i, j = 1, 2, 3, $i \neq j$ and the link between B_i and B_j exists.

c. Which link constitutes the primary bottleneck link?

d. What is the average number of links **ñ** traversed by a packet to go from any source to any destination?

e. Find ***T***, the average delay suffered by a packet to go from any workgroup switch to any other workgroup switch.

f. What is the largest load that can be sustained by the network before any of its links saturate?