King Fahd University of Petroleum and Minerals
College of Computer Sciences and Engineering
Department of Computer Engineering

COE 444 – Internetwork Design and Management (T122)

Homework # 02 (*due date & time: Monday 08/04/2011 during class period*)

*** Show all your work. No credit will be given if work is not shown! ***

Problem # 1 (100 points): 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 (i.e. **cannot** be used for 10 Mbps Ethernet connectivity).
Assume that the three backbone switches B_1, B_2, and B_3 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, labeled S_1 to S_6, 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 to be equal to 2000 bits. It has also been observed that the traffic (in pps) generated by the various workgroups is Poisson with rates as indicated in the following table:

	S_1	S_2	S_3	S_4	S_5	S_6
S_1	-	200	200	500	300	200
S_2	200	-	200	200	500	300
S_3	200	200	-	200	700	100
S_4	500	200	200	-	500	500
S_5	300	500	700	500	-	1000
S_6	200	300	100	500	1000	-

a. **(20 points)** 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. **(20 points)** 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. **(5 points)** Which link constitutes the primary bottleneck link?
d. **(20 points)** What is the average number of links **ñ** traversed by a packet to go from any source to any destination?
e. **(20 points)** Find ***T***, the average delay suffered by a packet to go from any workgroup switch to any other workgroup switch.
f. **(15 points)** What is the largest load that can be sustained by the network before any of its links saturate?