COE 444 - Internetwork Design and Management Fall 2004 (Term 041)

Quiz 4

Date: Monday, December 27, 2004

Q1. (10 points) Suppose that 3 backbone switches (**A**, **B**, and **C**) are connected, in a tree structure, to each other with **100 Mbps** full duplex links. **A** is the root node of this tree. The average packet size has been estimated equal to **2000 bits**. It has also been observed that the traffic (in pps) generated by the various switches is Poissonian with rates as indicated in the following table:

Destination

		Α	B	С
Source	Α	-	600	700
	В	500	-	300
	С	200	400	-

a. Find the internal traffic rate on link **AB** and **BA**, that is λ_{AB} , and λ_{BA} .

- **b.** Find the utilization on link **AB**, that is ρ_{AB} .
- c. Find the average delay suffered by a packet on link AB, that is Tr_{AB} .

- **d.** Find the average number of items waiting and being served on link **AB**, that is r_{AB} .
- e. 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 link **AB** to saturate?

Name:

ID:

Q2. (8 points) For the tree network in question **Q1.**, assume that the MTBF and MTTR of any link are respectively 100 days and 1 day, and the MTBF and MTTR of any switch are respectively 100 days and 2 days.

- **a.** Find P_l and P_s , the links and switches reliabilities.
- **b.** Find the overall network reliability, that is, the probability that the network is connected.
- c. Find *E(A)*, the expected number of nodes communicating with the root node *A*. Recall that, for any node i:

$$E(i) = P_i \times (1 + \sum_{k \in Succ(i)} P_{j_k} E(k))$$

where j_k is the link between node i and its successor node k.

d. Find *EPR(A)*, the expected number of node pairs communicating through the root node *A*. Recall that,

$$EPR(A) = \sum_{\substack{i,k \in Succ(A)\\i \neq k}} P_A P_{j_i} E(i) P_{j_k} E(k) + \sum_{i \in Succ(A)} P_A P_{j_i} E(i)$$

where P_{j_i} and P_{j_k} are respectively the reliabilities of the links between nodes *i* and *k* and the root *A*. P_A is the reliability of switch *A*, and *E(i)*, *E(k)* are as defined above.

Q3. (2 points) List the four models defined by the OSI network management standard.