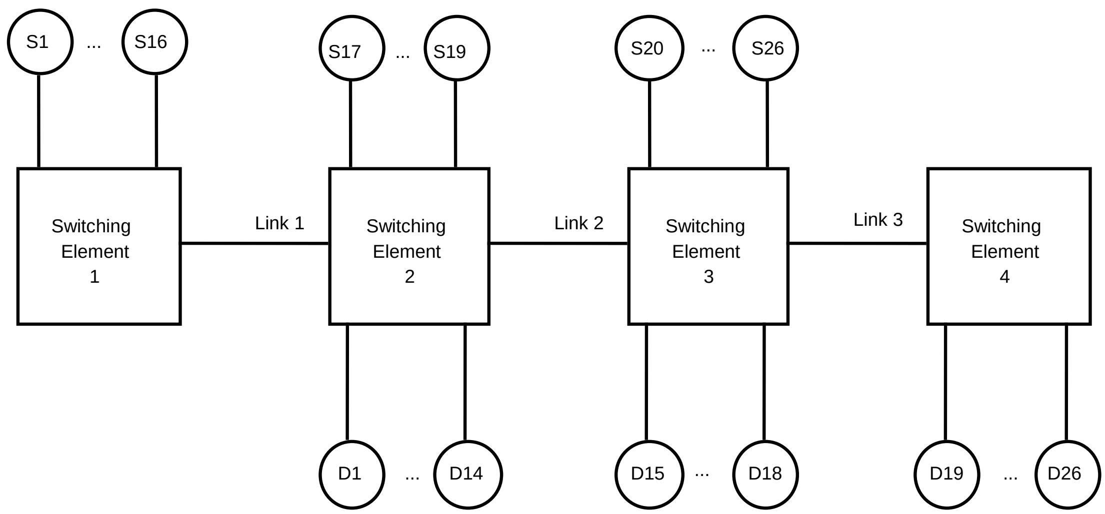
Assignment 3

CSC467/567 Fall 2014

Submission deadline: ***November 12, 2014***

Question 1 [10 points] (Network wide Max-Min Allocation)



Consider the network shown in the picture above. Assume that all network links (Link 1, 2 and 3) have equal bandwidth (1 unit each). Connections are setup between source destination pairs (Si, Di) for communication. Assume that all connections have equal weights and sources are not constrained (i.e., they can transmit at whatever the rate the switching elements can assign).

1. What would be bandwidth allocated connections at each of the links (local allocation) if network wide allocation for the flows is not considered?
2. What would be bandwidth allocated connections at each of the links if network wide max-min bandwidth allocation is considered?

Question 2 [5 points] (RED)

A router uses a single queue for AF service. All three classes (AF1x, AF2x and AF3x) and colors (x=1 for green, x=2 for yellow and x=3 for red) are to be supported.

1. Design a RED drop probability scheme (graph) such that the relative orders of class (priority order AF1, AF2 and AF3) and color (priority order green, yellow and red) are always maintained when dropping packets. You don't need to maintain same *minTh* and *maxTh* for each class.
2. Design a RED drop probability scheme (graph) such that the relative orders of class (priority order AF1, AF2 and AF3) and colors are maintained but colors belonging to different classes are mapped to the same drop probability curve

(e.g., AF12, AF21; AF13, AF22, AF31; AF23, AF32; etc). Design this scheme with the same *minTh* and *maxTh* for all classes.

Question 3 [25 points] (Traffic Marking)

A constant bit rate (CBR) connection contracts a peak rate (*PIR*) of ¼ of line rate with a network (i.e., *PIR=1/4 Line rate*). Assume the average packet size is 500 bytes. The network provider decides to mark the traffic with a single rate three color marker (srTCM) with CBS=500 bytes and EBS=100 bytes (allows some jitter). For simplicity you can assume that the Line rate is 1 byte/sec. The purpose of this question is to verify the working of srTCM algorithm in the following scenarios when a user sends conforming and non-conforming traffic. Your goal is to test the outcome of srTCM and check the marked traffic. The purpose is also to test parameter settings. You can consider up to 40 packet transmissions. The scenarios are:

1. Connection sends traffic at exactly the peak rate
2. Connection sends traffic at 1.5 times the peak rate (contract violation)
3. How will your answer for part (2) change if EBS=500 bytes?
4. If CBS set to 250 and EBS=100, what will be the outcome for part (1)?
5. What is your inference about the bucket settings on marking?

Question 4 [10 points] (EBW)

Consider the Equivalent Bandwidth (EBW) equation of Gibbens and Hunt (GH) (slide 19 of Admission Control). A switch uses two separate queues (of different lengths) for two classes of traffic, each requiring a different packet loss ratio (CLR), say 10^{-7} and 10^{-5}. For the same traffic parameters (*PCR, SCR, ABS*), prove that the number of connections admitted would be the same for both queues, if *log(Cell Loss Ratio)* and *Buffer* are provisioned in the same proportion in both queues. Verify your answer with an example of *PCR=1.0, SCR=0.3, ABS=10.* What do you infer from this? How much bandwidth is allocated if we use Robert's Heuristic (slide 18 of Admission Control) instead of GH?

Question 5 [10 points] (Multi-class EBW in a single queue)

A switch uses a single queue for three different traffic classes EF, AF and BE at a link of capacity 1.0. The switch admits 10 EF services (peak rate of 0.01); 20 services of AF (with a peak rate of 0.01, average rate of 0.001, average burst size of 10 packets, buffer size of 1000 packets, packet loss ratio of 10^{-7}) and 100 services of BE with a minimum rate of 0.001. Assume that the average packet size is 100 bytes for all services.

1. What's the remaining (available) bandwidth on the link?
2. What's the Statistical gain achieved for VBR services?
3. What is the load (utilization) on the switch?
4. What will the delay experienced by these packets when traversing through the switch?

Question 6 [10 points] (Multi-class EBW)

Please refer to Question 5. Let us assume that the switch is now replaced with a newer switch that uses three separate queues for EF, AF and BE traffic and has WFQ packet scheduler at a link of capacity 1.0. The switch sets weights of 20, 40 and 40 to these queues. Assume the same set of admitted services as in Question 5.

1. What is the load on EF queue?
2. What is the load on AF queue?
3. What is the load on BE queue?
4. Assuming that the unallocated bandwidth for EF and AF is given to BE queue by the WFQ, what will be the bandwidth achieved by the BE queue?
5. [6 points] As each queue can get its dedicated bandwidth, for now model each queue independently with that allocated bandwidth as an M/M/1 queue. With this assumption what would be the delay experienced by packets when traversing these queues? How does it compare with Question 5?

Question 7 [6 points] (Multi-class EBW)**(For CSC 567 Only)**

Repeat Question 6 part 5 with the assumption that the switch uses a priority queueing instead of WFQ. What would be delays experienced by each of the services?