## *EE511-F18 PROJECT 4: Switch Performance and HOL Blocking*
## *DUE: Tuesday OCTOBER 30th, 2018*

As discussed in class, you are study the operation of an $N \times N$ switch under heavy traffic, i.e. there are always packets on the input ports. In particular, the HOL (head of the line) slot is always full. The packet in the HOL position at any input of the $N$ input ports is addressed to output port $j : j = 1, ..., N$ with probability $\alpha_j$ and $\sum_{j=1}^{N} \alpha_j = 1$. Packets can be delivered from inputs to outputs in one clock cycle and the clock rate is $10^6$ cycles per second. If there is more than 1 packet destined to a specific port, only one of them can be delivered in the current slot, the others will remain in the HOL position on the input side. This will reduce switch throughput and is known as HOL-Blocking. Estimate the rate in pps (pps = packets per second) at which packets are delivered to each output port and the overall throughput of the switch (also in pps.)

$N = 2$

We are interested in finding the switch throughput for a range of values for $\alpha_1 = \{0, 0.1, 0.2, 0.3, 0.4, 0.5\}$ and recall that $\alpha_2 = 1 - \alpha_1$.

*Method 1:* Build the transition probability matrix (see class notes) and solve the Markov chain numerically to find the limit distribution. From this limit distribution, calculate throughput for each output port and the overall switch performance.

*Method 2:* Build a simulation model that simulates the operation of the switch. In each slot, one or two packets will be delivered to the output. The packets that are transmitted are replaced in the HOL positions with new packets with destination ports generated randomly according to $\alpha_j$.

For $N = 4$ and $N = 8$, appropriately generalize the simulation program for these cases (the numerical solution to the balance equations is not required). The number of packets delivered to any particular output in one slot is either 1 or 0. When there are multiple requests for the same output, one of them is selected to be delivered and the others remain in the HOL position on the input side. Simulate for 1) balanced traffic ( $\alpha_j = 1/N \quad \forall j$ and 2) Hot-spot traffic $\alpha_1 = 1/k, \quad \alpha_j = \left(\frac{1}{N-1}\right)\left(\frac{k-1}{k}\right)$ for $j \neq 1$. Look at the cases $k = 2, 3, ..., N$ (the case of $k = N$, reverts to being balanced traffic.)