S-38.149 Exercises for 26.10.1998 Antti Kuurne

- 1. In figure relating to exercise is a subnetwork, where all μ's are equal. We try to find throughput u(n) (you can think throughput means same as service rate) of Norton equivalent queue. One way to do this is to use combinatorics.

  a) Show that total number of ways n identical packets (balls, if you wish) can be distributed randomly among M queues (boxes) is given by

  $(n+M-1)! / [n!\,(M-1)!]=:C(M)$

  b) Show that $C(M-1):=(n+M-2)! / [n!\,(M-2)!]$ represents the number of combinations that result in zero packets (balls) in any, say first, queue (box). Hence show that the probability that a queue is empty is given by $C(M-1) / C(M)$. Use this to calculate the Norton equivalent throughput from equation $u(n)=n\mu / (n+M-1)$.

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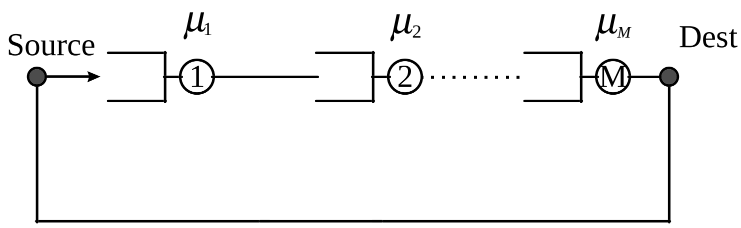
- 2. Fill in to the lower part of exercise one's figure an artificial queue with service rate to make it a complete virtual circuit model. Assume $\lambda= \mu_i=\mu$. Show that under sliding window control, the throughput of the virtual circuit and the time delay across it (from S to D) are given by

  $\gamma = N\mu / (N+M)$ and $E(T)=[M / (M+1)]\,(M+N) / \mu$.

  Show also that the window size N that maximizes $\gamma / E(T)$ is given by N=M.


Source
μ1
μ2
μM
Dest
1
2
M