Homework Set No. 8

ECE 642
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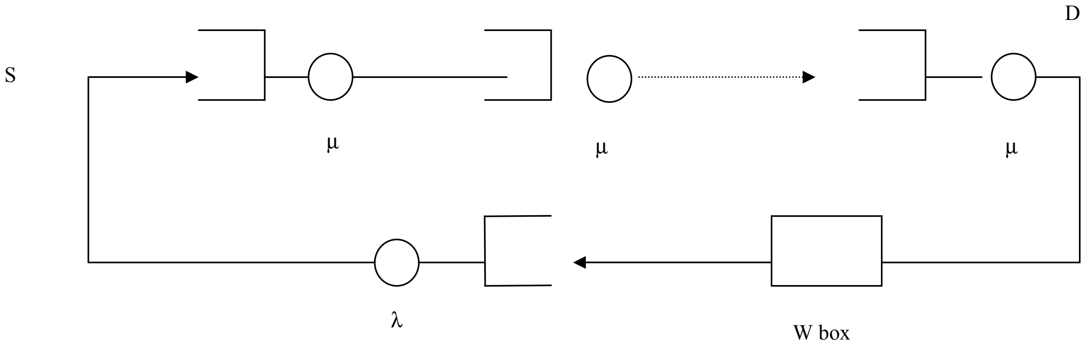
Problem 1 (Problem 5.11 from M. Schwartz)

1-Demonstrate that the model of the figure below captures the acknowledgement at the end of the window control mechanism.



Problem 2 (Problem 5.12 from M. Schwartz)

2-Consider the balance equations (1) that arise in the acknowledgement at the ends of window control mechanism in the heavy traffic case ($\lambda/\mu \longrightarrow \infty$).

a. Draw the figure for this case and focus on the w-box. Draw its state diagram and show that it has upward transitions only, except for state $w-1$, which wraps back around to state 0. Label the transitions and show how the balance equations arise from this state diagram.

$$u(w)p_0 = u(1)p_{w-1}$$

$$u(w-1)p_1 = u(w)p_0 \tag{1}$$

$$.$$

$$.$$

$$u(1)p_{w-1} = u(2)p_P w - 2$$

b. Solve the equation (1) to obtain the $\frac{p_j}{p_0} = \frac{u(w)}{u(w-j)}$ equation

c. Let $u(n) = \frac{n\mu}{n+M-1}$, the Norton equivalent function for the M-hop virtual circuit. Show that the probability of state occupancy of the w-box is given by the equations:

d.Derive the throughput-time delay performance expression given by:

$$\gamma = \frac{\mu w}{[w + (M-1)T_w]}$$

$$E(n) = \sum_{n=1}^{w} np(n) = \frac{\gamma}{\mu}[\frac{1+w}{2} + (M-1)]$$

$$\mu\ E(T) = \frac{E(n)}{\gamma/\mu} = (M - 1 + \frac{1+w}{2})$$

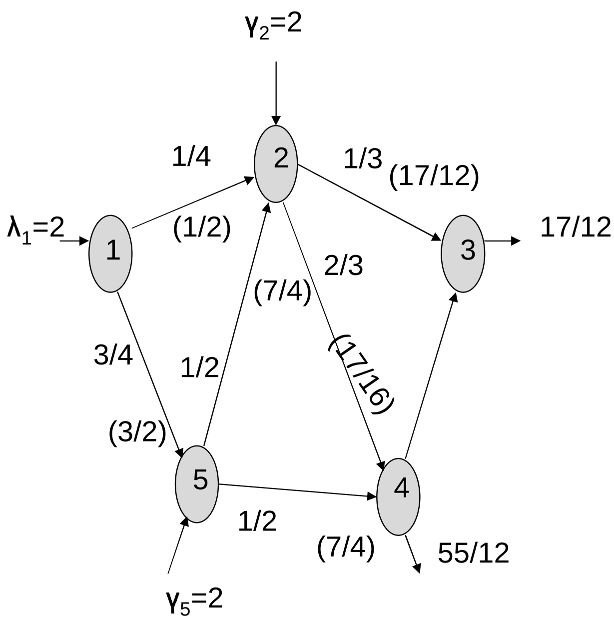
Show that for a given time delay the throughput in this case is always less than that for the sliding-window control.

Problem 3 (Problem 5.13 from M. Schwartz)

3-Obtain the throughput-time delay performance equation for the acknowledgement-at-end-of-window control mechanism for the case $\lambda = \mu$. Show that the window size that maximizes the "power", $(\gamma/\mu)/(\mu\ E(T)))$, is given by $w = 2M - 1$. Plot $\mu E(T)$ versus γ/μ for $M = 4$, $\lambda \longrightarrow \infty$, and $\lambda = \mu$. Superimpose these curves on those obtained for a sliding-window control for the same cases and compare. Compare with the curve of $M = 3$ as well. Judging from your curves, what would be the appropriate operating points (window size w) be? Compare with that obtained using the "power" criterion.

Problem 4 (Problem 5.20 from M. Schwartz)

4-Refer to the figure below. The link capacities are all $\mu = 3$ packets/sec. Find the average end to end delays from 1 to 3 via (1) node 2 and (2)nodes 5 and 2. The numbers on each link represent routing probability and flow in ( ), respectively.



Problem 5 (Problem 5.21 from M. Schwartz)

5- Refer to the above figure 3. The link capacities are all $\mu = 3$ packets/sec.

a. Find the network-wide average time delay E(T), as given by the equation

$$E(t) = \frac{1}{\gamma}\sum_{i=1}^{M} = \frac{1}{\gamma}\sum_{i=1}^{M}\frac{\lambda_i}{\mu_i - \lambda_i}$$

b. The routing probabilities are now changed to $q_{15} = 1/4, q_{12} = 3/4, q_{24} = 1/2$. Find E(T) and compare with the value found in part a.