

EECS 863 Homework

1. The traffic entering a stat mux has an arrival rate of 7500 packets/sec and a fixed message size of 1000 bits. The output link operates at 10 Mb/s.
 - a) What is the mean number in the system?
 - b) What is the mean delay?
 - c) Compare the results to an M/M/1 system with the same parameters
2. As the load ρ approaches 1 what is the ratio of the mean delay time for an M/M/1 to the mean delay for an M/D/1 queue.
3. Consider a M/G/1 system in which the service time is zero with probability p and pe^{-px} otherwise for $x \geq 0$, that is $f_X(x) = p\delta(x) + (1-p)pe^{-px}$, note p is a probability so $0 \leq p \leq 1$.

Find:

- a) Average service time.
 - b) Variance of the service time.
 - c) Average delay as a function of p assuming the arrival rate $\lambda=1$.
4. Consider a stop and wait protocol operating at 1 Mb/s link over a 750 km link (use 3×10^8 m/s for the speed of propagation). Packets arrive at a rate of 60 packets/sec and have a fixed length of 2500 bits. Let the packet error probability be 0.1. [Hint see: Example 5.3 in Queueing Modeling Fundamentals: With Applications in Communication Networks", 2nd Edition Chee-Hock Ng and Soong Boon-Hee]
 - a) Find the average time between the time a packet reaches the head of the queue until it is successfully transmitted, i.e., find the effective mean service time.
 - b) Find the maximum link utilization.
 - c) Find the variance of time between the time a packet reaches the head of the queue until it is successfully transmitted, i.e., find the effective service time variance.
 - d) Modeling the operation of the stop and wait protocol as an M/G/1 queue find the average packet waiting time.
 - e) At what arrival rate is the channel saturated.
 - f) Compare the results above with the stop and wait protocol simulation found at http://www.ittc.ku.edu/~frost/EECS_563/LOCAL/Extend_Models_2019-v10/Stop-Wait_Model-With-Errors_Queue-ES10.mox

5. A router output port operates at 50 Mb/s and supports three traffic types:

- Best-effort (BE) data traffic: Assume uniformly distributed message lengths with a range of 100 to 1900 bytes, and exponential interarrival times with an average of 0.6 ms
 - Variable Bit Rate (VBR) video traffic: Assume exponential message lengths with an average of 20 Kbytes and exponential interarrival times of 5 ms
 - Constant Bit Rate (CBR) fixed rate traffic. Assume fixed length packets of 80 bytes and exponential interarrival times of 0.4 ms.
- a) Find the normalized average **waiting** time for all packets without non-preemptive service priority. The normalized average **waiting** is the (average waiting time)/(average service time).
- b) Find the normalized average waiting time by priority class with non-preemptive service priority. The normalized average **waiting** is the (average waiting time)/(average service time). Here CBR is highest priority, followed by VBR followed by BE.

6. A controller polls a set of servers connected to a common transmission facility. The link rate is 10 Gb/s. The files/messages to be transmitted are uniformly distributed between 100 Mb and 1 Gb. The files arrive to each terminal at a rate of 4 files/sec. When a server receives a poll, i.e., permission to send, it empties its buffer before releasing the poll/token. The time between servers receiving polls is uniformly distributed between 100ms and 1sec. Find the average file delay time.