

EE 6340: Introduction to Telecommunications Networks

PROJECT 1

A. Performance of the M/M/1 queue with varying arrival and service rates:

1. **Plot #1:** plot the average number of customers (N) and the average time (T) spent in the M/M/1 queue with service rate $\mu = 1$ and arrival rate $\lambda \in (0, 1)$, versus the utilization factor $\rho = \lambda/\mu$.
2. Assume that in another M/M/1 queue the arrival rate and the service rates are $K > 1$ time larger, i.e., $\lambda' = K\lambda$ and $\mu' = K\mu$. **Plot #2:** plot the average number of customers ($N'(K)$) and the average time spent in the queue ($T'(K)$), versus the utilization factor $\rho' = \lambda'/\mu'$. Perform the experiment for $K = 2, 10$.
3. Explain any difference of the plots #1 and #2.
4. Is K affecting the average service time? If so, how?

B. Comparison of fixed and statistical multiplexing:

1. **Plot #3:** plot the average time (T) spent by a customer in a system of m M/M/1 queues, each queue with service rate μ/m and arrival rate λ/m , versus the utilization factor $\rho \in (0, 1)$. Perform the experiment for $m = 2, 10$, keeping always $\mu = 1$.
2. The system in B.1. represents a fixed multiplexing system, in which each one of the m customer flows arrives at rate λ/m and is processed by a M/M/1 queue with rate μ/m . The system in A.1. represents a statistical multiplexing system, in which m customer flows arrive at rate λ/m and they are multiplexed together into a single flow of rate λ , and processed by a single M/M/1 queue with service rate μ . **Plot #4:** Compare the average time (T) spent in a fixed multiplexing system and in a statistical multiplexing system (i.e., plots #1 and #3 for case $m = 10$).
3. Which system has the minimum average time and why?