

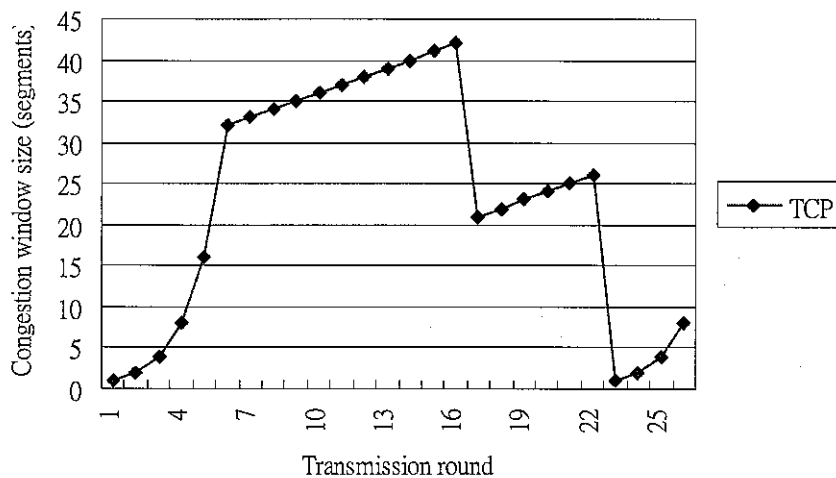
Qualified Exam. (Network) 10/12/2006

1. Derive the stationary distribution of an M/M/2 system where the two servers have different service rates μ_l and μ_h respectively. The arrival process is Poisson arrival with rate λ . A customer that arrives when the system empty is routed to the faster server, i.e., the server with service rate μ_h .
2. Packets arrive at a transmission facility according to a Poisson process with rate λ . Each packet is independently routed with probability p to one of two transmission lines and with probability $(1-p)$ to the other. Show that the arrival processes at the two transmission lines are Poisson with rate λp and $\lambda(1-p)$, respectively.
3. In our system, there are k machines and 2 repairmen. Each machine breaks down after a time that is exponentially distributed with parameter α . When a breakdown occurs, a request is sent to the repairman for fixing it. Requests are buffered. It takes an exponentially distributed amount of time with parameter μ for the repairman to repair a machine. What is the probability $p(i)$ that i machines are up? What is the overall failure rate?
4. Consider a model of telephone switching system consisting of n trunks with a finite caller population of M callers and $n < M$. The average call rate of an idle caller is λ calls per unit time, and the average holding time of a call is $1/\mu$. If an arriving call finds all trunks busy, it is lost. Assuming that call holding times and the inter-call times of each caller are exponentially distributed. Find
 - (a) A: the expected total traffic offered by the M sources per holding time.
 - (b) C: the expected total traffic carried by the switching system per holding time.
 - (c) B: the call congestion probability or the probability that a call is lost
5. Consider the following argument in the M/G/1 system: When a customer arrives, the probability that another customer is being served is $\lambda \bar{X}$. Since the served customer has mean service time \bar{X} , the average time to complete the service is $\frac{\bar{X}}{2}$. Therefore, the mean residual service time is $\lambda \bar{X}^2 / 2$. What is wrong with this argument?
6. Single-Vacation M/G/1 System. Consider the M/G/1 system with the difference that each busy period is followed by a single vacation interval. Once this vacation is over, an arriving customer to an empty system starts service immediately. Assume that vacation intervals are independent, identically distributed, and independent of the customer interarrival and service times. Prove that the average

waiting time in queue is $W = \frac{\lambda \bar{X}^2}{2(1-\rho)} + \frac{\bar{V}^2}{2I}$, where I is the average length of an

idle period, and show how to calculate I .

7. Consider the failures of a link in a communication network. Failures occur according to a Poisson process with rate 2.4 per day. Find (i) $P[\text{time between failures} \leq 5 \text{ days}]$ (ii) $P[5 \text{ failures in } 10 \text{ days}]$ (iii) Expected time between two consecutive failures. (iv) $P[0 \text{ failures in next day}]$ (v) Suppose 6 hours have elapsed since the last failure. Then, find the expected time to next failure.
8. To alleviate the poor performance of TCP in the wireless medium, please state 3 different types of proposed reliable transport-layer protocol and point out the advantages and disadvantages of each method.
9. Consider the following plot of TCP window size as a function of time.



Assuming TCP Reno is the protocol experiencing the behavior shown above, answer the following questions. In all cases, you should provide a short discussion justifying your answer.

- (a) Identify the intervals of time when TCP slow start is operating.
- (b) Identify the intervals of time when TCP congestion avoidance is operating.
- (c) After the 16th transmission round, is the segment loss detected by a triple duplicate ACK or a timeout?
- (d) After the 22nd transmission round, is the segment loss detected by a triple duplicate ACK or a timeout?
- (e) What is the initial value of Threshold at the first transmission round?
- (f) What is the value of Threshold at the 18th transmission round?
- (g) What is the value of Threshold at the 24th transmission round?
- (h) During what transmission round is the 70th segment sent?
- (i) Assuming a packet loss is detected after 26th round by the receipt of a triple duplicate ACK, what will be the values of the congestion-window size and of Threshold?

function. If it is required that the rendering of this object be obtained, can you design a method to solve this problem? How?

6. Shadow generation: (15%)

(a) (5%) Why there will be shadows in a scene with *Ray Tracing* Algorithm?

(b) (10%) Please describe briefly any method how to add fake shadows?

(Hint: Visible-surface algorithm with some modifications is one possible solution.

Maybe you can draw some pictures to show the ideas.)