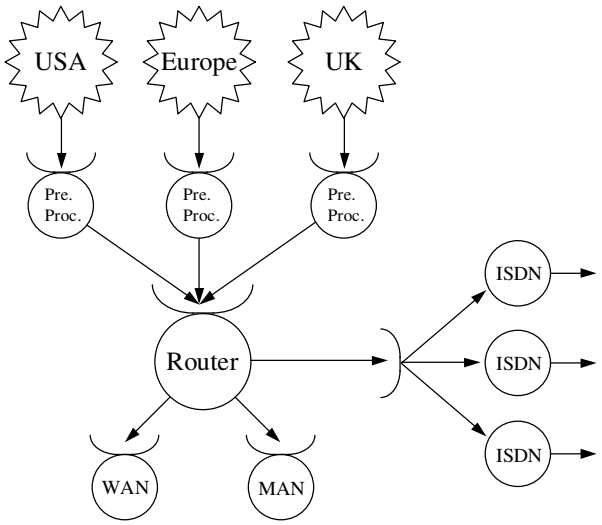
Answer THREE questions

1.



Consider the above data gateway used by CitySleekers Ltd to distribute messages to their customers. Data is received from through three separate feeds from the USA, Europe and the UK respectively. Traffic from each of these feeds is pre-processed by identical servers with Poisson distributed service rate before being queued for the router. Each server can on average handle 24000 messages per minute. They also have sufficient memory to provide an unlimited number of buffers. The service rate of the router is also Poisson distributed with a mean of 700 messages per second.

The router switches messages to three networks: a leased line WAN covering most large cities in the UK, a London wide MAN and an ISDN distribution network for selected customers.

Messages from the three feeds are Poisson distributed with mean rates of 165 messages per second from the USA, 350 from Europe and 185 from the UK.

a) Determine the mean delay which messages from Europe suffer, waiting to be served by the pre-processor.

[10 marks]

b) The queue of messages waiting to be served by the router is limited to 36 buffers. Determine the mean waiting time and the mean number of messages in the queue.

[11 marks]

c) The ISDN service is supported by three lines. Each line can be considered a Poisson server with a mean service rate of 15 messages per second. What is the mean number of messages waiting to be transferred if the mean number of messages routed across this connection is 25 messages per second and the system can be considered to have an unlimited supply of buffers?

[12 marks]

2.

a) Explain in detail how a satellite connection using ALOHA type access protocols operates and derive an expression giving the relationship between channel throughput and total channel traffic, assuming that the traffic is Poisson distributed and the number of users infinite.

[13 marks]

b) What is the maximum throughput per packet time for a channel using pure ALOHA?

[5 marks]

c) What is the mean retransmission rate per packet for pure ALOHA during maximum throughput, and how does it compare to that of Slotted ALOHA during maximum throughput?

[5 marks]

d) What is the main difference between CSMA and ALOHA protocol types, and why are CSMA protocols not used in satellite links?

[5 marks]

e) Explain how the throughput of a satellite channel using ALOHA protocols can be increased at minimal cost.

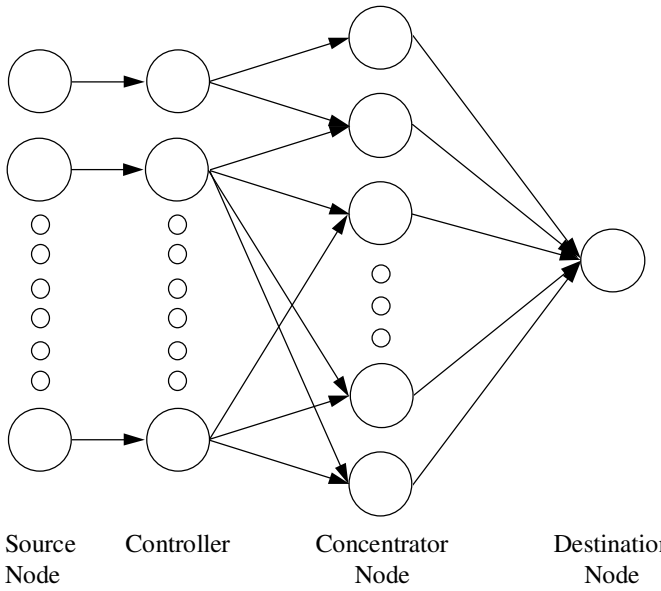
[5 marks]

3.

a) Explain in detail how delta routing is used to avoid congestion in networks.

[13 marks]

b)



Consider the network shown above, where a single destination node can be reached along Q independent paths. Every path is connected to a concentrator which is able to queue up to L messages. The transfer time between a concentrator and the destination is one time unit and the queues at the concentrators are decreased by one through transmission every time unit.

A number of source nodes use the network to access the destination node. They are connected through controllers, one for each source node, to one or more concentrators. The task of the controllers is to route each message to the concentrator which will result in the shortest delay. The controller makes its routing decisions based on reports submitted by the concentrators every T time units.

Outline a routing strategy which will minimise the mean delay in the network when the rate of traffic from the source nodes is Poisson distributed.

[20 marks]

4.

a) Describe how a k-connected network can be created from a given collection of nodes.

[10 marks]

b) Outline how it is possible to determine whether a given network topology provides N node disjoint paths between a given pair of nodes.

[10 marks]

c) We wish to perturb a given network configurations by replacing one or more links. Outline a method of link replacements which will secure that the connectivity of the network is retained.

[13 marks]

5.

a) Verify that 2 is a primitive element modolo 11.

[4 marks]

b) What conditions must a multiplicative congruential pseudo random number generator satisfy to secure that it provides a full cycle?

[5 marks]

c) Consider the generators

$$X_{k+1} = 2\ X_k \bmod 11$$

$$X_{k+1} = 5\ X_k \bmod 11$$

$$X_{k+1} = 8\ X_k \bmod 11$$

Which generator would you use to generate two-tupples, and why?

[8 marks]

d) Explain how a uniform random number generator can be used to generate random numbers which have a negative exponential distribution.

[8 marks]

e) Explain how a uniform random number generator can be used to generate random numbers which have a normal distribution.

[8 marks]

END OF PAPER