Homework-1

a) Goal and objectives:

Observe flow control mechanism and and decrease the variance of packet interarrival times of the packets while maintaining minimum packet queue length.

b) State Variables:

(i) $P(t)$ → no. of packets in packet queue

(ii) $K(t)$ → no. of tokens in token queue

Output Variables:

(i) Average Packet Delay (Job-average)

(ii) Average Packet Queue Length (Time average)

(iii) Packet Variance

c) Set of Events:

(i) Packet Arrival

(ii) Token Creation

d) State Equations:

For packet queue length

$$P(t^+) = \begin{cases} k(t) == 0 \,?\; p(t)+1 : p(t) & \text{packet arrival} \\ p(t) != 0 \,?\; p(t)-1 : p(t) & \text{token creation} \\ p(t) & \text{o/w} \end{cases}$$

For tokens in token queue:

$$k(t^+) = \begin{cases} k(t) != 0 \,?\; k(t)-1 : k(t) & \text{packet arrival} \\ p(t) == 0 \,?\; k(t)+1 : k(t) & \text{token creation} \\ k(t) & \text{o/w} \end{cases}$$

e) Output Equations:

(i) Average Packet Delay:

Every packet has an interarrival time. The packet will depart when token for that packet is created.

If packet arrival time is a_i and token creation time for i^{th} packet is b_i then,

Packet delay, $d_i = \max(b_i - a_i, 0)$

Let, tokens are created at a fixed rate λ.

So, $b_i = \lambda i$

Average packet delay, $\bar{d} = \frac{\sum_{i=0}^{n-1} d_i}{n}$

(ii) Average Packet Queue Length:

(ii) Let, packet queue length at time t is, $q(t)$.

As queue length is time-dependent,

average queue length is, $\bar{q} = \frac{\int_0^\tau q(t)}{\tau}$ for $(0, \tau)$

where τ is the simulation run-time.

(iii) Average Packet Variance: The variance of packet delay is

$$\sigma_d^2 = \frac{\sum_{i=0}^{n-1} (d_i - \bar{d})^2}{n}$$

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e) In the simulation,

the sample space for $P(t)$ is $X = \{0, 1, 2, 3 \ldots\}$

the sample space for $K(t)$ is $X_K = \{0, 1, 2, 3 \ldots\}$

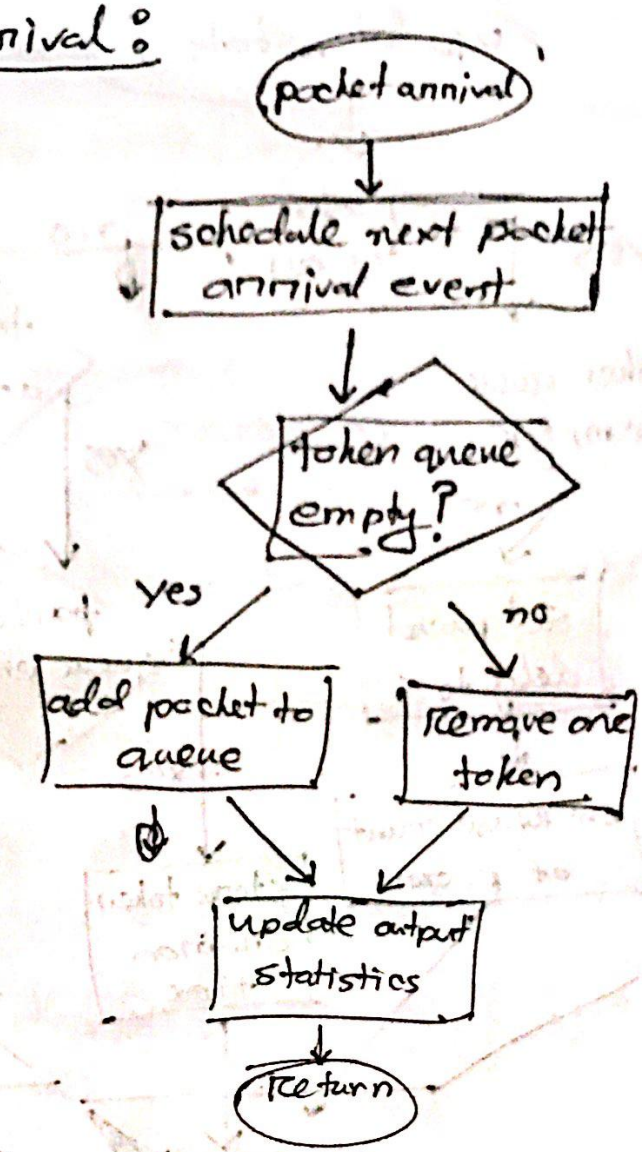
But both can't be non-empty at the same time.

So,

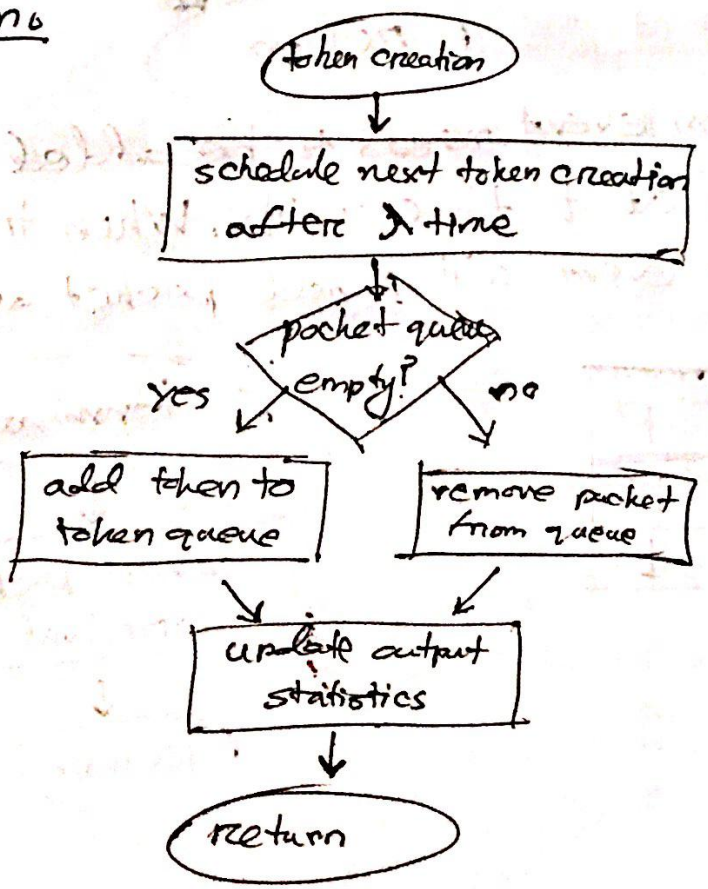
$X = \{(0,0), (0,1), (0,2), (0,3) \ldots (1,0), (2,0), (3,0) \ldots\}$

So, any natural number from 0 to infinity while one of the queue length is 0, or both are 0.

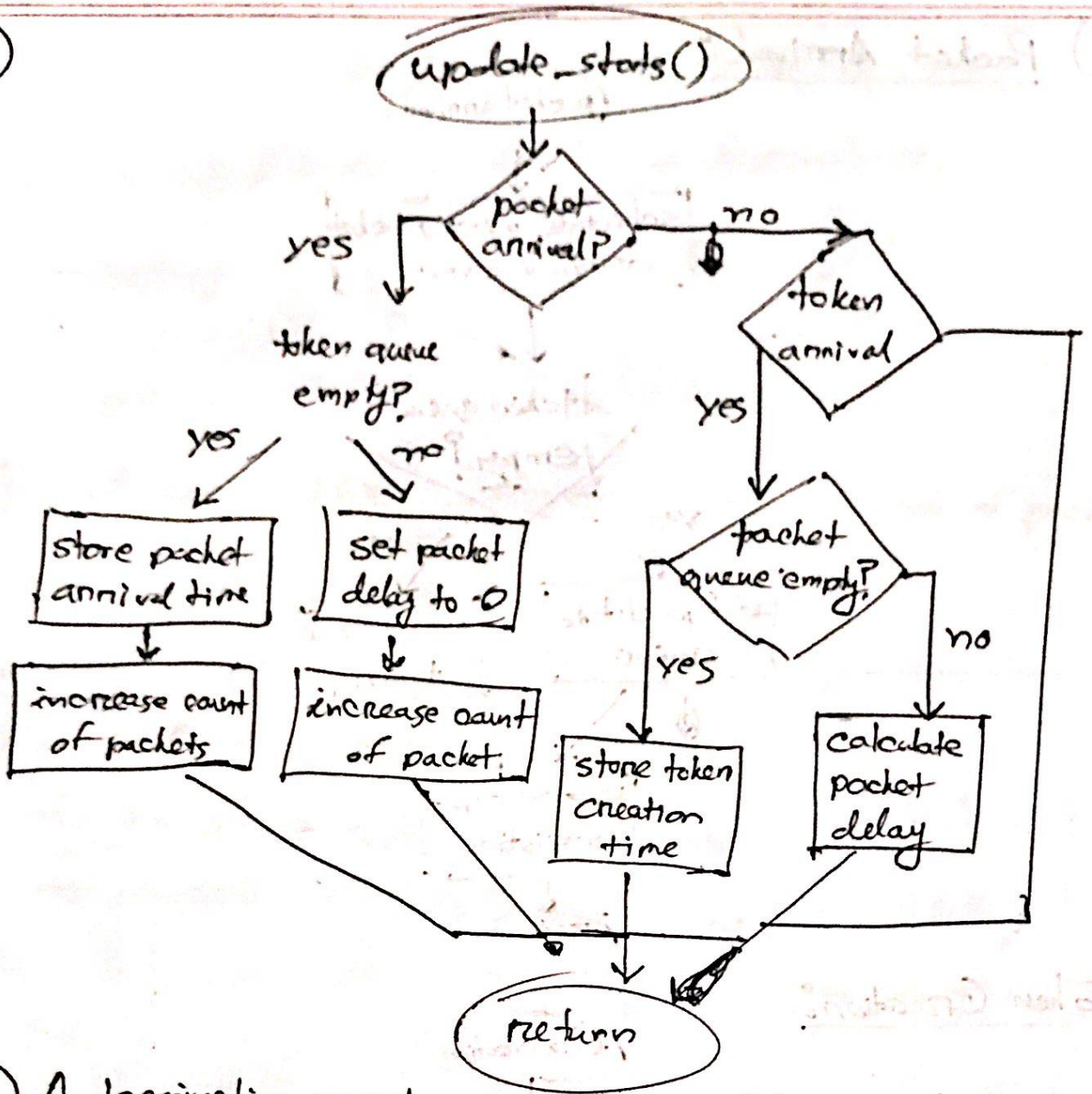
f) Packet Arrival:

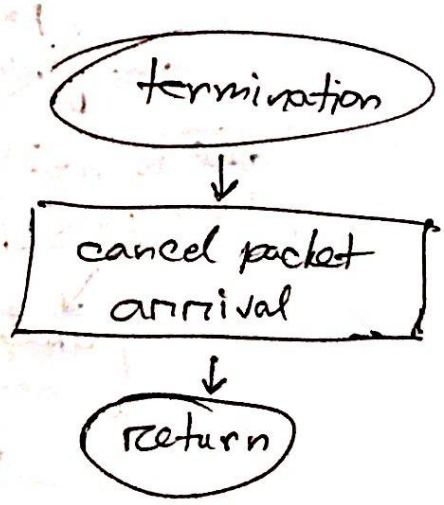


Token Creation:



g)



h) A termination event needs to be added which will be scheduled at 't' time units. When triggered the termination event will cancel packet arrival

packet arrival	p
token creation	K
termination	t