BULK QUEUES

This is a class of queues in which arrival or service (or both) is in bulks. This scenario is commonly found in ticket booking counters where a group of people arrive for ticket booking but they are served one at a time. This is referred to as BULK ARRIVAL. Another form of it is commonly seen in tourist places where a group of people arrive and a single tourist guide takes them through the place. This is referred to as BULK SERVICE, since one server, the tourist guide servers a group of people at the same time.

Bulk Arrival:
This form of the queue is an extension of the $M/M/1$ queuing system whereby we now make an additional assumption that x $(x \geq 1)$ customers arrive, with probability c_x, for service and are served one at a time by the server (assuming 1 server). It is denoted by: $M^{[X]}/M/1$. If λ_x is the arrival rate of a batch of size X, then $c_x = \frac{\lambda_x}{\lambda}$, λ being the composite arrival rate of all the batches and equals $\sum_{x=1}^{\infty} \lambda_x$. This is also known as compound Poisson process. We can similarly extend $M/M/c, M/M/c/c, M/M/c/k$ models in terms of bulk arrivals.

For an $M^{[X]}/M/1$ system, the measures of effectiveness are

a) Average number of customers in the system:

$$L = \frac{r(E(X) + E(X^2)}{2(1-\rho)} = \frac{\rho + rE(X^2)}{2(1-\rho)}, \left(\rho = \frac{\lambda E(X)}{\mu}, r = \frac{\lambda}{\mu} \right)$$

b) Average number of customers in the queue: By Little’s formula, we get:

$$L_q = L - \rho = \frac{\rho^2 + (r-1)\rho}{2(1-\rho)} \text{ for a batch of size } \left(\rho = \frac{\lambda E(X)}{\mu}, r = \frac{\lambda}{\mu} \right)$$

c) Steady State Probability: The probability of \$n\$ customers in the system is given by:

$$p_n = (1-\rho)\{[\alpha + (1-\alpha)\rho]^{n-1}[(1-\alpha)\rho]\}$$

Bulk Service:
In this form of queuing system, the customers arrive to the server one at a time and the server is capable of serving K customers at a time. This shows two possibilities: (a) the server waits to serve till there are K customers to be served or (b) the server performs service if there are $0 < i \leq K$ customers awaiting service. Hence, depending on the system, anyone of the disciplines is applicable. We denote a single server, bulk service by $M/M^{[X]}/1$. The other queuing models can be similarly extended.

It should be noted that the Markovian nature in these forms of queuing systems is maintained since the inter-arrival and service times are assumed to follow exponential distribution.