Queuing Models (1)

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Recap

- Probability
- Traffic characterization

Today's lecture

- Queuing systems
- M/M/1
- Little's Formula
- examples

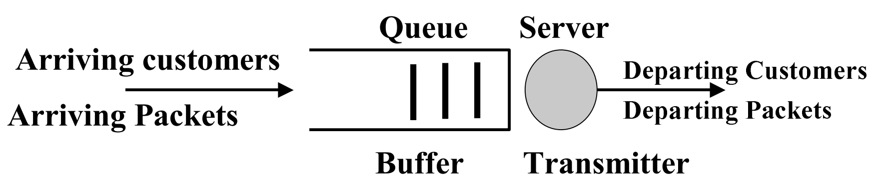
Queuing models

- Many phenomena in life can be thought of as queues
  - Cashier line in grocery store
  - Waiting for a teller in a bank
  - Bus stop
  - Getting a ticket in a theatre
  - Etc

Queuing models

- In data networks, we can find queues in many spots:
  - From DLL to network
  - From network to DLL
  - From L3 to L4
  - Between swicthes/routers
  - etc

Basic Queue Model



Example

- A 56 kbps transmission line can serve 1000-bit packets as a rate of
  - 56 pkts/sec

Little's Formula

- It is very general and can be applied to almost all types of queues and network of queues
  - The time spent by a customer, while waiting and being served, by the arrival rate of customers gives the number of customers in the Qing system (including the customer being currently serviced)

$$T = N$$

Kendall Notation

- X/Y/m/k where
  - X is a symbol representing the interarrival process:
    - M= Poisson (EXPO interarrival times)
    - D= Deterministic (Constant interarrival times)
  - Y is a symbol representing the service distribution
    - M= exponential
    - D= Deterministic
    - G= General
  - M is the number of servers
  - K is the buffer size (omitted when k=)

M/M/1 Queue

- Is the most basic and important Qing model
  - Poisson arrival with rate
  - Exponential service time with mean 1/ (is service rate)
  - Single server
  - Infinite buffer

M/M/1 Results

- normalized offered load or utilization ( ) = / = 1-p_0 = prob system is non-empty (busy)
- Avg number of customers in the Q= E(n)= /(1-)
- Average waiting time E(t)= E(n)/

Example

A switching node receives packets at a rate of 2000 pkt/sec with exponential interarrival times and sends them on a link with capacity of 1.5 Mb/s. The packet lengths are exponentially distributed with mean 515 bit/pkt. Find the average packet waiting time in this node?

Example

Solution:

Packet service time is exponential with mean

1/ =pkt_len/capacity=0.33ms/pkt

Packet service rate = = 3000pkt/s

From M/M/1; = / = .67 (unitless)

E(n) = 2 pkts/sec

E(t) = 1 ms !