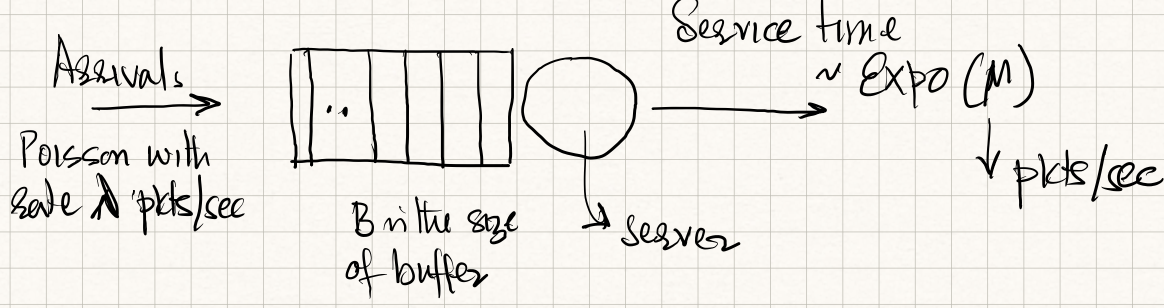
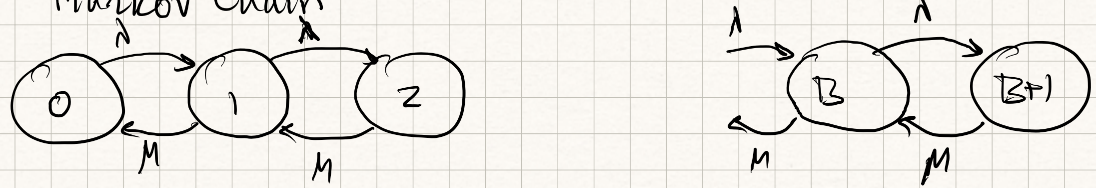
Lecture 4

1) Review Assignment 1
2) Statistical Multiplexing in circuit switching

Finite Buffer Queue



Markov Chain



- Note that B refers to the maximum number of waiting pkts. The pkt that is being transmitted is in the transmitter
- Hence, the maximum value of the state (number of pkts in the system) goes upto B+1
- We can use the same approach as in the infinite buffer case to find the

state probabilities $p_i = P(N = i)$
where $i \in \{0, 1, 2, \ldots, B+1\}$

- $P_D = P(\text{packet drop})$

$$= p_{B+1}$$

$$P_D = P(N = B+1 \mid \text{Arrival})$$

$$= \frac{P(N = B+1 \cap \text{Arrival})}{P(\text{Arrival})}$$

$$= \frac{P(N = B+1) \cap P(\text{Arrival})}{P(\text{Arrival})}$$ since arrivals are independent of state

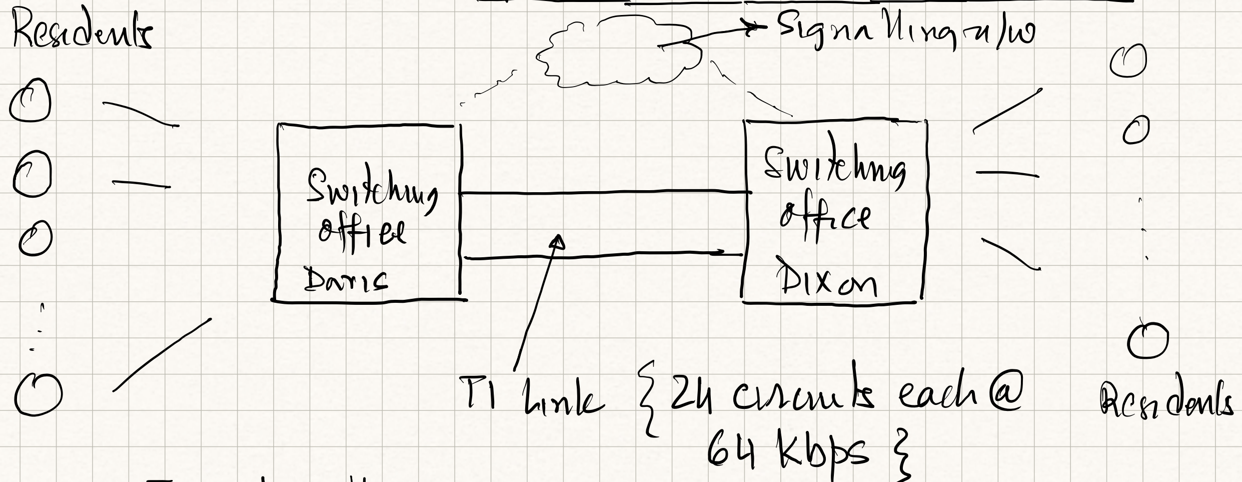
$$= P(N = B+1)$$

$$= p_{B+1}$$

- Modify the simulation to model the finite buffer and compare the simulation and theoretical results.

⇒ In the simulation code that is given the queue is implemented as a list which can grow unboundedly

Statistical Multiplexing in Circuit Switching



Typical call

- User picks up phone
  Gets dial tone
  Punches number
- Switch get the number and using the signaling n/w sets up circuits in the path to the destination switch
- Destination (callee) gets the ring & picks up the phone
- Talk
- One party hangs up which results in the circuits along the path to be deallocated (using the signalling n/w)

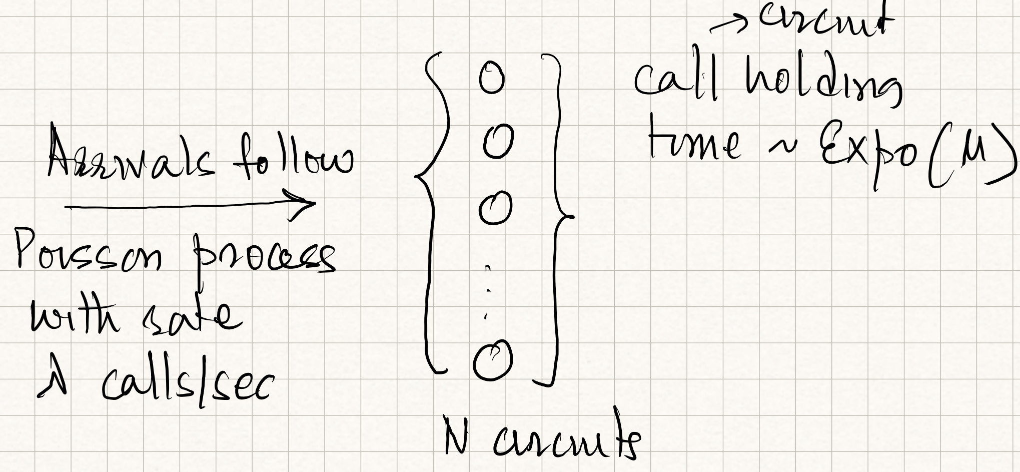
Notes:

1. Time to setup & tear down circuits is in the order of few tens to few hundreds of milliseconds

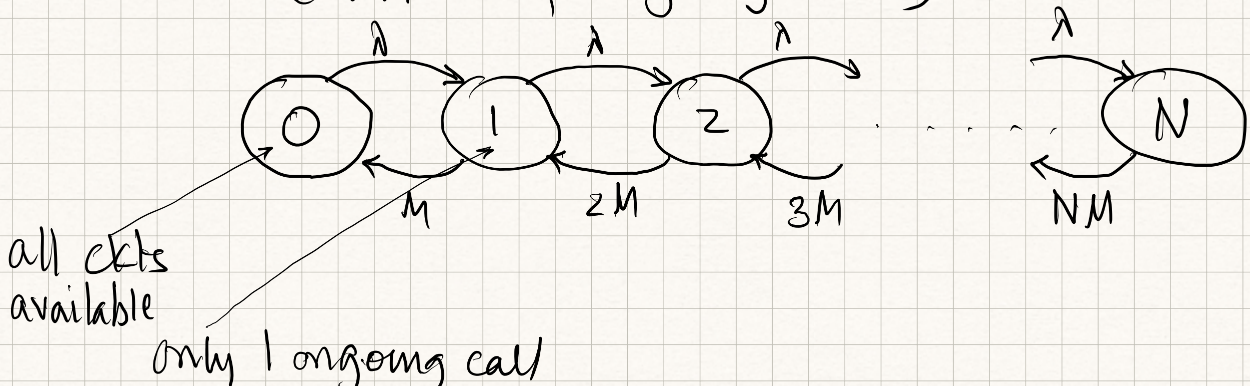
2. Talk time (call holding time) is a random variable $X \sim Expo(\mu)$ where $1/\mu = 180$ seconds

- A key question is how many circuits should be provisioned between Davis & Dixon?
  a) Setting ~~it~~ equal to the max of the number of residents in Davis & Dixon is wasteful since it is highly unlikely all residents will be calling simultaneously
  b) We can provision a smaller number of circuits and exploit the statistical behavior of users making calls but there will be a probability that a call may be blocked due to all circuits being busy

c) We want to calculate the call blocking probability P_B



We can draw the Markov Chain where the state is the number of busy circuits (number of ongoing calls)



Notes:

a) There is no buffer. A blocked call is cleared.

b) When i ckts are busy then

the rate at which a call is completed (a circuit is freed) is $i\mu$

- $X_1, X_2, \dots, X_i$ denote the random variables of the call holding times of i active calls. They are iid Expo(μ)
- We want to find the distribution of $Z = \min(X_1, \dots X_i)$

- You can show that $Z \sim \text{Expo}(i\mu)$

c) $P_B = P_N$ (Probability of being in state N)

d) One can find the steady state probabilities using the flow balance equations