

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

## Lecture: 07

### Quiz-01- Solution

1. Using LCM generate a sequence of random number with  $X_0 = 4$ ,  $a = 7$ ,  $C=3$  and  $m= 10$

**Solution:**

$$X_0=4; R_1= 4/10 =0.4$$

$$X_1 = (7*4+3) \bmod 10= 31 \bmod 10= 1; R_2 = 1/10=0.1$$

$$X_2 = (7*1+3) \bmod 10= 10 \bmod 10= 0; R_3 = 0/10= 0$$

$$X_3 = (7*0+3) \bmod 10= 3 \bmod 10= 3; R_4 = 3/10=0.3$$

$$X_4 = (7*3+3) \bmod 10= 24 \bmod 10= 4; R_5 = 4/10=0.4$$

**Random Sequence 4,1,0,3,4**

**Random Number 0.4, 0.1,0 ,0.3**

2. Fill up this table:

Time between Arrival (min)	Probability	Cumulative Probability	Random Digit Assignment
1	0.1	0.1	1
2	0.1	0.2	2
3	0.2	0.4	3-4
4	0.5	0.9	5-9
5	0.1	1.0	0

3. Problem-1:

- You have only one checkout counter
- Customer arrives at this checkout counter at random from 1 to 7. Each possible value of inter arrival time has the same probability of occurrence as shown in the Table 1.
- The service time varies from 1 to 5 minutes with the probabilities shown in Table 2.
- The problem is to analyze the system by simulating the arrival and service of 10 customer.
- Random value for time between arrivals- 913,727,015,948,309,922,753,235,302

6. Random value for service time- 84,10,74,53,17,79,91,67,89,38

**Table-1**

Time between Arrival (min)	Probability	Cumulative Probability	Random Number Assignment
1	0.143	0.143	001-143
2	0.143	0.286	144-286
3	0.143	0.429	287-429
4	0.143	0.572	430-572
5	0.143	0.715	573-715
6	0.143	0.858	714-858
7	0.143	1.000	859-1000

**Table-2**

Service Time (min)	Probability	Cumulative Probability	Random Number Assignment
1	0.10	0.10	01-10
2	0.20	0.30	11-30
3	0.30	0.60	31-60
4	0.25	0.75	61-75
5	0.25	1.00	76-100

**Solution:**

Customer No	Random Digit for Inter Arrival	Inter-arrival	Arrival Time	Random Digit for Service Time	Service Time	Waiting in the Queue	Service time Begin	Service time End	Idle Time of the Server
1	-	0	<b>0</b>	84	5	0	0	5	0
2	913	7	$0+7=7$	10	1	0	7	8	$0+2$
3	727	6	$7+6=13$	74	4	0	13	17	$2+5=7$
4	15	1	$13+1=14$	53	3	3	17	20	$7+0=7$
5	948	7	$14+7=21$	17	2	0	21	23	$7+1=8$
6	309	3	$21+3=24$	79	5	0	24	29	$8+1=9$
7	922	7	$24+7=31$	91	5	0	31	36	$9+2=11$
8	753	6	$31+6=37$	67	4	0	37	41	$11+1=12$
9	235	2	$37+2=39$	89	5	2	41	46	$12+0=12$
10	302	3	$39+3=42$	38	3	4	46	49	$12+0=12$
<b>Total</b>			<b>42</b>		<b>37</b>	<b>09</b>		<b>49</b>	<b>12</b>

Average Inter arrival time:  $\frac{42}{10} = 4.2$

Average Waiting Time:  $\frac{9}{10} = 0.9$

Average number of Customer in Queue or, Probability of Customer in Queue:  $\frac{4}{10} = 0.4$

Average Service Time:  $\frac{37}{10} = 3.7$

Average time spend in the counter: Avg Waiting time + Avg Service Time =  $0.9 + 3.7 = 4.6$

Probability of idle server:  $\frac{\text{Total idle time}}{\text{Total run time}} = \frac{12}{49} = 0.244 \sim 0.2$

Utilization of counter:  $\frac{\text{End time} - \text{Idle time}}{\text{End time}} = \frac{49 - 12}{49} = 0.75 \sim 0.8$

**Utilization 80%**

# Simulation of telephone system

## Problem 1:

- The system has a number of telephones (8 are shown) connected to a switchboard by lines.
- The switchboard has a number of links which can be used to connect any two lines, subject to the condition is that only one connection at a time can be made to each link.
- They established maximum 3 links.

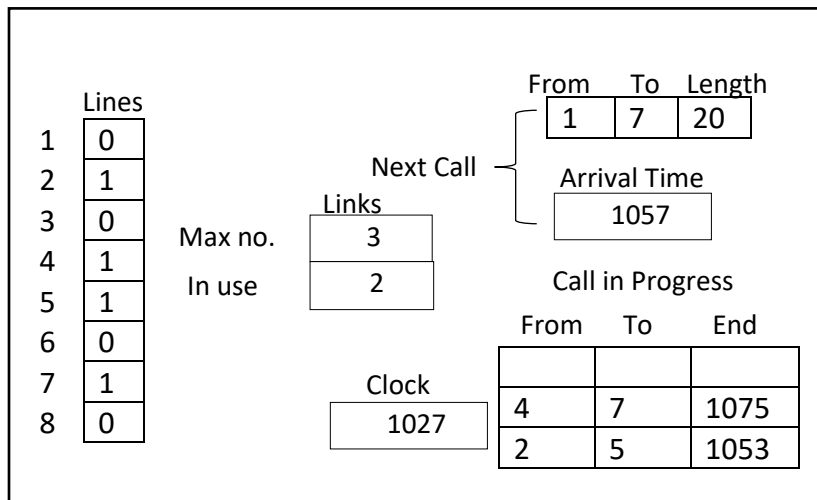
Process a given number of calls and determine what proportions are successfully

- Completed
- Blocked or
- Found to be busy

The system is lost call system

- A call is lost, if the call party is engaged, then it is a busy call
- A call may be lost if no link is available, it is blocked call

From	To	Length	Arrival time
3	6	98	1063
1	5	132	1082
2	4	30	1125



Links

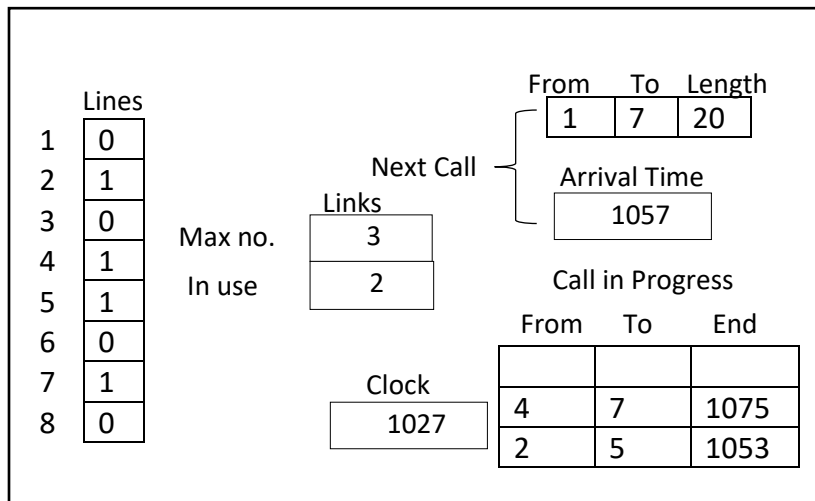
	1	2	3
1			
2			
3			
4			
5			
6			
7			
8			

Call Counter

Processed	Completed	Blocked	Busy
131	98	5	28

**Solution:**

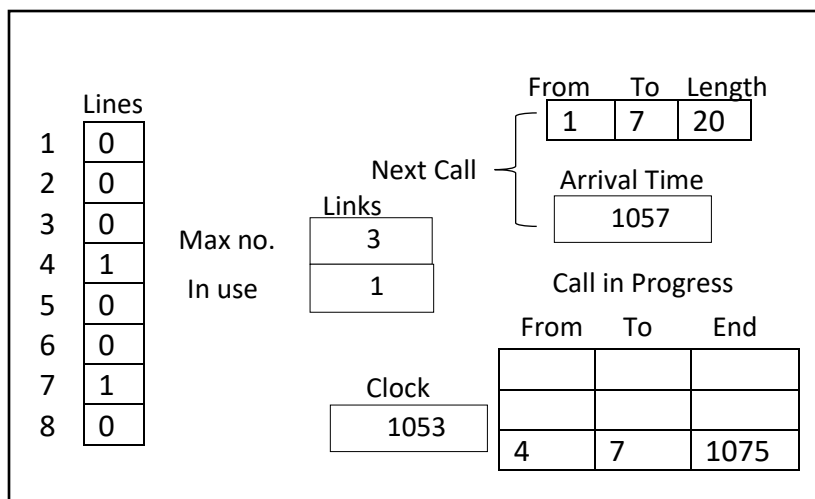
**System State-1**



**Call Counter**

Processed	Completed	Blocked	Busy
131	98	5	28

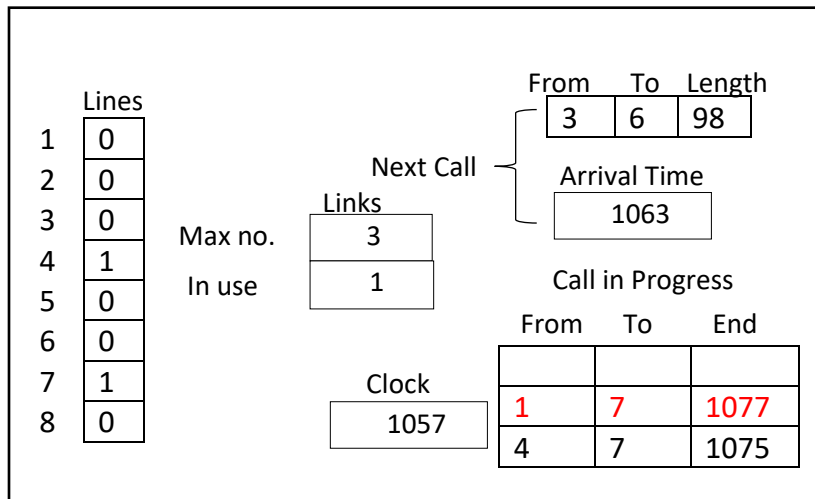
**System State-2**



**Call Counter**

Processed	Completed	Blocked	Busy
132	99	5	28

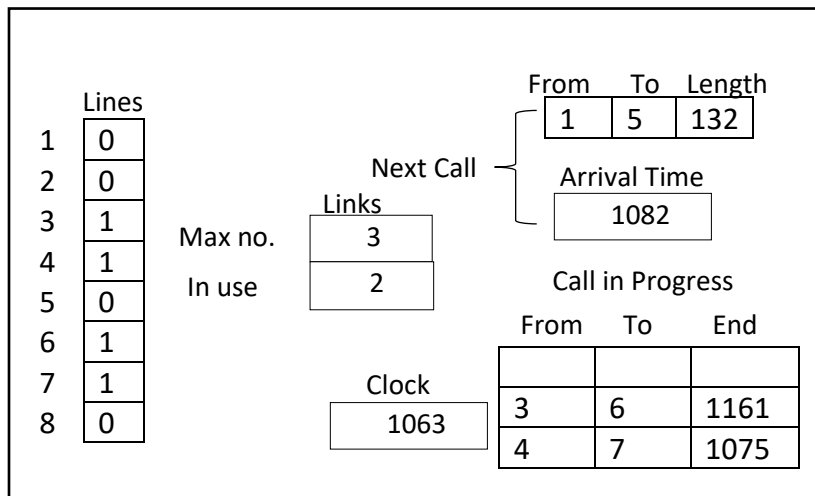
### System State-3



#### Call Counter

Processed	Completed	Blocked	Busy
133	99	5	29

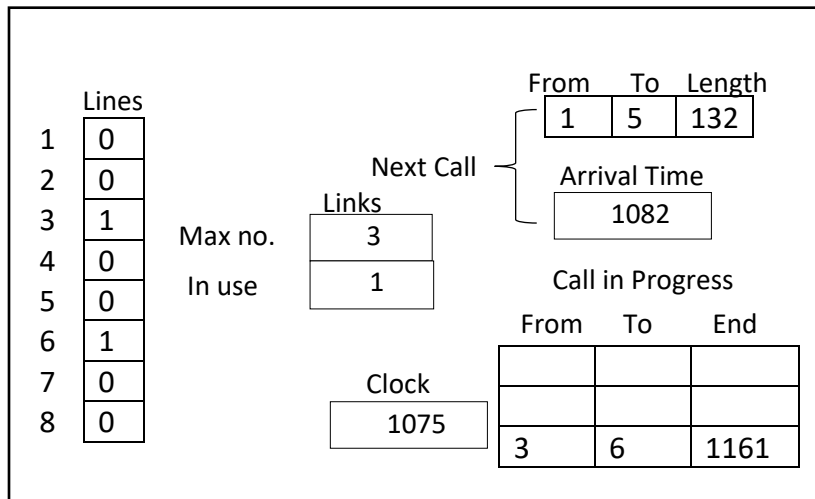
### System State-4



#### Call Counter

Processed	Completed	Blocked	Busy
133	99	5	29

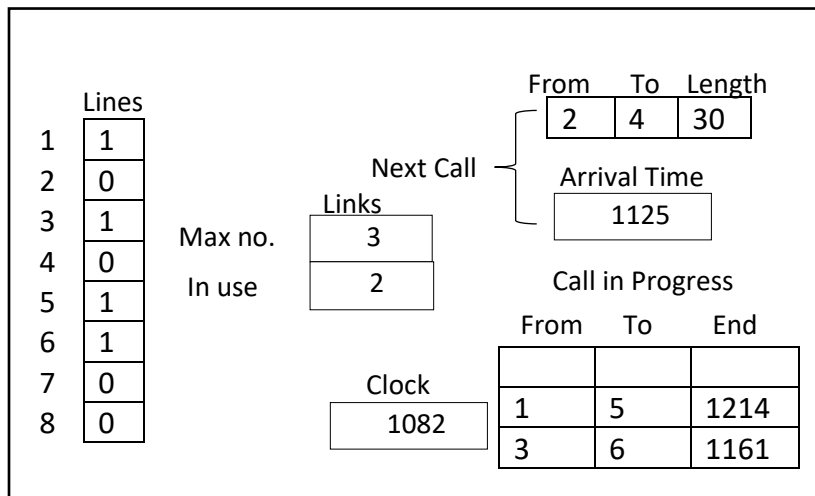
## System State-5



### Call Counter

Processed	Completed	Blocked	Busy
134	100	5	29

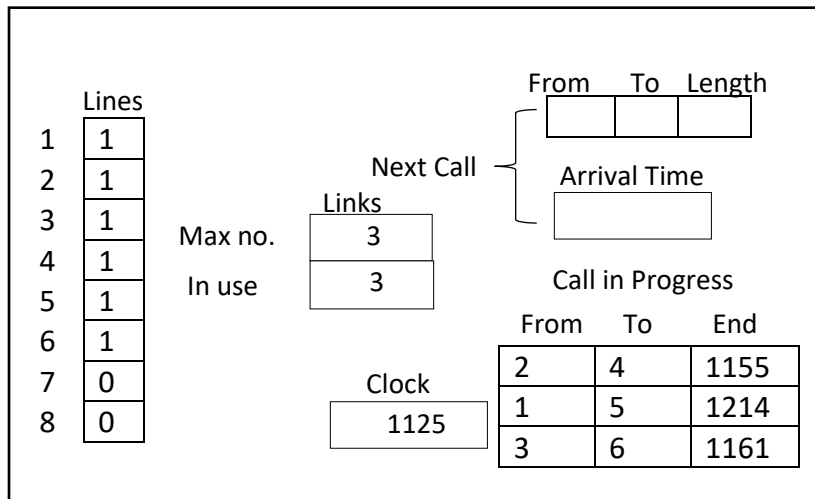
## System State-6



### Call Counter

Processed	Completed	Blocked	Busy
134	100	5	29

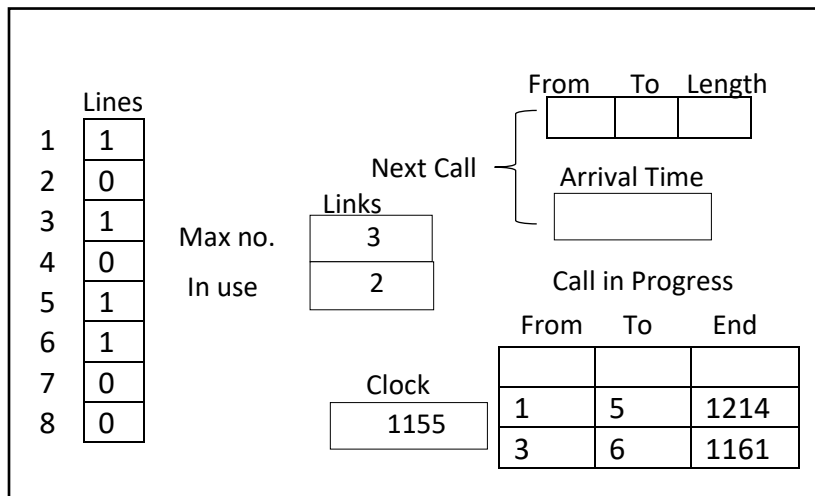
## System State-7



### Call Counter

Processed	Completed	Blocked	Busy
134	100	5	29

## System State-8

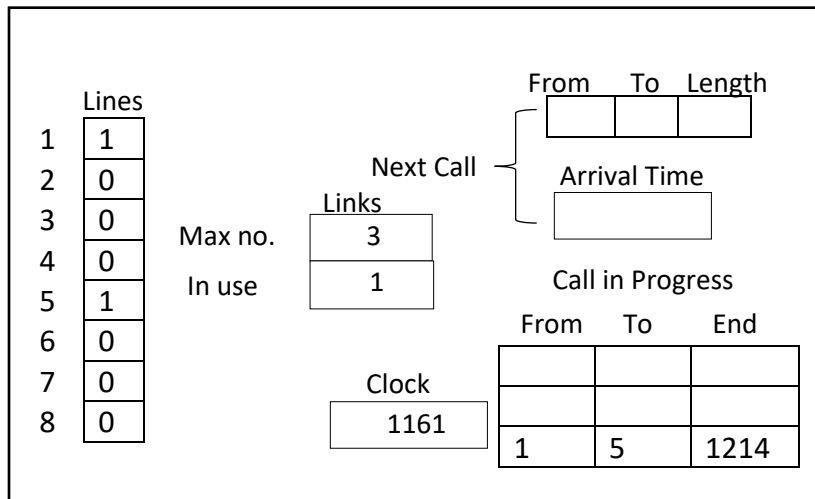


### Call Counter

Processed	Completed	Blocked	Busy
135	101	5	29



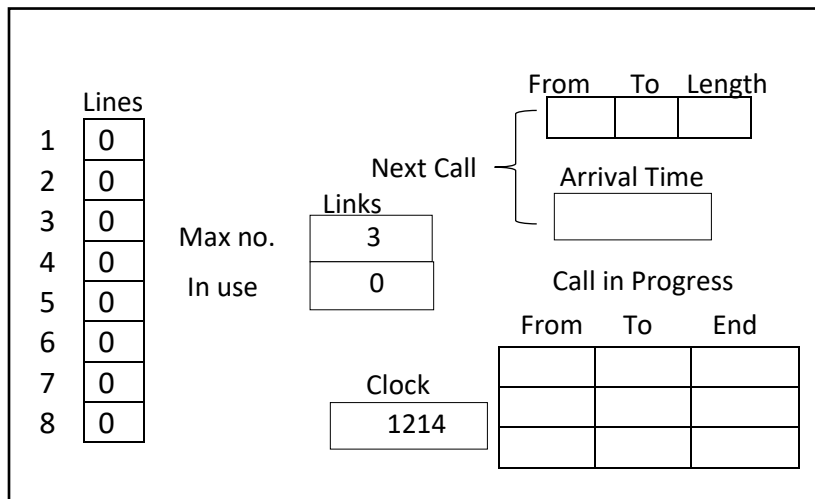
## System State-9



### Call Counter

Processed	Completed	Blocked	Busy
136	102	5	29

## System State-10



### Call Counter

Processed	Completed	Blocked	Busy
<b>137</b>	<b>103</b>	<b>5</b>	<b>29</b>

## Problem 2 (Homework)

- The system has a number of telephones (8 are shown) connected to a switchboard by lines.
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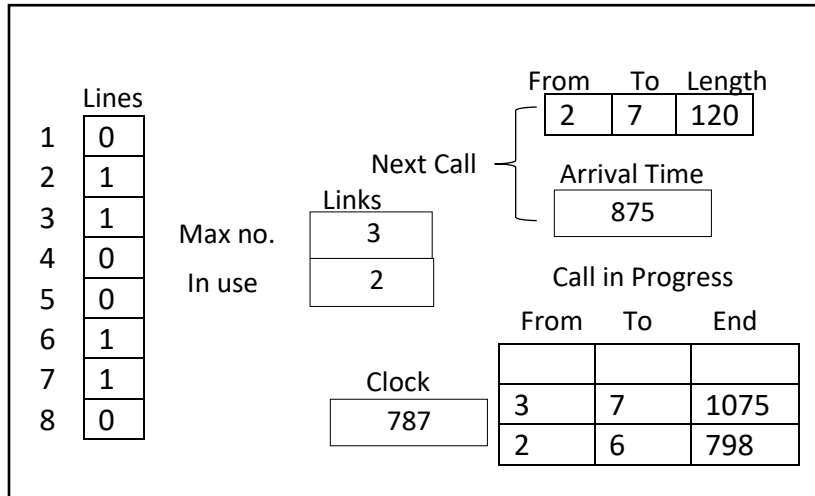
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- A call is lost, if the call party is engaged, then it is a busy call
- A call may be lost if no link is available, it is blocked call

From	To	Length	Arrival time
2	7	49	987
1	3	278	1049
8	5	130	1125



Links

	1	2	3
1			
2	●		
3			
4			
5		●	
6	●		
7			
8		●	

Call Counter

Processed	Completed	Blocked	Busy
122	87	8	49