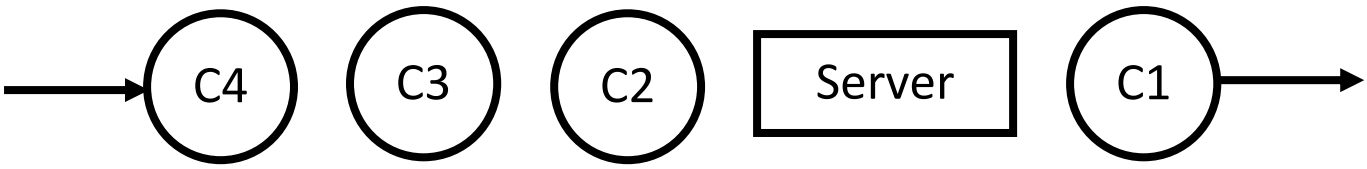
Simulation of Single Server Queue Example



- Customer arrive at the server at random from 1 to 8 minutes apart. Each possible value of inter arrival time has the same probability of occurrence.
- The service time vary from 1 to 6 minutes with the probability of 0.10, 0.20, 0.30, 0.25, 0.10, 0.05 respectably.

- The problem is to analyze the system by simulating the arrival and service of 20 customers.
- Random value for time between arrivals - 913, 727, 015, 948, 309, 922, 753, 235, 302, 109, 093, 607, 738, 359, 888, 106, 212, 493, 535.
- Random value for Service time - 84, 10, 74, 53, 17, 79, 91, 67, 89, 38, 32, 94, 79, 05, 79, 84, 52, 55, 30, 50.

Questions	
1.	Average Interval (Inter Arrival) Time
2.	Average Waiting Time of Those Who Wait
3.	Average number of Customer in Queue or, Probability of Customer in Queue
4.	Average Delay in Queue or, Average Waiting Time
5.	Average Service Time
6.	Average Time Spend in the Server
7.	Probability of Idle Server
8.	Utilization of the Server

- Customer arrive at the server at random from 1 to 8 minutes apart. Each possible value of inter arrival time has the same probability of occurrence.

Distribution of time between arrivals			
Time Between Arrival	Probability	Cumulative Probability	Random Digit Assignment
1	1/8 = 0.125	0.125	001 – 125
2	1/8 = 0.125	0.250	126 – 250
3	1/8 = 0.125	0.375	251 – 375
4	1/8 = 0.125	0.500	376 – 500
5	1/8 = 0.125	0.625	501 – 625
6	1/8 = 0.125	0.750	626 – 750
7	1/8 = 0.125	0.875	751 – 875
8	1/8 = 0.125	1.000	876 – 000

Table 1: Distribution of time between arrivals

- The service time vary from 1 to 6 minutes with the probability of 0.10, 0.20, 0.30, 0.25, 0.10, 0.05 respectably.

Distribution of service time			
Service Time	Probability	Cumulative Probability	Random Digit 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	0.85	61 – 85
5	0.10	0.95	86 – 95
6	0.05	1.00	96 – 00

Table 2: Distribution of service time

The problem is to analyze the system by simulating the arrival and service of 20 customers.

- Random value for time between arrivals - 913, 727, 015, 948, 309, 922, 753, 235, 302, 109, 093, 607, 738, 359, 888, 106, 212, 493, 535.
- Random value for Service time - 84, 10, 74, 53, 17, 79, 91, 67, 89, 38, 32, 94, 79, 05, 79, 84, 52, 55, 30, 50.

Time Between Arrival Determination		
Customer No	Random Digit	Time Between Arrival
1	-	-
2	913	8
3	727	6
4	015	1
5	948	8
6	309	3
7	922	8
8	753	7
9	235	2
10	302	3
11	109	1
12	093	1
13	607	5
14	738	6
15	359	3
16	888	8
17	106	1
18	212	2
19	493	4
20	535	5

Table 3: Time Between Arrival Determination using Table 1

Service Time Determination		
Customer No	Random Digit	Service Time
1	84	4
2	10	1
3	74	4
4	53	3
5	17	2
6	79	4
7	91	5
8	67	4
9	89	5
10	38	3
11	32	3
12	94	5
13	79	4
14	05	1
15	79	4
16	84	4
17	52	3
18	55	3
19	30	2
20	50	3

Table 4: Service Time Determination using Table 2

Now Simulation

Customer No	Time between Arrival	Arrival Time	Service Time	Service Start Time	Service End Time	Waiting time in Queue	Idle Time for server
1		0	4	0	4	0	0
2	8	8	1	8	9	0	4
3	6	14	4	14	18	0	5
4	1	15	3	18	21	3	0
5	8	23	2	23	25	0	2
6	3	26	4	26	30	0	1
7	8	34	5	34	39	0	4
8	7	41	4	41	45	0	2
9	2	43	5	45	50	2	0
10	3	46	3	50	53	4	0
11	1	47	3	53	56	6	0
12	1	48	5	56	61	8	0
13	5	53	4	61	65	8	0
14	6	59	1	65	66	6	0
15	3	62	4	66	70	4	0
16	8	70	4	70	74	0	0
17	1	71	3	74	77	3	0
18	2	72	3	77	80	5	0
19	4	76	2	80	82	4	0
20	5	81	3	82	85	1	0
20	**82**		**67**		**85**	**54**	**18**
Total Customer	Total Time between Arrival		Total Service Time		Server End Time	Total Waiting Time in Queue	Total Idle Time

Table 5: Simulation Table using Table 3 and Table 4

Performance Measure:

Average Interval (Inter Arrival) Time or, Average Time between Arrival

$$Average\ Interval\ (Inter\ Arrival) Time = \frac{Total\ Interval\ Time}{Total\ Customer\ -\ 1} = \frac{82}{20-1} = \frac{82}{19} = 4.32$$

$$Average\ Time\ between\ Arrival = \frac{Total\ Time\ between\ Arrival}{Number\ of\ Arrival\ -\ 1} = \frac{82}{20-1} = \frac{82}{19} = 4.32$$

Average Waiting Time of Those Who Wait

$$Average\ Waiting\ Time\ of\ Those\ Who\ Wait\ = \frac{Total\ Waiting\ Time}{Total\ Customer\ who\ wait} = \frac{54}{12} = 4.5$$

Average number of Customer in Queue or, Probability of Customer in Queue

$$Average\ number\ of\ Customer\ in\ Queue = \frac{Total\ Customer\ in\ Queue}{Number\ of\ Customer} = \frac{12}{20} = 0.6$$

$$Probability\ of\ Customer\ in\ Queue = \frac{Total\ Customer\ Wait\ in\ Queue}{Total\ Customer} = \frac{12}{20} = 0.6$$

Average Waiting Time or, Average Delay in Queue

$$Average\ Waiting\ Time\ = \frac{Total\ Waiting\ Time}{Total\ Customer} = \frac{54}{20} = 2.7$$

$$Average\ Delay\ in\ Queue\ = \frac{Total\ Delay}{Total\ Customer} = \frac{54}{20} = 2.7$$

Average Service Time

$$Average\ Service\ Time\ = \frac{Total\ Service\ Time}{Total\ Customer} = \frac{267}{20} = 3.35$$

Average Time Spend in Server

$$Average\ Time\ Spend\ in\ Server = Average\ Waiting\ Time + Average\ Service\ Time$$
$$= 2.7 + 3.35 = 6.05$$

Probability of Idle Server

$$Probability\ of\ Idle\ Server = \frac{Total\ Idle\ Time}{Total\ Runtime} = \frac{18}{85} = 0.2118$$

Utilization of the Server

$$Utilization\ of\ the\ Server = \frac{End\ Time\ -\ Idle\ Time}{End\ Time} = \frac{85 - 18}{85} = \frac{67}{85} = 0.7882$$