

Advanced Operating Systems Project-3

Objective : To gain experience with multithreading using the Pthreads library.

We've developed a C program that replicates multiple ticket sellers concurrently selling concert tickets over a span of one hour, utilizing the Pthreads library for thread and mutex creation.

Overview: At the program's initiation, there are ten distinct customer queues, each holding N customers. These queues monitor customer ID, their time of arrival, and the duration they're served. Both the arrival and service durations are expressed in minutes, with every customer set to arrive at the commencement of a given minute. Subsequently, every seller receives a customer queue to manage incoming consumers. These sellers are categorized into three types: L, M, and H, which dictates the speed of their service and their seat selection approach. When attending to a customer, a seller identifies an available seat based on their category. A seat becomes available when its associated mutex is not locked. This mechanism ensures that a seat is exclusively reserved by one seller. Upon securing a seat mutex, the seller logs details like response duration, total service time, and the seller's type at that seat. The process continues until either all seats are filled or the one-hour mark is reached. Unserved customers, if any, are informed that no seats are available. After the simulation concludes, metrics such as average response duration, service duration, and throughput for the respective seller types are determined. Shared across functions are variables like total customers for each seller, the overarching clock timer, pthread parameters, and seat-associated data structures.

Our model was conceptualized utilizing preliminary code, where we mimicked clock increments in the primary thread while managing critical zones and sales operations in the subsidiary threads that emulate ticket selling activities. The primary thread in our simulation is responsible for generating minute-wise clock ticks.

Simulation Assumptions:

1. Seller Thread Status: At any distinct time, a seller thread could be:
 - Idle: Awaiting the next customer.
 - Attending: Addressing a fresh customer from their queue.
 - Finalizing: Wrapping up the sales procedure for a customer.
 - Operational: Engaging in the actual sales task.
2. Time Increment: The smallest time unit recorded is a minute. Every subsidiary thread symbolizes a minute's activity, like assisting customers or concluding a sale.
3. A fresh clock tick is initiated for maintaining synchronized time.
4. To depict the concert seating, we employed a two-dimensional matrix, presuming that at any given time, only one thread would interact with the matrix, ensuring no clashes in seat allotment.

We also calculated Average Response Time, Average Turnaround Time and Throughput which came out to be:

	Average Response Time	Average Turnaround Time	Throughput
H	0.000000	32.60	0.08
L	0.466667	30.23	0.25
M	0.800000	29.33	0.47

Output:

Thread simulation starts here:

Time	SellerName	Activity	Response Time	Turnaround Time
00:00	M2	Customer No M201 arrived		
00:00	M2	Serving Customer No M201	0	
00:02	M2	Customer No M202 arrived		
00:03	L1	Customer No L101 arrived		
00:03	L1	Serving Customer No L101	0	
00:04	M2	Customer No M201 assigned seat 5,0		4
00:05	L5	Customer No L501 arrived		
00:05	L5	Serving Customer No L501	0	
00:05	M2	Customer No M203 arrived		
00:05	M2	Serving Customer No M202	3	
00:05	L6	Customer No L601 arrived		
00:05	L6	Serving Customer No L601	0	
00:07	M3	Customer No M301 arrived		
00:07	M3	Serving Customer No M301	0	
00:07	H1	Customer No H101 arrived		
00:07	H1	Serving Customer No H101	0	
00:07	L3	Customer No L301 arrived		
00:07	L3	Serving Customer No L301	0	
00:07	L5	Customer No L502 arrived		
00:08	H1	Customer No H101 assigned seat 0,0		8
00:08	M2	Customer No M202 assigned seat 5,1		8
00:08	L1	Customer No L101 assigned seat 9,9		8
00:08	L6	Customer No L602 arrived		
00:09	L5	Customer No L501 assigned seat 9,8		9
00:09	M2	Serving Customer No M203	4	
00:09	L6	Customer No L601 assigned seat 9,7		9
00:09	L1	Customer No L102 arrived		
00:09	L1	Serving Customer No L102	0	
00:10	H1	Customer No H102 arrived		
00:10	H1	Serving Customer No H102	0	
00:10	L6	Serving Customer No L602	2	
00:10	L5	Serving Customer No L502	3	
00:11	M3	Customer No M301 assigned seat 5,2		11
00:11	M2	Customer No M203 assigned seat 5,3		11
00:11	L3	Customer No L301 assigned seat 9,6		11
00:11	H1	Customer No H102 assigned seat 0,1		11
00:12	M2	Customer No M204 arrived		
00:12	M2	Serving Customer No M204	0	
00:13	L5	Customer No L503 arrived		
00:15	L5	Customer No L502 assigned seat 9,5		15
00:16	L6	Customer No L602 assigned seat 9,4		16
00:16	L5	Serving Customer No L503	3	
00:16	M2	Customer No M204 assigned seat 5,4		16
00:16	L1	Customer No L102 assigned seat 9,3		16
00:17	L1	Customer No L103 arrived		

00:17	L1	Serving Customer No L103	0	
00:18	L2	Customer No L201 arrived		
00:18	L2	Serving Customer No L201	0	
00:19	L4	Customer No L401 arrived		
00:19	L4	Serving Customer No L401	0	
00:21	L4	Customer No L402 arrived		
00:21	L5	Customer No L503 assigned seat 9,2		21
00:22	L1	Customer No L103 assigned seat 9,1		22
00:23	M3	Customer No M302 arrived		
00:23	M3	Serving Customer No M302	0	
00:23	L4	Customer No L401 assigned seat 9,0		23
00:23	M1	Customer No M101 arrived		
00:23	M1	Serving Customer No M101	0	
00:23	L2	Customer No L201 assigned seat 8,9		23
00:24	L4	Serving Customer No L402	3	
00:24	M1	Customer No M102 arrived		
00:25	M3	Customer No M302 assigned seat 5,5		25
00:26	M1	Customer No M101 assigned seat 5,6		26
00:26	L3	Customer No L302 arrived		
00:26	L3	Serving Customer No L302	0	
00:27	M2	Customer No M205 arrived		
00:27	M2	Serving Customer No M205	0	
00:27	M1	Serving Customer No M102	3	
00:30	L4	Customer No L402 assigned seat 8,8		30
00:30	M2	Customer No M205 assigned seat 5,7		30
00:30	M1	Customer No M102 assigned seat 5,8		30
00:31	L3	Customer No L302 assigned seat 8,7		31
00:31	L6	Customer No L603 arrived		
00:31	L6	Serving Customer No L603	0	
00:32	L3	Customer No L303 arrived		
00:32	L3	Serving Customer No L303	0	
00:32	M1	Customer No M103 arrived		
00:32	M1	Serving Customer No M103	0	
00:32	L5	Customer No L504 arrived		
00:32	L5	Serving Customer No L504	0	
00:33	L2	Customer No L202 arrived		
00:33	L2	Serving Customer No L202	0	
00:33	L4	Customer No L403 arrived		
00:33	L4	Serving Customer No L403	0	
00:36	L6	Customer No L603 assigned seat 8,6		36
00:36	L5	Customer No L505 arrived		
00:36	L5	Customer No L504 assigned seat 8,5		36
00:36	M1	Customer No M103 assigned seat 5,9		36
00:37	L3	Customer No L304 arrived		
00:37	L6	Customer No L604 arrived		
00:37	L6	Serving Customer No L604	0	
00:37	L5	Serving Customer No L505	1	
00:38	L3	Customer No L303 assigned seat 8,4		38
00:38	L2	Customer No L202 assigned seat 8,3		38
00:38	L4	Customer No L403 assigned seat 8,2		38
00:38	M1	Customer No M104 arrived		
00:38	M1	Serving Customer No M104	0	
00:38	H1	Customer No H103 arrived		
00:38	H1	Serving Customer No H103	0	
00:39	L2	Customer No L203 arrived		
00:39	L2	Serving Customer No L203	0	
00:39	L4	Customer No L404 arrived		
00:39	L4	Serving Customer No L404	0	
00:39	L3	Serving Customer No L304	2	
00:40	L1	Customer No L104 arrived		
00:40	L1	Serving Customer No L104	0	
00:40	H1	Customer No H103 assigned seat 0,2		40
00:40	M3	Customer No M303 arrived		

00:43	L5	Customer No L505 assigned seat 8,1	43
00:44	L3	Customer No L304 assigned seat 8,0	44
00:44	L1	Customer No L104 assigned seat 7,9	44
00:44	L2	Customer No L203 assigned seat 7,8	44
00:44	L6	Customer No L604 assigned seat 7,7	44
00:46	L4	Customer No L404 assigned seat 7,6	46
00:49	M1	Customer No M105 arrived	
00:49	M1	Serving Customer No M105	0
00:49	H1	Customer No H104 arrived	
00:49	H1	Serving Customer No H104	0
00:49	M3	Customer No M304 arrived	
00:49	M3	Serving Customer No M304	0
00:49	L1	Customer No L105 arrived	
00:49	L1	Serving Customer No L105	0
00:49	L4	Customer No L405 arrived	
00:49	L4	Serving Customer No L405	0
00:50	H1	Customer No H104 assigned seat 0,3	50
00:50	L3	Customer No L305 arrived	
00:50	L3	Serving Customer No L305	0
00:51	M1	Customer No M105 assigned seat 6,2	51
00:52	M3	Customer No M305 arrived	
00:53	M3	Customer No M304 assigned seat 6,3	53
00:53	H1	Customer No H105 arrived	
00:53	H1	Serving Customer No H105	0
00:54	M3	Serving Customer No M305	2
00:54	L3	Customer No L305 assigned seat 7,5	54
00:54	L1	Customer No L105 assigned seat 7,4	54
00:54	L6	Customer No L605 arrived	
00:54	L6	Serving Customer No L605	0
00:54	H1	Customer No H105 assigned seat 0,4	54
00:55	L2	Customer No L204 arrived	
00:55	L2	Serving Customer No L204	0
00:55	L4	Customer No L405 assigned seat 7,3	55
00:56	L2	Customer No L205 arrived	
00:57	M3	Customer No M305 assigned seat 6,4	57
00:59	L6	Customer No L605 assigned seat 7,2	59
00:60	L2	Ticket Sale Closed. Customer No L204 Leaves	
00:60	L2	Ticket Sale Closed. Customer No L205 Leaves	

Thread simulation Ended

Final Concert Seat Chart

H101	H102	H103	H104	H105	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-
M201	M202	M301	M203	M204	M302	M101	M205	M102	M103
M104	M303	M105	M304	M305	-	-	-	-	-
-	-	L605	L405	L105	L305	L404	L604	L203	L104
L304	L505	L403	L202	L303	L504	L603	L302	L402	L201
L401	L103	L503	L102	L602	L502	L301	L601	L501	L101

Multi-threaded Ticket Sellers

Input N = 05

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*****
Multi-threaded Ticket Sellers
Input N = 05
*****

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	No of Customers	GotSeat	Returned	Throughput
H	5	5	0	0.08
M	15	15	0	0.25
L	30	28	2	0.47

	Avg response Time	Avg turnaround time
H	0.000000	32.60
L	0.466667	30.23
M	0.800000	29.33

Conclusion:

From the results of our simulation, it's clear that the H, M, and L sellers exhibit different response and service durations. The cumulative time required to handle tickets has a cascading effect; it not only extends the service duration for each ticket but also increases the waiting period for every subsequent ticket, thereby affecting both response and service times. Additionally, as more sellers adopt a specific strategy, the average time they spend searching for seats escalates. Given the high number of L sellers, the front rows were rapidly occupied, pushing the L sellers to seek available seats further up. In contrast, the presence of H sellers is dwindling.