

LECTURE 5

SIMULATION AND MODELING

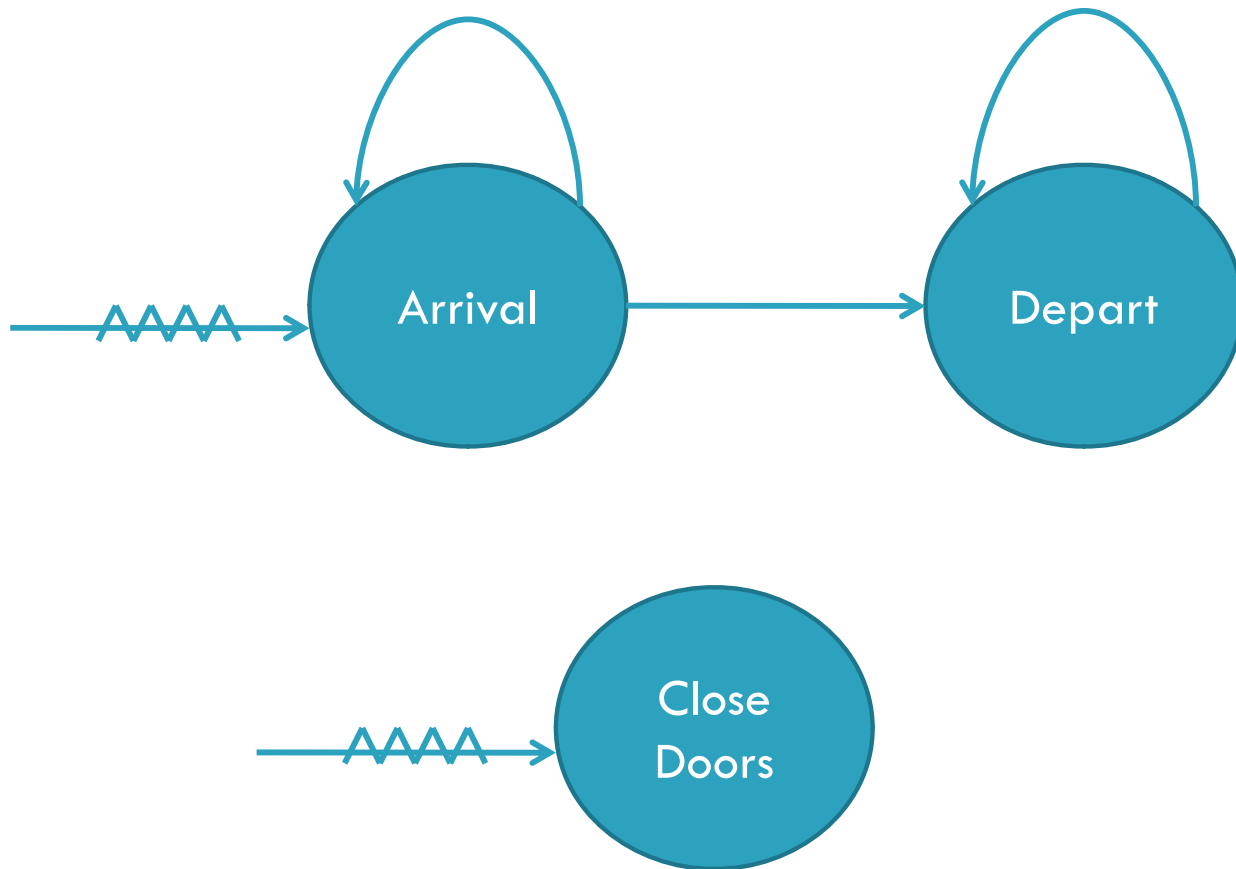
CSE 411

Md. Tanvir Al Amin, Lecturer, Dept. of CSE, BUET

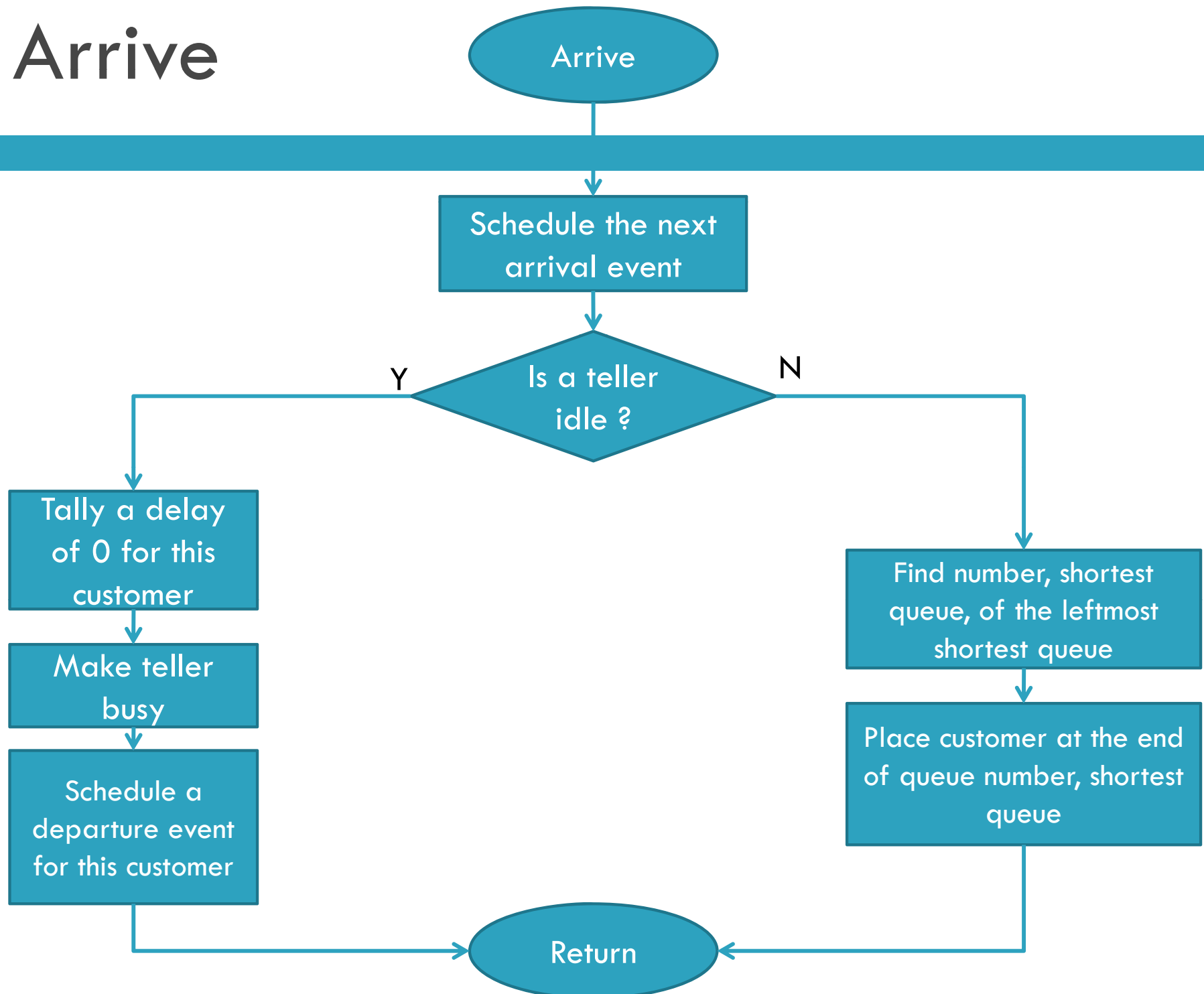
Multiteller Bank with Jockeying

- Bank with k tellers
- Customers arrive (exponential arrival)
- Each teller has separate Q
- Customers do jockey
- What is jockey ?
 - ▣ After completion of service at teller i , if the Q becomes shorter than some other queue w , then customer from tail of Q_w moves to i .

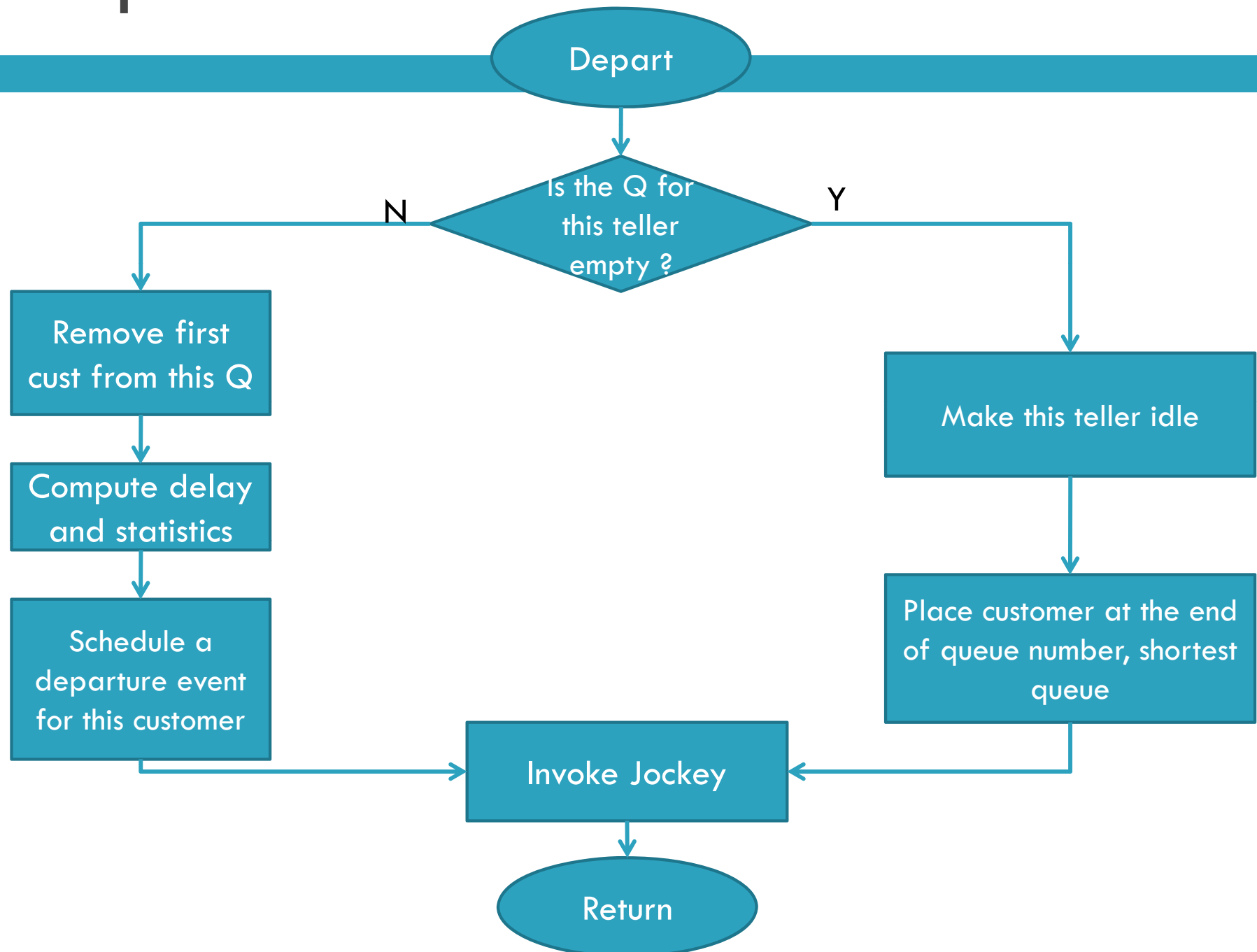
Event Graph



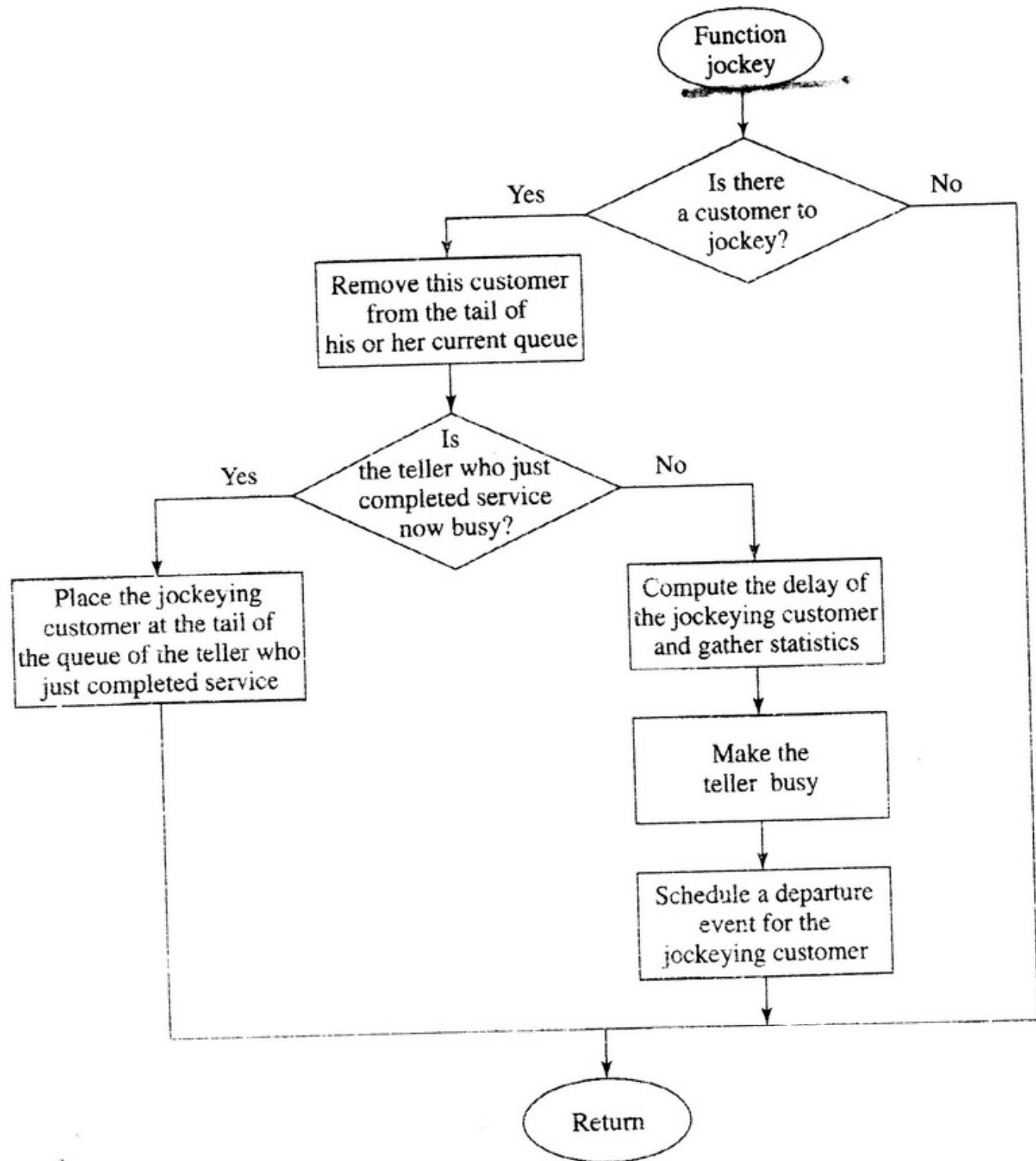
Arrive



Depart



Jockey

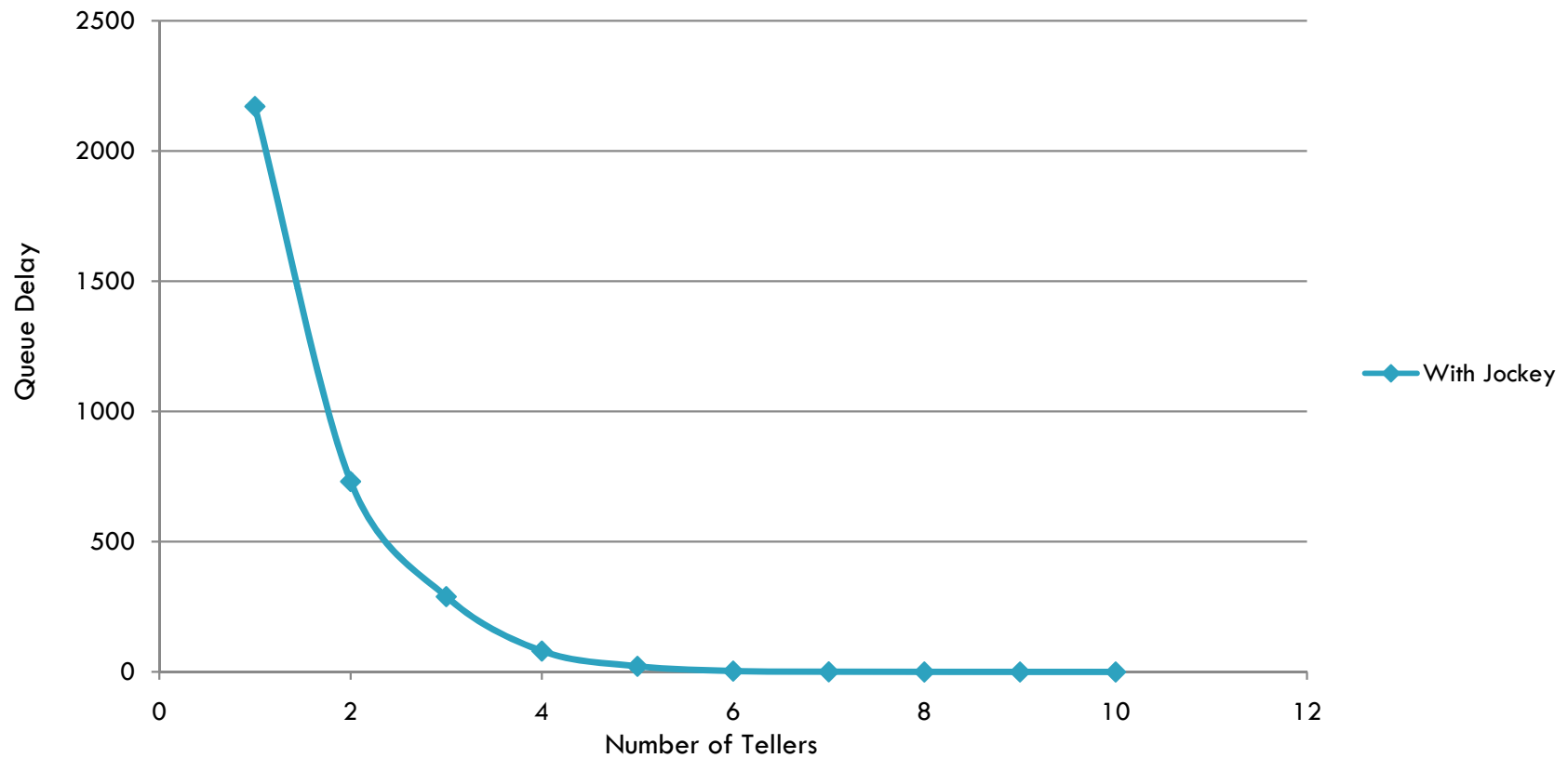


Code

- Simulation code available in book web site :
 - ▣ <http://www.mhhe.com/engcs/industrial/lawkelton/student/code.mhtml>
 - ▣ Download and run

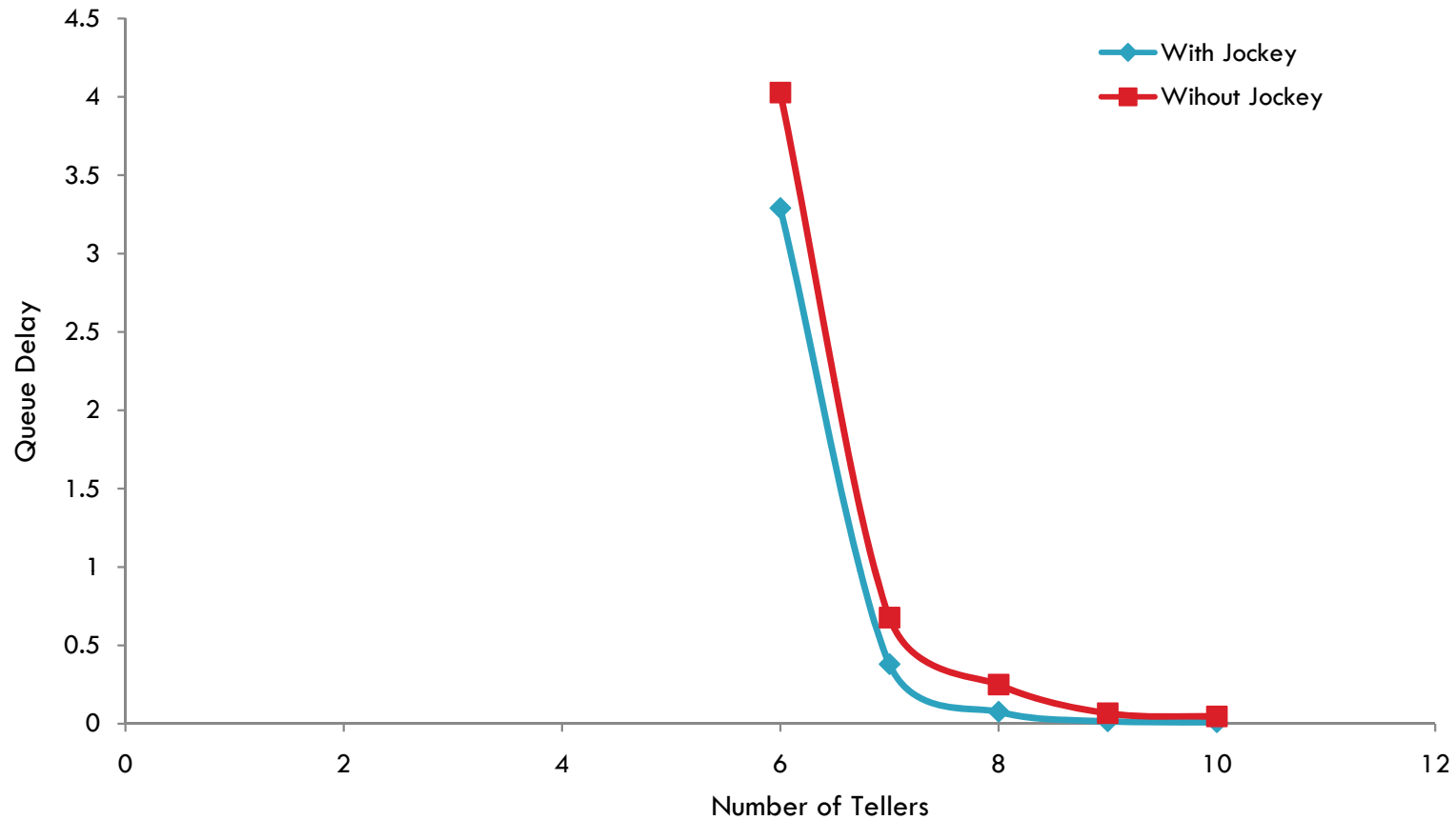
Simulation Run and Delay Values

With Jockey



1	Number of Tellers	1	2	3	4	5	6	7	8	9	10
2	With Jockey	2170.58	731.229	289.18	80.165	21.525	3.29043	0.380441	0.076584	0.015859	0.009997

With or Without Jockey

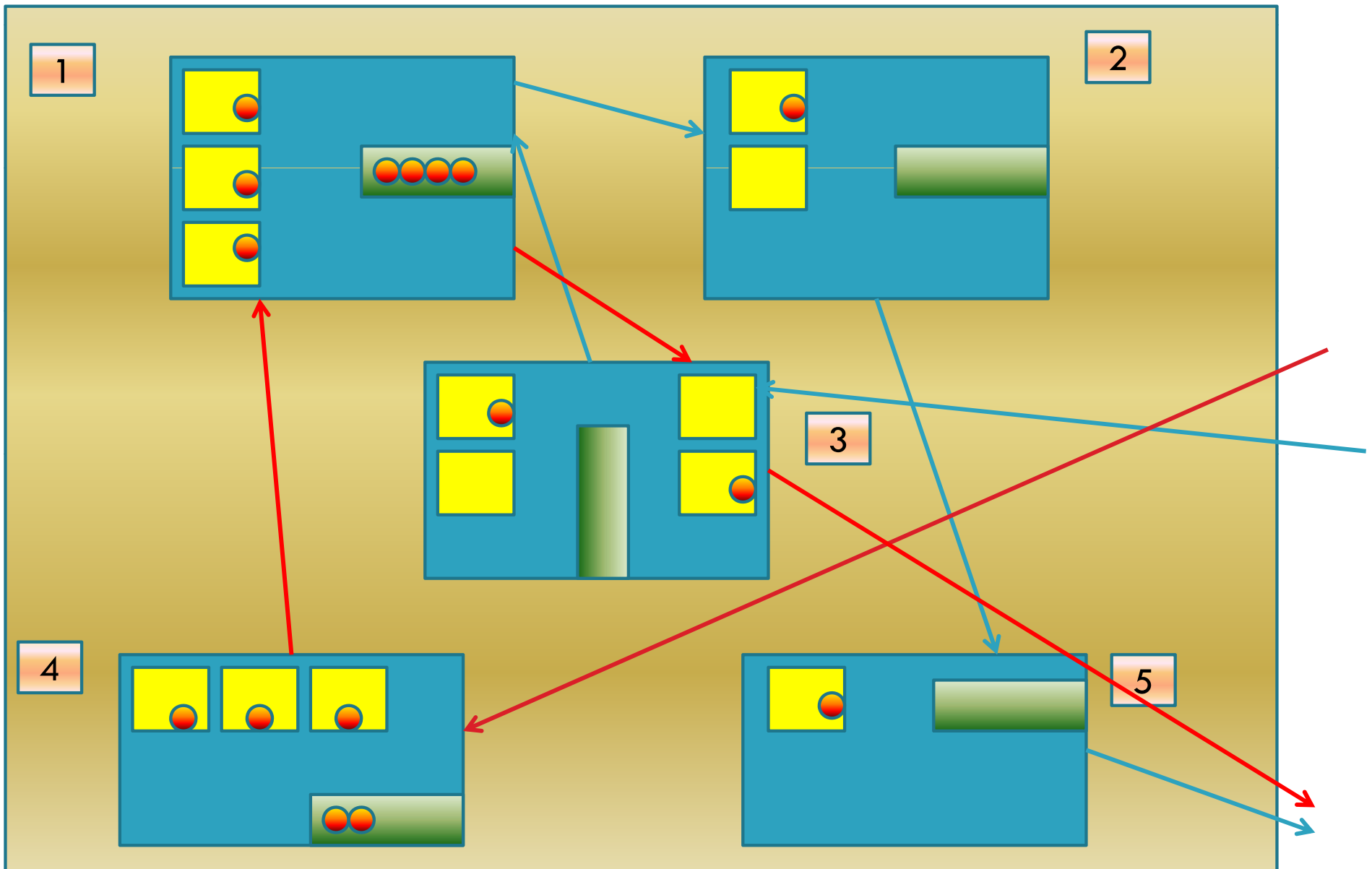


1	Number of Tellers	1	2	3	4	5	6	7	8	9	10
2	With Jockey	2170.58	731.229	289.18	80.165	21.525	3.29043	0.380441	0.076584	0.015859	0.009997
3	Without Jockey	2170.58	732.951	289.424	80.9681	22.5305	4.02737	0.677062	0.249901	0.066901	0.046542

Job Shop Model

- A manufacturing system consists of k workstations (ws), for example $k=5$
- At present ws i , consist of A_i identical machine.
- In effect, the system is a network of five multiserver queues.
- Jobs arrive exponentially
- s types of jobs, for example $s=3$
- Input job probability S_i , for $s=3$, 0.5, 0.3, 0.2

Physical View



Example Values

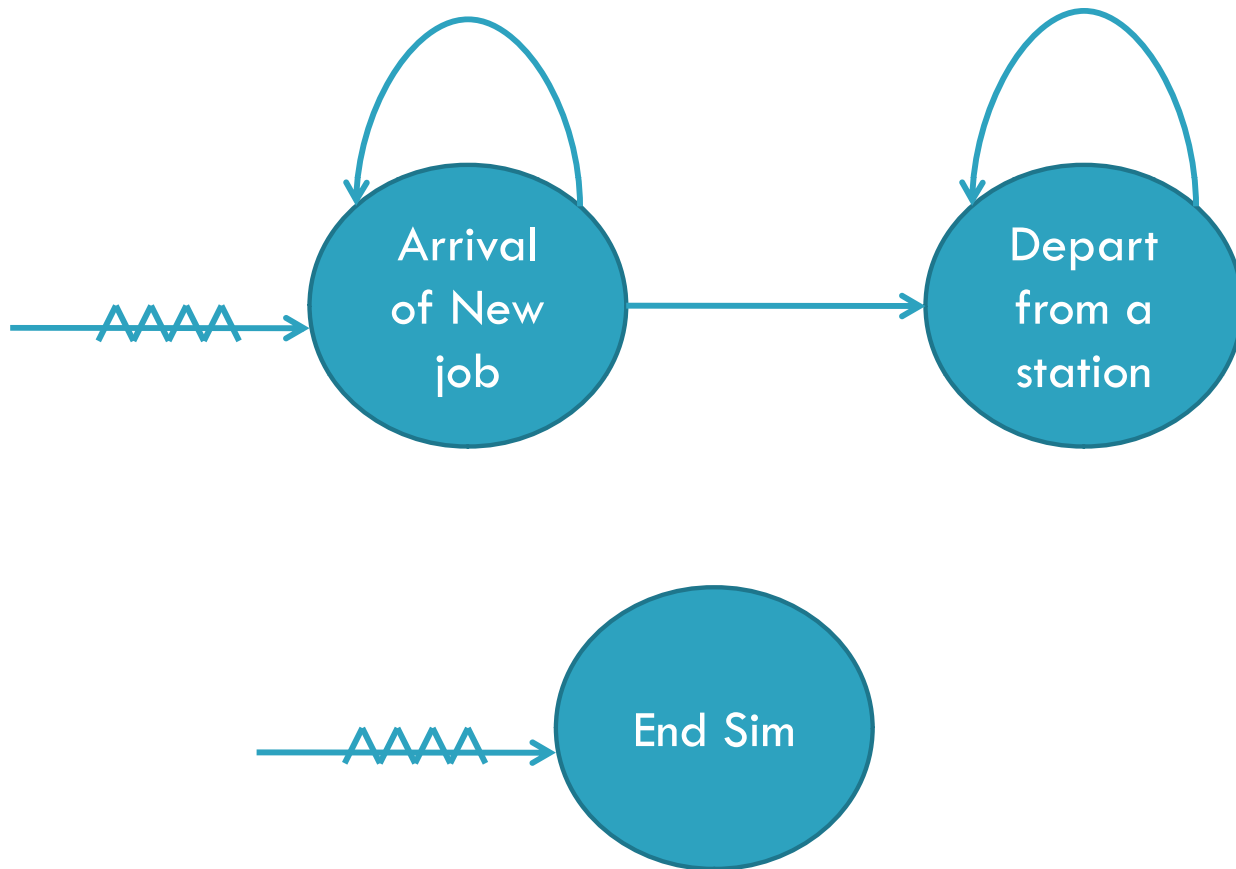
Workst.	WS1	WS2	WS3	WS4	WS5
N Of Machines	3	2	4	3	1

	Job Type = 1	Job Type = 2	Job Type = 3
Probability	0.5	0.3	0.2
Route :	3,1,2,5	4,1,3	2,5,1,4,3

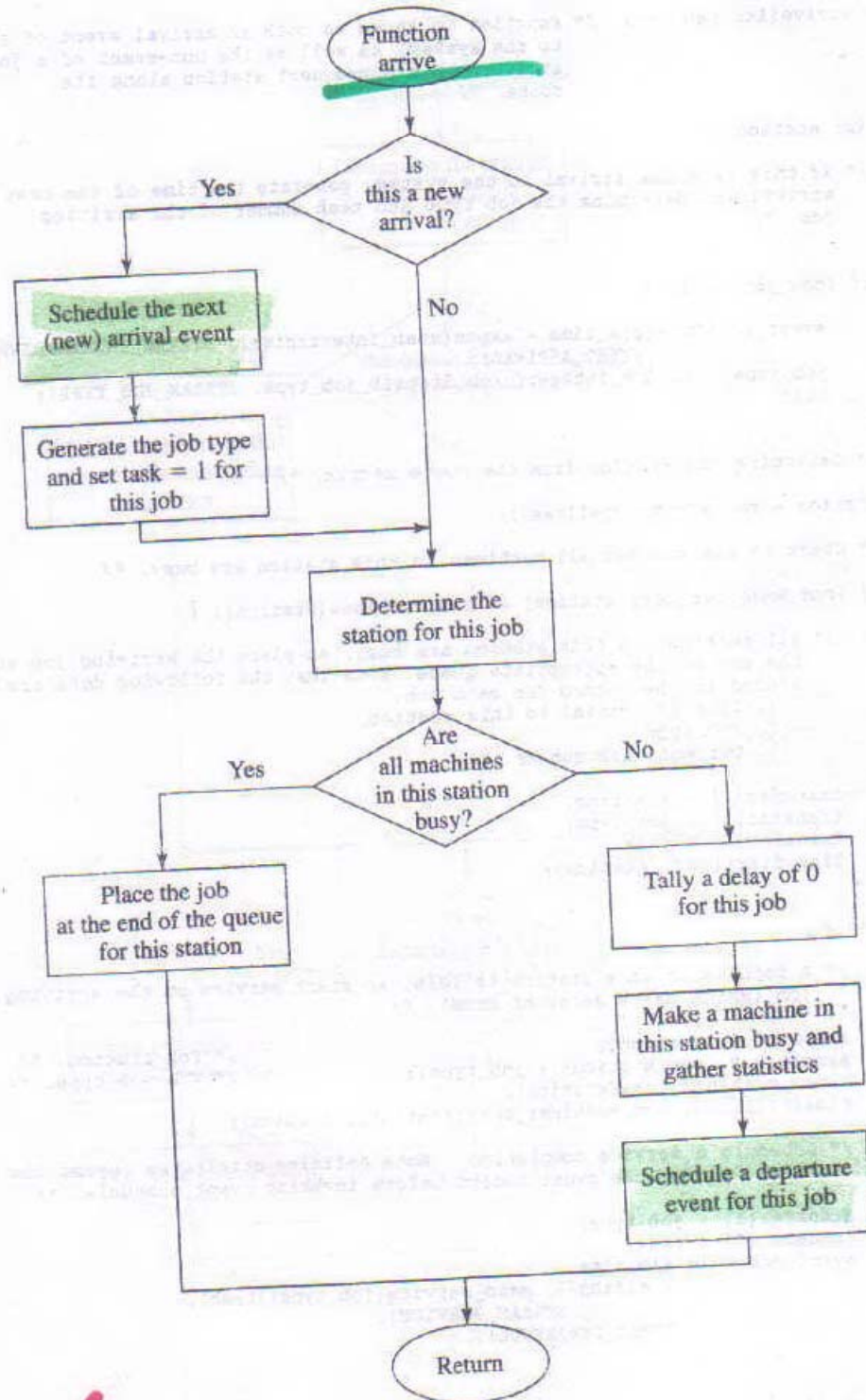
Company wants to buy a new machine. Which WS should get that ??

- If a job arrives at a particular station and finds all machines in that station busy, then joins a single FIFO queue at that station.
- Time to perform a task at a particular machine is an independent 2-Erlang Random variable whose mean depends on job type and the station to which the machine belongs.
 - ▣ If X is independent random variable with mean r , then $X = Y_1 + Y_2$, where Y_1 and Y_2 are independent random variables with mean $r/2$.

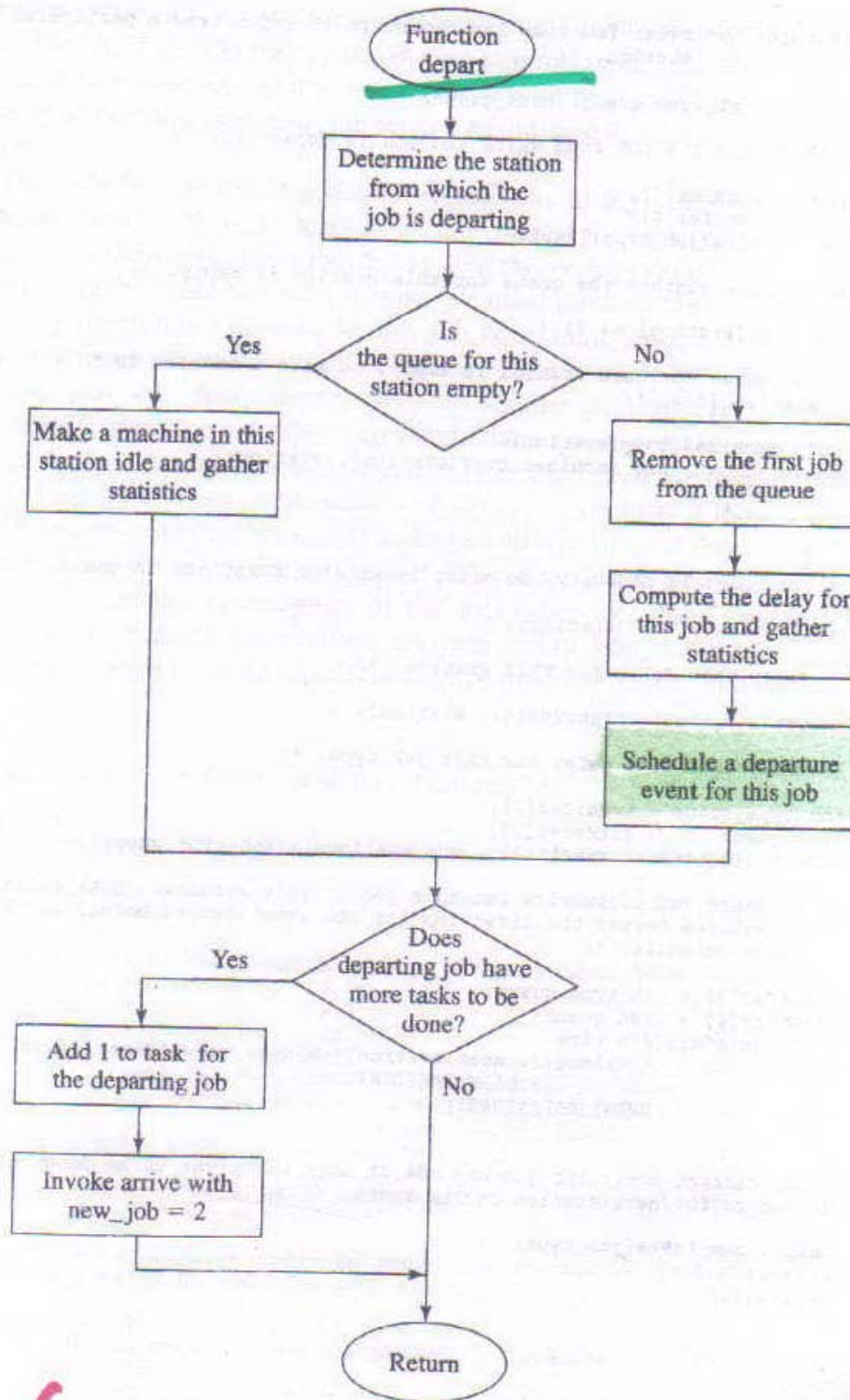
Event Graph



Arrive



Depart



Code

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Performance Output

Job type Mean service time (in hours) for successive tasks

1	0.50	0.60	0.85	0.50	
2	1.10	0.80	0.75		
3	1.20	0.25	0.70	0.90	1.00

Job type Average total delay in queue

1	10.640
2	8.499
3	15.419

Overall average job total delay = 10.525

Work station	Average number in queue	Average utilization	Average delay in queue
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1	11.979	0.958	2.978
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2	12.704	0.975	6.317
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3	0.803	0.729	0.200
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4	14.745	0.960	5.267
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5	2.026	0.800	1.008
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Reference in the text

- In today's lecture, we covered :
 - ▣ Kelton 2.6, 2.7

 - ▣ Assignments
 - Using Arena
 - Or Using C (see book website)
 - 2.19, 2.21, 2.22, 2.23, 2.26, 2.27, 2.28, 2.29, 2.30, 2.31
 - 2.36, 2.37, 2.38