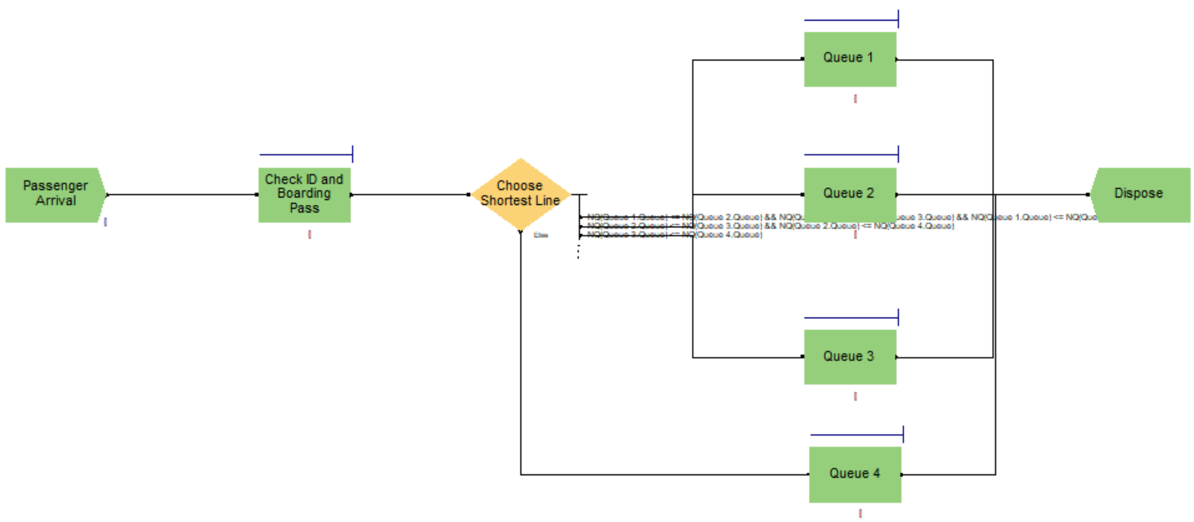
Question 13.2

In this problem you, can simulate a simplified airport security system at a busy airport. Passengers arrive according to a Poisson distribution with λ1 = 5 per minute (i.e., mean interarrival rate μ1 = 0.2 minutes) to the ID/boarding-pass check queue, where there are several servers who each have exponential service time with mean rate μ2 = 0.75 minutes. [Hint: model them as one block that has more than one resource.] After that, the passengers are assigned to the shortest of the several personal-check queues, where they go through the personal scanner (time is uniformly distributed between 0.5 minutes and 1 minute).

Use the Arena software (PC users) or Python with SimPy (PC or Mac users) to build a simulation of the system, and then vary the number of ID/boarding-pass checkers and personal-check queues to determine how many are needed to keep average wait times below 15 minutes. [If you're using SimPy, or if you have access to a non-student version of Arena, you can use λ1 = 50 to simulate a busier airport.]

To solve this problem, I developed a simulation using Arena. I used trial and error to land on the following model with an average wait time of 4.6 minutes.



Component	Details
Create Block (Passenger Arrival)	• Time Between Arrivals Type: Random(Expo) ○ Value: 0.2 minutes • Entities per Arrival: 1
Process Block (Check ID and Boarding Pass)	• Action: Seize Delay Release • Delay Type: Expression ○ EXPO(0.75) • Number of Resources: 1 • Resource Capacity: 4
Decision Block (Choose Shortest Line)	• Type: N-way by Condition • Conditions:

Component	Details
	○ NQ(Queue 1.Queue) <= NQ(Queue 2.Queue) && NQ(Queue 1.Queue) <= NQ(Queue 3.Queue) && NQ(Queue 1.Queue) <= NQ(Queue 4.Queue) ○ NQ(Queue 2.Queue) <= NQ(Queue 3.Queue) && NQ(Queue 2.Queue) <= NQ(Queue 4.Queue) ○ NQ(Queue 3.Queue) <= NQ(Queue 4.Queue)
Process Block (Queue 1)	• Action: Seize Delay Release • Delay Type: Uniform ○ Minimum: 0.5 ○ Maximum: 1 • Number of Resources: 1 • Resource Capacity: 1
Process Block (Queue 2)	• Action: Seize Delay Release • Delay Type: Uniform ○ Minimum: 0.5 ○ Maximum: 1 • Number of Resources: 1 • Resource Capacity: 1
Process Block (Queue 3)	• Action: Seize Delay Release • Delay Type: Uniform ○ Minimum: 0.5 ○ Maximum: 1 • Number of Resources: 1 • Resource Capacity: 1
Process Block (Queue 4)	• Action: Seize Delay Release • Delay Type: Uniform ○ Minimum: 0.5 ○ Maximum: 1 • Number of Resources: 1 • Resource Capacity: 1
Dispose Block (Dispose)	N/A

Key statistics from my simulation are included below:

Name	Type	Source	Average Of Replication Averages
⊟Entity 1	⊟NVA Time	Entity	0
	⊟Other Time	Entity	0
	⊟Total Time	Entity	0.102624463
	⊟Transfer Tin	Entity	0
	⊟VA Time	Entity	0.025185882
	⊟Wait Time	Entity	0.07743858
⊟Check ID and Boarding Pass.Qu	⊟Waiting Tim	Queue	0.051904327
⊟Queue 1.Queue	⊟Waiting Tim	Queue	0.028569461
⊟Queue 2.Queue	⊟Waiting Tim	Queue	0.025940633
⊟Queue 3.Queue	⊟Waiting Tim	Queue	0.024033874
⊟Queue 4.Queue	⊟Waiting Tim	Queue	0.023084842

I have also included a summary of results from my other trials:

#	Check ID and Boarding Pass Resource Capacity	Number of Queues	Did the Simulation Fail?	Average Wait Time
1	3	3	Yes	N/A
2	3	4	Yes	N/A
3	4	4	No	4.6 minutes
4	5	4	No	1.8 minutes

Since the goal is to keep wait time under 15 minutes with as few resources as possible, trial #3 is the best simulation.