

# Lab Experiment 1

Sim  
Analytical

## Performance Analysis of a single server queueing system

### Performance metrics

#### Job Average metrics

- w Average queueing delay //
- w Average sojourn/system time //

$$\frac{\# \text{ of jobs/customers}}{\text{total delay}} \leftarrow \begin{matrix} \text{queueing} \\ \text{system} \end{matrix}$$

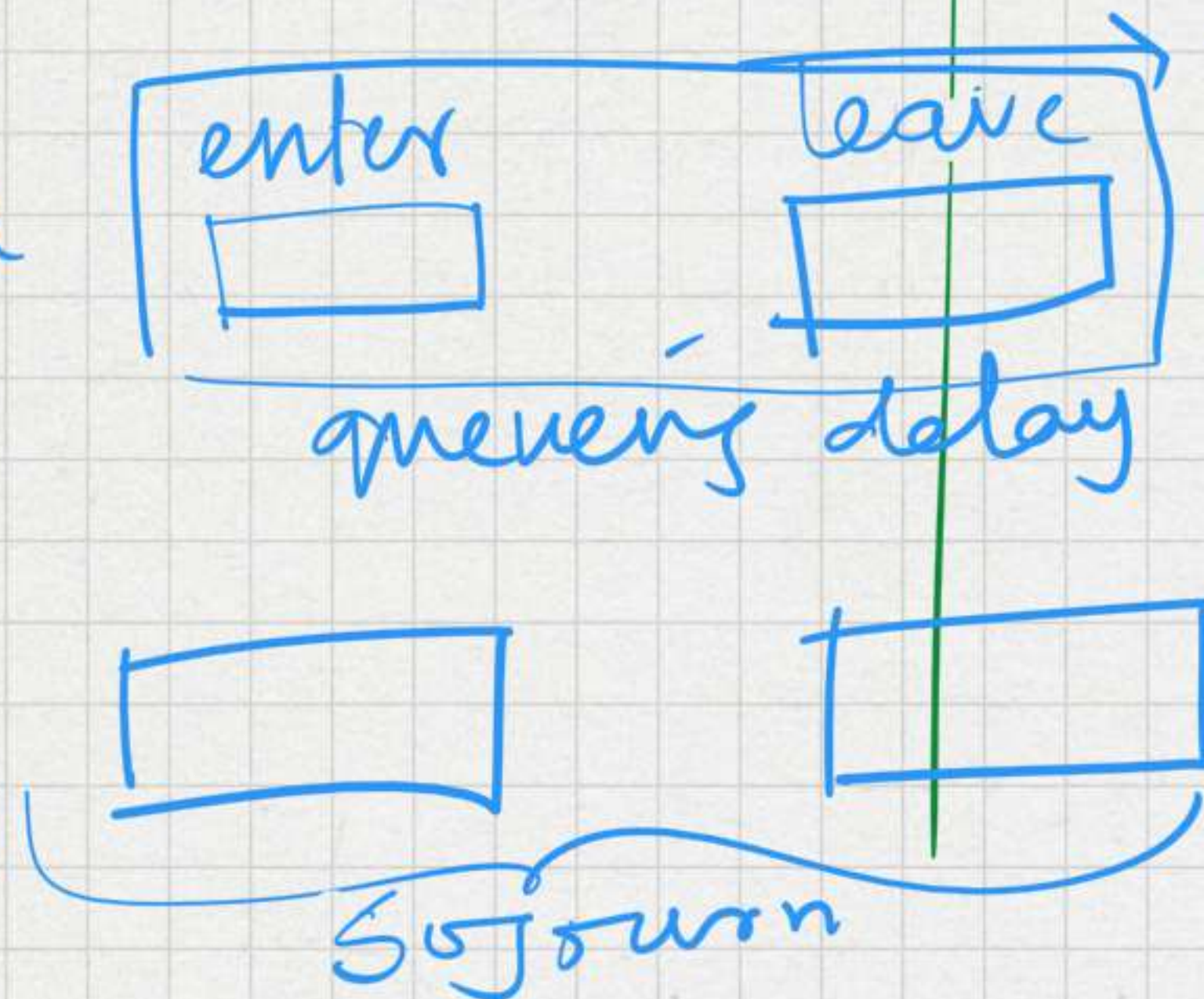
per customer delay

queue system

Count

System

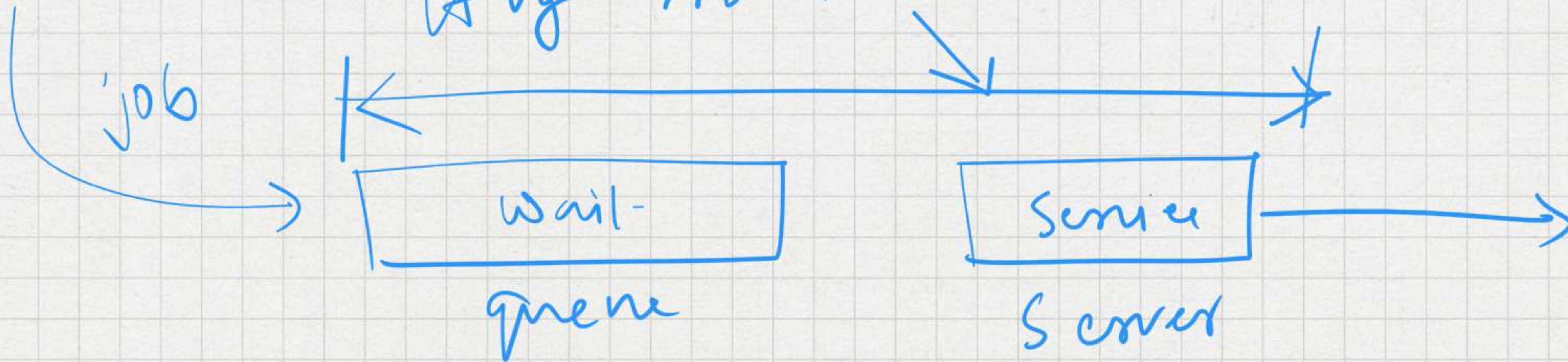
queue





$\text{Avg waiting delay} + \text{Avg service time}$

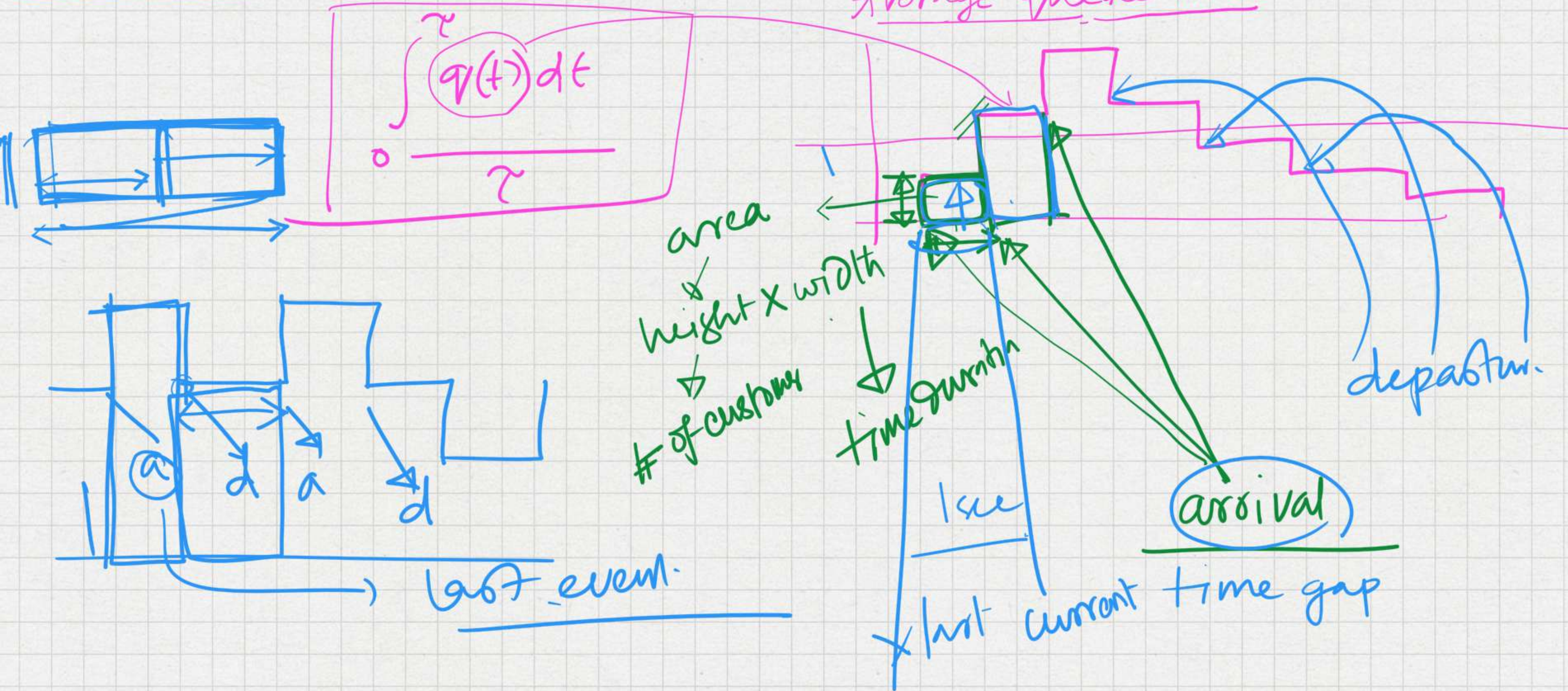
$\text{Avg round time}$





# Time Average quantities

# server utilization average queue size





time average

timeLastEvent-



areaQueue  
areaSystem

areaSystem  $+=$  durationSinceEvent \* ( $\square + \text{status}$ ) (queue  $\rightarrow$  length);

Server

event Hand/cr()

a d

updateStat() {

double durationSinceLE;

durationSinceLE =

Scheduler::now()

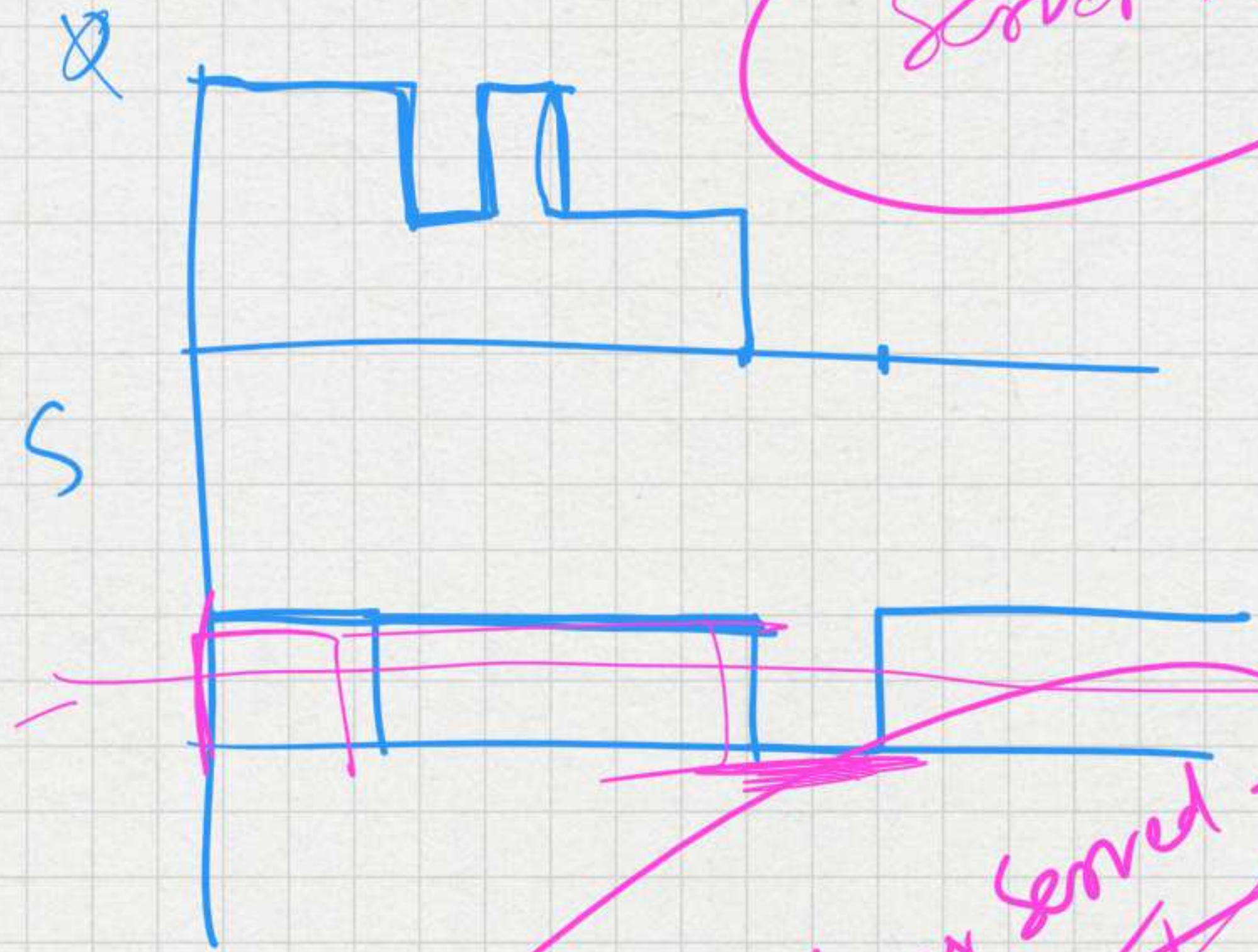
— timeLastEvent;

timeLastEvent =

Scheduler::now();

areaQueue  $+=$  durationSinceEvent \* (queue  $\rightarrow$  length);





Server Utilization

Job Arrive

Creation time

Ser

Total Customer Served

Total Queue Delay -

Total System Delay -

queue Delay -

system Delay -

Total Queue Delay

+

queue Delay -

0



$$\rho = \frac{\lambda}{\mu} \quad \frac{3}{5} = .6$$

20 - 30 lines

$L_s \Rightarrow$  # of customers in the system  
 $L_q \Rightarrow$  # of customers in the queue

$$E[L_s] = \sum_{n=1}^{\infty} n P_n = \sum_{n=1}^{\infty} n (1-\rho) \rho^n = \frac{\rho}{1-\rho} = \frac{\lambda}{\mu - \lambda}$$

Sim

$E[L_s]$

Sim

Analytical





$$E[L_q] = \sum_{n=1}^{\infty} (n-1) P_n = \frac{\rho^2}{1-\rho} = \frac{\lambda^2}{\mu(\mu-\lambda)}$$

Server Utilization  $= 1 - \boxed{P_0} = 1 - (1-\rho) = \underline{\rho}$



Job average  
 $T_s$        $T_q$

queuing delay

$$\underline{\underline{T_q}} = \frac{\lambda}{\mu(\mu - \lambda)}$$

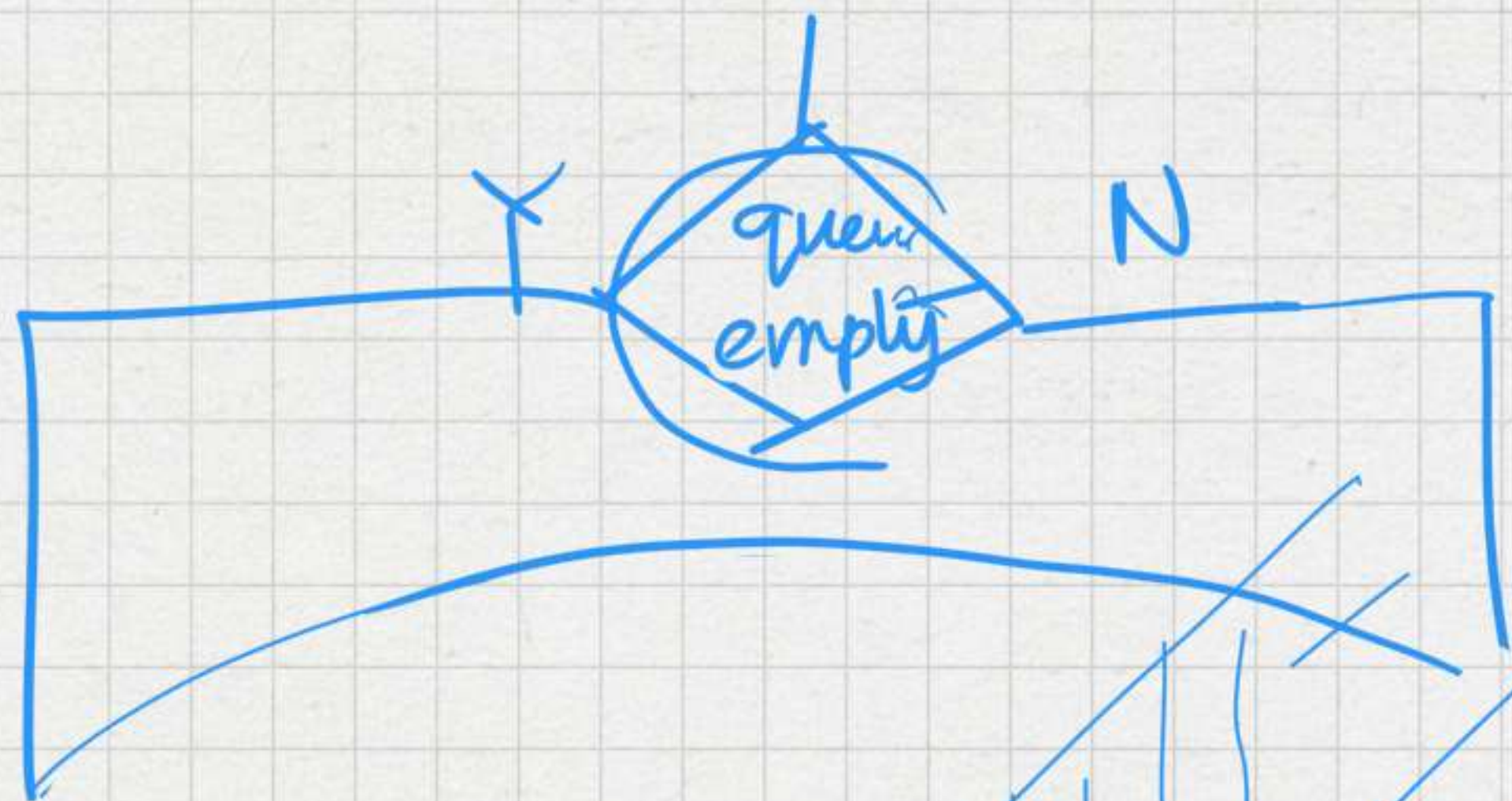
$$T_s = \frac{\lambda}{\mu(\mu - \lambda)} + \frac{1}{\mu}$$

$$E[L_s] = \lambda \textcircled{T_s}$$

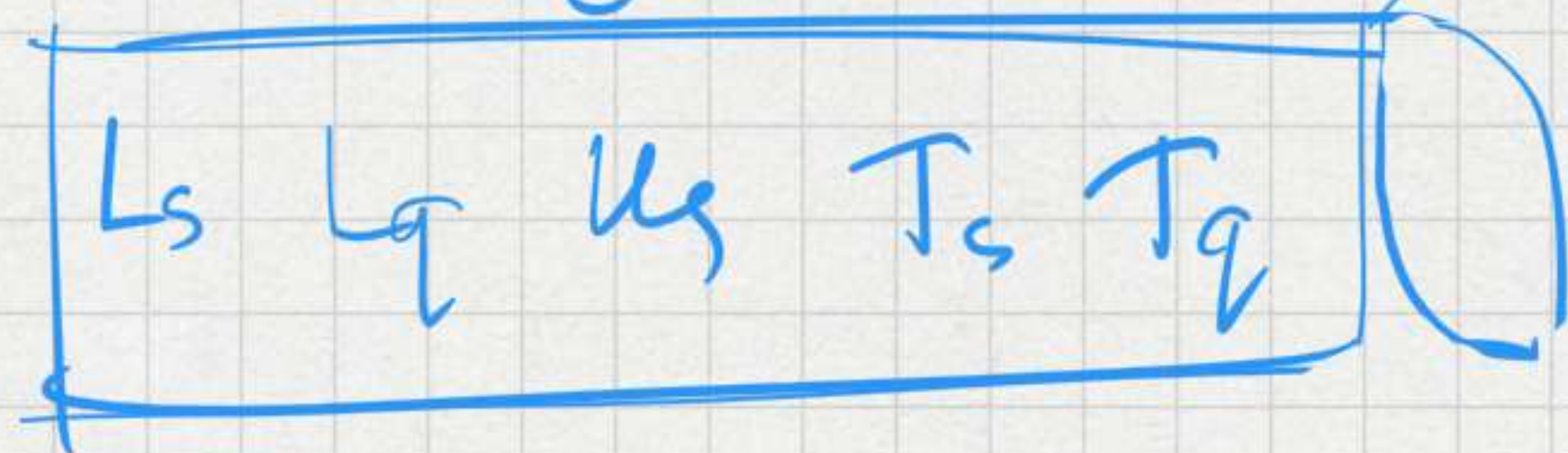
$$E[L_q] \rightarrow \textcircled{T_q}$$







5 graphs



Performance Analysis