Homework 1

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1.
   a.
   Throughput = 4 GB / 8000 seconds = 0.0005 GBPS

   b.
   Throughput of the DSL Line = 4% x 4GB = 0.04 x 4 GB = 0.16 GB
   = 0.16 GB / 8000 seconds = 0.00002 GBPS

   c.
   The distinction between transmission time and propagation time is not relevant in the context of the data transfer facilitated by Winston. This is because the transfer involves a single, direct exchange of information and does not involve any network infrastructure or communication between multiple nodes. In this scenario, the entire process of data transfer, from the moment Winston is given the data to the moment it reaches its destination, can be considered as the transmission time. There is no separate propagation time because there is no signal or data being transmitted through a medium.

   d.
   Throughput of this channel would be 4GB / 16000 = 0.00025

2.
   a.
   No. of bits that are sent per minute
   = 3 symbols per minute x 8 bits per symbol
   = 24 bits
   Throughput = 24 bits per minute = 24 / 60 = 0.4 bits/second

   b.
   The delay components for the Paris-Lille link would be the time it takes for the operator to get the message, encode it into symbols, transmit it to the next station, receive the symbol, decode it, and send it on to the next station. There would also be the time it takes for the message to go from tower to tower, which would be a function of distance and the speed of light (or the speed at which the symbols could be transmitted).

c.
We may suppose that the 9 minutes represents the time it takes for a single symbol to go from one tower to the next, as well as the time required to decode and encode the message at each station. The total time required to send the entire message is the sum of the transmission times for each symbol plus the processing periods at each station, which is 30 mins.

d.
Throughput = 150 characters x 8 bits per minute = 20 bits/second

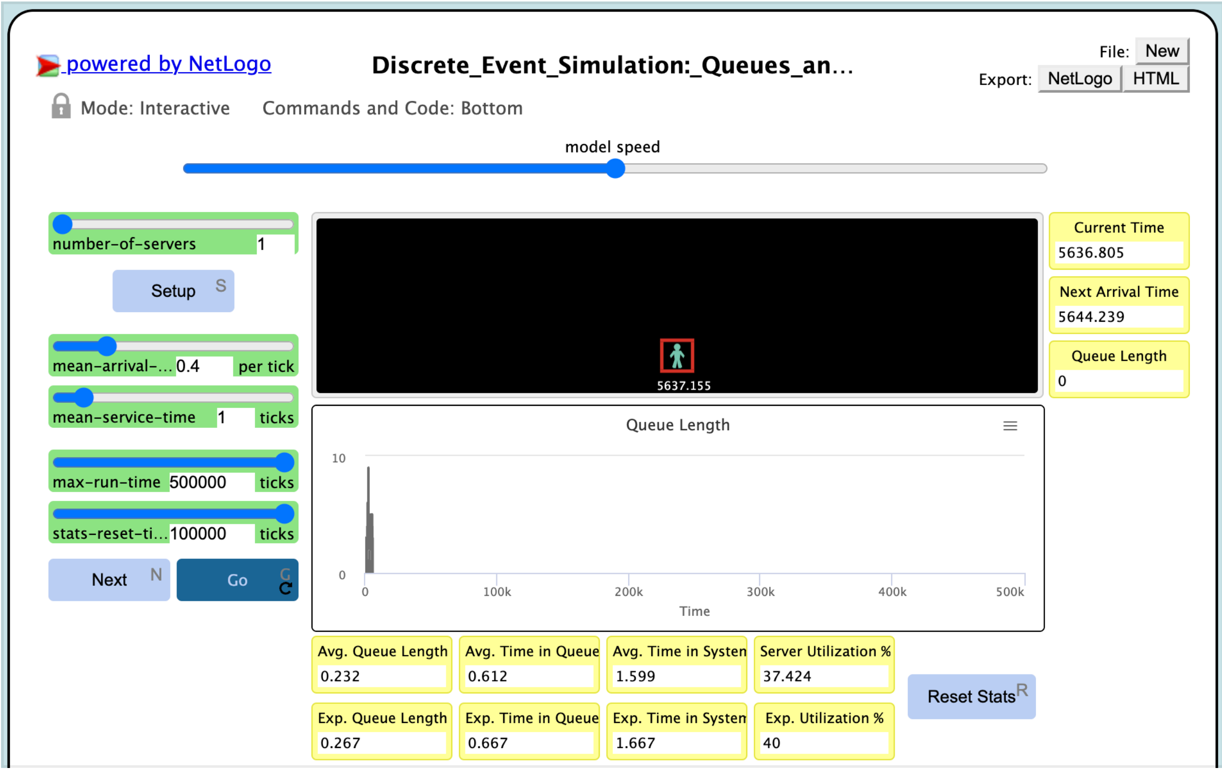
e.
The model of the transmission system in the telegraph was different from the semaphore system in that the telegraph used electrical signals transmitted over a wire, rather than visible symbols transmitted from tower to tower. This allowed for much faster transmission times, as well as the ability to transmit messages over longer distances and through areas where line of sight was obstructed.

f.
Speed of the initial telegraphs was close to 15 words per minute.
So to send 30 symbols or words, it would roughly take 2 minutes.

g.
The cost-effectiveness of the semaphore system was inferior to that of the telegraph system. This was due to the large number of towers and skilled operators required by the semaphore system to transmit messages, which made it expensive to construct and staff. In contrast, the telegraph system required fewer stations and less skilled personnel, resulting in lower construction and staffing costs. Furthermore, the telegraph system had faster transmission times and a higher level of efficiency, which allowed it to transmit messages over greater distances and handle a larger volume of traffic. The economic advantages of the telegraph system, such as its lower costs and higher efficiency, led to its widespread adoption and the eventual decline of the semaphore system.

3.

a.



b.

Mean Arrival Rate	Avg queue length	Avg time in queue	Avg time in system	Server utilization
0.4	0.15	0.4	1.35	36
0.5	0.21	0.5	1.41	41
0.6	0.9	1.38	2.35	60
0.7	1.2	1.8	2.7	66
0.8	3.1	4.1	5.1	79

c.

The table indicates that as the mean arrival rate increases, server utilization, queue length, wait time, and overall system time also increase. A higher mean arrival rate results in more crowded and inefficient queueing behavior and higher server utilization, potentially leading to further increases in wait times and system time. The average statistics provide an overview of the system's performance, but they do not show short-term fluctuations and variations. Slowing down the simulation can reveal these fluctuations and help to better understand the system's behavior and how it reacts to different scenarios. Observing the dynamic behavior gives a more comprehensive understanding of the system and can uncover potential problems not apparent from just examining average statistics.

d.

Having two servers instead of one improved the performance, as seen by the reduced average queue length and waiting time. However, the high server utilization rate suggests that they are often busy, which could become a bottleneck if the customer arrival rate continues to increase. On average, customers wait in line for 3.2 people and 2 units of time, and their total time in the system, including waiting and service, is 3 units.