Simulation :Analysis of Single Server Queuing Model

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ABSTRACT

A queue is a line of people or things to be handled in a sequential order. It is a sequence of objects that are waiting to be processed. Queuing theory is the study of queues for managing process and objects. Simulation has been applied successfully for modeling small and large complex systems and understanding queuing behavior. Analysis of the models helps to increases the performance of the system. In this paper we analyze various models of the Single server queuing system with necessaryimplementation using Matlab Software.

KEYWORDS

Entity, Queuing model, Service time, Arrival time.

1. INTRODUCTION

Simulation can be defined as a Process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behaviour of the system. Simulation can be applied for small and large systems. The cost of building the system is more and simulation provides a replica of the exact model with the behaviour of the system. Direct experimentation would cost more when compared with the simulated model of the system which is the main motive behind simulation. Simulation helps in delivering some very important decisions to be made by the system. It is a very efficient methodology to solve complicated problems. Simulation provides good strategy to analyze the client-server systems and help in better implementation of feasible solutions [1]. The Fig. 1 explains the classification of a system, where simulation plays an important role. Simulation helps in understanding the behaviour of a queuing system and also obtain certain very useful parameters.

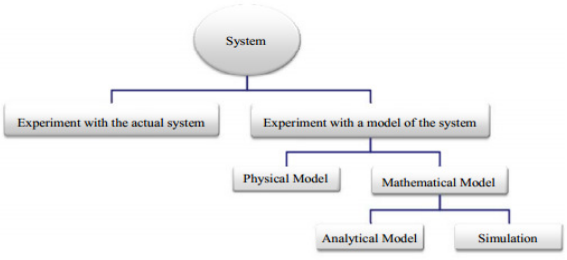

Figure 1. Classification of System [2]

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The queuing system is most important problem in discrete event simulation .Modeling the process of events as a discrete sequence of events in time is Discrete event Simulation .Every event occurs at a particular time and initiates the change of the system. No change in the system is assumed to occur in between the occurrence of events .With the aid of simulation we would be able to reduce the development cost of a system and analyze the faults before the actual system can be implemented .Simulation methodology is the important basic theory of Simulation Science and Technology [3]. We can also change the parameters and analyze the results based on the measurement of the parameters .In the queuing model, data units are often considered as processing elements or channels , terminals .A queuing model in which input, computation, transmission, storage and output are discrete in time field, is called discrete queuing model. In real life, a queue can be imagined as though to be of some people waiting in bank, usage of Atm machines or cash counter phenomenon.

1.2. Queuing Conceptions.

A Queue has to be maintained well to synchronize between the average waiting time and the idle time of server. The following are some of the methodology used for solving the queuing problem.

1.2. Entity arrival model.

Every entity may obtain certain conditions or in some cases may be limitless .The arrival entity is used to specify the arrival model .There are different probability distribution phenomenon available in this scenario like Index distribution ,Poisson distribution ,Normal distribution etc. We provide an overview of the Poison distribution for the arrival of entities. The Fig.2 describes diagrammatically the process involved in the arrival of entities and their departure after service. As per Poisson distribution in time interval t,s

In (t, t+s), the probability of entity number k is

$$P\{N(t+s) - N(t) = k\} = \frac{e^{-\lambda s} (\lambda s)^{k}}{k!}$$

In the formula, N (t) is the number of entity arrival in (0,t). t>=0, s>=0, k=0, 1, 2,. λ is the arrival velocity. The term queuing system is used to indicate a collection of one or more waiting lines along with a server or collection of servers that provide service to these waiting lines. Queues may be single waiting lines, Multiple waiting lines ,Single waiting with single server, Single waiting with multiple server, Multiple waiting with multiple servers .Some of the models are likely to be observed in super markets. Simulation can be used for the analysis of queuing models [4].

1.3. Basic Queuing Process

Customers requiring service are generated over time by an input source. The required service is then performed for the customers by the service mechanism, after which the customer leaves the queuing system. Here we analyze different scenarios of a single model server based on FIFO, first in first out queing Process. Simulation can be done based on various tools which can be either physical or conceptual [5]

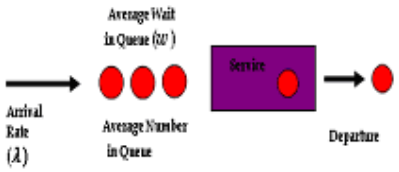

Figure 2.Entity arrival and departure.

2.RELATED WORK

Matlab provides a simulink events library to model a system and also execute the various parameters as required by the application .The Library has different blocks that we require to model a discrete based system.

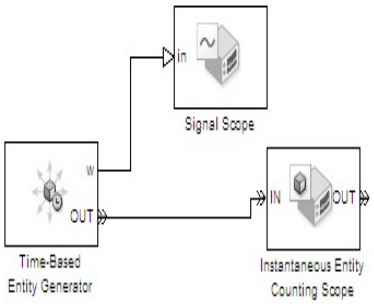

Figure.3 Modeling time generator.

We assume the customers as entities in of the system. Entities can be defined as discrete items to be used to model the system. The entity generator library of sim events in Matlab provides different blocks for the representation of entities. A Time based Generator is used as it provides the time between the generation of Two entities .This generator is connected with the Instantaneous Entity Scope .A signal scope provides the required result by connecting with the necessary parameter .Here we find the average waiting time in the model as depicted in Fig.3.The Simulation time is stated to 200 ms .The model on when simulated generates points indicating the creation of entities as in Fig.4.We observe that the entities are generated randomly based on the time events .Fig. 5 displays the average waiting time of the entities created. A uniform rise in the generation of the entities as the simulation time increases.

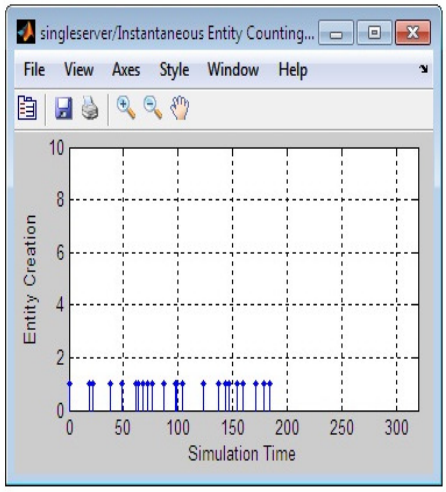

Figure. 4 Generation of Entities.

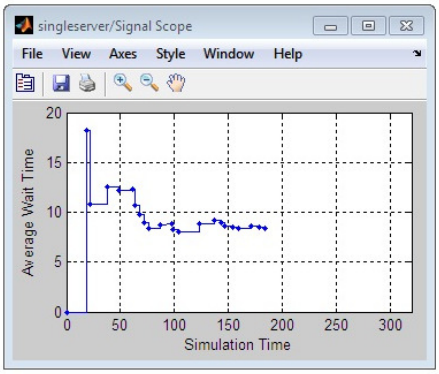

Figure.5 Average waiting time

A FIFO queue is a first in first out queue we use this queue to be connected to the entity counting scope. A single server block is connected from the out end of the FIFO queue block .The arrow marks represents the flow of events in the model.Fig. 6 depicts the model of single server with a FIFO queue Implementation. The number of entities is set to 5 in the FIFO queue. The service time is set to 40 ms for he single server to service the entities .The parameter w indicating the average waiting time is connected to the signal scope block. When the model is simulated we observer that the entities arrive in a sequential order one after the other based on the FIFO queue as shown in Fig.7.We observe a time gap of 40 ms sequentially for all the entities. A signal scope block is connected the average waiting time parameter of the single server. The entity sink block is connected with the out field of the single server.

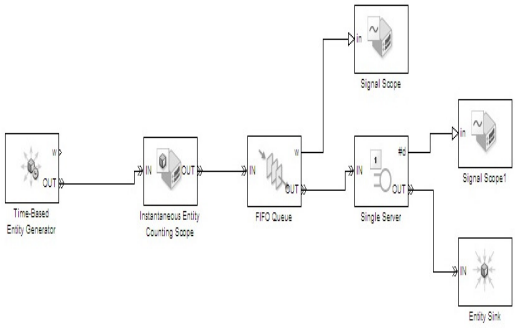

Fig.6 Model of Single server.

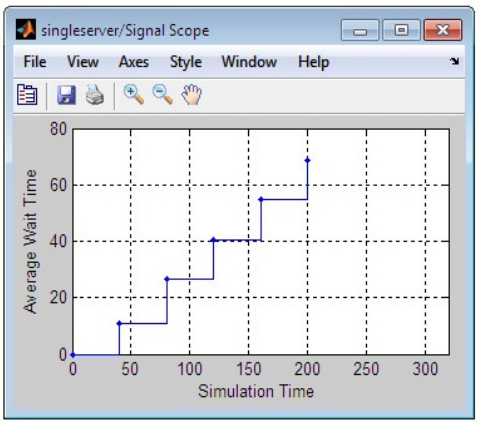

Fig .7 Waiting time of FIFO Queue.

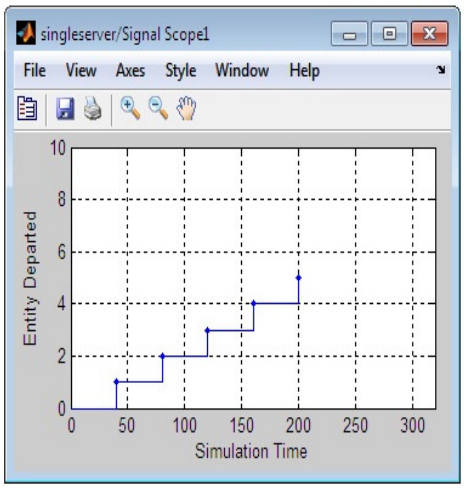

Fig. 8 Departure of entities after service.

We can change the parameter as per the requirement from the single server block and connect to the signal scope block.Fig.8 displays the output when we analyze the entity departed parameter of single server block. We observe that the entities exit after the service by the server with a time interval of 40 ms sequentially. The average waiting time is same for all the entities during this process as in Fig. 9.In some cases we may require a priority based queue to service special entities priority queue assigns a number to an attribute set in the priority queue block.

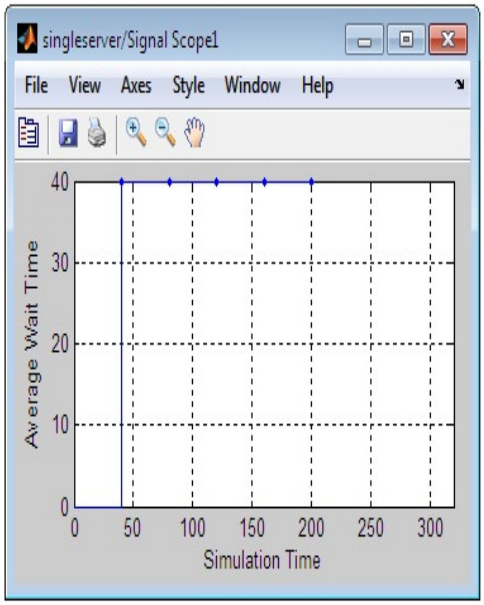

Fig.9 Waiting time of single server.

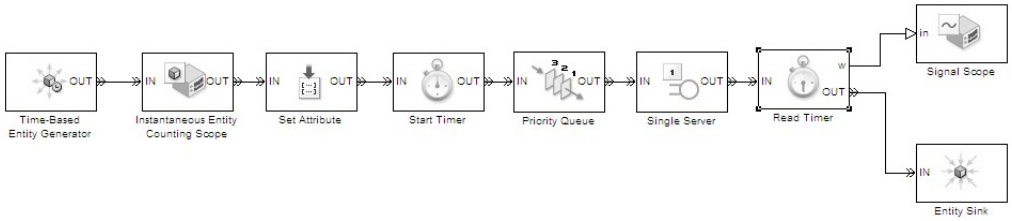

Fig.10 Priority queue model

A start timer, read timer is required before and after the priority queue, to set the timings of the queue, we set an attribute by name customers and initialize to priority of 1 i.e. high priority. We observer the average waiting time is almost the same for all with random arrival of entities as they are set for high priority as in Fig.11.A priority queue is modeled before the single server ,instead of signal scope to be connected to the output of single server we connect a read timer to start the event. The signal scope and entity sink and connected to it to analyze the results. Similarly when the priority is set to low we observe a large time gap between the service of each entity as in Fig.12.

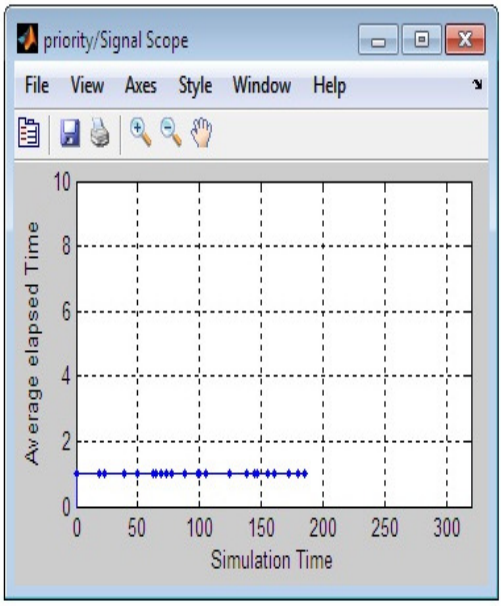

Fig.11 Average time High Priority Queue

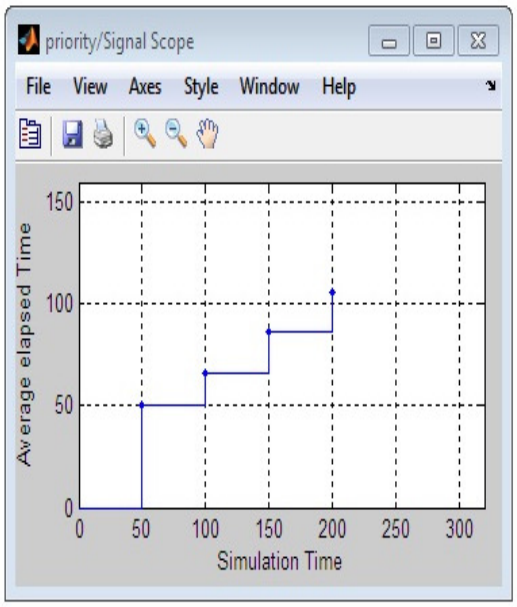

Fig .12 Low Priority Queue.

Simulink allows setting various parameters on the basis of the model and as per the requirement of the application.

3. CONCLUSIONS

Simulation has always been effective in study of behaviour patterns of different applications. Simulation is the art to create a physical and conceptual model which can represent a system or create the illusion of reality. Multiple servers are to be analyzed with different parameters, Different applications can be modeled based on the criteria and efficient results are to be computed. Simulation also needs to be performed on Distributed system environment.

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