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INTELLIGENT SELECTION OF A SERVER AMONG PARALLEL IDENTICAL SERVERS

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ABSTRACT

Systems with parallel identical servers allow a customer to choose a server based on some criterion. An exemplar is a supermarket billing counters where the decision to choose a counter is not just based on queue length in each counter but customers often resort to use an approximate estimate of the number of items in the customers' baskets in each queue to select a counter. This intelligent server selection behavior sometimes entail joining a longer queue to get processed quicker. Designing a service system of this kind to decide the number of counters required to provide the required level of service through simulation requires explicit modeling of intelligent server selection by customers. A simple simulation model of a parallel identical servers system and its experimentation indicates the benefits of capturing intelligent server selection in the model.

1 INTRODUCTION

There are many systems that have parallel identical servers and allow a customer to choose one to obtain service. Designing such a system entails determination of the number of servers required to provide the required level of service. A general way of modeling a customer's choice of the server is based on the queue length (Movaghar 2005), which is valid is many cases. However, these is a subset of these systems such as the supermarket with multiple billing counters, toll plazas with multiple toll collection booths (Obelheiro, Cybis and Ribeiro 2011, Zarrillo, Radwan and Al-Deek 1997) and airports with multiple check-in counters (Stolletz 2011), where the decision to choose a counter is not just based on queue lengths but customers often resort to a more intelligent assessment of each queue before joining one.

The intelligent assessment of server queues by a customer could take various forms such as an approximate estimate of the number of items in the customers' baskets in each queue at a super market, an approximate estimate of the number of vehicles in each queue at a toll plaza (the length of the queue does not depend only on the number of vehicles but also on the length of each vehicle) and an approximate estimate of the number of check-in bags in each queue at airport check-in counters.

The intelligent selection of a server among parallel identical servers sometimes entail joining a longer queue to get processed quicker. This behavioral aspect of customers need to be explicitly modeled when designing such systems using simulation.

2 SIMULATION MODELING AND EXPERIMENTATION

A supermarket billing counter is modeled and experimented to demonstrate the benefit of capturing the intelligent selection of server queues by a customer. The customer arrivals are assumed Poisson in nature with mean inter-arrival time of 1 second. The number of items shopped by a customer is assumed to Uni-

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formly vary between 1 and 70, and each item has a constant processing time of 4 seconds at the billing counter. There could be up to 10 billing counters and customers with 10 items or less are not differentiated, i.e., a customer could choose any of the available counters.

The experiment is conducted with 6 different server selection rules with 10 different settings of the number of counters present in the system where it was incremented from 1 to 10 in steps of 1, i.e., a total of 60 simulation runs are conducted. The server selection is based on one of the following attributes: (a) the number of customers in the queue (QL), (b) the number of items across all customers in a queue (QI), or (c) a combination of QL and QI as detailed in Table 1; a customer chooses the server with the lowest attribute value across the queues. The performance measure used in the model is the average time spent by a customer in the system, which includes waiting time in the queue and the processing time at the billing counter.

Table 1: Comparison of Server Selection Approaches

Number of Billing Counters	**Average Customer Time in the System (Minutes)**					
	Conventional Server Selection Rule	**Intelligent Server Selection Rules**				
	QL	QI	$QL \times QI$	$QL + QI$	$QL^2 + QI$	$QL^3 + QI$
1	237.00	237.00	237.00	237.00	237.00	237.00
2	118.50	118.38	118.27	118.38	118.52	118.51
3	79.20	78.57	78.93	78.85	78.96	79.20
4	59.52	59.07	59.28	59.10	59.20	59.40
5	47.59	47.26	47.34	47.22	47.33	47.42
6	39.78	39.32	39.53	39.35	39.46	39.69
7	33.99	33.70	33.89	33.72	33.87	33.87
8	29.88	29.42	29.75	29.44	29.53	29.72
9	26.49	26.15	26.24	26.16	26.31	26.40
10	24.02	23.56	23.76	23.53	23.60	23.73

It is observed that the impact of intelligent server selection rules in reducing the average customer time in the system is proportional to the number of servers. This behavior could be attributed to the fact that server selection decision takes more prominence with increased number of servers.

3 CONCLUSION

The experimentation reveals the importance of capturing customer's intelligent server selection behavior and the benefits will be even more evident while designing real life complex systems where there is a sequence of processes and confluence of events.

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