Balking Systems

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Terminology used

•Traffic intensity (A)
•Inter arrival time (λ)
•Service time (μ)
•Impatience time (α)
•Balking probability (p)

Correlation to what has been covered

•Full availability system – Customer finds the server idle and is serviced without going into the queue (a<1)
•Limited Availability – Customer finds the server busy and waits in the queue (a>1)
•The latter scenario is where the concept of Balking is so evident in the real world scenario

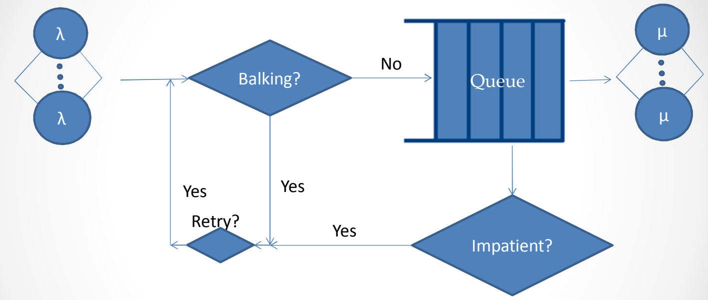
Balking Systems - Introduction

•What are Balking Systems?
•Example – Customer care scenario
•Difference between balking and reneging

Why study Balking Systems?

- Why do customers balk?
- Impatience from customers
- Does impatience affect performance?
- It contributes to an increase in response time, thus depreciating performance
- So, why study balking systems?
- Use in Telecommunication systems, Call Centers

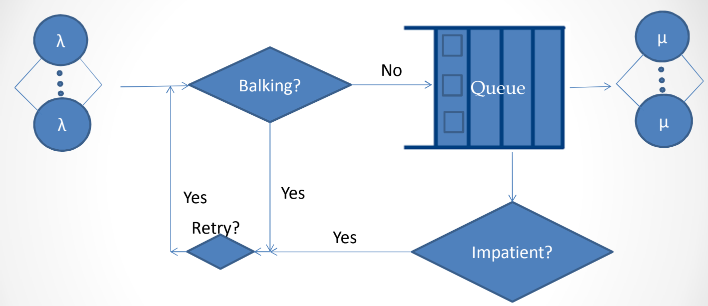
Flow of a typical Balking System



Scenarios

- No Balking, no impatience
- Balking, no impatience
- No Balking, Impatience
- There can be more scenarios as well where a combination of the above can happen

Simulation of Scenarios



Metrics affecting performance

- Inter arrival time
- Service time
- Reneging times
- Balking probability
- Retrial inter arrival times

Balking in M/M/s

$P_n = [(1/n!)(\lambda/\mu)^n]\, P_0$ (Result from Birth Death Processes) $n<=c$

Putting P_{c-1} and P_c and using BD process derivation equations:
$P_{c+1} = [(1/c!)(\lambda/\mu)^c\,(\lambda p/c\mu+\alpha)]P_0$; $n=c+1$
$P_{c+2} = [(1/c!)(\lambda/\mu)^c\,((\lambda p)^2/(c\mu+\alpha)(c\mu+2\alpha)]P_0$

Generalizing, we get:

$P_n = [(1/c!)(\lambda/\mu)^c\,[(\lambda p)^{n-c}]P_o / \prod_{r=1}^{n-c} c\mu + \alpha r]$ $n>c$

Where Pn denotes the transient state probability that there are n customers in the system.

Other results

$N = (1/c\mu)[\alpha+\lambda p\,(1-p) \sum_{n=c}^{\infty} P_n]$

$A = (1/c\mu)[\sum_{n=0}^{c} \lambda P_n + \sum_{n=c+1}^{\infty} \lambda p P_n]$

Where N represents the average number of customers lost

And A represents the average number of customers attended

Considerations for Algorithm

- Followed the algorithm for a regular M/M/s queue
- Response time was calculated by taking inter arrival time, service time, impatient time and retrial times for all individual calls into consideration.
- Buffer had a finite value
- All the aforementioned times are mutually independent.
- Customer reneges if the waiting time is above a particular threshold value
- Retrial inter arrival times assumed to be exponential

Considerations for Simulation

- Service rate was kept fixed at 1 customer per 1 ms.
- Number of buffers were fixed at 10
- Number of servers and arrival rate was varied to obtain respective response times.
- The customer balks with a probability of 0.2

Results of Simulation for number of servers=3

Response time vs Lambda	No. of servers = 3
Response Time (ms)	Lambda (Customers per ms)
0.275615	0.2
0.517	0.3
1.30433	0.4
1.51234	0.5
1.75072	0.6
2.16763	0.7
2.37624	0.8
2.45622	0.9
2.54721	1
2.64682	1.2
2.75313	1.4
2.83562	1.6
2.94453	1.8
3.008	2

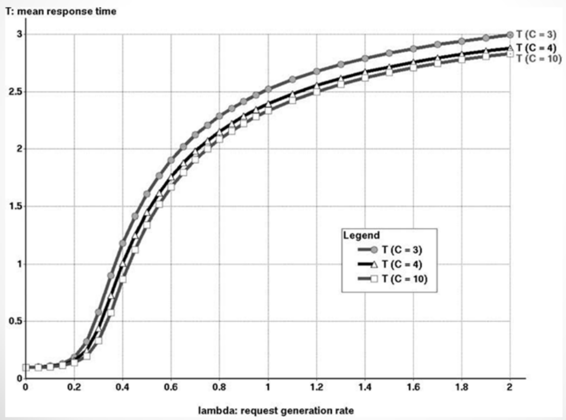
Results of Simulation for number of servers=4

Response time vs Lambda	No. of servers = 4
Response Time (ms)	Lambda (Customers per ms)
0.24307	0.2
0.46532	0.3
1.03064	0.4
1.50169	0.5
1.55284	0.6
2.07193	0.7
2.18843	0.8
2.33869	0.9
2.40513	1
2.52783	1.2
2.64623	1.4
2.75441	1.6
2.84671	1.8
2.89864	2

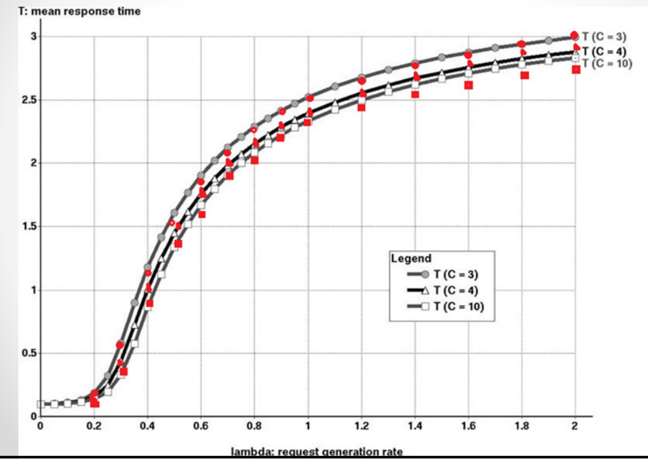
Results of Simulation for number of servers=10

Response time vs Lambda	No. of servers = 10
Response Time (ms)	Lambda (Customers per ms)
0.093043	0.2
0.365216	0.3
0.930796	0.4
1.351521	0.5
1.617698	0.6
1.864737	0.7
2.0790085	0.8
2.2217555	0.9
2.2848735	1
2.4014385	1.2
2.5139185	1.4
2.6166895	1.6
2.7043745	1.8
2.753708	2

Expected results for Simulation



Expected vs Calculated results for Simulation



References

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  Patrick Wüchner , János Sztrik , Hermann de Meer
- **On a multiserver markovian queueing system with balking and reneging**
  A. Montazer-Haghighi, J. Medhi, S.G. Mohanty
- **On the impact of customer balking, impatience and retrials in telecommunication systems**
  J.R. Artalejo , V. Pla
- **ECE 777 – Dr. Dutta's class lectures**

Test your comprehension

- Can a customer both balk and renege? How?
- Which out of balking and reneging is worse for performance and why?
- Does balking mitigate loss?