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DISTRIBUTED COMPUTER AND COMMUNICATION NETWORKS – 2017

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Institute of Information and Communication Technologies
of Bulgarian Academy of Sciences (Sofia, Bulgaria)
Peoples' Friendship University of Russia (RUDN University)
National Research Tomsk State University (NR TSU)
Research and development company **“Information and networking technologies”**

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Российская академия наук (РАН)
Институт проблем управления им. В.А. Трапезникова РАН (ИПУ РАН)
Институт информационных и телекоммуникационных технологий
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Научно-производственное объединение
«Информационные и сетевые технологии» («ИНСЕТ»)

РАСПРЕДЕЛЕННЫЕ КОМПЬЮТЕРНЫЕ И ТЕЛЕКОММУНИКАЦИОННЫЕ СЕТИ: УПРАВЛЕНИЕ, ВЫЧИСЛЕНИЕ, СВЯЗЬ

DCCN
2017

МАТЕРИАЛЫ ДВАДЦАТОЙ МЕЖДУНАРОДНОЙ НАУЧНОЙ КОНФЕРЕНЦИИ

(25–29 сентября 2017 г., Москва, Россия)

МОСКВА
ТЕХНОСФЕРА
2017

УДК 004.7:004.4].001:621.391:007
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Р 24

Распределенные компьютерные и телекоммуникационные сети: управление, вычисление, связь (DCCN-2017) = Distributed computer and communication networks: control, computation, communications (DCCN-2017) : материалы Двадцатой междунар. науч. конфер., 25–29 сент. 2017 г., Москва: / Ин-т проблем упр. им. В.А. Трапезникова Рос. акад. наук; под общ. ред. В.М. Вишневского. – М.: ТЕХНОСФЕРА, 2017. – 666 с. – ISBN 978-5-94836-491-9.

В научном издании представлены материалы Двадцатой международной научной конференции «Распределенные компьютерные и телекоммуникационные сети: управление, вычисление, связь» по следующим направлениям:

- архитектура и топология компьютерных сетей: управление, проектирование, оптимизация, маршрутизация, резервирование ресурсов;
- аналитическое и имитационное моделирование инфокоммуникационных систем, оценка производительности и качества обслуживания;
- технологии беспроводных сетей сантиметрового и миллиметрового диапазона радиоволн: локальные и сотовые сети 4G/5G;
- RFID-технологии и сенсорные сети;
- приложения распределенных информационных систем: Интернет вещей, анализ больших данных, интеллектуальные транспортные сети;
- распределенные системы и облачные вычисления, программно-определяемые сети, виртуализация;
- вероятностные и статистические модели в информационных системах;
- теория очередей, теория надежности и их приложения в компьютерных сетях;
- высотные беспилотные платформы и летательные аппараты: управление, передача данных, приложения.

В материалах конференции DCCN-2017, подготовленных к выпуску Козыревым Д.В., обсуждены перспективы развития и сотрудничества в этой сфере.
Сборник материалов конференции предназначен для научных работников и специалистов в области теории и практики построения компьютерных и телекоммуникационных сетей.

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Performance modeling of finite-source retrial queueing systems with collisions and non-reliable server using MOSEL

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Abstract. In this paper we investigate a single-server retrial queueing system with collision of the customer and an unreliable server. If a customer finds the server idle, he enters into service immediately. The service times are independent exponentially distributed random variables. During the service time the source cannot generate a new primary call. Otherwise, if the server is busy, an arriving (primary or repeated) customer involves into collision with customer under service and they both moves into the orbit. The retrial time of requests are exponentially distributed. We assume that the server is unreliable and could be break down. When the server is interrupted, the call being served just before server interruption goes to the orbit. Our interest is to give the main steady-state performance measures of the system computed by the help of the MOSEL tool. Several Figures illustrate the effect of input parameters on the mean response time.

Keywords: closed queuing system, finite-source queuing system, retrial queue, collision, unreliable server.

1. Introduction

The performance analysis of computing and communicating systems has always been an important subject of computer science. The goal of this analysis is to make predictions about the quantitative behavior of a system under varying conditions, e.g., the expected response time of a server under varying numbers of service requests, the average utilization of a communication channel under varying numbers of communication requests, and so on.

Retrial queueing systems (RQS) are characterized by the feature that arriving customers finding all the servers busy upon arrival are obliged to leave the service area and repeat their requests for service after some random time [1], [2], [3]. This feature plays an important role in modeling many problems in telephone switching systems, telecommunication networks, computer networks, call centers, etc. The main difference between retrial queues and classic queues is that the classic queueing theory does not take the actually existed retrial customers into account. It assumes these retrial customers are either lost due to congestion or delayed in the waiting line (if any).

Since in practice some components of the systems are subject to random breakdowns it is of basic importance to study reliability of retrial queues with server breakdowns and repairs. Finite-source retrial queues with unreliable server have been investigated in several recent papers, for example, [4], [5], [6], [7].

Many times when different data is transmitted and there are only a limited number of available free channels may cause a conflict. This may in many cases result in collisions that lead to data loss. Recent results on retrial queues with collisions can be found in, for example [8], [9].

The aim of the present paper is to investigate a single-server retrial queueing system with collision of the customer and an unreliable server.

Because of the fact, that the state space of the describing Markov chain is very large, it is rather difficult to calculate the system measures in the traditional way of writing down and solving the underlying steady-state equations. To simplify this procedure we used the software tool MOSEL (Modeling, Specification and Evaluation Language) to formulate the model and to obtain the performance measures. The organization of the paper is as follows. Section 2 contains the corresponding queueing model with components. In Section 3, we present some numerical examples.

2. System model

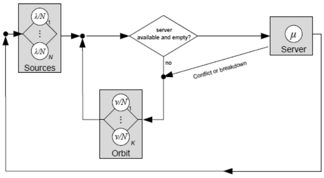

Figure 1. System

Let us consider (Figure 1) a closed retrial queuing system of type M/M/1//N with collision of the customers and an unreliable server. The number of sources is N and each of them can generate a primary request with rate λ/N. If a customer finds the server idle, he enters into service immediately. The service times are independent exponentially distributed random variables with parameter μ. During the service time the source cannot generate a new primary call. Otherwise, if the server is busy, an arriving (primary or repeated) customer involves into collision with customer under service and they both moves into the orbit. The retrial time of requests are exponentially distribution with rate σ/N. We assume that the server is unreliable and could be break down. The lifetime is supposed to be exponentially distributed with failure rate γ_0 if the server is idle and with rate γ_1 if it is busy. When the server breaks down, it is immediately sent for repair and the recovery time is assumed to be exponentially distributed with rate γ_2. All random variables involved in the model construction are assumed to be independent of each other.

Table 1

Numerical values of model parameters

Case	**N**	λ/N	γ_0	γ_1	γ_2	σ/N
Figure 2 case 1	100	0.01	0.01	0.01	1	0.1
Figure 2 case 2	100	0.01	0.1	0.1	1	0.1
Figure 2 case 3	100	0.01	1	1	1	0.1
Figure 3	100	0.03 - 8.1	0.01	0.01	1	0.1
Figure 4	100	0.03 - 8.1	0.1	0.1	1	0.1

3. Numerical results

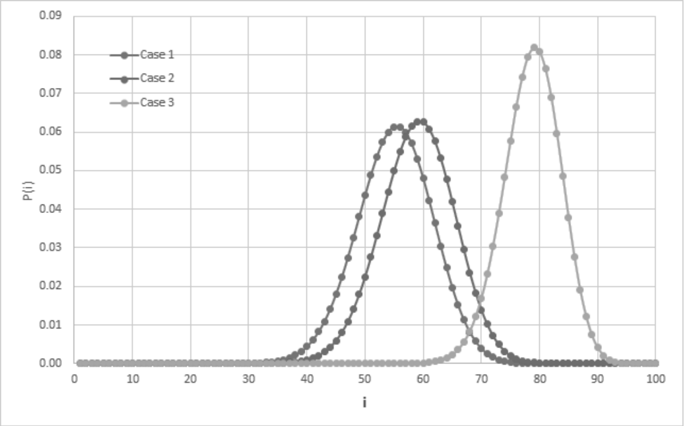

Figure 2. Steady-state distributions

The Table 1 shows the input parameters of the investigated Figures.

Figure 2 shows the steady-state distribution of the three investigated cases. In this figure we can see also the effect of the breakdown of the Server. We can see that the mean number of customers increases as the breakdown intensity are getting larger. From the shape of the curves it is clearly visible that the steady-state distribution of the cases are normally distributed.

Figure 3 and 4 shows the mean response time as a function of the customer generation rate. As we see the mean response time will be greater as we increase the generation rate, but after after λ/N is greater than 1.5 the mean response time starts to decrease.

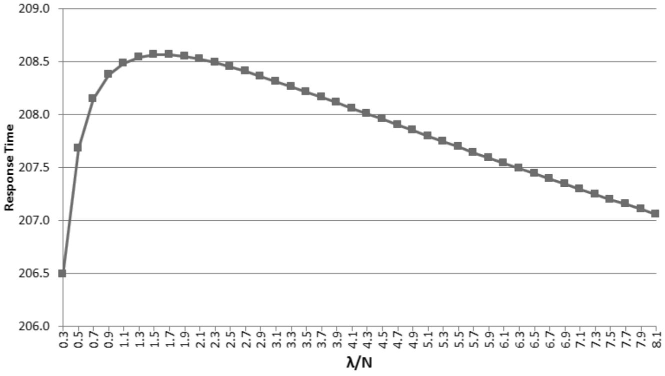

Figure 3. vs λ/N, $\gamma_0 = \gamma_1 = 0.01$

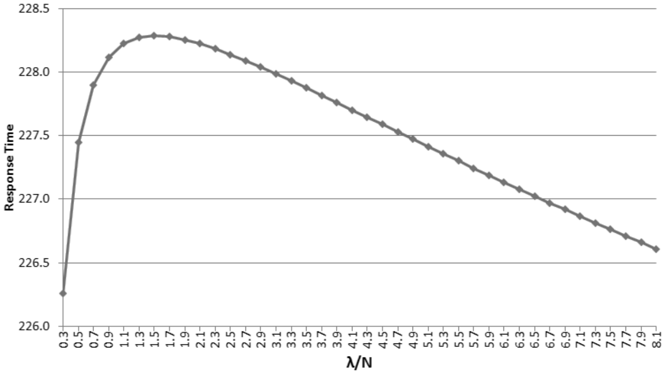

Figure 4. vs λ/N, $\gamma_0 = \gamma_1 = 0.1$

4. Conclusions

In this paper we investigate a single-server retrial queueing system with collision of the customer and an unreliable server. We the MOSEL tool to calculate the steady state probabilities and to get the main performance measures.

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