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WIELOKANAŁOWY SYSTEM MASOWEJ OBSŁUGI CENTRUM KONTAKTOWEGO

Streszczenie: W artykule rozważany jest wielokanałowy system masowej obsługi centrum kontaktowego. Wyznaczono wskaźniki wydajności systemu masowej obsługi z nieograniczoną kolejką dla efektywnej organizacji contact center i prognozowania jego obciążenia.

Słowa kluczowe: centrum kontaktowe, system masowej obsługi

MULTI-CHANNEL MASS SERVICE SYSTEM OF THE CONTACT CENTER

Summary: The multi-channel system of mass service of the contact center is considered in the article. The performance indicators of the mass service system with an unlimited queue were determined for the effective organization of the contact center and forecasting its loading.

Keywords: contact center, mass service system

Introduction

The activity of a modern enterprise, company or organization is not possible without a contact center, which processes requests by phone, e-mail and regular mail, and works with requests from customers. Queuing theory (in particular, mass service systems) is used for effective organization of the contact center and forecasting of its loading, mathematical models allow determining the optimal number of service channels necessary to provide the necessary service to customers. Both public telephone networks and IP telephony can be used to organize communications. Self-service systems for subscribers using interactive voice menus are often used. Contact centers also use a wide range of software to support interaction through E-mail, instant messaging (IM) and chat.

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Replicated software and hardware solutions for the organization of call centers can have the following functionality: registration of all incoming and outgoing calls; storage of information about the client from the history of calls from this number; static and intelligent call routing: queue organization, routing by subscriber number (using information from automatic number identifiers and CallerID); visualization on the operator's workstation of information about the call and the client's card (including using the CRM system); automated dialing; display of operator status (busy, free, pause); distribution of calls within the group by loading operators and in order; generation of reports on completed and received calls; recording of conversations; quality control of operators' work; planning the schedule of operators' work shifts, etc. Queueing theory has its origins in research by Agner Krarup Erlang when he created models to describe the system of Copenhagen Telephone Exchange company, a Danish company[1]. The ideas have since seen applications including telecommunication, traffic engineering, computing [2] and, particularly in industrial engineering, in the design of factories, shops, offices and hospitals, as well as in project management[3,4].

1. Multi-channel mass service system with an unlimited queue

When modeling systems, models of mass service systems (MSS) occupy an important place, such systems meet us every day. These are service processes in a queue at a gas station, in a store, a library, a cafe, as well as various repair and medical assistance services, transport systems, airports, train stations, etc. Queues arise due to the need to use a telephone connection or send a message over the Internet. Moreover, any production can also be represented as a sequence of such systems. MSSs have gained special importance in informatics. These are systems, information transmission networks, databases and data banks. There is a developed mathematical apparatus of the theory of mass service (scientists of Western countries call this theory the theory of queues), which makes it possible to analyze the effectiveness of the functioning of MSSs of certain types and to determine the relationship between the characteristics of the demand flow, the number of channels (service devices), their performance, the rules of operation of MSSs and its effectiveness.
In a broad sense, MSS is understood as a complex system consisting of one or more sources of requests (applications, requirements) for the performance of certain actions (service), several service devices (service lines, service channels) that perform these actions in accordance with certain rules (service disciplines) according to requests received in the system [1-16]. From the point of view of modeling the process of mass service, situations when queues of requests (requirements) for service are formed, arise as follows: after entering the service system, the request joins the queue of other (previously received) requests. The service channel selects a request from those in the queue in order to start servicing it. After completing the service procedure of the next request, the service channel starts servicing the next request, if there is one in the queue. The cycle of operation of the MSS of this kind is repeated many times during the entire period of operation of the service system. At the same time, it is assumed that the transition of the system to the service of the next request after the completion of the service of the previous request occurs instantly, at random moments of time.

In the paper, we will consider an example of the operation of the MSS contact center, namely an n-channel (multi-channel) system with an unlimited queue. The flow of applications arriving at the MSS has intensity λ, and the service flow has intensity μ . In fig. 1 shows the state graph of the system.

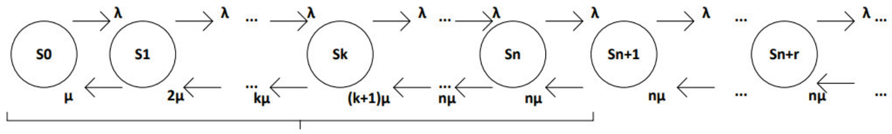

Figure 1. State graph for multi-channel MSS with unlimited queue

Multi-channel MSS can be in one of the following states:
S_0 – there are no applications in MSS (all channels are free);
S_1 - one channel is busy, others are free;
S_2 - two channels are occupied, the others are free;
…
S_k - k channels are occupied, others are free;
…
S_n - all n channels are occupied (there is no queue);
S_{n+1} – all n channels are occupied, one request is in the queue;
S_{n+r} – all n channels are occupied, r applications are in the queue.

2. Performance indicators of the mass service system with an unlimited queue

When the MSS is functioning, we can calculate indicators, including:
- the probability that the system is in state S_0:

$$p_0 = \left(\sum_{i=0}^{n} \frac{\rho^i}{i!} + \frac{\rho^{n+i}}{n!(n-\rho)} \right)^{-1}, \tag{1}$$

- the probability that the application will be in the queue:

$$P_q = \frac{\rho^{n+1}}{n!(n-\rho)} p_0 , \tag{2}$$

- average number of applications in the queue (queue length):

$$L_q = \frac{\rho^{n+1} p_0}{n \cdot n!(1-\frac{\rho}{n})^2}, \tag{3}$$

- average number of applications in the system:

$$L_s = L_q + \rho , \tag{4}$$

- the average time the application is in the queue:

$$T_q = \frac{L_q}{\lambda}, \tag{5}$$

- average time the application stays in the system:

$$T_s = \frac{L_s}{\lambda}, \tag{6}$$

- ratio of waiting time in the queue to service time:

$$\gamma = \frac{L_q}{L_s - L_q}, \tag{7}$$

- relative bandwidth – the probability that the request will be served:

$$Q = 1, \tag{8}$$

- absolute throughput of the system (average number of requests served per unit of time):

$$A = \lambda Q = \lambda, \tag{9}$$

- the average number of busy channels:

$$\bar{k} = \frac{\lambda}{\mu} = \rho. \tag{10}$$

Let's consider an example of the operation of a mass service system (Fig. 2). A queueing node with 3 servers. Server a is idle, and thus an arrival is given to it to process. Server b is currently busy and will take some time before it can complete service of its job. Server c has just completed service of a job and thus will be next to receive an arriving job.

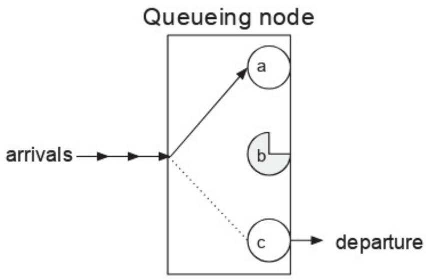

Figure 2. Example of the operation of a mass service system

3. Service disciplines

The rules by which requests are selected for service constitute a service discipline. Conventionally, all service disciplines are divided into two groups according to the benefits provided in the service: non-priority and priority. Each of these groups is divided into a number of subgroups.

Non-priority service disciplines are divided into first-come, first-served, reverse-order, random-queue service discipline, and cyclic service discipline.

The discipline of service in the order of arrival (in the international notation FIFO - First Input First Output) is the most common, most research on the theory of mass service is carried out for this discipline. It is widely used in operating systems (Fig. 3).
The service discipline in the reverse (inverse) order (in the international notation LIFO - Last Input First Output) is used in operating systems during interrupt processing and stack organization.
Cyclic service disciplines are used when processing information in time-sharing mode.
In the case of priority service disciplines, applications with a higher priority are first selected from the service queue. They are divided into disciplines with fixed and dynamic priorities.

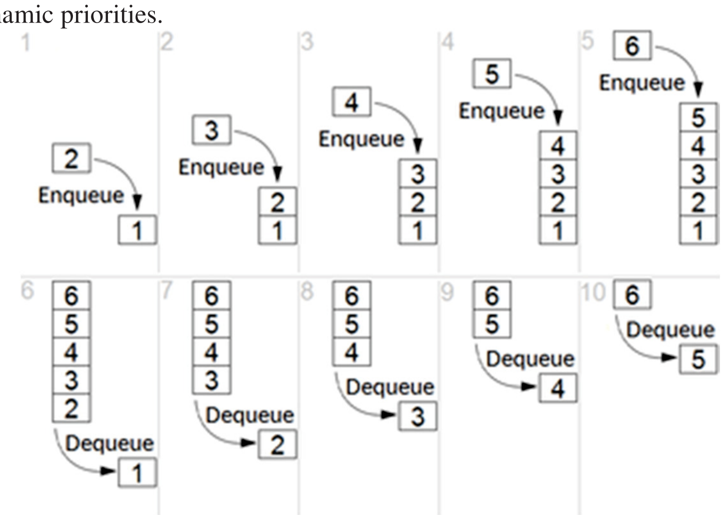

Figure 3. First in first out (FIFO) queue example

With the service discipline with relative priority, interrupting the service of the request on the channel is not allowed.
If a system with an absolute priority service discipline receives a request with a higher priority than the one being serviced, it will stop servicing that request and start servicing it.
Systems with absolute priority are distinguished by the number of priority levels, as well as by algorithms for servicing interrupted requests.
With service disciplines with dynamic priority, the priority of specific requests changes depending on the change of some values, for example, waiting time in queues.

Conclusions

For the effective organization of the contact center and forecasting of its loading, it is necessary to use the specified performance indicators of the mass service system. Also, it is expedient to build a simulation model of the system in advance, by studying which it is possible to find the optimal parameters of the functioning of the real system.

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