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ДО ПРОБЛЕМИ МОДЕЛЮВАННЯ ТА ОПТИМІЗАЦІЇ НЕНАДІЙНОЇ МЕРЕЖІ МАСОВОГО ОБСЛУГОВУВАННЯ

К ПРОБЛЕМЕ МОДЕЛИРОВАНИЯ И ОПТИМИЗАЦИИ НЕНАДЕЖНЫХ СЕТЕЙ МАССОВОГО ОБСЛУЖИВАНИЯ

ON A PROBLEM OF MODELING AND OPTIMIZATION OF UNRELIABLE QUEUEING NETWORK

М.Я. ПОСТАН, докт.техн.наук
Одесский национальный морской университет, Украина

В роботі описано результати дослідження проблеми моделювання та оптимізації ненадійної мережі чергування. Наведена математична модель абсолютно надійної системи управління двомісними нескінченними каналами. В результаті виконанного дослідження формалізована та сформована приоритетна задача оптимізації.

***Ключові слова**: ненадійна мережа черг, моделювання та оптимізація, мережа Джексона, функція розподілу життєвого періоду.*

В работе описаны результаты исследования проблемы моделирования и оптимизации ненадежной сети дежурство. Приведена математическая модель абсолютно надежной системы управления двухместными бесконечными каналами. В результате выполнения исследования формализована и сформирована приоритетная задача оптимизации.

***Ключевые слова**: ненадежная сеть очередей, моделирование и оптимизация, сеть Джексона, функция распределения жизненного периода.*

The results of research a problem of modeling and optimization of unreliable queuing network are described in this state. An absolutely reliable two-phase infinite channels queuing system is performed as an mathematical model. The corresponding optimization problem is formalized in conclusion.

***Keywords**: unreliable queuing network, modeling and optimization, Jacksonian network, life-period distribution function.*

Introduction. While considering the problem of computer or data communication networks' design the restricted reliability of some network's elements must be taken into account.

In spite of very important role of this factor in projecting of high-performance networks it did almost not enlighten in the special literature [1; 2].

Goal of the work. To solve this problem we represent the real computer communication network as a Jacksonian queueing network [1; 2]. It is assumed that the failures of the network as a whole may occur.

Any failure provokes the simultaneous interruption of service (data processing) at all nodes and stopping of arrival of new information messages (or customers) from the outside.

Basis of material. The process of life-periods and repair-periods changing for the network is described by an alternating renewal process and after repair completion the service and arrival processes are resumed.

It is assumed also that at moment of a failure appearance, with the probability ω no one message (customer) leaves the network and with the additional probability all of the messages being at this moment in the network are lost.

Let the life-period distribution function (d.f.) be exponential with parameter *a* and repair-period d.f. is denoted $B(t)$.

Let us denote

$$p(k_1,...,k_N) = p(\vec{k}), \vec{k} \geq \vec{0}, \quad (1)$$

where k_n is number of messages at the *n*th node of network, the stationary state-probabilities of unreliable queueing network described above (*N* is number of nodes).

It is shown that probabilistic distribution (1) may be expressed through the corresponding state-probabilities $q(\vec{k};t)$ of the absolutely reliable Jacksonian network (in the transient case) by the relation

$$[1 + a(1-\omega)\tau]p(\vec{k}) = a(1-\omega)\int_0^\infty e^{-a(1-\omega)t} q(\vec{k};t)dt, \quad (2)$$

where probabilities $q(\vec{k};t)$ are calculated under initial conditions

$$q(\vec{k};0) = \delta_{0,k_1+...+k_N} \quad (3)$$

(δ_{0k} is the Kronecker delta);

$$\tau = \int_0^\infty (1 - B(u))du < \infty.$$

Using the relation (2), for open queueing network with infinite number of channels at each node and for closed queueing network without waiting of service beginning the stationary distribution (1) may be found in the closed form.

For example, for absolutely reliable two-phase infinite channels queueing system, from the results of works [1; 3], it follows that (under conditions (3))

$$Q(x_1,x_2,t) \equiv \sum_{k_1=0}^{\infty}\sum_{k_2=0}^{\infty} q(k_1,k_2,t)x_1^{k_1}x_2^{k_2} = \\ = \exp\{-\frac{\lambda}{\mu_1}(1-x_1)(1-e^{-\mu_1 t}) - \lambda(1-x_2)[(1-e^{-\mu_2 t})/\mu_2 - \\ -(e^{-\mu_2 t} - e^{-\mu_1 t})/(\mu_1-\mu_2)]\}, \tag{4}$$

where λ is rate of the Poisson input flow of messages at the first phase, $1/\mu_1$ and $1/\mu_2$ are the mean processing times of messages at the first and second phases correspondingly.

Therefore, from (2), (4) we find

$$P(x_1,x_2) \equiv \sum_{k_1=0}^{\infty}\sum_{k_2=0}^{\infty} p(k_1,k_2)x_1^{k_1}x_2^{k_2} = \\ = a(1-\omega)[\int_0^{\infty} Q(x_1,x_2,t)e^{-a(1-\omega)t}dt]/[1+a(1-\omega)\tau].$$

In the general case, for finding of probabilities (1) the simple recurrent algorithm may be applied [4].

Conclusions. A special particular case $\omega = 1$ is closely studied. In this case some optimization problems are formulated and solved under supposition that $\mu_n = W_n / \beta_n$, where W_n is the processing rate at the *n*th node, β_n is the mean 'length' of a message.

For example, the corresponding optimization problem may be formulated by the following way: to find out the rates of information processing W_n of all nodes with the aim to minimize the mean square of deviation of time-in-nets of arbitrary message from the given value under some constraints [5].

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