Research of Efficiency Functioning Common Channel Signaling Systems

Bayram Ibrahimov[1], Faxri Huseynov[2]
[1]Azerbaijan Technical University, Baku, Azerbaijan
[2]Cybernetic Institute of ANAS, Baku, Azerbaijan
i.bayram@mail.ru, f.faxri@gmail.com

Abstract— **Methods of increase efficiency functioning of common channel signaling systems are investigated by transfer of the office traffic. Analytical expressions for an estimation likelihood - time characteristics of networks common channel signaling systems are received. Factors of an effective utilizations of the signaling channel by transfer of three types of signal units are defined.**

Keywords— common channel signaling; message signal unit; signaling point; digital subscriber signaling; message transfer part; signaling channel

I. INTRODUCTION

There are two types of communication networks: circuit-switched networks and packed-switched networks. In circuit-switched networks, a dedicated physical circuit between the calling and called party is set up at the start of a call, and released when the call has ended. Telephone networks are circuit-switched networks. Today, these networks are used for speech and other purposes, such as facsimile, and are usually referred to as telecommunication networks [1].

The modern level of development of telecommunication systems on the basis of information technologies demands creation of networks common channel signaling (alarm) systems (CSS) with the raised efficiency.

In systems of telecommunication among used systems of the alarm system in digital systems of switching the special place is occupied common channel with system of the signaling system No.7. Signaling system CSS No.7 under recommendation ITU-T Q.700 represents alarm system on the general channel of universal appointment, defines a management infrastructure digital communication networks at creation of logic signaling channels for an establishment of connection, data transmission and destruction of logic alarm connections [1, 2].

Efficiency of functioning of networks common channel signaling systems essentially depends on timely delivery and reliability of transfer of alarm traffic that gets the big importance in communication control systems.

Increase of efficiency of the multiservice communication networks making a basis of evolutionary development of system of telecommunication in a direction of realization of the concept «the Transport network - access networks», demands perfection of existing systems of the alarm system and working out of new methods and means of the decision of a problem of synthesis of system CSS [2, 3].

The signaling systems happens three types - user - on a site between user's terminals, switching station (the network terminal - a router, the switchboard, the multiplexer, the concentrator) and infestation (CAS-Channel Associated Signaling).

Considering the above-stated, in the given work methods of increase of efficiency of functioning common channel signaling systems by transfer of the office traffic are investigated.

II. PROBLEM STATEMENT

Telecommunications, which started as "telephony" before the turn of this century, has experienced a dramatic evolution in the past few decades. By pushing a few buttons on our telephones, we can make calls to almost any place in the world. Moreover, while the original purpose of these calls was to speak with a person at a distant location, we now also make calls to transmit written documents (facsimile), and other data.

The introduction of computer controlled exchanges has led to a host of new telecommunication services beyond "plain old telephone service," for example, "call waiting," "call forwarding," and intelligent network services such as "800 number calling." In addition, telecommunication networks are being converted from analog to digital technology, and Integrated Services Digital Networks (ISDN) have made their appearance in several countries. Finally, cellular mobile communications years [1].

In multiservice networks CSS defines a management infrastructure modern communication networks [1, 2, 3] and can be used in telephone systems of the general using with report TUP (Telephone User Part), digital networks with integration of services c report ISUP (ISDN User Part), networks of mobile communication systems (WCN) c report MAP (Mobile Application Part), intellectual communication networks (IN) c report INAP (Intelligent Network Application Part), ATM-networks with report DSS (Digital Subscriber Signaling), IP-networks with report Sigtran (Signaling Transport over IP) and NGN-networks with report SIP (Session Initiation Protocol).

On fig. 1. the general block diagrammed of use CSS No.7 in multiservice communication networks is presented and is object of research. From use scheme it is visible, that in CSS, working on the local level, one of the important elements of a subsystem of a link of the alarm system are MTP (Message

Transfer Part) and SCCP (Signaling Connection Control Part), providing management of connection and the alarm system channel.

In telecommunication infrastructure following networks are shown: telephone systems of the general using, a network of a mobile communication system, intellectual communication networks, digital networks with integration of services and networks of telecommunication of following generation

Under the given scheme in CSS the alarm information is transferred in the form of the packages of data of variable length named alarm units (Signal Unit - SU). It means, that CSS No.7, as a matter of fact, is system of data transmission with a mode of switching of packages.

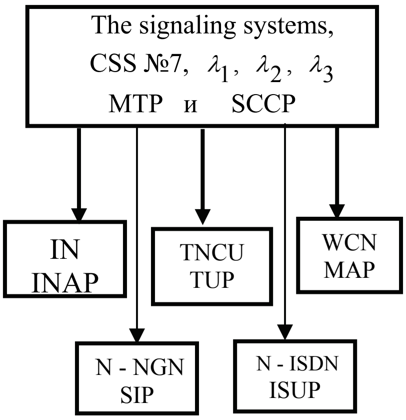

Figure 1. The general block diagrammed of use CSS № 7 in multiservice communication networks

In the investigated scheme, i.e. in system CSS three types SU are used and defined by the following alarm parameter which is considered as set of office traffic [2, 3]:

$$L_{SU} = L_{MSU} + L_{LSSU} + L_{FISU} \quad (1)$$

Where L_{MSU} - length meaning SU (MSE - Message Signal Unit) in which structure alarm messages are transferred, $L_{3нCE}$; L_{FISU} - filling SU (Fill in SU), it is applied to transfer of positive and negative acknowledgement in the absence of other types SU; L_{LSSU} - SU link conditions (Link Status SU, L_{LSSU}) which are used for management of condition LS, L_{CEC3}.

Using formats of alarm units, and also our discussion of level of the data link, on which there is an exchange of alarm units between next SP (Signaling Point), it is possible to define the characteristic «a delay - throughput» systems No.7 at various loadings Уn [1, 2]. In turn, this analysis is connected with throughput of channel CSS on processing of calls. Here the case of transfer without errors only is considered.

III. ESTIMATION OF CHARACTERISTICS OF EFFICIENCY OF FUNCTIONING OF NETWORKS CSS

For research and an estimation of characteristics of efficiency of functioning of networks CSS it is considered the basic scheme of transfer of three types of alarm units. Here we assume, that alarm units probably with variable length L_{MSU} = (10, …, 279) byte, form, Poisson an entering stream with intensity λ_1 of messages in unit time and arrive in turn for transfer on CSS at $T_{обр} \approx 0$.

Let's admit, that the average length of meaning signal unit is equal T_m to time. The second moment of distribution of this length is accepted equal to some size $E(\tau_1^2)$ which is equal [2]

$$E(\tau_1^2) = \sigma^2 + (1/\mu)^2, \quad (2)$$

where σ^2 – dispersions distributions of holding time SU in signaling system; μ – time service SU to alarm channels.

Thus the part of productivity of the channel, concerning meaning alarm units, is described, how usually, in a kind [2]

$$\rho_1 = \lambda_1 \cdot T_m \leq 1 \quad (3)$$

If messages for transfer are not present, instead of them filling alarm units L_{FISU} of the fixed length T_f time units are transferred. Though, strictly speaking, receipt of filling alarm units does not form Poisson a stream [2, 3], we neglect this difficulty and we assume now, that λ_2 и λ_3 too form Poisson a stream with intensity λ_2 and λ_3 signaling units in unit of time.

Thus, the contribution of filling alarm units to channel loading is defined as follows:

$$\rho_2 = \lambda_2 \cdot T_f \leq 1 \quad (4)$$

The alarm message arriving during transfer of filling alarm unit, expects end of its transfer then it is immediately transferred.

Considering, that on alarm communication channels, also is transferred SU conditions of a link of the alarm system then the factor of an effective utilization of the channel is expressed as follows [2] :

$$\rho_3 = \lambda_3 \cdot T_s \leq 1, \quad (5)$$

where T_s – is average holding time SU of a condition of a link of the signaling system (SU).

Unique, but thin enough remark which here needs to be made, consists that as in message transfer there are no breaks, the channel works with full use. Its loading, or operating ratio of alarm channel ρ_{sk}, should be accepted equal $\rho_{sk} = 1$.

Then, uniting channel operating ratios under meaning, filling and consisting alarm units, we will receive:

$$\rho = \rho_{OKC} = \rho_1 + \rho_2 + \rho_3 \leq 1, \qquad (6)$$

Expression (6) defines intensity of the combined loading of networks CSS.

IV. Definitions of the Average Waiting Time of Transfer Packages of the Office Traffic

The system-technical analysis has shown, that for definition of a waiting time of transfer of alarm units it is necessary to take advantage of the analysis of one-linear system of service with relative priorities and three classes of the demand. Demands in considered system of mass service SoMS correspond to the alarm units processed in knot of management by services - MTP and SCCP.

From (6) follows, that as, packages of three classes SU arrive in a random way with intensity accordingly λ_1, λ_2 and λ_3, the second moment of the combined stream is set by the weighed sum of the second moments

$$E(\tau^2) = \frac{\lambda_1}{\lambda} \cdot E(\tau_1^2) + \frac{\lambda_2}{\lambda} \cdot E(\tau_2^2) + \frac{\lambda_3}{\lambda} \cdot E(\tau_3^2) \qquad (7)$$

$$\lambda = \sum_{k=1}^{n} \lambda_i \, .$$

Considering the above-stated and algorithms of service SU in networks CSS can be used SoMS type M/G/1. It means, that at the analysis of a link of the alarm system taking into account SU are considered SoMS with entering Poisson a stream and any distribution of a holding time.

For average waiting time SU in links of the alarm system of service with priority $E_{ce}(w)$ to system M/G/1 it is expressed as follows [3]:

$$E_{ce}(w) = \frac{E(\tau^2)}{1 - \rho_{OKC}} \cdot \frac{\lambda_{okc}}{2} \qquad (8)$$

where λ_{okc} – the general average speed of receipt of packages of the alarm traffic in unit of time which arrive in turn for transfer on networks CSS and it is equal

$$\lambda_{okc} = \sum_{k=1}^{n} \lambda_k \, , \; k = \overline{1, n} \quad , \; n \geq 3 \qquad (9)$$

On the basis of equality (8) for an average waiting time in system M/G/1, we find the residual holding time SU $E(T_0)$, being on the serving channel

$$E(T_0) = \frac{\lambda_{okc}}{2} \cdot E(\tau^2) = \sum_{k=1}^{n} \lambda_k \cdot E(\tau^2)/2 \, , \; k = \overline{1, n} \qquad (10)$$

Considering expressions (6),…,(10), we will receive an average waiting time of meaning alarm unit:

$$E(W_1) = E(T_0)/(1 - \rho_{OKS}) \qquad (11)$$

On the basis of expression (11) residual holding time $E(T_0)$ in alarm system links is as follows:

$$E(T_0) = \frac{1}{2}\lambda_1 \cdot E(\tau_1^2) + \frac{1}{2}\lambda_2 \cdot T_f^2 + \frac{1}{2}\lambda_3 \cdot T_s^2 \qquad (12)$$

that fact here has been used, that filling alarm units as it was already spoken, have the fixed length T_f. Thus the factor of an effective utilization on the basis of (6) for filling alarm units in loadings of a signal of the channel is defined by expression:

$$\rho_2 = 1 - \rho_1 - \rho_3 \qquad (13)$$

Using to (11) equality (12), we will find for an average waiting time of meaning signaling unit in system CSS size:

$$E(W_1) = \frac{1}{2}T_f + \frac{1}{2}T_S + \frac{1}{2}\lambda_1 \frac{E(\tau_1^2)}{1 - \rho_1 - \rho_3} \qquad (14)$$

Thus, from (14) follows, that at very small loading in system (ρ_1, ρ_3 and λ_1, λ_3 are small) arriving meaning alarm units should wait for the termination of transfer of filling unit. On the average this expectation is equal to half of duration of filling unit. At loading increase it is added and the usual waiting time in system (M/G/1) at the expense of transfer expectation by other meaning alarm units starts to prevail.

V. Conclusion

As a result of research the method of increase efficiency of functioning of networks CSS is offered by transfer of meaning and filling signaling units, and also SU conditions of a link of the alarm system. The analytical expression for an estimation of efficiency signaling systems are received. The average waiting time of transfer of packages of office traffic and factors of an effective utilization of the signaling channel are defined.

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