ІНФОРМАТИКА, ОБЧИСЛЮВАЛЬНА ТЕХНІКА ТА АВТОМАТИЗАЦІЯ

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THE CALCULATING METHOD OF *NGN* ACCESS NODE CHARACTERISTICS WHEN SERVICING VOICE AND DATA TRAFFIC

Access nodes of NGN networks provide traffic aggregation to various network services and its transfer to the transport layer, which allows calling such networks multiservice. These networks are used to simultaneously transmit voice, video, and data presented in the from of standard packets. Network services provide an unlimited set of telecommunication services with specified characteristics of quality of service. The selected technology of information distribution in the NGN determines the degree of complexity of access nodes and, of course, affects the quality of information exchange service between user terminals. One of the ways to ensure a given level of quality of service for each of the services is the introduction of priority service for certain traffic flows. Introducing priorities for packets is an effective way to manage the size of queues and the time spent in it. When a high-priority packet is received, a packet with a lower priority is either interrupted (absolute priority) or a high priority packet becomes the beginning of the packets queue (relative priority). The NGN's access nodes provide aggregation of traffic to various services directed by the Public Switched Telephone Network (PSTN) and its transportation to a higher level, which allows you to call such networks multiservice ones. The new generation networks allow simultaneous transmission of mixed streams (voice, video, and data) represented in the form of standard packets. One of the ways to ensure the specified quality of service is to introduce a priority method for servicing traffic flows. In this paper, we study the characteristics of NGN access nodes as a two priority queuing system with a limited expectation. Formulas for calculating the probability of loss of speech packets, as well as data packets, and other characteristics of the access node have been proposed.

Key words: *access node, data flow, priority service mode, probability of loss, limited waiting.*

Introduction. The actuality of the subject. Currently, there is an intense interest of the NGN operators in the Public Switched Telephone Network (PSTN) in order to provide various communication services to the inhabitants of cities and suburbs. This interest is caused by the desire of operators to create convenient to use and maintain new communication services. From this point of view, terminal multiservice nodes of the NGN network are at the access layer in the network architecture [1, p. 3]. This layer provides aggregation of a mixed type of traffic and switching between the access layer (channel layer) and the transport layer. With this in mind, the affective functioning of the NGN network largely depends on the quality of its end access nodes. Characteristics of the performance of the NGN endpoint with priority methods for maintaining the interfaces used, connected from the access network side at the physical network layer for the transmission of mixed traffic.

Scientific novelty of research. It is known that speech information traffic coming from channel switching networks is first converted to a packet form. After that, it is encapsulated in IP packets [1]. In this case, RTP and UDP protocol headers of 12 and 8 bytes respectively are added to the new packet. Additional 20 bytes are required for voice IP packeting and 4 bytes per packet addressing for the MPLS network. Thus, the total length of the packet address field (header) is 44 bytes, which is transmitted each time when a packet containing speech information is sent. Since the length of the RTR protocol information field is 160 bytes, the total length of the RTR protocol packet is 204 bytes. It is known that the data flow in packet networks is transmitted over the IP/MPLS network, which is switched at LSP addresses to the transport network.

Purpose and tasks of the research. The aim is to develop engineering formulas for calculating the quality of service characteristics of multiservice access nodes of NGN networks.

Methods and sources of research. The issues raised in advance determine the methods of their resolution and verification. analysis, synthesis, induction, deduction, comparative analysis methods are used.

A review of recent research and publications. As one of the most important areas of calculating method, terminology has always played a very important role. Various terminology fields have been widely studied in Azerbaijan at different periods. *NGN* access node characteristics is not very wide analyzed, recent research has been conducted in this regard both in Azerbaijan and abroad. In connection with this topic, A.V. Roslyakov "Next Generation Networks NGN" (А.В. Росляков «Сети следующего поколения NGN»), B.S. Goldstein "IP Telephony" (Б.С. Гольдштейн «IP телефония»), A.G. Lozhkovsky "Theory of queuing in telecommunications" (А.Г. Ложковский «Теория массового обслуживания в телекоммуникациях»), A.N. Hasanov "Analysis of telecommunication networks" (А.Н. Гасанов «Анализ телекоммуникационных сетей»), N.N. Bulgakov "Multichannel system with limited queue and absolute priority" (Н.Н. Булгаков «Многоканальная система с ограниченной очередью и абсолютным приоритетом»), B.S. Livshis, A.P. Pshenichnikov, A.D. Kharkevich "Theory of Teletraffic" (Б.С. Лившис, А.П. Пшеничников, А.Д. Харкевич «Теория телетрафика») and other researches have been conducted.

Presentation of the main material. The intensities of speech and data packet flows that arrive simultaneously at the NGN endpoints can be regulated by setting the probability of service failure rate. The specified rates of failure (loss) of an NGN node shall be determined by the characteristics of mixed packets that have not been accepted for servicing by the network immediately and have been waiting in its buffer memory (in the queue). In NGN networks, the rate of loss of service quality for its endpoints is set based on the purpose, flows, their structure, and the technical means used to receive, process, and deliver information to their end users.

Let's consider the process of functioning of a multiservice terminal node of the NGN network, which receives two Poisson information flows different in intensity. With the receipt intensity of λ_1 when servicing, it has an absolute priority, and others with the intensity of λ_2 – have no priority (relative priority). In this case, the average total intensity of the information flow entering the j terminal node is determined by the formula of [3, p. 4]:

$$\Lambda = \lambda_1 + \lambda_2 \qquad (1)$$

It is assumed that the mixed traffic at the terminal node servicing in the stationary mode is equal to the incoming traffic. In this case, the time distribution function for both types of packets (speech and data) is exponential with the parameter of $\mu_1 = \mu_2 = \mu$. The discipline (algorithm) for servicing the packet stream is such that the first type of the stream has absolute priority over the second type of the stream. Packets that arrive within each priority are served in the order of the service algorithm used. During the receipt of the packet stream, when all V servicing devices (servers) have been busy, the first priority packets shall be interrupted and the second priority packets shall be serviced, taking into account its further return from the buffer memory (queue). If an incoming packet of the second priority is caught in the queue, it is to be queued on after the last packet of the first priority, and one packet of the second priority is to be lost. If other first-priority packets are already in the queue when the next first-priority packet arrives, it is to be lost as well, i.e. a limited service queue is allowed on each endpoint (fig. 1). With this in mind, in stationary mode the operations of terminal multiservice nodes in the NGN network, and the probabilistic states of nodes can be described by a system of linear homogeneous algebraic equations [3, p. 4].

$$\begin{aligned} &-[\lambda_1+\lambda_2]p_0=0 \\ &-[\lambda_1+\lambda_2+k\mu_J]p_K+[\lambda_1+\lambda_2]p_{K+1}+(k+1)\mu_j P_{K+1}=0 \quad 1\le K\le V \\ &-[\lambda_1+\lambda_2+V\mu_j]P_k+[\lambda_1+\lambda_2]p_{k-1}+V\mu_j P_{k+1}=0 \quad V\le k\le V+r-1 \end{aligned} \qquad (2)$$

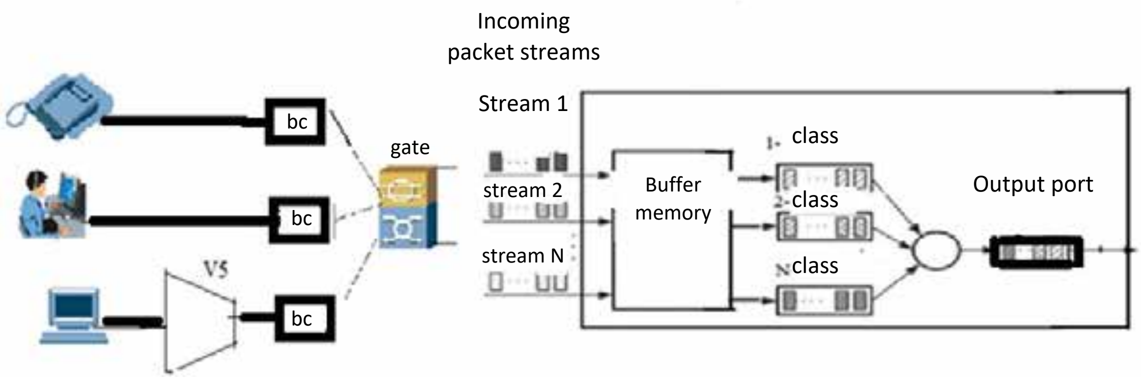

Fig. 1. Algorithm for serving the mixed packet queue in the buffer memory

Based on the system of algebraic equations (2), the probabilities of states of a classical multichannel system with a limited queue and absolute priority are determined. Using the normalization condition:

$$\sum_{k=0}^{v+1} P_{S+r} = 1$$

simultaneous equations (2) are solved in the form of (3) [6].

$$P_0 = \left(\sum_{V=0}^{s-1} \frac{Y^i}{i!} + \frac{Y^V}{V!} \sum_{i=1}^{V+r-1} S_i \right)^{-1} \quad (3)$$

For values of b_1=1, q=y/v, and n=r+1, using the formula for the sum of the terms of the decreasing geometric progression, we get:

$$\sum_{i}^{V+r-1} s_i = \frac{b_n - b_1}{q-1} = \frac{b_1 q - b_1}{q-1} = \frac{b_i(1-q^n)}{q-1} =$$

$$= \frac{1-q}{q-1} = \frac{1-\left(\frac{y}{V}\right)^n}{1-\frac{Y}{V}} = \frac{V}{V-Y}\left(1-\left(\frac{Y}{V}\right)^{r+1}\right) \quad (4)$$

where “r” is the number of waiting spaces (buffer memory duration) in buffer memory v- is the number of serving servers.

Here, $Y=Y_1+Y_2=(\lambda_1+\lambda_2)/\mu \quad (\rho_1+\rho_2)=\rho=y/v$ (5)

ρ is the bandwidth of the multiservice access node(server) of the NGN network.

Expression (5) specifies that using criteria $\rho\leq 1$, calculations can be made for the interval $\rho_1=0\div 1$ (ρ_2=const). Characteristics of the functioning quality of a multiservice terminal node (server) of the NGN network with a limited waiting queue and absolute priority are evaluated by such characteristics as the probability of failure to service a speech packet, the probability of failure to service servers, and others. Taking into account (5) the formulas (3) and (4), it can be rewritten as follows:

$$P_{V+r} = \frac{(\rho V)^{V+r}}{V!V^r} p_0 \qquad (1 \leq \rho \leq V) \quad (6)$$

$$P_0 = \left(\sum_{V=0}^{V-1} \frac{(\rho V)^i}{i!} + \frac{(\rho V)^V}{V!} \frac{1}{1-\rho}\left[1-\rho^{r+1}\right] \right)^{-1} \quad (7)$$

The average waiting time for a data packet to start processing (relative-second priority packets) is determined by the formula:

$$T = \rho V / (\lambda_1 + \lambda_2) \qquad T = L / B$$

$$T = \rho V (\lambda_1 + \lambda_2) = L / B \quad (8)$$

The probability that the server will be in a pending state (pending greater than zero packets) is calculated as follows:

$$P(\prec 0) = \frac{(\rho V)^V}{V!V(V\rho)}(1-\rho^{r+1}) \quad (9)$$

Based on the results of programming a family of characteristics, two of which are shown in fig. 2 and fig. 3 are obtained.

1. Taking into account the one-time multiservice nodes, the NGN network architecture is presented for review and for further calculation of analytical expressions.

2. An NGN network functioning under a system with a limited waiting time underthe condition V=3,

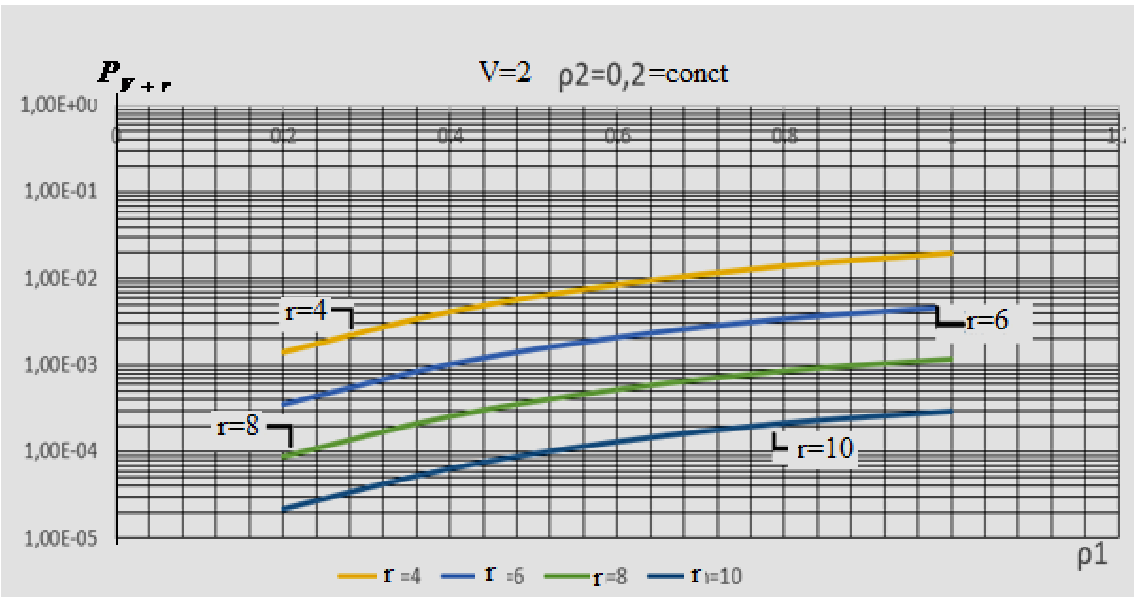

Fig. 2. Characteristics of quality of service ρ_1=0÷1 (λ=200 package, μ=125-4000)

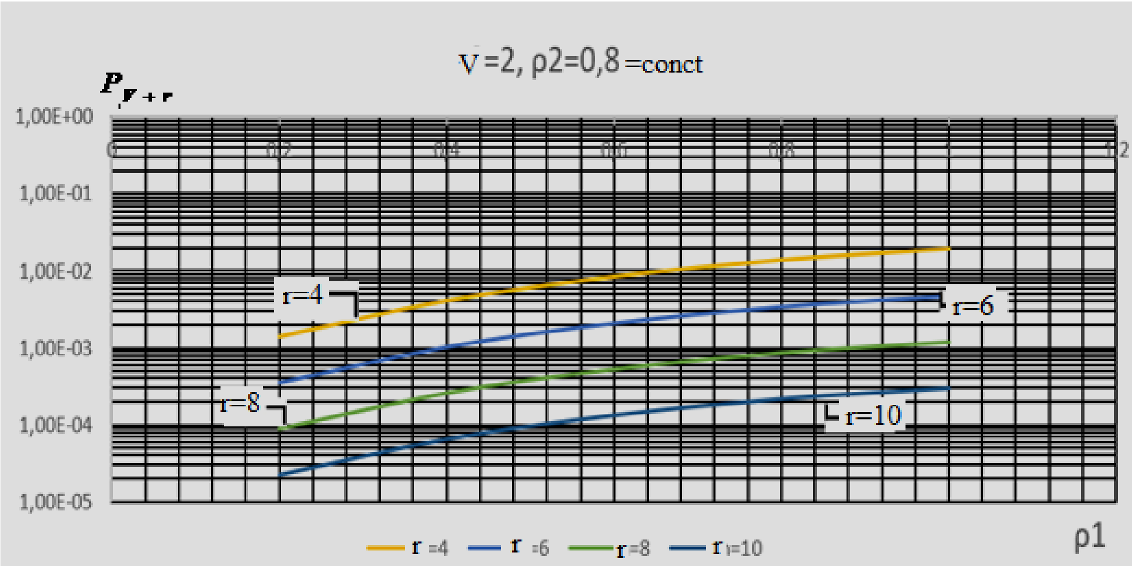

Fig. 3. Characteristics of quality of service ρ_1=0÷1 (λ=200 package, μ=125-4000)

r = 2; 4; 6; 8; 10 ρ_2=0.2 const, ρ_1=0÷1 analytical engineering expressions are proposed.

3. Based on newly defined analytic expressions for priority service methods and throughput characteristics of the quality service of terminal multiservice nodes (Numerous families of characteristics were obtained and two of them are presented in the proposed article.

Conclusions. To conclude, analytical relations that describe different States of the NGN network's multiservice nodes (servers) have been obtained. They allow calculating various performance characteristics, as well as bandwidth for priority packet servicing biased information flows. A method for calculating the quality of service characteristics of NGN network endpoints multiservice nodes (servers) that serve mixed packet streams with a limited queue and absolute priority has been proposed. The obtained analytical formulas and the method for calculating the terminal multiservice nodes (servers) with a limited waiting queue and absolute priority are more generalized. From these, in particular cases, analytical formulas are obtained for calculating characteristics when using two (V=2) communication servers with and without bandwidth priority ρ_1=0÷1, ρ_2=0,2=const, V=2; V=3 With the developed program, for example, two qualitative characteristics are proposed using the proposed formulas.

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Алієв Х.А. МЕТОД РОЗРАХУНКУ ХАРАКТЕРИСТИК ВУЗЛА ДОСТУПУ *NGN* ЗА ОБСЛУГОВУВАННЯ ПЕРЕДАЧІ ГОЛОСУ Й ДАНИХ

Вузли доступу мереж NGN забезпечують агрегування трафіку до різних мережевих служб і його передачу на транспортний рівень, що дає змогу викликати такі мережі мультисервісними. Ці мережі використовуються для одночасної передачі голосу, відео та даних, представлених із стандартних пакетів. Водночас мережеві послуги надають необмежений набір телекомунікаційних послуг із заданими характеристиками якості обслуговування. Обрана технологія розповсюдження інформації в СПП визначає ступінь складності вузлів доступу і, звичайно, впливає якість послуги обміну інформацією між користувацькими терміналами. Одним зі способів забезпечення заданого рівня якості обслуговування для кожної з послуг є запровадження пріоритетного обслуговування для певних потоків транспорту. Уведення пріоритетів для пакетів – це ефективний спосіб керувати розміром *черг і часом, проведеним у них. Коли приймається пакет із високим пріоритетом, пакет із нижчим пріоритетом або переривається (абсолютний пріоритет), або пакет із високим пріоритетом стає початком черги пакетів (відносний пріоритет). Вузли доступу NGN забезпечують агрегування трафіку до різних служб, спрямованих на комунальну телефонну мережу загального користування (PSTN), і його транспортування на більш високий рівень, що дає змогу називати такі мережі мультисервісними. Мережі нового покоління дають можливість водночас передавати змішані потоки (голос, відео та дані), представлені у вигляді стандартних пакетів. Одним зі способів забезпечення заданої якості послуги є запровадження пріоритетного методу обслуговування потоків транспорту. У роботі ми вивчаємо характеристики вузлів доступу NGN як двопріоритетної системи обслуговування з обмеженими очікуваннями. Запропоновано формули для розрахунку ймовірності втрати мовних пакетів, а також пакетів даних та інших характеристик вузла доступу.*

Ключові слова: *вузол доступу, потік даних, пріоритетний режим обслуговування, імовірність утрати, обмежене очікування.*