THE ALGORITHM OF THE METHOD OF CALCULATING THE QUALITY OF SERVICE ASYNCHRONOUS NETWORK

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Abstract

In this paper was considered a model for computing the statistical parameters of the quality of service of an asynchronous network. In many respects, the achievable level of the quality of the services provided is determined at the design stage of the network, when decisions are made regarding the subscriber capacity of stations, the capacity of the bundles of trunk channels, the composition and volume of telecommunications services provided. The current economic and political conditions created the creation of territorially distributed enterprises and structures, which necessitated the construction of corporate communication networks that provide high-quality and reliable communications to large departments, corporations and industries, for example, the central apparatus with regional enterprises or the connection of enterprises among themselves. The process of information exchange is actively stimulated by the expansion of the commercial activities of large companies. Thus, for today the problem of creation of corporate communication networks, having their principal differences from public networks is at the forefront.

Keywords : Broadband digital network with integration of services, multiservice traffic, asynchronous data transmission network, switching nodes, switches, asynchronous transfer mode.

I.   Introduction

At present, the dependence of the efficiency of the activities of large departments, corporations and manufacturing enterprises on the ability of the corporate communication network to satisfy all the needs for the transfer and delivery of information is clearly manifested. Constantly, the expansion of telecommunications services is required to provide up-to-date technologies for office management, management and automation of the production process, which causes the emergence of multiservice traffic (MT) and the creation of multi-service corporate networks. The expansion of the spectrum of telecommunications services and the requirements for a higher quality of information transfer required the transition from

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multiservice corporate networks that provide users with fixed bandwidth services (FBS), defined by the bandwidth limits of the link to 2.048 Mbps (narrowband), to broadband multiservice corporate communication networks that provide service users with both fixed and variable bandwidth of bit rates and parameters allocated bandwidth limits, starting at 155 Mbps and up to 2.4 Gbps [I,II].

The intensive development of information technologies and the growth of users' needs in various types of information put forward the problem of providing info communication services. As a result, corporate communication networks are moving to a new level - the integration of info communication and telecommunications services and become broadband integrated multi-service corporate communication networks (BIMSCCN). Currently, BIMSCCN are becoming more and more interesting due to the fact that they provide a number of strategic advantages, including protection of investments made in the existing network infrastructure, reduction of investment risk in the use of new technologies, acceleration of the promotion of new services to the market, increasing competitiveness of services.

The choice to transfer data of any type of a small cell of a fixed size does not yet solve the problem of combining heterogeneous traffic in one network, but only creates the prerequisites for its solution. To fully solve this problem, the technology of asynchronous transfer mode (ATM) attracts and develops ideas for ordering bandwidth, and quality of service, implemented in frame relay technology [III]. But if the frame relay network was originally designed to transmit only pulsed computer traffic (so it's so difficult to standardize voice transmission for frame relay networks), ATM technology designers analyzed all kinds of traffic patterns created by different applications and allocated 4 main traffic classes, for which various mechanisms of reservation and maintenance of the required quality of service were developed. The traffic class (also called the service class) qualitatively characterizes the required services for data transmission through the ATM network.

ATM technology provides network operators with unique opportunities to ensure high flexibility and adaptability of the network to changing the level of user requirements for quality of service, and the emergence of new services whose requirements for semantic and temporal transparency of the network are not yet clearly defined. Increases the efficiency of the use of network resources, as well as reduces the costs of design, construction and operation of the network, and the development of network equipment, as it creates and operates one network instead of a set of secondary networks.

The flexibility of the technology is confirmed by the fact that ATM, conceived initially as a self-sufficient, in a short time adapted to a wide range of transport access technologies, ATM interfaces support a significant amount of data link service with various non-ATM protocols (Frame Relay, X.25, xDSL), as well as the traffic of IP, IPX protocols within a single infrastructure [IV].

ATM technology is most effective when moving from TDM-networks to packet multiservice networks, and it makes it possible to optimally implement universal transport nodes at the points of transition from corporate networks to the level of public networks and at points of association of several public networks.

The main advantage of ATM is the consistent implementation of the method of asynchronous-address transmission and switching system, which allows to combine different types of traffic into a single stream and thereby ensure high efficiency of using the channel capacity [V]. At the same time, ATM management systems have been developed - a system of measures to reduce those deficiencies that are inherent in statistical multiplexing.

Communication operators need to build their own (corporate) information network to unite their branches and divisions and to improve the quality and quantity of services provided. When building its own corporate network, the operator solves the following tasks [VI]:

- consolidation of branches and units into a single network with centralized management;

    - ensuring the operability of a unified system of settlements with customers for communication services;

- support for unified documentation, documentary turnover and technical management of networks;

- connection of telecommunication offices to the Internet;

- rendering services to other organizations and rendering services to subscribers.

II. Materials and Methods

Consider a broadband digital network with service integration, based on ATM technology with three kinds of basic structure, in which a hybrid switching method is implemented, consisting of hybrid switching nodes (HSMs) and integral group paths (IGP) connecting them. Each such node is equipped with a special switching and channeling equipment, the degree of integration of which offers the possibility of access to it by subscribers for the transmission of heterogeneous information, voice information, data transmission, video images, videoconferencing materials, etc.

The network for a small telecommunications operator includes the structure of a network of one organization with separate corps. The core of the network is the central node (CN) and hybrid switching nodes of the GSNs, which are connected through an ATM cloud.

To provide subscribers with access services to the network, routers are installed. Routers must support RIP and OSPF protocols, and the Router must still support BGP's external routing protocol [VII].

It includes city and regional networks. Approximate network capacity of up to 200 thousand numbers. There is one CN and 6-7 HSNs. There are free resources in the form of several (two or three) digital streams E1, as well as in the form of optical fibers. As a reference network, fiber-optic communication (dark fiber, that is, without SDH) with STM1 or STM-4 bandwidth is used. The reference network has a ring topology. The topology "ring" has high fault tolerance. It is assumed that within the city all subscribers can access the physical line using xDSL technology. The ATM backbone network provides connection of X.25 and Frame Relay subscriber networks. In the central and additional nodes, in addition to the ATM switch, an

access server is installed on the PM channels and an access concentrator via xDSL channels [VIII, IX]. To provide access to the Internet in the central and some additional nodes are installed routers. The Router supports the BGP protocol in addition to the RIP and OSPF protocols.

It includes the city and regional network. Approximate capacity of more than 300 thousand numbers. The basis of the network is CN and 12 HSNs. The networks of a large telecommunications operator are similar to the networks of an average telecom operator.

Next, we estimate the data transfer characteristic for an asynchronous network, i.e. consider the distribution of the load and the quality of service of such a network in a mathematical model.

III. Results

Let the topological structure of an asynchronous network be represented by an undirected graph $G=\{V; l\}$, where $V-$ is the set of nodes of the network, $l-$ the set of branches corresponding to integral group paths, and $n-$ the number of nodes of V. In the model described, the asynchronous network is treated as a queuing system with obvious losses [8]. The quality of service on such a network is usually estimated by the values of the elements of some set $P=\{p_{ik}\}$, where the element $p_{ik}-$ is the probability of load loss on the branch $(ik)\square l$ (i, $k-$ neighboring nodes). Since the asynchronous network is represented as a maintenance system with obvious losses, then for all $(ik)\square l$ the value p_{ik} takes values In the interval (0;1]. If $(ik)\square l$, то $p_{ik}=0$.

When distributing the load between a pair of nodes along the branches of the path tree, the direct destination path is first chosen, if the forward path is busy, the input load is routed one of the outgoing directions of the workaround [IX, X].

We introduce the following notation

$$h_{ik}(j) = \varphi_{ik}(j)_{[1-p_{ik}(j)]} \forall i, k, j \square V, \tag{1}$$

Where $h_{ik}(j) \square [0;1) -$ is the characteristic of the load passed by (ik) the branch $t_i(j)$. A function $h_{ik}(j)$ is a conditional probability of passing a load $t_i(j)$ through a branch (ik), if it is occupied by servicing all previous branches of that direction. In what follows $h_{ik}(j)$ we will call the probability of servicing the load $t_i(j)$ by the branch (ik), and the value of $h_{ik}(j)$. is the load passed by the branch (ik).

The location of transit nodes at each node of the tree is carried out using the following formula

$$t_i^u(k,j) = t_l^u(i,j) \cdot h_{li}(j), \tag{2}$$

Where $(li) \in L^u(j)$, $i,j,k,l \in V^u(j)$.

Thus, for any nodes $i \square V^u(j) (i \neq u)$ and for all nodes $k_m \square K^u(j)$, $m = 1, 2, \ldots s$, we can have as following

$$t_i^u(k_1,j) = t_i^u(k_2,j) = \ldots = t_s^u(k_1,j) = r_i^u(j), \tag{3}$$

Where $r_i^u(j)$ - input load arriving at the node i, and assigned to the node j, s – number of outgoing directions from the node i. The input load $r_i^u(j)$ for any node i distributed over all outgoing directions $(ik) \in L^u(j)$, and also $g_{ik}^u(j)$ - the average address load intensity j, passed by the branch $(ik) \in L^u(j)$.

The distribution of the input load $r_i^u(j)$ along the path tree $G^u(j)$ defines the formula

$$g_{ik}^u(j) = t_i^u(k,j) \, h_{ik}(j). \tag{4}$$

Denote by $g_{ik}(j)$ - he total load missed by the branch $(ik) \in L$. The determination of this load for each branch is made by successively accumulating on it all the missed loads of each path tree, i.e.

$$g_{ik}(j) = \sum_u g_{ik}^u(j). \tag{5}$$

The node load $t_i(k,j)$ n this case is represented as a set of transit loads on the node i from all path trees, i.e.

$$t_i(k,j) = \sum_u t^u(k,i). \tag{6}$$

If there are $k \ \square \ K_i^u(j)$ outgoing from the node i directions in the path tree $G^u(j)$, the probability of servicing the input load is determined by the formula

$$1 - P_i^u(j) = \sum_{k \in K_i^u(j)} h_{ik}(j)[1 - P_k^u(j)].$$

(7)

Here $P_i^u(j)$ – the current probability of loss of the input load $r_i^u(j)$ throughout the path tree $G^u(j)$ from the source node i to the destination node j.

Note that for all branches (ik) the inequality $P_i^u(j) >_{} P_k^u(j)$ is satisfied. In fact, since cyclic routes are excluded between each pair of nodes i and j the cyclic routes are excluded and the node i for this address is the root node of the path tree G^u, then each path from node i to j, passing through a node k, differs from all paths between a pair of nodes k, j only on a branch (ik). In this case loses $P_i^u(j)$ will be proportionally reduced by the amount of branch loss (ik) and thereby $P_i^u(j) >_{} P_k^u(j)$.

Consider a broadband digital network with service integration based on ATM technology with three kinds of basic structure, which implements a hybrid switching method consisting of hybrid switching nodes (HSM) and integrated group paths (IGP) connecting them. Each such node is equipped with special switching and Sewerage equipment, the degree of integration of which provides access to subscribers for the transmission of heterogeneous information, voice information, data transmission, video images, video conferencing materials, etc.

We show the implementation of the algorithm on a specific numerical example. Building a path tree on route matrices. Let be given the network shown in Fig. 1, and the route matrices for each node [XI].
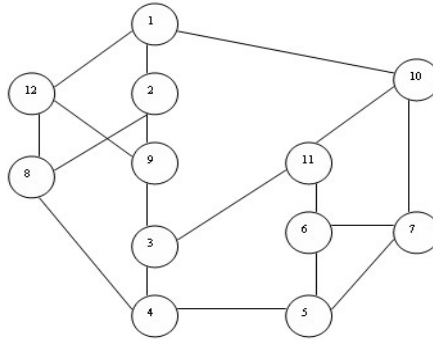
Figure 1. - Transmission network

The rows of the route matrix correspond to the outbound destination numbers in the order they are selected, and the columns correspond to the destination node numbers.

The matrix element is the m_{ijj} -number of the neighboring node in the i-th bypass direction to the j-th node. We construct a path tree for a pair of nodes (1,2), assuming that the length of each path does not exceed four transit sections. To create a tree we define the corresponding columns of the route matrices from the initial and transit nodes:

$$M_1 = \begin{array}{c} l_1 \\ l_2 \\ L_3 \end{array} \begin{bmatrix} 1\ 2...\ \ 12 \\ 2.......... \\ 12......... \\ 10........... \end{bmatrix}$$

From the matrix M_i we define branches 1 and 2 of the tree, ending respectively with nodes 2 and 12 (figure 2).
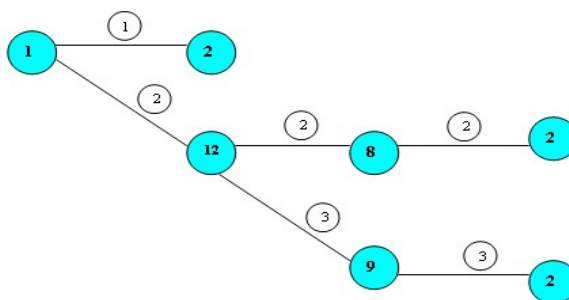

Figure 2-path Tree between pairs of nodes (1,2)

On the picture of the unpainted circles designate the numbers of IGT. The bandwidth and number of channels for each path is $C_j = 10$, $N_j = 50$. Time of service of one call of a network of KK is equal $1/C_j v_j = 60$ sec.

The direction through node 10 is not selected because the path through this node to node 2 exceeds four transit sections (see figure 1). At node 12, the procedure repeats and nodes 8 and 9 are selected, and so on.

IV. Discussions

In conclusion, we note the following. Certainly, the solution of the problem of providing the required quality of service in IP networks can be achieved directly, by providing guaranteed bandwidth, improving the performance of network devices-routers and gateways, using high-capacity highways.

However, the most appropriate approach seems to be the use of flexible methods that provide the required quality of service metrics while effectively using network resources for a wide range of different applications, including the most critical audio and video real-time applications. These include, first of all, such as, for example, the need to exchange additional information about the load conditions of subnets of circuit switching and packet switching for each switching node with the central control node, which leads to significant overloads of the asynchronous network and the central control node; blocking the central control node or its failure, and this is due to loss of coordination of management, etc.

V. Conclusion

The value obtained as a result of this algorithm corresponds to estimates, which confirms the correctness of the calculations.
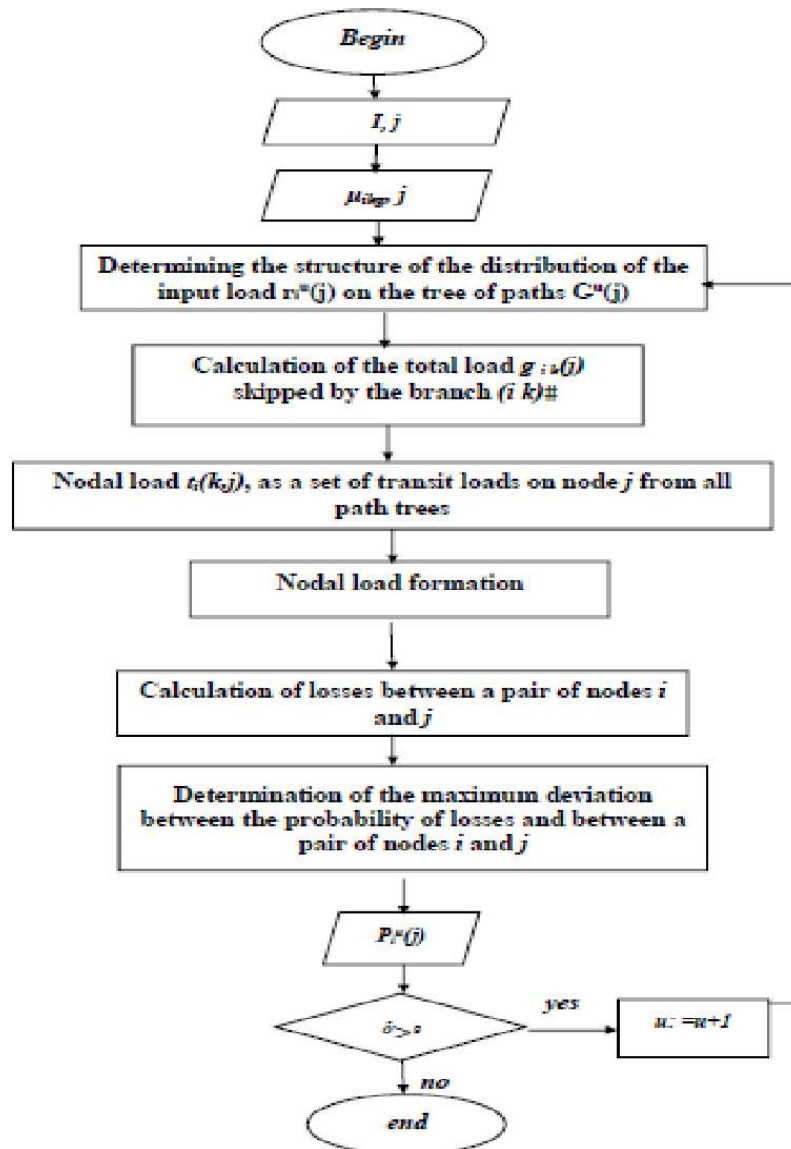
Figure 3 - Block - algorithm diagram

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