

Mathematical model of service quality performance's computing of multiservice network

Tulemisova Gulfarida, International academy of business, Almaty, Kazakhstan

Abstract *This article devoted to effectiveness of multiservice networks' functioning in order to provide the quality of these networks. Problem of the probability-time characteristics (PTC) of the network's calculation represents the designers of most interest. Solution of this problem gives you opportunity to: significantly improve network performance, prevent network failures during overload traffic information, to determine the optimal direction of bypass traffic; calculate the optimum quality of service parameters of integrated network. Development of technologies for network management is closely linked to the mathematical modeling of processes and network management elements. For ISDN simulation to determine its threshold or actually parameters of the network, with which it becomes necessary to achieve a particular effect on the control network elements. The article presents the mathematical model calculations PTC, a new method for the formation of nodal load subnet switching channels, a system of equations with respect to the probability of nodal load losses communication channels, obtained a new method for calculating call blocking probabilities between each pair of nodes, we have proved the dependence of these probabilities of blocking probabilities losses for all outgoing directions from the initial node, obtained by the method of calculating the flow channel.*

Keywords: multi-service networks (MSN), mathematical model of probabilistic-time characteristics, methods of hybrid and adaptive switching, adaptive routing, detours traffic, inter-zone connection graph.

1. Introduction

Today, the popularity of the Internet is so vast that the technical capabilities of the World Network do not have time to provide full growing with each passing day the flow of information. Therefore, the task of the qualitative approach to networking is reduced to the task of selecting the topological structure of the network, determining the optimal number of nodes and links of the network to the calculation of its capacity, finding the shortest-path load transfer calculation probability-time characteristics of the network, etc. In the process of analysis and synthesis of networks, the problem of calculating its probability-time characteristics for designers is of greatest interest as a solution to this problem, you can: significantly improve network performance, prevent network failures during overload traffic information, to determine the optimal direction of

bypass traffic; calculate the optimal parameters integrated network quality of service.

In multiservice networks delivery of video and voice must be carried out in real time with the need to prioritize in the case of transport network congestion. However, the network industry never focused on real-time network, data delivered in accordance with the capabilities of the network in a specific period of time [1]. An important function of the ISDN is the establishment of bandwidth on demand. Radical extension of bandwidth local area network problems can be solved with QoS, but from an economic point of view in the regional network is not feasible. Therefore, the regional communications network designed to meet the optimization of resource usage for a particular type of traffic. When designing and building a network is widely used technology, which regulates the distribution of costs of various services, provided by the network to transmit information. In such networks in the first place there is the concept of quality of service networks[2].

2. Qualitative problems of multi-service networks.

Quality of Service technology provides the platform necessary for advanced applications, having much more stringent requirements for the width of the provided bandwidth and delay the passage of information in the network. Newer technologies providing quality service depended primarily on various implementations queuing algorithms, which include algorithms "first in - first out" priority queue, fair queue, etc. These algorithms are used by routers and other network devices. But it was impossible to control the continuous flow of traffic. The technology is able to provide the quality of service traffic distribution by category to allow the passage of higher-priority traffic on the network with software settings and regardless of competition from other traffic. Determining when the use of technology is the quality of service is to provide protection for the most priority traffic from various "attacks" by the lower priority traffic, and not just "to use the media on a network".

3. The problem of finding probability-time characteristics of service quality ISDN

This article discusses finding the following statistical parameters:

1) Capacity of branches (bandwidth) subnets and manual CC composed ISDN;

2) The magnitude and nature of the load coming on each hybrid switching node in CC and manual modes and the total load is determined by each group path integral ISDN;

3) The probability of losses in the branches and between each pair of nodes subnet spacecraft, as well as the distribution of these losses on transit routes and nodes in the network, the value of the average delay in the transmission of messages composed subnet CP ISDN.

All of the above statistical parameters during operation ISDN, usually not constant, and changing them is often impossible to predict. So load change and gravity between switching nodes called the commissioning of new units, as well as other factors. In this regard, the modern communications systems a lot of attention paid to the choice of such an algorithm in customer service ISDN, which would take into account the emerging changes in the situation on the network and ensure conservation in a changing set point generalized criterion of quality of service.

4. Method of assessment service quality in subnet CS

This section presents the mathematical model for calculating the parameters of quality of service multiservice network[4]. It uses traffic types multiservice networks using the concept of load transfer detours.

In determining the parameters of quality of service on the subnet QC made the following assumptions:

- 1) Initial call flows are Poisson;
- 2) Poisson character is stored as streams for redundant and missing for loads;
- 3) The system is in a state of statistical equilibrium;
- 4) System with obvious losses;
- 5) Does not take into account losses in the switching and control devices;
- 6) Setup time is zero.

Baseline data to determine the parameters of quality of service are:

- 1) Structure (location and capacity of the branches);
- 2) input load for service in BH between the nodes of each pair of nodes;
- 3) a plan for flows on the network.
4. Probability of losses on branches

In summary, you can get a number of QoS parameters, which were obtained:

- 1) The magnitude of the total load on each branch;
- 2) The probability of losses in the branches;
- 3) The probability of losses between the nodes of each pair of nodes (the ratio of lost load to received);
- 4) The probability of losses in the middle on the network (the ratio of load lost on the network, received a service);
- 5) The value of the loads served and lost in each transit node on the network as a whole.

The main parameter here is the probability of losses in the branches, and other parameters can be easily calculated through these values. Calculation of the loss probabilities on the branches in networks with circuitous

directions complicated by the fact that the probability of losses in each branch in general depends on the loss probabilities for all other branches.

Score predicted bandwidth and quality of service is a very important stage of designing multiservice networks. Choosing an appropriate traffic model defined selection criteria that use the following parameters:

- Models Incoming calls
- A call blocking,
- Number of sources
- Hold Time.

These developments in the Erlang model is used for trunk groups without repeated calls since callers are redirected or expected low blocking factor. Calculation formula in Erlang traffic models

$$B(c, a) = \frac{\frac{a^c}{c!}}{\sum_{k=0}^c \frac{a^k}{k!}} \quad (1)$$

Let's reform it for more comfortable usage:

$$P(A; v) = \frac{A^v}{v! \sum_{j=0}^v \frac{A^j}{j!}} \quad (2)$$

This recurrence relation formula Erlang loss probability calculation and presentation of this formula in integral form. Give proofs of Lemmas, theorems, corollaries. And the formula (1) is transformed into formula (3), (4) and (5).

$$P(A, v) = \frac{A^v}{\sum_{s=0}^v \frac{d^s(A^v)}{dA^s}} \quad (3)$$

$$P(A, v+1) = \frac{1}{1 + \frac{v+1}{AP(A, v)}} \quad (4)$$

$$P(A, v) = \frac{A^v e^{-A}}{\int_A^{\infty} e^{-y} y^v dy} \quad (5)$$

These equivalent formulas much easier to calculate the probabilities of blocking subscriber messages[3].

4.1 Search for missing and excess burden

The magnitude of missing or excess burden depends on the probability of loss $t_i(j)$ of traffic distributed to

the branch (ik) .

Distribution of the input load for all subsequent branches of the tree is based on the probability of service, calculated on all the previous branches of the tree paths.

In turn, missed branch load $(mn) \in L^u(j)$ is simultaneously input to the load node \dot{i} .

Finding transit loads at each node of the tree is performed using the following formula:

$$t_i^u(k_1, j) = t_i^u(k_2, j) = \dots = t_i^u(k_n, j) = r_i^u(j) \quad (6)$$

Where $r_i^u(j)$ - input load \dot{i} coming to the site j and designed a node S - the node number of outbound directions. Note that in this case, the input load and stopovers are not fundamentally different from each other. In other words, the transit load input to the process to exclude the cyclic transfer paths. Input burden $r_i^u(j)$ for any node \dot{i} is distributed over all outgoing directions $(ik) \in L^u(j)$ from it. Above all, since any node in the tree paths, except the first, is included only one branch, then this node, regardless of the choice of outgoing directions there from, the values of transit loads are the same.

In accordance with the criterion of optimality for each branch, a member of one or the other route is determined by some of its weight (cost). The route with the minimum or the maximum weight which is a linear sum of the weights of the branches is optimal according to this criterion, or shortest route. If there are no available machines or free any one branch of the route - the path is considered locked. If all routes set ik blocked, the load is $t_i(j)$ a denial of service. When introduced assumptions subnet circuit switching (CS) is a Markov system with a finite - dimensional phase space E, which state changes occur at discrete points in time corresponding to the time of receipt message to the subnet CS. We assume that the network management $U = \{U_d, d = 0, 1, 2, \dots\}$ markov type, then operation of the network can be represented as a controlled markov type process.

4.2 Workarounds direction of load transfer subnet CS

For more efficient use of time channels tract modern automatic switching system located on the nodes, in addition to allow the main ways of communication (the way the first choice) to use workarounds (path next election). For clarity, the above-described use of bypass areas of load transfer CS subnet network is illustrated by the fragment consisting of the i -th switching node and out of t_i to neighboring nodes k_1, k_2, k_3 directions load transfer t_i (Figure 1).

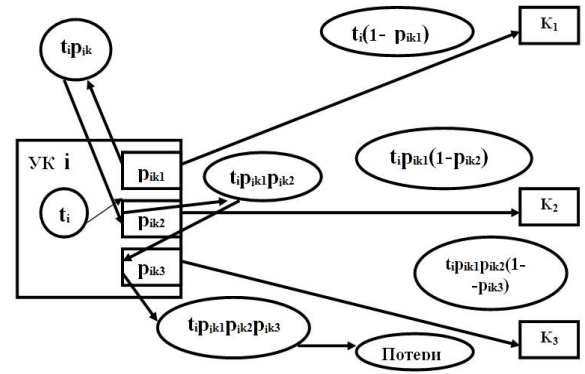


Figure 1 - Using detours transmission nodal load

Ordering of the elements of the set $K_i(j)$ is made in accordance with the choice of node j outgoing direction priority routes in the matrix M_i . Order given by a matrix of load distribution routes:

$$M_i = \begin{matrix} & j & \\ \begin{matrix} (ik_1) \\ (ik_2) \\ (ik_3) \\ (ik_4) \end{matrix} & \begin{bmatrix} \dots & 3 & \dots \\ \dots & 4 & \dots \\ \dots & 1 & \dots \\ \dots & 2 & \dots \end{bmatrix} & \end{matrix}$$

In accordance with the elements of this matrix is primarily used branch path of first choice (ik_3) . When it is formed overload excess flow, which is served by a sequence of branches $(ik_4), (ik_1)$ and (ik_2) . Then the set $K_i(j) = \{k_3, k_4, k_1, k_2\}$ [5].

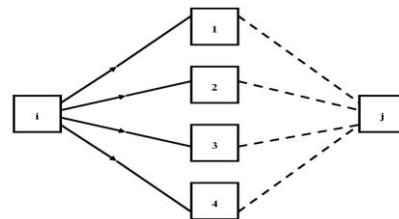


Figure 2 - Count four intermediate network nodes.

Probability of employment service areas (i, \bar{k}) is calculated by the formula

$$\varphi_{ik}(j) = \varphi_{i\bar{k}}(j) p_{i\bar{k}}(j) = \prod_{\bar{k} \in \bar{K}_i(j)} p_{i\bar{k}}(j) \quad (7)$$

Multiplication $\varphi_{i\bar{k}}(j) * p_{i\bar{k}}(j)$ is the share of the excess burden on the branch (ik) .

Probability of losses $\Pi_i(j)$ with load $t_i(j)$ in node j equals to

$$n_i(j) = \prod_{i=1}^s p_{ik}(j), \quad n_i(j) \in (0;1). \quad (8)$$

When calculating the total load (input at each branch, missed each branch and redundant for this branch) we restrict ourselves to only finding missing branch total load. In turn, through the values $p_{ik}(j)$ can easily determine the total load how each incoming branch and excessive for it.

To select a method for assessing the quality of service on the subnet spacecraft use highly complex adaptive systems, network management, information flows and processes call service, subscribers to share the information. Management system, finding quality deterioration characteristics of various channels, rearranges the order of channels so that these channels will be engaged in the last turn. Likewise was built adaptive control system, which allows reducing any likelihood of loss of calls, the delay time to connect. Quality of service requests for the transfer of information communication system depends on a number of parameters, the main of which usually include: the amount of information to be transmitted, the bandwidth network structural reliability and network survivability, etc.

In fact, as between each pair of nodes i and j are excluded cyclic routes, any node i for a given address is the upstream node relative to k . This means that every path from node i to j , passing through the node k , differs from all the paths between two nodes, k, j branch only (ik). In that case losses $P_i(j)$ will be proportionally decreased on amount of branch losses (ik), it means $P_i(j) > P_k(j)$. Bandwidth $t_i(j) * P_i(j)$ represents the excess load, and the value g_{ij} - missed load throughout the paths between nodes i and j . To describe the decentralized algorithms for calculating the main characteristics of data networks using circuitous directions formalized method of optimal allocation of channel resources multiservice network.

4.3 Zonal principle hierarchical addressing and routing

Hierarchical routing algorithm information flow based on the application of the principle of zonal hierarchical addressing and routing. When using a hierarchical addressing zonal address of any node may be represented as a vector

$$A_i = (A_{i1}^1, \dots, A_{i, l-1}^1, A_{ii}^1) \quad (9)$$

Where l - the number of levels of the hierarchical address,

A_{ik}^j - the node address in the area of j -th level.

When designing hierarchical routing algorithm has adopted the following assumptions:

1) The traffic between the MC levels in a single zone at any level using only the internal path of this zone;

2) The traffic between different zones CC k -th level ($k = l, m - l$) but belonging to the same zone $(k + 1)$ -th level, is sent to the central zone to the CC level, then the path zone $(k + 1)$ -th level to the Criminal Code, which is the central area in the k -th level, in which the recipient node, and further along the paths zone k -level node to the recipient;

3) May allow a direct link between adjacent CC adjacent zones at any level.

Task decomposition network into zones regarded as a goal graph partition

$$G^l = (X_i^1, Y_i^1) \quad X_i^1 \subseteq X^l, \quad Y_i^1 \subseteq Y^l, \quad (10)$$

$$i \in I^l = \{1, 2, \dots, l_l\},$$

Where, I^l - number of pieces into which the graph (number of zones l -level).

Partition graph G^l can be defined by analogy with the partition sets. Collection of pieces of $P(G^l)$ is called a partition of the graph $G^l = (X^l, Y^l)$,

$$\forall G_i^1 \in P(G^l) [G_i^1 \neq \emptyset], \quad i \in I;$$

$$\forall G_i^1 \in P(G^l) [G_i^1 \neq G_j^1] \Rightarrow X_i^1 \cap X_j^1 = \emptyset \& Y_i^1 \cap Y_j^1 = \emptyset$$

$$= \emptyset \vee Y_i \cap Y_j = [Y_{ij}], \quad \bigcup_i G_i = G. \quad (11)$$

In other words, the set pieces of $P(G^l) = \{G_i^1, \dots,$

$G_{l_1}^1\}$ is a partition of the graph G^l , if any piece of this

set is not empty, if for any two pieces of $P(G^l)$ the intersection of the set of vertices is empty and the intersection of the set of edges may not be empty, and if the union of all the pieces is exactly equal to the graph G^l .

The expression (11) defines a subset Y_{ij} of the set of edges $Y_{ij} \subseteq Y^l$, falling in between the pieces and cut the graph G_i^1 and G_j^1 , or in terms of hierarchical addressing, set Y_{ij} defines a set of direct links between zones G_i^1 and G_j^1 .

Each of the pieces $G_i^1, \dots, G_{l_1}^1$, you must select the

set of vertices corresponding to

$$X_i^{1,u} \subseteq X_i^1; X_i^{1,u} \subseteq S^2 \quad (12)$$

where the value of S^2 is determined by requirements to network connectivity. (When $S^2=1$ there is only one way out of the zone in the Criminal 1 other areas of the 1-st level, when $S^2=2$ - two paths, etc.) Next, we form a graph subnet level 2:

$$G_{1,u}^2 = (X^2, Y^2), \quad (13)$$

$$\text{where } X^2 = \bigcup_i X_i^{1,u}, Y^2 = \bigcup_i Y_i^{1,u}.$$

Isolation sets $X_{i,u}^1, \dots, X_{i,u}^i$ should be based on the requirements of the connected subnet level 2. Graph G^2 need break apart $G_i^2 = (X_i^2, Y_i^2)$, $i \in I^2 = \{1, 2, \dots, l_2\}$ and so on up until the next partition to $|I^k| = 1$. Thus, the resulting partitions \mathbf{m} obtain the following relation, specifies the identity of nodes and edges system-oriented graph (SOG) zones of different levels:

$$\{(X_1^1, Y_1^1), \dots, (X_{l_1}^1, Y_{l_1}^1), (X_1^2, Y_1^2), \dots, (X^m, Y^m)\} \quad (14)$$

$$\text{Let's call } K_{ij}^s = \sum r_{pq}^s, \forall (p,q) \in Y_{ij}^s \quad (15)$$

Thus, K_{ij}^s equal to the total length of all the pieces and the connecting edge G_i^s and G_j^s of the graph G^s . The connecting edges of all the pieces of the graph on the SIO s-m level

$$K^s = \frac{1}{2} \sum_{i=1}^{l_s} \sum_{j=1}^{l_s} k_{ij} \quad (16)$$

Total length of all edges of multilevel partitioning

$$K = \sum_{s=1}^m K^s \quad (17)$$

Total length of all edges of multilevel partitioning object of m -level partition graph $G^l = (X^l, Y^l)$ is to find a set of pieces, the total length of the connecting ribs at all levels meet the specified criteria $K \rightarrow \min$.

Let S level graph G^s broken into pieces $G_1^s, \dots,$

$G_{l_s}^s$. In accordance with this partition the set of edges Y^s of the graph G^s can be written as

$$Y^s = \bigcup_{i=1}^{l_s} Y_i^s \quad (18)$$

Then each subset Y_i^s represented as follows:

$$Y_i^s = Y_{i1}^s \cup Y_{i2}^s \cup \dots \cup Y_{ii}^s \cup Y_{il_s}^s, \quad (19)$$

Where Y_i^s - a subset of all the edges X_i^s incident to vertices piece G_i^s ; Y_{ii}^s - a subset of edges X_i^s connecting vertices subset piece G_i^s together; Y_{ij}^s - a subset of edges connecting pieces G_i and G_j

We call the ratio of the total length of the inner ribs (ribs subsets Y_{ii}^s) to the total length of connecting ribs (ribs subsets Y_{ij}^s) of the partition coefficient $\Delta(G^s)$ graph G^s :

$$\Delta(G^s) = \sum_{i=1}^{l_s} r_{ii}^s / K^s \quad (20)$$

Multilevel partition coefficient is defined as

$$\Delta(G^s) = \sum_{s=1}^m \sum_{i=1}^{l_s} r_{ii}^s / K^s. \quad (21)$$

This coefficient, as well as the value of K may serve as criterion for evaluating the tiered partition graph. The task refers to the problem of combinatorial and logical type, obtaining an optimal solution which is associated with a lot trying different partition. In order to simplify and reduce the result of the number of options offered to solve the problem using the own algorithm. In this case, each of the $(m - 1)$ steps necessary to solve the problem of partitioning the graph in a traditional setting. However, in this case the number of choices at each level of the partition is large enough. So, for a graph $G = (X, Y)$, $|X| = n$ when splitting into pieces G_1, \dots, G_l the same dimension $n_1 = \dots = n_l = p$ the number of options

$$N = \frac{1}{l!} C_n^p C_{n-p}^p \dots C_p^p = \frac{n!}{l!(p!)^l} \quad (22)$$

Even for $n = 9, l = 3, p = 3$, we get $N = 1680$.

Solve this problem by sorting options are not possible, so it is necessary to use heuristic algorithms.

Let us now determine the size of the zone issues, the choice of metric for determining the length of the edges of the central node and select zones SOG. In this case, since we are considering the problem of separating the control zones SOG on a topological level, we use the results obtained for symmetric networks and symmetric networks with centralization. Selecting an algorithm adaptive routing control within the zone should be based on the coefficient of centralization zone $k_u = N_c / (N - 1)$, where N_c - number of commutation point (CP), related to the central node; N - total number of nodes in the system. The maximum allowable size of the area should be determined by the selected method of adaptive routing. Average packet transfer delay time in the manual mode can be represented as a sum

4.4 Determining the size of the zone

The very choice of adaptive routing control algorithm inside the zone should be based on the coefficient of centralization zone $k_u = N_c / (N - 1)$, where N_c - number of the authorized capital, adjacent to the central node; N - total number of nodes in the system. The maximum allowable size of the zone should be determined by the selected method of adaptive routing. Average packet transfer delay time in the manual mode can be represented as a sum of

$$T_a = T_0 + T_c \quad (23)$$

Where T_0 - packet delay time at a fixed routing;

T_c - additional packet delay time, depending on the service traffic.

Given that T_c increases with the size of the zone, it is advisable to ask a certain threshold value and determine the size of the zone based on the relative N_3 : $N_3 \rightarrow \infty$

$$T_c \leq \delta. \quad (24)$$

Moreover, since it depends on the choice of control method, the value will depend on the $N_3 k_u$

$$N_3 = \begin{cases} N_u & k_u \leq k_u^{(2)}; \\ N_\partial & k_u > k_u^{(2)}, \end{cases} \quad (25)$$

Where $k_u^{(2)}$ - the boundary value of the coefficient of centralization, defined for a given network parameters and δ . Depending on the boundary values of the coefficient of centralization selected centralized or decentralized area.

Also adaptive routing algorithms in digital networks should be implemented algorithms for adaptive control constraint intensity of information flows. The control algorithm is a single set of procedures that control routing and volume (intensity) of the incoming streams of information. Management information exchange can be reduced only to the procedure of flow distribution

(routing) in a relatively small traffic, ie, at low intensities in the network flow information.

4.5 Algorithm limits the intensity of flows

In accordance with the decision of the above task and the bandwidth allocation by circuitous paths ISDN load transfer mode commutation point (CP) algorithm restrictions flux intensity can be written as follows:

Step 1. Data Entry: class with multi-channel call (MCC)c, tract integral group(TIG)k;

Step 2. Class definition with(MCC)c,

Step 3. Select (TIG)k according to the routing matrix;

Step 4. If the number of (MCC)c in buffer (TIG)k

$l_k^{(c)}$ less than the threshold $l_k^{(c)} < L_k^{(c)}$, then taken to load the information service, i.e. secured her an appropriate buffer. If the condition is $l_k^{(c)} < L_k^{(c)}$, not satisfied, then the load is a denial of service.

This algorithm to determine the flow of information (ADFI) quite simple to implement, but in certain conditions of ISDN, such as a rapid build-up of the load intensity of the upper classes in the commutation point, the restrictions imposed by them, may not be enough.

In order to more quickly and effectively limit the flux intensity in ISDN considers a more complicated algorithm IPR with the exchange of information overload between adjacent CC. The basic idea of the ADFI is that when the number of its own MCC buffer k -th TIG i -th CC threshold all neighboring j -th Commutation point relating to the channel switching (CS) transmitted message about blocking i -th CS. After that, the j -th CS own MCC who were to be sent to the j -th CS are blocked (or forwarded to the workaround). With decreasing values below the threshold all the j -th CS messages are sent to withdraw i -th block of the commutation point[6]

ADFI consists of two parts. Upon admission to the unit CC, follow these steps:

Step 1. Data Entry: class with MCC, TIG k;

Step 2. Class definition with MCC;

Step 3. Select TIG k in accordance with the matrices routes,

Step 4. If the number of MCC in buffer TIG k does not exceed the threshold of $l_k^{(c)} < L_k^{(c)}$, then go to step 6, otherwise - go to step 9.

Step 5. If $l_k^{(1)} < L_k^{(1)}$ and TIG is not blocked, go to step 6, otherwise - go to step 9.

Step 6. Take a load to the service.

Step 7 Enlarge counter MCC in buffer TIG k per unit : $l_k^{(c)} < L_k^{(c)} + 1$,

Step 8. If TIG k blocked, then finish; if not, send a message about blocking the i -th CC and finish.

Step 9. Block CS and finish.

By, the end of service in the i -th CC, CS perform the

following steps:

Step 10. Decrement counter CS in buffer TIG

$$l_k^{(c)} = l_k^{(c)} - 1;$$

Step 11. If $l_k^{(c)} < L_k^{(c)} - d$ and k -th TIG is blocked, then go to step 3, otherwise finish (parameter \mathbf{d} is introduced to ensure the stability of the algorithm);

Step 12. Send to all the j -th CC adjacent to the i -th of the commutation point, the notice of withdrawal of the lock i-ro CC.

The algorithms ADFI developed effectively control the intensity of flows in ISDN provided a constant ratio between different classes of traffic in CC. $\lambda^{(c_2)} = \text{const.}$

In terms of variables $\lambda^{(c_2)}$ ADFI needs, allowing optimal ratio between the quantities $L_k^{(1)} - L_k^{(4)}$ to redistribute - as otherwise the traffic will be blocked by the lower classes if there is sufficient spare capacity buffers CC reserved for the upper classes of traffic. The consequence of this is unjustified decline in performance ISDN.

Let Δt - update interval thresholds; \tilde{P} - Estimate of the average blocking probability MCC i -th interval of the commutation point on $[t_1 - \Delta t, t_1]$; $\tilde{P}^{(c)}$ - Estimate of the average blocking probability MCC class c in the interval in the i -th CC. The idea of the proposed algorithm is to convert thresholds that, under low load ISDN $\tilde{P} \leq P_1$ does not provide any advantages MCC of classes, by increasing a load, ie $\tilde{P} \leq P_1$ receives higher priority traffic classes. This algorithm can be included as part of the algorithms described above in the TIG; while periodically at intervals Δt , perform the following steps.

Step 1. Detect mode ISDN, for which to calculate \tilde{P} the interval $[t_1 - \Delta t, t_1]$ - the current time.

Step 2. Secure another traffic class T_c and perform pp 3-5.

Step 3. If $|\tilde{P}^{(c)} - \tilde{P}| < \mathcal{E}$, where \mathcal{E} a certain threshold value, then go to step 4, otherwise - to step 5.

Step 4. If $\tilde{P}^{(c)} - \tilde{P} \geq \mathcal{E}$ - then increase the threshold $L^{(c)}$: $L^{(c)} = L^{(c)} + l_0$.

Step 5. If $\tilde{P} - \tilde{P}^{(c)} \geq$ then reduce the threshold:

$L^{(c)}: L^{(c)} = L^{(c)} - l_0$ (l_0 - increment threshold).

Step 6. If considered all traffic classes, then finish, otherwise - go to p.2.

IPR developed control algorithms allow for the restriction in the flow intensity ISDN, working in a variety of conditions and can be used to limit the intensity of flows when accessing the control zone, so; and to limit the intensity of the flow when accessing GAM within the control area. Selection of a particular algorithm IPR defined compromise between implementation complexity

and efficiency, which in turn depends on the nature of the internal and mixed-zone traffic parameters IHT and GAM, dimension, zone control, and other factors, which may take into account when using a simulation model of ISDN. Numerical implementation of the algorithm is demonstrated by a specific example.

5. Conclusion

Solving the problem of accurately calculate network performance leads to a significant reduction in mean - time delivery of data packets to a user and reduce loss in the calls. Thus, due to the effective bandwidth redistribution integral paths network can achieve the optimal parameter values in customer service ISDN. All these above factors associated with the problem of optimal allocation of bandwidth between subnets CC and CP, in the end result, significantly increase the effectiveness of multi-network communication in general and thereby actually a transition to a more cost-effective networks.

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