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The Objective of Optimization the Structure of Communications Networks About Cost Criteria

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ABSTRACT: The following article is dedicated to the optimization of the structure of digital telecommunications networks (SDTN) by the criterion of network-wide discounted costs. The mathematical model for calculating the cost parameters of digital communication networks have been worked out. Numerical results of the structure optimization by the criterion given network-wide costs for various network parameters have been received.

KEY WORDS: Telecommunications networks, Criteria, Optimization, network parameters, Structure of digital telecommunications netwroks.

I.INTRODUCTION

The current stage of social development is continuously connected with the construction of a global information society. This trend is largely achieved through the development and improvement of info-communication networks, a significant improvement in their performance, which primarily include the quality of service characteristics of all classes of transmitted traffic on these networks [1, 2, 3].

In the problem of creation and development of telecommunications networks an important place occupy such matters like how to optimize the technical and economic indicators. The solution of these matters allows to design and develop telecommunications networks, to achieve minimum network costs and given technical effect.

A number of studies [1,2,3] conducted economic comparison of SDTN with packet-switching (PS) and SDTN with circuit switching (CS). It has been concluded about the economic efficiency of SDTN with packet-switching (PS), but a mathematical and algorithmic support for the design of such networks and optimization of their parameters have not been given, no recommendations for building structures of perspective SDTN.

By the present time the problem of structural optimization telecommunication systems have been considered in the narrow direction applied to any telecommunication system structure, for example, only to wireless telecommunications systems, or passive systems based on optical technologies. Combine existing problems in order to create a generalized structural optimization algorithm has not yet succeeded. The practice of design and planning of telecommunication networks is strongly needed for effective methods of optimizing the structure of the network, not limited in scope, easily adaptable to various design and management situations, taking into account the constant development of communication networks for integration.

In modern conditions it is necessary to develop a common set of methods of organization of telecommunication systems based on reducing costs and improving the quality of services.

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II. SIGNIFICANCE OF THE OPTIMIZATION

To reduce the cost it is required to solve the problem of structural optimization in the design phase , belonging to the class of discrete optimization problems and , as a result of a combinatorial nature of [1, 2].

At present, in the theoretical and applied aspects particular relevance in the design of SDTN gets their development of mathematical models to assess the likelihood - time characteristics given priority service discipline messages for further optimization of their structure.

III. LITERATURE SURVEY

In this article will be considered only how to optimize the structure of networks. The most important part of the problem of optimization of structure of communication networks is to set the objective function and selection criteria. The objective function should depend on external parameters or parts of these parameters; otherwise, optimizes the objective function does not make sense. For the purpose of optimization of complex systems most commonly used objective function is considered as the sum of the parameters of the same dimension or the amount of a monotonically increasing function of these parameters [4,5]. The solution to the problem of optimization of structure, is used as the objective function of technical and economic criteria, and in particular, given the costs allow you to choose to implement SDTN version of its structure, having the best technical and economic characteristics while maintaining performance at the level of the specified requirements.

For the development of digital telecommunications networks is advisable to choose economic criteria. In this case, as a criterion can be considered capital costs and payback period.

This work proposes as a criterion to select the minimization of the objective function equal to the sum of capital expenditures and operating costs for the product standard payback period, for instance, network-wide capital expenditure on establishment and operation of SDTN.

IV. METHODOLOGY

Challenge to optimize the structure of broadband SDTN is sought in the class of hierarchy, homogeneous level of the structure for what interlayer subnet have a radial structure; connection window items (WI) and hubs (Hs) are also produced by the radial principle; within the leveling subnet is the same type as the structure and technical equipment and describes a basic topologies.

The problem of optimizing the structure of SDTN is reduced to finding, components of the vector X, delivering network-wide minimum of reduced expenditures and includes in its membership [2, 6];

$$X = [R, W_r, W_{r-1,r}, n_{ir}, m_{jr}, m_{jr-1,r}], \qquad (1)$$

Where R – the number of levels of hierarchy, W_r , $r = \overline{1, R}$, subnets r-th level of the hierarchy, topology W_{r-1}, $r = \overline{2, R}$, interlayer subnets n_{ir}- number of switching nodes (hubs and centers of PS and CC) i-type on the r-th level of the hierarchy, m_{jr}- the number of communication channels (CC) of the j-th type on the r-th level of the hierarchy,$m_{jr-1,r}$- number of communication channels (CC) j-th type interlayer subnet with index (r-1, r).

The problem of optimizing the structure of SDTN has a following sight: minimize network-wide adjusted cost

$$\Pi(X) \rightarrow \min, \qquad (2)$$

When the standards for quality of service users SDTN, i.e. norms on the average time T_k delivery of data packets k-th priority and probability $P_k\{T \leq t\}$ package delivery speech for a random time T must not exceed a given t.
For the hierarchical SDTN network-wide adjusted cost P (X) have the form:

$$\Pi(X) = \sum_{r=2}^{R}\left[E_H \sum_{i=1}^{I} W_{ir} * C_j^y * n_r + \sum_{j=1}^{J} W_{jr} * C_j^K * M_{jr} + \sum_{j=1}^{J} W_{jr-1,r} * C_j^k * M_{jr-1,r}\right], (3)$$

Where R-number of levels of hierarchy.

$$E_н \text{standard cost} - \text{effectiveness ratio of capital expenditures}$$

I- number of types of concentrates ($К_ц$) and packet switching centers (channels) differing cost function

$$C_J^Y * \{G_j^{КП}(Кr_i^Y, d_i^Y), G_i^{КК}(Кr_i^Y, d_i^Y)\}, \quad (4)$$

Where $G_i^{КП}$, $G_i^{КК}$- performance centers of PS and CS respectively-availability ($Кr_i^Y$), the intensity of the recovery $(d_i^Y)i = \overline{1, I}$;

J-number of types of communication channels (CC) different cost function $C_j^K\{V_j, L_j\}$,(where V_j- speed in NCC(number of connection's channel) , L_j- length NCC);

N_{ir}- number of switching nodes I-type r-tion on the level of the hierarchy;

M_{jr}- number NCC j – th type between (r-1)– th and r- th level of the hierarchy;

$W_{ir} = \begin{cases}1, \\ 0,\end{cases}$ if the Ist CCU placed in the r − yustage; otherwise

$$W_{jr} - 1 = \begin{cases}1, \\ 0,\end{cases} \text{if } j - \text{ NCC placed between } (r-1) \text{ and } r - \text{th level of the hierarchy;}$$

in the opposite case.

Application of the above model allows to determine the topology of the SDTN, to distribute streams, select the bandwidth of the NCC and the performance of switching nodes, network-wide to calculate given the costs and determine the optimal structure of the SDTN. In the calculation of the functional (3) the size of the territory of the network are approximated by a regular geometric shape with sides (for a rectangular area) distribution of WI in the territory of uniform. The source data may be used any input constant (WI number, the number of R, the number of switching node (SN), etc.).

V. EXPERIMENTAL RESULTS

In solving the problem of optimizing the structure of SDTN, it is advisable to reduce the variables of the same type, for example, to an integer. In this case, it becomes the most profitable application of penalty functions NCC The choice of technique is dictated by the structural model SDTN, as well as the need to enable the calculation of probability-time characteristics of the SDTN with the heterogeneity of the incoming flow, as well as solve the problem of optimizing the structure of SDTN with more dimension to the number of WI reaching several thousand kilometers.

Initial data for calculation:
- the number of hierarchical levels R = 3;
- the number of endpoints N = 10000, 50000, 100000, 200000;
- territory of network is not limited to;
- the number of incoming streams is multidimensional;
- admissible delivery time voice packet 0,273s;
-capacity COP determined by the bandwidth of network nodes.

Based on the above methods were conducted multivariate numerical calculations of network parameters for different raw data and numerical results were obtained by optimizing the structure of hierarchical SDTN for R = 3, for different numbers of WI and territories network. The results are shown in Fig. 1 and Fig. 2.

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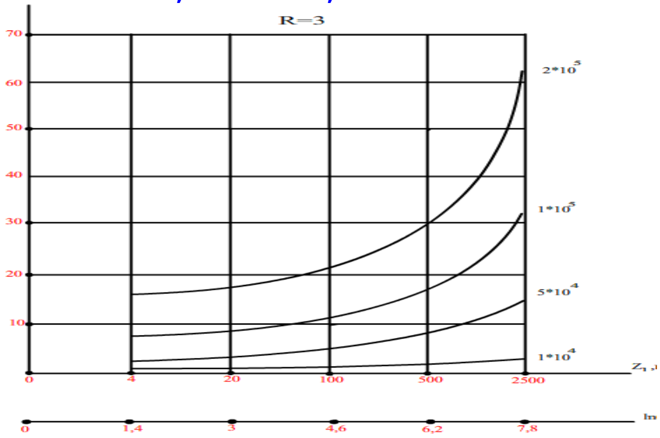

Fig. 1. The dependence of P (X) of the number of hierarchical levels at Z R XZ = 500x500 km ..

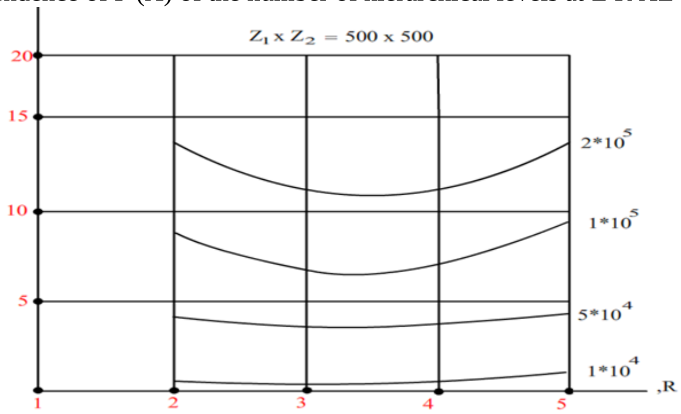

Fig. 2. The dependence of P (X) is the size of the territory of the network at R = 3.

VI.CONCLUSION AND FUTURE WORK

Numerical results showed the importance of optimizing the cost increases with increasing network capacity and network sizes. However, there is a large area where the index n (x) is weakly dependent upon these factors. Increasing the number of levels of hierarchy (R) does not change the nature of the findings, affecting perhaps, on the absolute value of P (X). For large values of the territory of the network there is an optimum in the number of hierarchical levels (Fig. 1), the optimum expressed more clearly for networks with a large subscriber capacity. The studies developed a method of optimizing the structure of hierarchical telecommunication networks for network-wide criteria given cost, which is the theoretical basis of a unified approach to the solution of applied structural and networking tasks. The results obtained optimizing the structure of telecommunications networks can be used in the preliminary stages of research to advance preparation of major projects network.

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