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Modeling Analysis of Telecommunication Networks

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ABSTRACT

To solve the problems of modeling telecommunications networks currently used by a large number of different methods. All of them can be divided into two classes[1-5]. First class combines methods of physical modeling in which, instead of the real system uses its simplified physical counterparts. In view of the significant limitations of these methods, they are rarely The second class includes methods of mathematical modeling, using appropriate analytical tools to describe transfer processes in the network. Depending on the used product are mathematical methods based on statistical (simulation) modeling, and theoretical and analytical methods Statistical and physical modeling to obtain accurate results, but because of the high labor intensity, considerable time and low degree of flexibility is of limited use.

Key words: Modeling, Telecommunication, Networks.

INTRODUCTION

Development of analytical methods for analysis devoid of these drawbacks, turns out to be almost impossible because of the complexity the modeled system. Therefore, to obtain positive results, various hypotheses, idealizing the actual processes of the system For example[6], a comparison of networks with different ways of switching is performed by the average time to send the right message and the efficiency of bandwidth. Thus completely eliminated the factors considered external load sharing network resources, and the associated queue, and the interaction of information flow in the network as a distributed structure More appropriate for the system under study are those based on the application of the theory of mass service. developed fairly complete theory of multi-phase bipolar networks[7-8], which allows them to carry out a comparative analysis of both indicators and performance, the priorities and disciplines of service and reliability of network elements Most real-world networks - multi, study them to solve the problem of optimal distribution of flows. In some cases it is possible to decompose the network into a set of multi-pole double-pole independent. This decomposition is not loss of essential properties is available only for some ad hoc networks, such as the radial[8]. A rigorous analytical solution of the optimal flow distribution can be obtained for a two-pole multi-network[8,9]. However, for networks with more complex structure, which include most of the real network, to obtain analytical expressions ion is not possible because of the need to solve a system of nonlinear equations of large dimension. This system is the result of the necessary conditions optimal solution of the general problem of nonlinear constrained optimization[9-11, 29]. For this type of problem a special algorithmic methods to a finite the number of iterations to obtain numerical solutions with a given degree accuracy. In this case, based on analytical models established view of the objective function and the relationship between parameters, and then use the machine to solve the problem of nonlinear programming optimization objective function based on the known limitations of admissibility and feasibility .

Approach

To obtain estimates of the potential effectiveness of networks, you can use gradient methods, which iteratively defined appropriate direction of change vector arguments of the objective function and set the value of these changes. more often chosen as a suitable direction opposite to the gradient of the objective function. The magnitude of the change of the optimized parameters, the argument should not lead to within the acceptable area. The specific methods for the numerical optimization of different ways of obtaining admissible directions modify the parameters and rules With reference to the problem of optimization of the distribution plan allowable flow direction is given by the possible routes of communication in the network. From this set of selected best routes on which part of the flow deviates from congested routes. The optimal route is minimal in the sense of its weight in the metric objective function. This approach is due the need to choose routes that are preferred the others in terms of being able to transfer it further flow. In addition, there is a wide range of algorithms with an acceptable computational complexity to determine the optimal routes on weighted graphs[12-24, 28, 29].

The value of the deflected flow can be either fixed or such to get the most improvement in efficiency. In the latter case, you have to decide further dimensional optimization problem. In one of the first algorithms for constructing an optimal flow distribution plan proposed by L. Klein rock[9, 25, 26, 30] in order to simplify the calculations provided baffling at best found routes in the same proportions, which significantly slows down the process of obtaining an acceptable solution. In subsequent versions method used a more subtle approach to the choice of directions and step modification flows[11, 26, 31]. But the essence of the known methods, however, remains unchanged: it is an iterative splitting (deviation) of external flows through alternative routes as long as you can improve the value of the target function. Supplement designed to change the appearance of the target function and consideration of possible restrictions on the choice of routes[9, 27, 32-35] . Not of a fundamental nature, even though they have significant practical importance. Despite the proven convergence of the most well-known methods for solving the problem of optimal distribution of flows in the network, it has a number of shortcomings . First, you must obtain a valid initial distribution flows. With a large external load attempt to use one route in each direction leads to a violation of restrictions on the flow rate in the channel. It is therefore proposed[26, 36] first artificially proportionally reduce the external load information in each direction to the values that satisfy the constraints, and then, after the distribution of the load, perform an optimization and to make an attempt to distribute the remainder of the flow Second, at each iteration, As noted, it is necessary to perform additional optimization problem to determine the proportion of deflected flow from the old to the new route. This implies an additional increase in the computational complexity of the algorithm .

Third, the low speed of convergence of gradient methods especially near the optimal solution, makes it necessary to perform a large, unknown a priori the number of iterations, which increases the network analysis. For performance optimization algorithms can be used more sophisticated methods, such as the Fletcher-Reeves, Newton, etc.[27, 37], which uses non-linear approximation of the objective function. However, increasing amounts of memory required to store intermediate results, and the high computational complexity matrix inversion procedures complicate the practical applicability of these methods Complexity and inefficiency of the known methods of modeling led to the development of heuristic approaches to solving the problem of the distribution of flows that provide a sub-optimal solution[9,28]. Ease of heuristics is achieved by eliminating the use of alternative routes for the transmission of information flow direction. Therefore, if the external load is a significant reduction in the accuracy of solutions.

It should be noted that there is a certain class of networks - the so-called balanced network[26], for which a fixed route selection procedure is effective. However, the real network, as a rule, not satisfy- are satisfied by the uniformity requirement in the load direction and other information necessary to the balance of the network .

As shown earlier, to model the potential effectiveness of networks with different ways of switching to find a plan of distribution of streams, optimizing the value of the objective function. The known methods of constructing such a plan is not fully suitable for practical problem solving studies of telecommunication networks. This is due, on the one hand, with significant computational complexity of obtaining accurate numerical solutions, and on the other - with the inability to account a number of important factors that influence the effectiveness of the network. These factors include the quality of the communication channels, the switching time, the requirements for the transfer of data, the type of optimization (network-wide or custom), routing type (static, dynamic or quasi-static), etc.

The space of possible object of study can be represented as a product of the sets of physical structures, options for external load requirements, and other features functioning of the system. Obviously, the dimension of this space is very large, and the number of alternatives analyzed systems can reach several thousand. For the study of communication networks with different ways of switching is necessary to develop a method that allows for a reasonable time to perform an analysis of a large number of different options for network under a variety of operating conditions and optimum synthesis .

Thus, it is possible to formulate a number of requirements to be met by modeling telecommunications Network: allows comparative analysis of circuit-switched communications, packages and channels based on the evaluation of network performance depending on the intensity of the external load, physical structure, requirements for probability of timely delivery, switching time, the channel capacity and quality, as well as the routing algorithm is adopted in the network; generate the optimal distribution plan information flow, ensuring the achievement of the potential effectiveness of the network in the specified operating conditions determine the allowable intensity of the external load, to assess the quality of decisions made on the structure of the network and to develop recommendations for their optimization, optimizes the physical network through the distribution of resources capacity without changing the topology based on a quantitative evaluation of network performance and analysis efficiency of resource use to provide a quantitative assessment of the quality of decision-making structure, implement the computational process on the basis of the capabilities of modern PCs. The dimension of the network must be dozens - hundreds of nodes, and the time of its analysis - up to several hours .

The analysis methods for modeling telecommunication networks has shown that most of them have a gradient in nature and as a consequence, the low rate of convergence. This circumstance does not allow practical use methods to analyze data and synthesis of networks.

Problems STETMNT

A shortest path problem

Weighted graph with a single source node is shown in Fig. 1. The weight of each edge is assumed to be the same in either direction. (a) Indicate the tree of shortest paths from s to all other nodes found by Dijkstra's shortest path algorithm. (b) Is the tree of shortest paths from s for the graph unique? Justify your answer. (c) How many iterations of the synchronous Bellman-Ford algorithm are required to and shortest length paths from the source node s to all other nodes of this graph

A minimum weight spanning tree problem

Consider again the graph of Figure 1. Find the minimum weight (undirected) spanning tree found by Dijkstra's MWST algorithm. Is the MWST for this graph unique? Justify your answer .

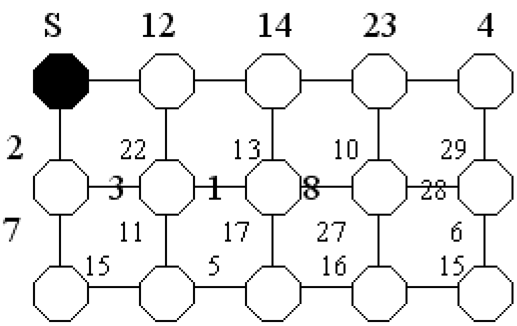

Fig. 1: An undirected weighted graph

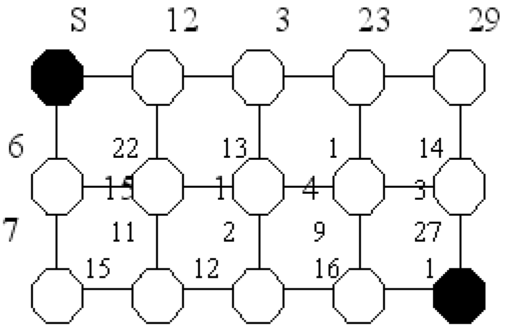

Fig. 2: A weighted graph with terminals s and t

A maximum flow problem

A flow graph with a source node s and a terminal node t is indicated in Figure 2. A line between a pair of nodes indicates a pair of directed links, one in each direction. The capacity of each directed It is proposed to model telecommunication networks use the parallel saturation network, enabling evaluate the optimal distribution of flows alternative routes right message. This decision will help to formulate a general algorithm for computing the performance of telecommunication networks and to ranking and adjust routes to optimality criteria, thereby minimizing the time to do the necessary modification of the distribution plan in the network. This method can be used as the basis for modeling telecommunication networks datagram and virtual mode switching and circuit-switched. The method allows to take into account the direct effect of the parameters of reliability and survivability of network performance. The proposed method of parallel network saturation for modeling telecommunication networks can be used to create automated rapid analysis and synthesis of modern and advanced telecommunications networks. Application of the method of parallel saturation network would create an effective tool for quantitative decision support as in the design phase and in the management of a telecommunications network in particular, the planning. The greatest advantage of this method compared to known analogs will be Xia in the study of large-scale networks and a wide range of changes in operating conditions. .

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