SESSION 4
Complex Algorithms

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Baydalka V., Ivanitskyy O., Koshulinskyy R.
Automated Control System Department,
Lviv Polytechnic National University,
S.Bandery Str., 12, Lviv, 79013, Ukraine,
E-mail: Roman.Koshulinsky@artfulbits.com

OPTIMIZATION SYGNAL PATH IN TELECOMMUNICATION SYSTEM

Algorythms for optimization sygnal passing in telecommunication system are presented. Computer program for realization those algorythms is developed.

Keywords – computer science, microelectronics, conference proceedings (use Index Terms style).

1. Introduction

Definition and solution of problems of structural optimization of telecommunication networks (TCN) subject to all the factors (schemes of routing into logical networks, algorithms of reservation into transportation networks) are known to be a complicated task extremely [1]. At the same time a rapid development of TCN in modern period of total informatization leads out of the TCN functioning optimization problem to the rank of extraordinately actual and practically important problems [1].

In many cases an evaluation of structural optimization of TCN was carried out by the method of calculation of connection of all the couple of graph peaks that belong to given network [2]. But such methodology takes into account only structural network scheme without peculiarities of telecommunication channels and nodes, for example, capacity of channel or concrete redundancy scheme. Such approach means that any being route between given couple of nodes is accepted as possible redundancy path. By other disadvantage of such approach there is the fact that the determination of connection all the graph couples nodes is complicated mathematical problem extremely. Therefore, for real networks with both many numbers of nodes and even more numbers of flows there is such great among possible paths and route flows that calculation by the given method become unsuitable[2].

In this abstract algorithms of finding optimal paths of signal in TCN are proposed. Such features as capacity and signal delay in nodes are taken into account. These algorithms are realized as a computer application for solving problems of signal passing in real time.

2. Algorithms of signals passing optimization

As is the convention in literature [2] we will simulate TCN using the graph theory. A graph is interpreted as a certain number of nodes and certain number of edges, which join couples of different nodes (one edge can bind no more than one couple of nodes). An optical linear route (section) answers to a graph edge, and apparatus of transmitting station to node (for example, multiplexers of input/output signal). For possibility of application of corresponding algorithms we are considering a simple graph, namely, graph, which does not include loops (edges, which connect node with own) and parallel edges. Hence, later the term of graph will be signified as a simple graph. In case of existence of two communication lines, which connect corresponding nodes, we assume it as the line with total capacity. We suppose that graph is directed and there are two edges with opposite orientation between every two nodes. Graph edges are characterized by communication channel capacity, and nodes by signal delay.

Classic target setting for shortest path finding looks as following [2]. For current initial vertex s and final vertex t find the shortest path in graph from s to t. The initial vertex we'll call entry (source) and the final one exit (destination). Obviously coherence of graph is needed for this path to exist. Or

$$\sum_{Sk} cij \to \min \quad , \qquad (1)$$

where S_k- path from vertex s to t, k=s,…,t; c_{ij} – path length from node i to node j.

Let's formulate optimization problem for finding minimal time of passing signal taking into account features in telecommunication networks. For current initial node s and final node t find signal pass in network from s to t with minimal connection time. Or

$$\sum_{Sk} Cij \to \min \quad , \qquad (2)$$

where $C_{ij}=c_{ij}+z_i$, z_i – delay time in node i. Depending on network load z_i can have different values.

In current problem we add delay time in node to time of passing signal along the rib.

Let our graph mark as Ψ and the shortest path from s to t as SP(s,t) with time of connection as a criterion. The calculation starts from entry s. Consider all nodes connected to it. Let they make multitude D_1 ={d_i | s-d_i belongs to Ψ}. Here d_i marks a vertex and s-d_i rib of graph Ψ. Firstly step we choose as optimal that node which realizes the shortest delay, or SP(s,t)= min {C_i | d_i belongs D_1 }. Then we consider all nodes that are tied with ones from multitude D_1 - D_2= { d_j | d_i-d_j belongs Ψ, d_i belongs D_1}. Choose the path that realizes the fastest combination from entry node s to node from multitude D_2, or SP(s,t)= min {C_{ip} +C_{pj} | d_i belongs D_1, d_j belongs D_2}. Checking whether moving along current rib gives us new shortest path to the destination node is called rib relaxation [2].

On k step we perform relaxation operation for multitude D_k that contains nodes tied with other ones from multitude D_{k-1}. When multitude D_k contains destination node t – this is the criterion for ending of algorithm. So found SP(s,t) realizes the shortest path of signal passing from source node to destination using delay time as a criterion.

Described method is known as Dijkstra algorithm. It is proven [2] that Dijkstra algorithm solves a problem of the shortest path finding when all coefficients c_{ij} are greater or equal to zero. In our case modification of this algorithm is proposed. We take into account signal delay in nodes and other features of information flows.

3. Computer realization of algorithm

In [2] it is proven that using Dijkstra algorithm in general case we can find the shortest path which is proportional to N^2. Because of truth of inequality E << N(N-1)/2 the graphs under our cosideration are rarefied. For rarefied graphs calculation quantity is proportional to ElgN. For realization of this algorithm graph is represented as a list of adjacent nodes. For such representing it is easy to implement rib relaxation operation.

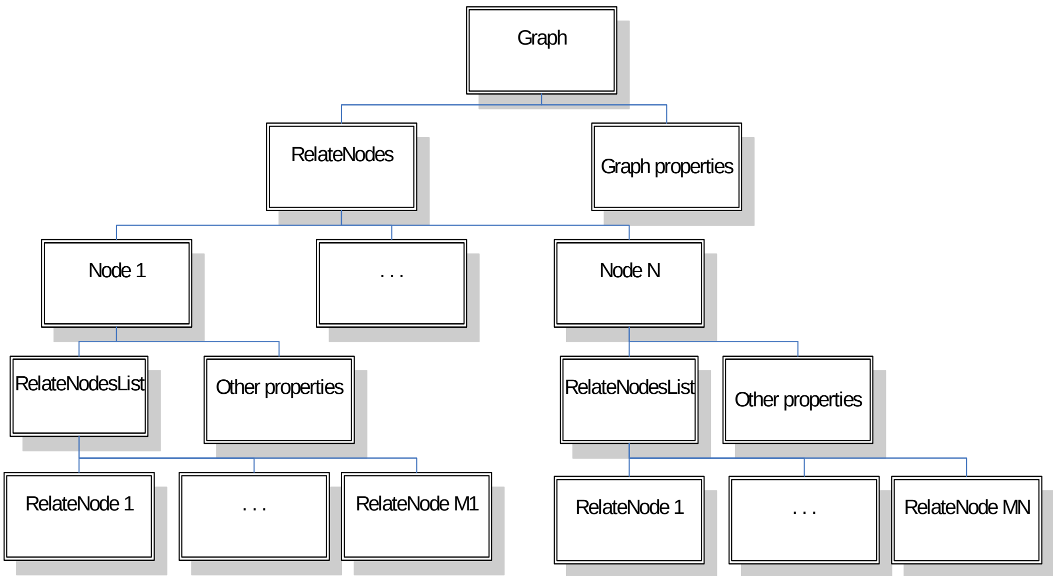

Fig.1. Structure of graph in computer realization.

We choose language C# oriented on platform .NET for developing current simulation program because it is object-oriented (that essentially simplifies developing large projects), safe, powerful and satisfies all engineering requirements. Using object-oriented method of attack an interface of abstract types was used [2]. Creating an abstract data model is one of the most important elements in solving problems using computer. During program development the following base classes were created – Graph (represents graph), Node (represents vertex of graph), RelateNode (represents rib). This method of attack allows using created computer system for solving different problems with minimal code changes. Graph is an hierarchical structure so there were created classes that contain collections of nodes and ribs - RelateNodes (represents collection of objects Node), RelateNodesList (represents collection of ribs). Common structure of graph using these classes is illustrated on fig.1.

All data about graph is stored in XML-files. Created system can be successfully used for simulation of TCN, oil pipelines or railway transportation. On fig.2 interface of program is represented. Program has rather simple and user friendly interface. So proposed model and modified algorithm are realized in computer program that can be used in TCN for calculation of optimal connection in real time.

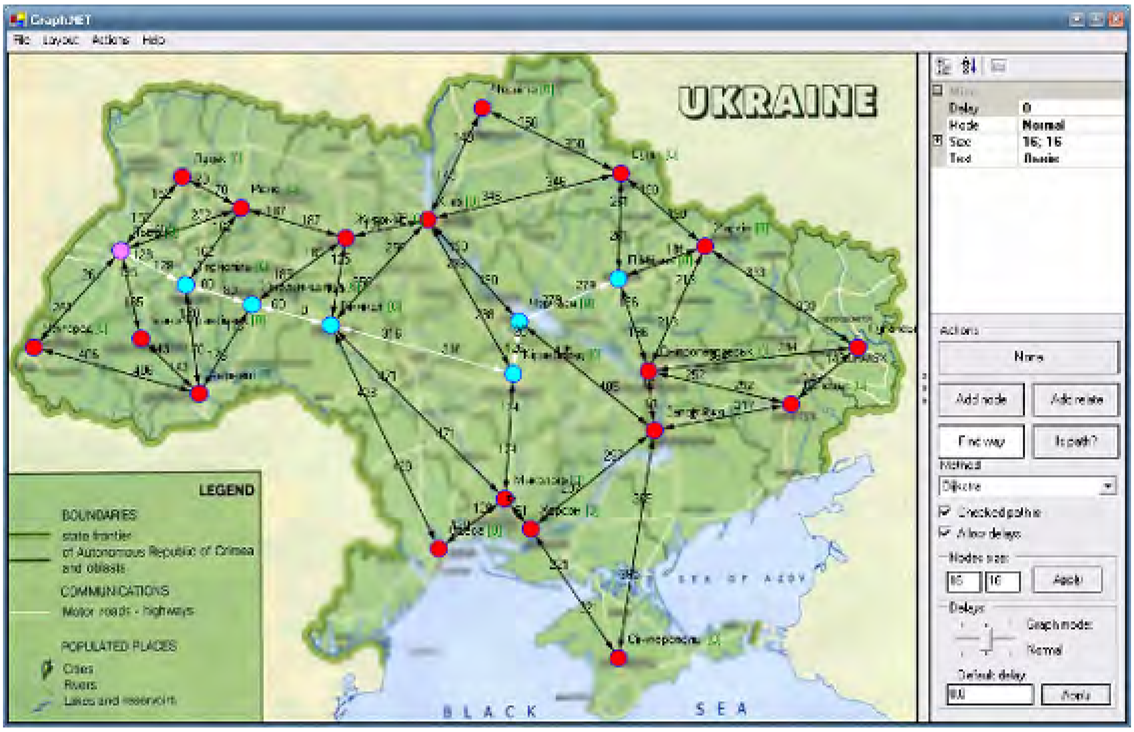

Fig.2 Interface of computer program.

4. Conclusion

1. Proposed simulation model in the form of graph can be used for calculation of optimal paths of signal passing in telecommunication networks.
2. Created computer system for transportation networks simulation. An application developed for platform .NET using language C# and object-oriented point of view.
3. Using described in abstract modification of Dijkstra algorithm an optimal path of signal passing in telecommunication network can be calculated.

References

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