Diakoptical Approach in Telecommunication Engineering

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Abstract – **A diakoptical approach to tensor methods of telecommunications networks engineering, including design, traffic control and maintenance of QoS, is offered. The using of it increases scalability of tensor methods.**

Keywords – **Telecommunication Network, Tensor Analysis, Diakoptics.**

I. INTRODUCTION

One of universal methods of telecommunication networks engineering is a tensor analysis. For example, problems of design, traffic control and maintenance of quality of service can be solved with the method. In general, decisions show next characteristics: multitpath routing; an exception of loops in routes; achieving the minimum possible in these conditions values of one from the QoS indicators (delay, loss probability or jitter). However, the principal limitation of tensor analysis of telecommunication networks is a low scalability of this method. The primary direction for increasing the scalability is an application of diakoptics ideas [1].

II. DIAKOPTICAL APPROACH

The tensor analysis' decision of all telecommunication problems is constructed on using of different bases of the structure description of a network and transitions between them. Frequently one of these bases is the basis of links B_{link}. In this case, the network is considered as set of isolated transmission channels (links). Each link has its own metric, which associated with the accepted model of service in this link. Set of metrics of isolated links forms projection of the metric tensor in the basis B_{link}. On the other hand, the structure of a telecommunication network can be considered as set of paths, cyclic paths or cut sets that form the other bases.

Transition between two bases of the network B_x and B_y is described by matrices of covariant A_x^y and contravarian C_x^y coordinate transformation. A dimension of the transformation matrices is $n \times n$, where n – the number of links. For large networks these matrices are very bulky. In diakoptikcs transition between basis B_{link} and some other basis B_x does not use a direct n-dimensional matrix C_x^{link}, and calculations performs according to the following scheme.

Step 1. Initial network break down (tearing) into S non-connected with each other subnets. A chain of intersections, what reflects the relationship of the S main subnets, represents $(S+1)$ th subsystem. All of subsystems (the subnets and the chain of intersections) are represented in the basis of links B_{link}^i, $i=\overline{1,S+1}$. For every subnet the projection of its metric tensor in the basis B_{link}^i forms.

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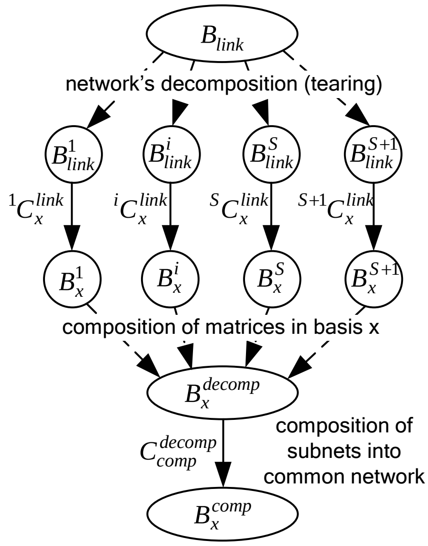
Step 2. For every isolated subsystem i, $i=\overline{1,S+1}$, transition from B_{link}^i to B_x^i is accomplished. Projections of the metric tensors for every isolated subsystem in basis B_x^i by means of a transformation matrix ${}^iC_x^{link}$ are defined. If B_x^i is the basis of paths, for example, the corresponding projection of the metric tensor contains metrics of basic paths in subnets.

Step 3. Projections of metric tensors, which were obtained independently for each subnet, now are lumping together. We obtain the metric tensor for decomposition system (projection in the basis B_x^{decomp}).

Step 4. Composition of subnets into common network is interpreted as a coordinate transformation with the transformation matrix C_{comp}^{decomp}. By means of this matrix the projection of the metric tensor for the composition system, i.e. projection in basis B_x^{comp}, can be found.



Thus, the metric of the network in basis B_x is found, so a concrete task can be solved. Now, for example, delays, traffic patterns, resources required, etc. can be defined. The described approach was successfully applied for the solution of multipath QoS-routing problem.

III. CONCLUSION

The main advantages of diakoptics are parallel and distributed computation; decreased time computation and storage requirements. In general, the using of diakoptical approach to the tensor methods of engineering of telecommunications networks, including issues of design, traffic control and maintenance of QoS, makes it possible to increase their scalability and expand fields of application for large networks.

REFERENCE

[1] Kron G, "Diakoptics: The Piecewise Solution of Large Scale Systems", MacDonald, 1963.