Mathematical Model and Method of Routing with Resources Reservation in IP/IntServ Network

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Abstract - **In this paper the mathematical model and two-level hierarchical method of routing jointly with resources reservation in IP/IntServ network are given.**

Keywords – **Routing, Resources Reservation.**

I. Introduction

A significant place in modern telecommunication networks takes a task of *guaranteed* quality of service [1], the solving of which is possible only on the basis of network resources reservation. In order to improve the efficiency of network routing and reservations problems must be solved in concert.

II. Model and Method of Routing with Resources Reservation

In order to coordinated solving of routing and reservation problems will define as control variables $z_{ij}^{k_r^s}$ and $\beta_{ij}^{s,r}$, where $z_{ij}^{k_r^s}$ is routing variables, equals intensity of traffic k_r^s in link (i,j); k_r^s is traffic, that is arriving through r^{th} boundary network router and will be serviced with s-type of the reservation filter, $r \in M^+$, $s = \overline{1, S_r}$, intensity of traffic k_r^s is $\lambda^{k_r^s}$; $\beta_{ij}^{s,r}$ is resources reservation variables, equals part of (i,j)-link capacity φ_{ij} assigned for traffics k_r^s. So flow model of routing and reservation can be offered as [2, 3]

$$\begin{cases} \sum\limits_{j:(i,j)\in E} z_{ij}^{k_r^s} - \sum\limits_{j:(j,i)\in E} z_{ji}^{k_r^s} = \lambda^{k_r^s}, \text{ if } i^{th} \text{ is router-sender;} \\ \sum\limits_{j:(i,j)\in E} z_{ij}^{k_r^s} - \sum\limits_{j:(j,i)\in E} z_{ji}^{k_r^s} = 0, \text{ if } i^{th} \text{ isn't boundary router;} \\ \sum\limits_{j:(i,j)\in E} z_{ij}^{k_r^s} - \sum\limits_{j:(j,i)\in E} z_{ji}^{k_r^s} = -\lambda^{k_r}, \text{ if } i^{th} \text{ is router-receiver;} \end{cases} \quad (1)$$

$$\sum_{k_r^s \in K_r^s} z_{ij}^{k_r^s} \le \beta_{ij}^{s,r}\varphi_{ij};\ 0 \le z_{ij}^{k_r^s} \le \lambda^{k_r^s};\ 0 \le \beta_{ij}^{s,r};\ \sum_{r\in M^+}\sum_{s=1}^{S_r}\beta_{ij}^{s,r} \le 1. \quad (2)$$

Combining the all control variables, we have vector $\vec{z}^{\,t} = \left[\vec{z}_r \ldots \vec{z}_r \ldots \vec{z}_{m^*} \mid \vec{\beta}_1 \ldots \vec{\beta}_r \ldots \vec{\beta}_{m^*}\right]$, where subvectors $\vec{z}_r$ and $\vec{\beta}_r$ are associated with boundary router r. Thus of routing and reservation problem can be formulated as optimization problem $\min F$ subject to Eqs. (1)-(2) (Fig.1). To solve the task can be implemented the objective coordination principle [4]. According to the principle we have two-level hierarchical method that shown in Fig. 1, where H_r, Q_r – matrices of weighting factors, $\Omega(z,\beta,\mu) = \min\limits_{z,\beta} L(z,\beta,\mu)$, $L(z,\beta,\mu)$ – Lagrangian for F, $\vec{\mu}$ – Lagrange multipliers vector, B_r – square matrix, I – unity vector.

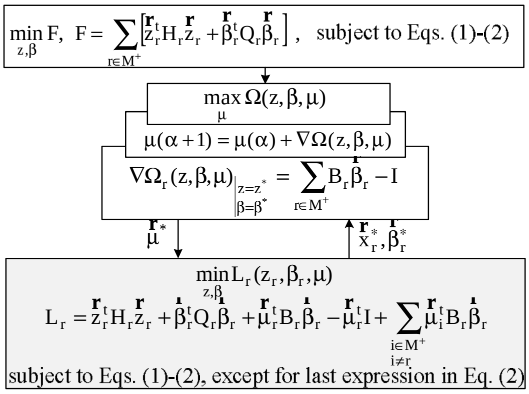

Fig.1. Computational structure of two-level hierarchical method of routing jointly with resources reservation

III. Conclusion

Thus tasks on traffic routing and resources reservation are solved on boundary routers; coordinating functions (in order to congestion prevent) are entrusted to the network coordinator. The offered method of routing jointly with resources reservation network allows to strengthen the scalability of obtained solutions due to the lowering of dimension and iterations number of coordinating procedure, what, as a result, will bring to a lowering of the volume of overhead traffic, as well as an increase of reliability and efficiency of the control.

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