Optimal Routing Based on Service-Oriented Architecture Approach

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The optimal routing problem in a computer network consists of the determination of the optimal routing policy, i.e., the set of routes on which packets have to be transmitted in order to optimize a well-defined objective function (e.g., delay, cost, throughput etc.). Under appropriate assumptions, the optimal routing problem can be formulated as a nonlinear multi commodity flow problem [1].

A new approach architecture of optimal routing of information flows in telecommunication networks based on service-oriented and using of Quality of Service parameters proposed [2].

$$F(x)= w_i\sum_{i=1}^{m_1} \frac{L_{i\max}-L(x)}{L_{i\max}-L_{i\min}} + w_j\sum_{j}^{m_2}\frac{L(x)-L_{j\min}}{L_{j\max}+L_{j\min}} \qquad (1)$$

Where: $L(x)\in(D(x), y(x), p(x), J(x))$

D(x) – delay of the flow; $y(e)=\sum_{t=0}^{t(e)} c_t(e)x_t(e)$ for all $e\in E$,

p(x) - probability of packet loss; *J(x)* – jitter.

$$F(x)= w_D\overline{\frac{D_{\max}-D(x)}{D_{\max}-D_{\min}}}.+w_c\frac{y(x)-C_{\min}}{C_{\max}-C_{\min}}+w_p\frac{p_{\max}-p(x)}{p_{\max}-p_{\min}}+w_j\frac{J_{\max}-J(x)}{J_{\max}-J_{\min}} \qquad (2)$$

Weights: $w_D+w_C+w_p+w_J=1$

subject to:

$$\frac{1}{\gamma}\sum_{e\in E} f_e(s,t,e)\left[\frac{1}{y_e(s,t,e)-f_e(s,t,e)}+\mu(P_e+K_e)\right]\le T_{\max}(s,t), \text{ for all } (s,t)\in D$$

where: $T_{max}(s,t)$– maximum possible delay; $1/\mu$ - the average packet length (bits/packet); λ_e - the average packet arrival rate to link *e* (packets/second); P_e – propagation delay on link *e*; K_e – node processing delay entering link *e*; γ - total traffic in the network (packets/second).

There are some ways to determine maximum possible delay. First of all, you should allocate $T_{max}(s,t)$ empirically, for example, from performance required by any application.

For each $e\in E$ set of possible capacities are determined by the following parameters:

t(e) = |*T (e)* | is the number of possible additional capacities for an edge *e*; $C_t(e)\in Z_+$ $(1\le t\le t(e))$ is the potential technologies for an edge *e* (it is supposed, that $C_0(e)\le C_1(e)\le \ldots \le C_{t(e)}(e)$); $c_t(e)=C_t(e)-C_{t-1}(e)$

For each edge $e\in E$ we enter the variables

$x_0(e)\ge x_1(e)\ge\ldots\ge x_t(e)$ $\qquad x_t(e)\in\{0,1\}$, for all $e\in E$,

A choice of the capacity $C_\tau(e)$ $(0\le\tau\le t(e))$ for an edge is equivalent to that, as

$x_0(e)=x_1(e) \ldots = x_\tau(e)=1$, $x_{\tau+1}(e)=\ldots=x_{t(e)}=0$.

For probability:

$$P\le P_{\max}$$

While for Jitter:

$$\frac{1}{\gamma^2}*\frac{d\gamma}{dt}*\sum_{e\in E}^{E} f_e(s,t,e)\left[\frac{1}{y_e(s,t,e)-f_e(s,t,e)}+\mu\left(P_e+K_e\right)\right]+\frac{1}{\gamma}\sum_{e\in E}^{E}\frac{d\,f\left(s,t,e\right)}{dt}\left[\frac{1}{y_e(s,t,e)-f_e(s,t,e)}+\mu\left(P_e+K_e\right)\right]$$

$$+\frac{1}{\gamma}\sum_{e\in E}^{E} f_e(s,t,e)\left[\frac{d\,y_e(s,t,e)+d\,f_e(s,t,e)}{\left(y_e(s,t,e)-f_e(s,t,e)\right)^2 dt}+\mu\left(\frac{d\,P_e}{dt}+\frac{d\,k_e}{dt}\right)\right]\le D_{\max}$$

In other words the General problems for QoS requirements of telecommunication networks could be formulated as the following: it’s necessary to provide maximum of bandwidth and minimums of delay, jitter and packet loss ratio.

References

1. H. Frank and W. Chou, "Routing in computer networks," Networks, vol. 1, pp. 99-122, 1971.
2. V.Cardellini, E.Casalicchio, V.Grassi, F.L.Presti, R.Mirandola. A Scalable Approach to QoS-Aware Self-adaptation in Service-Oriented Architectures./Quality of Service in Heterogeneous Networks/ 6th International ICST Conference on Heterogeneous Networking for Quality, Reliability, Security and Robustness, Q Shine 2009 and 3rd International Workshop on Advanced Architectures and Algorithms for Internet Delivery and Applications, AAA-IDEA 2009, Las Palmas, Gran Canaria, November 23-25, 2009, Proceedings. P-431-447.