Esin Anton A. (V. A. Trapeznikov Institute of Control Sciences of Russian Academy of Sciences, Moscow , Russia). Markov model for performance evaluation of multipath TCP networks.

In this paper, the Simple Multi-Threaded TCP network model with rerouteing and a multithreaded server processing TCP connections from multiple clients has been considered.

A queuing network model has been constructed aor such a model. And the following assumptions are made for this network model: Poisson arrival process with rate Λ, exponential service time. Also, the following traffic patterns have been defined: the service rate is μ_i for each thread $i, i = 0, 1, ...m$. And the each server can be modelled as an M/M/c queue.

A Multithreaded TCP Network can be described as a modified Open Queuing Network and the Stability conditions are defined by the following

Theorem (On Stability of Multi-Threaded TCP Network). Let P be the routing matrix where p_{ij} represents the probability that a job at node i moves to node j, then the network $\mathcal{N}$ is stable if and only if the utilization ρ_i of each node i is less than 1:

$$\rho_i = \frac{\Lambda_i}{\mu_i} < 1, \quad \forall i \in \{1, 2, \ldots, M\},$$

where $\mathbf{P} = [p_{ij}]$ is an $M \times M$ matrix with $\sum_{j=1}^{M} p_{ij} \leq 1$ for all i, and the performance metrics are defined by the following formulae

$$R_i = \frac{L_i}{\Lambda_i} = \frac{1}{\mu_i - \Lambda_i}, \quad \text{(Average Response Time)}$$

$$R = \sum_{i=1}^{M} R_i \cdot \frac{\Lambda_i}{\sum_{j=1}^{M} \Lambda_j}, \quad \text{(Total Average Response Time for the Network)}$$

$$L = \frac{\lambda\mu(c\rho)^c}{(c-1)!(c\mu - \lambda)^2} P_0 + \frac{\lambda}{\mu}. \quad \text{(Average Number of Requests in the System)}$$