Results of the Dynamic Flow-Based Queue Balancing Model Research

Olexandr V. Lemeshko, Ali S. Ali, Maxim V. Semenyaka

Abstract – **The paper presents the flow-based model that was designed for solving dynamic queue balancing problem on the telecommunication network routers. Within the proposed model the problem of queue balancing was reduced to solution of the linear programming optimization problem. The research of the queue balancing process was performed by using flow-based model in regard to improve quality of service in multiservice network nodes.**

Keywords – **telecommunication network, queues balancing, traffic, quality of service, traffic intensity, traffic priority.**

I. Introduction

The development of modern multiservice telecommunication networks and technologies is submitted to one important goal – improving the quality of service (Quality of Service, QoS) for users. Traffic management traditionally is the most productive tool among a set of measures to improve QoS. This applies to increasing of the service availability and service continuity, and in terms of network indicators – to improve the numerical values of the average packet delay, jitter, packet loss, etc. OSI network layer facilities are traditionally considered as the most productive tools among a large set of measures to improve QoS – packet classification and marking, routing, queue management, resource reservation, etc.

Recently, more and more scientist's attention in telecommunications sphere is occupied by problems of modeling and optimization of queuing, because thanks to the minimization of queue length, you can significantly improve the QoS indicators without increasing the value of available network resources, especially bandwidth. At the same time improving the facilities of queue management takes place both at the level of technology through the development of new mechanisms, and on a theoretical level, based on the synthesis of new mathematical models, methods and algorithms for network management.

II. FLOW-BASED QUEUE BALANCING MODEL

Suppose a_i $(i=\overline{1,M})$ – intensity of the i-traffic class, that goes to the service router, b_j $(j=\overline{1,N})$ – part of the bandwidth of outgoing link that assigned to service packets in the j-queue. It is necessary to satisfy the condition:

$$\sum_{j=1}^{N} b_j = b\,, \qquad (1)$$

here b – outgoing channel capacity.

Alexander Lemeshko, Ali Salem Ali, Maxim Semenyaka - Kharkiv National University of Radioelectronics, Lenina Str., 14, Kharkiv, 61174, UKRAINE, E-mail:maxisemen@gmail.com

In order to avoid router overloading it must be ensured that the following constraint would be performed:

$$\sum_{i=1}^{M} a_i \le b\,, \qquad (2)$$

which is implemented primarily due to efficient traffic routing in the multiservice network.

Early known queuing mechanisms determine order of packets per queue distribution mostly static. The injection of x_{ij} variable make possible to attach dynamic nature to the packet distribution process, where x_{ij} is the part of i-traffic class that serves by the j-queue. Constraints for x_{ij}:

$$x_{ij} \ge 0 \quad (i=\overline{1,M}\,,\; j=\overline{1,N}), \qquad (3)$$

$$\sum_{j=1}^{N} x_{ij} = a_i \quad (i=\overline{1,M}). \qquad (4)$$

The constraint that prevent overloading the queue is the main feature of this model.

$$\sum_{i=1}^{M} x_{ij} \le \alpha \cdot b_j \quad (j=\overline{1,N}), \qquad (5)$$

where α – parameter describe the upper dynamically managed queue load threshold on the router.

The optimality criterion for the obtained solutions:

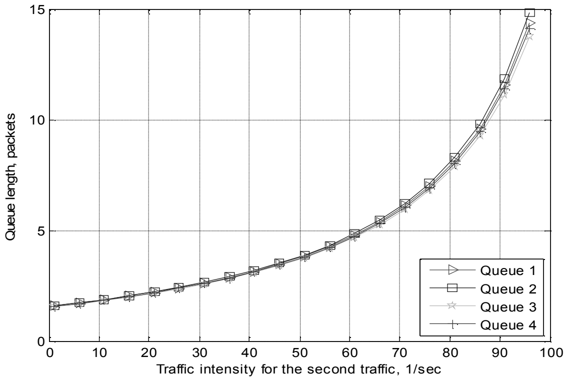
$$\min_{x,\alpha} \alpha\,. \qquad (6)$$

III. RESEARCHING RESULTS

The model, described in (1)-(6) provides optimal load queues balancing, unknown quantities is the vector $\vec{x}$ and the α-parameter.

The proposed model correspond to the requirements of the Traffic Engineering Queues concept, because all queues was balanced with increasing of the traffic intensity (Fig. 1), and the linear increasing of the upper dynamically managed queue load threshold was observed (Fig. 2).

The other advantages of the model that also should be referred are the clarity and relative simplicity in usage, because calculation of the unknown variables is reduced to the solution of linear programming objective. It is also important to note that the absence of the bandwidth overloading due to condition (5) is not a warranty that queue wouldn't overflow, because of packet buffer at the router that is finite, and amounts to tens of packets.



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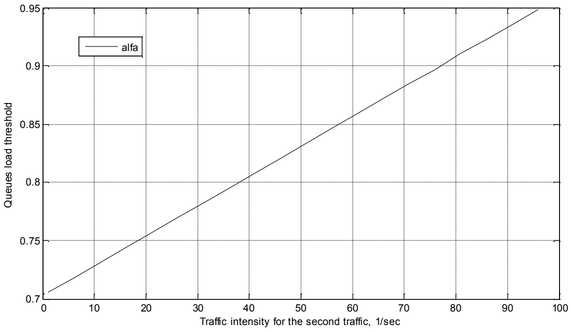

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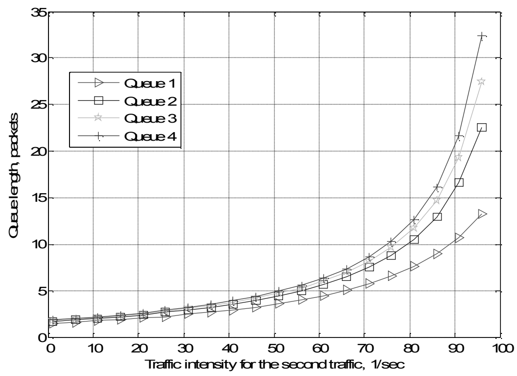
Fig. 1. Results of the model research. a) Queues loading dynamic; b) upper dynamically managed queue load threshold



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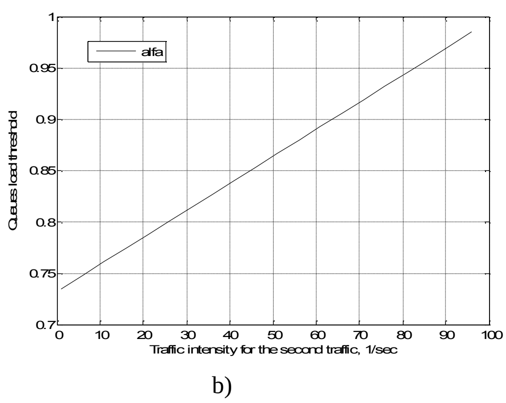

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Fig. 2. Results of the model research. a) Queues loading dynamic; b) upper dynamically managed queue load threshold

In order to provide better compliance of the obtained solution with the principles of the Traffic Engineering Queues concept, the constraint (5) was transformed to the form:

$$\sum_{i=1}^{M} x_{ij} \frac{p_j}{v \cdot d_j} \le \alpha \cdot b_j \,, \qquad (7)$$

where p_j and d_j – priority value and the packet length of the j queue, respectively; v – a normalization factor, which should smooth out the difference in priority values (0÷7) and packet length in bytes.

As a result, the differentiation of the incoming traffic flows, depended on the priority of the incoming flow was observed. The first traffic flow had priority 7. Second, third and fourth traffic flows had priorities 3, 2, 1 respectively. Flows with higher priority created smaller queues, thus the model provided the differentiation of incoming traffic by priority (Fig 2 a). The upper dynamically managed queue load threshold was increased linearly as well as in the previous event (Fig 2 b).

IV. CONCLUSIONS

Thus, in the paper flow-based model of the queues balancing at the nodes of multiservice network is proposed. The model provides an optimal balance of queues with linear increase of the utilization coefficient remaining at the same time as a linear programming problem. In order to provide better compliance of the obtained solution with the principles of the Traffic Engineering Queues concept, the model was transformed, it allowed to provide differentiation of incoming traffic by its priority and get better quality of service for traffic with higher priority.

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