

Multipath QoE-routing model with providing quality rating

This work has solved a relevant task to ensure the required level of quality of experience in an infocommunication network, which implied the development of a model of the multipath QoE-routing while maintaining the required quality rating. The result of studying the proposed model is the calculated quantitative indicator for a quality rating, which, compared to recommended indicators according to existing recommendations, makes it possible to evaluate the execution of the predefined level of QoE.

Introduction.

Nowadays various methods are used for assessment the quality of experience in the infocommunication network can be divided into subjective and objective [1-3]. The main difference between them is that subjective methods, such as Mean Opinion Score (MOS), do not allow quantifying factors affecting the quality of service (end-to-end delay, delay variation and packet loss) and, accordingly, timely respond to possible problems in the network and prevent the deterioration of service quality. Objective assessment methods, in turn, make it possible to take into account the structural and functional characteristics of infocommunication networks, as well as more than twenty different parameters for determining the connection assessment factor (Transmission Rating Factor, R-Factor). However, one of the most effective means to provide the required QoE in infocommunication networks is the use of a multipath routing strategy. For example, papers [4-7] suggest approaches to using routing models to ensure quality of service for a variety of network performance indicators: average delay, loss probability, and packet rates.

This paper proposes an approach based on providing QoE-performance requirements (in accordance with the Quality Rating), using for multipath routing optimization process to the control average end-to-end delay and packet loss.

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To ensure a recommended quality rating using multipath QoE routing in this work a flow model was used, in which the network structure was described using a one-dimensional network with many zero-dimensional simplexes – network nodes and a set of one-dimensional simplexes – network links. Each node has multiple interfaces through which it transmits packets to incident-nodes.

The implementation of multi-path routing in this model was achieved by introducing route variables that characterize the fraction of the flow intensity in the link. The flow conservation conditions used in the model took into account possible packet loss at the interfaces of the nodes caused by the queue buffer overload. In this case, the probability of packet loss was calculated using

expressions when the operation of the interfaces of the nodes was modeled by the queuing system with failures of the type $M/M/1/N$.

To ensure the control of the process of overload, restrictions were introduced into the model structure, within the framework of which the flow rate in the link, taking into account possible packet loss, did not exceed the bandwidth of the interfaces of the nodes.

The main restrictions in this model was an expression representing QoE requirements regarding voice transmission for a given type of terminal equipment and codec used according to recommendations G.109 and Y.1540 [8-10]. To enforce this condition mathematical expressions were used analytically describing the relationship of route variables, traffic characteristics, network parameters, end-to-end delay and packet loss probabilities, which were obtained using the tensor modeling functionality of routing processes in infocommunication networks [11-13]. In other words, in the framework of the tensor description of the infocommunication network, under the conditions of a multipath routing strategy, it was possible to calculate the probability of packet delivery and the average end-to-end delay, which resulted in the quality rating, according to which the quality rating was estimated.

Then, during the solution of the multipath QoE routing problem, the condition associated with maximizing the overall network performance was chosen as the criterion for the optimality of the solutions obtained.

Research of the proposed solution were carried out for a variety of network structures. At the same time, the operation of each of the interfaces of the nodes was modeled by the $M/M/1/N$ queuing system, and buffer size varied from ten to thirty packets. For each of the network structures, node-source and node-destination were selected. Then, with varying traffic intensity, as a result of modeling, the intensity of packet loss on one or another interface of network nodes was changed due to queue overflow depending on the network load.

So, as a result of simulation modeling, the problem of multipath QoE routing, formalized within the framework of this model, was solved, followed by evaluation of such indicators of quality of service as the average end-to-end delay and the probability of packet loss. The results of the study of the proposed multipath QoE routing flow model confirmed its efficiency and adequacy from the point of view of solving problems of ensuring QoE-indicators, namely the quality rating.

Conclusions.

The paper solves an urgent scientific problem related to providing the required QoE indicators in infocommunication network. Using tensor formalization the proposed model was able to obtain in analytical form the conditions for ensuring quality of service at the same time in terms of such factors as average delay and the probability of packet loss when implementing a multipath routing strategy.

In addition, the presence of a formal relationship of Service Quality estimates allow to synthesize the management of network parameters based on the requirements of end users, formulated as integral quality of experience

assessments. It is this way of expanding the mathematical models of information and communication networks to provide services of guaranteed quality is more flexible and allows to fully take into account the complexity of the relationship of network parameters in the framework of QoE.

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