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Approach to evaluating the quality of telecommunication services in next generation networks

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Abstract The article deals with approaches to identification of service quality indicators in next generation networks on the basis of accounting both the service provider viewpoint and user requirements. The concept of a system for managing a quality of services is given.

Keywords: *quality of services, next generation networks, quality management, fuzzy logic*

Introduction. Next generation networks (NGN) represent a single transport platform for combining multiple types of services. One of the main aspects that should be taken into account at designing NGN is ensuring the appropriate level of Quality of services (QoS). With the development of next generation networks, an approach to defining service levels on the basis of the customer's QoS requirements becomes prevailing. In the currently used QoS management systems the focus mainly is paid to technical parameters of the network. The development of an improved QoS management system in NGN which takes into account users' requirements is relevant. For this purpose it is the most expedient to use the artificial intelligent methods, because they allow evaluating user opinion most effectively.

A brief review of publications on the subject. There are examples of successful application of artificial intelligence methods in QoS management. The paper [1] proposes a network quality of service evaluation system that uses a combination of fuzzy C-means (FCM) and regression model to analyze and assess the QoS in a simulated network. The proposed QoS evaluation system provided valuable information about the network's QoS patterns and based on this information, the overall network's QoS is quantified. In paper [2] were analyzed different models to measure and monitor voice quality using Random Neural Networks (RNN). An article [3] presents a fine grain quality management method for real-time applications. Neural networks ensuring an early and accurate prediction of execution times of uncontrollable actions which allows selecting adequate quality level parameters. The paper [4] is proposing a neural network which is able to predict the customers' overall satisfaction of service quality with a promising level of accuracy. In article [5] combination of two types of neural networks – the Kohonen network and multilayer perceptron (MLP) – was used for the analysis and evaluation of QoS for VoIP traffic. However, in these and other studies attention is mainly given to technical aspects, such as delay, jitter, and packet loss ratio. Therefore, taking into account customers' QoS requirements is a relevant task.

The goal. With the development of next-generation networks the approach to the evaluation of QoS has changed. In these conditions it is essential to develop a reasonable system for service quality evaluation and management, which takes into account not only the technical aspects of the network, but also the users' requirements. The aim of this work is to develop the concept of QoS management system in NGN, which allows considering customer perception and customer's QoS requirements most effectively.

The body. According to ITU Recommendations, quality of services management in NGN is carried out on the basis of the application of the four views on QoS [6]. These viewpoints cover all aspects of QoS, both from the service provider's and user's (and customer's) viewpoints:

- customer's QoS requirements;
- service provider's offerings of QoS (or planned/targeted QoS);
- QoS achieved or delivered;
- customer perception (survey ratings of QoS).

Figure 1 shows service provider's and user's viewpoints on the QoS.

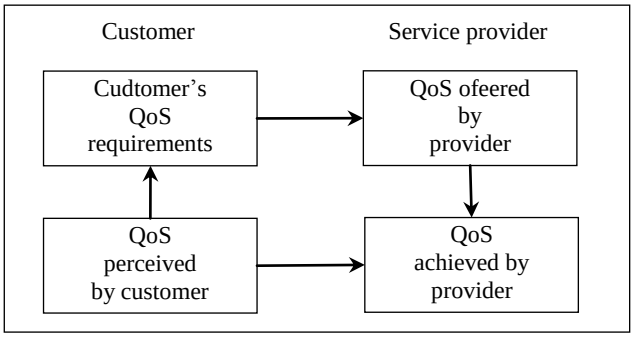

Figure 1. Four viewpoints of QoS

Customer's QoS requirements – this is an expression of the level of QoS required by the customer. The criteria and parameters identified to express these reflect the requirements.

QoS, offered by provider, – The QoS criteria or parameters offered by the service provider are formal terms specified unambiguously and may be used for the following: as the basis for SLA between the service provider and clients on a bilateral basis of agreement; public declaration by the service provider about the level of quality that can be expected by the users at large; As the basis for planning and maintaining the service at the level of performance being offered; as the basis for users to choose a level of quality to meet; their particular requirements among the service provider's offerings.

QoS, achieved by provider – The QoS delivered is the actual level of quality achieved or delivered by the service provider and may be used for the following: as the basis to compare the delivered with the offerings by the users, regulators and as a check in the SLAs; As the basis for any corrective action by the service providers.

QoS, perceived by customer – the QoS perceived by the user may be expressed by ratings based on customer sur-

veys and is an indicator of what the user thinks the level of quality received or experienced. This data may be used for comparison with delivered quality and identifying causes of any ambiguities; planning any corrective actions.

To get overall idea of QoS, these different viewpoints need to be taken into account. Thus, it is necessary to consider both objective and subjective measurements (evaluations), which are the only means to assess the user perception aspects of the QoS. The main difficulty of obtaining subjective measurements is that it is a time-consuming and expensive procedure. At the present time in the world an artificial intelligence is widely using to address these challenges. The paper of authors [7] introduces the concept of application of a hierarchical fuzzy system for determining the degree of user satisfaction with quality of services. The proposed approach can be used to extrapolate and predict the degree of user satisfaction with quality of services on a limited statistical material.

Based on ITU-T E.802 recommendations and the need to integrate the users' requirements we propose implementation of the process of ensuring the level of quality like it is shown in figure 2. A block for evaluating the degree of customers' satisfaction of service quality was included in the scheme. The block was implemented using fuzzy logic techniques. Fuzzy logic, which is the basis for the implementation of fuzzy control methods, describes the nature of the human mind and the course of his reasoning more naturally than the traditional formal logic systems [8].

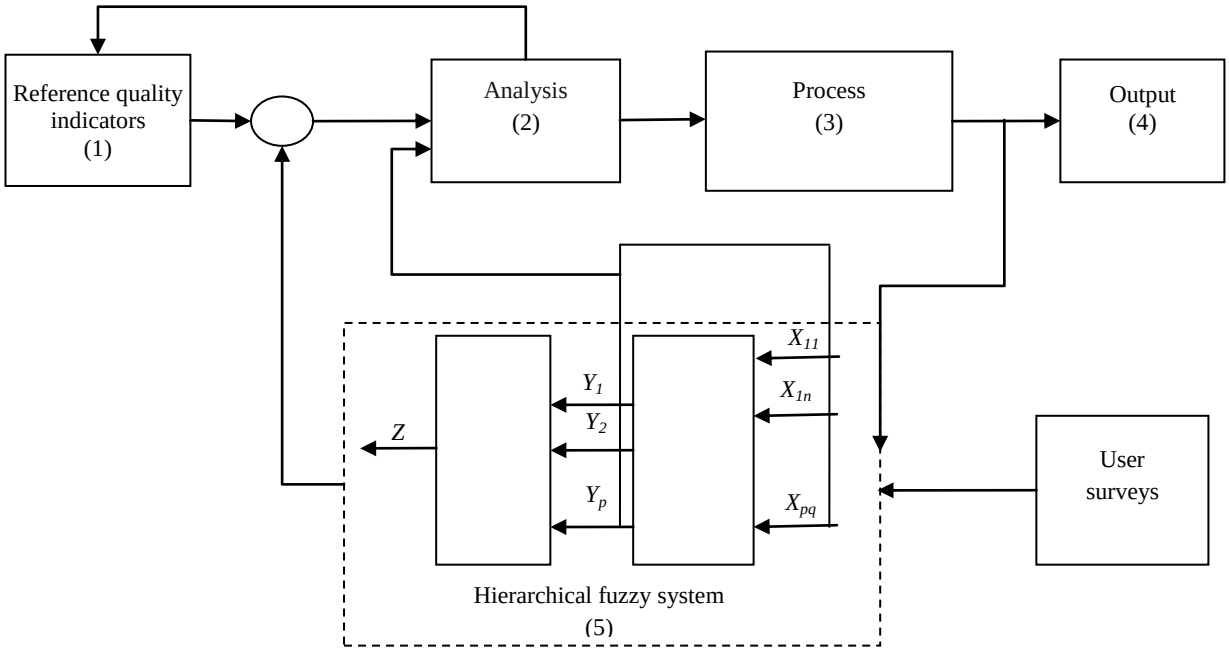

Figure 2. The scheme of the process of ensuring the level of quality

For accounting the users' perception of QoS the scheme has the following blocks:

1. Reference quality indicators. Are determined by the service provider, also are based on expert evaluations and user surveys.
2. Analysis. Block performs its functions when studies are carried out and compares the achieved quality indicators with reference quality indicators and information, provided by feedback channels. In case of need, generates the necessary control feedback. Initially, the action represented by this block is not applied.
3. Process. This block represents the process developed by the service provider in order to deliver a service with a level of quality as specified by the reference quality indicators.
4. Output. It is the quality effectively delivered to the customer by the service provider as the result of the quality process.
5. Hierarchical fuzzy system (HFS). On the basis of objective measurements of the network characteristics and the results of user surveys HFS determines the degree of user satisfaction with quality of services.

Consider the application of the scheme on an example of evaluating the quality of multimedia services. According to ITU-T Recommendation E.802, for multimedia services is especially suited four-market model, since the separation between the transport and service layer is taken into account. The model consists of four components that are used to describe the different elements of the services that contribute to the QoS: content creation, service management, delivery network and customer equipment. Different parties may be in charge of transport, provision and content and the supply of terminal equipment. Thus the overall quality of a service (as perceived by the user) is a combination of different elements that are working independently of each other [6]. Taking into account that the index for each of the components of QoS, in turn, depends on a set of criteria, implementation of this framework is requested to submit as a hierarchical system of fuzzy productive output. For each component Y_i are defined corresponding quality criteria X_{ij} (i – number of the component, j – number of the quality criteria of i-th component. Number of criteria for each i-th component can be different). On the first hierarchy level is determined the value that each of the QoS components reached (Y_1, Y_2,…, Y_i,..., Y_p) depending on quality criteria (X_{11}, X_{12}, ,..., X_{ij},…, X_{pq}). On the second hierarchy level the final index Z – the degree of satisfaction of users of ser-

vices – is determined, depending on the values achieved by each of the components.

An advantage of HFS is the transparency of the process, which allows the system to transmit to the analysis block not only the final quality indicator but also the level achieved by each of the components of QoS.

Further in analysis block it is determined whether the user's level of satisfaction with the provided service agrees with the required level. In case of discrepancies, the system determines the cause – compares the actual quality indicators (QoS, achieved by provider) with reference quality indicators (QoS, offered by provider). In case it was found that any of quality indicators haven't reached sufficient level, the recommendations /control actions aimed at bringing this indicator to the reference value are generated.

In case quality indicators were found to be in good agreement with the reference values, but the user is still not satisfied with received service quality (Customer's QoS requirements are higher than QoS, offered by provider), the recommendations on the necessity of the reference quality values correction are generated. Thus it is necessary to distinguish parameters that depend on the operator and problems related, for instance, with the quality of content or end user's equipment. In that case, the system generates recommendations on ways to improve the situation.

Conclusions. Proposed system of QoS management in next generation networks allows considering user's opinion of QoS most effectively. Proposed scheme of the quality assurance process makes it possible to take into account user's perception of the received QoS. This becomes possible through the introduction into the scheme the HFS block. It determines the degree of user's satisfaction with QoS using fuzzy logic methods and, with this solution, it possible to identify the most important QoS criteria and maintain their condition at required level at which user is satisfied with the quality of received services.

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Князева Н.А., Кальченко А.С. **Подход к оценке качества услуг связи в сетях следующего поколения**

Аннотация. В работе рассмотрены подходы к формированию показателей качества услуг в сетях следующего поколения на основании учета как точки зрении поставщика услуг, так и требований пользователей. Приведена концепция системы управления обеспечением качества услуг с использованием методов нечеткой логики.

Ключевые слова: *сети следующего поколения, качество услуг связи, управление качеством услуг, нечеткая логика*