Scientific Issues
Jan Długosz University
in Częstochowa
Mathematics XXII (2017)
99–116
DOI http://dx.doi.org/10.16926/m.2017.22.08

THE CONCEPT OF IMPLEMENTATION OF THE DECENTRALIZED APPLICATION LEVEL STRUCTURE FOR PROVIDERS OF A TYPICAL NEXT GENERATION NETWORK

N. KNIAZIEVA, S. SHESTOPALOV, W. SUSŁOW, A. YATSKO

Abstract

Based on the IPCC concept, the architecture of the Next Generation Network with the Decentralized Structure Applications Level to improve the quality control of the intellectual services (ISes) provisioning is proposed. It is recommended to evaluate the effectiveness of the control of provisioning ISes by means of the complex criterion, which takes into account the interests of three participants of ISes: process service providers, equipment suppliers and network users. The subcriteria are defined for each participant. The method used for the calculation of each subcriterion has been proposed as well. The problem of the association of subcriteria into the resulting complex criterion has been solved.

1. Introduction

Analysis of the Problem Domain

Nowadays, some Ukrainian operators offer (apart from basic services) a set of intellectual services (ISes) - services that can provide the level of applications of the Next Generation Network (NGN).

A Next Generation Network (NGN) is a packet-based network which is capable of providing telecommunication services, making use of multiple broadband, QoS-enabled transport technologies. It is worth noting that in

• *Nina Kniazieva* — e-mail: knyazeva@ukr.net
Odessa National Academy of Food Technologies, Ukraine.
• *Serhii Shestopalov* — e-mail: shestopalov.s@mail.ru
Odessa National Academy of Food Technologies, Ukraine.
• *Walery Susłow* — e-mail: walery.suslow@tu.koszalin.pl
Koszalin University of Technology, Poland.
• *Andrzej Yatsko* — e-mail: andrzej.jacko@gmail.com
Koszalin University of Technology, Poland.

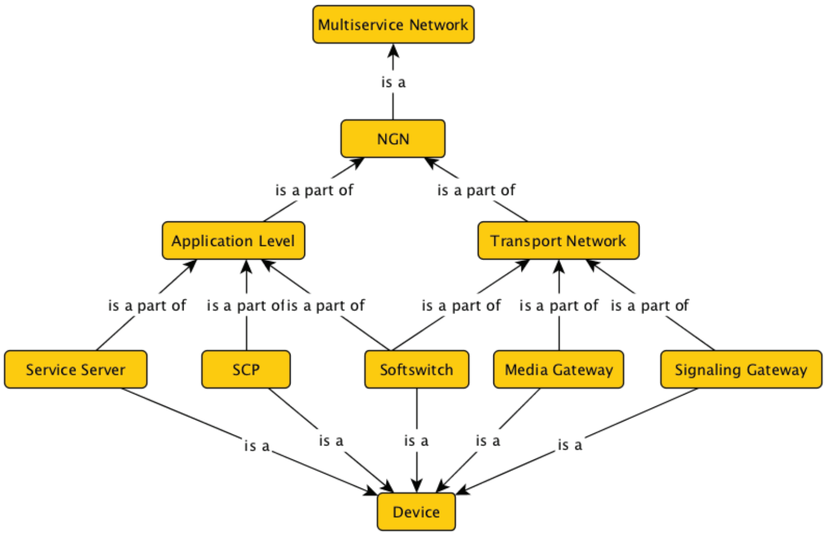

Figure 1. The concept map of the NGN domain

NGN the service-related functions are independent from underlying transport related technologies. It enables unfettered user access to subnetworks and to competing service providers or services. It supports mobility of users and operators and allows competitive provision of new services to users [1, 2]. The concept map [3] of the NGN domain is shown in Figure 1.

In Ukraine, as well as in many Eastern European countries, a complete NGN has not been created yet. As it stands, Ukraine does not even have full 3G coverage (see map in Figure 2), while European Union countries typically use LTE communication. However, some operators create networks that can provide Triple Play Service (speech, video, data). The transition to the next generation is slowly taking place.

Nowadays in the countries of Eastern Europe, telecom operators can choose between IMS/TISPAN or IPCC architecture when designing NGN. Most of such networks operated around the world are built in accordance to the IPCC concept. Selection of second architecture is supported by the fact that a large number of new technologies are being supported by IPCC. This allows the operator to make a dedicated network configuration and to expand network which will optimally interact with the already installed network equipment.

Additionally, under the conditions which now exist in Ukraine and many countries of Eastern Europe, the IPCC architecture allows to make a smooth

FIGURE 2. The 3G coverage of one of the leading mobile network operators in Ukraine

transition from the public telephone network (PSTN) to NGN. Such a business plan requires a smaller initial investment, while facilitating the gradual switch to modern equipment, while usually being more attractive and acceptable for the owners of the telecommunication network.

The biggest known drawback of the IPCC concept is the problem of compatibility between different equipment. IMS/TISPAN architectures simplify the problems that arise when using the concept of IPCC. In addition, it facilitates the convergence of mobile and fixed communications. Of course, from the point of view of the global network, the TISPAN architecture is an option as well, but not in the form of a simple controller connected to another controller, as the IPCC is regarded to be.

However, the possibilities of NGN with TISPAN architecture should be clarified in the future. But NGN with the IPCC architecture is now quite usual and familiar thing, which is used in many countries. So, a gradual transition to NGN using the already installed equipment is considered to be the optimal solution for Eastern European countries. Therefore, in the near future the NGN will be developed there most likely as a network using the architecture proposed by IPCC.

Intellectual services (ISes), which are granted by the application level of NGN, include Televoting (VOT), Virtual private networks (VPN), Abbreviated dialing (ABD) and many others. The variety of IS is growing day by day and the demand for them is growing as well. The Applications Level with Centralized Structure (ALCS) is usually used to manage the IS in NGN. In this context, one of the major issues regarding Eastern European telecom is the development of the implementation principles of the application level for the NGN to improvements of the provision control quality of ISes.

The review of NGN architecture is discussed in the works by B.S. Goldstein, O.B. Goldstein [4], M.O. Sokolov, A.A. Attsyk, A.V. Pinchuk, Y.S. Kryukov, A. Titov, M. Hlinnykova, O.B. Antonyan, E.M. Skuratovsky, I.G. Baklanov, V.V. Makarova. The NGN-architecture developed by them has been implemented by telecom leaders such as Alcatel, Ericsson, Lucent Technologies, Siemens, and Russian manufacturer - STC "Proteus".

The network service control issues, and of the evaluation of efficiency of the control systems, and also of the design of criteria of control quality are considered in the works of V.K. Steklov [5], V.G. Kryvutsa, L.N. Berkman, N.A. Knyazeva, E.V. Kilchitskaya, V.V. Makarova, B.J. Kostika, E. Steinberg, A.N. Starodub, N.Y. Parshenkov. The quality of service supported by NGN, was discussed by such authors as P. Ferguson, R. Haston.

2. Main results

The purpose and statement of the problem

The quality of NGN services significantly depends on the structure of the application level of the network. Based on the existing structures of the application level and also with the intension to improve the provision control quality of ISes, the authors propose the new way of organizing the application level and suggest comprehensive quality control criteria for NGN providers.

Variants of the structure of the NGN application level

Currently, there are essentially two distinguished concepts of building the application level: with a centralized structure or with a distributed structure.

The application level with a centralized structure

Modern NGNs normally use the Applications Level with the Centralized Structure (ALCS). Details of the network with such architecture are shown in Figure 3.

The ALCS modules responsible for control of ISes consist of Softswitches, which provide an SSF switching service, and also a Server, which provides the function maintenance service of SCF. It is assumed that there are several geographically separated areas. Network Control of the district of the area is performed by the installed Softswitch. Each Softswitch manages the transport network while being the switching point of IS. Each district has its own data network and its own signaling network.

The schematic in Figure 3 highlights the signaling network. Each district network must be connected to the single Softswitch. This schematic shows details for just one of districts. If the regional network uses not only packet-switched technology, but also switching channels, the Signaling Gateway (SG) in the signaling network and Media Gateway (MG) in the data network should be set.

SG - the device which mediates the interaction between packet transport networks and access networks at the signal level. Its function is to convert formats of the signaling messages. MG provides communication between packet-switched network and circuit-switched network, performing protocol and data format conversion. It can perform information flow processing and, in some cases, it provides support of the subscriber alarm system. MG is divided into transport gateways, which serve as the transition nodes between the PSTN and packet networks, and access gateways serving to connect users.

Intellectual services are given as follows. The requests for the IS comes from the user. If the user is in the IP network, packets are sent directly to the relevant Softswitch. If the user sent requests from outside the IP network, then the packets will be sent only after transformations by MG and SG. The Softswitch determines whether the ordered service is an intellectual service. If it is true, the switching to IS occurs and a request to the dedicated server is sent (this request is transmitted via the signaling network). If the server is not busy, it starts to serve the request. In the other case, it is checked whether there is a place in the buffer queue. If there is no free place, the application request is lost. Otherwise, the application is put into the queue and waits for service.

In [6] the drawbacks of NGN with ALCS are analyzed in detail:

1. There may be a problem regarding limited throughput of the signaling network and productivity of IS control centers. If the number of users using the IS grows, so does the number of requests for the IS and the resultant load per signaling network and control center for sequent providing the IS. This can degrade network productivity, which will either become unacceptable to the users or make it impossible to support the principle of centralized control.

2. Certain types of IS, within their properties, are not designed for centralized performance (for example, IS which forbid certain received calls

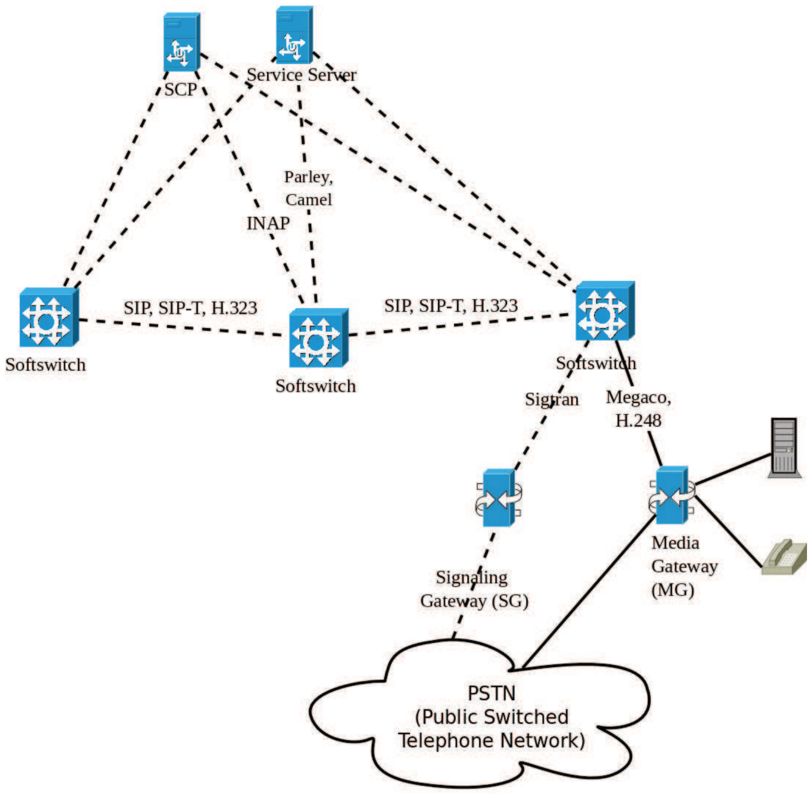

Figure 3. The NGN application level built according to the principle of centralized control

according to certain criteria). The criteria may vary depending on network conditions. The throughput limit of the signaling systems and an individual character of the criteria that have to sort calls lead to the need to determine the possibility of providing decentralized management of IS.

3. There exist intellectual services which do not admit performance degradation. Obviously, for the control of such IS it is necessary to establish the possibility to use the decentralized control. Decentralization, most of all, will reduce the delay of IS.

The application level with distributed structure

To manage the ISes in the Intelligent Network (IN), which was the forerunner of NGN and had great influence on it, the standard Applications Level with Distributed Structure (ALDtS) was offered. The architecture of the ALDtS is shown in Figure 4.

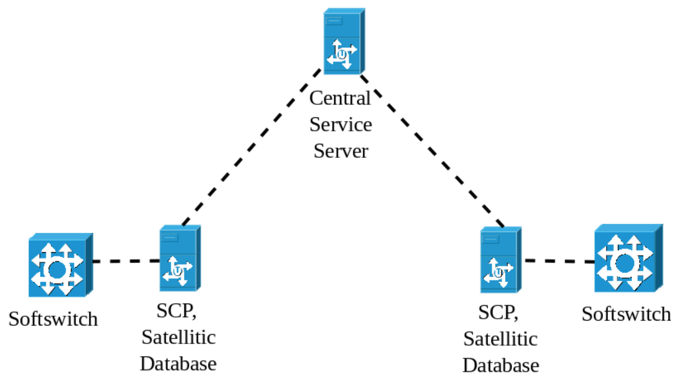

FIGURE 4. The NGN application level built according to the principle of distributed control

This architecture provides for the existence of the central server which contains all the necessary data and the logic of provisioning of ISes. At the same time, it provides for the existence of the Service Control Points (SCPs) with its own databases which are put into a switching points of service. They contain data and service logic for the most commonly used services. There are several districts with their own service control and own databases. Service Switching Point (SSP) and the Call Control Point (CCP) are physically located in a Softswitch. In the case of increasing the number of requests for some ISes, which are not in their own database, the data and the logic for the services can be downloaded from a central server. IS is given as follows. The request, similar to the ALCS case, goes to the Softswitch. The Softswitch asks the SCP and their own database. If the necessary data and service logic for that IS are found, then the request is served. In the other case, the request is sent to the central server for transmitting necessary information to the appropriate SCP. After receiving the data, the service is performed.

The architecture of a network with ALDtS can solve a part of the problems arising in the ALCS case. First of all, it allows reduction of the total time of service of IS requests. However, as it is illustrated in Figure 4, SCPs are not connected directly. Therefore, in the case of failure of the central server this control system is not able to function normally. In this case, at the request of the IS, which is not in its own database, the SCP cannot handle the request, regardless of normal functioning.

To solve the aforementioned problems, the authors proposed an alternative structure, called the Applications Level with Decentralized Structure

(ALDS), which is based on the concept of IPCC. The architecture of the network with the ALDS provides several service switching units (Softswitches) and several service control units (servers). Calculation of the number of servers and Softswitches is a separate problem that is not discussed in this paper.

The authors have proposed two approaches to the realization of ALDS. Using both approaches, first of all, the IS have to be classified. The classification may be performed, for example, according to the IS technologies. Some ISes, however, do not allow the delay of performance, those should be united under a separate class [7-9].

After that, by the first approach, each server has to contain the service logics for all classes of ISes (universal server). That is, each server repeats all the possibilities of the united center that operates in ALCS.

The second approach requires the usage of specialized servers. In such a case, the classes of ISes may be completed in accordance to the requests for their certain types on the corresponding territory. A certain set of classes of ISes and their service logic should be placed in a separate ISes control node (server). For each set of classes there should be its own node. It is necessary to predict the possibility to provide one set of the classes of ISes by several servers in the case of failure of any server. This variant seems to be the optimal. Believing that servers are specialized, the authors propose to consider the NGN with the ALDS.

While NGN architecture with the ALCS is investigated and described in detail, without paying attention to the lack of clear standards, problems of NGN architecture with the ALDS seem not to have been sufficiently investigated. In scientific works one can find only some variants of decentralized control of simplified systems. However, for NGN it has been believed until now that using the ALCS is the best solution.

The network architecture proposed by the authors of NGN with ALDS based on the concept IPCC is shown in Figure 5. As shown in Figure, the existence of multiple geographically separated areas is allowed. Each of them has its own Softswitch which controls district transport network and performs Switching Service Functions (SSF). Each district has its own data network and signaling network as well. In Figure 5, greater emphasis is put on the signaling system because of the subject of the article. A district network must be connected to a separate Softswitch. For simplicity, such a connection is shown in the Figure only for one of Softswitches.

If the district network uses both packet and channel switching technologies, it is necessary to establish the SG in the signaling network and the MG in the data transmission network.

While using the ALDS, the server performing the logic of the IS complex has to be placed next to the Softswitch. Then it can be assumed that the intellectual service is carried out practically at the point of switching service.

Figure 5 shows the distribution of NGN among the data transmission network (the transport platform) and the application level. At the lower layer of pseudo 3D scheme, the authors tried to show the data transmission network, at the higher layer - the application level.

The application level constitutes practically the separate logical network which is needed to exchange information and control messages between servers. This network may be carried out by the signaling network or by the data transmission network. However, as it is seen in Figure 5, the advantage is given by the authors to the signaling system. During an exchange of information between servers a protocol: MGCP, MEGACO, SIP can be used. The connection between the Softswitch and the server may be realized through an open API (Parlay, Camel).

In such architecture, the provision of IS is performed as follows. The request for IS comes from the user. If the user is in the IP-network, the packets are coming directly to a certain Softswitch. If the user is out of IP-network, the packets are coming only after transformations in MG and SG. If the service is not an IS, then it is provisioned by the Softswitch software. If it is the IS, then the Softswitch sends a request to a directly connected server to perform the request. If the server is not busy, it serves the request. Otherwise, a queue buffer check takes place. If it fails, the request will be lost. If there is a space, the request is placed into the queue.

Due to the fact that servers in different areas may contain different sets of classes of services and service logic, a situation where the server of the certain district will be not able to serve the request may occur. In that case, the server should redirect the request to the server of another district which will be able to perform the request. When selecting such a server, it's necessary to use the probability matrix of transitions of requests from the current server to another server for the corresponding class of IS. After examining the situation, the request will be sent from the current server to the selected server. If the selected server is not busy, the service will start. If it is busy, the request is placed into the queue. If there is no place in the server buffer, the request will be lost.

In the case that the server which is connected to the Softswitch breaks down, the Softswitch stops performing the IS switching function and sends the request to another Softswitch.

Comparing the logic of service provision in the ALCS and in the ALDS, one can assume that the architecture of NGN with ALDS will function

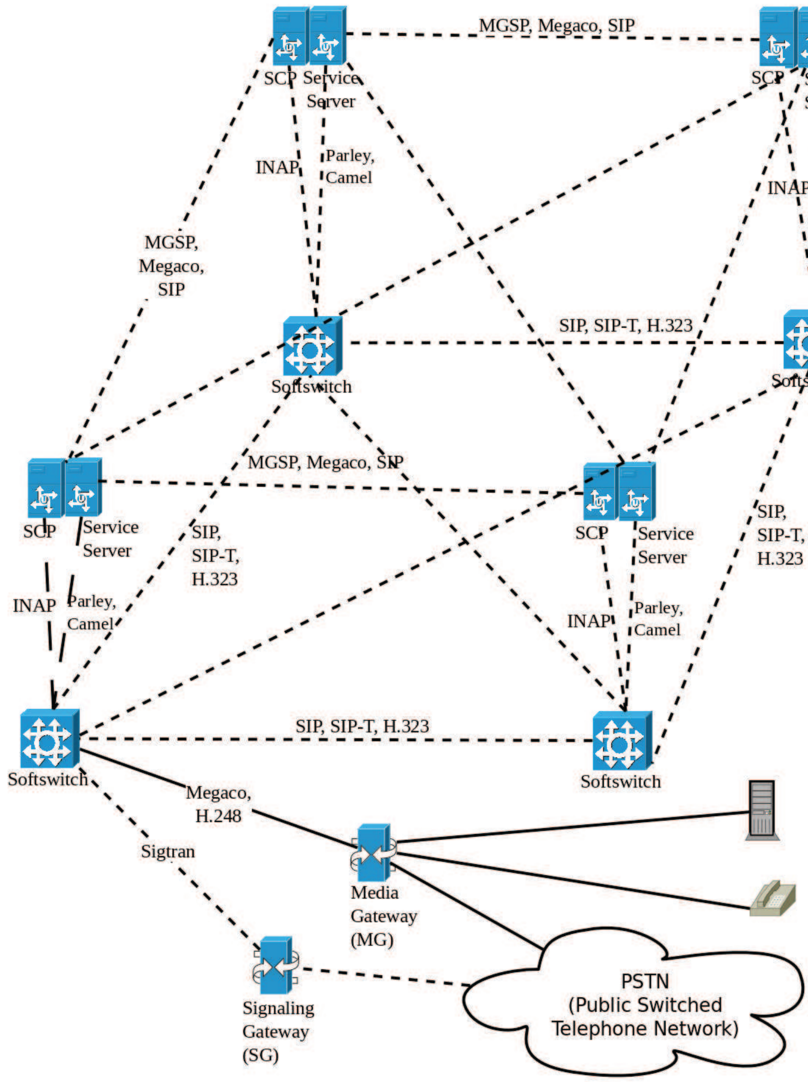

Figure 5. The NGN application level built according to the principle of decentralized control

better under significant network loads. It may happen for example, due the upsurge of the number of users and the number of IS applications at the success of the business campaign of telecom operator. However, the final conclusions can be made only after comparing the quality of IS provision control in the case of IALCS and ALDS. For a final resolution, it is necessary to create a comprehensive criterion of quality that will take into account the interests of all participants of IS provision process - service providers, equipment suppliers, and users.

Evaluation of intelligent services provisioning quality

The authors propose a methodical approach to evaluating of the IS provision control quality.

This approach should be implemented in the following six step sequence:

1. Decision about the degree of influence of each participant of the IS process on the value of the complex criterion of quality of control.
2. Selection of subcriteria for each participant of the process.
3. Creation the weighted coefficients for subcriteria.
4. Assessing the value achieved by each subcriterion.
5. Calculating the resulting scores for each participant of the process.
6. Calculating the complex criteria of the quality.

Let us consider the implementation of steps of the proposed methodical approach to assess the quality of control the IS provision from the perspective of all participants of the process.

Step 1. Decision about the degree of influence of each participant of the IS process on the value of the complex criterion of quality of control.

First of all, it is necessary to take into account the degree of importance of each participant of the process, more precisely the degree of its impact on the complex control quality criterion of the intellectual services provision. This is possible using the method of expert evaluations. Each ith participant of the process has to be assigned "weight" W_i in the accepted assessment system. If the experts conclude that the impact of some of the participants on the result is equal, they can set to them equal "weights" W_i.

Step 2. Selection of subcriteria for each participant of the process

For each participant of the process of forming the complex control quality criterion of the IS provision (for service provider, equipment supplier, and network user) the indexes have to be determined, which should be taken into account forming the complex criterion (hereinafter let us call them subcriteria).

From the user's viewpoint, the quality of control of provision of intellectual services can be most accurately evaluated using the value of users' satisfaction with the quality of received IS, which is formed by combination of different elements: user's equipment $\overline{E_u}$, service transport $\overline{T_s}$, service provision $\overline{P_s}$, and content creation $\overline{C_c}$ [10].

From the service provider's viewpoint, the quality of control may be evaluated by the complexity of the service logic implementation and administration $\overline{S_t}$ and by the quantity of successfully provided $\overline{S}$ that will raise the demand for them. It should be noted that the complexity of the service logic implementation and administration $\overline{S_t}$ is the subcriterion, the achieved level of which for ALCS and ALDS have to be established by the method of expert evaluations.

From the equipment supplier's viewpoint, the quality of control may be evaluated by indexes determined by the ITU-T Recommendations Y.1541 [10], namely: by time of service provision $\overline{T_{cs}}$ and by the probability of refuse of service provision $\overline{P_B}$. In addition to the specified subcriteria, in accordance with the ITU Recommendations for future networks [1, 12], the following quality indicators are proposed as subcriteria: structural survivability $\overline{P_{st}}$ and reliability of control systems $\overline{R}$. Additionally, it is proposed to take into account the cost of the intelligent superstructure $\overline{C}$.

Step 3. Creating the weighting coefficients for subcriteria

To take into account the degree of importance of each participants' subcriterion, the weighting coefficients K_{ij} have to be determined using expert evaluations. Here, j is a number of subcriterion of the ith participant of the process (see Table 1, column 2). The values of obtained weighting coefficients are normalized for each ith participant of the process, i.e. $\sum_{j=1}^{n_i} K_{ij} = 1$ (n_i is the number of subcriteria of the ith participant of the process, the values n_i can be different for each ith participant).

Step 4. Assessing the value achieved by each subcriterion

For each subcriterion of each participant of the process the acceptable maximum or minimum (depending on the subcriterion type) and current values (in appropriate units or in scores) are determined.

For each subcriterion the relative scores O_{ij} are found. Relative score may be formed as a product of the ratio of the current indicator value and its maximum acceptable value (or based on the ratio of minimum acceptable value and the current indicator value) and a weighting factor K_{ij} of the subcriterion determined in step 3. The method of calculation of each relative score is shown in Table 1 (column 5 is for ALCS and column 8 is for ALDS). Column 3 includes maximal or minimal acceptable values of the quality subcriteria for further definition of relative scores O_{ij}. Column 4 contains the current values of the quality subcriteria. Columns 6 and 7 are filled similarly for ALDS.

Step 5. Calculating the resulting scores for each participant of the process

At this stage, the resulting value is determined: it is an overall weighted score A_i of all the subcriteria for each ith participant of the process:

$$A_i = \sum_{j=1}^{n_i} O_{ij} \tag{1}$$

where O_{ij} is the relative score obtained for the jth subcriterion of the ith participant of the process and determined in step 4; $i = \overline{1, m}$ and m is the number of participants of the process; $j = \overline{1, n_i}$, n_i is the number of subcriteria for the ith participant of the process.

Step 6. Calculating the complex criterion of the quality

At this stage, the value of the resulting complex quality criterion for the application level with centralized and decentralized control architecture is calculated for each ith participant of the process. Having the values of the resulting score A_i (see formula (1)), the complex quality criterion K for ALCS and ALDS is calculated considering the interest of all the participants of the process:

$$K = \sum_{i=1}^{m} A_i W_i \tag{2}$$

The obtained value of the complex quality criterion K (formula (2)) for the ALCS and ALDS leads to the conclusion about feasibility of their application for control of provision of ISes.

Table 1 summarizes the method of calculating the relative valuations O_{ij} as well as the total weighted assessment of all subcriteria for each ith participant of the A_i process with the following initial data:
- the number of participants of the process $m = 3$;
- the number of subcriteria for the first participant of the process $n_1 = 4$;
- the number of subcriteria for the second participant of the process $n_2 = 2$;
- the number of subcriteria for the third participant of the process $n_3 = 5$.

The complex quality criterion K is calculated based on formula (2).

3. Final remarks

Conclusions and prospects for further research

1. The Next Generation Network with ALDS architecture is based on the IPCC concept in order to improve the quality control of IS provisioning. Two approaches to realizing the ALDS have been proposed. Using the first approach, each server contains the logic of service of all classes of services (universal server). That is, each of the servers repeats all the capabilities of a separate server that functions at ALDS. The second approach predicts the use of specialized servers.

2. On the basis of recommendations of the ITU, according to analysis of modern scientific publications concerning the issue of quality control in the provided services, the researchers recommend to evaluate the effectiveness of the control of provisioning ISes by means of complex criterion which takes into account the interests of three participants of IS process – service providers, equipment suppliers and network users.

Quality subcriterion	Weight of the subcriterion	Application level structure which is analyzed					
		ALCS			ALDS		
		Maximal or minimal admissible value	The resulting value	Evaluation (O_{ij})	Maximal or minimal admissible value	The resulting value	Evaluation (O_{ij})
1	2	3	4	5	6	7	8
I.From the user's viewpoint							
1. Customer Equipment,$\overline{E}_u$	K_{11}	$\overline{E}_{u_{\mathrm{ALCS}}}(\max)$	$\overline{E}_{u_{\mathrm{ALCS}}}$	$\frac{K_{11}\overline{E}_{u_{\mathrm{ALCS}}}}{\overline{E}_{u_{\mathrm{ALCS}}}(\max)}$	$\overline{E}_{u_{\mathrm{ALDS}}}(\max)$	$\overline{E}_{u_{\mathrm{ALDS}}}$	$\frac{K_{11}\overline{E}_{u_{\mathrm{ALDS}}}}{\overline{E}_{u_{\mathrm{ALDS}}}(\max)}$
2. Service Transport, $\overline{T}_s$	K_{12}	$\overline{T}_{s_{\mathrm{ALCS}}}(\max)$	$\overline{T}_{s_{\mathrm{ALCS}}}$	$\frac{K_{12}\overline{T}_{s_{\mathrm{ALCS}}}}{\overline{T}_{s_{\mathrm{ALCS}}}(\max)}$	$\overline{T}_{s_{\mathrm{ALDS}}}(\max)$	$\overline{T}_{s_{\mathrm{ALDS}}}$	$\frac{K_{12}\overline{T}_{s_{\mathrm{ALDS}}}}{\overline{T}_{s_{\mathrm{ALDS}}}(\max)}$
3. Service Provision, $\overline{P}_s$	K_{13}	$\overline{P}_{s_{\mathrm{ALCS}}}(\max)$	$\overline{P}_{s_{\mathrm{ALCS}}}$	$\frac{K_{13}\overline{P}_{s_{\mathrm{IALCS}}}}{\overline{P}_{s_{\mathrm{ALCS}}}(\max)}$	$\overline{P}_{s_{\mathrm{ALDS}}}(\max)$	$\overline{P}_{s_{\mathrm{ALDS}}}$	$\frac{K_{13}\overline{P}_{s_{\mathrm{ALDS}}}}{\overline{P}_{s_{\mathrm{ALDS}}}(\max)}$
4. Content Creation, $\overline{C}_c$	K_{14}	$\overline{C}_{c_{\mathrm{ALCS}}}(\max)$	$\overline{C}_{c_{\mathrm{ALCS}}}$	$\frac{K_{14}\overline{C}_{c_{\mathrm{ALCS}}}}{\overline{C}_{c_{\mathrm{ALCS}}}(\max)}$	$\overline{C}_{c_{\mathrm{ALDS}}}(\max)$	$\overline{C}_{c_{\mathrm{ALDS}}}$	$\frac{K_{14}\overline{C}_{c_{\mathrm{ALDS}}}}{\overline{C}_{c_{\mathrm{ALDS}}}(\max)}$
Total	$\sum_{j=1}^{4} K_{ij} = 1$			$\sum_{j=1}^{4} O_{ij}$			$\sum_{j=1}^{4} O_{ij}$

Quality subcriterion	Weight of the subcriterion	Application level structure which is analyzed					
		ALCS			ALDS		
		Maximal or minimal admissible value	The resulting value	Evaluation (O_{ij})	Maximal or minimal admissible value	The resulting value	Evaluation (O_{ij})
1	2	3	4	5	6	7	8
II.From the service provider's viewpoint							
1. The complexity of the logic of implementation and of administration of the service, $\overline{St}$	K_{21}	$\overline{St}_{\mathrm{ALCS}}(\min)$	$\overline{St}_{\mathrm{ALCS}}$	$\frac{K_{21}\overline{St}_{\mathrm{ALCS}}(\min)}{\overline{St}_{\mathrm{ALCS}}}$	$\overline{St}_{\mathrm{ALDS}}(\min)$	$\overline{St}_{\mathrm{ALDS}}$	$\frac{K_{21}\overline{St}_{\mathrm{ALDS}}(\min)}{\overline{St}_{\mathrm{ALDS}}}$
2. The number of successfully provided IS, $\overline{S}$	K_{22}	$\overline{S}_{\mathrm{ALCS}}(\max)$	$\overline{S}_{\mathrm{ALCS}}$	$\frac{K_{22}\overline{S}_{\mathrm{ALCS}}}{\overline{S}_{\mathrm{ALCS}}(\max)}$	$\overline{S}_{\mathrm{ALDS}}(\max)$	$\overline{S}_{\mathrm{ALDS}}$	$\frac{K_{22}\overline{S}_{\mathrm{ALDS}}}{\overline{S}_{\mathrm{ALDS}}(\max)}$
Total	$\sum_{j=1}^{2} K_{ij} = 1$			$\sum_{j=1}^{2} O_{ij}$			$\sum_{j=1}^{2} O_{ij}$

Quality subcriterion	Weight of the subcriterion	Application level structure which is analyzed					
		ALCS			ALDS		
		Maximal or minimal admissible value	The resulting value	Evaluation (O_{ij})	Maximal or minimal admissible value	The resulting value	Evaluation (O_{ij})
1	2	3	4	5	6	7	8
III.From the equipment supplier's viewpoint							
1. Time for Service Provision, $\overline{T}_{cs}$	K_{31}	$\overline{T}_{cs_{ALCS}}(\min)$	$\overline{T}_{cs_{ALCS}}$	$\frac{K_{31}\overline{T}_{cs_{ALCS}}(\min)}{\overline{T}_{cs_{ALCS}}}$	$\overline{T}_{cs_{ALDS}}(\min)$	$\overline{T}_{cs_{ALDS}}$	$\frac{K_{31}\overline{T}_{cs_{ALDS}}(\min)}{\overline{T}_{cs_{ALDS}}}$
2. The probability of Refusing at Service Provision,$\overline{P}_B$	K_{32}	$\overline{P}_{B_{\mathrm{ALCS}}}(\min)$	$\overline{P}_{B_{\mathrm{ALCS}}}$	$\frac{K_{32}\overline{P}_{B_{\mathrm{ALCS}}}(\min)}{\overline{P}_{B_{\mathrm{ALCS}}}}$	$\overline{P}_{B_{\mathrm{ALDS}}}(\min)$	$\overline{P}_{B_{\mathrm{ALDS}}}$	$\frac{K_{32}\overline{P}_{B_{\mathrm{ALDS}}}(\min)}{\overline{P}_{B_{\mathrm{ALDS}}}}$
3. Structural survivability, $\overline{P}_{st}$	K_{33}	$\overline{P}_{st_{ALCS}}(\max)$	$\overline{P}_{st_{ALCS}}$	$\frac{K_{33}\overline{P}_{st_{ALCS}}}{\overline{P}_{st_{ALCS}}(\max)}$	$\overline{P}_{st_{ALDS}}(\max)$	$\overline{P}_{st_{ALDS}}$	$\frac{K_{33}\overline{P}_{st_{ALDS}}}{\overline{P}_{st_{ALDS}}(\max)}$
4. Reliability, $\overline{R}$	K_{34}	$\overline{R}_{\mathrm{ALCS}}(\max)$	$\overline{R}_{\mathrm{ALCS}}$	$\frac{K_{34}\overline{R}_{\mathrm{ALCS}}}{\overline{R}_{\mathrm{ALCS}}(\max)}$	$\overline{R}_{\mathrm{ALDS}}(\max)$	$\overline{R}_{\mathrm{ALDS}}$	$\frac{K_{34}\overline{R}_{\mathrm{ALDS}}}{\overline{R}_{\mathrm{ALDS}}(\max)}$
5. Cost of intelligent superstructure, $\overline{!}$	K_{35}	$\overline{!}_{\mathrm{ALCS}}(\min)$	$\overline{!}_{\mathrm{ALCS}}$	$\frac{K_{35}\overline{!}_{\mathrm{ALCS}}(\min)}{\overline{!}_{\mathrm{ALCS}}}$	$\overline{!}_{\mathrm{ALDS}}(\min)$	$\overline{!}_{\mathrm{ALDS}}$	$\frac{K_{35}\overline{!}_{\mathrm{ALDS}}(\min)}{\overline{!}_{\mathrm{ALDS}}}$
Total	$\sum_{j=1}^{5} K_{ij} = 1$			$\sum_{j=1}^{5} O_{ij}$			$\sum_{j=1}^{5} O_{ij}$

Table 1. The calculations of the relative and total weighted ratings

3. Subcriteria are defined for each participant which should be taken into account when creating the complex criterion. The method for calculating each subcriterion has been proposed.

4. The problem of association of subcriteria into the resulting complex criterion has been solved. For the formation of complex criterion, a methodical approach has been proposed, which takes into account the performance of the next steps:

- Decision about the degree of influence of each participant of the IS process on the value of the complex criterion of quality of control.
- Selecting subcriteria for each participant of the process.
- Creating the weighting coefficients for subcriteria.
- Assessing the value achieved by each subcriterion.
- Calculating the resulting scores for each participant of the process.
- Calculating the complex criterion of quality.

The suggested methodical approach allows us to determine a complex quality criterion for providing ISes, and it can be used by designers of NGN, as well as by providers of typical multi-service network, for making the decisions concerning the choice of the application level structure.

References

[1] ITU-T: Telecommunication Standardization Sector, *Next Generation Networks: Frameworks and functional architecture models*, In: General overview of NGN, ITU-T Recommendation Y.2001 (12/2004), Printed in Switzerland Geneva, 2005, p. 5.

[2] J.L. Salina, P. Salina, *Next Generation Networks: Perspectives and Potentials*, Wiley, 2008.

[3] A. Yatsko, W. Susłow, *Insight into Theoretical and Applied Informatics. Introduction to information technologies and computer science*, De Gruyter Open, 2015.

[4] B.S. Goldstein, *Post-NGN communication networks*, In: B.S. Goldstein, A.E. Kucheryavy. St. Petersburg: BHV-Petersburg, 2013.

[5] V.G. Krivuca, V.K. Steklov, L.N. Berkman, B.J. Kostik, V.F. Olijnik, *Telecommunications control with the latest technology*, Kiev: Technika, 2007.

[6] S.V. Shestopalov, *Architecture of NGN with centralized and decentralizing control system*, In: 10th Anniversary International Scientific Conference "Modern Problems of Radio Engineering, Telecommunications and Computer Science" TCSET'2010, Lviv, 2010.

[7] N.A. Kniazieva, S.V. Shestopalov, *Improving the quality of service management by using the decentralized management system*, Visnyk DUIKT[1], vol. 8, issue 1, p. 21-28.

[8] S.V. Shestopalov, N.A. Kniazieva, *The method of improvement of the services management process*, In: II International scientific and technical symposium "New technologies in telecommunications" - (DUIKT- Carpathians' 2009, p. Vyshkiv), Kyiv, DUIKT, 2009, pp. 39-40.

[1]State University of Telecommunications, Ukraine

[9] S.V. Shestopalov, *Indicators of services management quality NGN*, In: Scientific Conference "Modern information and communication technologies" COMINFO'2008-Livadia, Theses of the report, Kyiv, DUIKT, 2008, pp. 187-189.
[10] N.A. Kniazieva, *Evaluation of the quality of communication services from the point of view of customer satisfaction*, In: N.A. Kniazieva, A.S. Kalchenko, Science and Education a New Dimension: Natural and Technical Science, vol. 8, Budapest, 2013, p. 156-161.
[11] *Network performance objectives for IP-based services*, ITU-T: Telecommunication Standardization Sector, Y.1541, Geneva, 2007.
[12] *About International Telecommunication Union (ITU)*, http://www.itu.int/en/about/Pages/default.aspx

Received: May 2017

Nina Kniazieva
Odessa National Academy of Food Technologies,
Department of information technology and cyber security,
1/3 Dvoryanskaya Street, 65-082 Odessa, Ukraine
E-mail address: `knyazeva@ukr.net`

Serhii Shestopalov
Odessa National Academy of Food Technologies,
Department of information technology and cyber security,
1/3 Dvoryanskaya Street, 65-082 Odessa, Ukraine
E-mail address: `shestopalov.s@mail.ru`

Walery Susłow
Koszalin University of Technology, Poland,
Faculty of Electronics and Computer Science,
2 Śniadeckich Street, 75-453 Koszalin, Poland
E-mail address: `walery.suslow@tu.koszalin.pl`

Andrzej Yatsko
Koszalin University of Technology, Poland,
Faculty of Civil Engineering Environmental and Geodetic Sciences,
2 Śniadeckich Street, 75-453 Koszalin, Poland
E-mail address: `andrzej.jacko@gmail.com`