Management of computing and information system

METHOD FOR DETERMINATION OF INTERRELATION BETWEEN ACCESS NETWORK CHARACTERISTICS

Galyna Gayvoronska, Svetlana Sakharova

***Annotation**: The paper is dedicated to the solving of the task of analyzing the access networks parameters and to the determination of correlations between them. Considering the network total cost as a system consisting of many individual components, there is given example of the establishment of relations between the components making the cost of the access network.*

***Keywords**: access network, access network parameters, correlation between the parameters, interrelation scheme.*

***Keywords classification of ACM**: C.2. Computer-communication networks, H. Information Systems - H.1 Models and Principles, K. Computing Milieux - K.6 Management of computing and information system*

Introduction

Nowadays one of the major problems in the field of telecommunications is the designing of perspective access networks (AN). The access networks are segment of the next generation networks (NGN) and provide access to all basic networks, which services are ordered by the user over a single access line (AL).

On the basis of the analysis of international standards and recommendations [1] and regional organizations for standardization in the field of AN designing the basic models for building of access segment were allocated and researched [2-4].

As researched AN have set of parameters which is different from the parameters of the existing subscriber networks, it's necessary to analyze and make a characterization of these parameters, to identify the correlation between them and bring them into a form suitable for modeling. The optimal network structure and consequently its cost will vary depending on the variation of predicted parameters. Even a slight change in the initial values can significantly affect the resulting performance, which indicates the importance of researching the question of how variations in input parameters affect the network configuration and its cost.

The necessity of analysis problem's solving is indicated in the work [4] at the statement of the research problem.

Made earlier [4-12] analysis of the initial parameters of AN allowed to identify those one that didn't significantly affect the process of network creating and could be neglected and essential in creating AN parameters influencing on their structure and cost. To classify parameters by their importance at the AN designing signs for the classification parameters were marked. Taking into consideration that there was allocated big number of parameters at the access system research for further research chosen parameters were divided into groups.

All set of the AN parameters is divided into two categories: qualitative and quantitative, which defined by the ranges and gradation of values taken by them.

Statement of the problem

The aim of the study is to improve the efficiency of perspective AN designing, to reduce the cost of their creation and to improve the operational efficiency.

The object of the study is the predicted parameters of AN.

The subject of the study are methods for analyzing the parameters of AN.

On the base of results presented earlier in authors works [4-12] there are following problems solving in this paper:

– forming the model for research the effect of the forecasted parameters’ variations on the resulting characteristics of AN;
– identifying the forecasted parameters that affect the values of the AN resulting characteristics;
– constructing the interrelation scheme of AN parameters;
– identifying the correlation between forecasted parameters.

The model for research of forecasted parameters' variation’s impact on the resulting characteristics of AN

The influence of the forecasted parameters’ variation on the characteristics of the designing AN is solved in this work. It is done by means of imitating modeling methods. For these purpose it is proposed the structure of the research, presented in Figure 1.

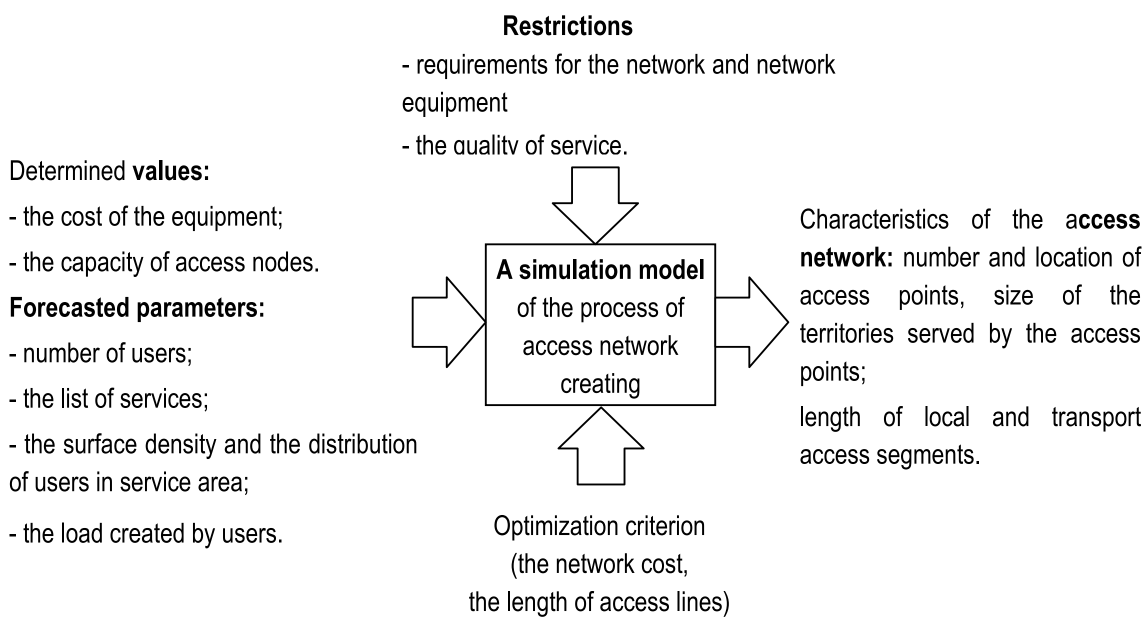

Figure 1. The model for research of forecasted parameters' variation’s impact on the resulting characteristics of AN

Forecasted parameters are chosen as the initial values. They include, first of all, the number of AN users, the list of infocommunication services (ICS), the surface density and the distribution of users at the AN service area, the load created by these users and many other variables. To implement the model, simulating the process of AN creating, several authors solutions are offered. They allow obtaining optimal values of the AN resulting characteristics, including number, capacity and location of access points (AP), sizes of areas served by these nodes (APT), the total cost of the network. The network cost and the length of the AL local segment are selected as the criteria for optimization. Quality of rendering services, network requirements to the network and network equipment are specified as restrictions. Peculiarities of the territory where construction of AN is planned and the presence of natural obstacles and objects which prevent the laying of lines and installation of AP are also considering. Users can connect to service rendering point (SRP) directly without the use of AP. The lines for which AP are used may have one-level or two-level structure of the connection, thus possible combinations of AP can have place. Options for users connecting to the SRP using direct connection and AL one-level structure: through individual AL for users located within the territory served by the SRP, through concentrators (C) for rather large groups of remote users, through multiplexers (M, for groups of remote users with digital terminals. Variants with two-level structure for connection of small groups of remote users: through concentrators connected to other concentrators, through concentrators connected to multiplexers, through multiplexers connected to other multiplexers, through multiplexers connected to concentrators.

AN parameters interrelation scheme

At the analysis of AN resulting characteristics forecasted parameters affecting the value of properties are discovered. Bandwidth of access nodes depends on the forecasted values: the number of users N_p connected to the node and the load created by these users:

$$\omega_{AP} = f_1(N_p, \omega_p, \omega_1, \omega_2, n_2)\,, \qquad (1)$$

were: ω_p – average bandwidth of one connection to the AP;

ω_1 – bandwidth of the access transport segment connecting AP with the SRP;

ω_2 – bandwidth of the link between the access nodes if two-level structure is used, $\omega_2 = 0$ at the one-level AP connection structure;

n_2 – number of AP.

The total bandwidth of the access transport segment's links which are to be connected to the AP at the one-level structure is being determined by the forecasted values:

$$\omega_1^{'} = f_2(N_p, \omega_p)\,. \qquad (2)$$

The forecasted surface density η of users and their placing in the service area affect the length of the AL segment.

For the rectangular structure:

$$l_{RecS} = f_3(\eta, \eta_{AP}, a, b, a_{SRP}, b_{SRP}, a_{AP}, b_{AP}, N_{SRP}, N_{AP}, N_{SRPT})\,, \qquad (3)$$

where: a, b – sizes of the rectangular sides of the territory served by the AN;

a_{SRP}, b_{SRP} – sizes of the rectangular area sides where AL are connected directly to the SRP;

a_{AP}, b_{AP} – sizes of the rectangular sides of the territory served by single AP;

η_{AP} – surface density of AP distribution;

N_{AP} – number of AL connected to the AP;

N_{SRP} – number of AL connected to the SRP;

N_{SRPT} – number of AL connected directly to the SRP within the territory served by AP.

For the radial structure:

$$l_{RadS} = f_4(\eta, \eta_{AP}, R, R_{SRP}, R_{AP}, m_{SRP}, N_{SRP}, N_{AP}, N_{SRPT}), \quad (4)$$

where R – AN territory radius;

R_{SRP} – radius of the territory where AL are connected to SRP;

R_{SRP_i} – radius of i^{th} SRP servicing;

m_{SRP} – number of SRP connected by AL;

R_{AP} – radius of the area serviced by single AP;

N_{AP} – number of AP at the APT;

R_{APT_i} – radius of i^{th} APT.

Optimal number of AP at the analyzed territory of AN:

$$n = f_5(N_0, c_1, \omega_1). \quad (5)$$

Common equation of AL costs:

$$C = f_6(c_{TC}, l_{TC}, c_{LC}, l_{LC}, c_T, L_T, \beta_T, l_T, \omega_T, c_L, L_L, \beta_L, l_L, \omega_L, c_{AP}, c'_{AP}, N_{L1}, c_P, v_P), \quad (6)$$

where for the AL local and transport segments:

c_{TC}, c_{LC} – cost of the length unit of the cable path construction;

c_T, c_L, c_{AP} – initial cost of length unit of the cable and AP;

l_{TC}, l_{LC} – length of the cable path construction;

L_T, L_L – total cable length;

l_T, l_L – average length of single AL;

β_T, β_L – coefficient for accounting the dependence between the cable cost and its bandwidth;

ω_T, ω_L – bandwidth of AL;

c'_{AP} – AP cost depending on the bandwidth;

c_P – cost of the SRP single port;

v_P – number of SRP ports.

If the total network cost is being considered as system consisting of many separate components each of which is represented as class of parameters with its own set of attributes, it is possible to establish relationship between the components of the cost. Such conception allows distinguishing among the set of parameters classes the object of research which is represented as AN forecasted parameters. Figure 2 illustrates the relationship between the elements which are represented as parameters influencing the AN cost.

Solid line at the fig. 2 identifying the generalization ratio between the scheme classes, dotted line - the ratio of aggregation between the classes. To get the access network cost C it is necessary to specify costs of its elements, costs of its installation $\{c\}$, to determinate length of the paths and access lines $\{L, l\}$, number of access points $\{n\}$, bandwidth of AL and AP $\{\omega\}$. At the definition of these values the forecasted parameters appear, including number and surface density of ICS users, specific bandwidth $C = f(\omega_p, \eta, N_p)$. These parameters are specified at the scheme.

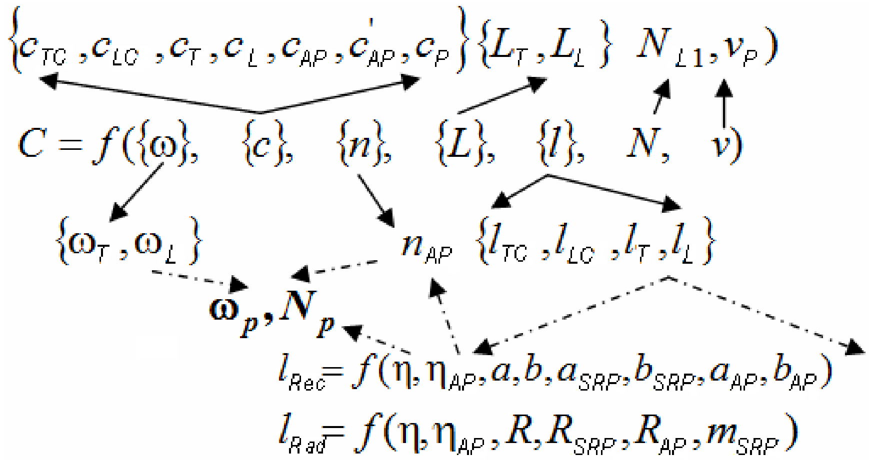

Figure 2. AN parameters interrelation scheme

In order to determine the network topology in addition to the forecasted values ω_p, η, N_p it is necessary considering of service area features: form of the territory, its size, the APT size, the size of the territory where users connect directly to SRP without the use of AP (SRPT).

For the distribution of the parameters according to their importance in the process of AN creation features which can make the classification parameters are being specifying. As an example: it is possible to classify the AN parameters according to the class of serviced areas, because at the network designing it is necessary to take into account local features of the territory for which it is being created. These parameters are geographic terrain features, population density, surface density of users, their financial facilities, terrain type.

Conclusion

The essential difference between the access network parameters and the existing subscriber networks parameters has necessitated the analysis of these parameters and identifying of the interrelation between them. Relations between the cost components are established during analyzing of the total cost of the network as a system consisting of many separate components, when each of them is being represented as class of options with its own set of attributes. This conception allowed to reveal correlation between the parameters and to select the object of research among the set of parameters classes. Object of research is forecasted parameters of access networks.

Acknowledgements

The paper is published with financial support by the project ITHEA XXI of the Institute of Information Theories and Applications FOI ITHEA Bulgaria www.ithea.org, and the Association of Developers and Users of Intelligent Systems ADUIS Ukraine www.aduis.com.ua.

Literature

1. “Международный союз электросвязи (ITU)”, официальное Интернет-представительство, [Электронный ресурс] — Режим доступа: \www/ http://www.itu.int / — 12.06.2012г. — Загл. с экрана.
2. Гайворонская Г.С. Основные задачи модернизации сетей пользовательского доступа / Г.С Гайворонская., А.И. Котова // Зв’язок. – 2010. – №1 (89). –С. 18-24;
3. Гайворонская Г.С. Концепция пользовательского доступа: Учебник для ВУЗов [Текст] / Г.С Гайворонская – Одесса: ОГАХ, 2008. – 408 с.
4. Галина Гайворонская Выбор сценария создания сети доступа / Галина Гайворонская, Светлана Сахарова, Александра Котова // International Journal “Information Theories and Knowledge”. – Sofia: ITHEA, 2012. – № 2 (Volume 6) – P. 143-156.
5. Гайворонська Г.С. Определение качества обслуживания на сетях доступа к мультисервисным сетям / Г.С. Гайворонская, С.В.Сахарова, А.А Крыжановская // Наукові праці Донецького інституту залізничного транспорту Української державної академії залізничного транспорту. – Донецьк 2012. Вип. 29.– С. 68-72.

6. Svetlana Sakharova Analysis and Justification for Selection Parameters of Wired Access Systems / Svetlana Sakharova // International Journal “Information models and analyses”. – Sofia: ITHEA, 2012. – № 3 (Volume 1) – P. 283-289.
7. Гайворонская Г.С. Дослідження впливу помилок прогнозу вихідних даних на процес планування мереж доступу / Гайворонська Г.С., Сахарова С.В. // Збірник наукових праць ВІТІ НТУУ „КПІ”. – 2010. – № 2., с 23-29.
8. Сахарова С.В. Задача выбора параметров сети доступа / С.В. Сахарова // Сборник тезисов Третьей международной конференции «Проблеми телекомунікацій», КПІ, Киев, 21-24 апреля 2009. – С.61.;
9. Гайворонская Г.С. Классификация параметров сетей доступа / Г.С. Гайворонская, С.В. Сахарова // Сборник тезисов Пятой международной НТК «Современные информационно-коммуникационные технологии», Крым, Ялта, Ливадия, 05-09 октября 2009. – С.77-78.;
10. Сахарова С.В. Исследование параметров сетей абонентского доступа / С.В. Сахарова // Материалы VIII МНТК «Математическое моделирование и информационные технологии» /ММИТ-2008/ - Одесса: ОГАХ. – 2008.–С. 29
11. Сахарова С.В. Оценка чувствительности характеристик сетей доступа к вариациям прогнозируемых параметров / С.В. Сахарова // Applicable Information Models. – Sofia: ITHEA, 2011. – № 22. - P.181-188.
12. Svetlana Sakharova The Interrelation Scheme of Access Networks Parameters / Svetlana Sakharova, Eugene Konyshev // “Modern problems of radio engineering, telecommunications and computer science”. Proceedings of the XIth International Conference TCSET’2012. – 2012. – Lviv: Publishing House of Lviv Polytechnic. – P. 264.
13. Sakharova S.V. Programming model to determine the effect of input parameters variation on the network characteristics / Svetlana Sakharova // International Conference on Modern Problems of Radio Engineering, Telecommunications and Computer Science. Proceedings of the International Conference TSCET’2010. Lviv-Svavske, Ukraine, - 2010. – P. 239.
14. Антон Бондаренко Анализ возможности использования модели балансных сетей при проектировании сетей доступа / Виталий Величко, Антон Бондаренко // International Journal “Information Theories and Knowledge”. – Sofia: ITHEA, 2012. – № 2 (Volume 6) – P. 126-130.
15. Максим Соломицкий Подход к разработке обобщенной модели взаимодействия внешней информационной метаструктуры и конвергентной телекоммуникационной сети / Максим Соломицкий // International Journal “Information Theories and Knowledge”. – Sofia: ITHEA, 2012. – № 2 (Volume 6) – P. 169-173.
16. Юрий Гриньков Разработка имитационной модели для оптимизации функционирования полностью оптических сетей / Юрий Гриньков // International Journal “Information Theories and Knowledge”. – Sofia: ITHEA, 2012. – № 2 (Volume 6) – P. 178-183.
17. Сахарова С.В. Корекція місця розташування вузлів доступу при наявності перешкод / С.В. Сахарова, А.А. Бондаренко // Матеріали VI НТК «Проблеми телекомунікацій»: Збірник тез. - Київ: НТУУ КПІ. – 2012. – с.109
18. Galyna Gayvoronska Optimization of Connection’s Structure of Remotely-operated Portables to Information Networks’ Basic Equipment / Galyna Gayvoronska // International Journal “Information Theories and Applications”. – Sofia: ITHEA, 2012. – № 3 (Volume 19) – P. 282-291.
19. Galyna Gayvoronska Program Model for Automated Design of Telecommunication Networks / Galyna Gayvoronska // International Journal “Information Theories and Applications”. – Sofia: ITHEA, 2012. – № 1 (Volume 19) – P. 292-299.

Authors’ information

***Galyna Gayvoronska** – Information technologies’ institute of Odessa state academy of refrigeration, technical science’s doctor, professor, chief of the information-communication technologies’ department; Dvoryanskaya str., 1/3, Odessa-26, 65026, Ukraine; tel. (048)-720-91-48, e-mail: gayvoronska@osar.odessa.ua*

Major fields of scientific research: optimization of transient periods at telecommunication networks’ evolution. Calls' streams, load and internodal inclination in nets. Problems of perspective access networks’ development. Problem of fully optical switching systems’ development.

***Svetlana Sakharova** – Information technologies’ institute of Odessa state academy of refrigeration, technical science’s candidate, lecturer of the information-communication technologies’ department; Dvoryanskaya str., 1/3, Odessa-26, 65026, Ukraine; tel. (048)-720-91-48;*

e-mail: switchonline@rambler.ru

Major fields of scientific research: problems of perspective access networks’ design.