# METHODS FOR SOLVING OF SOME TASKS WITHIN THE PROBLEM OF OPTIMAL SYNTHESIS OF INFORMATION NETWORKS IN THE COURSE OF THEIR EVOLUTION

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***Annotation**: Possible methods for solving particular problems arising from the decomposition of the problem of optimal synthesis of information networks in the course of their evolution are considered. The contribution of the scientific collective of the Information-communication Technologies Department of Odessa State Academy of Refrigeration is analyzed. The efforts of this collective allowed to come close to the formalized statement of this problem.*

***Keywords**: synthesis, information network, infocommunication services, access network, load, calls and messages streams.*

***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*

*«… sentient beings live only to*
*enrich the awareness …»*

*C. Castaneda*

## The status of the issue

Problems of development of the existing information networks (IN) with a rational redistribution of information streams and the most appropriate using of funds allocated for the network equipment's modernization contain elements of both analysis and synthesis [Roginsky, 1981].

In the context of this problem the difference between the concepts of information and telecommunication networks must be taken into account, since the information network involves a set of telecommunication networks (TN) and information technologies (IT), designed to provide infocommunication services (ICS). Earlier the concept of electrical communications was widely used. It was defined as the correspondent's tool for delivering to one or more correspondents information of any kind in any form (written or printed document, fixed or moving image, speech, music, visual or audible signals, control signals, etc.) using any electromagnetic system (wire transfer, radio transfer, optical transmission, or a combination of these systems) [Davydov, 1977].

However, the answer to the question: "What exactly is transmitted by electromagnetic systems?", - may be straightforward: "Electrical signals are transmitted by electromagnetic systems". To do this, information of any kind and form is converted into electrical signals for transmission and reception by electromagnetic systems. With the advent of optical telecommunication systems, the term electrical communication has ceased reflect the essence of the process of information transmission over communication networks longer, and was replaced by the term -"telecommunications". However, the term telecommunications does not reflect the fact that communications is moving kind of information too, because the tele- simply means "far", "at a distance." That is, telecommunications literally means "the movement at a distance". Plumbing, electrical networks, other tools designed to move anything may be included to communications. And hence it does not follow that we are talking

about electrical communications, but in fact the concept of electrical communications and telecommunications are very similar if not identical.

With this came the concept of infocommunications [Gayvoronska, 2008] that combines the processes of communication, information and the provision of ICS to users, by which we understand modern information-communication infrastructure of society that provides not only the transmission and reception of information, but also its processing and storage. Infocommunications include as one of the components of the user's terminal, in which information intended for transmission over the network converts into an electrical signal and its inverse transformation [Varakin, 2001]. That is, the user terminal can be seen as a means of information technology and telecommunication technology, as it supports aligns with the electrical parameters of the network, enters the service signals, etc. The question then arises: "What is Information Technology?" This term refers to a set of methods and hardware - software tools, combined in the processing chain, providing collection, processing, storage, distribution and display of information to reduce the complexity of the processes of using information resources and improve the reliability and efficiency. The main purpose of information technologies - providing information services (IS). It is necessary to settle on the concept of information-communication technologies, or simply infocommunication technologies (ICT). It implies a set of processes required to render that part of IS, which is associated with the transfer of information, i.e. infocommunication services (ICS) [Davydov, 1985].

Scientists from different countries are united in their opinion that we have entered an era of global information society, characterized by a new "information economy". This is due to the fact that, on the one hand, the services offered by modern IN can be viewed as a mass commodity for common using, having its price and its share in GDP of any country, on the other, infocommunications are an integral part of almost social processes and play very important role in the global economy. This thesis is supported by the fact that the total share of the world's infocommunications is more than 10% of total world GDP. As a rule, where is the higher the GDP - there is the higher proportion of infocommunications in it. This percentage is higher than the combined figures oil and automobile industries [Parliament hearings, 2005].

In the beginning of 21st century, there was a crisis in the global infocommunication sector, associated with the reassessment of the potential consumer demand. As a result there were excessive investments in steel industry and the very high rate of long-term debt. Currently, the world's infocommunications has emerged from the crisis and are strategically positioned not only in economics but also in politics and social life. For example, in the USA only 1 USD invested in telecommunications provides 6.2 USD of GDP growth, and one job in telecommunications generates 5.4 jobs in other industries. Telecommunications employing over 20 million professionals who provided 70-80 million jobs. At the same time there is a redistribution of jobs in various fields. For example, the banking system is experiencing an information revolution: banks use about 80% of its profits for their computerization. The transition to computer exchange of information has reduced employment in the banking sector by 30%. All this occurs against the backdrop of globalization, which requires establishment of an information infrastructure that provides the transmission and processing of information [Parliament hearings, 2005].

From this point of view the problem of optimal synthesis of switched IN, takes on a new extremely important meaning because of its decisions are depended not only by the cost of network and service quality, but without exaggeration, by the development of society as a whole. It caused by the fact that in the twenty-first century the spontaneous market mechanism of world civilization development is being replaced by the global order, when the power of the state is not determined by the number of iron and steel, tanks and missiles, but by the ability to produce knowledge and modern technologies, to manage the socio-economic processes and to exchange information rapidly, creating the conditions for the prosperity of its citizens.

In September 2005, in Ukraine, there were parliamentary hearings on the development of information society. The major tasks of the information society were identified in December 2003, in Geneva, at the World meeting on the creating of information society. In such a society, everyone should be able to create information and knowledge, to have access to them, to use and share them to individuals, societies and peoples were able fully realize their potential, adhering to the Universal Declaration of Human Rights. Education, knowledges, information and communication are the basis of human development. At the same time ICT have an enormous impact on practically all aspects of our lives. The rapid progress of ICT offers new prospects for the development of society, however, ICT should be seen as a tool but not as an goal in itself.

When the conceptual basis of the information society has just started to form, Ukraine was among the undisputed leaders and ideologists of its construction (see Table 1 [Parliament hearings, 2005]).

**Table 1.** Formation of the conceptual foundations of the Information Society of Ukraine

| | |
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| 1925 | The idea of mechanization of formalizing logical operations was formulated, mechanical thinking machine was built |
| 1941 | V.E. Lashkarev experimentally opened p-n junction. American scientists used it later for the creation of the transistor. |
| 1948 | S.O. Lebedev justified principles and structure of an universal digital computer with a recorded program (regardless of the American and British scientists). USSR Academy of Sciences. |
| 1951 | At first the digital electronic computer SECM (S.O. Lebedev) was introduced in the Soviet Union and continental Europe |
| 1953 | The principles of building, architecture and structure of the matrix-vector processor of the first Ukrainian specialized electronic computer (SEVM) for solving systems of linear algebraic equations was based, and introduced in 1955. |
| 1954 - 1957 | The base principles of construction, structure and architecture for the first Ukraine asynchronous computer "Kiev" with "address" of the language were developed. |
| 1961 | The theoretical basis for the design of computer was developed. V.M. Glushkov |
| 1966 | The idea of the circuit realization of high-level languages was proposed. Computer implementation of the project "Ukraine". |
| 1958 - 1968 | The principles of construction, structure and architecture of the first Soviet semiconductor general-purpose control computer "Dnepr" were developed. A full-scale production was launched into. |
| 1964 - 1967 | The principles of construction, structure and architecture, and the first in Ukraine information and control complex "Dnepr-2" for the automated control systems were developed. NPO "Electronmash." |
| 1965 | The principles of construction were developed, and the first Soviet digital regulator "Avtooperator" Severodonetsk NPO «IMPYLS» was created. |
| 1959 - 1975 | Principles of building, structure, and the architecture were developed, and the first production cars in the USSR for engineering calculations "Promin" and "MIR" - the forerunners of future PC - were implemented. |
| 1961 | V.M. Glushkov suggested brain-like structures of computers. |

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| 1963 | An inventor's certificate to a step microprogram control was received and implemented as a family of vehicles "Mir". V.M. Glushkov |
| 70-ties | A complex computer systems design was developed and used in many organizations of the USSR. Ukraine's first mini-computer M 180 Falcon was established, and released as series in 1972. |
| 1972 | Ukraine's first mini-computer M 180 Falcon was established, and released as series in 1972. |
| 1975 | The first domestic ideology of the family of micro-computers "Electronics C5-01" was developed. |
| 1975 | The first in Ukraine complex microprocessor means "Neuron" and setup tools for it were designed and produced. |
| 1965 - 1970 | Unique specialized computers Kiev 67 and Kiev 70 for the automation of design and manufacture of IPOs with Elyon technology were developed. |
| 1972 | Gage Complex Bars was created and released. |
| 1972 | The first World's "Encyclopedia of Cybernetics" has been prepared and published. |
| 1973 | The powerful control VC M4030 was developed, designed and made ready for commercial production. |
| 1974 | Ukraine, the Soviet Union and Europe for the first time launched mass production of large-scale integrated circuits at the NGO "Crystal". |
| 1974 | The principles of constructing a recursive (non-von Neumann) computers were proposed. |
| 1976 | Specialized computer "Neva" for digital communication systems was developed in cooperation with the GDR and the GDR has arranged industry production. |
| 70-ties | Specialized mini computers - Iskra, Mriya, Chyka, Moscow, Scorpion, Romb, Orion - were developed and produced by industry. |
| 80-ties | Unique specialized on-board computer systems for spacecraft control without reckoning were developed and produced by the Defense Ministry enterprises. |
| 1983 - 1987 | The family of specialized industrial computer for pre-flight testing and pre-mooring WIG, ships, hydrofoil ships, seaworthy for complex testing of ships of the Navy for testing and diagnostics of aircraft were developed, designed and produced. |
| 1978 - 1987 | Superproductive macroconveyor complexes ES-2701 and ES-1766, which have no analogues were developed, designed and created. The maximum number of processors 256. The maximum productivity of 500 mln. oper. / Sec. |
| 1965 - 1980 | A lot of great digital media industrial systems engineering were developed, designed and created (machine of control and communication with the object of management), to ensure the creation of wide range of control systems in industry and power for the entire former Soviet Union. Multi-processor systems for heavy duty systems, geophysical prospecting of mineral resources and a number of unique military systems were created and produced. |
| 1967 - | 12 types of on-board computers (including steady from influence radiations) for space-rocket complexes |

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|---|---|
| 1989 | strategic were developed designed and organized its production. |
| 1969 - 1989 | Ultra-reliable computer specialist «Carat» (17 models) for weapon systems and management of surface and underwater, including nuclear power, the courts of the Navy, and for solving problems of navigation in the merchant navy ships and nuclear power drifting ice was developed, designed and implemented its mass production. |
| 1969 | Implemented mass production of computers «Kashtan» for automated cutting of chestnut tissue according to the specified range. |
| 1981 | Serial production of the computer systems of small computers was mastered. |
| 1984 - 1988 | The principles of construction and developed a unique computer ultra speed system - complex «Star» to detect submarines. |
| 1997 | International Computer Society (IEEE Computer Society) awarded to S.O. Lebedev medal "Pioneer of computer technology" with the inscription:<br>S.O. Lebedev, 1902-1974. The developer and designer of the first computer. The founder of computer. |
| 1997 | International Computer Society (IEEE Computer Society) awarded to V.M. Glushkov medal "Pioneer of computer technology" for the foundation of the first in the USSR Institute of Cybernetics and creation the theory of digital automat and work in the industry macroconveyor computing architectures. |

New ways of communications and communication systems blur the boundaries between nations and peoples. Digital technologies have fundamentally changed not only connectivity but also the technology of exchange of goods, services, knowledge management, production, socio-economic and political processes in society. In the development of electronic union and the information co-operation gap among countries which have already made the transition to an information society, and others, for various reasons backward from this process, is becoming increasingly obvious. A detailed analysis of the level of global competitiveness of individual sectors shows that there are the most competitive country in which co-exist successfully hi-tech production and management of their own natural resources, knowledge, and information technology [Parliament hearings, 2005].

In this regard, the role of infocommunications and information networks, in particular, is immeasurably increased, and certainly increases the importance and relevance of their scientific support. Methods of synthesis of IN created in the last century and no longer meet any of networks, or the needs of society.

## The statement of the problem

Detailed formulation of the problem of synthesis of developing switched network is performed in [Gayvoronska, 2007]. The basic problems and the appropriate methods for their solving were formulated and analyzed in this paper too. However, during the five years since its publication, information networks are developing so rapidly that the formulation of the problem of optimal synthesis of developing switched networks no longer meets the current situation in the field of infocommunications sphere. In this connection, it took some refinement of the overall problem, the introduction of new tasks and more careful formulating of the tasks that were identified in the decomposition of the general problem of synthesis.

In addition, over these years a number of objectives set out in [Gayvoronska, 2007] are more or less solved. All of this required a revision of the formulating of some statements of the developing switched IN synthesis

problem. This article is aimed at the consecration of the possible approaches to solving of some aspects from the complex of tasks, mentioned in the decomposition of the overall problem.

## Overview of problems solved by collective of the ICT department within the general problem of synthesis of developing switched information network

In [Gayvoronska, 2007] it is showed that in terms of the topological structure, parameters and principles of information exchange in the network under research it can be divided into two subnets: access network and core network [Sokolov, 1999, Gayvoronska, 2008, Gayvoronska, 2010]. Thus, the overall problem is divided into: synthesis of the access network and synthesis of the core network. Formulated set of tasks in the problem of optimal synthesis of switched information network in the course of their evolution in recently is being solved by the collective of the information-communication technologies (ICT) department of Odessa State Academy of Refrigeration. Solving of separate problems is being studied by lecturers and post-graduates, supervised by Galyna Gayvoronska, namely: Alexander Ryabtsov [Ryabtsov, 2010-2012], Semen Pavlov [Pavlov, 2007-2012], Alexandra Kotova [Kotova, 2009-2012], Svetlana Sakharova [Sakharova, 2010-2012], Anna Kryzhanovskaya [Kryzhanovskaya, 2010-2012], Illya Gannitsky [Gannitsky, 2007-2011], Anton Bondrenko [Bondarenko, 2011-2012], Maxim Solomitsky [Solomitsky, 2011-2012], Yuri Grynkov [Grynkov, 2011-2012], Eugene Konyshev [Konyshev, 2012], Oleg Domaskin [Domaskin, 2012]. Masters' works, performed at the ICT department are devoted to the same topic.

In [Gayvoronska, 2007] all tasks within the researched problem of information networks' synthesis are grouped in such way that they are interrelated and stem from one another within each group of tasks.

The first group of problems, in particular, includes:

- analysis of users' needs in communications services, which are to be satisfied by the created network;
- definition of the requirements for network services and equipment for speed connectivity, bandwidth and volume of transmitted information, the absolute value of the allowable information delay and its variations in the network, the allowable error rate, etc.;
- development of recommendations for the necessary parameters of access parameters for the information services rendering in accordance with the requirements specified in the preceding paragraphs.

The first of this group of tasks includes the determination of projected volumes of information streams and their distribution in space and time. Existing algorithms that allow solving this problem by means of computers tools for the existing telephone networks or data transfer networks (DT) should be updated taking into account the specifics of integrated services and the convergence process of separate TN into unified information Next Generation Network (NGN). There are very strong expected fluctuations of the traffic in the network with mixed traffic (voice, dates, images). Interactive traffic often changes spasmodically (from periods of high to the low activity periods and vice versa) and those of its features should also be taken into account at the synthesis of the network structure. Here planning is clarifying types and volumes of traditional and new communication services, selecting the right relationship between the volume and nature of the distribution of streams generated by these services. Works in the field of economics, sociology, and other service sectors are accounted at the forecasting of the services.

Semen Pavlov's work is addressed to the relevant objectives of the study requirements for networks and network equipment from the ICS. There are analyzed properties and characteristics of the ICS, highlighted main factors affecting the provision of these services and the international documents governing the provision of ICS in this study. As the result of the done analysis there were denoted main characteristics of services, which became the

base of the proposed classification of all possible ICS, both existing and those that may occur in the future. The main purpose of this work is to identify the main characteristics of ICS. Its accounting is required for the synthesis of IN, the evaluation of correlation among them and the formalization of these characteristics with the way when they can be put into a general model of the synthesis of IN. To solve this problem there were analyzed the existing classification methods appropriate to apply to the ICS, identified advantages and disadvantages of these methods. The necessity of applied statistics methods' usage for classifying ICS is proved. With the help of factor, cluster and discriminant analysis the relationship between the parameters of providing ICS was revealed. The effect of ICS on the development of IN was researched, and revealed that both qualitative and quantitative changes in the parameters of service affect the development of IN. By using statistical methods for processing ICS parameters and reducing feature space classification of ICS was proposed. It is taking into account five parameters of these services rendering. The reliability of the process and the results of ICS classification are proved. Parameters are analyzed to provide services to the real IN. For each of the ICS classes requirements for IN and its equipment were definite. The method for classification of any existing or planned ICS to a particular class is developed. A model of the ICS classes' presentation is built. It is shown how this model can be extended with additional parameters of service rendering. Two types of formal description of the ICS for convenient human and computer perception are proposed. The formalized description of the services makes it easy to build interfaces and data entry programs into the various models of IN analysis and synthesis. It is unified representation of the service and it is characterized by the parameters of service's rendering. Software complex which automates the assignment of a specific service to a definite class and definition of requirements for the network equipment from service groups is developed. The implemented software improves the efficacy of IN design and modernization as compared to known methods by about 12-17%. The effectiveness of the program complex experimentally evaluated on real IN. That is evidenced by the introduction of the relevant statutes. Semen Pavlov has presented the research of this problem in the form of dissertation work and was awarded with the academic degree of Ph.D. after its main results' defense.

Alexandra Kotova's work is devoted to solving the problem of increasing the efficiency of the development of perspective access networks (AN) by upgrading existing subscriber networks. The solution of the problem allows to identify cost-effective options for the access network's organization, one of which is the usage of the existing subscriber network as the basis for its construction. Studies conducted in the work allowed detection of the structural characteristics of existing subscriber lines, value of which determine the ability of digital information transfer over the analog network and assessing the suitability of xDSL equipment and other access technologies of existing networks. A large amount of processed statistical information allows evaluation of the structure and technical condition of the existing subscriber network in Ukraine. Methods used to process of statistic allow determination of the possibility of extending these results to other areas that have not been participated in the study. The developed method for calculating the structural characteristics of the access lines (AL) for perspective AN allows determination of the most advantageous location and capacity of the access point (AP) from the standpoint of minimizing the cost, length and bandwidth of access lines in the transport and the local segments, taking into account the current configuration of the service area. The proposed method takes into account the existing principles of organization of subscriber access lines only to the PSTN, as well as possible connections to other core networks. Research was presented in the form of dissertation work. After the defense of its main theses academic degree of Ph.D. was awarded to Alexandra Kotova.

Besides it researches are conducted by post-graduates of ICT department in the following areas:

- improvement of the functioning of information networks by unifying the calculation method of network equipment - Illya Gannitsky;

- the method and model of accounting of inclination at the implementation of access networks - Anna Kryzhanovskaya;
- the model of optimal synthesis of access networks - Anton Bondarenko;
- peculiarities of optical switching in the access networks - Yuri Grynkov;
- the model of information network's user as badly formalized object - Anastasia Smirnova.

## Registration of errors in the course of access networks parameters' forecasting

The problem of AN designing efficiency's increasing by taking into account the sensitivity of networks' characteristics to forecasted parameters is being solved in Svetlana Sakharova`s work.

To solve the problem of estimating the sensitivity the simulation model of the development of perspective AN, taking into account their concept, structure and design principles was developed. Research and analysis of the parameters involved in the process of AN creating allowed identifying that parameters which variation had the most significant impact on the characteristics of these networks. Forecasted parameters, which are the subject of the study, are highlighted. They are the number of AN users, the list of requested by them ICS, the surface density and the distribution of users in the territory served by the network, the load created by these users and several other variables. Taking in account the concept, structure and functions of perspective AN, generalized scheme of the process of these networks' creating was developed. It differs by the analytical methods and program procedures. Developed scheme defines sequence of stages, each of which solves set of goals of AN creating. Existing methods are partially used to solve these problems. But for the most purposes author developed new methods and software procedures which were presented in the thesis. The method for optimizing the number, capacity, location of AP and size of areas served by them, by criterion of the network total cost was developed. To minimize the cost of the line facilities in the course of overcoming obstacles to the laying of access lines, it is proposed method of adaptation of access lines ways' construction and choose of AP places to the structure of the network. It allows taking into account the influence of local conditions on the choice of the optimal location of the AP.

Simulation model of AN, which allowed implementation of proposed methods for optimization of AN structural characteristics is developed. The modeling process has allowed for the first time to reveal the range of impact of input forecasting parameters' variation on the cost of the network and its structural characteristics.

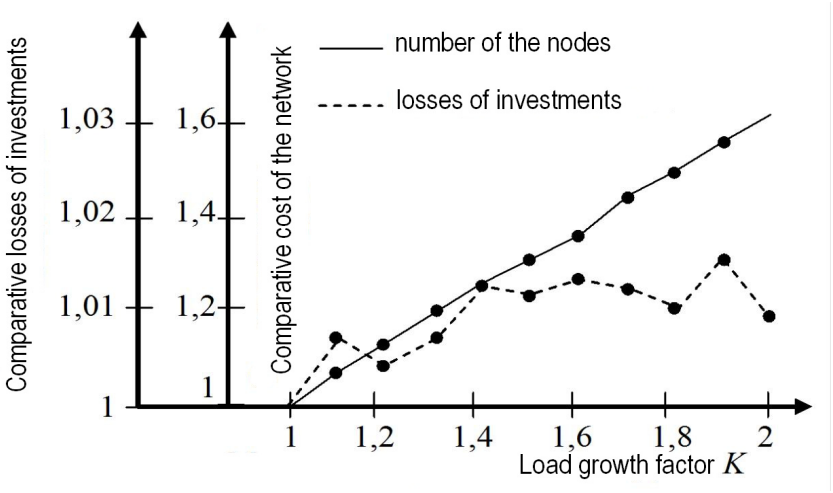


**Figure1**. Impact of carried load value forecasting on the network cost

Impact of load variation was investigated taking into account the cost of AN, quality of service and network structure. Let's denote load stream created by users of selected group i to the service rendering point of one of

the core network j as $F_{ij}$, and the load stream, which occurs as a result of unanticipated changes in advance - $F_{ij}^{'}$. Then it can be determined by multiplying by a constant $F_{ij}^{'} = KF_{ij}$. For instance, here it is given the research of forecasting faults of the values of two AN parameters when the factor that accounts deviation of the load's actual value from the forecasted, from 1 to 2 with step of 0.1. Parameters under research are cost of the network optimized for the original load structure and cost of the network optimized for the varied load. The latter case suggests that the capacity of AP is fixed, and bandwidth of local and transport segments of AL are calculated anew, to meet the quality of service standards. Fig. 1 shows the obtained results. The solid line shows the cost of the network, based on the original value of the load, and the dotted shows the loss of investment due to the difference between the calculated parameters, averaging about 1.1%.

Besides it the effect of the load distribution prediction fault is determined. Here it is suggesting that the total amount of load is calculated exactly. Load varying element $F_{ij}^{'}$ is calculated as $F_{ij}^{'} = F_{ij}(1+R)$, where $R$ - is uniformly distributed random variable in the range $[-a,+a]$ $a \in [0,1]$. The results are shown in Fig. 2.

At the same time here marked both the more expensive and less expensive than the original cost cases, depending on the nature of the error. Nevertheless, we can conclude that additional investment should be needed, as the average value of the network in all cases is higher than the calculated values. If the cost of the network becomes too high, the medium-and long-term planning may need to change the AP placement both with their service areas.

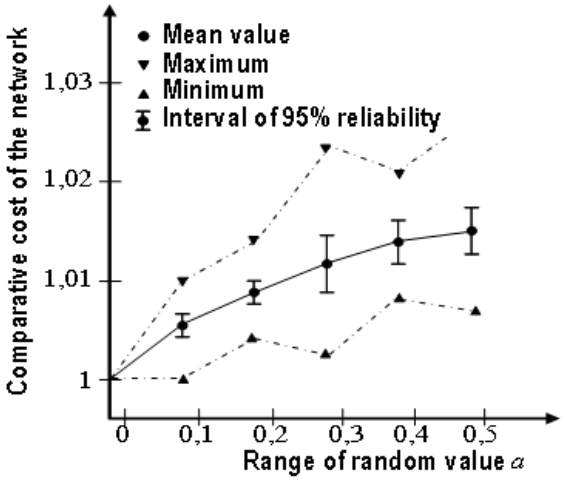


**Figure 2.** Impact of connections paths' load distribution's forecasting fault on the network cost

Created software implementing the model for estimation of the AN characteristics' sensitivity to variations of predicted initial parameters is being used for the design of modern TN. This fact is evidence of the introducing act of the research results by the enterprise "Ukrsvyazproekt", which states the following. The analysis has revealed that the cost of AN with increasing of the prediction error of the requirements for connection of new users increases linearly; the prediction error of the geographical distribution of requirements for connection of new users, while maintaining the overall forecast of network capacity growth leads to an increase in the total cost of the network up to 20%; minimum change of the node location increases the value of a network of about 8%. Fluctuations in the cost parameters lead to change of AP number more than ten times or until the loss in value to 16% in the worst case. Manual changes in the distribution of nodes and the boundaries of their service, as a rule, are inevitable at the last stage of network planning. As a result of the investigations it has been shown that the optimal network configuration is insensitive to variations of number of parameters. In order to optimize the location and boundaries of AP servicing the most important was the cost of AP hardware. Forecasting error of users' number, the load created by the ICS users and the coefficients of the inclination influence much less than it is usually indicated. As expected factors of AP cost, local access lines and transport segments have a dominant influence on the configuration and cost of the optimal network.

## Development of messages stream's model of convergent telecommunication network

Before to speak about information network's synthesis it is necessary to solve a problem of the analysis of users' requirements in communication services for which satisfaction the network is being established. Such analysis includes determination of predicted volumes of information streams, their distribution in space and time. Here it is necessary to specify kinds and volumes of traditional and new infocommunication services, to choose proper correlations between volumes and behaviour of streams' distribution established by these services.

The decision of the majority of problems of the information distribution theory is based on the law of stream preservation, saying that intensity of requirements number's growth in the system is defined by a difference of intensity of inlet and outlet streams. The stream of requirements, demands or calls is a set of the moments of these requirements' arrival in the system. The call is a requirement of connection between two network users for a message transfer. The message is the information converted to electromagnetic signals. Considering a difference between the call and the message it is possible to speak about the calls stream as arriving in the network, and the messages stream as circulating in networks for the users information transfer. Nowadays there is no common theory of distribution and calculation of quantitative and quality parameters for messages streams in the TN. The messages stream between points i and j is a sequence of messages transferred from the one point to another. Except the effective information network provides transfer of control handling and signalling messages which do not have values for the user. Callbacks as result of connection's deny for primary call essentially load networks without giving useful effect too.

At the network synthesis it is also necessary to solve problem of information streams' distribution. Existing algorithms allowing by means of computer computing tools to solve this problem for existing telephone networks or data networks should be modernised taking into account specificity of integrated service. In the network with the mixed traffic (speech, data, images) it should be expected very strong oscillations of traffic. Dialogue traffic often varies spasmodically (from the periods of high to the periods of low activity and on the contrary) and these features also should be considered at the network architecture's synthesis. It is not enough to speak only about need of information delivery: it is necessary to know what these information is (both from quantitative and qualitative positions), what information value is to be transferred and in what way it would be carried out. This information is to be known from the point of view of information transformation both in time and in space.

The model of messages stream allows defining quantitative parameters of the streams circulating in the TN at: interaction between the TN and an information metastructure in the context of processes of network service, transmission of messages streams through bypaths instead of the main ones, etc. Thus, it is possible to determine characteristics of mainly stochastic processes of convergent TN at the different moments and time intervals on different segments of the network that is especially important, for example, at realisation of interoperators interaction within the limits of common physical network's sharing. Such special case can be result not only of market relations in infocommunication sphere, but also can be a pressing need of providers in the conditions of monopoly. Proceeding from these assumptions principles of the description and the model of messages stream should differ essentially from the model of calls stream, however now there is no common theory of distribution and calculation qualitative and quantitative parameters for messages streams in the TN. Therefore the problem of making up of the messages stream's model in the network, and the method of these streams characteristics' registration at the designing of convergent TN is essential, actual and nontrivial at all.

The volume of transferred messages is rather important characteristic at the designing of the messages stream's model. Instead of duration of calls streams' service it is characterised not only by the message transfer time, but by volume and value of the information transmitted in this message. That is much more important. Besides, it is necessary to consider presence and level of priority of each message and number of other parameters.

Hence, a common problem of creation of the messages stream's model circulating in the network can be splitted into following subtasks.

1. An estimation of distribution function of the moments of messages' receipt in the network.
2. Research of correlation between duration of message transfer and volume of the information transmitted in it.
3. An estimation of influence of the transmitted information value on type of the transmitted message and a method of its account at designing of the messages stream's model.
4. A method of the message priorities' forming depending on its volume and value of the containing information.
5. A method of the registration of callbacks and other factors which are important for provision of qualitative message transfer service through the network.
6. Development of the generalised formalized messages stream's model circulating in the convergent TN.
7. Research of the offered model by imitating modelling.

The problem of development of messages stream's mathematical model circulating in the convergent telecommunication network (CTN) (fig. 3) and designing of based on it imitating model of CTN messages streams is being decided in work of Maxim Solomitsky.

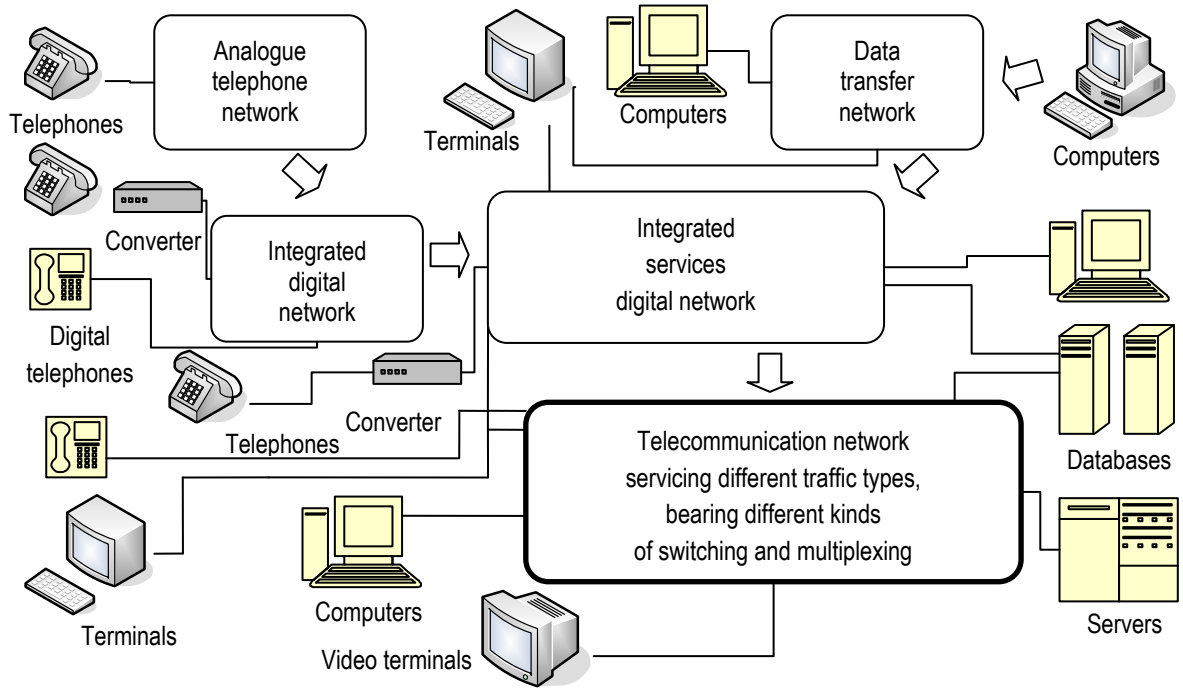


**Figure 3.** Stages of the convergent telecommunication network's development

Determination of CTN is given in the production paper [Solomitsky, 2011], where CTN is considered from system positions. Some formal representations and approach for decision of problems of CTN analysis and synthesis are formulated in this paper too. It is established that it is impossible to carry CTN directly to one of such well known classes of networks, as data-processing, data transfer, telephone which urged to render services for users only of the defined accurately limited area.

As a result of executed in [Solomitsky, 2011] analyses of possibility of the teletraffic theory mathematical apparatus' usage for the description of interaction between the CTN and environment it is concluded that existing models of networks functioning, networks processes' models and methods of calculation of the network equipment in their initial kind are unsuitable for the decision of problems of the CTN analysis and designing.

To develop the messages stream model in CTN first of all it is necessary to understand what is the CTN and what are its fundamental differences from other kinds of communication networks. The formal description of CTN architecture in the form of the environment and network medium is developed for its research [Solomitsky, 2012]. Each of these mediums is represented in their turn in the form of two mediums: environment - generation and distribution mediums, network medium - interaction and processing mediums (fig. 4).

Extraction of the generation medium allows to describe influence of users on the network, i.e., streams of their requests for the network resources; the distribution medium allows to reflect influence of any external prevent factors on propagation of physical signals in the network; the interaction medium gives the possibility to describe the network as a whole; the processing medium - possibility to describe the basic structural network elements processing the digital information.

An approach to formal determination of points of interaction between the CTN and information metastructure, processes of network service is offered in [Solomitsky, 2012]. That is important for adequate modeling of the messages streams circulating in CTN. The interaction medium is presented as some homogeneous data-processing medium consisting from SN and service nodes. Apparatus of hierarchical connectivity matrixes (CM) is offered for the description and analysis of the interaction medium features. Thus the configuration of nodes is set in a matrix form with usage of square CM for the given level nodes (dimension is $N_i$ x $N_i$, where $N_i$ – number of nodes of corresponding i-level) and rectangular CM for the adjacent levels nodes (dimension is $N_i$ x $N_{i-1}$, where $N_{i-1}$ – number of nodes of the bottom level). In CM there can be as the designations pointing presence or absence of connection between nodes, and designations of numerical value of some parameters characterizing corresponding connections. Interlevel CM are being made for displaying communications between nodes of the next levels. They can be primary, displaying physical connections between nodes, and secondary, showing internodes logic connections.

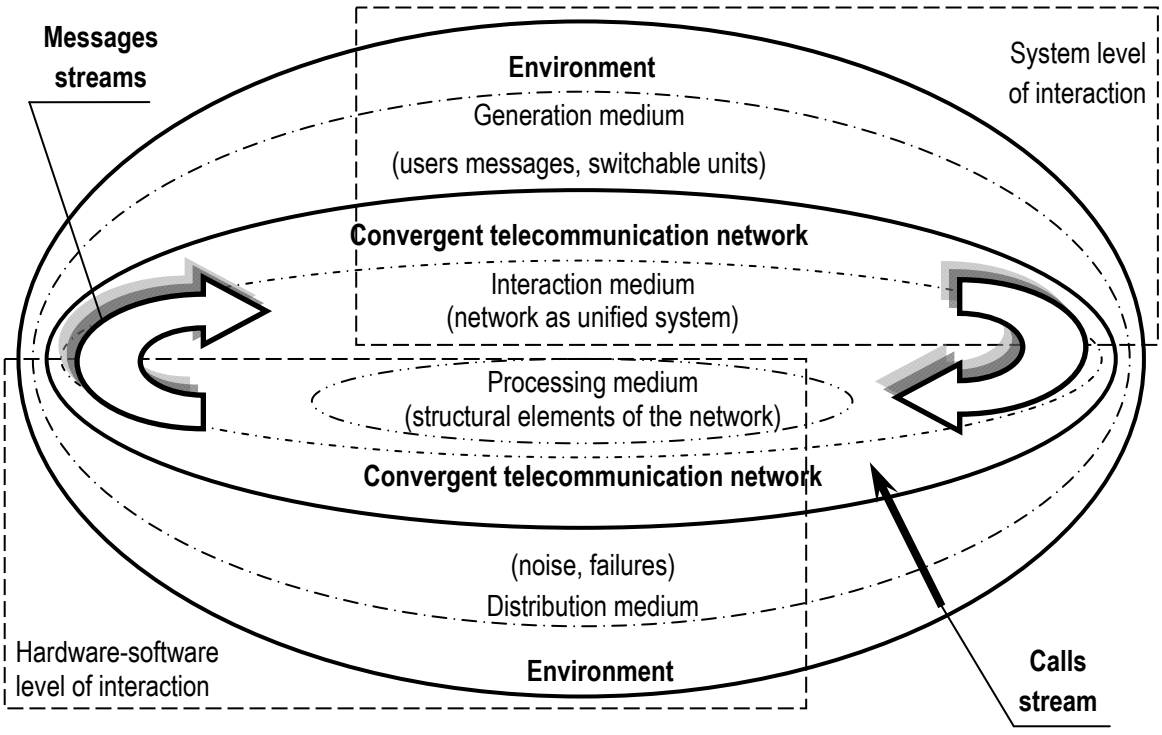


**Figure 4.** Formal conception of CTN architecture

According to the given decomposition of the problem of messages stream model's development, being based on the received results, further it is planned: development of the apparatus of the formal description of information content in the messages stream; determination of a distribution function of the messages stream in time and distribution function of information content of the messages stream; development of the apparatus of the formal description of control information in the CTN messages streams and the formalized apparatus of determination, whether is the separate message the finished semantic unit or represents a part of the whole; development of formalistic approach to determination of information value and function and/or set of functions of information value; development of the mechanism of formal determination of the messages stream's priority, including conditions of fuzzy statement. That is a direction of the further research.

## Conclusion

The formulated set of problems is being successfully solved by the collective of information-communication technologies department. However, nowadays it is impossible to formalize common problem of synthesis of optimum variant of information network as a whole in a general view. Furthermore this problem is the NP-difficult problem which does not have both the analytical decision and any solution at all. Possibility of use of analytical methods is coupled to introduction of some assumptions. Therefore in process of the decision of problems of separate network segments' topological structure's synthesis, algorithms of management and information exchange particular problems are being formulated and solved. Combination of these problems' decisions by analytical methods and by imitating modeling will allow to approach closely in due course to creation of general imitating model reflecting process of switched information network evolution. The similar model will allow to approach closely to the decision of a problem of these networks' optimum synthesis. There are assumptions to hope, that these works can be useful both scientists in the field of information technologies and at the practical planning and designing of information networks.

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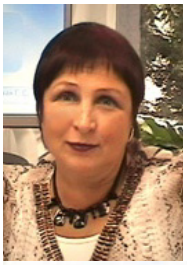

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