LABORATORY 10
Laboratory of Communications Network Theory
Head of Laboratory – Dr.Sc. (Math.) Valery Polesskii
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The leading researchers of the laboratory include:

Dr.Sc. (Math.)	N. Vvedenskaya	Dr.	V. Mikhailov
Dr.Sc. (Techn.)	A. Kuznetsov	Dr.	I. Orlov
Dr.Sc. (Techn.)	I. Levshin	Dr.	V. Polyakov
Dr.Sc. (Techn.)	B. Tsybakov	Dr.	A. Rubinov
Dr.	N. Likhanov		

DIRECTIONS OF ACTIVITY:

- network reliability theory;
- self-similar traffic in ATM networks;
- multiple access packet communications networks;
- asymptotical investigation of large queueing systems;
- coding and signal processing for storage systems;
- simulation models for hydroacustic information transmission systems.

MAIN RESULTS

In Laboratory No. 10 there are three scientific groups: 1) Polesskii V., Rubinov A., Kuznetsov A.; 2) Likhanov N., Vvedenskaya N., Tsybakov B., Mikhailov V.; 3) Levshin I., Orlov I. and Polyakov V. is an independent individual.

The groups develop the contemporary communication network theory. The first group elaborates discrete mathematics methods, the second group and third one elaborate probabilistic methods.

V. Polesskii worked in the field of theoretical bounds for system and network reliability. For the case of high reliability nodes and lines was found that good metrical topology properties don't gives us high structural reliability due to the possibility of the larger number of two-cuts (network losses connectivity due to the failure on two lines). It was found relations between metrical properties and reliability of the network. In the class of the two linked two trees graphs with given numbers of the nodes and edges, it was found the graph with maximum number of two-cuts. It was proved that in the class of $Z(n,m)$ – random graph with minimal failure probability exist only for the following cases $m=n$, $m=n+1$, $m=2(n-1)$.

A. Rubinov worked on measures of sequences similarity based on embedding of short subsequences. Such measures can be applied for genes and DNA analysis. Some results can be used for graph comparing and decomposition.

A. Kuznetsov works in the field of the coding theory and its application to the optical and magnetic recording. The main part of his research was concentrated on iterative decoding systems with low density codes for magnetic recording systems (hard disk drivers). To develop low density codes with regular structure it was used some constructions from the combinatorial methods. The main obtained results can be formulated as: a) development of the wide class of the low density codes from the Shtainer's systems and integer lattice; b) error probability investigation for some mag-

magnetic recording channels which used developed codes and iterative algorithms with soft decision. Main distinguish of the development system is the presence of the two soft decision decoders, one of which operate on trellis of the channel with partial response, while the second decode low density code. Soft decision exchange between these two decoders gives extremely low error probability while structural properties of the code gives us possibility that this approach can be implemented to the next generation of the hard disk drivers.

N. Likhanov for the feedforward arbitrary configuration network and On/Off traffic was developed approach to estimate packet loss and buffer overflow probabilities for any given node of the network. This result is essential generalization of the previously obtained results for the case of separately analyzed node. Developed analytical results give possibility to obtain network performance parameters with minimal computer complexity and they are also useful for the quality analysis of the considered systems.

N. Vvedenskaya worked on two problems. 1). A problem where a large deviation of delay in a system with two servers and three flows is considered. Two flows the first and the second are directed to the first and the second server correspondently. A job from the third flow is directed to the server where its delay will be less. The formulas are presented for the large delay of a virtual job put into the third flow. 2). The asymptotical investigation of large open Jackson network with constant service time is performed. The problem is reduced to the investigation of a new and nontrivial partial differential equations with non-local coefficients and the delay.

Some studies were performed by V. Mikhailov on the routing problem in the Broadband Integrated Services Digital Network (B-ISDN). A survey paper on service categories and network architecture was presented. The main interest was focused on the influence of traffic parameters and quality of service requirements on the efficiency of existing routing schemes. A new routing algorithm for Constant Bit Rate (CBR) connections in the B-ISDN was proposed. A computer simulations of the algorithm was made. Dr. V. Mikhailov is a current lecturer on the communication theory and data networks at the Moscow Institute of Physics and Technology.

It was considered the multiple access of mobile users into a common wireless channel to the base station by B. Tsybakov. The channel is slotted and has the binary feedback (empty slot/non-empty slot) to all accessing users. A review of known multiple access algorithms for such a channel is given and it shows a specific-for-each-of-algorithm Reason why the algorithm is not suitable for implementation. Two new algorithms are constructed that have no weaknesses of previously known algorithms. The new algorithms are stable contrary to aloha algorithm. The first algorithm throughput is upper bounded by 0.256 packets per slot. The second algorithm is more powerful than the first one and it can work in channel with capture and multiple reception. This second algorithm has the through up 0.2891 under the same conditions that were considered for our first algorithm. It is shown how the capture and multiple reception can increase the second algorithm throughput to 0.6548 for some fading models and decrease the packet delay. The average packet delay and variance are found for two fading models. The models are a Rayleigh-fading with incoherent and coherent cumulating of joint interference power. All considerations are presented for the Poisson accessing traffic.

I. Levshin is developed a technique of application of information technology of the simulation created and developed in IITP the Russian Academy of Science, in problems of the automated prognosis of quality of communication channels with random parameters between mobile sea objects. In the methodic the system approach is used for construction of mathematical and simulation models of complex physical en-

vironments when they serve as the channel of transfer of the information, and also models of separate components and their set, making information system. Existing and again created Banks of the geophysical and hydrological parameters used in models will be involved. In problems of the prognosis of efficiency of compound radio and hydroacoustic channels sea communications (coast-space-surface-depth) are defined specific criteria of quality of the channel (CR), allowing to carry out the prognosis of operating conditions systems of communication for operational planning ways and modes of transfer information in various water areas of World ocean and various signal/noise conditions. It were considered various criterions of estimation of quality of the channel, which have differences in a degree of complexity and reliability, from the most simple criterion such as relation – signal/noise to the most information criterion such as a capacity. With the purpose of research of physical properties of the open unknown person in 1991 earlier semi-particle of the solitons type, named as acuston and so-called 'acustons gas' capable to render appreciable influence on conditions underwater propagation acoustic signals, the imitating computer model of generation acustons is developed. The model allows to investigate features physical mechanism formations of acuston at various characteristics of undercurrents and a relief of a sea-bottom. By I. Orlov it is developed algorithms and the software simulation of systems of underwater acoustic communication with multi-frequency signals and noise likeness signals. Developed algorithms and software are a component of the hardware-software complex intended for realization of the elements of system of the automated prognosis of quality communications channels between mobile sea objects.

V. Polyakov participates in the software development for the computer animation. On the base of the automatic animation technology it was developed the prototype of the professional computer tools for cartoons animation. The new interactive system for creation, graphical editing, and structural control of the key frames allows very effective automatic way to add inter frames in the movie to improve the quality of the animated cartoons and essentially reduce the cost of the development process. Some movies production companies pay essential interest while the prototype was tested in Japan.

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