TRAFFIC AND TELECOMMUNICATION NETWORKS MODELING USING ATEB-TRANSFORM

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In this work the problem of traffic flows study is described. The concept of T-classes of systems for modeling of signals with time dependent parameters was produced. The expediency of using algebraic interpretation of the idea of T-classes with respect to Ateb-functions as elements of the bases of the spaces of signals for specific communication tasks was shown. Based on the proposed model, a software was developed for the analysis and forecasting of traffic flow in a computer network, which was tested on the real data of the network.

Related works and problem formulation

The problem of the traffic study is relevant because computer networks are increasingly used in human activity [1]. The problem of forecasting traffic remains a bottleneck in the establishment of computer network management systems. Introduction of information systems analysis and forecasting of traffic has proven to be effective, but computer network improvement requires the development of new approaches to modeling, analysis and prediction of the traffic.

At present building of new methods for mathematical modeling of traffic and telecommunication networks is practically important task. Another major challenge for the effective operation of communication networks is the adaptation of nodal equipment for the needs of the real traffic network in any time [2], so the project includes: development a mathematical model of the behavior of traffic in computer networks based on differential equations of oscillatory processes; development a method of solution of the corresponding system of differential equations using asymptotic method and on this basis to implement an information technology simulation, analysis and forecasting of traffic of computer networks; development an optimization algorithm of computer networks on the basis improved redistribution of the load device.

In the last century, there were created mathematical models of communication based on the use of harmonic functions , as an orthonormal system [3]. Along with the continued search for signals in the other orthogonal functions. Multi-channel communication systems based on the Hoare – Walsh system of functions was built and operated successfully in several countries [4] It was shown that this basis has an important advantage – the possibility of constructing a theory of filters for which there is no need to use inductance, as in the case of conventional frequency filters. These communication systems were used for special purposes. Further generalizations lead to a well-known concept of the generalized shift operator, which generic well-known T-classes [5]. The investigation discusses the properties of this operator from the point of view of applications in telecommunication networks modeling for communication theory. The concept of T-classes of systems and signals for analysis and modeling of signals with time dependent parameters and nonstationary random processes was produced. As a practical implementation of the models of T-classes for telecommunication modeling was described the application of the theory of Ateb-functions. The expediency of using algebraic interpretation of the idea of T-classes with respect to Ateb-functions as elements of the bases of the spaces of signals for specific communication tasks, in particular task of information protection in communication channels was shown. In the article implemented the deepening of research means based on the fact that the application of Ateb-functions can be expanded to all areas where there are the usual trigonometric functions. Ateb-functions were decomposed into the series, as a special type of Fourier series. Ateb-transforms algebra was built. Algebra contains "addition"and "multiplication"operations. The addition is the usual addition of functions (correctness follows from the additivity of the addition), and multiplication is a convolution.

System analysis as a powerful tool of scientific research has allowed to identify a new approach to the study of generalized non-harmonic signals and on this basis to use the theory of generalized shift operators [6]. An important direction for future research for modeling telecommunication networks is the study of properties of the decompositions based on Ateb-functions, which are derived from the introduced formal apparatus and to apply them to special problems of communication.

One of the important points in the development of network traffic models is an analysis of the relevance of these models behavior to experimental data. To do this, a second line of our study was developed. Another part of investigation is the analysis of the result of a mathematical model of traffic for self-similarity. For this the Hurst coefficient value for the data

of mathematical modeling of traffic by several methods was calculated:

1. Method of cumulative difference;
2. R / S plot method;
3. Absolute moments method;
4. Method of residuals difference.

The comparison of data based on mathematical modeling and data of real network traffic of the ACS NULP department is given is shown in fig.1.

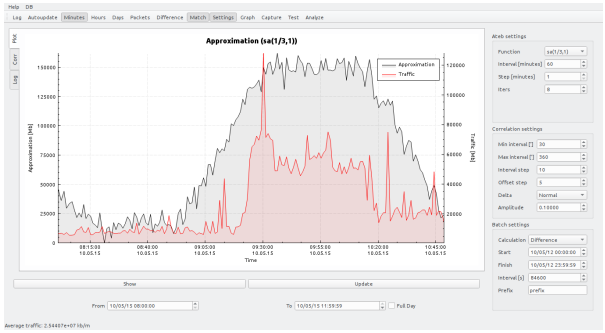

Рис. 1 – The comparison of real network traffic data and predicted traffic data

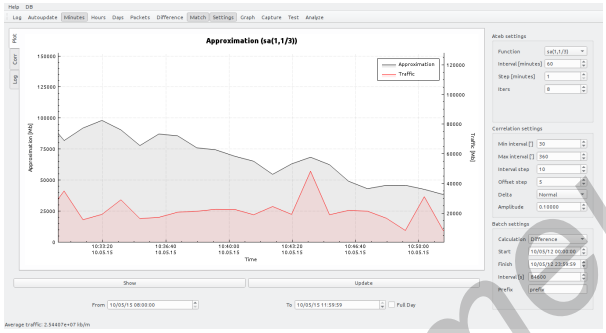

Рис. 2 – The detailed comparison of real network traffic data and predicted traffic data

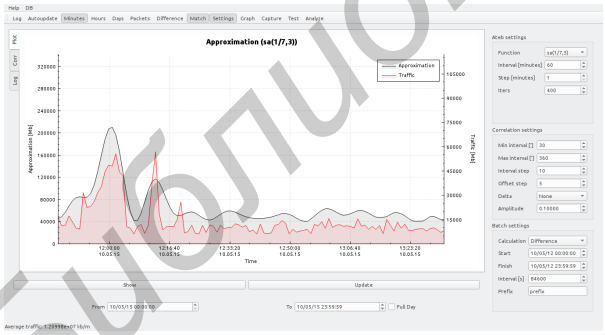

Рис. 3 – The detailed comparison of real network traffic data and predicted traffic data

The traffic and telecommunication networks modeling methods based on the differential equations is quite effective. Based on the proposed model, a software was developed for the analysis and forecasting of traffic flow in a computer network, which is tested on the real data of the network. The criterion of adequacy selected for the model was maximum correlation. In general, the software shows the positive results of the prediction method in the node of computer network. The next stage of the study is an investigation of traffic for self-similarity. This research proofs the correctness of used mathematical methods. Therefore proposed mathematical approaches are effective for traffic and telecommunication networks modeling.

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