УДК 656.07.

ANALYSIS OF MODERN METHODS OF MODELLING MUNICIPAL TRANSPORT IN THE SYSTEM OF ITS

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The current state of development of information and communication technology of land transport based on the practical implementation of synergistic integration of computer resources of all road users in a single information space of the global Internet - from an individual vehicle to the corporate level of a transport organisation - is the basis for solving the problem of informatisation of these processes due to the rapid development of both information resources and the information state of transport systems [1].

Today, most urban transport systems (UTS) equipped with telematics and having dispatch services with specialised software installed are becoming integral parts of an integrated system: "person - transport system - vehicle", where the latest information and control technologies are used to the maximum extent possible, which allows us to talk about the existence and operation of such systems in the ITS structure.

To solve ITS problems, the modern software market offers comprehensive solutions, but for small cities and, above all, for small ITS enterprises, there is a problem of implementing proprietary software products, as most of them are a multi-user product that involves the creation of several automated workplaces. To use such systems, it is necessary to have appropriate hardware: network equipment and specialised staff to support the operation of the information system, which is currently impossible due to the high cost. At the same time, the need for automated accounting and control of the operation status of MTs is obvious.

Today, modelling methods are used to provide a detailed analysis of the implementation and operation of ITS in the MT, based on a model that characterises a real object. Modelling is necessary for understanding the system and allows solving four different tasks

- visualise the system in its current or desired state;
- determine the structure or behaviour of the system;
- to obtain a template that allows you to design the system;
- document decisions made using the resulting models.

The modelling of modern systems involves the use of certain design technologies by designers, which should correspond to the scale and features of the project under development. The purpose of modelling at the stage of implementation and operation of complex systems is to play out possible situations in order to make informed and promising decisions on facility management.

There are several approaches to modelling. The most important of them are visual, structural and object-oriented. Visual modelling is "a way of perceiving problems with the help of visual abstractions that reproduce concepts and objects of the real world" [2]. Visual models are tools for visualising, describing, designing, and documenting system architecture.

Structural methods are a rigorous discipline of system analysis and design. Structural analysis and design methods seek to overcome the complexity of large systems by breaking them down into parts ("black boxes") and hierarchically organising these "black boxes"" [2]. The advantage of using black boxes is that their user does not need to know how they work, only their inputs and outputs and their purpose. The most common models of structural analysis are: RAD (Rapid Application Development) methodology; Data-driven Design (DATARUN) methodology; IDEF methodology.

RAD is an information systems development methodology based on the use of rapid application development tools and covering all stages of the life cycle of modern information systems. RAD tools have a completely new technology of application development: information objects are formed as some kind of operating models, the functioning of which is agreed with the user, and then the model developer can proceed directly to the formation of final applications, and at the same time

does not lose sight of the overall picture of the projected system [3,4]. RAD tools have a user-friendly graphical user interface and allow you to create simple applications based on standard objects without writing any application code.

The basis of modern software design and development processes is the DATARUN data design methodology. It was developed at CSA for the design and rapid development of software and information support for distributed information systems that are hosted in a client-server architecture. The DATARUN methodology is model-based and supports the principles of formation and development that are inherent in a complex of evolving systems. The DATARUN methodology combines the best features of relational design, object-oriented technology and the RAD approach.

The IDEF family of methodologies allows you to efficiently display and analyse business models of a wide range of complex systems in various sections. At the same time, the breadth and depth of the processes in the systems is determined by the developer, which allows not to overload the model with unnecessary data.

The basic building block of the structural approach is a procedure or function, and attention is paid primarily to the transfer of control and decomposition of larger algorithms into smaller ones [5]. But such systems are not very adaptable. When requirements change or the size of the application increases, it becomes more difficult to maintain them. The most modern approach to software development - object-oriented - is able to overcome these difficulties and shortcomings. Here, the basic building block is an object or class. The main ideas of the object-oriented approach are based on the following provisions:

- a programme is a model of a real process;
- a model of a real process or its parts can be described as a set of interacting objects;
- an object is described by a set of parameters, the values of which determine the state of the object, and a set of operations;
- interaction between objects is carried out by sending special messages from one object to another.

This technology represents the structure of a programme in the form of objects interacting with each other. As a result of this interaction, which is carried out by transferring messages between objects, the specified functions of the programme are implemented - after receiving a message, the object can perform a certain action (method). "The object-based approach allows us to analyse the system from all sides with a view to automating management functions. The possibility of automation implies a gain in time, and this, in turn, improves the quality and validity of decisions made [6]. The use of object-oriented methods allows to overcome one of the main difficulties encountered in the development of complex systems - the gap between the real world and the simulated environment.

The object-oriented approach generally makes it possible to use the mechanisms of encapsulation, inheritance and polymorphism both in the implementation of the kernel itself and in the development of application class libraries. Therefore, it is important to develop a graphical interface that combines the means of managing a package of external programs, as well as the means of visualising and editing the resulting visual image. This is a software system that should contain advanced tools for integrating already implemented tasks and possible adaptation to new ones.

The most significant contribution to the object approach was made by object and object-oriented programming languages: Simula, Smalltalk, C++ and the UML modelling language. The Unified Modelling Language (UML) is a language for defining, representing, designing and documenting software systems, organisational and economic systems, technical systems and other systems of various nature" [7,8,9].

Thus, the main idea of the object approach is to enclose data and related procedures in structures (objects) united by an inheritance mechanism. In general, object-oriented programming reflects an evolutionary process in design, and therefore this new methodology is not a sharp departure from past methods, but is built on past experience [9]. Today, the object-oriented approach to modelling and designing software systems is best suited for solving problems that require a detailed representation of real-world objects and dynamic relationships between them. And, above all, for solving the problems of technical control, on which passenger safety and reliability of the transport

system depend and for which it is advisable to make extensive use of mathematical modelling, which is an integral part of any research.

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