Development of a three-level information model for processing diagnostic information for electric transport systems

B V Malozyomov¹, N S Druzhinina², I M Daudov³

¹ Novosibirsk State Technical University, 20, Karla Marksa ave., Novosibirsk, 630073, Russia
² Irkutsk National Research Technical University, 83, Lermontov str., Irkutsk, Russia, 664074
³ Chechen State University, 32 Sheripova Street, Grozny, 634050, Russia

E-mail: mbv5@mail.ru

Abstract. The article proposes a way to improve the existing system for forecasting the technical condition of vehicles at electric transport enterprises. The authors propose a three-level architecture of the software and hardware of the information system and its implementation in Intranet and Internet technologies. The transition to a three-level system is primarily due to the desire to reduce the information system costs, which consists of the cost of equipment, software and operating expenditures. In addition, the work defines the structure of effective forecasting of the developed system operation.

1. Introduction

Currently, various information systems are actively developing at electric transport enterprises [1]. The systems used at these enterprises differ in the volume of existing software, tasks performed, processing power, branching, etc.

For the system forecasting their technical condition, the authors proposed a three-level architecture of the software and hardware of the information system. This system is implemented in Intranet and Internet technologies [2, 3]. The paper presents the developed architecture and hierarchy of network computing. Network computing is done using software of Oracle and Microsoft companies.

The basic principle underlying the management of a three-level information system is “devide et impera”, i.e. “divide and conquer”. This control principle is similar to the control principle of any complex system. According to it, a complex software system at the top level should consist of a small number of relatively independent components with clearly defined interfaces. Next it is decomposed into elements. The components selected in the first stage are subjected to it. Next, the same decomposition procedure is executed up to a specified level of detail. As a result, the system is represented by a hierarchy in which several levels of abstraction are distinguished.

Today, in software engineering, there are two main approaches to the development of software systems. The main difference between them is in the decomposition criteria [4]. The first approach is called structural or functional-modular. It is based on the principle of algorithmic decomposition, when the functional elements of the system are distinguished and a strict order of actions is established. The second, object-oriented approach, uses object decomposition. Moreover, the behavior of the system is described in terms of the interaction of objects [5].
The need to move from a two-level system, which has already become classical, client-server architecture to a three-level one is primarily due to the desire to reduce the cost of ownership of an information system, which consists of the cost of equipment, software and operating expenditures. To date, according to analysts at Gartner Group, the average US cost of ownership per workplace is $8,000 per year [6].

2. Theory
Research and analysis of existing work in this area allowed developing a three-level information system using the principles of object decomposition:

- first level is presentation level (data input and display functions);
- second level is application level (universal services, as well as functions related to the decision on the operability of the object as a whole);
- third level is access to information resources (fundamental functions of storage and management of information and computing resources).
Transaction and Communication Manager provides communication between levels. Intranet technology leaves its mark on this classic design. At the presentation level is a universal client, a WEB navigator. In this case, the WEB navigator is supplemented by application functions. The functions of the information concentrator are assigned to the WEB server [7, 8]. This combines the functions of an information hub with the functions of a transaction and communication manager. The resulting circuit is shown in Fig. 1.

3. Results and discussion
Based on the proposed architecture and software of Oracle Corporation, three key elements of the information system were proposed:
- Oracle 8 DBMS object-relational server;
- Oracle Application Server 6.0, as well as a number of specialized application servers (Oracle Payment Server, Internet Commerce Server, Video Server, etc.);
- a set of JDBC drivers [9], specially optimized for access from Java to the Oracle 8 DBMS, as well as SQLJ - SQL embedded in the Java language.

Using Oracle Corporation software gives the three-level architecture another feature. This architecture was originally conceived as extensible open architecture (Fig. 2). The main unit of expansion of such an architecture is a cartridge. This can be a client, application, or data cartridge. The system provides means for creating cartridges. Interfaces for connecting them with other components of the information system are also provided [10].
Procedural language (PL) and query language with support database operations (DO)

CLIENT

UNIVERSAL DATA STORAGE MECHANISM WITH HIERARCHIC STRUCTURE

ORACLE DATABASE SERVER

TECHNICAL APPLICATION SERVER

WORKING STATION

Figure 3. Information system diagram based on Oracle DBMS
The scheme of the developed information system is shown in Fig. 3. The concepts at the enterprises of electric transport are: employees of divisions, depots, diagnostic and repair divisions of the enterprise, warehouses. All these concepts are in a certain hierarchical relationship. They have directional (upper and lower) connections. As a result, units are part of the enterprise. Employees are part of the unit, etc.

The properties of the concept of "enterprise" can be: the name of the company, the actual and legal address of the company. For each concept (category), an instance (object) can be created that has (or does not have) upper and lower connections with other objects and has (or does not have) properties (attributes of the object).

An element that ensures the distribution of information flows in the system is a document. A document in a system is a screen form designed by a developer. This form has the necessary functionality to select the necessary information from the database and create new objects in the database with relationships and attributes.

Within the framework of the developed system, a database structure was developed and a functional was created. The developed functionality includes all the necessary development tools: a designer of screen forms (documents), a tool for describing a category graph (accounting scheme of the application) and category properties, a procedural language (PL) designed to describe the functionality of a document, and a database query language (LI) [11, 12].

The combination of such an ideology with the corresponding functionality and structure of the system database provides a powerful tool for creating applications. The main area of work of such a tool will be the storage and processing of various kinds of information. In such a system, the developer is completely spared from creating the database structure and its design. Also, there is no need to tune its performance. In the case of the used Oracle database management system, this is a very time-consuming and complex process. When creating a specific enterprise information system, the corresponding Oracle database structure is formed. In this case, when changing the logic of the system, it is necessary to change the structure of the database, which entails significant costs.

The implementation of the work of such systems can significantly reduce costs and expenses for organizations or when using equipment at various enterprises of heavy industry [13-19].

The data storage scheme developed and presented in this article allows implementing any technical process in the information system, perform its calculation and forecasting regardless of its level of complexity. The same applies to the ideology associated with the information system of constructing mechanisms for working with data. The developed data storage and processing scheme does not impose any restrictions on changing their structure. This approach to developers puts forward the requirements for knowledge and experience of analytical work in the subject area in the first place. And only then come the requirements for technical programming.

4. Conclusions
A system for predicting the technical condition was developed. Within its framework, a three-level architecture of software and hardware for the information environment was proposed. This three-level system is implemented in Intranet and Internet technologies. Architecture and hierarchy of network computing were elaborated. To create this hierarchy, Oracle and Microsoft software were used. The need to move to a three-level system from a two-level one architecture of the "client-server", which has already become classic, is due to the desire to reduce the cost of the information system. Total costs are the sum of the cost of software, hardware, and operating expenditures. The structure of effective forecasting of the developed system was determined.

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