STORAGE OF GEOMETRIC DATA

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ABSTRACT

The implementation of railway digitalization programs is associated with development of information management systems and telecommunications, with enhancement of integrated automation of management and control systems.

A new type of information system which is geographic information systems (GIS) is of interest as it is intended for decision-making in transport management and control systems. Besides, various training simulators, that simulate movement of various objects and control procedures, have been widely implemented in civil aviation, on railways and in other modes of transport. The development of simulators is associated with development of visualization systems based on computer software.

Respective operations are based on spatially distributed geometric information. The article depicts basic approaches to core methods of its storage and transmission via information networks.

Keywords: transport, geographic information systems, geometric data, SQL, DBMS.

Background. *Data storage systems are in high demand in the modern world. Every year the volume of information processed increases significantly. This is facilitated by the growth of productivity and the progress of electronic devices and communication networks.*

Requirements for storage systems remain unchanged:

- *reliability – the recorded data should not be corrupted;*
- *accessibility – authorized users should be provided with uninterrupted access to the system;*
- *performance – the ability to work with a large number of clients and large volume of data (the main performance indicators are the number of simultaneous input/output operations and the performance time);*
- *scalability – the ability to increase the amount of memory and the number of supported clients without affecting other system features.*

When creating a database, the designers strive to organize information according to various criteria for its quick retrieval. This is possible if data is structured [1].

Structuring is the process of grouping data according to certain parameters [2].

Unstructured data includes: information from social networks, XML, video/audio files, images, PDF documents [1].

Due to storage of strategically important information in the databases and the emerging issues of information security, the key point is the use of a database management system (DBMS) based on original developments. This determines the relevance of the research topic [3].

Objective. *The objective of the author is to consider different aspects related to storage of geometric data.*

Methods. *The author uses general scientific and engineering methods, information and IT methods, evaluation approach, graph construction.*

Results. *The graphic database of geometric objects based on MRO method [4] will contain the following information: geometric objects structural matrix R-descriptor, codes of pieces described by known methods (for example, by using the special contour method), descriptive parameters [5].*

The geometric object is the base class for all others, the only abstract (non-instantiable) class, all others being instantiated.

Consistency and accessibility in the absence of separation resistance – all traditional relational databases belong to this class [6].

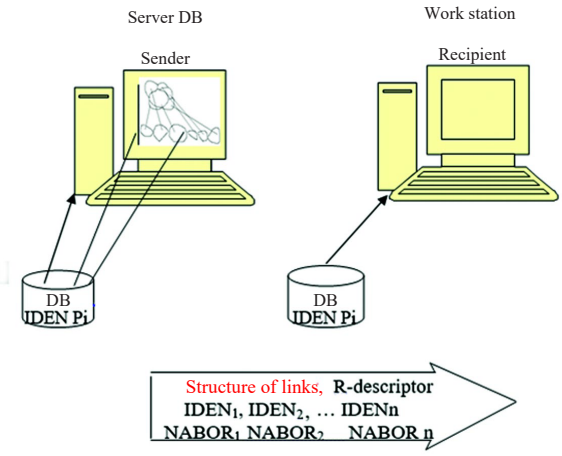
An illustration of the algorithm for processing and transmission through the network of composite GO based on MRO is shown in Pic. 1:

It is conditionally possible to distinguish two approaches to access to graphic data (Pic. 2) [4].

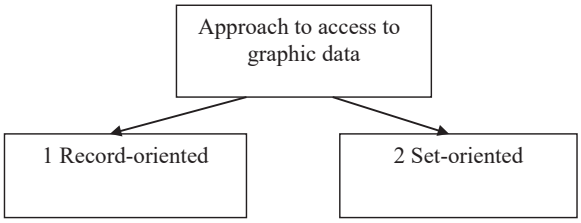
The second approach is used in SQL database servers [2]. Database language usually has two components:

- *Schema Definition Language – SDL [7];*
- *Data Manipulation Language – DML.*

The most common for various data types is the SQL declarative language (Structured Query Language), that supports SDL and DML of relational



Pic. 1. Illustration of the algorithm for processing and transmission through the network of composite geometric objects based on MRO.



Pic. 2. Approaches to access to graphic data.

Table 1

Database rating

Models	Relational	Key-value	Distributed storage	Document-oriented	Graph-based
1	Oracle	Redis	Cassandra	MongoDB	Neo4j
2	MySQL	Memcached	HBase	Amazon DynamoDB	Titan
3	Microsoft SQL Server	Riak KV	Microsoft Azure Table Storage	Couchbase	Giraph
4	PostgreSQL	Hazelcast	Hypertable	CouchDB	InfiniteGraph
5	DB2	Enhache	Google Cloud Bigtable	RethinkDB	Dgraph

Source: https://db-engines.com/en/.

DBMS. In computer networks, SQL is present along with some protocols and session-level interfaces:

• NFS (Network File System) – network file system, used on UNIX stations along with TCP/IP;

• RPC (Remote Procedure Call) – a call to remote procedures that are created on the client's PC and are executed on the server;

• Xwindows is aimed to communicate with remote UNIX PCs;

• DNASCP – session layer protocol in DECnet networks, it is widely used.

There are three forms of SQL: interactive, static and dynamic. They are operated basically in one and the same way, but are used differently. Interactive one is the basis of the language [8].

For some specific projects, new data storage models are more suitable. They are called non-relational or no SQL. At the moment there are already hundreds of different DBMS, each of which has its own advantages and disadvantages and is suitable for certain tasks. And in order to be able to choose the best tool for the task, it is necessary to have tools for testing and comparative analysis of databases. The choice of data storage technology should be made after receiving complete information about each type of database and testing them for the particular task. Of all the models, the relational one is most relevant, it is based on the relationship between the stored information. The results are grouped by selected models and are presented in Table 1 [9].

Let's suppose that there is a task to select a DBMS for storing geometric objects specified by MRO method [4]. Let's analyze DBMS following the sample in Table 2, containing the connection matrix of geometric objects and the simplest geometric objects [10] (the complete matrix is not shown because of big volume of data that can't be formatted for publication).

As a result of the analysis, Microsoft SQL Server [11] is proposed for exchange and storage of geometric information.

The advantages of SQL are, above all, an easy-to-understand language and at the same time a universal data management tool.

Table 2

matr	OB1	OB2	OB3

The following features have contributed to the success of SQL language:

• independence from specific DBMS;

• transferability from one computer system to another;

• availability of standards;

• IBM approval (DB2 DBMS);

• support from Microsoft (ODBC protocol);

• relational framework;

• high-level structure resembling English language;

• ability to perform special interactive requests:

• providing programmatic access to databases;

• possibility to present data in different forms;

• adequacy of the language designed to work with databases;

• ability to dynamically identify data;

• client/server architecture support.

All of these factors made SQL a standard tool for managing data on personal computers, mini-computers and large computers [12].

Table 3 presents the general sample view of a matrix of implementation of operations that is to be filled for particular cases. The matrix should comprise codes of pieces of a given surface and algorithms of their implementation with different methods.

Following the algorithm implementation by the given method the R-descriptor is transmitted over the network which is a method of filling in the parameters of network transport, where:

• state – state of the object, information about fragment locks [13];

• UserID – user mode identifier.

Table 3

Storage of geometric information

Codes of pieces	Algorithm implementation method 1	Algorithm implementation method 2	Algorithm implementation method 3	Algorithm implementation method 4

Further image processing relies on several successive levels of the ascending information line («iconic representation of objects (raster image, unstructured information) – a symbolic representation (vector and attribute data in a structured form, relational structures)») and is implemented through the following processing steps:

- *image preprocessing;*
- *primary image segmentation;*
- *selection of the geometric structure of the visible field;*
- *determination of the relative structure and semantics of the visible scene [15].*

The presented material depicts the steps to implement storage of geometric objects specified by MRO method [14].

Conclusion. *It should be noted that ways of specifying the surfaces of geometric objects, other than MRO, have rather labourious processing algorithms that are unsuitable for the line-by-line imaging of scenes, since they do not provide the required delay in a closed control system. The considered basic issues remain topical for transport industry.*

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