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Main Characteristics of Geoinformation Technologies and Modern Gis

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ABSTRACT

GAT is an interdisciplinary field and is widely used in cartography, remote sensing, land surveying, natural resource management, photogrammetry, geography, urban planning, aerial video, and local search systems. It is an internally positioned spatial information system designed for data management, cartographic images and analysis. GAT is a computer system designed to store, manage and describe geographical information of human activity and hardware.

"Geoinformation system is a generalized software system under the management of specialists and analysts whose main tasks are to collect, store, manage, analyze, model and describe geospatial data of natural and social phenomena using special tools" Geoinformation technologies are a new type of information about the surrounding world can be defined as a set of software-technological, methodological means of obtaining information. They consist of the implementation of geoinformation technologies in management processes, data storage, presentation, processing and production, and the practical application of information obtained about the surrounding reality. Geoinformation technologies are used in the informatization of new information technologies aimed at achieving various goals, including production and management processes. The feature of geographic information systems is that they are the result of the evolution of these systems as information systems, and therefore include the basics of building and using information systems. GIS as a system includes many interrelated elements, each of which is directly or indirectly related to each other, and of this set any two subsets cannot be independent without breaking the integrity, unity of the system. Another feature of GIS is that it is an integrated information system. Integrated systems are built on the principles of combining the technologies of different systems. They are often used in so many different areas that their name often does not define all their capabilities and functions. Therefore, GIS should not be associated only with solving problems in the field of geodesy or cadastre. "Geo" in the name of geographic information systems and technologies defines the object of research, not the object of using these systems. Integration of GIS with other information systems creates their multidimensionality. Complex data processing is performed in GIS, from data collection to its storage, updating and presentation, so GIS should be considered from different perspectives. Any control system GIS is designed to support decision-making for optimal land and resource management, urban planning, transportation and retail, ocean use, or other spatial features. Unlike information systems, GIS has many new technologies for spatial data analysis combined with electronic office technologies and optimization of solutions based on them. Therefore, GIS is an effective way to transform and synthesize various data for management purposes. All geosystems combine information collection technologies from systems such as GIS geographic information systems, cartographic information systems, automated mapping systems, automated photogrammetric systems, land information systems, automated cadastral systems, and others. All database systems are characterized by a wide range of data collected using various methods and technologies. At the same time, it should be noted that they combine the capabilities of text and graphic databases. Simulation systems GIS use the maximum number of modeling methods and processes used in other information systems, and primarily in CAD. GIS is unmatched in its breadth, as it is used in transportation, navigation, geology, geography, military affairs, topography, economics, ecology, and more. Therefore, making many decisions based on GIS technologies is not limited to creating maps, but uses all cartographic information. Thematic data are stored in GIS in the form of tables, so there are no problems with their storage and organization in databases. The biggest challenges are the storage and visualization of graphical data. The main class of GIS data is coordinate data, which contains geometric data and reflects the spatial dimension. The main types of coordinate data: point (nodes, vertices), line (open), contour (closed line), polygon (range, region). In practice, large amounts of data are used to construct real objects (for example, hanging node, pseudo-node, simple node, overlay, layer, etc.). The considered data types have more diverse relationships, which can be divided into three groups:

- ✓ relations of building complex objects from simple elements;
- ✓ relationships calculated with coordinates of objects;
- ✓ relationships defined by specific descriptions and semantics in data entry.

Figure-1.

In general, spatial (coordinate) models of data can have a vector or raster (cellular) image. This approach allows to divide the models into three types: raster model; vector non-topological model; vector topological model. All these models are interconvertible. Nevertheless, it is necessary to take into account their characteristics when taking each of them. There are two main subclasses of models in the GIS form of coordinate data representation: vector and raster (cellular or mosaic). Graphical representation of the situation on the computer screen implies the display of various graphic images on the screen. The graphic image created on the computer screen consists of two different parts from the point of view of the storage medium - the graphic "substrate" or graphic background and other graphic objects. In relation to these other graphic representations, the "image-substrate" is a "field" or spatial two-dimensional image. The main problem in the implementation of geoinformation applications is the formalized description of a specific subject area and the difficulty of displaying it on an electronic map. Thus, geoinformation technologies provide methods and means of information interaction on space-time information presented in the form of an electronic map system, and for processing heterogeneous information for different categories of users. designed for the widespread implementation of subject-oriented environments in practice. Vector patterns are widely used in GIS. They are built on vectors that occupy part of the space, unlike raster models that occupy the entire area. This determines their main advantage - less memory for storage and the requirement of orders, less time spent on processing and presentation, most importantly - allows for high-precision execution of positioning and data presentation. In the construction of vector models, objects are created by connecting points with straight lines, circular arcs, polylines. Area Objects - Areas are defined by a set of lines. GIS systems that work mainly with vector models are called vector GIS. In real GIS, they deal not with abstract lines and points, but with objects that contain lines and areas that occupy a spatial position, as well as with complex relationships between them. Therefore, a fully vector GIS data model represents spatial data as a set of the following basic parts: geometric (metric) objects (points, lines and polygons); attributes - properties associated with objects; relationships between objects, vector models (objects) use a sequence of coordinates that form a line as an elementary model. A line is a boundary, segment, chain or arc. The main types of coordinate data in the class of vector models are defined by the line of basic elements as follows. A point is defined as a broken line of zero length, a line is defined as a line of finite length, and an area is defined as a sequence of connected segments. Each part of the line can be a boundary for two areas or two intersections (nodes). The common boundary segment between two intersections (nodes) has different names that are synonymous in the GIS domain. Graph theorists prefer the term "edge" to "line" and use the term "vertex" to denote an intersection. A US national standard has officially sanctioned the term "chain". In some systems (Arcinfo, GeoDraw) the term "arc" is used. Unlike simple vectors in geometry, arcs have their own attributes.

- Arc attributes define polygons on both sides of them. These polygons are called left and right in relation to arc-sequential coding. The concept of an arc (chain, edge) is fundamental to vector GIS. Vector models are obtained in different ways. One of the most common is vectorization of scanned (bitmap) images.
- Vectorization is the procedure of selecting vector objects from a raster image and obtaining them in vector format. Vectorization requires high quality (clear lines and contours) of raster images. Sometimes it is necessary to improve the quality of the image to ensure the necessary clarity of the lines. Errors may occur during vectorization, their correction is carried out in two stages:

1) correction of bitmap image before vectorization;
2) correction of vector objects.

Vector models represent continuous objects or events using discrete data sets. Therefore, we can talk about vector discretization. At the same time, a vector image, compared to a raster image, allows for the display of more spatial variability for some regions than others, which means that the boundaries are more clearly visible and less dependent on the original image than with the raster display. liq. It is characteristic of social, economic, demographic phenomena, the variability of which is stronger in a number of regions. Some objects are vector objects by definition, such as the boundaries of the respective land parcel, district boundaries, etc. Therefore, vector models are usually used to collect coordinate geometry (topographic records), information about administrative-legal boundaries, etc.

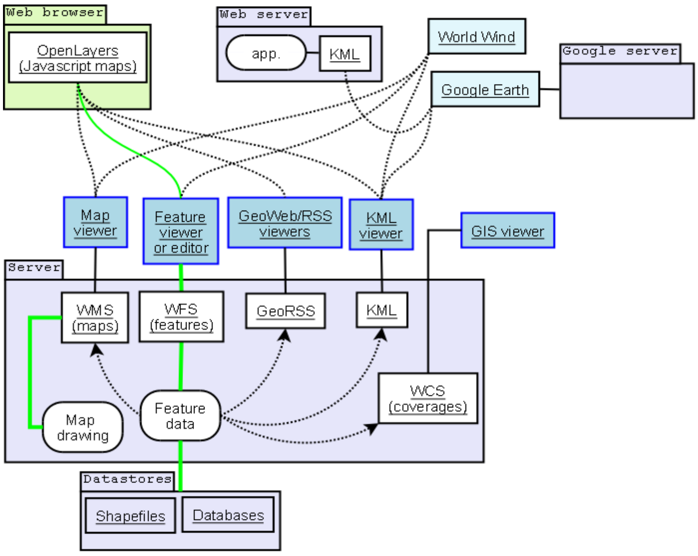

Figure-2.

Characteristics of vector models: In vector formats, data sets are defined by database objects. The vector model can arrange the space in any order and allow "random access" to the data. It is easier to perform operations with linear and point objects, for example, network analysis - development of traffic directions along the road network, replacement of signs. In raster formats, the point feature must occupy the entire cell. This creates a number of difficulties related to the ratio between the size of the raster and the size of the object. As for the accuracy of vector data, we can talk about the superiority of vector models over raster models, because vector data can be encoded with any level of accuracy, which is limited only by the capabilities of the internal coordinate display method. Typically, 8 or 16 decimal places (single or double precision) are used to represent vector data. Only some classes of data obtained in the measurement process correspond to the accuracy of vector data: these are data obtained by exact measurement (coordinate geometry); are maps of small areas based on topographic coordinates and political boundaries determined by precise photography. Not all natural phenomena have characteristic clear boundaries that can be expressed in the form of mathematically defined lines. This is related to event dynamics or spatial data collection methods. Soils, plant species, mountain slopes, habitats of wild animals - all these objects do not have clear boundaries. Usually, the lines on the map are 0.4 mm thick and often represent the uncertainty of the location of the object. In a raster system, this uncertainty is given by the cell size. Therefore, it is important to remember that in GIS, it is not the accuracy of the coordinates, but the size of the raster cell and the uncertainty in the position of the vector object that gives the true indicator of accuracy.

Raster models have the following advantages:

• Raster does not require prior knowledge of events, data is collected from a network of points located at the same distance, which allows to obtain objective characteristics of the studied objects based on statistical processing methods in the future. Because of this, raster models can be used to study new phenomena for which no material has been collected. Due to its simplicity, this method is the most widely used;

• raster data is easier to process using parallel algorithms, thus providing higher performance compared to vector data;

• it is much easier to solve some tasks, such as creating a buffer zone, in the form of a raster;

• many raster models allow entering vector data, but for vector models the reverse procedure is very difficult;

• rasterization processes are algorithmically simpler than vectorization processes and often require expert judgment. A digital map can be divided into several layers (overlays or sublayers). Layers in GIS represent a set of digital cartographic models built on the basis of association (recording) of spatial objects with common functional characteristics. A set of layers forms the overall basis of the graphic part of GIS. An example of integrated GIS layers is shown in Fig. An important point in designing a GIS is the size of the model. Two-dimensional (2D) and three-

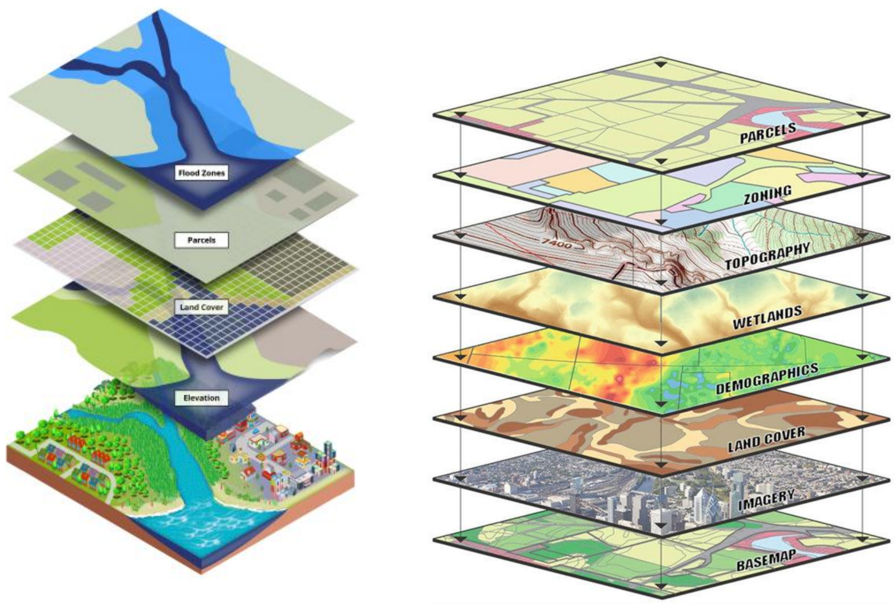

Figure-3.

dimensional (3D) coordinate models are used. Two-dimensional models are used in mapping, and three-dimensional models are used in modeling geological processes, designing engineering structures (dams, reservoirs, quarries, etc.), modeling gas and liquid flows.

There are two types of 3D models:

1) pseudo-three-dimensional, when the third coordinate is determined;

2) true three-dimensional image.

Many modern GIS perform complex data processing:

- ✓ primary data collection;
- ✓ collection and storage of data;
- ✓ various types of modeling (semantic, simulation, geometric, heuristic);
- ✓ automated design;
- ✓ supporting documents.

As a vector-raster GIS, the data sources for forming a GIS include:

- ➢ cartographic materials (topographic and general geographic maps, administrative-territorial division maps, cadastral plans, etc.). The data obtained from the maps is georeferenced, so it is convenient to use it as the main GIS layer. If there are no digital maps for the studied area, then the graphic original copies of the maps are transferred to digital form;
- ➢ remote sensing data (hereinafter referred to as RSD) are increasingly used to form GIS databases. ERS primarily contains materials from spacecraft. For remote sensing, different technologies are used to acquire images and transmit them to Earth, imaging equipment carriers (spaceships and satellites) are placed in different orbits and equipped with different equipment. With its help, images with different levels of visibility and detail are obtained

when displaying objects of the natural environment in different spectral ranges (visible and near infrared, thermal infrared and radio range). All this leads to a wide range of environmental problems that can be solved by remote sensing. Remote sensing techniques include aerial and ground-based surveys and other non-contact techniques such as hydroacoustic seabed surveys. The materials of such studies provide both quantitative and qualitative information about various objects of the natural environment;

- materials for field survey of territories Topographic, engineering-geodetic surveys, cadastral surveys, surveying of territories using levels, theodolites, electronic general stations, geodetic measurements of natural objects made by GPS receivers, as well as geobotany and other methods results, for example, studies consist of animal behavior, soil analysis, etc.; statistical data includes data from state statistical services on various sectors of the national economy, as well as data from stationary measuring observation points (hydrological and meteorological data, data on environmental pollution etc.) includes;

In GIS, only one type of data is rarely used, often resulting in varying data for any given area. The main directions of using GIS:

- ✓ electronic cards;
- ✓ city economy;
- ✓ state land cadastre;
- ✓ ecology;
- ✓ remote sensing;
- ✓ economy;
- ✓ special military systems.

A geographic information system (GIS) is a multifunctional information system designed to collect, process, model and analyze spatial data, display and calculate them, solve problems, prepare and make decisions. The main purpose of GIS is to form knowledge about land, separate areas, land cadastre, as well as timely delivery of necessary and sufficient spatial information to achieve the highest efficiency of users' work.

Advantages of geoinformation technologies. Using GIS technologies, you will have the following opportunities: significantly increase the efficiency of all stages of working with spatially distributed data, from inputting initial data, analyzing it to developing a specific solution; using modern electronic surveying tools and global positioning systems (GPS) to enter and update data in the database, which means that you will always have the most accurate and up-to-date information; Attracting high-quality specialists who develop software for GIS systems; for example, it is not necessary to have a mathematical background to use pollution emission calculation programs.

Fields of application of geoinformation technologies. Today, the fields of application of GIS are very diverse: land management, state cadastres, resource management, ecology, urban management, transport, economy, social tasks, etc. Interest in these technologies is growing sharply in the geodesy, cartography and cadastral fields of our republic. Traditionally, GIS technologies are used in land cadastre, natural resource cadastre, ecology, real estate and operational management of resources and other fields. Currently, GIS systems are increasingly being used in public areas such as electronic city plans, transportation schemes, and other fields. According to some estimates, up to 80-90% of all data that we usually deal with can be presented in the form of GIS. GIS is a natural step on the way to paperless information processing technology, which opens up new opportunities for manipulating data with spatial reference.

CONCLUSION

The use of geographic information systems not only changes our ideas about the ways of perceiving reality, but also makes serious corrections to the theoretical foundations of mapping. The synthesis of geoinformation technologies and the Internet space gives the basis to talk about a special geoinformation space. Basically, the main stages of creating a computer map correspond to the stages of traditional historical research, but some specific points should also be noted. They are primarily concerned with finding sources and preparing them for analysis. Spatial analysis requires the selection of cartographic sources, in addition to the creation of databases already familiar to the historian (mainly statistical data), and this, in turn, is impossible without understanding the traditional methods of creating maps, without knowledge of history.

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