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CONCEPTUAL MODEL OF A SPECIALIZED GEOINFORMATION SYSTEM

One of the most important directions for solving the problem of improving the process of providing geospatial information on the systems of command and control of troops and weapons is the implementation into the practice of the Armed Forces of Ukraine management of military information systems (MIS), representing software and hardware complexes, that was designed to collect, process, store, analyze, simulation and visual display of geospatial information necessary to support decision-making on military command in peacetime and wartime, and tactics digital (electronic) cards and perform military applications (settlement) problems associated with the assessment of operational and tactical planning properties of the terrain and the use of force (means). To this end, the author proposes a conceptual model of a specialized geoinformation system in this article. This model allows us to combine into a single whole the views of researchers on the creation and operation of specialized geoinformation system. In the course of the study, classic methods of analysis and synthesis, methods of decomposition, mathematical statistics, modeling, complex technical systems, and others were used. As a result of the research carried out in the article, the author obtained a conceptual model of a specialized geoinformation system. The given model makes it possible to combine separate theoretical researches, to supplement and improve them and to enter a new scientific level. The proposed research may become a new scientific basis for the development and improvement of existing specialized geoinformation system. The author's proposed model allows describing the functioning of individual subsystems of a specialized geoinformation system, as a whole, and individual subsystems. The practical implementation of the above conceptual model of MIS will provide the provision of geoinformational resources to all information necessary for the management of troops and weapons. A distinctive feature of MIS will be the differentiation of the provision of geospatial data for various parts of the control of troops and weapons systems. In other words, this or that unit of military control will be provided only by the set of geospatial data that is necessary and sufficient for the purpose of the task.

Keywords: geoinformation systems; mathematical modeling; special systems; conceptual model; Armed Forces of Ukraine; analysis; synthesis; decomposition; generalization.

Introduction

At the present stage of historical development in connection with the emergence of new weapon types, such as high-precision weapons and weapons, is based on new physical principles (electromagnetic, laser, infrasound, etc.), which has a great destructive force, as well as in the coup in the military affair took place with the creation of their devices of delivery, which led to the necessity to improve the process of providing geospatial information on the control systems of troops and weapons [1-7].

One of the most important directions for solving this problem is the introduction in the practice of the Armed Forces of Ukraine management of military information systems (MIS) that represent hardware and software complexes designed to collect, process, store, analyze, simulate and visualize the geospatial information, that is required for supporting the decision-making on military command in peacetime and wartime, as well as the creation of digital (electronic) maps and execution of military-applied (settlement) tasks, according to associated with the assessment of operational-tactical properties of the area and the planning of the forces (devices) using.

Modern geoinformation systems, that is using in the Armed Forces of Ukraine are different in purpose, incompatible with one another and functionally limited.

An urgent scientific task arises, which consists in generalization, systematization and improvement of existing views on the creation and application of geoinformation systems of special purpose [5-7].

Proceeding from the foregoing, *the purpose of this article* is to develop a conceptual model of a special-purpose geographic information system.

Presentation of the main material

Nowadays, the following MIS are supplied to the Armed Forces of Ukraine: "Violit", "KIDD", "Arta" and "Combat". These geoinformation systems are actively used to provide troop control units with geospatial information. However, despite the positive recommendations of users about MIS adopted, their significant disadvantages were also noted, the main ones are [7-11]:

1) special software is not implemented in the network, but in the form of local automated workplaces, which causes its high cost;

2) devices of remote access through MIS servers are poorly designed;

3) there is no single database of geospatial information in the interests of providing users of MIS, which is part of the geographic information space of Ukraine, containing updated digital (electronic) topographical, naval navigation, special maps and plans of cities of all scale; spatial models of terrain in various formats with metadata, which ensures the creation of a mapping coverage on any parts of the Earth's surface in two-dimensional and three-dimensional form in vector and raster forms in different coordinate systems; providing this information on a user's request, subject to their permission, through geoservices for its viewing and download;

4) military-applied (estimated) tasks related to the assessment of tactical properties of the area and the planning of using of forces (devices) in MIS are not

implemented, analytical functions are based only on cardometry, morphometry and graphic transformation, due to the lack of algorithms for the transformation of geospatial information according to consumer requests. Despite a number of developments in this direction [1, 2, 5, 6], they are still underdeveloped. At the beginning of the XXI century, a similar situation occurred in the US Army and a number of NATO member states, that refused to develop new MIS and selected the ArcGIS specialized software as the MIS core of the combined commercial set of cartographic instruments (JCMTK). This specialized software is widely used in most government departments and commercial structures and is constantly being improved by ESRI, and units of the engineering corps develop and implement in the practice of geoinformational support for troops individual modules for solving military-applied tasks and processing of non-standard geospatial data;

5) knowledge base, that is necessary for solving military-applied (settlement) tasks;

6) MIS architecture is based on the principles of the so-called "stable" system, that contain once and for all the volume of special information contained therein;

7) during the life cycle of MIS are not accompanied by software developers, so new versions, and systems in general, differ little from each other (in the best case, add separate modules for solving one or two military applications (settlement) tasks).

In addition, MIS users point out, that the contents of databases and knowledge bases should be updated promptly as new and/or more accurate and detailed data is received. It is also necessary to improve and special software both in terms of increasing the efficiency of providing information to the consumer, and in terms of the reliability of the protection of special information from unauthorized admission. At the same time, the software must ensure correct operation of existing databases and knowledge bases. In the article, the author considers the conceptual model of MIS, which in his opinion, will eliminate the above-mentioned shortcomings and will ensure the effective transformation and presentation of large volumes of various geospatial information to military command, both in peacetime and in wartime.

The proposed conceptual model of MIS consists of three main subsystems (Fig. 1):

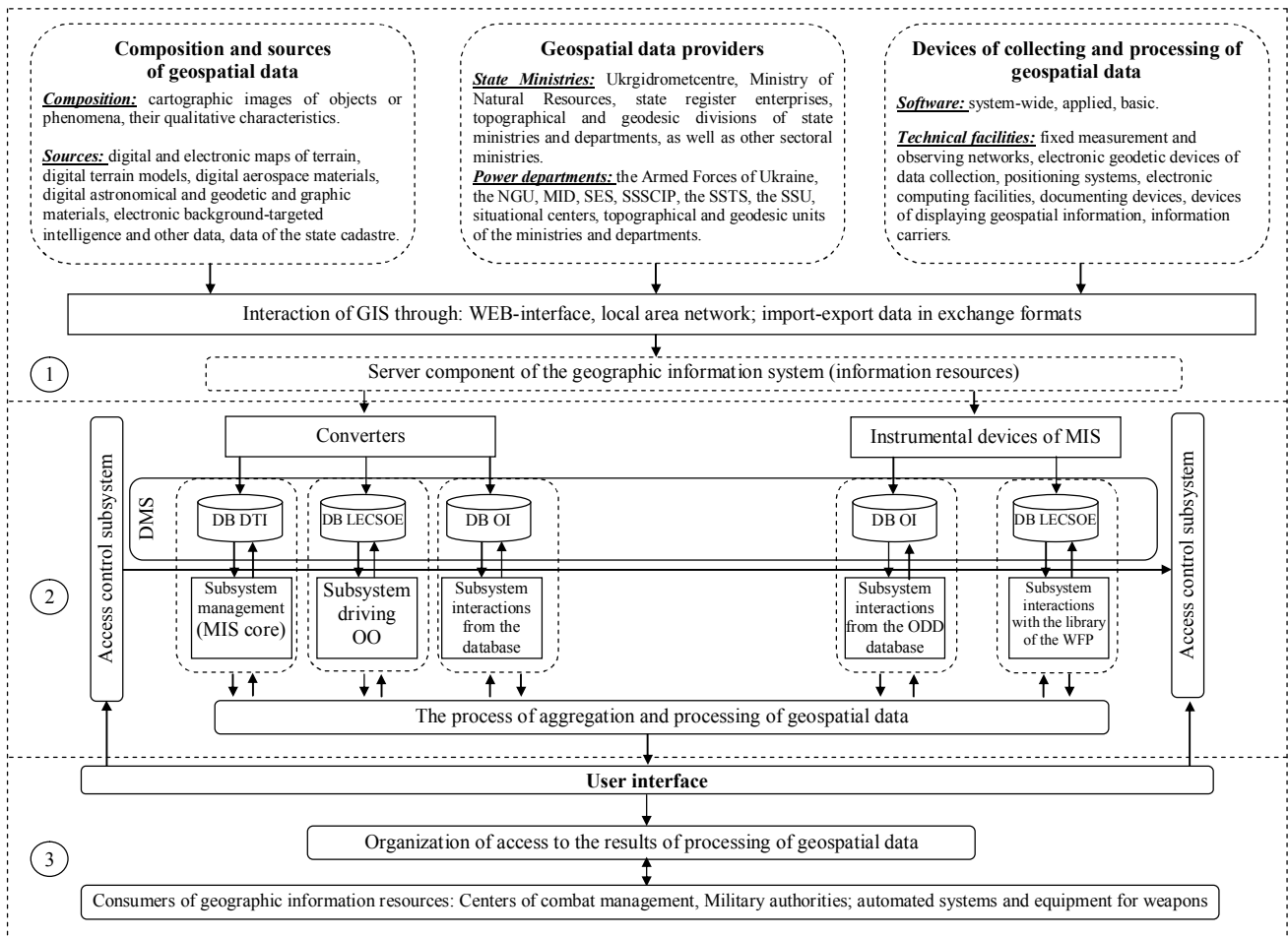


Fig. 1. The conceptual model of the geoinformation system of special purpose

1) subsystem of information support, that characterizes the process of obtaining geospatial data necessary for the functioning of MIS;

2) the subsystem of processing geospatial data, characterizing the process of automated and interactive

conversion of coordinate-time information in accordance with user requests and the need to submit it in a convenient way for them;

3) the subsystem of access to information resources of MIS, which characterizes the process of

obtaining information resources of the processed information by consumers.

Briefly consider the features of each of these subsystems.

1. A subsystem of information support. It deals with the content, sources, suppliers, devices of collection and pre-processing of geospatial data necessary for the functioning of MIS. It is assumed, that the source information will include the entire spectrum of astronomical-geodetic and gravimetric data, that determine the spatial position of the objects of the area, and cartographic models of the earth's space with their quantitative and qualitative characteristics.

The sources of geospatial information are all available data on terrain objects with their characteristics, including various digital and electronic maps, various special maps and schemes, digital models of the parameters of the gravitational field of the earth and coordinate directories of geodetic points

Suppliers of geospatial information should be all ministries and departments, that use in their work data on the terrain and objects located on it. First of all, suppliers of such information will be geodetic and cartographic enterprises of the State Register, as well as parts and topographic units of the Armed Forces of Ukraine.

Once the content of the source information has been generated, there will be a problem of bringing the heterogeneous data to the uniform appearance set for MIS.

First of all, it concerns the transformation of all the original information into a single system of geodetic coordinates, which will ensure the creation of a single geoinformation space for all geospatial data, used in the system.

In addition to this problem, the problem of the correct combination of all formats of geospatial information and the transition to a single internal format established for the geoinformation system under development is relevant. In this format, the representation of geospatial information in the domestic MIS is the SFX format.

The actual task will be the filtration of the original geospatial information. The fact is that the same objects and elements of the locality may be contained in various specialist materials supplied by various ministries and departments.

At the same time, the same information in different sources will be kept with different accuracy, and in relation to the plane objects of the terrain and relief, and with different details. Hence, there is a problem of allocation from the available output arrays of the highest quality in accuracy and most detailed in the content of information.

2. A subsystem of geospatial data processing.

It contains five main elements:

- 1) electronic card control (MIS core);
- 2) element of conducting operational environment;
- 3) element of interaction with the database of operational information;
- 4) element of interaction with the database of knowledge of military-applied (settlement) tasks;

5) element of interaction with the library of military-applied (settlement) tasks.

Let's briefly consider the main functions of each element of this subsystem [4]. Electronic card control (MIS core). It communicates with the database of digital terrain information (DTI) and provides the following functions:

- 1) control the display of electronic maps at a given scale, coordinate system, cartographic projection, according to the specified display criteria, in accordance with the requirements of the information and cartographic provision of the Armed Forces of Ukraine;
- 2) searching for objects of digital information about terrain by the given criteria;
- 3) conducting a classifier of digital information on terrain;
- 4) realization of the calculated functions of cartographic algebra, analytic and geometric functions;
- 5) preservation of digital terrain information in the internal format of MIS or using the cartographic converter of digital information on the terrain in an exchange format;
- 6) reception of solid copies of digital information about the terrain.

An element of operating the operating environment. It communicates with the library of electronic conditional signs of the operational environment (LECSOE) and provides the following functions:

- 1) support of the library of conventional signs of operational and tactical appointment, which corresponds to the domain of military information systems;
- 2) support of the rules of applying the operational-tactical situation in accordance with the domain of military information systems;
- 3) the formation of an operational-tactical situation on an electronic card in an interactive mode;
- 4) the formation in an automatic mode of a tactical situation on an electronic map in a given system of conditional signs according to the data available in the database of operational-tactical information;
- 5) display of the operational situation, deposited on an electronic card.

The element of interaction with the database of operational information (OI). It communicates with the database of operational information and provides the following functions:

- 1) the interaction of MIS with the database of the operational environment through the software interfaces;
- 2) viewing, editing, adding of records and sections of thematic information in the database of the operational environment;
- 3) the formation and execution of requests for data necessity for decision-making by public officials;
- 4) application of operational and tactical situation on electronic maps;
- 5) graphical representation of the results of the decision of military-applied tasks;
- 6) execution of queries and reception of reference attributive information about objects of the electronic card from the database of the operational environment.

An element of interaction with a database of knowledge of military-applied tasks. He communicates with the database of knowledge of military-applied (settlement) tasks and provides the following functions:

1) support in the current state of knowledge necessary for solving military and applied problems in the environment of MIS;

2) formation of the knowledge about the subject area;

3) formation of requests to the knowledge base for obtaining the reference information necessary for decision-making by public officials.

An element of interaction with the library of military-applied (settlement) tasks. He communicates with the library of military-applied (settlement) tasks and provides the following functions:

1) Launching and solving military-applied (settlement) tasks in the environment of MIS;

2) obtaining and displaying the results of the decision of military-applied (settlement) tasks on electronic maps;

3) using of MIS-core functions while working with digital terrain information;

4) using of operational-tactical information in the decision of military-applied (settlement) tasks;

5) preservation of the results of the decision of military-applied (settlement) tasks in the database of operational information.

3. A subsystem of access to information resources of MIS. It contains two elements: an access control and a user interface.

Let's briefly consider their main functions. Access control It provides the following functions:

1) authentication of users and verification of their rights and powers to work with information resources MIS;

2) delimitation of access to information resources of MIS;

3) Individual setting of parameters for each user (official).

User interface. It provides the following functions:

1) the visibility of using the subject area, adopted for the solution of military-applied (settlement) tasks;

2) informing the operator about the results of checking the correctness of his actions and warning about possible errors of the operator or failure of the software as a result of his improper actions;

3) connection of the operator to the MIS help system by interactively calling the electronic instructions and context-sensitive information about those or other MIS capabilities necessary for the solution of the task, and also by using "pop-up" prompts;

4) the ability to configure the operator to configure the necessary elements of the user interface for the more effective solution to a military application task.

The conclusion from this explosion

In the article, a conceptual model of a specialized geoinformation system is proposed.

The proposed model allows describing the functioning of individual subsystems of a specialized geoinformation system, as a whole, and individual subsystems.

The practical implementation of the above conceptual model of MIS will provide the provision of geoinformational resources to all information necessity for the management of troops and weapons.

A distinctive feature of MIS will be the differentiation of the provision of geospatial data for various parts of the control of troops and weapons systems.

In other words, this or that unit of military control will be provided only by the set of geospatial data that is necessary and sufficient for the purpose of the task.

Directions of further research will be the development of methods for processing various types of information in geoinformation systems of special purpose.

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Концептуальна модель геоінформаційної системи спеціального призначення

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Одним з найважливіших напрямків вирішення завдання удосконалення процесу забезпечення геопросторовою інформацією систем управління військами та зброєю є впровадження в практику управління Збройними Силами України геоінформаційних систем (ГІС) військового призначення, що представляють собою програмно-апаратні комплекси, призначені для збору, обробки, зберігання, аналізу, моделювання та наочного відображення геопросторової інформації, необхідної для підтримки прийняття рішень по управлінню військами в мирний і воєнний час, а також створення цифрових (електронних) карт і виконання військово-прикладних (розрахункових) завдань, пов'язаних з оцінкою оперативно-тактичних властивостей місцевості й плануванням застосування сил (засобів). З цією метою в зазначеній статті автором запропоновано концептуальну модель геоінформаційної системи спеціального призначення. Зазначена модель дозволяє поєднати в єдине ціле погляди дослідників щодо створення та експлуатації геоінформаційних систем спеціального призначення. В ході проведеного дослідження використовувалися класичні методи аналізу та синтезу, методи декомпозиції, математичної статистики, моделювання, складних технічних систем та інш. За результатами проведеного в статті дослідження автором отримано концептуальну модель геоінформаційної системи спеціального призначення. Зазначена модель дозволяє об'єднати окремі теоретичні дослідження, доповнити та удосконалити їх та вийти на новий науковий рівень. Зазначене дослідження може стати новим науковим підґрунтям при розробці нових та удосконаленні існуючих геоінформаційних систем спеціального призначення. Запропонована автором модель дозволяє описати функціонування окремих підсистем геоінформаційної системи спеціального призначення як в цілому та і окремі підсистемами. Практична реалізація розглянутої вище концептуальної моделі ГІС забезпечить надання споживачам геоінформаційних ресурсів всієї інформації, необхідної для управління військами й зброєю. Відмінною рисою ГІС стане диференційованість надання геопросторових даних для різних ланок управління військами та системами озброєння. Інакше кажучи, той або інший орган військового керування буде забезпечуватися тільки тим комплектом геопросторових даних, що необхідний і достатній для рішення завдань за призначенням.

Ключові слова: геоінформаційні системи; математичне моделювання; спеціальні системи; концептуальна модель; Збройні Сили України; аналіз; синтез; декомпозиція; узагальнення.

Концептуальная модель геоинформационной системы специального назначения

А. А. Кошлань

Одним из важнейших направлений решения задачи совершенствования процесса обеспечения геопространственной информации систем управления войсками и оружием является внедрение в практику управления Вооруженных Сил Украины геоинформационных систем (ГИС) военного назначения, представляющие собой программно-аппаратные комплексы, предназначенные для сбора, обработки, хранения, анализа, моделирования и наглядного отображения геопространственной информации, необходимой для поддержки принятия решений по управлению войсками в мирное и военное время, а также создание цифровых (электронных) карт и выполнения военно-прикладных (расчетных) задач, связанных с оценкой оперативно-тактических свойств местности и планированием применения сил (средств). С этой целью в указанной статье автором предложена концептуальная модель геоинформационной системы специального назначения. Указанная модель позволяет объединить в единое целое взгляды исследователей по созданию и эксплуатации геоинформационных систем специального назначения. В ходе проведенного исследования использовались классические методы анализа и синтеза, методы декомпозиции, математической статистики, моделирования, сложных технических систем и др. По результатам проведенного в статье исследования автором получены концептуальную модель геоинформационной системы специального назначения. Указанная модель позволяет объединить отдельные теоретические исследования, дополнить и усовершенствовать их и выйти на новый научный уровень. Данное исследование может стать новым научным основанием при разработке новых и совершенствовании существующих геоинформационных систем специального назначения. Предложенная автором модель позволяет описать функционирование отдельных подсистем геоинформационной системы специального назначения как в целом и отдельные подсистемы. Практическая реализация рассмотренной выше концептуальной модели ГИС обеспечит предоставление потребителям геоинформационных ресурсов всей информации, необходимой для управления войсками и оружием. Отличительной особенностью ГИС станет дифференцированность предоставления геопространственных данных для различных звеньев управления войсками и системами вооружения. Иначе говоря, тот или иной орган военного управления будет обеспечиваться только тем комплектом геопространственных данных, необходимый и достаточный для решения задач по назначению.

Ключевые слова: геоинформационные системы; математическое моделирование; специальные системы; концептуальная модель; Вооруженные Силы Украины; анализ; синтез; декомпозиция; обобщения.