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ANALYSIS OF METHODS OF INFORMATION AND TECHNOLOGICAL CONSTRUCTION OF THE SATELLITE SYSTEM OF DATA COLLECTION AND DATA PROCESSING

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Abstract

The object of the research is the satellite remote monitoring system (SDM). The purpose of their research is to analyze trends in the development of SDM, to develop and implement new approaches and tools necessary for their creation and operation. The most important changes that have a significant impact on the technology of creating and using SDM are presented in order to assess the main directions of SDM development. In recent years, there has been a rapid increase in the capabilities of satellite Earth observation systems, as well as the volume and frequency of information from them, in connection with which there was a need to create new approaches and methods for organizing work with the data of remote sensing of the Earth (RS) and the development of construction technologies SDM There was a need to ensure the most efficient work of SDM, as well as to improve the scheme of work with data and develop new methods and tools for their implementation. By way of empirical research, the authors proposed a generalized scheme for the construction of SDM, the main feature of which is that in the interests of SDM, only those blocks that provide work with the remote sensing data to solve specific tasks specific to a particular system are created and maintained. Thus, SDM itself can provide services for the provision of various information services. It can be expected that the direction of providing specialized information obtained on the basis of remote sensing data will be sufficiently rapid to develop in the coming years. This, in particular, will allow the SDM to expand the scope of use of finished information products obtained on the basis of its deep processing, along with the use of basic satellite information.

Keywords: remote monitoring systems, information system, satellite system, remote sensing of the earth, data processing, archives.

Introduction

Recently, the space systems for the transfer of information are developing. It is known that the effectiveness of any activity largely depends on the availability and timeliness of obtaining the objective information necessary for its planning and execution. It is no coincidence that in recent years active growth of development and implementation of various information systems has been noted. Of particular importance are such systems in areas where it is necessary to promptly receive heterogeneous objective information about rapidly changing processes and occur in sufficiently large territories.

Development of the Capabilities of Information Technologies

The development of the capabilities of information technologies, computer, communication and satellite systems in recent decades has allowed us to begin the creation and fairly wide introduction of various remote monitoring systems (SDM) of various phenomena, objects and resources. At the same time, in recent years there has been a rapid, virtually explosive growth of the capabilities of satellite Earth observation systems, including the volumes and frequency of information from them (Trofimov *et al., 2015*), which required the creation of new approaches and methods for organizing work with the data of remote sensing of the Earth (RSZ) (Savorsky *et al., 2012*) and the development of technologies for the construction of SDM.

It should be noted that on the basis of existing technologies (Lupyan *et al., 2011*) more than a dozen large SDMs are created and developed today (Bartalev *et al., 2010*). The practical use of the developed technologies and the experience of exploiting and developing various SDMs, created on their basis, allows us to analyze the trends in the development of such systems, to develop and implement the new approaches and tools necessary for their creation and operation.

In order to assess the main directions of SDM development in recent years, it is necessary to start by briefly discussing the major changes that have taken place in the area associated with the use of satellite remote sensing data in solving various scientific and applied problems. The most important changes that have a significant impact on the technology of creating and using SDM are the following:

• There has been a dramatic change in the capabilities of satellite Earth remote sensing systems (remote sensing). First and foremost, due to the increase in the number of spacecraft of remote sensing devices, the frequency and volumes of information that may flow to SDM has increased. This led to the fact that it was possible to organize monitoring of processes that proceed quickly enough. For example, instead of simply fixing the existence of certain processes, it became possible to identify them at an early stage of development.

• Also, the number of satellite remote sensing systems with "measuring" properties has increased, that is, they provide not only qualitative but also well-calibrated quantitative information about various objects, processes and phenomena. This allowed not only to use the remote sensing data for a qualitative assessment of the situation, but also to receive quantitative estimates based on them and to build forecasts for the development of various processes and phenomena necessary, in particular, for operational reaction to them.

• The level of information availability has increased. Data from many satellite systems has become freely distributed. This allowed us to start massively using them in various SDMs without significant financial costs. Therefore, it is natural that in many cases it became more profitable to create SDM than to develop ground and aviation surveillance systems.

• The growth of the amount of satellite information and the development of requirements and cost of their reception and initial processing systems have led to an increase in the trend of switching from the use of local reception systems to information services from large specialized centers. Apparently, it should be recognized that in the coming years specialized professional SDMs will almost completely switch to such data schemes and will organize and maintain reception centers in their own interests only in those cases where specific SDM will own their own satellite facilities.

• The availability of remote sensing information and increase of its volumes has led to the need to significantly improve the technology of working with remote sensing data in a number of different aspects, including in terms of increasing the level of automation of data acquisition and processing processes, optimizing the maintenance of own data archives, and the use of capabilities of external systems providing conducting superlarge satellite data archives and those that provide various computing resources to work with them.

• The need to optimize data processing systems in different SDMs has led to the fact that it became inappropriate for a particular system to create and maintain the entire data processing cycle. First and foremost, this concerned standard primary processing and the formation of basic information products (Lupyan *et al., 2012)*, for which production now requires significant computing resources. This, in turn, led to the fact that many SDMs began to focus on obtaining sufficiently standardized, stable, well-calibrated and tied basic products.

• New technological opportunities have emerged that allow for the organization of fundamentally new data-processing schemes, including the efficient operation of distributed, supersized archives and various computing resources.

• Significant expansion of the tasks solved by monitoring systems and the number of specialists involved in their work required the creation of new available tools for working with satellite data and various information products derived from them, which allow to use, including, the possibility of various distributed computing resources .

Thus, it can be noted that in the area of working with data remote sensing and related technologies in recent years, there were quite significant changes. Therefore, in order to maximize the effectiveness of the SDM, it became necessary to improve the data flow diagrams and to develop new methods and tools for their implementation.

Earlier in the early stages of the development of SDM in the construction of a specific system, it had to implement all stages of data processing RS and to fully create a special infrastructure for this, now it is possible to avoid this. There were opportunities to use various "external" information and computing resources in the interests of a particular system. In this case, a generalized scheme for constructing the SDM, presented in Figure 1, may be proposed. The main feature of which is that in the interests of SDM only blocks are created and supported that provide the work with the data of remote sensing data to solve special tasks characteristic of a particular system. In this case, the SDM does not need to duplicate the information and technical capabilities of the centers for collecting, processing, archiving and distributing satellite information. Today's technologies allow the efficient use of the resources of such centers to solve the problems of building different blocks and subsystems of a specific SDM. All this makes it easier to create and maintain SDMs and make them less resource-intensive. With this approach, in the interests of a specific SDM, the following main blocks and subsystems are created (Figure 1):

- subsystem of data processing;
- subsystem of keeping data archives;
- subsystem of provision and analysis of data;
- control and control unit.

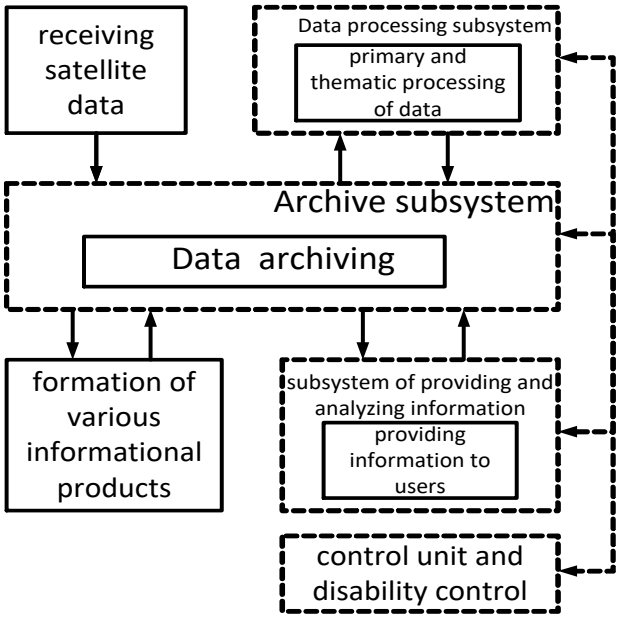

Figure 1. *General scheme of remote monitoring system.*

The peculiarity of the implementation of the data processing system in a specific SDM for the organization of its separate units may be the use of equipment provided by the centers of reception and processing of information. This in many cases avoids the need to transfer large volumes of information from the centers in the SDM. For example, SDM blocks implemented at the computing power centers, processing data directly in the center, allows you to organize the transfer to the SDM only information products that are used for the tasks it solves. In addition, the owners of SDM in this case there is no need to create and maintain their own powerful computing complexes.

Undoubtedly, the main factor that determines the choice of approaches and methods for constructing SDM archives is the rapid growth of the amount of satellite information. This leads to the fact that in the end, when constructing SDM it is necessary to abandon the traditional way of using

remote sensing data - to receive (collect) all sorts of data from different sources and to place them in their own archives of SDM. Such a path leads to the fact that either SDM has to be significantly limited in the data used, or to create and maintain their own huge and expensive storage capacity. Both the one and the other way are obvious shortcomings. The most reasonable choice is the use of distributed storage systems, the ability of which today is provided by many information providers and centers for receiving, processing and archiving of remote sensing data. In this case, SDMs are not signing up to obtaining all the necessary data flows, but on the possibility of online receiving information from the supplier's archives at any time when it is necessary for SDM and its users. With this approach, SDM can focus only on owning its own special archives of data obtained as a result of special thematic processing created in their interests. We note that this approach is largely provided not only by the possibility of using the storage resources provided by remote sensing data providers, but also by the computing resources that can be provided by the SDM for processing.

Another significant factor influencing the choice of approaches to constructing archives of SDM data is that today the new technologies of remote sensing data analysis and the results of their processing are actively developing. In particular, there are opportunities for creating rather complicated instruments for processing and analyzing data of remote sensing (Kashnitsky 2015; Somov 2014), as well as actively implementing methods that allow "on the move" to form and represent different information products for users (Balashov 2008). All this requires the organization of archives of remote sensing data that could provide fast access to data, both from user interfaces and for data processing procedures. It should also be noted that in many cases SDMs become not only consumers of different information, but also suppliers to other SDMs, as the created data archives should provide the possibility of working with the information stored in them both for their (users of a specific SDM) and for external users.

A traditional factor defining the architecture of building archiving systems for remote sensing data and the results of their processing, there is a rather large heterogeneity of surveillance systems and data from them (Storchak 2018). Due to the fact that modern SDM has to work with large, heterogeneous sets of information, the question of unification of storage systems is all the more acute. For efficient data archiving today, we must provide storage and work not only with the data itself and a set of metadata (calibration, quality, where and when received, etc.), but also with information about which products (including " virtual "(under the" virtual "products we mean data processing products that are not stored in the system, but are" on the go "if there is a user request)) can be obtained on the basis of these data, including the description of the schemes (algorithms) for obtaining such products. This information should be kept in a formalized form so that it can be used in automated data processing procedures.

One of the most important elements of any SDM is the subsystem of providing and analyzing information. Currently, there are several key factors that most strongly influence the technology of creating and developing these subsystems.

The first factor is that most SDMs should be able to work with their information and tools for its analysis to distributed users. This results in web-interfaces becoming one of the main tools for working with data. On the one hand, it imposes certain limitations on the functionality of such interfaces, and on the other hand, gives an undeniable advantage over traditional desktop applications. These benefits are primarily due to the simplicity of their updating and the absence of the need to purchase and maintain a significant number of licenses necessary for the creation and operation of desktop applications.

The second factor is that in recent years, work is under way to develop approaches that allow the development of rather complex tools for distributed data analysis using various Internet technologies (Kashnitsky 2015; Kozelkova 2004). It should be expected that in the coming years, most SDMs will almost completely switch to web-interfaces to provide users with access to and analysis of various information.

The third factor is that in recent years, the technical capabilities that allow online access to external information systems data, including the resources of RS data providers, are rapidly improving. This allows you to work in the interfaces of specific SDMs with information received from different sources at the time of the request. As a result of the development of such technologies, SDMs themselves have quite large opportunities today to provide their specialized information to various external users. Thus, SDM itself can provide services for the provision of various information services. It can be expected that the direction of providing specialized information obtained on the basis of remote sensing data will be sufficiently rapid to develop in the coming years. This, in particular, will allow the SDM to expand the scope of use of finished information products obtained on the basis of its deep processing, along with the use of basic satellite information.

Conclusions

Due to the fact that in recent years, approaches to the creation and development of SDM have evolved significantly, new tasks and functions have arisen in the technologies aimed at building SDM control and control units. In fact, most of the SDM's infrastructure has become distributed, the number of sources of information and data archives increased, as well as the processing and provision of data. All of this, of course, requires an increase in the level of automation of work control processes, as well as the creation of technologies for the automated detection and diagnosis of collision situations.

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