Technologies and software for the regional catalog of Russian spacecraft satellite data

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Abstract. The results of research and development devoted to the creation of technologies and software for the satellite data catalog from Russian spacecraft, formed at the Regional Center for Remote Sensing of the Earth in Krasnoyarsk, are examined. The created software package provides a full cycle of operations with satellite data, including their downloading from the Roscosmos Geoportal, pre-processing, archiving, conversion and visualization operations using a specialized geographic information web system. Practical experience with the data provider revealed a number of problems in the source information, which were taken into account when creating the software. In particular, some files were damaged (files are filled with zeros or have an incomplete size), some files in the data folder were missing, the names of files and directories did not meet the declared standards, and so on. Separately, we should pay attention to significant delays in data delivery, which reached six months or more. These problems were taken into account when creating the software.

1. Introduction

Geographic features of large areas: a vast territory with a diverse topography and climate, a large proportion of poorly developed and inaccessible zones, large reserves of natural resources and other factors, which are many in the Russian Federation and which include the Krasnoyarsk Territory, objectively lead to the need for remote sensing systems of the Earth. The integration of the obtained remote sensing data with the real processes of ensuring the vital functions of state authorities and the population is becoming a strategic factor in further accelerating the socio-economic development of the Krasnoyarsk Territory in the modern era of a gradual transition to a new technological structure.

In recent years, considerable attention in Russia has been given to the development of satellite systems for remote sensing of the Earth. Although today it is difficult for them to compete with market leaders from the USA and Europe\textsuperscript{1, 2}, we can already talk about the first successful results. This article is devoted to the creation of specialized software for automating the work with data coming from Russian spacecraft.

The main source of remote sensing data from Russian spacecraft is the Roscosmos Geoportal. Roscosmos Geoportal is a geoinformation web resource for access to unified Earth remote sensing data bank. It is a a unique web resource which combines the means of viewing satellite images and the means of Earth remote sensing data search (both data from Russian and non-Russian satellites are available) that uses the fullest in Russia catalogue. Using it, the customers can not only make a request for data
found in archive, but also order a new survey specifying necessary parameters. The remarkable feature of Roscosmos Geoportal is active publication of data (at full resolution) taken by satellites. Up to 50 scenes from Russian satellites Resurs-P, Kanopus-V and Meteor-M appear on Geoportal every day. In addition to the web interface, data access can be arranged using the ftp protocol.

The main customers of Roscosmos Geoportal data are the governmental authorities such as the Ministry of Emergency Situations, the Ministry of Natural Resources and the Environment of the Russian Federation and the Federal Service for Hydrometeorology and Environmental Monitoring of Russia. Orders for Earth remote sensing data can also be made by companies and individuals. The customer should only choose the region he is interested in and search through the catalogue.

Roscosmos Geoportal was developed by Joint-Stock Company «Research Institute of Precision Instruments» (JSC «RI PI») and is maintained by the Research Center for Earth Operative Monitoring (NTs OMZ).

Satellite information received from Russian spacecraft through the geoportal under consideration has been received by the KSC SB RAS for about two years now. The subject of interest in the research is significant areas of Siberia and the Far East (figure 1). Several institutes and units included in the Krasnoyarsk Scientific Center are interested in obtaining satellite data. Large volumes of incoming information made it unacceptable to access the source information through a web browser, so a technology was developed for the automated processing of data received from Roscosmos in the form of a specialized service running on the server. This service replenishes the local archive of satellite information, access to which is available to all interested departments of the organization. This approach allows you to streamline and systematize the information received in order to avoid re-loading it.

![Figure 1](image-url)  
*Figure 1. Areas of interest for research in the regions of Siberia and the Far East on the map of Russia.*

Development is carried out in accordance with generally accepted approaches and standards [3, 4]. The practice of operating the created service during 2019 revealed a number of problems associated with the source data. We believe that they are largely due to the fact that the source data is manually
generated by NTs OMZ operators, which inevitably leads to errors / typos in file and directory names, partial skipping of data, confusion in scene numbers, and so on. All errors that occurred should have been fixed manually. The number of errors cannot be considered insignificant, but, in general, they did not prevent the successful solution of the problem of organizing effective access to locally located satellite data.

The developed service for processing incoming data of Roscosmos, along with the creation of a local archive, solves another important problem. This is the formation of multiscale multichannel survey images for visualizing operational data on the geoportal of the Krasnoyarsk Scientific Center [5, 6].

2. Materials and methods
In our case, access to images from the Roscosmos geoportal is organized through an ftp protocol. The data on the Roscosmos geoportal ftp server is stored for a limited time (usually no more than a month), so they must be periodically downloaded to local storage. Each snapshot contains shape files with its borders or the borders of each channel separately, xml with metadata of the image, jpeg with an overview image and one or more tiff files with raster data with one or more channels. XML metadata format and file name format for each type of spacecraft is different. XML formats also differ for different levels of processing of received images.

The developed service performs data loading from Roscosmos geoportal, validation of received data and their preliminary processing, loading to the local storage, updating the local metadata catalog. During data processing errors are fixed. File names may contain Russian characters, which introduces a number of problems when working with them on Unix systems. Files of the same image in different representations can be uploaded by the operators to the FTP of the Roscosmos geoportal at different times (with a time difference from a week to a month). In the developed system, interactive tools have been created to solve problems associated with regularly recurring errors in the preparation of images by NTs OMZ operators. There are situations when files fall into erroneous folders on the ftp server; file names are set incorrectly, and so on. Details of this process are shown in figure 2.

![Diagram](image_url)

**Figure 2.** The process of automatic processing of satellite images from the Roscosmos Geoportal.
To facilitate access to data, dual addressing of satellite scenes was created. All files of the resulting scene are placed in the file storage in a folder whose name has the format

\[ <\text{SATELLITE}>/\text{YYYYM}<\text{SCENE}> \]

where \(<\text{SATELLITE}>\) is the satellite code (kvx for Canopus-V, rpx for resource-P), YYYYMM is the year and month, \(<\text{SCENE}>\) is the name of the scene in which the date of acquiring is encoded, the spacecraft code according to the standards of the Russian Space Agency, internal identifier and type of scene (PSS – panchromatic, MSS – multispectral). An example of such a folder is shown in figure 3 on the left. Then, for each such folder, a symbolic link is additionally created, which is placed in the corresponding subdirectory (Kanopus or RusursP) with the name ”area of interest” (figure 3 on the right). This data scheme is convenient for users who get rid of the need to view and filter a large number of unnecessary files. This data scheme is convenient for users who get rid of the need to view and filter a large number of unnecessary files.

Due to licensing restrictions, access to the satellite data catalog is limited to the organization’s local area network.

**Figure 3.** Dual addressing of satellite data catalog objects using ftp protocol (fragment).

### 3. Results and discussion

In 2019, the Krasno!yarsk Scientific Center of the Siberian Branch of the Russian Academy of Sciences formed an order with Roscosmos for images from April to October 2019, inclusively, from Canopus spacecraft equipment PSS (panchromatic shooting system) and MSS (multi-zone shooting system) with a resolution of 2.7 m and 12 m, respectively [7]. And also from the Resource-P satellite of the Sangur-1U equipment with panchromatic and spectral imaging with a resolution of 1 and 3 m, respectively. Data was requested with a processing level of 1A and 2A with cloudiness not exceeding 40%. Areas of interest for research in the regions of Siberia and the Far East are presented above, in figure 1. Their total area was approximately 670 thousand km².

Data delivery on the generated order began almost from the moment of its placement on the Roscosmos geoportal. However, it later became clear that part of the data was transmitted to us as the customer with significant delays, sometimes reaching six months or more.

Data availability in 2019 was highly uneven, and the latest data for 2019 were received in March 2020. As an example, table 1 below presents data on the number of images of processing level 2A from the Canopus-B satellite from April 2019 to March 2020 inclusive. The rows show the number of scenes by months of acquiring, the columns show the time (months) of data delivery to the customer, i.e. placing scene files on the ftp server of the Roscosmos geoportal.
Table 1. Monthly preparation of data from the Canopus-B satellite by operators of NTs OMZ (acquiring month in rows, delivery month in columns).

|      | 2019 |       |       |       |       |       |       |       | 2020 |       |       |       |       |
|------|------|-------|-------|-------|-------|-------|-------|-------|------|-------|-------|-------|-------|
|      | 04   | 05    | 06    | 07    | 08    | 09    | 10    | 11    | 12   | 01    | 02    | 03    |
| 04   |      | 126   | 14    |       |       |       |       |       |      |       |       |       |       |
| 05   | 19   | 55    | 14    | 12    | 1     | 33    | 2     |       | 8    | 6     |       |       |       |
| 06   |      |       |       |       | 2     | 13    | 148   | 65    | 13   |       |       |       |       |
| 07   |      | 7     | 7     |       | 8     | 5     | 142   | 58    | 32   |       |       |       |       |
| 08   | 2    | 2     | 3     |       | 29    |       | 48    | 29    | 7    |       |       |       |       |
| 09   |      |       |       | 7     | 20    | 41    | 31    |       |       |       |       |       |       |
| 10   |      |       |       |       |       | 1     | 53    | 40    |      |       |       |       |       |

The table shows that most of the data on Canopus devices for 2019 was prepared in the winter of 2020. Thus, it is currently impossible to expect prompt data acquisition. It remains to be hoped that the situation will improve in the future.

To search and navigate the satellite data catalog, a satellite image web application was developed using the server programming language PHP, PostgreSQL, SQLite3 DBMS and the client web interface in the TypeScript programming language using the Angular 5 framework [8, 9, 10]. The search system has all the standard features for applications of this type, with a choice of satellite / sensor, spatial and temporal filtering. You can get a set of links for downloading scenes selected using the geoportal via the web interface, or create a script for batch loading a large amount of data (figure 4).

![Figure 4. The web interface of the satellite imagery catalog on the geoportal.](image)
4. Conclusions
The developed technologies and software for cataloging satellite images from Russian spacecraft have significant potential for versatile use. The proposed solutions take into account the specifics of the source information and the needs of consumers, based on practical experience working with Roscosmos data. The capabilities of the created software product allow you to combine any combination of channels available in the image, without additional configuration of server software.

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