

Capabilities of Russian Unified Geografically-Distributed Information System (UGDIS) for providing users with ERS data

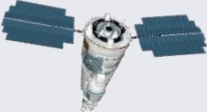
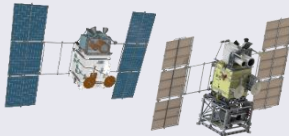
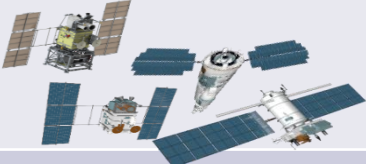



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South Korea, Seoul
October, 2019

CAPABILITIES OF RUSSIAN ERS SATELLITE CONSTELLATION WITHIN THE FRAMEWORK OF RUSSIA'S FEDERAL SPACE PROGRAM FOR 2016-2025

2019 – current state




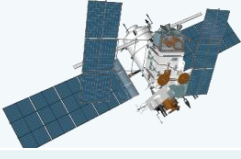

Resolution	Ultra-high 0.35-0.7 m	High 1.0 – 5.0 m	Moderate 5.0-50.0 m	Low 50 m – 1 km
Purpose	Highly detailed periodic monitoring of local areas	Highly detailed/ high frequency monitoring of the areas	Global periodic surveillance of vast territories	High frequency round-the-clock global surveillance of visible Earth's full disk
Satellite Constellation (SC) composition	<p>1 «Resurs-P» spacecraft ("Geoton" Optoelectronic Complex, OEC)</p> 	<p>5 «Kanopus-V» spacecraft (Panchromatic Survey System, PSS) 1 «Kanopus-V-IR» (PSS) spacecraft</p> 	<p>1 «Resurs-P» spacecraft (Complex of Wide-Swath Multispectral Survey Instruments, CWSMSI; Hyperspectral Survey Instruments, HSI) 5 «Kanopus-V» spacecraft (Multispectral Survey System, MSS) 1 «Kanopus-V-IR» (MSS) spacecraft 1 «Meteor-M» (Complex for Multi-spectral Satellite Survey, CMSS)</p> 	<p>1 «Elektro-L» spacecraft (Hydro-meteorological Multi-zone Scanning Device, HMMSD) 1 «Meteor-M» spacecraft (Low Resolution Multi-channel Scanning Device, LRMSD)</p> 
Frequency of observation	0.3 (once in three days)	Once a day (ВД) + 0.4 (twice in five days' time) (B – IR)	1,7	48 times a day (full disk)
Continuous coverage of the RF territory	213 days (excluding cloud cover)	2 days (excluding cloud cover)	2 days (excluding cloud cover)	Constantly

Note. The territory of the Russian Federation is 17.1 million sq. km.

Frequency is passing over the southern point of the territory of the Russian Federation

CAPABILITIES OF RUSSIAN ERS SATELLITE CONSTELLATION WITHIN THE FRAMEWORK OF RUSSIA'S FEDERAL SPACE PROGRAM FOR 2016-2025

2025 - predicted state of satellite constellation for Optoelectronic observation


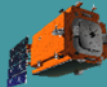
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Purpose	Highly detailed periodic monitoring of local areas	Highly detailed/ high frequency monitoring of the areas	Global periodic surveillance of vast territories	High frequency round-the-clock global surveillance of visible Earth's full disk
Satellite Constellation (SC) composition	1 «Resurs-P» spacecraft ("Geoton" OEC) 4 «Resurs-PM» (OEC HR, High Resolution) spacecraft 	4 «Resurs-PM» (Panchromatic Wide-swath Observational Complex, PWSOC) 2 «Kanopus-V» spacecraft, Multispectral MCA (ПК) 	4 «Resurs-PM» (PWSOC) 2 «Kanopus-V» spacecraft, Multispectral (MK) 4 «Meteor-M» (Complex for Multispectral Satellite Survey, CMSS) 	4 «Electro-L» (Hydro-meteorological Multi-zone Scanning Device, HMMSD) 3 «Arctic-M» (HMMSD) spacecraft 4 «Meteor-M» spacecraft (Low Resolution Multi-channel Scanning Device, LRMSD) 
Frequency of observation	1,8	2	2	every 15 min. (full disk and North pole) 
Continuous coverage of the RF territory	20 days (excluding cloud cover)	Every day (excluding cloud cover)	Twice a day (excluding cloud cover)	Instantly

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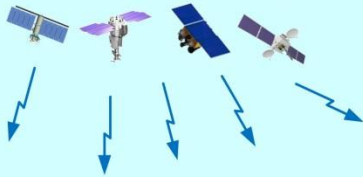
2025 – predicted state of satellite constellation for Radar observation

Satellite Constellation (SC) composition	2 «Kondor-FKA» spacecraft 			1 «Obzor-R» spacecraft 		
Frequency of observation	4 times a day, interferometric survey 1 time in 16 days			4...5 times a day		
Survey mode	Detailed Search-light	Detailed continuous	Observational	Highly-detailed	Detailed framed	Narrowband route
Resolution, m	1...2	1...3	6...12	1,0	3...5	2...5
Production rate, thousand km ² / day	16...45	No less than 100	No less than 500	4,5	60	90...200

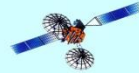
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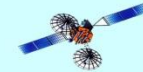
ERS satellite constellation



«Luch-5B» satellite repeater



«Luch-5A» satellite repeater

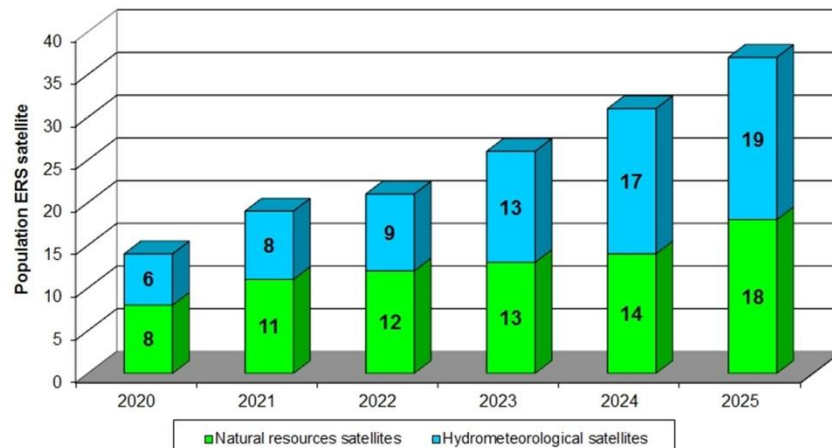


Unified geographically-distributed information system – a set of geographically distributed ground-based facilities for reception, collection, processing, storage and dissemination of data, received from ERS spacecraft, functioning in order to provide Russian consumers with ERS data and products for based on them subsequent solution of a number of socio-economic, scientific and applied problems

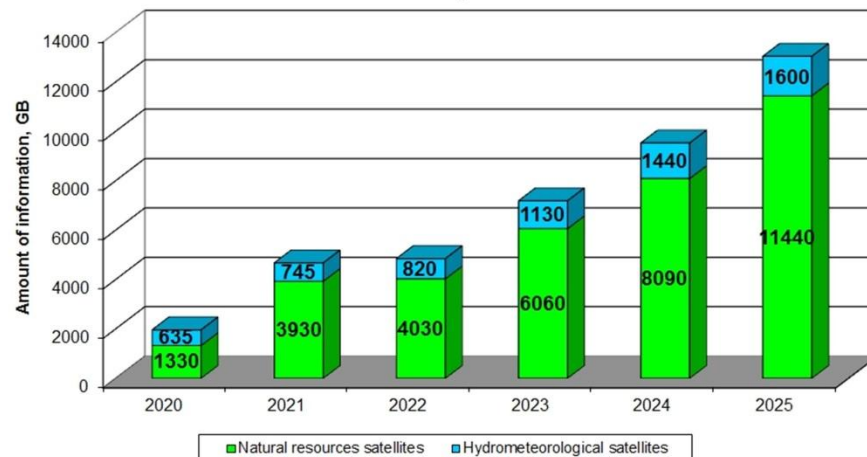




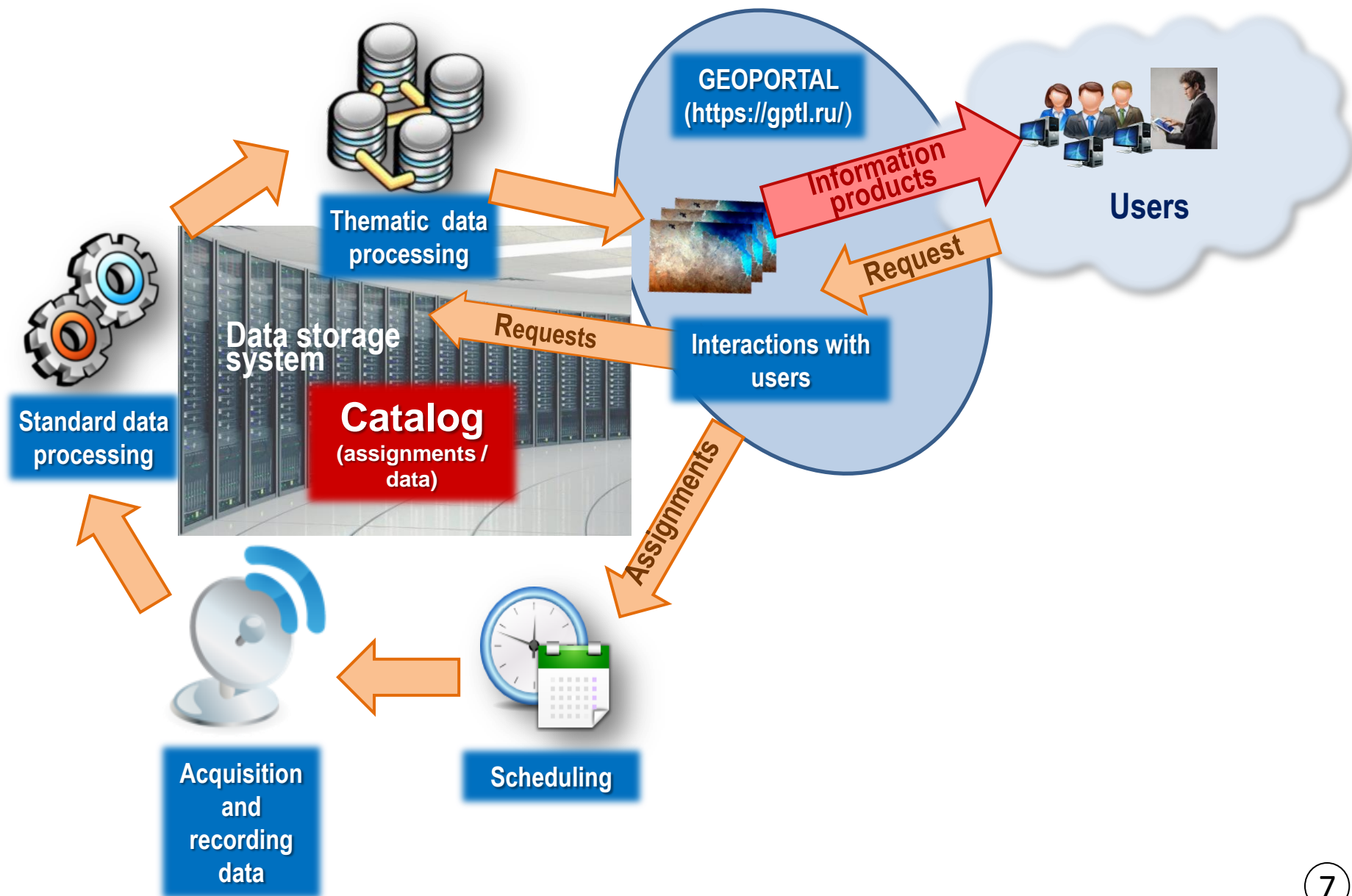
The planned ERS satellite constellation for 2020-2025



Daily amount of information from ERS satellite constellation, transmitted to points



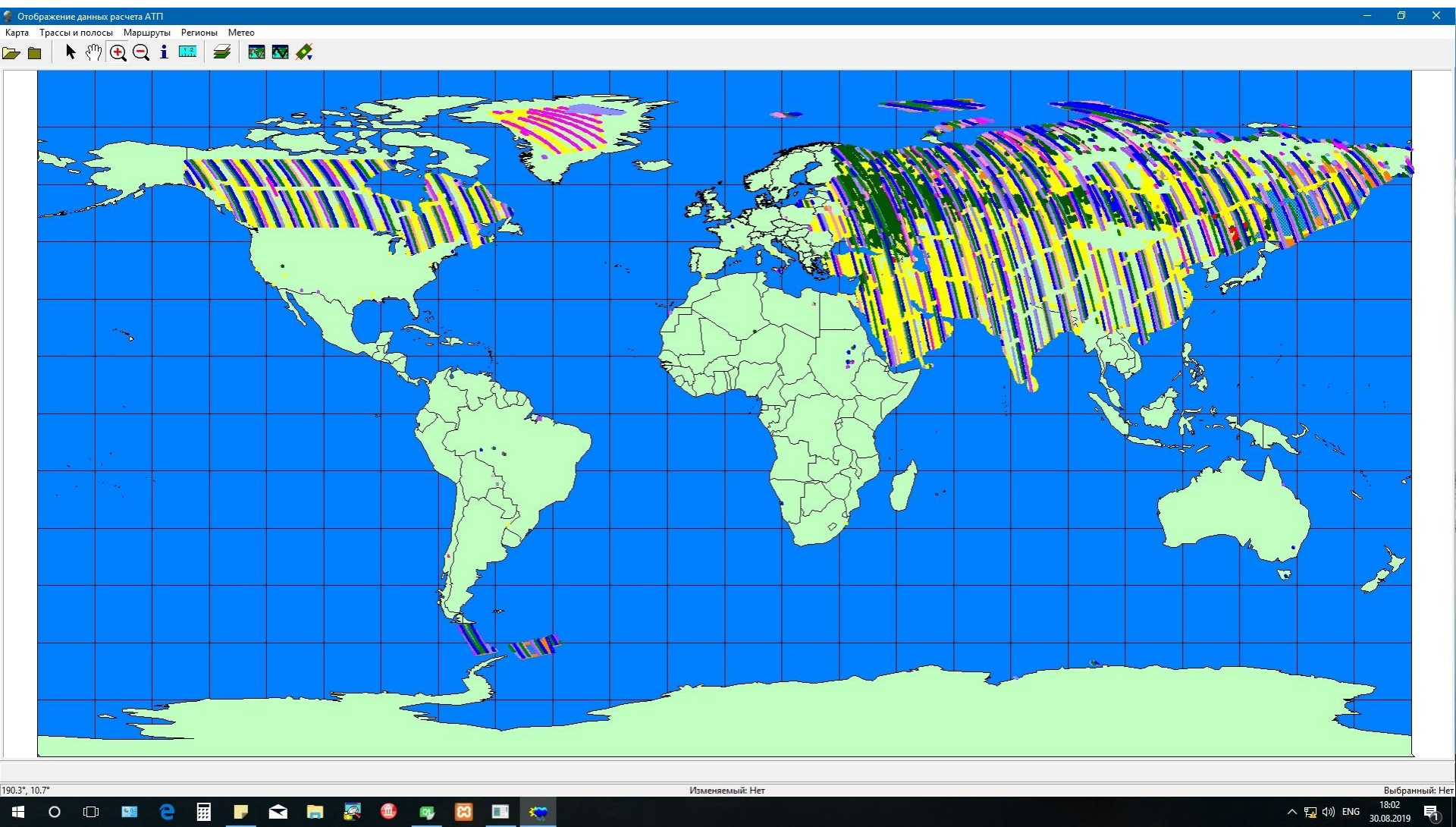
TECHNOLOGY FOR PROVIDING USERS with ERS DATA



Scheduling and management

- ⇒ Implementation of an optimized "continuous coverage" strategy with the possibility of rapid re-targeting and forestalling survey of the most requested areas during the scheduling activities .
- ⇒ Ensuring maximum productivity while conducting targeted survey by a satellite constellation using automatic planning.

Example of current monitoring plan for “Kanopus-V” spacecraft (for 5 days)



Data Acquisition from ERS spacecraft

Satellite data receiving complexes as a part of Ground-based Complex for Receive/Process of ERS data of the UGDIS



	Resurs-P	Terra Aqua NoAA	Meteor	Kanopus	Suomi NPP	Luch relay satellite
DRC-3.6	+	+	-	-	-	-
DRC-9	+	-	+	+	-	-
DRC-7	+	+	+	+	-	-
DRC-4.8	+	+	-	-	+	-
DRC-5	+	+	+	+	+	-
Ground complex of reception and retransmission	+	+	-	-	+	+



Sr.No.	Spacecraft type	Start of operation	Data transmission rate
1	Resurs-P # 1	present	2×150 Mbit/s
2	Resurs-P #4, 5	2021	2×300 Mbit/s
3	Obzor-R	2020	2×300 Mbit/s
4	Kanopus-V # 1-6, Kondor FKA	present	2×122 Mbit/s
5	Meteor-M # 2-1, 2-2	present	2×122 Mbit/s, 1×1.33 Mbit/s
6	Resurs-PM	2022	2×600 Mbit/s
7	Kondor FKA-M, etc.	2024	2×600 Mbit/s or 2×900 Mbit/s or 2×1200 Mbit/s

ПК-3.6Н – Murmansk



Antarctica (“Progress” Station)



Dudinka



Moscow, ПК-5





Mobile Transmit/Receive Complex (MTRC)



1. Data Processing Module (DPC-MTRC)
with an automated satellite exchange system
through Ku-band relay satellite; data exchange rate
of up to 2 Mbps



2. Antenna Complex for direct reception (AC-MTRC) ERS data from
«Resurs-P», «Terra», «Aqua», «NOAA»
and data exchange via «Luch-5» relay
satellite

MTRC Specifications

Parameters, unit of measurement	Value
AC-MTRC	
Reflector, D, m	D= 4,2 offset
Arrangement scheme of rotary mechanism	triaxial scheme
Range of guidance angles, deg.: - in azimuth - in elevation - in azimuth tilted	± 270 from 0 to 180 deflection angle 4
Angular speeds for antenna guidance, deg./s (no less than): - in azimuth - in elevation	18 12
Maximum guidance errors, arcminute: - in azimuth - in elevation	3 3
Operation at maximum wind speed, m / s	25
Container mass, kg, no more than	8 000
Reflector material	aluminum

MRTC specifications

Parameters, unit of measurement	Value
X-band	
Receive frequency band, GHz	7,70-8,40
Polarization	left and right circular
Receiver noise temperature, ° K	90
Gain factor, dB	46
Type of received signal modulation	BPSK, QPSK, OQPSK, 8PSK, 16QAM, 16APSK
Data reception rate and recording, Mbit/s	up to 600 (300 over one channel)
Operation mode	manual guidance program guidance
L-band	
Receive frequency band, GHz	1,6-1,7
Polarization	right circular
Gain factor, dB	30

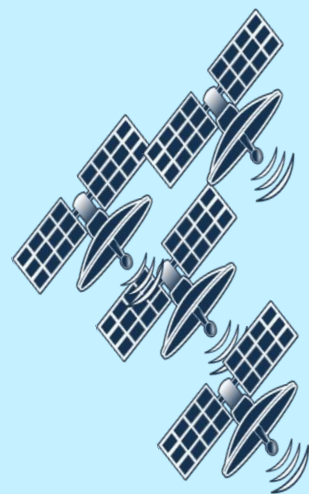
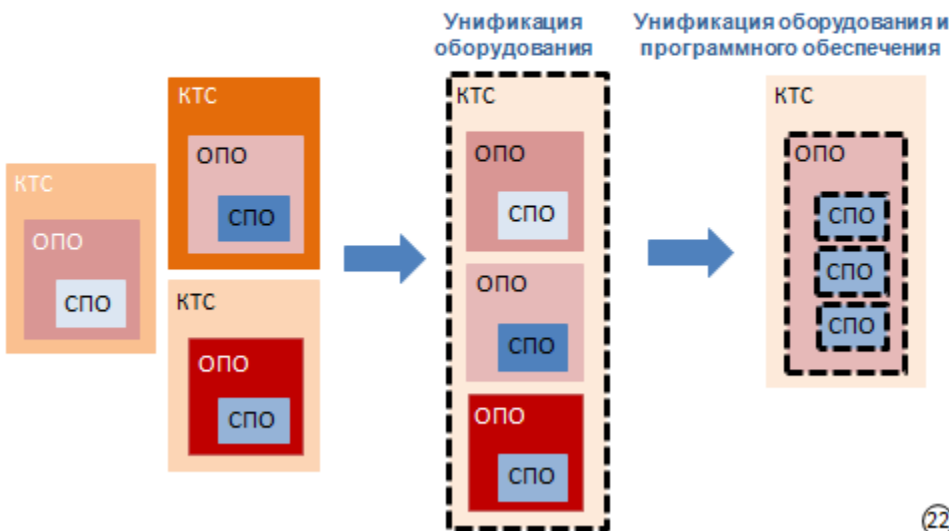
MRTC specifications

Parameters, unit of measurement	Value
Ku-band	
Receive frequency band, GHz	13.5-13.6/10.7-11.2
Transmit frequency band, GHz	15.1-15.4/14.6-14.7
Polarization	left and right circular
Gain factor, dB	48
Power supply	380/220 V 50 Hz
Reception of ERS data from spacecraft	RESURS-P, KANOPUS-V, METEOR-M, LUCH -5, TERRA, AQUA , SPOT, RADARSAT, NOAA, NPP

ERS data processing

ERS information products should be adapted to the modern users requirements and advanced data

The direction of the processing



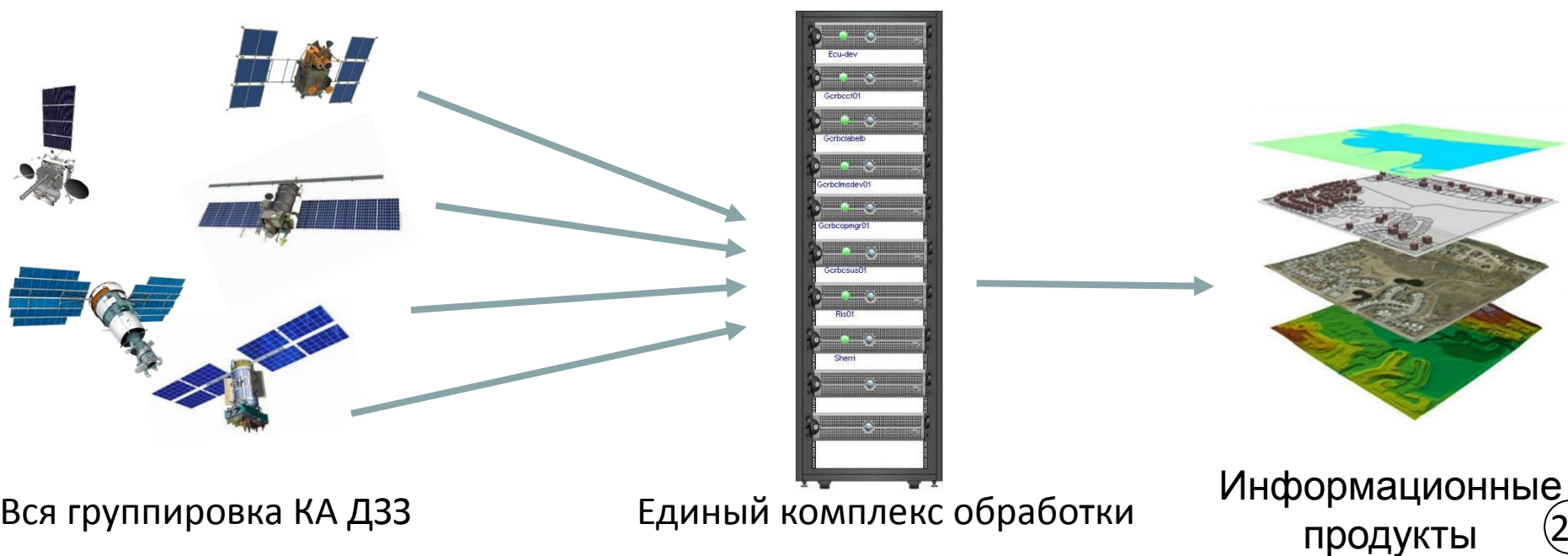
Increase in amounts of information

- efficiency
- scalability
- зщкештп

- types of products
- standartization
- delivery speed

Increase in number of information users

- **Единый комплекс обработки**
(все КА, все сенсоры, все этапы потоковой обработки: первичная, стандартная, ЦММ, мозаики, оценка качества, каталогизация, хранение, публикация...)
- **Унификация технических средств**
(вычислительный кластер однотипных серверов, возможность установки в ЦОД)
- **Унификация программных средств**
(кроссплатформенность, динамические библиотеки, API, распараллеливание и распределение, обмен данными через память ...)



Advantages of Advanced Processing Technologies

- **Unified processing of information from various satellites within the framework of a single new generation processing complex**
based on modern approaches for distributed processing over large amounts of data, which has a maximum degree of automation, allowing to process data from various survey systems and SC, implementing all stages of streaming processing (primary, standard, quality assessment, cataloging, storage, publication).
- **Unification of processing processes**
unified management, unified operator interfaces, unified quality assessment approaches, unified metadata formats, etc.
- **Unification of technical means**
information processing using a computing cluster of similar relatively cheap servers, the ability to install a processing complex in the data center.
- **Unification of software**
common requirements for SPO processing: cross-platform, dynamic libraries, API, parallelization and distribution, etc.

Storage of information in level 0

Create all products from level 0

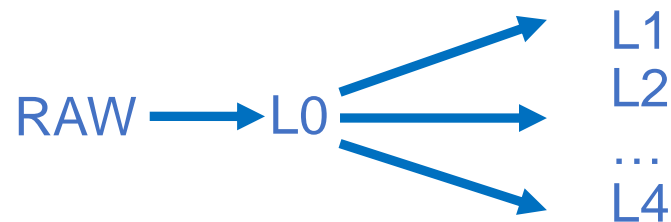
One-time resampling data

НКПОР

RAW → L0 → L1 → L2 ... L4



АПОИ

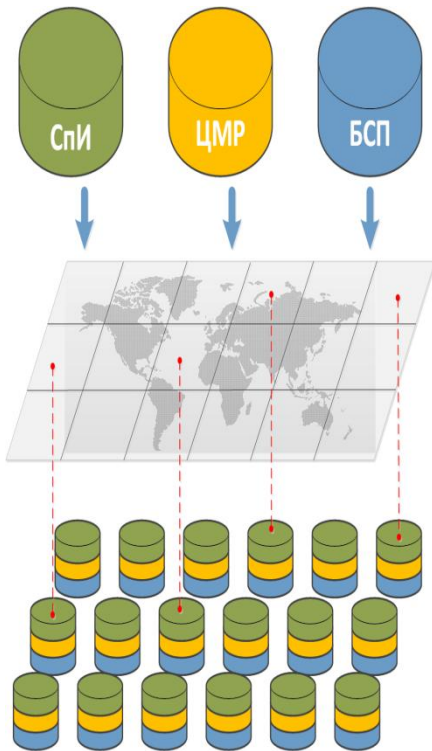


Data storage and distribution



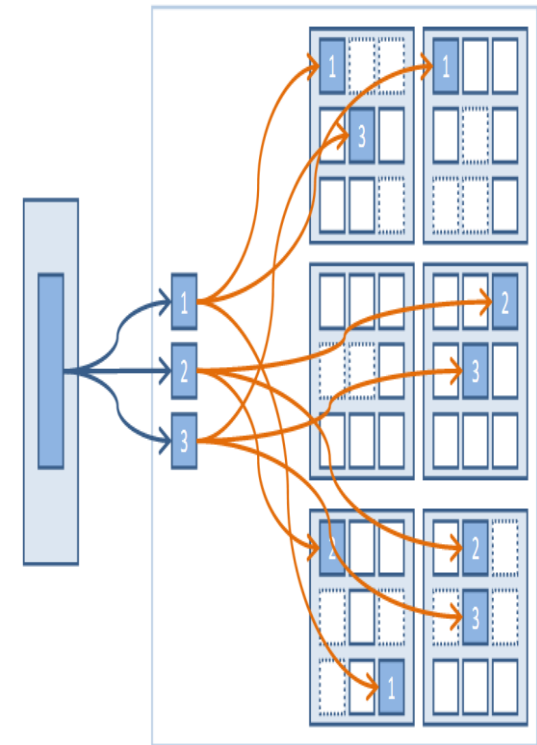
The basic principles of the development of the ERS data Storage Complex for 2018-2025

Geographical principle for data storage



- Setting up online file storage **on the same servers together with processing**
- Ability to store a **large amount of information** not limited by one physical server
- Combining a distributed data warehouse into a single logical structure under the geographical principle
- Implementing fault tolerance by applying redundancy of stored information and its even distribution across several servers

Implementing fault tolerance



- ⇒ Implementing a cloud (object) data warehouse with online access
- ⇒ Ensuring collection of metrics indicating the usage of ERS data by users (necessary for billing)
- ⇒ Providing functioning of billing tools when users apply ERS data
- ⇒ Ensuring automatic management of the ERS data lifecycle (automatic migration between an archive and an operational circuit, integrity monitoring, product delivery control)
- ⇒ «Reformatting» the stored archives (now they are optimized for quick archiving, but they need to be optimized for quick extraction).

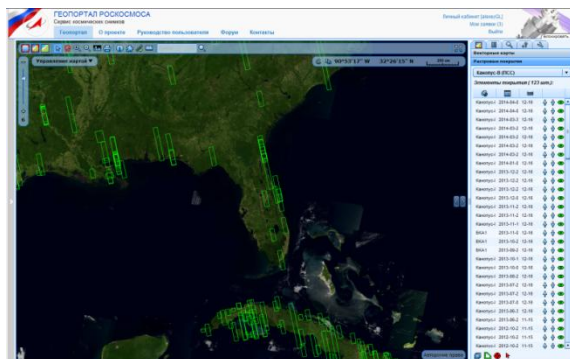
Parameters characterizing the storage and dissemination of ERS data and information products

Parameter	2019	2025
Long-term storage capacity	4,4 PB	35 PB
Data disk storage capacity	120 TB	3 PB
Number of daily assignments for extracting data from the archive	200 assignments	2000 assignments
Number of simultaneously working Roscosmos Geoportal users	250	2000
Access to online storage via the S3 cloud protocol	No	Yes

Roscosmos Geoportal is the key geoinformation service for Unified Geographically-Distributed ERS Information System (UGDIS ERS)



Web-application



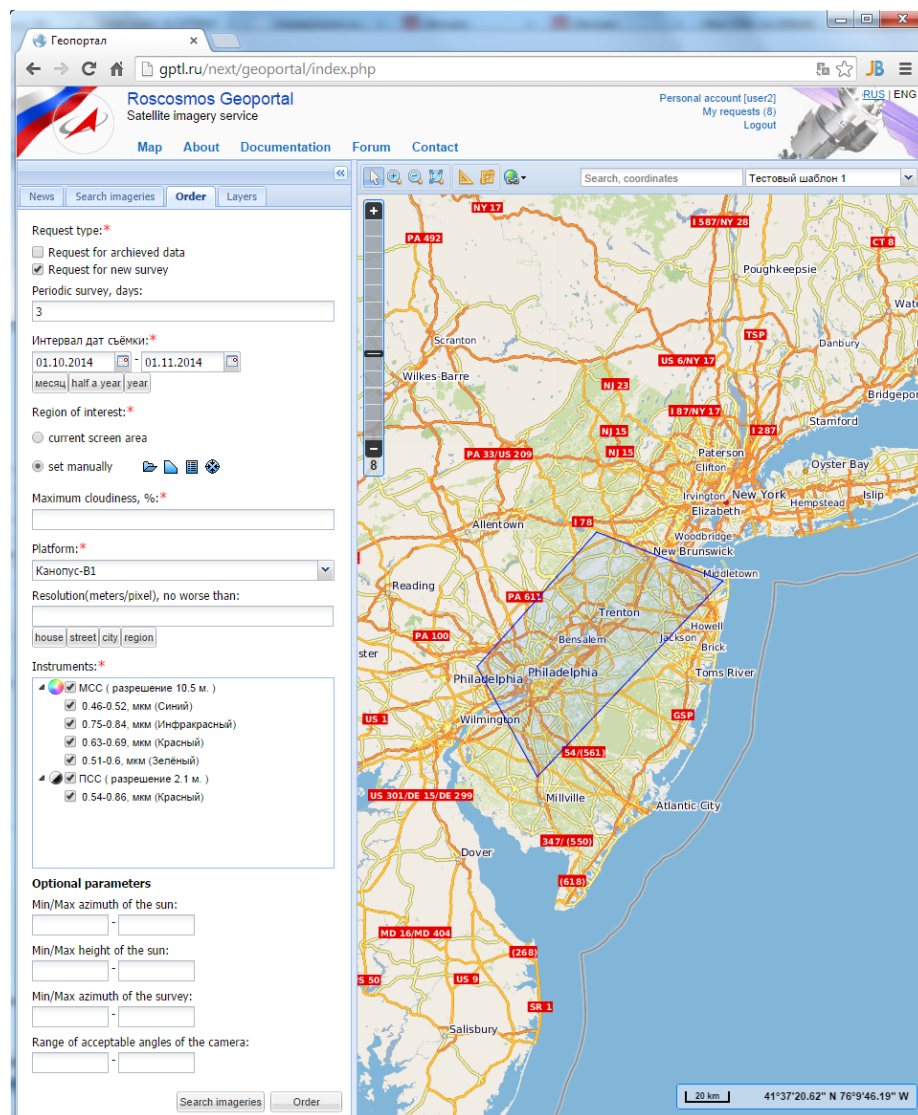
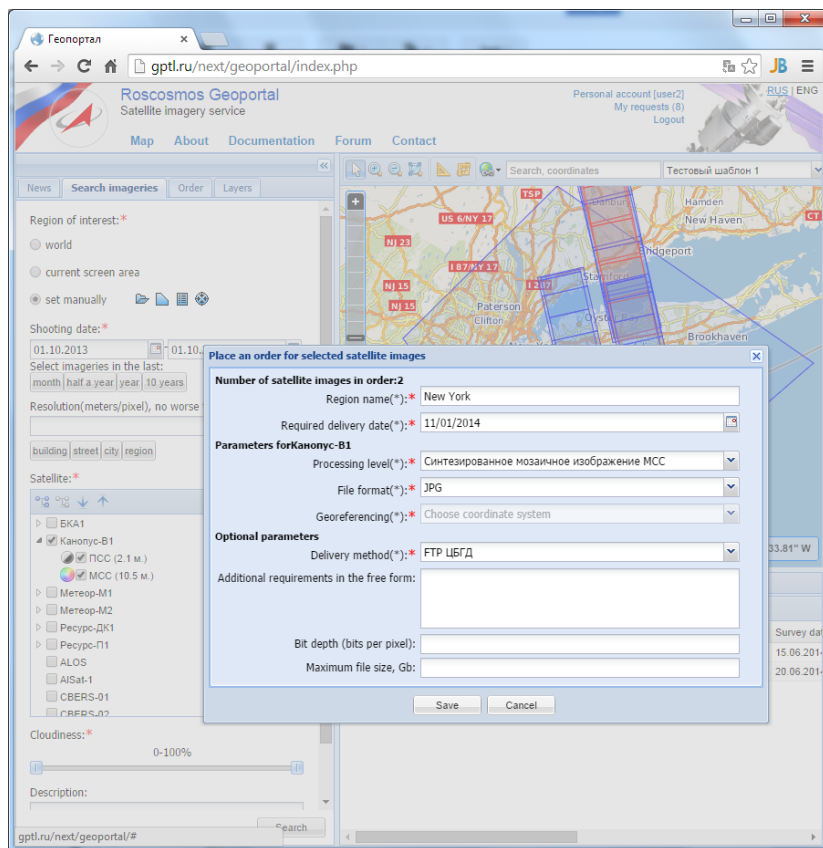
Web-services



The key functions of the Roscosmos Geoportal in interactive user access mode

- ☐ Navigation through geographic objects
- ☐ Searching for ERS products across Unified catalogue
- ☐ Viewing satellite images
- ☐ Viewing thematic layers (fire situation, weather data, etc.)
- ☐ Ordering ERS archive products
- ☐ Order for conducting satellite survey
- ☐ Order for ERS data processing
- ☐ Issuing ordered ERS products via FTP
- ☐ Providing OGC WMS web services and catalogue search web services

Generation and placement of order for archive products or conducting new survey



Thanks for your attention !

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