

GLONASS Status, Performance and Modernization Efforts

Tatiana Mirgorodskaya

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Satellite Systems

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РОСКОСМОС





Content



- GLONASS Policy, Architecture and Status
- GLONASS Modernization Plan
- SDCM
- International cooperation
- Summary



Content



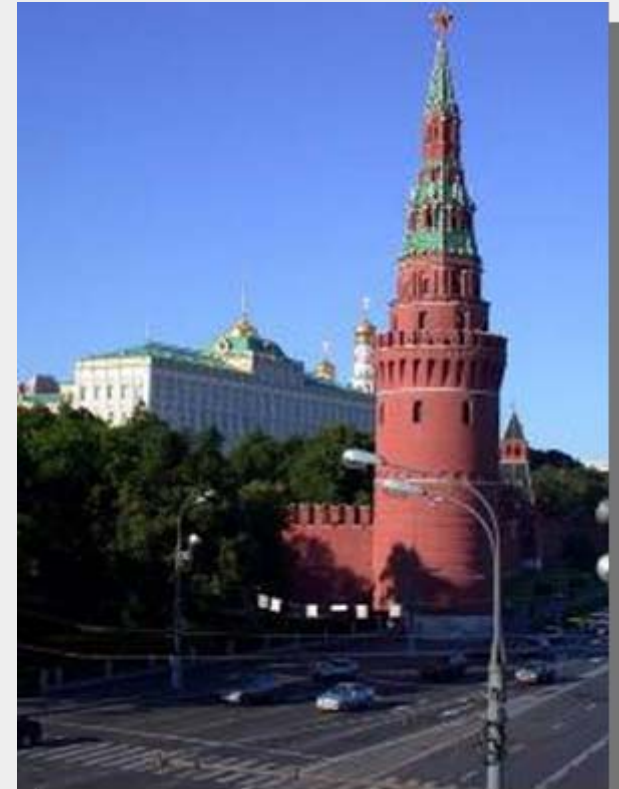
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State Policy Basic Principles



- GLONASS is a part of the critical state PNT infrastructure providing national security and economy development
- Creating, developing and sustaining the PNT infrastructure is a State responsibility
- No direct user fees for civil GLONASS services
- Open, free access to GLONASS information necessary to develop and build user equipment
- GLONASS use in combination with other GNSS to increase reliability of navigation
- Mandatory GLONASS use for Governmental and critical applications
- International cooperation on GNSS compatibility and interoperability and worldwide use



Federal GLONASS Program is a basis for GLONASS sustainment, development and use

Constellation



Launchers

Proton-M

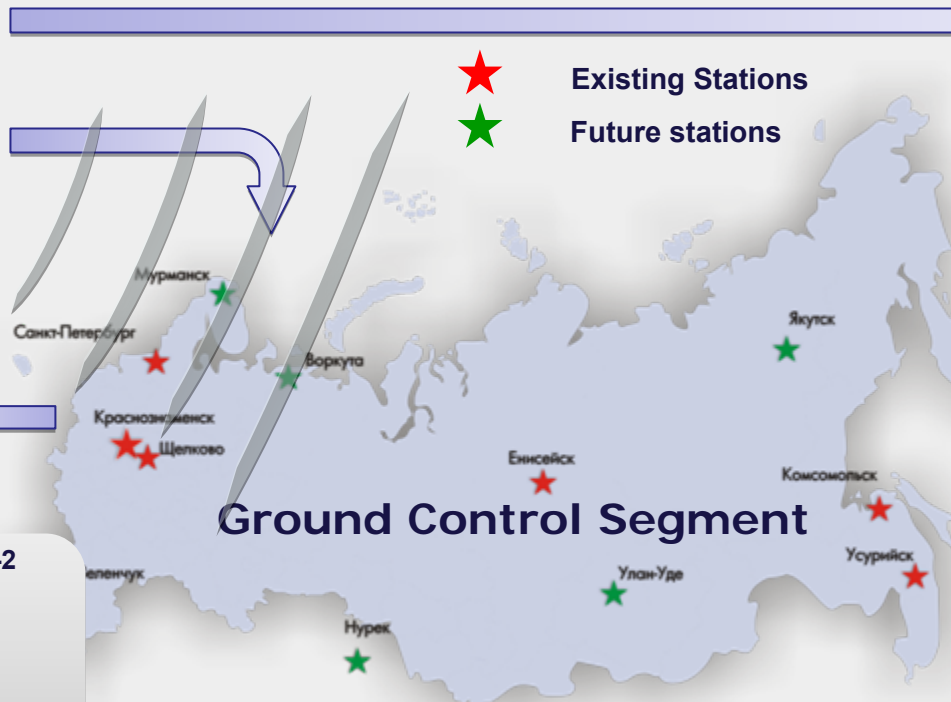


Baykonur

Soyuz-2



Plesetsk



Users



Orbit constellation:

24 SV + spare (3 planes by 8 satellites)

Orbit parameters:

circular, $H = 19\,100\text{ km}$, $i = 64.8^\circ$
 revolution : 11h 15 min

Two types of signal:

- Standard (open)
- Special (authorized)



Recent Event



Block 42 launch at 02.09.2010

- 3 SV “Glonass-M” satellites

Block 43 launch failure at 05.12.2010

- 3 SV “Glonass-M” satellites lost

Next Launches:

- Flight Test of “Glonass-K”
- 5 SV “Glonass-M” in production to be launched in 2011



Launch program of 2011 will ensure full constellation deployment and sustainment



Constellation Status

11.01.2011

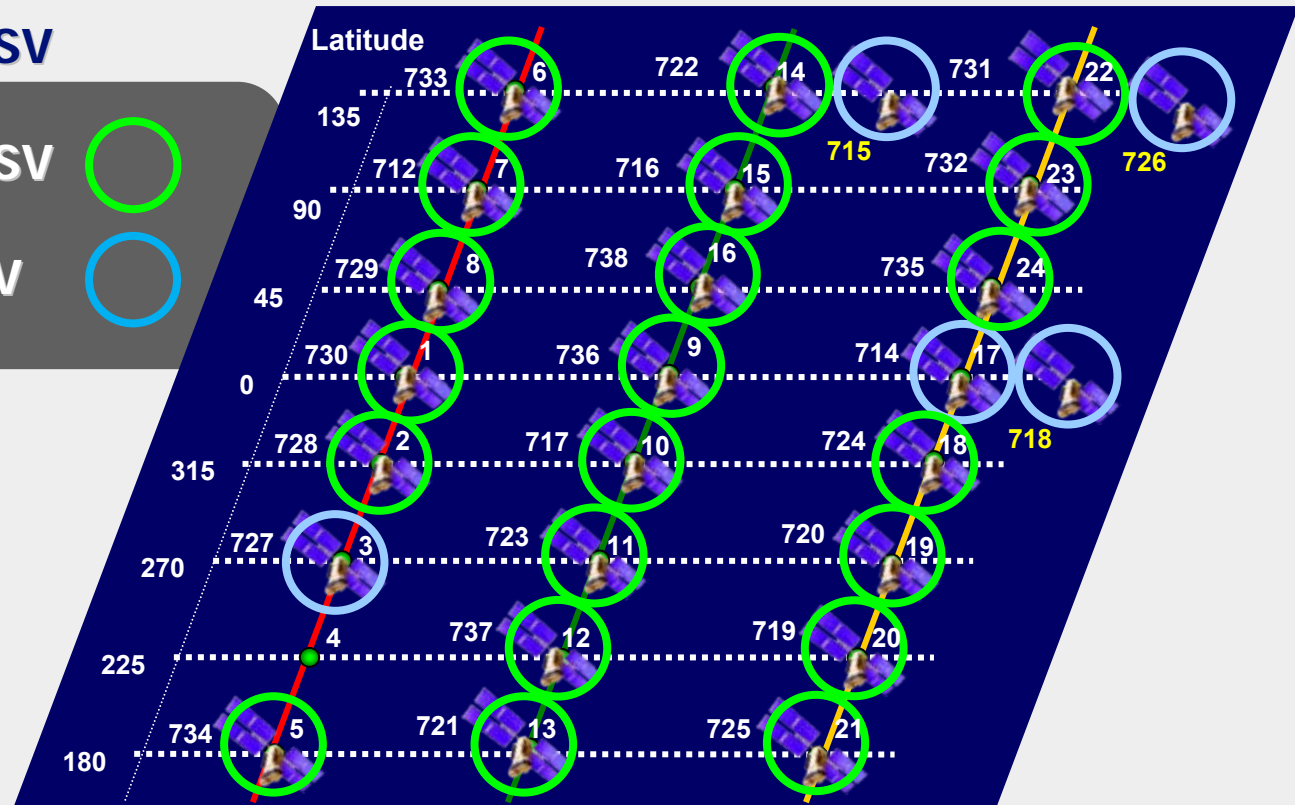


In orbit: 26 SV

Operational: 21 SV

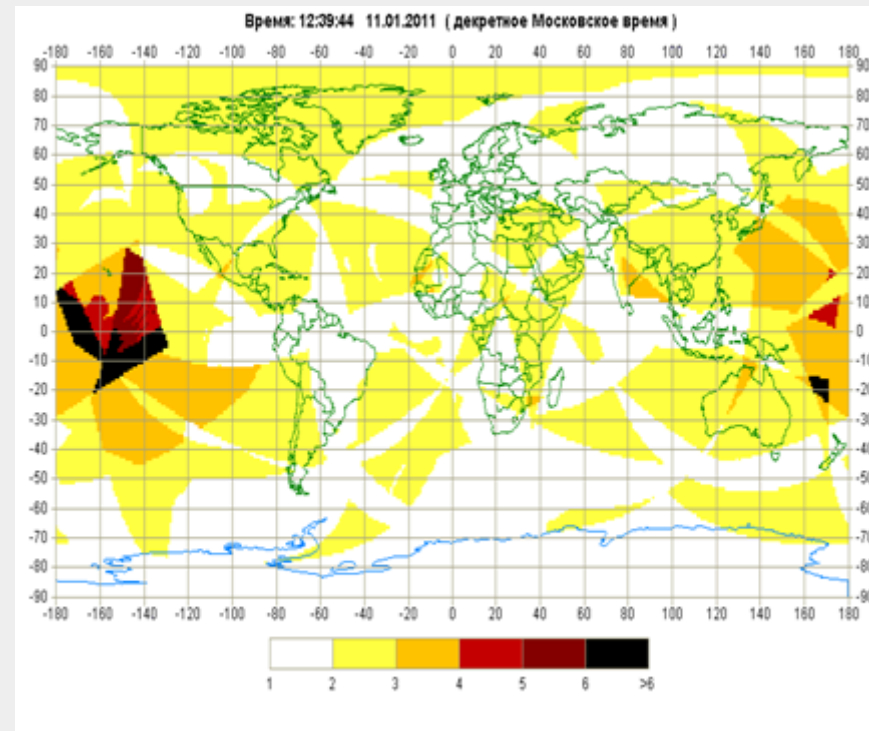
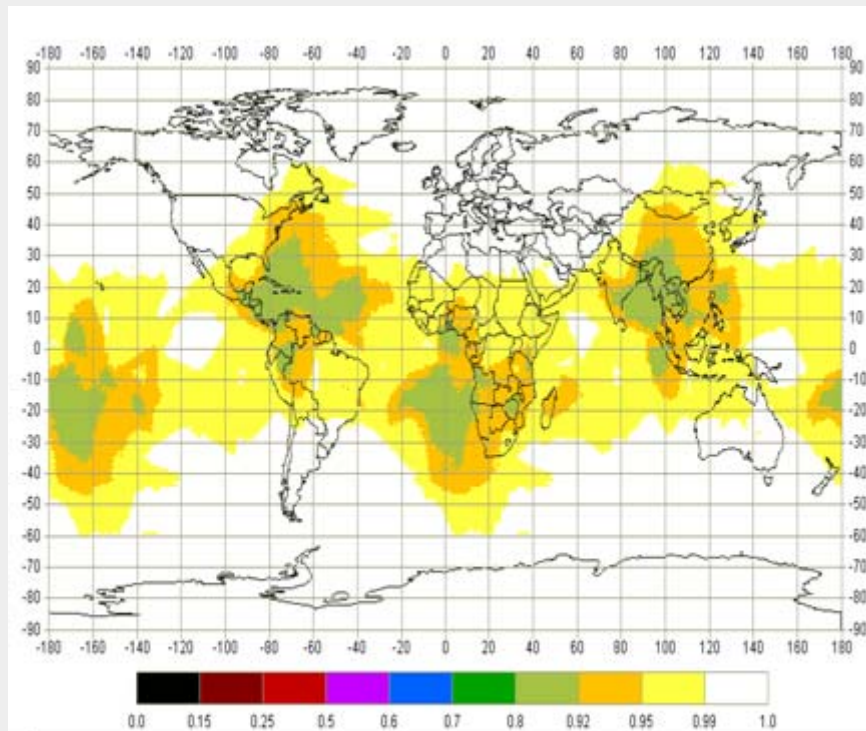


In maintenance: 5 SV



The constellation provides:

- Continuous navigation over Russia
- Practically global continuous navigation



Mean availability for a day

Instant availability (PDOP)

Global availability is 97% (PDOP<6, $\gamma>5^\circ$)

➤ **GLONASS accuracy has 5 times improved for last three years**

➤ **Now it is the same order of GPS**

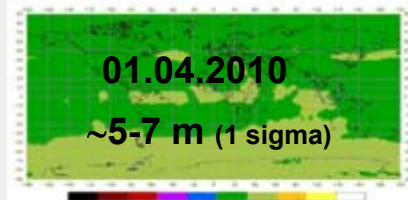
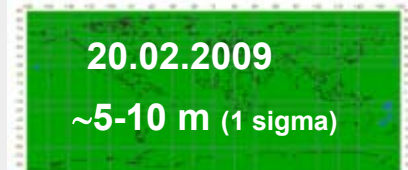
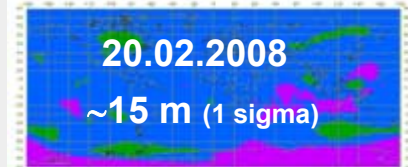
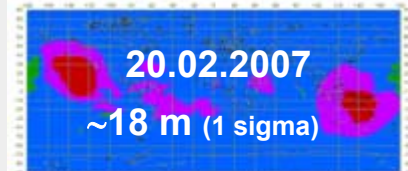
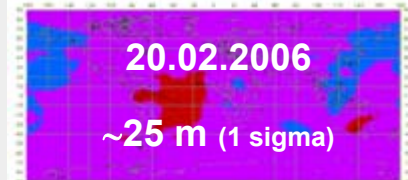
➤ **Next improvement phase is expected by the end of 2011**



Instant GLONASS SISRE (1 sigma)

according to IAC PNT

GLONASS position accuracy map





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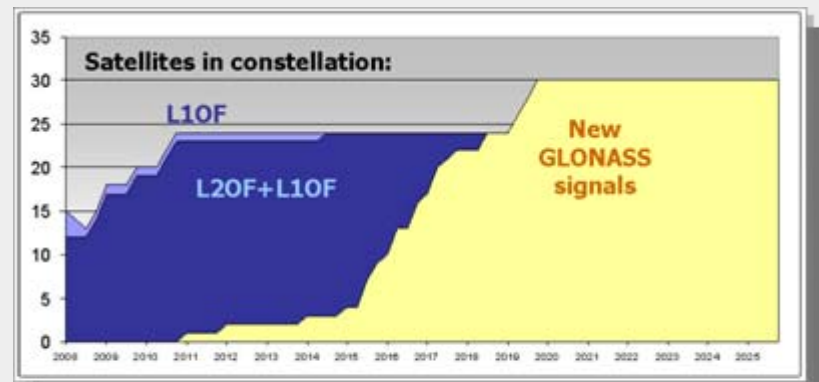
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GLONASS Modernization Plan



- Full constellation deployment in 2011
- Ground Control Segment modernization
- New GLONASS-K satellite (with improved performance) IOV start in 2011
- GLONASS will continue transmitting existing FDMA signals
- Additional new CDMA signals since GLONASS-K deployment
- GLONASS performance competitive ability provision plan
- GLONASS Federal Program extension until 2020





GLONASS Modernization Plan



1982

2009

2011

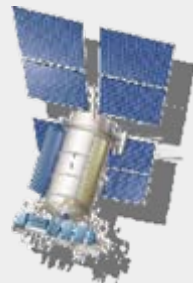
2013

“Glonass”



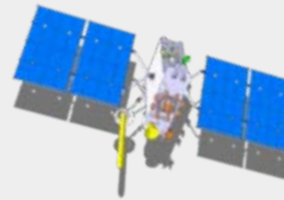
- 3 year design life
- Clock stability - $5 \cdot 10^{-13}$
- Signals: L1SF, L2SF, L1OF, (FDMA)
- Totally launched 81 satellites
- Real operational life time 4.5 years

“Glonass-M”



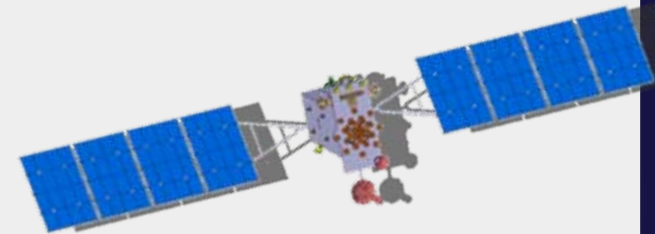
- 7 year design life
- Clock stability $1 \cdot 10^{-13}$
- Signals: Glonass + L2OF (FDMA)
- Totally launched 28 satellites and going to launch about 11 satellite by the end 2012

“Glonass-K1”



- 10 year design life
- Unpressurized
- Clock stability $10 \dots 5 \cdot 10^{-14}$
- Signals: Glonass-M + L3OC (CDMA) – test
- SAR

“Glonass-K2”



- 10 year design life
- Unpressurized
- Clock stability $5 \dots 1 \cdot 10^{-14}$
- Signals: Glonass-M + L1OC, L3OC, L1SC, L2SC (CDMA)
- SAR



The direction of GLONASS navigation signals modernization



- **Better accuracy**
- **Better interference and multipath protection**
- **Greater interoperability with other GNSS, less cost and complexity for combined use**

Introduction of new CDMA signals since GLONASS-K deployment



GLONASS signals modernization



L1	L2	L3	L1, L2	Future	Status
L1OF, L1SF	L2OF, L2SF	–	–		Done
L1OF, L1SF	L2OF, L2SF	–	–		Done
L1OF, L1SF	L2OF, L2SF	L3OC test	–		From first test sat (2011)
L1OF, L1SF	L2OF, L2SF	L3OC	L1OC, L1SC, L2SC		From №3 sat Glonass-K
L1OF, L1SF	L2OF, L2SF	L3OC	L1OC, L1SC, L2SC	L3SC, L1OCM, L2OC, L5OC	Under development after 2015



FDMA signals



CDMA signals

Major principles of the GLONASS-2020 Concept



Sustainment, Development, Use

- **Sustainment**

- **State commitments** on performance (constellation, availability, accuracy, reliability)
 - Launch program until 2020 with spares on-orbit and on the ground

- **Development**

- Constellation improvement
- New signals implementation
- Accuracy and availability improvement
- Interference protection improvement
- New capabilities implementation
- Service area extension

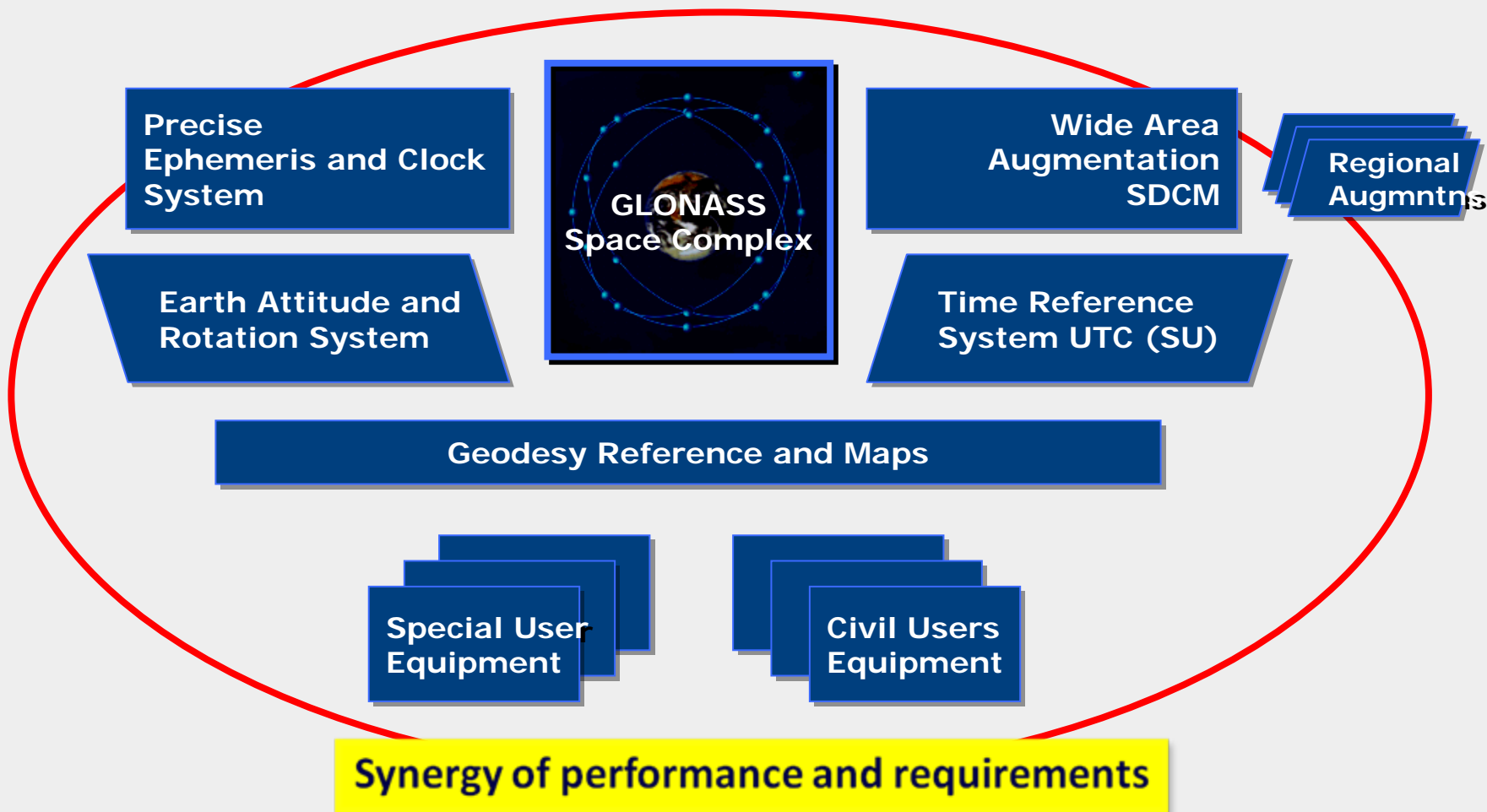
- **Use**

- Governmental use support
- Private activity encouraging
- Make GLONASS as worldwide utility





Extended PNT Architecture of Russia





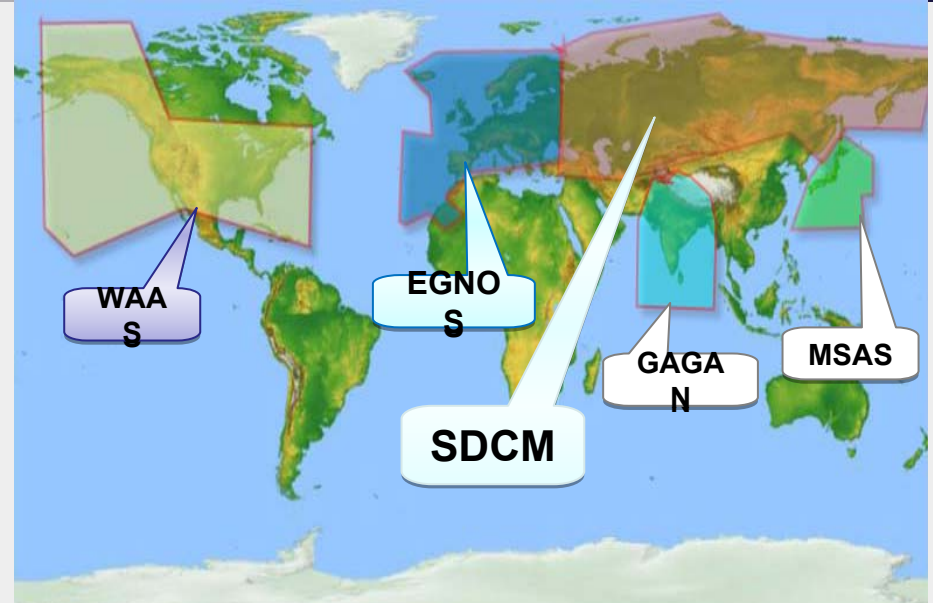
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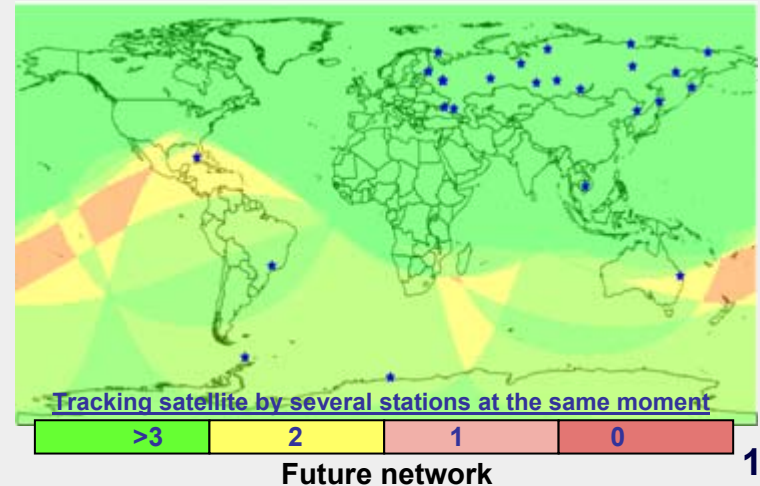
Objectives

- GNSS monitoring
 - Integrity
 - Deep analysis in postprocessing
- Differential corrections
- Service area – Russian territory



Current status of monitoring stations

- **Operational network**
 - 14 stations in Russia
 - 2 station in Antarctic
- **Future development**
 - 8 stations more in Russia
 - 5 stations more outside





SSI-01 monitoring station installation and commissioning (Bellingshausen, Antarctica, 2010)



Main view of the SSI-01



Off-site equipment



**GLONASS/GPS antenna +
Vaisala weather station**

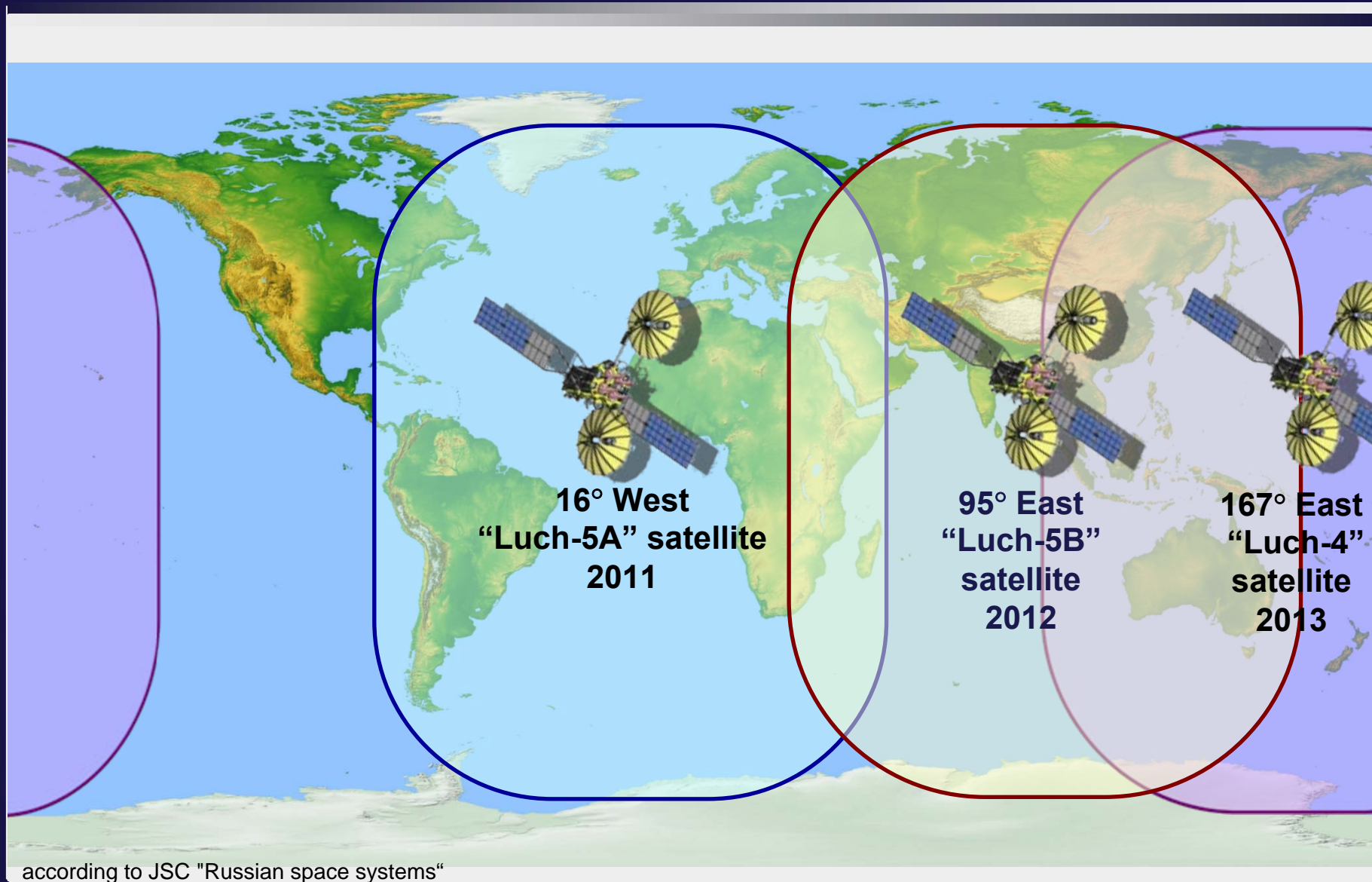


**Satellite communication
channel antenna**





Envisaged locations for GEOs “Luch” with SDCM payload (2011-2013 timeframe)





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International Cooperation



- Goals:
 - Promote GLONASS worldwide use
 - Provide GNSS compatibility and interoperability
 - Integrate GLONASS into the Global GNSS Infrastructure
- Cooperation with GNSS providers
 - The United States – GPS/GLONASS compatibility and interoperability
 - European Union – Galileo/GLONASS and augmentations compatibility and interoperability
 - India – GLONASS deployment support, augmentations interoperability, user receiver joint development and production
 - UN GNSS Providers Forum
- GLONASS Use Cooperation
 - Former USSR countries
 - India
 - Middle East, Australia, Latin America...
 - UN ICG





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Summary



- GLONASS Program is the high priority of the Russian Government policy
- GLONASS open service is free for all users
- GLONASS Program is in a progress, objective to be achieved by 2011
- GLONASS improvement is a major objective:
 - Performance to be comparable with GPS by the end of 2011
 - Full constellation (24 sats) by the mid of 2011
- GLONASS will continue
 - Keep the GLONASS traditional frequency bands
 - Transmit existing FDMA signals
 - Introduce new CDMA signals
- New GLONASS Program (2012 – 2020) is under development to be adopted by the end of 2011
 - State commitments for major performance
 - GLONASS sustainment, development, use
- International cooperation – make GLONASS as one of key elements of the international GNSS for worldwide use



**Thank you for your
attention!**