GLONASS Status and Modernization

Ekaterina Oleynik

Central Research Institute of Roscosmos
Federal Space Agency

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РОСКОСМОС

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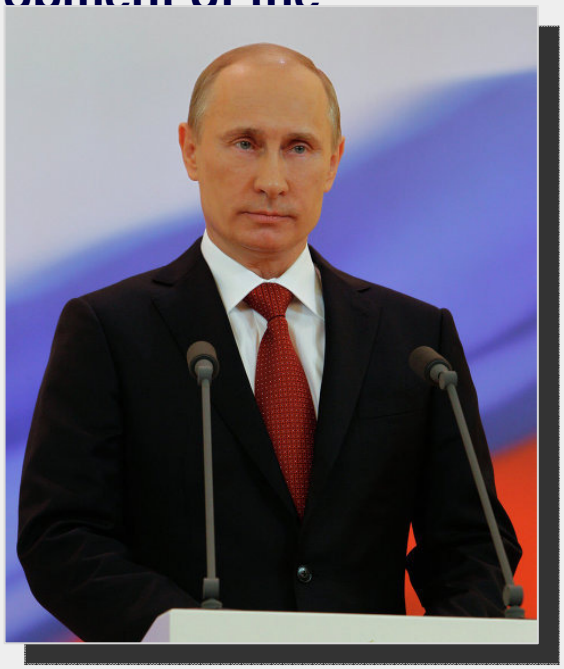
Presidential Decree

The Presidential Decree № 638 of May, 17, 2007

"On Use of GLONASS Global Navigation Satellite System for the Benefit of Social and Economic Development of the Russian Federation"

- Access to GLONASS civil signals is free and unlimited for both Russian and international users
- Federal organizations, Federal subjects' executive authorities, local self-governments and authorities, neglecting their organizational and legal status, shall use navigation equipment utilizing GLONASS signals
- Russian Federation Government shall approve and adopt the GLONASS Federal Program



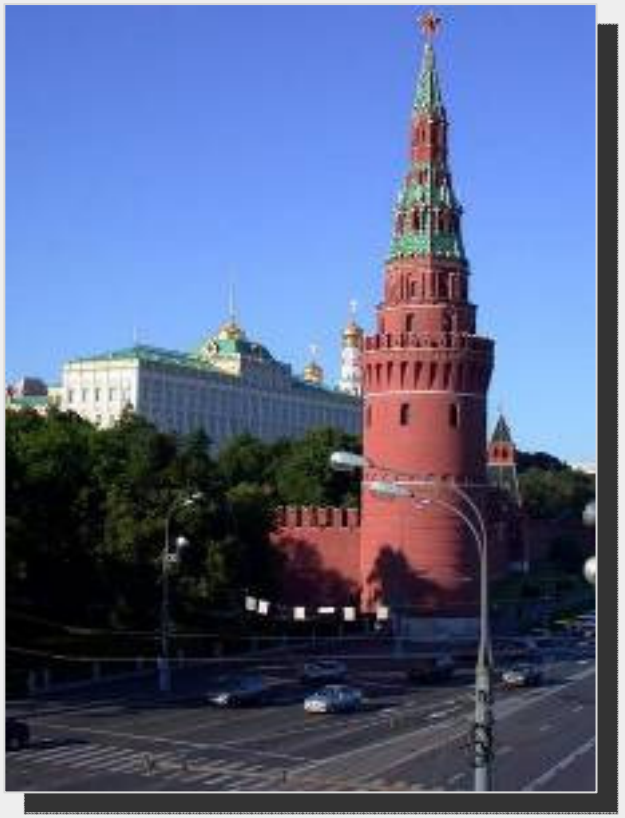
State Policy Basic Principles

Basic Documents:

- Presidential Decree, May 17, 2007
- GLONASS Federal Program
  - 2002 – 2011
  - 2012 – 2020 (adopted, 3 March, 2012)

Basic Principles

- GLONASS is a dual use system
  - GLONASS free of charge worldwide
  - GLONASS mandatory use for Russian critical infrastructure and governmental applications
  - Promotion of GLONASS commercial use
  - GNSS compatibility and interoperability

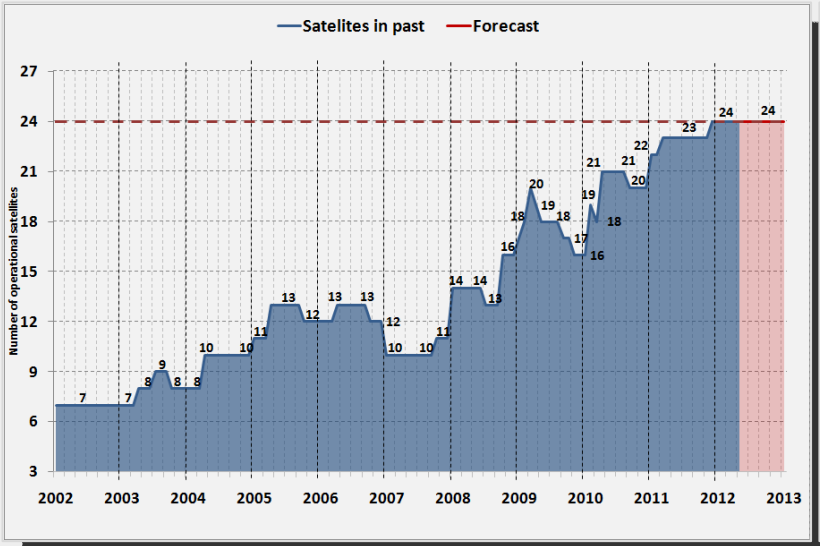


Federal GLONASS Program is a basis for GLONASS State Policy in PNT

GLONASS Program Results

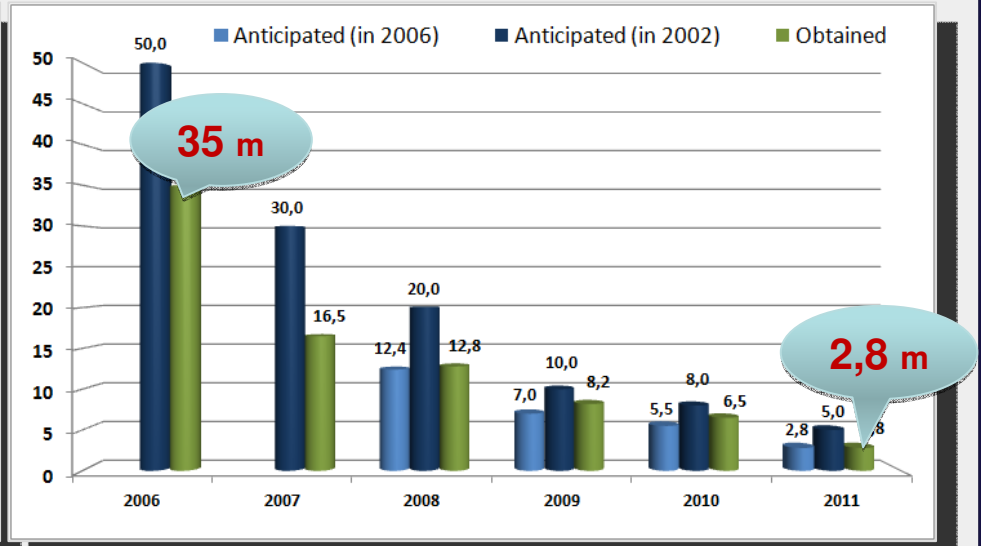
Constellation recovery

Number of operational satellites



Accuracy improvement

User positioning error (RMS, SIS)



- GLONASS recovered!
- GLONASS recognized worldwide!
- Performance is comparable to that of GPS!
- Open for cooperation!

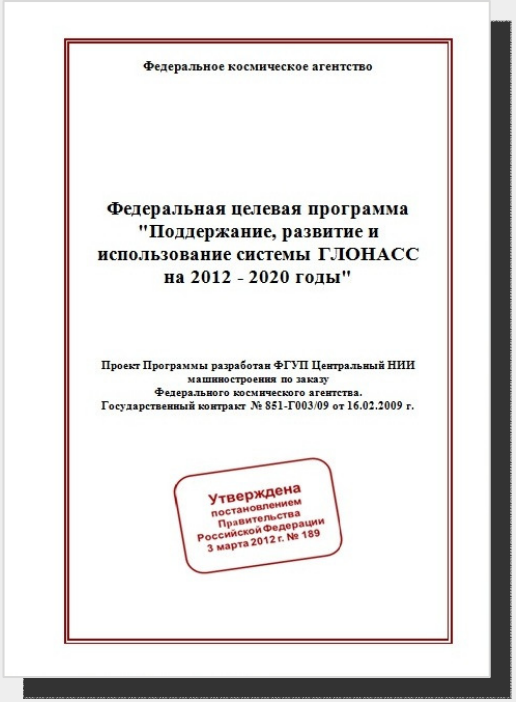
Federal Program for GLONASS Sustainment, Development and Use for 2012-2020

Program Goals:

- **Mass introduction of domestic navigation technologies**
- **Guaranteed provision of navigation services to meet continuously growing requirements of all categories of users**
  - for the national security purposes
  - for social and economic benefit
  - for pursuing leadership in satellite navigation

by means of

- Sustaining
- Further development of GLONASS
  - improvement of performance
  - broadening functional capabilities
  - conditions and domains of usage
  - balanced evolution of system's components


Федеральное космическое агентство

Федеральная целевая программа "Поддержание, развитие и использование системы ГЛОНАСС на 2012 - 2020 годы"

Проект Программы разработан ФГУП Центральный НИИ машиностроения по заказу Федерального космического агентства. Государственный контракт № 851-Г003/09 от 16.02.2009 г.

Утверждена постановлением Правительства Российской Федерации 3 марта 2012 г. № 189

- **Program Approved**
- **Budget for 9 years defined**
- **RFPs opened**

Key Quality Indicator of Program – guaranteed provision of announced GLONASS performance characteristics

GLONASS Segments

GLONASS Space Complex (core)	• Open basic navigation service • Authorized basic navigation service
SDCM Ground based augmentations	• SBAS service • Accuracy improvement • Integrity
Precise Orbit and Clock Determination System	• Post processed data • Real time data (in development)
Fundamental Segment	• Geodesy reference system • System time scale steering to UTC • Earth rotation and attitude parameters
User Segment	• Governmental segment • Civil segment

GLONASS Constellation Status

(14.05.2012)

Total satellites in constellation	31 SV
Operational	24 SV
In commissioning phase	- SV
In maintenance	2 SV
Spares	4 SV
In flight tests phase	1 SV

Orb. slot	Orb. pl.	RF chnl	# GC	Launched	Operation begins	Operation ends	Life-time (months)	Satellite health status		Comments
								In almanac	In ephemeris (UTC)	
1	1	01	730	14.12.09	30.01.10		29.0	+	+ 18:59 13.05.12	In operation
2	1	-4	728	25.12.08	20.01.09		40.6	+	+ 18:59 13.05.12	In operation
3	1	05	744	04.11.11	08.12.11		6.3	+	+ 19:15 13.05.12	In operation
4	1	06	742	02.10.11	25.10.11		7.4	+	+ 20:31 13.05.12	In operation
5	1	01	734	14.12.09	10.01.10		29.0	+	+ 20:30 13.05.12	In operation
6	1	-4	733	14.12.09	24.01.10		29.0	+	+ 20:30 13.05.12	In operation
7	1	05	745	04.11.11	18.12.11		6.3	+	+ 18:59 13.05.12	In operation
8	1	06	729	25.12.08	12.02.09		40.6	+	+ 18:59 13.05.12	In operation
9	2	-2	736	02.09.10	04.10.10		20.4	+	+ 19:00 13.05.12	In operation
10	2	-7	717	25.12.06	03.04.07		64.6	+	+ 20:14 13.05.12	In operation
11	2	00	723	25.12.07	22.01.08		52.6	+	+ 20:30 13.05.12	In operation
12	2	-1	737	02.09.10	12.10.10		20.4	+	+ 20:30 13.05.12	In operation
13	2	-2	721	25.12.07	08.02.08		52.6	+	+ 20:42 13.05.12	In operation
14	2	-7	715	25.12.06	03.04.07		64.6	+	+ 18:59 13.05.12	In operation
15	2	00	716	25.12.06	12.10.07		64.6	+	+ 18:59 13.05.12	In operation
16	2	-1	738	02.09.10	11.10.10		20.4	+	+ 18:59 13.05.12	In operation
17	3	04	746	28.11.11	23.12.11		5.5	+	+ 18:59 13.05.12	In operation
18	3	-3	724	25.09.08	26.10.08		43.6	+	+ 18:59 13.05.12	In operation
19	3	03	720	26.10.07	25.11.07		54.6	+	+ 20:00 13.05.12	In operation
20	3	02	719	26.10.07	27.11.07		54.6	+	+ 20:31 13.05.12	In operation
21	3	04	725	25.09.08	05.11.08		43.6	+	+ 20:31 13.05.12	In operation
22	3	-3	731	02.03.10	28.03.10		26.4	+	+ 20:30 13.05.12	In operation
23	3	03	732	02.03.10	28.03.10		26.4	+	+ 18:59 13.05.12	In operation
24	3	02	735	02.03.10	28.03.10		26.4	+	+ 18:59 13.05.12	In operation
21	3	-5	701	26.02.11			14.5			Flight Tests
2	1		743	04.11.11			6.3			Spares
14	2		722	25.12.07	25.01.08	12.10.11	52.6			Spares
7	1		712	26.12.04	07.10.05	14.12.11	88.6			Spares
17	3		714	25.12.05	31.08.06	19.12.11	76.6			Spares
3	1		727	25.12.08	17.01.09	08.09.10	40.6			Maintenance
22	3		726	25.09.08	13.11.08	31.08.09	43.6			Maintenance

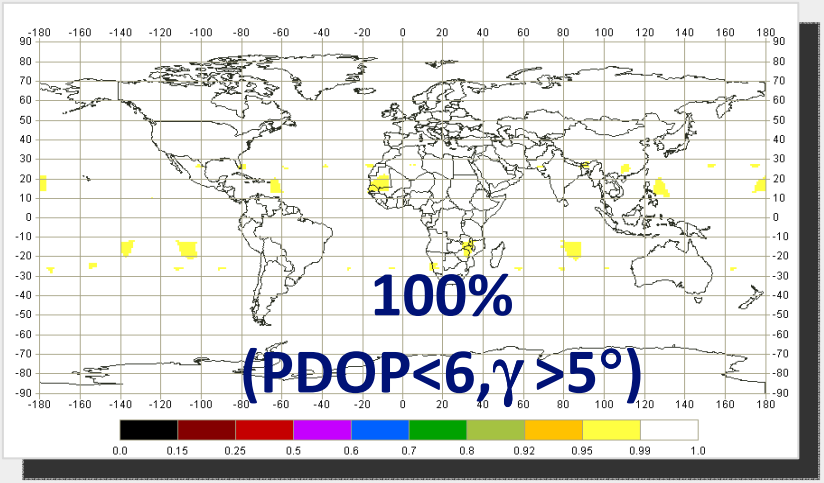
The constellation provides global continuous navigation

GLONASS Performance

(14.05.2012)

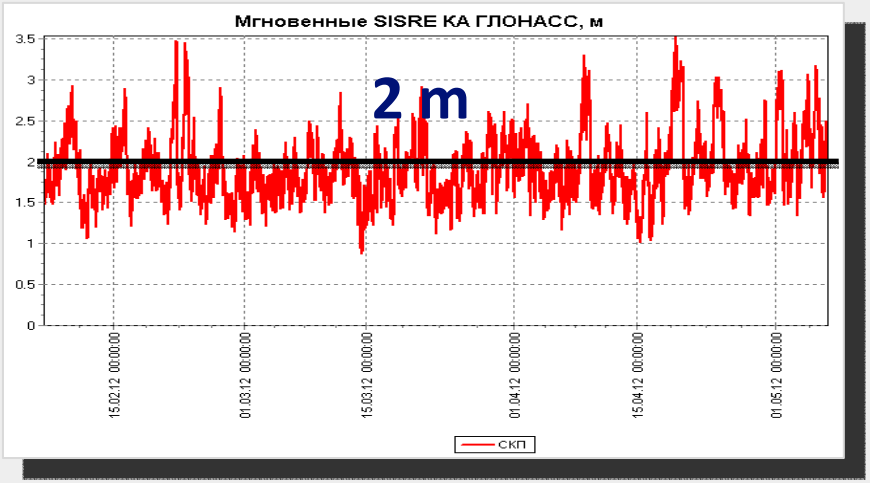
Availability

Mean availability for a day

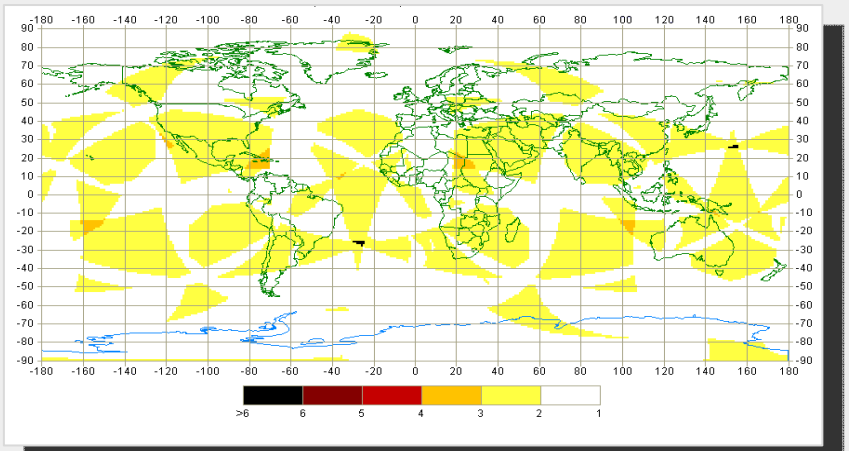


Accuracy

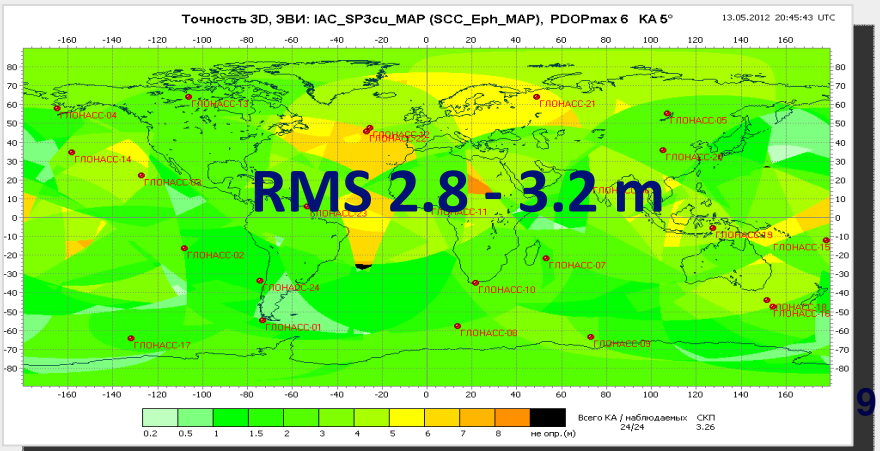
SISRE, m



Instant availability (PDOP map)



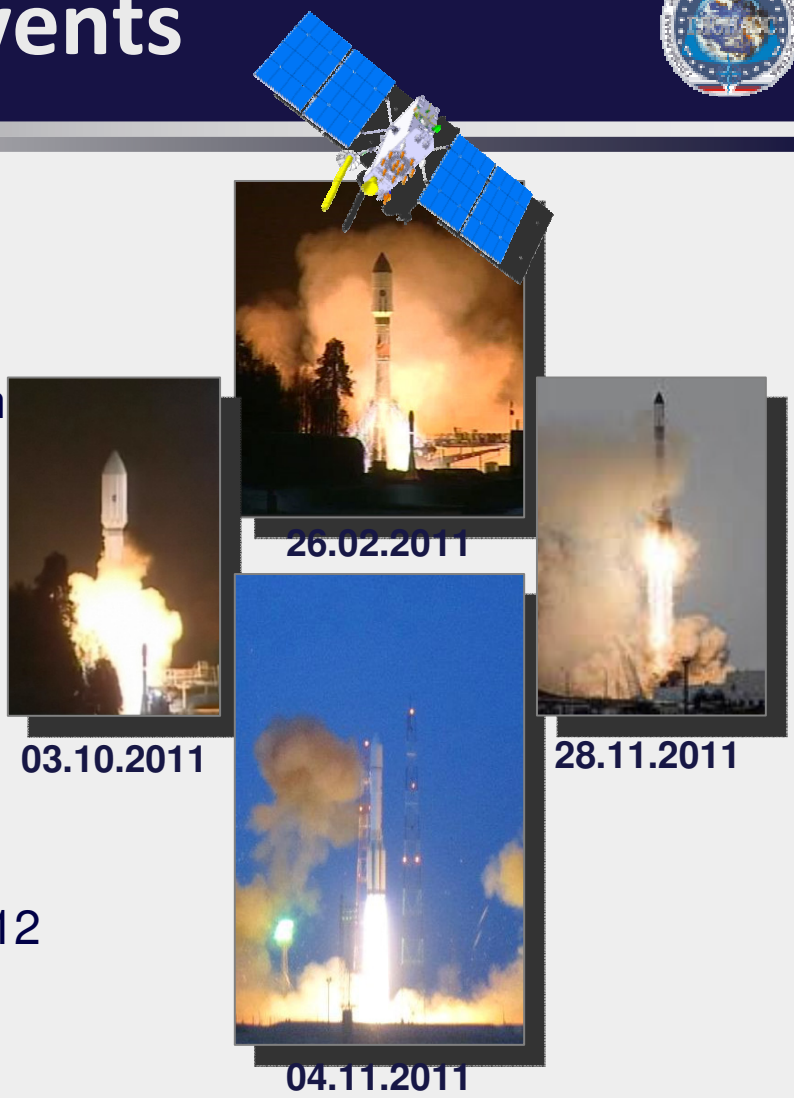
User position accuracy map (SIS)



Recent Events

Launches in 2011:

- 26.02.2011 the first GLONASS-K launch (Flight test begins)
- 03.10.2011 – 1 SV GLONASS-M
- 04.11.2011 – 3 SV GLONSSS-M
- 28.11.2011 – 1 SV GLONASS-M



Next launches:

- 2nd GLONASS-K (test) at the mid of 2012

Launch program of 2011 ensured full constellation deployment and created the basis for further development

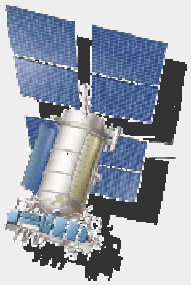
GLONASS Modernization

1982 **2003** **2011** **2014**

"Glonass"

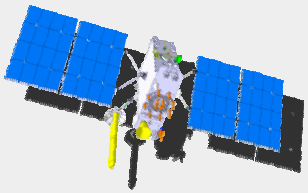
- 3 year design life
- Clock stability - $5*10^{-13}$
- Signals: L1SF, L2SF, L1OF, (FDMA)
- Totally launched 81 satellites
- Real operational life time 4.5 years

"Glonass-M"



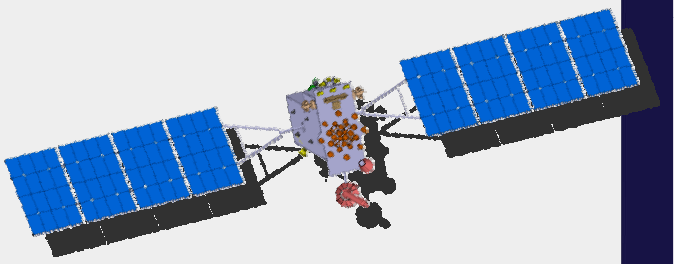
- 7 year design life
- Clock stability $1*10^{-13}$
- Signals: Glonass + L2OF (FDMA)
- Totally launched 36 satellites and going to launch 3 satellite by the end 2012

"Glonass-K1"



- 10 year design life
- Unpressurized
- Expected clock stability ~10…$5*10^{-14}$
- Signals: Glonass-M + L3OC (CDMA) – test
- SAR

"Glonass-K2"



- 10 year design life
- Unpressurized
- Expected clock stability ~5…$1*10^{-14}$
- Signals: Glonass-M + L1OC, L3OC, L1SC, L2SC (CDMA)
- SAR

CDMA signals general structure already designed

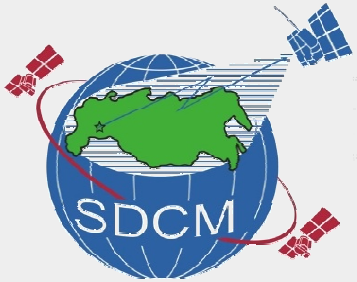
Directions of GLONASS Signal Modernization

- Improved accuracy of phase and range measurements
- Better interference protection and robustness
- Interoperability with GPS, Galileo and other GNSS

New CDMA signals introduced on Glonass-K

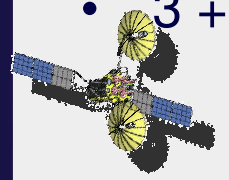
Keeping on transmitting the existing FDMA signals

SDCM (SBAS Augmentation)



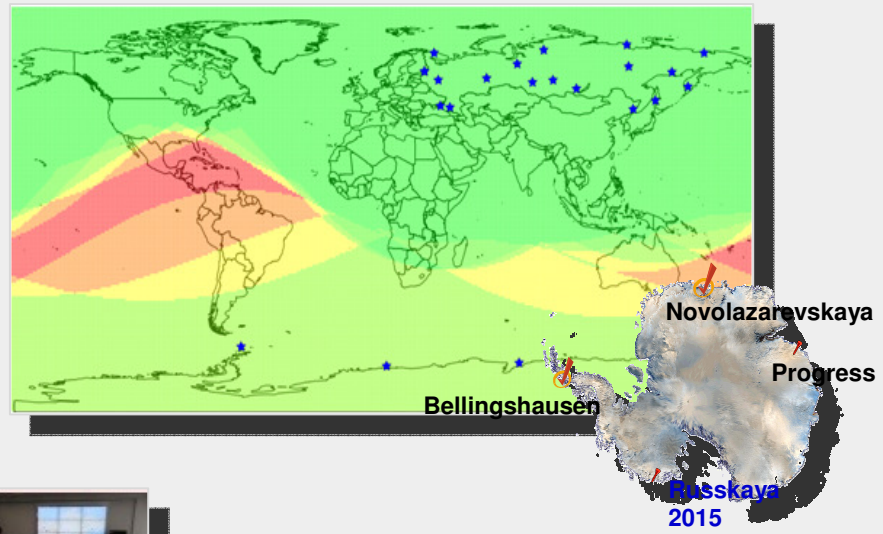
Broadcasting facilities

- 3 + 1 GEO satellites
  - Luch 5A launched 11 Dec. 2011
  - Luch 5B – Oct. 2012
  - Luch 5V – Mar. 2014
- SiSnet server



Objectives

- GNSS monitoring
  - integrity
  - differential corrections
  - orbit and clock data
  - GNSS quality monitoring (GLONASS and GPS)
- Service area – Russian territory

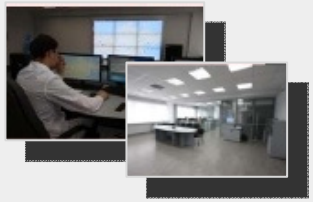


Reference stations network

- 18 station in Russia
- 3 station abroad

Central Processing Facilities

- Main (Moscow)
- Reserve (TBD)



www.sdcm.ru

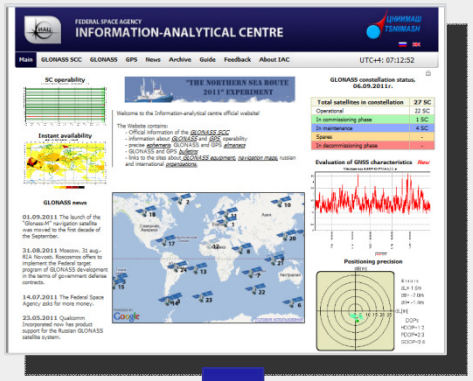
International Cooperation

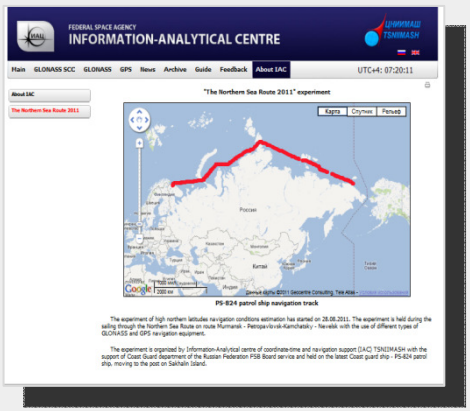
- GLONASS is an element of the global GNSS infrastructure
- Compatibility and Interoperability provision
- Development of common GNSS standards
- Promotion of GLONASS worldwide use for all user benefit

Multilateral cooperation in the framework of ICG and Working Groups,
Bilateral working contacts with USA, EU, India, China and other countries on GNSS compatibility and interoperability and global use

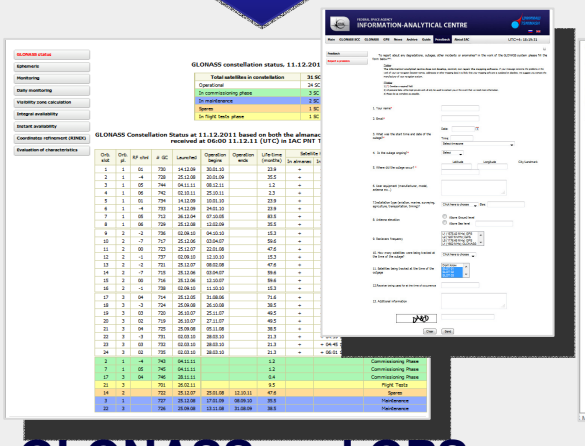
GLONASS Information Service

www.glonass-center.ru
(www.glonass-iac.ru)

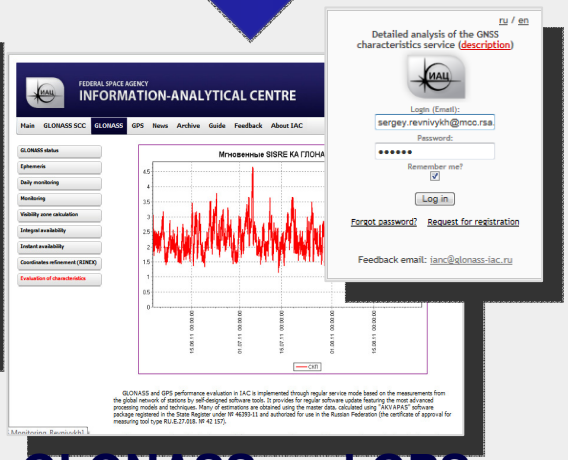




GLONASS News



GLONASS and GPS Status & Feedback



GLONASS and GPS Performances

Summary

- GLONASS Program is among priorities of the Russian Government policy
- GLONASS open service is free for all users
- GLONASS Program (2002-2011) completed, goal achieved
  - Performance are comparable with GPS
  - Full constellation (24 sats) deployed
- New GLONASS Program (2012 – 2020) approved 3 March 2012
  - Government commitments for major performance characteristics
  - GLONASS sustainment, development, use
- GLONASS will continue
  - Keep the GLONASS traditional frequency bands
  - Transmit existing FDMA signals
  - Introduce new CDMA signals
- International cooperation – make GLONASS as one of key elements of the international GNSS infrastructure for worldwide user benefits

РОСКОСМОС

МЕЖДУНАРОДНАЯ ШКОЛА
2012
ПО СПУТНИКОВОЙ НАВИГАЦИИ

The Second International School on GNSS 2012

Ryazan. September 16-23. 2012

supporting by Roscosmos

Main Objective

To study the basics of GNSS, remote sensing and its applications

The working language is Russian

www.school.oninnovations.ru

Thank you for your attention!

Ekaterina Oleynik
Information service & International relations
Central Research Institute of Machine Building
PNT Information and Analysis Center
4 Pionerskaya str,
141070 Korolyov, Moscow reg.,
The Russian Federation

ekaterina.oleynik@glonass-iac.ru
www.glonass-iac.ru
tel/fax: + 7 495 5134882