GLONASS Status and Modernization

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International GNSS Committee IGC-7
Beijing, 4-9 November, 2012

РОСКОСМОС

ЦНИИМАШ
TSNIIMASH

ИАЦ

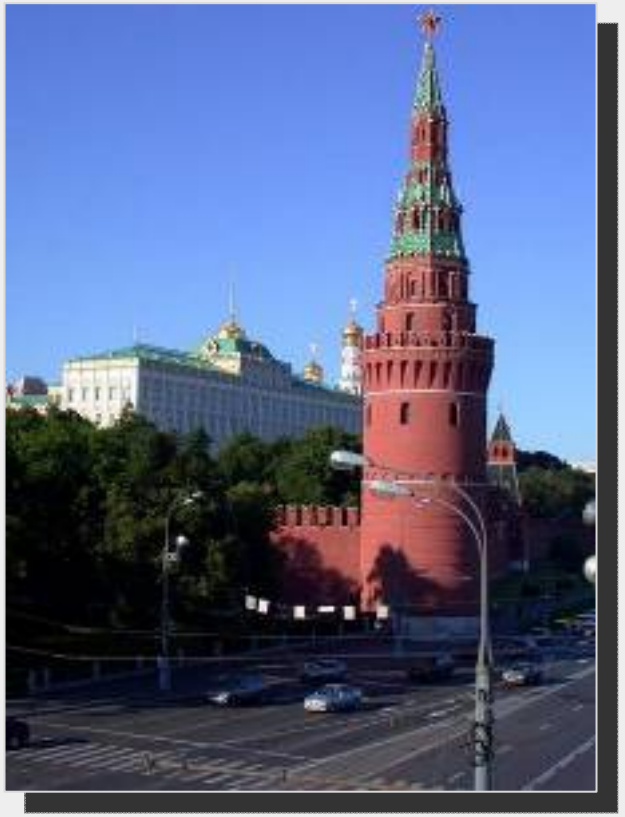
State Policy Basic Principles

Basic Documents:

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

Basic Principles

- GLONASS is a dual use system
  - GLONASS is a free open service worldwide
  - GLONASS is mandatory use for Russian critical infrastructure and governmental applications
  - Governmental support of of GLONASS commercial use
  - GNSS compatibility and interoperability



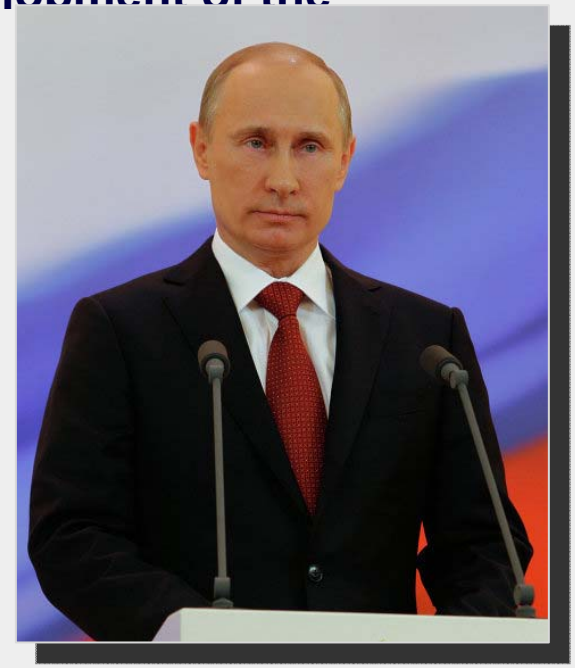
Federal GLONASS Program is a basis for GLONASS State Policy in PNT

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"

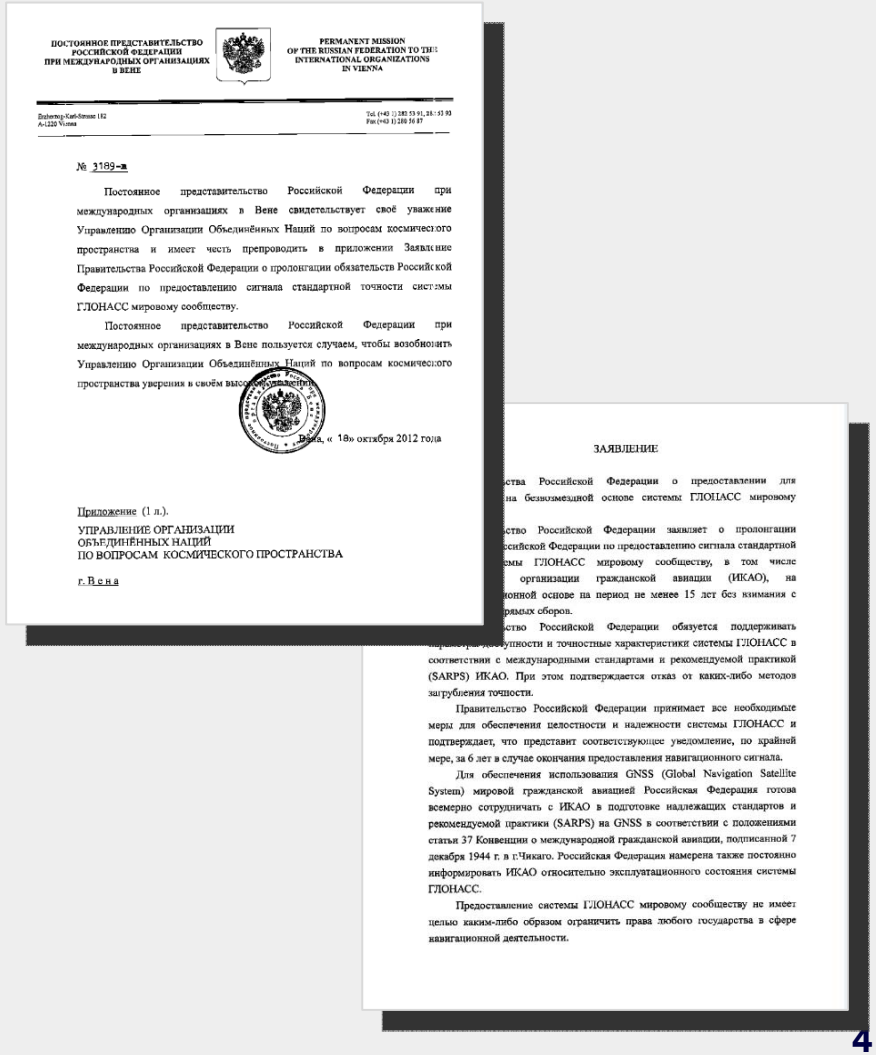
- Access to GLONASS civil signals is free and unlimited for both Russian and international users
- Federal organizations, Federal subjects' executive authorities, local self-governments and authorities, neglecting their organizational and legal status, shall use navigation equipment utilizing GLONASS signals
- Russian Federation Government shall approve and adopt the GLONASS Federal Program by 2011



Official Declaration of the Russian Government

October 18, 2012

- Extension of the Russian Government commitments on the GLONASS open service free of charge for the next 15 years at least
- Commitments of the Russian Government to keep GLONASS performance according to SARPs ICAO



ПОСТОЯННОЕ ПРЕДСТАВИТЕЛЬСТВО РОССИЙСКОЙ ФЕДЕРАЦИИ ПРИ МЕЖДУНАРОДНЫХ ОРГАНИЗАЦИЯХ В ВЕНЕ

PERMANENT MISSION OF THE RUSSIAN FEDERATION TO THE INTERNATIONAL ORGANIZATIONS IN VIENNA

№ 3189-а

Постоянное представительство Российской Федерации при международных организациях в Вене свидетельствует своё уважение Управлению Организации Объединённых Наций по вопросам космического пространства и имеет честь препроводить в приложении Заявление Правительства Российской Федерации о пролонгации обязательств Российской Федерации по предоставлению сигнала стандартной точности системы ГЛОНАСС мировому сообществу.

Постоянное представительство Российской Федерации при международных организациях в Вене пользуется случаем, чтобы возобновить Управлению Организации Объединённых Наций по вопросам космического пространства уверения в своём высоком

Вена, «18» октября 2012 года

Приложение (1 л.).

УПРАВЛЕНИЕ ОРГАНИЗАЦИИ
ОБЪЕДИНЁННЫХ НАЦИЙ
ПО ВОПРОСАМ КОСМИЧЕСКОГО ПРОСТРАНСТВА

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ЗАЯВЛЕНИЕ

...ства Российской Федерации о предоставлении для ...на безвозмездной основе системы ГЛОНАСС мировому

...ство Российской Федерации заявляет о пролонгации ...ссийской Федерации по предоставлению сигнала стандартной ...мы ГЛОНАСС мировому сообществу, в том числе ... организации гражданской авиации (ИКАО), на ...нной основе на период не менее 15 лет без изменения с ...рядных сборов.

...ство Российской Федерации обязуется поддерживать ...характеристики доступности и точностные характеристики системы ГЛОНАСС в соответствии с международными стандартами и рекомендуемой практикой (SARPS) ИКАО. При этом подтверждается отказ от каких-либо методов загрубления точности.

Правительство Российской Федерации принимает все необходимые меры для обеспечения целостности и надежности системы ГЛОНАСС и подтверждает, что представит соответствующее уведомление, по крайней мере, за 6 лет в случае окончания предоставления навигационного сигнала.

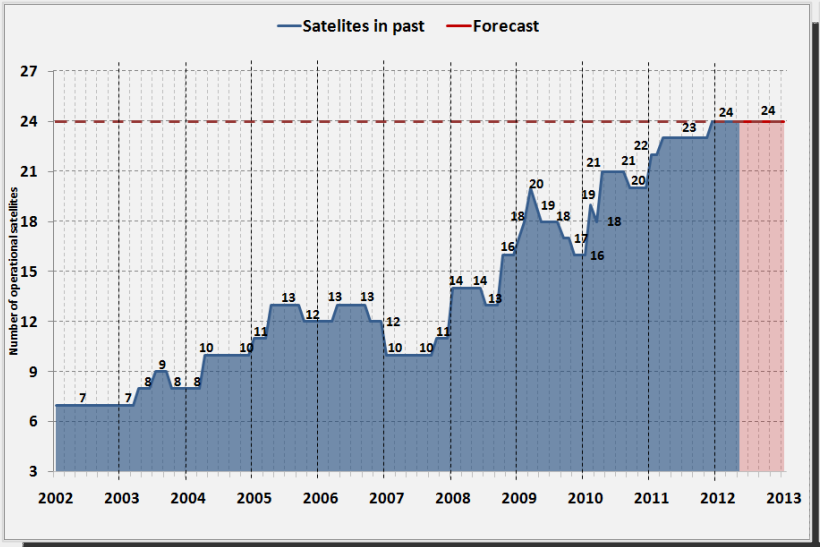
Для обеспечения использования GNSS (Global Navigation Satellite System) мировой гражданской авиацией Российская Федерация готова всемерно сотрудничать с ИКАО в подготовке надлежащих стандартов и рекомендуемой практики (SARPS) на GNSS в соответствии с положениями статьи 37 Конвенции о международной гражданской авиации, подписанной 7 декабря 1944 г. в г.Чикаго. Российская Федерация намерена также постоянно информировать ИКАО относительно эксплуатационного состояния системы ГЛОНАСС.

Предоставление системы ГЛОНАСС мировому сообществу не имеет целью каким-либо образом ограничить права любого государства в сфере навигационной деятельности.

GLONASS Program (2002 – 2011) Results

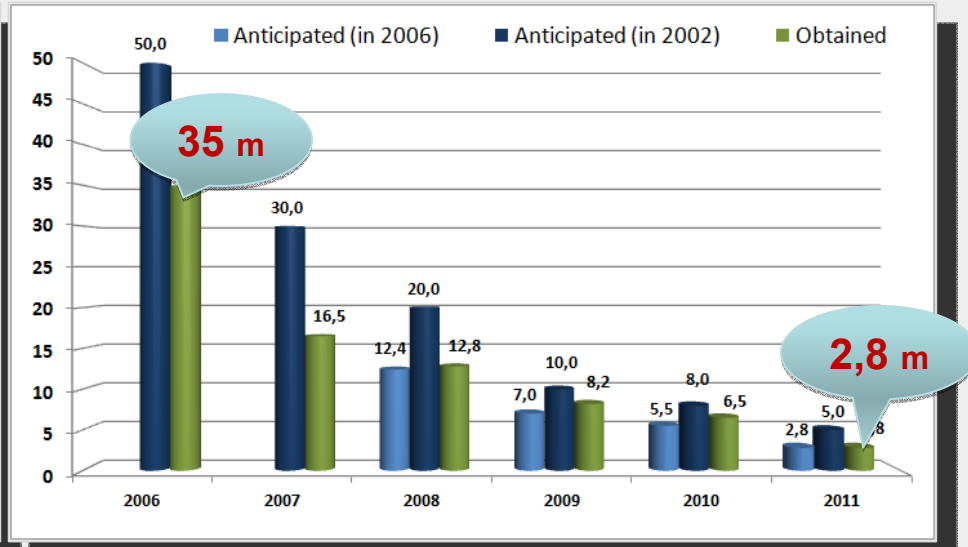
Constellation recovery

Number of operational satellites



Accuracy improvement

User positioning error (RMS, SIS)



- GLONASS recovered
- GLONASS recognized worldwide
- GLONASS performances are comparable to that of GPS
- GLONASS is open for international cooperation

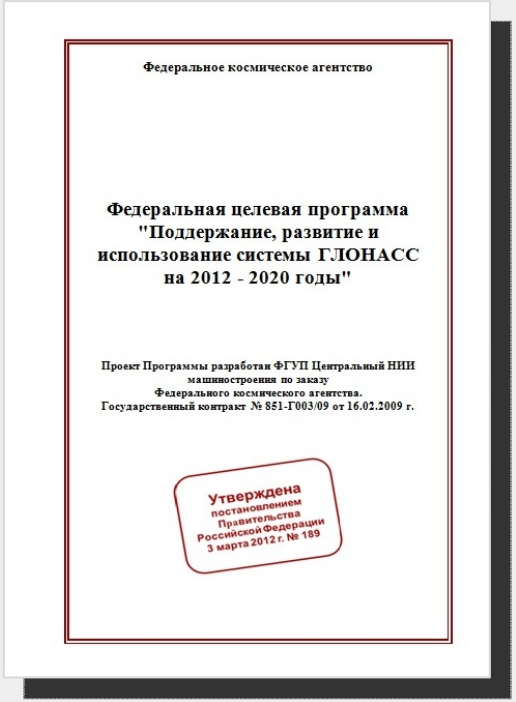
Federal Program for GLONASS Sustainment, Development and Use for 2012-2020

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
  - pursuing leadership in satellite navigation

by means of

- Sustainment of GLONASS
- 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 at 03/03/2012**
- **Budget for 9 years accepted**

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
Space and Ground based augmentations	• SBAS service • Accuracy improvement • Integrity
Precise Orbit and Clock Determination System	• Post processed data • Real time data
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
(04.11.2012)

Total satellites in constellation	31 SV
Operational	24 SV
In commissioning phase	- SV
In maintenance	3 SV
Spares	3 SV
In flight tests phase	1 SV

GLONASS Constellation Status at 04.11.2012 based on both the almanac analysis and navigation messages received at 14:00 04.11.12 (UTC) in IAC PNT TsNIImash

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		34.7	+	+ 14:45 04.11.12	In operation
2	1	-4	728	25.12.08	20.01.09		46.4	+	+ 12:00 04.11.12	In operation
3	1	05	744	04.11.11	08.12.11		12.0	+	+ 12:00 04.11.12	In operation
4	1	06	742	02.10.11	25.10.11		13.1	+	+ 12:00 04.11.12	In operation
5	1	01	734	14.12.09	10.01.10		34.7	+	+ 12:30 04.11.12	In operation
6	1	-4	733	14.12.09	24.01.10		34.7	+	+ 14:29 04.11.12	In operation
7	1	05	745	04.11.11	18.12.11		12.0	+	+ 14:45 04.11.12	In operation
8	1	06	712	26.12.04	07.10.05		94.4	+	+ 14:45 04.11.12	In operation
9	2	-2	736	02.09.10	04.10.10		26.1	+	+ 14:45 04.11.12	In operation
10	2	-7	717	25.12.06	03.04.07		70.4	+	+ 12:00 04.11.12	In operation
11	2	00	723	25.12.07	22.01.08		58.4	+	+ 12:00 04.11.12	In operation
12	2	-1	737	02.09.10	12.10.10		26.1	+	+ 11:45 04.11.12	In operation
13	2	-2	721	25.12.07	08.02.08		58.4	+	+ 12:30 04.11.12	In operation
14	2	-7	715	25.12.06	03.04.07		70.4	+	+ 12:59 04.11.12	In operation
15	2	00	716	25.12.06	12.10.07		70.4	+	+ 13:45 04.11.12	In operation
16	2	-1	738	02.09.10	11.10.10		26.1	+	+ 14:45 04.11.12	In operation
17	3	04	746	28.11.11	23.12.11		11.2	+	+ 12:00 04.11.12	In operation
18	3	-3	724	25.09.08	26.10.08		49.3	+	+ 12:00 04.11.12	In operation
19	3	03	720	26.10.07	25.11.07		60.4	+	+ 12:00 04.11.12	In operation
20	3	02	719	26.10.07	27.11.07		60.4	+	+ 12:00 04.11.12	In operation
21	3	04	725	25.09.08	05.11.08		49.3	+	+ 13:31 04.11.12	In operation
22	3	-3	731	02.03.10	28.03.10		32.2	+	+ 14:44 04.11.12	In operation
23	3	03	732	02.03.10	28.03.10		32.2	+	+ 14:45 04.11.12	In operation
24	3	02	735	02.03.10	28.03.10		32.2	+	+ 14:45 04.11.12	In operation
21	3	-5	701	26.02.11			20.3			Flight Tests
14	2		722	25.12.07	25.01.08	12.10.11	58.4			Spares
2	1		743	04.11.11	20.09.12	17.10.12	12.0			Spares
17	3		714	25.12.05	31.08.06	19.12.11	82.4			Spares
3	1		727	25.12.08	17.01.09	08.09.10	46.4			Maintenance
22	3		726	25.09.08	13.11.08	31.08.09	49.3			Maintenance
8	1		729	25.12.08	12.02.09	10.09.12	46.4			Maintenance

The constellation provides global continuous navigation

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 end of 2012

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

GLONASS Modernization

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

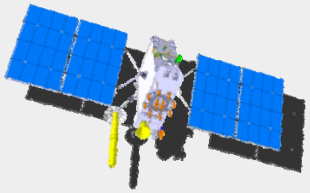
"Glonass"

- 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"

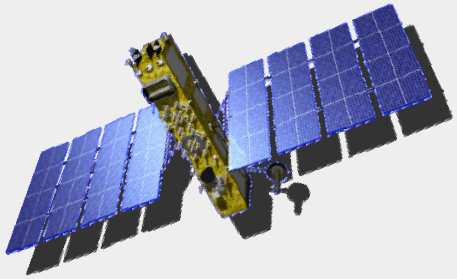
- 7 year design life
- Clock stability $1*10^{-13}$
- Signals: Glonass + L2OF (FDMA)
- Totally launched 36 satellites
- Another 12 satellites ordered

"Glonass-K1"



- 10 year design life
- Unpressurized bus
- 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 + full set of CDMA signals
- SAR

CDMA signals general structure already designed

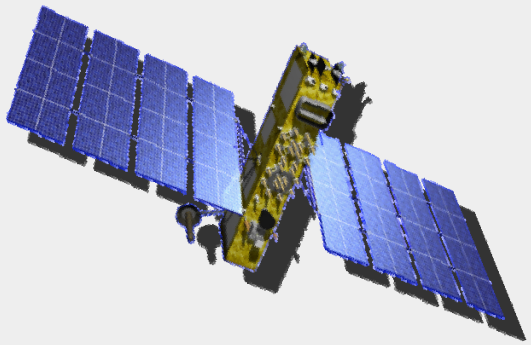
Directions of GLONASS Signal Modernization

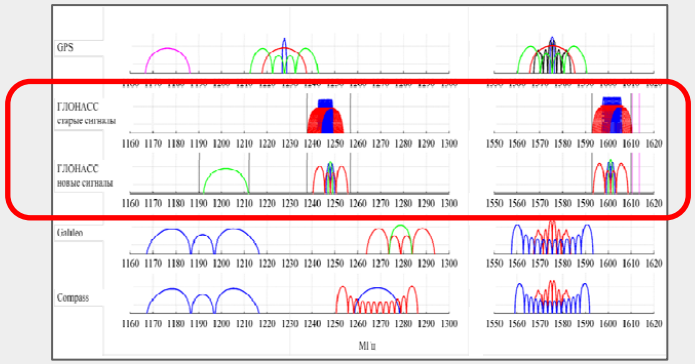
- Improved accuracy of phase and range measurements
- Better interference protection and robustness
- Interoperability with GPS, Galileo and other GNSS

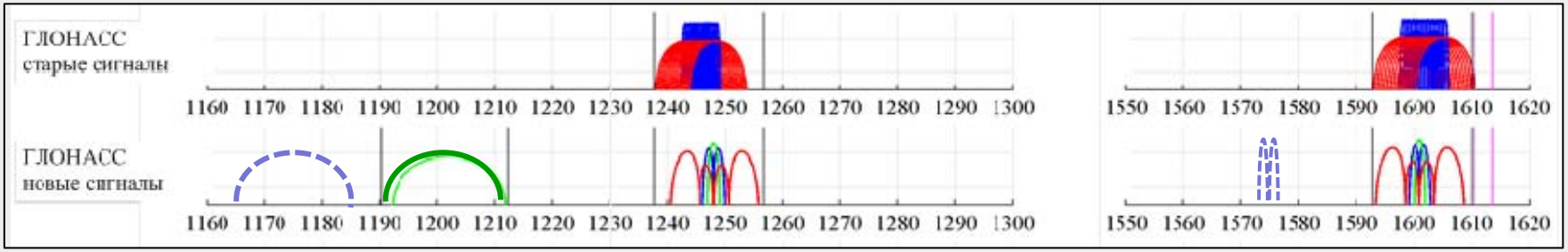
New CDMA signals introduced on Glonass-K

Keeping on transmitting the existing FDMA signals

GLONASS CDMA Signals







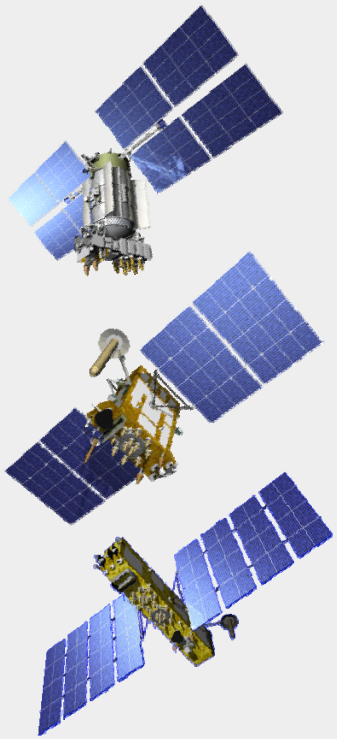
Signal	L3OC	L5OCM
Central frequency	1202.025	1176.45
Data	BPSK(10)	Study
Pilot	BPSK(10)	Study

Signal	L2SC	L2OCM
Central frequency	1248.06	
Data	BOC(5,2.5)	BPSK(1)
Pilot	BOC(5,2.5)	BOC(1,1)

Signal	L1SC	L1OC	L1OCM
Central frequency	1600.995		1575.42
Data	BOC(5,2.5)	BPSK(1)	Study
Pilot	BOC(5,2.5)	BOC(1,1)	Study

Under study on power, mass, dimension on-board budget capability and user benefits for next generation of GLONASS satellites

GLONASS Signal Implementation Plan



Satellite	FDMA Signals		CDMA Signals		
	L1	L2	L1	L2	L3
«Glonass-M»	L1OF L1SF	L2OF L2SF	-	-	L3OC (с 2014 г.)
«Glonass-K» 1G	L1OF L1SF	L2OF L2SF			L3OC
«Glonass-K» 2G	L1OF L1SF	L2OF L2SF	L1OC L1SC	L2OC L2SC	L3OC

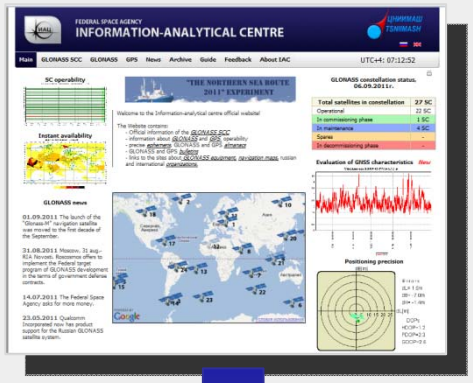
Bacic Principles of International Cooperation

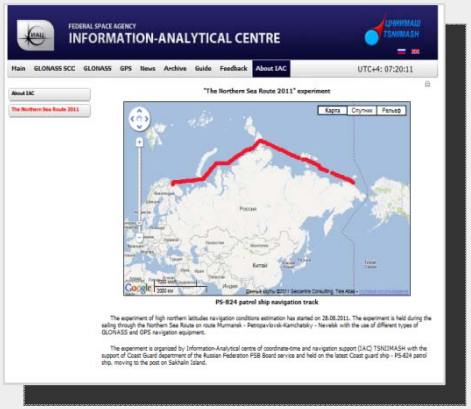
- GLONASS is an element of the global GNSS infrastructure
- Compatibility and Interoperability provision
- Development of common GNSS standards
- Promotion of GLONASS worldwide use for all user benefit

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

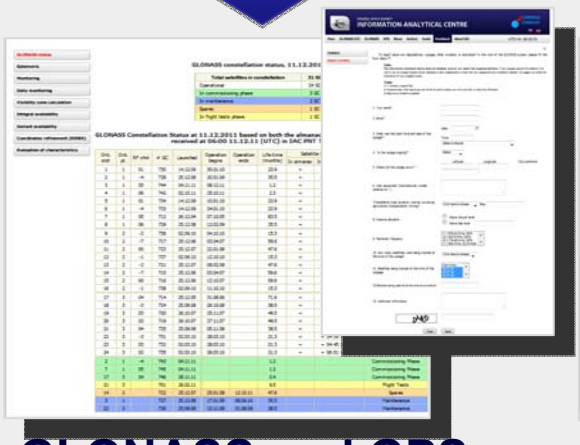
GLONASS Information Service

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

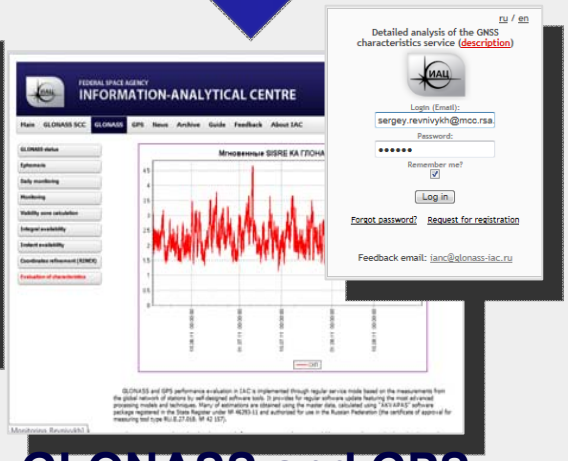




GLONASS News



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, the goal achieved
  - Performance significantly improved
  - Full constellation (24 sats) deployed
- New GLONASS Program (2012 – 2020) approved at 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

Thank you for your attention!

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