



# FEDERAL SPACE AGENCY



## GLONASS Status and Progress

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**3d meeting of the International Committee on GNSS (ICG)**  
**8-12 December, 2008, Pasadena CA, US**

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# Content



- **GLONASS Status and Performance**
- **GLONASS Modernization (including signals)**
- **SDCM**
- **GLONASS Policy**
- **Summary**

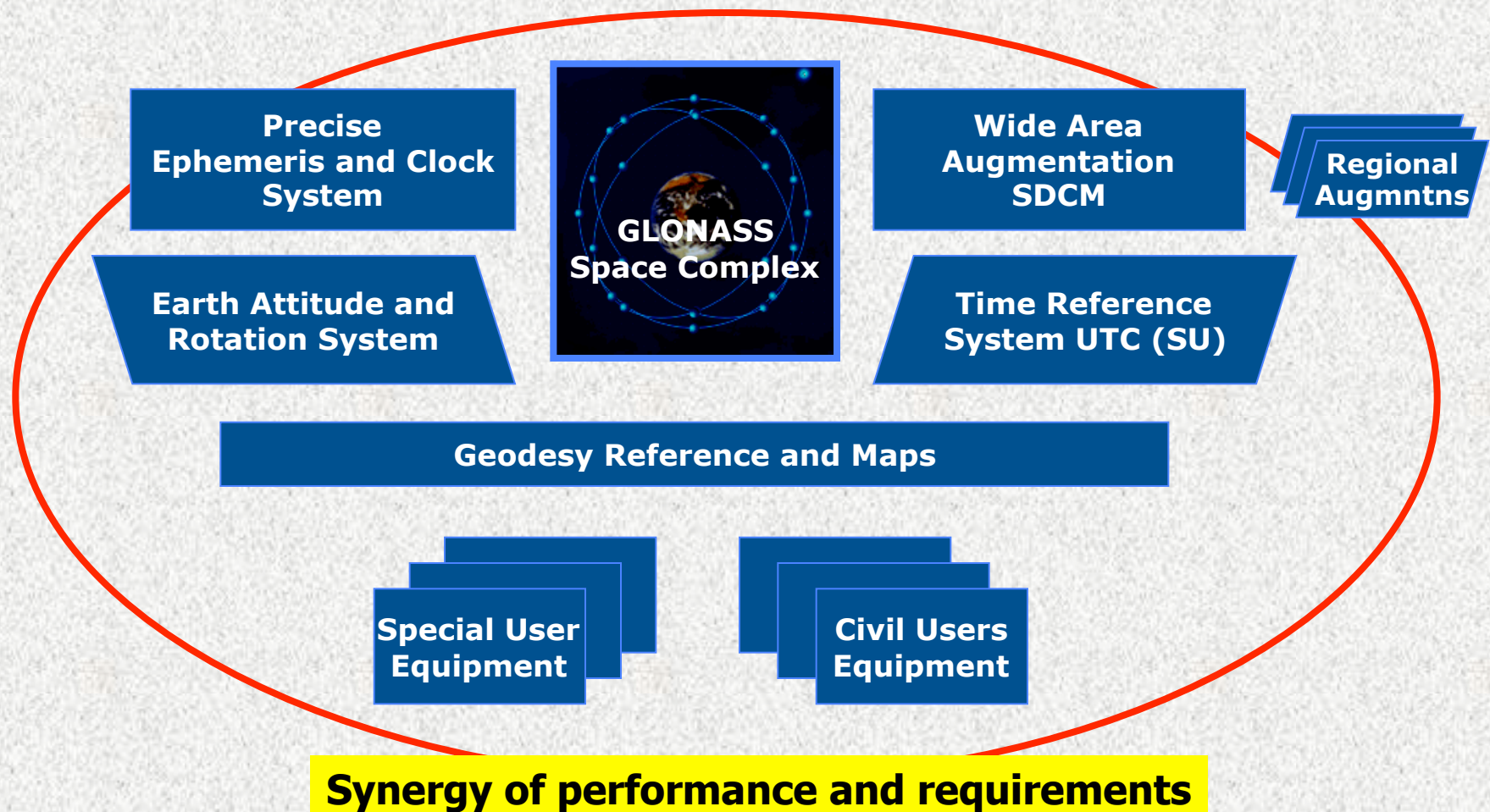


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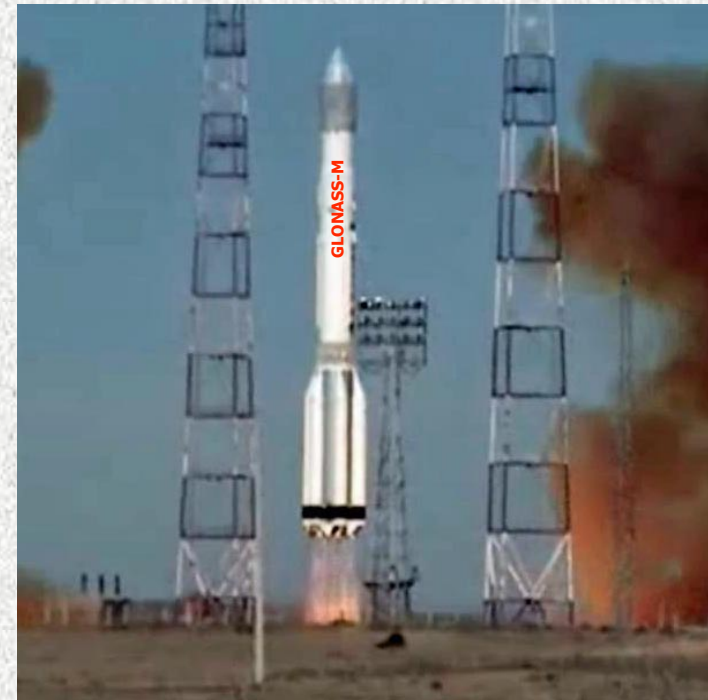
## New GLONASS Technical Requirements Document





# Recent GLONASS Improvements

- **Block 38 “Glonass-M” launch at Oct 25, 2008**
- **Orbit determination and Time synchronization subsystem improvement (1<sup>st</sup> phase)**
- **Ground Control Segment modernization (1<sup>st</sup> phase)**
- **Geodesy Reference update (PZ-90.02 version)**
- **15 Glonass-M satellites are transmitting the second civil signal in L2**



- **September 25, 2008**
- **3 Glonass-M satellites  
## 24, 25, 26**
- **Plane III, slots 18, 21, 22**

## 17 Healthy Satellites

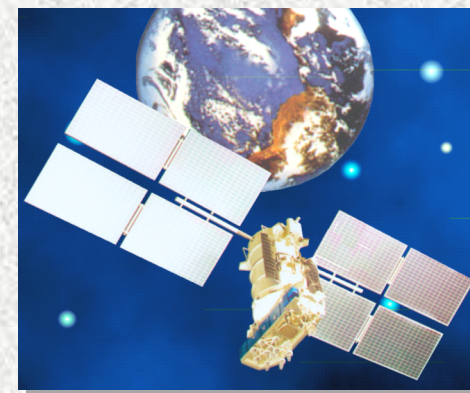
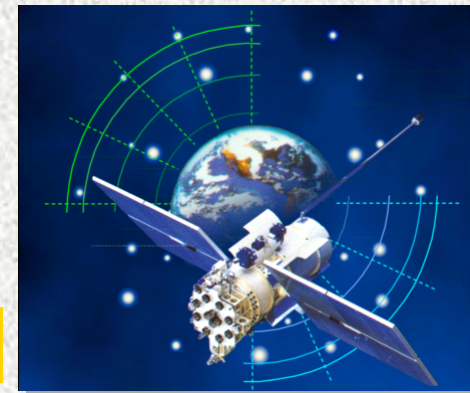
As of December 8, 2008 (Baseline Constellation: 24)

### ➤ 17 Satellites on Orbit

- 1 "Glonass" Satellite
- 16 "Glonass-M" Satellites

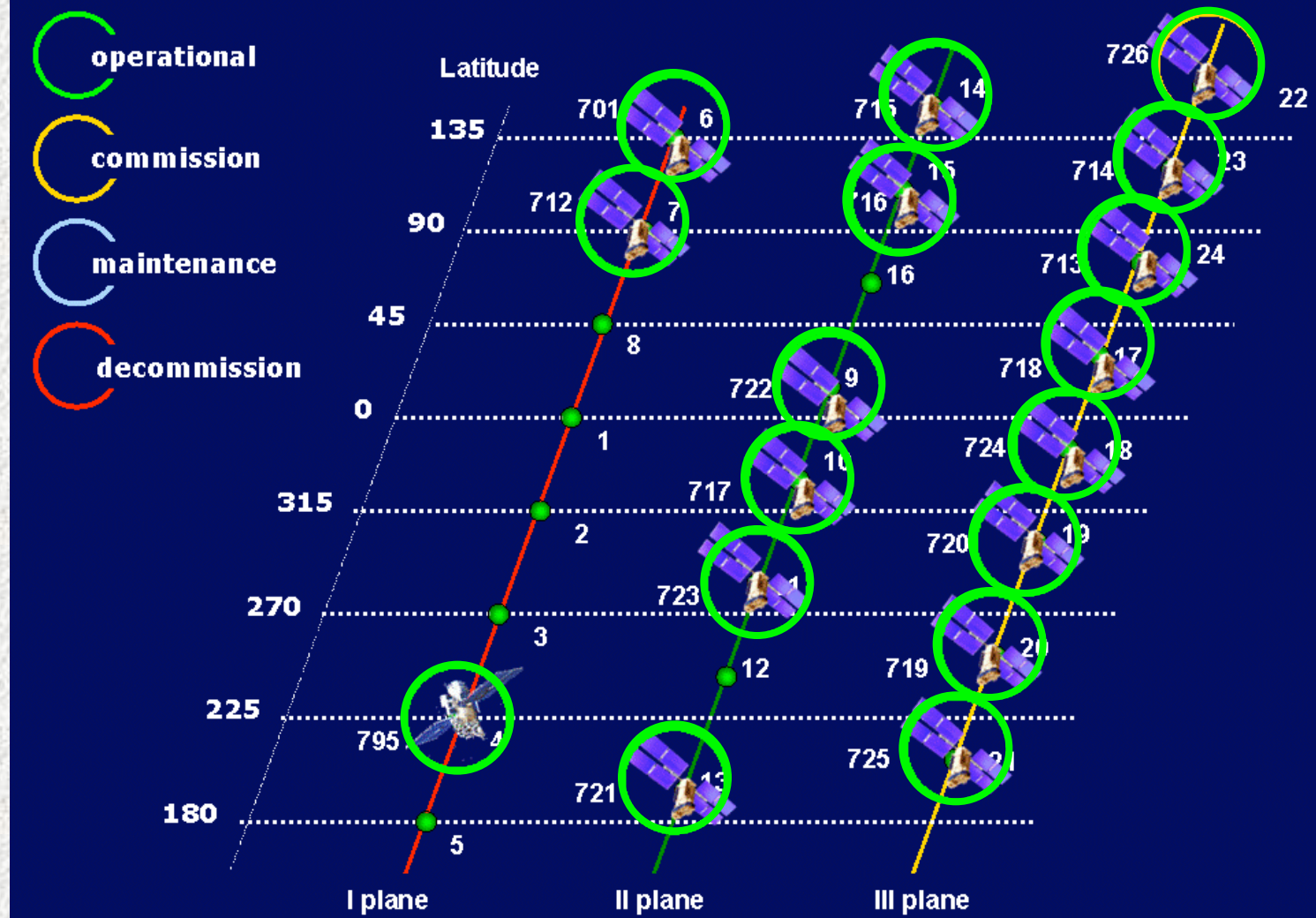
### ➤ Next launches:

- 25 December 2008 – 3 "Glonass-M" sats
- September 2009 – 3 "Glonass-M" sats
- December 2009 – 3 "Glonass-M" sats





# GLONASS Constellation Status (08.11.2008)

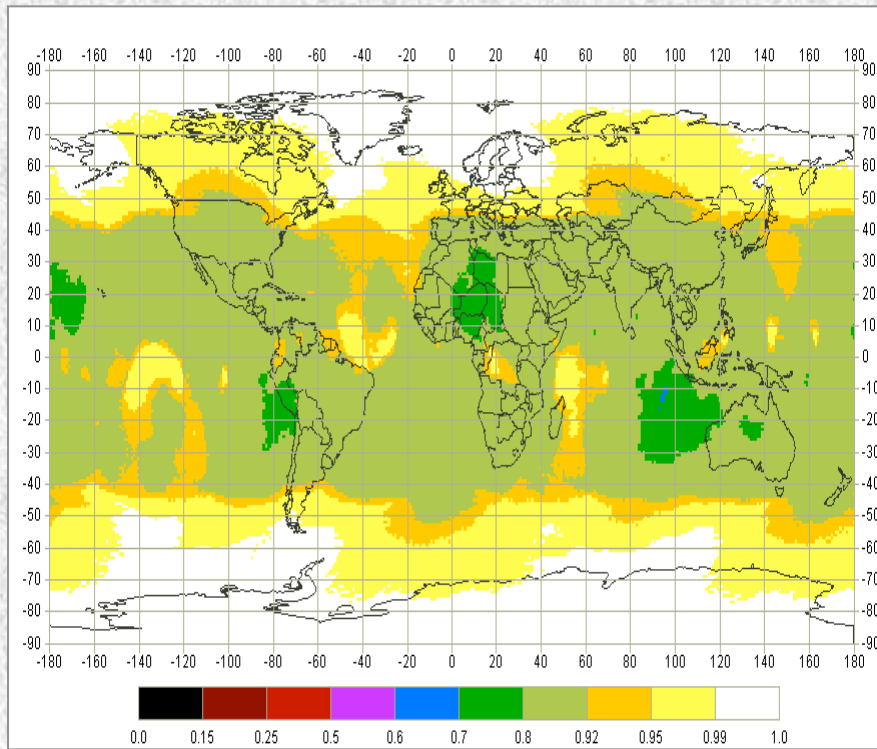




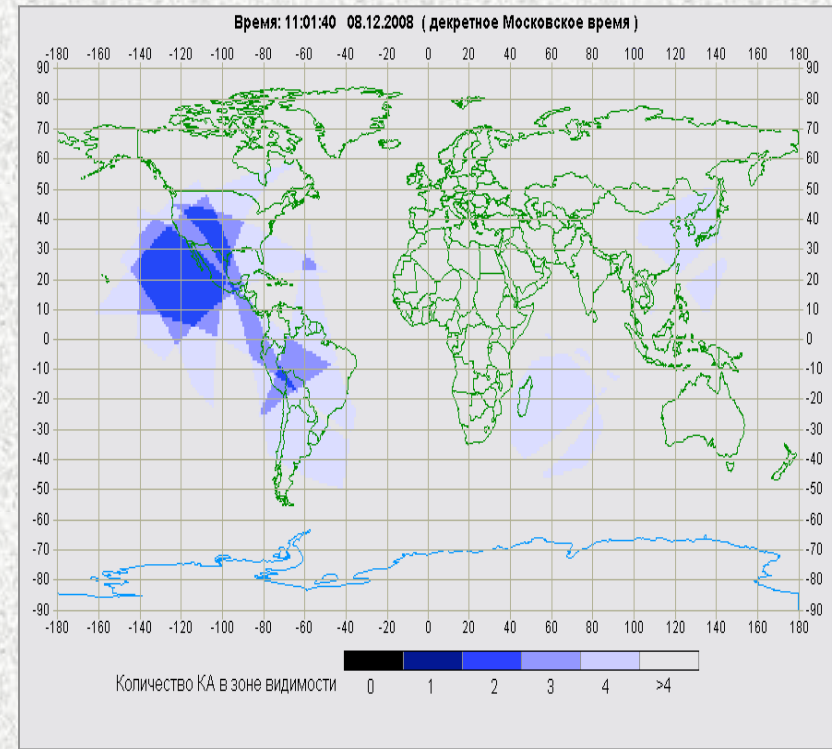
# GLONASS Availability (08.12.2008)



**Global availability is 90-97% ( $PDOP < 6$ ,  $\gamma > 5^\circ$ )**

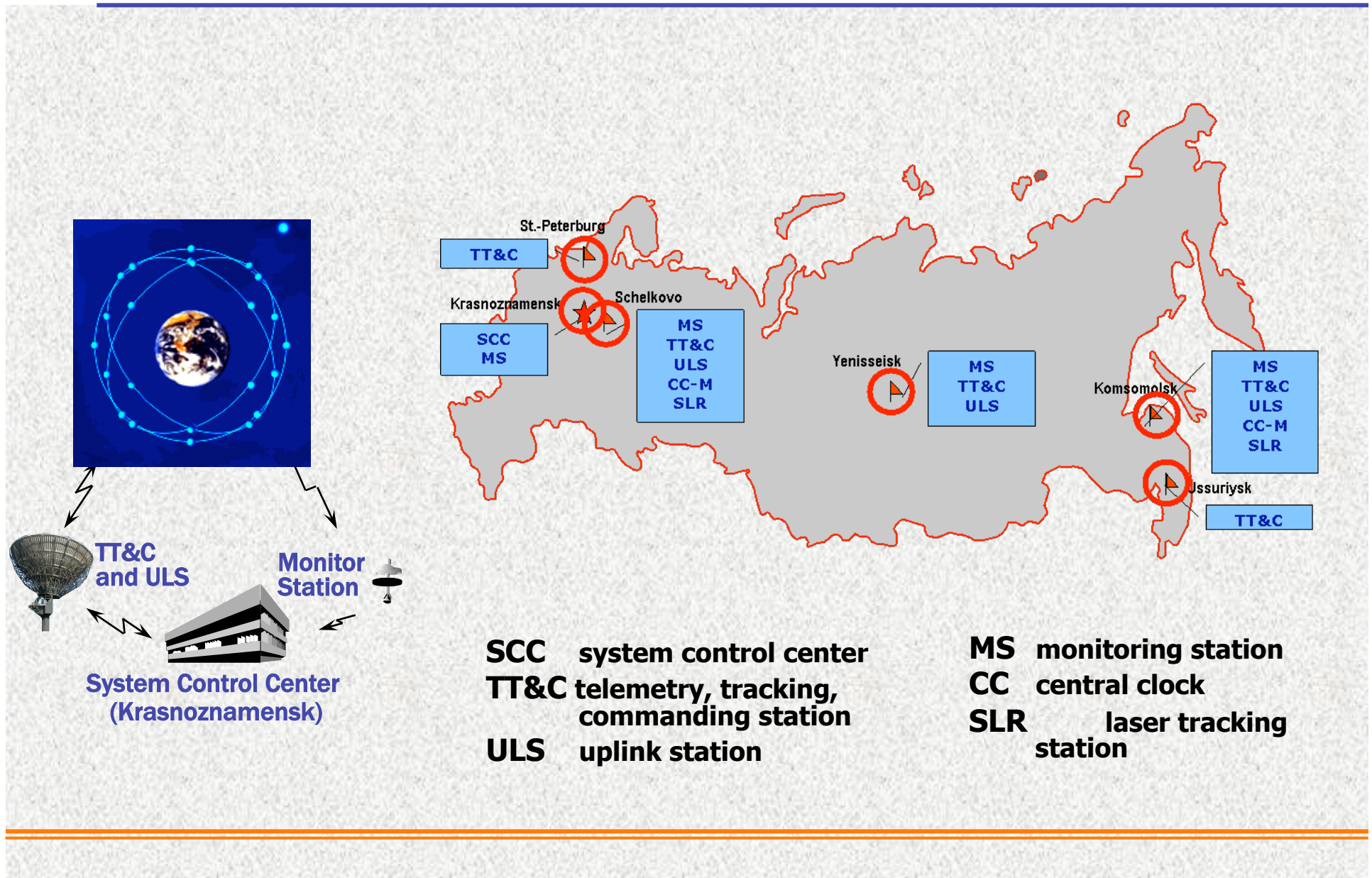


**Mean availability for a day**

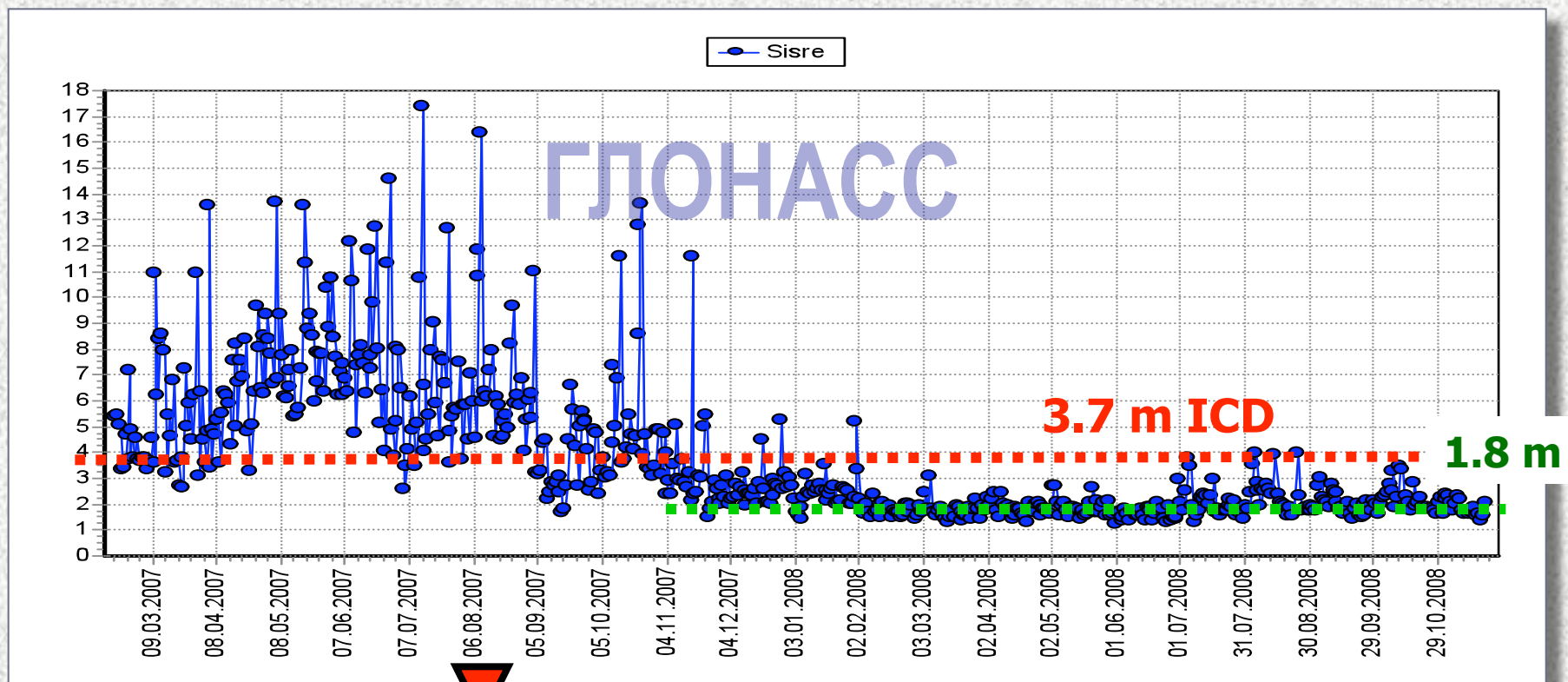


**Instant availability**





## SIS URE: result of the first phase of GCS modernization

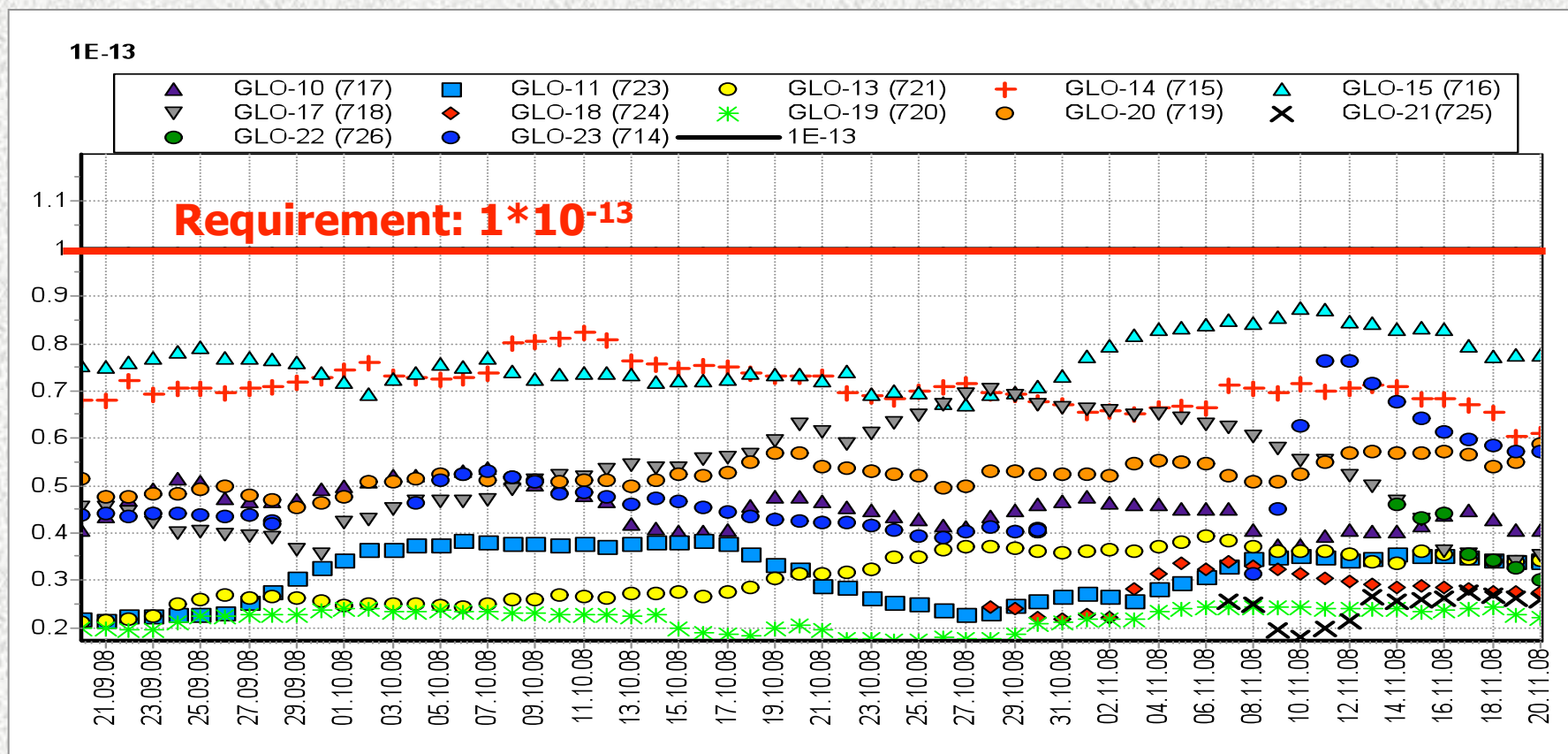


first phase of GCS modernization

# Clock Stability (21.09.2008 – 20.11.2008)

Allan Deviation @ 100 000 s

## ГЛОНАСС-М







# Content



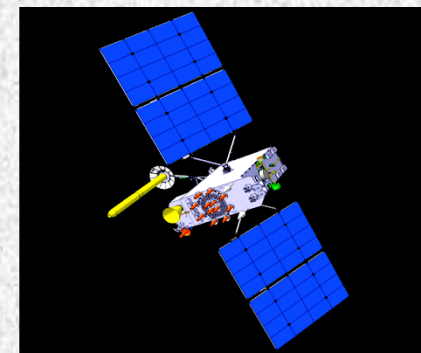
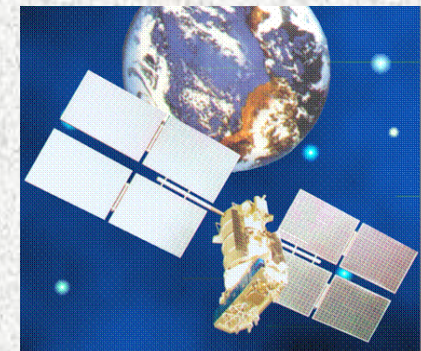
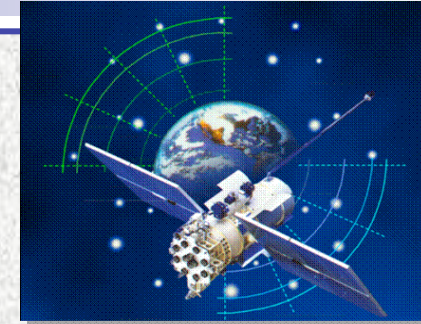
- **GLONASS Status and Performance**
- **GLONASS Modernization (including signals)**
- **SDCM**
- **GLONASS Management Structure**
- **Summary**



# GLONASS Development Program

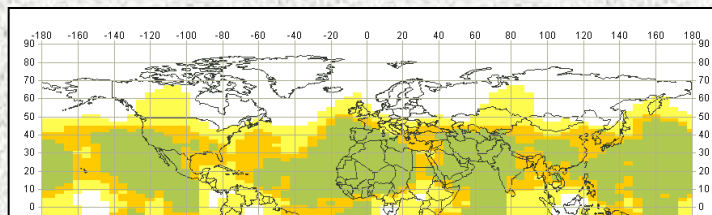


- **Continuous global navigation provision plan**
- **"Glonass-K" flight test (2010)**
- **GLONASS accuracy improvement plan**
- **Ground control segment modernization**
  - Ground control network extension**
  - System time and orbit improvement**
  - Monitoring network extension**
- **Signal modernization**
- **New signals in "Glonass-K" (including CDMA)**
- **Interoperability with GPS and future GALILEO**
  - Signals**
  - Geodesy reference**
  - Time reference**
- **Further modernization of GLONASS based on new satellite**

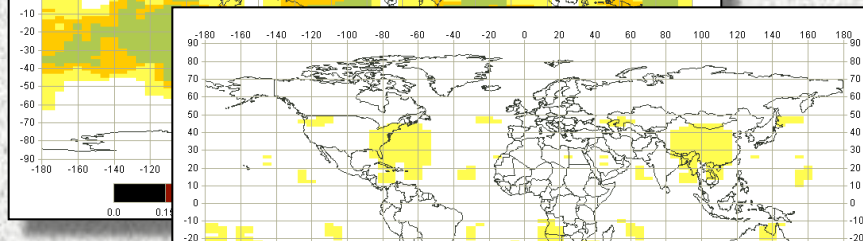




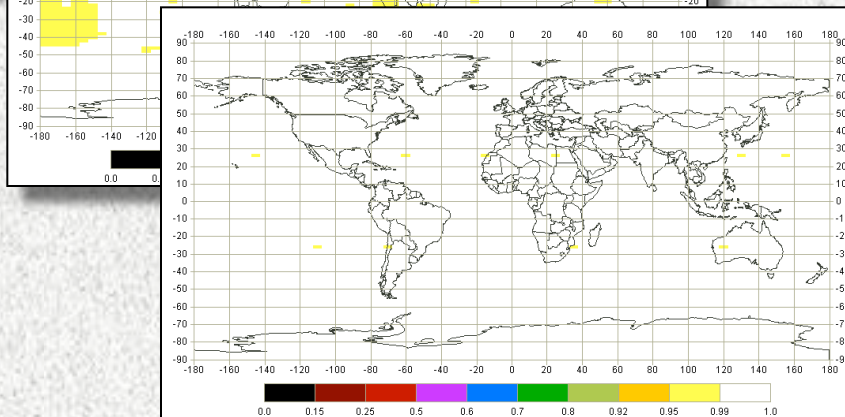
# GLONASS Deployment Program



**January 2009**  
**18 satellites.**  
**96% global availability**



**December, 2009**  
**22 satellites.**  
**99.7% global availability**



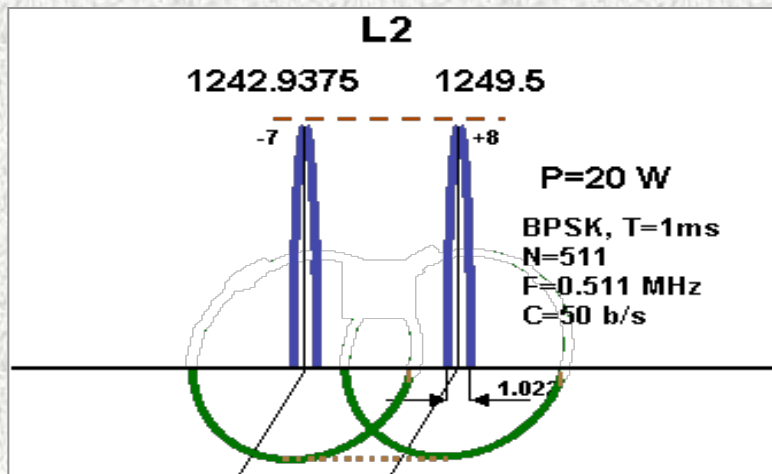
**December, 2010**  
**24 satellites.**  
**99.99% global availability**



# Existing GLONASS FDMA Signals

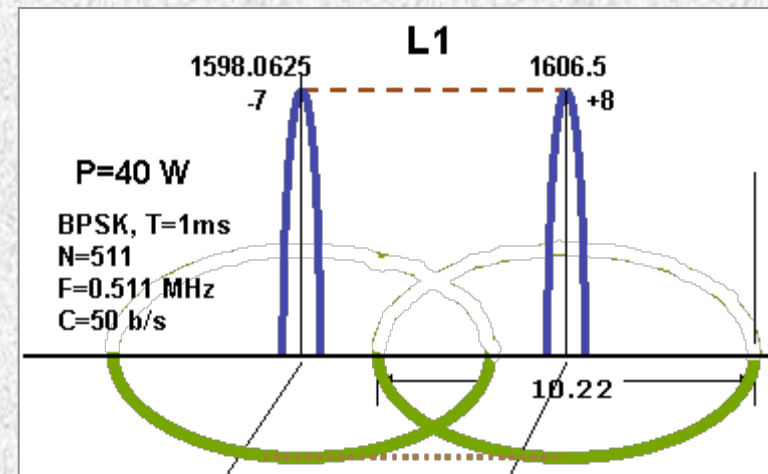
## ➤ L2

- L2 open FDMA
- L2 authorized FDMA



## ➤ L1

- L1 open FDMA
- L1 authorized FDMA



**GLONASS will continue transmitting existing FDMA signals for the future**



# New GLONASS CDMA Signals



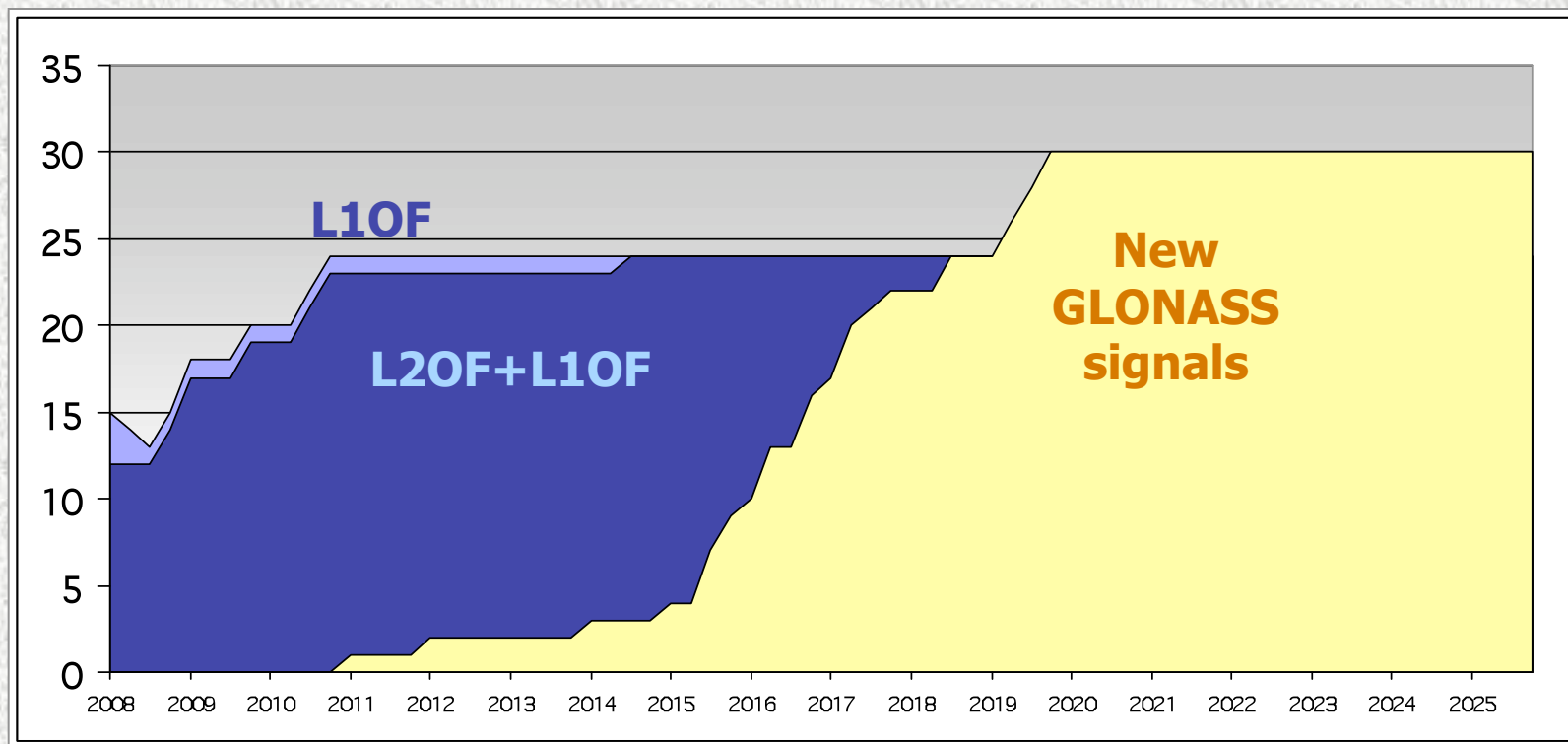
- **Decision made to transmit new CDMA signals at GLONASS bands**
- **Final decision pending for signal at L3 band: CDMA or FDMA**
- **Decision on L1C, L5 is the subject of US/Russia WG-1 negotiations**
- **Detail signal design is in progress**



# GLONASS Signals Forecast



## Satellites in constellation:



GLONASS-K Flight Tests → Constellation Update based on GLONASS-K





# Content



- **GLONASS Status and Performance**
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- **GLONASS Policy**
- **Summary**



# SDCM Objectives



- **GNSS Monitoring**
  - ❑ Integrity monitoring
  - ❑ A posteriori detail analysis of system performance
- **Differential corrections**
  - ❑ Real-time positioning with the meter-level accuracy for service area:
    - ✓ horizontal: 1-1.5 m
    - ✓ vertical: 2-3 m
  - ❑ Real-time precise positioning with cm-level accuracy at the 200 km area around base stations
    - ✓ horizontal: 1-2 cm
    - ✓ vertical: 4-6 cm
- **Service area – the Russian Federation**





➤ **Reference stations (2008):**

1. Moscow (Mendeleevo)
2. Pulkovo
3. Kislovodsk
4. Norilsk
5. Irkutsk
6. Petropavlovsk-Kamchatka
7. Khabarovsk
8. Novosibirsk
9. Gelnzhik

➤ **Reference stations (further development):**

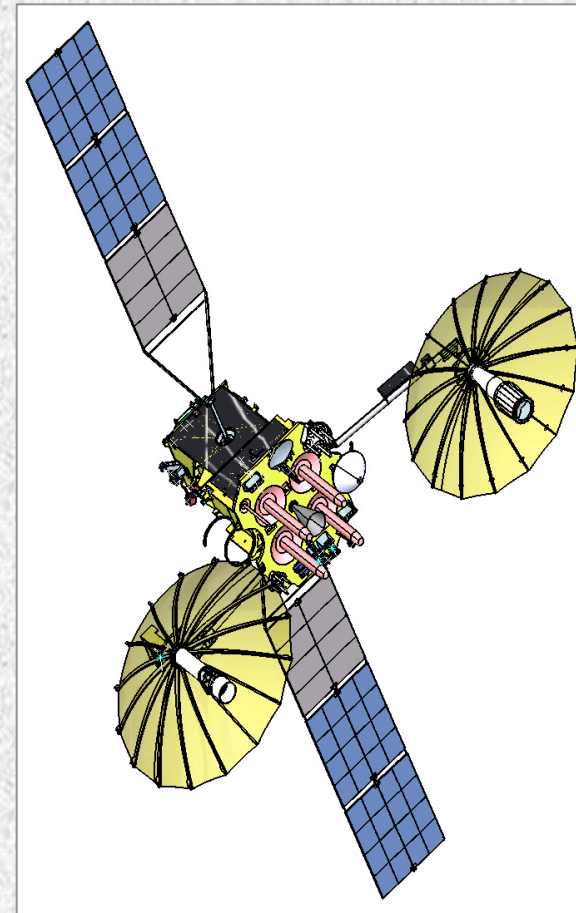
10. Tiksi
11. Bilibino
12. Magadan
13. Yuzhno-Sakhalinsk
14. Yakutsk
15. Vladivostok
16. Sverdlovsk
17. Lovozero
18. Voronezh
19. Pechery

First part of SDCM reference stations network was put into the test operation in 2007



## «Луч – 5А» with L1 transponder

- **Mass**
  - ❑ 1000 kg
- **Life-time**
  - ❑ 10 years
- **Antenna pattern:**
  - ❑ Narrow
  - ❑ Re-steering
  - ❑ Omni directional
- **Longitudes:**
  - ❑ Луч-5А: 16° west
  - ❑ Луч-5Б: 95 ° east





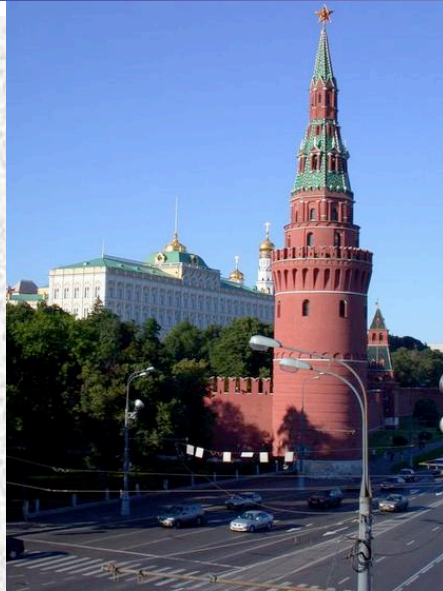
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# History of the GLONASS Policy



- **1976: Decree of the Soviet Union Communist Party Central Committee and Council of Ministers of the USSR №1043-361 from 16.12.1976 on the creation of GLOBal NAVigation Satellite System system**
- **1982: First launch of GLONASS SV**
- **1986: Decree of the CPSU Central Committee and CM of the USSR № 136-46 from 27.01.1986 on GLONASS modernization**
- **1993: Russian Federation (RF) Presidential Instruction №658 RPS from 24.09.1993 started the system operational with IOC**
- **1995: The RF Governmental Decree № 237 from 07.03.1995 to start GLONASS operation with FOC**
- **1998: RF Presidential Order to the Government of Russia on the GLONASS development plan**
- **2001: RF Governmental Decree № 587 from 20.08.2001 adopted the Federal Program “Global Navigation System”**
- **2007: Decree of the President of the Russian Federation on GLONASS development and use**





# 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**
- **Use of GLONASS is mandatory for state entities and major sectors of economy in Russia**
- **GLONASS is used in combination with other GNSS, terrestrial radio navigation, other navigation means to increase reliability of navigation**
- **International cooperation on GNSS compatibility and interoperability**



# Presidential Decree on GLONASS (May 18, 2007)



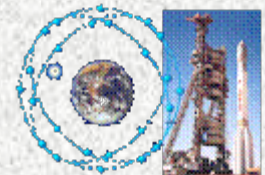
- **Main statements:**
  - ❑ Free access to the civil signals
  - ❑ GLONASS binding use for governmental and critical applications
- **Recommended:**
  - ❑ GLONASS use for regional authorities and commercial companies
- **General coordination of GLONASS sustainment, development and application**
  - ❑ **Federal Space Agency**
- **To the Government:**
  - ❑ GLONASS promotion, including international cooperation
  - ❑ Digital maps issue to be resolved asap
  - ❑ Preparation of the new GLONASS Program for 2012 – 2020.

- Provide full constellation of 24 satellites by 2010
- Improve GLONASS performance
- Implement new GLONASS signals
- Encourage the GLONASS worldwide use

## Subprograms

1

GLONASS sustainment, development and deployment



2

User equipment development for civil users



3

Satellite navigation technique implementation in transport areas



4

Geodesy reference improvement



5

User equipment development for authorized users

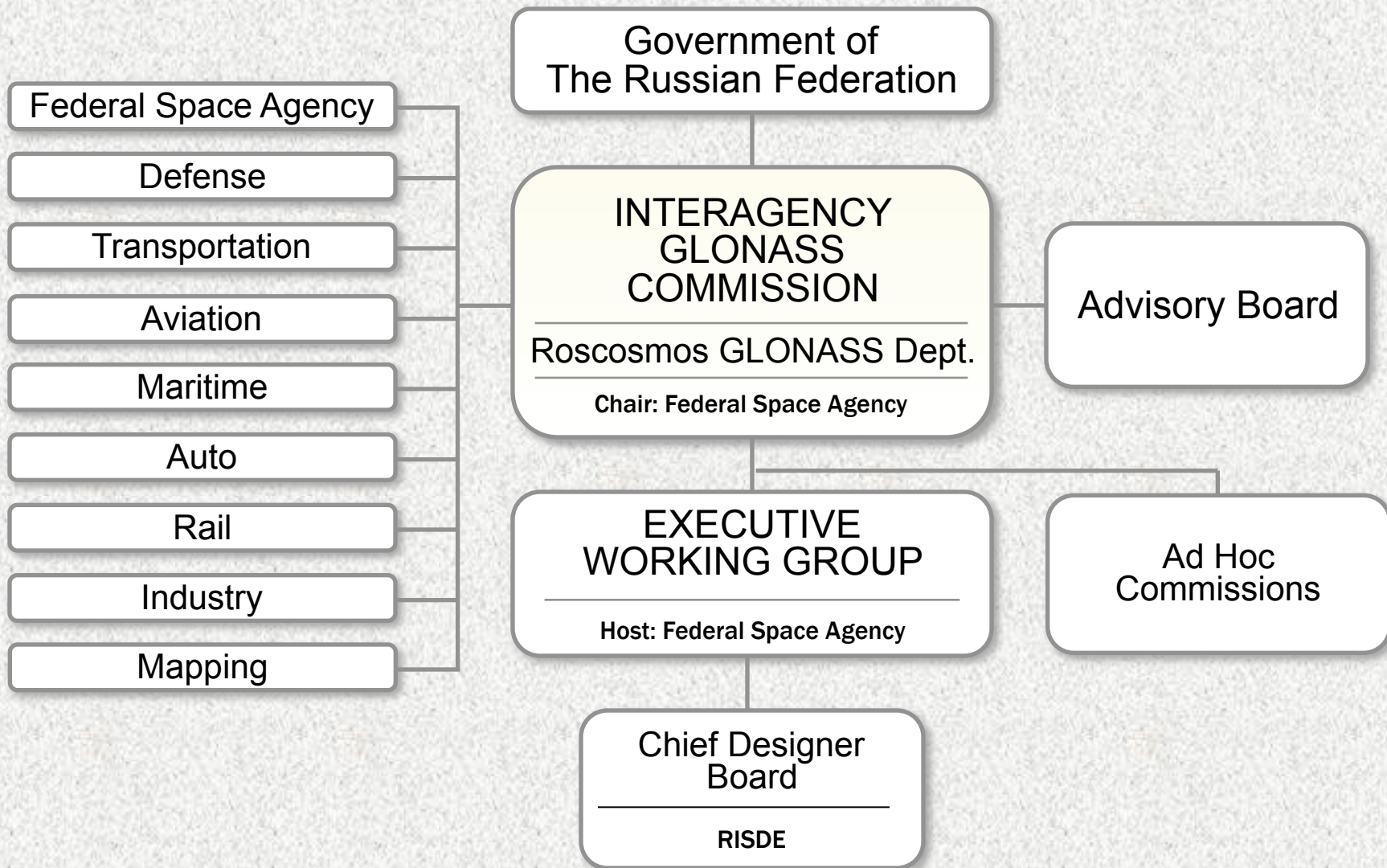


**Update of September 12, 2008**





# GLONASS Organization







# 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
  - ❑ UN GNSS Providers Forum
- **GLONASS Use Cooperation**
  - ❑ Former USSR countries
  - ❑ Middle East, Australia, Latin America...
  - ❑ UN ICG



# Future GNSS – Convergence of Interests



## Interests

- **Providers:**
  - ❑ Global use of their own systems
- **Users:**
  - ❑ Simultaneous use of all systems available

## Requirements

- **Positioning accuracy improvement**
- **Navigation service availability improvement in the canyons with restricted visibility**
- **Integrity service**



## Solution



***GNSS Compatibility and Interoperability***



# GNSS Compatibility

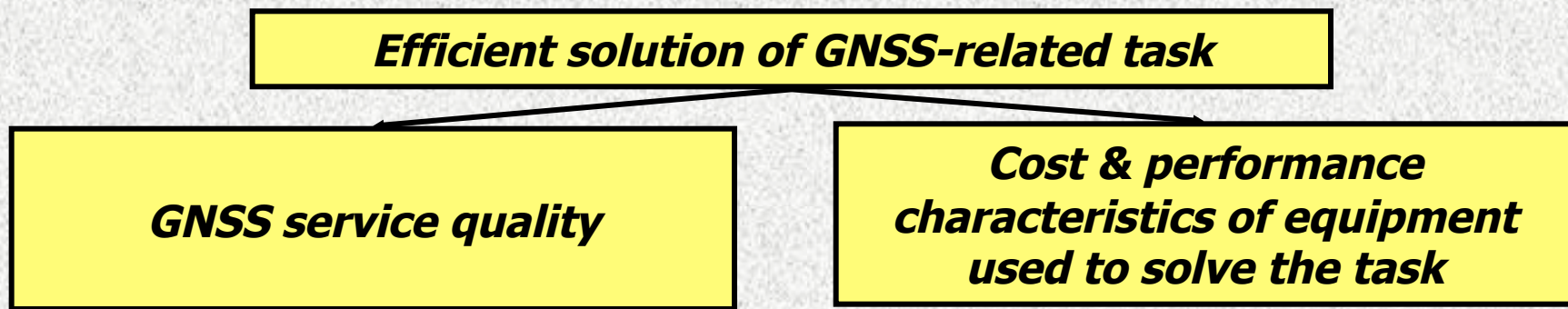


- **The basic principle of system compatibility is**  
**«Do Not Harm!»**
- ***Compatibility* referred to the ability of space-based positioning, navigation and timing services to be used separately or together without interfering with each individual service or signal**
  - ❑ **Quality of the navigation service for users must not be worsen**

*Radiofrequency compatibility by appropriate coordinated evaluation procedures is a major issue for the compatibility*

*ITU procedure is a basis for radiofrequency compatibility*

- The basic principle of interoperability is  
    **«Better Together Than Separate»**
- ***Interoperability*** referred to the ability of open global and regional satellite navigation and timing services to be used together to provide better capabilities at the user level than would be achieved by relying solely on one service or signal





## ➤ Parameters of service quality:

- positioning accuracy
- availability, particularly in cities and mountainous areas
- reliability of service, robustness in conditions of interference

## ➤ Technical solutions:

- Ephemeris and clock corrections accuracy on the comparable level
- Signals (one band or more, one central carrier or more...)
- Geodesy and time reference (one reference or two coordinated...)
- More satellites in one constellation or combination of constellations

***Different user groups may have different priorities***



# Compatibility and Interoperability Principles



- **Basis is the definitions in Bangalor's documents**
- **Revision, refinement, improvement of the principles – one of the major objectives of the WG-A ICG and Providers Forum**
  - ❑ **Example: both *Common centre frequencies* and *Signal diversity* are important for different user groups**
- ***Quantitative* approach for interoperability analysis**
- ***Spectral separation* must be refined taking into account existing and future "*collisions*"**



# GLONASS Status User Interface



- **GLONASS Constellation Status**
- **GLONASS Performance**
- **GLONASS ICD**
- **Federal Official Documents**
- **GLONASS News**

GLONASS constellation status, 08.11.2008r.

Total satellites in constellation		17 SC
Operational		16 SC
In commissioning phase		1 SC
In maintenance		-
In decommissioning phase		-

GLONASS Constellation Status at 08.11.2008 based on both the almanac analysis and navigation messages received at 11:00 08.11.08 (UTC) in IAC PNT TsNIlmash

Orb. pl.	Orb. slot	RF chnl	# GC	Launched	Operation begins	Operation ends	Life-time (months)	Satellite health status		Comments
								In almanac	In ephemeris (UTC)	
I	4	06	795	10.12.03	29.01.04		59.0	+	+ 08:41 08.11.08	In operation
	6	01	701	10.12.03	08.12.04		59.0	+	+ 11:11 08.11.08	In operation
	7	05	712	26.12.04	07.10.05		46.5	+	+ 11:11 08.11.08	In operation
II	9	-2	722	25.12.07	25.01.08		10.5	+	+ 05:56 08.11.08	In operation (L1 only)
	10	04	717	25.12.06	03.04.07		22.5	+	+ 07:55 08.11.08	In operation
	11	00	723	25.12.07	22.01.08		10.5	+	+ 10:00 08.11.08	In operation
III	13	-2	721	25.12.07	08.02.08		10.5	+	+ 11:11 08.11.08	In operation
	14	04	715	25.12.06	03.04.07		22.5	+	+ 11:11 08.11.08	In operation
	15	00	716	25.12.06	12.10.07		22.5	+	+ 11:30 08.11.08	In operation
III	17	-1	718	26.10.07	04.12.07		12.5	+	+ 04:02 08.11.08	In operation
	18	-3	724	25.09.08	26.10.08		1.4	+	+ 05:23 08.11.08	In operation
	19	03	720	26.10.07	25.11.07		12.5	+	+ 06:56 08.11.08	In operation
	20	02	719	26.10.07	27.11.07		12.5	+	+ 08:41 08.11.08	In operation
	21	-1	725	25.09.08	05.11.08		1.4	+	+ 10:35 08.11.08	In operation

[www.glonass-ianc.rsa.ru](http://www.glonass-ianc.rsa.ru)



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# Summary



- **GLONASS Program is the high priority of the Russian Government policy**
- **GLONASS Program is in progress, will be extended to 2020**
- **GLONASS improvement is a major objective:**
  - ❑ **Performance to be comparable with GPS and Galileo by the end of 2011**
  - ❑ **Full constellation (24 sats) by the end of 2010**
  - ❑ **New signals implementation to improve the service for both military and civil users**
- **Compatibility and interoperability are the goals of international cooperation, as well as the GLONASS worldwide use, and integration it into W(orld)GNSS**



# FEDERAL SPACE AGENCY



**Thank you!**

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