РОСКОСМОС

FEDERAL SPACE AGENCY

GLObal Navigation Satellite System (GLONASS)

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Content

- **GLONASS Status and Performance**
- **GLONASS Modernization**
  - **New GLONASS Technical Requirement**
  - **GLONASS Space Complex**
  - **Wide Area Augmentation (SDCM)**
- **GLONASS Policy**
- **Summary**

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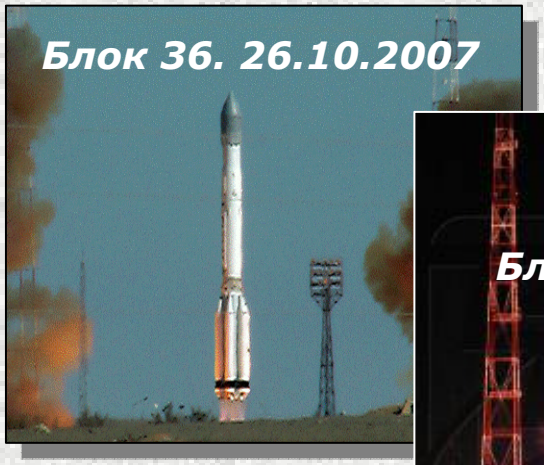
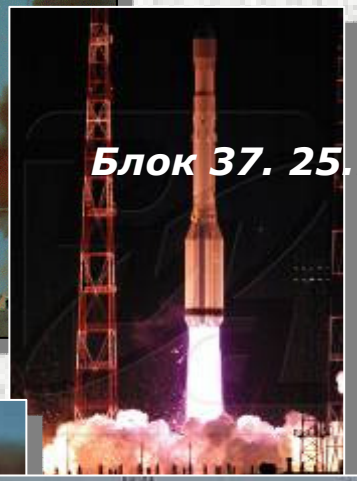
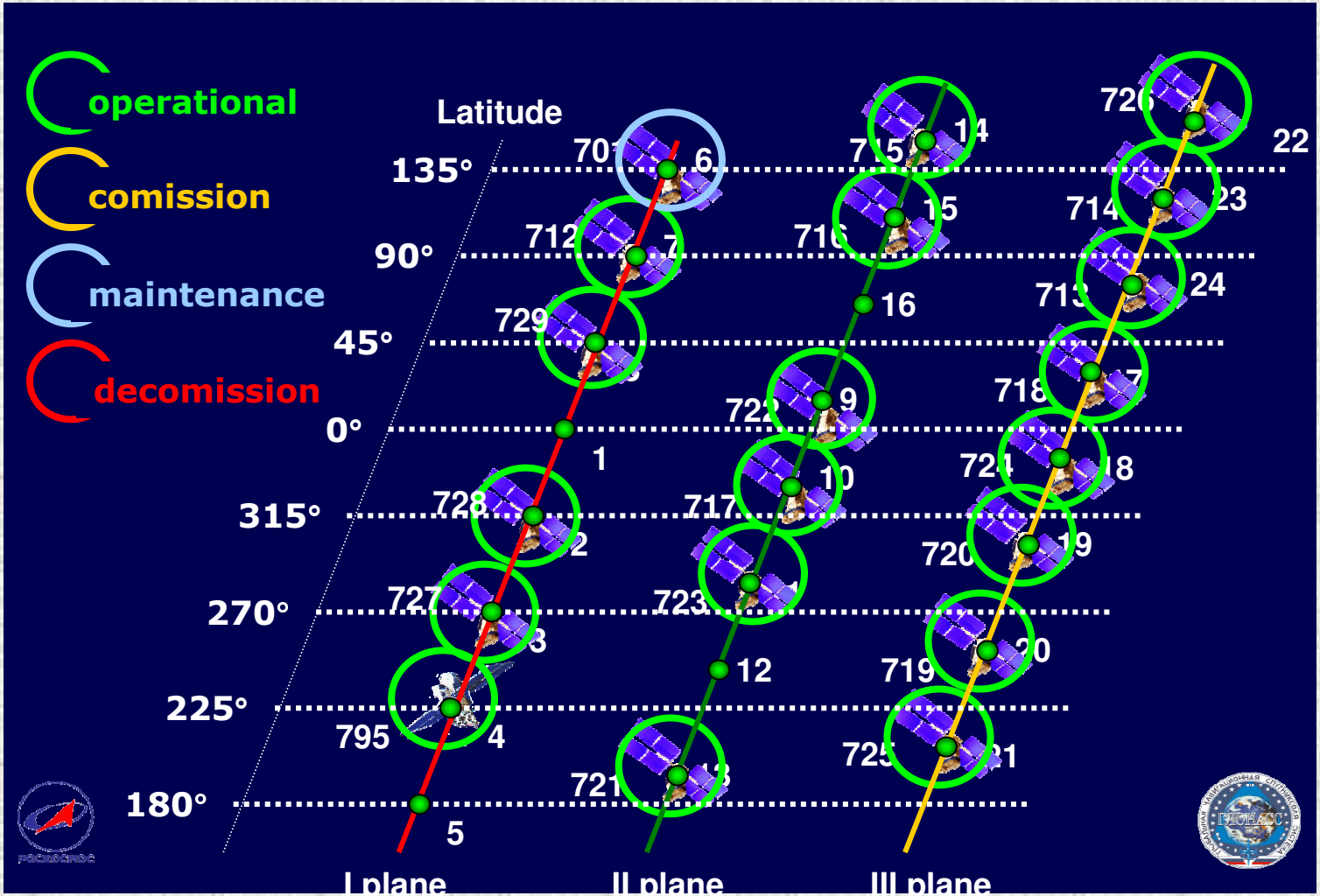
GLONASS Improvement Events

- In 2007-2008 12 GLONASS-M satellites launched
- 1st phase of Ground Control modernization
- Refined geodesy reference implemented (PZ-90.02)
- 20 Satellites on Orbit
  - 1 "Glonass" Satellite
  - 19 "Glonass-M" Satellites
- 18 GLONASS-M satellites are transmitting two civil signals in L1 и L2
- Next launches:
  - September 2009 – 3 "Glonass-M" sats
  - December 2009 – 3 "Glonass-M" sats



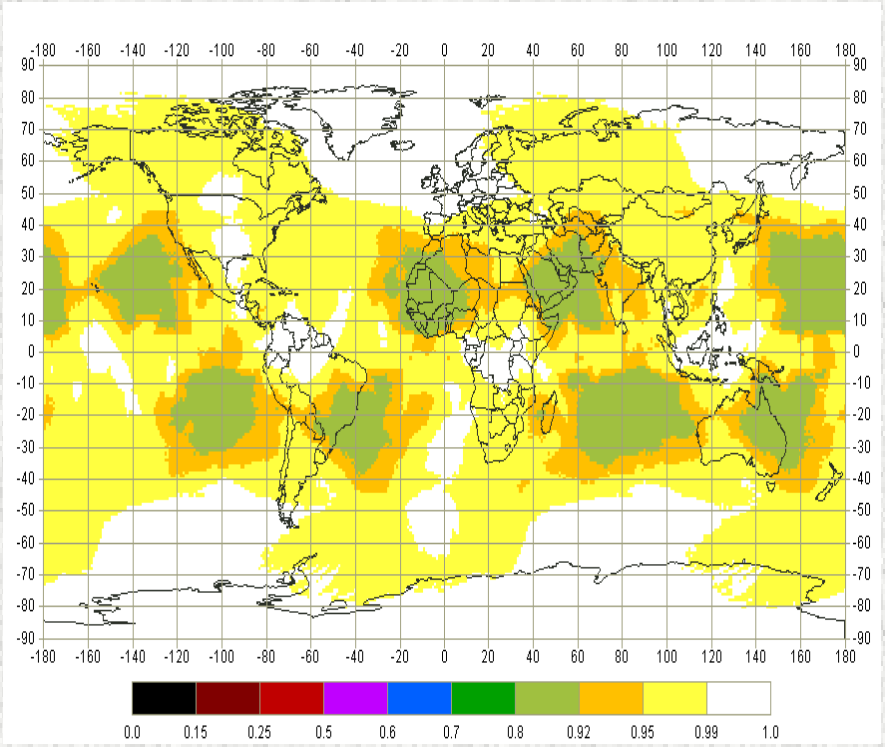


GLONASS Constellation Status (08.02.2009)

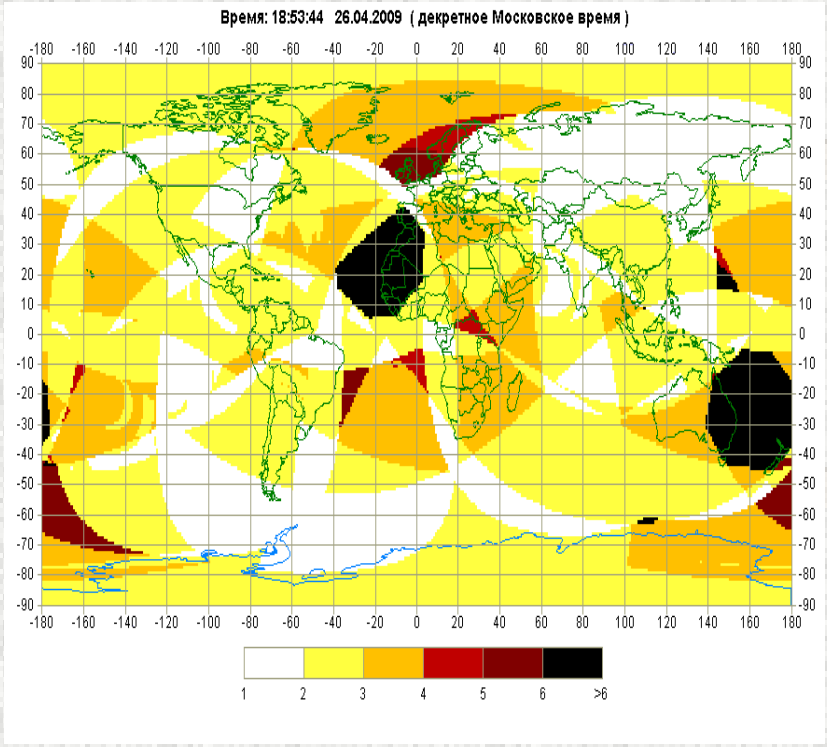


GLONASS Availability (08.02.2009)

Global availability is 90-97% (PDOP<6, γ>5°)

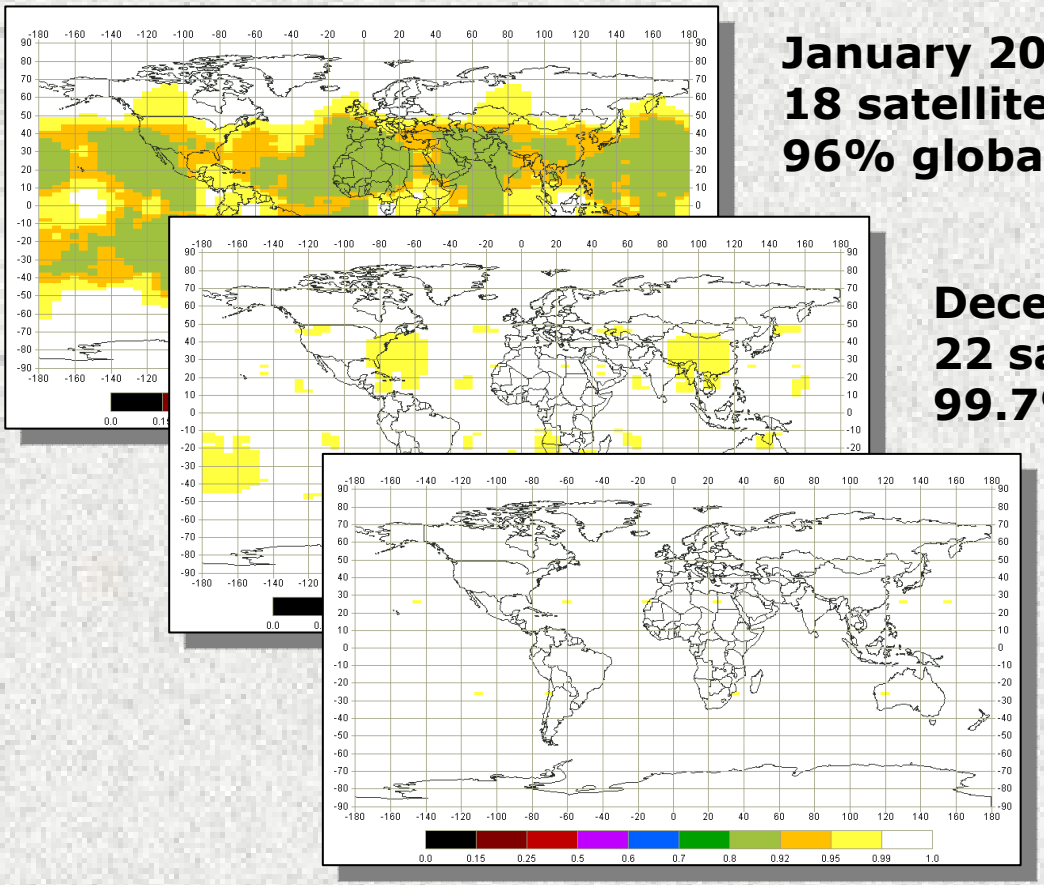


Mean availability for a day



Instant availability

GLONASS Deployment Program



January 2009
18 satellites.
96% global availability

December, 2009
22 satellites.
99.7% global availability

December, 2010
24 satellites.
99.9% global availability

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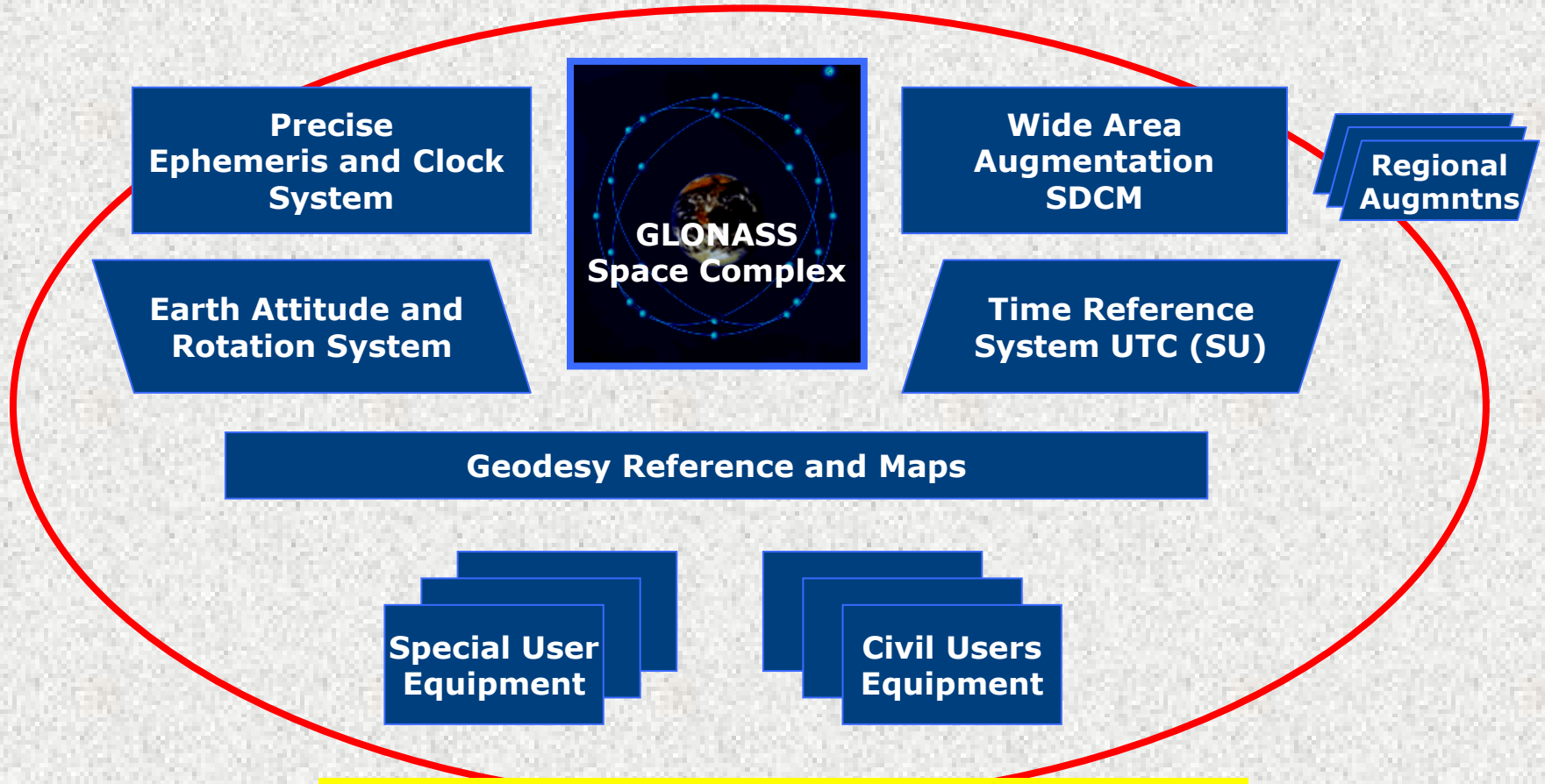
Extended PNT Architecture of Russia

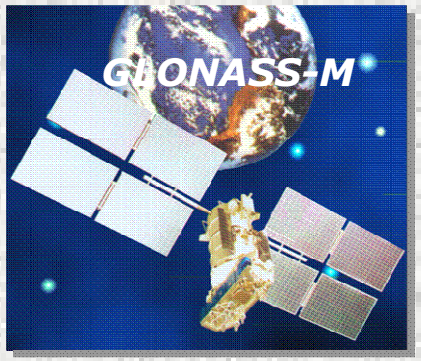
New GLONASS Technical Requirements

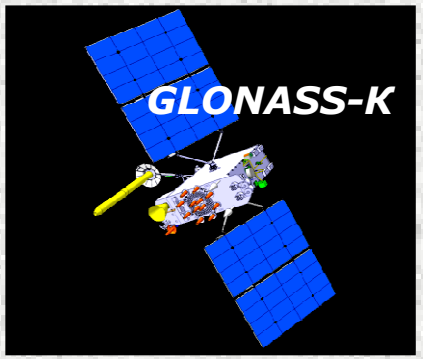


Synergy of performance and requirements

GLONASS Development Program

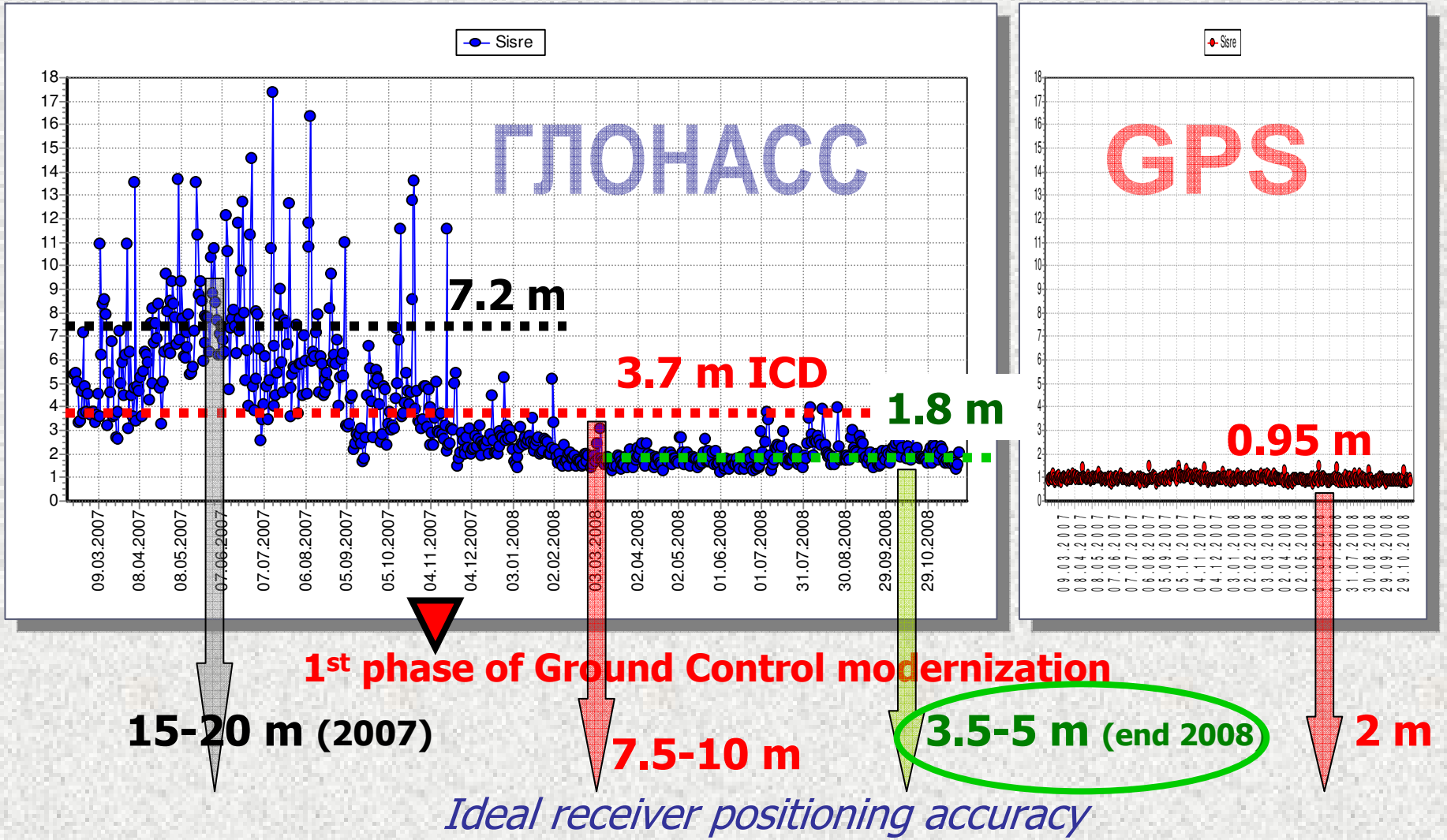
- "Glonass-K" flight test (2010)
- Continuous global navigation provision plan
  - Modernization of the orbital constellation
- GLONASS accuracy improvement plan
- Ground control segment modernization
  - Ground control network extension
  - System time and orbit improvement
  - Monitoring network extension
- 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 Accuracy Improvement

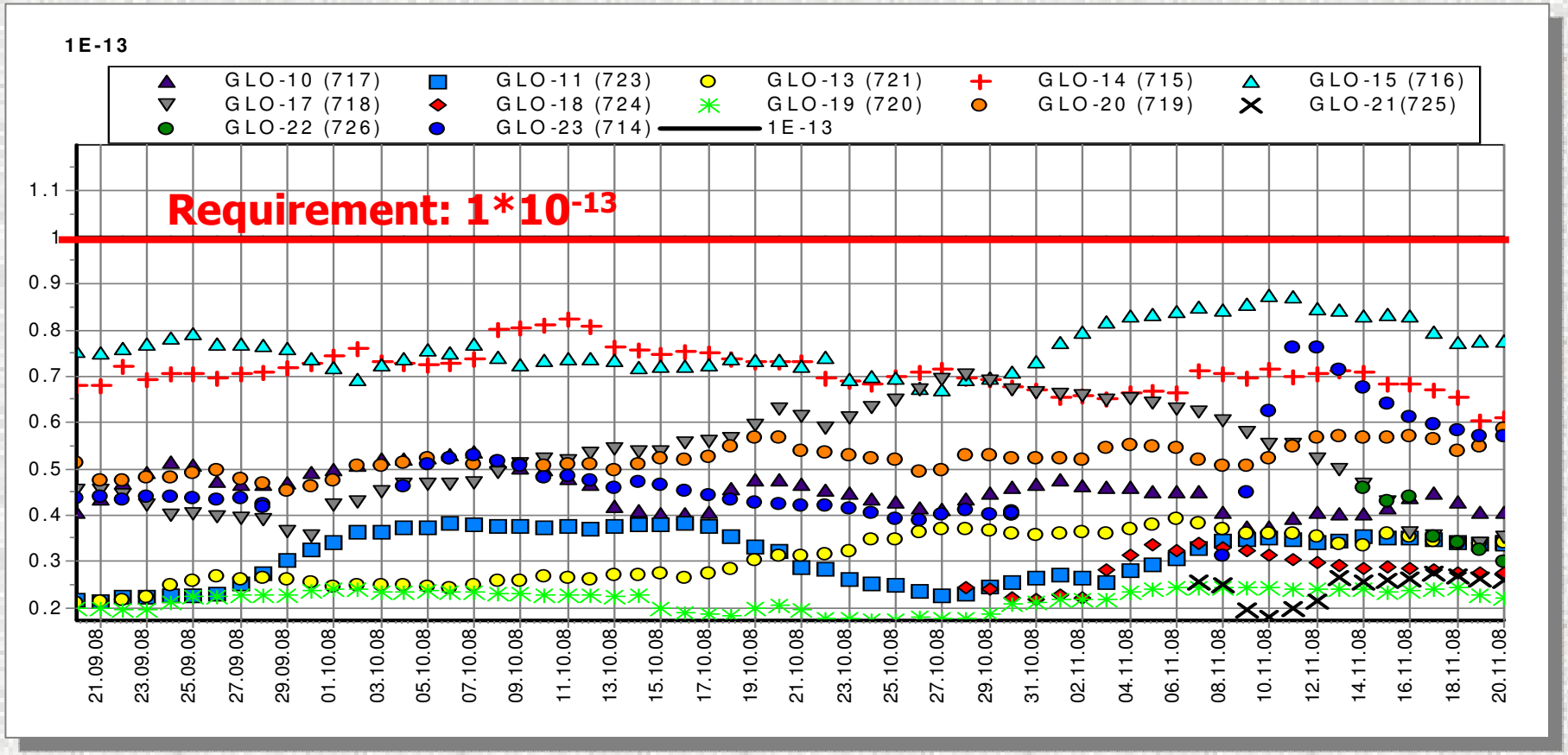
SISRE (1 sigma)



Clock Stability (21.09.2008 – 20.11.2008)

Allan Deviation @ 100 000 s

GLONASS-M

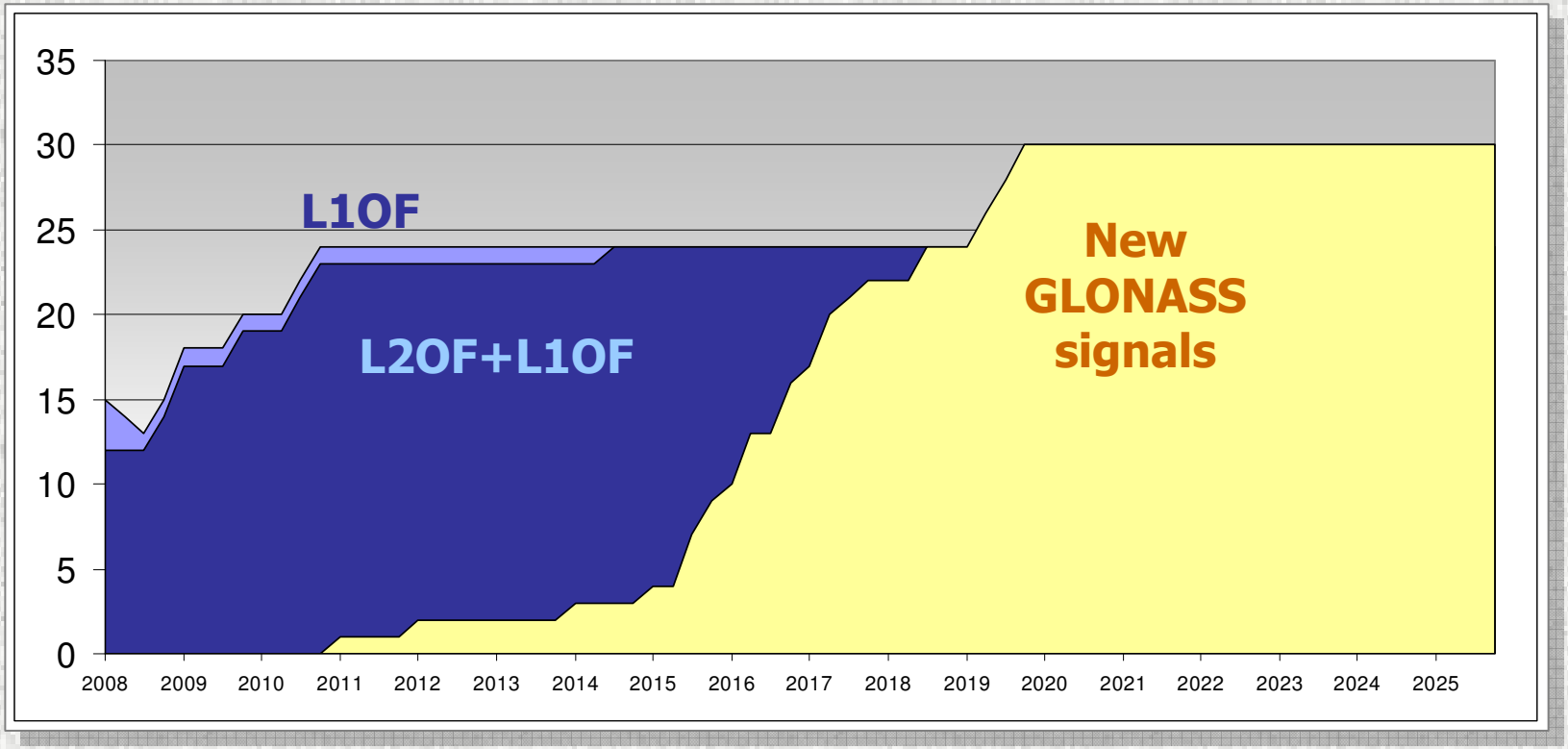


New GLONASS CDMA Signals

- **Decision made to transmit new CDMA signals at GLONASS bands**
  - **L3 CDMA since GLONASS-K # 1 in 2010**
- **Decision on L1C, L5 is the subject of Russia/US/EU WG-1 negotiations**
- **Detail signal design is in progress**

GLONASS Signals Forecast

Satellites in constellation:



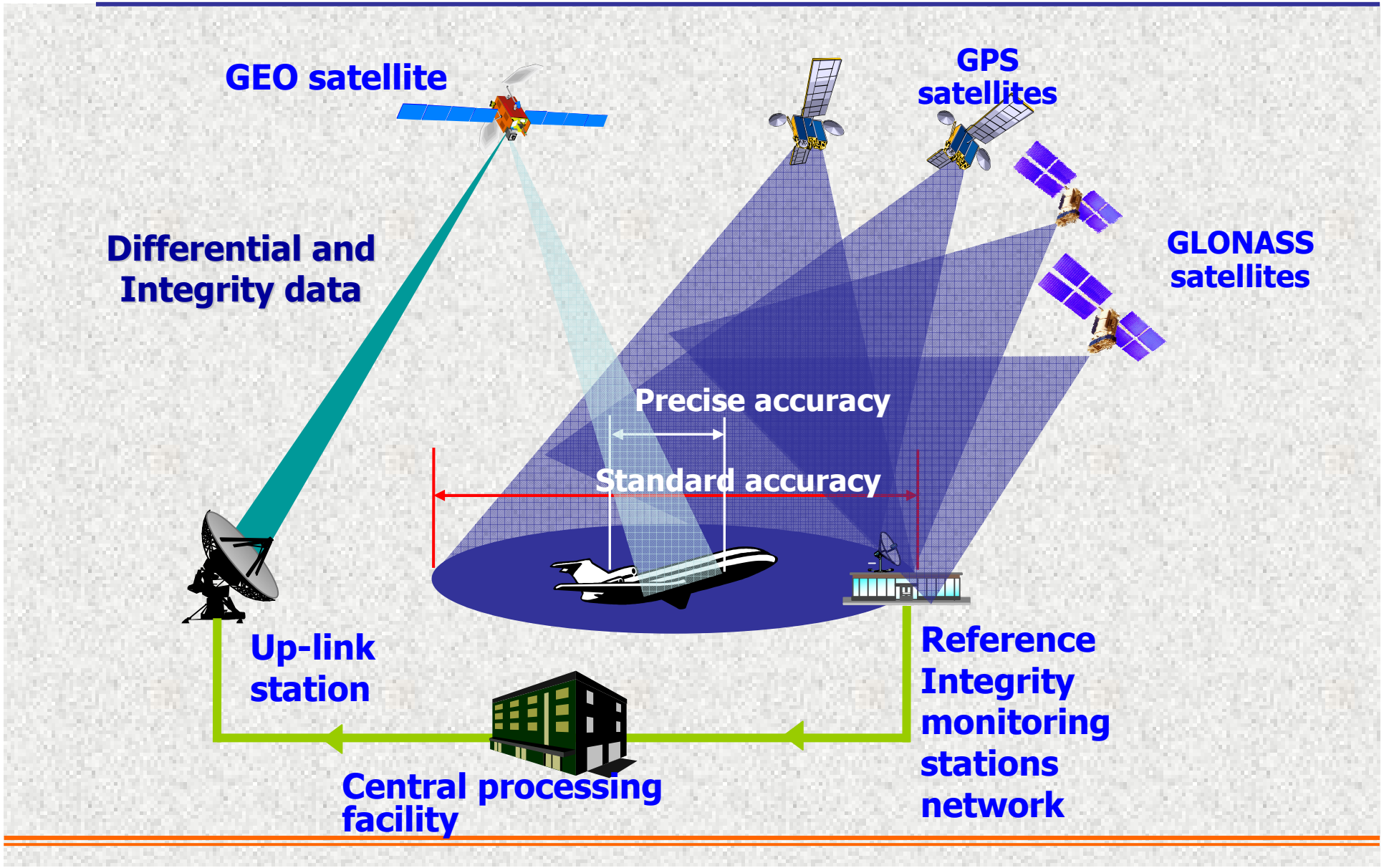
Constellation Update based on GLONASS-K

GLONASS-K Flight Tests

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**

SDCM General Architecture



SDCM Reference Stations

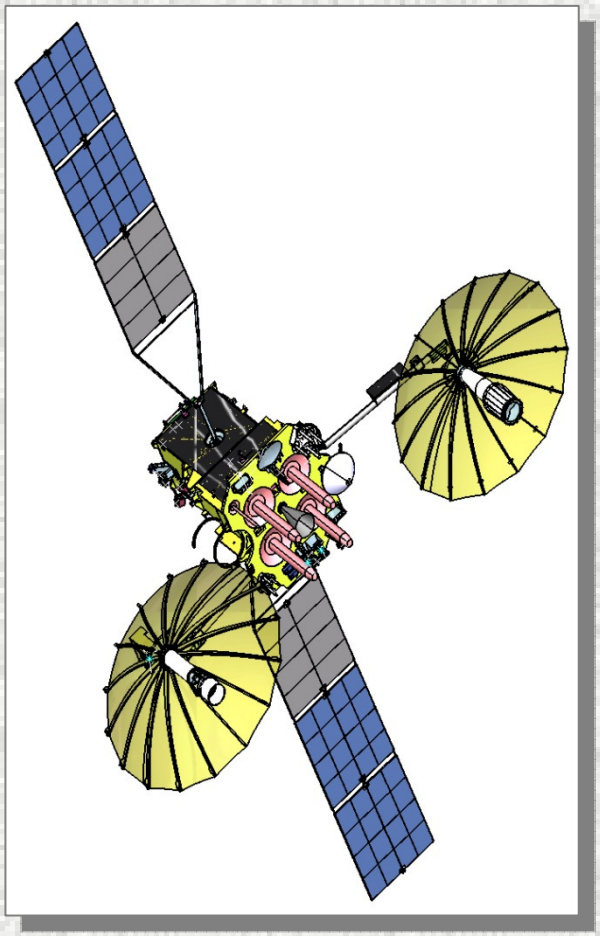
- **Reference stations (2008):**
  1. Moscow (Mendeleevo)
  2. Pulkovo
  3. Kislovodsk
  4. Norilsk
  5. Irkutsk
  6. Petropavlovsk-Kamchatka
  7. Khabarovsk
  8. Novosibirsk
  9. Gelenzhik
- **Reference stations (further development):**
  10. Tiksi
  11. Bilibino
  12. Magadan
  13. Yuzhno-Sakhalinsk
  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

SDCM Space Segment

- **Mass**
  - 1000 kg
- **Life-time**
  - 10 years
- **Antenna pattern:**
  - Narrow
  - Re-steering
  - Omni directional
- **Longitudes:**
  - Luch-5A: 16° west
  - Luch-5B: 95 ° east

«Luch – 5A» with L1 transponder



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State Policy Basic Principles

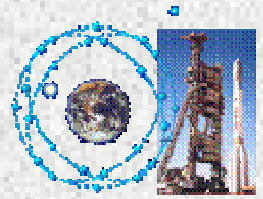
- **GLONASS is a part of the critical state PNT infrastructure providing national security and economy development**
- **Creating, developing and sustaining the PNT infrastructure is a State responsibility**
- **No direct user fees for civil GLONASS services**
- **Open, free access to GLONASS information necessary to develop and build user equipment**
- **GLONASS 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**

Federal GLONASS Program 2002-2011

- 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

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

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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 World GNSS**

FEDERAL SPACE AGENCY

Thank you!

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