



GLONASS Status and Progress

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47-th CGSIC Meeting
Fort Worth, Texas ★ September 24-25, 2007

- **GLONASS State Policy**
- **GLONASS Architecture**
- **GLONASS Modernization Program**
- **International cooperation**
- **User Interface**
- **Summary**



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GLONASS State Policy



Basic principles of the GLONASS State Policy



- ❑ PNT is the critical state infrastructure ensuring national security and development of economy
- ❑ GLONASS is a dual use system and the central part of national PNT
- ❑ Access to civilian GLONASS service is free of direct user charge
- ❑ Documentation on the open GLONASS service is available for user community, developers and manufacturers of the navigation equipment
- ❑ Support development and production of the combined receivers GLONASS/GPS
- ❑ Providing compatibility and interoperability with others GNSS and augmentations (GPS, GALILEO...)
- ❑ Encouraging the navigation mass market development
- ❑ Binding use of GLONASS or GLONASS/GPS combine receivers to the state users and critical applications





New Presidential Decree on GLONASS (May 18, 2007)



□ Main statements:

- ↖ Free access to the civil signals
- ↖ GLONASS binding use for governmental and strategic applications

□ Recommended:

- ↖ GLONASS use for regional authorities and commercial companies

□ General coordination of GLONASS sustainment, development and application

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□ To the Government:

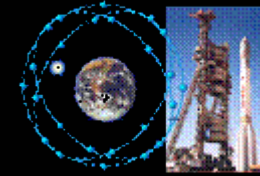
- ↖ GLONASS promotion, including international cooperation
- ↖ Digital maps issue to be resolved asap
- ↖ Preparation of the new GLONASS Program for 2012 – 2020.



Subprograms

1

GLONASS sustainment, development and deployment



2

User equipment development for civil users



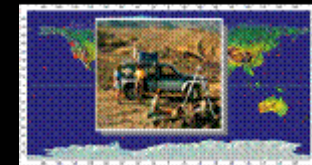
3

Satellite navigation technique implementation in transport areas



4

Geodesy reference improvement



5

User equipment development for military users

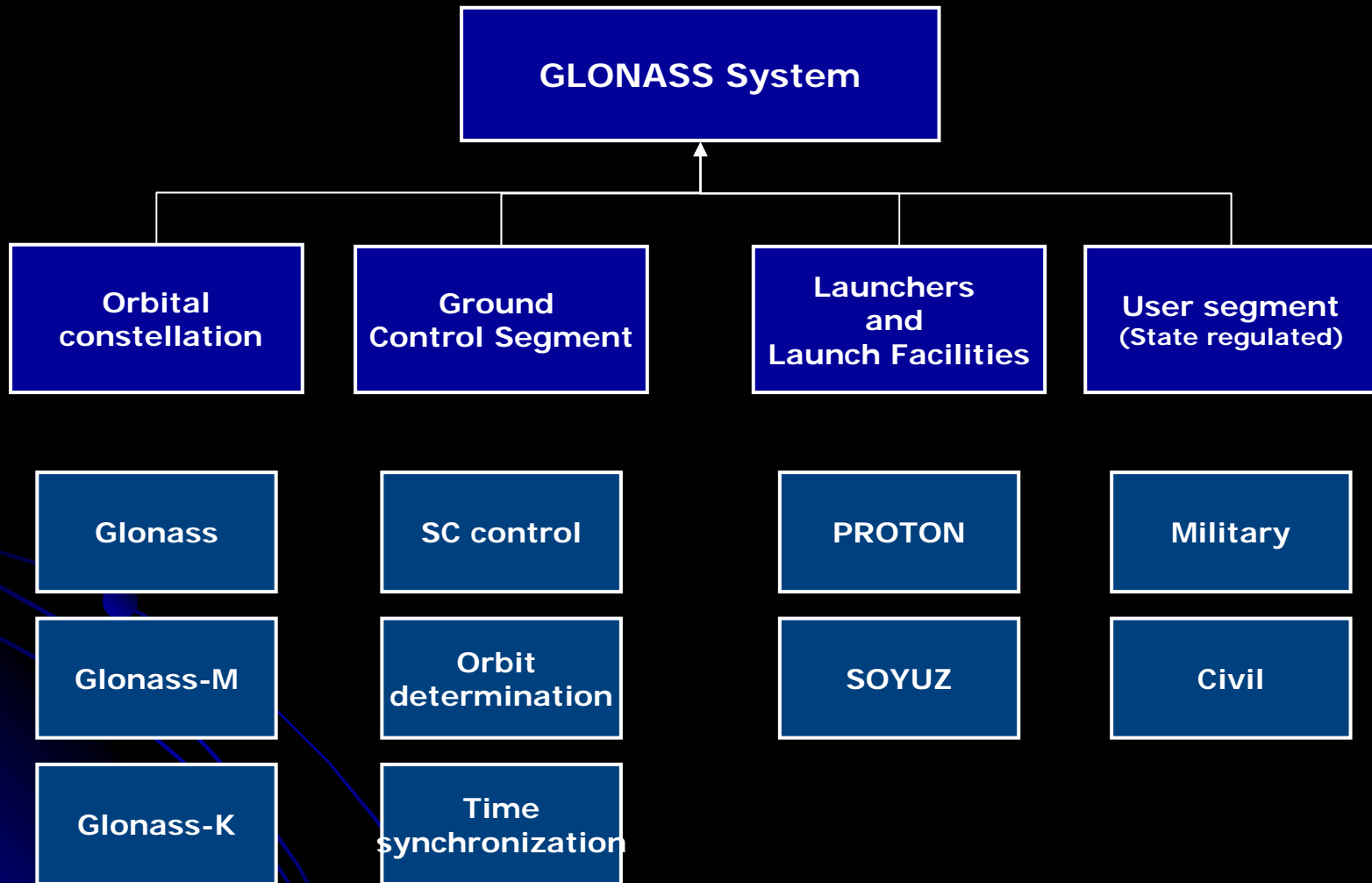




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GLONASS Architecture



□ Orbit constellation:

- ↗ 24 satellites, 3 planes by 8 satellites
- ↗ Orbit shift by 120° along the equator

□ Orbit parameters

- ↗ orbit – circular
- ↗ height 19100 km
- ↗ inclination 64.8°
- ↗ revolution 11h15min



Constellation Status (21.09.2007)

□ In operation 11 satellites

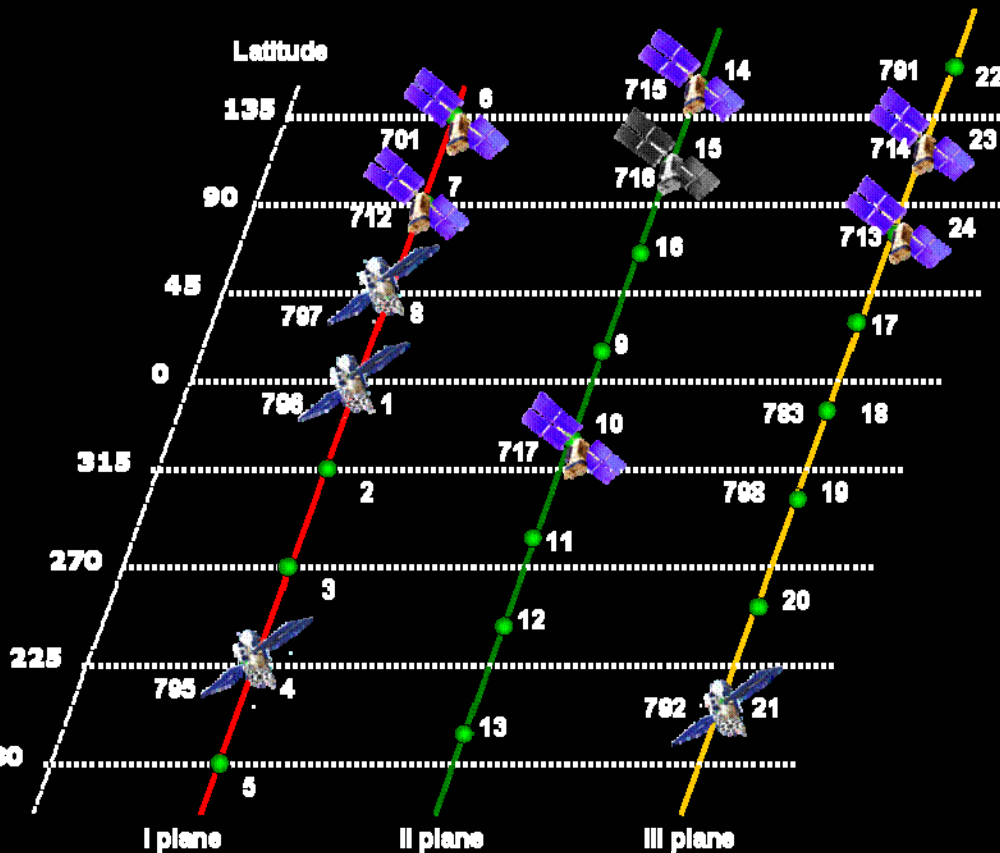
- ↪ 7 new GLONASS-M
- ↪ 4 old GLONASS

□ Healthy 9 sats

- ↪ In commissioning 1 sat
- ↪ In maintenance 1 sat

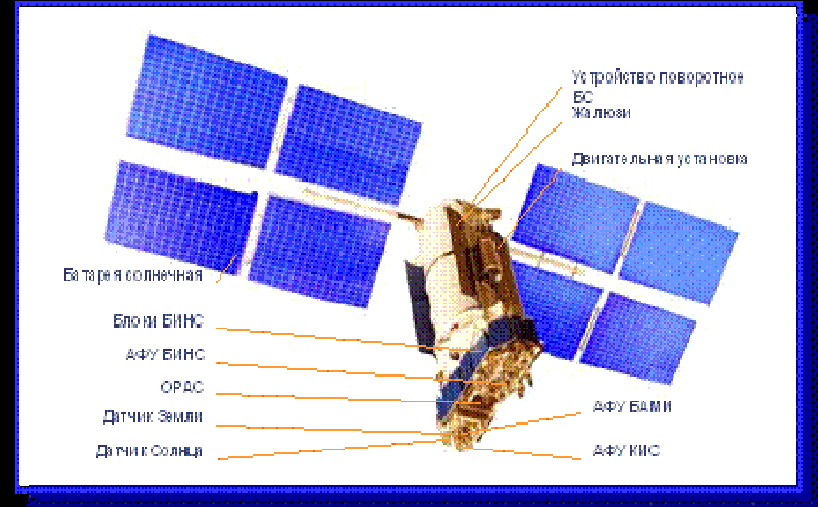
□ Launches in 2007:

- ↪ Block 36 (3 Glonass-M)
- ↪ Block 37 (3 Glonass-M)



□ Main Specifications

Guaranteed life time	7 years
Spacecraft mass	1415 kg
Power supply	1450 W
Navigation payload	
Mass	250 kg
Power consumption	580 W
Clock stability	$1 * 10^{-13}$
Attitude control accuracy	0.5 deg
Solar panel pointing accuracy	2 deg

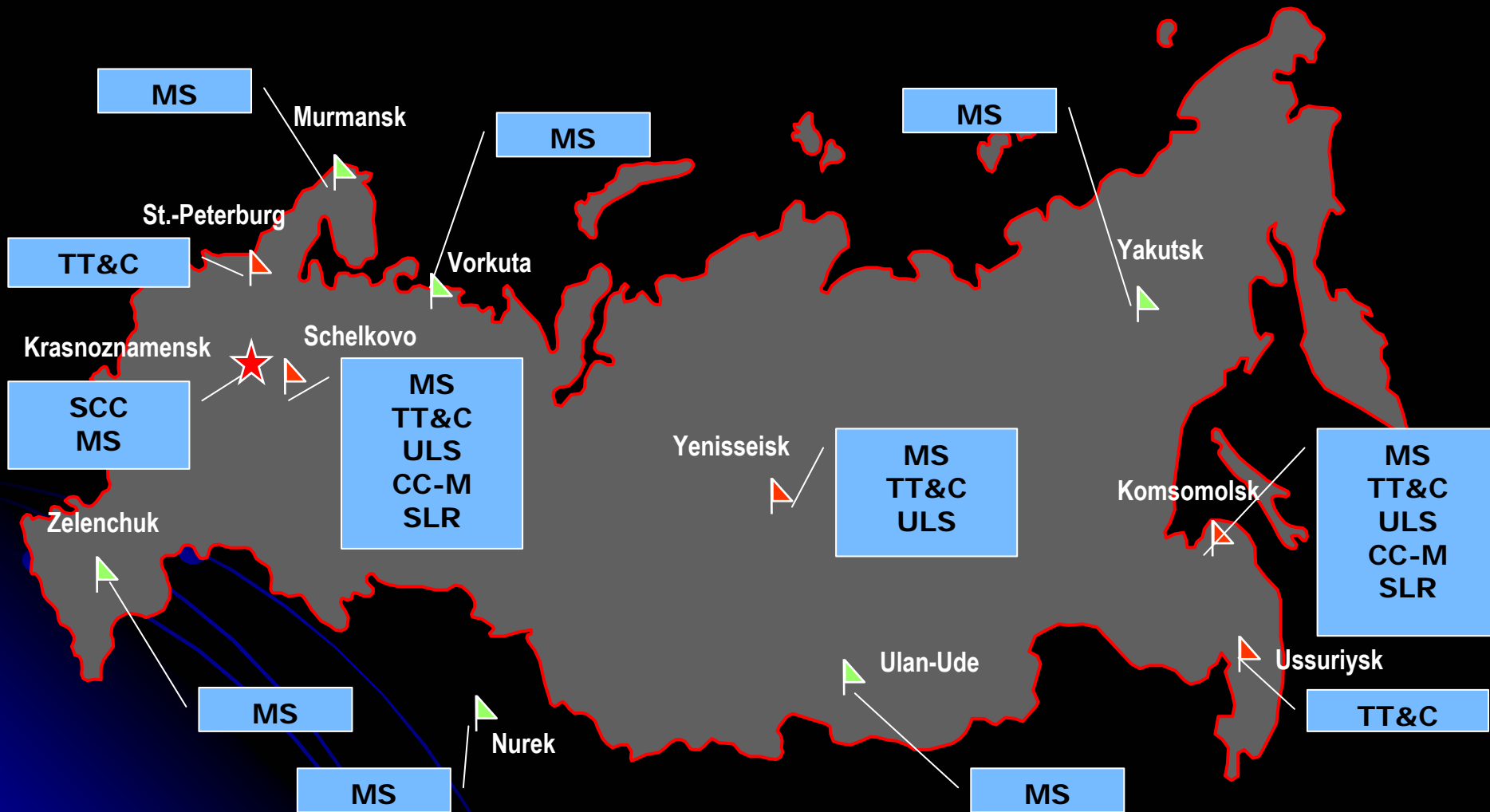


□ Main features

- ↙ Extended life time
- ↙ Second civil signal L2
- ↙ Increased clock stability
- ↙ Better accuracy of the solar panel pointing
- ↙ Improved dynamic model



Ground Control Segment



Launchers



PROTON-K launcher with «DM» booster



Baykonur



SOYUZ-2 launchers with FREGAT booster

Plesetsk





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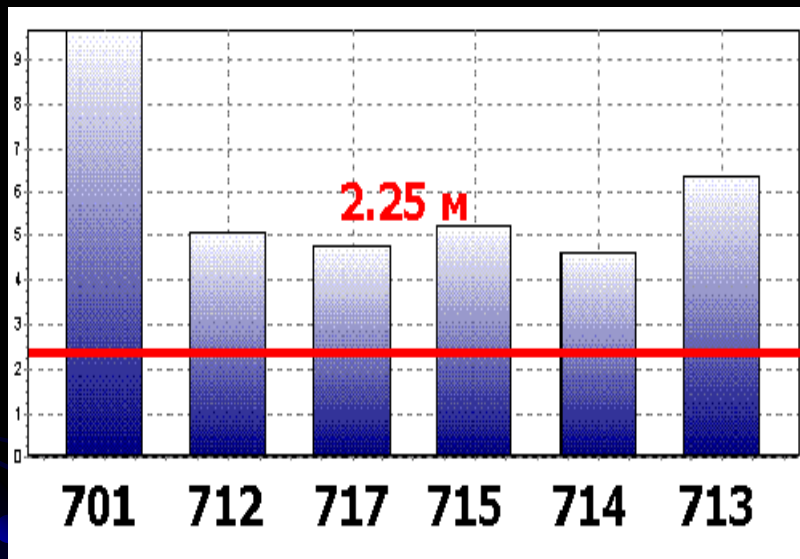


GLONASS-M Flight Test (not yet completed)

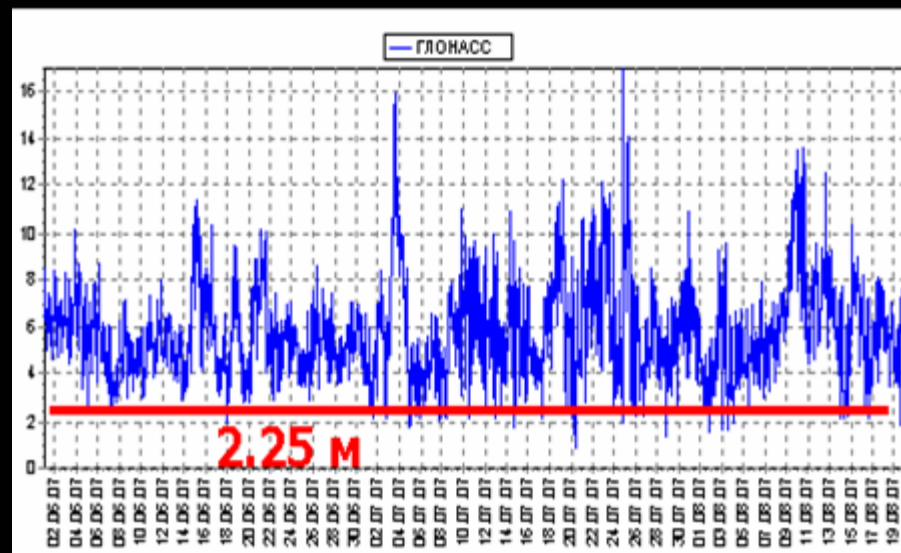
GLONASS-M Performance (SISRE 21.09.2007)

Flight test current results

SISRE, м



Изменение SISRE во времени, м



Main problem – synchronization



On-board clock stability (observed)



□ Requirement:

$$1 * 10^{-13}$$

□ Achieved results:

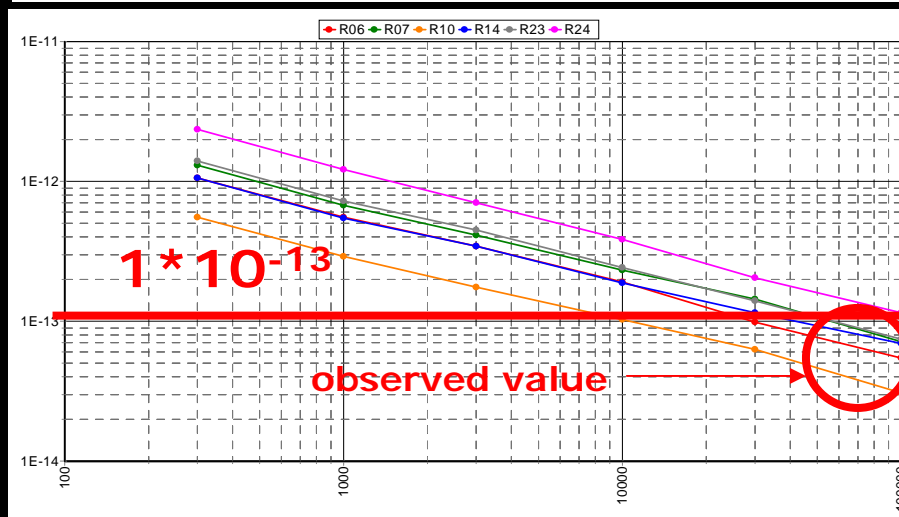
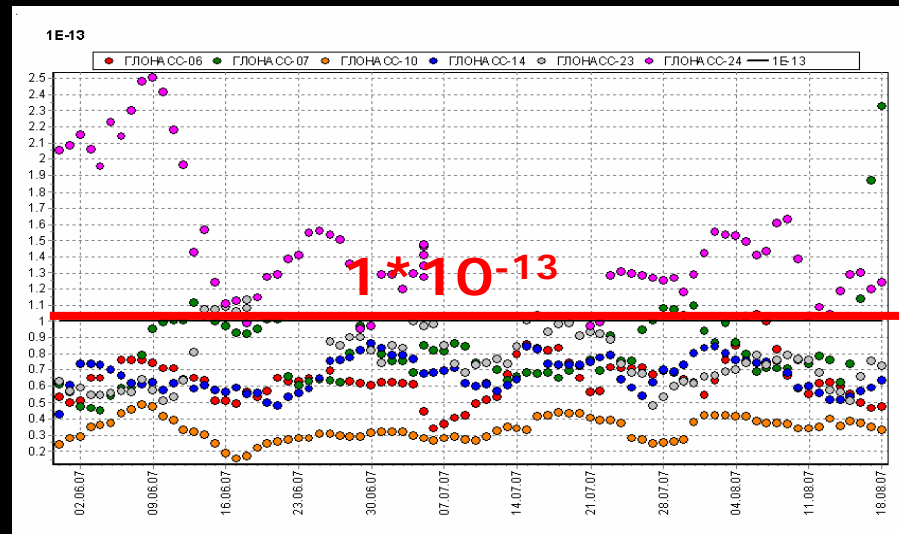
↙ For all GLONASS-M (without GI-M # 13)

$$< 1 * 10^{-13}$$

↙ GLONASS-M # 17

$$2-4 * 10^{-14}$$

Better than requirements





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GLONASS Modernization



GLONASS Requirement Document Update



- ❑ **Improved Accuracy (open service)**
 - ↗ SIS positioning and timing, all-in-view, full constellation (95%)
 - <2.8 m
- ❑ **New civil signals**
 - ↗ L3PT FDMA
 - ↗ L1CR and L5R CDMA interoperable with GPS and Galileo
- ❑ **Availability requirements**
- ❑ **Integrity requirements**
- ❑ **Improved geodesy reference**
 - ↗ PZ-90.XX wrt ITRF < 5 cm
- ❑ **Improved time reference**
 - ↗ GloST wrt UTC (SU) <120 ns with accuracy 12 ns

Approval has to be done by the end of 2007





GLONASS Modernization Program

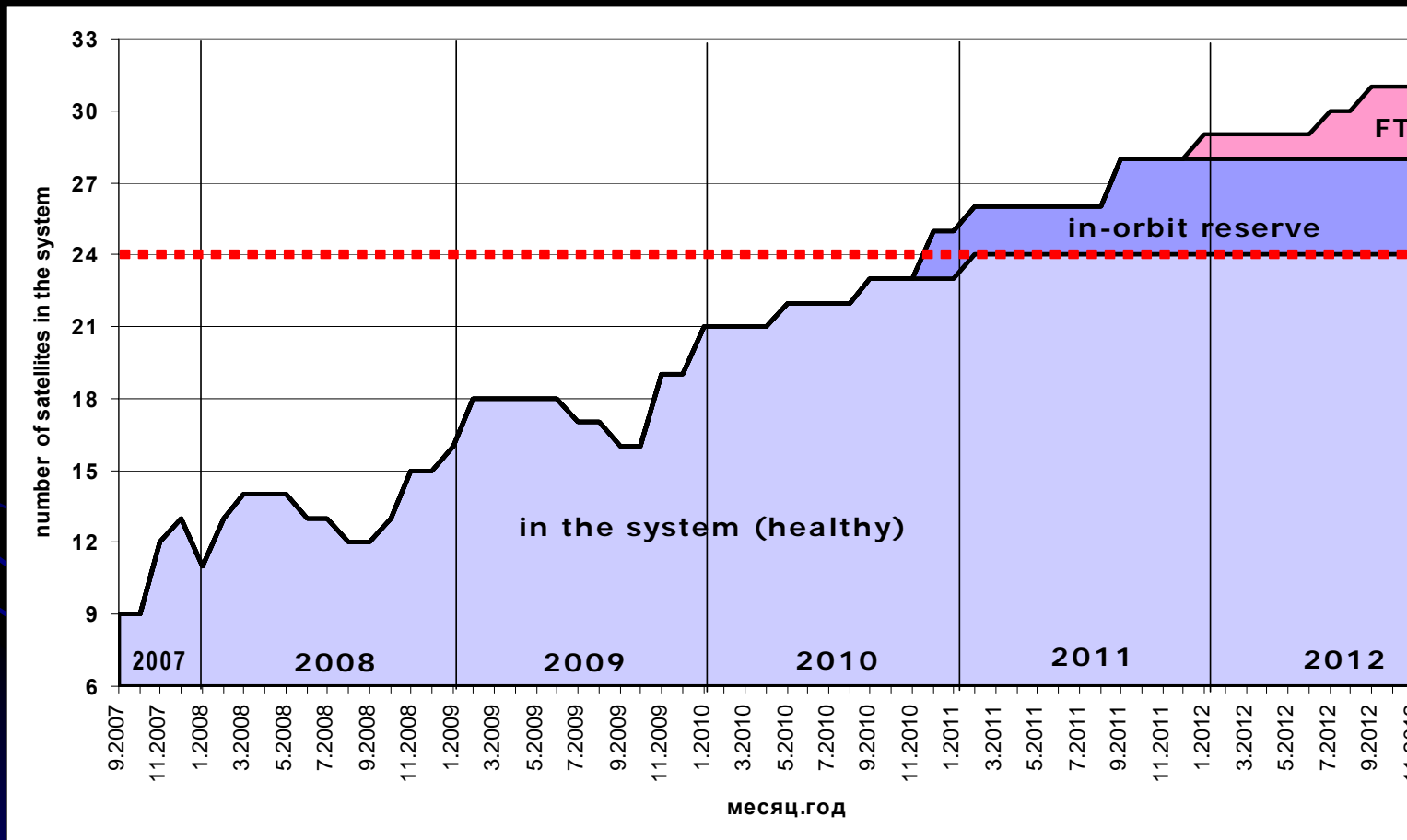


- ❑ **Continuous global navigation by 2010**
 - ↙ 24 satellites in constellation
- ❑ **GLONASS accuracy improvement plan (AIP)**
- ❑ **Ground control segment modernization**
 - ↙ Monitoring station network extension (Russia)
 - ↙ System time scale improvement
 - ↙ Monitoring network outside Russia
- ❑ **Signal modernization**
 - ↙ Third civil signal at L3 (since GLONASS-K in 2009-2010)
 - ↙ New interoperable signals at L1 (L1CR) and L5 (L5R)
- ❑ **Interoperability with GPS and future GALILEO**
 - ↙ Geodesy system
 - ↙ Time system
- ❑ **Further modernization of GLONASS based on new GLONASS-KM satellite**



Constellation Progress

Prediction of the satellite amount in the constellation based on the launch program and statistics

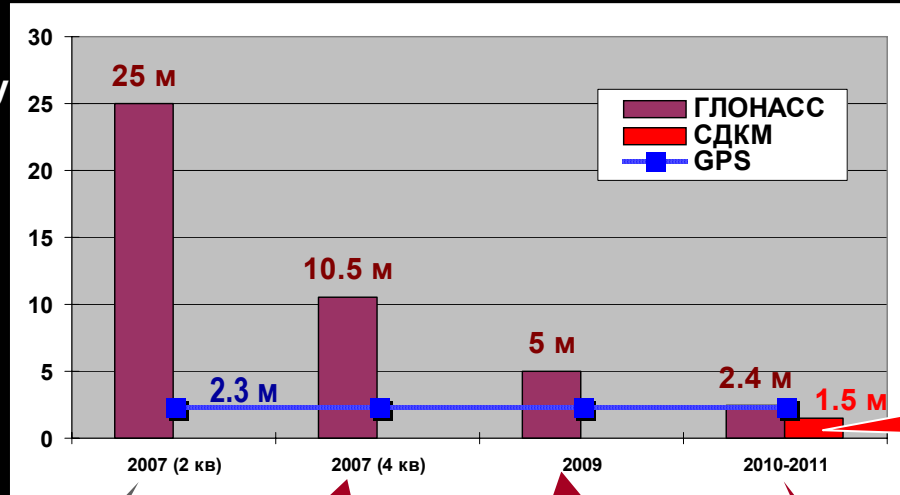




GLONASS Accuracy Improvement Plan (AIP)



positioning accuracy (SIS)



Wide Area Augmentation

- Two-way technique for OD&TS
- Measurements:
 - 5 TT&C stations

- Combine Two-way and One-way OD&TS technique
- Measurements +
 - 3 MS
 - 1 ULS
- Geodesy reference update

- Full constellation of 24 satellites
- Extension of monitoring network
- Measurements ++
 - 6 MS
 - 2 ULS

- On-board clock stability improvement to $5 \cdot 10^{-14}$
- Global MS network
- Measurements +++:
 - 6-10 stations outside Russia





AIP Implementation: PZ-90.02



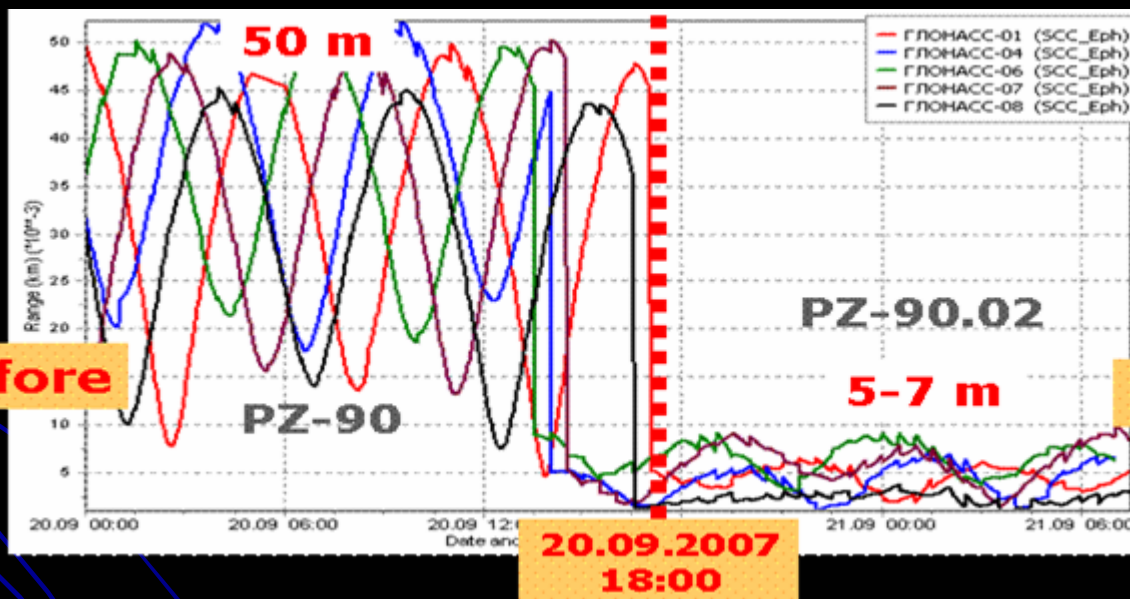
- **Governmental Decision of 20 June 2007:**
 - ↗ PZ-90.02 implementation in GLONASS
 - ↗ Further permanent improvement toward ITRF
- **New geodesy reference in GLONASS**
 - ↗ To be introduced at 20 September 2007
- **PZ-90.02 coordination to ITRF:**
 - ↗ No rotation
 - ↗ Delta X: -36 cm
 - ↗ Delta Y: +8 cm
 - ↗ Delta Z: +18 cm

Implemented at September 20, 2007, 18:00



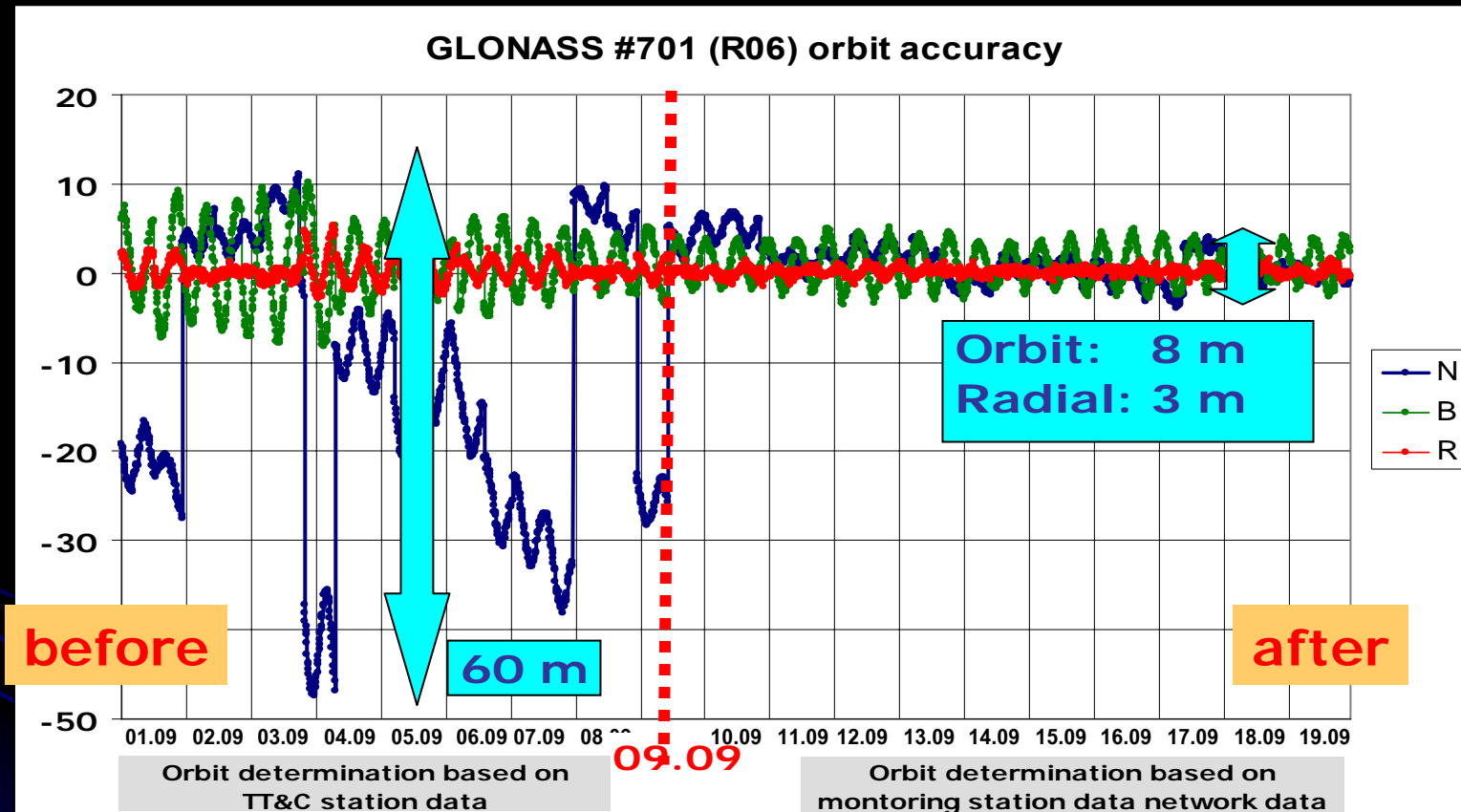
Difference of GLONASS orbits (range) wrt. ITRF

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{\text{GLONASS (ITRF)}} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{\text{GLONASS (PZ-90...)}}$$



Further improvement is foreseen in the AIP

AIP Implementation: GLONASS Orbit Accuracy Improvement



Next step – clock accuracy improvement



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GPS



GLONASS

Galileo

International cooperation

- **GNSS become the global strategic utility for**
 - ↪ National security
 - ↪ Economy development

- **Necessity to coordinate activity between system providers during the system development and modernization (compatibility)**

- **Necessity to provide interoperability to benefit users**



Basis for international cooperation on the user level



- **GNSS become the global strategic utility used in many countries in the all areas of economy in many applications**
 - ↗ Presently the US GPS is widely in use. The Russian GLONASS has been fully deployed in 1995, now is under reconstruction and in development phase. The EU GALILEO is in progress to be deployed by 2012.
 - ↗ GNSS systems are highly sensitive to interference and jamming

GLONASS is an actual tool to reduce the risk and improve robustness and reliability of satellite navigation applications





International Cooperation Principles



- ❑ Encouraging of GLONASS use all over the world to sustainable development
- ❑ Open access of all users to the civil signals free of direct user charge
- ❑ GLONASS compatibility and interoperability with other GNSS and augmentations (GPS, Galileo, WAAS, EGNOS, IRNSS/GAGAN, QZSS...)
- ❑ Ensure the interests of the Russian Federation having in mind the dual use status of GLONASS as an element of the strategic state infrastructure





Priority direction of the International Cooperation in GNSS



- ❑ Radio frequency compatibility
- ❑ RNSS frequency band protection
- ❑ Interoperability with GPS and GALILEO and augmentations in sense of signals, geodesy reference and time reference
- ❑ Development of common standards for GNSS application
- ❑ GNSS service certification
- ❑ Advance SatNav technology development
- ❑ Search and rescue service implementation on GNSS
- ❑ Integrity monitoring
- ❑ Promotion of GLONASS use in combination with GPS

International Cooperation Concept is to be completed by the end of 2007





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GLONASS User Interface

www.glonass-ianc.rsa.ru

□ PNT Information Analysis Center (division of the Central Research Institute of Machine Building)

- ↗ Daily bulletins on GLONASS and GPS status based on global data
- ↗ GLONASS control center official information
- ↗ Monthly bulletin with detail analysis of system performance
- ↗ Navigation news
- ↗ GLONASS ICD



PNT IAC – feed back in the GLONASS control segment



Moscow Satellite Navigation Forum



Agenda for 2008: February 11-12

GNSS programs

↖ GLONASS

↖ GPS

↖ Galileo

Legal aspects of GNSS application

GNSS application for civil use

Scientific GNSS applications

User equipment

Integrated systems

МЕЖДУНАРОДНЫЙ ФОРУМ ПО СПУТНИКОВОЙ НАВИГАЦИИ 2007

www.glonass-forum.ru www.navigator-forum.ru

При поддержке:

 Роскосмос Правительство Москвы

ОБЪЕКТЫ:

- об международных технологиях спутниковой навигации - системах GLONASS, GPS и GALILEO
- о рамках интеграционных задач, потребности различных отраслей экономики России в навигационной информации
- о принципах российской государственной политики в области использования GLONASS и других спутниковых навигационных систем
- о возможности построения новых типов высокоточных систем базиса для системы спутниковой навигации
- об опыте модерн российских и зарубежных компаний в разработке и использовании оборудования и технологий спутниковой навигации
- об этапах и технологиях интеграции систем в составе сети связи

YOU WILL LEARN ABOUT:

- GLONASS, GPS and GALILEO innovative navigation service markets and demand for navigation data by the users in various of Russian economy
- Russian Government's policy for the use of GLONASS or other satellite navigation systems
- Potential for creating new types of highly profitable satellite-navigation based businesses
- Experiences gained by leading companies of Europe concerning the development and/or use of satellite navigation technologies and hardware
- Publishing technologies and services offered by mobile communication operators

В рамках Форума состоится:

- Специальная конференция в области спутниковых систем связи и интеграционных задач
- Выставка оборудования и технологий спутниковой навигации
- Презентационно-лекционный семинар-конференция, посвященная актуальным вопросам спутниковой навигации в России

Topics of the forum's program include:

- Presenters consider and evaluate latest leading efforts in the field of satellite navigation and include GPS, as well as navigation hardware and software developments will be presented
- An exhibition of satellite equipment and industrial applications
- A press conference on the pressing issues of the satellite navigation in Russia

Организатор Форума:

Информационные партнеры:

РЕГИСТРАЦИЯ: +7 (495) 797 0222 INFO@IPTCENTRE.RU

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www.m2m-t.ru, www.bnavigator.ru





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GLONASS

Summary

- ❑ **GLONASS system is an element of the critical state infrastructure, ensuring national security and economy development, remains being a dual use system**
- ❑ **Urgent GLONASS restoration, development and mass use is one of priorities of the Russian State policy**
- ❑ **GLONASS – essential element of the international GNSS to secure sustainable development and economy growth**



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Thank you for your attention !



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