GLONASS
Status and Progress

Sergey Revnivykh

CGSIC Meeting

16.09.2008, Savannah, GA, US

GLONASS Architecture

System Architecture in the GLONASS Requirement Document:

Precise Ephemeris and Clock System

Wide Area Augmentation SDCM

Regional Augmntns

Earth Attitude and Rotation System

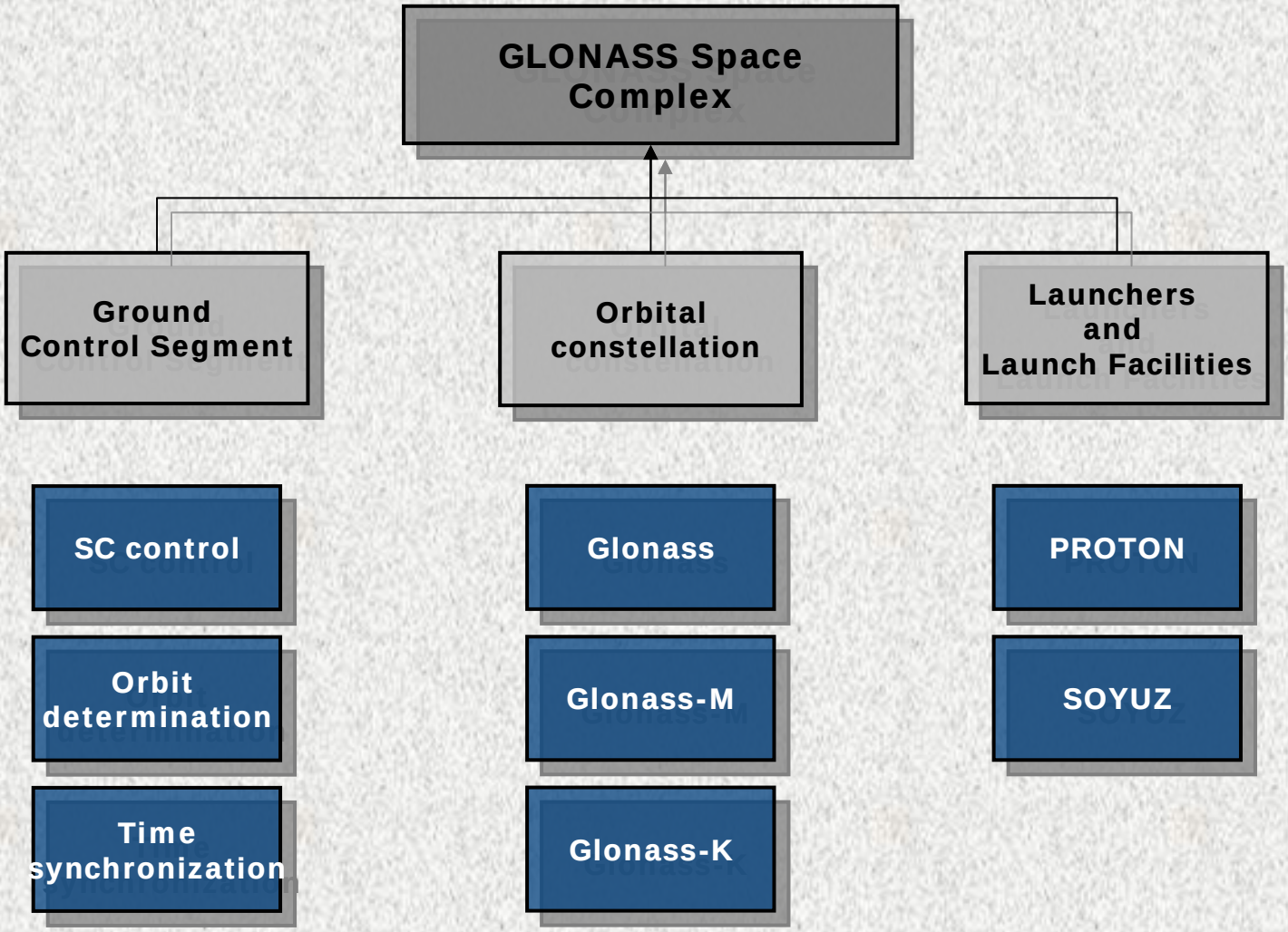
Time Reference System UTC (SU)

Geodesy Reference and Maps

Special User Equipment

Civil Users Equipment

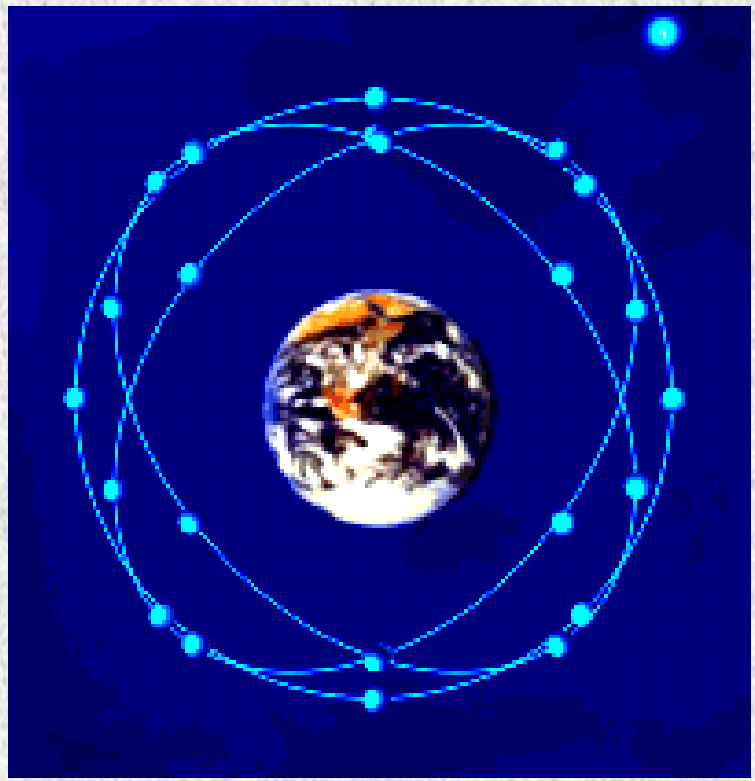
GLONASS Space Complex Architecture



Constellation

➢ 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

Spacecraft

Main Specifications

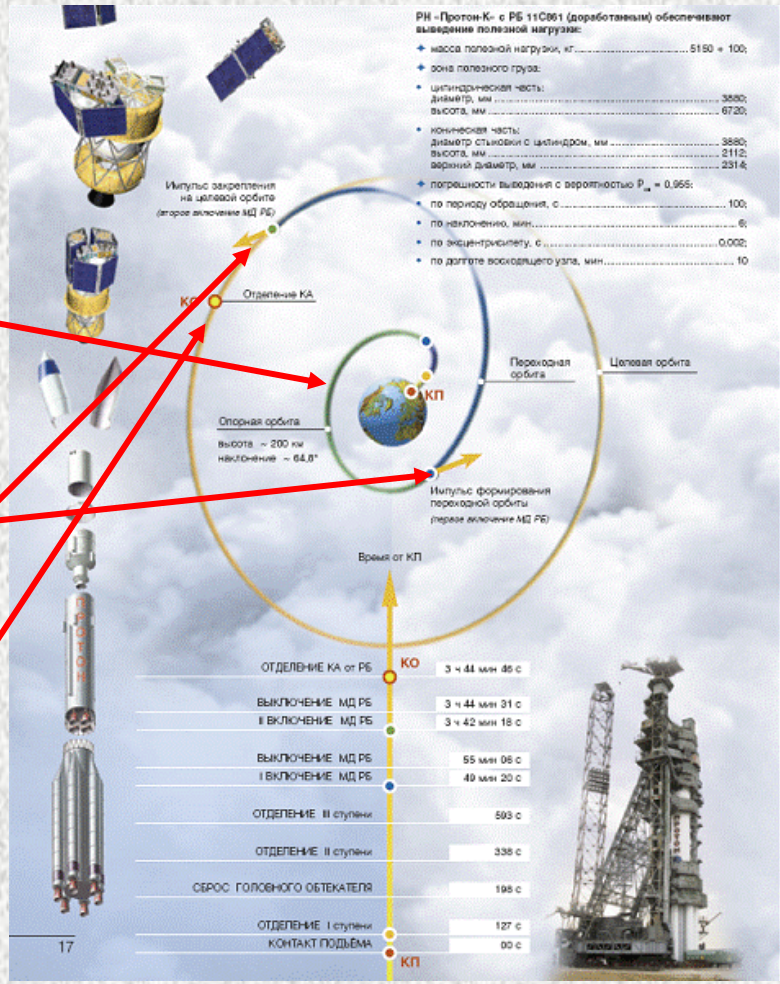
Guaranteed life time	**7 years**
Spacecraft mass	**1415 kg**
Power supply	**1450 W**
Navigation payload	
Mass	**250 kg**
Power consumption	**580 W**
Clock stability	**$1*10^{-13}$**
Attitude control accuracy	**0.5 deg**
Solar panel pointing accuracy	**2 deg**

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

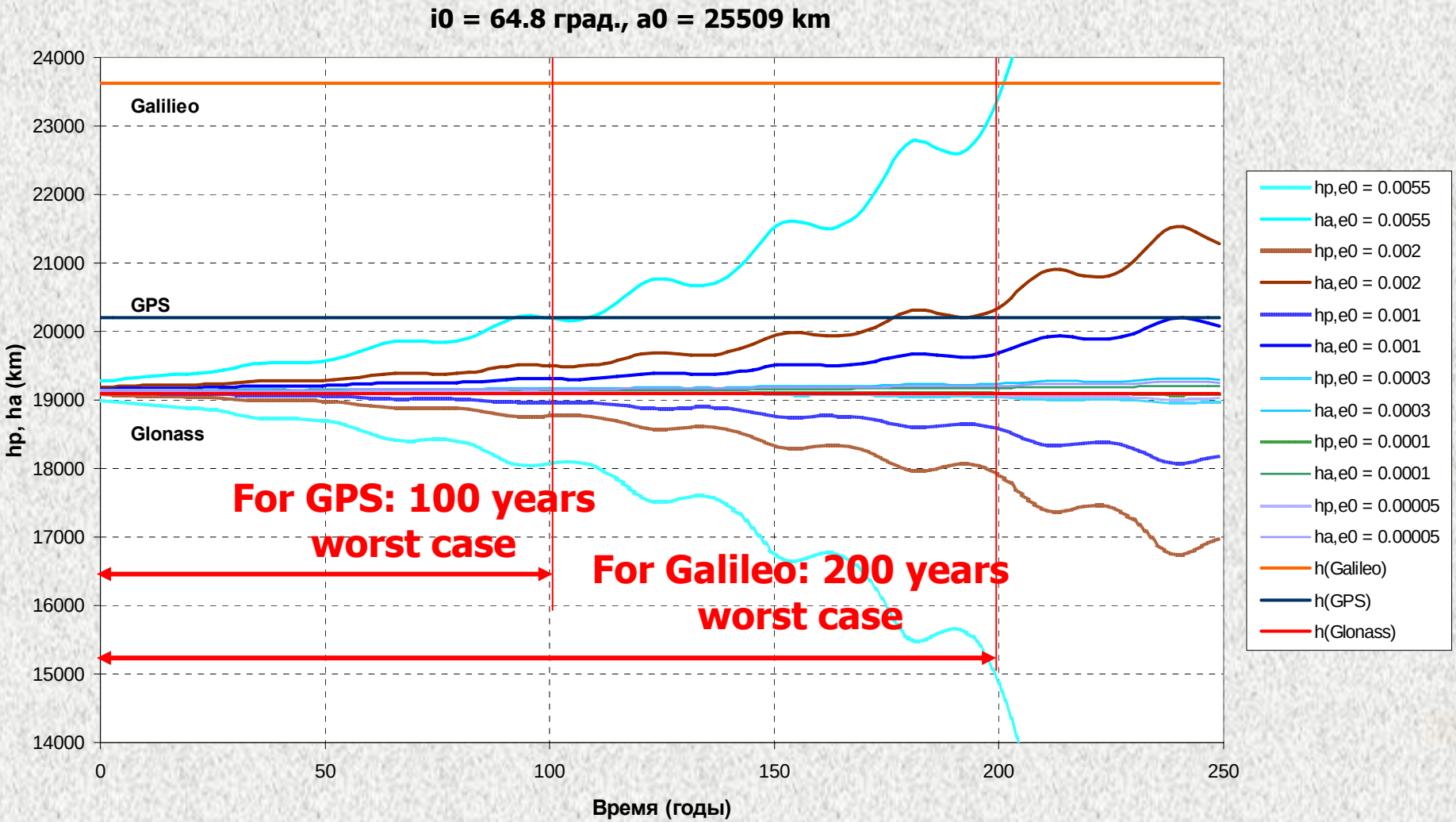
Injection Scheme

Direct injection

- **PROTON Launcher**
  - Basic orbit, 200 km circular
- **Booster stage**
  - First impulse, transition orbit
  - Second impulse, final orbit
- **Satellite separation**
  - Initial operations

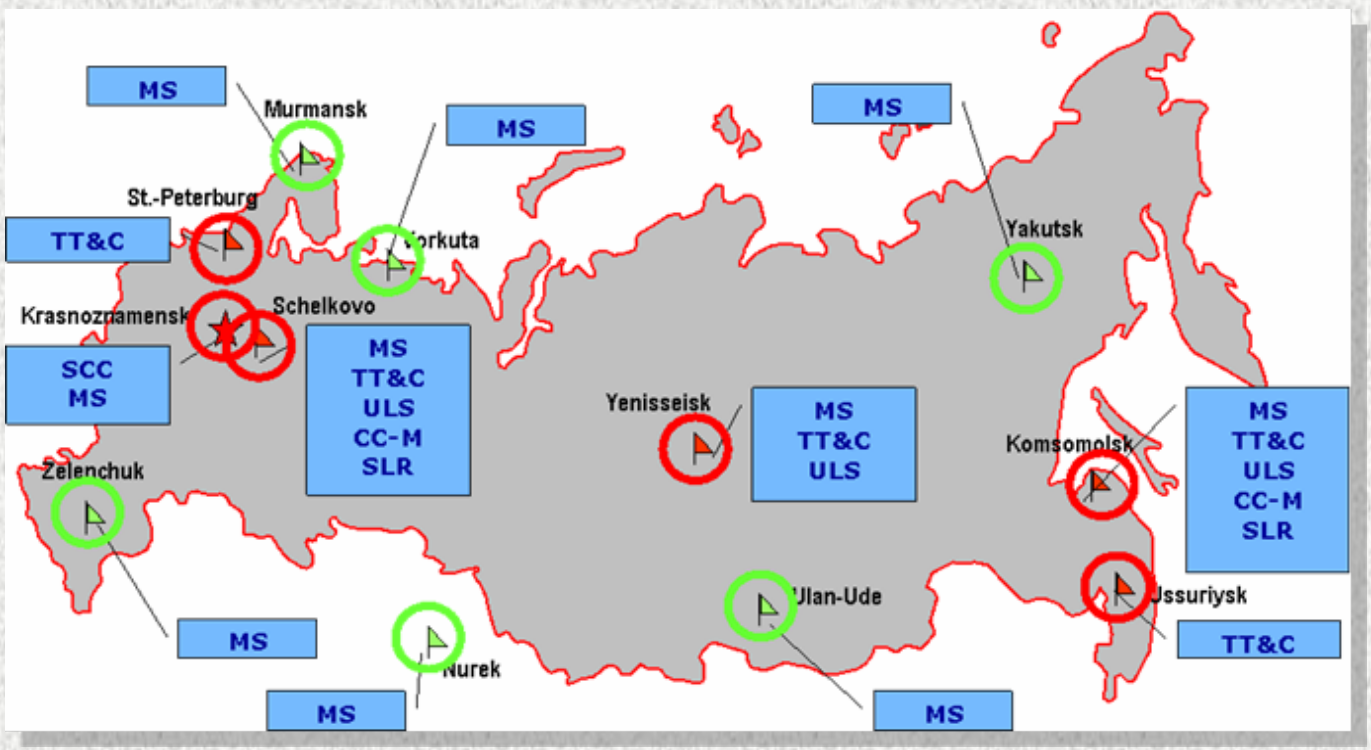


GLONASS Orbit Evolution



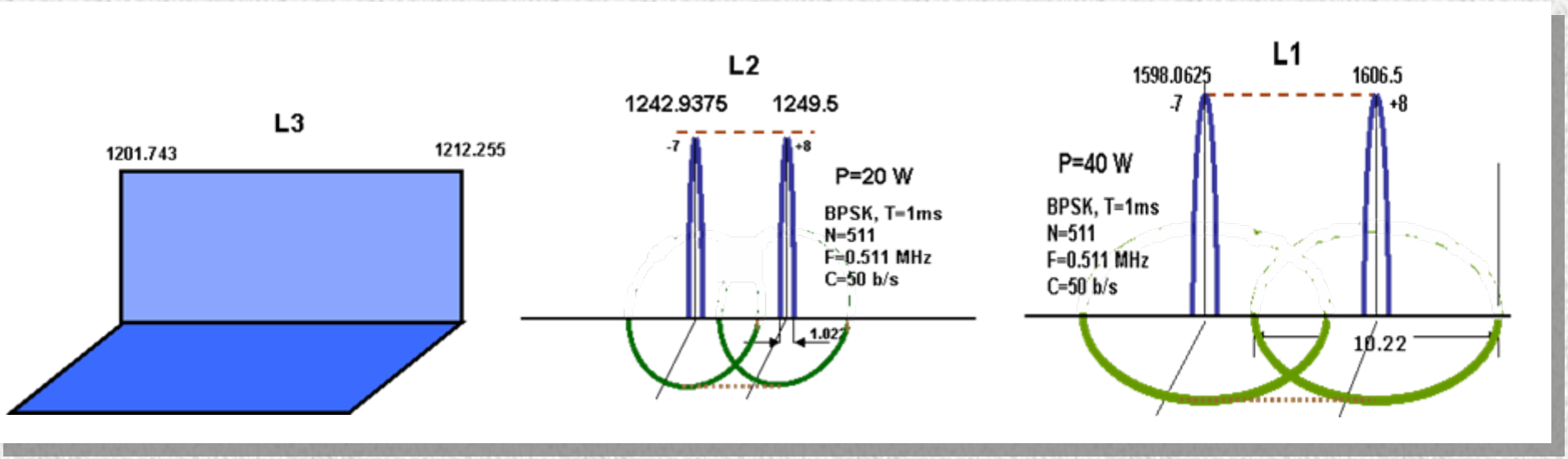
Ground Control Segment Architecture

- SCC – system control center
- TT&C – telemetry, tracking, commanding station
- ULS – uplink station
- MS – monitoring station
- CC – central clock
- SLR – laser tracking station



GLONASS Signals (present status)

- **L1**
  - L1 open FDMA
  - L1 authorized FDMA
- **L2**
  - L2 open FDMA
  - L2 authorized FDMA
- **L3 to be refined**



Last Year Events: GLONASS Launch

BLOCK-36
GLONASS-M # 18, 19, 20
26.10.2007

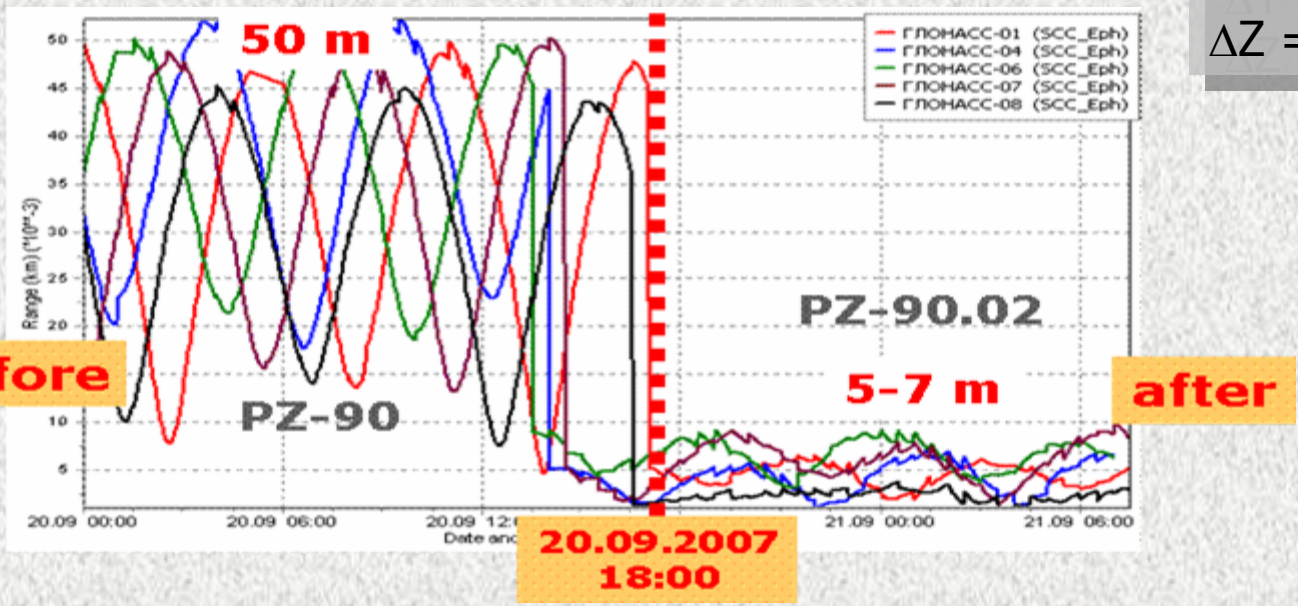
BLOCK-37
GLONASS-M # 21, 22, 23
25.12.2007

GLONASS Geodesy Reference

Difference of GLONASS orbits (range) wrt. ITRF

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{ITRF} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{PZ\text{-}90.02}$$

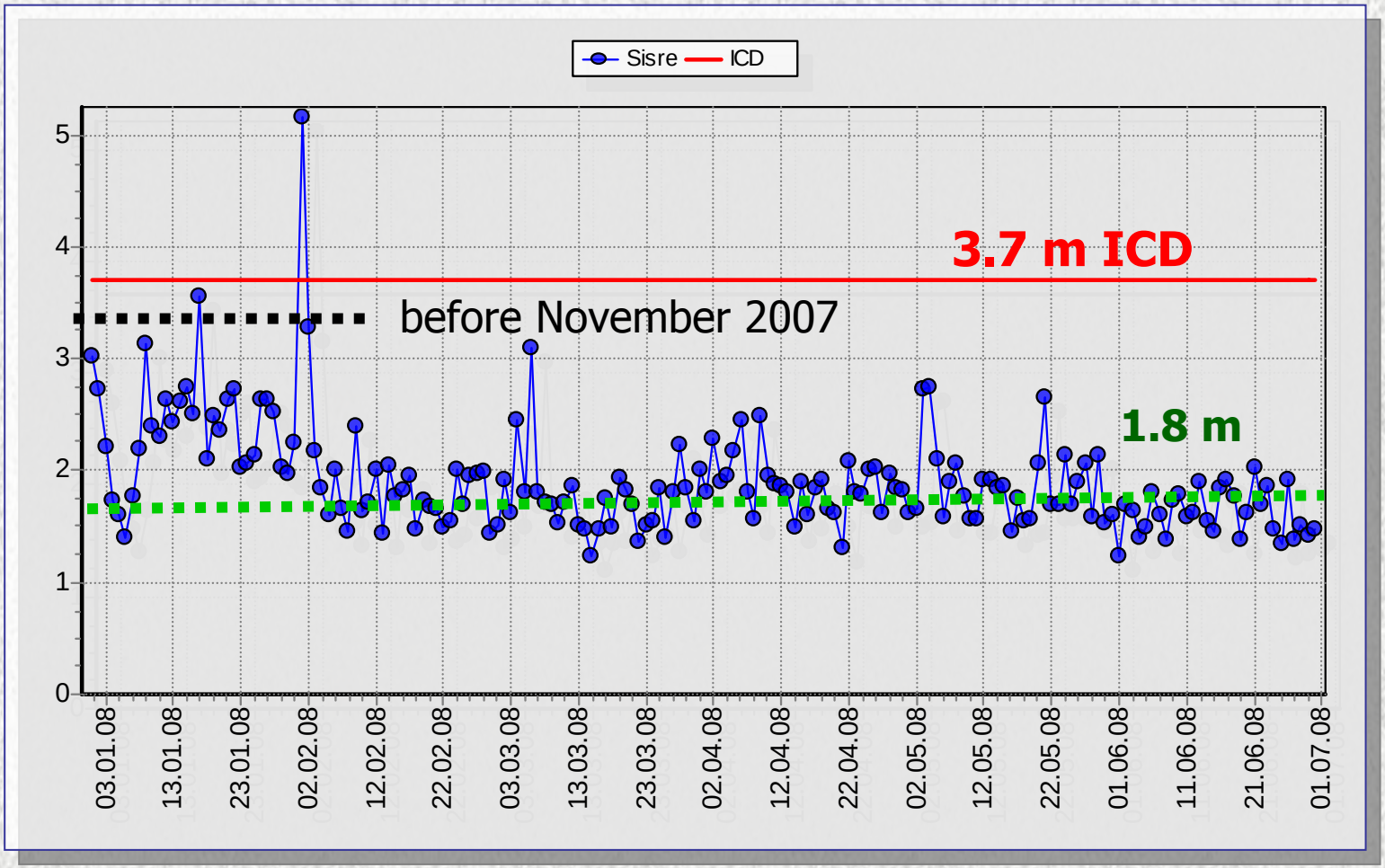
ITRF2000 → PZ 90.02
ΔX = 0.36 m
ΔY = - 0.08 m
ΔZ = - 0.18 m



Further improvement is foreseen in the AIP

GLONASS-M Performance wrt Standard

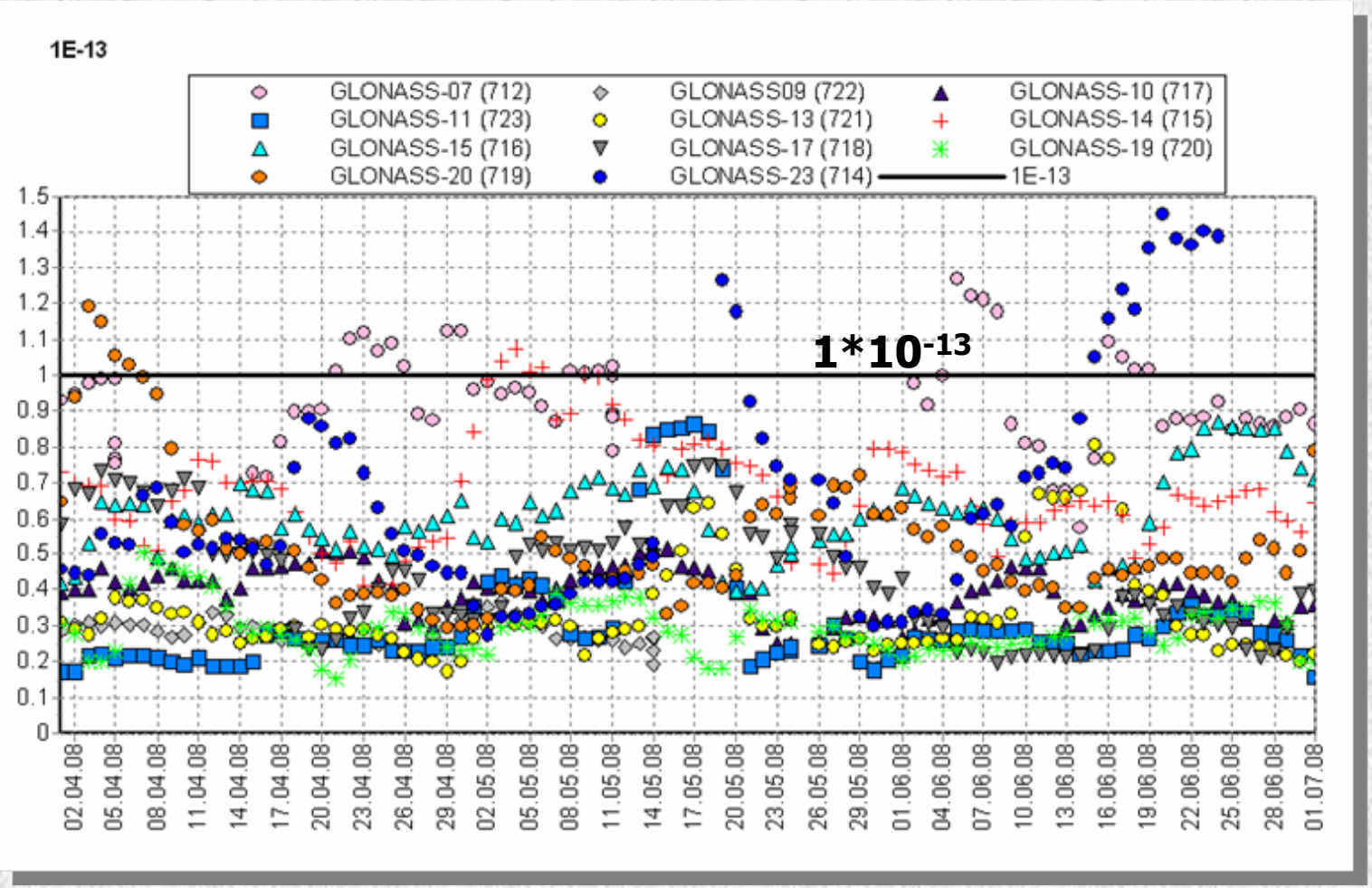
SISRE: result of the first phase of GCS modernization



GLONASS-M Clock Stability

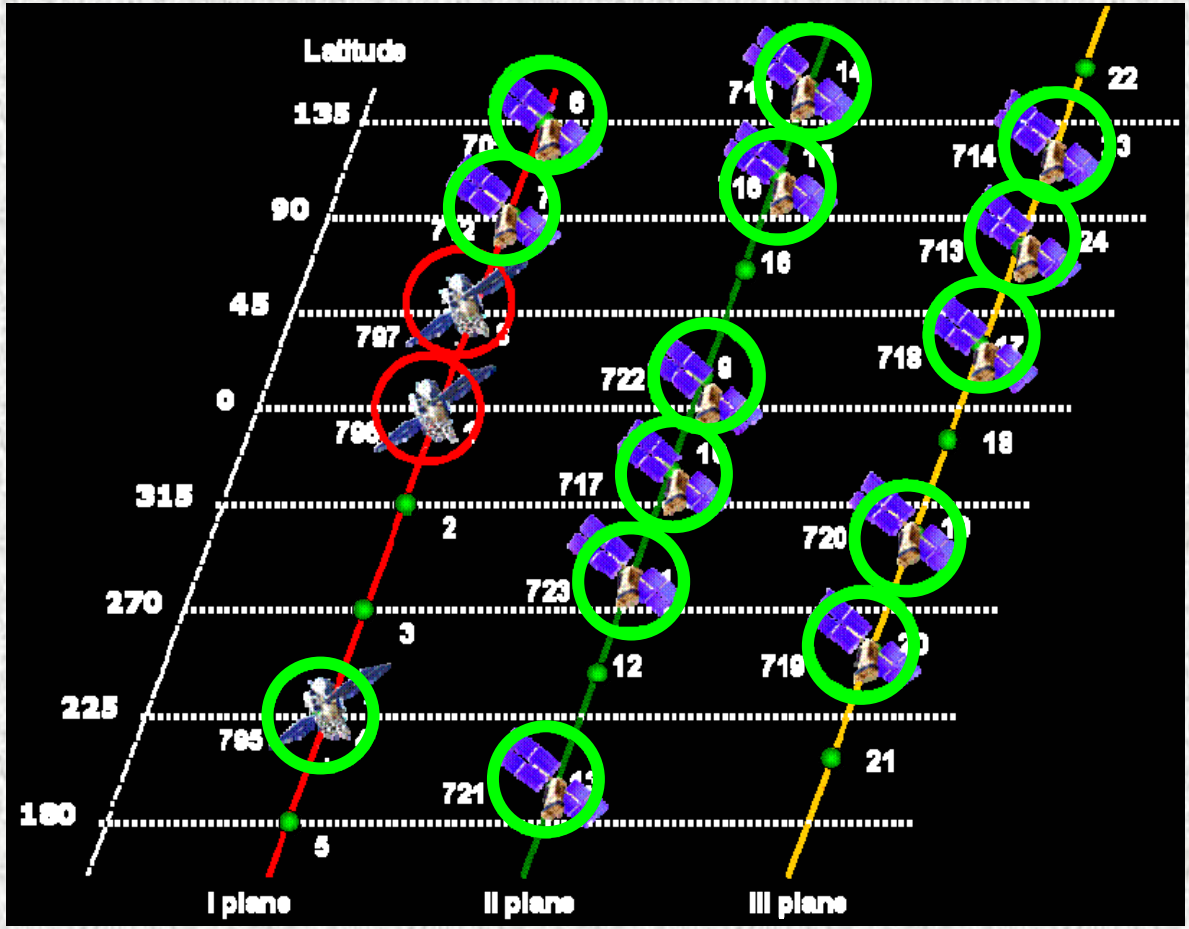
GLONASS-M Cs atomic clock performance:

01.04.2008 – 01.07.2008



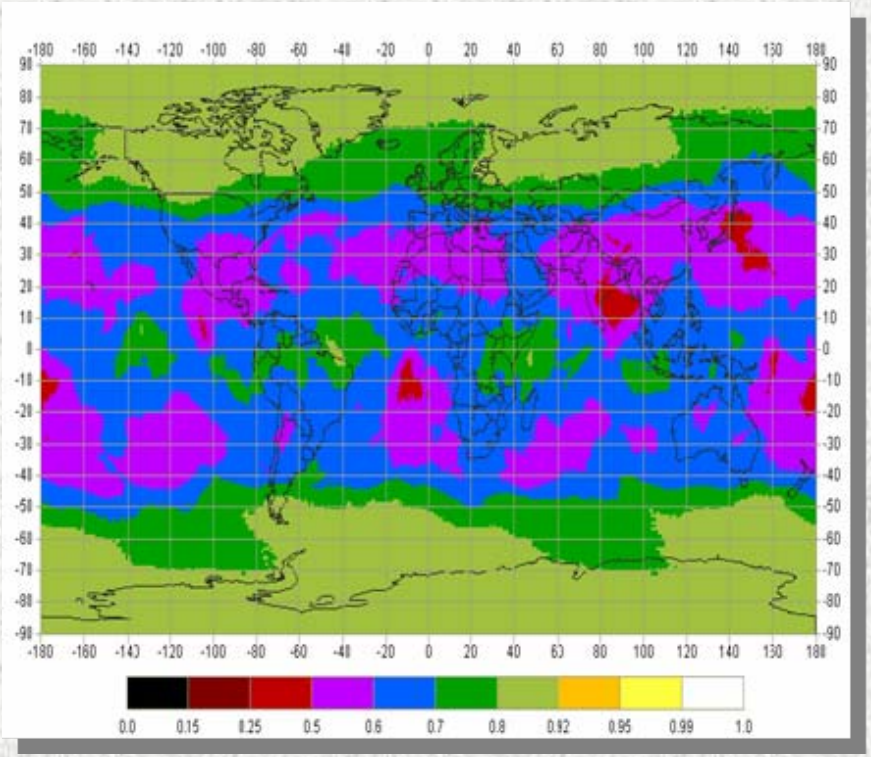
GLONASS Constellation Status

- **In constellation: 16 satellites**
  - 3 "Glonass"
  - 13 "Glonass-M"
- **Healthy**
  - 14 sats
- **Decommissionning**
  - 2 sat
- **Next Launch:**
  - 25 September 2008, Block 38
    - ✓ 3 Glonass-M
  - 25 December 2008, Block 39
    - ✓ 3 Glonass-M

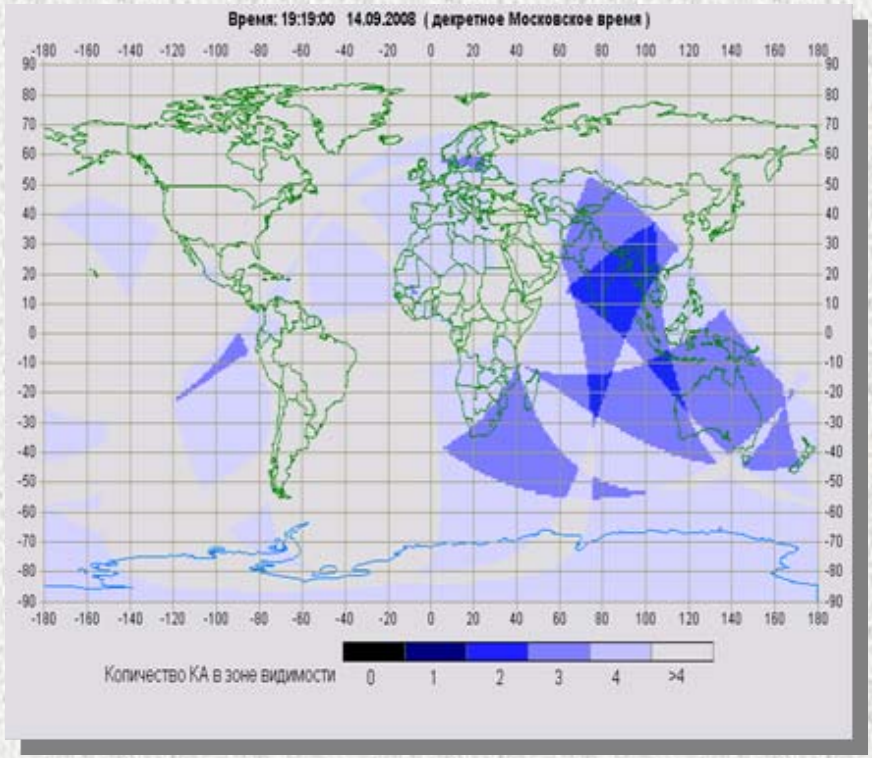


GLONASS Availability (14.09.08)

Global availability is 67-80% (PDOP<6, γ>5°)

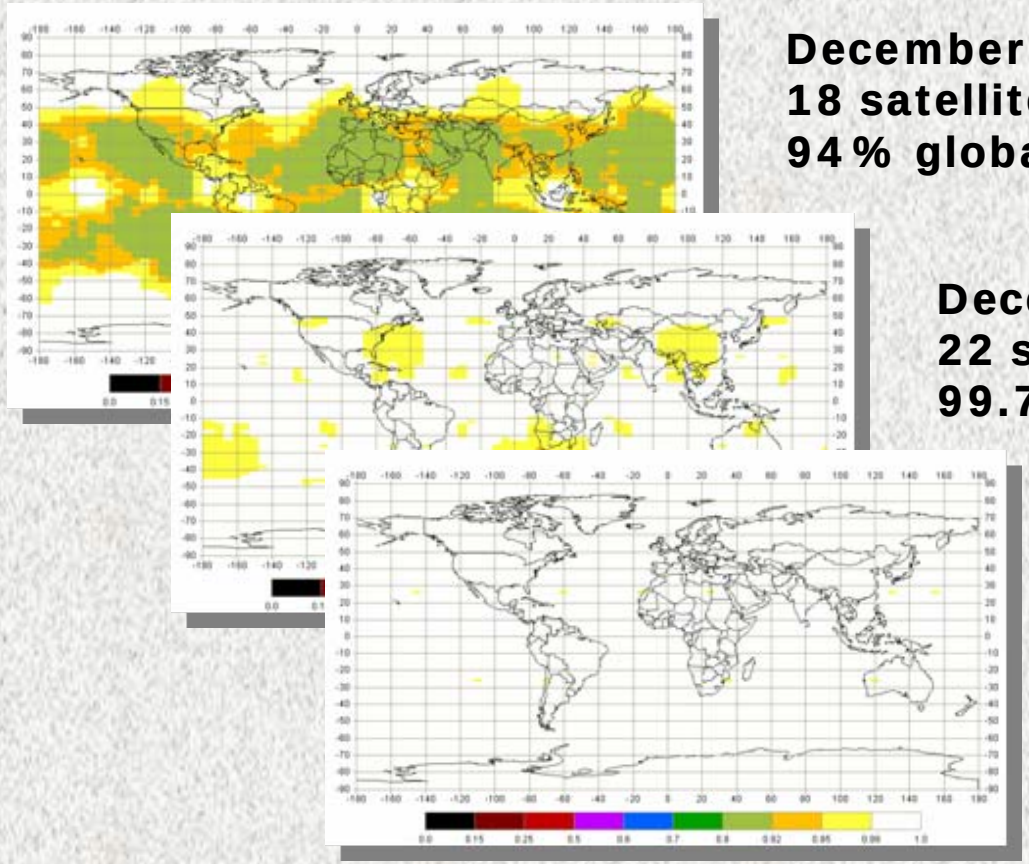


Mean availability for a day



Instant availability

GLONASS Deployment Program



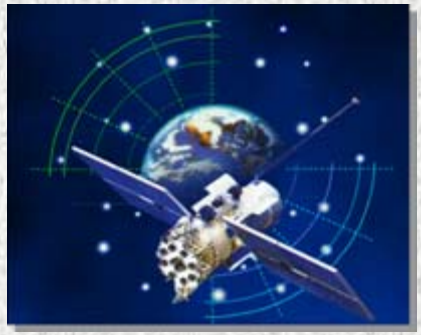
December 2008 – January 2009
18 satellites.
94% global availability

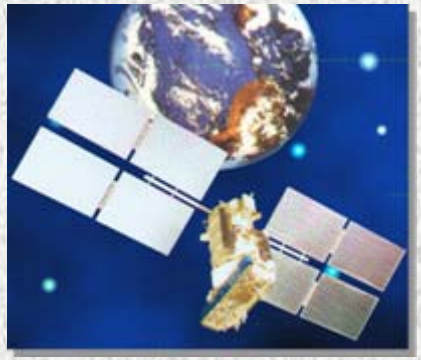
December, 2009
22 satellites.
99.7% global availability

December, 2010
24 satellites.
99.99% global availability

GLONASS Development Program

- Continuous global navigation provision plan
- Glonass-K flight test (2011)
- GLONASS accuracy improvement plan
- Ground control segment modernization
  - Ground control network extension
  - System time and orbit improvement
  - Monitoring network outside Russia
- Signal modernization
- New signals in GLONASS-K (including CDMA)
- Interoperability with GPS and future GALILEO
  - Signals
  - Geodesy system
  - Time system
- Further modernization of GLONASS based on new satellite





State Policy

- GLONASS is a part of the critical state infrastructure providing national security and economy development
- Creating, developing and sustaining the PNT infrastructure is a state responsibility
- Use of GLONASS is mandatory for state entities and major sectors of economy
- GLONASS is used in combination with other GNSS, terrestrial radio navigation, other navigation means
- Basic civil navigation services are free of direct user fees
- Open, free access to GLONASS information necessary to develop and produce user equipment
- International cooperation on GNSS compatibility and interoperability

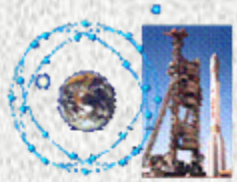
Presidential Decree on GLONASS (May 18, 2007)

- **Main statements:**
  - Free access to the civil signals
  - GLONASS mandatory 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.

GLONASS Program

Subprograms

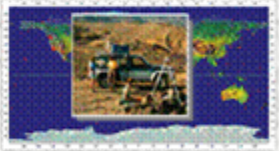
1. GLONASS sustainment, development and deployment



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

Last Friday Event:
GLONASS Program update approval for 2008-2011 with 67 BRub extra!

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 development is in a progress in line with Federal GLONASS Program (scheduled up to 2020)
- GLONASS – essential element of the international GNSS

Thank you for your interest!

Sergey G. Revnivykh
Deputy Director General
Central Research Institute of Machine Building
Head of PNT Information Analysis Center
Sergey.revnivykh@mcc.rsa.ru
www.glonass-ianc.rsa.ru
tel/fax: + 7 495 586 9000