



***Federal Space Agency***



# GLONASS

**Sergey Revnivykh**

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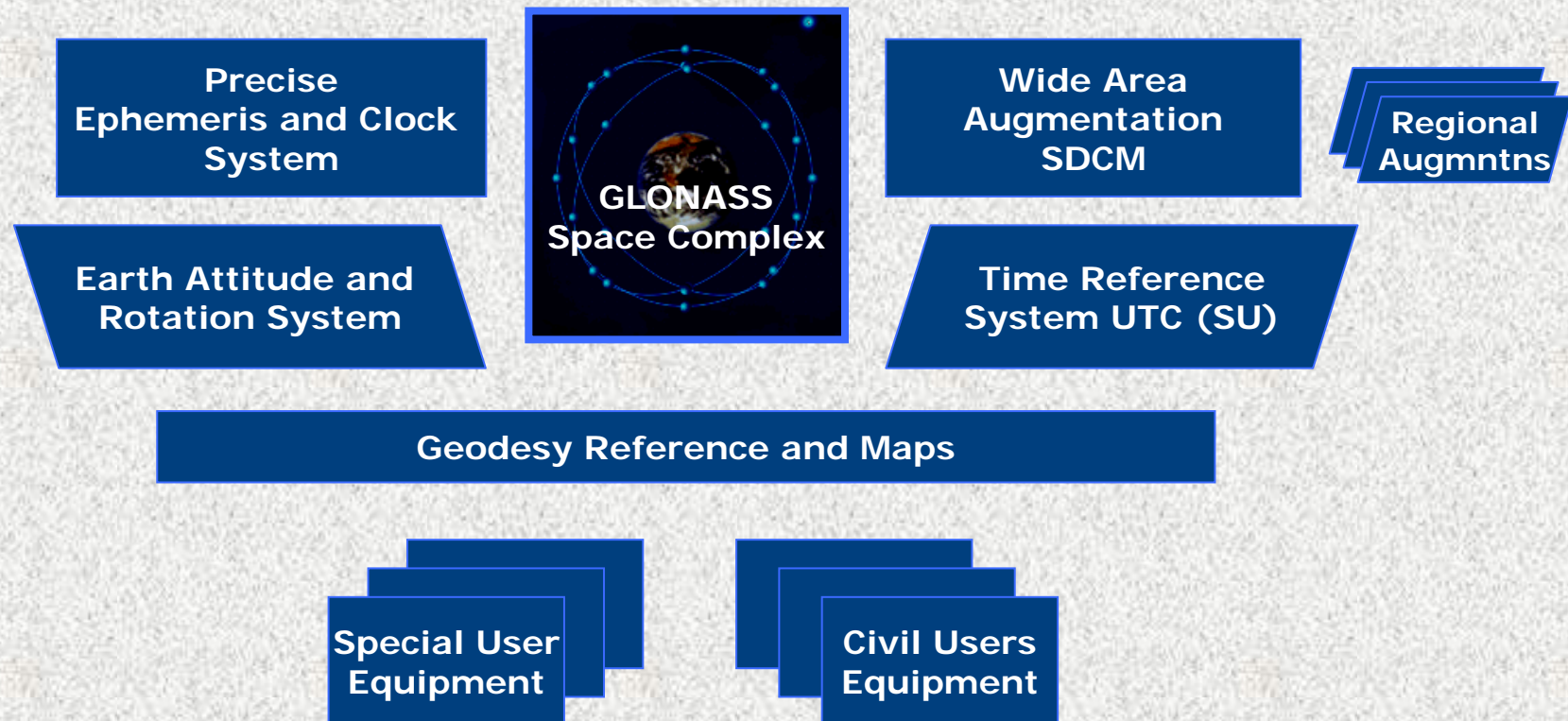
**ICG Expert Meeting on GNSS  
15 July 2008, Montreal Canada**



# GLONASS Architecture

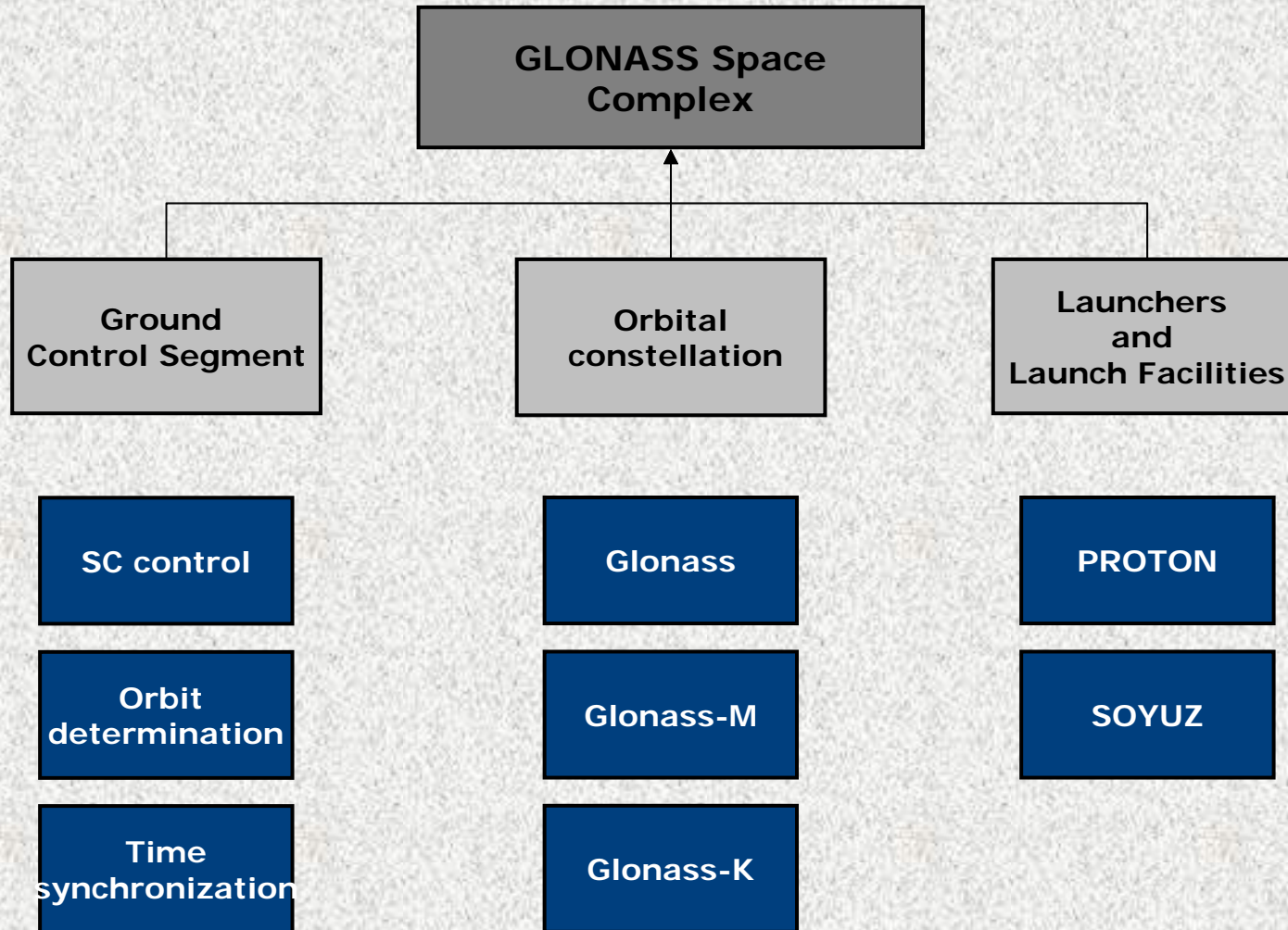


## System Architecture in the GLONASS Requirement Document:





# GLONASS Space Complex Architecture





# Constellation

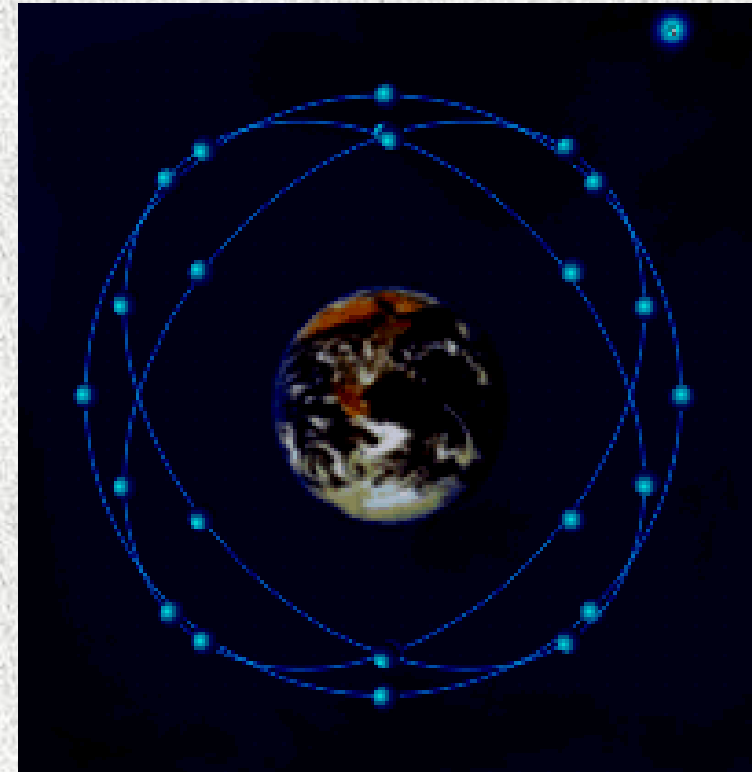


## ➤ Orbit constellation:

- ❑ 24 satellites, 3 planes by 8 satellites
- ❑ Orbit shift by  $120^\circ$  along the equator

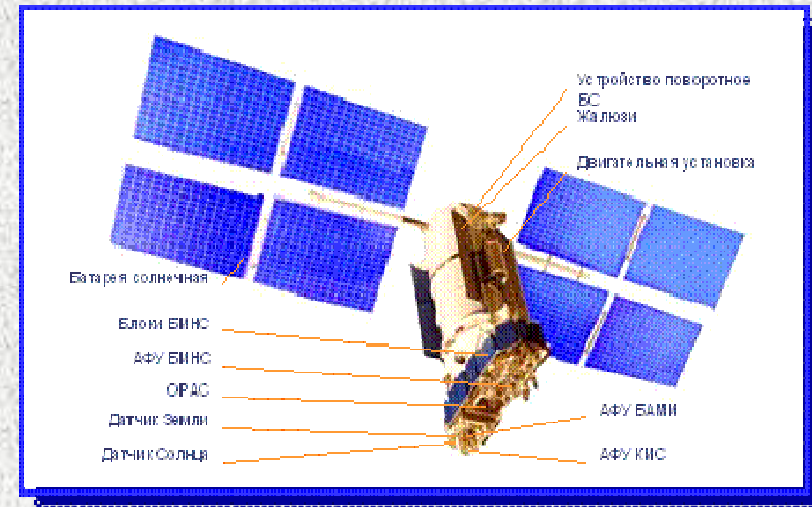
## ➤ Orbit parameters

- ❑ orbit – circular
- ❑ height 19100 km
- ❑ inclination  $64.8^\circ$
- ❑ revolution 11h15min



## Main Specifications

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



### ➤ Main features

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

## Direct injection

### ➤ PROTON Launcher

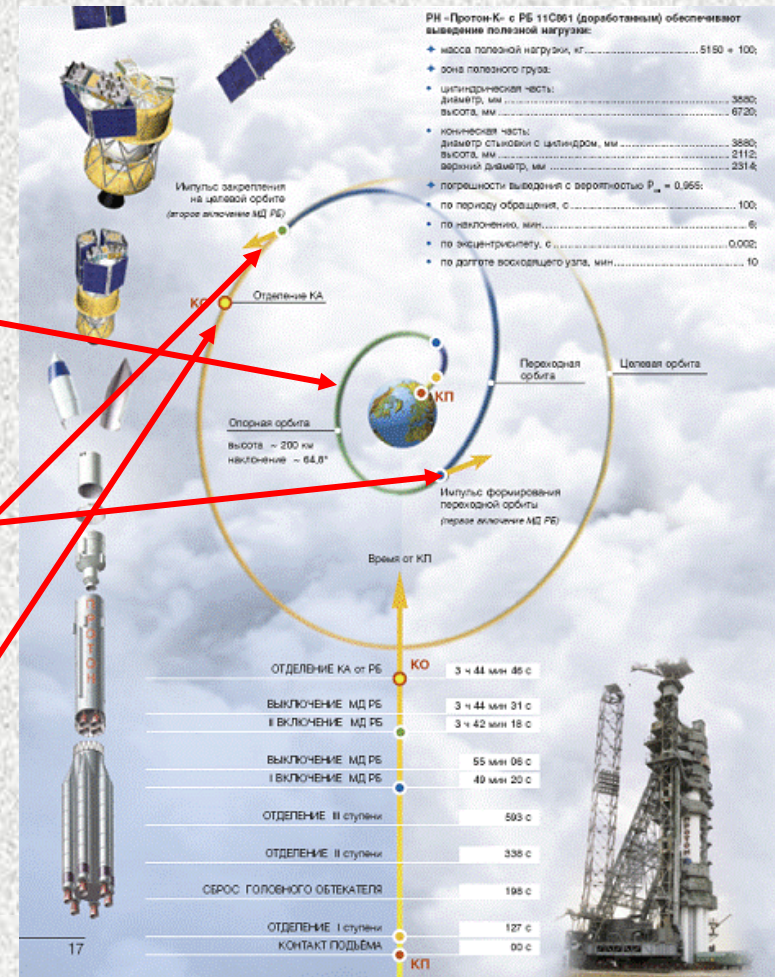
- ❑ Basic orbit, 200 km circular

### ➤ Booster stage

- ❑ First impulse, transition orbit
- ❑ Second impulse, final orbit

### ➤ Satellite separation

- ❑ Initial operations

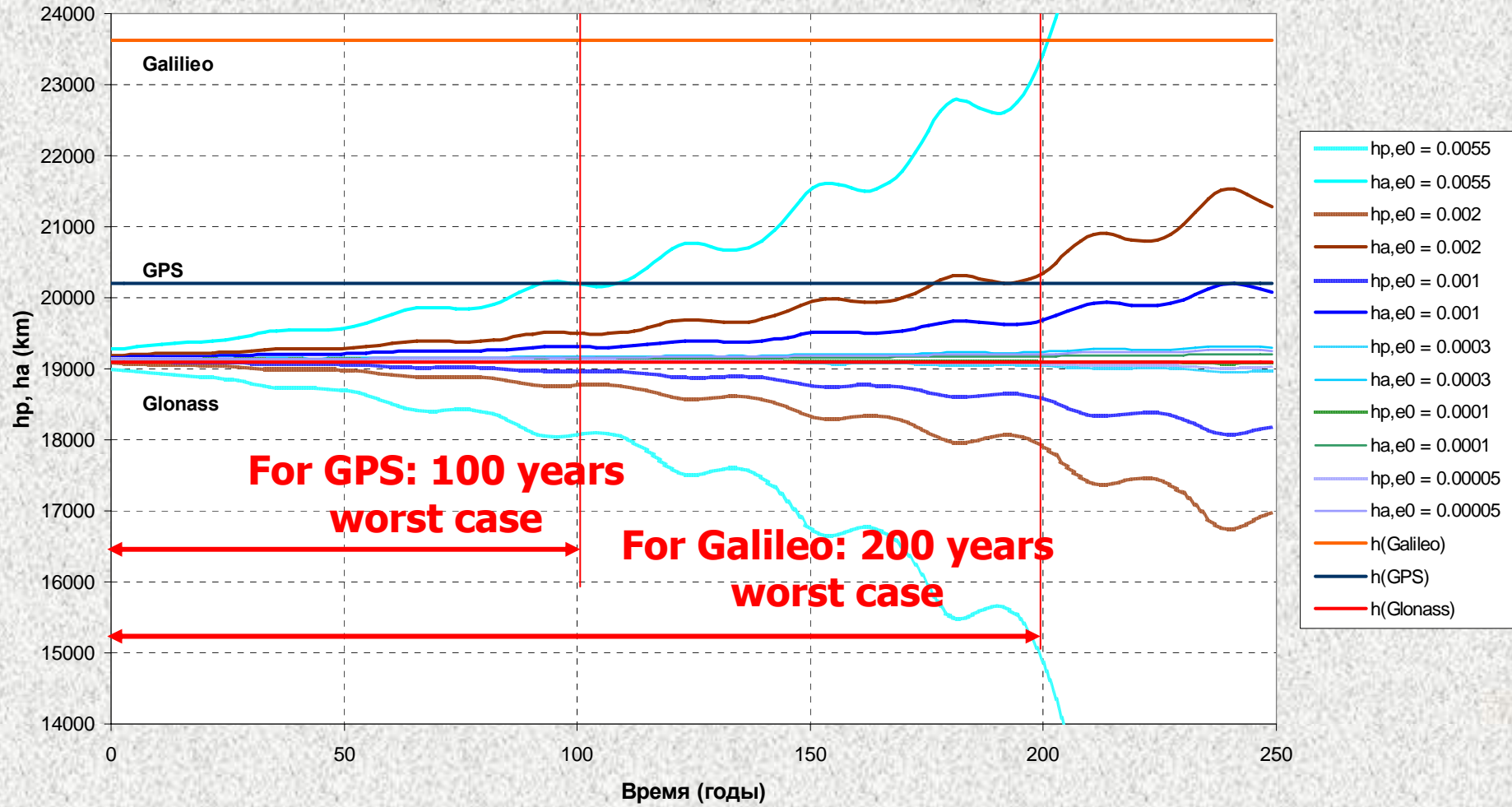




# GLONASS Orbit Evolution



$i_0 = 64.8$  град.,  $a_0 = 25509$  km

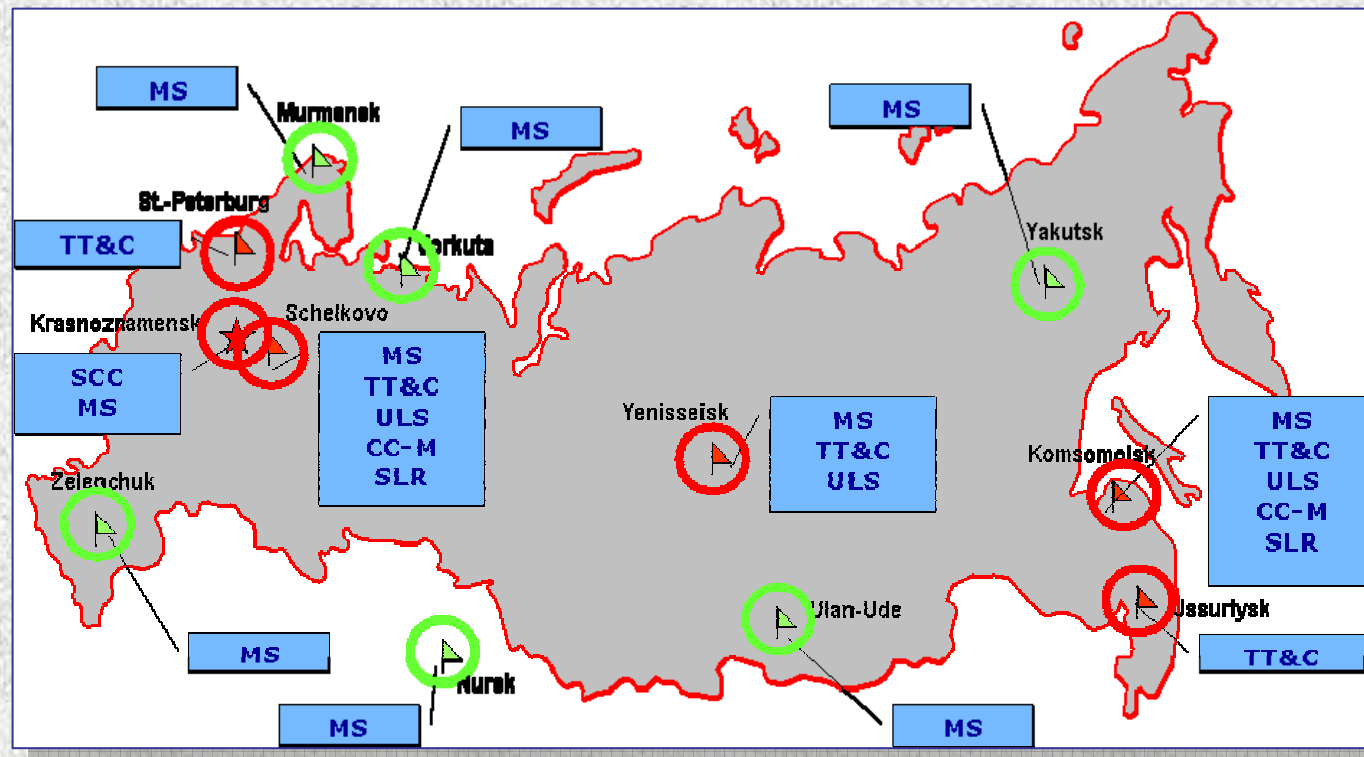




# Ground Control Segment Architecture



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







# GLONASS Signals (present status)



## ➤ L1

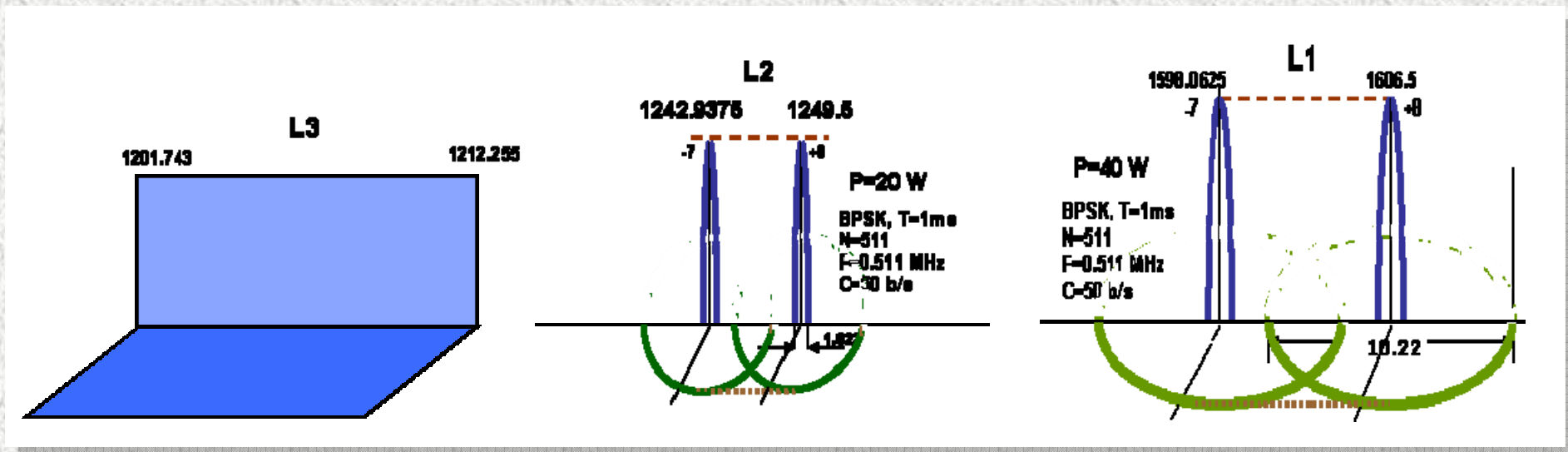
- L1 open FDMA
- L1 authorized FDMA

## ➤ L2

- L2 open FDMA
- L2 authorized FDMA

## ➤ L3 to be refined

- options: FDMA or CDMA





# GLONASS Geodesy Reference



## Difference of GLONASS orbits (range) wrt. ITRF

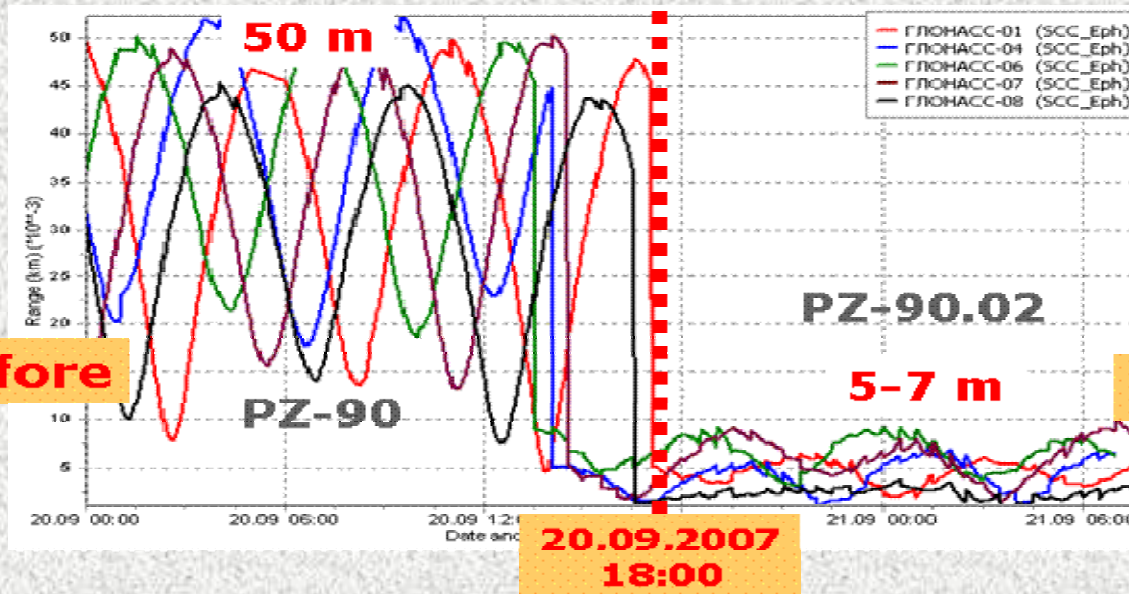
$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{\text{ITRF}} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{\text{PZ-90.02}}$$

**ITRF2000 → PZ 90.02**

$\Delta X = 0.36 \text{ m}$

$\Delta Y = -0.08 \text{ m}$

$\Delta Z = -0.18 \text{ m}$



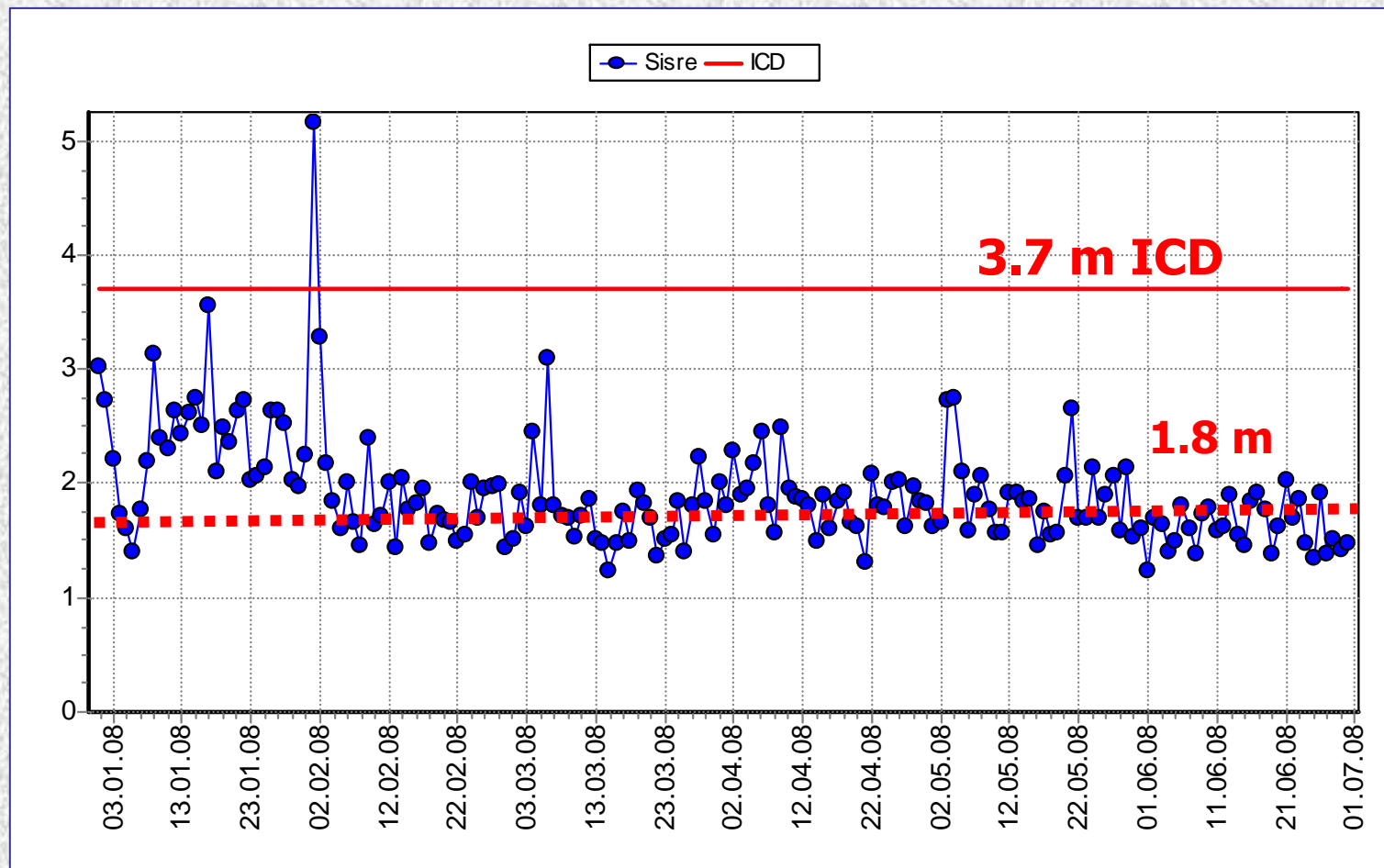
Further improvement is foreseen in the AIP



# GLONASS-M Performance wrt Standard



## SISRE: result of the first phase of GCS modernization

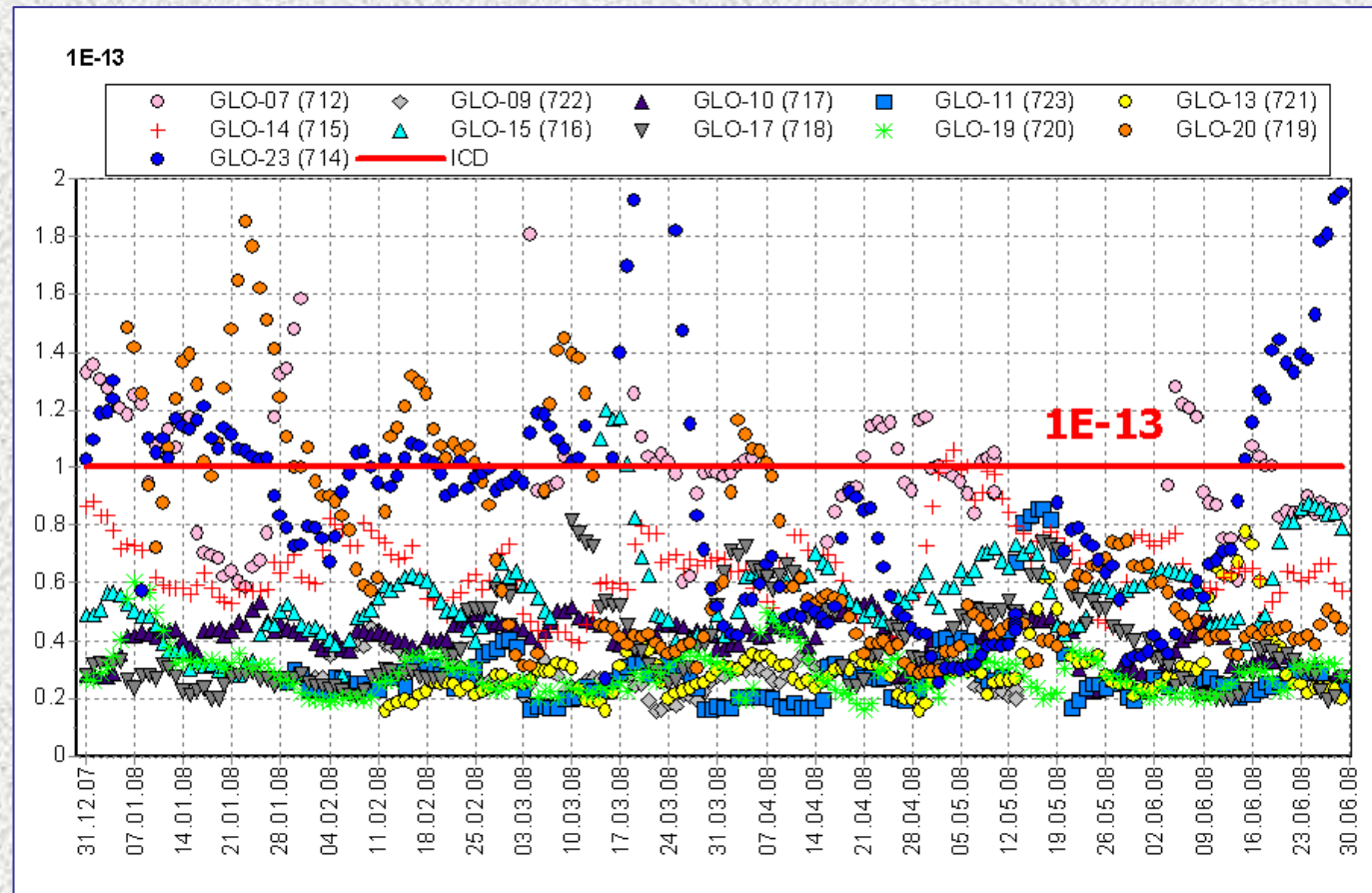




# GLONASS-M Clock Stability

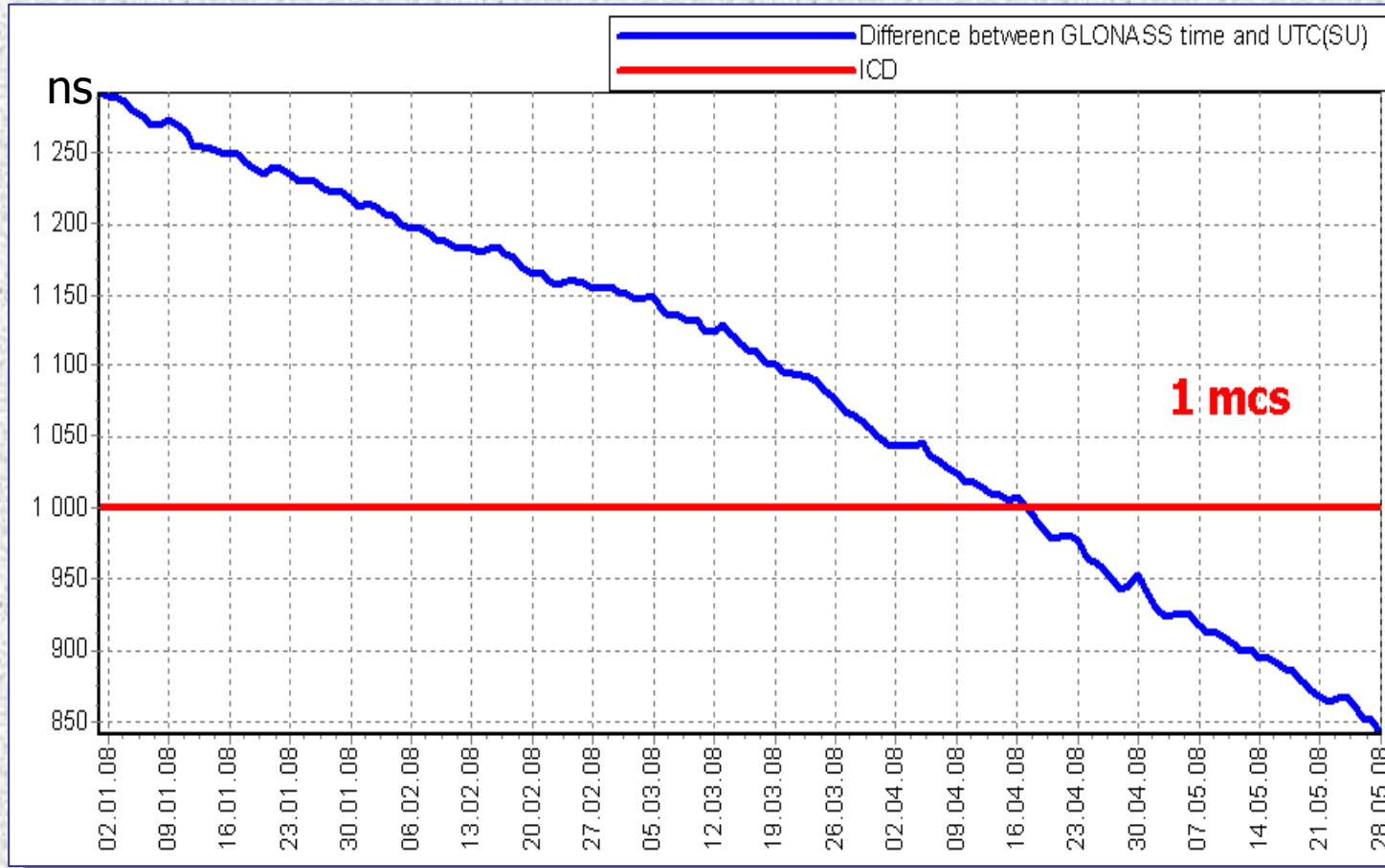


## GLONASS-M Cs atomic clock performance:





# GLONASS Time vs UTC (SU)

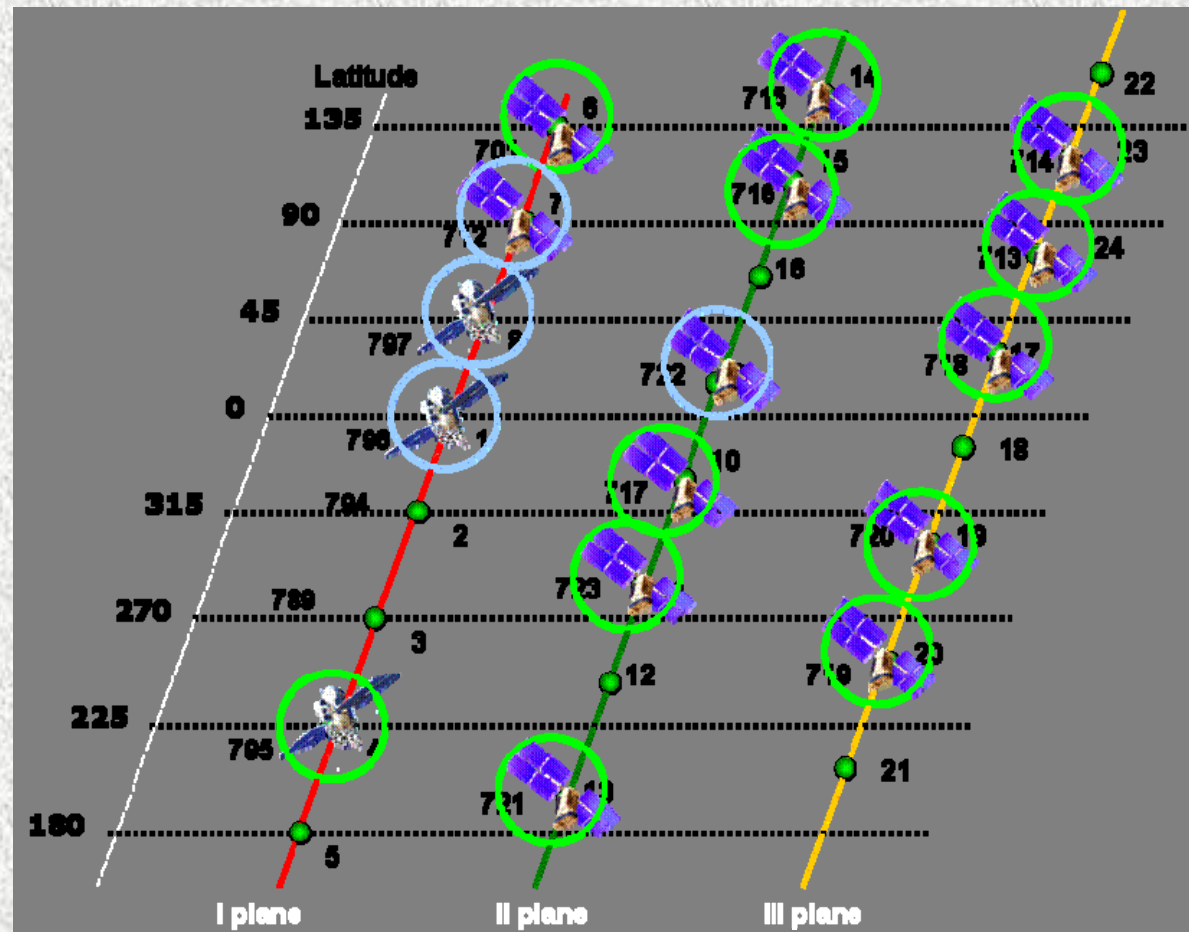




# GLONASS Constellation Status



- **In constellation:**  
**16 satellites**
  - 3 "Glonass"
  - 13 "Glonass-M"
- **Healthy**  
**12 sats**
- **In maintenance**  
**4 sat**
- **Next Launch:**
  - September 2008, Block 38**
    - ✓ 3 Glonass-M
  - November – December 2008, Block 39**
    - ✓ 3 Glonass-M

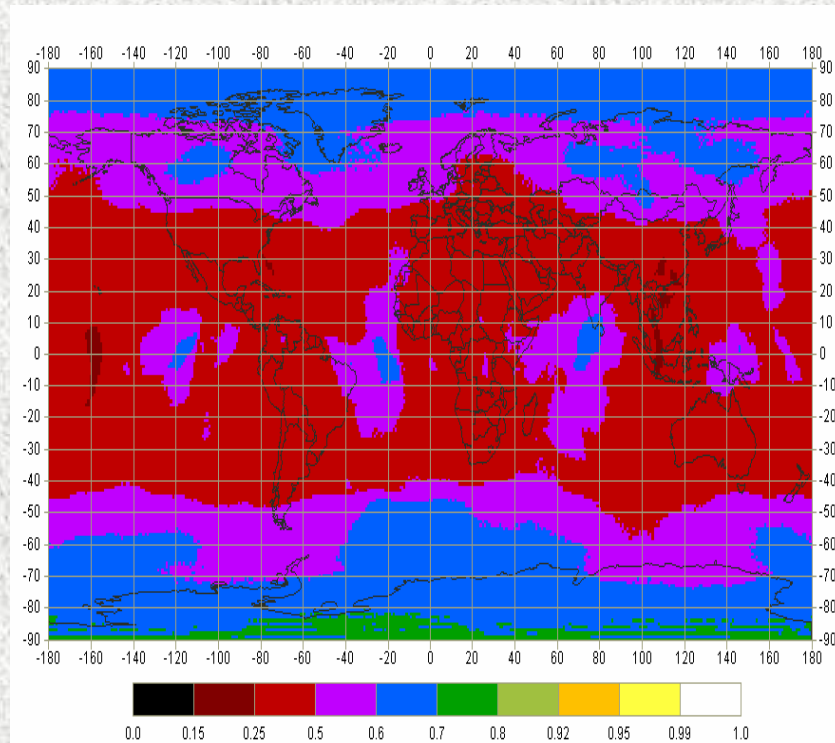




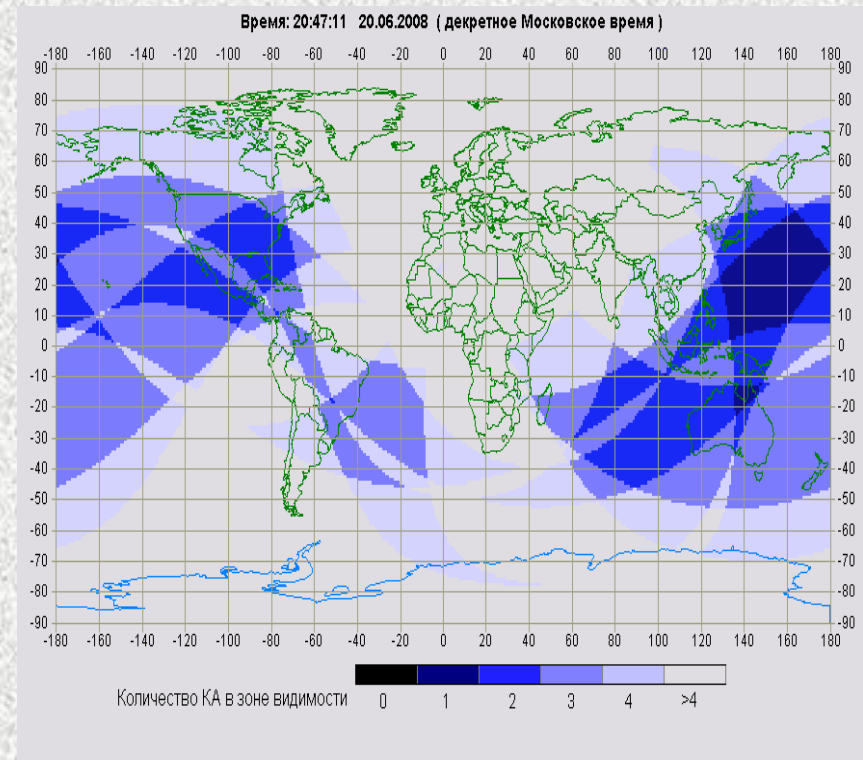
# GLONASS Availability (Current)



Global availability is 47-52% (PDOP < 6,  $\gamma > 5^\circ$ )



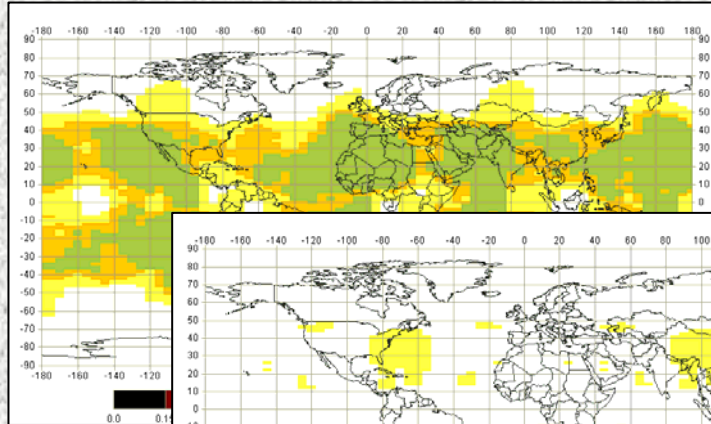
Mean availability for a day



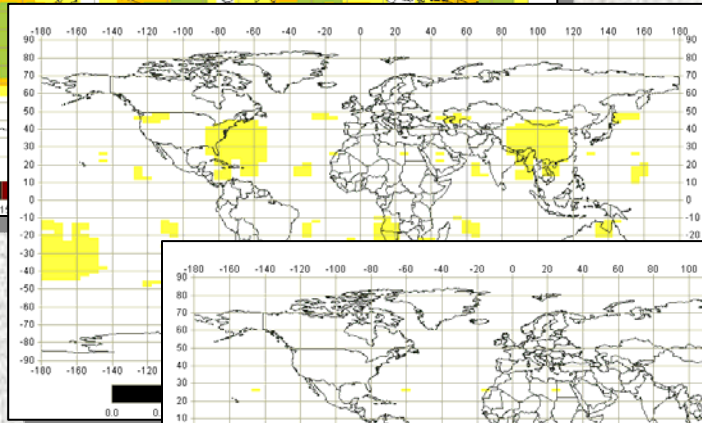
instant availability



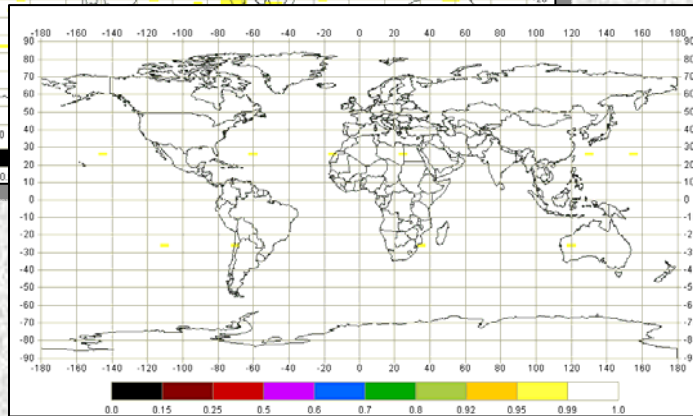
# GLONASS Deployment Program



**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**

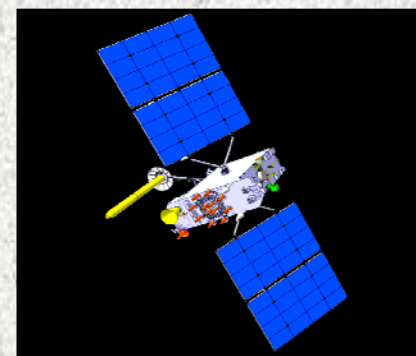
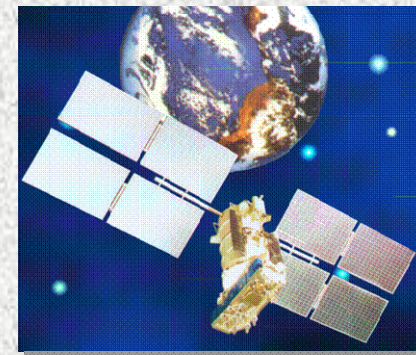
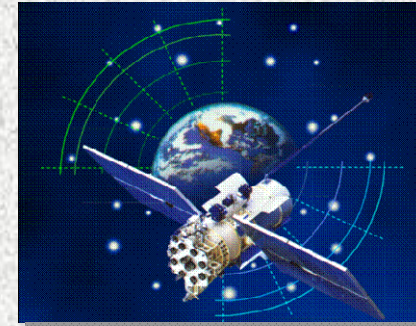




# GLONASS Development Program



- **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



- **PNT is the critical state infrastructure ensuring national security and development of economy**
- **GLONASS is a dual use system and the central part of the 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/Galileo...**
- **Compatibility and interoperability with others GNSS and augmentations (GPS, Galileo...)**
- **Encouraging the navigation mass market development**
- **Use of GLONASS is the binding condition for GNSS use in Russia for the governmental users and critical applications**



# 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.



# 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





# 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!**



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