



STATE SCIENTIFIC CENTER  
OF THE RUSSIAN  
FEDERATION



*NATIONAL RESEARCH INSTITUTE FOR  
PHYSICAL-TECHNICAL AND RADIO ENGINEERING MEASUREMENTS*

**Perspective system for the GLONASS and  
other GNSS monitoring, being developed in  
Russian Federation**

**ICG-7  
WG-A**

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## **Main goals of the GNSS monitoring system being developed**

Independent monitoring and prediction of the main GNSS characteristics (first of all – for the GLONASS system)

definition of consumer characteristics for GNSS (first of all – for the GLONASS system)

calculation of the initial data for the certification of GNSS (first of all – for the GLONASS system)

# System development timetable

Stage 1 –  
Implementation of  
the functional  
GNSS  
characteristics  
monitoring in  
aposterior mode

Stage 2 –  
Implementation of  
the functional  
GNSS  
characteristics  
monitoring in real-  
time mode

Stage 3 –  
Development of the  
information,  
required for the  
international  
certification of  
GLONASS using  
the international  
requirements

# GNSS characteristics monitoring system

Measurement  
stations

Signal energy characteristics  
monitoring equipment

Initial data  
development complex

Data collection and  
preprocessing  
subsystem

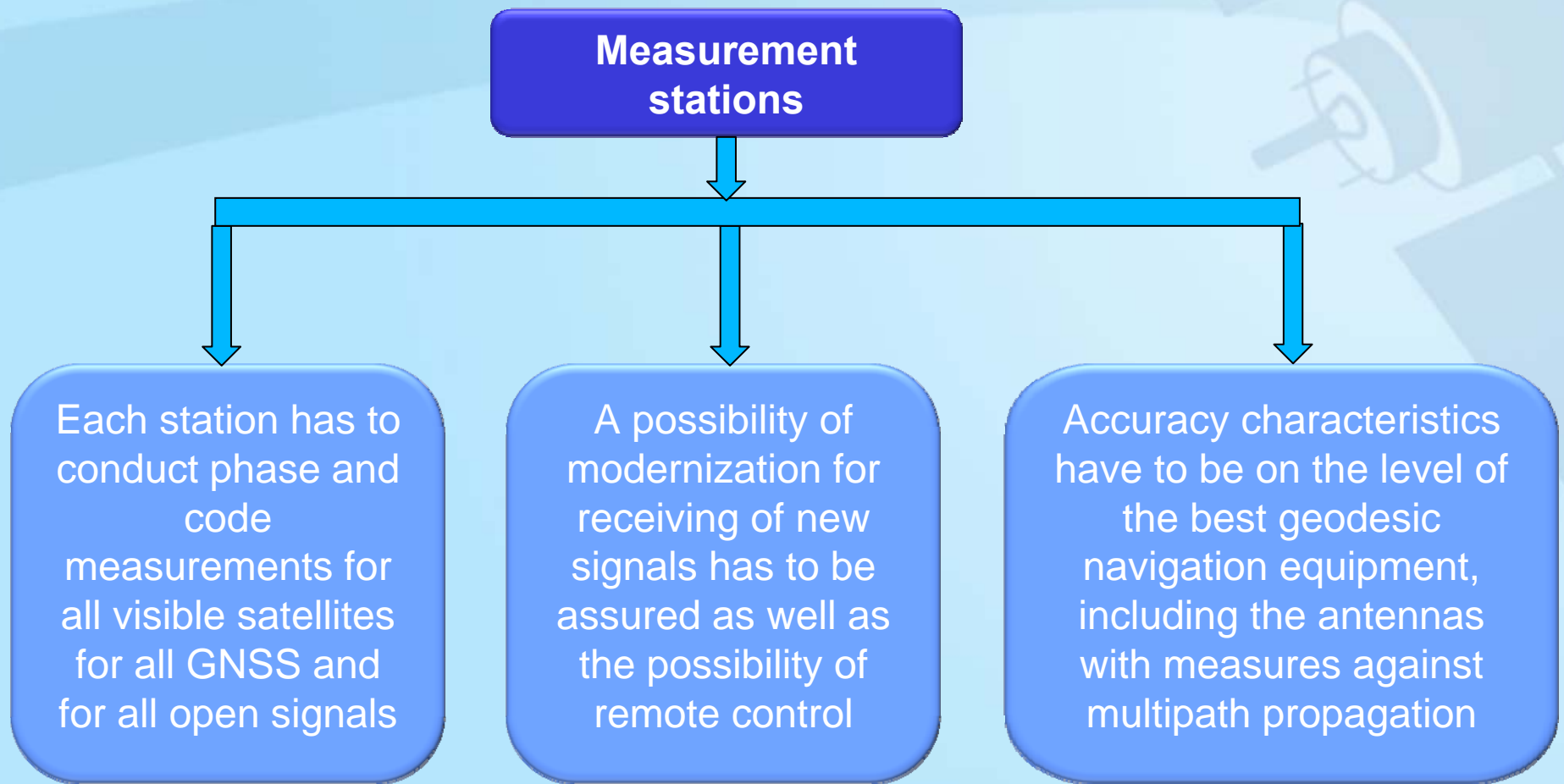
Basis reference  
station

GNSS characteristics control  
complex

Functional and accuracy  
characteristics control center

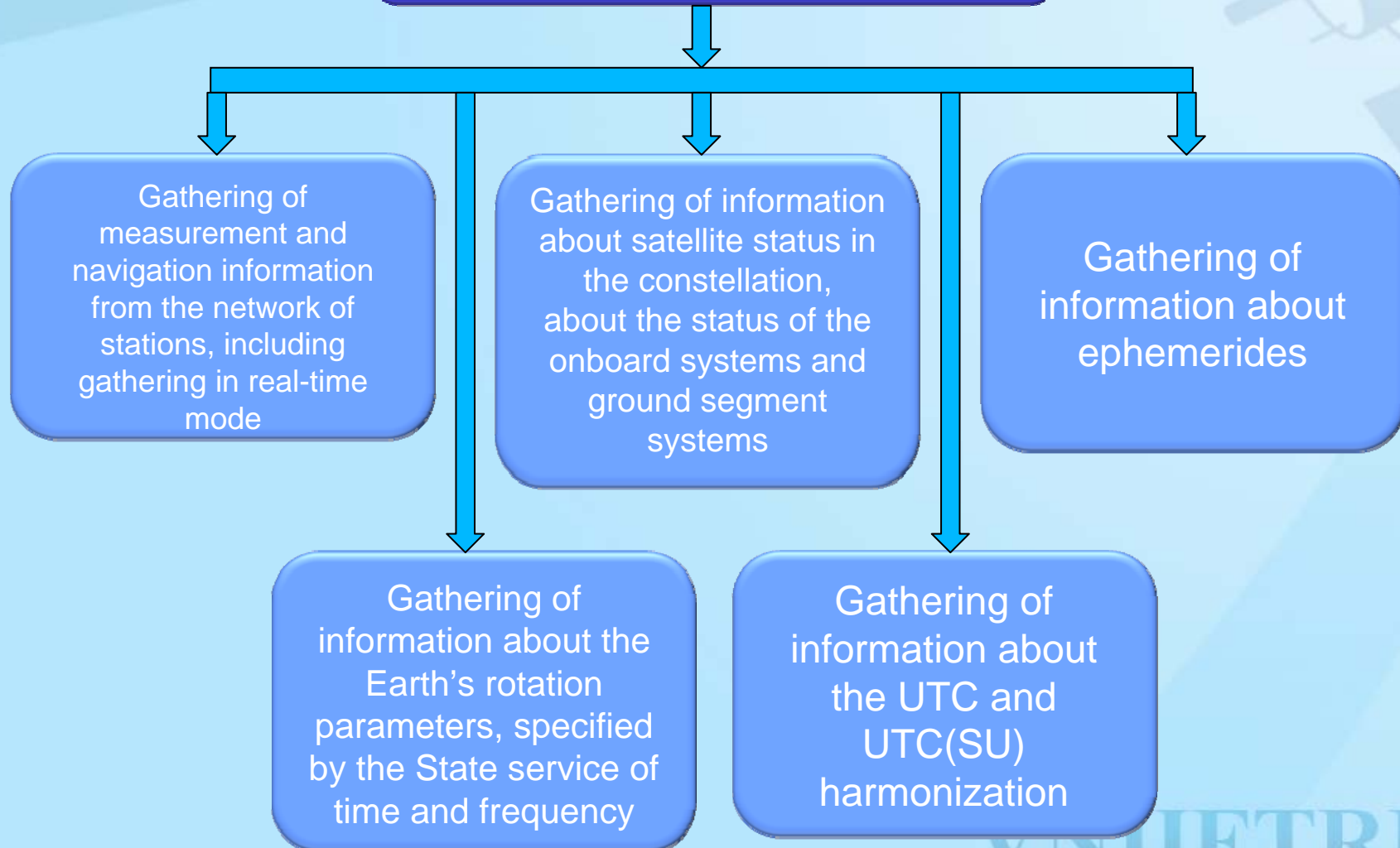
Analysis and prediction system

Data distribution system



The number and location of the measurement stations will be determined by the condition of continuous monitoring of all GLONASS satellites at elevations above 10 degrees

## Initial data development complex



## Signal energy characteristics monitoring equipment

```
graph TD; A[Signal energy characteristics monitoring equipment] --> B[Has to assure the evaluation of the signal energy characteristics for the open signals of all GNSS in use as well as for the augmentation signals with the accuracy no more than 1 dB]; A --> C[In automatic mode measurements have to be conducted for all GNSS satellites with preference to the GLONASS system. In manual mode the possibility of monitoring of any selected satellite, emitting navigation signal, have to be assured.];
```

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In automatic mode measurements have to be conducted for all GNSS satellites with preference to the GLONASS system. In manual mode the possibility of monitoring of any selected satellite, emitting navigation signal, have to be assured.

## GNSS characteristics control complex

Accurate definition of the ephemerides for GNSS will be made in several modes:

- Final ephemerides will be created every day with the delay of five days since the end of the measurements
- Fast ephemerides will be created every day with the delay of fifteen hours since the end of the measurements
- Ultra fast ephemerides will be created every six hours with the delay of three hours since the end of the measurements
- Real-time ephemerides will be created with the delay of ten seconds since the end of the measurements



## GNSS characteristics control complex



Evaluation of the following characteristics will be conducted for GLONASS and other GNSS both for the separate and for the joint use:

- availability of navigation in open terrain at any point of the earth's surface
- Signal-in-space user range error
- mean Position Dilution of Precision
- mean Time Dilution of Precision
- navigation signal's power, received by consumers
- onboard clock performance
- time scale difference estimates for the system time scale and UTC(SU)
- time scale difference estimates for UTC and UTC(SU)
- geodesy reference difference estimates

## GNSS characteristics control complex

```
graph TD; A[GNSS characteristics control complex] --> B[Delay of the final evaluation of the GNSS characteristics will be no more than 10 days]; A --> C[Delay of the preliminary evaluation of the GNSS characteristics based on the results of the measurement made on the previous day will be no more than 15 hours]; A --> D[Delay of the current evaluation of the GNSS characteristics will be no more than 1 minute];
```

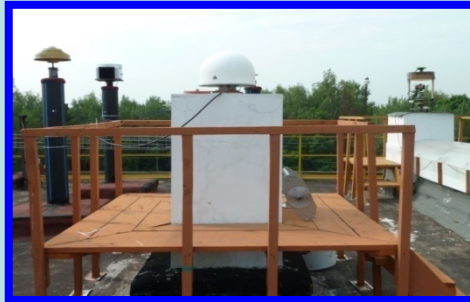
Delay of the final evaluation of the GNSS characteristics will be no more than 10 days

Delay of the preliminary evaluation of the GNSS characteristics based on the results of the measurement made on the previous day will be no more than 15 hours

Delay of the current evaluation of the GNSS characteristics will be no more than 1 minute

# Main standards which are the base for the monitoring system equipment (length)

State special standard of length in the range  
from 24 m up to 4000 km



Reference basis points  
«Mendeleevo»

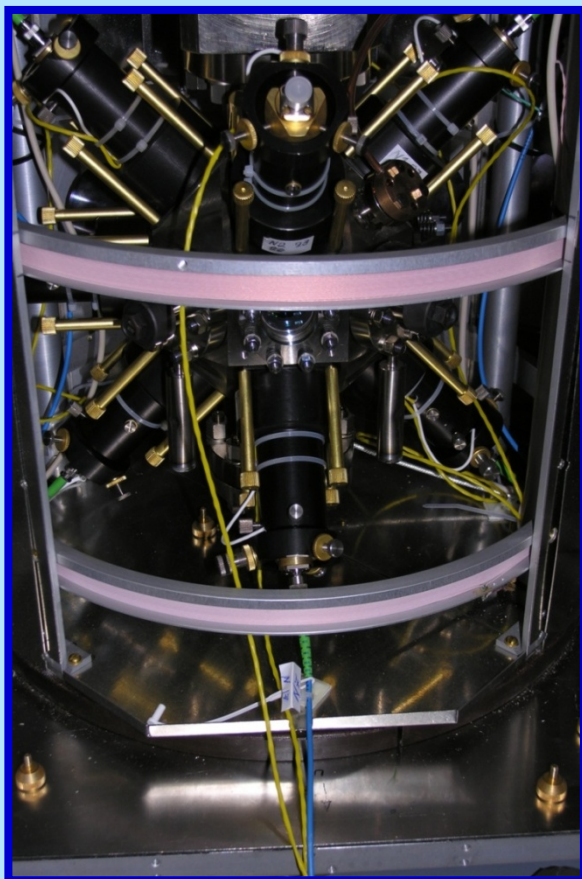


Reference basis points  
«Irkutsk»

Up to 60 m:  
Uncertainty < 40 мкм  
Up to 3 км:  
Uncertainty < 1 мм.  
«Big length» up to 4000 км:  
Uncertainty ≤ 2 см.

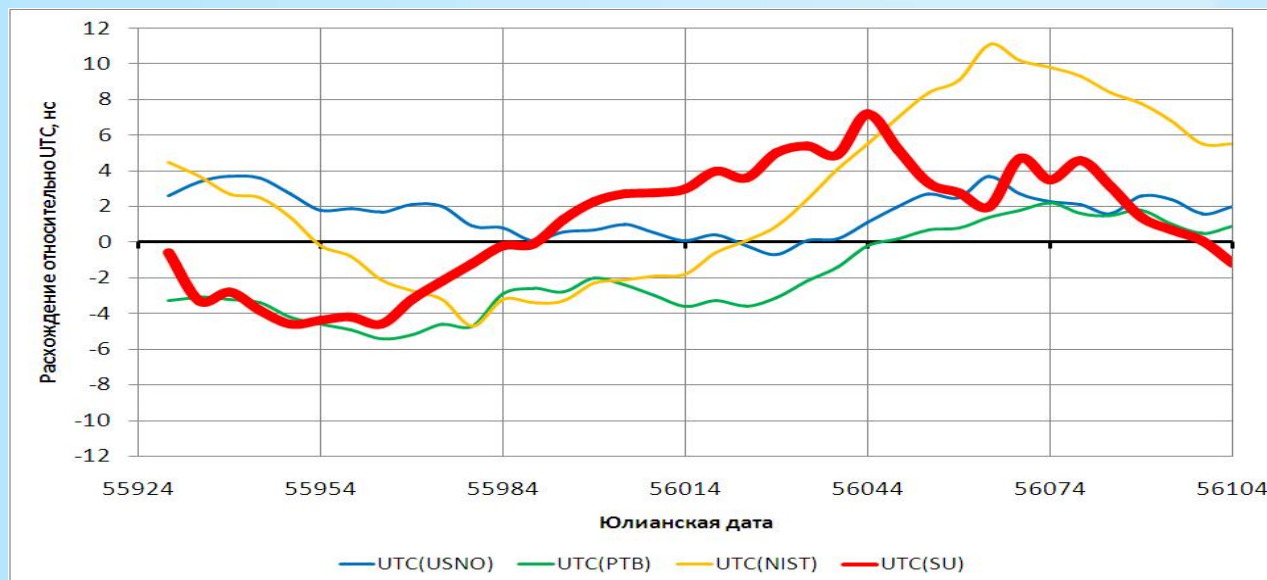
# Main standards which are the base for the monitoring system equipment (synchronization)

Russian cesium fountain with an uncertainty  $5 \cdot E-16$



Uncertainties for cesium fountains

	SYRTE-F01	SYRTE-F02	SYRTE-F0M	NIST-F1	PTB-CsF1	IEN-CsF1	NPL-CsF1
Uncertainty (in units $\cdot E-16$ )	7.2	6.5	7.7	3.3	9	16	10



Time scale differences IUTC(i) – UTCI < 10 ns

# Main standards which are the base for the monitoring system equipment (synchronization)

## Two-Way Satellite Time and Frequency Transfer equipment

time scale difference estimate uncertainty  
 $\pm 2$  ns for the distances up to thousands km



Mobile station



Stationary equipment

Mobile time-transfer standard  
error less than 2 ns per 24 hours



By the year 2020 the system of monitoring being developed will assure:

- Independent monitoring and prediction of the main GNSS characteristics
- definition of consumer characteristics for GNSS (first of all – for the GLONASS system)
- calculation of the initial data for the certification of GNSS
- Possibility of its use as a part of the international system of GNSS monitoring (starting from 2014)



**Thank you for your attention!**

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