Open Joint-stock company
«Research-and production corporation
«Precision systems and instruments»

State Scientific Center
of the Russian Federation
"National Research Institute for
Physical-Technical and Radio Engineering Measurements"

«Proposals on the development of the International GNSS Monitoring and Assessment System in light of existing civil means of monitoring in Russian Federation»

Contents:

1. GNSS Monitoring and Assessment system being developed in Russian Federation.

2. Proposals on the main development principles of the International GNSS Monitoring and Assessment System.

3. Proposals on the list of parameters to be monitored by the International System.

GNSS Monitoring and Assessment system being developed in Russian Federation.

Directions of development for the GNSS Monitoring and Assessment system in Russian Federation

- Extension of the functional characteristics list to be monitored (monitoring for the new signals and frequency ranges, including L1OC, L2OC, L3OC GLONASS signals, signals of Galileo, Beidou, QZSS etc.; monitoring of signals' energy characteristics).

- Improving the accuracy characteristics of means of monitoring (error of pseudorange measurement no more than 0.3 (0.003-0.001)m, error of of signals' energy characteristics measurement for signals no more than 1 dB)

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GNSS Monitoring and Assessment system being developed in Russian Federation.

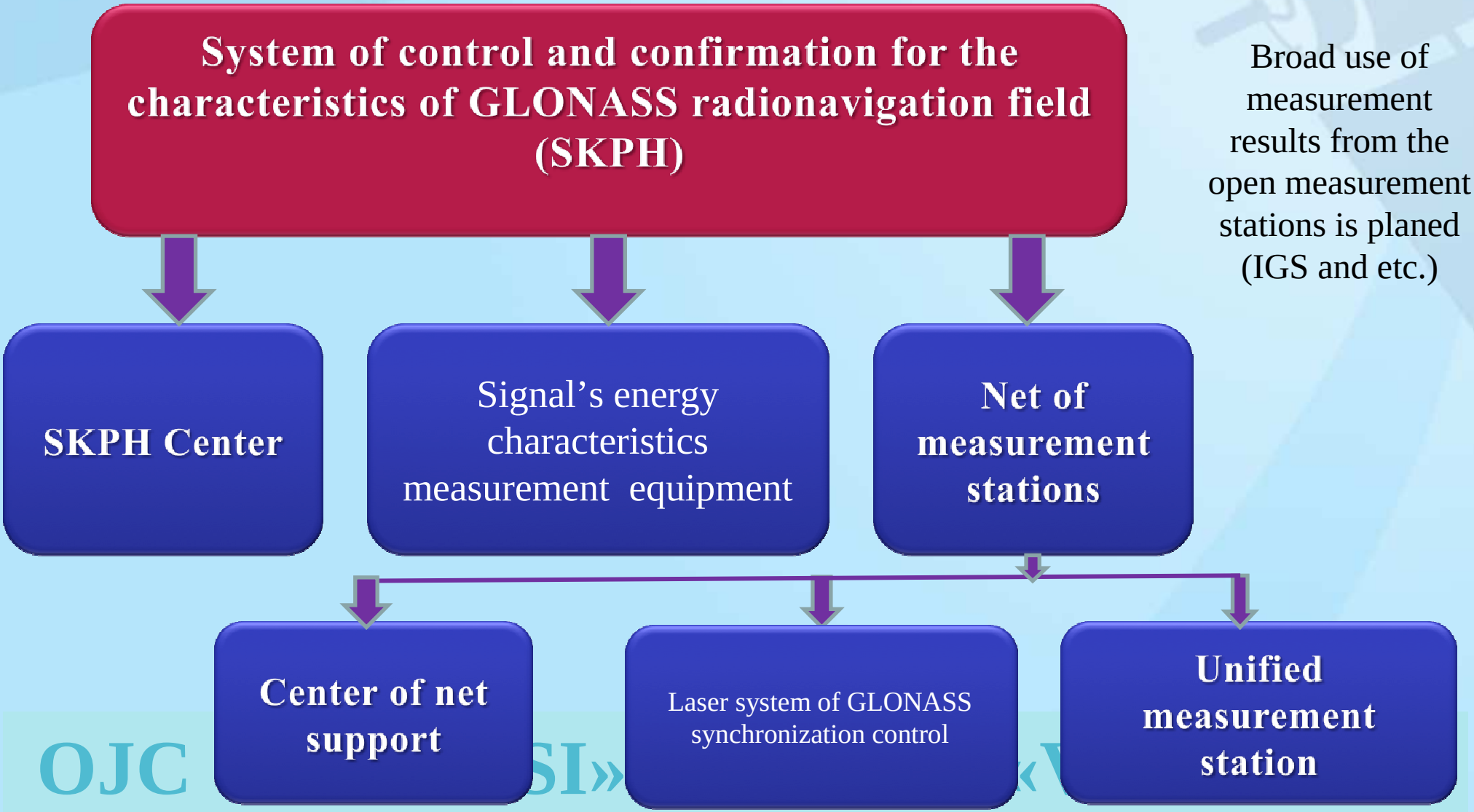
Main goals of the GNSS Monitoring and Assessment system:

- Independent monitoring 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 monitoring and evaluation of functional characteristics in aposterior mode	Stage 2 – Implementation of the monitoring and evaluation of functional characteristics in real-time mode and of accuracy characteristics in aposterior mode	Stage 3 – Implementation of the monitoring and evaluation of accuracy characteristics in real-time mode. Development of the initial data, required for the certification of GLONASS based on international rules and regulations
Designation of the characteristics to be controlled, development of methods and techniques	Confirmation of the GLONASS characteristics monitoring and evaluation system accuracy characteristics	International recognition of the results of GLONASS certification on conformity to the international rules and regulations

GNSS Monitoring and Assessment system being developed in Russian Federation.



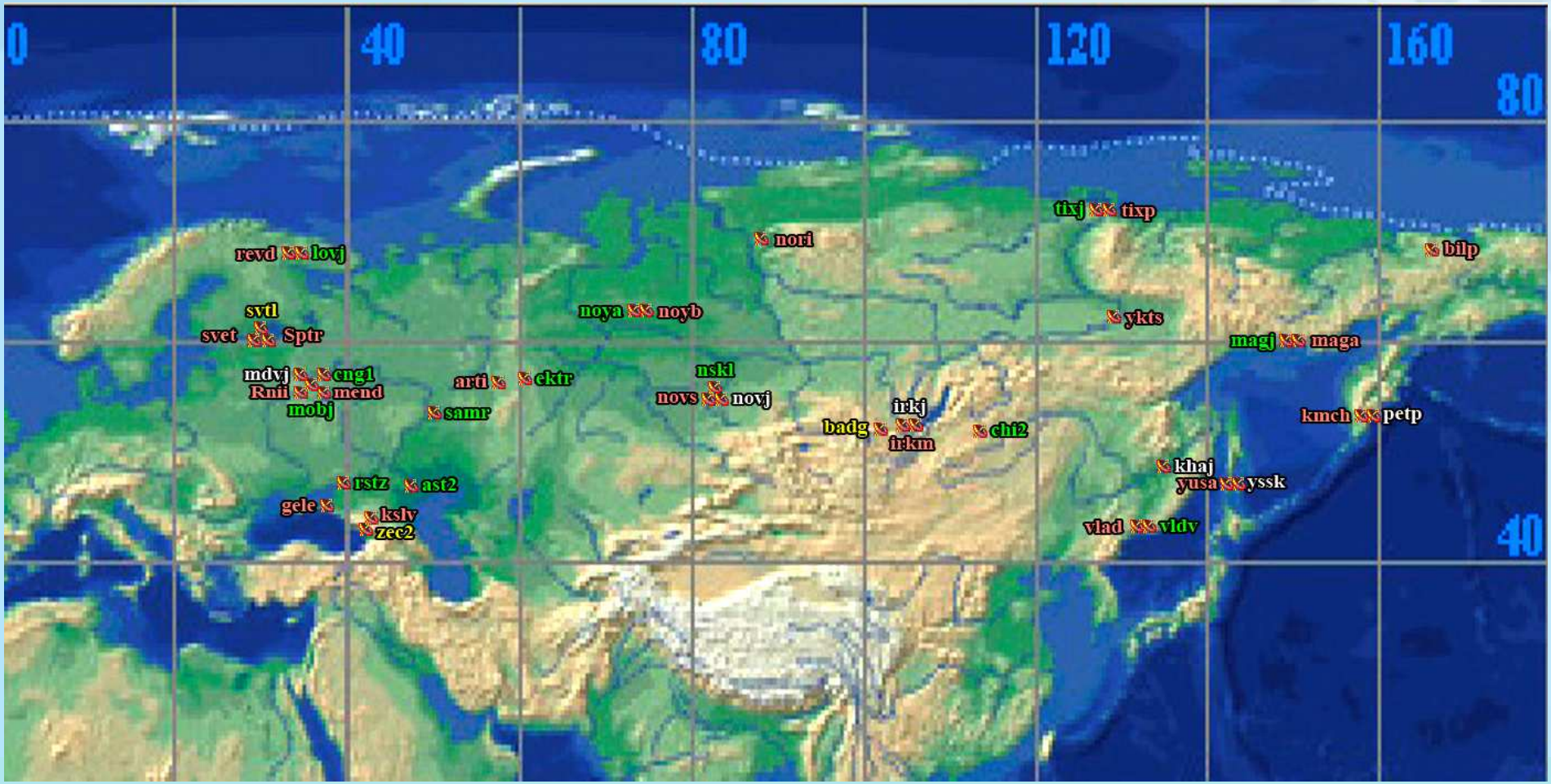
Broad use of measurement results from the open measurement stations is planed (IGS and etc.)

GNSS Monitoring and Assessment system being developed in Russian Federation.

Positioning of the measurement stations belonging to the different projects being developed in Russian Federation

GNSS Monitoring and Assessment system being developed in Russian Federation.

Positioning of the measurement stations in Russian Federation



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GNSS Monitoring and Assessment system being developed in Russian Federation.

Positioning of the signal's energy characteristics measurement equipment in Russian Federation

GNSS Monitoring and Assessment system being developed in Russian Federation.

Antenna assembly for the signal's energy characteristics measurement equipment (possible prototypes)

АС-5,4-L:
- **diameter 5,4 м;**
- **gain factor 32,5…36,5 dB**

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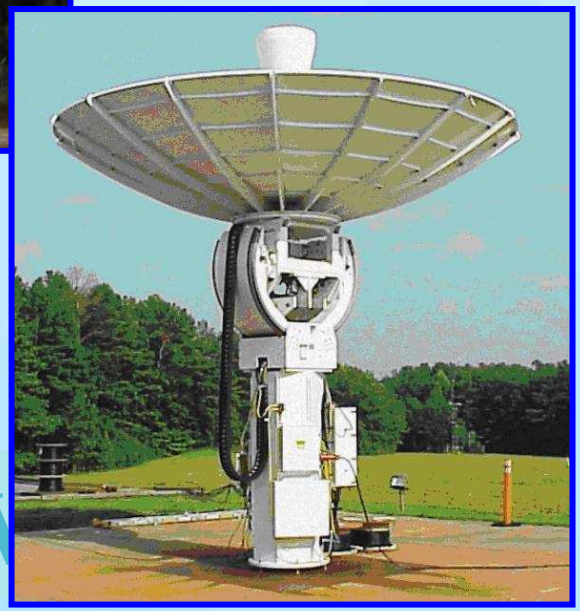
«Polus-5.4H»:
- **diameter 5,4 м;**
- **gain factor 35,4 dB**

ViaSat
(5,4 m fixed X-band tracking system):
- **diameter 5,4 м;**
- **gain factor G/T 31,5 dB/K (typical)**

General Dynamics SATCOM Technologies
(6,5 m full motion antenna):
- **diameter 6,5 м;**
- **gain factor 34,7…35,3 dB**

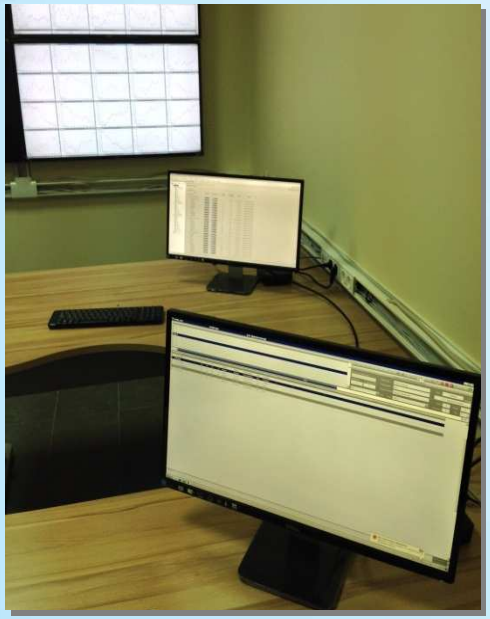
FSUE «V



Measurements results conducted on the Center prototype

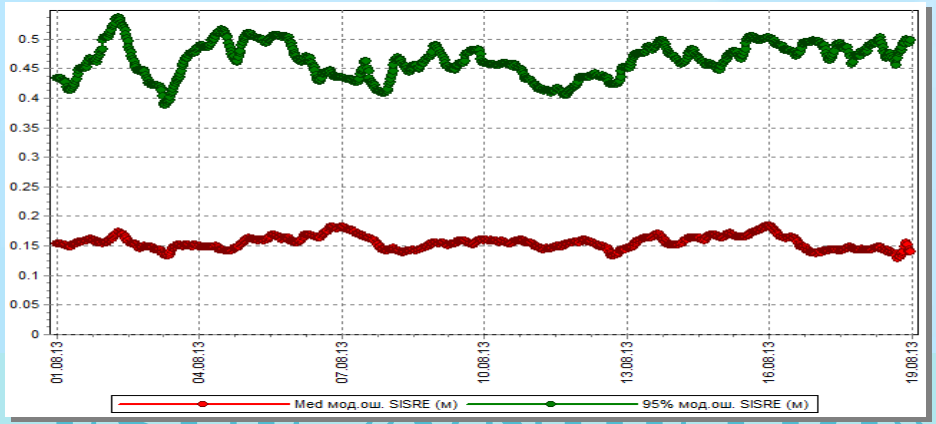
Features of measurement processing:

- Implementation of IAU, IERS, IGS, ILRS recommendations concerning the models of processing
- Integer ambiguity resolution for phase measurements
- Joint processing for the GNSS-receivers and quantum-optical systems
- Solution of computational problems of high dimensionality (more than 100 thousands parameters)
- The implementation of recurrent filtering methods
- Multi-threaded distributed processing



- Processing period: from 15/07/2013 to 19/08/2013
- Structure of measurement sources
  - Final orbits and clocks: 70 stations
  - Ultrafast orbits and clocks : 57 stations
  - Real-time: 46 stations

Real-time accuracy assessment



GLONASS

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Proposals on the main development principles of the International GNSS Monitoring and Assessment System.

Authority in charge for the development of IGMA

National/
International authorities in charge of regional/global monitoring systems

List of characteristics, definitions and methods of assessment, requirements for the technical means

Means of measurement, traceable to the national standards

Mutual recognition agreement for the monitoring results, conducted by the individual monitoring systems

Increase of the accuracy and reliability for the monitoring and assessment results, international recognition of the monitoring and assessment results

Proposals on the main development principles of the International GNSS Monitoring and Assessment System.

Mutual recognition agreement for the monitoring results, conducted by the individual monitoring systems

Goals:

- establish the degree of equivalence for national/international monitoring systems
- assure the mutual recognition of the GNSS monitoring results by different monitoring systems
-increase of the accuracy and reliability for the monitoring and assessment results, provide the concerned authorities with reliable technical base for broader arrangements in the fields of trade, business and in the field of normative documents

Directions of development:

-Use of unified terminology regarding the characteristics to be evaluated and monitored and unified calculation methods;
-Use of unified technical base, traceable to the national standards;
-Comparison of results for different monitoring systems

ILAC as an example of an international assessment system

International Laboratory Accreditation Cooperation (ILAC)

National/ Regional accreditation bodies

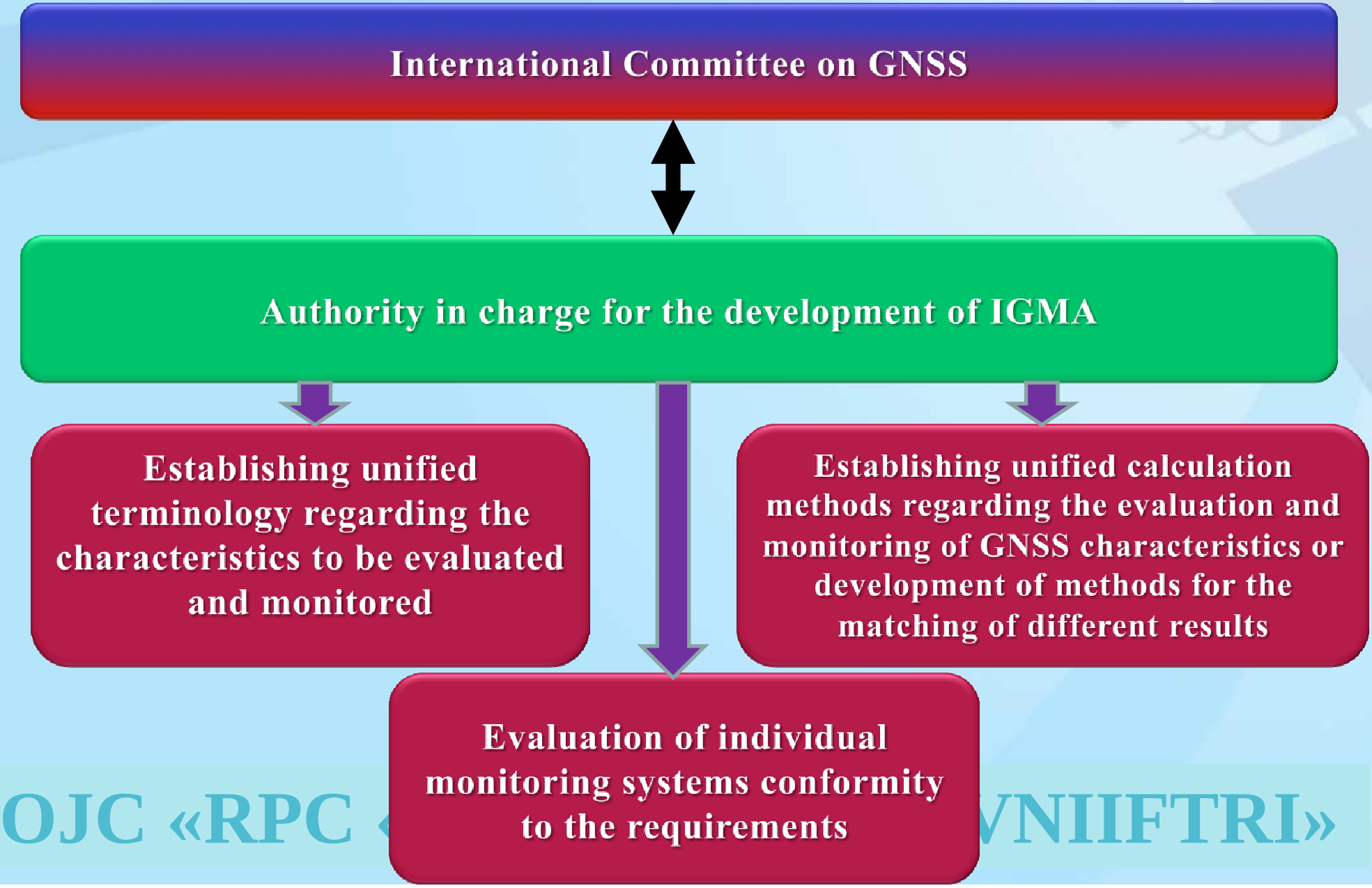
Setting the requirements for the inspection bodies, evaluation of their conformity to the requirements

Necessary technical means and organizational approaches, including traceability to national standards of physical values

ILAC MRA

-Removal of technical barriers in trade
-Creating the conditions for ensuring the reliability of the results accreditation
-Ensuring recognition of evaluation results all over the world

Proposals on the main development principles of the International GNSS Monitoring and Assessment System.



Proposals on the list of parameters to be monitored by the International System.

System characteristics	
1	**Constellation structure/** number of satellites, number of orbital planes, satellites distribution on the planes, reference orbits parameters
2	**Time to alert/** Amount of time required to provide consumers with the information about system integrity breach
3	**Continuity (Probability of assuring the necessary availability)/**The probability that healthy signal-in-space will remain healthy without unscheduled interruption over a specified time interval
4	**Time scale difference estimates for the system time scale and UTC(SU)**
5	**Time scale difference estimates for UTC and UTC(SU)**
6	**The difference of the frame of reference between each GNSS**
7	**Signal power for each satellite on the ground level**
8	**Differential Code Bias, Phase Center Variation(PCV) and Phase Center Offset(PCO) of satellite antenna, Inter-Frequency Bias, Inter-Signal Bias**

Proposals on the list of parameters to be monitored by the International System

Consumers characteristics	
1	**GNSS Constellation Coverage/** The surface area or volume of space in which the signal-in-space must ensure a certain level of accuracy
2	**Availability /** The percentage of time in which the signal-in-space is available to user equipment
3	**Position Dilution of Precision**
4	**Time Dilution of Precision**
5	**Signal-in-Space User Range Error, User Range Rate Error**

List accuracy characteristics for the International System

1	**Precise orbit and clock offset accuracy (or monitoring system requirements to the initial measurement data for precise orbit and clock offset calculation, including information about measurements sources)**
2	**Error of internal convergence for the network of geodetic sites of monitoring stations**
3	**Error of geodetic sites of monitoring stations binding to the GNSS frame of reference and of GNSS frame of reference to the ITRF**
4	**Error of Differential Code Bias, Inter-Frequency Bias, Inter-Signal Bias measurements for monitoring stations GNSS-receivers**
5	**Error of Phase Center Variation (PCV) and Phase Center Offset (PCO) measurements for GNSS-receivers antennas**
6	**Error of national time scale and UTC transfer to the measurement equipment of the monitoring system and error of time scale measurement of the monitoring system equipment**

Thank you for your attention!