GLONASS Policy, Status and Evolution

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• Summary
The Presidential Decree № 638 of May, 17, 2007

- GLONASS civil services are free and unlimited globally
- GLONASS is used as a basis for the National PNT System

- GLONASS Federal Program approved and adopted in March 2012 to support implementation of the National PNT Policy
  - Budget for 9 years secured
  - Contracts awarded

Federal GLONASS Program is a basis for Russian Policy in PNT
GLONASS Federal Program Goals

• Improving system performance in terms of accuracy and integrity
• Ensuring guaranteed positioning, navigation and timing solutions in restricted visibility, interference and jamming conditions
• Enhancing current application efficiency and broadening application domains

Key Quality Indicator of Program – guaranteed provision of announced GLONASS performance characteristics
Performance Improvement Plan

Four-fold accuracy improvement

by means of

- ground control segment modernization
- introduction of new onboard atomic frequency standards (2 CAFs + 2 RAFs)
- introduction of advanced satellite control and command, orbit and clock determination technologies based on crosslinks in RF and optical bands
- transition to PZ-90.11 Geodetic System aligned to ITRF with mm level
- synchronization of GLONASS Time Scale with UTC(SU) at less than 2ns while keeping UTC(SU) long-term stability at $10^{-17}$
GLONASS Constellation Status
(23/10/2013)

GLONASS constellation status, 23.10.2013

<table>
<thead>
<tr>
<th>Total satellites in constellation</th>
<th>28 SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational</td>
<td>24 SC</td>
</tr>
<tr>
<td>In commissioning phase</td>
<td>-</td>
</tr>
<tr>
<td>In maintenance</td>
<td>-</td>
</tr>
<tr>
<td>Spares</td>
<td>3 SC</td>
</tr>
<tr>
<td>In flight tests phase</td>
<td>1 SC</td>
</tr>
</tbody>
</table>

Current values of PDOP over the Earth surface (mask elevation angle ≥ 5°)

The constellation provides global continuous navigation
SIS User Positioning Accuracy – 2.5 m globally, 2.4 m over Russia (RMS)
Latest Launches and Short-term Sustainment

- 1 Glonass-M #47 launched 26 April 2013
- 3 Glonass-M lost 2 July 2013
- 2 Glonass-M (#51, #52) are in storage
- 3 Glonass-M (##53-55) under manufacturing
- Launches by Soyuz or Proton will be determined by operational necessity
- 1 Glonass-K in ground storage to be launched in the 2nd half of 2014

Launch schedule restructured to make up for the loss of satellites
GLONASS Architecture

- Regional and local differential systems for transport, geodesy
- Assisted systems
- Pseudolites

GLONASS MEO Space Complex (incl. Ground Control)
UTC (SU), Earth Rotation Model and parameters, reference systems, maps, precise orbits and clocks

Supporting Systems

Space-based Augmentations
- SDCM (SBAS)
- Global Precise Point Positioning System
- Regional Navigation System (GEO and HEO based) – under feasibility study

Special User Capabilities

Civil User Capabilities (including commercial)
Integrated user equipment (communication, inertial sensors and other sources of navigation information)
Space Segment Modernization

- Glonass-M
- Glonass-K1
- Glonass-K2

- increase of guaranteed life-time
- evolution of satellite service systems
- more stable on-board clock
- new control, command and OD&TS technologies
- introduction of SAR payload
- new signals

Phased build-up of capabilities
<table>
<thead>
<tr>
<th>Satellite</th>
<th>FDMA Signals</th>
<th>CDMA Signals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1</td>
<td>L2</td>
</tr>
<tr>
<td>Glonass-M</td>
<td>L1OF L1SF</td>
<td>L2OF L2SF</td>
</tr>
<tr>
<td>Glonass-K1</td>
<td>L1OF L1SF</td>
<td>L2OF L2SF</td>
</tr>
<tr>
<td>Glonass-K2</td>
<td>L1OF L1SF</td>
<td>L2OF L2SF</td>
</tr>
</tbody>
</table>

L3OC ICD to be finalized by the end of 2013
Objectives
• SBAS L1 full coverage over Russian territory by 2016
• SBAS L1 dual coverage and L5 service in the central part of Russia by 2018
• SDCM SBAS service certification for LPV-200 by 2019
• Precise point positioning service by signals from GEO in L1/L3 GLONASS bands by 2020

System Architecture

Broadcasting channels
✓ 3 L1 GEO
✓ 1 L1/L5 GEO
✓ SiSnet server

RIMS network
✓ 46 stations in Russia
✓ up to 8 stations abroad

Processing Facilities
✓ Main (Moscow)
✓ 2 Regional

Constellation Status
• Luch-5A launched at 16° W on 11 December 2011
• Luch-5B launched at 167° E on 3 November 2012
• Luch-5V to be launched at 95° E in Q1 2014
Global Precise Positioning System Architecture

Objectives:
- Global Precise Point Positioning service (real time)
- Precise Orbit and Clock generation (real-time and post-processed)
International Cooperation on GNSS

- Provision of Compatibility and Interoperability of GLONASS with other GNSS
- Promoting Global Use of GLONASS
- Pursuing competitiveness of GLONASS, Enhancing System Performance
Participation in and contribution to ICG

- Participation in yearly ICG Meetings (since 2006)
- Hosting the ICG-4 Meeting in Saint-Petersburg in September 2009
- Plans to host UN Workshop on the Applications of GNSS in May 2014 in Krasnoyarsk
- Plans to host ICG- in 2016

- Russia – active participant of ICG and its working groups
- Russia co-chairs the ICG Working Group A on Compatibility and Interoperability
Bilateral Cooperation

**USA**
- 9 June 2012 - Renewed Statement of Cooperation between GLONASS and GPS
- Resuming activities of the Working Group on GPS-GLONASS Cooperation

**EU**
- Consultations on Agreement on Cooperation in Satellite Navigation
- May 2013 EC-Roscosmos bilateral discussions - finalizing Joint Statement on Russia – EU Cooperation in GNSS

**China**
- Russia-China Working Group on Space Cooperation
- Including GNSS Signal Monitoring in the Space Cooperation Program for 2013-2017
- Discussion of monitoring stations deployment on mutual basis
GLONASS Program is among priorities of the Russian Government policy

GLONASS open service is free for all users

GLONASS Program (2002-2011) completed, goal achieved
  – Performance is comparable with GPS
  – Full constellation (24 sats) deployed

New GLONASS Program (2012 – 2020) approved 3 March 2012
  – Government commitments for major performance characteristics
  – GLONASS sustainment, development, use

GLONASS will continue
  – Keep the GLONASS traditional frequency bands
  – Transmit existing FDMA signals
  – Introduce new CDMA signals

International cooperation aims at making GLONASS one of the essential elements of the international GNSS infrastructure for worldwide user benefits
Thank you for your attention!

Denis Lyskov  
Deputy Head  
Russian Federal Space Agency (Roscosmos)