Improving the accuracy of GLONASS in the interests of operational and aposteriori applications

Vladimir Pasynkov
The achieved level of accuracy of the space GLONASS segment

Conclusion: As a result of the executed actions of the program GLONASS 2002-2011, accuracy of a space segment has improved several times and amounted to approximately 2.8 m (with probability 0.95) by the end of 2011, that corresponds to the competitive level of the GLONASS system.
Conclusion: Decrease of a contribution of an error of the receiving equipment to an error of navigation of consumers is provided to the level of 1-3 cm.
Navigation on GLONASS signals (ephemeris-time information from structure of a navigation frame)

Characteristic $Q_2$

Error of determination of location in real time in GGSK at the expense of a space segment, m

<table>
<thead>
<tr>
<th>Year</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.8</td>
<td>1.4</td>
<td>1.1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Conclusion: Maintaining of competitive level of accuracy of GLONASS system is provided for 2015-2020.
GLONASS aposteriori technologies

**Method No. 1**
Parrying of the main components of an error of measurements in the aposteriori mode.

**Method No. 2**
Direct high-precision collateral processing of code and phase measurements.

**Conclusion:** The main lack of aposteriori technologies is obtaining the decision with the essential delay, exceeding 1 days.
Conclusion: Accuracy of navigation at the decimeter level – is provided problem solving of applied geodesy
Conclusion: Accuracy of navigation at the centimetric level – prerequisites are created for problem solving of fundamental geodesy.
Conclusion: The solution of a wide range of issues is provided of navigation and geodesy with use of GLONASS, however introduction of GLONASS technologies interferes with the organizational and technical restrictions generated by the competing systems of geodetic support.
High-precision navigation on GLONASS signals

Positioning accuracy 5–10 cm ($P = 0.95$) at the time of the first solution (TTF) no more than 30 minutes

### Table: Error of determination of location in real time in GGSK at the expense of a space segment, m

<table>
<thead>
<tr>
<th>Characteristic $Q_3$</th>
<th>2011</th>
<th>Program GLONASS 2012-2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error of determination of location in real time in GGSK at the expense of a space segment, m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational mode ($Q_{31}$)</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Operational mode with initial initialization ($Q_{32}$)</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>Aposteriori mode ($Q_{33}$)</td>
<td>0.3</td>
<td>0.1</td>
</tr>
</tbody>
</table>

### Conclusion: Perspective level of accuracy is provided of navigation of consumers of GLONASS with use of high-precision ephemeris-time information in real time

Global network of measurements stations in real time (50 stations)

Global informational covering on means of a satellite segment

Global network of measurements stations in real time (50 stations)
Conclusion: Transfer of the GAMI (Global Adaptive Model of an Ionosphere) parameters as a part of digital information of the navigation message L3OS. Increase of accuracy of the accounting of effect – to 2 times in comparison with known models.
Conclusion: It is planned to transfer of parameters of global adaptive model of the troposphere for consumers of GLONASS as a part of digital information of the navigation message (L3, L5, ...
Conclusion: Intensity of development of the Russian economy depends on development of the GLONASS navigation technologies.
Conclusion: The navigation equipment of GLONASS system has become a key element of the onboard equipment of perspective satellites.
Conclusion: Increase of accuracy and efficiency not less than by 1.5 times, decrease in investment risks when creating the combined equipment.
Conclusions

1. Improvement of operational and aposteriori accuracy of GLONASS system provided entire range of navigation and surveying applications, and also its introduction in all sectors of the Russian economy.

2. Perspective development of the GLONASS system is realization of system of real time high-precision navigation, which will provide the decimeter level of accuracy without use of basic differential stations, including its introduction in practice of orbital flights.

3. The perspective direction of development of the international cooperation is combined use of GLONASS and BEIDOU with potential increase of accuracy and efficiency of navigation providing consumers not less than by 1.5 times, and also decrease of investment risks in creating of the combined equipment.

4. The significant progress in the accuracy of GLONASS creates a conflict of interests of the established corporate groups, which openly interfere with introduction of GNSS-technologies in aircraft, the sphere of low-orbital flights, geodesy, etc. These artificial restrictions must be overcome organizationally and technically.
Open Joint-Stock Company
"RESEARCH-AND-PRODUCTION CORPORATION
"PRECISION SYSTEMS AND INSTRUMENTS"
(RPC “PSI”, OJSC)

address: 53, Aviamotornaya Str.,
111024, Moscow, Russia
phone: +7 (495) 234-9847
fax: +7 (495) 234-9859
web: www.npk-spp.ru