“Laser GLONASS”

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Improvement of navigation accuracy is a key problem of global navigation systems. The largest error components of determination of user position are those introduced by orbital group of navigation spacecraft (S/C) and by the ground control system. The “Laser GLONASS” is a combination of methods and technology that will radically reduce that error. Development and full-scale deployment of GLONASS onboard and ground systems can be considered as an effective asymmetric response to competing systems (GPS, Galileo, etc.). Laser GLONASS systems can not only secure parity in terms of accuracy of the space segment, but also exceed the world level of navigation accuracy.

Development of laser means utilizing break-through information and measurement technologies is foreseen to achieve high accuracy characteristics of the GLONASS.

The set of GLONASS technical means includes:

1. Inter-satellite laser navigation and communication system – ISLNCS (fig. 1) designed to solve the following problems:

- high-accuracy inter-satellite one-way measurements for operational ephemeris and time support: for repeated determination of deviation of a S/C time scale drift with sub-nanosecond accuracy at every orbit, and for integrity check;
- provision for global coverage by selection of locations for ground support systems, first of all for S/C time synching – only on Russian territory.

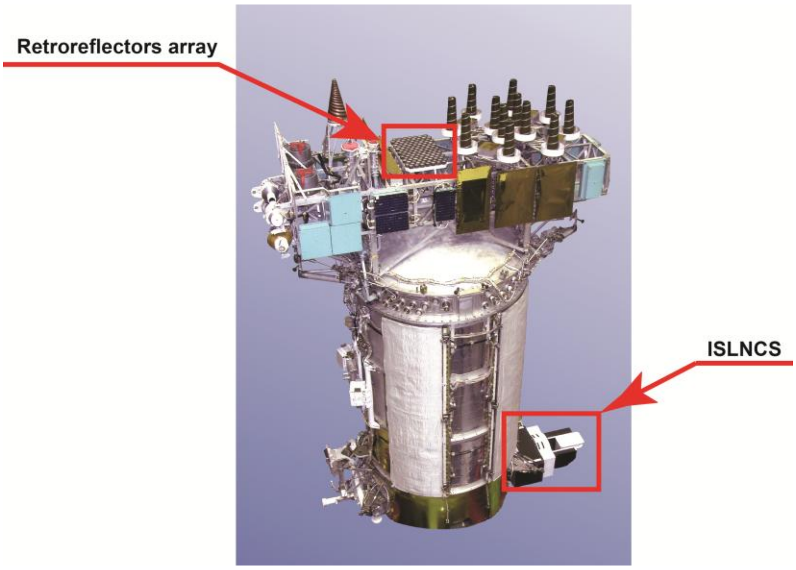

Fig.1 Retroreflectors array and ISLNCS on “Glonass-M”

These ISLNCS tasks are solved using high-accuracy counter-measurements of pseudo range between pointed at each other onboard terminals working in angular auto-tracking mode, placed on GLONASS satellites.

2. One-way SLR (fig. 2) designed for solution of problems at the link “ground-GLONASS satellite”:
- gauging of on-board- and calibration of ground one-way radio systems during their flight operations;
- synching remote ground clocks at accuracy levels not achievable by radio systems and mobile frequency standards.

The one-way SLR employs method of determination of difference between onboard and ground time scales using comparison of one-way and two-way distances measured at sub-centimeter levels.

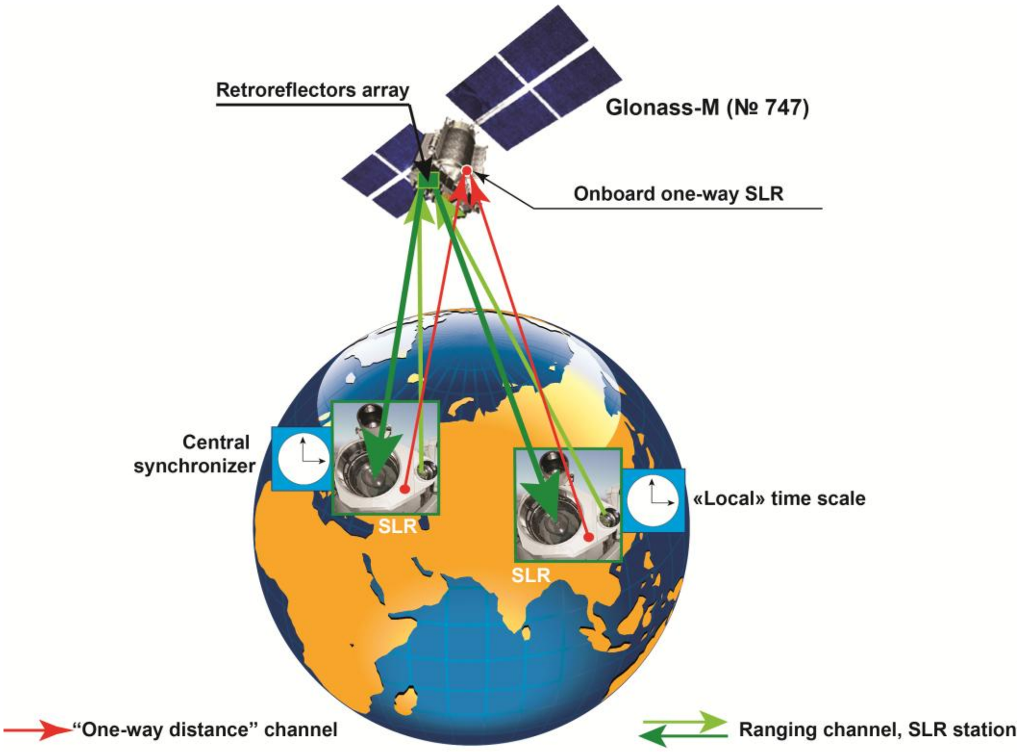

Fig.2. Scheme of time transfer to the ground station by one-way SLR

3. Network of laser systems – SLR, where every system has laser ranger working with retroreflectors installed on S/C (fig. 1), which, together with the International Laser Ranging Service, is designed to solve the following problems:
- gauging of on-board- and calibration of ground active radio systems for trajectory measurements during their flight operations to determine their

systematic and slow-changing measurement errors with sub-centimeter accuracy;

- provision for GLONASS high-accuracy coordinate system to ensure required error of Federal Geocentric Coordinate System expansion when new measurement means are introduced;
- evaluation of representation of Federal Geocentric Coordinate System by GLONASS navigation field.

Effectiveness of laser measurements is the greatest with VLBI, SLR and GNSS monitoring systems (GMS) collocation.

Creation of “Laser GLONASS” and, therefore, dramatic improvement of potential accuracy of ephemeris and time support is a real deal in the near future.