Improvement of Remote Clock Comparisons by GLONASS Signals

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Signals broadcast by GNSS GLONASS and GPS are widely used for high-accuracy comparisons of remote clocks.

However, the accuracy of remote clock comparisons by GLONASS signals is considerably lower than by GPS signals, mainly due to different techniques used for the transmission of navigation signals: frequency division multiple access (FDMA) in GLONASS and code division multiple access (CDMA) in GPS. Using FDMA increases the error of clock comparisons due to different signal delays in SV transmitting equipment and time receivers.

There are several approaches that can increase the accuracy of remote clock comparisons by GLONASS signals. The approaches include using the results of time receiver calibration, combined using of code and phase measurements, improved measurement processing techniques, using *a posteriori* data for measurement processing, etc.

A new Time Transfer Unit (TTU-1) for remote clock comparisons on the basis of 36-channel dual-frequency GLONASS/GPS receiver was developed at "RIRT" JSC in 2011. TTU-1 operates with using the results of antenna and receiver calibration for each GLONASS and GPS frequency and gives out comparison results for code measurements in L1, L2 frequency bands (L1C, L2C), ionosphere-free combination of code measurements (L3C) and ionosphere-free combination of code and phase measurements (CL3). Special testing equipment with GLONASS/GPS signal simulator was developed for calibration. Now the total error of calculated absolute signal delay is about 5 ns. Besides, the delay corrections are measured for each GLONASS frequency with the error no more than 1 ns.

Improved technique for processing the results of remote clocks mutual comparisons includes averaging of measurements by signals from all Space Vehicles (SV) for each session. This technique compensates partly the errors caused by signal delays in SV transmitting equipment.

The results of remote clock comparisons obtained with using the new dual-frequency Time Transfer Unit show that the proposed methods can improve the accuracy of remote clock comparisons to (2-3) ns by GLONASS signals and (1–2) ns by GPS signals.