



Current State and Perspectives of UTC(SU) Broadcast by GLONASS

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GLONASS Time Generation

GLONASS provides high-accuracy determination of position, velocity and time for land, marine, air and other kinds of users.

To achieve this the time scales of all space vehicles (SV) are synchronized to GLONASS Time and GLONASS Time is synchronized to Reference Time. Universal Time Coordinated of Russia UTC(SU) generated by State Time/Frequency Reference (STFR) is used as GLONASS Reference Time.

GLONASS Time is generated as a continuous “paper” time scale on the basis of the Main and/or Reserved Central Synchronizers (CS).



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Central Synchronizers

CS accuracy parameters:

- relative frequency error – within $\pm 3 \cdot 10^{-14}$;
- daily frequency instability – below $2 \cdot 10^{-15}$.

The backbone of CS is Frequency/Time Keeping Facility (FTKF) including four active Hydrogen Frequency Standards (HFS), a system for internal comparisons and a system for steering frequencies and phases of signals from HFS.

HFS which provides the best accuracy characteristics on the results of internal comparisons becomes master standard, the others operate as secondary.

$$\Delta T^{ph}(t_k)$$

$$\Delta T^{fr}(t_l)$$



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GLONASS Time – UTC(SU) Offset

In compliance with GLONASS Interface Control Document, GLONASS Time offset relative to UTC(SU) should not exceed 1 μ s.

At the same time, there is a 3-hour constant offset between GLONASS Time and UTC(SU) due to GLONASS Terrestrial Control Complex operational principles.

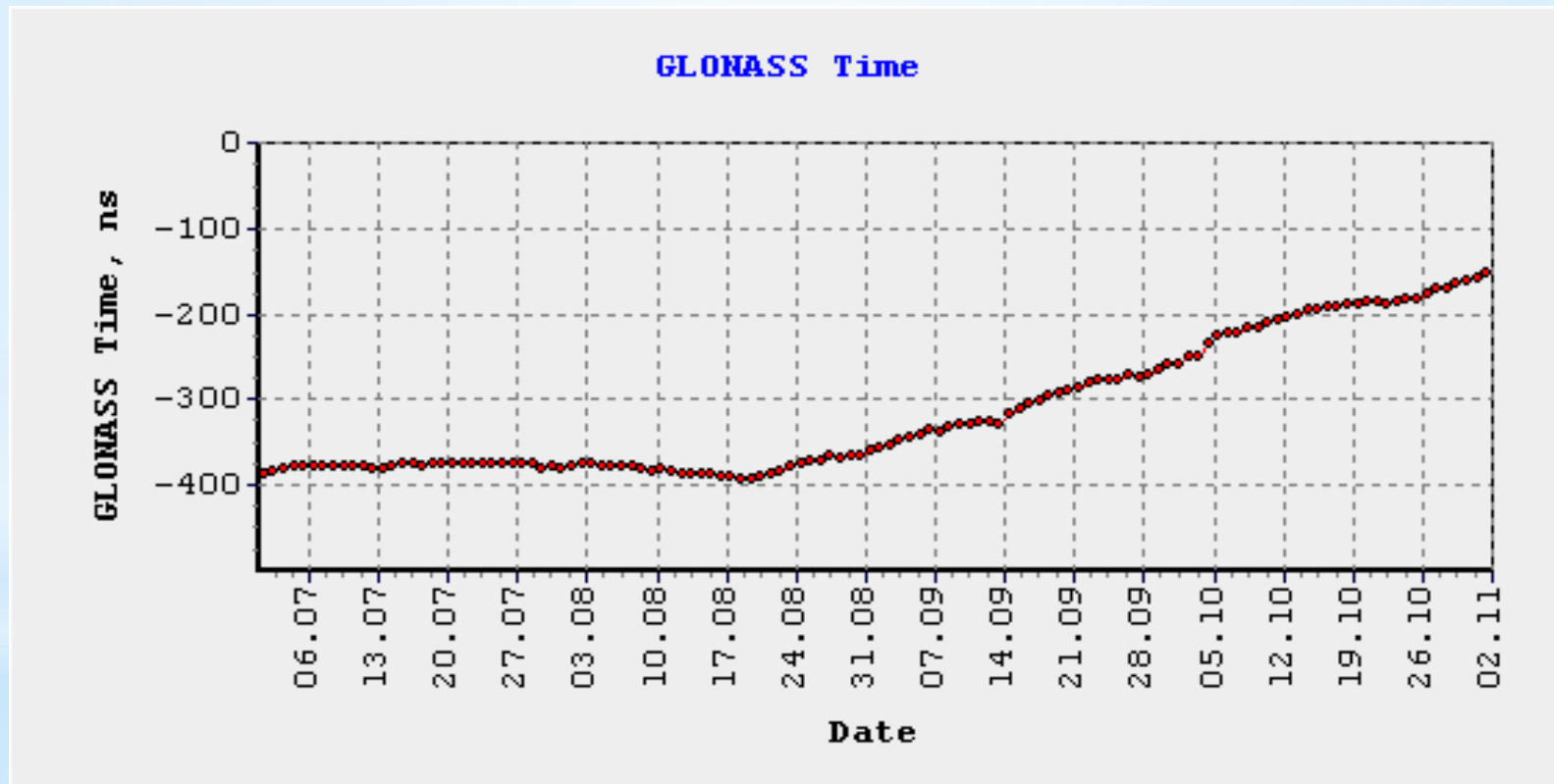
Until recently GLONASS Time – UTC(SU) offset was about 400 ns. It meets the specified requirements but is not satisfactory for time users.

To decrease GLONASS Time – UTC(SU) offset on 18th August 2014 the value of controlling correction was changed.



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GLONASS Time – UTC(SU) offset





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GLONASS Time Correction Change

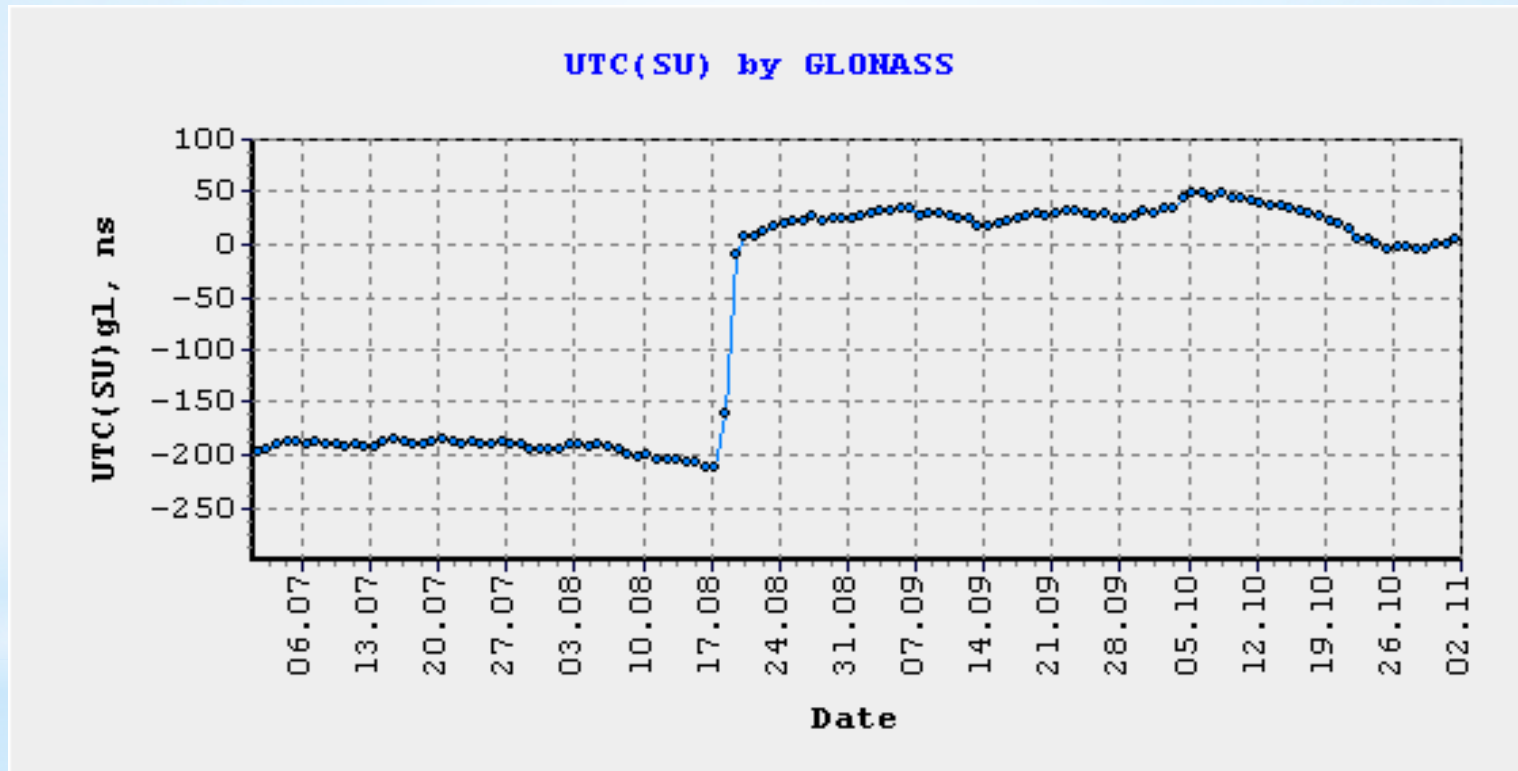
Besides, until recently the error of broadcast corrections for GLONASS Time – UTC(SU) offset contained a systematic component of approximately 200 ns. It caused the error of UTC(SU) broadcast by GLONASS of about 200 ns.

To eliminate the systematic error component of GLONASS Time corrections on 18th August, 2014 the generated corrections to GLONASS Time were also changed.



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Improvement of UTC(SU) broadcast by GLONASS





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Improvement of GLONASS Time Generation and Synchronization to UTC(SU)

The main approaches used to increase the accuracy of GLONASS Time generation and its synchronization to UTC(SU) are:

- a) to decrease GLONASS Time - UTC(SU) offset;
- b) to decrease the random component of broadcast corrections for GLONASS Time - UTC(SU) offset by increasing the accuracy of CS - STFR time comparisons.

As a result of further GLONASS development the following accuracy characteristics are planned to be achieved:

- GLONASS Time - UTC(SU) offset below 120 ns at the 1st stage, 20 ns at the 2nd stage and 4 ns at the 3rd stage;
- the error of broadcast corrections to GLONASS Time below 10 ns at the 1st stage, 5 ns at the 2nd stage and 2 ns at the 3rd stage.



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Thank you for your attention!