The Russian Institute of Radionavigation and Time

System Time Scale Generation and Coordination to UTC(SU)

Arkady Tyulyakov

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Global Navigation Satellite Systems GLONASS is used for high-accuracy determination of position, motion velocity and time by land, marine, air and other kinds of users

To achieve this the time scale (TS) of all Space Vehicles (SV) are synchronized relative to System Time Scale (STS) and STS is synchronized to the Reference Time Scale (RTS)

GLONASS Time Scale Generation

GLONASS STS is generated as a continuous TS based on the Central Synchronizer (CS) TS using the following equation:

$$\Delta T_{STS}(t) = \Delta T_m(t) - \Delta T_m^{syst}(t - t_0) + \Delta T_m^{ph}(t_i) + \Delta T_m^{fr}(t_j)$$

where $\Delta T_{STS}(t)$ - GLONASS STS offset relative to RTS;

- $\Delta T_m(t)$ - CS TS offset relative to RTS;
- $\Delta T^{syst}(t - t_0)$ - compensated system component of CS TS offset;

$\Delta T^{ph}(t_i)$ - corrections for CS phase steering at t_i ;

$\Delta T^{fr}(t_j)$ - corrections for CS frequency steering at t_j .

GLONASS Time Scale Generation

The Universal Time Coordinated of Russia UTC(SU) generated by State Time/Frequency Reference (STFR) is used as RTS

According to the Interface Control Document the GLONASS STS offset relative to UTC(SU) should not exceed 1 ms. At present, this offset is about 380 ns. The systematic error component of broadcast corrections for the GLONASS STS offset relative to UTC(SU) is approximately 100 ns, the random component – does not exceed 10 ns

There is no whole second time offset between GLONASS STS and UTC(SU) because GLONASS STS is corrected simultaneously with the corrections of UTC. However, there is a 3-hour constant offset between GLONASS STS and UTC(SU) due to the Terrestrial Control Complex operational principles

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Central Synchronizer

CS on the base of four active hydrogen frequency standards (HFS) provides the following accuracy characteristics of 5 MHz output signal:

- relative frequency error below $3 \cdot 10\text{-}14$

- daily frequency instability below $2 \cdot 10\text{-}15$

GLONASS STS Synchronization to UTC(SU)

Central Synchronizer time scale offset relative to STFR time scale is determined by simultaneous measuring the Central Synchronizer time scale and STFR time scale offsets relative to GLONASS-time and GPS-time and their joint processing according to the following equation:

$$\Delta T_{STFR-CS} = \Delta T_{GL(GPS)-CS} - \Delta T_{GL(GPS)-STFR}$$

where $\Delta T_{STFR-CS}$ - CS time scale offset relative to STFR time scale

$\Delta T_{GL(GPS)-STFR}$ - CS time scale offset relative to GLONASS/GPS-time

$\Delta T_{GL(GPS)-CS}$ - STFR time scale offset relative to GLONASS/GPS-time

At present the error of determining an offset between Central Synchronizer time scale and STFR time scale is about 8 ns (random mean squares) using GLONASS signals and about 3 ns (rms) using GPS signals

GLONASS STS Synchronization to UTC(SU)

Corrections for the offset between GLONASS STS and UTC(SU) are broadcast to users in navigation messages

The systematic error component of broadcast corrections for GLONASS-time offset relative to UTC(SU) is approximately 100 ns, the random component does not exceed 10 ns

Thank you for your attention!