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ABSTRACT BOOK

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USING SIGNALS OF SATELLITE TELEVISION TO DETERMINE THE DISTANCE TO TELECOMUNICATIONS GEOSTATIONARY SATELLITES

F.I. Bushuev[1], N.A. Kalyuzhny[1], A.V. Shulga[1], A.P. Slivinsky[1,2]

[1]RI "Nikolaev Astronomical Observatory", Mykolaiv, Ukraine;

[2]Ukraine Radio Engineering Institute, Mykolaiv, Ukraine

In the RI NAO an experimental hardware and software complex have been designed to determine the difference of the slant range of a geostationary satellite (GSS). The complex consists of two spaced receivers and the processing centre of the received data. Each receiver has an identical set of hardware and software. A standard antenna-feeder system and a TV-tuner card SkyStar-1 are used for receiving DVB-S signals. The TV-tuner card has been modified in part of outputting the in-phase and the quadrature (IQ) signals of the quadrature detector. Temporary realizations of these signals are input data to determine the difference between the slant ranges of the GSS. The signals are recorded on the hard disk of a personal computer (PC) using digital USB-oscilloscopes with a bandwidth of 40 and 200 MHz and with 8 and 9 bit ADC respectively. The moment of the beginning of IQ signals sampling is set by the 1PPS (pulse per second) signal of a GPS receiver Resolution-T and for this reason the 1PPS signal is sent to the external start clamp of an oscilloscope. Reading the temporary realizations of IQ signals from the oscilloscope's memory and recording them on the PC hard disk are made at the moment when the packet with time information arrives from the GPS receiver. The DVB-S transport stream with a symbol rate 27.5 Msym/s is digitized with a sampling rate equal to 102.4 Msample/s. Recording rate – once per second or less.

In the processing centre the cross-correlation functions of temporary realizations of IQ signals obtained by the two receivers at the same moments of time are computed. At the same time the realization of one receiver is used in full (the first sample) and the second one – only the middle part which has the duration of about 10% (the second sample). The time shift of the maximum of correlation function is determined from the beginning of the first sample. A zero-crossing of the Hilbert transform of the correlation function is used to specify this time shift more carefully. The difference between the resulting shift of

the maximum of the correlation function and a given shift of the second sample is calculated. This difference is equal to the relative delay of TV-signal received by the two receivers and it is proportional to the difference between the GSS ranges to these receivers.

Tests of the complex were carried out in condition when the receiver sites were placed in the same position (the distance between the antennas was about 10 m) and the same 1PPS signal was used to run the oscilloscopes. During the tests an additional coaxial cable of around 6.94 m physical length was connected into one of the tracts and a changing of the relative delay of TV-signal due to the cable was determined. The mean delay caused by the cable was 0.025 μs for the standard deviation equal 0.007 μs.

Diurnal variations of the GSS ranges difference were defined in condition when the receiver sites were placed at a distance of about 145 km from one another. The measured standard deviation of the difference equal to 6.0 m or 0.02 μs and it corresponds to the accuracy of the 1PPS signal of the Resolution-T.

Thus, the complex has some worse accuracy than the similar system “DARTS” (Digital Advanced Ranging with Transport-stream Signals) [Harles et al., 2001]. The DARTS ranging system has been developed in cooperation between Fraunhofer Institute for Integrated Circuits and the ASTRA Satellite System. The main reason of the inferior accuracy is the imperfection of the synchronization system. The use of more accurate time and frequency reference at all stages of signal processing starting with the analog-to-digital conversion should improve the complex's accuracy to the level of the best world analogues. The considering complex could be a prototype of an orbit determination system of geostationary satellites. This system will be cheap to implement and fully independent, do not tied to uplink station as is in the case of the DARTS ranging system.

REFERENCE

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