Proposal to use geodetic-type receivers for time transfer using the CGGTTS format

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We propose to use calibrated geodetic-type GPS receivers like the ASTECH Z-XII3T, for time transfer by processing the pseudo-range measurements obtained in the standard RINEX format with a procedure consistent with the standards defined by the CGGTTS Working Group. The procedure is based on a program developed by Pascale Defraigne and presented in (Defraigne and Bruyninx, 2001). The results obtained in the standard CGGTTS format are directly usable for the standard multi-channel common-view computation of a time link of the type (geodetic-type to geodetic-type) or (geodetic-type to time-receiver). The proposed procedure is slightly modified with respect to that implemented in the classical time receivers (see section 2.1 below), and it uses the Ionosphere-free code (P3) and the IGS rapid orbits. The procedure has been validated by the comparison between CGGTTS files obtained with this method applied to RINEX files generated by a geodetic receiver and those obtained with collocated classical GPS time receivers (Defraigne et al., 2001a). In (Defraigne et al., 2001b), several GPS time transfer techniques have been compared on short (500 km) and long (transatlantic) time links. The comparison of the Allan deviations for an averaging time between 1000 s and 10 days shows that, on long baselines, using P3 code improves by a factor of two with respect to using P1 code with IGS ionosphere maps. On short baselines, the results obtained with the P3 code are equivalent to those obtained with the P1 code or the C/A code, with IGS ionosphere maps.

We present the transformation program and the operating routines to be implemented by a laboratory in section 1 and we describe how the output conforms to the CGGTTS format version 2 (and what adaptations are necessary) in section 2.

1. Implementation of the program and procedures

The program, written in Fortran 77, computes the CGGTTS results using the method described in 2.1. It should run every day; for the day *i*, the files required are the 30-second RINEX observation files of the days *i* and *i*+1 (for the tracks around midnight), and the IGS rapid orbit files (igrXXXXX.sp3 where XXXXX is the IGS representation of the date with GPS week and day number) for the days *i*-1*,* *i,* and *i*+1. Because the IGS rapid orbits are available after 2 days, the CGGTTS files of the day *i* can be computed during the day *i*+3. The output of the program is directly in the CGGTTS format.

The procedure consists of automatic daily ftp connections in order to collect the RINEX observation files and the IGS rapid orbits needed to perform the computations. There is also a daily run of the code in order to generate the file in the CGGTTS format. Parameters such as laboratory code, station coordinates, delays, leap seconds, are read in a separate local file called paramcggtts.dat. At the end of the week, an automatic construction of the file is performed, with the header inserted in the top of the file. This weekly operation is made for consistency with the usual rate of sending data to the BIPM. This file is named gzXXYYMJ.DAY where XX and YY identify the laboratory and receiver (please consult the BIPM for proper nomenclature), and MJDAY is the mjd of the first day of data in the file.

In the Linux environment, the procedure has been developed by Pascale Defraigne (pascale.defraigne@oma.be).

In the Windows environment, the corresponding procedure has been developed by Philippe Moussay (pmoussay@bipm.org).

The software, named RINEX_CGGTTS.f, as well as the Linux procedure to implement it will be freely available by anonymous ftp at omaftp.oma.be/dist/astro/time/RINEX-CCTF/. The Windows procedure will be freely available from the BIPM.

2. Compliance with CGGTTS format version 2

Following are some specific items for which this application requires some adaptation to the CGGTTS format or which conform to the format but deserve some comments:

2.1 Data processing

The short term data processing used in classical time transfer receivers is not implemented in this program. The geodetic receiver operates with a sample time of 30 s (as is standard in IGS operations) and records the observations, dated at the round minute and half minute of GPS time, in a RINEX file. For each 13-minute UTC track, the 26 points included in the duration of the track are used. Ionosphere-free (P3) pseudo-distances are used to compute 26 values of Ref-SV and Ref-GPS from which are computed, with linear fits, the REFSV at mid-track and the corresponding slope SRSV, and the REFGPS at mid-track and the corresponding slope SRGPS. It has been checked that this procedure and the classical short term data processing are equivalent with an uncertainty below 0.1 ns (Defraigne et al., 2001a).

2.2 File header

- IMS will contain the name of the receiver itself because the P1 and P2 measurements will be used to compute a measured ionospheric delay (MSIO).

- INT DLY will contain two values (GPS P1 and GPS P2), in a similar way as in the GPS + GLONASS case where two values are present. In the present version of the format, INT DLY refers to the sum of the internal delay and the antenna delay. These values are determined by absolute or relative calibration (Petit et al. 2001). Following the notations in this reference, INT DLY corresponds to $X_R + X_S$.

- Following the notations in (Petit et al., 2001) CAB DLY corresponds to $X_C + X_D$ and REF DLY corresponds to $X_O + X_P$.

2.3 Data lines

- IOE will contain a code to indicate that IGS rapid orbits are used to compute REFSV and REFGPS. The value 900 is proposed for this code.

- Because MSIO will contain the measured ionospheric delay at L1 (computed with the P1 and P2 measurements), and because REFGPS will be a ionosphere-free value computed with the P3 linear combination, MDIO will also contain the same value as MSIO. Thus someone willing to apply another measured ionospheric delay will proceed as usual, adding MDIO to REFGPS and substracting back the desired value.

- The column of FRC will contain the code L3P for ionosphere-free combination.

References

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G. Petit, Z. Jiang, P. Moussay, J. White, E. Powers, G. Dudle, P. Uhrich, 2001, Progresses in the calibration of geodetic like GPS receivers for accurate time comparisons, Proc. 15th EFTF, pp. 164-166.