CCTF 2004: Report of the Royal Observatory of Belgium

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Clocks and Time scales:

The Time Lab of the Royal Observatory of Belgium (ROB) contains presently 3 Cesium clocks HP5071A with standard tubes, one active H-maser CH1-75 and one passive H-maser CH1-76. In 2002, all the time laboratory was moved in a new room, where temperature variations are kept smaller than 0.2°C.
The UTC(ORB) time scale is generated from the frequency of the active H-maser, of which the auto-tuning is adjusted by the passive H-maser. The monitoring of UTC(ORB) is performed daily from a comparison with the USNO Master Clock MC3 used to steer the USNO Ashtech Z-XII3T receiver (IGS station). This comparison is done using the self-developed RINEX-CGGTTS conversion software using the P3 ionosphere free combination and IGS rapid and ultra-rapid orbits. The behavior of UTC(ORB) with respect to UTC is shown in Figure1. The epochs of large variations correspond to maintenance of one of the masers due to failures; at these epochs UTC(ORB) was realized by a cesium clock.

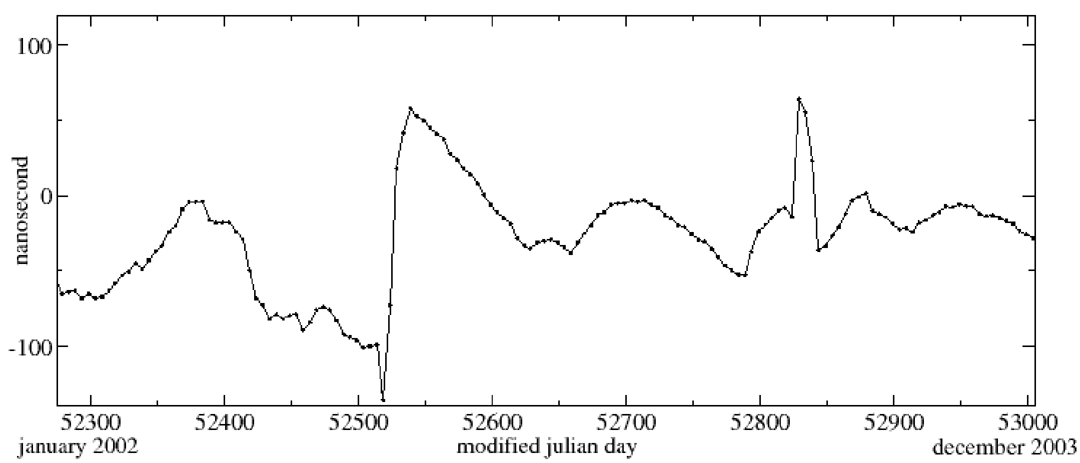

Figure 1. UTC-UTC(ORB) from 2002.0 to 2004.0

Test of new equipment fo time and frequency transfer using GPS codes and carrier phases.

The ROB time laboratory is equipped with two Ashtech Z-XII3T receivers. One is used for both TAI (within the TAIP3 project) and IGS; the other one is used as a backup. Both receivers have been calibrated in the frame of the BIPM calibration campaign.
As the ROB is strongly involved in the EUREF Permanent Network (EPN), we are routinely computing the time link between all the EPN stations equipped with an Ashtech Z-XII3T receiver and BRUS (name of our IGS station). Two separate analyses are performed: a RINEX-CGGTTS analysis using ionosphere free code P3 and rapid IGS orbits (Defraigne and Petit, 2003) and a combined code-carrier phase analysis based on the Bernese V4.2. software. We improved the carrier-phase based time transfer using the Bernese analysis software by determining optimal ways to deal with the errors on the station coordinates and the modeling of the troposphere.

We also tested a new type of geodetic receiver for suitability to time transfer by common view: the PolaRx2 (Septentrio). The first results showed variations that were associated with variable load of the processor inducing internal temperature changes and hence variations of the internal hardware delays (solved now). We also pointed out a remaining problem of synchronization on the input 1pps (also solved now). Finally we determined differentially the receiver hardware delays for P1 and P2 and obtained very similar biases for both of the receivers tested. All our results showed very small noise level, and demonstrated the suitability of the receiver for very precise time and frequency transfer.

Time transfer to TAI using geodetic receivers

At the ROB were developed the procedure and the software tool that allow to generate the CCTF files needed for time transfer to TAI using RINEX files produced by geodetic receivers driven by an external frequency. We proposed some modifications to the CCTF procedure to adapt it for the links between geodetic receivers, in order to take advantage of the P codes available on L1 and L2. This new procedure forms the ionosphere-free combination of the P1 and P2 codes as given by the 30-second RINEX observations files, the standard of the International GPS Service (IGS). The procedure is tested using the Ashtech Z-XII3T geodetic receivers and the results are compared to those obtained with the classical CCTF procedure based on the C/A code by computing the fractional frequency stability (Allan deviation) of the time links. Over short baselines, the two techniques are equivalent, while the new technique provides a factor 2 improvement for a transatlantic time link. For time links between one time receiver and one geodetic receiver, the differential satellite delays (P1-C/A or P2-C/A) must additionally be introduced. Some tests showed here that these biases however do not alter the long term (>3 days) stability of the time transfer results. The corrections associated with tidal station displacement were also investigated, and shown to be at the level of tenths of nanosecond.

References:

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