

RECOMMENDATION

On the utilization and monitoring of redundant time transfer equipment in the timing laboratories contributing to UTC

The Consultative Committee for Time and Frequency (CCTF)

realizing that

- atomic frequency standards have achieved unprecedented precision and accuracy, and that further rapid advances in this field are underway,
- the ability to compare these standards for the realization of UTC is limited by the accuracy, precision, and stability of time transfer equipment;

considering that

- time and frequency transfer data from the use of Global Navigation Satellite Systems (GNSS) signals and from Two-Way Satellite Time and Frequency Transfer (TWSTFT) systems play an important role in the realization of UTC,
- regular time link calibrations and GNSS equipment calibrations have been carried out through cooperation of the BIPM, the Regional Metrology Organizations (RMO) and the UTC contributing laboratories resulting in calibration uncertainties at the level of order 1 ns to 1.5 ns,
- hardware delay variations in the time transfer data limit the validity of calibration results, and random variations in measurements also limit the ability to combine data from redundant and complementary techniques.

noting that

- Recommendation CCTF 4 (2012) asked laboratories contributing to UTC to upgrade their GNSS equipment towards multi-frequency multi-constellation receiving systems providing code- and carrier-phase measurements and to supply data from at least three receivers,
- the calibration of GNSS receivers of the Group One (G1) laboratories designated by the RMOs has special importance as they influence the calibrations or links of multiple other laboratories in a consistent manner,
- variations of the common clock difference (CCD) between GNSS systems and variations of the double clock difference (DCD) between Global Positioning System (GPS) and TWSTFT links exceeding the combined calibration uncertainty of the most recent calibrations have been observed,
- several ongoing studies consider ways to mitigate the effects of time transfer system's calibration variations;

recommends that laboratories participating in UTC-generation

- maintain at least two (three in the case of G1 labs) independent GNSS systems, some of which being state-of-the-art if resources are available,
- provide all data from redundant GNSS systems to the BIPM,
- monitor their CCDs and the internal characteristics of their laboratory reference signals, such as the shape of their pulse-per-second signal as seen at their time transfer systems, on an annual or other appropriate basis,

- document all setup and configuration changes relevant to time transfer and report them to the BIPM,
- record and maintain both external and relevant internal temperature and humidity information and report to the BIPM,
- calibrate at least one operational link every two years,

recommends that the BIPM and the CCTF WGs on TWSTFT and on GNSS Time Transfer

- coordinate TWSTFT and GNSS calibrations so that they can be compared and that the seasonal impacts can be studied and their effects minimized;
- study the impact of introducing calibration results on the long-term CCD and DCD series

recommends that the BIPM

- continue to publish its computed time transfer differences (links and link comparisons) on its web pages in computer readable files with self-descriptive names;
- continue to publish the information about system configurations and calibration results on its web pages, along with the associated reports;
- continue to study the use of redundant time transfer systems in UTC generation;
- add in the timing data base the station temperature and humidity information and make these data available to the WGs.
- add in the timing database the station setup and configuration changes relevant to time transfer