

## Calibration of time links for TAI

Contribution by the BIPM

There have been a number of past Recommendations dealing with different aspects of calibration issues: CCDS Recommendation S6 (1993) recommended “that methods be developed and implemented for frequent and systematic calibration of GPS timing receiving equipment”. CCTF Recommendation S4 and S5 (1999) have also stressed the importance of calibration for multi-channel GPS/GLONASS receivers and for GPS phase-code receivers respectively.

The fractional frequency instability of TAI and of other independent atomic time scales is now below  $1 \times 10^{-15}$  for averaging duration around one month so that changes in hardware delays by a few ns over one month may now be significant. There is evidence that such events have occurred in some time links used in TAI computation over recent years, some of which could not be detected or corrected. Even if such an event may be detected and corrected *a posteriori*, modifying TAI after the fact is another source of instability for those using TAI as soon as it is made available each month.

Therefore it is desirable to pursue an important program of calibration measurements, aiming at 1 ns uncertainty, a level compatible with sub- $10^{-15}$  fractional frequency instability for TAI. This is the rationale for a draft Recommendation, which considers calibration issues with the aim of improving the stability of TAI and the accuracy of the access to UTC:

The CCTF

Considering that

- previous recommendations of the CCDS and CCTF have stressed the importance of the calibration of time transfer equipment to ensure the accuracy of time links,
- improvements in clock technology and in time transfer techniques have resulted in better stability for ensemble time scales, particularly for TAI,
- uncompensated changes of the hardware delays in a time link may cause a significant instability in an ensemble time scale like TAI,

recommends that

- absolute and differential calibration methods be continued to be developed and put to operation for all time transfer techniques used in TAI computation, with the aim of achieving 1 ns uncertainty (one sigma),
- laboratories participating to TAI carry out regular calibration exercises and continuous monitoring of time transfer equipment,
- techniques used for the time links of TAI be independently calibrated.