The Consultative Committee for Time and Frequency

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Bureau
International des Poids et Mesures
The CCTF promotes research on time scales, primary and secondary frequency standards, time and frequency transfer techniques, and their applications.

The CCTF met in 2015 and 2017.

Nine Working Groups allow world-wide exchange among NMIs, stimulating collaborations, comparisons, and support to the users.

Main drivers are:
- Global forum for progressing the state-of-the art
- Facilitating dialogue between NMIs and stakeholders
- Global comparability of measurements
Global forum for progressing the state-of-the-art

The CCTF coordinates the realization of the international time scale, **Coordinated Universal Time (UTC)**, computed monthly by the BIPM, leading to the key comparison **CCTF-K001.UTC**.

An approximation, called **rapid UTC (UTCr)**, has been computed weekly since 2013.

UTC is based on **International Atomic Time (TAI)**, which is computed from 450 clocks maintained in 80 time laboratories.
The NMIs realize a local real-time approximation of UTC, called UTC($k$) kept in agreement with UTC.

The NMI time labs are in continuous contact with the BIPM for data and information exchange.
Recent achievements at the NMI’s

- New primary and secondary standards reported for use in UTC
  (Seven Cs and one Rb fountain frequency standards, two Sr optical standards).

- Research on optical transitions, development of very accurate clocks with $10^{-18}$ intrinsic accuracy (Sr, Yb, Ca, Hg$^+$, Al$^+$, ...).

- Continuous improvement of time and frequency comparison by satellite links: Two Way Satellite Time and Frequency Transfer and by Global Navigation Satellite Systems.

- Development of optical fibre links for TF comparisons on national and continental scales, allowing better than $10^{-18}$ frequency transfer.
Facilitating dialogue between NMIs and stakeholders

Time and Frequency metrology shares mutual benefits with different liaison communities

Earth and space sciences need precise timing for observation, research and modelling in the fields of geodesy, geophysics and astronomy – for example tectonic movements and space probe navigation

Astronomy and geodesy provide precise data for timekeeping

Relativistic geodesy measures gravity potential with atomic clocks
Facilitating dialogue between NMIs and stakeholders

- **Global Navigation Satellite Systems (GNSS)** are based on precise timing
- GNSS offer positioning services and Dissemination of UTC

NMIs and Time labs are involved in global or regional satellite navigation systems by supporting their timing systems

The BIPM supports the International Committee on GNSS of the United Nations
Facilitating dialogue between NMIs and stakeholders

Several industrial applications are based on precise timing; the BIPM and NMIs work in close cooperation

- **Telecommunications** are based on network synchronization. Telecommunication techniques allow dissemination of time and frequency signals. The BIPM works in close cooperation with the International Telecommunication Union.

- UTC is the reference for **financial market** coordination (the recent EU MiFID II regulation) and **cross-border energy transmission**.

**Traffic applications such** as train synchronization, road transportation, bus and taxi fleet control.

**Civil time keeping** and legal times are based on UTC.
The CCTF coordinates the strategies for time and frequency comparisons and dissemination with NMIs and relevant international and regional organizations.

- 1174 CMCs in 19 service categories
- 1 KC CCTF- K001.UTC, 1 Supplementary Comparison (GULFMET.TF-S1)
Future challenges

✓ Moving towards a new definition of the second, achieving $10^{-18}$ accuracy.

✓ Improving UTC in terms of stability (low $10^{-16}$), accuracy (few ns), and accessibility (new interactive web page).

✓ Promoting the important benefits of the unique reference time UTC to the international scientific and industrial communities.