




# Consultative Committee for Time and Frequency

Noël Dimarcq, CCTF President

Patrizia Tavella, BIPM Time Dept. Director

A graphic on the right side of the slide consisting of numerous concentric, slightly offset circles in a rainbow color palette (red, orange, yellow, green, blue, purple). The circles are of varying radii and are not perfectly concentric, creating a dynamic, swirling effect.

Working together to  
promote and advance  
the global comparability  
of measurements

November 2022




# Comité Consultatif du Temps et des Fréquences

Noël Dimarcq, Président du CCTF

Patrizia Tavella, Directrice BIPM Time Dept

November 2022



27<sup>e</sup> réunion de la  
Conférence générale  
des poids et mesures

# Composition of CCTF

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**President:** Dr N. Dimarcq, CIPM Member

**Executive Secretary:** Dr P. Tavella, Director of BIPM Time Department

**Members:** 26 Institutes

**Official Observers:** 4 Institutes

**Representatives of Institutes from Member States invited to attend as Observers:** ~ 2 Inst.

**Liaisons:** International Astronomical Union (IAU), International GNSS Service (IGS), International Telecommunication Union / Radiocommunication Bureau (ITU-R), International Union of Geodesy and Geophysics (IUGG), International Union of Radio Science (URSI)

**Ex officio member:** Dr M.J.T. Milton, Director of the BIPM

**Guest participants:** RMO representatives, CCTF WG Chairs, BIPM staff



# Permanent CCTF Working Groups

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**CCL-CCTF-WGFS:** Joint CCL-CCTF Working Group on Frequency Standards

**CCTF-WGPSFS:** Working Group on Primary and Secondary Frequency Standards

**CCTF-WGTAI:** Working Group on International Atomic Time (TAI)

**CCTF-WG-ALGO:** Working Group on Time Scale Algorithms

**CCTF-WGATFT:** Working Group on Coordination of the Development of Advanced Time and Frequency Transfer Techniques

**CCTF-WGGNSS:** Working Group on GNSS Time Transfer

**CCTF-WGTWSTFT:** Working Group on Two-Way Satellite Time and Frequency Transfer

**CCTF-WGMRA:** Working Group on the CIPM MRA

**CCTF-WGSP:** Working Group on Strategic Planning



# CCTF activities

CCTF activities concern matters related to the definition and realization of the second, establishment and diffusion of International Atomic Time (TAI) and Coordinated Universal Time (UTC), and advice to the CIPM on matters related to time and time scales.

CCTF has been concentrating on 4 “hot topics” for which task groups have been created in 2020 under the coordination of the CCTF Strategic Planning WG (extended since 2020 to the chairs of WGs on “hot topics”):

- |  |   |
|--|---|
| <b>1. Task Force on <i>Updating the Roadmap towards the redefinition of the SI second</i></b><br><i>Roadmap and mandatory criteria</i><br>A. <i>Request from user communities, NMIs and Liaisons</i><br>B. <i>Atomic frequency standards, and possible redefinition approaches</i><br>C. <i>TF Dissemination and time scales</i> | <b><i>Chairs</i></b><br>(N. Dimarcq, P. Tavella)<br>(M. Gertsvolf, NRC; G. Mileti, Uni Neuchatel)<br>(S. Bize, SYRTE; E. Peik, PTB; C. Oates, NIST)<br>(D Calonico, INRIM; T. Ido NICT) |
| <b>2. Leap seconds in UTC and building a consensus for a continuous timescale</b>  | (J. Levine, NIST; P. Tavella, BIPM)   |
| <b>3. Promoting the mutual benefit of UTC and GNSS, Traceability to UTC from GNSS measurement</b>  | (P. Defraigne, ORB; A. Bauch, PTB)  |
| <b>4. Sharing Resources to Improve the International Timekeeping</b>   | (M. Gertsvolf NRC, Y. Hanado, NICT)   |

**Dedicated task groups with more than 80 people working together with bimonthly meetings, dedicated workshops, presentations in fora, congresses, and online GIT forum discussion**

# CCTF activities

*October 2020: 22<sup>nd</sup> CCTF Session 1* online meeting (introduction of the topics, main issues)

*From Nov 2020 to Feb 2021: online questionnaire* with > 200 answers

*March 2021: 22<sup>nd</sup> CCTF Session 2* online meeting to discuss main expectations/constraints/possible schedule and way forward on hot topics

*September 2021: Validation of the CCTF contributions to CIPM and CGPM*

*June 2022: 23<sup>rd</sup> CCTF* online meeting



# CCTF achievements

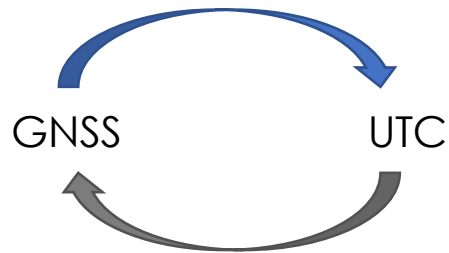
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- **Roadmap towards the redefinition of the second**  
→ 2 Recommendations approved by CCTF + Draft Resolution E to CGPM
  - **Leap seconds in UTC and building a consensus for a continuous timescale**  
→ 1 Recommendation approved by CCTF + Draft Resolution D to CGPM
  - **Promotion of the mutual benefit of UTC and GNSS** (including traceability of GNSS signals to UTC)  
→ 3 Recommendations approved by CCTF
  - **Sharing of resources to improve international timekeeping**  
→ Recommendation approved by CCTF
- + 3 other Recommendations approved by CCTF (optical freq. standards, Time transfer tech.)

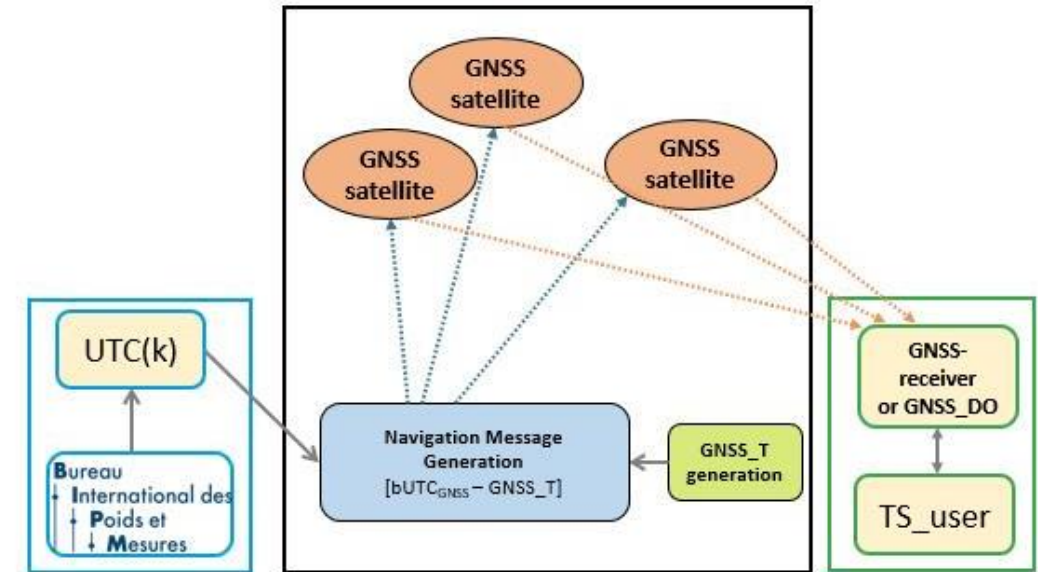


# Promotion of the mutual benefit of UTC and GNSS

- Most of UTC clocks are compared by GNSS
- GNSS disseminate an approximation of UTC and collaborate with the UTC labs



- The synchronization of GNSS to UTC support interoperability
- Guidelines proposed and discussed in CCTF to recognize traceability to UTC from GNSS measurements



Increasing use of GNSS for synchronization  
& increasing demand for traceability

Need for guidelines on

- how the user can get UTC from GNSS (including equipment and calibration)
- and how traceability can be obtained when using GNSS for synchronization to UTC

Task force of the GNSS WG, with the help of the WG on MRA.

- Provide guidelines
- Disseminate the information to the end user, via e. g. RMOs, ICG, GNSS providers, GNSS stakeholders



# Sharing of resources to improve international timekeeping

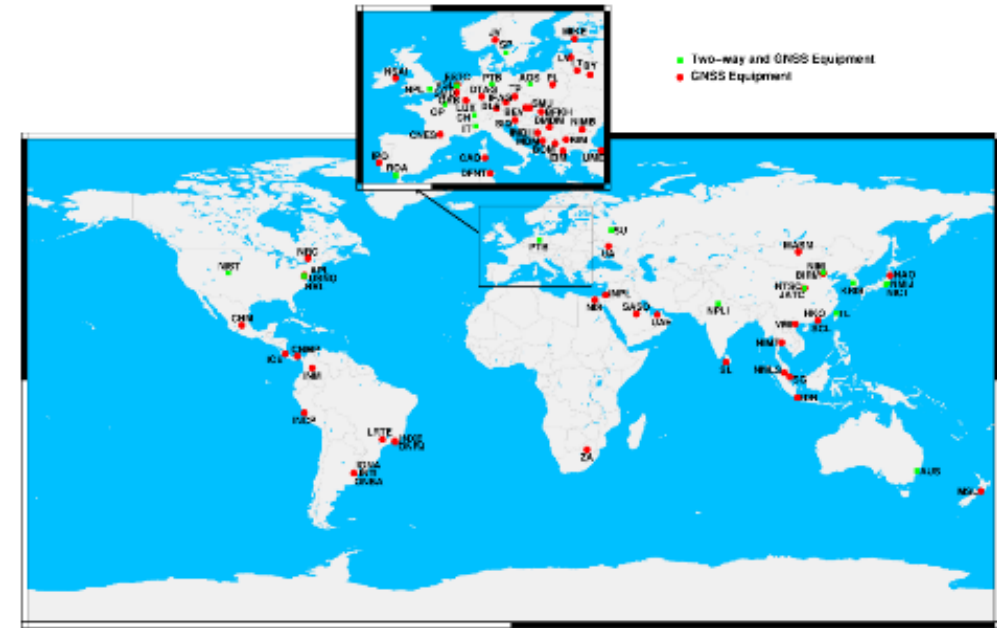
The Coordinated Universal Time UTC is constructed from ~ 450 atomic clocks kept in ~ 85 time laboratories

Small and large labs are contributing and welcome

The capacity to monitor and validate the measurements in each lab improves the quality of UTC and the realization in real time UTC(k)

→ The CCTF aims to build new capacities by sharing the resources among labs to quickly develop a good level of expertise in all labs

→ We have recently signed a collaboration agreement with the IEEE - Institute of Electrical and Electronics Engineers recognizing our common aims to improve the training in Time and Frequency metrology



# Outlook

**Continue to follow activities, trigger and foster reflexions, studies and collaborations on:**

- Primary and secondary standards, with a connection to CCL
- TF transfer techniques: GNSS, TWSTFT, advanced techniques as optical fibres, ACES MWL, optical links in space
- Time scales: TAI, UTC, UTCr, UTC(k), algorithms
- MRA and Metrological traceability

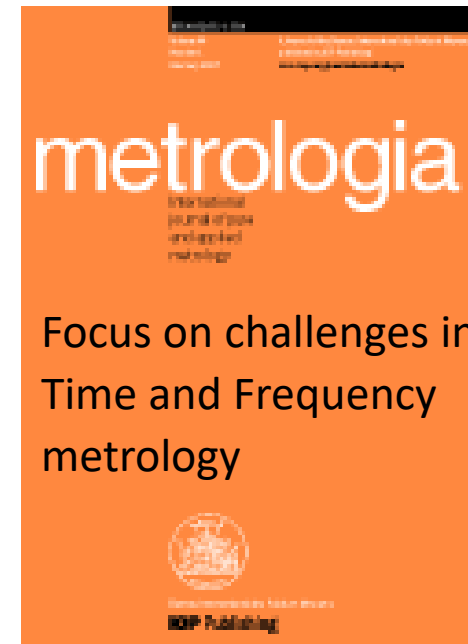
**Continue to support transverse activities related to Hot Topics, along the roadmaps described in the draft resolutions D and E**

## **Metrologia special focus under preparation**

- 1. CCTF strategy introduction**
- 2. Roadmap towards the redefinition of the second**
- 3. Towards a consensus on a continuous Coordinated Universal Time**  
<https://iopscience.iop.org/article/10.1088/1681-7575/ac9da5>
- 4. Achieving traceability to UTC through GNSS measurements**  
<https://iopscience.iop.org/article/10.1088/1681-7575/ac98cb>

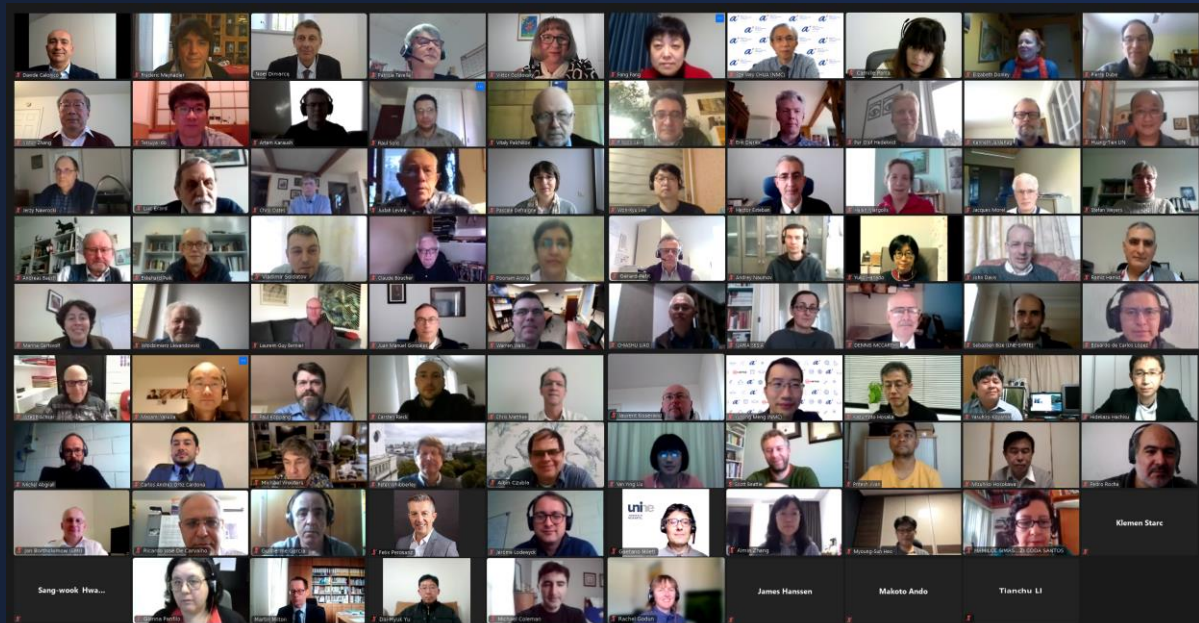
A white paper on each hot topic will be published in early 2023

<https://www.bipm.org/en/committees/cc/cctf/publications>





Thanks to all the CCTF  
colleagues, the WG chairs, the  
external experts and the BIPM  
Time Department for their  
support and contribution



27th meeting  
of the General Conference  
on Weights and Measures

27<sup>e</sup> réunion  
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**Thanks for your attention**

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# Extra slides

# Approval of 6 recommendations at 22nd CCTF meeting (March 2021)

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- ✓ TWSTFT-1 On Developing and Utilizing the Next-Generation Modems and Technologies for Two-Way Satellite Time and Frequency Transfer (TWSTFT) Used in UTC Generation
- ✓ GNSS-1 On the use of existing time scales to generate GNSS inter-system information
- ✓ GNSS-2 On absolute calibration of GNSS equipment for time transfer
- ✓ PSFS-1 Recommendations for operating, comparing and reporting frequency standards to improve TAI and to prepare for a redefinition of the second by optical transitions
- ✓ PSFS-2 Updates to the CIPM list of standard frequencies
- ✓ PSFS-3 Handling of Dead Time Uncertainty and Frequency Transfer Uncertainty by Laboratories Operating Optical Frequency Standards

# Approval of 4 recommendations at 23rd CCTF meeting (July 2022)

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- ☑ CCTF-23-1 – On developing awareness on options for the redefinition of the second, on criteria required for enabling such redefinition and for developing activities to fulfill these criteria
- ☑ CCTF-23-2 – On the support to the CGPM resolution D towards a continuous UTC
- ☑ CCTF-23-3 – On the establishment of a UTC capacity building program based on shared resources
- ☑ CCTF-23-4 – On the Traceability to UTC from GNSS signal reception



# (Metrological) Traceability

## DEFINITION from The International vocabulary of metrology (VIM)

“property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty”

## BIPM, International Organization of Legal Metrology (OIML), and accreditation bodies:

The required **calibrations** should be performed by **NMIs or DIs** participating in the CIPM-MRA and having their **CMCs** published in the KCDB.

In addition, **measurements traceable to the SI** can as well be made by an **accredited laboratory** whose calibration and testing capabilities were formally approved by an accreditation body, so that they fulfil the rules of **ISO/IEC 17025** recommended by CIPM.