The Consultative Committee for Time and Frequency

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CCTF

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:

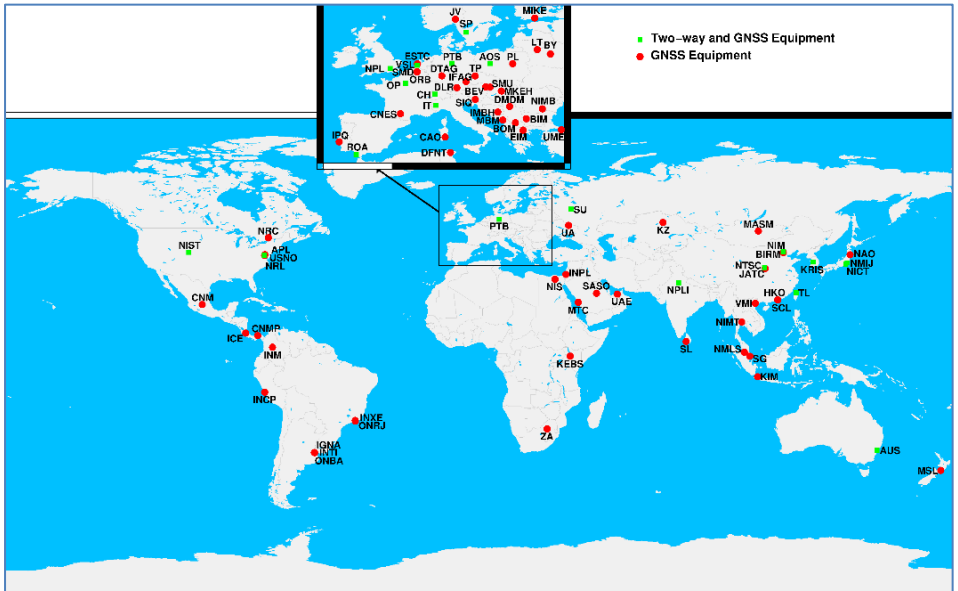
- Global forum for progressing the state-of-the art
- Facilitating dialogue between NMIs and stakeholders
- Global comparability of measurements

Global forum for progressing the state-of-the art

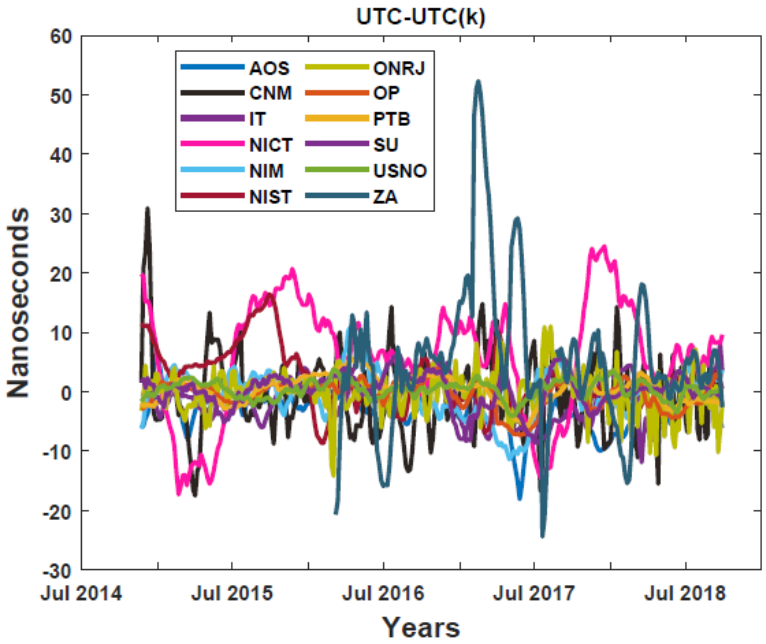
The CCTF coordinates the realization of the international time scale, **Coordinated Universal Time (UTC)**, computed monthly by the BIPM, leading to the key comparison **CCTF-K001.UTC**

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



Global forum for progressing the state-of-the art



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

Bureau International des Poids et Mesures

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BUREAU INTERNATIONAL DES POIDS ET MESURES
THE INTERGOVERNMENTAL ORGANIZATION ESTABLISHED BY THE METRE CONVENTION
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The contents of the sections of BIPM *Circular T* are fully described in the document " Explanatory supplement to BIPM Circular T " available at ftp://ftp2.bipm.org/pub/tai/publication/notes/explanatory_supplement_v0.1.pdf

1 - Difference between UTC and its local realizations UTC(k) and corresponding uncertainties. From 2017 January 1, 0h UTC, *TAI-UTC* = 37 s.

Date 2018 0h UTC			AUG 29	SEP 3	SEP 8	SEP 13	SEP 18	SEP 23	SEP 28	Uncertainty/ns			Notes
		MJD	58359	58364	58369	58374	58379	58384	58389	u_A	u_B	u	
Laboratory *k*						[*UTC-UTC(k)*]/ns							
AOS	(Borowiec)		-2.1	-3.0	-3.0	-3.6	-4.2	-4.8	-6.1	0.4	4.1	4.1	
APL	(Laurel)		-1.6	0.8	0.6	0.2	-0.7	0.7	1.0	0.4	11.3	11.3	
AUS	(Sydney)		-39.5	-55.2	-49.7	-42.9	-42.0	-36.3	-47.0	0.4	6.4	6.4	
BEV	(Wien)		-10.8	-6.4	2.0	10.1	14.6	22.1	18.6	0.4	3.3	3.3	
BIM	(Sofiya)		-	-	-	-	-	-	-				
BIRM	(Beijing)		13.0	12.0	10.5	10.9	10.9	12.4	15.0	0.5	3.2	3.2	
BOM	(Skopje)		-676.6	-703.4	-728.9	-753.4	-775.5	-804.8	-821.1	1.5	8.2	8.3	
BY	(Minsk)		-1.5	-1.6	-2.6	-3.1	-3.4	-1.7	-3.0	1.5	12.2	12.3	
CAO	(Cagliari)		-6328.6	-6433.0	-6540.4	-6642.6	-6753.2	-6851.2	-6944.9	1.5	20.0	20.1	
CH	(Bern-Wabern)		0.0	-2.1	-2.9	-3.5	-5.6	-5.7	-5.4	0.4	2.2	2.2	
CNES	(Toulouse)		20.0	19.6	25.3	30.9	27.9	25.7	22.3	0.4	4.6	4.6	
CNM	(Queretaro)		6.9	-2.3	3.7	0.9	1.5	-1.0	-2.2	2.5	11.3	11.5	
CNMP	(Panama)		3.9	9.2	1.1	-3.8	-1.6	-7.6	-7.5	0.7	7.4	7.4	
DFNT	(Tunis)		472.2	668.9	871.6	1091.4	1267.9	1480.0	1694.9	0.7	20.0	20.1	
DLR	(Oberpfaffenhofen)		-	-	-	-	-	-	-				
DMDM	(Belgrade)		-53.5	-39.6	-24.1	-10.2	8.7	20.6	17.9	0.4	3.3	3.3	
DTAG	(Frankfurt/M)		-95.5	-105.6	-103.2	-103.6	-97.0	-107.6	-110.3	0.4	3.0	3.0	(1)
EIM	(Thessaloniki)		9.1	2.5	1.0	6.7	1.1	6.3	2.9	3.0	11.3	11.7	
ESTC	(Noordwijk)		-1.2	0.9	1.3	0.8	0.4	0.1	-1.0	0.4	3.2	3.2	

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Recent achievements at the NMIs

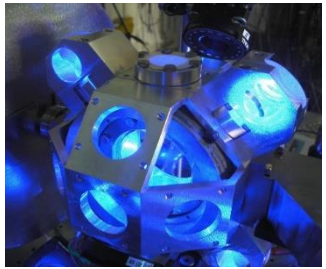
- ✓ New primary and secondary standards reported for use in UTC

  (Seven Cs and one Rb fountain frequency standards, two Sr optical standards).

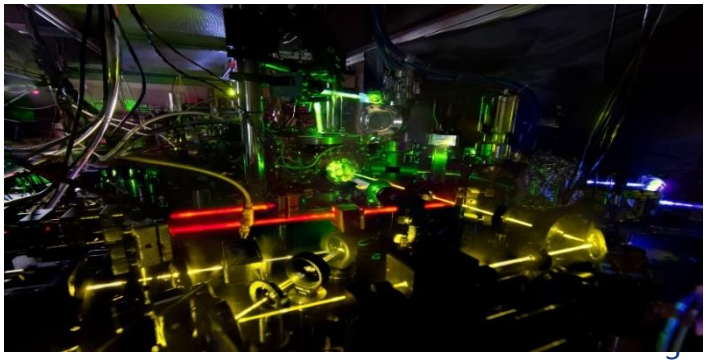
- ✓ Research on optical transitions, development of very accurate clocks with 10^{-18} intrinsic accuracy (Sr, Yb, Ca, Hg^+, Al^+, …).

- ✓ 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.



Sr Clock (Photo: LNE – SYRTE)



Yb Lattice Clock (Photo: NIST)

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

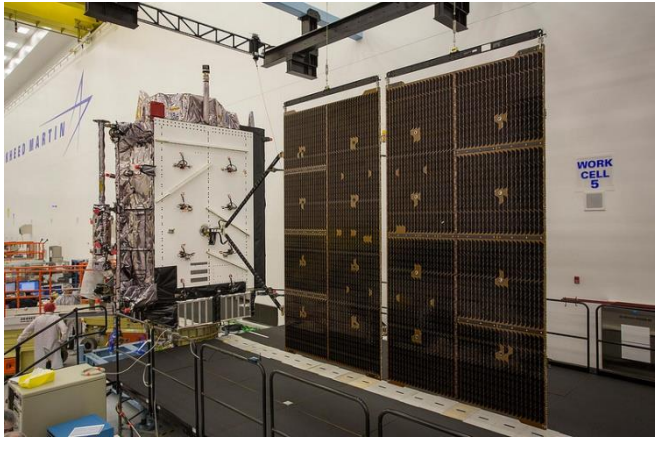
Astronomy and geodesy provide precise data for timekeeping

Relativistic geodesy measures gravity potential with atomic clocks

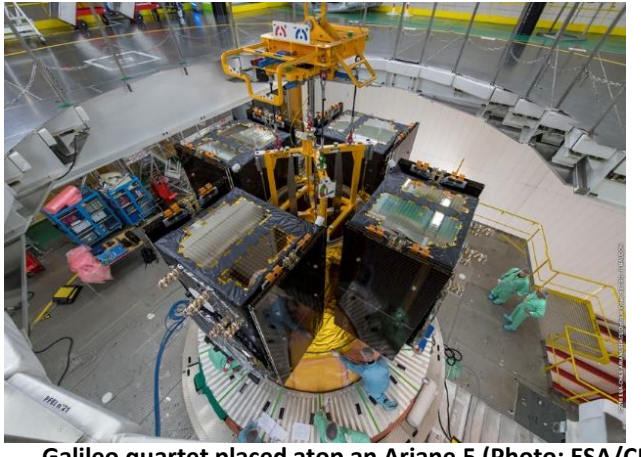
IGS

Facilitating dialogue between NMIs and stakeholders

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



GPS III SV02 Array Deployment Test
(Photo: Lockheed Martin)



Galileo quartet placed atop an Ariane 5 (Photo: ESA/CNES)

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.**

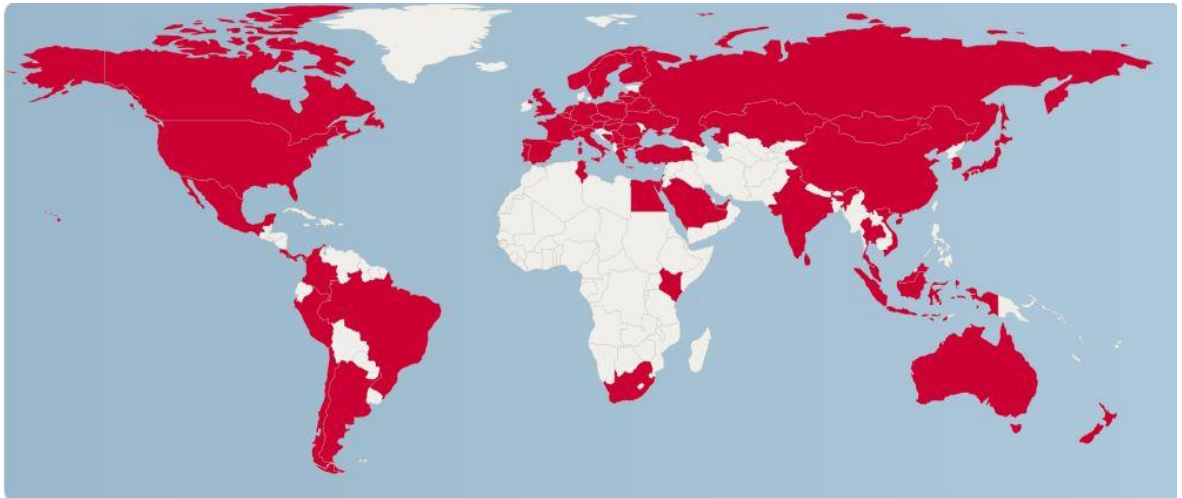
Traffic applications such as train synchronization, road transportation, bus and taxi fleet control.

Civil time keeping and legal times are based on UTC.

Global comparability of measurements

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. ⟹ poster
- ✓ Improving **UTC** in terms of stability (low 10^{-16}), accuracy (few ns), and accessibility (new interactive web page). ⟹ poster
- ✓ **Promoting** the important benefits of the unique reference time UTC to the international scientific and industrial communities.

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