TC Chair Annual Report 2018 - 2019

TC for Time and Frequency (TF)
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1. General Aspects

This report summarises the activities of the EURAMET Technical Committee for Time and Frequency (TC-TF) during 2018-2019.

TC-TF at present has contact persons from 29 EURAMET member countries.

A core aspect of the work of TC-TF is to support the generation of the international reference time scale, Coordinated Universal Time (UTC), by the BIPM under the single Key Comparison in Time & Frequency. Institutes participating in UTC generation provide both clock data and time transfer data regularly to the BIPM, and TC-TF supports this activity by coordinating the calibration of GPS-based time transfer links. The BIPM Time Department therefore maintains close contacts with the TC, and participates in its annual meetings.

2. Projects

There are currently 2 active projects within TC-TF:

Project 1152: *GNSS receiver performance monitoring*.
The project started in 2010, and aims to investigate the long-term performance and stability of GNSS timing receivers. The method adopted is to compare data from 2 or more receivers referenced to the same clock, and to investigate the environmental and other causes of changes observed in the differences between the receivers. The extended duration of the project enables it to obtain valuable information about the actual long-term behaviour of GNSS receivers that contribute to the generation of UTC.
Coordinating institute: GUM (Poland); 4 other participating partners.

Project 1156: *GPS link calibrations in support of CCTF-K001.UTC*.
The Key Comparison on the generation of UTC is dependent on accurate calibration of the time transfer links between participating institutes. The most widely used time transfer method is based on observations of GNSS satellite signals using dedicated timing receivers. To reduce its workload, the BIPM Time Department now only calibrates directly the GNSS timing receivers at a small number of institutes (the G1 laboratories) within each RMO. The G1 laboratories in turn carry out calibrations of the GNSS timing receivers at other institutes within the RMO, and the purpose of this project is to support the organisation and coordination of regular calibration campaigns to ensure that all institutes are able to maintain the calibration status of their time transfer equipment. During 2018, the 3 G1 labs within EURAMET all carried out campaigns that supported a total of 9 G2 institutes.
Coordinating institute: ROA (Spain); 15 other participating partners.

One other TC-TF project was completed during early 2019:

Project 1288: *Time interval comparison Pilot Study*.
The purpose of the project was to develop portable delay standards and measurement protocols for use in time interval measurement intercomparisons, building on the work carried out under EUROMET project 828. New optical fibre-based travelling standards prepared by a Slovenian partner company, InLambda,

in collaboration with SIQ (Slovenia), were thoroughly characterised at GUM (Poland) during 2017-2018 along with an additional travelling standard developed by GUM. The final report and supporting information are available on the project web page. The devices developed under the project are expected to be used in a Supplementary Comparison starting in 2019.
Coordinating institute: MIRS (Slovenia); 8 participating partners; 4 further partners.

3. Comparisons

Within the Time & Frequency field there is one Key Comparison, CCTF-K001.UTC, which is of indefinite duration and covers the computation of UTC by the BIPM. An essential aspect of this work is the regular submission of clock difference and time transfer data to the BIPM by approximately 70 contributing institutes worldwide. The majority of institutes represented in TC-TF participate in the KC.

There were no active Supplementary Comparisons in Time & Frequency during 2018. However, TC-TF Project 1288 (described above) has developed the transfer standards required for a Supplementary Comparison of time interval measurement capabilities. Work is in progress to complete the technical protocol, a support group has been set up to assist the pilot laboratory, and the SC is expected to start during summer 2019.

4. CMCs

TC-TF has a working group There has been little change to the EURAMET TF CMCs during the period, with only IMBiH (Bosnia and Herzegovina) submitting a revised set of CMCs for review by the TC-TF.

The revised TF CMCs from Bosnia and Herzegovina, along with revised CMCs from France and Spain (reviewed earlier within EURAMET), have been submitted for inter-RMO review. The review process is nearing completion in all 3 cases.

During the reporting period, 1 set of TF CMCs from another RMO has been reviewed by TC-TF. It was submitted by APMP on behalf of RCM-LIPI (Indonesia).

5. Activities of the Subcommittees

The TC-TF does not have any Sub-committees.

6. Participation in EMRP/ EMPIR

There are several active EMPIR projects closely related to Time & Frequency, including the following.

JRPs approved following the 2015 calls:

15SIB03 OC18 *Optical clocks with 1E-18 uncertainty*
Coordinator: Rachel Godun (NPL)

15SIB05 OFTEN *Optical frequency transfer – a European network*
Coordinator: Harald Schnatz (PTB)

15SIP04 TIMEFUNC *Time synchronisation impact enabling future network communication*
Coordinator: Erik Dierikx (VSL)

JRPs approved following the 2017 calls:

17IND14 WRITE *White Rabbit industrial timing enhancement*
Coordinator: Davide Calonico (INRIM)

17FUN03 USOQS *Ultra-stable optical oscillators from quantum coherent and entangled systems*
Coordinator: Filippo Levi (INRIM)

17FUN07 CC4C *Coulomb crystals for clocks*
Coordinator: Ekkehard Peik (PTB)

JRPs approved following the 2018 calls:

18SIB05 ROCIT *Robust optical clocks for international timescales*
Coordinator: Helen Margolis (NPL)

18SIB06 TiFOON *Time and frequency over optical networks*
Coordinator: Jochen Kronjaeger (NPL)

7. Capacity Building: Activities of the last year and future needs

Within the TF field, Researcher Mobility Grants (RMGs) have proved to be a useful mechanism for capacity building. In the EMPIR OC18 project, two visiting researchers from ROA (Spain) were funded by RMGs. One worked at INRIM (Italy) for 13 months, and the other was at SYRTE (France) for 18 months. The long durations of these RMGs were found to be particularly effective for transferring expertise in optical clock construction and operation to another institute. Possibilities for setting up RMGs in other TF-related JRPs are being investigated.

The TC-TF has not run any training activities during the last year, but the requirement for technical training in time and frequency in Europe is being met by other courses supported by the NMIs and DIs. For example:

- The BIPM held a 2-day course on “Effective participation in Coordinated Universal Time (UTC)” under its Capacity Building and Knowledge Transfer (CBKT) programme in February 2018.
- The week-long European Frequency and Time Seminar is held annually in Besançon (France), providing lectures and hands-on laboratory training.
- The CLONETS (Clock Network Services) project funded through the Horizon 2020 InfraInnov call has delivered several training courses in time and frequency transfer over optical fibre links.
- The OC18 EMPIR project ran a one-week school on optical clocks in September 2018.

8. Meetings

The TC-TF meets annually, usually in March. The 2019 meeting was held at NPL, UK, over 7-8 March, with plenary sessions during the first day and morning of the second day, followed by laboratory tours.

In addition to the TC-TF contact persons, the 30 attendees included 2 GULFMET observers from SASO (Saudi Arabia), the Director of the BIPM Time Department and one of her colleagues, and other invited representatives from TL (Taiwan) and NPL who gave presentations on specific projects.

The main topics covered during the meeting were:

a) Reports from the BIPM Time Department on recent activities;
b) Reports on recent work for the TC-TF projects;
c) Discussion of EC proposals to promote the use of Galileo as a source of legal time;
d) Updates on EMPIR, Horizon 2020 and other projects;
e) News from EURAMET;
f) TF involvement in EMNs;
g) CMC changes and reviews;
h) Presentations on other subjects of interest to the TC.

The next annual TC-TF meeting will take place at PTB Braunschweig over 10-11 March 2020.

9. Issues

A number of European Metrology Networks (EMNs) with a significant TF component are being established or under consideration. Three are of particular interest to the TC: EMN-Q (Quantum Technologies), EMN-SEG (Smart Electricity Grids) and EMN-PNTG (Positioning, Navigation, Timing and Geodesy), and effective mechanisms still need to be developed for interactions between the TCs and the EMNs.

10. Strategic Planning

The TF community was successful in the 2018 EMPIR call, with 2 JRPs being approved under the SI Broader Scope programme. These projects will build on and extend the work carried out in existing JRPs due to finish in 2019.

Updating of the EURAMET road maps for TF, which have not been revised since 2012, remains a priority. The most effective approach is still being discussed, but is expected to involve revision of each road map by an individual expert followed by review within a working group of the TC, with the aim of presenting the new versions to the 2020 annual meeting for approval. A key challenge will be to ensure consistency with other strategic planning activities, including the metrology strategies expected to be defined by the EMNs and the road map towards a new definition of the SI second developed by the CCTF Working Group on Strategic Planning.

11. Outlook for 2019/2020

Inter-RMO review of revised TF CMCs from France, Spain, and Bosnia and Herzegovina should be completed within the next few weeks.

A new Supplemental Comparison on time interval measurement capabilities is being set up, and is expected to start in summer 2019.

The next annual meeting of the TC-TF will be held at PTB on 10-11 March 2020.

Peter Whibberley
EURAMET TC-TF Chair