Noël Dimarcq
President of CCTF – Consultative Committee for Time and Frequency

December 11, 2020

SUBJECT: Request to reply to a questionnaire addressing important topics in the field of Time & Frequency Metrology

Dear Madam, Dear Sir,

The Consultative Committee for Time and Frequency (CCTF[1]) is currently working on very important topics concerning the field of Time & Frequency Metrology and its applications. In order to make sure that the needs and wishes of concerned institutional bodies and stakeholder communities are integrated into the general debate that will take place, we have prepared specific questionnaires available online for different categories that we kindly ask you to answer.
Here the link:
https://www.surveymonkey.com/r/CCTF_Survey_2020
Your answers, opinion and ideas are very important. They will be carefully examined and taken into account by the CCTF in order to provide future guidelines and recommendations.

This survey aims at collecting feedback from a very wide range of concerned communities including:

- CCTF Members, Observers[2], and other Institutes contributing to the Coordinated Universal Time (UTC) (UTC Labs)
- NMIs not yet contributing to UTC
- CCTF liaisons (IAU, IGS, ITU, IUGG, URSI)
- Stakeholders: science, industry, international and national institutions/projects/services, space/defence agencies, …

According to your community, you may find some questions worded in a way different to your own practice, or they may not concern your particular field of expertise. We will appreciate any information you may wish to provide, but feel free to skip questions that you do not feel are relevant to the entity or user community you represent. In order to help you to better understand the context and the issues related to the topics listed below, recorded videos and introductive presentations are accessible online (links provided in the questionnaire).

In the frame of this internationally coordinated activity, we would really appreciate your support by completing this questionnaire **before January 31, 2021**, in order to provide feedback and share your concerns, ideas and thoughts about the following topics.
Please forward this letter to stakeholders you may know in your country and kindly support them in understanding our questions and provide their feedback

Roadmap towards the redefinition of the international unit of time, the SI[3] second

Since 1967, the definition of the SI second relies on the Caesium atom hyperfine transition frequency. Caesium primary frequency standards are currently realizing this unit with a relative frequency uncertainty at low 10^{-16}

[1] https://www.bipm.org/en/committees/cc/cctf/
[2] https://www.bipm.org/en/committees/cc/cctf/members-cc.html
[3] SI : International System of Units (https://www.bipm.org/en/publications/si-brochure/)

level, but they are now surpassed by optical frequency standards showing much lower uncertainties, typically 2 orders of magnitude better.
In order to prepare a future redefinition of the SI second, the CCTF is investigating possible options and their possible impacts on concerned communities and applications, not just scientific and technological, but also regulatory and legislative. The possible scenarios depend on capabilities of optical clocks and their envisaged evolutions, considering their performance, their readiness for sustainable contributions to the realization of time scales, especially UTC, and also their potential for commercial availability and space qualification. The roadmap addresses also Time / Frequency transfer techniques required for the comparison of atomic clocks, for the construction of international time scales and for the dissemination of reference signals towards users, with an adequate precision level.

Leap seconds in UTC and building a consensus for a continuous timescale

In order to keep UTC within 0.9 s of UT1, a time scale based on the rotational angle of the Earth, the current realization of UTC adds an extra "leap" second after 23:59:59 UTC on 30 June or 31 December whenever the difference UT1-UTC is close to exceeding 0.9 s. The name of the leap second is 23:59:60, and the following second is 00:00:00 of the next day.
Almost all clocks, and especially digital representations of UTC, cannot represent the leap second correctly, and various communities have implemented private methods of addressing this problem. These methods are not compatible with UTC or with each other, and most often the user is not aware. The multiplicity of incompatible time scales is very undesirable, and this problem is likely to grow worse as additional non-conforming methods are implemented. CCTF therefore considers it urgent to disseminate awareness on this issue and to promote a common understanding.

Promoting the mutual benefit of UTC and GNSS

The BIPM[4] calibration scheme for UTC is a distributed system: the BIPM performs calibrations for “Group 1” laboratories within Regional Metrology Organizations (RMOs), repeated every two years. Group 1 laboratories perform “Group 2” calibrations for the rest of the laboratories aiming at complete coverage and possibly a repetition rate of 3 years. The CCTF is analysing the efficiency of this organization with the goal to propose possible evolutions if needed.
In the field of timing, by far the largest number of GNSS receivers operated world-wide is used in so-called GNSS-disciplined oscillator devices which provide standard frequency and time signals, or which are embedded in servers providing time information via IT protocols (NTP or PTP). Many device manufacturers and many communities relying on such devices consider their output signals as providing traceability to UTC. This view is opposed by others who refer to the strict definition of traceability in clause 2.41 of the *Vocabulaire international de métrologie* (VIM[5]). The CCTF goal is to propose guidelines for a general user on achieving traceability to a realization of UTC through GNSS measurements, and a suitable way for documenting and disseminating the UTC(k) traceable GNSS measurements to the users.

Sharing Resources to Improve the International Timekeeping (*questions for NMIs and UTC Labs only*)

The focus of the CCTF is to enhance Time & Frequency laboratory capabilities and improve the accuracy of timescales internationally via resource sharing and capacity building activities. The aim is to inform NMIs about different training opportunities and collect feedback on specific activities NMIs may be interested in participating.

Thanks for your kind attention and contribution
Yours faithfully,

[4] Bureau International des Poids et Mesures (https://www.bipm.org)
[5] https://www.bipm.org/en/publications/guides/vim.html