

DIVISION A / FUNCTIONAL WORKING GROUP TIME METROLOGY STANDARDS (TMS)

STANDARDS DE MÉTROLOGIE DU TEMPS

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1. Introduction

The reference time scale Coordinated Universal Time (UTC) of atomic nature is maintained by the Bureau international des poids et mesures (BIPM) in coordination with national metrology institutes, research institutes, observatories and space agencies that operate atomic standards. UTC is computed on the basis of International Atomic Time TAI, a realization of Terrestrial Time TT. Earths rotational time UT1 is obtained from space techniques and the values of UT1-UTC are computed and disseminated by the International Earth Rotation and Reference Systems Service (IERS). The dynamical pulsar time scale which could complement atomic time with enhanced long-term stability is a dynamical realization of Terrestrial Time TT.

During the triennium the discussion on the possible adoption of a continuous reference time scale continued in different organizations. An important step forward in the clarification of time scale definitions and responsibilities was done with the adoption of a resolution on the definition of time scales by the 26th Conf rence g n rale des poids et mesures (CGPM) in November 2018.

New definitions of most SI units have been adopted by 26th CGPM in November 2018, linking all units to the constants of nature. It is expected to adopt a new definition of

the SI second by a frequency different from that of the hyperfine transition of cesium 133, motivated by the progress in the development and operation of optical frequency standards. The Consultative Committee for Time and Frequency (CCTF) has initiated actions in this direction. The preparation of the future new definition of the second will call for mutual cooperation in the upcoming years.

The membership of the WG TMS includes astronomers and metrologists. The number of members has increased to 19 in this period, including one associate. The membership reflects the variety of institutions and fields relating the involvement of astronomers in time metrology. The WG communicated by correspondence; there were no meetings in the period covered by this report.

2. On the future of Coordinated Universal Time (UTC)

Resolution 655 of the World Radiocommunication Conference 2015 (WRC-15) invited the relevant international organizations and scientific associations to cooperate submitting results of studies on the possible implementation of a continuous time scale. Work continued at the Working Party 7A of the International Telecommunication Union (ITU) on the establishment of a report on the “content and structure of time signals to be disseminated by radiocommunication systems and various aspects of current and potential future reference time scales, including their impacts and applications in radiocommunication”. This document, and its outcome, will be included in a report of the Radiocommunication Bureau at the World Radiocommunication Conference 2023.

The 26th CGPM adopted in 2018 Resolution 2, “On the definition of time scales” which had been drafted, at the initiative of the CCTF, by task group which included members of the Division A WG on Time Metrology Standards (F. Arias, G. Petit and the associate member P. Koppang), supported by Dr D. McCarthy, UAU representative to the CCTF. The metrological definition of International Atomic Time (TAI) in the Resolution is consistent with IAU Resolutions A4 (1991) and B1.9 (2000). The CCTF (see section below) launched a survey that included items relating to leap seconds in UTC. The survey indicates that a high majority of users and national metrology institutes would prefer the extension of the tolerance on UT1-UTC now limited to 1 second. The CCTF will prepare a recommendation to extend the value of tolerance to be proposed to the CGPM in 2022. In the meantime, work will be done to support the preparation to the change, as reinforcing the dissemination of UT1-UTC, work with relevant organizations to fix the new tolerance, and support the astronomical community for the necessary upgrades and information.

3. Meetings of the CCTF

The CCTF met virtually on October 28-29, 2020 and March 11-12 and 18-19, 2021. The meetings concentrated on four hot topics: updating the roadmap for the redefinition of the second, Leap seconds in UTC and building a consensus for a continuous time scale, promoting the mutual benefits of UTC and GNSS and sharing resources to improve the international time keeping. Task forces have been established to study each topic, and a survey has been launched to get the feedback of the various communities. The questionnaire received more than 200 answers, 20

The CCTF prioritized the criteria and fixed the conditions to change the definition of the SI second. An update of the existing roadmap is under elaboration for approval by the 27th CGPM in 2022.

4. Time developments relevant to astronomical work

Seventeen astronomical/research institutions officially maintained local representations of UTC for applications in astronomy, geodesy and/or space navigation in the triennium. They include ten astronomical observatories and centres (AOS Poland, CAO Italy, HKO Hong-Kong, NAO Japan, NTSC China, ONBA Argentina, ONRJ Brazil, OP France, ORB Belgium, ROA Spain, USNO USA), two metrology institutes (NICT Japan, SP Sweden supporting Onsala geodetic station), one university (APL USA), three space agencies (CNES France, DLR Germany, ESA/ESTEC Europe) and one fundamental station (IFAG Germany). Many observatories maintain unofficial realizations of UTC for time domain astronomy, time-tagging of data for analysis, telescope pointing, etc.

Other the maintenance of local realizations of UTC, some of these institutions operate primary and secondary frequency standards (OP, NICT, AOS), and the USNO currently maintains four continuously running rubidium fountains at its Washington DC facility.

5. BIPM realization of Terrestrial Time

The BIPM Time department released TT(BIPM18), TT(BIPM19) and TT(BIPM20), available on <ftp://ftp2.bipm.org/pub/tai/ttbipm/>. The computation interval of TT(BIPM20) starts on 28 December 2012; before that date it is identical to its past realization TT(BIPM19).

6. Closing remarks

Two changes in the standards of time and frequency metrology will impact on astronomy in the next years: the redefinition of the SI second and a modification of UTC either to increase maximum value of UT1-UTC or to make it continuous. Interaction with the time community is expected for both processes.

In 2020 we had exchanges by correspondence on the possibility on having a collective position regarding the adoption of a continuous UTC, and to propose a resolution in this sense. Only a few members responded and supported to the proposal. The meeting of the Working Party 7A of the IUT in April 2021, together with the outcome from the CCTF could bring some progress towards a consensus.