Towards a continuous UTC

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Abstract

Coordinated Universal Time (UTC) is the world-wide reference time scale computed by the *Bureau International des Poids et Mesures* (**BIPM).** It is based on about 450 atomic clocks that are maintained in 85 national time laboratories, and which regularly provide measurement data to the BIPM.
The International Earth Rotation and Reference Systems Service (**IERS)** determines and publishes the difference of UTC versus the Earth rotation angle UT1 and when this difference reaches 0.9 seconds, a new leap second is announced and applied in all time laboratories.

UTC and the difference UT1-UTC are transmitted by several time and frequency services regulated by the International Telecommunication Union, **ITU-R**.

At the beginning of the atomic clock era, it was decided to maintain UTC in agreement with the irregular rotation of the Earth. This was needed mostly for the navigation systems based on celestial observations. At the outset, UTC was corrected by small time and frequency steps, in 1972 the correction with one entire leap second was agreed.

Starting from the year 2000, the current need of the leap second process is under large discussion. The insertion of the leap second needs an additional second labelled as 23:59:60 which is not available in most digital networks and that has caused a proliferation of *ad hoc* methods, which are being used as alternative to the leap second. Google for example "smears" the additional second over the previous 24 hours, Facebook on the subsequent 18 hours, Microsoft over the last 2 seconds, and Alibaba on an interval of 24 hours centred on the leap second.

The Global Navigation Satellite Systems (GNSSs) consider the application of the leap second on all the satellite clocks at the same instant as a risk, and decided to synchronize their clocks and their time scale with UTC at the outset, but subsequently did not add any additional leap seconds (with the exception of GLONASS). GNSS time scale are easily available to the users, and the use of GPS time, for example, considered as UTC without discontinuities, is recommended in ITU-T international standards.

This situation is causing confusion among users on the day the leap second is applied and concerns regarding the serious risk of anomalies, undermining the reliability of national critical infrastructures, have been raised.

After evaluation of the impact on the different user communities and an extended survey, the 27th meeting of the General Conference on Weights and Measures in November 2022 decided

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that the process to keep UTC in agreement with the rotation of the Earth shall continue but with a larger tolerance. This tolerance could be 100 seconds, or even one hour, to ensure the continuity of UTC for at least 100 years. This new process is expected to come into force in 2035 and the BIPM is working together with the ITU-R and the other organizations affected by this change to identify the best value for the next tolerance on the offset UT1-UTC to efficiently serve current and future timing applications.
The possible choices for the extended tolerance UT1-UTC will be discussed and the feedback of the astronomical community is highly welcome.