3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

Performance Review of Several UTC(k) During the Last 25 Years

J. M. López-Romero*(1), C.A. Ortiz (2), and E. de Carlos-López(2)
(1) Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, CINVESTAV, Unidad Querétaro, Libramiento Norponiente No. 2000, Fracc. Real de Juriquilla, Querétaro, México; jm.lopez@cinvestav.mx
(2) Dirección de Tiempo y Frecuencia, Centro Nacional de Metrología, CENAM, km 4.5 carretera a los Cués, El Marqués, 76246, Querétaro, México; cortiz@cenam.mx, edlopez@cenam.mx

Abstract

The second, the time unit, is one of the seven base units of the SI [1] defined since 1967 [2] in terms of the energy separation of the unperturbed hyperfine levels of the Cs-133 ground state. Currently the uncertainty of the best primary frequency standards is around one part in 10^{16} [3]. Time is probably the most measured quantity worldwide. It is hard to overestimate the importance of time measurement in science, technology, and commerce. The continuous accumulation of seconds from precise atomic clocks allows the formation of accurate time scales that serve as references for applications that require synchronization to national and international standards. The official time worldwide is named Coordinated Universal Time, the UTC [4], produced at the *Bureau International des Poids et Mesur*es (BIPM) with data contribution from 86 timing laboratories distributed around the globe. Those timing laboratories generate a prediction of the UTC named UTC(*k*) [5], where *k* is an acronym that indicates a specific laboratory. In this paper we present, and discuss, a performance evaluation of several UTC(k) timescales in the long-term analyzing the BIPM Circular T data [6]. More precisely, we evaluate the UTC(k) performance starting from 50814 MJD (January 1st, 1998). In general terms, we found an improvement of about two orders of magnitude on the UTC(k) time stability when a time window of several months is take as averaging time. This progress is in line with the improvement of the SI second realization through the operation of primary frequency standards, that reduce their uncertainty around one order of magnitude per decade. We also correlate the UTC(k) performance improvement with the development of different techniques and technologies related to time and frequency transfer [7].

References

[1] Miguel A. Martín-Delgado, "The new SI and the fundamental constants of nature", Eur. J. Phys. 41 (2020) 063003 (31pp)

[2] Resolution 1 of the 13th CGPM (1967)

[3] See for example: S. Weyers *et al*, "Advances in the accuracy, stability, and reliability of the PTB Primary fountain clocks", *Metrologia* **55** (2018) 789–805

[4] G. Panfilo and F. Arias, "The Coordinated Universal Time (UTC)", *Metrologia* 56 (2019) 042001 (26pp)

[5] W Lewandowski *et al, "*The evaluation of uncertainties in [*UTC − UTC*(*k*)]", 2006 *Metrologia* **43** 278,

[6] https://webtai.bipm.org/ftp/pub/tai/Circular-T/cirthtm/

[7] D. Matsakis *et al*, "Precise Time and Frequency Transfer", Radio Science Bulletin No. 351 (December 2014)