



Algorithm for a robust Real-Time Time Scale realization at INRiM

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Recently, at the Italian National Institute of Metrological Research (INRiM), we developed and tested new time scale algorithms for the automated generation of a real-time time scale, capable of continuous operation and with high performance in terms of accuracy, stability, and availability. Such algorithms make full use of the frequency standards available at INRiM, and are based on a different steering reference, namely an ensemble clock, a primary frequency standard (the INRiM's cesium fountain ItCsF2), an optical clock (the INRiM's ytterbium optical clock IT-Yb1) and the Coordinated Universal Time (UTC), or its rapid version, UTCr [1, 2, 3, 4, 5].

The developed new time scale algorithms are designed to be robust and high performing, but also modular, so that they can be adapted to the capabilities and the real needs of any time laboratory.

The collected data are initially pre-processed, then given as input to the core of the time scale algorithm, that is a set of different steering algorithms, each of which is based on a different steering reference and produces a different steering correction. Such corrections are given as input to the final stage of the time scale algorithm, i.e. a post-processing able to validate and combine them in a unique frequency steering correction, which is then applied to the master clock to be steered. A monitoring is also included in the algorithm, which is capable of detecting anomalies and sending warnings and alarms, keeping everything under control and enabling a fast reaction of dedicated operators to any possible problem in the generation of the real-time time scale.

The generation of the legal Italian time scale UTC(IT) is based on one of the described algorithms, namely the one based on UTCrapid data, since January 2020; the other algorithms are being extensively tested online generating real time test time scales. In particular, the last developed steering algorithm, relying on INRiM's optical clock, has been tested offline both on simulated [5] and real historical data; online tests are foreseen for mid-2022, according to the availability of the INRiM IT-Yb1 optical clock.

We show here the details of the developed algorithms and their performances.

References

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