A deeper analysis of the clocks contributing to UTC

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The Coordinated Universal Time (UTC) is the international time scale calculated at BIPM. The first step of the calculation process involves obtaining the free atomic time scale (EAL) through a weighted average of atomic clocks located in 87 participating time laboratories/observatories around the world.

Continuous work is made by the BIPM to use all the available clocks (more than 410) at the best to improve the long-term stability and accuracy of UTC. We have, currently, more than 200 cesium clocks, 180 H-masers, 5 Rubidium Fountains and a few other clocks of different types.

Special attention in clock data treatment is given to:

- the prediction of the clocks
- the anomalous behavior detection.

As the data entry of the time scale (EAL) is the difference between the real data and their prediction, it is essential to predict accurately the behavior of the atomic clocks. A quadratic model taking into account the drift/aging of the clocks is currently used for all the clocks participating in UTC.

A deeper analysis of the drift affecting the clocks will be presented. The BIPM uses 3 months of past frequency data of the clock with respect to TT(BIPM) to evaluate the monthly drift used for UTC calculation. The analysis, over 5 years, of the long-term variations of the drift will be presented and analyzed showing the difference among the different clocks.

Furthermore, Rubidium fountains have been participating in UTC for more than 10 years now and allowing the possibility to make a consistent statistical analysis of the best model to be used to predict the fountains. We will demonstrate that the linear model describes in a very accurate way the behavior of these clocks allowing them to achieve more weight in UTC.

The use of the least square analysis to estimate the frequency instead of the current method (the last value of clock versus EAL minus the first one over the duration of the interval) will be also tested to verify if some improvement can be obtained.

On the other hand, it is essential to perform an accurate check of the clocks exhibiting anomalous behavior to prevent any negative impact on UTC performance. This issue is complex as the clocks being integrated into UTC may be influenced by external factors such as the time links used for comparison and their prediction. In order to ensure that all clocks are thoroughly examined, we will analyze the final data that are integrated into UTC by comparing their values with respect to EAL and their predicted values. A tool will be developed to identify clocks exhibiting anomalous behavior that could potentially affect the performance of UTC.

To demonstrate the impact of these algorithm changes, EAL will be simulated for a long period and compared with the original data.