

UTC for the 21st Century

Discussion meeting held at the Kavli Royal Society International Centre

on 3rd and 4th of November 2011

Organizers, Dr Terry Quinn CBE FRS, Emeritus Director of BIPM

Dr Felicitas Arias, Director of the BIPM Time Department

Among the points discussed¹ were the following:

1. Needs for precise timing

There exists a broad spectrum of needs for precise timing, extending from the most demanding requirements of satellite navigation systems for a continuous atomic time scale accurate at the level of nanoseconds, through the increasing number of precise time-stamping or dating systems working at the level of milliseconds, to the far end of this spectrum where space geodesy, space navigation and astronomy require measurements of the orientation of the Earth at the level of microseconds. In the middle of these, of course, is the essential need for a common world civil time scale. It is impossible to meet all these needs with just one time scale for the obvious reason that an atomic time scale is uniform while the rotation of the Earth is not. Nevertheless, the atomic time scale UTC and the time scale of the rotating Earth, UT1, are, and have always been, securely linked together through the publication of values for the difference UT1-UTC.

2. The proposal to abolish leap seconds in UTC

The proposal at the International Telecommunication Union to abolish leap seconds in UTC stems essentially from:

- a. The use of different continuous atomic time scales in satellite navigation systems such as GPS time and in the future Galileo time and BeiDou time, which has stemmed from the great difficulty of using an atomic time scale that includes occasional but not accurately predictable one-second steps. This complicates unnecessarily their internal time keeping operations, inter-operability and even reliability.
- b. Difficulties foreseen in ensuring the security and reliability of the increasing range of timing systems at all levels of accuracy if they have to operate in the presence of one-second step changes. The problem of ensuring completely unambiguous time and date information at the

¹ Among the participants from around the world were invited experts from the International Telecommunication Union and its relevant Study Groups and Working Parties, other international organizations with interests in time and frequency, astronomical organizations and observatories, satellite navigation systems, universities and national metrology institutes.

instant of the step change is not easy to solve. A broad range of infrastructural systems, such as, communications, power grids, air traffic control and synchronization of financial operations all depend critically on precise and reliable timing. The public is becoming more and more demanding as regards the safety and reliability of these systems.

3. The continued use of UTC for civil time in the absence of leap seconds

Taking all this into account, we are of the opinion, and this reflects the majority view expressed at the Discussion Meeting, that if the proposal to abolish the leap second in UTC is adopted, it will continue to be legitimate in the UK, for example, or in the time zone centred on the Greenwich meridian, to represent civil time by the atomic time provided by the National Physical Laboratory, namely UTC(NPL). The additional small, albeit increasing, offset that will result from the abolition of leap seconds will remain insignificant compared to the already existing annual variations in local solar time on the Greenwich meridian. These variations, which amount to plus and minus about sixteen minutes, are due to the orbit of the Earth around the Sun being an ellipse rather than a circle and to it being inclined with respect to the Equator. In addition, there exists the range of local solar times across the UK from East to West which amount to some thirty minutes.

UTC will continue to be securely linked to the rotation of the Earth since the difference UT1-UTC will be available at the level of microseconds from the relevant international service.

4. Further expected improvements foreseeable for UTC

Among other topics that were presented and noted by the participants were:

- Time laboratories being equipped with better clocks;
- New primary frequency standards, in particular optical clocks;
- Improved time and frequency comparisons using fibre-optic links and other possible solutions;
- Improved algorithms for time scale calculation;
- More frequent publication of UTC by the BIPM.

All of these taken together are expected to reduce the uncertainty of UTC from its present level of about 4 parts in 10^{16} to approaching 1 part in 10^{17} , with all the advantages and possibilities that this will bring.

For further information contact: webmaster@bipm.org

Bureau International des Poids et Mesures (BIPM)

F-92312 Sèvres Cedex

France

Please note and mention that these documents are reproduced with permission of the BIPM, which retains full internationally protected copyright.

The BIPM takes no responsibility for the accuracy or content of a reproduced document, as this is the responsibility of the person or organization making the reproduction.