

Programme of Work and Budget of the BIPM Time Department 2013-2015

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Introduction

At its 24th meeting in October 2011, the General Conference on Weights and Measures (CGPM) discussed the programme of work of the BIPM that was submitted by the CIPM and adopted Resolution 3 “Dotation of the BIPM for the years 2013 to 2015”. The CGPM agreed on a dotation but at a level significantly below what is needed to fully implement the submitted programme of work. The dotation period adopted on this occasion is for a three-year period, which represents a change from the four-year period submitted in the programme of work for the years 2013 to 2016. As a result there is a need to revise the programme of work and to adjust the corresponding budget in line with the agreed dotation. This revision is now referred to as the programme of work 2013 to 2015. The programme of work 2013 to 2015 and its corresponding budget was discussed and was approved by the CIPM in Session I of its 101st meeting on 6 June 2012 at the BIPM headquarters.

The activities of the Time Department described in the programme of work 2013 to 2015 will be fundamentally unchanged from those proposed for 2012-2016. By delaying the purchase of some equipment until the programme of work 2016 to 2019, investment and operating costs will be reduced by about 65 thousand Euros, resulting on an expenditure of 280 thousand Euros for the triennium.

The retirement of one of the six scientists in the Time Department in 2014 will lead to a re-prioritization of the Time Department’s relations with international organizations and to a re-distribution of functions within the staff.

Programme, activities and deliverables for 2013 to 2015

The overall aim of the activity is to compute, and distribute the world time scales International Atomic Time (TAI), Coordinated Universal Time (UTC) and TT(BIPM) to laboratories in Member States and Associates, and to improve the international time transfer infrastructure. This would allow, in particular, the BIPM to meet increasing demands for accuracy from new global time systems. A longer-term aim is to prepare for a potential redefinition of the second.

T-A1 Frequency stability and accuracy of TAI

This activity includes:

- the calculation of TAI and UTC;
- improvement of time transfer for clock comparison between participating laboratories;
- enhancements of two-way links, and establishment of more robust multi-GNSS time links with Global Positioning System (GPS), Global Navigation Satellite System (GLONASS), the new Galileo GNSS system and with others as new systems emerge;
- improvement of algorithms and associated software for the inclusion of data from new microwave and optical frequency standards which are, and will continue to be, recommended as secondary representations of the second and to improve the frequency accuracy of TAI.

Decreasing the uncertainty due to the statistical noise in clock comparisons and including multi-GNSS time links will result in the international time system becoming more robust and more reliable. Adapting the algorithms for the use of highly accurate frequency standards will render TAI more accurate, thus enhancing traceability to the SI.

T-A2 Publication of the values of $[UTC - UTC(k)]$, where $UTC(k)$ is the local realization of UTC kept by laboratory k , gives traceability to the reference UTC to NMIs and other participants through the BIPM *Circular T*. The values $[UTC - UTC(k)]$ together with their uncertainties constitute the degrees of equivalence for the key comparison in time CCTF-K001.UTC. BIPM *Circular T* is also the unique means of dissemination of TAI and UTC to NMIs.

Publication of the values of $[UTC_r - UTC(k)]$. The current publication of BIPM *Circular T* allows NMIs to assess the steering of the local timescales with a delay that can reach up to 45 days. Present applications require more frequent validations of the steering strategies, in particular for $UTC(k)$ which serves to align the time scales of GNSS. The TAI contributing laboratories welcomed the BIPM initiative to start the

production of a “rapid UTC” (UTC_r) based on a weekly calculation and publication. As in September 2012, 39 laboratories contribute data to the Pilot Experiment on a rapid UTC launched by the BIPM Time Department in January 2012. Since February 2012, weekly values of $[UTC_r - UTC(k)]$ have been published on Wednesdays. Results are available at <ftp://tai.bipm.org/UTCr/>.

T-A3 Underpinning of the accuracy of time links through characterization of delays in GNSS equipment in laboratories

This activity includes:

- maintenance by the BIPM of travelling standards for relative delay measurements and the coordination of campaigns of measurements in NMIs and other participating laboratories;
- coordinating campaigns with Regional Metrology Organizations (RMOs), with their own travelling standards;
- linking RMO results with the BIPM comparisons;
- assessing the potential application of measurement of absolute delays in GNSS equipment, as output of research in the period 2009 to 2012.

Characterization of delays in time transfer equipment is essential to the laboratories, because it supports the accuracy of time dissemination and the calculation of TAI and UTC by avoiding the time steps provoked by changes in the equipment.

T-A4 Secondary representations of the second

The ability to perform highly accurate frequency comparisons is needed to exploit the full potential of the new secondary representations of the second, which may provide the basis for a redefined second, therefore the Time Department will continue to:

- support the joint activities of the CCTF and Consultative Committee for Length (CCL) in the evaluation of optical and other frequency standards as candidates for secondary representations of the second and for the *mise en pratique* of the metre;
- contribute to studies, and to the CCTF activity, on time and frequency transfer techniques for highly accurate optical standards based on novel methods (optical fibres, microwave links to atomic clocks in space, time transfer through TW and laser ranging in T2L2, frequency combs) and determine the methods to be implemented for enabling the data of these frequency standards to contribute to TAI in order to improve its accuracy.

T-A5 Coordination activities

In addition to its work on management of the CCTF and the CCL, together with their joint activities, the activities already listed for time and frequency work all include a considerable amount of international collaboration and coordination as the field involves a number of other bodies such as:

- International Telecommunications Union – Radiocommunication Sector (ITU-R);
- International Earth Rotation and Reference Systems Service (IERS);
- International GNSS Service (IGS);
- International Astronomical Union (IAU);
- International Committee for GNSS (ICG).

T-A6 Internal Services

The Time Department will maintain the BIPM’s internal UTC-traceable frequency dissemination service.

Resources

Guest workers or secondees will be needed as follows:

- for the work on alternatives to the measuring of relative delays of GNSS equipment;
- for the microwave link for time transfer, in cooperation with the Atomic Clock Ensemble in Space project (ACES). This is to start in 2015 and extend into the following programme of work by one additional year.

The first project will fall within a cooperation arrangement with the CNES. We plan to have a similar arrangement with one or more national structures for the second, as has been successfully done in the past. Such collaborative projects avoid the creation of additional positions at the BIPM.