

## **Title: International traceability for time and frequency measurements**

### **Abstract**

NMIs and DIs typically realise a time scale that represents the basis for legal or official time dissemination in the respective country. Such disseminations cover time-of-day and the unit of time, the second, through standard frequency signals. But before disseminating time information and offering calibration services, the responsible institutes should ensure traceability to the international standard for time scale and SI unit of time and frequency, by participating in the Key Comparison CCTF-K001.UTC. Whilst some institutes have adequate time and frequency standards and technical infrastructure available, they do not participate in CCTF-K001.UTC because of a variety of aspects that need to be improved e.g. procedures for data acquisition, operation of existing measurement infrastructure and calibration of equipment.

### **Keywords**

CIPM Key Comparison CCTF-K001.UTC, International traceability of time and frequency measurements, time and frequency dissemination, calibration of the time transfer equipment, defining calibration and measurement capabilities.

### **Background to the Metrological Challenges**

The International Bureau of Weights and Measures (BIPM) is responsible for organising continuous Key Comparisons of NMI clocks and time scales, processing the results of these comparisons, and maintaining and disseminating the Coordinated Universal Time (UTC) in the form of UTC-UTC(k). Currently, about 75 institutes worldwide cooperate with BIPM in this activity. The institutes contribute with clock data from about 150 commercial caesium clocks and active hydrogen masers. They operate GPS time receivers for time comparisons and, in addition, some institutes use GLONASS receivers and equipment for two-way satellite time and frequency transfer through geostationary telecommunication satellites.

The local time transfer equipment need to be calibrated. Without such calibration, the uncertainty attributed to this equipment is set to a conventional value of 20 ns whereas the standard equipment would technically allow reaching 3 ns. With calibration of time transfer links, NMIs can improve their calibration and measurement capabilities.

In the time and frequency metrology area, the favourite option for NMIs to provide permanent traceable measurement results is their participation in the International Committee for Weights and Measures (CIPM) Key Comparison CCTF-K001.UTC. The participation in this key comparison requires the reliable operation of time transfer equipment and the fulfilment of some requirements imposed by the Consultative Committee for Time and Frequency (CCTF) and BIPM. In addition, participation ensures that the relation UTC-UTC(k) between UTC and its local realisation, together with the related uncertainty are published by BIPM.

Many NMIs provide dissemination services for time and frequency mostly via Internet (using the NTP protocol), although public telephone and radio transmissions are also used. In the context of power network management, integration of renewable energy sources into the traditional power networks and increased capabilities of (mobile) telecommunication networks, secure and accurate dissemination of time-of-day information is gaining much importance. But the dissemination of time information to the external world and calibrations offered to customers should be preceded by participation in the CCTF-K001.UTC. Some institutes in emerging EURAMET member countries or regions have adequate time and frequency standards and technical infrastructure available. However, they do not participate in CCTF-K001.UTC for various reasons e.g. poor understanding of equipment operation and participation rules, and fragile infrastructure

(electric power, IT). Without such participation and calibration of the time transfer equipment, no Calibration and Measurement Capabilities (CMCs) can be declared.

## Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the development of metrological capacity in time and frequency.

The specific objectives are

1. To develop procedures for data acquisition and submission according to established rules and prepare the participation in the CIPM Key Comparison CCTF-K001.UTC;
2. To establish the reliable operation of the required measurement infrastructure and identify routes for improvement, e.g. by developing measurement procedures for GPS common view comparison with associated uncertainty budget, including GPS antenna cable delay calibration.
3. To improve the time transfer accuracy of smaller NMI's through calibration of time transfer equipment and circulation of reference equipment owned by participating larger NMIs;
4. To define the NMI's Calibration and Measurement Capabilities according to the needs of the country and the available equipment;
5. For each participant, to develop an individual strategy for the long-term operation of the capacity developed in time and frequency, including regulatory support, research collaborations, quality schemes and accreditation. They should also develop a strategy for offering calibration services from the established facilities to their own country and neighbouring countries. The individual strategies should be discussed within the consortium and with other EURAMET NMIs/DIs, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

Joint Research Proposals submitted against this SRT should identify

- the particular metrology needs of stakeholders in the region,
- the research capabilities that should be developed (as clear technical objectives),
- the impact this will have on the industrial competitiveness and societal needs of the region,
- how the research capability will be sustained and further developed after the project ends.

The development of the research potential should be to a level that would enable participation in other TPs.

Proposers should note that the programme funds the activity of researchers to develop the capability, not the required infrastructure and capital equipment, which must be provided from other sources.

EURAMET has defined an upper limit of 500 k€ for the EU Contribution to any project in this TP, and a minimum of 100 k€.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 10 % of the total EU Contribution to the project. Any deviation from this must be justified.

## Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the "end user" community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the "end user" community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Provide a lasting improvement in the European metrological capability and infrastructure beyond the lifetime of the project,
- Facilitate improved industrial capability or improved quality of life for European citizens in terms of personal health or protection of the environment,
- Transfer knowledge to the related industrial sectors and the metrology community.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”.

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

### **Time-scale**

The project should be of up to 3 years duration.