EMPIR Call 2017 – Industry, Fundamental, Normative and Research Potential

Selected Research Topic number: **SRT-i26**
Version: 1.0

Title: Precision Time for Industry

Abstract

Many industries, such as power grids, telecommunications and e-commerce, need reliable and traceable precision time and frequency (T&F) measurements to advance their capabilities, reliability, and security. The high accuracy profile of the Precise Time Protocol - White Rabbit (PTP-WR) could enable T&F transfer over optical fibre with similar or better performance compared to Global Navigation Satellite System (GNSS). Therefore, proposals addressing this SRT should develop the metrological capacity required to accelerate the industrial adoption of PTP-WR. This should include calibration techniques, validated techniques for redundant and resilient time transfer, and new PTP-WR devices, as well demonstration of PTP WR's capability to deliver Coordinated Universal Time (UTC(k)) and frequency in the radio frequency (RF) domain to industrial users.

Keywords

Time transfer, synchronisation, precision time protocol, resilience.

Background to the Metrological Challenges

Traceable, accurate, and resilient time distribution is needed for time-stamping industrial processes. Industries such as wireless telecommunications, electrical power grids and financial markets also need sub-microsecond precision to improve their capabilities. For example, computer based trading and e-commerce require synchronisation and traceability to a common reference time scale, to ensure an equal playing field, prevent fraud, and allow post-trade investigations and audits. The common reference time scale required for high frequency trading and business clocks is UTC(k) with a maximum uncertainty of 100 microseconds. However, this requirement cannot currently be met with traditional time synchronisation, such as via primary reference time clocks (e.g. ITU-T G.8272), and GNSS implementations are vulnerable to jamming and spoofing.

Synchronisation traceable to UTC(k) laboratories through optical fibres has been investigated in previous projects, EMRP JRP SIB02 (NEAT-FT) and EMPIR JRP 15SIB05 (OFTEN), and demonstrated to be feasible from a metrological point of view. However, the technologies developed by these projects are not mature enough for a straightforward transfer to industry and require substantial work for use with the telecommunications network. The most advanced technology is PTP-WR which is based on the Synchronous Ethernet protocol. However, the wide-scale industrial deployment of PTP-WR faces several challenges, such as the need for efficient and scalable calibration techniques, improved performance of the PTP-WR devices, and validated techniques for redundant and resilient time transfer. In addition the use of PTP-WR to deliver UTC(k) and frequency in the RF domain to industrial users needs to be demonstrated and evaluated.

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 for precision time for industry.

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The specific objectives are

1. To develop scalable calibration techniques for PTP-WR fibre links. This should include existing telecommunication configurations both with single fibre and with duplex fibres, and have target uncertainties of 200 ps for device calibrations and target uncertainty of 5 ns for propagation-calibration for link lengths up to 1000 km.
2. To develop validated techniques for redundant and resilient time transfer that meet the recommendations for the timing characteristics of primary reference time clocks (ITU-T G.8272) and enhanced- Primary Reference Clocks in Telecommunication networks (PRTC) performance levels, in particular during the switch of PTP-GrandMaster and the hold-over situations.
3. To develop PTP-WR devices with improved performance, that also interface better with existing protocols and standards (e.g. IEC 61850 for Smart Grids). The target frequency instability, expressed as Allan deviation with an observation time of 100 s, is $< 10^{-13}$.
4. To demonstrate the use of PTP-WR to deliver Coordinated Universal Time UTC(k) and frequency in the radio frequency (RF) domain to industrial users, including an evaluation of the end-to-end uncertainty of the established time transfer.
5. To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain (accredited laboratories, instrumentation manufacturers), standards developing organisations (e.g. IEEE Precise Networked Clock Synchronisation (PNCS) Working Group and IEC TC 57) and end users (e.g. National Research and Education Networks (NRENs) and the telecommunication industry).

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs – both through project steering boards and participation in the research activities.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMRP JRP SIB02 ‘Accurate time/frequency comparison and dissemination through optical telecommunication networks’ (NEAT-FT) and EMPIR JRP 15SIB05 ‘Optical frequency transfer – a European network’ (OFTEN) and how their proposal will build on those.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 1.5 M€, and has defined an upper limit of 1.8 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

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,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the telecommunication sector.

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.