European Partnership on Metrology
Call 2024 –Digital Transformation, Green Deal, Normative and Research Potential

Selected Research Topic number: **SRT-r07**
Version: 1.0

Title: Robust time and synchronisation as European critical infrastructure

Abstract

Numerous European critical infrastructures strongly depend on the Global Satellite Navigation Systems (GNSS) for accurate timing. The development of backups and alternative infrastructures is important for minimising the consequences arising from possible long-term GNSS disruptions. Proposals addressing this SRT should explore the potential of National Metrology Institutes (NMIs) integration into a resilient common cross-border timing distribution network to act as a reliable, accurate and traceable source of time, synchronisation and time transfer.

Keywords

Time and frequency transfer, synchronisation, resilience, critical infrastructure, security, White Rabbit, PTP (Precision Time Protocol)

Background to the Metrological Challenges

Today's digital society and economy rely critically on the services of GNSS, such as the European Galileo and the USA's Global Positioning System (GPS) for positioning, navigation, and timing (PNT). These systems significantly impact various European strategic domains, including digitalisation, economy, green deal, security and defence. The development of backups and alternative infrastructures is essential in order to minimise the potential consequences of a GNSS disruption. Lack of awareness on GNSS dependence, unreliable backup solutions and insufficiently developed international infrastructure for alternative timing distribution are the key shortcomings of the current level of development. Solutions and strategies must be explored to decrease the dependency of European reliance on GNSS in critical infrastructure, including energy supply networks, telecommunications, financial and transportation systems. As an alternative to GNSS timescales, a local timescale or UTC realisation is a commonly accepted solution. The time transfer from this source to the user can robustly and redundantly be established via optical fibre networks. However, in several European countries, a well-developed and widely used time dissemination network is not yet developed, while in some cases, there is no metrological infrastructure available to underpin these requirements. Techniques have already been developed for accurate time and frequency distribution by optical fibre networks, proven to be valuable as a backbone system for synchronisation in critical infrastructure. To secure infrastructures in which synchronisation to a common clock or timescale is required (e.g. smart electric power grids, telecom networks, financial trading facilities and infrastructure for autonomous transportation), complementary solutions should be developed to avoid any single points of failure. Both for the time source and for the time transfer from the source to the application, redundant solutions must be made available. There is a need to develop and implement timescales within the national critical infrastructures by utilising the multiple available national UTC(k) realisations, available at short distances within Europe. Time scales, where the traceability to UTC is established in real time, would be based on time data from multiple clocks, transferred through multiple links and calculated dynamically to minimise being deceived by interference in single connections. While the connections are redundant, wireless transfer such as GNSS or any ground-based radio transmission could also be used, complemented by single wired or fibre optic connections. In many European countries, the national timescale is realised in a single laboratory. This makes the national time source a single point of failure which is undesirable for critical infrastructure. So far, there is no common approach for a timescale realisation based on a dynamic availability of distributed clocks and a combination of GNSS, wireless and optical fibre time transfer links, nor widely used network for time dissemination. The potential of NMIs acting as sources of

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Coordinated Universal Time (UTC) to the end-users in critical infrastructure has not been explored yet as a way to address this need.

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 proposal shall focus on the development of metrology capability in time and synchronisation.

The specific objectives are

1. To develop an infrastructure for time and synchronisation that crosses country borders and is suitable for transfer of multiple timing signals from more than one UTC(k) source. This should include the use of (i) multiple redundancy schemes, (ii) non-GNSS based links and (iii) combining clocks from neighbouring countries, traceable to UTC.
2. To design accurate network solutions for multiple timing links between NMIs, service providers and end-users, by improving the reliability and redundancy of the time transfer and dissemination. The target accuracy for time dissemination should be better than 30 ns for links between NMIs from neighbouring countries, and at sub micro-second level accuracy to critical end-users in the network.
3. To develop tools and implement systems for real-time monitoring of spectrum jamming, GNSS data and signal verification to detect spoofing and GNSS system errors, and real-time monitoring of network timing links stability. Then to evaluate the systems in terms of identifying GNSS status for all constellations and bands (including the alarm functionality) in cases where, for example, the traceability chain to UTC via GNSS is broken, the GNSS is disturbed or becomes unreliable, or network timing link becomes unstable, etc.
4. To facilitate the take up and long-term operation of the capabilities, technology and measurement infrastructure for time and frequency measurements developed in the project, by the measurement supply chain (NMIs/DIs, calibration and testing laboratories), and end users (e.g. industry, instrument manufacturers, regulators). The approach should be discussed within the consortium and with other EURAMET NMIs/DIs, e.g. via EURAMET TC-Time & Frequency (TF), 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 area for which the capabilities will be built (Green Deal, Digital Transformation, Health, Integrated European Metrology, Industry, Normative or Fundamental Metrology) and in which future main call the developed research capabilities are planned to be employed,
- the impact the developed research capabilities 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.

Proposers should establish the current state of the art and explain how their proposed research goes beyond this. In particular, proposers should outline the achievements of the EMRP project 12SIB02 NEAT-FT and the EMPIR projects 15SIP04 TIMEFUNC, 17IND14 WRITE and 18SIB06 TiFOON, and how their proposal will build on those.

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 expects the average EU Contribution for the selected JRPs in this TP to be 0.7 M€ and has defined an upper limit of 0.9 M€ for this proposal.

EURAMET also expects the EU Contribution to the external funded beneficiaries to not exceed 20 % of the total EU Contribution across all selected projects in this TP.

Any industrial beneficiaries that will receive significant benefit from the results of the proposed project are expected to be beneficiaries without receiving funding or associated 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 proposal's 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, protection of the environment and the climate, or energy security,
- Transfer knowledge to the energy, telecommunications and transport 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 the Metrology Partnership 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.

Timescale

The project should be of up to 3 years duration.