

Title: Support for a European Metrology Network on mathematics and statistics

Abstract

In recent years metrology has expanded to address societal challenges related to energy, climate and environmental monitoring, life sciences and health. Mathematics and statistics are crucial to successfully deal with the challenges in these emerging fields of metrology. The European Centre for Mathematics and Statistics in Metrology was founded in 2016 to address these needs. While it has provided a good starting point, its extension and integration into EURAMET is desirable. EURAMET intends to re-establish MATHMET as an EMN including a substantial extension of the existing membership to include stakeholders from industry, standardisation organisations and academia. The EMN will develop a strategic research agenda addressing the needs of modern metrology and establish a platform and a quality management system ensuring that MATHMET software or guidance documents meet highest quality levels.

This SNT is intended to support that network in their initial tasks.

Keywords

Network for Mathematics and Statistics in Metrology, Software Support for Metrology, Large-Scale Data Analysis, Uncertainty Quantification, Metrology-Software Benchmarking, Consultation, Education

Background

In recent decades metrology has expanded into new fields to address societal challenges relating to climate and environmental monitoring, energy and sustainability, life sciences and health by exploiting novel measurement modalities such as imaging, spectroscopy, earth observation and sensor networks. This trend will be continued and accelerated. In addition, new data analytics such as machine learning, real-time simulations and artificial intelligence will start to influence measurement procedures making them more and more complex. A measurement system may consist of a large network of connected sensors, and mathematical algorithms for processing the data collected by the sensors are an integral part of such a system. Conformity assessment based on European directives for such systems is not presently possible.

The added value of a product is significantly influenced by the software part of the product. Model based software and mathematical algorithms are increasingly an integrated part of measurement devices, necessitating the development of novel mathematical and statistical tools. The emerging challenges for metrology in applied mathematics and statistics include uncertainty quantification of large sets of correlated data, handling of complex systems, and in processing the results from the application of methods from machine learning and artificial intelligence. Further challenges are real-time simulations, forecasting for large-scale systems, virtual measurements, multiscale, and multi-physics modelling. Mathematical and statistical tools for emerging fields (e.g. personalised medicine) that achieve the high-quality levels of those tools used in conventional metrology are currently lacking.

The development of mathematical and statistical tools addressing the upcoming challenges in metrology amounts to a substantial effort and goes far beyond the capabilities of a single national metrology institute. The foundation of MATHMET represented a first step towards developing a strong European Metrology Network (EMN) with a leading position in mathematics and statistics in metrology. In the future, the new EMN will substantially extend the existing network by also incorporating stakeholders from industry, regulation bodies and academia. Furthermore, explicit guidance, advice and support for end users and regulators will be provided through guidelines, software tools and consultation. Through establishing a quality assurance system within EURAMET, MATHMET will ensure that its recommendations meet the highest quality levels, and it will become an integral and sustainable part of the European metrological infrastructure.

How and where NMIs should focus limited resources to obtain maximum impact for society urgently requires a strategic plan and significant coordination both at European and global levels. No single NMI has the expertise or resource to tackle all or even a significant fraction of the most critical priorities without collaboration. Without coordination, there is a strong likelihood of unnecessary duplication, with NMIs (nationally and/or regionally) potentially independently choosing to focus efforts on the same challenge with consequential neglect of others. EURAMET intends to establish a European Metrology Network to coordinate the European NMI response, to establish close links to the stakeholder community, to develop and implement a strategic agenda and establish a knowledge, technology transfer and promotion plan, to ensure an effective response is put in place. This SNT is intended to support that network in their initial tasks.

Objectives

Proposers should address the objectives stated below, which are based on the PNT 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 / legal / regulatory / market constraints, but the reasons for this should be clearly stated in the protocol.

The JNP shall focus on developing a long term ongoing dialogue between the metrology community and relevant stakeholders. This dialogue should support the take-up of research outputs from the metrology community and the collection of needs from industry to inform future research related to mathematics and statistics.

The specific objectives are to:

1. To develop a strategic research agenda for the EMN that supports EU and EURAMET priorities by addressing the grand challenges in mathematics and statistics in metrology (e.g. large-scale and multivariate data analysis, new data analytics including machine learning, mathematical modelling, uncertainty quantification for large-scale metrology and virtual experiments and simulation).
2. To develop stakeholder consultation processes for the EMN to enable it to identify the most urgent guidelines, software tools, virtual training and reference data in line with the strategic research agenda.
3. To create and implement a quality management system that includes criteria and procedures for the assessment of advanced metrology software and guidance documents which ensures that the EMN recommendations meet the highest quality levels and achieve wide use and substantial impact.

The proposed activities shall be justified by clear reference to the measurement needs within strategic documents published by the relevant stakeholders. Proposers should establish the current state of the coordination in this area, and explain how their proposed project goes beyond this.

The proposed activities should not include those essential for the establishment and operation of the EMN. EMNs will be established and operated by the EURAMET members using their own national resources regardless of whether specific EMPIR proposals are funded. EMPIR funding is for specific tasks aimed at ensuring a planned EMN will progress quickly towards contributing to the objectives of the programme.

EURAMET expects the average EU Contribution for the selected JNPs in this TP to be 0.4 M€, and has defined an upper limit of 0.5 M€ for this project.

Potential Impact

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

You should detail how your JNP results are going to:

- Address the SNT objectives and deliver solutions to the documented needs,
- Provide a lasting improvement to coordination in the European metrological community and communication with their stakeholders beyond the lifetime of the project,

You should detail other impacts of your proposed JNP.

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

Time-scale

The project should be of up to 5 years duration.