EMRP Call 2012 – Open Excellence, Industry and SI Broader Scope

Selected Research Topic number: **SRT-i11**
Version: 1.0

Title: Metrology for optical and RF communication systems

Abstract

The Digital Agenda for Europe strategic targets require upgrading of the communication platforms. This SRT calls for metrology support to be developed for a range of communication technologies across the network to aid the required research and development work within Europe. Research areas include traceable waveform metrology for terabit optical transport employing spectrally efficient coherent communication, efficient testing of satellites, radio-over-fibre (RoF) for last-mile deployment and over-the-air (OTA) testing of Multiple-Input Multiple-Output (MIMO) antenna systems and dynamically reconfigurable antenna systems.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Industry & Fundamental Metrology on pages 29 and 31.

Keywords

Antenna measurements; Sampling strategies; Measurement uncertainty; Satellite communications; Optical communications; MIMO; Over-the-air (OTA) testing; Terabit optical communications; Optical waveform; Electrical waveform.

Background to the Metrological Challenges

The need for a well-developed communication infrastructure to promote growth is part of the 2020 Digital Agenda for Europe. The targets include that all households will have >30 Mbit/s internet access and 50 % of households will have >100 Mbit/s access by 2020. This, coupled with the expected increase in wireless devices will drive the need for increased bandwidth for the core network. This SRT calls for the development of the metrology infrastructure to support this strategy.

Advanced antennas and OTA testing of MIMO presents significant metrology challenges. Currently available test methods use channel emulators and reverberation chambers that simulate the environment. Uncertainty data are needed to qualify the results for testing of adaptive systems such as micro-satellites, MIMO and dynamically directed antenna systems that will be present in future RF sensor networks and wearable antenna systems.

Nanosatellites represent a low-cost approach to space engineering that is becoming increasingly attractive. Testing of nanosatellites antennas, payload and solar panel systems requires good metrology and a multidisciplinary approach.

Several technologies, including *Passive-Optical-Networks* (PON) and RoF, have been identified as candidates for the “last mile” distribution of the communications network, an extremely price sensitive area. RoF has potential for high bandwidth, short range, line of sight communications in the 60 GHz band.

Large satellite communication systems have a typical turnaround time of 24 months with costs in the range of 200 to 400 M€. Test and validation times are critical and occur at a high-cost stage in the programme cycle. Delays have implications for “frequency filing”, the date at which the satellite must begin broadcasting. Within the industry EM simulation of products and components is the norm and measurement is used to validate the simulation. The reduction of test time, realised through modelling and metrology, will dramatically reduce costs and win business for Europe.

Optical communication systems are the backbone of modern communication networks. Coherent optical systems use similar modulation formats to achieve the spectral efficiencies achieved in RF albeit with different metrological challenges. The data rates for optical communication systems are around a thousand

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times higher than for RF communications systems and this places considerable strain on the electronics. The semiconductor roadmap ITRS indicates where development is needed over many disciplines. Using it as a guide together with current research, it is envisaged that the development of 1 Tbit/s systems and supporting metrology and instrumentation needs will take place during the lifetime of the proposed research. Metrology support for this development effort will give Europe a competitive advantage.

Scientific and Technological 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 JRP-Protocol.

The JRP shall focus on developing metrology support for a range of communication technologies across the network to aid the research and development work within Europe.

The specific objectives are:

1. To develop and verify a sound methodology that qualifies the measurement and associated uncertainties for *Over-the-air* (OTA) testing of *Multiple In-Multiple-Out* (MIMO) and adaptive antenna systems.
2. To extend the testing methodology for multi-physics problems: adaptive antennas used in nano-satellite networks, wearable antennas and sensor network testing where power is restricted, derived from batteries, solar cells or other energy harvesting, and to traceably validate the techniques in collaboration with industrial partners.
3. To develop traceable testing methods for *Radio-over-Fibre* (RoF), validated in conjunction with industry and disseminated through relevant standards bodies.
4. To develop and validate a sound methodology that links antenna modelling, sub-Nyquist spatial-sampling measurement-strategies with *Electromagnetic-Model* (EM) based interpolation to give a quantified uncertainty for the result. To validate the methods against traditional technique using both small and large antenna structures. To provide a rule-based approach that relates the measurement reduction to an increase in uncertainty.
5. To develop measurement and analysis techniques for high spectral-efficiency modulation strategies such as QAM, traceable to electrical-waveform standard primary standards, to underpin the optical test instrumentation and commercial portable secondary reference standards required for terabit coherent optical transport. The techniques must provide uncertainties for key parametric measures, such as *Error-Vector-Magnitude* (EVM).

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.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call. The available budget for integral Research Excellence Grants is 42 months of effort.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the “end user” community (e.g. letters of support) is encouraged.

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the telecommunications sector.

You should detail other impacts of your proposed JRP as detailed in the document “Guide 4: Writing a Joint Research Project”

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.