EMPIR Call 2014 – Industry and Research Potential

Selected Research Topic number: **SRT-i13**
Version: 1.0

Title: Metrology for 5G communications

Abstract

The demand for high-speed communication and the strong link between good communications infrastructure and economic activity has driven the EU telecommunications industry to play a crucial role in developing 5G technologies. At present research projects [1, 2] are defining the technology requirements. The critical areas where enabling metrology is needed are: definition and measurement of SINR, traceability for MIMO measurements at frequencies up to 100 GHz, and improving energy efficiency through nonlinear measurement. 5G Networks will be deployed from 2020.

Keywords

5G, Over-the-air testing, antenna measurement, nonlinear measurement, MIMO, SINR

Background to the Metrological Challenges

For the European citizen, mobile communication is an essential part of modern life and as a consequence the traffic demand is growing at 40 % p.a. This growth rate implies that by 2020 5G mobile data traffic will have a data transfer rate of 1000x that of 4G communication systems compared with a 2010 baseline (and x1 million by 2030).

Complex performance requirements have been identified for the new 5G systems covering latency (1 ms – 1 s), link density up to $10^6/km^2$ and throughput up to 1 Tbit/s.km^2. In addition, a range of mobility up to 500 km/hour is considered with operation over the spectral bandwidth covering a few hundred megahertz to mm-wave.

Test-equipment is available for MIMO under the current 4G (LTE) communications technology but activity within COST IC1004 and the earlier COST 2100 illustrates that the measurement issues have not been fully resolved. From the metrology perspective, areal density and throughput will impact MIMO discrimination and SINR. The proposed techniques used for MIMO measurement will need to be studied at mm-wave frequencies, covering up to 100 GHz but is expected to make this approach very costly or even impractical. Testing these performance envelope extremes will present significant metrology challenges. Developing traceable methods and an understanding of the uncertainties for the devices and test environments will support test equipment manufacturers.

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 proposal.

The JRP shall focus on the development of metrological capability for 5G mobile communication technology.

The specific objectives are

1. To develop methods to traceably measure Signal to Interference plus Noise Ratio (SINR) over a wide frequency range. Measurement of system performance should take into account competing signals as well as Gaussian noise. Proposers should work with industry standardisation bodies, such as COTIS and 3GPP with the aim of defining the language, terminology and definition for SINR.
2. To extend the underpinning and supporting metrology for traceable MIMO antenna system measurement to accommodate higher areal density of interference signals and operation at mm-wave frequencies over the spectrum from a few hundred MHz to mm-wavelengths. To develop new

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measurement approaches and definitions to address the lack of recognised standards for traceable calibration of the spatial field in a complex electromagnetic environment.

3. To develop the metrology for 5G mobile communication to facilitate balancing spectral efficiency with cost and energy efficiency, focussing in particular on developing metrology at the component and sub-system level where hardware impairments affect capacity. Traceability should be established for nonlinear measurements (X-parameters and S-functions), supporting uncertainty relationships and model extraction parameters (e.g. for nonlinear behavioural models) over a wide frequency range at the design stage. The techniques developed should enable design validation to be performed using signals with the correct waveform and statistics, rather than traditional CW testing.
4. To engage with industry that manufactures 5G mobile communication technology and or / exploits it in order to facilitate the take up of the technology and measurement infrastructure developed by the project, to support the development of new, innovative products, thereby enhancing the competitiveness of EU 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. Particular reference should be made to projects funded by EMRP, JRP IND51 MORSE and JRP SIB62 HFCircuits.

EURAMET expects the average EU Contribution for the selected JRPs to be 1.5 M€, and has defined an upper limit of 1.8 M€ for any 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 deviation from this must be justified.

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,
- Drive innovation in industrial production and facilitate new or significantly improved products through exploiting top-level metrological technology,
- Improve the competitiveness of EU industry,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the EU telecommunications sector.

You should detail other impacts of your proposed JRP as specified in the document "Guide 4: Writing Joint Research Projects"

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.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] Mobile and Wireless Communications Enablers for the 2020 Information Society, EU FP7 ICT-317669-METIS, www.metis2020.com

[2] 5GNOW - 5th Generation Non-Orthogonal Waveforms for Asynchronous Signalling, www.5gnow.eu