EMRP Call 2010 - Industry & Environment

Topic number: SRT-08i

Title: Radio frequency metrology for wireless networks in industrial environments

Abstract

Wireless networks offer considerable advantages in terms of cost, flexibility and access to data compared to hard-wired systems, but uptake by industry is limited by the poor reliability and interoperability of the radio links when use in industrial environments. This topic addresses the required radio-frequency metrology to improve the robustness of the wireless links and to facilitate a step change in the application of smart and reconfigurable antennas to these systems. It will provide radio test platforms to ensure that the wireless networks operate correctly in the field and can co-exist with other digital systems. Specific applications of wireless networks and precision localisation should be developed with industrial and where appropriate academic partners. Proposals must ensure metrological solutions are appropriate in cost terms given the goal of low cost, near ubiquitous sensor deployment.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP 2008, section II.6.2 Page 31 in the section “Electricity and magnetism”, under the “Improvement of EM field measurements” heading includes “wireless or broadcast RF and microwave signals.”

Keywords

Wireless Sensor Networks (WSN), Reconfigurable Networks, Adaptive Antennas, SMART Antennas, Process Control, Radio Propagation, Industrial Monitoring, Health and Safety, radio frequency identification (RFID), precision localisation.

Background to the Metrological Challenges

In the last decade, radio frequency (RF) networked devices and wireless sensor networks have found many different commercial applications in such diverse areas as automation, safety and security, environmental monitoring and localisation. Due to advances in electronic integration and miniaturisation, RF networked devices and sensor networks have become more powerful, easier to handle and cheaper. Emergent applications include cashier-less supermarkets, RFID tags in logistics in the metalworking industry, smart car-to-car communication networks and precision localisation. Wireless senor networks (WSN’s) have industrial applications for condition monitoring of equipment, process monitoring and control, and plant management. They offer considerable advantages in terms of cost, flexibility and access to data compared to hard-wired systems and can improve plant efficiency, product quality and workplace health and safety. However, uptake of wireless networks by industry is limited by poor reliability of the radio links in industrial environments, poor interoperability of the systems, and the power requirements of the wireless nodes. A particular problem is that the RF propagation paths may be constantly changing due to movement of people or objects around the environment, or when the sensor, tags or reader are not stationary, and line-of-sight transmissions may not be possible, so that obtaining robust and reliable networks is challenging. Industrial environments are generally highly reflective to radio signals, so that multi-path effects are prevalent, and electromagnetic “machine noise” may affect low frequency transmission. The power requirements for battery power nodes is an important issue, since changing the batteries is an additional maintenance requirement and prevents wireless deployments being “fit and forget”.

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The use of smart networks that can reconfigure the radio links dynamically, can enhance the reliability of the radio link and optimise data transmission. SMART or reconfigurable antenna systems, whose radiation pattern can change dynamically, can enhance radio link performance and reduce the effects of interference signals and reduce the power requirements, but these pose metrological challenges as the antennas are small and may have many operating modes which must be characterised. At present, laboratory tests of the radio link performance do not ensure that the systems will operate correctly in the field, and a robust test platform is required that simulates (electronically) the signal propagation effects in industrial environments where interference and fading multi-path effects can occur. The ability to simulate moving nodes in the network is also important. For coexistence with other systems, and to prevent interference between the RF link and the sensor element, it is important to be able to test the electromagnetic compatibility (EMC) for digital or pulse modulated signals. To enable industry to develop smaller, lower cost nodes for WSN, the sensor and RF link must be highly integrated and it is necessary to perform RF measurements at chip level to ensure interference effects do not occur.

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 focus of this topic is the metrological support for the development of new technologies in the area of radio frequency networks, the specific objectives are:

1. To provide the metrology for rapid and cost-effective measurement of smart antennas to bring about a step change in the application of these emergent technologies to wireless networks
2. To establish robust testing methodologies to ensure that wireless networks will operate correctly in the field and will coexist with other systems
3. To provide the metrology at chip level to facilitate high-level integration of the sensor and wireless link
4. To provide traceable metrology with quantified measurement uncertainties for specific applications of wireless network devices, such as wireless sensor networks at 2.45 GHz, 5.8 GHz, 6 - 9 GHz, 61 GHz for industrial process monitoring and control, 3-D precision localisation, and vehicle-to-vehicle-communication
5. To develop testing procedures of disposable on-metal RFID tags

Proposers shall give priority to work that meets documented industrial needs and that which supports transfer into industry e.g. by cooperation and/or by standardisation.

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

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 (eg letters of support) is encouraged.

Where a European Directive is referenced in the proposal, the relevant paragraphs of the Directive identifying the need for the project should be quoted and referenced. It is not sufficient to quote the entire Directive per se as the rationale for the metrology need. Proposals must also clearly link the identified need in the Directive with the expected outputs from the project.

In your JRP submission please detail the impact that your proposed JRP will have on Directive 1999/5/EC [1]. You should also detail other Impacts of your proposed JRP as detailed in the document “Guidance for writing a JRP”

You should explain how your JRP results are going to:

- feed into the development of standards through appropriate standards bodies

- transfer knowledge to the sensor and potential end user sector.

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. 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 3 years duration.

Additional information

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

[1] DIRECTIVE 1999/5/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.