Publishable Summary for 18SIP02 5GRFEX
Metrology for RF exposure from Massive MIMO 5G base station: Impact on 5G network deployment

Overview

Current radiofrequency electromagnetic field (RF-EMF) exposure limits have become a critical concern for fourth generation (4G) and fifth generation (5G) mobile network deployment across Europe. Regulation is not harmonized and in certain countries and regions goes beyond the guidelines set out by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). This project will produce specific RF-EMF exposure measurement guidance for 5G Massive MIMO (multiple-input-multiple-output) base stations which will be disseminated to technical, business and regulatory communities to support the development of effective regulation and enable 5G implementation that balances performance with public safety.

Need

High bandwidth mobile communication is an essential tool for wealth creation in Europe, as illustrated by demand-led compound data growth rates of 40 % per year. In Europe, exposure to RF-EMF is regulated based on the 1998 guidelines of the ICNIRP, which are recommended by the World Health Organisation (WHO). Within the European Union (EU) legal framework these guidelines are enshrined in Council Recommendation 1999/519/EC. However, certain EU member states have imposed stricter EMF exposure limits which are significantly lower than the WHO or EU recommendations. For example, in the region of Brussels the cumulative limit is 6 V/m instead of 41 V/m at 900 MHz. This more stringent exposure limit has had an impact on 4G network rollout and will be worse for 5G deployment.

Proximus Belgium (Belgium's leading mobile network operator and primary supporter of this SIP) has identified the need for robust methods to measure the realistic RF-EMF exposure from 5G base stations. Current measurements of RF-EMF exposure from third generation (3G) and 4G base stations include an exclusion zone (a compliance boundary around the base station with no access to general public), based on the assumption that the theoretical maximum power is transmitted in every possible direction for a defined time-period. However, the beamforming Massive MIMO base stations employed in 5G allow energy to be focussed in sharp high-gain beams in the direction of a specific mobile user. This means that it is difficult for operators to deploy 5G Massive MIMO on sites with pre-existing 3G and 4G base stations. Regulators, operators and 5G equipment suppliers therefore require up-to-date, reliable and agreed assessments of RF-EMF exposure levels to support consistent and effective 5G regulation and network design.

Previously, EMPIR project 14IND10 MET5G developed 5G testbed capability that sought to establish metrological traceability for massive MIMO base stations and measurement capability in generating traceable known EMF measurements. This project will develop and validate these measurement techniques for RF-EMF exposure using the 5G testbeds developed under 14IND10 MET5G, make recommendations on how to properly measure RF-EMF exposure from 5G base stations using Massive MIMO and share the recommendations with the relevant technical, business and regulatory communities.

Objectives

The overall objective is to create impact from the use of the hardware and metrological capabilities of JRP-14IND10 MET5G by establishing real-world 5G scenarios in a laboratory environment, developing metrology for RF exposure from 5G Massive MIMO base stations, and validating the methods with real-world measurements.

The project addresses the following objectives:

1. To establish a realistic, rigorous measurement capability for traceable RF-EMF measurement of 5G NR Massive MIMO base stations. This will include RF-EMF assessment of real-world 5G NR Massive MIMO base stations based on RF-EMF measurement and data processing methods/protocols of 5G Massive MIMO base stations.
2. To make recommendations to the technical, business and regulatory communities (e.g. EU regulatory bodies and ICNIRP, ITU, 3GPP, CTIA, IEEE, ETSI, GSMA) on how to robustly measure RF-EMF from 5G NR Massive MIMO base stations in order to establish appropriate base station exclusion zones for 5G.

Results

The expected final outputs in relation to the two objectives are:

1. A Good Practice Guide recommending new approaches and robust measurement methods/protocols for the assessment of traceable RF-EMF exposure from 5G Massive MIMO base stations in laboratory and real-world environments.
2. Evaluation report describing how the stringent RF-EMF limits affect the 5G wireless communication performance.
3. Dissemination of measured scientific evidence on the impact of current RF-EMF regulatory limits on 5G network deployment to end users (the mobile network operators) and relevant EU regulatory bodies.

Impact

This project will deliver impact by focusing on the development of rigorous measurement techniques using 5G MIMO testbeds (developed under EMPIR 14IND10 MET5G) with a Massive MIMO testbed and the measurement capabilities that generate a known traceable EMF field. This will result in a Good Practice Guide on how to measure EMF exposure from 5G Massive MIMO base stations in real-world conditions and lead to better informed evidence-based discussions concerning 5G regulation with regulatory bodies. This in turn will support the safe, effective implementation of 5G. The timing of this project is ideal for 5G infrastructure development, which is planned for deployment from 2020.

The project's primary supporter, Proximus, is the leading Belgian operator. In Belgium, there are three separate RF-EMF regulation limits across the three regions of Brussels, Flanders and Wallonia, all of which are more stringent than the Council Recommendation 1999/519/EC based on ICNIRP guidelines. These more onerous local RF-EMF limit restrictions have resulted in Proximus's business being impacted. The outputs from this project will enable mobile network operators to inform the European Commission on the need to harmonise RF-EMF exposure limit policies based on the international guidelines and to adopt evidence-based policies that enable more effective deployment of mobile broadband and other wireless technologies.

The move to wider bandwidths and more complex modulation schemes in 5G systems places greater demands on the measurement equipment used in production and testing, and in research and development. The overall EU investment from 2007 to 2013 amounted to more than €600M in research on future networks, half of which was allocated to wireless technologies contributing to development of 4G and beyond 4G. This project is directly relevant to these activities carried out by the 5G communications industry, and academia, in developing the necessary infrastructure and standards for 5G communications.

The requirement to design mobile networks in compliance with more restrictive RF-EMF exposure limits results in less flexibility in network deployment. Network operators, in order to respect stricter limits, have to reduce the output power of their antennas. Such reduction affects coverage and creates gaps in the network, which then affects the quality of the service provided to consumers. This project will develop rigorous RF-EMF exposure measurement methods that will help industry assess 5G Massive MIMO base station performance more reliably in order to prove their safety to regulators. Furthermore, this project focus on areas where 5G is subject to complex scenarios and/or technologies, or, where it is in an early stage of development, such as Massive MIMO. The outputs from this SIP will support industry end users (mobile network operators) by providing scientific evidence to enable them to better influence policy discussions and future regulatory decisions concerning 5G regulation with EU, international and local regulatory bodies to support effective 5G implementation – that balances 5G performance and public safety.

The advantages of 5G and emerging wireless technologies will extend well beyond telecommunications. The European Commission estimates that almost 100 million students, more than 70 million workers, almost 2

million doctors and more than 2.5 million patients in hospitals across EU will benefit directly from the emerging wireless technologies with much faster data transfer speeds by 2025. Currently, associated industries employ 1.3 million people in the EU, representing a contribution of €160bn to the economy. 5G is also a basic requirement of the fields of eHealth, smart grids, smart cars, connected homes, entertainment, and smart asset tracking systems. Reliable mobile and fixed connectivity will make new digital applications a reality, e.g. virtual and augmented reality, autonomous driving, artificial intelligence, smart manufacturing, and precision farming – available for the benefits of all Europeans.

For the European citizen, 5G and emerging wireless technologies are envisaged to provide a universal communication environment that enables us to address the wider societal challenges, such as transport, automotive, safety, employment, health, environment, energy, manufacturing and food production. By underpinning the 5G deployment with sound metrology, this project will help satisfy the EU citizen's demand for more and better data, providing huge societal benefit. Furthermore, fast reliable high bandwidth communications will change the way in which we interact with the medical and social services e.g. 24/7 monitoring of Dementia patients in their own homes.

This project will disseminate information to European and international standardisation committees, such as ICNIRP, ITU, 3GPP, ETSI, CTIA, IEEE, and GSMA.

List of publications
N/A

Project start date and duration:	01 June 2019, 24 months	
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