Electromagnetic artificial human: paradigm shift in dosimetry for 5G and beyond

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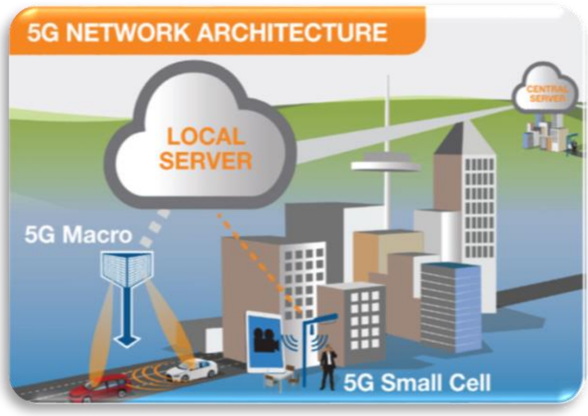
Summary

The upcoming mass deployment of 5G networks will make human exposure in the upper part of the microwave spectrum ubiquitous worldwide.

Because of fundamental limitations related to shallow penetration depth of high frequency electromagnetic fields in biological tissues and equivalent human phantoms, the conventional dosimetry and user exposure compliance testing techniques employed below 10 GHz cannot be directly scaled to higher microwave frequencies.

EM-ART project will explore a fundamentally novel approach addressing challenges in terms of accurate and realistic dosimetry measurements at millimeter-wave (mmWave) frequencies allocated for 5G wireless networks. The project will merge the complementary expertise and know-how of IETR and IRISA in advanced mmWave technologies, computational electromagnetics, multi-physics dosimetry, bio-inspired models, and sensor-based robotics to pave the way towards a new generation of dosimetry systems for 5G and beyond.

Context: Towards mmWave 5G / xG



Integration of small cells in 5G infrastructure
[5G Explained - How 5G Works. www.emfexplained.info/?ID=25916]

The continuous development of mobile terminals, such as smartphones, tablets, and body-worn devices, has increased the wireless data traffic that will keep growing due to the video streaming apps and cloud computing. According to the International Telecommunication Union, the exponential surge of mobile data traffic will reach 5 zettabyte/month by 2030, while the number of devices connected to internet worldwide is expected to exceed 75.4 billion by 2025.

The growing need for high-performance communications leads to fast development of heterogeneous cellular mobile networks. Evidently, the conventional microwave spectrum cannot serve this booming demand for higher data rates. Thus, the wireless industry is propelled towards underused spectrum above 10 GHz, including millimeter-wave (mmWave) bands. Since the launch of 5G mobile communications in 2020, this spectrum has been deployed to provide an ultra-low latency (≈1 ms) and ultra-high data rates (several GB/s).

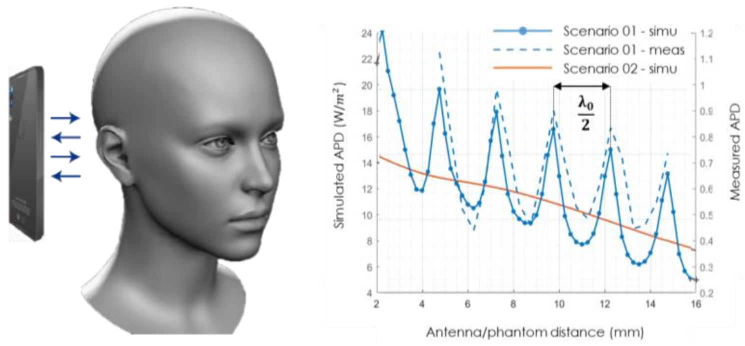
Motivation

The systematic and continuous push towards the emerging 5G mobile communications will make human exposure to mmWave radiation ubiquitous worldwide. Scenarios where the wearable or mobile device is operating in vicinity of the human body (e.g. phone call, browsing, etc.) involve bi-directional interaction of radiating devices with the human head and / or hand, both in terms of the body impact on wireless device performances as well as in terms of user exposure. Radiated powers of user terminals (e.g. smartphones, tablets), that range from tens to hundreds of mW depending on the country, may result in locally very high exposure levels under near-field exposure conditions due to localized absorption at mmWaves. To ensure the user safety, the wireless devices have to go through the exposure compliance testing certification.

Current challenges in mmWave dosimetry for 5G / xG

Available dosimetry methods and systems are not suitable for user exposure compliance testing of wireless devices at frequencies above 10 GHz, allocated for 5G and future xG wireless networks

State of the Art: **Free-space** measurements in vicinity of mmWave device under test



Challenge: for accurate and representative exposure assessment **antenna / body interactions shall be taken into account** in measurements

Main objective

The EM-ART project will explore a novel approach for electromagnetic dosimetry measurements in emerging 5G bands above 10 GHz that allows to:

- **Reproduce realistic use case scenario**
- **Take into account the antenna/human body interaction**
- **Determine the most critical exposure conditions**

Project home page
https://project.inria.fr/emart

EM-ART project overview