European Metrology Programme for Innovation and Research

Delivering Impact

Practical 5G signal quality testing

The promise of fifth-generation (5G) mobile networks is ubiquitous telecoms and a platform from which innovations can exploit breakthrough levels of connectivity. Full readiness will require several technologies to be developed, presenting some complex testing challenges. Reducing unwanted radio signal interference will be critical for maintaining device connectivity, but no metric was validated as capable of providing accurate measurements of signal quality.

Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

The promise of 5G is revolutionary advances in mobile device user experience, sufficient to drive a transformation in personal connectivity, and form a platform for new market opportunities.

5G is less of a technology platform, more a performance specification, defined by low-latency, multi-Gigabit per second data capacity, low energy consumption, and seamless connectivity. Yet, if these promises cannot be delivered at tolerable cost, the long-term marketability and returns on investments in 5G will be compromised, and potential economic and social benefits impaired.

For device developers, the complexities of the implementing technologies amplify some challenging measurement requirements. For example, massive multiple-input-multiple-out (MIMO) base stations can include hundreds of antennas to serve higher densities of connected devices than possible with previous-generation technologies.

Signal-to-Noise Ratio is used as a metric of radio signal quality in device testing, but for 5G, signal quality is more influenced by interference between devices than equipment noise, making this metric impractical.

Signal-to-Interference-plus-Noise Ratio (SINR) becomes more representative; taking account of noise, interference, and signal strength, but no traceable definition was developed suited to all 5G devices, including massive MIMO systems.

Solution

The EMPIR project *Metrology for 5G Communications* defined and developed traceable, cost-effective and efficient methods for measuring over-the-air signal quality.

After consulting with industry, existing and newly devised definitions of SINR were evaluated in 4G and 5G simulated systems. A measurement campaign validated traceable channel power and error vector magnitude (EVM) as practical predictors of SINR, and a field trial validated SINR as an accurate and reliable metric for 5G assessing signal quality.

Traceable channel power and EVM are parameters relating to differences in signal modulation errors between device decoders and reference signals.

Impact

Before participating in the project, Keysight Technologies, the market-leading electronic measurement company, developed applications of channel power and EVM for use in 5G signal quality testing but had not exploited these approaches in the market.

As it generates around $1 BN in sales from its 5G test businesses, Keysight is positioned to provide solutions for current test needs while incorporating the latest measurement science. Based on new assurance in the validity of channel power and EVM measurements, and recognition of the resulting 'paradigm shift' in testing, it chose to educate the market by a gradual introduction of new signal measurement capabilities.

Keysight released its *S93070xB Modulation Distortion software for the PNA-X Vector Network Analyzer,* that, for the first time, provided calibration of 'vector corrected' EVM measurements. It later released its first signal strength and channel power measurement capability for over-the-air testing, as an upgrade to its *N9913A FieldFox Handheld Microwave Analyzer.*

Keysight is an important participant in the follow-on *Metrology for RF exposure from massive MIMO 5G base station: Impact on 5G network deployment project*, that is developing guidance on traceable radio field strength measurement methods.

Practical and cost-effective 5G signal testing and device development will boost the competitiveness of Europe's communications sector and, with support for deployment, increase its potential for transforming mobile connectivity.

Metrology for 5G Communications

The project *Metrology for 5G Communications* defined and developed practical and traceable methods to measure SINR over a wide frequency range. It also developed a broadly-applicable definition of SINR for potential 5G modulation and coding schemes.

To improve metrology for traceable MIMO antenna systems, three new 5G MIMO testbeds were constructed: one capable of mm-wave Massive-MIMO communications providing remote access so developers can simulate connected or over-the-air device testing without leaving their facilities. The availability of testbeds enabled traceable test methods and algorithms to be developed, overcoming significantly increased system test-complexity arising from multiple antenna elements and operation at mm-wave frequencies.

The project also developed traceable test methods for 5G mobile communication devices, supporting vastly increased numbers of users and devices densities.

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

www.euramet.org/project-14IND10

Tian Hong Loh

NPL (UK)

+44 20 8943 6508 | tian.loh@npl.co.uk

11326/0420 - 14IND10