

3: it's the magic number

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The first 3D channel emulation technique for testing MIMO devices in a more realistic environment

3: it's the magic number*

More realistic testing of mobile terminals is a step closer thanks to the first 3D channel emulation technique for use in multi-probe anechoic chamber-based testing, developed and implemented by collaborating researchers in Denmark and Finland.

"Mobile network operators and manufacturers urgently require standard test methods to test MIMO device performance," said Wei Fan from Aalborg University, the first author of this work.

"Field testing and traditional conductive testing are not sufficient to truly evaluate MIMO device performance...there is a strong need to perform proper MIMO over-the-air testing. Our technique provides a general channel emulation framework for any incoming spherical, or 3D, power spectrum of the channel."

Nice and quiet

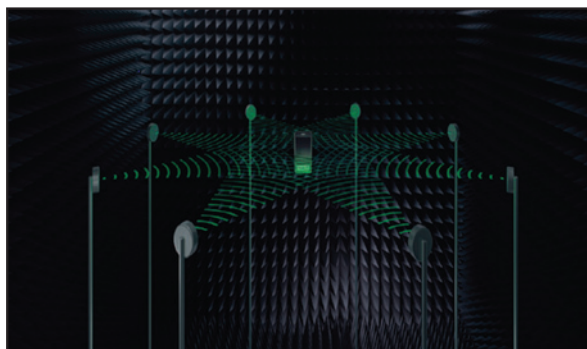
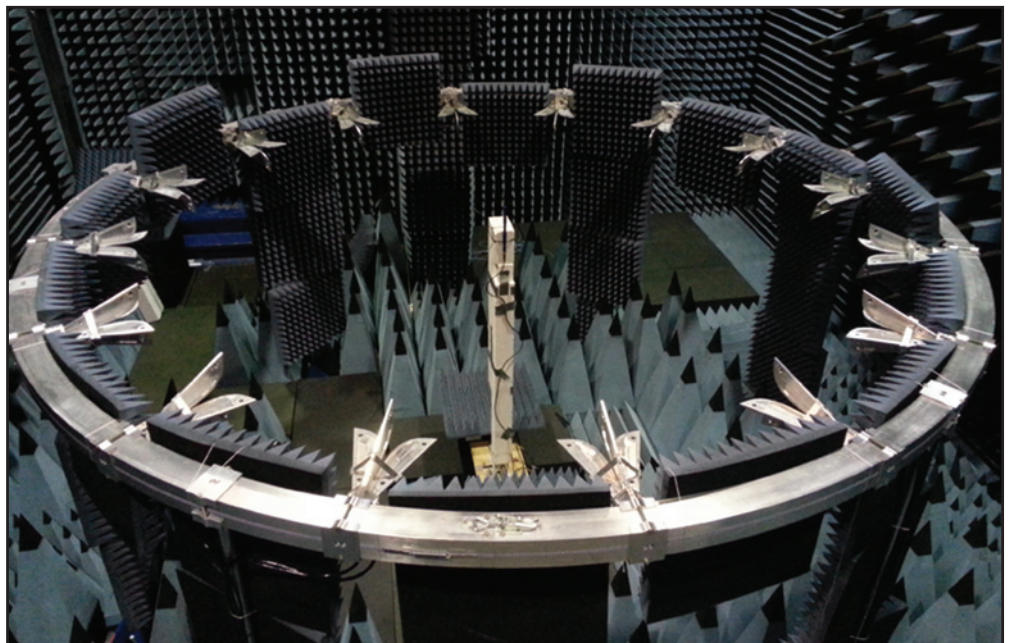
Over-the-air (OTA) testing of the radio performance of mobile terminals has the advantage, compared to other test methods, of not needing to break or otherwise modify the mobile device. OTA testing for mobile terminals with single antennas (SISO OTA) was standardised by CTIA and 3 GPP about ten years ago, but these methods cannot be used directly for MIMO technology. Testing methods for MIMO devices using an anechoic chamber were first introduced in CTIA, COST action 2100 and 3GPP in 2009.

There are three main types of test methods for MIMO devices: multi-probe anechoic chamber-based methods, reverberation chamber-based methods and two-stage methods. All currently have their limitations: there is limited temporal and spatial control of the reproduced channel in the reverberation chamber-based method; practical issues including self-interference still exist in the two-stage method; and the cost of the setup and the emulation of realistic channels with multi-probe and channel emulators are the main issues with the multi-probe anechoic chamber-based method.

Growing up...

Most of the standard channel models are 2D and MIMO over-the-air testing is currently limited to the use of these models which are defined only in the azimuth plane and assume that there is no spread over the elevation direction.

"The 2D channel model assumption is generally not valid," said Fan.



"Measurements have demonstrated that the channel elevation spread cannot be ignored in many propagation environments."

The idea and theory behind the 3D channel emulation model presented in this issue of *Electronics Letters* is a result of a collaboration between three organisations. The work was supported by the Danish National Advanced Technology Foundation via the 4th Generation Mobile Communication and Test Platform (4GMCT) project, of which two of the main partners are Intel Mobile Communications and Aalborg University. They worked with Anite who is the main developer and technology provider of the commercially available Proprietary radio channel emulators used in MIMO OTA. The implementation was carried out by the APNet section at Aalborg University which

TOP: In this 2D MIMO over-the-air test system at Aalborg University, a mobile device sits in the centre of a ring of probe antennas. The new technique will also allow channel emulation in the vertical direction

BOTTOM: Plane waves inside the test zone can be approximated in a 2D setup (illustrated). Future work will include extending this to 3D

has been involved in radio propagation research for over 20 years, and also has extensive research expertise in electromagnetics, mobile devices and reliable radio networking.

...fast

The new technique is the first to emulate 3D channel models efficiently, allowing a more accurate reflection of a realistic wireless propagation environment inside an anechoic chamber. One of the next stages of development is to use the emulated 3D channels in some live phone testing with commercially available consumer devices.

Future work will also investigate several practical issues with the 3D multi-probe configuration. For a 3D MIMO OTA setup, the number of probes may be larger than the number of output ports of the emulator. Setting up a 3D multi-probe configuration is very costly, and so investigating properties such as the reflection and coupling can enable the system to be optimised. Finding ways to limit the number of probes while still approximating the target channels could make the test system both cheaper and simpler to implement as less calibration effort would be needed.

Other future developments will be focused on the relationship between the number of probes needed and the test volume size (for example the number needed for a MIMO device or a laptop), and to study ways to approximate plane waves inside the test zone.