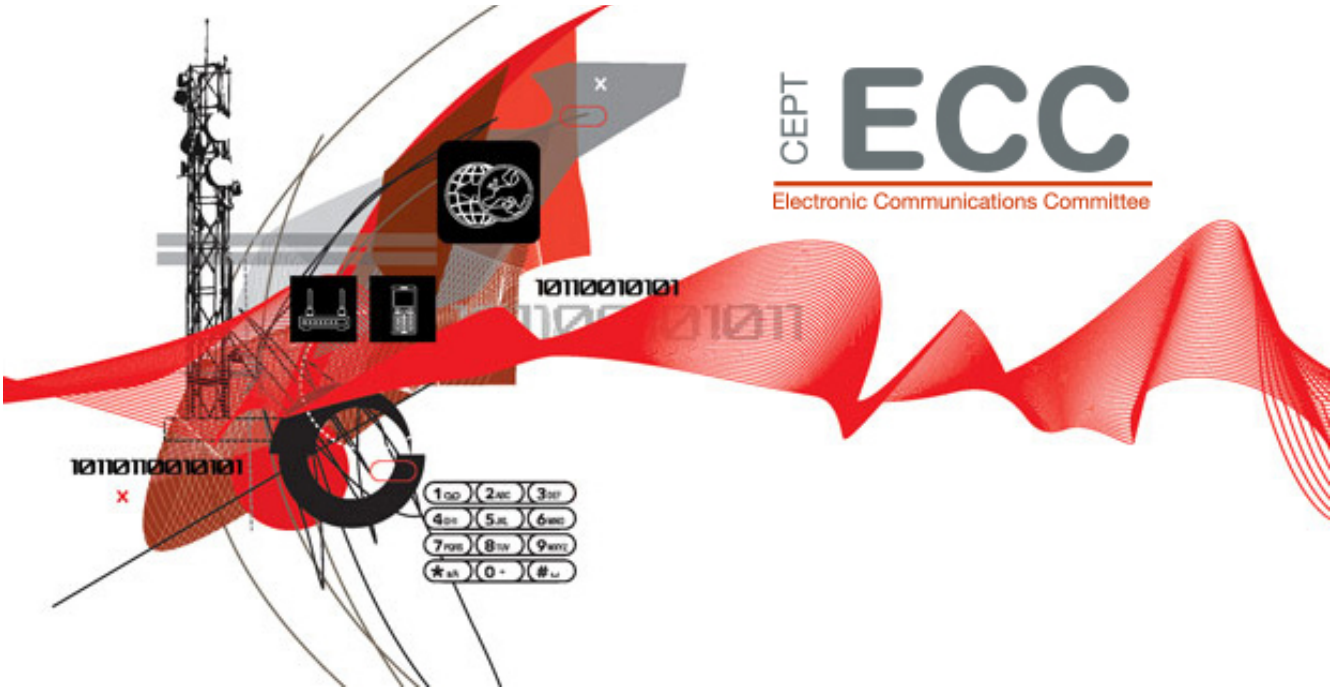

ECC Newsletter August 2022

The unique challenges of measuring emissions from 5G active antenna systems in the field

Peter Faris, ECO Spectrum Expert, explores recent ECC moves to develop techniques for field measurements of 5G active antenna systems.

Active antenna systems (AAS) are a key component of 5G networks. The ECC has been developing the harmonised European framework for 5G to allow the use of AAS in both existing and new frequency bands. This has led to the need to develop novel techniques for measurements in the field of both in-band and unwanted emissions of 5G AAS. Those techniques will help administrations to check compliance with regulations and perform interference investigations. However, there is a unique set of challenges when it comes to measuring emissions in the field.

AAS to enable 5G

One of the main innovations of 5G compared with previous generations of mobile technology is the use of AAS. These "smart antennas" consist of an array of active elements which are controlled in software to allow a base station to dynamically steer a beam towards an individual user. AAS allows wider coverage, higher capacity and end-user high speed connectivity up to several gigabits per second.

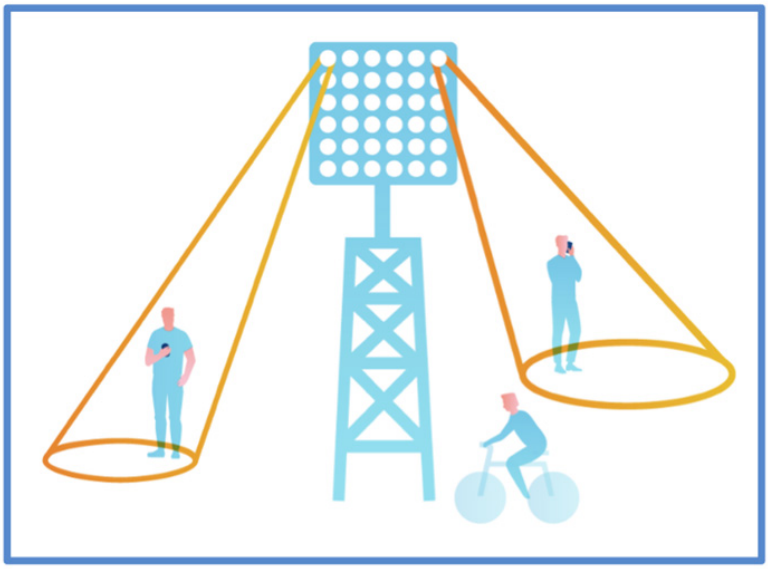

Figure 1: Illustration of beam steering in 5G AAS (Source: draft ECC Report 345)

As reported in newsletter articles in 2018 and 2020, ECC PT1 has been engaged in work in recent years to develop a harmonised European framework for 5G, in both existing and new frequency bands. One of the major challenges of this work has been to develop technical conditions which are compatible with AAS. In parallel, Project Team SE 21 has been leading the work to develop techniques for measurements of both in-band and unwanted emissions of 5G AAS which would enable administrations to check compliance with regulations and perform interference investigations.

How to define regulatory limits for AAS?

With other "conventional" antenna technologies emission limits for both in-block and out-of-block power defined in ECC Decisions have been based on EIRP (equivalent isotropically radiated power) which defines the maximum power in the direction of the antenna's main beam. This is not possible with AAS due to the dynamic nature of the antenna beam. It is difficult to determine the antenna gain in any specific direction at a specific point in time. As a result, it was necessary to define the emission limits in terms of a different metric – total radiated power (TRP) – which is defined as the integral (summation) of the power radiated by the antenna array in different directions over the entire radiation sphere.

The concept of TRP was also introduced in 2019 in ERC Recommendation 74-01 which defines the generic spurious emission limits for all types of systems. The previous limits for mobile systems were based on conducted power measured at the antenna input. As mentioned in a 2018 newsletter article, this type of measurement is not possible for AAS, which is why the limits for mobile systems needed to be revised to be defined in TRP.

The need for measurements

These revisions to the regulatory framework are not the end of the story. They provide the important mechanisms for administrations and operators to enable the roll-out of 5G while ensuring protection of systems in adjacent bands from interference, but a whole new set of challenges has been raised in terms of how to measure the emissions of AAS.

Administrations undertake measurements both in the lab and in the field for a variety of reasons depending on national needs - including to ensure compliance with the limits and to investigate potential cases of interference. With other non-AAS based systems, administrations can either take a conducted power measurement at the antenna input, or an EIRP measurement at a fixed location in the antenna pointing direction. The dynamic nature of AAS beamforming, as well as the fact that no antenna connectors are available for measurement, means these standard methods cannot give a representative estimation of the TRP for comparison with the emission limits.

Novel field measurement approaches for AAS

Project Team SE 21 has been investigating these issues. Draft ECC Report 345, which is currently undergoing public consultation and is planned for publication in October, provides proposed novel methods for in-band measurements of 5G AAS base stations in the field.

The methods investigated in the draft Report include the use of ground-based measurements where a test user moves around the base station, and airborne measurements using a drone to fly around the base station. The draft Report presents examples of proof-of-concept measurements using these methods on actual 5G base stations.

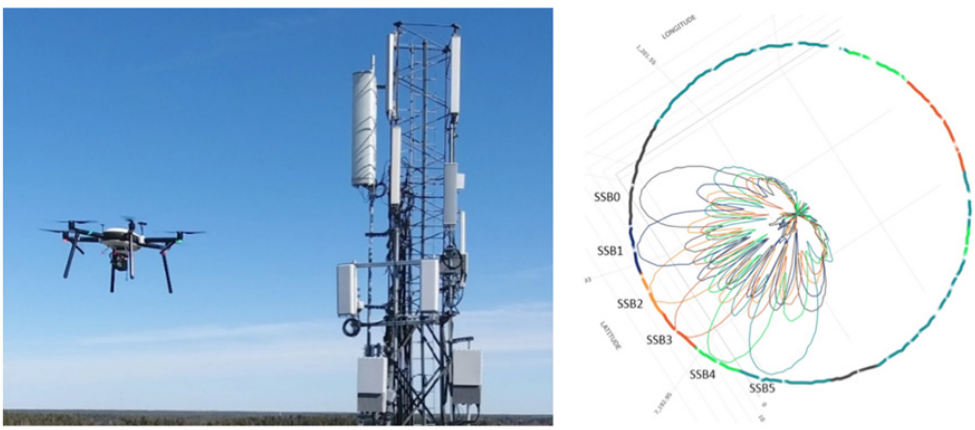

Figure 2: Example of airborne drone-based measurements of a 5G AAS base station (Source: draft ECC Report 345)

These methods rely on measurement of EIRP at a range of selected points, from which TRP can be estimated using a set of equations defined in the draft Report.

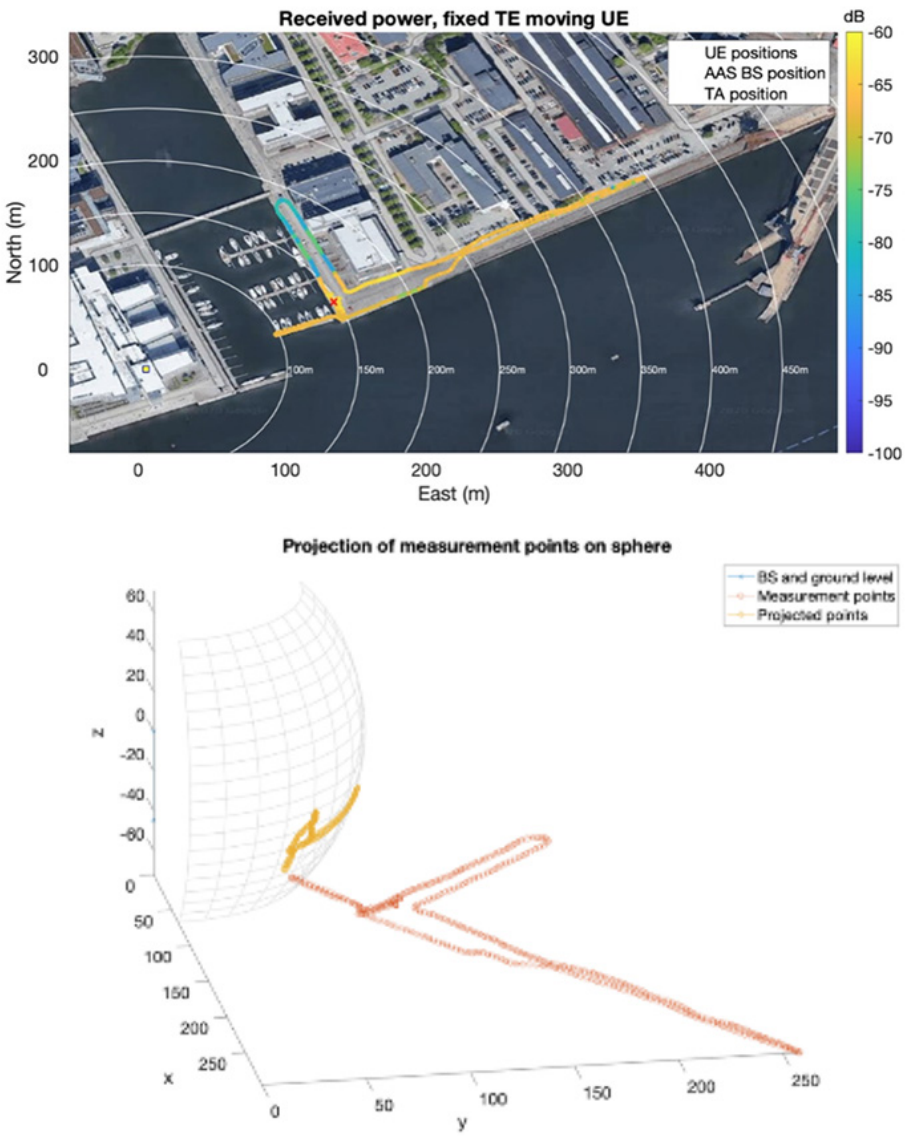

Figure 3: Results of ground-based measurements of EIRP, projected onto a sphere for TRP estimation (Source: draft ECC Report 345)

The limitations of these methods and their suitability to different types of measurement are explored in the draft Report.

Next steps – unwanted emissions, lab measurements and modelling

The work so far has focussed on the in-band case, as identifying suitable methods for field measurements of unwanted emissions proves more challenging due to additional uncertainties, as well as lower signal levels involved in these measurements. More time is therefore needed to study this case. SE 21 has started work on a separate draft ECC Report

to address this. The report is planned for finalisation by 2023. It will provide crucial guidance to allow administrations to monitor compliance with the unwanted emissions limits.

Measurements in the lab are another method used by administrations to determine the characteristics of equipment. ECC Report 249 on "Unwanted emissions of common radio systems: measurements and use in sharing/compatibility studies" is being updated. Its publication is planned for October. It will include a limited number of measurements of unwanted emissions of 5G AAS base stations taken in an anechoic chamber. These measurements are taken at a fixed point based on EIRP, but the principle could be extended to measure TRP if multiple points are measured around a sphere.

In the future when more lab and field measurement results are available, it will be useful to compare them against the existing theoretical models used in simulations to calculate capacity and potential interference (e.g. using the SEAMCAT tool). It will be beneficial to inform on the accuracy of these models and to ascertain if modifications are needed. ECC PT1 plans to undertake such studies when suitable information becomes available.

All these activities will help to ensure continued smooth operation of 5G networks while ensuring both protection of systems in adjacent bands from interference, and end-user high speed connectivity up to several gigabits per second.

ECC develops technical proposals for new innovative millimetre wave security scanners

Millimetre wave scanners are making it easier to detect security breaches at airports and other public buildings but spectrum regulation has to be updated to accommodate them, writes Robin Donoghue, ECO Spectrum Expert

This summer, as millions of people travelled through airports in Europe on their holidays, they would have had to go through airport security. New technologies have taken the ability of security scanners further than ever before: new millimetre wave security scanners can detect metallic and non-metallic objects concealed inside or beneath clothing.

A security scanner is a device that detects objects on a person's body for security screening purposes, without making any physical contact. Modern scanners can be deployed as an early warning of concealed weapons, operating at a larger distance of up to 15 m, covering up to 400 m^3 and could therefore be installed in locations such as entrances or public walkways in airports.

Millimetre wave security scanners detect objects underneath a person's clothing. However millimeter waves don't penetrate the body as they are mainly reflected by the surface of the skin. Typical uses for this technology include detection of items for commercial loss prevention, detection of smuggling, and screening at government buildings, as well as airport security checkpoints.

The security scanners that are currently used in airport security checkpoints are typically short range. In February 2020, the ECC received a draft System Reference Document (SRdoc) from ETSI. Known as TR 103 664, the document proposed to place security scanners within the frequency range 60-90 GHz. Essentially, this document describes the system and technology and the relevant technical information. It proposes to update the spectrum regulation to accommodate two types of systems:

- Indoor use at 68-82 GHz, with the power limit of 10 dBm peak EIRP in the direction of main radiation, and -30 dBm/MHz mean EIRP in the direction of main radiation. The bandwidth required is up to 10 GHz.
- Indoor and outdoor use at 71-75 GHz with a power limit of 20 dBm peak EIRP in the direction of main radiation, and -23 dBm/MHz mean EIRP in the direction of main radiation. The bandwidth required is up to 4 GHz.

Airports are not the only place these millimetre wave security scanners can be used. As well as airport terminals, the SRdoc suggests they could be used at:

- central transportation centres;
- major shopping centres;
- stadiums, concert halls, museum and major sport sites and events;
- government offices/major court houses/correction facilities;
- education - universities, colleges and schools;
- VIP offices and visiting sites.

The SRdoc also suggested that millimetre wave security scanners be included in the ERC Recommendation 70-03, relating to the use of short range devices. Specifically, they would be included under Annex 6: Radiodetermination Applications.

The ECC considered the request and initiated the relevant coexistence studies, which resulted in the draft ECC Report 344 on "Sharing and compatibility studies of Security Scanners (SScs) within the frequency range 60-82 GHz" currently under public consultation. The report looked at two main different types of millimetre wave security scanner: A "Continuous Wave" scanner and a "Burst of Chirps" scanner.

The draft ECC Report 344 identified the services and applications that could potentially be affected by the introduction of millimetre wave security scanners, namely fixed service, automotive radar and amateur and amateur-satellite service. Of these, the fixed service is typically used for transmitting vast amounts of data with applications including, the connections between mobile phone base-stations, or private networks such as connections between financial services hubs – for example, City of London, Frankfurt or Zurich. Automotive radars are sensors built into modern vehicles to enable certain driver assistant features such as automatic cruise control and emergency breaking. The amateur (4mm band) service is currently largely used for research and experimentation.

The studies in draft ECC Report 344 concluded that the indoor use of the Continuous Wave security scanner shows no risk of interference when operating with a peak EIRP of 19 dBm in the 69.89 GHz to 79.89 GHz frequency band with a peak EIRP of 7 dBm. Therefore, this meets the requirement for an allocation of up to 10 GHz for indoor use, albeit with a slightly reduced maximum power from that requested in the SRdoc.

The studies also concluded that for either type of security scanner, for both indoor and outdoor operation, no harmful interference is caused towards the fixed service when operating in the band 76.5-80.5 GHz, where 23 dB of out-of-band attenuation can be assumed. It also concluded that although there may potentially be a risk of interference to

automotive radar in this frequency band when only the coupling loss is considered, in practice however, this would be mitigated were the timing of the transmit signals considered. The ECC Report 344 concluded there was no risk to the amateur service in the band 76.5-80.5 GHz. Therefore, this meets the requirement for an allocation of up to 4 GHz for indoor and outdoor use, albeit with a slightly reduced maximum power of 19 dBm, from that requested in the SRdoc.

The draft ECC Report is due to be published in October, taking into account the results of the public consultation. It is also expected that new activities will be undertaken in the ECC, in particular, to develop new regulations permitting the use of this new innovative millimetre wave security scanner technology.