Measurements of Radiofrequency Emissions in Rural Sites Using VIAVI Equipment Mounted on Drones

Introduction

The study, measurement, and control of exposure levels due to radiofrequency electromagnetic fields (RF-EMF) produced by mobile phone base stations is a key factor in the deployment of these sites.

International regulations, such as those from the *International Commission on Non-Ionizing Radiation Protection (ICNIRP)*, define the exposure limits that must be met—both for occupational workers and the general public—in order for a mobile operator to deploy a 4G/5G base station at a given site.

Therefore, conducting measurements to verify existing exposure levels at a site where a 4G/5G base station is installed or will be installed is an activity that requires time, suitable instrumentation, and financial resources.

The company VANTAGE TOWERS and the Information Processing and Telecommunication Centre (IPTC) of the Technical School of Telecommunication Engineering (ETSIT) at the Universidad Politécnica de Madrid (UPM) have signed a collaboration agreement for *"Carrying out studies and measurements of 5G mobile telephony sites."*

As part of this agreement, several activities have been carried out, including:

a) the development of simulation software to predict power density levels at a site,
b) a measurement campaign in rural and urban areas to assess the viability of the tool, and
c) the development of an innovative measurement methodology.

To evaluate the potential of the simulation software, a measurement campaign was conducted in rural sites using drones equipped with VIAVI instruments, allowing real-time measurements of field strength and power density at selected points of interest. These were then compared with simulated values.

Equipment and Measurement Instrumentation

The VIAVI OneAdvisor 800 device was used to carry out field measurements. This equipment was mounted on a drone, enabling movement to various points of interest around the base station for in-situ measurements. The device can segment the spectrum into different frequency bands, allowing it to measure different technologies such as 3G, 4G LTE, or 5G NR by selecting the relevant frequency band for each type of cellular transmission.

The device also allows for different measurement durations per frequency band, depending on the technologies deployed at the site. Due to drone battery limitations, each measurement lasted six minutes, with at least one minute dedicated to each frequency band used by the site's operators.

A photo of the drone with the onboard equipment is shown in Figure 1.

Figure 1. Ground view of the drone with mounted equipment.

Measurements with Mounted Equipment

To select the measurement points around the base station, a preliminary study of the transmitted power from the site's antennas was conducted. Once the points were selected, GPS coordinates were calculated and uploaded to the drone. The drone then automatically navigated to each location, hovering in place for six minutes to complete the measurement.

The drone's range is limited by the weight of the total amount of mounted equipment (over 5 kg). For this reason, after every three or four measurement points—depending on the technologies present at the site—the drone had to return to the ground for a battery change. Therefore, the time needed to characterize a site depends on factors such as the number of points selected and the deployed technologies.

Figure 2 shows a photo of the site during measurement, with the drone in flight aiming at an antenna from one of the base station sectors. Antennas in rural areas are typically a few dozen meters high, and a ground operator monitors the drone's position at all times. As seen in the photo, the drone hovers just a few meters from the antenna, oriented perpendicular to it.

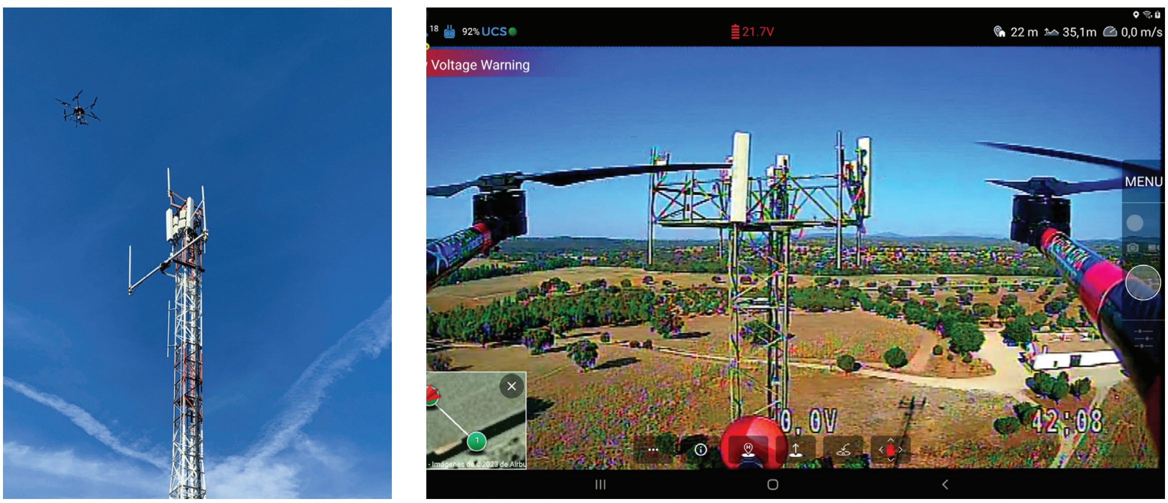

Figure 2. Drone in flight, aiming at antennas from one base station sector.

The operating frequencies for each technology at the site must be known in advance. Figure 3 displays a screenshot from the VIAVI OneAdvisor 800 user interface, showing several services at specific frequencies for the different operators sharing the site. For each, a power density value is obtained, enabling both the individual contribution per technology and the total power density at each selected site point to be determined.

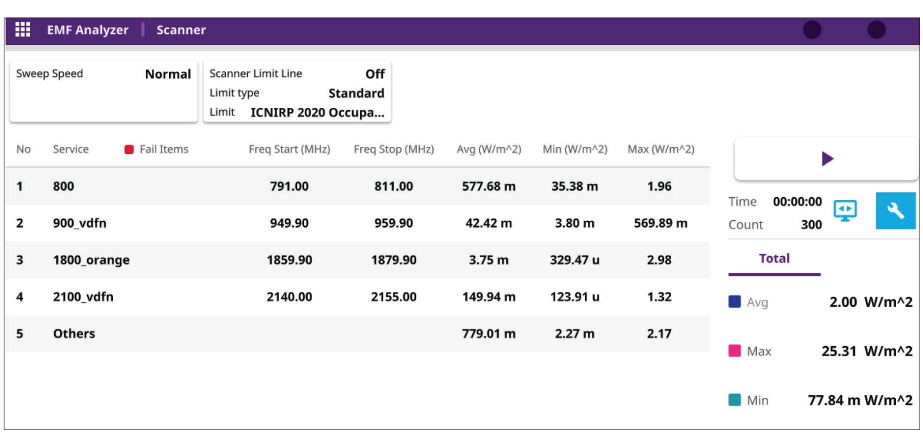

Figure 3. Screenshot from the VIAVI device showing selected frequency ranges at the site.

Simulation Software

As part of the aforementioned collaboration agreement, a simulation software tool called EMF Tool has been developed. It simulates a mobile telephony site and calculates parameters such as the power density received by a user at any surrounding location. The software also determines exclusion zones where international exposure limits are exceeded and thus pose a potential risk to the public.

Many countries have established exposure limits for mobile phone base stations in their legislation, largely based on the ICNIRP's 2020 guidelines.

Figure 4 shows an exclusion zone generated by the simulation software, along with the measurement points where VIAVI equipment on the drone was used.

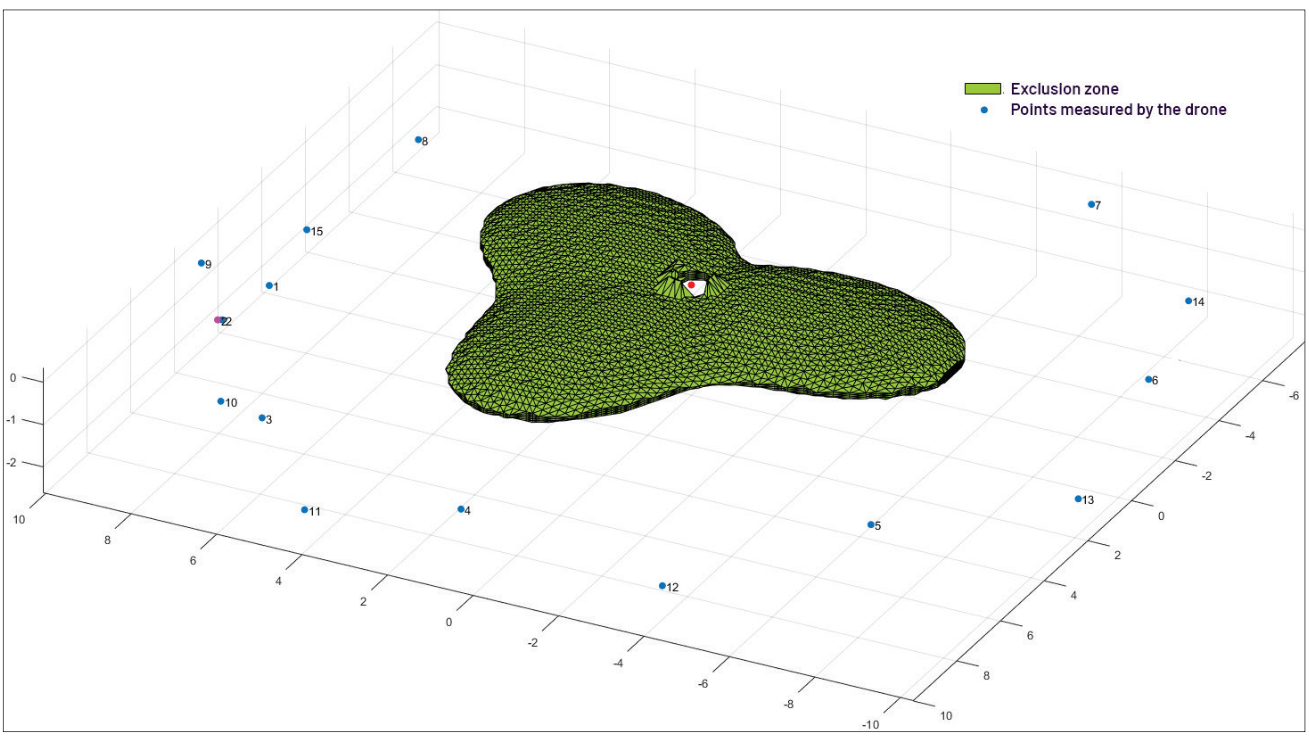

Figure 4. Exclusion zone generated by the simulation software.

Results: Comparison Between Simulated and Measured Data

Finally, the simulated power density values generated by the software were compared to the measured values collected by the drone-mounted VIAVI equipment at each selected point. The exclusion zone calculation and comparative analysis took into account the instantaneous transmission power values provided by the operator for the base station.

Figure 5 illustrates an example of the comparison made at one of the measured sites.

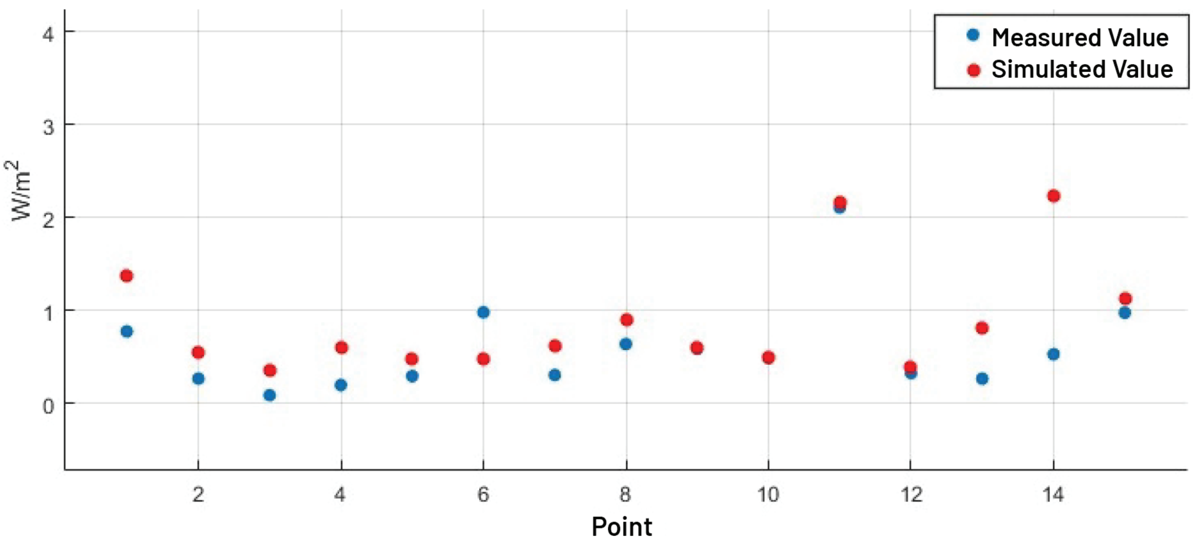

Figure 5. Comparison between measured values (VIAVI equipment) and simulated values.

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