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B47

Assessment Methods for 5G EMF Exposure: Comparing Theoretical Maximum and Total Exposure in Valencia

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Introduction

- Use of new wireless technologies, including 5G, has raised concerns about the potential health effects of increased exposure to RF-EMF.
- Current methodologies for assessing human exposure to electromagnetic fields may not be suitable for evaluating EMF in 5G due to its characteristics.
- A combination of mobile exposimeters and code-selective measurements can provide a comprehensive evaluation of RF-EMF exposure, allowing for precise identification of 5G signals and the contribution of different operators and cells.

Objetive

To assess 5G exposure using different techniques, comparing the results and establishing initial guidelines for evaluation.

Materials & Methods

- Scenario:
  - 16 measurement points were established across a 1.5x0.5 km^2 area of the campus of the Universitat Politècnica de València (Spain), ensuring homogeneous coverage and avoiding metallic elements or walls (Figure 1).
  - Personal exposimeters and a code-selective measurement testbed were used to assess both total exposure and the maximum theoretical exposure at each measurement point (Figure 2).
- 5G Code-Selective Methodology:
  - Code-selective exposure measurements were conducted using a TMSE-6 drive test scanner and SmartONE ROMES4 software from Rhode & Schwarz. This equipment allowed for scanning and identification of various parameters of 5G signals.
  - A Cobham OA2-0.3-10.0V/1505 omnidirectional antenna operating in the 0.4-10 GHz band was connected to the scanner to acquire data, providing detailed information on gain as a function of frequency and angle.
  - The Synchronization Signal Block (SSB) in 5G, specifically the Reference Signal Received Power (RSRP) of the secondary synchronization signal (SSS), was considered for code-selective measurements.
  - A Real-Time Spectrum Analyzer (RTSA) from Keysight, along with a triaxial isotropic antenna, was utilized to verify measurements and determine the channel bandwidth. Data analysis was performed using SmartONE ROMES4 software and further analysis in Matlab for efficiency and specificity.
- Instantaneous Measurements with Exposimeters:
  - Measurements were conducted using the EME Spy Evolution exposimeter, with 6-minute measurement periods taken every 10 seconds, excluding values below the device's detection threshold (nondetect), resulting in 36 recordings and determining the mean value (Table I).

Results

- Tables II to IV display the results of maximum theoretical and instantaneous exposure for the first three PCI measurements, demonstrating values significantly below the ICNIRP limit.
- However, it should be noted that these measurements were taken per PCI without 5G traffic, and real traffic is expected to increase exposure levels, necessitating consideration of total exposure from all operators in the future.

Figure 1: Measurement points ( ) and Mobile Phone Base Stations ( ).

Figure 2. Measurement set.

Figure 3: 5G Operator with the highest value of exposure and percentage of exposure compared to ICNIRP for every measurement point

TABLE I. FREQUENCY BANDS SELECTED AT THE EXPOSIMETER.

Name	Frequency bands
FM	87-107 MHz
R2DL	758-803 MHz
R2DL-LTE800	791-821 MHz
R3UL-LTE-B-GSM-900	925-960 MHz
R5UL-LTE-1800	1805-1880 MHz
R5UL-GSM-LTE	1864-1879 MHz
DECT	1880-1900 MHz
R1810DL-LTE-IMT-FDD-2100	2110-2170 MHz
R4TDD	2300-2400 MHz
R7UL-LTE-FDD-2600	2620-2690 MHz
R4TDD-5G	3600-3800 MHz

TABLE II. THEORETICAL MAXIMUM EXPOSURE FOR POINT 1

Operator	Frequency (GHz)	Cell ID (PCI)	S (W/m²)
Movistar	3.55	389	$3.63 \cdot 10^{-5}$
Vodafone	3.73	327	$1.21 \cdot 10^{-5}$
Orange	3.61	147	$0.85 \cdot 10^{-5}$

TABLE III. THEORETICAL MAXIMUM EXPOSURE FOR POINT 2

Operator	Frequency (GHz)	Cell ID (PCI)	S (W/m²)
Orange	3.61	147	$2.02 \cdot 10^{-5}$
Vodafone	3.73	131	$1.71 \cdot 10^{-5}$
Orange	3.61	408	$0.64 \cdot 10^{-5}$

TABLE IV. THEORETICAL MAXIMUM EXPOSURE FOR POINT 3

Operator	Frequency (GHz)	Cell ID (PCI)	S (W/m²)
Movistar	3.51	355	$1.42 \cdot 10^{-5}$
Orange	3.61	408	$0.88 \cdot 10^{-5}$
Vodafone	3.73	131	$0.58 \cdot 10^{-5}$

Conclusions

- The study compares total exposure and theoretical maximum exposure in 5G through measurements using a mobile exposimeter and code-selective testbed.
- Future work will involve calculating the theoretical maximum exposure considering contributions from all cells and operators and collaborating with Spanish operators for advanced extrapolation using base station configuration parameters.

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