3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022

In-Situ Measurement of EMF Exposure on a 28 GHz Band 5G Base Station

Sen Liu* (1), Kazuhiro Tobita(1), Teruo Onishi(1), Masao Taki(1), Soichi Watanabe(1), and Yukihisa Suzuki(2)
(1) National Institute of Information and Communications Technology, Tokyo, Japan; e-mail: liusen, ka_tobita, t_onishi, m_taki, wata@nict.go.jp
(2) Tokyo Metropolitan University; e-mail: y_suzuki@tmu.ac.jp

5G era is on its way, providing base infrastructures for many unprecedented scenarios (e.g.: smart cities, autonomous driving, industry 4.0, etc.). Despite the advantages, publics have raised concerns about the electromagnetic safety relating to 5G systems, since novel technologies, such as millimeter-wave (mm-wave) techniques and beamforming, are employed. On one hand, mm-wave frequency bands are required to alleviate the current frequency shortage in sub-6GHz band and provide an ultra-wide bandwidth for high data rate transmission. On the other hand, high-directional narrow-radiating-beams are needed to overcome the severe path loss at mm-wave bands. Anticipating that both of them will impact on the radio frequency (RF) electromagnetic field (EMF) exposure level, many organizations over the world have worked on figuring out the exact exposure levels, e.g., [1]. In this work, measurements of electric-field (E-field) strength as a metric of exposure level on a 28 GHz-band 5G base station are reported.

The measurements were conducted in a hall in Tokyo Metropolitan University, Japan, where a 5G base station is installed at a height of 4.0 m from the floor. The operating frequency ranges from 28.2-28.3 GHz covering a total bandwidth of 100 MHz. The subcarrier spacing (SCS) is 120 kHz and the symbol duration is 8.33 μs. There are 64 beams pointing to different directions for synchronization signals. A 5G mobile phone is used to load the base station. At the time of the measurement, only ping test is used for mimicking data traffic. An omnidirectional antenna placed at a height of 1.5 m from the floor and at a horizontal distance of 5.8 m from the base station is cabled to a spectrum analyzer (MS2090A, Anritsu) with Freq=28.2-28.3 GHz, RBW=1 MHz, Points=101, Sweep=3.37 ms (≈ 4×symbol duration). The phone is placed at a height of 1 m from the floor and at a horizontal distance of 1.5 m to the omnidirectional antenna. Measurements were conducted with/without traffic loading. For traffic loading, 100 times of ping tests were performed continuously. The measurement duration for each scenario lasts 34 sec (≈ times of 100 ping tests), and root mean square (RMS) E-field strength over the measurement duration is calculated separately. The measurement results are listed in Table I. The maximum E-field strengths are 118.7/105.5 dBμV/m, respectively, for traffic on/off, while those of RMS values are 99.1/89.7 dBμV/m. Besides, all the results even for maximum values are well below the exposure limits of 155.76 dBμV/m [2].

In this work, E-field strengths from a 28 GHz-band 5G base station were measured under different traffic conditions. The results show about 10 dB higher of E-field strength when traffic on. However, comprehensive evaluations are required, and comprehensive measurements are going to be conducted in the near future.

Acknowledgement:
The authors would like to appreciate the support from the Ministry of Internal Affairs and Communications, Japan (JPMI10001) and TMU local 5G research funding.

1. ANFR, "Assessment of Public Exposure to 5G Electromagnetic Waves: First Measurement Results on 5G Pilots in 26 GHz Band," June 2021, doi: https://www.anfr.fr/toutes-les-actualites/actualites/5g-a-mulhouse-lanfr-installe-des-capteurs-pour-mesurer-levolution-de-lexposition-aux-ondes/.

2. ICNIRP, "Guidelines for Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz)," *Health Phys.*, **118**, 5, May 2020, pp. 483-524.

TABLE I
MEASUREMENT RESULTS

Data Traffic	Max [dBμV/m]	RMS [dBμV/m]
On	118.7	99.1
Off	105.5	89.7