Influence of the Radiating UE Distribution Irregularity in Building Internal Space on the Level of Indoor Electromagnetic Background

Vladimir Mordachev
EMC R&D laboratory
China-Belarus Belt and Road joint Laboratory on Electromagnetic Environment Effect
Belarusian State University of Informatics and Radioelectronics
Minsk, Belarus
mordachev@bsuir.by

***Abstract*—Previous results of studies of the radio frequency electromagnetic background (EMB) created in buildings by radiations of user's equipment (UE), including mobile phones and mMTC/IoT equipment, are based on the model of uniform random distribution of this equipment over the building internal space. However, the main part of this devices located in buildings is distributed along the walls of the premises with a tendency of concentration near the intersections of flat surfaces of walls, floors and ceilings. Paper presents the results of comparative analysis of the average EMB intensity inside building for different types of UE indoor spatial distribution: for their uniform distribution over internal space, for their uniform distribution over internal surfaces, and for their uniform distribution along the lines of intersection of these surfaces. Results of this analysis indicate relatively small differences in average EMB levels received for each of considered types of UE spatial distribution what makes it possible to ignore these differences at worst-case estimations of indoor EMB.**

Keywords—mobile communications, 5G, indoor space, user's equipment, radiation, electromagnetic background

I. INTRODUCTION

In [1, 2], a technique of integral estimation of the average intensity of EMB created by a multitude of radiating UE of mobile communications (MC) in multi-storey buildings is proposed, based on the following:

a) on the UE representation in the form of the point sources of non-directional electromagnetic radiation (EMR) of equal power;

b) on the use of a model of the UE random uniform distribution over the building internal volume with the average density of ρ [UE/m^3], or over the internal volumes of its I separate parts with known densities ρ_i, $i \in [1, I]$, or over the separate parts of space of urban development;

c) on the use of the known integral empirical model [3-5] of radio wave propagation (RWP) in buildings;

d) on the definition of the EMB intensity as a scalar sum of values of the power flux densities (PFD) of radio frequency electromagnetic fields (EMF) created at the observation point (OP) by a set of radiating UE distributed in ambient space;

e) on the representation of the entire ambient space around the OP inside the building and, if necessary, outside it, in the form of a set of relatively narrow solid angles Ω_j, $j \in [1, J]$, tightened by elements of the external surfaces of the building or surfaces of elements of urban development, in the sum forming a full solid angle $\Omega_\Sigma = 4\pi$ (Fig. 1).

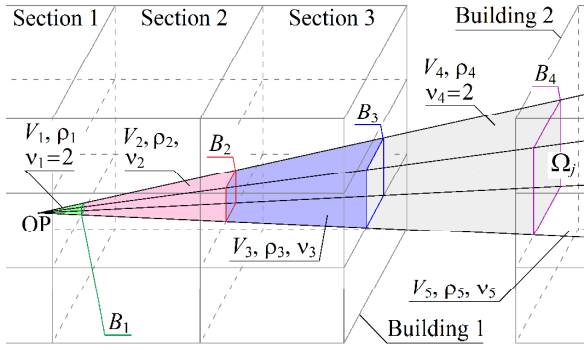

Fig. 1. An example of the division of the building inner space covered by the solid angle Ω_j, into parts $V_1 - V_5$

The latter is its fundamental advantage, which ensures the existence of the first initial moments of the probability distributions of PFD values created by the nearest to the OP point EMF sources located inside each of the solid angles Ω_j, $j \in [1, J]$ and having the greatest influence on the EMB intensity in OP. This made it possible for the first time to develop a practical algorithm for the integral estimation of the average EMB intensity in OP, created by EMR sources both from the surrounding space inside the building and outside it.

The results of the discussion at the presentation [2] of this technique confirmed its relevance and practical significance, but revealed the need to analyze its inaccuracy associated with the use of uniform spatial distribution of sources, since the bulk of the mMTC/IoT peripheral radio equipment of 4G/5G networks located in buildings are placed on the walls of premises with a tendency of their concentration near the intersection of flat wall surfaces, floor and ceiling.

The goal of this work is a comparative analysis of estimates of the average EMB intensity in OP inside building according to the approaches [1, 2], with a different nature of the distribution of a set of point sources of equal EMR power in building internal space: with their 3D uniform distribution over this space and with two types of heterogeneity of the distribution of the same number of sources: with an uniform 2D distribution along its inner surfaces and with an uniform 1D distribution of these sources along the lines of intersection of these surfaces.

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