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

A study on indoor mm-wave propagation

L. Possenti, M. Barbiroli, F. Fuschini, E. M. Vitucci, V. Degli-Esposti
Department of Electrical, Electronic and Information Engineering "Guglielmo Marconi", University of Bologna, Italy, email: leonardo.possenti2@unibo.it, marina.barbiroli@unibo.it

In order to cope with the very high data rates – of tens or hundreds of Gbit/s – and the very low latency required by forthcoming 5G and 6G broadband wireless applications, millimeter-wave (mm-wave) frequencies have to be used, where large free band blocks are still available.

Numerous studies have addressed mm-wave propagation to date, including material characterization, path-loss modeling, and the dispersion of the channel in multiple domains [1]. Although with proper high-bandwidth, directional-antenna setups it is possible to perform multi-dimensional channel sounding, including time-delay, polarization and angle domains at the radio-link ends [2], few studies have tried to analyze the inner nature of the mm-wave channel, i.e. what propagation processes actually generate such channel characteristics. Questions related to the actual reverberation degree of mm-wave indoor propagation, the relative importance of multiple-bounce vs. single-bounce reflections, of diffraction vs. diffuse scattering, etc. still need to be fully addressed. Indeed, such questions are important for the development of fast and reliable ray-based, spatially consistent propagation models that are needed for the design, deployment and functioning of the coming wireless systems [3].

In order to perform and in-depth analysis of indoor, 27 GHz and 38 GHz propagation, both measurements and Ray tracing (RT) simulations are combined in the present work. Directional measurements are first performed in a large-indoor environment using a portable spectrum analyzer and a rotating positioner with directive antennas over multiple receiving points, see Fig. 1.a. Then the RT model developed in house is calibrated using such measurements in order to achieve an overall RMSE error lower than 2 dB. Finally, the calibrated RT tool is used to analyze which propagation mechanisms contribute -and to what extent - to the overall signal level for each Rx position. Preliminary results are shown in Fig 1.b, with the following meaning of the identifiers: L=Line-of-Sight (LoS), R=reflection, D=diffraction, T=transmission, S=scattering. Besides the obvious dominance of the LoS in directly visible Rx locations, reflections – including multiple reflections up to 4 bounces (not shown) - are dominant in the remaining ones. Diffraction appears to be negligible, while diffuse scattering, which accounts for non-specular reflection due to irregularities and furniture, is surprisingly important in strongly non-LoS locations. Further results will be shown and discussed during the presentation of this work.

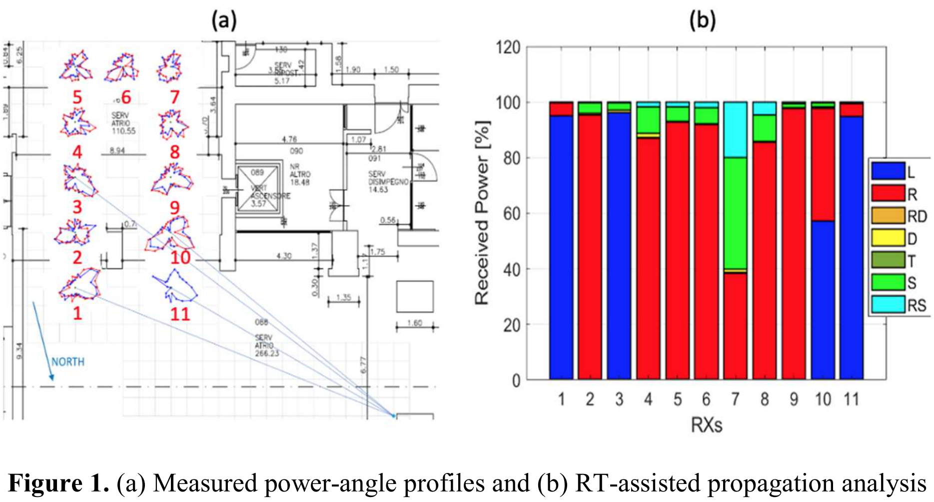

Figure 1. (a) Measured power-angle profiles and (b) RT-assisted propagation analysis

1. S. Salous, et al. "Millimeter-Wave Propagation Characterization and modeling toward fifth-generation systems," IEEE Antennas and Propag. Magazine, vol. 58, no. 6, pp. 115-127, Dec. 2016

2. C. Ling, X. Yin, R. Müller, S. Häfner, D. Dupleich, C. Schneider, J. Luo, H. Yan, and R. S. Thomä, "Double-Directional Dual-Polarimetric Cluster-Based Characterization of 70–77 GHz Indoor Channels," in IEEE Transactions on Antennas and Propagation, vol. 66, no. 2, pp. 857-870, Feb. 2018

3. Tataria, H., Haneda, K., Molisch, A.F. et al. "Standardization of Propagation Models for Terrestrial Cellular Systems: A Historical Perspective." Int J Wireless Inf Networks 28, 20–44 (2021)