Evaluation of RF Transfer Functions Between the Outside and the Inside of Building Rooms.

I. Junqua, J.P. Parmantier, F. Issac, W. Quenum

Evaluation of RF Transfer Functions Between the Outside and the Inside of Building Rooms

EM topology and Power Balance Approaches

I. Junqua – J.P. Parmantier – F. Issac – W. Quenum
ONERA – The French Aerospace Lab, F-31055, Toulouse, France
isabelle.junqua@onera.fr

***Abstract*— This paper focuses on the experimental work led in the context of the European HIPOW project. The objective is to evaluate RF transfer functions between different areas of a building in order to assess EM environment in potential critical rooms in case of external or internal EM source threat. As a first step, an experimental protocol has been developed. Then, EM coupling between different rooms has been evaluated. Finally, transfer functions between the exterior and the interior of the building have been measured and first attempts to demonstrate the application of EM topology to buildings have been carried out.**

Keywords-component; Critical Infrastructures; RF transfer functions; HPM; IEMI

I. INTRODUCTION

This paper deals with the experimental evaluation and analysis of electromagnetic (EM) coupling inside buildings or from the outside to the inside of buildings. This work is carried out in the context of the HIPOW European project which intends to improve the current European situation regarding awareness of NEMP/HPM threats and the adequacy of protection of critical infrastructures against EM threats. Here, the objective is to evaluate the transfer functions in a representative building and to analyze how incident EM external or internal fields penetrate and propagate inside different rooms. This work is based on experimental analysis of ONERA's own office building in a frequency range from 300MHz up to 6GHz. Such an evaluation implies the development of an optimized experimental protocol. Then, first electromagnetic topology concepts based on Power Balance can be used to build a quantitative interaction diagram sequence of the problem as in Electromagnetic Topology.

II. EXPERIMENTAL SET-UP

An experimental protocol has been optimized in order to be able to measure transfer functions with a distance up to about 100m from each other (Fig. 1).

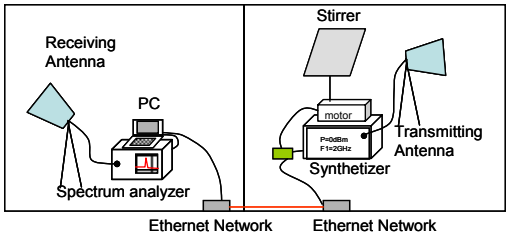

Figure 1. Experimental Set-Up

It is based on mode stirring techniques combined to a set of pre-defined configurations of antennas to take into account imbalanced polarizations (HH, HV and VV). All apparatus are driven by a PC through the internal building Ethernet network.

III. EM COUPLING BETWEEN ROOMS OF A SINGLE BUILDING

The first step consisted in measuring EM cross-coupling between one laboratory room (Lab 2) in which the transmitting antenna and synthesizer were installed and several surroundings rooms (offices, corridor and storage rooms) via a receiving antenna connected to a spectrum analyzer. An example of EM resulting cross coupling expressed in dB is given in Fig. 2

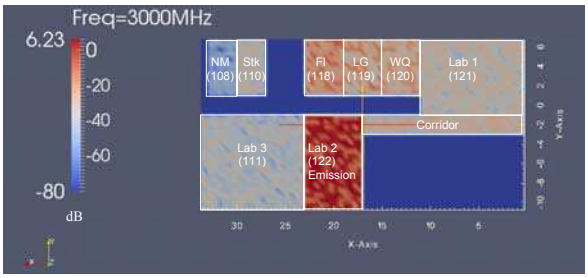

Figure 2. EM cross-coupling between rooms (injection in Lab. 2 room)

IV. EM COUPLING BETWEEN THE OUTSIDE AND ROOMS OF THE BUILDING

Then, transfer functions from the outside and various rooms of the building have been evaluated. External source was about 50m away from the reception building. As an example, the effect of metallic curtains versus polarizations has been shown. As a final step, applicability of EM topology concepts to EM propagation and penetration in buildings has been successfully demonstrated by analyzing shielding effectiveness with topological network decomposition for different configurations of windows. Various examples and parametric analysis will be given in the oral presentation.

This work has received funding from the European Community's Seventh Framework Program (FP7/2012-2015) under grant agreement number 284802 HIPOW project.

REFERENCES

[1] HIPOW Description of work. EU project Grant n 284802

[2] "Safety of installations submitted to EM threats", Special Session of EUROEM 2012 – HPEM-TC02-SS1, Toulouse, France, July 2012

.