Prediction and Measurement of Electromagnetic Field Distributions Inside Complicated Metallic Enclosures using Wave Chaos.

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Abstract:

With the environment becoming ever more cluttered with electromagnetic (EM) radiation from numerous sources such as wireless data services, radars and the potential threat of HPM weapons, the ability of sophisticated electronics such as computers and aircraft avionics to function properly becomes problematic. The erroneous response of these electronics when exposed to high levels of EM radiation is broadly termed "RF upset". One method to increase the resilience of these electronic systems to RF upset demands characterizing the distribution of EM energy inside complicated metallic cavities such as computer boxes and aircraft fuselages - which typically enclose these electronic systems. When the wavelength of the impinging radiation is much smaller than the typical length scale of the cavity, the distribution of energy within such cavities is highly sensitive to small changes in the frequency, structure of the cavity as well as the nature of the channels which couple EM energy into the cavity. Thus, a statistical approach to understanding this problem is called for. Here we present a new stochastic model called the "Random Coupling Model" (RCM)[1] which can accurately predict the Probability Density Functions (PDFs) of voltages and EM field quantities on objects within such cavities, given a minimum of assumptions about the cavity and the nature of its internal details. In fact, the frequency, volume of the cavity, losses within the cavity and the "radiation impedance" of the coupling channels are all that is needed to predict the nature of these PDFs. RCM is based upon the fundamental concepts of scattering of waves inside chaotic-cavities and has been experimentally validated with great success [2, 3]. In this presentation, our objective is to demonstrate how the RCM can make statistical predictions about the PDFs of the induced voltages inside a computer box and a room-for a given hypothetical situation. This work is supported by DoD MURI AFOSR Grant F496200110374, DURIP Grants FA95500410295 and FA95500510240. We would also like to thank M. Harrison and J. Gaudet for their valuable discussions and feedback.

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