Introduction to EMI Effects on Complex Platforms

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Electromagnetic threats on electrical systems and equipment include both ultrawide-band environments and narrow-band, high-power microwave sources. Complex platforms and the integrated circuits they carry are becoming electrically comparable to a wavelength; their resonances and coupling effects alter significantly the physics of electronic components, circuits, and systems. This work outlines a major, comprehensive effort to study such EMI effects analytically, numerically, and experimentally. Four major tasks are surveyed.

The first task is the characterization of coupling mechanisms responsible for guiding EMI energy from outside the platform down to electronic components. The platform is broken down into pieces that are studied individually and then connected topologically. Use is made of advanced frequency-domain and time-domain EM solvers. The codes are validated by comparison with each other and with some exact analytical solutions to boundary-value problems.

The second task is the characterization of the spurious waveforms at the ports of a digital system. A full-wave 3D analysis of linear passive systems converts the radiating and conducting EMI into sets of noise sources at the input ports of nonlinear active circuits. Circuit models for coupling paths are developed. A network-oriented nonlinear transient simulator is developed for small- and large-signal analysis of nonlinear electronics.

The third task is the determination of conditions for induced change-of-logic states and alterations of logic functions for digital circuits and computer systems. A fault-tolerance analysis is developed to determine, classify, monitor and control various system program errors under EM threat. The fourth task is to perform system, subsystem and component design and testing for the validation of EM penetration and coupling models, and of circuit and system fault models.

This comprehensive program is being carried out by groups of researchers at Clemson University, University of Houston, University of Illinois at Chicago, University of Illinois at Urbana-Champaign, University of Michigan, and Ohio State University, with the assistance of US Air Force personnel and DOD consultants.