

# Abstract

We propose to explore and develop a nascent mathematical methodology in the general field of computational electromagnetism. Based on use of “smooth windowing” of integral operators, the proposed approach can integrate a wide variety of mathematical and computational methods, including the method of stationary phase, rigorous asymptotic expansions for arrays of frequency-domain electromagnetic equivalent sources, rigorous fast and high-order integral equation methods as well as novel volumetric time-domain methods. Relying on the power of such a hybrid solution capability, the proposed approach is expected to break through severe limitations that are found in the existing mathematical methodologies for simulation of electromagnetic propagation and scattering in the high-frequency regime. Some of the most novel basic principles inherent in the proposed approach, which concern use of smoothly windowed integral operators, have already been demonstrated in simple but important contexts---for which they have in fact enabled solution of previously intractable problems. The results of the proposed work could have significant impact on the fields of communications, stealth and remote sensing, electronic and photonics, as well as variety of other areas of interest at DoD, NASA, the aero-space industry, and, indeed, science and engineering in general. Indeed, engineers and scientists in these areas often require an understanding of the electromagnetic properties of structures whose electrical size is of the order of many hundreds or thousands of wavelengths, but which also contain significant complex structures of electrical sizes of a single wavelength or less. Accurate electromagnetic simulation for such structures lies beyond the modeling capabilities of existing numerical methods. We believe the proposed development of the aforementioned ideas will lead to a quantum leap in electromagnetic simulation capabilities, enabling accurate solution of problems of scattering by complex structures of electrical sizes of thousands of wavelengths and beyond.