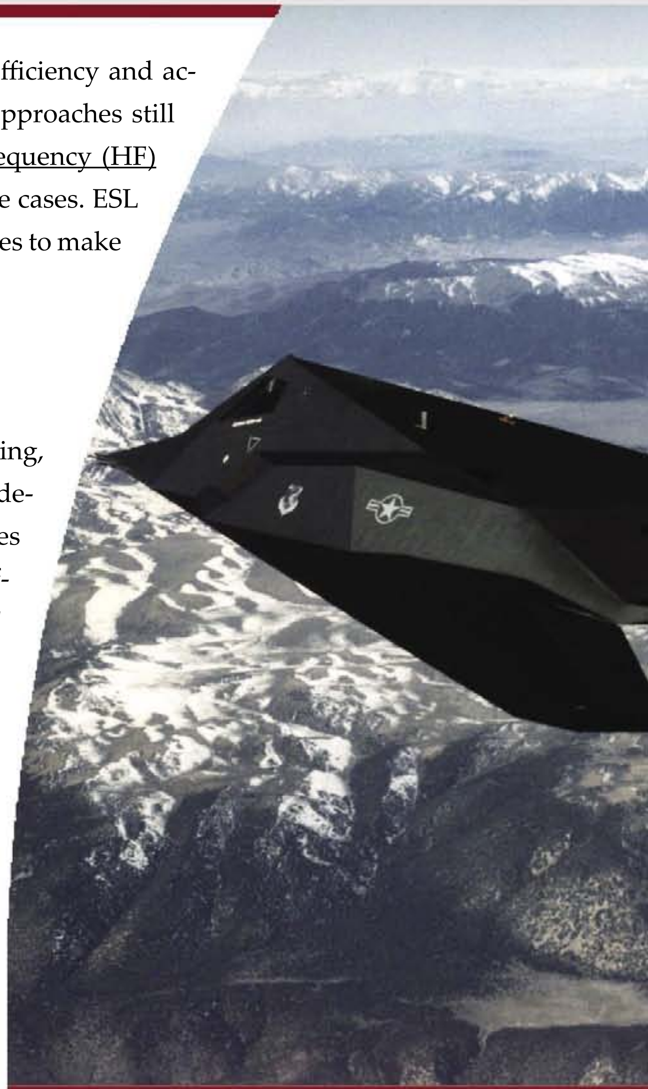
High Frequency & Hybrid Methods

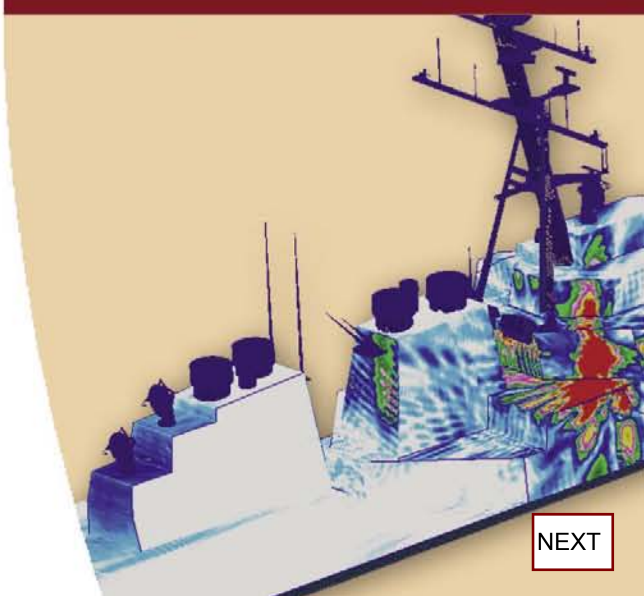
Numerical methods for electromagnetics have made impressive gains in efficiency and accuracy in recent years. Nevertheless, the computational expense of such approaches still makes them impractical for electrically large objects. Asymptotic high frequency (HF) methods remain the optimal techniques for radiation and scattering in these cases. ESL has made key contributions to the development of HF methods, and continues to make significant advances in this area.



Modeling Scattering From Complex Objects

At sufficiently high frequencies, EM wave radiation, propagation, scattering, and diffraction exhibit a highly local character, so that propagation can be described by local paths or rays. Reflection and diffraction effects from obstacles or discontinuities along the ray path can be described by reflection and diffraction coefficients, respectively. The latter are found from asymptotic HF solutions to canonical problems that locally model the electrical and geometrical properties of the radiating/scattering object at or near the point of interest. EM modeling of very large complex objects can therefore be constructed in terms of local scattering events, which in turn can be described by a few reflected and diffracted rays. Of importance is that their resulting computational efficiency can be several orders of magnitude less as compared to numerical approaches . An added bonus is the clear physical insight achieved into the radiation and scattering properties of an object.

Hybrid Methods for Enhanced Accuracy



In many practical cases, it becomes necessary to deal with objects that contain both electrically large and small parts. In this "multi-scale" situation, high frequency analytical methods (for the large parts) can be combined with numerical methods (for the small parts) in a hybrid fashion. Hybrid approaches being developed at ESL include the Iterative Physical Optics (IPO) and the Asymptotic Phasefront Extraction (APEx) methods. Computational gains from these techniques are again orders of magnitude less as compared to standard numerical approaches.