A Direct Domain Decomposition Method (D^3M) for Modeling Large Finite Antenna Arrays and FSS

J. Moshfegh and M. N. Vouvakis
Department of Electrical and Computer Engineering
University of Massachusetts, Amherst, MA, USA
Email: {jmoshfegh, vouvakis}@ecs.umass.edu

Modern communication and radar systems rely on large finite antenna arrays, frequency selective surfaces (FSS), and periodic engineered materials. The design of those structures often requires the full-wave solution of Maxwell's equations with many million degrees of freedom. Parallel iterative solvers based on domain decomposition methods (DDM) ((G. N. Paraschos, PhD thesis, University of Massachusetts Amherst, 2012) have shown extraordinary ability to tackle such "almost periodic" problems by leveraging geometry repetitions and symmetries. However, they may experience convergence difficulties for near-resonance or multi-scale problems and significant slow-down at multiple excitation scenarios required for the full radiation or scattering characterization of such structures.

Thus, recent research trends in CEM solvers have shifted from parallel iterative solvers to parallel direct solvers such as direct DDM (D^3M) (J. Moshfegh, and M. N. Vouvakis, IEEE APS, 2016) which are robust, reliable and very suitable for multiple excitations such as S-parameter computation and RCS. The D^3M framework forms a small blocked sparse matrix of auxiliary unknowns defined on the domain interfaces. Then, uses a special block LDL^T with restricted pivoting for efficient factorization. Repetition of domains in an array leads to repetition of blocks in the blocked sparse matrix. Considering these repetitions during FEM assembly, and symbolic and numeric factorization stages, one can achieve significant saving on time and memory. Results showcasing the validity and efficiency of the method on scattering and radiation of large finite arrays with multiple excitations will be presented.