High Performance Solution of Dense Linear Systems with Application to Large 3D Electromagnetics Problems on the TERA supercomputer

The numerical treatment of high frequency electromagnetic scattering is very computationally intensive. For scattering, the electromagnetic field must be computed around and inside 3D bodies. Because of this, accurate numerical methods are used to solve Maxwell's equations in the frequency domain, and it leads to solve large dense linear systems. We have developed on our Petascale supercomputer a hybrid CPU/GPU solver for systems with millions of complex unknowns and thousands of right hand sides. Moreover, to address very large problems, we enhanced our Full-MPI direct solver with a block low-rank compression method. We show how we derived a block low-rank version from our existing solver, and detail the optimizations we used to increase its scalability on thousands of cores of the TERA supercomputer at CEA/DAM, for example by introducing hybrid programming models, or with algorithmic improvements.