Massively Parallel Linear Solver For Large 3D Problems

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Large-scale scientific simulations are nowadays fully integrated in many scientific and industrial applications. Many of these simulations rely on modelisations based on PDEs that lead to the solution of huge linear or nonlinear systems of equations involving millions of unknowns. In that context the use of large high performance computers in conjunction with advanced fully parallel and scalable numerical techniques is mandatory to efficiently tackle these problems.

The main topic of this talk is the study of a numerical technique that has attractive features for an efficient solution of large scale linear systems on large parallel platforms. The parallel numerical scheme is a high performance hybrid direct/iterative approach for solving large 3D problems. In that general framework, several algebraic preconditioning techniques will be presented.

The robustness and the weak scalability of the preconditioners will be illustrated through extensive parallel experiments on up to two thousand processors and for solving up to a 75 millions unknown problem.

In order to enhance the scalability of our solver we also consider an approach based on two levels of parallelism, that offers the flexibility to combine the numerical and the parallel implementation scalabilities. The combination of the two levels of parallelism enables an optimal usage of the computing resources while preserving attractive numerical performance. Consequently such a numerical technique appears as a promising candidate for intensive simulations on large massively parallel platforms.

The robustness and parallel numerical performance of the solver is reported on large challenging linear systems arising from electromagnetism, structural mechanics and seismic modeling applications.

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