Extending the STF model to design a hierarchical direct solver for distributed memory machines with manycore nodes

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Abstract

Compression techniques have revolutionized the Boundary Element Method used to solve the Maxwell equations in frequency domain by reducing the amount of ressource and the time required to solve large problems by several orders of magnitude. Implementing direct solvers enhanced with hierarchical compression however remains a significant challenge, especially on large scale distributed memory machines.
In this talk, we will present the techniques we have used to design a fast direct solver using a flexible task-based programming model which extends the Sequential Task Flow (STF) paradigm. This model is not only based on seamless dependencies between tasks accessing hierarchical data dependencies, but also on a task pre-emption mechanism which makes it possible to introduce advanced communication patterns directly into the task graph.

We will illustrate the the scalability of our approach by solving large scale problems such as a hierarchical matrix with 4.4 million unknowns compressed at 99% in less than 40 minutes with about 70% of parallel efficiency over 24320 cores of the Tera1000-2 machine, which is based on Intel KNL processors.
Finally, we will briefly describe how we plan to deal with the remaining load imbalance that exists between the different processes.

Keywords: Hierarchical matrix, direct solver, MPI, task parallelism

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