CS7 High performance computational electromagnetics

cHiPSet - CS7 Final Report

Elisabeth Larsson

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Participants in the Case Study

Coordination and implementation

Elisabeth Larsson	Uppsala University (SE)
Afshin Zafari	Uppsala University (SE)

Application expertise

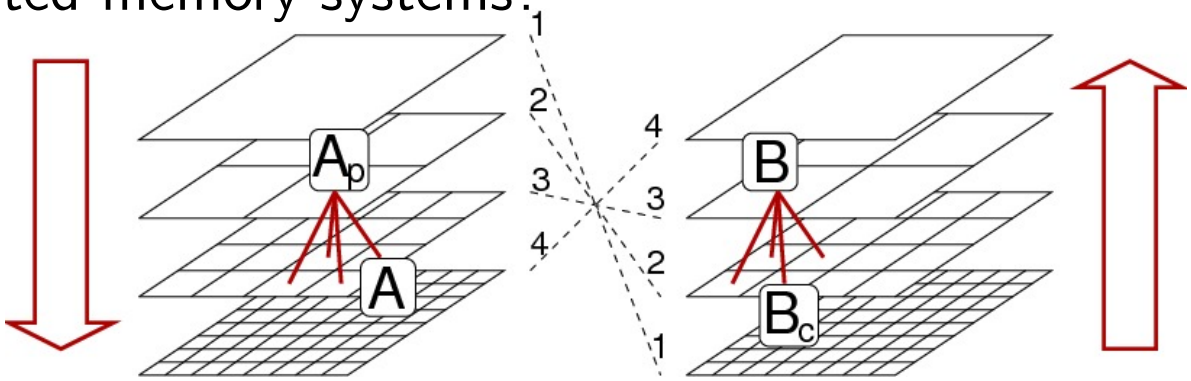
Francesca Vipiana	Politecnico di Torino (IT)
Giorgio Giordanengo	Antenna and EMC Lab, LINKS Foundation (IT)
Marco Righero	Antenna and EMC Lab, LINKS Foundation (IT)
Alessandro Francavilla	ASML (NL)
Giuseppe Vecchio	Politecnico di Torino (IT)

Parallel expertise

Corinne Ancourt	MINES ParisTech (FR)
Clemens Grelck	University of Amsterdam (NL)
Christoph Kessler	Linköping University (SE)

Problem description

How can software for large scale electromagnetic scattering problems be parallelized in an efficient way for shared and distributed memory systems?



- Hierarchical algorithm. Up-exchange-down.
- Typical application problem, 10 levels
- Varying amount of work per box
- Varying degree of parallelism between stages
- Irregularly distributed data. 2-D surface in 3-D volume.

Activities: STSM

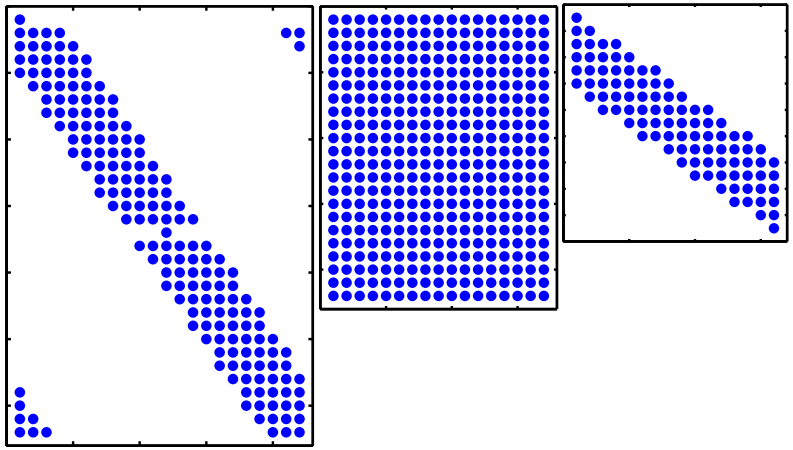
Afshin Zafari, Uppsala University visited Politecnico di Torino for 1 week in February 2016. The purpose of the visit was

- to learn about the application problem,
- to set up a simplified model problem to work on,
- to start working on a parallel shared memory implementation.

Activities: Algorithm analysis

Two different algorithms from one academic software and one industrial software.

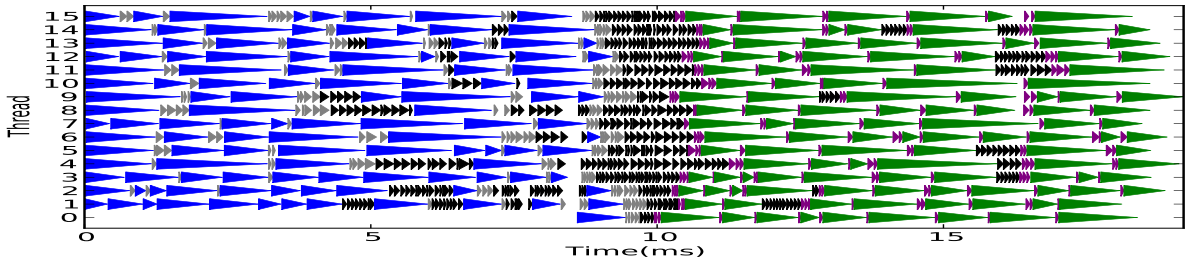
- Both algorithms typically have a computational intensity of 2 flop/load.
- The 'classical' algorithm has a wide range of work sizes, from 72 elements on the finest level to 368082 elements on the coarsest level.



Activities: Pilot implementation

Task parallel shared memory implementation using SuperGlue[1] and OpenMP. There are several benefits

- The algorithm formulation is already based on groups/tasks.
- Changes to original code minimal.
- Mixing of computational stages is beneficial for performance.
- Challenge: Task sizes are too small.
  Potential solution: Batched tasks.



[1] `https://github.com/tillenius`

Activities: Publications

- Zafari et al., Task parallel implementation of a solver for electromagnetic scattering problems. CoRR abs/1801.03589 (2018). `http://arxiv.org/abs/1801.03589` (submitted).
  On the pilot implementation
- Larsson et al. (2019) Parallelization of Hierarchical Matrix Algorithms for Electromagnetic Scattering Problems. In: Kołodziej J., González-Vélez H. (eds) High-Performance Modelling and Simulation for Big Data Applications. Lecture Notes in Computer Science, vol 11400. Springer, Cham.
  On the algorithms and their parallelization properties