Boosting seismic computations using a dataflow machine (Master Thesis Project)

Background
In the past few years, the availability of enormous computing power has allowed to make spectacular progress on problems that were previously considered intractable. Advanced computational methods and their efficient implementations on state-of-the-art computer architectures is key to perform 3-dimensional seismic problems.

Problem description
In order to have a clear picture of the earth crust seismic computations have to be done. These computations are compared with measurements in order to estimate the structure of layers within the earth crust. In order to provide fine grain details, 3-dimensional simulations with a high wave number have to be performed. It appears that the step size of the used grid should be inverse proportional to the wavenumber. This implies that for larger and larger wavenumbers the size of the problems will explode. In our group we have developed an iterative method where the number of iterations scales linearly with the wave number. This is much better than previous state of the art methods, but overall the required simulation times are too long on existing high-performance systems. In order to do realistic simulations within one week of computing time new parallel hardware platforms should be used.

Time schedule
The following tasks are foreseen:

- Literature study in order to understand the problem, the used iterative method, parallel computing and background information about state-of-the-art computer architectures like GPUs and FPGAs.
- Implement a 'toy problem' in Matlab to gain insight in the performance of the studied solver.
- During this project you will have access to state-of-the-art multiscale dataflow computing system from Maxeler Ltd. available at the faculty of Electrical Engineering, Mathematics and Computer Science. Start by learning to program this hardware (including tutorials and help from Maxeler and staff members).
- Implement a Krylov iterative method with a diagonal preconditioner.
- Implement the shifted Laplace preconditioner and do a number of tests on large 3-dimensional problems in order to investigate the speedup of the method on this new hardware.

Contact
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