**Multilevel Summation Level Solver: A Performance Portable Exascale Capable Electrostatic Solver**

Arnold Tharrington

Oak Ridge National Laboratory

arnoldt@ornl.gov

**Abstract**

We are developing a long-range electrostatic solver that is performance portable and targets HPC centers with hybrid CPU-GPU architectures. The solver uses the Multilevel Summation Method (MSM) which is a local (nearest-neighbor communication) hierarchal grid-based algorithm.

The current MSM developmental activities can be grouped in two broad categories. The first category is disentangling the MSM algorithm from the underlying HPC architecture hardware. This is primarily accomplished by software abstraction layers between the MSM algorithm and the CPU and GPU compute devices. This design feature helps performance portability by minimizing the amount of code modifications needed for various HPC CPU/GPU architectures and the ongoing improvements in the GPU hardware and CUDA API.

The second activity is the implementation of a CUDA direct kernel for the direct stencil calculation on the grid hierarchies. This direct kernel uses large stencils with minimum dimensions of 13x13x13 and will explore the use of unified memory. Importantly, the direct kernel is not a simple function but a C++ class that is designed by composition and derivation from an abstract base class. This design structure helps attain performance portability and permits rapid implementation of other types of large stencil calculations.