

APR16-2016-000633

Abstract for an Invited Paper
for the APR16 Meeting of
the American Physical Society

A portable approach for PIC on emerging architectures.¹

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A portable approach for designing Particle-in-Cell (PIC) algorithms on emerging exascale computers, is based on the recognition that 3 distinct programming paradigms are needed. They are: low level vector (SIMD) processing, middle level shared memory parallel programming, and high level distributed memory programming. In addition, there is a memory hierarchy associated with each level. Such algorithms can be initially developed using vectorizing compilers, OpenMP, and MPI. This is the approach recommended by Intel for the Phi processor. These algorithms can then be translated and possibly specialized to other programming models and languages, as needed. For example, the vector processing and shared memory programming might be done with CUDA instead of vectorizing compilers and OpenMP, but generally the algorithm itself is not greatly changed. The UCLA PICKSC web site at <http://www.idre.ucla.edu/> contains example open source skeleton codes (mini-apps) illustrating each of these three programming models, individually and in combination. Fortran2003 now supports abstract data types, and design patterns [1] can be used to support a variety of implementations within the same code base. Fortran2003 also supports interoperability with C so that implementations in C languages are also easy to use. Finally, main codes can be translated into dynamic environments such as Python, while still taking advantage of high performing compiled languages. Parallel languages are still evolving with interesting developments in co-Array Fortran, UPC, and OpenACC, among others, and these can also be supported within the same software architecture. [1] E. Gamma, R. Helm, R. Johnson, and J. Vlissides, ‘Design Patterns: Elements of Reusable Object-Oriented Software,’ [Addison-Wesley, 1995].

¹work supported by NSF and DOE grants.