Joint DOE/SC-NNSA PM/E Workshop

Dates: March 9 – 11, 2015
Location: Rockville Hilton, Rockville, MD

This planned community forum will be the first of a series of workshops that are to be focused on determining the research agenda and eventual deployment plans for the Programming Model(s)/Environments(s) (PM/E) thrust area of the DOE Exascale Computing Initiative (ECI). A parallel programming model provides a set of abstractions that simplify and structure the way the programmer thinks about and expresses a parallel algorithm. A Programming environment (PE) is an ensemble of interoperable tools supporting all aspects of program development, which also includes workflow management, data analytics, visualization and steering, and storage management.

Goals:
The goal of the first workshop is to propose, articulate, and consider multiple visions of candidate Programming Models and the essential architecture of potential Programming Environments to be explored and evaluated as part of the ECI program. The PM/E workshop will discuss the multiple visions that currently exist and consider the means by which they can be effectively evaluated. There is a significant need to identify the PM/E(s) requirements in the exascale era and to establish the PM/E research questions and methods for evaluation of anticipated research results. We anticipate that this workshop will result on a better articulation of the vision for the ECI PM/E efforts , which will be used as input for subsequent workshops, and eventually culminate in an overarching plan for the ECI.

The workshop attendees will consist of a mix of PM/E researchers and application developers who are the target audience for adoption of these models. We envision that the final DOE vision for PM/E(s) will be built upon a common understanding of forward-looking PM/E research, and grounded in requirements of application teams targeting exascale architectures.

Workshop objectives:

1. Propose, articulate, and consider semantics of future Programming Models
2. Identify the key capabilities and elements of future Programming Environments
3. Review the requirements for ECI PM/E(s)
4. Determine the research questions that need to be addressed
5. Propose the methods for evaluating PM/E(s) research results

The ASCR X-stack program has been pursuing a research agenda that involves programming models and several elements of programming environments, including multiple visions of runtime systems, driven by the underlying and crosscutting execution models for extreme scale parallel computing systems. Several ASCR Exascale Co-Design Centers have been exploring programming models driven in these cases by mission-critical applications. Similarly, the ASC program has been investigating several some promising techniques by its PSAAP Centers and internally-developed programming models for its own next-generation code development needs. This first PM/E workshop will provide an opportunity for application developers to understand and consider these efforts, providing their input on requirements for future programming models.

This workshop will not attempt a consensus driven strategy of deriving an early single vision, as we believe that such strategy would be premature. There will not be a report written that summarizes the discussions that occurred during this workshop.

PM/E Vision:

The ECI PM/E vision will support a two-pronged approach with the first being short-term maintaining (and supporting) continuation of extended conventional practices. The second is one that is a "full break" with the past so as to maximize opportunity potentially available through full innovation (not yet proved).

A parallel PM/E vision needs to be tied to an extreme scale execution model, an anticipated allocation of responsibilities and capabilities to the system component layers (e.g., architecture, runtime software); the needs of generality, strong scaling, and performance portability (i.e., capable computing); and the challenges of exposing parallelism at unprecedented scale.

A parallel PM/E vision needs to be grounded in applications requirements of relevance to DOE. The following are some requirements that should be considered, refined, and augmented:

- Performance – enable optimal time to solution
- Parallelism – enough to provide billion-way concurrency, plus what is needed to mitigate latency and overhead effects (contention too)
- Execution Model – reflect a consistent and comprehensive parallel execution model in order to work effectively with all other component layers
- Performance portability – one code serves many different machine types, scales, and generations without intensive human intervention or code tweaking
- Invariants – define the aspects of the application code that are always the same independent of the execution environment; needed for performance portability and leveraging existing codes
- Programmability – ease of programming, dealing with complexity in ways that ensure correctness and minimizes manual programming efforts

These requirements should all be considered and articulated in the context of productivity. Requirements should also be described in terms of strong scalability of the applications; setting a target for weak scalability, which is possible for existing MPI codes, completely misses the point of the ECI PM/E efforts.

Application Team Input:

Application requirements should be described in terms of future execution computing environments, given that algorithms will have orders of magnitude more scale in comparison to current practices. It is not clear that the current applications efforts will yield the insights that are needed to establish a future vision for the "full break" ECI PM/E efforts. Strong scaled applications need to be discussed, not just weak scaled problems.