SC13 BOF: Codesign for the Department of Energy's Computational Science Community

Session leaders: Richard Barrett, Sandia National Laboratories; Bert Still, Lawrence Livermore National Laboratory; Allen McPherson, Los Alamos National Laboratory.

Allen and Bert did not attend SC13 due to budget constraints, so they provided replacements: Rob Neely, Lawrence Livermore National Laboratory; Sriram Swaminarayan, Los Alamos National Laboratory.

Abstract: The Department of Energy high performance computing community is actively engaged in codesign efforts as a means of ensuring that new architectures more effectively support mission critical workloads. The combinations of application codes, represented by proxy programs, algorithms, programming models, system software, and architecture provides a concrete and powerful means for interacting with vendors. In this session we will present and discuss concrete examples of the impact of these efforts. We invite members of the computational science community to participate in this session, as a means of learning about, forming collaborations, and influencing the direction of this work.

Thuc Hoang, program manager for computing resources from the Department of Energy's National Nuclear Security Agency's (NNSA) Advanced Simulation Computing (ASC) program opened the program. She encouraged the sort of interactions enabled by this BOF.

Richard, Rob, and Sriram provided brief overviews of codesign activities at their respective laboratories. Mantevo Suite 2.0 was official announced.

Speakers:

- Guillaume Colin de Verdiere, CEA
- Jonathan Gallmeier, AMD
- Scott Hemmert, Sandia
- Andy Herdman, AWE
- Eric van Hensbergen, ARM
- Allan Knies, Intel
- Allan Porterfield, RENCI
- Jim Sexton, IBM
- John Shalf, LBL

Brief summaries of their point of view are listed below.

Guillaume Colin de Verdiere, CEA. Codesign is a holistic process that encompasses the breadth of Supercomputing solutions. As has been demonstrated through CEA's TERA100 project, codesign must also cover fields such as infrastructure, power distribution to the computing units along with software issues. Software is probably too vague a word or at least is a reality with many faces. Each of those faces are subject to codesign activities.

The first face can be at the OS level trying, for example, to deliver a noiseless operating system to maximize the compute time on a node. The library level is yet another face. It is common place to see iteration between vendors and facilities to optimize a MPI implementation. It can even touch the compilers, as CEA did in collaboration with Intel, to implement new features (through our MPC framework) that will help moving legacy codes

to new architectures.

The most active field is the face of miniapps since the latter can be used at least for three purposes:

1. Understand a given architecture for a given algorithmic roadblock (or supposed roadblock)
2. Tell apart proposed architectures in a given RFP for a typical workload represented through miniapps
3. Give the vendors tangible means to improve the forthcoming designs to give us, the users, a viable compute solution.

CEA, as other labs from DOE or elsewhere, own suites of miniapps. We discovered that ours overlap a good portion of what is currently available on the net. Recognizing that vendors can't work on hundreds of miniapps, we will try to work in collaboration with the other labs to provide a more focused set. Doing so, we hope to send a stronger signal to the vendors in that this set must run well on their solutions, meaning that the software should be there and the hardware display the needed features for our codes.

Jonathan Gallmeier, AMD. AMD depends upon the proxy applications and associated co-design opportunities to better understand the exascale challenges faced by the DOE. In addition, AMD has identified a co-design methodology that enables us to better bridge the gap between the domain scientist and AMD researcher. This methodology progresses through interactive code optimizations, "hack-a-thons" - open discussions regarding code and designs between DOE staff and AMD research teams, and ends with targeted research co-design opportunities.

Allan Knies, Intel. Fast forward provides opportunity for exploring space with maximum risk. Proxies are social tools. Storage discussion. Warned us of the precarious situation where the popularity of proxy apps is leading to a "proliferation of proxy apps".

Allan Porterfield, RENCI In my mind, the most important success of the Co-design centers will be the understanding of the problem that is being solved by the architects (hardware and system software). This knowledge is transferred not only though proxy-apps (where it is formalized) but though informal interactions between the various groups working on the problem. Providing a mechanism to have not only formal interfaces (APIs ...) is useful, but needs an informal path to pass along information about what problems the various groups are struggling to solve (maybe its not so important or a slight change is ok).

Jim Sexton, IBM asked the community to consider three issues. a) Clearly state what we are optimizing toward. b) Take into account the entire workflow, not just processor speed (e.g. UQ workloads), and c) Work toward reducing the impact of IP and proprietary work by vendors. These are challenging issues.

John Shalf, LBL provided a general overview of exascale challenges for DOE. He described a codesign model based on the use and interactions of proxy applications, advanced architecture testbeds, simulators, and proxy architectures. He broke down the exploration space into: a) Design optimization b) Path finding, or c) Radical changes, described some characteristics of the architectures that may be developed.

Scott Hemmert, Sandia provided a brief overview on the Extreme-Scale Grand Challenge project at Sandia.

End speaker summaries.

Some general observations:

1) Intellectual property issues can interfere with true codesign. Various multi-way NDAs are in place, but this can still be an issue that must be considered and mitigated.
2) The increasing set of proxies must be managed. This is the classic imbalance between keeping things simple, and making sure we cover the design space. One approach to addressing this is to think about building a decision-chart for interested parties to help them identify which proxies they should target. For example, "If you're looking to learn about the physics, see A, B, C…"; if you are studying [memory bandwidth, NUMA, FP performance, …], see D, E…" Discussion also pointed out that the open venue enabled by this BOF informed collaboration opportunities between organizations as a means of combining efforts.
3) The ASC co-design effort needs to be better "marketed". This BOF is a step in that direction, but increased, visible coordination
4) All speakers were comfortable presenting their own views, ideas, and opinions.
5) Although follow-up conversations were positive, the organizers feel that we had too many speakers. This was seemingly a natural outcome of the popularity of this BOF the previous two years, with many different groups wanting their voice heard. In one sense this is a good thing. However, it did limit the amount of open floor discussion that characterized this BOF in previous years. Our challenge for future sessions is to significantly reduce the number of “official speakers” while not appearing to favor any particular point of view. We may also constrain the space to a particular set of issues, e.g. power and energy. The organizers and other interested parties will continue to address this, and are confident a successful approach will be determined.