Workshop on Exascale Programming Challenges
July 27 – 29, USC/ISI, Marina del Rey, CA

Workshop Committee:
Saman Amarasinghe (MIT), Mary Hall (U. Utah), Pat McCormick (LANL), Richard Murphy (Sandia), Keshav Pingali (U. Texas-Austin), Dan Quinlan (LLNL), Vivek Sarkar (Rice), John Shalf (BNL).

Advisory Committee:
Bob Lucas and Kathy Yellick.

ASCR POC:
Sonia R. Sachs and Lenore Mullin

Workshop Goals Summary:
1. Define objective criteria for assessing programming models, language features, compilers, and runtime systems and metrics for success
2. Prioritize programming model, language, and compiler challenges for exascale systems
3. Prioritize options for (i) evolutionary solutions, (ii) revolutionary solutions, and (iii) bridging the gap between evolutionary and revolutionary solutions.
4. Lay out a roadmap, with options, timeline, and rough cost estimates for programming Exascale systems that are responsive to the needs of applications and future architectural constraints.

Workshop Agenda:

Day 1:
- 7:00-8:00 a.m. Breakfast
- 8:00-8:15 a.m. Welcome and Introduction (Bill Harrod and Sonia Sachs)
- 8:15-8:40 a.m. Bob Lucas, “Exascale: Can My Code Get from Here to There?”
- 8:40–10:15 a.m. Application Requirements Session: Challenges for programming highly parallel codes and scaling them to Exascale computing.
  1. Alice Koniges, "Challenges and Application Gems on the Path to Exascale"
  2. Richard Barrett, “Preparing Multi-physics, Multi-scale Codes for Exascale HPC”
  3. Sriram Swaminarayan, "Exaflops, Petabytes, and Gigathreads... Oh my!"
  4. Curtis Jansen, “Pushing back the point of diminishing returns for parallel performance"
- 10:15–10:30 a.m. Break
- 10:30-12:00 p.m. State-of-the-art Session I: Advanced programming models and languages.
  1. Vijay Saraswat, “The return of logic”
  2. Guy Blelloch, “Nested Parallelism and Hierarchical Locality”
  3. Mike Heroux, “Next generation programming environments: What we need and do not need”
- 12:00-1:00 p.m. Lunch
- 1:00-1:30 p.m. Jayadev Misra keynote, “The Challenge of Exascale”
• 1:30-3:00 p.m. **State-of-the-art Session I: Advanced programming models and languages.**
  1. **John Shalf,** “Functional vs. Imperative Languages (Dataflow 2.0)”
  2. **Richard Murphy,** “How I Learned to Stop Worrying and Love New Models of Computation”
  3. **Tim Mattson,** “Unintelligent Design for asynchronous exascale Systems”
  4. **Sriram Krishnamoorthy,** “(De)composable abstractions for a changing architectural landscape”

• 3:00–3:15 p.m. **Break**

• 3:15-4:15 p.m. **Focused Session I Parallel Panel Discussions:** Develop objective criteria to assess programming models in the context of application requirements, considering various models of computation primitives.
  I-a **Communication and Synchronization Primitives Panel**
  I-b **Scheduling Primitives Panel**
  I-c **Partitioning and Placement Primitives Panel**

• 4:15-4:45 p.m. **Summary of Session I Focused Panels (10 min per panel)**
  1. **Rajeev Thakur,** Summary of I-a
  2. **David Padua,** Summary of I-b
  3. **Marc Snir,** Summary of I-c

• 4:45-5:45 p.m. **Session I General Panel Discussion.**

### Day 2:

• 7:00-8:00 a.m. **Breakfast**

• 8:00-8:15 a.m. **Introduction** (Sonia Sachs)

• 8:15-8:40 a.m. **Kathy Yelick,** “To Virtualize or Not to Virtualize”

• 8:40-10:20 a.m. **State-of-the-art Session II:** Language constructs, compiler and runtime engines that support advanced programming models.
  1. **Keshav Pingali,** “Why compilers have failed and what we can do about it”
  2. **Richard Lethin,** “Reconceptualizing to Unshackle Programmers from the Burden of Exascale Hardware Issues”
  3. **Sanjay Kale,** “Composable and modular Exascale Programming Models with intelligent runtime systems”
  4. **Pavan Balaji,** “Evolutionary Support for Revolutionary Programming Models and Runtime Systems”

• 10:20-10:35 a.m. **Break**

• 10:35-12:15 (noon) **State-of-the-art Session II:** Language constructs, compiler and runtime engines that support advanced programming models.
  1. **Saman Amarasinghe,** “Why have compilers failed to help parallel programmers”
  2. **Vivek Sarkar,** “Programming Constructs for Exascale Systems and their Implementation Challenges”
  3. **John Mellor-Crummeys,** “Lessons from the past, challenges ahead, and a path forward”

- **12:15-1:15 p.m.** Lunch
- **1:15-1:45 p.m.** George Almasi keynote, “PGAS languages in the exascale era”
- **1:45-3:00 p.m.** Focused Session II Parallel Panel Discussions.
  - II-a Language Constructs Panel: Develop objective criteria to assess language constructs in the context of co-design application development requirements
  - II-b Compiler and Runtime Engines Panel: Develop objective criteria to assess compiler and runtime engines to support advanced programming models and language constructs.
  - II-c Migration Panel: Develop options to automatically connect/transform/migrate to advanced programming environments

- **3:00-3:15 p.m.** Break
- **3:15-3:45 p.m.** Summary of Session II Focused Panels (10 minutes per parallel panel)
  1. Kath Knobe, Summary II-a
  2. Mary Hall, Summary II-b
  3. Greg Bronevetsky, Summary II-c

- **3:45-4:45 p.m.** Session II General Panel Discussions.
- **4:45-5:45 p.m.** Workshop General Discussions
- **5:45-6:00 p.m.** Closing remarks (Bill Harrod)

**Day 3:**

- **7:00-8:00 a.m.** Breakfast
- **8:00-10:00 a.m.** Report section leads summarize discussions and findings (first level refinement)
- **10:00-10:15 a.m.** Break
- **10:15-11:30 a.m.** Organize report writing & assignments
- **11:30-12:00 (noon)** Briefing by lead technical writer on timelines & formatting requirements.