

## 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(LBNL).

### Advisory Committee:

Bob Lucas and Kathy Yelick.

### 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"
  4. **Sung-Eun Choi**, "Five Things About HPC Programming Models That I Can Live Without"
- **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-Crummey**, “Lessons from the past, challenges ahead, and a path forward”

4. **Dan Quinlan**, “Challenges for Compiler Support for Exascale Computing”

- 12:15-1:15 p.m.
- 1:15-1:45 p.m.
- 1:45-3:00 p.m.

**Lunch**

**George Almasi keynote**, “PGAS languages in the exascale era”

**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.
- 3:15-3:45 p.m.

**Break**

**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.
- 4:45-5:45 p.m.
- 5:45-6:00 p.m.

**Session II General Panel Discussions.**

**Workshop General Discussions**

**Closing remarks** (Bill Harrod)

**Day 3:**

- 7:00-8:00 a.m.
- 8:00-10:00 a.m.
- 10:00-10:15 a.m.
- 10:15-11:30 a.m.
- 11:30-12:00 (noon)

**Breakfast**

**Report section leads summarize discussions and findings** (first level refinement)

**Break**

**Organize report writing & assignments**

**Briefing by lead technical writer** on timelines & formatting requirements.