An Introduction to Parallel Supercomputing

Pete Beckman
Argonne National Laboratory
“If our R&D is going to be relevant ten years from now, we need to shift our attention to parallel computer architectures”

“Los Alamos has a Denelcor HEP: let’s experiment with it”
Parallel Platform Paradox

“The average time required to implement a moderate-sized application on a parallel computer architecture is equivalent to the half-life of the latest parallel supercomputer.”

“Although a strict definition of “half-life” could be argued, no computational physicist in the fusion community would dispute the face that most of the time spent implementing parallel simulations was focused on code maintenance, rather than on exploring new physics. Architectures, software environments, and parallel languages came and went, leaving the investment in the new physics code buried with the demise of the latest supercomputer. There had to be a way to preserve that investment.”
Understand the Model
INTEL MARRYING FPGA, BEEFY BROADWELL FOR OPEN COMPUTE FUTURE

March 14, 2016    Nicole Hemsoth

For those who read here often, there are clear signs that the FPGA is set to become a compelling acceleration story over the next few years.

From the relatively recent Intel acquisition of Altera by chip giant Intel, to less talked-about advancements on the programming front (OpenCL progress, advancements in both hardware and software from FPGA competitor to Intel/Altera, Xilinx) and of course, consistent competition for the compute acceleration market from GPUs, which dominate the coprocessor market for now

Last week at the Open Compute Summit we finally got a glimpse of one of the many ways FPGAs might fit into the hyperscale ecosystem (along with other future hardware insight) with an announcement that Intel will be working on future OCP designs featuring an integrated FPGA and Xeon chip. Unlike what many expected, the CPU mate will not be a Xeon D, but rather a proper Broadwell EP. As seen below, this appears to be a 15-core part (Intel did not confirm, but their diagram makes counting rather easy) matched with the Altera Arria 10 GX FPGAs.
High-bandwidth In-Package Memory

Top View

Side View

CPU Package

PCB

Far Memory

Near Memory

Near Memory

DDR

DDR

DDR

Cache

 KNL CPU

HBW In-Package Memory

HBW In-Package Memory

HBW In-Package Memory

HBW In-Package Memory
Pete’s Investment Recommendations

- **OPM (Other People’s Math (libraries))**
- **Encapsulation**
  - Parallelism & Messaging & I/O
- **Embedded Capabilities**
  - Debugging
  - Performance Monitoring
  - Correctness Detection
  - Resilience
- **The Two Workflow Views**
  - Science: (problem setup, analysis, etc.)
  - Programmer: (mod, testing, document, commit)
- **Automation**
  - A+ Build system, nightly test and build, configuration
  - Embedded versioning and metadata
- **Community: web, tutorial, email, bug tracking, etc**
Memory
Heterogeneity
Variability
Of Refractions.

If a ray be refracted at the centre of a circle and directed at an angle of 90 degrees, then suppose the central angle to be 45 degrees. Let the circle be an hyperbola, the distance of whose foci be equal to its transversal axis by a. If the wave be reflected, then the ray will be reflected at the exterior focus b. See C. P. P. R.

3. Having the proportion of d to e, or d/e, the hyperbola may be thus described.

Upon the center of the instrument, the ray will be moved in such a way that the beam of light will be in the same plane as the ray and the two rays will be parallel to each other. The using of a concave mirror will facilitate the process. The concave mirror should be placed at a distance of d from the instrument, and the ray will be exactly touched by the mirror.

2. By the same proceeding Descartes concave hyperbolical wheels may be described by being moved with a chisel. If the wheel has a straight line in it, the angle is found by making it coincide with the mirror. If the angle is not known, it can be determined by making the wheel coincide with the mirror, or a plate may be turned hyperbolically concave.