An Introduction to Parallel Supercomputing

Pete Beckman
Argonne National Laboratory
MCS Division meeting c. 1983

- “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
ATPESC Dinner Talk: 2014

Today…
Google on track for quantum computer breakthrough by end of 2017

“Google is leading the pack when it comes to quantum computing. The company is testing a 20-qubit processor – its most powerful quantum chip yet – and is on target to have a working 49-qubit chip by the end of this year.”
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.
Machine Learning Hardware (for now.. just accelerators…)  

Edge Processing

- Movidius (Intel) Myriad 2 Processor
- Array of Things
- Working to integrate machine learning hardware

Server / Cloud:

- Google TensorFlow Processors

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Pete Beckman  Argonne National Laboratory
Histogram of Execution Time

Number of occurrences

Time(s)

Stampede
Cab
Edison
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 of light, refracted at the centre of a circle, move towards 1 at an angle γ,
then suppose ab = d, i.e., see C. Pietsch's "Elements of Geometry," chap. 2, sect. 4. If the ray be an hyperbolic, a line parallel to its transverse axis is the focal line of the hyperbola. Then the ray will be refracted towards the exterior focus.

Having the proportion of 1 to 2, or 1/2:1, the hyperbola may be thus described.

Upon the centres a, b, let a fixed instrument be placed, and moving up and down in a straight line, observe if the beam of light cut the plane of the paper at a constant distance from a, b.

If the beam of light cut in the same plane at a, b, it intersects it at an angle equal to 90 degrees, from which the refracted rays will be parallel. In the same manner, a plate may be inserted between the rays of light and the plate, and the plate may be turned hyperbolically concave, the hyperbola being concave. Or a plate may be turned hyperbolically concave.