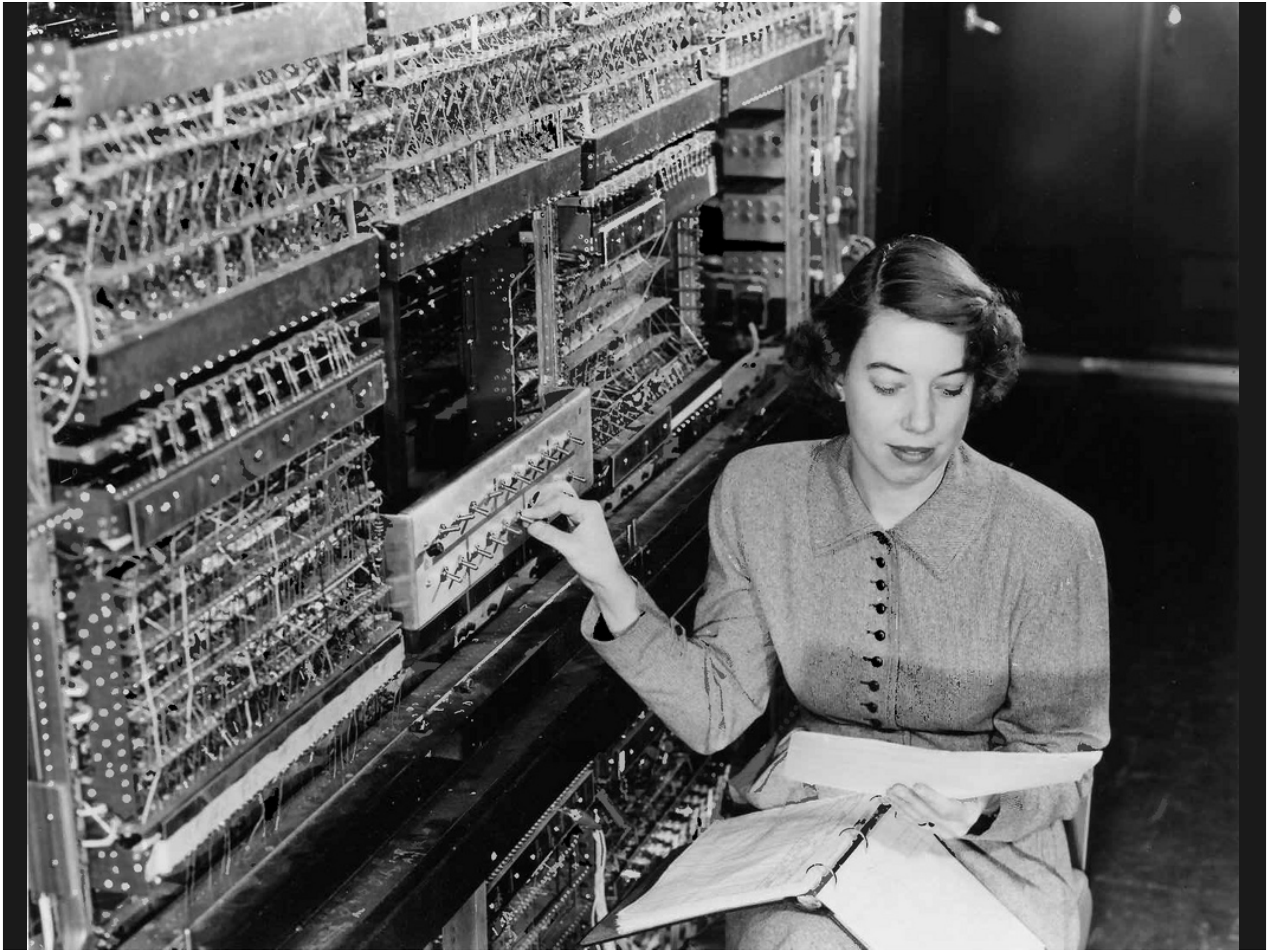
An Introduction to Parallel Supercomputing

Pete Beckman

Argonne National Laboratory



MCS Division meeting c. 1983

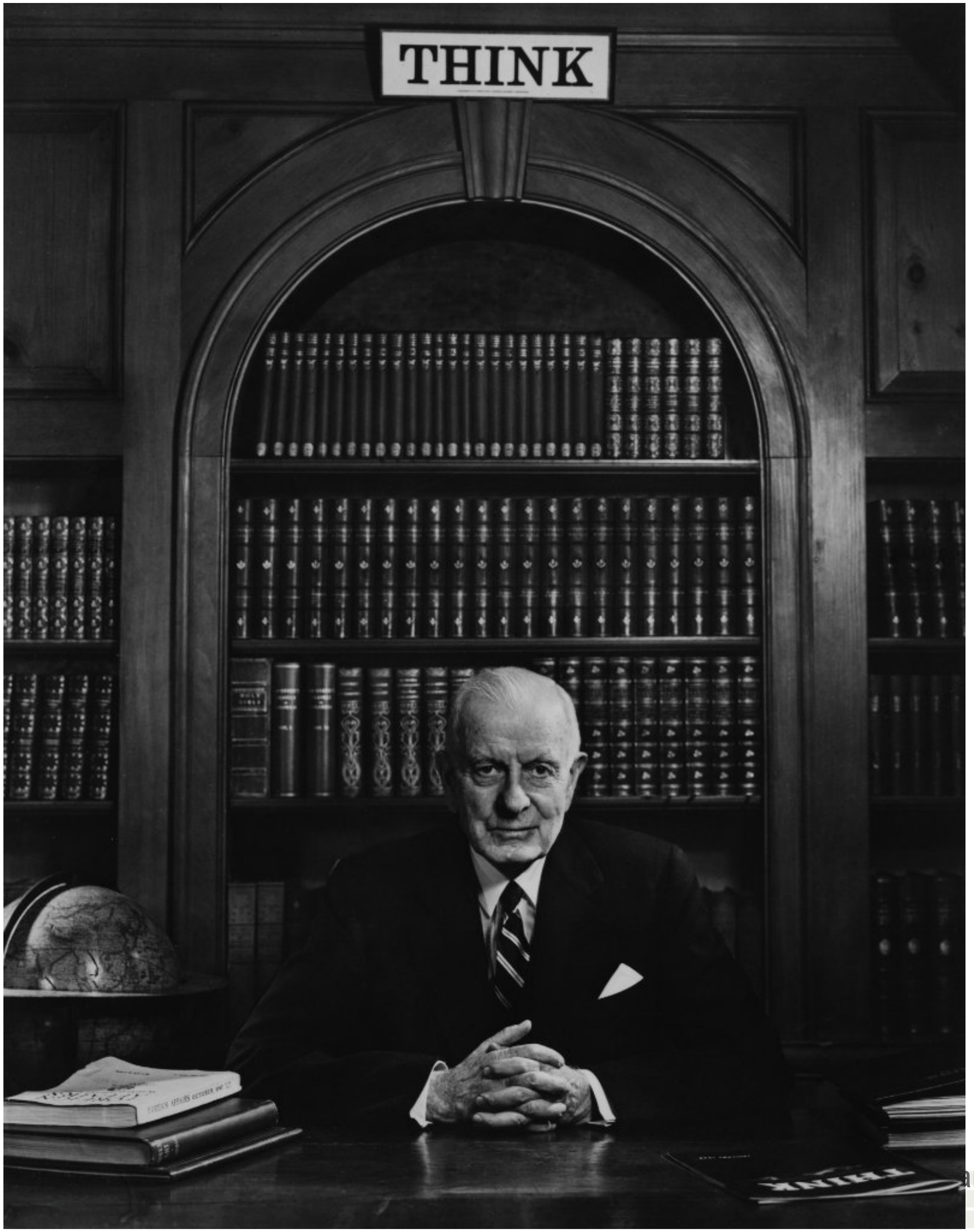
- "If our R&D is going to be relevant ten years from now, we need to shift our attention to parallel computer architectures"
- "Los Alamos has a Denelcor HEP: let's experiment with it"

POOMA Project: 1996
John Reynders

Parallel Platform Paradox

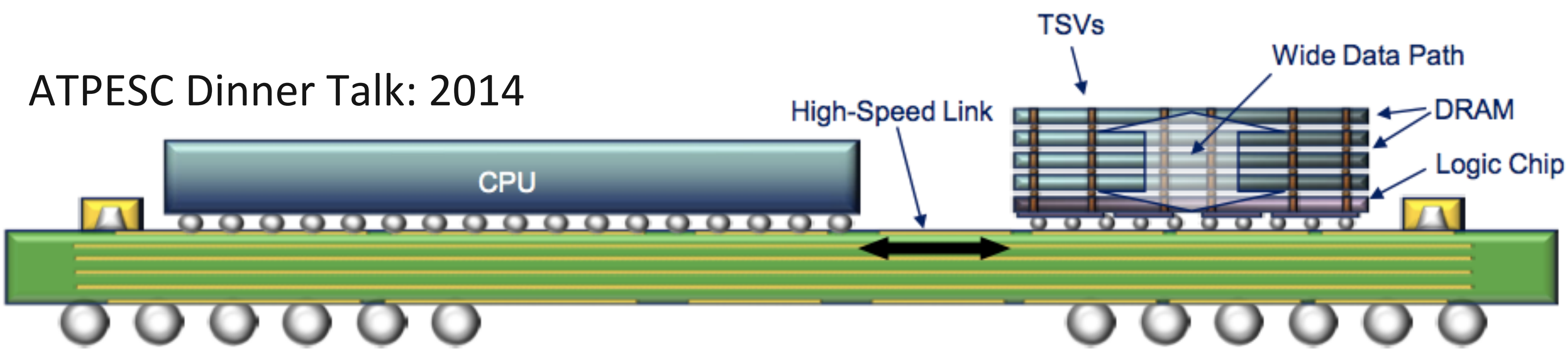
"The average time required to implement a moderate-sized application on a parallel computer architecture is equivalent to the half-life of the latest parallel supercomputer."

"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."

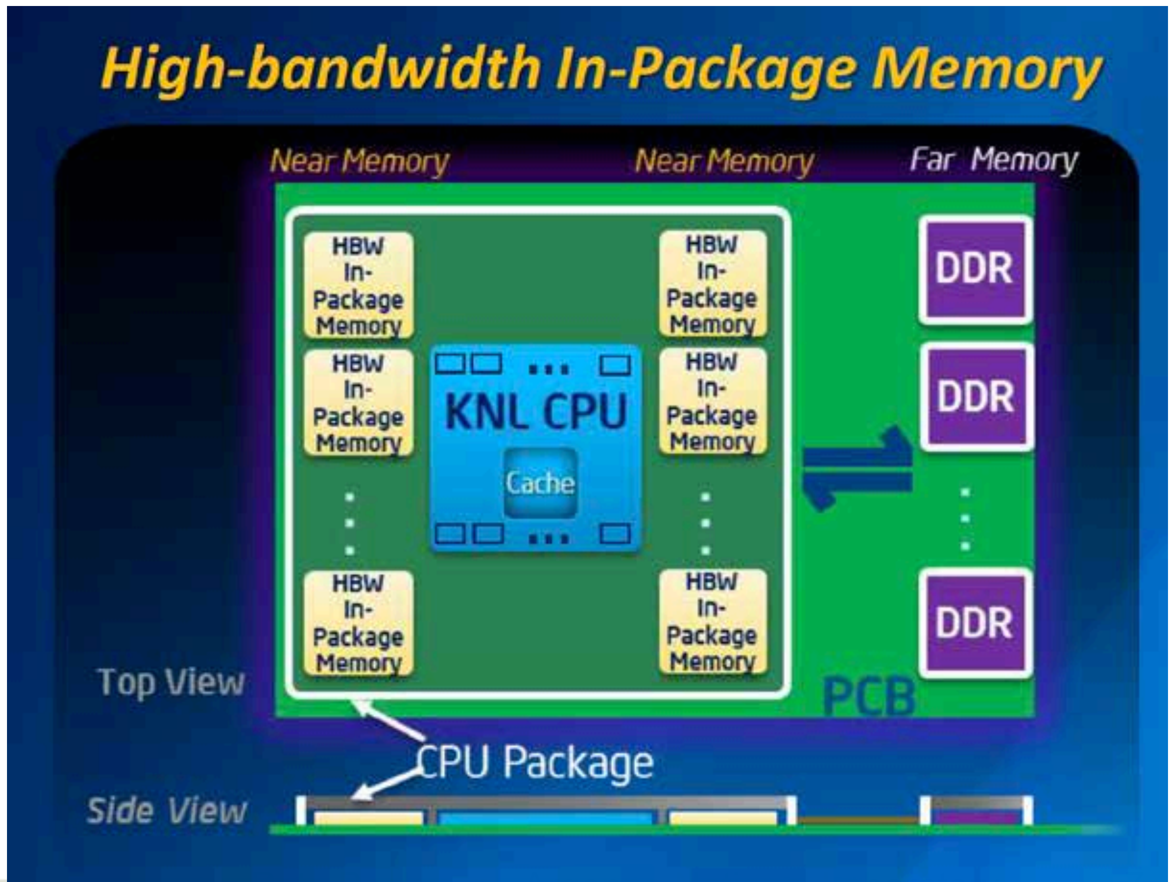


Understand the Model

ATPESC Dinner Talk: 2014

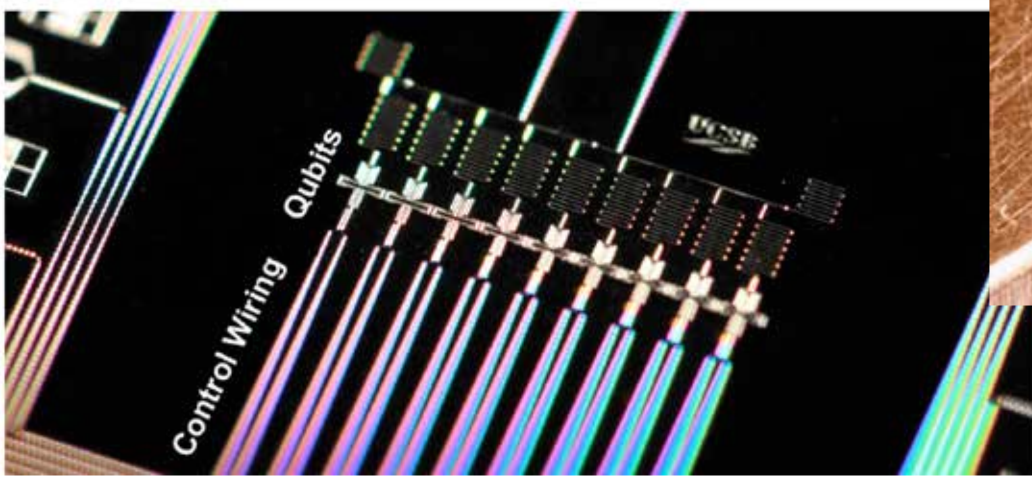


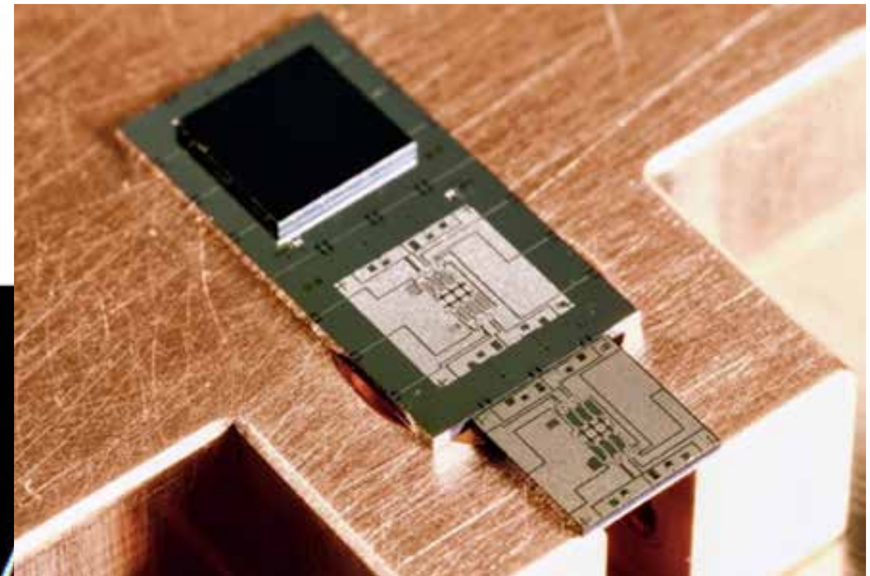
Today…



NewScientist.com

Google on track for quantum computer breakthrough by end of 2017

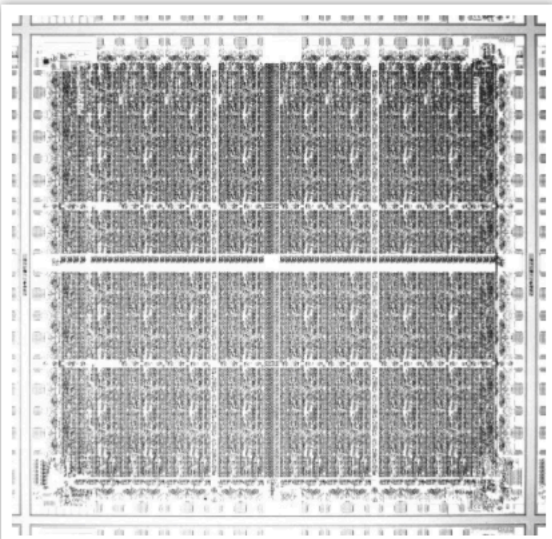




“Google is leading the pack when it comes to quantum computing. The company is testing a 20-qubit processor – its most powerful quantum chip yet – and is on target to have a working 49-qubit chip by the end of this year.”

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.

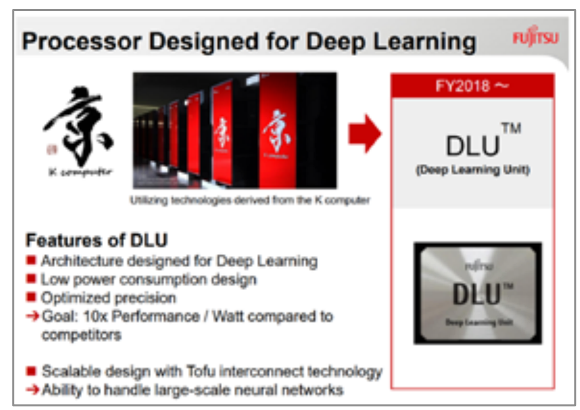
From the relatively recent Intel acquisition of Altera by chip giant Intel, to less talked-about advancements on the programming front (OpenCL progress, advancements in both hardware and software from FPGA competitor to Intel/Altera, Xilinx) and of course, consistent competition for the compute acceleration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

Server / Cloud:

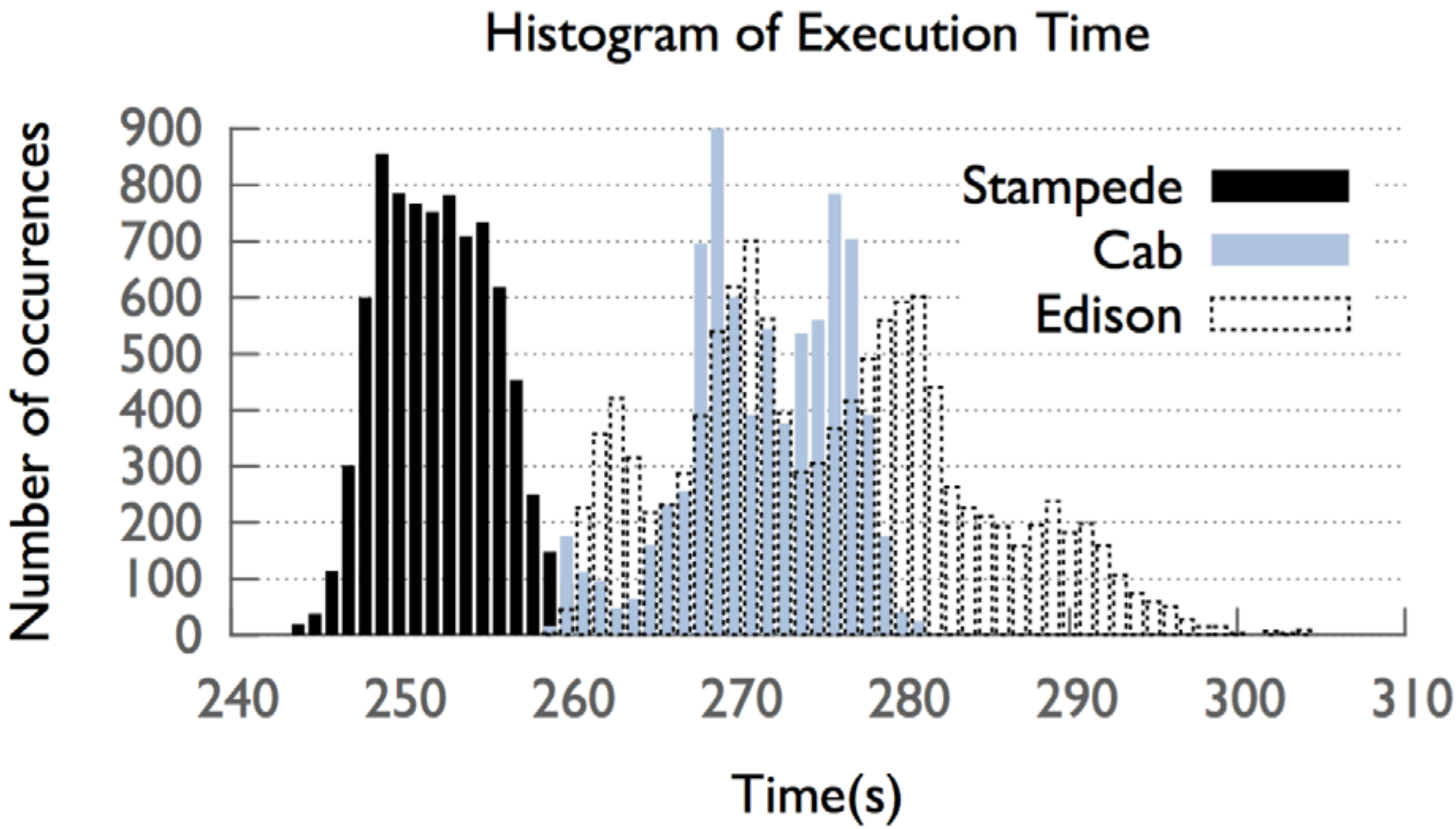
Google TensorFlow Processors



Edge Processing

Movidius (Intel)
Myriad 2 Processor

Array of Things
Working to integrate machine learning hardware


Histogram of Execution Time
Number of occurences
900
800
700
600
500
400
300
200
100
0
240
250
260
270
280
290
300
310
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

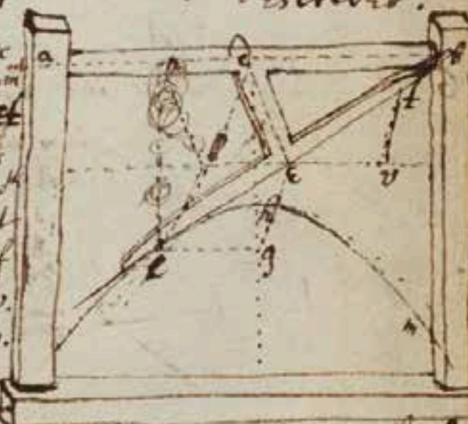
Of Refractions.

1 If ye ray ac bee refracted at the center of ye circle acdg towards d & ab⊥be⊥gc∥ed. Then suppose ab : εd :: δ : ε. See Cartes Dioptricks.

2 If there be an hyperbola the distance of whose foci bd are to its transverse axis hf as δ to ε. Then ye ray ac ∥ bd is refracted to ye exterior focus (d). See C: Diopt.

3 Having ye proportion of δ to ε, or bd : hf. The Hyperbola may bee thus described.

1 Upon ye centers a, b let ye instrument adbtec bee moved in wch instrument observe yt ad⊥de⊥ce & yt the beame cet is not in ye same plane wth adbe but intersects it at ye angle tev soe yt if tv ⊥ ev, then δ : ε :: et : tv. Or δ : ε :: Rad : sine of ∠tev. Also make de = q/2 i.e. halfe ye transverse diameter. Then place the fiduciall side of ye plate ckm in the same plaine wth ab. & moving ye instrument adbect to & fro its edge ct shall cut or weare it into ye shape of ye desired Parabola. Or the plate ckm may bee filed away untill ye edge ct exactly touch it every where.



2 By the same proceeding Des-Cartes concave Hyperbolicall wheele may bee described by being turned wth a chissell &c whose edge is a streight line inclined to the axis of the mandrill by ye ∠tev wch angle is found by making δ : ε :: et : tv :: Rad : sine of ∠tev.

3 By the same reason a wheele may be turned Hyperbolically concave ye Hyperbola being convex. Or a Plate may bee turned Hyperbolically concave