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Architectures and More

Embeeded, Reconfigurable
35 YEARS OF MICROPROCESSOR TRENDS DATA

Original data collected and plotted by M. Horowitz, F. Labdon, C. Schacham, K. Olukotun, L. Hammond and C. Batten.
WHAT CAN WE CONCLUDE?

• Power / Energy wall drives computing
• Single cores hardly improve
• Need Multi-Core => Many-Core
  • E.g. GPUs may contain thousands of Processing Elements
• Need Heterogeneous systems:
  • Scalable Vdd - Performance
  • Near Vth designs
  • Big - Little configurations
• Include DSPs / VLIWs
• Include accelerators

WHAT CAN WE CONCLUDE?

- Single cores hardly improve
- Power / Energy wall drives computing
- Power Efficiency is the Pocket
- HPC could be in the Human
- Smart is (not only) Mandatory
- Pervasive Computing is Connected
- Everything is Connected
- Devices are Connected

Micro-Architectures and Micro-Services

High Cohesion

Multiple Monolithic Systems

Fragile

Distributed Monolithic Services

Loose Coupling

Single Purpose

Microservice

Without "Single Purpose", we will end up with "Distributed Monolithic" services together and shipping multiple loosely coupled. Without "High Cohesion", we will impact other services. Without "Loose Coupling", changes can’t ship changes fast and scale.

The full benefit of microservices, so we will not get building and maintaining multiple.
What is the proposal of the Market?
INTEL ARCHITECTURE SCALES FOR INTERNET OF THINGS

The right performance for the right application

Gateways, mobile devices, and purpose-built, application-specific hardware.

Scalable and efficient computing performance.

Cloud, data center, and HPC.

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NVIDIA TESLA V100

World's First Fused HPC and AI Processor

7.8 TFLOPS FP64
15.7 TFLOPS FP32
5120 NVIDIA CUDA Cores
125 TFLOPS Tensor Ops
640 TENSOR CORES
32GB/16GB HBM2
MEMORY
300GB/s NVLink
HIGH-SPEED NVidia NVLink® To GPUs, I/O, Power

From NVIDIA® Site: www.nvidia.com
The Jetson Family

From AI at the Edge to Autonomous Machines
Special Invitation for the Smart Autonomous Machines Seed Group at CAGE @ SC3UIS

HOWEVER THERE ARE MORE IN THE MARKET…

(2) IN HOUSE EXAMPLES

However there are more in the market…
The HiPEAC Vision for Advanced Computing in Horizon 2020
The Era of Data (Centric) Infrastructure
Embedded System Architecture

From the Book: "Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers"
Embedded Hardware needs Embedded Software
JETSON TK1
THE WORLD'S 1st EMBEDDED SUPERCOMPUTER

CUDA Embedded
192 Cores · 326 GFLOPS
Computer Vision, Robotics, Medical
Development Platform for Embedded Systems

US $1,00 by Core = US $192 + Tax
JETSON WITH Tegra K1

ARCHITECTURE

From http://www.nvidia.com

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>POWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>4K panel, 4K HDMI</td>
<td>Lower Power</td>
</tr>
<tr>
<td>DSI, eDP, LVDS, High Speed HDMI 1.4a</td>
<td>1.2 Gigapixel throughput, 10Mpp sensor</td>
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</tbody>
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<table>
<thead>
<tr>
<th>CAMERA</th>
<th>CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual High Performance ISP</td>
<td>Quad Core Cortex A15 &quot;x8&quot;</td>
</tr>
<tr>
<td>With 512 battery-saver core; 2MB L2 cache</td>
<td>Open GL 4.4, OpenGL ES 3.0, DirectX 11, CUDA 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GPU</th>
<th>Kepler GPU (192 CUDA cores)</th>
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</table>
AN EXAMPLE OF USE...
PROJECTS IN SC3UIS USING JETSON

HPC/AI Convergence
AI Support
Applications
Energy Efficiency
(Milli-Clusters)
HPC Embedded Architectures
Performance Evaluation
Architectures
Applications
Real-Time Processing Systems

Drilling
Forecast
Health

MilliClusters
HOWEVER WE HAVE JETSON X1

- More Powerful than Jetson TK1 and more tiny

Jetson TX1 development board

- 16 GB FloatingPoint
- Maxwell GPU 1 TFLOPS (for 16-bit)
- Quad ARM A57
- SDK supporting Deep Learning
- Core
- 16 and more cores
- Support
- OpenCL C/C++
- Open Hardware
PARALLEL ARCHITECTURE
PARALLELLA APPLICATIONS EXAMPLE

Projects in SC3UIS with Parallela

Model Applications for HPC@Pocket Real Time Processing

Computing Heterogeneity Evaluation IoT Fog/Cloud

UltraScale Systems
SINGLE BOARD ARCHITECTURES

- Open Source Hardware
- High Density, High Performance
- Power Efficiency
- Cubieboard
- Raspberry Pi
- Arduino...
CUBIEBOARD
From http://cubieboard.org/

• SingleBoard Computer
• Open source hardware and Software
• Made in China. Low Price (less than US$50)
• SingleBoard Computer
Raspberry Pi

- High Density Single Board Computer
- Open Source Hardware and Software
- Educative Issues

Raspberry Pi Architecture and Organization
AI IoT Smart Data Centric
Fault Tolerance
Heterogeneity Interaction
Performance Evaluation
In Situ Visual Processing
Real Time Processing
HPC@Pocket
Model Applications for
Raspberry Pi SC3
projects with Cubieboard and
Technology allows (almost) human evolution -
Better Quality of Life -
New Problems and Questions -
Survival -
More Competitively Life -
Constant Auto Learning -
Where found Knowledge?
How use it?
Where found Knowledge?
Speed Life... but different life.
... all life!
Where found Knowledge?
Technology allows (almost) human evolution -
Better Quality of Life -
New Problems and Questions -
Survival -
More Competitively Life -
Constant Auto Learning -
Where found Knowledge?
How use it?
Technology demands (almost) new humans - Earth planet habitants (almost) new humans - Etics (Please don't) - Knowledge is Fun - Beings without Fear - Creative Humans - Sustainably - Beyond Notes III
REFERENCES

https://www.ted.com/talks/jason_pontin_can_technology_solve_our_big_problems