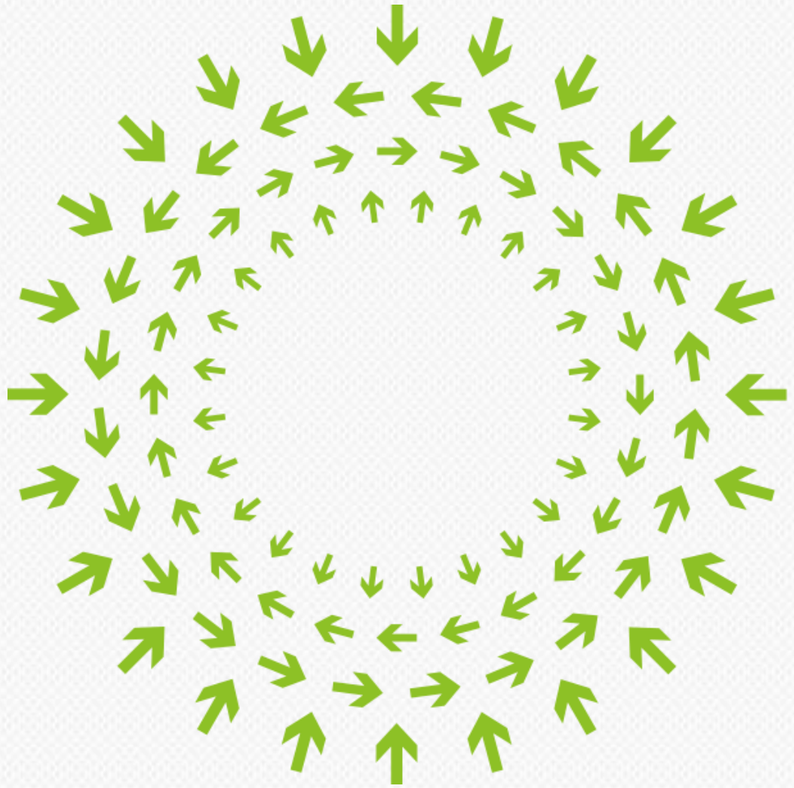

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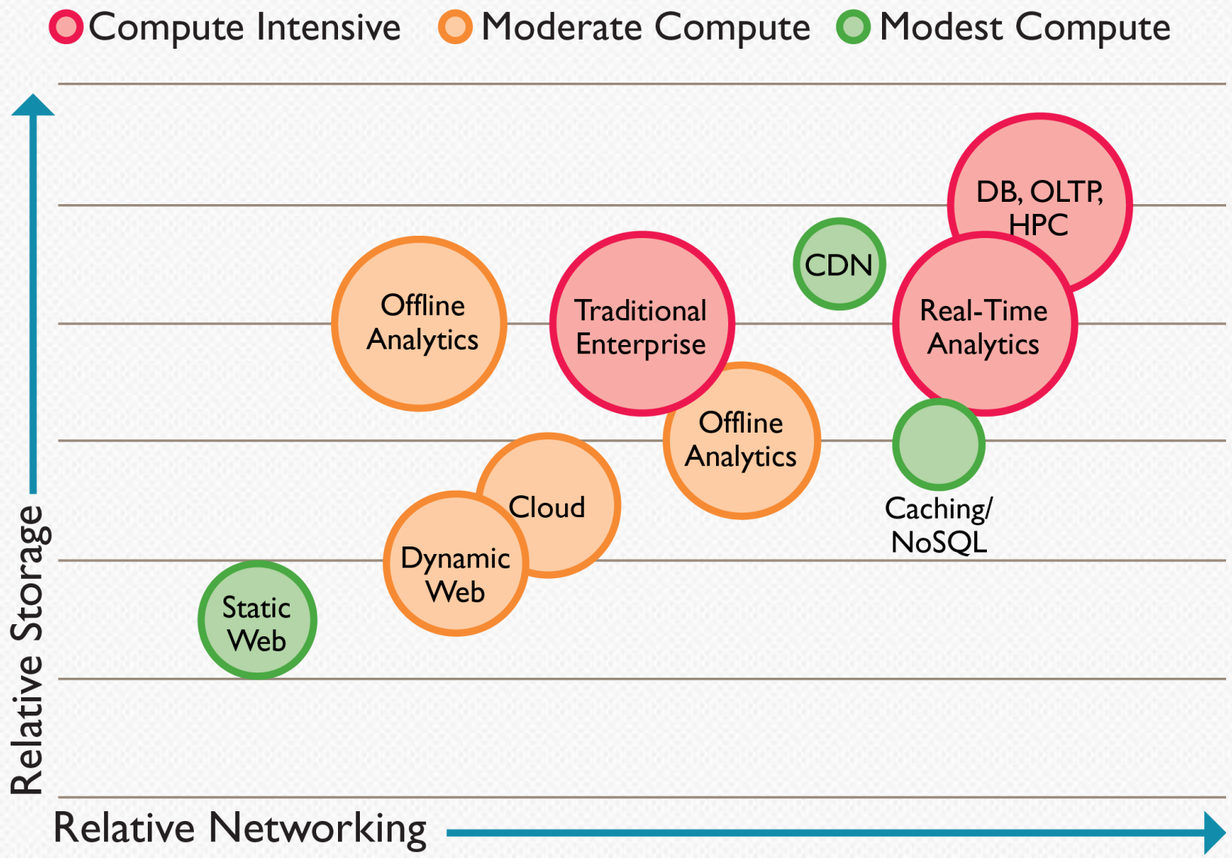
Open Software

Building Interoperability across low power SoCs

George Grey
Linaro
CEO

Requirement for Innovation

- Little change in server architectures in 2+ decades
- But workloads are now rapidly evolving



Source: ARM 2012

New Problems need new Solutions

Prodigious increases in data year on year

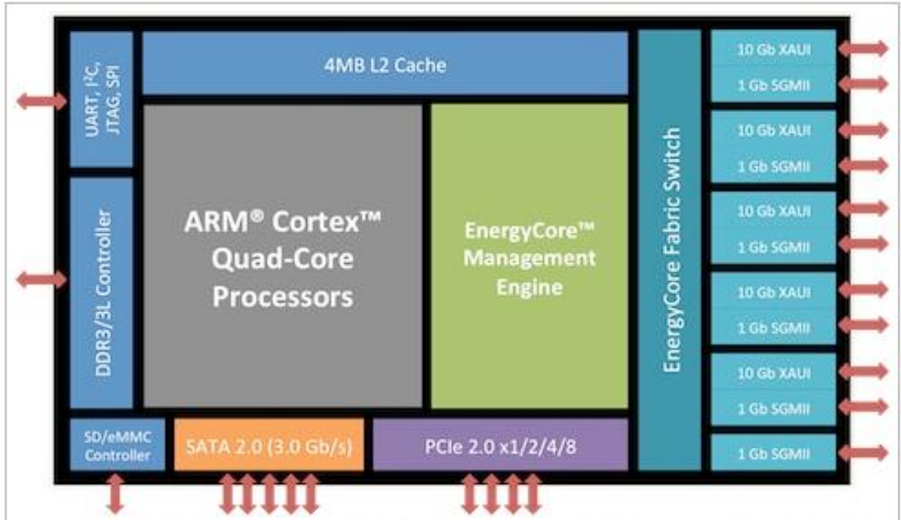
- Billions of embedded and mobile devices
  - ARM partners shipped 7.9 Billion chips in 2011
- Mobile data explosion
- The Cloud requires massive data centers
  - Power consumption is now not just a mobile focus
    - 3 million data centers, 2.2% of US power consumption
    - Technical, cost & environment considerations in the data center

Sources: ARM, Fortune

The Rise of the SoCs

SoCs become “Server on Chips”

- The Move to the SoC
  - Multiple GHz cores
  - Caches with multi-core coherency
  - On Board SoC interconnects
  - On-chip I/O and Storage Interfaces
  - Smaller footprint, lower power, lower cost, high reliability



ECX-1000 SoC: An embedded EnergyCore Fabric Switch inside every chip provides high bandwidth, low-latency networking across thousands of server nodes. The EnergyCore Management Engine provides real-time power and fabric routing optimizations within each SoC.

ARM

Develops IP; Licenses vendors to build ARM SoCs

- Multiple Cortex-A series licensees
  - 32 and 64 bit multi-core designs
- Model drives innovation from large companies and startups
- Value creation through differentiation
- ARM’s DNA is in low power design

The Challenge

“Interoperability is critical”

- Innovation brings change & differentiation
- Proliferation of SoCs is a threat to interoperability
- The lesson learned:
  - “Gaah. Guys, this whole ARM thing is a f*cking pain in the ass.”

    Linus Torvalds, March 11th, 2011

Interoperability

Multiple SoC vendors working together

- Linaro was founded in 2009 by a group of ARM SoC vendors to work on consolidating and optimizing open source software for the ARM architecture
- “Over the last year, ARM has gone from a constant headache every merge window to an outstanding citizen in the Linux community”

  Linus Torvalds, August 29th, 2012

Business Model

Open Source Software is not “free”

- Engineering experts from a range of competitive companies develop and maintain Linux for a wide range of platforms and CPU/SoCs
- Linaro exists to work with the ARM SoC vendors and software ecosystem to reduce duplication, fragmentation and costs
  - Shared software engineering for common Linux software for ARM
  - Kernel, toolchain, middleware, testing & validation
  - Embedded, Mobile, Server and Network Equipment segments
  - Works in the open, delivers upstream and in monthly developer releases
- Delivers high ROI through shared engineering costs

Real World Example

Company A — Memory management Scheme 1

Company B — Memory management Scheme 2

Company N — Memory management Scheme N

Upstream Blockage = Cost

✗

Company A

Company B

Company N

Shared engineering:
Develop single memory management scheme

UMM
(dmabuf, CMA)

Directly upstream to kernel.org

✓

Benefits

- Lower software development cost
- Frees up key engineering resources for differentiation and real value add
- Creates interoperability
- Increases quality
- Reduces maintenance
- Speeds time to market

Commoditization

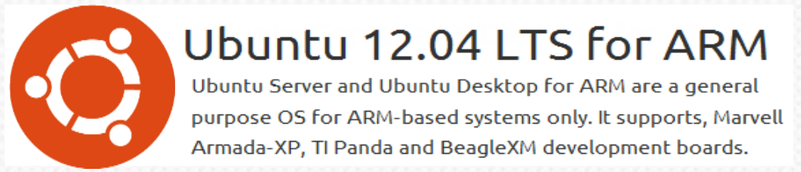
- Isn’t this commoditization?
  - Yes it is, for the common critical core software
  - And …. everyone has to have it
  - In Linux, one version is much better than many
- The ARM architecture enables differentation - to be successful hardware and software innovation must occur OUTSIDE the common core feature set:
  - High speed specialized interfaces for networking, storage and I/O
  - Switching & Cache fabrics extending to hundreds or thousands of cores
  - Rapid integration of new technologies such as GPGPU
  - Low power and/or low cost focused solutions
- This is where value is added, and is key to ROI across the ecosystem

Trends

- Today’s differentiation is tomorrow’s commoditization
- This especially applies to advances that need to be widely adopted to be successful
  - Either by patents & fair and reasonable licensing
  - Or by open sourcing hardware and software

ARM in Servers

- 32 bit SoCs are shipping today
  - Calxeda, Marvell, Samsung
- Software ecosystem is building
  - Ubuntu 12.04 LTS, LAMP stack, Java, RoR, Python, Juju, OpenStack
- HP Redstone and Dell Copper announced
- ARMv8 64 bit architecture introduced
  - Announcements include AMD, Applied Micro
- Linaro forms ARM server ecosystem Group



Linaro & Open Compute

Linaro Enterprise Group announced in November 2012

- Focused on accelerating the ARM server software ecosystem
- Shared investment in open software engineering team

Key Initial LEG Projects

- Common UEFI & ACPI development for ARM
- Virtualization including KVM
- ARM single kernel zImage
- ARM architecture optimization for key server workloads
  - LAMP
  - Hadoop
  - HipHop
  - OpenStack
- AArch64 ARM 64 bit architecture software development
- Test & Validation using OE, Ubuntu and Fedora/Red Hat

Open Software for Open Hardware

- Linaro shared work is engineered in the open
- Linaro Connect
  - For engineers
  - USA, Europe, Asia
  - Attendance is free for members, nominal charge for non-members
- Linaro’s members drive the technical agenda and participate in the engineering effort

Delivering Interoperable Low Power Servers

Value Chain

- End users & Service Providers
- Enterprise Software Providers
- Commercial Distributions
- OEMs
- SoC vendors

+

Key Enablers

OPEN Compute Project

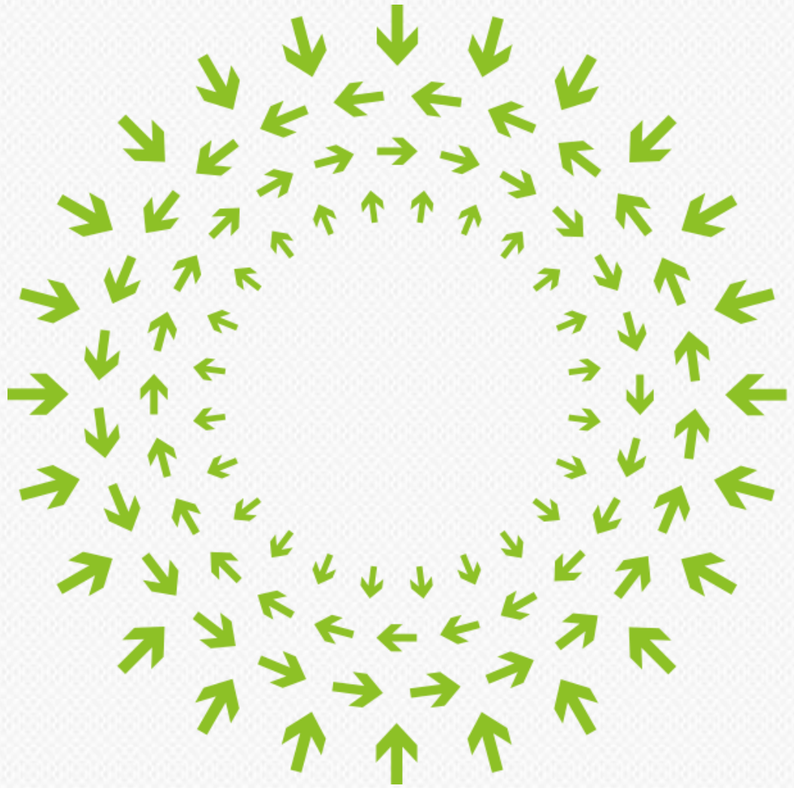
Linaro

ARM

THE LINUX FOUNDATION

Find out more about Linaro

- Linaro membership
  - www.linaro.org/members
- Linaro Enterprise Group
  - www.linaro.org/engineering/leg
- Linaro Software
  - www.linaro.org/downloads
- ARMv8 64 bit
  - www.linaro.org/engineering/armv8



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