Application diversity demands accelerated Linux

Embedded Linux Conference 2013
Mark Orvek - Director, Linaro Working Groups
Linaro – Working Together

- Linaro founded in 2010 by a group of ARM SoC vendors to consolidate and optimize open source software for the ARM architecture
- Increase collaboration; 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
Linaro – Working Together in Groups

- **Enterprise Group (LEG)**
  - Members deliver optimized open-source software for ARM servers
- **Groups for specific market segments**
- **Shared investment in open software engineering team**
**Linux is Key To Industry Growth Areas**

- Majority of key ARM growth areas are opportunities for Linux
  - Mobile, home and enterprise (networking)

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### Markets for ARM in 2017

<table>
<thead>
<tr>
<th>Devices Shipped (Million of Units)</th>
<th>2017 Devices</th>
<th>Device CAGR</th>
<th>Chips/Device</th>
<th>2017 Chips</th>
<th>Chip CAGR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mobile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smart Phone</td>
<td>1,700</td>
<td>20%</td>
<td>3-5</td>
<td>6,800</td>
<td>20%</td>
</tr>
<tr>
<td>Feature Phone</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Low End Voice</td>
<td>710</td>
<td>-1%</td>
<td>1-2</td>
<td>1,400</td>
<td>15%</td>
</tr>
<tr>
<td>Portable Media Players</td>
<td>90</td>
<td>-10%</td>
<td>1-3</td>
<td>180</td>
<td>-5%</td>
</tr>
<tr>
<td>Mobile Computing* (apps only)</td>
<td>850</td>
<td>20%</td>
<td>1</td>
<td>850</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Home</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Camera</td>
<td>130</td>
<td>-5%</td>
<td>1-2</td>
<td>200</td>
<td>-5%</td>
</tr>
<tr>
<td>Digital TV &amp; Set-top-box</td>
<td>600</td>
<td>10%</td>
<td>1-4</td>
<td>2,000</td>
<td>25%</td>
</tr>
<tr>
<td><strong>Enterprise</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desktop PCs &amp; Servers (apps)</td>
<td>200</td>
<td>Flat</td>
<td>1</td>
<td>200</td>
<td>Flat</td>
</tr>
<tr>
<td>Networking</td>
<td>1,500</td>
<td>5%</td>
<td>1-2</td>
<td>1,700</td>
<td>5%</td>
</tr>
<tr>
<td>Printers</td>
<td>130</td>
<td>2%</td>
<td>1-3</td>
<td>130</td>
<td>2%</td>
</tr>
<tr>
<td>Hard Disk &amp; Solid State Drives</td>
<td>1,100</td>
<td>10%</td>
<td>1</td>
<td>1,100</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Embedded</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>3,800</td>
<td>10%</td>
<td>1</td>
<td>3,800</td>
<td>10%</td>
</tr>
<tr>
<td>Smart Card</td>
<td>8,500</td>
<td>10%</td>
<td>1</td>
<td>8,500</td>
<td>10%</td>
</tr>
<tr>
<td>Microcontrollers</td>
<td>11,400</td>
<td>5%</td>
<td>1</td>
<td>11,400</td>
<td>5%</td>
</tr>
<tr>
<td>Others **</td>
<td>3,000</td>
<td>10%</td>
<td>1-2</td>
<td>3,000</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>34,000</td>
<td>5%</td>
<td>1-2</td>
<td>41,000</td>
<td>10%</td>
</tr>
</tbody>
</table>

* Including tablets, netbooks and laptops
** Includes other applications not listed such as headsets, DVD, game consoles, etc.

Source: ARM earnings announcement 5 Feb 2013
Challenges – Linux and ARM

- **Consolidation**
  - Reduce / eliminate code duplicated across SoC implementations
  - Single memory management scheme – UMM (dmabuf, CMA)
  - Single zimage on multiple server and mobile platforms
  - Prevent future fragmentation

- **Working in upstream**
  - Increase in new developers without community experience
    - Patches need to be reviewed and refactored – rinse and repeat
  - Tendency to create internal implementation then refactor for upstream
    - Wastes time and increases effort
Challenges: ARM Encourages Differentiation

Linus Torvalds

• “Gaah. Guys, this whole ARM thing is a f**king pain in the ass.” Mar 2011, http://lwn.net/Articles/437170/

• “ARM Linux is getting better, and the ARM community seems to be making progress.” Oct 2011, http://lwn.net/Articles/463908/

• “Over the last year, ARM has gone from a constant headache every merge window to an outstanding citizen in the Linux community,…” Aug 2012, http://www.zdnet.com/torvalds-touts-linuxs-advances-in-power-arm-and-cell-phones-7000003509/

Lines of code in the Linux kernel

arch/arm in kernel: 250k lines less than the past trend
Challenges – Power Management

- Power Management
  - Billions of embedded and mobile devices
    - ARM partners shipped 8.7 Billion chips in 2012 \[^1\]
  - Smartphone and tablets generating a mobile data explosion
    - Mobile data to hit 134 Exabytes by 2017 \[^2\]
  - The Cloud requires massive data centers
    - Power consumption is no longer just about mobile devices
      - 3 million data centers, 2.2% of US power consumption \[^3\]
    - Doubling of big data growth by 2014 \[^4\]

[1] Source: ARM
[3] Source: Fortune
Challenges – Power Management

- **SoC Innovation**
  - ARM’s DNA is in low power design
    - big.LITTLE
      - HMP (Heterogeneous Multiprocessing) - clusters of low power and high performance cores on a single chip to accomplish both high intensity and low intensity tasks in the most energy efficient manner

- **SoCs become “Server on Chips”**
  - Smaller footprint, lower power, lower cost, high reliability

- **ARMv8**
  - ARM 64-bit architecture designed for high performance and power efficiency while maintaining compatibility with existing 32-bit software
Challenges – Networking Infrastructure

- Explosive growth in mobile data
- Adapting to dynamic workloads
- Product cycle time is 2-3+ years, how to keep pace with technology innovation?
  - Legacy code – Big Endian data
  - Long validation/certification cycles
  - Need for higher performance and lower power consumption with existing software applications
- Different software environments to meet the requirements of control and data plane
Challenges – Organizing Groups

- Collaborative software engineering among companies which naturally compete
- Identifying the boundaries between common (commodity) and differentiating software
  - Competing companies need room to differentiate
- Defining common requirements, goals and objectives
- Building Teams
- Agreeing on need to work upstream
Technology Roadmap – Power Management

- big.LITTLE MP vs. In-Kernel Switcher (IKS)
  - MP\(^1\) = all cores can be scheduled and used at the same time
    - Touches many subsystems in the kernel
    - Will require much discussion and testing to achieve final upstream implementation
    - Commercial products in 2H’2013 or early 2014
  - IKS\(^2,3\) = manage pairs of cores between A7 and A15 clusters to balance performance versus power consumption
    - Migrating execution states between the two clusters.
    - Less complex than MP while still providing excellent power-performance results
    - Commercial products in 1H’2013

- Less about the processor architecture, more about kernel re-factoring

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\[1\] https://wiki.linaro.org/projects/big.LITTLE_MP
\[2\] http://www.linaro.org/documents/download/d364018e38b473315767d5479039751a50925b90d6cc6
\[3\] In Kernel Switcher: A Solution to Support ARM’s New big.LITTLE Implementation - Mathieu Poirier, Linaro – Friday, Feb 22\(^{nd}\) @ 9:00AM PT
Technology Roadmap - Server

- 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
Technology Roadmap - Virtualization

- KVM running on ARMv7a\[1\]
  - Tested on ARM Fast Models and Versatile Express TC2
  - Fully boots both Ubuntu (user space Thumb-2) and Debian (user space ARM) guests

- Linaro Mini-Summit Feb 2013\[2\]
  - [https://wiki.linaro.org/LEG/Engineering/Virtualization/201302MiniSummit](https://wiki.linaro.org/LEG/Engineering/Virtualization/201302MiniSummit)
  - Initial focus areas:
    - Continuous integration and validation for ARMv7 / ARMv8 (models)
    - Booting in HYP-mode\[3,4\]
    - QEMU model for ARMv8
    - Ensure libvirt works properly with KVM on ARMv7 / ARMv8 (models)
    - Support for VM migration

- Sessions at Linaro Connect Asia (LCA13 Hong Kong)
  - KVM for Core and LEG
  - KVM Status and Plans
  - Information and registration at: [http://www.linaro.org/connect](http://www.linaro.org/connect)

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\[1\] [http://lwn.net/Articles/516652/](http://lwn.net/Articles/516652/)
\[2\] [http://www.linaro.org/linaro-blog/2013/02/08/linaro-takes-an-active-role-in-virtualization-on-arm/](http://www.linaro.org/linaro-blog/2013/02/08/linaro-takes-an-active-role-in-virtualization-on-arm/)
\[4\] [http://lwn.net/Articles/516652/](http://lwn.net/Articles/516652/)
Technology Roadmap – Real Time

- Although real-time has been available since Linux 2.4, it is a new technology for Linaro

- Define requirements
  - Who needs it and why?
  - Soft vs. hard deadlines (“uncertainty about determinism”)
  - Single or segregated environments
  - Virtual or physical platforms

- Understand current status
  - PREEMPT_RT
    - Is not yet, and may never be, fully integrated into the mainline kernel tree
    - ARM Platform support variable
    - Interactions with virtualization

- Review existing research

- Create a plan and execute
Summary

- Challenges create opportunities
  - ARM innovation and diversity
  - Growth in data; more data centers
  - Higher performance and lower power consumption
  - Linux everywhere in everything
- Differentiation is necessary and shifts over time
- Work together to solve common problems
- Solve common problems in the open

Potential TAM For Linux across all architectures and segments (billion units)

Source: Estimated from ARM Feb 2013 analyst presentation
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
Questions?
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Thank you!