Embedded segment market update

China Technical Seminar Series
July 2015

Richard York – VP Embedded Marketing
Agenda

- The broad embedded market
- The right device for each and every market
- A survey of some important vendors
- Ecosystem and a brief look at Yocto
- The growth in Embedded Computing Boards (ECBs)
- MCU growth and the latest high performance devices
- ARM’s focus on Functional Safety
- Conclusions
ARM: the world’s most scalable architecture

- ARM ecosystem meets needs of vertical markets – from sensors to servers
  - Addressing automotive, consumer, industrial, mobile, medical, metering and beyond
  - 12bn ARM chips shipped in 2014 alone – increasingly becoming connected as part of IoT
- ARM’s market share now at 37% overall
Energy Efficiency Critical to Embedded

- Power efficiency is important for all applications
  - Thinner and lighter
  - Lower cost – minimal thermals
  - Lower energy use – reduced operating costs and carbon footprint
  - New product categories – wireless sensors with 15 year battery life

- The ARM Architecture has low-power design in its DNA
  - Instruction set architecture
  - Processor micro-architecture
  - System design
  - Implementation
  - Operating systems and software
  - Partnership and ecosystem
Right SoC for the right use case
Range of capability from ARM – scalable, compatible, standards-based
ARM Cortex Processors: Scalability for Every Market

Cortex-A Processors
- Highest performance
- Rich OS

Cortex-R Processors
- Fast response / real-time control
- RTOS

Cortex-M Processors
- Smallest footprint / lowest power
- DSP + MCU
ARM Cortex-A MPU portfolio

- **Cortex-A15**
  - 32-bit performance with enterprise class features

- **Cortex-A57**
  - 64/32-bit high-end CPU

- **Cortex-A72**
  - Highest 64/32-bit performance CPU

- **Cortex-A9**
  - 32-bit CPU
  - Shipping since 2009

- **Cortex-A53**
  - Highest efficiency 64/32-bit CPU

- **Cortex-A5**
  - Smallest and lowest power CPU

- **Cortex-A7**
  - Highest efficiency 32-bit CPU

- **SAMA5**
  - Most cost effective

Performance optimised

Highest performance

Most cost effective
Atmel’s offerings

- SAM A5 family, D3 and D4
- They have some unique capabilities:
  - Very low power, 150mW running, 0.5mW low power mode
- Practical integration features to simplify board design, memory integration
- H264, VP8 and MPEG4 720p video playback capability at 30fps for an enhanced user interface experience, bringing significant increases in processing and system performance
- Additionally, the series also provides higher security leveraging ARM® TrustZone® technology to protect the system against counterfeiting, remote firmware updates and allow safe storage of critical data
Freescale – a huge range of devices

- Eleven members of the i.MX range
- Innovation at both ends of the spectrum:
  - New i.MX7 solo and dual.A7 processors at up to a GHz
  - New i.MX6 Ultra Lite - $5
- Some of the most advanced security features we have so far seen in an apps processor, for the most demanding applications such as POS
- Power consumption around 100mA at full speed

- And commitment to supply many products for ten to fifteen years – really important for automotive, industrial, medical and other markets
Qualcomm – an important new entrant

- We all know Qualcomm from their wireless products, now that technology is coming to the embedded world

TI: high performance products with great DSP integration

- Sitara: a range of high performance Cortex-A8, A9 and A15 products
- Includes, Keystone II “many core” processors for advanced designs demanding high performance
- Popular Beaglebone boards give a great open source development platform
The RZ products, great display technology for an increasingly display-oriented control world and also great motor control and real-time features
Announced in February: Cortex-A72, highest efficiency and performance

- **Highest single-threaded performance**
  - Lower power enabling maximum performance within thermal limits
  - Large performance increase across integer, memory-streaming, floating point

- **Significant advancements in power efficiency**
  - >15% power reduction from Cortex-A57

- **Support for embedded and automotive reliability requirements**
  - ECC protection to Instruction and Data Caches, 4MB memory & DRAM
  - Functional safety package

![ARM® Cortex®-A72](image)

10~50% Performance Increase over Cortex-A57

- Floating point: 25%
- Mem Streaming: 50%
- SpecInt2000: 10%
Cortex-A72 matches highest embedded performance goals

**ARM Benefits:**

- Less than 1/3rd the power for equivalent performance
- Allows high performance embedded computing in a significantly reduced power budget

Comparison for equivalent number of threads

- Platforms used:
  - Xeon-E5 2660 10C20T platform (measured)
  - Xeon-E5 2650 10C20T platform (measured)
  - Gcc compiler v4.9 with –o3 flag

- Estimated result on example 20C ARM Cortex platforms with CCN-508, 28MB total L2+L3 cache
  - per-core measurements on RTL with relevant memory system
  - Gcc compiler v4.9 with –o3 flag
  - Scaled to 20T based on modelled and empirical results
  - Power estimated in 16nm based on ARM internal implementations for entire CPU+ interconnect
This diagram is a sample representation of the ARM Partner Ecosystem for illustration purposes only.
Yocto Project

- Collaboration of technology, tools and methods used to build a custom embedded Linux distribution regardless of hardware architecture
- Unprecedented adoption for a young open source project
  - Virtually all of the largest semi vendors, OSVs, and ISVs have adopted the Yocto Project as a foundation for their own offerings
- Large and diverse developer community
- Sponsored by the Linux Foundation, the Yocto Project is independently governed by a board of advisors
Yocto Project Highlights

- Yocto Project is a comprehensive, customizable embedded Linux "build system"
- Yocto Project provides a "reference distribution"
- Yocto Project contains recipes for thousands of software packages, including various Linux kernel versions and application software packages
- Yocto Project has support for dozens of off-the-shelf BSPs
- Yocto Project allows the developer to build a custom embedded Linux distribution suitable for a given product profile
Embedded Compute Boards
Embedded Compute Boards – a place for discovery

- Site launched in June and getting a lot of attention
- http://community.arm.com/community/arm-cc-cn/ecb-cn
- Growing steadily as we add boards and vendors
- Already getting lots of attention

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>SoC</th>
<th>ARM Core</th>
<th>Onboard DDR3</th>
<th>Onboard DRAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantech</td>
<td>RS4-4210</td>
<td>Freescale</td>
<td>LM153</td>
<td>512 MB DDR3</td>
<td>Yes</td>
</tr>
<tr>
<td>Advantech</td>
<td>RS4-4220</td>
<td>TI Sitara</td>
<td>AM3352</td>
<td>512 MB DDR3</td>
<td>No</td>
</tr>
<tr>
<td>Anuta</td>
<td>Matrix-513</td>
<td>Atmel AT91SAM9G</td>
<td></td>
<td>128MB</td>
<td>No</td>
</tr>
<tr>
<td>Anuta</td>
<td>M-5390A</td>
<td>Freescale</td>
<td>LM153</td>
<td>1GB</td>
<td>No</td>
</tr>
<tr>
<td>Anuta</td>
<td>PAC-4000</td>
<td>Atmel AT91SAM9G</td>
<td></td>
<td>512 MB DDR3</td>
<td>No</td>
</tr>
</tbody>
</table>

探索基于ARM的嵌入式计算机世界

文中作者：David Blaza
英文译者：Exploiting the world of ARM based Embedded Computing Boards (ECB)

嵌入式计算机诞生于20世纪70年代，根据所处的产业不同，规格也不一样，比如有VPX，COM Express，xTCA等等。嵌入式计算机，有时候也被称为单板机或者模块电脑/系统。其实是一个隐形的计算机世界，我们日常生活的公共汽车，火车，起重机，自动取款机以及医疗设备很多都是由它们在驱动的。嵌入式计算机市场一直以未发展的不温不火，但是近两年以来，随着处理器架构和规格的变化，基于ARM的嵌入式计算机市场开始快速发展。嵌入式计算机和Beaglebone，Raspberry Pi，Arduino等开发板有一定的区别。嵌入式计算机设计时需要考虑固定在特定的底座或者底板之上，以期能够强化对抗具有极端温度，震动，晃动的环境。
ARM is enabling rapid embedded market growth

24% share of microcontrollers and smartcards

All top 10 MCU vendors now shipping ARM-based microcontrollers

Over 3,500 different ARM-based microcontroller chips available

200 companies have licensed Cortex-M family of processors to date

ARM Cortex®-M Market Share (32 bit MCUs)

70% market share in 32 bit MCUs
3x increase in mbed Partners
25% YoY increase in Cortex-M

Cortex-M Shipments

Billions

2012 2013 2014
2 2.9 4.4
ARM Cortex-M: Trusted Choice for Embedded Intelligence

12.1 Bn
Units shipped to date

Scalable and Compatible Architecture

Cortex-M7

Cortex-M4

Cortex-M3

Cortex-M0+

Cortex-M0

90 µm

Lowest Area

Highest Energy Efficiency

15 years

Energy-Performance Balance

Blended MCU and DSP

Highest Performance

3500+
Catalogue parts
Cortex-M7 products – broad application space

**ST**
- STM32F7 family
- Design wins across consumer and industrial
- High performance CoM options

**Freescale**
- Kinetis V family
- Four MCUs -> ½ of a Kinetis V

**Atmel**
- SAM V family
- Perfect for cost effective IVI systems using AVB
Functional Safety
Functional safety support is becoming essential

- Compliance with safety standards is required in many markets
- Visible reminders everywhere of the importance of electronics to automotive industry
- Also applies to other sectors: medical, factory automation, robotics, automotive, transport...

- ARM white papers provide more detail
Functional safety example

Electric power steering

- An example of a control system which must demonstrate functional safety
  - Must continue to function or at least behave predictably in event of a fault
  - By predictable behaviour we mean it must shut down, fail safe, reset and restart etc.

- Functionally safe systems aim at preventing hazardous behaviour in event of a fault

- Level of risk resulting from potential malfunctioning behaviours is quantified through hazard analysis and risk assessment
  - Automotive Safety Integrity Levels range from ASIL A to ASIL D
  - The higher ASIL requirement dictates the level of robustness of design and verification processes, and often also leads to inclusion of more fault detection and control features
Functional safety – standards

Functional safety of E/E/PE systems

- Automotive: ISO 26262
- Industrial: IEC 61511, IEC 61513
- Medical: IEC 62304
- Aviation: DO-178, DO-254
- Railways: EN 5012x
- Machinery: IEC 61508, IEC 62061, ISO 13849

---

27
Our announcements this year

The growing importance of safety and fault management
- Across many markets requirements for compliance to safety standards growing
- Very visible reminders everywhere at CES about the importance of electronics to automotive industry
- Also applies to many others, from medical to transport, factory automation to robotics, automotive to aerospace

Functional safety
Developing CPUs with fault detection and control features in the hardware

Functional safety – standards
- ISO 26262
- IEC 61508
- IEC 62254
- ISO 10012a

Safety Package
- Safety Manual
- Failure Modes and Effects Analysis
- Development Interface Report
- SW-BIST program (selected CPUs)
ADAS sensors and functions

- 360 Surround View
- Front Camera Mono or Dual
- Interior Cockpit Camera
- Long-range Radar
- Mid-range Radar
- Ultrasonic Sensors
- Back-up Camera
- Automatic Parking Object Detection
- Adaptive Cruise
- Automatic Braking
- Smart Lighting
- Object Recognition
- Drowsy Driver
- Occupant Detection
- Facial Recognition
- Collision Warning
- Object Detection
- Adaptive Cruise
- Cross traffic warning
- Object Detection
- Parking Assist
- Blind spot detection

- Lots of sensors – cameras, radars, ultrasonic, and many more to come.
- Lots of opportunity for redundancy of functions.
- Semi-autonomous driving can be achieved today with embedded control.
- V2V and V2I will offer supplemental control from the cloud and greater redundancy.
- Fail functional is needed for safety features.
Enabling future advanced ADAS capabilities
Functional safety support for ARM IP

Safety management
- Requirements management
- Quality

Processes
- Errata management
- Training
- Documentation

Fault detection/control features
- Memory Protection
- Error Correction
- Dual Core Lock-Step

Design & Verification
- Abort mode
- System Error
- Fault containment

Safety Package
- ARM IP Product Safety Package *
- Safety Manual
- Failure Modes and Effects Analysis
- Development Interface Report

* Supported IPs have separate licensable package
Conclusions
ARM: at the heart of embedded intelligence

<table>
<thead>
<tr>
<th>ARM technology is at the heart of IoT</th>
<th>ARM ecosystem enabling the developer</th>
<th>Huge and growing opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Sensor" /></td>
<td><img src="image2" alt="MCU" /></td>
<td><img src="image3" alt="Radio" /></td>
</tr>
<tr>
<td><strong>ARM Share:</strong> 26%</td>
<td><strong>ARM Share:</strong> &gt;50%</td>
<td><strong>Embedded market forecast:</strong> $25bn in 2020</td>
</tr>
<tr>
<td>Common software, low-power platform</td>
<td>Advanced development platforms and software</td>
<td></td>
</tr>
</tbody>
</table>