Introduction to ARM

P. Mai P. Schoonbrood C. Steinhaus C. Wedding

patric.mai@gmx.de, pierre.schoonbrood@rwth-aachen.de,
christian.{wedding, steinhaus}@rwth-aachen.de

January 29, 2015

Basic Outline

- Mostly 32 bit architecture, first 64 bit (ARMv8-A) launched late 2012
- Product profiles for "Application" (A), "Real-Time" (R) and "Microcontroller" use
- Many Coprocessor Extensions available
- Mainly used in low-power/low-cost SoC applications
- Not produced by ARM itself
- Licensing model allowing IC vendors to sell ARM Processors and SoCs

Notable Features

- Big Endian and Little Endian modes
- Modified Harvard Architecture (Separate Instruction and Data Cache on L1)
- Small Cache sizes
- Conditional Execution

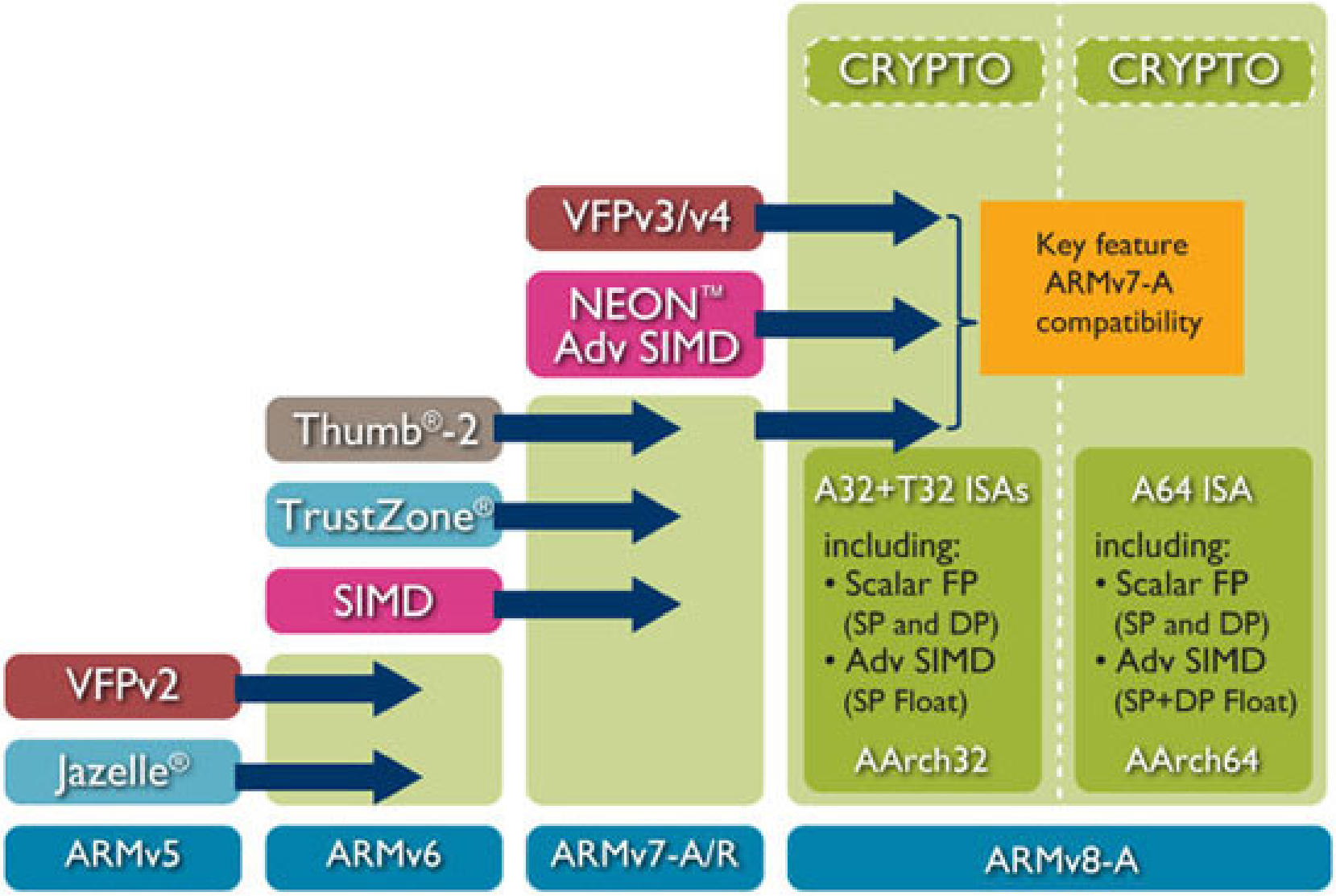
Conditional Execution

- Every asm instruction has a predicate condition
- Allows skipping code instead of branching
- Prevents emptying pipelines and thus prevents wait cycles for small if- and while-segments
- First 4 bits of instruction used for condition

Extensions

- Hardware FPU
- Neon - SIMD Extension
- Jazelle - Direct Java Bytecode Execution
- Thumb(2) - (16-bit Mode for higher compiled code density)
- Optional cryptographic extensions

Extensions


CRYPTO
CRYPTO
VFPv3/v4
NEON™ Adv SIMD
Key feature ARMv7-A compatibility
Thumb®-2
TrustZone®
SIMD
A32+T32 ISAs
including:
• Scalar FP (SP and DP)
• Adv SIMD (SP Float)
AArch32
A64 ISA
including:
• Scalar FP (SP and DP)
• Adv SIMD (SP+DP Float)
AArch64
VFPv2
Jazelle®
ARMv5
ARMv6
ARMv7-A/R
ARMv8-A

Timeline of ARM

1985	first commercial RISC processor
1991	first embedded RISC Core ARM6 (ARMv3)
1996	introduction for ARM8 (ARMv4)
1999	announcement of ARM9E (ARMv5) with enhanced signal processing
2002	ARM11 (ARMv6)
2004	Cortex-M (ARMv7)
2010	Cortex-A8 with 2GHz (ARMv7)
2012	Cortex-A50 (ARMv8)

http://www.arm.com/about/company-profile/milestones.php

Cortex family

- Cortex A for Application (relevant for HPC)
- Cortex M for embedded computing (Microcontroller)
- Cortex R for Real-time

Boards with ARM Cores

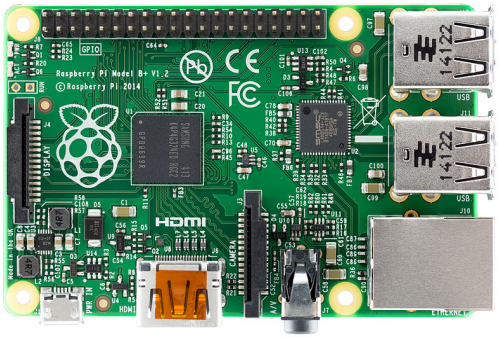


Figure: Raspberry Pi B+ with an ARMv6 Core(ARM11)[1]

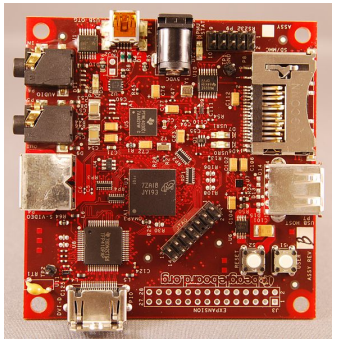


Figure: BeagleBoard big with an ARMv7(Cortex A8)[2]

- Features GPIO pins
- Very common boards
- Lots of software, hardware and OS available

[1] https://en.wikipedia.org/wiki/Raspberry_Pi

[2] https://en.wikipedia.org/wiki/BeagleBoard

Boards with ARM Cores

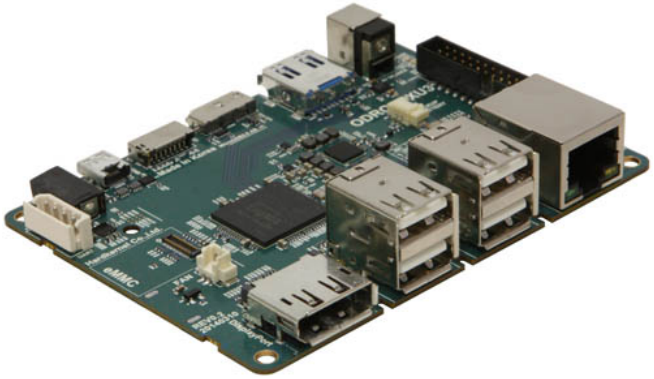


Figure: Odroid-XU3 with an ARMv7 Core(Cortex A15)[1]

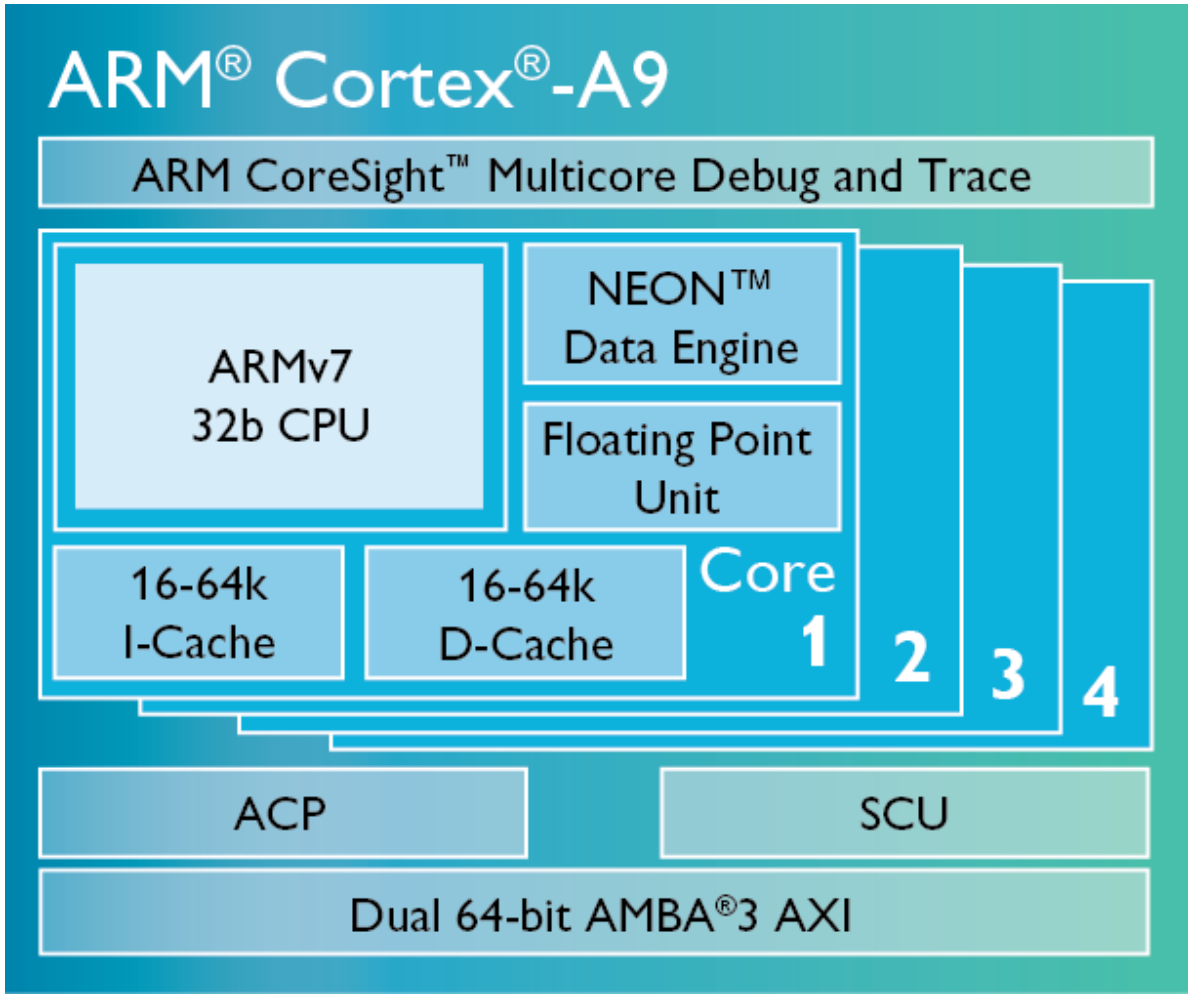
Figure: Apple A7 an ARMv8 Core[2]

- the more powerful ARM processors
- A7 currently used in iPhone 5S

[1] http://www.hardkernel.com/main/main.php

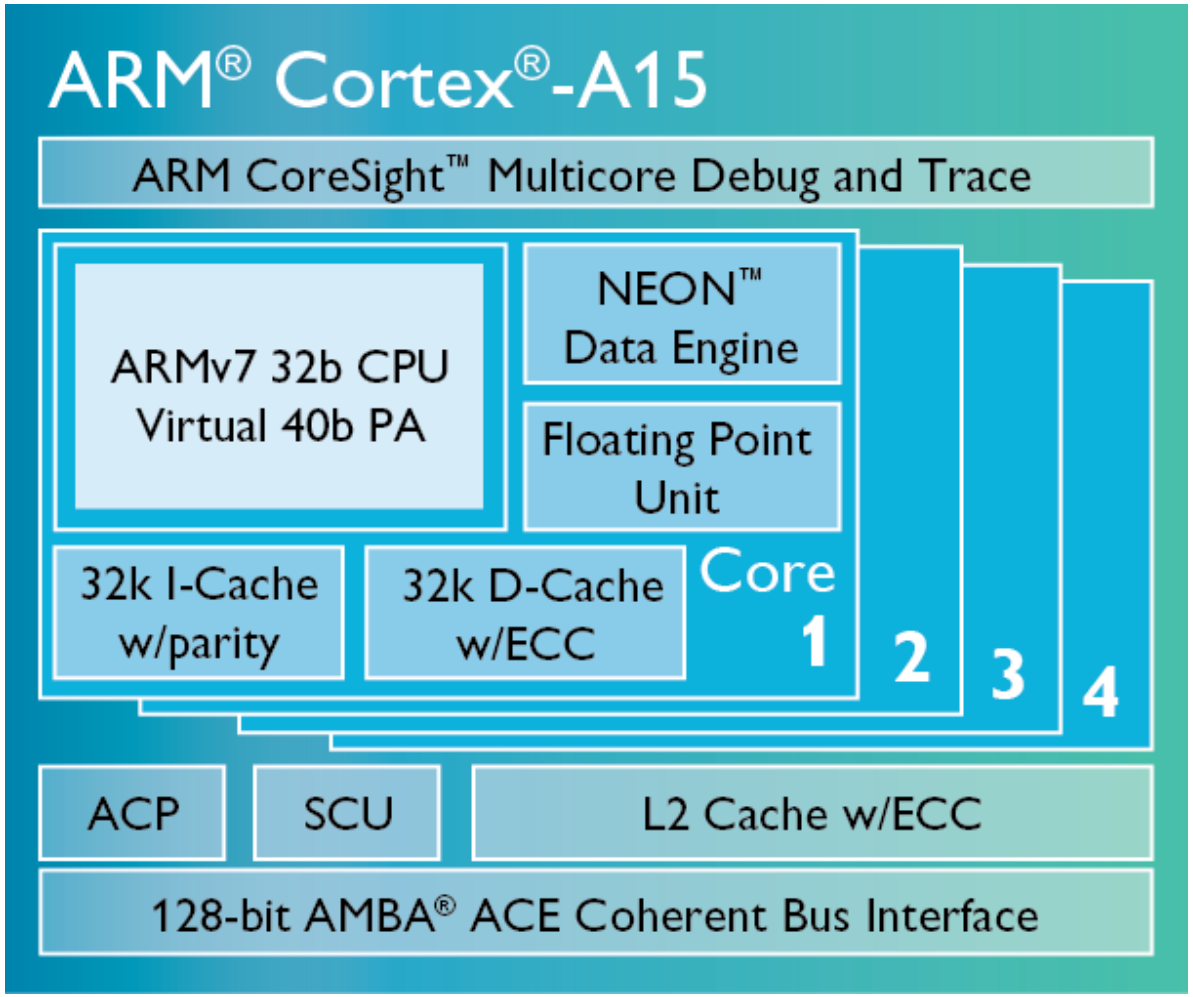
[2] https://en.wikipedia.org/wiki/Apple_A7

ARMv7 Cortex A9(2007)



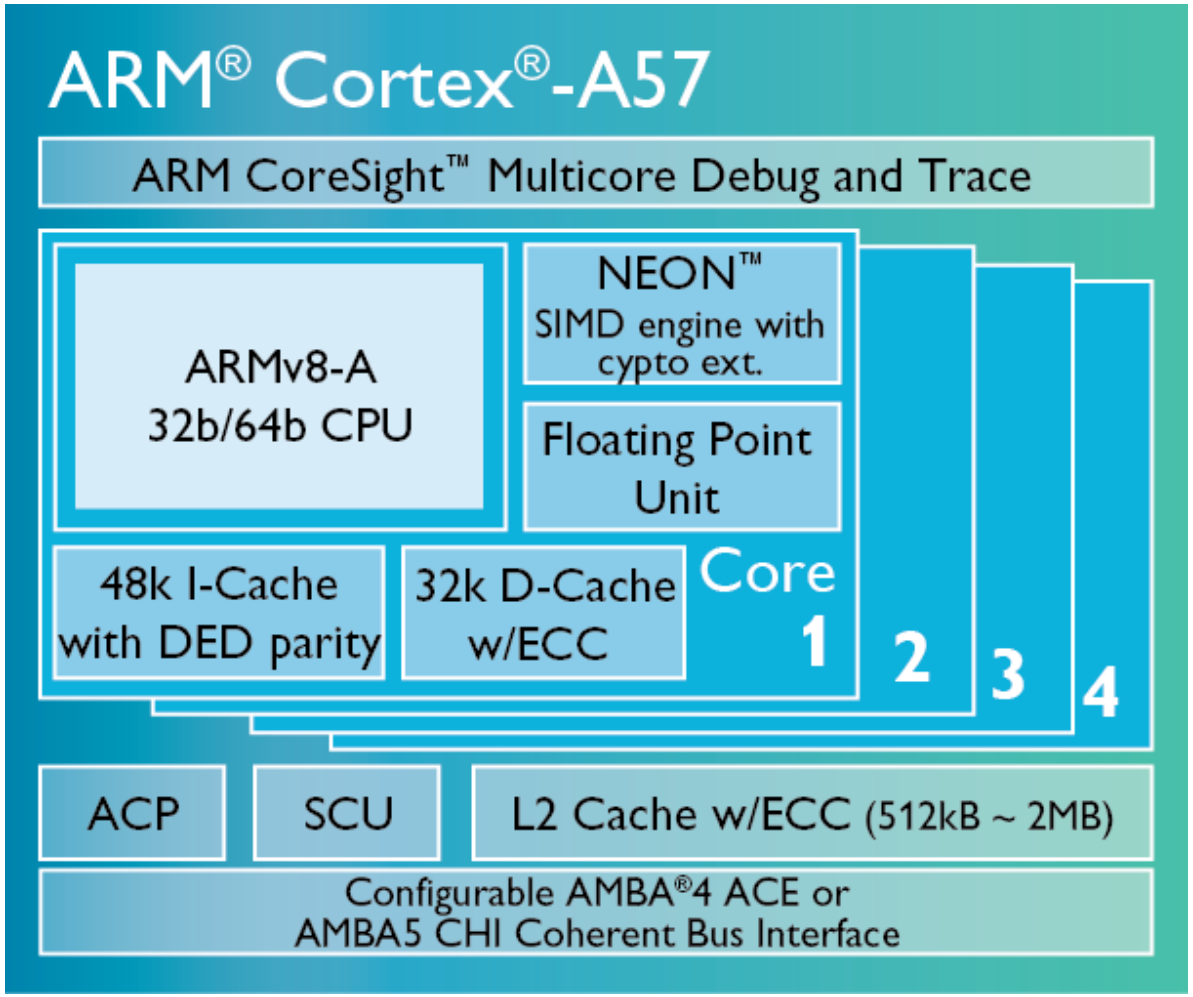
http://www.arm.com/products/processors/cortex-a/cortex-a9.php/

ARMv7 Cortex A15(2010)



http://www.arm.com/products/processors/cortex-a/cortex-a15.php

ARMv8 Cortex A57(2012)



http://www.arm.com/products/processors/cortex-a/cortex-a57-processor.php