ARM University
Worldwide Education Program

嵌入式系统联谊会
www.esbf.org.cn

Chang Ahead

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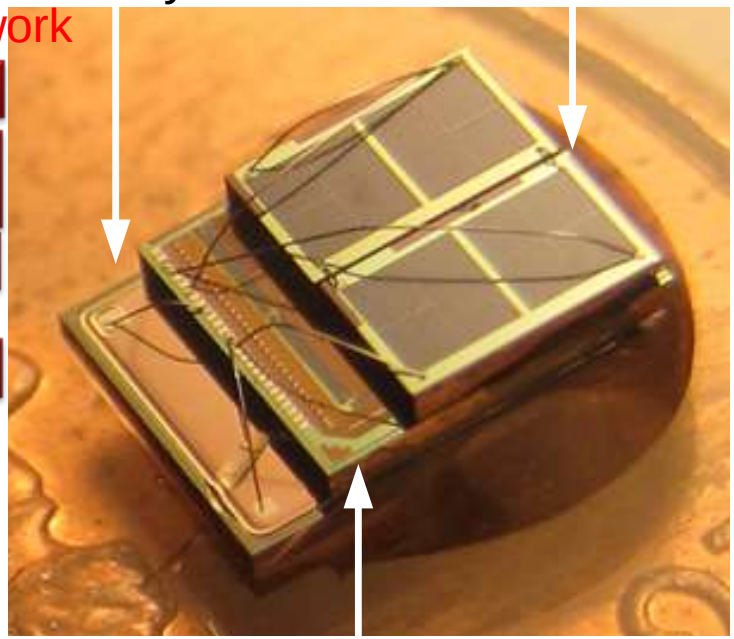
23rd November 2013

Specified Only for Embedded Salon

World's Smallest ARM Computer?

Wireless Sensor Network

- Sensors, timers
- Cortex-M0 +16KB RAM 65nm
  UWB Radio antenna
- 10 kB Storage memory ~3fW/bit
- 12µAh Li-ion Battery

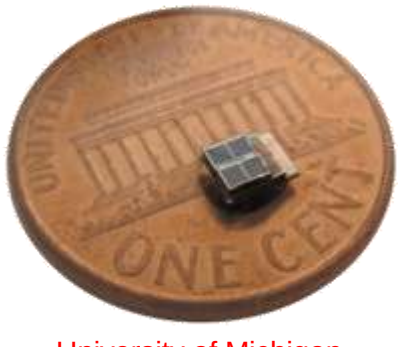


Processor, SRAM and PMU

A

Cortex-M0; 65¢

B



University of Michigan

Wirelessly networked into large scale sensor arrays

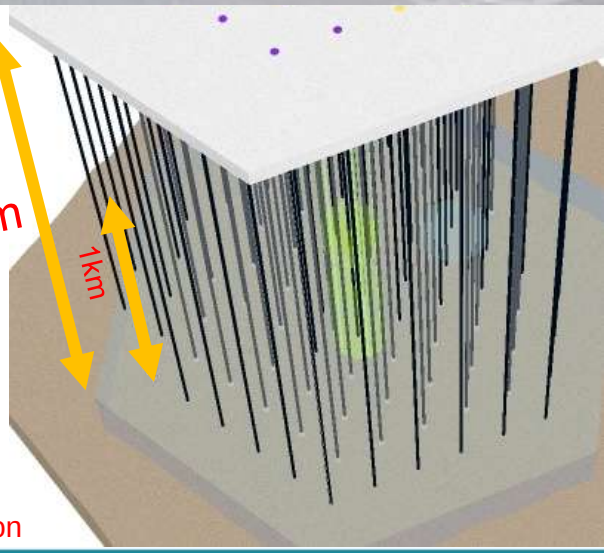
World's Largest ARM Computer?

4200 ARM powered
Neutrino Detectors

70 bore holes 2.5km deep

60 detectors per string
starting 1.5km down

1km^3 of active telescope



Work supported by the National Science Foundation and University of Wisconsin-Madison

Complex Low Power IOT Device

Antennas
NFC
GPS
RFID
Bluetooth LE

Capacitive Touch Button & Slider

Accelerometer

Magnetometer

Tactile Button

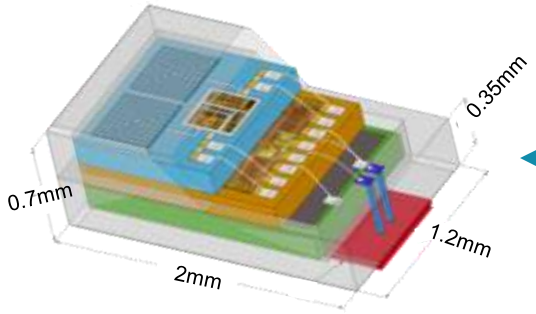
LED Indicator Ring

LCD e-paper Display

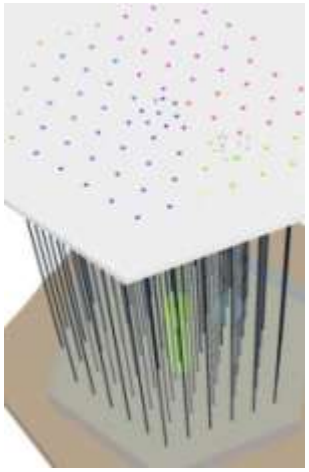
ARM MCU x 4
Main
BLE
Biometric
GPS

Fingerprint Sensor

ARM: from 1mm^3 to 1km^3?



1mm^3 — 1km^3



10¢ — $1000

Mobile Home Mobile Computing Server

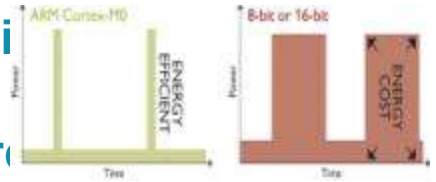
Embedded Consumer Enterprise PC HPC

The Architecture for the Digital World

Cortex-M processor solution

- **Energy efficiency**
  - Lower energy costs

Low power implementati
Sleep mode support
Wake-up Interrupt Contr
Increased intelligence at node



- **Ease of use**
  - Lower software costs

Broad tools and OS support
Binary compatible roadmap
CMSIS support
Pure C target

- **High performance**
  - Competitive products

32-bit RISC architecture
High efficiency processor cores
Integrated Interrupt Controller (NVI

- **Reduced system cost**
  - Lower silicon costs

Thumb®-2 code density
Area optimised designs
CoreSight support

The widest MCU platform portfolio

- Chose from 2,194 products – and the list keeps growing

freescale (495)	ST life.augmented (389)	Texas Instruments (272)
FUJITSU (266)	NXP (262)	nuvoTon (106)
Energy micro (86)	Cypress Perform (52)	Atmel (51)
Silicon Labs (50)	TOSHIBA (49)	Infineon (43)
SAMSUNG (29)	HOLTEK (19)	Microsemi (17)
Analog Devices (3)	accent (3)	sonix (2)

Listed parts on partners web as of end of November 2012

The Cortex-M Microcontroller Processors




Coherent architecture across all applications

Cortex-M0

"8/16-bit" applications

Lowest cost

Cortex-M0+

"8/16-bit" applications

Lowest power

Outstanding Energy efficiency

Cortex-M3

"16/32-bit" applications

Performance efficiency

Feature rich connectivity

Cortex-M4

"32-bit/DSC" applications

MCU plus DSP

Accelerated SIMD, FP & SP

Cortex-M

Energy Efficient Configurable Deterministic

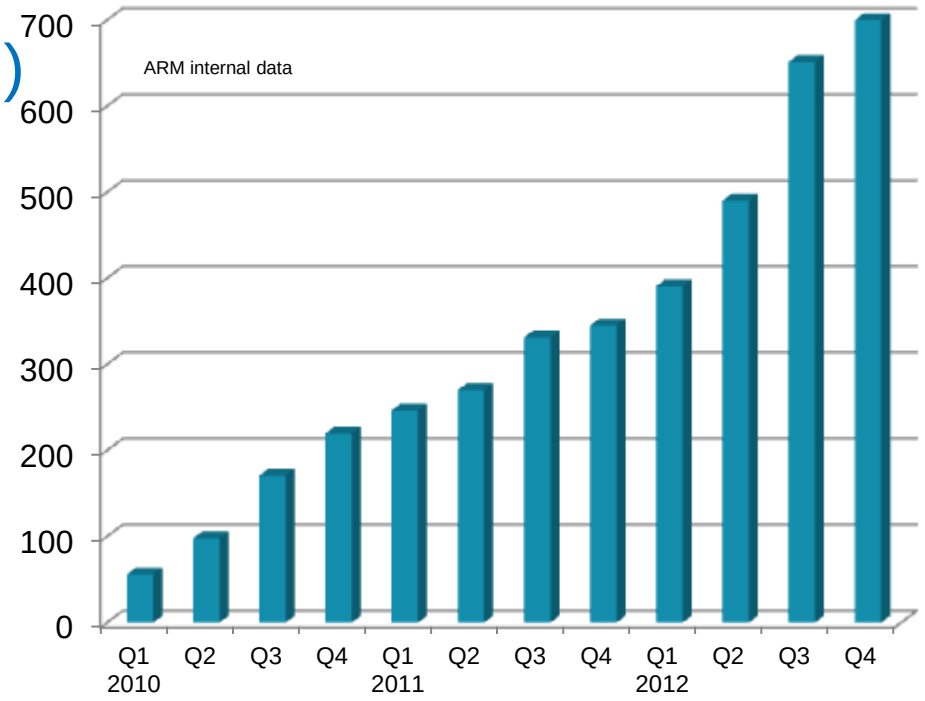
Ease of Use Low Silicon Area

WIDELY **ADOPTED MARKET PROVEN** HIGH VOLUME

ARM Cortex-M Reaching Beyond MCU

- Total Cortex-M volume
  - 2010 = 376M
  - 2012 = 2.2Bn (~6x growth)
- Cumulatively >3.5B Cortex-M processors shipped
- >160 Licensees
- Wireless, SoCs, Automotive
- Emerging markets
  - Sensors
  - MEMS
  - Power Management IC (PMIC)
  - Touch controllers
  - Connectivity - *Internet of Things (IoT)*

Total Cortex-M Shipments (Million Units)

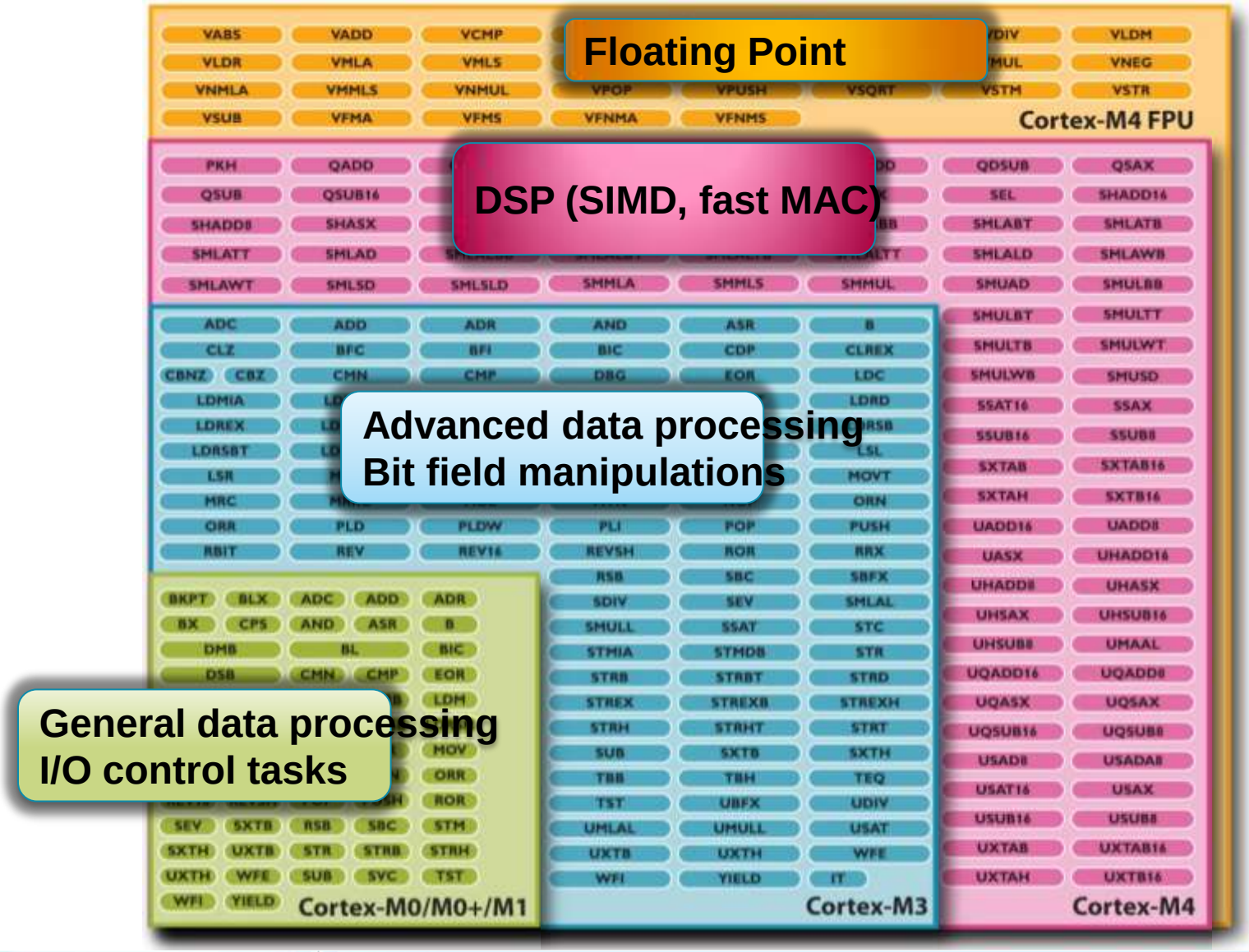


ZigBee Control your world

Wi Fi

Bluetooth

Powerful & scalable instruction set



Cortex-M feature set comparison

	ARM7TDMI	Cortex-M0	Cortex-M0+	Cortex-M3	Cortex-M4
Instruction set architecture	ARM, Thumb	Thumb, Thumb-2 System Instructions	Thumb, Thumb-2 System Instructions	Thumb + Thumb-2	Thumb + Thumb-2, DSP, SIMD, FP
DMIPS/MHz	0.72 (Thumb), 0.95 (ARM)	0.84	0.93	1.25	1.25
CoreMark/MHz		1.99	2.15	3.32	3.40
Bus interfaces	1	1	1 (+1 opt.)	3	3
Integrated NVIC	No	Yes	Yes	Yes	Yes
Number interrupts	2 (IRQ and FIQ)	1-32 + NMI	1-32 + NMI	1-240 + NMI	1-240 + NMI
Interrupt priorities	None	4	4	8-256	8-256
Breakpoints, Watchpoints	2 Watchpoint Units	4-0, 2-0	4-0, 2-0	8/2/0, 4/1/0	8/2/0, 4/1/0
Memory Protection Unit (MPU)	No	No	Yes (Option)	Yes (Option)	Yes (Option)
Integrated trace option (ETM or MTB)	ETM (Option)	No	MTB (Option)	ETM (Option)	ETM (Option)
Single Cycle Multiply	No	Yes (Option)	Yes (Option)	Yes	Yes
Hardware Divide	No	No	No	Yes	Yes
WIC Support	No	Yes	Yes	Yes	Yes
Bit banding support	No	System option	System option	Yes (Option)	Yes (Option)
Single cycle DSP/SIMD	No	No	No	No	Yes
Floating point hardware	No	No	No	No	Yes
Bus protocol	Use AHB bus wrapper	AHB Lite	AHB Lite	AHB Lite, APB	AHB Lite, APB
CMSIS Support	No	Yes	Yes	Yes	Yes

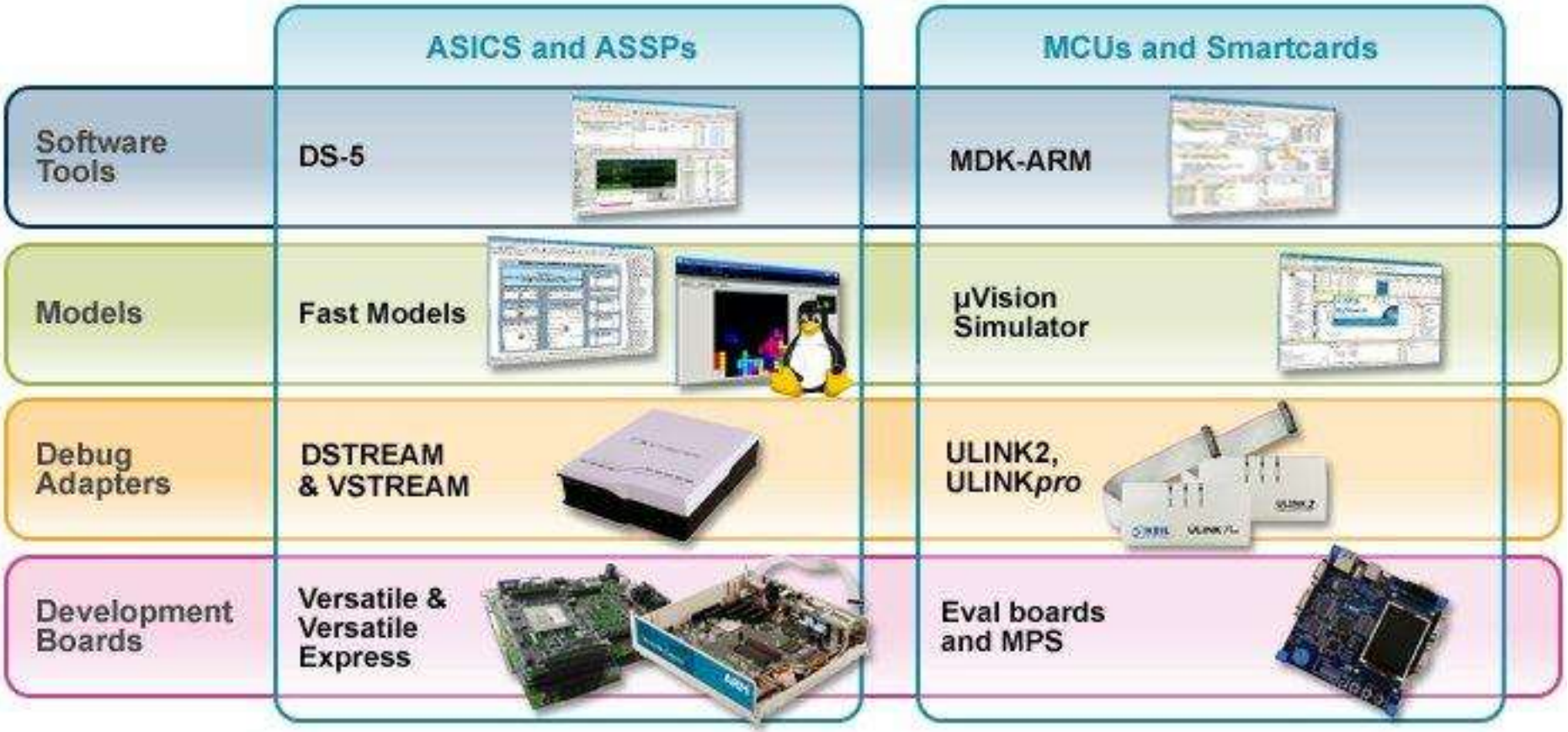
Cortex Microcontroller Standard (CMSIS)

- Abstraction layer for all Cortex-M processor based devices
  - CMSIS-CORE: API for Cortex-M processor and core peripherals
  - CMSIS-DSP : DSP Library with 61 function types for Cortex-M
  - CMSIS-SVD : XML system view description for peripherals
  - CMSIS-RTOS : API for RTOS integration

- Benefits to the embedded developer
  - Consistent software interfaces for silicon and middleware vendors
  - Simplifies re-use across Cortex-M processor-based devices
  - Reduces learning curve, development costs, and time-to-market

ARM Tools for the Entire Design Flow

- A summary of all ARM development tool products
- All are compatible with the Cortex-M family of processors



Cortex-M Tools Ecosystem

- ARM has an exceptionally broad ecosystem of 3rd parties supporting the Cortex-M profile processor family.

- Real-time Operating Systems
  - 26+ of the **world's leading** vendors

- IDEs and C/C++ compilers
  - 13+ of the **world's leading** vendors

- Debugger vendors
  - 21+ of the **world's leading** vendors

- … and these numbers are growing all the time


Change
Just Ahead

ARM University Program

The ARM University Program – Preparing Today's Students for Tomorrow's Technology

www.arm.com/university

Enabling Coursework and Research in SoC design, Computer Architecture, Embedded Systems Design, Microprocessors/controllers, Assembly Programming, Operating Systems, Application Development, Robotics, and Mechatronics

The World's Leading Semiconductor IP Supplier

Flagship offering: Lab-in-a-Box (LiB)

- LiB package based on Varieties of Silicon Vendors' boards
  - Efficient Embedded Systems Design and Programming (ARM Cortex M)
  - Package contains certain number of boards, 100 MDK Pro licences, in addition to a complete teaching material from ARM or inspection copy of textbook

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ARM MPD Lab-in-a-box

ARM MPD Lab-in-a-box project

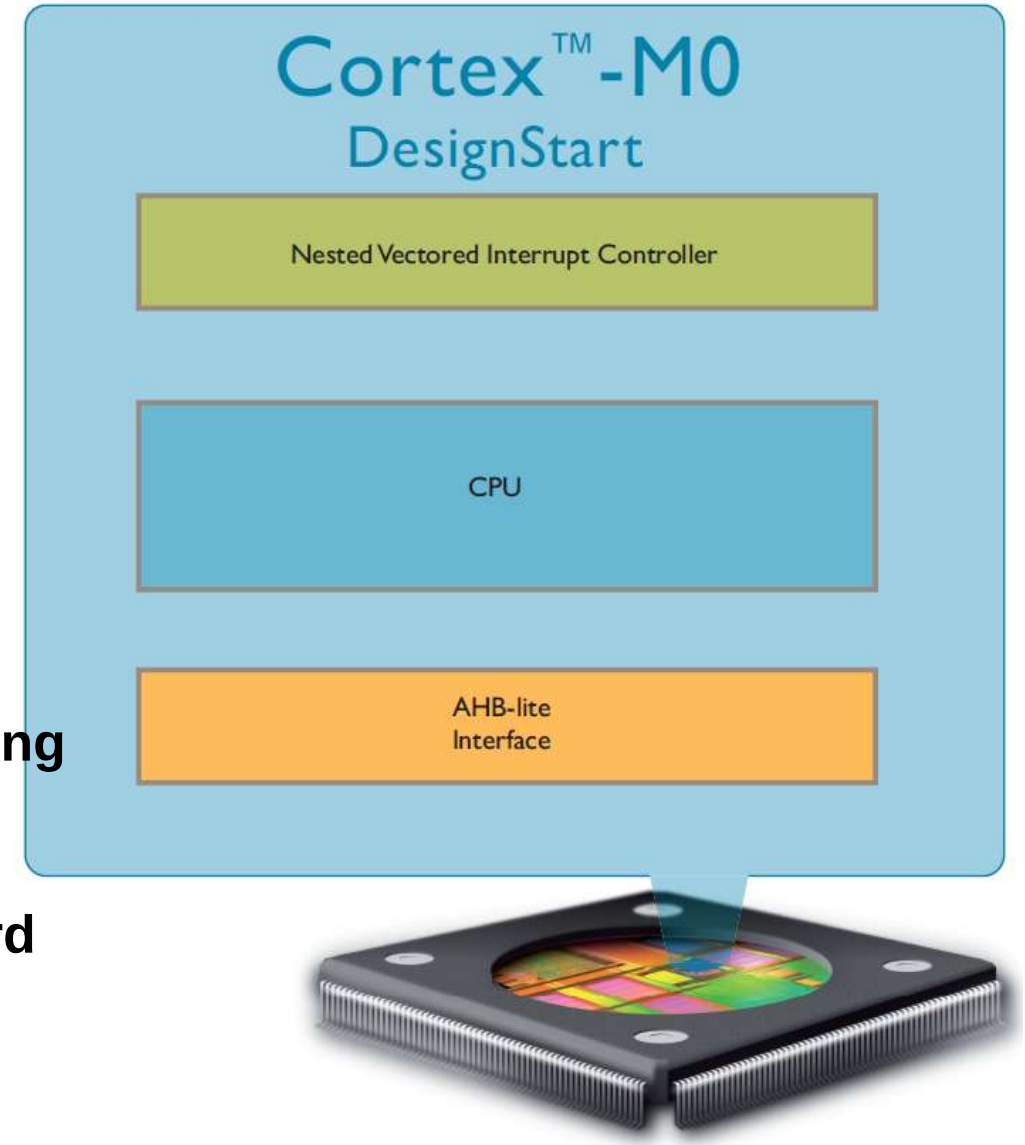
Undergraduate Students

- 12 tutorials for lab-in-a-box project – to complete and start promoting by April 2014 to Computer Sciences and Gaming Development Universities worldwide.
- The tutorials are based on Khronos standard OpenGL ES2.0 APIs for ARM Mali GPU devices:
  1. Build your 1st Android Application
  2. Graphics Set Up
  3. Render a Triangle
  4. Intro to Shaders I
  5. Intro to Shaders II
  6. 3D and the Camera
  7. Textures
  8. Fonts
  9. Lighting
  10. Particle effects
  11. Shadows
  12. Bump mapping
- Wrap up module
  - Unity Game Engine for Mali GPUs

Cortex-M0 DesignStart Processor IP

Cortex
Low-Power Leadership from ARM

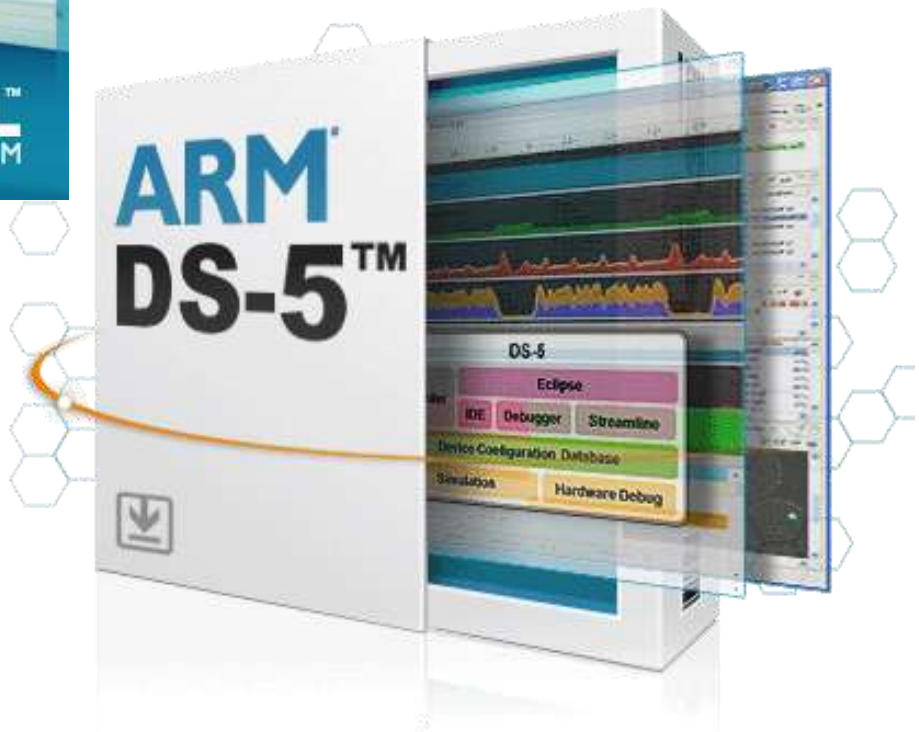
DesignStart™
Online Access to ARM IP



- **A real ARM core for teaching and research!**
- **Labs based on FPGA board**

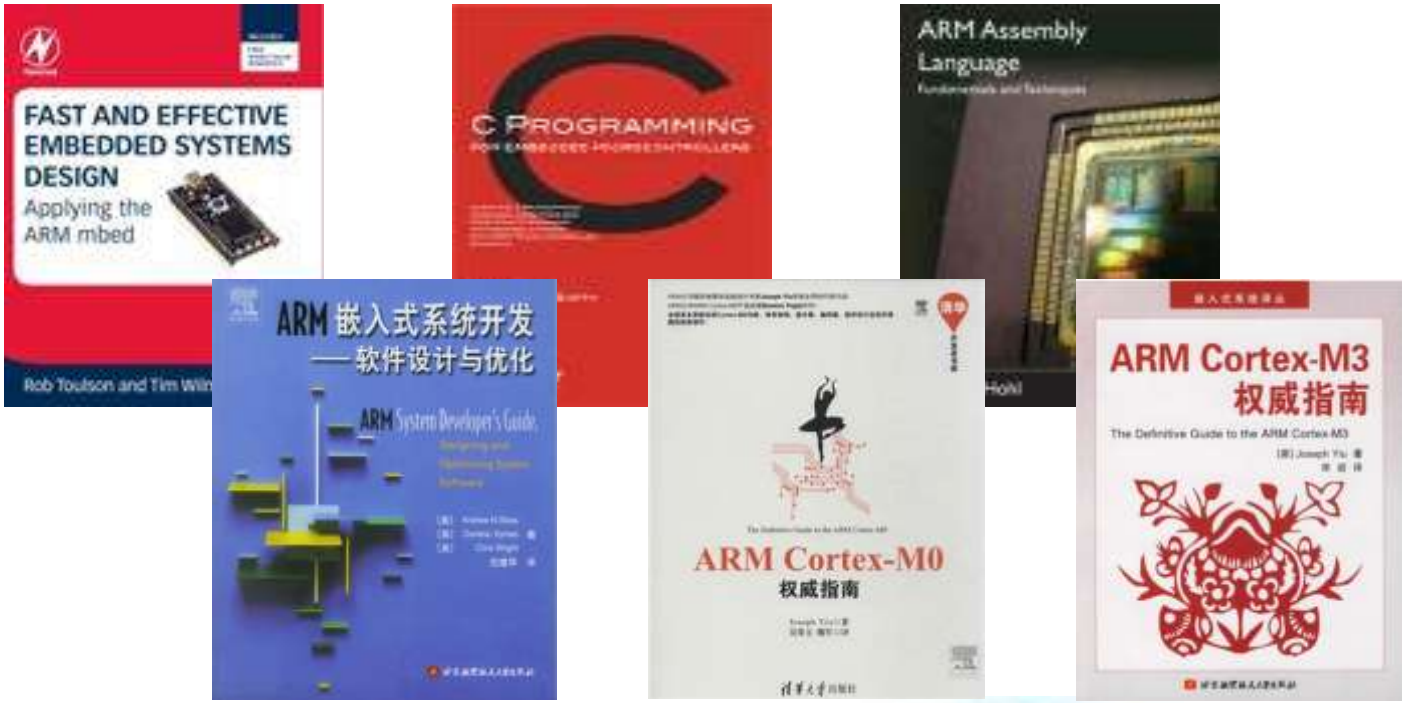
ARM University Program (AUP) Partners

Software Tools for Universities



- **Optimised programming tools from ARM**

Teaching Materials and Textbooks



- Free **textbook** evaluation copies from publishers
- **Teaching and Lab materials** at www.arm.com/university.

AUP Activities – Faculty Workshops

AUP Activities –Seminars/Conferences

AUP Activities – Students Contests

AUP Registration

- To keep up with AUP offerings and ARM developments overall, register to the ARM University Programme online:

- Tell us about your ARM-based activities and feedback on our various offerings

The Future in Our Hands