Applications & Tools

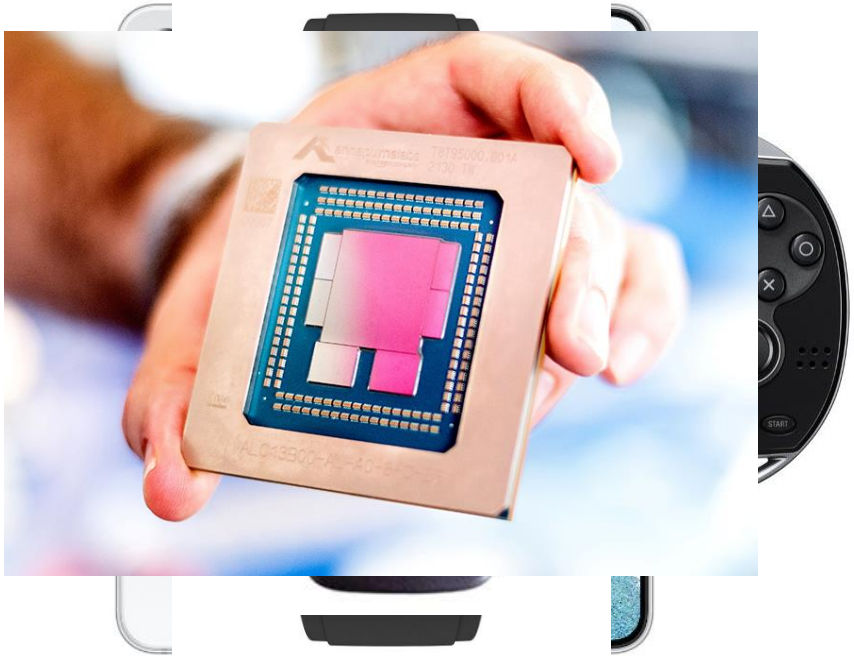
Introduction

- The ARM processor was first developed (between 1983 and 1985) by Acorn Computers, Ltd., based in Cambridge (UK).
- ARM designers were heavily influenced by Berkeley RISC I.
- In 1990, ARM Ltd. was founded by Acorn, Apple and VLSI.
- Several versions of ARM processors were designed in the following years.
- Today, ARM cores are widely popular among SoC designers, mainly because they show a very good tradeoff between performance and power consumption.
- ARM does *not* manufacture silicon
- More information about ARM on the web site:
  - http://www.arm.com/aboutarm/

A few iconic products based on Arm Architecture

Some of them with processors developed by local Arm team

- Nokia 3310 (2000)
  - ARM7TDMI (150-250MHz)
- Playstation Vita (2011)
  - Cortex-A9 MP Core
- Galaxy watch 4 (2018)
  - Cortex-A55 (1.18Ghz) – GPU Mali G68
- Samsung Galaxy S22 (2022)
  - Cortex-X2 (3GHz) + Cortex-A710 + Cortex-A510
- Graviton3 (2020)
  - Neoverse-V1

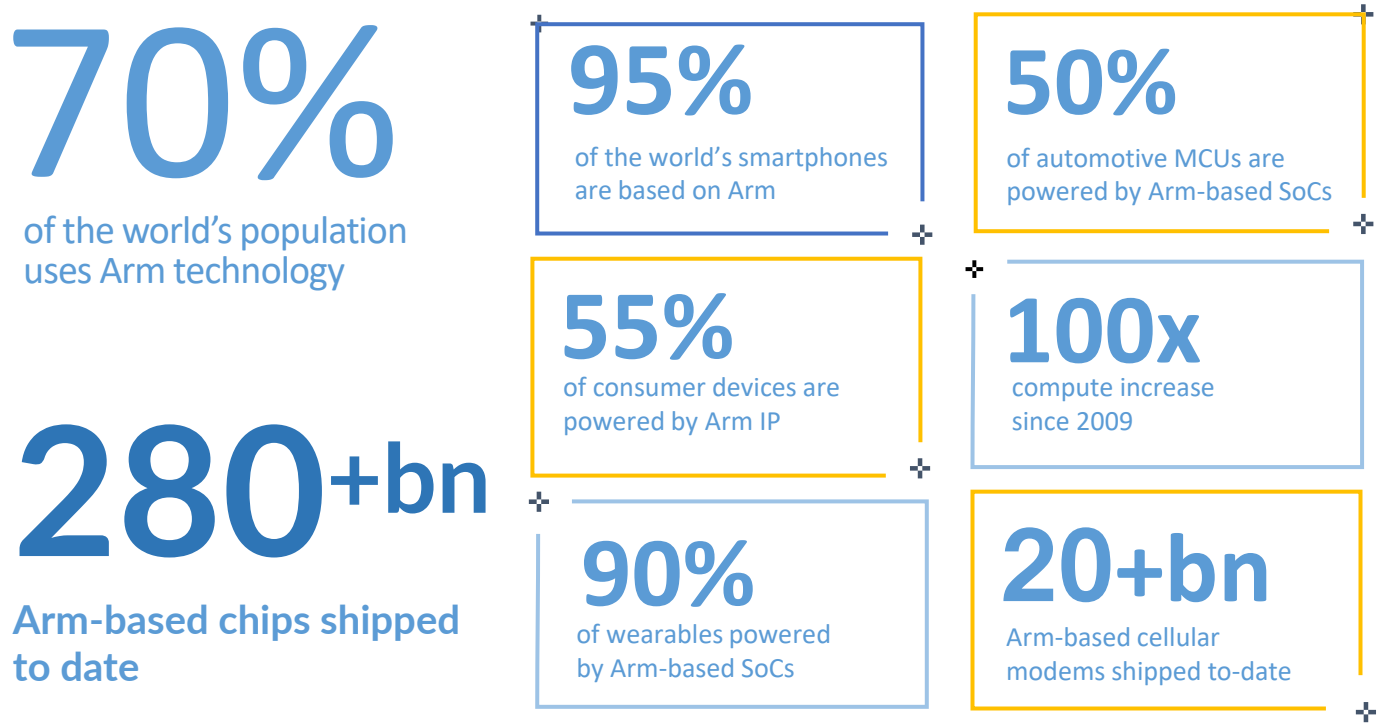


ARM Offices Worldwide

ARM processors

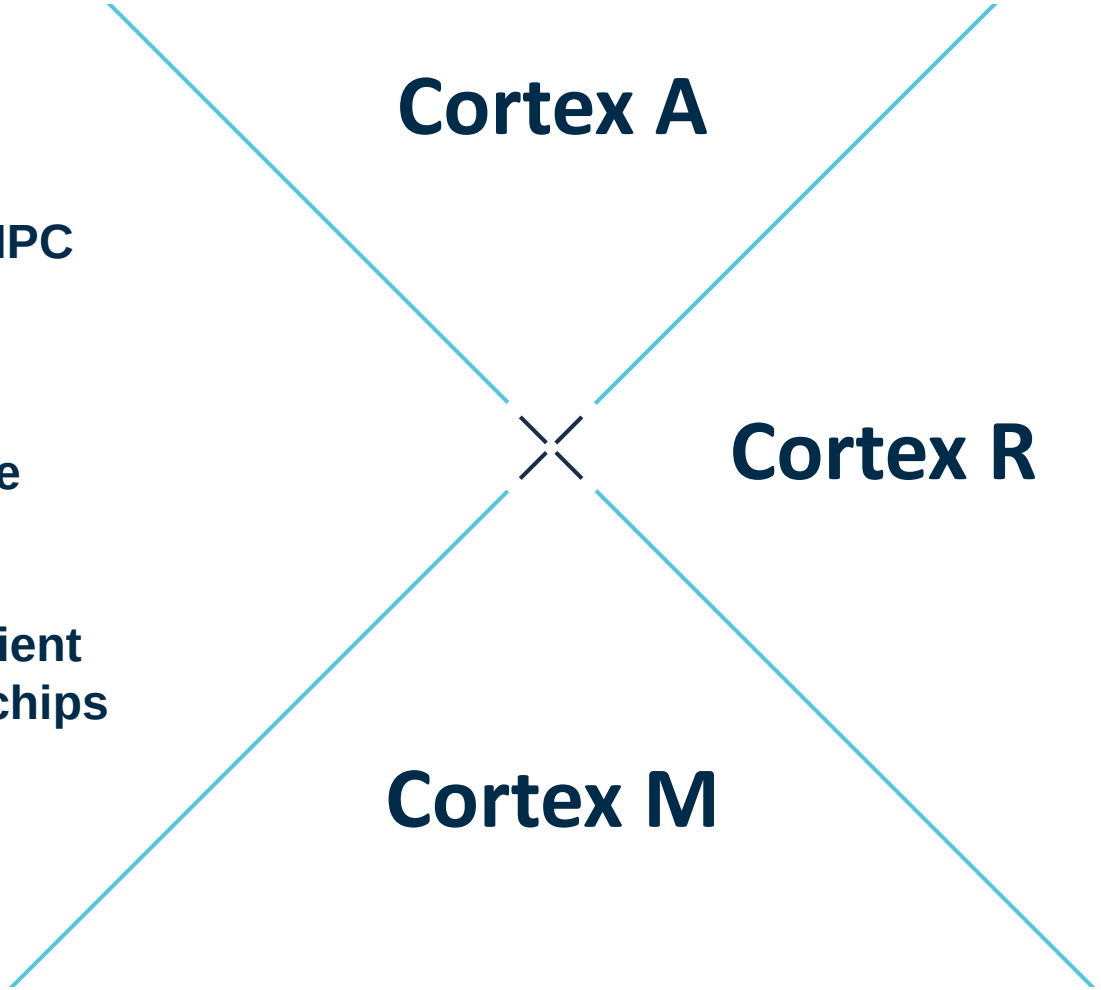
- They are mainly sold as cores, to be used for integration in Systems on Chip (SoCs).
- Cores can be
  - *Hard cores*: ARM provides a physical layout implemented in a given technology
  - *Soft cores*: ARM provides a high-level description that can be then synthesized to any technology by the designer.
- In a few cases, ARM processors have been delivered as stand-alone devices.

Arm is everywhere

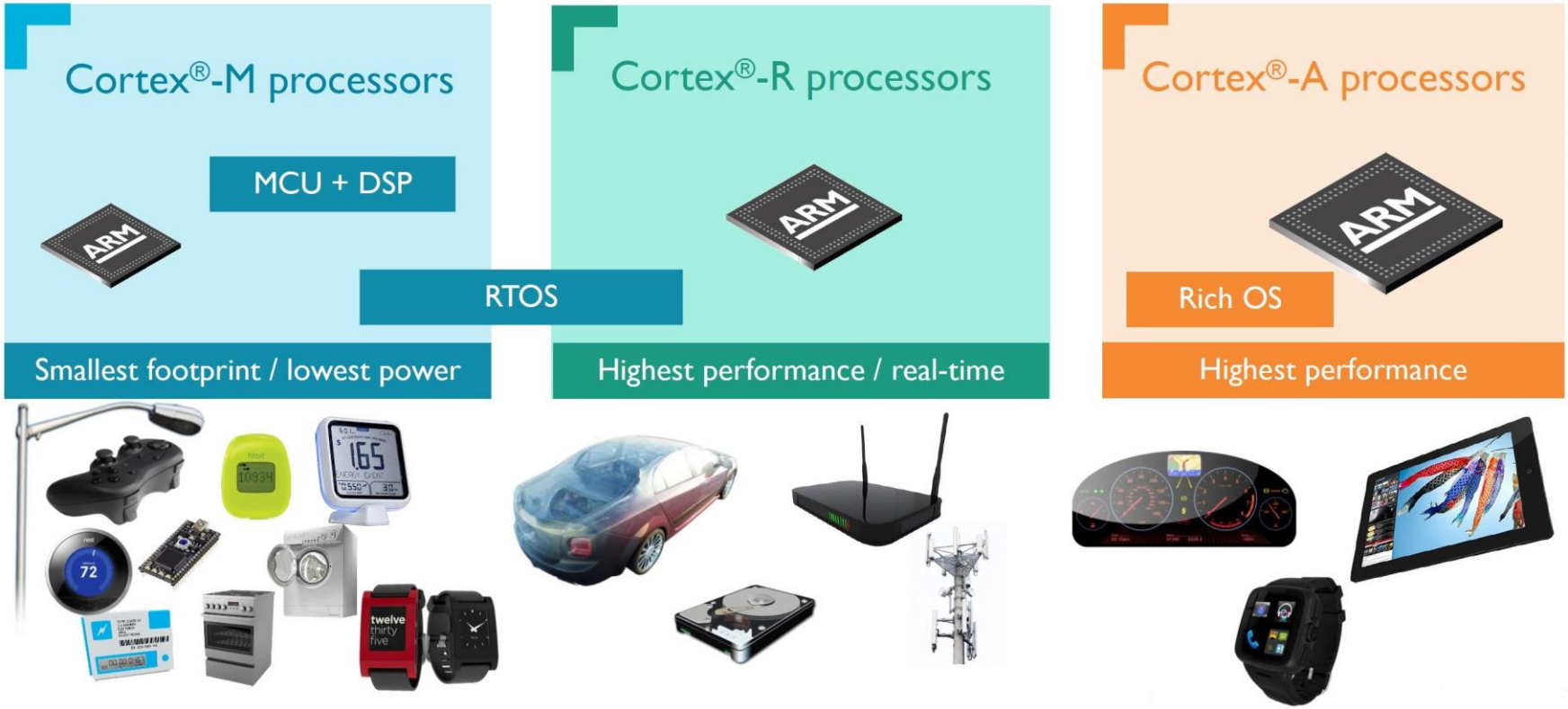


Arm processor families

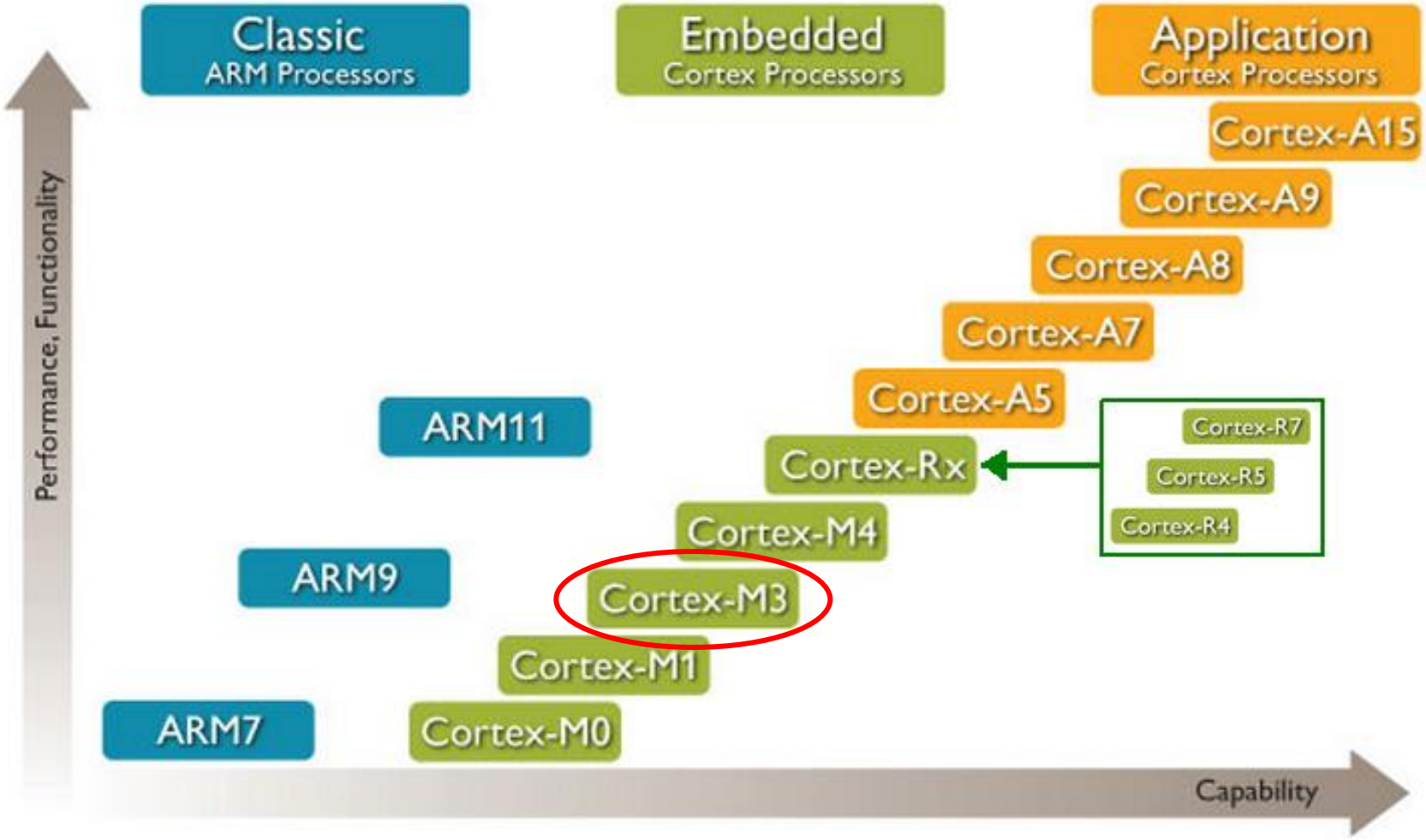
- **Application-Class CPU**
  - **Smartphones**
  - **Datacenters/Cloud/HPC**
- **Real Time Class CPU**
  - **Brake systems**
  - **Avionics, Automotive**
  - **Medical devices**
- **Embedded Energy efficient**
  - **Embedded in other chips**
    - **ASICs**
    - **Microcontroller**
    - **IoT**



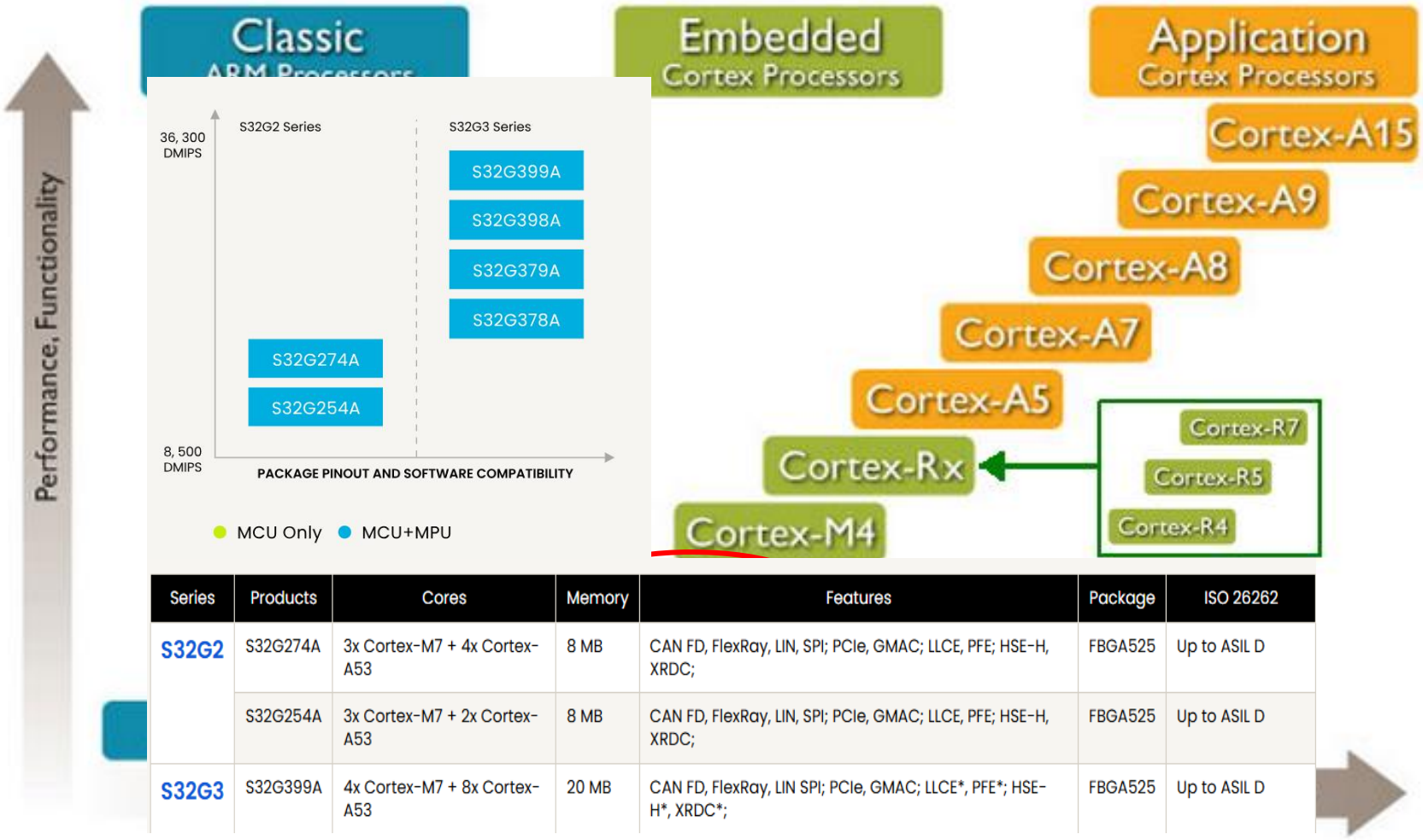
Arm processor families



ARM processors



ARM processors



Series	Products	Cores	Memory	Features	Package	ISO 26262
S32G2	S32G274A	3x Cortex-M7 + 4x Cortex-A53	8 MB	CAN FD, FlexRay, LIN, SPI; PCIe, GMAC; LLCE, PFE; HSE-H, XRDC;	FBGA525	Up to ASIL D
	S32G254A	3x Cortex-M7 + 2x Cortex-A53	8 MB	CAN FD, FlexRay, LIN, SPI; PCIe, GMAC; LLCE, PFE; HSE-H, XRDC;	FBGA525	Up to ASIL D
S32G3	S32G399A	4x Cortex-M7 + 8x Cortex-A53	20 MB	CAN FD, FlexRay, LIN SPI; PCIe, GMAC; LLCE*, PFE*; HSE-H*, XRDC*;	FBGA525	Up to ASIL D

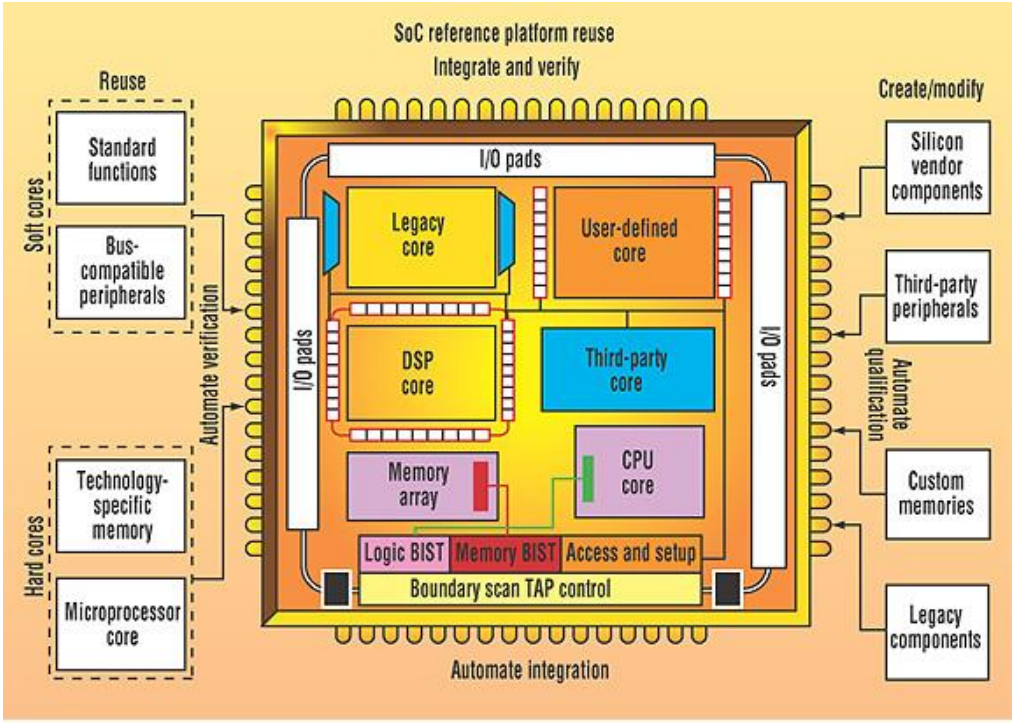
infineon
XILINX
ALL PROGRAMMABLE™
cadence
Mentor
A Siemens Business
SYNOPSYS®
Silicon to Software™
IBM
Windows Embedded
ubuntu
redhat
Green Hills SOFTWARE
vmware
KEIL™
Tools by ARM

ARM world

- ARM architecture embedded in System-on-chip (SoC)
- ARM Operating Systems
- ARM Compile – Support – Debug tools

System-on-Chip (SoC)

- SoCs are entire systems integrated in a single piece of silicon
  - They are composed of modules called **Embedded Cores**.



1. This diagram shows a usual SoC derivative built from a reuse platform in which over 70% of the design content could come from reuse.

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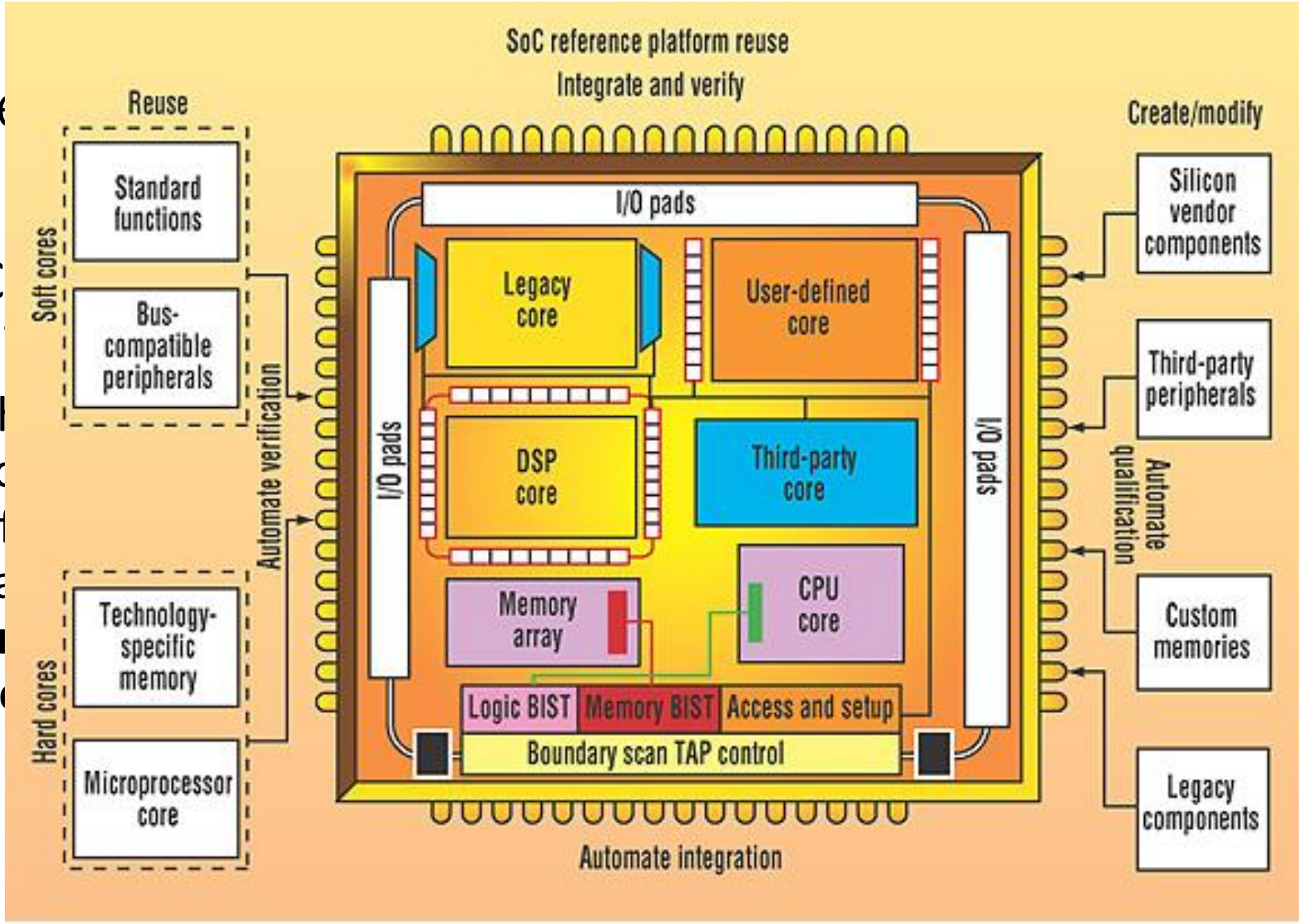

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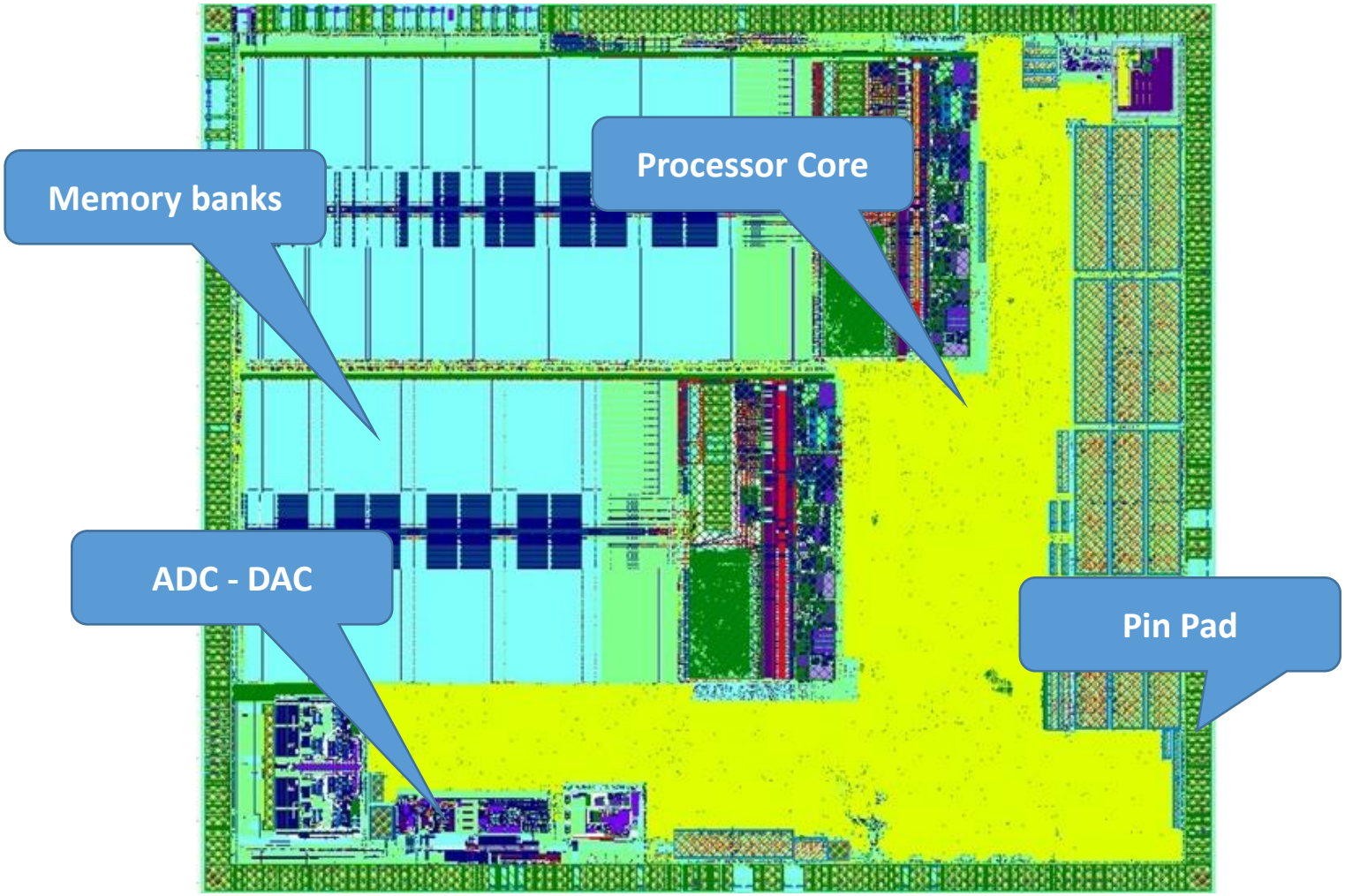
SoC layout example



ARM-based commercial SoCs

- *SAMSUNG:* http://www.samsung.com/global/business/semiconductor/products/mobilesoc/Products_ApplicationProcessor.html
  - http://pdf.datasheetcatalog.com/datasheet2/e/0lrp9fdj0zyd6e2k2e8ej8lkzupy.pdf (page 35)
- *NXP:* http://www.standardics.nxp.com/microcontrollers/
  - http://www.nxp.com/documents/data_sheet/LPC1769_68_67_66_65_64_63.pdf (page 6)
- *STMicroelectronics:* http://www.st.com/mcu/
  - http://www.st.com/st-web-ui/static/active/en/resource/technical/document/datasheet/CD00067905.pdf?s_searchtype=keyword (page 8)
  - http://www.st.com/mcu/contentid-34-86-STR710_EVAL.html
- …and many others…

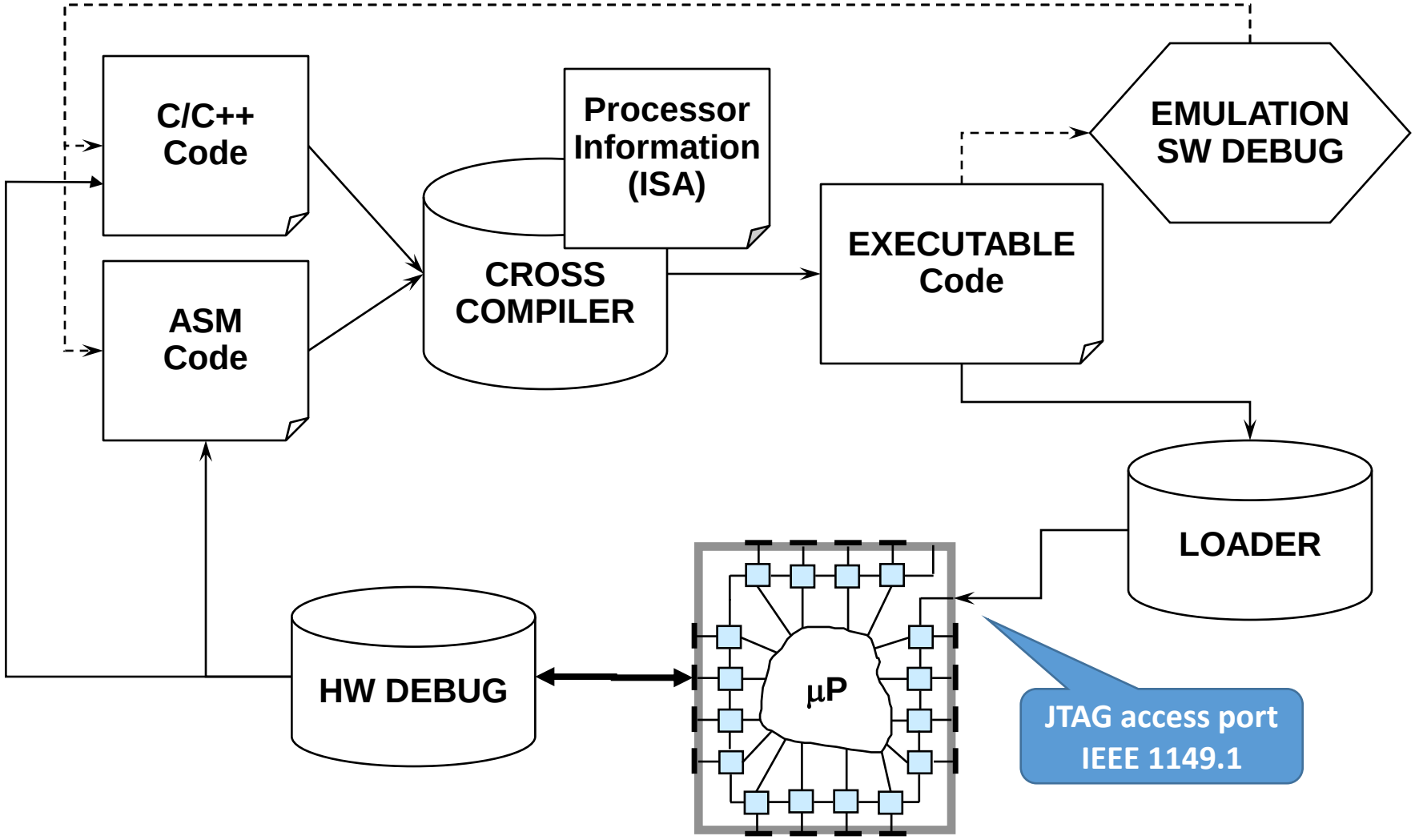
ARM compliant Operating Systems

- Microsoft Windows CE: http://www.microsoft.com/presspass/press/2002/sep02/09-18armsummitpr.mspx (old news removed)
- Linux: *many releases*
  - http://www.debian.org/ports/arm/
  - plenty of kernel to be customized
  - WIKI for problem solving

All of them requires a *bootloader* to be launched

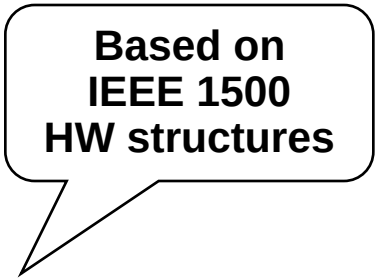
Das U-Boot: http://sourceforge.net/projects/u-boot/

Tool chain


C/C++
Code
ASM
Code
Processor
Information
(ISA)
CROSS
COMPILER
EXECUTABLE
Code
EMULATION
SW DEBUG
LOADER
HW DEBUG
µP
JTAG access port
IEEE 1149.1

ARM Tool chain

- CROSS-COMPILATION/EMULATION/SW DEBUG
  - WINDOWS: http://www.keil.com/
  - LINUX: http://www.codesourcery.com/gnu_toolchains/arm
- LOADING TOOLS
  - Ad-hoc tools released with products:
    - http://www.keil.com/
  - Generic and customizable tools
    - OPENWINCE: http://openwince.sourceforge.net/
- HW DEBUG TOOLS
  - Based on internal debug structures such as ***Embedded ICE***
    - http://infocenter.arm.com/help/index.jsp?topic=/com.arm.doc.dai0201a/index.html



What do we learn in this part of the course

- ARM assembly principles
  - Instruction Set Architecture
  - C + ASM programming by following ABI standards
  - System-on-Chip level programming including
    - Peripheral management
    - clock and power modes management
- Internal, SW and HW interrupts management
  - Exceptions due to unexpected execution flaws
  - SW interrupts towards system call understanding
  - HW interruptions
    - Possible sources of hw interrupt including internal modules (i.e., timers) and external evants (i.e., button pression)
    - Interrupt controller behavior
- Extended system on-board features.

Case of study

ARM V7-M Architecture

- **Landtiger board**
  - Based on a NXP system-on-chip **LPC1768** including a ARM 32-bit Cortex-M3 Microcontroller with a full set of on-chip peripheral cores
  - Mounting several additional devices and connectors on board
- KEIL uVision software
  - Trial version with 32K code limitation
  - Full use of the debugging features
  - Very accurate timing calculation
- HW debug enabled by an additional component called real-view, which implements a ULINK2 jtag based connection.

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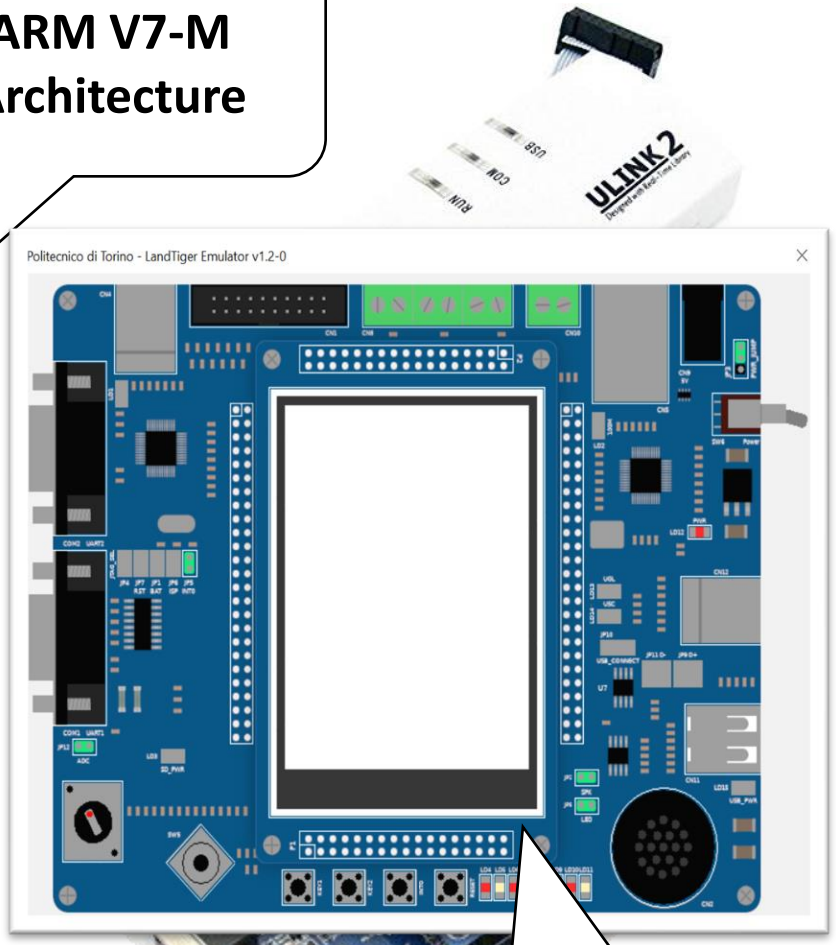

Board Emulation system