



Applications & Tools

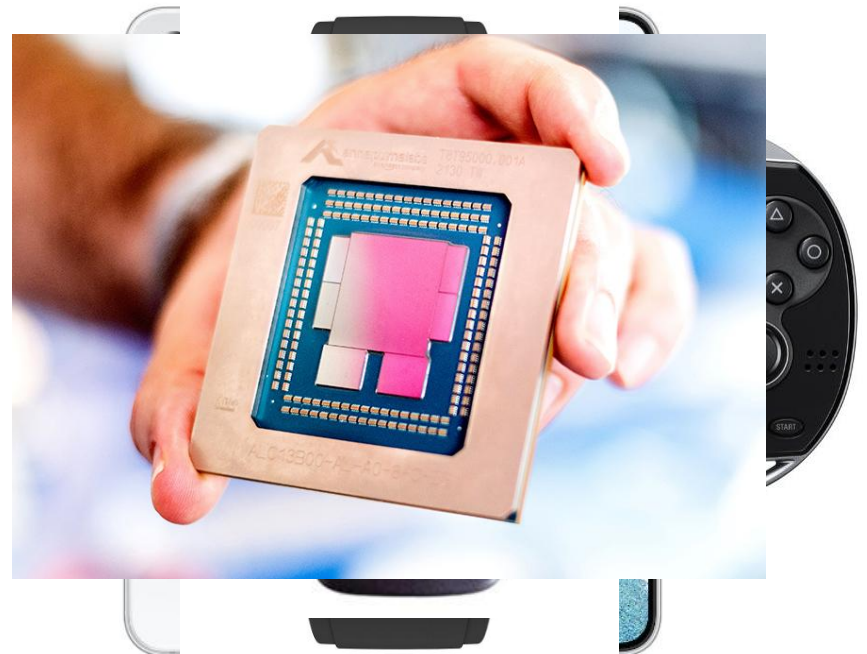
Introduction

- 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

70%

of the world's population
uses Arm technology

280+bn

Arm-based chips shipped
to date

95%

of the world's smartphones
are based on Arm

55%

of consumer devices are
powered by Arm IP

90%

of wearables powered
by Arm-based SoCs

50%

of automotive MCUs are
powered by Arm-based SoCs

100x

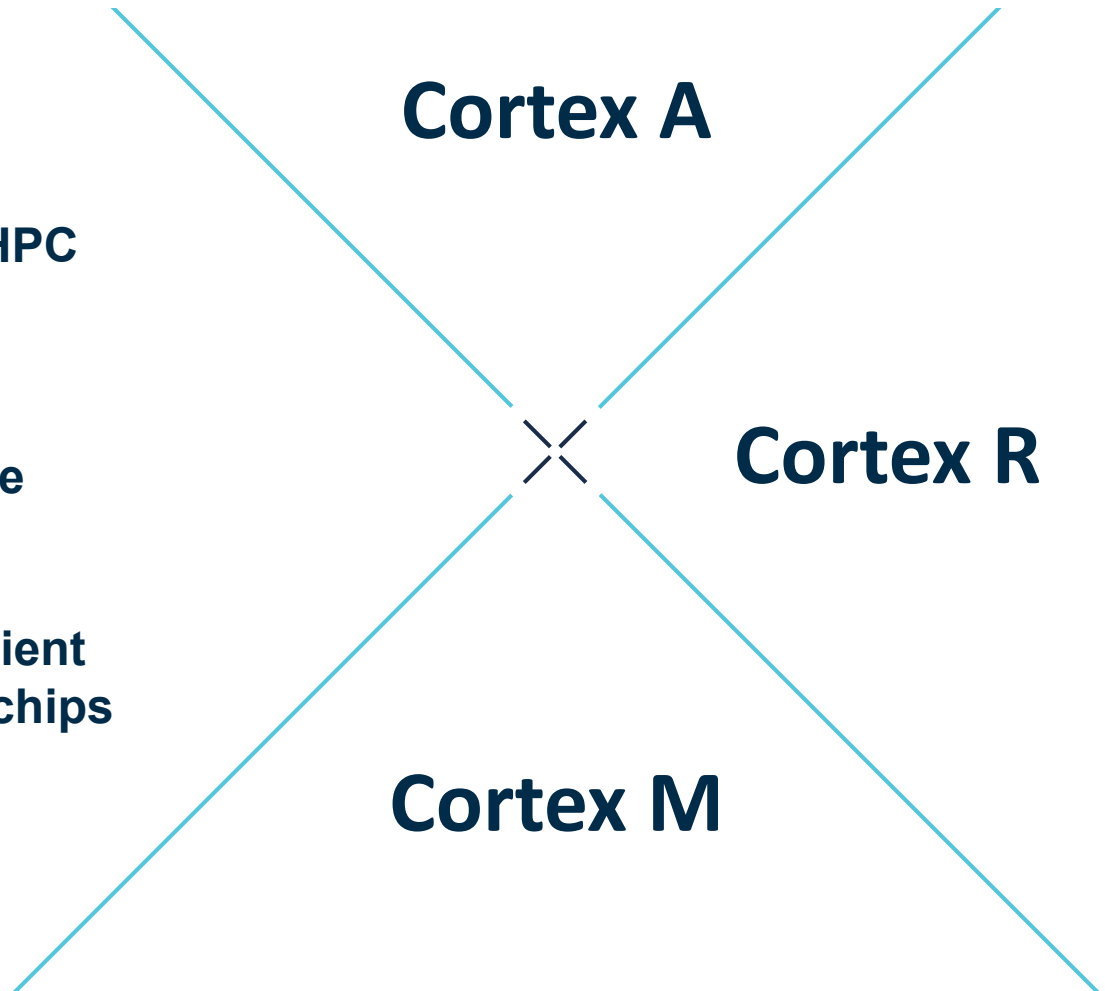
compute increase
since 2009

20+bn

Arm-based cellular
modems shipped to-date

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

Cortex[®]-M processors

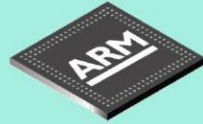
MCU + DSP

RTOS

Smallest footprint / lowest power



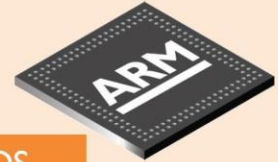
Cortex[®]-R processors



Highest performance / real-time



Cortex[®]-A processors

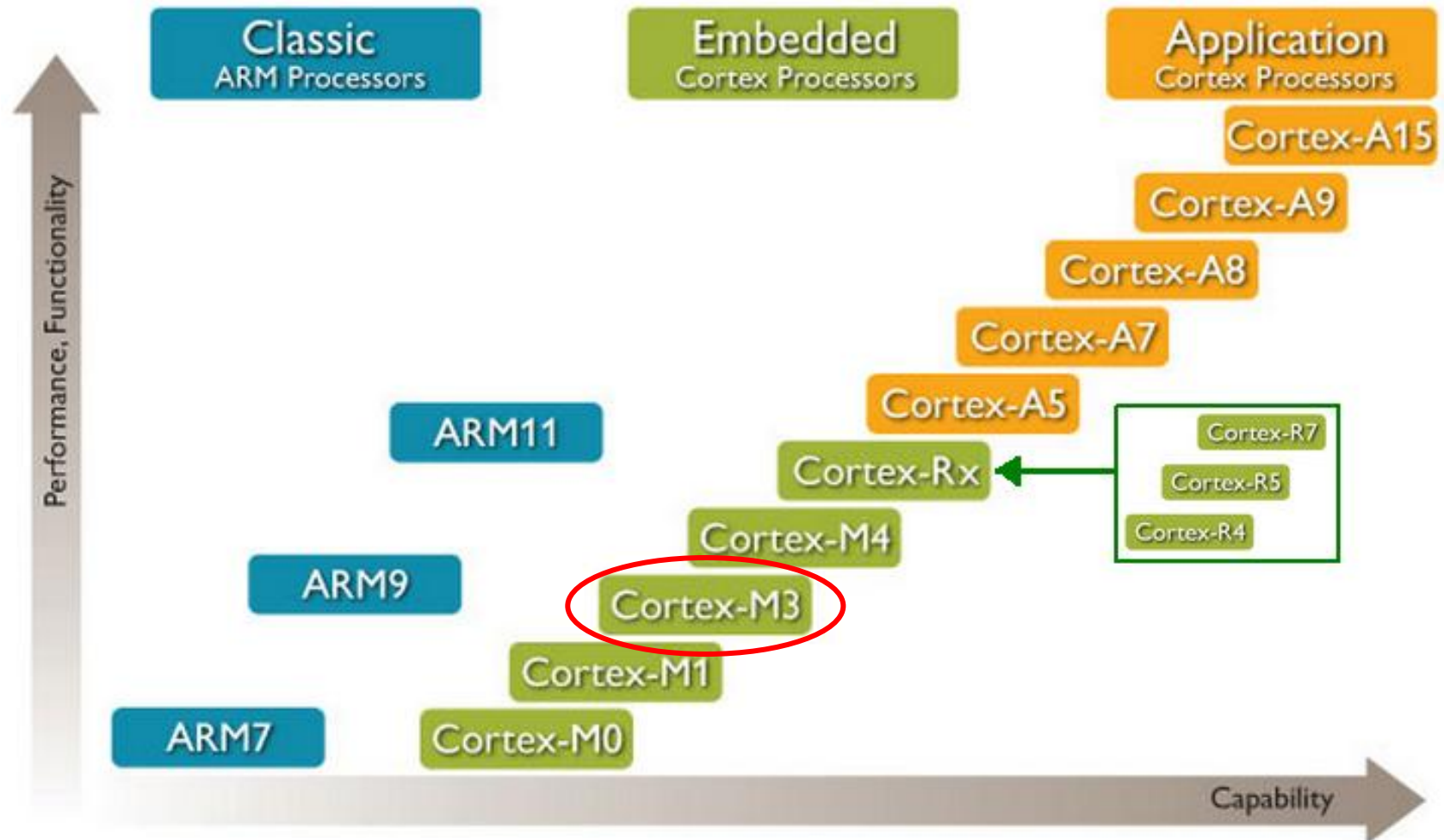


Rich OS

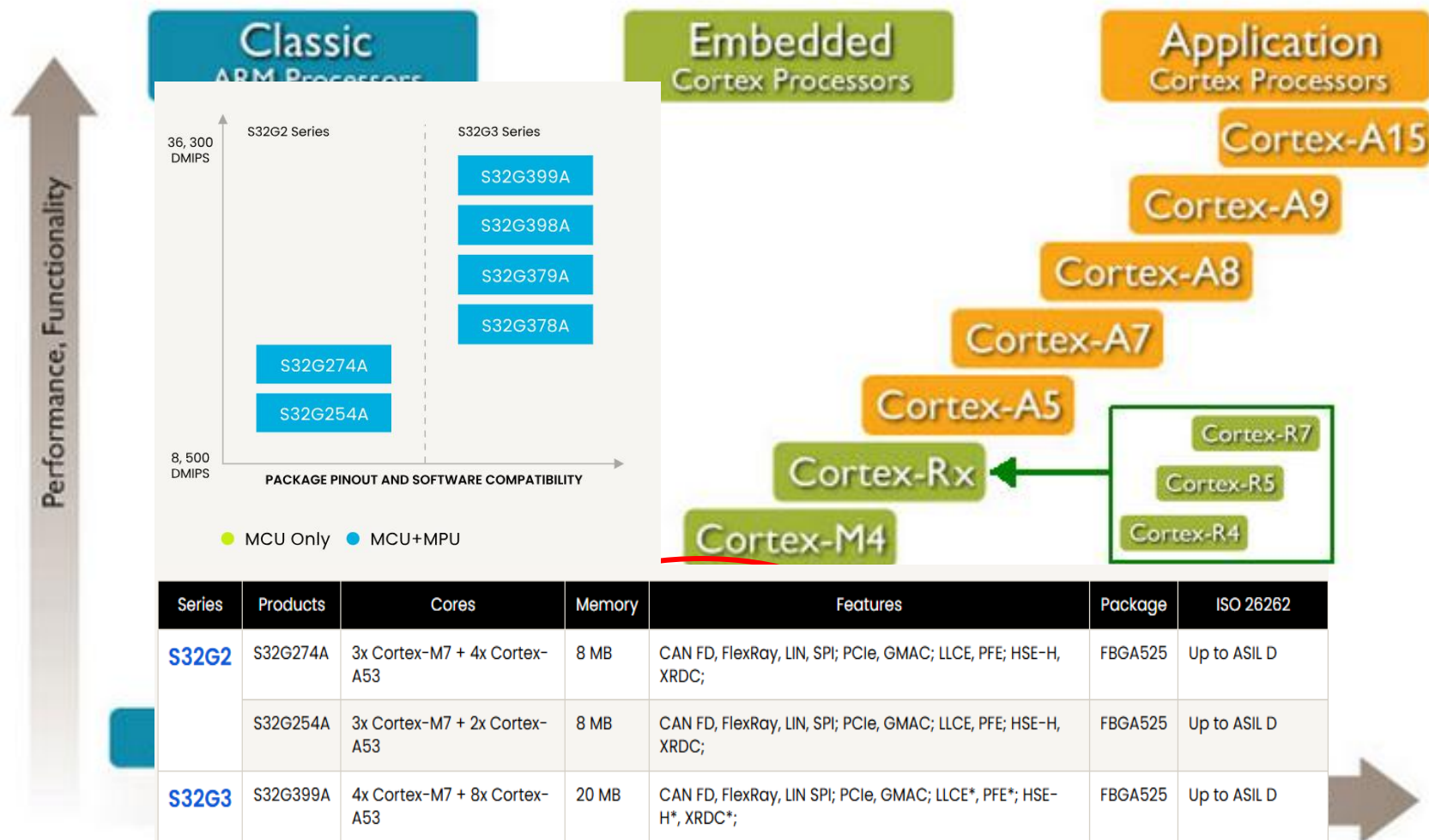
Highest performance



ARM processors



ARM processors



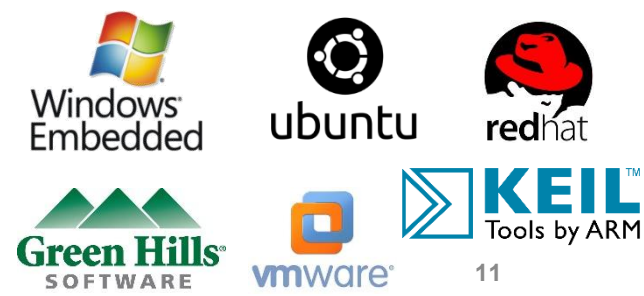
Silicon Partners



Design Support Partners



Software, Training and Consortia Partners

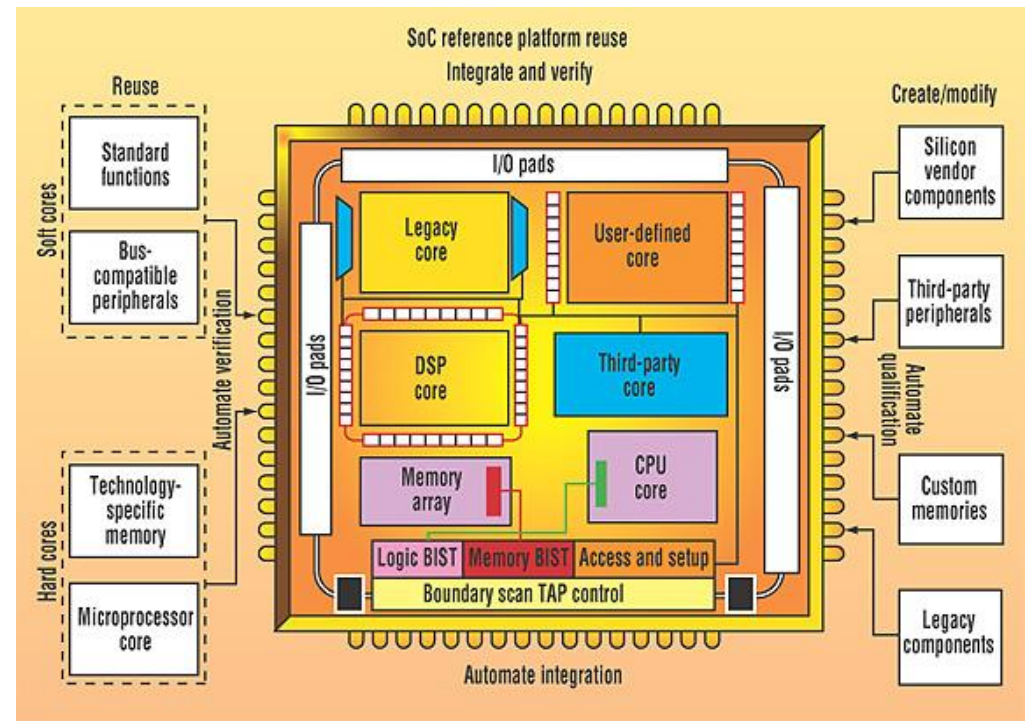


ARM world

- 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**.

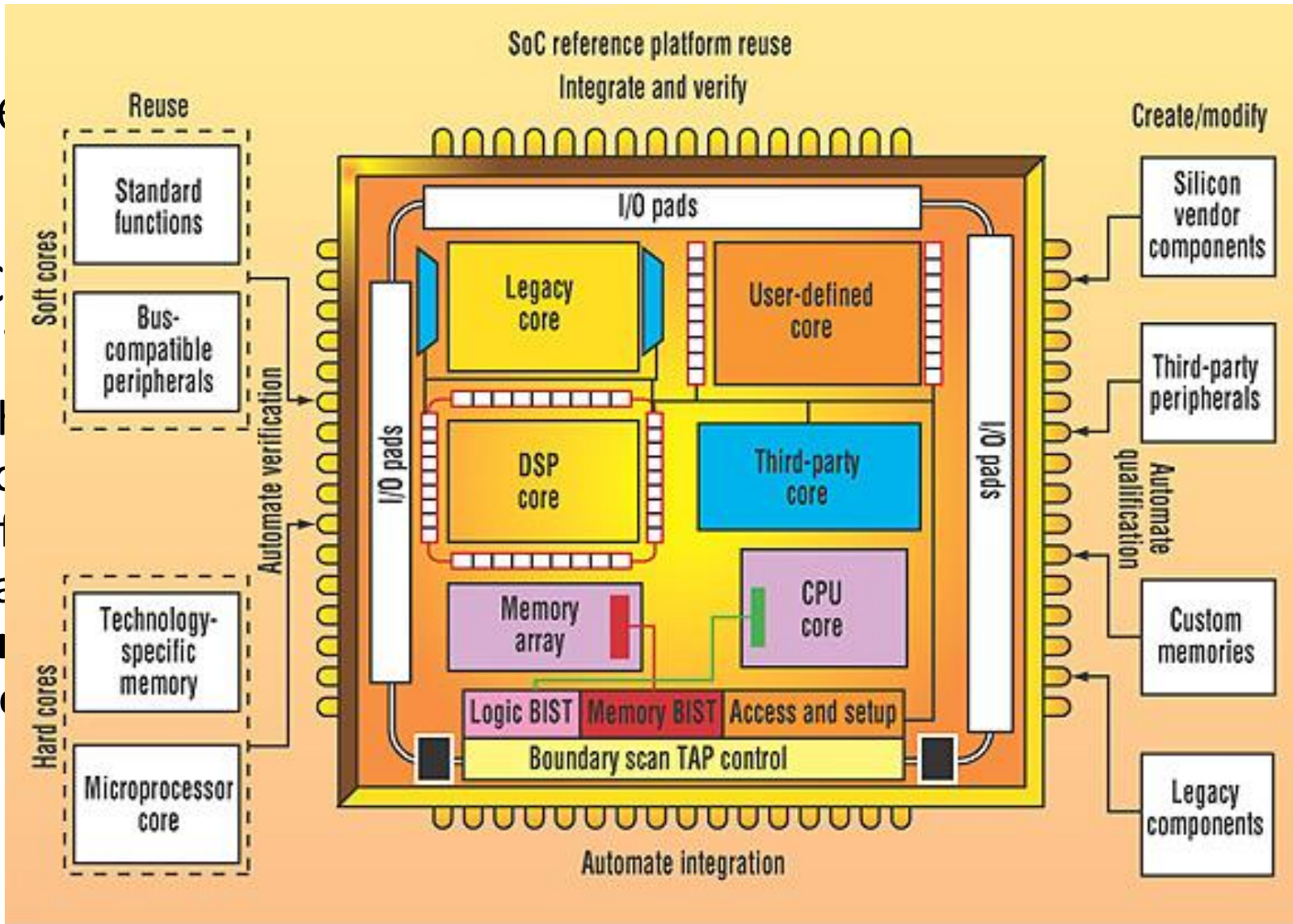


1. This diagram shows a usual SoC derivative built from a reuse platform in which over 70% of the design content could come from reuse.

System

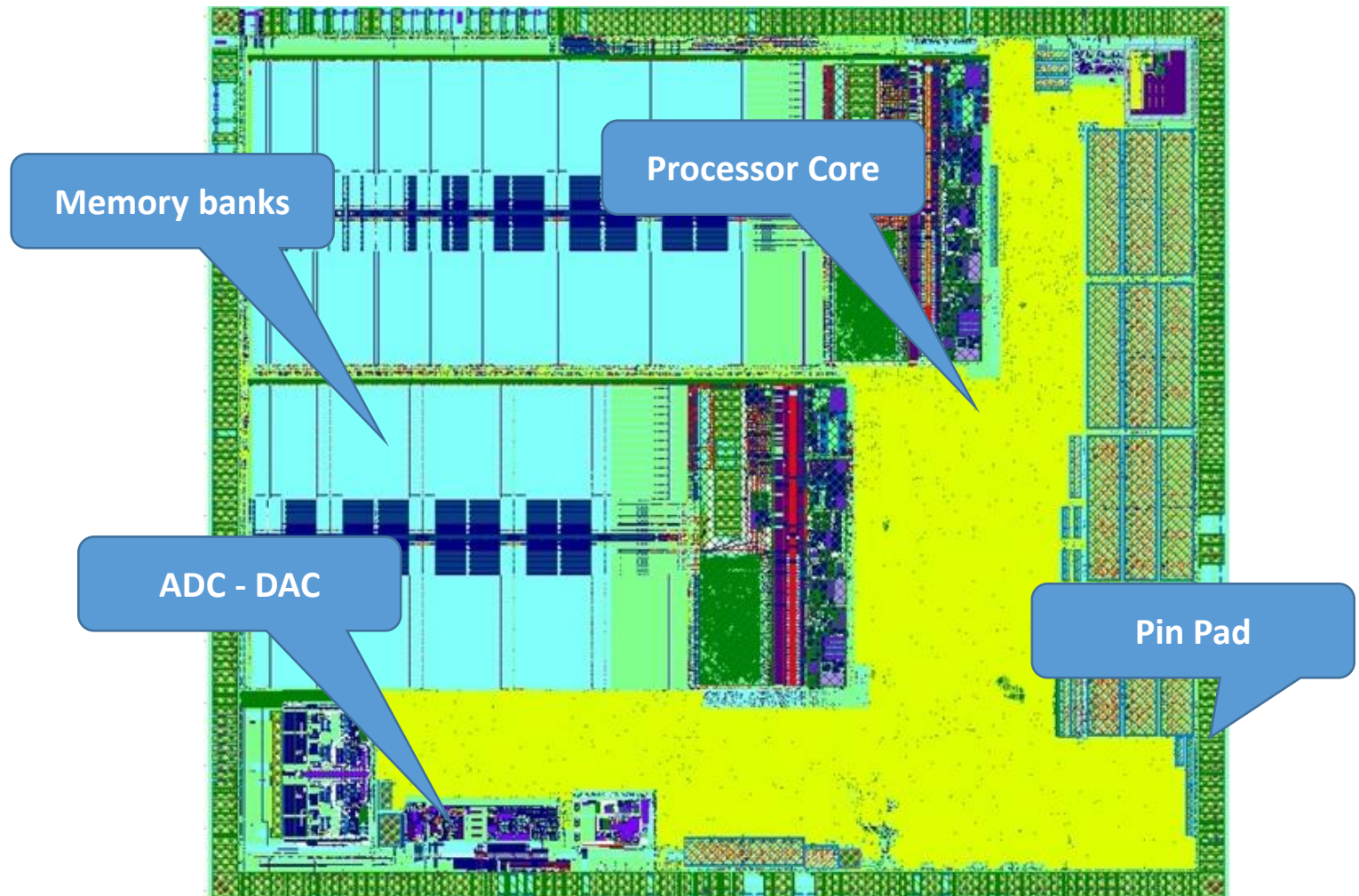
- SoC
- of s

- The core of a SoC is a microprocessor core



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.

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...

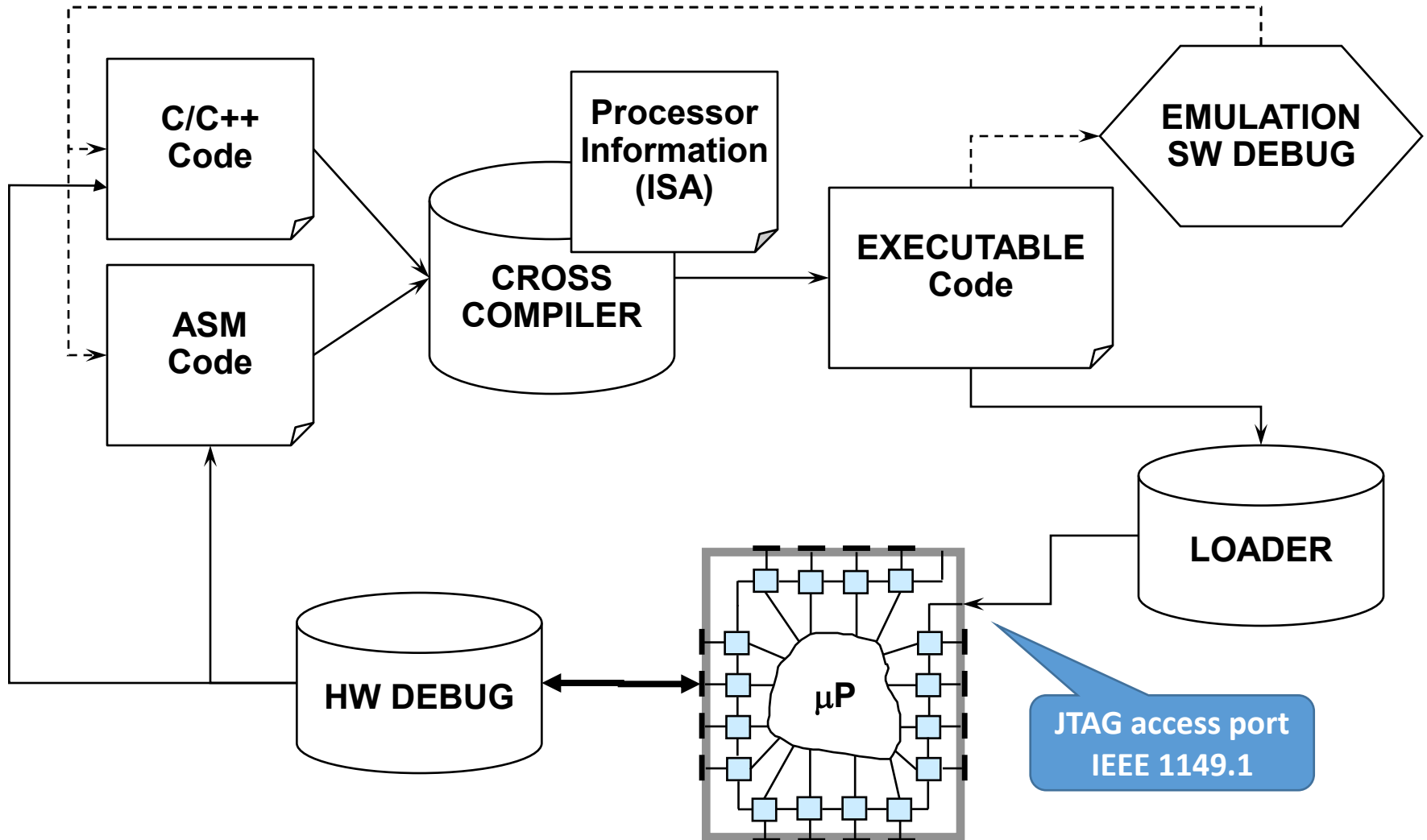
ARM compliant Operating Systems

- 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

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

**All of them
requires a
bootloader
to be
launched**

Tool chain



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>

Based on
IEEE 1500
HW structures

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 events (i.e., button presson)
 - Interrupt controller behavior
- Extended system on-board features.

Case of study

- **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.

**ARM V7-M
Architecture**



Case of study

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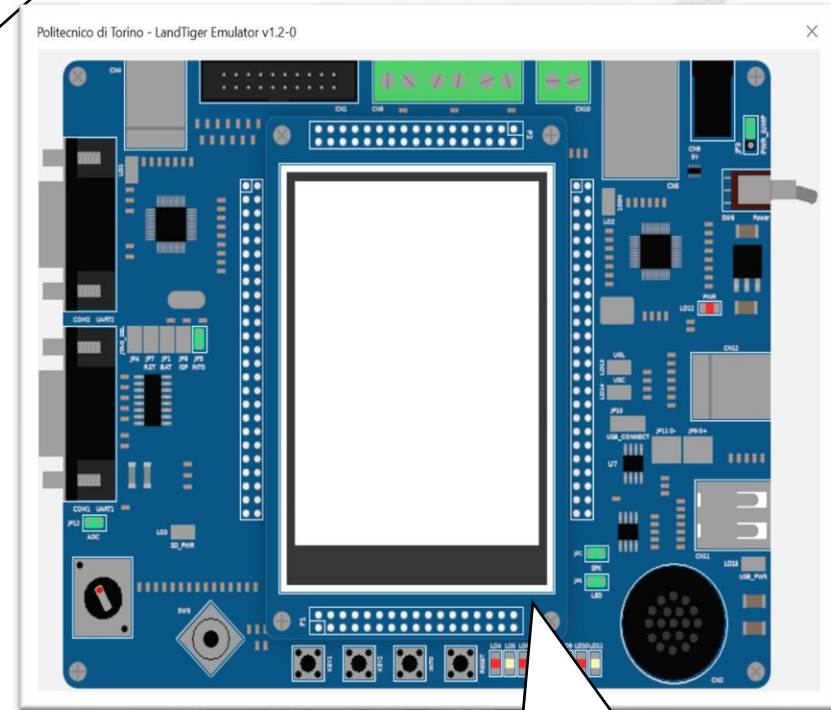
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**ARM V7-M
Architecture**



**Board Emulation
system**