Introduction to ARM systems

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ARM: Advanced RISC Machines

- RISC: Reduced Instruction Set Computers
- Advantages with respect to CISC (Complex Instruction Set Computers):
  - instructions execute in a single cycle
  - instructions have same size and fixed format
  - instructions are simple to decode
  - RISC machines are validated more easily
- Disadvantages:
  - more code in the program
  - instructions for accessing data from memory.

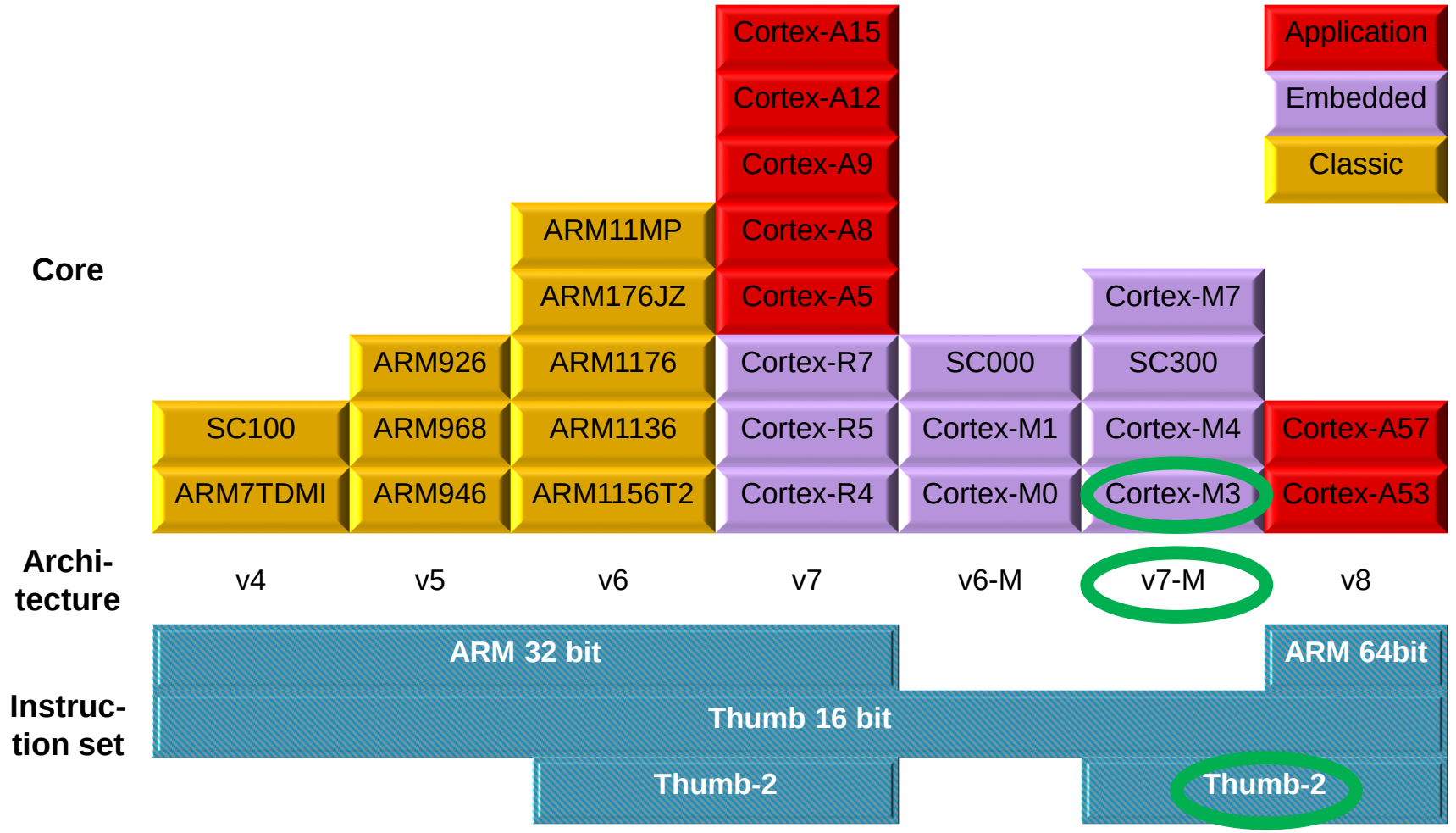
History: origin

- 1985: ARM1, first ARM processor
  - designed by Acorn Computers
  - produced by VLSI Technology (now NXP)
- 1987-1989: ARM2 and ARM3
  - used by Acorn in its desktop PCs
  - sold by VLSI as part of processor chip sets
- 1990: Acorn and Apple found ARM Ltd.
  - Business model: instead of selling processors, it sells the rights to manufacture its processors
  - VLSI become first licensee.

History: modern families

- 1991: ARM6
- 1993: ARM7
  - ARM7TDMI: Debug and ICE (In-Circuit Emulation)
  - new compressed instruction set: Thumb
- 1996-2006: new ARM cores (ARM8-ARM11)
- 2004-today: Cortex cores
  - Cortex-A: high-end applications (smartphones)
  - Cortex-R: real-time and safety-critical applications
  - Cortex-M: microcontrollers (Cortex-M3 LPC1768).

ARM families and architectures



ARM today


UNITED KINGDOM
Cambridge
Blackburn
Maidenhead
Sheffield
NORWAY
Trondheim
SWEDEN
Lund
WASHINGTON
Olympia
Seattle
MICHIGAN
Detroit
MASSACHUSETTS
Boston
GERMANY
Munich
CHINA
Beijing
Shanghai
Shenzhen
KOREA
Seoul
JAPAN
Yokohama
FRANCE
Paris
Grenoble
Sophia Antipolis
SLOVENIA
Sentjernej
CALIFORNIA
Irvine
San Jose
San Diego
TAIWAN
Taipei
TEXAS
Austin
Plano
ISRAEL
Kfar Saba
INDIA
Bangalore
SINGAPORE
Toa Payoh

Partnership

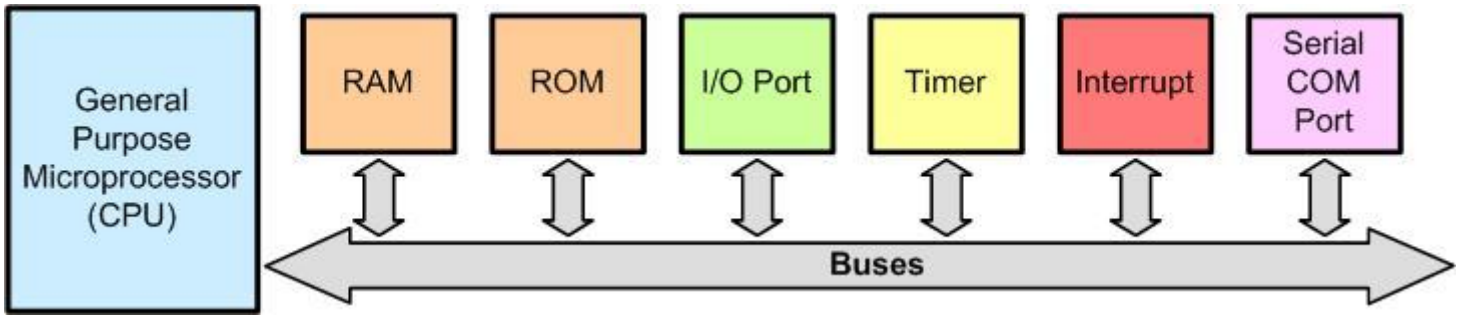
ARM powered products

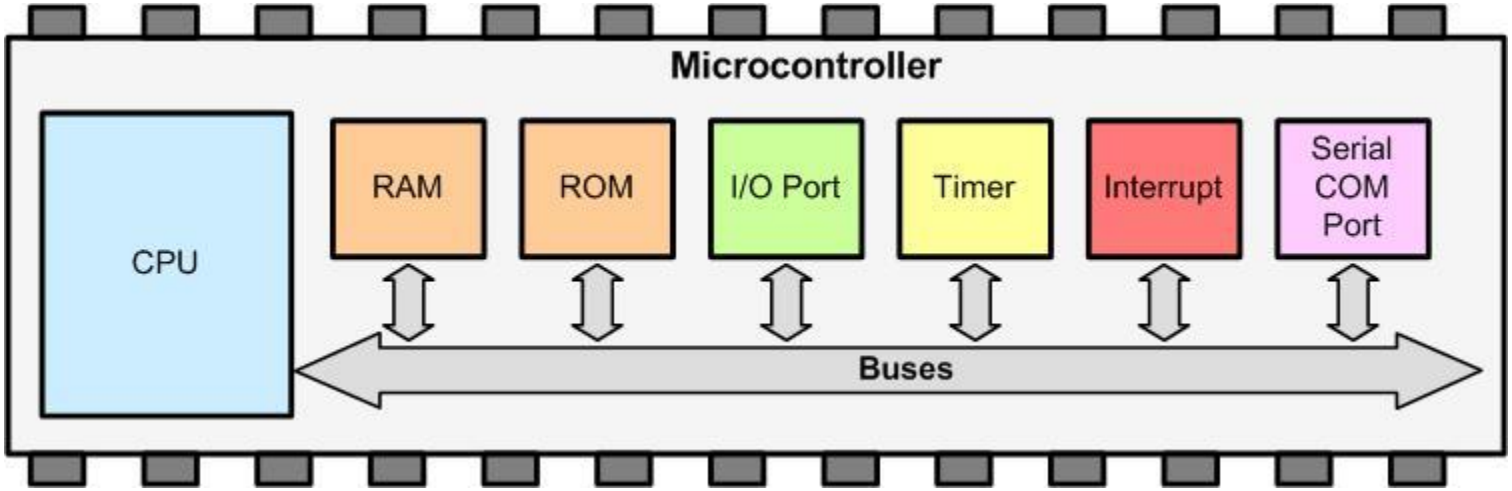
ARM-based processors

- ARM has seldom delivered stand-alone devices with its own microprocessor.
- ARM mainly sells cores, to be used for integration in microcontrollers or Systems on Chip (SoCs).
  - *Hard cores*: ARM provides a physical layout implemented in a given technology.
  - *Soft cores*: ARM provides a high-level description, which can be then synthesized to any technology by the designer.

make by synthesis, especially chemical

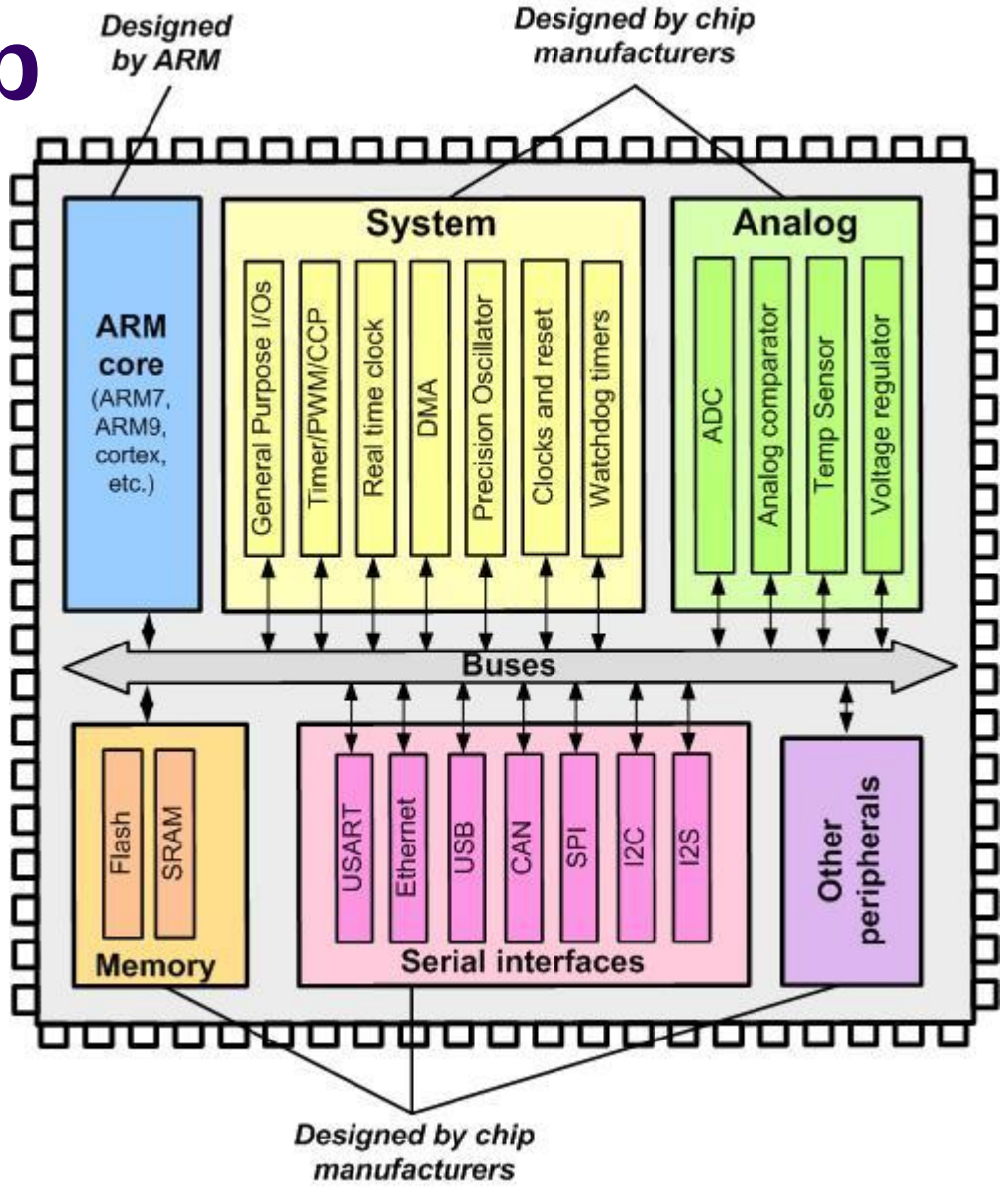
Microprocessor Vs. microcontroller



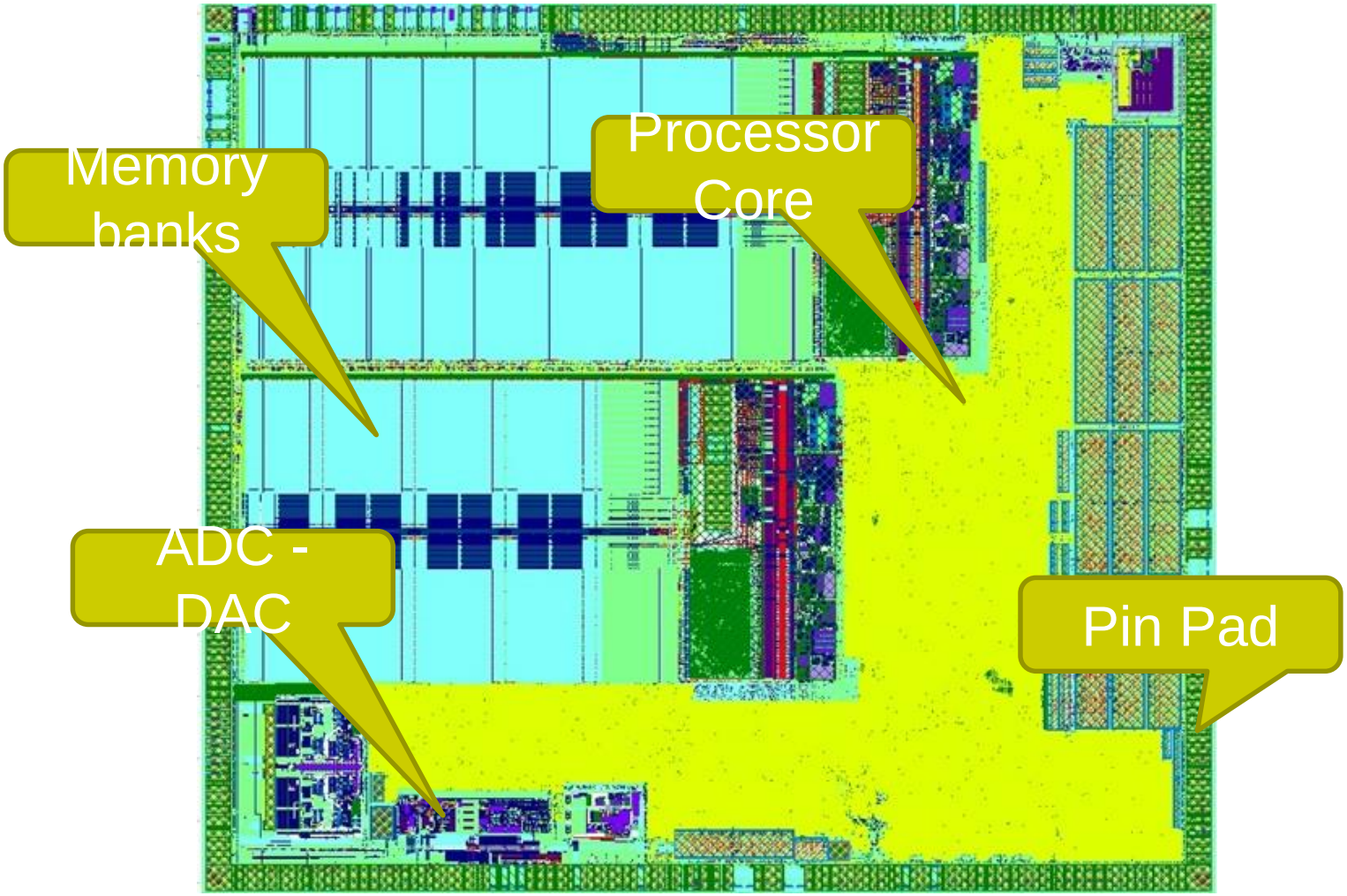


System on Chip

- An SoC is an entire system integrated in a single piece of silicon.



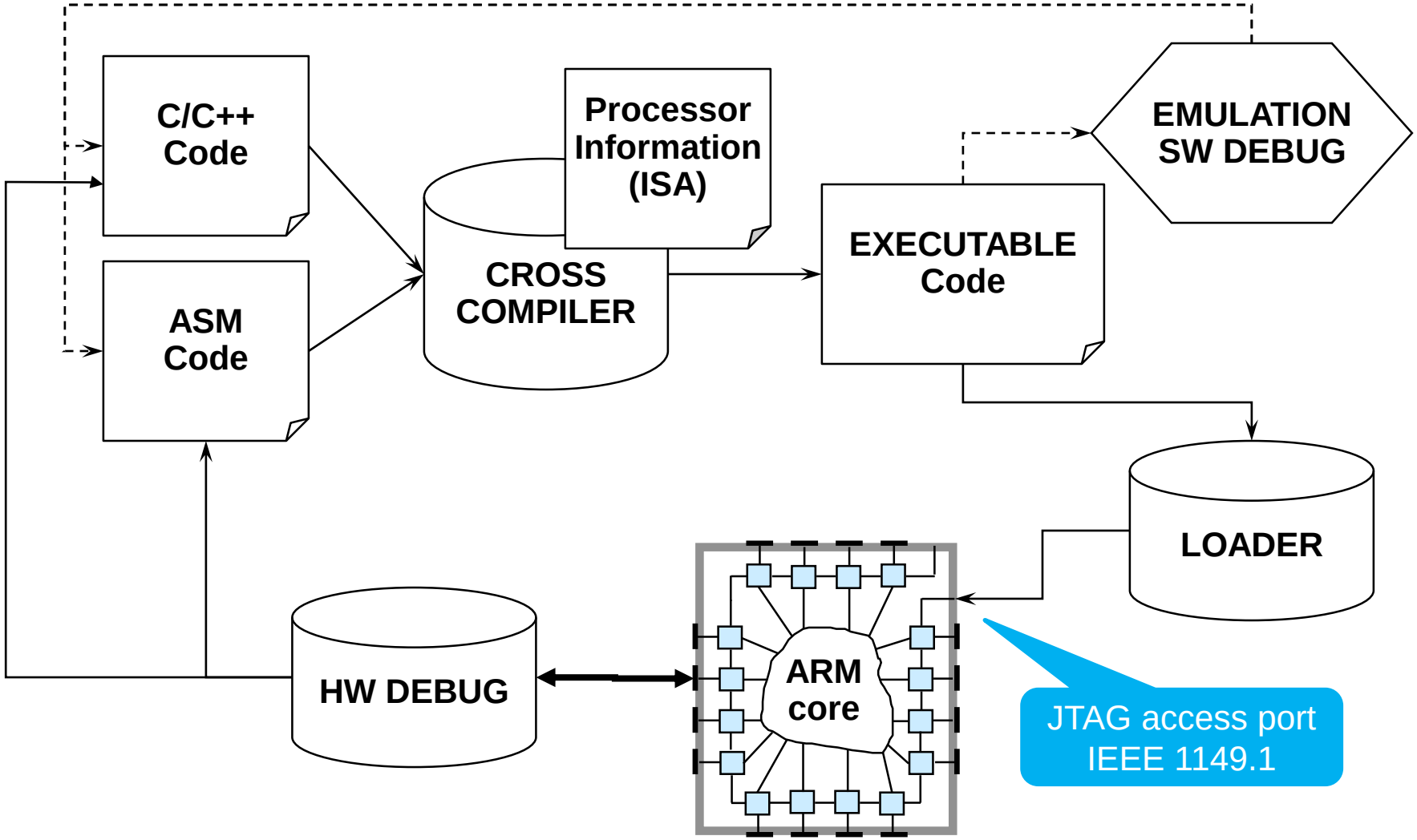
SoC layout example



ARM-based commercial SoCs

- Samsung: http://pdf.datasheetcatalog.com/datasheet2/e/0lrp9fdj0zyd6e2k2e8ej8lkzupy.pdf (page 35)
- NXP: http://www.nxp.com/documents/data_sheet/LPC1769_68_67_66_65_64_63.pdf (page 6)
- STMicroelectronics: http://www.st.com/st-web-ui/static/active/en/resource/technical/document/datasheet/CD00067905.pdf?s_searchtype=keyword (page 8)
- …and many others…

Tool chain


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

Case of study

- Cross compilation + SW debug: KEIL uVision
  - http://www.keil.com/
  - trial version with 32K code limitation
  - latest version 5.28a (June 2019)
- Development board: Landtiger
  - Based on NXP LPC1768 SoC
  - ARM Cortex-M3 core
- Hardware debug: RealView
  - with ULINK2 JTAG-based connection

Suggested books

- W. Hohl and C. Hinds (2016, second edition). *ARM Assembly Language: Fundamentals and Techniques*. Crc Press.
- J. Yiu (2009). *The definitive guide to the ARM Cortex-M3*. Newnes.
- M. Mazidi, S. Naimi, S. Naimi, and S. Chen, (2016). *ARM Assembly Language Programming & Architecture*. www.microdigitaled.com
- Smith, Bruce (2013). *Raspberry Pi Assembly Language RASPBIAN Beginners: Hands On Guide*. www.brucesmith.info