Generic course information

Introduction to Embedded System

Embedded System

An embedded system

- combination of computer hardware and software
- specifically designed for a particular function

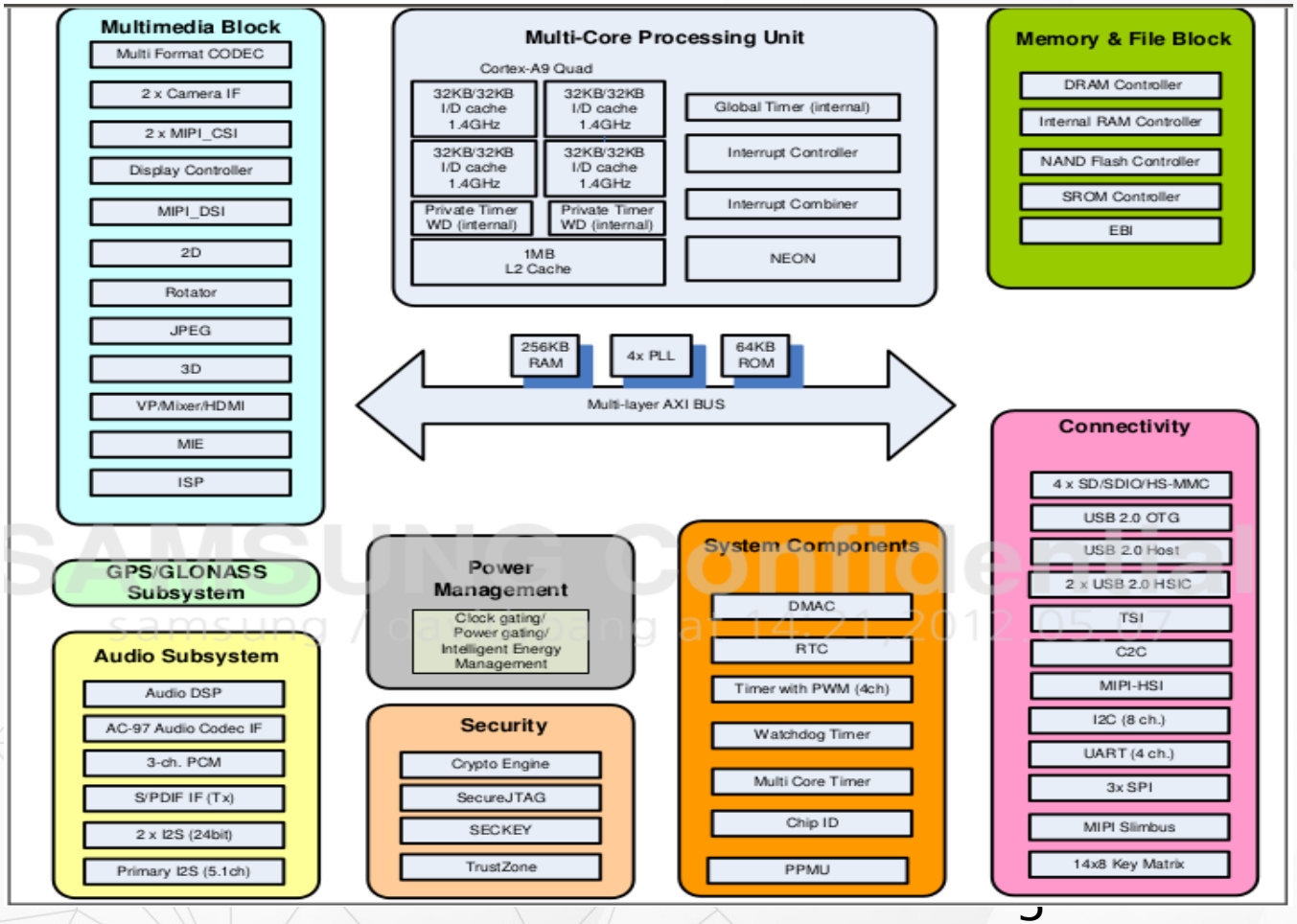
- Applications
  - Mobile phone
  - Digital camera
  - Smart TV
  - Navigation system

Feature

- Designed to do some specific task
  - Low power
  - Small size
  - Special operating ranges
  - Low cost
- Install OS ?

SOC

- System On Chip

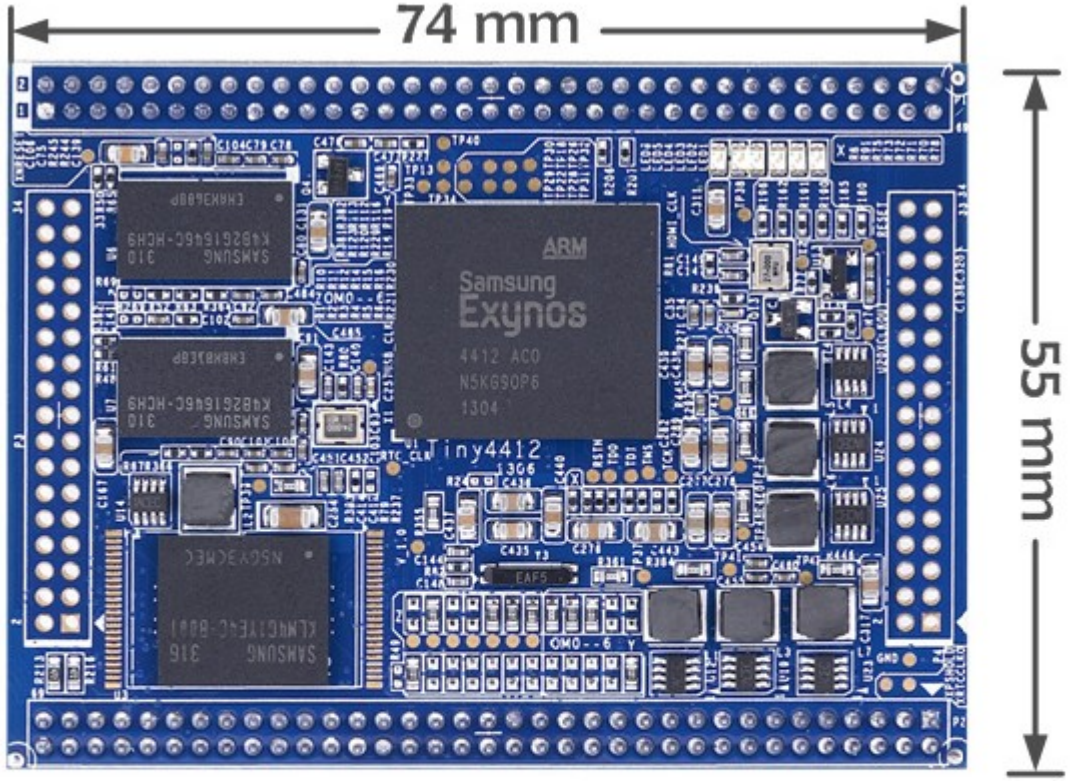


Component of embedded system

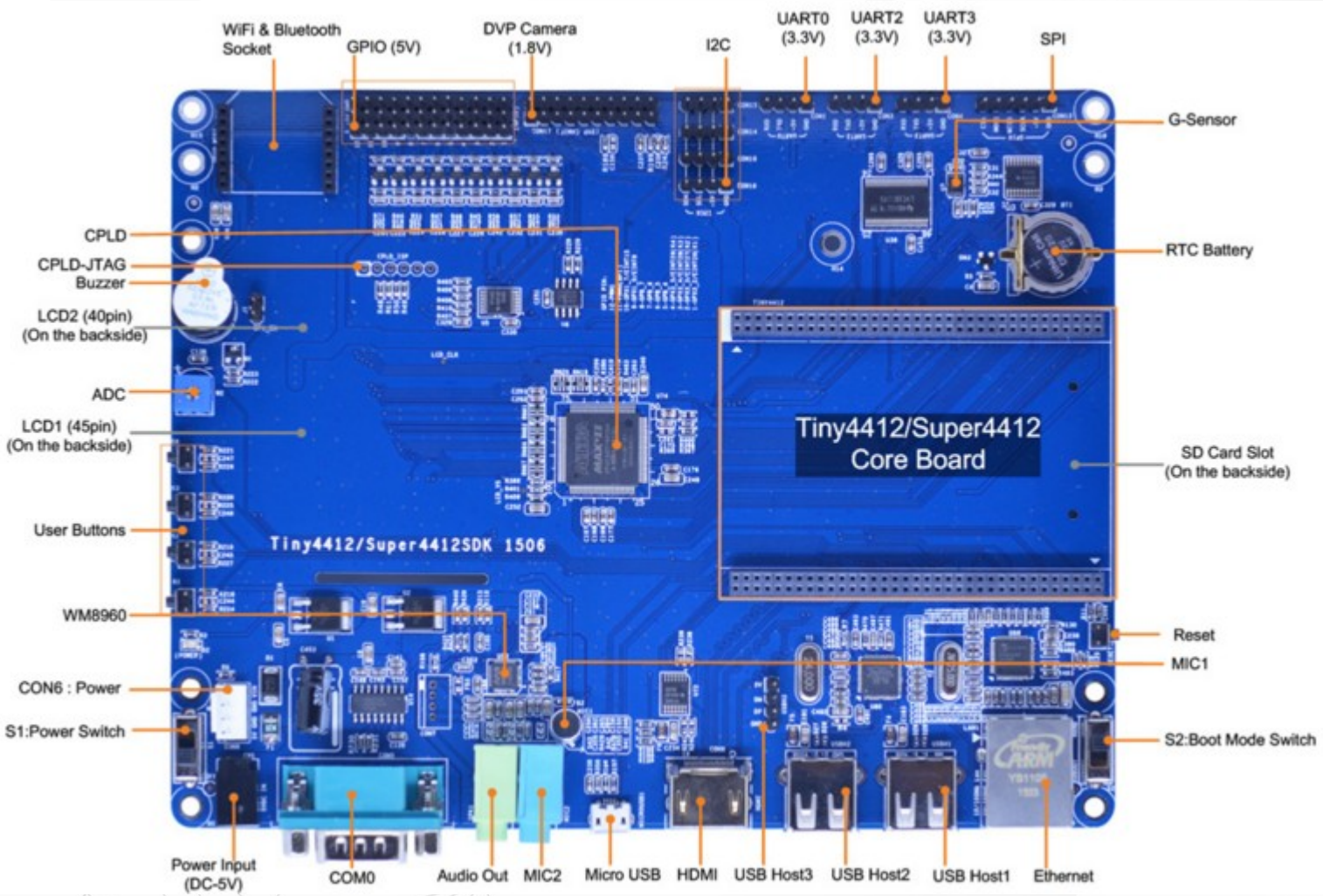
- Processor
  - ARM, X86, MIPS ....
- RAM
  - 8MB ~ 32 MB
- Storage
  - Nand, Nor flash
  - SD/MMC/eMMc
- System Bus
  - AMBA, AHB, APB, AXI ...

Component of embedded system

- Communication
  - I2C, I2S, USB, PCI/PCIe ...
- Media system
  - JPEG, H.264 ..
- System component
  - DMA, RTC ..



1.5GHz Cortex-A9 | 1.5GHz Cortex-A9 | 1.5GHz Cortex-A9 | 1.5GHz Cortex-A9



Experiment EVB

Tiny4412 | Exynos4412 ARM Cortex-A9 Board

FriendlyARM Tiny 4412 Stamp Module with 1.5 GHz Samsung Exynos4412 ARM Cortex-A9 processor.

Specification: Stamp Module

- **Dimension:** 74 x 55 mm
- **CPU:** 1.5 GHz Samsung Exynos4412 ARM Cortex-A9 (Quad-Core)
- **RAM:** 1 GB, 32 bit Bus
- **Flash:** up to 32GB eMMC Flash
- **User Outputs:** 4x LEDs
- **Expansion headers** (2.0 mm)
- **Power:** 2-6V
- **OS Support**
  - Linux
  - Ubuntu
  - Android

Experiment EVB

Specification: SDK-Board

- **Dimension:** 180 x 130 mm
- **EEPROM:** 256 Byte (I2C)
- **Ext. Memory:** SD-Card socket
- **Serial Ports:** DB9 connector (RS232), RS485, total: 4x serial port connectors)
- **USB:** USB-A Host 1.1, miniUSB Slave/OTG 2.0
- **mini PCIe**
- **Audio:** WM8960 codec
- **Audio Output:** 3.5 mm stereo jack, connector for a speaker (Class D Amp)
- **Audio Input:** 3.5mm jack + Condenser microphone
- **Ethernet:** RJ-45 10/100M (DM9000)
- **RTC:** Real Time Clock with battery
- **Beeper:** PWM buzzer
- **G-Sensor**
- **Camera:** 20 pin (2.0 mm) Camera interface
- **Monitor:** HDMI
- **LCD:** 40 pin FFC and 45 pin FFC connector
- **User Inputs:** 8x buttons and 1x A/D pot
- **Expansion:** (2.0 mm)
- **Power:** regulated 5V

Introduction to Embedded Linux

Birth

- 1991, Linus Torvalds, Linux kernel project, a Unix-like operating system kernel.
- 2000, Linux is more and more popular on embedded systems.
- 2008, Linux is more and more popular on mobile devices
- 2010, Linux is more and more popular on phones (Android ?)

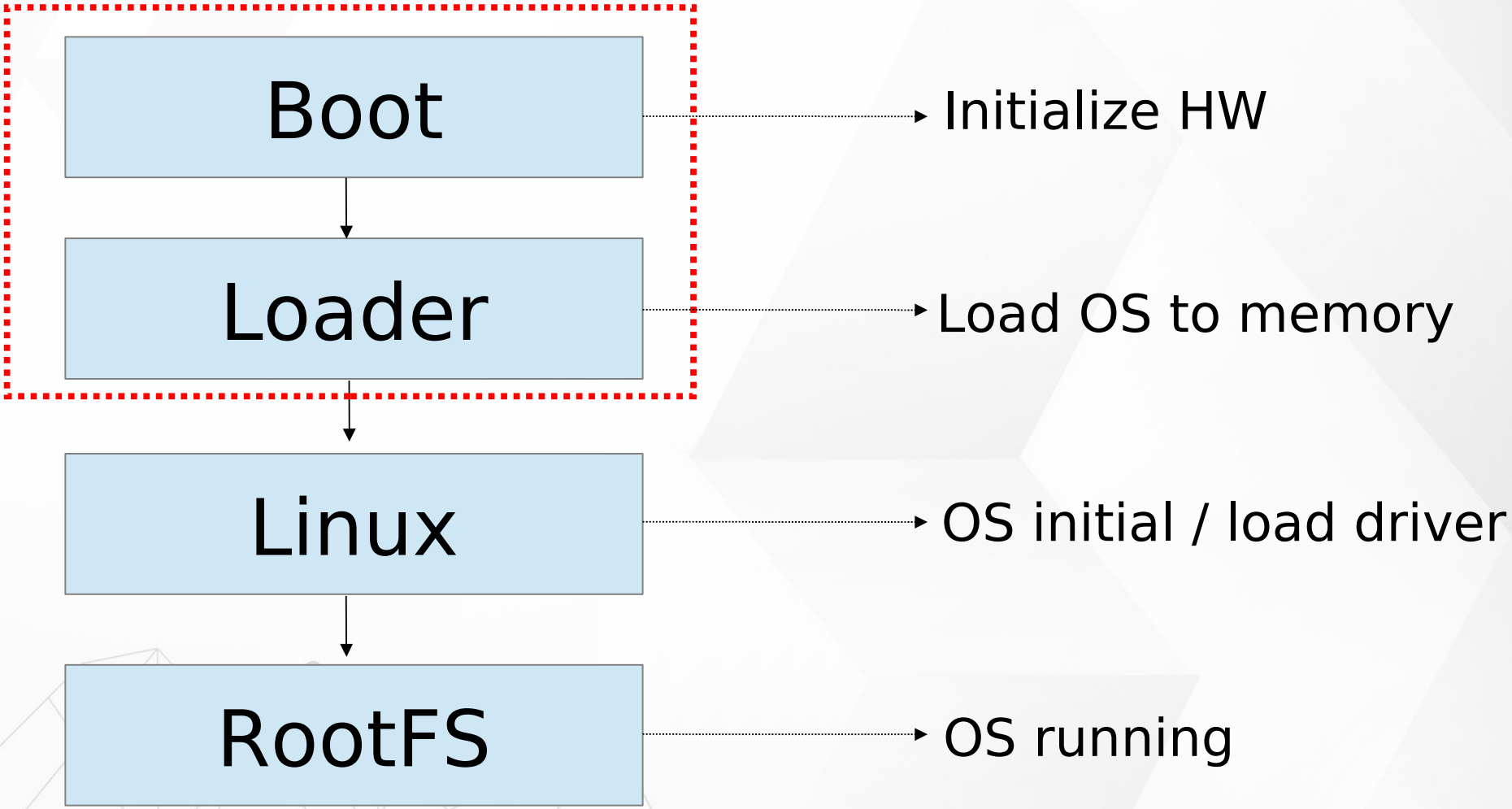
Embedded Linux ?

Embedded Linux is the usage of the Linux kernel and various open-source components in embedded systems (from Free Electrons)

Advantages

- Re-use components
- Quickly design and develop complicated products
- No need to re-develop components
  - TCP/IP stack, USB stack, PCI stack ...
- Allow you modify components

Embedded Linux System Booting



Embedded Linux System Software components

- Cross-compilation toolchain
- Bootloader
- Linux Kernel
- Rootfs
- C library
- Libraries and applications
- BSP (Board Support Package)

Develop Environment

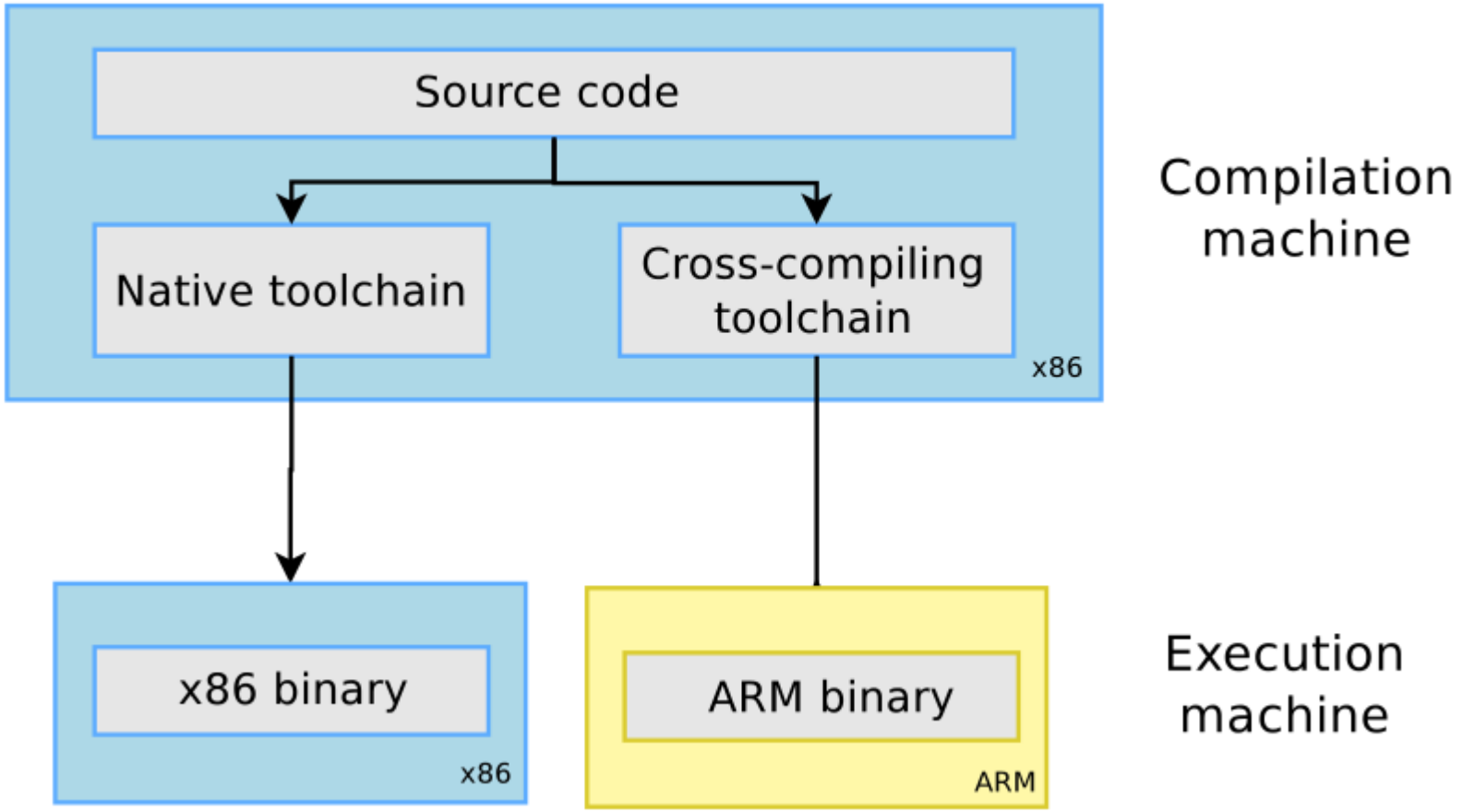
Develop Environment

- Host PC
- Toolchain
- Target EVB
- BSP

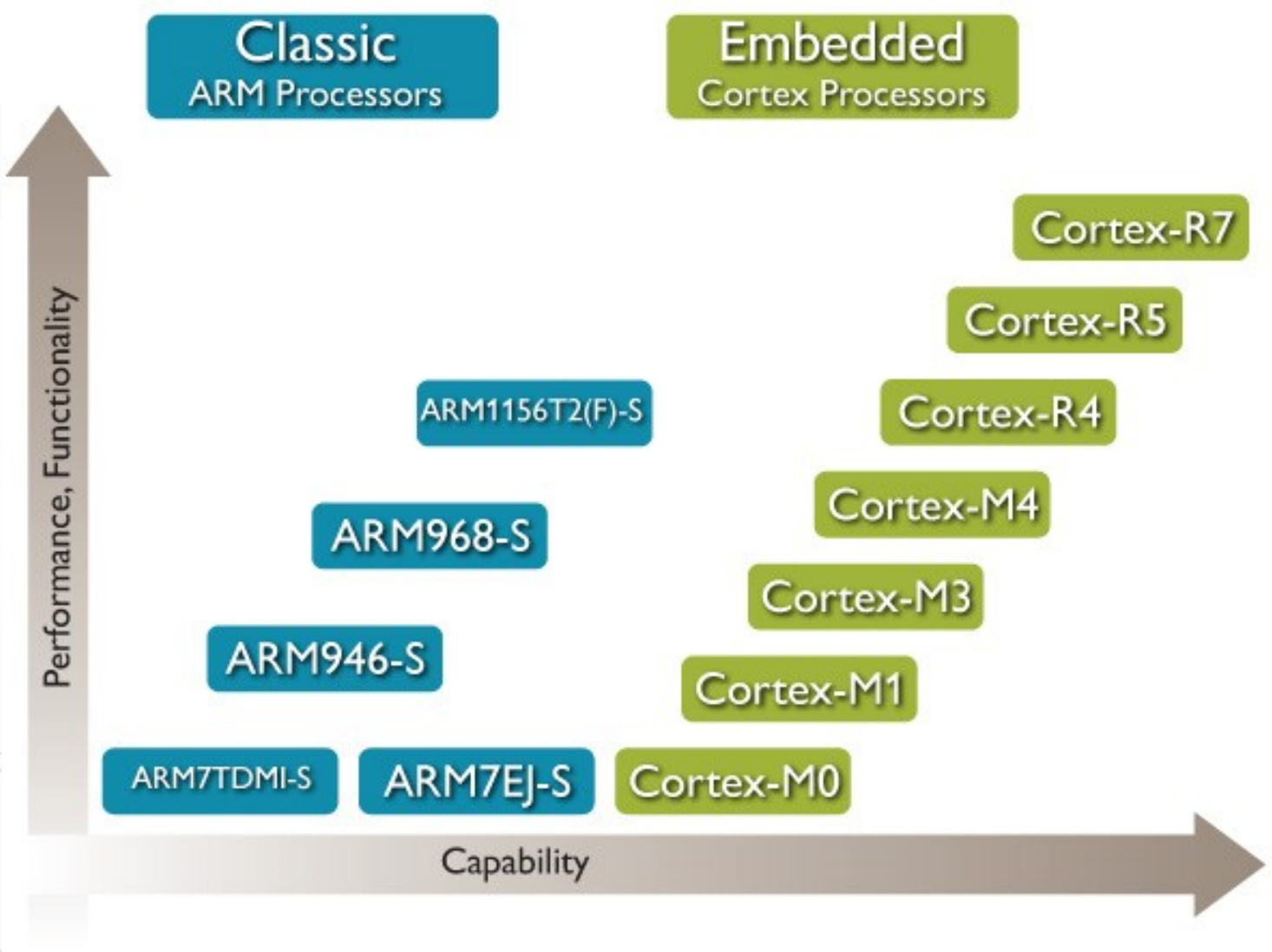
BSP

- Board Support Package
- From chip vendor
  - Bootloader
  - OS (Linux kernel)
  - Device driver
  - Shell (Android)
  - Rootfs

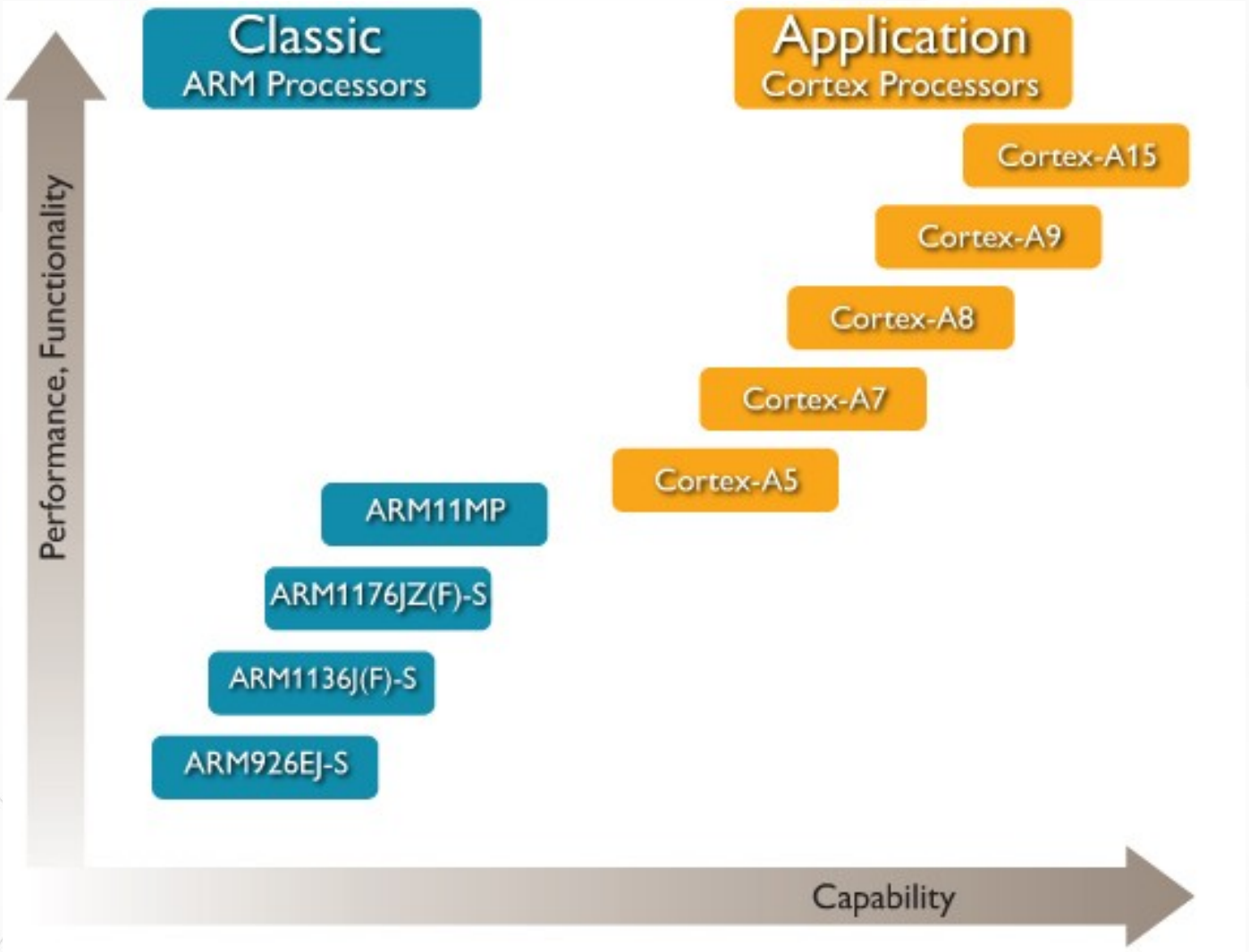
Cross Compilation toolchain



Embedded Processors



Application Processors



Development of the ARM Architecture

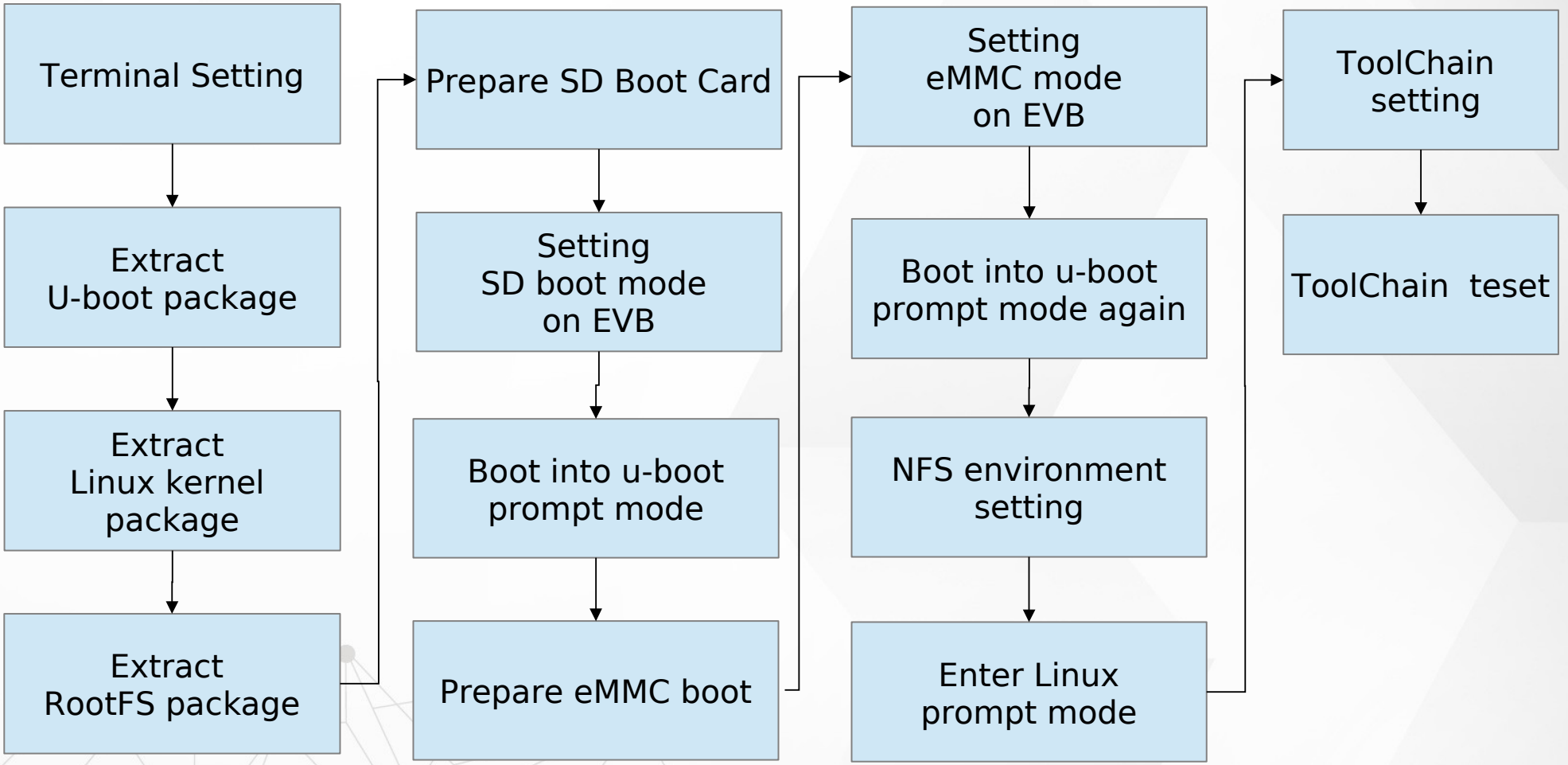
v4	v5	v6	v7
Halfword and signed halfword / byte support System mode Thumb instruction set (v4T)	Improved interworking CLZ Saturated arithmetic DSP MAC instructions Extensions: Jazelle (5TEJ)	SIMD Instructions Multi-processing v6 Memory architecture Unaligned data support Extensions: Thumb-2 (6T2) TrustZone® (6Z) Multicore (6K) Thumb only (6-M)	Thumb-2 Architecture Profiles 7-A - Applications 7-R - Real-time 7-M - Microcontroller

- **Note that implementations of the same architecture can be different**
  - Cortex-A8 - architecture v7-A, with a 13-stage pipeline
  - Cortex-A9 - architecture v7-A, with an 8-stage pipeline

Just do it!

- Understand tiny-4412 EVB
- Build develop environment
  - Terminal Setting
    - Gtkterm, minicom ..
  - Prepare Tiny4412 BSP
    - U-boot, Linux kernel, RootFS
  - Setting toolchain
  - Build NFS Environment

Exercise Step



Terminal Setting

- sudo apt-get install gtkterm
- sudo gtkterm
- Connect serial port to Host PC
- Connect network line to Host PC
- Connect micro USB line to Host PC

EVB Setting

Tiny-4412 EVB Boot Select

- Boot method
  - SD boot – switch down
  - eMMC boot - switch up