

# Architectures for Embedded Systems

Masters on Computers and Telematics

2021/22

2nd Semester

Arnaldo Oliveira

[arnaldo.oliveira@ua.pt](mailto:arnaldo.oliveira@ua.pt)

Gab. @ IT2

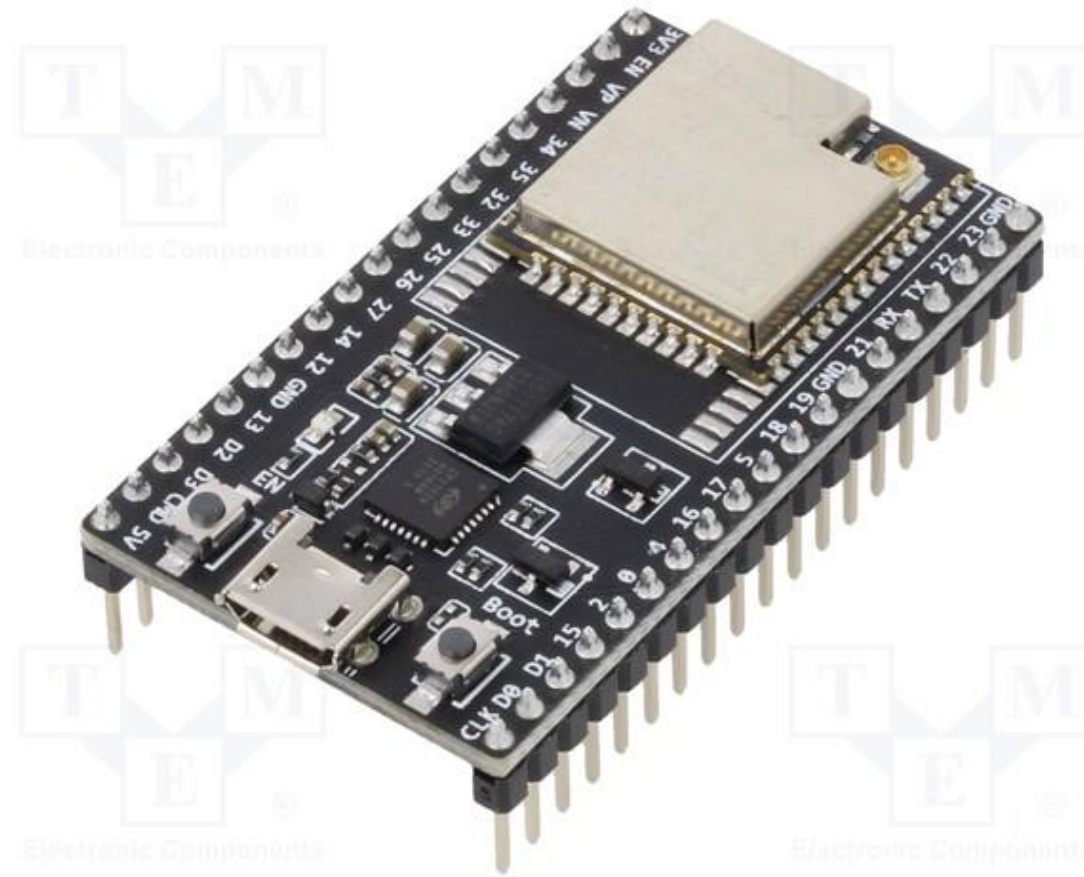
# Objective

- Become familiar with the state-of-the-art architectures and tools for embedded systems development
  - Processor architecture and implementation
  - Interfaces and peripherals
  - Languages, tools and development flow

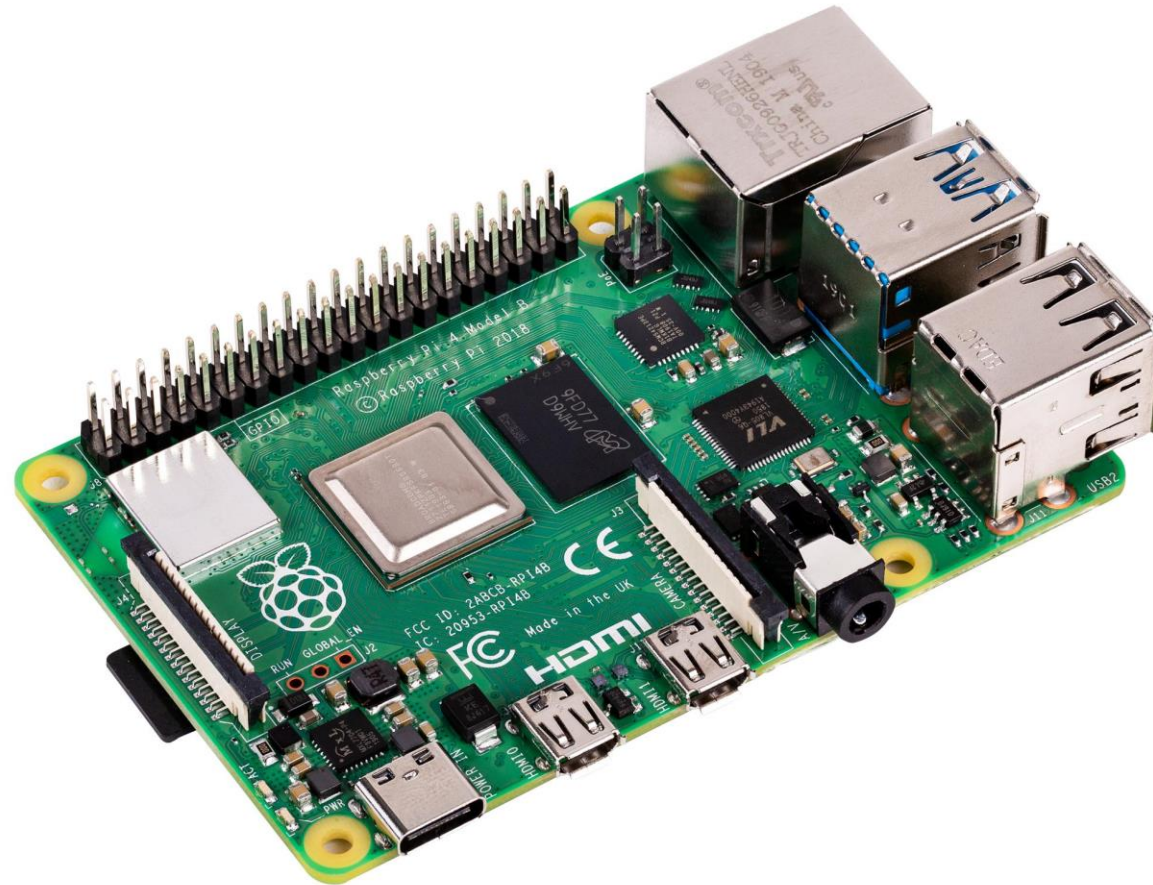
# Basic Concepts

- What are embedded systems?
  - Definition
  - Comparison with general purpose systems
    - Resource, cost, size and power consumption constraints
    - Development flow
- What are...
  - General Purpose Processors (CPUs)?
  - Digital Signal Processors (DSPs)?
  - Microcontrollers?
  - Graphics Processing Units (GPUs)?
  - Field Programmable Gate Arrays (FPGAs)?
  - Systems-on-Chip (SoCs)?
  - Programmable System-on-Chip (PSoCs)?

# ESPRESSIF ESP32-DEVKITC



# Raspberry Pi 4 B



# PCEngines APU4d4

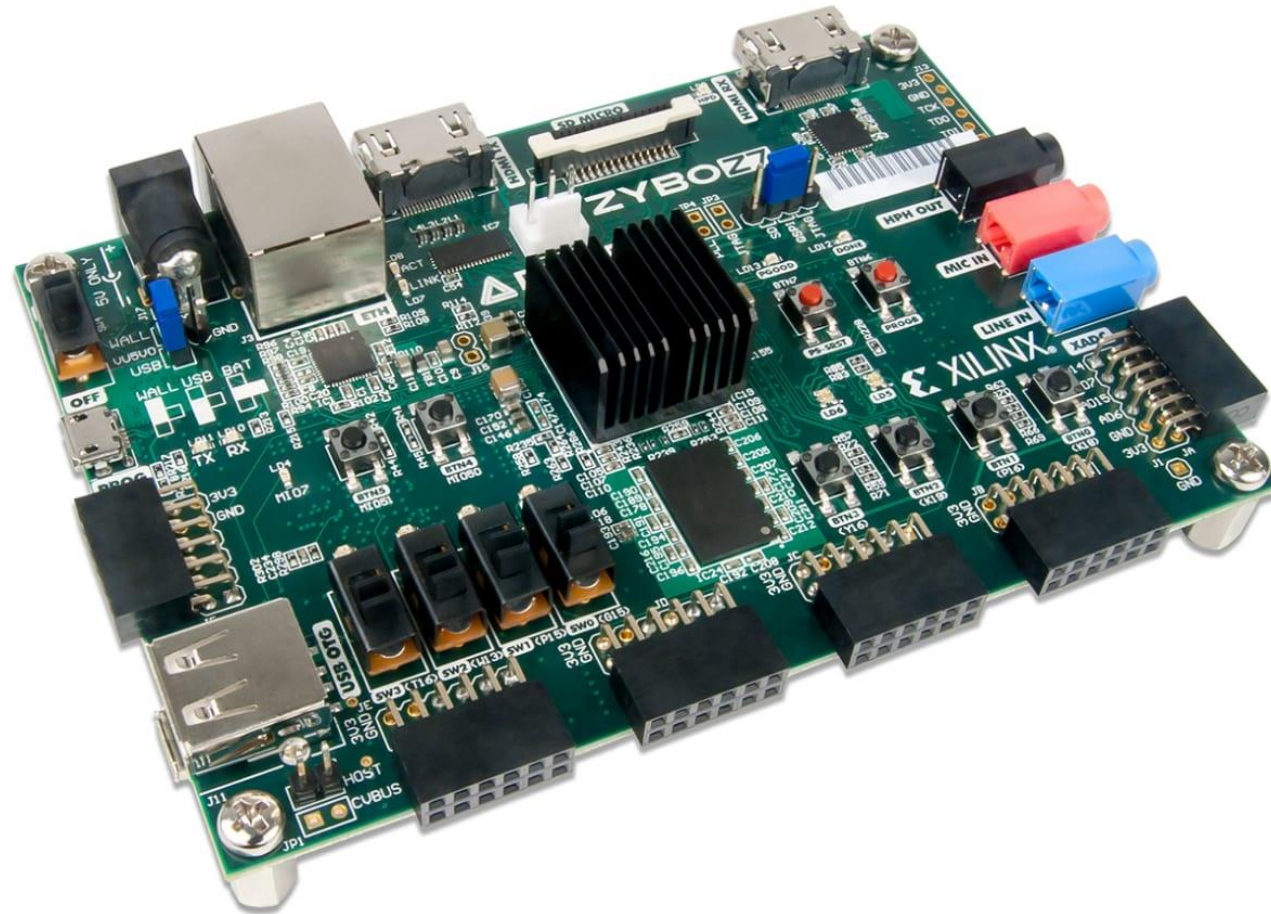


# Nvidia Jetson Nano





# Digilent Zybo Z7 (Xilinx Zynq 7000 PSoC)





# Organization of the Classes

- 14 weeks
  - 1 week for ASE course introduction
  - 1 week for short presentations about highlights and high-level comparison of a subset of the architectures to be considered (including Xilinx PSoC)
    - Each group prepares a brief presentation with 2...3 slides per architecture + 1 slide for comparison to be presented in a 15 minutes time slot
- 12 classes/weeks
  - 3 classes devoted to each architecture (except Xilinx PSoC)
    - 2 classes for presentation and discussion of the concepts
    - 1 class to implement a micro-project

# Organization of the Classes

- Students are divided into 8 groups of 2 elements
- 8 presentations every week on specific topics of the selected architectures (total of 90 minutes, random selection known at the beginning of the class/lesson)
  - First one: 40 min.
  - Second one: 20 min.
  - Third one: 10 min.
  - Fourth one: 4 min.
  - Fifth one: 4 min.
  - Sixth one: 4 min.
  - Seventh one: 4 min.
  - Eighth one: 4 min.
- 75 min. for discussion, wrap-up and demonstration

# Topics to be Studied and Presented

- First week for each architecture (ESPRESSIF ESP32, Raspberry Pi 4, PCEngines APU4d4, Nvidia Jetson Nano)
  - Architecture of the main processing device, including preferred applications and main blocks/functional units/peripherals
  - Structure of the development kit, including external interfaces, memory devices, power supplies and other features
- Second week for each architecture
  - Languages and development tools for both baremetal and operating system-based applications
  - Power management features
  - Deployment of applications in the real-world, including support for remote access and upgrades

# Assesement

- Presentations in classes, supported by slides, written documents (2...3 pages long, each week) and a short demo: 45%
  - First one: 10%
  - Second one: 10%
  - Third one: 5%
  - Fourth one: 4%
  - Fifth one: 4%
  - Sixth one: 4%
  - Seventh one: 4%
  - Eighth one: 4%
- Micro-projects: 30% (7,5%, one for each architecture / board type, except Xilinx PSoC)
- Final exam: 25%

# Next Assignments

- Answers to “Basic Concepts”
  - Each group fills the quiz available in [e-learning.ua.pt](http://e-learning.ua.pt) (ASE course webpage) until March 9th, 23:59 (quiz already available)
- Each group prepares a brief presentation with highlights and high-level comparison of three architectures and respective kits
  - 2...3 slides per architecture + 1 slide for overall comparison to be presented in a 15 minutes time slot
    - Group 1 and 5: ESPRESSIF ESP32, Raspberry Pi 4, Xilinx Zynq 7000
    - Group 2 and 6: Raspberry Pi 4, PCEngines APU4d4, Xilinx Zynq 7000
    - Group 3 and 7: Raspberry Pi 4, Nvidia Jetson Nano, Xilinx Zynq 7000
    - Group 4 and 8: PCEngines APU4d4, Nvidia Jetson Nano, Xilinx Zynq 7000