# Microcontroller architecture

## ISA and Microarchitecture

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# Definition of architecture

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Architecture describes the internal organization of a computer in an abstract way; that is, it defines the capabilities of the computer and its programming model.[1]

Basically, it is an abstraction that outlines how a computer’s hardware components interact and work together to process data. Of course it is important. But why?

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- **Cost and size:** Choosing a microcontroller with just enough features to develop the intended functionality is key to saving money, but also in some cases the size, which in turn also reduces the cost.
- **Performance and memory:** Depending on the application, some devices might only run certain OS which is targeted for a specific arquitechture, or maybe they need to be compatible with external memory.

# Importance of architecture (cont.)

So, just like buying any other thing, when buying a microcontroller to design an embedded system, you should take into account the size, your budget, the style, among many other things. But the thing with architecture in computer science and embedded systems is that saying ”architecture” is really, really broad.

# Importance of architecture (cont.)

So, just like buying any other thing, when buying a microcontroller to design an embedded system, you should take into account the size, your budget, the style, among many other things. But the thing with architecture in computer science and embedded systems is that saying ”architecture” is really, really broad.

Why? you may ask... Well, in the beginning we had very simple circuits compared to those nowadays. We also had one way to program them: 1’s and ’0s. But today we have a huge variety of variables, even with circuits themselves, since we’re not limited to Microcontrollers(µCs or MCUs) and Microprocessors(µPs), we also have Digital Signal Processors (DSPs), Field Programmable Gate Arrays (FPGAs), System-on-Chips (SoCs), and Application Specific Integrated Circuits (ASICS).

# Different kinds of architectures

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So, let us explore some different kinds of architectures.

# ISAs

## Instruction Set Architecture

An Instruction Set Architecture (ISA) is part of the abstract model of a computer that defines how the CPU is controlled by the software. The ISA acts as an interface between the hardware and the software, specifying both what the processor is capable of doing as well as how it gets done. [2]

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The ISA provides the only way through which a user is able to interact with the hardware. It can be viewed as a programmer's manual because it's the portion of the machine that's visible to the assembly language programmer, the compiler writer, and the application programmer.

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- **MIPS:** Based in RISC and used in many network systems.
- **AVR:** 8-bit RISC, which we will explore and use in this course.

## Microarchitecture

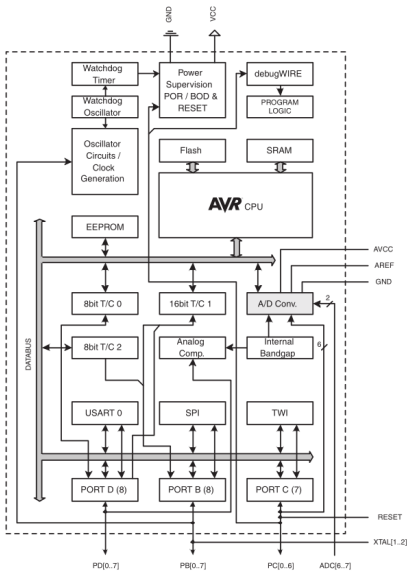
Microarchitecture is the implementation of the ISA in hardware. It defines how a processor's internal components are organized and interact to execute the instructions described by the ISA.

ISAs can be executed in different implementations of hardware, so, a microarchitecture (or µarch) is the description of that exact thing.

# Microarchitecture (cont.)

Microarchitectures are usually represented as diagrams that describe the interconnections of the various microarchitectural elements of the machine, which may include gates, registers, arithmetic ALUs and even larger elements. These diagrams generally also include the buses.

# Microarchitecture (cont.)



# References


[1] Alan Clements. *Principles of Computer Hardware*. Oxford University Press, 2006.

[2] Arm Ltd. *What is Instruction Set Architecture (ISA)? — arm.com*. URL: https://www.arm.com/glossary/isa (visited on 09/24/2024).