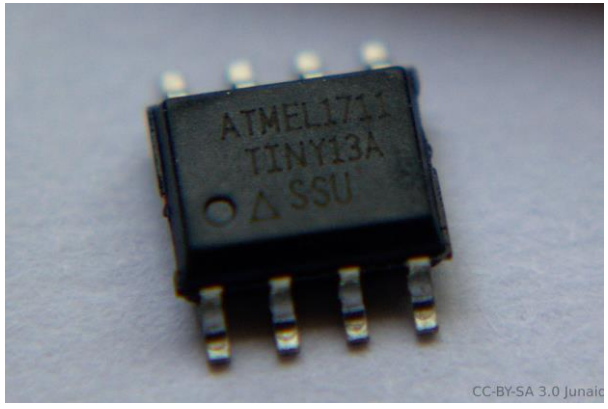
2. Basics of microcontrollers

2.1. What is a MCU

What is a microcontroller? (MCU or µC)

- IC = CPU + memory + additional hardware
- Designed to interact with other components
- Microcontroller ≠ microprocessor
- It is not possible to add external devices
- Different families with different features
- Preferred in embedded systems :
  - Low cost
  - Small size (portable)
  - Low power consumption
  - Efficiency
  - Diverse functions

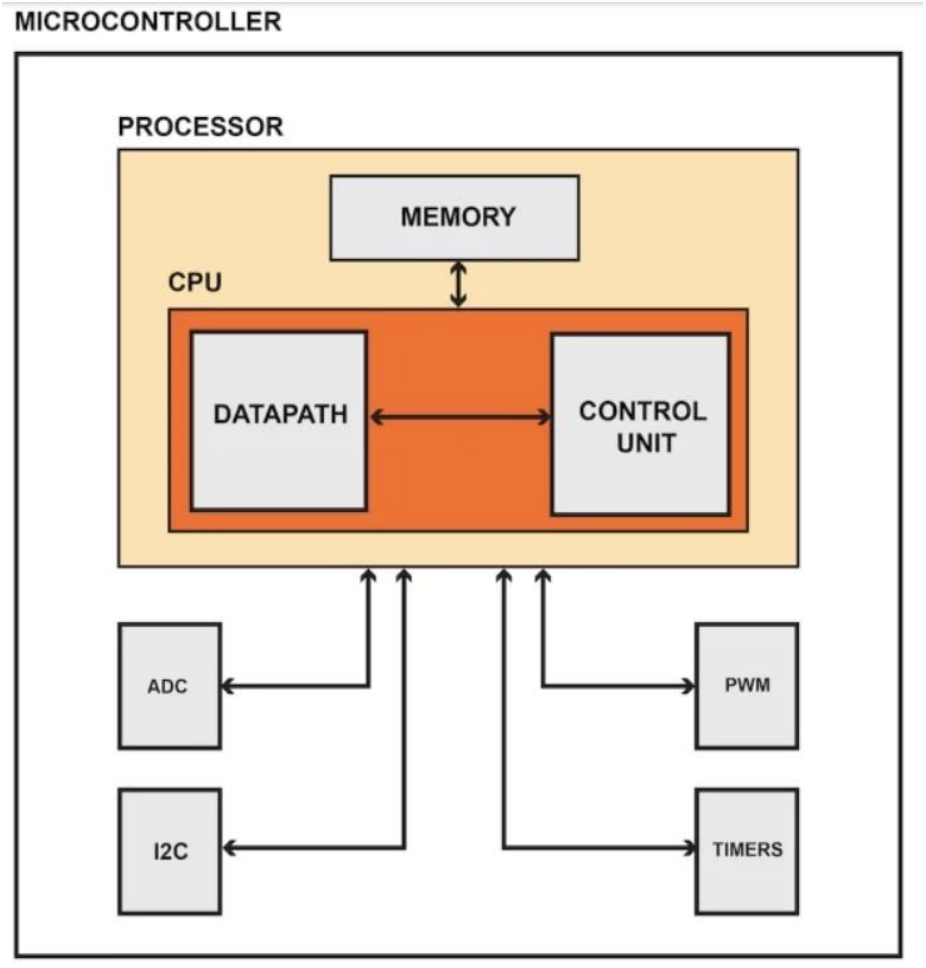


0,95 euros
150µA at 3.6Volts (3xAAA)
10 or 20 MHz

The Elements of a Microcontroller

A microcontroller consists of a:

- CPU
- Memory
  - Non volatile
  - FLASH → program.
  - EEPROM → data
  - Volatile memory
  - SRAM →temporary data.
- Clock generation
  - Internal oscillator
  - External circuitry



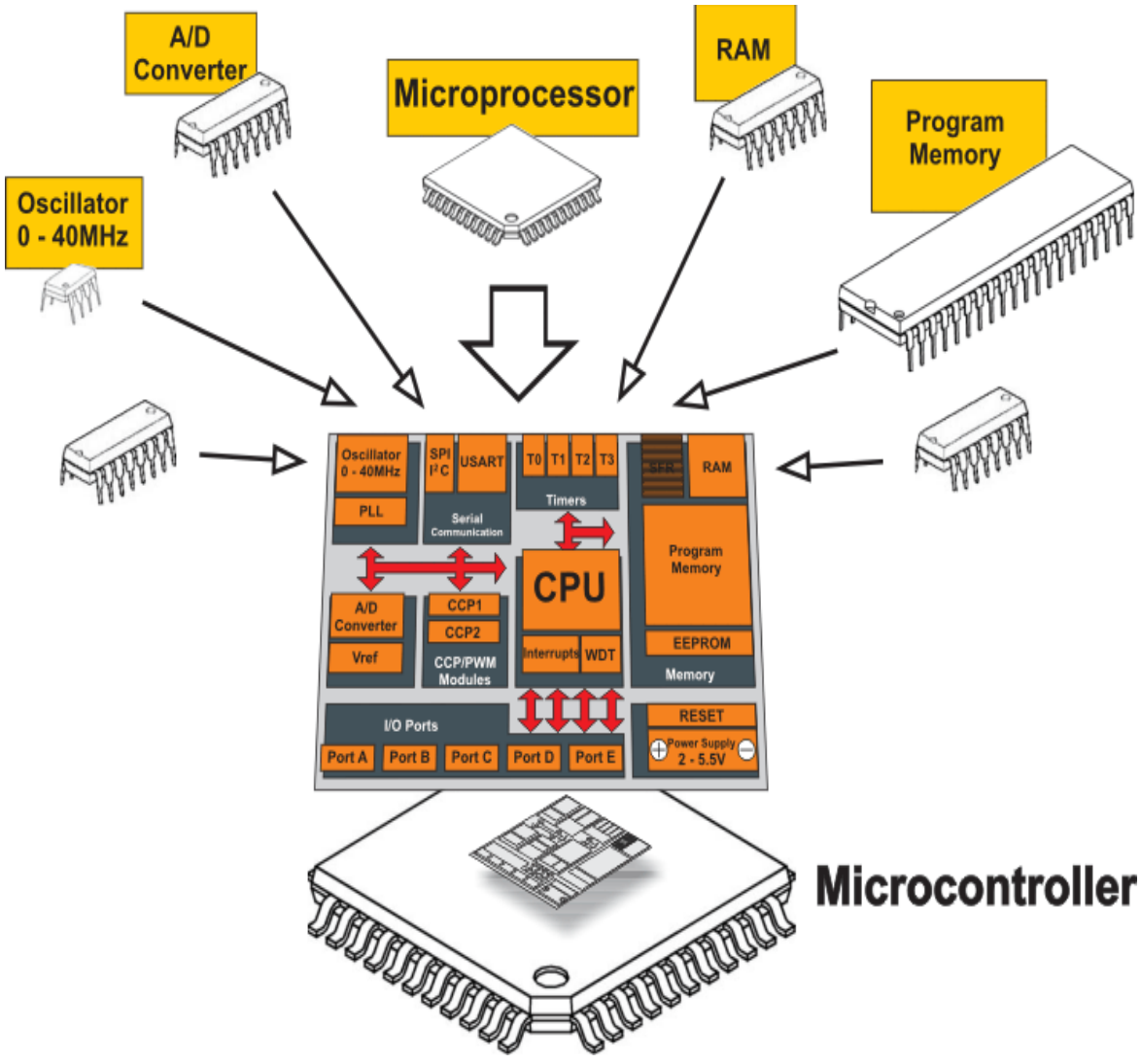
Source: https://www.allaboutcircuits.com/technical-articles/what-is-a-microcontroller-introduction-component-characteristics-component/

The Elements of a Microcontroller

- Peripherals: modules to interact with the external system.
  - Timing
    - General-purpose timer
    - External-event counter
    - Pulse-with modulation (PWM)
  - Analog signal processing
    - Analog comparator
    - ADC/DAC
  - Input/output:
    - General-purpose digital input and output circuitry (GPIO)
  - Communication
    - UART
    - SPI
    - I2C
    - USB

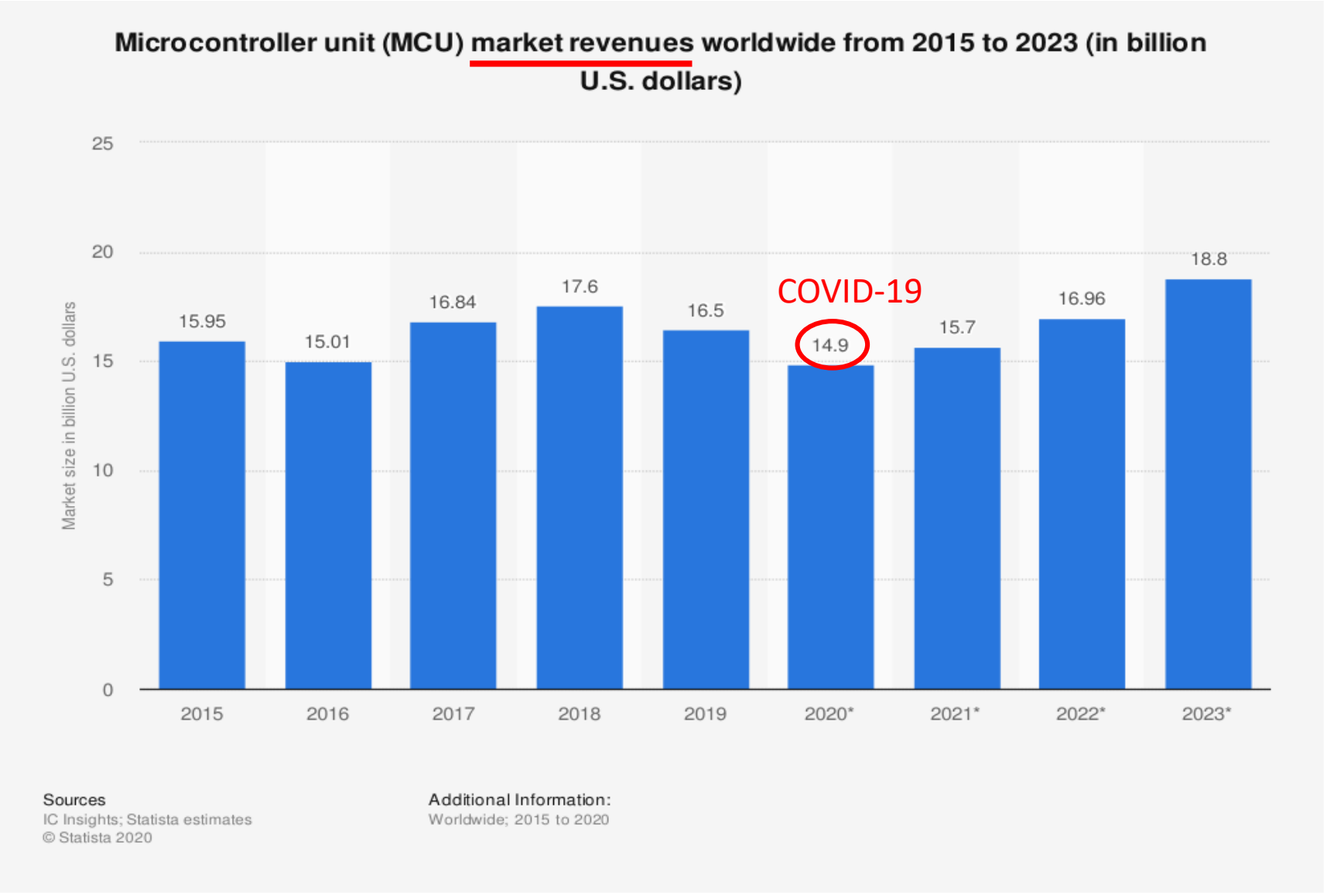
….and much more

The Elements of a Microcontroller

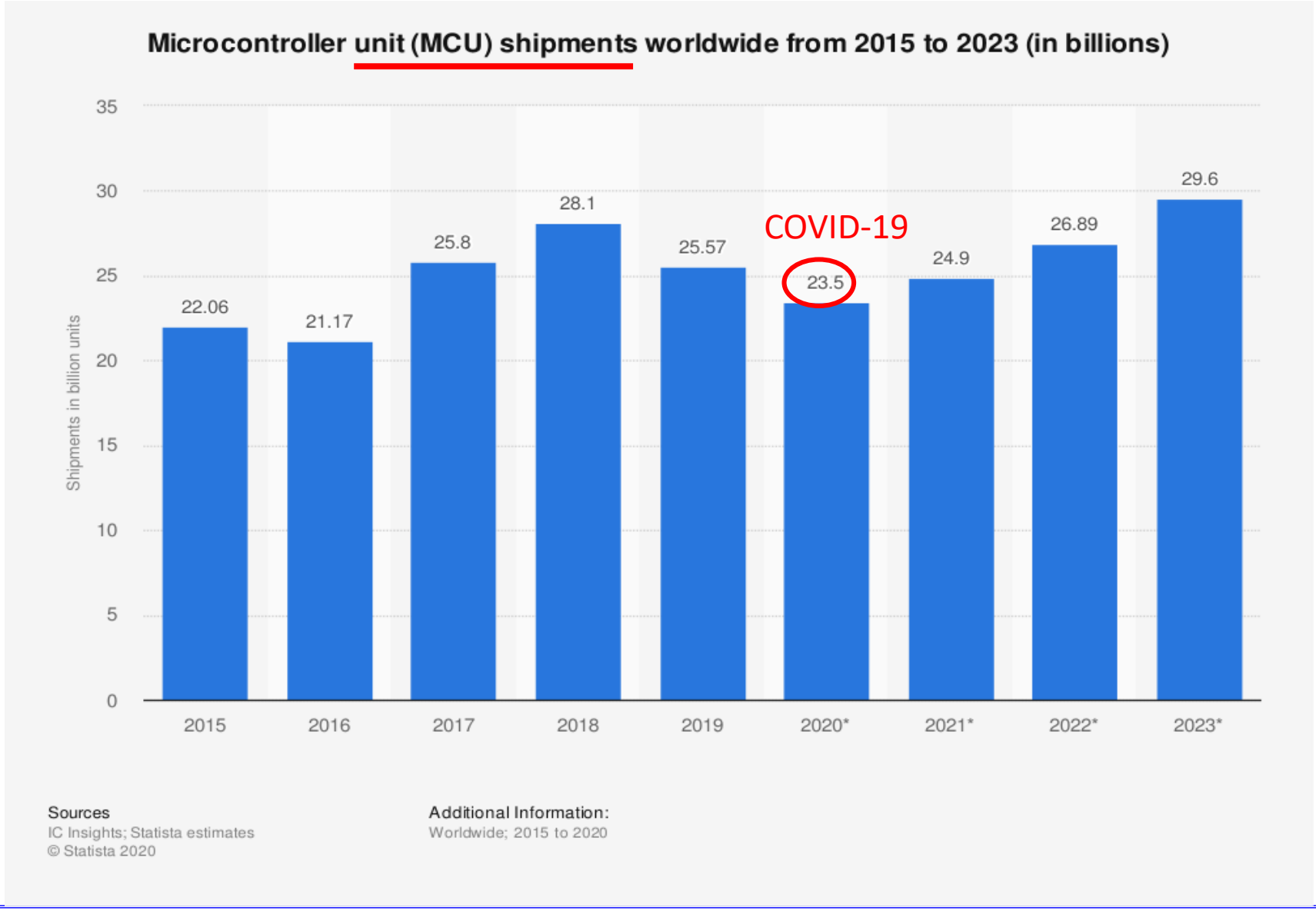


2.2. MCU market

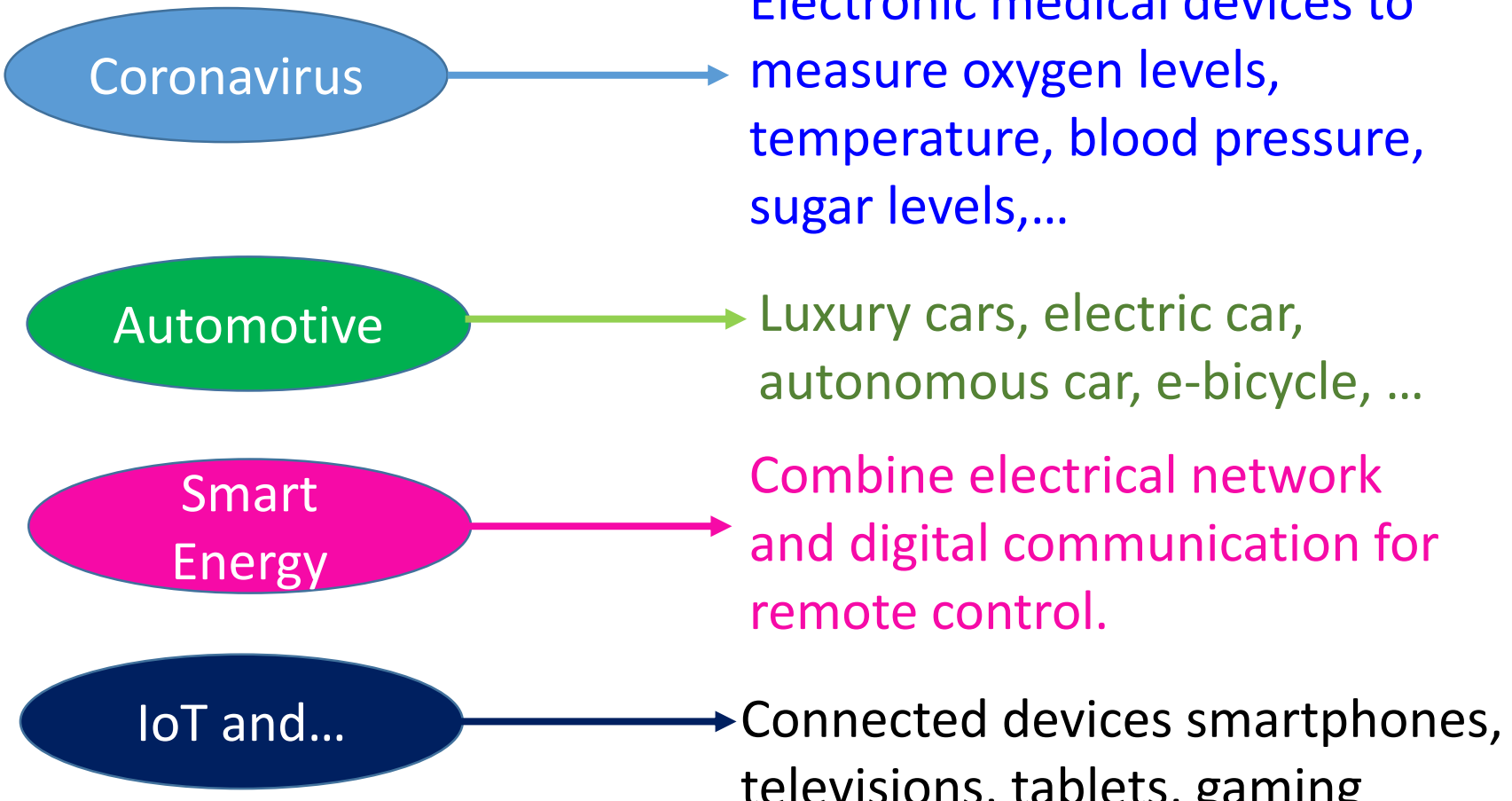
Microcontrollers market review



Microcontrollers market review



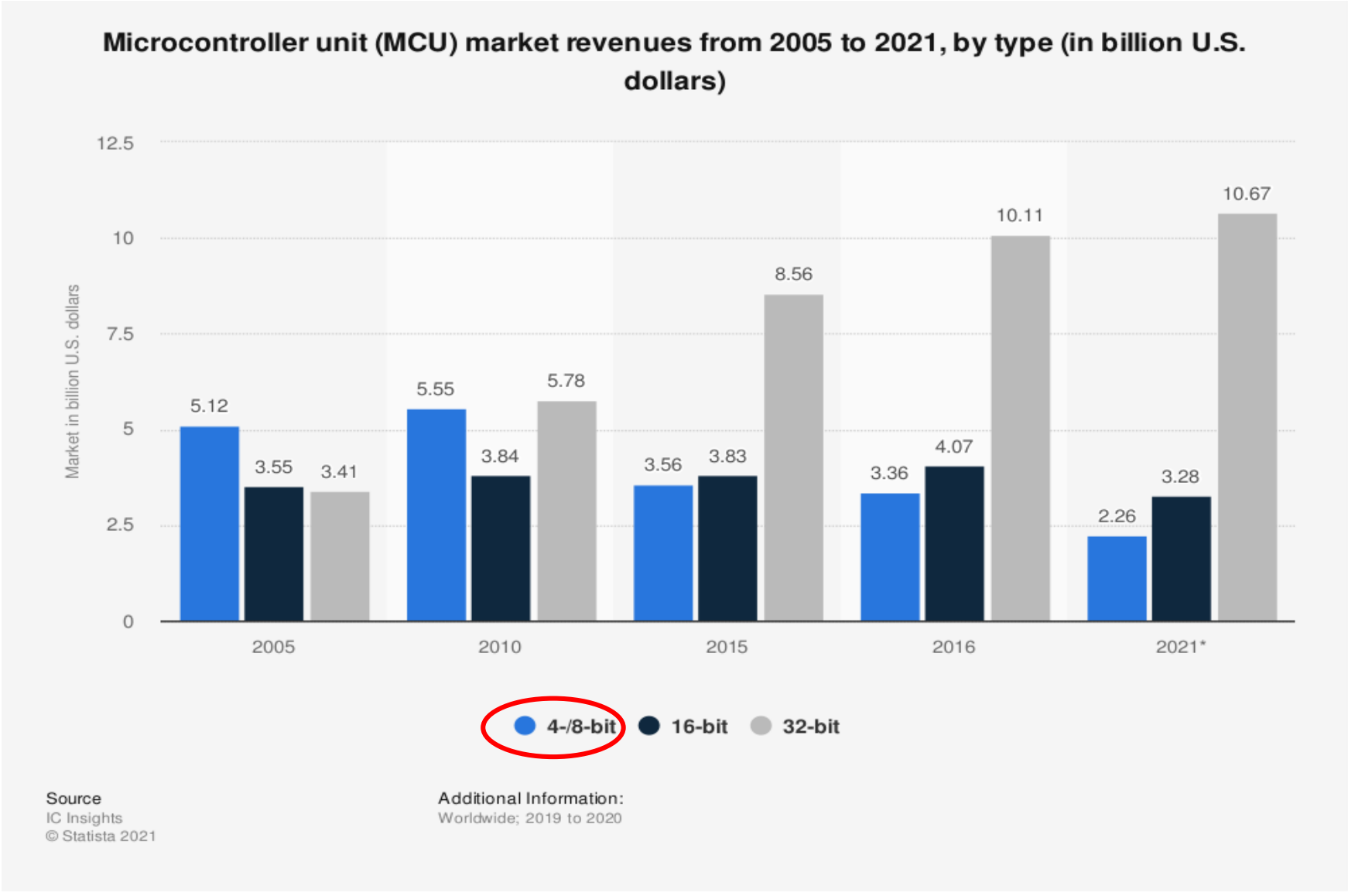
MCU market review: Boosting the market growth



https://www.grandviewresearch.com/industry-analysis/microcontroller-market

2.3. 8-bit MCU

MCU market review: by type



MCU market review: Why 8-bit ?

- 8-bit low-pin-count (LPC) microcontrollers:
  - **Process shrinks**
  - **Lower cost.**

- **Automotive:**
  - Motor control: fuel efficiency
  - Connectivity
  - HVAC (air conditioner,…)

Ethernet and wireless connectivity requirements

- **Smart energy** management at home: **thermostats**

- **Consumer Electronics and Home Appliance**
  - Internet of Things (IoT)
  - Connected technologies: wearables, smoke detectors, **thermostats**, ….
    → ultra-low power consumption
    → integrated high-performance analog features.

MCU market review: Why not 8-bit ?

- Intense competition from 16-bit and 32-bit
- The automotive industry → uses 16-bit and 32-bit MCUs on a large scale.
- New 32-bit MCUs have a higher processing power than their counterparts and consume less power.
- 32-bit MCUs is decreasing unit price.
- 8-bit MCU → low processing speed (8 MHz)
  → not have substantial RAM

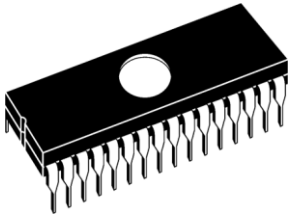
"32-bit CPUs will dominate when a complete 32-bit microcontroller costs $0.50"

(By Prof. Philip Koopman)

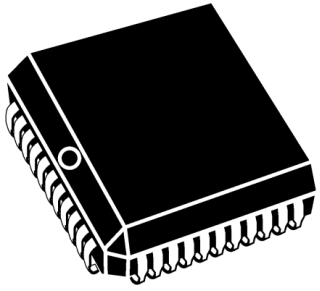
2.4. How to select a MCU

How to select a Microcontroller

➢ Know Hardware Requirements:

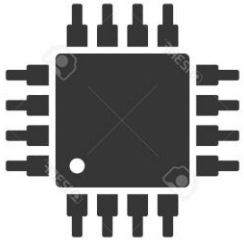


- Need communication interfaces like UART, Ethernet…?
- How many output and input **pins** you need to connect?
- Need analogic conversion?
- Do you want PWM?



➢ Know Software Requirements

- What processing speed is required?
- What type of calculations are involved?
- How much processing power is required?
- What are the timing constraints?



➢ Architecture

4 bit, 8 bit, 16 bit and 32 bit

How to select a Microcontroller

➢ Cost and Power Requirements

- Complex operations requires a higher cost
- Battery or not. Meet the power.

➢ Memory Requirement

- How much memory is required by your code

➢ Know Software Tools

- Assemblers, compilers, debuggers and simulating tools

https://en.wikipedia.org/wiki/List_of_common_microcontrollers

Microcontrollers market review

8-bit

- Lower end applications
- Low-cost
- Low-power
- Suitable for one job
- Small size
- From small 6-pin devices to chips with 64 pins.
- Flash → 256/512KB,
- SRAM → 32 to 8KB
- EEPROM → 0 to 4K

Microcontrollers market review

8-bit Most popular

- 8051 series (Intel):
  - Appliances, wireless communication devices, satellite modules…
  - Now used as IP
  - Suitable for low-cost and low-power

- PIC (Microchip):
  - Lot of tools (MPLAB IDE)
  - USART, SPI, I2C, ADC, USB, LIN, CAN and ….

- AVR (ATMEL now Microchip):
  - PIC comparable performance
  - IDE Arduino. Wide range of available libraries for Arduino
  - Software development → AVR studio

Microcontrollers market review

16-bit

- Mid-end applications
- Faster, more peripherals, more memory, more IO pins, have hardware multipliers.
- Both ADC's and DAC's
- More hardware :
  - Encryption engines
  - Operational or Programmable Gain Amplifiers
  - DMA controllers.

Microcontrollers market review

16-bit Most popular

- Microchip (dsPIC33 is a popular choice),
- NXP
- Infineon
- Cypress
- Texas instruments→ TI MSP430
- Renesas

Microcontrollers market review

32-bit

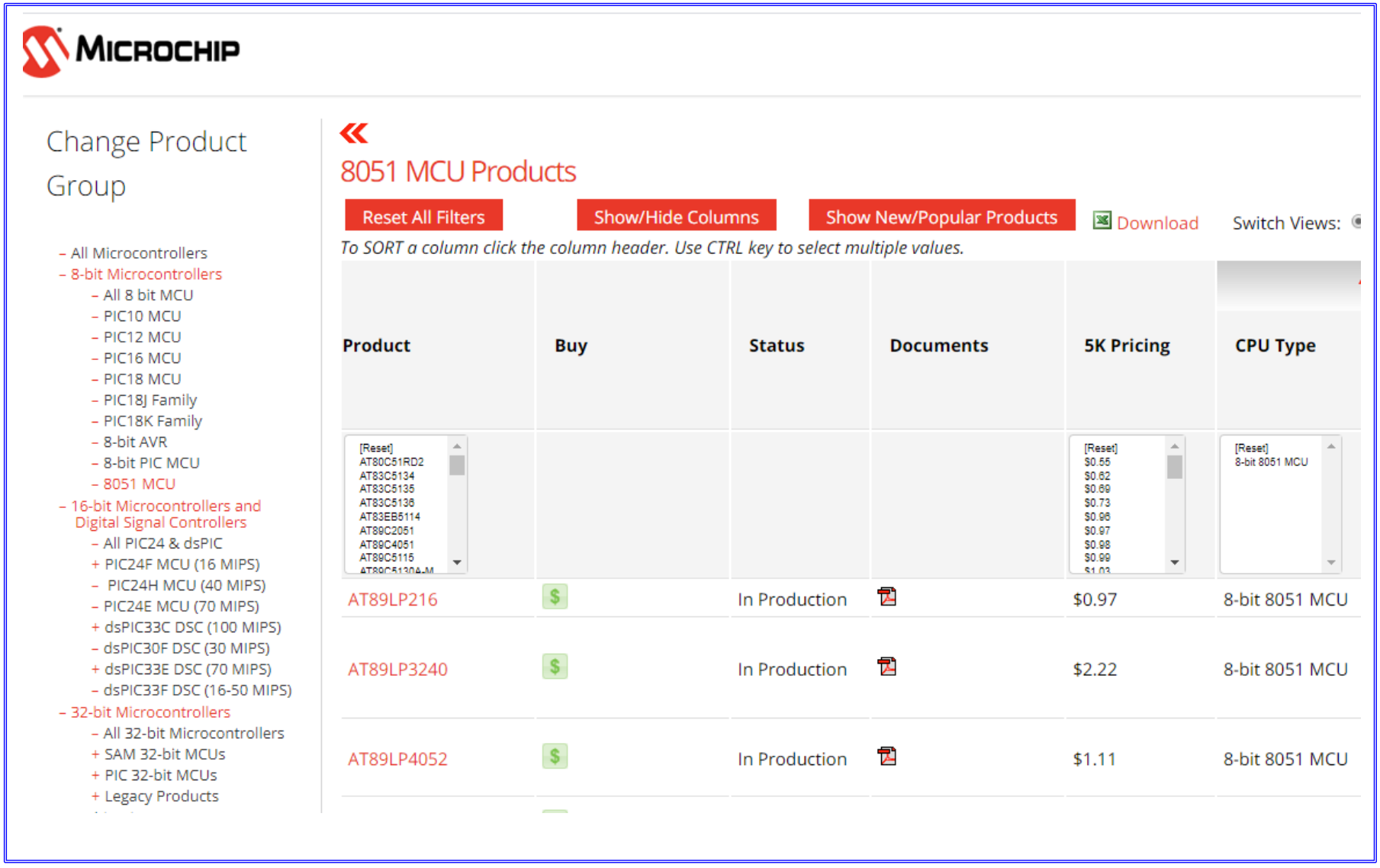
- Powerful with microprocessor-like features.
- Advanced features
  - Instruction pipelining
  - Branch prediction
  - Nested Vectored Interrupts (NVI),
  - Floating Point Units (FPU),
  - Memory protection
  - On-board debuggers.
- Run large, fast, and robust applications.
- Real Time Operating Systems (RTOS)

Microcontrollers market review

32-bit Most popular

- ARM Cortex M-based
- Vendors of ARM-based chips :
  - Atmel → SAM device line
  - STMicroelectronics → STM32
- Espressif → ESP32 includes:
  - WiFi and Bluetooth hardware on the chip: protocol stacks, radio transceivers and theres is a small pre-certified module with integrated antenna.
  - Very affordably priced
  - 10 capacitive touch GPIOs.

Microcontrollers market review



MICROCHIP

Change Product Group

- All Microcontrollers
- 8-bit Microcontrollers
  - All 8 bit MCU
  - PIC10 MCU
  - PIC12 MCU
  - PIC16 MCU
  - PIC18 MCU
  - PIC18J Family
  - PIC18K Family
  - 8-bit AVR
  - 8-bit PIC MCU
  - 8051 MCU
- 16-bit Microcontrollers and Digital Signal Controllers
  - All PIC24 & dsPIC
  - + PIC24F MCU (16 MIPS)
  - PIC24H MCU (40 MIPS)
  - PIC24E MCU (70 MIPS)
  - + dsPIC33C DSC (100 MIPS)
  - dsPIC30F DSC (30 MIPS)
  - + dsPIC33E DSC (70 MIPS)
  - dsPIC33F DSC (16-50 MIPS)
- 32-bit Microcontrollers
  - All 32-bit Microcontrollers
  - + SAM 32-bit MCUs
  - + PIC 32-bit MCUs
  - + Legacy Products

8051 MCU Products

Reset All Filters | Show/Hide Columns | Show New/Popular Products | Download | Switch Views:

To SORT a column click the column header. Use CTRL key to select multiple values.

Product	Buy	Status	Documents	5K Pricing	CPU Type
[Reset] AT80C51RD2 AT83C5134 AT83C5135 AT83C5136 AT83EB5114 AT89C2051 AT89C4051 AT89C5115				[Reset] $0.55 $0.62 $0.69 $0.73 $0.96 $0.97 $0.98 $0.99	[Reset] 8-bit 8051 MCU
AT89LP216	$	In Production		$0.97	8-bit 8051 MCU
AT89LP3240	$	In Production		$2.22	8-bit 8051 MCU
AT89LP4052	$	In Production		$1.11	8-bit 8051 MCU