
{EPITECH}

{EPITECH}

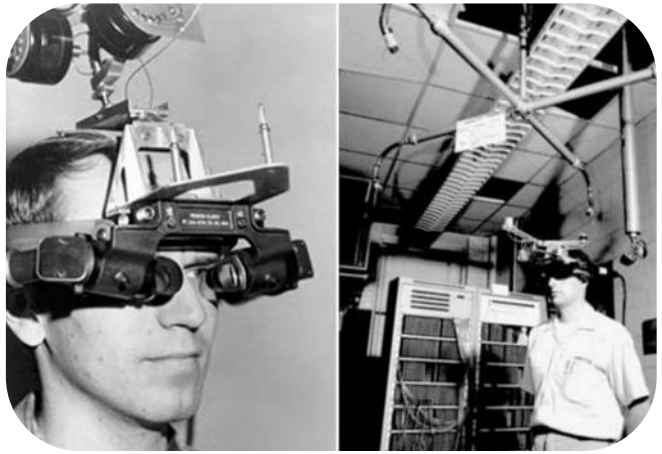
T-DEV-811

Smart Trash Cans

IOT – Augmented Reality

Augmented Reality

History



1968, Harvard

Ivan Sutherland
1st Head-mounted display called 'The Sword of Damocles'

1990, Boeing's Computer Services Research

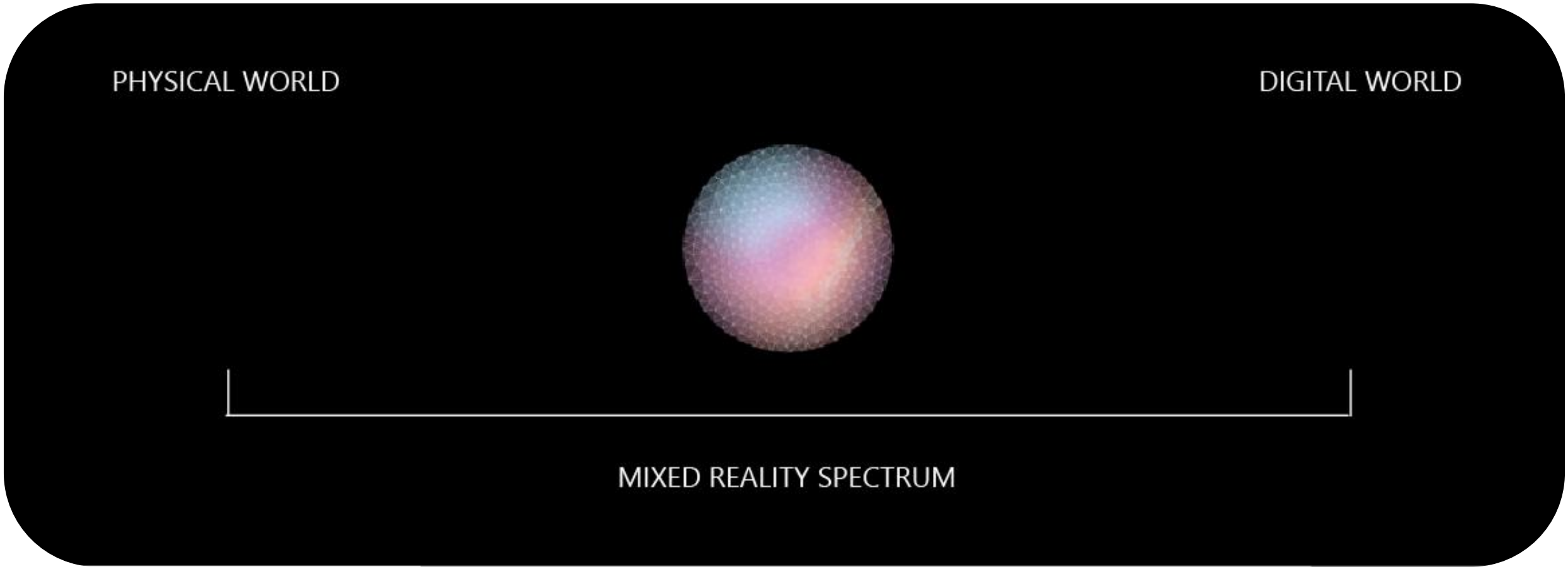
Tom Caudell
Coined the term "Augmented Reality"

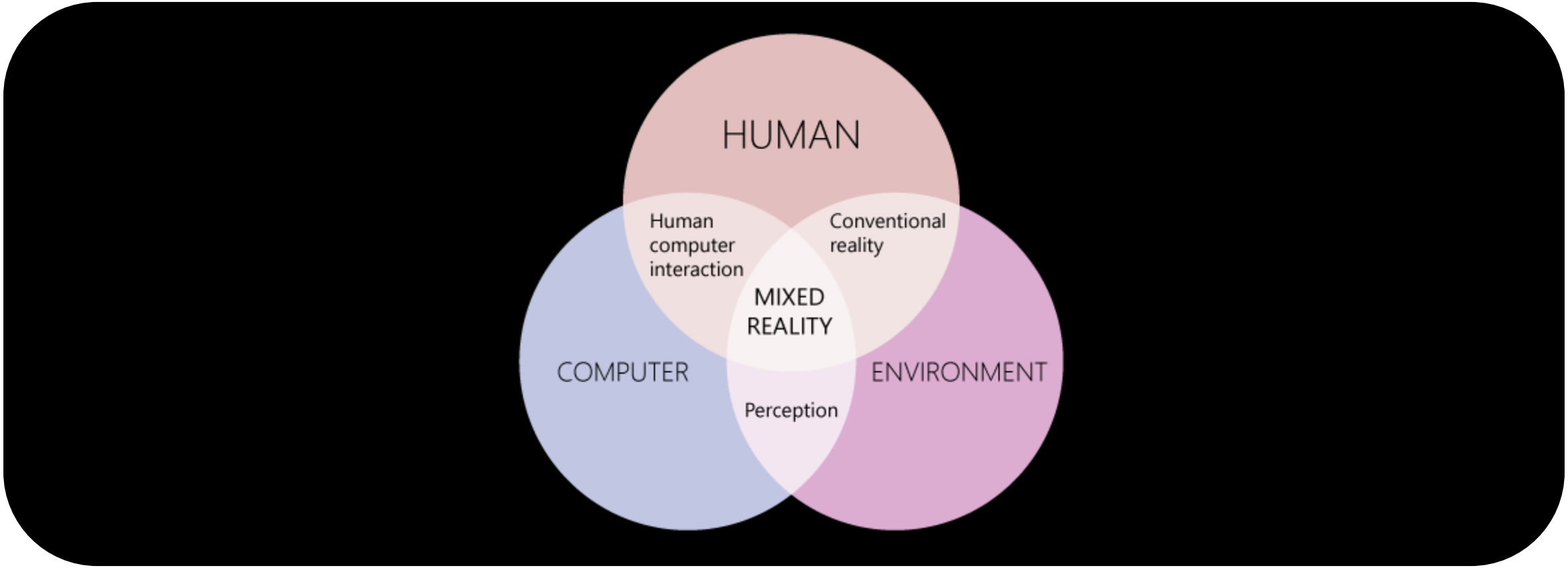
Developed a software which displayed the position of key cables during construction

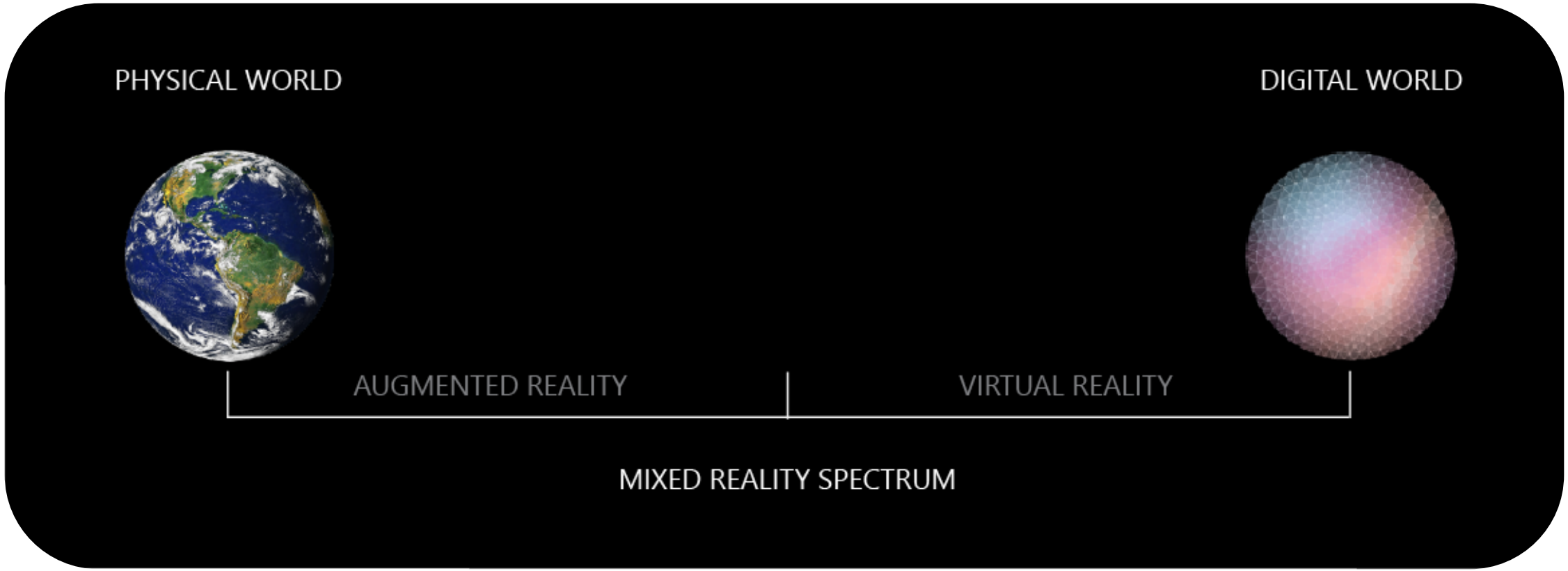
Today

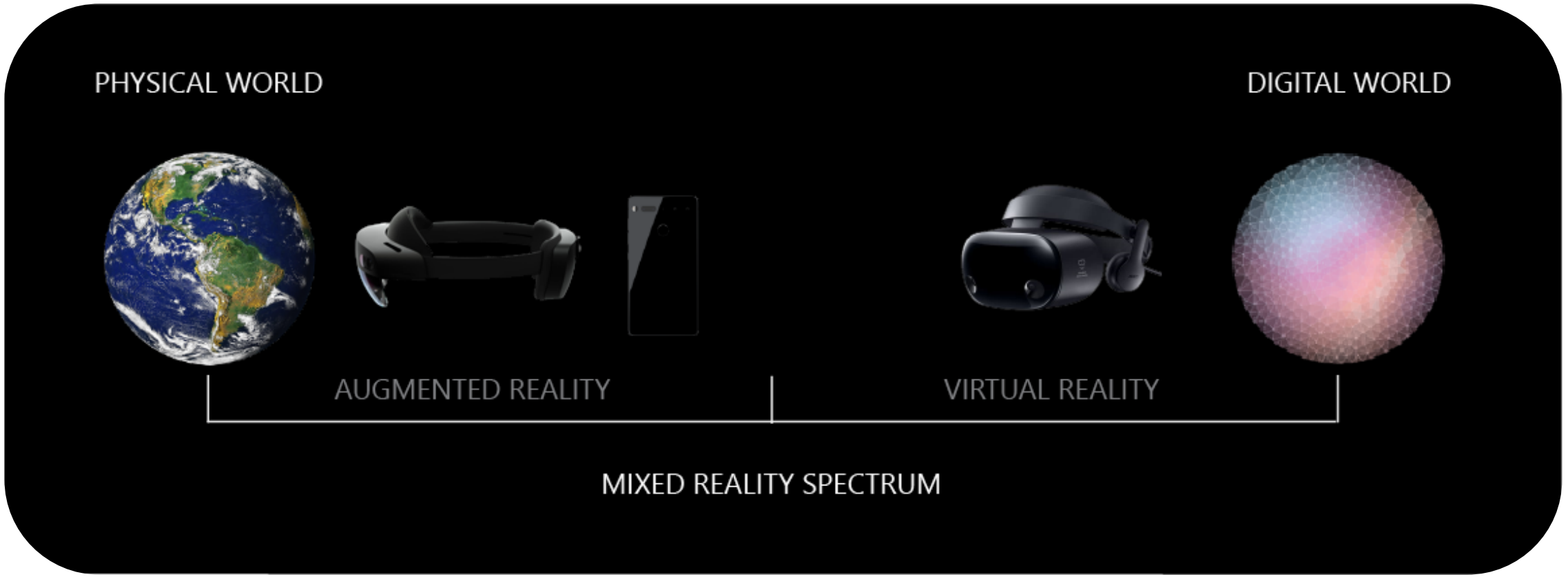
AIRBUS

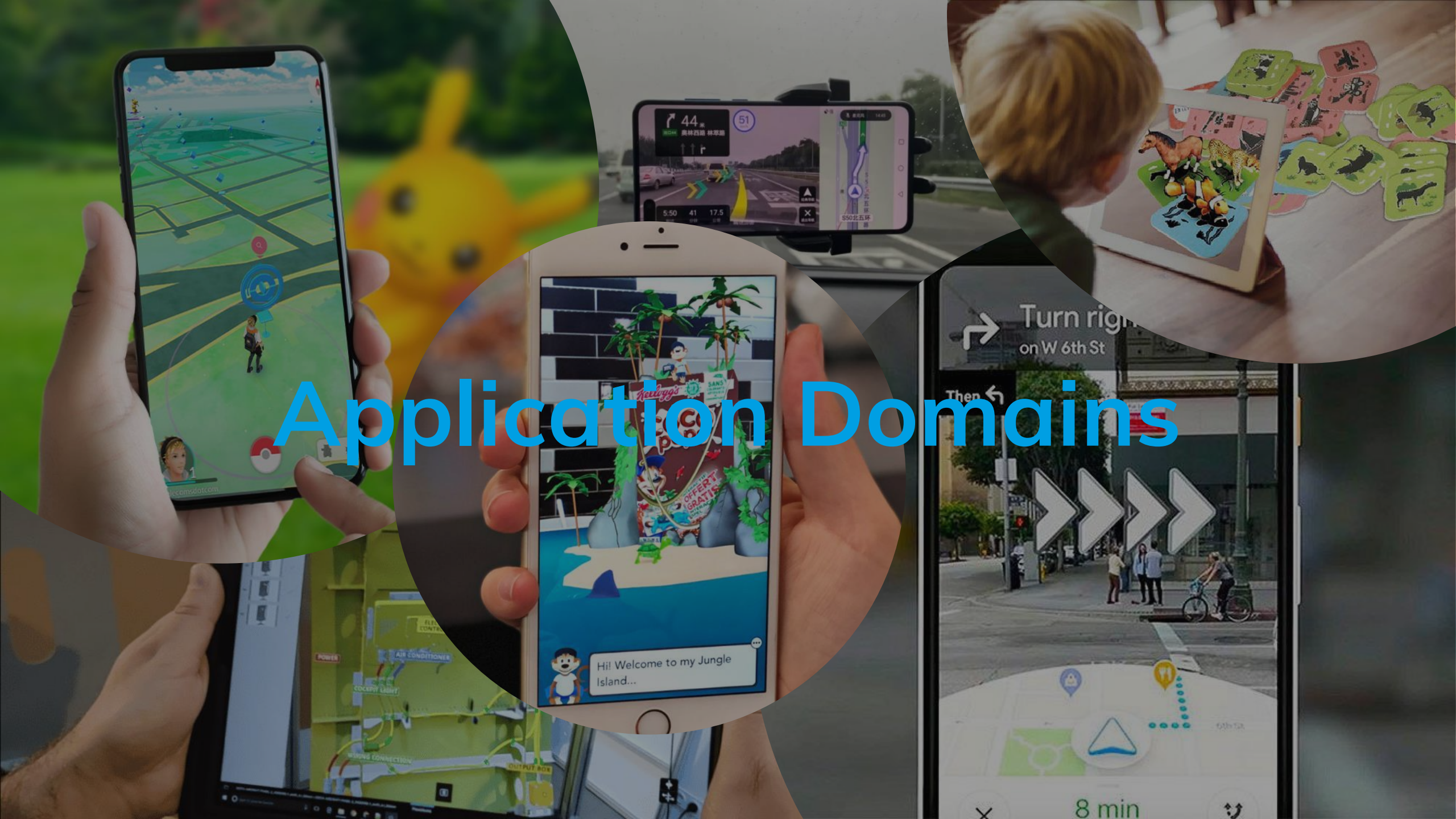
Microsoft HoloLens 2


PHYSICAL WORLD
DIGITAL WORLD
MIXED REALITY SPECTRUM


HUMAN
Human computer interaction
Conventional reality
MIXED REALITY
COMPUTER
ENVIRONMENT
Perception


PHYSICAL WORLD
DIGITAL WORLD
AUGMENTED REALITY
VIRTUAL REALITY
MIXED REALITY SPECTRUM


PHYSICAL WORLD
DIGITAL WORLD
AUGMENTED REALITY
VIRTUAL REALITY
MIXED REALITY SPECTRUM



Application Domains

What Are The Different Types of Augmented Reality?

Marker Based AR

Projection AR

Location Based AR

Overlay

Contour Based

Marker-based AR

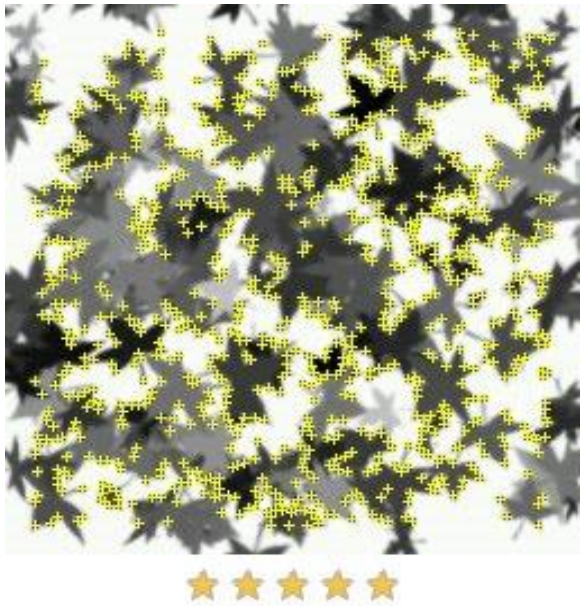
- Just need a

  (2D or 3D) target marker …

  … and an overflowing imagination!

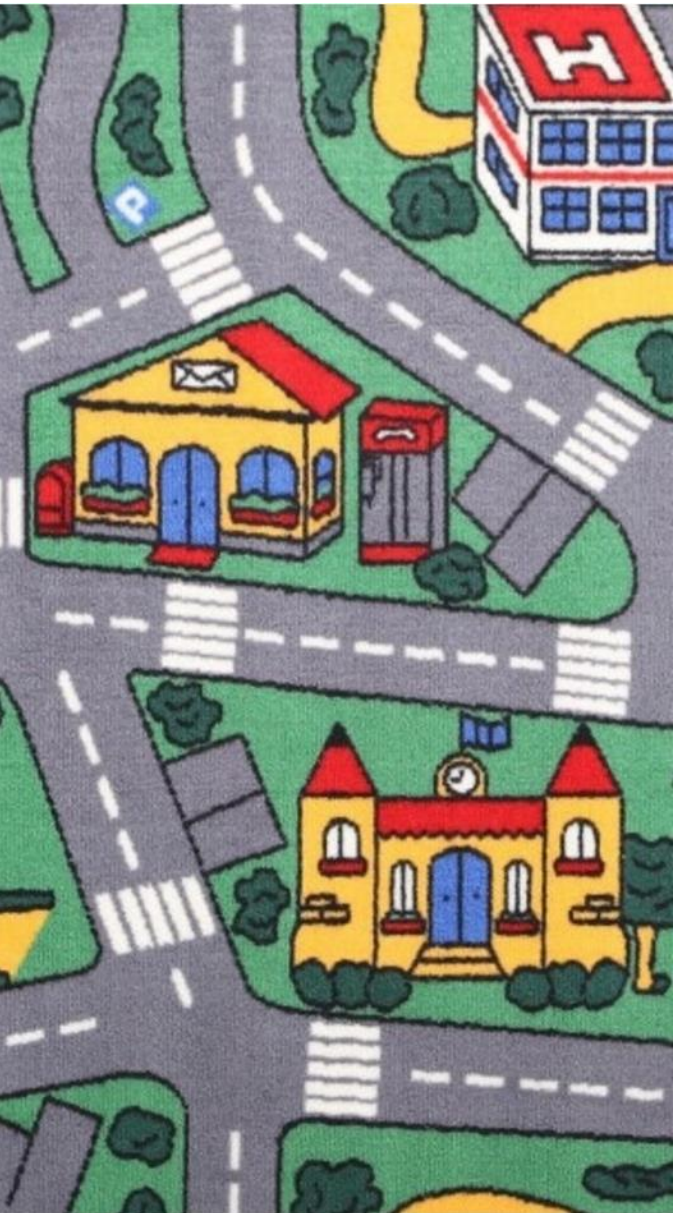
or

Markers: Best Practices



- **DOs**
  - Feature-rich target markers
  - Various shapes / curves / shadows
  - Distinctive designs
  - Bright and clear images
  - Large, graphic targets
  - Matte finish
  - …
- **DO NOTs**
  - Minimalist design
  - Repeated textures
  - Duplicating symbols across markers
  - Blurry images or background
  - Tiny markers
  - Text-heavy markers
  - Glossy print-outs
  - …

Overlaying data



- « Real-life » states of the trash cans

- Have you heard of 3D animations ?

Overlaying data

- Garbage truck equipped with a high-performance GPS to optimize journeys

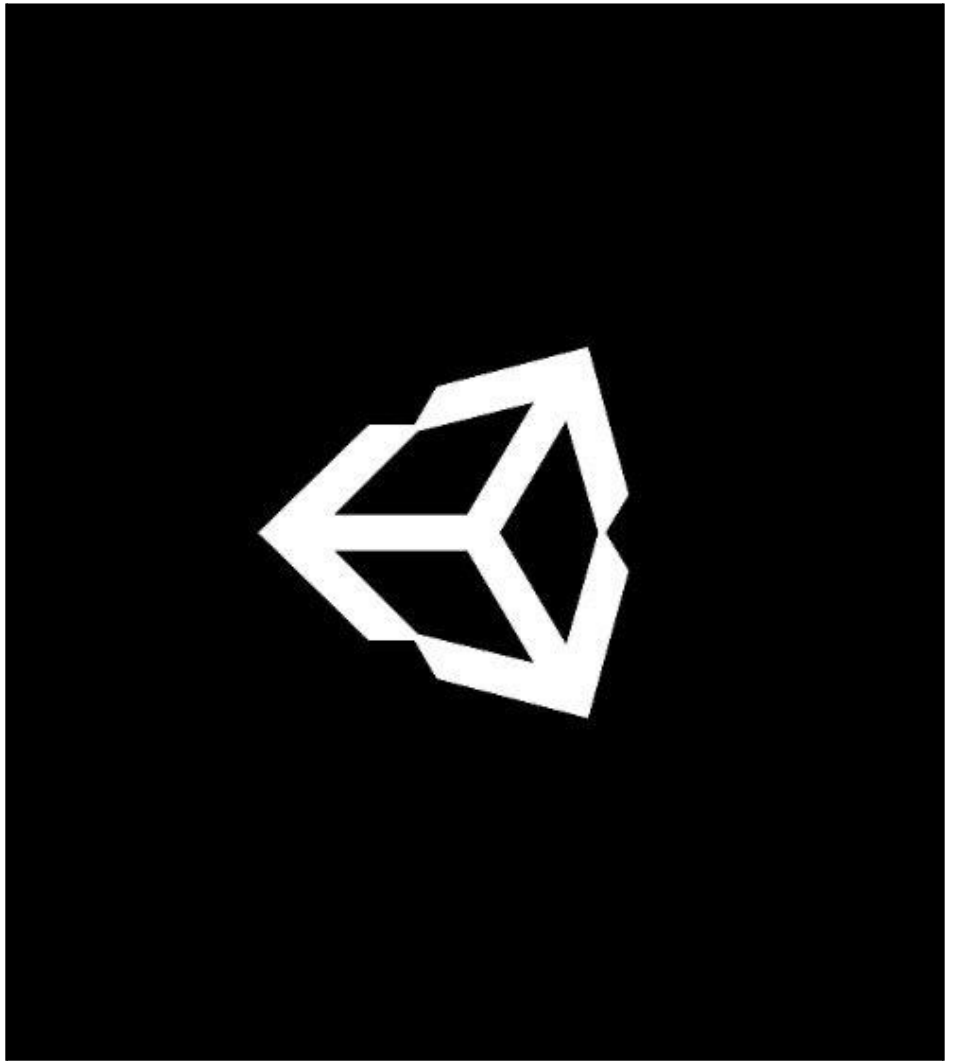
- Have you ever heard of “Pathfinding algorithms” ?

Choosing the right engine

- Unity3D is recommended but not mandatory!

- **Why** Unity3D?
  - Lots of tutorials
  - Huge community
  - Cross-platform
  - Asset store
  - SDK manager

... and MORE!



IoT

Example : industrial maintenance

IoT

- Internet of the Things
- Extremely wide range of applications

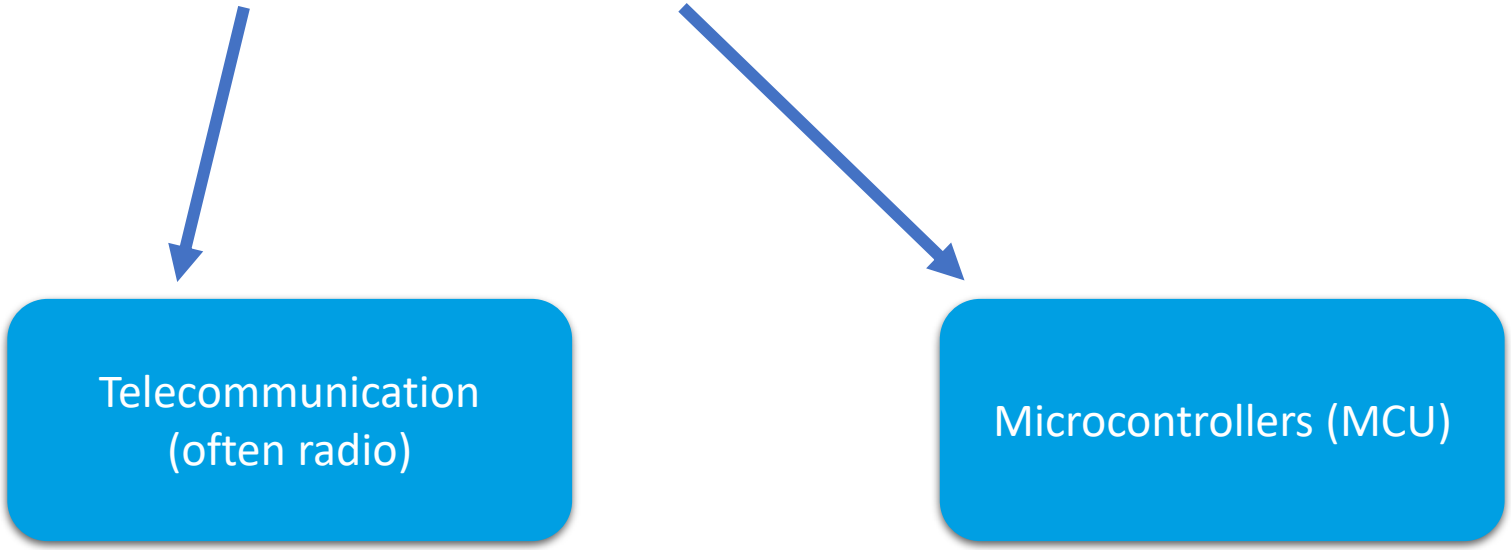
How many devices ?

- **2018 : 7 billions devices**
- **2025 : 21 billion devices (estimated)**

- **Far more connected objects than humans using Internet**

IoT

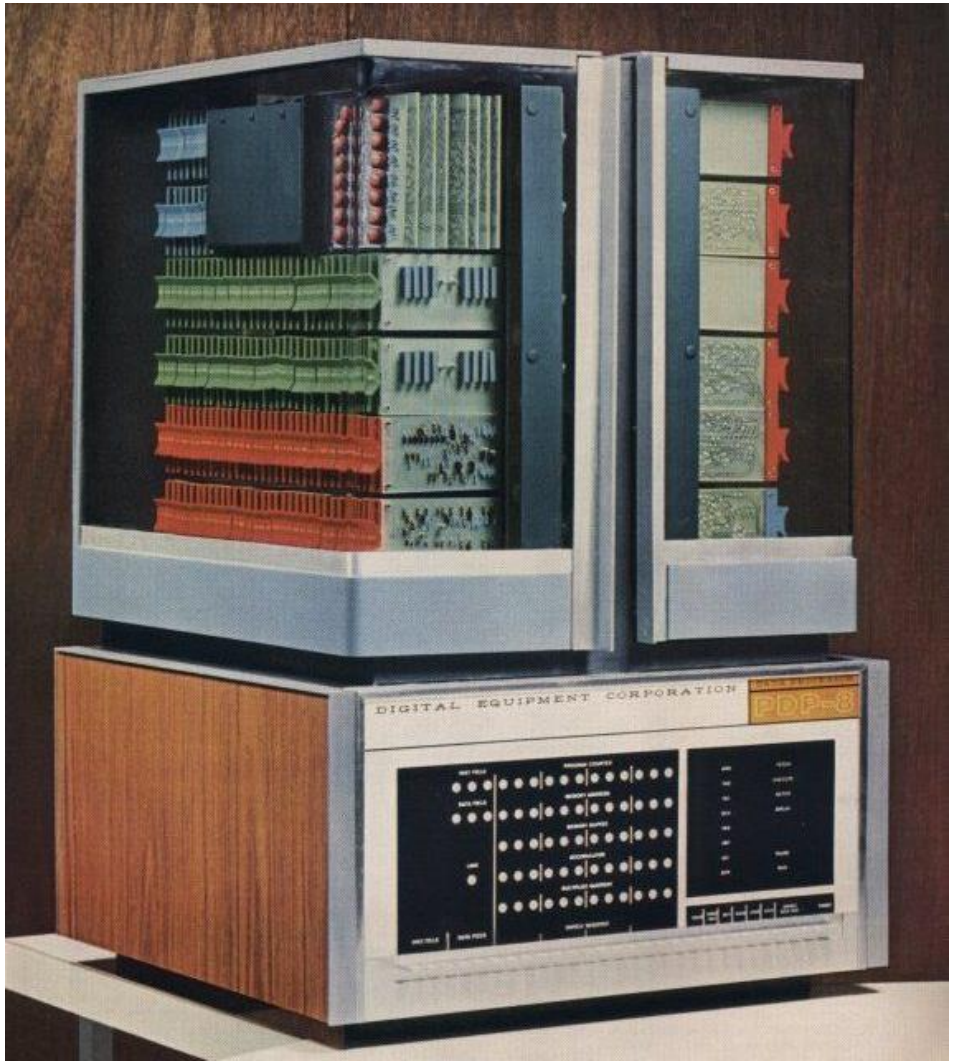
- **Internet of the Things**



History

- PDP-8 (1965-1984)
- Designed for research lab automation
- Huge success (for the time) : > 50000 units

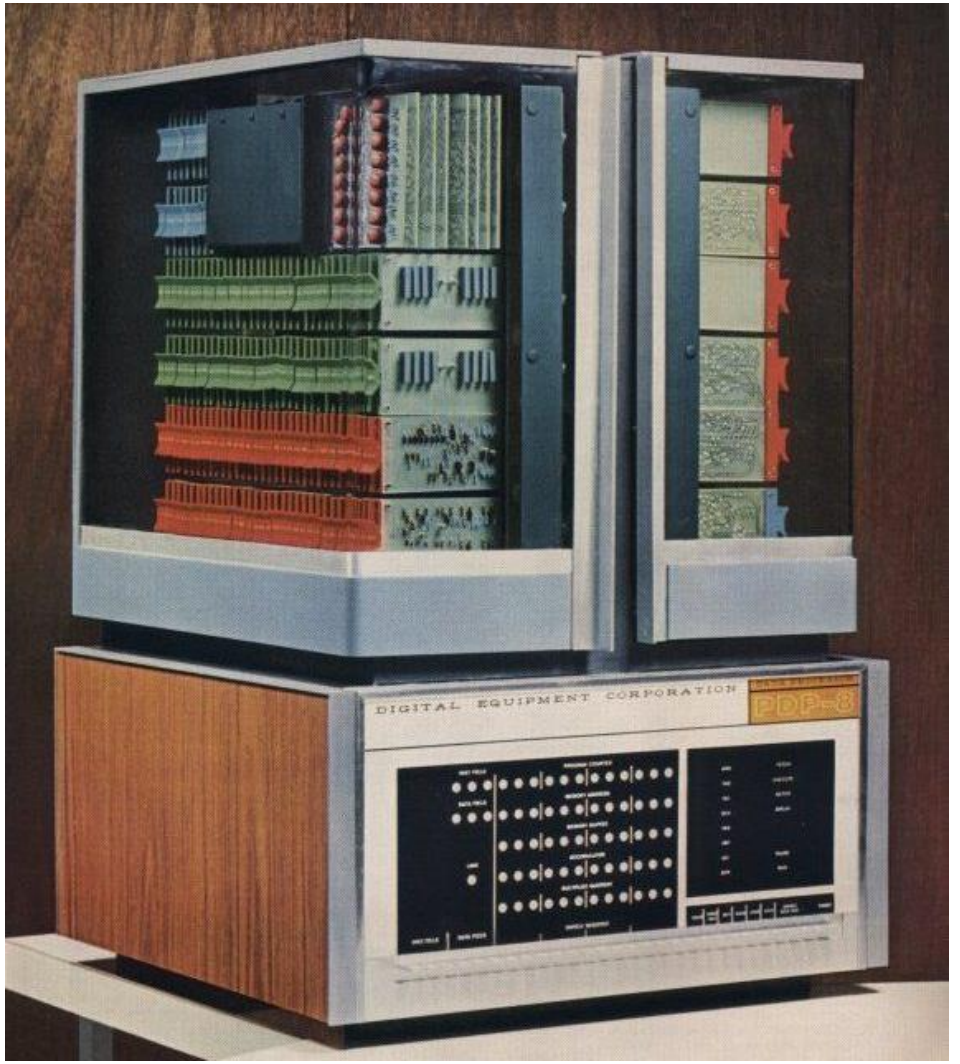
- Why ?



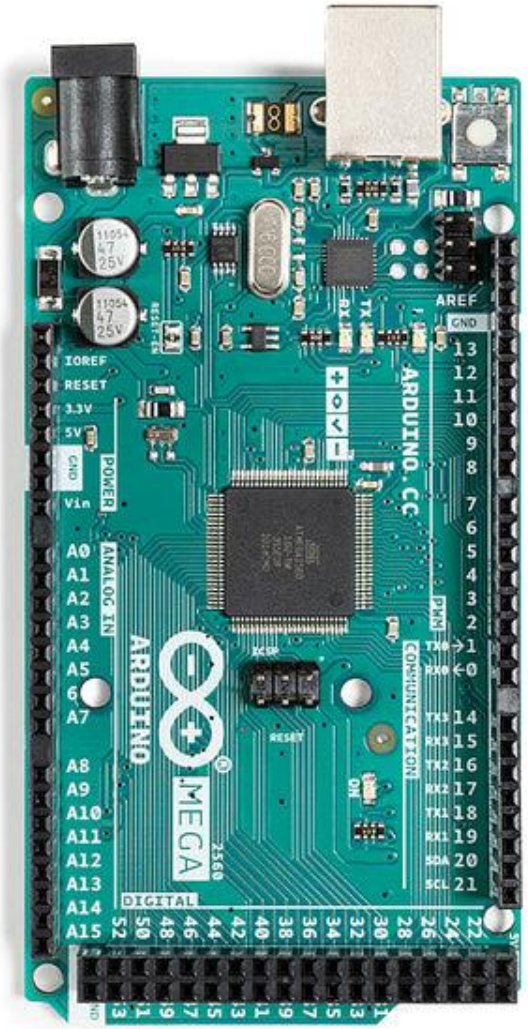
History

- PDP-8 (1965-1984)
- Designed for research lab automation
- Huge success (for the time) : > 50000 units

- Why ?
  - Low cost
  - Easy to use IO bus
  - Compact (easy to integrate in a lab)
  - 12 bits words = suitable range for measures
    (most ADC today are 12 bits)

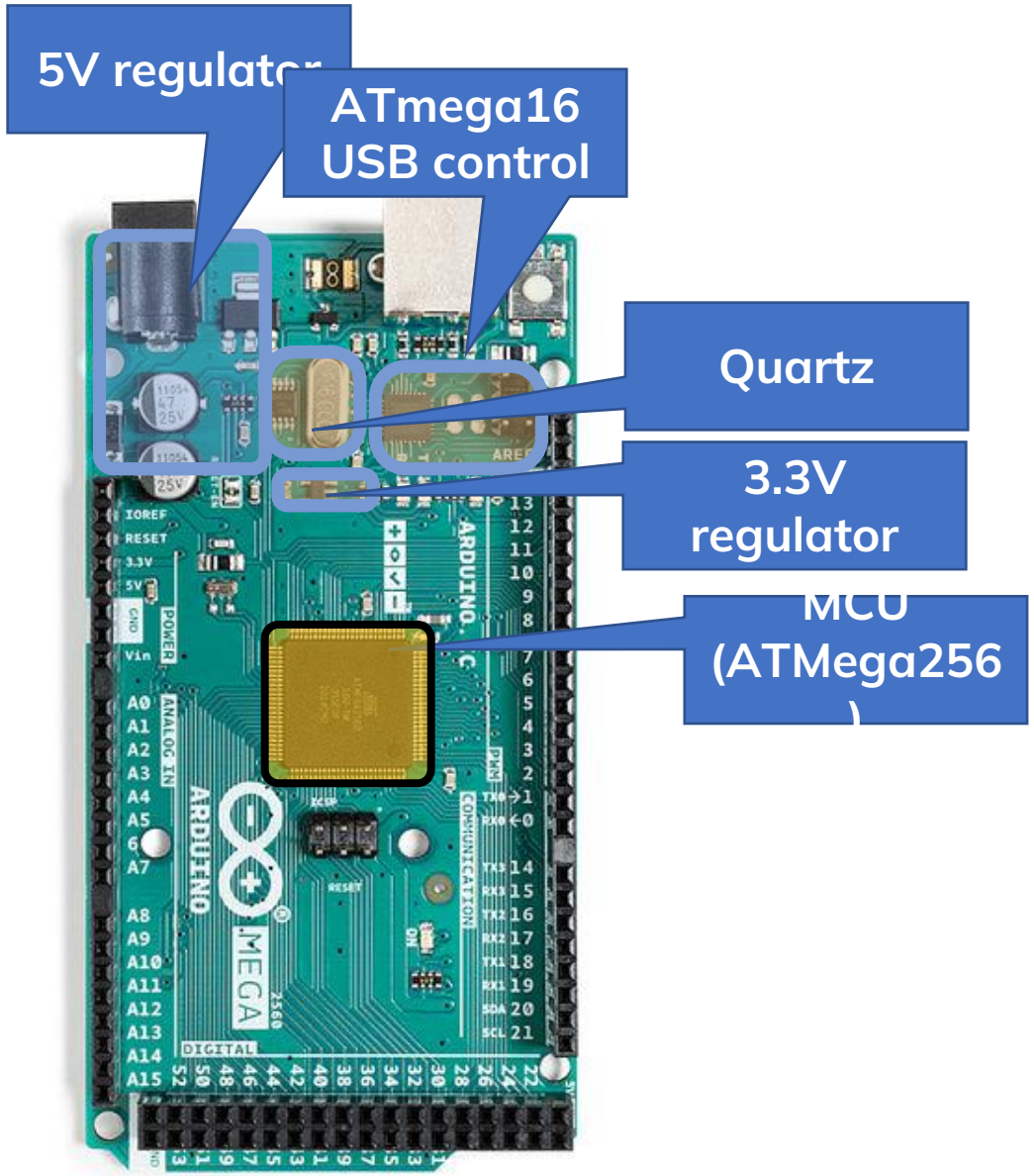


MCU



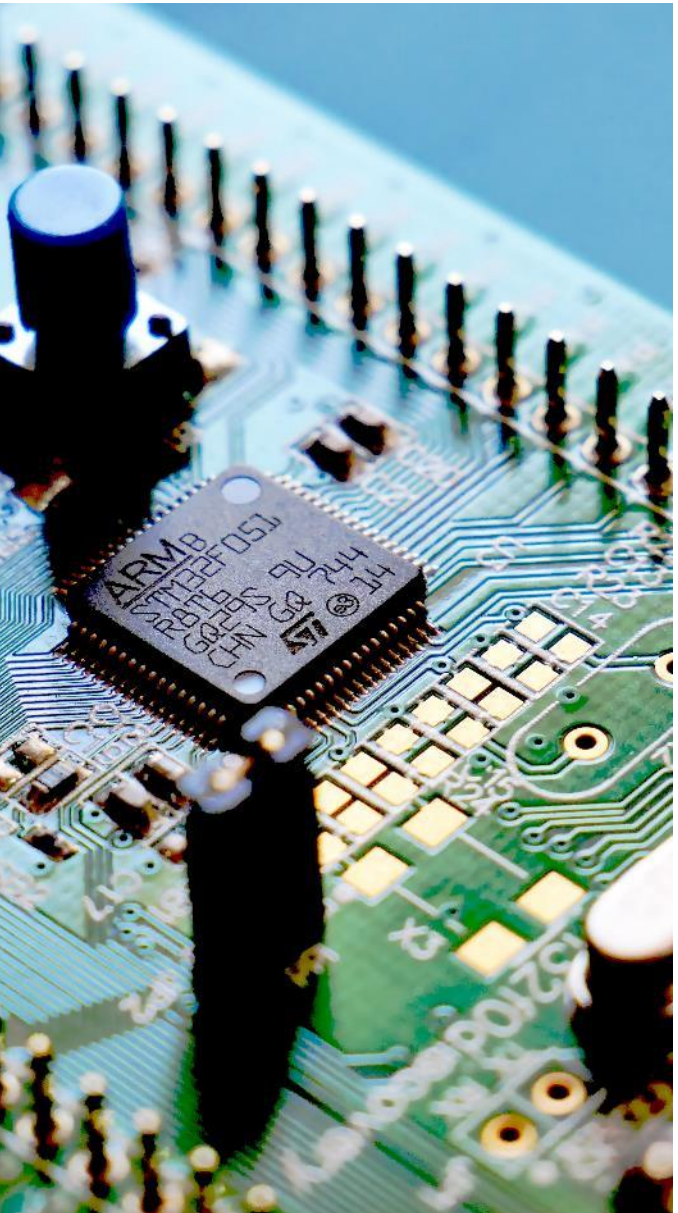
- « Everything on a single chip »
- Very few side components needed
  - Even quartz is optional

MCU



- « Everything on a single chip »
- Very few side components needed
  - Even quartz is optional

MCU



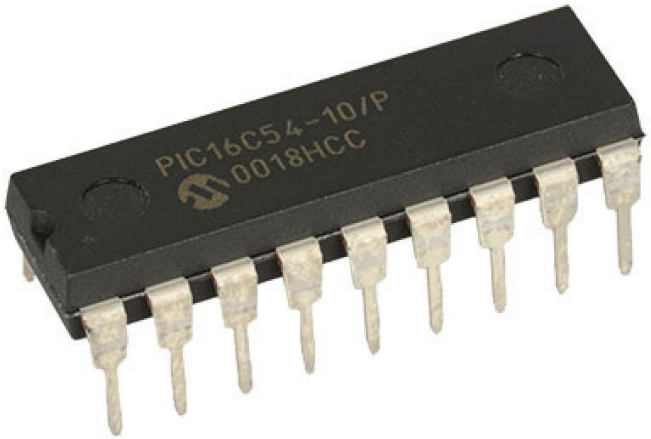
- Integrates all parts of computer (CPU, Flash, RAM, IOs…)
- Mostly : single chip board (only the MCU + power)
  - Even quartz is optional
- Low range CPU :
  - 8 bits are common
  - Low MHz (low power)
- Few kB of RAM and Flash
- But many IOs

MCU

- **Mass market**
  (billions of units / years)
- **Cost effective**
  (dozen of units in a car ; multiply unit cost by number of produced car…)
- **Very wide range of MCU**
  - **Cost effective**
- **Time to market**

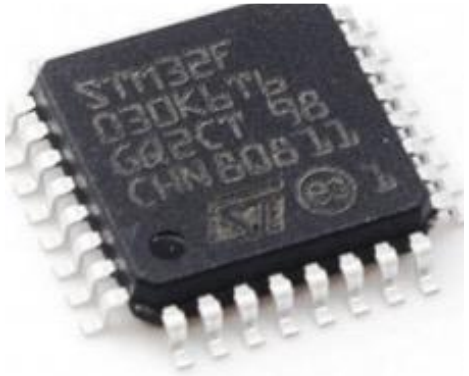
MCU examples

- PIC10F200
  - 6 pins package
  - 256 words FLASH for programs
  - 16 bytes RAM
  - 4MHz



- PIC16C54
  - 18 pins package
  - 8bit (12 bits instructions), 40 MHz
  - ROM : 512 words, RAM 20 bytes
  - 12 IO pins

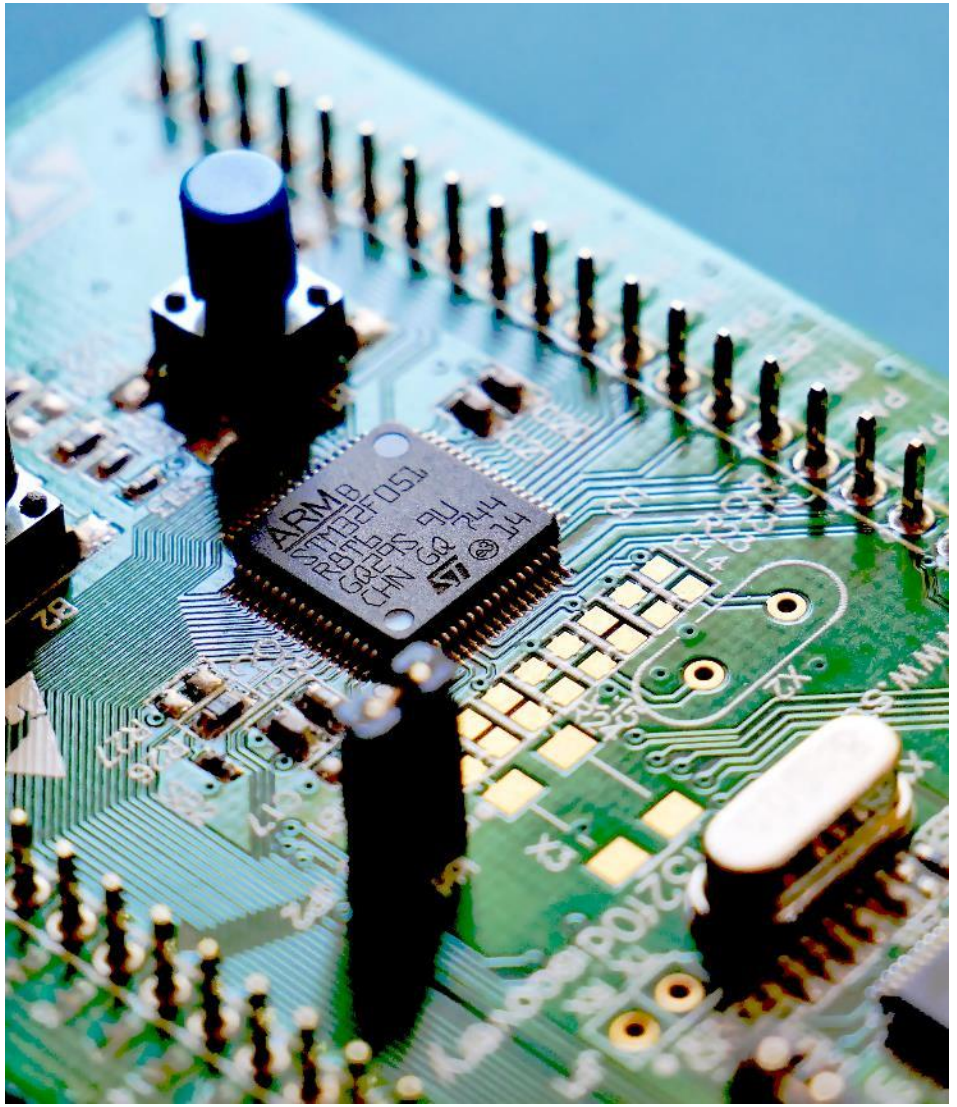
MCU examples



- STM32F103
  - 68K flash, 20K RAM
  - ARM 32 bits, 72MHz
  - 80 GPIO, 7 timers, 9 communication interfaces, 16 ADC channels, 7 DMA channels
- STM32H757
  - Dual ARM Cortex-M5, 480 MHz
  - DP FPU
  - JPEG codec, crypto hardware
  - 2MB FLASH, 1MB RAM

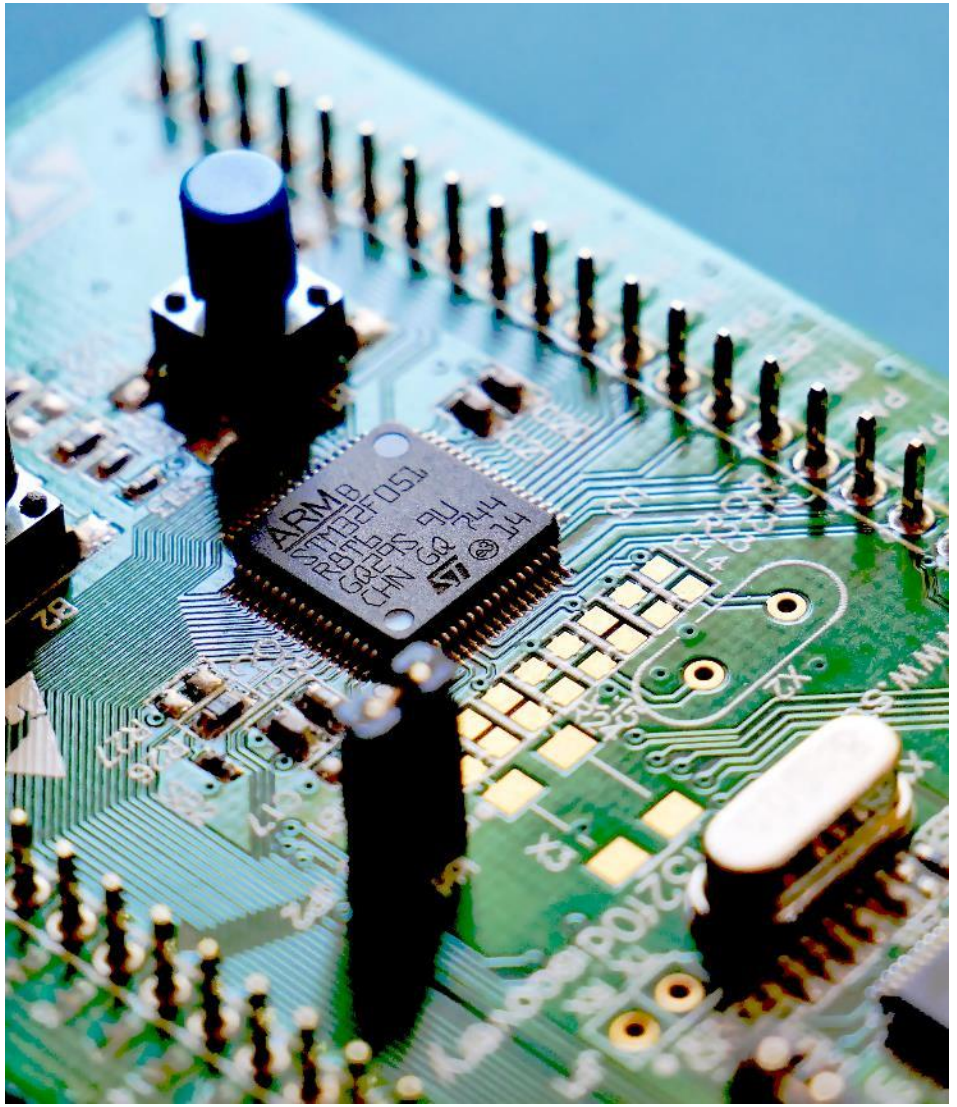
MCU

- Low power usage
  - For battery powered devices or solar powered
  - MCU often have low consumption
  - Configurable frequency
  - Advanced low power modes



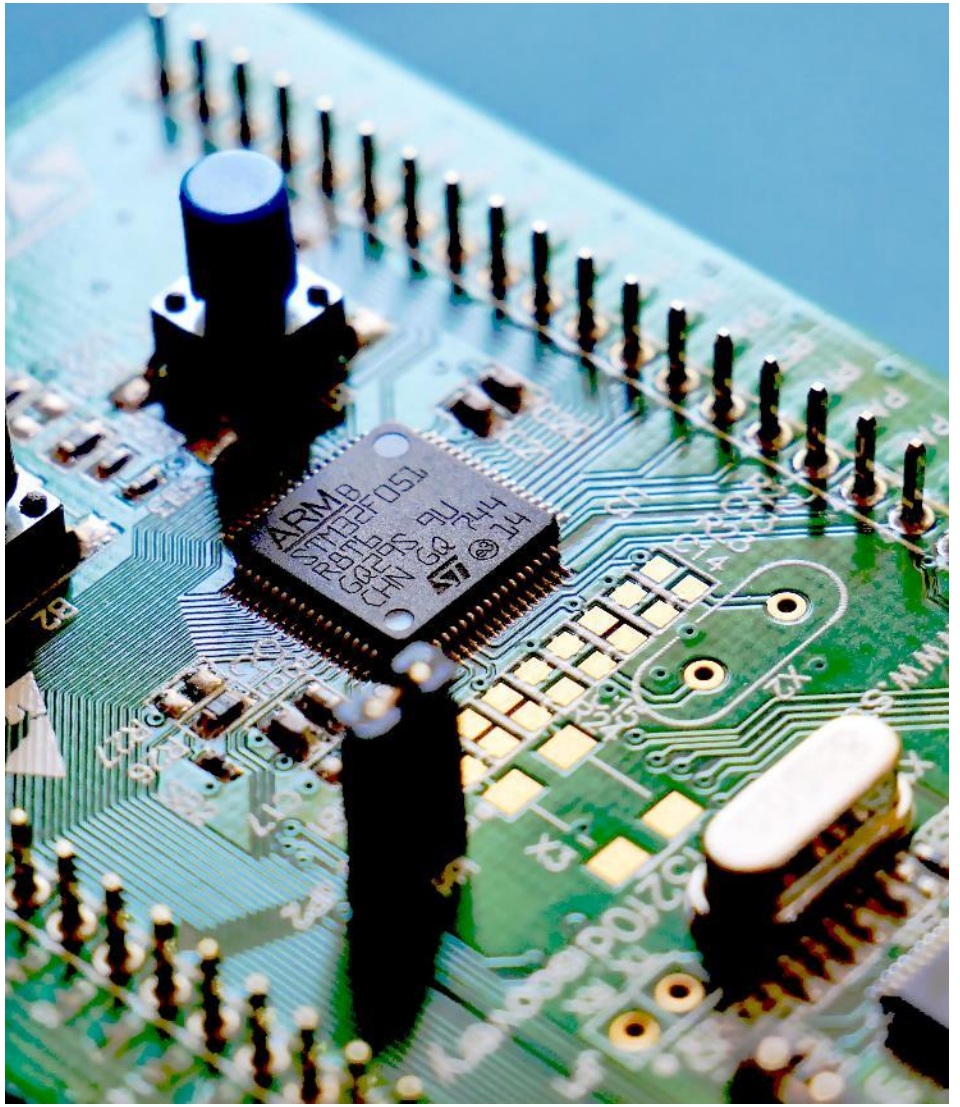
Inputs/Outputs

- GPIO
  - General purpose IO, can be configured as input or output
- Timers
  - Some can be used to generate PWM, or as counter
- ADC
  - Generally multichannel, 12 bits
- DAC
  - Seldom present, PWM is suitable for many uses
- Watchdog



Communication channels

- I2C
  - Communication with sensors / actuators
- CAN
  - Communication bus for multiple MCU (automotive)
- UART
  - « old style» serial port, asynchronous or synchronous
- SPI
  - High speed serial port (serial flash, etc..)
- USB, support for ethernet, Wifi, display, etc...



Sensors and actuators

- Interaction with real words
- Sensors
  - Get information from the world
  - Can be simple (contact, IR barrier, ...)
  - MEMS : inertial sensor, pressure measure...
- Actuators
  - Act on the world
  - Generally require external power !
  - Motors (DC, step, servo), relay
  - Display, LED, audio...
  - MEMS (ex: inkjet), DLP...

MCU difficulties

- Low memory
  - Low level languages
  - Design constraints (algorithm choice)
- Interaction with real world
  - Problems cannot be easily reproduced
  - Breakpoint : can’t continue after a breakpoint
  - Unit tests are more complex
- Hardware/Software
  - Both developed simultaneously (often)
  - Investigate if problem is hardware or software (or connection)
- But often very high reliability expected !

MCU difficulties

- Hopefully small programs
- Strict methodology
  - Never change hardware and software at the same time
  - QA standards for automotive, aviation, space
- Test environments
  - Dedicated hardware that simulate external world
  - Cross compilation on PC for tests / debug
  - MCU emulation (eg. QEMU)
  - ...

Communication

- **Shannon theorem**

$$C = B\ log(1 + \frac{S}{N})$$

  - C channel capacity
  - B bandwidth
  - S signal, N noise
- Noise cannot be suppressed (cosmic noise)
- Bandwidth is expensive + power consumption
- Signal can be increase but radio Tx consume a lot
- It is not possible to have high data rate, low power and low cost

For this project

- Discovering of MCU
- Discovering of sensors and actuators
- Discovering MCU development with both hardware and software
- Many of your issues : cable connection, sensor misuse
- Wide knowledge requirements
  - HW and SW are closely linked
  - Datasheets contains a lot of information, one need to get use to find relevant part.
- Wi-Fi communication
- No power consumption constraints

Merci.