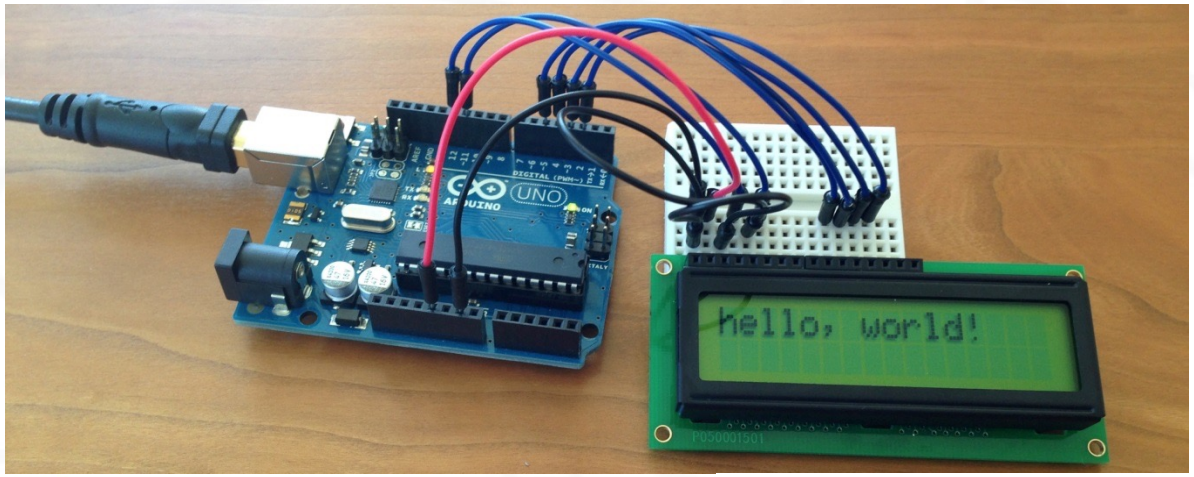
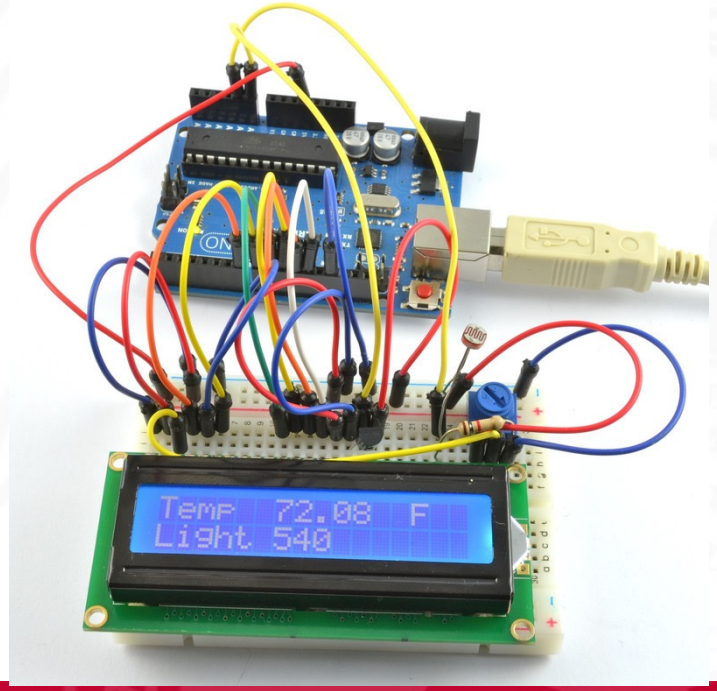
UNIVERSIDAD COMPLUTENSE MADRID

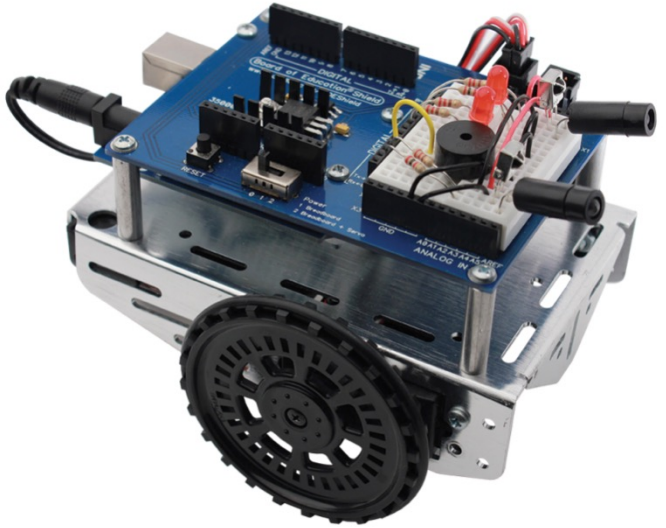
ESP-IDF. Intro I/O

IoT Node Architecture

I/O: interact with the external world

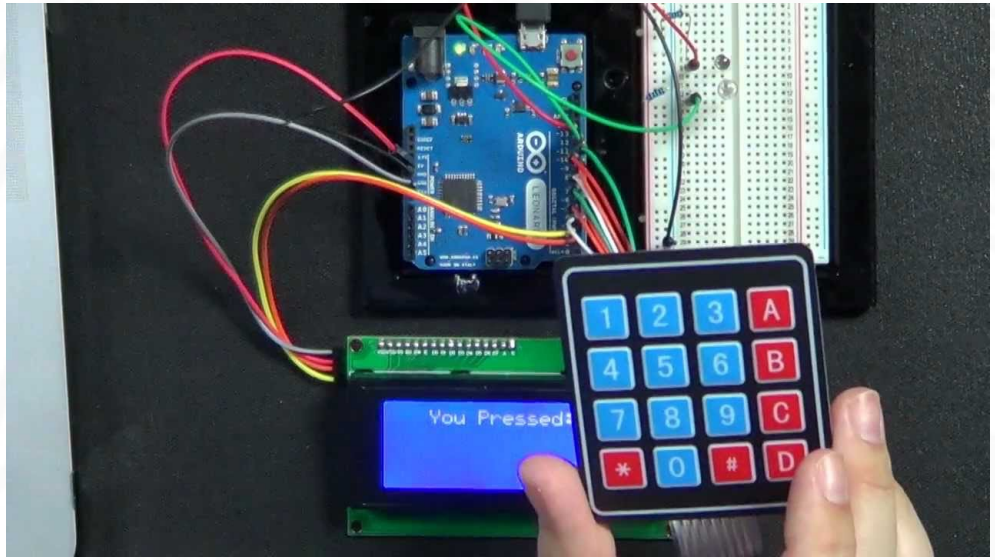






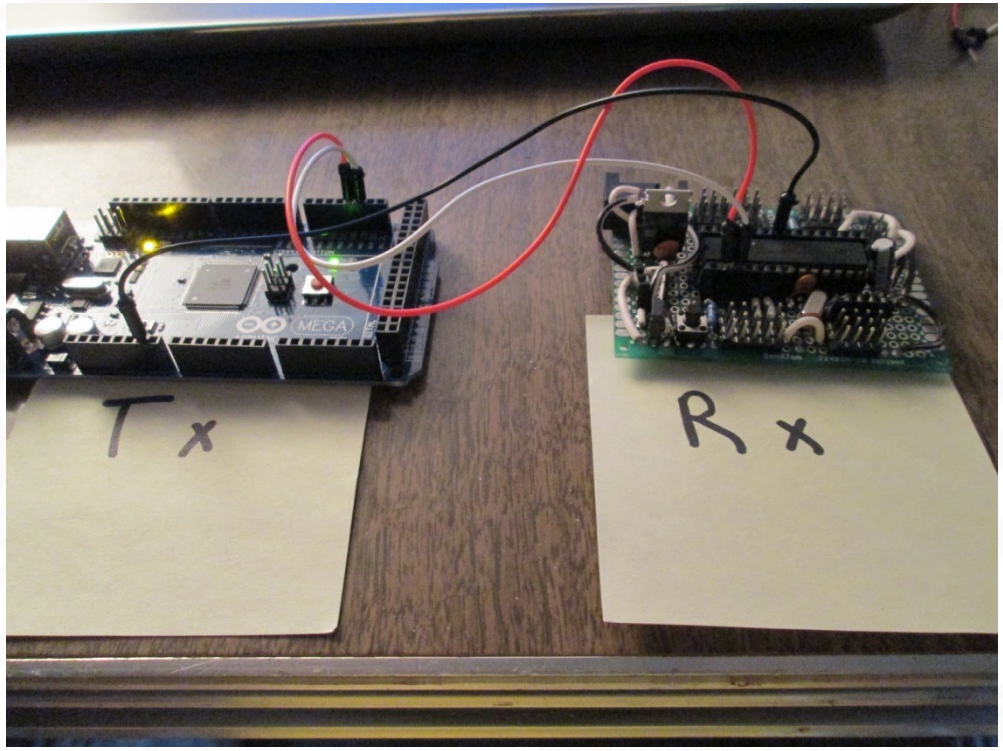
Types of devices

- Data presentation
  - Interact ith users *moving* data between users and the system
  - Mouse, keyboard, screen, printer...



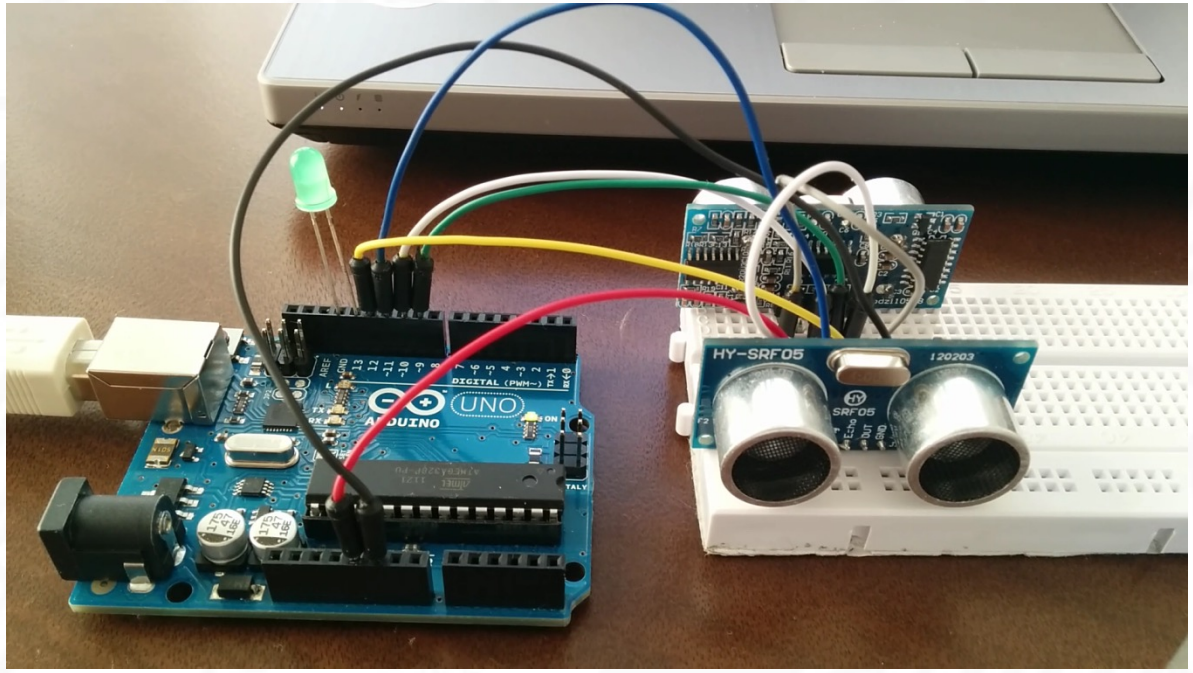
Many type of devices

- Communication devices between systmes
  - They allow remote communication through network
  - Network Interface Card, modem..



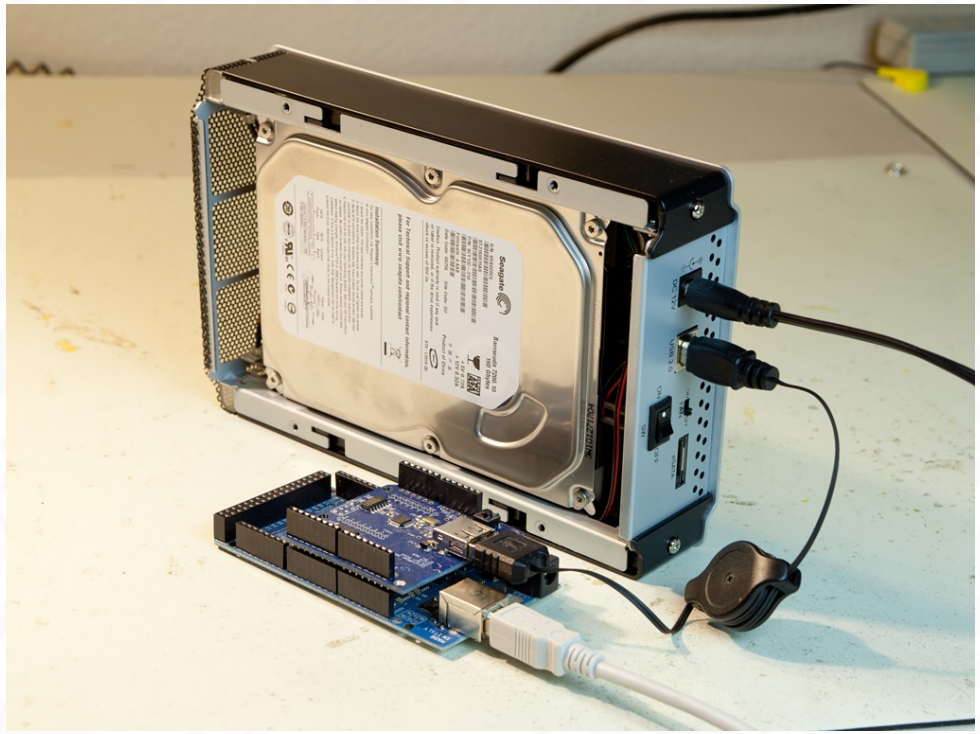
Type of devices

- Data acquisition
  - Communication with sensors and actuators
  - The use to include (or require) ADC / DAC devices



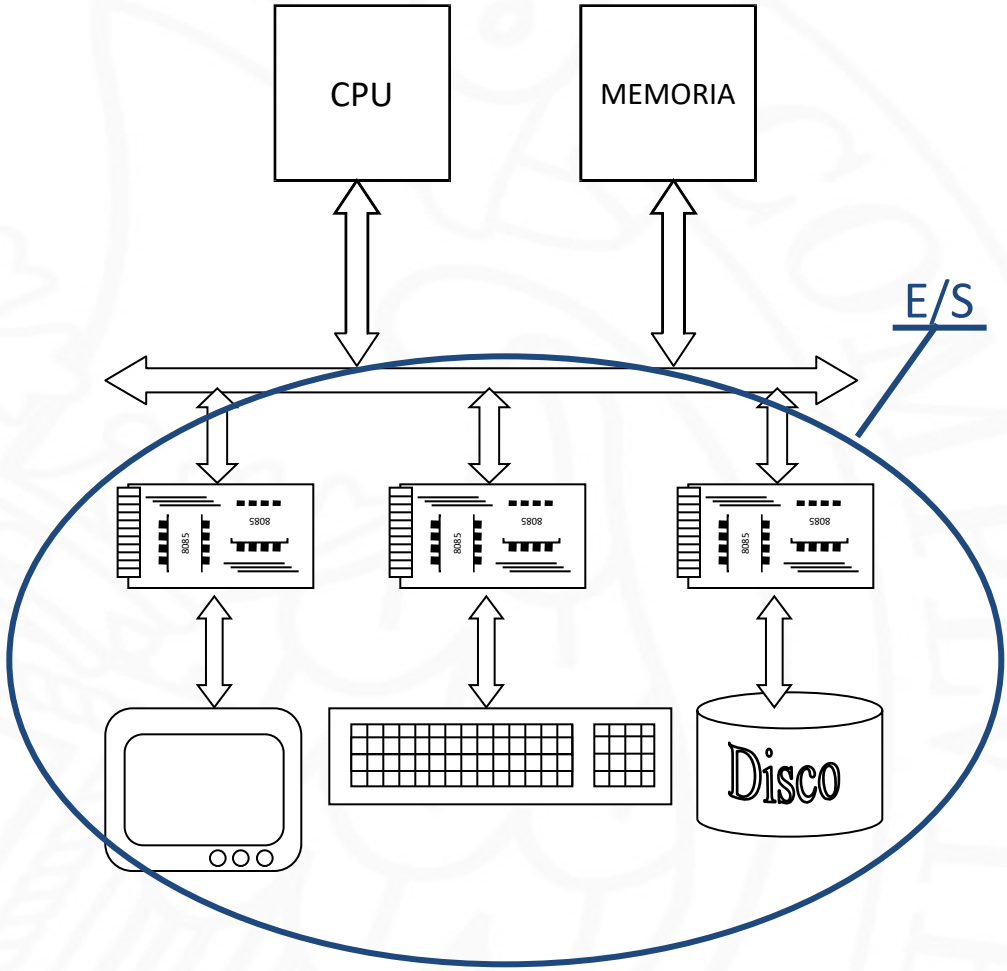
More devices

- **Storage**
  - Flash, SD Card, magnetic...



I/O system goal

- Inteaction CPU <-> real world
- Input
  - From devices to CPU
  - From devices to memory
- Output
  - From CPU to device
  - From memory to device
- In some scenarions, I/O performance becomes the bottleneck
  - Because it is much slower than CPU or memory

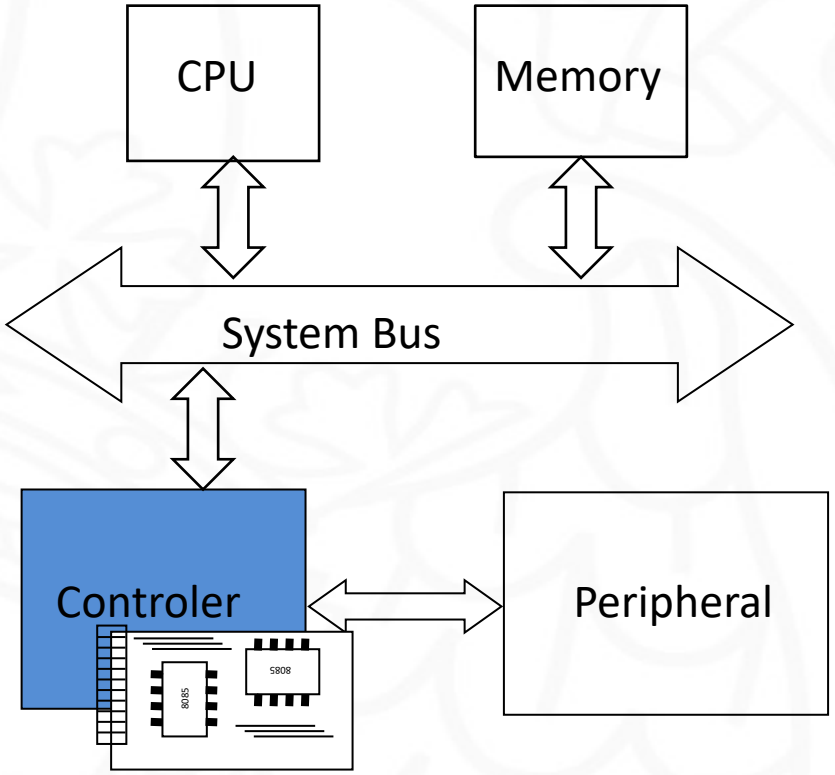


Global I/O system structure

- Componentes:
  - Peripheral device
  - I/O device controller (hardware)

  External / SoC
  - Device driver
    - Software

    S.O.
  - Communication line
    - Bus,...



Device controller (HW part)

- Interace between device and processor
- Role:
  - Control and timing
    - It may adapt the transfer speed
  - Communicates with CPU
  - Communcates with device
  - Buffering
  - Error detection

It has 2 interfaces

Controller addressing

Isolated I/O

- Different address spaces (memory – I/O)
- Specific instructions in ISA
  - **IN IOport, Ri (CPU ← perfipheral)**
  - **OUT Ri, IOPort (peripheral ← CPU)**
- Example: Intel x86

Memory mapped I/O

- Same address space (memory – I/O)
- We can use regular load/store operations
  - **LOAD Ri, IOaddr(CPU ← Peripheral)**
  - **STORE Ri, IOaddr (Peripheral ← CPU)**
- Example: ARM

I/O in FreeRTOS / ESP-IDF

- We will use services provided by the OS
  - We are NOT going to write our own drivers
  - We DO NOT need to know the address of each device
    - But if you are interested.....

Bus Type	Boundary Address		Size	Target	Comment
	Low Address	High Address			
Data	0x3FF0_0000	0x3FF0_0FFF	4 KB	DPort Register	
Data	0x3FF0_1000	0x3FF0_1FFF	4 KB	AES Accelerator	
Data	0x3FF0_2000	0x3FF0_2FFF	4 KB	RSA Accelerator	
Data	0x3FF4_0000	0x3FF4_0FFF	4 KB	UART0	
	0x3FF4_1000	0x3FF4_1FFF	4 KB	Reserved	
Data	0x3FF4_2000	0x3FF4_2FFF	4 KB	SPI1	
Data	0x3FF4_3000	0x3FF4_3FFF	4 KB	SPI0	
Data	0x3FF4_4000	0x3FF4_4FFF	4 KB	GPIO	
	0x3FF4_5000	0x3FF4_7FFF	12 KB	Reserved	
Data	0x3FF4_8000	0x3FF4_8FFF	4 KB	RTC	
Data	0x3FF4_9000	0x3FF4_9FFF	4 KB	IO MUX	