MICROCONTROLLERS & COMMUNICTION

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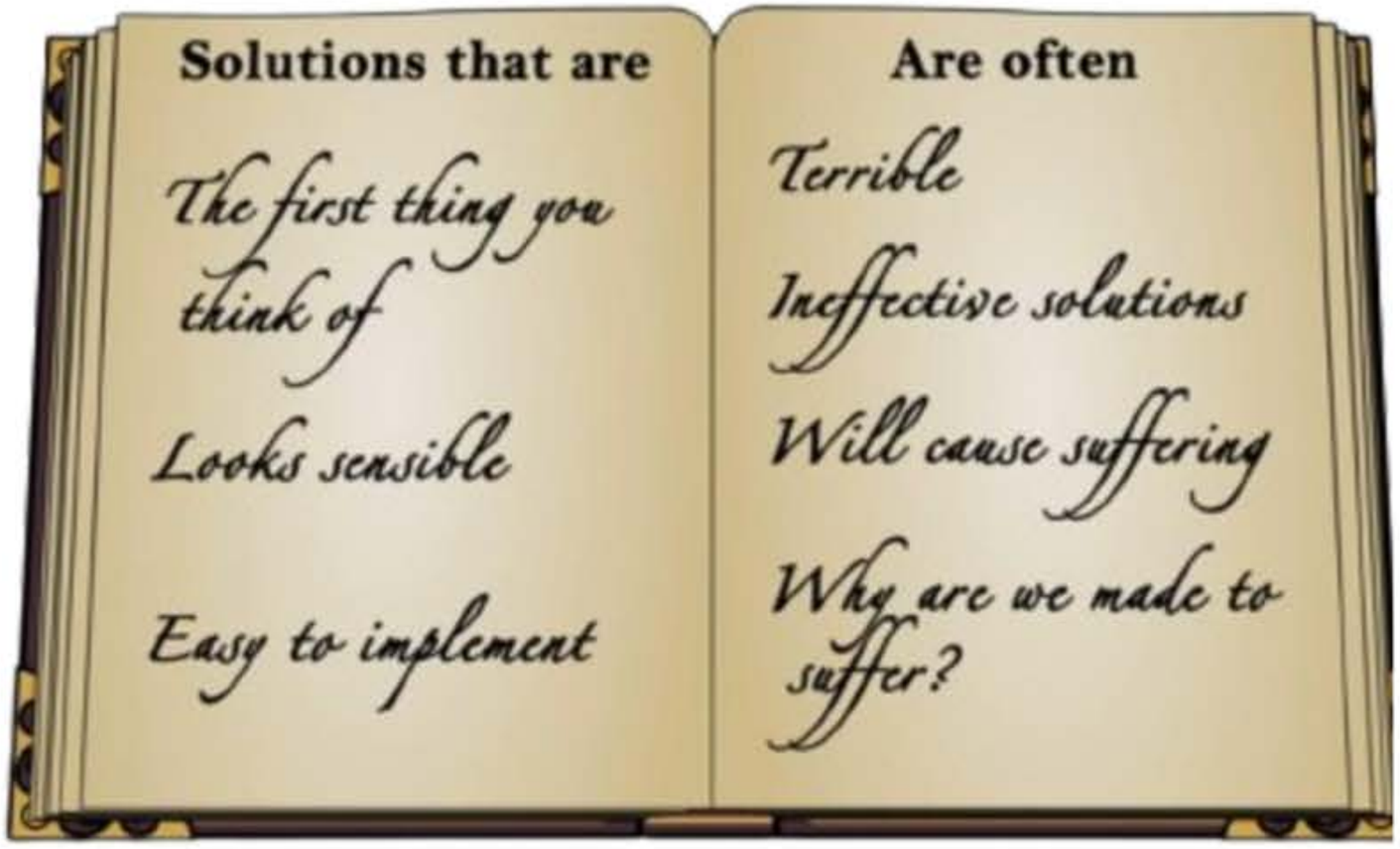
Of course, not intricacies!

-by support from fellow ERC conveners

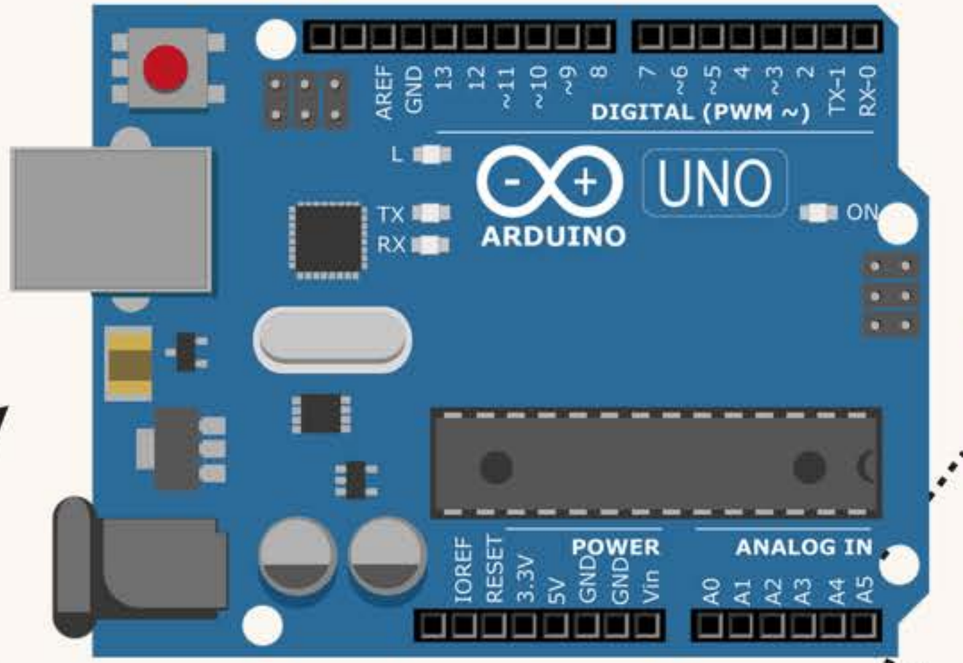
I consider that I understand an equation when I can predict the properties of its solutions, without actually solving it.

- Paul A. M. Dirac



Agenda

1. Microcontroller: Code to Hardware
2. GPIOs, ADCs and DACs
3. Communication Protocols: SPI, I2C, UART & Wireless
4. IOT



Microcontroller Board

MicroController

parts of μCONTROLLER

- CLOCK
- GPIO PINS
- ADC
- DAC
- MICROPROCESSOR

Code to Hardware

1 Code on an IDE

0101 0111 0000 1111
1111 0000 1110 1010
0101 0111 0000 1111
0101 0111 0000 1111
1111 0000 1110 1010
0101 0111 0000 1111

2 Machine Code

The code written in the Arduino IDE is first converted to assembly and then compiled using a toolchain like AVR-GCC.

3 Hex file transferred via USB

The .hex file is uploaded to the microcontroller's flash memory using avrdude

4 Execution

Instruction is fetched from flash memory, decoded and executed by the ATMega chip

BUT HOW IS AN INSTRUCTION DECOED?

Lets take an exmample

(in assembly language)

```
ldi r16, 0x25
```

OpCode
Load immediate

Destination register

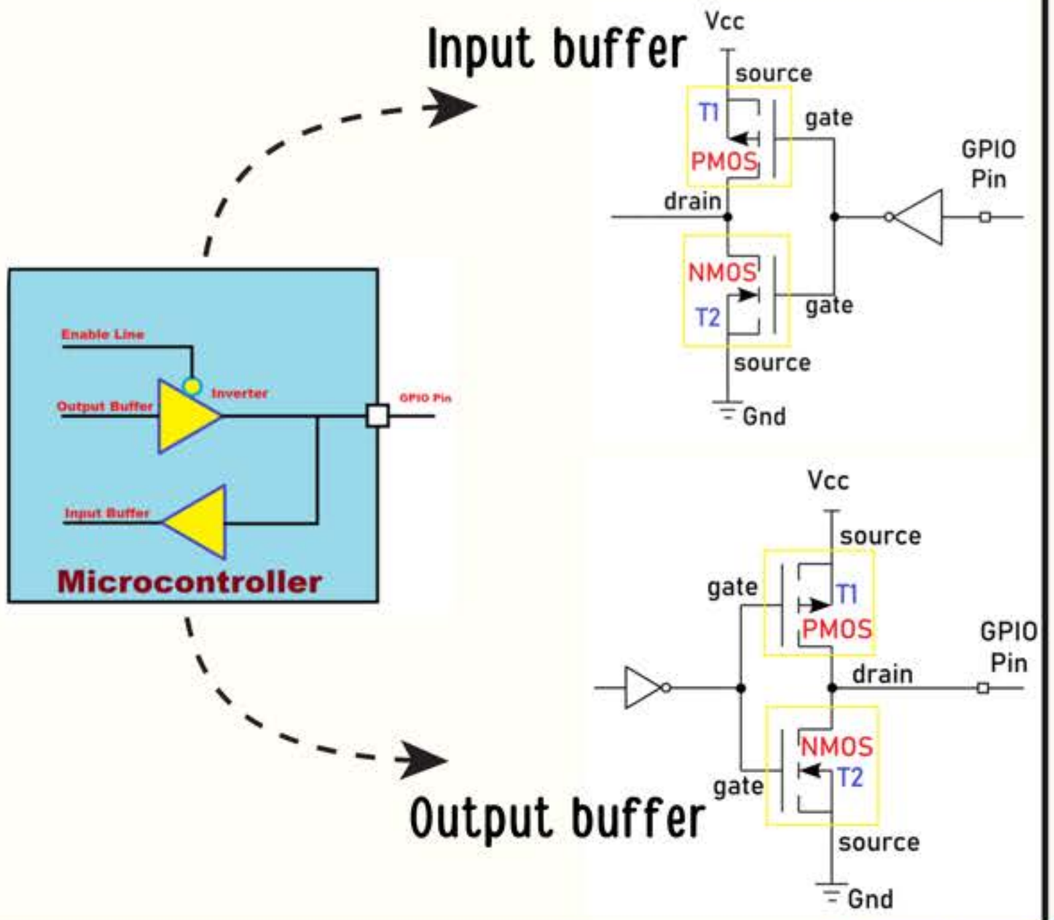
Operand
Immediate value

GPIOS, ADCS & DACS

General-Purpose Input Output (GPIO) is a digital pin of an IC which can be used as input or output for interfacing devices.

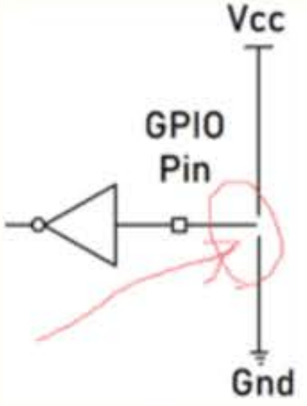
They can be used in multiple ways:

- Input mode: further configured into one of these three ways
  a) High impedance or floating
  b) Pull up &
  c) Pull down
- Output mode: two configurable options
  a) Push - Pull
  b) Open - Drain
- Analog mode

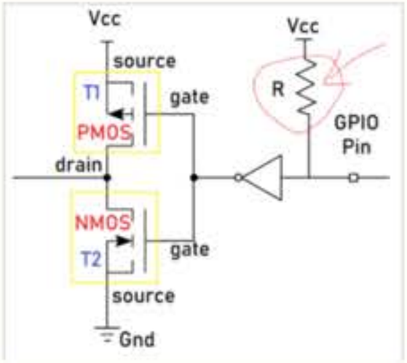


INPUT MODE

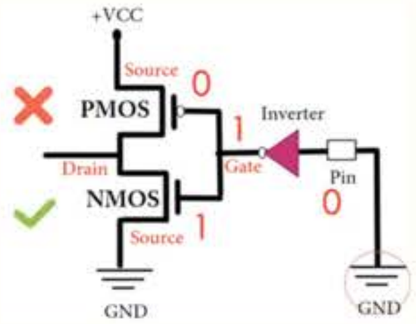
1. High impedance or Floating



2. Pull - Up mode

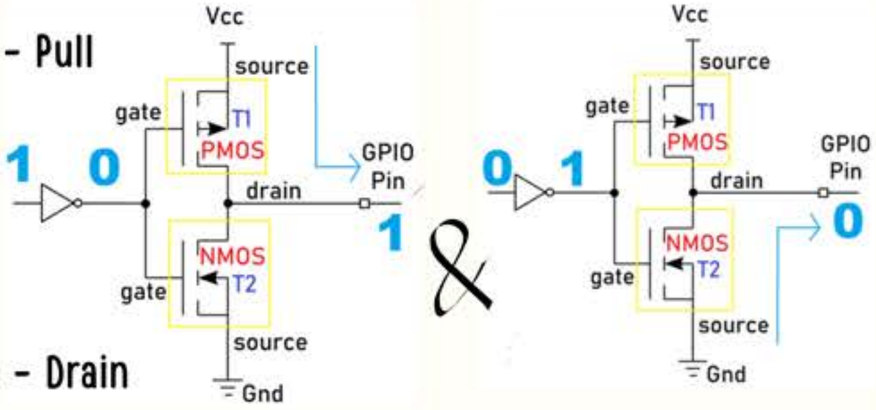


3. Pull - Down mode

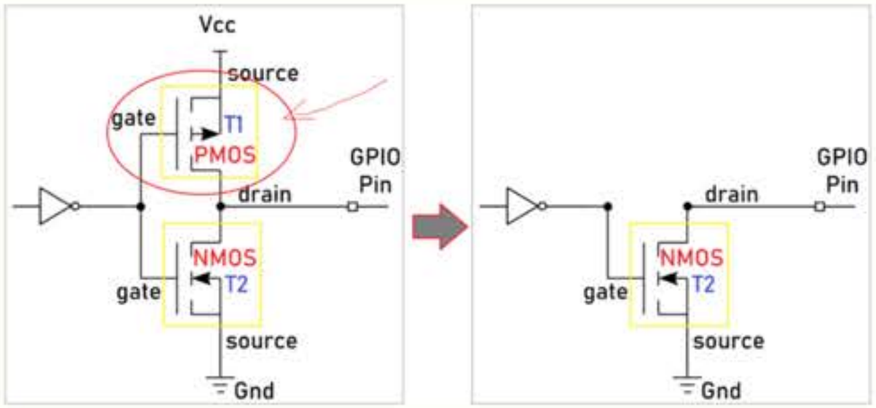


OUTPUT MODE

1. Push - Pull



2. Open - Drain



Analog Mode:

OUTPUTs USING PWM

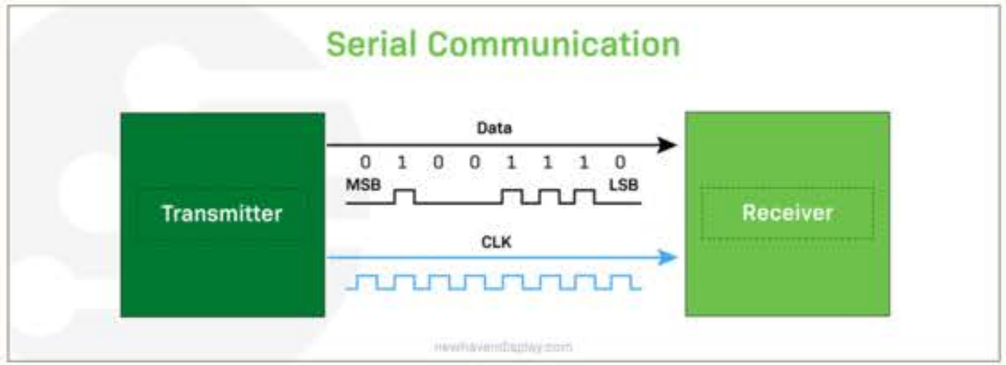
By changing the duty cycle of the generated Square wave one can generate analog outputs

INPUTs USING ADC

Board has an inbuilt ADC which converts the different voltages into a number which depends upon ref. voltage.

COMMUNICATION

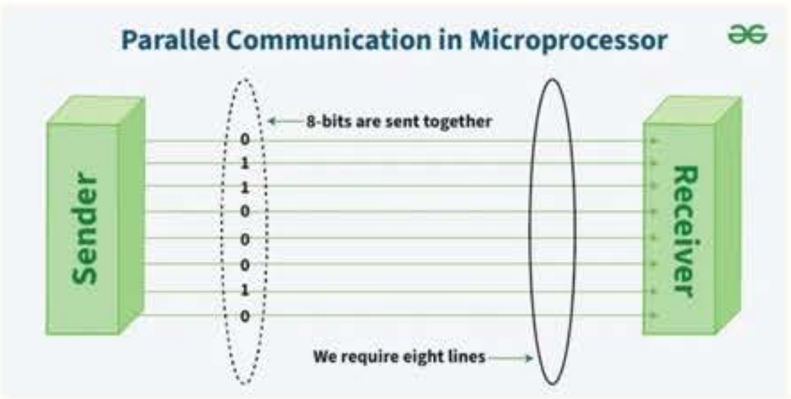
SERIAL TRANSFER



SYNCHRONOUS

ASYNCHRONOUS

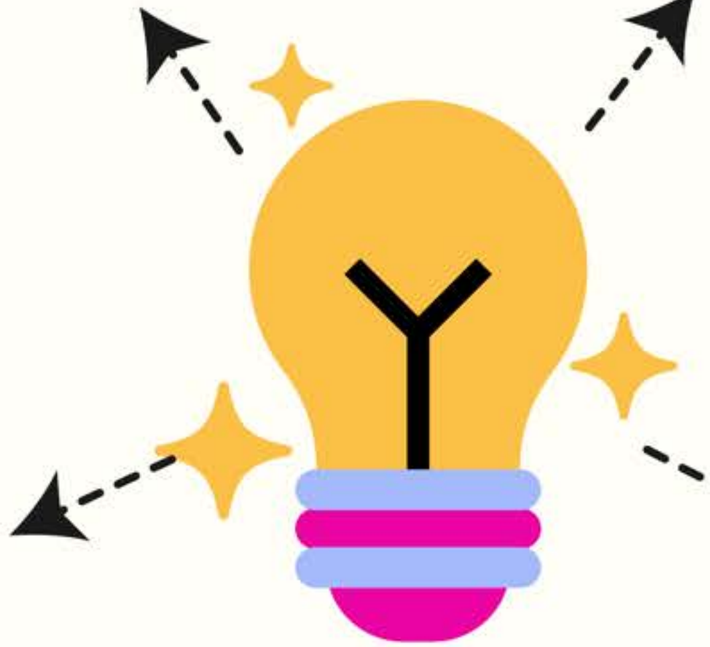
PARALLEL TRANSFER



SOME DATA TRANSFER PROTOCOLS

SPI

I2C

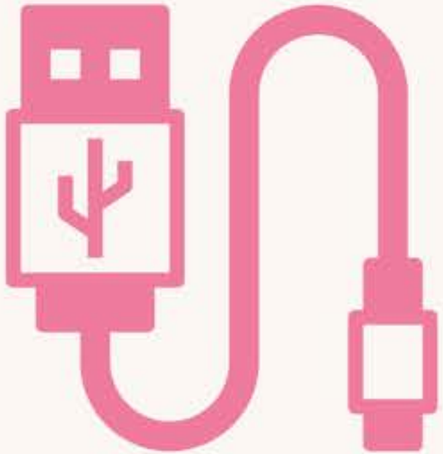


UART

Wireless

USB

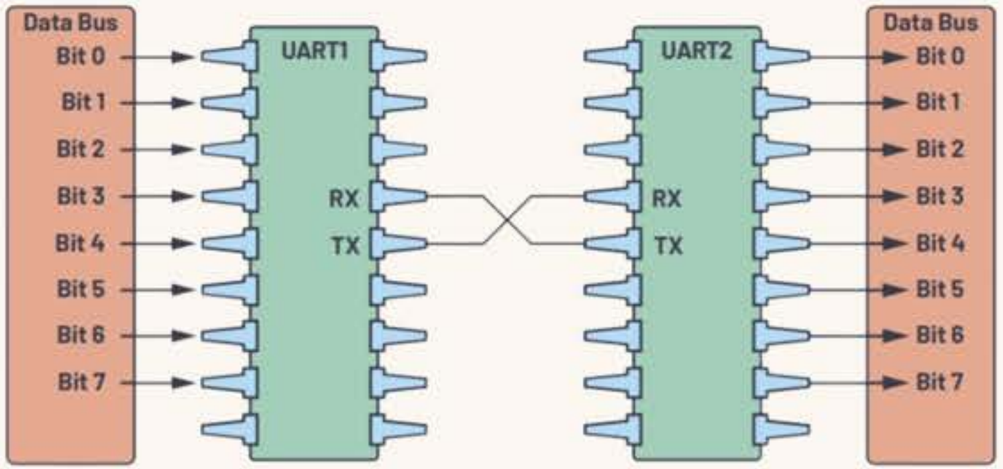
UNIVERSAL SERIAL BUS



not a protocol!

UART

UNIVERSAL ASYNCHRONOUS RECEIVER TRANSMITTER

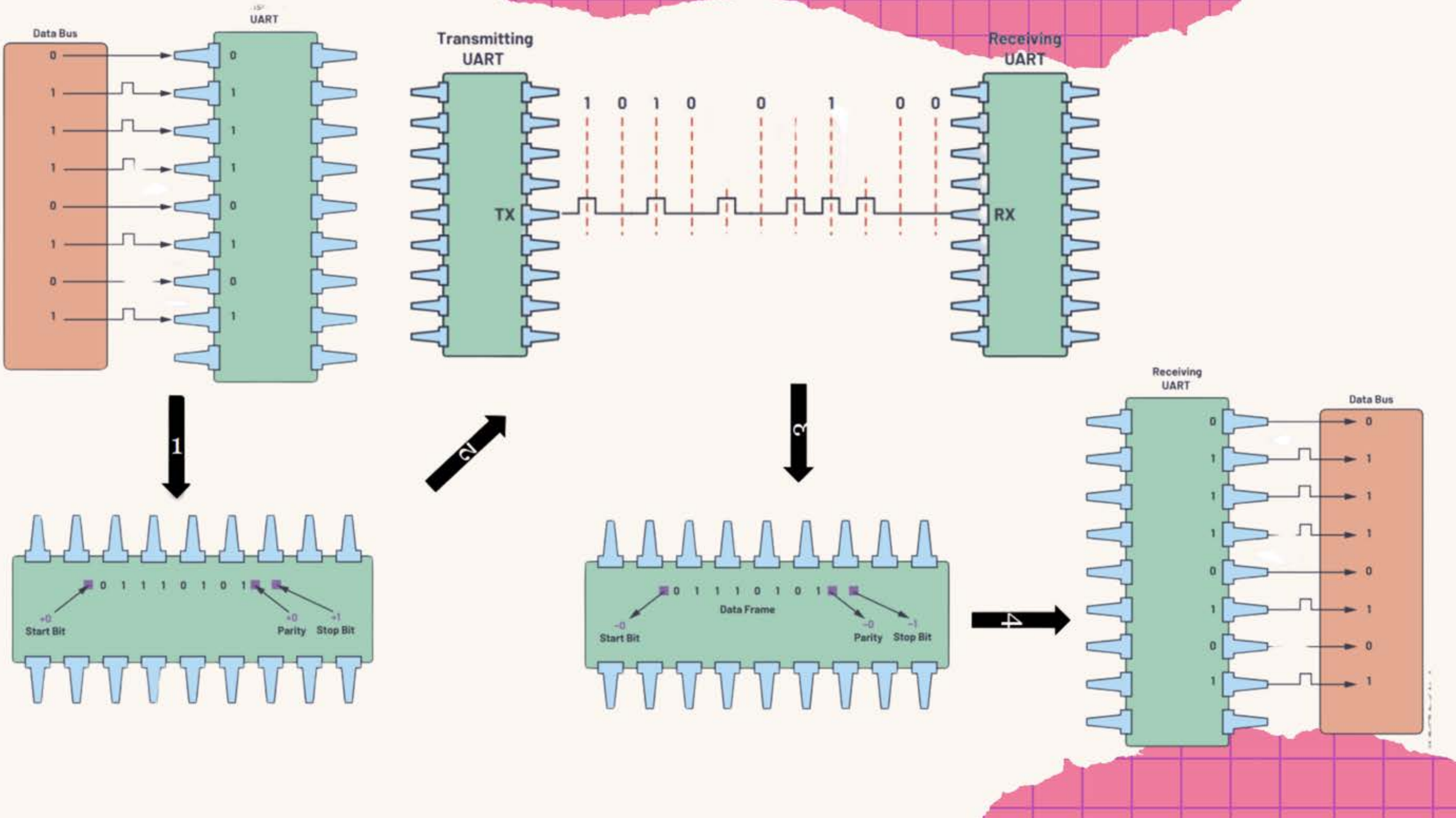


1.Need to set the same baud rate at the Tx and Rx side (remember its asynchronous)!

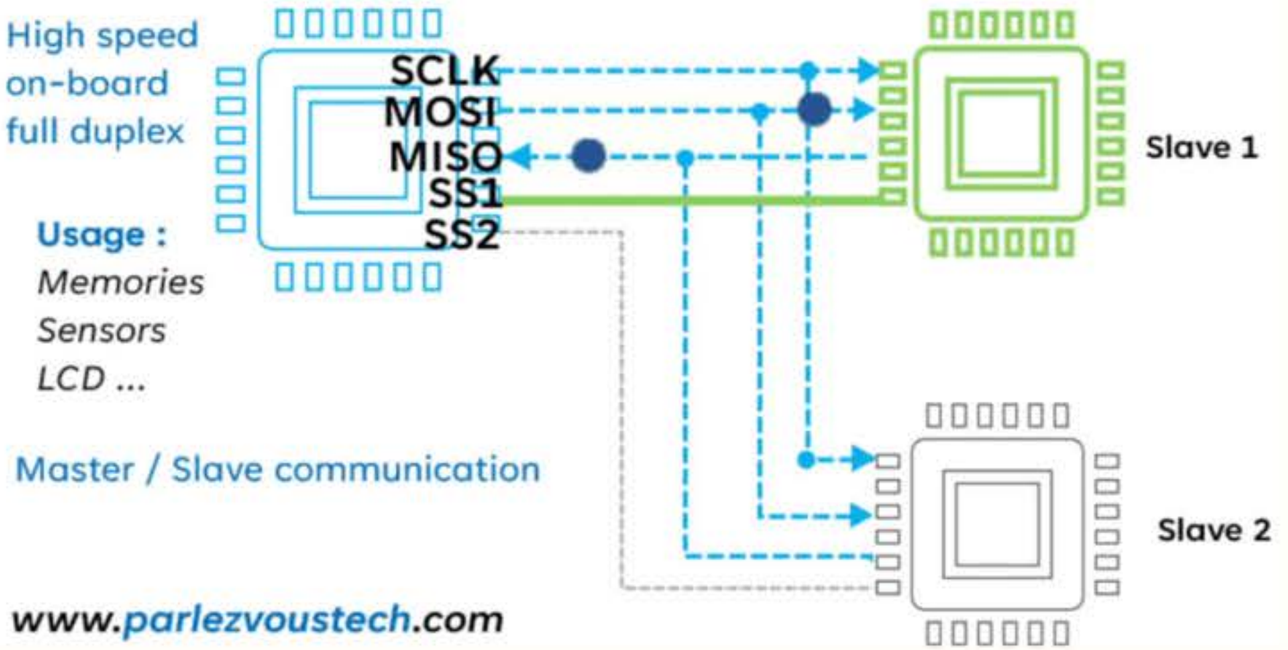
2. Synchronization is managed by having same baud rates – allowable difference in baud rate is 10%

3. Baud rate: rate at which information (a symbol) is transferred to a communication channel

Is baud rate the same as bit-rate?

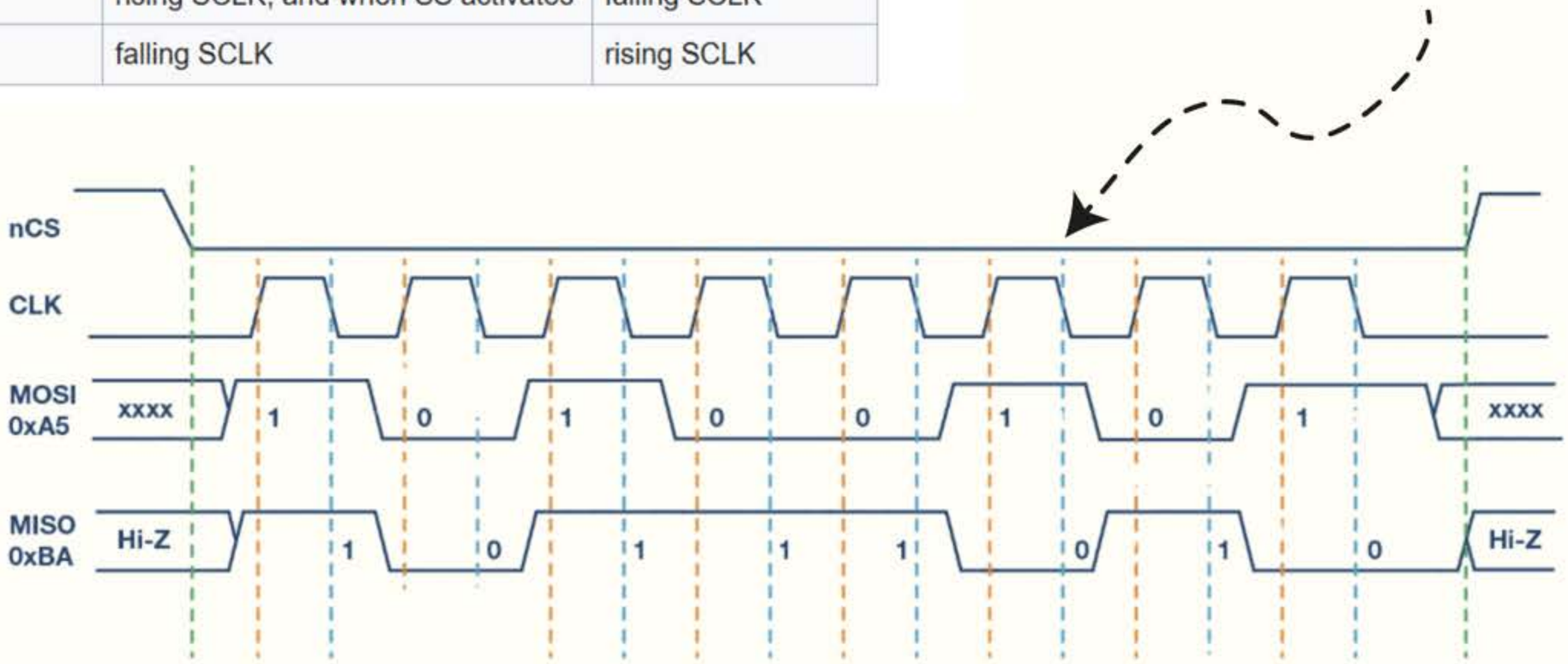

Data Bus
UART
Transmitting UART
Receiving UART
TX
RX
1 0 1 0 0 1 0 0
1
2
3
4
Start Bit
Parity
Stop Bit
Data Frame
Receiving UART
Data Bus

SPI: Serial Peripheral Interface

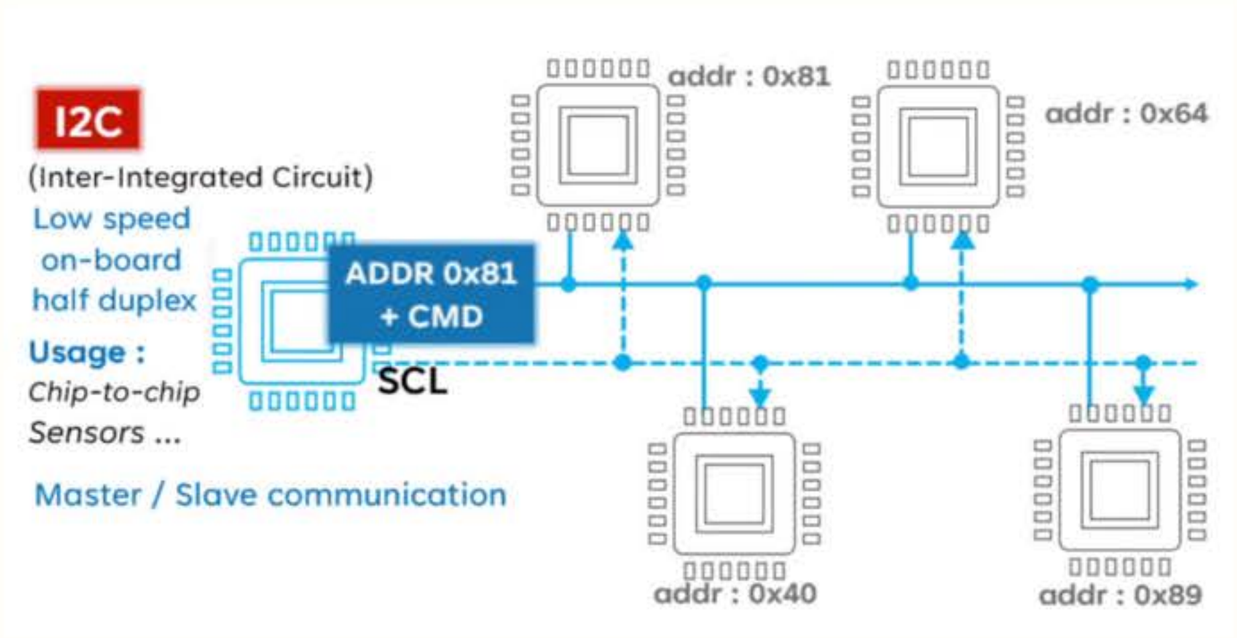


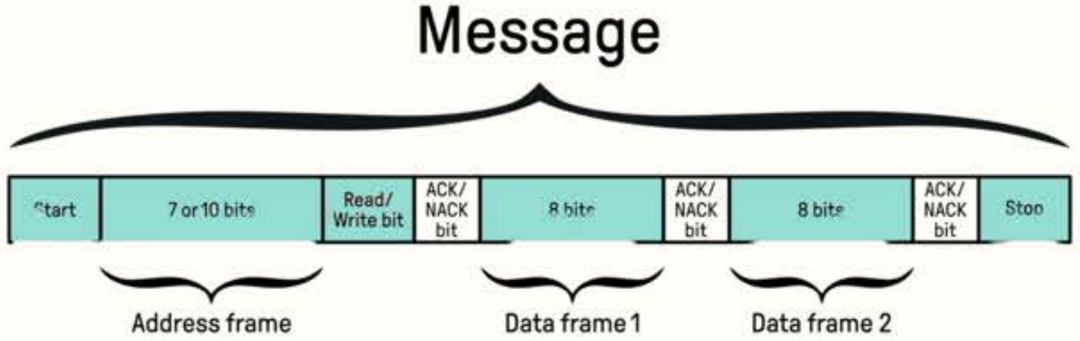
SPI mode	Clock polarity (CPOL)	Clock phase (CPHA)	Data is shifted out on	Data is sampled on
0	0	0	falling SCLK, and when $\overline{SS}$ activates	rising SCLK
1	0	1	rising SCLK	falling SCLK
2	1	0	rising SCLK, and when $\overline{SS}$ activates	falling SCLK
3	1	1	falling SCLK	rising SCLK

SPI Mode 0, CPOL = 0, CPHA = 0: CLK idle state = low, data sampled on rising edge and shifted on falling edge.



I2C:Inter Integrated Circuit





IrDA (Infrared Data Association)

1. Serial, half duplex, line of sight based wireless technology

2.Point-point and point-to-multipoint communication (within line of sight)

3. Range can be improved by increasing the transmitting power of the IR device.

4. A popular interface for file exchange and data transfer in low cost devices

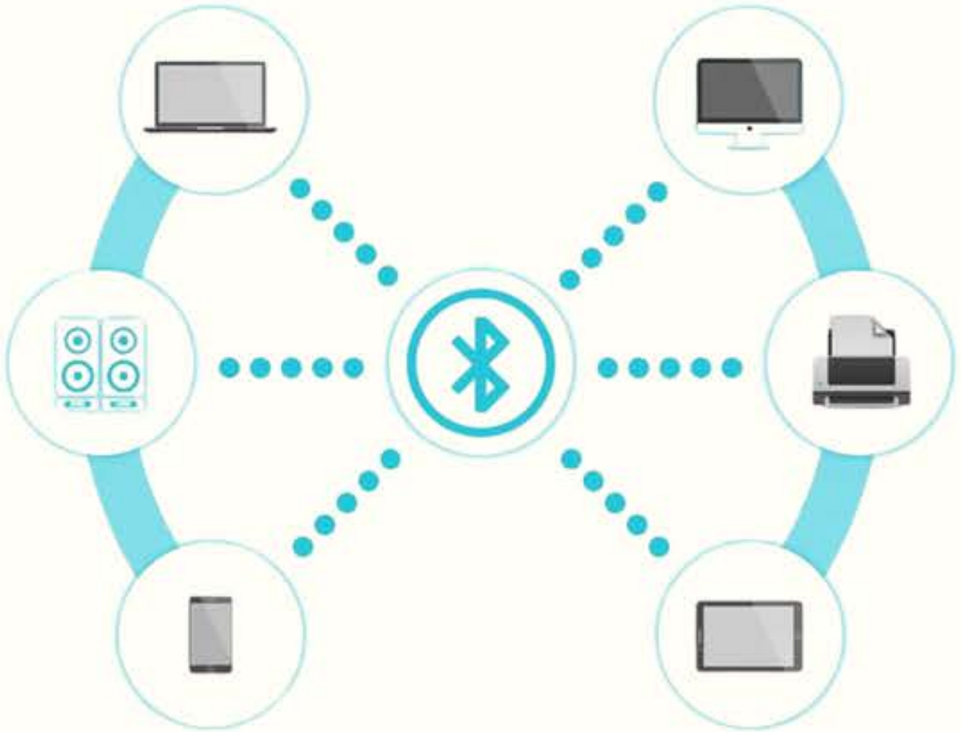
5. Physical link part and a protocol part

BT (Bluetooth)

1. A favourite choice for short range data communication in embedded systems

2. Operates at 2.4GHz and uses FHSS (frequency Hopping Spread Spectrum) Technology

3. Max. connection are limited to seven in a piconet



Wi-Fi (Wireless Fidelity)

1. Intended for network communication and it also supports Internet Protocol (IP) based communication

2. Routing data packets to the intended devices on the netwok.

3. Operates at 2.4GHz or 5GHz of radio spectrum

4. Employs different security mechanism like Wired Equivalency Privacy (WEP) and Wireless Protected Access (WPA).

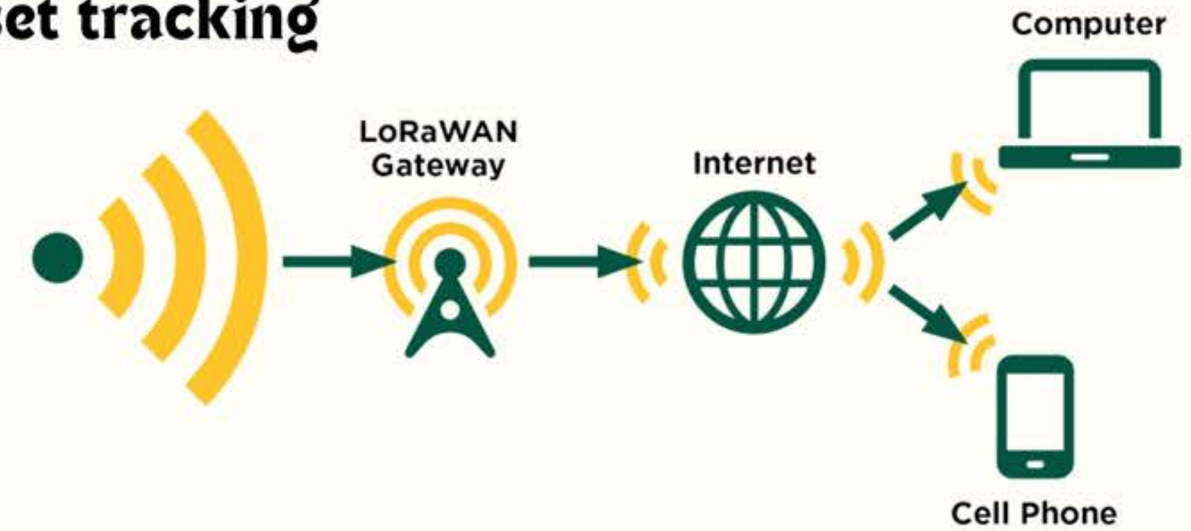
LoRaWAN (LoRa Wide Area Network)

1. Low power & wider area converage

2. Uses LoRA modulation technique

3. Suited for applications requiring low data rates and long-range coverage, such as remote asset tracking

4. Uses ALOHA protocol

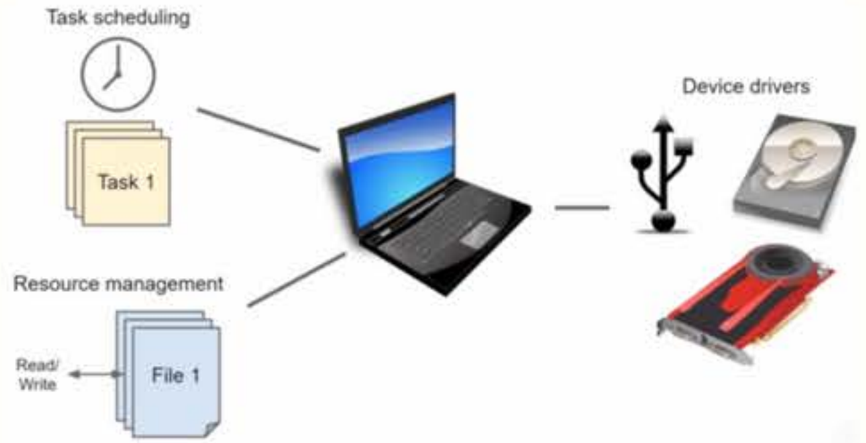


RTOS

a lil' bit!

What is it?

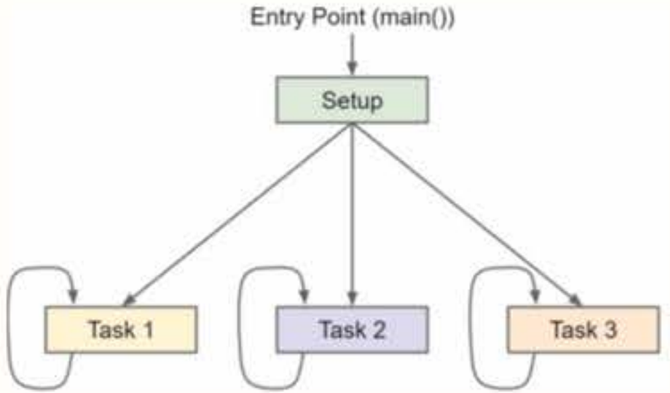
RTOS = Real-Time Operating System: manages tasks in real-time with deterministic timing.



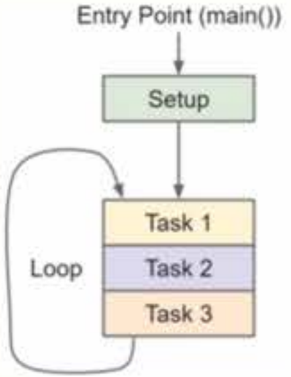
Functions of a GPOS(General Purpose Operating System)

PROGRAMMING STRUCTURE

RTOS



Super Loop



THANK YOU!