IoT Simplified: Learn with ESP32

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Introduction to IoT

Welcome to the world of IoT, where everyday objects become intelligent participants in a connected ecosystem. IoT, or the Internet of Things, transforms the way we live and work by interconnecting devices, enabling data-driven decision-making,
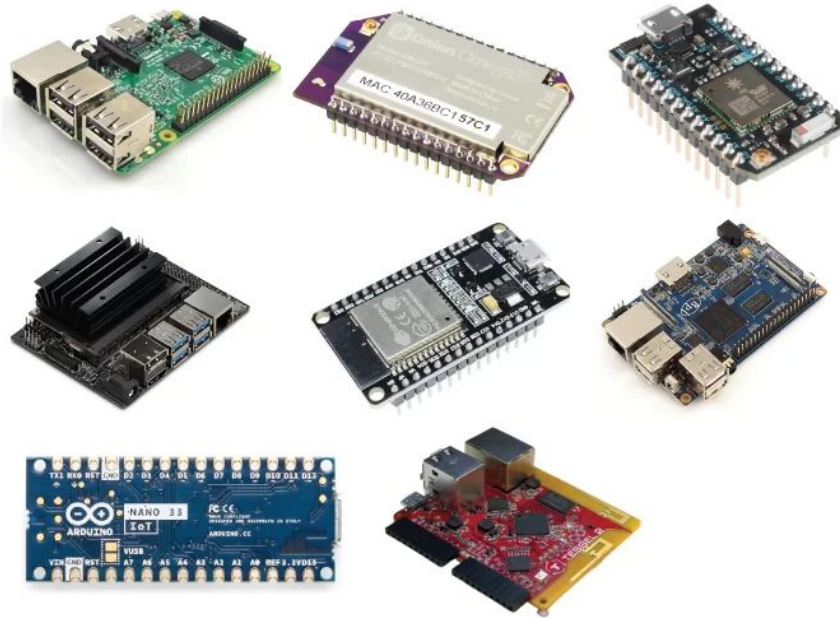
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What are Microcontrollers?

A microcontroller is a compact integrated circuit (IC) that contains a processor core, memory, and programmable input/output peripherals. It is designed to perform specific tasks in embedded systems.

Components of a Development board

- Power circuit
- Programming interface
- Basic Input
- Basic Output
- I/O pins

Arduino

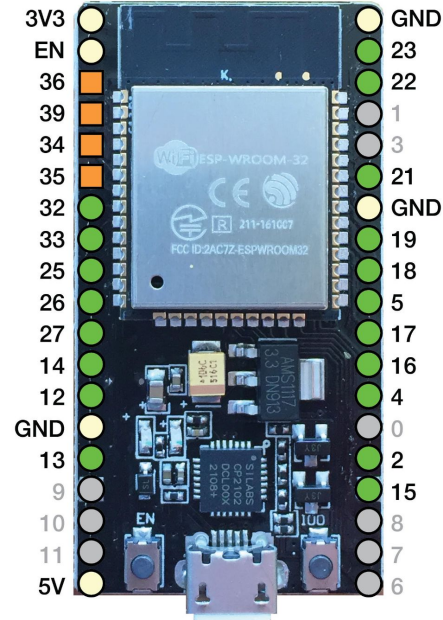# ESP32

Microcontroller Signals

- **Digital vs Analog:** A digital signal varies between two possible states HIGH or LOW, while an analog signal can take any value within a range of voltages.

- **Digital Input:** An external device controls the voltage and the microcontroller its changes, so we can read it as HIGH or LOW.

- **Digital Output:** The microcontroller can set a HIGH or LOW voltage.

- **Analog Input:** An internal ADC converts the analog value into a decimal number.

Microcontroller Signals

- **Bus Signals:** Used to transmit digital data between the microcontroller and another external device

  - UART
  - I2C
  - SPI

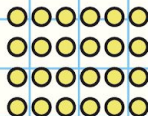GDG SCHOOL

ESP32 Pins

GPIO_NUMs

- 🟢 Usable I/O pins
- 🟧 Input Only
- ⚪ Non-GPIO
- ⚫ Not Recommended

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ESP32 Pins

ESP-WROOM-32

RandomNerdTutorials.com

| EN |
RTC_GPIO0	Sensor VP	ADC1 CH0	GPIO36
RTC_GPIO3	Sensor VN	ADC1 CH3	GPIO39
	RTC_GPIO4	ADC1 CH6	GPIO34
	RTC_GPIO5	ADC1CH7	GPIO35
RTC_GPIO9	TOUCH9	ADC1 CH4	GPIO32
RTC_GPIO8	TOUCH8	ADC1 CH5	GPIO33
RTC_GPIO6	DAC1	ADC2 CH8	GPIO25
RTC_GPIO7	DAC2	ADC2 CH9	GPIO26
RTC_GPIO17	TOUCH7	ADC2 CH7	GPIO27
RTC_GPIO16	HSPI CLK	TOUCH6	ADC2 CH6	GPIO14
RTC_GPIO15	HSPI MISO	TOUCH5	ADC2 CH5	GPIO12
RTC_GPIO14	HSPI MOSI	TOUCH4	ADC2 CH4	GPIO13
GND
VIN

GPIO23	VSPI MOSI
GPIO22	I2C SCL
GPIO1	UART 0 TX
GPIO3	UART 0 RX
GPIO21	I2C SDA
GPIO19	VSPI MISO
GPIO18	VSPI CLK
GPIO5	VSPI CS0
GPIO17	UART 2 TX
GPIO16	UART 2 RX
GPIO4	ADC2 CH0	TOUCH0	RTC_GPIO10
GPIO2	ADC2 CH2	TOUCH2	RTC_GPIO12
GPIO15	ADC2 CH3	TOUCH3	HSPI CS0	RTC_GPIO13
GND
3V3

EN

BOOT

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Sensors and Actuators

Sensors

Sensors are devices or instruments that detect and measure physical properties, environmental conditions, or changes in the surroundings and convert this information into electrical signals or other readable formats.
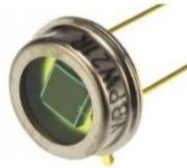
Sensors Examples

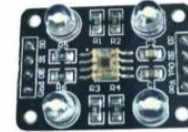Temperature Sensor   Humidity Sensor   Proximity Sensor

Light Sensor   Metal Sensor   Color Sensor

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Actuators

Actuators are devices that convert electrical signals or control inputs into physical actions or movements. They enable a system to perform tasks or respond to changes in the environment.
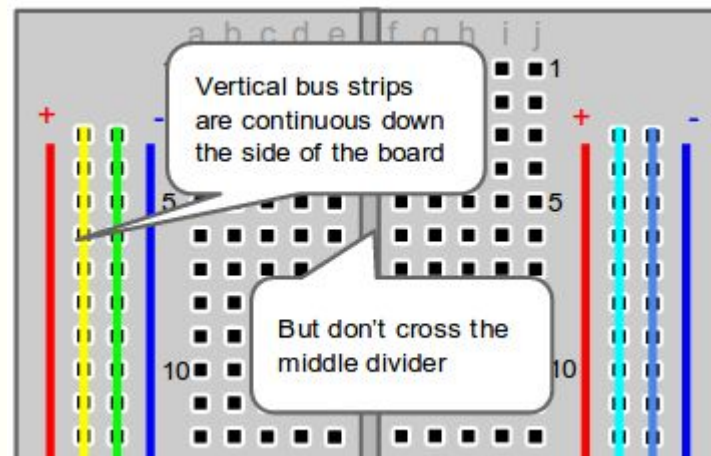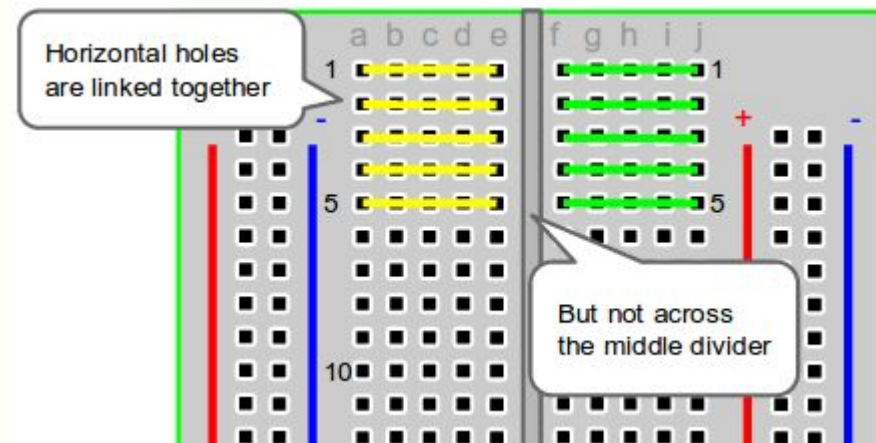
Actuators Examples

LED

Servomotor

Bread Board

Making the Magic: Let's program ESP32

Programming ESP32

All programs have the same structure, anything not defined or called within the following 2 scopes will never be used

```
setup(){
//called once at each boot
}


loop(){
//called an infinite amount of times
}
```

Activity 1

Turn on a led each 1 second

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Activity 2

Control the Led using a push button

Activity 3
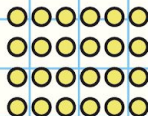
Print: "Hi! I'm YOURNAME " on LCD

Activity 4

Turn on the Buzzer for 1s with a frequency of 2000 Hz when the button is pressed

Activity 5

Use Ultrasonic sensor to tell the distance of an object

Communication Protocols
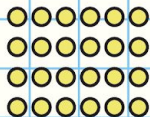
Communication protocols

Wireless Protocols

- WIFI
- Bluetooth
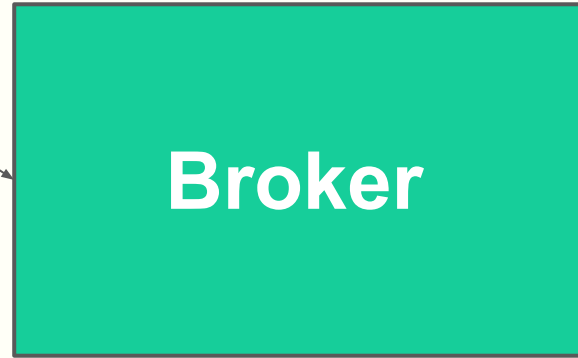

- MQTT
- HTTP

Wired Protocols

- I2C
- SPI
- USB
- UART

Basics of MQTT

Basics of MQTT

Broker

Operations in MQTT

Connect: Establishing a connection between a device/application and the MQTT broker, enabling the exchange of messages.

Disconnect: Gracefully terminating the connection between a device/application and the MQTT broker.

Operations in MQTT

Publish: Sending a message from a device/application to the MQTT broker, which then distributes it to interested subscribers.

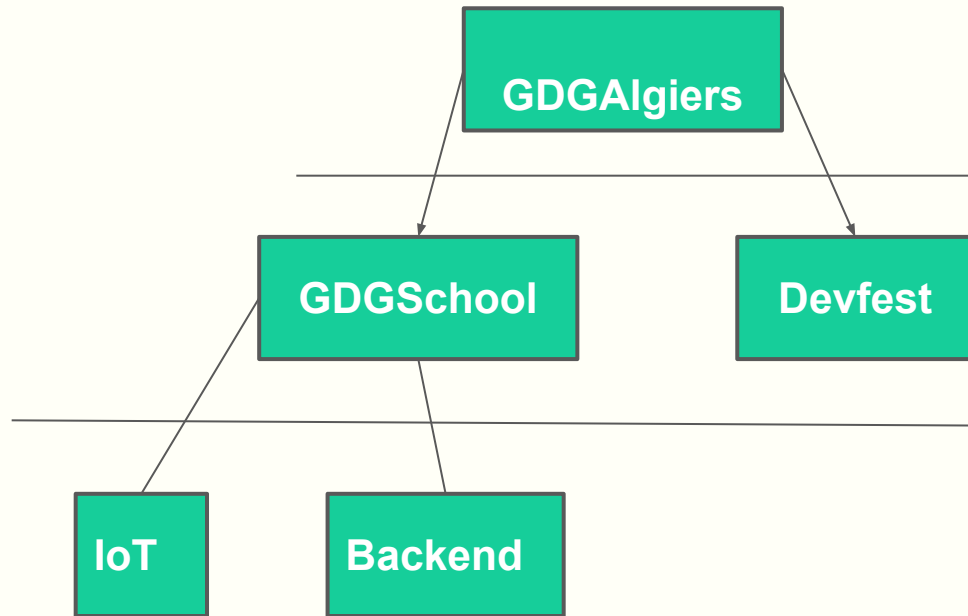**Subscribe:** Expressing interest in receiving messages on specific topics from the MQTT broker, allowing for targeted information retrieval.

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Basics of MQTT

Topics

It is the path of the data that is sent, Topics follow the same linux file system.

```
GDGAlgiers
├── GDGSchool
│   ├── IoT
│   └── Backend
└── Devfest
```

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Basics of MQTT

Topics

It is the path of the data that is sent, Topics follow the same linux file system.

GDGAlgiers/#

```
GDGAlgiers
├── GDGSchool
│   ├── IoT
│   └── Backend
└── Devfest
```

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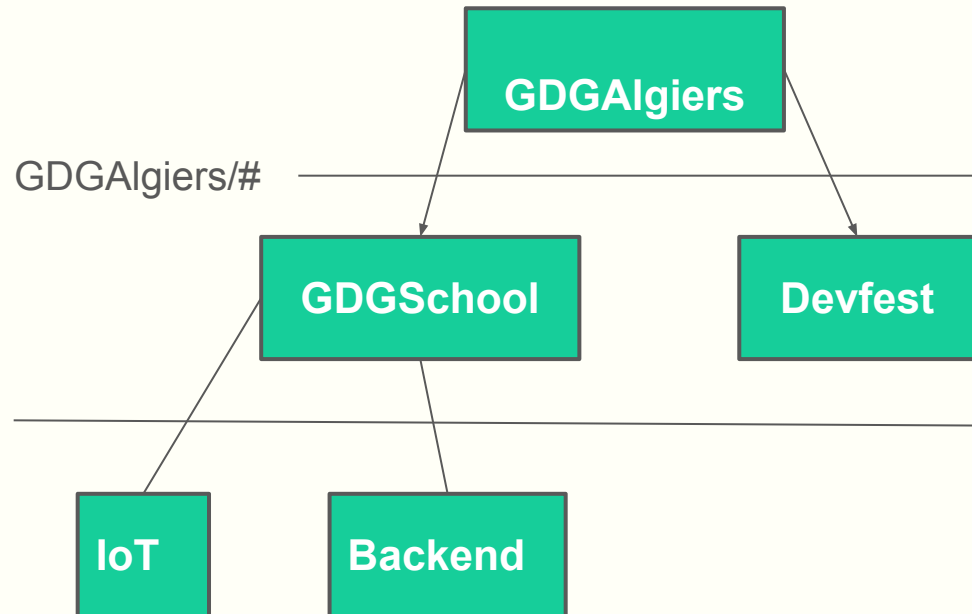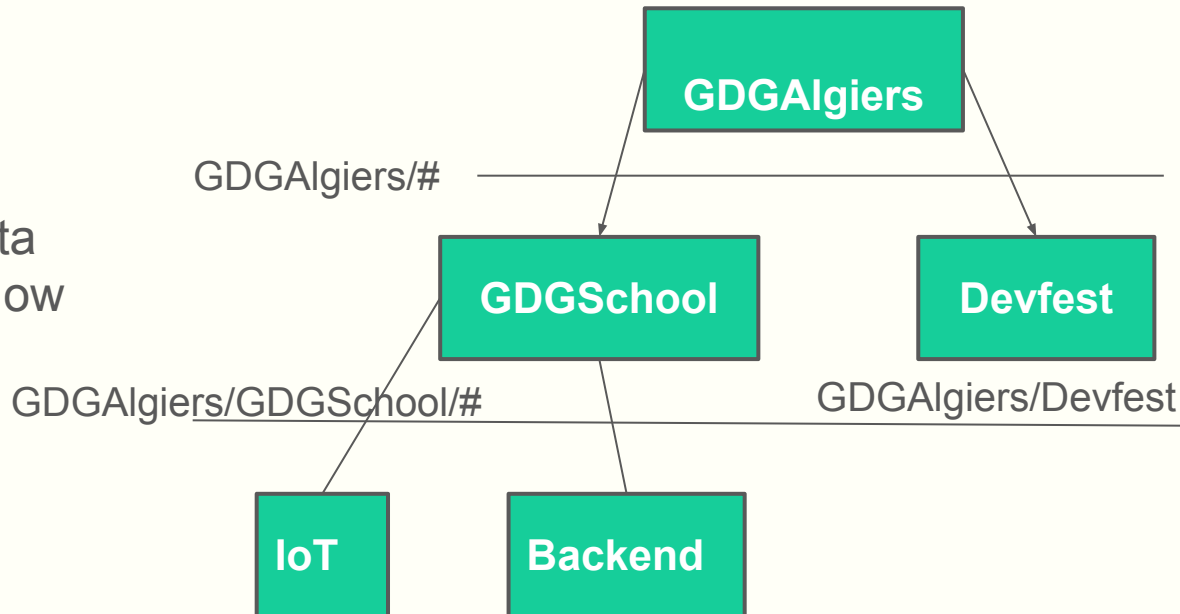
Basics of MQTT

Topics

It is the path of the data that is sent, Topics follow the same linux file system.

```
                                    ┌─────────────┐
                                    │  GDGAlgiers │
                                    └─────────────┘
GDGAlgiers/#  ─────────────────────────────

        ┌─────────────┐                    ┌─────────────┐
        │  GDGSchool  │                    │   Devfest   │
        └─────────────┘                    └─────────────┘
                                                GDGAlgiers/Devfest
GDGAlgiers/GDGSchool/#  ──────────────────────────

    ┌───────┐        ┌─────────────┐
    │  IoT  │        │   Backend   │
    └───────┘        └─────────────┘
```

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Basics of MQTT

Topics

It is the path of the data that is sent, Topics follow the same linux file system.

GDGAlgiers

GDGAlgiers/#

GDGSchool

Devfest

GDGAlgiers/GDGSchool/#

GDGAlgiers/Devfest

IoT

Backend

GDGAlgiers/GDGSchool/IoT

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Quality of Service (**QoS**)

QoS 0: The message is sent only once.
QoS 1: The message keeps being sent until the device confirms the reception
QoS 2: The message is sent only once and the reception is confirmed

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Subscribe to the Topic **GDG/GDGSCHOOL**
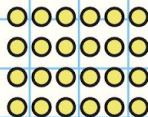
What did you receive?

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Simulation with MQTT

Work in pairs

A: Send a message in the topic GDGSCHOOL/A_NAME/… with QoS1
B: Subscribe to the topic GDGSCHOOL/A_NAME/# with QoS 2
B: Change the QoS to 0, did you receive the message?

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Practical Session

Activity 1

Print "GDG Algiers" in the Serial Monitor

Activity 2

Turn on a led each 1 second

Activity 3

Send your team name to my phone via MQTT

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Activity 4

Control the LED using a pushbutton

Activity 5

Measure the distance of an object
and print it in the Serial Monitor

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Activity 6

With the same circuit, turn the buzzer on if the object's distance is less than 4cm

Activity 7

With the same circuit in Activity 6,
Display the data on the LCD

Activity 8

I cannot see your LCD, send me
the Data via MQTT!

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