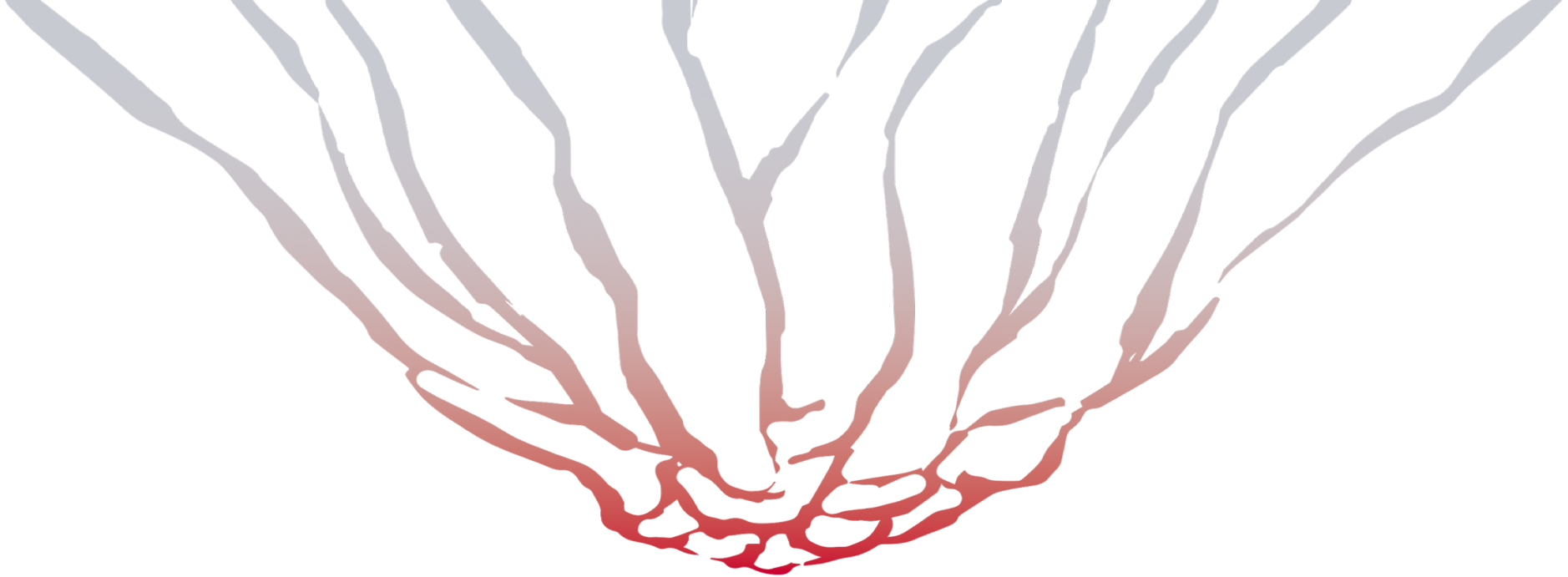

ESPRESSIF

TRAINING_Day 1

ESP Jumpstart

ESP Jumpstart Overview

Getting started

Part 1: Hello World !

Part 2: Driver

Part 3: WIFI

Part 4: Network Configuration

Hands–on session & Demo Show

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Agenda

项目	时间	时长	内容
Opening Ceremony & Espressif Introduction	9:30-10:15	45min	开营仪式 乐鑫公司与产品介绍（人才计划）
Getting started with Jumpstart	10:30-12:00	1.5h	1. JumpStart 项目介绍 2. ESP32 开发环境、SDK（ESP-IDF->MDF、ADF） 介绍、工程结构等 3. JumpStart 与 IDF 关系 4. 搭建 JumpStart 开发环境 5. 从源代码到机器码（执行指令） bin 以及烧写的过程（编译原理浅述）

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Agenda

Hello world!	1:00-2:00	1h	1. ESP32 启动流程 2. FreeRTOS 操作系统简介
Driver	2:10-3:40	1.5h	1. 实体按钮实现 2. 输出端 3. 按键去抖动、继电器控制 4. ESP32 GPIO 资源、使用介绍 5. 扩充: 利用 driver 实现其他的产品形态
WiFi			1. Wi-Fi 介绍（AP、STA、Router） 2. Wi-Fi 编程模型介绍、示意图 3. Wi-Fi 信息硬编码的弊端

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Agenda

Network Configuration	3:50-5:20	1.5h	1. 设备为什么要配网? 2. 网络配置介绍、配网方式介绍（SoftAP、BLE） 3. 演示过程 4. 统一配置 5. 网络信息保存，NVS 介绍 6. 恢复出产设置
Hands-on session + Demo Show	5:30-6:30	1h	1. 人体检测-灯光控制-状态反馈到 PC/手机 2. 温湿度控制器-状态反馈到 PC/手机 3. Espressif Show: ESP32-Touch-LCD, ESP-Sense Kit

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Let‘s Start ！

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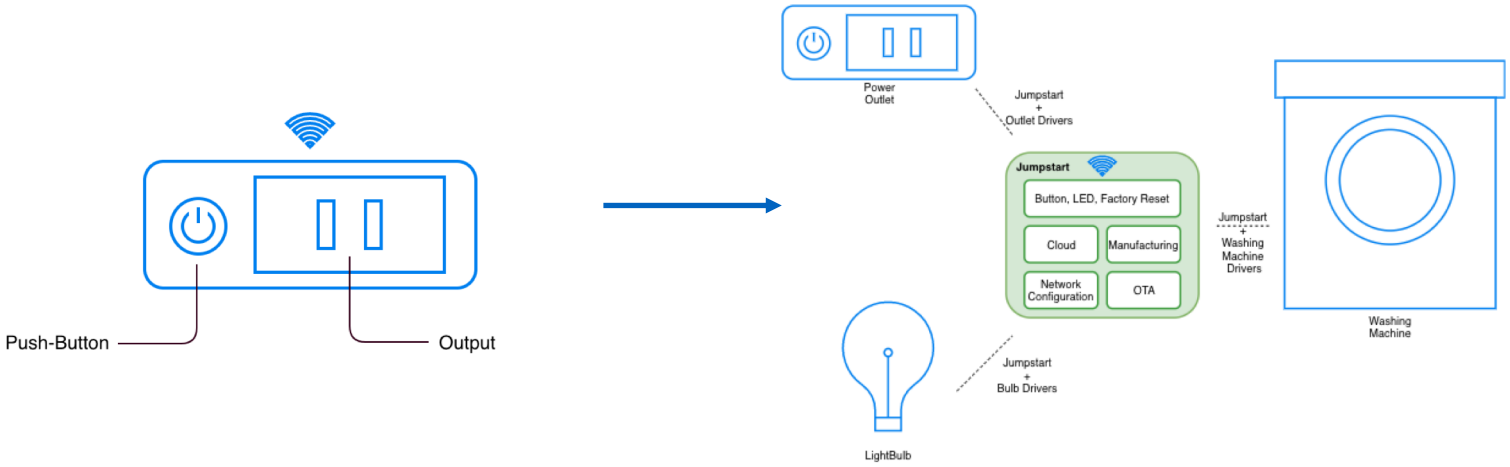
Getting started

Building Products with ESP32 fast: Jumpstart from concept to production



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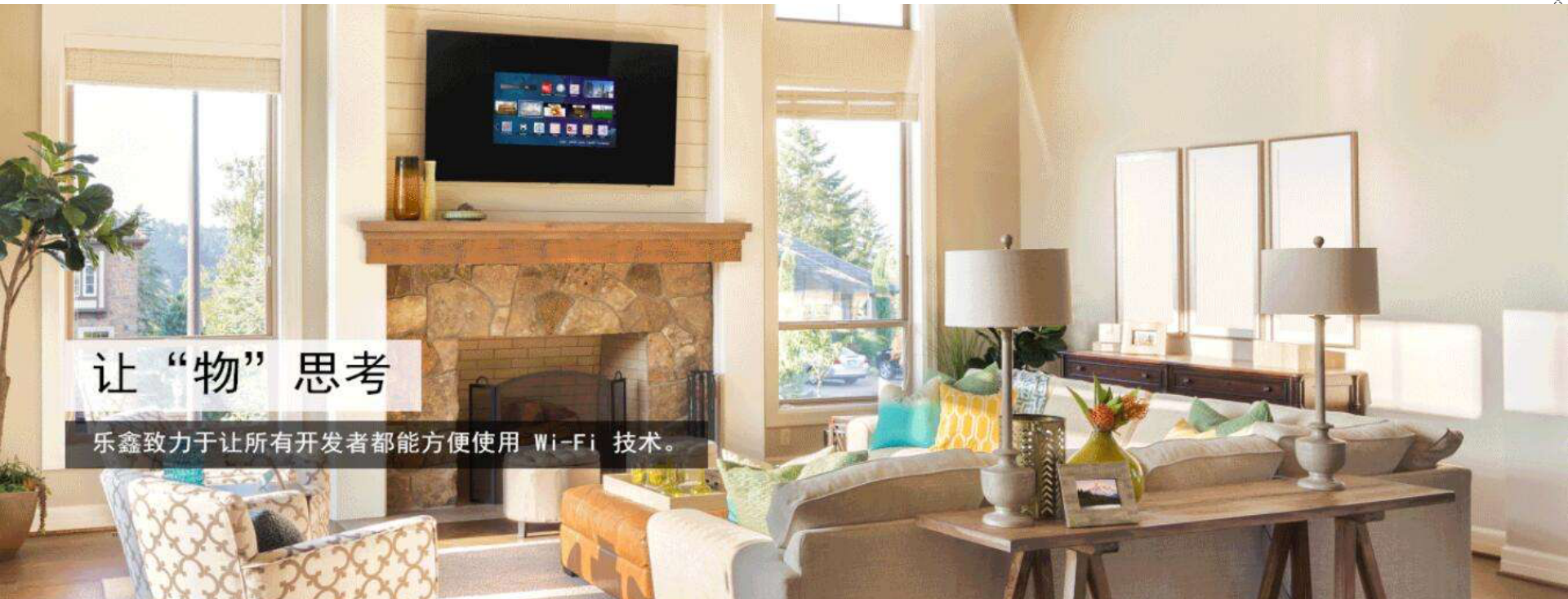
ESP JumpStart

Replace and implement your smart home！



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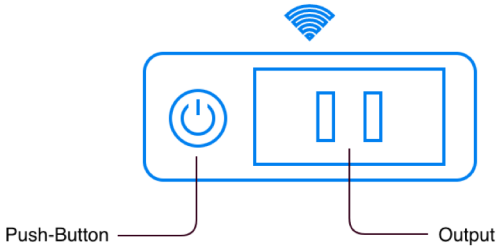
ESP Jumpstart: Objective

- Build a complete “product”: Smart Power Outlet
  - Control GPIO output
  - Network Configuration
  - Remote control through cloud
  - OTA Upgrades
  - Reset to Factory



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Part 1: Hello World

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Part 1 Objective

- Preparations
- Development Host Setup
- ESP-IDF
- Build, Flash & Monitor

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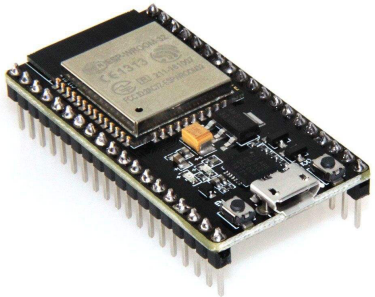
Preparations

- Development Host PC
  - Windows
  - Linux
  - Mac
- ESP32-DevKitC
- USB to mini-USB cable
- Wi-Fi Access Point



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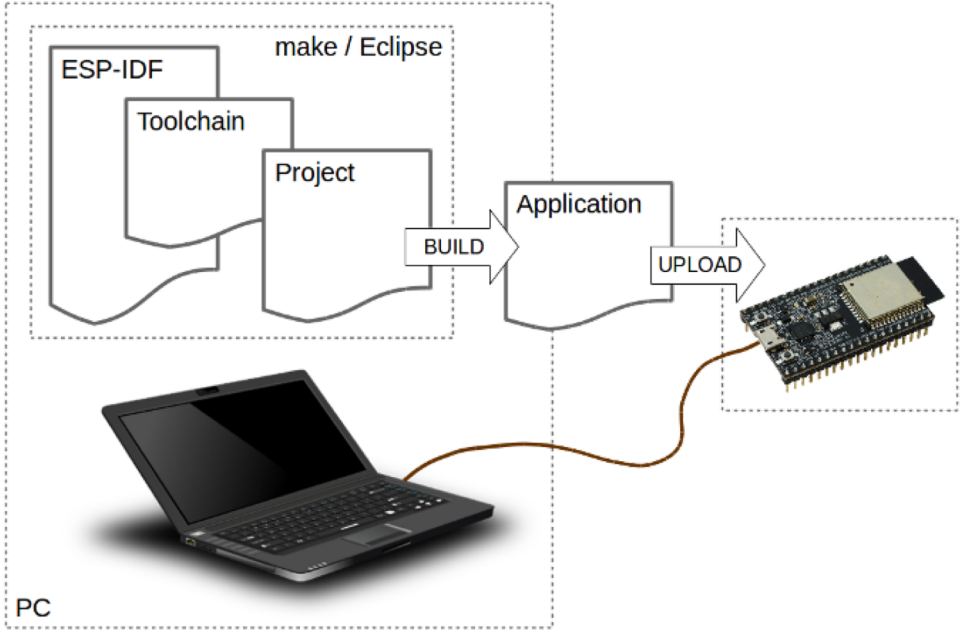
Typical Development Setup

The diagram depicts the typical setup for development with ESP32.



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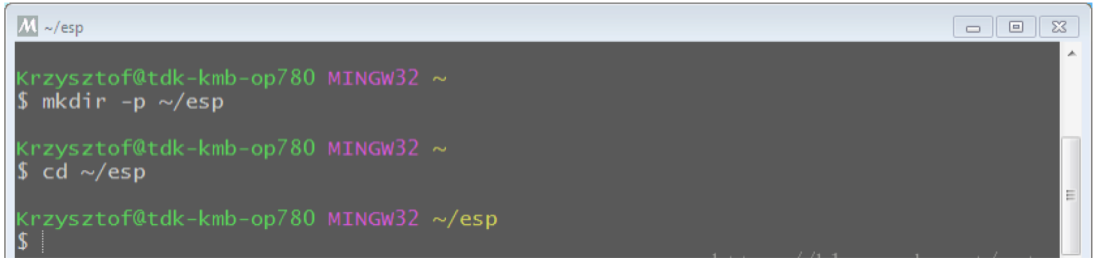
ESP-IDF

ESP-IDF is Espressif's IoT Development Framework for ESP32

- A collection of Libraries and Header files
- Tools and utilities: build, flash, debug



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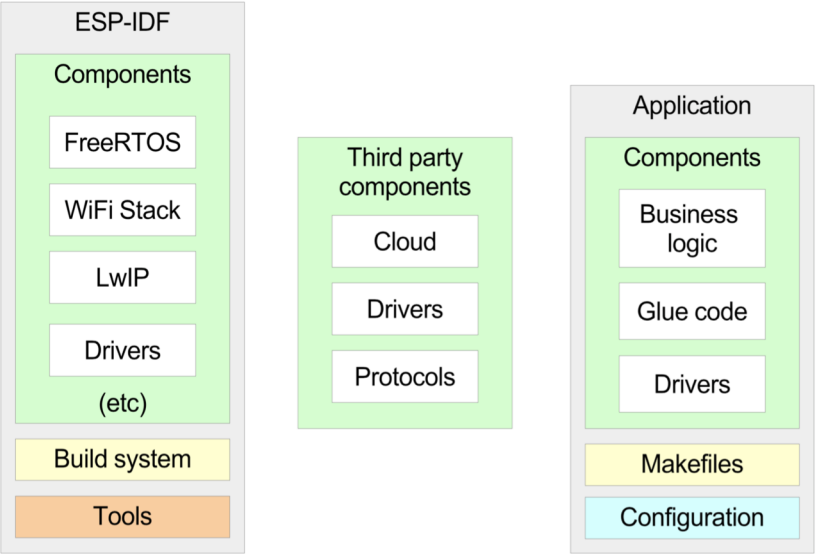
IDF Details - a component based design

- All the software in the IDF is available as components.



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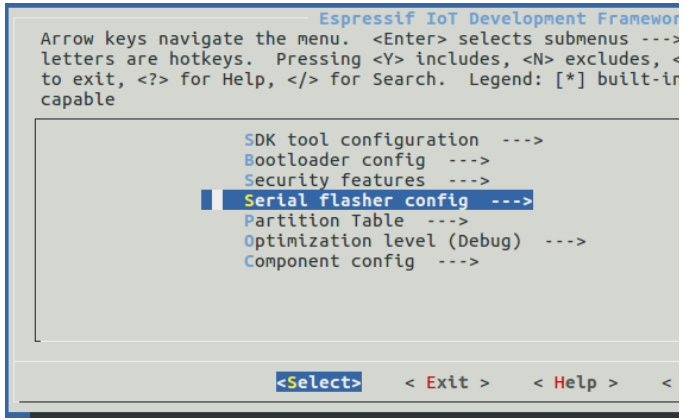
Development Framework Configuration

- Configuration system based on Linux kernel's kconfig
- Configure settings for your project (impacts feature, performance, memory)
- Each component can define its own configuration options
- Use *make menuconfig* command to edit the configuration



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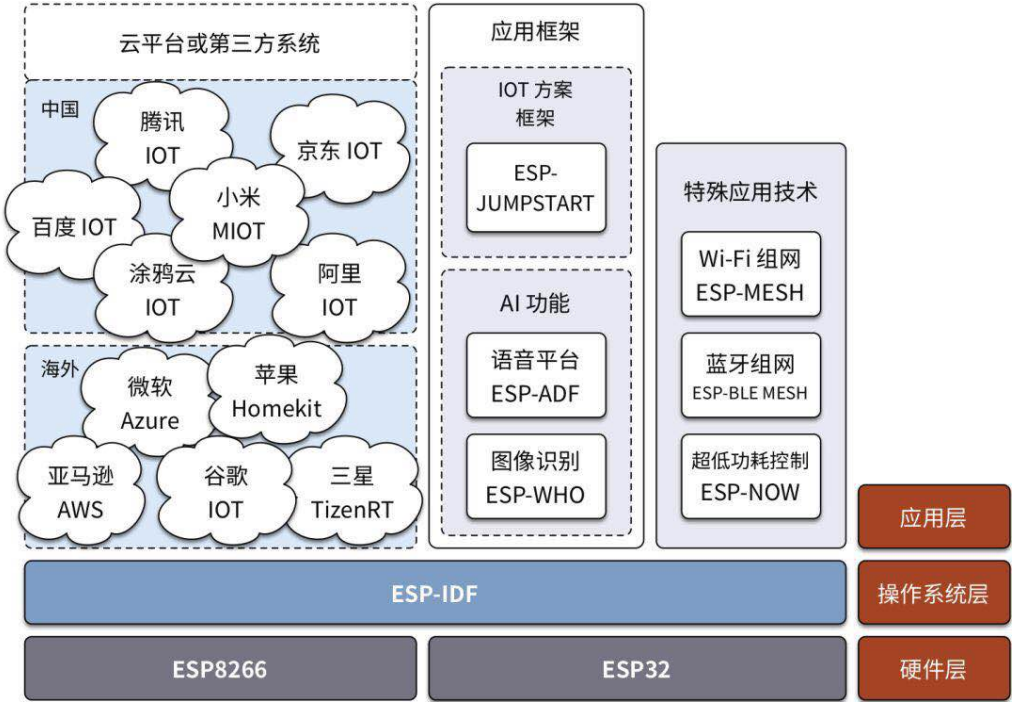
基于ESP-IDF的应用框架



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应用实例

MESH:

Espressif Wi-Fi Mesh 组网方案

使用乐鑫 Wi-Fi Mesh 组网的智能灯与人脸识别技术结合的应用 Demo

BLE MESH

当 ESP-MESH 应用于节能照明

HMI:

Thermostat for air-conditioner

Control Panel for coffee machine

Audio Player Device

LittlevGL-demo-video

ESP32:

让智能陪伴成长：ESP32 绘本故事机方案

ESP32 生态应用概览(2019.01-02)

ESP32 可移动网络摄像头

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Resources

ESP-IDF Programming Guide

Espressif Systems GitHub

ESP32 Forum

Espressif document

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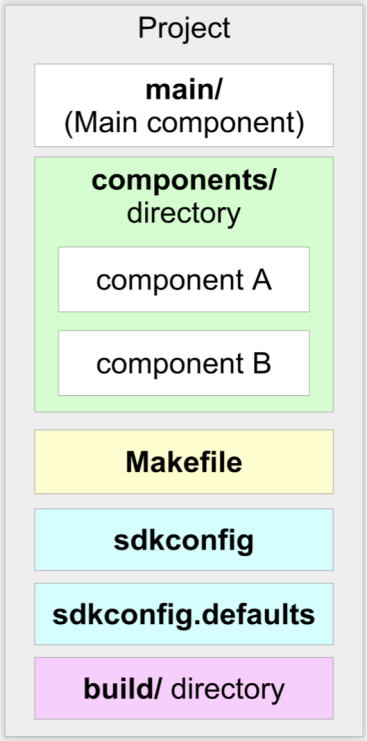
IDF Details - Application's Structure

- An application must contain one *main* component.



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Build, Flash & Monitor

- make flash
- make monitor

```
$ make monitor
MONITOR
--- idf_monitor on /dev/ttyUSB0 115200 ---
--- Quit:Ctrl+] | Menu:Ctrl+T | Help:Ctrl+T followed by Ctrl+H ---
ets Jun  8 2016 00:22:57

rst:0x1 (POWERON_RESET),boot:0x13 (SPI_FAST_FLASH_BOOT)
ets Jun  8 2016 00:22:57
...
```

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Code

```
#include <stdio.h>
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"


void app_main()
{
    int i = 0;
    while (1) {
        printf("[%d] Hello world!\n", i);
        i++;
        vTaskDelay(5000 / portTICK_PERIOD_MS);
    }
}
```

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Code Explanations

- app_main: Application Entry Point
- Runs in the application thread
- C Library
- FreeRTOS: Real-Time Operating System

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Code Explanation: C standard Library

ESP-IDF uses newlib 2.2.0 as C standard library

- Most of the C standard library is supported, plus extras

- stdlib, stdio, string, math, time
- File/Directory operations
- Reentrant functions
- Timezones, DST

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Code Explanation: FreeRTOS

Real-Time Operating System https://www.freertos.org

- Task management
- Message Queues, Semaphores and Mutexes
- Timers

API Reference: https://www.freertos.org/a00106.html
FreeRTOS基础篇 FreeRTOS高级篇

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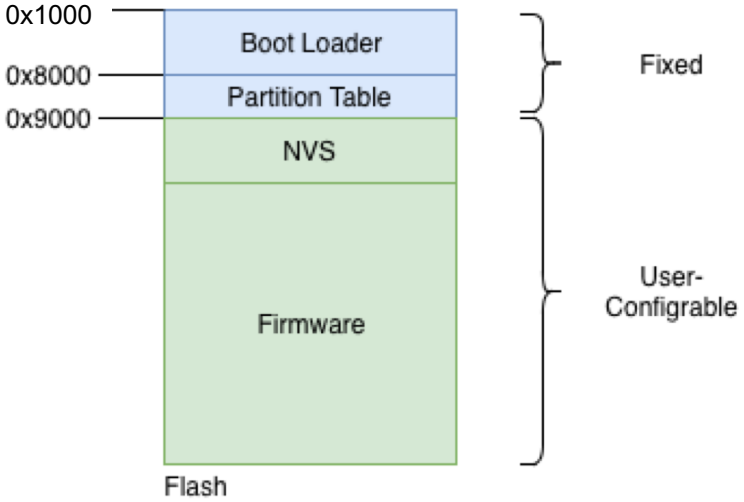
General Notes - Flash



1. First-stage bootloader in ROM loads second-stage bootloader image to RAM (IRAM & DRAM) from flash offset 0x1000.
2. Second-stage bootloader loads partition table and main app image from flash. Main app incorporates both RAM segments and read-only segments mapped via flash cache.
3. Main app image executes. At this point the second CPU and RTOS scheduler can be started.

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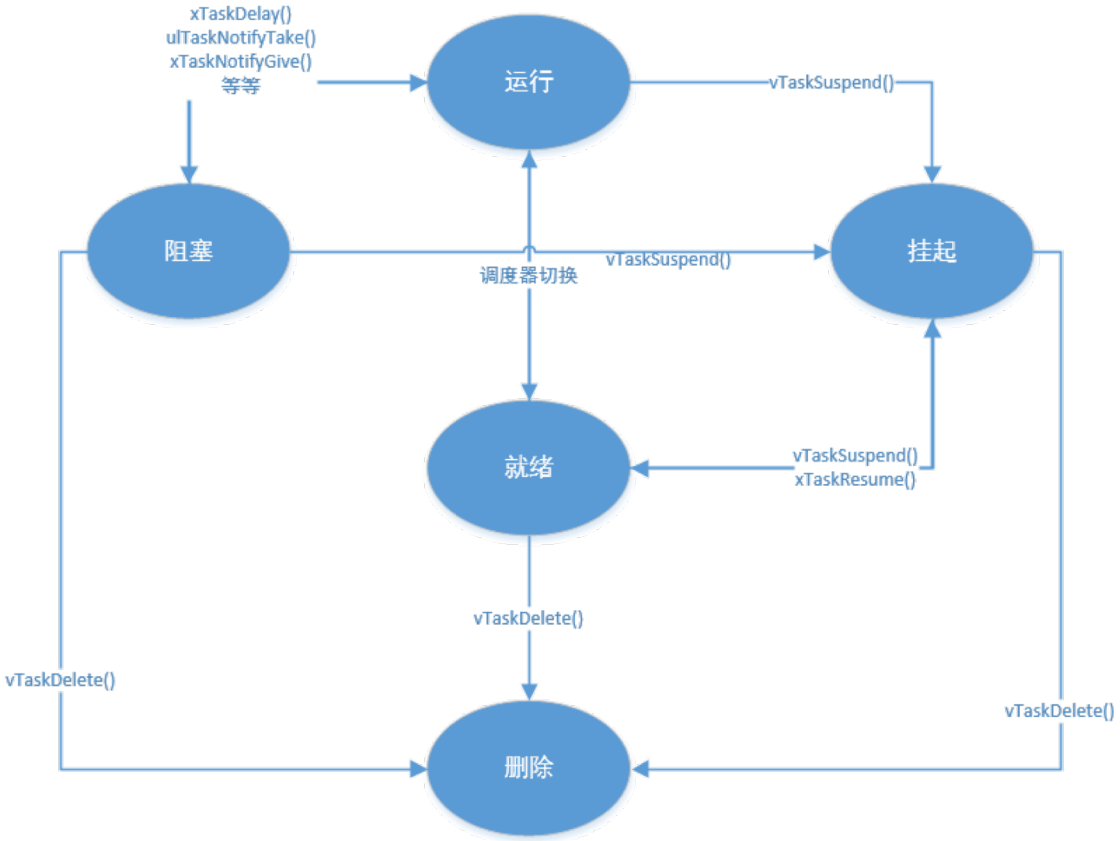
General Notes: Task



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Part 2: Driver

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Part 2 Objective

Now we will configure a GPIO to act as the output of the power outlet. We will assert this GPIO on or off which would ideally trigger a relay to switch the output on or off.

- Configure a push-button
- Use GPIOs
- Configure an output

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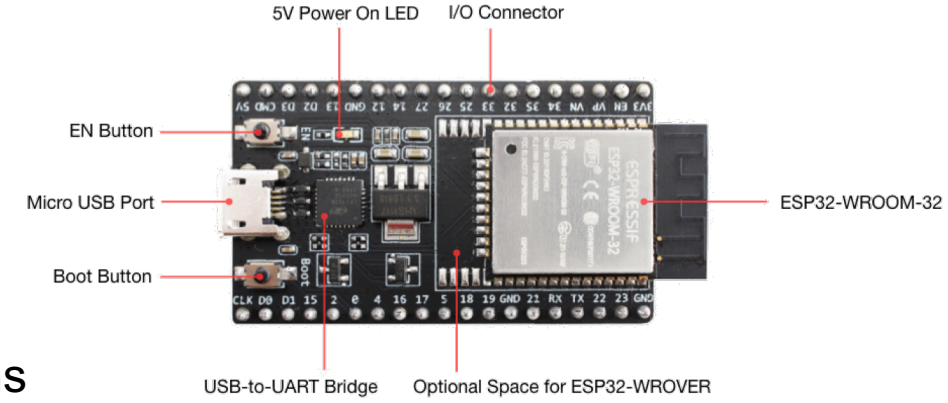
Push-Button

Let’s first create a push-button.

- Assert a GPIO
- Callback handler
- iot_button component: Allows long-hold actions



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GPIO & Output

- Configure mode
- Set output

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Code

The code for enabling this is shown as below:

```
#include <iot_button.h>


button_handle_t
btn_handle=iot_button_create(BUTTON_GPIO,
                                BUTTON_ACTIVE_LEVEL);


iot_button_set_evt_cb(btn_handle, BUTTON_CB_RELEASE,
                            btn_cb, "RELEASE");
```

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Code

```
gpio_config_t io_conf;
io_conf.mode = GPIO_MODE_OUTPUT;
io_conf.pull_up_en = 1;
io_conf.pin_bit_mask = ((uint64_t)1 << OUTPUT_GPIO);

/* Configure the GPIO */
gpio_config(&io_conf);

/* Assert GPIO */
gpio_set_level(OUTPUT_GPIO, target);
```

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ESP32 Functional Block Diagram

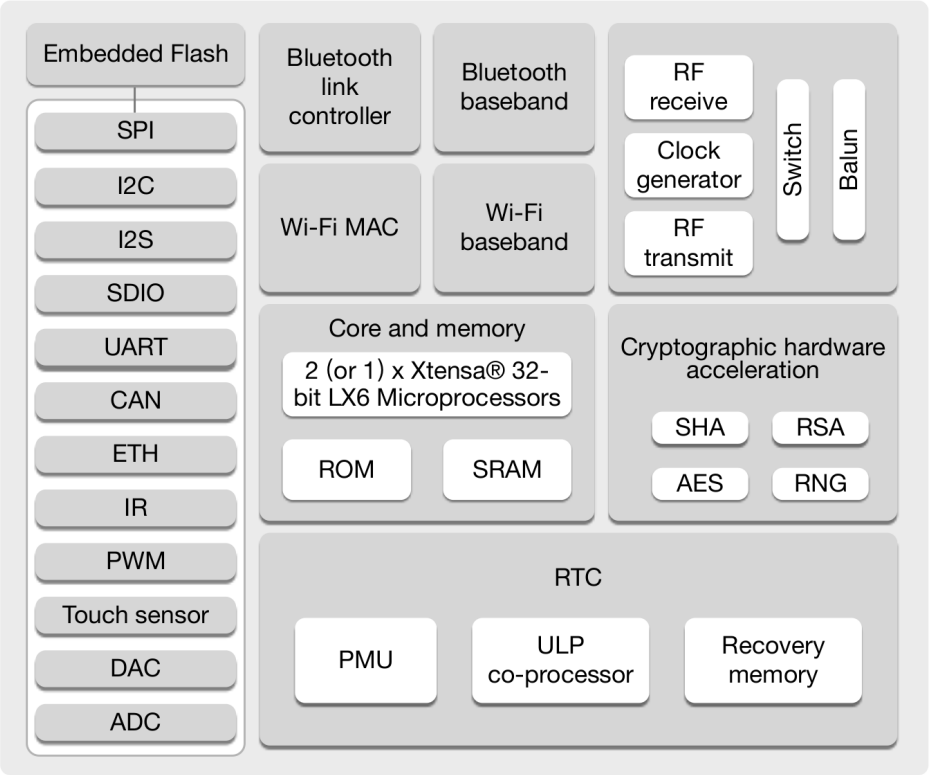

图 1: 功能框图

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ESP32 Peripherals

PWM	**16**	**light,motor**
I2C	2 * HW I2C	Sensor
I2S	2	Audio,LCD,Camera
SPI	2	LCD
Timer	4	
RMT	8	
PCNT	8	
SD/MMC	1	SD-Card
UART	3	

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Part 3: Wi-Fi

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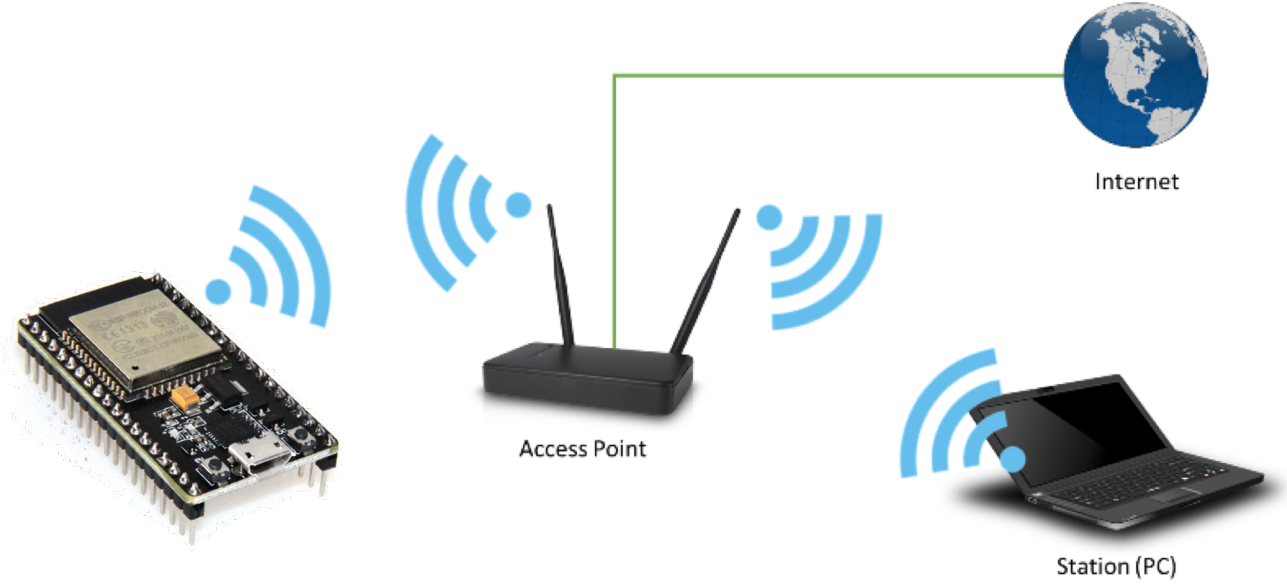
Wi-Fi Introduction



ESP32 operating in the **Station** mode

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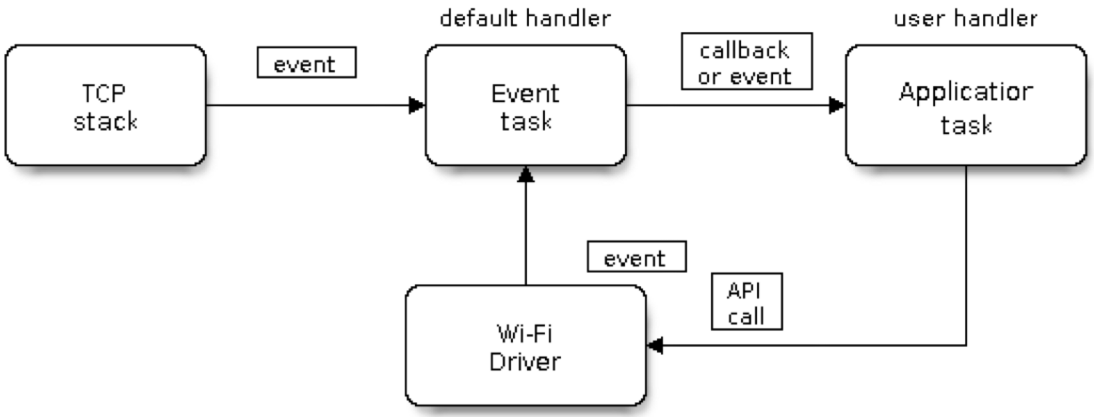
ESP32 Wi-Fi Programming Model



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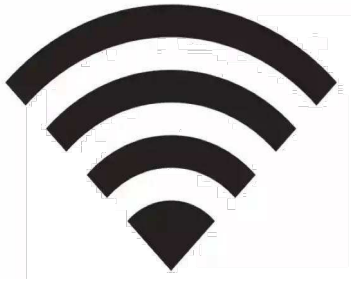
Objective

- Configure Wi-Fi station interface
- Connect to pre-configured AP
- Asynchronous event handler:
  - Connected
  - Disconnected
  - IP Address assignment



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Code

```
#include <esp_wifi.h>
#include <esp_event_loop.h>

tcpip_adapter_init();
esp_event_loop_init(event_handler, NULL);


wifi_init_config_t cfg = WIFI_INIT_CONFIG_DEFAULT();
esp_wifi_init(&cfg);
esp_wifi_set_mode(WIFI_MODE_STA);
```

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Code

```
wifi_config_t wifi_config = {
    .sta = {
        .ssid = EXAMPLE_ESP_WIFI_SSID,
        .password = EXAMPLE_ESP_WIFI_PASS,
    },
 };
esp_wifi_set_config(ESP_IF_WIFI_STA, &wifi_config);

esp_wifi_start();
```

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Code

```
esp_err_t event_handler(void *ctx, system_event_t
*event)
{
    switch(event->event_id) {
    case SYSTEM_EVENT_STA_START:
        esp_wifi_connect();
        break;
    case SYSTEM_EVENT_STA_GOT_IP:
        ESP_LOGI(TAG, "Connected with IP Address:%s",
ip4addr_ntoa(&event->event_info.got_ip.ip_info.ip));
        break;
    case SYSTEM_EVENT_STA_DISCONNECTED:
        esp_wifi_connect();
        break;
    return ESP_OK;
}
```

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Part 4: Network Configuration

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Objective

- Network Provisioning
- NVS: Persistent key-value store
- Reset to Factory

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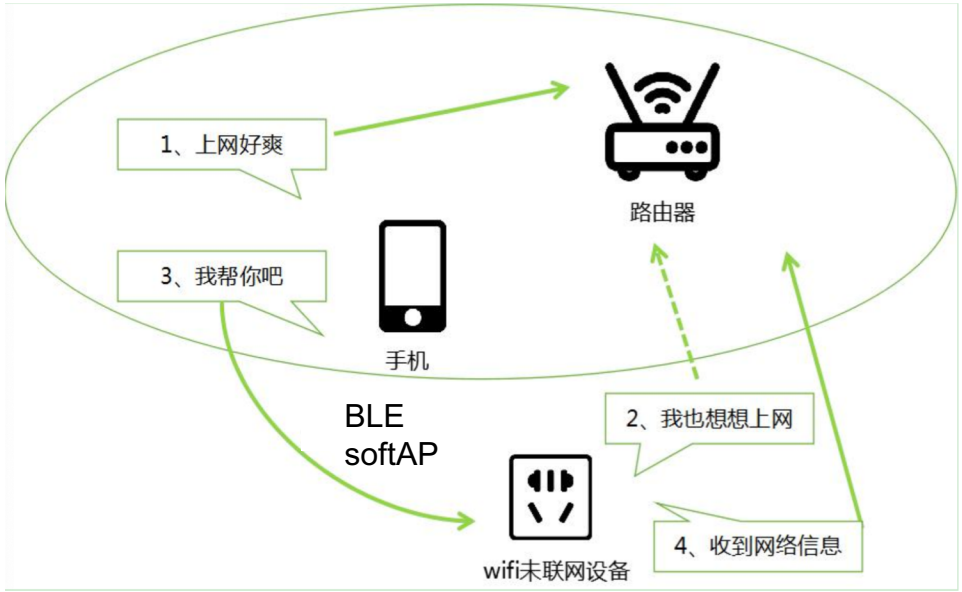
Provisioning Methods Overview

In this step we will build a firmware such that the end-user can configure his/her Wi-Fi network's credentials into the device at run-time.



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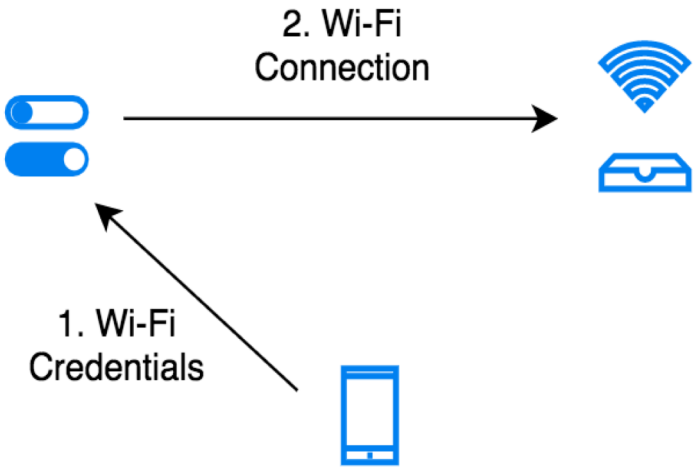
Provisioning Methods Overview

The end-user typically uses his/her smart-phone to *securely* configure the Wi-Fi credentials into their device. Once the devices acquire these credentials, it can then connect to his/her home Wi-Fi network.

- Soft AP
- Bluetooth
- Smart-Config



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Comparison

	Advantages	Disadvantages
SoftAP	1. 非常可靠（SoftAP 只作为 Wi-Fi 接入点，技术成熟） 2. 简洁（无需在设备固件中增加额外代码）。	1. 要求客户手动切换手机连接的 Wi-Fi 网络，用户体验不友好。 2. 通常很难直接将 “切换网络” 的过程写入代码，交由 app 自动完成（全部 iOS 和部分 Android 版本均并不允许手机 app 进行上述操作）。
BLE	1. 用户无需切换 Wi-Fi 2. iOS 和 Android 系统都支持手机 app 扫描并连接到周围的 BLE 设备。	1. 需要加入蓝牙相关代码。这就意味着固件大小会增加，因而会对 flash 提出更高要求。 2. BLE 在配网结束前还会一直占用内存。

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配网底层结构组件

- 统一配置规范
- IDF 组件
- Android/iOS 手机库
- Reference applications on the device and Android/iOS

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Code

```
if (conn_mgr_prov_is_provisioned(&provisioned) !=
ESP_OK) {
    return;
}

if (! provisioned) {
    /* Starting provisioning */
    conn_mgr_prov_start_provisioning(prov_type,
                security, pop, service_name,
service_key);
} else {
    /* Start the station */
    wifi_init_sta();
}
```

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Code

```
esp_err_t event_handler(void *ctx, system_event_t
*event)
{
     conn_mgr_prov_event_handler(ctx, event);

     switch(event->event_id) {
     case SYSTEM_EVENT_STA_START:
…
…
…
```

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Flash Partitions

- Store user’s configuration: NVS
- Custom Partition Table: partitions.csv
- Update in ‘menuconfig’

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NVS

The NVS is a software component that maintains a persistent storage of key-value pairs.

- 永久储存键值对 (key-value pairs)
- 可以防止设备断电带来的数据损坏 (metadata corruption)
- 可以通过将写入的内容分布到整个 NVS 分中以处理 flash 磨损的问题。
- Support namespaces
- Used for: manufacturing settings, user’s configuration, state maintenance after reset

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Reset to Factory

Once the user configuration is stored into the NVS as discussed above, **Reset to Factory** behaviour can be achieved by simply erasing the NVS partition.

- Long-press Push Button
- Erase NVS

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Code

```
static void button_press_3sec_cb(void *arg)
{
    nvs_flash_erase();
    esp_restart();
}

iot_button_add_on_press_cb(btn_handle, 3,
                           button_press_3sec_cb, NULL);
```

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Hands-on session & Demo Show

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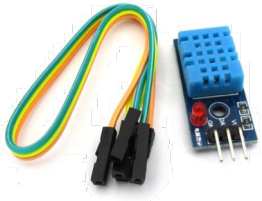
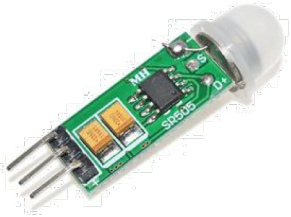
Hands-on

- Work in groups of 2 or 3
- Use modules we provide or other modules you like



DHT 11 Humidity sensor
Humidity Sensor: state to PC/smart phone



HC-SR505 Mini human body sensor
Human detection: state feedback to PC/smart phone

- It can be a demo, a prototype, even an idea!
- Group Demo Show next week

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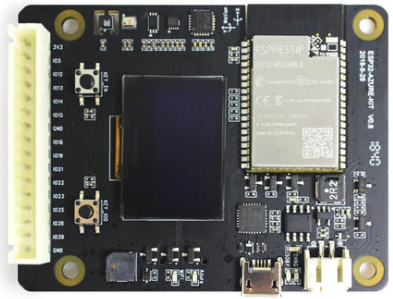
ESP32-Azure IoT Kit



ESP32-Azure IoT Kit

An Espressif development board with powerful functions, designed for sensor data acquisition, cloud platform access and a wide range of applications.

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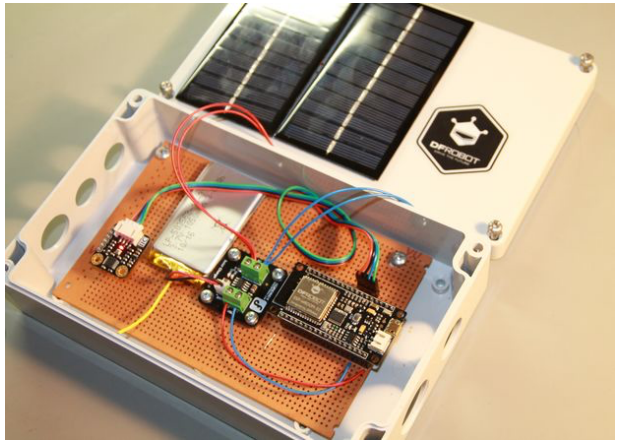
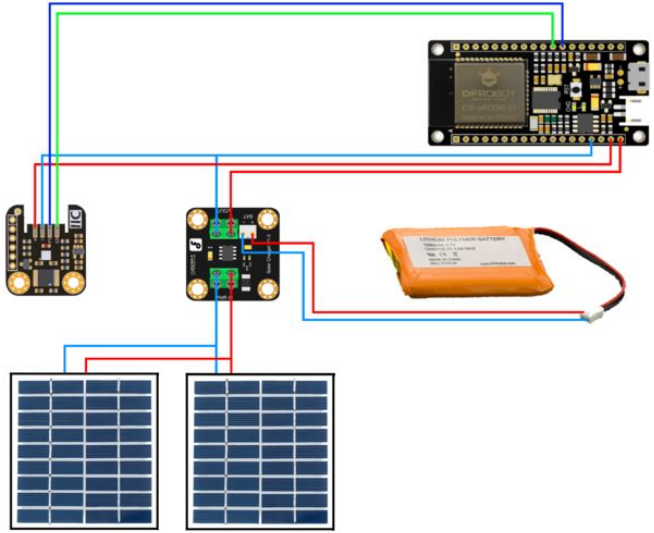
Projects from foreign developers



ESP32 Solar Weather Station

https://www.dfrobot.com/blog-699.html



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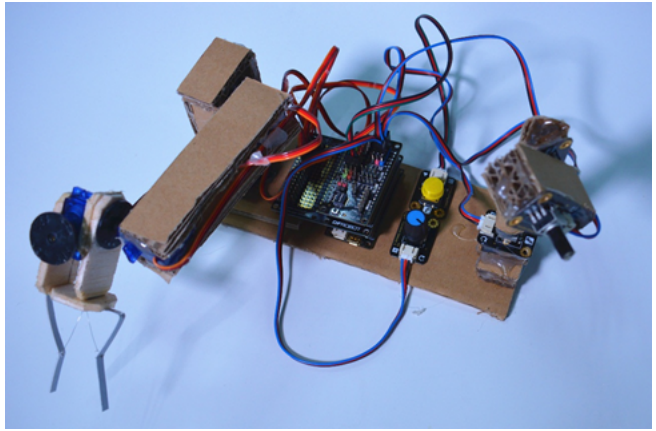
Projects from foreign developers



DIY an intelligent robot arm
https://www.dfrobot.com/blog-699.html

A Step-Counter that shows the time
https://www.dfrobot.com/blog-699.html

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Demo Show

What’s your idea?

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