AI FARM Robotics Factory

Lab 01: Understanding WiFi_Station

July 25 2024

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I. Introduction

The ESP32 is a popular microcontroller with integrated Wi-Fi and Bluetooth capabilities, making it suitable for IoT applications. ESP-IDF (Espressif IoT Development Framework) is the official development framework for the ESP32 chip. In the context of Wi-Fi, the ESP32 can operate in different modes, including Station (STA), Soft Access Point (AP), and both simultaneously.

II. Understanding WIFI Station Mode

In Wi-Fi Station mode, the ESP32 connects to an existing Wi-Fi network as a client. This mode is used when you want your ESP32 to connect to a router or access point, enabling it to communicate with other devices on the network or access the internet.

III. Key Components of ESP-IDF Wi-Fi Station Code

- Make a new project of Espressif and then select type of esp board (esp32, eps32s3, esp32c3 , esp32c6……..)
- **Initialization and Configuration**: This involves initializing the TCP/IP stack and configuring the Wi-Fi settings.
- **Event Handling**: ESP-IDF uses an event-driven model where various Wi-Fi events (like connection, disconnection, IP acquisition) are handled through event handlers.
- **Connecting to the Wi-Fi Network**: This involves specifying the SSID and password of the target network and initiating the connection process.

My code:

Includes and Setup: Necessary headers for Wi-Fi, FreeRTOS, logging, and NVS

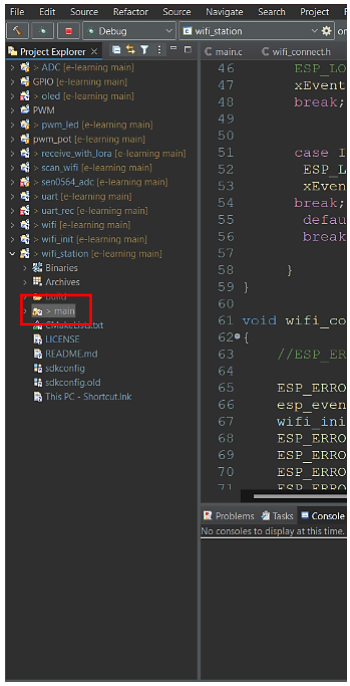
(Non-Volatile Storage) are included in file main.c .

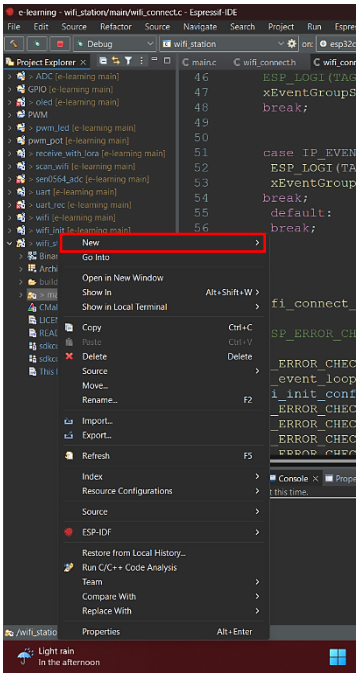
```
#include <stdio.h>
#include "portmacro.h"
#include "nvs_flash.h"
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"
```

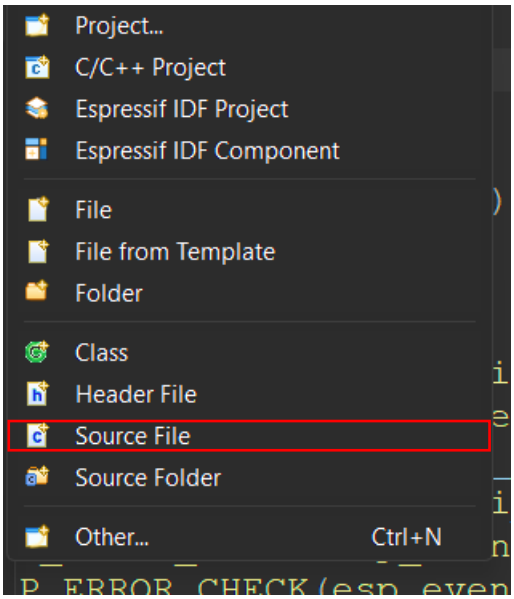
After include some library in main.c , we have to create new library your own.

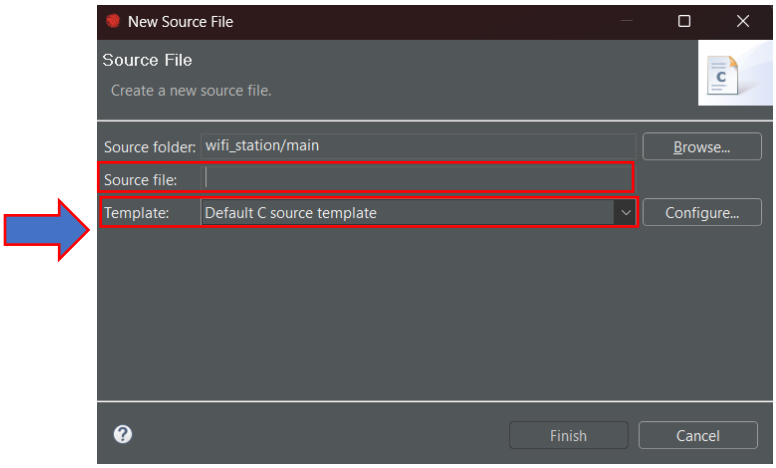
For create new library we need to do like :

- Go to file that have name “main” -> right click on “ main ” -> click on “new” -> click on source file and then give name for this file , for this file name need to end by “.c” (example: wifi_connect.c) -> at the last we select “ Default C Source template “ in Template and click finish .

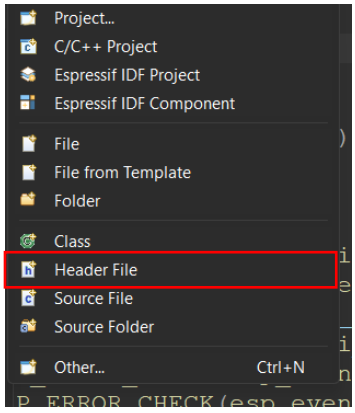


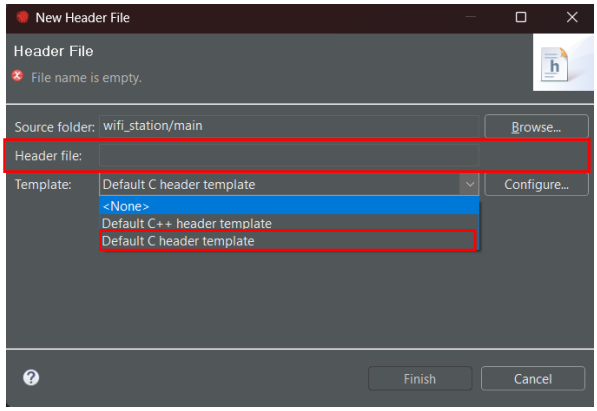




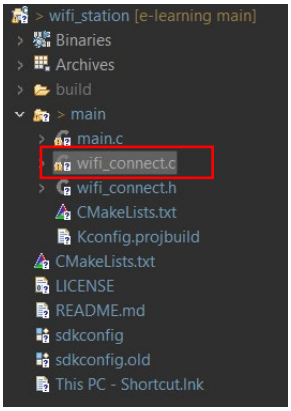


- Do it again and we make header file after right click on “new “ -> click on header file -> give name for this (for recommendation should give the same name of source file) for header name need to end by “.h” (example: wifi_connect.h).





i. Create new file (source file , and header file) and give wifi_connect.c for source file and wifi_connect.h for header file . create source file for write code for make own library and header file for include to in file main.c .



we write code for library in file wifi_connect.c:

1. Step1:

Include necessary library

```
#include <stdio.h>
#include "esp_err.h"
#include "esp_event.h"
#include "esp_log.h"
#include "esp_netif_types.h"
#include "esp_wifi.h"
#include "esp_netif.h"
#include "esp_wifi_default.h"
#include "esp_wifi_types.h"
#include "riscv/encoding.h"
```

```
#include "string.h"
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"
#include "freertos/event_groups.h"
```

2. Step2:

Define some parameter

```
static char* TAG = "WIFI CONNECT" ;
static esp_netif_t *esp_netif ;
static EventGroupHandle_t wifi_events ;
static int CONNECTED = BIT0 ;
static int DISCONNECTED = BIT1 ;
```

3. Step3

The `wifi_event_handler` function handles various Wi-Fi events such as connection start, disconnection, and IP address acquisition.

```
void event_handler(void *event_handler_arg,esp_event_base_t
event_base,int32_t event_id, void *event_data)
{
         switch (event_id) {
          case WIFI_EVENT_STA_START:
          ESP_LOGI(TAG ,"WIFI_EVENT_STA_START");
          esp_wifi_connect();
          break;
          case WIFI_EVENT_STA_CONNECTED:
          ESP_LOGI(TAG ,"WIFI_EVENT_STA_CONNECTED");
          break;

          case WIFI_EVENT_STA_DISCONNECTED:
        /*{
                  wifi_event_sta_disconnected_t *wifi_event_sta_disconnected
= event_data ;
          ESP_LOGI(TAG ,"DISCONNECTED %d"wifi_event_sta_disconnected->
reason);*/
          xEventGroupSetBits(wifi_events, DISCONNECTED);
          break;


          case IP_EVENT_STA_GOT_IP:
           ESP_LOGI(TAG ,"IP_EVENT_STA_GOT_IP");
           xEventGroupSetBits(wifi_events, CONNECTED);
          break;
           default:
           break;

         }
}
```

4. Step4

The wifi_init_sta function initializes the TCP/IP stack, creates a default Wi-Fi station interface, and sets up the Wi-Fi configuration with SSID and password.

```
void wifi_connect_init(void)
{
        //ESP_ERROR_CHECK(x)

        ESP_ERROR_CHECK(esp_netif_init());
        esp_event_loop_create_default();
        wifi_init_config_t wifi_init_config = WIFI_INIT_CONFIG_DEFAULT();
        ESP_ERROR_CHECK(esp_wifi_init(&wifi_init_config));
        ESP_ERROR_CHECK(esp_event_handler_register(WIFI_EVENT,ESP_EVENT_ANY_
ID,event_handler,NULL));
        ESP_ERROR_CHECK(esp_event_handler_register(IP_EVENT,
IP_EVENT_STA_GOT_IP, event_handler, NULL));
        ESP_ERROR_CHECK(esp_wifi_set_storage(WIFI_STORAGE_RAM));
}
```

5. Step5:
   - This function **wifi_connect_sta** takes three parameters: ssid (the Wi-Fi SSID), pass (the Wi-Fi password), and timeout (the timeout duration for connecting).
   - **wifi_events** is created as an event group using **xEventGroupCreate()**. Event groups are used for task synchronization and signaling.
   - **esp_netif**_create_default_wifi_sta( ) start with the default Wi-Fi station (STA) interface.
   - **esp_wifi_set_mode(WIFI_MODE_STA)** sets the Wi-Fi mode to station mode. This allows the device to connect to an access point.
   - A **wifi_config_t** structure named **wifi_config** is created and start off .The SSID and password are copied into the **wifi_config** structure using strncpy(). The -1 in **sizeof(wifi_config.sta.ssid)-1** ensures there is space for the null terminator.
   - esp_wifi_set_config() applies the Wi-Fi configuration to the STA interface using the wifi_config structure.
   - **esp_wifi_start()** starts the Wi-Fi driver.
   - **xEventGroupWaitBits()** waits for either the CONNECTED or DISCONNECTED event bits to be set in the wifi_events event group.
   - **true**: Clears the bits before returning.
   - **false**: Do not wait for all bits to be set.
   - **pdMS_TO_TICKS(timeout)** converts the timeout value from milliseconds to FreeRTOS ticks.
   -
   - Condition **if** :

     If the CONNECTED bit is set, it prints "connect...yey".

If the DISCONNECTED bit is set in type of loop , it prints ".....can not connect.....".

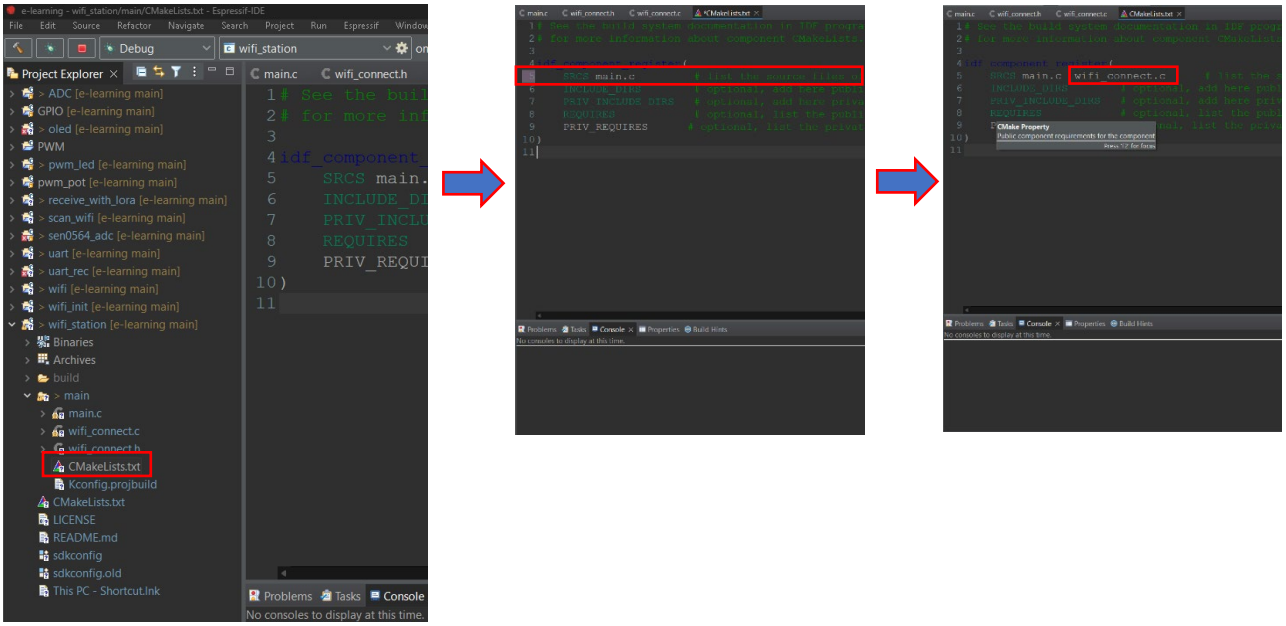
```
esp_err_t wifi_connect_sta(char* ssid, char* pass , int timeout){
        wifi_events = xEventGroupCreate();
        esp_netif = esp_netif_create_default_wifi_sta();
        esp_wifi_set_mode(WIFI_MODE_STA);
        wifi_config_t wifi_config = {};
        strncpy((char *)wifi_config.sta.ssid, ssid,
sizeof(wifi_config.sta.ssid)-1);
        strncpy((char *)wifi_config.sta.password, pass,
sizeof(wifi_config.sta.password)-1);
        esp_wifi_set_config(WIFI_IF_STA, &wifi_config);
        esp_wifi_start();

        EventBits_t result = xEventGroupWaitBits(wifi_events, CONNECTED
|DISCONNECTED ,
        true,false,pdMS_TO_TICKS(timeout));

                if(result == CONNECTED) {
                printf("connect...yey  \n");
        }for(;;)
        if (result == DISCONNECTED) {
                printf(".............can not connect.................\n");
        }
        vTaskDelay(100/portTICK_PERIOD_MS);
}
```

ii. After prepared code in source, we have to prepare code in header file, but before write code in header file we have to edit something in CMakeList.Txt . So we need to do like this:

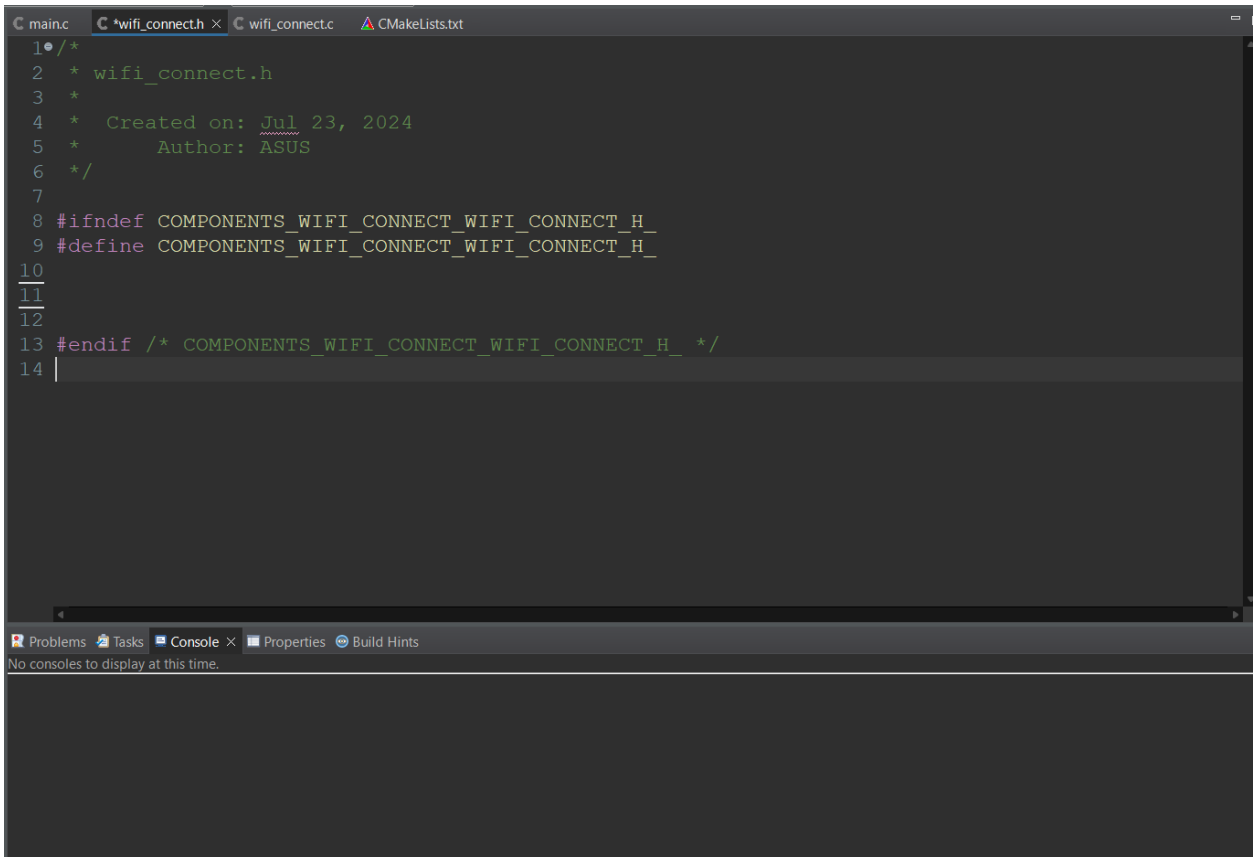
- Step to setup in CMakeList.txt



iii. Add wifi_connect.c in CMAkeList.txt and then we write code in header file .

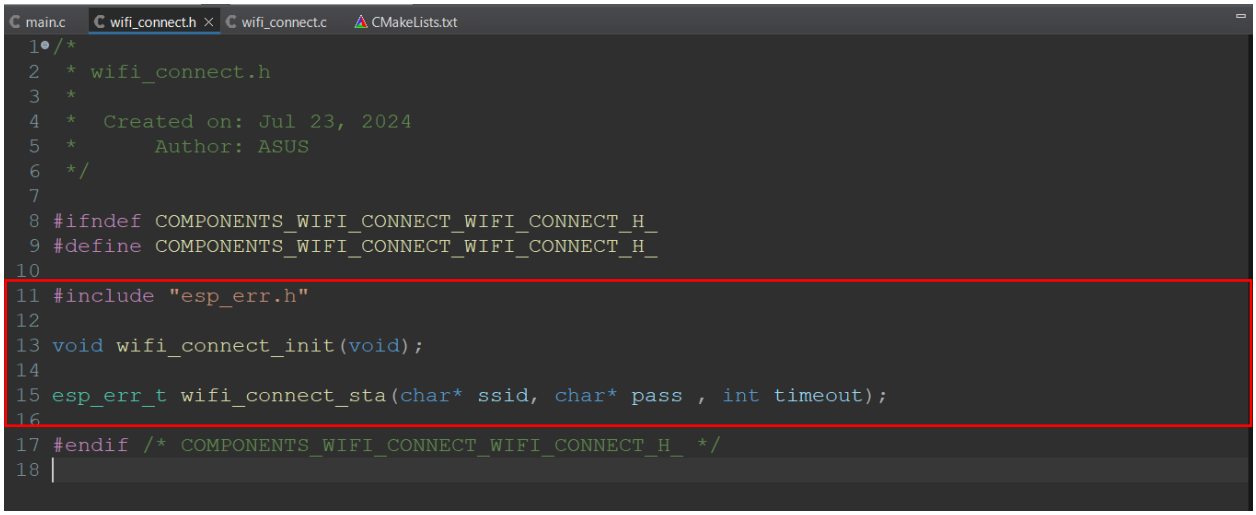
1) Step1

Go to header file (wifi_connect.h) and we will see like this .



2) Step2

Include some library and call function that create in source file. At last click CTRL+S for save.



After we prepare library your own already we go to file main.c to write code for esp32 let it work. We have to add code in void app_main(void):

```c
#include <stdio.h>
#include "portmacro.h"
#include "wifi_connect.h"
#include "nvs_flash.h"
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"



void app_main(void)
{
    nvs_flash_init();// use for turn on our esp to communicate something such set set esp for

     wifi_connect_init();

    vTaskDelay(1000/portTICK_PERIOD_MS);

    esp_err_t err = wifi_connect_sta("Tara","0972373850Aa", 10000);

}
```

Include library that we made into file main.c .

For code in link 18 esp_err_t err = wifi_connect_sta("Tara","0972373850Aa", 10000); it is function that we created in wifi_connect file:

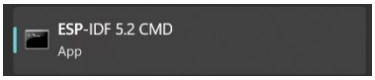
esp_err_t wifi_connect_sta(char* ssid, char* pass , int timeout)

- place of ssid: it write name wifi that we want to connect .
- place of pass: it write the password of wifi.
- Place of timeout : we choose 10000 .

iv. Running code

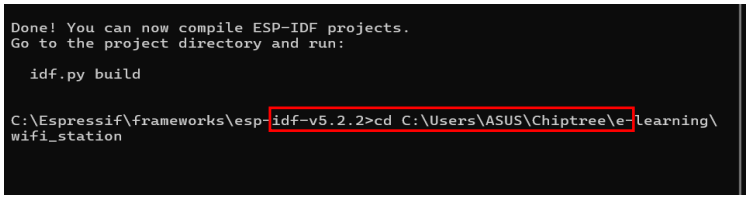
- Step1

Go find ESP-IDF CMD and open it .



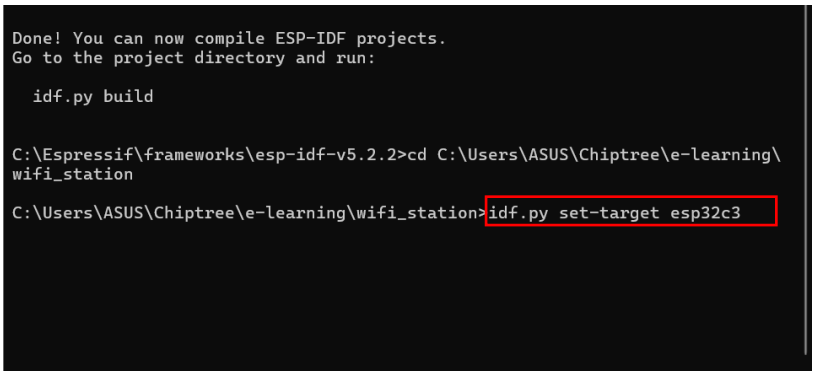
- Step2

Use comment cd for change directory . write cd and add 1 space and past the directory of our project .

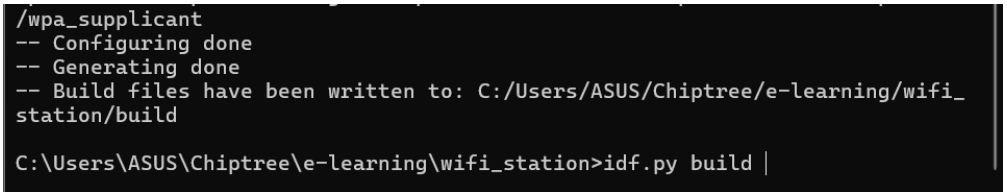


- Step3

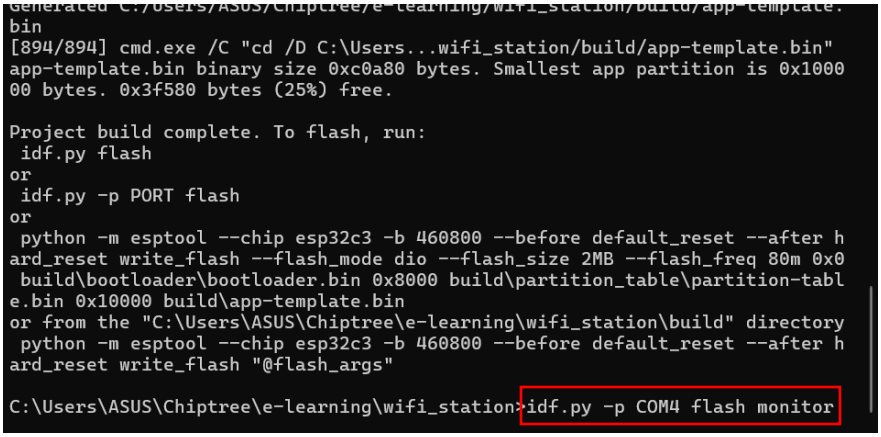
Use comment idf.py set-target esp32 (type of your board) to set type of esp32



- Step4
  Use comment “idf.py build” for build your code in your project



- Step5
  Use comment “idf.py -p COM4 flash monitor for enter the code into esp and we will see IP address in monitor .



IV. Conclusion

Implementing a Wi-Fi station on the ESP32 using ESP-IDF involves several steps, including initializing NVS, configuring the Wi-Fi settings, handling Wi-Fi events, and starting the Wi-Fi driver. By following these steps, you can connect your ESP32 to a Wi-Fi network and handle various network events efficiently.