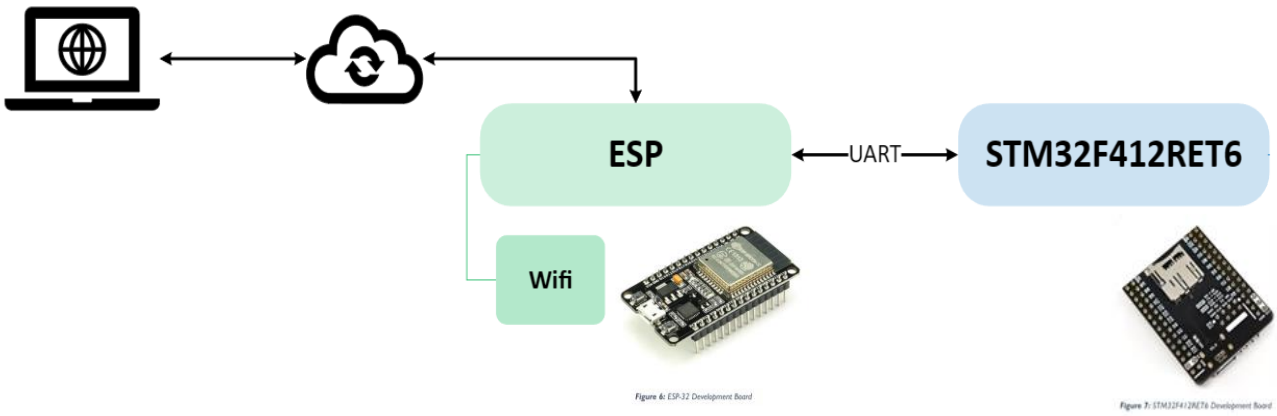
Vehicle-to-Cloud Communication Setup

1. Setup

- Establish UART communication between the STM32F4 and the ESP module.
- Configure the ESP module to interface with a Wi-Fi network.
- Transmit data from the ESP to the cloud via the Wi-Fi connection.
- Manage data reception.



2. Cloud

1.1 Communication Protocol

- MQTT (Message Queuing Telemetry Transport): A protocol designed specifically for collecting telemetry for dashboards and control systems and is now widely used in IoT. There are a lot of libraries for it on the ESP32.

1.2 Cloud brokers & Servies Providers

1) **HiveMQ:** A cloud MQTT broker (goes between publishers and subscribers)
   - ❖ Advantages
     1. Cloud provider: AWS.
     2. Up to 100 connections free.
     3. Up to 10GB free.
     4. No need to manage server infrastructure.
   - ❖ Disadvantages
     1. Not reliable.

2) **AWS IoT Core:** Central service for connecting IoT devices to the cloud. It allows devices to securely connect and communicate with cloud applications and other devices.
   - ❖ Advantages
     1. Compatible with python through AWS SDK for python (Boto3) or MQTT libraries (like Paho MQTT) to subscribe to the MQTT topics and retrieve data in the Python GUI.
     2. Reliable.

- Disadvantages
    1. While there is a free tier, usage beyond certain limits can lead to costs.
    2. A USD Visa is required to create an account.
- Prices

Tier	Price	Vehicle's data exchange limit on the track
Free	Free	Up to 1500 KB
Paid	$1.32 USD	Up to 100 MB
Paid	$6.6 USD	Up to 500 MB

For more prices information check out AWS invoice.

3) **Excel Sheet:** A cloud-based Excel file used to store data.
    - Advantages
        1. Free for light usage, accessible and easy to set up with minimal configuration.
    - Disadvantages
        1. Not reliable.
        2. Not organized.
        3. Not secure.

4) **Other Options:** Mosquitto with AWS Free Tier, google cloud IoT, Azure IoT.