Edge Computing Laboratory
Lab Assignment 4

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Title

Setting Up MQTT Broker on Raspberry Pi and Reading DHT11 / Air Quality Sensor Data

Objective

This lab aims to teach participants how to set up a Mosquitto MQTT broker on a Raspberry Pi, interface with a DHT11 temperature and humidity sensor, and publish the sensor data to an MQTT topic. Participants will also learn to subscribe to this topic using an MQTT client on an Android device.

Theory

1. MQTT (Message Queuing Telemetry Transport)

MQTT is a lightweight, publish-subscribe-based messaging protocol designed for low-bandwidth, high-latency, or unreliable networks. It is widely used in IoT applications due to its efficiency.

- **Broker**: Acts as a central hub that relays messages between publishers and subscribers (e.g., Mosquitto).
- **Publisher**: A device (e.g., Raspberry Pi) that sends data to a topic.
- **Subscriber**: A device (e.g., Android phone) that receives data from a topic.

2. DHT11 Sensor

The **DHT11** is a low-cost digital temperature and humidity sensor with a single-wire interface. It provides:

- Temperature range: 0°C to 50°C (±2°C accuracy)
- Humidity range: 20% to 80% (±5% accuracy)

3. Air Quality Sensor (e.g., MQ135)

The **MQ135** detects harmful gases like CO_2, NH_3, and benzene. It provides analog output, which can be read using an ADC (Analog-to-Digital Converter).

Lab Sections
Section 1: Setting Up the MQTT Broker:
1. Update and Upgrade Raspberry Pi:
 - Open the terminal and execute `sudo apt-get update` and `sudo apt-get upgrade`.
2. Install Mosquitto MQTT Broker:

- Run `sudo apt-get install -y mosquitto mosquitto-clients`.
3. Enable Mosquitto Service:
- Use `sudo systemctl enable mosquitto.service`.
4. Start Mosquitto Service:
- Execute `sudo systemctl start mosquitto.service`.
5. Test Installation:
- Subscribe to a test topic in one terminal using `mosquitto_sub -h localhost -t test/topic`.
- Publish a message from another terminal with `mosquitto_pub -h localhost -t test/topic -m "Hello MQTT"`.
- Confirm "Hello MQTT" message appears in the subscriber terminal. Section 2: Interfacing with DHT11 Sensor 1. Connect DHT11 to Raspberry Pi:
- Connect VCC to 5V, Data to GPIO4, and GND to Ground.

2. Install Python Libraries:
- Install Adafruit_DHT and paho-mqtt using `sudo pip3 install Adafruit_DHT paho-mqtt`. Section 3: Publishing Sensor Data to MQTT 1. Write Python Script:
- Create `dht11_mqtt_publisher.py` to read sensor data and publish it to `home/sensor/dht11` topic.
2. Run the Script:
- Execute the script with `python3 dht11_mqtt_publisher.py`.

Section 3: Subscribing with an Android MQTT
Client 1. Configure MQTT Client App:
- Set the Raspberry Pi's IP as the MQTT server and subscribe to `home/sensor/dht11`.
2. Receive Data:
- Observe the temperature and humidity data published from the Raspberry Pi on the Android device.

Section 4: Enhancements and Troubleshooting
- Discuss JSON formatting, security with TLS/SSL, error handling, and MQTT client configuration. - Troubleshoot common issues related to sensor readings, MQTT connections, and data reception.

Setup & Python Code

1. **Install Mosquitto MQTT Broker on Raspberry Pi**

   ```
   sudo apt update
   sudo apt install mosquitto mosquitto-clients
   sudo systemctl enable mosquitto
   sudo systemctl start mosquito
   ```

2. **Install Required Python Libraries**
   ```
   pip install paho-mqtt adafruit-circuitpython-dht
   ```

3. **Python Code to Read DHT11 and Publish to MQTT**
   ```
   import time
   import board
   ```

```
import adafruit_dht
import paho.mqtt.client as mqtt

dht_device = adafruit_dht.DHT11(board.D4)  # GPIO Pin 4

# MQTT Broker Details
MQTT_BROKER = "localhost"  # or Raspberry Pi's IP
MQTT_PORT = 1883
MQTT_TOPIC = "sensor/dht11"

# MQTT Client Setup
client = mqtt.Client("RPi_Publisher")
client.connect(MQTT_BROKER, MQTT_PORT)

try:
    while True:
        try:
            temperature = dht_device.temperature
            humidity = dht_device.humidity

            payload = f"Temperature: {temperature}°C, Humidity: {humidity}%"
            client.publish(MQTT_TOPIC, payload)
            print(f"Published: {payload}")

        except RuntimeError as e:
            print(f"Error reading DHT11: {e}")

        time.sleep(2)  # Publish every 2 seconds

except KeyboardInterrupt:
    print("Exiting...")
    client.disconnect()
```

4. Subscribe to MQTT Topic on Android (Using MQTT Client App)

- Install an MQTT client (e.g., **MQTT Dash** or **MQTT Explorer**).
- Connect to the Raspberry Pi's IP.
- Subscribe to sensor/dht11 to see live data.