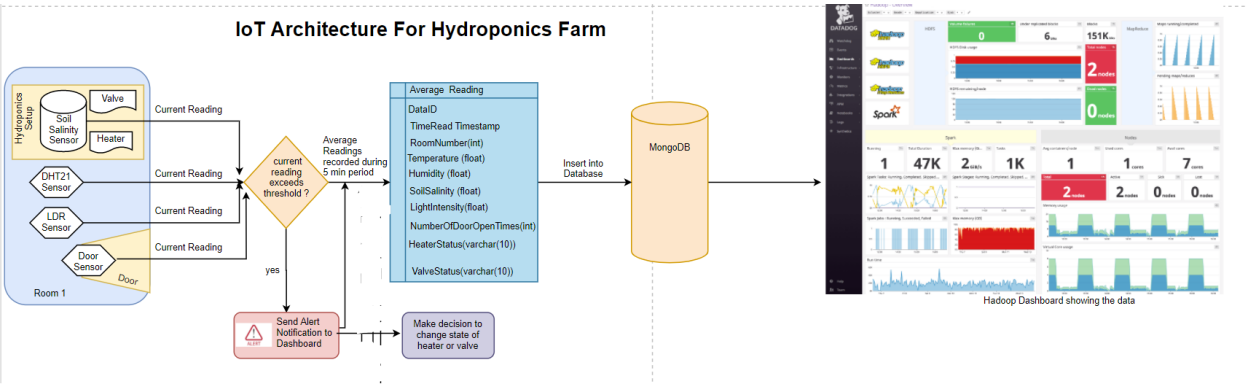
HANNAH BOADIWAA LORMENYO

IOT FINAL EXAM

PART A

For each hydroponics farm, a door switch magnet will be used at the door to check the number times the door is opened. An LDR and a DHT sensor will be placed in every room to measure the light intensity, temperature, and humidity of the room. There will also be a heater to regulate the temperature of the room when necessary. A soil salinity sensor will be placed in the hydroponics solution to measure the soil salinity of the solution. When the threshold for the different sensors is exceeded, an alert is sent to the dashboard for an action to be taken. The average readings recorded during every 5 minutes period is sent to the MongoDB cloud database using IEEE 802.11 WiFi as an access technology. In the database, the time stamp is recorded as well as the temperature, humidity, light intensity, door switch magnet status, the heater status, the soil salinity, and the room number. Afterwards, the data is retrieved from the database and displayed on a dashboard**.**

The image below shows the snippet of the architecture for one room. Then entire architecture can be found in the image file attached to the submissions.



ii. Reasons for Design

a. **MongoDB:** I choose MongoDB because it is flexible. Since the IoT system of the hydroponics farm is liable to changes (for example the addition of new sensors like sensors for measuring oxygen and pH levels) it is best to use a database that can easily be changed without causing much effect on the database. One more reason is that MongoDB is much more scalable. IoT is a big data issue because the IoT systems have

a high data ingestion rate, the data is voluminous, and it has a wide variety. MongoDB is globally known for its efficiency with Big Data since it can easily scale as the data grows.

b. **Real Time Data Processing in the Cloud:** To ensure real time data processing and data analytics, I included Hadoop in the design. Hadoop will consume the data from MongoDB and perform analytics using machine learning and other algorithms in real time. This would help the MIS manager make very informed decisions in real time. He/She can detect problems and provide solutions before they happen using prescriptive analysis on the data. Another advantage of Hadoop is its speed.

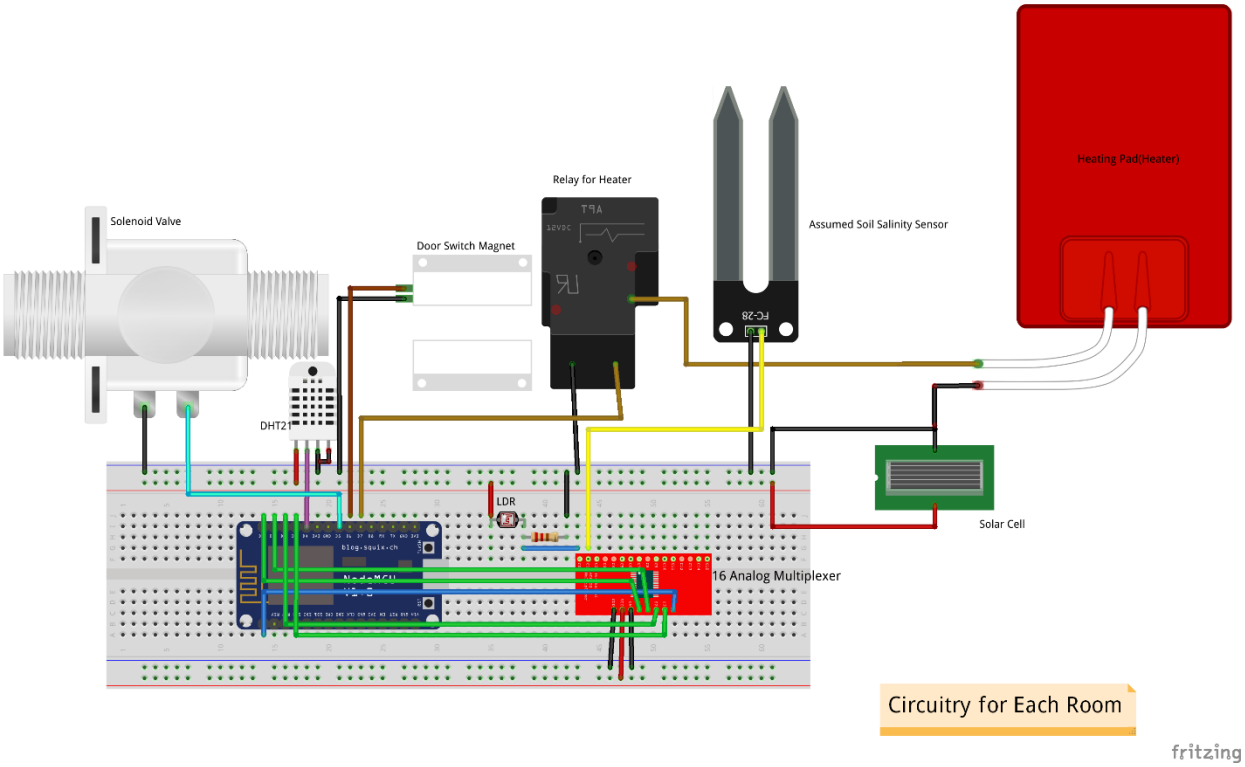
c. **Access Technology:** All the sensors will be connected to NodeMCU with ESP8266 Wi-Fi module. The ESP8266 module uses IEEE 802.11g protocol which uses 2.4 GHz range. Hence, it is compatible with a lot of devices. Its range is less the 15km which is the distance between the farm and the headquarters. Due to this, the data will be stored in a cloud storage which can be accessed from anywhere provided you have the necessary rights to access the data.

d. **Security**: JSON Web Tokens will be used to authenticate the devices in the network. For every data that is sent from the device to the database, a token will be added to the request which confirms the identity and rights of the device in the network. This will help to prevent unauthorized penetrations into the network. This authentication will also be

included at the dashboard. To view the dashboard, users will be required to log in with the credentials given by the company.

e. **Data frequency:** The data is recorded in real time but only the average of the readings recorded in the 5-minute window period is inserted into the database. This is meant to reduce the ingestion rate and the volume of data accumulated over time. When any of the readings exceed the respective threshold set by the manager, an alert is sent to the manager via the dashboard for him/her to take an action[turn heater on/off or open/close solenoid valve].

iii. The circuitry can be seen below:

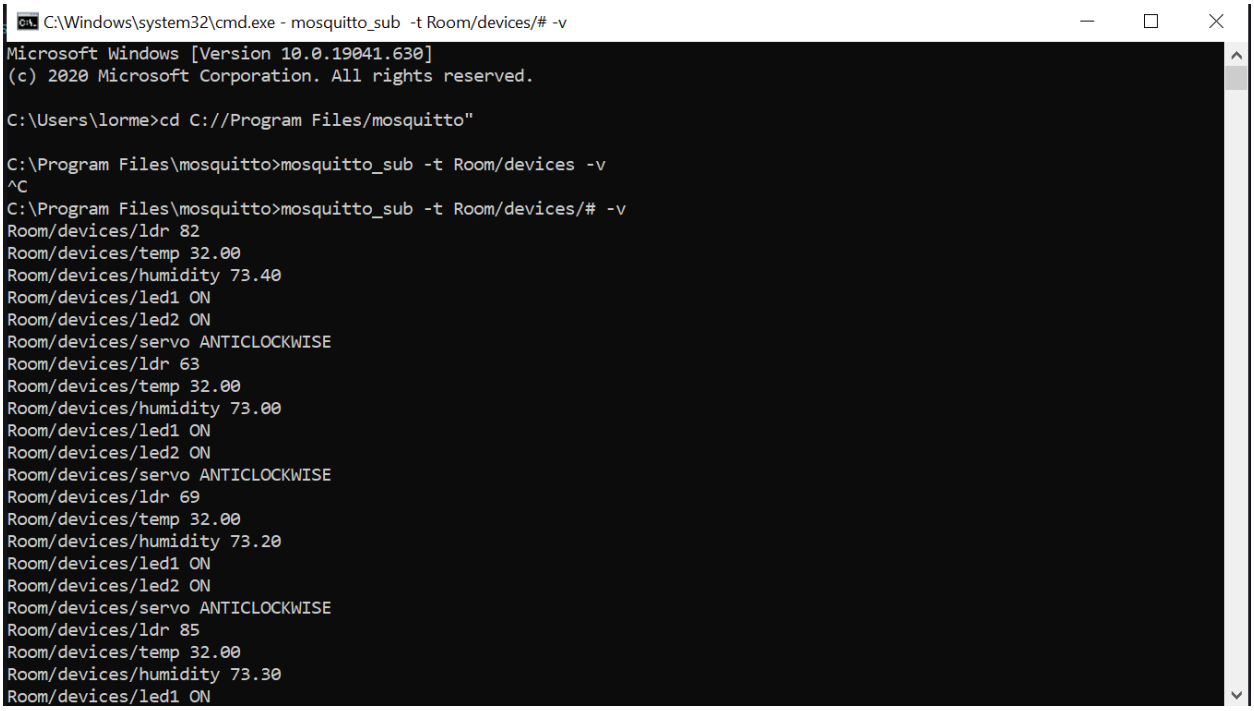


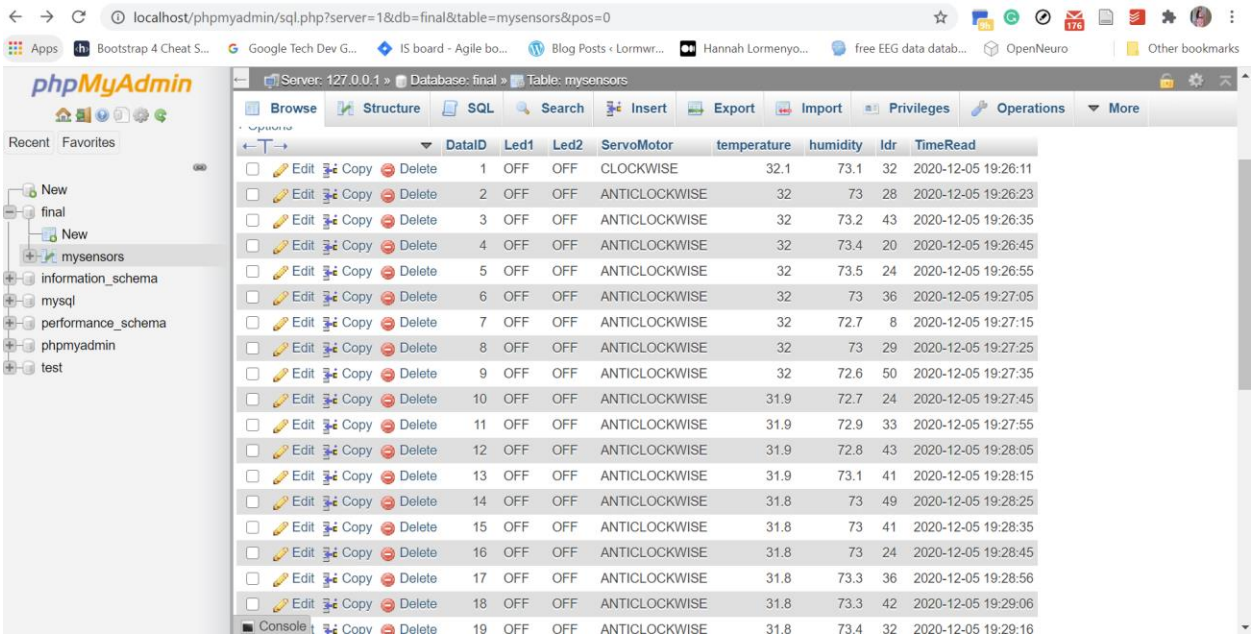
Components used:

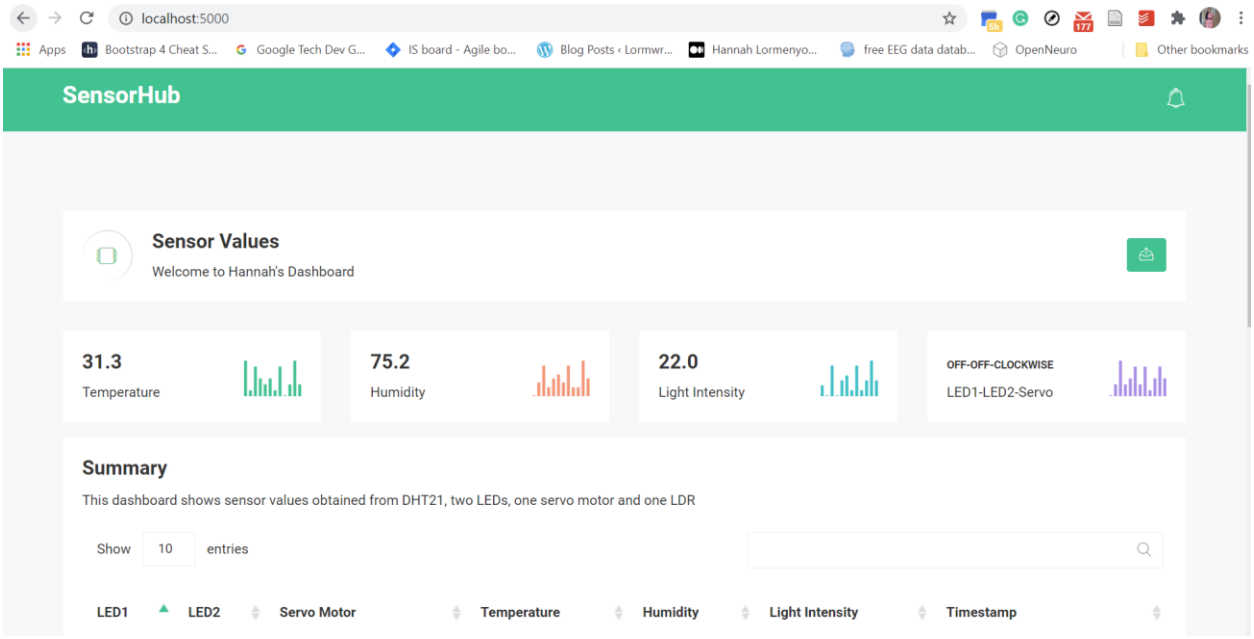
1. Solar cell
2. NodeMCU (x4)
3. DHT21 (x4)
4. LDR (x4)
5. Solenoid valve(x4)
6. Relay(x4)
7. Door Switch Magnet(x4)
8. Heater(x4)
9. Soil Salinity sensor (x4)
10. Connecting wires

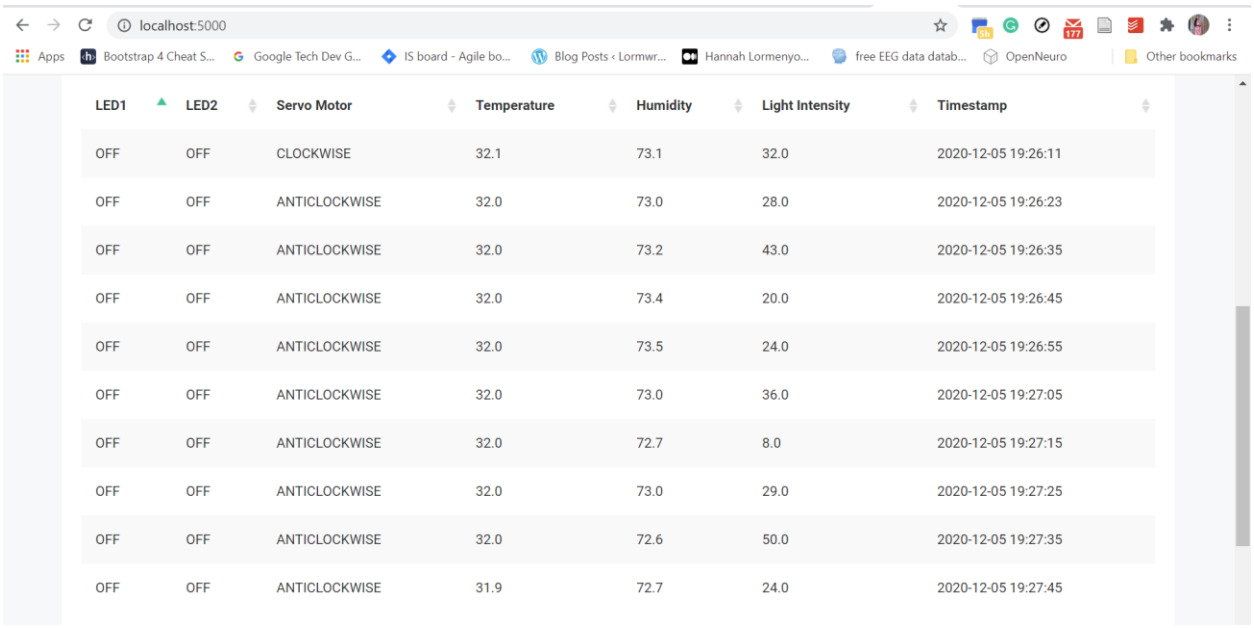
PART B

You can find the dashboard here: https://mysensors.herokuapp.com/




localhost/phpmyadmin/sql.php?server=1&db=final&table=mysensors&pos=0
phpMyAdmin
Recent Favorites
New
final
New
mysensors
information_schema
mysql
performance_schema
phpmyadmin
test
Server: 127.0.0.1 » Database: final » Table: mysensors
Browse Structure SQL Search Insert Export Import Privileges Operations More
DataID Led1 Led2 ServoMotor temperature humidity ldr TimeRead
1 OFF OFF CLOCKWISE 32.1 73.1 32 2020-12-05 19:26:11
2 OFF OFF ANTICLOCKWISE 32 73 28 2020-12-05 19:26:23
3 OFF OFF ANTICLOCKWISE 32 73.2 43 2020-12-05 19:26:35
4 OFF OFF ANTICLOCKWISE 32 73.4 20 2020-12-05 19:26:45
5 OFF OFF ANTICLOCKWISE 32 73.5 24 2020-12-05 19:26:55
6 OFF OFF ANTICLOCKWISE 32 73 36 2020-12-05 19:27:05
7 OFF OFF ANTICLOCKWISE 32 72.7 8 2020-12-05 19:27:15
8 OFF OFF ANTICLOCKWISE 32 73 29 2020-12-05 19:27:25
9 OFF OFF ANTICLOCKWISE 32 72.6 50 2020-12-05 19:27:35
10 OFF OFF ANTICLOCKWISE 31.9 72.7 24 2020-12-05 19:27:45
11 OFF OFF ANTICLOCKWISE 31.9 72.9 33 2020-12-05 19:27:55
12 OFF OFF ANTICLOCKWISE 31.9 72.8 43 2020-12-05 19:28:05
13 OFF OFF ANTICLOCKWISE 31.9 73.1 41 2020-12-05 19:28:15
14 OFF OFF ANTICLOCKWISE 31.8 73 49 2020-12-05 19:28:25
15 OFF OFF ANTICLOCKWISE 31.8 73 41 2020-12-05 19:28:35
16 OFF OFF ANTICLOCKWISE 31.8 73 24 2020-12-05 19:28:45
17 OFF OFF ANTICLOCKWISE 31.8 73.3 36 2020-12-05 19:28:56
18 OFF OFF ANTICLOCKWISE 31.8 73.3 42 2020-12-05 19:29:06
19 OFF OFF ANTICLOCKWISE 31.8 73.4 32 2020-12-05 19:29:16


localhost:5000
SensorHub
Sensor Values
Welcome to Hannah's Dashboard
31.3
Temperature
75.2
Humidity
22.0
Light Intensity
OFF-OFF-CLOCKWISE
LED1-LED2-Servo
Summary
This dashboard shows sensor values obtained from DHT21, two LEDs, one servo motor and one LDR
Show 10 entries
LED1 LED2 Servo Motor Temperature Humidity Light Intensity Timestamp



LED1	LED2	Servo Motor	Temperature	Humidity	Light Intensity	Timestamp
OFF	OFF	CLOCKWISE	32.1	73.1	32.0	2020-12-05 19:26:11
OFF	OFF	ANTICLOCKWISE	32.0	73.0	28.0	2020-12-05 19:26:23
OFF	OFF	ANTICLOCKWISE	32.0	73.2	43.0	2020-12-05 19:26:35
OFF	OFF	ANTICLOCKWISE	32.0	73.4	20.0	2020-12-05 19:26:45
OFF	OFF	ANTICLOCKWISE	32.0	73.5	24.0	2020-12-05 19:26:55
OFF	OFF	ANTICLOCKWISE	32.0	73.0	36.0	2020-12-05 19:27:05
OFF	OFF	ANTICLOCKWISE	32.0	72.7	8.0	2020-12-05 19:27:15
OFF	OFF	ANTICLOCKWISE	32.0	73.0	29.0	2020-12-05 19:27:25
OFF	OFF	ANTICLOCKWISE	32.0	72.6	50.0	2020-12-05 19:27:35
OFF	OFF	ANTICLOCKWISE	31.9	72.7	24.0	2020-12-05 19:27:45

PART C

The notebook can be found here:

https://colab.research.google.com/drive/18DrViL3kXp8pCfcy8hnMibyd_6Luf1WN?usp=sharing

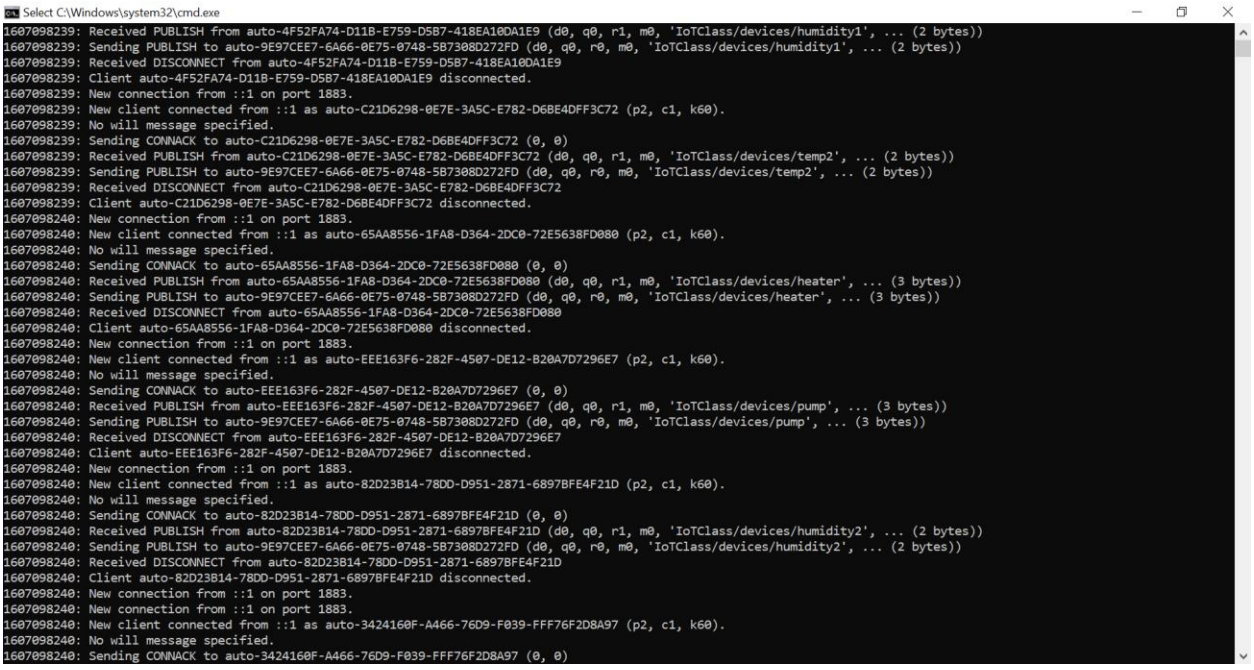


Figure 1: MQTT server

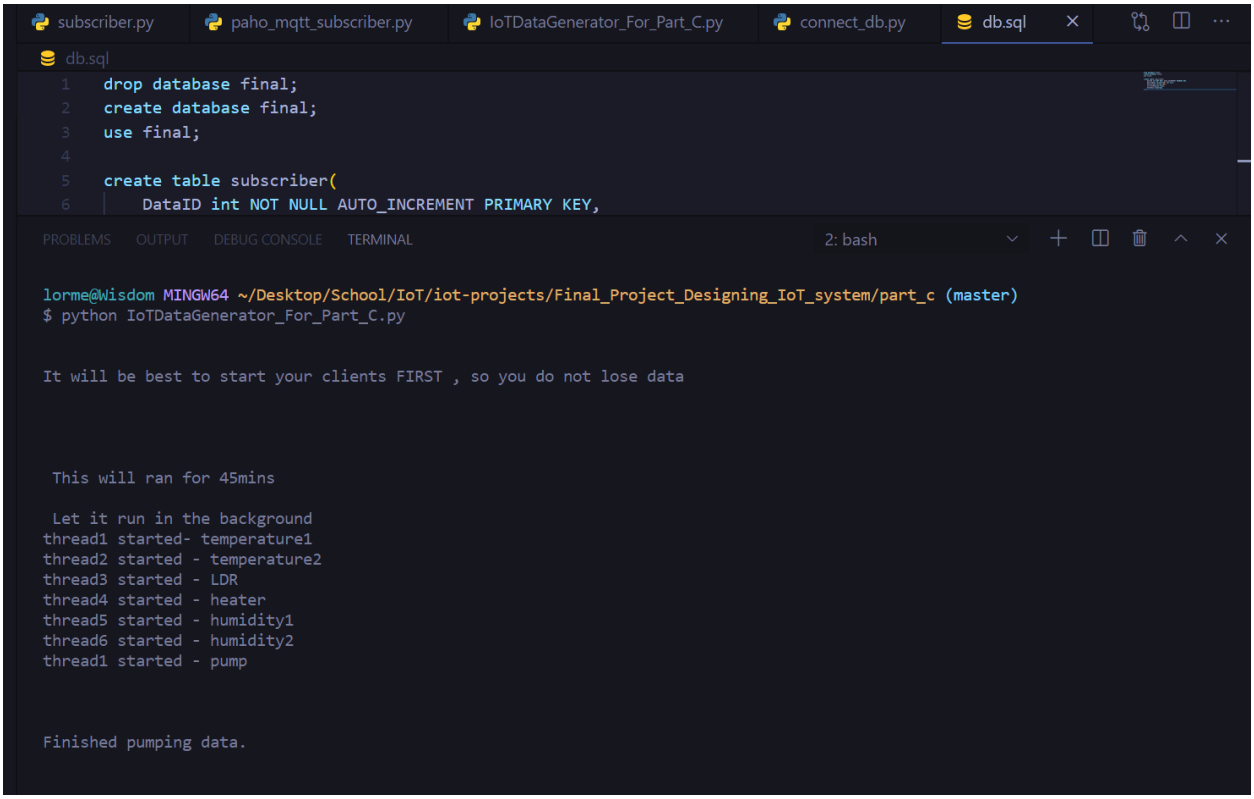


Figure 2: Data Generator

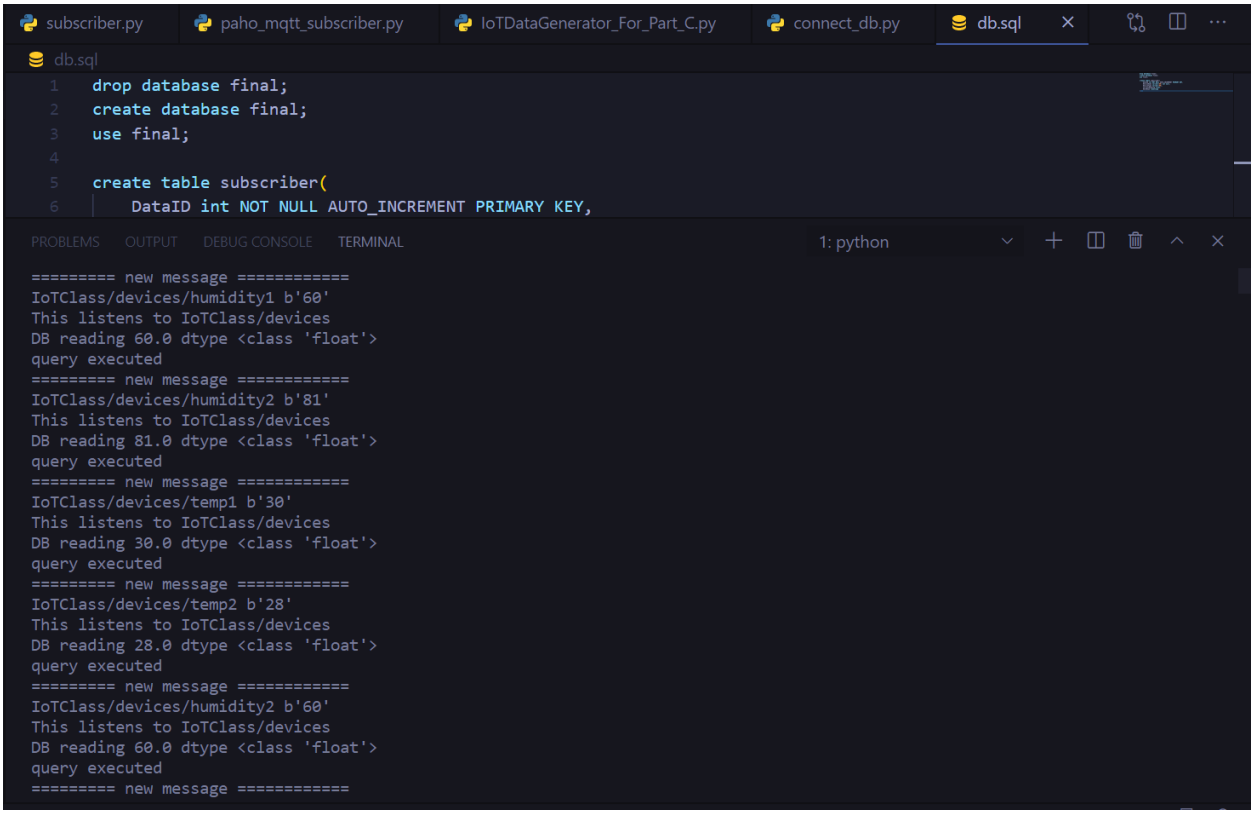
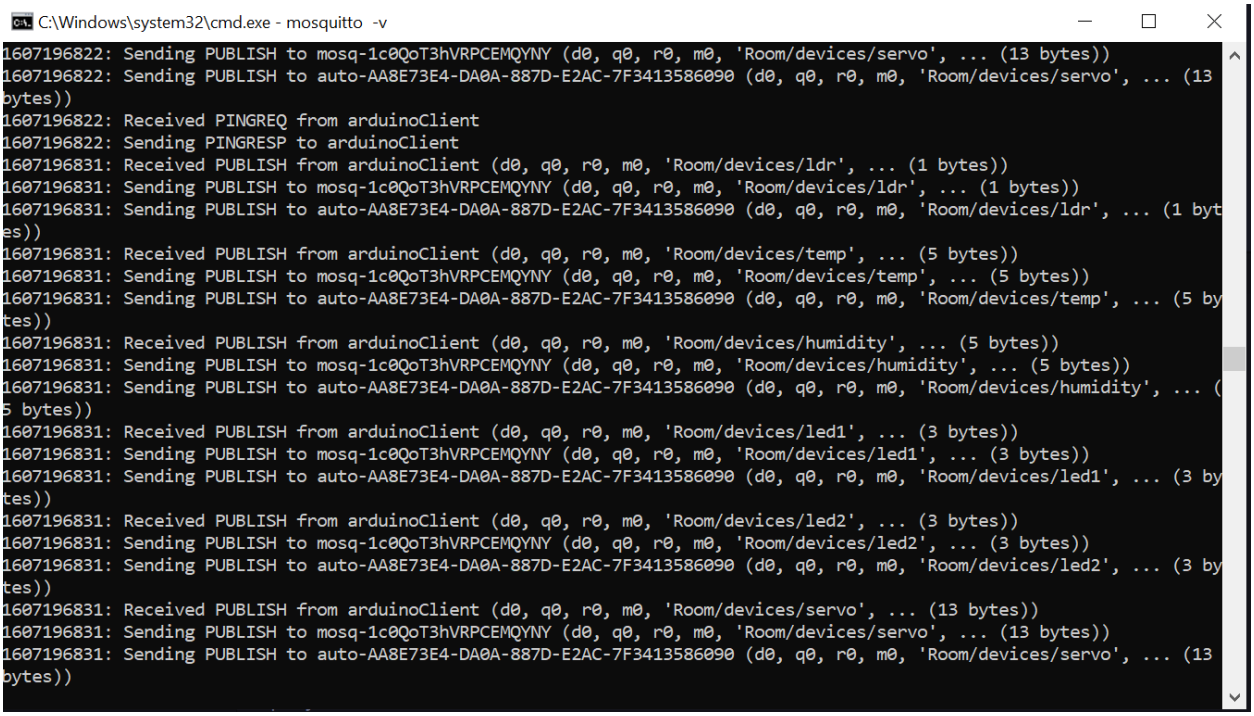
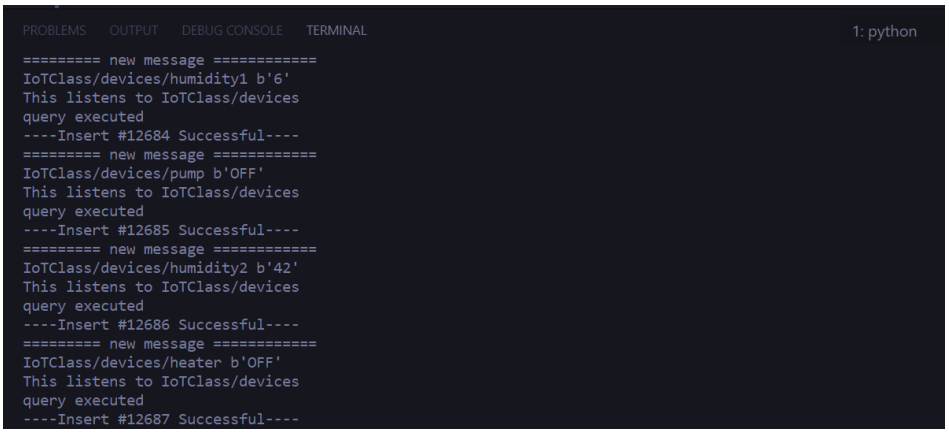
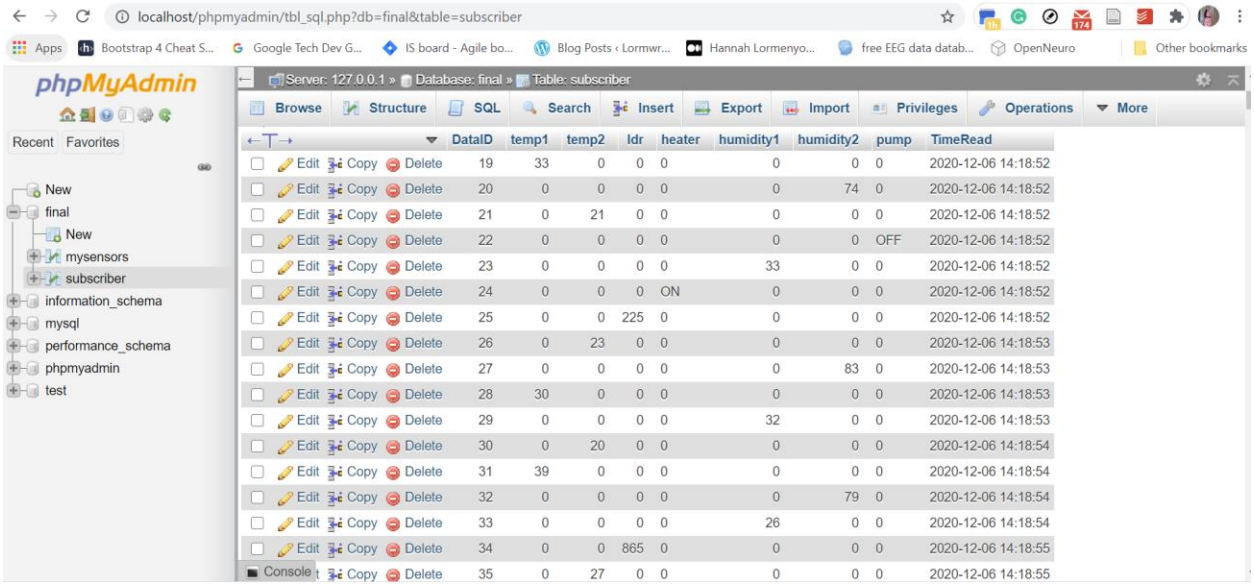
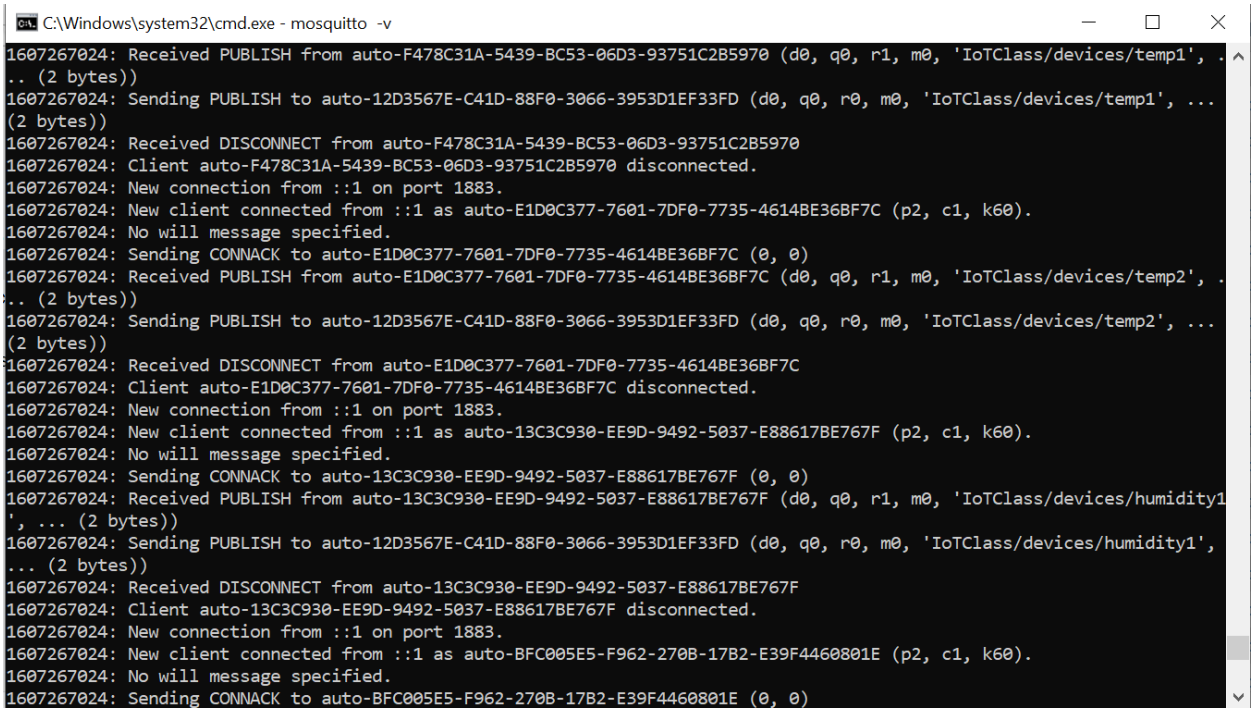


Figure 3: Subscriber


C:\Windows\system32\cmd.exe - mosquitto -v
1607196822: Sending PUBLISH to mosq-1c0QoT3hVRPCEMQYNY (d0, q0, r0, m0, 'Room/devices/servo', ... (13 bytes))
1607196822: Sending PUBLISH to auto-AA8E73E4-DA0A-887D-E2AC-7F3413586090 (d0, q0, r0, m0, 'Room/devices/servo', ... (13 bytes))
1607196822: Received PINGREQ from arduinoClient
1607196822: Sending PINGRESP to arduinoClient
1607196831: Received PUBLISH from arduinoClient (d0, q0, r0, m0, 'Room/devices/ldr', ... (1 bytes))
1607196831: Sending PUBLISH to mosq-1c0QoT3hVRPCEMQYNY (d0, q0, r0, m0, 'Room/devices/ldr', ... (1 bytes))
1607196831: Sending PUBLISH to auto-AA8E73E4-DA0A-887D-E2AC-7F3413586090 (d0, q0, r0, m0, 'Room/devices/ldr', ... (1 bytes))
1607196831: Received PUBLISH from arduinoClient (d0, q0, r0, m0, 'Room/devices/temp', ... (5 bytes))
1607196831: Sending PUBLISH to mosq-1c0QoT3hVRPCEMQYNY (d0, q0, r0, m0, 'Room/devices/temp', ... (5 bytes))
1607196831: Sending PUBLISH to auto-AA8E73E4-DA0A-887D-E2AC-7F3413586090 (d0, q0, r0, m0, 'Room/devices/temp', ... (5 bytes))
1607196831: Received PUBLISH from arduinoClient (d0, q0, r0, m0, 'Room/devices/humidity', ... (5 bytes))
1607196831: Sending PUBLISH to mosq-1c0QoT3hVRPCEMQYNY (d0, q0, r0, m0, 'Room/devices/humidity', ... (5 bytes))
1607196831: Sending PUBLISH to auto-AA8E73E4-DA0A-887D-E2AC-7F3413586090 (d0, q0, r0, m0, 'Room/devices/humidity', ... (5 bytes))
1607196831: Received PUBLISH from arduinoClient (d0, q0, r0, m0, 'Room/devices/led1', ... (3 bytes))
1607196831: Sending PUBLISH to mosq-1c0QoT3hVRPCEMQYNY (d0, q0, r0, m0, 'Room/devices/led1', ... (3 bytes))
1607196831: Sending PUBLISH to auto-AA8E73E4-DA0A-887D-E2AC-7F3413586090 (d0, q0, r0, m0, 'Room/devices/led1', ... (3 bytes))
1607196831: Received PUBLISH from arduinoClient (d0, q0, r0, m0, 'Room/devices/led2', ... (3 bytes))
1607196831: Sending PUBLISH to mosq-1c0QoT3hVRPCEMQYNY (d0, q0, r0, m0, 'Room/devices/led2', ... (3 bytes))
1607196831: Sending PUBLISH to auto-AA8E73E4-DA0A-887D-E2AC-7F3413586090 (d0, q0, r0, m0, 'Room/devices/led2', ... (3 bytes))
1607196831: Received PUBLISH from arduinoClient (d0, q0, r0, m0, 'Room/devices/servo', ... (13 bytes))
1607196831: Sending PUBLISH to mosq-1c0QoT3hVRPCEMQYNY (d0, q0, r0, m0, 'Room/devices/servo', ... (13 bytes))
1607196831: Sending PUBLISH to auto-AA8E73E4-DA0A-887D-E2AC-7F3413586090 (d0, q0, r0, m0, 'Room/devices/servo', ... (13 bytes))


PROBLEMS
OUTPUT
DEBUG CONSOLE
TERMINAL
1: python
========= new message ============
IoTClass/devices/humidity1 b'6'
This listens to IoTClass/devices
query executed
----Insert #12684 Successful----
========= new message ============
IoTClass/devices/pump b'OFF'
This listens to IoTClass/devices
query executed
----Insert #12685 Successful----
========= new message ============
IoTClass/devices/humidity2 b'42'
This listens to IoTClass/devices
query executed
----Insert #12686 Successful----
========= new message ============
IoTClass/devices/heater b'OFF'
This listens to IoTClass/devices
query executed
----Insert #12687 Successful----


localhost/phpmyadmin/tbl_sql.php?db=final&table=subscriber
phpMyAdmin
Recent Favorites
New
final
New
mysensors
subscriber
information_schema
mysql
performance_schema
phpmyadmin
test
Server: 127.0.0.1 » Database: final » Table: subscriber
Browse Structure SQL Search Insert Export Import Privileges Operations More
DataID temp1 temp2 ldr heater humidity1 humidity2 pump TimeRead
Edit Copy Delete 19 33 0 0 0 0 0 0 2020-12-06 14:18:52
Edit Copy Delete 20 0 0 0 0 0 74 0 2020-12-06 14:18:52
Edit Copy Delete 21 0 21 0 0 0 0 0 2020-12-06 14:18:52
Edit Copy Delete 22 0 0 0 0 0 0 OFF 2020-12-06 14:18:52
Edit Copy Delete 23 0 0 0 0 33 0 0 2020-12-06 14:18:52
Edit Copy Delete 24 0 0 0 ON 0 0 0 2020-12-06 14:18:52
Edit Copy Delete 25 0 0 225 0 0 0 0 2020-12-06 14:18:52
Edit Copy Delete 26 0 23 0 0 0 0 0 2020-12-06 14:18:53
Edit Copy Delete 27 0 0 0 0 0 83 0 2020-12-06 14:18:53
Edit Copy Delete 28 30 0 0 0 0 0 0 2020-12-06 14:18:53
Edit Copy Delete 29 0 0 0 0 32 0 0 2020-12-06 14:18:53
Edit Copy Delete 30 0 20 0 0 0 0 0 2020-12-06 14:18:54
Edit Copy Delete 31 39 0 0 0 0 0 0 2020-12-06 14:18:54
Edit Copy Delete 32 0 0 0 0 0 79 0 2020-12-06 14:18:54
Edit Copy Delete 33 0 0 0 0 26 0 0 2020-12-06 14:18:54
Edit Copy Delete 34 0 0 865 0 0 0 0 2020-12-06 14:18:55
Console Copy Delete 35 0 27 0 0 0 0 0 2020-12-06 14:18:55


C:\Windows\system32\cmd.exe - mosquitto -v
1607267024: Received PUBLISH from auto-F478C31A-5439-BC53-06D3-93751C2B5970 (d0, q0, r1, m0, 'IoTClass/devices/temp1', ... (2 bytes))
1607267024: Sending PUBLISH to auto-12D3567E-C41D-88F0-3066-3953D1EF33FD (d0, q0, r0, m0, 'IoTClass/devices/temp1', ... (2 bytes))
1607267024: Received DISCONNECT from auto-F478C31A-5439-BC53-06D3-93751C2B5970
1607267024: Client auto-F478C31A-5439-BC53-06D3-93751C2B5970 disconnected.
1607267024: New connection from ::1 on port 1883.
1607267024: New client connected from ::1 as auto-E1D0C377-7601-7DF0-7735-4614BE36BF7C (p2, c1, k60).
1607267024: No will message specified.
1607267024: Sending CONNACK to auto-E1D0C377-7601-7DF0-7735-4614BE36BF7C (0, 0)
1607267024: Received PUBLISH from auto-E1D0C377-7601-7DF0-7735-4614BE36BF7C (d0, q0, r1, m0, 'IoTClass/devices/temp2', ... (2 bytes))
1607267024: Sending PUBLISH to auto-12D3567E-C41D-88F0-3066-3953D1EF33FD (d0, q0, r0, m0, 'IoTClass/devices/temp2', ... (2 bytes))
1607267024: Received DISCONNECT from auto-E1D0C377-7601-7DF0-7735-4614BE36BF7C
1607267024: Client auto-E1D0C377-7601-7DF0-7735-4614BE36BF7C disconnected.
1607267024: New connection from ::1 on port 1883.
1607267024: New client connected from ::1 as auto-13C3C930-EE9D-9492-5037-E88617BE767F (p2, c1, k60).
1607267024: No will message specified.
1607267024: Sending CONNACK to auto-13C3C930-EE9D-9492-5037-E88617BE767F (0, 0)
1607267024: Received PUBLISH from auto-13C3C930-EE9D-9492-5037-E88617BE767F (d0, q0, r1, m0, 'IoTClass/devices/humidity1', ... (2 bytes))
1607267024: Sending PUBLISH to auto-12D3567E-C41D-88F0-3066-3953D1EF33FD (d0, q0, r0, m0, 'IoTClass/devices/humidity1', ... (2 bytes))
1607267024: Received DISCONNECT from auto-13C3C930-EE9D-9492-5037-E88617BE767F
1607267024: Client auto-13C3C930-EE9D-9492-5037-E88617BE767F disconnected.
1607267024: New connection from ::1 on port 1883.
1607267024: New client connected from ::1 as auto-BFC005E5-F962-270B-17B2-E39F4460801E (p2, c1, k60).
1607267024: No will message specified.
1607267024: Sending CONNACK to auto-BFC005E5-F962-270B-17B2-E39F4460801E (0, 0)