

# Connected Devices

## Semester Project

### Name and Course

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- Course: Connected Devices
- Semester and Year: Spring 2020

### Project Description:

Project Title: **“IoT based live condition monitoring systems for electrical substations & industrial switchgears”**

- Electrical substations & switchgears serves as the power hub of continuous manufacturing industries & power-plants. They are functional 24x7 due to meet high demand in supply chain prevailing in market. These electrical power distribution systems deployed in current industries seems to be reliable, but in long term they may cause sudden catastrophic events like electrical short-circuiting, tripping & flashing due to lack of scheduled periodic maintenance of electrical feeders & organization's negligence pertaining to continuous power-distribution. This project provides low cost reliable, remote & wireless monitoring solutions for electrical substations located at remote worksite. Parameters such as magnetic flux, ground resistivity, temperature inside power cabins & corona level will be monitored continuously, in order to avoid imminent power shutdown
- This problem falls under industrial internet of things (IIoT) category, which requires us to use special industrial interoperability standard that can communicate information to enterprise SCADA (Supervisory control & data acquisition). Hence OPC (Open platform communication) protocol helps to log data locally & LoRA-RF wireless transceivers to communicate between device to gateway. Further the data from gateway will be published to AWS & Ubidots cloud via MQTT/TLS
- Further cloud data can be analyzed properly to predict failures or schedule maintenance of HV electrical equipment

## Implementation Strategy:

- GatewayHandlerApp present in Raspberry Pi starts 6 different threads which performs various tasks to achieve desired outcomes of the project
- Thread 1 - ArduinoDataReceiver class receives data from field sensors connected to (Arduino 1 & 2) constrained devices using LoRA RF protocol
- Thread 2 - Creates OPC-Client instance on raspberry pi, which transfers data to OPC server running on laptop. This data can be historized & recorded as backup
- Thread 3 - SensorDataManager performs the task of triggering & actuation. It collects the Sensor data from ArduinoDataReceiver class & actuator data from ubidots client connector class. Based on sensor data collected this class triggers e-mail notification to engineer in charge using SMTP client connector class. Based on actuator data received from cloud, actuation event is performed by sending actuation command to relay connected with Arduino at remote location, with the help of LoRA RF class protocol
- Thread 4 - Device performance monitoring class which records the details of resource utilized by gateway device
- Thread 5 - Ubidots cloud connector class, that help to publish sensordata & subscribe to actuator data
- Thread 6 - AWS Cloud connector class, that help to publish sensordata & subscribe to actuator data

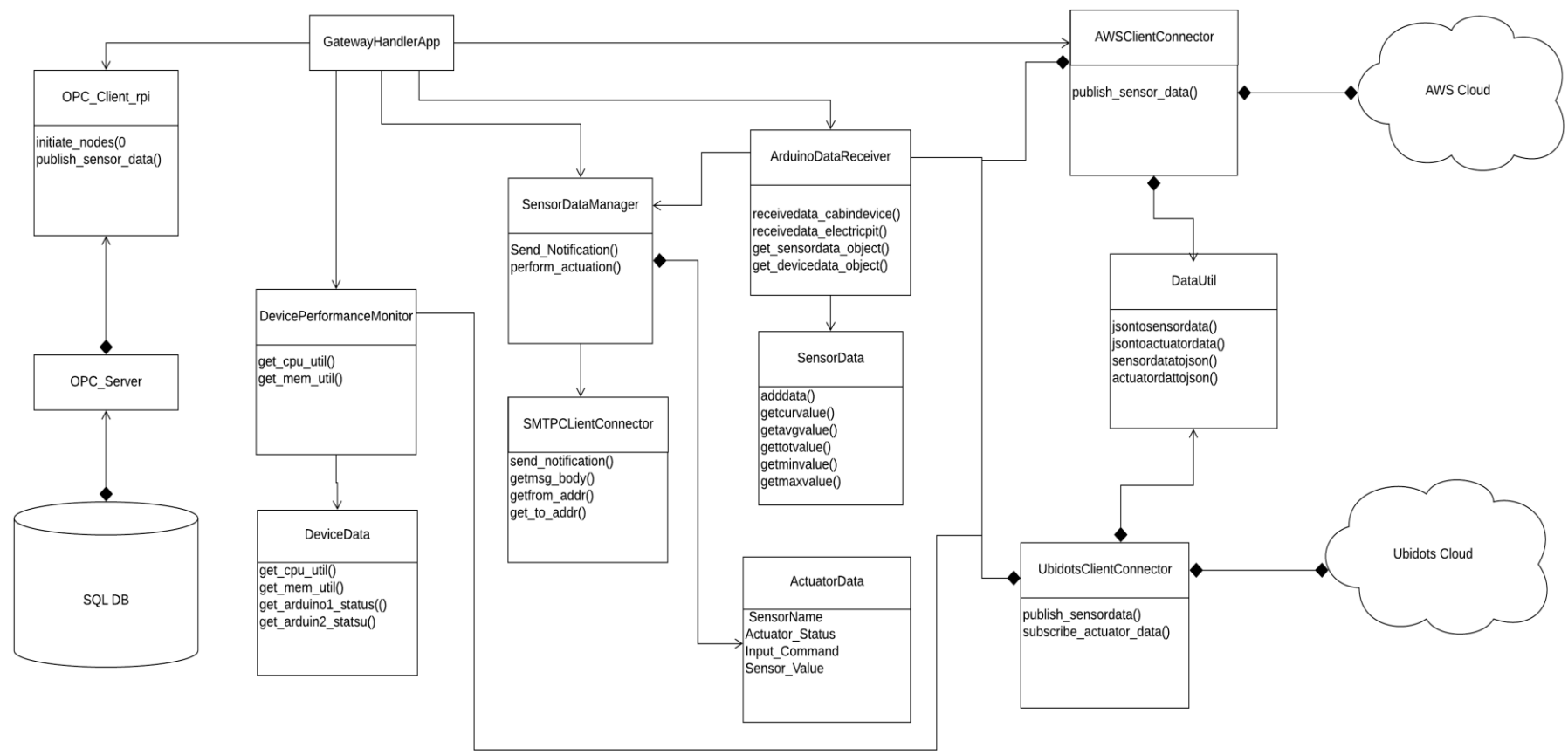
## Code Repository:

- URL: <https://bitbucket.org/naveenORT/iot-device/src/master/apps/labs/module09/GatewayHandlerApp.py>

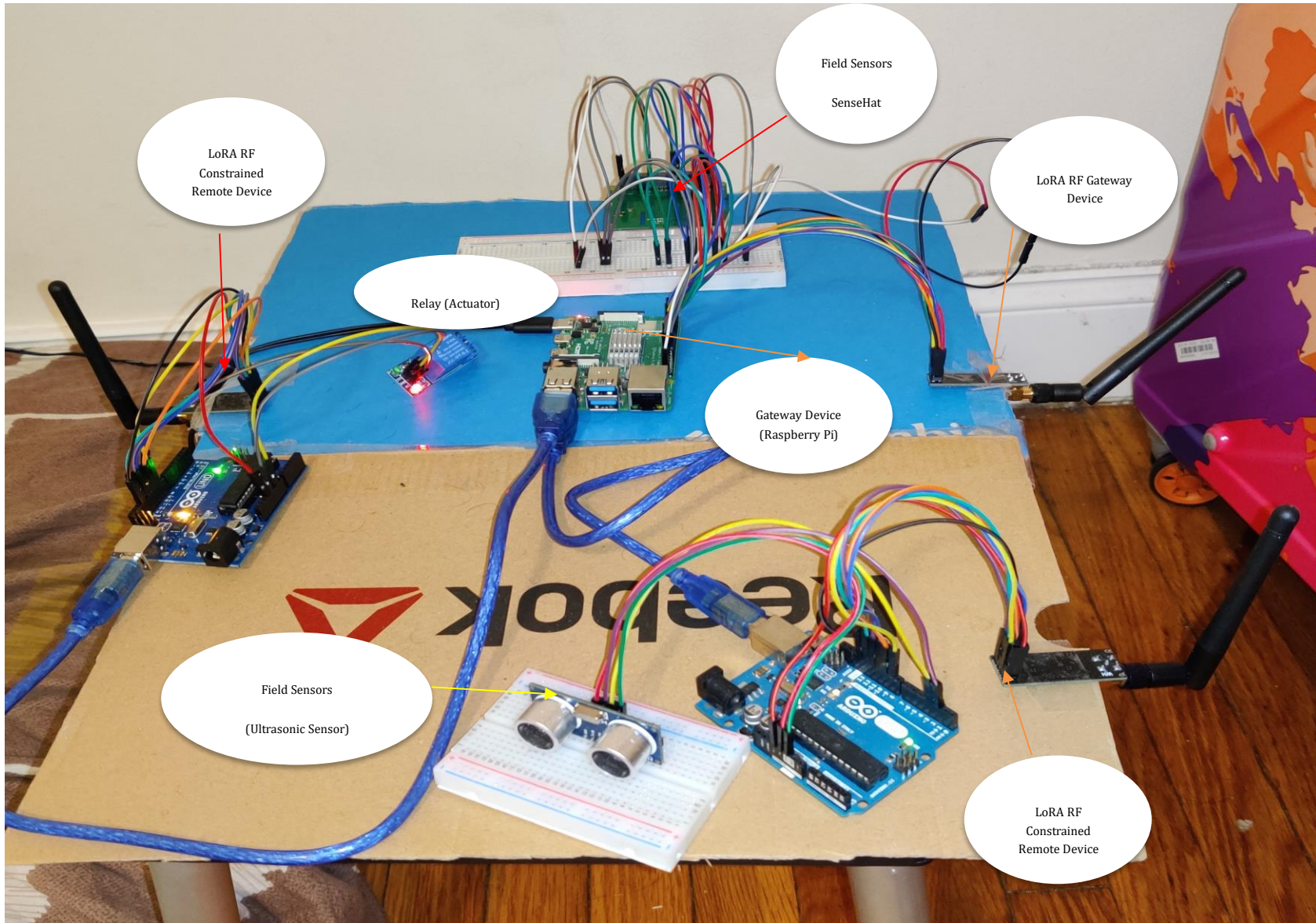
## Video Link to Demonstration

- URL: <https://drive.google.com/open?id=1uYS5XCZtTjK4DzweTxi38Jh-Q3td7KdF>

UML Diagram:



## Hardware Setup:



## Unit Test Results Screenshot(s)

```
pi@raspberrypi: ~/workspace/iot-device/apps/tests/labs
2020-04-17 11:04:40 INFO Cabin Temp:22.46
2020-04-17 11:04:40 INFO Room Humidity:37.5
2020-04-17 11:04:40 INFO Magnetic Flux:58.08
2020-04-17 11:04:41 INFO Earthpit Resistance 106
2020-04-17 11:04:41 INFO Corona Level 36
2020-04-17 11:04:41 INFO

2020-04-17 11:04:41 INFO CPU Utilization = 47.3%
2020-04-17 11:04:41 INFO Memory Utilization = 0.5%
2020-04-17 11:04:44 INFO Temperature Level Exceeded By: 8.079999999999998 Units
..
-----
Ran 4 tests in 10.013s

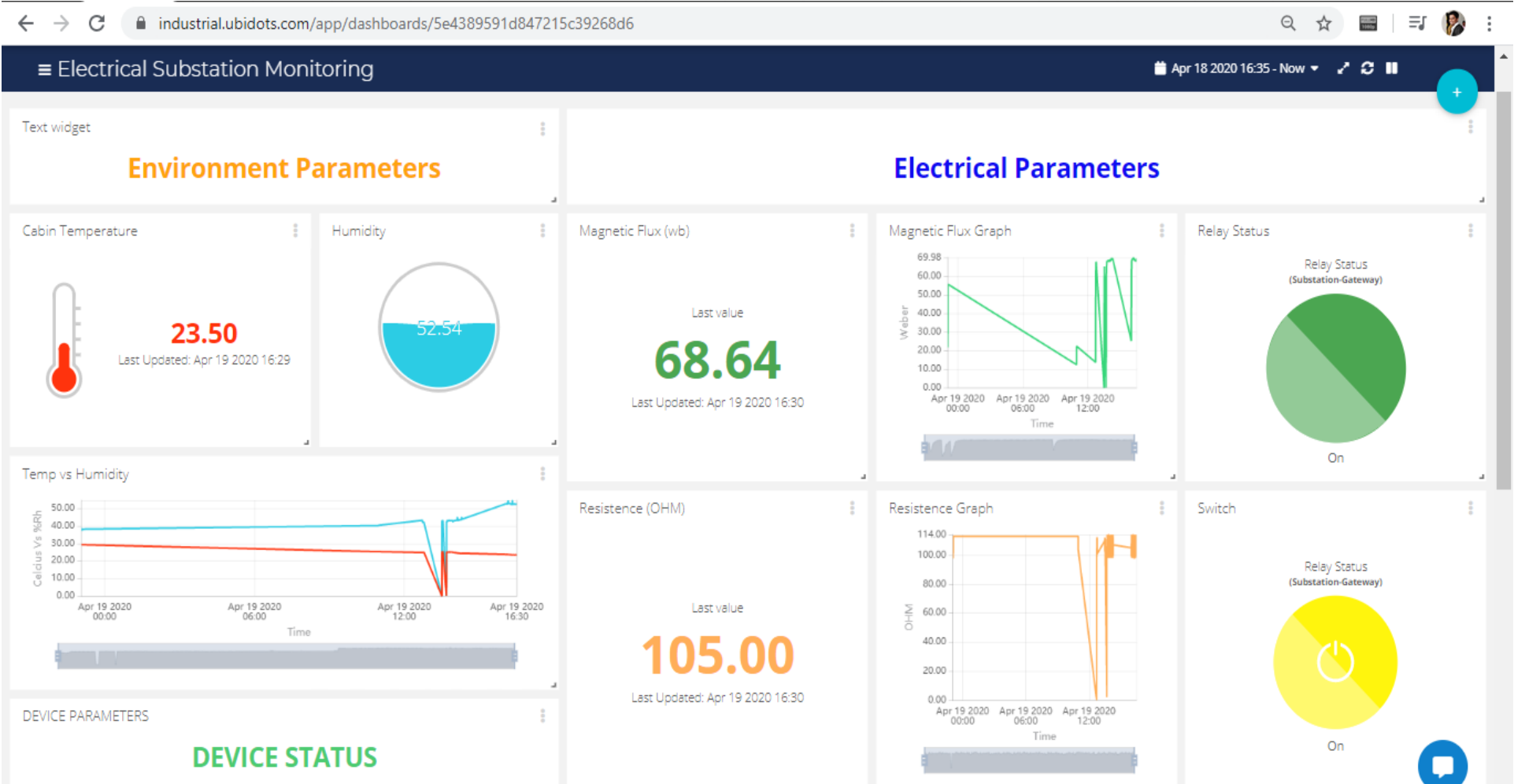
OK
2020-04-17 11:04:44 INFO {"temperature": 22.46, "humidity": 37.5, "magflux": 58.08, "resistance": 106, "corona_level": 36}
{"ram": 1.5, "cpu": 47.3, "arduino1_status": 1, "arduino2_status": 1}
2020-04-17 11:04:44 INFO Data Published to Ubidots
2020-04-17 11:04:44 INFO Data Published to Ubidots
decode [post] --> 0.0
2020-04-17 11:04:45 INFO Relay Off
2020-04-17 11:04:45 INFO Successfully mailed alert from address naveen.iot69@gmail.com

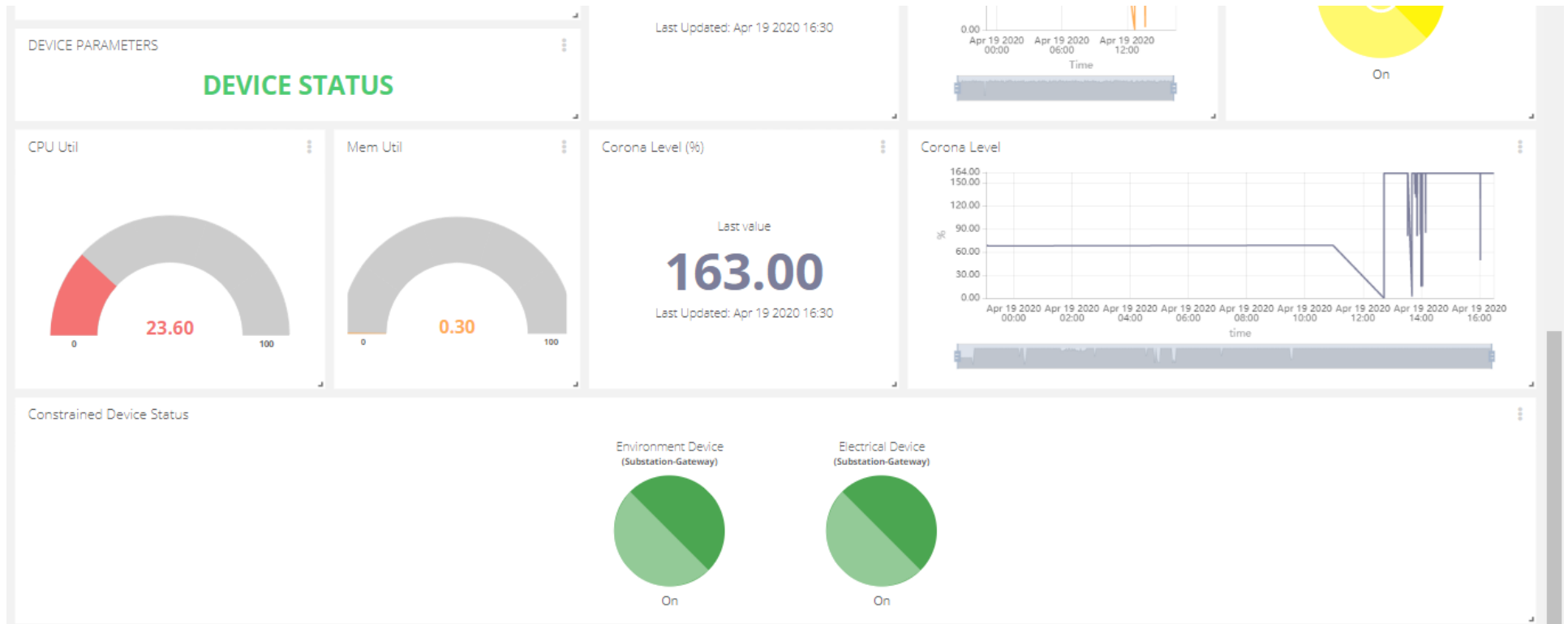
2020-04-17 11:04:46 INFO Cabin Temp:22.39
2020-04-17 11:04:46 INFO Room Humidity:37.54
2020-04-17 11:04:46 INFO Magnetic Flux:70.29
2020-04-17 11:04:46 INFO CPU Utilization = 47.3%
2020-04-17 11:04:46 INFO Memory Utilization = 1.5%
2020-04-17 11:04:46 INFO Earthpit Resistance 100
2020-04-17 11:04:46 INFO Corona Level 35
2020-04-17 11:04:46 INFO

^CException ignored in: <module 'threading' from '/usr/lib/python3.7/threading.py'>
Traceback (most recent call last):
  File "/usr/lib/python3.7/threading.py", line 1281, in _shutdown
    t.join()
  File "/usr/lib/python3.7/threading.py", line 1032, in join
    self._wait_for_tstate_lock()
  File "/usr/lib/python3.7/threading.py", line 1048, in _wait_for_tstate_lock
    elif lock.acquire(block, timeout):
KeyboardInterrupt
pi@raspberrypi:~/workspace/iot-device/apps/tests/labs $
```

Cloud Variables / Metrics Screenshot(s)

Ubidots Cloud Service







AWS Cloud Service:

aws

Services

Resource Groups

Naveen\_Rajendran

←

DATA SET

mysensordata\_dataset

SUCCEEDED

Actions

Details

Content

Most recent version

14/04/2020, 22:14:11

2d16e38c-6768-4d96-b46e-028bc51ce956

Succeeded

3822 ms

Delete

6ef37663-6cad-403d-9ea5-12b358e1f874.csv

Download

Result preview

corona	temperature	humidity	resistence	magflux	
11.43	7.62	5.71	22.86	11.43	20
12.0	8.0	6.0	23.99	12.0	20
10.19	6.79	5.09	20.37	10.19	20
10.56	7.04	5.28	21.11	10.56	20
12.04	8.03	6.02	24.09	12.04	20

## Application Runtime Log Output

<https://bitbucket.org/naveenORT/iot-device/src/master/apps/labs/module09/Sensor.log> - Log data for 2 + hrs

```
Sensor.log - Notepad
File Edit Format View Help
2020-04-19 16:59:59 INFO Earthpit Resistance 106
2020-04-19 16:59:59 INFO Corona Level 163
2020-04-19 16:59:59 INFO 
2020-04-19 17:00:01 INFO CPU Utilization = 23.6%
2020-04-19 17:00:01 INFO Memory Utilization = 1.8%
2020-04-19 17:00:02 INFO Data Published to AWS_IoT_Core ----->>>>>
2020-04-19 17:00:04 INFO Cabin Temp:23.48
2020-04-19 17:00:04 INFO Room Humidity:53.04
2020-04-19 17:00:04 INFO Magnetic Flux:68.47
2020-04-19 17:00:06 INFO CPU Utilization = 23.6%
2020-04-19 17:00:06 INFO Memory Utilization = 0.3%
2020-04-19 17:00:07 INFO {"temperature": 23.29, "humidity": 53.04, "corona_level": 163, "magflux": 68.47, "resistance": 106}
2020-04-19 17:00:07 INFO {"ram": 2.0, "cpu": 23.6, "arduino1_status": 1, "arduino2_status": 1}
2020-04-19 17:00:07 INFO Data Published to Ubidots ----->>>>>
2020-04-19 17:00:07 INFO Data Published to Ubidots ----->>>>>
2020-04-19 17:00:07 INFO <<<<<<<<<-----Subscribed Data Received from Cloud
2020-04-19 17:00:07 INFO Relay On
2020-04-19 17:00:11 INFO CPU Utilization = 23.6%
2020-04-19 17:00:11 INFO Memory Utilization = 0.3%
2020-04-19 17:00:15 INFO Earthpit Resistance 104
2020-04-19 17:00:15 INFO Corona Level 163
2020-04-19 17:00:15 INFO 
2020-04-19 17:00:16 INFO CPU Utilization = 23.6%
2020-04-19 17:00:16 INFO Memory Utilization = 1.8%
2020-04-19 17:00:17 INFO Data Published to AWS_IoT_Core ----->>>>>
2020-04-19 17:00:17 INFO {"temperature": 23.29, "humidity": 53.04, "corona_level": 163, "magflux": 68.47, "resistance": 104}
2020-04-19 17:00:17 INFO {"ram": 0.3, "cpu": 23.6, "arduino1_status": 1, "arduino2_status": 1}
2020-04-19 17:00:17 INFO Data Published to Ubidots ----->>>>>
2020-04-19 17:00:17 INFO Data Published to Ubidots ----->>>>>
2020-04-19 17:00:17 INFO <<<<<<<<<-----Subscribed Data Received from Cloud
2020-04-19 17:00:17 INFO Relay On
2020-04-19 17:00:20 INFO Cabin Temp:23.39
2020-04-19 17:00:20 INFO Room Humidity:52.74
2020-04-19 17:00:20 INFO Magnetic Flux:68.75
```