

Lab session week 9: IoT Programming with Cloud Computing Platforms

Aim

The aim of this tutorial is for students to be able to confidently use a cloud computing platform such as ThingsBoard.

Background

ThingsBoard is an open-source IoT platform for data collection, processing, visualization, and device management. It enables device connectivity via industry standard IoT protocols - MQTT, CoAP and HTTP and supports both cloud and on-premises deployments.

ThingsBoard can be used on premise (our own server, or computer), on the cloud (AWS, Google Cloud platform, etc.), or using ThingsBoard Cloud services. Given that we are smart enough to not fall in free trial subscription traps, we will install ThingsBoard in our own computer (or server if you have one).

Figure 1 depicts the intended setup for this tutorial. We will reuse the code from the previous tutorial developed for the edge device.

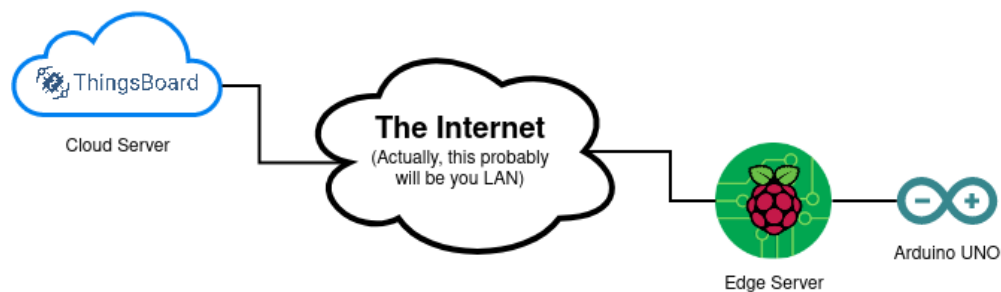


Figure 1: Network Diagram of this Tutorial

Task 1: Installing ThingsBoard Community Edition

ThingsBoard is designed to run and utilise on majority of hardware, from local Raspberry Pi to powerful servers in the cloud. In this tutorial, we recommend to install ThingsBoard in your own computer or any other computer you have network access. Please note: we do not recommend to install ThingsBoard on the Virtual Raspberry Pi OS.

Installation

Install ThingsBoard Community Edition on your device (Figure 2) following the installation steps from:

<https://thingsboard.io/docs/user-guide/install/installation-options/>

If asked, use PostgreSQL for database, and In Memory for queue service.

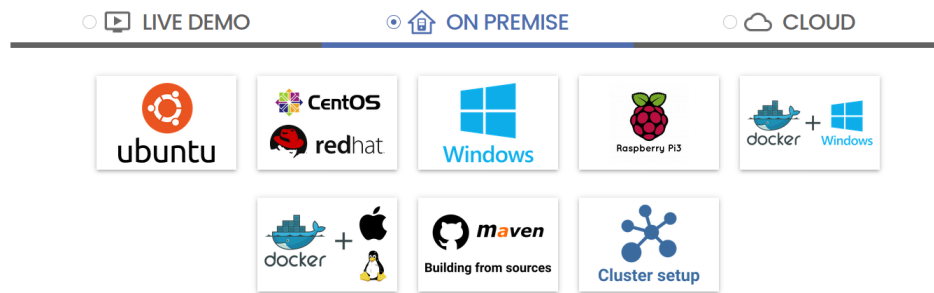


Figure 2: ThingsBoard on premise installation options

Once the installation is completed and the service has been started, you should be able to open the Web UI (Figure 3) using the localhost IP address and port 8080 if installed in your computer:

`http://localhost:8080/` or `http://127.0.0.1:8080/`

or using the host IP address if installed in any other device in your network:

`http://IP_ADDRESS:8080/`

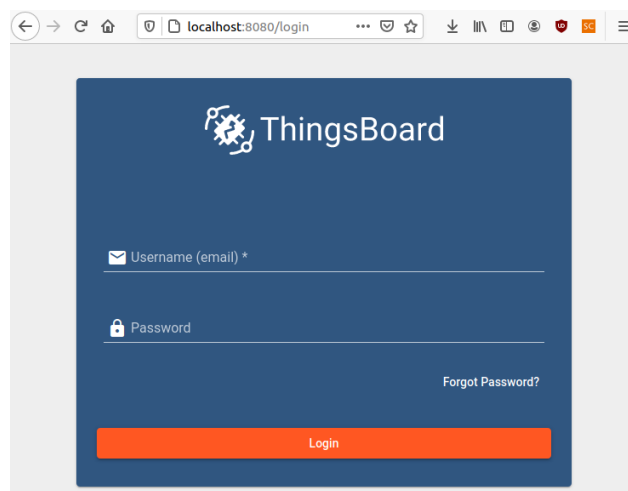


Figure 3: ThingsBoard Web UI - Login

Users Login

ThingsBoard Community Edition (TB CE) supports a straight-forward security model with three main roles: **System administrator**, **Tenant administrator**, and **Customer user**. A system administrator is able to manage tenants, while a tenant administrator manages devices, dashboards, customers, and other entities that belong to a particular tenant. Customer user is able to view dashboards and control devices that are assigned to a specific customer.

The following default credentials are available if you have specified `--loadDemo` during the installation script:

- System Administrator: `sysadmin@thingsboard.org / sysadmin`
- Tenant Administrator: `tenant@thingsboard.org / tenant`
- Customer User: `customer@thingsboard.org / customer`

Log in with the Tenant user. You will find some demo devices and dashboards already provisioned during the installation when indicating the `--loadDemo` flag.

Task 2: Getting Started with ThingsBoard

The Hello World tutorial demonstrates the basic usage of the most popular ThingsBoard features:

<https://thingsboard.io/docs/getting-started-guides/helloworld/>

Follow the Hello World tutorial together with the instructions we provide below in order to connect our Arduino board to ThingsBoard.

Step 1. Provision Device

Input device can be named "Potentiometer" or something similar.

Step 2. Connect device

The device we will connect is the edge server which is connected to the Arduino board via serial communication. We will connect the edge server using MQTT protocol which is already installed from the previous tutorial. This time though, we will use the `-u` parameter which indicates a username (access token) to be used for authenticating with the broker.

Execute the following from the edge server:

```
mosquitto_pub -d -q 1 -h "IP_ADDRESS_THINGSBOARD" -p "1883" -t "v1/devices/me/telemetry"
-u "$DEVICE_ACCESS_TOKEN_GENERATED_IN_THINGSBOARD" -m {"Potentiometer":25}
```

You should immediately see the value in the Device Telemetry Tab if the output of the command is similar to the following:

```
Client mosqpub|3344-raspberry sending CONNECT
Client mosqpub|3344-raspberry received CONNACK (0)
Client mosqpub|3344-raspberry sending PUBLISH (d0, q1, r0, m1, 'v1/devices/me/telemetry', ... (18 bytes)
Client mosqpub|3344-raspberry received PUBACK (Mid: 1)
Client mosqpub|3344-raspberry sending DISCONNECT
```

Step 3-5. Create Dashboard and Alarm

Once you complete those steps, you should have something like Figure 4. You might need to publish a few more values via MQTT.

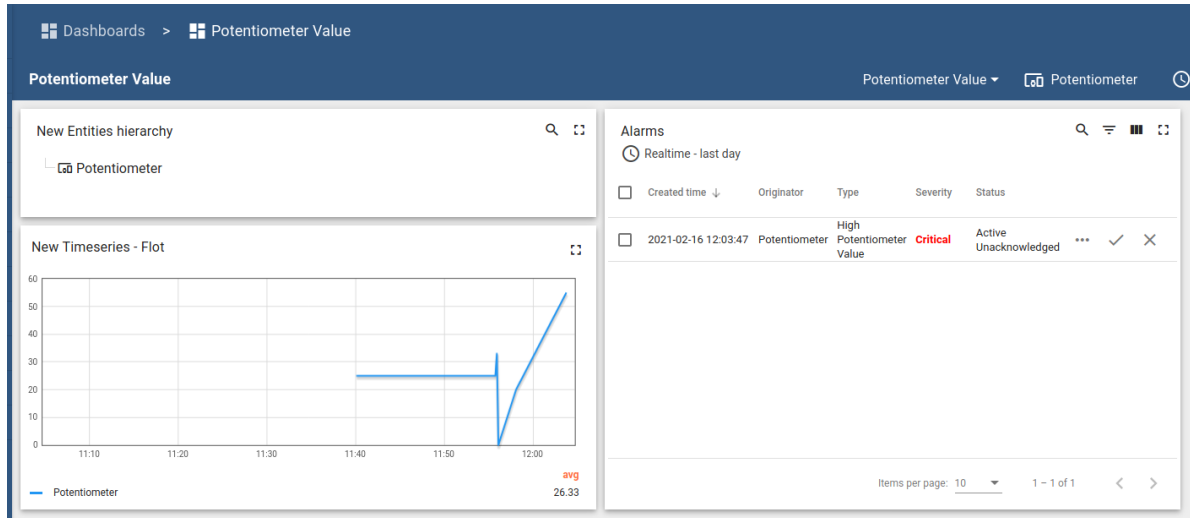


Figure 4: ThingsBoard Potentiometer Dashboard

Step 6. Alarm notifications

Feel free to explore Telegram or email notifications:

<https://thingsboard.io/docs/user-guide/device-profiles/#notifications-about-alarms>

Task 3: Sending Arduino data to ThingsBoard

Use the code developed in the previous tutorial in order to send data from the Arduino board to ThingsBoard:

1. Program the Arduino board to read data (e.g., read the potentiometer) and send it periodically via serial communication to the edge server.
2. Program the edge server to read the data received via serial communication, and publish it to a topic for the ThingsBoard. You can use this example as a guide on how to configure ThingsBoard and program the edge server: <https://thingsboard.io/docs/samples/raspberry/temperature/>

Do not forget to use the correct topic, access token, and IP address.

Once everything is connected, you should be able to visualise the value of the potentiometer (or whatever sensor you are using) in the ThingsBoard Dashboard like in Figure 5.

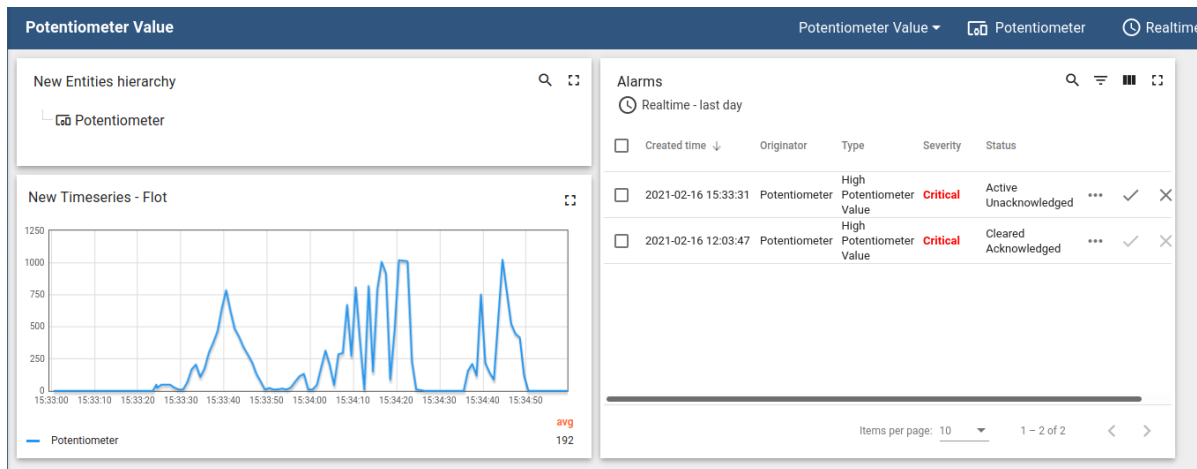


Figure 5: ThingsBoard Potentiometer Dashboard connected to Arduino

Task 4: Explore ThingsBoard

Explore other functionalities of ThingsBoard and think how you can use it in your group project!

Data Visualisation guides: <https://thingsboard.io/docs/guides#AnchorIDDDataVisualization>

Data Processing and actions guides: <https://thingsboard.io/docs/guides/#AnchorIDDDataProcessing>

IoT Data analytics guides: <https://thingsboard.io/docs/guides#AnchorIDDDataAnalytics>

For instance, check how to get weather data, configure complex ThingsBoard dashboards, or how to predict time series data.

Resources

ThingsBoard

- ThingsBoard Open-source IoT Platform. <https://thingsboard.io/>
- ThingsBoard source code. <https://github.com/thingsboard>

Raspberry Pi

- <https://www.raspberrypi.org/>

GNU/Linux

- Linux Journey is a site dedicated to making learning Linux fun and easy. <https://linuxjourney.com/>
- Introduction to Linux: A Hands on Guide. <https://tldp.org/LDP/intro-linux/intro-linux.pdf>

- Introduction to Linux (LFS101), the Linux Foundation training course: <https://training.linuxfoundation.org/training/introduction-to-linux/>

MQTT

- MQTT: The Standard for IoT Messaging. <https://mqtt.org/>
- Eclipse Mosquitto: An open source MQTT broker. <https://www.mosquitto.org/>
- Eclipse Paho MQTT Python client library. <https://pypi.org/project/paho-mqtt/>

Python

- Python for Beginners (Programmers). <https://www.python.org/about/gettingstarted/>