

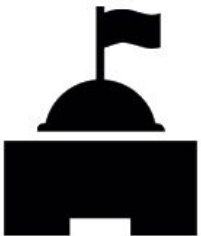


# #HackTheBase Workshop

Environment monitoring with The Things Network, InfluxDB, and Grafana

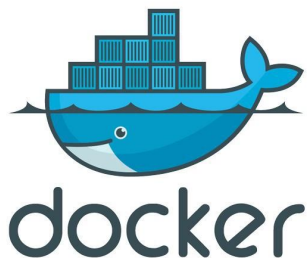
**Tomas Hrdlicka**  
[hrdlicka@ucwlab.com](mailto:hrdlicka@ucwlab.com)

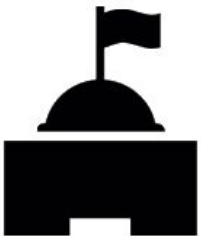
Twitter: @Tomas\_Hrdlicka  
LinkedIn: <https://www.linkedin.com/in/tomashrdlicka>



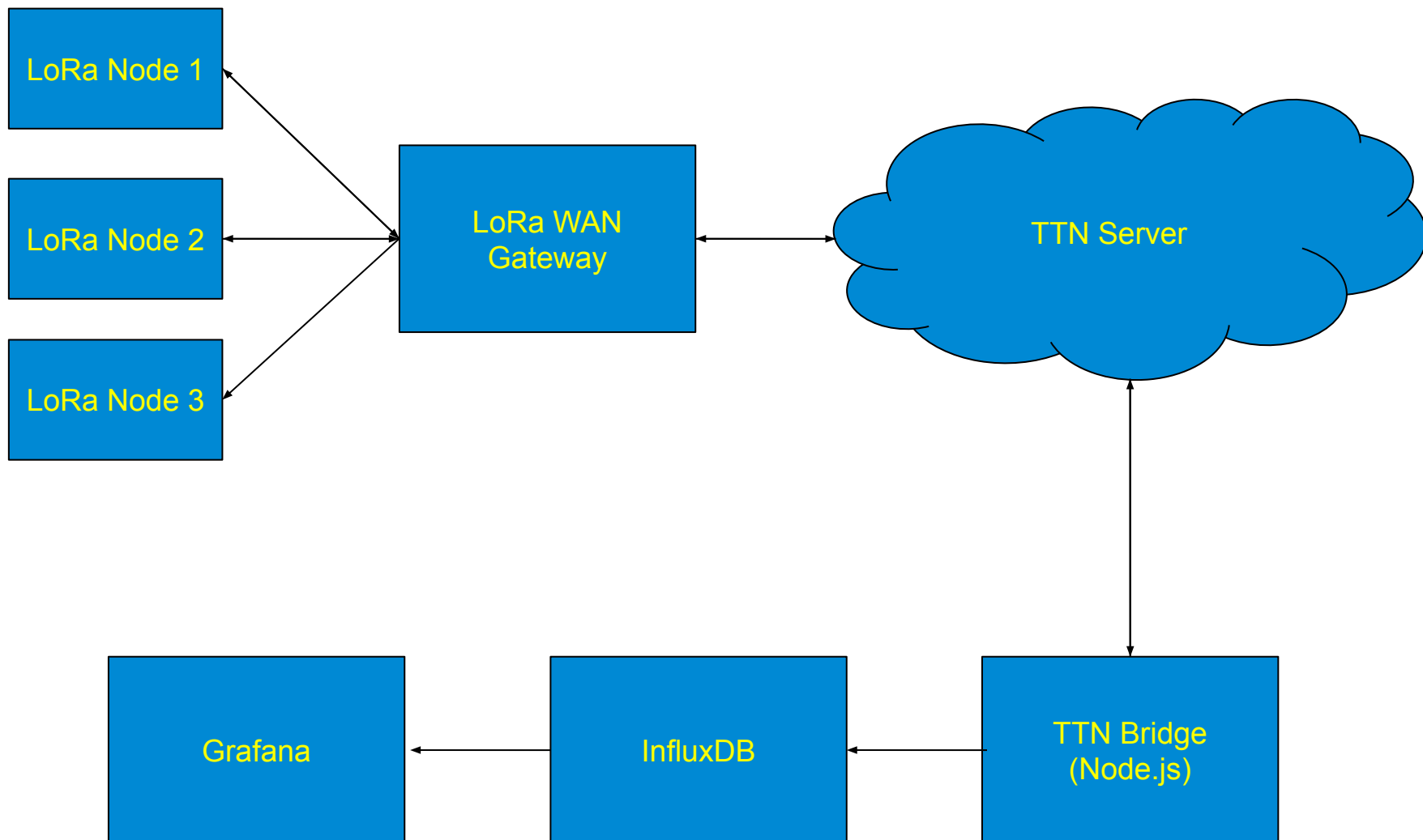
# IoT Monitoring (1/2)

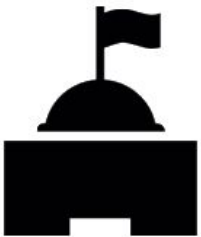
- Let's build a system to monitor the environmental conditions such as temperature and humidity in a room.
- We will build a LoRa sensor node with DHT/BME280 sensor connected to The Things Network.
- To see graphs in Grafana, we will build a Node.js application (TTN Bridge) reading data from MQTT and storing them in the time series database InfluxDB.





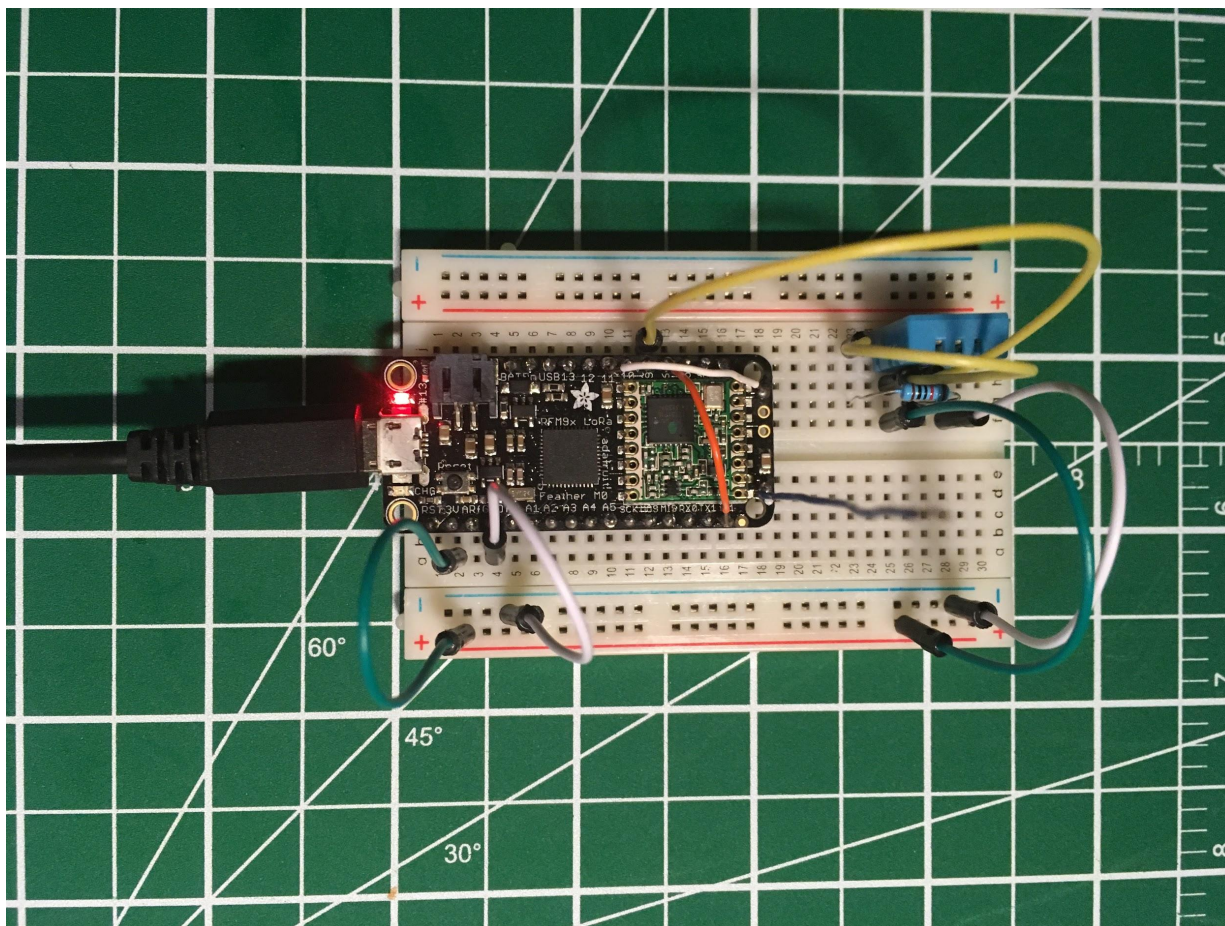
# IoT Monitoring (2/2)

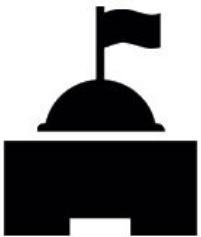




# LoRa Sensor Node

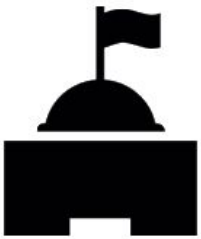
- Adafruit Feather M0 as LoRa Sensor Node with DHT11 sensor



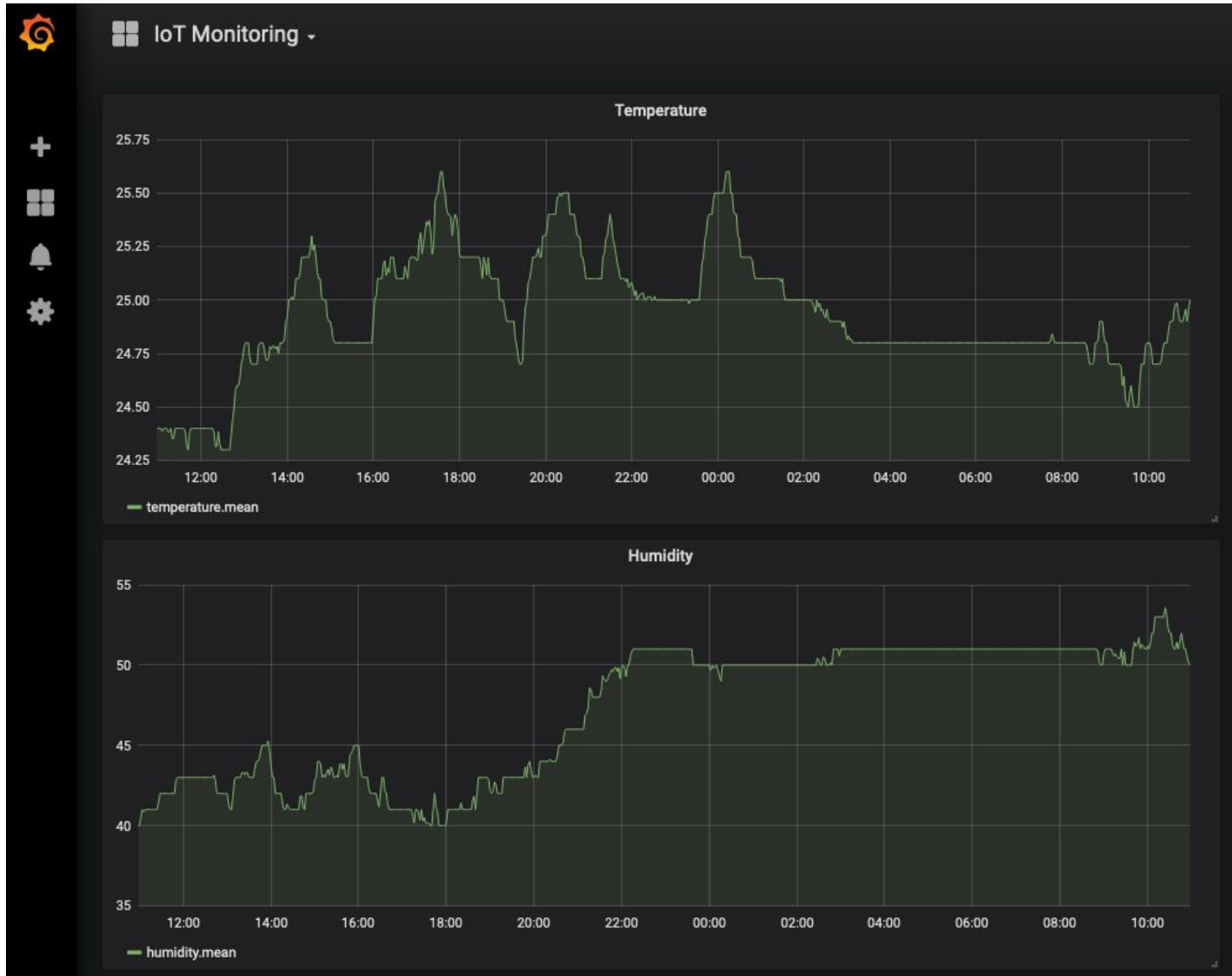


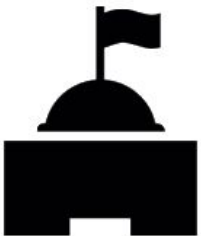
# InfluxDB

- It is a time-series database which means that it is specially designed to store time-series data.
- Time-series is a set of values/measurements that are taken over a successive period of time. For eg. data collected by an IoT sensor.
- Time-series can have 0-many points. A point wherein can have the following elements:
  - Time (timestamp)
  - Measurement
  - Key-value field (at least one)
  - Key-value tags



# Sensor Data Monitoring





# TTN Application (1/5)

Applications > htb-iot-monitoring-dht

Overview Devices Payload Formats Integrations Data Settings

## APPLICATION OVERVIEW

[documentation](#)

**Application ID** htb-iot-monitoring-dht

**Description** LoRa Node Sensors - DHT

**Created** 2 days ago

**Handler** ttn-handler-eu (current handler)

## APPLICATION EUIs

[manage euis](#)

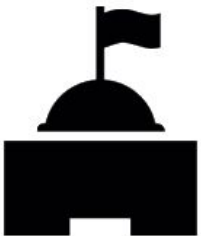
70B3D57ED0021F18

## DEVICES


[register device](#) [manage devices](#)



2 registered devices



# TTN Application (2/5)

Applications >  htb-iot-monitoring-dht > Devices

Overview

**Devices**

Payload Formats

Integrations

Data

Settings

## DEVICES

 [register device](#)

< >

1 – 2 / 2

device01

00 C1 FE 17 7E 87 7E 2A

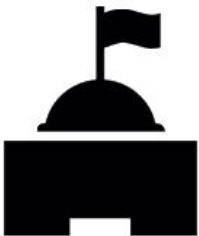


device02

00 4D 16 91 F4 24 AF 81







# TTN Application (3/5)

Applications >  htb-iot-monitoring-dht > Devices >  device01

Overview

Data

Settings

## DEVICE OVERVIEW

Application ID **htb-iot-monitoring-dht**



Device ID device01



Activation Method **ABP**

Device EUI <> ⇅ 00 C1 FE 17 7E 87 7E 2A 

Application EUI <> ⇅ 70 B3 D5 7E D0 02 1F 18 

Device Address <> ⇅ 26 01 17 E8 

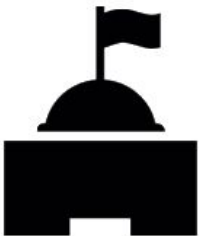
Network Session Key <> ⇅  msb { 0x00, 0xFB, 0xA7, 0xBC, 0x12, 0x16, 0x35, 0x12, 0x9C, 0x42, 0xEC, 0x48, 

App Session Key <> ⇅  msb { 0xEC, 0x0A, 0x3C, 0x05, 0x9F, 0xD4, 0xDA, 0x68, 0xBE, 0xF4, 0xA4, 0xD7, 

Status ● 3 seconds ago

Frames up 7762 [reset frame counters](#)

Frames down 1



# TTN Application (4/5)

Applications > htb-iot-monitoring-dht > Devices > device01 > Data

Overview Data Settings

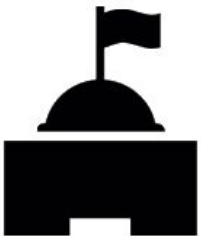
## APPLICATION DATA

|| pause || clear

Filters

uplink downlink activation ack error

	time	counter	port	
▲	11:10:17	7759	1	payload: 09 C4 1E 14 13 EC dht.humidity: 51 dht.temperature: 25 dht.temperatureF: 77
▲	11:09:59	7758	1	payload: 09 C4 1E 14 13 EC dht.humidity: 51 dht.temperature: 25 dht.temperatureF: 77
▲	11:09:41	7757	1	payload: 09 C4 1E 14 13 EC dht.humidity: 51 dht.temperature: 25 dht.temperatureF: 77
▲	11:09:23	7756	1	payload: 09 C4 1E 14 13 EC dht.humidity: 51 dht.temperature: 25 dht.temperatureF: 77
▲	11:09:05	7755	1	payload: 09 C4 1E 14 13 88 dht.humidity: 50 dht.temperature: 25 dht.temperatureF: 77
▲	11:08:47	7754	1	payload: 09 CE 1E 26 13 88 dht.humidity: 50 dht.temperature: 25.1 dht.temperatureF: 77.18
▲	11:08:28	7753	1	payload: 09 CE 1E 26 13 88 dht.humidity: 50 dht.temperature: 25.1 dht.temperatureF: 77.18
▲	11:08:10	7752	1	payload: 09 CE 1E 26 13 88 dht.humidity: 50 dht.temperature: 25.1 dht.temperatureF: 77.18
▲	11:07:52	7751	1	payload: 09 CE 1E 26 13 88 dht.humidity: 50 dht.temperature: 25.1 dht.temperatureF: 77.18
▲	11:07:34	7750	1	payload: 09 CE 1E 26 13 EC dht.humidity: 51 dht.temperature: 25.1 dht.temperatureF: 77.18
▲	11:07:16	7749	1	payload: 09 C4 1E 14 14 50 dht.humidity: 52 dht.temperature: 25 dht.temperatureF: 77
▲	11:06:58	7748	1	payload: 09 C4 1E 14 13 88 dht.humidity: 50 dht.temperature: 25 dht.temperatureF: 77
▲	11:06:40	7747	1	payload: 09 C4 1E 14 13 88 dht.humidity: 50 dht.temperature: 25 dht.temperatureF: 77
▲	11:06:03	7745	1	payload: 09 C4 1E 14 13 88 dht.humidity: 50 dht.temperature: 25 dht.temperatureF: 77
▲	11:05:27	7743	1	payload: 09 C4 1E 14 13 88 dht.humidity: 50 dht.temperature: 25 dht.temperatureF: 77



# TTN Application (5/5)

Applications > htb-iot-monitoring-dht > Payload Formats

Overview

Devices

Payload Formats

Integrations

Data

Settings

## PAYLOAD FORMATS

### Payload Format

The payload format sent by your devices

Custom

decoder

converter

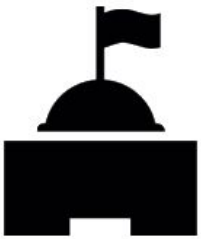
validator

encoder

[remove decoder](#)

```
1 function Decoder(bytes, fport) {
2   var t = (bytes[0] & 0x80 ? 0xFFFF << 16 : 0) | bytes[0] << 8 | bytes[1];
3   var f = bytes[2] << 8 | bytes[3];
4   var h = bytes[4] << 8 | bytes[5];
5   return {
6     dht: {
7       temperature: t / 100,
8       temperatureF: f / 100,
9       humidity: h / 100
10    }
11  }
```

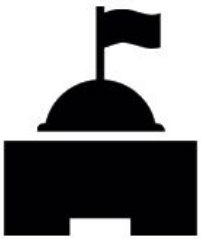
decoder has no changes



# Lora Sensor Node - DHT

- Source code
  - <https://github.com/ucwlabs/iot-monitoring-ttn/blob/master/lora-sensor-node-dht/lora-sensor-node-dht.ino>

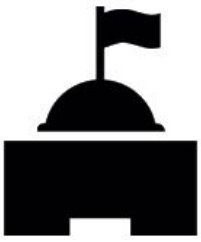
```
lora-sensor-node-dht
27
28 #include <lmic.h>
29 #include <hal/hal.h>
30 #include "SPI.h"
31 #include "DHT.h"
32
33 #define DHTPIN 9
34 #define DHTTYPE DHT11
35
36 DHT dht(DHTPIN, DHTTYPE);
37
38 // LoRaWAN NwkSKey - Network session key
39 static const PROGMEM u1_t NWKSKEY[16] = { 0x00, 0xFB, 0xA7, 0xBC, 0x12, 0x16, 0x35, 0x12, 0x9C, 0x42, 0xEC, 0x48, 0xE1, 0x59, 0xB7, 0x7E };
40
41 // LoRaWAN AppSKey - Application session key
42 static const u1_t PROGMEM APPSKEY[16] = { 0xEC, 0x0A, 0x3C, 0x05, 0x9F, 0xD4, 0xDA, 0x68, 0xBE, 0xF4, 0xA4, 0xD7, 0xA6, 0xFD, 0xB8, 0x46 };
43
44 // LoRaWAN end-device address (DevAddr)
45 static const u4_t DEVADDR = 0x260117E8; // <-- Change this address for every node!
46
47 // These callbacks are only used in over-the-air activation, so they are
48 // left empty here (we cannot leave them out completely unless
49 // DISABLE_JOIN is set in config.h, otherwise the linker will complain).
50 void os_getArtEui (u1_t* buf) { }
51 void os_getDevEui (u1_t* buf) { }
52 void os_getDevKey (u1_t* buf) { }
53
54 static osjob_t sendjob;
55
56 // Schedule TX every this many seconds (might become longer due to duty cycle limitations).
57 const unsigned TX_INTERVAL = 16;
58
59 // Pin mapping
60 const lmic_pinmap lmic_pins = {
61   .nss = 8,
62   .rxtx = LMIC_UNUSED_PIN,
63   .rst = 4,
64   .dio = {3, 6, 11},
65 };
66
```



# TTN & MQTT (1/2)

- `$ mosquitto_sub -h eu.thethings.network -p 1883 \`  
    `-u htb-iot-monitoring-dht \`  
    `-P your_access_key \`  
    `-t 'htb-iot-monitoring-dht/devices/device01/up'`

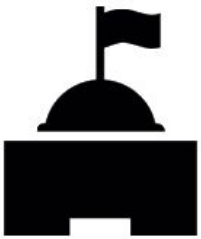
```
{"app_id":"htb-iot-monitoring-dht","dev_id":"device01","hardware_serial":"00C1FE177E877E2A","port":1,"counter":7800,"payload_raw":"Cc4eJhOI",  
"payload_fields":{"dht":{"humidity":50,"temperature":25.1,"temperatureF":77.18}},  
"metadata":{"time":"2019-09-09T09:22:40.591968971Z","frequency":868.1,"modulation":"LORA",  
"data_rate":"SF7BW125","airtime":51456000,"coding_rate":"4/5","gateways":[{"gtw_id":"eui-b827ebfffe91af1e",  
"timestamp":147734291,"time":"","channel":0,"rssi":-43,"snr":10.2,"rf_chain":1,  
"latitude":49.06326,"longitude":17.494406,"location_source":"registry"}]}}
```



# TTN & MQTT (2/2)

- `$ mosquitto_sub -h eu.thethings.network -p 1883 \`  
    `-u htb-iot-monitoring-dht \`  
    `-P your_access_key \`  
    `-t 'htb-iot-monitoring-dht/devices/device01/up/dht'`

```
{"humidity":50,"temperature":25.1,"temperatureF":77.18}
```

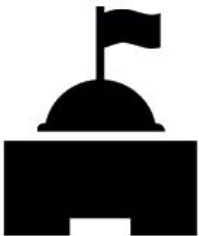


# Application


```
$ git clone https://github.com/ucwlabslabs/iot-monitoring-ttn.git
iot-monitoring-ttn
$ cd iot-monitoring-ttn/
$ chmod +x run.sh
$ ./run.sh
$ docker ps -a
```

CONTAINER ID	IMAGE	COMMAND	CREATED	STATUS	PORTS	NAMES
eee82f9625b9	ucwlabslabs/ttn-bridge:latest	"docker-entrypoint.s..."	36 hours ago	Up 11 hours		ttn-bridge
c4523c7fffcf	grafana/grafana:5.4.3	"/run.sh"	39 hours ago	Up 36 hours	0.0.0.0:3000->3000/tcp	grafana
673ff0c4cba9	influxdb:1.7.8	"/entrypoint.sh infl..."	39 hours ago	Up 36 hours	0.0.0.0:8086->8086/tcp	influxdb

```
$ docker container logs -f ttn-bridge
{ deviceId: 'device01',
  payload:
    { dht: { humidity: 50, temperature: 25.1, temperatureF: 77.18 } } }
{ deviceId: 'device01',
  payload:
    { dht: { humidity: 50, temperature: 25.1, temperatureF: 77.18 } } }
```



# Grafana (1/6)

 **Data Sources / InfluxDB**  
Type: InfluxDB

Settings

### Settings

Name	InfluxDB	Default	<input checked="" type="checkbox"/>
------	----------	---------	-------------------------------------

### HTTP

URL	http://influxdb:8086	
Access	Server (Default)	<a href="#">Help</a>
Whitelisted Cookies	Add Name	

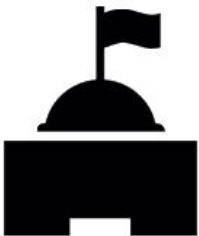
### Auth

Basic Auth	<input type="checkbox"/>	With Credentials	<input type="checkbox"/>
TLS Client Auth	<input type="checkbox"/>	With CA Cert	<input type="checkbox"/>
Skip TLS Verify	<input type="checkbox"/>		

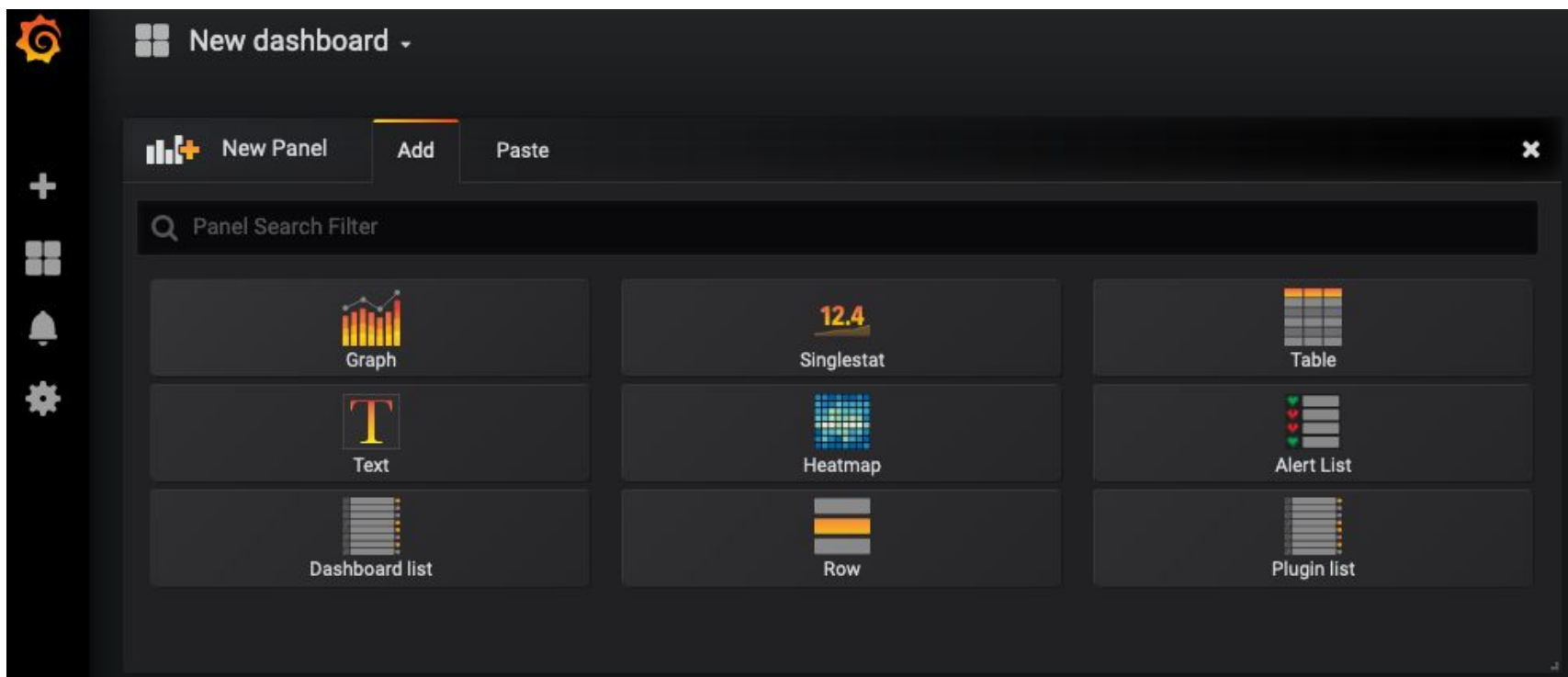
### InfluxDB Details

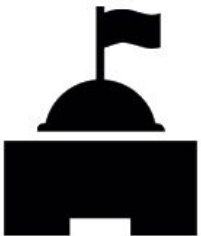
Database	iot-monitoring		
User	root	Password	....



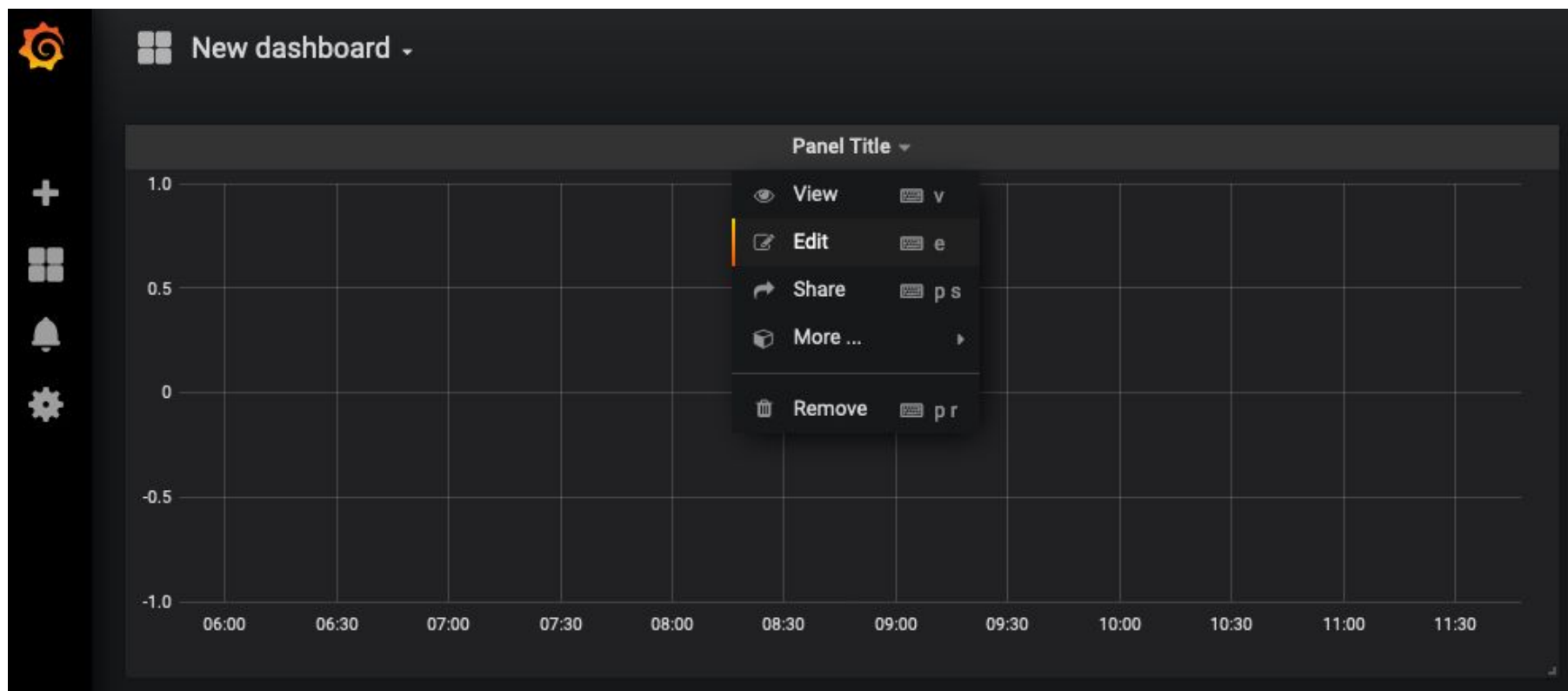


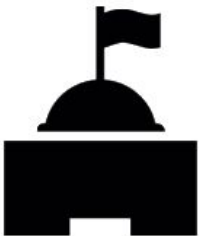
# Grafana (2/6)



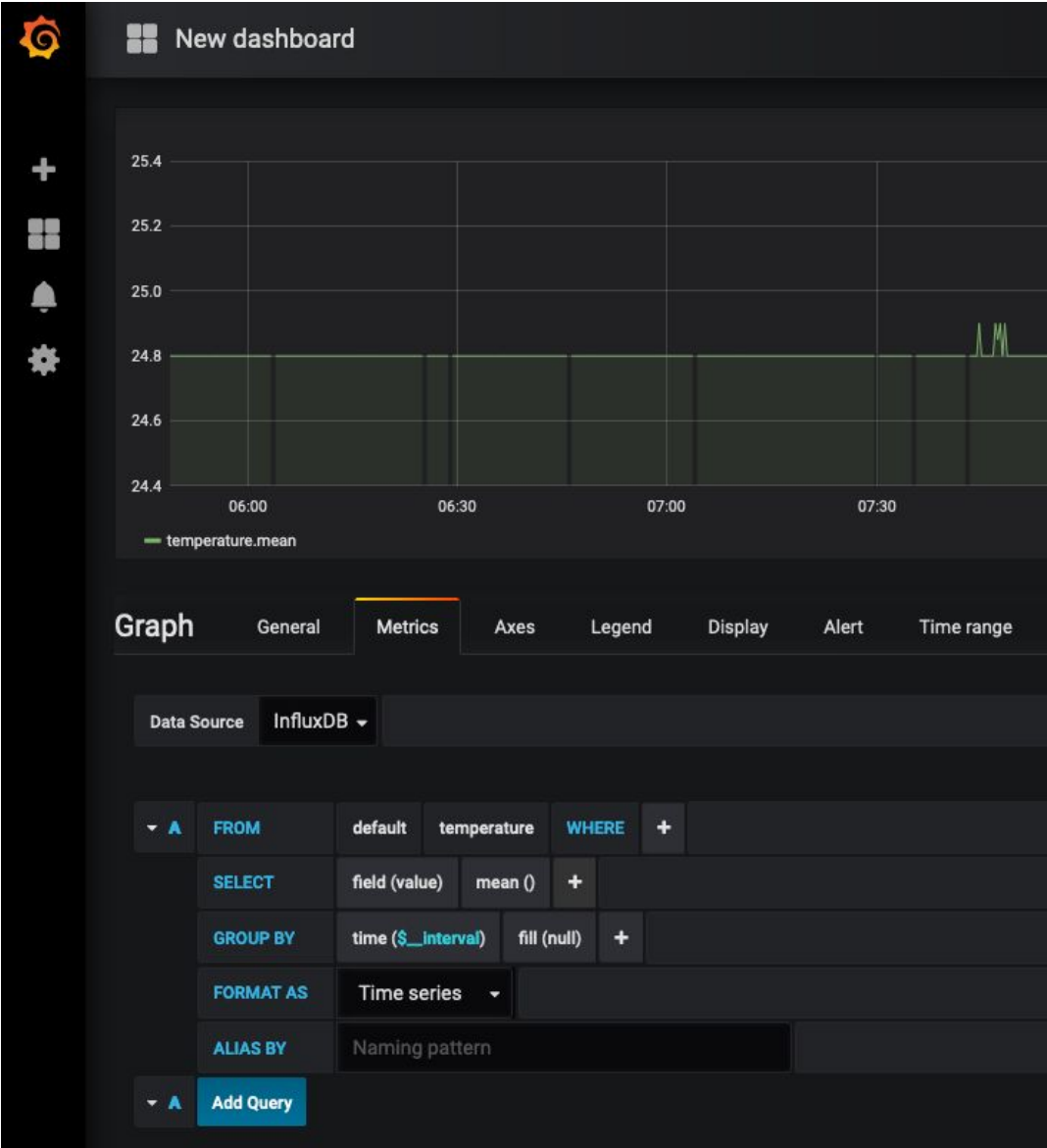


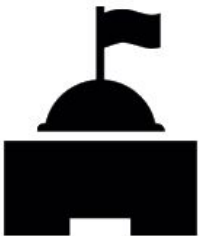
# Grafana (3/6)



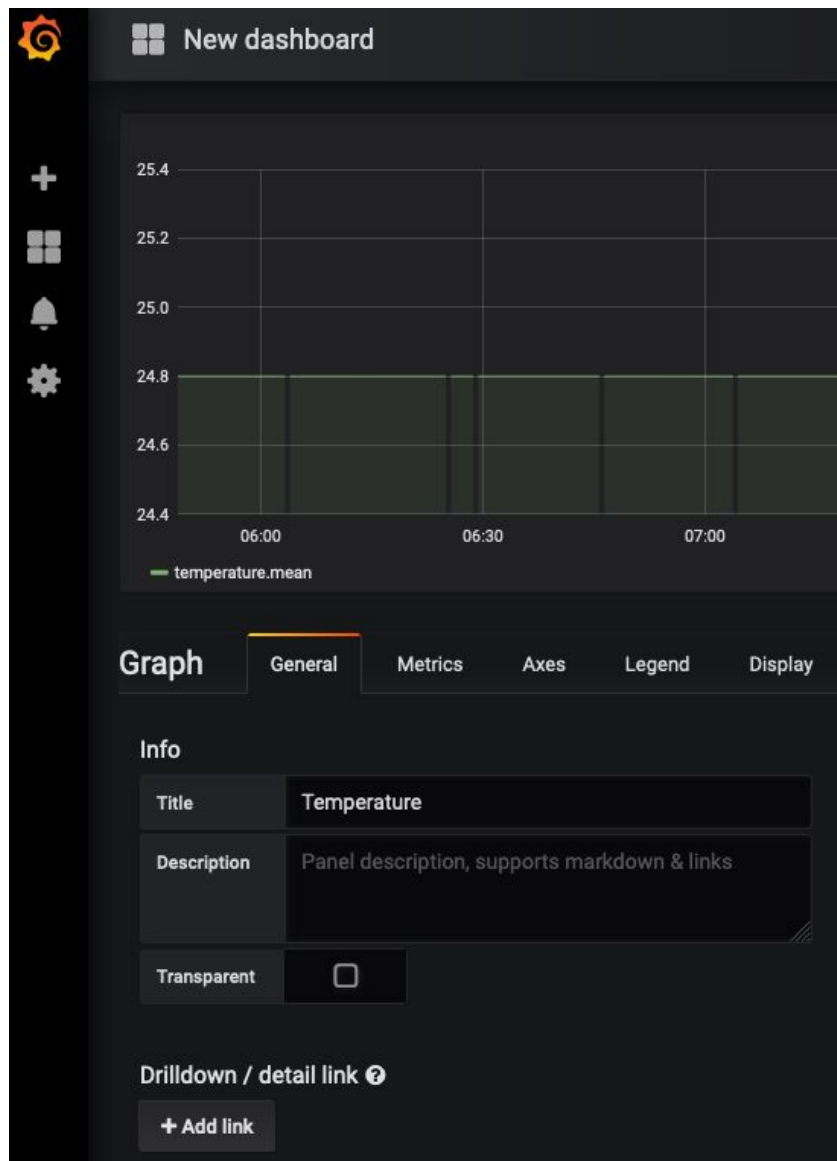


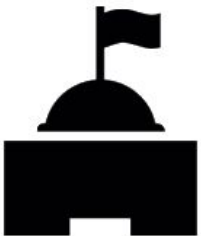
# Grafana (4/6)



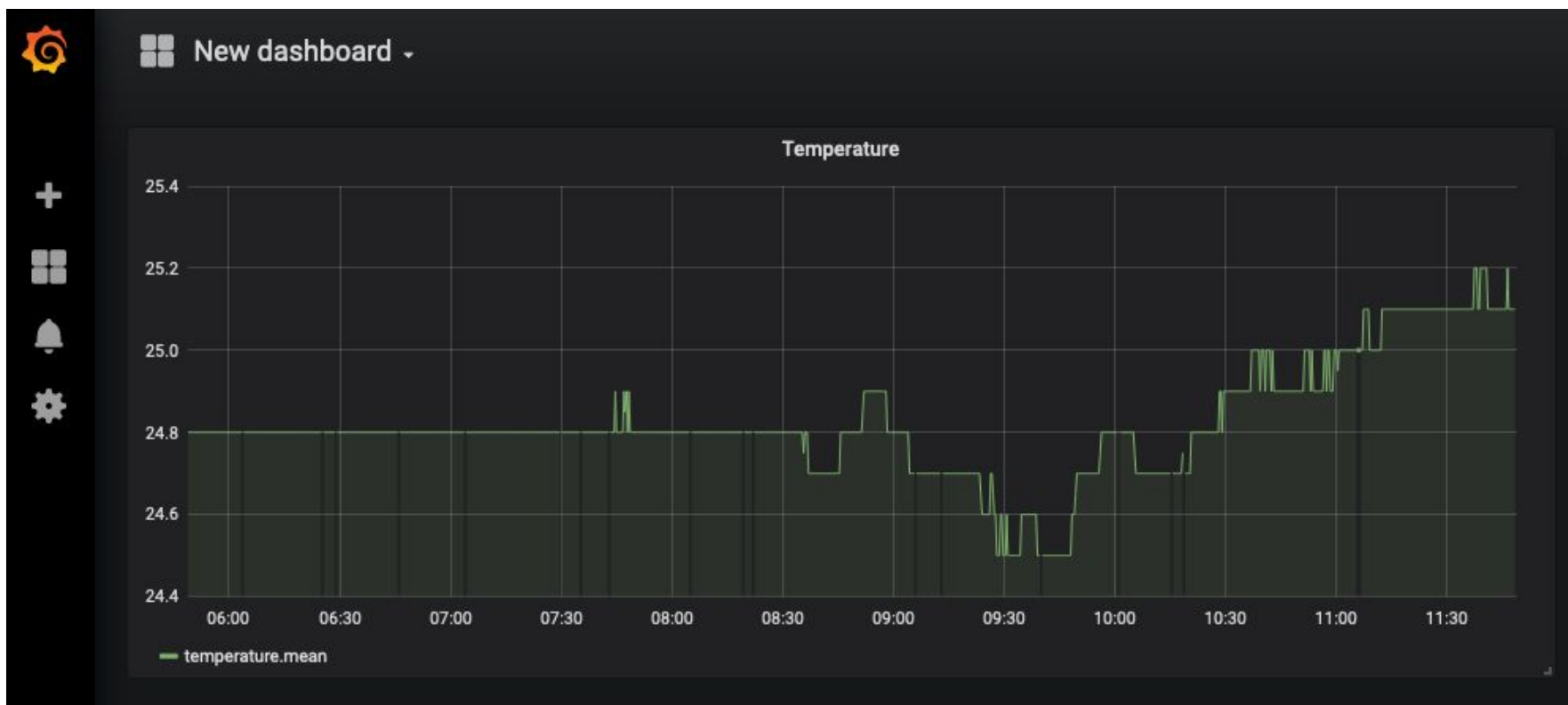


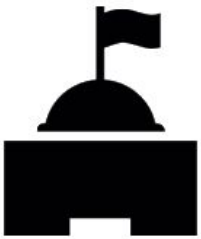
# Grafana (5/6)





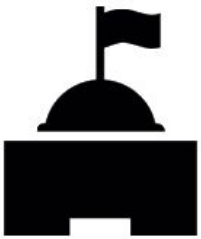
# Grafana (6/6)





# References

- Workshop materials
  - <https://github.com/ucwlabs/iot-monitoring-ttn>
- Adafruit Feather M0 Radio with Lora Radio Module
  - <https://learn.adafruit.com/adafruit-feather-m0-radio-with-lora-radio-module>
- Sensors
  - DHT 11/22
    - <https://www.adafruit.com/product/386>
    - <https://www.adafruit.com/product/385>
  - BME280
    - <https://www.adafruit.com/product/2652>
- The Things Network Console
  - <https://console.thethingsnetwork.org>
- The Things Network API - MQTT
  - <https://www.thethingsnetwork.org/docs/applications/mqtt/api.html>
- The Things Network SDK - Node.js
  - <https://www.thethingsnetwork.org/docs/applications/nodejs/quick-start.html>



# Thank you for your attention

## Q & A



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