

# Environment Monitoring



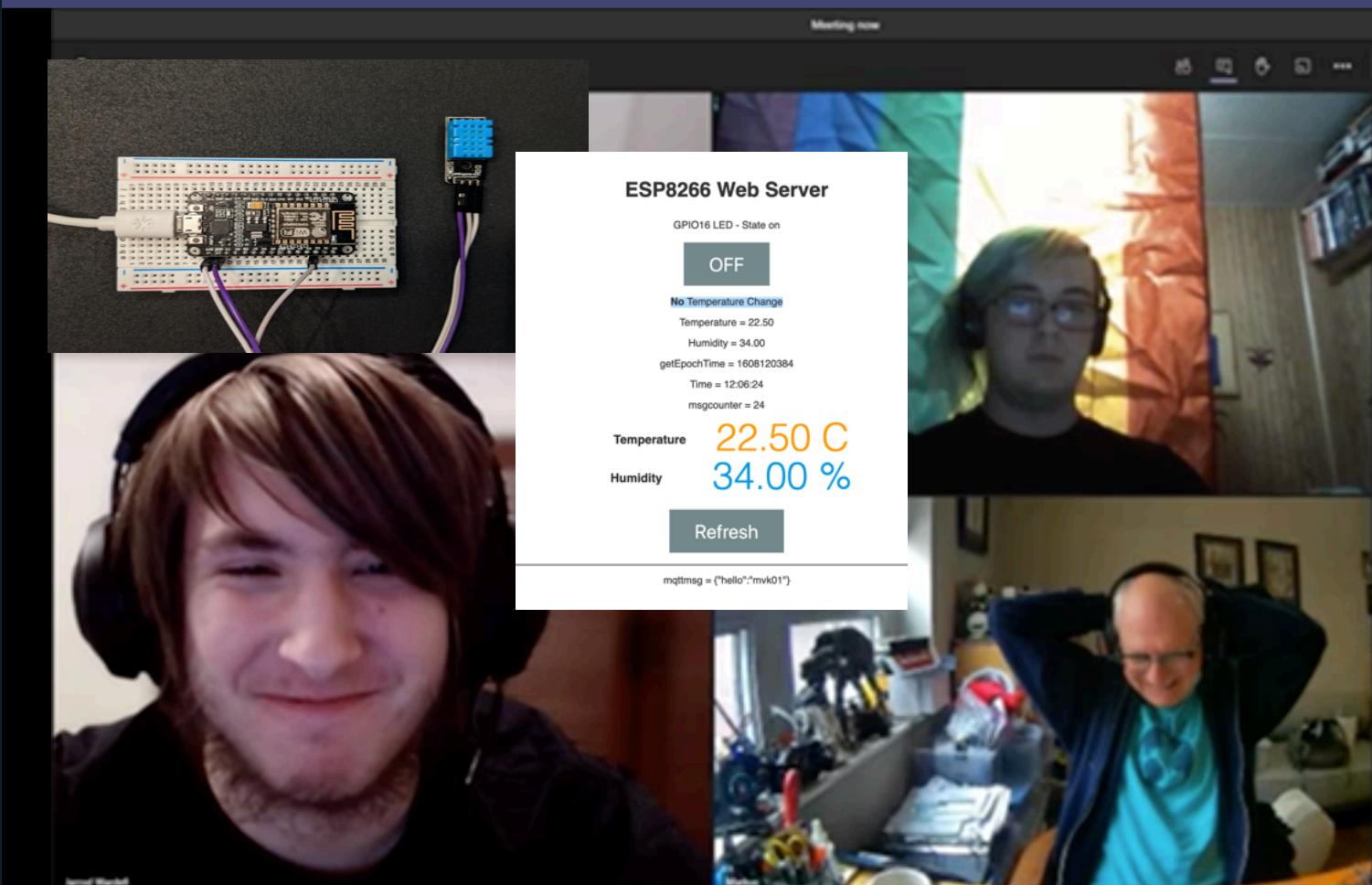
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🐦 @markusvankempen

**Version: 20210210**

<https://discord.com/channels/809863505908858931/809866377765715978>



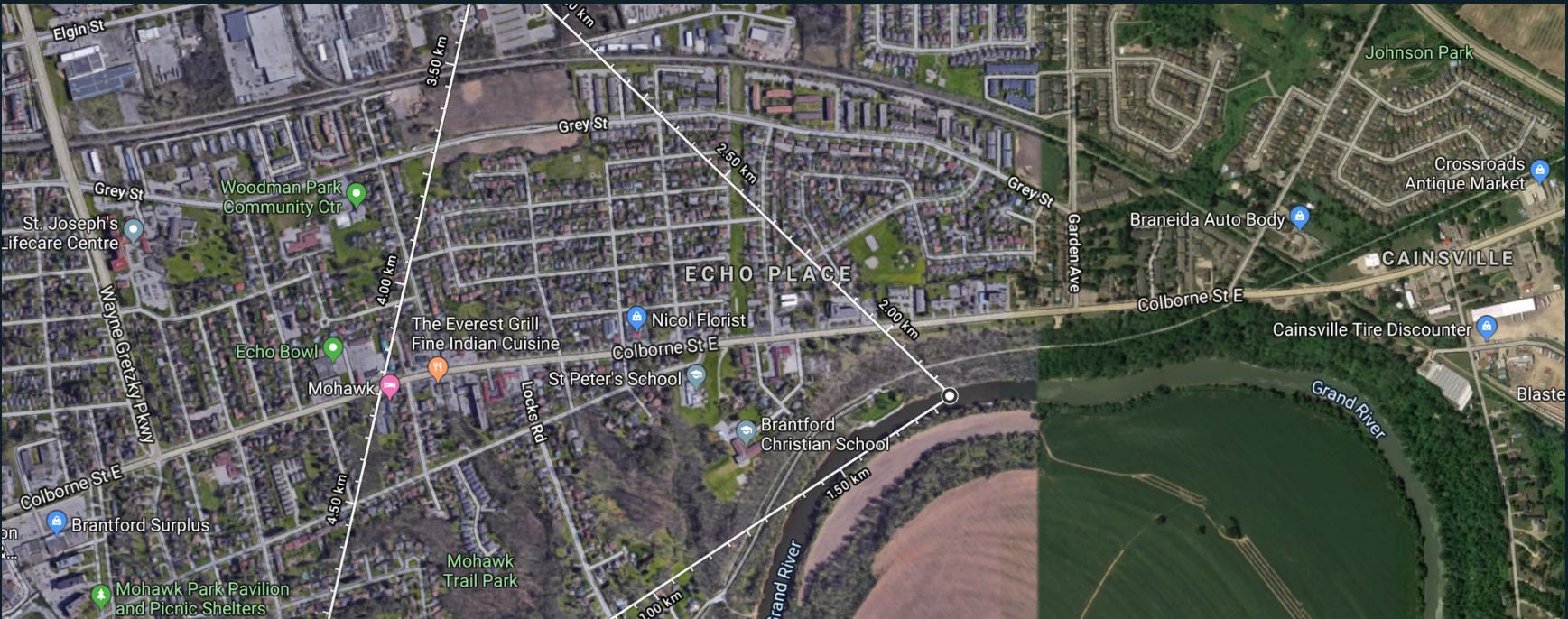
# SNP STEAM ACADEMY

Code and instruction for this class can be found here

<https://github.com/markusvankempen/esp8266andDHT11>



# Our Goal – Environmental Monitoring Project



## Why LoraWAN

- It's free - no Telco costs
- LORA = LongRange 10km and LowPower (LPWan)
- Lots of use-cases / examples and support available
- 
- More infos
- <https://www.semtech.com/lora/why-lora>
- <https://os.mbed.com/docs/mbed-os/v5.15/tutorials/LoRa-tutorial.html>

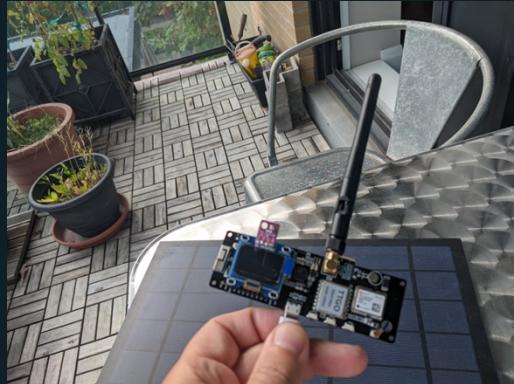


# Lora Gateway & LoraServer



- Has Wifi/lora/GPS/LTE
- Power via Power over Ethernet (POE)
- More infos here
- <https://www.rakwireless.com/en-us/products/lpwlan-gateways-and-concentrators/rak7249>
- So far tested Gateway setup with different lora Nodes connection to TTN and MQTT
- ToDo's
  - Test LTE setup
  - Need Solar Kit
  - <https://store.rakwireless.com/products/solar-kit?variant=31385712885805>

# Lora Nodes –with batteries and solar panel – TTGO -T-Beam



TTGO ... lots of software support Arduino based and wifi support  
Pro

Really good power management ... all one ... with gps options for tracking

<http://www.lilygo.cn/products.aspx?TypeId=50003&FlId=t3:50003:3>

[https://github.com/JoepSchyns/Low\\_power\\_TTGO\\_T-beam](https://github.com/JoepSchyns/Low_power_TTGO_T-beam)

<https://github.com/LilyGO/TTGO-T-Beam>

[https://tinyomics.com/wiki/TTGO\\_T-Beam](https://tinyomics.com/wiki/TTGO_T-Beam)



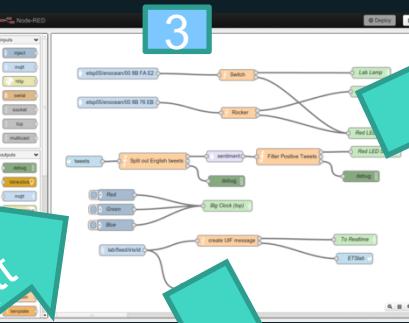
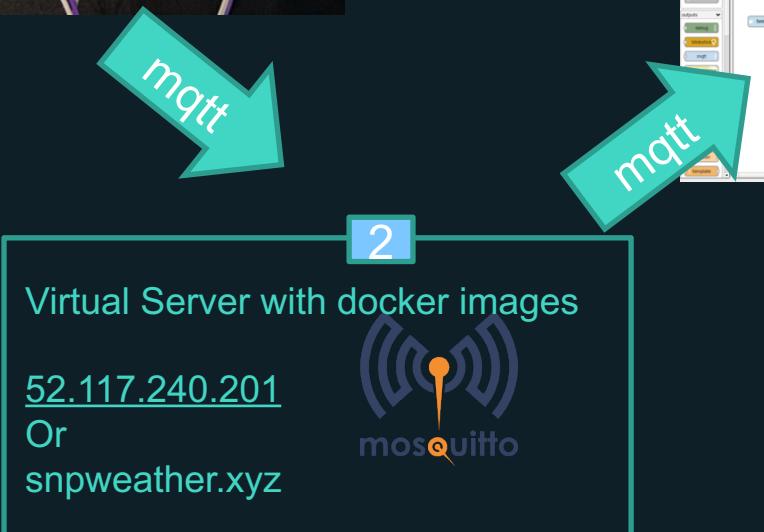
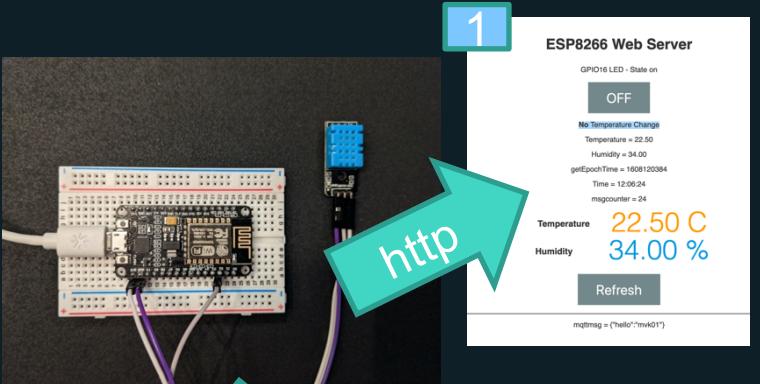
# Today



We will simulate the LoRa network using a WIFI network with our esp8266 & DHT11 to send temperature data via mqtt to a server and save the data into a database and than “surf” the data and visualize it using Grafana.

In our esp8266 journey we will setup the Arduino IDE, using the esp8266 as a webserver, Integrate the NetworkTimeProtocol and look at the deep sleep mode for es8266 and and of course send and store the temperature data.

# Overview – ESP8266 and DHT11



# Agenda

1<sup>st</sup> Chapter (One) – Arduino and ESP8266 Setup

2<sup>nd</sup> Chapter (two) – ESP8266 as a webserver

3<sup>rd</sup> Chapter (three) – ESP8266 and NTP/RTC (Time Server)

4<sup>th</sup> Chapter (four) – ESP8266 and MQTT



# 1<sup>st</sup> Chapter (One)



Arduino IDE setup

ESP and DHT11 wiring

Esp8266 and dht11 test program

Some exercises/play

# Arduino IDE setup - esp8266 board

We need to add the esp8266 board and libraries to the IDE

## Instructions

- Start Arduino and open Preferences window.
- Enter [https://arduino.esp8266.com/stable/package\\_esp8266com\\_index.json](https://arduino.esp8266.com/stable/package_esp8266com_index.json) into *Additional Board Manager URLs* field. You can add multiple URLs, separating them with commas.
- Open Boards Manager from Tools > Board menu and find esp8266 platform.
- Select the version you need from a drop-down box.
- Click *install* button.
- Don't forget to select your ESP8266 board from Tools > Board menu after installation

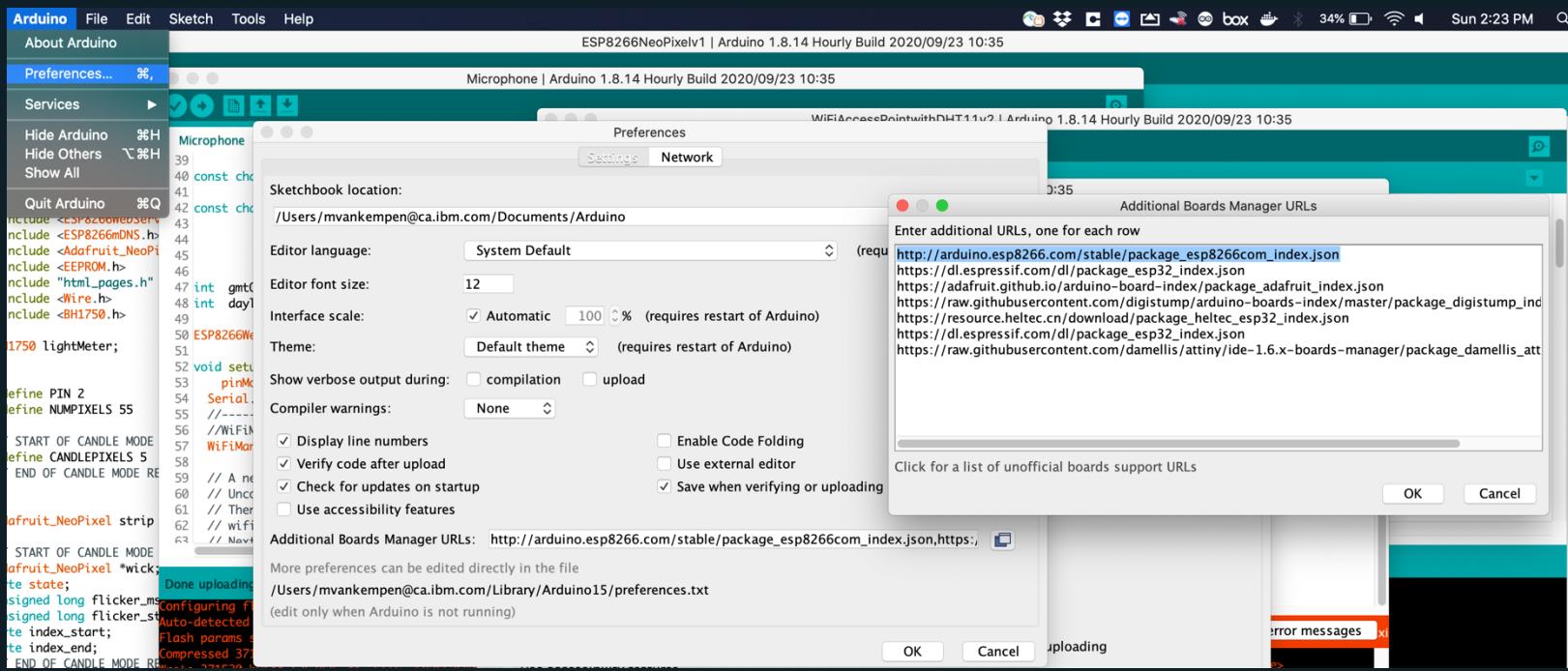
## More reference

<https://arduino-esp8266.readthedocs.io/en/latest/installing.html>

<https://www.hackster.io/rajthavti/dht11-sensor-interfacing-with-nodemcu-086762>



# ESP8266 board import



## Arduino IDE setup - dht11 library

You should have the [Arduino IDE](#) software running at this time. Next isto install our DHT library, which can be done though the Arduino Library Manager:

**Sketch→Include Library→Manage Libraries...**

Enter “dht” in the search field and look through the list for “**DHT sensor library by Adafruit.**” Click the “Install” button, or “Update” from an earlier version.

DHT Sensor Library: <https://github.com/adafruit/DHT-sensor-library>

More reference

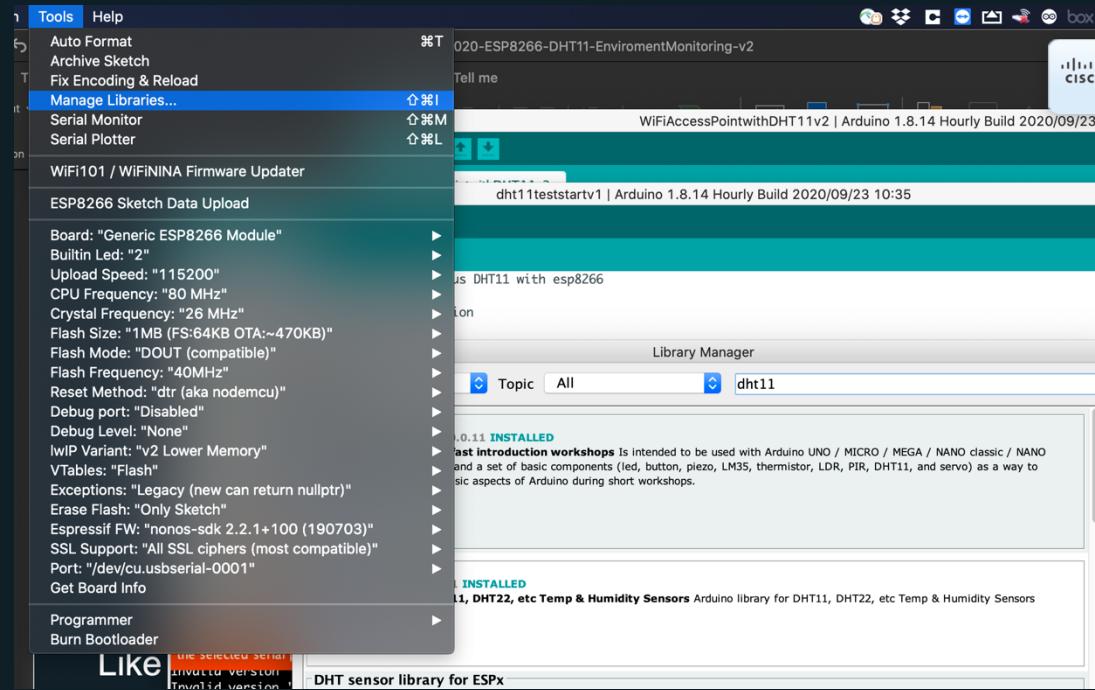
<https://arduino-esp8266.readthedocs.io/en/latest/installing.html>

<https://www.hackster.io/rajthavti/dht11-sensor-interfacing-with-nodemcu-086762>

<https://learn.adafruit.com/dht/downloads?view=all>



# Import DHT11 Library



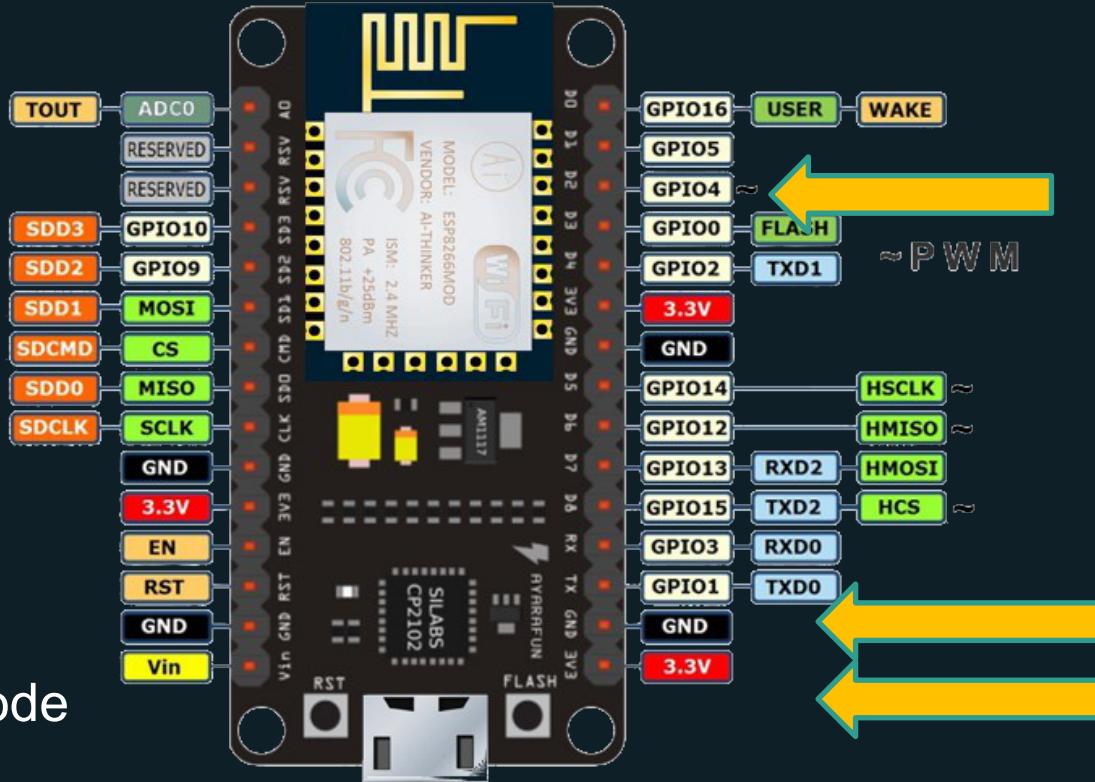
## ESP8266 and DHT11 wiring

# PIN on the esp8266

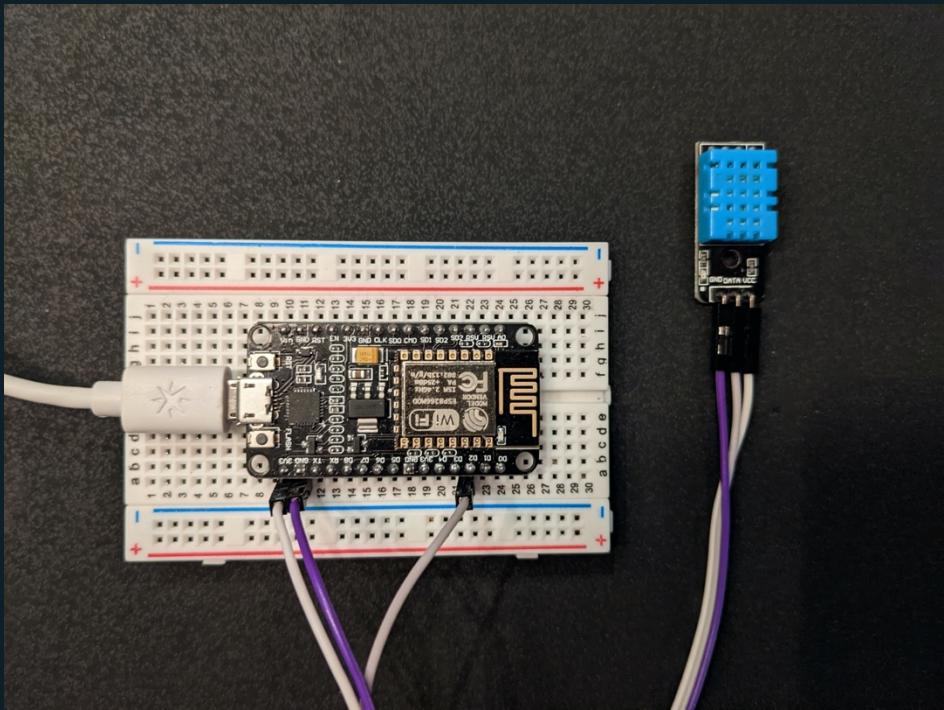
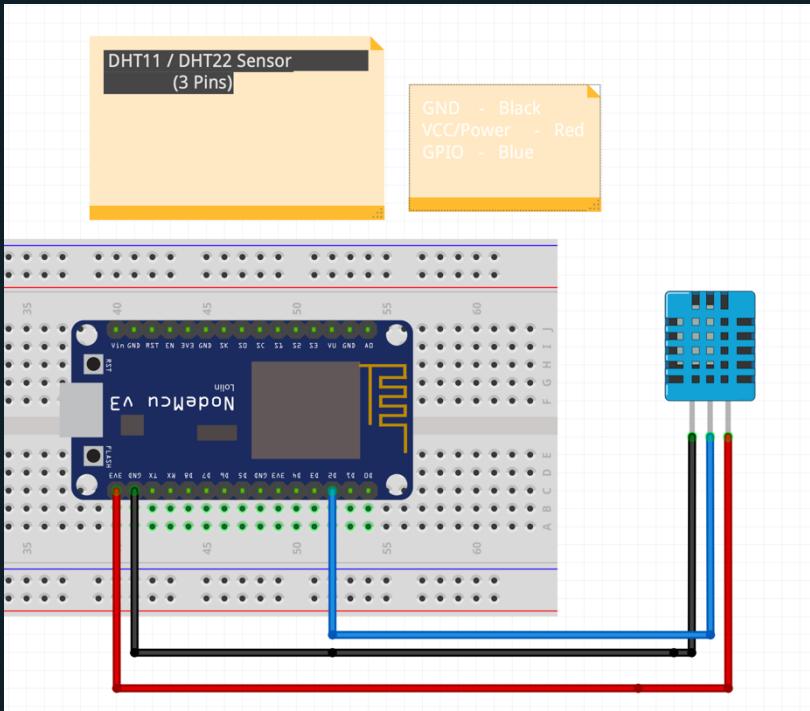
**NOTE:** we will be using  
The GPIO numbers  
**NOT** the PINs

Like Pin D2 = GPIO4

We use number 4 in our code



# ESP8266 & DHT11 Wiring





## Code for esp8266 with dht11 - Number one

All code and instruction can be found here

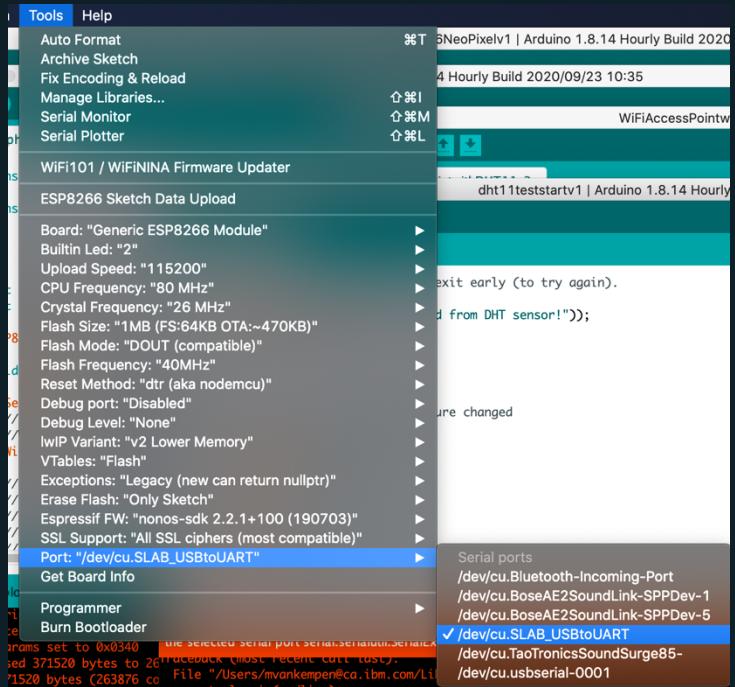
<https://github.com/markusvankempen/esp8266andDHT11>

Here our 1st code to upload to the esp8266 which is connected to DH11

### Note:

- Make sure u select the right board
- Copy the code into your IDE make sure to select the right serial Port

# Serial Port Selection



# Board Selection

The screenshot shows the Arduino IDE interface on a Mac OS X desktop. The menu bar includes 'File', 'Tools' (selected), 'Help', and system status icons. The main window displays a list of sketches and their details. A context menu is open over the sketch 'dht11teststartv1'. The 'Tools' menu is expanded, showing various options like 'Auto Format', 'Archive Sketch', etc., and the 'Board' section which is currently set to 'Generic ESP8266 Module'. The 'Boards Manager...' option is highlighted. A dropdown menu for 'ESP8266 Boards (2.7.3)' is open, listing several board variants. The 'Generic ESP8266 Module' option is selected and checked.

Sketches:

- 6NeoPixelv1 | Arduino 1.8.14 Hourly Build 2020/09/23 10:35
- 4 Hourly Build 2020/09/23 10:35
- WiFiAccessPointwithDHT11v2 | Arduino 1.8.14 Hourly Build 2020/09/23 10:35
- dht11teststartv1 | Arduino 1.8.14 Hourly Build 2020/09/23 10:35

Tools:

- Auto Format
- Archive Sketch
- Fix Encoding & Reload
- Manage Libraries...
- Serial Monitor
- Serial Plotter
- WiFi101 / WiFiNINA Firmware Updater
- ESP8266 Sketch Data Upload
- Board: "Generic ESP8266 Module"
- Builtin Led: "2"
- Upload Speed: "115200"
- CPU Frequency: "80 MHz"
- Crystal Frequency: "26 MHz"
- Flash Size: "1MB (FS:64KB OTA:~470KB)"
- Flash Mode: "DOUT (compatible)"
- Flash Frequency: "40MHz"
- Reset Method: "dtr (aka nodemcu)"
- Debug port: "Disabled"
- Debug Level: "None"
- lwIP Variant: "v2 Lower Memory"
- VTables: "Flash"

Boards Manager...:

- Adafruit SAMD (32-bits ARM Cortex-M0+ and Cortex-M4) Boards
- Arduino AVR Boards
- Arduino megaAVR Boards
- Arduino nRF528x Boards (Mbed OS)
- Arduino SAMD (32-bits ARM Cortex-M0+) Boards
- ATtiny Microcontrollers
- Digistump AVR Boards
- ESP32 Arduino
- ESP8266 Boards (2.7.3)
- Heltec ESP32 Arduino

ESP8266 Boards (2.7.3):

- ✓ Generic ESP8266 Module
- Generic ESP8285 Module
- ESPDuino (ESP-13 Module)
- Adafruit Feather HUZZAH ESP8266
- Invent One
- XinaBox CW01
- ESPresso Lite 1.0



# Upload the code to esp8266

Code :

<https://raw.githubusercontent.com/markusvankempen/esp8266andDHT11/main/code/esp-dht11-1.ino>

Once you upload and open the serial terminal /

make sure the Baudrate is 115200

The screenshot shows the Arduino IDE interface. The top menu bar includes File, Sketch, Tools, and Help. The title bar indicates the sketch is named "SNP-2020-ESP8266-DHT11-EnviromentMonitoring-v2" and is connected to port "/dev/cu.SLAB\_USBtoUART". The bottom status bar shows "Done uploading." The central area has two panes: the left pane displays the serial monitor output, and the right pane displays the code editor.

**Serial Monitor Output:**

```
14:37:56.640 -> readTemperature in C = 26.20
14:37:56.640 -> readHumidity in % = 36.00
14:37:56.640 -> readTemperature in C = 26.20
14:37:56.640 -> readHumidity in % = 37.00
14:37:56.640 -> readTemperature in C = 26.20
14:37:56.640 -> readHumidity in % = 37.00
14:37:56.640 -> readTemperature in C = 26.20
14:37:56.640 -> readHumidity in % = 36.00
14:38:01.276 -> readTemperature in C = 26.30
14:38:01.276 -> readHumidity in % = 36.00
14:38:01.276 -> readTemperature in C = 26.30
14:38:01.276 -> readHumidity in % = 37.00
14:38:01.276 -> readTemperature in C = 26.30
14:38:01.276 -> readHumidity in % = 37.00
14:38:02.892 -> readTemperature in C = 26.30
14:38:02.892 -> readHumidity in % = 37.00
14:38:04.883 -> readTemperature in C = 26.30
14:38:04.919 -> readHumidity in % = 37.00
14:38:06.939 -> readTemperature in C = 26.30
14:38:06.939 -> readHumidity in % = 38.00
14:38:08.954 -> readTemperature in C = 26.30
14:38:08.954 -> readHumidity in % = 38.00
14:38:10.984 -> readTemperature in C = 26.30
14:38:10.984 -> readHumidity in % = 38.00
```

**Code Editor (esp8266-dht11-1.ino):**

```
#include "DHT.h"
// Set the data pin for the DHT sensor
#define DHTPIN 17
// Define the type of DHT sensor
#define DHTTYPE DHT11
// Create a DHT object
DHT dht(DHTPIN, DHTTYPE);

void loop() {
    // Wait a few seconds between measurements.
    delay(2000);

    // Reading temperature or humidity takes about 250 milliseconds!
    // Sensor readings may also be up to 2 seconds 'old' (its a very slow sensor)
    float h = dht.readHumidity();
    // Read temperature as Celsius (the default)
    pt = t;
    t = dht.readTemperature();

    // Check if any reads failed and exit early (to try again).
    if (isnan(h) || isnan(t)) {
        Serial.println("Failed to read from DHT sensor!");
        return; //restart
    }

    Serial.println("readTemperature in C = "+String(t));
    Serial.println("readHumidity in % = "+String(h));
}
```



# Exercise #1 ... display temperature and Humidity in the Arduino IDE plotter



<https://arduinogetstarted.com/tutorials/arduino-serial-plotter>

Format is Label:Value Space Label: Value Space

```
Serial.print("readTemperature:"+String(t));
```

```
Serial.println(" readHumidity:"+String(h));
```

Arduino File Edit Sketch Tools Help

Auto Save OFF

Home Insert Draw Design T

esp8266-dht11-1

Serial Plotter

```
esp8266-dht11-1 §
1  t = dht.readTemperature();
2
3  // Check if any reads failed
4  if (isnan(h) || isnan(t)) {
5    Serial.println(F("Failed to read DHT sensor"));
6    return; //restart
7  }
8  Serial.println("readTemperature");
9  Serial.println("readhumidity");
10
11 // exrise #1 - display temp
12 Serial.println(t);
13
14 // exrise #2 ... print temp
15 //
16 //
17 // if(pt != t) // Check if
18 //{
19 //   Serial.println("Same temp");
20 //   ...
21
22
23
24
25
26
27
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31
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33
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48
49
50
51
52
53
```

Done Saving.

lectures.wrl  
Crystal is 26MHz  
MAC: ec:fa:bc:c2:f0:76  
Uploading stub...  
Running stub...  
Stub running...  
Configuring flash size...  
Auto-detected Flash size: 4MB  
Flash params set to 0x0340

Sketch Data Upload

Board: "Generic ESP8266 Module"  
Built-in LED: "2"  
Upload Speed: "115200"  
CPU Frequency: "80 MHz"  
Crystal Frequency: "26 MHz"  
Flash Size: "1MB (FS:64KB OTA:~470KB)"  
Flash Mode: "DOUT (compatible)"  
Flash Frequency: "40MHz"  
Reset Method: "dtr (aka nodemcu)"  
Debug port: "Disabled"  
Debug Level: "None"  
lwIP Variant: "v2 Lower Memory"  
VTables: "Flash"  
Exceptions: "Legacy (new can return nullptr)"  
Erase Flash: "Only Sketch"  
Espressif FW: "nonos-sdk 2.2.1+100 (190703)"  
SSL Support: "All SSL ciphers (most compatible)"  
Port: "/dev/cu.SLAB\_USBtoUART"

Get Board Info

Programmer  
Burn Bootloader



## Exercise #2 ... print temperature only if previous temperature has changes

```
//  
//  
// if(pt != t) // Check if temperature changed  
//{  
//   Serial.println("Same temp");  
// ...
```



## 2<sup>nd</sup> Chapter (two)

### Web Server



## 2<sup>nd</sup> Chapter (two)



Create a webserver and Display humidity and temperature and other data

### ESP8266 Web Server

GPIO16 LED - State on

OFF

No Temperature Change

Temperature = 22.50

Humidity = 34.00

getEpochTime = 1608120384

Time = 12:06:24

msgcounter = 24

Temperature 22.50 C

Humidity 34.00 %

Refresh

mqttmsg = {"hello": "mvk01"}



## Esp8266 and Wifi

### Note:

The esp8266 and works as wifi access point – meaning you have to join the esp8266 wifi network to access a webpage

Or

The esp8266 can join your Wifi network which is what we will be using to display the humidity etc on a web pages

# Esp8266 WebServer



In the code you need to adjust the SSID / password to your wifi credentials as well as personalize some other parameters – Note: 2.4 G wifi only

```
////>>>>>>> CHANGE HERE
// Replace with YOUR network credentials
const char* ssid    = "YOURSSID"; //>>>>>>> CHANGE HERE
const char* password = "YOURPASSWORD"; //>>>>>>> CHANGE HERE
String DEVICEID   = "markus01"; //>>>>>>> CHANGE HERE

// find ur LAT LON use https://www.latlong.net/ and ur cityname like Brantford,canada for Branford =43.139410,-80.263650

String LATITUDE = "43.6711581" ; //>>>>>>> CHANGE HERE
String LONGITUDE = "-79.4129989" ; //>>>>>>> CHANGE HERE
```

# The Code and Deployment

Code can be found here

<https://raw.githubusercontent.com/markusvankempen/esp8266andDHT11/main/2nd-Chapter/2-esp8266-webserver-with-dht11-c2b.ino>

**Note:** If you can not upload the code via serial port maybe blocked just hit the rest button or unplug the device and select the serial port in the IDE again.



Upload the code and check the serial monitor to message

Serial Monitor should show

13:05:26.861 -> WiFi connected.

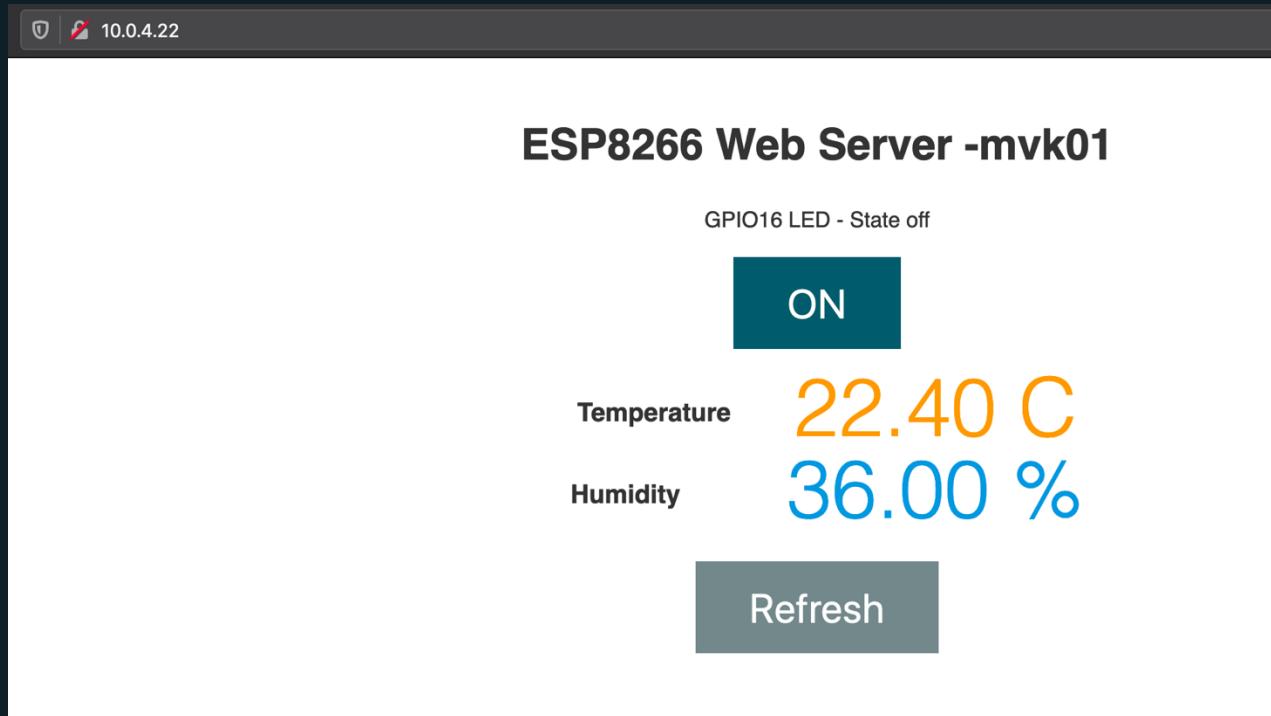
13:05:26.861 -> IP address:

13:05:26.861 -> 192.168.1.26 <<< Your IP address should be different

Use the ip address and open it in a browser like **http://192.168.1.26/**

Display play the WebPage of the esp8266

<http://your-ip-address> - you should see





## Exercise:

- Display the Voltage Parameter
- Display a message if the Temperature changes

ESP8266 Web Server - YOURNAME

GPIO16 LED - State off

ON

prevTemp = 25.10

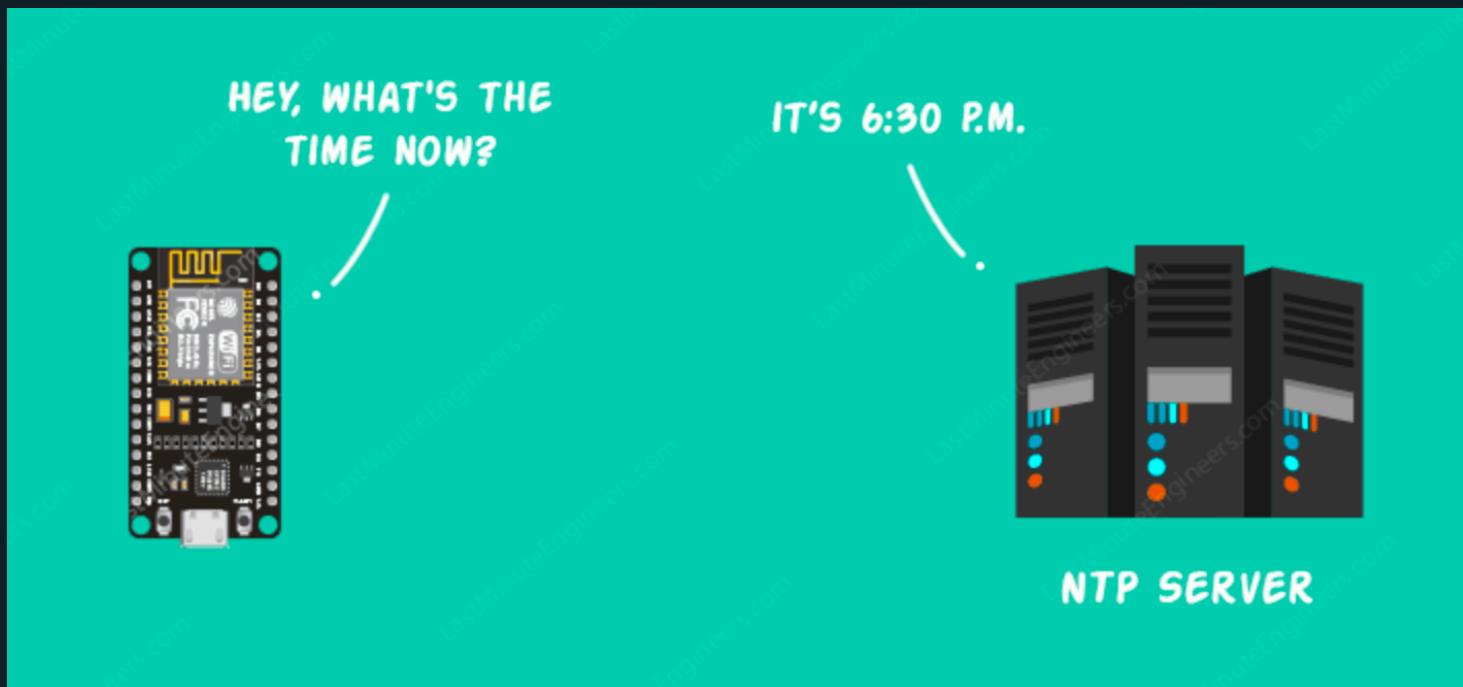
Temperature Changed from 25.10

Temperature	25.30 C
Humidity	24.00 %
Voltage	2.89 V

Refresh

 IBM Watson IoT 31

## 3<sup>rd</sup> CHAPTER (three)



## 3<sup>rd</sup> CHAPTER (three)

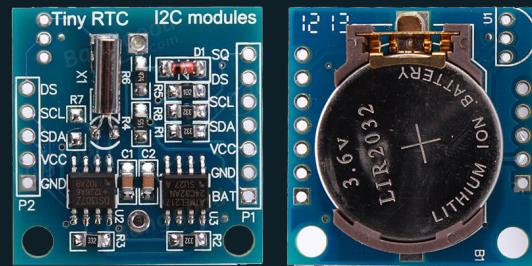


The esp8266 has no RealTimeClock aka RTC so we need to connect to a NTP(**Network Time Protocol**) Server to get the current time.

We need to load the NTPClient Library into the IDE

You can use the example code from the library for testing

File>Examples>NTPClient-Basic

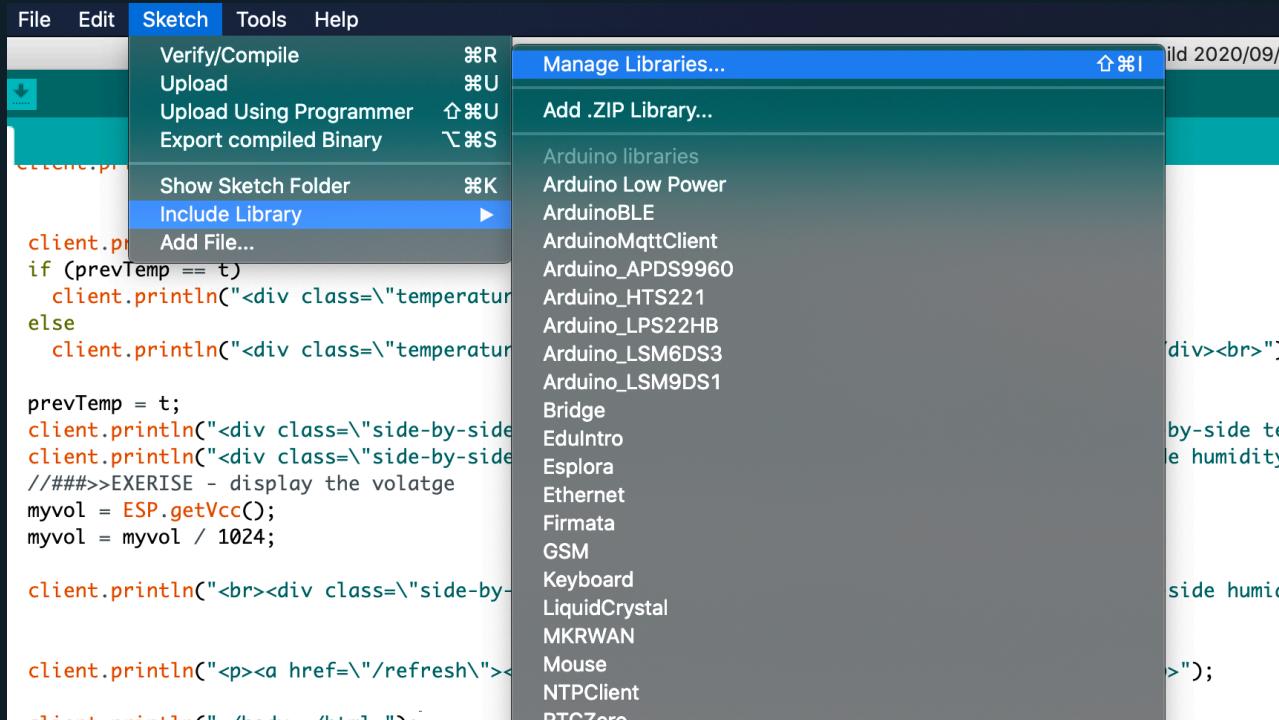


Example of RTC IBM Watson IoT 33



# Download and Import the Library

<https://randomnerdtutorials.com/esp32-ntp-client-date-time-arduino-ide/>



# Test NTP Client via the example code



ino File Edit Sketch Tools Help

New ⌘N  
Open... ⌘O  
Open Recent ▾  
Sketchbook  
Examples ▾  
Close ⌘W  
Save ⌘S  
Save As... ⌘S  
Page Setup ⌘P  
Print ⌘P

```
client.println("<p>prevTemp = t;  
if (prevTemp == t)  
    client.println("<div class="refresh">");  
else  
    client.println("<div class="refresh">");  
  
prevTemp = t;  
client.println("<div class="refresh">");  
client.println("<div class="refresh">");  
//###>EXERISE - display  
= ESP.getVcc();  
=myvol /1000;  
  
    client.println("<br><div class="refresh">");  
  
    client.println("<p><a href=");  
    client.println("</body>");  
  
    // The HTTP response ends here
```

Built-in Examples

- 01.Basics
- 02.Digital
- 03.Analog
- 04.Communication
- 05.Control
- 06.Sensors
- 07.Display
- 08.Strings
- 09.USB
- 10.StarterKit\_BasicKit
- 11.ArduinoISP

Examples for any board

- Adafruit Circuit Playground
- Arduino\_APDS39960
- Arduino\_HTS221
- Arduino\_LPS22HB
- Arduino\_LSM6DS3
- Arduino\_LSM9DS1
- ArduinoMqttClient
- Bridge
- EduIntro
- Ethernet
- Firmata
- LiquidCrystal
- NTPClient ▾
- Advanced
- Basic

ino WebServerWithDH

File Edit Sketch Tools Help

Examples ▾

14:36:05.077 -> r\$\$\$\$\$ \$11 \$15 #1\$\$ \$rscs b\$son\$nnn\$ b\$pss# \$p\$nt \$ \$ \$ o\$1 \$l\$ss b\$bson\$ \$11 \$ool n\$ssn # \$ ssin bl ss

14:36:11.263 -> 19:36:11  
14:36:12.253 -> 19:36:12  
14:36:13.269 -> 19:36:13  
14:36:14.254 -> 19:36:14  
14:36:15.245 -> 19:36:15  
14:36:16.247 -> 19:36:16  
14:36:17.256 -> 19:36:17  
14:36:18.271 -> 19:36:18  
14:36:19.278 -> 19:36:19  
14:36:20.277 -> 19:36:20  
14:36:21.246 -> 19:36:21  
14:36:22.265 -> 19:36:22  
14:36:23.250 -> 19:36:23  
14:36:24.275 -> 19:36:24  
14:36:25.262 -> 19:36:25

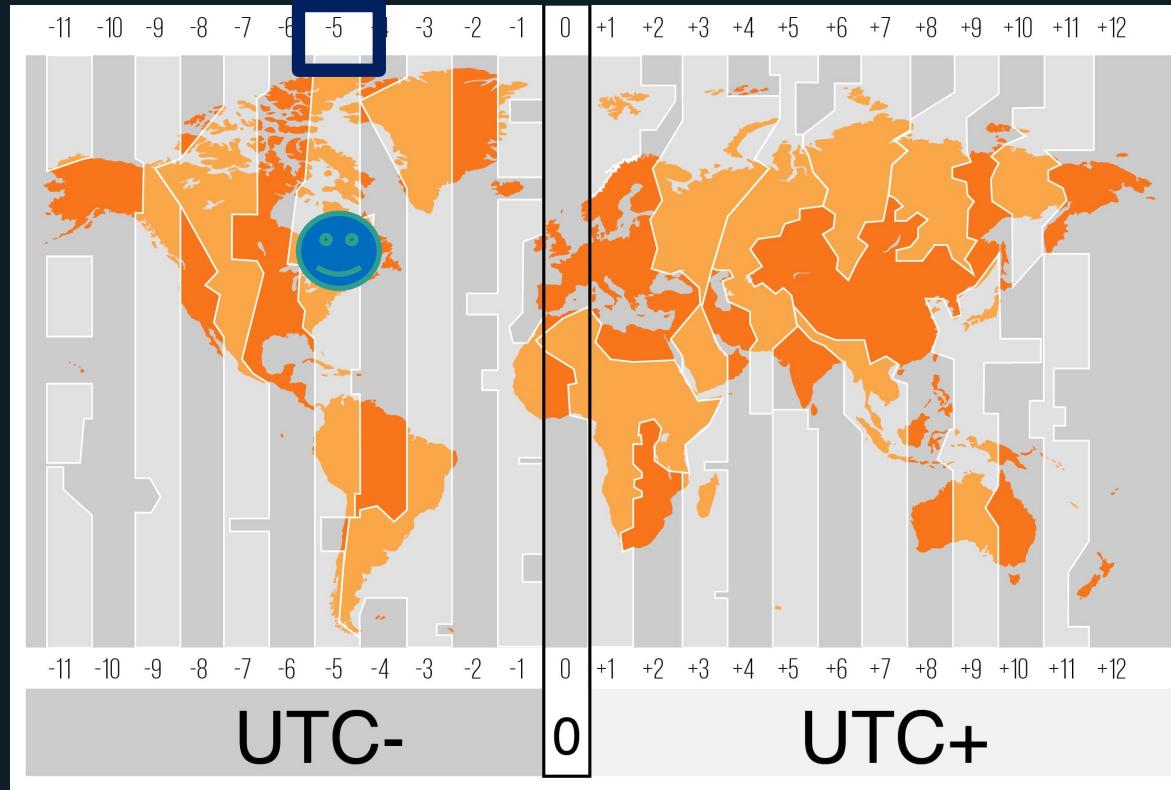
14:36:17.256 -> 19:36:17  
14:36:18.271 -> 19:36:18  
14:36:19.278 -> 19:36:19  
14:36:20.277 -> 19:36:20  
14:36:21.246 -> 19:36:21  
14:36:22.265 -> 19:36:22  
14:36:23.250 -> 19:36:23  
14:36:24.275 -> 19:36:24  
14:36:25.262 -> 19:36:25

Autoscroll Show timestamp

Both NL & CR 11

Done uploading.

# UTC/GMT vs EST



## NTP service



The NTP service will return the GMT/UTC time which is 5 Hour before EST  
We will need to adjust the time using an offset

Detailed information here

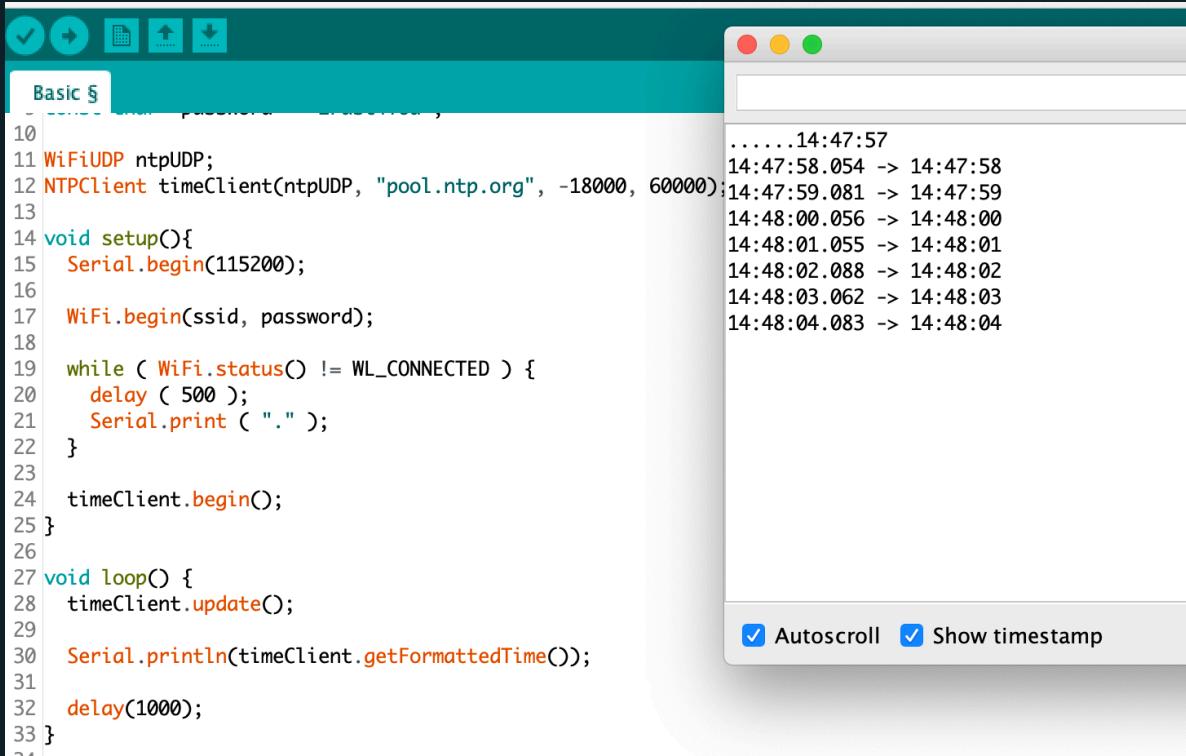
<https://randomnerdtutorials.com/esp32-ntp-client-date-time-arduino-ide/>

Adjust the code with the offset time in seconds e.g  $5*60*60 = -18000$

```
NTPCClient timeClient(ntpUDP, "pool.ntp.org", -18000, 60000); //with EST adjustment
```

# EST Timezone time

```
NTPClient timeClient(ntpUDP, "pool.ntp.org", -18000, 60000);
```



The image shows the Arduino IDE interface. On the left, the code for setting up WiFi and connecting to an NTP server is displayed:

```
10
11 WiFiUDP ntpUDP;
12 NTPClient timeClient(ntpUDP, "pool.ntp.org", -18000, 60000);
13
14 void setup(){
15   Serial.begin(115200);
16
17   WiFi.begin(ssid, password);
18
19   while ( WiFi.status() != WL_CONNECTED ) {
20     delay ( 500 );
21     Serial.print ( "." );
22   }
23
24   timeClient.begin();
25 }
26
27 void loop() {
28   timeClient.update();
29
30   Serial.println(timeClient.getFormattedTime());
31
32   delay(1000);
33 }
```

On the right, the Serial Monitor window shows the received NTP time data:

Received Time	Adjusted Time
.....14:47:57	14:47:57
14:47:58.054	14:47:58
14:47:59.081	14:47:59
14:48:00.056	14:48:00
14:48:01.055	14:48:01
14:48:02.088	14:48:02
14:48:03.062	14:48:03
14:48:04.083	14:48:04

At the bottom of the Serial Monitor, there are two checkboxes:  Autoscroll and  Show timestamp.



# Exercise

Add NTP code to the WebServer and display the time  
On the WebPage



## ESP8266 Web Server - mvk01

GPIO16 LED - State on

OFF

15:14:11

prevTemp = 22.40

NO Temperature Change

Temperature 22.40 C  
Humidity 34.00 %  
Voltage 2.96 V

Refresh

Code here

<https://raw.githubusercontent.com/markusvankempen/esp8266andDHT11/main/3rd%20Chapter/3-WifiWebServerWithDHT11AndNTP.ino>



# Agenda

- 4<sup>th</sup> CHAPTER (four) – MQTT messaging
  - deep sleep / HW reset
- 5<sup>th</sup> CHAPTER – Real time Visualization
- 6<sup>th</sup> CAPTER (6) – Saving the data to an SQL database
- 7<sup>th</sup> CHAPTER (7) - Visualizing Time series Data



# ESP8266 Web Server

GPIO16 LED - State on

OFF

No Temperature Change

Temperature = 22.50

Humidity = 34.00

getEpochTime = 1608120384

Time = 12:06:24

msgcounter = 24

Temperature

22.50 C

Humidity

34.00 %

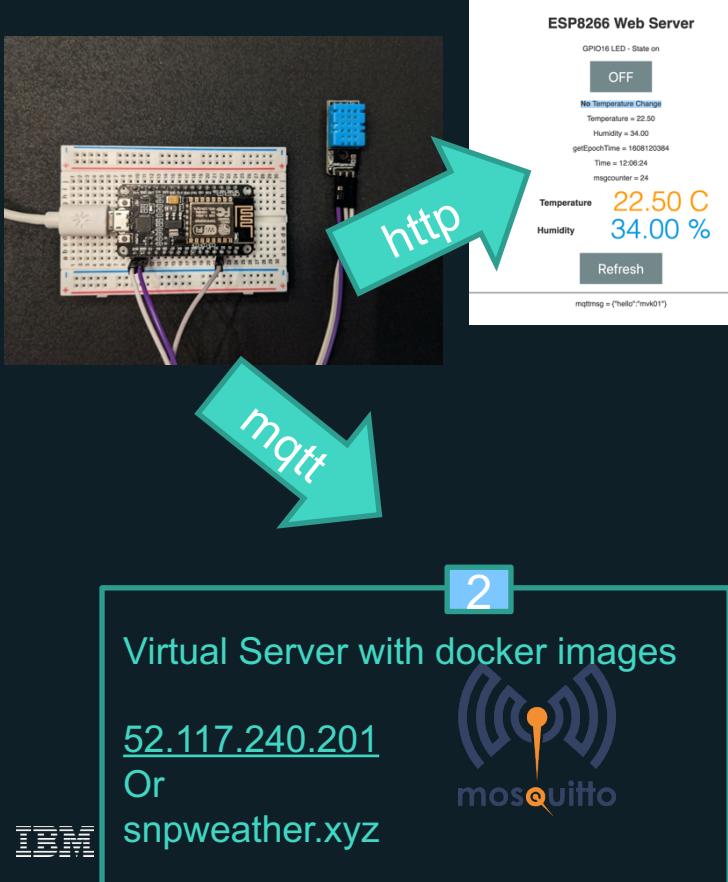
Refresh

---

mqttmsg = {"hello": "mvk01"}

# Recap

## 4<sup>th</sup> CHAPTER (four)



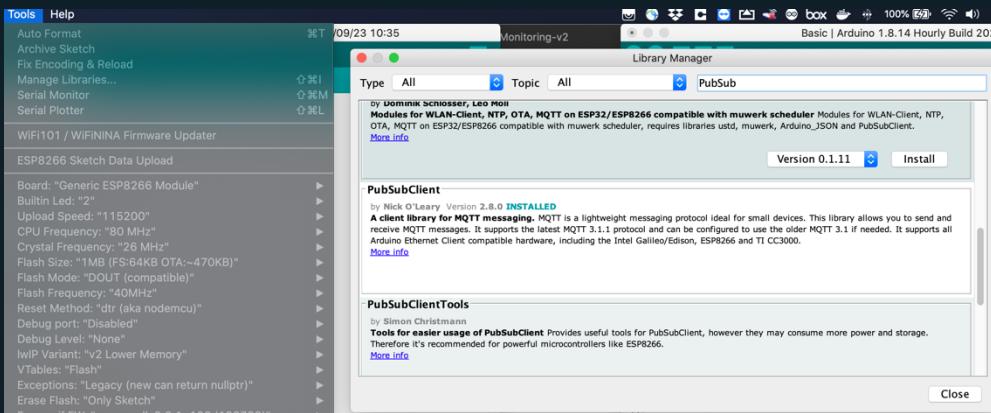
- Send Data to external Server
- Use the DeepSleep Mode
- Use the external reset

# 4<sup>th</sup> CHAPTER (four)



In this section we will add a mqtt client to our WebServer and send a json message with temperature, voltage etc to a mqtt broker.

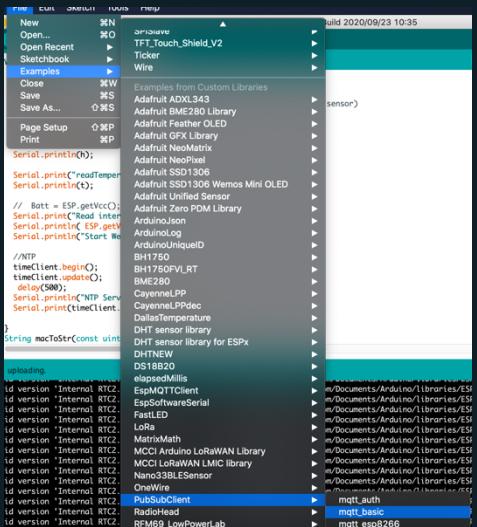
We will need to add a mqtt client library called PubSubClient



# MQTT Client and Message Publishing

You can use the mqtt client example to send a test message to our mqtt broker (which is a docker on our virtual Server) once you add the library to the IDE. The Library is called PubSubClient.h

The example Code is under Examples – choose esp8266 example

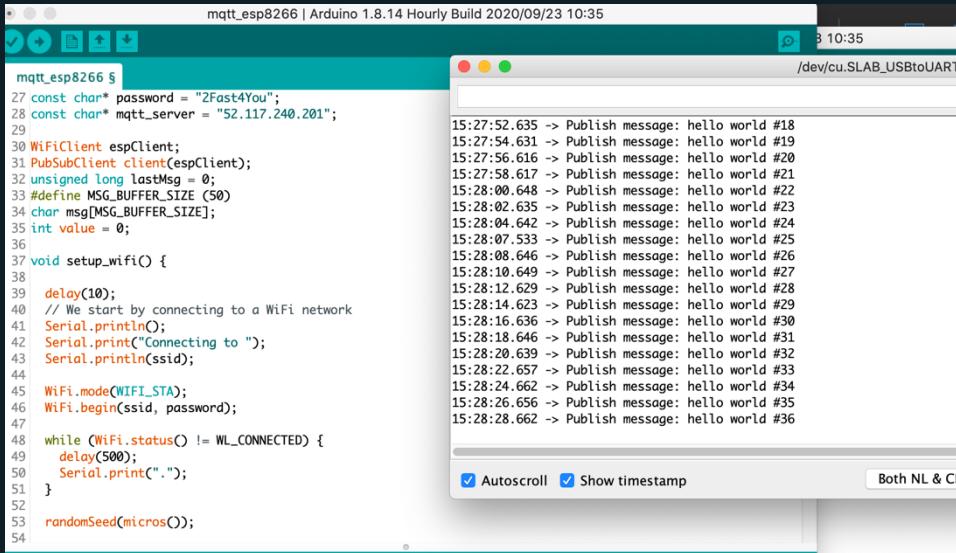


# Test MQTT Message Publishing

Add the our Mqtt broker IP

```
const char* mqtt_server = "52.117.240.201";
```

And the topic or message



```
mqtt_esp8266 | Arduino 1.8.14 Hourly Build 2020/09/23 10:35
10:35 /dev/cu.SLAB_USBtoUART

27 const char* password = "2Fast4You";
28 const char* mqtt_server = "52.117.240.201";
29
30 WiFiClient espClient;
31 PubSubClient client(espClient);
32 unsigned long lastMsg = 0;
33 #define MSG_BUFFER_SIZE (50)
34 char msg[MSG_BUFFER_SIZE];
35 int value = 0;
36
37 void setup_wifi() {
38
39   delay(10);
40   // We start by connecting to a WiFi network
41   Serial.println();
42   Serial.print("Connecting to ");
43   Serial.println(ssid);
44
45   WiFi.mode(WIFI_STA);
46   WiFi.begin(ssid, password);
47
48   while (WiFi.status() != WL_CONNECTED) {
49     delay(500);
50     Serial.print(".");
51   }
52
53   randomSeed(micros());
54 }
```

10:35 /dev/cu.SLAB\_USBtoUART

```
15:27:52.635 -> Publish message: hello world #18
15:27:54.631 -> Publish message: hello world #19
15:27:56.616 -> Publish message: hello world #20
15:27:58.617 -> Publish message: hello world #21
15:28:00.648 -> Publish message: hello world #22
15:28:02.635 -> Publish message: hello world #23
15:28:04.642 -> Publish message: hello world #24
15:28:07.533 -> Publish message: hello world #25
15:28:08.646 -> Publish message: hello world #26
15:28:10.649 -> Publish message: hello world #27
15:28:12.629 -> Publish message: hello world #28
15:28:14.623 -> Publish message: hello world #29
15:28:16.636 -> Publish message: hello world #30
15:28:18.646 -> Publish message: hello world #31
15:28:20.639 -> Publish message: hello world #32
15:28:22.657 -> Publish message: hello world #33
15:28:24.662 -> Publish message: hello world #34
15:28:26.656 -> Publish message: hello world #35
15:28:28.662 -> Publish message: hello world #36
```

Autoscroll  Show timestamp Both NL & CR

Example code also here:

<https://raw.githubusercontent.com/markusvankempen/esp8266andDHT11/main/4th%20Chapter/4-mqtt-esp8266-test.ino>



# Check if message are received by the mqtt broker

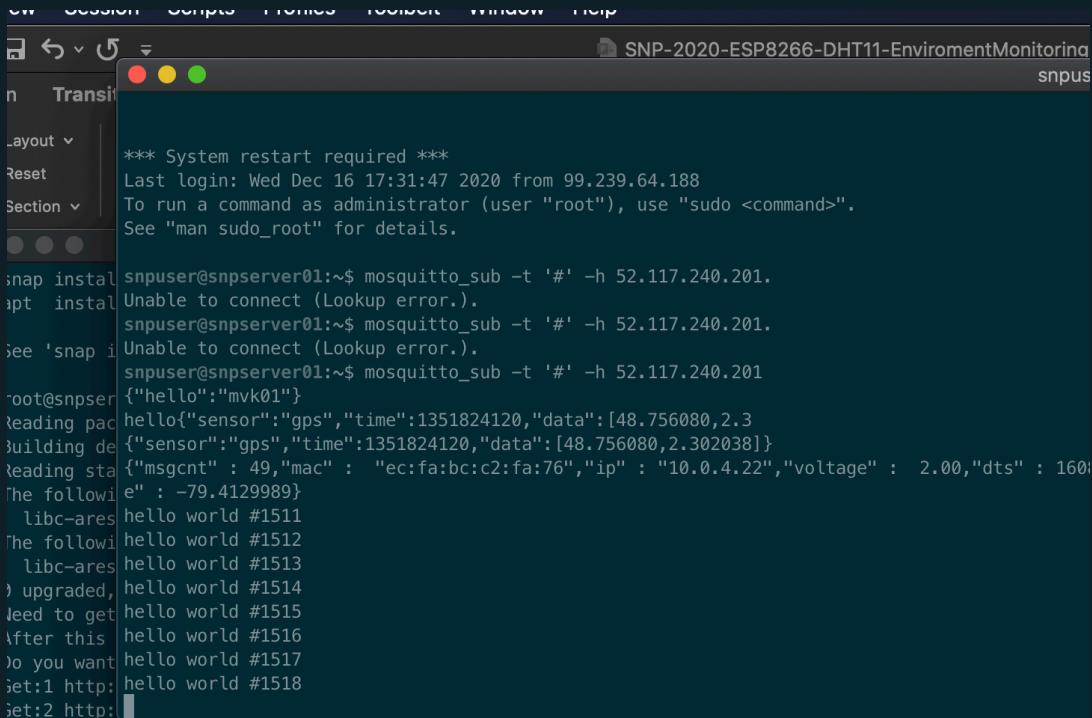
You can check if mqtt messages are received on the server using a mosquito client. U can install mosquito client locally or use the server via ssh.

Example:

ssh [snpuser@52.117.240.201](mailto:snpuser@52.117.240.201)

Or `snpuser@snpweather.xyz`

`mosquitto_sub -v -t "sensor/YOURDEVICEID/#"`



The screenshot shows a terminal window titled "SNP-2020-ESP8266-DHT11-EnviromentMonitoring" with the user "snpus". The terminal displays the following text:

```
*** System restart required ***
Last login: Wed Dec 16 17:31:47 2020 from 99.239.64.188
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

snpuser@snpserver01:~$ mosquitto_sub -t '#' -h 52.117.240.201.
Unable to connect (Lookup error.).
snpuser@snpserver01:~$ mosquitto_sub -t '#' -h 52.117.240.201.
Unable to connect (Lookup error.).
snpuser@snpserver01:~$ mosquitto_sub -t '#' -h 52.117.240.201
{"hello":"mvk01"}
hello{"sensor":"gps","time":1351824120,"data":[48.756080,2.3
 {"sensor":"gps","time":1351824120,"data":[48.756080,2.302038]}
 {"msgcnt": 49,"mac" : "ec:fa:bc:c2:fa:76","ip" : "10.0.4.22","voltage" : 2.00,"dts" : 160
 "e" : -79.4129989}
    libc-ares hello world #1511
    The following packages have been newly installed:
    libc-ares hello world #1512
    ) upgraded, hello world #1513
    lead to get hello world #1514
    After this hello world #1515
    Do you want to proceed? hello world #1516
    Set:1 http://hello world #1517
    Set:2 http://hello world #1518
```

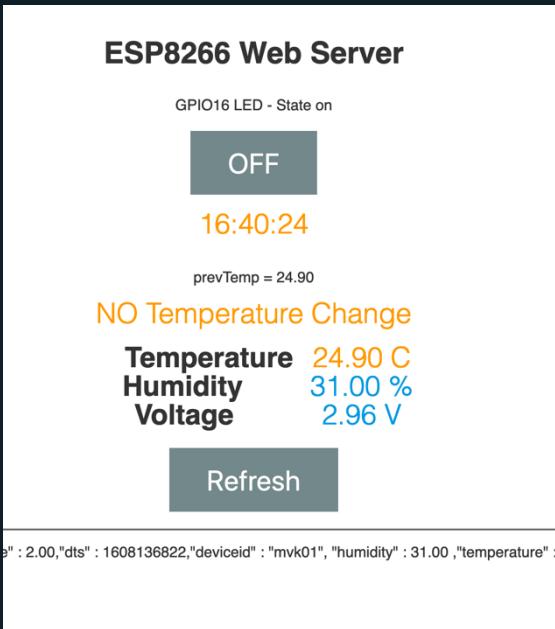


# Add the mqtt client code to our WebServer

The code for the webserver,ntp and mqtt client is here

Code is here:

<https://raw.githubusercontent.com/markusvankempen/esp8266andDHT11/main/4th%20Chapter/4-WifiWebServerWithDHT11NTPandMqtt-c4a.ino>



e" : 2.00, "dts" : 1608136822, "deviceid" : "mvk01", "humidity" : 31.00 , "temperature" :

## WebServer With NTP and MQTT client

The WebServer is now getting the current time/date and send mqtt with temperature , humidity etc. as json to the broker

:31:08.584 -> Sending Sensor Data

```
16:31:08.584 -> {"msgcnt" : 59,"mac" : "ec:fa:bc:c2:fa:76","ip" :  
"10.0.4.22","voltage" : 2.00,"dts" : 1608136267,"deviceid" : "mvk01",  
"humidity" : 36.00 , "temperature" : 22.80 , "latitude"  
:43.6711581,"logitude" : -79.4129989}
```

## Exercise



Add the message counter (see field msgcounter) to the json message and validate the message is received by the broker.

```
\"msg\" : "+String(msgcounter)+"
```

## Exercise – Enable/Test Deep sleep (optional)



Our device are eventually powered by batteries/Solarpanels and therefore we want to conserve energy and shutdown/ go into deepsleep if there is nothing to do. We also only want to send if the has changed.

Enable the code deepsleep code and check if the wifi connection is available on wake up!



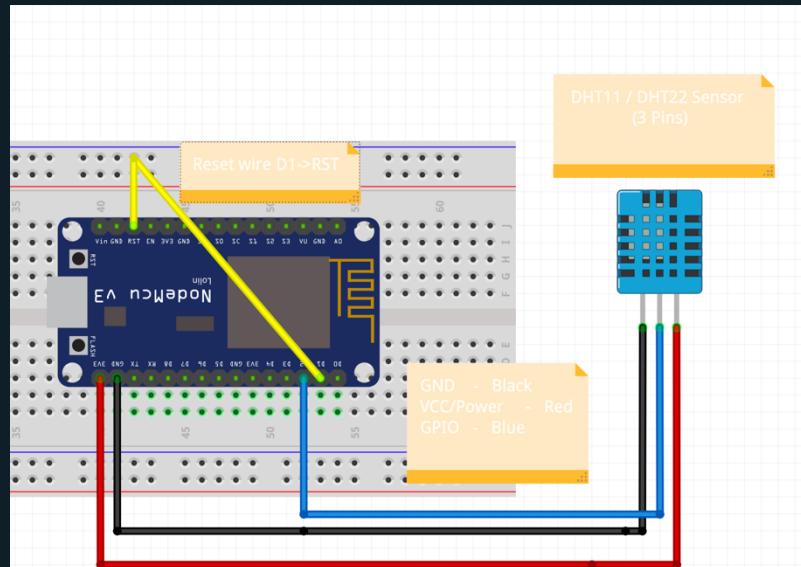
## Exercise – Soft vs Hard reset (optional)

You can force a reboot via `ESP.reset()`/`ESP.reboot()`.

You can also use the Digital pin to enable Hard reset like via `D1->RST`  
`pinMode(D1, OUTPUT);`

`digitalWrite(D1, HIGH); //D1 -> RESET PIN via a wire`

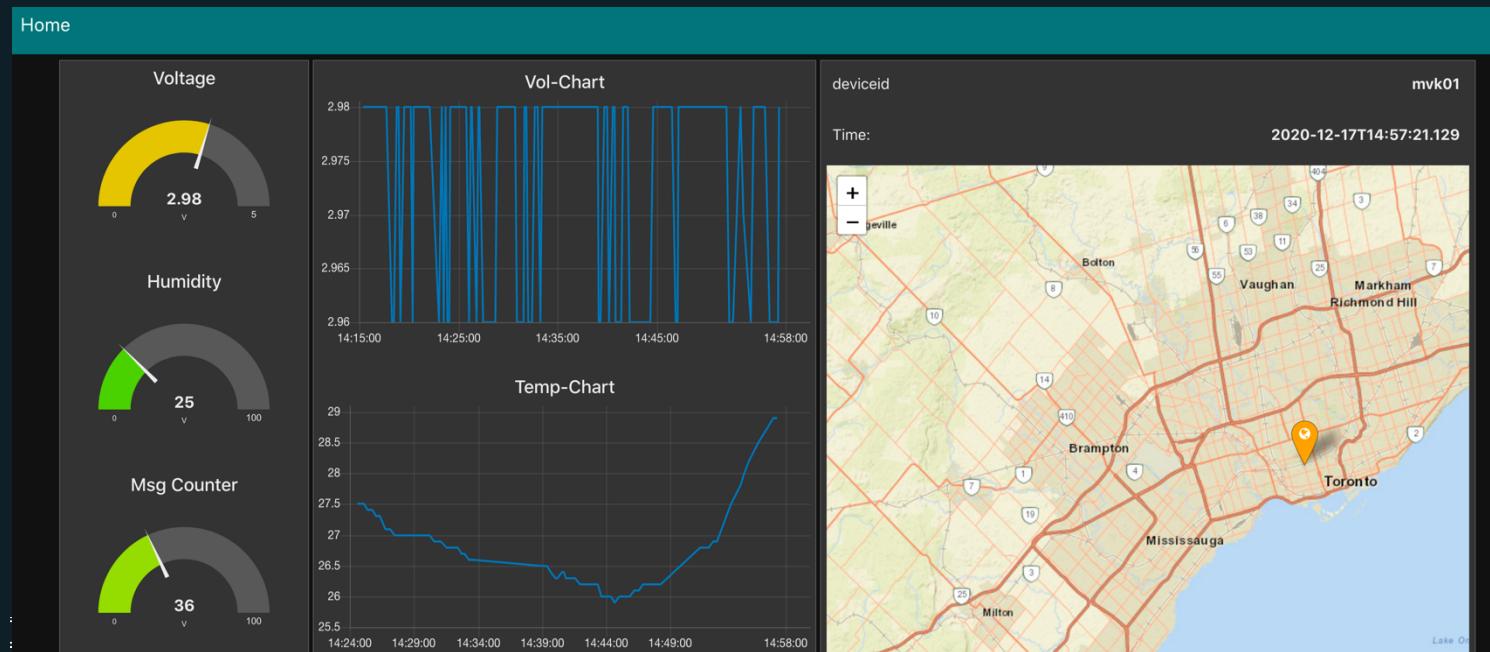
`digitalWrite(D1, LOW); // =>RESET`





## 5<sup>th</sup> CHAPTER – Real time Visualization

Now we have the mqtt message flowing to the server id would be nice to see visualize the data in a real time dash board



## Import missing plugins

Like

node-red-contrib-web-worldmap

node-red-dashboard

Via Menu -> Manage Pallet



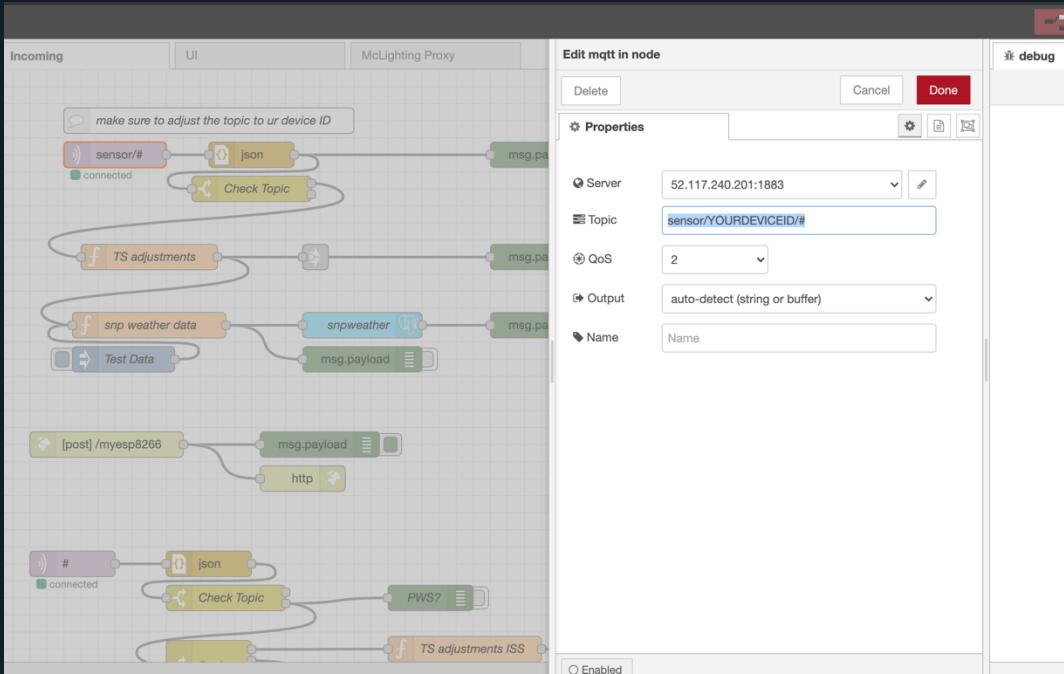
## Real Time Dashboard

Choose one of Node-RED instance <http://52.117.240.201:1000> to  
<http://52.117.240.201:1007>

- Import the node-red flow from here
- <https://raw.githubusercontent.com/markusvankempen/esp8266andDHT11/main/5th%20Chapter/node-red.flow>
- Adjust the deviceid in the mqtt topic to your deviceid
- Add the missing humidity charts and other message data to the dashboard
- Map all device from all students on your map
- You can access the

# Node-RED flow

Make sure to adjust the Topic with Your Device ID



## 6<sup>th</sup> CAPTER (6) – Saving the data to an SQL database



The server has a posgres sql database docker instance which we can use to store the sensor data.

The admin tool is on port 80 and is called pgAdmin

<http://52.117.240.201/browser/>

# Time series database

The database “snpweather” is already created and matches the json mqtt message format. We will walk you thru the admin tool and show you the fields and existing data.

pgAdmin File Object Tools Help

mvk@ca.ibm.com (int)

Browser

- Foreign Data Wrappers
- Languages
- Schemas (1)
  - public
    - Collations
    - Domains
    - FTS Configurations
    - FTS Dictionaries
    - FTS Parsers
    - FTS Templates
    - Foreign Tables
    - Functions
    - Materialized Views
    - Procedures
    - Sequences
  - snpweather
    - Columns (14)
      - location
      - name
      - temperature
      - humidity
      - deviceid
      - latitude
      - longitude
      - timestamp
      - dts
      - voltage
- Tables (1)

Query Editor Query History

```
1 SELECT location, name, temperature, humidity, deviceid, latitude, longitude, "timestamp", dts, voltage, ip, mac, tsutc, msg
2      FROM public.snpweather WHERE msg <> 0
```

Data Output Explain Messages Notifications

latitude	longitude	timestamp	dts	voltage	ip	mac	tsutc
		timestamp without time zone	timestamp without time zone	double precision	text	text	timestamp without time zone
43.6711	-79.4129	2020-12-17 15:13:38.639	2020-12-17 15:13:37	2.98	10.0.4...	ec:fab...	2020-12-17 20:13:38.639
43.6711	-79.4129	2020-12-17 15:13:48.903	2020-12-17 15:13:48	2.98	10.0.4...	ec:fab...	2020-12-17 20:13:48.903
43.6711	-79.4129	2020-12-17 15:13:59.153	2020-12-17 15:13:58	2.98	10.0.4...	ec:fab...	2020-12-17 20:13:59.153
43.6711	-79.4129	2020-12-17 15:14:09.454	2020-12-17 15:14:08	2.98	10.0.4...	ec:fab...	2020-12-17 20:14:09.454
43.6711	-79.4129	2020-12-17 15:14:19.697	2020-12-17 15:14:18	2.98	10.0.4...	ec:fab...	2020-12-17 20:14:19.697
43.6711	-79.4129	2020-12-17 15:14:29.932	2020-12-17 15:14:29	2.98	10.0.4...	ec:fab...	2020-12-17 20:14:29.932
43.6711	-79.4129	2020-12-17 15:14:40.188	2020-12-17 15:14:39	2.98	10.0.4...	ec:fab...	2020-12-17 20:14:40.188
43.6711	-79.4129	2020-12-17 15:14:50.403	2020-12-17 15:14:49	2.98	10.0.4...	ec:fab...	2020-12-17 20:14:50.403
43.6711	-79.4129	2020-12-17 15:15:10.763	2020-12-17 15:15:09	2.98	10.0.4...	ec:fab...	2020-12-17 20:15:10.763
43.6711	-79.4129	2020-12-17 15:15:20.99	2020-12-17 15:15:20	2.98	10.0.4...	ec:fab...	2020-12-17 20:15:20.99
43.6711	-79.4129	2020-12-17 15:15:31.235	2020-12-17 15:15:30	2.98	10.0.4...	ec:fab...	2020-12-17 20:15:31.235
43.6711	-79.4129	2020-12-17 15:15:51.5	2020-12-17 15:15:50	2.98	10.0.4...	ec:fab...	2020-12-17 20:15:51.5



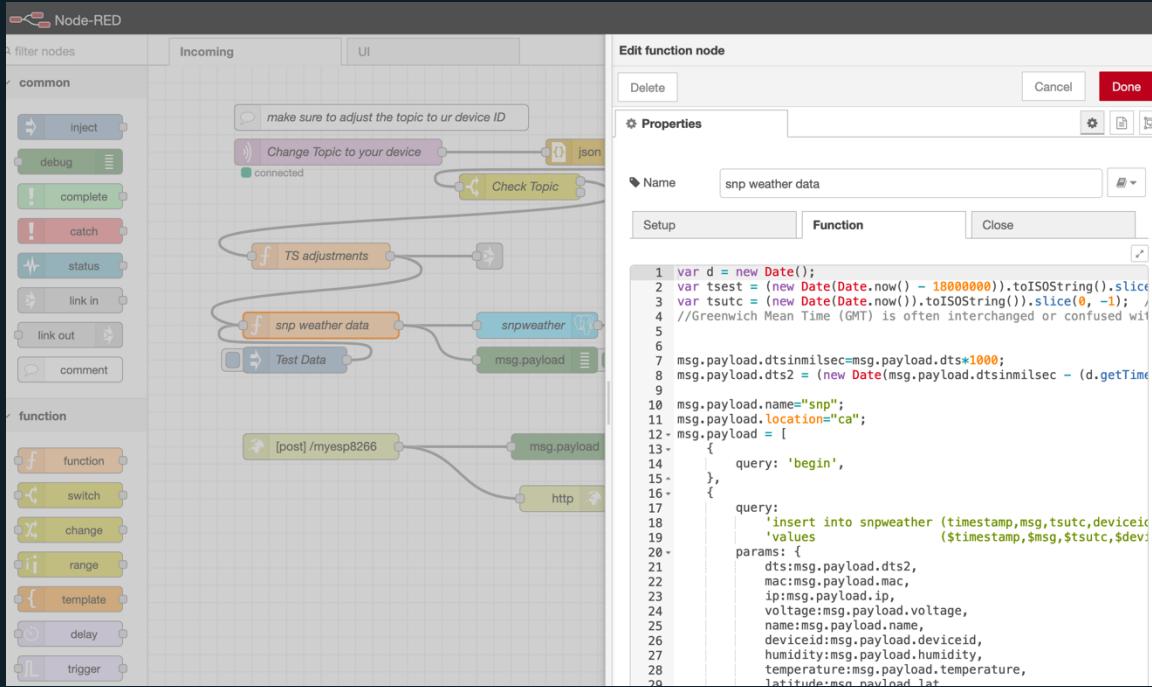
## Storing sensor database in a time series database

We will use Node-RED to store the data with the mqtt topic sensor/YOURDEVICEID/data into the database. The flow is already there and we can add some missing fields to the table.

You may have to connect some of the flows and deploy the changes.

# Storing the data

The PostGres Plugin has a nice SQL function to map and store the data



## Exercise



Add some of the missing fields like msg counter and mac address to same them into the database.

Add the mapping  
ip:msg.payload.ip,  
mac:msg.payload.mac,



## 7<sup>th</sup> CHAPTER (7) - Visualizing Time series Data

This this chapter we will visualize the timeseries Data using Grafana

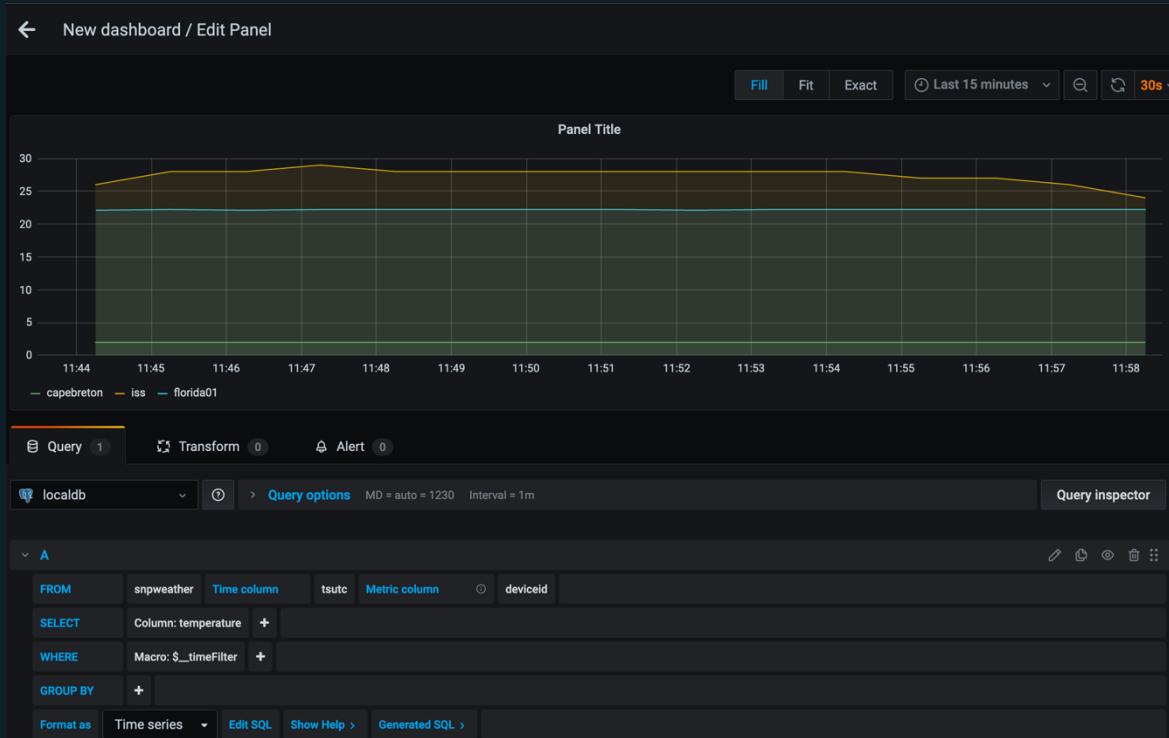
Grafana is installed on our virtual server on port 3000

<http://52.117.240.201:3000/>

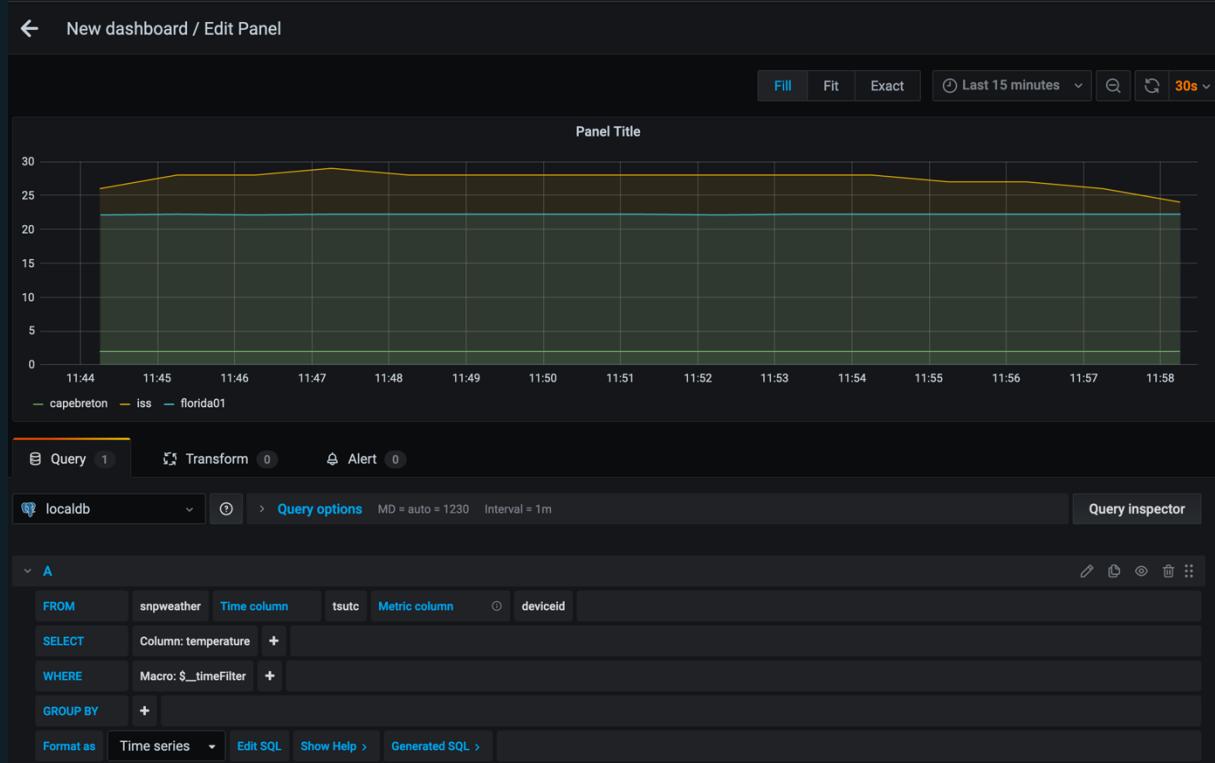
We have user1-6 setup to create dashboard.



# Exercise – Create a dashboard which show the Temperature walkthrough



# Exercise – create a Dashboard which show all device on a Map



## Review

- We create a WebServer using an esp8266 with DHT11
- We use an NTP client to get the right time
- We send a json message to an mqtt broker
- We added some esp8266 deepsleep and reset functionality
- We displayed the DHT11 in a Node-RED realtime Dashboard
- We stored the Data into a SQL Database as a time series
- We visualized the time series data using grafana

Questions ?



