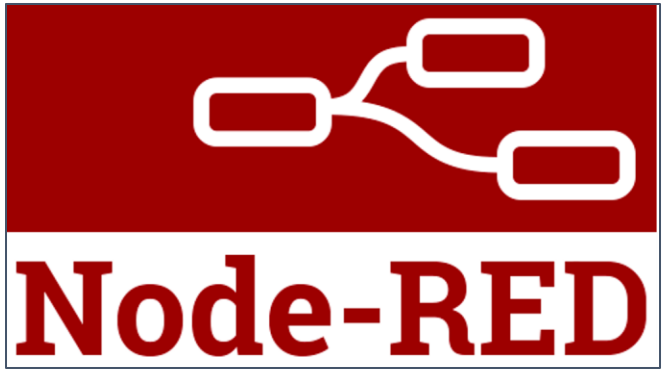
NodeRED RoboCamp:

From Hero to Superhero

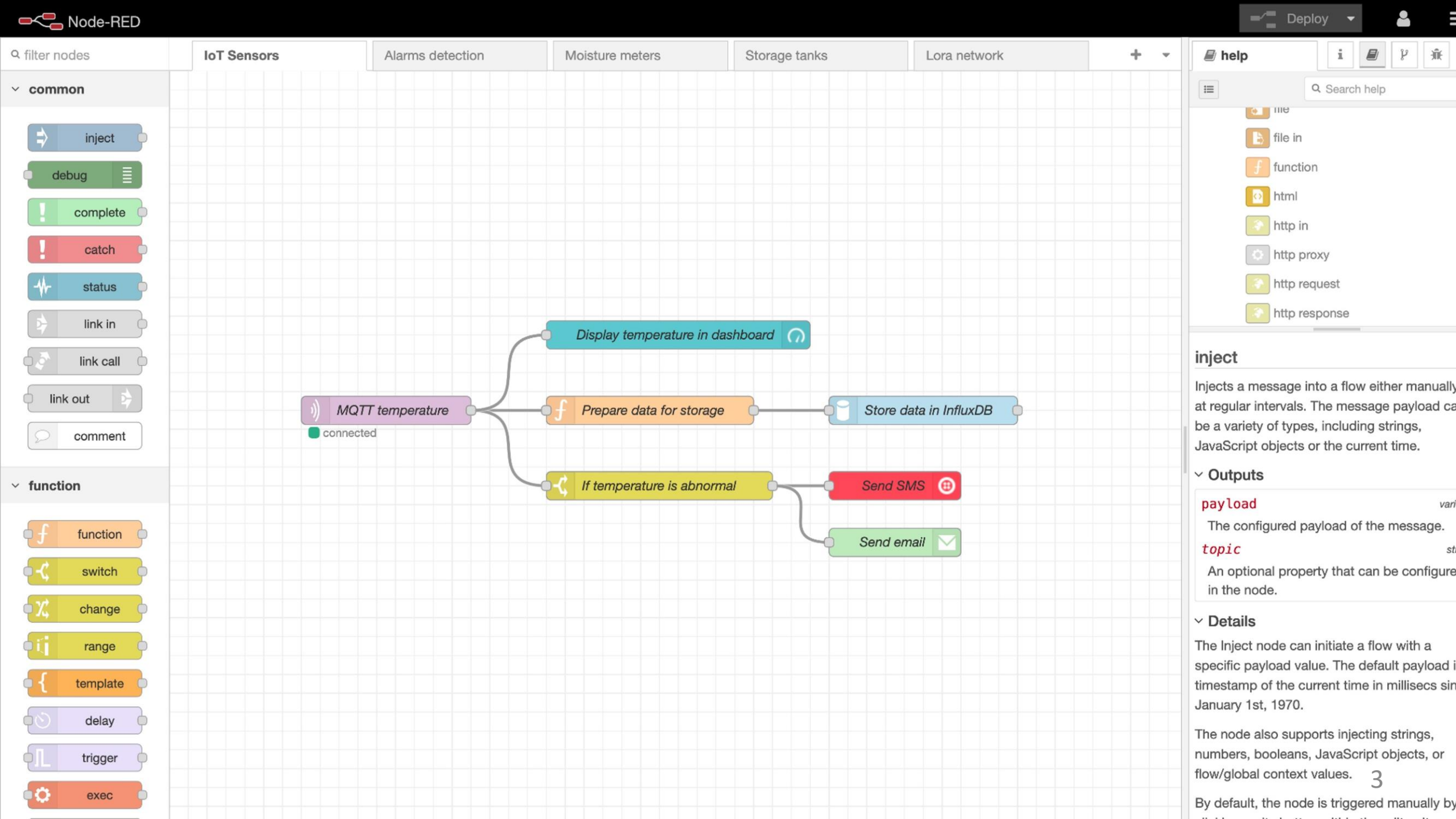
Building IoT applications with ESP32 and NodeRED



Introduction to Node-RED

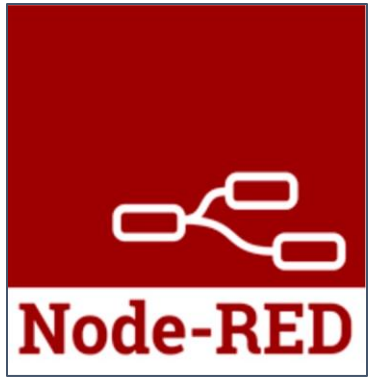
Web-based Visual Programming Tools

Wiring of the Internet of Things Programming

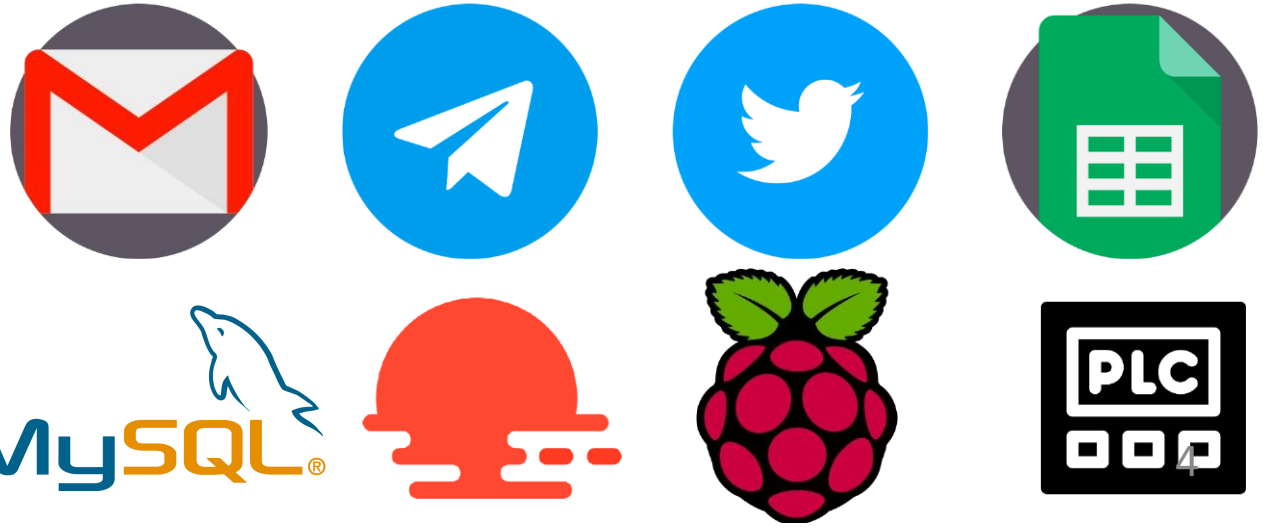

Node-RED
Deploy
filter nodes
IoT Sensors
Alarms detection
Moisture meters
Storage tanks
Lora network
help
Search help
common
inject
debug
complete
catch
status
link in
link call
link out
comment
function
function
switch
change
range
template
delay
trigger
exec
file in
function
html
http in
http proxy
http request
http response
Display temperature in dashboard
MQTT temperature
connected
Prepare data for storage
Store data in InfluxDB
If temperature is abnormal
Send SMS
Send email
inject
Injects a message into a flow either manually
at regular intervals. The message payload ca
be a variety of types, including strings,
JavaScript objects or the current time.
Outputs
payload
The configured payload of the message.
topic
An optional property that can be configure
in the node.
Details
The Inject node can initiate a flow with a
specific payload value. The default payload i
timestamp of the current time in millisecs sin
January 1st, 1970.
The node also supports injecting strings,
numbers, booleans, JavaScript objects, or
flow/global context values.
3
By default, the node is triggered manually by

Introduction to Node-RED

- Visual programming tool that can be accessed right from the web browser.
- Functional programming block called **nodes** are ready to use with less code or without having to program anything.
- Allow us to visually create automation system, system bot or even web scrapping.
- Able to interact with online services, such as Gmail, Telegram, Twitter, Google Sheet, OpenWeather, or even with the connected machine.



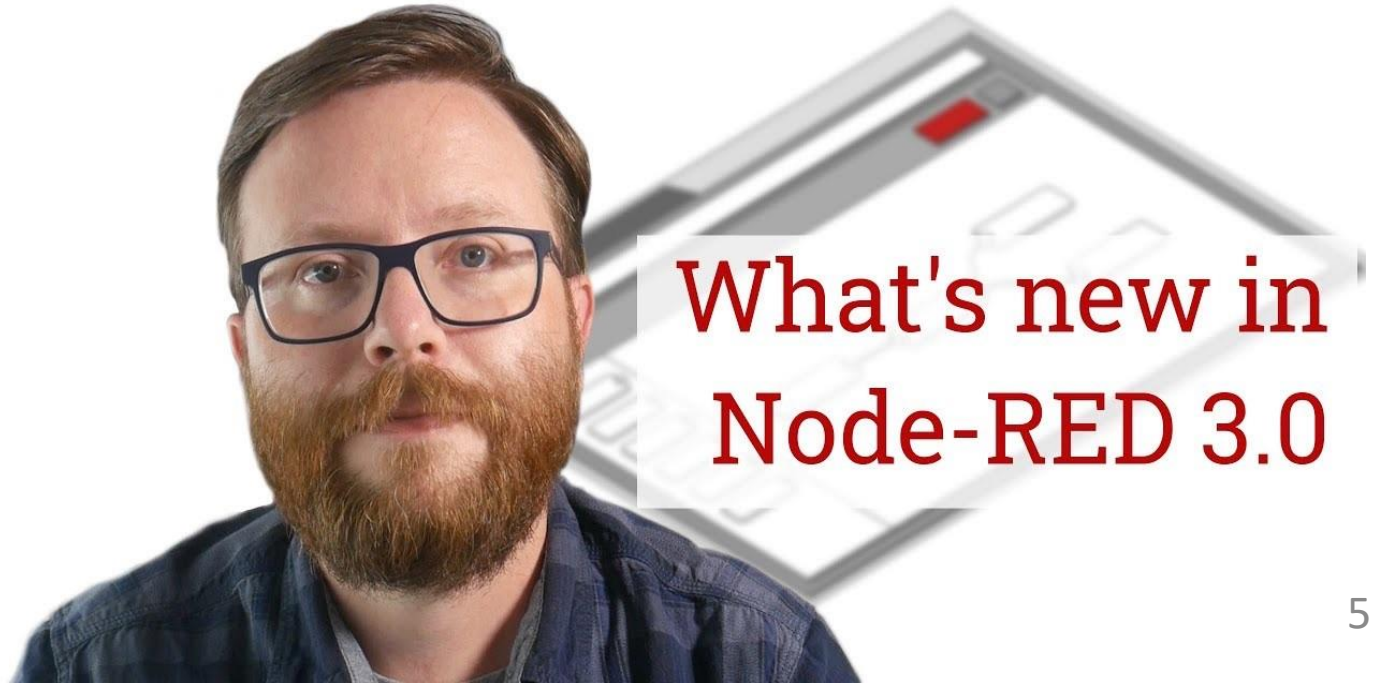
Programming & Integrations



Introduction to Node-RED

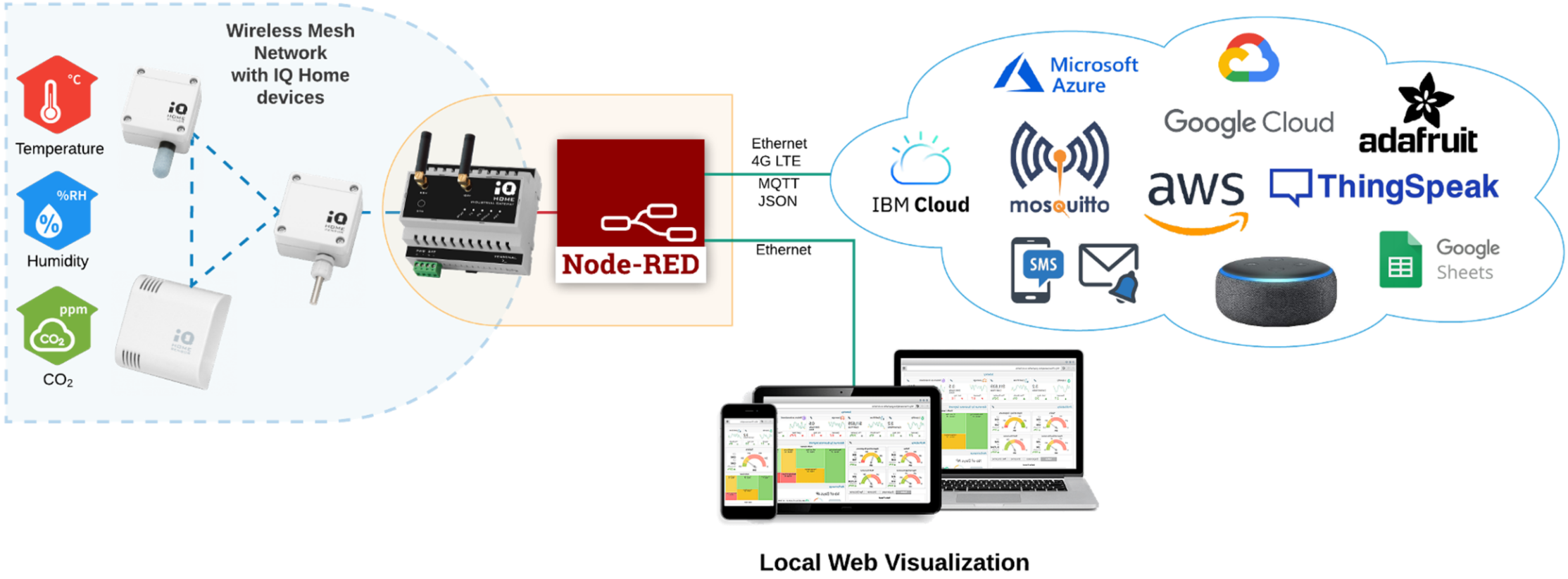
Who created Node-RED?

- Originally developed in 2013 by two IBM employees, Nick O'Leary and Dave Conway-Jones.
- They open sourced the source code which made available on GitHub https://github.com/node-red/node-red



Introduction to Node-RED

Node-RED is the IoT middleware between the physical world, where data is collected by the smart devices and provision the data to the cloud computing or Internet services.



Introduction to Node-RED

Basic IoT architecture using Node-RED as the middleware.

IOT DEVICES

Data Capturing using Sensors

IOT MIDDLEWARE

WIFI

Protocol

MQTT

Node-RED

Google Sheets
Data Storage

MySQL
Data Storage

IOT APPS

Telegram Bot
Data Alert & Monitoring

Dashboard
Data Visualization & Monitoring

Data Studio
Data Visualization & Data Analytics

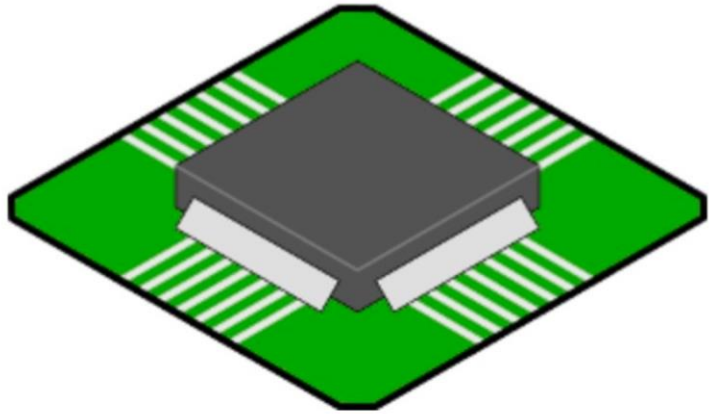
DATA FROM THINGS - MACHINE

HUMAN - DECISION MAKING

Introduction to Node-RED

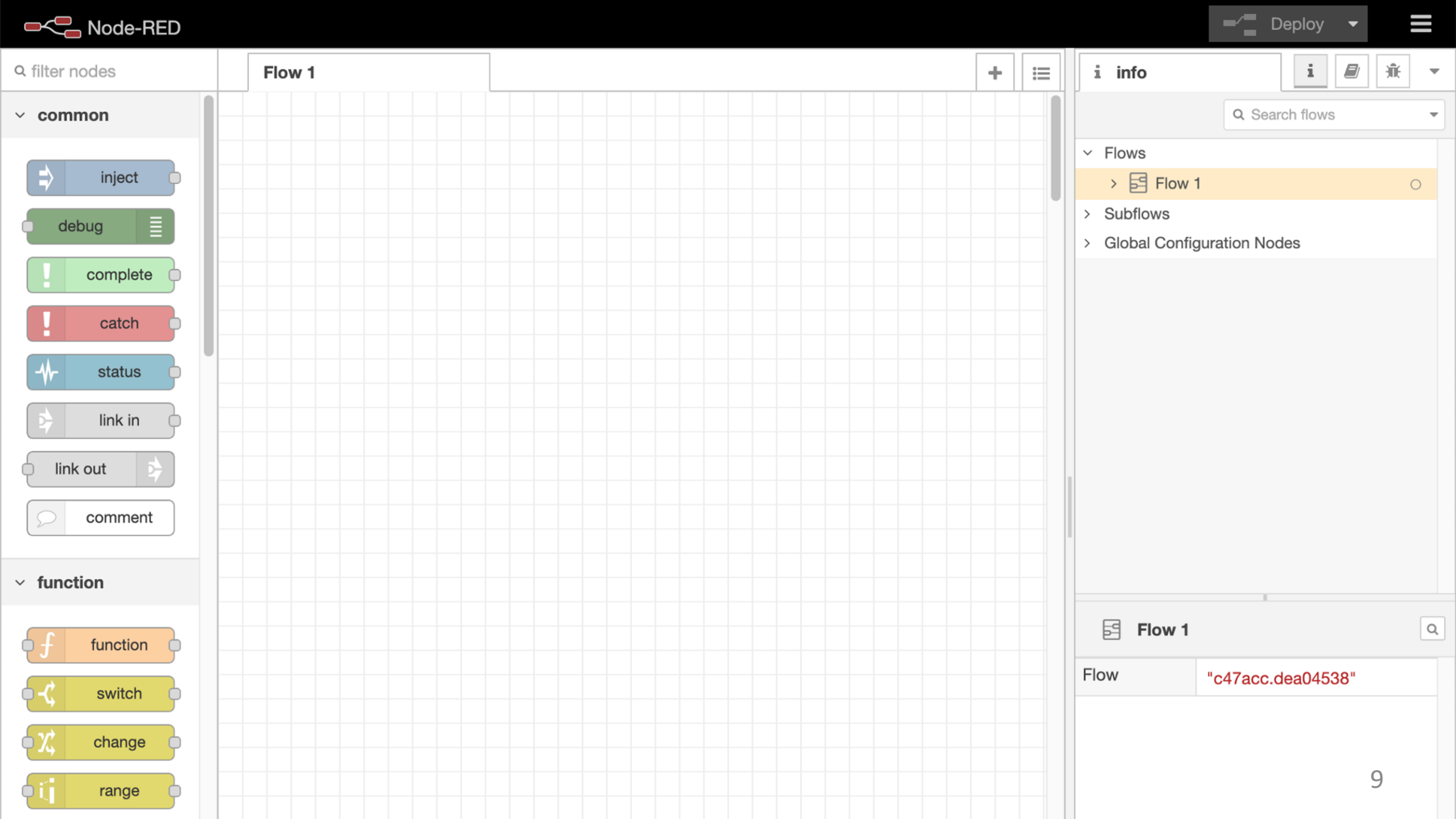
- Node-RED is a flexible middleware that can run on multi-cross platform such as:
  - Personal computer (PC running on Windows, Linux or Mac OS)
  - Local server or tiny computer (e.g. Raspberry Pi, Beagle Bone, Orange Pi)
  - Cloud computing services.

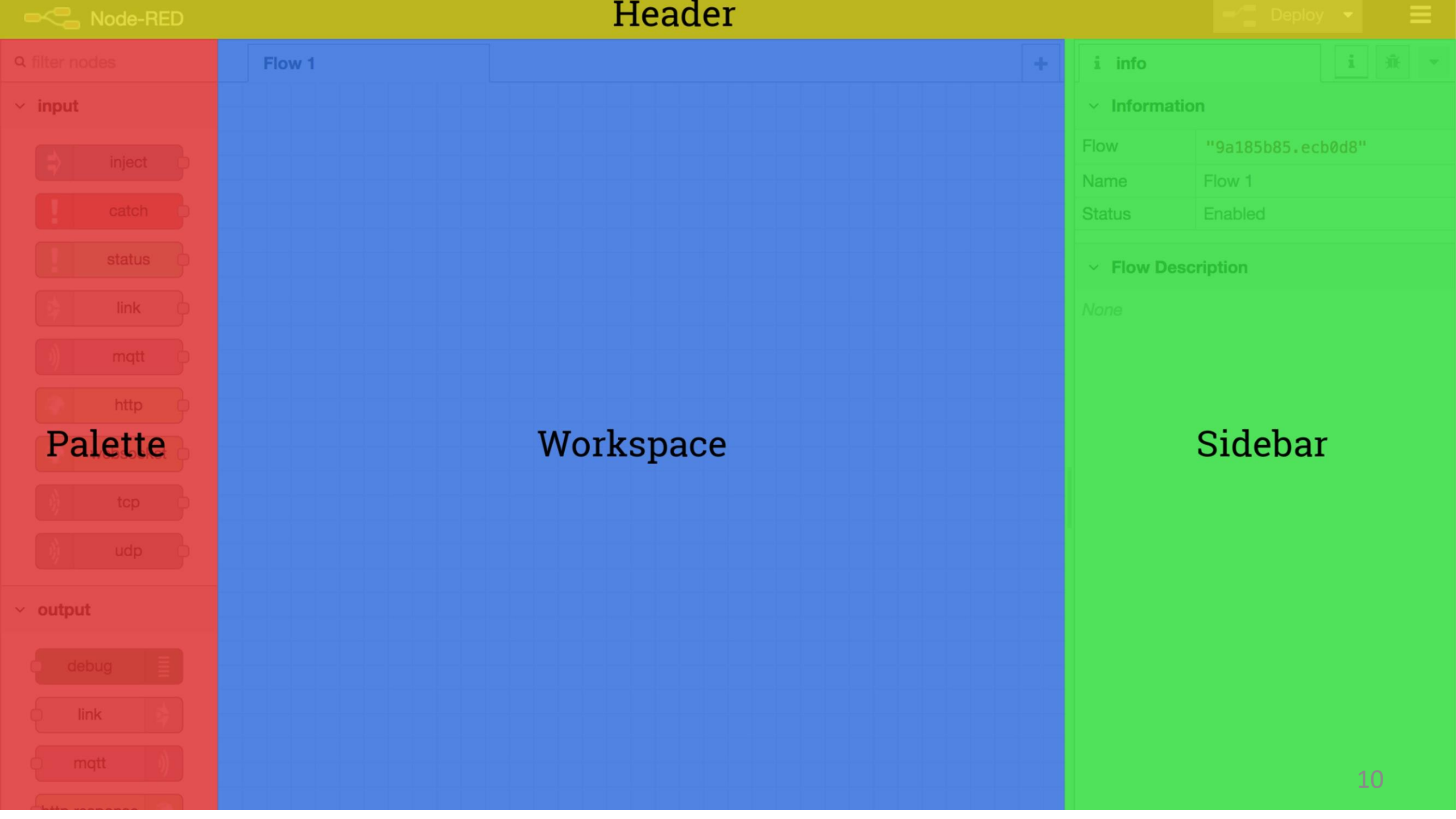
Run locally



On a device

In the cloud

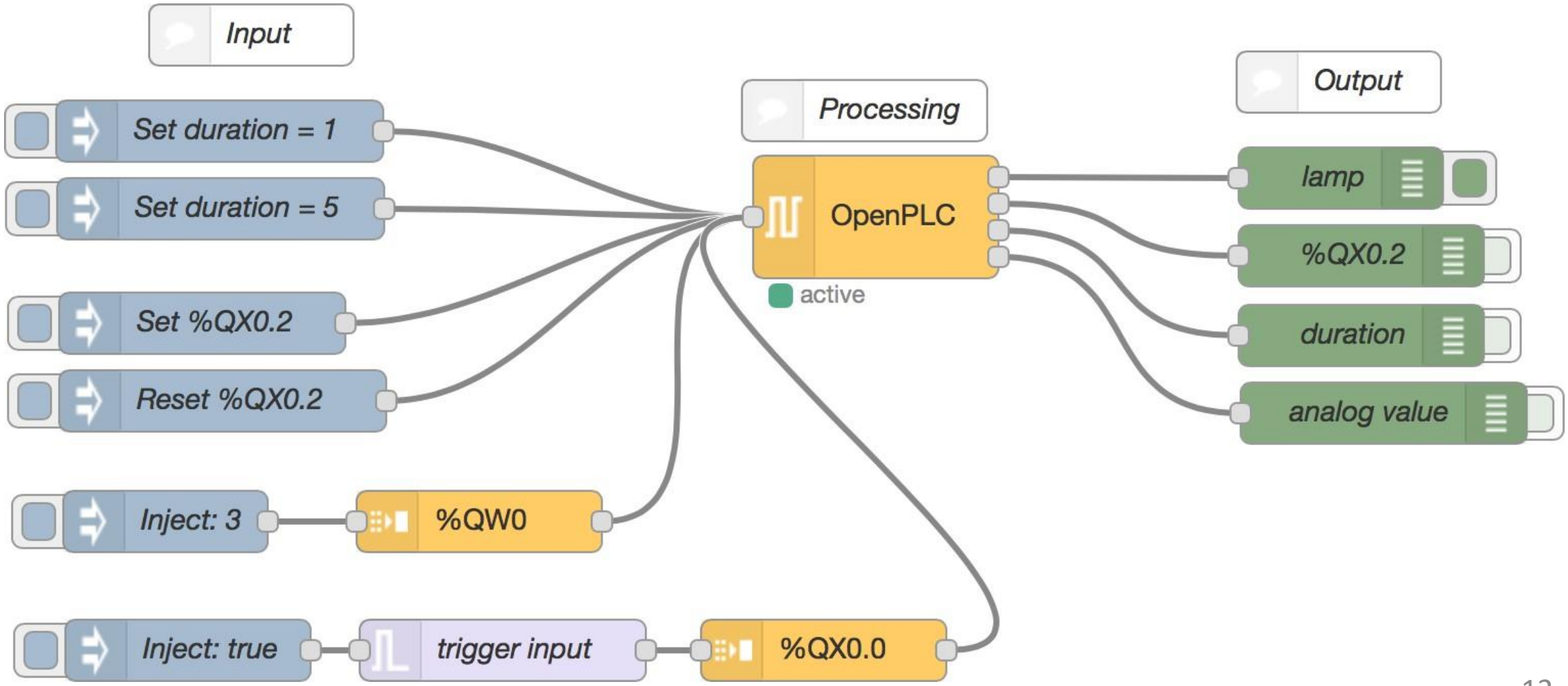

Node-RED
Deploy
filter nodes
Flow 1
info
common
inject
debug
complete
catch
status
link in
link out
comment
function
function
switch
change
range
Search flows
Flows
Flow 1
Subflows
Global Configuration Nodes
Flow 1
Flow
"c47acc.dea04538"


Node-RED
Header
Deploy
filter nodes
Flow 1
info
input
inject
catch
status
link
mqtt
http
tcp
udp
Information
Flow
"9a185b85.ecb0d8"
Name
Flow 1
Status
Enabled
Flow Description
None
Palette
Workspace
Sidebar
output
debug
link
mqtt

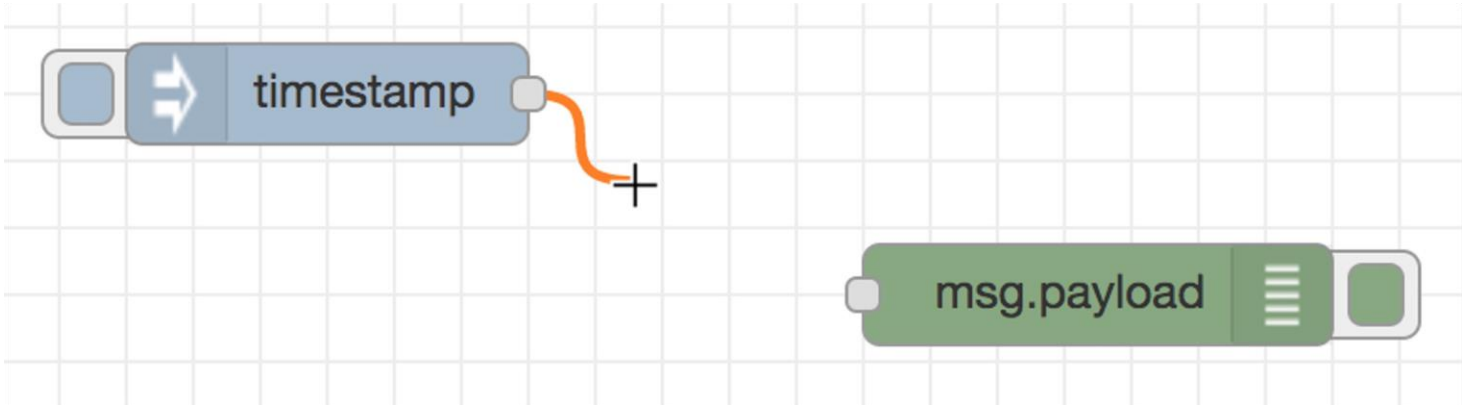
Common Node-RED Nodes

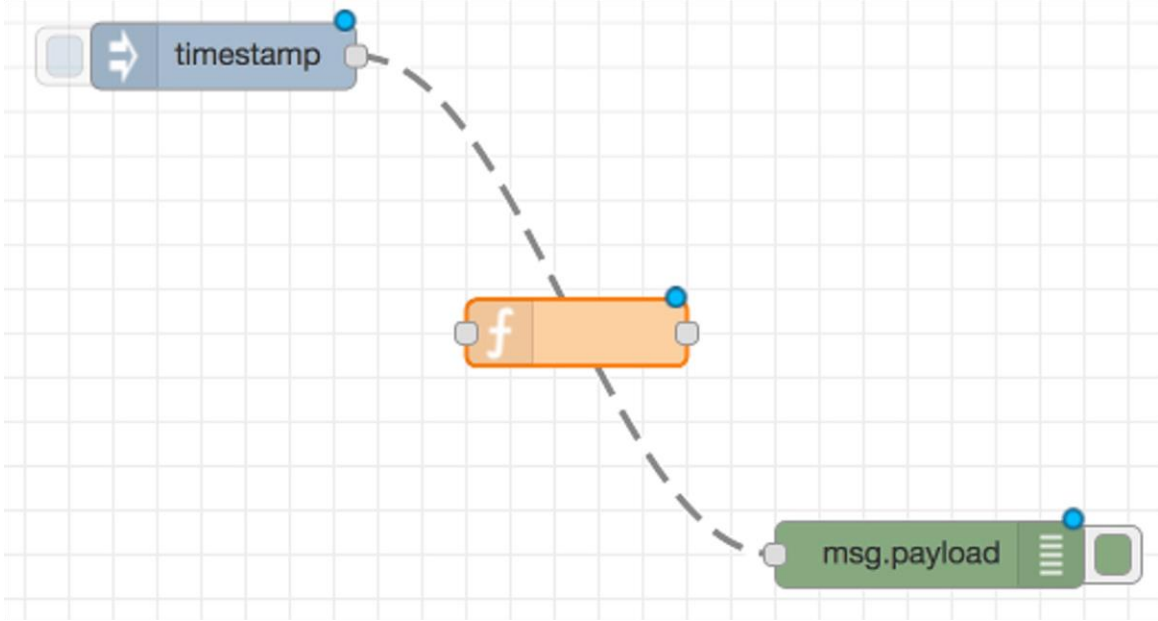
Node	Description
	The **Inject node** can be used to manually trigger a flow by clicking the node's button within the editor. It can also be used to automatically trigger flows at regular intervals.
	The **Debug node** is used to display messages which comes from the output of other node, which the messages can be seen by the debug tab, within the Node-RED sidebar. The button on the node can be used to enable or disable the output node. It is recommended to disable or remove any Debug nodes that are not being used.
	The **Function node** allows developers to write JavaScript code to be run on the node, against the messages that are passed through it.

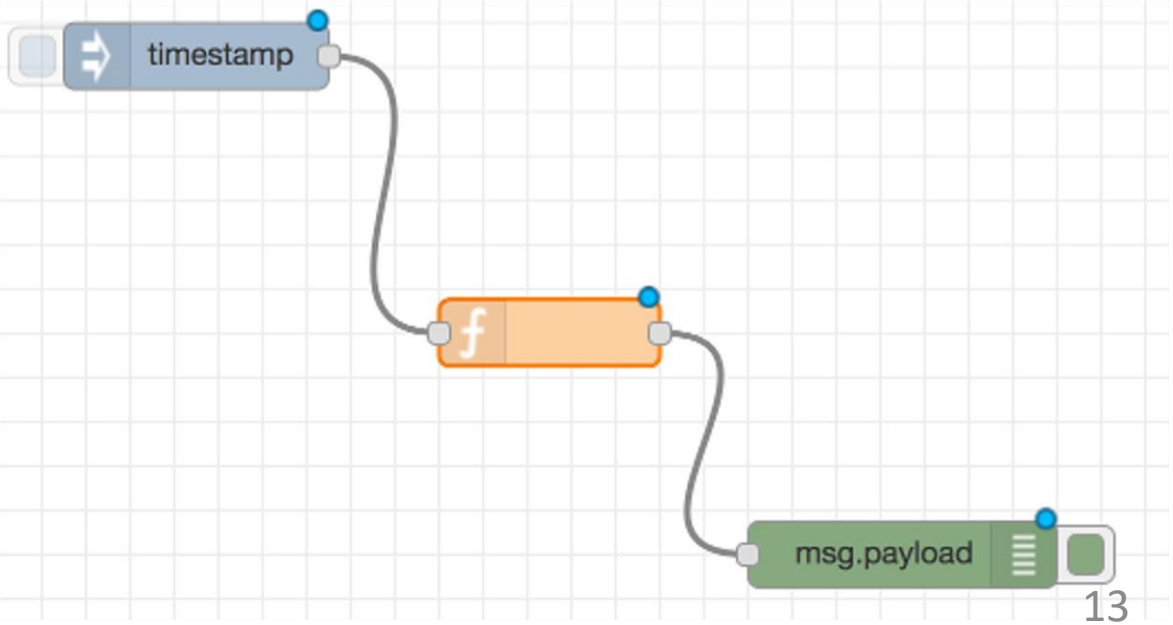
Node-RED Flow Programming Logic



Node-RED Flow Programming Logic

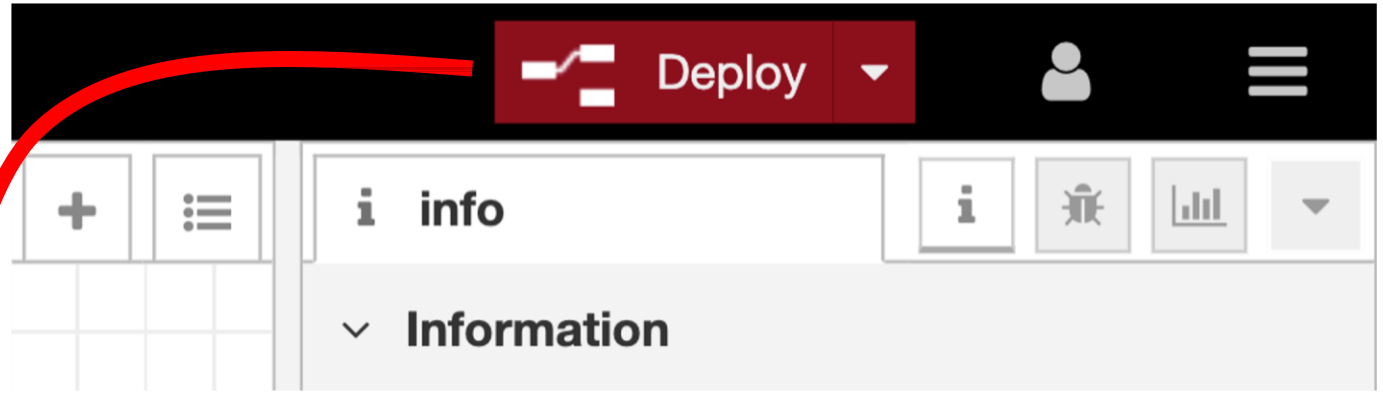




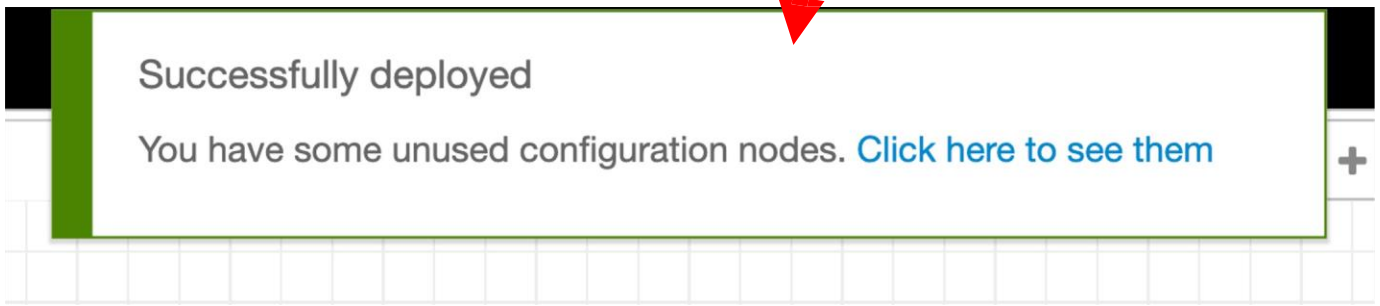


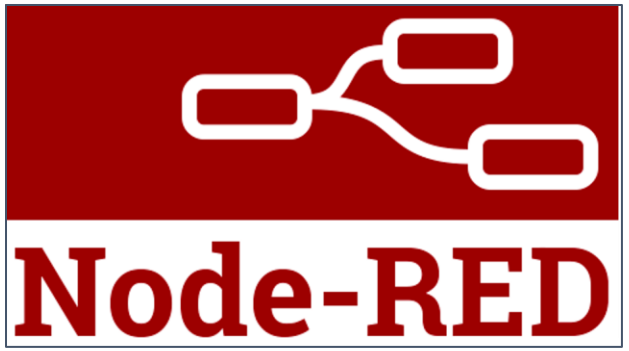
Node-RED Flow Programming Logic

- Very important button to execute the Node-RED flow process function.
- Click for every flow or nodes changes.



Deployed notification



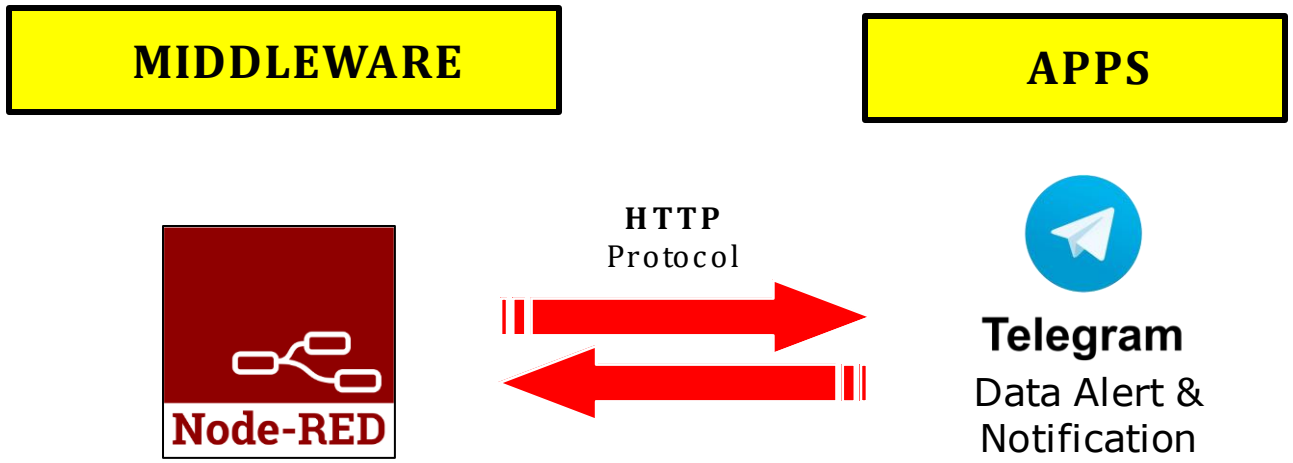


Node-RED & Telegram

Integrating visual based programming with the most popular messaging platform in the world

Node-RED with Telegram Bot

The architecture:

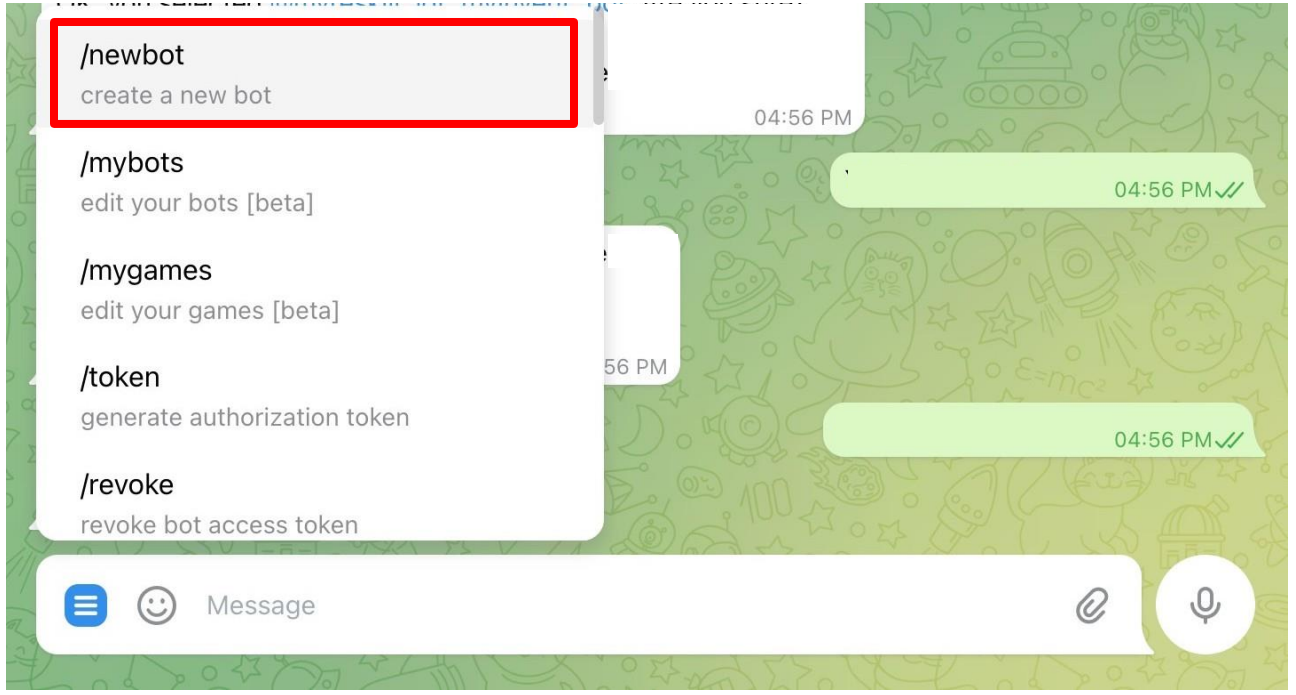


Node-RED with Telegram Bot

Let's Create a Telegram Bot (4 Steps)

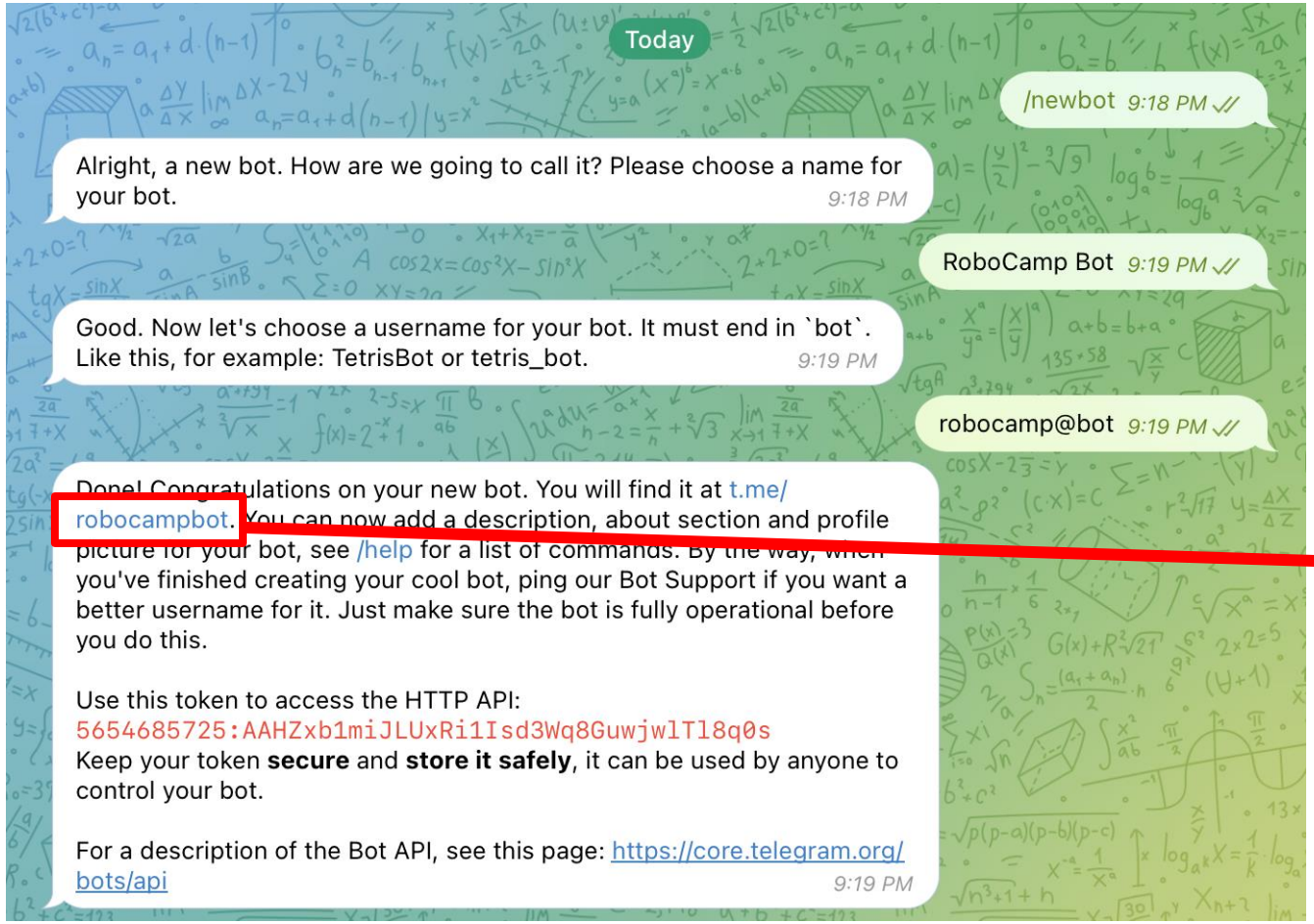
1. In Telegram, search for botfather or go to https://t.me/BotFather

2. Click on the chat menu and click **/newbot** to create new bot.

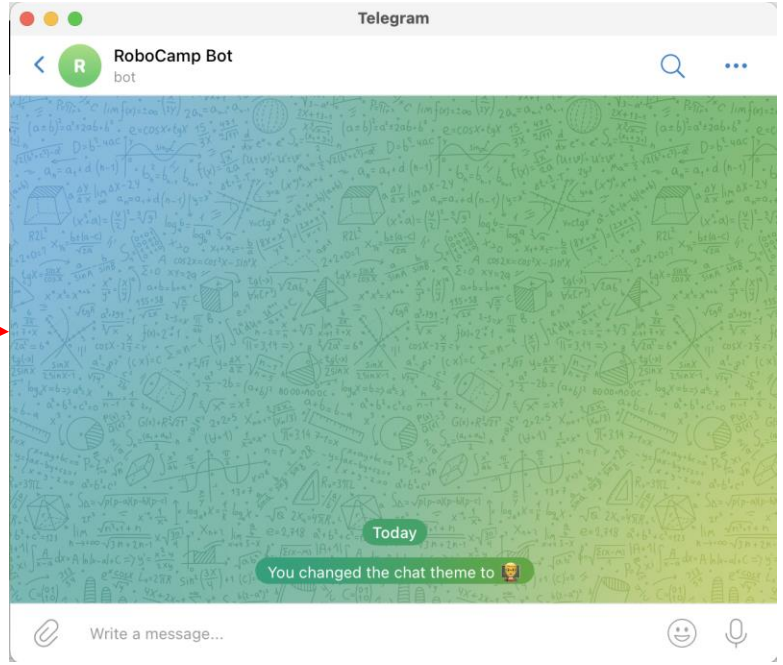


Node-RED with Telegram Bot

3. Follow the instruction to create bot's name and bot's username as below conversation.

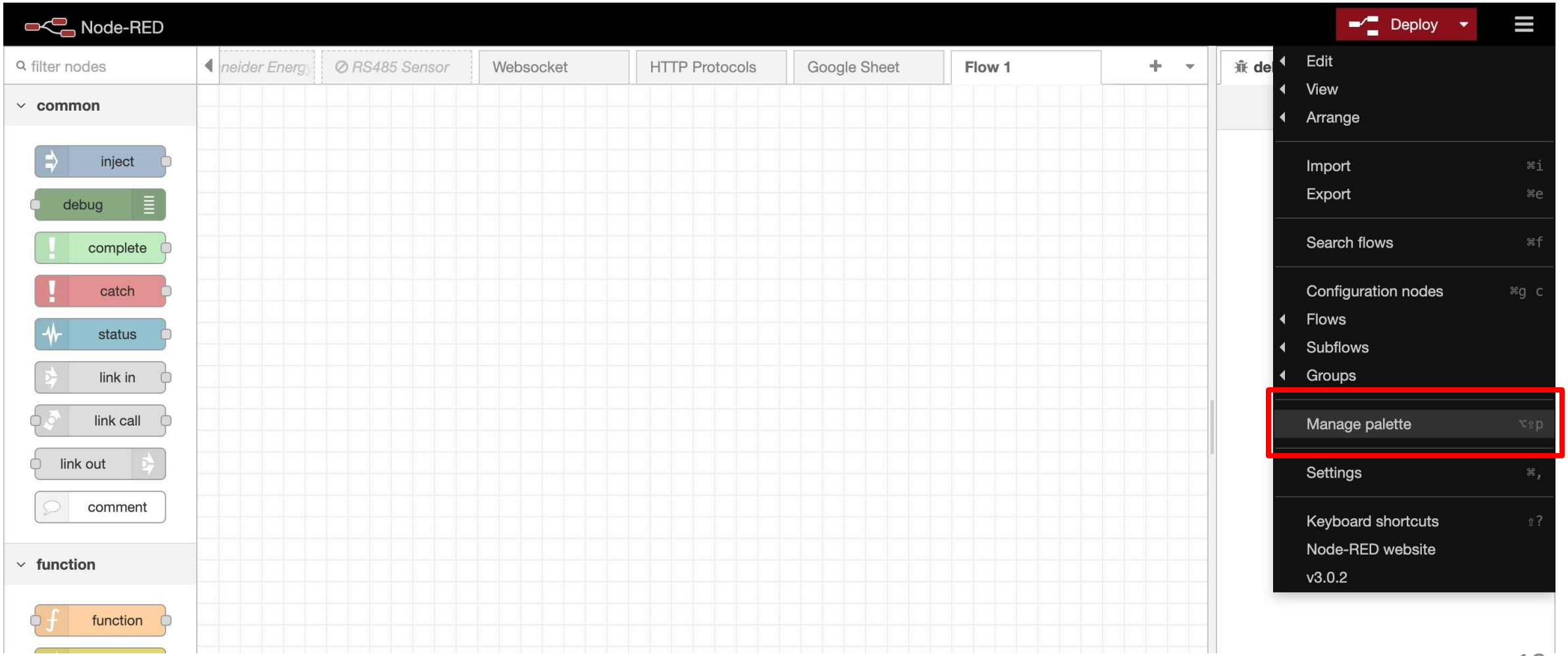


4. Click on the created bot's link and the bot is now accessible. Let's connect with Node-RED.



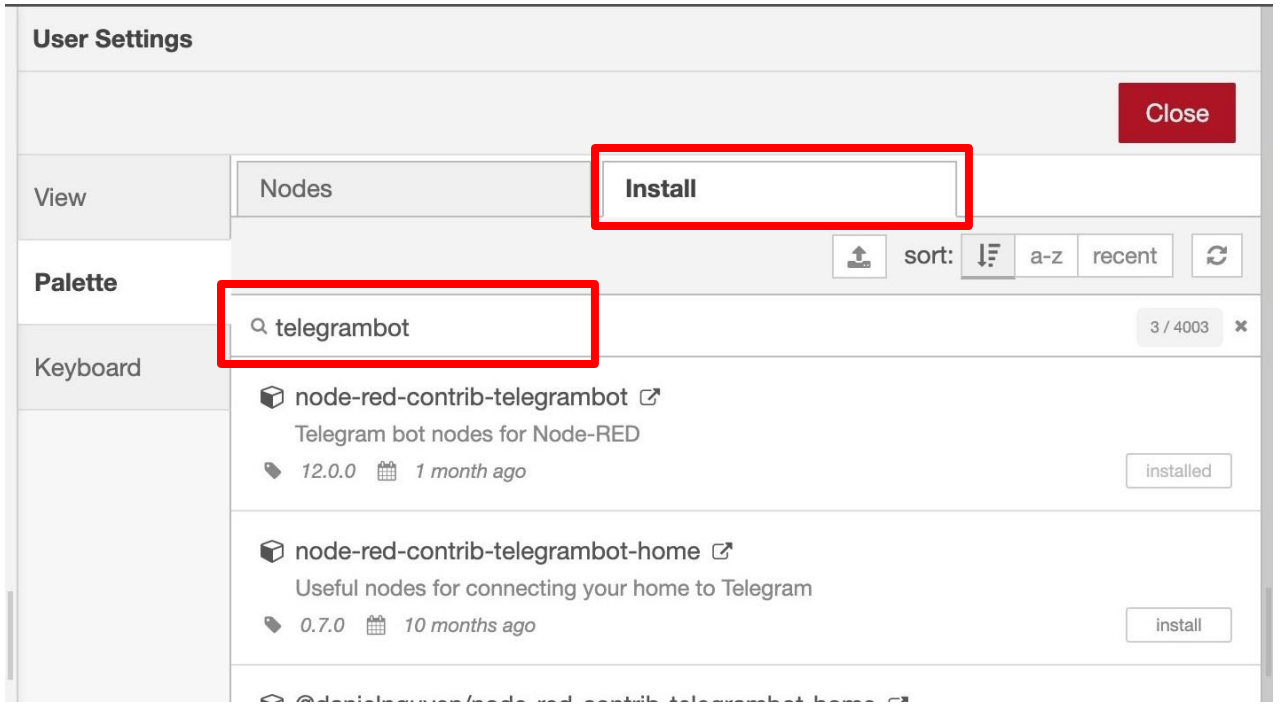
Node-RED with Telegram Bot

- Click on the Node-RED's menu, and click **Manage palette**



Node-RED with Telegram Bot

- Click on the **Install** tab and on the **search modules** fields type **telegrambot** to filter the list of the available modules.
- Click the **install** button to install the **node-red-contrib-telegrambot** module and wait until the installation process is successful.



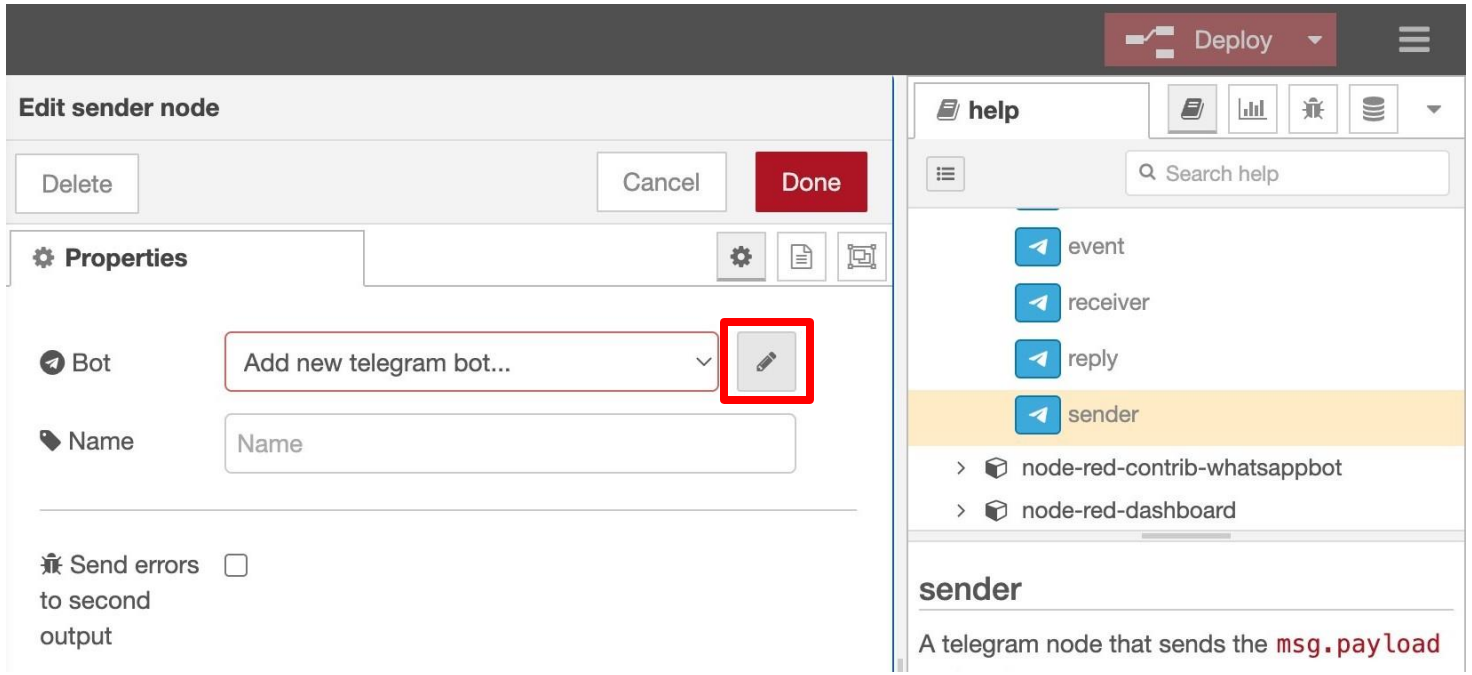
Node-RED with Telegram Bot

- Once the installation is successful, the telegram nodes is available on the palette under category: **telegram**. The nodes includes *receiver*, *command*, *event*, *sender* and *reply*.

Node-RED with Telegram Bot

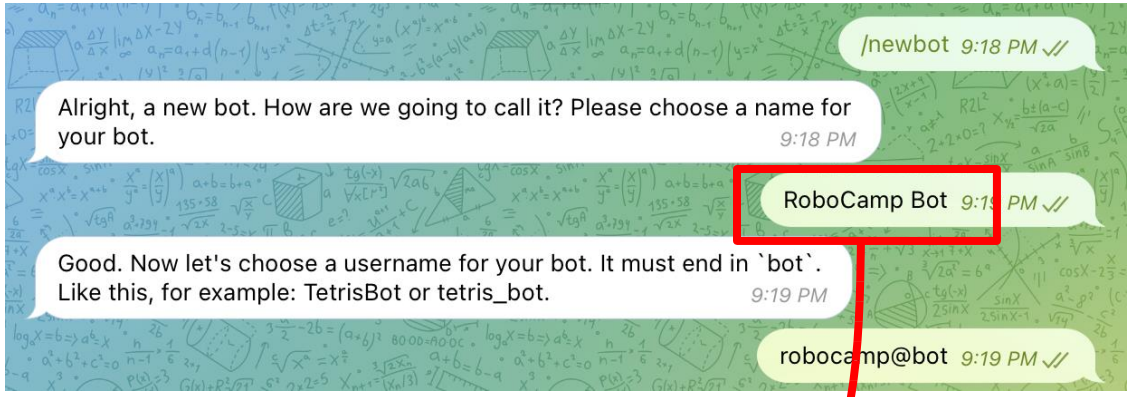
Let's Get Bot's Chat ID (12 Steps)

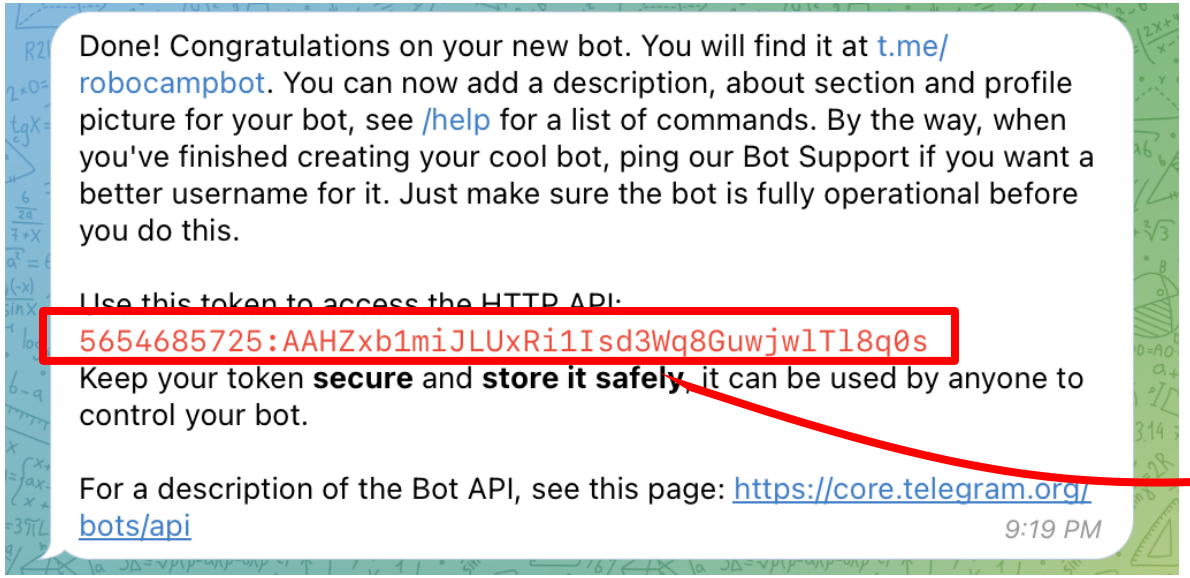
1. Insert **receiver** telegram node into the workspace.
2. Double click the node to edit the Properties.
3. Click **pencil icon** to **Add new telegram bot...**

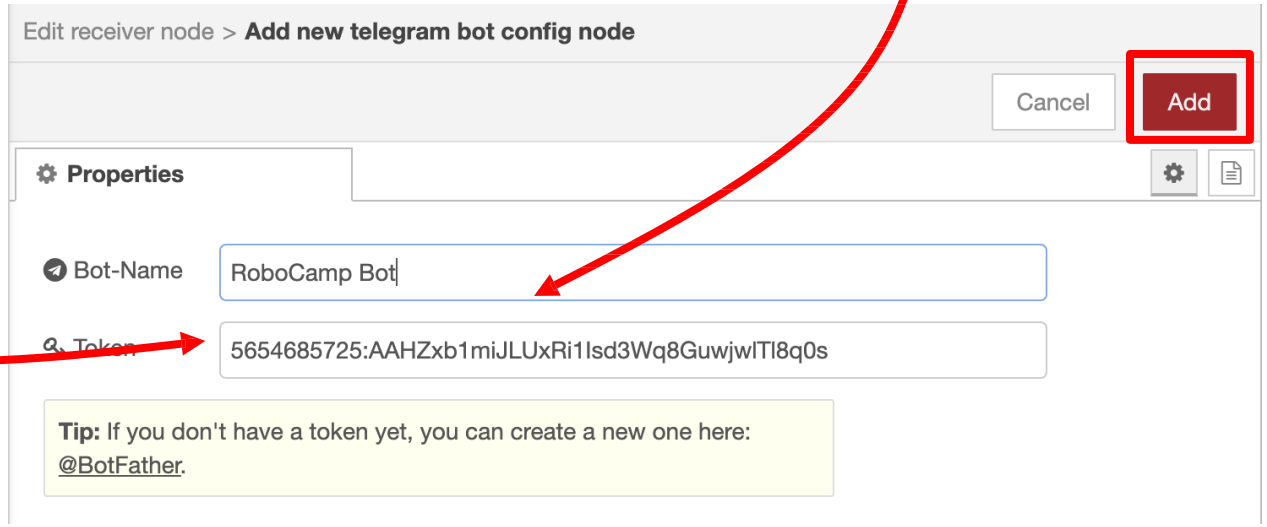


Node-RED with Telegram Bot

4. Insert **Bot-Name**
5. Insert **Token**
6. Click the **Add** button.

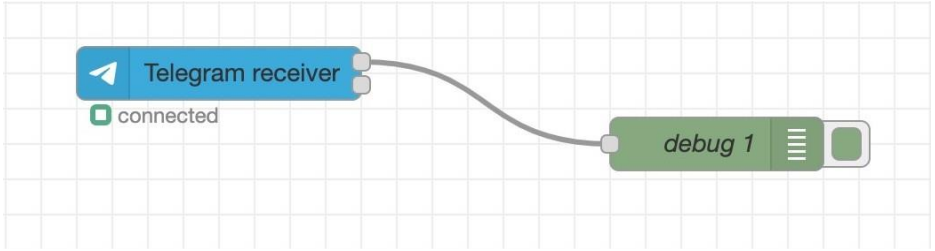


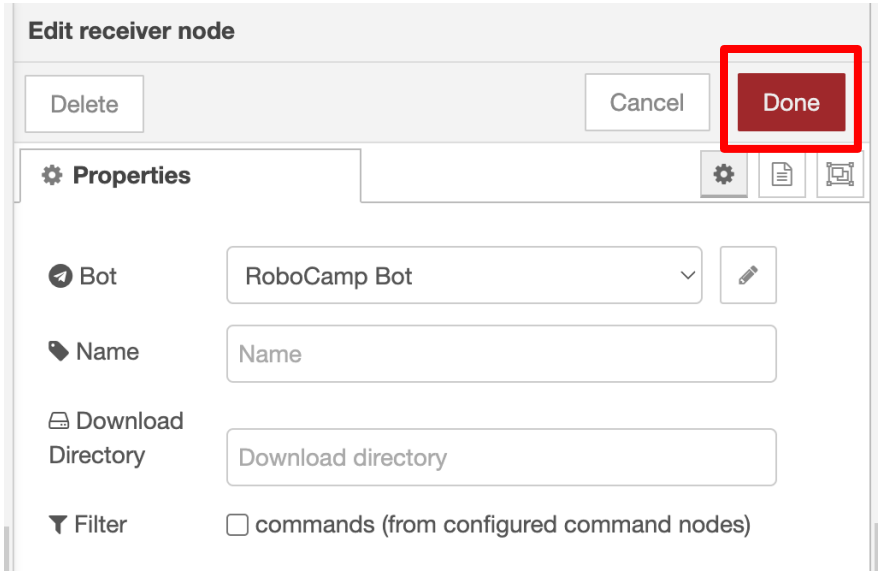




Node-RED with Telegram Bot

7. The **Bot** information is ready.
8. Click the **Done** button.
9. Click the Node-RED's **Deploy** button.

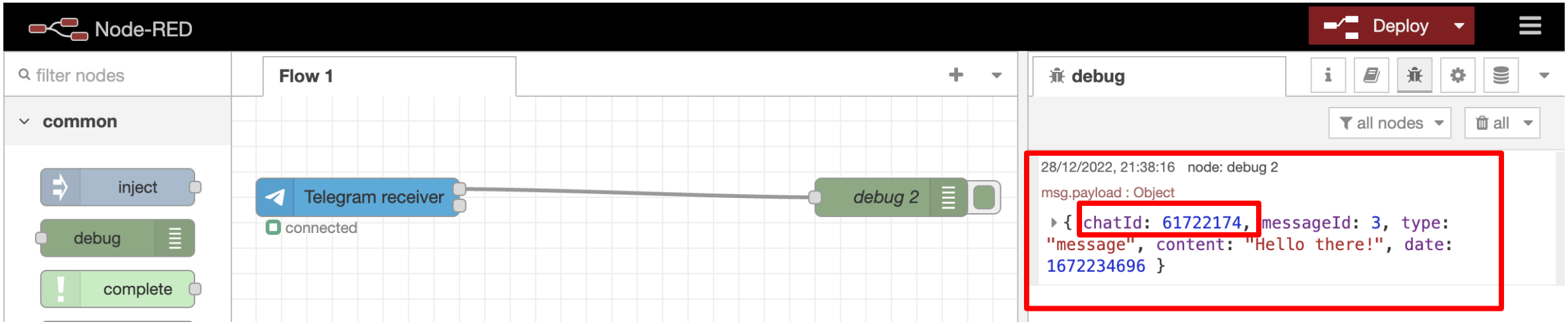




10. Go to Bot chat box and send some message.

Node-RED with Telegram Bot

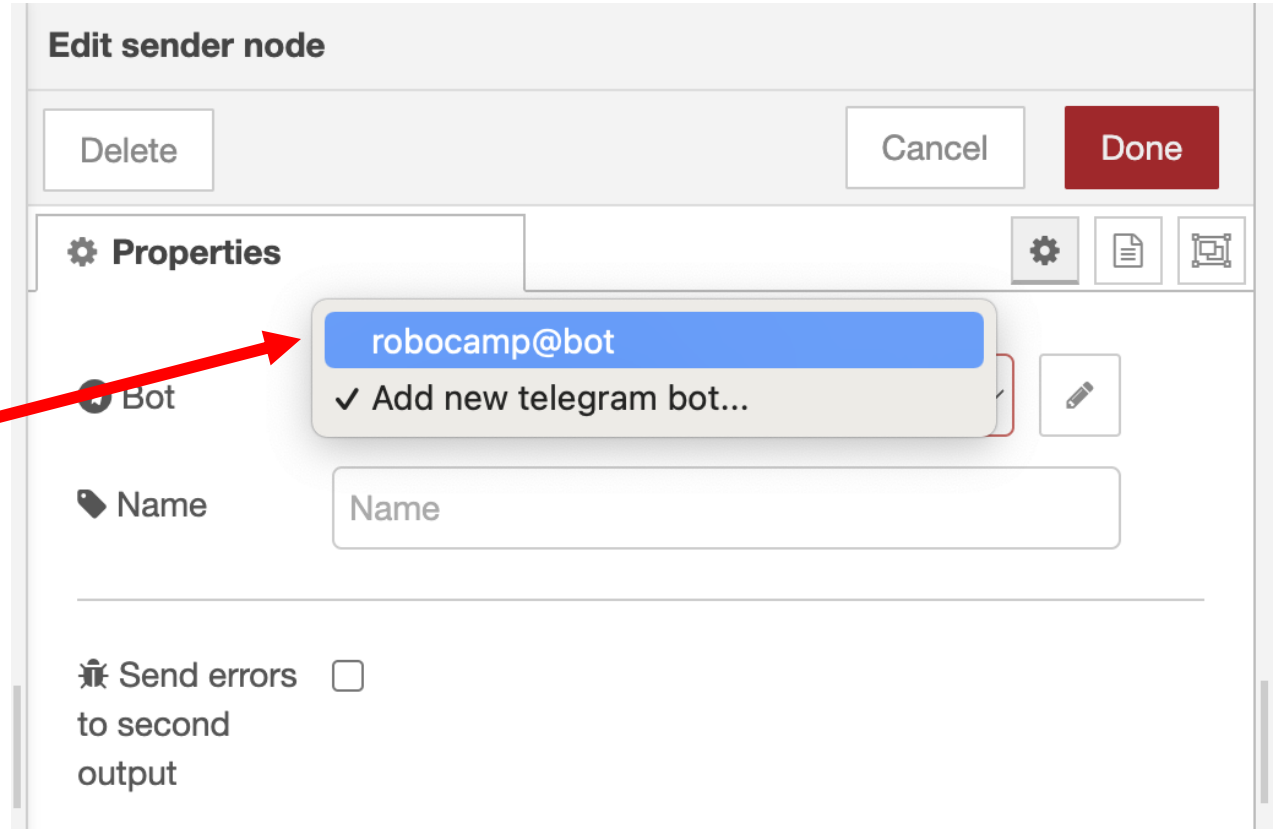
11. Observe the Debug tab output on the Node-RED's sidebar.
12. The Bot's Chat ID is the value of **chatId** key as available on the **msg.payload** object.



Node-RED with Telegram Bot

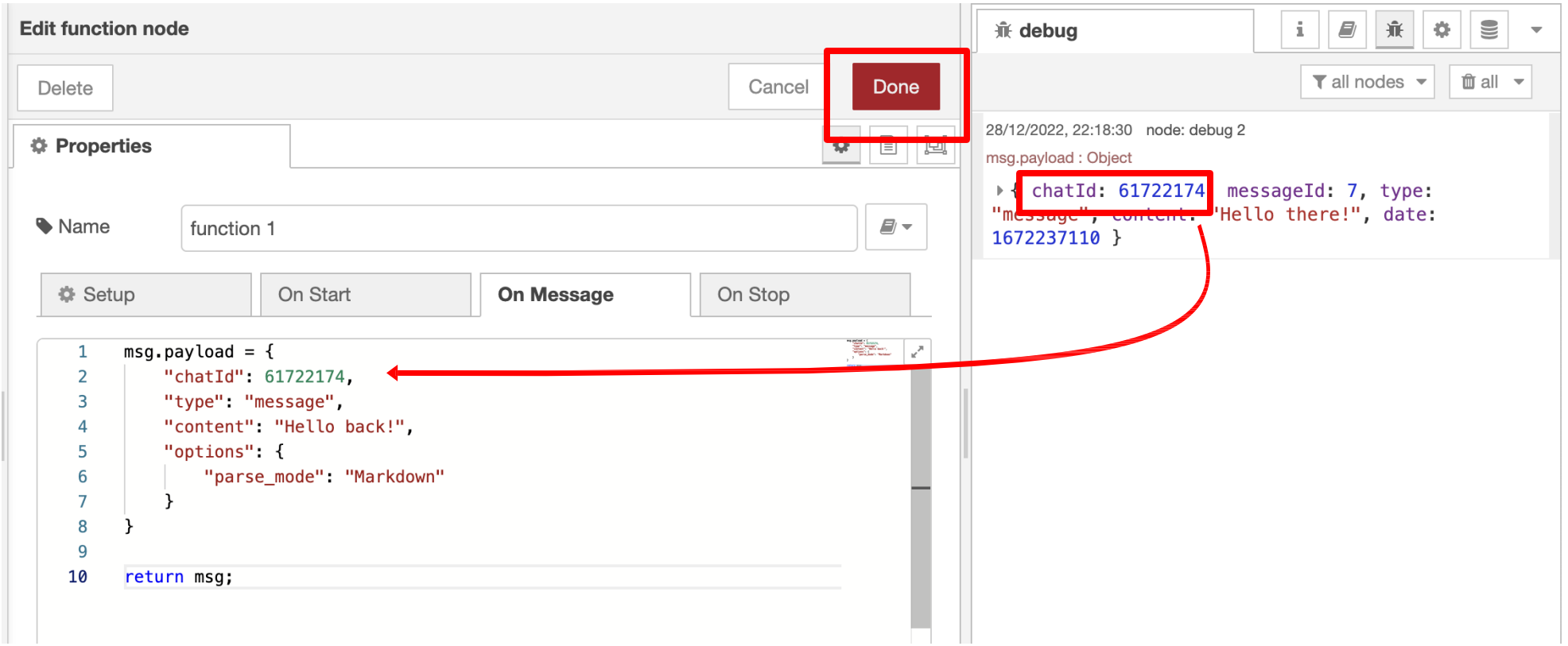
Send Automated Message to the Telegram Bot (7 Steps)

1. Insert **Inject** node, **Function** node and Telegram **sender** node into the workspace.
2. Edit the Telegram **sender** node Bot's properties, select your existing Bot that had been setup before.



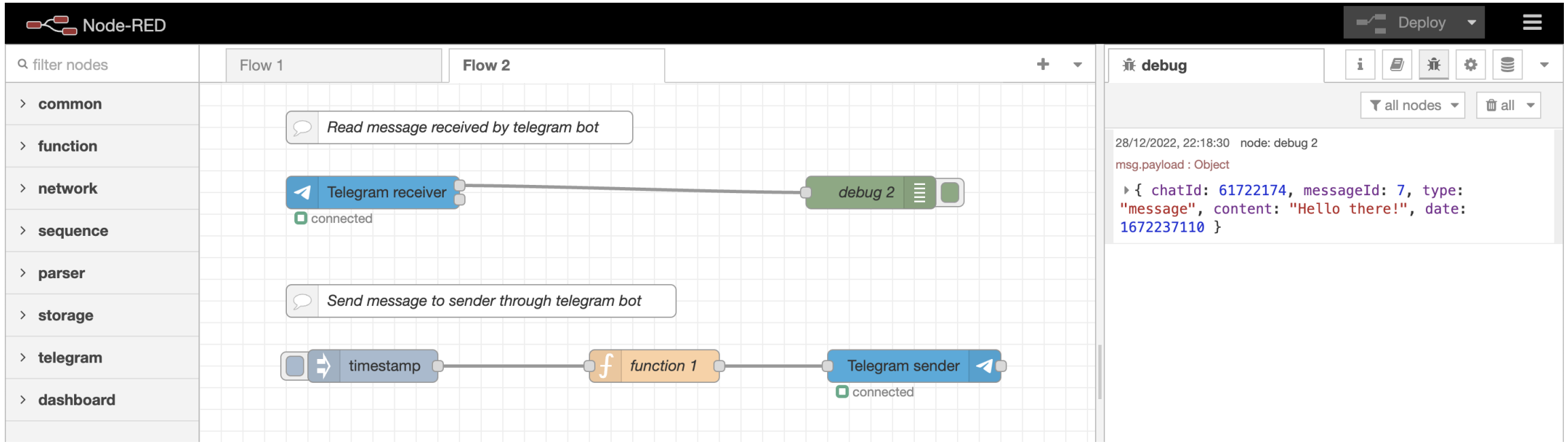
Node-RED with Telegram Bot

3. Open the **Function** node to add Telegram's chat information as in the image below.



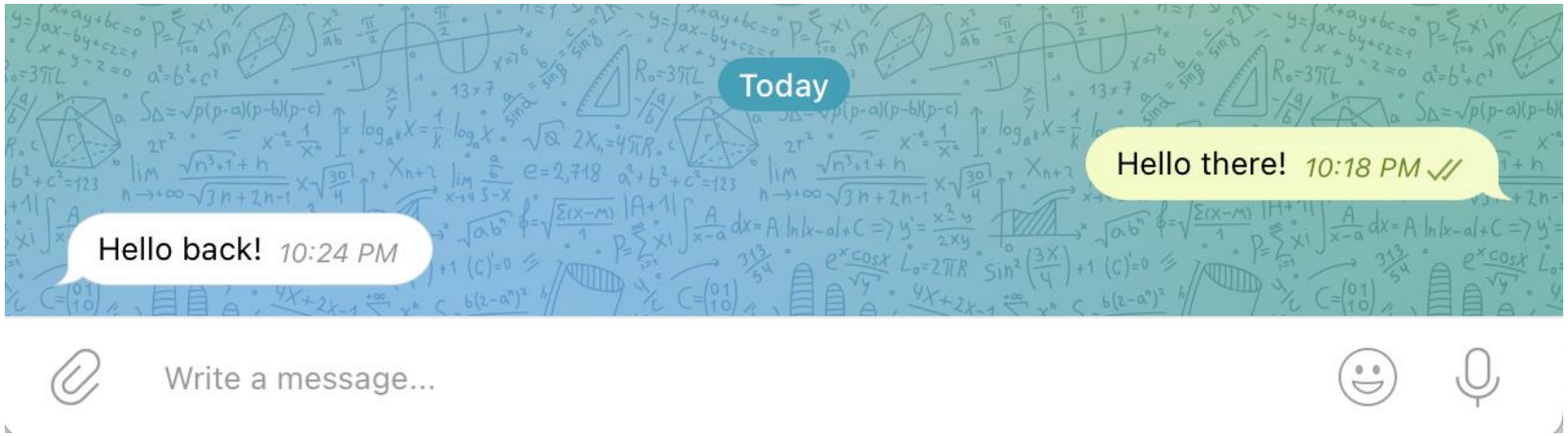
Node-RED with Telegram Bot

4. Connect the nodes.
5. Click the Node-RED's **Deploy** button.
6. Click the **Inject** node button to send the message of **Assalamualaikum** to the Bot.

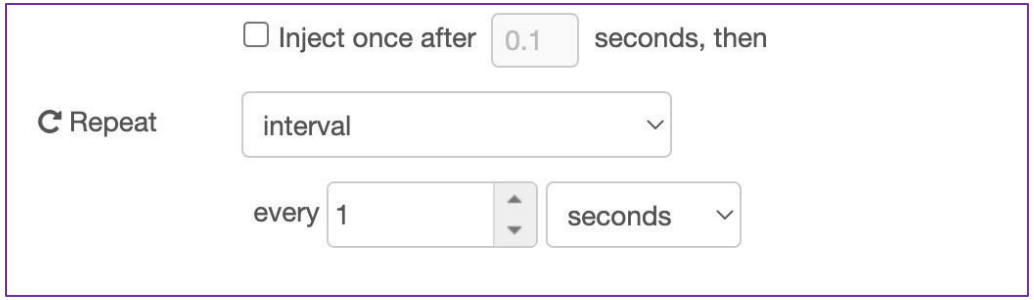


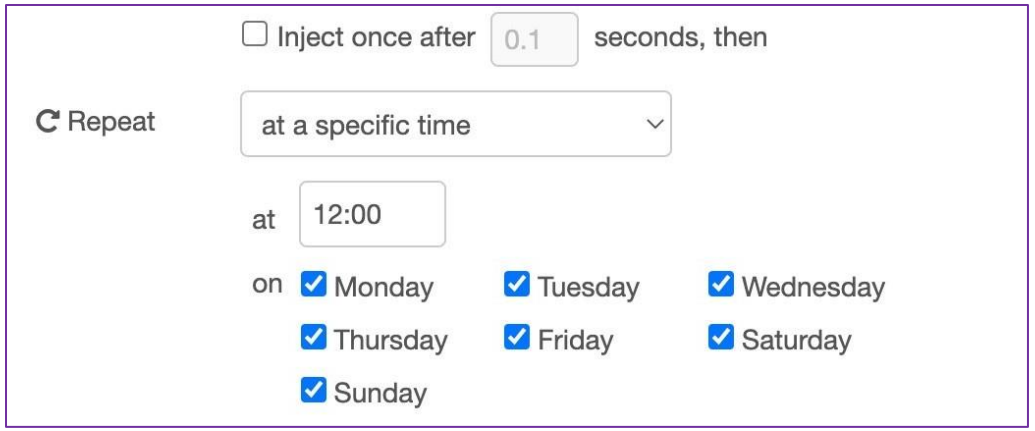
Node-RED with Telegram Bot

7. Check the Telegram, the Bot has received the message from Node-RED.



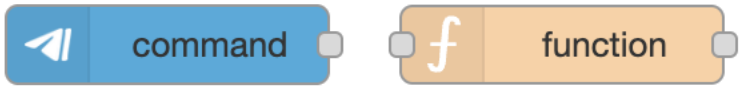
8. Change the Inject node **Repeat** properties to automatically send the message by interval time or specific time.



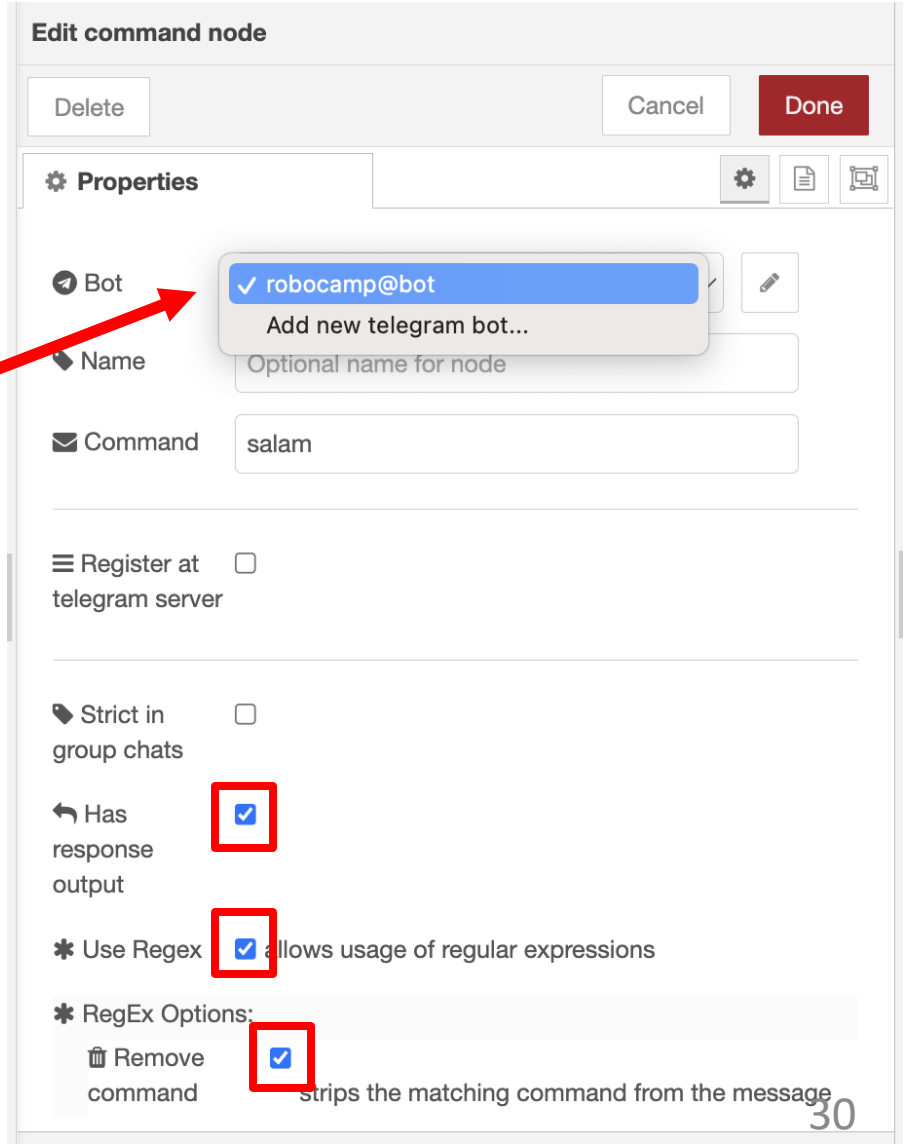


Node-RED with Telegram Bot

Automated Reply Message to the Telegram Bot (8 Steps)

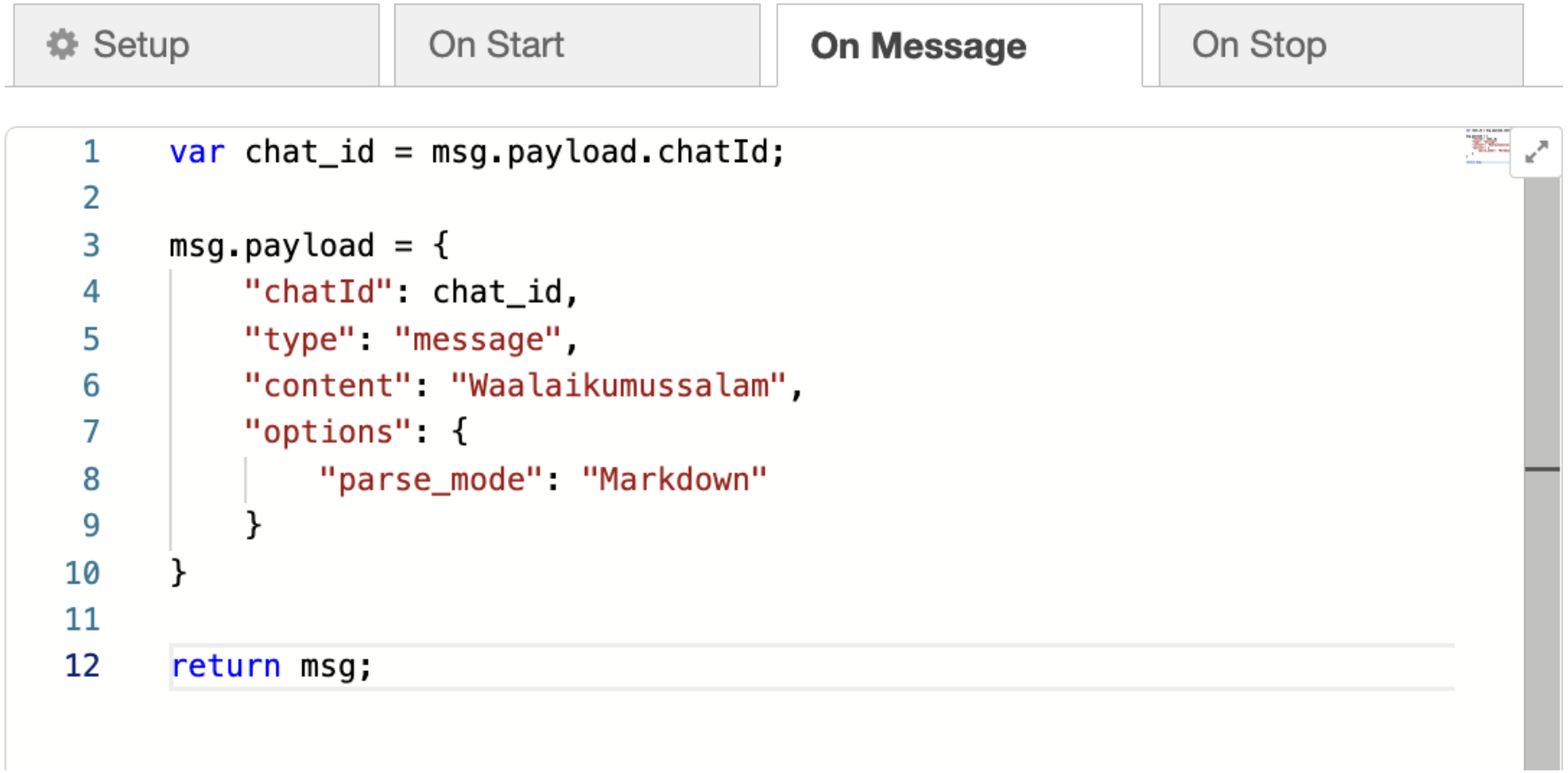


1. Insert telegram **command** node and **Function** node into the workspace.
2. Edit the Telegram **sender** node Bot's properties, select your existing Bot that had been setup before.
3. Command is **salam**.
4. Enable these options:
   - Has response output
   - Allows usage of regular expressions
   - Strips the matching command from the message



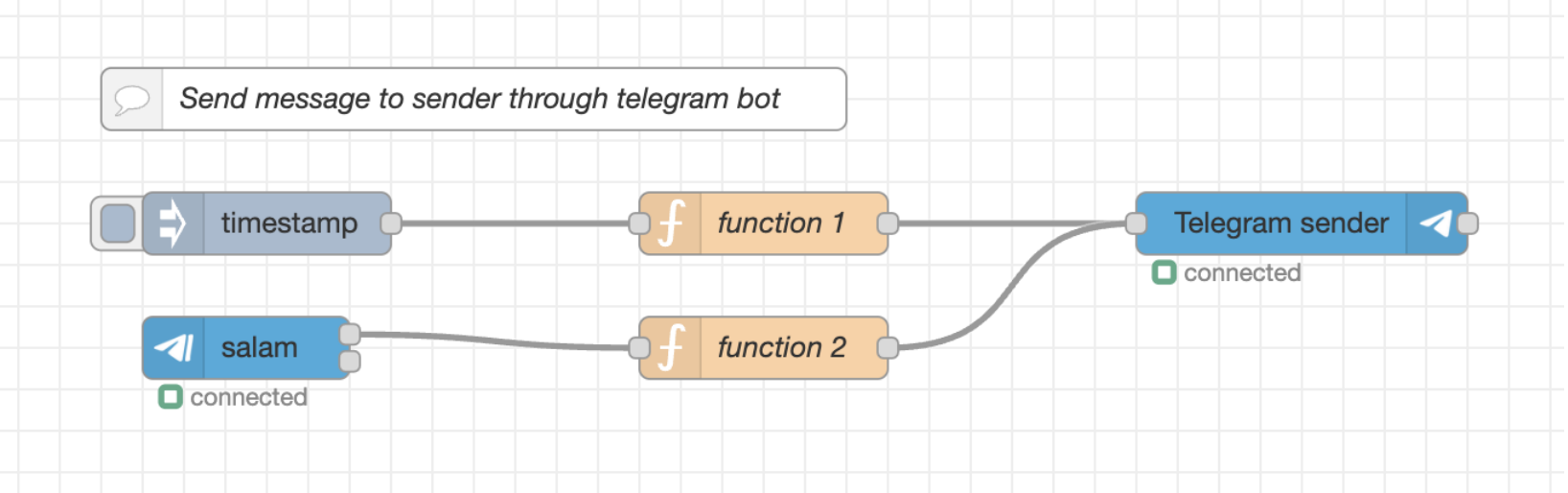
Node-RED with Telegram Bot

5. Open the **Function** node to add the code below in the **On Message** tab. Click Done.



Node-RED with Telegram Bot

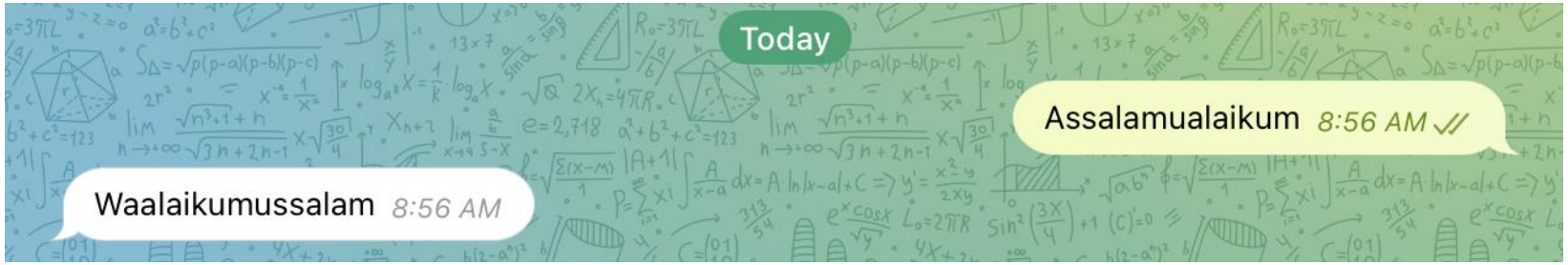
6. Connect the **command (salam)** node to **function** node. Connect **function** node to the previous **sender** node.



7. Click the Node-RED's **Deploy** button.

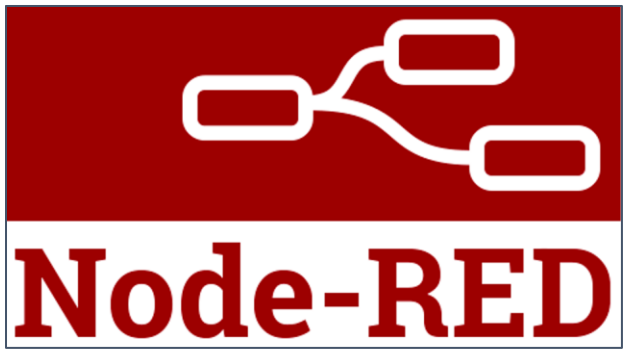
Node-RED with Telegram Bot

8. Open the Telegram, send "*Assalamualaikum*" message, the Bot should reply "*Waalaikumussalam*" automatically.



Note:

The command node will look for any message containing the command word "*salam*". If it find any, function node will send "*Waalaikumussalam*" text to the sender **ChatId**. Sender ChatId is obtained from **msg.payload.chatId** received by the command node.



Node-RED Dashboard

Set of nodes in Node-RED to quickly create a live data dashboard.

It provides nodes to quickly create a UI (user interface) with buttons, text input, sliders, charts, gauges, etc.

Node-RED Dashboard

The architecture:

MIDDLEWARE

DATA VISUALISATION

Data Visualization (Dashboard)
Data Monitoring

Environment

Temperature

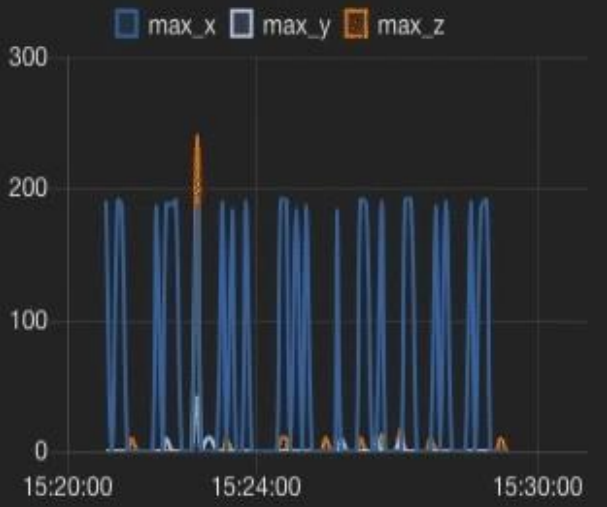
Humidity

Battery 3.275V

Vibration

RMS

Max



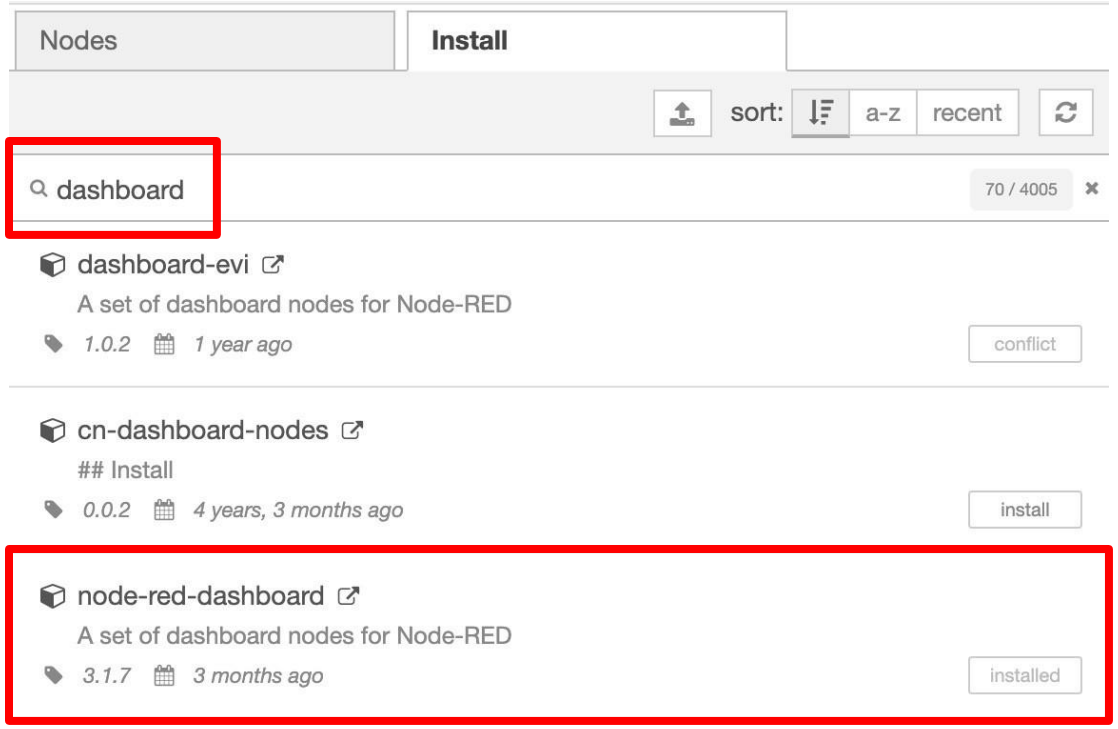
Min

Battery 3.268V

Node-RED Dashboard

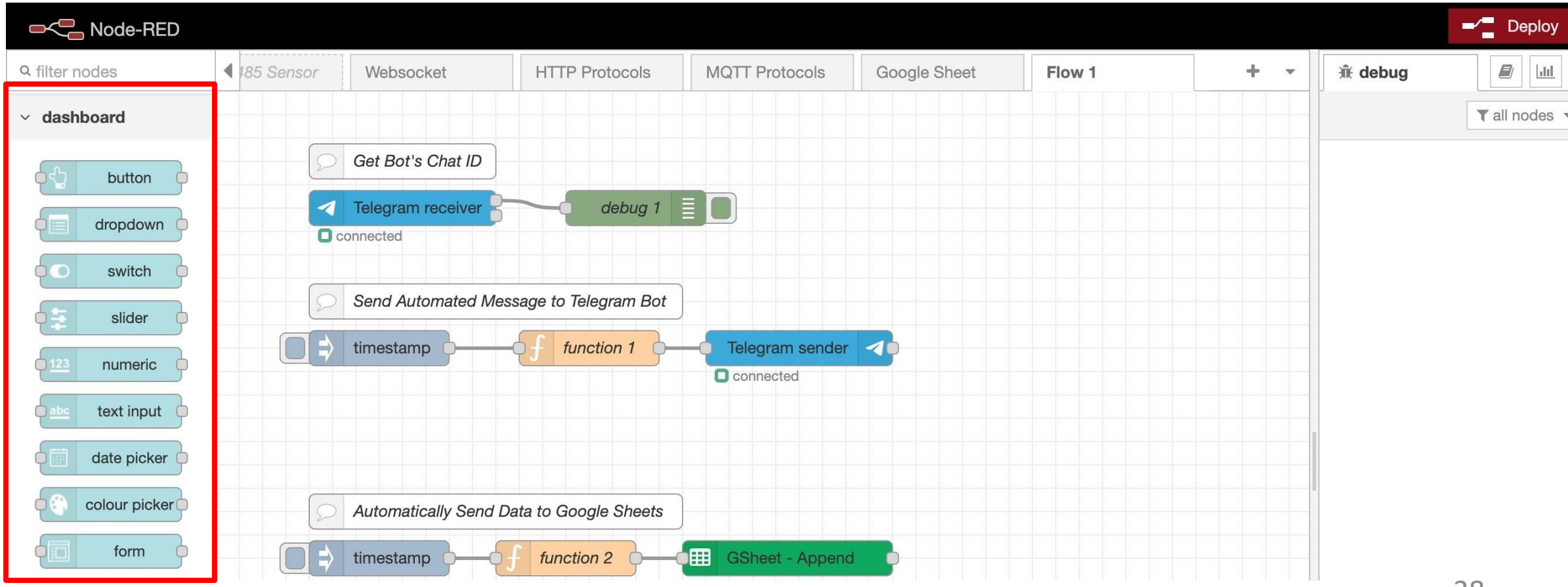
Install Node-RED Dashboard

- Open Node-RED Palette Manager.
- Click on the **Install** tab and on the **search modules** fields type **dashboard** to filter the list of the available modules.
- Click the **install** button to install the **node-red-dashboard** module and wait until the installation process is successful.



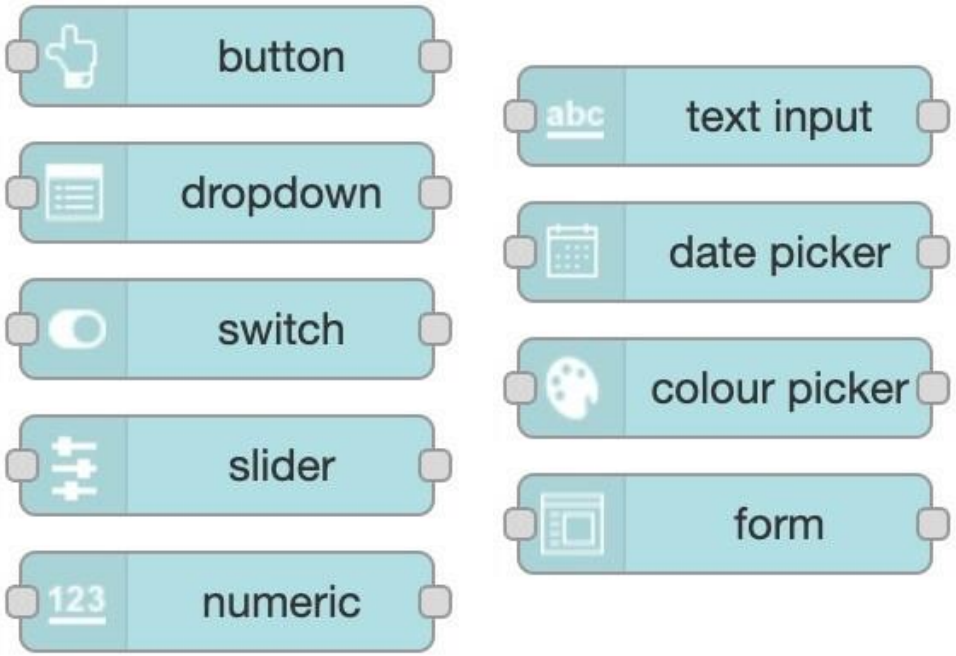
Node-RED Dashboard

- Once the installation is successful, the dashboard's widget as a set of Node-RED Dashboard nodes is available on the palette under new category: **dashboard**.



Node-RED Dashboard

Input UI nodes for the Dashboard



Example of Input UI on the Dashboard

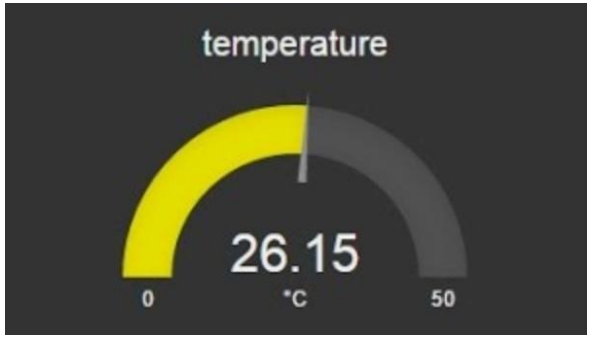
- Form and
- button

Node-RED Dashboard

Output UI nodes for the Dashboard

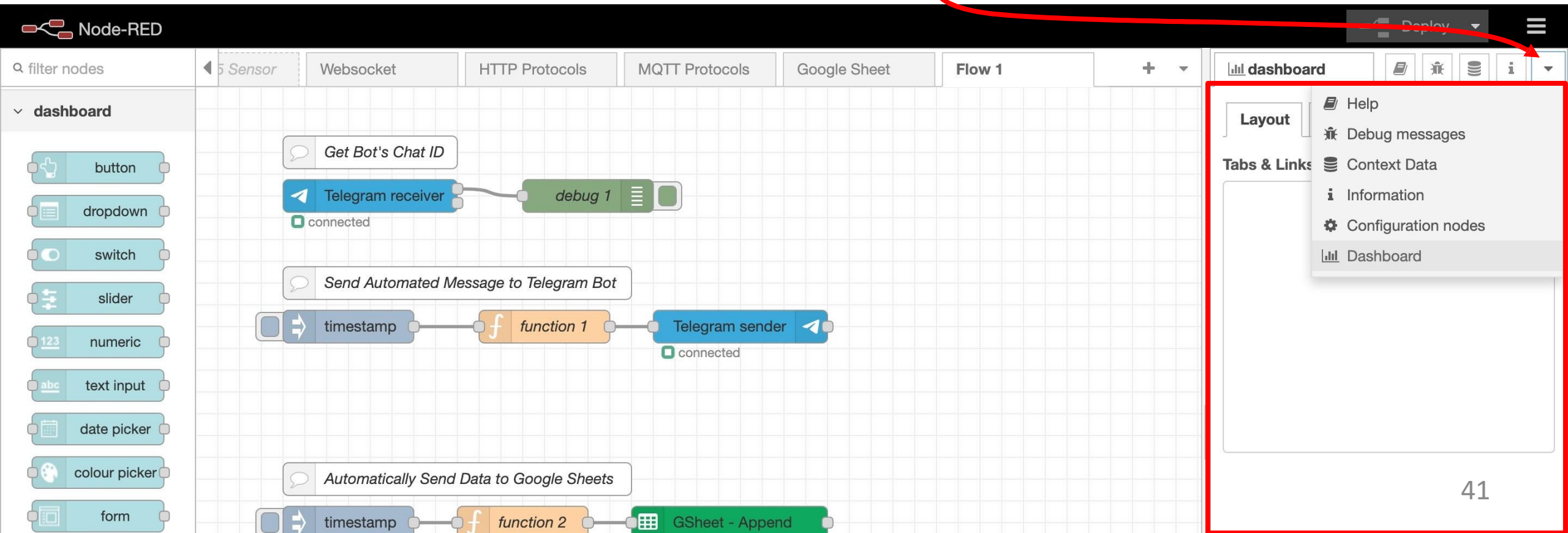
Example of Input UI on the Dashboard

- Gauge and
- Chart



Node-RED Dashboard

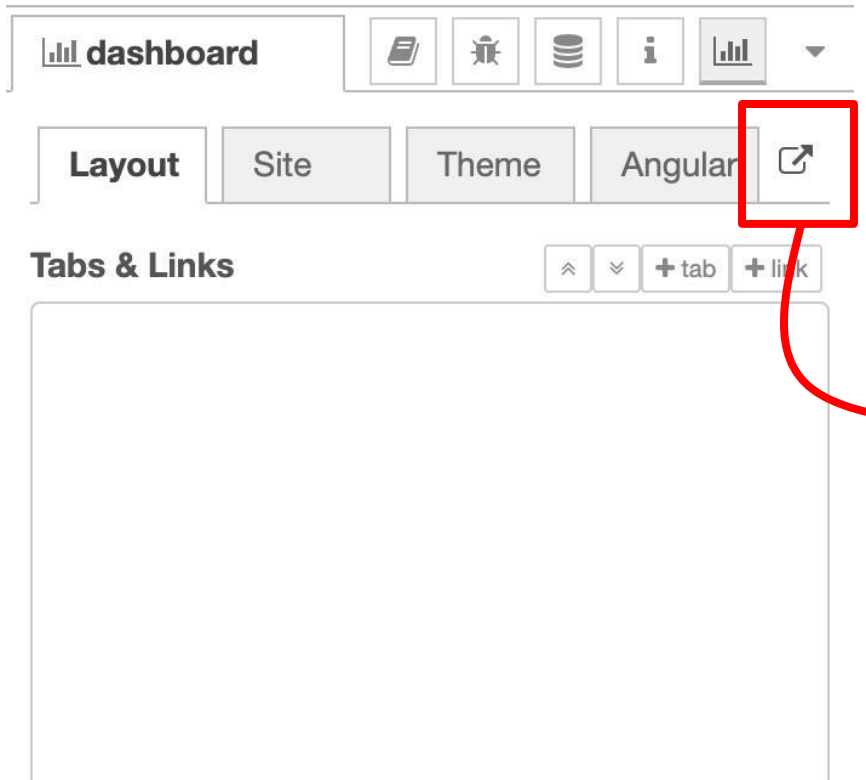
- Node-RED Sidebar also has a new tab specifically for dashboard configurations.
- The **dashboard** tab can be access by clicking the dropdown and select Dashboard.

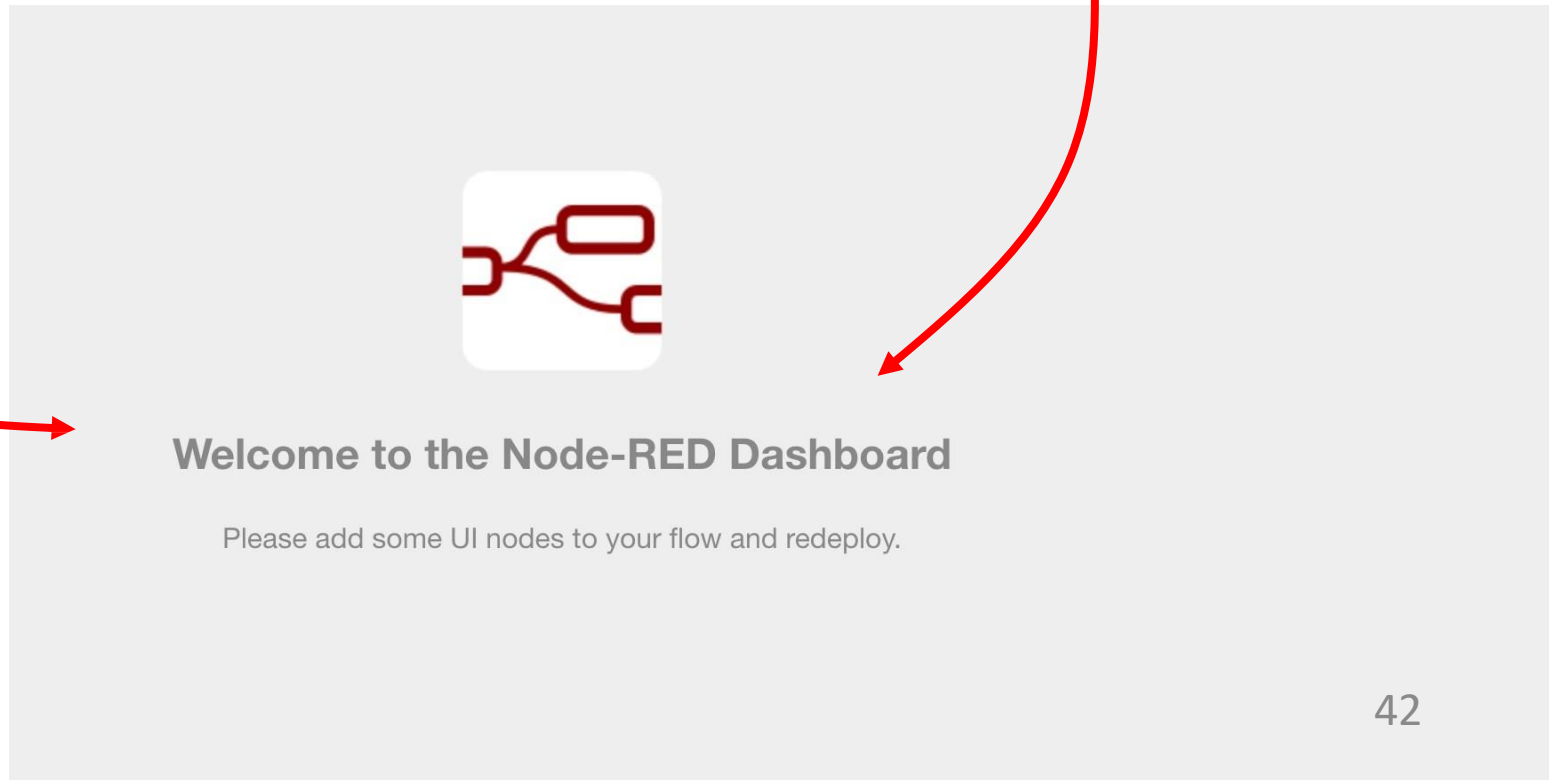


Node-RED Dashboard

There are two ways to access to Node-RED dashboard.

1. Go to the Node-RED URLs followed by **/ui**. For example, http://localhost:1880/ui
2. Click the **external icon** on the Dashboard tab under Node-RED sidebar.

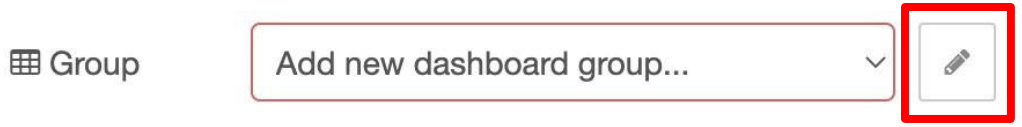




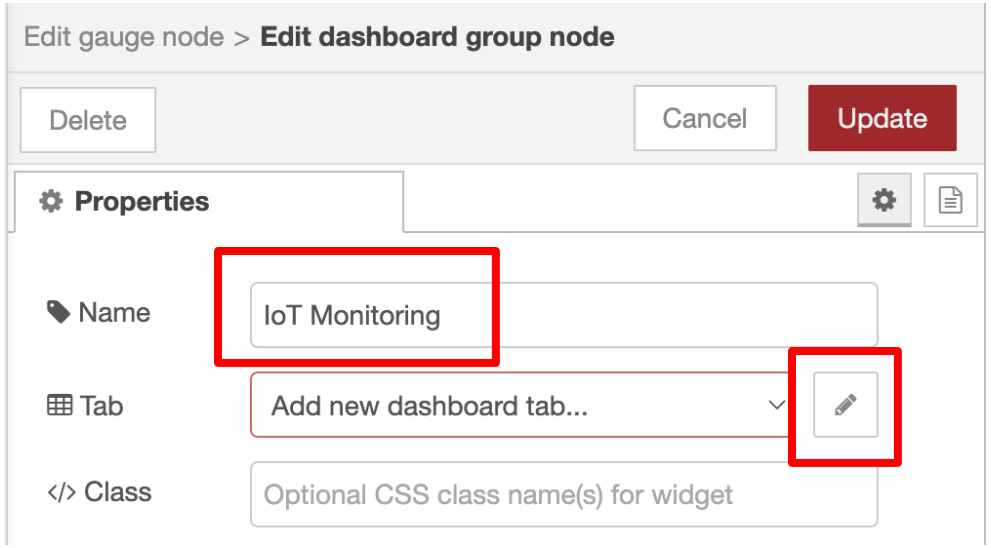
Node-RED Dashboard

Add Gauge widget to the Node-RED Dashboard (17 Steps)

1. Insert **gauge** node into the workspace.
2. Double click the node to edit the properties.
3. Setup the dashboard's group by clicking the pencil icon.

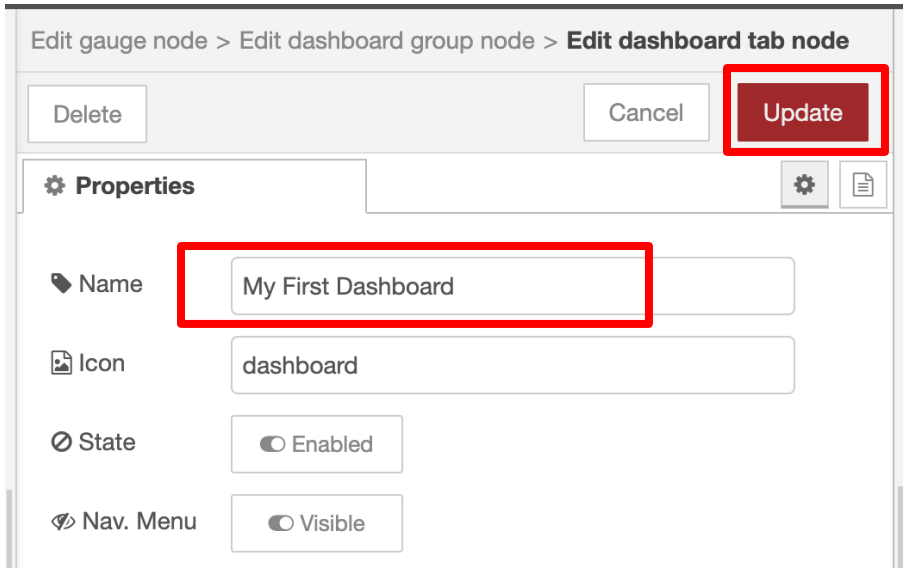


4. Rename the group's name, such as **IoT Monitoring**.
5. Click the pencil icon to add new dashboard tab.



Node-RED Dashboard

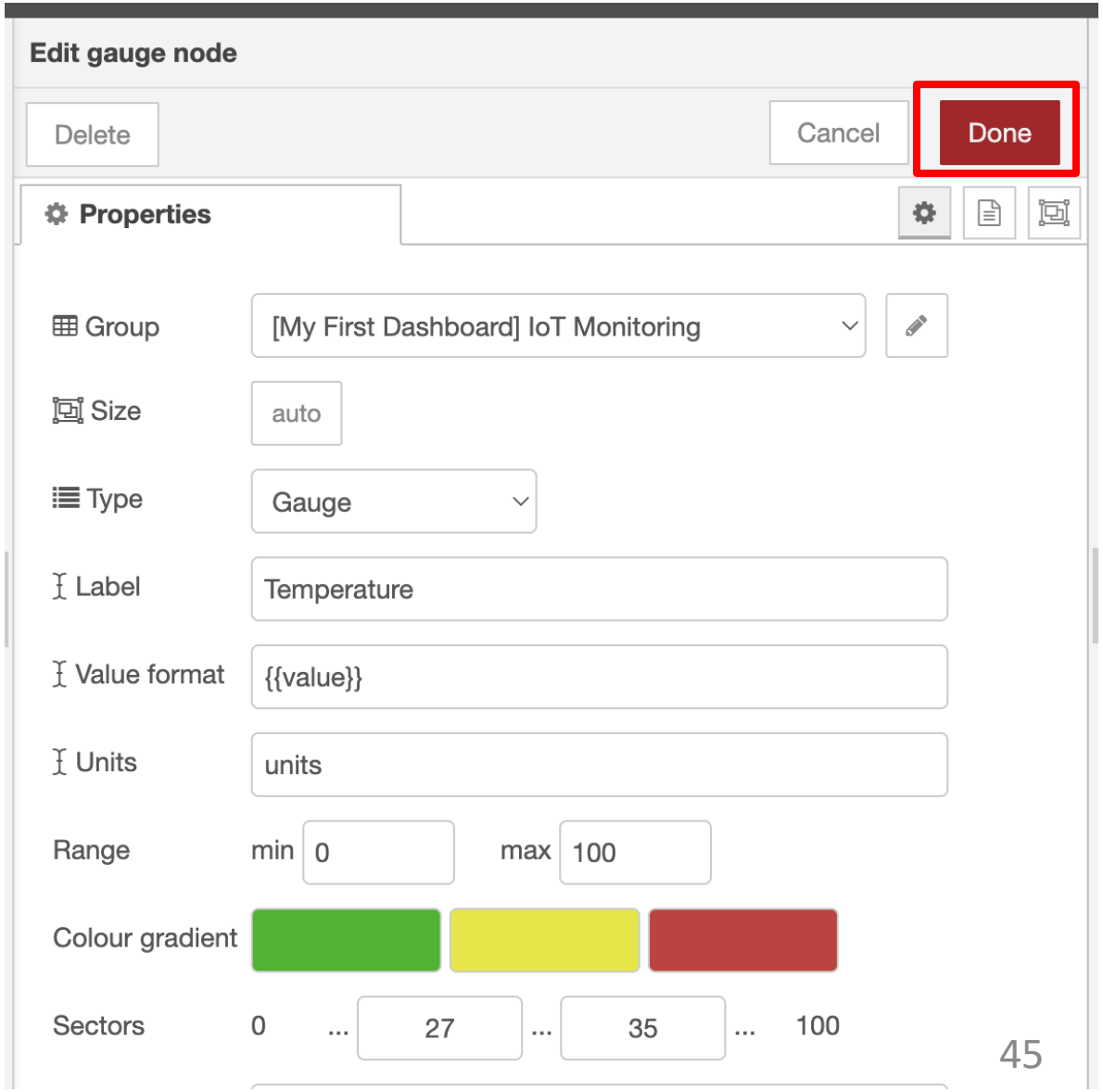
6. Rename the dashboard's tab name, such as **My First Dashboard**.
7. Click the **Add** button to add the new dashboard's tab.



8. Click the **Add** button to add the group.

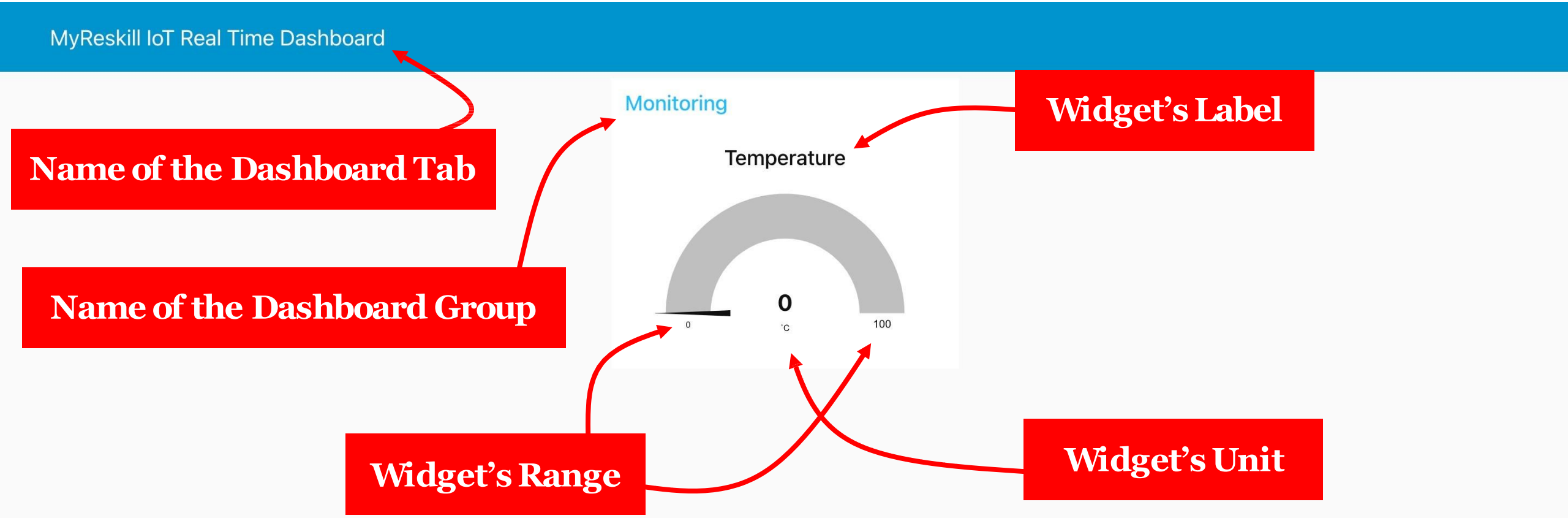
Node-RED Dashboard

9. Remain the type of the gauge is **Gauge**.
10. Rename the label to **Temperature**.
11. Format of the value remain **{{value}}**.
12. Insert the unit as Degree Celsius symbol.
13. Range of the value, min: 0 and max: 100.
14. Other configurations is default.
15. Click the **Done** button to save the configurations.
16. Click the **Deploy** button.
17. Access the Node-RED Dashboard URL to view the dashboard with the Gauge widget.



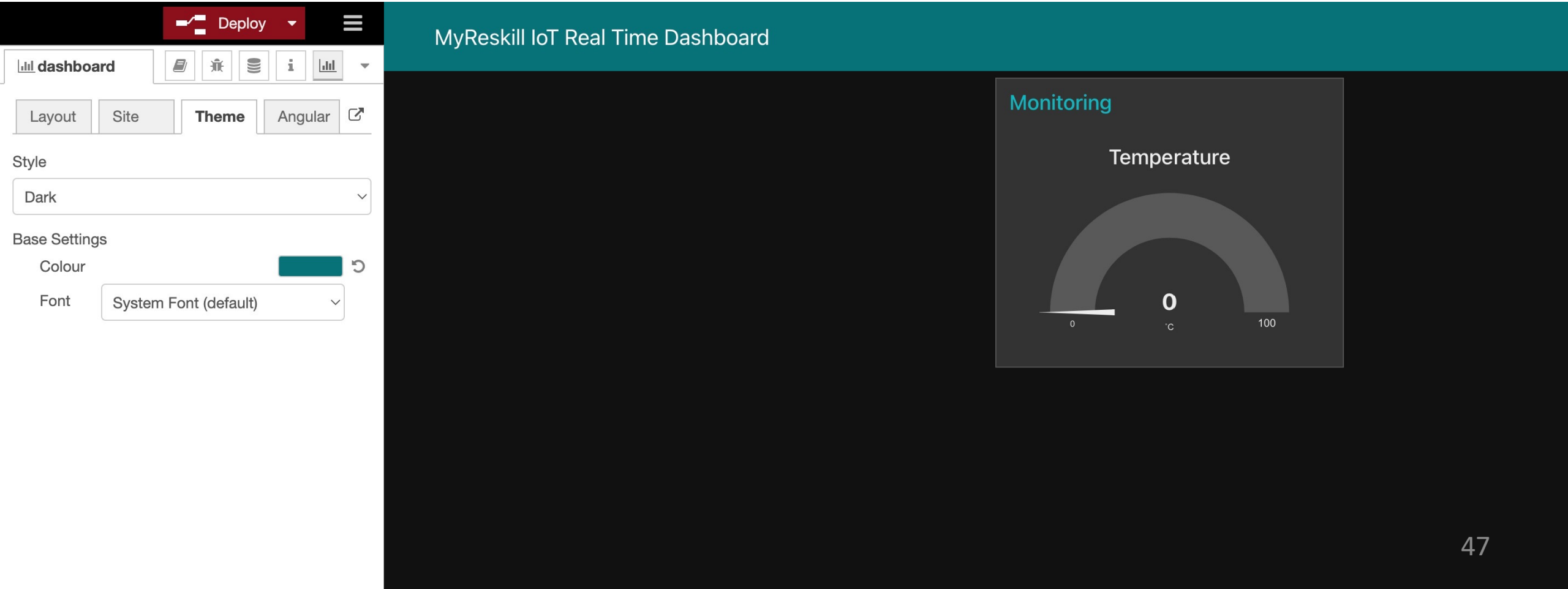
Node-RED Dashboard

Node-RED Dashboard light theme (default) with the Gauge widget.



Node-RED Dashboard

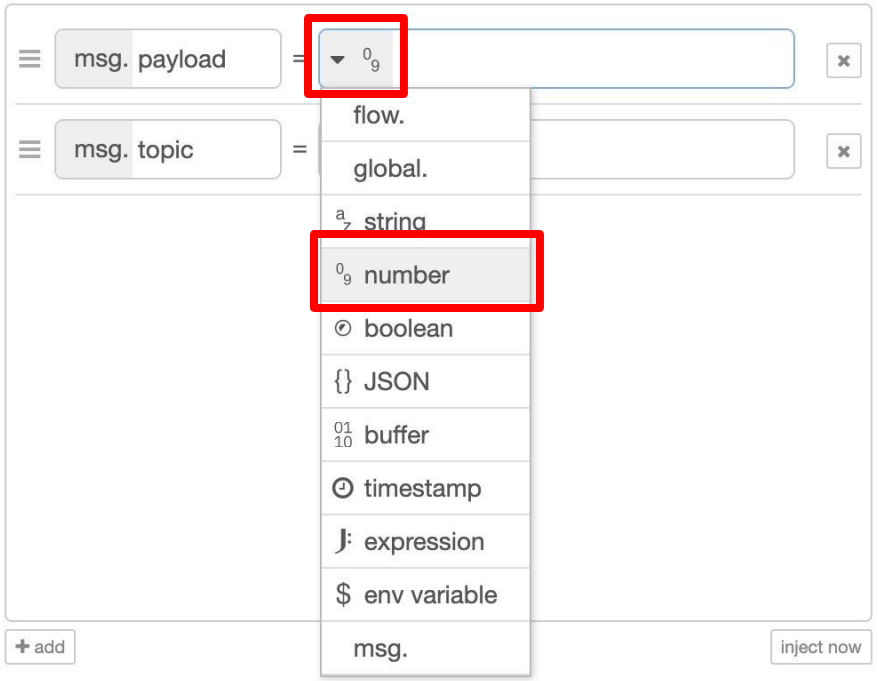
Node-RED Dashboard Theme Dark.

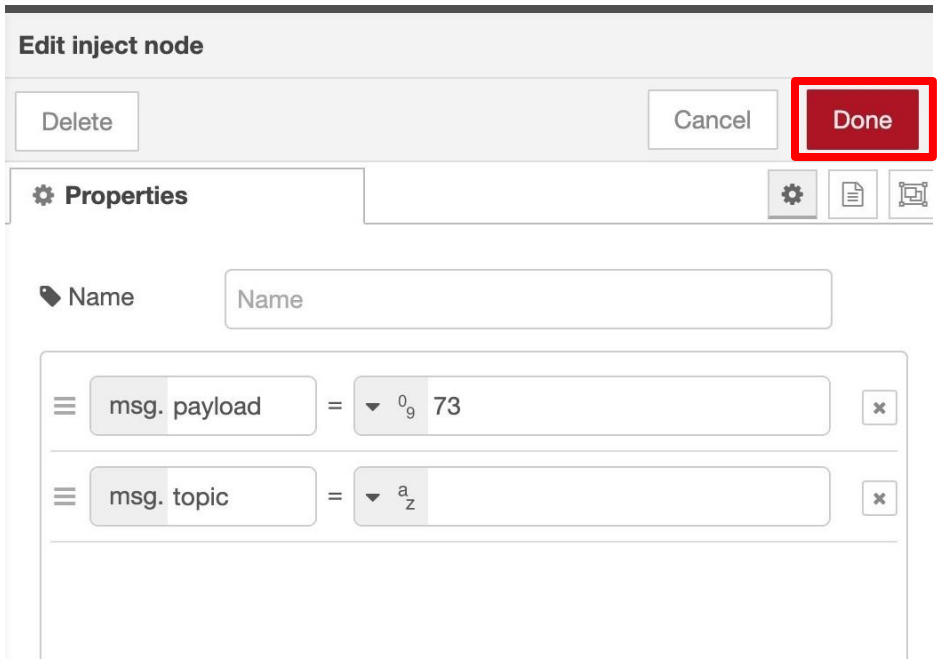


Node-RED Dashboard

Send Dummy Data to Gauge Widget (6 Steps)

1. Insert the **Inject** node into the workspace.
2. Double click the node and change the **msg.payload** data type to **number** and insert dummy value, such as 73 or 28 and click the **Done** button.

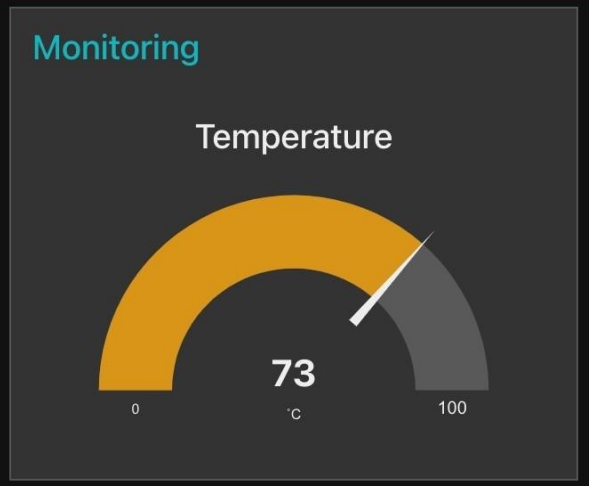




Node-RED Dashboard

3. Connect both of the nodes, the inject node and the gauge node.
4. Click the **Deploy** button.
5. Click the inject node button to inject the data to the gauge node.
6. View the dashboard for real-time data update.

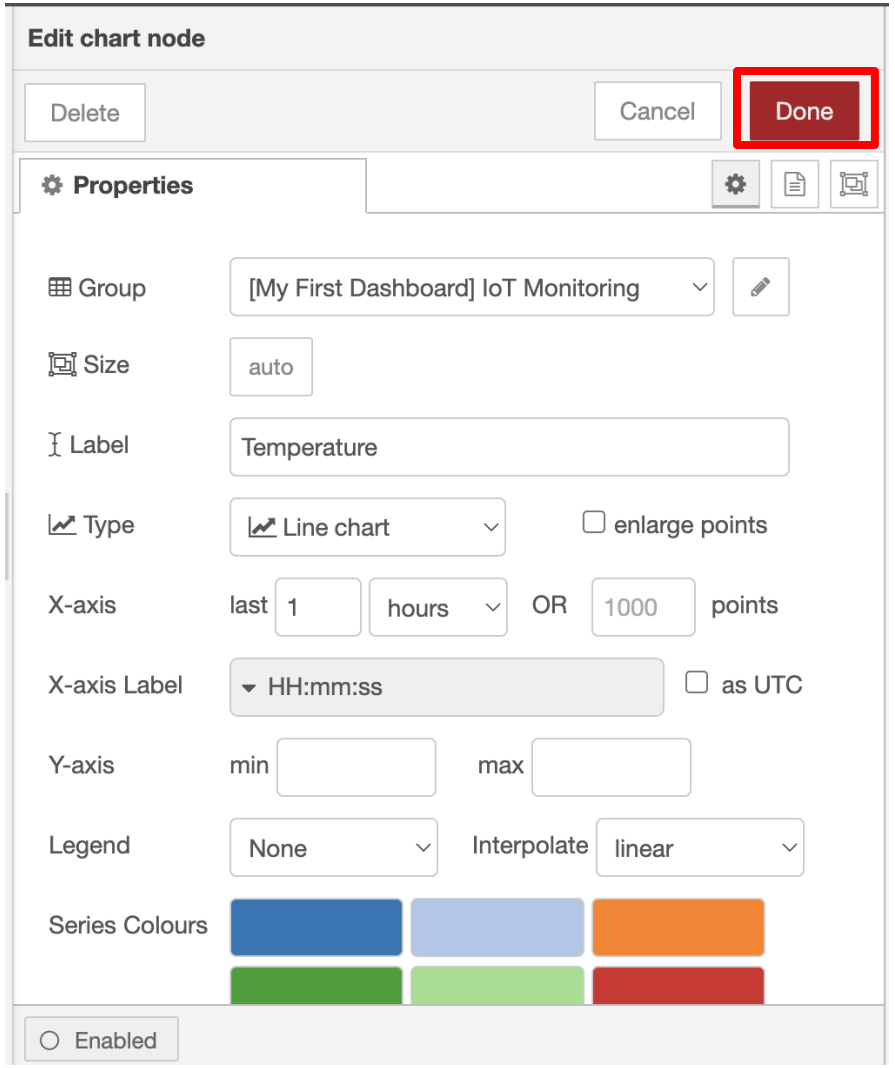
MyReskill IoT Real Time Dashboard



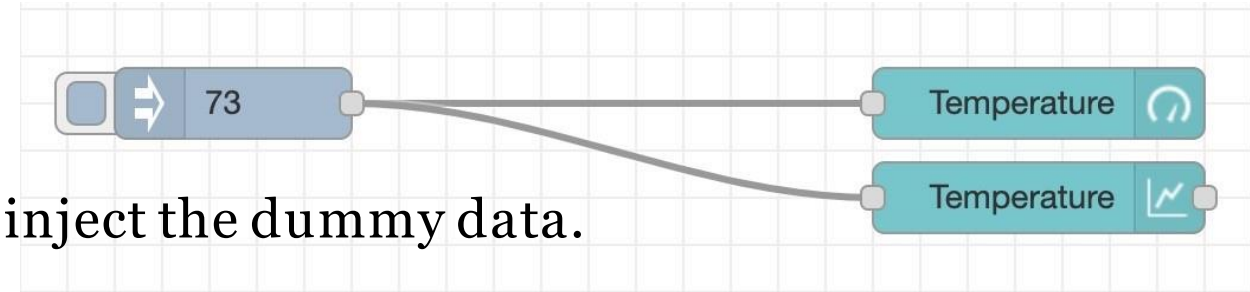
Node-RED Dashboard

Add Chart widget to the Node-RED Dashboard (13 Steps)

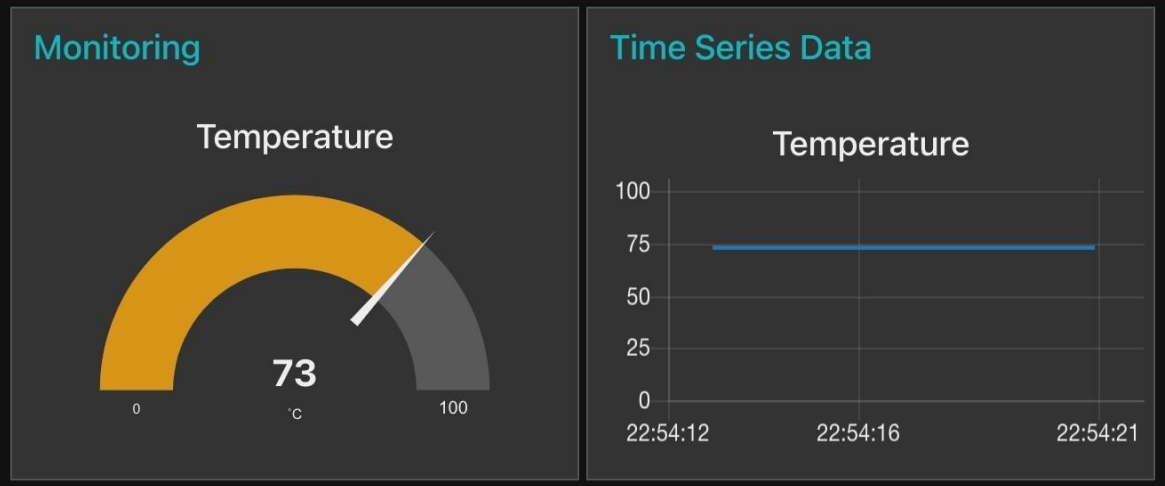
1. Insert **chart** node into the workspace.
2. Double click the node to edit the properties.
3. Click the group and choose **Add new dashboard group…**
4. Click the **pencil icon**.
5. Change the default group name to **Time Series Data**.
6. Click the **Add** button to continue.
7. Change the label to **Temperature**.
8. Y-axis, min value is 0 and max value is 100.
9. Click the **Done** button.
10. Connect the **chart** node with the dummy data **inject** node.



Node-RED Dashboard



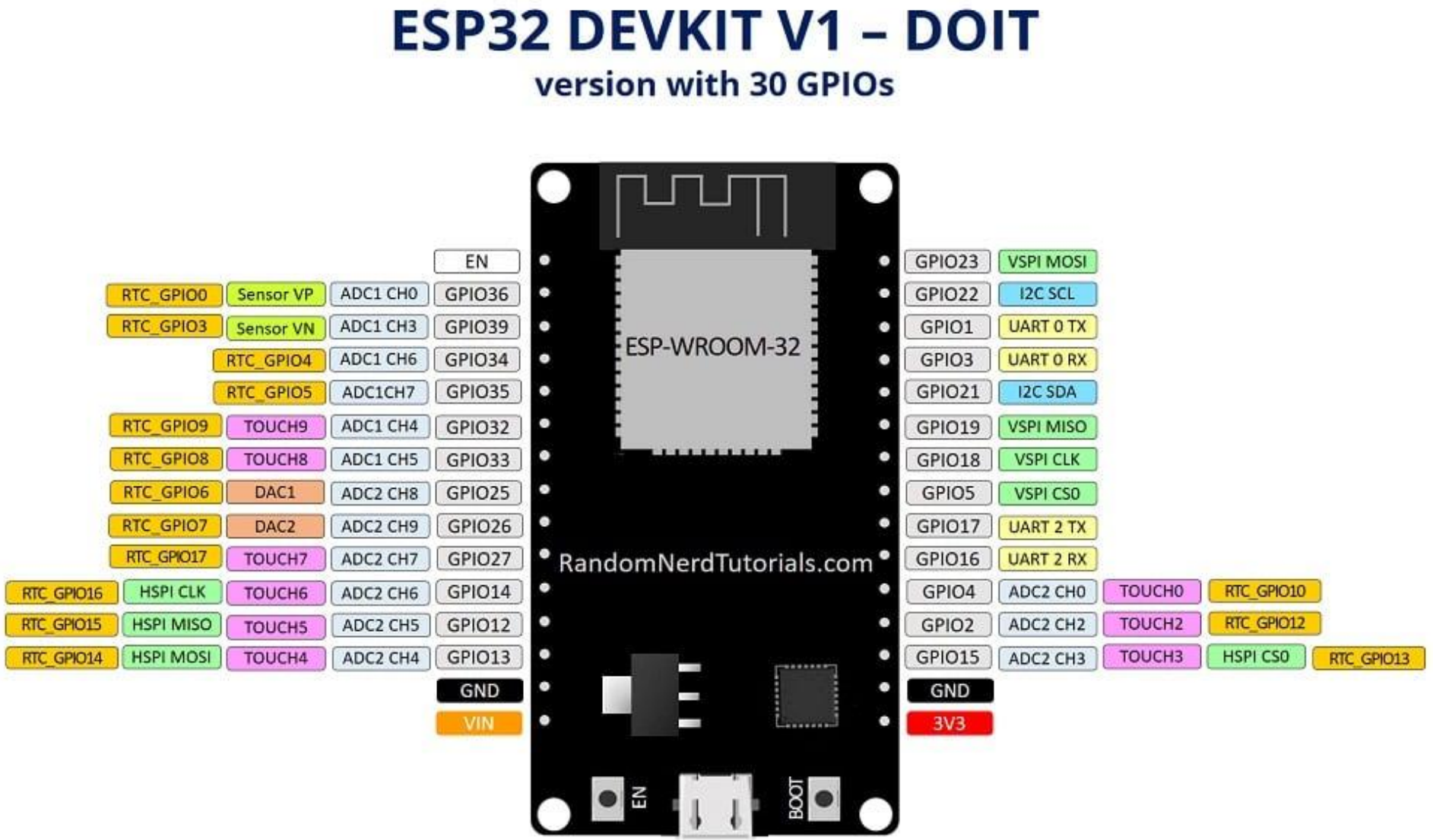
11. Click the **Deploy** button.
12. Click the **inject** node button several time to inject the dummy data.
13. View the dashboard for real-time data update.



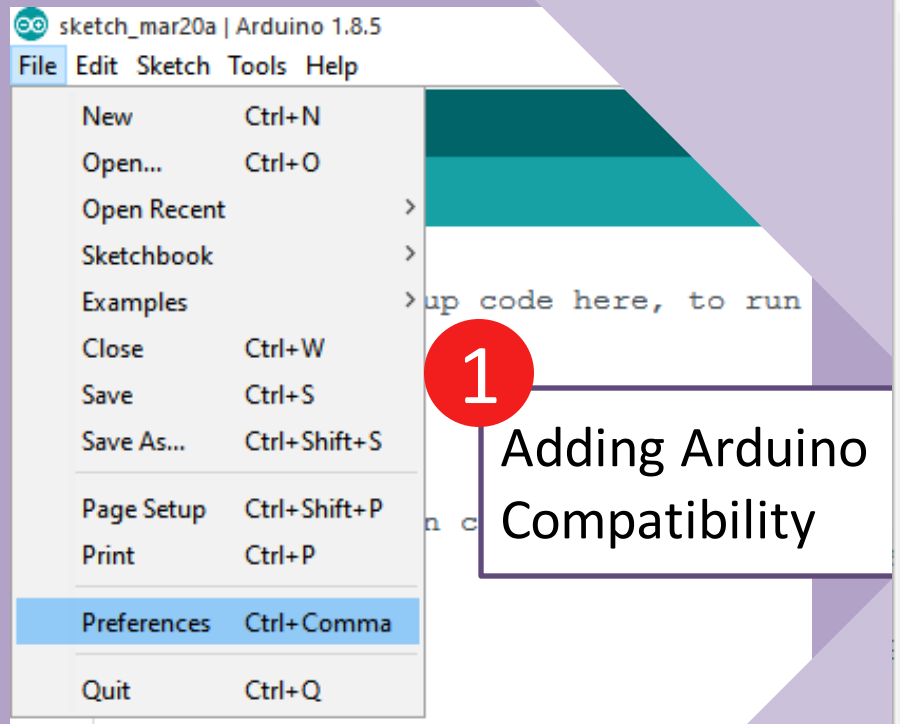
Getting Started with ESP32

Setting up ESP32 with input and output

ESP32 PIN Mapping

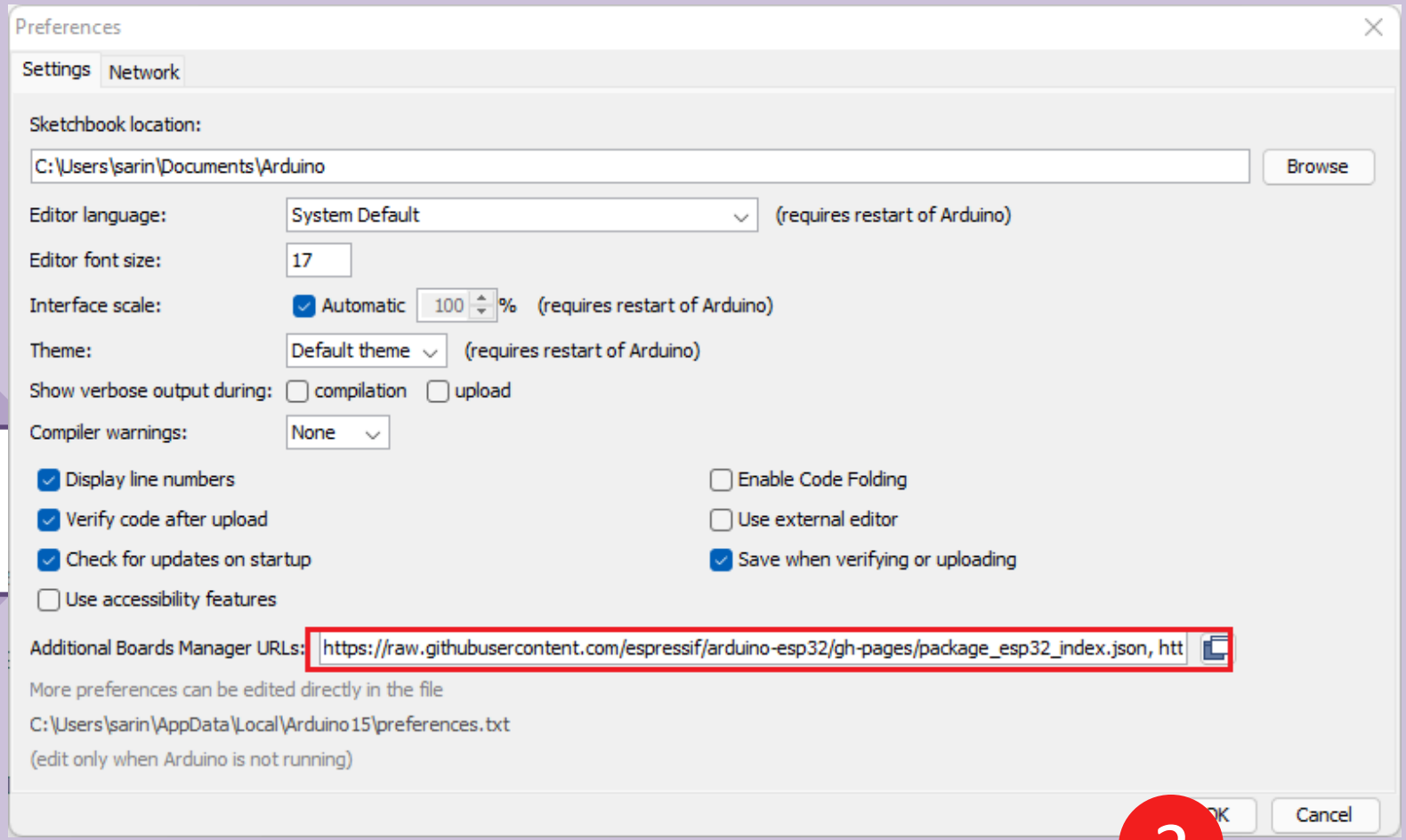


ESP32 Setup



1

Adding Arduino Compatibility

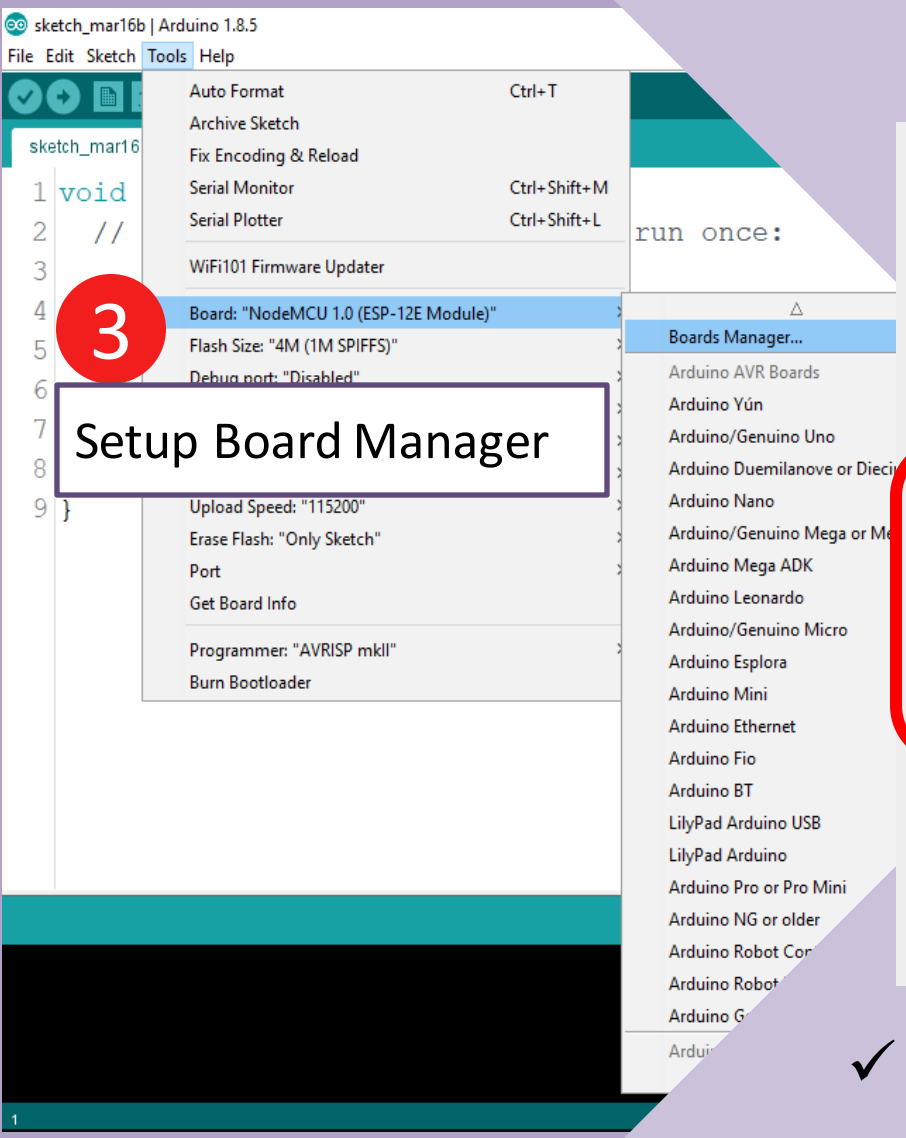


2

Type in:

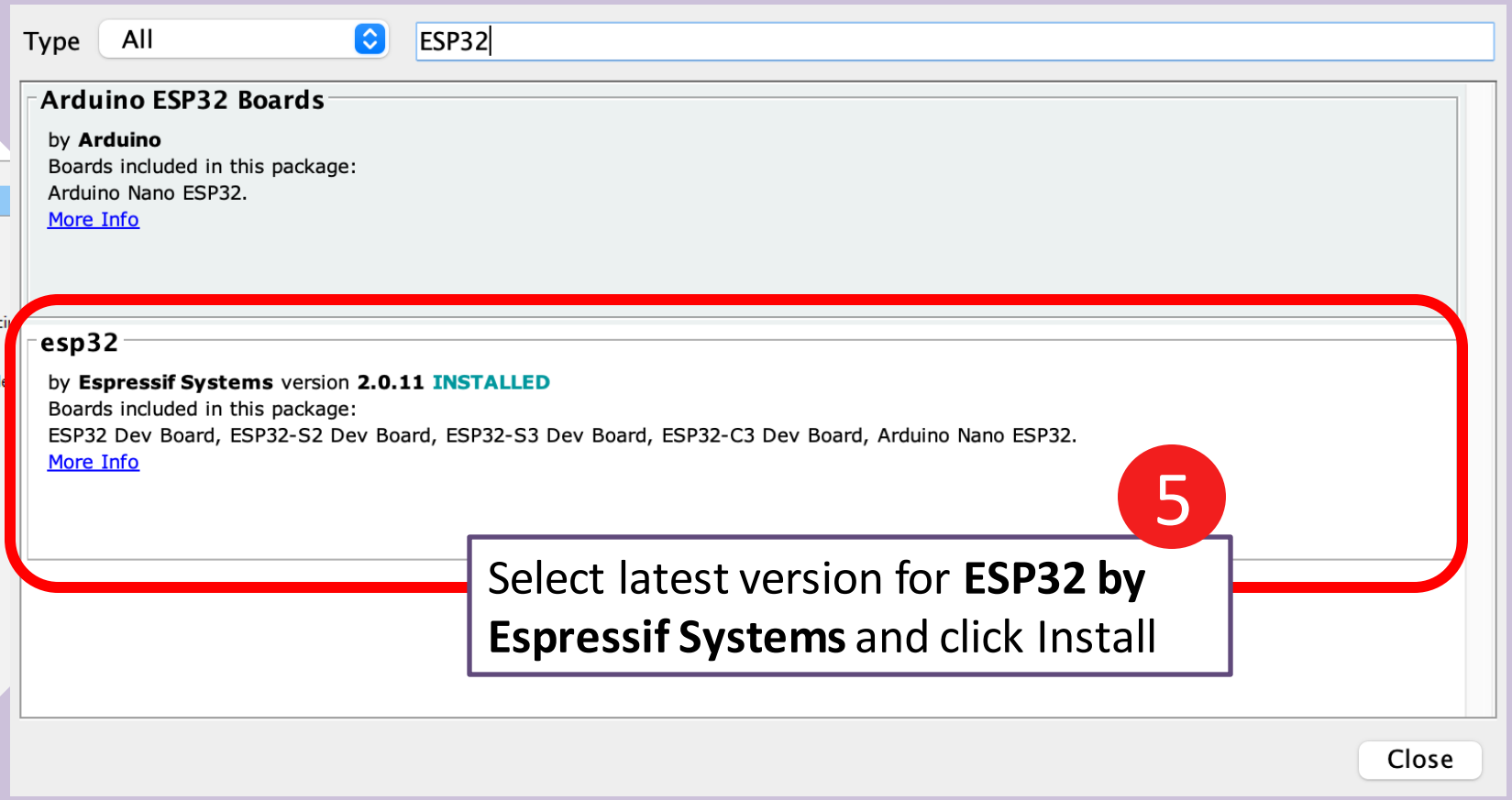
https://raw.githubusercontent.com/espressif/arduino-esp32/gh-pages/package_esp32_index.json

ESP32 Setup



3 Setup Board Manager

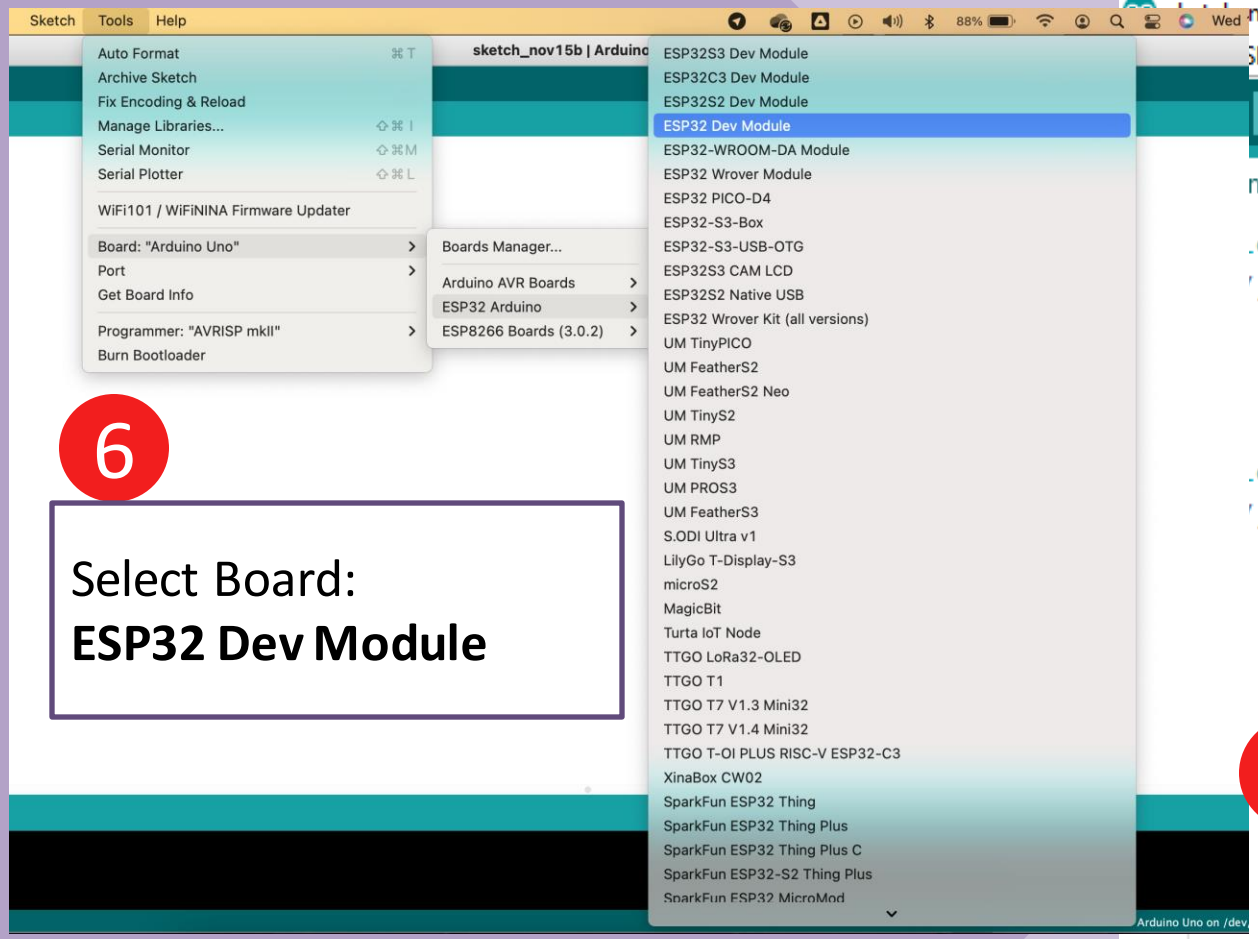
4 Type in **ESP32**



5 Select latest version for **ESP32 by Espressif Systems** and click Install

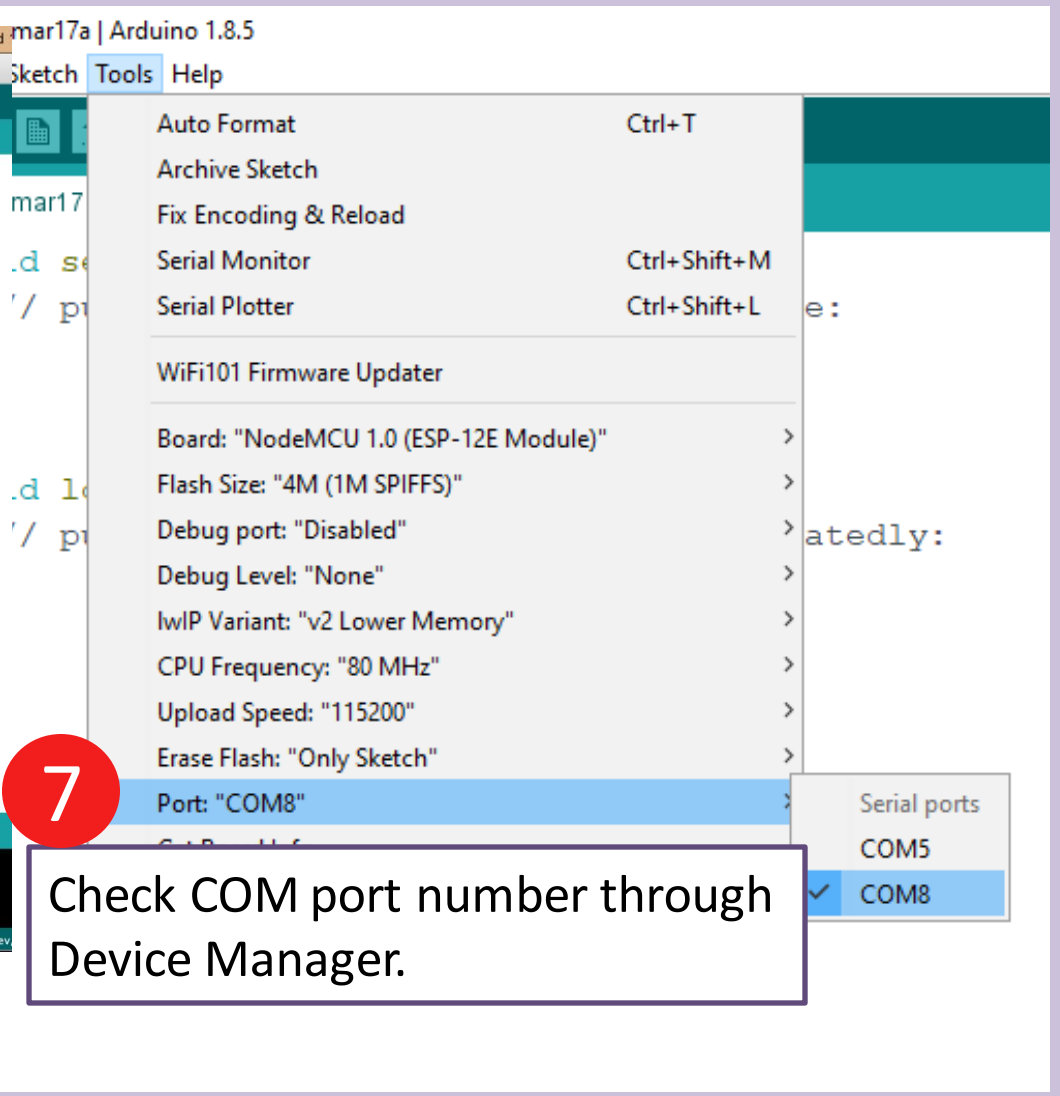
✓ Click **Close**, when the installation process is completed.

ESP32 Setup



6

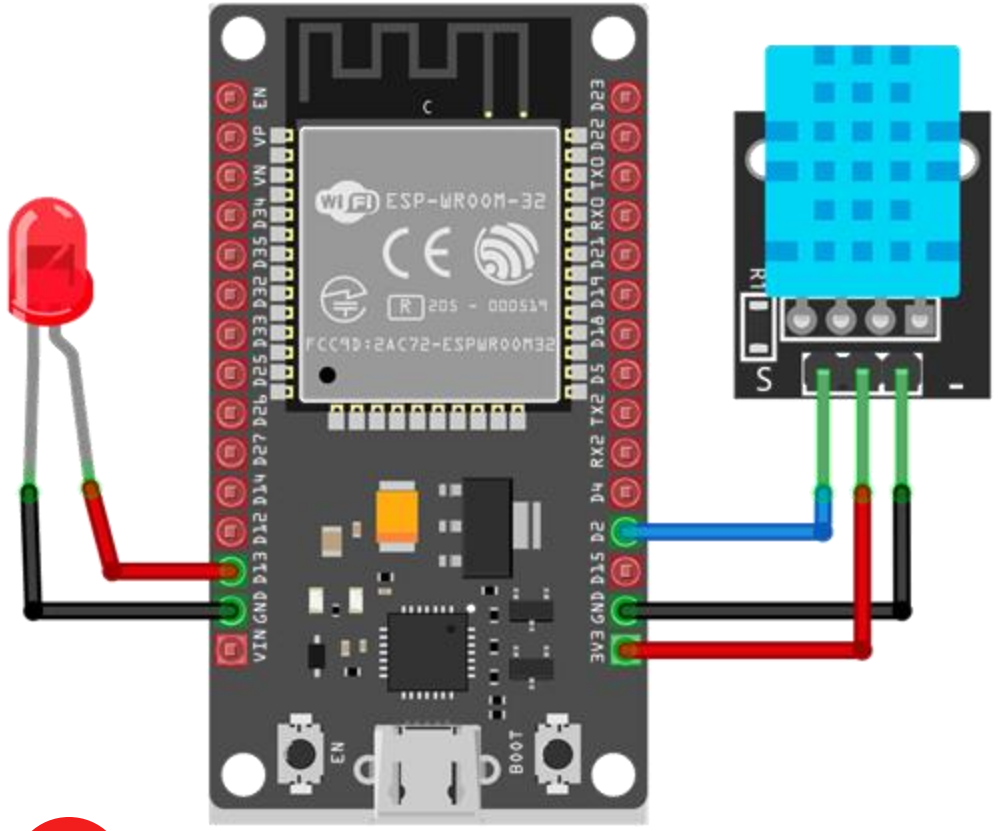
Select Board:
ESP32 Dev Module



7

Check COM port number through Device Manager.

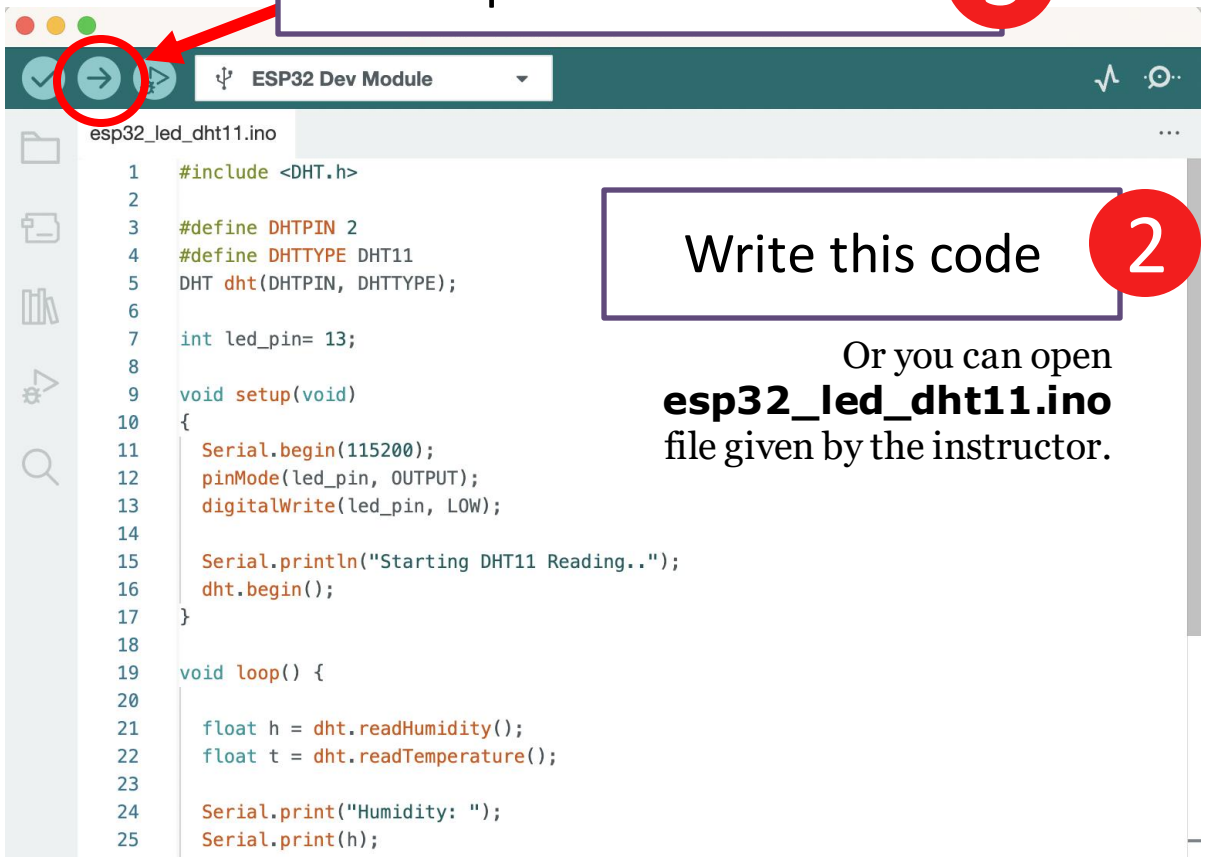
Getting Started with ESP32



1

Setup this board

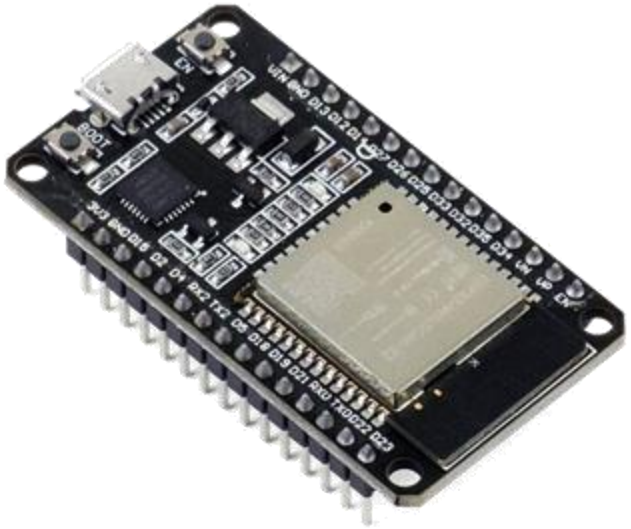
Upload to board 3



Write this code 2

Or you can open **esp32_led_dht11.ino** file given by the instructor.

Open Serial Monitor and observe the output. 4



Node-RED

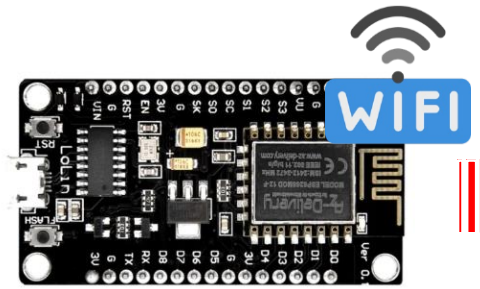
ESP32 & Node-RED

Integrating the IoT devices with the IoT middleware

ESP32 with Node-RED

Basic IoT architecture using Node-RED as the middleware.

IOT DEVICES



Data Capturing
using Sensors

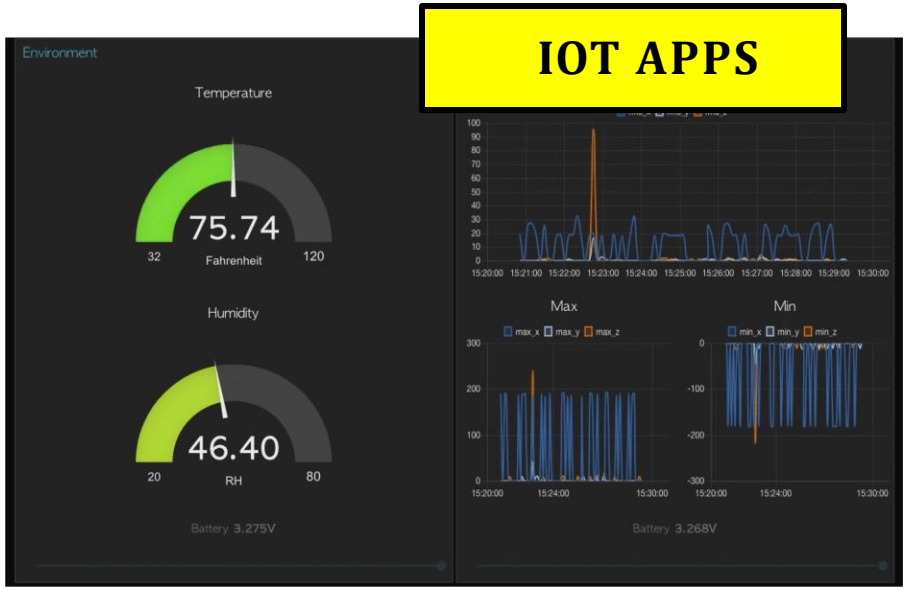
Protocol
MQTT

IOT MIDDLEWARE

Node-RED

Protocol
HTTP

IOT APPS



Data Visualization (Dashboard)
Data Monitoring

Telegram
Data Alert & Notification

Google Sheets
Data Storage

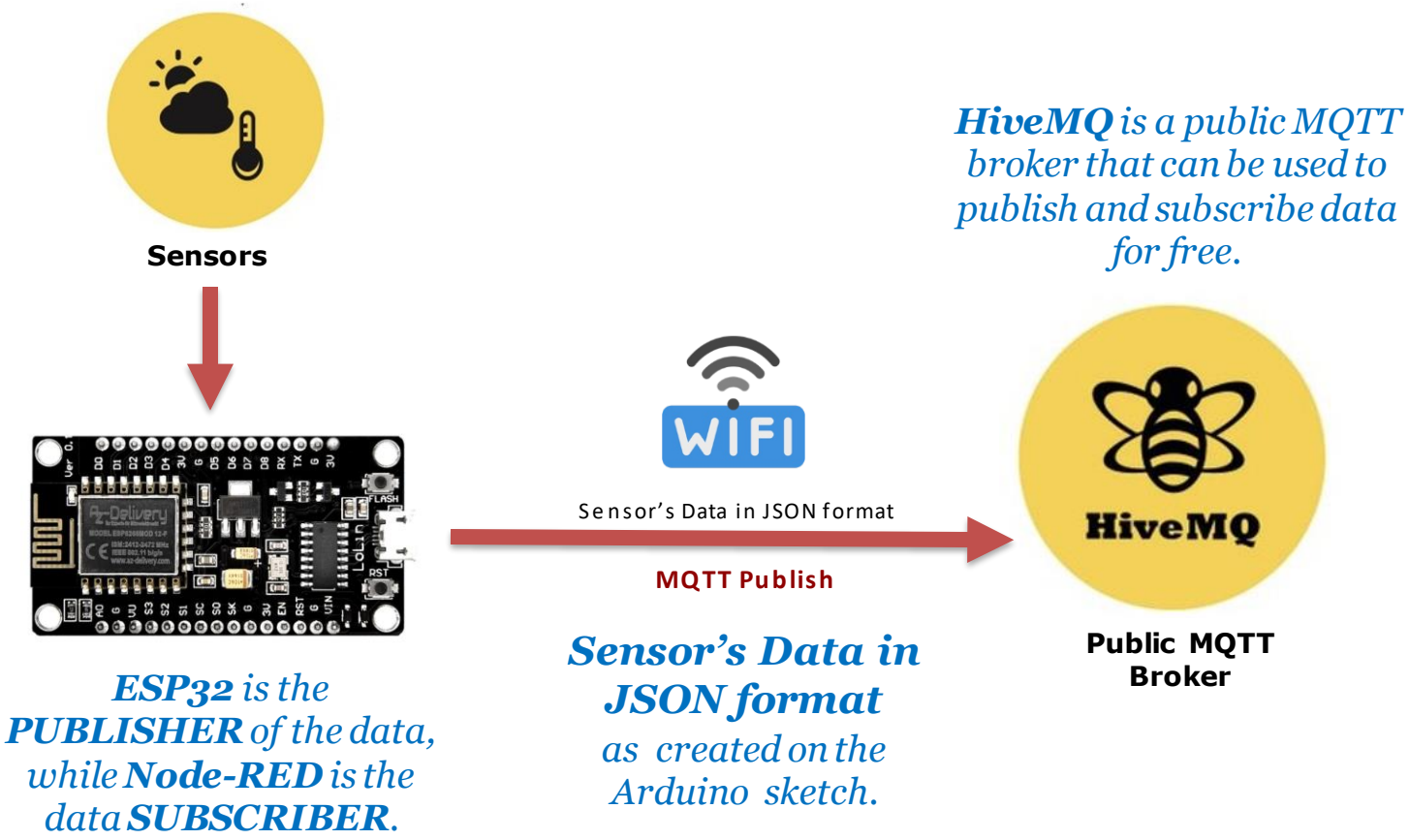
Data Studio
Data Visualization (Dashboard)
Data Analytics

DATA FROM THINGS, MACHINE | **HUMAN, DECISION MAKING**

ESP32 publish MQTT to Broker

The connectivity of ESP32 with HiveMQ public MQTT broker.

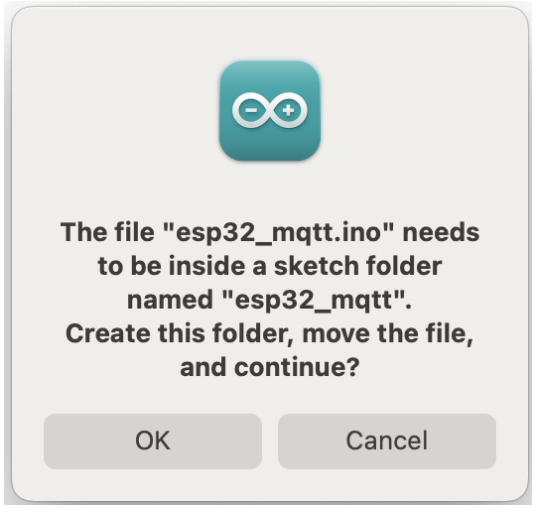
The architecture:

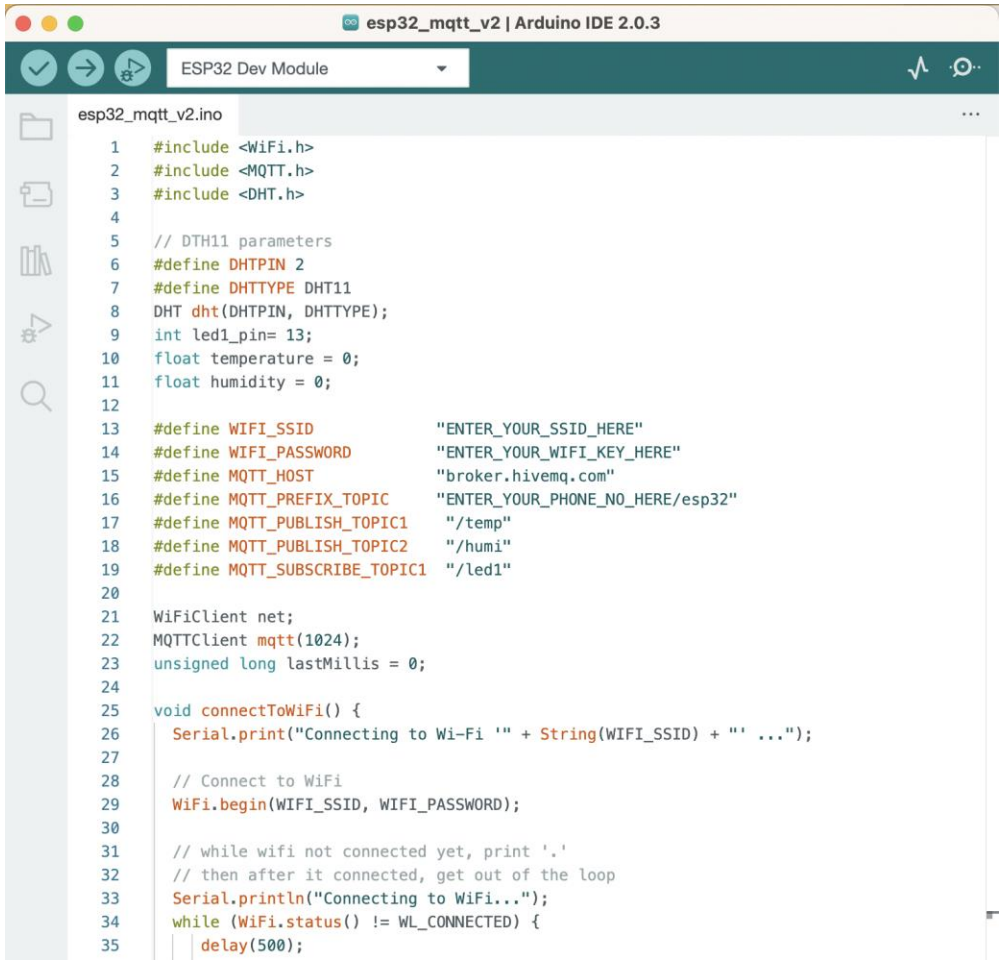


ESP32 publish MQTT to Broker

Open ESP32 Example Sketch (3 Steps)

1. Open the **esp32_mqtt.ino** given by your instructor.
2. Double click the file to open it on Arduino IDE.
3. Click **OK** on the Moving pop-up window. The file will be added inside a folder with named followed by the file name.





ESP32 publish MQTT to Broker

ARDUINO SKETCH EXPLAIN

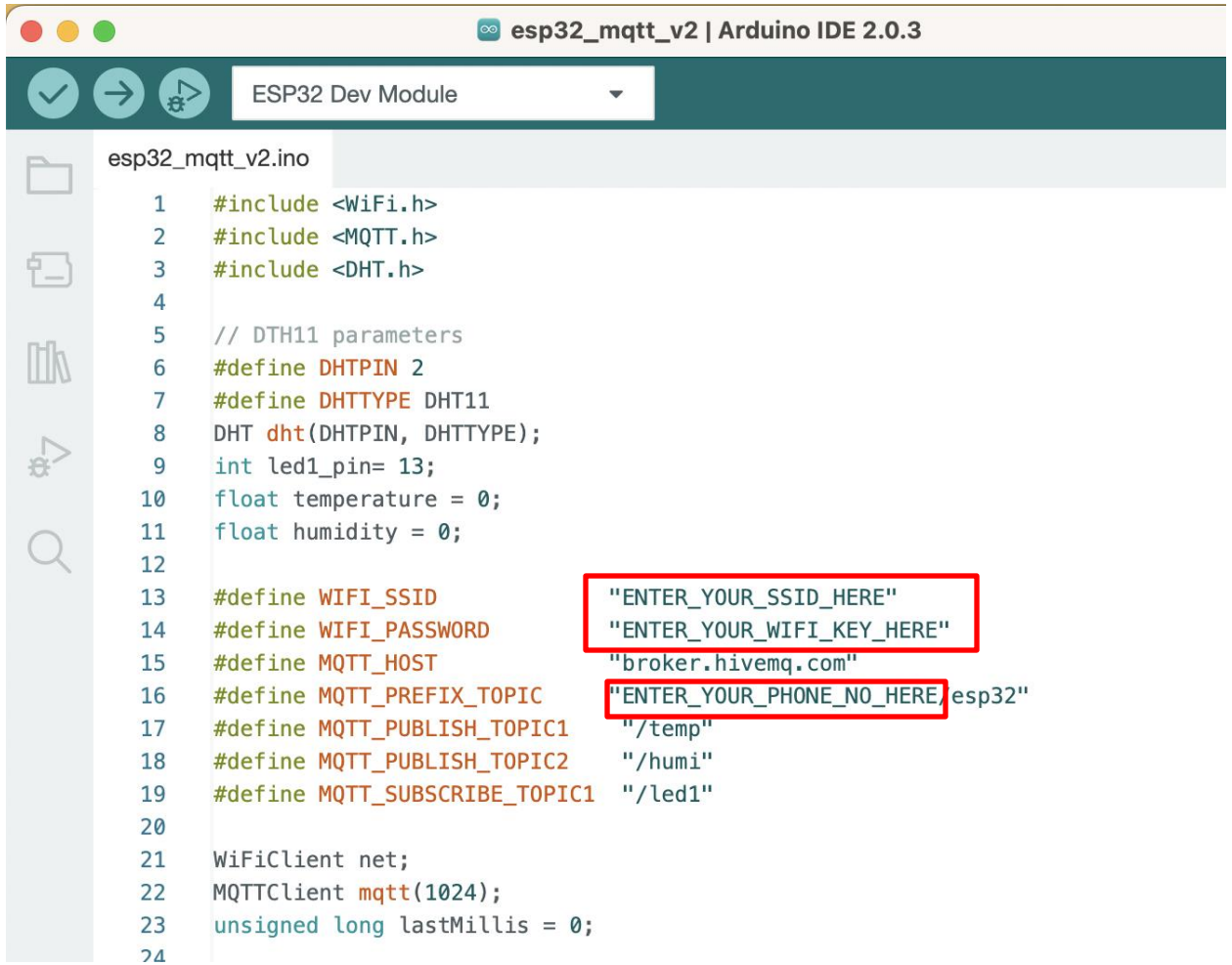
It is a complete program, as sets of function for ESP32 microcontroller to execute tasks:

EXECUTE ONCE

1. Connect to nearest Wi-Fi access point.
2. Connect to public MQTT broker.

EXECUTE REPEATEDLY

3. Check if ESP32 Wi-Fi's disconnected to reconnect to the Wi-Fi access point.
4. Check if connection to public MQTT broker disconnected to reconnect.



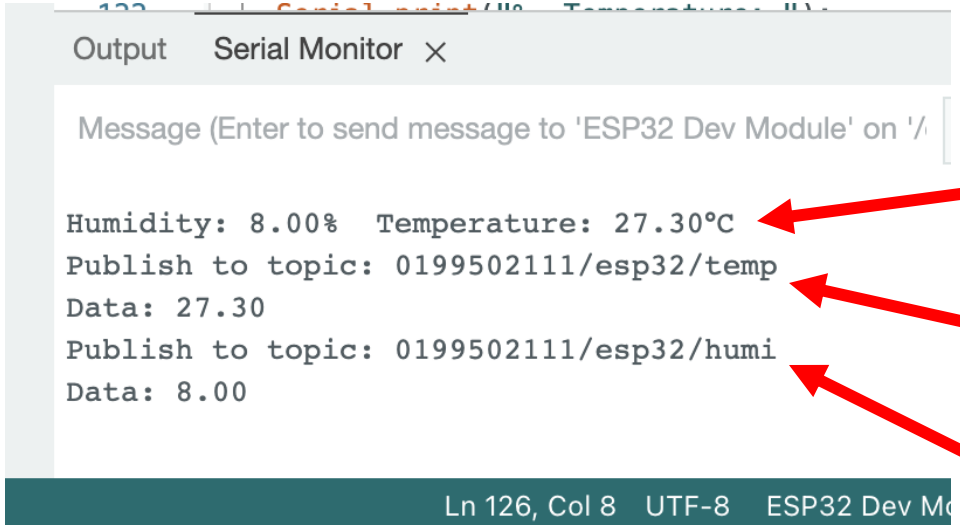
ESP32 publish MQTT to Broker

5. Read DHT11 sensor value:
   - Temperature, ˚C
   - Humidity, %
6. Print the sensor values on the Serial Monitor.
7. Convert Temperature sensor reading to String and publish to broker
8. Convert Humidity sensor reading to String and publish to broker
9. Repeat step 5 to 8 in every 5 seconds.

```
109   if (!mqtt.connected()) {
110     connectToMqttBroker();
111   }
112
113   if (millis() - lastMillis > 5000) { // publish every 5 seconds
114     lastMillis = millis();
115
116     // Read DHT11 sensors
117     float humidity = dht.readHumidity();
118     float temperature = dht.readTemperature();
119
120     Serial.print("Humidity: ");
121     Serial.print(humidity);
122     Serial.print("%  Temperature: ");
123     Serial.print(temperature);
124     Serial.println("°C ");
125
126     // Convert sensor reading to String and publish to broker
127     String strTemp = String(temperature);
128     Serial.println("Publish to topic: " + String(MQTT_PREFIX_TOPIC) + String(MQTT_PUBLI
129     Serial.println("Data: " + strTemp);
130     mqtt.publish(String(MQTT_PREFIX_TOPIC) + String(MQTT_PUBLISH_TOPIC1), strTemp);
131
132     // Convert sensor reading to String and publish to broker
133     String strHumi = String(humidity);
134     Serial.println("Publish to topic: " + String(MQTT_PREFIX_TOPIC) + String(MQTT_PUBLI
135     Serial.println("Data: " + strHumi);
136     mqtt.publish(String(MQTT_PREFIX_TOPIC) + String(MQTT_PUBLISH_TOPIC2), strHumi);
137
138   }
139   Serial.println("..");
140   delay(500);
141 }
```

ESP32 publish MQTT to Broker

The result of **Step No. 6, 7 & 8** on the Serial Monitor as shown in the image below.




```
109   if (!mqtt.connected()) {
110     connectToMqttBroker();
111   }
112
113   if (millis() - lastMillis > 5000) { // publish every 5 seconds
114     lastMillis = millis();
115
116     // Read DHT11 sensors
117     float humidity = dht.readHumidity();
118     float temperature = dht.readTemperature();
119
120     Serial.print("Humidity: ");
121     Serial.print(humidity);
122     Serial.print("%  Temperature: ");
123     Serial.print(temperature);
124     Serial.println("°C ");
125
126     // Convert sensor reading to String and publish to broker
127     String strTemp = String(temperature);
128     Serial.println("Publish to topic: " + String(MQTT_PREFIX_TOPIC) + String(MQTT_PUBLI
129     Serial.println("Data: " + strTemp);
130     mqtt.publish(String(MQTT_PREFIX_TOPIC) + String(MQTT_PUBLISH_TOPIC1), strTemp);
131
132     // Convert sensor reading to String and publish to broker
133     String strHumi = String(humidity);
134     Serial.println("Publish to topic: " + String(MQTT_PREFIX_TOPIC) + String(MQTT_PUBLI
135     Serial.println("Data: " + strHumi);
136     mqtt.publish(String(MQTT_PREFIX_TOPIC) + String(MQTT_PUBLISH_TOPIC2), strHumi);
137
138   }
139   Serial.println("..");
140   delay(500);
141 }
```

ESP32 publish MQTT to Broker

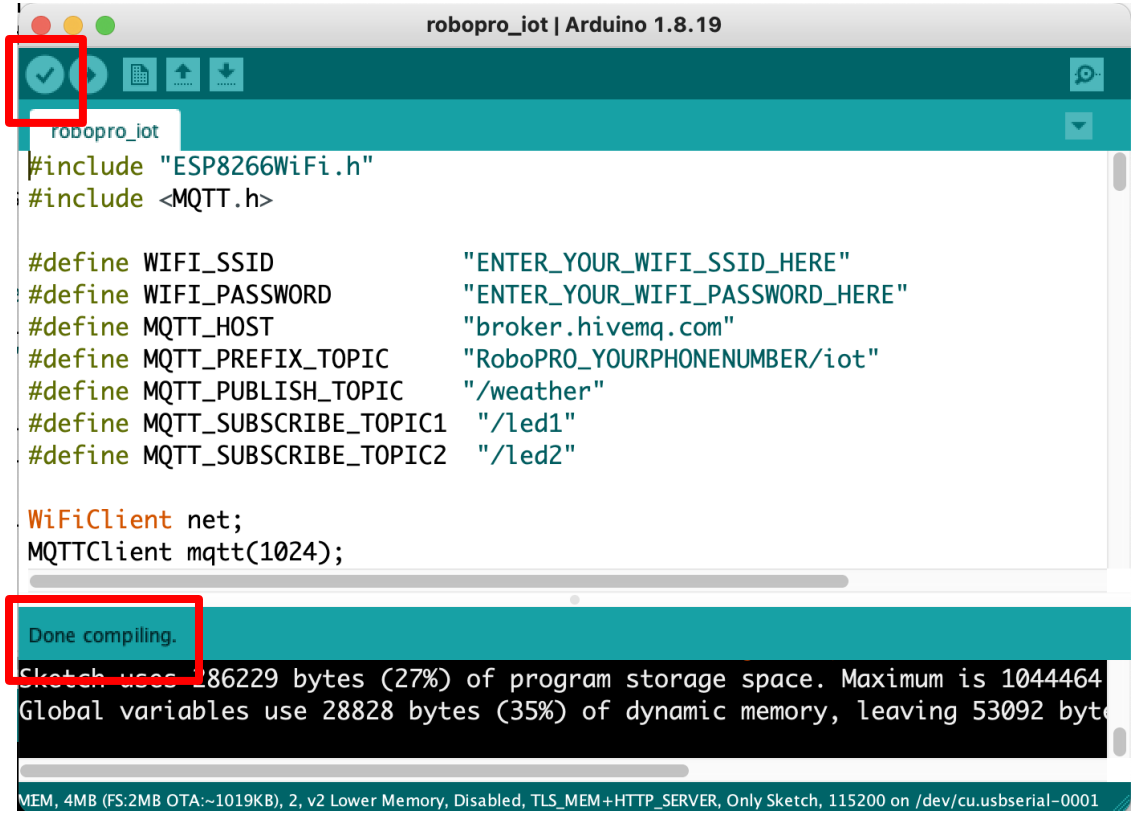
Install MQTT Library (4 Steps)

1. Go to menu, **Tools > Manage Libraries ...**

2. On Library Manager window, type in **MQTT** on the field to filter the list of libraries.
3. Click the **Install** button on the MQTT Library and wait until it is done.

ESP32 publish MQTT to Broker

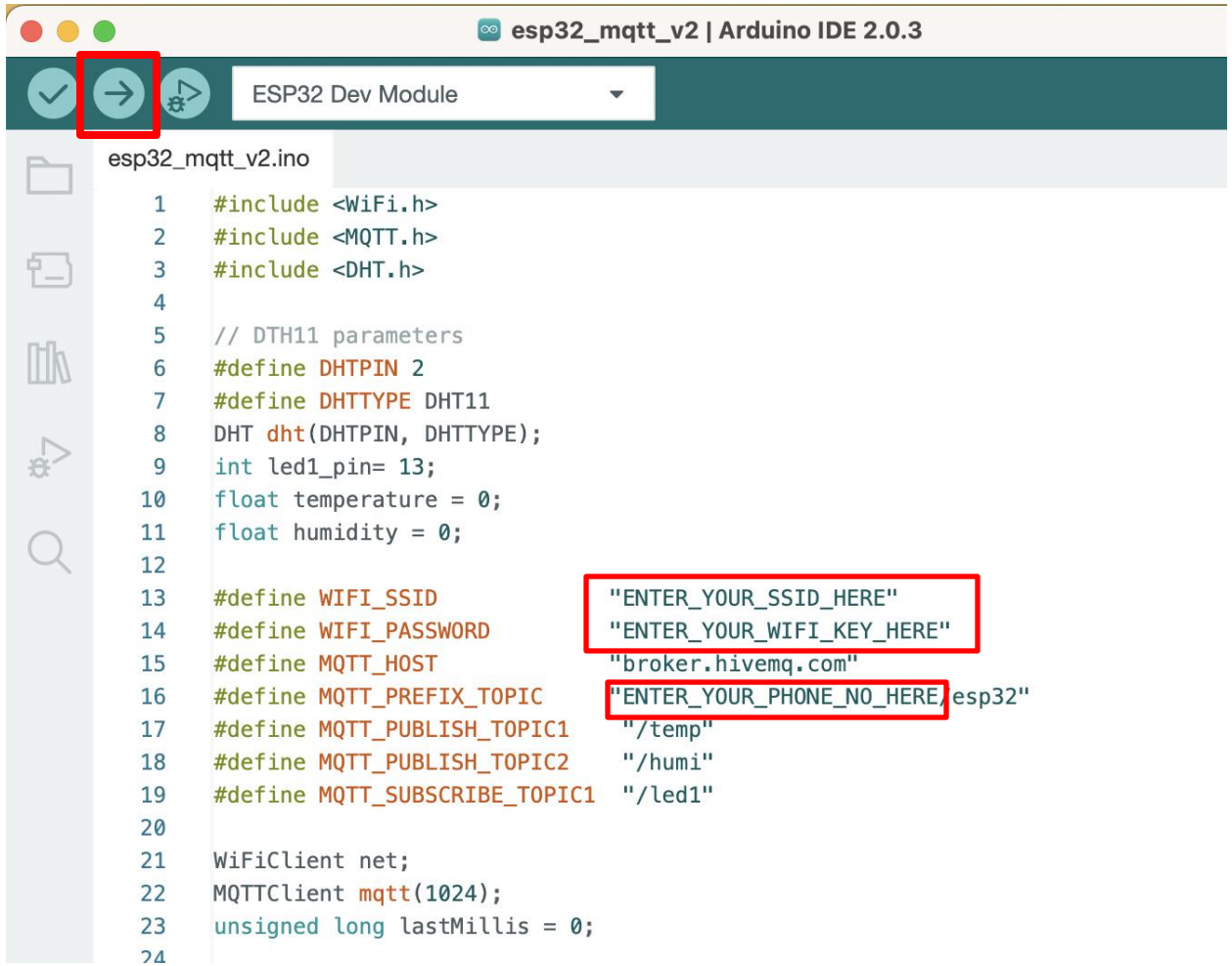
4. Click the verify button to compile the example sketch.
   If the status is **Done compiling**, the library installation is successful without error.



ESP32 publish MQTT to Broker

Upload Example Sketch (4 Steps)

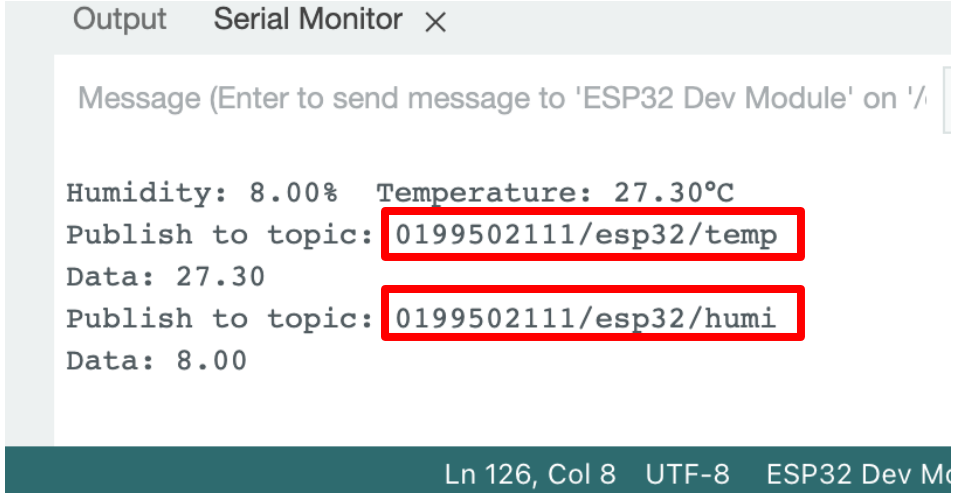
1. Replace the **WIFI_SSID** value to the correct information of your Wi-Fi name.
2. Replace the **WIFI_PASSWORD** value to the correct information your Wi-Fi password.
3. Replace the **MQTT_PREFIX_TOPIC** of mobile number with your own mobile number.
4. Click the **Upload** button to compile and upload the program into the ESP32 microcontroller, wait until the status is **Done uploading**.



ESP32 publish MQTT to Broker

Get the MQTT Publish Topic (3 Steps)

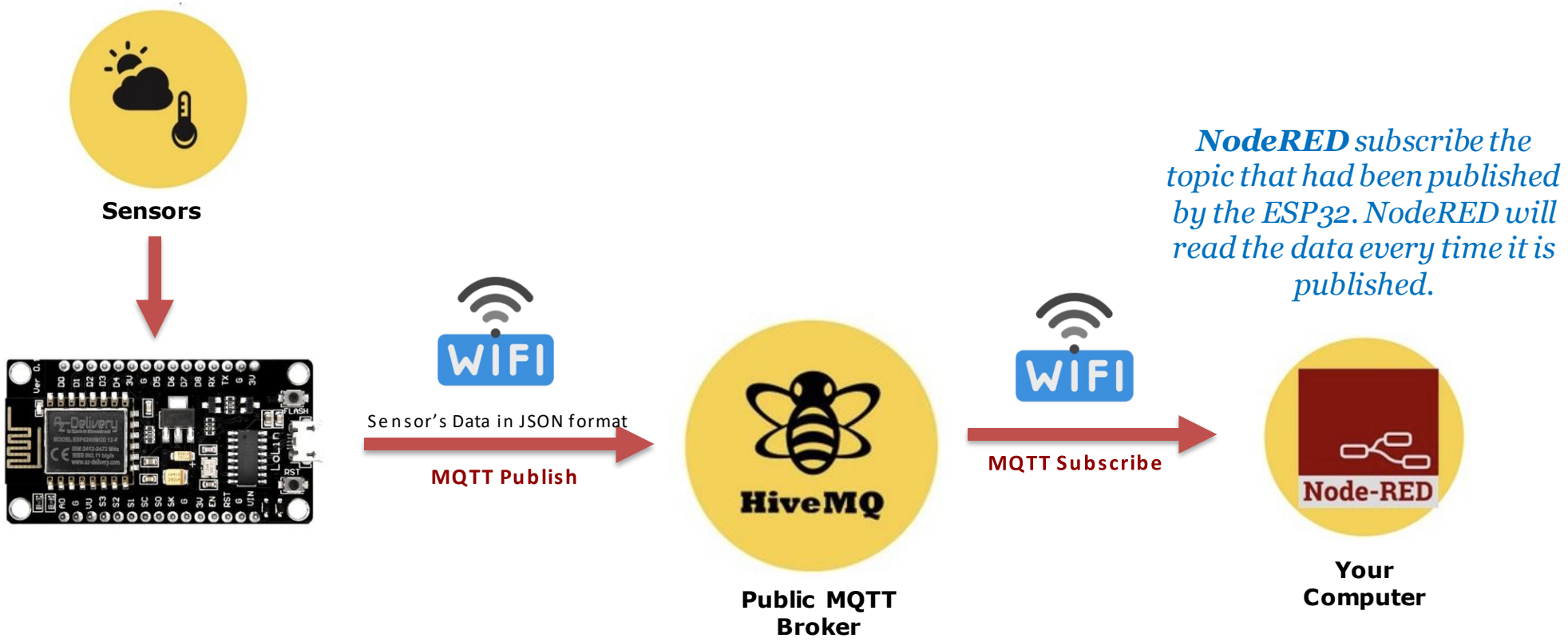
1. Open the Serial Monitor. If the result is not right (gibberish) as shown on the right image below, make sure the baud rate is **115200**.
2. Wait until around 5 seconds to see the data publish to MQTT topic as shown below.
3. Copy the **Publish to:** MQTT topic (as highlighted) below. This topic will be use to subscribe by Node-RED node.



Node-RED subscribe MQTT from Broker

The connectivity of ESP32 and Node-RED is via HiveMQ public MQTT broker.

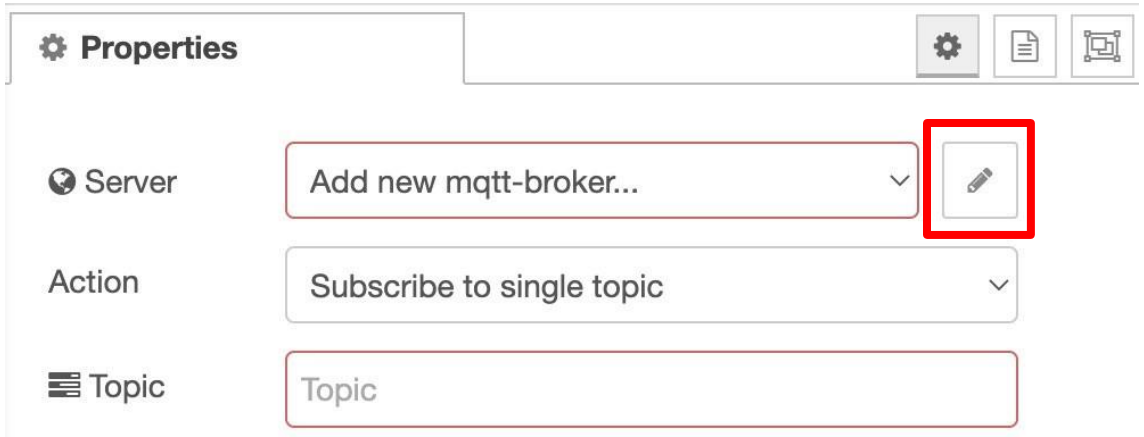
The architecture:



Node-RED subscribe MQTT from Broker

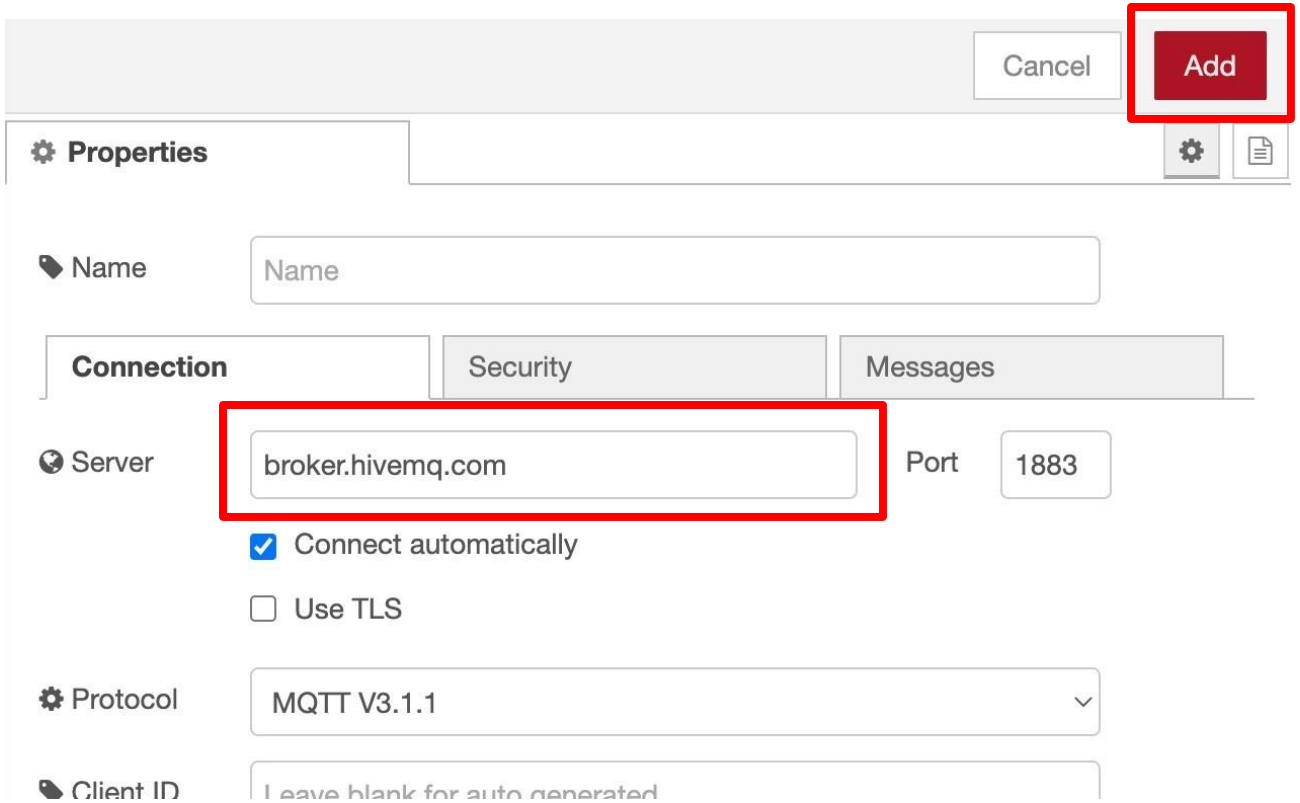
Node-RED Receive JSON Data from ESP32 (10 Steps)

1. Insert **mqtt in** node into the workspace (can be found in **Network** palette).
2. Double click the node to edit the properties.
3. Add new MQTT broker setup by clicking the pencil icon.



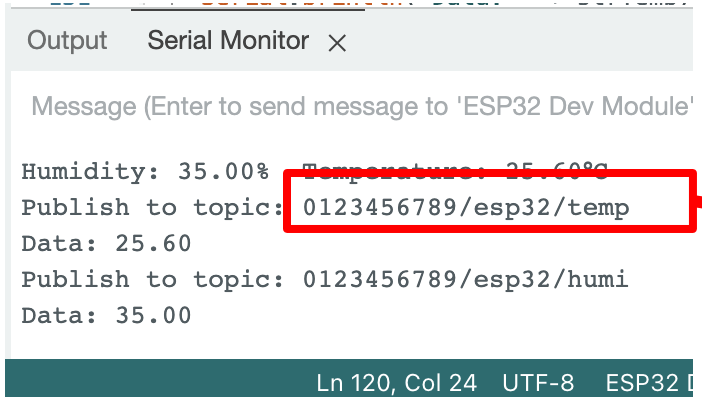
Node-RED subscribe MQTT from Broker

4. Type in **broker.hivemq.com** to the **Server** field.
5. Left others configuration as default.
6. Click the **Add** button to confirm adding the MQTT broker.

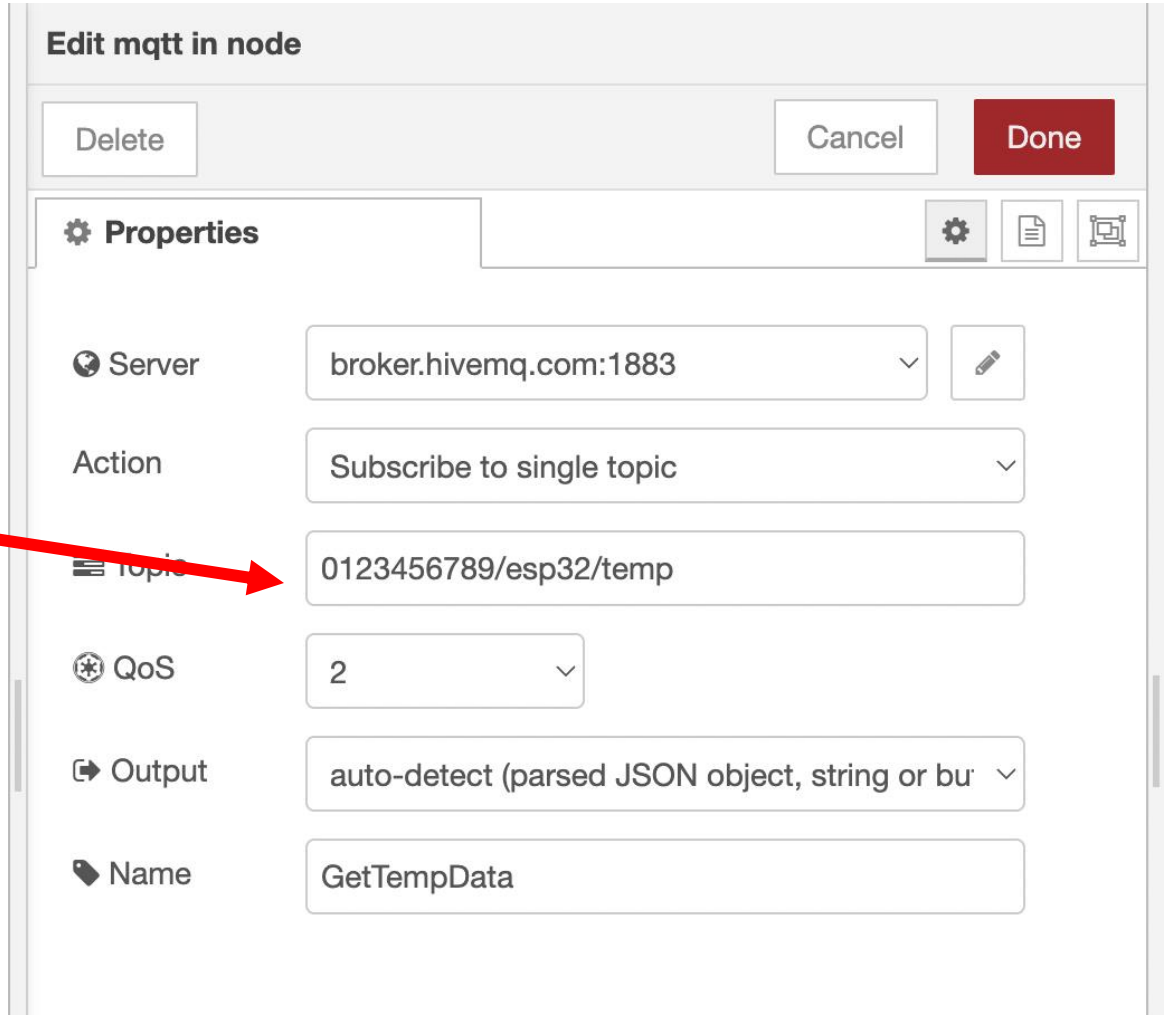


Node-RED subscribe MQTT from Broker

4. Set MQTT topic to provided MQTT topic by ESP32, from the Serial Monitor.

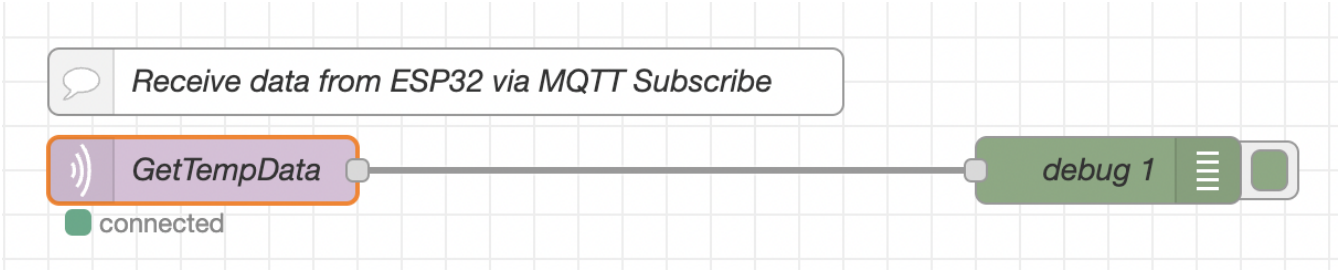


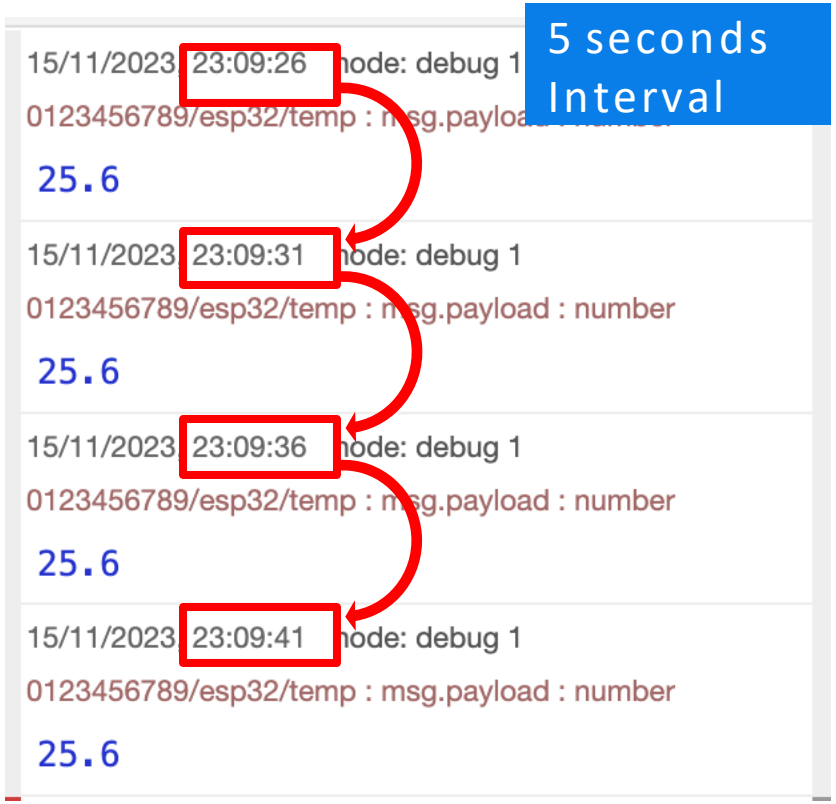
5. The Name of the node is **GetTempData**.
6. Leave other configurations as default.
7. Click the **Done** button to confirm the **mqtt in** node properties configuration.



Node-RED subscribe MQTT from Broker

8. Insert **debug** node into the workspace and connect with **mqtt in** node.

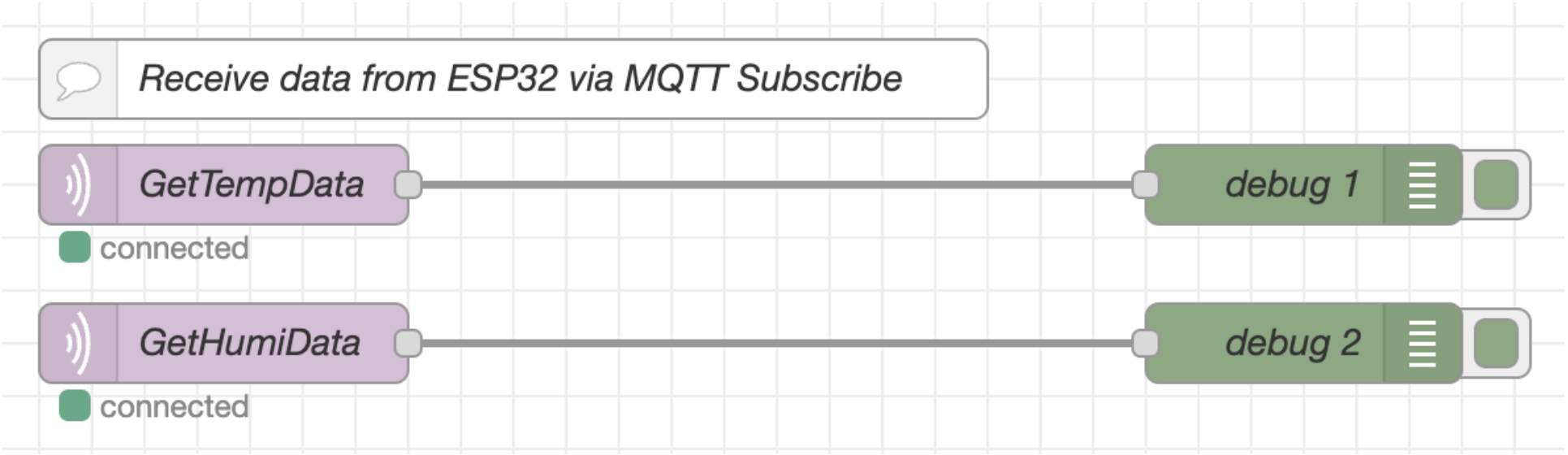




9. Click the **Deploy** button to redeploy the flow.
10. Observe the incoming JSON payload on the Node-RED's debug sidebar from the MQTT topic published by ESP32, where the time interval as it is **5 seconds**.

Node-RED subscribe MQTT from Broker

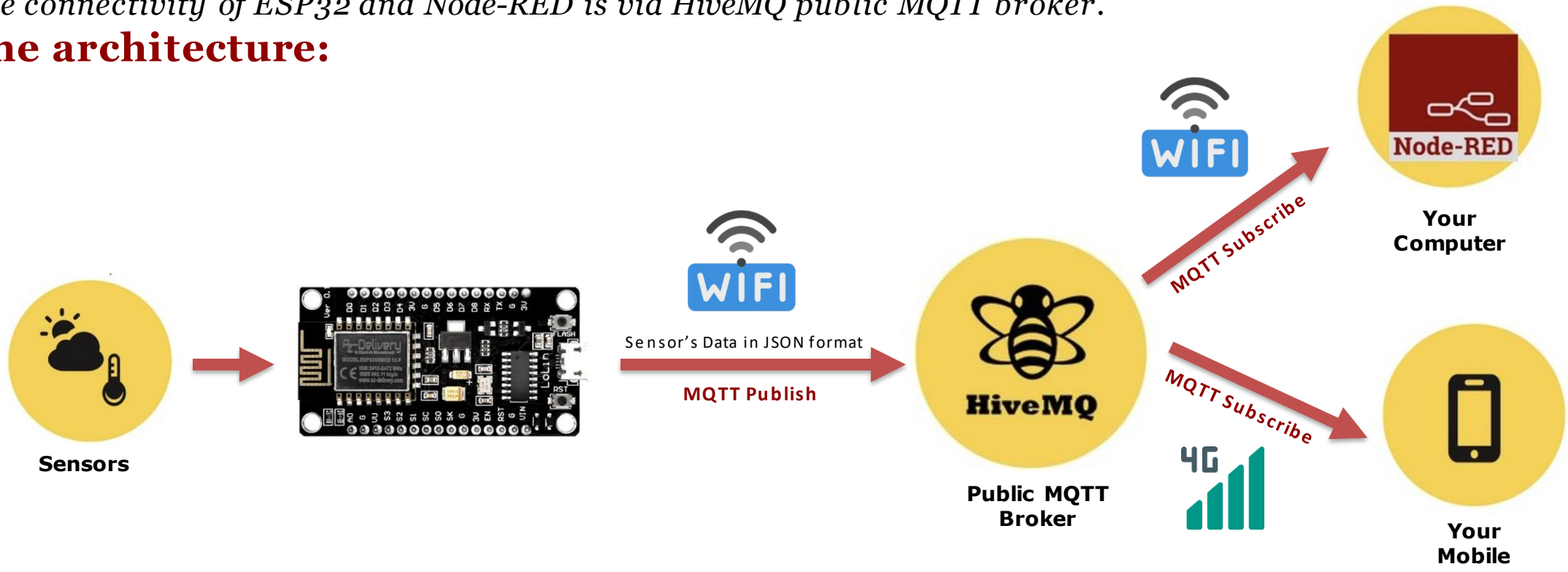
Repeat Step 1 – 10 above for Humidity topic



Mobile Apps subscribe MQTT from Broker

The connectivity of ESP32 and Node-RED is via HiveMQ public MQTT broker.

The architecture:

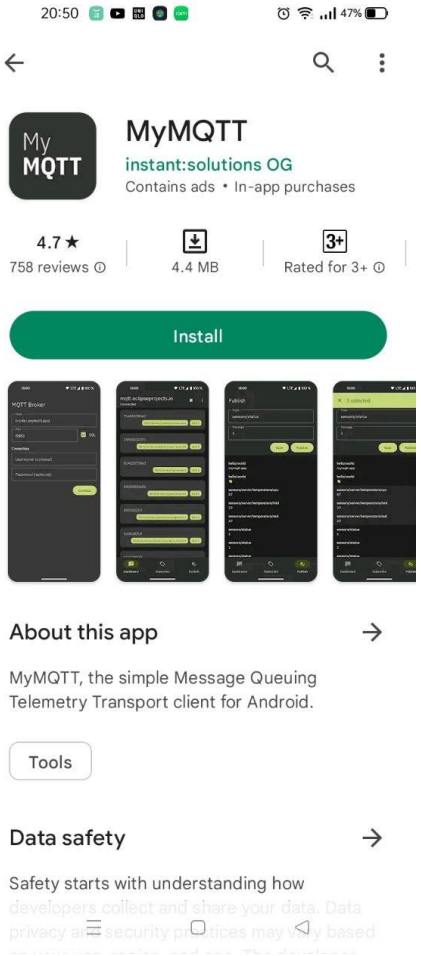


Mobile Apps *subscribe the topic that had been published by the ESP32. The apps will read the data every time it is published.*

Mobile Apps subscribe MQTT from Broker

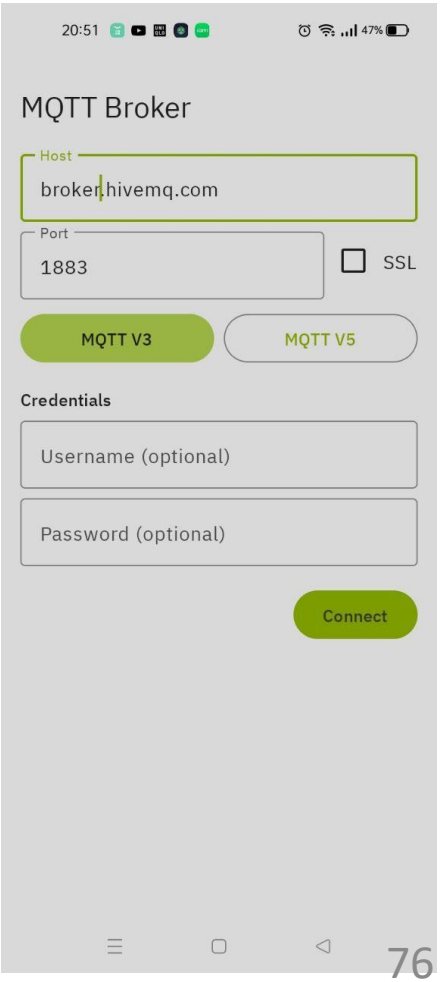
Setup MQTT Client Apps on Mobile Phone (6 steps)

1. Download **MyMQTT** Apps from Google Play or Apple Store



2. Setup the Broker connection:
   - **Host**: broker.hivemq.com
   - **Port**: 1883
   - **Protocol**: MQTT V3

3. Click **Connect** to connect to the broker server



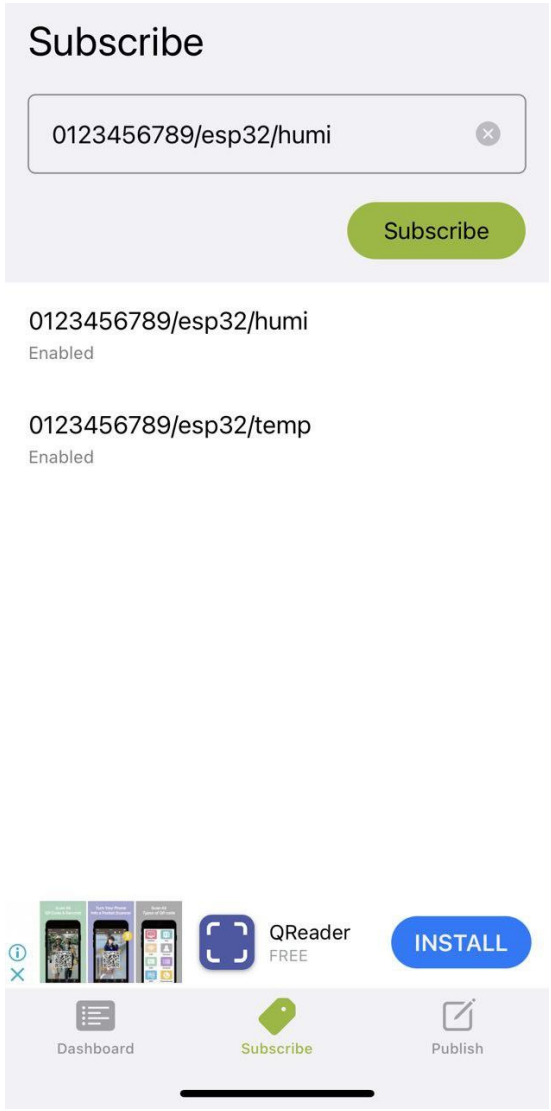
Mobile Apps subscribe MQTT from Broker

4. Click **Subscribe** icon.

5. Enter your **subscribe topic** as stated in your Arduino Sketch.

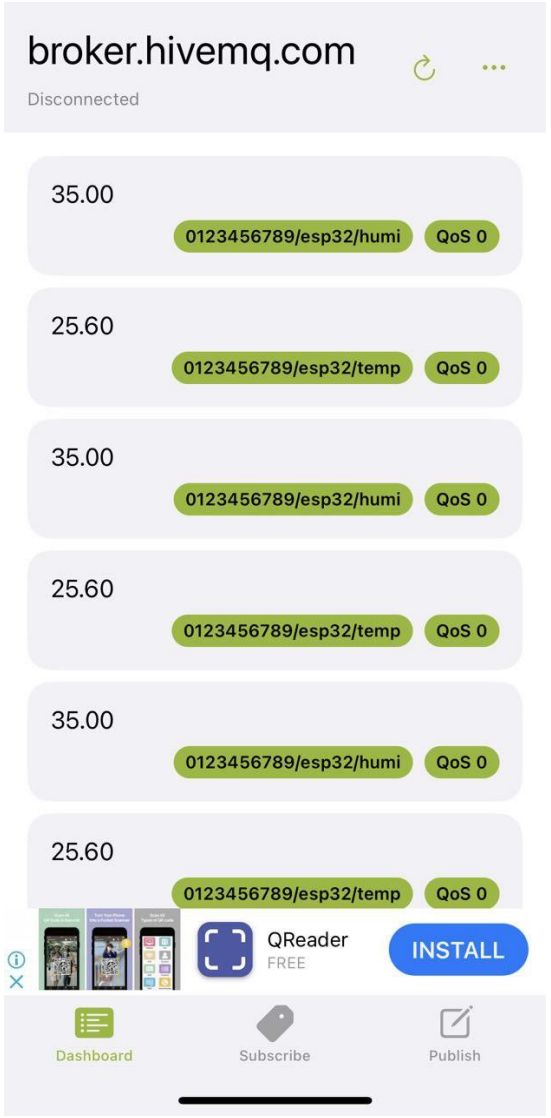
6. Click **Subscribe** button.

7. Repeat step 5 & 6 for another topic.



8. Click **Dashboard**. You should receive sensors data every time it is published by the ESP32.

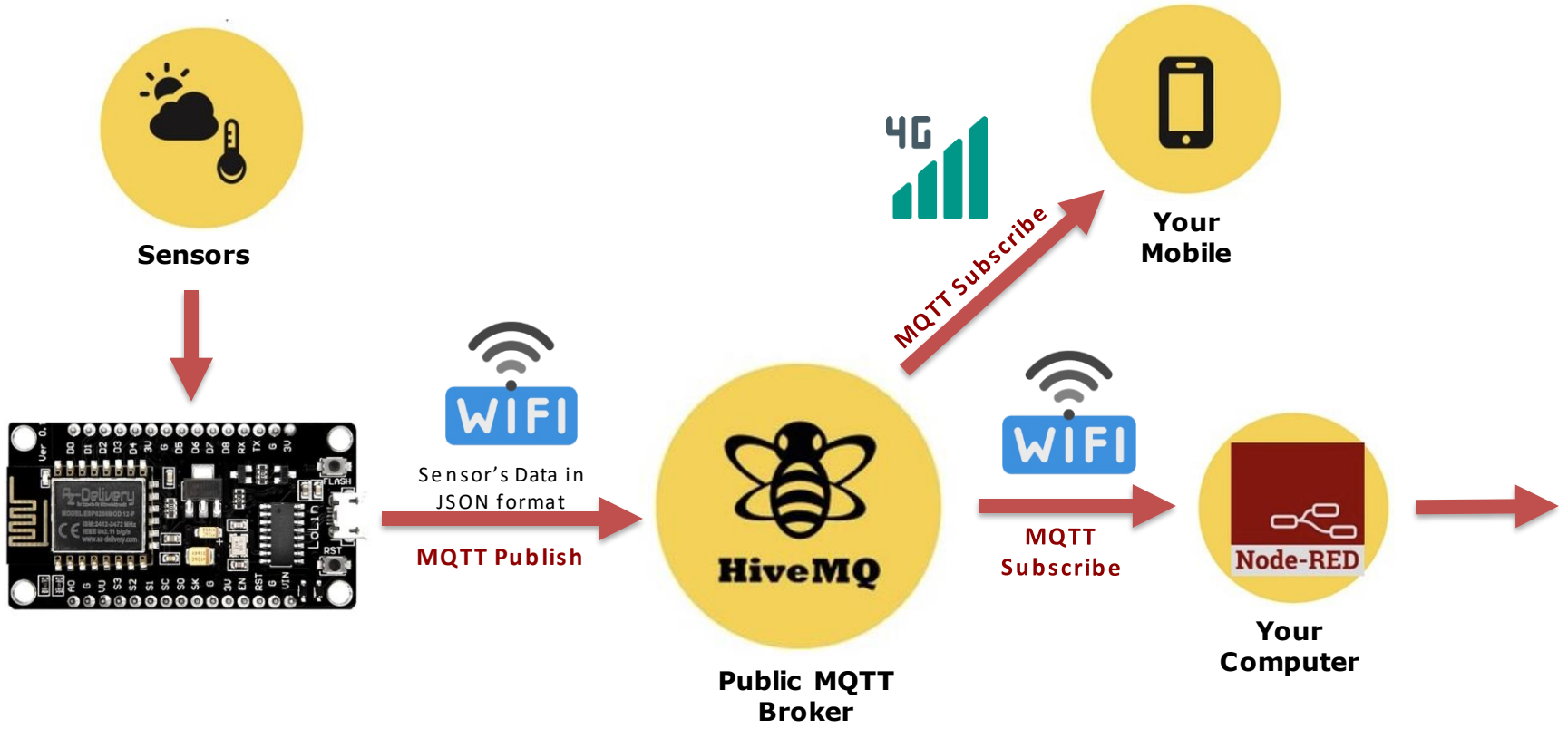
9. Observe the dashboard. You will receive all the data published from ESP32 on the dashboard.



Data Visualization through Node-RED Dashboard

The connectivity of ESP32 and Node-RED is via HiveMQ public MQTT broker.

The architecture:

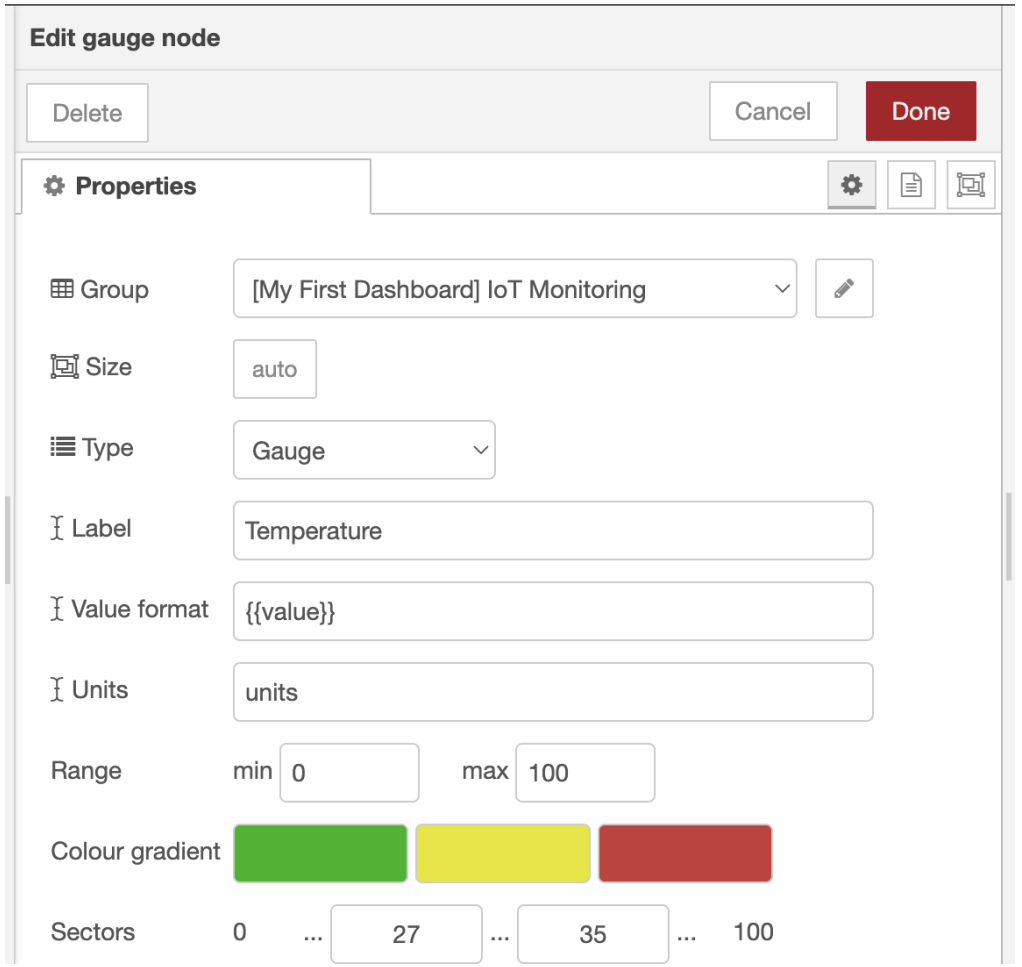


Data visualization *by Node-RED will view sensors data in real time according to user design*

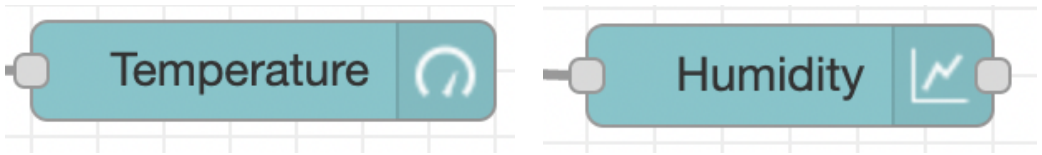
Node-RED Dashboard

Data Visualization through Node-RED Dashboard

- Insert **gauge** and **chart** node into the workspace.
- Double click the **gauge** node to edit the properties.
- The Label is "**Temperature**". Leave other values as default.
- Select the existing group (that you had created before) – eg. *[My First Dashboard] IoT Monitoring*
- Click Done.



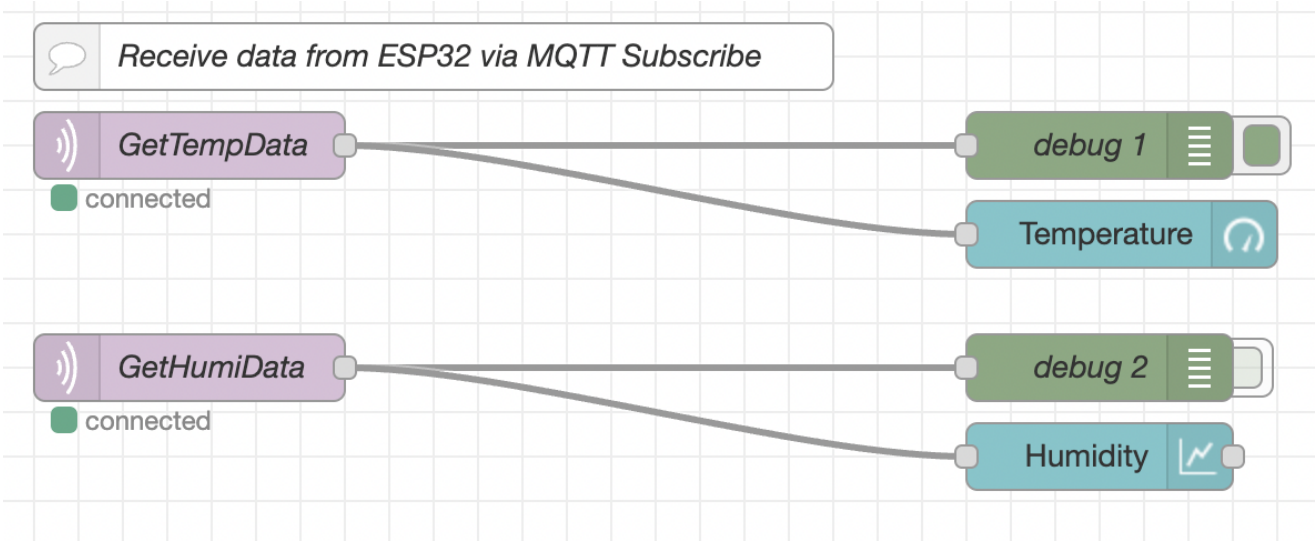
Data Visualization through Node-RED Dashboard

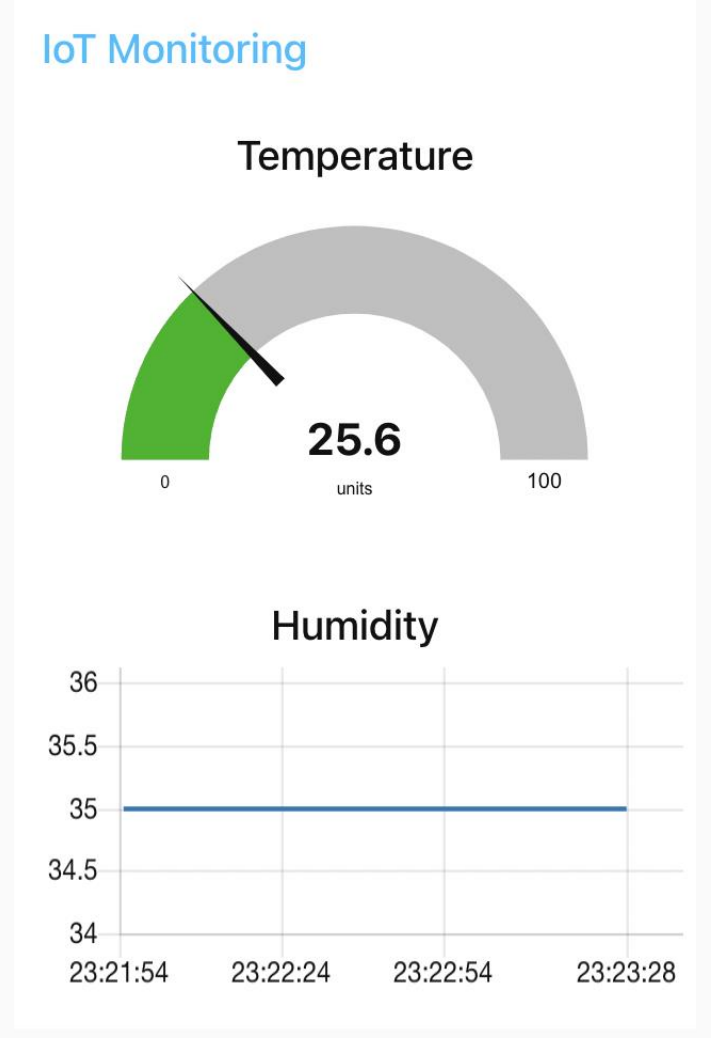


- Double click the **chart** node to edit the properties.
- The Label is "**Humidity**".
- Select the existing group (that you had created before) – eg. *[My First Dashboard] IoT Monitoring*
- Click Done.

Data Visualization through Node-RED Dashboard

4. Wire **GetTempData** to Temperature gauge.
5. Wire **GetHumiData** to Humidity chart.
6. View the dashboard to see real-time widget changing value depending on the interval of MQTT publish from the ESP32.

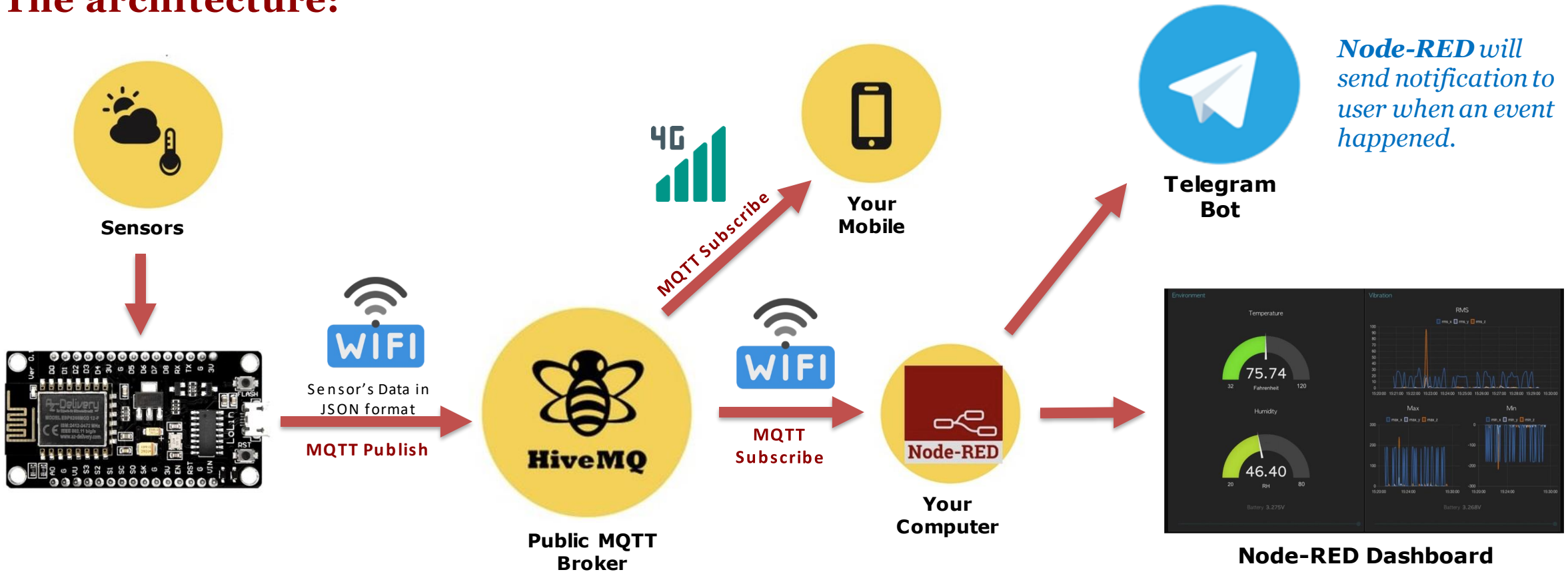




Node-RED Send Notification to Telegram

The connectivity of ESP32 and Node-RED is via HiveMQ public MQTT broker.

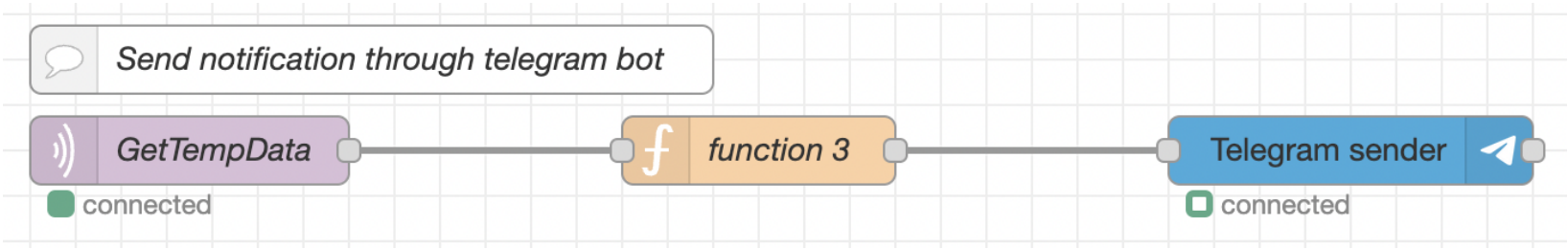
The architecture:



Node-RED Send Notification to Telegram

Real-Time Data Alert Notification to Telegram (8 Steps)

1. Copy the **mqtt in** node **GetTempData** from the previous lesson and paste the node in the workspace .
2. Insert a **function** node and a **Telegram sender** node and wire them together.



3. Double click the **function** node to setup to the Telegram notification based on specific threshold value. For example, trigger an alert when temperature's value is above 30.

Node-RED Send Notification to Telegram

4. Create a variable named **suhu** and its value equivalent to JSON object from **mqtt in** node **msg.payload**.

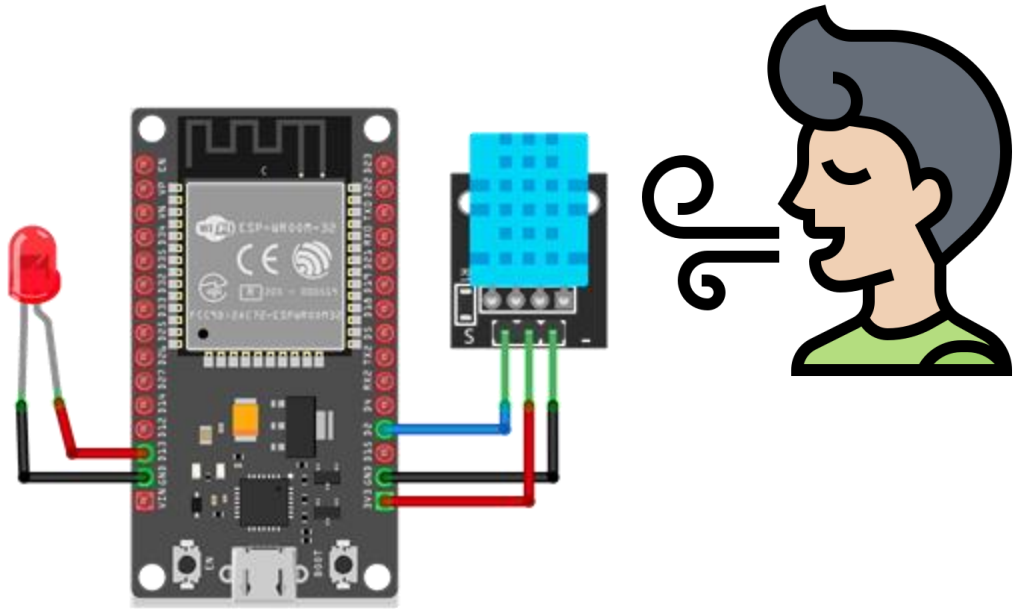
5. The previous Telegram configurations will only be executed if the suhu value is more than 30, with message of "**Awas! Suhu terlampau panas!**"

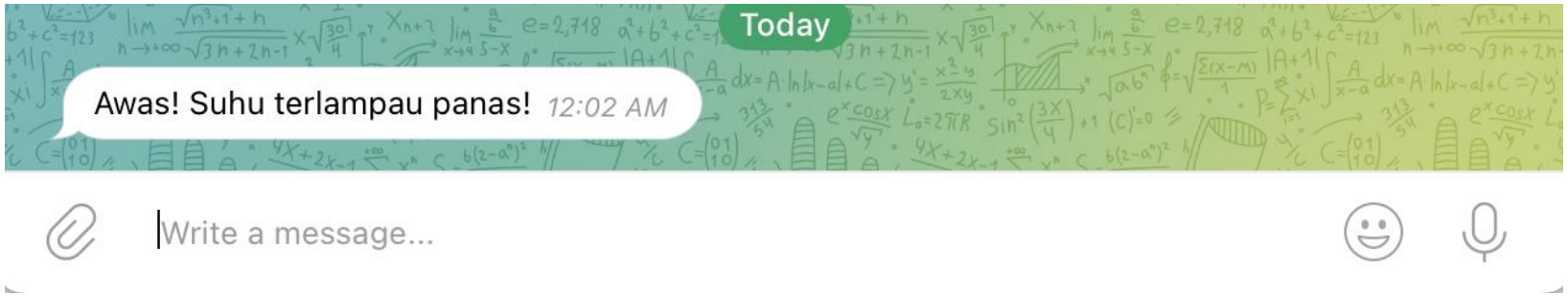
Setup | On Start | **On Message** | On Stop

```
1   var suhu = msg.payload;
2
3   if(suhu>30){
4       msg.payload = {
5           "chatId": 999999,
6           "type": "message",
7           "content": "Awas! Suhu terlampau panas!",
8           "options": {
9               "parse_mode": "Markdown"
10          }
11      }
12      return msg;
13  }
14
```

Node-RED Send Notification to Telegram

6. Click the **Done** button and redeploy the flow.
7. Provide high value of temperature by using your breathe pointing on the LM35 sensor on the ESP32.
8. Check Telegram alert notification receive when the temperature's value above 30.

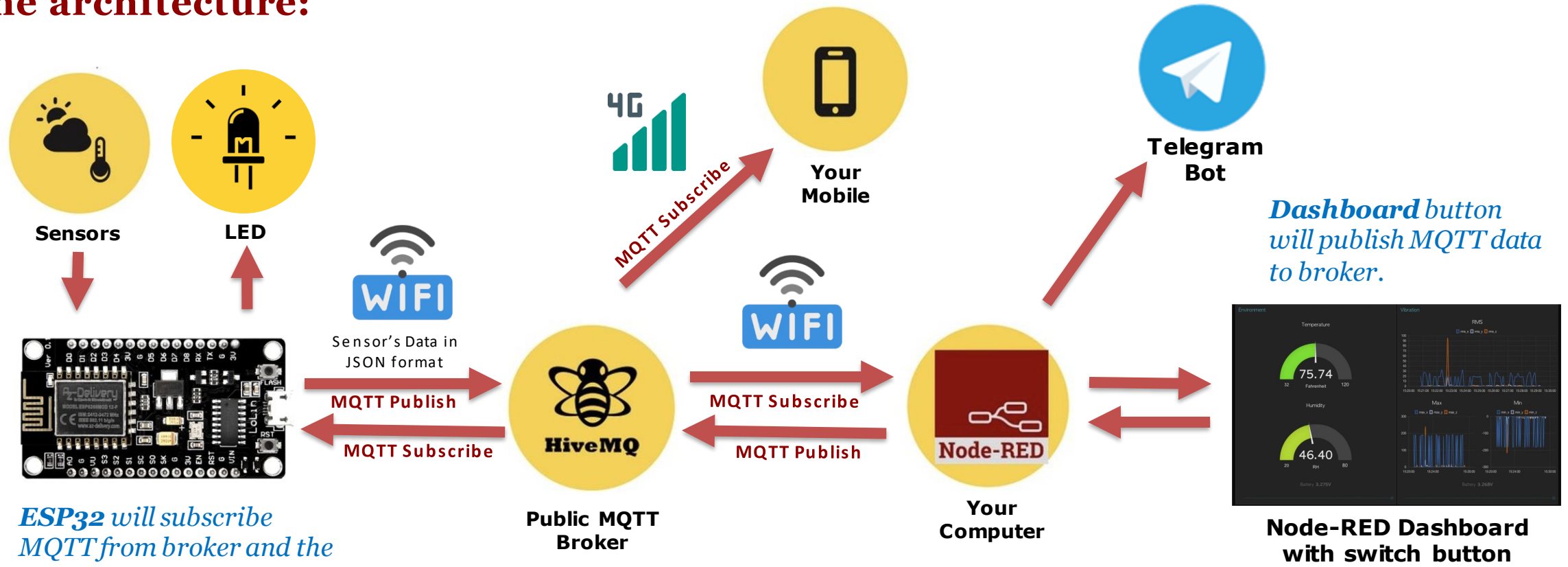




Controlling ESP32 from Dashboard

The connectivity of ESP32 and Node-RED is via HiveMQ public MQTT broker.

The architecture:



ESP32 *will subscribe MQTT from broker and the LED will behave accordingly every time* ***dashboard*** *publish data.*

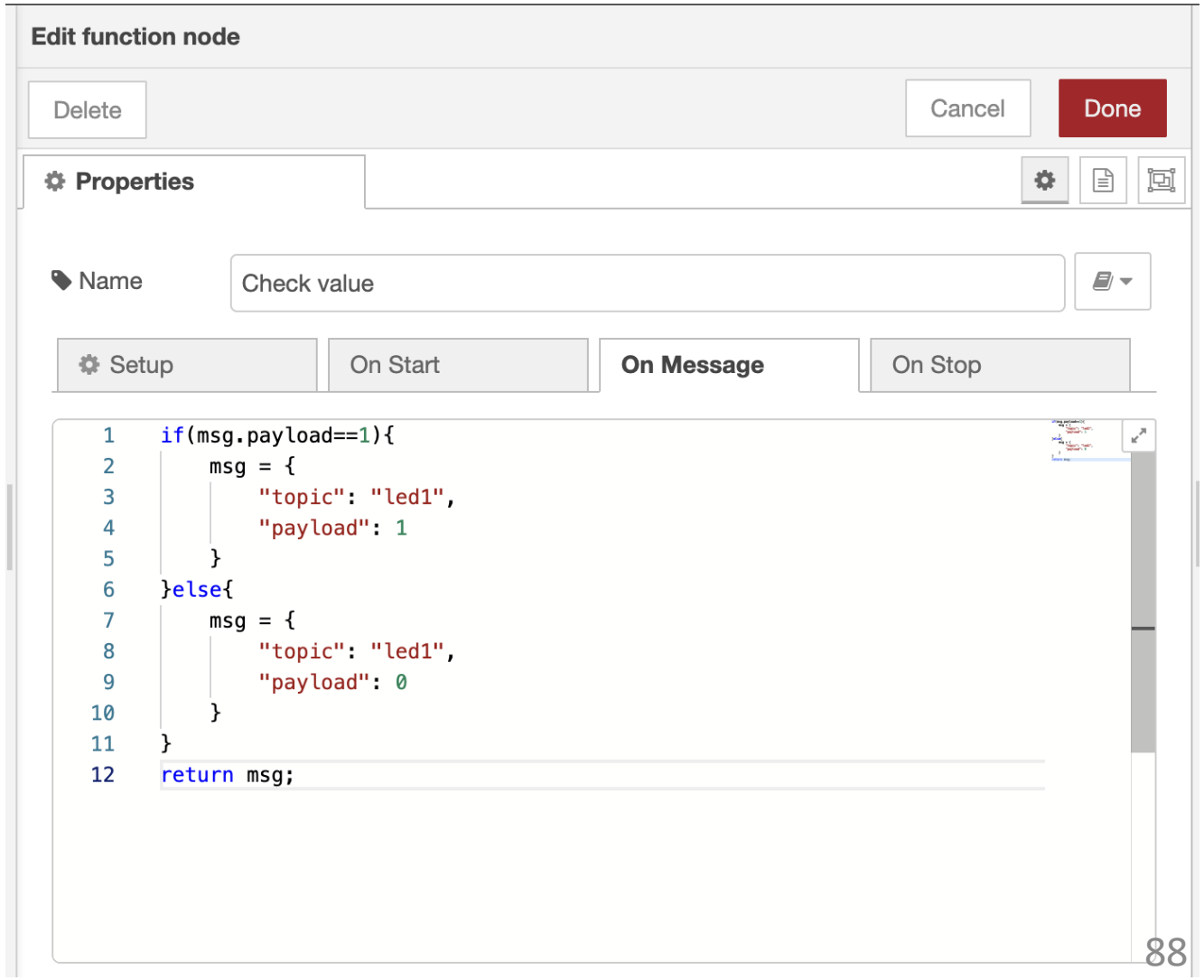
Controlling ESP32 from Dashboard

Integrate Switch/Button to the Node-RED Dashboard Nodes.

- Insert Dashboard **Switch**, **function**, and **mqtt out** nodes.
- Double click the **switch** node to edit the properties.
- The Label is "**LED 1**".
- Select the existing group (that you had created before) – eg. *[My First Dashboard] IoT Monitoring*
- Click Done.

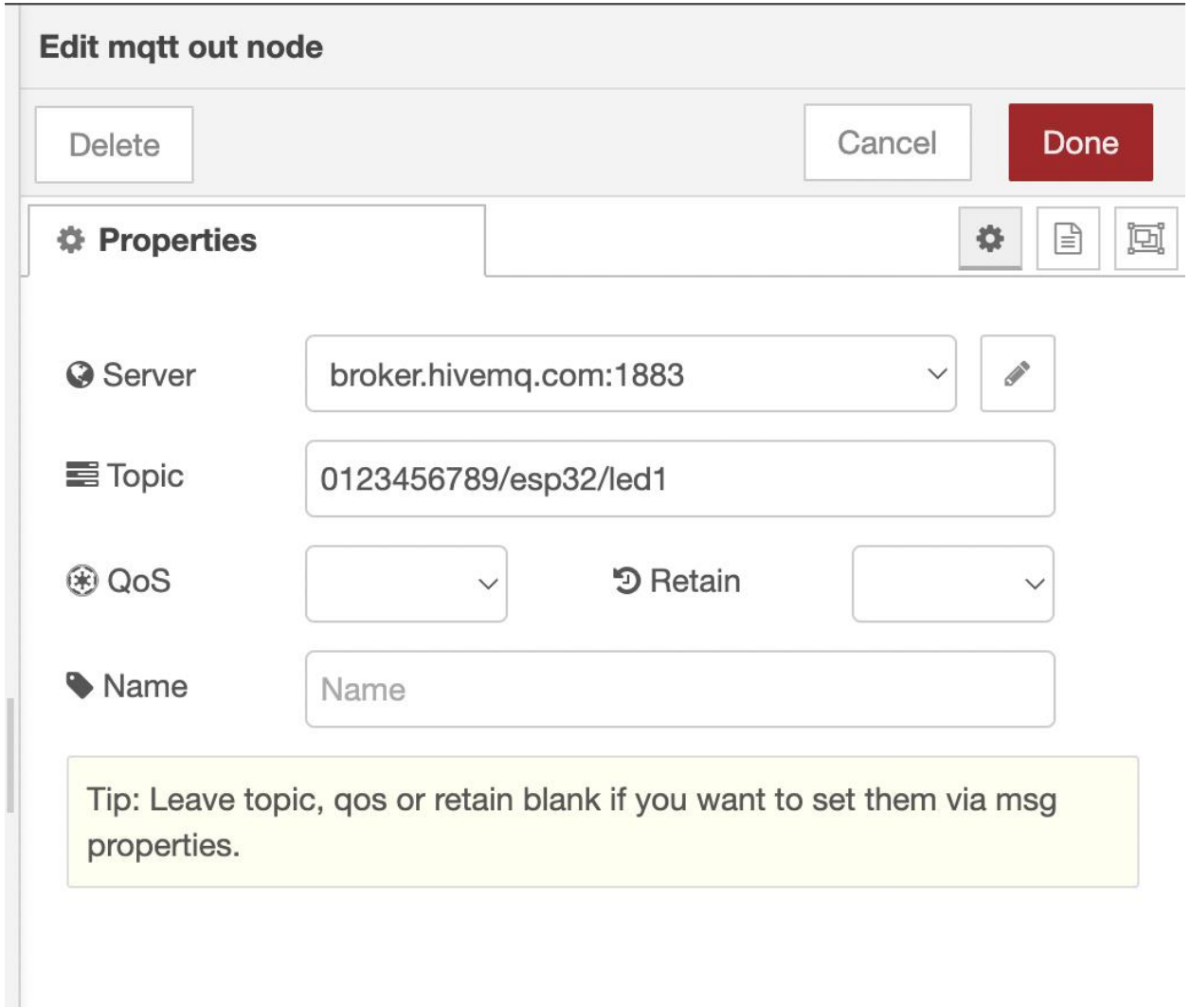
Controlling ESP32 from Dashboard

- Double click the **function** node to edit the properties.
- Insert the given code in the **On Message** tab.
- Click Done.

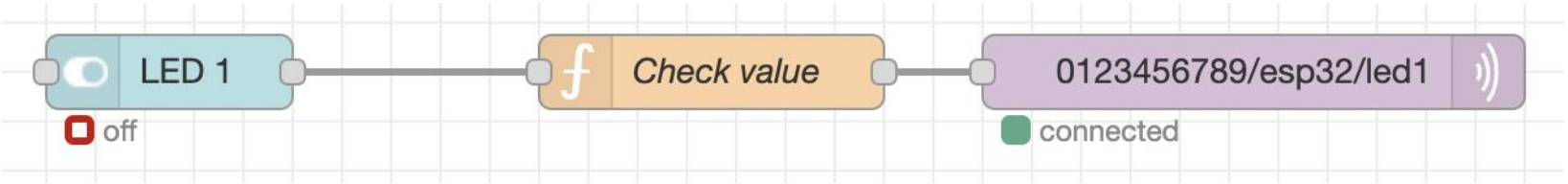


Controlling ESP32 from Dashboard

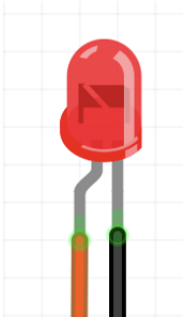
- Double click the **mqtt out** node to edit the properties.
- Select the existing Server (broker.hivemq.com:1883).
- Insert your LED1 topic, eg.: **0123456789/esp32/led1**
- Click **Done**.

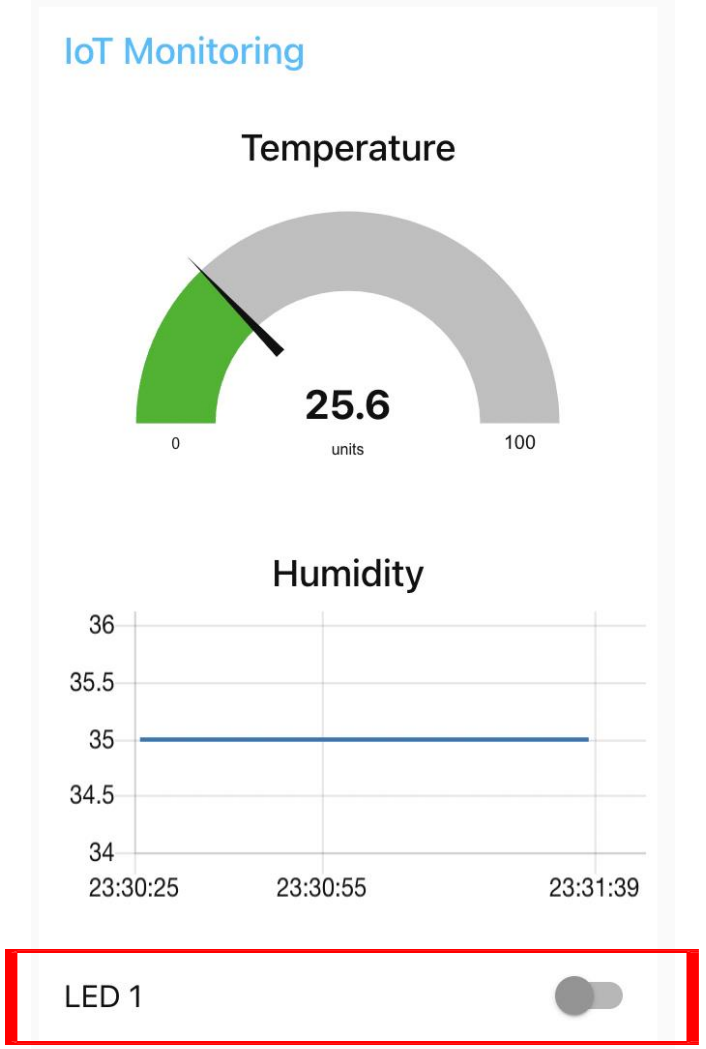


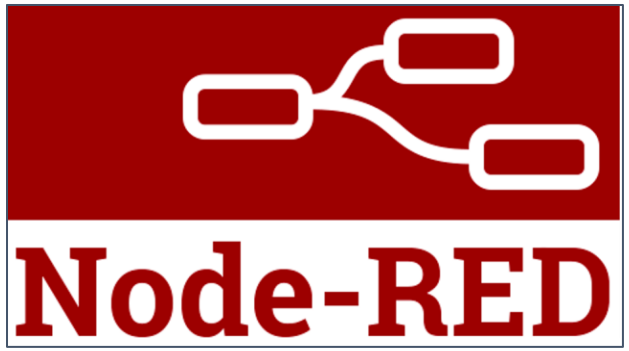
Controlling ESP32 from Dashboard



- Connect the nodes.
- Open your dashboard, you will see a switch button labelled "LED 1" will appear.
- Click the **switch** on/off, it will turn your LED on ESP32 on/off accordingly.
- Check your LED!







Node-RED with MySQL

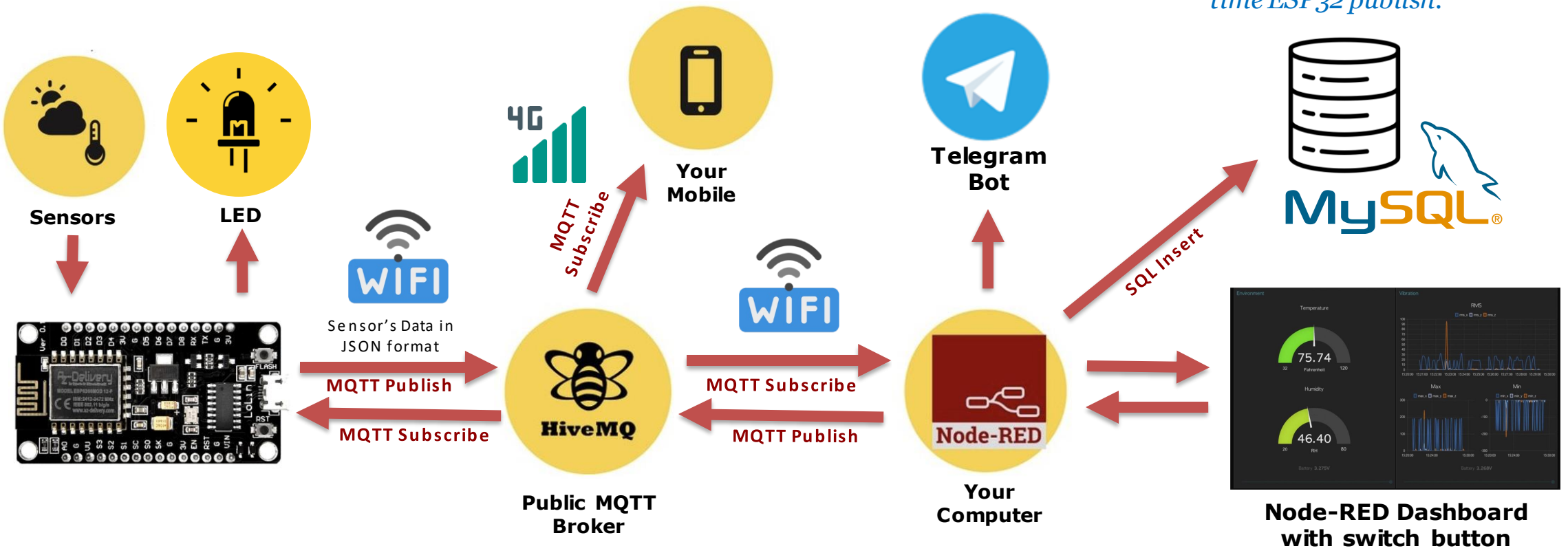
Using Node-RED to read and write data to a MySQL Database.

Saving Data into MySQL via Node-RED

The connectivity of ESP32 and Node-RED is via HiveMQ public MQTT broker.

The architecture:

***Node-RED** will insert data into MySQL Database every time ESP32 publish.*

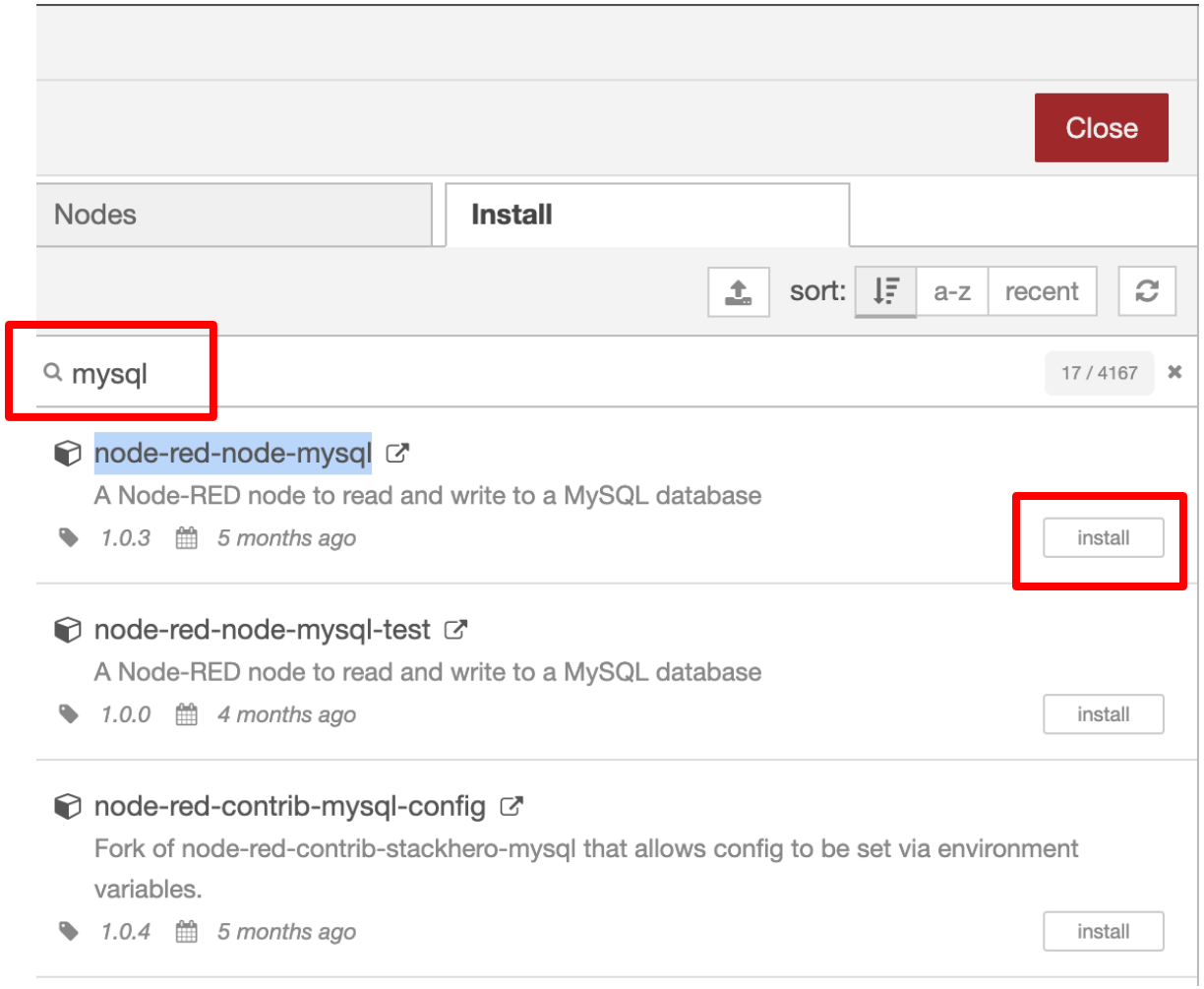


Node-RED Dashboard with switch button

Saving Data into MySQL via Node-RED

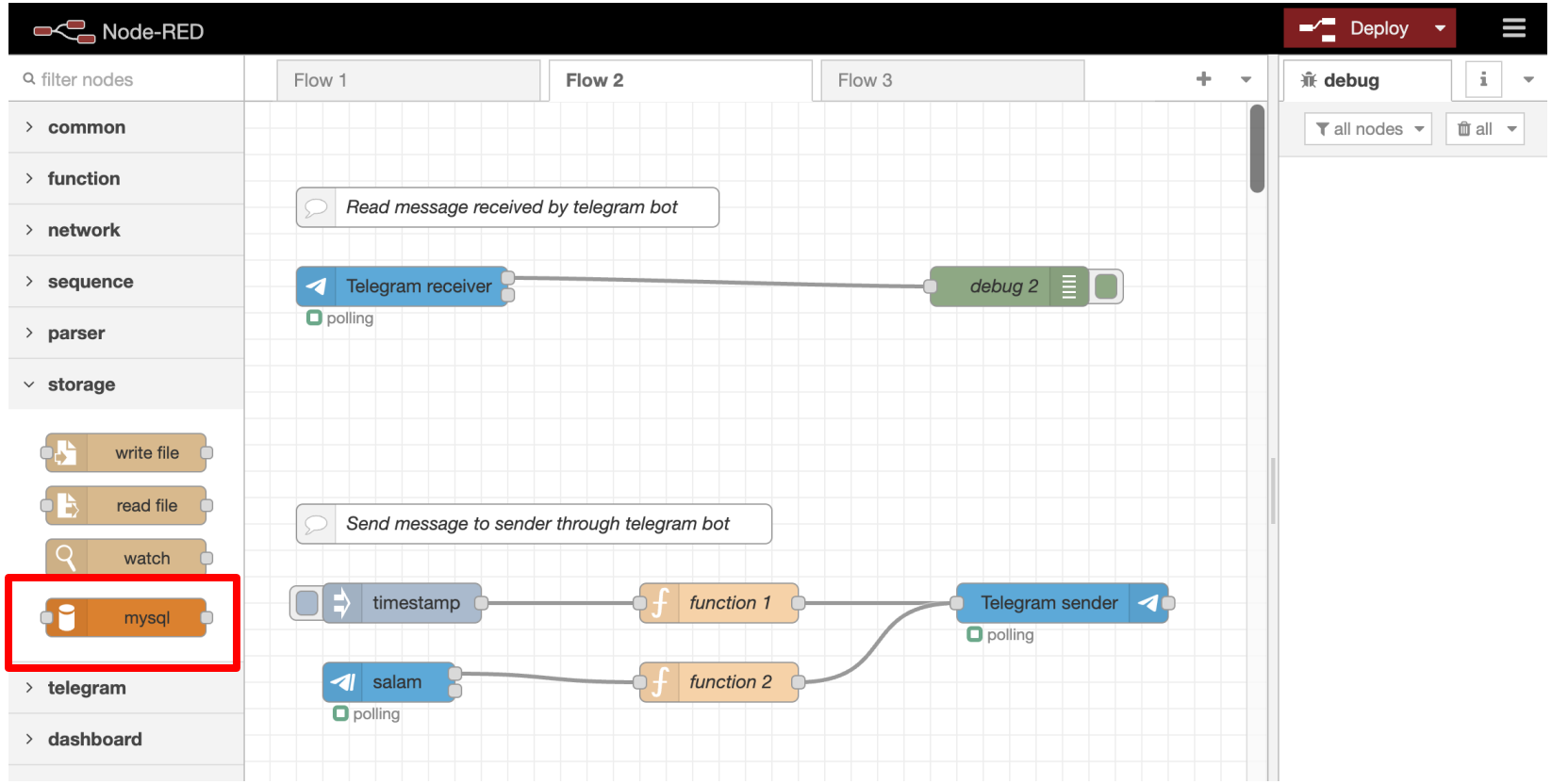
Install Node-RED Dashboard

- Open Node-RED Palette Manager.
- Click on the **Install** tab and on the **search modules** fields type "**mysql**" to filter the list of the available modules.
- Click the **install** button to install the **node-red-node-mysql** module and wait until the installation process is successful.



Saving Data into MySQL via Node-RED

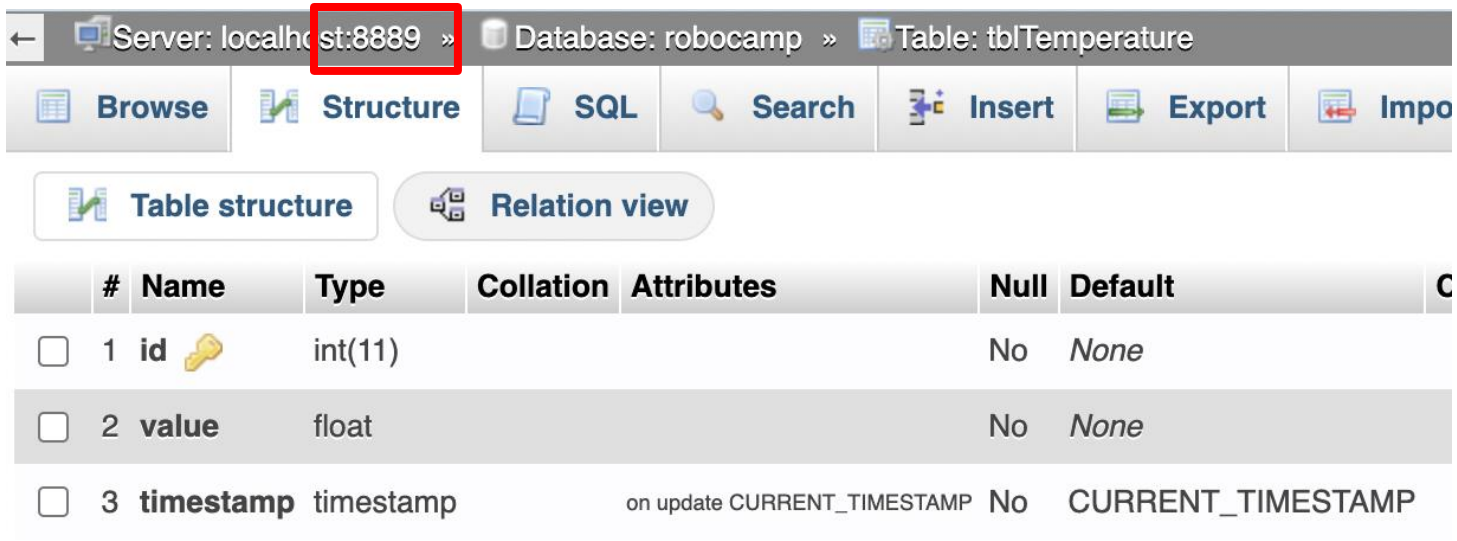
- Once the installation is successful, the mysql node will be available on the palette under an existing category: **storage**.



Saving Data into MySQL via Node-RED

Node-RED get MQTT data and write into MySQL table (10 Steps)

1. Make sure you already have MySQL or MariaDB installed on your localhost.
2. Create a new database name "**robocamp**" and a new table name "**tblTemperature**" with the same structure as below:

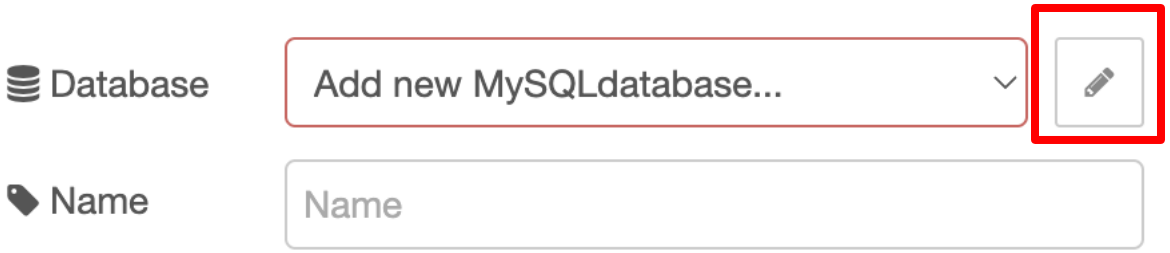


	#	Name	Type	Collation	Attributes	Null	Default
☐	1	id	int(11)			No	*None*
☐	2	value	float			No	*None*
☐	3	timestamp	timestamp		on update CURRENT_TIMESTAMP	No	CURRENT_TIMESTAMP

3. Keep note on the **port number** of your database. You are going to use it later.

Saving Data into MySQL via Node-RED

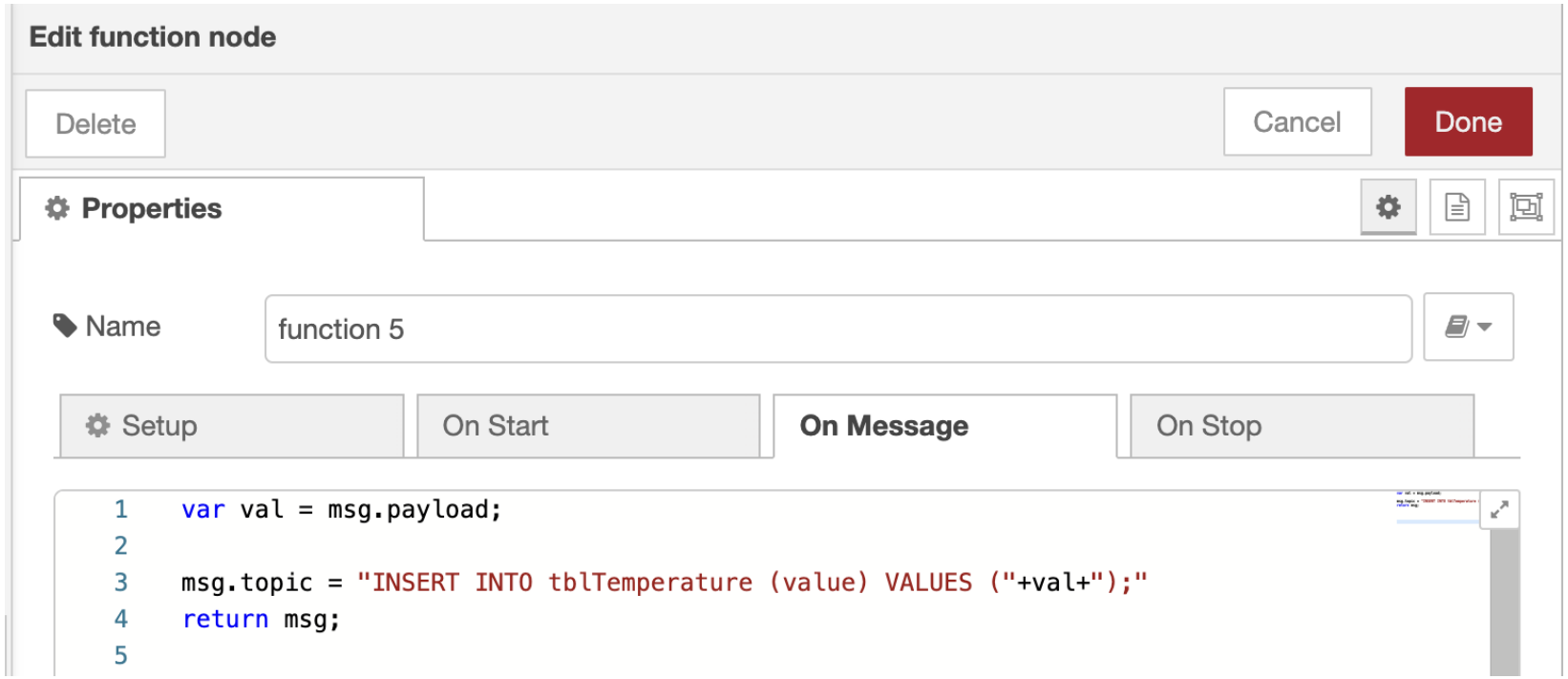
4. Insert **function** and **mysql** nodes into the workspace.
5. Double click **mysql** node and add *a new MySQL database* by clicking the pencil icon.



6. Enter the following details:
   - **Host**: 127.0.0.1
   - **Port**: enter the port number from step 3.
   - **User**: enter your MySQL username
   - **Password**: enter your MySQL password
   - **Database**: robocamp
7. Leave other values as default. Click **Add** when finished.

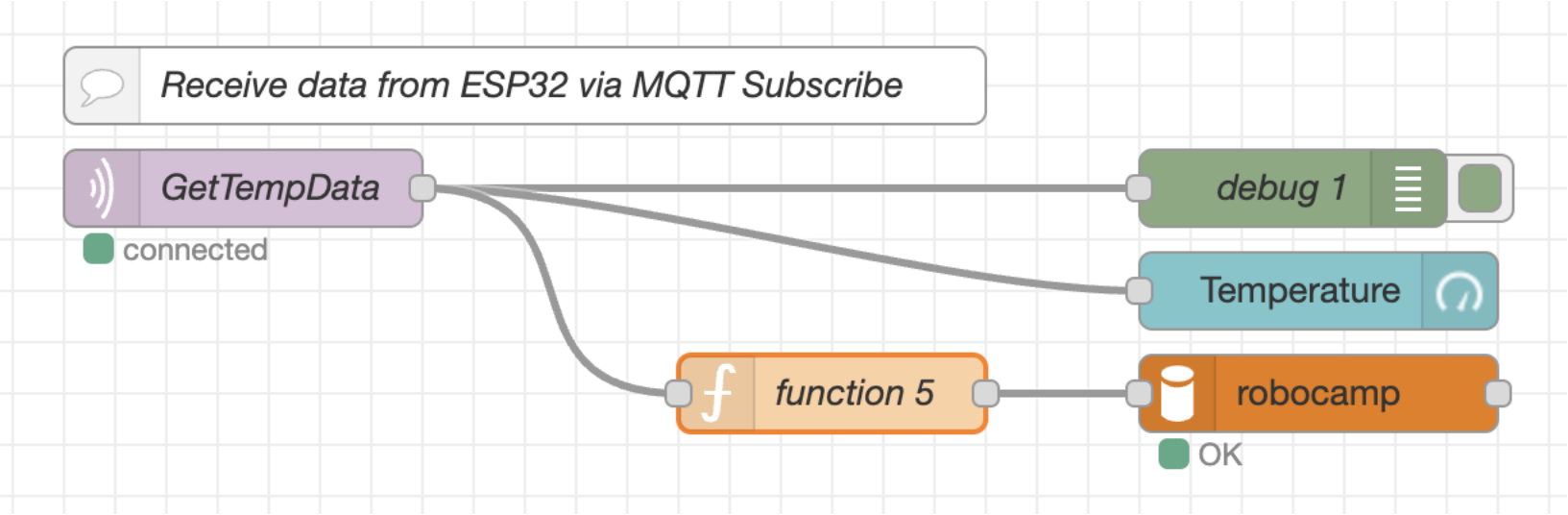
Saving Data into MySQL via Node-RED

8. Double click the **function** node to edit the properties. Insert the given code in the On Message tab.



9. Click **Done**.

Saving Data into MySQL via Node-RED



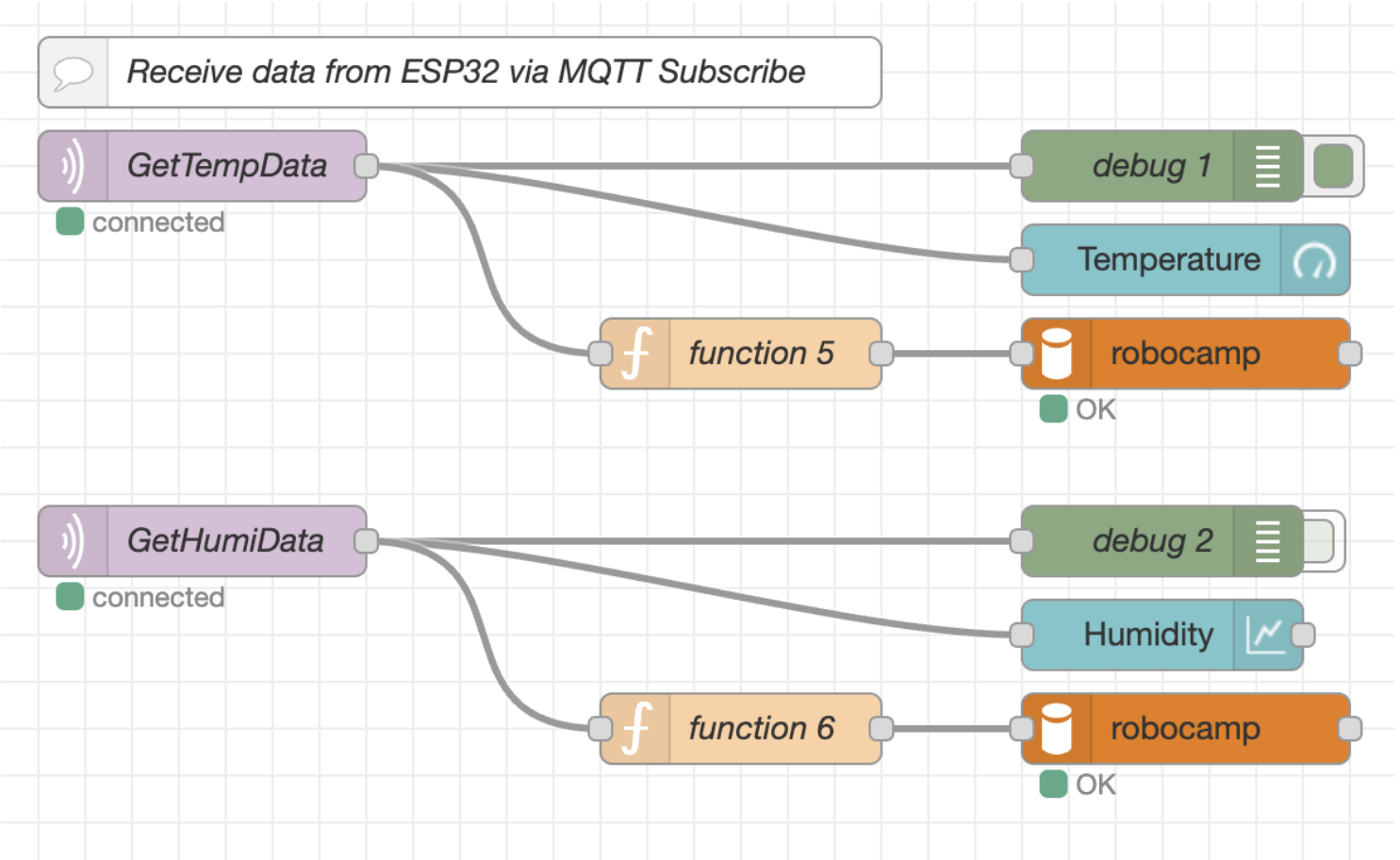
10. Connect all the nodes. Click **Deploy**. Check your database, a new value should had been inserted in the **tblTemperature** table, every time new data is published by ESP32.

Note:

This is how you can store your sensor data into a database. You can also read data from your table by changing the SQL statement in the **function** node.

Saving Data into MySQL via Node-RED

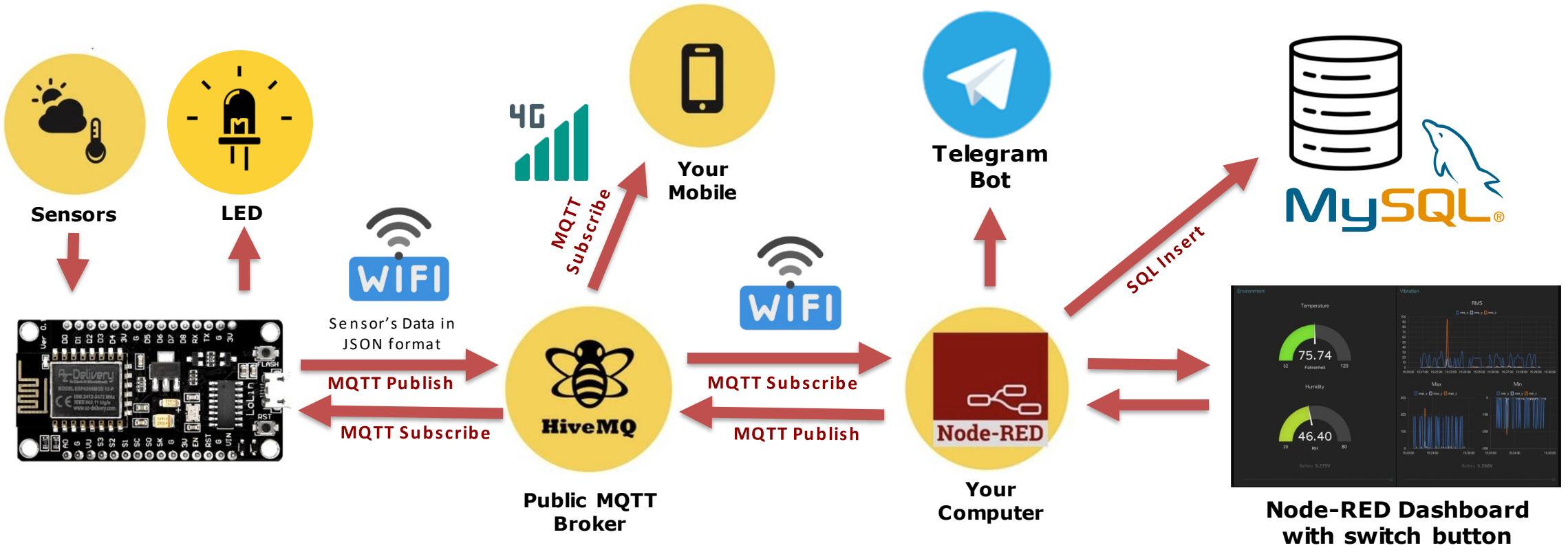
Repeat step 1 – 10 above for Humidity data.



Wrapping Up!

What have we learned today?

The final architecture:



Got it? You can do so much from here. Be creative!

That's it!

There is only so much I can teach.

Knowledge is a great treasure that has no limits.

The only limitation is your imagination.

Thank you.

- Cikgu Fadzli -