Internet of Things - Third Challenge

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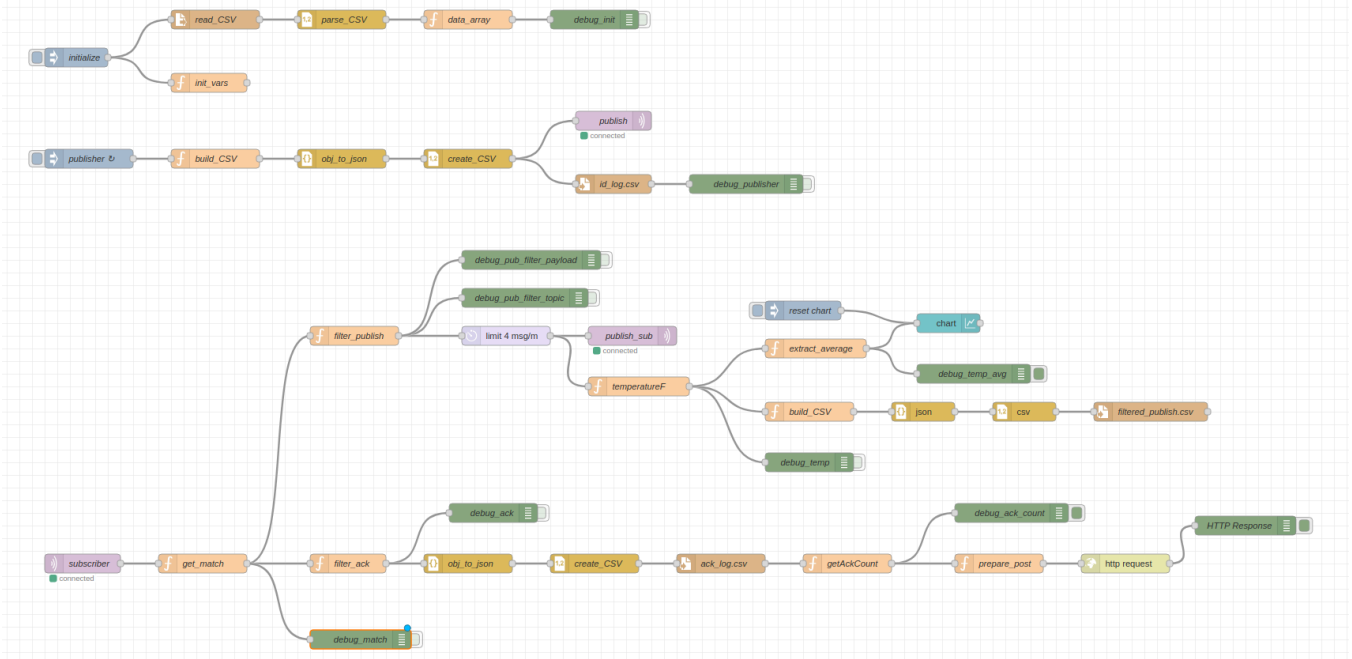
Thingspeak channel ID: https://thingspeak.mathworks.com/channels/2929989

Project topic

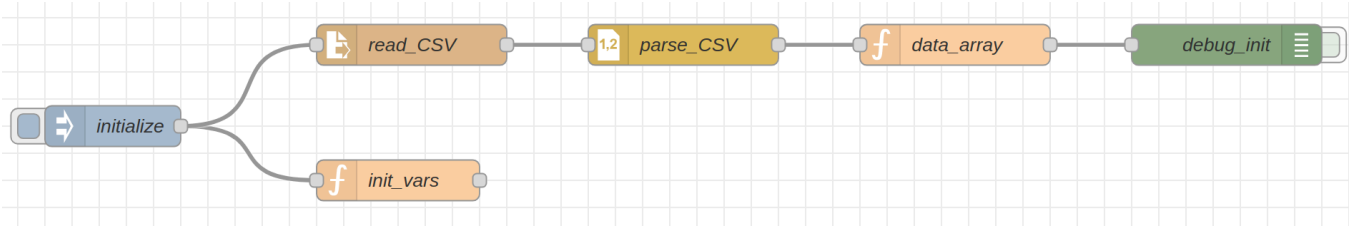
The project consists in building some **Node-Red flows**:



First Part

> Periodically publish MQTT messages to the local mosquitto broker (localhost, port 1884), to the topic *challenge3/id_generator*.
>
> Messages should be sent with a rate of 1 message every 5 seconds.
>
> Each message should contain in the payload a string of JSON format with a random number (id) between 0 and 30000, and the time in which the msg is generated (UNIX timestamp)

Initialize



- **Initialized**: start global variable initialization
- **init_vars**: initialize global variables

```
global.set("Status", "FLOWING");
global.set("row_num", 1)
global.set("ack_count", 0);
global.set("msg_count", 0);
global.set("row_temp", 1);

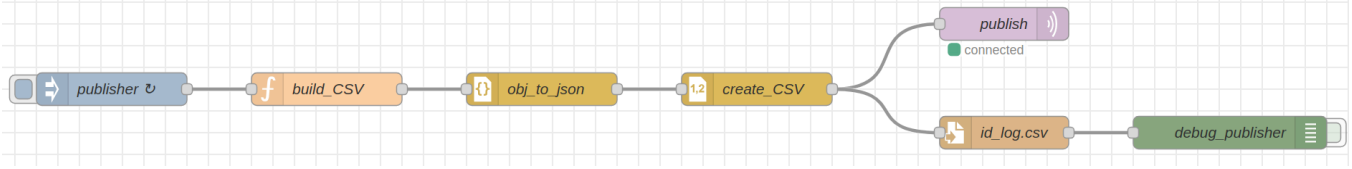
return msg;
```

```
- **read_csv**: read the _challenge3.csv_ file
- **parse_csv**: parse the _.csv_ file
- **data_array**: declare a global variable with all file's data
```javascript
var data = msg.payload;
global.set("csv_data",data);

return msg;
```

```

Publisher



- **publisher**: publish with a rate of 1 message every 5 second to activate the flow
- **build_csv**: prepares the payload of the MQTT message and *id_log.csv* file:

```
let row_num = global.get("row_num");

// Define the ID field as a random integer between 0 and 30000
const id = Math.floor(Math.random() * 30001);
const timestamp = Math.floor(Date.now() / 1000);

// Set the message payload
msg.payload = JSON.stringify({
    "No.": row_num,
    "ID": id,
    "TIMESTAMP": timestamp
});

// Progressively increases the row number
row_num++;
global.set("row_num", row_num);

return msg;
```

- **obj_to_json**: translate the object message into JSON format
- **create_csv**: use JSON input to produce a line for a *.csv* file
- **publish**: send a MQTT message with defined payload on fixed topic *challenge3/id_generator*
- **id_log.csv**: append the payload to the *id_log.csv* file

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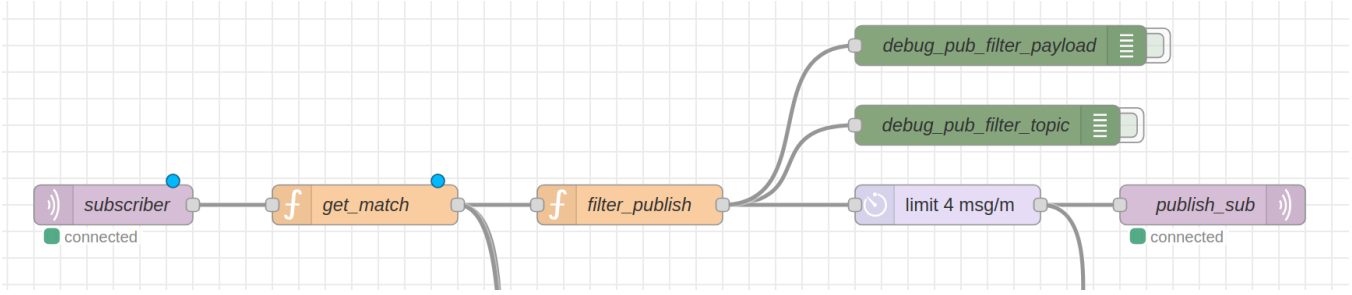
Second Part

> Subscribe to the topic *challenge3/id_generator* in the local broker.
>
> After receiving a message from the subscription, take the ID and compute **N = ID %7711**
> At every received message, process the challenge3.csv file and take the message with frame number equal to N.
>
> If the message contains an MQTT Publish then, publish a message on the same topic found with.



- **subscriber**: connects to the broker and subscribes to messages from the specified topic
- **get_match**: finds the line of the data which "No." matches with the calculated "N" and produces a node message object with its payload. This node feeds multiple branches:

```
let msg_count = global.get("msg_count");

// No more than 80 csv entries has to be processed
if(msg_count >= 80){
    global.set("Status","COMPLETE");
    return null;
}

var fields = msg.payload.split(',');

var id = fields[1];
var data = global.get("csv_data");

// Compute N (computed_id)
var computed_id = id % 7711;
var matching_obj = data.filter(
    function(obj){
        return parseInt(obj["No."])===computed_id;
    }
);

msg.payload = matching_obj;

msg_count++;
global.set("msg_count", msg_count);

return msg;
```

- **filter_publish**: filter to transmit forward only the messages containing a MQTT Publish. If a single message contains more than a publish, then separate the payload into different messages:

```
if (global.get("Status") === "COMPLETE") {
    return;
}

let matching_obj = msg.payload;
let row_num = matching_obj[0]["No."];
let info = matching_obj[0]["Info"];
let rawPayload = matching_obj[0]["Payload"] || "";

if (matching_obj && info.includes("Publish Message")) {

    // Use a regex to find all the topics [../../..]
    let topic_regex = /\[([^\]]+)\]/g;
    let topics = [ ...info.matchAll(topic_regex)].map(match => match[1]);

    // Parsing
    let payloads;
    try {
        // Normalize the payload removing ""
        let normalized = "[" + rawPayload.replace(/""/g, '"') + "]";
        payloads = JSON.parse(normalized);
    } catch (err) {
        node.error("Error while parsing JSON: " + err.message);
        return null;
    }

    // Match each topic and message
    let output_msgs = [];
    for (let i = 0; i < Math.min(topics.length, payloads.length); i++) {
        output_msgs.push({
            topic: topics[i],
            payload: {
                timestamp: Math.floor(Date.now() / 1000),
                id: row_num,
                payload: payloads[i]
            }
        });
    }

    return [output_msgs]; // output
} else {
    return null;
}
```

- **limit 4msg/m**: limit message rate to 4 per minute, add messages exceeding the rate to a queue
- **publish_sub**: publish the payload as a MQTT message on topic defined by .csv file

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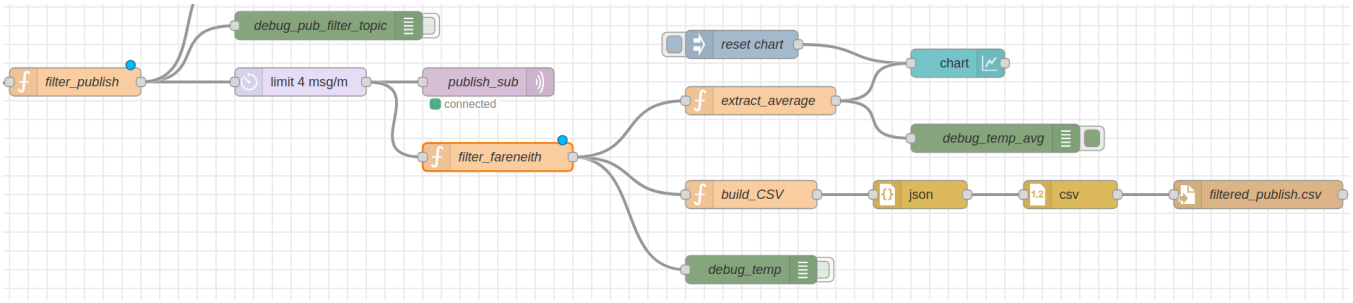
Third part

> If the filtered message contains in the payload a temperature in Fahrenheit, use it to produce a chart in Node-Red plotting the temperature value, taking the mean value of the "range" attribute in the payload.
> Save the payload of these msgs in a CSV (filtered_pubs.csv)



- **filter_fareneith**: filter to forward only messages with `type: temperature, unit: F` :

```
let input = msg.payload;

if (!input || !input.payload) {
    return null;
}

let data = input.payload;

if (data.type === "temperature" && data.unit === "F") {
    return {
        topic: msg.topic,
        payload: input
    };
}

return null;
```

- **extract_average**: extracts the average temperature from the payload of the message:

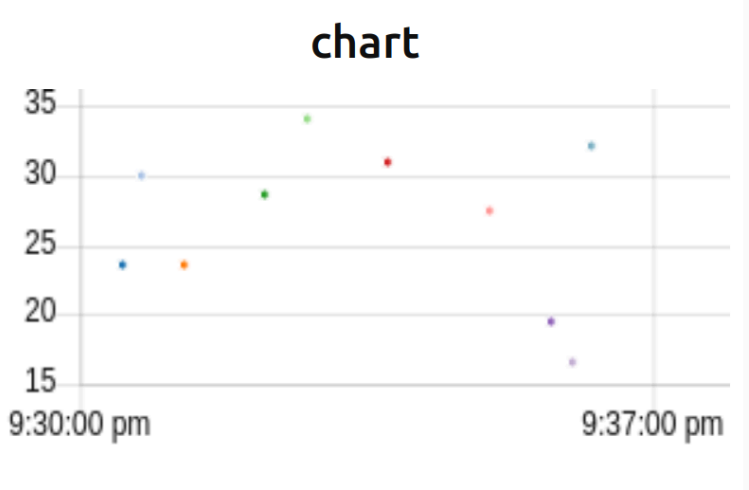
```
let data = msg.payload.payload;

let sum = data.range.reduce((a, b) => a + b, 0);
let avg = sum / 2;

msg.payload = avg;

return msg;
```

- **chart**: plot the average contained inside the payload onto a chart:



- **build_csv**: prepares the payload for the *filtered_publish.csv* file:

```
var unit = data.unit;
var description = data.description;

let avg = (range[0] + range[1]) / 2;

msg.payload = JSON.stringify({
    "No.": row_temp,
    "LAT":lat,
    "LONG": long,
    "RANGE": avg,
    "TYPE":type,
    "UNIT":unit,
    "DESCRIPTION":description,
});

row_temp++;
global.set("row_temp", row_temp);
return msg;
```

- **json**: translate the object message into JSON format
- **csv**: use JSON input to produce a line for a *.csv* file
- **filtered_publish.csv**: append the payload to the *filtered_publish.csv* file

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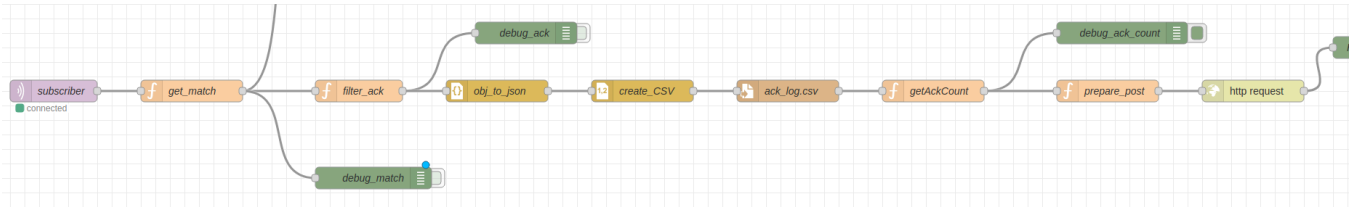
Fourth part

> If the message with Frame No. = N instead contains an MQTT ACK message, increment a global ACK counter, then save the message into a CSV file named *ack_log.csv*
>
> Send the value of the global ACK counter to a *thingspeak* channel, passing to the field1 of the channel the value of the global ACK counter



- **filer_ack**: filter to forward only messages containing an ACK:

```
if(global.get("Status")==="COMPLETE"){
    return;
}

var ack_count = global.get("ack_count");
var matching_obj = msg.payload;
var row_num = matching_obj[0]["No."];

if(matching_obj && matching_obj[0]["Info"].includes("Ack")){
    var ack_regex = /(Connect|Publish|Subscribe|Unsubscribe)\sAck/;
    var matching_msg_info = matching_obj[0]["Info"].match(ack_regex);

    //Use JSON.stringify to convert string in right format
    msg.payload = JSON.stringify({
        "TIMESTAMP": Math.floor(Date.now() / 1000),
        "SUB_ID":row_num,
        "MSG_TYPE":matching_msg_info[0]
    });

    // Increment acq counter
    global.set("ack_count", ack_count +1);

    return msg;
} else {
    return null;
}
```

- **obj_to_json**: translate the object message into JSON format
- **create_csv**: use JSON input to produce a line for a *.csv* file
- **ack_log.csv**: append the payload to the *ack_log.csv* file
- **get_ack_count**: exttract ack counter from payload:

```
msg.payload = global.get("ack_count");
return msg;
```

- **prepare_post**: setup the payload to be published as an HTTP POST:

```
let apiKey = "S7CY4USHQ42EZI0S";

msg.payload = `api_key=${apiKey}&field1=${msg.payload}`;

msg.headers = {
    "Content-Type": "application/x-www-form-urlencoded"
};
```

```
return msg;
```

- **http request**: send the payload as an HTTP POST

The graph visualized on Thingspeaks: