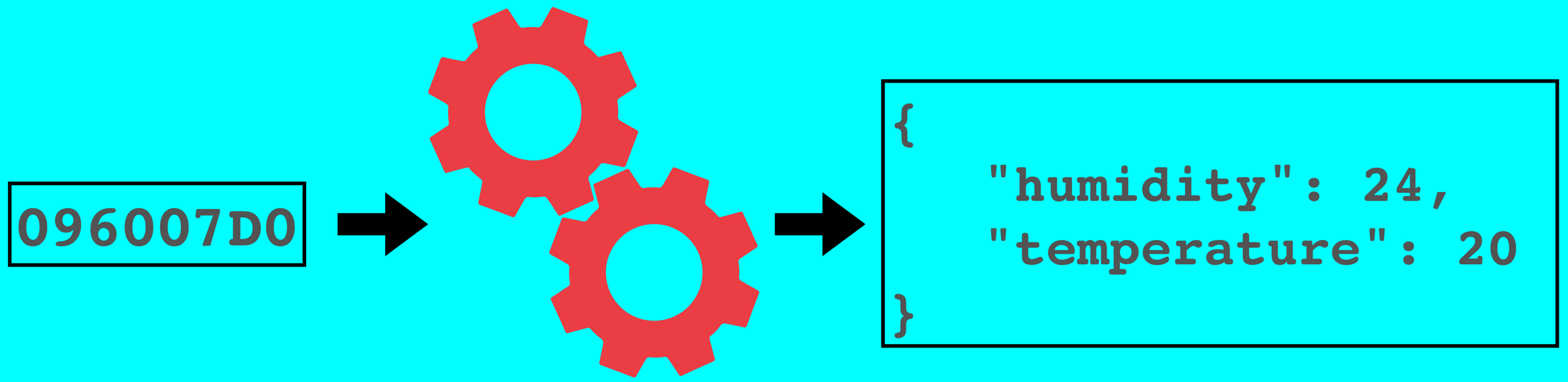
# LORA / LORAWAN TUTORIAL 53

## Payload Formatters (V3), fport & json



# INTRO

- In this tutorial I will explain what fport is and a short refresher what a json object is.
- I will also explain what payload formatters are and show you several Javascript payload formatters examples.

# PRESENTATION

- This presentation can be found at:
  https://www.mobilefish.com/download/lora/lora_part53.pdf

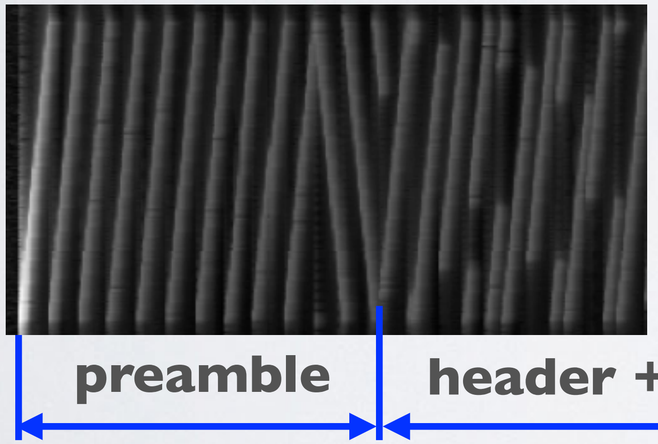
- All my LoRa/LoRaWAN tutorials and presentations can be found at:
  https://www.mobilefish.com/developer/lorawan/lorawan_quickguide_tutorial.html

- In this video when V2 is mentioned, V2 refers to The Things Network
  and when V3 is mentioned, V3 refers to The Things Stack Community Edition.
  This is to keep this video as short as possible.

# LORA PACKET FORMAT

- In tutorial 17, I have discussed the LoRa packet format.
  The LoRa packet comprises of three elements:
  Preamble, header (optional) and payload.

**CRC = Cyclic Redundancy Check**


**Spectogram of a LoRa packet**

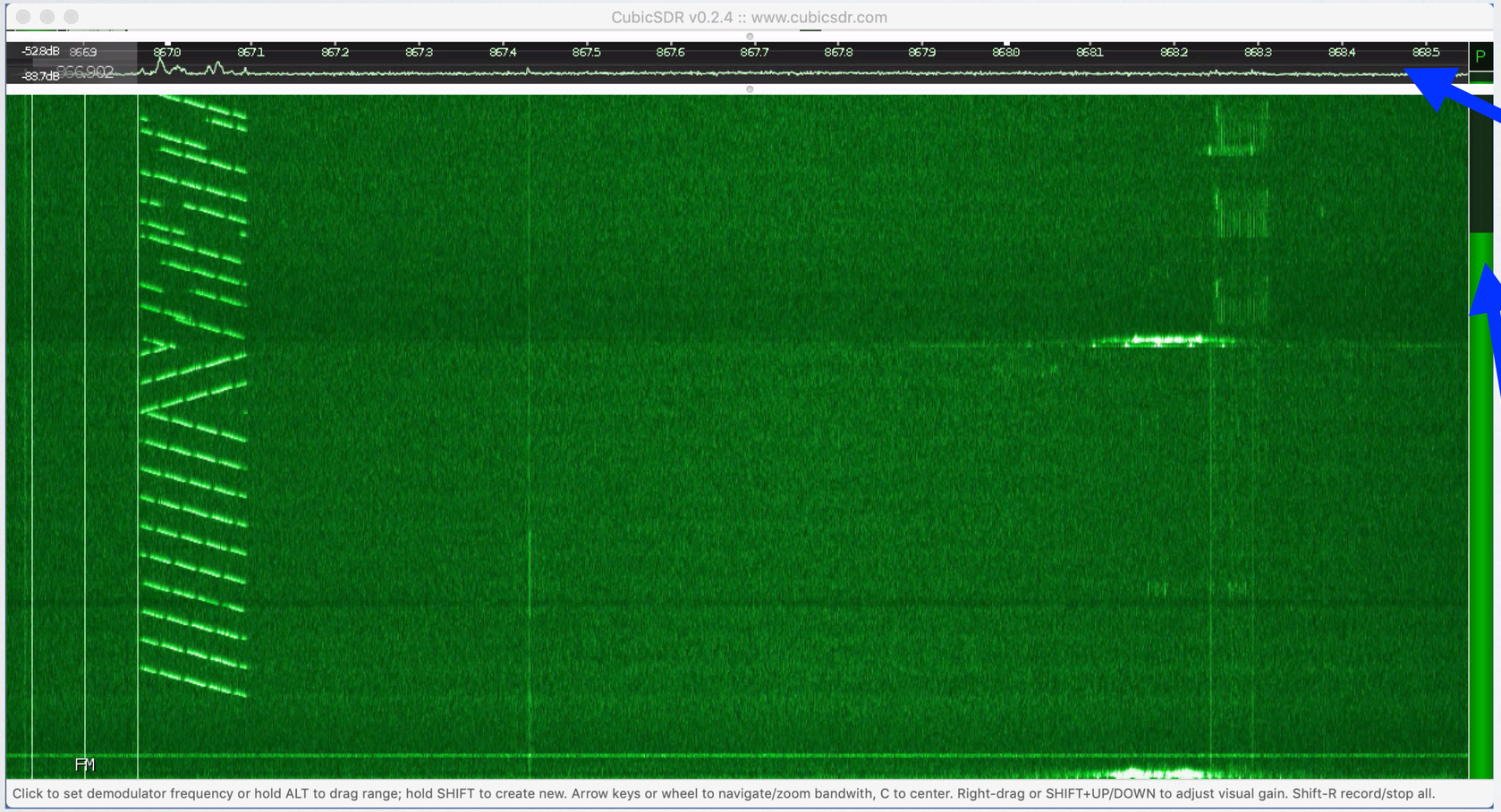
# RTL-SDR DONGLE

- To create the Radio Frequency (RF) waterfall, I used a RTL-SDR (Software Define Radio) dongle and a sleeve dipole antenna (antenna C in tutorial 33).
  Information about RTL-SDR dongle:
  https://youtu.be/bSAa2aOXpCc

- The RTL-SDR dongle is nameless but has the following chipsets:
  The radio tuner: Rafael Micro R820T2
  The demodulator: RealTek RTL2832U

# CUBICSDR SOFTWARE

- To create the Radio Frequency (RF) waterfall the CubicSDR software v0.2.4 is used on a macbook. More information: https://cubicsdr.com/




**Make sure the freq. range lies between 867.1 - 868.5 MHz (Europe).**

**Waterfall max speed changed to 400 lines per second.**

# LORA PACKET FORMAT

*Radio PHY layer:*


Figure 5: Radio PHY structure (CRC* is only available on uplink messages)

*PHYPayload:*

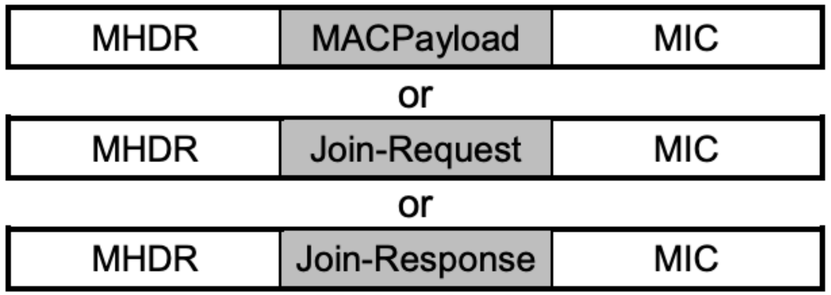



Figure 6: PHY payload structure

*MACPayload:*


Figure 7: MAC payload structure

*FHDR:*


Figure 8: Frame header structure

Source:
LoRaWAN Specification
v1.0.2

https://lora-alliance.org/wp-content/uploads/2020/11/lorawan1_0_2-20161012_1398_1.pdf

# LORA PACKET FORMAT

*Radio PHY layer:*


Figure 5: Radio PHY structure (CRC* is only available on uplink messages)

*PHYPayload:*

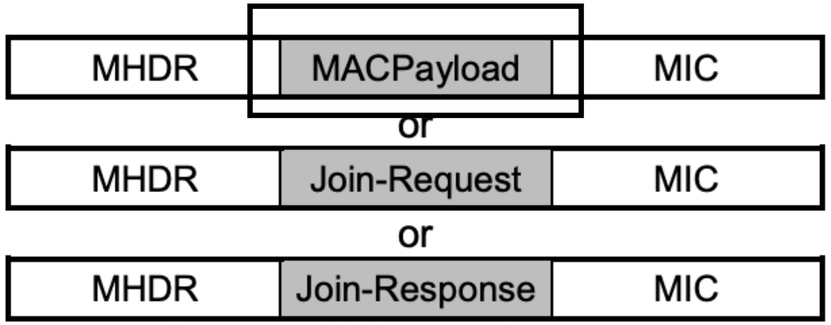



Figure 6: PHY payload structure

*MACPayload:*


Figure 7: MAC payload structure

*FHDR:*


Figure 8: Frame header structure

All LoRa uplink and downlink messages carry a PHYPayload starting with a MAC header (MHDR), followed by a MACPayload and ending with a message integrity code (MIC).

# LORA PACKET FORMAT

*Radio PHY layer:*


Figure 5: Radio PHY structure (CRC* is only available on uplink messages)

*PHYPayload:*

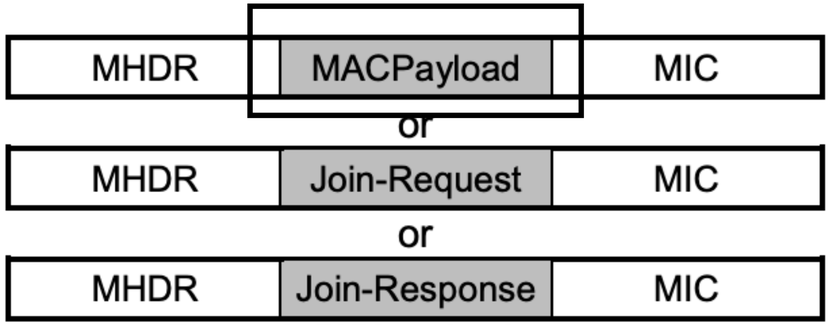



Figure 6: PHY payload structure

*MACPayload:*

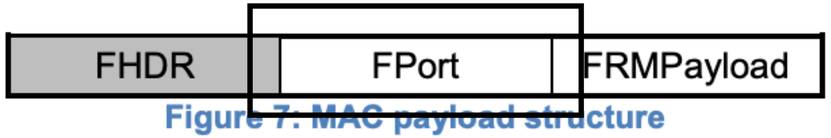



Figure 7: MAC payload structure

*FHDR:*


Figure 8: Frame header structure

The MACPayload contains a frame header (FHDR) followed by an optional port field (FPort) and an optional frame payload field (FRMPayload).

# FPORT

- **FPort** means **F**rame **Port**. If the frame payload field (FRMpayload) is not empty, the port field must be present. If present, an FPort value of 0 indicates that the FRMPayload contains MAC (Media Access Control) commands only.


- According to the LoRaWAN specification:
  - FPort values 1- 223 (dec) are application specific.
  - FPort value 224 is dedicated to LoRaWAN Mac layer test protocol.
  - FPort values 225 - 255 (dec) are reserved for future standardized application extensions.

# FPORT

- …but in the technical recommendation "FUOTA Process Summary Technical Recommendation TR002 v1.0.0" regarding **F**irmware **U**pdate **O**ver-**t**he-**A**ir on top of the LoRaWAN protocol, fports 225 and 200-203 are listed for specific usage. https://lora-alliance.org/wp-content/uploads/2020/11/tr002-fuota_process_summary-v1.0.0.pdf

| Package ID | Allocated FPort | Proposed FPort | Package version | Name | Version | Document link | Status | Release Date |
|---|---|---|---|---|---|---|---|---|
| 0 | **225** | | 1DRAFT | Multi Package Access Protocol over LoRaWAN | RC1 | Multi_Package_Access_rc1.docx | Release candidate | |
| 1 | | 202 | 1 | LoRaWAN Application Layer Clock Synchronization | v1.0.0 | LoRaWAN Application Layer Clock Synchronization Specification v1.0.0 | Published | September 10, 2018 |
| 2 | | 200 | 1 | LoRaWAN Remote Multicast Setup Specification | v1.0.0 | LoRaWAN Remote Multicast Setup Specification v1.0.0 | Published | September 10, 2018 |
| 3 | | 201 | 1 | LoRaWAN Fragmented Data Block Transport | v1.0.0 | LoRaWAN Fragmented Data Block Transport Specification v1.0.0 | Published | September 10, 2018 |
| 4 | | 203 | 1DRAFT | LoRaWAN Firmware Management Protocol | RC1 | Firmware_Management_Protocol_rc1.docx | Release candidate | |

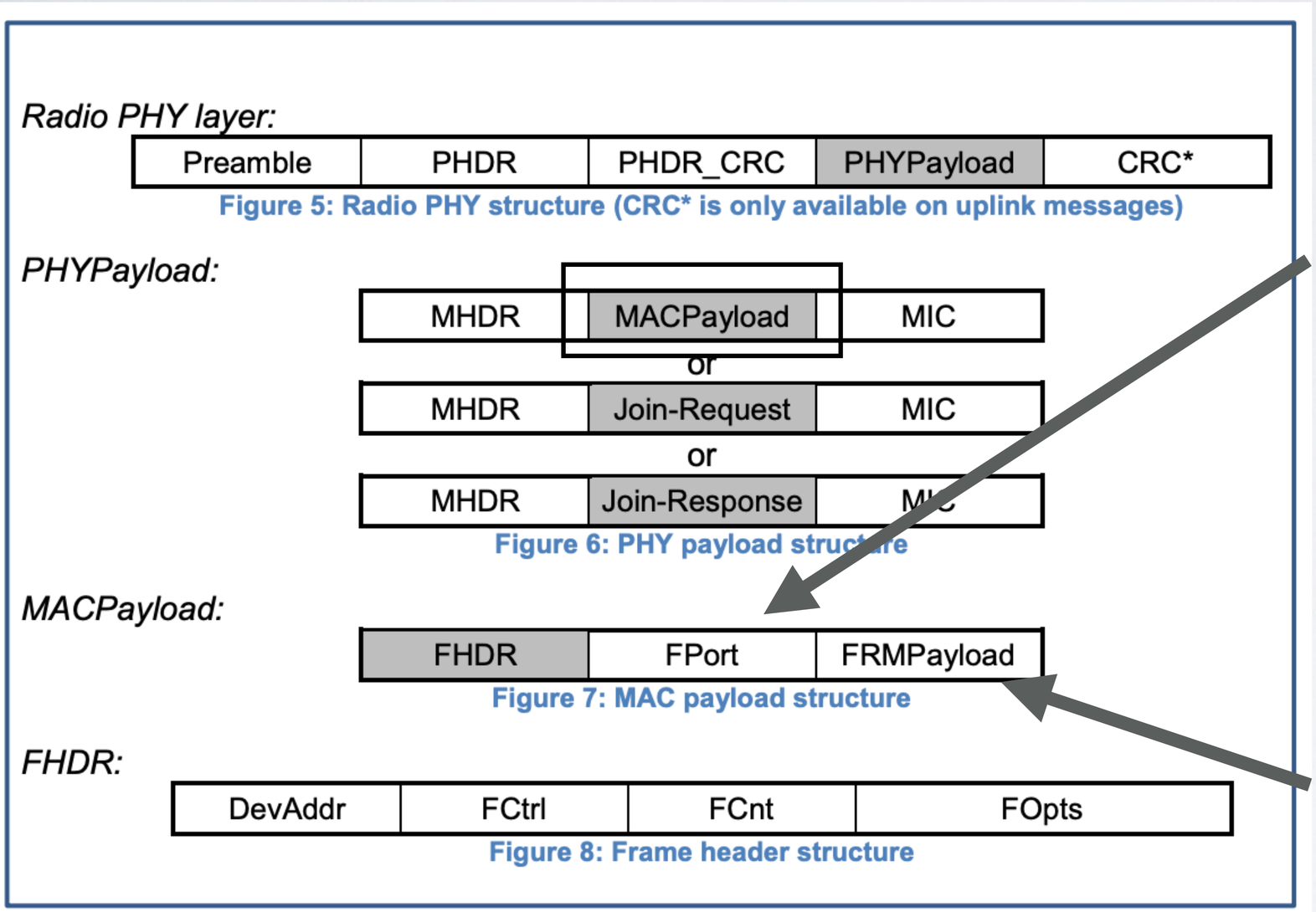
Table 1: Package Identifier List

# FPORT

- Combining the LoRaWAN specification and the FUOTA Process Summary Technical Recommendation, users should only use the following ports:

**fport 1- 223, except 200, 201, 202 and 203**

# FPORT FOR DUMMIES EXPLANATION




FPort is 1 byte in size.
Allowed values:
1 - 223, except fports 200-203.
This byte is always sent, even if you use it or not.

Hackers can read this value, but if they change this value, the package is dropped by the gateway because of the Message Integrity Code (MIC).

Encrypted sensor data is stored here. (Frame Payload)

# FPORT HAS ANOTHER PURPOSE

- If a data frame carries a payload, FRMPayload must be encrypted before the message integrity code (MIC) is calculated.


- The FRMPayload is encrypted with the NwkSkey if FPort is 0 otherwise it is encrypted with the AppSkey.

- *But you can ignore the above mentioned information because it is not relevant for this tutorial.*

# WHERE DO I SET THE FPORT?

- My end device uses this Arduino sketch:
  https://www.mobilefish.com/download/lora/ttn-otaa-pro-mini-sensors.ino.txt

- This sketch uses the MCCI LoRaWAN LMIC library in my Arduino IDE (v1.8.10)
  https://github.com/mcci-catena/arduino-lmic

> **MCCI LoRaWAN LMIC library** by **IBM, Matthis Kooijman, Terry Moore, ChaeHee Won, Frank Rose** Version **3.3.0** **INSTALLED**
> **Arduino port of the LMIC (LoraWAN-MAC-in-C) framework provided by IBM.** Supports LoRaWAN 1.0.2/1.0.3 Class A devices implemented using the Semtech SX1272/SX1276 (including HopeRF RFM92/RFM95 and Murata modules). Support for EU868, US, AU, AS923, KR and IN regional plans. Untested support for Class B and FSK operation. Various enhancements and bug fixes from MCCI and The Things Network New York. Original IBM URL http://www.research.ibm.com/labs/zurich/ics/lrsc/lmic.html.
> More info

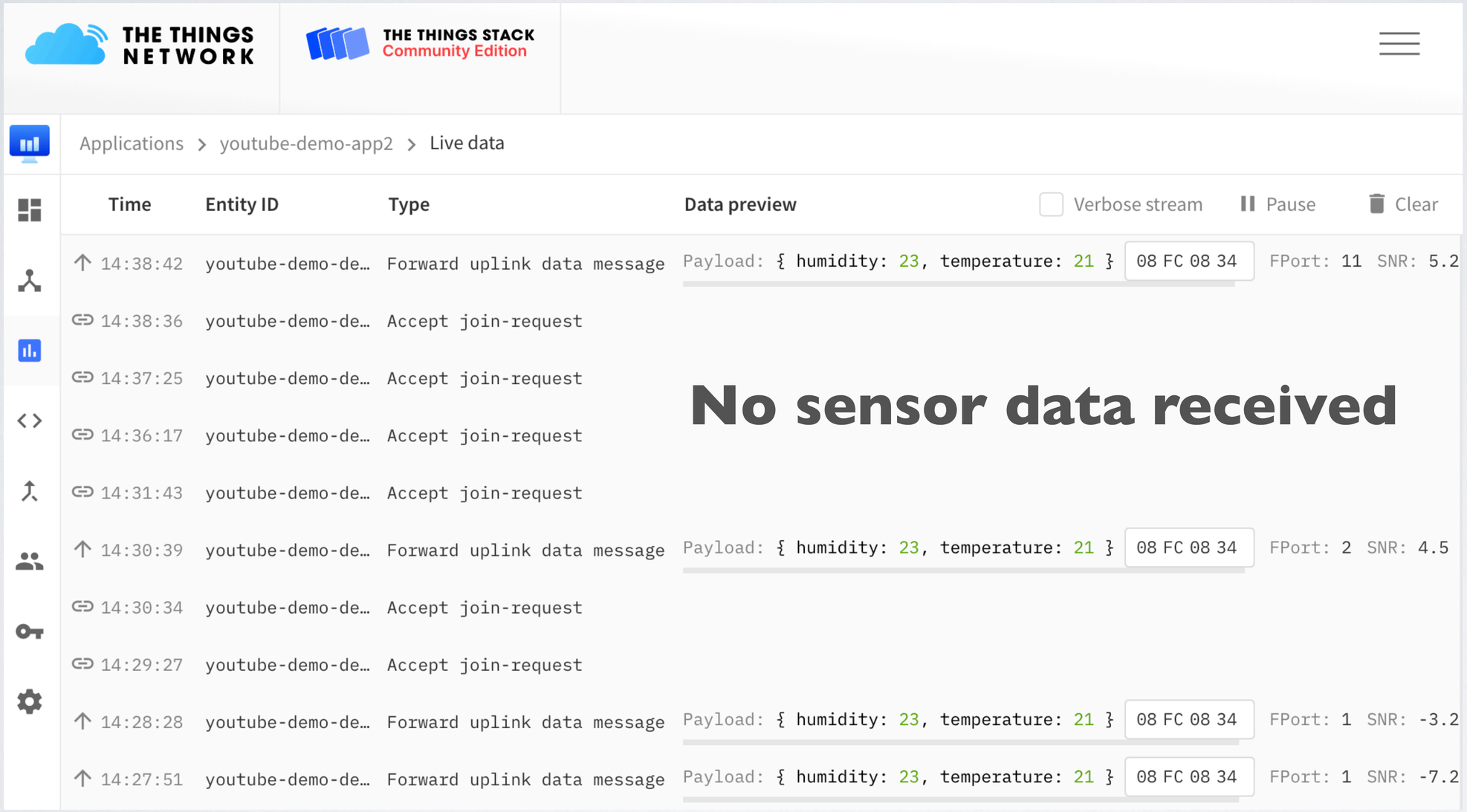
- In the sketch, change function LMIC_setTxData2 to change the fport value.

```
LMIC_setTxData2(fport, data, data_length, confirmed)
LMIC_setTxData2(1, payload, sizeof(payload), 0);
```

# WHERE DO I SET THE FPORT?

- If you use the MCCI LoRaWAN LMIC library, more sketch examples: https://github.com/mcci-catena/arduino-lmic/tree/master/examples

# FPORT VALUE CHANGED TO DIFFERENT VALUES



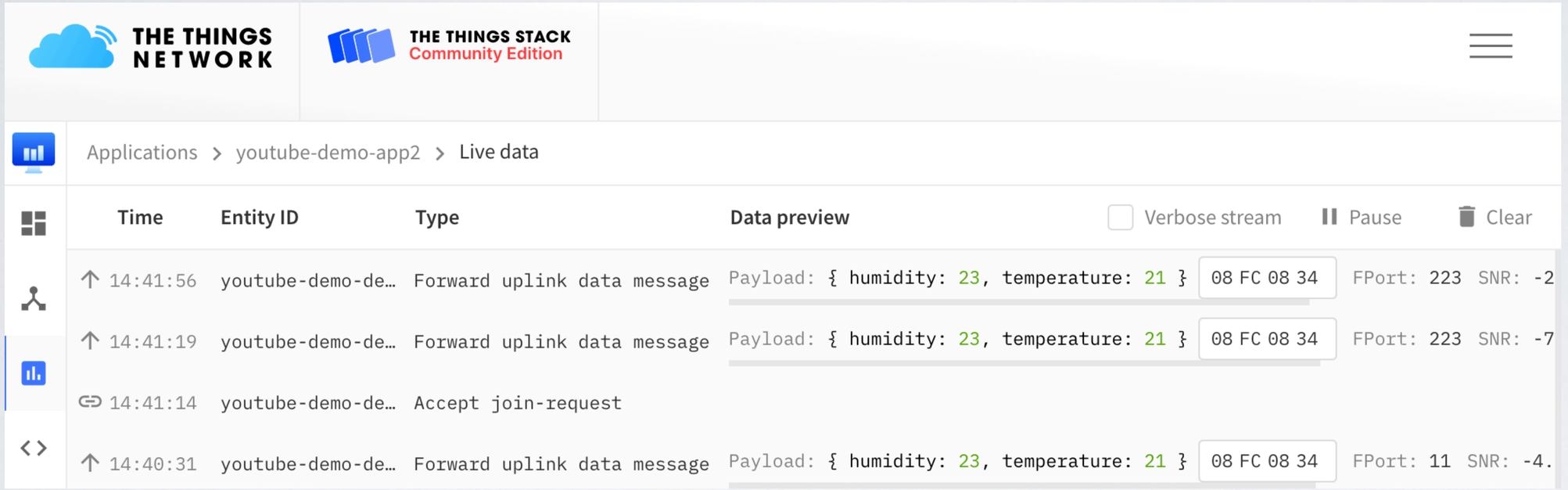

**FPort = 11**

**No sensor data received** **FPort = 0**

**FPort = 2**

**FPort = 1**

# FPORT VALUE CHANGED TO DIFFERENT VALUES




**FPort = 223**

# DEMO TO INTERCEPT THE FPORT VALUE

- I am using the RAK7244C (WisGate Developer D4+) LoRaWAN gateway.
  This gateway uses the Raspberry Pi 4.
  More information this gateway, see tutorial 51.

- To monitor UDP messages send between the RAK7244C and the V3 network install the tcpdump application:

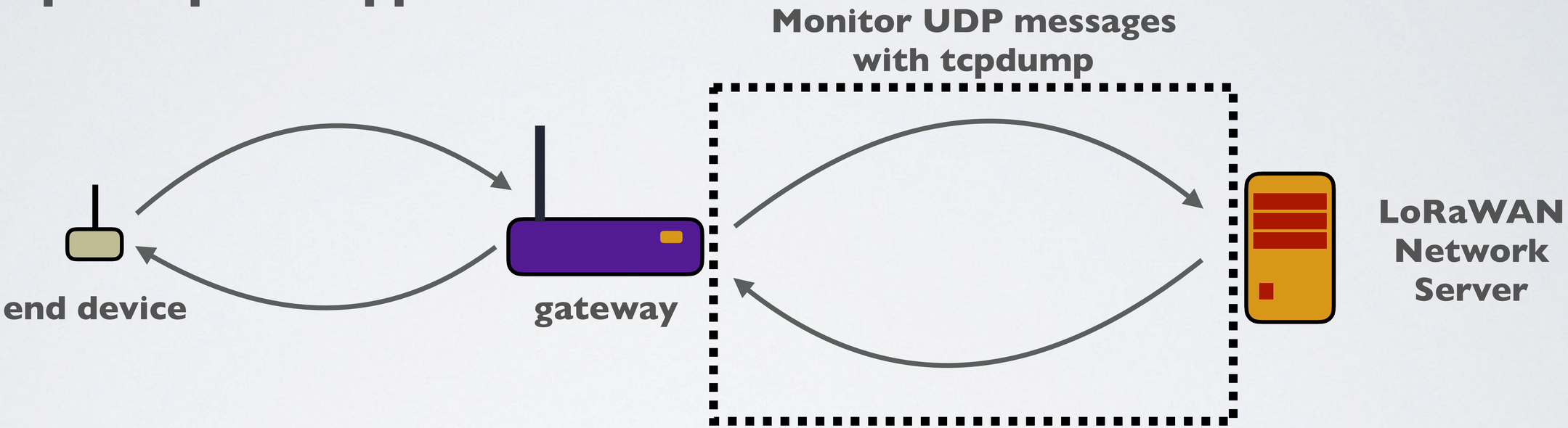
  - Access the RAK7244C, for example: **ssh pi@192.168.2.167**

  - Upgrade the Raspberry Pi packages:
    **sudo apt-get update && sudo apt-get upgrade -y**

  - Install tcpdump:
    **sudo apt-get install tcpdump -y**

# DEMO TO INTERCEPT THE FPORT VALUE

- Start tcpdump:
  **sudo tcpdump -AUq port 1700**




robertlie — pi@rak-gateway: ~ — ssh pi@192.168.2.167 — 77×22

```
E..._I@.@.......4.................2..6[G{"rxpk":[{"tmst":922138443,"chan":0,"
rfch":1,"freq":868.100000,"stat":1,"modu":"LORA","datr":"SF7BW125","codr":"4/
5","lsnr":9.0,"rssi":-40,"size":17,"data":"QIbHCyaAAQAKGjp4Iigma3E="}]}
```

# DEMO TO INTERCEPT THE FPORT VALUE

- More information about the UDP messages, see tutorial 29.

- There is an online tool available which can decode the LoRaWAN 1.0.x packet.
  https://lorawan-packet-decoder-0ta6puiniaut.runkit.sh/
  This tool uses the LoRa radio packet decoder created by Anthony Kirby:
  https://github.com/anthonykirby/lora-packet

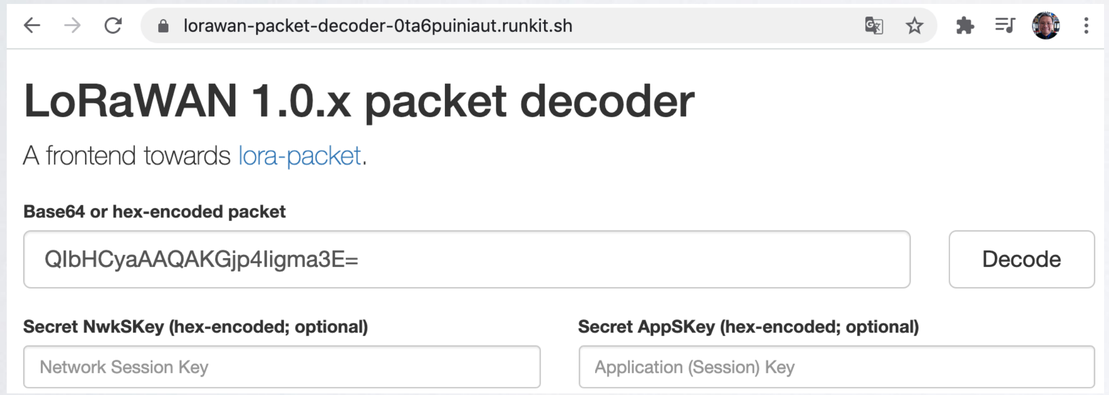
  **USE THE ONLINE TOOL FOR EDUCATIONAL, DEMONSTRATION OR TEST PURPOSES.**

  **NEVER ENTER YOUR PRODUCTION SECRET NWKSKEY OR APPSKEY.**

# DEMO TO INTERCEPT THE FPORT VALUE

- From tcpdump get the base64 encoded data:
  **QIbHCyaAAQAKGjp4Iigma3E=**

- Enter the base64 encoded data in the LoRaWAN 1.0.x packet decoder.




```
Assuming base64-encoded packet
QIbHCyaAAQAKGjp4Iigma3E=

Message Type = Data
  PHYPayload = 4086C70B268001000A1A3A782228266B71

( PHYPayload = MHDR[1] | MACPayload[..] | MIC[4] )
        MHDR = 40
  MACPayload = 86C70B268001000A1A3A7822
         MIC = 28266B71

( MACPayload = FHDR | FPort | FRMPayload )
        FHDR = 86C70B26800100
       FPort = 0A
  FRMPayload = 1A3A7822

     ( FHDR = DevAddr[4] | FCtrl[1] | FCnt[2] | FOpts[0..15] )
    DevAddr = 260BC786 (Big Endian)
      FCtrl = 80
       FCnt = 0001 (Big Endian)
      FOpts =

Message Type = Unconfirmed Data Up
   Direction = up
        FCnt = 1
   FCtrl.ACK = false
   FCtrl.ADR = true
```

**FPort = 10**

# CHANGE FPORT IN LORAWAN END DEVICES

- There are LoRaWAN end devices where fports can not be changed.
  These devices have fixed fport values.

- There are LoRaWAN end devices where fports can be changed programmatically (for example in an Arduino sketch) or with at-commands.

- There are LoRaWAN end devices where fports can only be changed by modifying, compiling and uploading the new firmware to the end device.

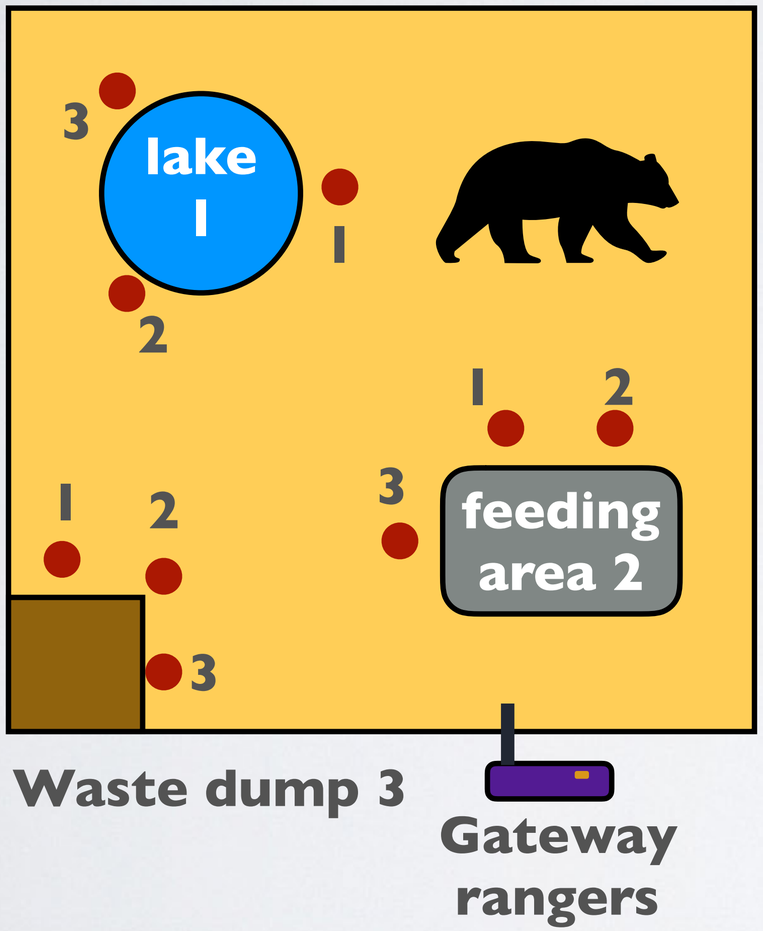
- If you want to know if you can change your LoRaWAN end device fport value, check your end device manual.

# FPORT USAGE

- It is recommended that you use the fport because this byte is always sent, you might as well use it.
- Every byte not transmitted improves the end device battery life.
- But be careful of the kind of information the fport value represents.
  Hackers can use this information for criminal activities.

# EXAMPLE NOT USING FPORT

- Do not use fport if it contains information which can be useful to criminals.




Park rangers are researching the bear's behaviour.
This bear is unique, it is 3x its normal size (very large).
Rangers are monitoring how often does the bear visits the lake, feeding area and waste dump.

Motion sensors are placed near the entrances.

```
Lake         - fport = 1
Feeding area - fport = 2
Waste dump   - fport = 3
```

# EXAMPLE NOT USING FPORT

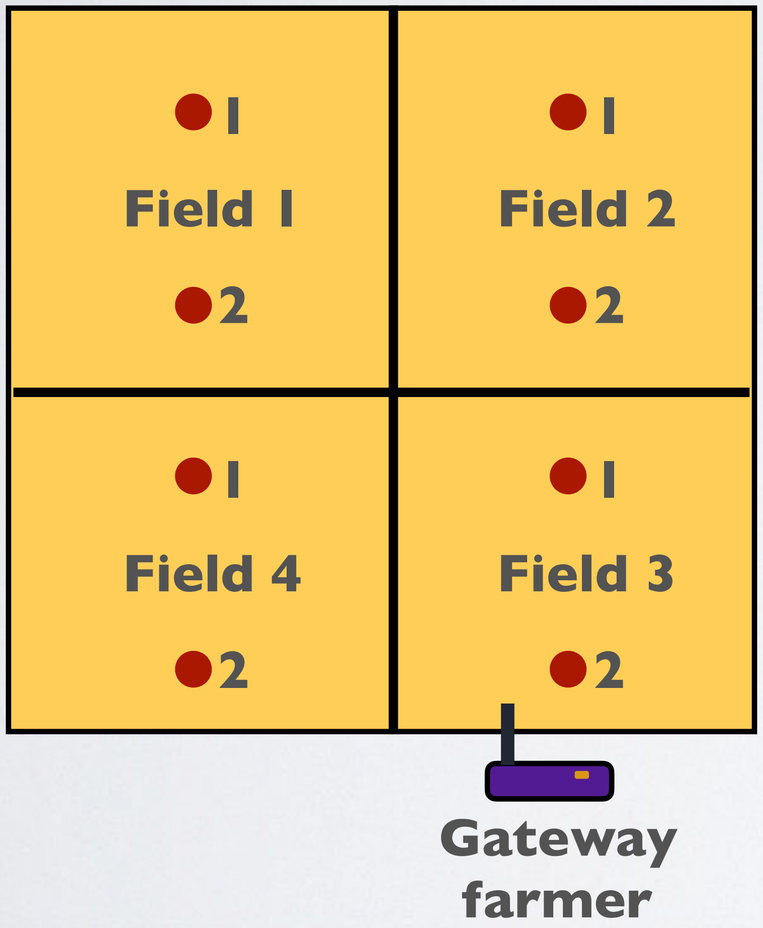
- A criminal can sell the bear's location to illegal hunters.


Lets assume the criminal knows which area each fport value represents.

By monitoring the fport value the criminal will know in which area the bear is located.

# EXAMPLE USING FPORT

- Potato farm with sensors measuring temperature and soil moisture.




The fport value is not interesting to hackers.
There is no monetary gain, if someone knows the fport values.

```
Field 1       - fport = 1
Field 2       - fport = 2
Field 3       - fport = 3
Field 4       - fport = 4
```

# JSON

- JSON (JavaScript Object Notation) is a syntax for storing and exchanging data.

- This is a json object:

```
{
   "device": 2,
   "id": "ab123",
   "temperature": [12, 56],
   "location": {
      "lat": 12.44,
      "lon": 45.88
   },
   "info": null,
   "enable": true
}
```

- The json object starts and ends with curly brackets.

- Data consists of key/value pairs separated by commas.

- **The key must be wrapped in double quotes**.

- The key and its value are separated by a colon.

- The value can be a number (12 or 23.56) , string (“Hello”), boolean (true/false), array ([“aa”,“bb”]) another json object ({…}, or the value null).

# JAVASCRIPT OBJECT

- This is a Javascript object.

```
{
  device: 2,
  id: "ab123",
  temperature: [12, 56],
  location: {
    lat: 12.44,
    lon: 45.88
  },
  info: null,
  enable: true
}
```

- In Javascript objects the keys are not required to be wrapped in double quotes.
- There are other differences but I will not discuss these in this tutorial.

# JAVASCRIPT OBJECT

```
var sensor =
{
  device: 2,
  id: "ab123",
  temperature: [12, 56],
  location: {
    lat: 12.44,
    lon: 45.88
  },
  info: null,
  enable: true
}
```

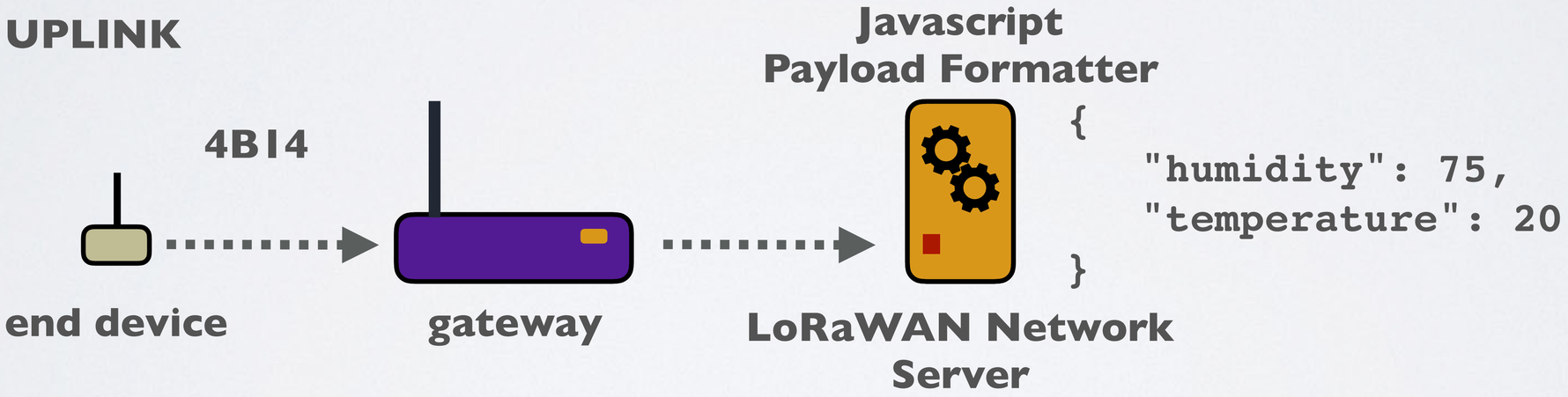
To create the sensor Javascript object:

```
var sensor = {};
sensor.device = 2;
sensor.id = "ab123";
var temp_arr = [];
temp_arr[0] = 12;
temp_arr[1] = 56;
sensor.temperature = temp_arr;
var coord = {};
coord.lat = 12.44;
coord.lon = 15.88;
sensor.location = coord;
sensor.info = null;
sensor.enable = true;
```

# WHAT ARE PAYLOAD FORMATTERS

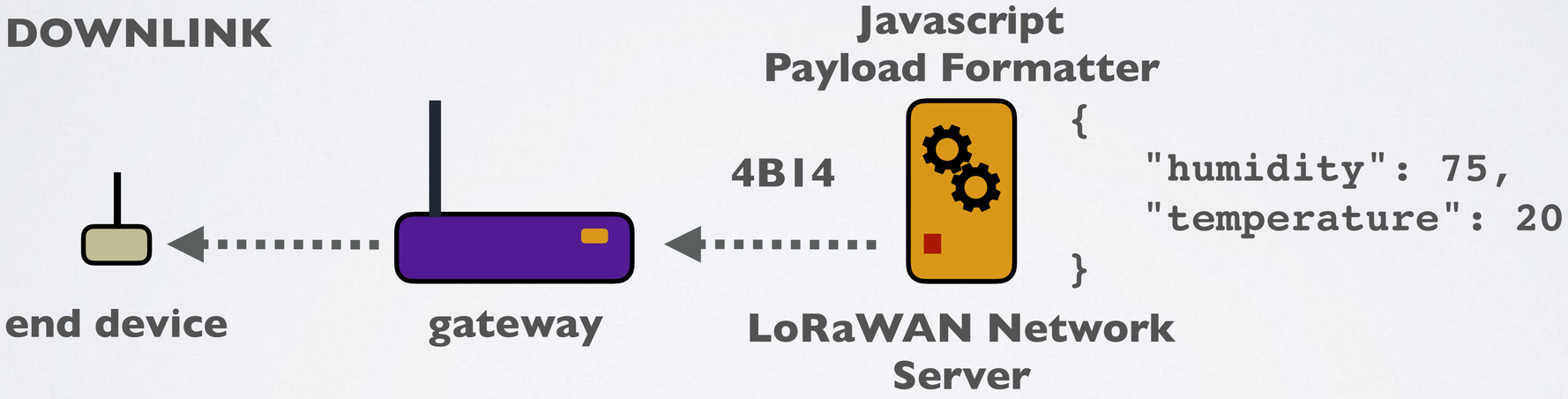
- Payload formatters allow you to process data going to and from end devices.

- When a binary payload is sent from end device to LoRaWAN network (uplink), the data can be converted using, for example, a Javascript payload formatter. The data can be converted to human readable data.



# WHAT ARE PAYLOAD FORMATTERS

- When a message is sent from the LoRaWAN network to the end device (downlink), the message can be converted using, for example, a Javascript payload formatter. The message can be converted from human readable data to binary data.



# THE V2 AND V3 PAYLOAD FORMATTERS ARE DIFFERENT

- The payload formatters used in the V2 console can not be copy-and-pasted directly in the V3 console.
- The V2 and V3 payload formatters are different.
- For example, the function names and the function parameters are different.
- In this tutorial I will only focus on the payload formatters used in the V3 console.

# JAVASCRIPT PAYLOAD FORMATTER (UPLINK)

**V2**

```
function Decoder(bytes, port) {
    if(bytes.length == 1) {
        if(bytes[0] == 1) {
            return {
                'button': 'activated'
            }
        } else {
            return {
                'error': 'button action unknown'
            }
        }
    } else if(bytes.length == 4) {
        var humidity = (bytes[0]<<8) | bytes[1];
        var temperature = (bytes[2]<<8) | bytes[3];
        return {
            'humidity': humidity/100,
            'temperature': temperature/100
        }
    } else {
        return {
            'error': 'payload unknown'
        }
    }
}
```

**V3**

```
function decodeUplink(input) {
    var data = {};
    var warnings = [];
    var errors = [];

    if(input.bytes.length == 1) {
        if(input.bytes[0] == 1) {
          data.button = "activated";
        } else {
          errors.push("button action unknown");
        }
    } else if(input.bytes.length == 4) {
        var humidity = (input.bytes[0]<<8) | input.bytes[1];
        data.humidity = humidity/100;
        var temperature = (input.bytes[2]<<8) | input.bytes[3];
        data.temperature = temperature/100;
    } else {
        errors.push("payload unknown");
    }

    return {
        data: data,
        warnings: warnings,
        errors: errors
    };
}
```

# JAVASCRIPT PAYLOAD FORMATTER (UPLINK)

- Decoder example (V2)
  https://www.mobilefish.com/download/lora/tutorial_26_decoder.txt

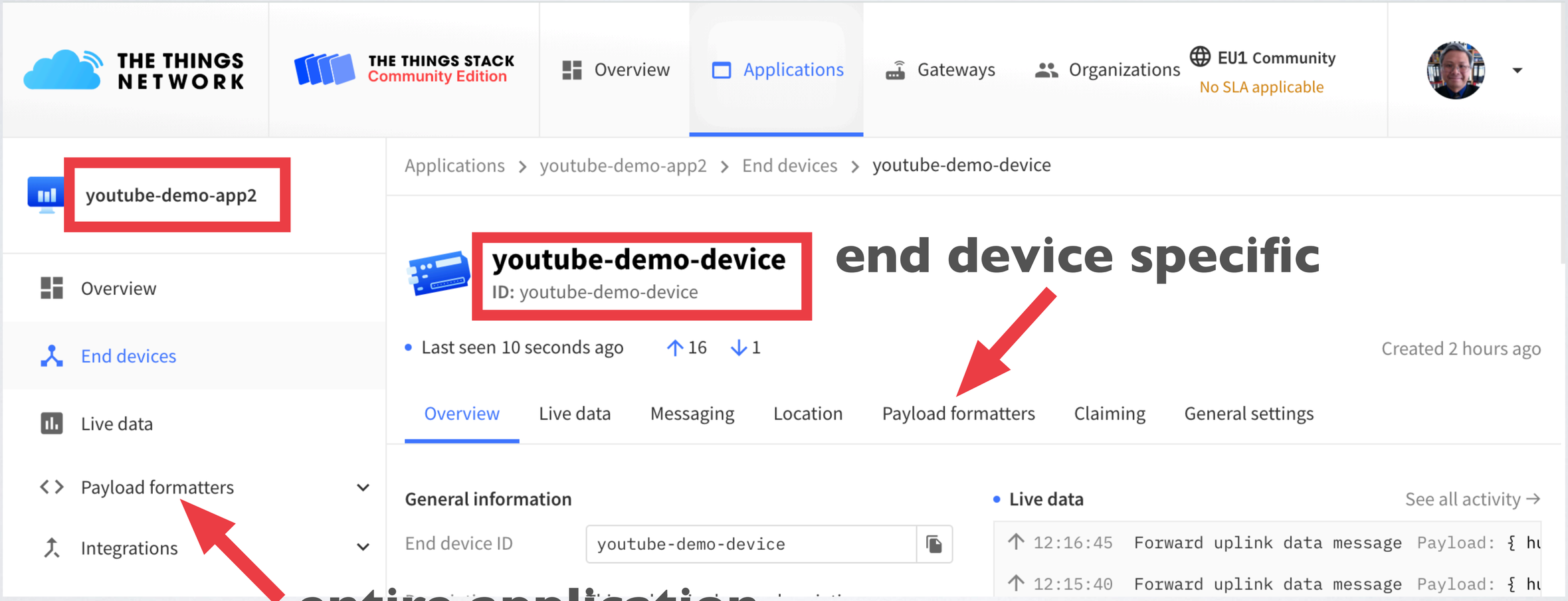
- decodeUplink example (V3)
  https://www.mobilefish.com/download/lora/tutorial_53_decodeuplink.txt

# PAYLOAD FORMATTERS

- In the V3 console several payload formatters can be used:
  - Javascript payload formatters
    https://www.thethingsindustries.com/docs/integrations/payload-formatters/javascript
  - Cayenne Low Power Payload formatters
    https://www.thethingsindustries.com/docs/integrations/payload-formatters/cayenne/
  - Device specific payload formatters
    Device manufacturers may have payload formatters designed to work with their devices.
    https://github.com/TheThingsNetwork/lorawan-devices
- I will only focus on the Javascript payload formatters.

# PAYLOAD FORMATTERS

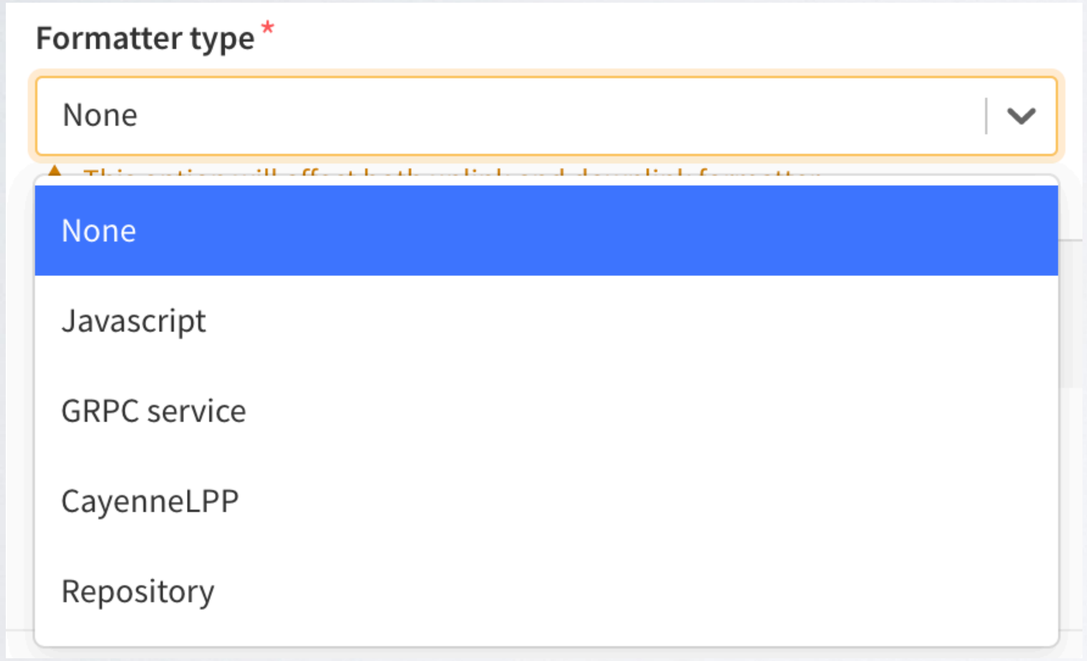
- The V3 payload formatters can be applied to an entire application, or to a specific end device.



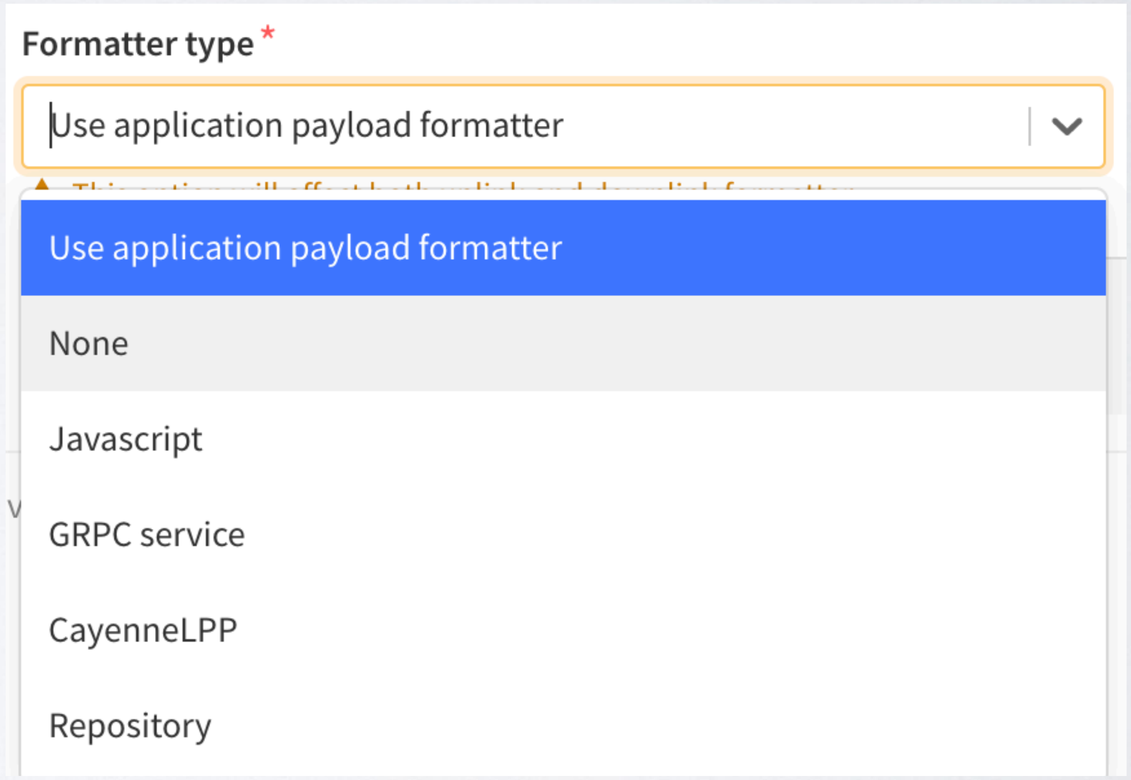
# PAYLOAD FORMATTERS

- Depending on the selected payload formatter (entire application or end device specific) you will see 5 or 6 formatter type options.

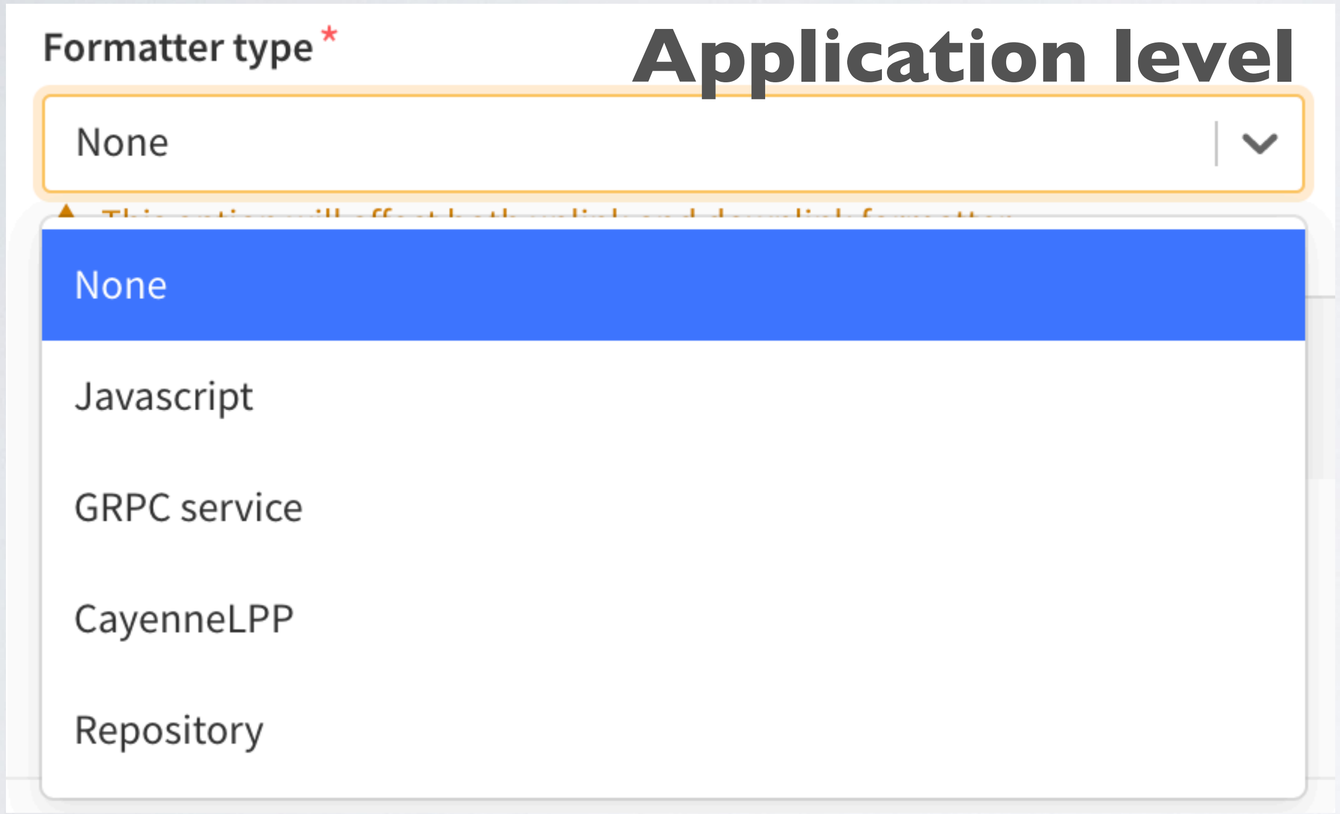
## entire application




## end device specific



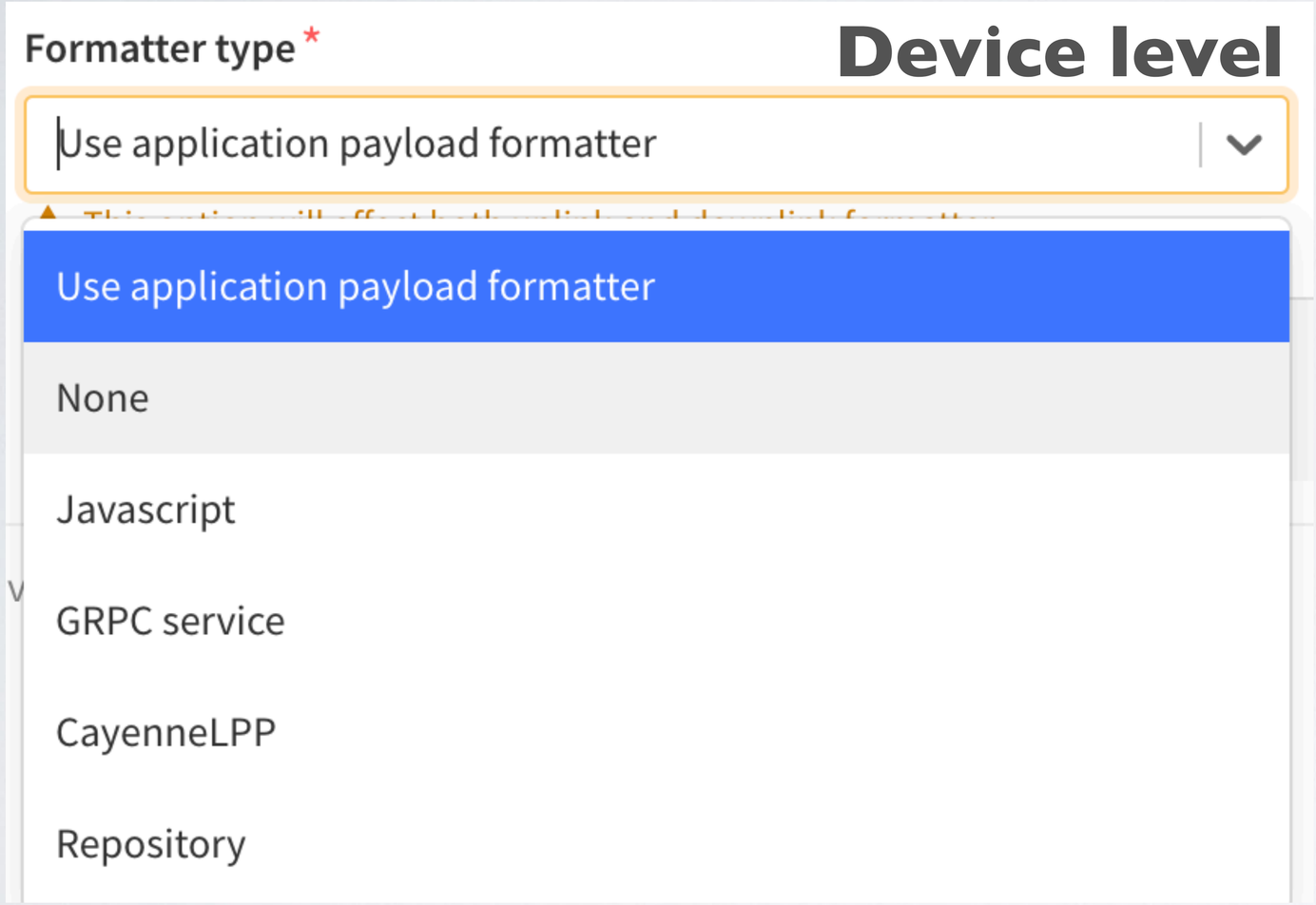
# PAYLOAD FORMATTERS




On the **application** level these are the formatter type options.

When selecting None any entered payload formatter is removed and replaced with the default payload formatter.

# PAYLOAD FORMATTERS




On the **device** level these are the formatter type options.

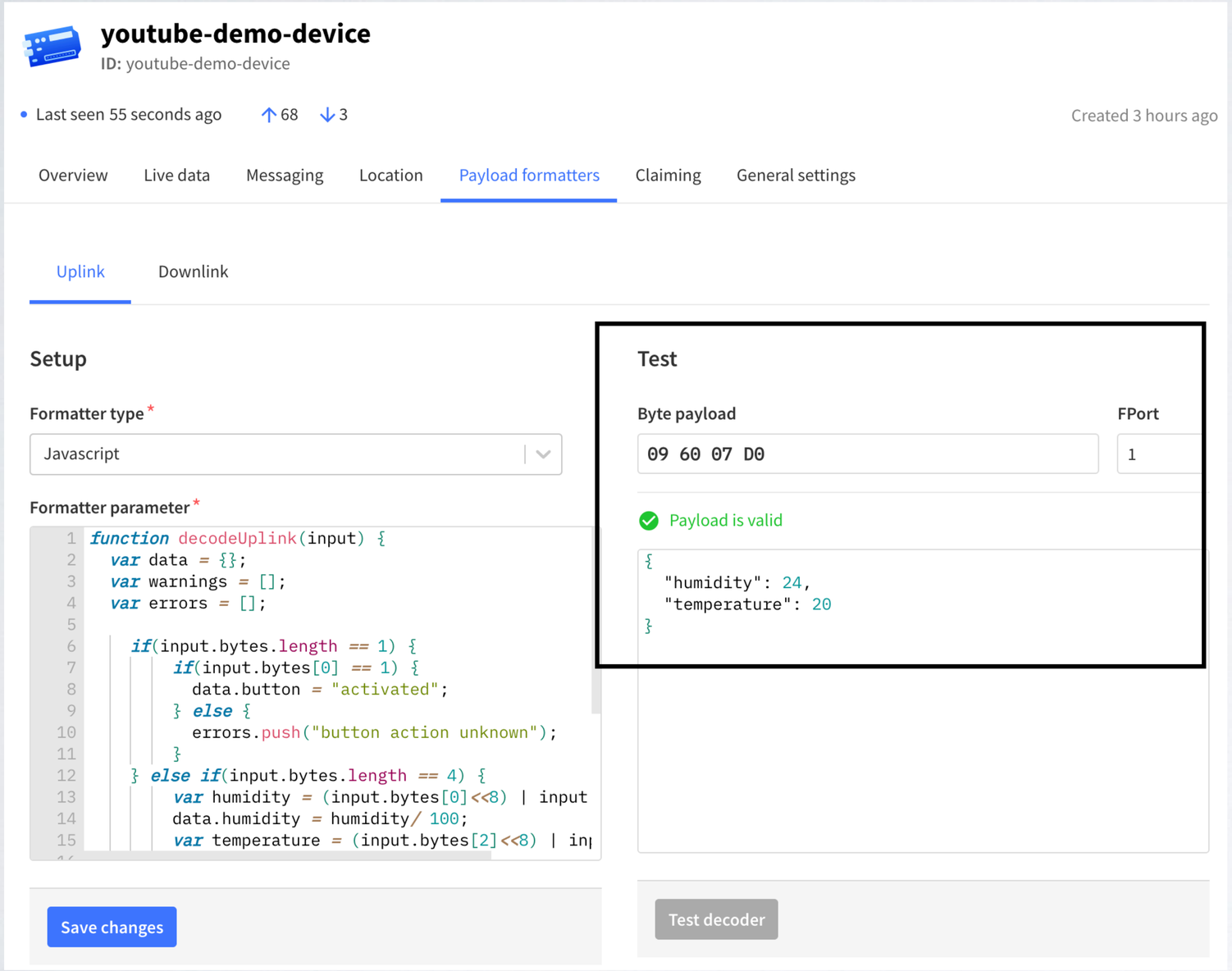
When both device and application payload formatter are specified the device payload formatter is used. But when you select the option "Use application payload formatter", the application payload formatter is used.

# PAYLOAD FORMATTERS

- It is recommended to use application payload formatters and only use device payload formatters when there is a need.

- If your application has two or more LoRaWAN end devices and they all transmit the same kind of sensor data, of course, you should specify the payload formatter on the application level.

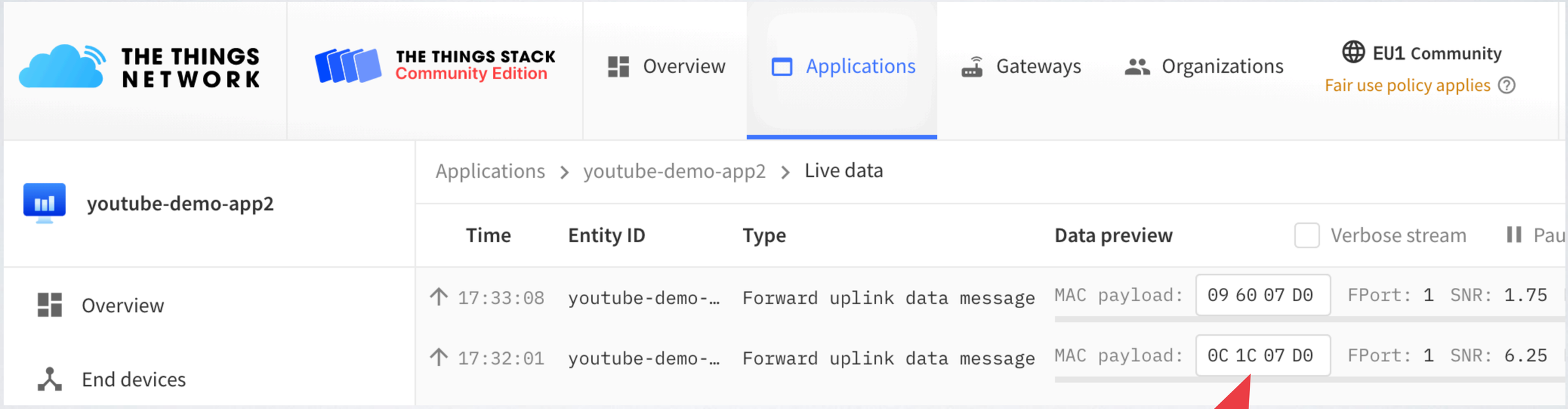
# PAYLOAD FORMATTER TESTER




The payload formatter tester is only available on the device level and not on the application level.

# NO PAYLOAD FORMATTER USED

- When no payload formatter is used:




**only received payload (bytes)**

# NO PAYLOAD FORMATTER USED

Applications > youtube-demo-app2 > Live data

| Time | Entity ID | Type |
|---|---|---|
| 17:35:21 | youtube-demo-… | Forward u |
| 17:34:15 | youtube-demo-… | Forward u |
| 17:33:08 | youtube-demo-… | Forward u |
| 17:32:01 | youtube-demo-… | Forward u |
| 17:31:56 | youtube-demo-… | Accept jc |
| 17:30:48 | youtube-demo-… | Accept jc |

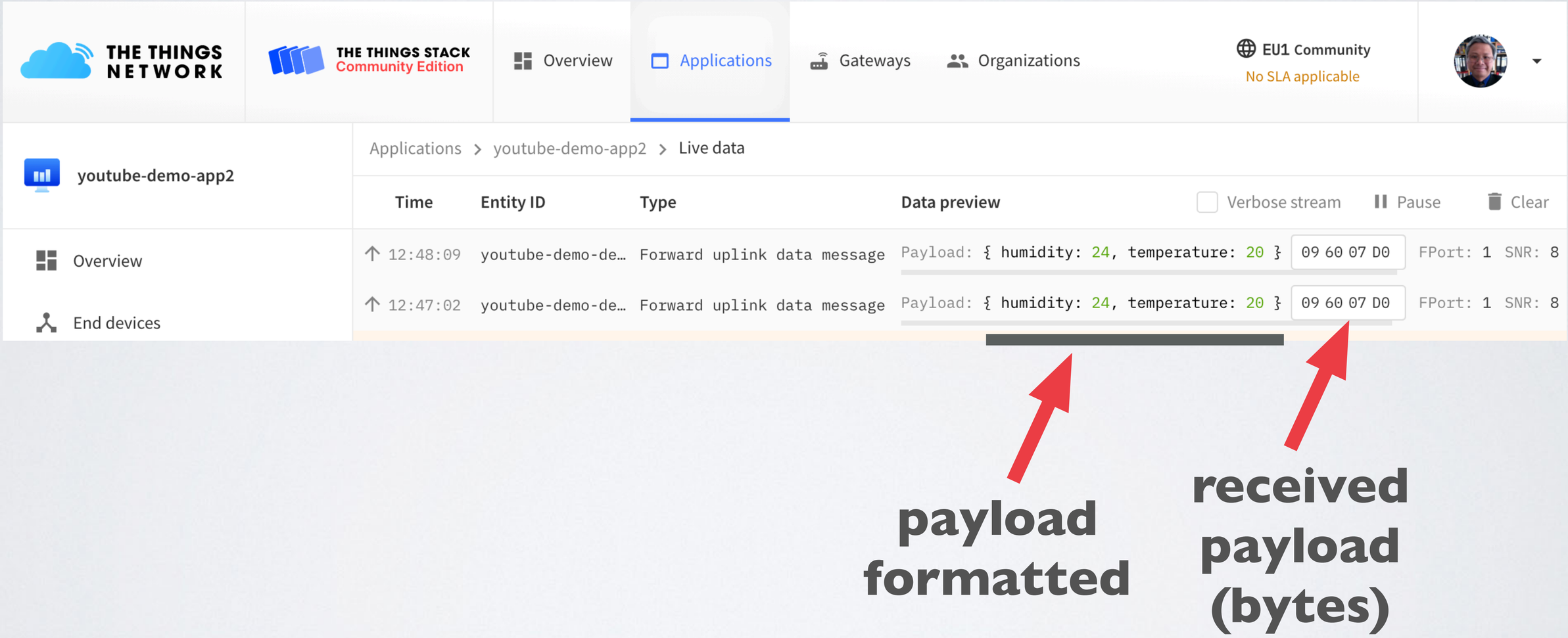
Event details

```
39        "gs:up:host:01F6M1PHMP1CSAN0M14SXV3MJB",
40        "gs:uplink:01F6SSQ4S5RSVEJP7BKNYYDXXP",
41        "ns:uplink:01F6SSQ4S6A30FDHSK1ZYMKKV1",
42        "rpc:/ttn.lorawan.v3.GsNs/HandleUplink:01F6SSQ4
43        "rpc:/ttn.lorawan.v3.NsAs/HandleUplink:01F6SSQ4
44      ],
45      "received_at": "2021-05-28T15:33:08.215928905Z",
46      "uplink_message": {
47        "session_key_id": "AXmzmno4ObAjcg5V4Gr+LA==",
48        "f_port": 1,
49        "f_cnt": 1,
50        "frm_payload": "CWAH0A==",
51        "rx_metadata": [
52          {
```

**No formatted payload**

# PAYLOAD FORMATTER IS USED

- When a payload formatter is used:



# PAYLOAD FORMATTER IS USED

Applications > youtube-demo-app2 > Live data

| Time | Entity ID | Type |
|---|---|---|
| 12:58:09 | youtube-demo-de… | Forward uplink data |
| 12:57:02 | youtube-demo-de… | Forward uplink data |
| 12:55:56 | youtube-demo-de… | Forward uplink data |
| 12:54:49 | youtube-demo-de… | Forward uplink data |
| 12:53:44 | youtube-demo-de… | Forward uplink data |

Event details

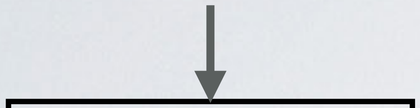
```
44    ],
45    "received_at": "2021-05-25T10:47:02.611022456Z",
46    "uplink_message": {
47      "session_key_id": "AXmi9no9i1M57A7Bu7c5Ug==",
48      "f_port": 1,
49      "f_cnt": 46,
50      "frm_payload": "CWAH0A==",
51      "decoded_payload": {
52        "humidity": 24,
53        "temperature": 20
54      },
55      "rx_metadata": [
56        {
```

**Formatted payload**

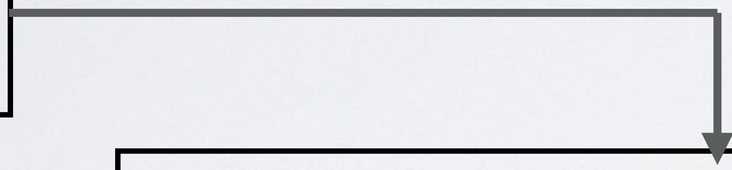
# UPLINK JAVASCRIPT PAYLOAD FORMATTER

# UPLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

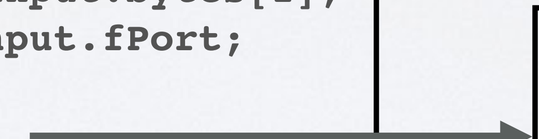
```
fPort = 8
sensor data = 010A
```



```
input = {
 "fPort": 8,
 "bytes": [1,10]
}
```



```
function decodeUplink(input) {
    data = {};
    data.led = input.bytes[0];
    data.color = input.bytes[1];
    data.port = input.fPort;
    return {
        data: data
    };
}
```



```
{
  led: 1,
  color: 10,
  port: 8
}
```

**Formatted data displayed in console.**

# UPLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

```
TX sensor
data = 0A0B
fPort = 5
```

```
input = {
  "fPort": 4,
  "bytes": [11,12]
}
```

```
function decodeUplink(input) {
  :
  return {
    data: {…},
    warnings: ["warning1","warning2"],
    errors: ["error1","error2"]
  }
}
```

# UPLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

```
input = {
  "fPort": 4,
  "bytes": [9,96,7]
}
```

```
Tx sensor
data:
096007
fPort:4
```

```
function decodeUplink(input) {
  var dt = {};
  dt.port = input.fPort;
  dt.val1 = input.bytes[0];
  dt.val2 = input.bytes[1];
  dt.val3 = input.bytes[2];
  return {
    data: dt
  };
}
```

```
{
  port: 4,
  val1: 9,
  val2: 96,
  val3: 7,
}
```

returned object

The decodeUplink function has only one function parameter (input) which is a json object.

The json object is automatically created and always contains two key/value pairs.
fPort contains the fport value.
When binary sensor data is transmitted (eg: 096007) this data is automatically converted to an array of separate bytes each in its decimal representation (eg: [9,96,7]) and is assigned to the bytes key in the json object.

# UPLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

```
input = {
  "fPort": 4,
  "bytes": [9,96,7]
}
```

```
Tx sensor
data:
096007
fPort:4
```

```
function decodeUplink(input) {
  var dt = {};
  dt.port = input.fPort;
  dt.val1 = input.bytes[0];
  dt.val2 = input.bytes[1];
  dt.val3 = input.bytes[2];
  return {
    data: dt
  };
}
```

```
{
  port: 4,
  val1: 9,
  val2: 96,
  val3: 7,
}
```

returned object

The payload formatter outputs a javascript (JS) object.
The JS object can be empty {} or contains:

- a data key with a javascript object as its value,
- an errors key with an array of error messages as its value,
- a warnings key with an array of warning messages as its value.

```
{
  data: {…},
  errors: […],
  warnings: […]
}
```

# BYTE PAYLOAD IS CONVERTED TO DECIMAL VALUES

## Setup

Formatter type *

Javascript

Formatter parameter *

```
1  function decodeUplink(input) {
2    var dt = {};
3    dt.port = input.fPort;
4    dt.val1 = input.bytes[0];
5    dt.val2 = input.bytes[1];
6    dt.val3 = input.bytes[2];
7    return {
8      data: dt
9    };
10 }
```

## Test

Byte payload

hex values

09 60 07

FPort

4

Payload is valid

```
{
  "port": 4,
  "val1": 9,
  "val2": 96,
  "val3": 7
}
```

**The hex values are automatically converted into an array of decimal values:**

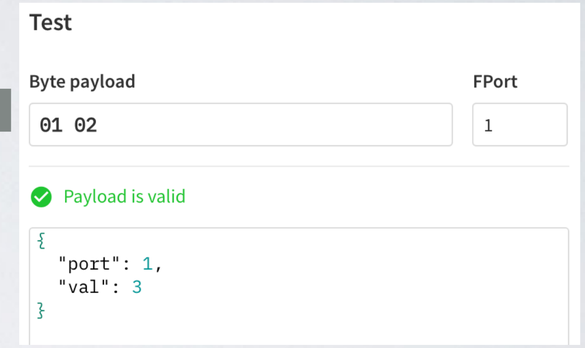
**input = {**
**“fPort”: 4,**
**“data”: [9,96,7]**
**}**

# JAVASCRIPT PAYLOAD FORMATTER (UPLINK) EXAMPLE 1

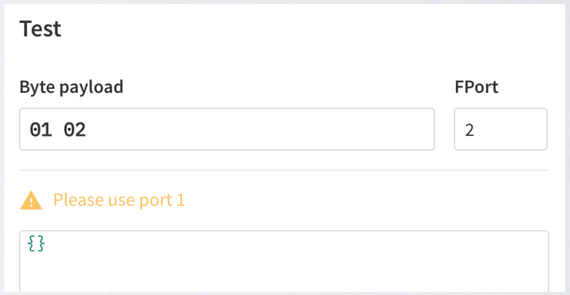
```
function decodeUplink(input) {
  var dt = {};
  var warn = [];
  var err = [];
  if (input.fPort == 2) {
    warn.push("Please use port 1");
  } else if(input.fPort == 3) {
    err.push("Do not use port 3");
  } else {
    dt.val = input.bytes[0] + input.bytes[1];
    dt.port = input.fPort;
 }

  return {
    warnings: warn,
    errors: err,
    data: dt
  };
}
```

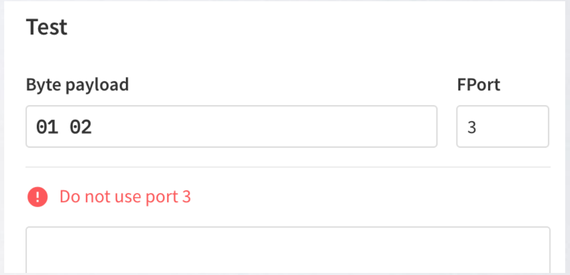
```
input = {
  "fPort": 1,
  "bytes": [01, 02]
}
```




```
input = {
  "fPort": 2,
  "bytes": [01, 02]
}
```




```
input = {
  "fPort": 3,
  "bytes": [01, 02]
}
```



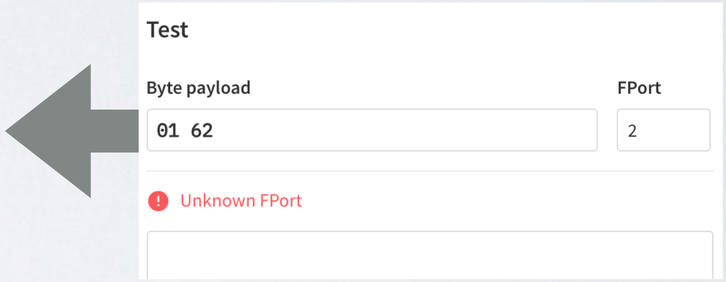

**If a warning is present in warnings, the warning is displayed. The payload is valid and the message will not be dropped.**
**If an error is present in errors, the error is displayed. The payload is invalid and the message will be dropped.**

# JAVASCRIPT PAYLOAD FORMATTER (UPLINK) EXAMPLE 2

```
var directions = ["N", "E", "S", "W"];
function decodeUplink(input) {
  switch (input.fPort) {
  case 1:
    return {
      // Decoded data
      data: {
        direction: directions[input.bytes[0]],
        speed: input.bytes[1]
      }
    }
  default:
    return {
      errors: ["unknown FPort"]
    }
  }
}
```

```
input = {
  "fPort": 1,
  "bytes": [1, 98]
}
```


```
input = {
  "fPort": 2,
  "bytes": [1, 98]
}
```

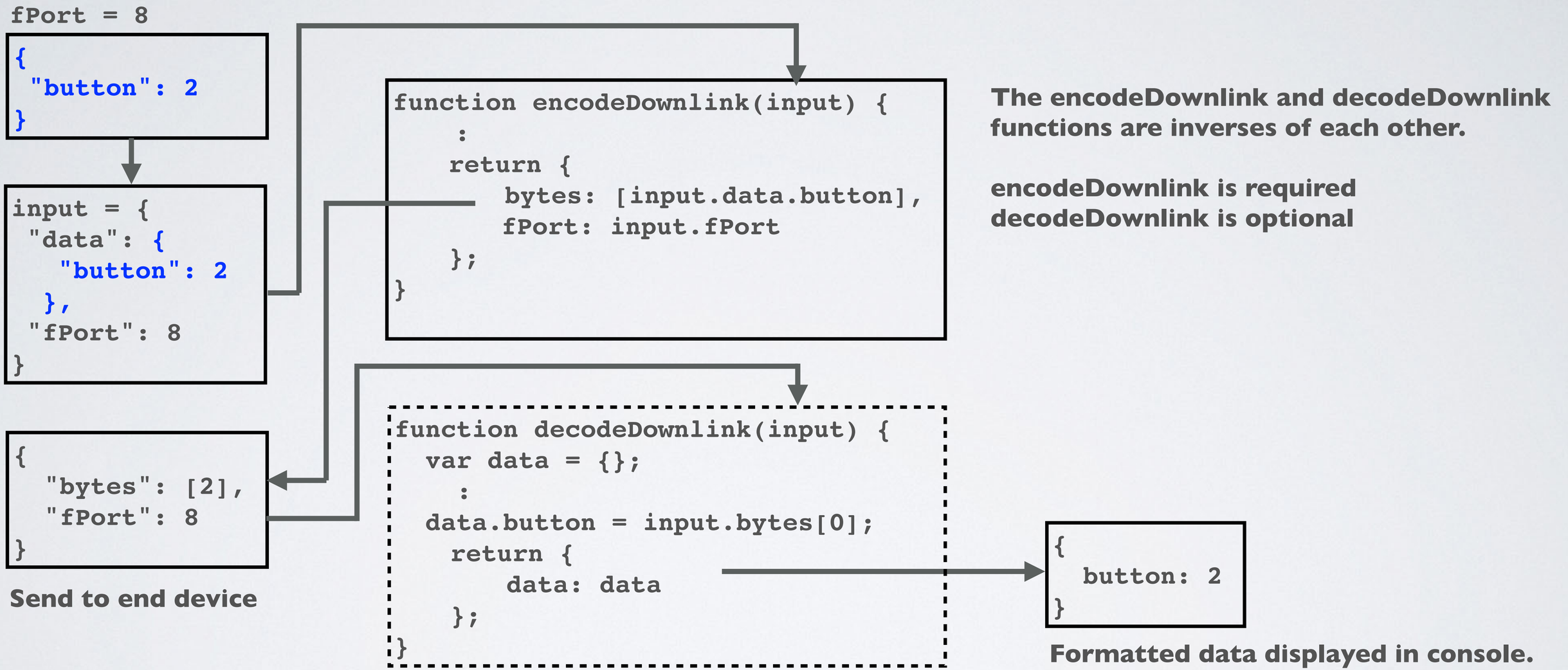



```
input = {
  "fPort": 1,
  "bytes": [3, 10]
}
```


**If a warning is present in warnings, the warning is displayed. The payload is valid and the message will not be dropped.**
**If an error is present in errors, the error is displayed. The payload is invalid and the message will be dropped.**

# DOWNLINK JAVASCRIPT PAYLOAD FORMATTER

# DOWNLINK JAVASCRIPT PAYLOAD FORMATTER (V3)



# DOWNLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

```
fPort = 4
payload = {
   "led": 1,
   "color": 3
}
```

```
input = {
   "fPort": 4,
   "data": {
      "led": 1,
      "color": 3
   }
}
```

```
function encodeDownlink(input) {
   :
   return {
      bytes: [input.data.led,input.data.color],
      fPort: input.fPort,
      warnings: ["warning1","warning2"],
      errors: ["error1","error2"]
   }
}
```

```
{
 bytes: [1,3],
 fPort: 4
}
```

# DOWNLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

```
encodeDownlink
output converted
to json input
object

input = {
  "bytes": [1,3],
  "fPort": 4
}
```

```
function decodeDownlink(input) {
  :
  return {
    data: {…},
    warnings: ["warning1","warning2"],
    errors: ["error1","error2"]
  }
}
```

If you specify a downlink formatter the encodeDownlink function is required but not the decodeDownlink function. The decodeDownlink formats the binary data "bytes" into human readable data, just like the decodeUplink function.

# DOWNLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

fPort = 5

```
{
  "color": "green"
}
```

1

The encodeDownlink function has only one function parameter (input) which is a json object.

```
input = {
  "data": {
     "color": "green"
  }
  "fPort": 5
}
```

2

The user creates a json object (1).This object is assigned to the data key of the input json object (2). This is done automatically

```
function encodeDownlink(input) {
  var colors = ["red", "green",
                "blue"];
  return {
    bytes:[colors.indexOf(
           input.data.color)],
    fPort: input.fPort
  };
}
```

The encodeDownlink has access to the input object.

```
{
  bytes: [1],
  fPort: 5
}
```

# DOWNLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

## Setup

Formatter type *

Javascript

Formatter parameter *

```
function encodeDownlink(input) {
  var colors = ["red", "green","blue"];
  return {
    bytes:[colors.indexOf(input.data.color)],
    fPort: input.fPort
  };
}
```

```
input = {
  "data": {
     "color": “green"
   },
  "fPort": 5,
}
```

## Test

JSON payload

```
{
  "color": "green"
}
```

FPort

5

Payload is valid

```
01
```

# DOWNLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

## Setup

Formatter type *

Javascript

Formatter parameter *

```
function encodeDownlink(input) {
  var colors = ["red", "green","blue"];
  return {
    bytes:[colors.indexOf(input.data.color)],
    fPort: input.fPort,
    errors: ['aaaa']
  };
}
```

## Test

JSON payload

```
{
  "color": "blue"
}
```

FPort

10

**If a warning is present in warnings, the warning is displayed.**
**The payload is valid and the message will not be dropped.**

**If an error is present in errors, the error is displayed.**
**The payload is invalid and the message will be dropped.**

Aaaa

# DOWNLINK JAVASCRIPT PAYLOAD FORMATTER (V3)

## Setup

Formatter type *

Javascript

Formatter parameter *

```
function encodeDownlink(input) {
  var colors = ["red", "green","blue"];
  return {
    bytes:[colors.indexOf(input.data.color)],
    fPort: input.fPort,
    warnings: ['bbbb']
  };
}
```

## Test

JSON payload

```
{
  "color": "blue"
}
```

FPort

10

**If a warning is present in warnings, the warning is displayed.**
**The payload is valid and the message will not be dropped.**

**If an error is present in errors, the error is displayed.**
**The payload is invalid and the message will be dropped.**

⚠ bbbb

02

# JS PAYLOAD FORMATTER (DOWNLINK) EXAMPLE 1

## Setup

Formatter type *

Javascript

Formatter parameter *

```
function encodeDownlink(input) {
  return {
    bytes: [1, 2, 3],
    fPort: 1
  }
}
```

```
input = {
  "data": {},
  "fPort": 4,
}
```

## Test

JSON payload

```
{}
```

FPort

4

Payload is valid

```
01 02 03
```

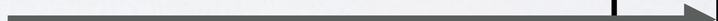
# JS PAYLOAD FORMATTER (DOWNLINK) EXAMPLE 2

fPort = 8

```
{
 "fan":"low"
}
```

```
input = {
 "data": {
   "fan":"low"
  },
 "fPort": 8
}
```

```
function encodeDownlink(input) {
  var out = [];
  var fan_position = ["low","medium","high"];
  if (input.data.fan == fan_position[1]) {
    out.push(11); //medium 0B
  } else if (input.data.fan == fan_position[2]) {
    out.push(12); //high 0C
  } else {
    out.push(10); //low 0A
  }
   return {
     bytes: out,
     fPort: input.fPort
   };
}
```



```
{
  bytes: [10],
  fPort: 8
}
```

# JS PAYLOAD FORMATTER (DOWNLINK) EXAMPLE 2

## Setup

**Formatter type** *

Javascript

**Formatter parameter** *

```
function encodeDownlink(input) {
var out = [];
var fan_position = ["low","medium","high"];
if (input.data.fan == fan_position[1]) {
  out.push(11); //medium 0B
} else if (input.data.fan == fan_position[2]) {
  out.push(12); //high 0C
} else {
  out.push(10); // low 0A
}
  return {
    bytes: out,
    fPort: input.fPort
  };
}
```

## Test

**JSON payload**

```
{
 "fan":"low"
}
```

**FPort**

8

Payload is valid

**0A**