การจัดฝึกอบรมเชิงปฏิบัติการหลักสูตร:
LoRaWAN Workshop
For Developer

บริษัท กสท โทรคมนาคม จำกัด (มหาชน)
99 หมู่ 3 ถนนแจ้งวัฒนะ แขวงทุ่งสองห้อง เขตหลักสี่ กรุงเทพฯ 10210-0298
www.cattelecom.com

LoRa IoT by CAT

TOPIC

- **IoT Concept**
- **Network Concept**
- **LoRa Network and Basic Concept**
- **Workshop : LoRa Account and Device Management**
- **Workshop : LoRa Example Application**

LoRa IoT by CAT

TOPIC

- **Embedded System คือ อะไร**
- **ภาควิชา และหน้าที่ในทีม**
- **LoRa คือ อะไร**

LoRa IoT by CAT

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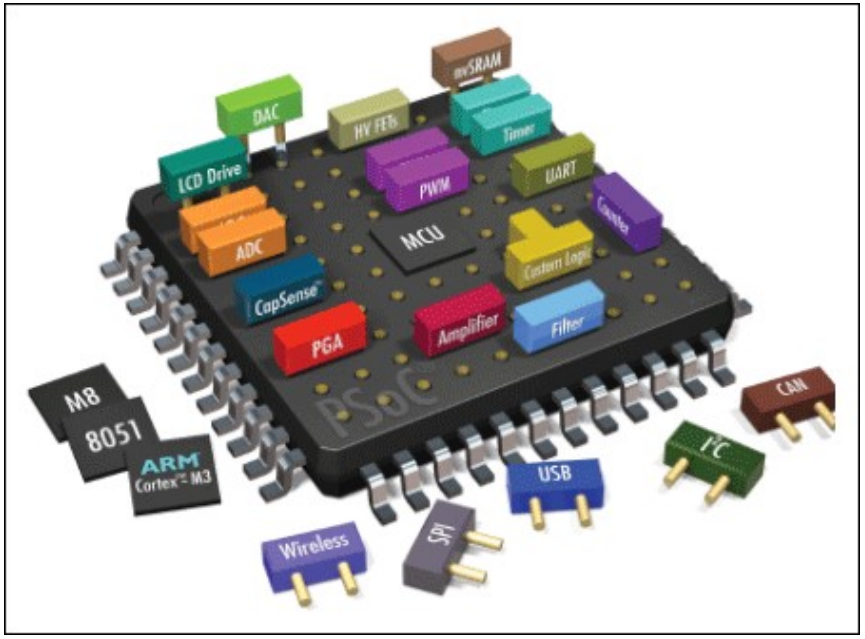
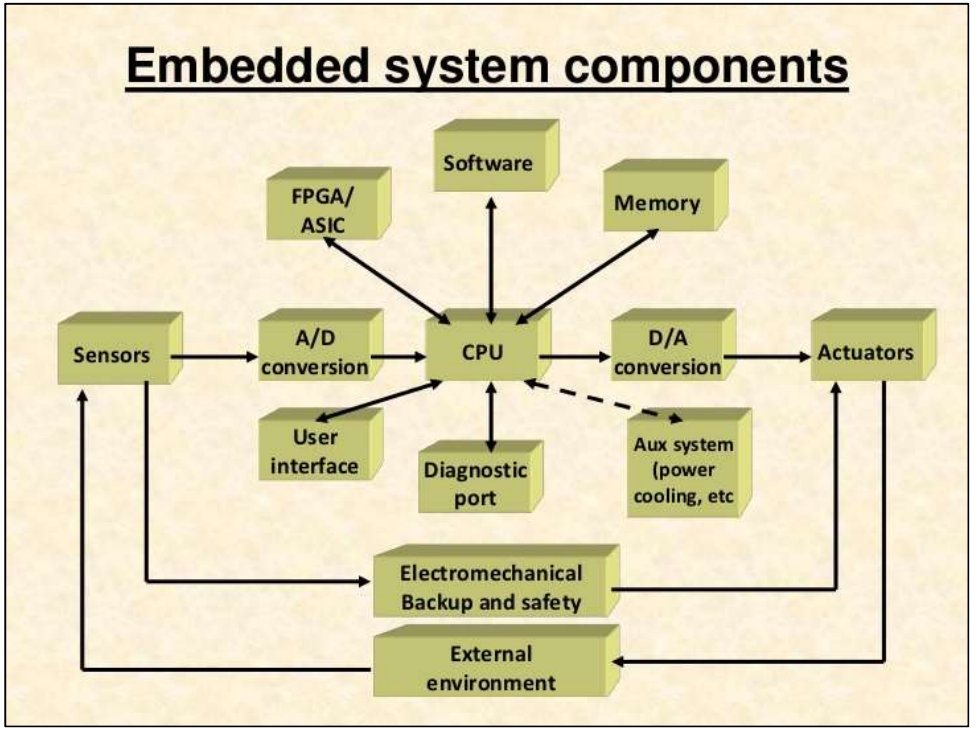
IoT Concept





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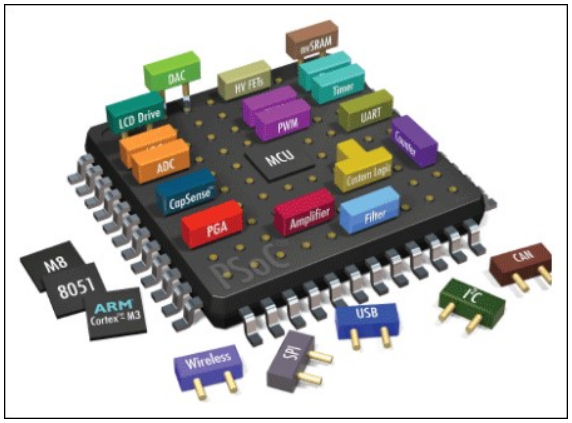

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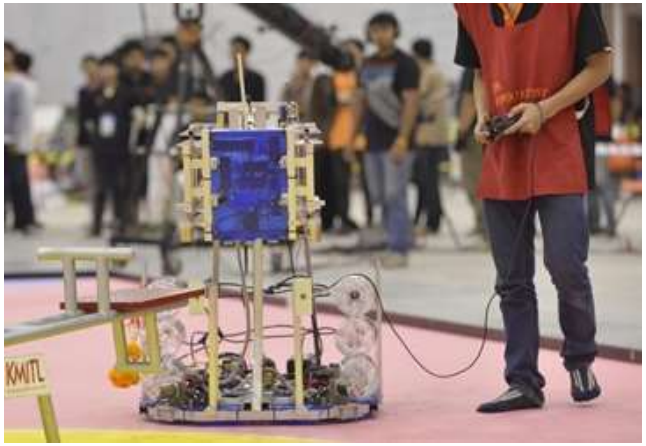
Network Concept

Hello, Thai Embedded System Association



Network Concept

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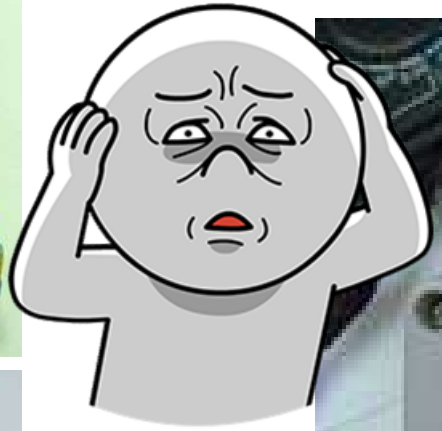

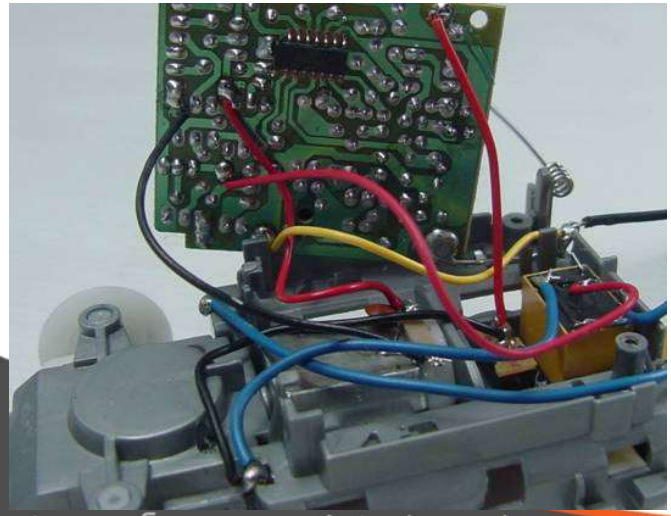

Network Concept

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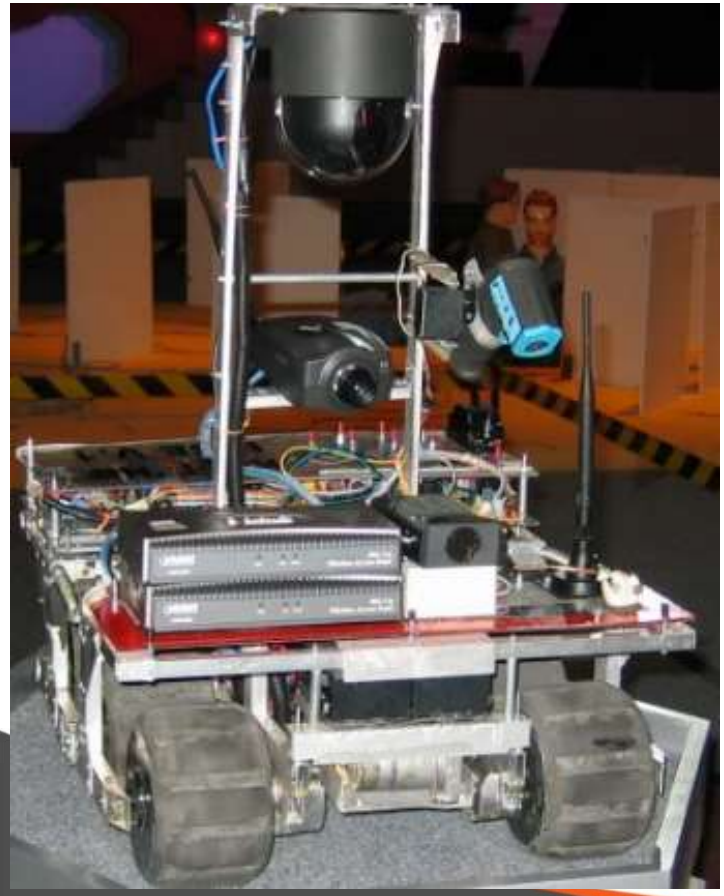

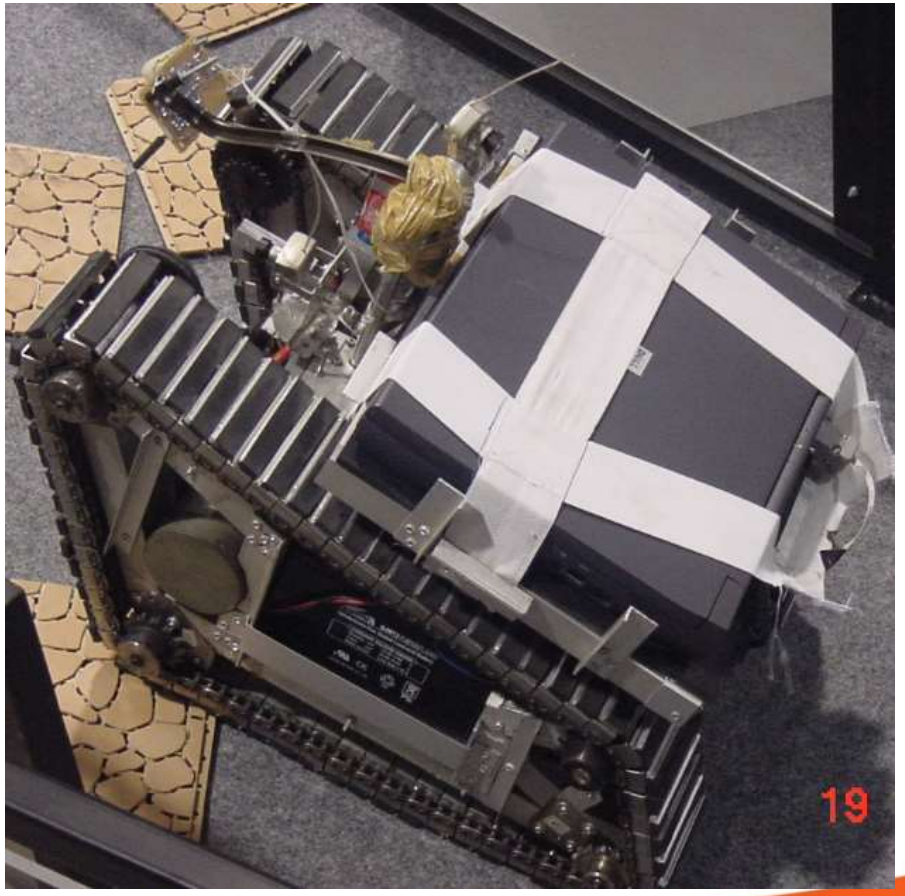

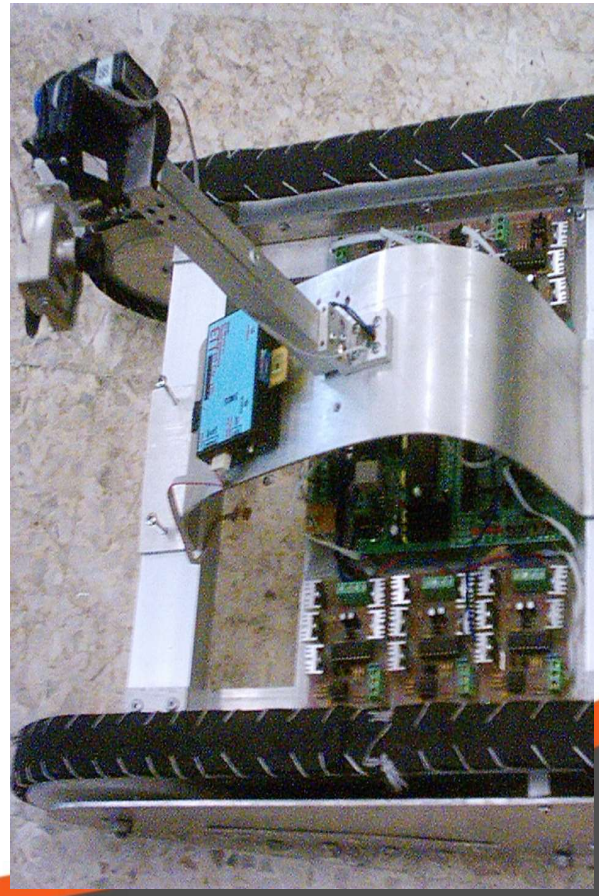

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Network Concept

Discussion

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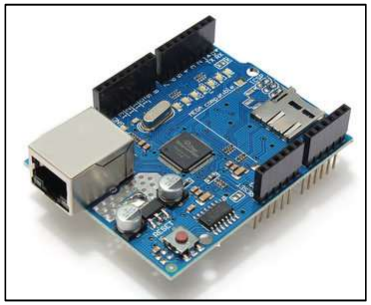

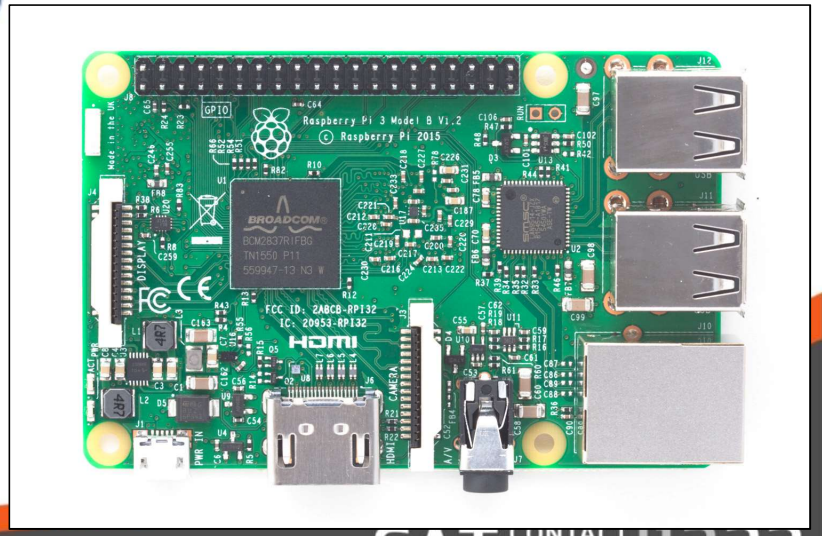

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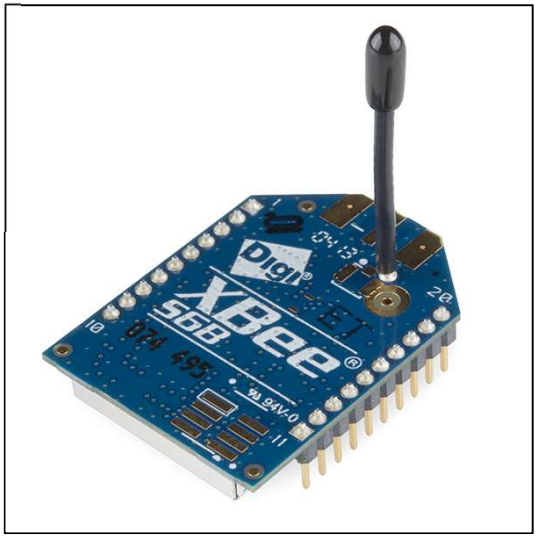

Network Concept

LoRa IoT by CAT

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Network Concept

LoRa IoT by CAT

Setup | Wireless | Security | Storage | Access Restrictions

Basic Wireless Settings | Wireless Security |

Manual Wi-Fi Protected Setup™

Network Mode:	Mixed
Network Name (SSID):	Linksys00037
Channel Width:	20 MHz Only
Channel:	Auto (DFS)
SSID Broadcast:	Enabled Disabled

Settings Wi-Fi

Wi-Fi

CHOOSE A NETWORK...

network_name

Wi-Fi_network

Wi-Fi_secure

Other...

Ask to Join Networks

Known networks will be joined automatically. If no known networks are available, you will have to manually select a network.

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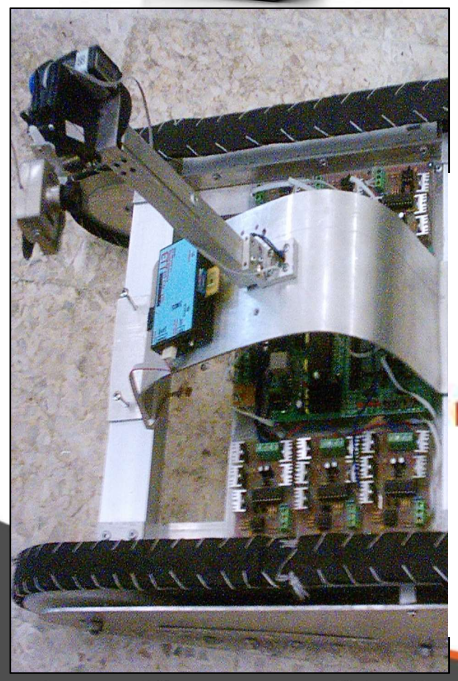
Network Concept



Notebook B

SSID:	WiFly-GSX-XX
Channel:	1
DHCP:	OFF
IP address:	169.254.1.1
Netmask:	255.255.0.0
Port:	2000

set wlan join 4	<Enter>	ให้โมดูลเข้าสู่ Adhoc mode
AOK		
set wlan ssid My_Adhoc	<Enter>	ตั้งชื่อ SSID ของโมดูล
AOK		
set wlan chan 1	<Enter>	เลือกช่องสัญญาณ
AOK		
set ip address 169.254.1.1	<Enter>	ตั้งค่า ip address
AOK		
set ip netmask 255.255.0.0	<Enter>	ตั้งค่า subnet mask
AOK		
set ip dhcp 0	<Enter>	ปิดการทำงาน dhcp
AOK		
save	<Enter>	บันทึกค่า
Storing in config		
reboot	<Enter>	เริ่มการทำงานใหม่

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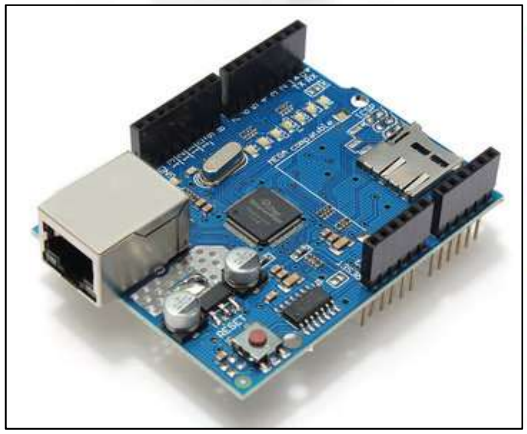
Network Concept


```ino
#include <ESP8266WiFi.h>

WiFiServer server(88); // ประกาศสร้าง TCP Server ที่พอร์ต 88

int pin = 2;
String line;

void setup() {
  pinMode(pin, OUTPUT);

  Serial.begin(115200); // เปิดใช้การ Debug ผ่าน Serial
  WiFi.mode(WIFI_AP); // ใช้งาน WiFi ในโหมด AP
  WiFi.softAP("ESP_IOXhop"); // ตั้งให้ชื่อ WiFi เป็น ESP_IOXhop

  server.begin(); // เริ่มต้นใช้ TCP Server
}

void loop() {
  WiFiClient client = server.available();
  if (!client) // ถ้าไม่มีการเชื่อมต่อมาใหม่
    return; // ส่งลับค่าว่าง ทำให้ลูปนี้ถูกยกเลิก

  Serial.println("New client"); // ส่งข้อความว่า New client ไปที่ Seria
  while (client.connected()) { // วนรอบไปเรื่อย ๆ หากยังมีการเชื่อมต่ออยู่
    if (client.available()) { // ถ้ามีการส่งข้อมูลเข้ามา
      char c = client.read(); // อ่านข้อมูลออกมา 1 ไบต์
      if (c == '\r') { // ถ้าเป็น \r (return)
        Serial.println(line); // แสดงตัวแปร line ไปที่ Serial Monitor
        if (line == "LEDON") { // ถ้าสงข้อความเข้ามาว่า LEDON
          digitalWrite(pin, HIGH); // ให้ LED ติด
        } else { // ถ้าไม่ใช่
          digitalWrite(pin, LOW); // ให้ LED ดับ
        }
        line = ""; // ล้างค่าตัวแปร line
        break; // ออกจากลูป
      } else if (c == '\n') { // ถ้าเป็น \n (new line)
        // Pass {new line}
      } else { // ถ้าไม่ใช่
        line += c; // เพิ่มข้อมูล 1 ไบต์ ไปต่อท้ายในตัวแปร line
      }
    }
  }

  delay(1);
  client.stop(); // ปิดการเชื่อมต่อกับ Client
  Serial.println("Client disconnect"); // ส่งข้อความว่า Client disconn
}
```

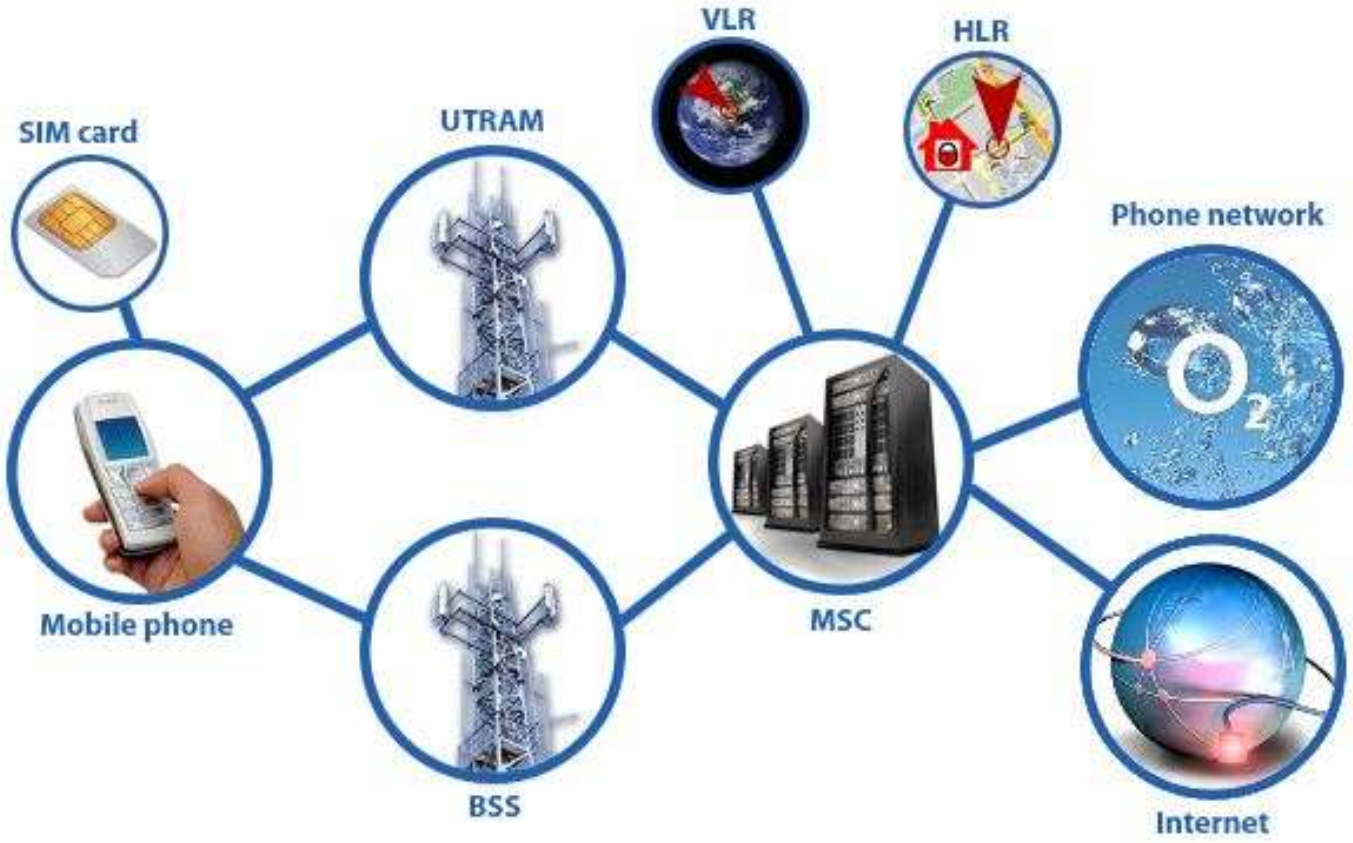
Network Concept



```
#include "SPI.h"
#include "Ethernet.h"


byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };
byte server[] = { 173,194,126,119 }; // www.google.co.th

EthernetClient client;

void setup()
{
Serial.begin(9600);
if(Ethernet.begin(mac) == 0) { // start ethernet using mac & DHCP
Serial.println("Failed to configure Ethernet using DHCP");
while(true) // no point in carrying on, so stay in endless loop:
;
}
delay(1000); // give the Ethernet shield a second to initialize

Serial.print("This IP address: ");
IPAddress myIPAddress = Ethernet.localIP();
Serial.print(myIPAddress);
if(client.connect(server, 80)>0) {
Serial.println(" connected");
client.println("GET /search?q=arduino HTTP/1.0");
client.println();
} else {
Serial.println("connection failed");
}
}
```

```
void loop()
{
if (client.available()) {
char c = client.read();
// uncomment the next line to show all the received characters
// Serial.print(c);
}

if (!client.connected()) {
Serial.println();
Serial.println("disconnecting.");
client.stop();
for(;;)
;
}
}
```

Network Concept



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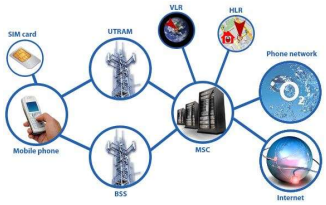
Network Concept




```
#include "SIM900.h"
#include "SoftwareSerial.h"
//#include "inetGSM.h"
//#include "sms.h"
//#include "call.h"

//To change pins for Software Serial, use the two lines in GSM.cpp.

//GSM Shield for Arduino
//www.open-electronics.org
//this code is based on the example of Arduino Labs.

//Simple sketch to communicate with SIM900 through AT commands.

//InetGSM inet;
//CallGSM call;
//SMSGSM sms;

int numdata;
char inSerial[40];
int i=0;
```

```
void serialhwread()
{
    i=0;
    if (Serial.available() > 0) {
        while (Serial.available() > 0) {
            inSerial[i]=(Serial.read());
            delay(10);
            i++;
        }

        inSerial[i]='\0';
        if(!strcmp(inSerial,"/END")) {
            Serial.println("_");
            inSerial[0]=0x1a;
            inSerial[1]='\0';
            gsm.SimpleWriteln(inSerial);
        }
        //Send a saved AT command using serial p
        if(!strcmp(inSerial,"TEST")) {
            Serial.println("SIGNAL QUALITY");
            gsm.SimpleWriteln("AT+CSQ");
        } else {
            Serial.println(inSerial);
            gsm.SimpleWriteln(inSerial);
        }
        inSerial[0]='\0';
    }
}
```

```
ATT: SHUT OK
RIC:
SHUT OK


status=READY

OK

RING

+CLIP: "0815930607",129,"",,"",0

RING

+CLIP: "0815930607",129,"",,"",0

RING

+CLIP: "0815930607",129,"",,"",0

NO CARRIER
```

Network Concept

Discussion

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LoRa IoT by CAT

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LoRa Network and Basic Concept

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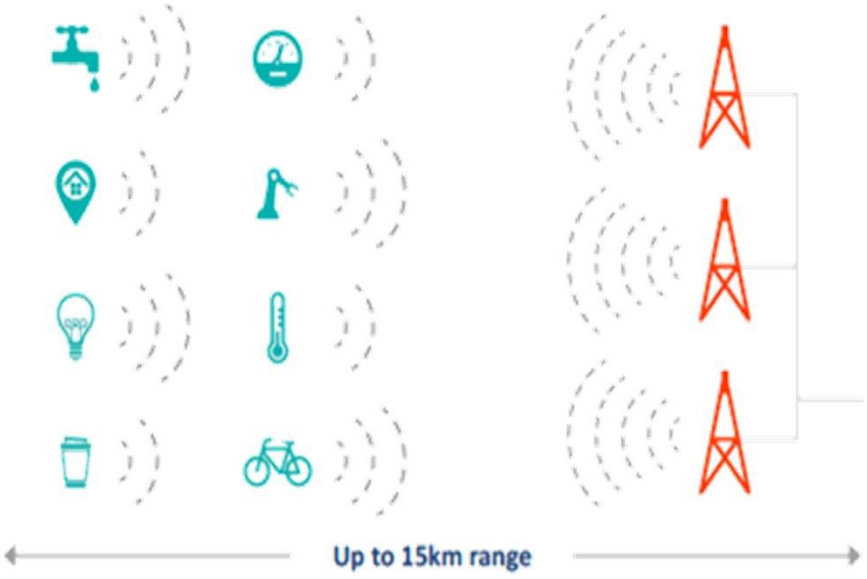
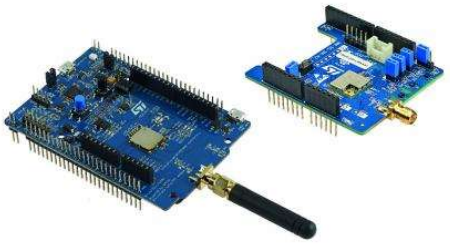


STM32 hardware tools
boost LoRa® technology



LoRa

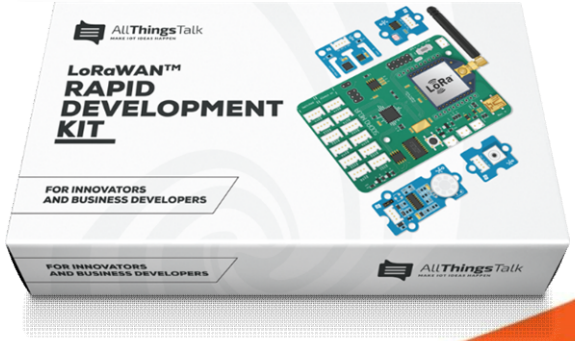
MICROCHIP

LoRa Technology Evaluation Kit

- Everything needed to develop a LoRaWAN™ Network
- 868MHz and 915MHz kits available
- Includes an 8 channel* gateway and 2 motes
- Local LoRaWAN Network/Application server (docker image)
- GUI for Config & Testing (Windows, Linux and MAC OS)
- DV164140-1 (868 MHz); $499
- DV146140-2 (915 MHz); $499
- www.microchip.com/LoRa

* 6 channel for the DV164140-1

19



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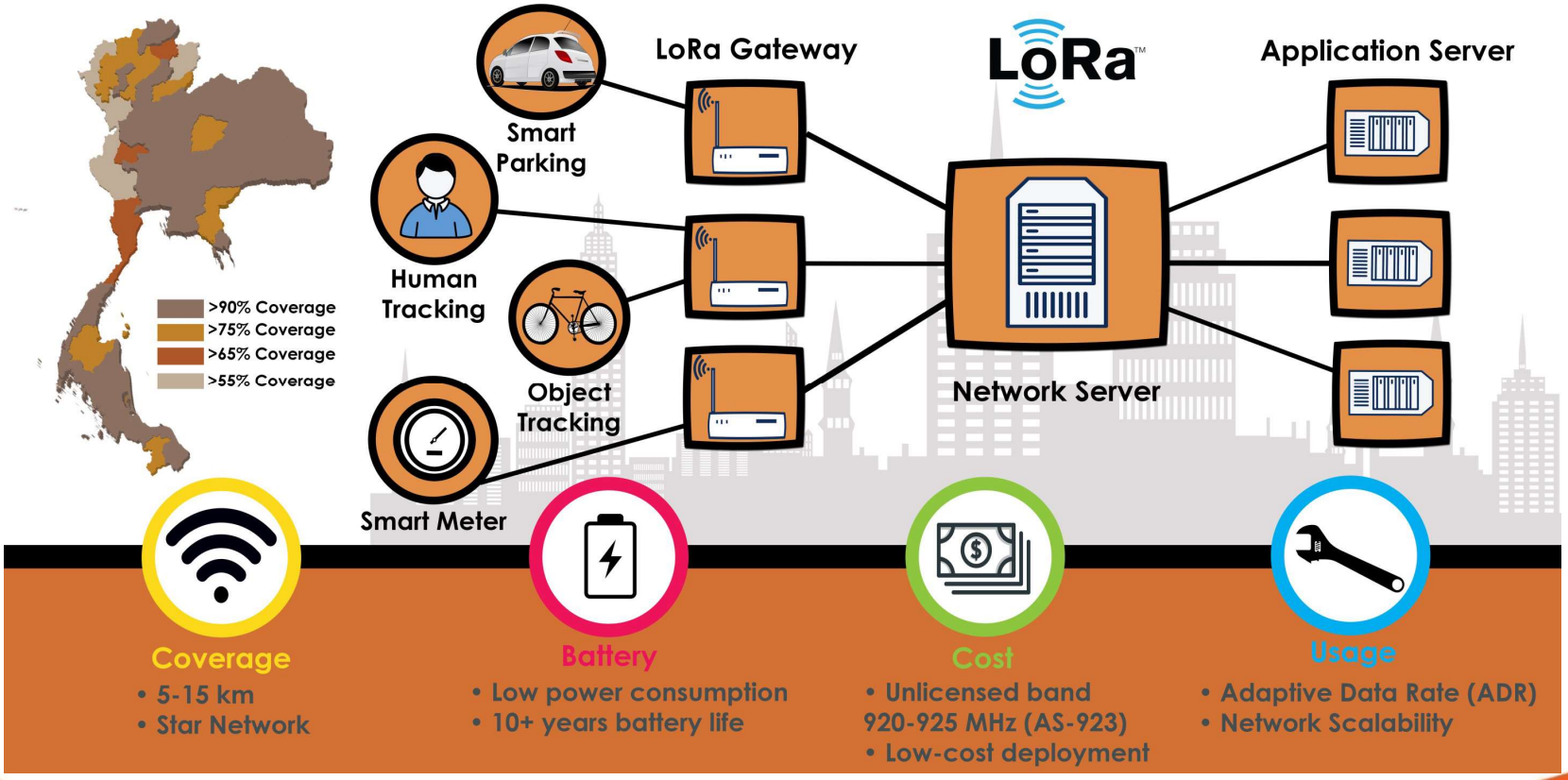

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LORA BASIC CONCEPT

- **Frequency**
- **Channel**
- **Data Rate**
- **LoRa Class**
- **Activation Mode**
- **Data Message (Flow & Payload)**
- **Configuration**

LORA BASIC CONCEPT

- **Frequency**
- Channel
- Data Rate
- LoRa Class
- Activation Mode
- Data Message (Flow & Payload)
- Configuration

Frequency

LoRa IoT by CAT

LoRa®

In Thailand

กสทช.

Frequency Band	433MHz	920-925 MHz	2.4-2.5 GHz
Availability	✓ now	In process	✓ now
LoRaWAN Regional Parameters	EU 433 MHz ISM Band	AS 923 MHz (APAC Cluster)	International 2.4 GHz ISM Band
Transceiver Modules (Examples, not limited to)	Semtech SX1276-1279 Semtech SX1236	Semtech SX1276-1279 Semtech SX1272-1273	Semtech SX1280 Semtech SX1281
Frequency Plan		LoRa Regional Parameters v. 1.0.2	
Operating Range	10-30 km	7-15 km	3-7 km
Applications	• Automated Meter Reading • Building Automation • Wireless Alarm and Security Systems • Industrial Monitoring and Control • Long range precision farming	• Automated Meter Reading • Building Automation • Wireless Alarm and Security Systems • Industrial Monitoring and Control • Long range precision farming	• Home automation • Tracking applications • Wearables & sports/fitness sensors • Radio-controlled toys & drones • Smart watches & beacons

Frequency

LoRa IoT by CAT

LoRa

With AS923 Mhz ISM Band

กสทช.

2.7.2 AS923 ISM Band channel frequencies

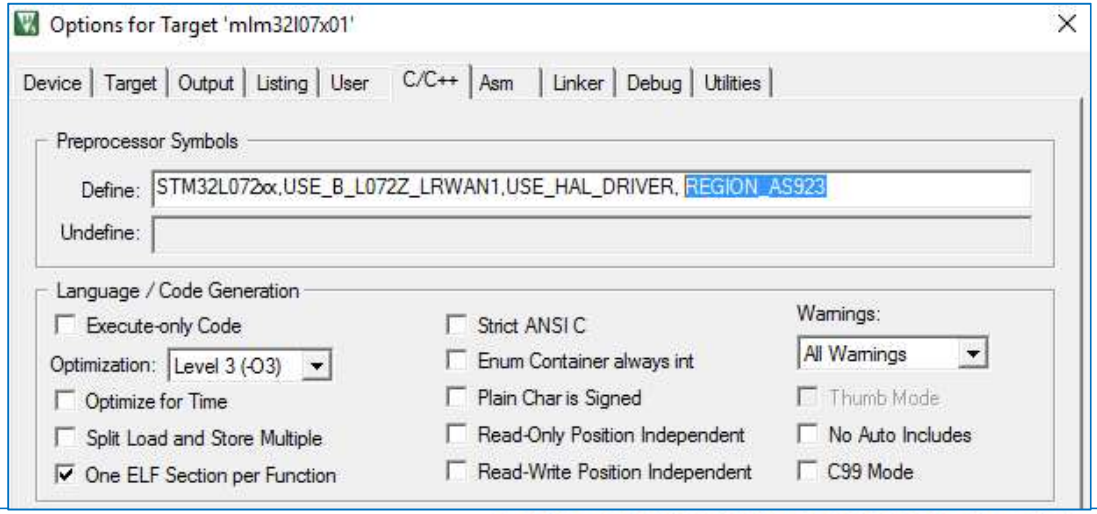
This section applies to regions where the frequencies [923…923.5MHz] are comprised in the ISM band, which is the case for the following countries:

- Brunei [923-925 MHz]
- Cambodia [923-925 MHz]
- Hong Kong [920-925 MHz]
- Indonesia [923-925 MHz]
- Japan [920-928 MHz]
- Laos [923-925 MHz]
- New Zealand [915-928 MHz]
- Singapore [920-925 MHz]
- Taiwan [922-928 MHz]
- Thailand [920-925 MHz]
- Vietnam [920-925 MHz]

End-point max power := 14 dBm ERP = 25mW ERP= 41 mW e.i.r.p.

Channel plan and configuration please see: “LoRaWAN Regional Parameters 1.0.2”
https://portal.lora-alliance.org/DesktopModules/Inventures_Document/FileDownload.aspx?ContentID=1397

Frequency




```
#define AS923_BAND0                                 { 100, AS923_DEFAULT_TX_POWER, 0,  0 } //  1.0 %

/*!
 * LoRaMac default channel 1
 * Channel = { Frequency [Hz], RX1 Frequency [Hz], { ( ( DrMax << 4 ) | DrMin ) }, Band }
 */
#define AS923_LC1                                   { 923200000, 0, { ( ( DR_5 << 4 ) | DR_0 ) }, 0 }

/*!
 * LoRaMac default channel 2
 * Channel = { Frequency [Hz], RX1 Frequency [Hz], { ( ( DrMax << 4 ) | DrMin ) }, Band }
 */
#define AS923_LC2                                   { 923400000, 0, { ( ( DR_5 << 4 ) | DR_0 ) }, 0 }
```

LORA BASIC CONCEPT

- Frequency
- **Channel**
- Data Rate
- LoRa Class
- Activation Mode
- Data Message (Flow & Payload)
- Configuration

Channel

LoRa IoT by CAT

AS923-925

Used in Brunei, Cambodia, Hong Kong, Indonesia, Laos, Taiwan, Thailand, Vietnam

Channel	Frequency
1	923.2
2	923.4
3	922.0
4	922.2
5	922.4
6	922.6
7	922.8
8	923.0

Channel	Frequency
9	920.4
10	920.6
11	920.8
12	921.0
13	921.2
14	921.4
15	921.6
16	921.8

LORA BASIC CONCEPT

- Frequency
- Channel
- **Data Rate**
- LoRa Class
- Activation Mode
- Data Message (Flow & Payload)
- Configuration

Data Rate

Spreading Factor (at 125 kHz)	Bitrate	Range	Time on Air (ms)
SF7	5470 bps	2 km	56 ms
SF8	3125 bps	4 km	100 ms
SF9	1760 bps	6 km	200 ms
SF10	980 bps	8 km	370 ms
SF11	440 bps	11 km	740 ms
SF12	290 bps	14 km	1400 ms

Show the Data Rate as function of the distance and the Spreading Factor (SF).

LoRaWAN optimizes the communication by **Adaptative Data Rate** >> The network instructs a node to perform a rate adaptation by using a requested data rate (and a requested TX Power).

Data Rate

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2.7.6 AS923 Maximum payload size

The maximum **MACPayload** size length (*M*) is given by the following table for both dwell time configurations: No Limit and 400ms. It is derived from the PHY layer limitation depending on the effective modulation rate used taking into account a possible repeater encapsulation layer.

DataRate	*Uplink MAC Payload Size (M)*		*Downlink MAC Payload Size (M)*	
	UplinkDwellTime = 0	UplinkDwellTime = 1	DownlinkDwellTime = 0	DownlinkDwellTime = 1
0	59	N/A	59	N/A
1	59	N/A	59	N/A
2	59	19	59	19
3	123	61	123	61
4	230	133	230	133
5	230	250	230	250
6	230	250	230	250
7	230	250	230	250
8:15	RFU		RFU	

Table 53: AS923 maximum payload size

LORA BASIC CONCEPT

- Frequency
- Channel
- Data Rate
- **LoRa Class**
- Activation Mode
- Data Message (Flow & Payload)
- Configuration

LoRa Class

Class Name	Intended Usage
A (“all”)	Battery powered sensors (or actuators with no latency constraint) Most energy efficient communication class. Must be supported by all devices.
B (“beacon”)	Battery powered actuators Energy efficient communication class for latency controlled downlink. Based on slotted communication synchronized with a network beacon.
C (“continuous”)	Main powered actuators Devices witch can afford to listen continuously. No latency for downlink communication.

LORA BASIC CONCEPT

- Frequency
- Channel
- Data Rate
- LoRa Class
- **Activation Mode**
- Data Message (Flow & Payload)
- Configuration

Activation Mode

Over-the-Air Activation (OTAA)

- Based on Globally Unique Identifier
- Over the air message handshaking

Activation By Personalization (ABP)

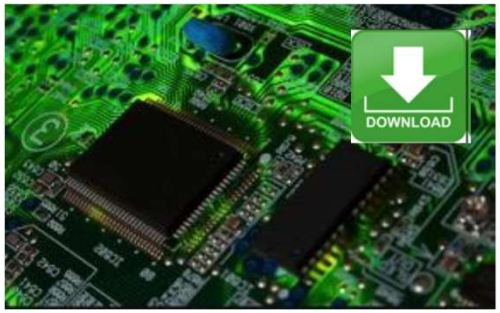
- Shared keys stored at production time
- Locked to a specific network

Activation Mode : Over-the-Air Activation (OTAA)

- End-device transmits **Join Request** to application server containing:
  - Globally unique end-device identifier (**DevEUI**)
  - Application identifier (**AppEUI**)
  - Authentication with Application key (**AppKey**)
- End-device receives **Join Accept** from application server
- End-device authenticates **Join Accept**
- End-device **decrypts** Join Accept
- End-device extracts and stores Device Address (**DevAddr**)
- End-device **derives**:
  - Network Session Key (**NwkSKey**)
  - Application Session Key (**AppSKey**)

Activation Mode : Activation By Personalization (ABP)

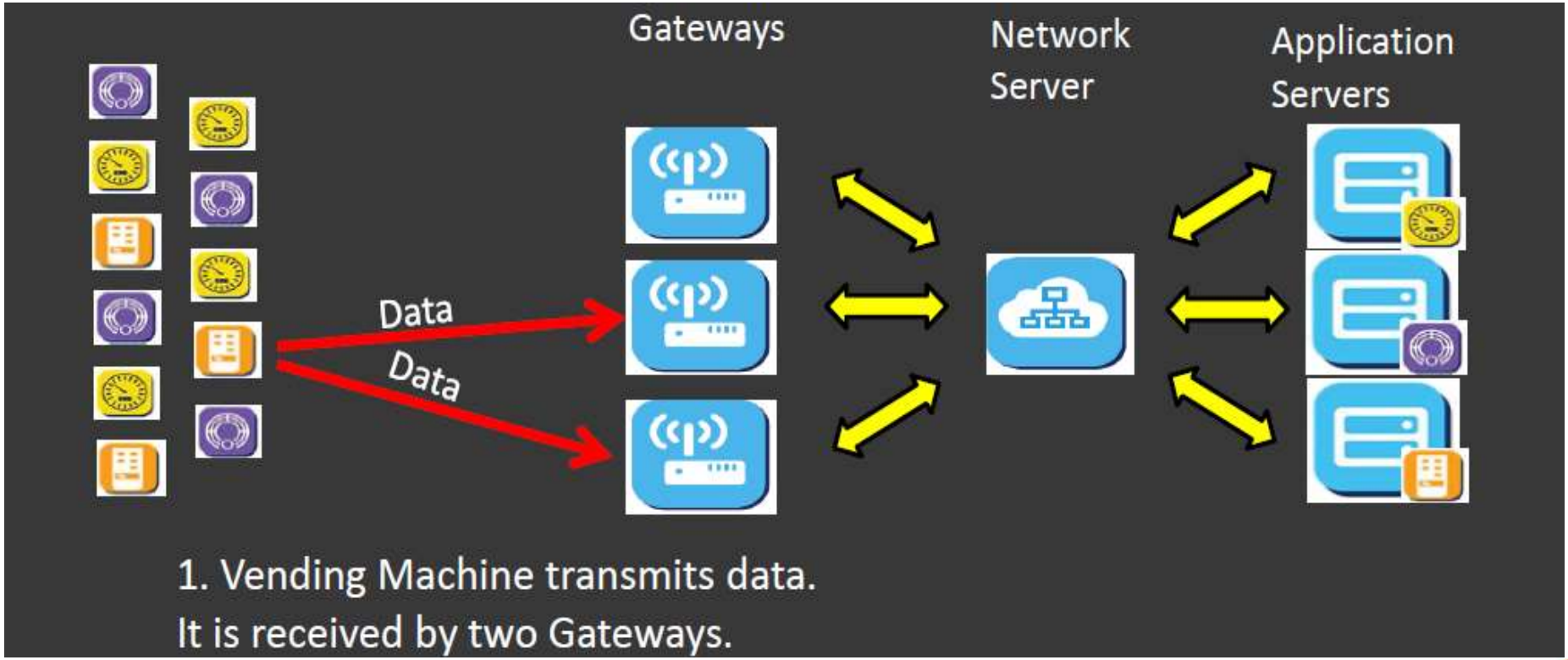
- The following information is configured at production time:
  - Device Address (**DevAddr**)
  - Network Session Key (**NwkSKey**)
  - Application Session Key (**AppSKey**)
- **No over the air handshaking**
- Device is ready to communicate on the network without any additional procedure.



LORA BASIC CONCEPT

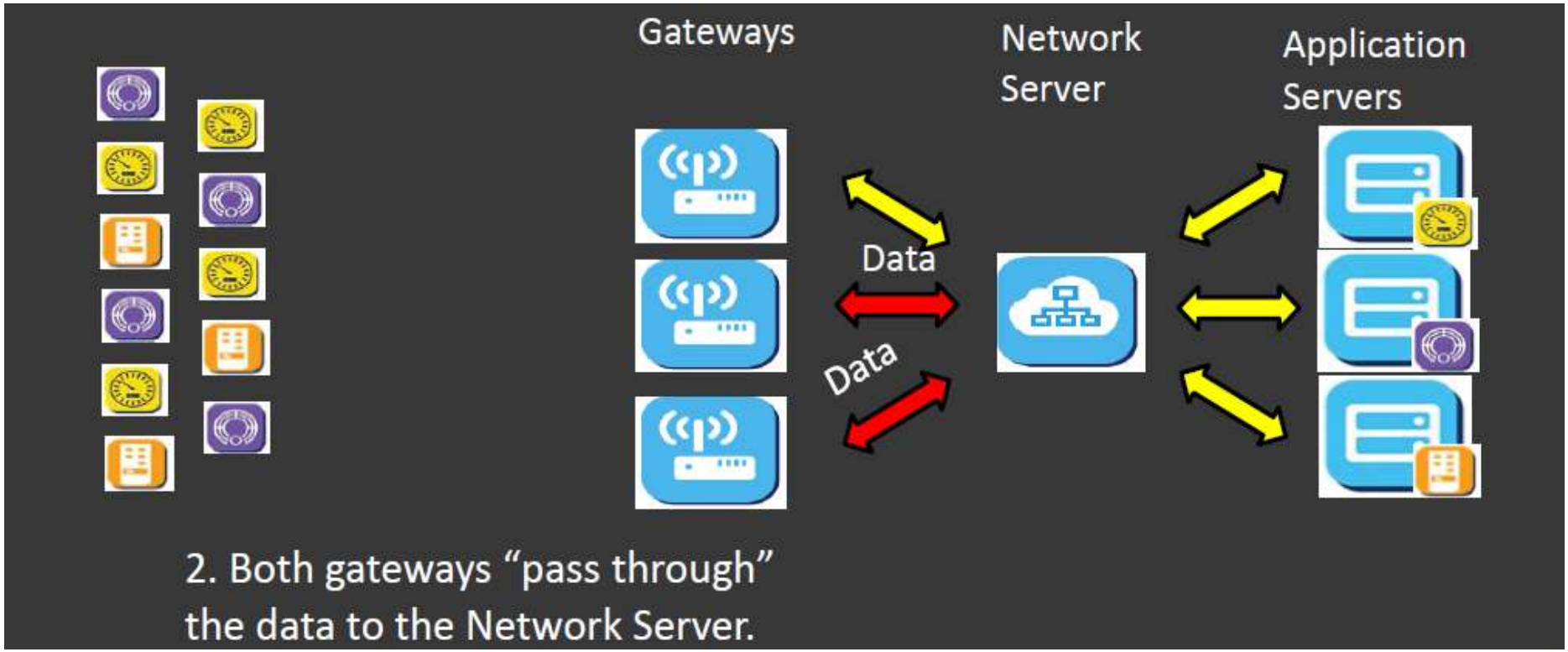
- Frequency
- Channel
- Data Rate
- LoRa Class
- Activation Mode
- **Data Message (Flow & Payload)**
- Configuration

Data Message (Flow & Payload)



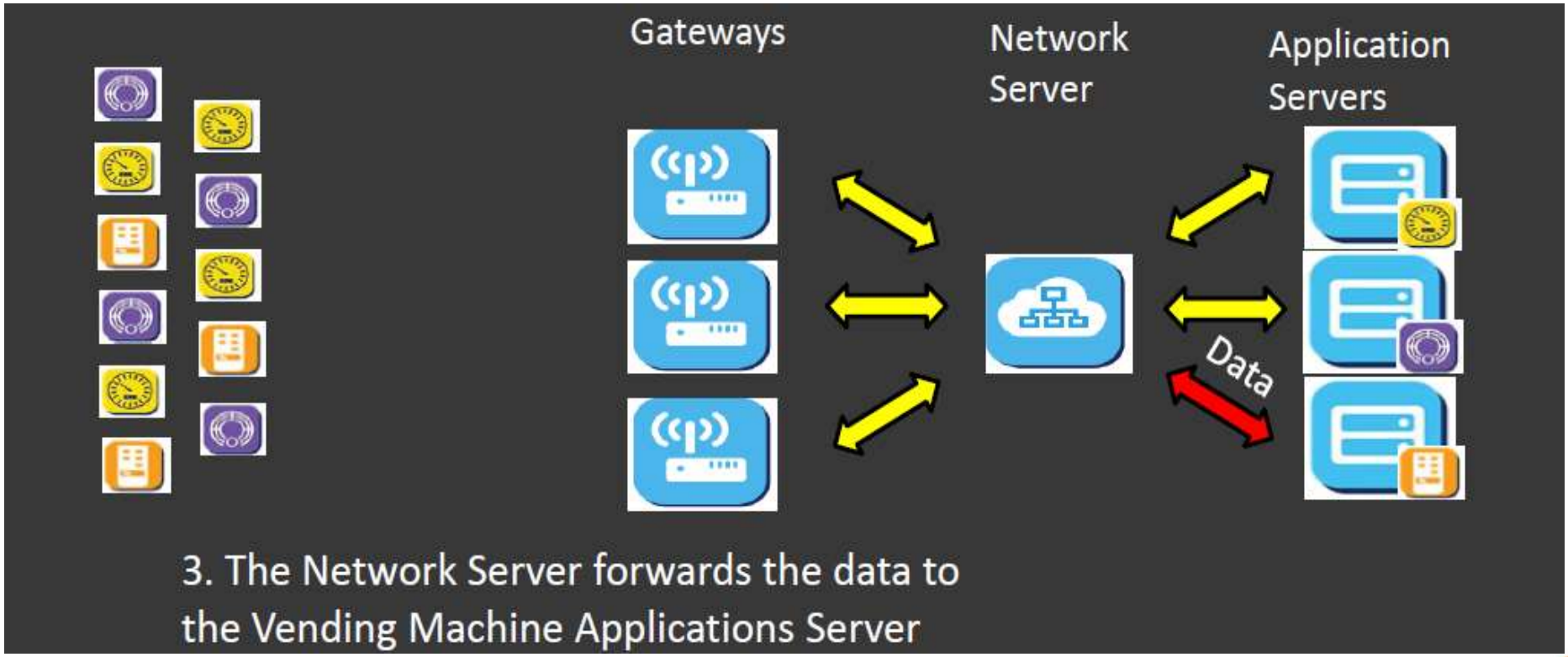
Ref: LoRa-Aliance.org

Data Message (Flow & Payload)



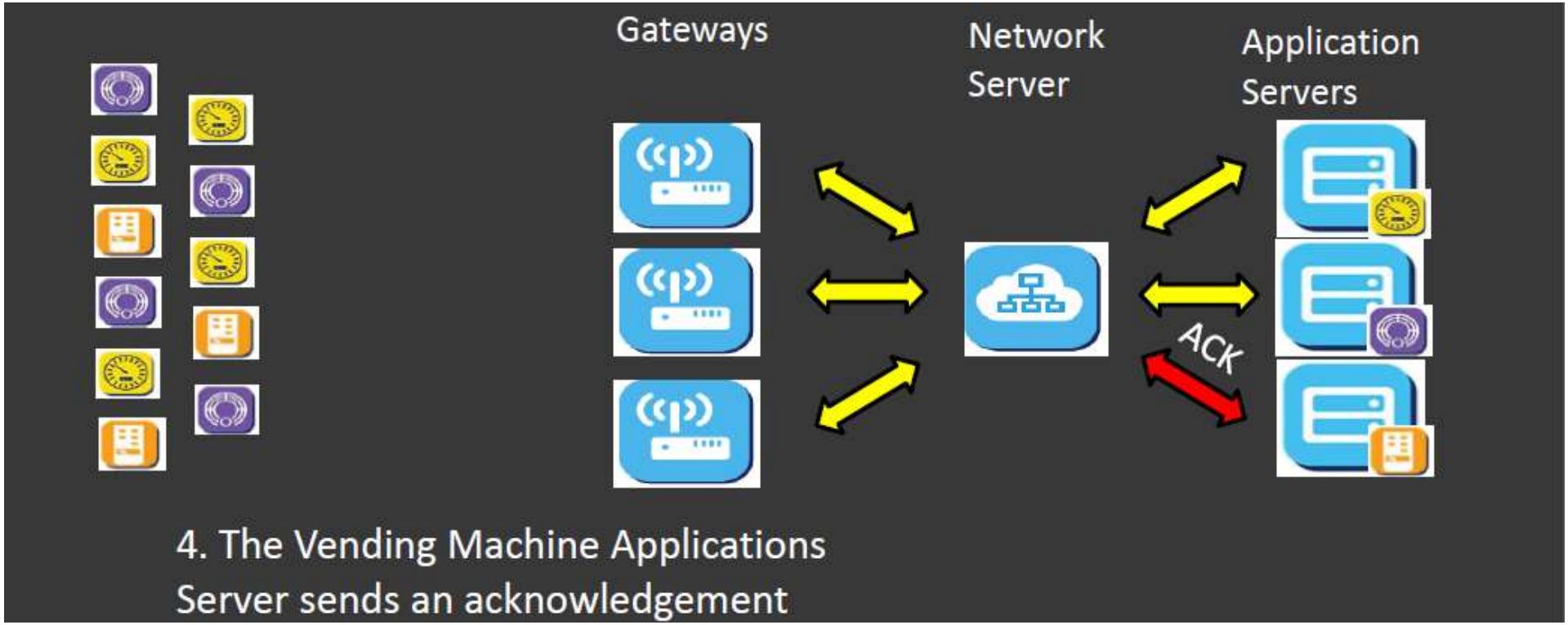
Ref: LoRa-Aliance.org

Data Message (Flow & Payload)



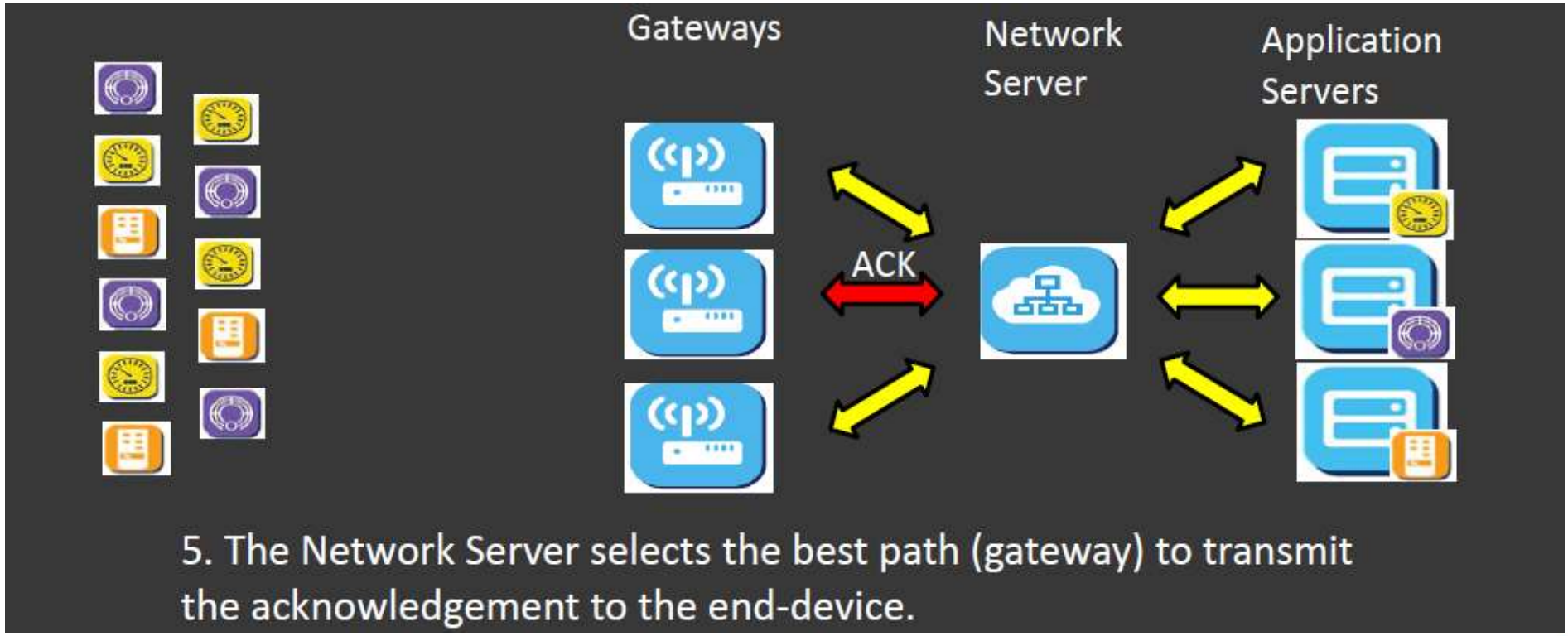
Ref: LoRa-Aliance.org

Data Message (Flow & Payload)



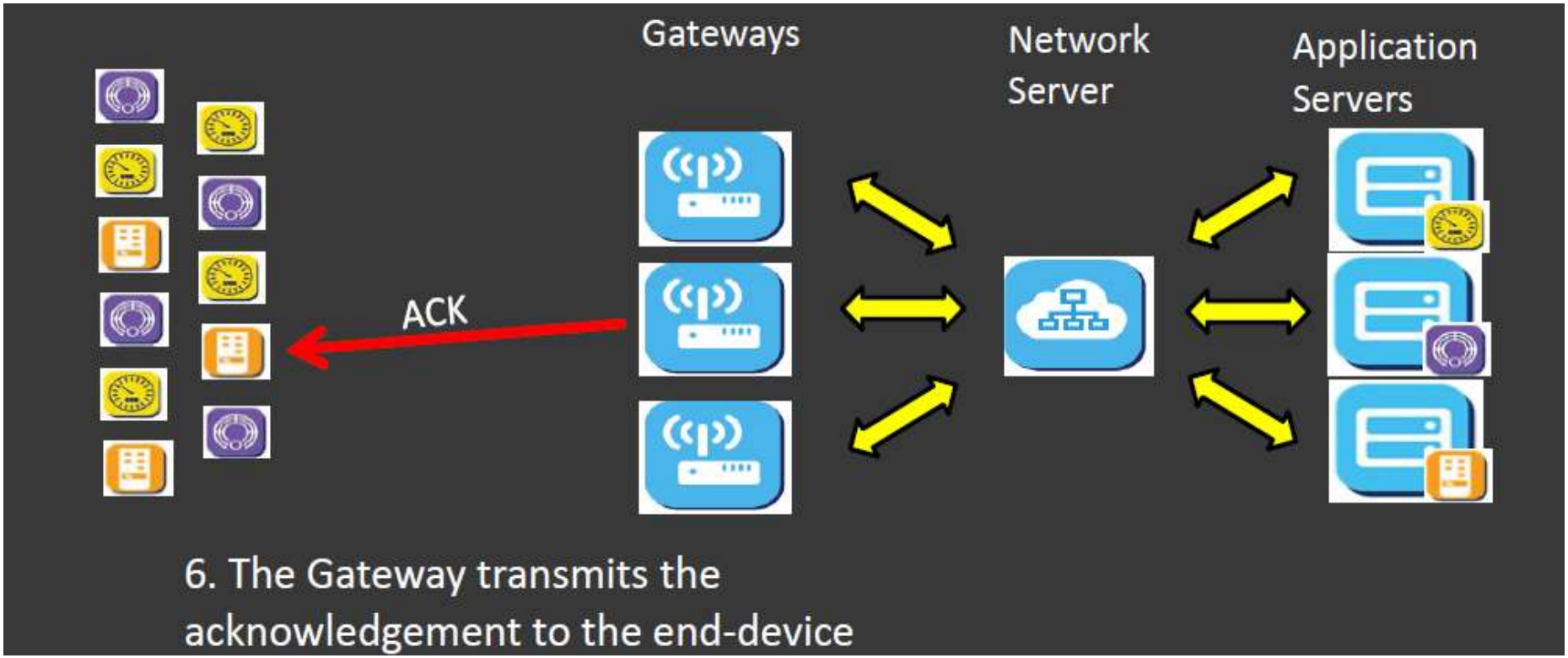
Ref: LoRa-Aliance.org

Data Message (Flow & Payload)



Ref: LoRa-Aliance.org

Data Message (Flow & Payload)



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Data Message (Flow & Payload)

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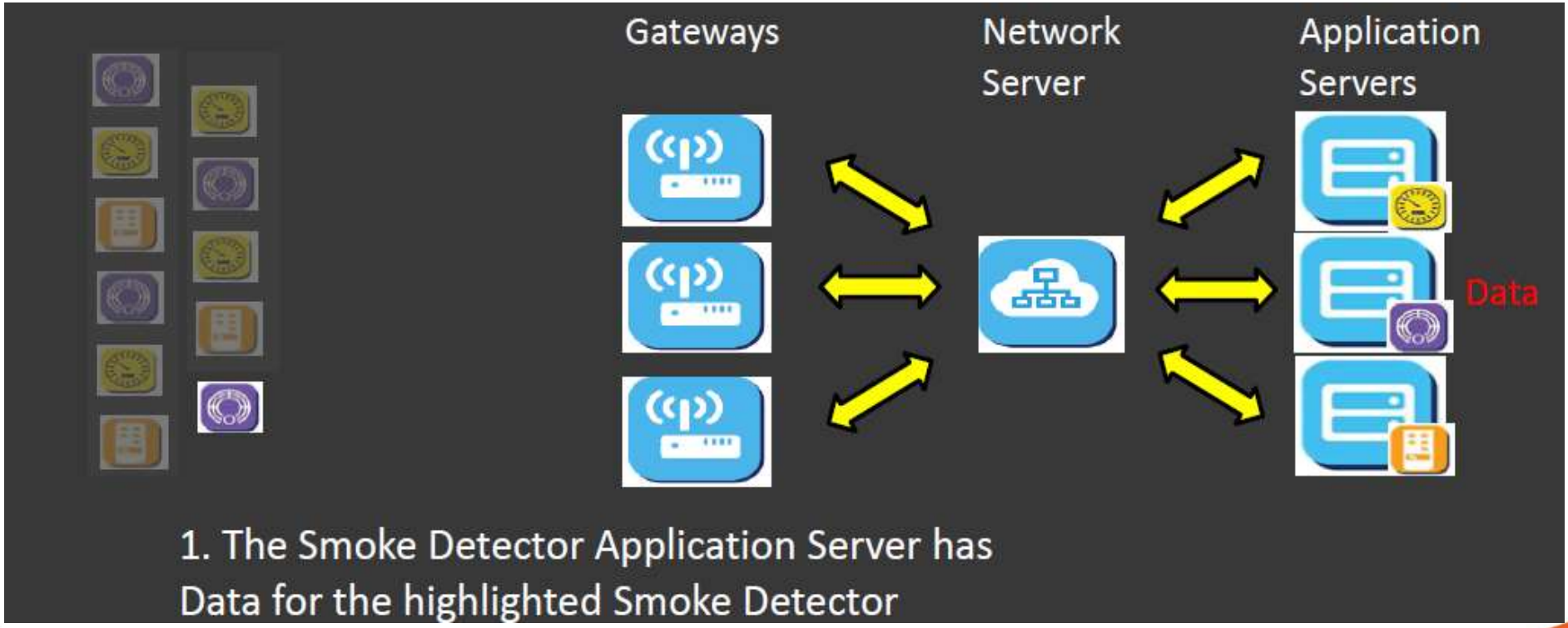

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Data Message (Flow & Payload)

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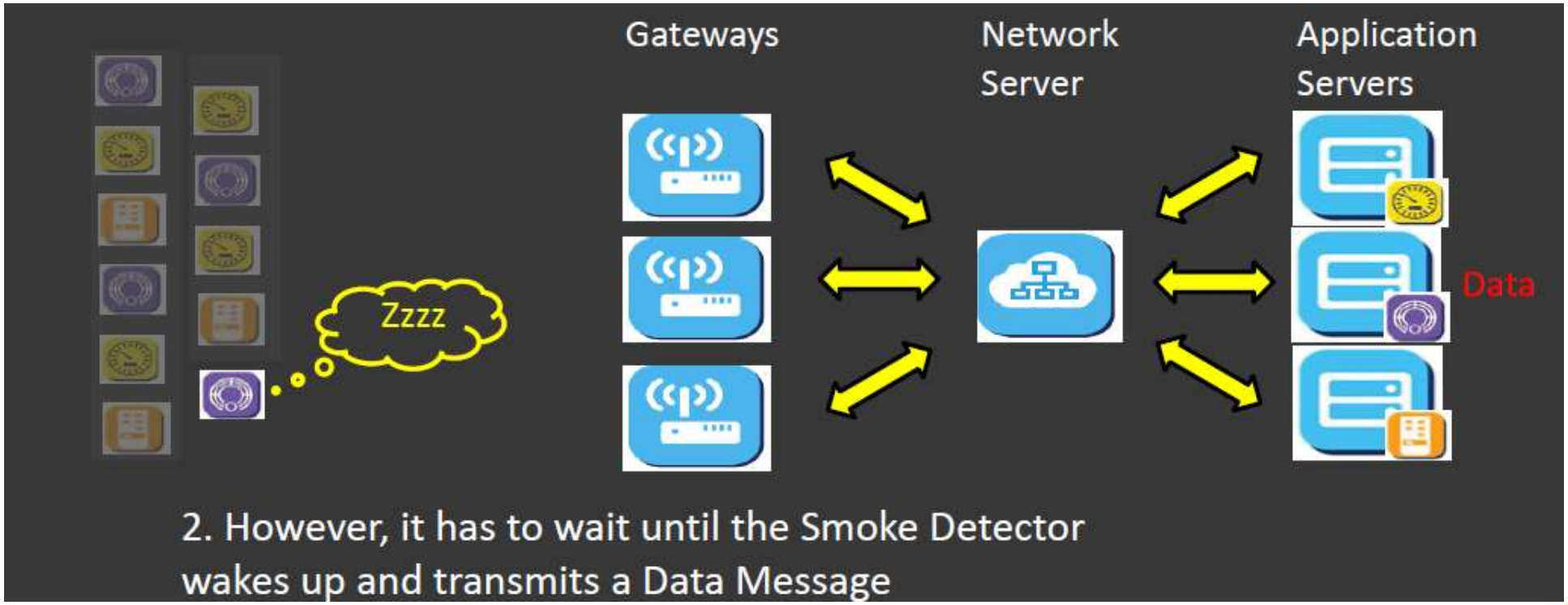

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Data Message (Flow & Payload)

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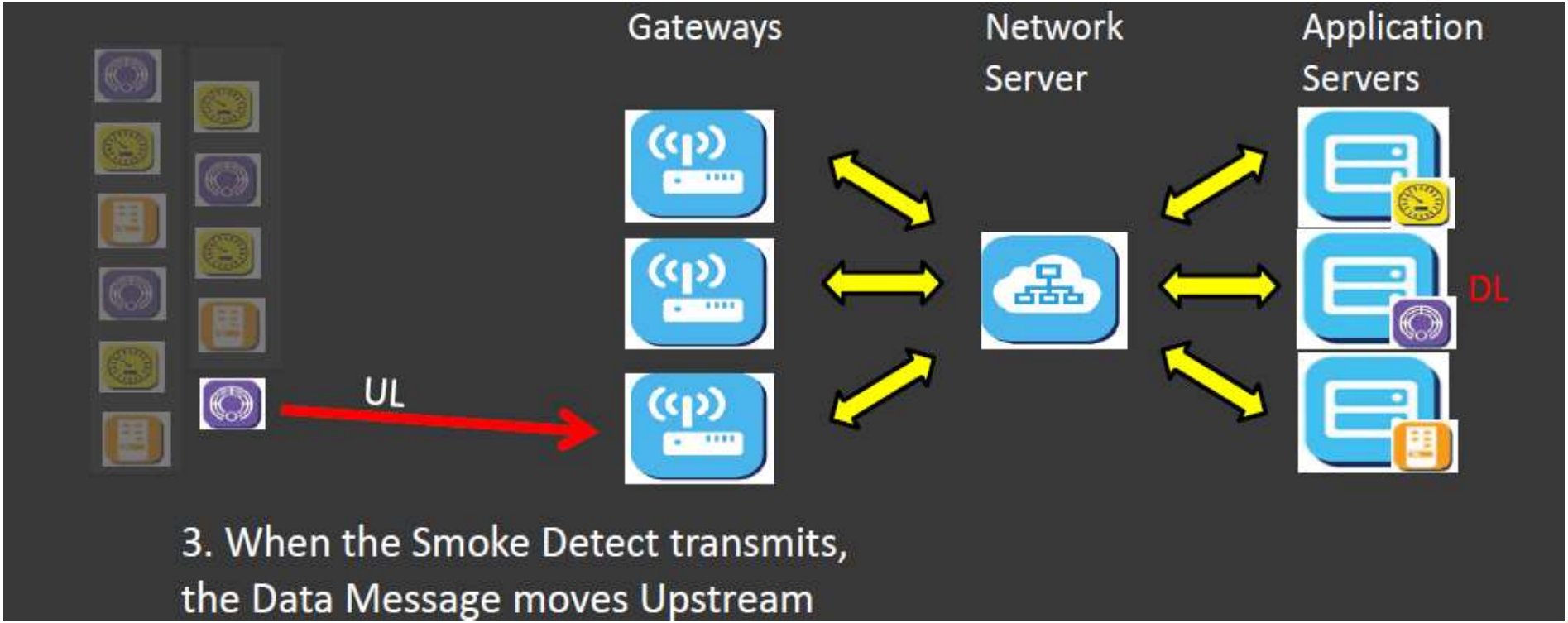

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Data Message (Flow & Payload)

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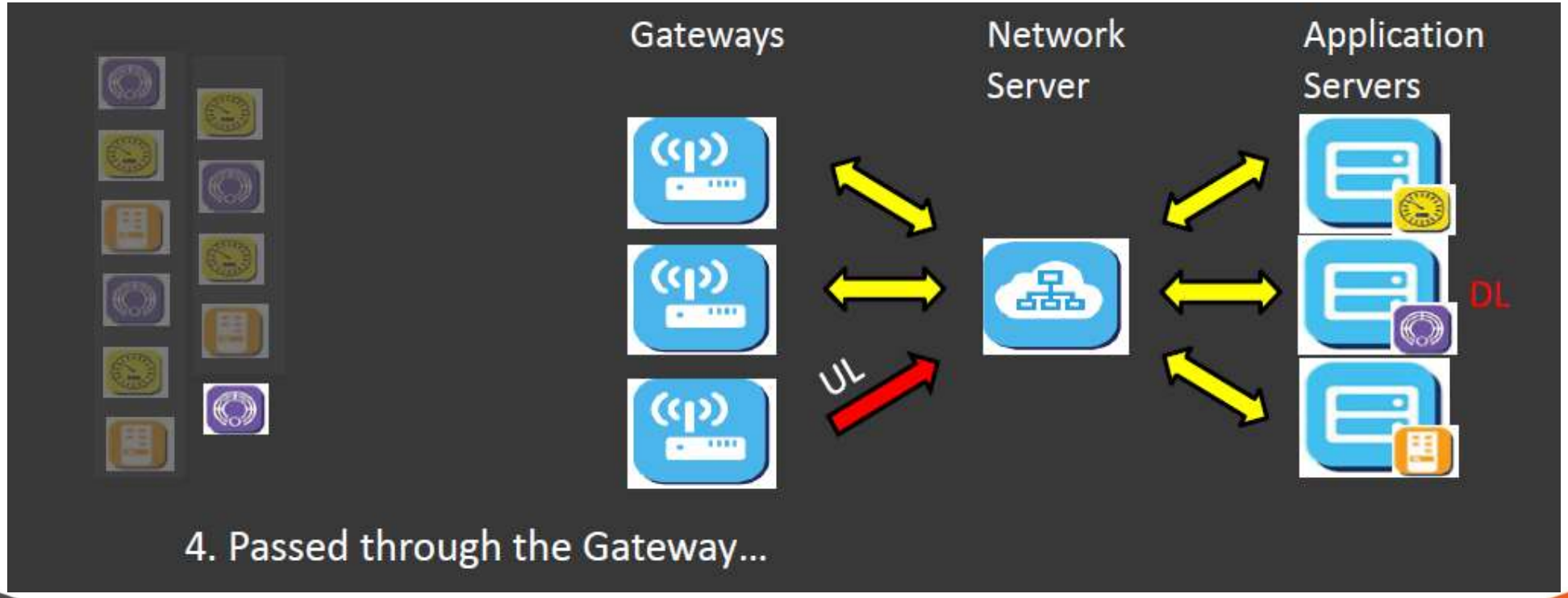

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Data Message (Flow & Payload)

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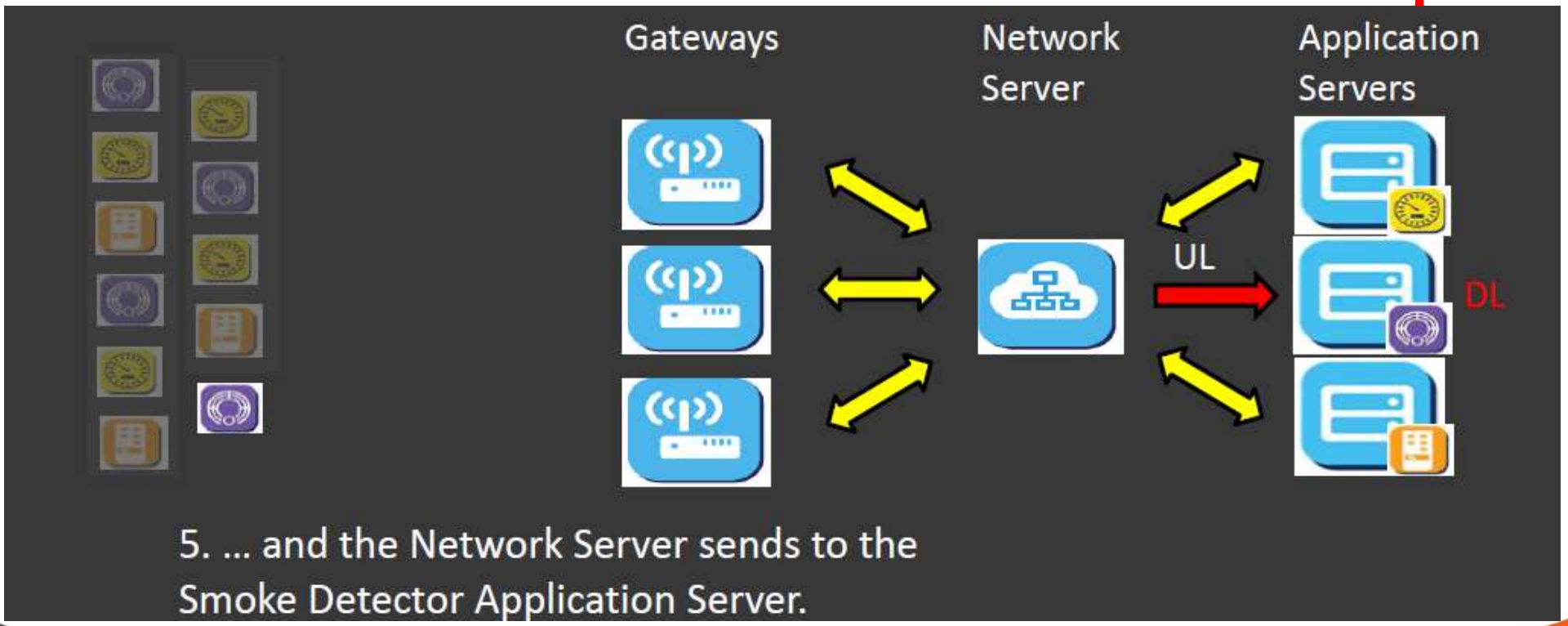

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Data Message (Flow & Payload)

LoRa IoT by CAT

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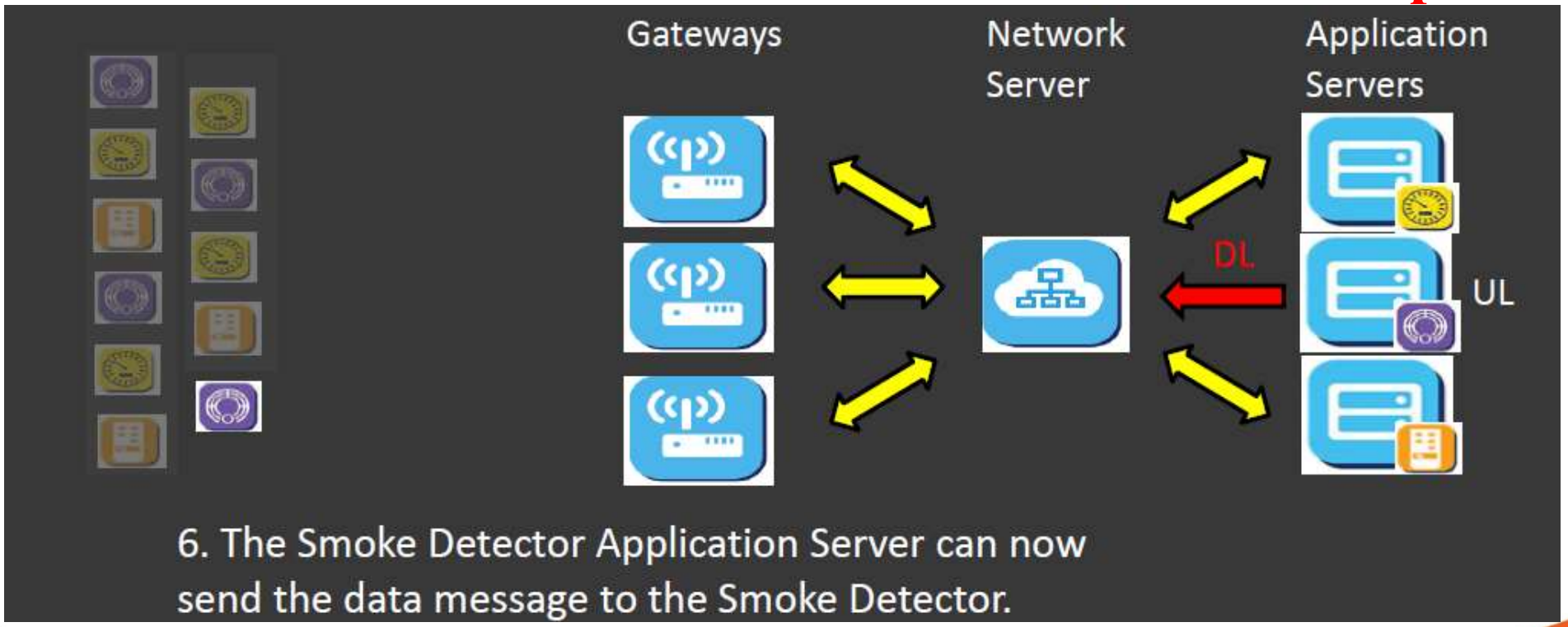

Ref: LoRa-Aliance.org

Data Message (Flow & Payload)

LoRa IoT by CAT

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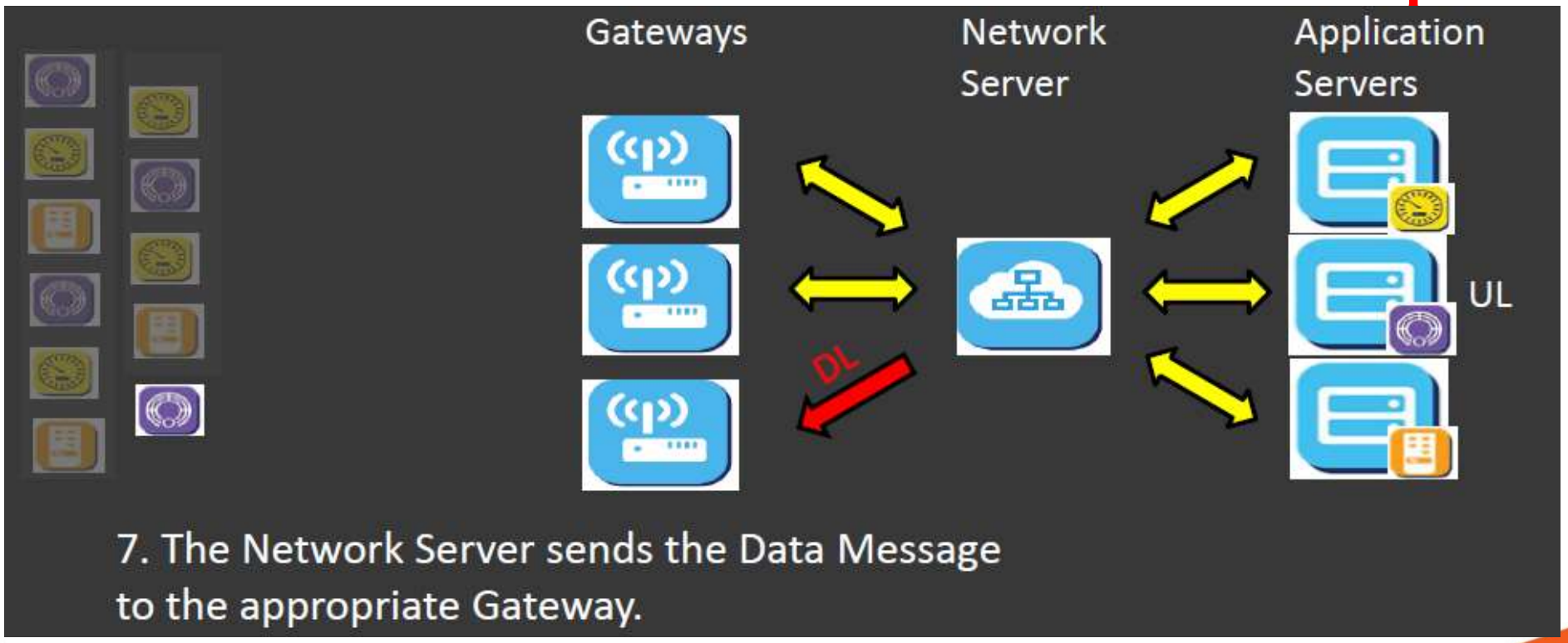

Ref: LoRa-Aliance.org

Cayenne Application Server

Type	IPSO	LPP	Hex	Data Size	Data Resolution per bit
Digital Input	3200	0	0	1	1
Digital Output	3201	1	1	1	1
Analog Input	3202	2	2	2	0.01 Signed
Analog Output	3203	3	3	2	0.01 Signed
Illuminance Sensor	3301	101	65	2	1 Lux Unsigned MSB
Presence Sensor	3302	102	66	1	1
Temperature Sensor	3303	103	67	2	0.1 °C Signed MSB
Humidity Sensor	3304	104	68	1	0.5 % Unsigned
Accelerometer	3313	113	71	6	0.001 G Signed MSB per axis
Barometer	3315	115	73	2	0.1 hPa Unsigned MSB
Gyrometer	3334	134	86	6	0.01 °/s Signed MSB per axis
GPS Location	3336	136	88	9	Latitude : 0.0001 ° Signed MSB
					Longitude : 0.0001 ° Signed MSB
					Altitude : 0.01 meter Signed MSB

Ref: https://mydevices.com/cayenne/docs/lora/

Cayenne Application Server

Examples

Device with 2 temperature sensors

Payload (Hex)	03 67 01 10 05 67 00 FF	
Data Channel	Type	Value
03 ⇒ 3	67 ⇒ Temperature	0110 = 272 ⇒ 27.2°C
05 ⇒ 5	67 ⇒ Temperature	00FF = 255 ⇒ 25.5°C

Device with temperature and acceleration sensors

Frame N

Payload (Hex)	01 67 FF D7	
Data Channel	Type	Value
01 ⇒ 1	67 ⇒ Temperature	FFD7 = -41 ⇒ -4.1°C

Ref: https://mydevices.com/cayenne/docs/lora/

TESA Application Server

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Payload Structure

1 Byte	N Byte	1 Byte	M Byte	1 Byte	O Byte	...
Data1 Type	Data1	Data2 Type	Data2	Data3 Type	Data3	...

Data Type

Type	Data Type	Data Type (HEX)	Data Size (Byte)	Data Resolution
Pressure	1	01	2	0.1 hPa Unsigned MSB
Temperature	2	02	2	0.1 °C Signed MSB
Humidity	3	03	2	0.1 % Unsigned
Gyroscope	4	04	6	0.01 °/s Signed MSB per axis
Accelerometer	5	05	6	0.001 G Signed MSB per axis
Magnetometer	6	06	6	1 mGauss Signed MSB per axis
LEDs	7	07	1	1 for each bit
Digital Input 1	8	08	1	1
Digital Input 2	9	09	1	1
Digital Input 3	10	0A	1	1
Digital Input 4	11	0B	1	1
Digital Input 5	12	0C	1	1
Digital Output	160	A0	1	1

TESA Application Server

LoRa IoT by CAT

Examples

Device with temperature and acceleration sensors

Payload (HEX)	02 01 00 05 00 ED 06 07 FE 0C

Data Type	Data
02 => 2 => Temperature	0100 => 256 => 25.6 °C
05 => 5 => Accelerometer	X: 00ED => 237 => 0.231 G
	Y: 0607 => 1543 => 1.543 G
	Z: FE0C => -500 => -0.5 G

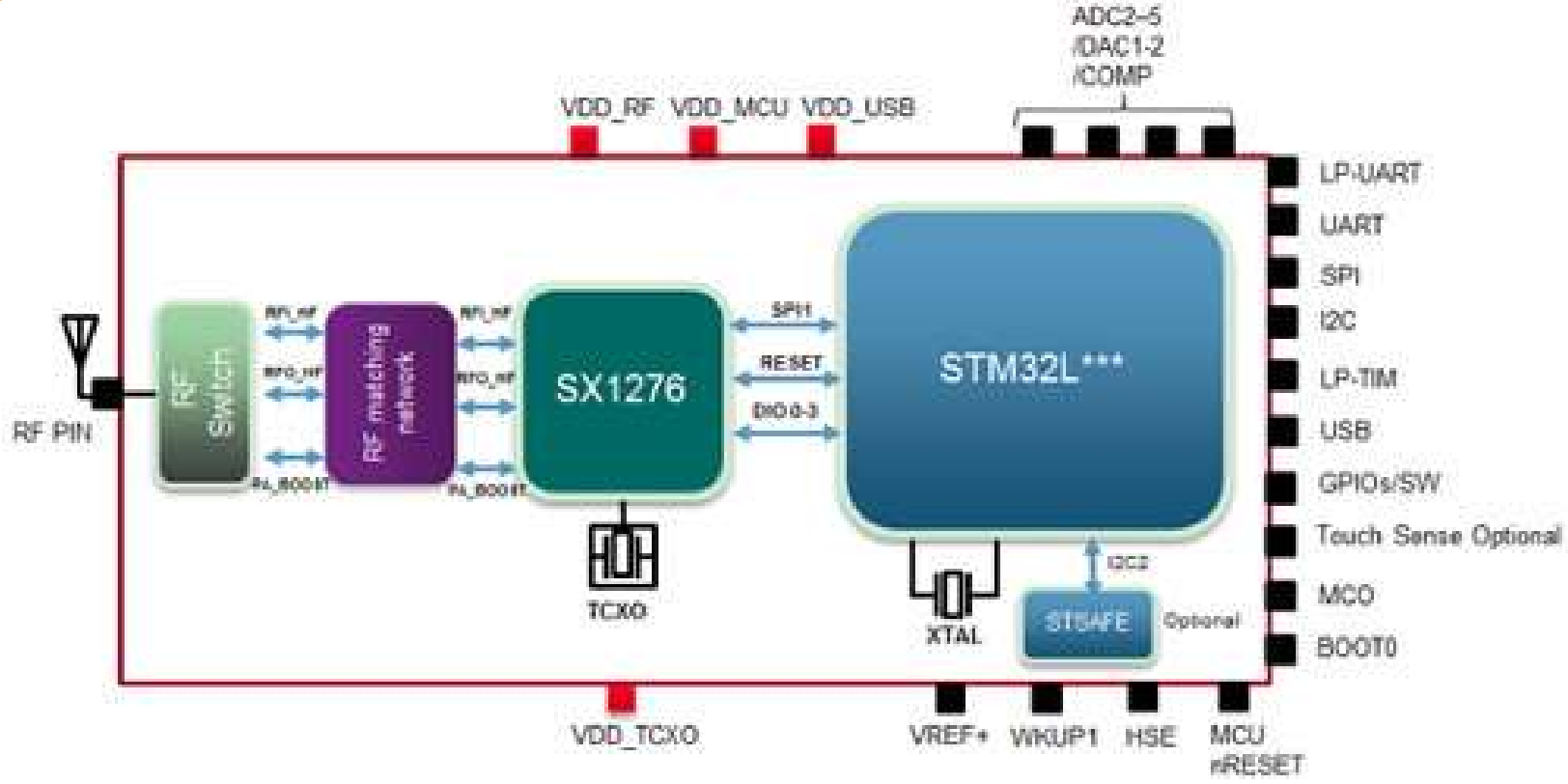
LORA BASIC CONCEPT

- Frequency
- Channel
- Data Rate
- LoRa Class
- Activation Mode
- Data Message (Flow & Payload)
- **Configuration**

Configuration

Key	Description
Device EUI (DevEUI)	Unique device ID 64 bit
Device Profile	Refer to Device Class, Frequency and version
Network Key (NwkSKey)	The optional 128-bit key used to encrypt the payload of the messages.
Application Server (AS) Routing Profile	The routing information defining how sensor data is routed to an application back-end connected to the core network platform.
Application Key (AppSKey)	The optional 128-bit key used to encrypt the payload of the messages.

Configuration



Configuration

LoRa IoT by CAT

LoRa Alliance™

CERTIFICATE OF COMPLIANCE

LoRaWAN™ Certified Product

The LoRa Alliance™ is pleased to congratulate Murata Electronics Europe on the completion of the LoRaWAN™ Certification Program for the following product:

MANUFACTURER	Murata Electronics Europe
TYPE OF DEVICE	Module
MODEL IDENTIFICATION	CMWX1ZZABZ-078
LoRaWAN REGION	EU868
FIRMWARE VERSION	1.0.3
HARDWARE VERSION	MP
CERTIFICATION DATE	February 2, 2017
LoRaWAN SPECIFICATION	V1.0.1
Class of Operation (A, B or C)	A

This Certificate serves to confirm that the above mentioned product has passed all relevant tests in conjunction with the LoRaWAN™ Certification Program and is deemed compliant to it. The Manufacturer has been granted the right to use the following term and all associated logos:

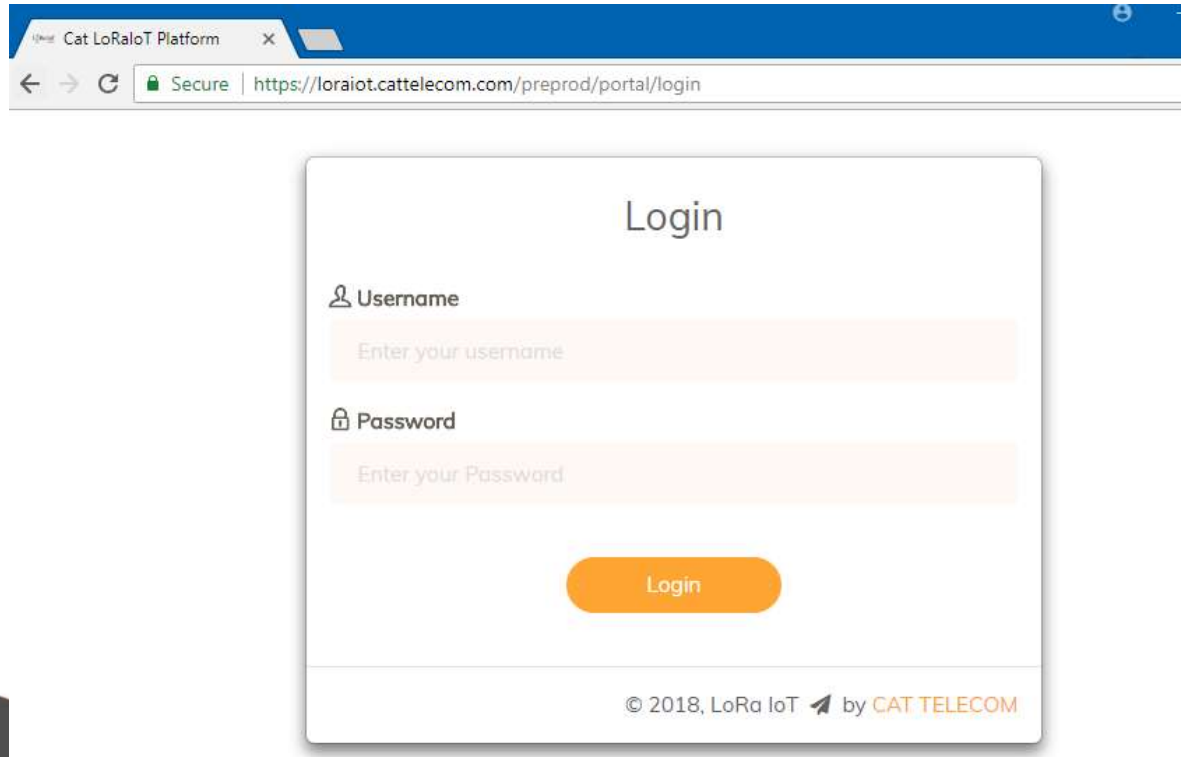
LoRa IoT by CAT

TOPIC

- IoT Concept
- Network Concept
- LoRa Network
- LoRa Basic Concept
- **LoRa Account**
- Device Manager
- Example Application

LoRa Account

https://loraiot.cattelecom.com/portal/login



ตามกระดาษ

Username

Password

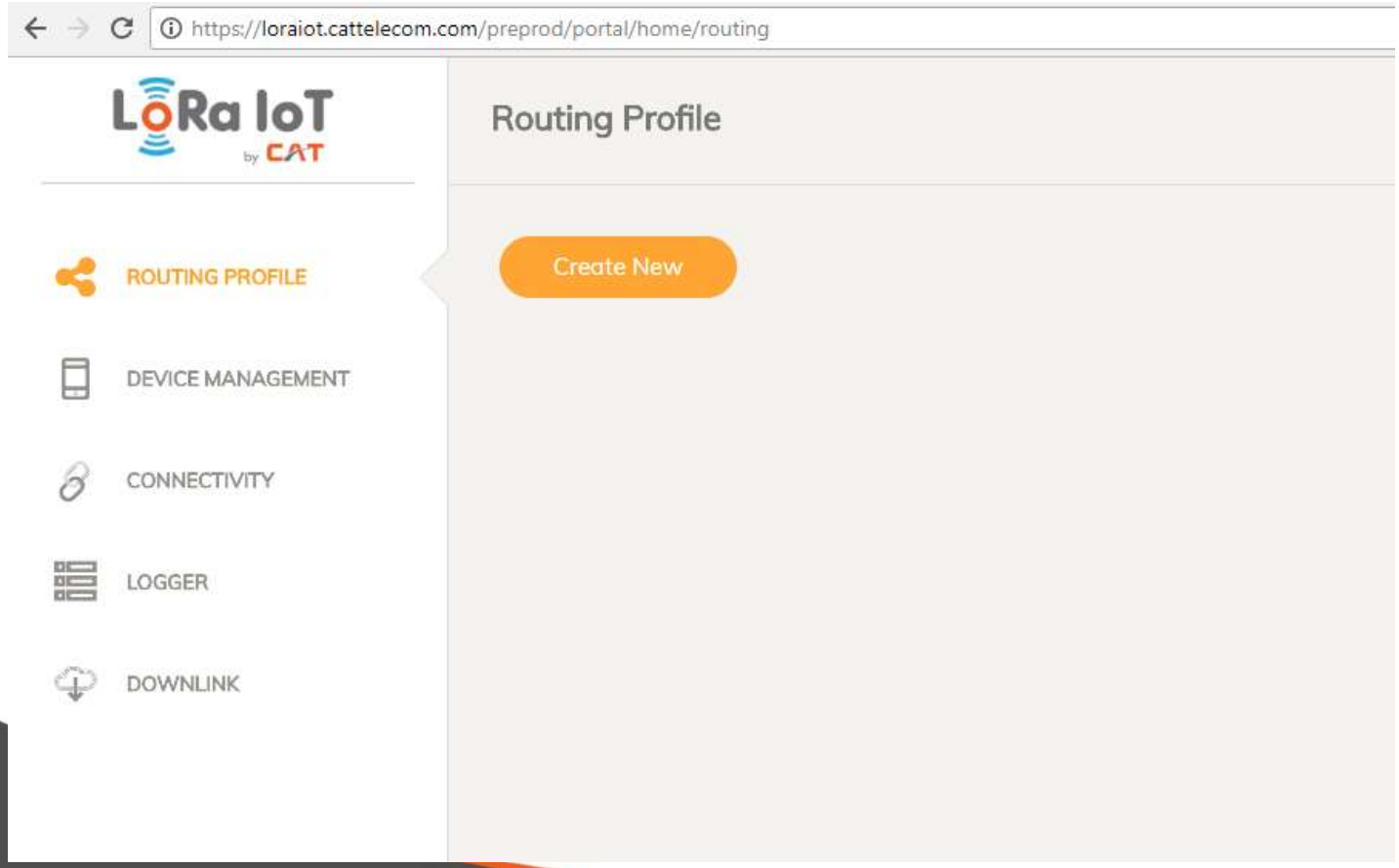
ของแต่ละทีม

LoRa IoT by CAT

TOPIC

- IoT Concept
- Network Concept
- LoRa Network and Basic Concept
- **Workshop : LoRa Account and Device Management**
- Workshop : LoRa Example Application

Device Manager



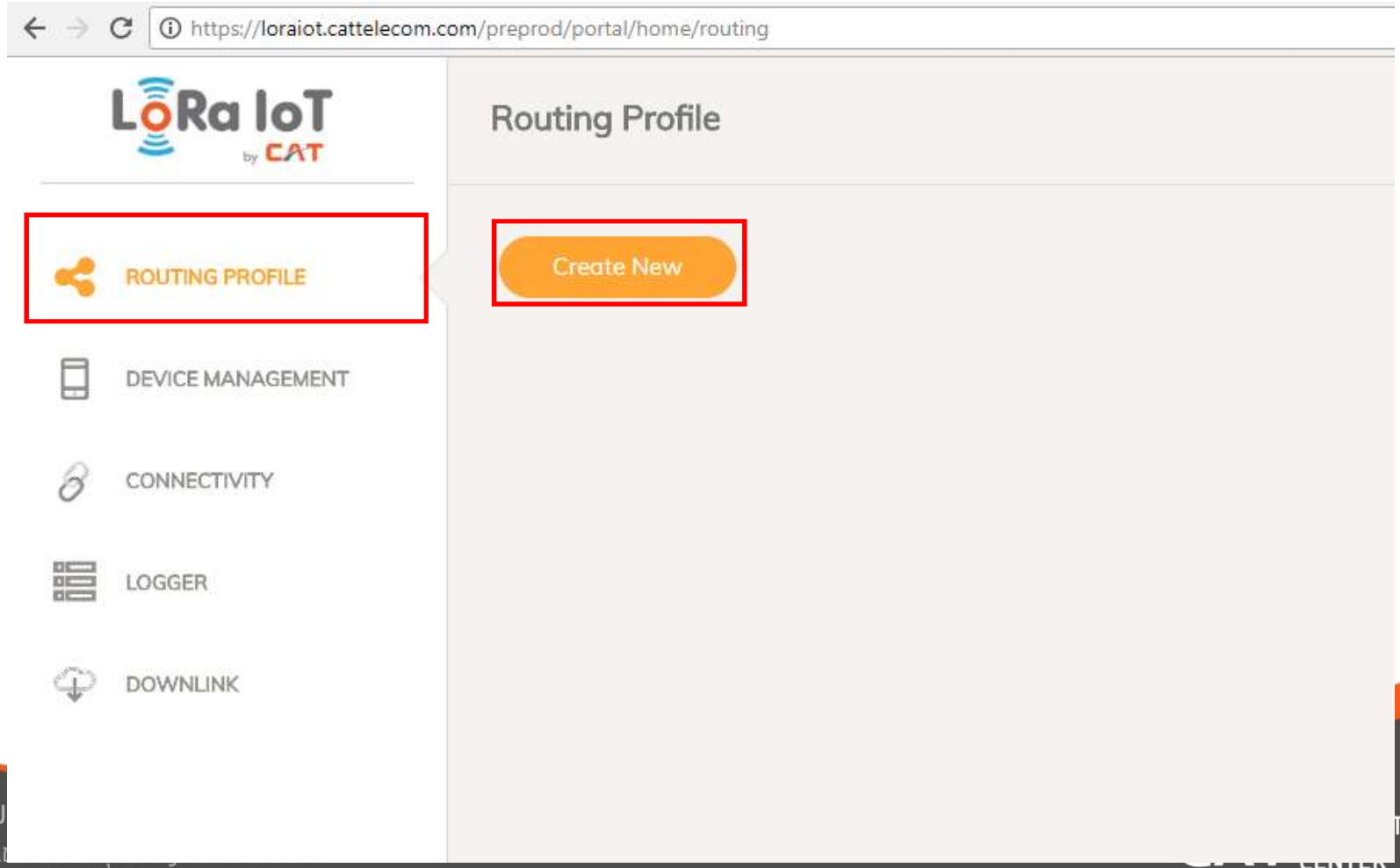
- Routing Profile
- Device Management
- Connectivity
- Logger
- Downlink

LoRa IoT by CAT

Routing Profile

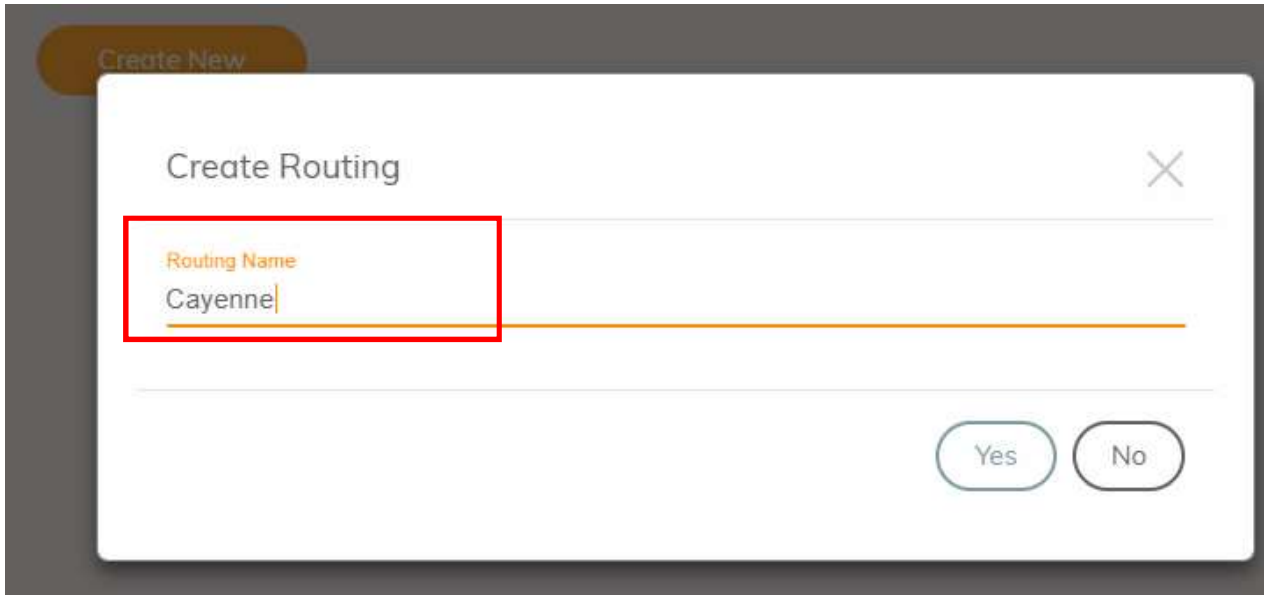
Device Manager

Routing Profile



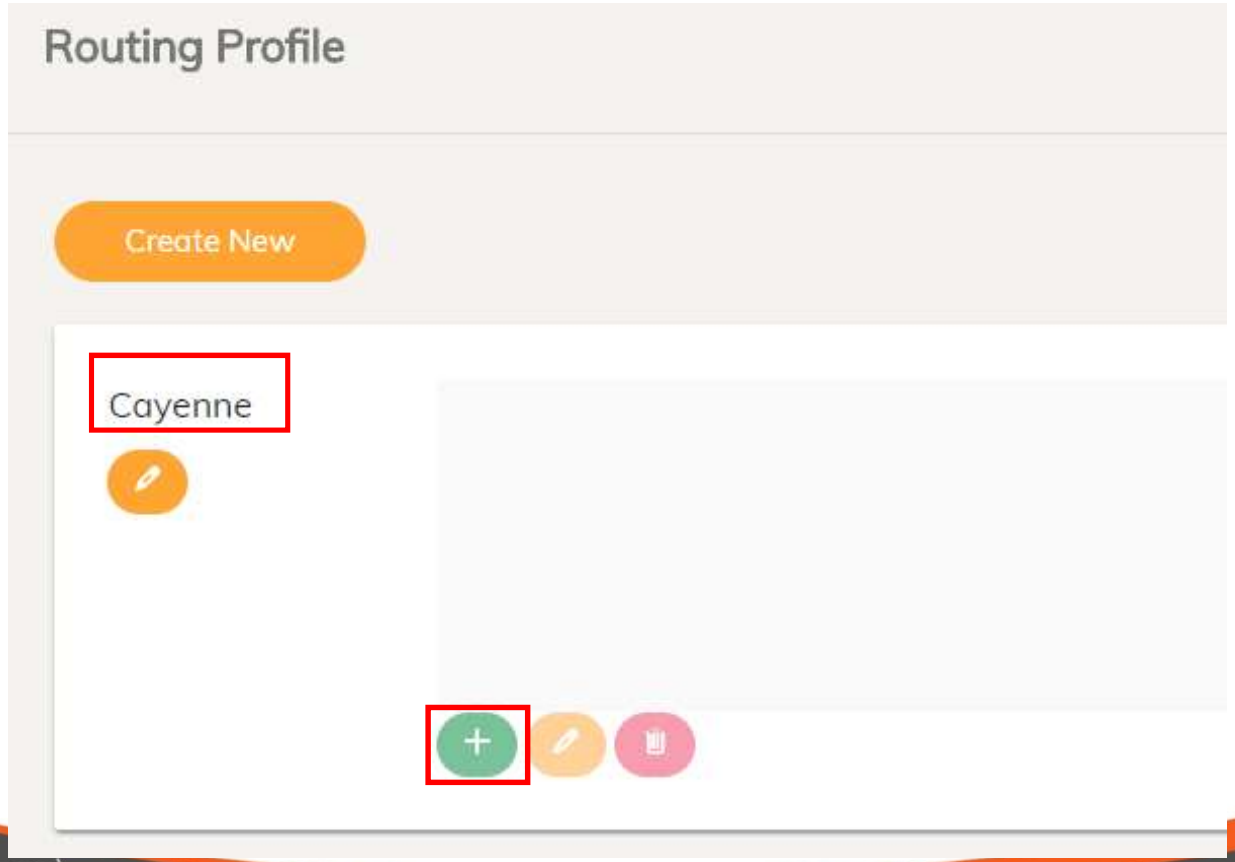
Device Manager

Routing Profile



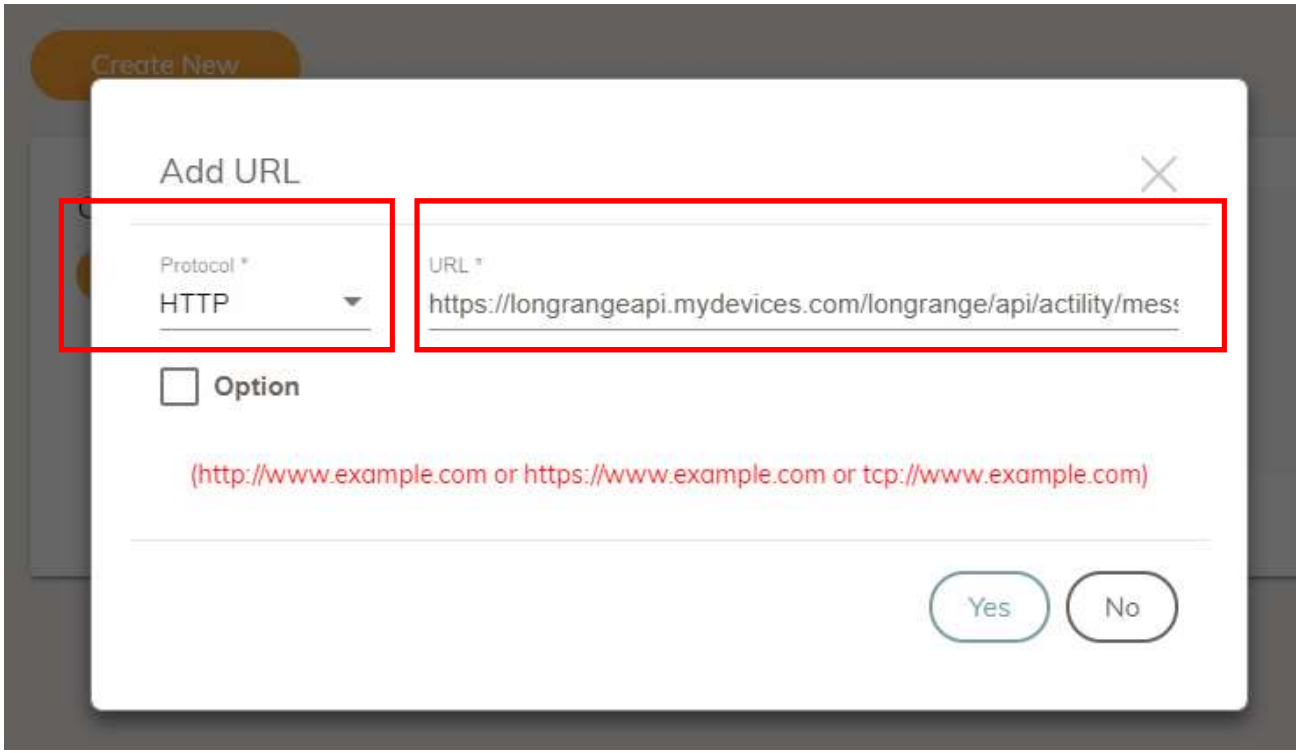
Device Manager

Routing Profile



Device Manager

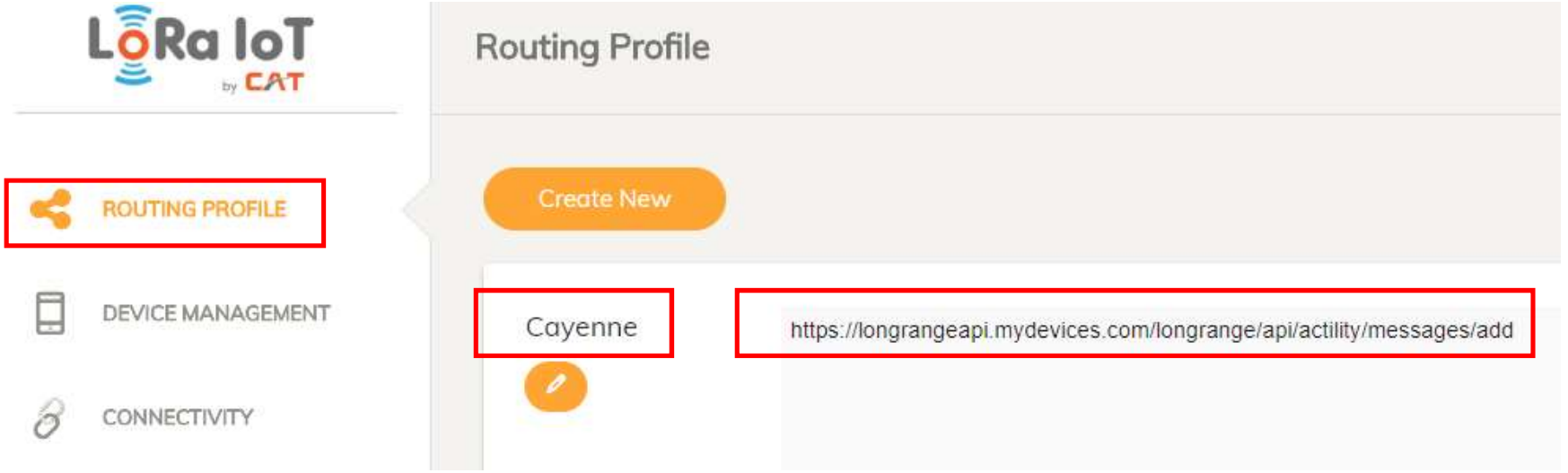
Routing Profile



https://longrangeapi.mydevices.com/longrange/api/actility/messages/add

Device Manager

Routing Profile



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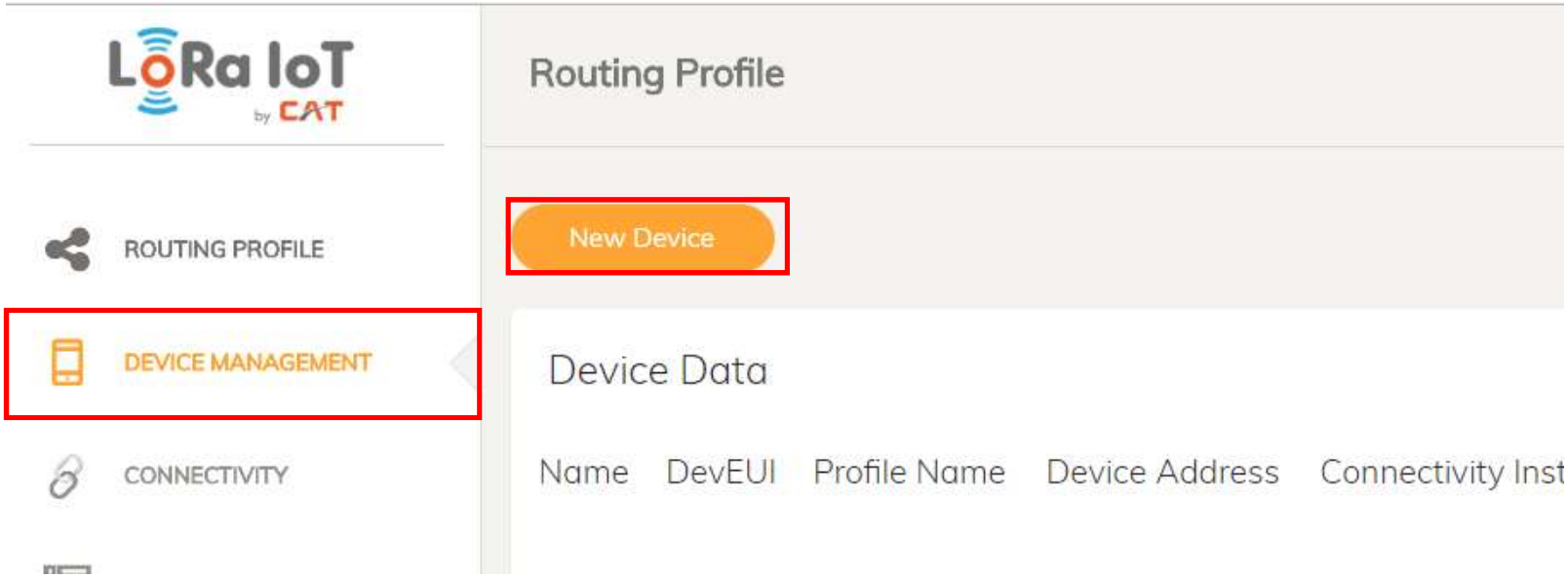
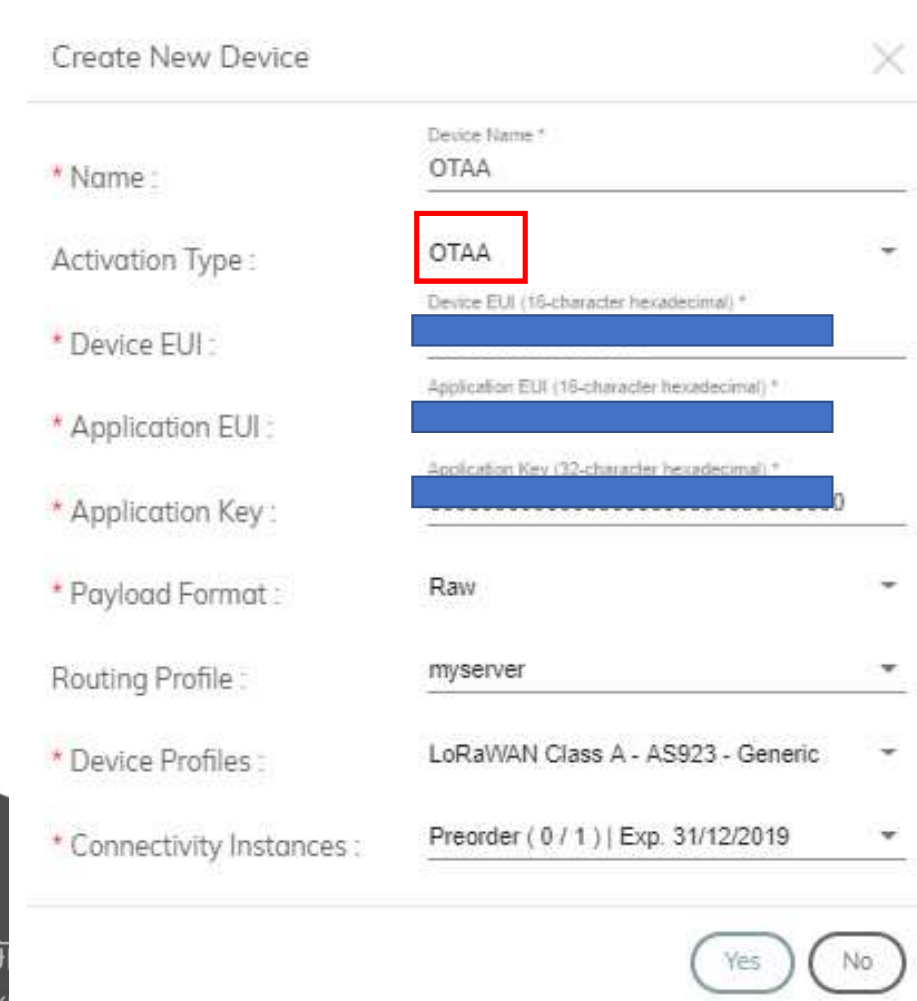
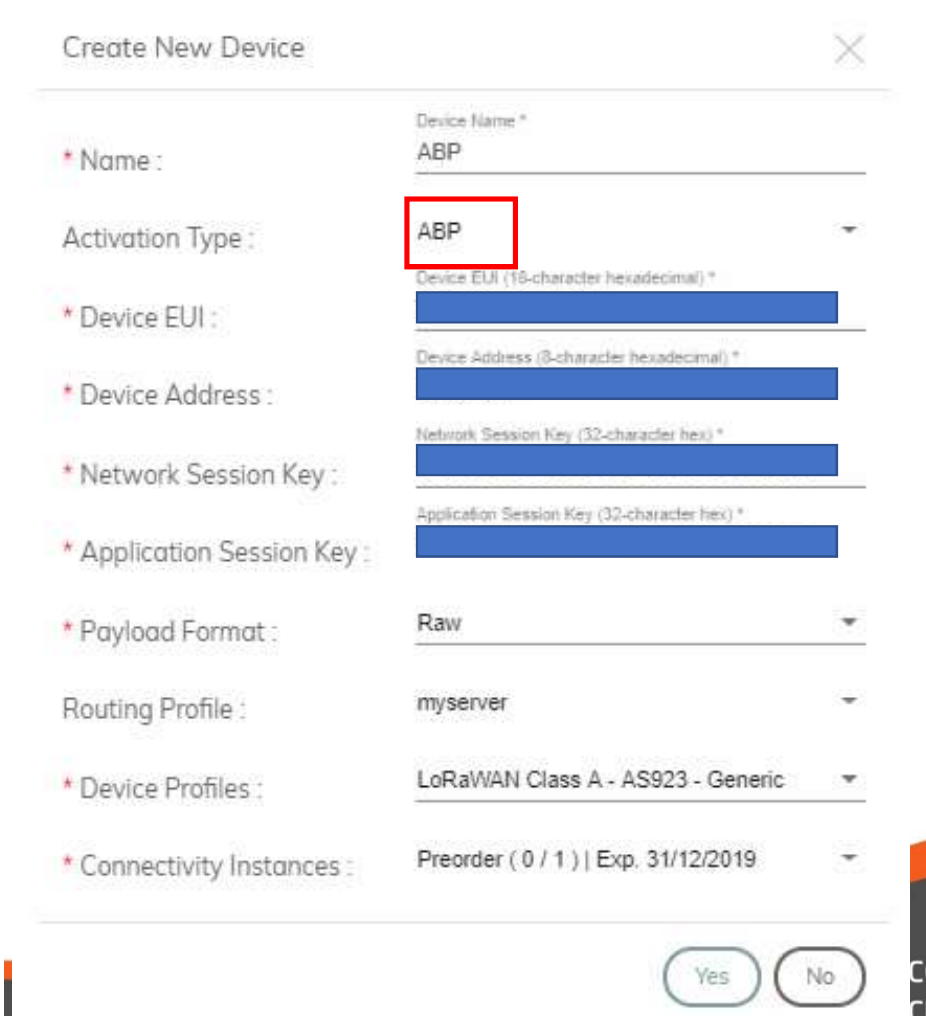
Device Management

Device Manager



Device Manager





Device Manager

Device Management

ABP

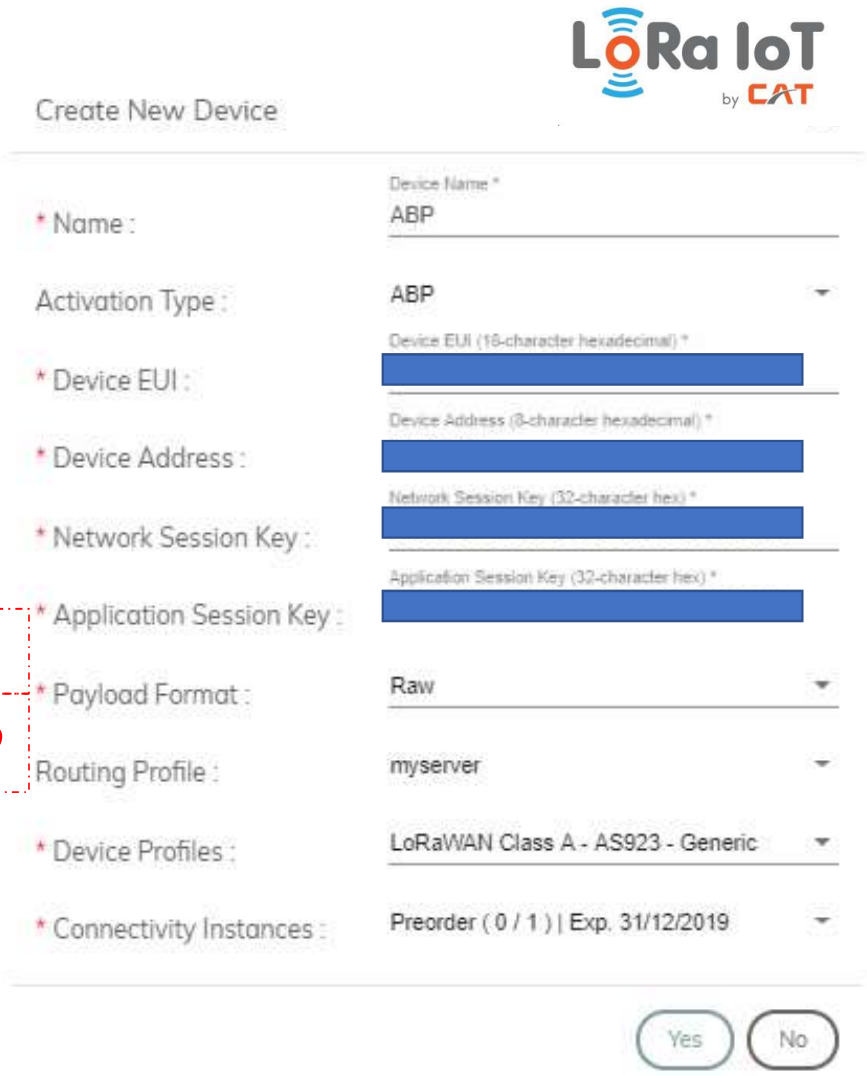
DeviceEUI: AA-00-DB-CA-12-EF-11-XX

DeviceAddr: 12-EF-11-XX

Network Session Key : 28-AE-D2-2B-7E-15-16-A6-09-CF-AB-F7-15-88-4F-3C

Application Session Key: 16-28-AE-2B-7E-15-D2-A6-AB-F7-CF-4F-3C-15-88-09

LoRaWAN 1.0.2 Class A – AS933



Device Manager

LoRa IoT by CAT

Device Management

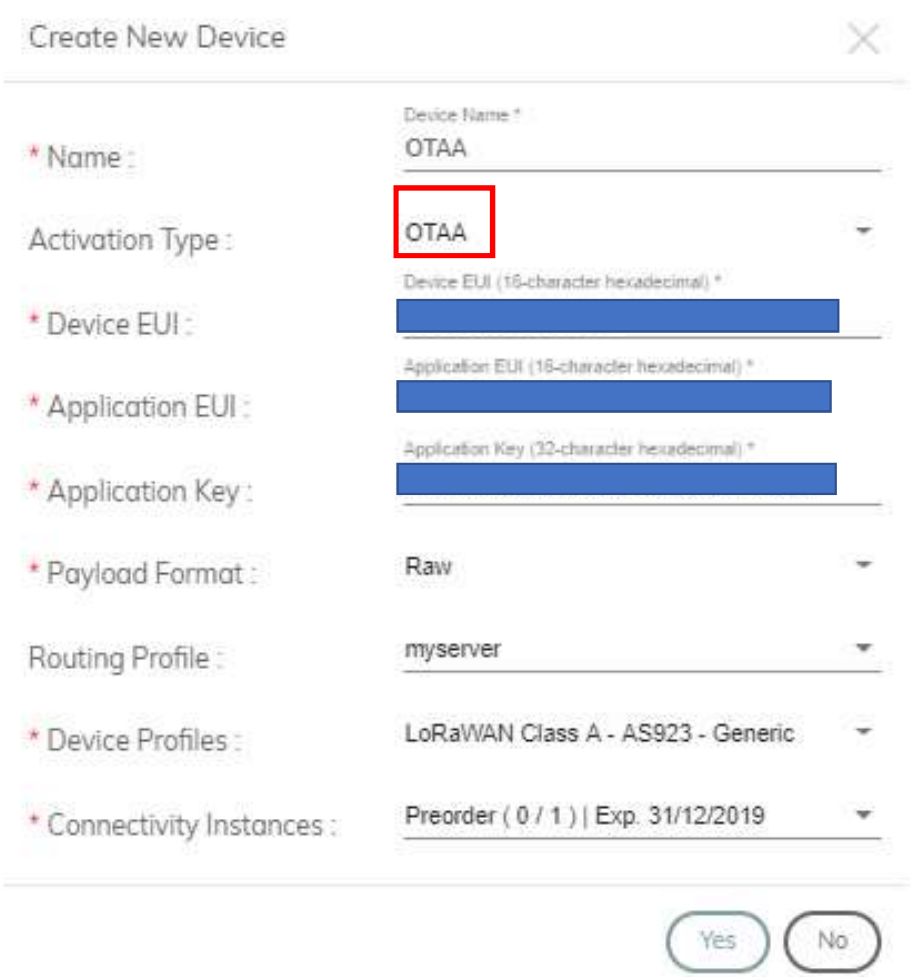
OTAA

DeviceEUI: AA-00-DB-CA-12-EF-11-XX

Application EUI : 16-28-AE-2B-7E-15-D2-A6

Application Key: 16-28-AE-2B-7E-15-D2-A6-AB-F7-CF-4F-3C-15-88-09

LoRaWAN 1.0.2 Class A – AS933



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www.cattelecom.com

Device Manager

Device Management

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99 หมู่ 3 ถนนแจ้งวัฒนะ แขวงทุ่งสองห้อง เขตหลักสี่ กรุงเทพฯ 10210-0298
www.cattelecom.com

Device Manager

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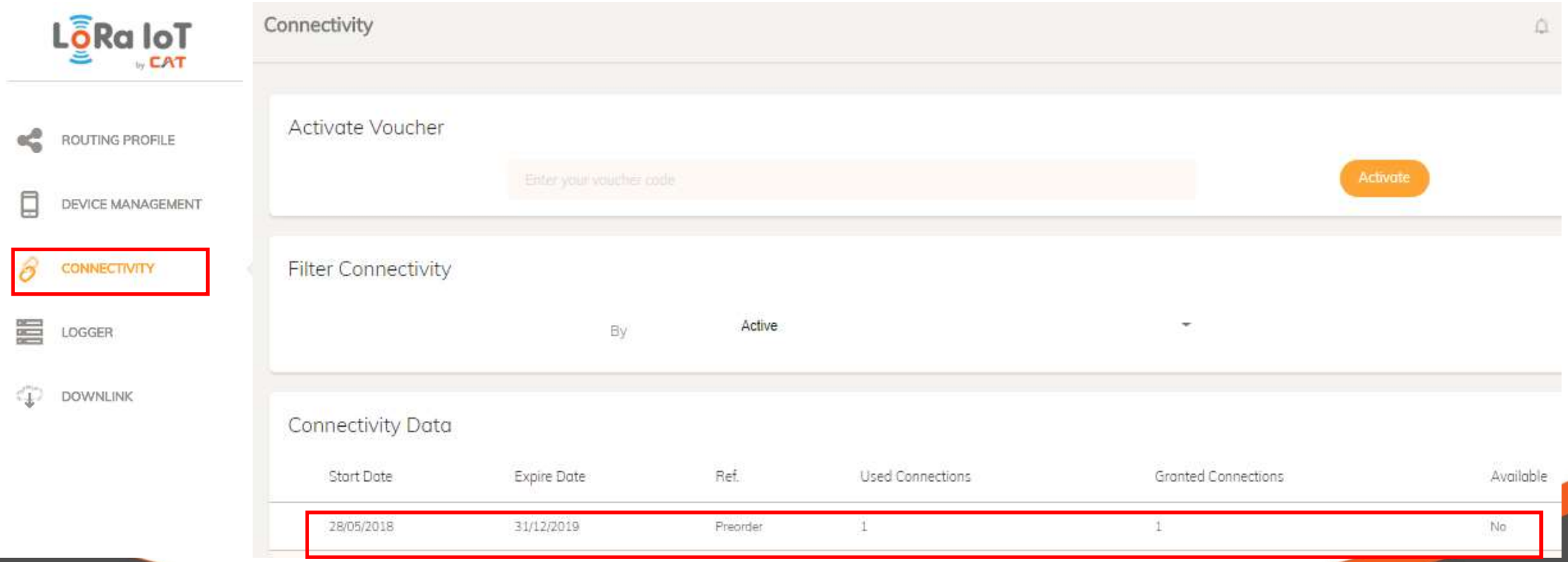
Connectivity

Device Manager



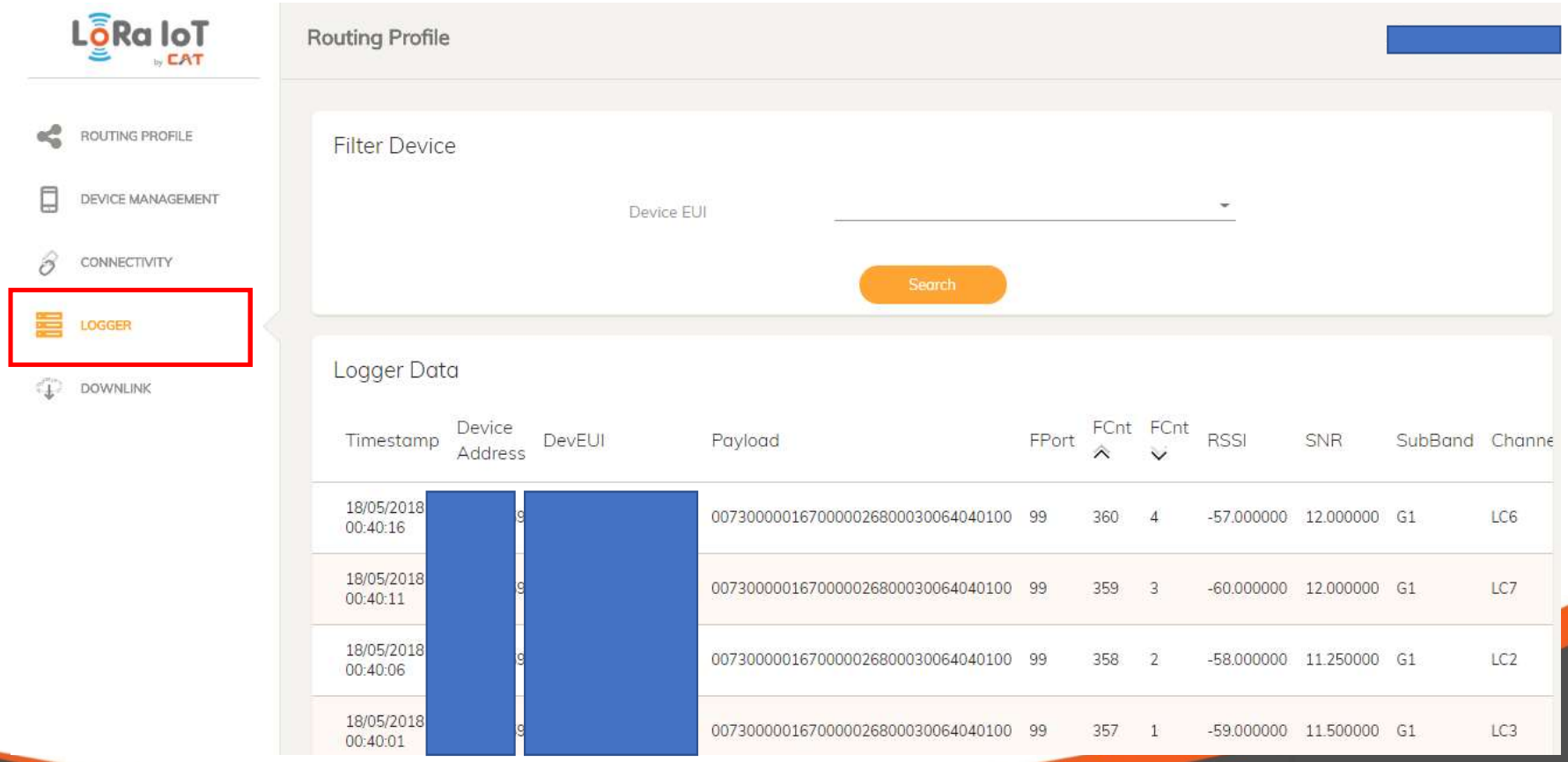
Device Manager

LoRa IoT by CAT

Logger

Device Manager

Logger



Device Manager

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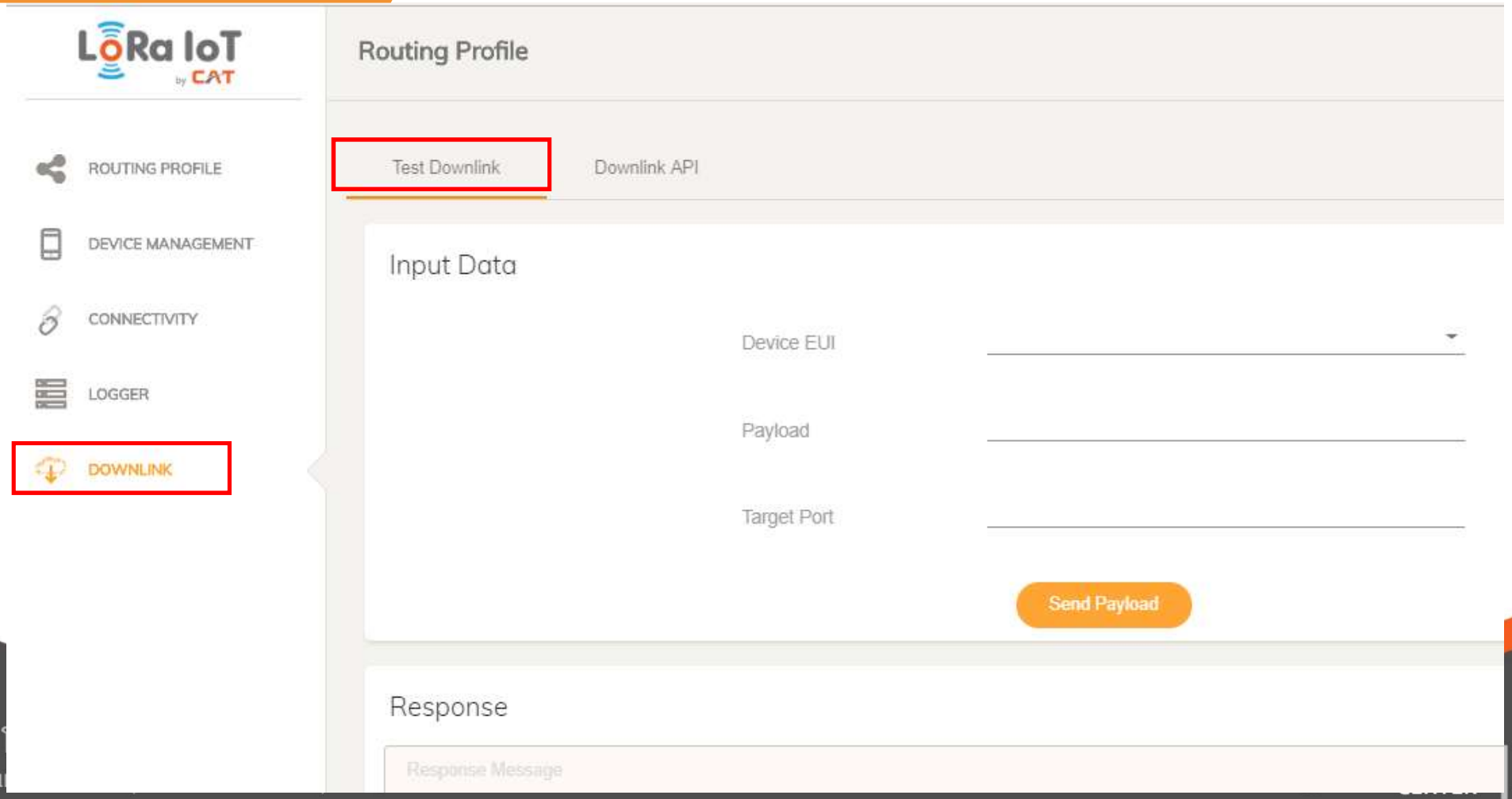
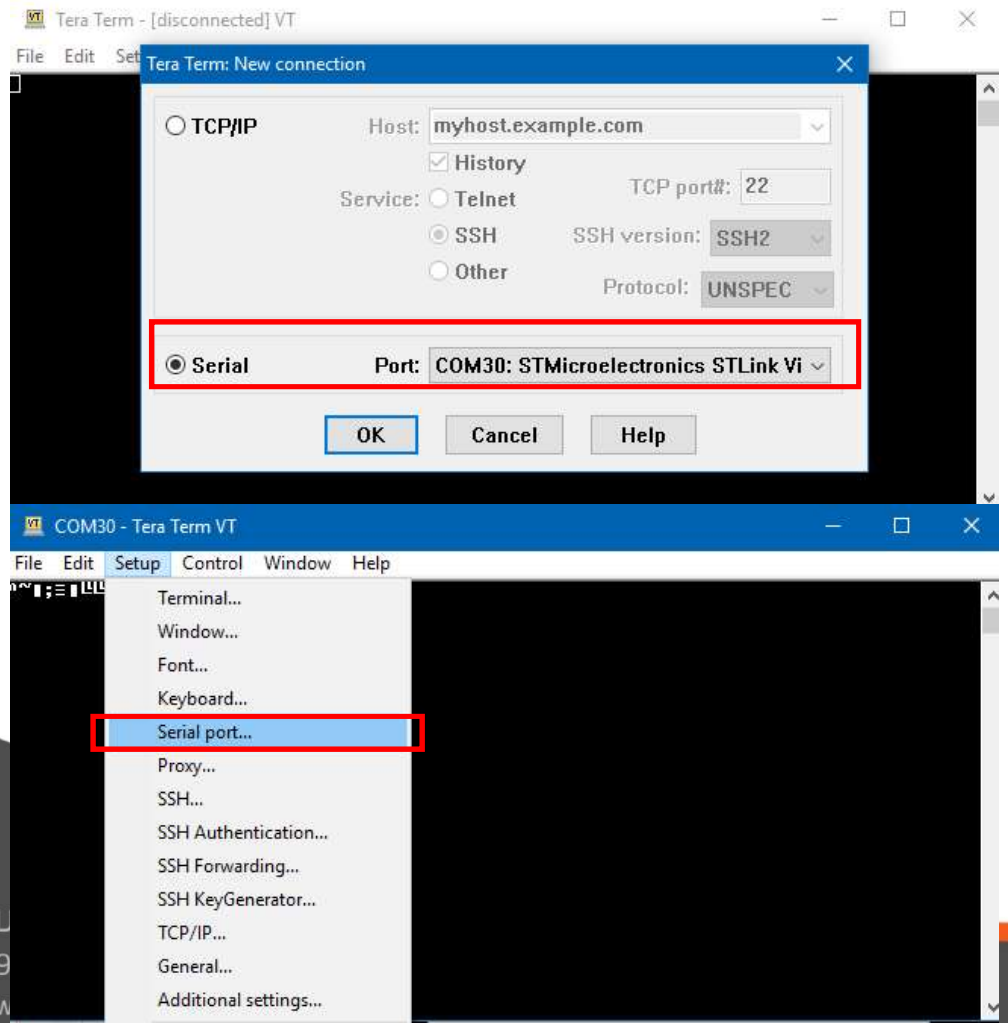
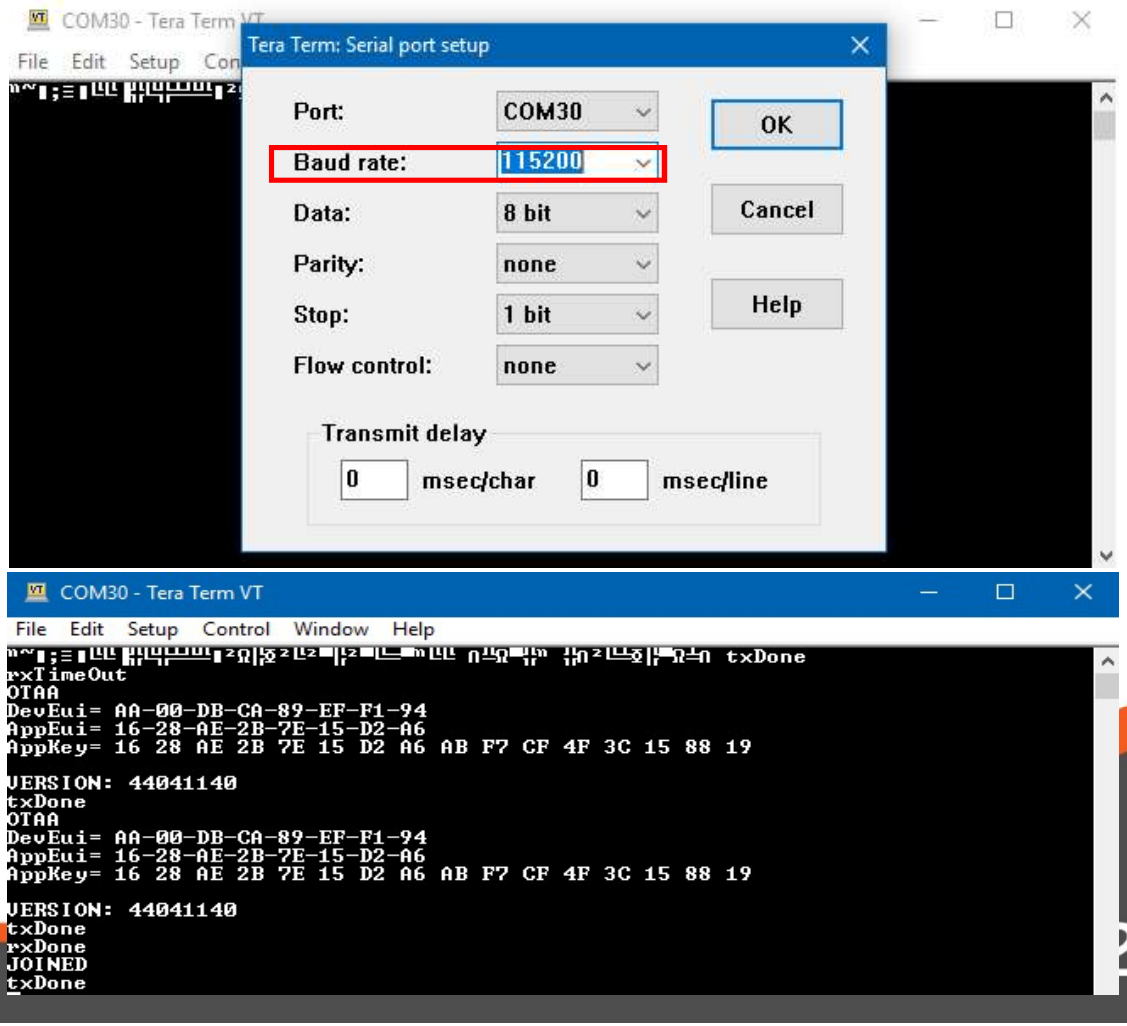
Downlink

Device Manager

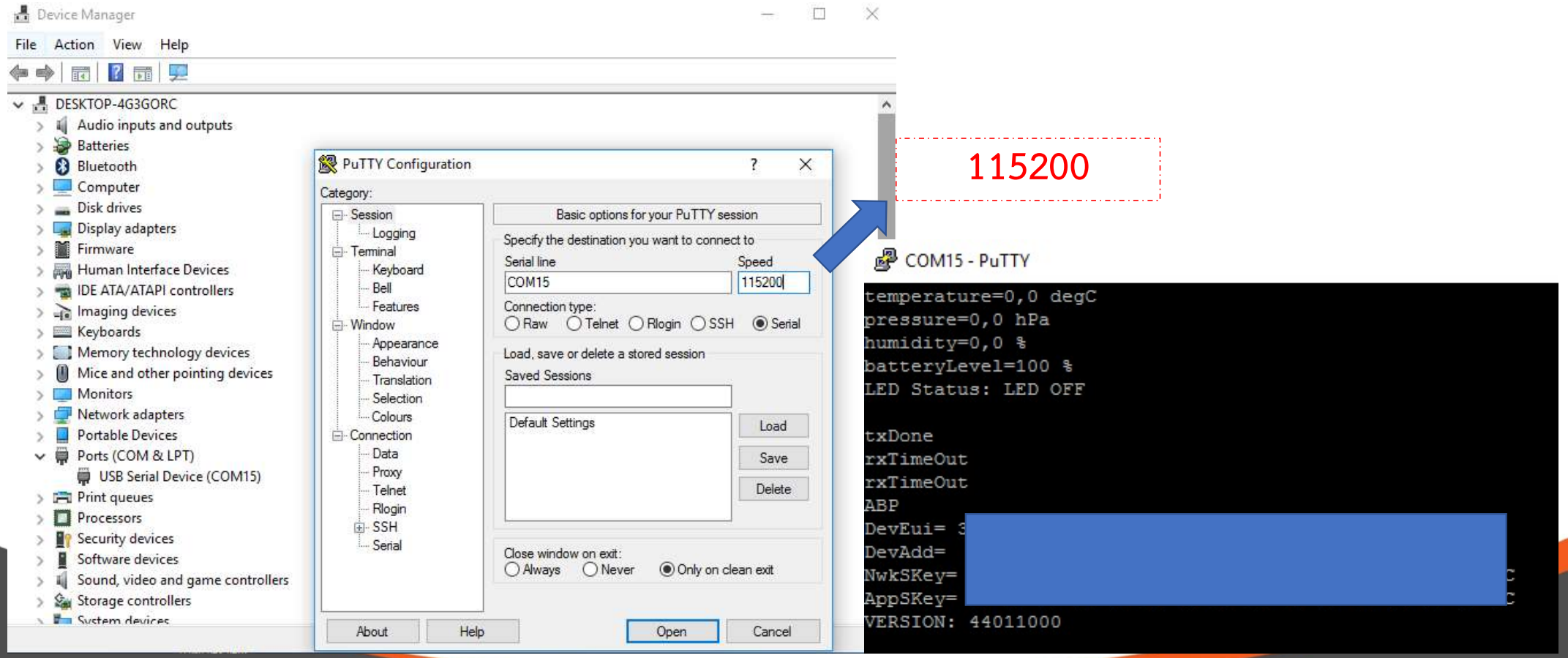


Get Device EUI and Address From Node

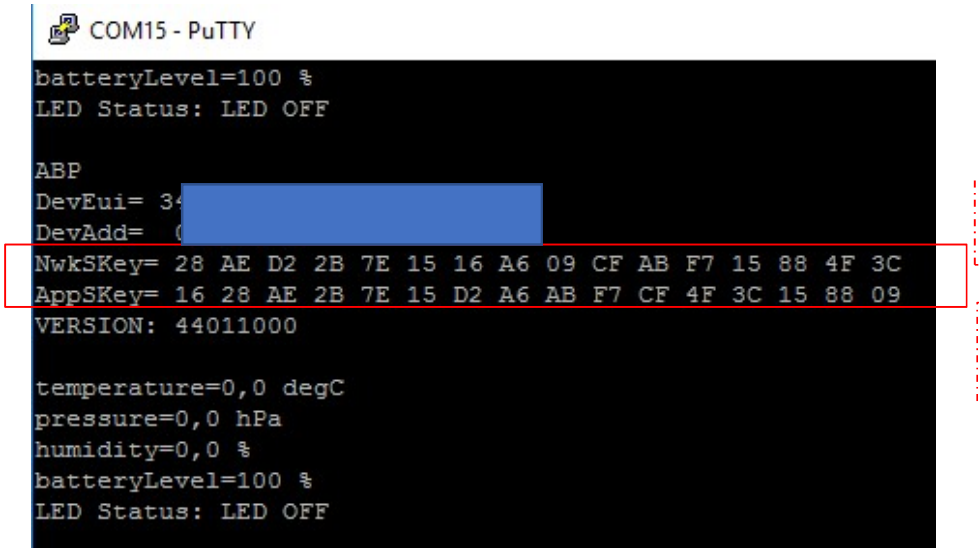




Get Device EUI and Address From Node



Device Manager



28-AE-D2-2B-7E-15-16-A6-09-CF-AB-F7-15-88-4F-3C

16-28-AE-2B-7E-15-D2-A6-AB-F7-CF-4F-3C-15-88-09

Comissioning.h

Change LORAWAN_NWKSKEY

Change LORAWAN_APPSKEY

Device Manager

LoRa IoT by CAT

ABP

Device Manager

**** Please check payload format and LoRaWAN Key Setting !!**

LoRa IoT by CAT

ABP

```
74   * When set to 1 the application uses the Over-the-Air activation procedure
75   * When set to 0 the application uses the Personalization activation procedure
76   */
77  #define OVER_THE_AIR_ACTIVATION                     0
78
79  /*!
80   * Indicates if the end-device is to be connected to a private or public network
81   */
82  #define LORAWAN_PUBLIC_NETWORK                      true
83
84  /*!
85   * When set to 1 DevEui is LORAWAN_DEVICE_EUI
86   * When set to 0 DevEui is automatically generated by calling
87   *         BoardGetUniqueId function
88   */
89  #define STATIC_DEVICE_EUI                           1
90
91  /*!
92   * Mote device IEEE EUI (big endian)
93   *
94   * \remark see STATIC_DEVICE_EUI comments
95   */
96  #define LORAWAN_DEVICE_EUI                          { 0xAA, 0x00, 0xDB, 0xCA, 0x[redacted], 0xEF, 0x[redacted], 0x5[redacted] }
```

Comissioning.h

DeviceEUI: 0xAA, 0x00, 0xDB, 0xCA, 0x12, 0xEF, 0x11, 0xXX

Device Manager

**** Please check payload format and LoRaWAN Key Setting !!**

LoRa IoT by CAT

ABP

Comissioning.h

DeviceAddr: 0x12EF11XX

```
115 /*!
116  * When set to 1 DevAdd is LORAWAN_DEVICE_ADDRESS
117  * When set to 0 DevAdd is automatically generated using
118  *         a pseudo random generator seeded with a value derived from
119  *         BoardUniqueId value
120  */
121 #define STATIC_DEVICE_ADDRESS                       1
122 /*!
123  * Device address on the network (big endian)
124  *
125  * \remark see STATIC_DEVICE_ADDRESS comments
126  */
127 #define LORAWAN_DEVICE_ADDRESS                      ( uint32_t )0x[redacted]
128
129 /*!
130  * AES encryption/decryption cipher network session key
131  */
132 #define LORAWAN_NWKSKEY                             { 0x28, 0xAE, 0xD2, 0x2B, 0x7E, 0x15, 0x16, 0xA6, 0x09, 0xCF, 0xAB, 0xF7, 0x15, 0x88, 0x4F, 0x3C }
133
134 /*!
135  * AES encryption/decryption cipher application session key
136  */
137 #define LORAWAN_APPSKEY                             { 0x16, 0x28, 0xAE, 0x2B, 0x7E, 0x15, 0xD2, 0xA6, 0xAB, 0xF7, 0xCF, 0x4F, 0x3C, 0x15, 0x88, 0x09 }
```

{ 0x28, 0xAE, 0xD2, 0x2B, 0x7E, 0x15, 0x16, 0xA6, 0x09, 0xCF, 0xAB, 0xF7, 0x15, 0x88, 0x4F, 0x3C }

{ 0x16, 0x28, 0xAE, 0x2B, 0x7E, 0x15, 0xD2, 0xA6, 0xAB, 0xF7, 0xCF, 0x4F, 0x3C, 0x15, 0x88, 0x09 }

Device Manager

LoRa IoT by CAT

OTAA

Device Manager

**** Please check payload format and LoRaWAN Key Setting !!**

LoRa IoT by CAT

OTAA

Comissioning.h

```
74   * When set to 1 the application uses the Over-the-Air activation procedure
75   * When set to 0 the application uses the Personalization activation procedure
76   */
77  #define OVER_THE_AIR_ACTIVATION                     1
78
79  /*!
80   * Indicates if the end-device is to be connected to a private or public network
81   */
82  #define LORAWAN_PUBLIC_NETWORK                      true
83
84  /*!
85   * When set to 1 DevEui is LORAWAN_DEVICE_EUI
86   * When set to 0 DevEui is automatically generated by calling
87   *         BoardGetUniqueId function
88   */
89  #define STATIC_DEVICE_EUI                           1
90
91  /*!
92   * Mote device IEEE EUI (big endian)
93   *
94   * \remark see STATIC_DEVICE_EUI comments
95   */
96  #define LORAWAN_DEVICE_EUI                          { 0xAA, 0x00, 0xDB, 0xCA, 0x[redacted], 0xEF, 0x[redacted], 0x5[redacted] }
```

DeviceEUI: 0xAA, 0x00, 0xDB, 0xCA, 0x12, 0xEF, 0x11, 0xXX

Device Manager

**** Please check payload format and LoRaWAN Key Setting !!**

LoRa IoT by CAT

OTAA

Comissioning.h

```
102 /*!
103  * Application IEEE EUI (big endian)
104  */
105 #define LORAWAN_APPLICATION_EUI                 { 0x16, 0x28, 0xAE, 0x2B, 0x7E, 0x15, 0xD2, 0xA6 }
106 /*!
107  * AES encryption/decryption cipher application key
108  */
109 #define LORAWAN_APPLICATION_KEY                 { 0x16, 0x28, 0xAE, 0x2B, 0x7E, 0x15, 0xD2, 0xA6, 0xAB, 0xF7, 0xCF, 0x4F, 0x3C, 0x15, 0x88, 0x19 }
110 #if( OVER_THE_AIR_ACTIVATION == 0 )
```

{ 0x16, 0x28, 0xAE, 0x2B, 0x7E, 0x15, 0xD2, 0xA6}

{ 0x16, 0x28, 0xAE, 0x2B, 0x7E, 0x15, 0xD2, 0xA6, 0xAB, 0xF7, 0xCF, 0x4F, 0x3C, 0x15, 0x88, 0x09 }

Device Manager

**** Please check payload format and LoRaWAN Key Setting !!**

LoRa IoT by CAT

```
/*!
 * CAYENNE_LPP is myDevices Application server.
 */
#define CAYENNE_LPP
```

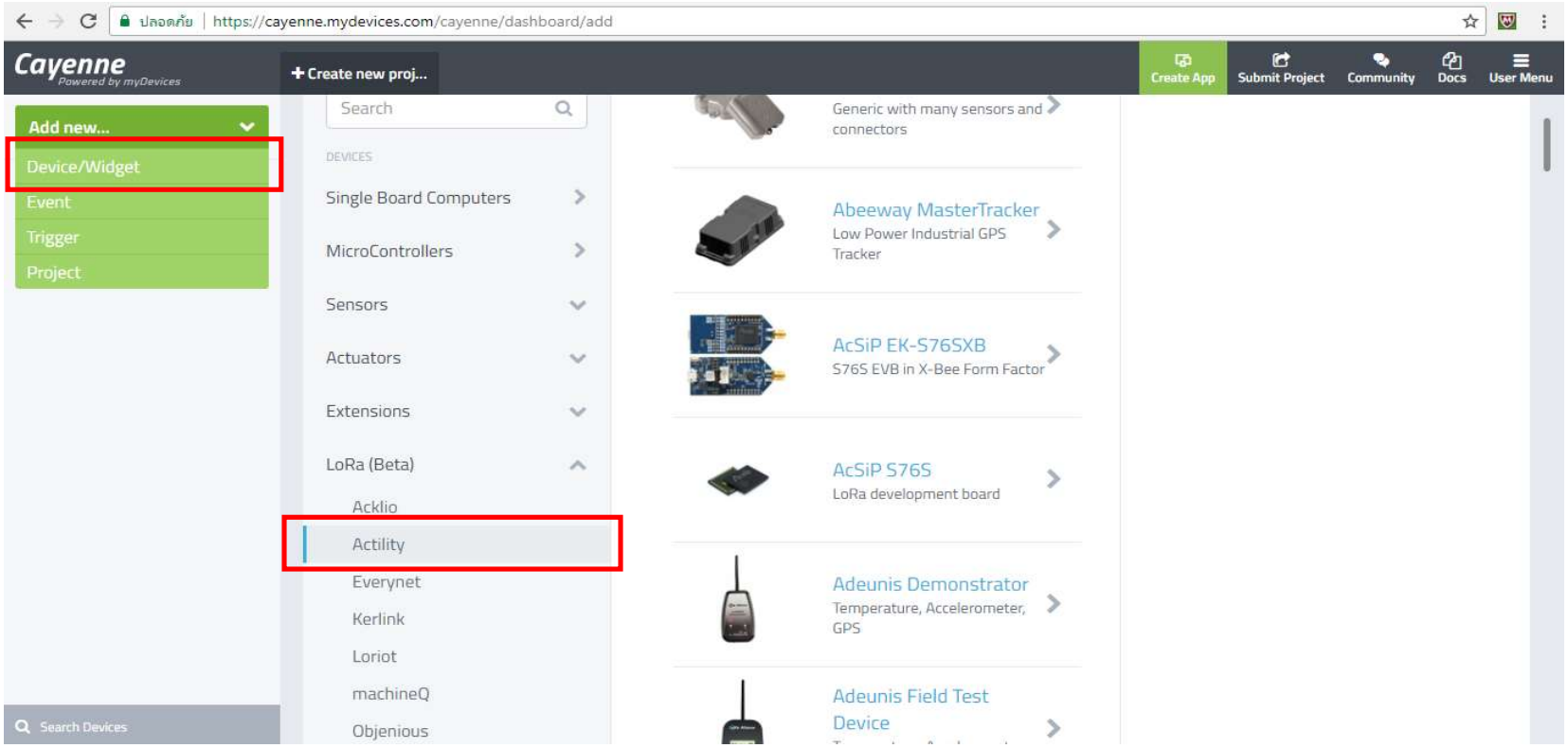
main.c

```
#ifdef CAYENNE_LPP
  uint8_t cchannel=0;
  temperature = ( int16_t )( sensor_data.temperature * 10 );     /* in °C * 10 */
  pressure    = ( uint16_t )( sensor_data.pressure * 100 / 10 );  /* in hPa / 10 */
  humidity    = ( uint16_t )( sensor_data.humidity * 2 );        /* in %*2     */
  uint32_t i = 0;
  int16_t Bat_Display;

  batteryLevel = HW_GetBatteryLevel( );                     /* 1 (very low) to 254 (fully charged) */
  Bat_Display = (batteryLevel*10000/254);
  Bat_Display = 9712;
  AppData->Port = LPP_APP_PORT;

  *IsTxConfirmed =  LORAWAN_CONFIRMED_MSG;
  AppData->Buff[i++] = cchannel++;
  AppData->Buff[i++] = LPP_DATATYPE_BAROMETER;
  AppData->Buff[i++] = ( pressure >> 8 ) & 0xFF;
  AppData->Buff[i++] = pressure & 0xFF;
  AppData->Buff[i++] = cchannel++;
  AppData->Buff[i++] = LPP_DATATYPE_TEMPERATURE;
  AppData->Buff[i++] = ( temperature >> 8 ) & 0xFF;
  AppData->Buff[i++] = temperature & 0xFF;
  AppData->Buff[i++] = cchannel++;
  AppData->Buff[i++] = LPP_DATATYPE_HUMIDITY;
  AppData->Buff[i++] = humidity & 0xFF;
#if !defined(REGION_US915) && !defined(REGION_US915_HYBRID)
  AppData->Buff[i++] = cchannel++;
  AppData->Buff[i++] = LPP_DATATYPE_DIGITAL_INPUT;
  AppData->Buff[i++] = Count_SW_up;//batteryLevel*100/254;
  AppData->Buff[i++] = cchannel++;
  AppData->Buff[i++] = LPP_DATATYPE_DIGITAL_OUTPUT;
```

TOPIC

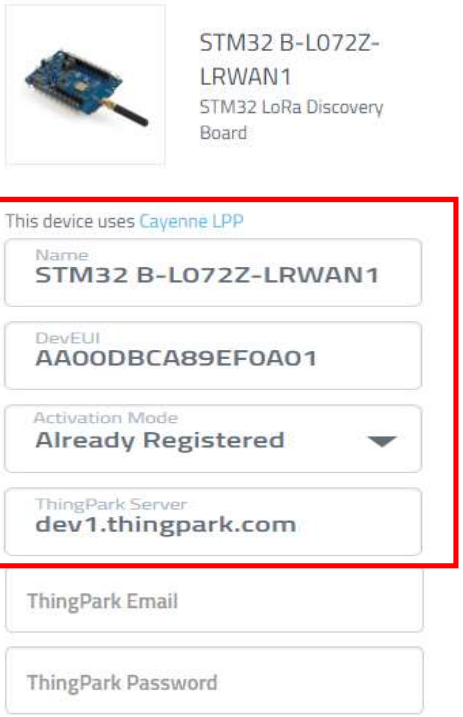
- IoT Concept
- Network Concept
- LoRa Network and Basic Concept
- Workshop : LoRa Account and Device Management
- **Workshop : LoRa Example Application**

Example Application



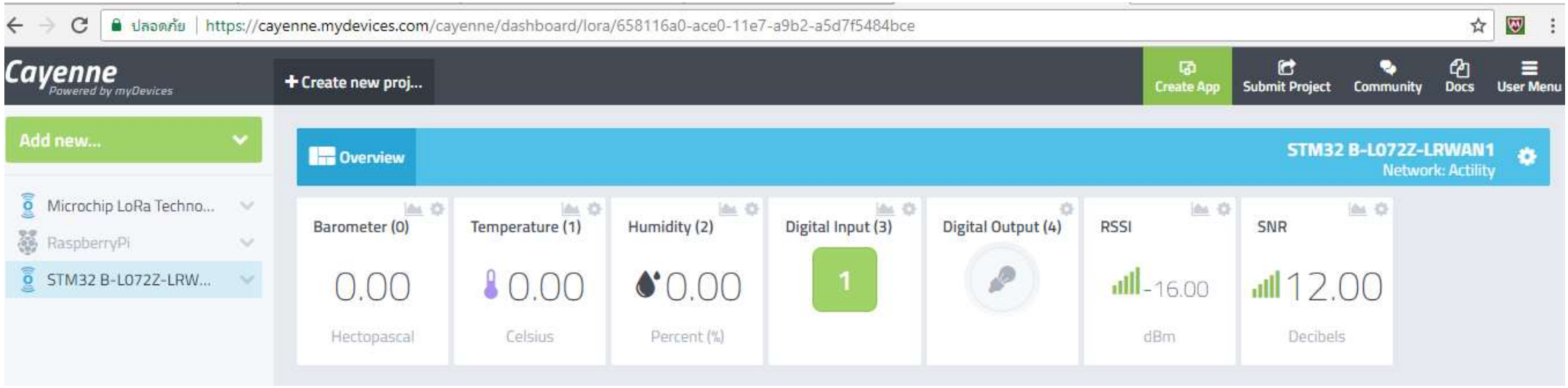
https://cayenne.mydevices.com/cayenne/dashboard/add

Example Application



https://cayenne.mydevices.com/cayenne/dashboard/add

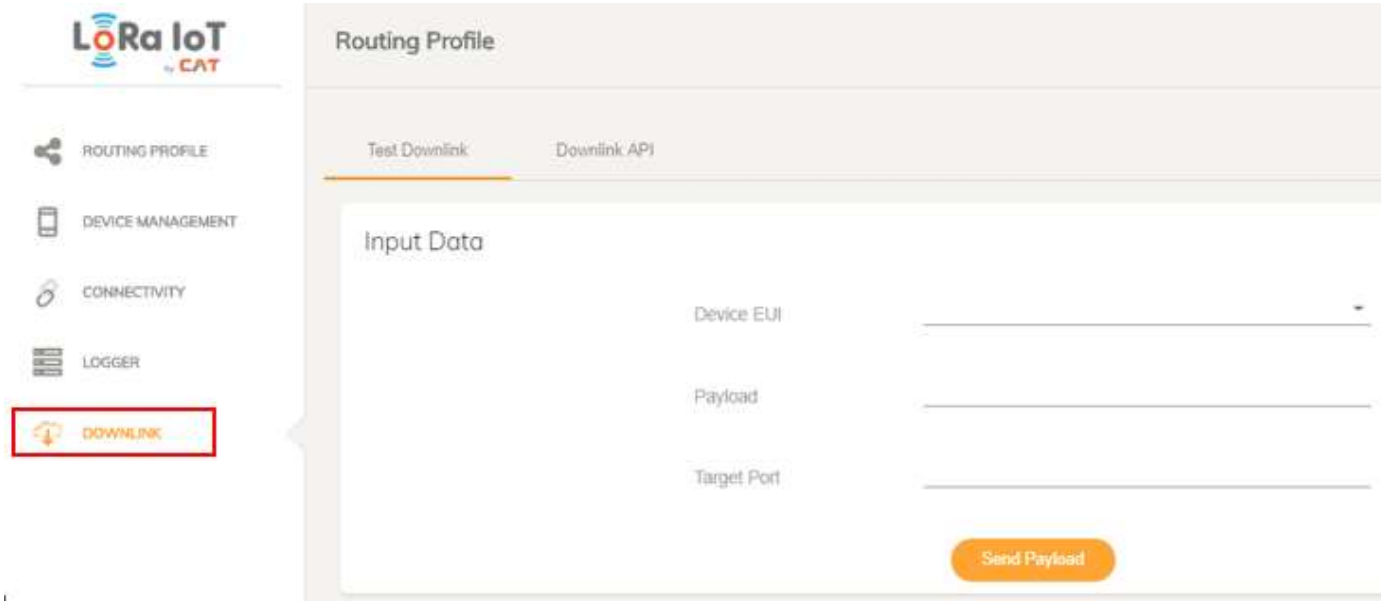
Example Application



https://cayenne.mydevices.com/cayenne/dashboard/add

Extra Challenge

Lab1: Turn on and Turn off LED status



Lab2: Compare response from Class_A and Class_C

Example Application

Node-RED

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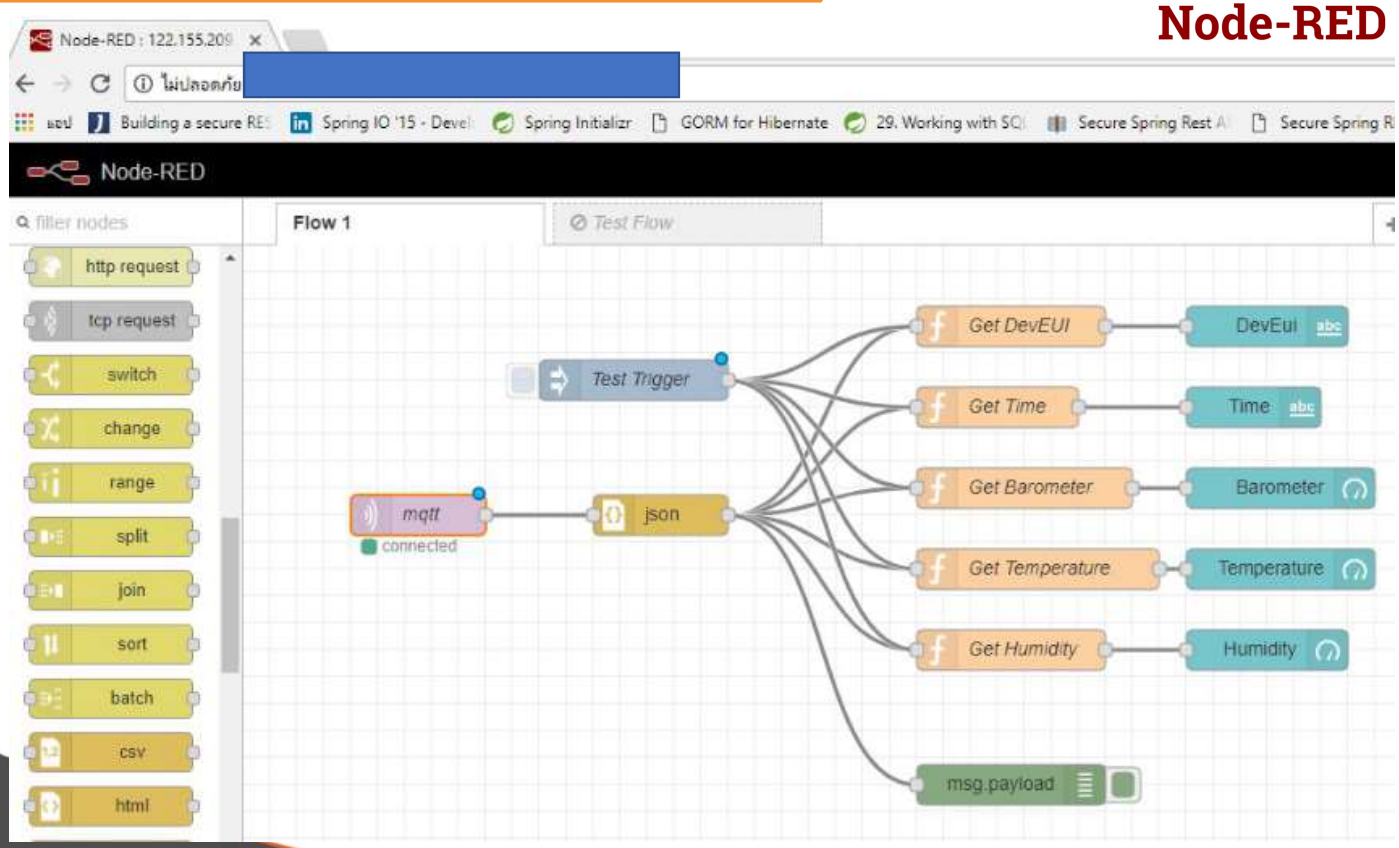

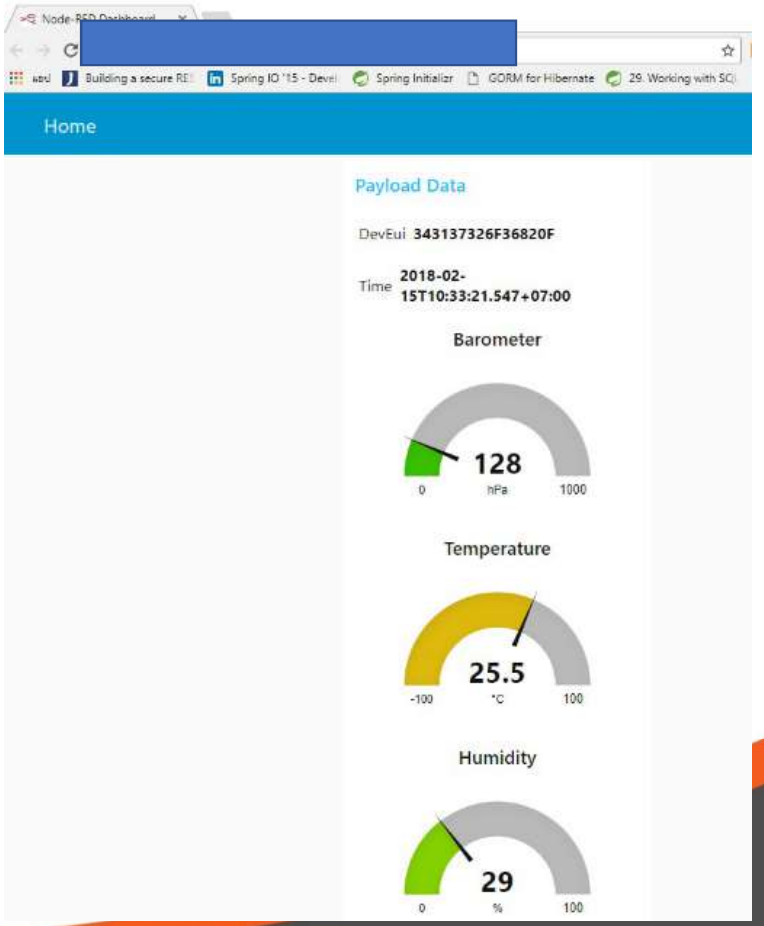

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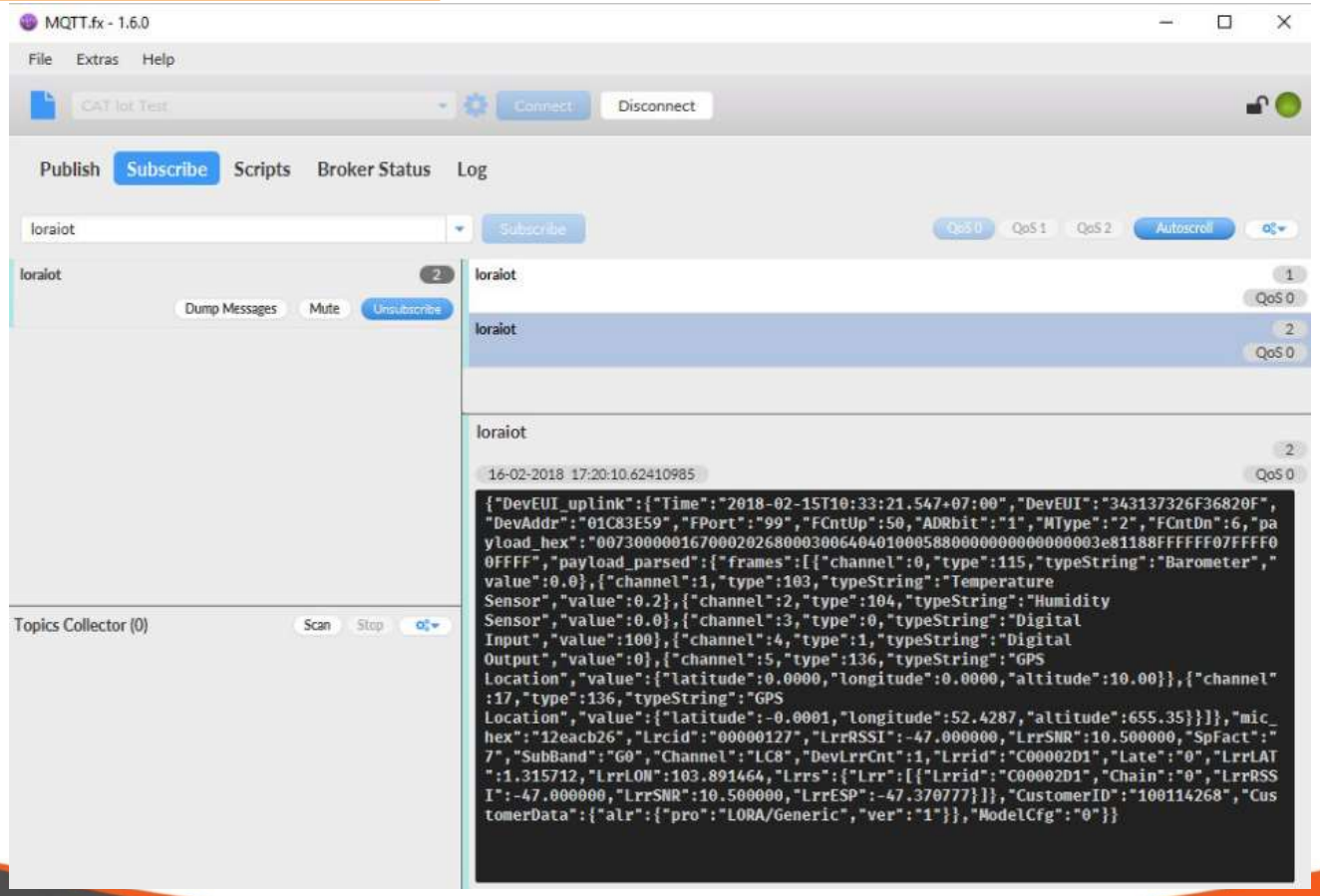
www.cattelecom.com

Example Application



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Q&A

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