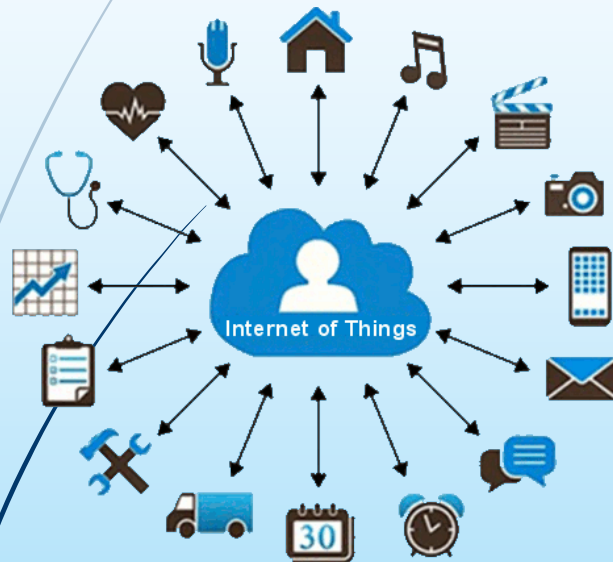


Sensor Networks - Project 1



- LoRaWAN connectivity implementation for the embedded plant monitoring IoT system platform using the B-L072Z-LRWAN1 ARM mbed-based platform
- Pedro J. Lobo
Office A4202
e-mail: pedro.lope@upm.es
- Guillermo Azuara
Office A4206
e-mail: g.azuara@upm.es

📶 Project main goal

- Add LoRaWan connectivity to the project developed in the Embedded Systems course.

📶 Hardware, software and other resources to be used

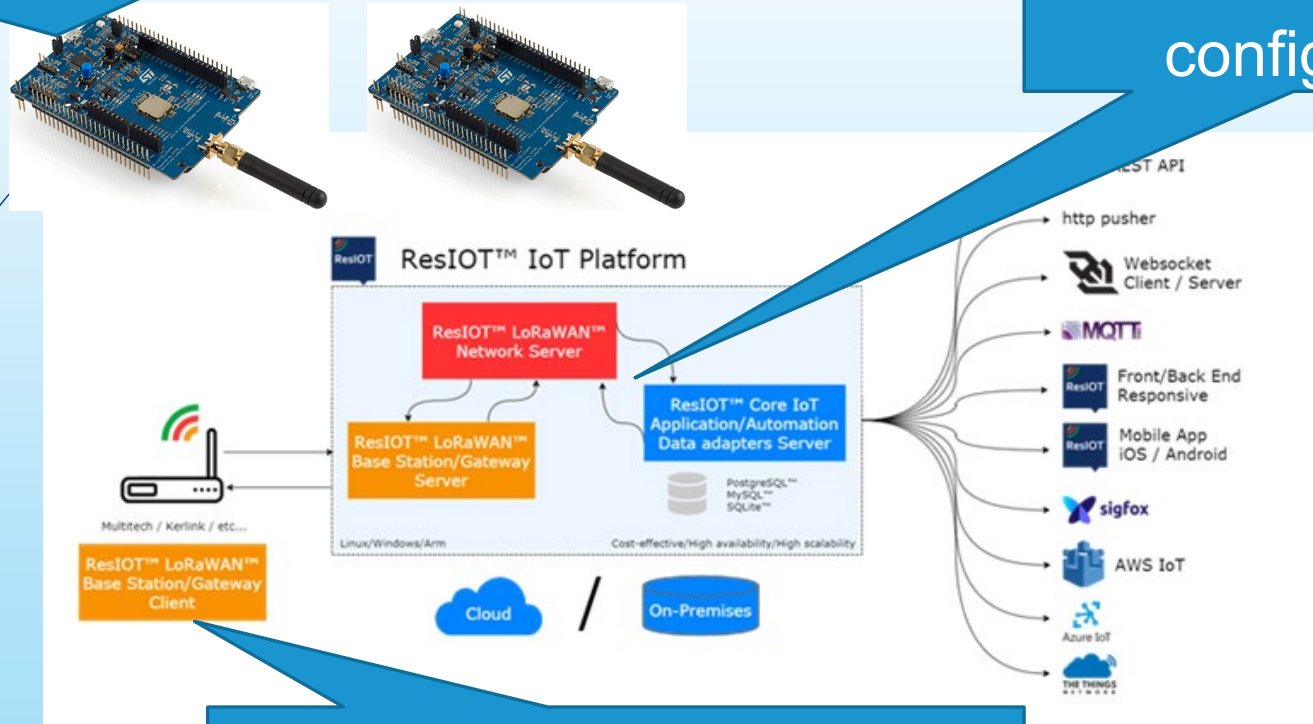
- HW: B-L072Z-LRWAN1, Multitech Conduit Access Point (Gateway)
- SW: Mbed (node), Packet-Forwarder (Gateway) and ResloT Server (software cloud applications)

📶 Project Specifications:

- Work to be done by students
 - SW development using Mbed and Keil Microvision using a template provided by instructors.
 - Configuration of ResloT software application, LUA script development
- Report and demonstration
 - Implemented code (C++ and LUA)
 - Results

Software development using LoRaWan protocol for B-L072Z-LRWAN1 device

LoRaWan cloud
Application
LoRaWan server
configuration

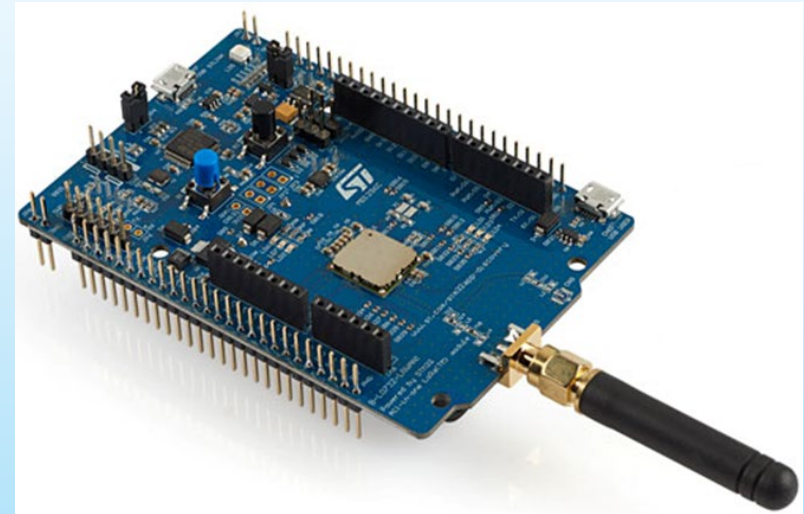


LoraWan Access Point
(Gateway) Configuration

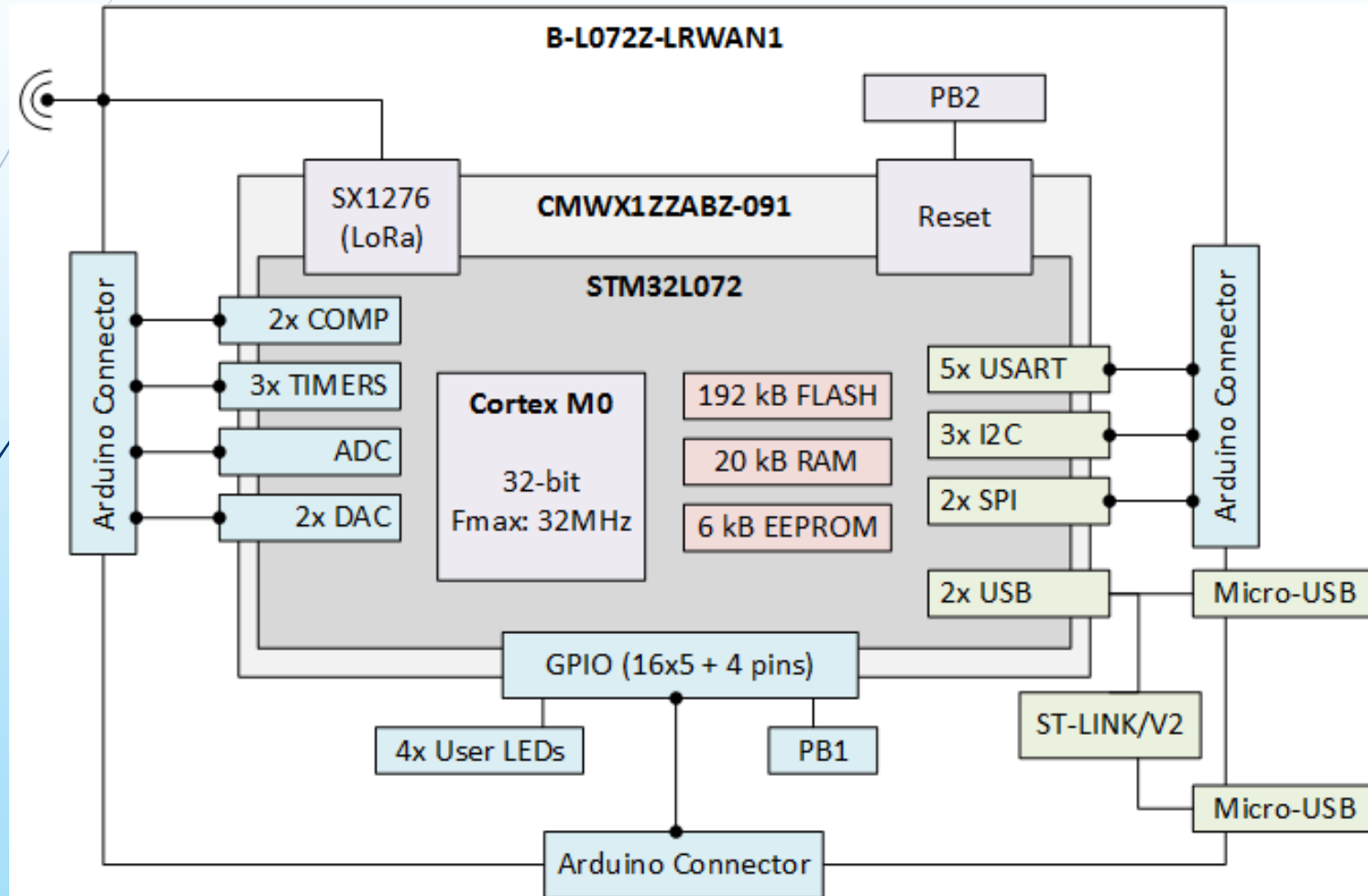
Recall: The B-L072Z-LRWAN1

Our platform: B-L072Z-LRWAN1

- Core: STM32L072CZ
 - ARM Cortex M0+
 - **Ultra-low-power**
- Peripherals
 - ADC, DAC, timers
- Serial connections
 - I2C, UART, SPI
- **Embedded LoRa module**
- User LEDs and buttons
- Arduino compatible connectors
- *Much more...*

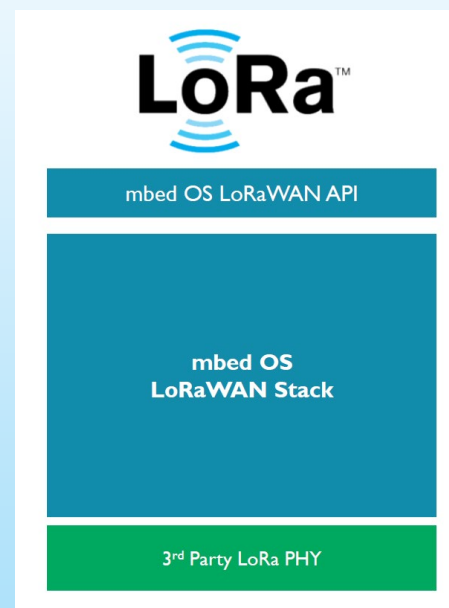


Recall: General diagram of the B-L072Z-LRWAN



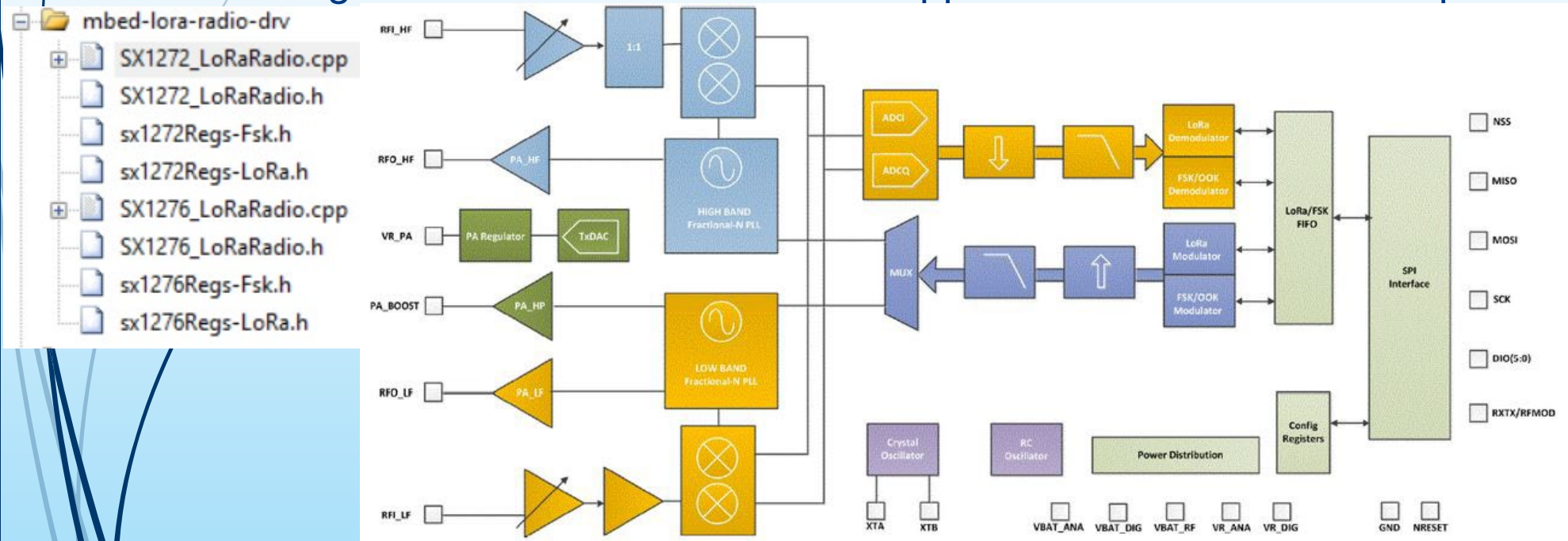
LoRa OS already supports:

- LoRa radio devices (PHY)
- mbed LoRa radio drivers reside out of the mbed OS tree. Arm provides support for SX1272 and SX1276 LoRa radios, which are the most widely used LoRa end-device radio chipsets
- LoRaWAN protocol (stack): LoRaWAN API
- LoRaWAN Specification v1.0.2 and v1.1 (Some of the features in v1.1 are the improved security primitives and the support for roaming)
- Two classes of devices: **A** and C
- The LoRaWAN specification defines two methods for connecting to an access network
 - Over the air activation (OTAA)**
 - Activation by personalization (ABP)



LoRa PHY Layer in Mbed

- Developed by SEMTECH and STACKFORCE for SX1272/6 chips
- Supported in mbed or in mbed-os
- Configuration of SPI interface and support for the SX127x interrupts



SX1276 radio features

- 📶 168 dB maximum link budget (maximum attenuation between Device and Gateway)
- 📶 High sensitivity (RX) : down to -148 dBm
- 📶 $+20$ dBm – 100 mW constant RF output vs supply voltage (TX)
- 📶 $+14$ dBm high efficiency Power Amplifier
- 📶 Programmable bit rate up to 300 kbps
- 📶 Low RX current of 9.9 mA, 200 nA register retention
- 📶 Fully integrated synthesizer with a resolution of 61 Hz
- 📶 FSK (Frequency), GFSK (Gaussian Frequency Shift Keying) , MSK (Minimum), GMSK (Gaussian Minimum), LoRa and OOK (ASK ON/OFF) modulation
- 📶 127 dB Dynamic Range RSSI
- 📶 Built-in temperature sensor and low battery indicator

Software configuration on LoRaWAN in Mbed (parameters, default values) I

- 📶 **Name: lora.adr-on**
 - Description: Turns Automatic Data Rate on/off
 - Defined by: library:lora
 - Value: 1 (set by library:lora)
- 📶 **Name: lora.app-port**
 - Description: Set the application port
 - Defined by: library:lora
 - Value: 15 (set by library:lora)
- 📶 **Name: lora.application-eui**
 - Description: Set AppEUI (application EUI needed for OTAA)
 - Defined by: library:lora
 - Value: {0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00} (set by library:lora)
- 📶 **Name: lora.application-key**
 - Description: Set AppKey (application key needed for OTAA)
 - Defined by: library:lora
 - Value: {0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00} (set by library:lora)

Software configuration on LoRaWAN in Mbed (parameters, default values) II

- 📶 **Name: lora.appskey**
 - Description: Set AppSkey (application session key needed for ABP)
 - Defined by: library:lora
 - Value: {0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00} (set by library:lora)
- 📶 **Name: lora.device-address**
 - Description: Set DevAddr (device address needed for ABP)
 - Defined by: library:lora
 - Value: 0x00000000 (set by library:lora)
- 📶 **Name: lora.device-eui**
 - Description: Set DevEUI (device EUI needed for OTAA)
 - Defined by: library:lora
 - Value: {0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00} (set by library:lora)
- 📶 **Name: lora.duty-cycle-on**
 - Description: Turns duty cycle on/off
 - Defined by: library:lora
 - Value: 1 (set by library:lora)

- 📶 **Name: lora.lbt-on**
 - Description: Turns LBT on/off
 - Defined by: library:lora
- 📶 **Name: lora.nb-trials**
 - Description: Set number of retries for a join request
 - Defined by: library:lora
 - Value: 12 (set by library:lora)
- 📶 **Name: lora.nwkskey**
 - Description: Set NwkSKey (network session key needed for ABP)
 - Defined by: library:lora
 - Value: {0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00} (set by library:lora)
- 📶 **Name: lora.over-the-air-activation**
 - Description: Enable or disable OTAA. **Value set to false would enable ABP**
 - Defined by: library:lora
 - Value: 1 (set by library:lora)

Software configuration on LoRaWAN in Mbed (parameters, default values) IV

- 📶 Name: lora.phy
 - Description: Set the region of operation for the device
 - Defined by: library:lora
 - Value: **EU868** (set by library:lora)
- 📶 Name: lora.public-network
 - Description: Set the public network parameter
 - Defined by: library:lora
 - Value: 1 (set by library:lora)
- 📶 Name: lora.tx-max-size
 - Description: Maximum outgoing buffer size
 - Defined by: library:lora
 - Value: 64 (set by library:lora)

Software configuration on LoRaWAN in Mbed (parameters, default values) V

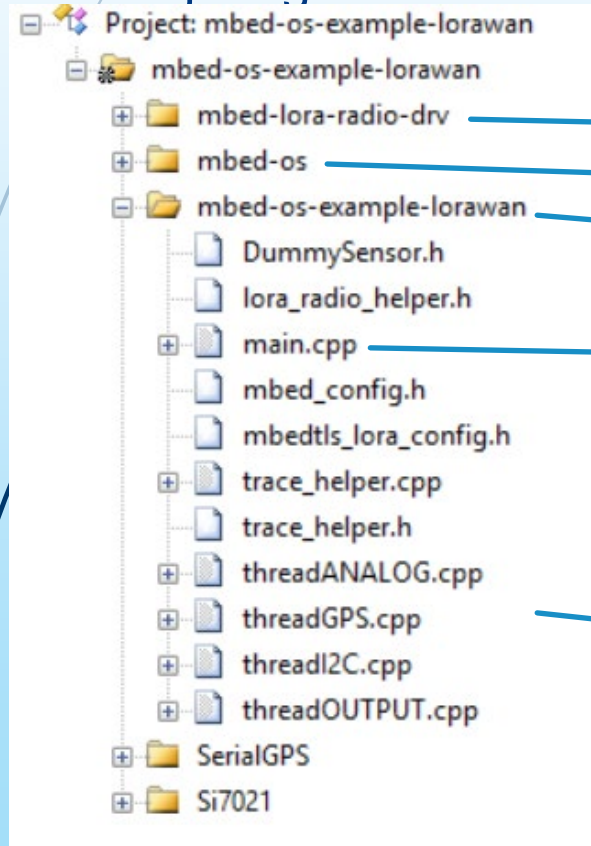
- 📶 If you want to change the default values (you have to, really):
 - You can edit the file `mbed_app.json`
 - `mbed_config.h` is generated from it
 - BUT if you modify it, the whole project (incl. Mbed) is recompiled
 - 10+ minutes
 - So, the parameters that you have to change are overridden in `main.cpp`

```
static uint8_t DEV_EUI[] = {0xNN, 0x39, 0x32, 0x35, 0x59, 0x37, 0x91, 0x94};
static uint8_t APP_EUI[] = {0x70, 0xb3, 0xd5, 0x7e, 0xd0, 0x00, 0xfc, 0x4d};
static uint8_t APP_KEY[] = {0xf3, 0x1c, 0x2e, 0x8b, 0xc6, 0x71, 0x28, 0x1d,
                             0x51, 0x16, 0xf0, 0x8f, 0xf0, 0xb7, 0x92, 0x8f};
```
- 📶 Get the DEV_EUI values from the user account information that is published in Moodle
- 📶 Do not change any other parameters!!!
- 📶 If the LoRaWAN layer is correctly configured, you can start using the LoRaWAN API

- 📶 Download the example project from Moodle

- Beware! 700+ MB ZIP file

- 📶 Project generated using mbed repositories, with mbed compiler and provision



on of the project provided by the instructors

Lora PHY
Mbed OS
Application using LoRaWAN
Your main application
Other software modules

Example (I) Having a look at the main.cpp file

1. static EventQueue **ev_queue** (MAX_NUMBER_OF_EVENTS * EVENTS_EVENT_SIZE);
2. SX1276_LoRaRadio **radio** (MBED_CONF_APP_LORA_SPI_MOSI, MBED_CONF_APP_LORA_SPI_MISO, MBED_CONF_APP_LORA_SPI_SCLK, MBED_CONF_APP_LORA_CS, MBED_CONF_APP_LORA_RESET,.....);
3. static LoRaWANInterface **lorawan** (**radio**);
4. static lorawan_app_callbacks_t callbacks;
5. **lorawan**.initialize(&**ev_queue**); // initialization of LoRaWAN
6. callbacks.events = mbed::callback(lora_event_handler);
7. lorawan.add_app_callbacks(&callbacks); // setting a callback function

Example (II) Having a look at the main.cpp file

- 📶 Having a look at the main.cpp file!!!!
- 📶 `retcode = lorawan.connect();` // see possible errors
- 📶 `ev_queue.dispatch_forever();` Every time that an event occurs the callback is executed
- 📶 Return `//main.cpp`

Callback code in main.cpp

```
static void lora_event_handler(lorawan_event_t event)
{
    switch (event) {
        case CONNECTED:
            printf("\r\n Connection - Successful \r\n");
            if (MBED_CONF_LORA_DUTY_CYCLE_ON) {
                send_message();
            } else {
                ev_queue.call_every(TX_TIMER, send_message);
            }

            break;
        case DISCONNECTED:
            ev_queue.break_dispatch();
            printf("\r\n Disconnected Successfully \r\n");
            break;
        case TX_DONE:
            printf("\r\n Message Sent to Network Server \r\n");
            if (MBED_CONF_LORA_DUTY_CYCLE_ON) {
                send_message();
            }
            break;
    }
}
```

Example (III)

Having a look at the callback code in main.cpp

```
case TX_TIMEOUT:
    case TX_ERROR:
    case TX_CRYPTO_ERROR:
    case TX_SCHEDULING_ERROR:
        printf("\r\n Transmission Error - EventCode = %d \r\n", event);
        // try again
        if (MBED_CONF_LORA_DUTY_CYCLE_ON) {
            send_message();
        }
        break;
    case RX_DONE:
        printf("\r\n Received message from Network Server \r\n");
        receive_message();
        break;
    case RX_TIMEOUT:
    case RX_ERROR:
        printf("\r\n Error in reception - Code = %d \r\n", event);
        break;
    case JOIN_FAILURE:
        printf("\r\n OTAA Failed - Check Keys \r\n");
        break;
    case UPLINK_REQUIRED:
        printf("\r\n Uplink required by NS \r\n");
        if (MBED_CONF_LORA_DUTY_CYCLE_ON) {
            send_message();
        }
        break;
    default:
        MBED_ASSERT("Unknown Event");
}
```

📶 Having a look at the callback code in main.cpp

```
static void send_message()
{
    retcode = lorawan.send(MBED_CONF_LORA_APP_PORT, tx_buffer, packet_len,
                           MSG_UNCONFIRMED_FLAG);

    .....
    printf("\r\n %d bytes scheduled for transmission \r\n", retcode);
    memset(tx_buffer, 0, sizeof(tx_buffer));
}

static void receive_message()
{
    int16_t retcode;
    retcode = lorawan.receive(rx_buffer, sizeof(rx_buffer), port, flags);

    if (retcode < 0) {
        printf("\r\n receive() - Error code %d \r\n", retcode);
        return;
    }

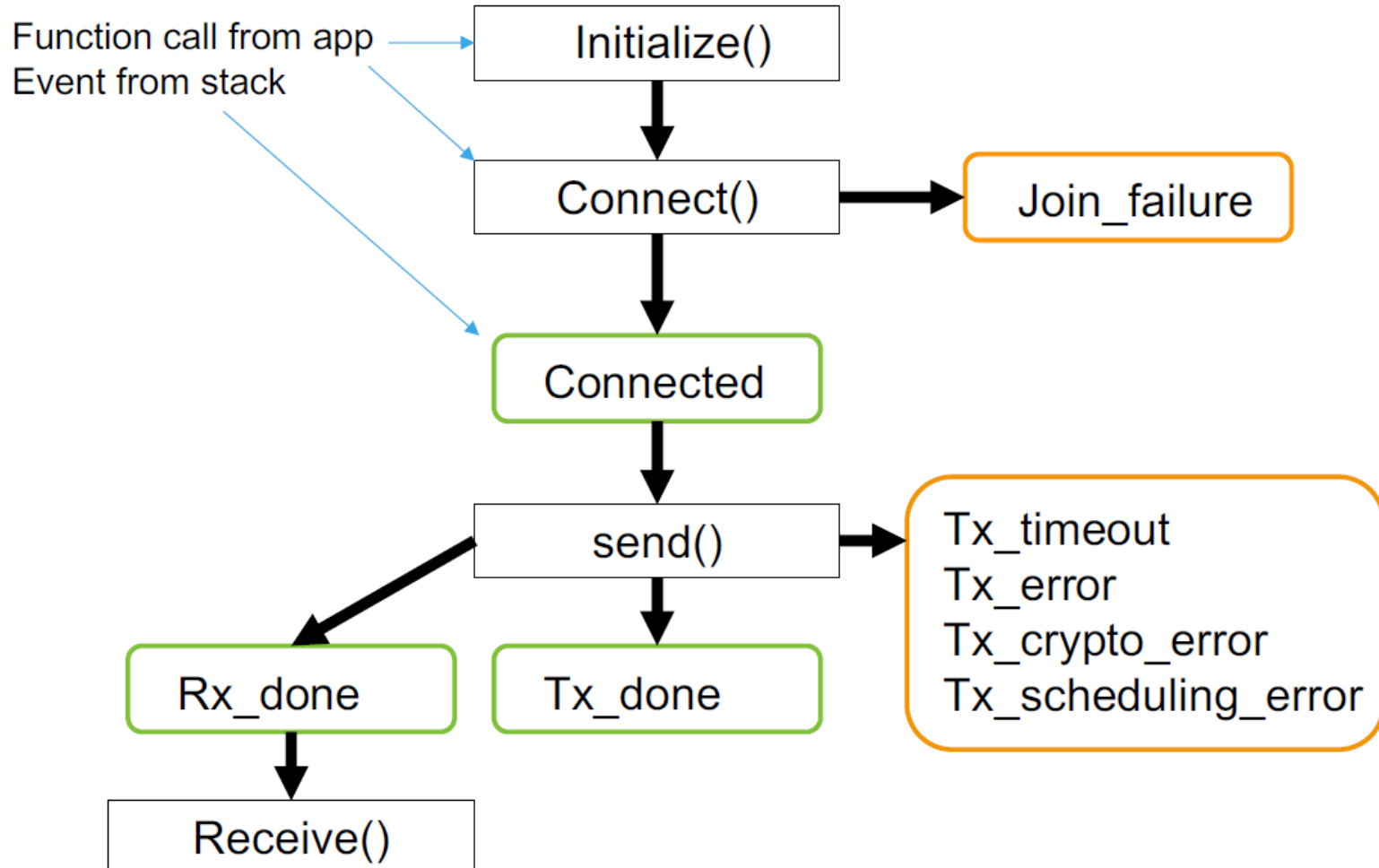
    printf(" Data:");

    for (uint8_t i = 0; i < retcode; i++) {
        printf("%x", rx_buffer[i]);
    }

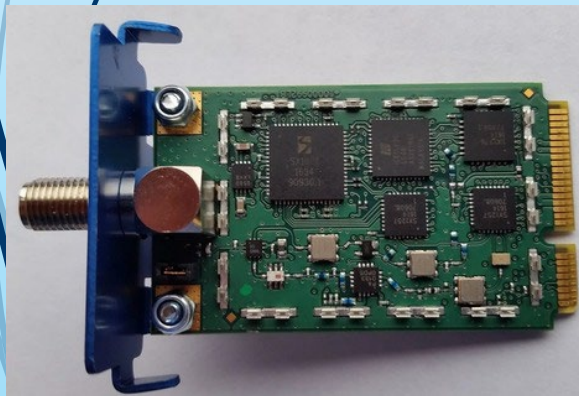
    printf("\r\n Data Length: %d\r\n", retcode);

    memset(rx_buffer, 0, sizeof(rx_buffer));
}
```


LoRa in Mbed - Example stack events visible to application



Demo



- 📶 Programmable Gateway for the Internet of Things (MTCDT-247A)
- 📶 Wi-Fi communication supporting 802.11 a/b/g/n 2.4 GHz and 5GHz with WPA2 personal transmission security. Wi-Fi Access Point and Client modes are supported simultaneously.
- 📶 BT Classic and BLE 4.1 communication supports local connectivity with automatic pairing with target devices utilizing 128 bit link key length security.
- 📶 GNSS module for LoRaWAN packet time-stamping and geo-location capability
- 📶 Backhaul options include 4G-LTE, 3G, 2G cellular or **Ethernet** for cost effective global deployment
- 📶 LORA FEATURES
 - Certified for Europe 868 MHz, North American and Australian 915 MHz ISM bands
 - 27 dBm (output power) support for European region
 - ISM band scanning for optimum LoRa® performance
 - Listen Before Talk LoRa operating protocol


MULTITECH

MultiConnect® Conduit - Application Execution Platform
MTCDDT-247A Firmware 1.4.16

Logged In: [admin](#) Logout
Search:

- Home
- Save and Restart
- Setup
- LoRaWAN™
- Wireless
- Firewall
- Administration
- Status & Logs
- Commands
- Apps
- Help

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Device Information

Gateway

Model Number	MTCDDT-247A
Serial Number	19721601
Firmware	1.4.16
Current Time	01/09/2019 17:15:20
Up Time	25 days 22:15:12
WAN Transport	Ethernet

LAN

Bridge	(br0)
Mode	Static
MAC Address	
IP Address	
Mask	255.255.255.0
DHCP State	Disabled
Lease Range	undefined - undefined

WAN

Ethernet	(eth0)
Mode	DHCP Client
MAC Address	00:08:00:4A:50:CE
IP Address	192.168.10.23
Mask	255.255.255.0

Wi-Fi AP

Wi-Fi AP	(wlan1)
State	Disabled

Accessory cards

Card 1	(AP1)
Model Number	MTAC-LORA-H-868
Serial Number	19498521
Hardware	MTAC-LORA-1.5

Bluetooth Classic

State	Disabled
MAC Address	88:DA:1A:9A:37:48

Last updated: 17:13:36

Home

Save and Restart

Setup

LoRaWAN™

Network Settings

Wireless

Firewall

Administration

Status & Logs

Commands

Apps

Help

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LoRaWAN Networking 2

Reset To Default

LoRa Mode

Mode

PACKET FORWARDER

Packet Forwarder

3.1.0-r11.0

Status

RUNNING

Network Server

2.0.19

Status

DISABLED

Lens Server

2.0.19

Status

DISABLED

FPGA Version

31

Restart LoRa Services

LoRa Packet Forwarder Configuration

Manual Configuration

Gateway Info

Gateway EUI

00-80-00-00-A0-00-1E-B7

UUID

5C94F1DD-9519-C76D-47DA-7BE1991B5C2D

Serial Number

19721601

SX1301

Frequency Band

868

Channel Plan

EU868

Additional Channels

869.5

MHz

Basics

Public

☒

Gateway ID

00800000A0001EB7

Packet Forwarder Path

/opt/lora/lora_pkt_fwd

Intervals

Keep Alive Interval

10

s

Stat Interval

20

s

Push Timeout

100

ms

Server

Server Address

eu72udp.resiot.io

Upstream Port

7677

Downstream Port

7677

Forward CRC

Forward CRC Disabled

☐

Forward CRC Error

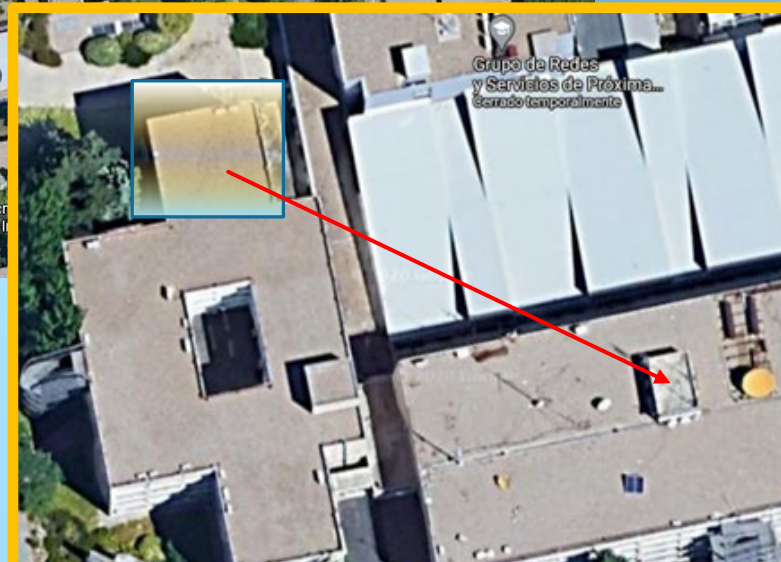
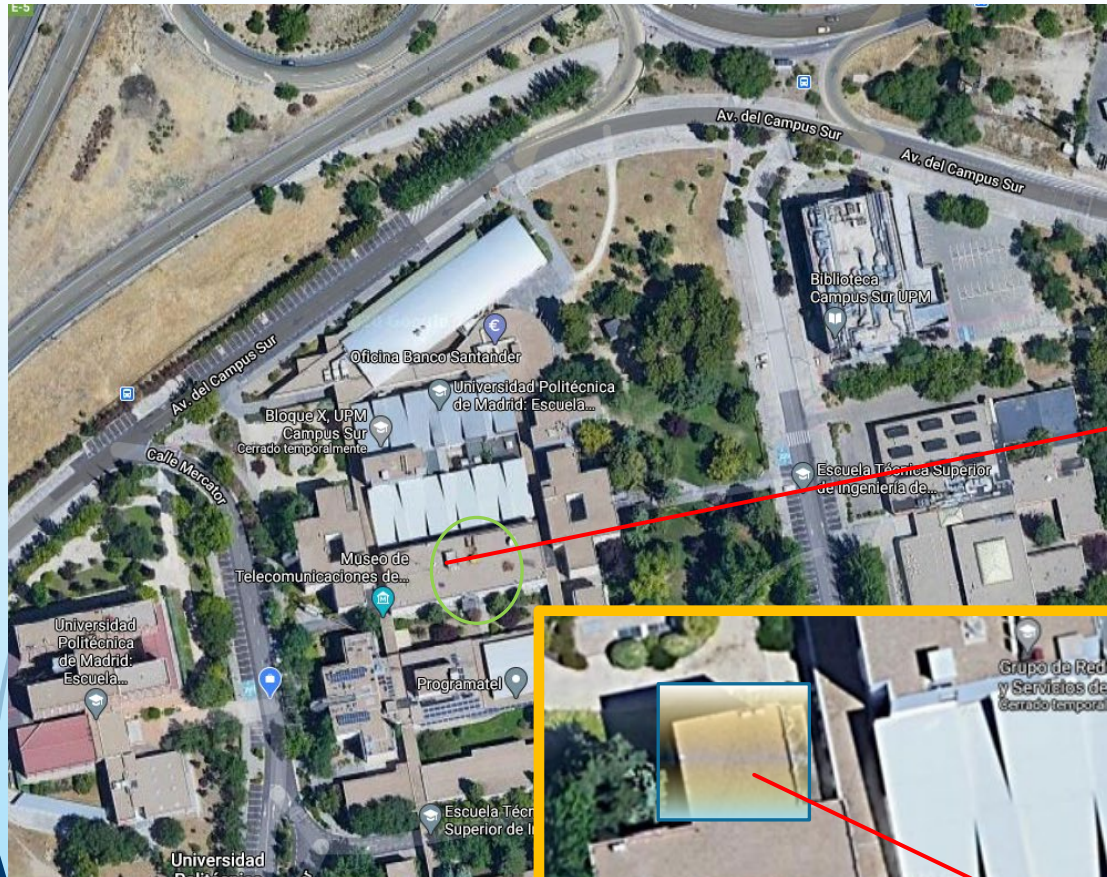
☒

Forward CRC Valid

☒

Submit

Where is the GW?



ResloT: Main features

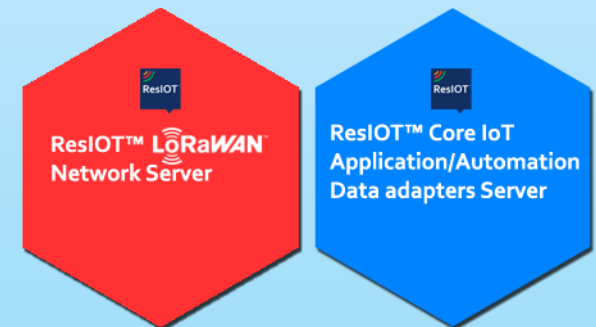
- 📶 IoT Platform and LoRaWAN™ Network Server (On-Premises or Cloud)
- 📶 ResIoT™ IoT Platform provides all the necessary software to manage networks with millions of devices but also to manage small private network
- 📶 The entire platform can be installed on Linux or Windows server clusters but also on Embedded Arm, x86, x64 systems, as an all-in-one gateway. Below you will find all the software features of the ResIoT™ IoT Platform
- 📶 ResIoT™ is suitable for all LPWAN and IoT projects for Smart City or Industry 4.0 and can be used free of charge up to 15 Devices and 1 LoRaWAN™ Gateway

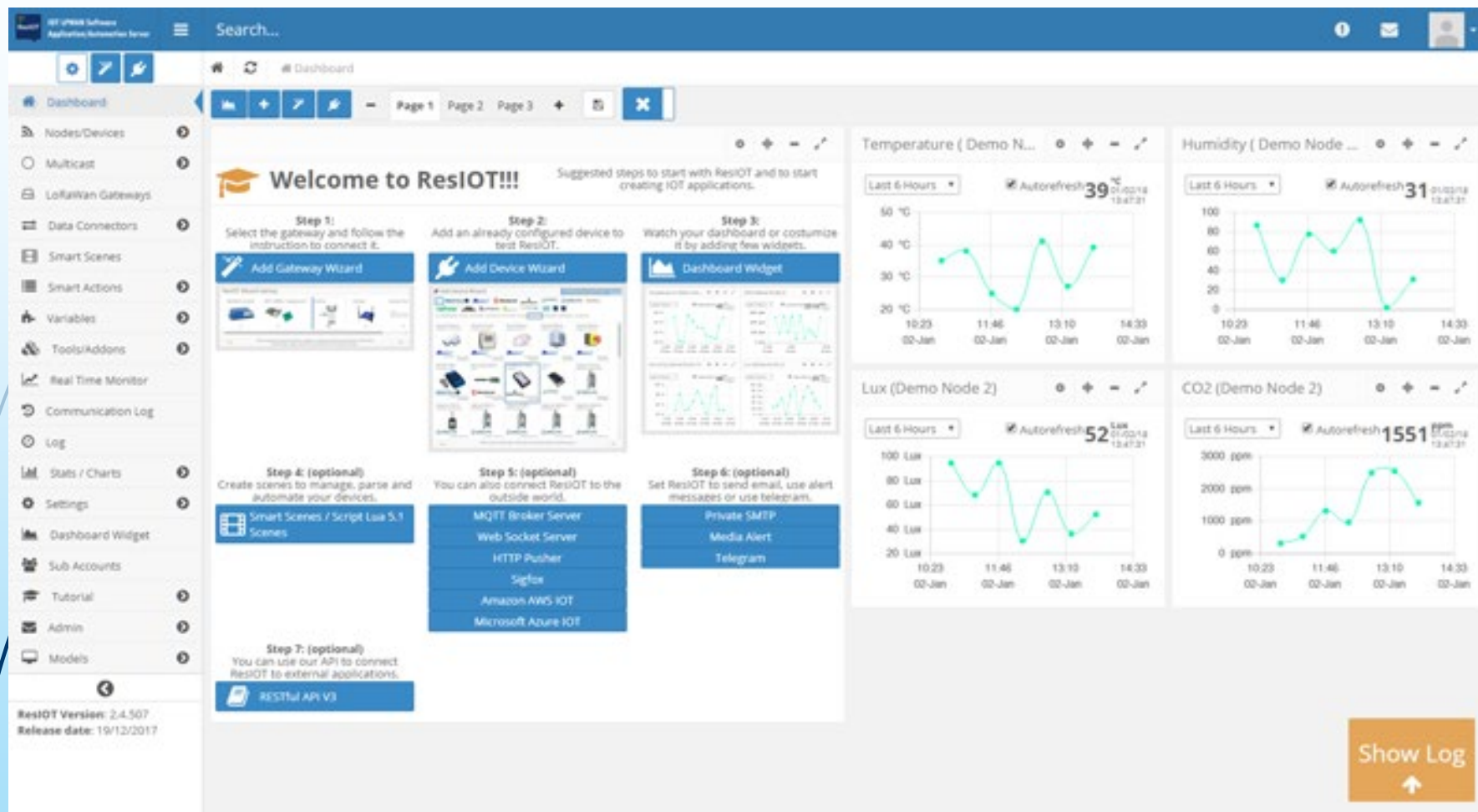
ResIoT Core IoT Application Automation Data adapters Server

- Is the heart of the platform, manages all configured data, maintains the link with all ResIoT™ LoRaWAN™ Network Servers and all other connectors, provides a web interface for configuration but also for the creation of IoT projects, manages the data automation, data store in the database and many other features

ResIoT™ LoRaWAN™ Network Server

- Manages all the features of the LoRaWAN™ network, such as node authentication, encryption key maintenance, uplink management and downlink transmission through all the base stations / gateways of the LPWAN network





ResIoT™ LoRaWAN™ Base Station/Gateway Server

- It is the main component for connection to all the LoRaWAN™ Base Station / Gateway of the network. Allows the receipt and transmission of all data from the LoRaWAN™ devices and collects the monitoring data of each Base Station / Gateway. ResIoT™ LoRaWAN Base Station / Gateway Server communicates with ResIoT™ LoRaWan Network Server and ResIoT™ IoT Application / Automation / Data adapters Server with MQTT protocol



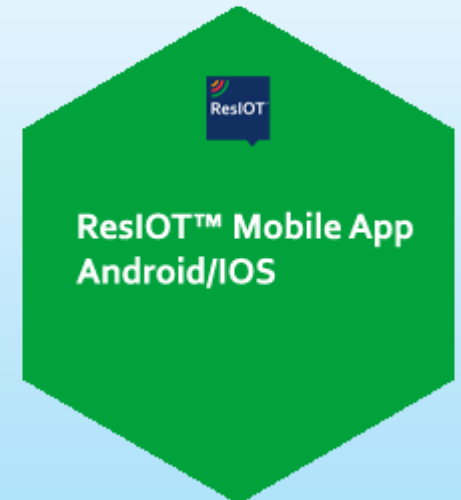
ResIoT™ LoRaWAN™ Base Station/Gateway Packet forwarder

- It is the component that is installed on the Base Station / Gateway. It allows the management of the LoRa radio cards, takes care of the transmission and reception of all data and communicates constantly with the ResIoT™ component LoRaWAN™ Base Station / Gateway Server. Available for Multitech Ftdi, Multitech SPI, Kerlink Ftdi, IMST + Raspberry SPI and other gateways. It also allows to remotely configure data such as gain antenna, frequencies, server connection parameters, etc

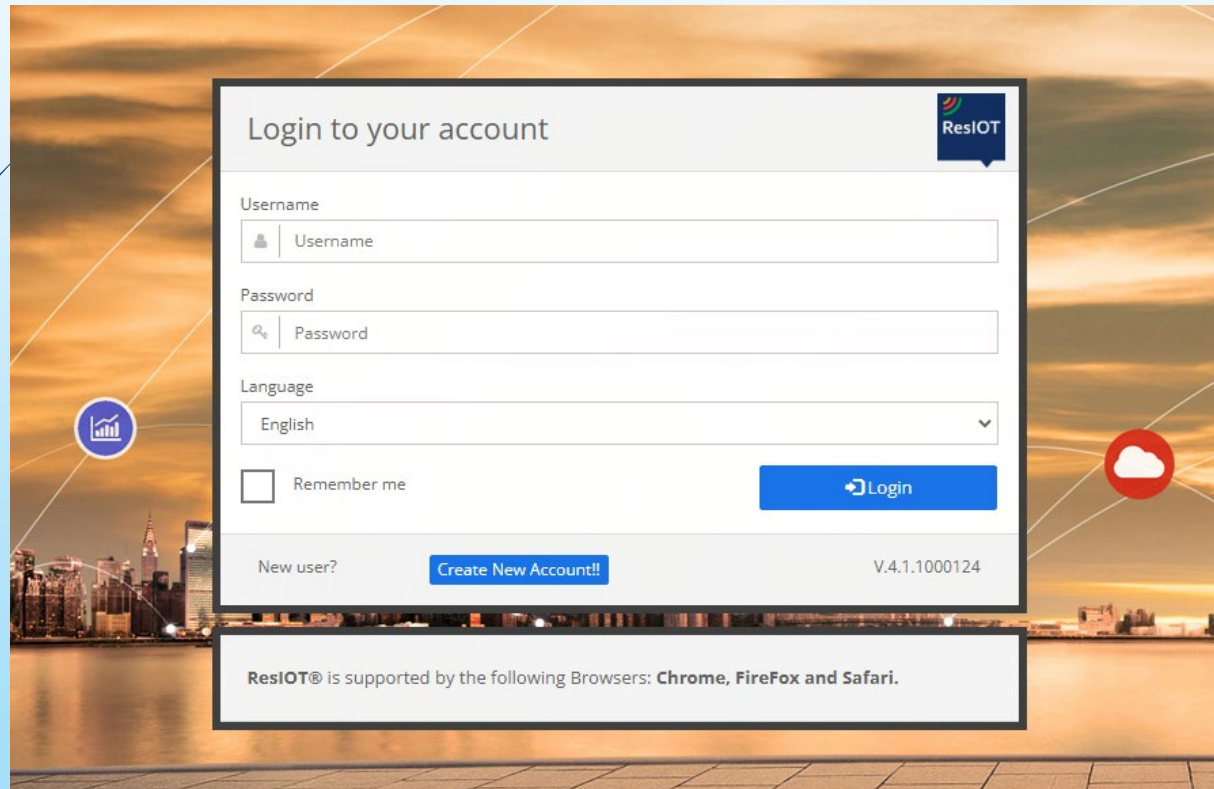
We are not using this option



- 📶 Automatic update of the software installed in your local installation (not our case)
- 📶 Mobile APP for Android/IOS. Please install it in your mobiles!



- 📶 URL: <https://eu72.resiot.io/>
- 📶 Every student has a login and a password to access to the cloud application



The image shows a login interface for ResIoT. The background is a cityscape at sunset. The login form is a white box with a dark border. It has a title 'Login to your account' and the ResIoT logo. The form contains fields for 'Username' and 'Password', a 'Language' dropdown menu set to 'English', a 'Remember me' checkbox, and a blue 'Login' button. At the bottom, there is a link for 'New user?' and a 'Create New Account!!' button. The version number 'V.4.1.1000124' is displayed. A footer note states: 'ResIoT® is supported by the following Browsers: Chrome, FireFox and Safari.'

Login to your account

Username

Password

Language

English

☐ Remember me

Login

New user? Create New Account!!

V.4.1.1000124

ResIoT® is supported by the following Browsers: Chrome, FireFox and Safari.

The dashboard interface includes a sidebar with navigation options: Dashboard, Nodes/Devices, Multicast, LoRaWAN™ Gateways, Data Connectors, Smart Scenes/Lua Scripts, Smart Actions, Variables, Tools/Addons, Real Time Monitor, Communication Log, Log, Stats / Charts, Settings, Dashboard Widget, Sub Accounts, and Tutorial.

The main content area displays a map of Madrid with a red location pin. To the right of the map are several widgets:

- sensor wireless**: Includes a map view and a table with coordinates.

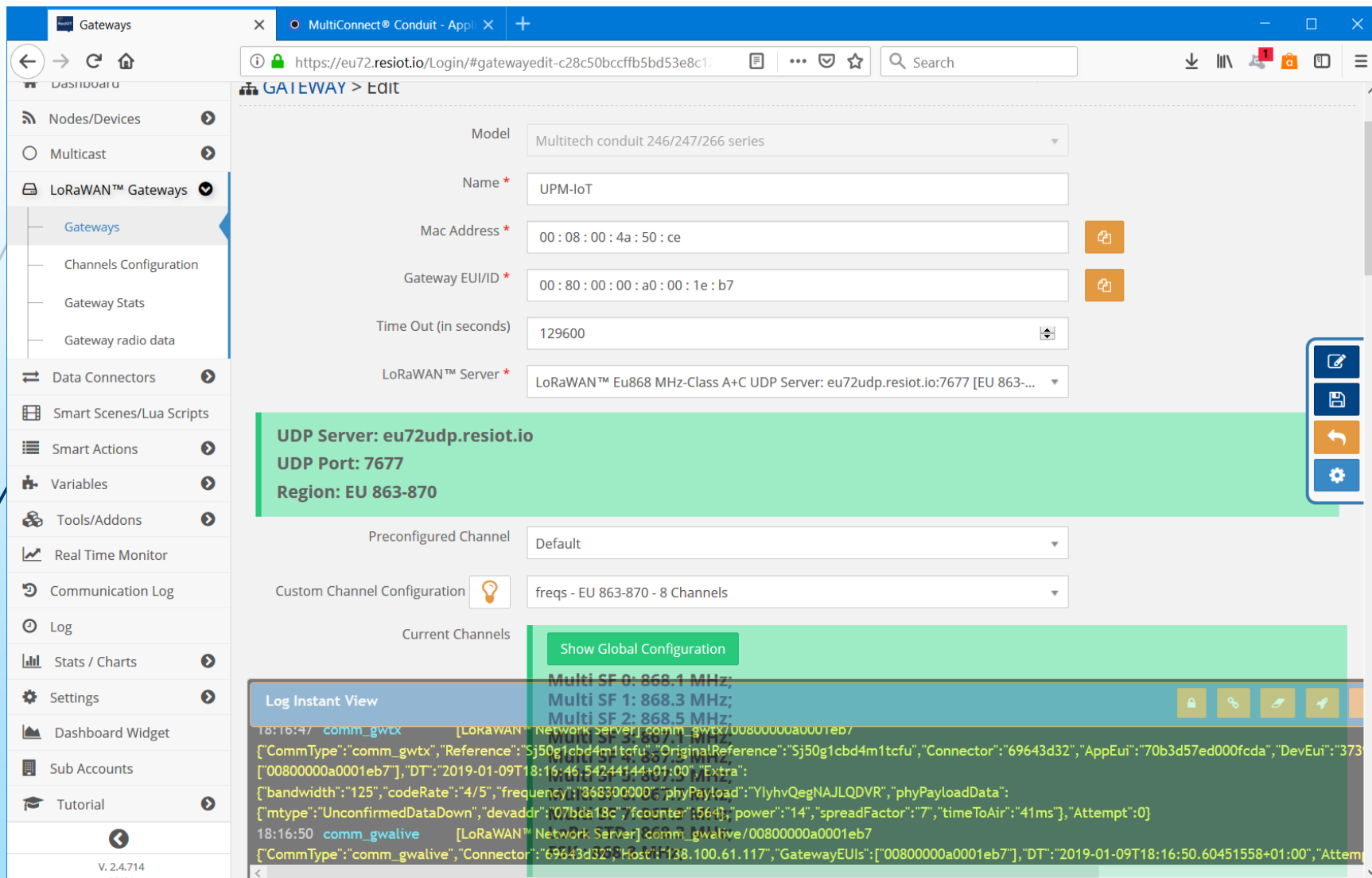
UPMIOSTN	Latitude	Longitude
UPMIOSTN	40.388653	-3.629552
- New Widget**: A table showing sensor data.

UPMIOSTN	Latitude	Longitude
UPMIOSTN	40.388653	-3.629552
- New WidgetSoil ...**: A line graph showing data over time (09-Jan to 09-Jan).
- Light (UPMIOST...)**: A line graph showing light intensity over time (07-Jan to 10-Jan).
- NSats (UPMIOS...)**: A line graph showing satellite count over time (09-Jan to 09-Jan).

At the bottom, a **Log Instant View** window displays a log entry:

```
[CommType: comm_txsendack, Reference: Stykuz42rp1c12u, OriginalReference: Stykuz42rp1c12u, Connector: 69643d32, GatewayEui: 00800000a0001eb7], "DT": "2019-01-09T18:11:15.275053826+01:00", "Attempt": 0}
18:11:15 comm_gwtx [LoRaWAN™ Network Server] comm_gwtx/00800000a0001eb7
[CommType: comm_gwtx, Reference: Stykuz42rp1c12u, OriginalReference: Stykuz42rp1c12u, Connector: 69643d32, AppEui: 70b3d57ed000fcda, DevEui: 37393200800000a0001eb7], "DT": "2019-01-09T18:11:15.236154958+01:00", "Extra":
{"bandwidth": "125", "codeRate": "4/5", "frequency": "868500000", "phyPayload": "YlyhvQegFgK21Kud", "phyPayloadData":
{"mtype": "UnconfirmedDataDown", "devaddr": "07bda18c", "fcounter": 5343, "power": 14, "spreadFactor": 8, "timeToAir": 82ms}, "Attempt": 0}
```

Adding a Gateway



The screenshot shows the 'GATEWAY > EDIT' configuration page in the MultiConnect® Conduit - Appl web interface. The left sidebar contains a navigation menu with options like Dashboard, Nodes/Devices, Multicast, LoRaWAN™ Gateways (selected), Channels Configuration, Gateway Stats, Gateway radio data, Data Connectors, Smart Scenes/Lua Scripts, Smart Actions, Variables, Tools/Addons, Real Time Monitor, Communication Log, Log, Stats / Charts, Settings, Dashboard Widget, Sub Accounts, and Tutorial.

The main configuration area includes the following fields:

- Model:** Multitech conduit 246/247/266 series
- Name *** UPM-IoT
- Mac Address *** 00 : 08 : 00 : 4a : 50 : ce
- Gateway EUI/ID *** 00 : 80 : 00 : 00 : a0 : 00 : 1e : b7
- Time Out (in seconds)** 129600
- LoRaWAN™ Server *** LoRaWAN™ Eu868 MHz-Class A+C UDP Server: eu72udp.resiot.io:7677 [EU 863-...

A green banner displays the server information:

- UDP Server:** eu72udp.resiot.io
- UDP Port:** 7677
- Region:** EU 863-870

Below this, the 'Preconfigured Channel' is set to 'Default', and the 'Custom Channel Configuration' is set to 'freqs - EU 863-870 - 8 Channels'. The 'Current Channels' section has a 'Show Global Configuration' button.

The 'Log Instant View' section shows a log entry for a gateway activation:

```
18:16:47 comm_gwtcx [LoRaWAN™ Network Server] comm_gwtcx/00800000a0001eb7
{"CommType":"comm_gwtcx","Reference":"Sj50g1cbd4m1tcfu","OriginalReference":"Sj50g1cbd4m1tcfu","Connector":"69643d32","AppEui":"70b3d57ed000fcda","DevEui":"373
[\"00800000a0001eb7\"],\"DT\":\"2019-01-09T18:16:46.54244144+01:00\",\"Extra\":
[\"bandwidth\":\"125\",\"codeRate\":\"4/5\",\"frequency\":\"868.300000\",\"phyPayload\":\"YihvQegNAJLQDVR\",\"phyPayloadData\":
[\"mtype\":\"UnconfirmedDataDown\",\"devaddr\":\"07bda18c\",\"fcounter\":\"5640\",\"power\":\"14\",\"spreadFactor\":\"7\",\"timeToAir\":\"41ms\"],\"Attempt\":0}
18:16:50 comm_gwalive [LoRaWAN™ Network Server] comm_gwalive/00800000a0001eb7
{"CommType":"comm_gwalive","Connector":"69643d32","Host":"138.100.61.117","GatewayEUIs":["00800000a0001eb7"],\"DT\":\"2019-01-09T18:16:50.60451558+01:00\",\"Attem
```

Adding a Node: Step 0, wizard

The screenshot shows the 'Add Device Wizard' in the ResiOT web application. The interface includes a sidebar with navigation options like Dashboard, Nodes/Devices, and AppEUI. The main content area is titled 'Add Device Wizard' and features a grid of device categories and specific models. The 'ALL FREQUENCIES' tab is selected, showing a list of frequency ranges. Below this, a grid of device cards is displayed, each with a product image, name, and details. The devices are categorized by manufacturer (Ascoel) and type (Cabinet Sensor, Magnetic contact, Door Sensor, etc.).

ALL FREQUENCIES AS 923 AU 915-928 CN 470-510 CN 779-787 EU 443 EU 863-870 IN 865-867 KR 920-928 US 902-928

Device Name	Count	Manufacturer	Frequency Range
Meteo	153	Ascoel	EU 863-870
Ascoel CMxxxLR...	118	Ascoel	EU 863-870
CMxxxLR CB & C...	126	Ascoel	EU 863-870
Ascoel CMxxxLR...	8	Ascoel	EU 863-870, US 902-928
CMCB_EU868	135	Ascoel	EU 863-870
Ascoel COxxxLR...	37	Ascoel	EU 863-870
Ascoel COxxxLR...	125	Ascoel	EU 863-870
Ascoel IRxxxLR (...)	7	Ascoel	EU 863-870
Ascoel PBxxxLR...	23	Ascoel	EU 863-870
Ascoel PBxxxLR...	36	Ascoel	EU 863-870

Close

LoRa is trademark owned by Semtech. LoRaWAN™ is trademark owned by LoRa Alliance. All the other product names, logos, and brands are property of their respective owners.

IOT LPWAN Software Application/Automation Server

Nodes/Devices / Nodes/Devices

Search Name 6 / 75 (75)

State	Child of	Name	DevEUI	AppEUI	DevAddr	Last Msg	Auth.	ADR	Alias	Tag
<input type="checkbox"/>		Generic device	8239323559379194	70b3d57ed000fcda		Nov 10 2022, 12:53:26	GENERIC			
<input type="checkbox"/>		Generic device	8239323559379194	70b3d57ed000fcda		Jun 15 2022, 11:42:08	GENERIC			
<input type="checkbox"/>		wl55	0080e115000a95e7	0101010101010101		Jul 14 2022, 08:52:59	OTAA Class A	ADR:ON, DChR:ON		
<input type="checkbox"/>		Node ATarrias	4139323559379194	70b3d57ed000fcdd		Dec 14 2021, 14:42:09	OTAA Class A	ADR:ON, DChR:ON	atarrias	
<input type="checkbox"/>		UPM_RRSS	9939323559379194	70b3d57ed000fcda		Nov 28 2022, 11:45:18	OTAA Class A	ADR:ON, DChR:off	TestClase RedesSen mruizrn sores	
<input type="checkbox"/>		UPM_IOT2	4039323559379194	70b3d57ed000fcda		Nov 28 2022, 11:18:40	OTAA Class A	ADR:ON, DChR:off	MarianoR uiz	Tag2

IOT LPWAN Software Application/Automation Server

Nodes/Devices / AppEUI

Application/Join EUI * 70 : b3 : d5 : 7e : d0 : 00 : fc : 99

Name SSNN your.id



Nodes/Devices

+

←

↻

https://eu72.resiot.io/Login/#nodes-fd905f3ac937ee9a2cfc91b5c793ac43478f8b6e21f27dfd262953f9d1477041

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⋮

ResIoT

IOT LPWAN Software

Application/Automation Server

⋮

⚙️

📄

🔗

Nodes/Devices / Nodes/Devices

Search

🔍

Name

▼

+ New

+ Custom Device

☰

▼

7 / 75 (75)

	State	Child of	Name	DevEUI	AppEUI	DevAddr	Last Msg	Auth.	ADR	Alias	Tag
<input type="checkbox"/>					Node your.id 00	9a39323559379194	70b3d57ed000fc99		OTAA Class A	ADR:ON, DChR:ON	dummy
<input type="checkbox"/>					Generic device 8239323559379194	8239323559379194	70b3d57ed000fcda	Nov 10 2022, 12:53:26	GENERIC		
<input type="checkbox"/>					Generic device 8239323559379194	8239323559379194	70b3d57ed000fcda	Jun 15 2022, 11:42:08	GENERIC		
<input type="checkbox"/>					wl55	0080e115000a95e7	0101010101010101	Jul 14 2022, 08:52:59	OTAA Class A	ADR:ON, DChR:ON	
<input type="checkbox"/>					Node ATarrias	4139323559379194	70b3d57ed000fcdd	Dec 14 2021, 14:42:09	OTAA Class A	ADR:ON, DChR:ON	atarrias
<input type="checkbox"/>					UPM_RRSS	9939323559379194	70b3d57ed000fcda	Nov 28 2022, 11:46:57	OTAA Class A	ADR:ON, DChR:off	TestClase RedesSen mruizrn sores
<input type="checkbox"/>					UPM_IOT2	4039323559379194	70b3d57ed000fcda	Nov 28 2022, 11:18:40	OTAA Class A	ADR:ON, DChR:off	MarianoR uiz Tag2

<

>

Go to page:

Show rows:

Page 1 of 1 (1 - 15 of 7)

Page loaded in: 238.30065ms

Instant View [1]

🔍

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📄

📄



Nodes/Devices

https://eu72.resiot.io/Login/#nodes-fd905f3ac937ee9a2cfc91b5c793ac43478f8b6e21f27dfd262953f9d1477041

ResIoT IOT LPWAN Software Application/Automation Server

Nodes/Devices / Nodes/Devices

Search
Name
+ New + Custom Device
7 / 75 (75)

	State	Child of	Name	DevEUI	AppEUI	DevAddr	Last Msg	Auth.	ADR	Alias	Tag
<input type="checkbox"/>			Node your.id 00	9a39323559379194	70b3d57ed000fc99		Nov 28 2022, 12:07:46	OTAA Class A	ADR:ON, DChR:ON		dummy
<input type="checkbox"/>			Generic device 8239323559379194	8239323559379194	70b3d57ed000fcda		Nov 10 2022, 12:53:26	GENERIC			
<input type="checkbox"/>			Generic device 8239323559379194	8239323559379194	70b3d57ed000fcda		Jun 15 2022, 11:42:08	GENERIC			
<input type="checkbox"/>			wl55	0080e115000a95e7	0101010101010101		Jul 14 2022, 08:52:59	OTAA Class A	ADR:ON, DChR:ON		
<input type="checkbox"/>			Node ATarrias	4139323559379194	70b3d57ed000fcdd		Dec 14 2021, 14:42:09	OTAA Class A	ADR:ON, DChR:ON		atarrias
<input type="checkbox"/>			UPM_RRSS	9939323559379194	70b3d57ed000fcda		Nov 28 2022, 11:46:57	OTAA Class A	ADR:ON, DChR:off	TestClase RedesSen mruizrnsores	
<input type="checkbox"/>			UPM_IOT2	4039323559379194	70b3d57ed000fcda		Nov 28 2022, 11:18:40	OTAA Class A	ADR:ON, DChR:off	MarianoRuiz	Tag2

Go to page: 1

Show rows: 15

Page 1 of 1 (1 - 15 of 7)
Page loaded in: 559.81566ms

Instant View [1]

Adding a Node: Step 1, identification

The screenshot shows the 'Nodes/Devices' page in the ResiIoT web application. The browser address bar indicates the URL is <https://eu72.resiot.io/Login/#nodescreate>. The left sidebar contains a menu with options: Dashboard, Nodes/Devices (selected), AppEUI, ADR Profiles, Primary Group, Secondary Group, Import Nodes, Node Command, Node Downlink, Node Fields Data History, Downlink Queue, UP/DOWNlink RSSI Stats, Node Timeout Reports, Uplink History, Set Nodes Geolocation, Smart Triggers, and Zones. The main content area is titled 'Nodes/Devices / Nodes/Devices' and includes a 'Create' button and a 'Node Box Detail' link. The form fields for creating a new node are as follows:

Field	Value	Status
Node Model	-	
Name	Node your.id 00	✓
Alias	Alias	
Node AUTH / Type	LoRaWAN OTAA Class A [Auth:OTAA Class:A]	
Device EUI	9a : 39 : 32 : 35 : 59 : 37 : 91 : 94	✓
Application/Join EUI	SSNN pedro.lobo	
Enabled	<input checked="" type="checkbox"/>	
Application KEY	f3 : 1c : 2e : 8b : c6 : 71 : 28 : 1d : 51 : 16 : f0 : 8f : f0 : b7 : 92 : 8f	✓
LoRaWAN™ Network Server	LoRaWAN™ Eu868 MHz-Class A+C UDP Server: eu72udp.resiot.io:7677	
Tag		✓
Node Info	This field will be available after the first save	
Tags	Tags	
Graphs	UP/DOWNlink RSSI Stats	
Primary Group	-	
Secondary Group	-	
Retain Radio/Comm Logs for days	180	
Timeout (in seconds)	129600	

At the bottom of the form, there are expandable sections: 'LoRaWAN™ advanced settings', 'Node fields', 'Create Widget on Dashboard', and 'Widget Maps and Image'. The bottom status bar shows 'Instant View [1]' and 'Node Detail Box'.

Adding a Node: Step 2, adding Node Fields

Node fields

Field Tag	Line gr.	Gauge gr.	Content Type	Last Value	UM	Last Set Date
Latitude	<input type="checkbox"/>	<input type="checkbox"/>	Numeric ▾	Last Value	UM	Last Set Date
Longitude	<input type="checkbox"/>	<input type="checkbox"/>	Numeric ▾	Last Value	UM	Last Set Date
Altitude	<input type="checkbox"/>	<input type="checkbox"/>	Numeric ▾	Last Value	UM	Last Set Date
Timeout_State	<input type="checkbox"/>	<input type="checkbox"/>	Numeric ▾	27	UM	2019-01-07 10:46:42.002
DummySensorValue2	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Numeric ▾	162.7	UM	2018-11-16 16:21:21.856

+ Add New

Edit Value

✕

Adding a Node: Step 3, store payload data into Node Fields

- Is your responsibility to define the content of the payload and how to use it. ResIoT uses LUA scripting to “translate” the content of the payload to the TAGS
- In order to test the LUA script, ResIoT allows to execute the script in a test environment.
- Define your custom payload and use the terminal to debug your script

Scene on Rx

Scene mode Payload Parsing

Manual Lua Scene

Lua Code

☐ Decode before running

```

3 Tag1 = "DummySensorValue2"
4 value = resiot_hexdecode_ascii(payload)
5 --Calls for LUA Script engine prints
6 resiot_debug(string.format("Tag: %s Value: %s \n",Tag1, value))
7 worked, err = resiot_setnodevalue(appeui, deveui, Tag1, value)
8 if (not worked) then
9     resiot_debug(string.format("Set Value Error %s \n",err))
10 else
11     resiot_debug("Set Node value successful\n")
12 end
13 end
14
15 Origin = resiot_startfrom() --Scene process starts here
16
17
18 --Manual script execution for testing
19 if Origin == "Manual" then
20     payload = "312e32" --Set your test payload here in hexadecimal
21     appeui = "70b3d57ed000foda" --Set your Application EUI here
22     deveui = "9939323559379194" --Set your own Device EUI here
23 -- Normal execution, get payload received from device
24 else
25     appeui = resiot_comm_getparam("appeui")
26     deveui = resiot_comm_getparam("deveui")
27     payload, err = resiot_getlastpayload(appeui, deveui)
28 end
29 --Do your stuff
30 parsePayload(appeui,deveui,payload)
31

```

✖ Clear Log

■ Stop

▶ Start Script

```

---SCRIPT ENGINE CONNECTED---
12:16:13: --SCRIPT STARTED---
12:16:13: --SCRIPT STARTED---
12:16:13: Tag: DummySensorValue2 Value: 1.2
12:16:13: --SCRIPT ENDED---
12:16:13: Set Value Error Invalid Node.

```

MASTER

Smart Scenes/Lua Scripts

https://eu72.resiot.io/Login/#scenelua

ResIoT IOT LPWAN Software Application/Automation Server

Dashboard

Nodes/Devices

Multicast

LoRaWAN™ Gateways

Standard Gateway

Data Connectors

Real Time Monitor

Log

Smart Scenes/Lua Scripts

Calendar

Smart Actions

Variables

Tools

Plugins/Addons

Stats / Charts

Settings

Tutorial

V. 4.1.1-124

19/10

Smart Scenes/Lua Scripts

Search

Name

+ New

7 / ∞

	Name	Hex ID	Type	Enabled	Last Start Time
<input type="checkbox"/>	<div><div></div><div>TestJuly</div></div>	736365393432	Advanced	Enabled	
<input type="checkbox"/>	<div><div></div><div>Tetskk</div></div>	736365393339	Advanced	Enabled	
<input type="checkbox"/>	<div><div></div><div>TestRRSS-Binary</div></div>	736365393137	Advanced	Enabled	Nov 28 2022, 11:46:57
<input type="checkbox"/>	<div><div></div><div>wl55</div></div>	736365393134	Advanced	Enabled	Jul 14 2022, 08:53:01
<input type="checkbox"/>	<div><div></div><div>Scene DTE TB2Device (Example)</div></div>	736365393037	Smart	Enabled	Nov 10 2022, 12:53:26
<input type="checkbox"/>	<div><div></div><div>Lua DTE TB2Device (Example)</div></div>	736365393036	Advanced	Enabled	Nov 10 2022, 12:53:26
<input type="checkbox"/>	<div><div></div><div>TestRRSS-String</div></div>	736365383732	Advanced	Enabled	Nov 28 2022, 11:18:40

<

>

Go to page: 1

Show rows: 15

Page 1 of 1 (1 - 15 of 7)

Page loaded in: 32.000045ms

Máster Universitario en Internet of Things. Sensor Networks - 43 -

MASTER

Smart Scenes/Lua Scripts

https://eu72.resiot.io/Login/#scenelua

ResIoT IOT LPWAN Software Application/Automation Server

Dashboard

Nodes/Devices

Multicast

LoRaWAN™ Gateways

Standard Gateway

Data Connectors

Real Time Monitor

Log

Smart Scenes/Lua Scripts

Calendar

Smart Actions

Variables

Tools

Plugins/Addons

Stats / Charts

Settings


Tutorial

V. 4.1.1-124
19/10

Choose your scene


Smart Scene

Create a **Scene** in a simple way: select your objects, your actions and your values and see the results!



Script Lua 5.1 Scene

Create a **Scene** coding in **Lua** scripting. Recommended for developers!



Close

Search

Testlu

Tetskk

TestR

wi55

Scene

Lua D

TestR

Go to page

Show rows: 15

Page 1 of 1 (1 - 15 of 7)
Page loaded in: 32.000045ms

Enabled

Last Start Time

Enabled

Enabled

Enabled

Enabled

Enabled

Enabled

Enabled

Enabled

MASTER

Smart Scenes/Lua Scripts

https://eu72.resiot.io/Login/#sceneluacreate

ResIoT IOT LPWAN Software Application/Automation Server

⚙️

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🏠 ↻ 📄 Smart Scenes/Lua Scripts

🕒 ⚠️ 📧 👤

🕒 ⚠️ 📧 👤

🏠 Dashboard

📶 Nodes/Devices

📡 Multicast

📡 LoRaWAN™ Gateways

📡 Standard Gateway

🔗 Data Connectors

📈 Real Time Monitor

🕒 Log

📅 Smart Scenes/Lua Scripts

📅 Calendar

☰ Smart Actions

🔗 Variables

🔗 Variables

🔗 Value History

🔗 Tools

🔗 Plugins/Addons

📊 Stats / Charts

⚙️ Settings

🎓 Tutorial

🏠

↻

📄 Smart Scenes/Lua Scripts

🔗 Create and stay

📄 Create

🔗 Help

Name *

Read dummy sensor value

Tag

dummy

Lua Code

☐ Decode before running

📄

✂️

📄

📄

🔄

🔄

📄

Find

Replace

☐ All

1

🔗

📄

🔄

🔗

V. 4.1.1-124

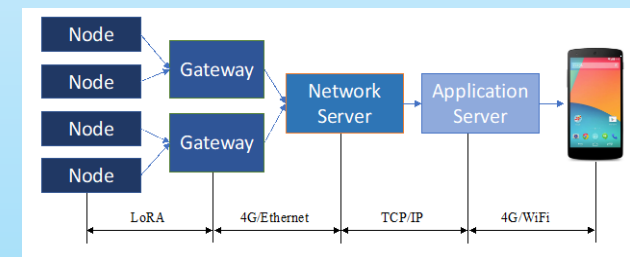
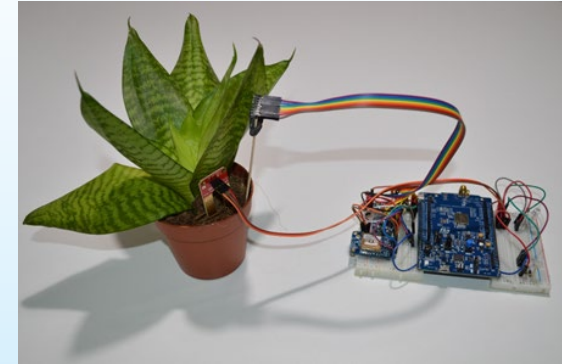
19/10

- 📶 Logging window
- 📶 Communication logs
- 📶 Statistics
- 📶 Creation of widgets
- 📶 Wizards to add gateways and nodes

```
21:34:55comm_rx[LoRaWAN™ Network Server] comm_rx/70b3d57ed000fcda/3639323559379194
{"CommType":"comm_rx","Connector":"69643d32","AppEui":"70b3d57ed000fcda","DevEui":"363
9323559379194","DevAddr":"074eebe0","Port":"15","GatewayEUIs":["00800000a0001eb7"],"Pa
yload":"302e302c302e302c302c302e3030303030302c302e303030303030","DT":"2019-01-
13T21:34:51.814948713+01:00",
"Extra":{"JSONRXINFO":[{"altitude":0,"latitude":40,"loRaSNR":9.5,"longitude":-3,
"mac":"00800000a0001eb7", "name":"00800000a0001eb7", "rssi":-
66}],"adr":"true","bandwidth":"125","fCnt":"14809","frequency":"868100000","spreadFact
or":"7"},"Attempt":0}
```

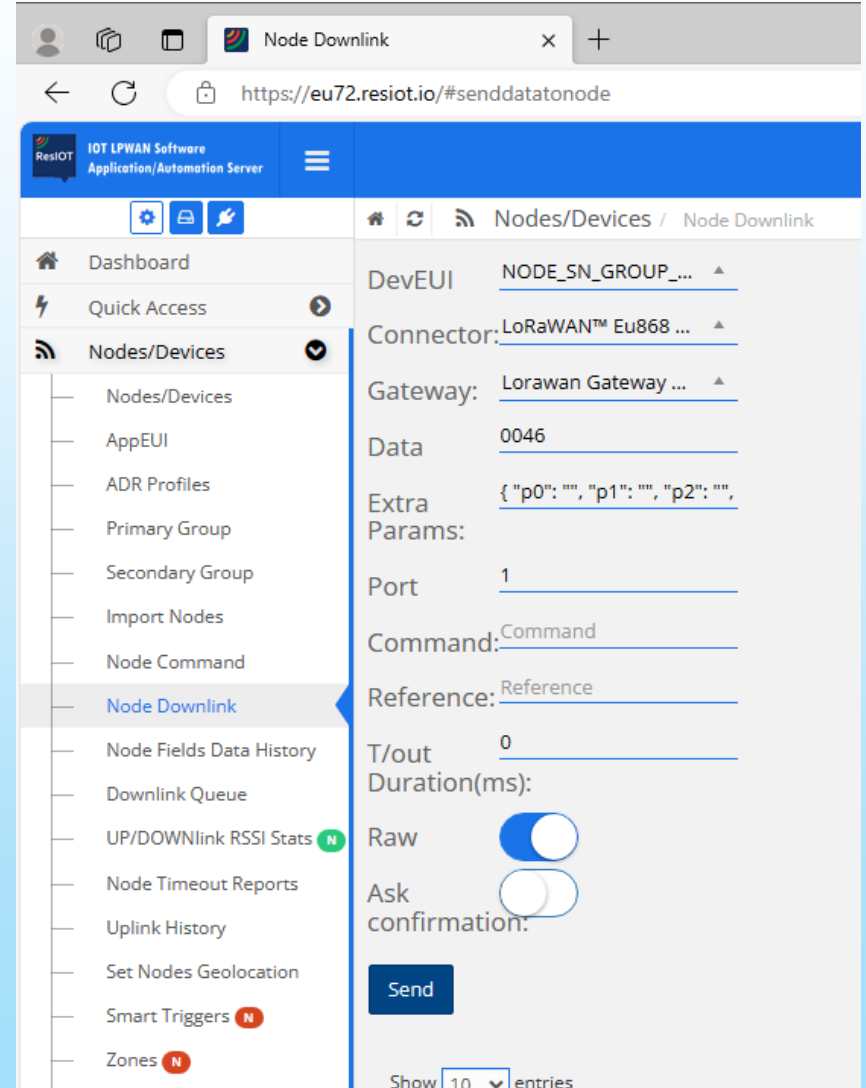
Project phases and basic specifications

- 📶 The project has three different phases (see specifications document)
- 📶 Phase A: Use of LoraWAN Mbed example available at Moodle
 - Configuration
 - Setup of the node in ResloT (add the basic LUA code)
 - Test (using Widgets). Use also your mobile
- 📶 Phase B: Adding your custom code developed in embedded hardware course
 - Adding code incrementally
 - Define the organization of your payload (maximum number of bytes to be used)
 - Add your LUA custom code and test
- 📶 Phase C: optional part! Improving the design



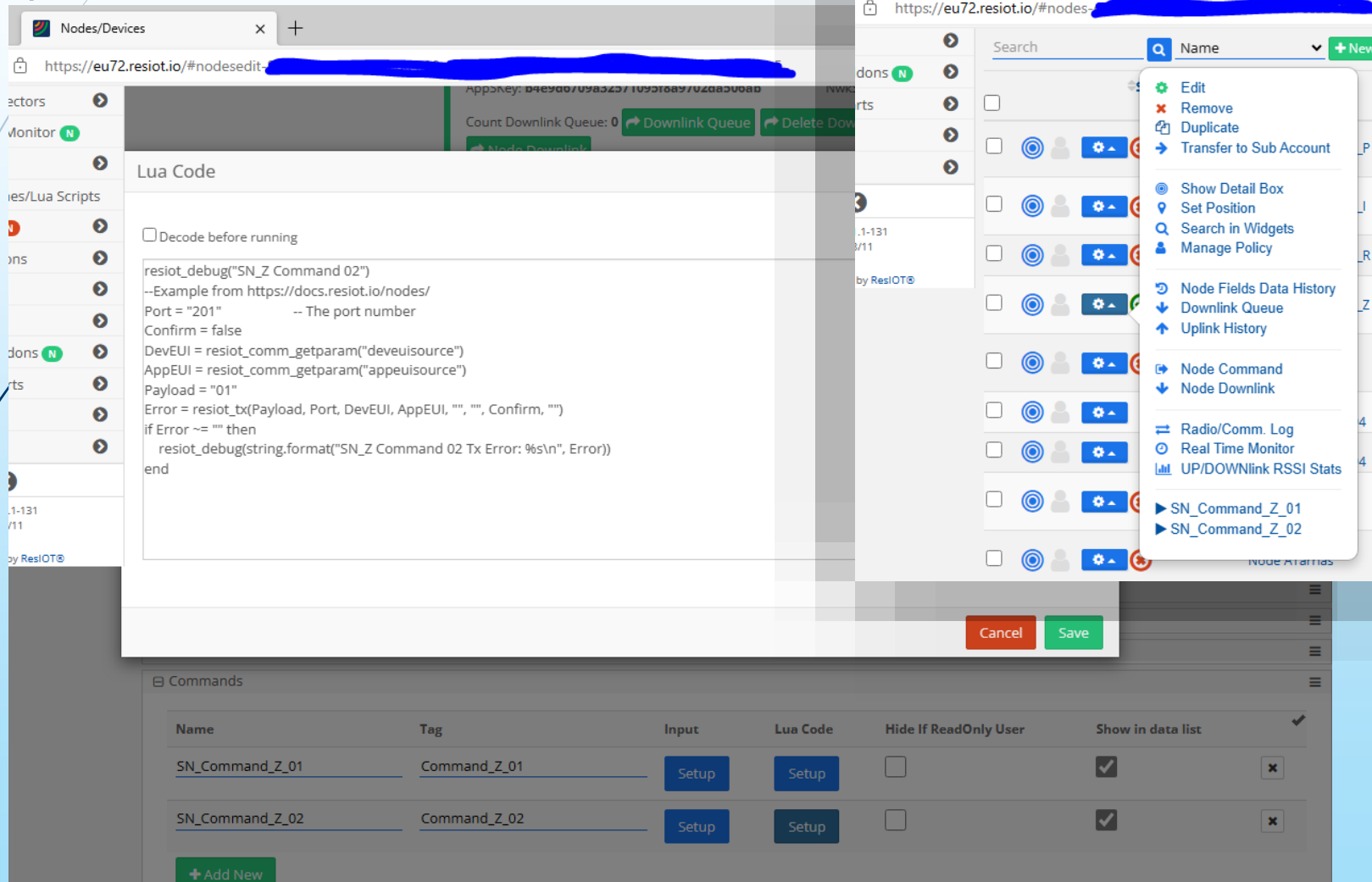
Option 1 – Direct interface

- Raw (hex) / Text
- Mind the confirmation



The screenshot shows the 'Node Downlink' interface in the ResIoT application. The browser address bar displays 'https://eu72.resiot.io/#senddatatonode'. The interface has a blue header with the ResIoT logo and 'IOT LPWAN Software Application/Automation Server'. A left sidebar contains a menu with options: Dashboard, Quick Access, Nodes/Devices (selected), Node Fields Data History, Downlink Queue, UP/DOWNlink RSSI Stats, Node Timeout Reports, Uplink History, Set Nodes Geolocation, Smart Triggers, and Zones. The main area is titled 'Nodes/Devices / Node Downlink' and contains several input fields: DevEUI (NODE_SN_GROUP...), Connector (LoRaWAN™ Eu868 ...), Gateway (Lorawan Gateway ...), Data (0046), Extra Params ({ "p0": "", "p1": "", "p2": "" },), Port (1), Command (Command), Reference (Reference), T/out Duration(ms) (0), Raw (toggle on), and Ask confirmation (toggle off). A 'Send' button is at the bottom, and a 'Show 10 entries' dropdown is at the bottom right.

Option 2 – Command definition



The screenshot shows the ResIoT web interface. The 'Nodes/Devices' page is active, displaying a list of nodes. A context menu is open over the list, showing options like 'Edit', 'Remove', 'Duplicate', 'Transfer to Sub Account', 'Show Detail Box', 'Set Position', 'Search in Widgets', 'Manage Policy', 'Node Fields Data History', 'Downlink Queue', 'Uplink History', 'Node Command', 'Node Downlink', 'Radio/Comm. Log', 'Real Time Monitor', and 'UP/DOWNlink RSSI Stats'. The 'Node Command' option is highlighted.

The 'Lua Code' tab is selected, showing the following code:

```

resiot_debug("SN_Z Command 02")
--Example from https://docs.resiot.io/nodes/
Port = "201" -- The port number
Confirm = false
DevEUI = resiot_comm_getparam("deveuisource")
AppEUI = resiot_comm_getparam("appeuisource")
Payload = "01"
Error = resiot_tx(Payload, Port, DevEUI, AppEUI, "", "", Confirm, "")
if Error ~= "" then
    resiot_debug(string.format("SN_Z Command 02 Tx Error: %s\n", Error))
end
    
```

The 'Commands' table at the bottom lists two commands:

Name	Tag	Input	Lua Code	Hide If ReadOnly User	Show in data list
SN_Command_Z_01	Command_Z_01	Setup	Setup	<input type="checkbox"/>	<input checked="" type="checkbox"/>
SN_Command_Z_02	Command_Z_02	Setup	Setup	<input type="checkbox"/>	<input checked="" type="checkbox"/>

A '+ Add New' button is visible at the bottom left of the table.

 Questions Comments Next steps:

- Read document with the Project specifications
- Check the example provided and give us your feedback!
- Check your solutions in the lab or at least close to the gateways!

Tested Coverage

- 📶 Around campus 200m (problems with walls and other metallic object)
- 📶 From a point with direct visibility (1.4km)





<https://www.pasternack.com/t-calculator-friis.aspx>

Transmitter Power: dBm

Transmitter Gain (dBi):

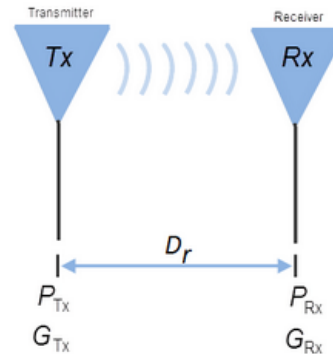
Frequency: MHz

Distance: Meters

Receiver Gain (dBi):

Result:

Received Power: -51.95 dBm



Statistics

Rx/Uplink RSSI analysis

GwEui

Last RSSI | SNR

Min RSSI

Max RSSI

Average RSSI

1) 00800000a0003d71

-89 | 10

-114 | -14.8

-62 | 9

-81.67 | 8.22

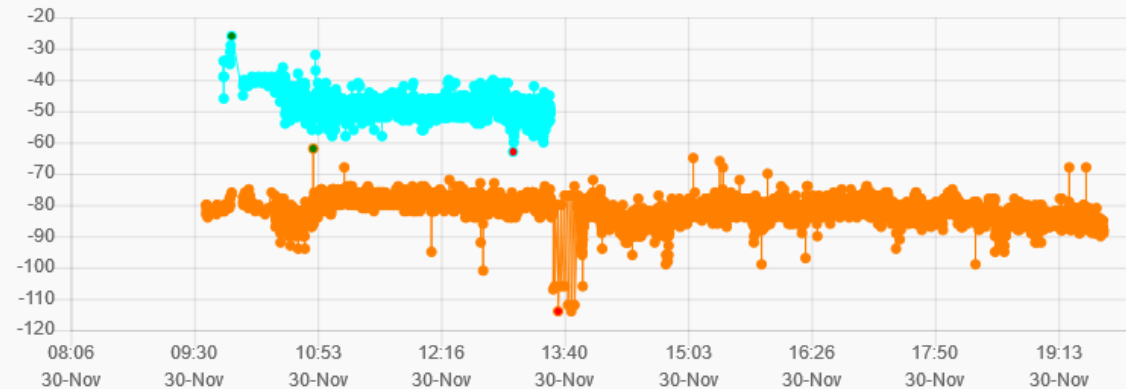
2) 00800000a0001eb7


-50 | 10.5


-63 | 8.5

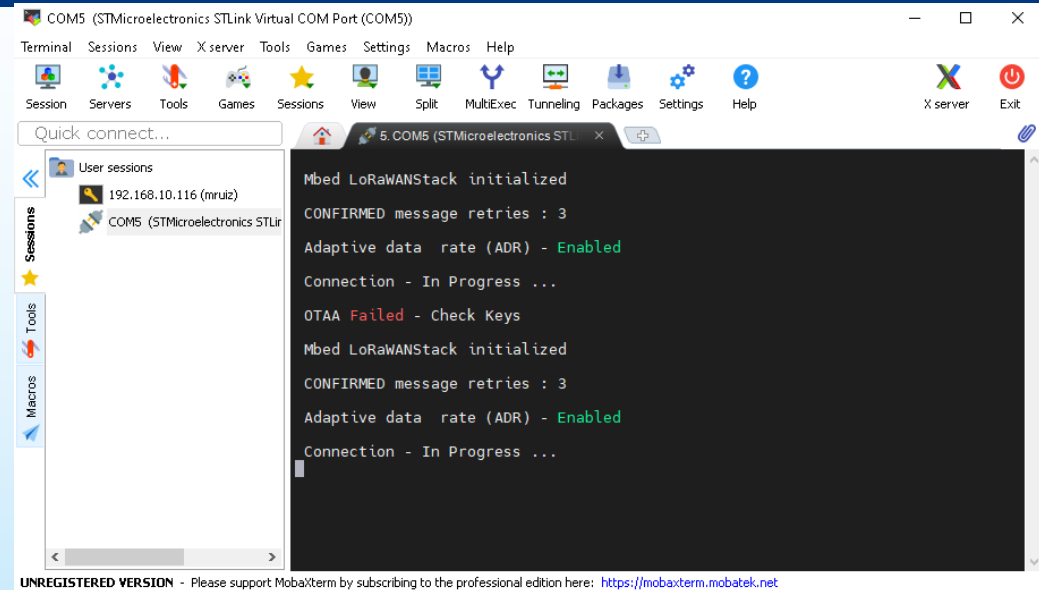
-26 | 10.8

-48.46 | 8.92



 Bad configuration
or communication
error in the
initialization

 Successful TX and
RX



COM5 (STMicroelectronics STLink Virtual COM Port (COM5))

```

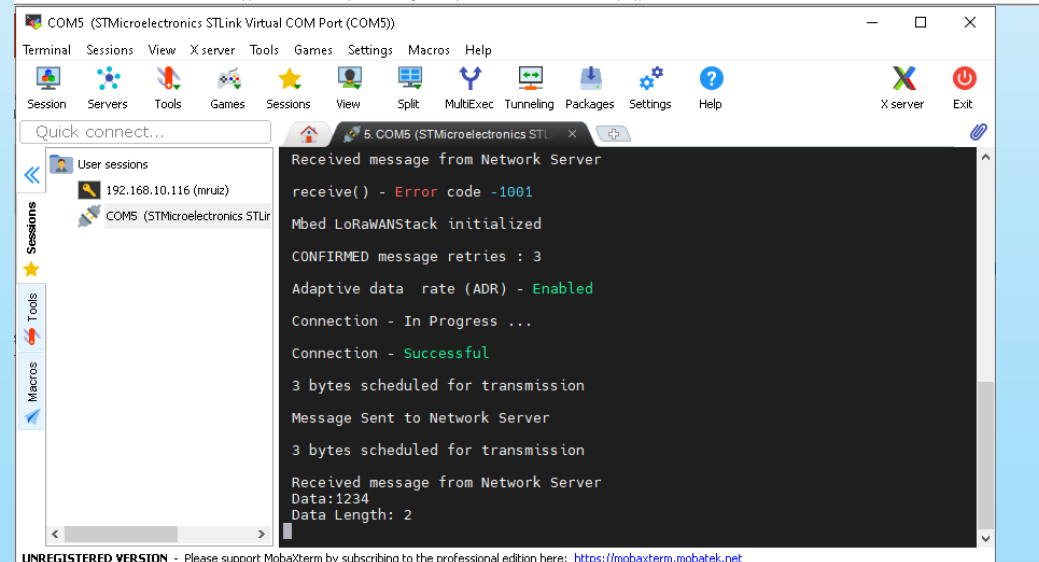
Terminal  Sessions  View  X server  Tools  Games  Settings  Macros  Help
Session  Servers  Tools  Games  Sessions  View  Split  MultiExec  Tunneling  Packages  Settings  Help  X server  Exit

Quick connect...

User sessions
192.168.10.116 (mruiz)
COM5 (STMicroelectronics STLink Virtual COM Port (COM5))

Mbed LoRaWANStack initialized
CONFIRMED message retries : 3
Adaptive data rate (ADR) - Enabled
Connection - In Progress ...
OTAA Failed - Check Keys
Mbed LoRaWANStack initialized
CONFIRMED message retries : 3
Adaptive data rate (ADR) - Enabled
Connection - In Progress ...
  
```

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COM5 (STMicroelectronics STLink Virtual COM Port (COM5))

```

Terminal  Sessions  View  X server  Tools  Games  Settings  Macros  Help
Session  Servers  Tools  Games  Sessions  View  Split  MultiExec  Tunneling  Packages  Settings  Help  X server  Exit

Quick connect...

User sessions
192.168.10.116 (mruiz)
COM5 (STMicroelectronics STLink Virtual COM Port (COM5))

Received message from Network Server
receive() - Error code -1001
Mbed LoRaWANStack initialized
CONFIRMED message retries : 3
Adaptive data rate (ADR) - Enabled
Connection - In Progress ...
Connection - Successful
3 bytes scheduled for transmission
Message Sent to Network Server
3 bytes scheduled for transmission
Received message from Network Server
Data:1234
Data Length: 2
  
```

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Some guidelines

- 📶 Next class could be chaotic if all the nodes try to join simultaneously
 - Be patient! Joining and first connection takes some minutes
 - (yes, **minutes**)
 - Trial an error process!
- 📶 ResloT:
 - We have an academic license with “low low low low, the lowest” priority. This implies that once the data is received it takes some minutes until widgets are updated
 - The platform has a lot of features for debugging, try to play with that and understand the internals of Lorawan