

ESIB IoT Challenge

Welcome to the ESIB IoT Challenge. In this challenge, you will designing and prototyping the first IoT services based on a LoRaWAN network.

-. What is a LoRaWAN Platform?

In this challenge, you will benefit from the first experimental platform implementing an end-to-end LoRaWAN solution in Lebanon. The platform consists of the following elements:

- Devices that communicate to one or more gateways via a wireless interface using single hop LoRa and implementing the LoRaWAN protocol. These devices are physically connected to sensors that generate data.
- Gateways or base stations that forward frames between the devices and the network server. Gateways are connected to the network server via IP interfaces.
- A LoRAWAN backend that implements the network server functions and provides frame control and security.
- Applications that enable to visualize and store the sensor data obtained from the devices.

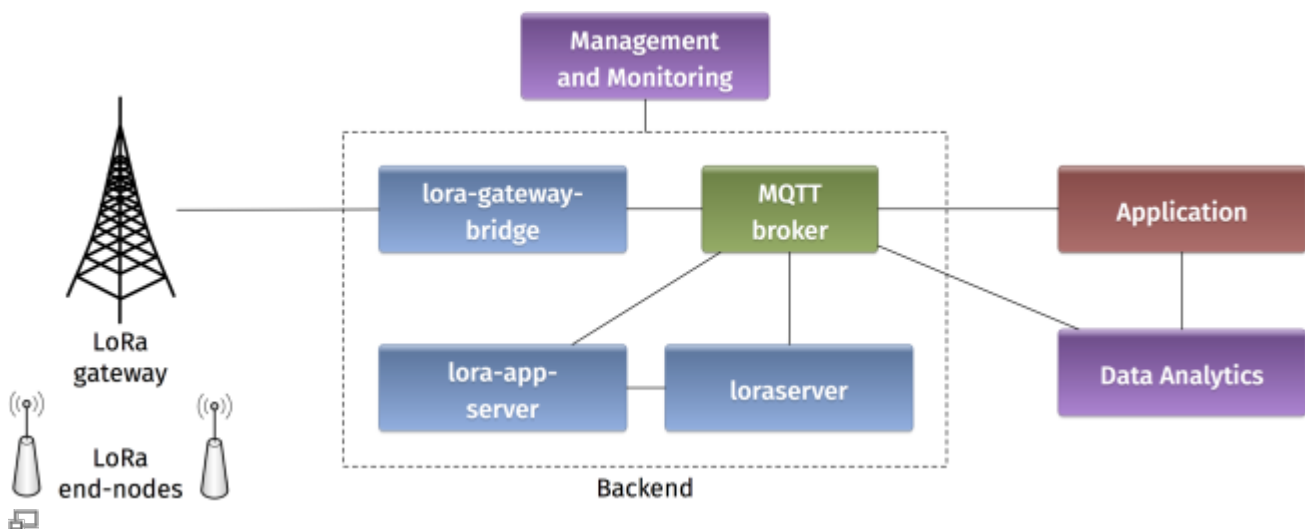


Figure 1. Architecture of the LoRaWAN Platform

-. Devices

-. Arduino with Dragino Shield

-. Periodic Message Sending

Devices in the LoRaWAN platform can also be implemented on Arduino boards with Dragino shields. The combined module as well as the basic configuration steps are presented in [Simple Prototype of LoRa Communications](#). Similarly to the Autonomo device, you can download the following sketch

test-loraserver-comb-loraserver-dragino.zip

and modify it according to your preferences. Below you can find some commented extracts of the sketch.

The pin mapping corresponds to the Dragino electronic schematic:

```
const lmic_pinmap lmic_pins = {
  .nss = 10,
  .rxtx = LMIC_UNUSED_PIN,
  .rst = 9,
  .dio = {2, 6, 7},
};
```

The send function is rescheduled TX_INTERVAL seconds after each transmission complete event:

```
case EV_TXCOMPLETE:
  Serial.println(F("EV_TXCOMPLETE (includes waiting for RX
windows)"));
  if(LMIC.dataLen) {
    // data received in rx slot after tx
    Serial.print(F("Data Received: "));
    Serial.write(LMIC.frame+LMIC.dataBeg, LMIC.dataLen);
    Serial.println();
  }
  // Schedule next transmission
  os_setTimedCallback(&sendjob,
os_getTime()+sec2osticks(TX_INTERVAL), do_send);
  break;
```

The send function is initially scheduled here:

```
do_send(&sendjob);
```

The message containing the sensor values is transmitted on one of the radio channels (as in the Autonomo case):

```
LMIC_setTxData2(1, (uint8_t*) buffer, message.length() , 0);
```

The adaptive data rate is not supported, and the spreading factor is configured as follows:

```
LMIC_setDrTxpow(DR_SF7, 14);
```

-. Triggered Message Sending

[You can also find another example of sketch to download:](#)

test-loraserver-moisture-on-move.ino.zip

. Here the message sending is not periodic but related to an event. For example, an infrared sensor detects a movement and triggers a signal for the device to send a LoRaWAN message. Note also that the join method used in this second sketch is Activation by Personalisation (ABP): the device address,

the network session key, and the application session key are directly configured on the device.

-. Gateways

-. Single Channel Gateway

The single channel gateway includes a LoRa transmission module (Dragino Shield) connected to a Raspberry Pi (2 or 3) as shown in Figure 2. Communication between the two modules is done over an SPI interface.

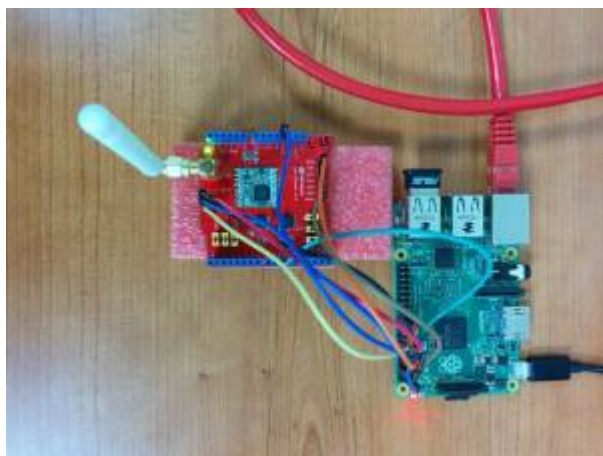


Figure 2. LoRa single channel gateway

In order to assemble the gateway, start by making the wire connections: the connection pins are identified in Figures 3 and 4.

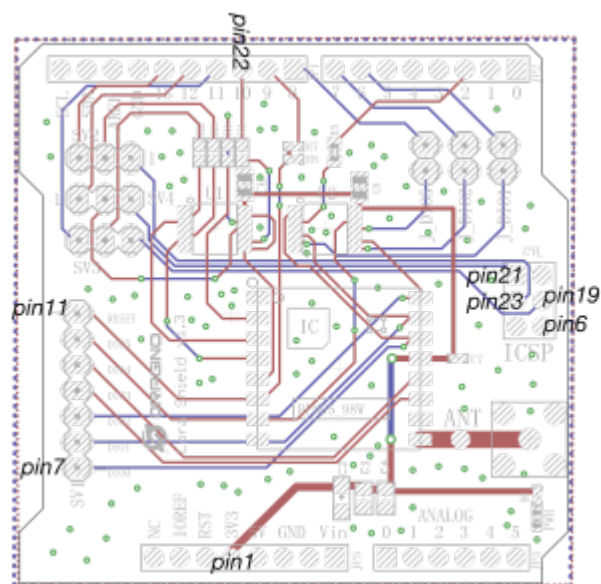


Figure 3. Dragino pin mapping

Raspberry Pi 3 GPIO Header			
Pin#	NAME		NAME Pin#
01	3.3v DC Power	⬤	DC Power 5v 02
03	GPIO02 (SDA1, I ² C)	⬤	DC Power 5v 04
05	GPIO03 (SCL1, I ² C)	⬤	Ground 06
07	GPIO04 (GPIO_GCLK)	⬤	(TXD0) GPIO14 08
09	Ground	⬤	(RXD0) GPIO15 10
11	GPIO17 (GPIO_GEN0)	⬤	(GPIO_GEN1) GPIO18 12
13	GPIO27 (GPIO_GEN2)	⬤	Ground 14
15	GPIO22 (GPIO_GEN3)	⬤	(GPIO_GEN4) GPIO23 16
17	3.3v DC Power	⬤	(GPIO_GEN5) GPIO24 18
19	GPIO10 (SPI_MOSI)	⬤	Ground 20
21	GPIO09 (SPI_MISO)	⬤	(GPIO_GEN6) GPIO25 22
23	GPIO11 (SPI_CLK)	⬤	(SPI_CE0_N) GPIO08 24
25	Ground	⬤	(SPI_CE1_N) GPIO07 26
27	ID_SD (I ² C ID EEPROM)	⬤	(I ² C ID EEPROM) ID_SC 28
29	GPIO05	⬤	Ground 30
31	GPIO06	⬤	GPIO12 32
33	GPIO13	⬤	Ground 34
35	GPIO19	⬤	GPIO16 36
37	GPIO26	⬤	GPIO20 38
39	Ground	⬤	GPIO21 40

Figure 4. Raspberry pi 3 pins

Connect the Raspberry Pi to the Internet and install the packet forwarding software. The source code of the single channel packet forwarder is available on:

https://github.com/samerlahoud/single_chan_pkt_fwd. In order to install it, you need to:

- Enable SPI on the Raspberry Pi using raspi-config
- Download and unzip the source code:

```
wget https://github.com/hallard/single_chan_pkt_fwd/archive/master.zip
unzip master.zip
```

- Install the wiring library:

```
apt-get update
apt-get install wiring
```

Compile the packet forwarder:

```
make all
```

For gcc version 4.6.3, a compilation error results in the following warning unrecognized command line option '-std=c++11'. Replace -std=c++11 by -std=c++0x in the Makefile and recompile:

```
CFLAGS = -std=c++0x -c -Wall -I include/
```

Now, you need to configure the single channel packet forwarder. This is done in the

global_config.json.zip

configuration file. Particularly, you need to choose the channel, the spreading factor, the pins for SPI communication, and the address of the backend server. Note that you can specify multiple backends for testing purposes.

Finally, you can run the packet forwarder as root!

```
nohup ./single_chan_pkt_fwd &
```

-. Kerlink IoT Station

```
# activates eth0 at startup
ETHERNET=yes
# claims dhcp request on eth0
ETHDHCP=yes

# Selector operator APN
GPRSAPN=gprs.touch.com.lb
# Enter pin code if activated
GPRSPIN=0000
# Update /etc/resolv.conf to get dns facilities
GPRSDNS=yes
# PAP authentication
GPRSUSER=
GPRSPASSWORD=

# Bearers priority order
#BEARERS_PRIORITY="eth0,ppp0,eth1"
BEARERS_PRIORITY="ppp0,eth0,eth1"
```

```
./gps-pkt-fwd.sh > /dev/null &
```

```
3270 root      2548 S    /bin/sh ./gps-pkt-fwd.sh
3288 root      34908 S   ./gps_pkt_fwd
```

```
/etc/init.d/gprs start
```

```
[root@Wirgrid_0b03008c demo_gps_loramote]# /etc/init.d/gprs status
pppd (pid 5273) is running...
Session: Rx=58, Tx=163
Globals: Rx=1130457, Tx=1195592
Sum:      Rx=1130515, Tx=1195755
[root@Wirgrid_0b03008c demo_gps_loramote]#
```

-. Backend

-. Loraserver

The Loraserver has a web interface for configuring the applications and devices on the platform. Full details for installing the software are provided on <https://www.loraserver.io>.



Figure 5. Loraserver web interface

Start by creating an application as in Figure 5. Then create a node in this application and provide the following information:

- A unique node name
- The node description
- A unique device EUI on 64 bits: Random identifiers can be generated on <https://www.random.org/bytes/>
- The application EUI on 64 bits: this can be a common identifier for all nodes using the same application.
- A unique application key on 128 bits

In order to enable OTAA join method, you have to make sure that the ABP activation button is unchecked.

-. The Things Network

-. Applications

-. mqtt-spy

mqtt-spy is an open source utility intended to help you with monitoring activity on MQTT topics. It has been designed to deal with high volumes of messages, as well as occasional publications. mqtt-spy is a JavaFX application, so it should work on any operating system with an appropriate version of Java 8 installed. A very useful tutorial is available on <https://github.com/eclipse/paho.mqtt-spy/wiki>. You can use mqtt-spy to debug the messages received from the LoRaWAN devices. For this, you should download the software tool from <https://github.com/eclipse/paho.mqtt-spy/wiki>. After starting the application, configure a new connection to the MQTT broker by simply adding the IP address of the broker in the Server URI field. Now you can subscribe to any MQTT topic. If you want to receive all messages arriving at the backend, you can use the generic topic #. You can also limit to the topic including the messages of any specific device: application/APPLICATION_ID/node/DEVICE_EUI/rx.

-. Emoncms

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