EE4500-CNS-2025-BL2 LAB 1 LoRaWAN Gateway

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Unit	Lab 1
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Contents

Objectives

The purpose of this lab exercise is to set up a LoRaWAN Gateway using a supplied kit. The kit should be constructed and connected as a LoRaWAN gateway to the public The Things Network.

It is acknowledged that the public on-line documentation for much of this process is – as is so often the case – not entirely accurate and complete. The second purpose of the lab is to write a clear and simple recipe that would allow a 1st year Engineering undergraduate to complete the process quickly and correctly. The recipe should include photographs and screenshots as appropriate.

Deliverables

There are two target deliverables for the lab: a functioning LoRaWAN Gateway device and a written document containing complete instructions sufficient for a 1st year engineering undergraduate to duplicate the work.

Deliverable 1: Device

The device is specified below.

1) A fully functioning LoRaWAN gateway device, based around the following configuration:
    a. Raspberry Pi 4.
    b. Waveshare SX1303 915M LoRaWAN Gateway HAT.
2) Computer setup
    a. Connected to the Internet via a provided WiFi router, using AU Australia connection standards.
    b. Connected to mains power.
    c. No keyboard, mouse or screen - all control must be via the WiFi connection using SSH.
    d. Hostname `cc4959gtwN` where *N* is your group number (e.g. `cc4959gtw3`).
    e. User name: `admin;` password: hostname as above.
    f. SSH allows authentication by public-key only.
3) The device should run the following software:
    a. Raspberry Pi Debian Bullseye 32-bit Lite
    b. git
    c. sx1302 hardware access layer
    d. LoRaWAN Packet Forwarder
4) The device should be connected as follows:
    a. Connected to The Things Network using The Things Stack.
    b. Gateway ID & name: same as hostname.
    c. Gateway EUI: as output by the chip_id utility of the SX1302 hardware access layer toolkit.
    d. Frequency plan: Australia FSB 2
    e. Require authenticated connection: False

The device should be demonstrated working by monitoring the TTN Gateway page when a LoRaWAN packet is force-delivered using the Dragino SN50V3-LB node supplied.

Deliverable 2: Recipe

Write a simple and accurate recipe for this process.

- The recipe should allow a 1st year Engineering undergraduate to complete the process quickly and correctly.
- The recipe should include photographs and screenshots as appropriate.
- The document should contain your group number and members' names, and any other relevant details.
- It should be delivered as a PDF.

Websites

Raspberry Pi imager	https://www.raspberrypi.com/software/
Waveshare product site	https://www.waveshare.com/wiki/SX1302_LoRaWAN_Gateway_HAT
Hardware access layer	https://github.com/Lora-net/sx1302_hal.git
The Things Network	https://www.thethingsnetwork.org/

Procedure

Gateway construction

Assemble the gateway following the instructions at the Waveshare website.

Raspberry Pi configuration

Download and install the Raspberry Pi imager on to your PC from.

Run the imager. Once you have selected the correct image, you should use the ***Edit Settings*** command on the ***Use OS Customisation?*** dialog. Set as many of the configuration details as possible at this point, including:

- hostname
- username & password
- WiFi country, SSID & password
- keyboard layout
- Time zone
- SSH settings and public key.

Also, ensure that Enable telemetry is set to Off.

Once the Raspberry Pi has been booted with the imaged SD card, use the WiFi router's GUI to determine the PI's IP address. You can use this to log in to the Pi from your PC using SSH.

Log in, enable SPI and I2C and reboot.

Raspberry Pi software

You should use `apt-get` to update and upgrade all installed software and to install `git`. (Git will be used to download the LoRa Basics station software.)

If necessary, create a folder `~/Documents.`

Clone the Hardware Access Layer git repo into the `~/Documents` folder.

Build the repo using:

```
make clean all
make all
```

Find the `reset_lgw.sh` script and copy it into each of the `util_chip_id` and `packet_forwarder` subdirectories. Ensure the file is executable.

From the `util_chip_id` subdirectory, run the tool `chip_id`. Note the EUI value.

Create Gateway on The Things Stack

- Register at The Things Network and log in.
- Find your way to the Console and make sure that you're in the Australia 1 cluster.
- Register a Gateway as specified in the Objectives.

You can now use the **Gateways** tab to monitor the gateway's actions on TTN.

Hint: Make sure that you join The Things Network, not The Things Stack Industries. If it's not free, you're in the wrong place.

Configure the packet forwarder

There is no single configuration file that is correctly set up for Australian use with this gateway hardware.

- The instructions at the Waveshare website (see above) are for the European region.
- The file you can download from TTN as `global_conf.json` also has some useful values.

Hint: You can use the `scp` command to copy files between the PC and the Pi.

Combine the two to create a correct configuration file and save it in the appropriate folder on the Raspberry Pi.

Run the Packet Forwarder

Follow the Waveshare instructions to start the packet forwarder.

Monitor the Gateway at the TTN website to see if it is running.

Test the gateway

Force an uplink message from the LoRaWAN node you have been provided.

Monitor the Gateway's *Live Data* page at the TTN website to see if it is arriving.

Final steps

Make the Gateway start automatically as a service when the Pi boots.

- Rename the test configuration file to `global_conf.json`.
- Create a `systemd` service file named `start_packet_forwarder.service`.
- Ensure that service restarts automatically 5 seconds after failure.
- Write standard and error outputs to two log files in the executable's directory.
- Set the log identifier to be `ttn-gateway`.
- Register the service using `systemctl`.

Reboot the Pi and ensure that the Gateway service starts correctly.

Troubleshooting

- To list relevant running tasks, use:
  ```
  ps -ef | grep "lora"
  ```
- If the packet forwarder does not start, check both the logs in the executable file's directory.
- If the packet forwarder does not connect to the TTN server, check the configuration file and the logs.
- You can also search the `systemd` log:
  ```
  journalctl -u start_packet_forwarder.service
  ```
  or
  ```
  journalctl -u start_packet_forwarder.service | tail
  ```
- To stop the packet forwarder, type:
  ```
  sudo systemctl stop start_packet_forwarder.service
  ```
- To stop the packet forwarder directly, type:
  ```
  ps -ef | grep "lora"
  ```
  Note the process ID, then type, e.g.:
  ```
  sudo kill -9 862
  ```
  where `862` is the process ID.

Appendix – Hardware list

For each group:

- Raspberry Pi 4
- Raspberry Pi 4 power supply
- Keyboard + mouse
- 32 GB SD Card
- Waveshare SX1303 915M LoRaWAN Gateway HAT

For the lab:

- WiFi Router (supplied)
- Dragino SN50V3-LB Sensor Node, configured for Australian TTN use (supplied)