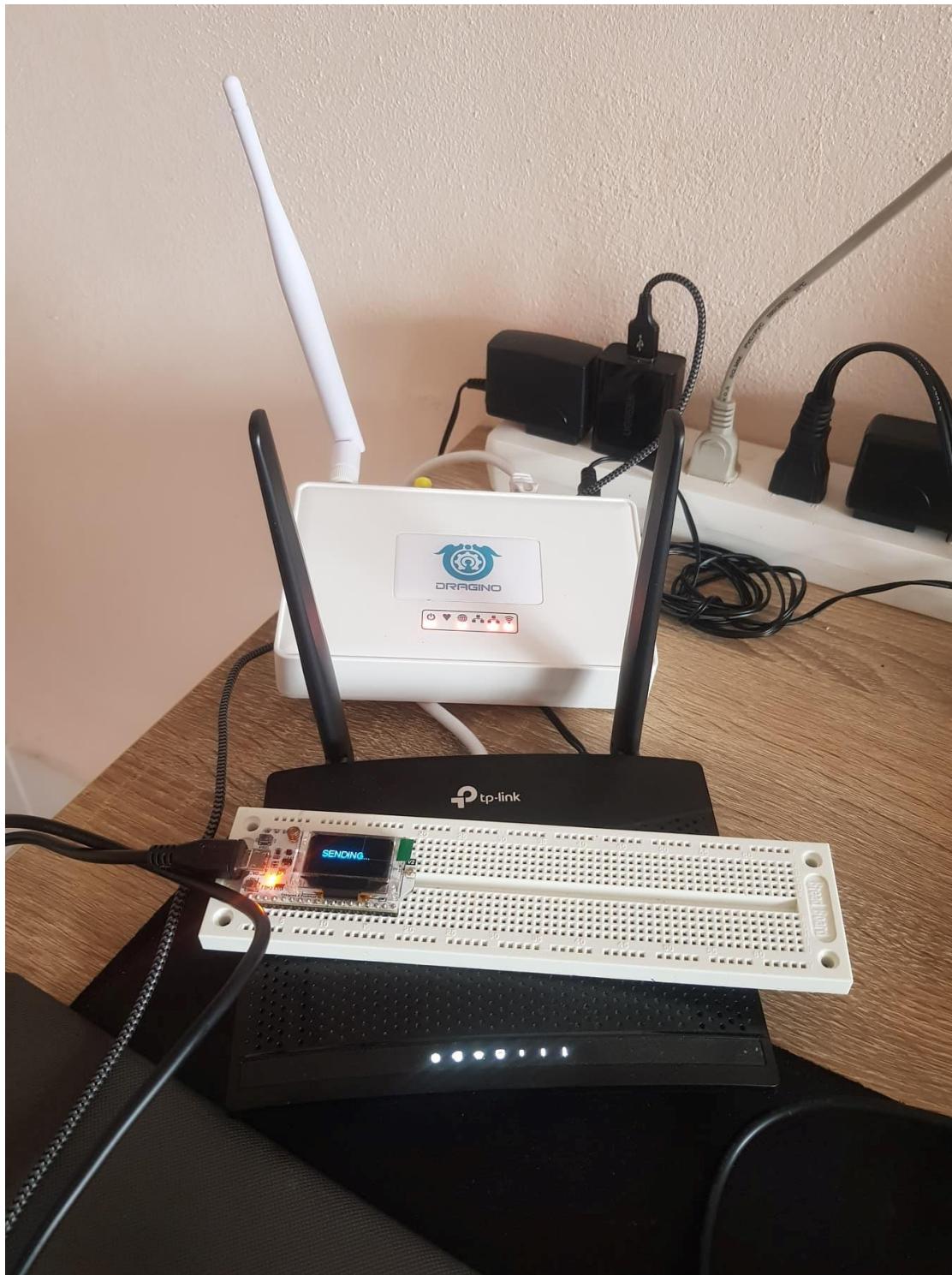


## คู่มือการใช้งาน Chirp Stack Lora WAN® Network Server



## ติดตั้ง Chirp Stack Lora WAN® Network Server บน PI 4B

ก่อนอื่นให้ติดตั้ง Noob หรือ Raspbian ให้เรียบร้อยแล้วใช้คำสั่งดังนี้

```
sudo apt updatesudo apt upgradegit clone
https://github.com/m2mlorawan/ChirpStack\_on\_Raspbiancd
ChirpStack_on_Raspbian/chmod +x install.shsudo
./install.shsudo reboot
```

หลังจาก Pi บูทเสร็จ เรียกใช้งานด้วย Port 8080

<http://<PI IP>:8080>

และใช้ User admin และ Password admin

The screenshot shows the ChirpStack web application interface. The top navigation bar includes a back button, forward button, refresh button, and a search bar with the placeholder 'Search organization, application, gateway or device'. The URL bar shows the address '10.130.1.203:8080/#/network-servers'. The main content area is titled 'Network-servers' and displays a table with one row. The table columns are 'Name' and 'Server'. The single entry is 'ns' with 'localhost:8000' listed under 'Server'. At the bottom right of the table, there is a 'Rows per page:' dropdown set to '10'. On the left side, there is a sidebar with a search bar containing 'chirpstack'. Below the search bar is a list of navigation items: Network-servers, Gateway-profiles, Organizations, All users, API keys, chirpstack (selected), Org. settings, Org. users, Service-profiles, Device-profiles, Gateways, Applications, and Multicast-groups.

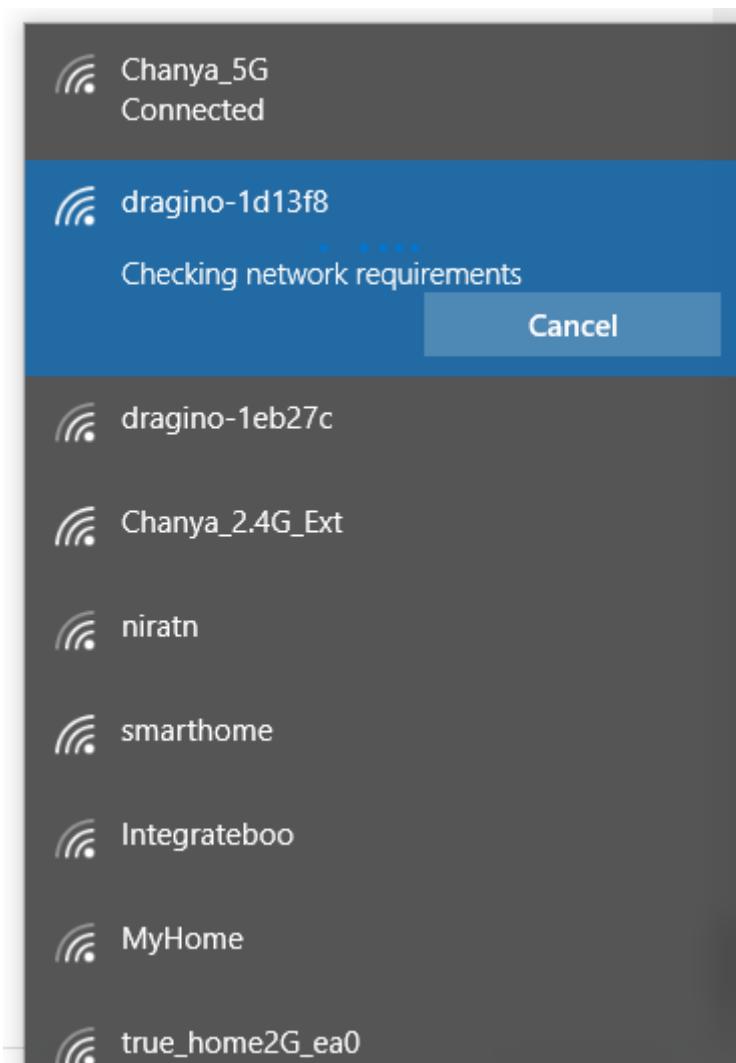
Name	Server
ns	localhost:8000

### แก้ค่าใน LoRaWAN® gateway

ให้แก่ที่ Gateway โดยให้เข้าไปที่ IP ของ LoRaWAN® Network Server ที่เราสร้างขึ้น  
ตัวอย่าง เช่น ถ้าใช้ Dragino LG308-AS923-EC25 ตามรูป



ให้ Connect gateway ด้วย WIFI เลือก Hotspot ที่ขึ้นด้วย Dragino



เข้ามายังต่อตัวโดยรหัสผ่าน dragino+dragino เปิดเว็บที่หน้า 10.130.1.1 เข้าด้วย ยูสเซอร์และรหัสผ่าน admin/admin

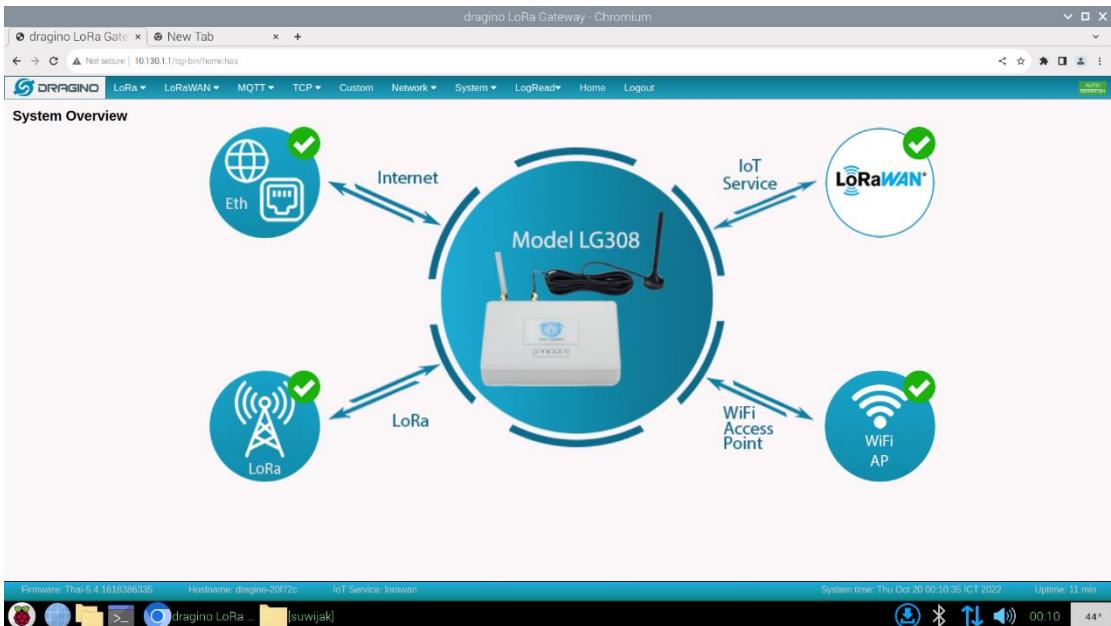
① 10.130.1.1/cgi-bin/home.cgi

ลงชื่อเข้าใช้

http://10.130.1.1  
การลงชื่อต้องกับชื่อที่มีเป็นส่วนตัว

ชื่อผู้ใช้	admin
รหัสผ่าน	*****

## การทำงาน Gateway



Gateway Dragino Home หน้านี้เป็นหน้าที่บอกการทำงานของ Gateway ว่าทำงานยังไง และ เชื่อมต่ออะไรบ้าง

Firmware: THi-E4.1613306335 Hostname: dragino-20f72c IoT Service: lorawan System time: Thu Oct 20 00:18:35 ICT 2022 Uptime: 11 min

dragino LoRa Gate x | +

Not secure | 10.130.1.1/cgi-bin/home.cgi

**dragino** LoRa ▾ LoRaWAN ▾ MQTT ▾ TCP ▾ Custom Network ▾ System ▾ LogRead ▾ Home Logout

**LoRaWAN Configuration**

**General Settings**

Email: topstop0023@hotmail.co.th  
Gateway ID: a8404120f72c4150

**Primary LoRaWAN Server**

Service Provider: Custom / Private LoRaWAN Server Address: 10.130.1.238  
Uplink Port: 1700 Downlink Port: 1700

**Packet Filter**

Fport Filter: 0 DevAddr Filter: ?[0]

Current Mode: LoRaWAN Semtech UDP

Save&Apply | Cancel

Gateway Dragino Setup เป็นหน้าการตั้งค่าอีเมล และ Password ID ของ Gateway

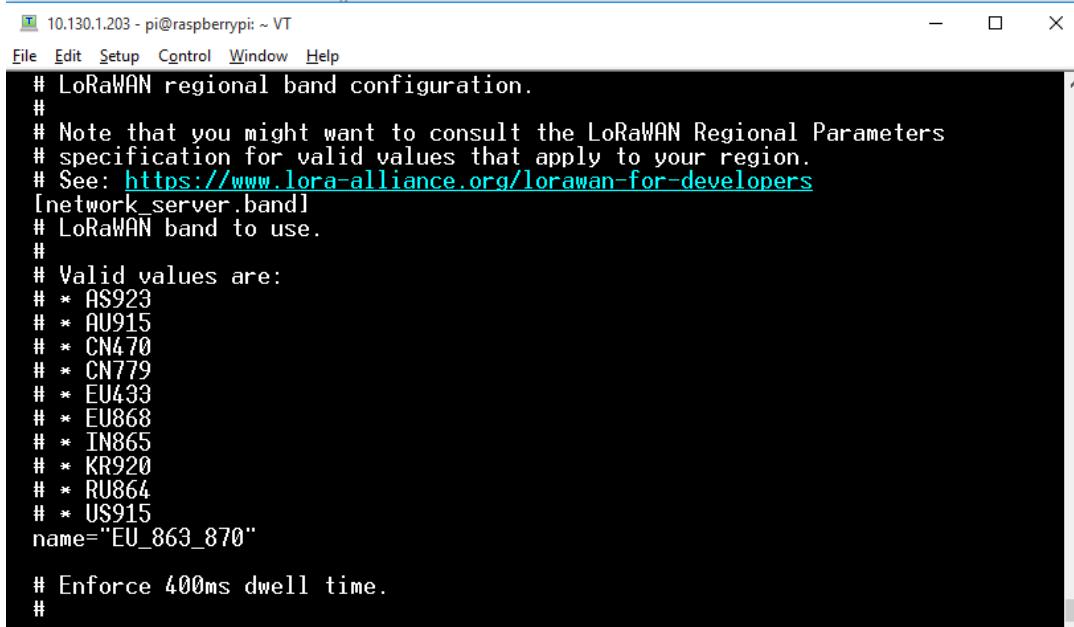
The screenshot shows the ChirpStack web interface for managing network-servers. On the left, there's a sidebar with options like Network-servers, Gateway-profiles, Organizations, All users, API keys, and a dropdown for 'chirpstack'. The main area is titled 'Network-servers / ns (EU868 @ 3.9.0)'. It has three tabs: GENERAL (selected), GATEWAY DISCOVERY, and TLS CERTIFICATES. Under GENERAL, there are two fields: 'Network-server name' with the value 'ns' and 'Network-server server' with the value 'localhost:8000'. A red circle highlights the network-server name, and two red arrows point to the 'ns' and 'localhost:8000' fields respectively. At the bottom right, there's a blue 'UPDATE NETWORK-SERVER' button.

ความถี่ของสัญญาณ

Script ที่ติดตั้งวิธีที่กล่าวข้างต้น จะติดตั้งค่าความถี่ Default ของ network-server เป็น EU868 โดยสังเกตุจาก NS ของเรา Default จะมี (EU868 @ 3.9.0) ต่อท้าย ซึ่งจะมีปัญหากับเราตอน Downlink ซึ่งหากมี Node แบบ OTAA ติดต่อเข้ามา จังหวะ Downlink ตัว Hardware ของ Lora WAN Gateway จะถูกสั่งให้ปรับความถี่กลับไปที่ช่อง 868 ซึ่งตัว Lora WAN Gateway จะไม่ยอมอนุญาติตามที่ chirp stack-network-server ร้องขอ แต่จะรายงาน Error กลับมาที่ Network Server ทำให้การ Downlink ทั้งหมดทำไม่สำเร็จ ดูว่า Config ที่ใช้อยู่ปัจจุบันของ chirp stack-network-server มีค่าอะไรบ้าง โดยใช้คำสั่ง

chirp stack-network-server configfile

จะเห็นว่ามีการตั้งค่าเป็น name="EU\_868\_870"



```

10.130.1.203 - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
# LoRaWAN regional band configuration.
#
# Note that you might want to consult the LoRaWAN Regional Parameters
# specification for valid values that apply to your region.
# See: https://www.lora-alliance.org/lorawan-for-developers
[network_server.band]
# LoRaWAN band to use.
#
# Valid values are:
# * AS923
# * AU915
# * CN470
# * CN779
# * EU433
# * EU868
# * IN865
# * KR920
# * RU864
# * US915
name="EU_863_870"

# Enforce 400ms dwell time.
#

```

แก้ไขความถี่

ก่อนอื่น เข้าสิทธิ System Admin ก่อนโดยใช้คำสั่ง คำสั่งหนึ่งดังนี้

sudo -i หรือ sudo su หรือ sudo -s

เปลี่ยน Dir ให้งานเป็น /etc/chirp stack-network-server

cd /etc/chirp stack-network-server

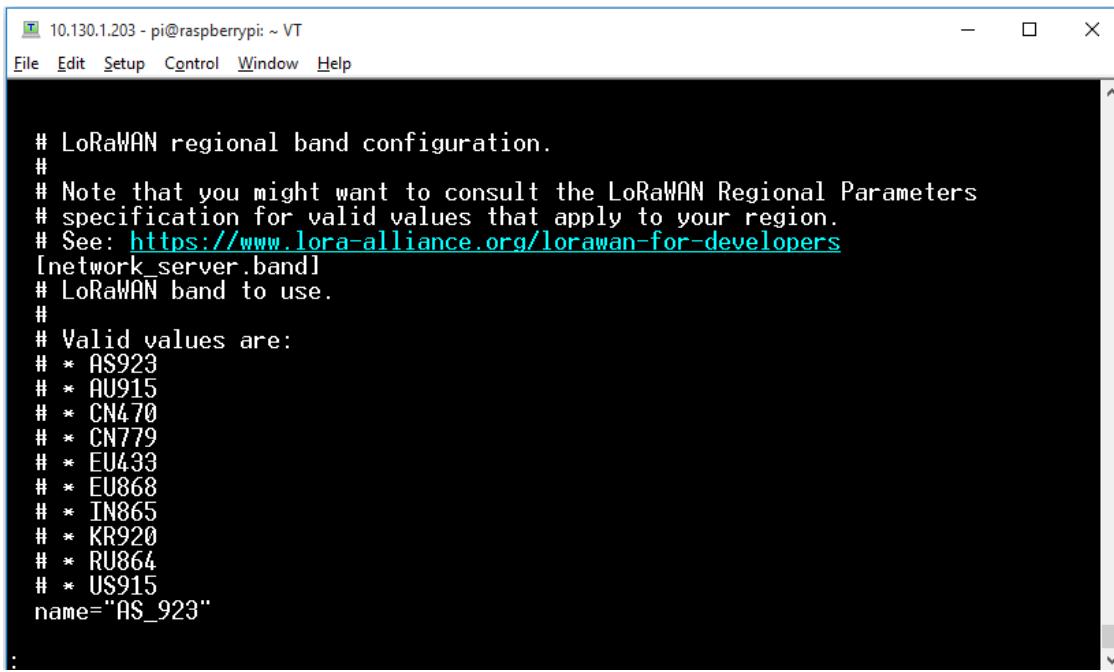
Backup ไฟล์เดิมไว้ก่อน โดยใช้คำสั่ง

cp chirp stack-network-server.toml chirp stack-network-server.toml.BAK

ให้ Copy ไฟล์ AS\_923 ไปแทน

cp chirpstack-network-server.as\_923.toml chirp stack-network-server.toml

ลองเช็คอ่านค่า config อีกครั้งจะเห็นว่า name="AS\_923"



```
# LoRaWAN regional band configuration.
#
# Note that you might want to consult the LoRaWAN Regional Parameters
# specification for valid values that apply to your region.
# See: https://www.lora-alliance.org/lorawan-for-developers
[network_server.band]
# LoRaWAN band to use.
#
# Valid values are:
# * AS923
# * AU915
# * CN470
# * CN779
# * EU433
# * EU868
# * IN865
# * KR920
# * RU864
# * US915
name="AS_923"
```

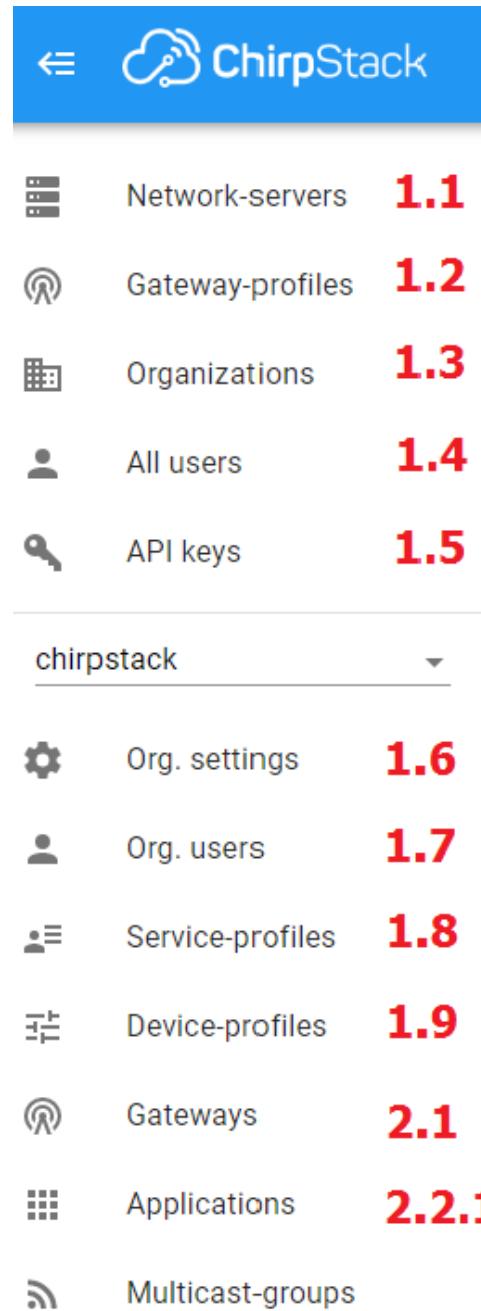
แก้ไขความถี่เป็น AS\_923

Restart chirp stack-network-server ใหม่โดย

sudo systemctl restart chirp stack-network-server

## ใช้งาน Chirp Stack Lora WAN® Network Server บน PI 4B

การใช้งานจะเริ่มต้นจากเมนูข้างซ้ายของจอภาพ จากบนลงล่าง หลังล็อกอินเสร็จจะมีเมนูด้านซ้ายดังนี้ บทความนี้จะแนะนำให้เรียงแต่ละเมนูตามทัวร์ข้อสีแดงในภาพ



เมนูภายใน chirp stack ก็จะมี ปุ่ม Network-servers, Gateway-profiles, Organizations, allusers, API keys, Org. Settings, Org.Users, Service-Profiles ,Device-Profiles, Gateways, Applications, Multicast-groups

The screenshot shows the ChirpStack web interface. On the left, a sidebar menu under the 'chirpstack' section includes 'Network-servers', 'Gateway-profiles', 'Organizations', 'All users', and 'API keys'. The main content area is titled 'Network-servers' and displays a table with one row. The row contains 'ns' in the 'Name' column and 'localhost:8000' in the 'Server' column. Two red arrows point to these entries. A search bar at the top right says 'Search organization, application, gateway or device'.

เมนู Network-server หน้านี้จะบอก ชื่อของ Network และ ID ของ Server Network

The screenshot shows the ChirpStack web interface. On the left, a sidebar menu under the 'chirpstack' section includes 'Network-servers', 'Gateway-profiles', 'Organizations', 'All users', and 'API keys'. The main content area is titled 'Network-servers / ns (EU868 @ 3.9.0)' and shows a configuration form for the network server 'ns'. The 'GENERAL' tab is selected. It has fields for 'Network-server name' (containing 'ns') and 'Network-server server' (containing 'localhost:8000'). A red arrow points to each of these fields. A 'DELETE' button is visible in the top right corner. At the bottom right is a 'UPDATE NETWORK-SERVER' button.

หน้านี้จะบอกถึงว่ามีการตั้งค่า ns ไว้แล้วเป็น localhost:8000

Gateway-profiles

Important: Gateway profiles are deprecated and will be removed in the next major release.

Name	Network-server
gateway_profile	ns

หน้านี้จะบอกรหัสชื่อของ Gateway-profile และชื่อของ Network server

Gateway-profiles / gateway\_profile

Name \*  
gateway\_profile

Enabled channels \*  
0, 1, 2

[ADD EXTRA CHANNEL](#) [UPDATE GATEWAY-PROFILE](#)

มีการตั้งค่า gateway profile ไว้แล้ว เชื่อมเข้ากับ Network Server ชื่อ NS

ChirpStack

Search organization, application, gateway or device

Network-servers  
Gateway-profiles  
Organizations  
All users  
API keys

chirpstack

Org. settings  
Org. users

Organizations

Name	Display name	Can have gateways
chirpstack	ChirpStack	<input checked="" type="checkbox"/>

Rows per page: 10 1-1 of 1

หน้าของเมนู Organization จะบอกชื่อของ Organization และชื่อ display ของ Organization ชื่อ chirp Stack

ChirpStack

Search organization, application, gateway or device

Network-servers  
Gateway-profiles  
Organizations  
All users  
API keys

chirpstack

Org. settings  
Org. users  
Service-profiles  
Device-profiles

Organizations / chirpstack

DELETE

Organization name \*  
chirpstack

The name may only contain words, numbers and dashes.

Display name \*  
ChirpStack

Gateways  
 Organization can have gateways

When checked, it means that organization administrators are able to add their own gateways to the network. Note that the usage of the gateways is not limited to this organization.

UPDATE ORGANIZATION

หน้านี้จะเป็นหน้าของเมนู Org. settings ตั้งไว้แล้วตามรูป

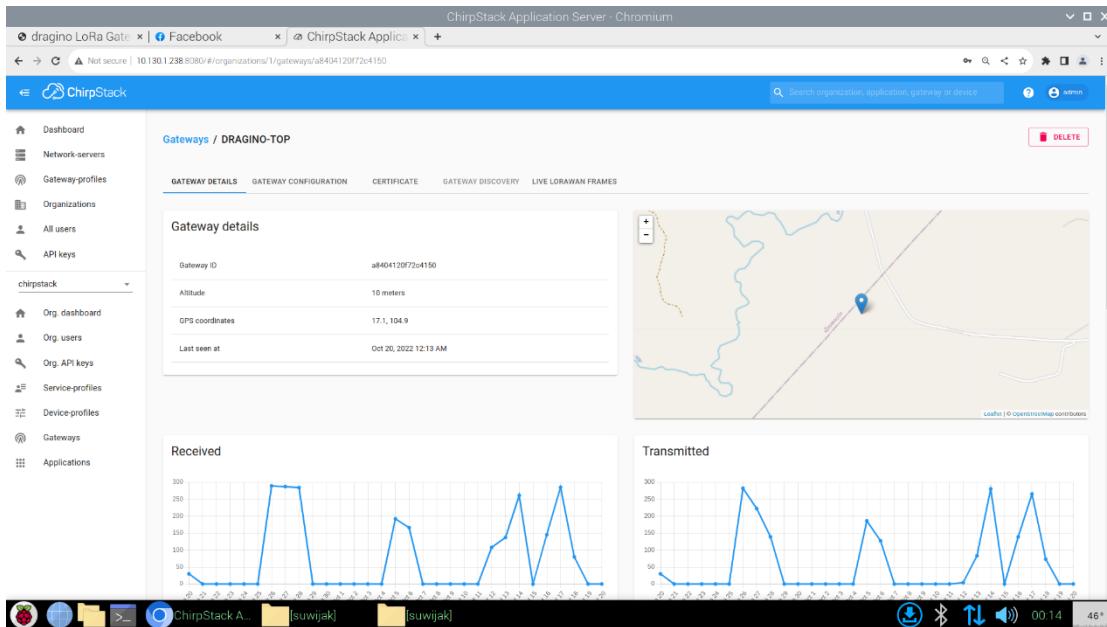
ID	Username	Admin
1	admin	<input checked="" type="checkbox"/>

หน้านี้จะเป็นหน้าของเมนู Org. users จะมี Username ชื่อ admin และมี ID คือ 1

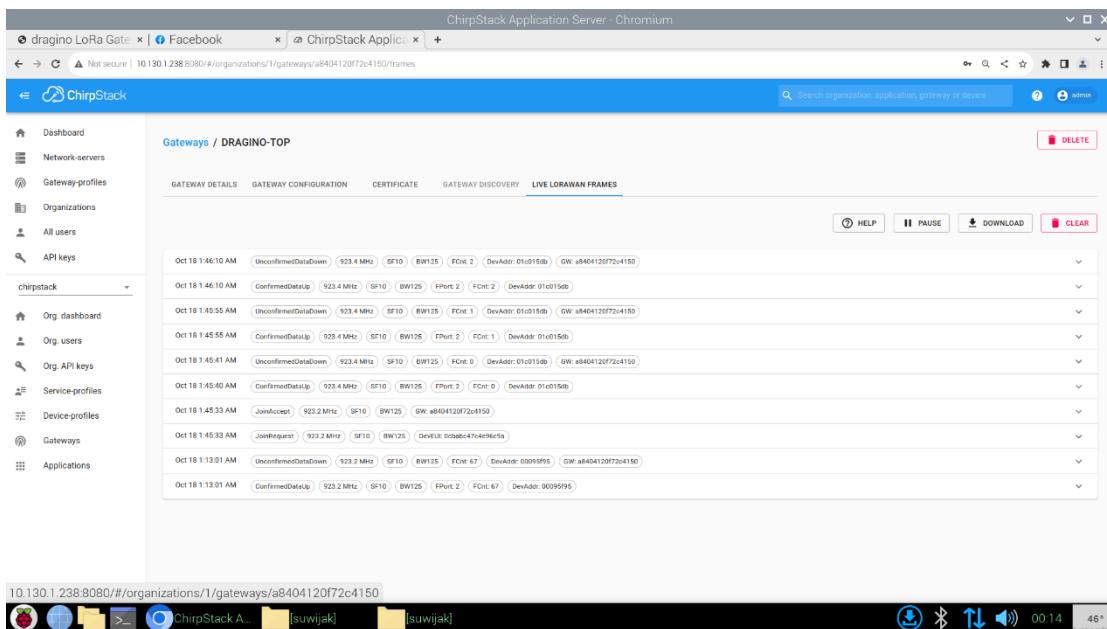
Last seen	Name	Gateway ID	Network server	Gateway activity (30d)
a few seconds ago	DRAGINO-TOP	a8404120f72c4150	ns	
Never	rak_gateway	0000000000000000	ns	

หน้านี้จะเป็นหน้าของ Gateway Menu หน้านี้จะบอก ว่า Gateway Menu มีอะไรบ้าง

LORAWAN GUIDE BY SUWIJAK



หน้านี้จะบอกรายละเอียด Gateway ที่จะบอกราฟ received และราฟ Transmitted



หน้านี้จะบอกถึงข้อมูลที่ส่งผ่าน Gateway

## LORAWAN GUIDE BY SUWIJAK

The screenshot shows the ChirpStack Application Server interface in a Chromium browser window. The URL is 10.130.1.238:8080/#/organizations/1/applications. The left sidebar has a 'chirpstack' section with 'Applications' selected. The main area is titled 'Applications' and lists two entries:

ID	Name	Service-profile	Description
1	app	service-profile	app
2	heltec-bike1	heltec	123132

At the bottom, there are navigation links: 'Rows per page: 10', '1 of 2', and '>'. The status bar at the bottom shows the IP address 10.130.1.238:8080, the ChirpStack logo, and two yellow [suwijak] icons.

หน้านี้จะเป็นหน้า Application Menu ที่จะบอกรายชื่อ Application profile

The screenshot shows the ChirpStack Application Server interface in a Chromium browser window. The URL is 10.130.1.238:8080/#/organizations/1/applications/2. The left sidebar has a 'chirpstack' section with 'Applications / heltec-bike1' selected. The main area is titled 'Devices' and lists one device entry:

Last seen	Device name	Device EUI	Device profile	Link margin	Battery
a few seconds ago	heltec-bike1	0cbabc47c4e96c9a	device_profile_etaa	n/a	n/a

At the bottom, there are navigation links: 'Rows per page: 10', '1 of 1', and '>'. The status bar at the bottom shows the IP address 10.130.1.238:8080, the ChirpStack logo, and two yellow [suwijak] icons.

หน้านี้จะบอกรายชื่อ Device ที่จะแสดงใน Application

## LORAWAN GUIDE BY SUWIJAK

ChirpStack Application Server - Chromium

dragino LoRa Go | ChirpStack Appl... | Node-RED : 10.1 | +

Not secure | 10.130.1.238:8080/#/organizations/1/applications/2/devices/0cda847c4e95ca1/data

ติดต่อ Chir... ChirpSta... dragino L... ใจหาย Chi... ก้าวติดเพร... Notes for... MQTT au... TLS -> C... ssl - Mos... MQTT - C... MQTT W...

ChirpStack

Dashboard Network-servers Gateway-profiles Organizations All users API keys chirpstack Org. dashboard Org. users Org. API keys Service-profiles Device-profiles Gateways Applications

Applications / Bike-keep / Devices / Bike-keep1

DETAILS CONFIGURATION KEYS (OTAA) ACTIVATION DEVICE DATA LORAWAN FRAMES

**Details**

Name	Bike-keep1
Description	lora@be1
Device profile	device_profile_otaa
Multicast groups	

**Received**

**SNR**

**RSSI**

**Status**

Last seen at: Oct 31, 2022 2:59 PM  
State: enabled

**Errors**

**RSS**

ChirpStack A... suwijak@ras... suwijak

12:33 45°

หน้านี้จะแสดงข้อมูล Device Detail

ChirpStack Application Server - Chromium

dragino LoRa Go | ChirpStack Appl... | Node-RED : 10.1 | +

Not secure | 10.130.1.238:8080/#/organizations/1/applications/2/devices/0cda847c4e95ca1/data

ติดต่อ Chir... ChirpSta... dragino L... ใจหาย Chi... ก้าวติดเพร... Notes for... MQTT au... TLS -> C... ssl - Mos... MQTT - C... MQTT W...

ChirpStack

Dashboard Network-servers Gateway-profiles Organizations All users API keys chirpstack Org. dashboard Org. users Org. API keys Service-profiles Device-profiles Gateways Applications

Applications / Bike-keep / Devices / Bike-keep1

DETAILS CONFIGURATION KEYS (OTAA) ACTIVATION DEVICE DATA LORAWAN FRAMES

Nov 02 12:33:55 PM up 923.4 MHz SF10 BW125 FPort: 164 FPort: 2 Confirmed

Nov 02 12:33:40 PM up 923.2 MHz SF10 BW125 FPort: 163 FPort: 2 Confirmed

```

applicationID: "2"
applicationName: "Bike-keep"
deviceName: "Bike-keep1"
radioEUI: "0cda847c4e95ca1"
radioType: "LoRa"
rx2: 0 keys
rx1: 0 keys
rx0: 0 keys
tx1: 0 keys
tx0: 0 keys
fPort: 2
deviceProfile: "device_profile_otaa"
decodeDataHex: "4254445744fe654fe"
decodeDataString: "TTDevOneOn"
tags: 0 keys
confirmedUplink: true
devAddr: "01fe9715"
publishedAt: "2022-11-02T12:33:40.731931192Z"
deviceProfile: "device_profile_otaa"
deviceProfileName: "device_profile_otaa"
  
```

ChirpStack A... suwijak@ras... suwijak

12:34 46°

หน้านี้จะจัดทำข้อมูลของ Device Data

Organization name\*: chirpstack  
The name may only contain words, numbers and dashes.

Display name\*: ChirpStack

Gateways

Organization can have gateways

When checked, it means that organization administrators are able to add their own gateways to the network. Note that the usage of the gateways is not limited to this organization.

UPDATE ORGANIZATION

หน้านี้จะบอกการตั้งค่า Organization ไว้แล้วข้อ chirp stack

Username	Active	Admin
admin	✓	✓

Rows per page: 10 1-1

หน้านี้จะเป็นหน้าเมนู All users ที่บอกรหัส Username ชื่อ admin

ChirpStack Admin UI - Users / admin

Username \* admin

E-mail address \*

Optional note

Optional note, e.g. a phone number, address, comment...

Permissions

Is active

Is global admin

UPDATE USER

หน้านี้จะบอกว่ามีการตั้งเพิ่มค่าในเมนู All users ไว้แล้วซึ่งเป็น User : admin

ChirpStack Admin UI - Global API keys

+ CREATE

ID	Name

Rows per page: 10 0-0 of 0

ยังไม่ได้มีการตั้งค่าใดๆ เราสามารถสร้าง API KEY โดยคลิก Create มุมขวาบน บทความนี้เรายังไม่ได้ใช้ค่านี้

Organization users / admin

Username: admin

An user without additional permissions will be able to see all resources under this organization and will be able to send and receive device payloads.

User is organization admin ←

An organization admin user is able to add `join request` resources part of the organization.

**UPDATE USER**

หน้านี้จะบอกว่ามีการตั้งค่าไว้แล้วคือ หน้า Organization users ชื่อ admin

Service-profiles

Name
service-profile <span style="color:red">←</span>

Rows per page: 10 1-1 of 1 < >

หน้านี้จะบอกถึงเมนู Service profile ที่มี Username ชื่อ Service profile

## LORAWAN GUIDE BY SUWIJAK

ChirpStack Application Server - Chromium

dragino LoRa Gate Facebook ChirpStack Application Server

Not secure | 10.130.1.238:8080/#/organizations/1/service-profiles/993405dc-7299-42f5-b151-23ef96d7b255

ChirpStack

Service-profiles / heltec

Service-profile name \* heltec

Add gateway meta data

GW metadata (RSSI, SNR, GW geoloc., etc.) are added to the packet sent to the application-server.

Enable network geolocation

When enabled, the network-server will try to resolve the location of the devices under this service profile. Please note that you need to have gateways supporting the fine-timestamp feature and that the network-server needs to be configured in order to provide geolocation support.

Device-status request frequency 0

Frequency to initiate an End-Device status request (request/day). Set to 0 to disable.

Minimum allowed data-rate \* 10

Minimum allowed data rate. Used for ADR.

Maximum allowed data-rate \* 10

Maximum allowed data rate. Used for ADR.

Private gateways

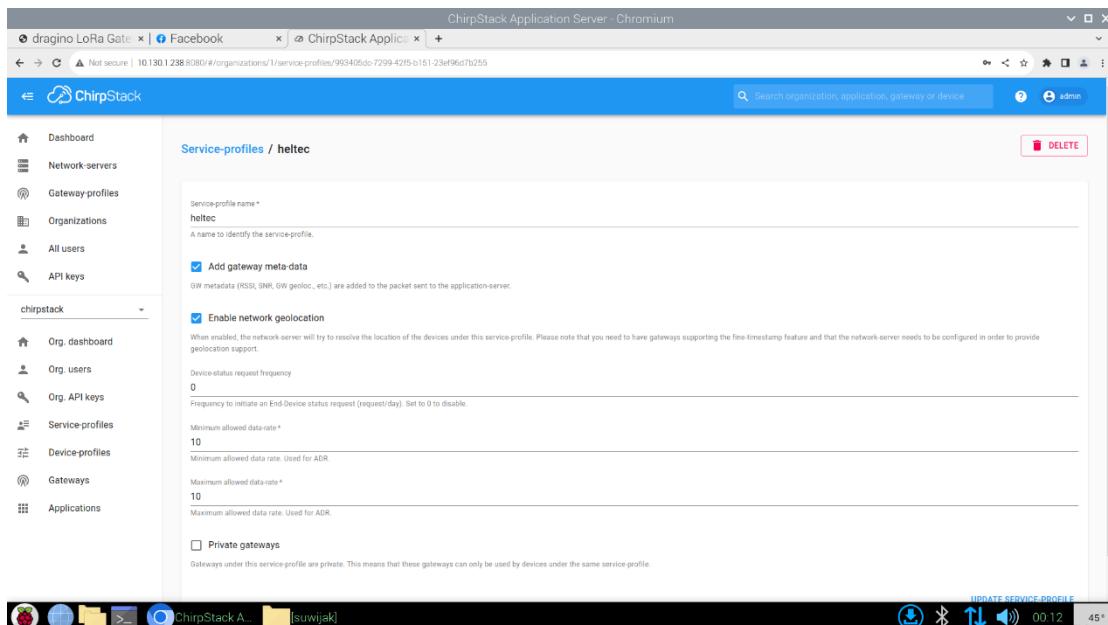
Gateways under this service-profile are private. This means that these gateways can only be used by devices under the same service-profile.

UPDATE SERVICE PROFILE

Org. dashboard Org. users Org. API keys Service-profiles Device-profiles Gateways Applications

ChirpStack A [suwijak]

00:12 45°



ChirpStack Application Server - Chromium

dragino LoRa Gate Facebook ChirpStack Application Server

Not secure | 10.130.1.238:8080/#/organizations/1/device-profiles

ChirpStack

Device-profiles

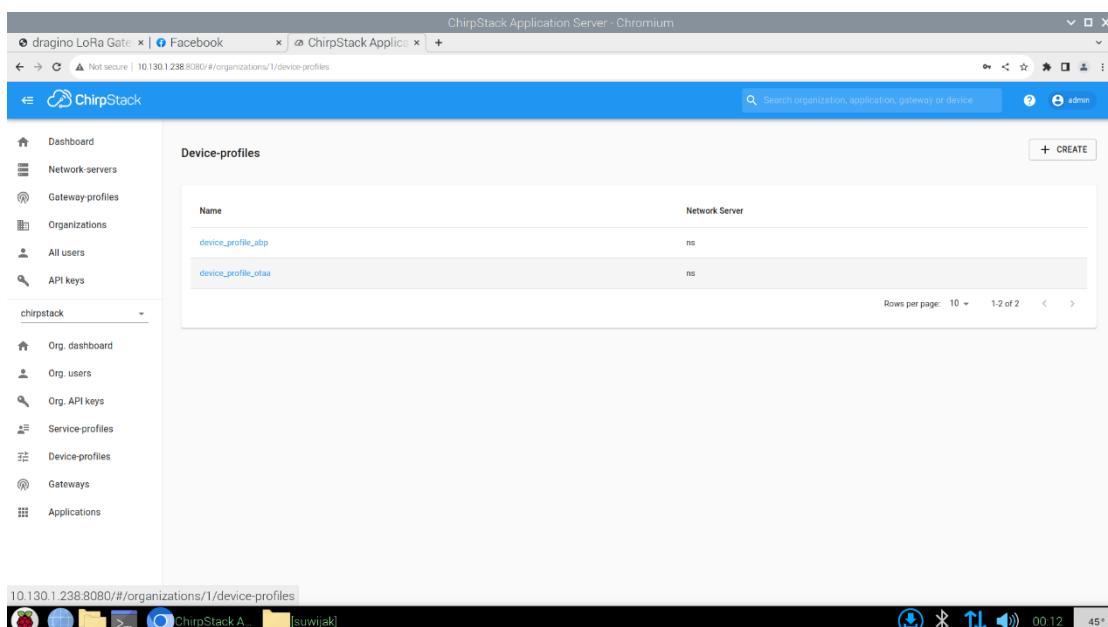
+ CREATE

Name	Network Server
device_profile_abp	ns
device_profile_oiaa	ns

Rows per page: 10 1-2 of 2 < >

10.130.1.238:8080/#/organizations/1/device-profiles

ChirpStack A [suwijak] 00:12 45°



## LORAWAN GUIDE BY SUWIJAK

ChirpStack Application Server - Chromium

dragino LoRa Gate | Facebook | ChirpStack Application Server

Not secure | 10.130.1.238:8080/#/organizations/1/device-profiles/9e89a1f2-fbf-46fa-840d-73f238053b0d

ChirpStack

Device-profiles / device\_profile\_otaas

GENERAL JOIN (OTAA / ABP) CLASS-B CLASS-C CODEC TAGS

Device profile name \* device\_profile\_otaas

LoRaWAN MAC version \* 1.0.2

LoRaWAN Regional Parameters revision \* A

ADR algorithm \* Default ADR algorithm (LoRa only)

Max EIRP \* 0

Uplink interval (seconds) \* 86400

UPDATE DEVICE-PROFILE

ChirpStack A [suwijak] [suwijak]

00:13 44°

ChirpStack Application Server - Chromium

dragino LoRa Gate | Facebook | ChirpStack Application Server

Not secure | 10.130.1.238:8080/#/organizations/1/device-profiles/9e89a1f2-fbf-46fa-840d-73f238053b0d

ChirpStack

Device-profiles / device\_profile\_otaas

GENERAL JOIN (OTAA / ABP) CLASS-B CLASS-C CODEC TAGS

Device supports Class-B

Class-B confirmed downlink timeout \* 30

Class-B timeout (in seconds) for confirmed downlink transmissions.

Class-B ping slot periodicity \* every 4 seconds

Class-B ping-slot periodicity

Class-B ping-slot data-rate \* 5

Class-B ping-slot frequency (Hz) \* 1

UPDATE DEVICE-PROFILE

ChirpStack A [suwijak] [suwijak]

00:13 46°

## LORAWAN GUIDE BY SUWIJAK

ChirpStack Application Server - Chromium

dragino LoRa Gate | Facebook | ChirpStack Application Server

Device-profiles / device\_profile\_otaas

GENERAL JOIN (OTAA / ABP) CLASS-B CLASS-C CODEC TAGS

Device supports Class-C

Select this option when the device will operate as Class-C device immediately after activation. In case it sends a DeviceModelId mac-command when it changes to Class-C, do not select this option.

Class-C confirmed downlink timeout \*

60

Class-C timeout (in seconds) for confirmed downlink transmissions.

UPDATE DEVICE-PROFILE

DELETE

Dashboard Network-servers Gateway-profiles Organizations All users API keys chirpstack

Org. dashboard Org. users Org. API keys Service-profiles Device-profiles Gateways Applications

ChirpStack Application Server - Chromium

dragino LoRa Gate | Facebook | ChirpStack Application Server

Device-profiles / device\_profile\_otaas

GENERAL JOIN (OTAA / ABP) CLASS-B CLASS-C CODEC TAGS

Payload codec

Custom JavaScript codec functions

By defining a payload codec, ChirpStack Application Server can encode and decode the binary device payload for you.

```
23 }  
24 } return str;  
25 }  
26 }  
27 function Decode(PPort, bytes)  
28 {  
29 } var myObj = {"DecodeDataToString": "", "DecodeDataHex": ""};  
30 var toString = decodeURIComponent(bytes);  
31 var hexString = bytes.toString('hex');  
32 myObj.DecodeDataToString = toString;  
33 myObj.DecodeDataHex = toHexString;  
34 return myObj;  
35 }  
36 }  
37 }  
The function must have the signature function Decode(PPort, bytes) and must return an object. ChirpStack Application Server will convert this object to JSON.  
1 // Decode decoder for given object into an array of bytes.  
2 // - PPort contains the ChirpStack PPort number  
3 // - obj contains an object, e.g. {"temperature": 22.5}  
4 // - variables contains the device variables e.g. {"calibration": "3.5"} (both the key / value are of type string)  
5 // - The function must return an array of bytes, e.g. [225, 230, 205, 0]  
6 function Decode(PPort, obj, variables) {  
7 return [];  
8 }
```

DELETE

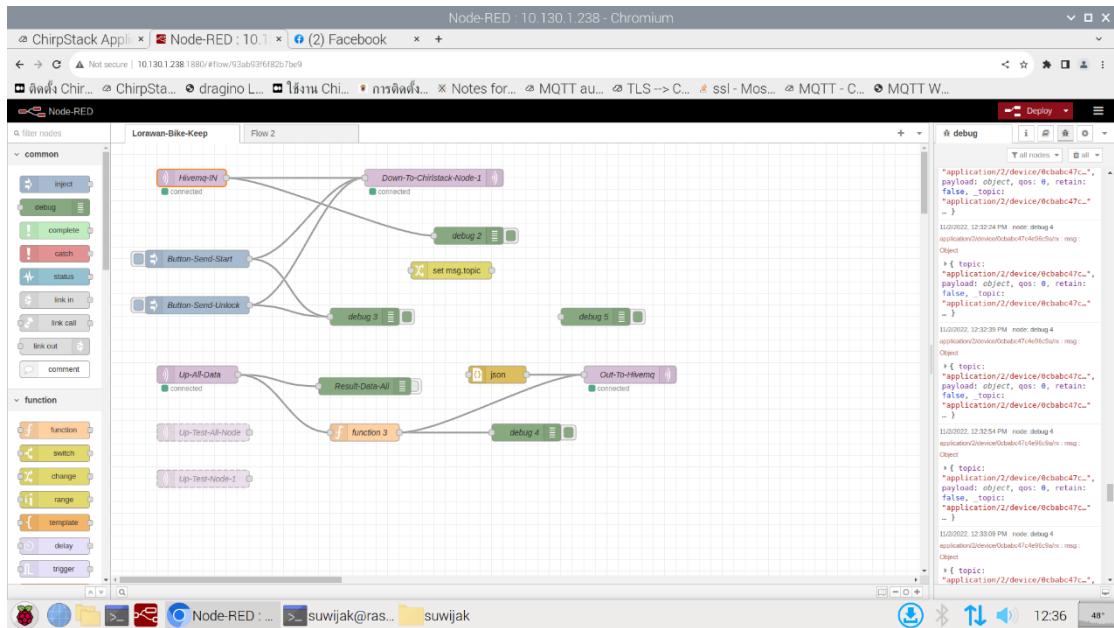
Dashboard Network-servers Gateway-profiles Organizations All users API keys chirpstack

Org. dashboard Org. users Org. API keys Service-profiles Device-profiles Gateways Applications

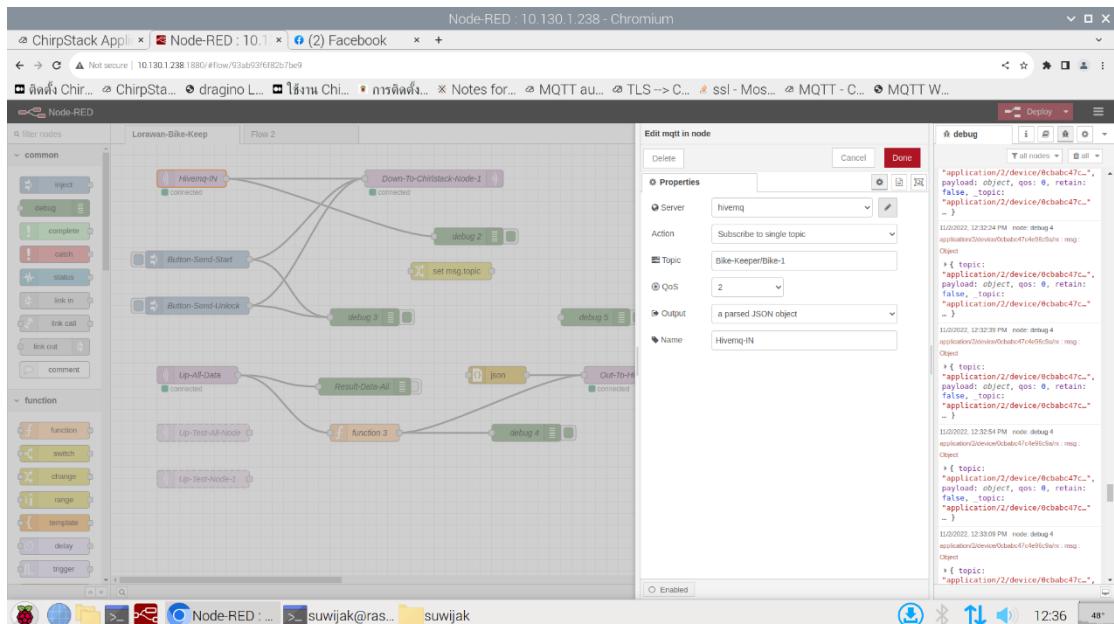
## LORAWAN GUIDE BY SUWIJAK

```
// Function encodes the given object into an array of bytes.
// - PPort contains the LoRaWAN FPort number
// - obj is an object, e.g. {"temperature": 22.5}
// - tmp is a temporary variable e.g. ("calibration": "3.5") (both the key / value are of type string)
// The function must return an array of bytes, e.g. [220, 230, 250, 0]
function Encode(PPort, obj, variables) {
    var str = "";
    for(var i=0; i<arr.length; i++) {
        var tmp = arr[i].toString(16);
        if(tmp.length == 1) {
            tmp = "0" + tmp;
        }
        str += tmp;
    }
    return str;
}
```

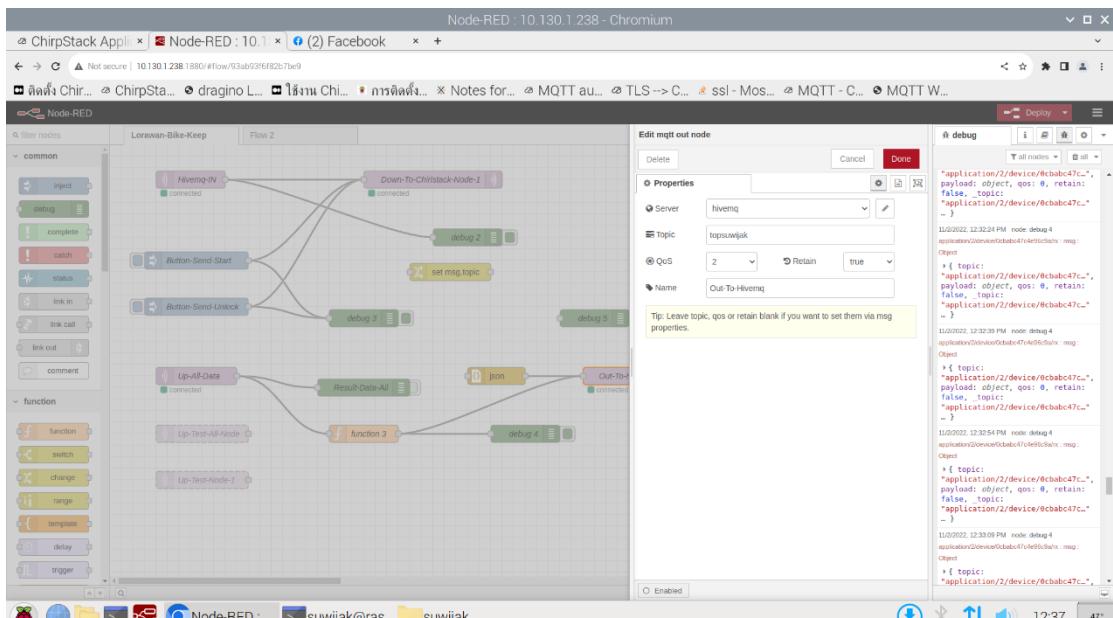
## การทำงานของ Node-red



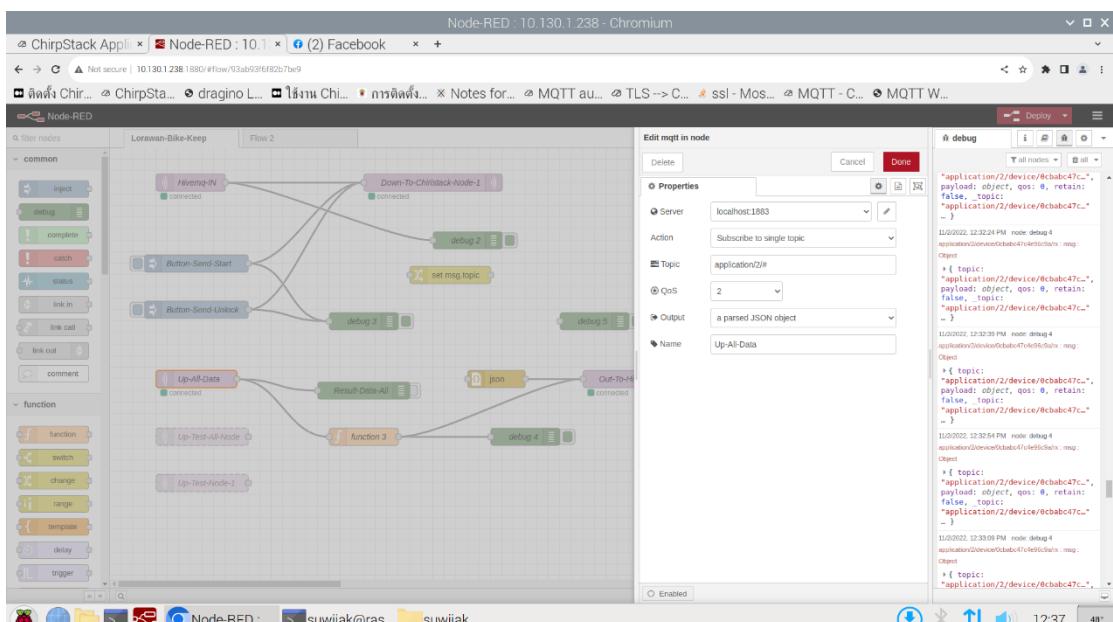
หน้านี้จะเป็นหน้าของ Node-red ที่จะบอกว่า Node-red เชื่อมไปไหนบ้างทำงานยังไงบ้าง



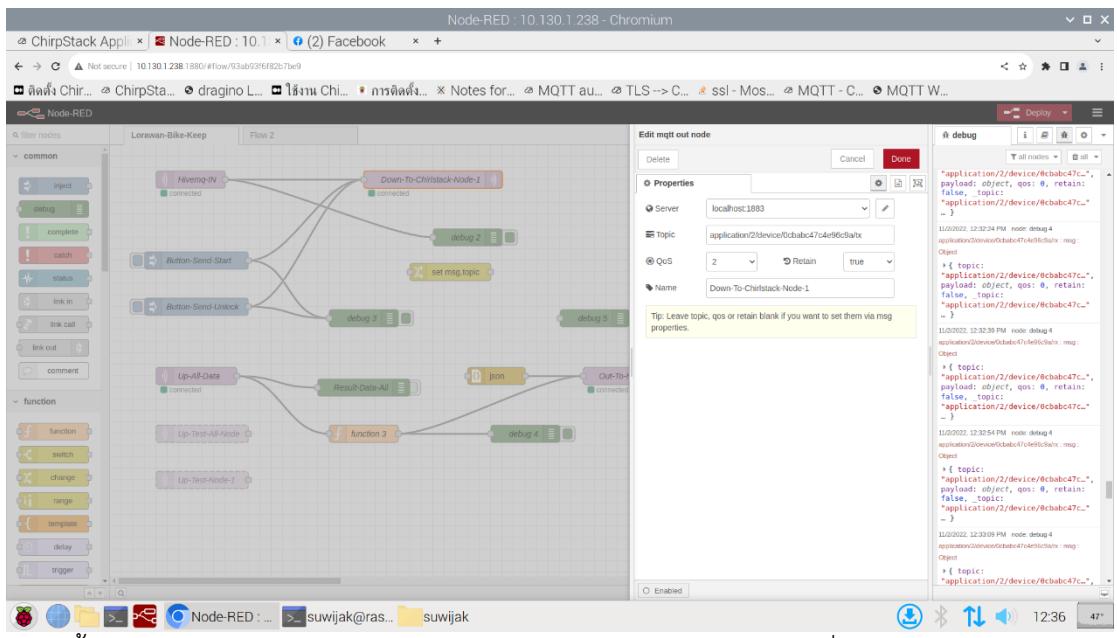
หน้านี้จะบอกว่า Node-red input from Hivemq คือการที่ Node-red เชื่อมต่อหรือ input ไปยัง Hivemq



หน้านี้จะแสดงให้เห็นว่า Node-red Output from Hivemq คือการที่ Node-red ทำการ Output หรือออกจาก Hivemq



หน้านี้จะแสดงหน้า Node-red Get data จาก Chirp stack คือ Node-red รับค่าข้อมูลมาจากการ Data และจาก Chirp stack



หน้านี้จะแสดงให้เห็นว่า Node-red send data ไป Chirp stack คือการที่ Node-red data ส่งข้อ  
มูลไปยัง chirp stack

## การทำงานของ MQTT

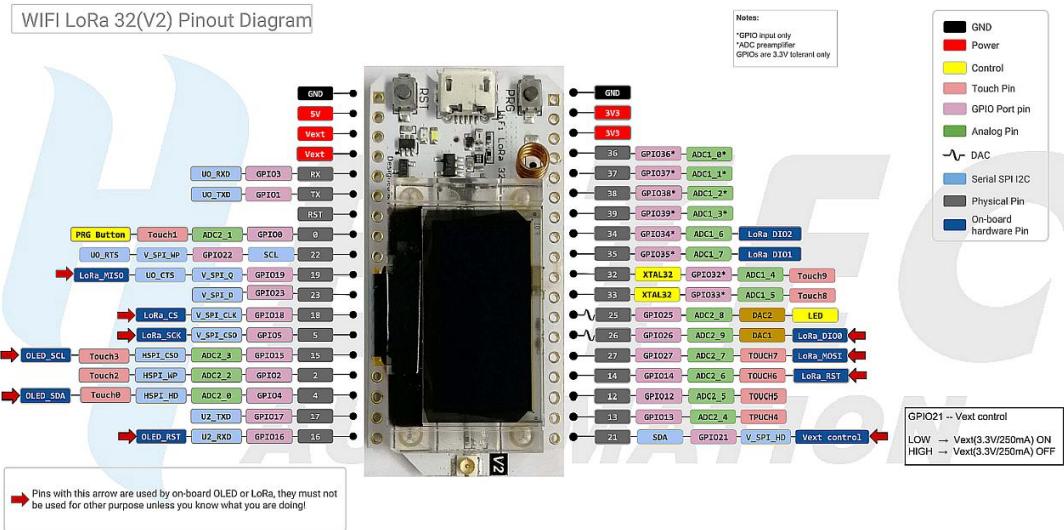
```
File Edit Tabs Help
sunijk@raspberrypi: ~ $ sudo service mosquitto stop
sunijk@raspberrypi: ~ $ mosquitto -v
1667392683: mosquitto version 2.0.11 starting
1667392683: Using default config.
1667392683: Starting in local only mode. Connections will only be possible from clients running on this machine.
1667392683: Create a configuration file which defines a listener to allow remote access.
1667392683: For more details see https://mosquitto.org/documentation/authentication-methods/
1667392683: Opening ipv4 listen socket on port 1883.
1667392683: Opening ipv6 listen socket on port 1883.
1667392683: New client connection from 127.0.0.1:55930 on port 1883.
1667392684: New client connected from 127.0.0.1:55930 as auto-E3F36EDF-1672-5482-E096-C93EAD934980 (p2, c1, k30).
1667392684: No will message specified.
1667392684: Sending CONNACK to auto-E3F36EDF-1672-5482-E096-C93EAD934980 (0, 0)
1667392684: New connection from ::1:35380 on port 1883.
1667392684: New client connected from ::1:35380 on port 1883.
1667392684: No will message specified.
1667392684: New client connected from ::1:35394 on port 1883.
1667392684: No will message specified.
1667392684: Sending CONNACK to auto-D37E11A1-DE72-BB05-2E13-9A601B95D060 (p2, c1, k30).
1667392684: New client connected from ::1:35394 on port 1883.
1667392684: No will message specified.
1667392684: Sending CONNACK to auto-10F1A685-7264-1B51-6A66-8A96EEC78002 (p2, c1, k30).
1667392684: Received SUBSCRIBE from auto-D37E11A1-DE72-BB05-2E13-9A601B95D060
1667392684: application/+device/+tx (QoS 0)
1667392684: auto-D37E11A1-DE72-BB05-2E13-9A601B95D066 0 application/+device/+tx
1667392684: Sending SUBACK to auto-D37E11A1-DE72-BB05-2E13-9A601B95D069
1667392684: Received SUBSCRIBE from auto-10F1A685-7264-1B51-6A66-8A96EEC78002
1667392684: gateway/+event/+ (QoS 0)
1667392684: auto-10F1A685-7264-1B51-6A66-8A96EEC78002 0 gateway/+event/+
1667392684: Sending SUBACK to auto-10F1A685-7264-1B51-6A66-8A96EEC78002
1667392684: Received SUBSCRIBE from auto-E3F36EDF-1672-5482-E096-C93EAD934980
1667392684: gateway/a8a04120f72c4150/command/# (QoS 0)
1667392684: auto-E3F36EDF-1672-5482-E096-C93EAD934980 0 gateway/a8a04120f72c4150/command/#
1667392684: Sending SUBACK to auto-E3F36EDF-1672-5482-E096-C93EAD934980
1667392687: Received PUBLISH From auto-E3F36EDF-1672-5482-E096-C93EAD934980 (d0, q0, r0, m0, "gateway/a8a04120f72c4150/state/conn", ... (12 bytes))
1667392687: Received PUBLISH From auto-10F1A685-7264-1B51-6A66-8A96EEC78002 (d0, q0, r0, m0, "gateway/a8a04120f72c4150/event/up", ... (120 bytes))
1667392688: Sending PUBLISH To auto-10F1A685-7264-1B51-6A66-8A96EEC78002 (d0, q0, r0, m0, "gateway/a8a04120f72c4150/event/up", ... (120 bytes))
1667392688: Received PUBLISH From auto-D37E11A1-DE72-BB05-2E13-9A601B95D060 (d0, q0, r0, m0, "application/2/device/0cababc47c4e96c9a/error", ... (194 bytes))
```

## หน้านี้จะแสดงการใช้งาน MQTT

```
File Edit Tabs Help
suwijk@raspberrypi: ~
suwijk@raspberrypi: ~ $ mosquitto_sub -t "application/2/#" -v
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"USRhnRMQ=="]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"TEN#S=="]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"Bike-keep","deviceName":"Bike-keep1","deviceProfileName":"device_profile_otaaa","deviceProfileID":"98e89af2-fbbf-4fb7-840d-73d83053bd","rxInfo":[{"gatewayID":"8484120f72c4150","linkID":"c0c04959_75ac_4460_88b0_46b99e239ef0","name":"D_RAGINO","time":"2022-11-02T12:39:46.054387","rssi":-66,"loRaSNR":9.2,"location":{"latitude":17.1,"longitude":104.9,"altitude":1010}],"txInfo":[{"frequency":923200000,"dr":2}];"adr":true,"Fcnt":18,"Fport":2,"data":"QIREZXZPbmPgB=","objct":{""DecodedDataHex":"42544465764fe654fe6","DecodedDataString":"BTDevOneOn"}]
application/2/device/0xcbabc47c4e96c9a/event/txack [{"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","fcnt":182}
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"USRhnRMQ=="]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","acknowledged":true,"Fcnt":182}
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","deviceProfileName":"device_profile_otaaa","deviceProfileID":"98e89af2-fbbf-4fb7-840d-73d83053bd","devEUI":"0xcbabc47c4e96c9a","rxInfo":[{"gatewayID":"8484120f72c4150","linkID":"b122ea70_3f95_4537_b6d-b05d5039eb4a","name":"D_RAGINO","time":"2022-11-02T12:39:46.054387","rssi":-66,"loRaSNR":9.2,"location":{"latitude":17.1,"longitude":104.9,"altitude":1010}],"txInfo":[{"frequency":923200000,"dr":2}];"adr":true,"Fcnt":181,"Fport":2,"data":"QIREZXZPbmPgB=","objct":{""DecodedDataHex":"42544465764fe654fe6","DecodedDataString":"BTDevOneOn"}]
application/2/device/0xcbabc47c4e96c9a/event/txack [{"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","fcnt":183}
application/2/device/0xcbabc47c4e96c9a/error {"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","type":"ULINK_FCNT_RETRY_ANSMISSION","error":"frame counter did not increment","Fcnt":181}
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"USRhnRMQ=="]
application/2/device/0xcbabc47c4e96c9a/error {"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","type":"ULINK_FCNT_RETRY_ANSMISSION","error":"frame counter did not increment","Fcnt":181}
application/2/device/0xcbabc47c4e96c9a/error {"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","type":"ULINK_FCNT_RETRY_ANSMISSION","error":"frame counter did not increment","Fcnt":181}
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","rxInfo":[{"gatewayID":"8484120f72c4150","linkID":"c0c03a44_2268_4622_966a_a0c3758e3fb4","name":"D_RAGINO","time":"2022-11-02T12:39:46.054387","rssi":-67,"loRaSNR":10.8,"location":{"latitude":17.1,"longitude":104.9,"altitude":1010}],"txInfo":[{"frequency":923200000,"dr":2}];"adr":true,"Fcnt":0,"Fport":2,"data":"QIREZXZPbmPgB=","objct":{""DecodedDataHex":"42544465764fe654fe6","DecodedDataString":"BTDevOneOn"}]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"USRhnRMQ=="]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","rxInfo":[{"gatewayID":"8484120f72c4150","linkID":"5c03a44_2268_4622_966a_a0c3758e3fb4","name":"D_RAGINO","time":"2022-11-02T12:39:46.054387","rssi":-67,"loRaSNR":10.8,"location":{"latitude":17.1,"longitude":104.9,"altitude":1010}],"txInfo":[{"frequency":923200000,"dr":2}];"adr":true,"Fcnt":0,"Fport":2,"data":"QIREZXZPbmPgB=","objct":{""DecodedDataHex":"42544465764fe654fe6","DecodedDataString":"BTDevOneOn"}]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"USRhnRMQ=="]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","rxInfo":[{"gatewayID":"8484120f72c4150","linkID":"addfd3f1d7-4647-be13-12adba96d4ff","name":"D_RAGINO","time":"2022-11-02T12:40:19.984672","rssi":-67,"loRaSNR":9.8,"location":{"latitude":17.1,"longitude":104.9,"altitude":1010}],"txInfo":[{"frequency":923400000,"dr":2}];"adr":true,"Fcnt":1,"Fport":2,"data":"QIREZXZPbmPgB=","objct":{""DecodedDataHex":"42544465764fe654fe6","DecodedDataString":"BTDevOneOn"}]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"USRhnRMQ=="]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"applicationID":2,"applicationName":"Bike-keep","deviceName":"Bike-keep1","devEUI":"0xcbabc47c4e96c9a","rxInfo":[{"gatewayID":"8484120f72c4150","linkID":"29afda16_ffda_f019ec0_62c82cc9250","name":"D_RAGINO","time":"2022-11-02T12:40:19.984672","rssi":-67,"loRaSNR":9.8,"location":{"latitude":17.1,"longitude":104.9,"altitude":1010}],"txInfo":[{"frequency":923400000,"dr":2}];"adr":true,"Fcnt":1,"Fport":2,"data":"QIREZXZPbmPgB=","objct":{""DecodedDataHex":"42544465764fe654fe6","DecodedDataString":"BTDevOneOn"}]
application/2/device/0xcbabc47c4e96c9a/cx [ "confirmed":true,"FPort":10,"data":"USRhnRMQ=="]
```

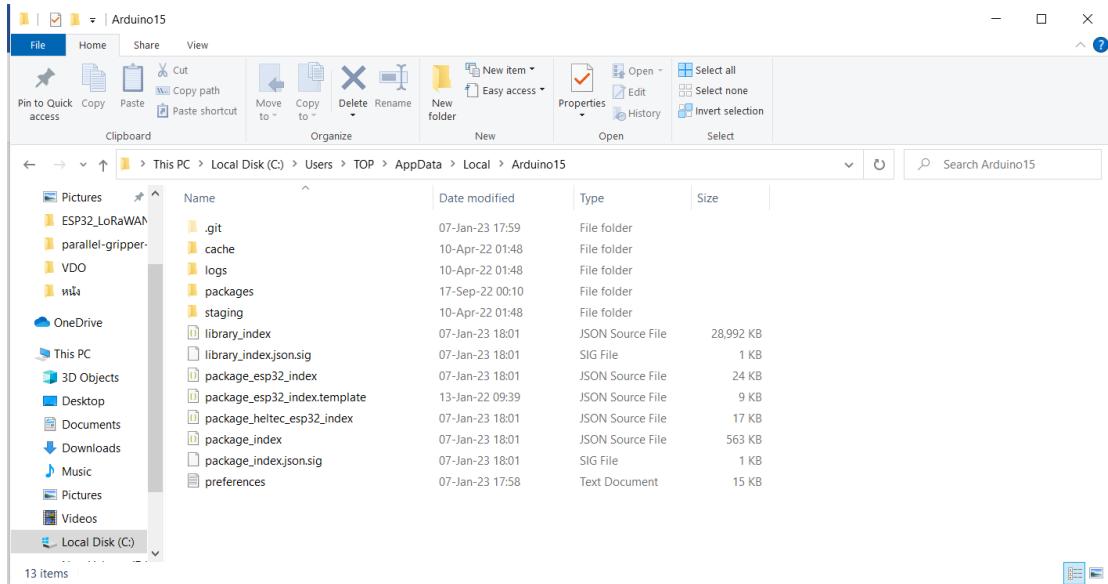
หน้านี้จะแสดงข้อมูล จาก Application ID คือการส่งข้อมูลจาก Application many MQTT

## การทำงานของ Arduino

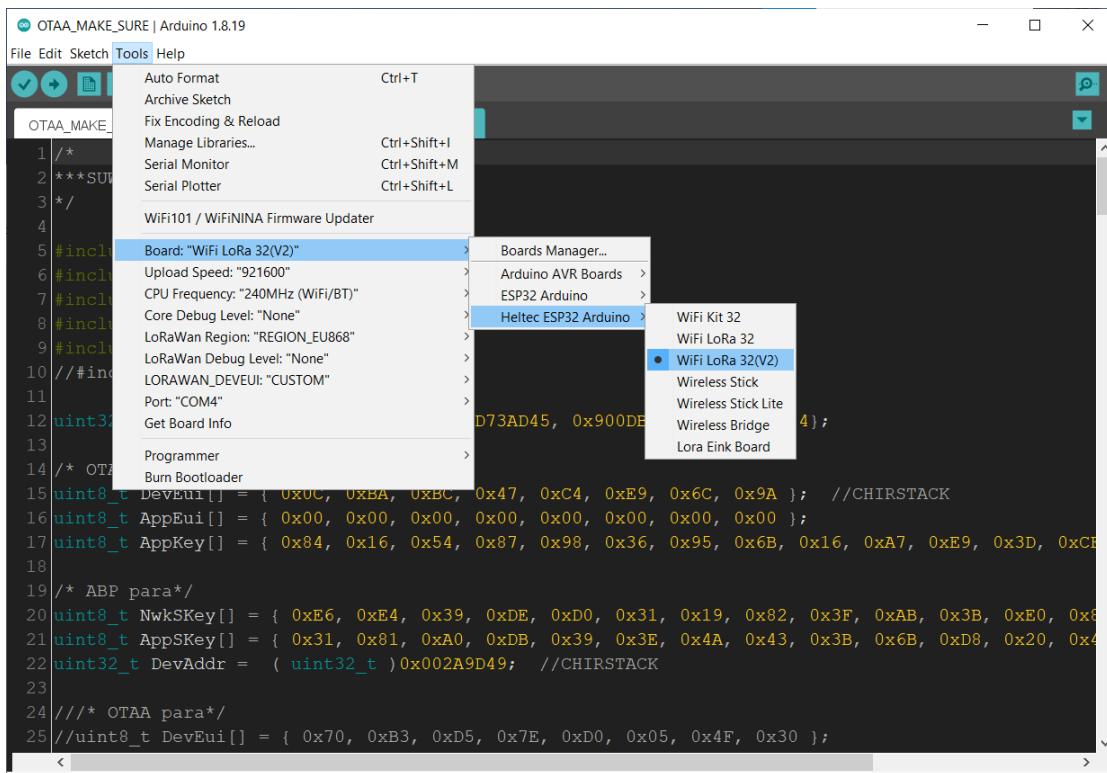


ติดตั้ง ข้อมูลของ Board heltec + libraries ใน โฟลเดอร์ C:\Users\(ชื่อของ user ที่ใช้)\AppData\Local\Arduino15

<https://github.com/suwijak0023/Arduino15>



## LORAWAN GUIDE BY SUWIJAK



The screenshot shows the Serial Monitor window with the port set to "COM4". The log output displays the following messages:

```
18:49:52.274 -> DIOU:RX Done
18:49:52.274 -> RX on freq 923200000 Hz at DR 2
18:49:52.274 -> receive data: rssi = -118, snr = 2, datarate = 2
18:49:56.015 -> DIOO:RX Done
18:49:56.015 -> RX on freq 923200000 Hz at DR 2
18:49:56.015 -> receive data: rssi = -116, snr = 3, datarate = 2
18:49:56.015 -> +REV DATA:RXWIN2,RXSIZE 7,PORT 10
18:49:56.015 -> +REV DATA:data:83
18:49:56.015 -> Status : START DEVICE 1
18:49:56.015 ->
18:49:56.015 -> 1:Data InPut : StartD1
18:49:56.015 ->
18:50:05.538 -> confirmed uplink sending ...
18:50:05.584 -> TX on freq 923200000 Hz at DR 2
18:50:06.000 -> DIOO:TX Done
18:50:06.000 -> RX on freq 923200000 Hz at DR 2
18:50:07.019 -> RX on freq 923200000 Hz at DR 2
18:50:07.342 -> DIOO:RX Done
18:50:07.342 -> RX on freq 923200000 Hz at DR 2
18:50:07.342 -> receive data: rssi = -117, snr = 4, datarate = 2
18:50:11.133 -> DIOO:RX Done
18:50:11.133 -> RX on freq 923200000 Hz at DR 2
18:50:11.133 -> receive data: rssi = -119, snr = 1, datarate = 2
18:50:11.133 -> +REV DATA:RXWIN2,RXSIZE 4,PORT 10
18:50:11.133 -> +REV DATA:data:76
18:50:11.133 -> Status : UNLOCK DEVICE 1
18:50:11.133 -> 2:Data InPut : LOCK
18:50:11.133 ->
```

At the bottom of the Serial Monitor window, there are checkboxes for "Autoscroll" and "Show timestamp", and dropdown menus for "Newline", "115200 baud", and "Clear output".

หน้านี้จะแสดงการรับข้อมูลจาก MQTT และจะสั่งการทำงานของ Node

LORAWAN GUIDE BY SUWIJAK

หน้านี้จะแสดงหน้าของ Down link รับข้อมูลจาก Server และได้ตั้งเงื่อนไขแบบ Switch case



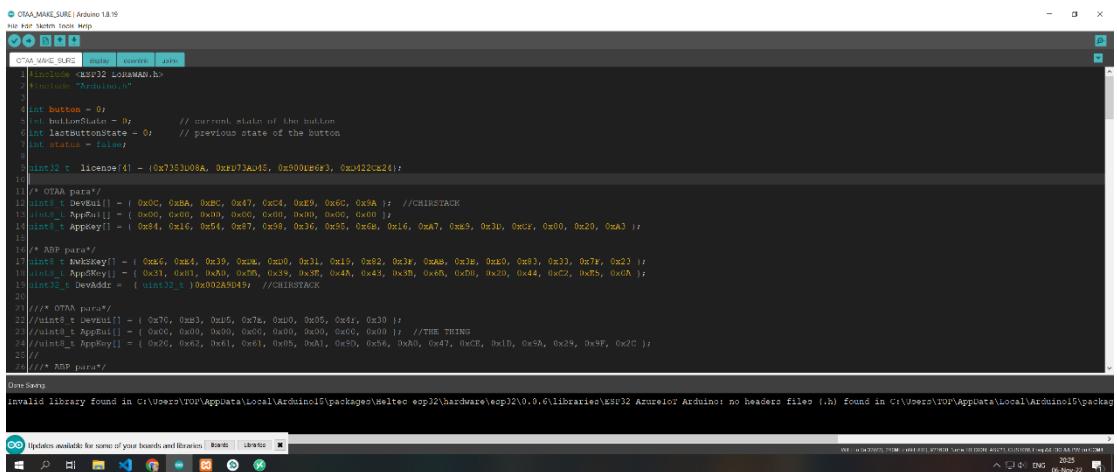
The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** C:\AA\MAKE\_SURE - downloadine | Arduino 1.8.9
- File Menu:** File New Sketch Tools Help
- Code Area:** The main code area contains C++ code for LoRaWAN downlink handling. It includes functions for handling downlinks, setting up LoRa parameters, and printing data to the serial port.
- Serial Monitor:** A small window at the bottom left shows the message "Updates available for some of your boards and libraries".
- Bottom Status Bar:** Shows the path "C:\Users\YON\AppData\Local\Arduino15\packages\WeMos\esp32\hardware\esp32\0.0.0\libraries\esp32\_Arduino" and the status "no headers files (.h) found".

หน้านี้จะแสดงหน้าของ Down link รับข้อมูลจาก Server และทำการแปลงข้อมูลให้เป็น string

หน้านี้จะแสดงหน้าของหน้า Up link ข้อมูลไป Server โดยทำการแปลงข้อมูลให้เป็นรูปแบบ Hex

## LORAWAN GUIDE BY SUWIJAK



```
/* OTAA para/
uint8_t DevEui[] = { 0x0C, 0x0A, 0x0C, 0x07, 0xC4, 0x9, 0x0C, 0xA }; //CHIRPSTACK
uint8_t AppKey[] = { 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 }; //THE THING
uint8_t Appkey[] = { 0x94, 0x16, 0x0f, 0x07, 0x98, 0x36, 0x0e, 0x16, 0x07, 0x09, 0x04, 0x00, 0x20, 0x03 }; //CHIRPSTACK
// APP para/
uint8_t NwkSKey[] = { 0x06, 0x01, 0x05, 0x00, 0x31, 0x01, 0x02, 0x03, 0x0A, 0x0E, 0x00, 0x03, 0x03, 0x7, 0x21 }; //CHIRPSTACK
uint8_t AppSKey[] = { 0x31, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 }; //THE THING
//uint8_t AppKey[] = { 0x26, 0x02, 0x01, 0x05, 0x0A, 0x50, 0x56, 0x00, 0x47, 0xCE, 0x10, 0x5A, 0x24, 0x5F, 0x2C }; //CHIRPSTACK
//*/
// Device Parameters
#define DEV_EUI {0x0C, 0x0A, 0x0C, 0x07, 0xC4, 0x9, 0x0C, 0xA}
#define APP_KEY {0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
#define APP_SKEY {0x06, 0x01, 0x05, 0x00, 0x31, 0x01, 0x02, 0x03, 0x0A, 0x0E, 0x00, 0x03, 0x03, 0x7, 0x21}
#define NWKSKEY {0x31, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00}
#define APPSKEY {0x26, 0x02, 0x01, 0x05, 0x0A, 0x50, 0x56, 0x00, 0x47, 0xCE, 0x10, 0x5A, 0x24, 0x5F, 0x2C}
```

หน้านี้จะแสดงหน้าของ DevEui,AppKey ของ OTAA และ Activation ของ ABP



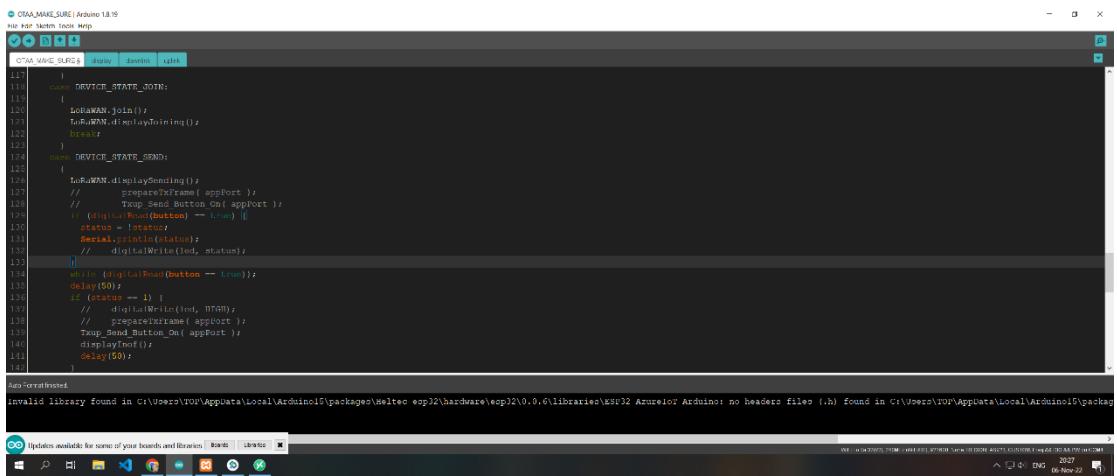
```
#include <LoRaWAN.h>
#include <Arduino.h>
#include <esp32_lorawan.h>

void setup() {
    Serial.begin(115200);
    pinMode(button, INPUT_PULLUP);
    while (!Serial);
    SPI.begin(SCK, MISO, MOSI, SS);
    MuxInit(SS, INT_LORA, DIO0, DIO1, license);
    attachInterrupt(37, analogSetClockDTR, HIGH);
    analogSetClockDTR(255); // 133ms
    deviceState = DEVICE_STATE_INIT;
}

void loop() {
    while (deviceState == DEVICE_STATE_INIT) {
        if (LoRaWAN.deviceAuto()) {
            LoRaWAN.generateDevEuiByChipID();
        } else {
            LoRaWAN.init(lorawanEui, lorawanRegion);
        }
    }
}
```

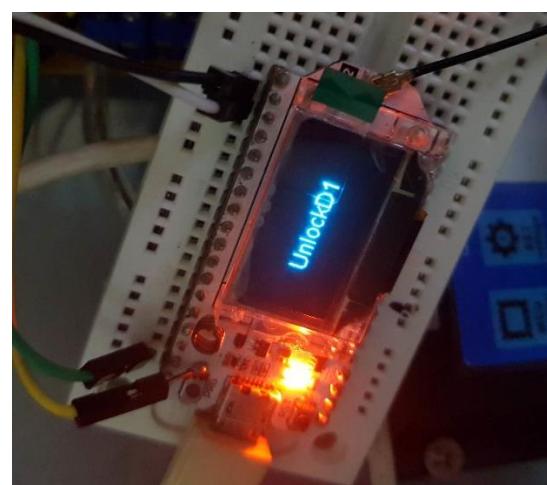
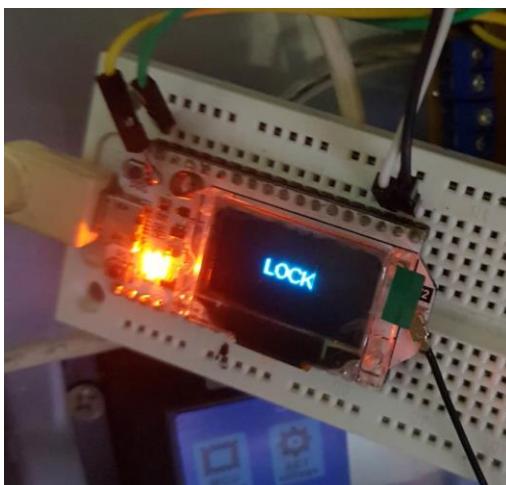
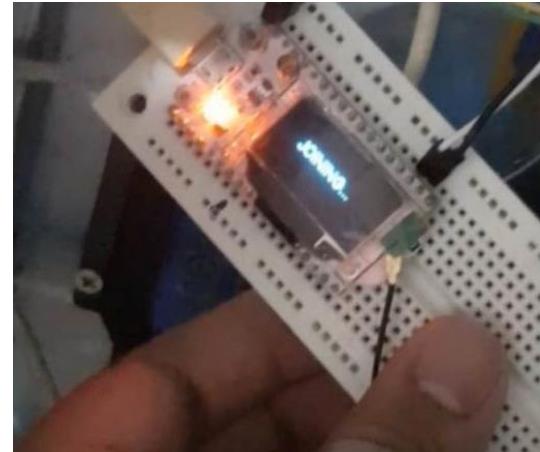
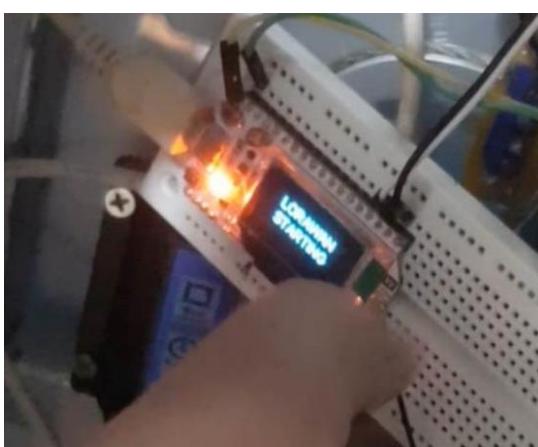
หน้านี้จะเป็นการ Setup หรือการตั้งค่าข้อมูล

## LORAWAN GUIDE BY SUWIJAK



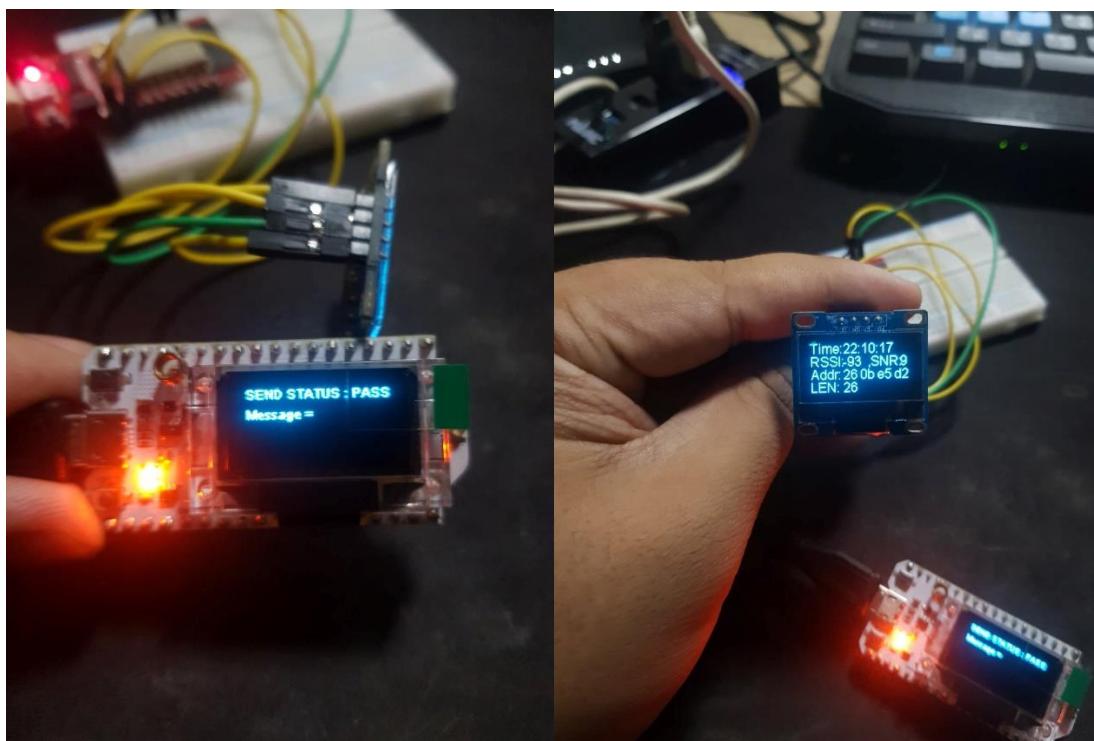
```
� C:\AM\MC-SURE\Arduino\1.8.19
File Edit Sketch Tools Help
C:\AM\MC-SURE\Device\Device.ino:117
117 |     DEVICE_STATE_JOIN;
118 | }
119 | {
120 |     LoRaWAN.join();
121 |     LoRaWAN.displayJoining();
122 |     break;
123 | }
124 | case DEVICE_STATE_SEND:
125 | {
126 |     LoRaWAN.displaySending();
127 |     // prepareTxFrame( appPort );
128 |     // Txup_sendButton_On( appPort );
129 |     if ( digitalRead(button) == LOW ) {
130 |         status = HIGH;
131 |         Serial.println(status);
132 |         // digitalWrite(led, status);
133 |     }
134 |     while ( digitalRead(button) == LOW );
135 |     delay(50);
136 |     if ( status == 1 ) {
137 |         // digitalWrite(led, HIGH);
138 |         // prepareTxFrame( appPort );
139 |         Txup_sendButton_On( appPort );
140 |         displayNot();
141 |         delay(50);
142 |     }
}
Auto-format selected.
invalid library found in C:\Users\YU\AppData\Local\Arduino15\packages\Heltec\esp32\hardware\esp32\0.0.6\libraries\LoRaWAN\Arueles\ Arduino: no headers file (.h) found in C:\Users\YU\AppData\Local\Arduino15\packag
Updates available for some of your boards and libraries | Boards | Libraries |
```

หน้าจอแสดงหน้า loop



หน้านี้แสดงการรับข้อมูลที่ได้ Server นายัง Node ปลายทาง

## NODE TO NODE



หน้านี้แสดงถึงการส่งข้อมูลระหว่าง Node หา Node ด้วยกันโดยจะมีฝั่งส่งและรับ

## SC GATEWAY HELTEC

กรณีใช้ Esp32 เป็น Gateway

## ESP Gateway Config

Version: V.5.3.3.H; 180825a

ESP alive since Saturday 13-8-2022 14:55:20, Uptime: 0-00:54:52

Current time Saturday 13-8-2022 15:50:00

[Documentation](#) [Basic Mode](#) [Log Files](#)

### Package Statistics

Counter	C 0	C 1	C 2	Pkgs	Pkgs/hr
Packages Downlink				0	
Packages Uplink Total				8	8
Packages Uplink OK				8	
SF7 rcvd	6	1	1	8	100 %
SF8 rcvd	0	0	0	0	0 %
SF9 rcvd	0	0	0	0	0 %
SF10 rcvd	0	0	0	0	0 %
SF11 rcvd	0	0	0	0	0 %
SF12 rcvd	0	0	0	0	0 %

### Message History

Time	Node	C	Freq	SF	pRSSI
Saturday 13-8-2022 15:45:17	26 0d 26 15	2	923600000	7	-71
Saturday 13-8-2022 15:30:26	26 0d 26 15	0	923200000	7	-73
Saturday 13-8-2022 15:29:59	26 0d 26 15	0	923200000	7	-75
Saturday 13-8-2022 15:28:14	26 0d 26 15	0	923200000	7	-72
Saturday 13-8-2022 15:25:52	26 0d 93 bc	0	923200000	7	-75
Saturday 13-8-2022 15:09:09	26 0d 26 15	0	923200000	7	-73
Saturday 13-8-2022 15:01:31	26 0d 26 15	1	923400000	7	-71
Saturday 13-8-2022 14:57:57	26 0d 26 15	0	923200000	7	-70

### Gateway Settings

Setting	Value	Set
CAD	ON	ON OFF
HOP	ON	ON OFF
SF Setting	AUTO	
Channel	AUTO	
Debug level	1	- +
Debug pattern	SCN CAD RX TX PRE MAI GUI RDIO	
Usb Debug	1	
WWW Refresh	ON	ON OFF
Update Firmware		UPDATE
Format SPIFFS		FORMAT
Statistics	0	RESET
Boots and Resets	17	RESET

### WiFi Config

Parameter	Value
WiFi host	esp32-e282c4
WiFi SSID	SANGTONG 2.4G
IP Address	192.168.1.142
IP Gateway	192.168.1.1
NTP Server	nl.pool.ntp.org
LoRa Router	au1.cloud.thethings.network
LoRa Router IP	13.55.29.193

### System Status

Parameter	Value	Set
Gateway ID	2462abFFFFe282c4	
Free heap	942040	

ជំនួយ

ชื่อ - นามสกุล  
อีเมล  
การศึกษา

Mr. Suwijk Pimpa  
toptop0023@hotmail.co.th

จบหลักสูตรวิศวกรรมศาสตร์บัณฑิต  
คณะวิทยาศาสตร์และวิศวกรรมศาสตร์  
สาขาวิชการร่มไฟฟ้าและคอมพิวเตอร์  
หลักสูตรวิศวกรรมคอมพิวเตอร์  
มหาวิทยาลัยเกษตรศาสตร์ วิทยาเขตเฉลิม  
พระเกียรติจังหวัดสกลนคร

Link ข้อมูลและวิดีโอที่เกี่ยวข้อง (อ้างอิง)

Github ของผู้จัดทำ

<https://github.com/suwijak0023/Lorawan-libraries-Code-Esp32>

Board libraries

<https://github.com/suwijak0023/Arduino15>

Chirstack Setup

<https://www.youtube.com/watch?v=FnTP7t47DlI&list=PL9FegcZTeB9LRLnXtN6OMkVSZYgHdlmOr>

MQTT LORA CHIRSTACK

<https://www.youtube.com/watch?v=J4LITgZljPE>

ESP32 LoRaWan Gateway + LoRa Node

<https://meetjoeblog.com/2018/04/29/esp32-lorawan-gateway/>

LoRaWAN node วัดอุณหภูมิและความชื้น ด้วย Heltec ESP32 Wifi LoRa Oled V.2 ใช้ได้ กับ TheThings หรือ Helium

<https://khunsomsak.medium.com/%E0%B8%97%E0%B8%B3-lorawan-node-%E0%B8%A7%E0%B8%B1%E0%B8%94%E0%B8%AD%E0%B8%B8%E0%B8%93%E0%B8%AB%E0%B8%A0%E0%B8%B9%E0%B8%A1%E0%B8%B4%E0%B9%81%E0%B8%A5%E0%B8%B0%E0%B8%84%E0%B8%A7%E0%B8%B2%E0%B8%A1%E0%B8%8A%E0%B9%89%E0%B8%99-%E0%B8%94%E0%B9%89%E0%B8%A7%E0%B8%A2-heltec-esp32-wifi-lora-oled-v-2-836fabd400b1>

[LoRaWAN] ทดสอบสร้าง Server รับข้อมูลจาก End-node [ต่อ]

<https://iamteam.me/lorawan-%E0%B8%97%E0%B8%94%E0%B8%AA%E0%B8%AD%E0%B8%9A%E0%B8%>

[AA%E0%B8%A3%E0%B9%89%E0%B8%B2%E0%B8%87-server-%E0%B8%A3%E0%B8%B1%E0%B8%9A%E0%B8%82%E0%B9%89%E0%B8%A  
D%E0%B8%A1%E0%B8%B9%E0%B8%A5%E0%B8%88%E0%B8%B2%E0%B8%  
81-end-node-%E0%B8%95%E0%B9%88%E0%B8%AD-75e9484c2df8](#)

End node and gateway connection

<https://www.thethingsnetwork.org/forum/t/end-node-and-gateway-connection/47147/3>

ESP8266 / ESP32 & Mesh Network ตอนที่ 4: Painlessmesh Bridge with LoRa

<https://meetjoeblog.com/2018/04/25/esp8266-esp32-painlessmesh-bridge-with-lora-ep4/>

<https://www.thethingsnetwork.org/forum/t/how-do-i-send-data-from-my-gateway-to-node/17912/3>

<https://how2electronics.com/esp32-lora-thingspeak-gateway-sensor-node/>

<https://www.sparkfun.com/products/18074>

<https://electropeak.com/learn/the-beginners-guide-to-display-text-image-animation-on-oled-display-by-arduino/>

<a href="http://lorawan.lnwshop.com/product/75/heltec-esp32-wifi-lora-oled-v-2-%E0%B9%80%E0%B8%AA%E0%B8%B2%E0%B8%81%E0%B8%A5%E0%B8%A<br/>1%E0%B8%9A%E0%B8%B1%E0%B8%94%E0%B8%81%E0%B8%A3%E0%B8%  
B5%E0%B8%82%E0%B8%B2%E0%B9%84%E0%B8%A7%E0%B9%89%E0%B  
9%81%E0%B8%A5%E0%B9%89%E0%B8%A7

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<https://circuitdigest.com/microcontroller-projects/esp32-lora-communication-with-the-things-network>

<http://10.130.1.1/cgi-bin/lorawan.has>

<https://robotzero.one/heltec-lora32-lorawan-node/>

<http://wiki.dragino.com/xwiki/bin/view/Main/LoRaWAN%20Communication%20Debug/>

<https://how2electronics.com/esp32-lora-sx1278-76-transmitter-receiver/>

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<https://www.youtube.com/watch?v=VXNfNDcFU2c>

<https://www.youtube.com/watch?v=k5-1o8WifQM>

<https://www.youtube.com/watch?v=lZXiaMFYwfw>

<https://iamteam.me lorawan-%E0%B8%97%E0%B8%94%E0%B8%AA%E0%B8%AD%E0%B8%9A%E0%B8%81%E0%B8%B2%E0%B8%A3%E0%B8%AA%E0%B9%88%E0%B8%87%E0%B8%82%E0%B9%89%E0%B8%AD%E0%B8%A1%E0%B8%B9%E0%B8%A5%E0%B8%88%E0%B8%B2%E0%B8%81-server-%E0%B9%84%E0%B8%9B%E0%B8%A2%E0%B8%B1%E0%B8%87-end-node-downlink-491f59c20f2e>

[https://www.youtube.com/watch?v=\\_XkVR-XiHkw](https://www.youtube.com/watch?v=_XkVR-XiHkw)

[https://docs.heltec.cn/#/en/products/lora/lora\\_node/heltec\\_lora\\_node\\_list](https://docs.heltec.cn/#/en/products/lora/lora_node/heltec_lora_node_list)

[https://docs.heltec.cn/general/how\\_to\\_config\\_raspberry\\_pi.html](https://docs.heltec.cn/general/how_to_config_raspberry_pi.html)

<http://wiki.dragino.com/xwiki/bin/view/Main/Notes%20for%20ChirpStack/>

<https://forums.raspberrypi.com/viewtopic.php?t=259977>

<https://thingsboard.io/docs/user-guide/integrations/chirpstack/>

<https://www.youtube.com/watch?v=E-DjCbFyR7U>

<https://www.hackster.io/sidikalamin/full-stack-rpi-chirpstack-lorawan-environment-dashboard-f51bd0>

<https://sidik.my/gabungan-node-lorawan-gateway-bridge-network-server-application-server-mqtt-node-red-influxdb-grafana/>

[https://www.youtube.com/watch?v=jp\\_2gwBrOc8](https://www.youtube.com/watch?v=jp_2gwBrOc8)

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<https://www.youtube.com/watch?v=llFwNOlhwck>

<https://www.instructables.com/Intelligent-Street-Light-Using-LoRa/>

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<https://tutorial.cytron.io/2021/12/13/sending-data-from-node-to-the-things-stack/>

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