



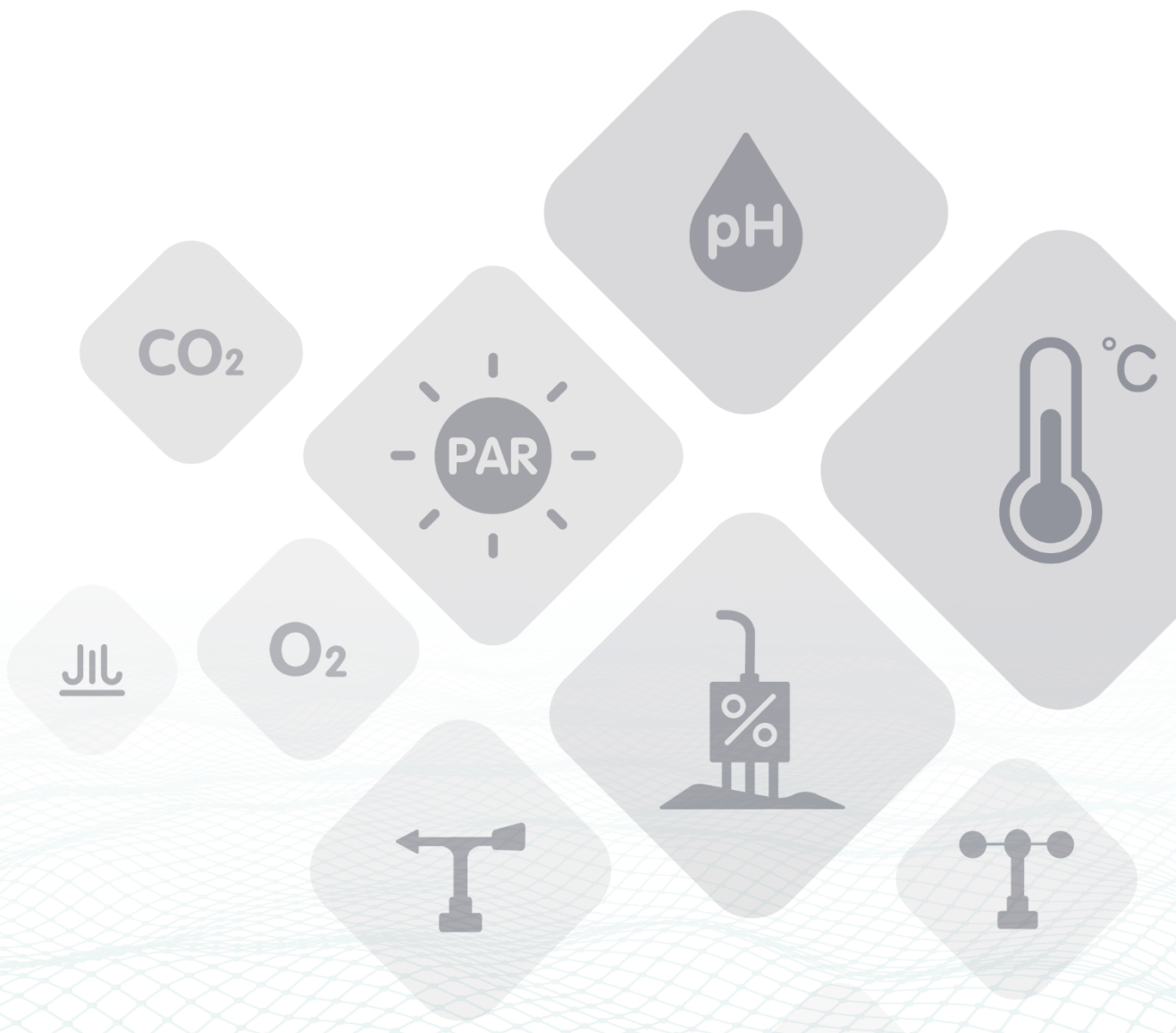
SENSECAP

Wio-E5 LoRa® Module

Relay Function

Instruction Manual

Version: V1.0



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1. Test preparation

1.1 Server

Since TTN does not have the ability to accept only relay messages at this stage, this guide uses ChirpStack in the testing phase and TTN in the deployment phase.

1.2 Gateway

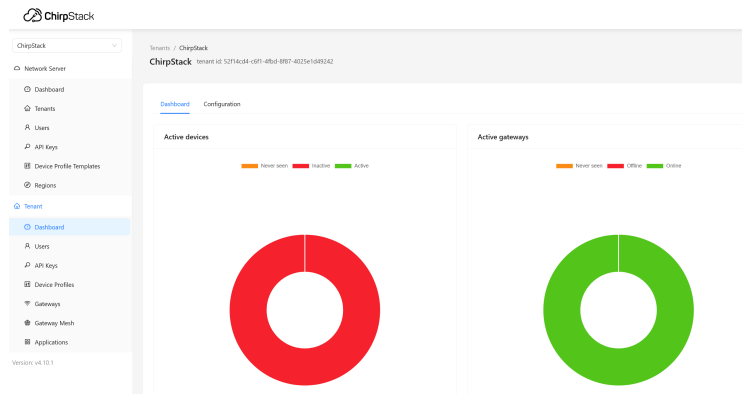
1.2.1 Register a gateway

Take SenseCAP M2 multi-platform LoRaWAN gateway as an example, the specific steps can be referred to:

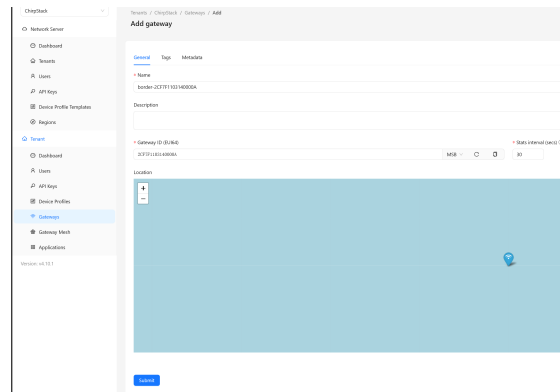
https://wiki.seeedstudio.com/quick_start_with_M2_MP/

and

https://wiki.seeedstudio.com/Network/SenseCAP_Network/SenseCAP_M2_Multi_Platform/Tutorial/Connect-M2-Multi-Platform-Gateway-to-ChirpStack/#gateway-configuration

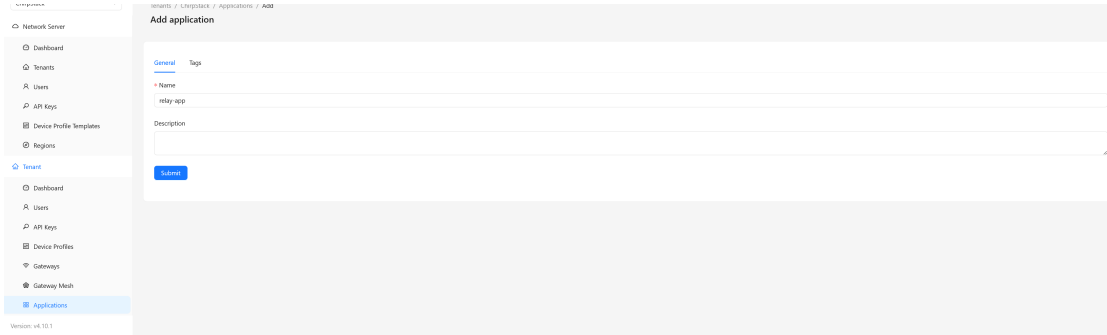


First register the gateway: Click gateways->Add gateway.
Enter name, gateway EUI, then click submit.



1.3 Register Node Application

Click Applications->Add application.
Enter name, and click submit.



1.4 Relay Slave Device Configuration

Model: LoraE5

Firmware: rhf0m055-v5.1.2-20250319.ebin.bin

Open the serial port tool and select the correct serial port with a baud rate of 9600
Enter the following command for parameter configuration:

Parameter name	Command
MODE(OTAA)	AT+MODE=OTAA
DR(EU868)	AT+DR=EU868
CH(CH0-2)	AT+CH=NUM,0-2
STDRELAY(Relay slave mode)	AT+STDRELAY=MODE,SLAVE

```
[14:29:04.628]发->◇AT+MODE=OTAA
[14:29:04.732]收<-◆+LOG: DEBUG 21482 RELAY_Txrelay tx: enable
+MODE: LWOTAA

[14:29:15.605]发->◇AT+DR=EU868
[14:29:15.626]收<-◆+LOG: DEBUG 32377 RELAY_Txrelay tx: enable
+DR: EU868

[14:29:15.711]收<-◆+LOG: DEBUG 32461 RELAY_Txrelay tx: enable
+DR: EU868

[14:29:27.429]发->◇AT+DR=EU868
[14:29:27.450]收<-◆+LOG: DEBUG 44200 RELAY_Txrelay tx: enable
+DR: EU868

[14:29:27.533]收<-◆+LOG: DEBUG 44284 RELAY_Txrelay tx: enable
+DR: EU868

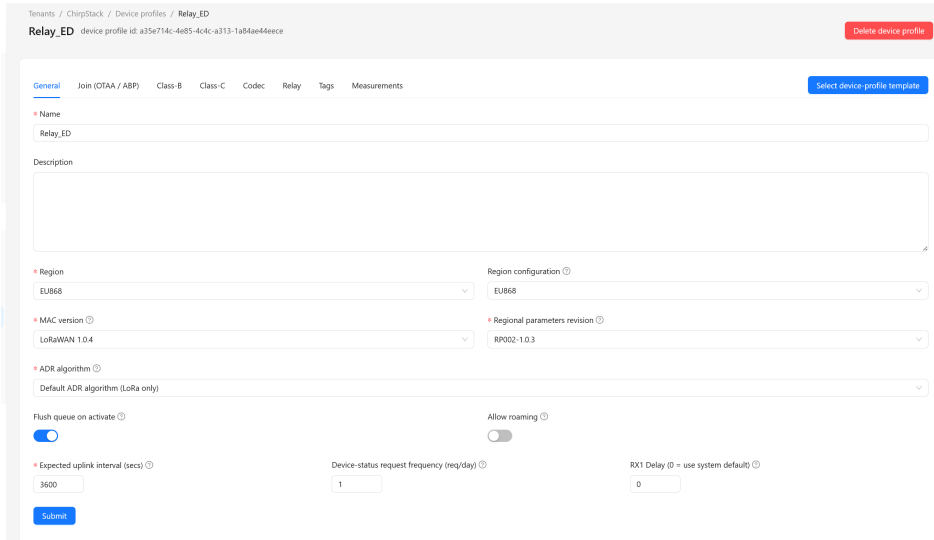
[14:29:36.021]发->◇AT+STDRELAY=MODE,SLAVE
[14:29:36.053]收<-◆+LOG: DEBUG 52803 RELAY_Txrelay tx: enable
+STDRELAY: MODE, SLAVE
```

Enter AT+ID to get node information:

```
[14:30:00.253]发->◇AT+ID
[14:30:00.267]收<-◆+ID: DevAddr, 60:20:2F:1D
+ID: DevEui, 2C:F7:F1:20:60:20:2F:1D
+ID: AppEui, 52:69:73:69:6E:67:48:46
+ID: JoinEui, 52:69:73:69:6E:67:48:46
```

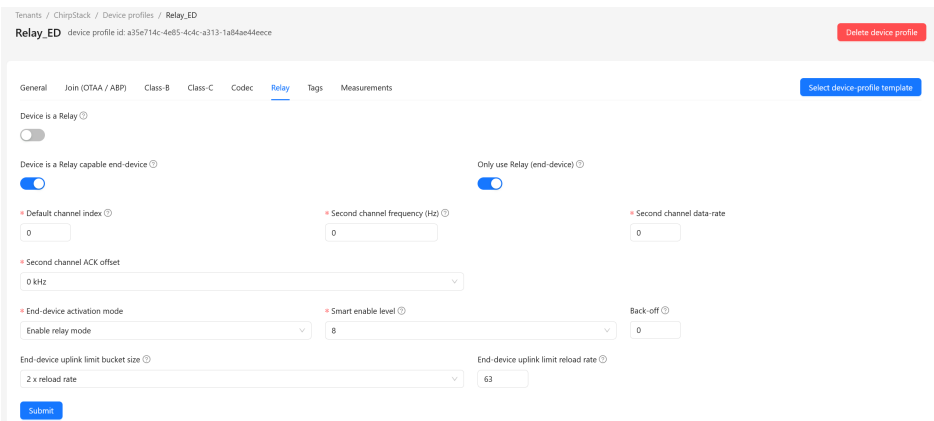
1.4.1 Configure Slave Device Profile

Click: Device Profile -> Add device profile -> General



The screenshot shows the 'General' configuration page for a device profile named 'Relay_ED'. The breadcrumb trail is 'Tenants / ChirpStack / Device profiles / Relay_ED'. The device profile ID is 'a35e714c-4e85-4c4c-a313-1a84ae44eece'. A 'Delete device profile' button is in the top right. The 'General' tab is selected, with other tabs including 'Join (OTAA / ABP)', 'Class-B', 'Class-C', 'Codec', 'Relay', 'Tags', and 'Measurements'. A 'Select device profile template' button is also present. The form includes fields for 'Name' (Relay_ED) and 'Description'. Below these are dropdown menus for 'Region' (EU866), 'Region configuration' (EU866), 'MAC version' (LoRaWAN 1.0.4), and 'Regional parameters revision' (RPO02-1.0.3). There are also dropdowns for 'ADR algorithm' and 'Default ADR algorithm (LoRa only)'. Toggles for 'Flush queue on activate' (checked) and 'Allow roaming' (unchecked) are present. Input fields for 'Expected uplink interval (secs)' (3600), 'Device-status request frequency (req/day)' (1), and 'RX1 Delay (0 = use system default)' (0) are shown. A 'Submit' button is at the bottom left.

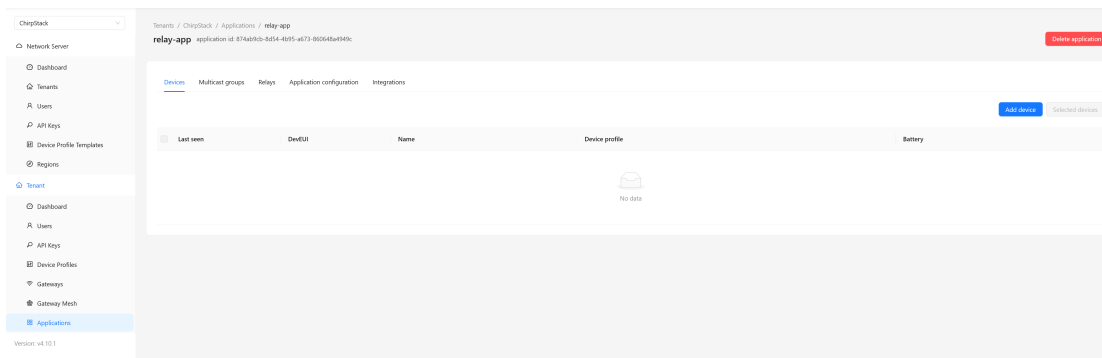
Relay option configuration, check Only use Relay (end-device)



The screenshot shows the 'Relay' configuration page for the same device profile. The breadcrumb trail is 'Tenants / ChirpStack / Device profiles / Relay_ED'. The device profile ID is 'a35e714c-4e85-4c4c-a313-1a84ae44eece'. A 'Delete device profile' button is in the top right. The 'Relay' tab is selected, with other tabs including 'General', 'Join (OTAA / ABP)', 'Class-B', 'Class-C', 'Codec', 'Tags', and 'Measurements'. A 'Select device profile template' button is also present. The 'Device is a Relay' toggle is checked. The 'Device is a Relay capable end-device' toggle is checked. The 'Only use Relay (end-device)' toggle is checked. Input fields for 'Default channel index' (0), 'Second channel frequency (Hz)' (0), and 'Second channel data-rate' (0) are shown. A dropdown for 'Second channel ACK offset' is set to '0 kHz'. Dropdowns for 'End-device activation mode' and 'Smart enable level' are set to '8'. A 'Back-off' field is set to '0'. Dropdowns for 'End-device uplink limit bucket size' (set to '2 x reload rate') and 'End-device uplink limit reload rate' (63) are shown. A 'Submit' button is at the bottom left.

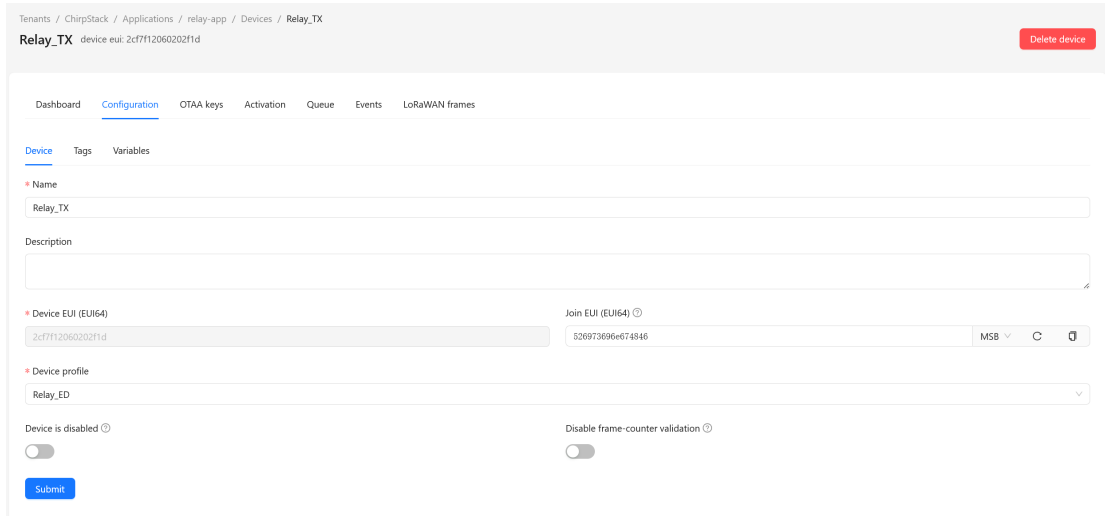
1.4.2 Registering Relay Slaves to the Server

Select the application just registered, "relay-app", and select Devices->Add device.

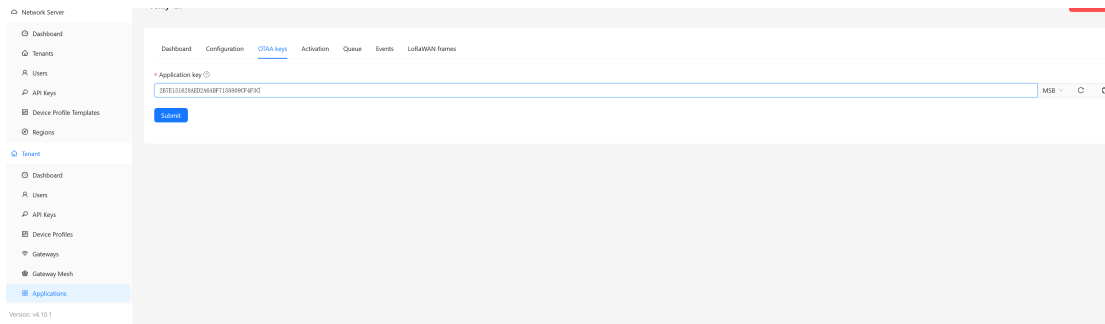


The screenshot shows the 'Add device' page for the 'relay-app' application. The breadcrumb trail is 'Tenants / ChirpStack / Applications / relay-app'. The application ID is '874a68b-8d64-4b95-a873-892684d9816c'. A 'Delete application' button is in the top right. The 'Devices' tab is selected, with other tabs including 'Multicast groups', 'Relays', 'Application configuration', and 'Integrations'. An 'Add device' button is in the top right. Below the button is a table with columns: 'Last seen', 'DevEUI', 'Name', 'Device profile', and 'Battery'. The table is currently empty, showing 'No data'. A sidebar on the left contains navigation links: 'Dashboard', 'Tenants', 'Users', 'API Keys', 'Device Profile Templates', 'Regions', 'Tenant', 'Dashboard', 'Users', 'API Keys', 'Device Profiles', 'Gateways Mesh', and 'Applications' (which is highlighted). The version 'v4.10.1' is shown at the bottom left.

Enter Name, Device EUI, Join EUI, select the Device profile just created, and click Submit.



Enter the APPkey and click Submit



1.5 Relay Master device Configuration

Model: LoraE5

Firmware: rhf0m055-v5.1.2-20250319.ebin.bin

Open the serial port tool and select the correct serial port with a baud rate of 9600

Enter the following command for parameter configuration:

Parameter name	Command
MODE(OTAA)	AT+MODE=OTAA
DR(EU868)	AT+DR=EU868
CH(CH0-2)	AT+CH=NUM,0-2

Enter AT+ID to get node information

Send AT+KEY=APPKEY, "APPkey" to set APPkey

1.5.1 Configuring Master Device Profile

Click: Device Profile -> Add device profile -> General

Tenants / ChirpStack / Device profiles / Relay_Master

Relay_Master device profile id: 95aa881d-5981-472f-a2dc-71922c6785ff Delete device profile

General Join (OTAA / ABP) Class-B Class-C Codec Relay Tags Measurements Select device-profile template

* Name
Relay_Master

Description

* Region
EU868

Region configuration

* MAC version
LoRaWAN 1.0.4

* Regional parameters revision
RP002-1.0.3

* ADR algorithm
Default ADR algorithm (LoRa only)

Flush queue on activate

Allow roaming

* Expected uplink interval (secs)
3600

Device-status request frequency (req/day)
1

RX1 Delay (0 = use system default)
0

Submit

Relay Options Configuration:

Tenants / ChirpStack / Device profiles / Relay_Master

Relay_Master device profile id: 95aa881d-5981-472f-a2dc-71922c6785ff Delete device profile

General Join (OTAA / ABP) Class-B Class-C Codec **Relay** Tags Measurements Select device-profile template

Device is a Relay

Relay enabled

Device is a Relay capable end-device

* Default channel index
0

* Second channel frequency (Hz)
0

* Second channel data-rate
0

* Second channel ACK offset
0 kHz

* CAD periodicity
1 second

Join-request limit bucket size
1 x reload rate

Join-request limit reload rate
127

Notify limit bucket size
2 x reload rate

Notify limit reload rate
127

Global uplink limit bucket size
4 x reload rate

Global uplink limit reload rate
127

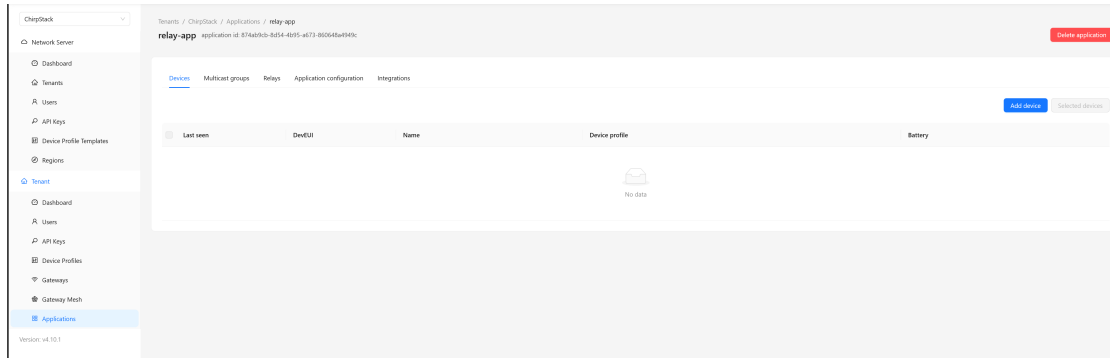
Overall limit bucket size
12 x reload rate

Overall limit reload rate
127

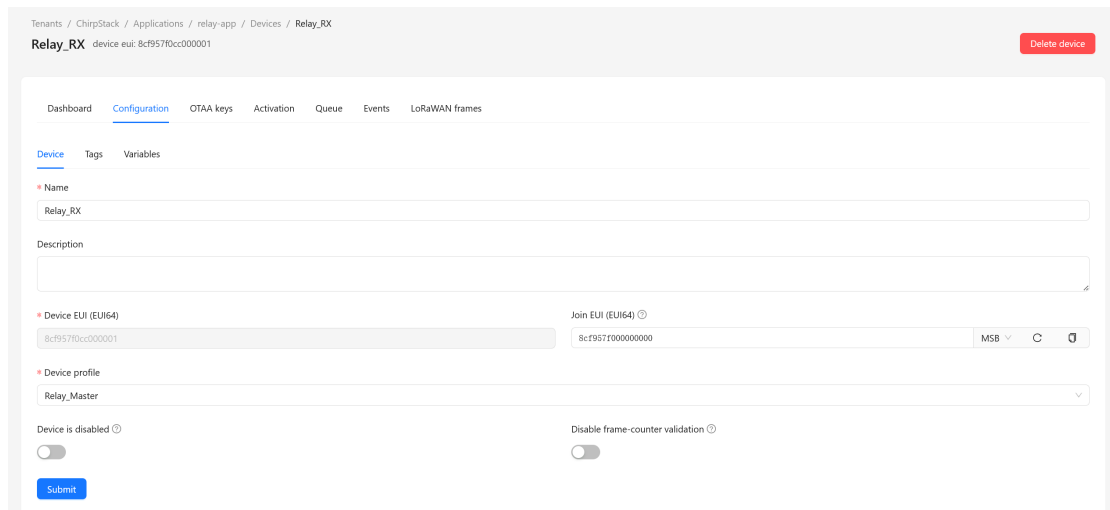
Submit

1.5.2 Registering Relay Master Device to the Server

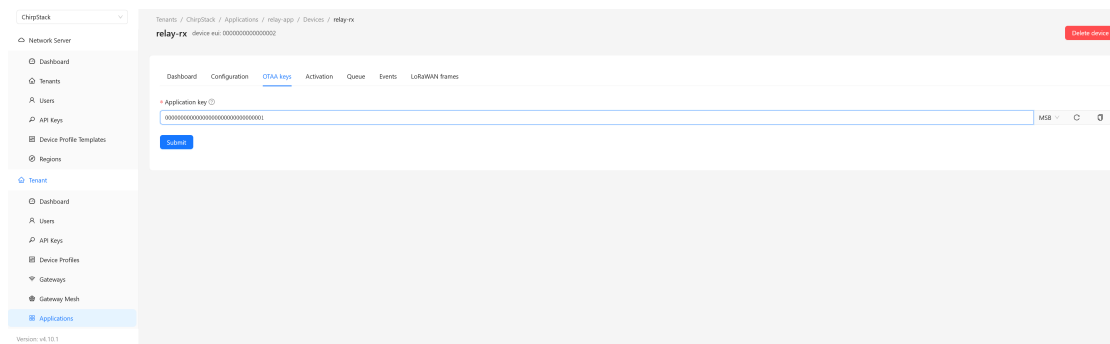
Select the application just registered, “relay-app”, and select Devices->Add device.



Enter Name, Device EUI, Join EUI, select the Device profile just created, and click Submit.

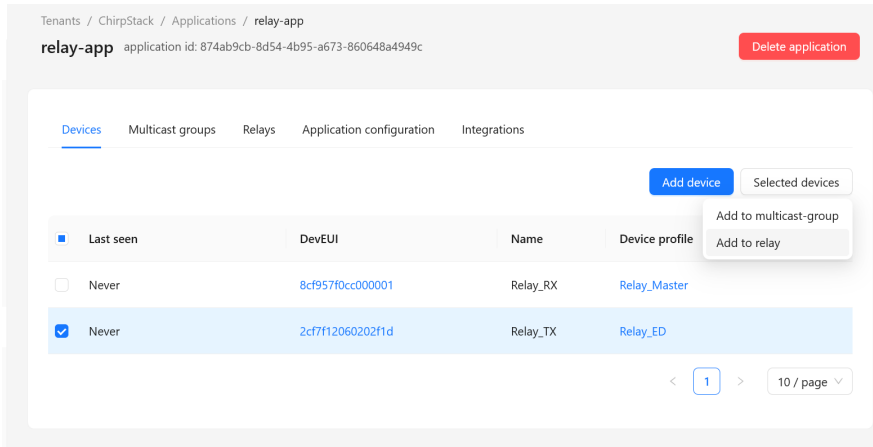


Enter the APPkey and click Submit:

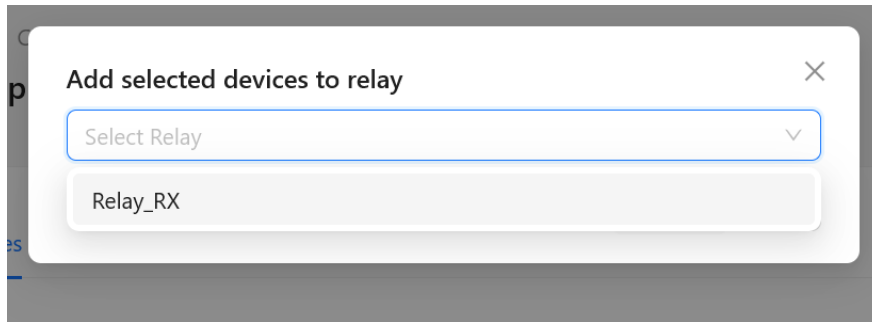


1.6 Binding Relay Master Device

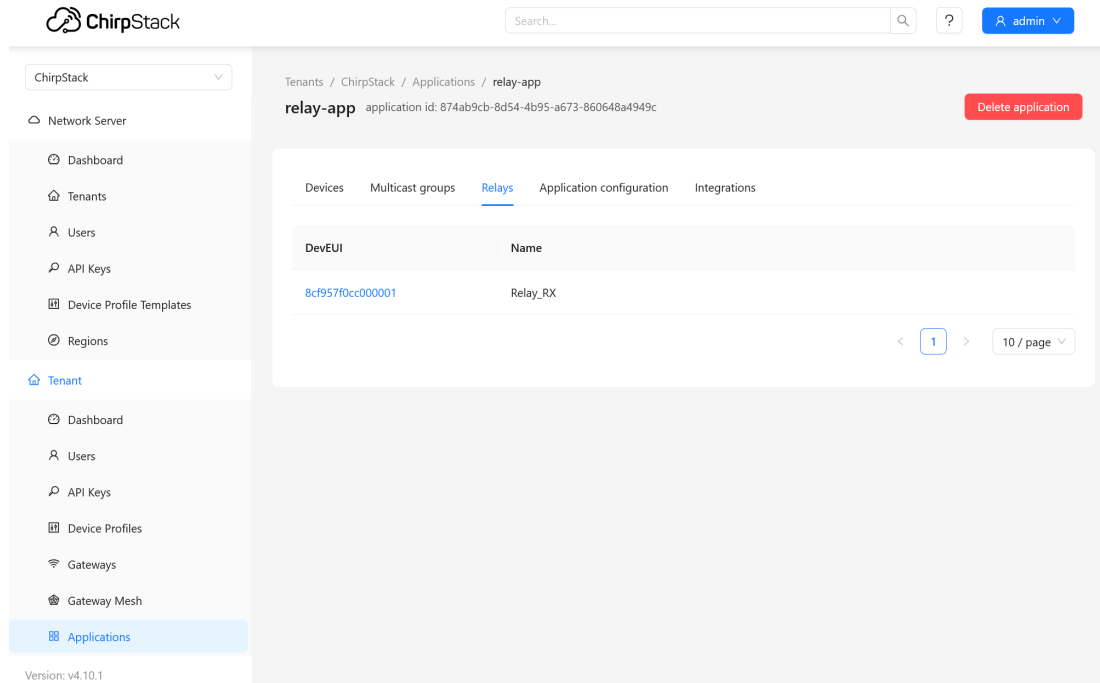
Select the slave device and click: Selected devices->Add to relay

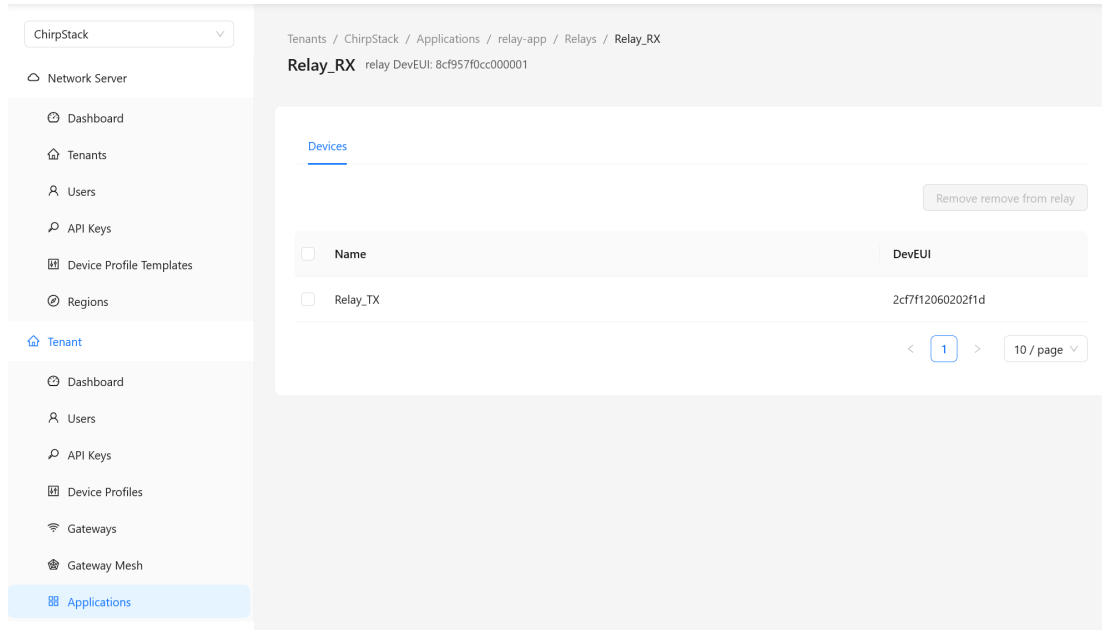


Select Relay Master in the pop-up window:



Viewing Relay Master Binding Status:





2. Validation testing

2.1 Relay Master Enabling Relay Mode

Open the serial port tool and select the correct serial port with a baud rate of 9600, monitoring Log.

Turn on log output: AT+LOG=DEBUG

Reset: AT+RESET

```
[08:40:07.934]发->◇ AT+LOG=DEBUG
□
[08:40:07.957]收<-◆+LOG: DEBUG
[08:40:17.493]发->◇ AT+RESET
□
[08:40:17.510]收<-◆+RESET: OK
[08:40:18.783]收<-◆+LOG: DEBUG      235 FMCUDRV mou flash init
+LOG: DEBUG      235 FCFG      FDBT DRIVER: mou_flash
```

The Relay Master is turned on and off by the server downlink control, so need to enter "AT+STDRELAY=MODE,OFF" to turn off the Relay mode first.

```
[08:41:56.445]发->◇ AT+STDRELAY=MODE, OFF
□
[08:41:56.478]收<-◆+STDRELAY: MODE, OFF
```

Send the "AT+JOIN" command to set the Relay Master to LoRaWan network.

```
[09:14:09.742]发->◇ AT+JOIN
□
[09:14:09.781]收<-◆+JOIN: Start
+JOIN: NORMAL
+LOG: DEBUG 2031360 LW      ch 02
+LOG: DEBUG 2031360 LORA   TX, 868500000, SF12, 125KHz, 8, 14
+LOG: DEBUG 2031360 LORA   TX, 004648676E69736952AF97304320F1F72C0B005E88D537
[09:14:16.304]收<-◆+LOG: DEBUG 2037882 LORA   RX, 868500000, SF12, 125KHz, 6
[09:14:18.112]收<-◆+LOG: DEBUG 2039690 LORA   RX, 20BD559BACB22226099AA0A8ED66D3C9E07A0E6B6AD6028162B6368CC734F6C57B, -98,
-9
+JOIN: Network joined Successful access to the network
+JOIN: NetID 000000 DevAddr 00:FC:B4:36
+JOIN: Done
```

After successfully entering the network, you need to use “AT+MSG” to manually trigger a packet of uplink to receive the relay configuration MAC command from the server downlink.

```
[09:15:29.927]发->◇AT+MSG
[09:15:29.958]收<-◆+LOG: WARN 2111541 LW tx 8, NULL(0)
+MSG: Start
+LOG: DEBUG 2111541 LW MACCMD, TX, 02
+LOG: DEBUG 2111542 LW ch 01
+LOG: DEBUG 2111542 LORA TX, 868300000, SF12, 125KHz, 8, 14
+LOG: DEBUG 2111542 LORA TX, 4036B4FC0081000002C1B00E14
[09:15:32.153]收<-◆+LOG: DEBUG 2113737 LORA RX, 868300000, SF12, 125KHz, 6
[09:15:34.948]收<-◆+LOG: DEBUG 2116531 LW MACCMD, RX, 0219010350FF00010640002000000042400043007F07
+LOG: DEBUG 2116532 LORA RX,
6036B4FC0080000000CFB7CB4F02C3D6BA1F64FF80F48DCBB2780B43F529947D072B2E408D97F5FA27BAD02A4FDE34128363D66CA0A4E4AED1CAD9186144
0A1, -99, -5
+MSG: PENDING
+MSG: Link 25, 1
+MSG: RXWIN1, RSSI -99, SNR -6.0
+MSG: Done
[09:15:35.424]收<-◆+LOG: DEBUG 2117008 LORA CAD, 865100000, SF9, 125KHz
[09:15:36.424]收<-◆+LOG: DEBUG 2118008 LORA CAD, 865100000, SF9, 125KHz
[09:15:37.423]收<-◆+LOG: DEBUG 2119007 LORA CAD, 865100000, SF9, 125KHz
```

Relay MAC Configuration Commands Received Downstream from the Server

CAD window opens every 1 second when the relay host is ready

At this point, the Relay Master is ready to wake up and forward using the Relay Slave.

2.2 Relay slave wake-up and forwarding

Open the serial port tool and select the correct serial port with a baud rate of 9600, monitoring Log

The relay slave needs to be enabled manually, sent: AT+STDRELAY= MODE,SLAVE

```
[09:21:55.486]发->◇AT+STDRELAY=MODE, SLAVE
[09:21:55.522]收<-◆+STDRELAY: MODE, SLAVE
```

Reset: AT+RESET

Turn on log output: AT+LOG=DEBUG

```
[09:22:22.919]发->◇AT+RESET
[09:22:22.936]收<-◆+RESET: OK
[09:22:24.214]收<-◆+LOG: DEBUG 233 FMCUDRV mcu flash init
+LOG: DEBUG 233 FCFG FDBT DRIVER: mcu_flash
[09:22:38.207]发->◇AT+LOG=DEBUG
[09:22:38.228]收<-◆+LOG: DEBUG
```

Switch OTAA mode: AT+MODE=OTAA

```
[09:23:01.488]发->◇AT+MODE=OTAA
[09:23:01.599]收<-◆+MODE: LWOTAA
```

Use “AT+JOIN” to start the network access request, and receive the access answer forwarded by the RXR Relay Master, then the network access is successful.

```
[09:23:27.752]发->◇AT+JOIN
[09:23:27.789]收<-◆+JOIN: Start
+JOIN: NORMAL
+LOG: DEBUG 63811 LW ch 02
+LOG: DEBUG 63814 LORA TX, 0000C88584
+LOG: DEBUG 63815 LORA TX, 865100000, SF9, 125KHz, 259, 22
[09:23:29.004]收<-◆+LOG: DEBUG 65028 LORA TX, 868500000, SF12, 125KHz, 8, 14
+LOG: DEBUG 65028 LORA TX, 004C48676E697369521C2F206020F1F72C0500E9A8FCF5
[09:23:35.527]收<-◆+LOG: DEBUG 71551 LORA RX, 868500000, SF12, 125KHz, 6
[09:23:36.528]收<-◆+LOG: DEBUG 72552 LORA RX, 869525000, SF12, 125KHz, 6
[09:23:48.497]收<-◆+LOG: DEBUG 84521 LORA RX, 865100000, SF12, 125KHz, 6
[09:23:50.378]收<-◆+LOG: DEBUG 86402 LORA RX, 20C069ED8D6FEFBF267CC326B6B9F6B808E6E17C3582AC7C684DA2C0F3F18BEC90, -50
+JOIN: Network joined
+JOIN: NetID 000000 DevAddr 00:C9:F4:5F
+JOIN: Done
```

Initiation of requests for access to the network

CAD wake-up frame

LORAWAN uplink data

RXWIN1

RXWIN2

RXWIN3 (RXR) receives an answer forwarded by the host

Access successful

The entire forwarding process can be observed at the Relay Master's side at the same time (the following figure shows the log of the Relay Master)

```
[09:23:28.395]收←◆+LOG: DEBUG 2590008 LORA CAD, 865100000, SF9, 125KHz
+LOG: DEBUG 2590018 LORA RX, 865100000, SF9, 125KHz, 10
[09:23:28.951]收←◆+LOG: DEBUG 2590564 LORA RX, 0000C88584, -47, 10
+LOG: DEBUG 2590613 LORA RX, 868500000, SF12, 125KHz, 10
[09:23:30.526]收←◆+LOG: DEBUG 2592138 LORA RX, 004C48676E697369
[09:23:30.594]收←◆521C2F206020F1F72C0500E9A8FCF5, -54, 4
+LOG: WARN 2592206 LW tx 226, F04100C88584004C48676E697369521C2F206020F1F72C0500E9A8FCF5 (29)
+LOG: DEBUG 2592207 LORA TX, 867300000, SF7, 125KHz, 8, 2
+LOG: DEBUG 2592208 LORA TX, 4036B4FC00801100E23D7DD4A0FCBEEF110C1940E3E965E5B930E1010E2E79824B42C38DB982A6A8A5EA
+LOG: DEBUG 2592209 LW ch 04
[09:23:31.680]收←◆+LOG: DEBUG 2593294 LORA RX, 867300000, SF7, 125KHz, 24
[09:23:31.781]收←◆+LOG: DEBUG 2593394 LORA RX,
6036B4FC00800400E20881EFEBEC1567C38D36EA4964D3F9A8796D40A2EE839F3DF51160BE92F7D817B866E6CFC, -103, 0
+MSG: RXWIN1, RSSI -103, SNR 0.0
+MSG: Done
[09:23:48.526]收←◆+LOG: DEBUG 2610141 LORA TX, 865100000, SF12, 125KHz, 8, 22
+LOG: DEBUG 2610141 LORA TX, 20C069ED8D6FEEBF267CC326B6B9F6B808E6E17C3582AC7C684DA2C0F318BEC90
[09:23:50.362]收←◆+LOG: WARN 2611976 LW tx 8, NULL(0)
+LOG: DEBUG 2611976 LORA TX, 868300000, SF7, 125KHz, 8, 2
```

Host woken up by CAD

Receive slave LORAWAN inbound request

Host packages slave access request into its own LORAWAN data frame and forwards it upstream via Port226

Host receives a LORAWAN ingress reply from its own RXWIN1

The host extracts and forwards the LORAWAN ingress reply to the slave at the agreed time.

AT+RETRY=1

Send Confirmed package: AT+MSGHEX= AA

At this point, WOR_ACK will be received and time synchronization will be performed, and the number of subsequent leading codes derived from the calculation will be greatly reduced.

```
[09:36:41.485]收←◆+RETRY: 1
[09:36:56.375]发→◇ AT+MSGHEX=AA
[09:36:56.414]收←◆+LOG: WARN 872486 LW tx 8, AA(1)
+MSGHEX: Start
+MSGHEX: Wait ACK
+LOG: DEBUG 872486 LW ch 05
+LOG: DEBUG 872489 LORA TX, 865100000, SF9, 125KHz, 259, 22
+LOG: DEBUG 872490 LORA TX, 015FF4C90054066CF01006A3A2EA8
[09:36:57.671]收←◆+LOG: DEBUG 873743 LORA RX, 865300000, SF9, 125KHz, 10
[09:36:57.801]收←◆+LOG: DEBUG 873874 LORA RX, D33D95098D11EF -50, 10
+LOG: DEBUG 873829 LORA TX, 867500000, SF12, 125KHz, 8, 14
+LOG: DEBUG 873829 LORA TX, 805FF4C900800000085E0A2B2FFB
[09:37:00.051]收←◆+LOG: DEBUG 876125 LORA RX, 867500000, SF12, 125KHz, 6
[09:37:01.052]收←◆+LOG: DEBUG 877126 LORA RX, 869525000, SF12, 125KHz, 6
[09:37:17.021]收←◆+LOG: DEBUG 893095 LORA RX, 865100000, SF12, 125KHz, 6
[09:37:18.574]收←◆+LOG: DEBUG 894649 LORA RX, 605FF4C900AD00000352FF0001064104000000000E5D36A34, -49, 4
+MSGHEX: ACK Received
+MSGHEX: RXWIN3, RSSI -49, SNR 4.0
+MSGHEX: Done
```

Unsynchronized, sends long leading code WOR wake-up packet covering one CAD cycle, 1 second at SF9/125KHz equals approximately 259 leading code times

Receive WOR_ACK for synchronization time between master and slave

Send LORAWAN packet upstream

RXWIN1

RXWIN2

RXWIN3 (RXR) receives forwarded downstream answer ACKs

The entire forwarding process can be observed at the Relay Master's side at the same time (the following figure shows the log of the Relay Master)

```
[09:36:57.345]收←◆+LOG: DEBUG 3399008 LORA CAD, 865100000, SF9, 125KHz
+LOG: DEBUG 3399018 LORA RX, 865100000, SF9, 125KHz, 10
[09:36:57.618]收←◆+LOG: DEBUG 3399281 LORA RX, 015FF4C90054066CF01006A3A2EA8, -47, 11
+LOG: DEBUG 3399330 LORA TX, 865300000, SF9, 125KHz, 8, 22
+LOG: DEBUG 3399331 LORA TX, D33D95098D11EF
[09:36:57.850]收←◆+LOG: DEBUG 3399514 LORA RX, 867500000, SF12, 125KHz, 10
[09:36:59.048]收←◆+LOG: DEBUG 3400712 LORA RX, 805FF4C900800000085E0A2B2FFB, -54, 4
+LOG: WARN 3400779 LW tx 226, F04100B85E84805FF4C900800000085E0A2B2FFB (20)
+LOG: DEBUG 3400780 LW ch 05
+LOG: DEBUG 3400780 LORA TX, 867500000, SF7, 125KHz, 8, 2
+LOG: DEBUG 3400781 LORA TX, 4036B4FC00802900E226F96E910BA2A8A8569A0C5314DFDD22487DF6743268D5B
[09:37:00.188]收←◆+LOG: DEBUG 3401852 LORA RX, 867500000, SF7, 125KHz, 24
+LOG: DEBUG 3401941 LORA RX, 6036B4FC00800600E2E8496FBEE2EE01C4A612D6CA122CB6F263D092A9F512F2A199386DFA6, -95, 7
+MSG: RXWIN1, RSSI -95, SNR 7.0
+MSG: Done
[09:37:17.050]收←◆+LOG: DEBUG 3418715 LORA TX, 865100000, SF12, 125KHz, 8, 22
+LOG: DEBUG 3418716 LORA TX, 605FF4C900AD00000352FF0001064104000000000E5D36A34
```

WOR Wake Up

Send WOR_ACK

Receive LORAWAN packet uplink

Forward LORAWAN packets uplink

Receive LORAWAN packet answer

Forward LORAWAN packet answer

Use: AT+CMGHEX= AA

Send the Confirmed packet again at this point you can observe that the number of Symbol leading codes is greatly reduced after time synchronization, from 259 to 15.

```

[09:56:55.504]发->◇AT+CMGHEX=AA
□
[09:56:55.539]收<-◆+LOG: WARN 141134 LW tx 8, AA(1)
+CMGHEX: Start
+CMGHEX: Wait ACK
+LOG: DEBUG 141134 LW ch 01
+LOG: DEBUG 141135 RELAY_TXt_ref: 111849
+LOG: DEBUG 141135 RELAY_TXcurrent_ms: 141134
+LOG: DEBUG 141135 RELAY_TXn: 30
+LOG: DEBUG 141135 RELAY_TXt_next: 141849
+LOG: DEBUG 141136 RELAY_TXdrift_error: 1
+LOG: DEBUG 141136 RELAY_TXt_start: 141849
+LOG: DEBUG 141136 RELAY_TXpreamble_symb: 15, start_at: 141849, current: 141134, delay 715 ms
[09:56:56.258]收<-◆+LOG: DEBUG 141852 LORA TX, 865100000, SF9, 125KHz, 15, 22
+LOG: DEBUG 141853 LORA TX, 81BB408201E3B9247A836816A89B99
[09:56:56.513]收<-◆+LOG: DEBUG 142107 LORA RX, 865300000, SF9, 125KHz, 10
[09:56:56.642]收<-◆+LOG: DEBUG 142237 LORA RX, ABD4C2F344950, -49, 10
+LOG: DEBUG 142291 LORA TX, 868300000, SF12, 125KHz, 8, 14
+LOG: DEBUG 142292 LORA TX, 80BB408201800200086D1F9FC723
[09:56:58.892]收<-◆+LOG: DEBUG 144487 LORA RX, 868300000, SF12, 125KHz, 6
[09:56:59.893]收<-◆+LOG: DEBUG 145488 LORA RX, 869525000, SF12, 125KHz, 6
[09:57:15.861]收<-◆+LOG: DEBUG 161457 LORA RX, 865100000, SF12, 125KHz, 6
[09:57:17.415]收<-◆+LOG: DEBUG 163011 LORA RX, 60BB408201AC01000352FF0001410400000000008944152, -49, 6
+CMGHEX: ACK Received
+CMGHEX: RXWIN3, RSSI -49, SNR 6.0
+CMGHEX: Done
  
```

After synchronization time, the leading code has been reduced to 15

Downlink answer also received from RXWIN3 (RXR)

The Relay Slave is now connected to the Relay Master.

3. TTN Deployment

This chapter covers the configuration and registration of servers (TTN), gateways, Relay Masters, and Relay Slaves

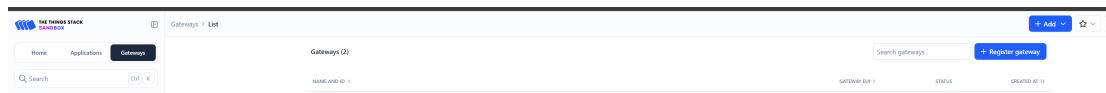
3.1 Server

The following operation uses the TTN server

3.2 Gateway

3.2.1 Register Gateway

Register Gateway: Gateways->Register gateway



Fill in the gateway EUI and click Confirm.

Register gateway

Register your gateway to enable data traffic between nearby end devices and the network. Learn more in our guide on [Adding Gateways](#).

Does your gateway have a LoRaWAN® Gateway Identification QR Code? Scan it to speed up onboarding.

[Scan gateway QR code](#)

Gateway EUI

2C F7 F1 10 54 20 00 1C

To continue, please confirm the Gateway EUI so we can determine onboarding options

Fill in the Gateway ID, Gateway name, select Frequency plan, and finally click Register gateway.

Register gateway

Register your gateway to enable data traffic between nearby end devices and the network. Learn more in our guide on [Adding Gateways](#).

Does your gateway have a LoRaWAN® Gateway Identification QR Code? Scan it to speed up onboarding.

[Scan gateway QR code](#)

Gateway EUI

2C F7 F1 10 54 20 00 1C

Gateway ID

gatewaytest1

Gateway name

gatewaytest1

Frequency plan

Europe 863-870 MHz (SF9 for E2X - recommended)

[+ Add frequency plan](#)

Note: most gateways use a single frequency plan. Some 16 and 64 channel gateways however allow setting multiple within the same band.

Require authenticated connection

Choose this option eg. if your gateway is powered by LoRa Basic Station

Share gateway information

Select which information can be seen by other network participants, including [Packet Broker](#)

Share status within network

Share location within network

3.2.2 Gateway link to server

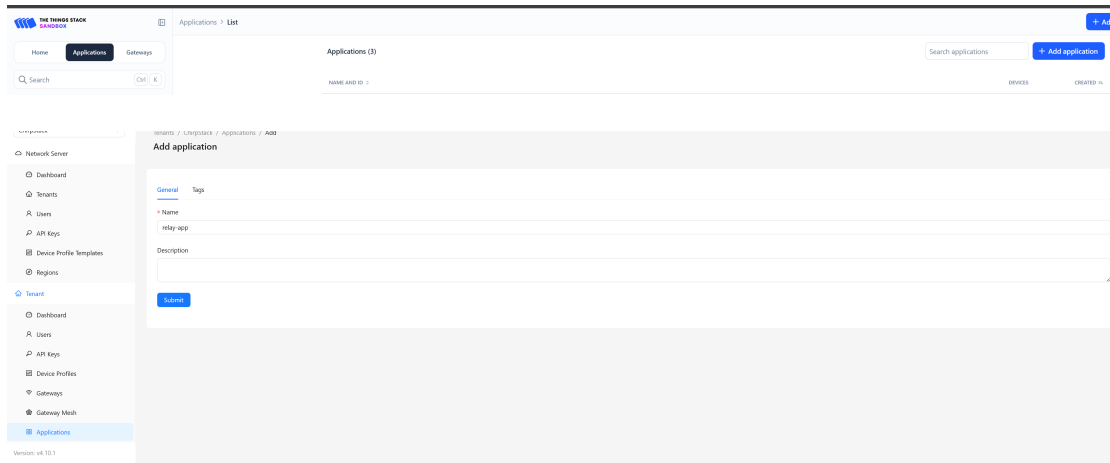
This step is to configure the gateway to connect to the server, take SenseCAP M2 Multi-Platform LoRaWAN Gateway as an example.

https://wiki.seeedstudio.com/quick_start_with_M2_MP/

https://wiki.seeedstudio.com/Network/SenseCAP_Network/SenseCAP_M2_Multi_Platform/Tutorial/Connect-M2-Multi-Platform-Gateway-to-The-Things-Network/

3.3 Registration Server Node Application

Applications->Add application



Fill in the ID and name and click Create application.

Create application

Within applications, you can register and manage end devices and their network data. After setting up your device fleet, use one of our many integration options to pass relevant data to your external services. Learn more in our guide on [Adding Applications](#).

Application ID *

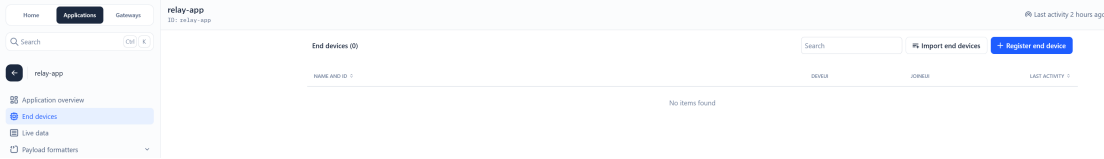
Application name

Description

Optional application description; can also be used to save notes about the application

3.4 Registering a Relay Slave

Select the app just registered “relay-app”, select End devices->Register end device.



Select: Enter end device specifics manually, Frequency plan, LoRaWAN version, Regional Parameters version

Register end device

Register end device

Does your end device have a LoRaWAN® Device Identification QR Code? Scan it to speed up onboarding.

[Device registration help](#)

End device type

Input method

Select the end device in the LoRaWAN Device Repository
 Enter end device specifics manually

Frequency plan *

Europe 863-870 MHz (SF9 for RX2 - recommended)

LoRaWAN version *

LoRaWAN Specification 1.0.4

Regional Parameters version *

RP002 Regional Parameters 1.0.3

[Show advanced activation, LoRaWAN class and cluster settings](#)

Enter JoinEUI, DevEUI, AppKey, and End device ID (set to relay-tx, which will be used later to enable the relay function), and click Register end device. this ID information was obtained in the first chapter.

Provisioning information

JoinEUI *

52 69 73 69 6E 67 48 46

Reset

This end device can be registered on the network

DevEUI *

2C F7 F1 20 60 20 2F 1D

Generate

0/50 used

AppKey *

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

Generate

End device ID *

relay-tx

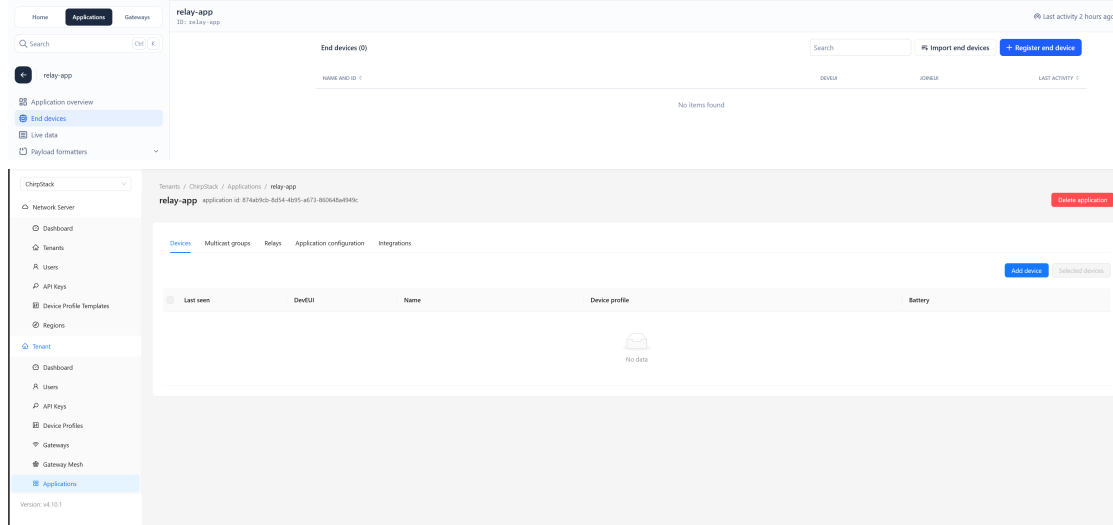
After registration

- View registered end device
- Register another end device of this type

Register end device

3.5 Registering Relay Master

Select the app just registered “relay-app”, select End devices->Register end device.



Select: Enter end device specifics manually, Frequency plan, LoRaWAN version, Regional Parameters version

Register end device

Does your end device have a LoRaWAN® Device Identification QR Code? Scan it to speed up onboarding.

[Scan end device QR code](#) [Device registration help](#)

End device type

Input method Select the end device in the LoRaWAN Device Repository Enter end device specifics manually

Frequency plan

LoRaWAN version

Regional Parameters version

[Show advanced activation, LoRaWAN class and cluster settings](#)

Enter JoinEUI, DevEUI, AppKey, and End device ID (set to **relay-rx**, which will be used later to enable the relay function), and click Register end device. this ID information was obtained in the first chapter.

Provisioning information

JoinEUI

This end device can be registered on the network

DevEUI 0/50 used

AppKey

End device ID

After registration

View registered end device Register another end device of this type

3.6 TTN Server Enable Relay Function

Use the TTN CLI tool for configuration:

<https://www.thethingsindustries.com/docs/concepts/features/cli/installing-cli/>

Windows

No package manager is available for Windows. Follow instructions in the [Installing using pre-built binaries](#) section below to download the [pre-built binaries](#) for Windows based on the processor architecture.

Note that Windows binaries must be run with a `.exe` extension on the end, so if an example uses `ttn-lw-cli`, that will be `ttn-lw-cli.exe` on Windows.

Installing using pre-built binaries

If your operating system does not support a package manager or you do not want to use one, you can still download pre-built binaries for your operating system and processor architecture.

The commands to determine your processor architecture depend on your operating system. On Linux and macOS you can use `uname -m` in your terminal, while on Windows you can use `echo %PROCESSOR_ARCHITECTURE%`.

Use the following form to select the correct binaries for your architecture.

Deployment

Open Source

OS

macOS

Arch

amd64 (64-bit Intel)

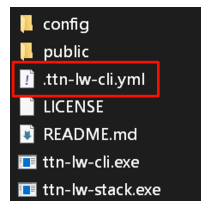
Download:

[Download CLI](#)

Choose a version to download (take 3.32.2 as an example)

lorawan-stack_3.32.2_linux_armv7.rpm	55.8 MB	Nov 18, 2024
lorawan-stack_3.32.2_linux_armv7.tar.gz	53.4 MB	Nov 18, 2024
lorawan-stack_3.32.2_windows_386.zip	54.2 MB	Nov 18, 2024
lorawan-stack_3.32.2_windows_amd64.zip	56.8 MB	Nov 18, 2024
lorawan-stack_3.32.2_windows_arm64.zip	52.3 MB	Nov 18, 2024
Source code (zip)		Nov 18, 2024
Source code (tar.gz)		Nov 18, 2024

Unzip it and open the folder, delete the `.yml`, type `cmd` in the address bar and press enter.



Import: `ttn-lw-cli.exe` use **"Your TTN server address"**

Like:

Import: `ttn-lw-cli.exe` use **`eul.cloud.thethings.network`**

```
D:\seed\software\lorawan-stack_3.32.2_windows_amd64>ttn-lw-cli.exe use eul.cloud.thethings.network
INFO Telemetry is enabled. Check the documentation for more information on what is collected and how to disable it
{"documentation_url": "https://www.thethingsindustries.com/docs/reference/telemetry/cli"}
INFO Configuring for The Things Stack Community Edition {"cluster_id": "eul"}
INFO Set OAuth Server address {"address": "https://eul.cloud.thethings.network/oauth"}
INFO Set Identity Server gRPC address {"address": "eul.cloud.thethings.network:8884"}
INFO Config file for eul.cloud.thethings.network written in .ttn-lw-cli.yml
WARN New minor version available {"current": "3.32.2", "docs_url": "https://www.thethingsindustries.com/docs/getting-started/upgrading/", "latest": "3.33.1"}
```

Input “ttn-lw-cli.exe login” to automatically pop up a web page to log in to your registered TTN account:

```
D:\seed\software\lorawan-stack_3.32.2_windows_amd64>ttn-lw-cli.exe login
INFO Telemetry is enabled. Check the documentation for more information on what is collected and how to disable it
{"documentation_url": "https://www.thethingsindustries.com/docs/reference/telemetry/cli"}
WARN [dns]dns: TXT record v=spf1 -all missing grpc_config= attribute
INFO Revoking the old OAuth token...
INFO Opening your browser on https://eu1.cloud.thethings.network/oauth/authorize?client_id=cli&redirect_uri=local-cal
lback&response_type=code
INFO After logging in and authorizing the CLI, we'll get an access token for future commands.
INFO Waiting for your authorization...
INFO Successfully got an access token.
WARN New minor version available {"current": "3.32.2", "docs_url": "https://www.thethingsindustries.com/docs/gett
ing-started/upgrading/", "latest": "3.33.1"}
```

Enter “ttn-lw-cli.exe relays create relay-app relay-rx -mode.serving” to enable Relay Master. where “relay-app” is the application ID and “relay-rx” is the Relay Master ID.

```
D:\seed\software\lorawan-stack_3.32.2_windows_amd64>ttn-lw-cli.exe relays create relay-app relay-rx --mode.serving
INFO Telemetry is enabled. Check the documentation for more information on what is collected and how to disable it
{"documentation_url": "https://www.thethingsindustries.com/docs/reference/telemetry/cli"}
WARN [dns]dns: TXT record v=spf1 -all missing grpc_config= attribute
{"settings": {
  "serving": {}
}}
WARN New minor version available {"current": "3.32.2", "docs_url": "https://www.thethingsindustries.com/docs/gett
ing-started/upgrading/", "latest": "3.33.1"}
```

Enter “ttn-lw-cli.exe relays create relay-app relay-tx --mode.served.mode.always --mode.served.serving-device-id relay-rx” “Enable relay slaves and associate them with the corresponding Relay Masters

“relay-app” is the application id, “relay-tx” is the relay slave id, and “relay-rx” is the associated Relay Master

```
D:\seed\software\lorawan-stack_3.32.2_windows_amd64>ttn-lw-cli.exe relays create relay-app relay-tx --mode.served.mode.
always --mode.served.serving-device-id relay-rx
INFO Telemetry is enabled. Check the documentation for more information on what is collected and how to disable it
{"documentation_url": "https://www.thethingsindustries.com/docs/reference/telemetry/cli"}
WARN [dns]dns: TXT record v=spf1 -all missing grpc_config= attribute
{"settings": {
  "served": {
    "always": {},
    "serving_device_id": "relay-rx"
  }
}}
WARN New minor version available {"current": "3.32.2", "docs_url": "https://www.thethingsindustries.com/docs/gett
ing-started/upgrading/", "latest": "3.33.1"}
```

Enter “ttn-lw-cli.exe relays uplink-forwarding-rules create relay-app relay-rx 0 --device-id relay-tx” to create uplink forwarding rule:

```
D:\seed\software\lorawan-stack_3.32.2_windows_amd64>ttn-lw-cli.exe relays uplink-forwarding-rules create relay-app rela
y-rx 0 --device-id relay-tx
INFO Telemetry is enabled. Check the documentation for more information on what is collected and how to disable it
{"documentation_url": "https://www.thethingsindustries.com/docs/reference/telemetry/cli"}
WARN [dns]dns: TXT record v=spf1 -all missing grpc_config= attribute
{"rule": {
  "device_id": "relay-tx"
}}
WARN New minor version available {"current": "3.32.2", "docs_url": "https://www.thethingsindustries.com/docs/gett
ing-started/upgrading/", "latest": "3.33.1"}
```

The above is the default parameter, if you need special settings, please refer to the official article of TTN:

<https://www.thethingsindustries.com/docs/hardware/devices/configuring-devices/relay-settings/>

4. Document Version

Version	Date	Description	Editor
V1.0.0	5/23/2025	First edition	Zeke CAI