WF288 LoRA Gateway Application Note

Amp'ed RF Technology, Inc.

1. WF288 LoRaNetGateway

1.1. Overview

WF288 LoRaNetGateway is a LoRa gateway product. This product enables users to remotely control LoRa through the network.

1.2. Product Introduction

1.2.1. Layout

- LoRa: LoRa antenna SMA interface.
- Wi-Fi: Wi-Fi antenna SMA interface.

- Reset: Press and hold for 1 second to reset the system; Press and hold for 10 seconds to restore factory settings.
- Update: System firmware update interface.
- Debug: System debugging, parameter setting interface.
- WAN: Ethernet socket.

- LAN: Ethernet socket.

Power supply: Both the Update and Debug interfaces can serve as power supply interfaces.

1.2.2. Key Features

- Supports IPV4/IPV6
- 802.11 a/b/g/n, dual band
- Support STA mode connection to AP
- Supports WAN and LAN ports
- WPA3 security enabled
- Support TCP client connection
- Support MQTT connection
- DC5V/2A Input

1.3. Antenna Installation

Install the LoRa and Wi-Fi antennas separately onto the SMA interface of WF288 LoRaNetGateway.

1.4. Power Connection

A USB to Type-C data cable provides the voltage input connection. Insert the Type-C connector of the data cable into the Type-C “Update/Debug” interface of WF288 LoRaNetGateway, and the other end into the DC5V/2A adapter. The red indicator light of WF288 LoRaNetGateway is on. After the system startup is complete, the blue indicator light will light up.

1.5. Ethernet network

A network may be established through Ethernet interface to achieve remote control of LoRa.

1.5.1. Network topology diagram

As shown in the network topology diagram in Figure 2-5-1-1. If MQTT Broker supports IPV6, the entire network can be configured using IPV6. If MQTT Broker only supports IPV4, the entire network can be configured using IPV4. In this network, Gate needs to be in the same network segment as the router.

- LoRaNetGateway loads “MQTT” functionality:

  It is necessary to ensure that PC and Gate can access the MQTT Broker normally. Since the MQTT Broker in the figure is on the Internet, the PC and Gate need to be able to access the Internet normally. Use the "ping 8.8.8.8" command to test on the PC and Gate to confirm whether the Internet can be accessed normally.

- LoRaNetGateway loads “TCP” functionality:

  PC can access Gate, and router may need to NAT the port that Gate listens.

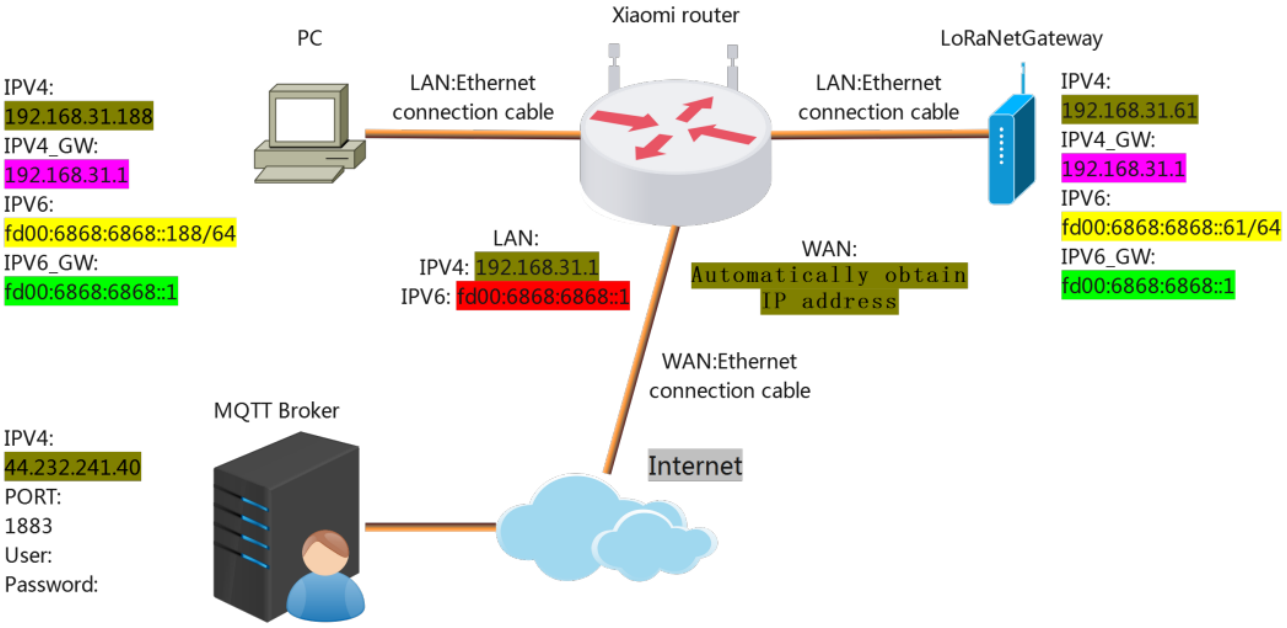


Figure 2-5-1-1. Network topology diagram

1.5.2. Configure the parameters of Gate for MQTT

Use the WF88 configuration tool to configure the parameters of Gate for MQTT.

(1) Start the WF88 configuration tool, as shown in Figure 2-5-2-1.

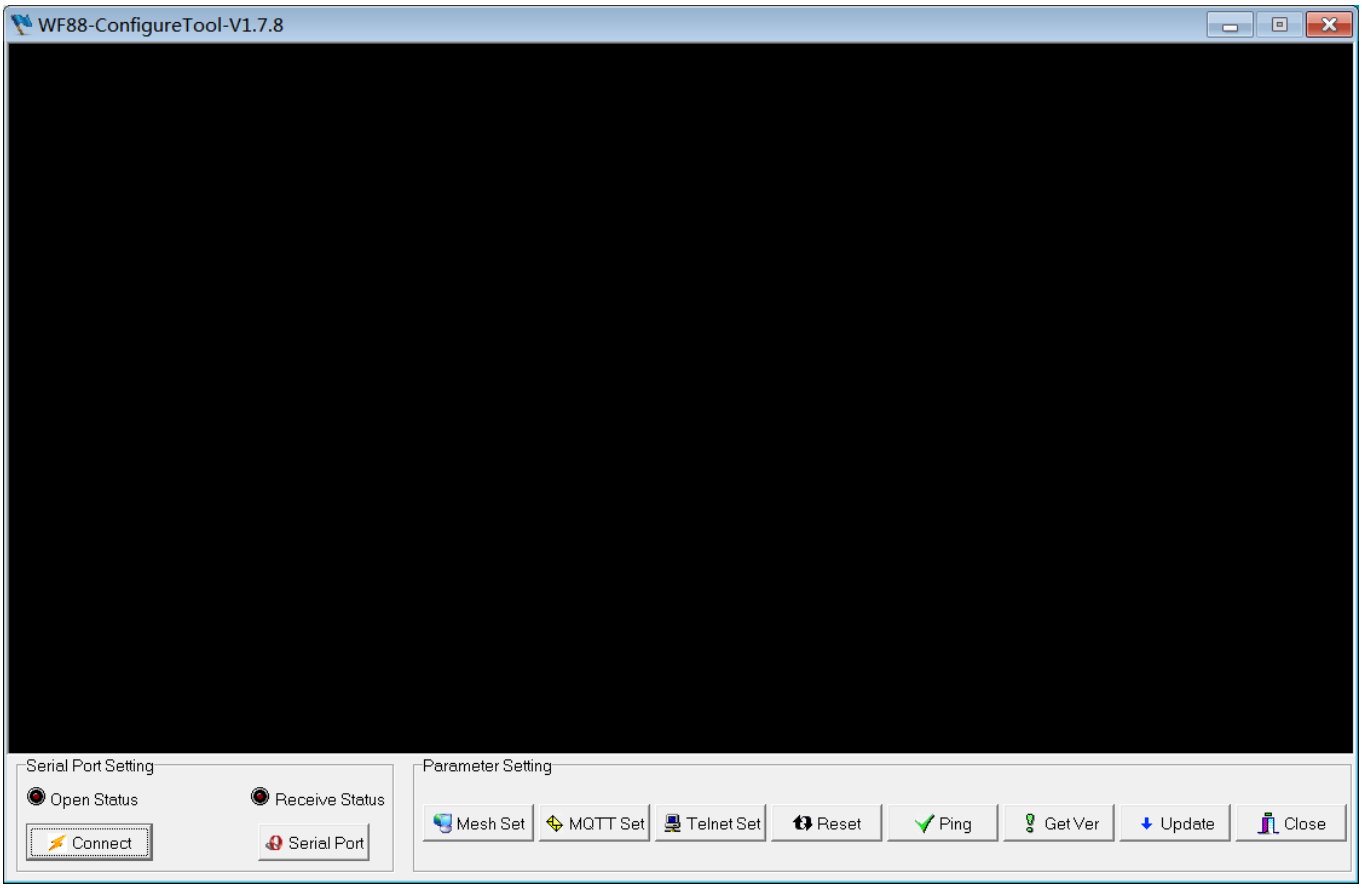


Figure 2-5-2-1. WF88 configuration tool

(2) Clicking the "Serial Port" button will bring up the "Setup" dialog box. Select the serial port number of the PC connected to the Gate “Debug” port from the "Port" drop-down list in the dialog box, and click the "OK" button. As shown in Figure 2-5-2-2.

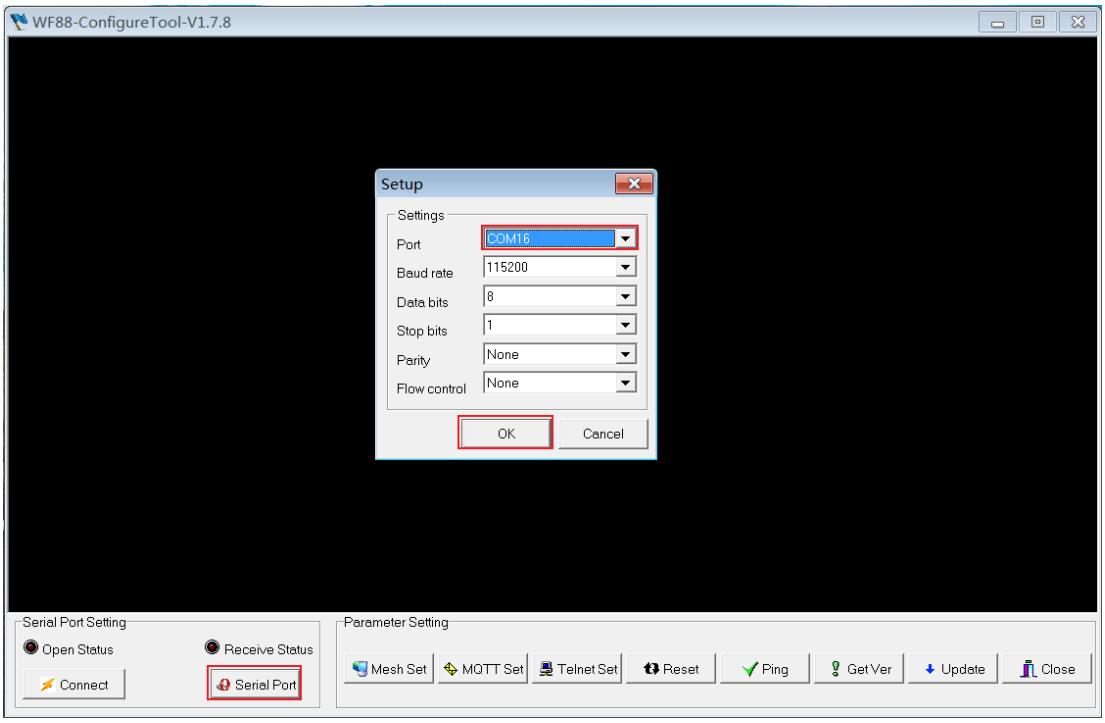


Figure 2-5-2-2. The serial port configuration

(3) Click the "Connect" button to open the serial port, as shown in Figure 2-5-2-3.

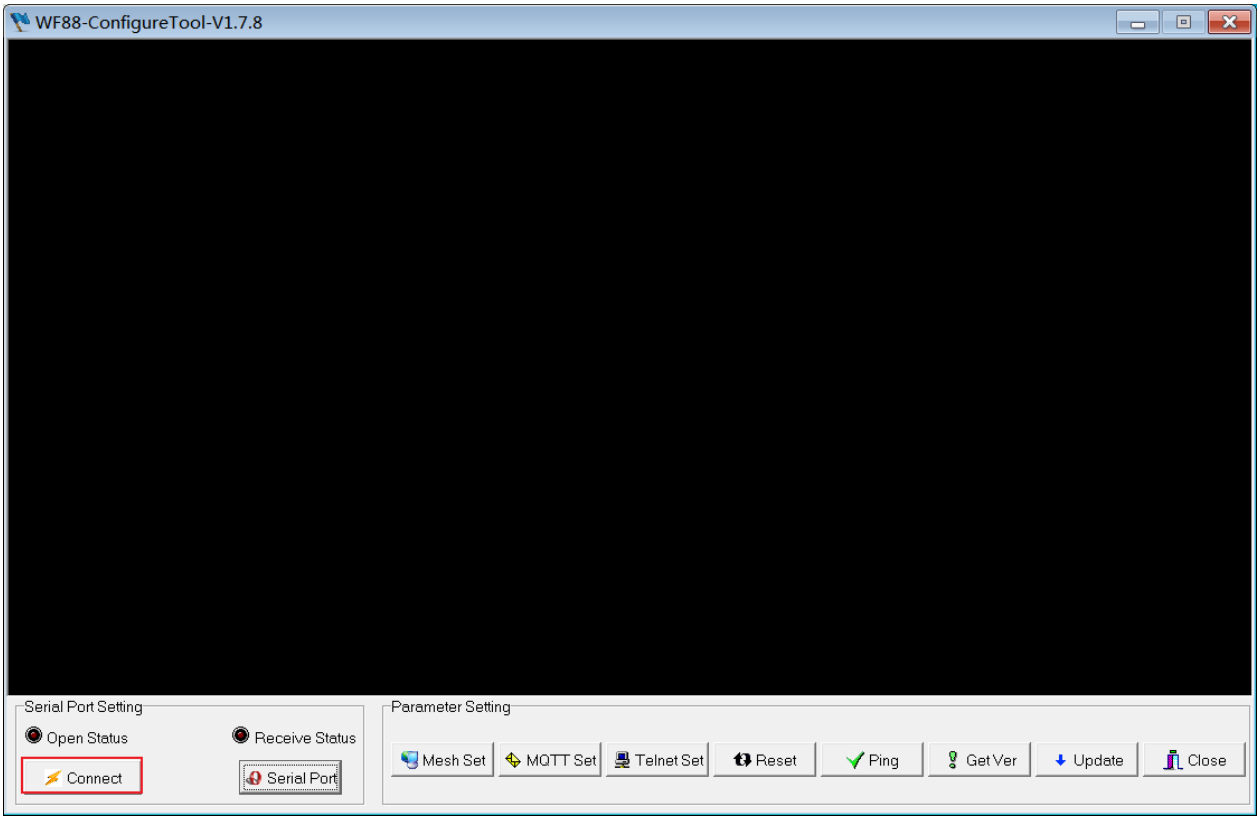


Figure 2-5-2-3. Open the serial port

(4) Click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. Select "Ethernet" from the "Connection mode" drop-down list. Select "mqtt" from the "LoadModule" drop-down list. Select the corresponding IP version based on the user's network support in the "IP Version" drop-down list, and enter the IP address in the corresponding IP version below. Finally, click the "Save" button. As shown in Figure 2-5-2-4 and Figure 2-5-2-5.

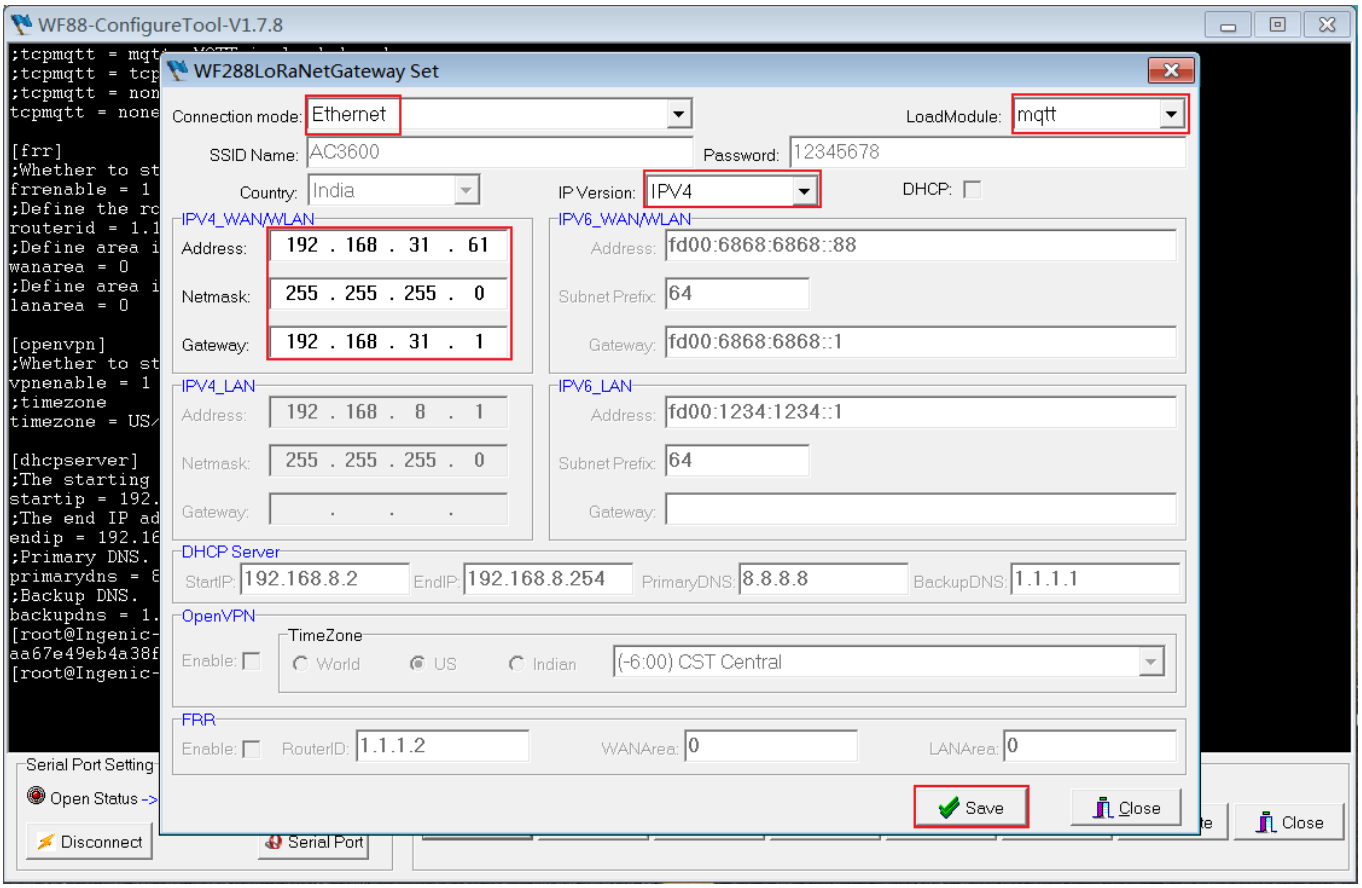


Figure 2-5-2-4. WF288 LoRaNetGateway Set configuration

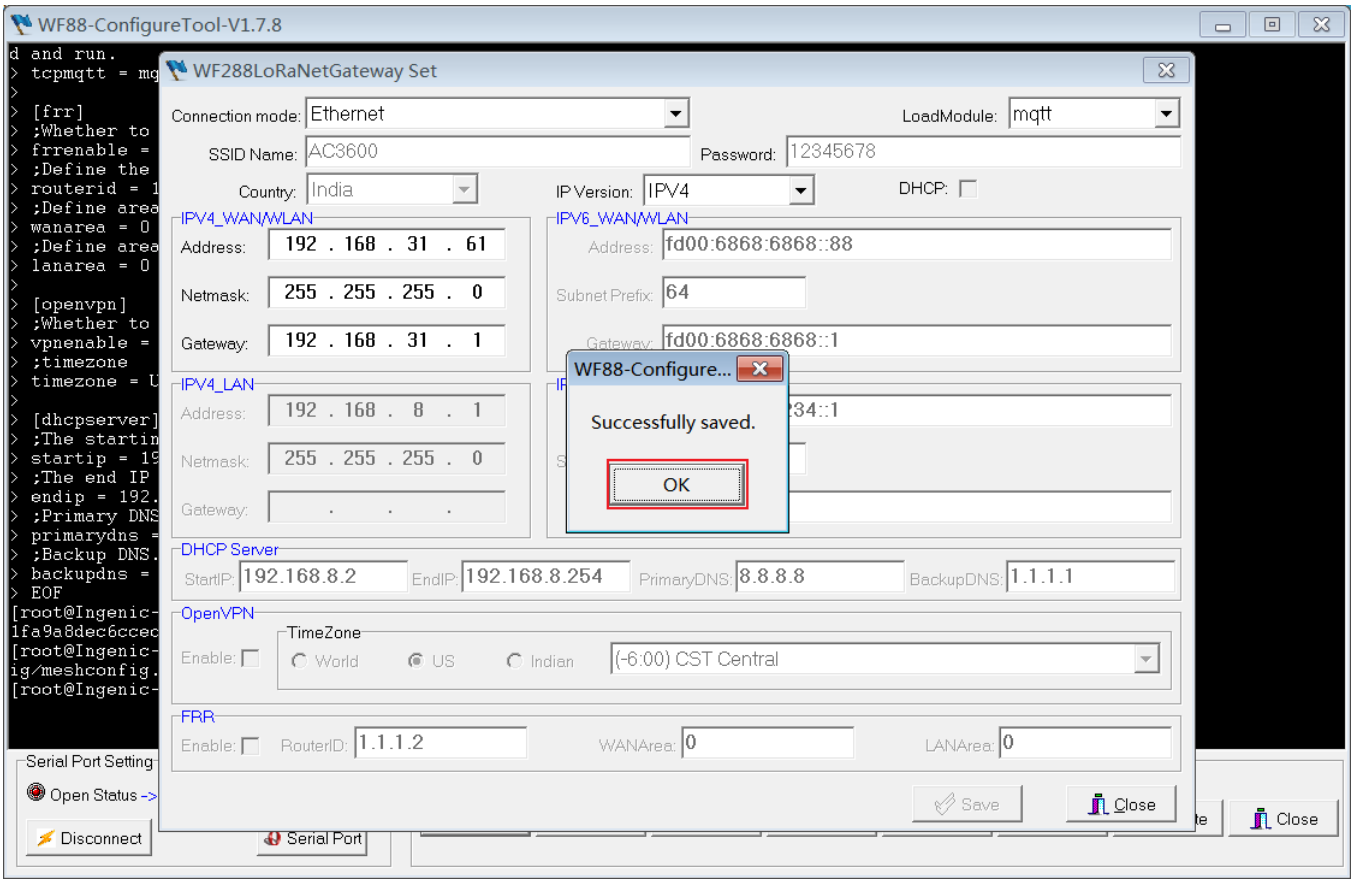


Figure 2-5-2-5. Successfully saved

(5) Click the "MQTT Set" button to bring up the "MQTT Set" dialog box. Select "TCP" from the "Protocol" drop-down list. Enter the IP address "44.232.241.40" of MQTT Broker in the "ServerIP" editing box. Enter the port "1883" of MQTT Broker in the "RemotePortNum" editing box. Other options can be set to default values. Finally, click the "Save" button. As shown in Figure 2-5-2-6.

"UART0 BaudRate" represents the communication rate of the UART interface of LoRa. User does not need to modify it, keep it as default.

The port number of MQTT Broker corresponds to Protocol (tcp/ssl), which means that when using "TCP" protocol, there is a corresponding port number; when using "SSL" protocol, it will correspond to another port number.

"UserName" and "PassWord" indicate that MQTT Broker requires a username and password to establish a connection.

"SubTopic" represents topic the client subscriptions to, with a default value of "SToC"; "PubTopic" represents topic the client publishes to, with the default value being "CToS"; "KeepAliveInterval" refers to the time interval in seconds during which MQTT client sends keep alive messages to MQTT Broker; "QoS" refers to quality of service, with a default value of "0"; "ClientId" represents the ID of the MQTT client.

"OpenCert" and "OpenKey" indicate that MQTT Broker requires a client certificate and client private key to establish a connection.

"OpenCA" indicates that a CA certificate is required to verify MQTT Broker when establishing a connection. The five options of "UserName", "PassWord", "OpenCert", "OpenKey", and "OpenCA" need to be filled in according to the protocol and access requirements of MQTT Broker. If necessary, they should be filled in according to the requirements. Otherwise, they can be left blank by default.

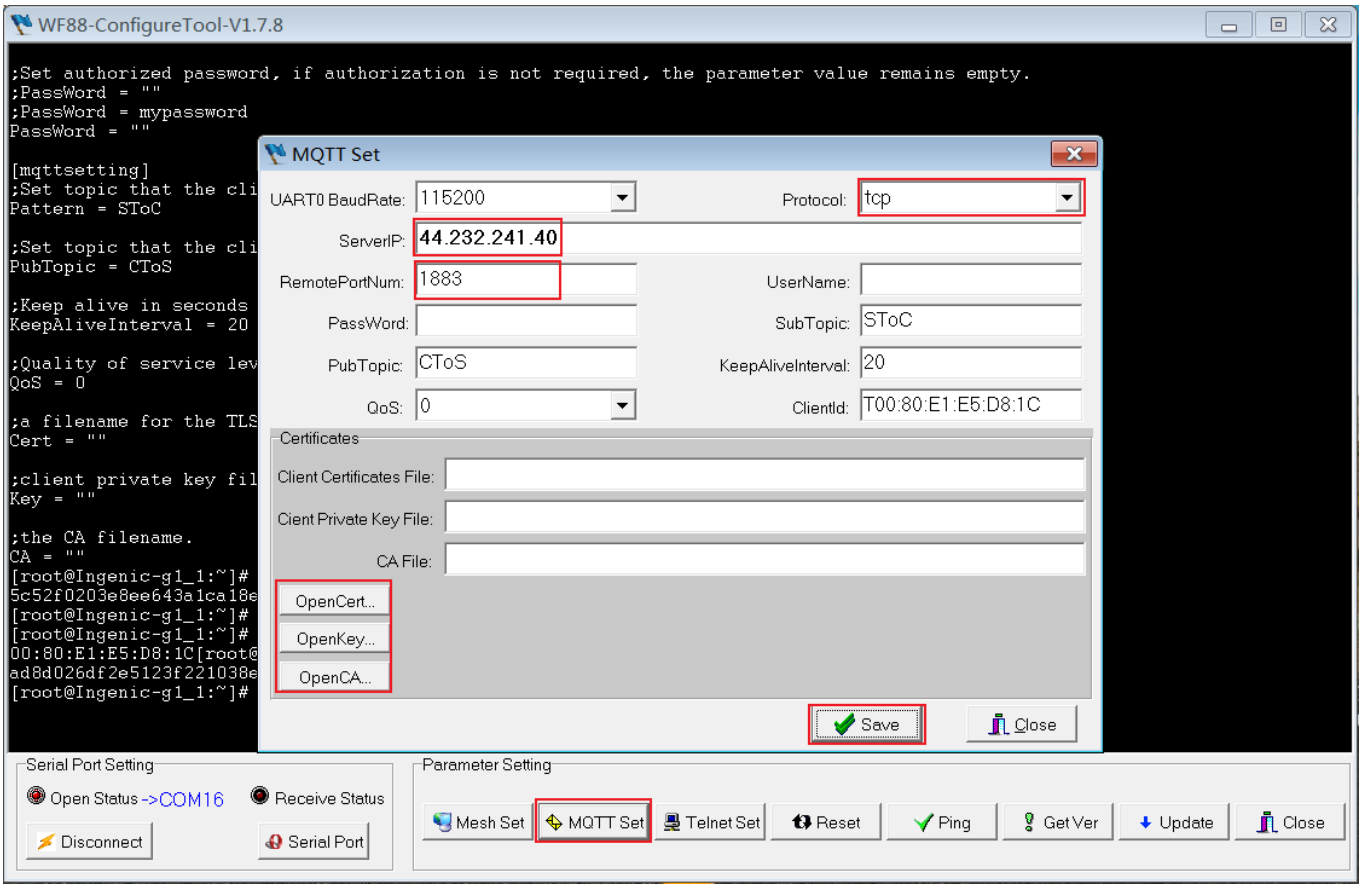


Figure 2-5-2-6. MQTT Set configuration

(6) Click the "Reset" button to restart, as shown in Figure 2-5-2-7.

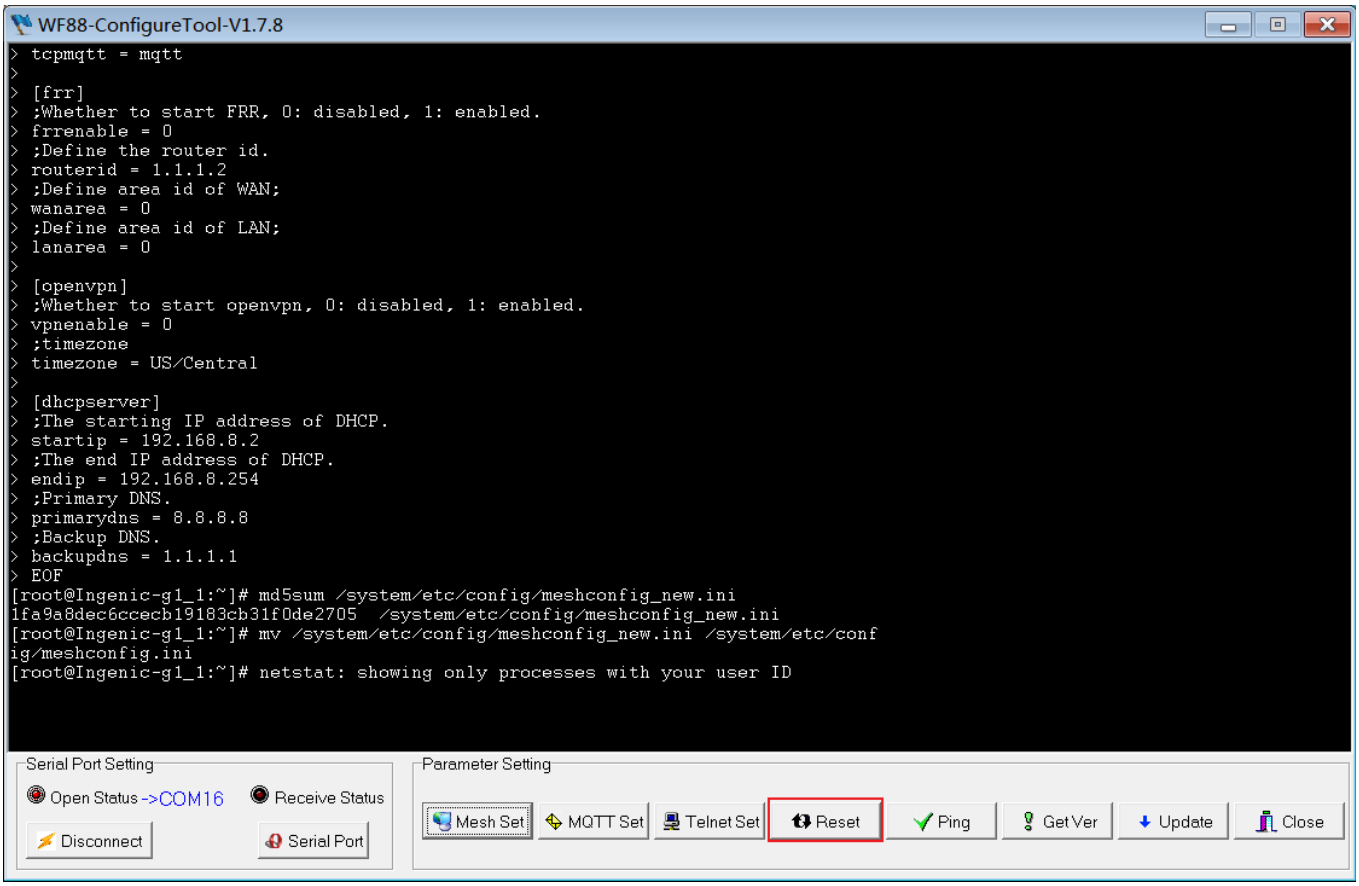


Figure 2-5-2-7. Reset

(7) After the system restarts, note a prompt message "Device Setup complete." indicating that the MQTT connection has been successfully established, as shown in Figure 2-5-2-8.

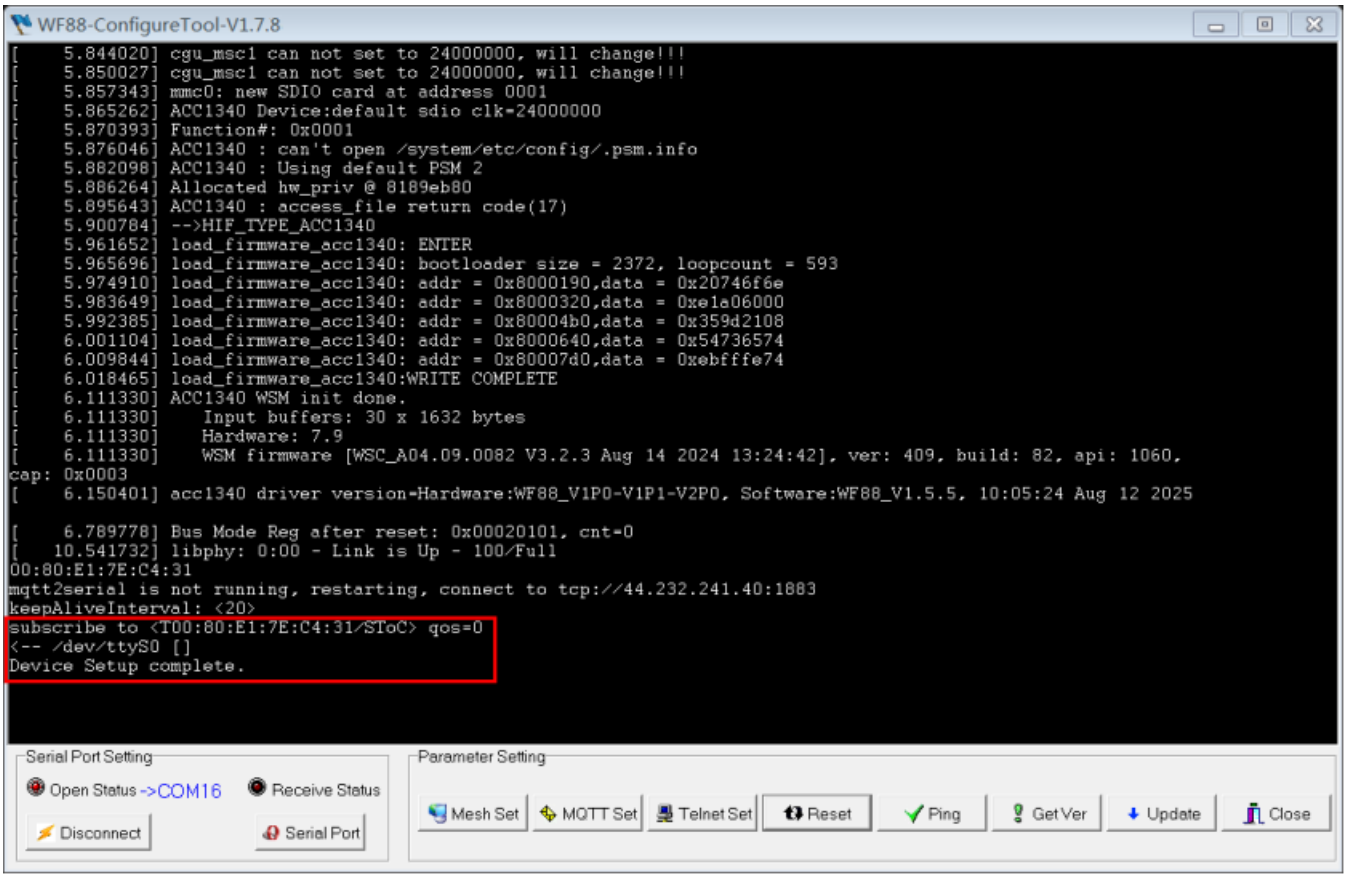


Figure 2-5-2-8. MQTT connection has been successfully established

(8) Clicking the "Ping" button will bring up the "Ping Test" dialog box. Enter the IP address to be tested in the "PingIP" editing. First, test whether the communication with router is normal, input "192.168.31.1" for testing. As shown in Figure 2-5-2-9, ping test router indicates if Gate can access it normally.

If MQTT Broker accepts the ping command, it can directly ping its IP address. If the MQTT Broker does not accept the ping command and is still on the Internet, ping the 8.8.8.8 IP address.As shown in Figure 2-5-2-10, ping test indicates if Gate can access the network normally.

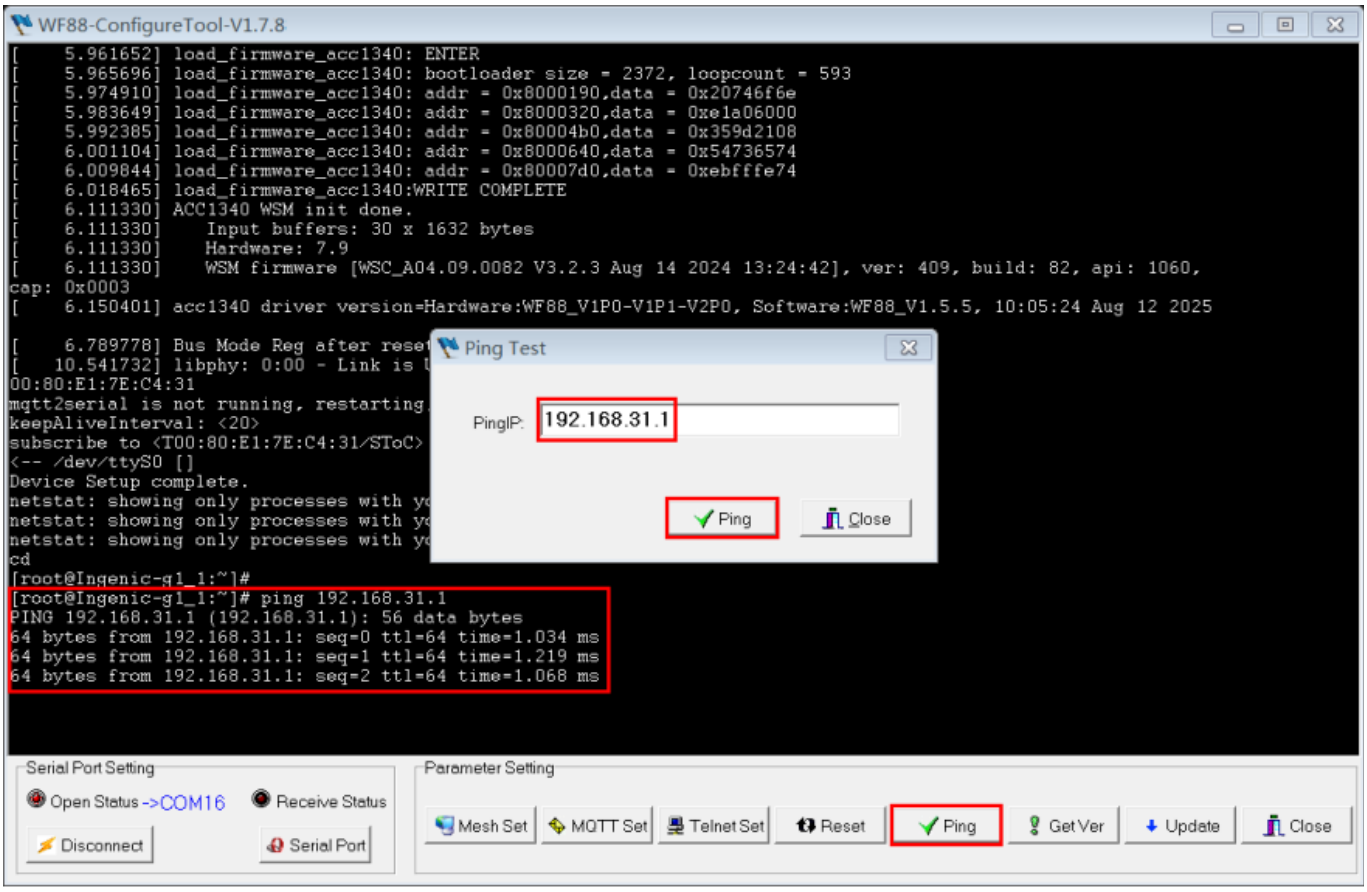


Figure 2-5-2-9. Ping test router

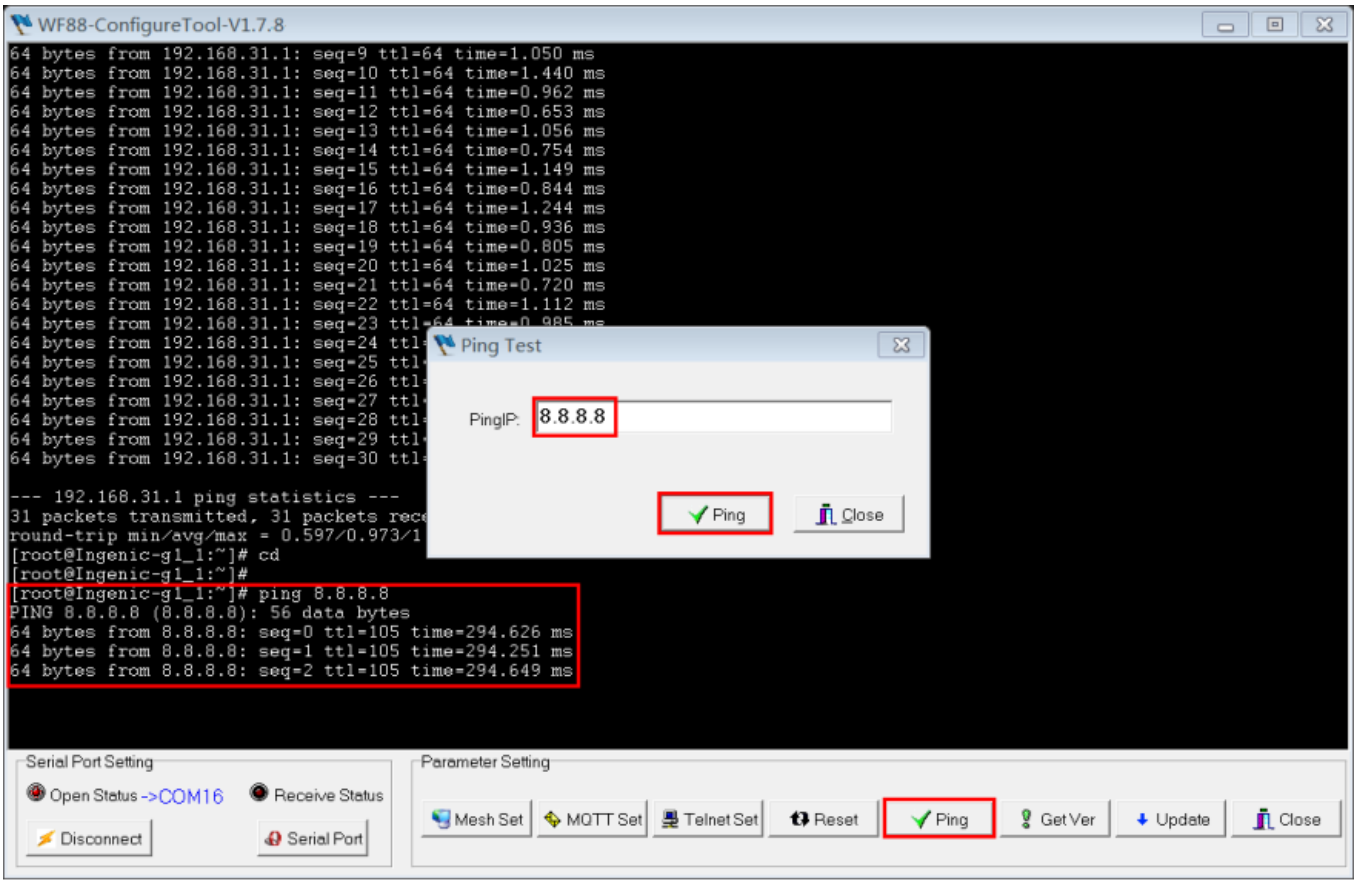


Figure 2-5-2-10. Ping test

(9) The setting of Gate is completed.

1.5.3. Configuration and usage of MQTT PC tool

Use the **mqttfx-1.7.1-windows-x64.exe** as the client. Use the "**broker.emqx.io**" website. This is a convenient test site. Note that this test site does not support Username & Password for login authorization.

(1) Running **MQTT.fx** will bring up its main interface, and clicking on the blue gear icon will bring up the "Edit Connection Profile" dialog box, as shown in Figure 2-5-3-1.

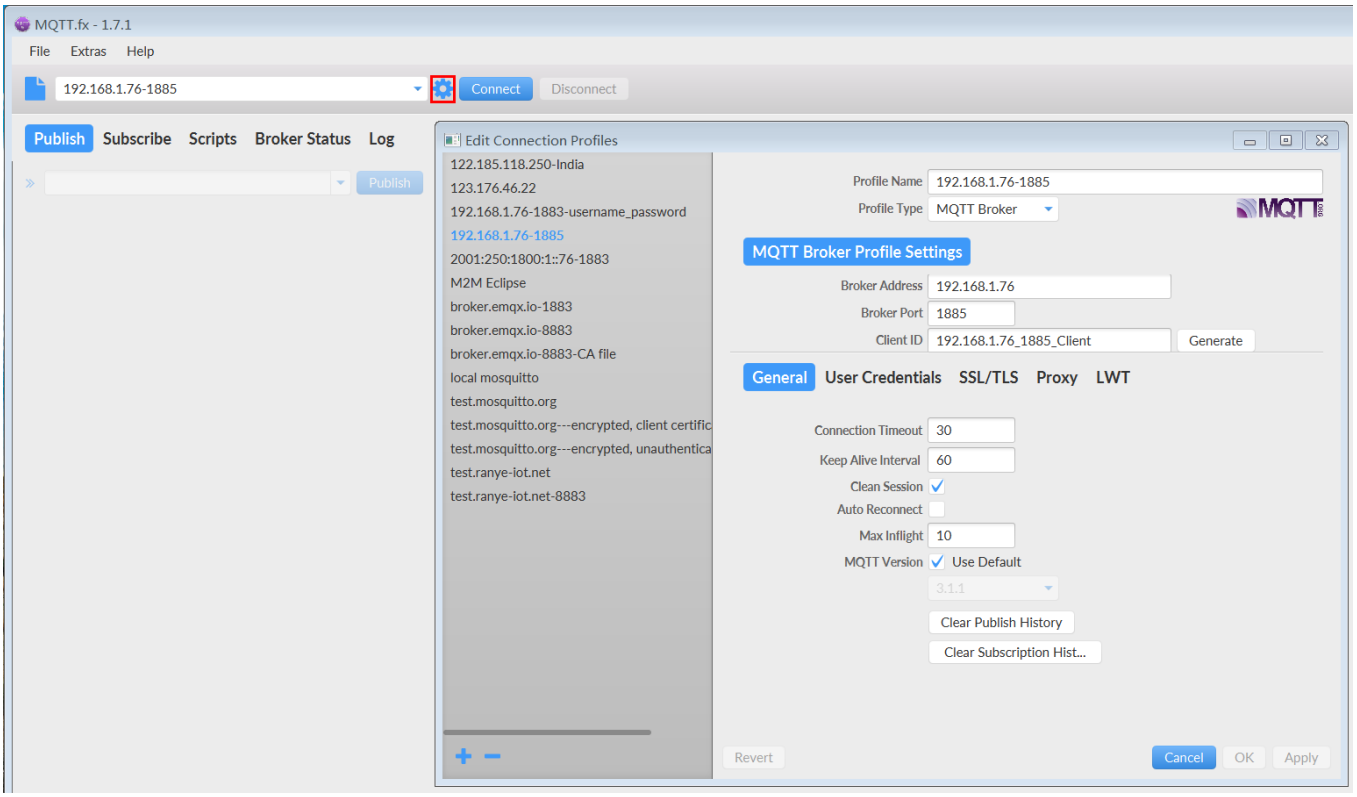


Figure 2-5-3-1. Edit Connection Profile

(2) In the "Edit Connection Profiles" dialog box, click the blue plus sign ("+") icon in the bottom right corner to create a new profile. Enter the name of the configuration file in the "Profile Name" edit box. Enter the MQTT Broker domain name "broker.emqx.io" in the "Broker Address" edit box. The default "Broker Port" is 1883. Clicking the "Generate" button will generate a Client ID. Select the "Auto Reconnect" checkbox. Finally, click the "OK" button to complete the configuration. As shown in Figure 2-5-3-2.

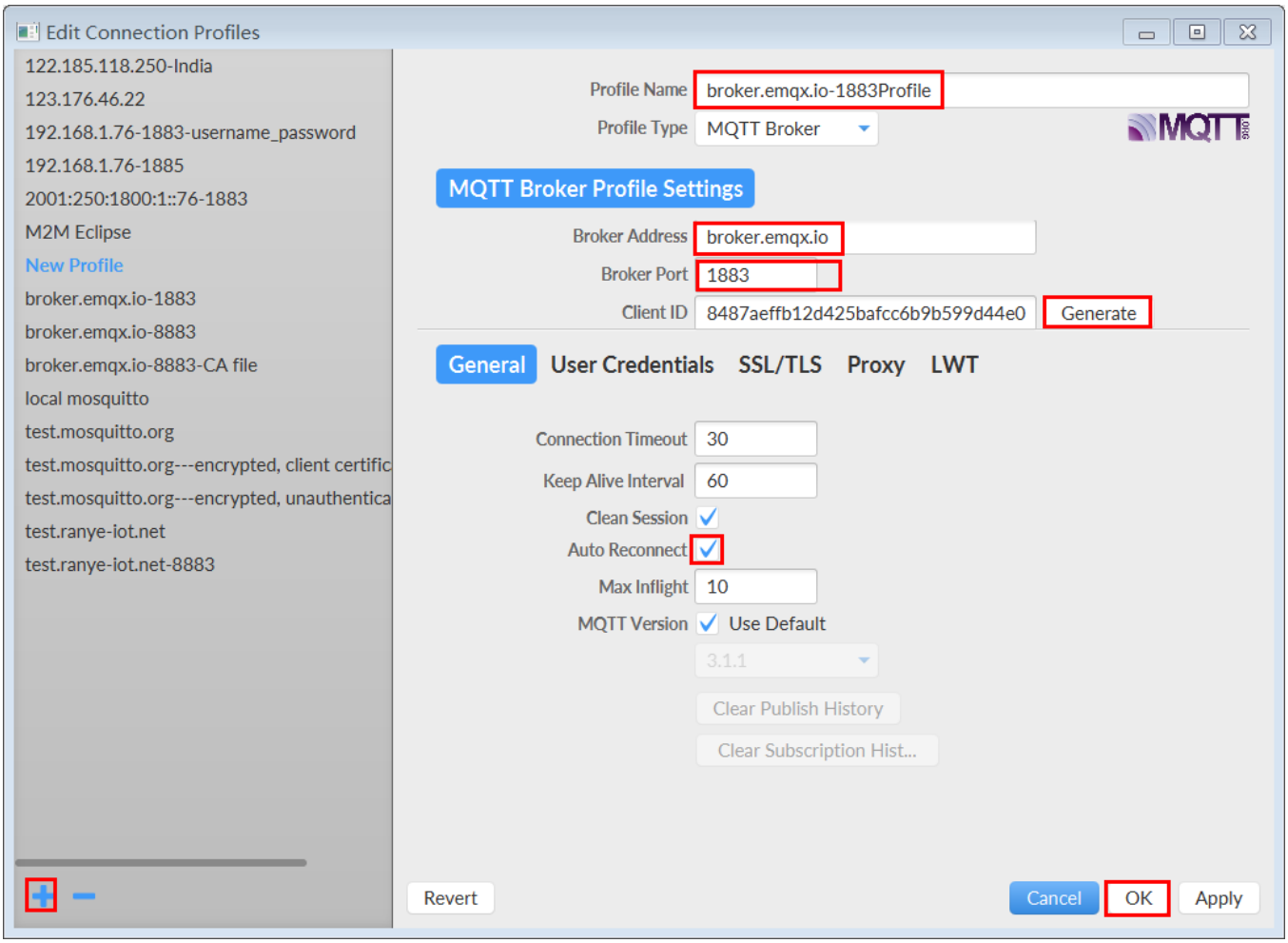


Figure 2-5-3-2. Create a new profile

(3) Click the "Connect" button to successfully establish a connection with MQTT Broker, and a green circle will appear in the upper right corner of the window. As shown in Figure 2-5-3-3.

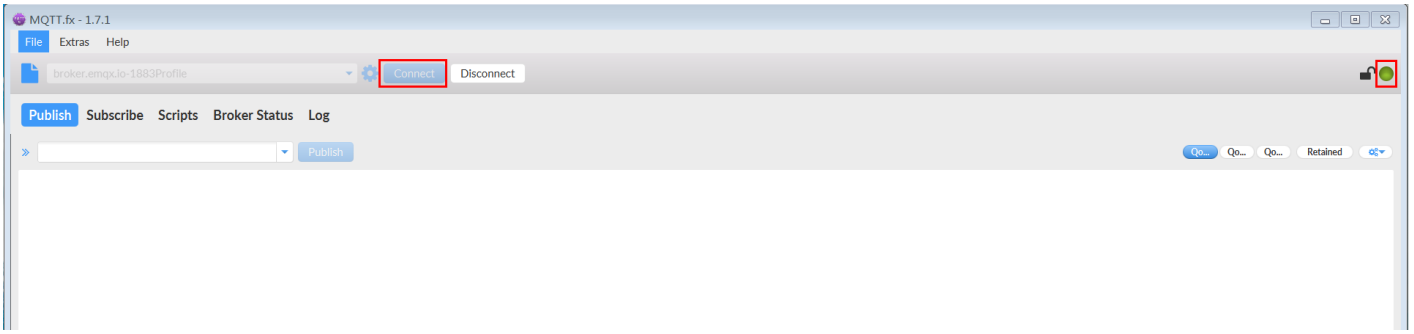


Figure 2-5-3-3. Connect to MQTT Broker

(4) To subscribe to data from Gate, click on the "Subscribe" tab, then enter "T00:80:E1:7E:C4:31/CToS" in the edit box below, and click the "Subscribe" button. As shown in Figure 2-5-3-4.

Format for: T + MAC address/Topic, for which T is fixed to character, the MAC address is Gate own MAC. Topic is defined in the "PubTopic" of the "MQTT Set" dialog box.

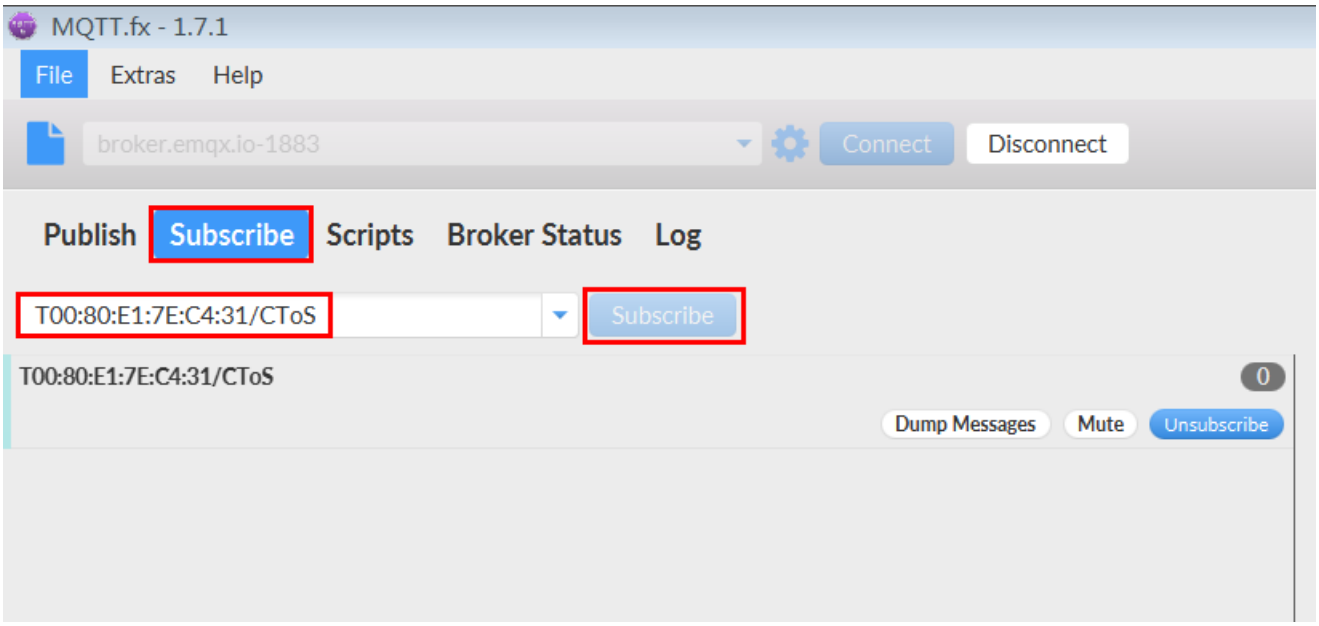


Figure 2-5-3-4. Subscribe to data from Gate

(5) Publish data to Gate, click on the "Publish" tab, then enter "T00:80:E1:7E:C4:31/SToC" in the editing box below, then input “at+ab config” and “enter” as the content to be sent. That is to say, any AT command sent to LoRa needs to end with a carriage return. Finally, click the "Publish" button. It can receive the corresponding content from the LoRa. As shown in Figure 2-5-3-5.

Format for: T + MAC address/Topic, for which T is fixed to character, the MAC address is Gate own MAC. Topic is defined in the "SubTopic" of the "MQTT Set" dialog box.

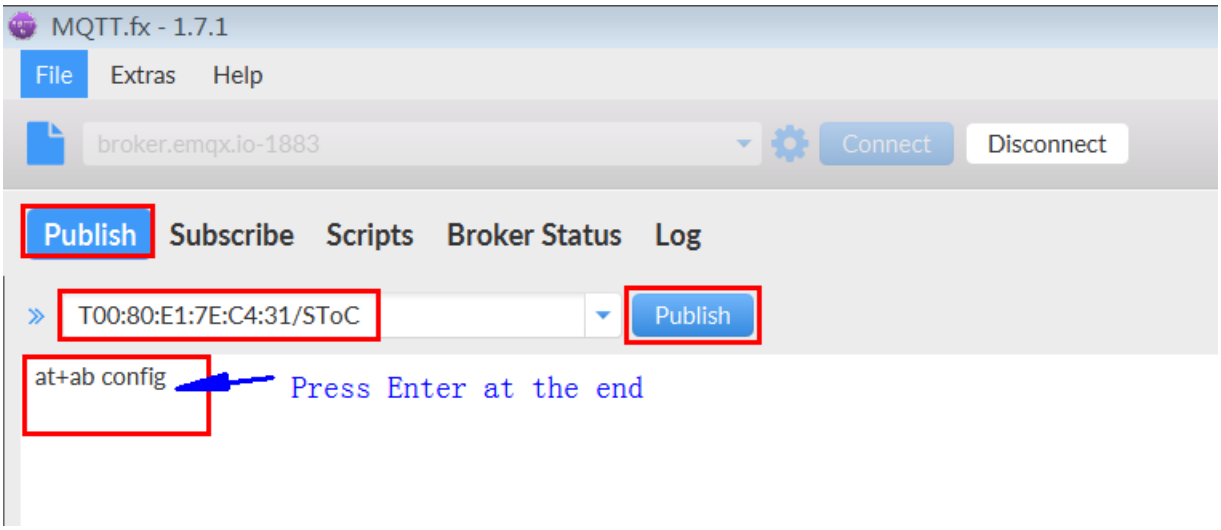


Figure 2-5-3-5. Publish data to Gate

(6) Note the Gate's response information in the subscribe. As shown in Figure 2-5-3-6.

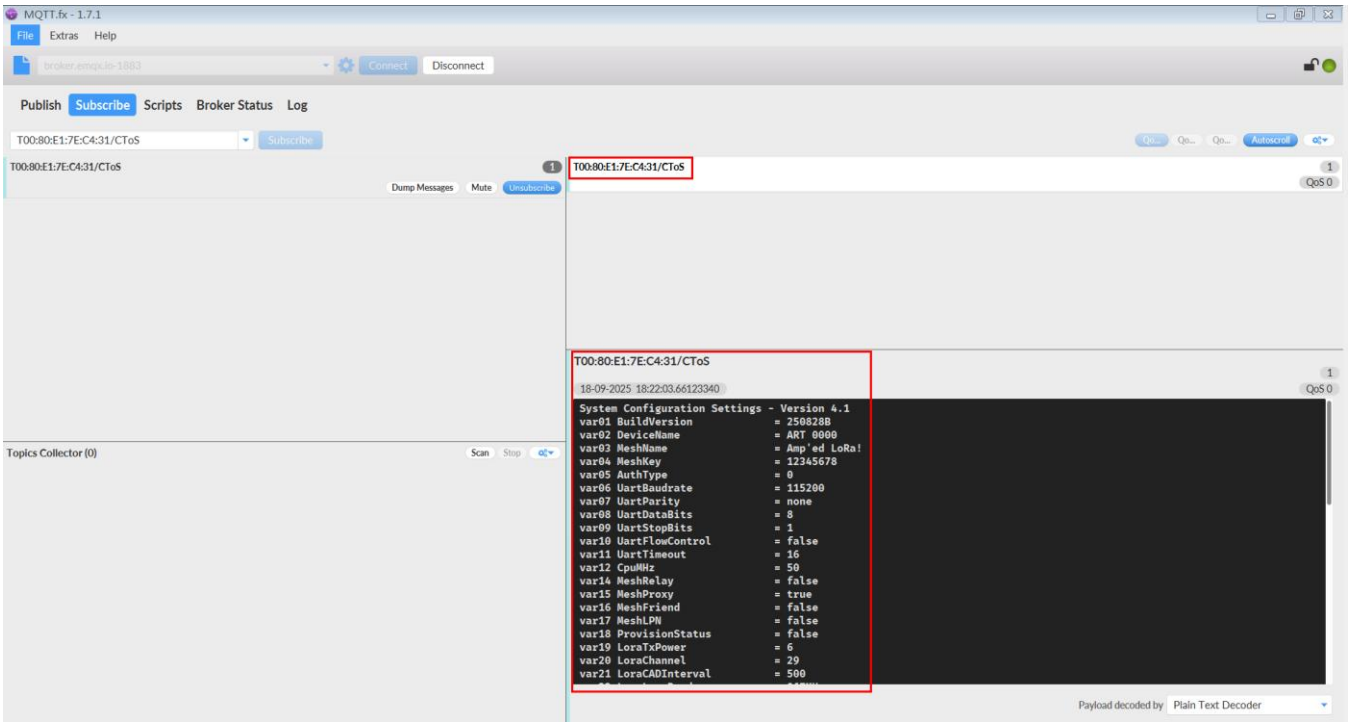


Figure 2-5-3-6. Receive Gate's response information

1.5.4. Configure the parameters of Gate for tcp

Use the WF88 configuration tool to configure the parameters of Gate for TCP. The use of WF88 configuration tool is similar to what was described earlier. Please refer to the section "2.5.2 Configure the parameters of Gate for MQTT".

(1) Click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. Select "Ethernet" from the "Connection mode" drop-down list. Select "TCP" from the "LoadModule" drop-down list. Select the corresponding IP version based on the user's network support in the "IP Version" drop-down list, and enter the IP address in the corresponding IP version below. Finally, click the "Save" button. As shown in Figure 2-5-4-1.

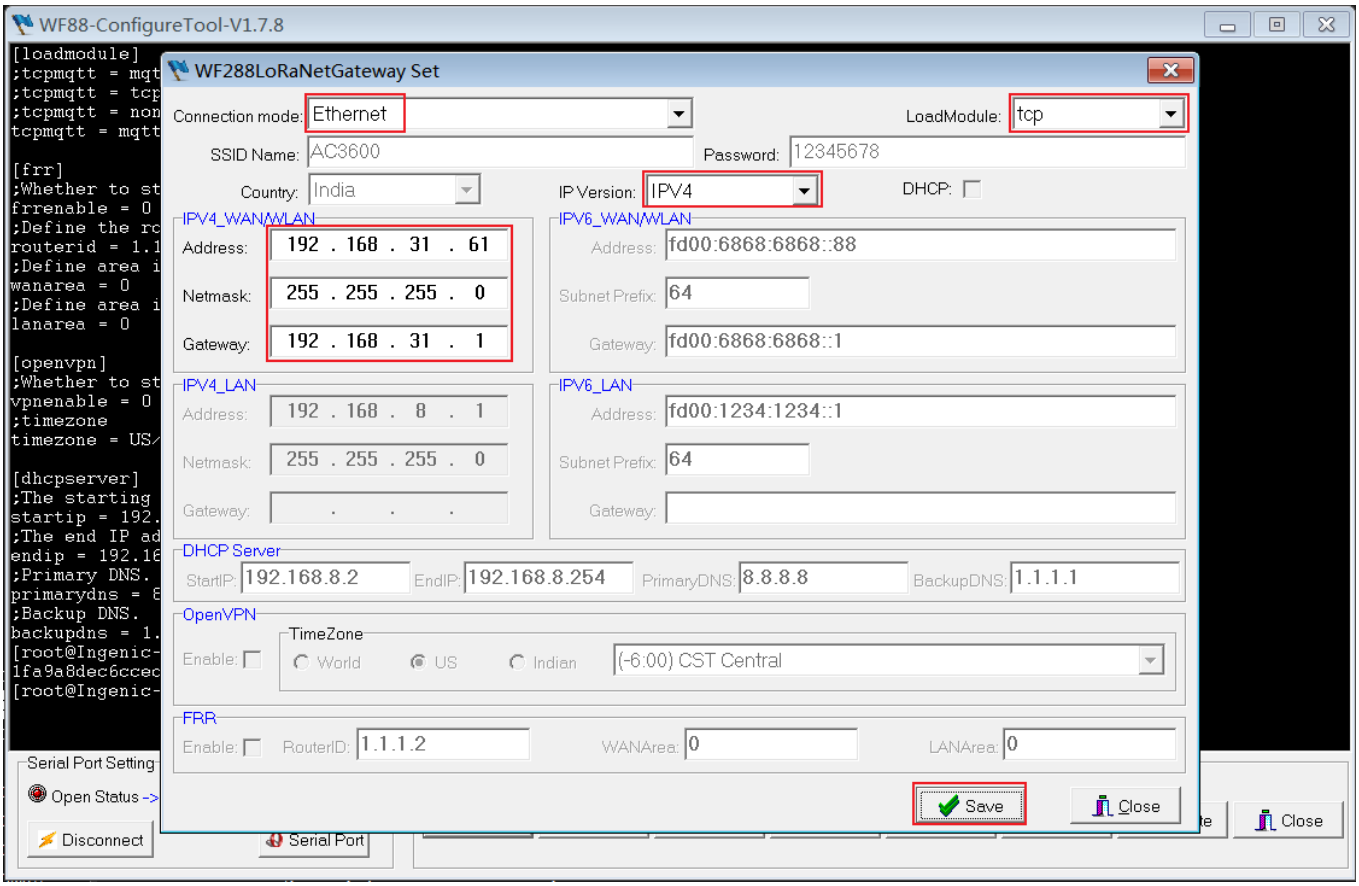


Figure 2-5-4-1. WF288 LoRaNetGateway Set configuration

(2) Click the "Telnet Set" button to bring up the "Telnet Set" dialog box. Enter the listening port "20000" of TCP in the "LocalPortNum" editing box. Finally, click the "Save" button. As shown in Figure 2-5-4-2.

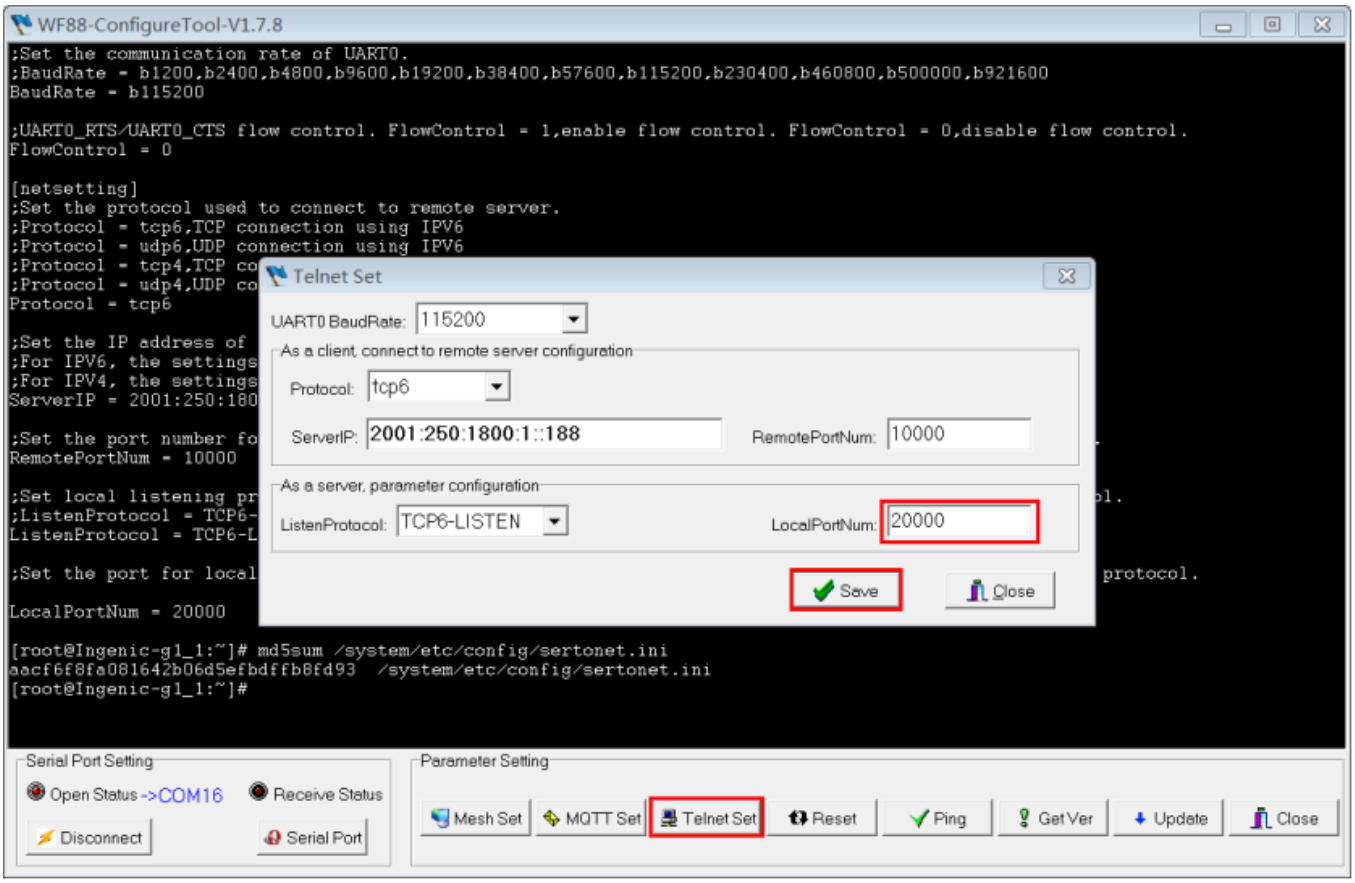


Figure 2-5-4-2. Telnet Set configuration

(3) Click the "Reset" button to restart.

(4) After the system restarts, we will see a prompt message "LocalPortNum:xxx" indicating that the Gate has started the TCP service and is listening on port xxx, as shown in Figure 2-5-4-3.

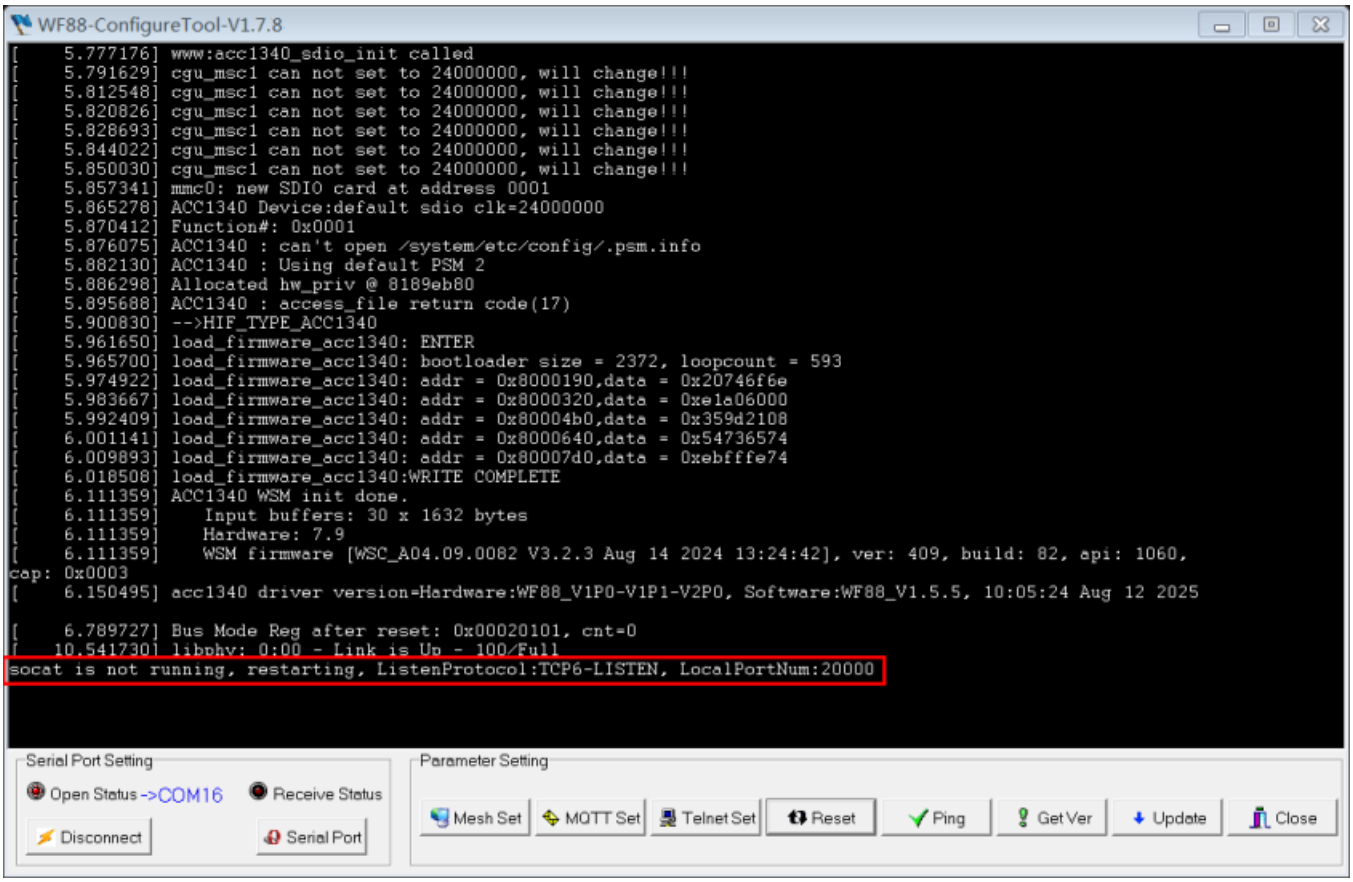


Figure 2-5-4-3. TCP service and is listening on port xxx

(5) The setting of Gate is completed.

1.5.5. Configuration and usage of tcp PC tool

Use the **TCPUDP.exe** as the client for tcp test.

(1) Running **TCPUDP.exe** will bring up its main interface, as shown in Figure 2-5-5-1.

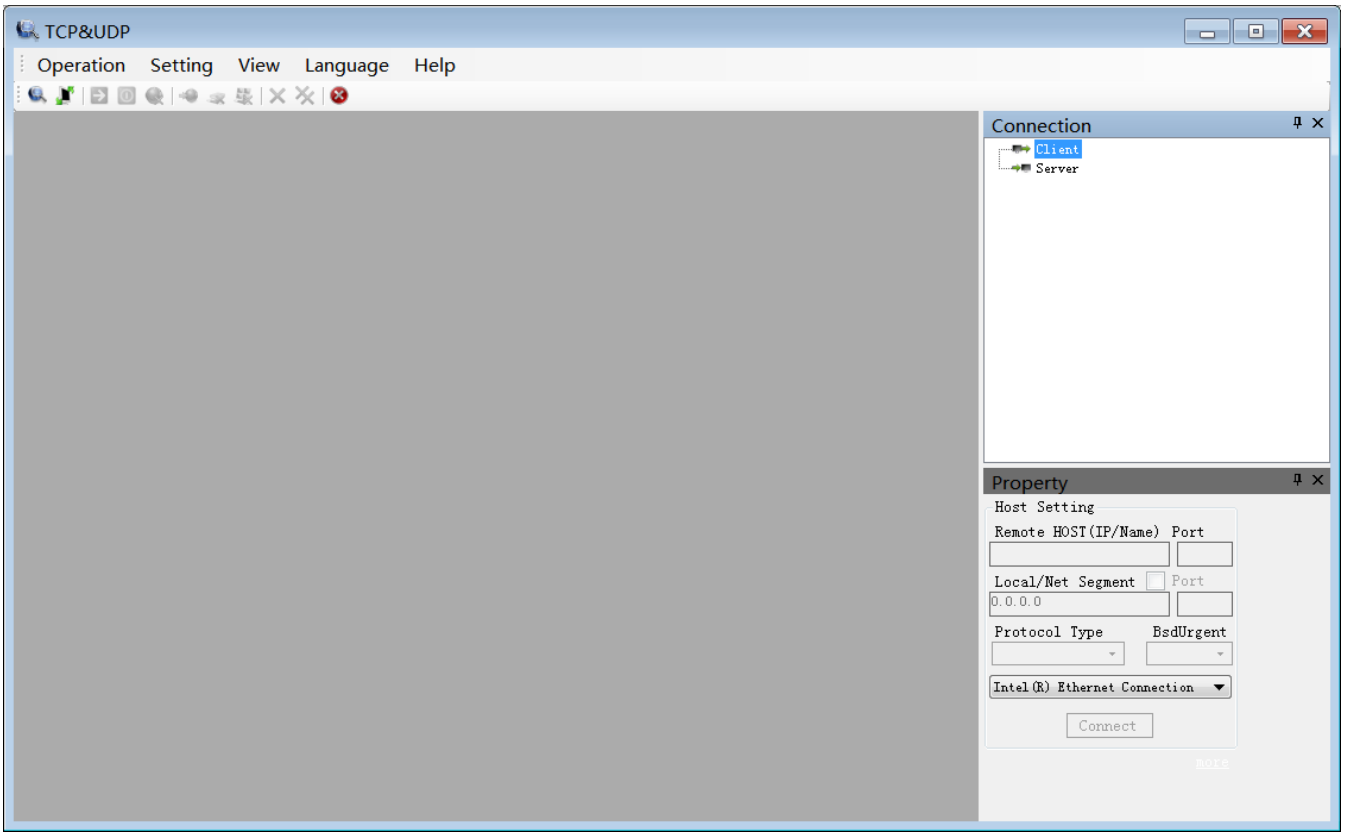


Figure 2-5-5-1. TCP&UDP main interface

(2) Right click on "Client" in the "Connection" window to bring up a shortcut menu, as shown in Figure 2-5-5-2.

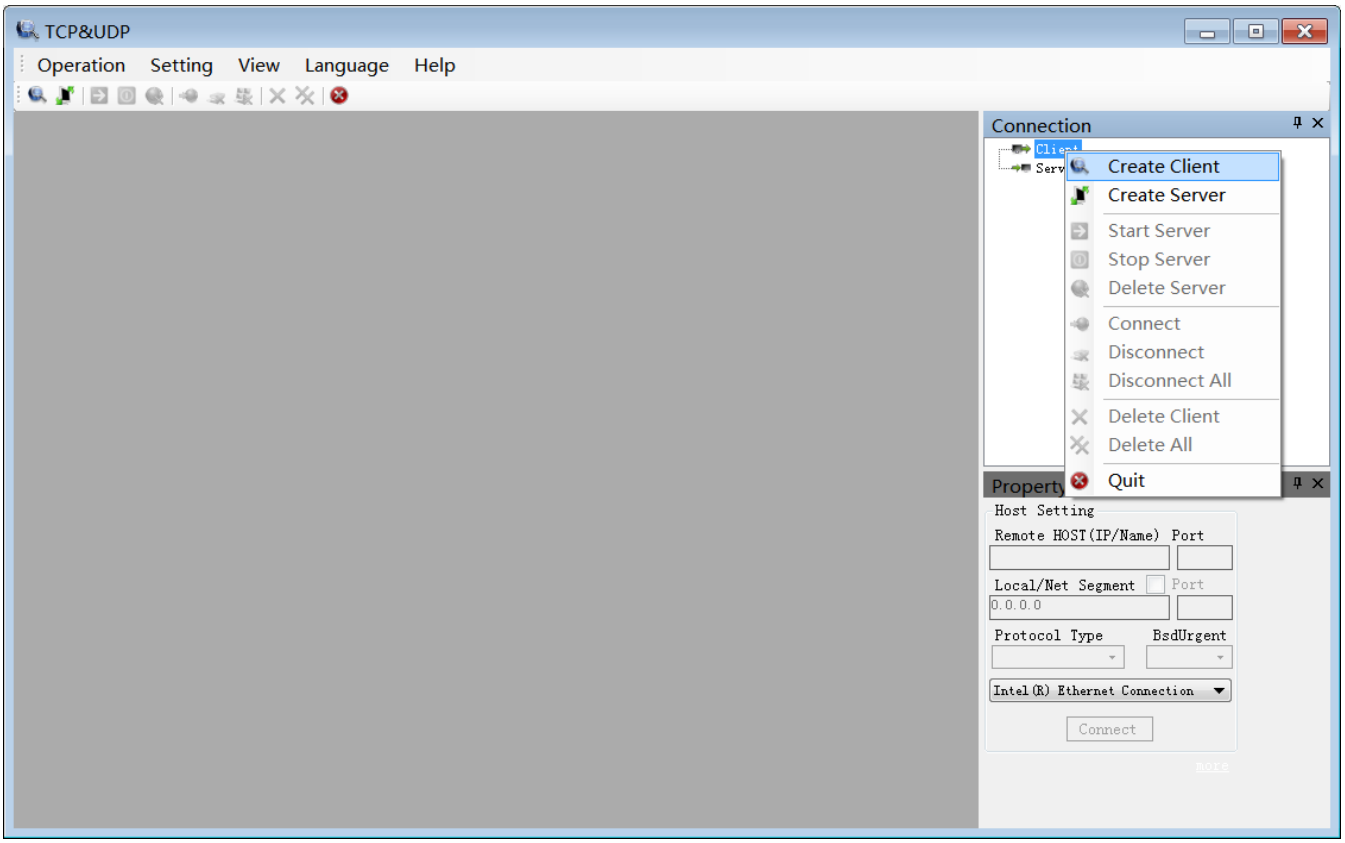


Figure 2-5-5-2. Shortcut menu

(3) In the shortcut menu, select the "Create Client" option, and a "New Connection" dialog box will pop up. Select "TCP" from the "Protocol Type" drop-down list. Enter the IP address "192.168.31.61" of Gate in the "Remote Host" editing box. Enter the port "20000" of listening in the "Remote Port" editing box, as shown in Figure 2-5-5-3.

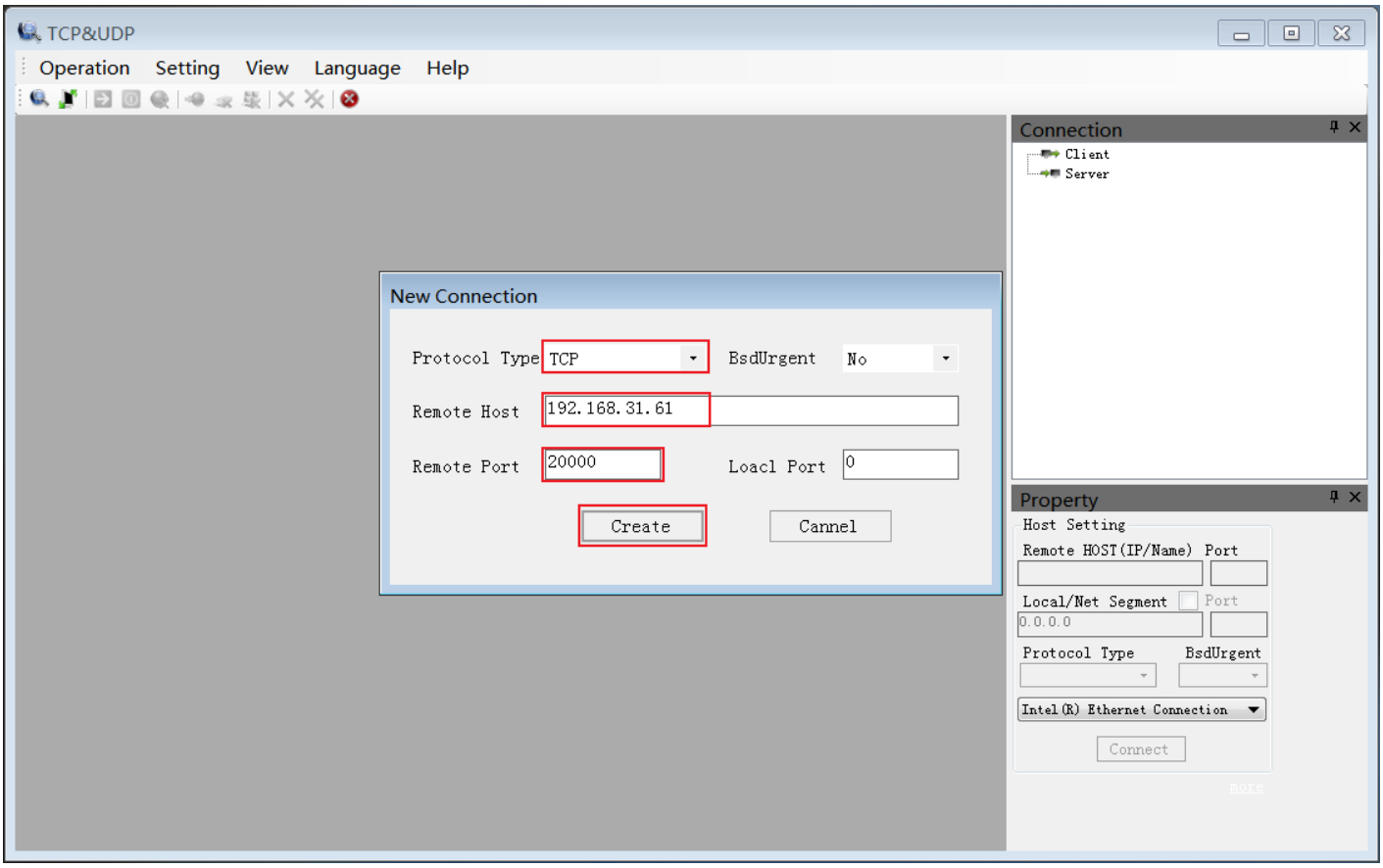


Figure 2-5-5-3. New Connection dialog box

(4) Click the “Create” button to create a new connection. Select the network card on the PC side for the connection, as shown in Figure 2-5-5-4.

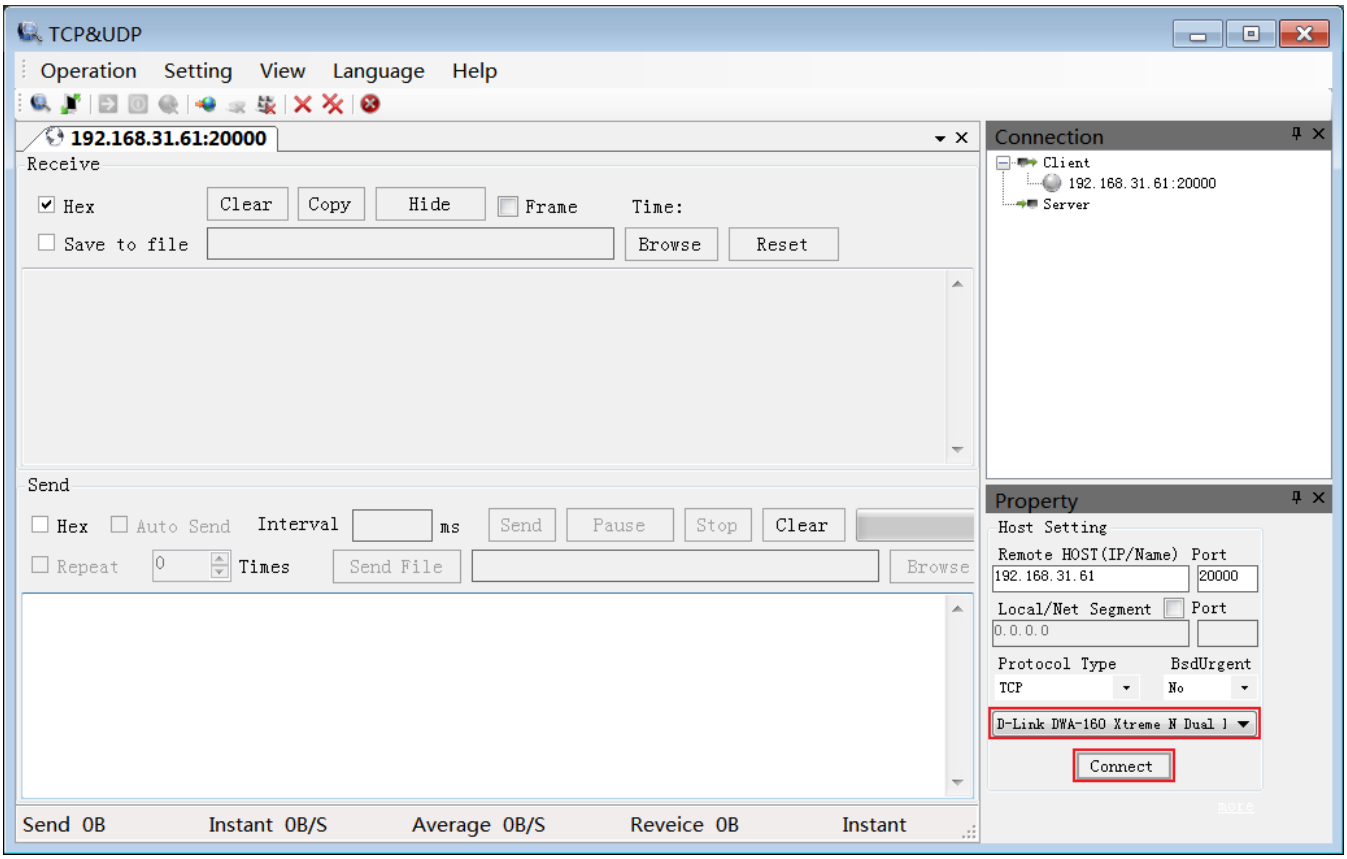


Figure 2-5-5-4. Create a new connection

(5) Clicking the “Connect” button will initiate a TCP connection to Gate. After a successful connection, click the “Hex” checkbox to deselect it, as shown in Figure 2-5-5-5.

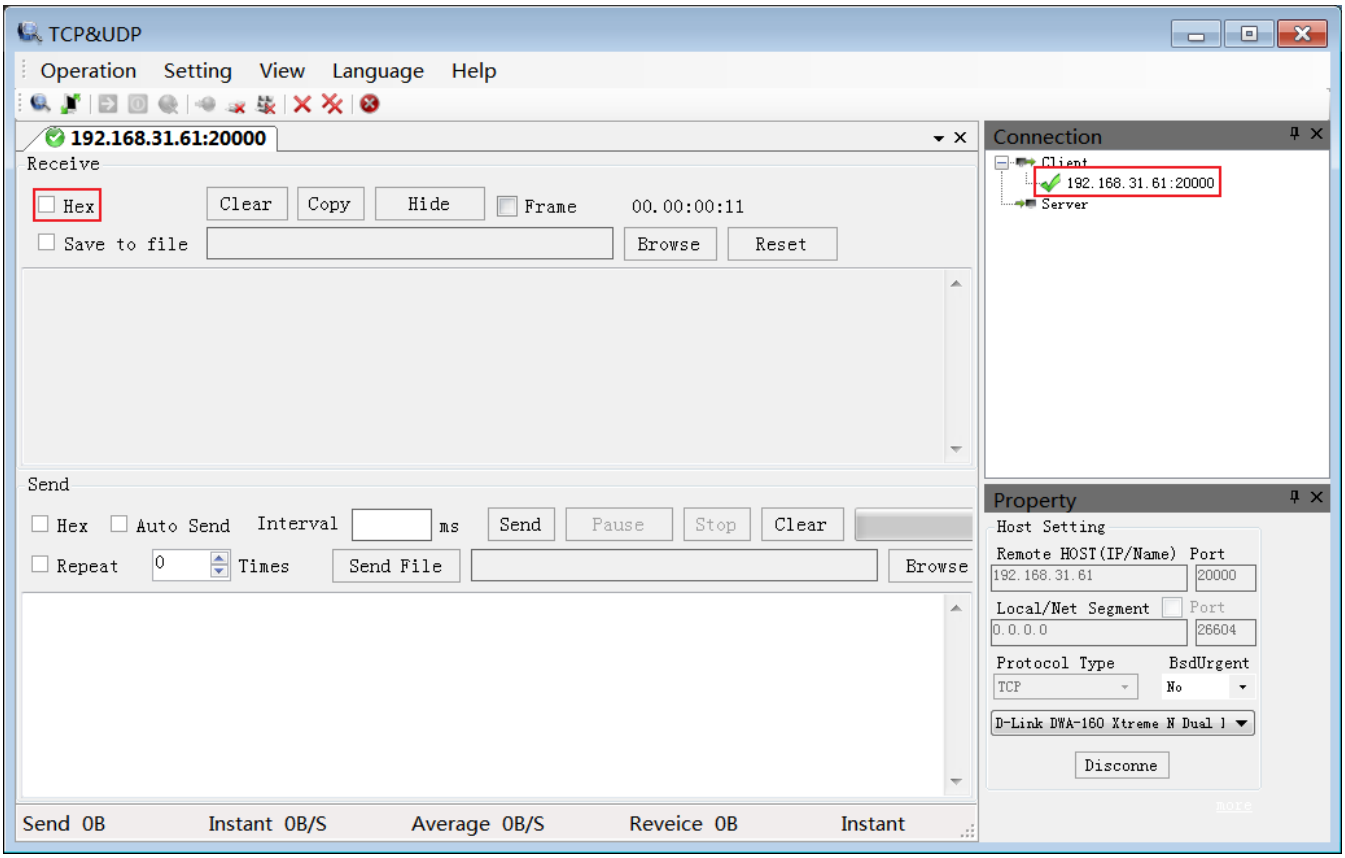


Figure 2-5-5-5. Initiate a TCP connection to Gate

(6) In the sending area, we input “at+ab config” and “enter” as the content to be sent. That is to say, any AT command sent to LoRa needs to end with a carriage return. Finally, click the "Send" button. In the receiving area, we can receive the corresponding content from the LoRa, as shown in Figure 2-5-5-6.

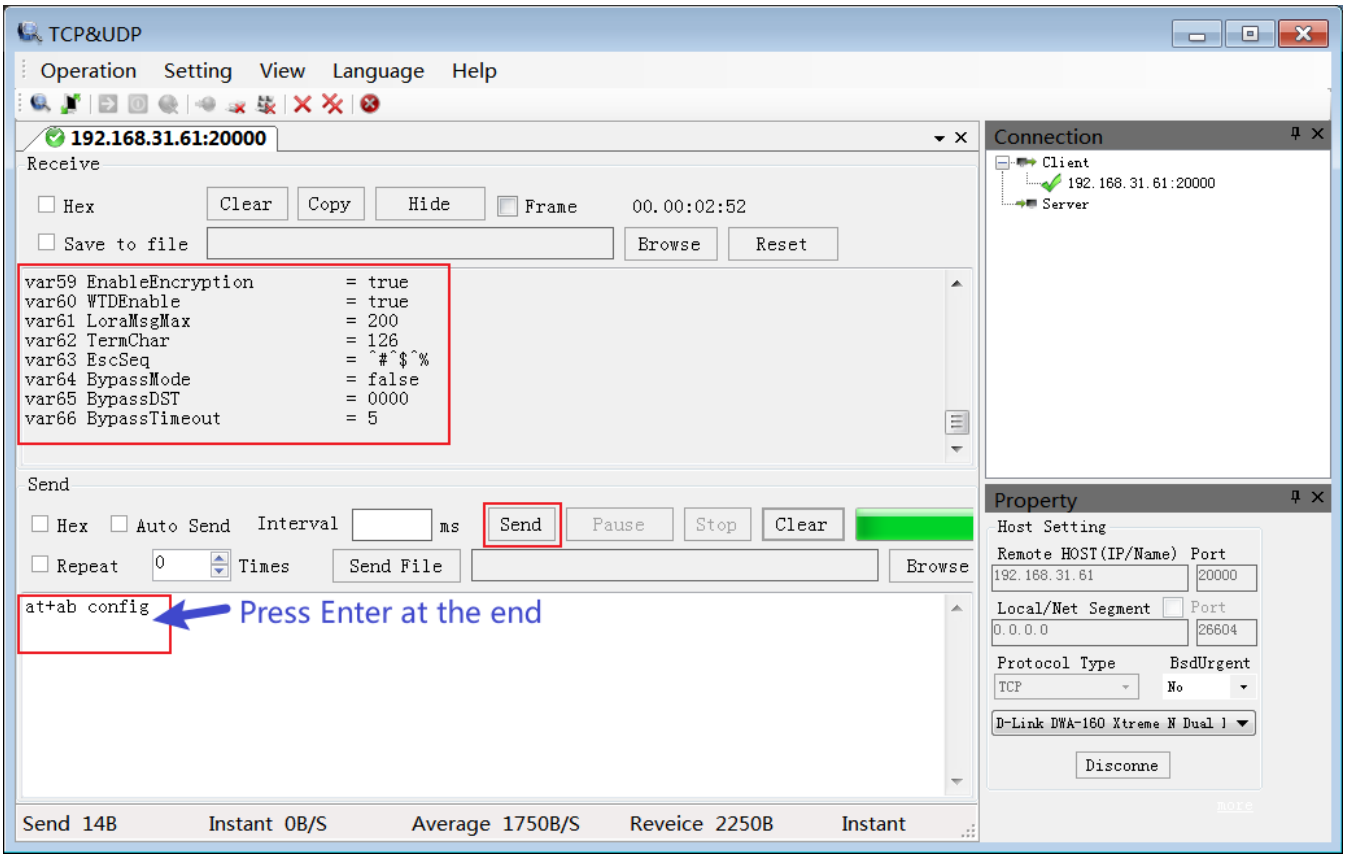


Figure 2-5-5-6. Receive the corresponding content

1.6. Build a network through Wi-Fi

Build a network through Wi-Fi interface to achieve remote control of LoRa.

1.6.1. Network topology diagram

As shown in the network topology diagram in Figure 2-6-1-1. If MQTT Broker supports IPV6, the entire network can be configured using IPV6. If MQTT Broker only supports IPV4, the entire network can be configured using IPV4. In this network, Gate can obtain an IP address from the router through DHCP, or manually enter the IP address, in which case it needs to be in the same network segment as the router.

- LoRaNetGateway loads “MQTT” functionality:

  It is necessary to ensure that PC and Gate can access MQTT Broker normally. Since the MQTT Broker in the figure is on the Internet, the PC and Gate need to be able to access the Internet. Use the "ping 8.8.8.8" command to test on the PC and Gate to confirm whether the Internet can be accessed normally.

- LoRaNetGateway loads “TCP” functionality:

  PC can access Gate, and router may need to NAT the port that Gate listens.

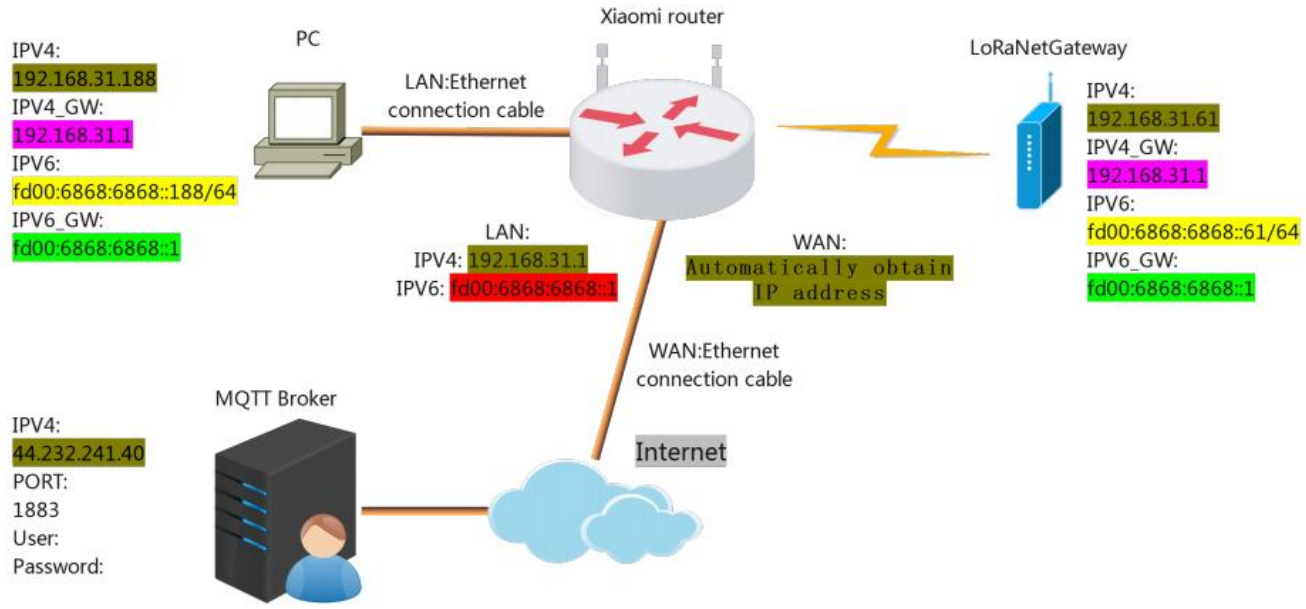


Figure 2-6-1-1. Network topology diagram

1.6.2. Configure the parameters of Gate for MQTT

Use the WF88 configuration tool to configure the parameters of Gate for MQTT. The use of WF88 configuration tool is similar to what was described earlier. Please refer to the section "2.5.2 Configure the parameters of Gate for MQTT". (skipping some steps)

(1) Click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. Select "Wi-Fi" from the "Connection mode" drop-down list. Select "MQTT" from the "LoadModule" drop-down list. Enter the SSID and password of the AP we want to connect to in the "SSID Name" and "Password" editing boxes respectively, and select the "DHCP" checkbox. To manually enter the IP address, select the corresponding IP version based on the user's network support in the "IP Version" drop-down list, and enter the IP address in the corresponding IP version below. Finally, click the "Save" button, as shown in Figure 2-6-2-1.

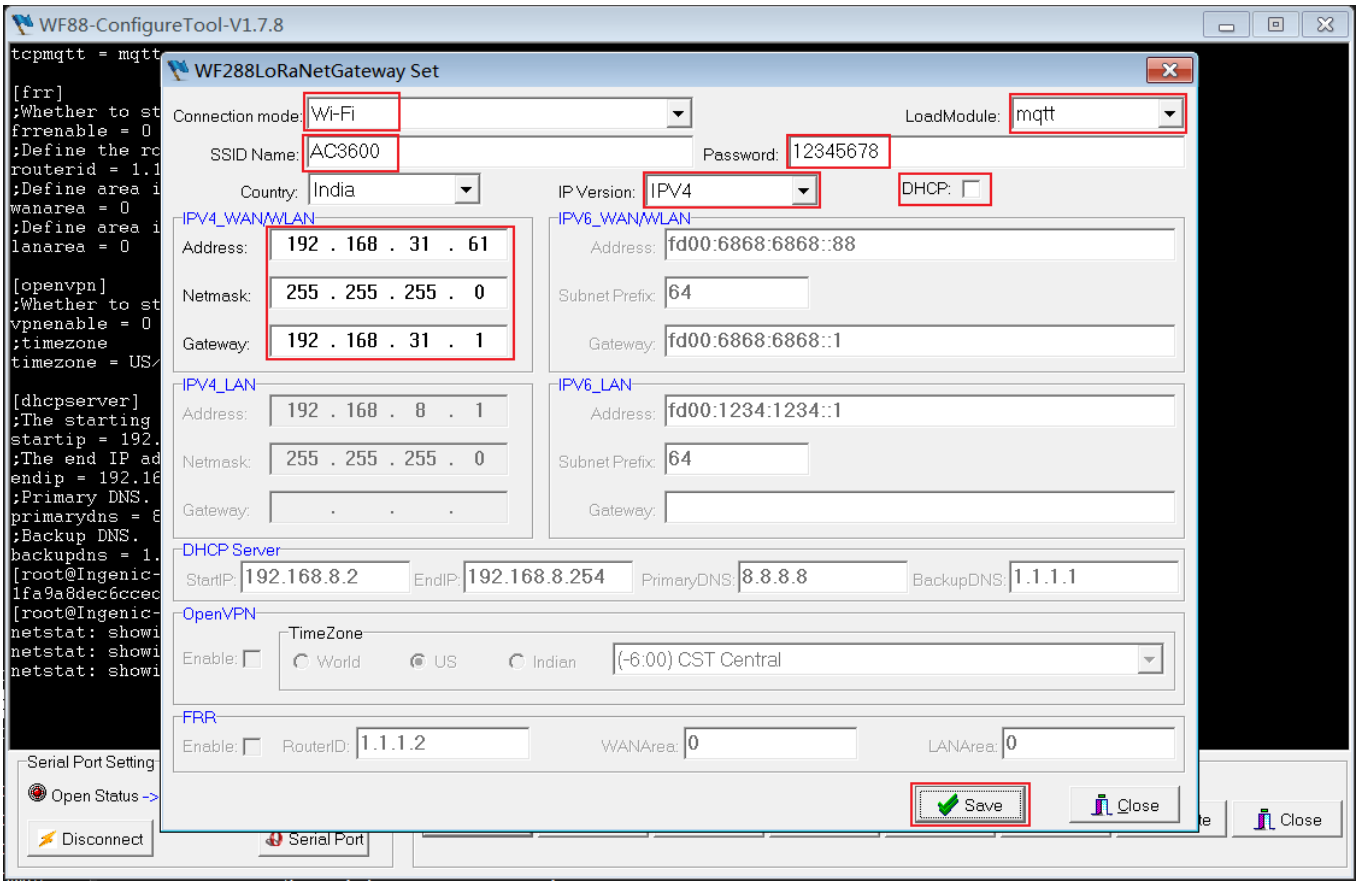


Figure 2-6-2-1. WF288 LoRaNetGateway Set configuration

(2) Typically, using the default parameters. If the parameter settings are changed, restart the Gate.

(3) After the system restarts, note a prompt message similar to "Connection to 88:c3:97:ce:b0:c5 completed" and "Sending select for 192.168.31.61", indicating that the Gate has been successfully established a connection with the AP and obtained an IP address.

Note a prompt message "Device Setup complete." indicating that the MQTT connection has been successfully established, as shown in Figure 2-6-2-2.

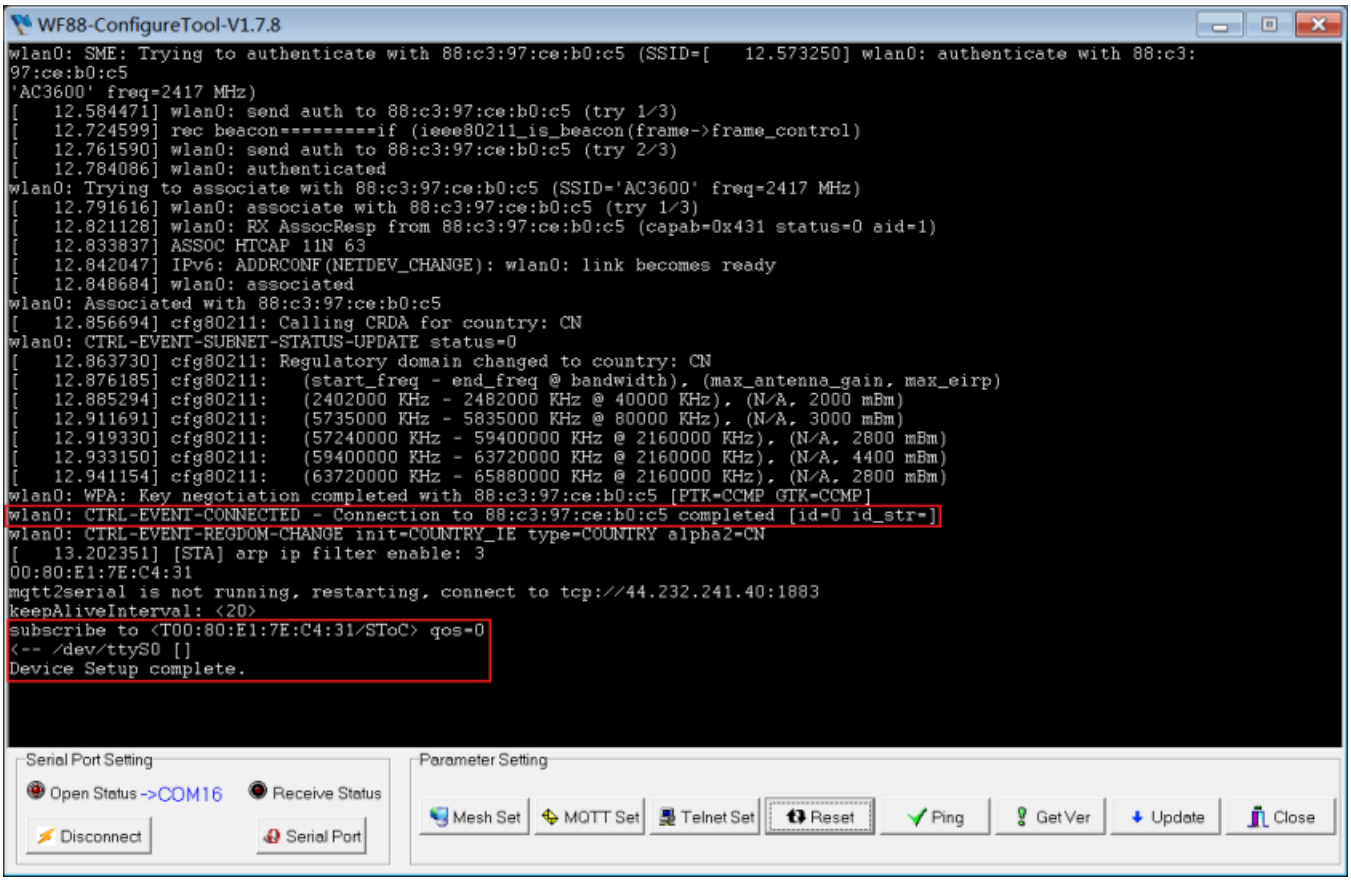


Figure 2-6-2-2. Establish MQTT through Wi-Fi interface

(4) Test whether the network communication is normal. Clicking the "Ping" button will bring up the "Ping Test" dialog box. Enter the IP address to be tested in the "PingIP" editing. First, test whether the communication with router is normal, input "192.168.31.1" for testing. As shown in Figure 2-6-2-3, ping test router indicates if Gate can access it normally.

If MQTT Broker accepts the ping command, it can directly ping its IP address. If the MQTT Broker does not accept the ping command and is still on the Internet, directly ping the 8.8.8.8 IP address. As shown in Figure 2-6-2-4, ping test indicates if Gate can access the network normally.

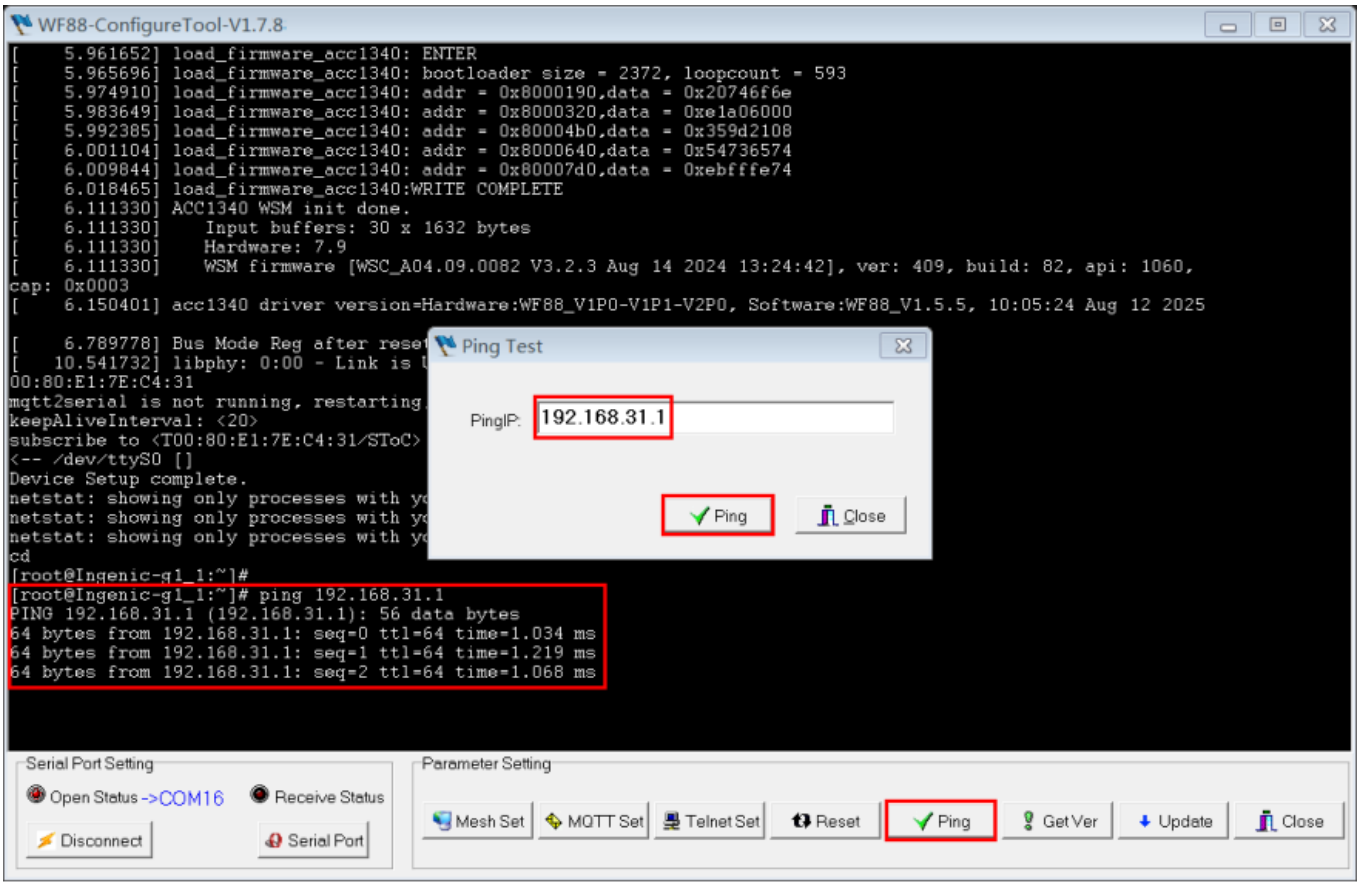


Figure 2-6-2-3. Ping test router

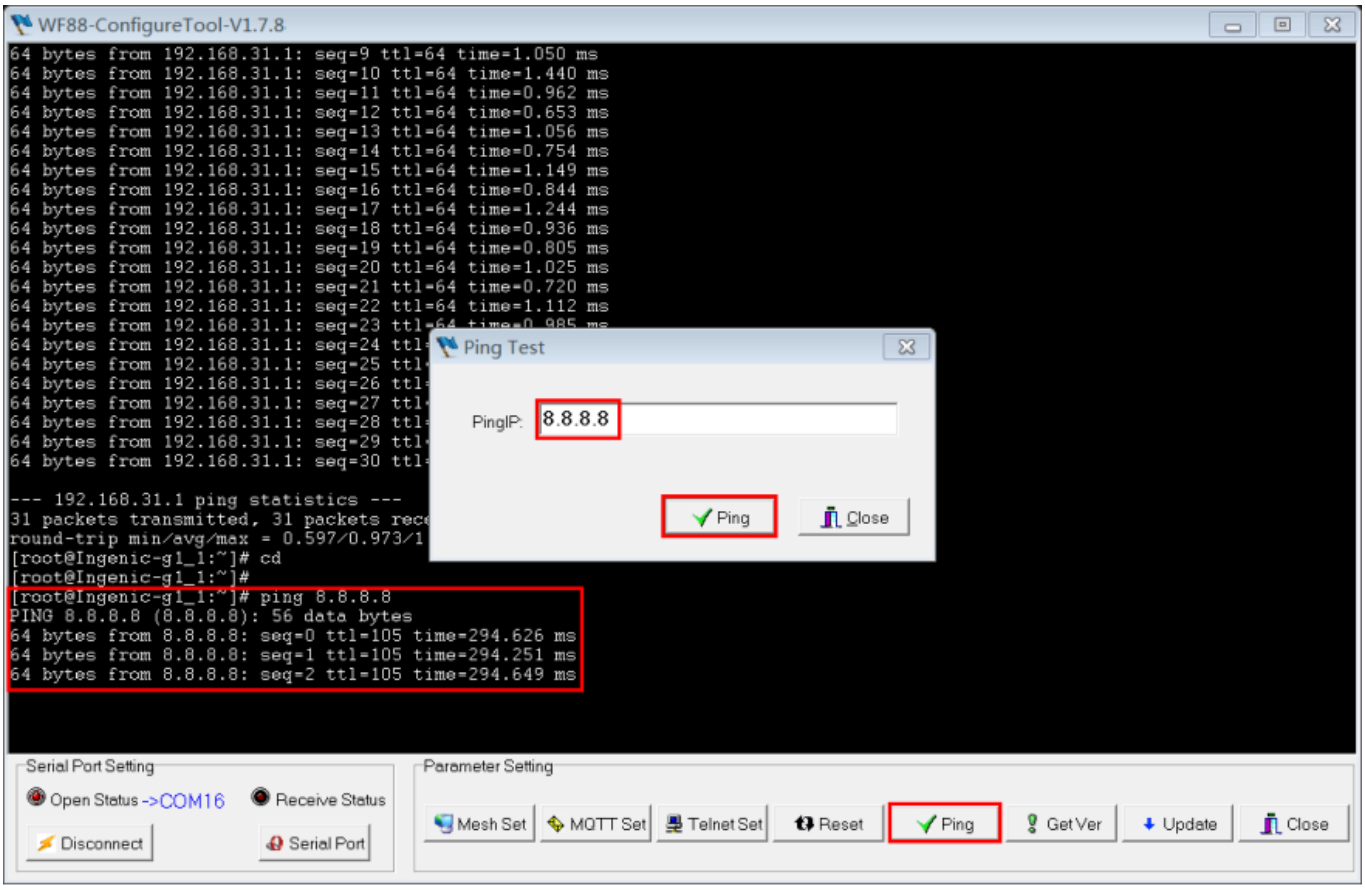


Figure 2-6-2-4. Ping test

(5) The setting of Gate is completed.

1.6.3. Configuration and usage of MQTT PC tool

Please refer to the section "2.5.3. Configuration and usage of MQTT PC tool" for the settings and usage of this section.

1.6.4. Configure the parameters of Gate for TCP

Use the WF88 configuration tool to configure the parameters of Gate for TCP. The use of WF88 configuration tool is similar to what was described earlier. Please refer to the section "2.5.2 Configure the parameters of Gate for MQTT".

(1) Click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. Select "Wi-Fi" from the "Connection mode" drop-down list. Select "TCP" from the "LoadModule" drop-down list. Enter the SSID and password of the AP we want to connect to in the "SSID" and "PSK" editing boxes respectively, and select the "DHCP" checkbox. If manually entering the IP address, select the corresponding IP version based on the user's network support in the "IP Version" drop-down list, and enter the IP address in the corresponding IP version below. Finally, click the "Save" button, as shown in Figure 2-6-4-1.

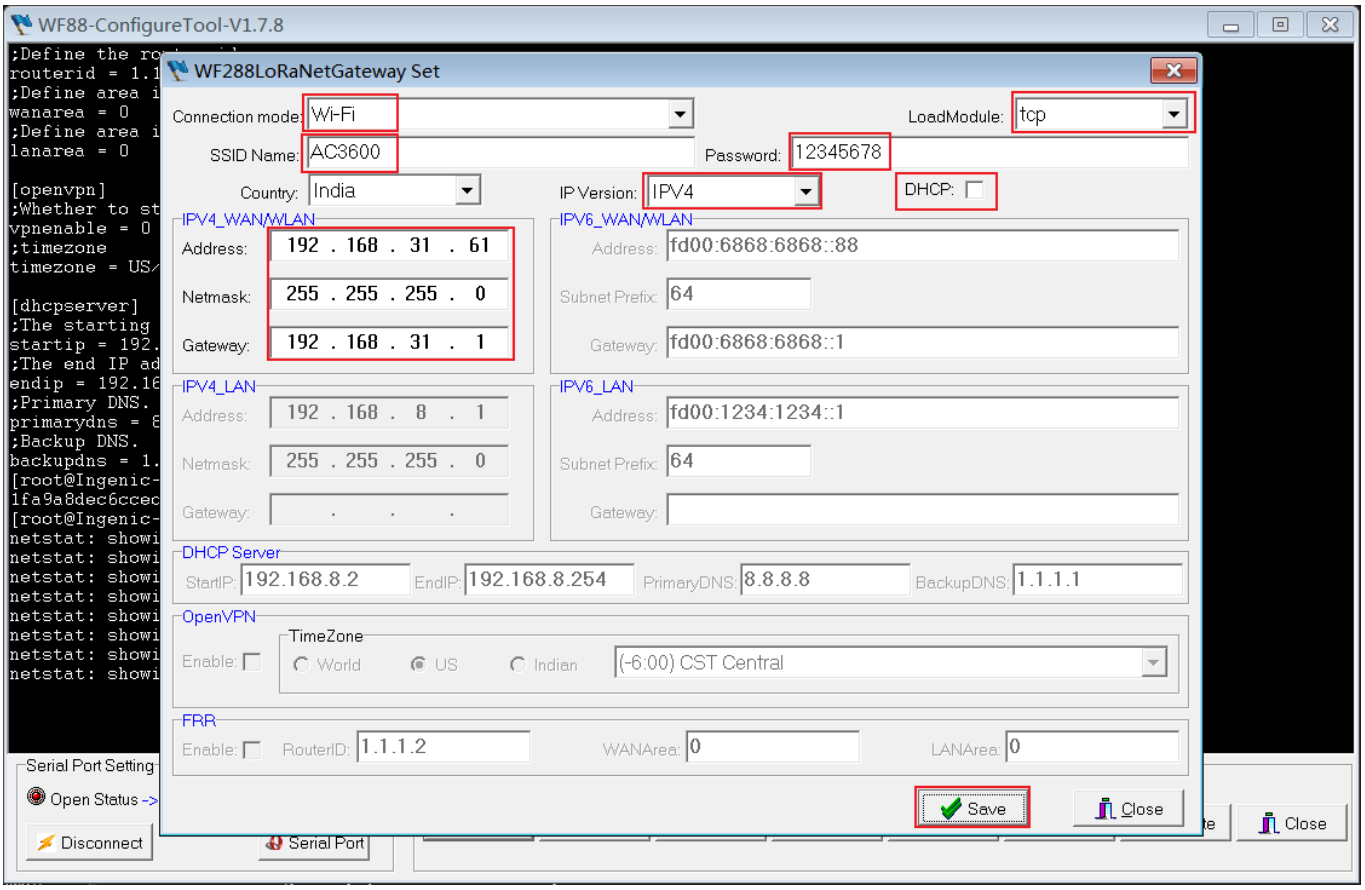
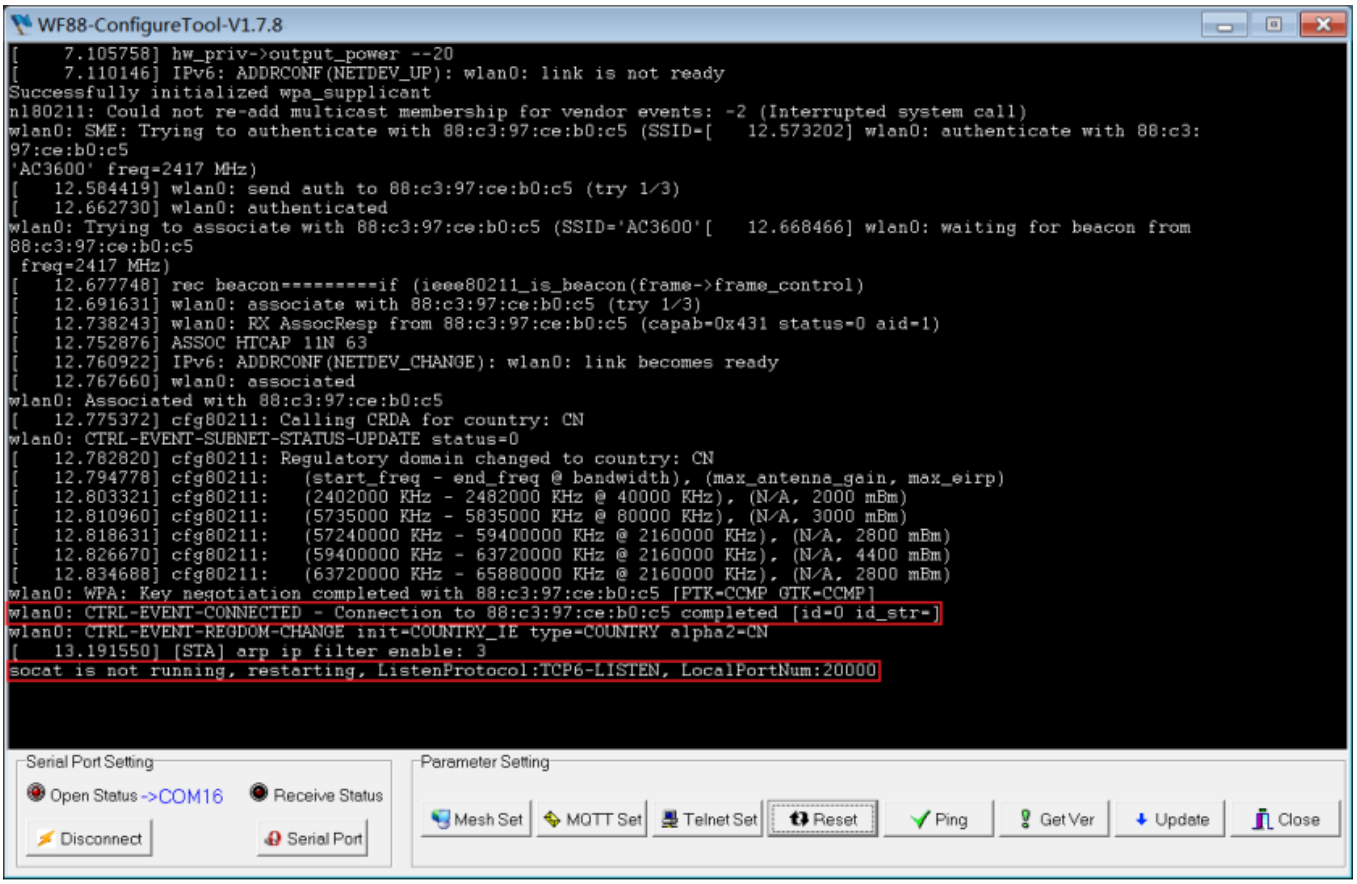


Figure 2-6-4-1. WF288 LoRaNetGateway Set configuration

(2) Using the default parameters typically. After the parameter settings are completed, we will restart the Gate if settings are changed.

(3) After the system restarts, note a prompt message similar to "Connection to 88:c3:97:ce:b0:c5 completed" and "Sending select for 192.168.31.61", indicating that the Gate has been successfully established a connection with the AP and obtained an IP address.



(4) Test whether the network communication is normal. Clicking the "Ping" button will bring up the "Ping Test" dialog box. Enter the IP address to be tested in the "PingIP" editing. First, test whether the communication with router is normal, input "192.168.31.1" for testing. As shown in Figure 2-6-4-3, ping test router indicates if Gate can access it normally.

If MQTT Broker accepts the ping command, it can directly ping its IP address. If the MQTT Broker does not accept the ping command and is still on the Internet, directly ping the 8.8.8.8 IP address. As shown in Figure 2-6-4-4, ping test indicates if Gate can access the network normally.

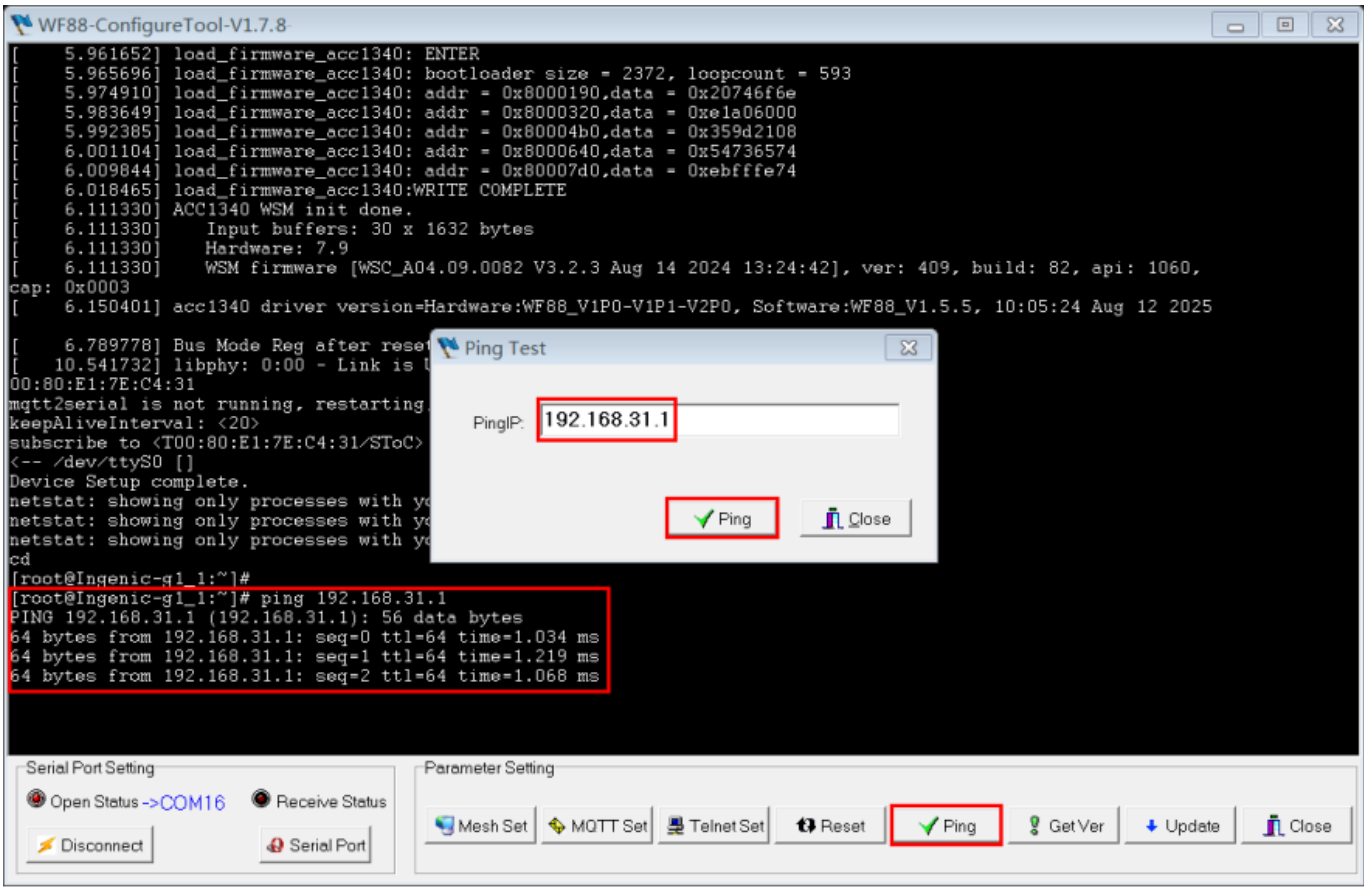


Figure 2-6-4-3. Ping test router

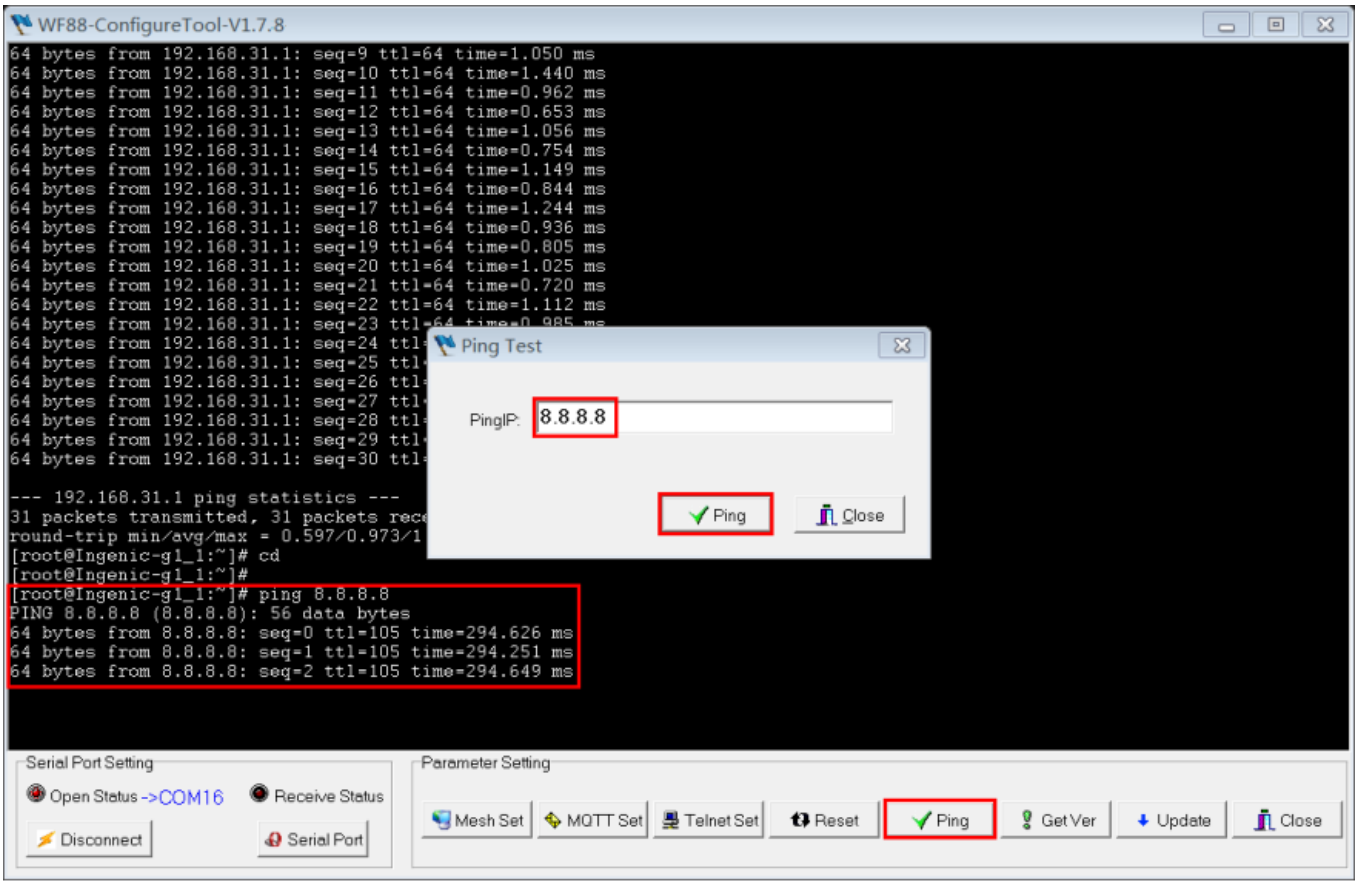


Figure 2-6-4-4. Ping test

(5) The setting of Gate is completed.

1.6.5. Configuration and usage of tcp PC tool

Please refer to the section "2.5.5. Configuration and usage of tcp PC tool" for the settings and usage of this section.

1.7. Build a network through Routing ETH by WLAN

We build a network through Routing ETH by WLAN. Devices connected to the LAN interface can access the Internet through Wi-Fi. If OpenVPN is enabled, devices on external networks can access internal devices.

1.7.1. Network topology diagram

As shown in the network topology diagram in Figure 2-7-1-1. Router accesses the Internet through WAN. PC1 is connected to the router, Gate is connected to the router via Wi-Fi, and PC2 is connected to the LAN interface of Gate. In this network, Gate can obtain an IP address from the router through DHCP, or manually enter the IP address, in which case it needs to be in the same network segment as the router.

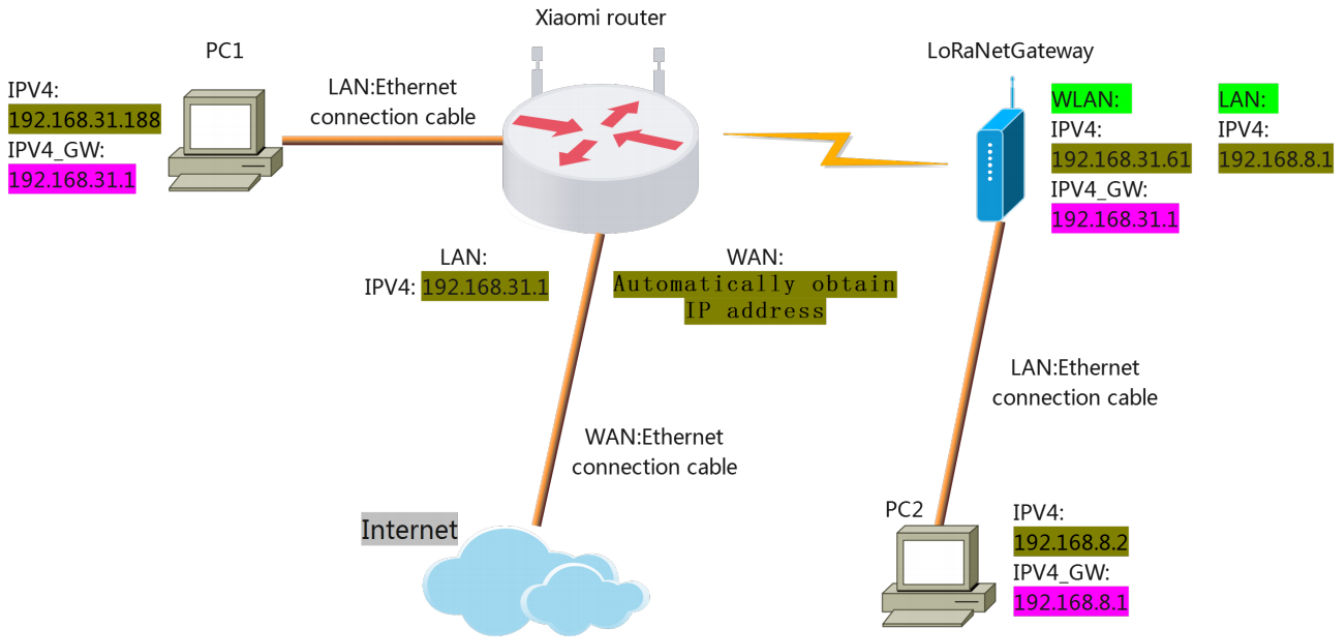


Figure 2-7-1-1. Network topology diagram

1.7.2. Configure the parameters of Gate for Routing ETH by WLAN

Use the WF88 configuration tool to configure the parameters of Gate for Routing ETH by WLAN. The use of WF88 configuration tool is similar to what was described earlier. Please refer to the section "2.5.2 Configure the parameters of Gate for MQTT".

(1) Click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. Select "Router (Route ETH by WLAN)" from the "Connection mode" drop-down list. Enter the SSID and password of the AP we want to connect to in the "SSID Name" and "Password" editing boxes respectively, and select the "DHCP" checkbox. If manually entering the IP address, select the corresponding IP version based on the user's network support in the "IP Version" drop-down list, and enter the IP address in the corresponding IP version below (IPV4_WAN/WLAN). In IPV4_LAN, input the IP address and subnet mask of the LAN interface for Gate. In DHCP Server, input the range of dynamic IP addresses and corresponding DNS for devices connected to the LAN interface of Gate. Finally, click the "Save" button, as shown in Figure 2-7-2-1.

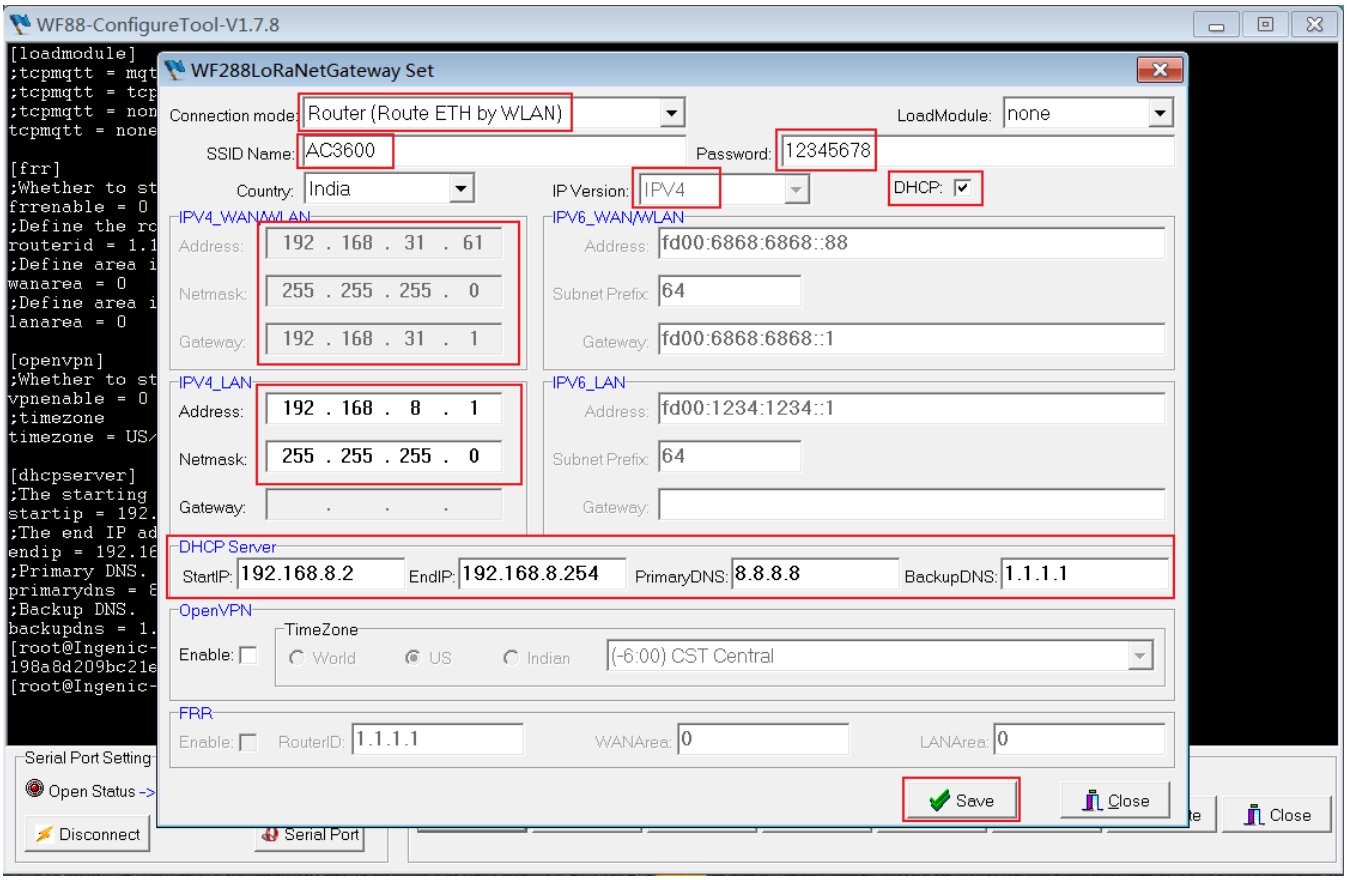


Figure 2-7-2-1. WF288 LoRaNetGateway Set configuration

(2) After the system restarts, we will see a prompt message similar to "Connection to 88:c3:97:ce:b0:c5 completed" and "Sending select for 192.168.31.61", indicating that the Gate has been successfully established a connection with the AP and obtained an IP address. If manually entering the IP address, it will not display "Sending select for 192.168.31.61" information.

(3) PC2 connected to the LAN interface of Gate can dynamically obtain the IP address 192.168.8.2 assigned by Gate. At this time, PC2 can access the Internet.

1.7.3. Enable OpenVPN for Routing ETH by WLAN

OpenVPN based on the “2.7.2 Configure the parameters of Gate for Routing ETH by WLAN” chapter, allowing PC1 in the network topology to access PC2.

(1) Click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. In OpenVPN, click the "Enable" checkbox to enable OpenVPN. Then select the corresponding time zone. Because Gate needs to calibrate according to time zones. Therefore, the Gate needs to be able to access the Internet. Finally, click the "Save" button, as shown in Figure 2-7-3-1.

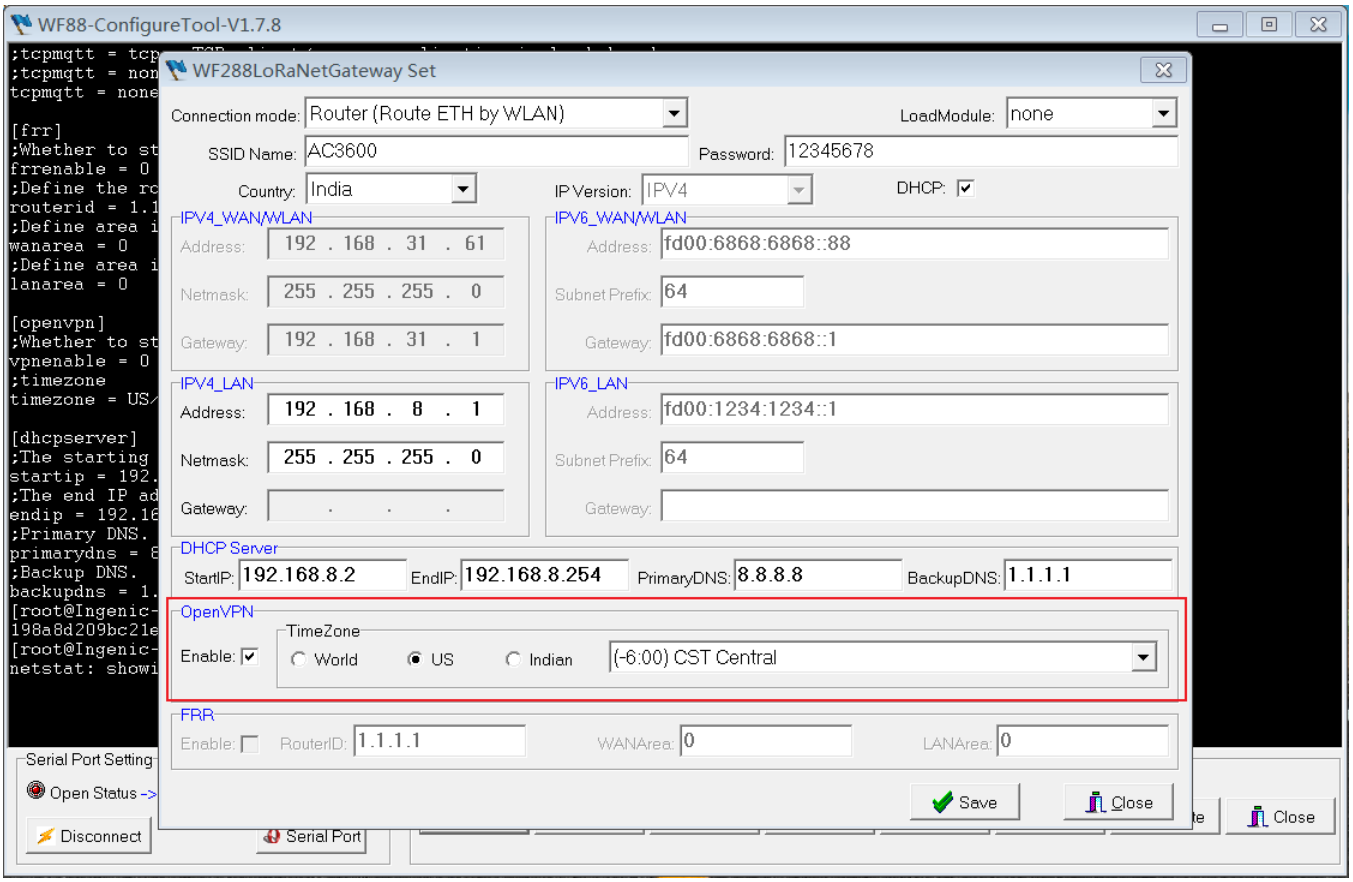


Figure 2-7-3-1. WF288 LoRaNetGateway Set configuration

(2) After the system restarts, note a prompt message similar to "Connection to 88:c3:97:ce:b0:c5 completed" and "Sending select for 192.168.31.61", indicating that the Gate has successfully established a connection with the AP and obtained an IP address.

(3) It is necessary to ensure that the Gate can successfully access the Internet and complete the timing in about 1 minute. If the timing is not successful, the OpenVPN client will not be able to successfully connect to Gate.

(4) Install and deploy the OpenVPN client on the Windows system on PC1.

(5) By accessing the “https://openvpn.net/community/” address, download the OpenVPN client, as shown in Figure 2-7-3-2.

Figure 2-7-3-2. Download OpenVPN Client For Windows

(6) Follow the prompts step by step to complete the software installation.

(7) Place ca.crt, client.crt, client.key, and ta.key in the C:\Program Files\OpenVPN\config directory. These certificate files will be placed in the OpenVPNCertificate directory corresponding to the firmware release on Alibaba Cloud or Sharefile. Or place it in the OpenVPNCertificate directory where the firmware file is located in the release.

(8) Create a client.ovpn configuration file in the C:\Program Files\OpenVPN\config directory, with the following content and modify the IP address in the “remote” keyword of the configuration file to the IP address of Gate, as shown in Figure 2-7-3-3.

```
client

#Protocol
proto udp

#Types of equipment in tunnel
dev tun

#The most important line: Replace with the [Public IP Address] or [Domain
Name] and [Port] of your embedded device
remote 192.168.31.61 1194
```

```
resolv-retry infinite
nobind

#certificate verification
remote-cert-tls server

#Persistent option, keep tunnel and route after restart
persist-key
persist-tun

#Specify the file name for the certificate and key (if the file is in the
same directory as client.conf, simply write the file name)
ca ca.crt
cert client.crt
key client.key

#TLS Auth Key (Enhanced Security)
tls-auth ta.key 1

#Must match the encryption method set by the server
cipher AES-256-GCM

verb 3
```

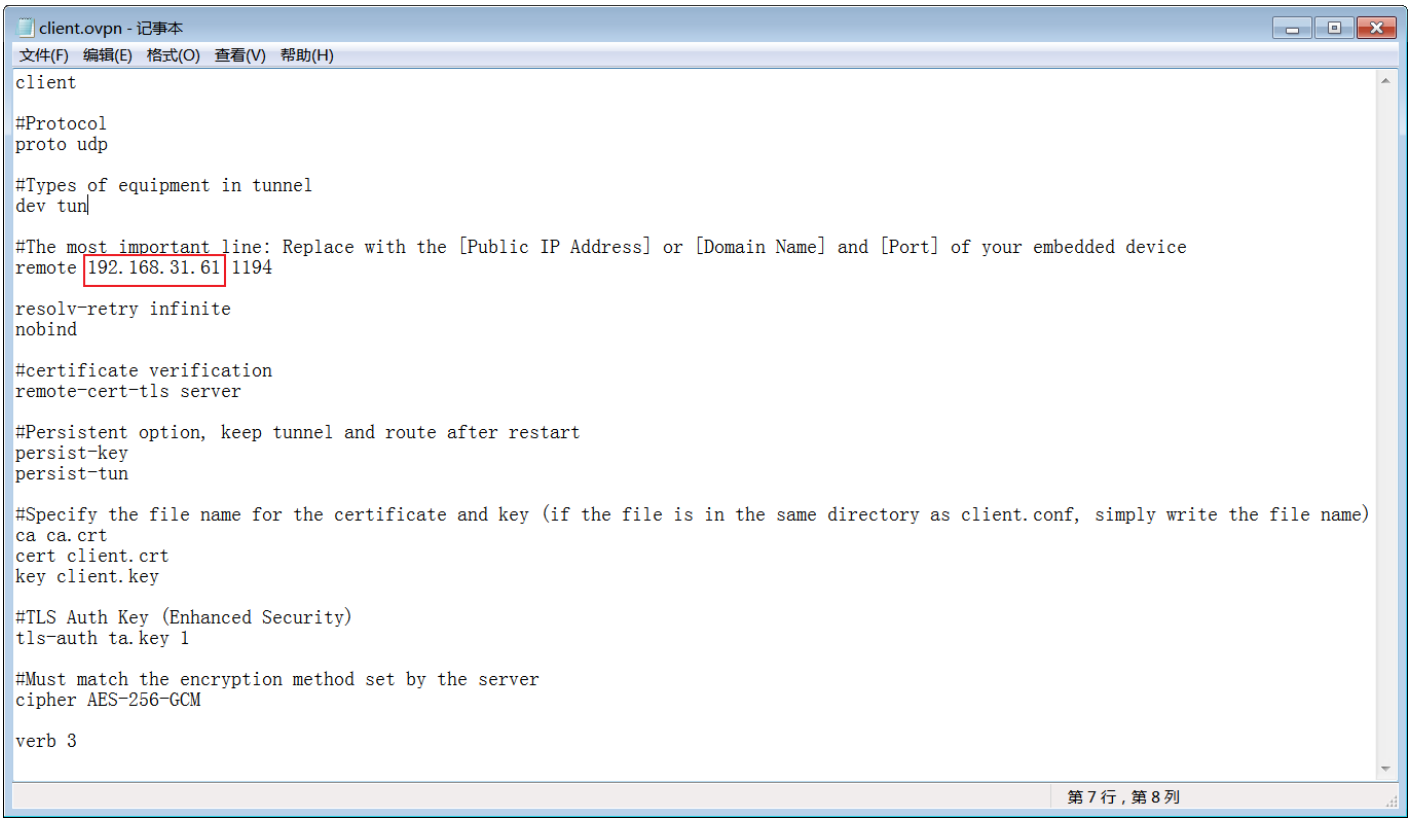


Figure 2-7-3-3. Create a client.ovpn configuration file

(9) In the tray at the bottom right corner of the Windows system, find the client icon for OpenVPN. Right click on the tray icon and then click "Connect" to connect with Gate. After successful connection, obtain the 10.18.0.0/24 segment IP address, as shown in Figure 2-7-3-4.

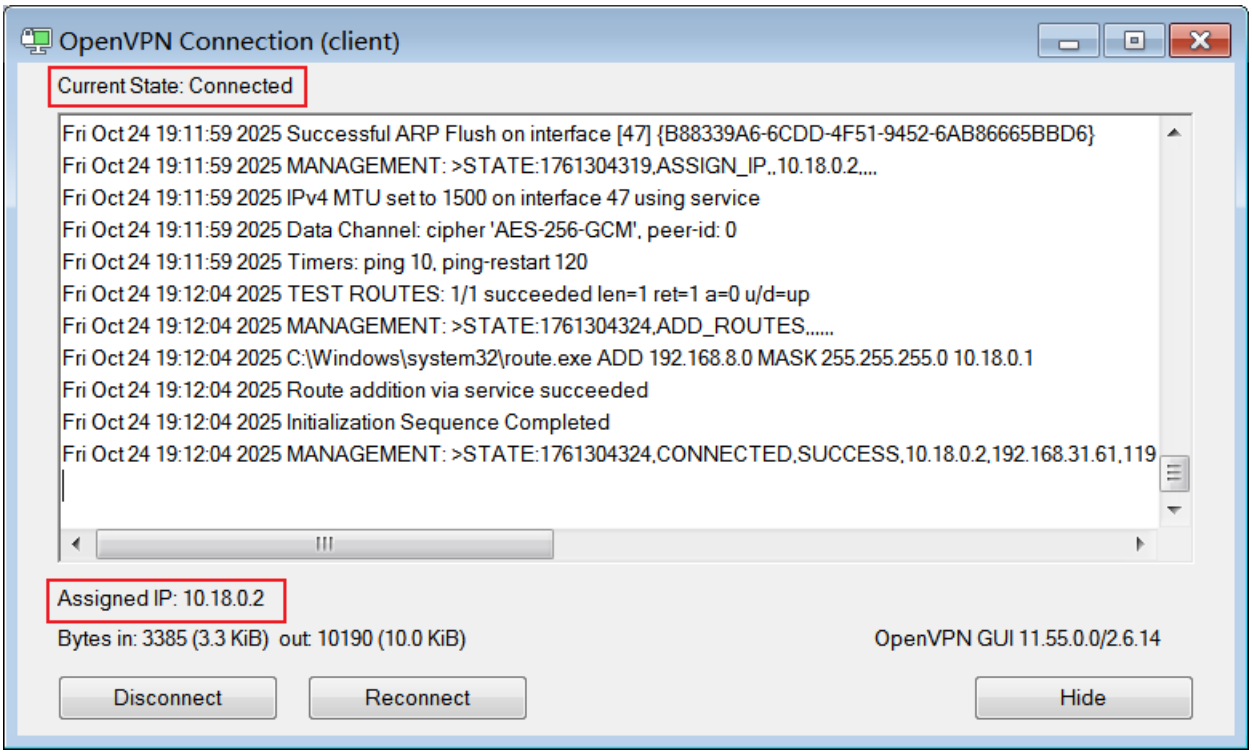


Figure 2-7-3-4. OpenVPN Connection

(10) PC2 connected to the LAN interface of Gate can dynamically obtain the IP address 192.168.8.2 assigned by Gate. At this time, PC2 can access the Internet and PC1 can ping PC2.

1.8. Build a network through Routing LAN by WAN

We build a network through Routing LAN by WAN. Devices connected to the LAN interface can access the Internet through WAN. If OpenVPN is enabled, devices on external networks can access internal devices. If FRR is enabled, it can implement router functionality and support OSPF routing protocol.

1.8.1. Network topology diagram

As shown in the network topology diagram in Figure 2-8-1-1. Router accesses the Internet through WAN. PC1 is connected to the router, Gate1 is connected to the router through its WAN interface., and PC2 is connected to the LAN interface of Gate1. Gate2 is connected to the router through its WAN interface.

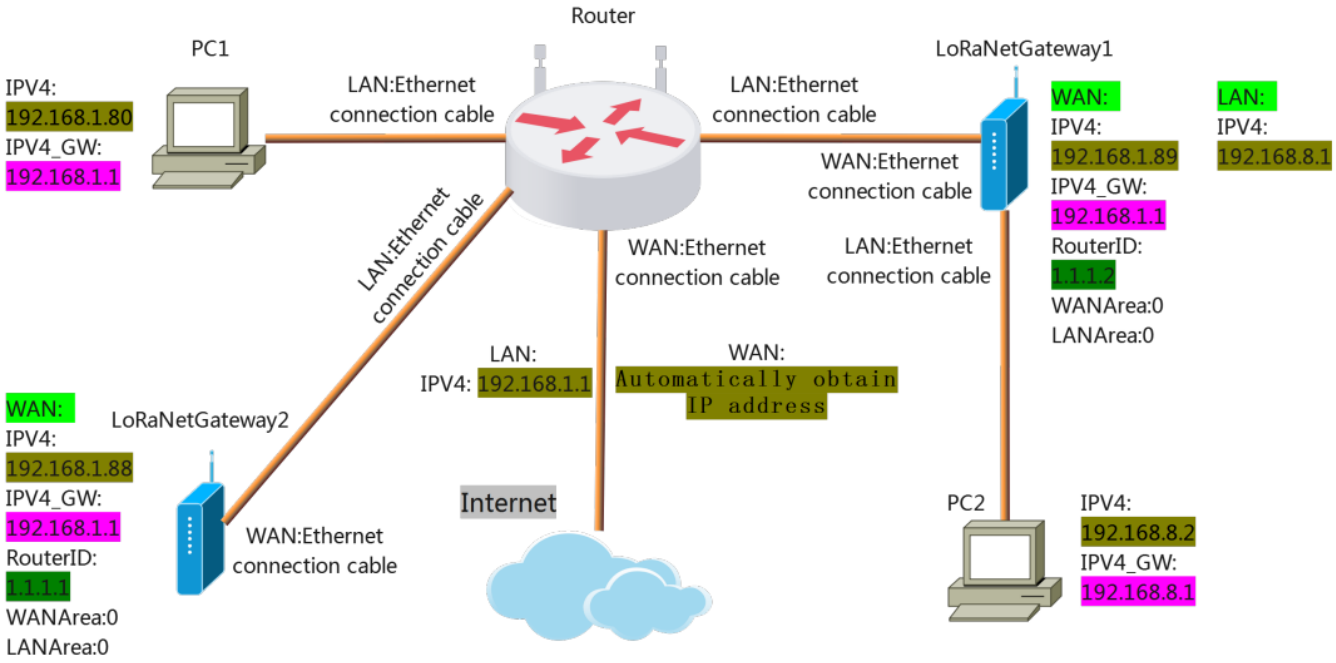


Figure 2-8-1-1. Network topology diagram

1.8.2. Configure the parameters of Gate for Routing LAN by WAN

Use the WF88 configuration tool to configure the parameters of Gate for Routing LAN by WAN. The use of WF88 configuration tool is similar to what was described earlier. Please refer to the section "2.5.2 Configure the parameters of Gate for MQTT".

(1) Click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. Select "Router (Route LAN by WAN)" from the "Connection mode" drop-down list. Select the corresponding IP version based on the user's network support in the "IP Version" drop-down list and enter the IP address in the corresponding IP version below (IPV4_WAN/WLAN). In IPV4_LAN, input the IP address and subnet mask of the LAN interface for Gate1. Finally, click the "Save" button, as shown in Figure 2-8-2-1.

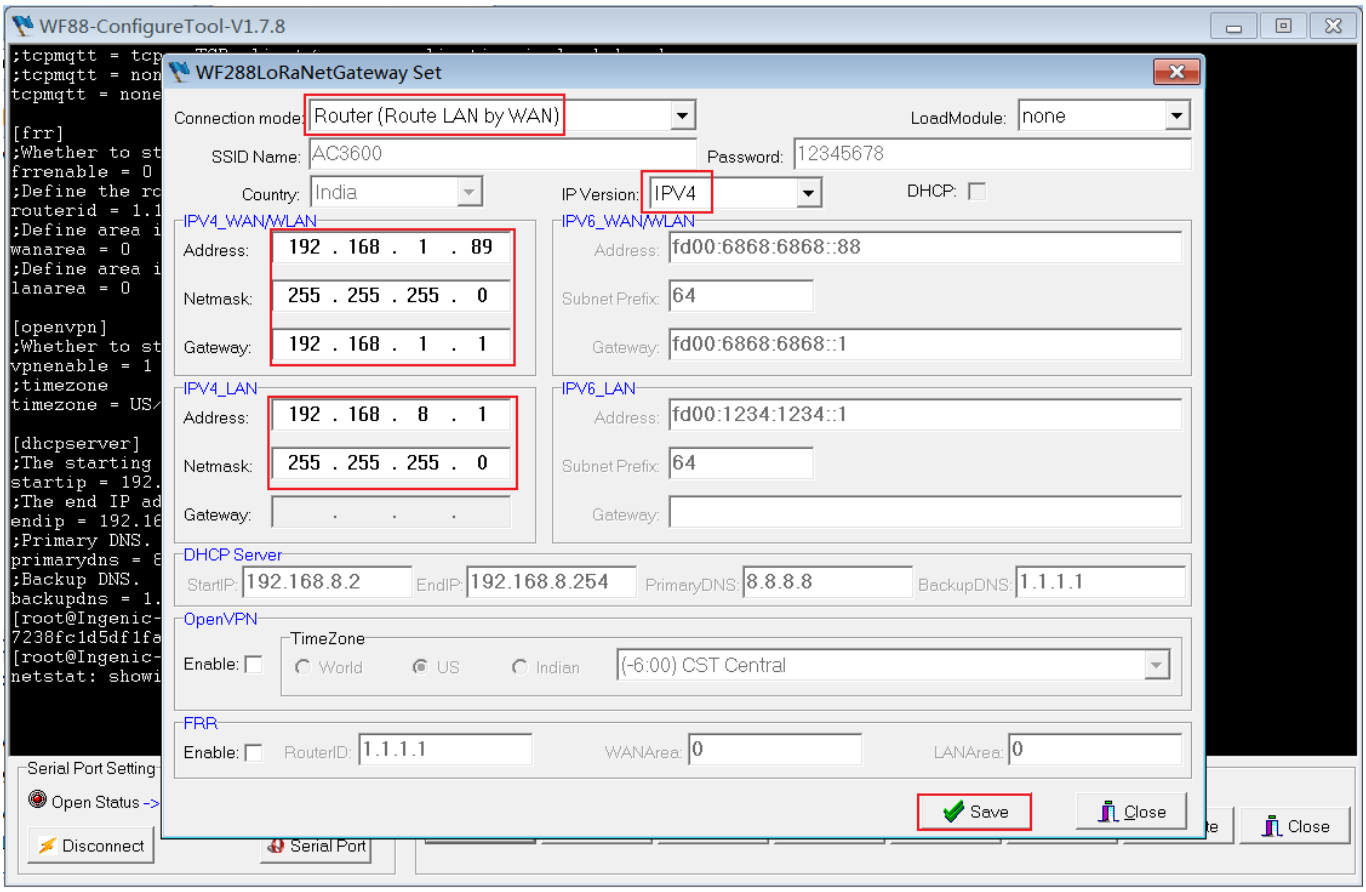


Figure 2-8-2-1. WF288 LoRaNetGateway Set configuration

(2) After the system restarts, we manually set the IP address of PC2 to 192.168.8.2, subnet mask to 255.255.255.0, gateway to 192.168.8.1, and DNS to 8.8.8.8.

(3) PC2 connected to the LAN interface of Gate1 can access the Internet.

1.8.3. Enable OpenVPN for Routing LAN by WAN

We can enable OpenVPN based on the “2.8.2 Configure the parameters of Gate for Routing LAN by WAN” chapter, allowing PC1 in the network topology to access PC2.

(1) Click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. In OpenVPN, click the "Enable" checkbox to enable OpenVPN. Then select the corresponding time zone. Because Gate needs to calibrate according to time zones. Therefore, the Gate needs to be able to access the Internet. Finally, click the "Save" button, as shown in Figure 2-8-3-1.

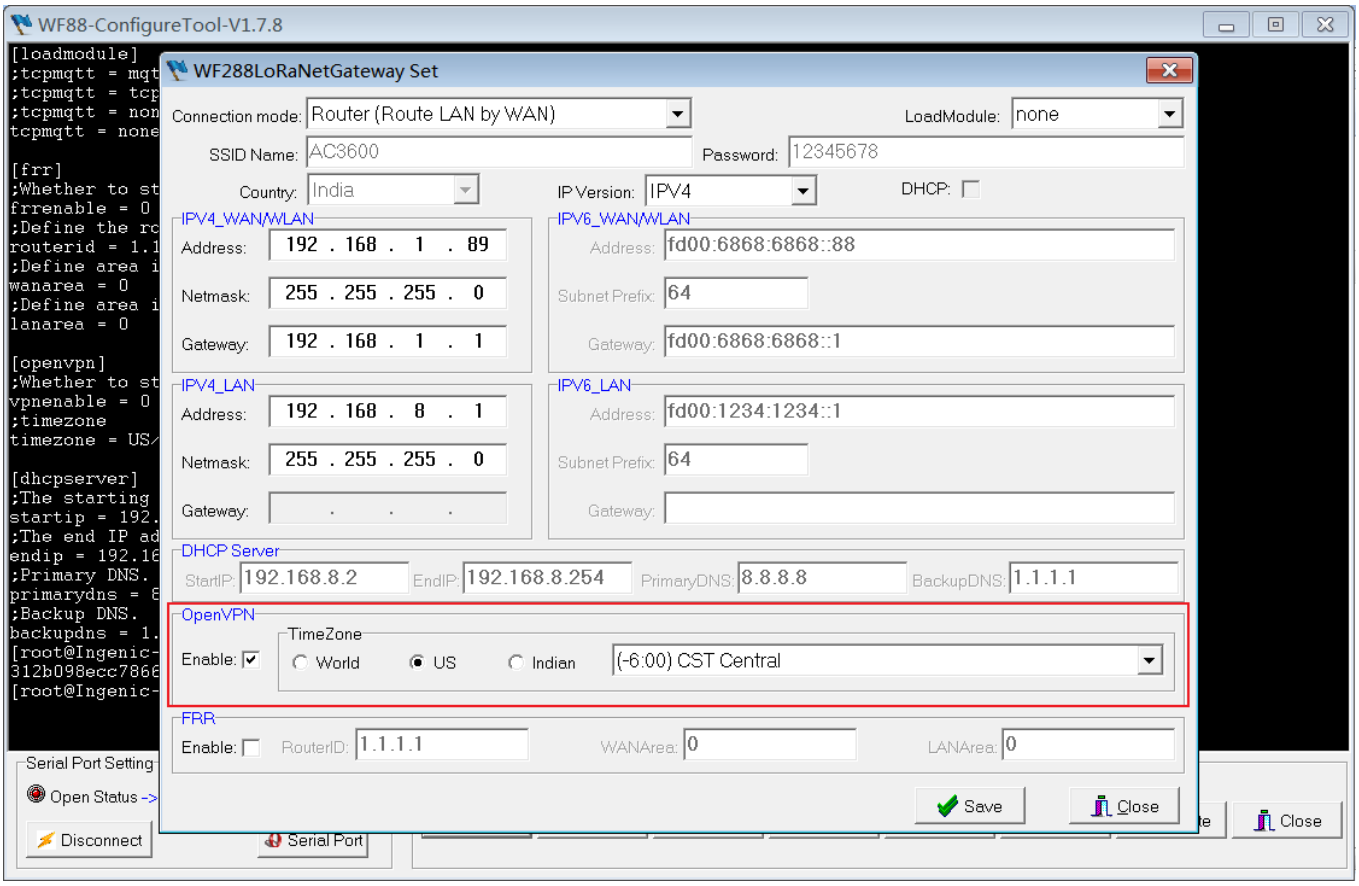


Figure 2-8-3-1. WF288 LoRaNetGateway Set configuration

(2) After the system restarts, we manually set the IP address of PC2 to 192.168.8.2, subnet mask to 255.255.255.0, gateway to 192.168.8.1, and DNS to 8.8.8.8.

(3) It is necessary to ensure that the Gate1 can successfully access the Internet and complete the timing in about 1 minute. If the timing is not successful, the OpenVPN client will not be able to successfully connect to Gate1.

(4) We need to install and deploy the OpenVPN client on the Windows system on PC1.

(5) By accessing the “https://openvpn.net/community/” address, download the OpenVPN client, as shown in Figure 2-8-3-2.

Figure 2-8-3-2. Download OpenVPN Client For Windows

(6) Follow the prompts step by step to complete the software installation.

(7) Place ca.crt, client.crt, client.key, and ta.key in the C:\Program Files\OpenVPN\config directory. These certificate files will be placed in the OpenVPNCertificate directory corresponding to the firmware release on Alibaba Cloud or Sharefile. Or place it in the OpenVPNCertificate directory where the firmware file is located in the release.

(8) Create a client.ovpn configuration file in the C:\Program Files\OpenVPN\config directory, with the following content and modify the IP address in the “remote” keyword of the configuration file to the IP address of Gate1, as shown in Figure 2-8-3-3.

```
client

#Protocol
proto udp

#Types of equipment in tunnel
dev tun

#The most important line: Replace with the [Public IP Address] or [Domain
Name] and [Port] of your embedded device
remote 192.168.1.89 1194
```

```
resolv-retry infinite
nobind

#certificate verification
remote-cert-tls server

#Persistent option, keep tunnel and route after restart
persist-key
persist-tun

#Specify the file name for the certificate and key (if the file is in the
same directory as client.conf, simply write the file name)
ca ca.crt
cert client.crt
key client.key

#TLS Auth Key (Enhanced Security)
tls-auth ta.key 1

#Must match the encryption method set by the server
cipher AES-256-GCM

verb 3
```

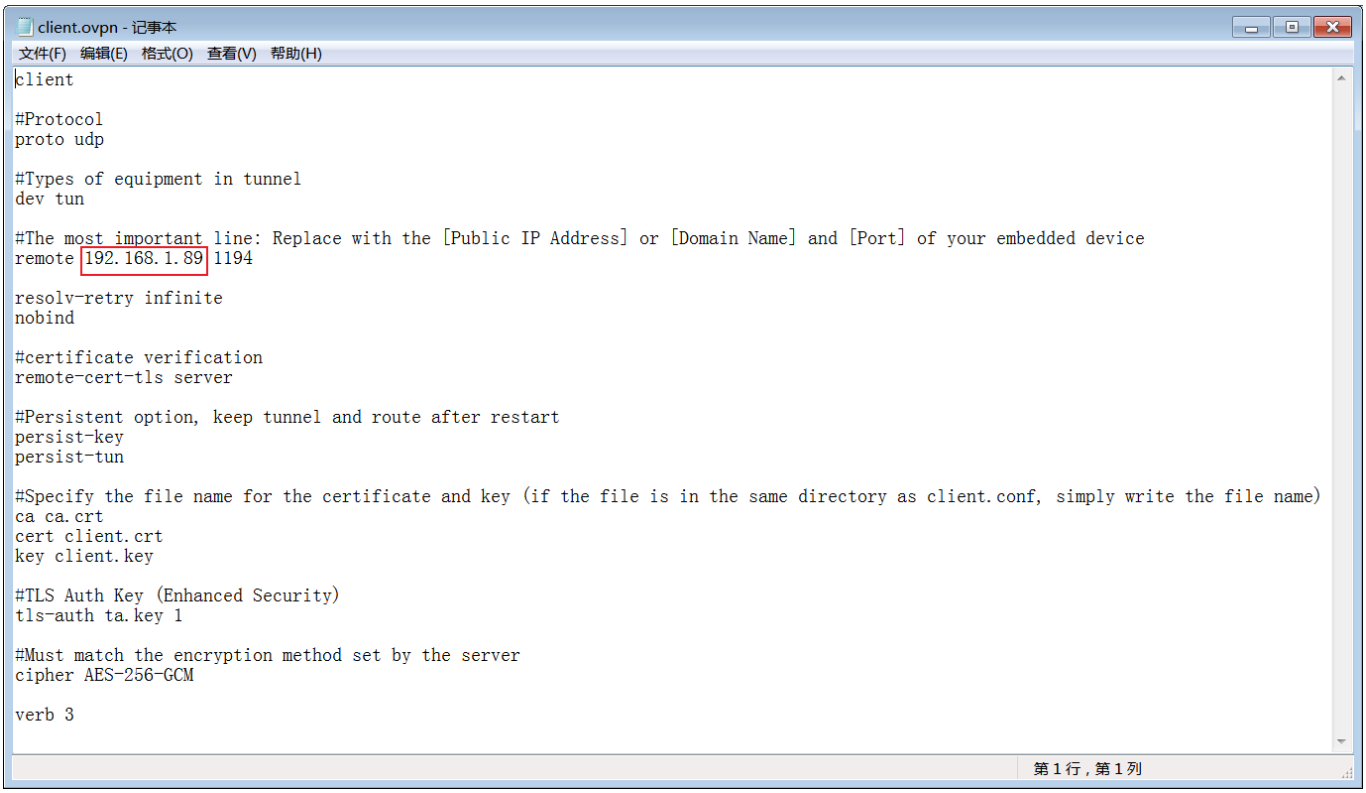


Figure 2-8-3-3. Create a client.ovpn configuration file

(9) In the tray at the bottom right corner of the Windows system, find the client icon for OpenVPN. Right click on the tray icon and then click "Connect" to connect with Gate1. After a successful connection, obtain the 10.18.0.0/24 segment IP address, as shown in Figure 2-8-3-4.

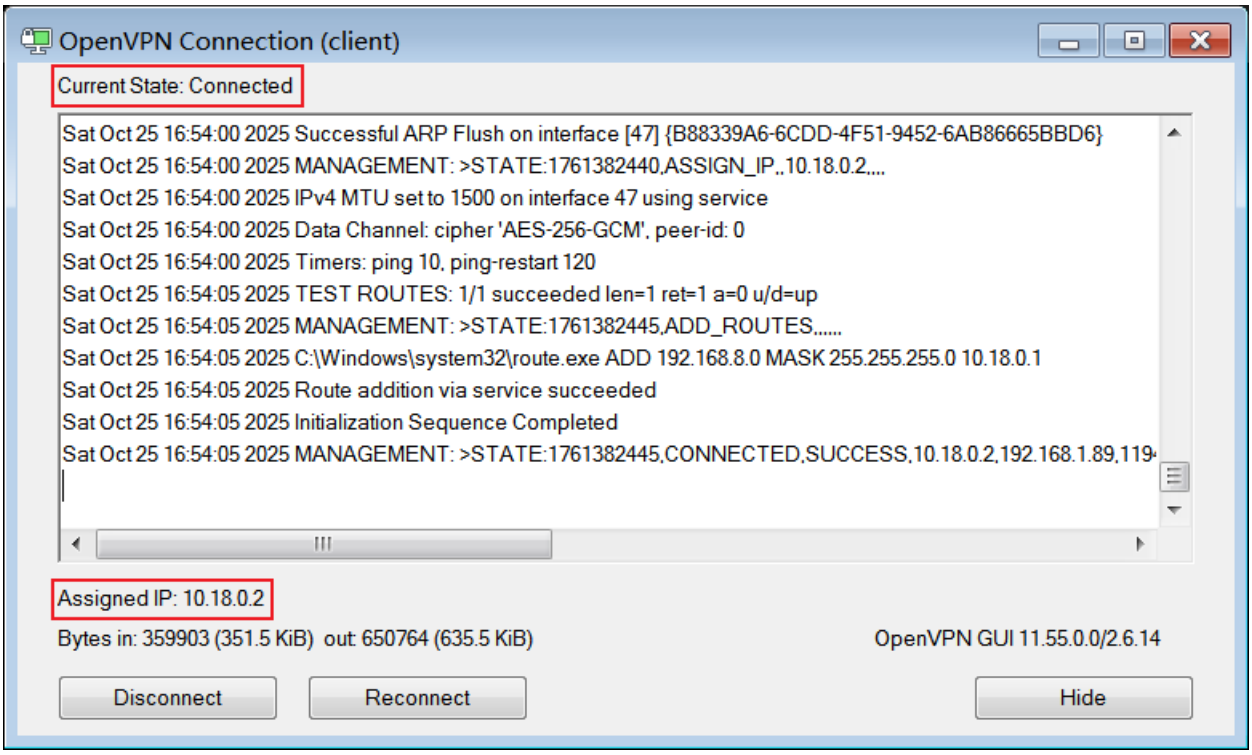


Figure 2-8-3-4. OpenVPN Connection

(10) PC2 connected to the LAN interface of Gate1 can access the Internet and PC1 can ping PC2.

1.8.4. Enable FRR for Routing LAN by WAN

Enable FRR based on the “2.8.3 Enable OpenVPN for Routing LAN by WAN” chapter, allowing Gate1 and Gate2 to mutually learn routing through OSPF routing protocol.

(1) To Gate1, click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. In FRR, click the "Enable" checkbox to enable FRR. In the "RouterID" editing box, enter the ID of the router in the format of IPV4. RouterIDs in the same network segment cannot be duplicated. Set it to 1.1.1.2. Enter 0 in the "WANArea" edit box. Enter 0 in the "LANArea" edit box. Finally, click the "Save" button, as shown in Figure 2-8-4-1.

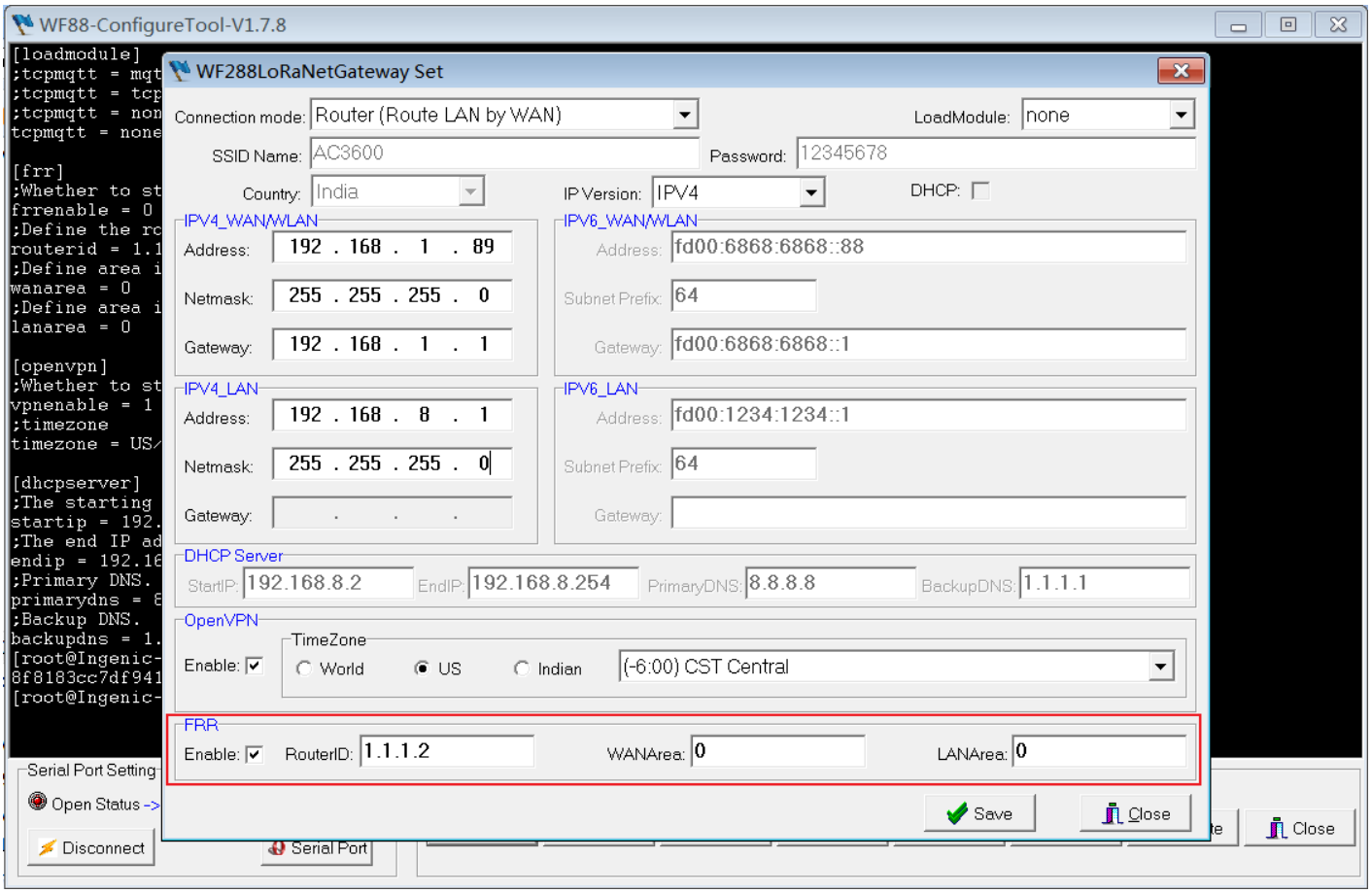


Figure 2-8-4-1. WF288 LoRaNetGateway1 Set configuration

(2) After the system restarts, we can refer to chapters “2.8.2” and “2.8.3” for parameter settings of Gate2. If enable OpenVPN on Gate2 is not needed, disable OpenVPN.

(3) To Gate2, click the "Mesh Set" button to bring up the "WF288 LoRaNetGateway Set" dialog box. In FRR, click the "Enable" checkbox to enable FRR. In the "RouterID" editing box, enter the ID of the router in the format of IPV4. RouterIDs in the same network segment cannot be duplicated. We set it to 1.1.1.1. Enter 0 in the "WANArea" edit box. Enter 0 in the "LANArea" edit box. Finally, click the "Save" button, as shown in Figure 2-8-4-2.

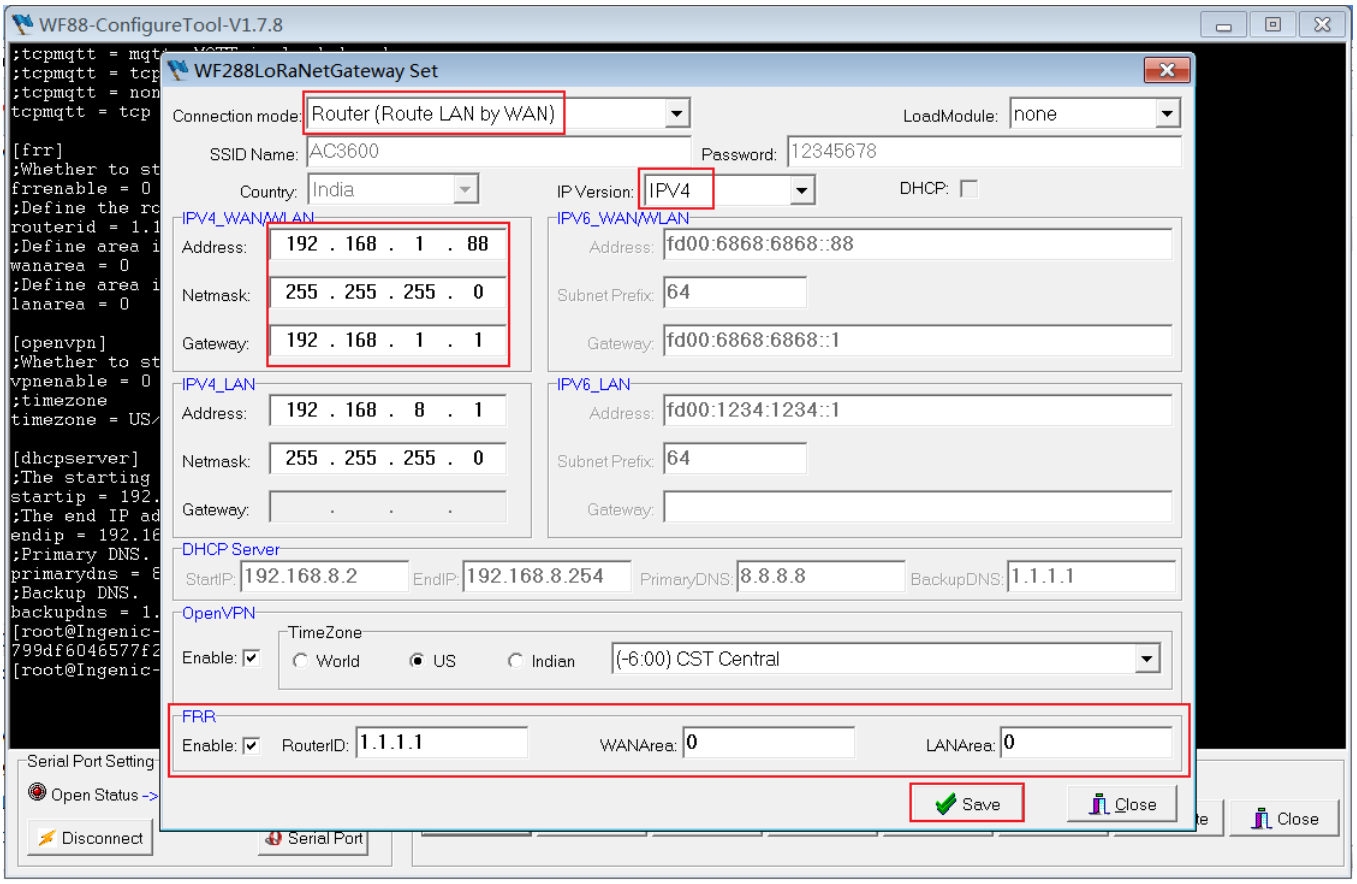


Figure 2-8-4-2. WF288 LoRaNetGateway2 Set configuration

(4) After the system restarts, use the vtysh -c "show ip ospf neighbor" command to check the neighbor status, which should show the FULL status.

(5) To Gate1, its IP address is 192.168.1.89, and it can be seen that Gate2's RouterID is 1.1.1.1, as shown in Figure 2-8-4-3.

```
[root@Ingenic-g1_1:~]# ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 02:22:8C:30:9C:98
          inet addr:192.168.1.89  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: 240e:328:3f9:9f00:22:8cff:fe30:9c98/64 Scope:Global
          inet6 addr: fe80::22:8cff:fe30:9c98/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:809 errors:0 dropped:603 overruns:0 frame:0
          TX packets:86 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:56881 (55.5 KiB)  TX bytes:9793 (9.5 KiB)

[root@Ingenic-g1_1:~]#
[root@Ingenic-g1_1:~]# vtysh -c "show ip ospf neighbor"

Neighbor ID     Pri State           Dead Time Address         Interface            RXmtL RqstL DBsmL
1.1.1.1           1 Full/DR           38.205s 192.168.1.88    eth0:192.168.1.89        0     0     0
[root@Ingenic-g1_1:~]#
```

Figure 2-8-4-3. OSPF Neighbor of WF288 LoRaNetGateway1

(6) To Gate2, its IP address is 192.168.1.88, and it can be seen that Gate1's RouterID is 1.1.1.2, as shown in

Figure 2-8-4-4.

```
[root@Ingenic-g1_1:~]#
[root@Ingenic-g1_1:~]# ifconfig eth0
eth0      Link encap:Ethernet  HWaddr 2E:6A:C0:8A:F3:2C
          inet addr:192.168.1.88  Bcast:192.168.1.255  Mask:255.255.255.0
          inet6 addr: 240e:328:3f9:9f00:2c6a:c0ff:fe8a:f32c/64 Scope:Global
          inet6 addr: fe80::2c6a:c0ff:fe8a:f32c/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:4355 errors:0 dropped:2527 overruns:0 frame:0
          TX packets:639 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:284374 (277.7 KiB)  TX bytes:58210 (56.8 KiB)

[root@Ingenic-g1_1:~]#
[root@Ingenic-g1_1:~]# vtysh -c "show ip ospf neighbor"

Neighbor ID     Pri State           Dead Time Address         Interface            RXmtL RqstL DBsmL
1.1.1.2           1 Full/Backup       31.250s 192.168.1.89    eth0:192.168.1.88        0     0     0
[root@Ingenic-g1_1:~]#
```

Figure 2-8-4-4. OSPF Neighbor of WF288 LoRaNetGateway2