Remote Management Guide for Mesh Rider Radio

Introduction

The Mesh Rider Radio runs the Mesh Rider OS. It is a customized version of Openwrt with enhancements useful for applications requiring low-latency command-and-control transmission and high-throughput video - e.g. UAV and robotics.

The purpose of this guide is to aide a user in remotely configuring Mesh Rider Radio settings. There are three primary ways to configure the Mesh Rider Radio. All of these interfaces can be accessed either locally (over Ethernet/USB) or remotely (over the wireless link).

1. The Web GUI
2. SSH
3. The JSON-RPC API
4. MQTT

Each of these interfaces serves a different purpose. The Web GUI is designed for initial configuration. For example, when you first start using the device, during bench testing.

SSH access is enabled for advanced system configuration and status monitoring. It provides root access to the underlying Linux system and is a very powerful way to access the system. Typically, equipment manufacturers should not allow SSH access to the end users of the radios. SSH can be very fast when using multiplexing.

The JSON-RPC API is designed for integration into customer software. As with SSH access, it potentially provides complete access to the underlying Linux system, however access permissions can also be tailored to the equipment manufacturer’s requirements so that end-users cannot access the nuts and bolts of the radios system.

MQTT is an alternative to the JSON-RPC API which is ubiquitous in IoT applications. Only user-defined messages can be sent using MQTT. MQTT can be very fast if encryption is turned off.

A summary of the differences between the command-line APIs is shown in Table 1.

Table 1: Comparison of Mesh Rider Radio APIs

	SSH	JSON-RPC	MQTT

	SSH	JSON-RPC	MQTT
Network Model	P2P, Client-server	P2P, Client-server	Centrally Managed
Primary Usage	Debugging	Software Integration	IoT, simple messaging
Access	Full	User-Defined	User-Defined
Command Set	All	ubus only	User-defined messaging
Security	Required	Required	Optional
Latency	Fast with multiplexing (10s of milliseconds)	Fast (10s of milliseconds)	+ Slow with TLS (~2s) + Fast without (10s of milliseconds)

End users will typically never use any of these APIs directly. In fact, they should not even have the password to access the radios. Instead, they use application software such as ground-control-station (GCS) software which uses the JSON-RPC API to talk to the radio and relay information to the user.

The remainder of the main content of this document discusses how to run commands in the CLI.

The Web GUI

The Web GUI can be accessed in any web browser at `https://<IP ADDRESS>` (port 443). Note that the web browser uses a self-signed certificate. This means that connection to the web browser is encrypted, but not authenticated. The first time you access the Mesh Rider Radio from a new browser, you will get an SSL certificate warning. It is okay to ignore the warning and proceed.

SSH

SSH or Secure Shell is a way to securely login to the Mesh Rider Radio. The easiest way to do so is to open up a command prompt (Windows) or terminal (Linux), and type

```
ssh root@<IP ADDRESS>
```

Where `<IP ADDRESS>` is the IP address of the Mesh Rider Radio. There are numerous configuration options that your SSH client supports, such as public key authentication, and quiet output and you are encouraged to research them.

Note that your SSH client keeps a list of known hosts, and after a firmware upgrade, you may need to remove the Mesh Rider Radio from the known hosts list. You can do so by running

```
ssh-keygen -R <IP ADDRESS>
```

Sending Remote Commands

You can remotely execute a command via SSH to obtain network information from the node. For example,

```
ssh root@<IP ADDRESS> "iw wlan0 info"
Interface wlan0
    ifindex 13
    wdev 0x7
    addr 00:30:1a:4e:86:46
    type mesh point
    wiphy 0
    channel 12 (915 MHz), width: 20 MHz, center1: 915 MHz
    txpower 32.00 dBm
```

Speeding up the Connection

If your SSH client supports Multiplexing (OpenSSH for example), then it is a good way to improve the connection speed. Multiplexing allows you to send multiple commands over a single SSH connection. Information about the setup can be found here:

https://en.wikibooks.org/wiki/OpenSSH/Cookbook/Multiplexing

As an example, modify your SSH config file (usually `~/.ssh/config`) with the following settings

```
Host *
    IdentitiesOnly yes
    ControlPersist yes
    COntrolMaster auto
    ControlPath ~/.ssh/%r@%h:%p
```

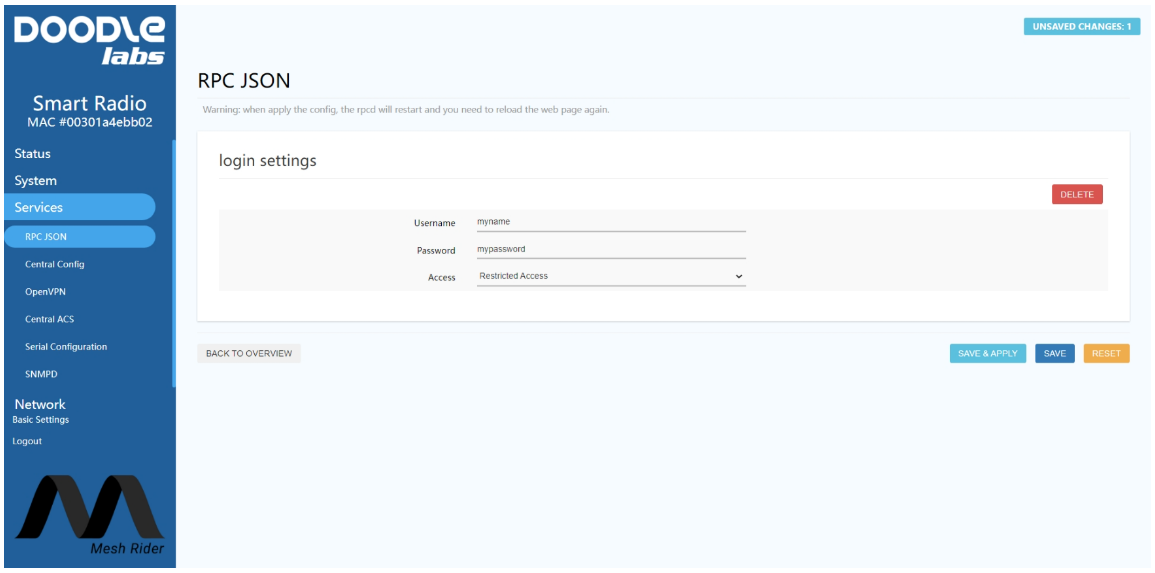
Create the file if it doesn't exist.

The JSON-RPC API

The JSON-RPC API is normally preferred when integrating radio access into custom software. In order to enable the JSON-RPC API, navigate to

```
https://<IP ADDRESS>/cgi-bin/luci/admin/services/rpcd
```

in your web browser. Fig. 1 shows the JSON-RPC API web configuration page.



RPC JSON

Warning: when apply the config, the rpcd will restart and you need to reload the web page again.

login settings

Username: myname
Password: mypassword
Access: Restricted Access

Fig. 1 JSON RPC API Configuration Page

Click Add to configure the API. Choosing Restricted Access opens up the API for a limited set of commands which we will detail later. You can also choose Full Access which allows unrestricted access to the Linux filesystem, and Custom Access, if you know how to customize the JSON RPC API. We recommend choosing Restricted Access if you are not sure.

The default username and password for the JSON-RPC API is `root`, `DoodleSmartRadio`.

Restricting Access

Only UBUS commands can be executed over the JSON-RPC API. The commands which can be executed over the JSON-RPC API are configured in the file `/usr/share/rpcd/acl.d/root.json`. We suggest that you read the file to gain an understanding of how to control user access. A listing is shown below with `Restricted Access` applied.

```
root@smartradio:~# cat /usr/share/rpcd/acl.d/root.json
{
        "root": {
                "description": "user access role",
                "read": {
                        "ubus": {
                                "file": [ "exec", "read", "stat" ],
                                "iwinfo": [ "info" ],
                                "system": [ "reboot", "info" ],
                                "dhcp": [ "*" ],
                                "central-config" : [ "*" ],
                                "uci": [ "*" ]
                        },
                        "uci": [ "wireless", "network" ],
                        "file": {
                                "/usr/bin/free": [ "exec" ],
                                "/usr/bin/top -n1": [ "exec" ],
                                "/bin/dmesg": [ "exec" ],
                                "/sbin/logread": [ "exec" ],
                                "/usr/sbin/alfred *": [ "exec" ],
                                "/usr/sbin/batadv-vis *": [ "exec" ],
                                "/usr/sbin/batctl *": [ "exec" ],
                                "/usr/sbin/iw *": [ "exec" ],
                                "/etc/init.d/* start": [ "exec" ],
                                "/etc/init.d/* stop": [ "exec" ],
                                "/etc/init.d/* restart": [ "exec" ],
                                "/usr/bin/link-status.sh *": [ "exec" ],
                                "/tmp/run/pancake.txt": [ "read" ],
                                "/var/run/gps/*": [ "read" ],
                                "/tmp/status.json": [ "read" ],
                                "/tmp/longtermlog/status.json": [ "read" ]
                        }
                },
                "write": {
                        "ubus": {
                                "central-config" : [ "*" ],
                                "uci": [ "*" ]
                        },
                        "uci": [ "wireless", "network" ],
                        "file":{
                                "uci *": [ "exec" ]
                        }
                }
        }
}
```

Using the JSON-RPC API

To use API, you need to get a session ID and use it for subsequent requests. For example, you can try the following call,

```
USER=myusername
PASS=mypassword
curl -k https://<IP-ADDRESS>/ubus -d '
{
  "jsonrpc": "2.0",
  "id": 1,
  "method": "call",
  "params": [ "00000000000000000000000000000000", "session", "login", {
"username": '\"$USER\"', "password": '\"$PASS\"'  } ]
}'
```

the `-k` option is required because the Mesh Rider Radio doesn't use a third party certificate authority. An example of using JSON-RPC API for file access is shown below. Substitute `<TOKEN>` with the value returned above.

```
TOKEN=$1
curl -k https://<IP-ADDRESS>/ubus -d '
{
  "jsonrpc": "2.0",
  "id": 1,
  "method": "call",
  "params": [ '\"$TOKEN\"', "file", "read", { "path": "/tmp/status.json" } ]
}'
```

We recommend parsing data on your local machine rather than trying to parse it on the Mesh Rider Radio.

Using the JSON-RPC API requires knowledge of UBUS. Please read the section Running Commands in the CLI for more information.

Speeding up the connection

In the commands above, we ran the `curl` utility directly from the command prompt. The speed is limited when doing this because each curl command establishes a new session and closes it once the command is complete. A faster way to poll data is to open a session, send all of your commands, and the close the session when you are done. The listing below shows how this could be done using `python3`.

```
#!/usr/bin/python3

import requests
import json

IPADDR = "10.223.59.152"
USER = "root"
PW = "DoodleSmartRadio"

url = 'https://{}/ubus'.format(IPADDR)

# Create a session
session = requests.Session()

# JSON payload for login request
login_payload = {
    "jsonrpc": "2.0",
    "id": 1,
    "method": "call",
    "params": ["00000000000000000000000000000000", "session", "login",
{"username": USER, "password": PW}]
}

# Send the login POST request
response = session.post(url, json=login_payload, verify=False)
```

```
# Parse the JSON response
data = json.loads(response.text)

# Extract the desired value (token)
token = data['result'][1]['ubus_rpc_session']

# Print the token
print("Token:", token)

# JSON payload for distance request
time_payload = {
    "jsonrpc": "2.0",
    "id": 1,
    "method": "call",
    "params": [ token, "file", "exec", { "command": "cat", "params": [
"/proc/uptime" ] } ]
}

# Send the distance POST request
response = session.post(url, json=time_payload, verify=False)

# Parse the JSON response
data = json.loads(response.text)

# Extract the desired value (distance)
radioTime = data['result'][1]['stdout']

# Print the distance
print("Radio Time:", radioTime)

# Repeat to show the speed
response = session.post(url, json=time_payload, verify=False)
data = json.loads(response.text)
radioTime = data['result'][1]['stdout']
print("Radio Time:", radioTime)

# Repeat again to show the speed
response = session.post(url, json=time_payload, verify=False)
data = json.loads(response.text)
radioTime = data['result'][1]['stdout']
print("Radio Time:", radioTime)

# Close the session
session.close()
```

MQTT

The Mesh Rider Radio has supported MQTT broker and client protocols since the February 2022 firmware release. MQTT uses a publish/subscribe model. Clients can publish messages to a topic, and all clients which are subscribed to that topic will receive the message. All communications are handled by a central broker.

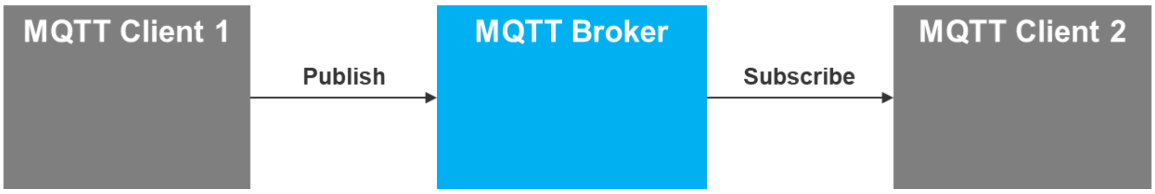
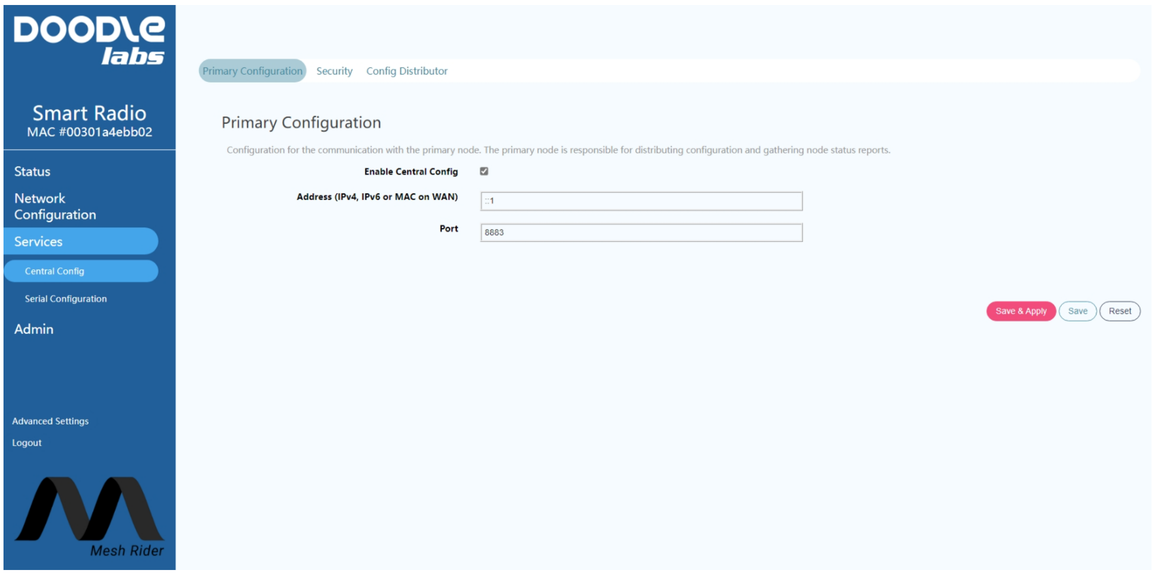


Fig. 2 MQTT publish/subscribe model

The Mesh Rider Radio uses MQTT for it's Central Config utility, so the easiest way to start a broker is to simply set one of the radios as the primary node in the Central Config configuration page. Navigate to `Services -> Central Config` in the GUI and use the setup below.



Primary Configuration

Configuration for the communication with the primary node. The primary node is responsible for distributing configuration and gathering node status reports.

Enable Central Config ✓

Address (IPv4, IPv6 or MAC on WAN): ::1

Port: 8883

Fig. 3 Central Config setup

This radio will now run an MQTT broker. You can modify the security settings on the broker in the security tab. You can check that the broker is running by logging into the radio over SSH and running the following command

```
ssh root@<host IP>
ps w | grep mosquitto | grep -v grep
```

You can test out the following pub/sub commands from the Mesh Rider Radio itself.

Subscribe to the topic `"mytopic"`

```
mosquitto_sub -h <BROKER IP> -p 8883 -t "mytopic" --psk "0123456789abcdef" --
psk-identity "doodlelabs"
```

Publish a message to the topic `"mytopic"`

```
mosquitto_pub -h <BROKER IP> -p 8883 -t "mytopic" --psk "0123456789abcdef" --
psk-identity "doodlelabs" -m 'Hello'
```

For details on common CLI commands, or if you want to create program that starts automatically on boot, see our command-line guide.

Speeding up MQTT

The speed at which MQTT can send commands is limited by the TLS handshaking required for every message sent. You can also run an MQTT broker without TLS security by simply running

```
mosquitto
```

over the CLI. You can also create a start-up script to do this automatically on boot. The insecure MQTT broker listens on port 1883, so you will need to open the firewall on port 1883 for the broker to receive messages. With TLS disabled, the `mosquitto_pub/sub` commands are the same except the `--psk` and `--psk-identity` arguments are not required.

As with SSH and the JSON-RPC API, you can also explore different MQTT library implementations for ways to send multiple commands in a single session.