IoTManagement System

status active

IoTManagement System

📝 Table of Contents

🧐 About

This repo contains

- Backend
- RPiClient Software
- Client auto-Installer script
- Detailed instructions

for IoTManagement System.

Getting Started

These instructions will get you a copy of the project up and running on you raspberry pi.

Prerequisites

Turn on your Raspberry Pi and execute the following commands

```
- sudo apt update
- sudo apt upgrade
```

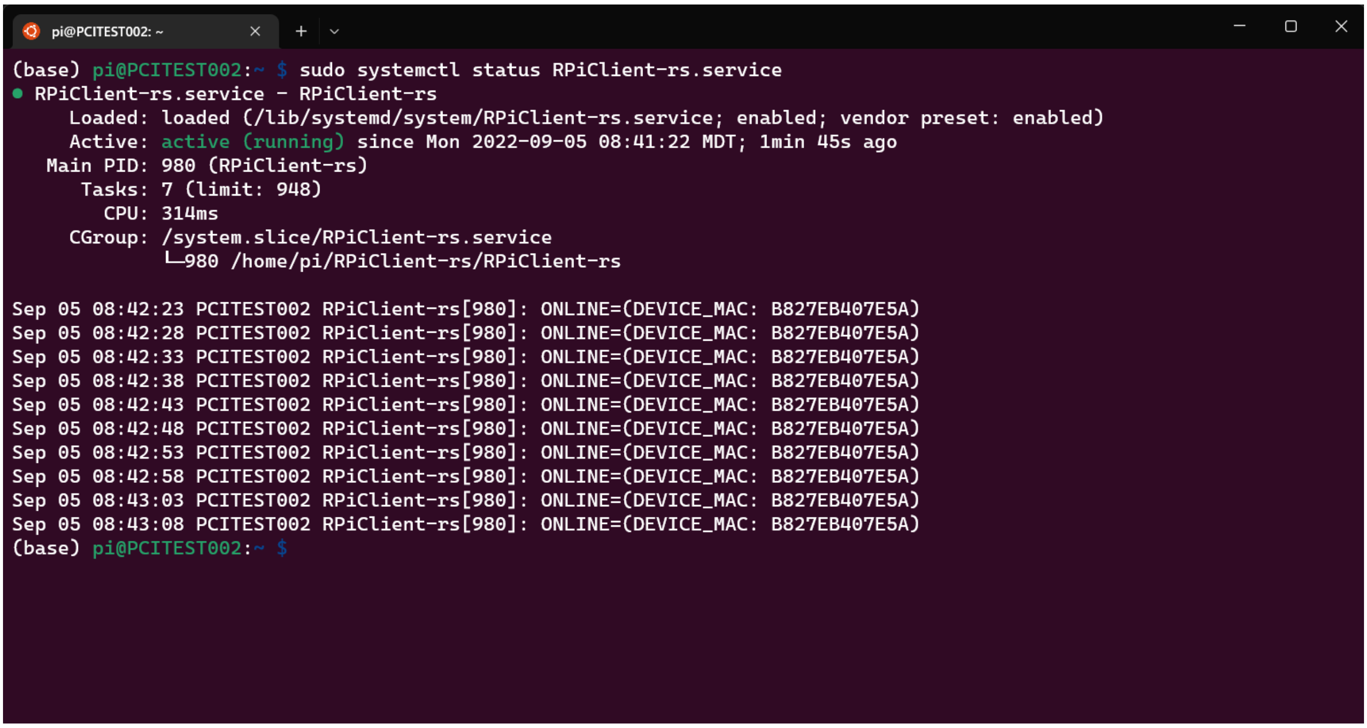
RPiClient Installation

Pre-configured Image

1. Download Raspberry Pi iamge with RPiClient-rs pre-configured and flash it to your Raspberry Pi.

2. ssh into the Raspberry Pi and execute the following command to get the MAC Address:

   ```
   sudo systemctl status RPiClient-rs.service
   ```



```
(base) pi@PCITEST002:~ $ sudo systemctl status RPiClient-rs.service
● RPiClient-rs.service - RPiClient-rs
     Loaded: loaded (/lib/systemd/system/RPiClient-rs.service; enabled; vendor preset: enabled)
     Active: active (running) since Mon 2022-09-05 08:41:22 MDT; 1min 45s ago
   Main PID: 980 (RPiClient-rs)
      Tasks: 7 (limit: 948)
        CPU: 314ms
     CGroup: /system.slice/RPiClient-rs.service
             └─980 /home/pi/RPiClient-rs/RPiClient-rs

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(base) pi@PCITEST002:~ $
```

Server Details

Monitoring

- pm2 list
- pm2 monit

List of Packages installed on server

- Mosquitto Broker
- NodeJS, NPM, Node, NVM
- PM2
- ufw
- mongod
- mongo-express

Version Details

- Node v12.16.1
- NPM v6.13.4

Server Links

- MQTT Broker Link: 44.195.192.158:1883
- Backend Link: 44.195.192.158:3000

Backend

- Backend is based on NodeJS and it is being managed by PM2. It starts automatically on server start.

MQTT Topic Details

Topics List

Logs

1. iotm-sys/device/logs `(all log messages are published to this topic) READ-ONLY`

Fimrware

2. iotm-sys/device/firmware/file/all `(global firmware update files are received at this topic) WRITE-ONLY`
3. iotm-sys/device/firmware/file/[macaddress] `(the fimrware file for specific device are received at this topic {replace [macaddress] with the Mac address of the device without : in the address}) WRITE-ONLY`
4. iotm-sys/device/firmware/script/all `(global user-script update file is received at this topic) WRITE-ONLY`
5. iotm-sys/device/firmware/script/[macaddress] `(the user-script file for specific device are received at this topic {replace [macaddress] with the Mac address of the device without : in the address}) WRITE-ONLY`
6. iotm-sys/device/firmware/url/all `(global firmware update files via URL received at this topic) WRITE-ONLY`
7. iotm-sys/device/firmware/url/[macaddress] `(the fimrware file URL for specific device are received at this topic {replace [macaddress] with the Mac address of the device without : in the address}) WRITE-ONLY`
8. iotm-sys/device/client/url/all `(global client update .tar file via URL received at this topic) WRITE-ONLY`
9. iotm-sys/device/client/url/[macaddress] `(the client update .tar file URL for specific device are received at this topic {replace [macaddress] with the Mac address of the device without : in the address}) WRITE-ONLY`
10. iotm-sys/device/heartbeat/[macaddress] `(MAC Address of the online device is sent to this topic {replace [macaddress] with the Mac address of the device without : in the address}) READ-ONLY`

Device Management

11. iotm-sys/device/add `(for adding a new device message format 'deviceName;macAddress;updatedAt') WRTIE-ONLY`

Device OS

12. iotm-sys/device/upgrade/* `(global device OS upgrade) WRITE-ONLY`
13. iotm-sys/device/upgrade/[macaddress] `(specific device OS upgrade, replace [macaddress] with device mac address without : chars ) WRITE-ONLY`
14. iotm-sys/device/osug/all `(global OS upgrade instructions are received at this topic) READ-ONLY`
15. iotm-sys/device/osug/[macaddress] `(OS upgrade instructions for specific device are received at this topic {replace [macaddress] with the Mac address of the device without : in the address}) READ-ONLY`
16. iotm-sys/device/info/[macaddress] `(device and os info of specific device can be requested from this topic) WRITE-ONLY`
17. iotm-sys/device/config/[macaddress] `(device and os info of specific device can be requested from this topic) WRITE-ONLY. Acceptable parameters in the table below`

Config	Description
`command;[bash command]`	`executes any bash command. Use the command in place of [bash command] place holder`
`logs=stdout`	`Reads and sends the stdout logs of the RPiClient-rs to the *logs* topic`
`logs=stdout-user-script`	`Reads and sends the stdout logs of the user script to the *logs* topic`
`logs=stderr`	`Reads and sends the stderr logs of the RPiClient-rs to the *logs* topic`
`logs=stderr-user-script`	`Reads and sends the stderr logs of the user script to the *logs* topic`
`logs=update-status`	`Reads and sends the last OS update status to the *logs* topic`

API Details

Add Device

```
POST http://44.195.192.158:3000/v1/addDevice
```

Parameter	Type	Description
`operation`	`string`	**Required**. *value of operation should be 'add'*
`name`	`string`	**Required**. *value of param could be a name*

Parameter	Type	Description
`macAddress`	`string`	**Required**. *value of param should be a MAC Address of your RPi Device being displayed by RPiClient Installer*
`updatedAt`	`string`	**Required**. *value of param should be the current timestamp*

Upgrade OS

```
POST http://44.195.192.158:3000/v1/upgrade
```

Parameter	Type	Description
`operation`	`string`	**Required**. *value of operation should be 'upgrade'*
`devices`	`string`	**Required**. *value of devices param could be 'all' or 'device MAC Address'*

Update Firmware

```
POST http://44.195.192.158:3000/v1/update
```

Parameter	Type	Description
`operation`	`string`	**Required**. *value of operation should be 'update'*
`devices`	`string`	**Required**. *value of devices param could be 'all' or 'device MAC Address'*
`programFile`	`multipart/form-data`	**Required**. *a Firmware file to be sent to repective device(s)*

Update Firmware via URL

```
POST http://44.195.192.158:3000/v1/update-url
```

Parameter	Type	Description
`operation`	`string`	**Required**. *value of operation should be 'update'*
`devices`	`string`	**Required**. *value of devices param could be 'all' or 'device MAC Address'*
`fileName`	`string`	**Required**. *name of the file along with the directory*
`url`	`string`	**Required**. *a valid url. Could be S3 or any other CDN.*

Update User Script

```
POST http://44.195.192.158:3000/v1/update-script
```

Parameter	Type	Description
`operation`	`string`	**Required**. *value of operation should be 'update'*
`devices`	`string`	**Required**. *value of devices param could be 'all' or 'device MAC Address'*
`programFile`	`multipart/form-data`	**Required**. *a valid bash script file to be sent to repective device(s)*

Update OTA - For Client

```
POST http://44.195.192.158:3000/v1/update-ota
```

Parameter	Type	Description
`operation`	`string`	**Required**. *value of operation should be 'update'*
`devices`	`string`	**Required**. *value of devices param could be 'all' or 'device MAC Address'*
`url`	`string`	**Required**. *a valid url. Could be S3 or any other CDN.*

Client Config

```
POST http://44.195.192.158:3000/v1/config
```

Parameter	Type	Description
`operation`	`string`	**Required**. *value of operation should be 'update'*
`devices`	`string`	**Required**. *value of devices param could be 'all' or 'device MAC Address'*
`command`	`string`	**Required**. *any valid bash command*

List Devices

```
GET http://44.195.192.158:3000/v1/listAll
```

Parameter	Type	Description

`nothing`

Responses

Many API endpoints return the JSON representation of the resources created or edited. However, if an invalid request is submitted, or some other error occurs, Gophish returns a JSON response in the following format:

```
{
  "status"  : int,
  "message" : string
}
```

The `message` attribute contains a message commonly used to indicate errors or to return the logged status/

The `status` attribute describes if the transaction was successful or not.

Status Codes

IoTManagementSystem Backend returns the following status codes in its API:

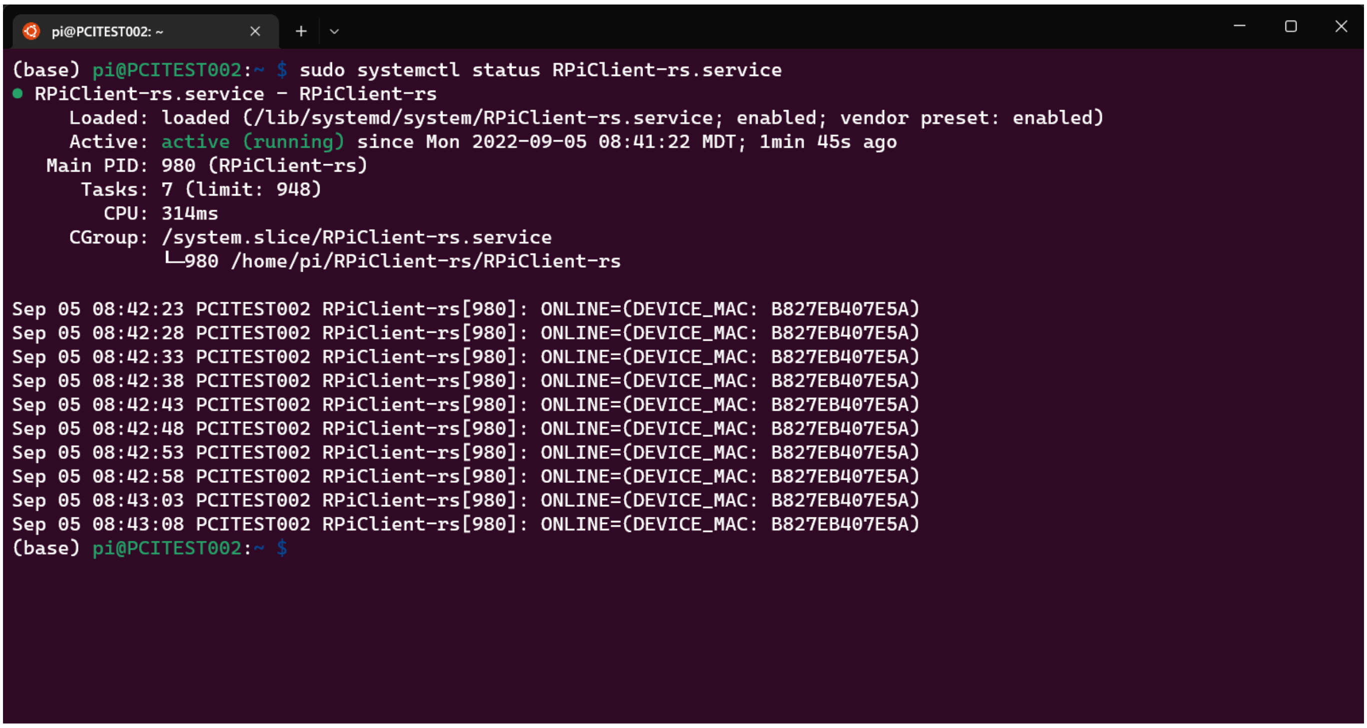
Status Code	Description
200	`OK`
201	`CREATED`
400	`BAD REQUEST`
404	`NOT FOUND`
500	`INTERNAL SERVER ERROR`

Usage

1. Download Raspberry Pi iamge with RPiClient-rs pre-configured and flash it to your Raspberry Pi.

2. ssh into the Raspberry Pi and execute the following command to get the MAC Address:

   ```
   sudo systemctl status RPiClient-rs.service
   ```



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(base) pi@PCITEST002:~ $
```

3. Add the device with the MAC Address collected in the previous step to the database using addDevice API endpoint mentioned above
4. Interact with the device with using MAC Address, or interact with all the devices in the system by using `all` in devices parameter of the API.

Running Services

There are two systemd services running in the background:

1. `RPiClient-rs`
2. `RPiClient-rs-user-script`

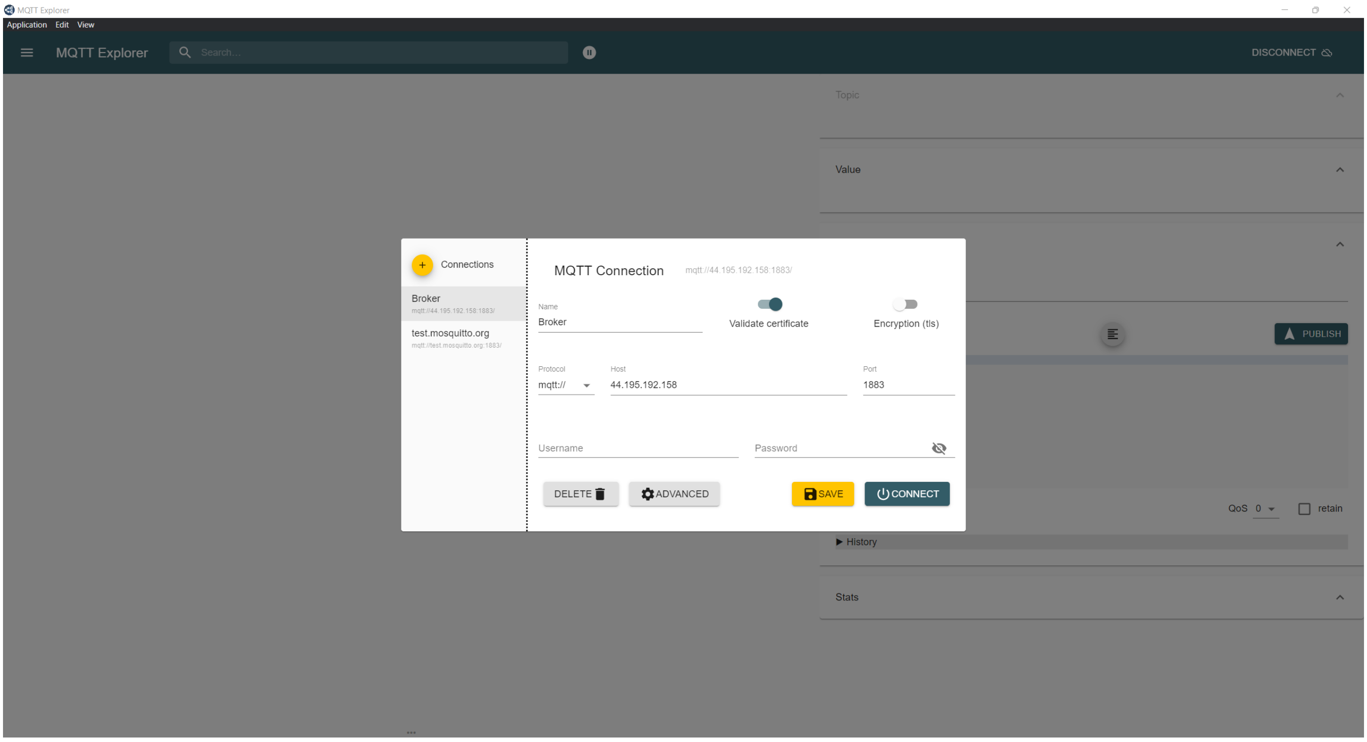
The first one is the Client program managing all sort of updates and communication related stuff while the second one is the user-script sent by the user to the device. Both of these service recover themselves from any errors automatically and both of them start running on the system boot.

Test

Use MQTT Explorer to test the remote communication over the internet. You can run MQTT Explorer or any computer placed anywhere on the internet.

Install and Open MQTT Explorer

1. Add a new connection with following details



MQTT Connection mqtt://44.195.192.158:1883/

Broker mqtt://44.195.192.158:1883/

test.mosquitto.org mqtt://test.mosquitto.org:1883/

Name: Broker

Validate certificate: on

Encryption (tls): off

Protocol: mqtt://

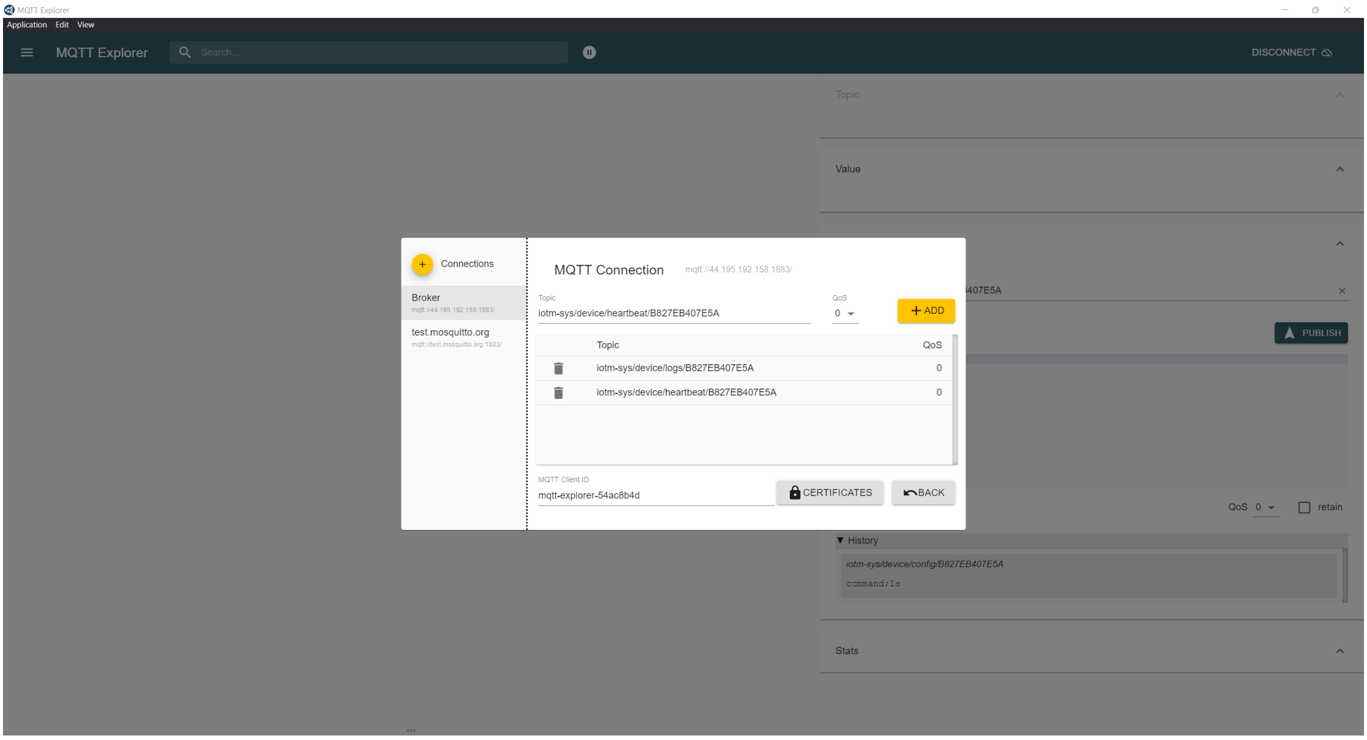
Host: 44.195.192.158

Port: 1883

Username

Password

2. Then add follwoing advaced options



iotm-sys/device/config/B827EB407E5A

command;ls

MQTT Connection mqtt://44.195.192.158:1883/

Broker mqtt://44.195.192.158:1883/

test.mosquitto.org mqtt://test.mosquitto.org:1883/

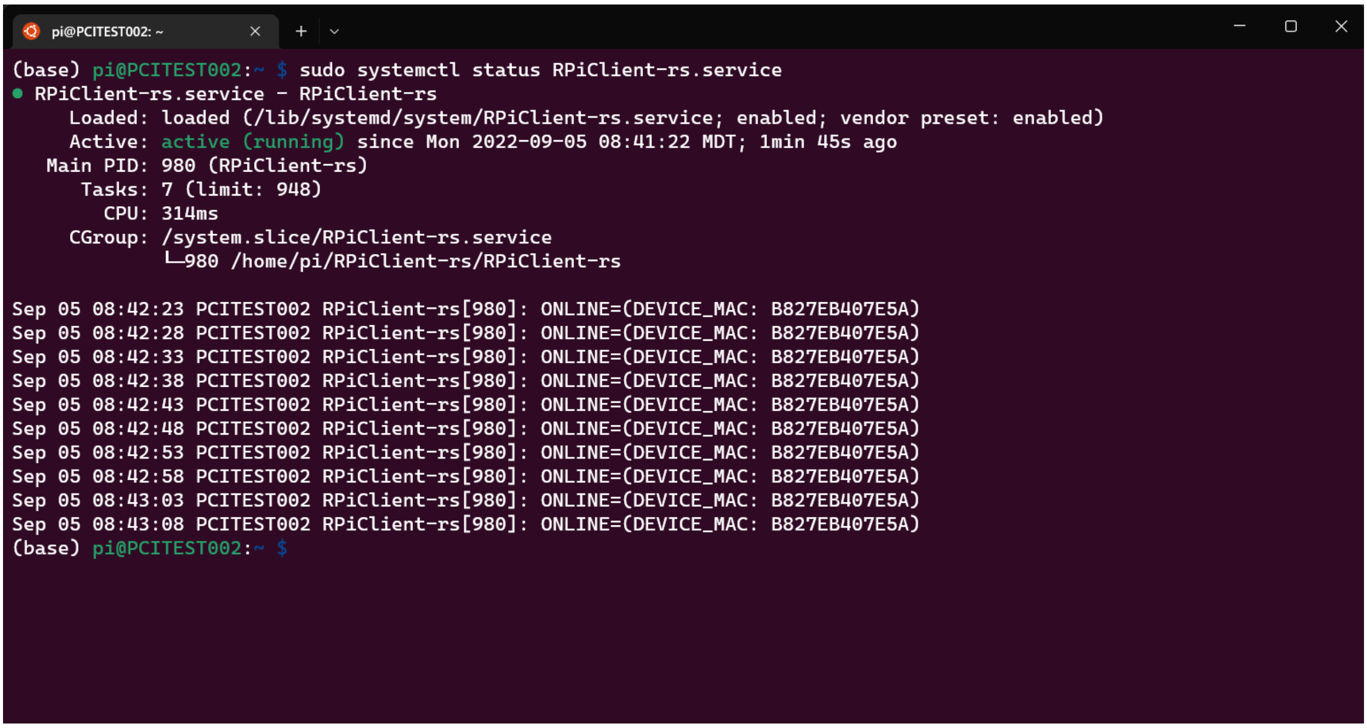
Topic: iotm-sys/device/heartbeat/B827EB407E5A QoS: 0

Topic	QoS
iotm-sys/device/logs/B827EB407E5A	0
iotm-sys/device/heartbeat/B827EB407E5A	0

MQTT Client ID: mqtt-explorer-54ac8b4d

3. ssh into the Raspberry Pi and execute the following command to get the MAC Address:

```
sudo systemctl status RPiClient-rs.service
```



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(base) pi@PCITEST002:~ $
```
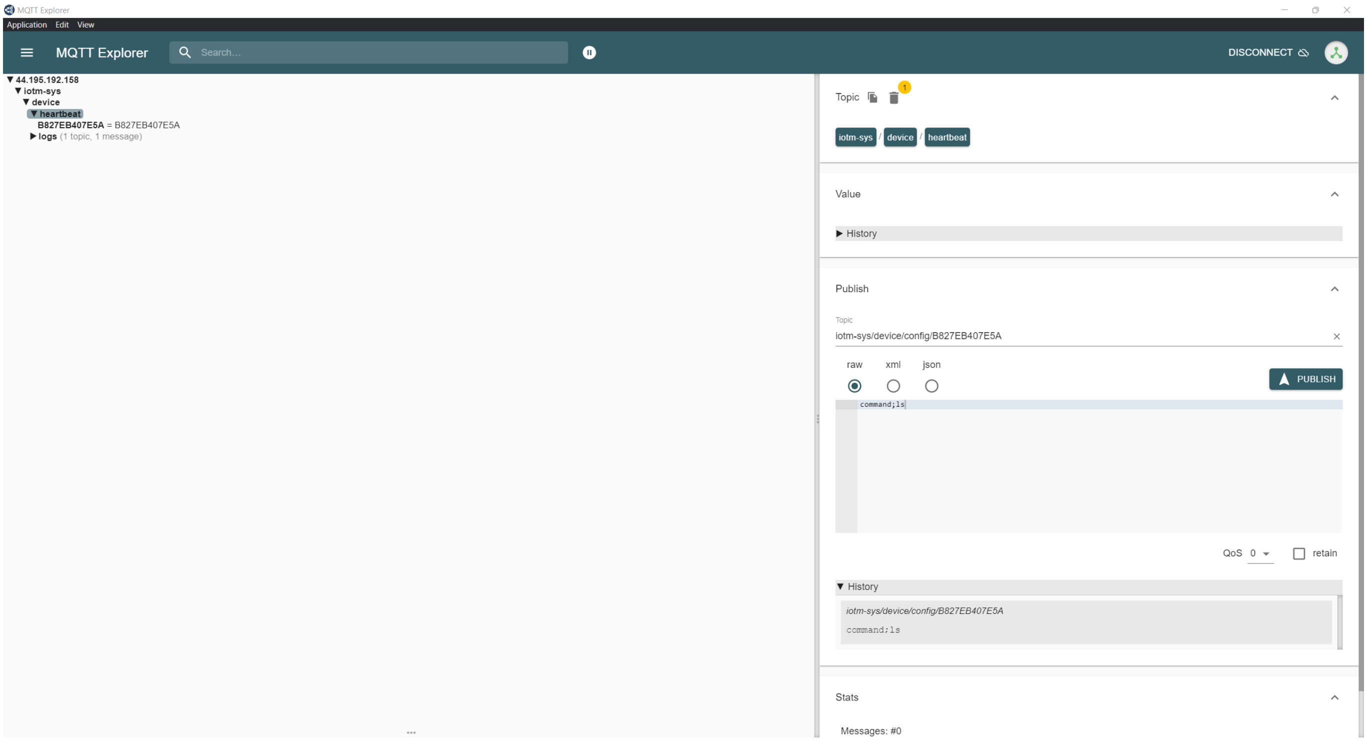

4. Then you can publish to various topics and see the response on the same screen. You can get the topics list from the MQTT Topic Details section above.



```
▼ 44.195.192.158
  ▼ iotm-sys
    ▼ device
      ▼ heartbeat
        B827EB407E5A = B827EB407E5A
      ▶ logs (1 topic, 1 message)
```

Topic: iotm-sys/device/config/B827EB407E5A

● raw ○ xml ○ json

```
command;ls
```

QoS 0 □ retain

iotm-sys/device/config/B827EB407E5A
command;ls

Messages: #0

Built Using

- NodeJS - JS Framework for Backend Programming
- Eclipse Paho MQTT - MQTT Client for Backend and RPiClient Software
- MongoDB - Database for Managing devices
- Rust - Systems Programming Language. For programming RPi Client

Demo Videos

- Complete Demo Part 1: This is a part 1 of complete demo of IoT Management System, showing how to install the Client on Raspberry Pi and run it.
- Complete Demo Part 2: Part 2 of complete demo showing how to interact with all the devices or specific devices in the system using API.
- Demo of Rust-based RPiClient: A complete re-write of the Client in Rust Programming Language
- Complete Demo 3: Updated backend with multiple new features. See CHANGELOG.md for more details.
- Client and User-Script Failure-saftey test: Fail-saftey features test.

✍ Authors

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