SCUTTLE IoT Guide (version 2020.10.10)

This guide is not a requirement.

The purpose of this guide is to offer a central structure for the SCUTTLE fleet to communicate over IoT. Everything that follows is based on using MQTT as the IoT protocol.

Benefits:

- In the classroom, instructors may use this guide to offer students a starting point for interacting with robotic data and for evaluation. Only once there is a template can the instructor see if students successfully produced data.
- For users with limited hardware, real-time IoT data will become available from SCUTTLE users globally for practice in performing data manipulation.
- For project designers starting with SCUTTLE chassis, there is a standard template to save time in deciding how to organize their data.
- For the SCUTTLE community to discover each other and help each other in new ways.

Inspiration:

For a couple of years, the department of Engineering Technology perused the web for easy IoT toolkits and discovered Cayenne which met the needs of wide-ranging student projects from transmission of data between [mobile phone + microcontroller + computers], which had a reconfigurable GUI with no required coding, and was free and easy to set up.

Since Cayenne offers services to many full scale corporate customers their topic structure was notable for the detail and thoroughness. The SCUTTLE MQTT Topic Hierarchy version 1.0 does not imitate the Cayenne structure but it carries several lessons learned from their system, all aimed at robustness.

Going forward:

We know that this structure will require changes in the future but it's best to start something instead of waiting for the perfect. Plus, we already have a method to smooth future changes.

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What is MQTT?

MQTT is a protocol for machines to send messages to each other.

Please visit our favorite documentation to learn how MQTT works!

https://www.hivemq.com/blog/mqtt-essentials-part-1-introducing-mqtt/

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Quick-Start Guide

Preferred Parameters

Broker: Hive MQ

Host: broker.hivemq.com
~~broker.mqttdashboard.com~~

Port: 8000 (from web)
1883 (from edge device)

Client ID: your choice. May be auto-generated.

Other settings: usually leave as default.

Example Topic: scuttle/fleet/onboard/444/temperature
Example Payload: 24.5

TRY OUT THE WEBSOCKET CLIENT

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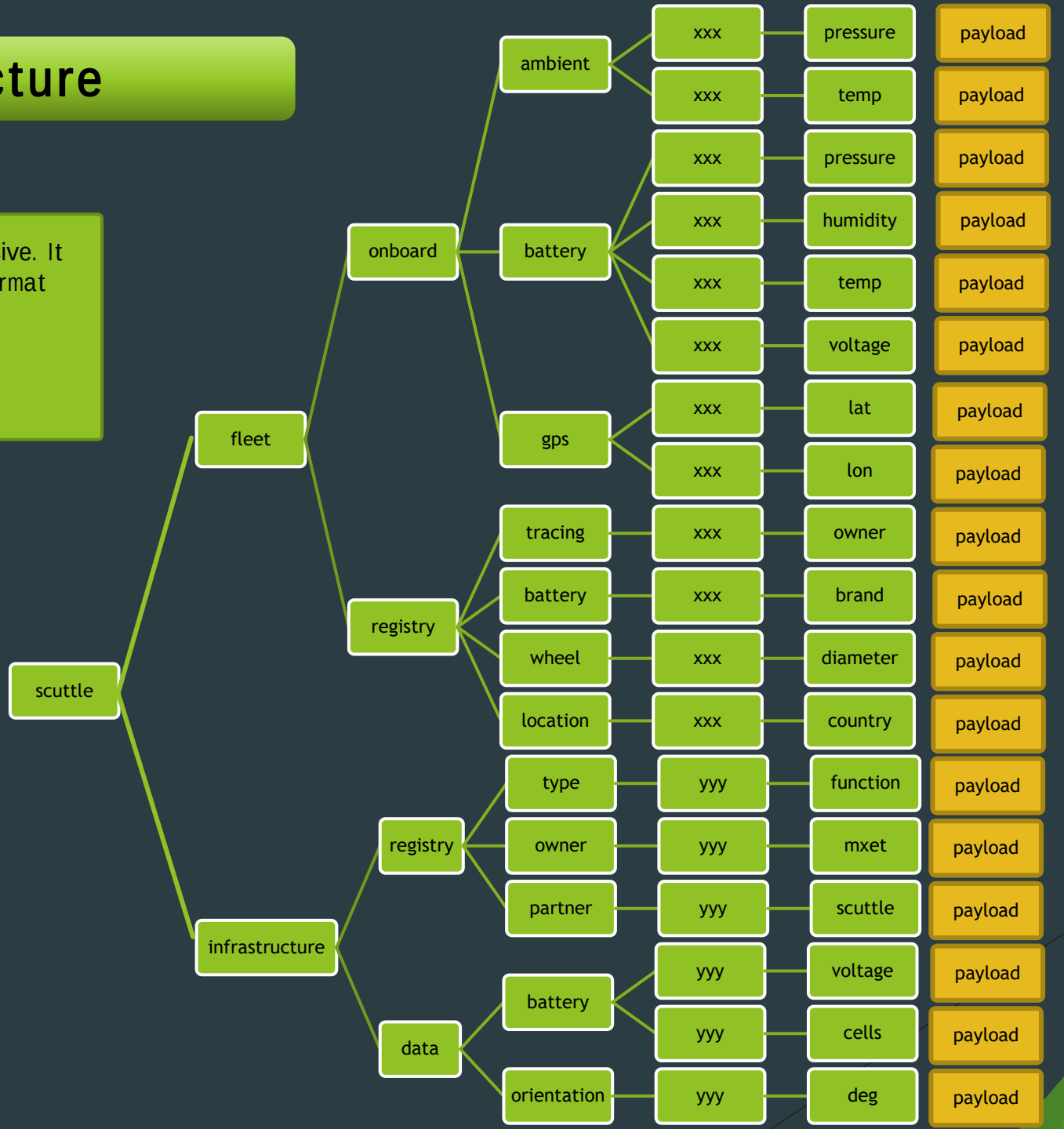
MQTT Topic Structure

This list is not comprehensive. It is designed to lay out a format for your topic selections.

xxx = your robot number
yyy = your gadget number



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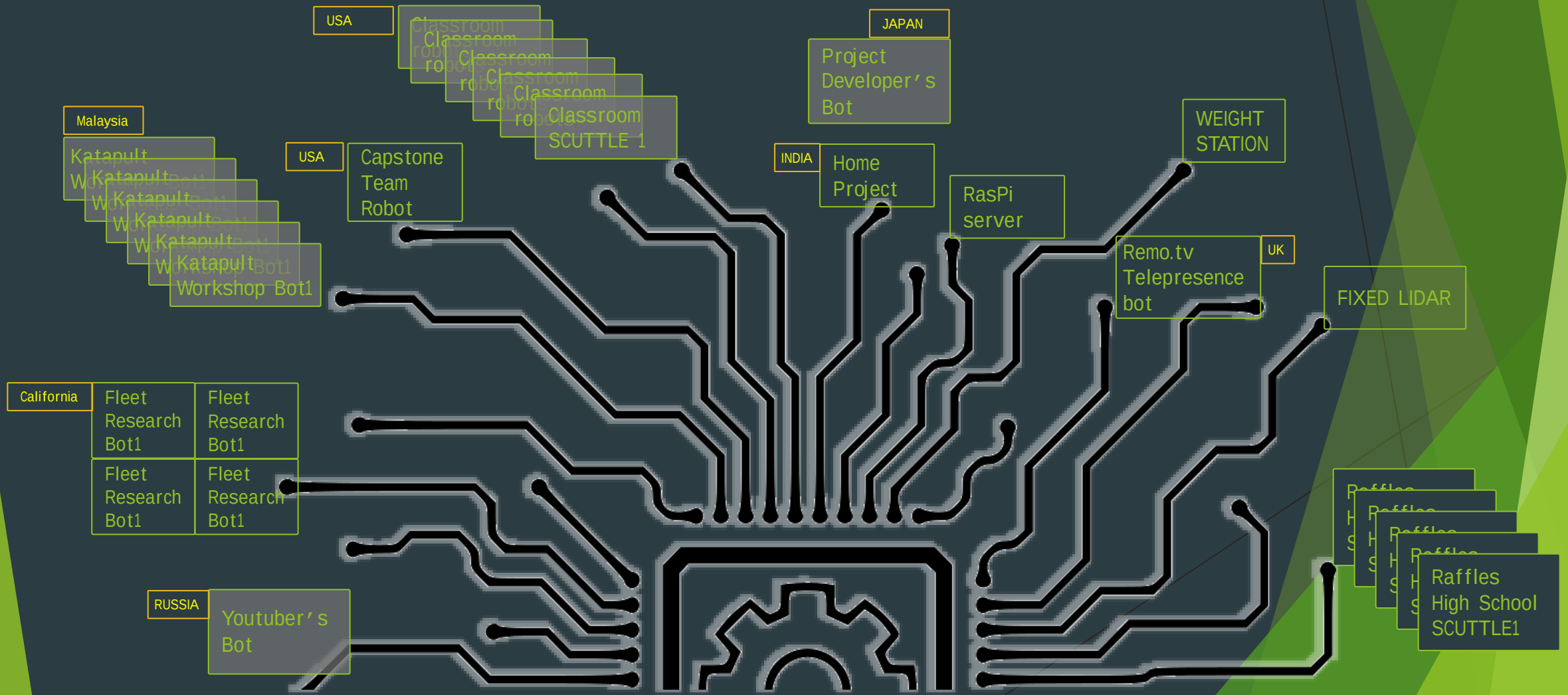
SCUTTLE ECOSYSTEM

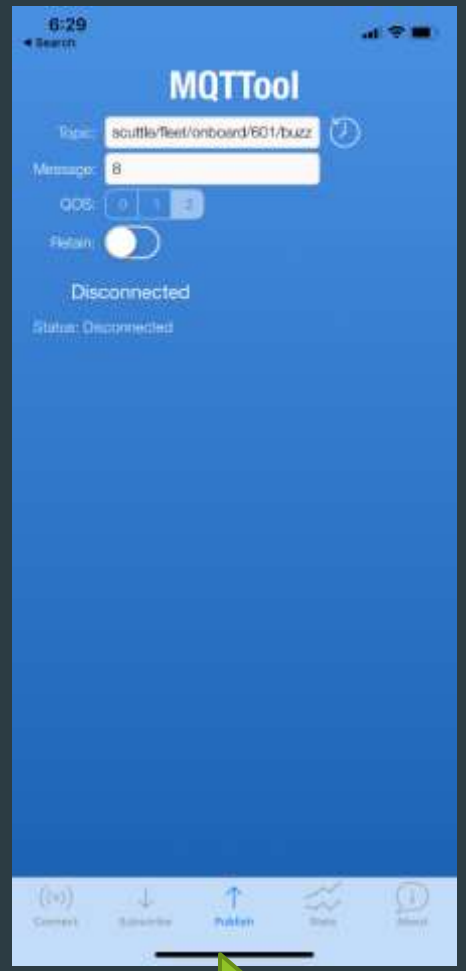
SHARING OUR DATA WILL OPEN NEW POSSIBILITIES



Example: Pub / Sub on mobile:

Step 1: Connect

Step 2: Subscribe



Step 3: Publish

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Structure Explanation

- Explanation is on the way…
  - This slide will explain why the proposed structure has been chosen and how to use it effectively.
  - Most likely, it will need a video =)

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Best Practices

We don't have a Networking Expert on our team but until then:

Frequency:
send out registry data once per hour or more. Then it will be very easy to notice if two people are sending data on the same channel

Robot Number:
Choose a 3 digit number for now. Also choose a 3 digit number for your accessories. If you mount your accessory on your robot, don't treat it as a separate machine.

Broker:
Please use the same broker as us, so we can discover each other. If you use a different broker, nobody will find your data. If you think a different broker is better, please get in touch with us and maybe we will all switch!

Capitals/Lowercase:
Everything is in lowercase with no special characters. Just letters and numbers.

How things will Evolve:
MQTT is the Email of Things. Looking back at email evolution, tons of servers were offered but some surfaced over time as most popular (gmail, yahoo, etc). Common practices are not yet established. There are no rules. Our architecture is being implemented to DISCOVER problems and opportunities so we can be part of the evolution.

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Q & A

- How do I choose a device number?
  - Just choose any device number you wish. But, before going forward, subscribe to a topic under that robot to see if any data is being published, indicating that number is taken.
  - Country: We recommend you use the first 2 digits of your country code from https://countrycode.org/ then pick the last digit.
- What if my number gets taken?
  - Email us with your ideas, or if you reach this problem. As of 2020, that is intended to be dealt with in a future outline.
- Is it secure?
  - No but that's OK. outgoing data is visible to the whole world. Incoming data will only include data you request.
- Can I make it secure?
  - Yes. MQTT brokers offer client ID and passwords but you will need to research how to use them.
- What if I message on the wrong channel?
  - That's okay. Nothing bad will happen unless someone has created a dependency on having perfectly formatted data on every channel.
- What if someone spams my topic?
  - That's okay too. If it happens repeatedly, the community will notice and come up with a solution. As of 2020, mqtt bots aren't creating spam on these channels.
- Why would I waste my time publishing information like my wheel diameter?
  - The more you share with the community the more possibilities will open up. With new AI algorithms it will be possible to passively examine the whole robot fleet, detect nuances such as damaged batteries, or create benchmarks for performance that we can all use to

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Use Cases

- Use cases are on the way
  - This slide will explain how to choose a nice topic for a new kind of data, or for new projects.

I want to	Use this Topic:
Subscribe to all SCUTTLE data	scuttle/#
See all SCUTTLE data from robots	scuttle/fleet/#
Reserve scuttle number #212 for myself	scuttle/fleet/registry/location/212/country

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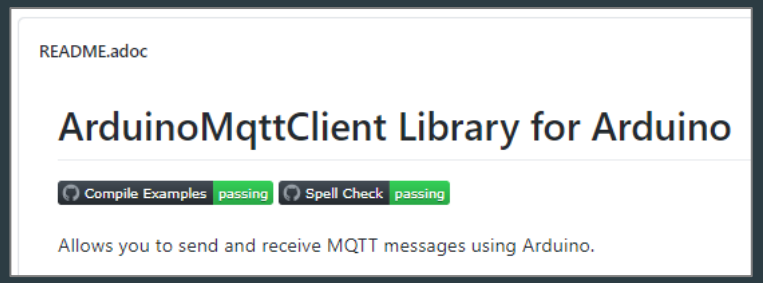
Using MQTT on Arduino?

Our favorite arduino Library: ArduinoMqttClient

Find it on github or add it through your Arduino IDE



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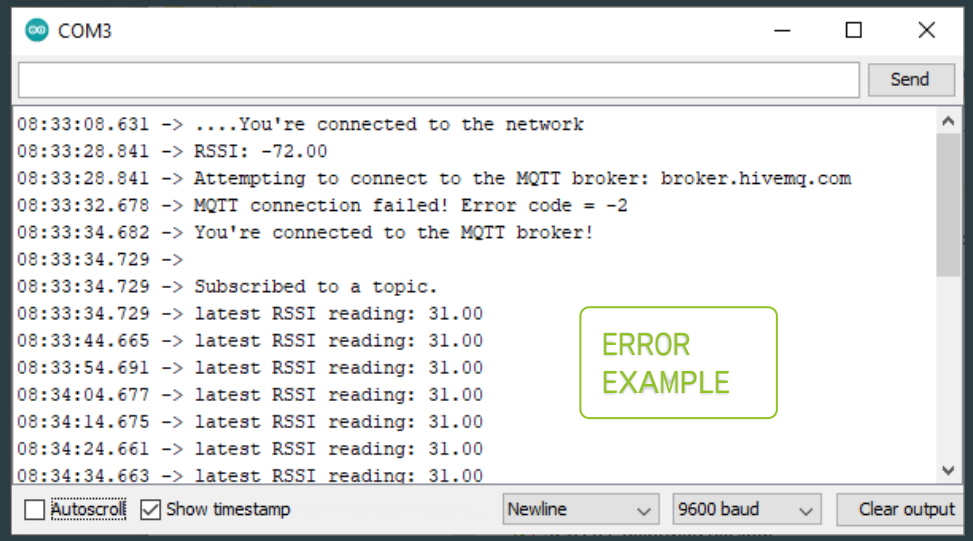
Troubleshooting – Error Codes

At times your device will alert you of an error in MQTT operation.

These codes are returned by the broker to the client when there is a problem with the connection or message. They can help in troubleshooting.

Find more info at VTSCADA.com



ERROR EXAMPLE

Error code (Decimal)	Error code (Hex)	Meaning
0	0x0	No Error
1	0x1	Connection Refused: Unacceptable protocol version
10	0xa	Timeout waiting for SUBACK
11	0xb	Timeout waiting for UNSUBACK
12	0xc	Timeout waiting for PINGRESP
13	0xd	Malformed Remaining Length
14	0xe	Problem with the underlying communication port
15	0xf	Address could not be parsed
16	0x10	Malformed received MQTT packet
17	0x11	Subscription failure
18	0x12	Payload decoding failure
19	0x13	Failed to compile a Decoder
2	0x2	Connection Refused: Identifier rejected
20	0x14	The received MQTT packet type is not supported on this client
3	0x3	Connection Refused: Server Unavailable
4	0x4	Connection Refused: Bad username or password
5	0x5	Connection Refused: Authorization error
6	0x6	Connection lost or bad
7	0x7	Timeout waiting for Length bytes
8	0x8	Timeout waiting for PayLoad
9	0x9	Timeout waiting for CONNACK

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