Lesson 2

Objectives

- Introduce the MQTT library and gateway app

- Use the lib/app as examples for using the cFS App Exchange
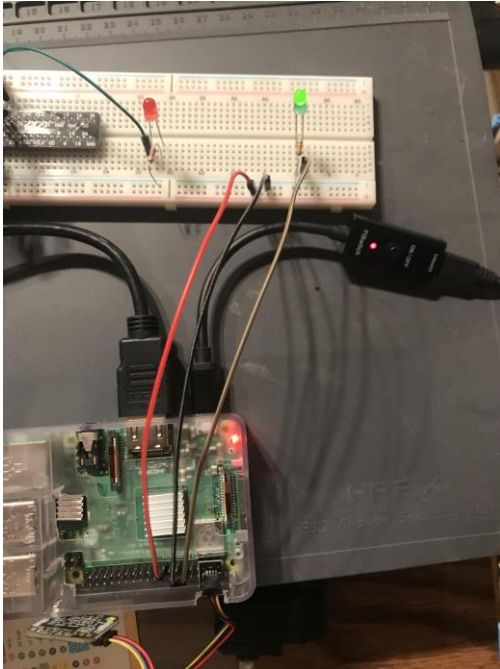
Open STEMware's MQTT cFS Components

- *"MQTT is an OASIS standard messaging protocol for the Internet of Things (IoT). It is designed as an extremely lightweight publish/subscribe messaging transport that is ideal for connecting remote devices with a small code footprint and minimal network bandwidth."***

- **Open STEMware has developed two cFS components that bridge the cFS to an MQTT broker**

- **Multiple organizations provide free MQTT services so the Basecamp GUI can communicate with a remote cFS target without the need for a paid service**

- **In this tutorial you will install MQTT_LIB and MQTT_GW (gateway) and receive data that is being produced by an Open STEMware Raspberry Pi that is publishing data to an MQTT server**

** https://mqtt.org/

Demo MQTT-cFS Architecture

Open STEMware Raspberry Pi

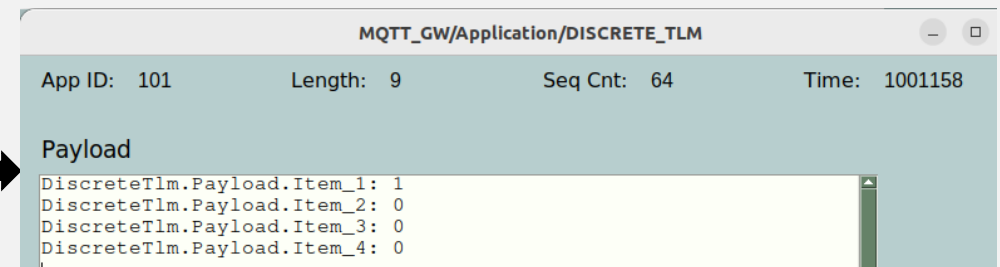**MQTT Broker**
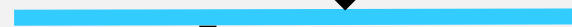
1. An Open STEMware Raspberry Pi is configured to continuously turn on and off an LED and publish the LED's state in an MQTT JSON message

2. The local MQTT Gateway app receives and translates the MQTT JSON messages into CCSDS messages and publishes them on the software bus

3. Telemetry Output receives the CCSDS messages from the software bus and sends them over UDP to the Basecamp GUI

Local Basecamp

MQTT Library

MQTT Gateway

cFS Software Bus

Telemetry Output

MQTT_GW/Application/DISCRETE_TLM

| App ID: | 101 | Length: | 9 | Seq Cnt: | 64 | Time: | 1001158 |

Payload

```
DiscreteTlm.Payload.Item_1: 1
DiscreteTlm.Payload.Item_2: 0
DiscreteTlm.Payload.Item_3: 0
DiscreteTlm.Payload.Item_4: 0
```

MQTT JSON Message   CCSDS Packet

Running the MQTT (1 of 2)

- **Use the steps described in lesson one to download, install and build MQTT_LIB and MQTT_GW**
  - MQTT_LIB must be added first so it is loaded before MQTT_GW when the cFS initializes
  - MQTT_GW requires MQTT_LIB global symbols to be defined when it is loaded

- **After you start the new cFS target scroll through the start messages and verify that MQTT_LIB and MQTT_GW were loaded and initialized without any errors**
  - You should see something like the messages below
  - As MQTT_GW evolves the messages may not be identical
  - For this demo to work the MQTT_GW must subscribe to the MQTT *basecamp/demo/discrete* MQTT topic in cpu1_mqtt_topic.json
    - The "basecamp/demo/discrete" entries should 'id: 1' and 'sb-role: "pub"' (These are the defaults)

```
1980-012-14:03:20.51706 CFE_ES_ParseFileEr
MQTT Library Initialized. Version 1.0.0
1980-012-14:03:20.51774 CFE_ES_ParseFileEr
```

```
EVS Port1 66/1/MQTT_GW 142: Successfully connected to MQTT broker broker.hivemq.com:1883 as client basecamp-dev
EVS Port1 66/1/MQTT_GW 25: Successfully replaced table 0 using file /cf/mqtt_topic.json
EVS Port1 66/1/MQTT_GW 120: Subscribed to MQTT client for topic basecamp/discrete
EVS Port1 66/1/MQTT_GW 120: Topic subscriptions: SB 1, MQTT 1, Errors 0
EVS Port1 66/1/MQTT_GW 100: MQTT Gateway App Initialized. Version 1.0.0
EVS Port1 66/1/MQTT_GW 51: Child task initialization complete
```

Running the MQTT (2 of 2)

The first discrete item is the LED state, and it should toggle between 1 and 0

MQTT_GW/Application/HK_TLM

App ID: 100   Length: 45   Seq Cnt: 401

Payload

```
HkTlm.Payload.ValidCmdCnt        : 0
HkTlm.Payload.InvalidCmdCnt      : 0
HkTlm.Payload.ChildValidCmdCnt   : 0
HkTlm.Payload.ChildInvalidCmdCnt: 0
HkTlm.Payload.LastTblAction      : LOAD
HkTlm.Payload.TopicTblLoaded     : TRUE
HkTlm.Payload.MqttYieldTime      : 1000
HkTlm.Payload.SbPendTime         : 250
HkTlm.Payload.MqttConnected      : TRUE
HkTlm.Payload.ValidMqttMsgCnt    : 906
HkTlm.Payload.InvalidMqttMsgCnt  : 0
HkTlm.Payload.ValidSbMsgCnt      : 0
HkTlm.Payload.InvalidSbMsgCnt    : 0
HkTlm.Payload.SbTopicTestActive  : FALSE
HkTlm.Payload.SbTopicTestId      : 0
HkTlm.Payload.SbTopicTestParam   : 0
```

MQTT_GW/Application/DISCRETE_TLM

App ID: 101   Length: 9   Seq Cnt: 784

Payload

```
DiscreteTlm.Payload.Item_1: 1
DiscreteTlm.Payload.Item_2: 0
DiscreteTlm.Payload.Item_3: 0
DiscreteTlm.Payload.Item_4: 0
```

MQTT should be connected, and the valid message count should increment

Open STEMware's MQTT cFS Architecture Options

Custom Python

Pi-Sat Sensor → Python App

MQTT Broker

Space-Steps: Pi-Sat Architect

Basecamp: Pi-Sat

Berry IMU

MQTT Gateway

cFS Software Bus

Basecamp: Ground System

MQTT Library → MQTT Gateway

cFS Software Bus

Telemetry Output

MQTT_GW/Application/RATE_TLM

App ID: 101   Length: 17   Seq Cnt: 116   Time: 1001941

Payload
RateTlm.Payload.X: -0.41999998688697815
RateTlm.Payload.Y: 1.190000057220459
RateTlm.Payload.Z: 9.59000015258789

⭐ Data Source

→ MQTT JSON Message

➡ CCSDS Packet