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Projekt/Project GT-800	Version 1.0	Rev. 2	Ersteller/Writer J. Schorowski	Kontrolle/Control	Datum/Date 08.05.19	

IoT – Gateway GT-800





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1 Read me first

Most of the following instructions, samples or description use the IP address 172.22.0.88. Please exchange it with the IP address of the used broker (see 5 MQTT broker on RasPi).

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2 Overview

The GT-800 is a transparent gateway between CAN bus and a MQTT broker. Messages on the CAN bus can be routed to the MQTT broker and MQTT messages from the broker can be routed to the CAN bus. To get information about MQTT see <https://en.wikipedia.org/wiki/MQTT>.

The GT-800 can be connected by WiFi to


- every open MQTT broker
- a local MQTT broker on a RasPI
- every internet service, supported by NodeRed, using a local MQTT broker on a RasPI

The range of CAN-ID's is limited to a maximum of 10 sequenced ID's, e.g. 0x100 to 0x109. CAN-ID's for send and receive can be different. The rate of transactions from CAN to MQTT is limited to 100 ms and one ID per second, but this is depending on internet latency (can be more seconds) also.

The GT-800 status is cyclically sent to the CAN bus and shown by the green LED.

Example for send over MQTT 0x100 – 0x101 and receive with MQTT 0x200 – 0x201:

CAN Bus CAN Message ID	GT-800	WiFi MQTT
0x0FF	X	
0x100	→	/topic/itemTx 100 ...
0x101	→	/topic/itemTx 101 ...
0x102	X	
0x103	X	/topic/itemRx 103
...	X	
0x1FF	X	
0x200	←	/topic/itemRx 200 ...
0x201	←	/topic/itemRx 201 ...
0x202	X	
0x203	X	

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3 Setup

3.1 Requirements

3.1.1 Hardware

To bringing into service following parts are necessary:

- GT-800
- Connection Cable VK-16
- Power supply 12 or 24 V DC
- WiFi router with possible connection to broker
- PC/Notebook with USB and serial Terminal program

3.1.2 Information's

Following information are required for setup GT-800:


- SSID and password of the WiFi router
- Name or IP-address of the MQTT broker
- Topic for communication to the GT-800 (/topic/itemRx)
- Topic for communication to the broker (/topic/itemTx)
- Start-CAN-ID to send over CAN (0x200)
- Count of CAN-ID's to send over CAN (2)
- Start-CAN-ID to send over MQTT (0x100)
- Count of CAN-ID's to send over MQTT (2)
- Quality of Service for MQTT message (2)
- Retain flag for MQTT message (1)
- CAN-ID for status message (0x800)

3.2 GT-800 configure

For configure, simply connect the GT-800 to the PC using a VK-16 cable and open the serial port with a terminal program. Following the example using PuTTY (7.2 PuTTY):

1. Power up the GT-800 and connect it to the PC/Notebook by Connection Cable VK-16
2. Open the Terminal program (7.2.2 Serial Terminal)
3. Type "h" for help to see the actual configuration
4. Configure all items by type in the character showed on the left side followed by the new content and the return key
5. Restart the GT-800 by pressing "e" or cycle power.
6. Press "m" immediately after welcome message to see the connection status.



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```


COM4 - PuTTY
e
Restart system

Welcome at GT-800 configuration
Press H for help or type commands.

m
Show connection state now
ConnectionStatus: 1 AP_STA_START
ConnectionStatus: 4 AP_CONNECTION_OK
ConnectionStatus: 6 CONNECTED
ConnectionStatus: 8 SUBSCRIBED
    
```

3.3 Menu description

Short-cut	Text	Description	Comment
h	Help	Print the stored configuration	
s	Set SSID for WLAN connection	SSID of the WiFi router	
p	Set Password for WLAN connection	Password for the WiFi router	
b	Set MQTT broker address	IP-Address or name of the MQTT broker	Publically-accessible MQTT broker for testing: <ul style="list-style-type: none"> • iot.eclipse.org • test.mosquitto.org • broker.hivemq.com
r	Set topic for communication to the GT-800	Topic to route MQTT to the CAN bus	
t	Set topic for communication to the broker	Topic to route CAN messages to MQTT	
1	Start-CAN-ID to send over CAN	Start-CAN-ID to route from MQTT to the CAN bus	Type in as hexadecimal number without 0x
2	Count of CAN-ID's to send over CAN	Count of CAN-ID to route from MQTT to the CAN bus	Type in as decimal number, allowed 1..10
3	Start-CAN-ID to send over MQTT	Start-CAN-ID to route from CAN bus to the MQTT	Type in as hexadecimal number without 0x


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Short-cut	Text	Description	Comment
4	Count of CAN-ID's to send over MQTT	Count of CAN-ID to route from CAN bus to the MQTT	Type in as decimal number, allowed 1..10
5	Quality of Service for MQTT message	Quality of Service for published messages	0 At most once (fire and forget) 1 At least once (acknowledged delivery) 2 Exactly once (assured delivery)
6	Retain flag for MQTT message	Content of published messages stored on the broker	0 Not retained 1 Retained on the broker
7	CAN-ID for status message	CAN-ID for cyclic status message on the CAN bus	Type in as hexadecimal number without 0x
m	Toggle connection state show	Toggle showing of the connection status at the serial terminal	See the connection status at the serial terminal
e	Restart system with new parameters	Restart the GT-800	To load changed parameters or (re)connect
F	Bootloader mode (only for admins)	Update Firmware	Only for BARTH service


3.4 Connection Status and trouble-shooting

The GT-800 status is cyclic send to the CAN bus and showing by the green LED. At the serial terminal the status is available after pressing "m".

Green LED count of flash	CAN bus status message	Terminal output	Description	trouble-shooting
0	0	AP_CONNECTION_ERROR	No WiFi connection possible	GT-800 firmware error, contact BARTH service
1	1	AP_STA_START	Connect to the WiFi router	Check SSID and password
2	2	AP_GOT_IP	Get the IP address	Check DHCP server configuration of the WiFi router
3	3	AP_DISCONNECTED	WiFi connection fails	Check SSID, password and DHCP server

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<i>Green LED count of flash</i>	<i>CAN bus status message</i>	<i>Terminal output</i>	<i>Description</i>	<i>trouble-shooting</i>
4	4	AP_CONNECTION_OK	WiFi connection established	
5	5	ERROR	Internal error	GT-800 firmware error, contact service
6	6	CONNECTED	Connected to the broker	
7	7	DISCONNECTED	Connected to the broker not successful	Check MQTT broker address or status
8	8	SUBSCRIBED	Topic subscription for communication to the GT-800 successful	Check topic
9	9	UNSUBSCRIBED	Not implemented	
10	10	PUBLISHED	CAN message published to the broker	Check "Start-CAN-ID to send over MQTT"
11	11	DATA	MQTT message received from broker	If not routed to the CAN bus, check "Start-CAN-ID to send over CAN" and "Topic for communication to the GT-800"

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4 Data format of the MQTT message

MQTT data for every CAN message, send or received, have the same format:

200 8 01 02 03 04 05 06 07 08


- 200 CAN-ID as hexadecimal number, minimal 3 characters (CAN-ID = 0x200)
- 8 Data length code, 0..8 data bytes available, must be one character (8 data bytes)
- 01 first data byte as hexadecimal number, must be two characters (Byte 0 = 0x01)
- ...
- 08 last data byte as hexadecimal number, must be two characters (Byte 7 = 0x08)

Examples for valid MQTT data:

001 2 77 FF

001 0

A06F 8 60 0F AB e8 70 ba 00 fF

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5 MQTT broker on RasPi

To minimize latency for the communication it is recommend to run own MQTT broker on the local LAN. Following two solutions with the RasPi.

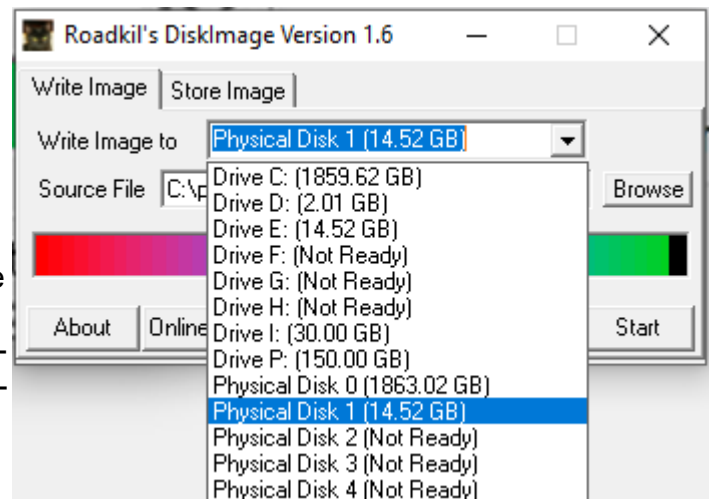
5.1 Preinstalled image

5.1.1 Requirements

- microSD card with 8 GB or more space
- Raspberry Pi Zero W (<https://www.raspberrypi.org/products/raspberry-pi-zero-w/>)
- Image downloaded from <https://github.com/jasysdotde/GT-800>
- Roadkil's Disk Image downloaded from <https://www.roadkil.net/program.php/P12/Disk%20Image>

5.1.2 Create SD card

1. Unzipping the image
2. Open Roadkil's Disk Image with administrator rights
3. Write image to the SD card using the "Physical Disk" mode (be sure that the drive is the SD card, in other case the operating system can be damaged. Double check the correct disk by size. If uncertain about the Physical Disk number, remove the SD card and restart the Roadkil's Disk Image to see which Physical Disk number is lost)



5.1.3 Set up

Put the SD card in the RasPi and power up. After booting, log in with user=pi and password=raspberry.

Type in "sudo raspi-config" and press return. Choice → Network options → Wi-fi and type in the SSID and the password.

Restart the RasPi with "sudo reboot".


At the end of the boot process the IP is shown. Use this IP address as MQTT broker address (see 1 Read me first).

Log in by SSH is enabled (see 7.2.3 SSH Terminal) per default.

```

[ OK ] Reached target Network.
Starting OpenBSD Secure Shell server...
Starting /etc/rc.local Compatibility...
Starting Permit User Sessions...
My IP address is 172.22.0.88
[ OK ] Started /etc/rc.local Compatibility.
[ OK ] Started Permit User Sessions.
Starting Terminate Plymouth Boot Screen...
Starting Hold until boot process finishes up...

Raspbian GNU/Linux 9 raspberrypi tty1
raspberrypi login:
    
```

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5.2 Manual setup for RasPi

5.2.1 Requirements

- microSD card with 8 GB or more space
- Raspberry Pi Zero W (<https://www.raspberrypi.org/products/raspberry-pi-zero-w/>)
- NOOBS downloaded from <https://www.raspberrypi.org/downloads/noobs/>

5.2.2 Install

1. Unzip the NOOBS
2. Copy content of NOOBS to the empty SD card
3. Put the SD card in the RasPi and power up.
4. Install Raspbian Lite
5. Log in with user=pi and password=raspberry
6. Type in "sudo raspi-config" and press return.
 1. Choice → Network options → Wi-fi and type in the SSID and the password.
 2. Choice → Interfacing options → SSH and enable it
7. Restart the RasPi with "sudo reboot".
8. Log in again
9. Type in "sudo apt-get update" and „sudo apt-get dist-upgrade“, after done reboot again
10. Install mosquitto with "sudo apt-get install -y mosquitto mosquitto-clients"
11. Test mosquitto using two terminal windows:
 1. mosquitto_sub -h localhost -v -t test
 2. mosquitto_pub -h localhost -t test -m "Hello world, Mosquitto"
12. Install Node red:
 1. "sudo apt-get install nodered"
 2. "node-red-start"
 3. "sudo apt-get install npm"
 4. "cd ~/.node-red"
 5. "npm install node-red-dashboard"
13. "sudo reboot"


At the end of the boot process the IP is shown. Use this IP address as MQTT broker address (see 1 Read me first).

```
[ OK ] Reached target Network.
Starting OpenBSD Secure Shell server...
Starting /etc/rc.local Compatibility...
Starting Permit User Sessions...
My IP address is 172.22.0.88
[ OK ] Started /etc/rc.local Compatibility.
[ OK ] Started Permit User Sessions.
Starting Terminate Plymouth Boot Screen...
Starting Hold until boot process finishes up...

Raspbian GNU/Linux 9 raspberrypi tty1
raspberrypi login:
```


5.3 Test MQTT broker

To test the MQTT broker open mqtt-spy (see 7.3 Mqtt-spy) and use the RasPi IP-address as Server URI.

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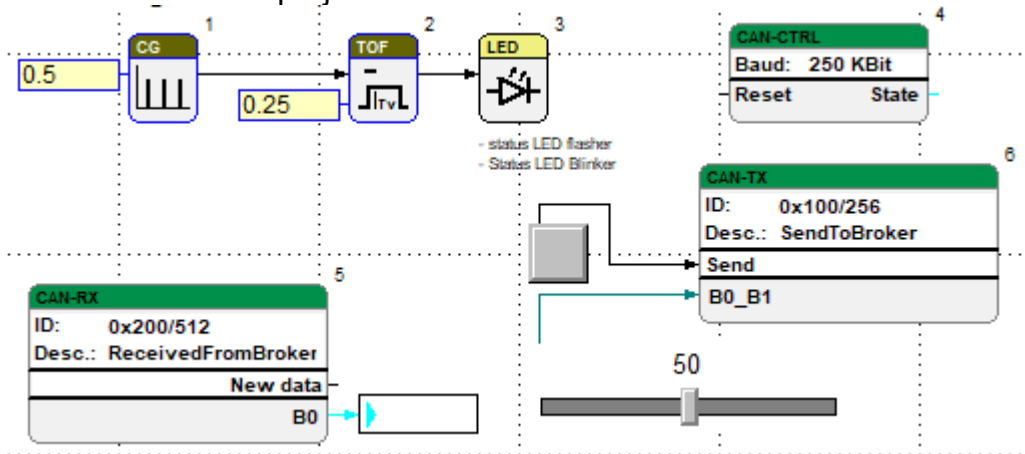
5.4 Test Node-RED

Open a browser window with <RasPi-IP>:1880 to test Node-RED, to test the access to the GUI, open a browser window with <RasPi-IP>:1880/ui.

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6 Examples

To test, a CAN device (STG-8xx) must be connected to the GT-800. With it, CAN messages can be sent and received. CAN-H and CAN-L of both units must be connected. Additionally, a termination resistor (68 Ohm) between CAN-H and CAN-L is required. Simply create a small miCon-L project:



The miCon-L project is available on Github at <https://github.com/jasysdotde/GT-800>.

6.1 Publically-accessible MQTT broker

Set up (see 3 Setup) the GT-800 like the sample and check for connection status like "SUBSCRIBED".

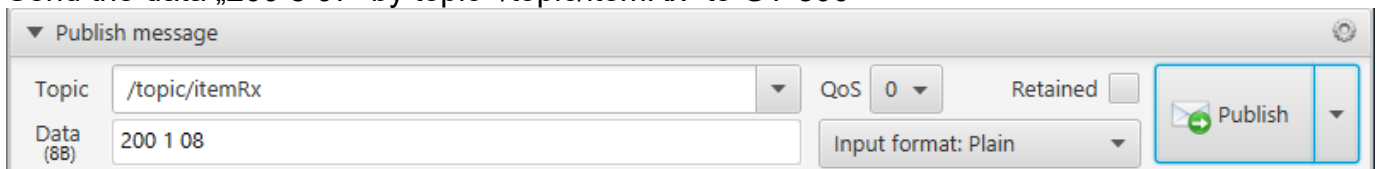
Next, start and set up mqtt-spy (see 7.3 Mqtt-spy) and the miCon-L program to test the data transfer.

```

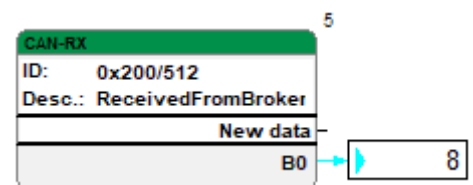
COM4 - PuTTY
-- GT-800 Menu --
h - Help
s - Set SSID for WLAN connection (TestNet)
p - Set Password for WLAN connection
b - Set MQTT broker address (iot.eclipse.org)
r - Set topic for communication to the GT-800 (/topic/itemRx)
t - Set topic for communication to the broker (/topic/itemTx)
1 - Start-CAN-ID to send over CAN (0x200)
2 - Count of CAN-ID's to send over CAN (2)
3 - Start-CAN-ID to send over MQTT (0x100)
4 - Count of CAN-ID's to send over MQTT (2)
5 - Quality of Service for MQTT message (1)
6 - Retain flag for MQTT message (1)
7 - CAN-ID for status message (0x800)
m - Toggle connection state show
e - Restart system with new parameters
F - Bootloader mode (only for admins)
    
```


6.1.1 Data transfer MQTT → CAN

Send the data „200 8 07“ by topic “/topic/itemRx” to GT-800



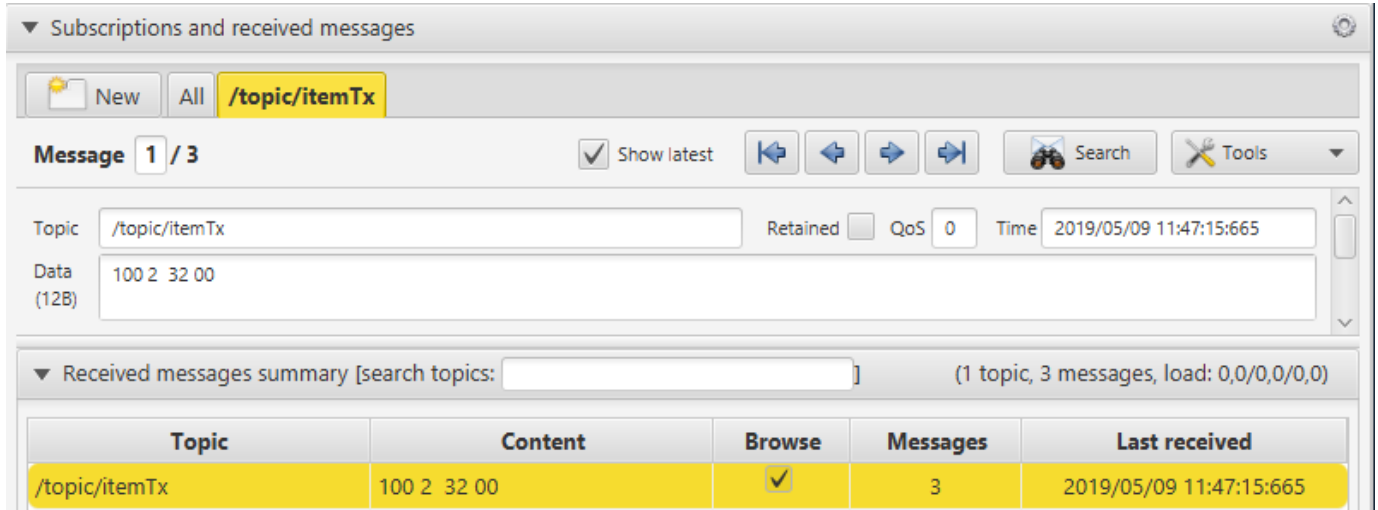
Data B0 of the miCon-L program will be changed depending of Byte 0 of the MQTT data.



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6.1.2 Data transfer CAN → MQTT

Send the value of 50 by CAN by pressing send button at the miCon-L program and see the incoming message at mqtt-spy.



The screenshot shows the MQTT Spy interface. The 'Subscriptions and received messages' window is active, displaying a message received on the topic '/topic/itemTx'. The data field shows '100 2 32 00' (12B). Below the message details, a 'Received messages summary' table is visible:

Topic	Content	Browse	Messages	Last received
/topic/itemTx	100 2 32 00	✓	3	2019/05/09 11:47:15:665

Value of 50 (decimal) is shown as two byte 32 00 = 0x0032 (word) = 50 decimal.

6.2 Own MQTT broker on RasPi

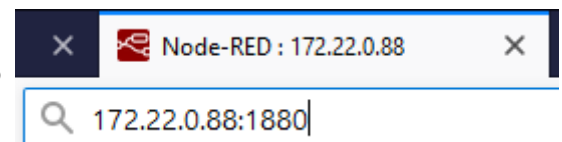
Functionality for connections to the local MQTT broker on the RasPi is the same like 6.1 Publically-accessible MQTT broker, but the Parameter "" on the GT-800 ist set to RasPi's IP address.

b - set MQTT broker address (172.22.0.88)

6.3 Other internet service

Other internet service, like TCP, UDP, http, Watson IoT, Twitter, email, ... are accessible using local MQTT (see 5 MQTT broker on RasPi) and Node-RED (see 5.4 Test Node-RED).

To access, open a browser window with <RasPi-IP>:1880.



Set up (see 3 Setup) the GT-800 like the sample and check for connection status like "SUBSCRIBED".


Next, start the miCon-L program to test the data transfer.

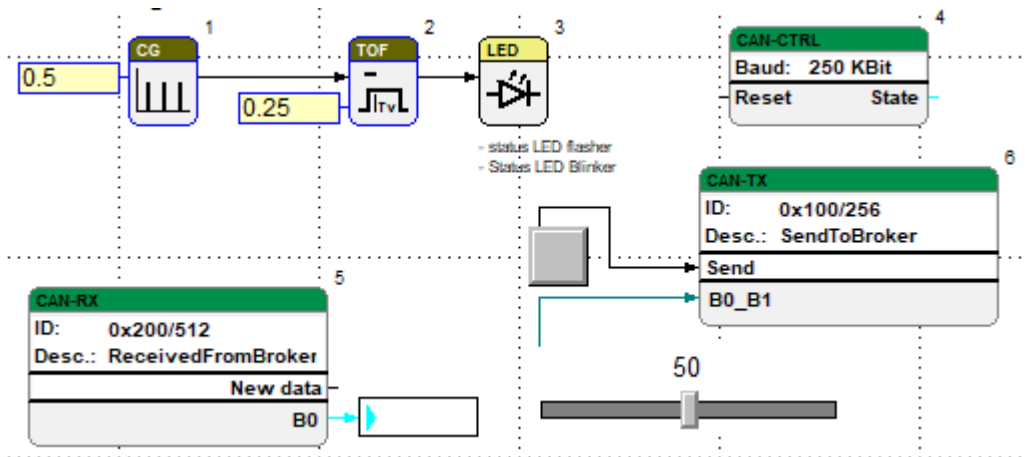
Node-RED flows (Menu → Import → Clipboard) and miCon-L program are available on Github at

<https://github.com/jasysdotde/GT-800>.

```

-- GT-800 Menu --
h - Help
s - Set SSID for WLAN connection (TestNet)
p - Set Password for WLAN connection
b - Set MQTT broker address (172.22.0.88)
r - Set topic for communication to the GT-800 (/topic/itemRx)
t - Set topic for communication to the broker (/topic/itemTx)
1 - Start-CAN-ID to send over CAN (0x200)
2 - Count of CAN-ID's to send over CAN (2)
3 - Start-CAN-ID to send over MQTT (0x100)
4 - Count of CAN-ID's to send over MQTT (2)
5 - Quality of Service for MQTT message (1)
6 - Retain flag for MQTT message (1)
7 - CAN-ID for status message (0x800)
    
```

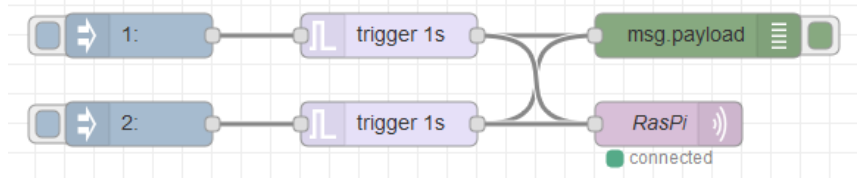
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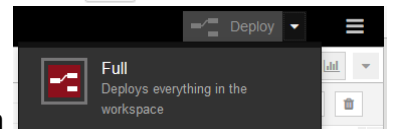
6.3.1 Data transfer Node-RED → CAN

With Node-RED create following flow:

Add two “inject”, two “trigger”, one “mqtt out” and one “debug” to the flow. Connect it like the schema.

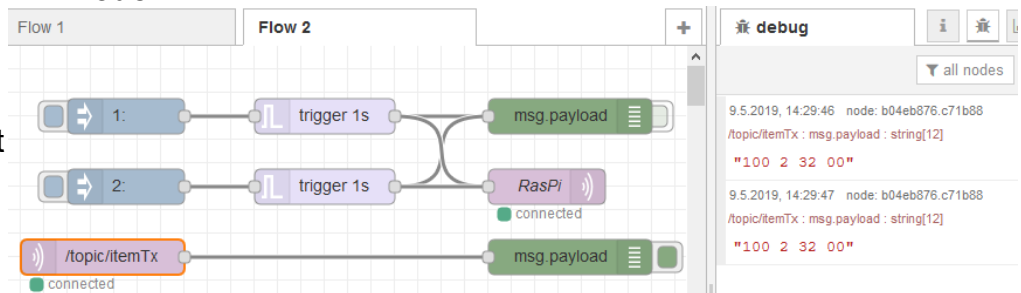


1. Configure the “inject” with double click on it: “Payload=”, “Topic=1” and the second “Payload=”, “Topic=2”.
2. Configure “trigger”: “Send=200 1 01”, “then=wait for 1 Seconds” and the second “Send=200 1 02”, “then=wait for 1 Seconds”.
3. Configure the “mqtt out”: “Server=RasPiBroker” (Click on the button  to create: “Name=RasPiBroker”, “Server=172.22.0.88”, “Port=1883”, “Topic=/topic/itemRx”, “QoS=2”, “Retain=true”, “Name=RasPi”
4. Deploy it Full
5. Click on the button on “inject” left side and see the response in the miCon-L program.




6.3.2 Data transfer CAN → Node-RED

Add to the Flow (6.3.1 Data transfer Node-RED → CAN) one “mqtt in”, one “debug” and connect it.



1. Configure the “mqtt in”: “Server=RasPiBroker”, “Topic=/topic/itemTx”, “QoS=2”
2. Deploy it Full
3. Activate debug output by click on the button on “debug” right side

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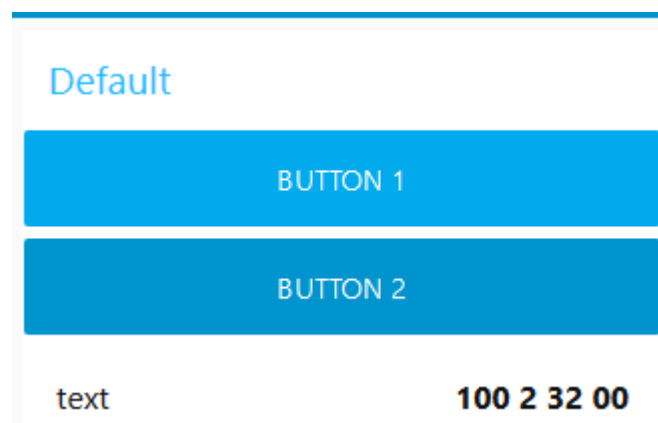
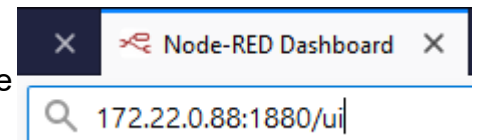
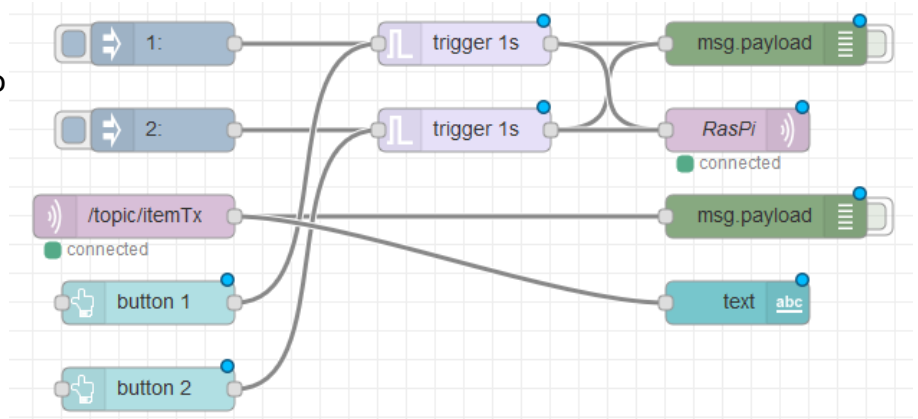
- Press the send button at the miCon-L program and see the incoming message at Node-RED's debug console.

6.4 Graphical User Interface

Graphical User Interface for Node-RED (see 5.4 Test Node-RED) is available too.


Add to the Flow (6.3.2 Data transfer CAN → Node-RED) two "ui button", one "ui text" and connect it.

- Configure the "ui button": "Label=button 1", "Payload=1" and the second "Label=button 2", "Payload=2"
- Deploy it Full
- To access the GUI, open a browser window with <RasPi-IP>:1880/ui.
- Press the send button at the miCon-L program to see the feedback at the GUI
- Press the buttons at GUI to see the feedback in the mi-Con-L program



6.5 Advanced Node-RED programming

Node-RED comes with build in programming options. With the "function" nodes it is possible to write java script programs. For examples, use the preinstalled RasPi image and study Flow 1.

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7 Appendix


7.1 Find COM-Port

To get the number of the COM-Port, open the Open Device Manager and expand Ports (COM & LPT). The COM Port number is showed at "USB Serial Port (**COM4**)"

7.2 PuTTY

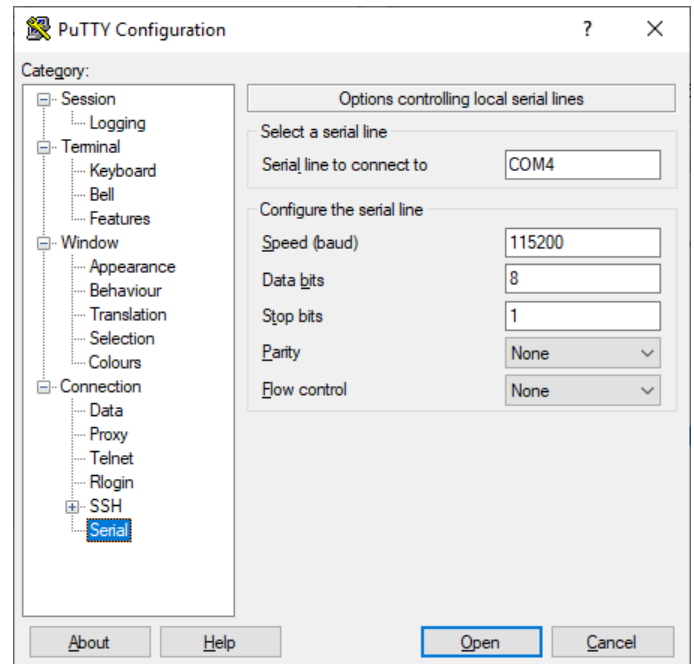
7.2.1 Get it

Downloading PuTTY (<https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>) and install it on the PC or Notebook.

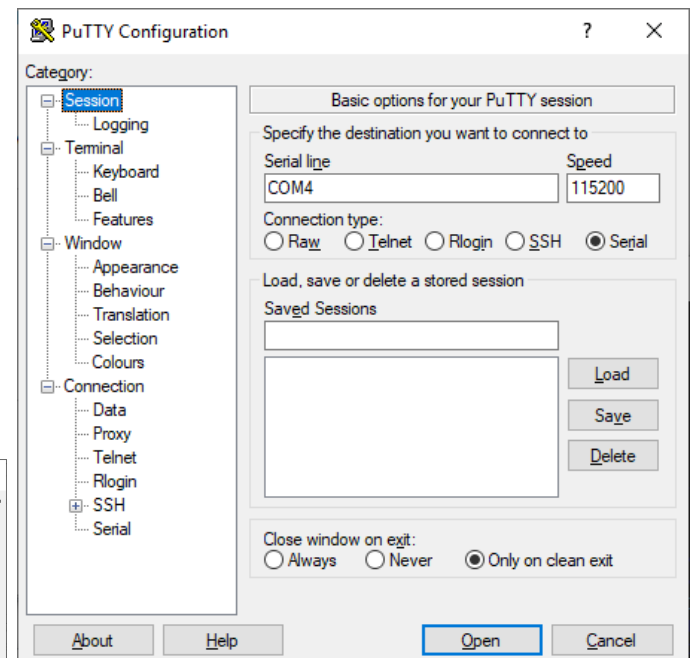
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7.2.2 Serial Terminal

Open PuTTY and select Connection → Serial.
Check all fields and put in the correct serial line
(see 7.1 Find COM-Port).




Open the session: Session → Serial → Open



Type "h" for help

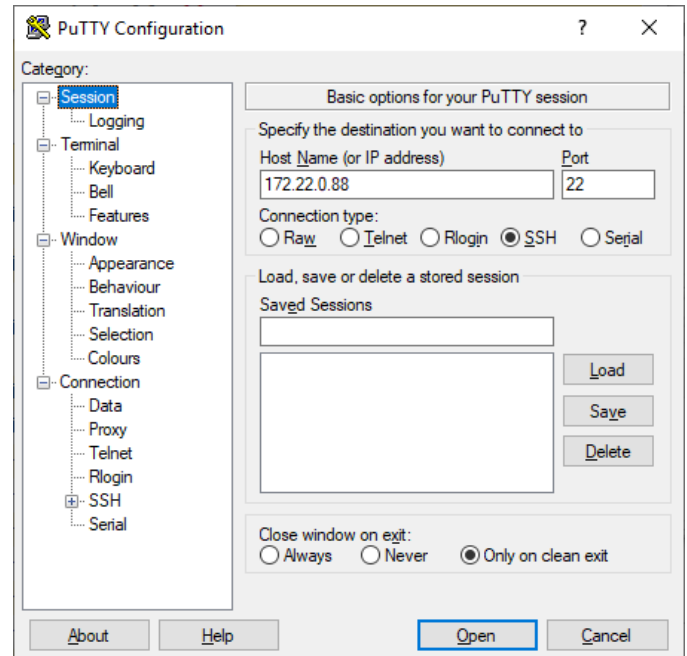
```

COM4 - PuTTY
-- GT-800 Menu ==
h - Help
s - Set SSID for WLAN connection (TestNet)
p - Set Password for WLAN connection
b - Set MQTT broker address (iot.eclipse.org)
r - Set topic for communication to the GT-800 (/topic/itemRx)
t - Set topic for communication to the broker (/topic/itemTx)
1 - Start-CAN-ID to send over CAN (0x200)
2 - Count of CAN-ID's to send over CAN (2)
3 - Start-CAN-ID to send over MQTT (0x100)
4 - Count of CAN-ID's to send over MQTT (2)
5 - Quality of Service for MQTT message (1)
6 - Retain flag for MQTT message (1)
7 - CAN-ID for status message (0x800)
m - Toggle connection state show
e - Restart system with new parameters
F - Bootloader mode (only for admins)
    
```

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7.2.3 SSH Terminal

Type in the IP address to the host name field and set the connection type to SSH. After that, press the open button.



After login with user “pi” and password “raspberrypi” the connection is ready to use.

```


pi@raspberrypi: ~
login as: pi
pi@172.22.0.88's password:
Linux raspberrypi 4.14.98+ #1200 Tue Feb 12 20:11:02 GMT 2019 armv6l

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Tue Apr  2 09:47:18 2019 from 172.22.0.226

SSH is enabled and the default password for the 'pi' user has not been changed.
This is a security risk - please login as the 'pi' user and type 'passwd' to set
a new password.

pi@raspberrypi:~ $ █
    
```

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7.3 Mqtt-spy

mqtt-spy is an open source utility intended to help you with monitoring activity on MQTT topics.

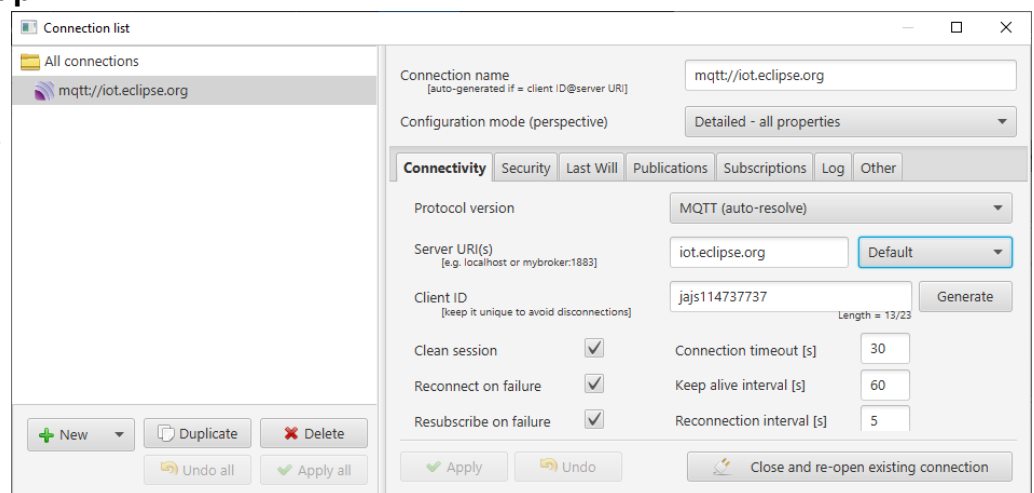
7.3.1 Get it

Downloading mqtt-spy (<https://github.com/eclipse/paho.mqtt-spy/wiki/Downloads>) and start the jar file on the PC or Notebook.

7.3.2 Connection set up

Click on the connection bar and create a new connection.

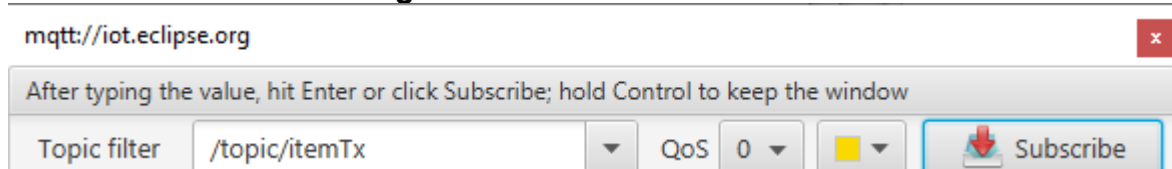
Then click on the “Close and re-opening existing connection” button and select the green connected tab.




7.3.3 Publish a MQTT message



7.3.4 Subscribe a MQTT message



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7.3.5 Receive a MQTT message

Subscriptions and received messages

New All **/topic/itemTx**

Message 1 / 1 Show latest ⏪ ⏩ 🔍 Search 🔧 Tools

Topic Retained QoS Time

Data (30B)

Received messages summary [search topics:] (1 topic, 1 message, load: 0,0/0,0/0,0)

Topic	Content	Browse	Messages	Last received
/topic/itemTx	100 8 08 07 06 05 04 03 02 01	<input checked="" type="checkbox"/>	1	2019/05/09 10:53:13:382