Professorship for Computer Science Communication Services, Telecommunication Systems and Computer Networks



Towards Implementing a MQTT-SN Gateway for Semi-Constrained Devices

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Project Goal

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MQTT-SN Gatewa Implementation

Project Goal



Project Goal

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Conclustion & Futur Work

Implement a Prototype for a MQTT-SN gateway runnable on Semi-Constrained devices.



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Eclipse IoT Developer Survey 2017

MESSAGING STANDARDS

What messaging protocol(s) do you use for your IoT solution?

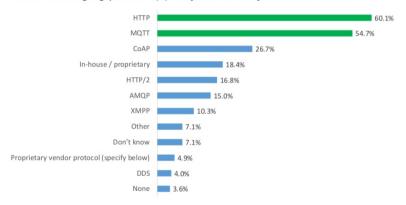


Figure 1: Eclipse IoT Developer Survey 2017 - Messaging Standards



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Messaging Standards

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MQTT-SN Gateway
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HTPP

- client-server paradigm
- addressable resource (URI)

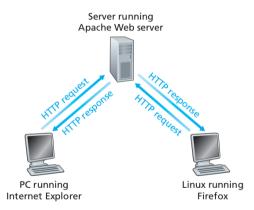


Figure 2: publish subscribe example



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MQTT

- publish-subscribe
- data centrich approach

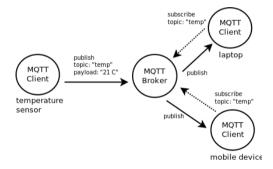


Figure 3: HTTP request response



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MQTT QoS

- QoS 0 (at most once)
- QoS 1 (at least once)
- QoS 2 (exactly once)

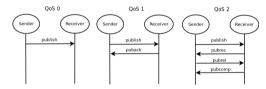


Figure 4: MQTT QoS methods



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MQTT-SN

- version of MQTT
- not connection oriented (no TCP)
- supports short & pre-defined topic names
- supports sleeping clients
- QoS -1 (QoS 0 publish without connect)



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Comparing HTTP, MQTT, MQTT-SN

- comparing minimal packet sizes in TCP/IP Model
- minimum valuable example: HTTP GET, MQTT publish QoS 0, MQTT-SN publish QoS 0
- result: MQTT + TCP + WiFi = 82 bytes vs MQTT-SN + BLE 21 bytes

TCP/IP Model Layer	Protocol including the minimial length				
Application Layer	HTTP (20) MQTT (8)		MQTT-SN (8)		
Transport Layer	TCP (20)		UDP (8)		
Network Layer	IP (20)			1	
Network Interface	Ethernet (20)	WiFi (20)		ZigBee (28)	BLE (13)

Figure 5: TCP/IP Model Layer with minimal protocol length



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IoT Environments

IoT Environments



Figure 6: IoT Environment from small hardware to the cloud



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MQTT-SN Gateway Implementation

Device Types

- Constrained Devices
 - Limited resources (FLASH, CPU, RAM, Energy)
- Semi-Constrained Devices
 - Limited resource (FLASH, CPU, RAM, not Energy)
- Unconstrained Devices
 - Nealy unlimited resources (HDD, CPU, RAM)



Device Types

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Target Hardware and Software Environment



Figure 7: NodeMCU v2 (ESP8266) + SDHC Card as Target Environment



Figure 8: Arduino as Software Environment



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MOTT-SN Architecture

MQTT-SN Architecture

■ three MQTT-SN components: client, gateway, forwarder

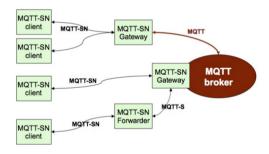


Figure 9: MQTT-SN Architecture



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MQTT-SN Gateway Architecture

■ two kind of gateways: transparent and aggregating

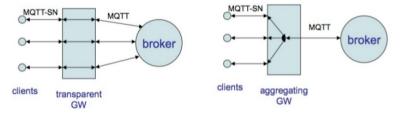


Figure 10: MQTT-SN gateway architecture



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MQTT-SN Client Lify Cycle

- MQTT-SN client as a constrained device:
 - find a MQTT-SN Gateway via advertisement or searching a gateway
 - connect to the MQTT-SN gateway with a will message
 - register topics
 - subscribe to topics
 - send and receive publishes
 - unsubscribe from topics
 - sleep
 - wake up and collect queued publishes
 - sleep and wake up frequently
 - power source is empty will message is published

MOTT-SN Architecture

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Transmission Protocols











Figure 11: example transmission protocols



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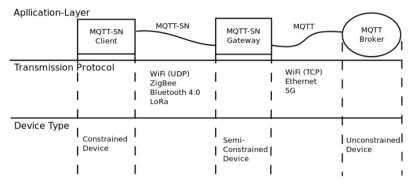


Figure 12: MQTT-SN, Transmission Protocols, Device Types



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Core Components

Unit and Regression Testin MOTT-SN & MOTT Test

Core Components

- environment independent implementation
- MqttSnMessageHandler + Core implemented rest interfaces

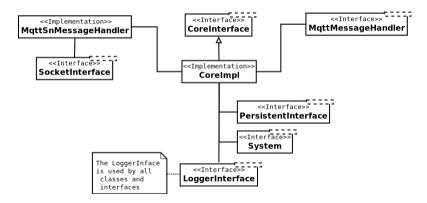


Figure 13: Core Component class diagram



Core Components

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Linux Gateway

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Core Components

- holds references to implementation single class to embed
- initializes components' references
- loop()s over components

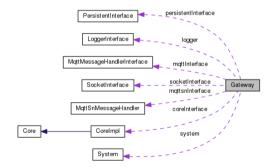


Figure 14: Gateway class collaboration diagram



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Linux Gateway

Implementation

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Linux Gateway Implementation

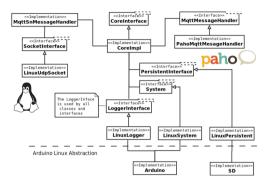


Figure 15: Linux Gateway implements Core Component's interfce. Using UDP and Paho embedded C/C++ MQTT Client



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Core Components Gatway Class

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Unit and Regression Testing

- using GoogleTest and GoogleMock
- starting tests inside IDE CLion
- using Docker for running MQTT broker (Mosquitto)
- writing a MqttSnTestClient + PahoMqttTestMessageHandler



Figure 16: Clion. GoogleTest. Docker. Mosquitto



Unit and Regression Testin

3 MQTT-SN Gateway Implementation

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MQTT-SN & MQTT Test Client

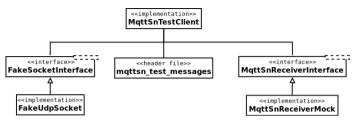


Figure 17: MQTT-SN test client class diagram

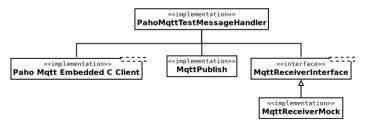


Figure 18: MQTT test client class diagram



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MQTT-SN G

Core Components

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Test Results

- compliance tests (well and ill-formed MQTT-SN packets)
- functional tests (behaviour correct)
- Total: 96 unit tests
- 90 pass + 6 fail (QoS 2 not implemented but tested)
- Not everyting is tested, but: Important functionality is tested and working



Unit and Regression Testin

Test Results

3 MQTT-SN Gateway Implementation

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BLESocket.

- drop in replacement for LinuxUdpSocket
- uses self written SimpleBluetoothLowEnergySocket

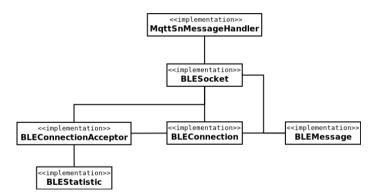


Figure 19: BLESocket class diagram



Unit and Regression Testin MOTT-SN & MOTT Test

BLESocket

Conclustion

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- tl;dr: project successful
- implemented a MQTT-SN gateway prototype on Linux
- runs partly tested on target hardware and software environment (ESP8266+SDCard)
- tested (reusable)
- designed to be easy adaptable to multiple environments

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Implementation

Future work

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- Conclustion & Future Work

- implement a MQTT-SN client for constrained devices
- more transmission protocols (WS17/18 LoRa)
- support more platforms: Mbed, RTOS
- implement: QoS 2 & will update
- enhance tests: more tests, stress tests, measure code coverage



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Related Worl

MQTT-SN Gateway Implementation

Conclustion & Future Work

Gabriel Nikol github.com/S3ler

Questions?