Open Source MQTT Brokers

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OpenIoT Summit 2018

Konsulko Group

- Services company specializing in Embedded Linux and Open Source Software
- Hardware/software build, design, development, and training services
- Based in San Jose, CA with an engineering presence worldwide
- http://konsulko.com/

Agenda

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- Brief history of MQTT
- Deep dive in the MQTT protocol
- Overview of popular open source MQTT brokers
- Notes, conclusions and discusssions

Introducing MQTT

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MQTT

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- Lightweight publish/subscribe machine-to-machine protocol on top of TCP/IP
- Near real-time communication between clients through a message broker
- Small source code footprint for embedded devices
- Protocol versions 3.1, 3.1.1 and 5.0
- MQTT-SN (MQTT for Sensor Networks) uses UDP

MQTT Milestones

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- Created by Dr Andy Stanford-Clark of IBM, and Arlen Nipper of Arcom (now Eurotech) in 1999
- Available under a royalty free license as protocol version 3.1 since 2010
- OASIS standard since 2014
- ISO standard (ISO/IEC 20922) since 2016
- MQTT version 5 was released as a specification in 2018

Trends

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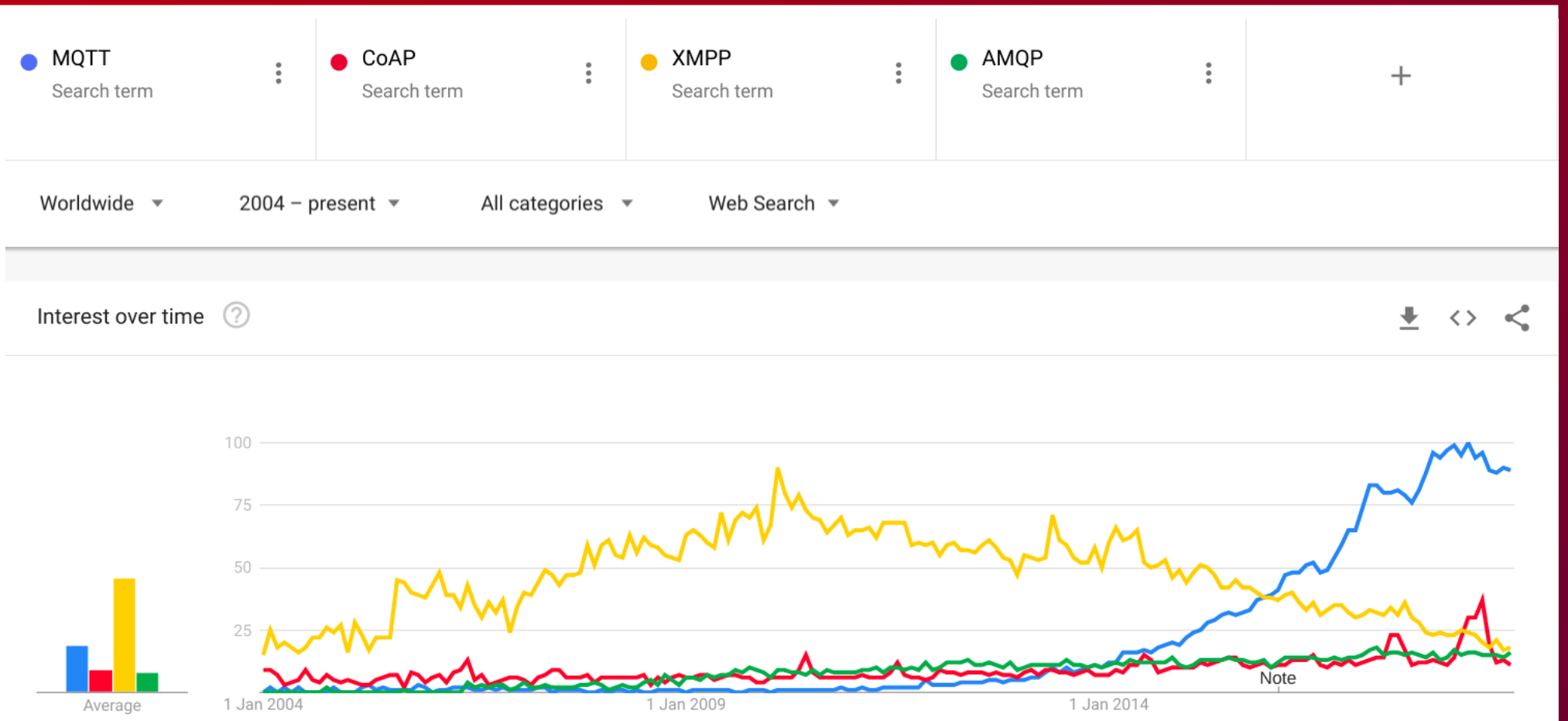

https://trends.google.com/trends/explore?date=all&q=MQTT,coap,xmpp,AMQP

Understanding MQTT

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MQTT Operations

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- Connect
- Disconnect
- Subscribe
- Unsubscribe
- Publish

The role of the MQTT Broker

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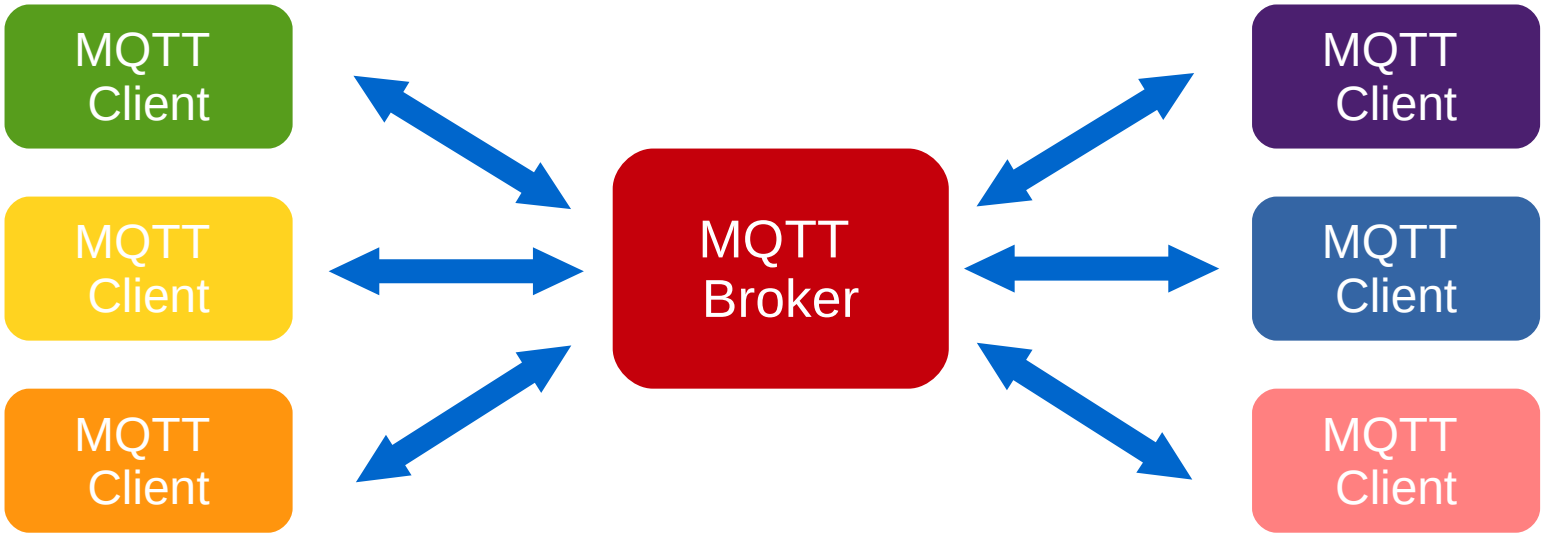
- Connect and handle multiple clients
- Deliver published messages to the subscribed MQTT clients depending on the topic of the message



MQTT Message

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- Topic
- Payload (text or binary)
- Quality of service (0, 1 or 2)
- Retain (true or false)

Example message	
Topic	"hello/1"
Payload	{ "temperature": 20 }
QoS	2
Retain	false

MQTT Quality of Service (QoS)

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- 0 - at most once (no delivery guarantee)
- 1 - at least once
- 2 - exactly once

MQTT Retained Messages

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- Message published with retain flag set to true that is used to store the last know good value
- The MQTT broker is responsible for transmitting the retained message to all newly-subscribed for this topic MQTT clients
- To delete a retained message publish another message with the same topic and an empty payload

LWT

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- Last Will & Testament (LWT) allows the broker to notify interested clients about an ungracefully disconnected client by publishing a message on his behalf
- The MQTT client should register the will message when connecting to the MQTT broker
- The minimum requirement for a will message is to specify at least a topic

Topics & Wildcards

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- Topic

  home / bedroom / temperature

- Single level wildcards

  home / + / temperature

- Multiple levels wildcards

  home / #

Security

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- Transport encryption with TLS/SSL
- Authentication: username/password
- Authorization: Access Control Lists (ACL)

What is new in MQTT 5?

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- Improvements and provisioning features for large scale systems
- Metadata and user properties
- Request/response interactions
- Improvements for authentication, error handling, lower bandwidth consumption and performance on clients with restrained hardware

What happened with MQTT 4?

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- 8 bit unsigned value represents the protocol level (aka version) in the variable header of the CONNECT Packet
- “The value of the Protocol Level field for the version 3.1.1 of the protocol is 4 (0x04)”
  http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/csprd02/mqtt-v3.1.1-csprd02.html
- “The value of the Protocol Level field for the version 5.0 of the protocol is 5 (0x05)”
  http://docs.oasis-open.org/mqtt/mqtt/v5.0/cs02/mqtt-v5.0-cs02.html

Exploring MQTT Brokers

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Mosquitto

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- Free and open source MQTT broker written in the C programming language
- Supports MQTT protocol version 3.1 and 3.1.1
- Supports QoS 0, 1 and 2
- Supports web sockets
- Available for Windows, FreeBSD, Mac OS and GNU/Linux distributions
- Also provides simple command line MQTT clients called mosquitto_pub and mosquitto_sub

Mosquitto Pulse

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- Created by Roger Light in 2010
- Project of iot.eclipse.com and using git since 2014
- Development has been sponsored by Cedalo AG since 2018
- Available at GitHub under dual license (Eclipse Public License 1.0 and the Eclipse Distribution License 1.0): https://github.com/eclipse/mosquitto
- 56 contributors, 1107 commits (as of 8th October)
- Most of the commits are by the author (924)
- 24 releases, current stable v1.5.3

Mosca

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- Free and open source MQTT broker written in JavaScript
- Can be used standalone or embedded in another Node.js application
- Supports MQTT protocol version 3.1 and 3.1.1
- Supports web sockets
- Supports QoS 0 and 1
- Available for all platforms on which you can run Node.js: MS Windows, Mac OS and GNU/Linux distributions

Mosca Pulse

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- Available at GitHub under MIT license: https://github.com/mcollina/mosca
- Started by Matteo Collina in 2013
- 56 contributors, 973 commits (as of 7th October)
- Most of the commits are by the author (551)
- 98 releases, current stable version 2.8.3 from 12 July 2018
- Above 2 thousands weekly downloads of the Node.js package from npmjs

EMQ (emqttd)

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- Free and open source MQTT broker written in Erlang/OTP
- Supports MQTT protocol version 3.1, 3.1.1 and 5.0
- Supports QoS 0, 1 and 2
- Supports web sockets, MQTT-SN, CoAP, STOMP and SockJS
- Available for Windows, FreeBSD, Mac OS and GNU/Linux distributions

EMQ (emqttd) Pulse

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- Available at GitHub under Apache License 2.0: https://github.com/emqx/emqx
- Started by Feng Lee in 2012
- 35 contributors, 3147 commits (as of 8th October)
- Most of the commits are by the author (1970)
- 112 releases, current stable version 2.3.11 from 27 July 2018
- EMQ Enterprise provides commercial support and services for the open source EMQ project

VerneMQ

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- Free and open source MQTT broker written in Erlang/OTP
- Supports MQTT protocol version 3.1, 3.1.1 and 5.0
- Supports QoS 0, 1 and 2
- Supports websockets
- Available for GNU/Linux distributions and Mac OS
- **Not** working on Windows due due to the LevelDB code

VerneMQ Pulse

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- Available at GitHub under Apache License 2.0: https://github.com/erlio/vernemq
- Started in 2016
- 18 contributors, 1734 commits (as of 9th October)
- Most of the commits are by Andre Graf (958) and Lars Hesel Christensen (502)
- 38 releases, current stable version 1.5.0 from 21 August 2018
- Octavo Labs AG (successor of Erlio GmbH) provides commercial support and services

Apache ActiveMQ

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- Free and open source message broker written in JAVA
- Supports large number of transport protocols: MQTT, OpenWire, STOMP, AMQP & others
- Supports MQTT protocol version 3.1
- Supports QoS 0, 1 and 2
- Supports websockets
- Available for GNU/Linux distributions, UNIX compatible systems and Windows

Apache ActiveMQ Pulse

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- Project of the Apache Software Foundation
- Available under Apache License 2.0: https://git-wip-us.apache.org/repos/asf?p=activemq.git
- Started in 2004 by LogicBlaze, donated to the Apache Software Foundation in 2007
- 104 contributors, 10070 commits (as of 9th October)
- 8 contributors with more than 500 commits
- 61 releases, current stable version 5.15.6 from 10 September 2018

RabbitMQ

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- Free and open source message broker written in Erlang
- Supports large number of transport protocols: MQTT, STOMP, AMQP, HTTP
- Supports MQTT protocol version 3.1 via a plugin
- Supports QoS 0 and 1
- Supports websockets
- Available for GNU/Linux distributions, BSD & UNIX compatible systems, Mac OS and MS Windows

RabbitMQ Pulse

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- Available at GitHub under Mozilla Public License 1.1:
- https://github.com/rabbitmq/rabbitmq-server
- Started as a joint venture between LShift and CohesiveFT in 2007, acquired SpringSource, a division of VMware in 2010,part of Pivotal Software since 2013
- 74 contributors, 17238 commits (as of 9th October)
- 3 contributors with more than 500 commits
- 219 releases, current stable version 3.7.8 from 21 September 2018

HiveMQ

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- MQTT broker implement in the Java programming language
- Supports MQTT protocol version 3.1 and 3.1.1
- Supports web sockets
- Commercial license, owned by dc-square GmbH
- Lead developer Dominik Obermaier
- Open source plugins available at GitHub under Apache-2.0: https://github.com/HiveMQ

More open source MQTT brokers

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- Apache ActiveMQ Artemis (written in JAVA, based on HornetQ)
- Moquette (written in JAVA, available in GitHub under Apache License 2.0)
- Vertx-mqtt-broker (written in JAVA with Vert.x, available in GitHub under Apache License 2.0)
- Wave (written in Erlang, available in GitHub under GNU Affero General Public License v3.0, latest release from June 2016)
- MQTTnet (written in C#, available in GitHub under MIT)

Commercial MQTT brokers

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- HiveMQ
- IBM IoT MessageSight
- Flespi
- JoramMQ
- PubSub+

… and one more thing

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- The Paho project (of Eclipse Foundation) offers MQTT client implementations for C/C++, Java, JavaScript, Python, Go, Rust and C#:
  http://www.eclipse.org/paho/

  Node.js open source library for implementing MQTT clients
  https://www.npmjs.com/package/mqtt
- Arduino open source client for MQTT:
  http://pubsubclient.knolleary.net/

Conclusions

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- MQTT is an excellent protocol for (near) real-time communication of IoT
- There is a huge variety of high-quality free and open source MQTT brokers which business model is providing commercial support and services
- Open source MQTT brokers are highly dependent from their authors who remain leading developers up to date
- Most popular languages for implementing MQTT brokers are Erlang/OTP, JAVA and C
- All reviewed open source MQTT brokers run on GNU/Linux distributions

DEMO

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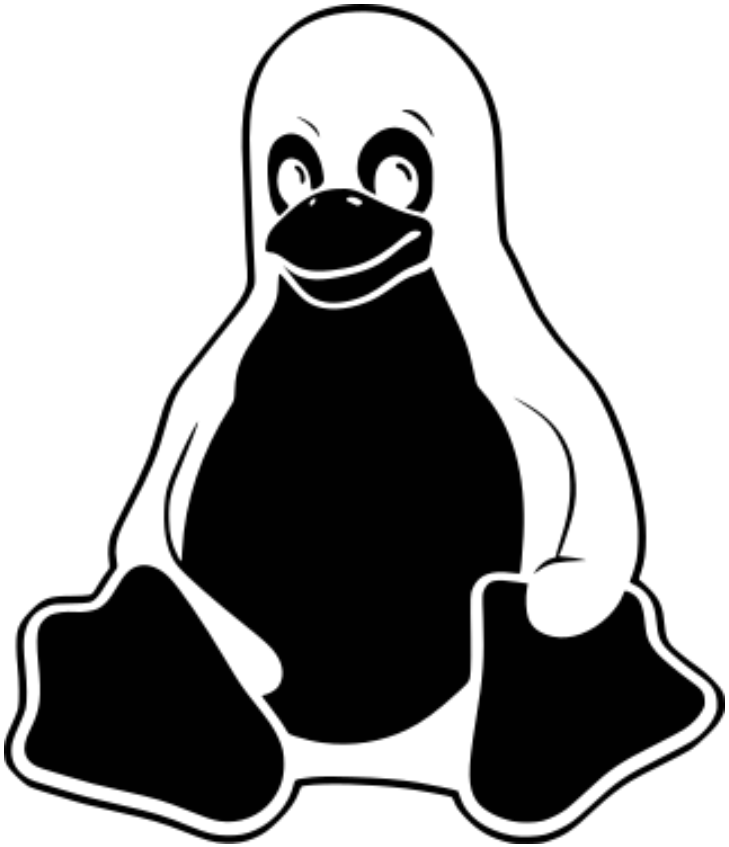

Thank You!

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Useful links:

- http://mqtt.org/
- https://github.com/mqtt/mqtt.github.io/wiki
- http://docs.oasis-open.org/mqtt/mqtt/v5.0/cs02/mqtt-v5.0-cs02.html
- https://en.wikipedia.org/wiki/Comparison_of_MQTT_Implementations