EMMA
Distributed QoS-Aware MQTT Middleware for Edge Computing Applications

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http://dsg.tuwien.ac.at
AWS IoT
Subscribe to topic: /robot/arm

Publish “move x,y,z” to /robot/arm

Decoupled messaging
Trust?

Availability?

End-to-end latency: ??ms
Edge-Enabled MOM

- Message broker
- Cloud-based MOM
- Edge-enabled MOM

Scale

Proximity & Responsiveness

Diagram showing the integration of various technologies including Data centers, Internet, Cloudlets, Mobile edge, Extreme edge, and IoT, with arrows indicating the flow of data and connectivity.
- Popular platform for IoT
  - ISO standardized pub/sub protocol
  - Low-bandwidth design
- Simple Protocol
  - CONNACK
  - SUBSCRIBE(t), SUBACK(t)
  - PUBLISH(t, msg)
  - ...

MQTT.org
Static MQTT Topic Bridging

M. Garcia, “How to Bridge Mosquitto MQTT Broker to AWS IoT”
The Internet of Things on AWS -- Official Blog, 2016. 
Goals

- Decentralized messaging middleware
- Leverages edge resources to reduce latency
- Can handle mobile clients
- Can handle volatile resources
- Seamlessly integrates with IoT infrastructure
QoS Optimization & Balancing

- Continuously monitor network QoS via simple UDP protocol
- For each client create latency group to brokers
- Connect gateways to a broker in closest group
- Balance load between brokers in same group
Evaluation

https://git.dsg.tuwien.ac.at/emma/pubsub-benchmark
Message Loss

- Caused by subscriber mobility
- Guaranteed message delivery requires transactional reconnection
More Results in the Paper
**EMMA MQTT Middleware**

![Diagram of EMMA MQTT Middleware]

**QoS Monitoring & Reconfiguration**

![Diagram of QoS Monitoring & Reconfiguration]

**TU Wien!**

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Related Work – P2P Pub/Sub

**NCA’05**

Scalable QoS-Based Event Routing in Publish-Subscribe Systems*

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**DEBS’05**

Publisher Mobility in Distributed Publish/Subscribe Systems

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**MW’05**

Opportunistic Overlays: Efficient Content Delivery in Mobile Ad Hoc Networks

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**PODC’07**

Constructing Scalable Overlays for Pub-Sub with Many Topics

Problems, Algorithms, and Evaluation

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ABSTRACT

We investigate the problem of designing a scalable over-

Categories and Subject Descriptors
C.2.1 [Computer-Communication Networks]: Network...
FogMQ: A Message Broker System for Enabling Distributed, Internet-Scale IoT Applications over Heterogeneous Cloud Platforms

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An Autonomous and Dynamic Coordination and Discovery Service for Wide-Area Peer-to-peer Publish/Subscribe

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PopSub: Improving Resource Utilization in Distributed Content-based Publish/Subscribe Systems

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ABSTRACT

Industrial Internet of Things (IIoT) such as smart-grids, intelligent transportation systems, and healthcare systems, are developing rapidly. These applications require new and innovative approaches to manage their large-scale, distributed and heterogeneous environments. Traditional message brokers, though ensuring message delivery, cannot scale and cannot meet the requirements of direct delivery with low overhead.

ABSTRACT

Distributed content-based publish/subscribe systems provide a selective, scalable, and decentralized approach to data dissemination. In a pub/sub overlay network, hop-by-hop routing allows brokers to correctly forward messages without requiring global knowledge. However, this model causes brokers to forward publications without 24]. Clients can subscribe to fine grained data using content-based subscriptions and receive notifications whenever matching publications are disseminated by publishers. In a distributed pub/sub system, the task of matching and forwarding messages to all interested clients are divided and allocated to a network of brokers, collectively called the pub/sub overlay network. In many systems,
ScalAgent. **JoramMQ, a distributed MQTT broker for the Internet of Things.**
White paper. 2014.