EMMA
Distributed QoS-Aware MQTT Middleware for Edge Computing Applications

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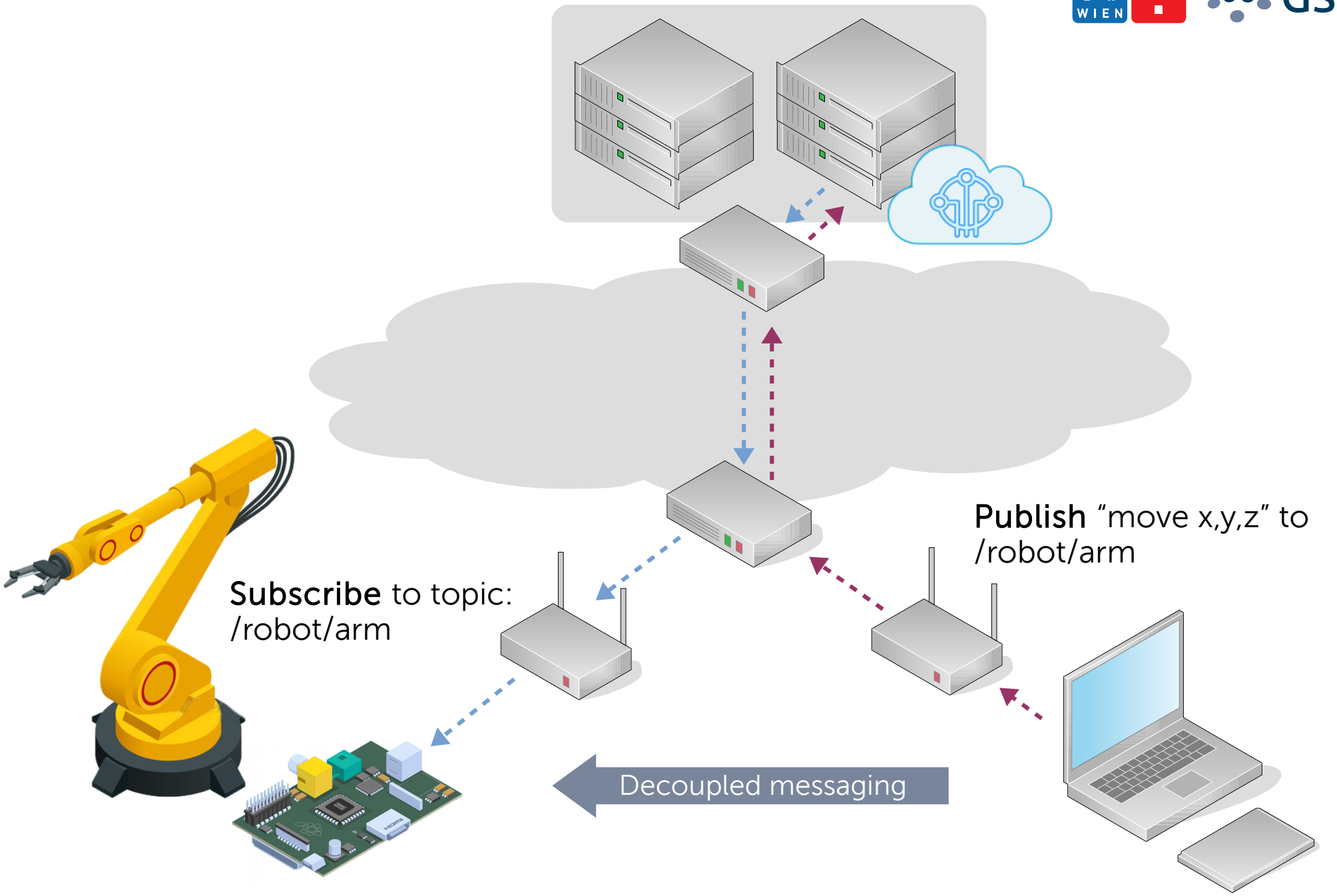
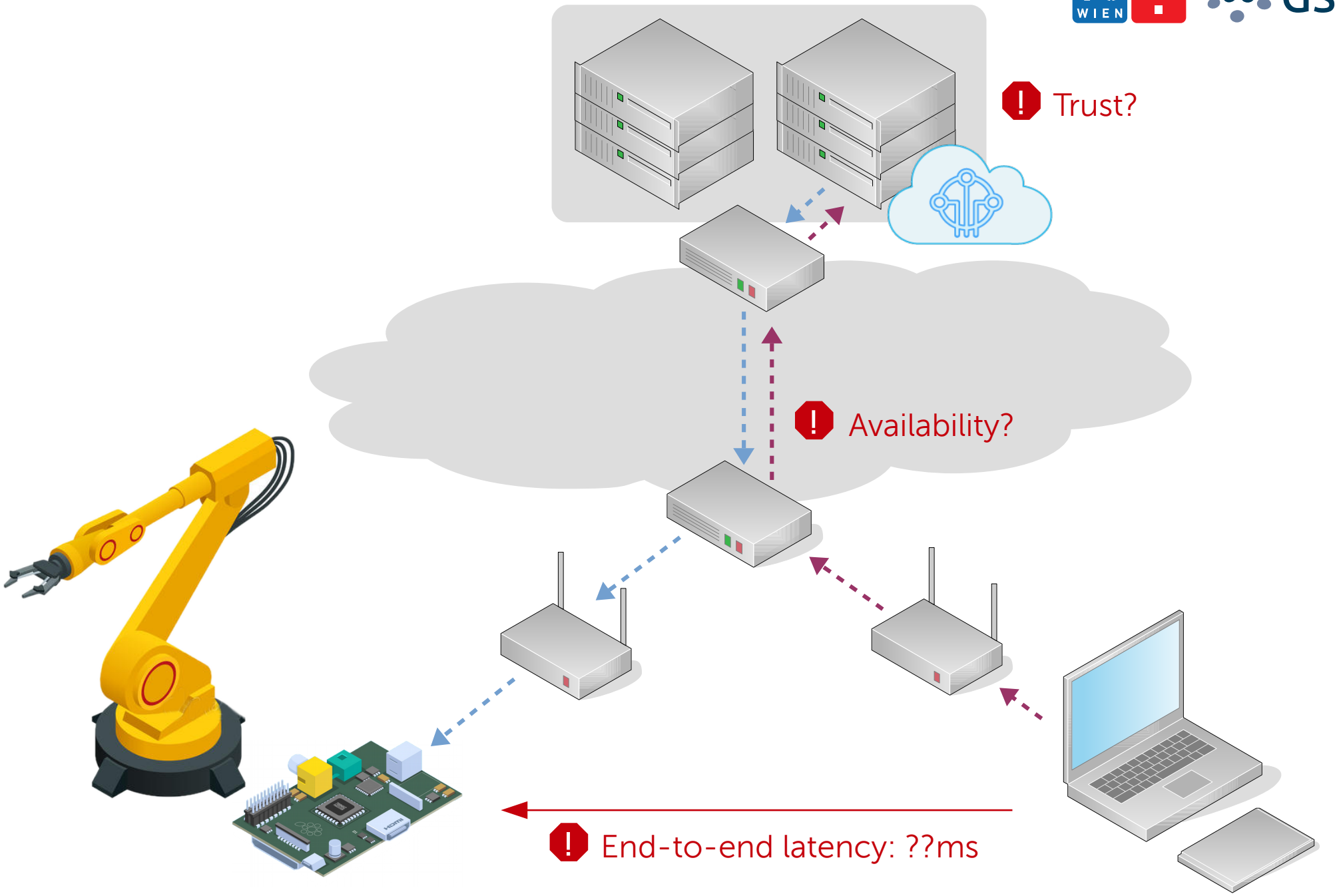
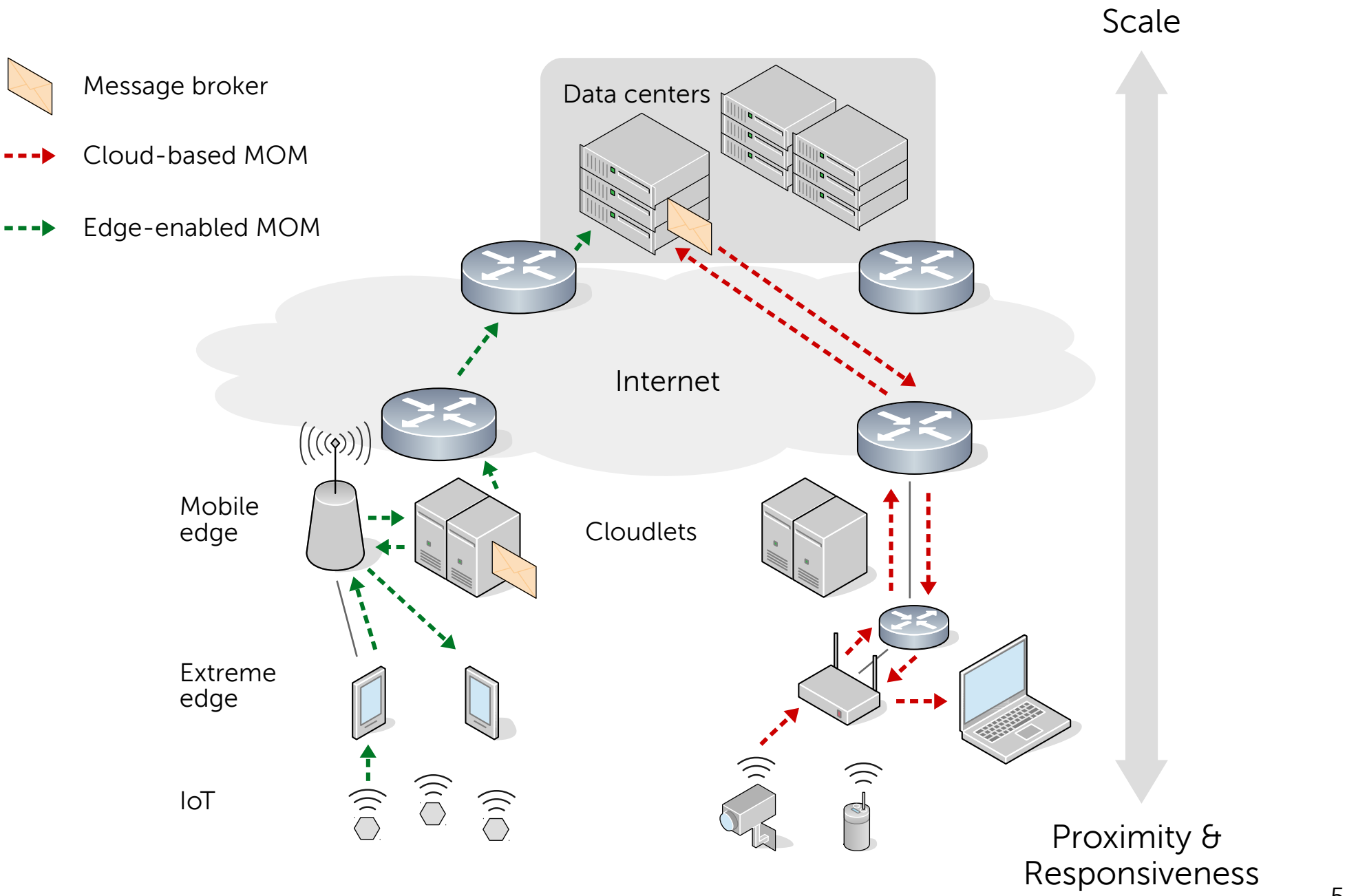
Distributed Systems Group
http://dsg.tuwien.ac.at

AWS IoT


Subscribe to topic:
/robot/arm
Publish "move x,y,z" to
/robot/arm
Decoupled messaging

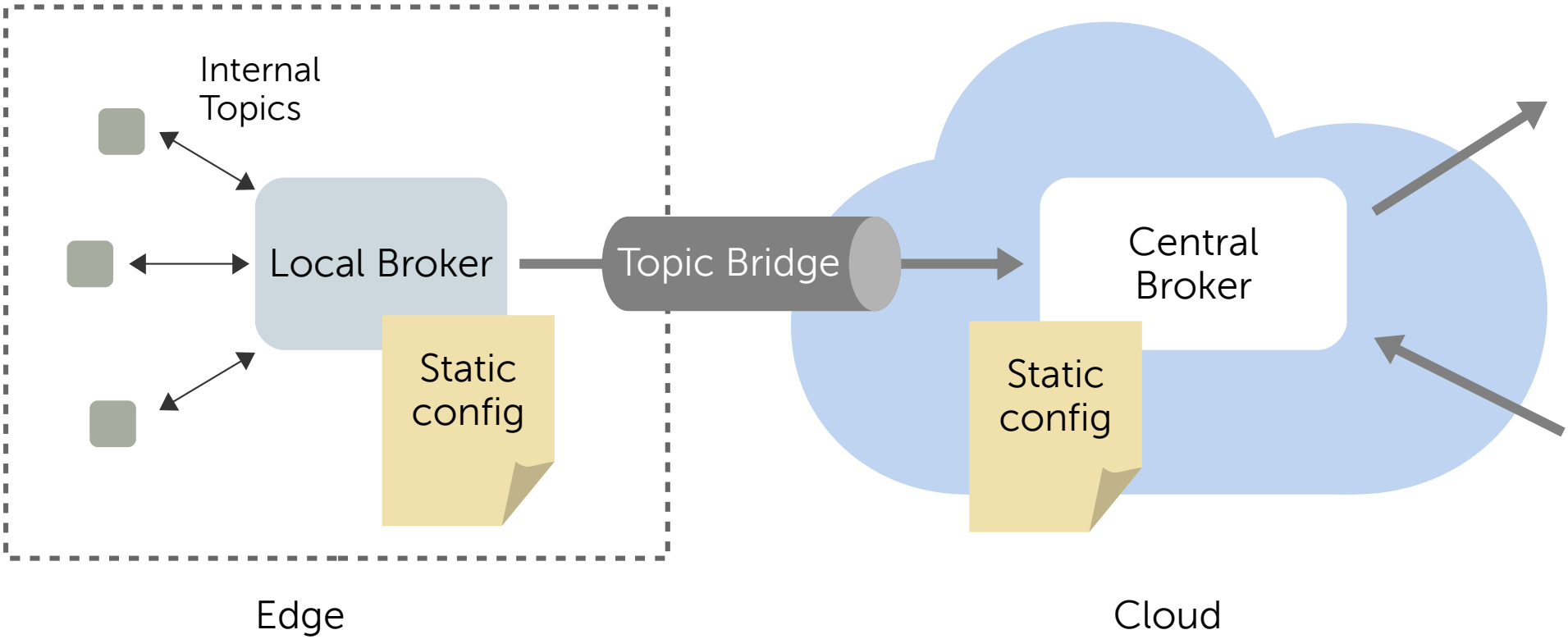

Trust?
Availability?
End-to-end latency: ??ms

Edge-Enabled MOM



- Popular platform for IoT
  - ISO standardized pub/sub protocol
  - Low-bandwidth design
- Simple Protocol
  - CONNACK
  - SUBSCRIBE(t), SUBACK(t)
  - PUBLISH(t, msg)
  - …

Static MQTT Topic Bridging



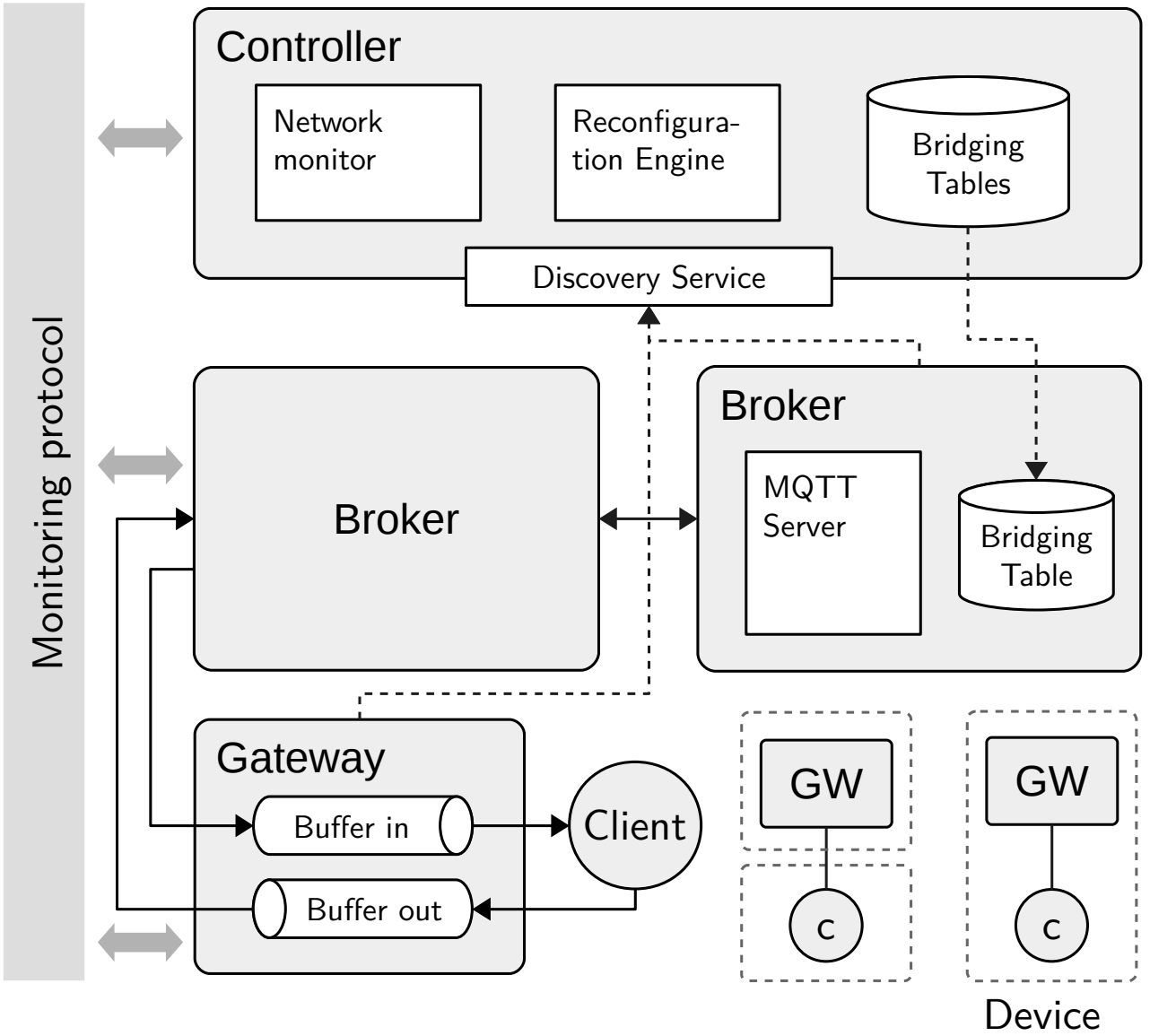
M. Garcia, "**How to Bridge Mosquitto MQTT Broker to AWS IoT**"
The Internet of Things on AWS -- Official Blog, 2016.
https://aws.amazon.com/blogs/iot/how-to-bridge-mosquitto-mqtt-broker-to-aws-iot/

Goals

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

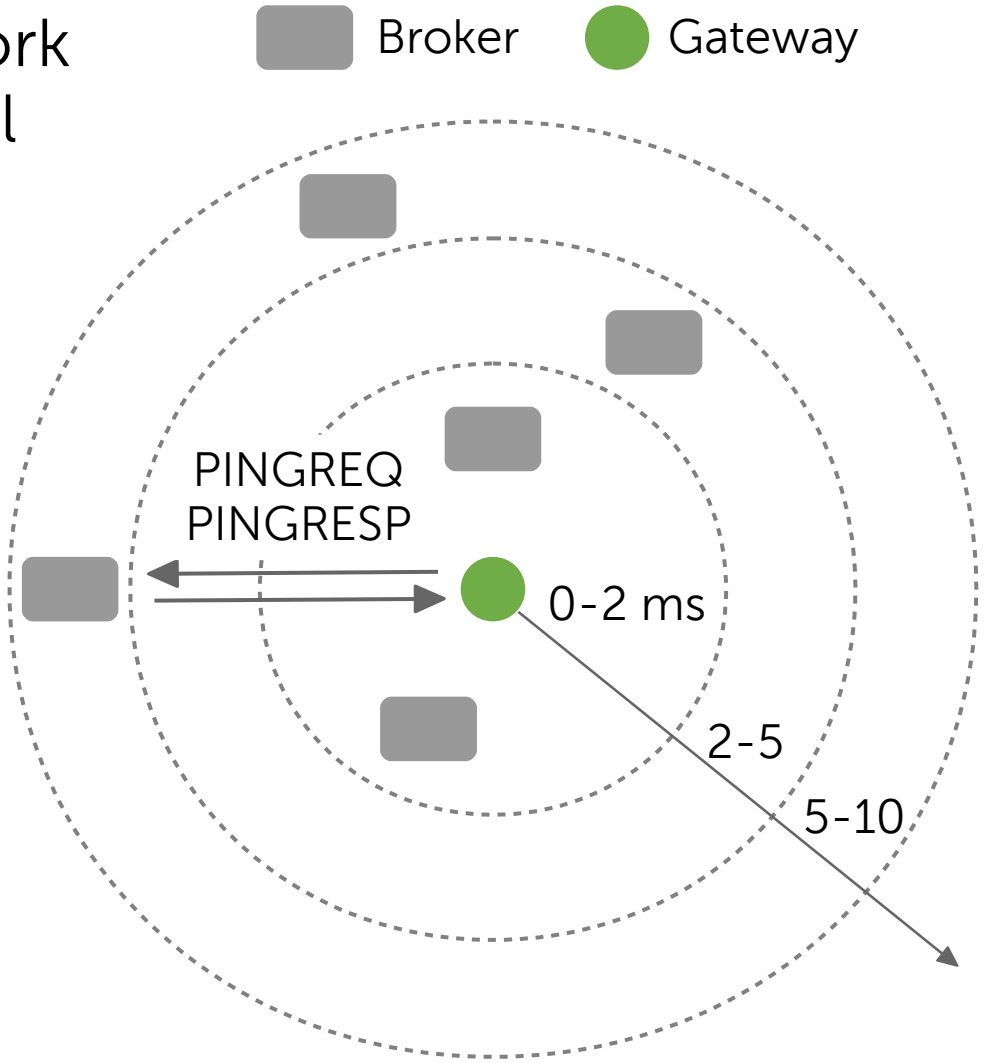
EMMA MQTT Middleware

https://git.dsg.tuwien.ac.at/emma/emma

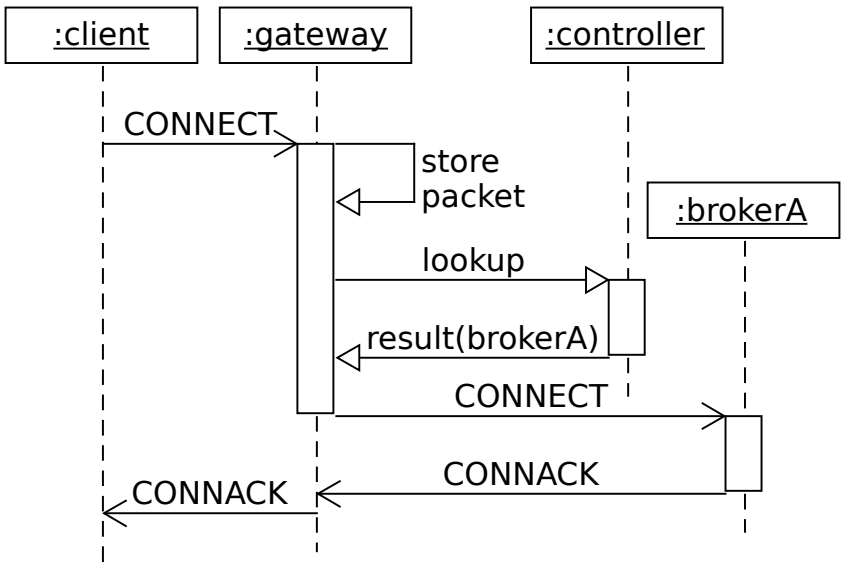


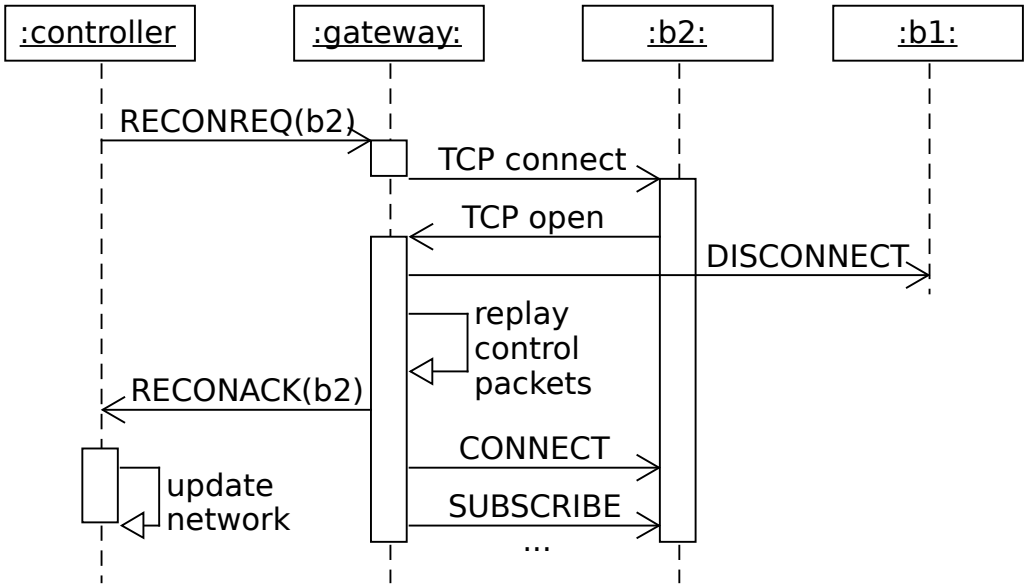
QoS Optimization & Balancing

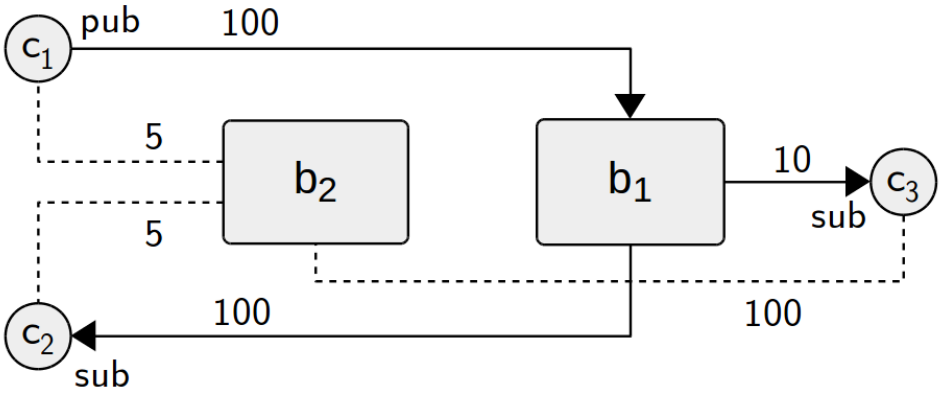
- Continuously monitor network QoS via simple UDP protocol
- For each client create latency group to brokers
- Connect gateways to a broker in closest group
- Balance load between brokers in same group

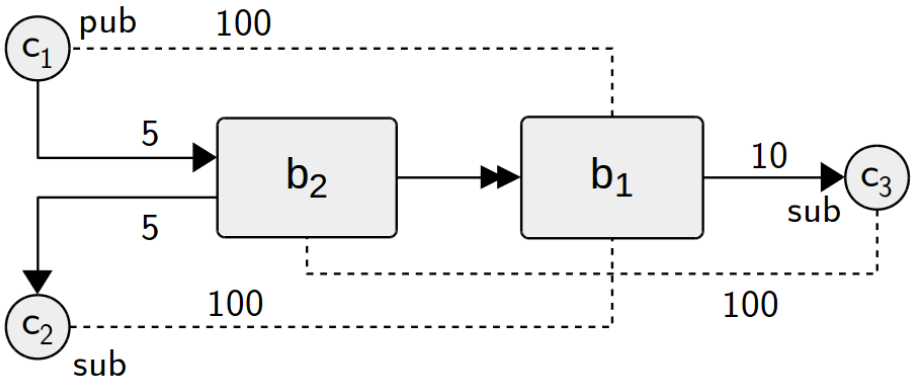


Orchestration



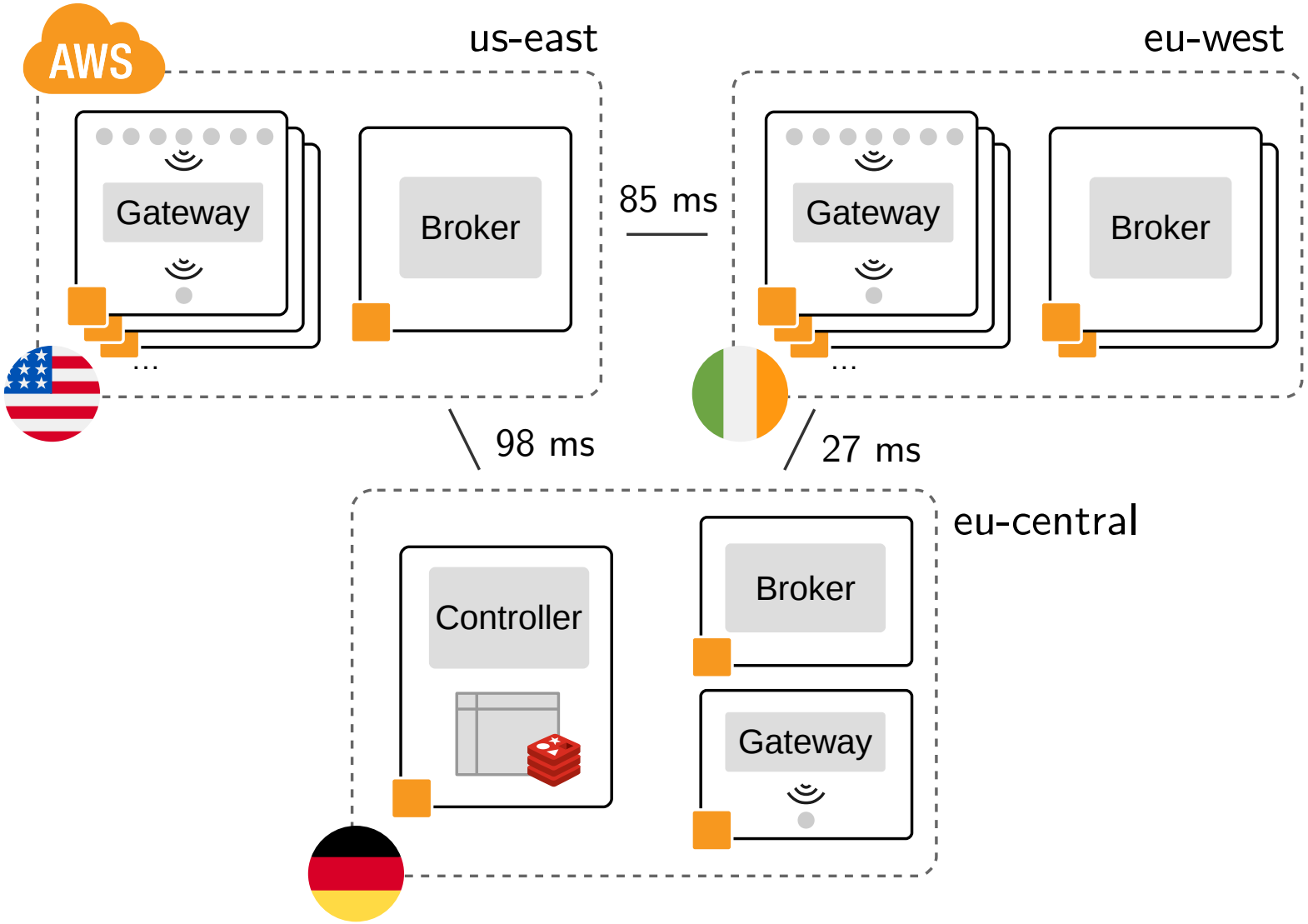


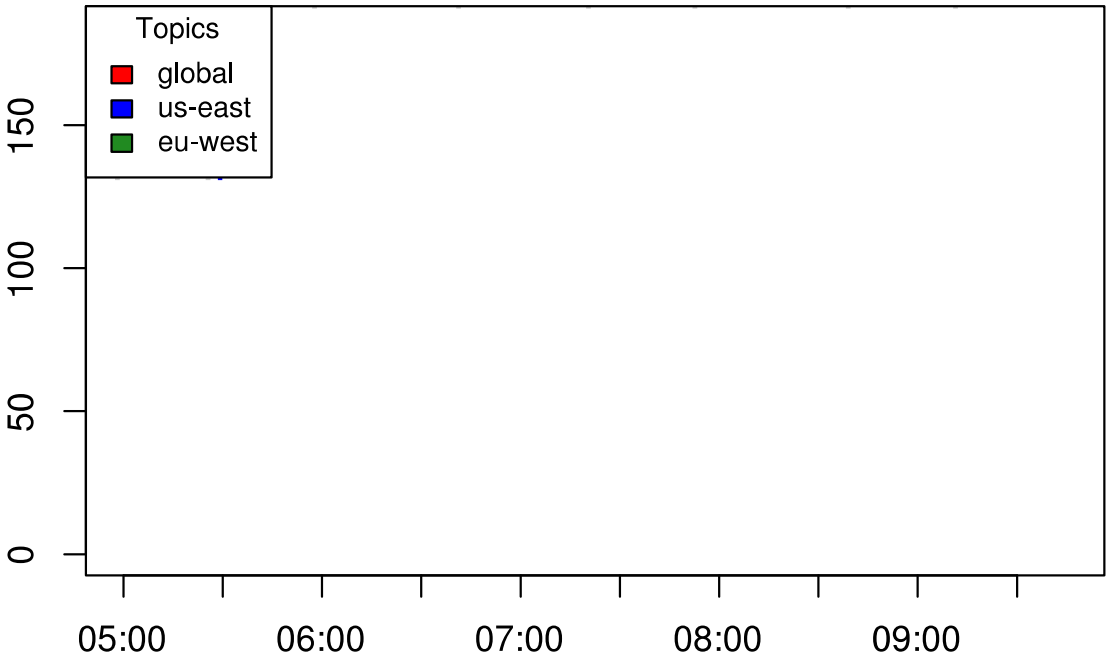




Evaluation

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



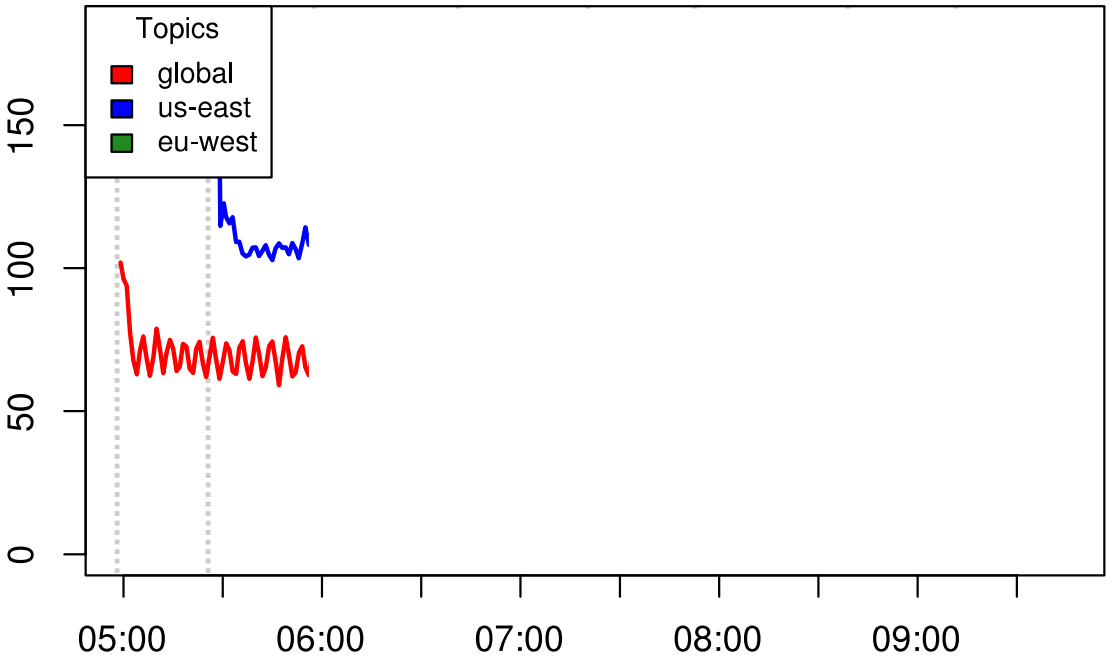


eu-west

us-east

eu-central

Controller


Topics
global
us-east
eu-west
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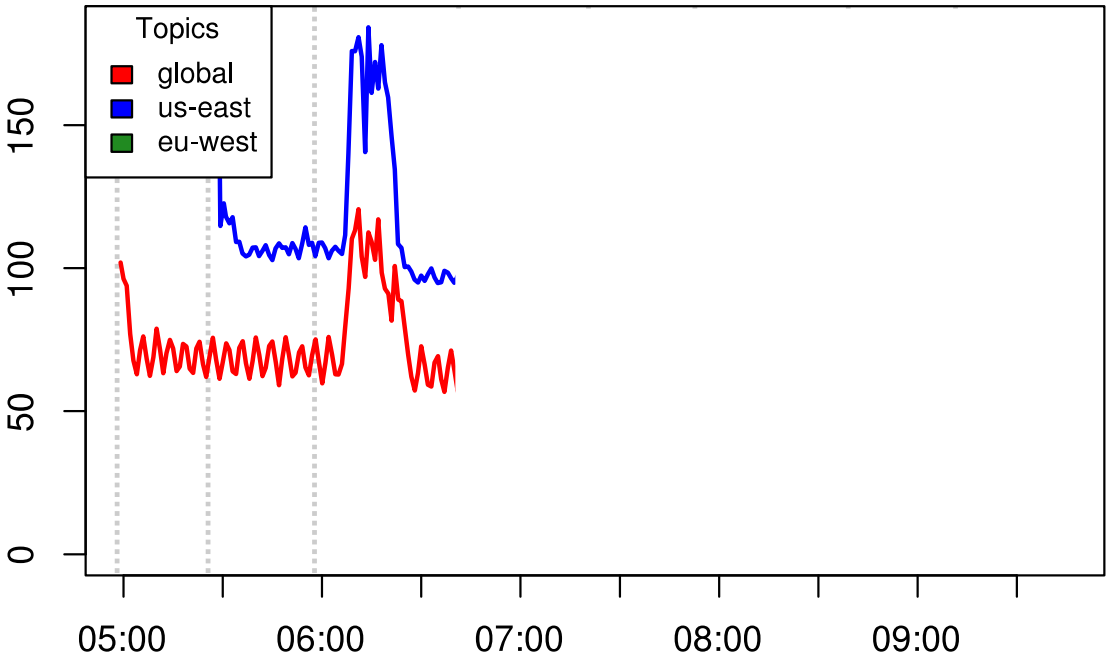
<1 ms
85 ms
27 ms
Controller
98 ms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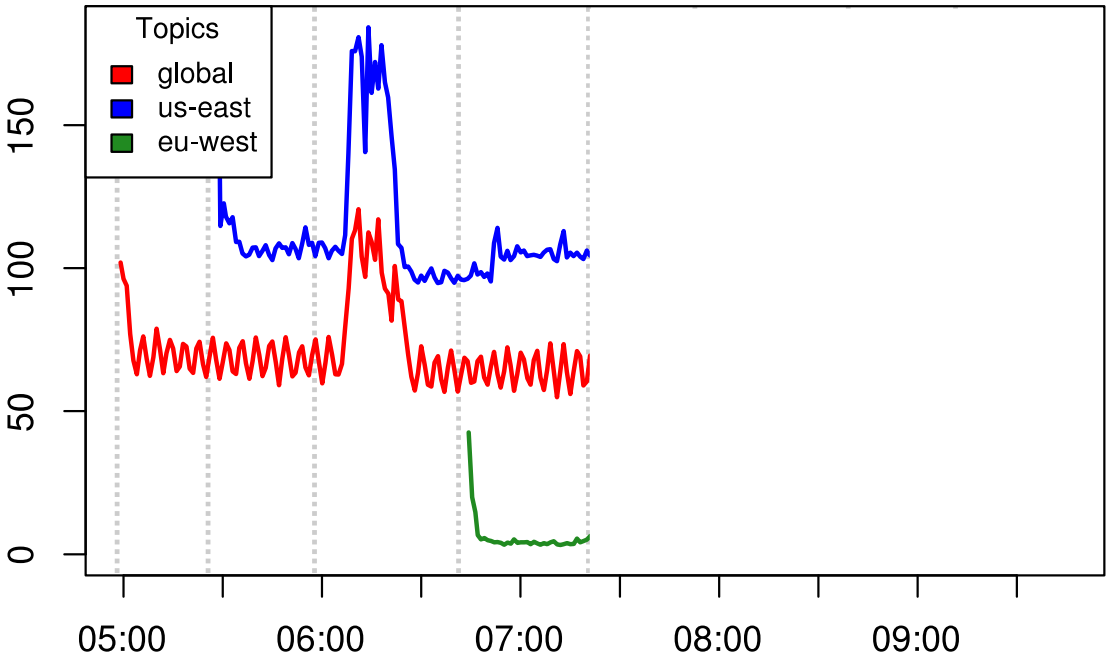
Controller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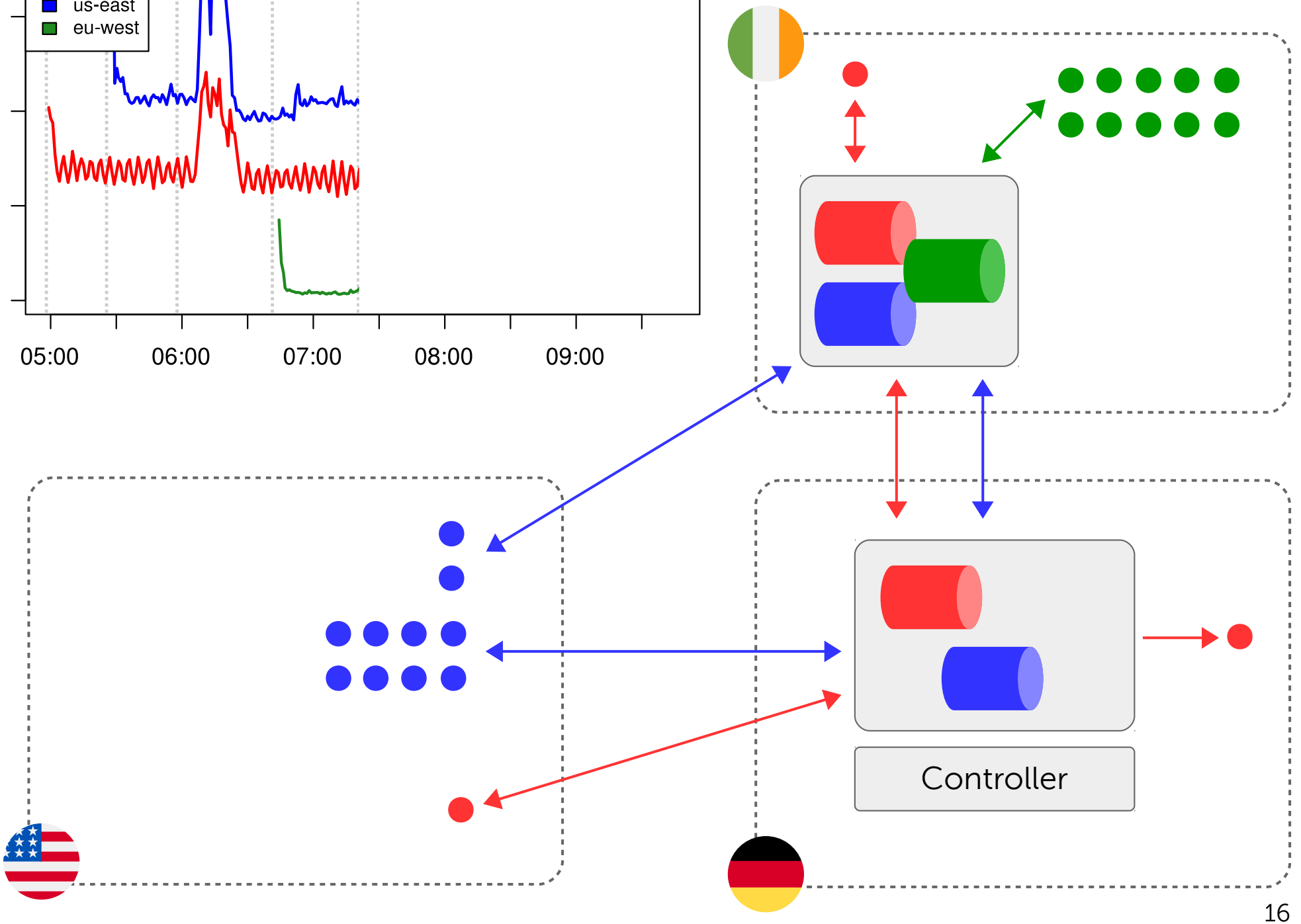
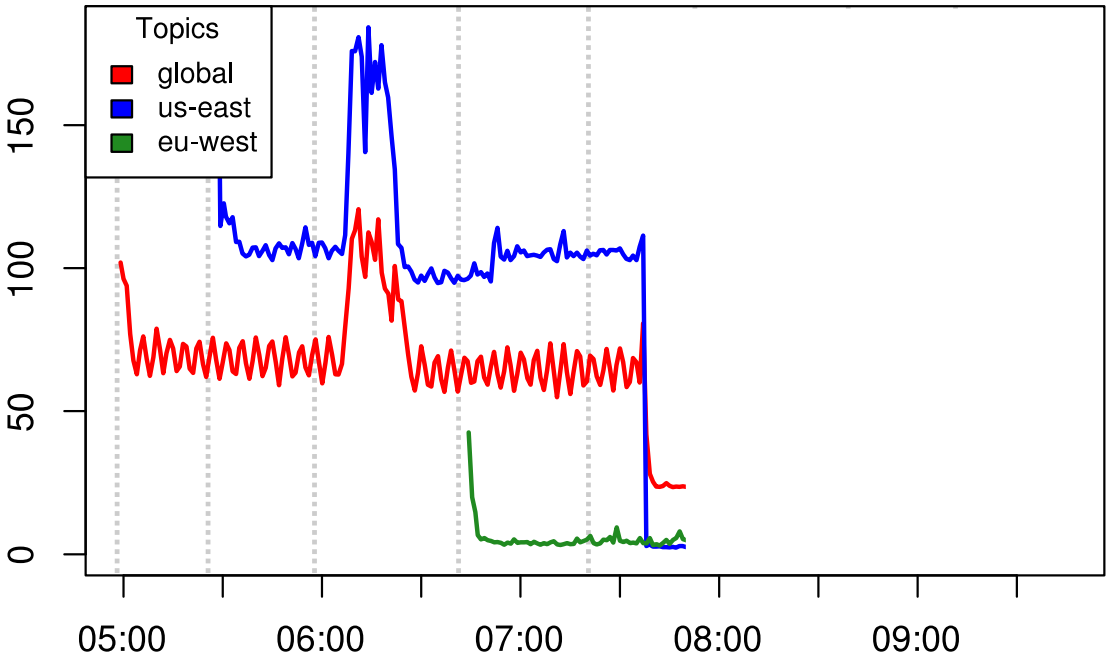

Controller


Topics
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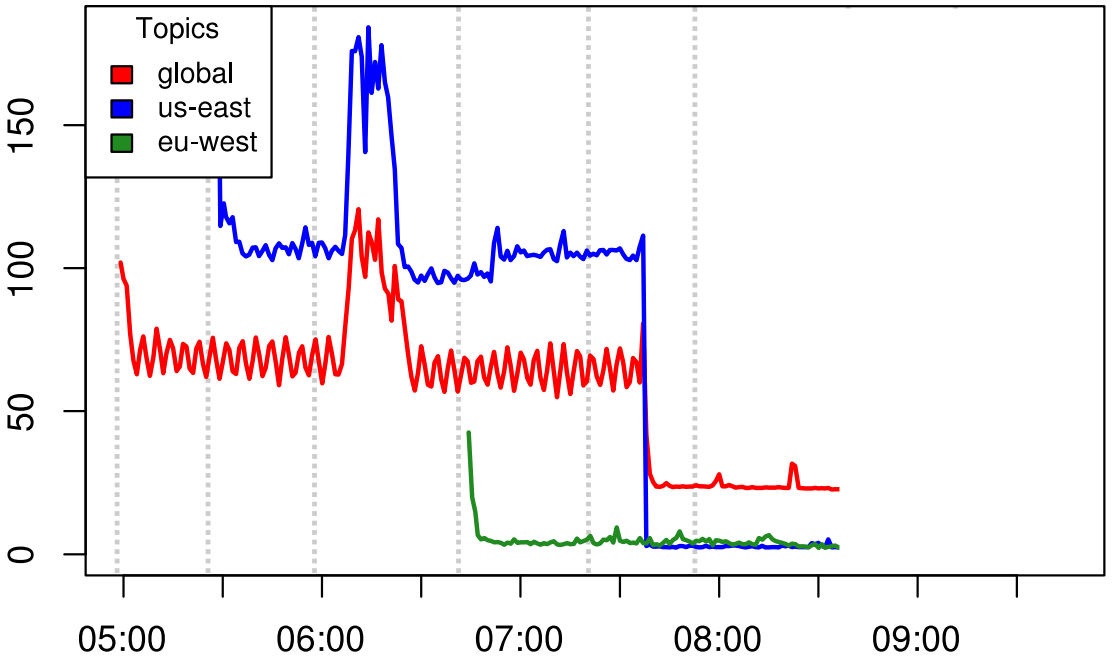
Controller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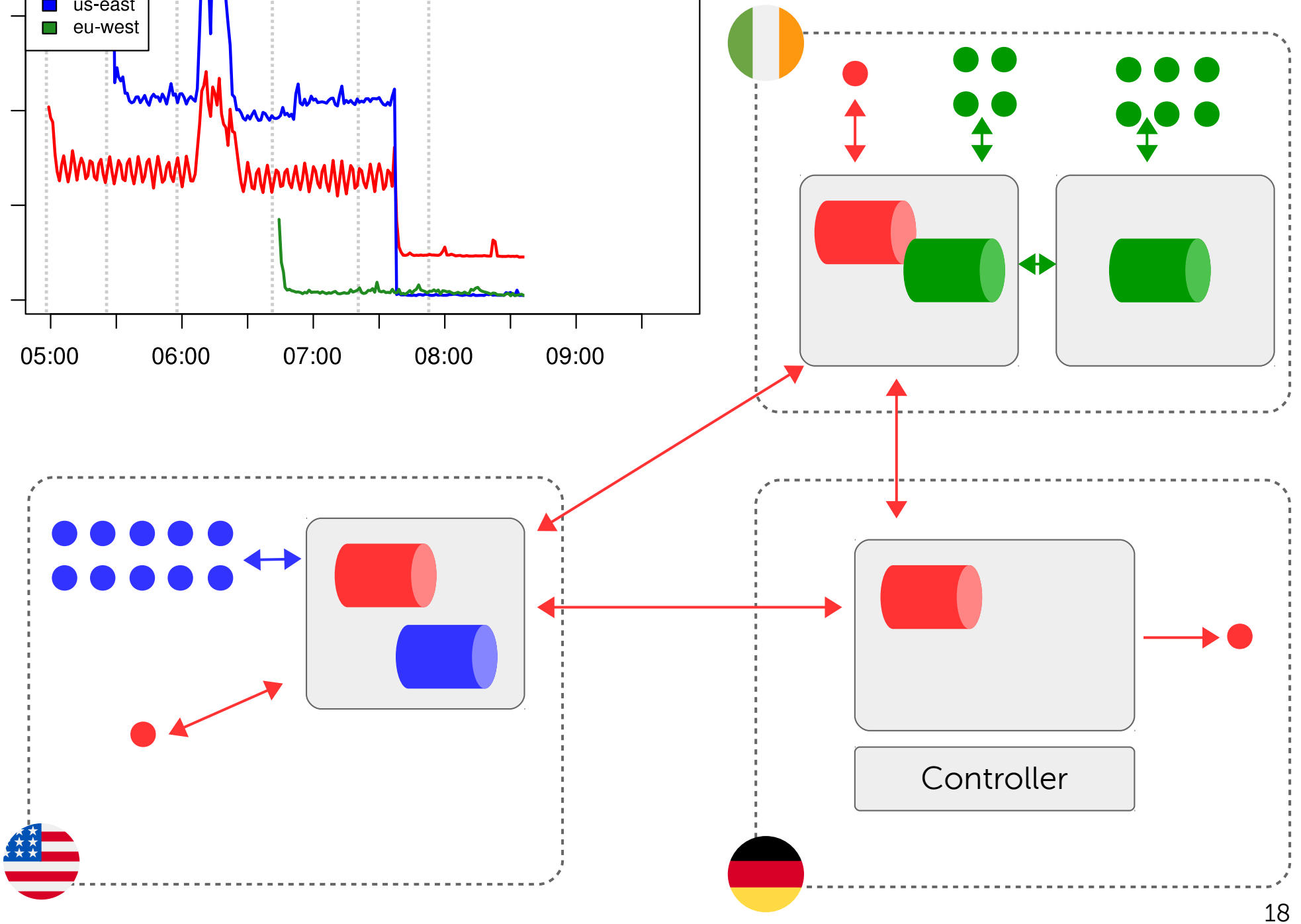
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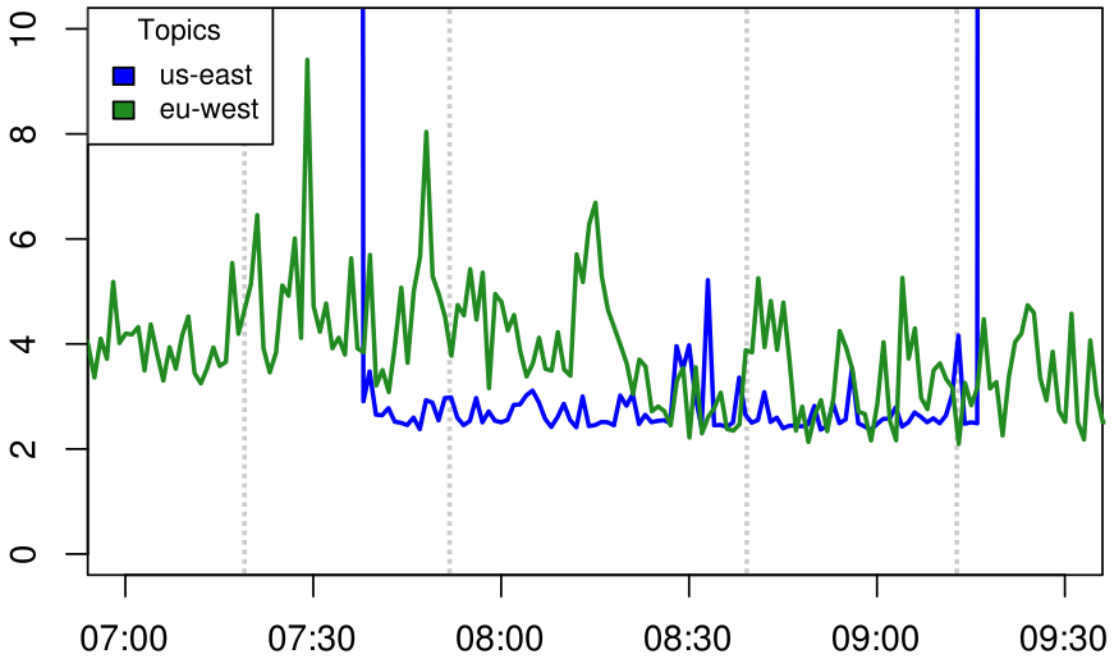

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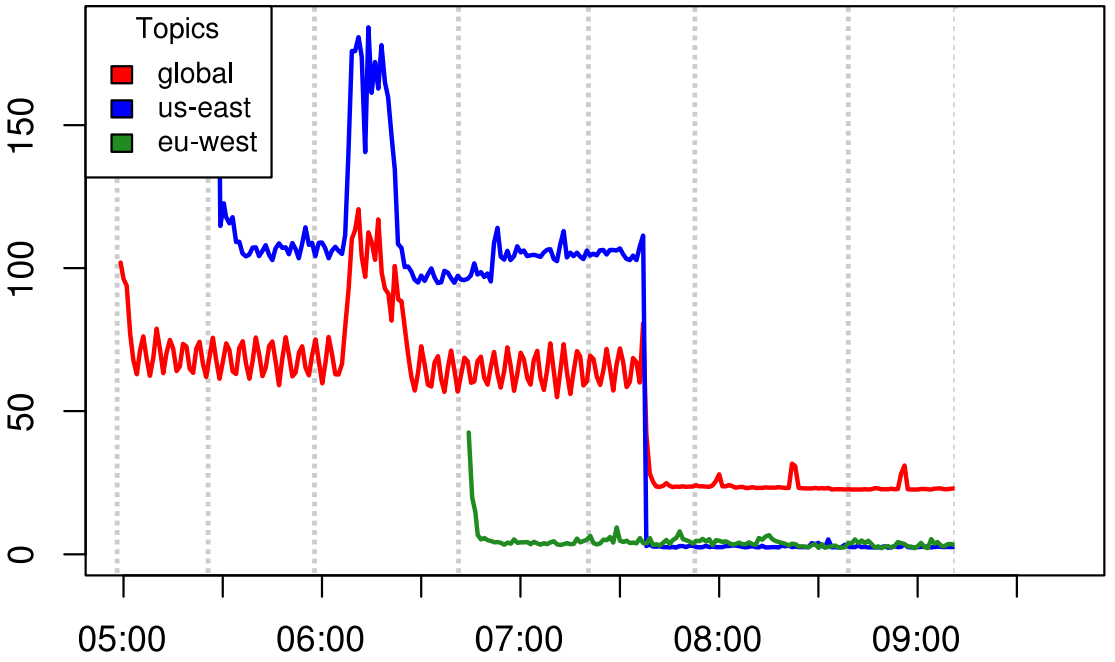
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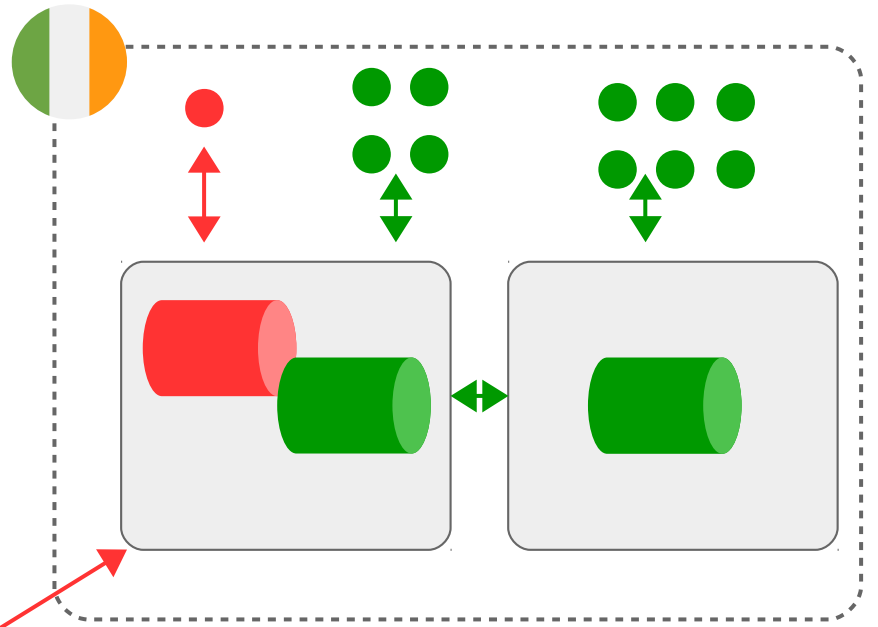

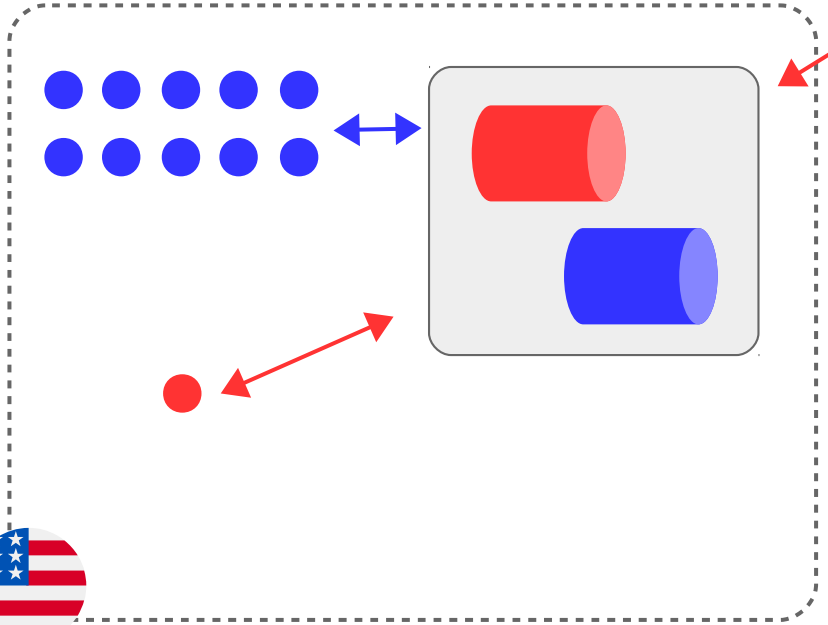

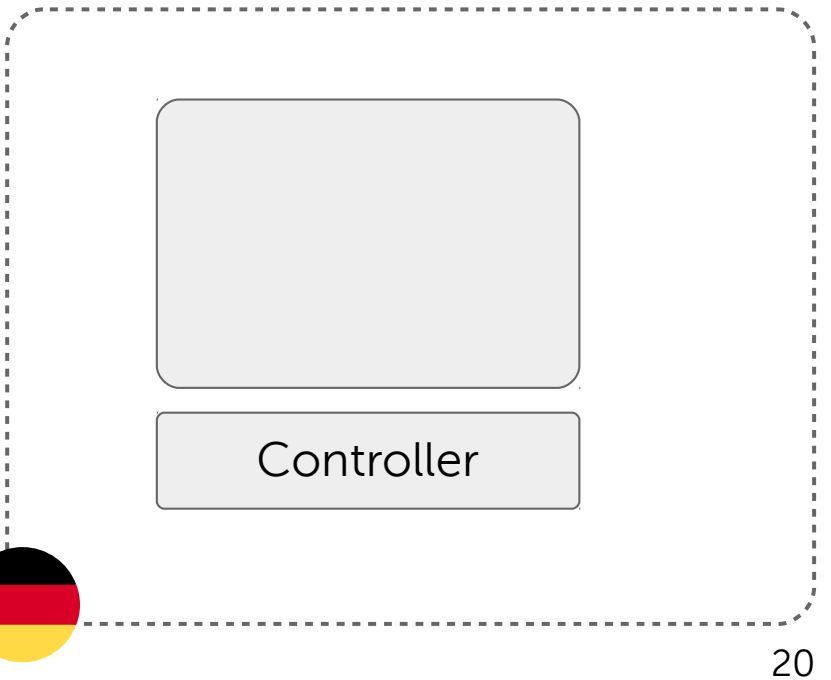
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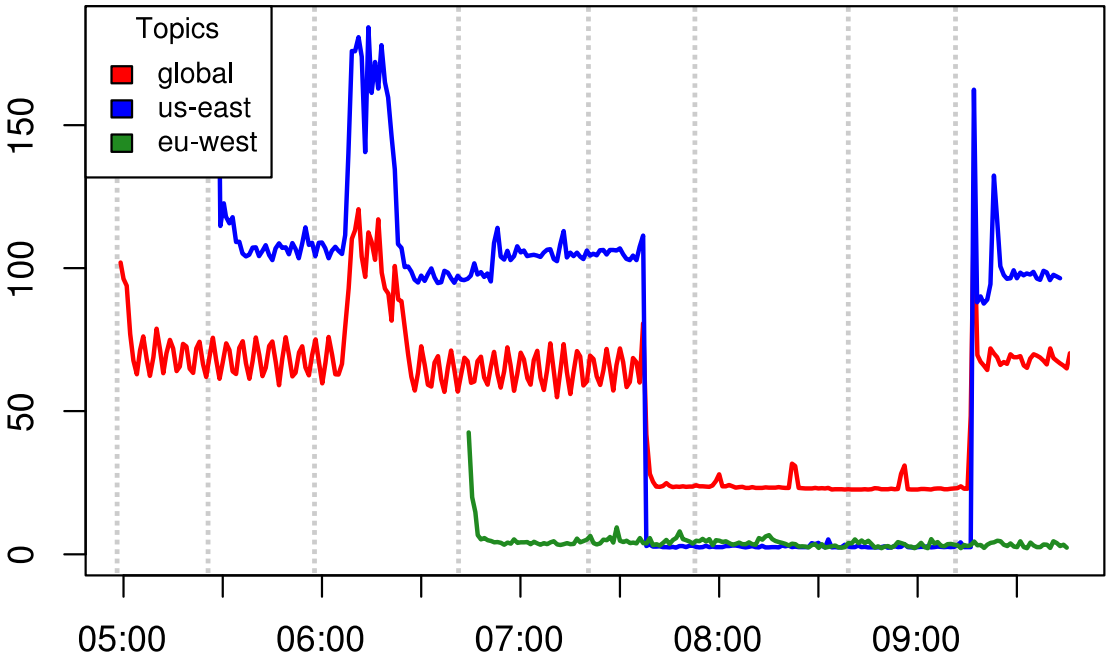
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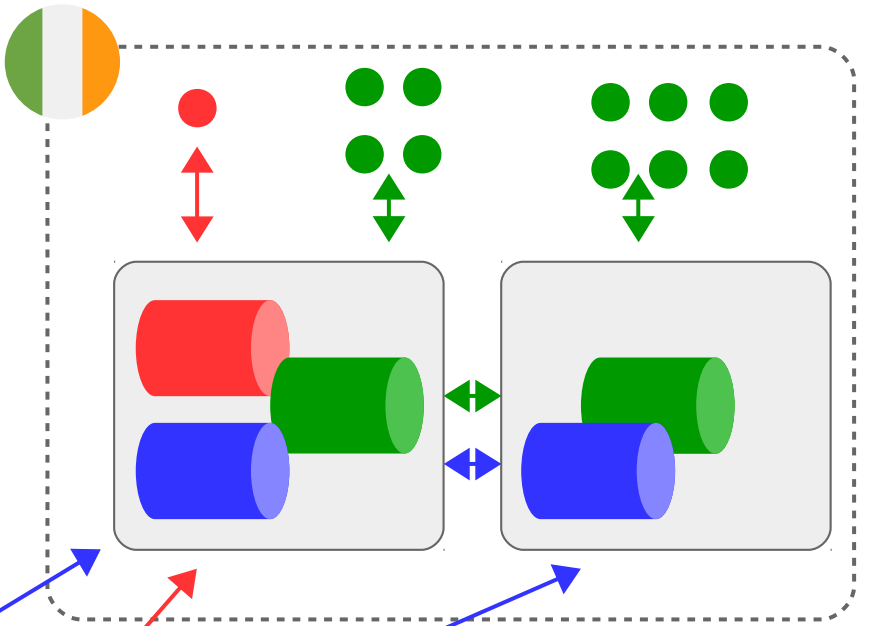
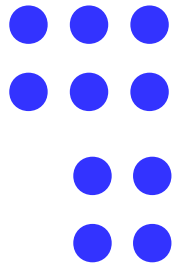
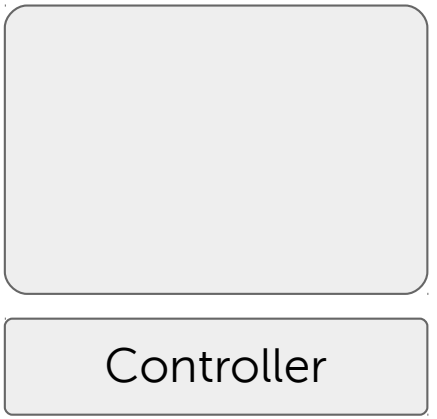
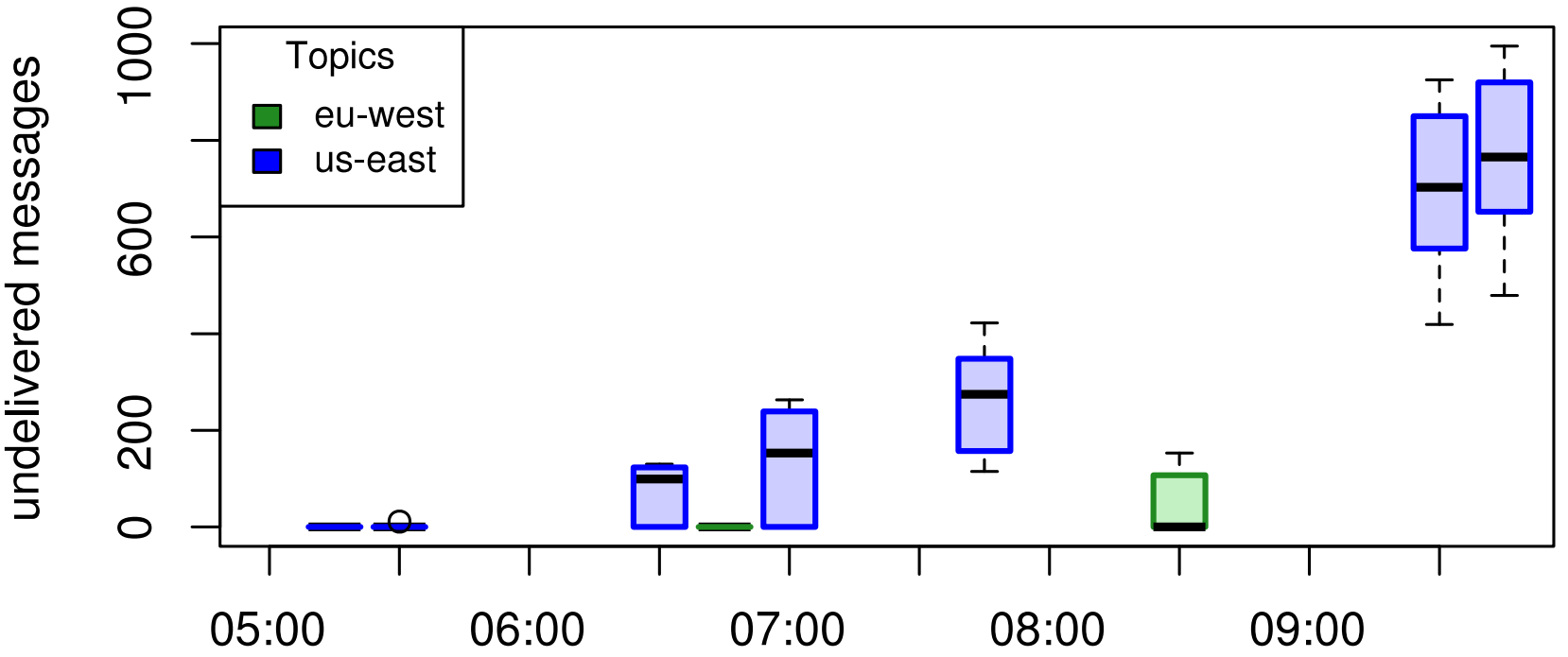




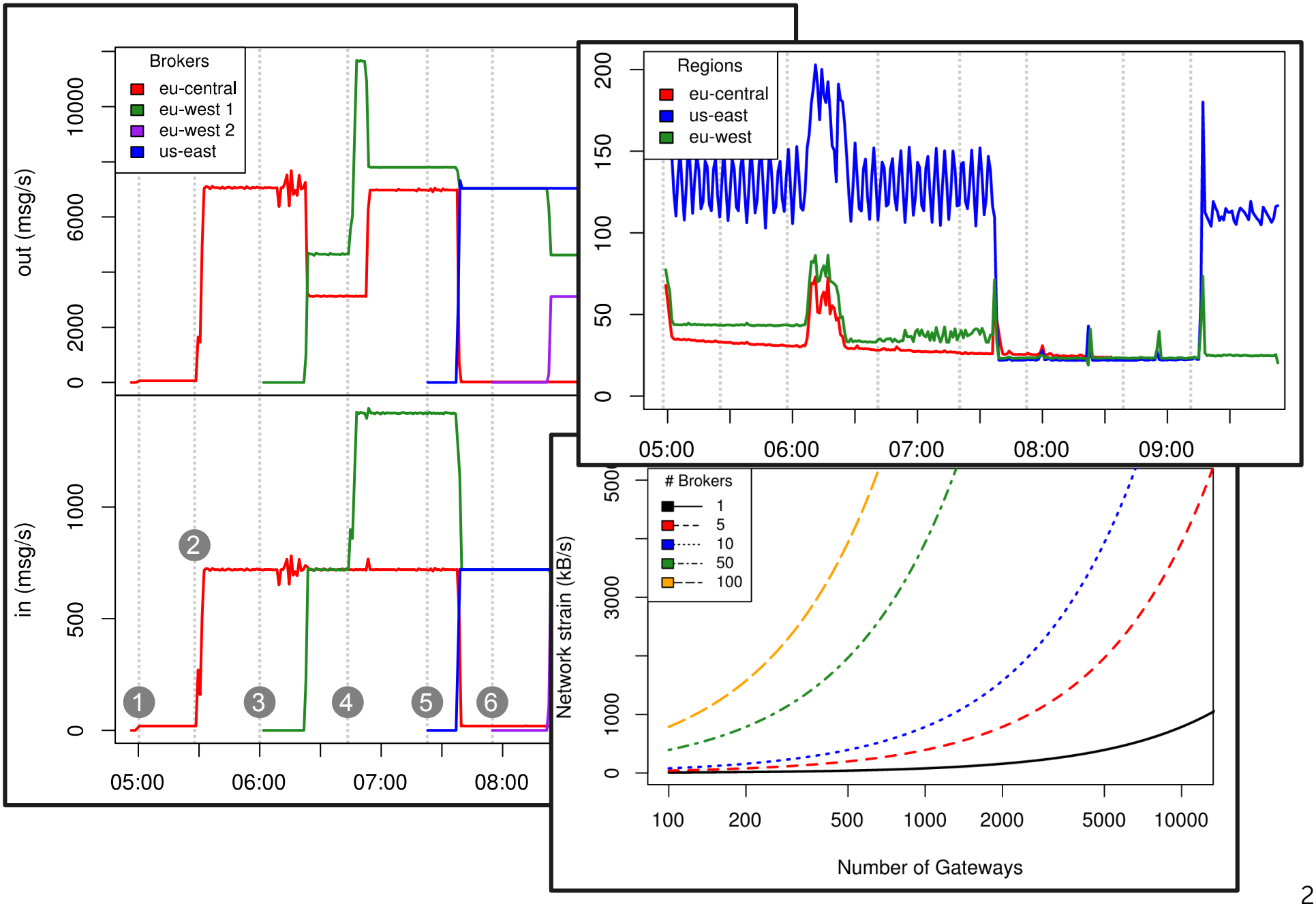

Controller

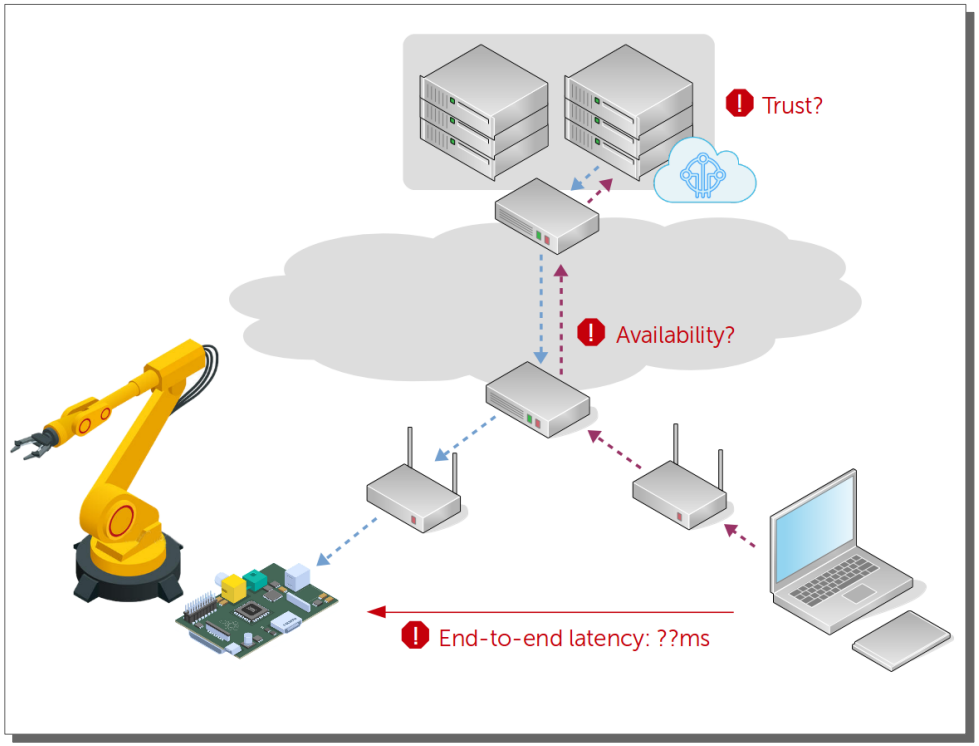
Message Loss

- Caused by subscriber mobility
- Guaranteed message delivery requires transactional reconnection

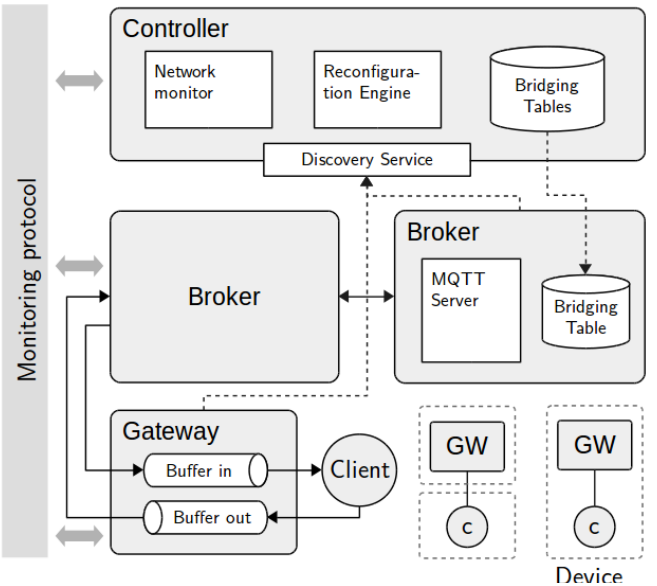


More Results in the Paper

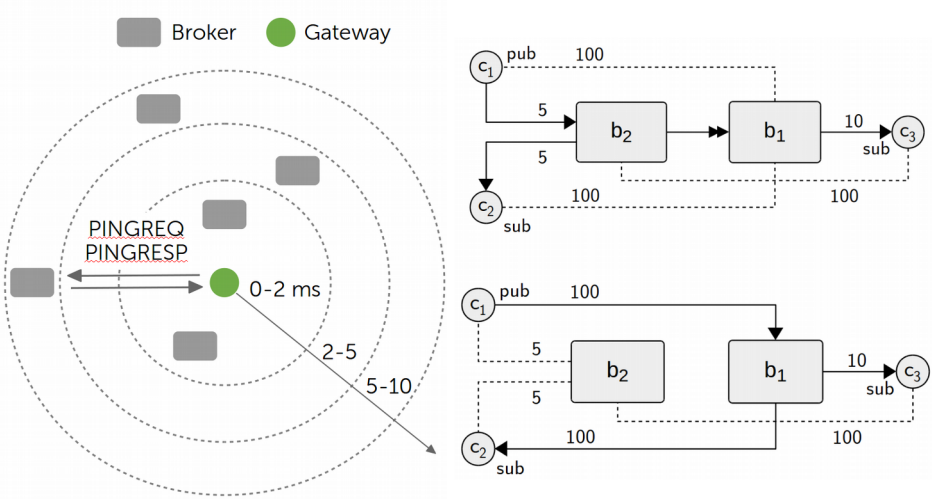




EMMA MQTT Middleware



QoS Monitoring & Reconfiguration



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dsg DISTRIBUTED SYSTEMS GROUP

Dipl.-Ing. (MSc)

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Research Assistant

TU Wien

Distributed Systems Group

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dsg.tuwien.ac.at/staff/trausch

Related Work – P2P Pub/Sub

NCA'05

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

Nuno Carvalho
University of Lisbon
nunomrc@di.fc.ul.pt

DEBS'05

Publisher Mobility in Distributed Publish/Subscribe Systems

Vinod Muthusamy†, Milenko Petrovic†, Dapeng Gao†, Hans-Arno Jacobsen†‡
Middleware Systems Research Group
nent of Electrical and Computer Engineering
‡Department of Computer Science
University of Toronto
petrovi,gilbert,jacobsen}@eecg.toronto.edu

has studied subscriber mobility [4, 5, 7], we are not aware of any that examines publisher mobility. We will see that this

MW'05

Opportunistic Overlays: Efficient Content Delivery in Mobile Ad Hoc Networks

Yuan Chen and Karsten Schwan

College of Computing, Georgia Institute of
{yuanchen, schwan}

Abstract. Current content-based pu
network environments with stable node
bile environments, one resulting probl
broker topologies and dynamic underly

PODC'07

Constructing Scalable Overlays for Pub-Sub with Many Topics

Problems, Algorithms, and Evaluation

Gregory Chockler Roie Melamed Yoav Tock
IBM Haifa Research Laboratory
{chockler,roiem,tock}@il.ibm.com

Roman Vitenberg
Department of Informatics,
University of Oslo, Norway
romanvi@ifi.uio.no

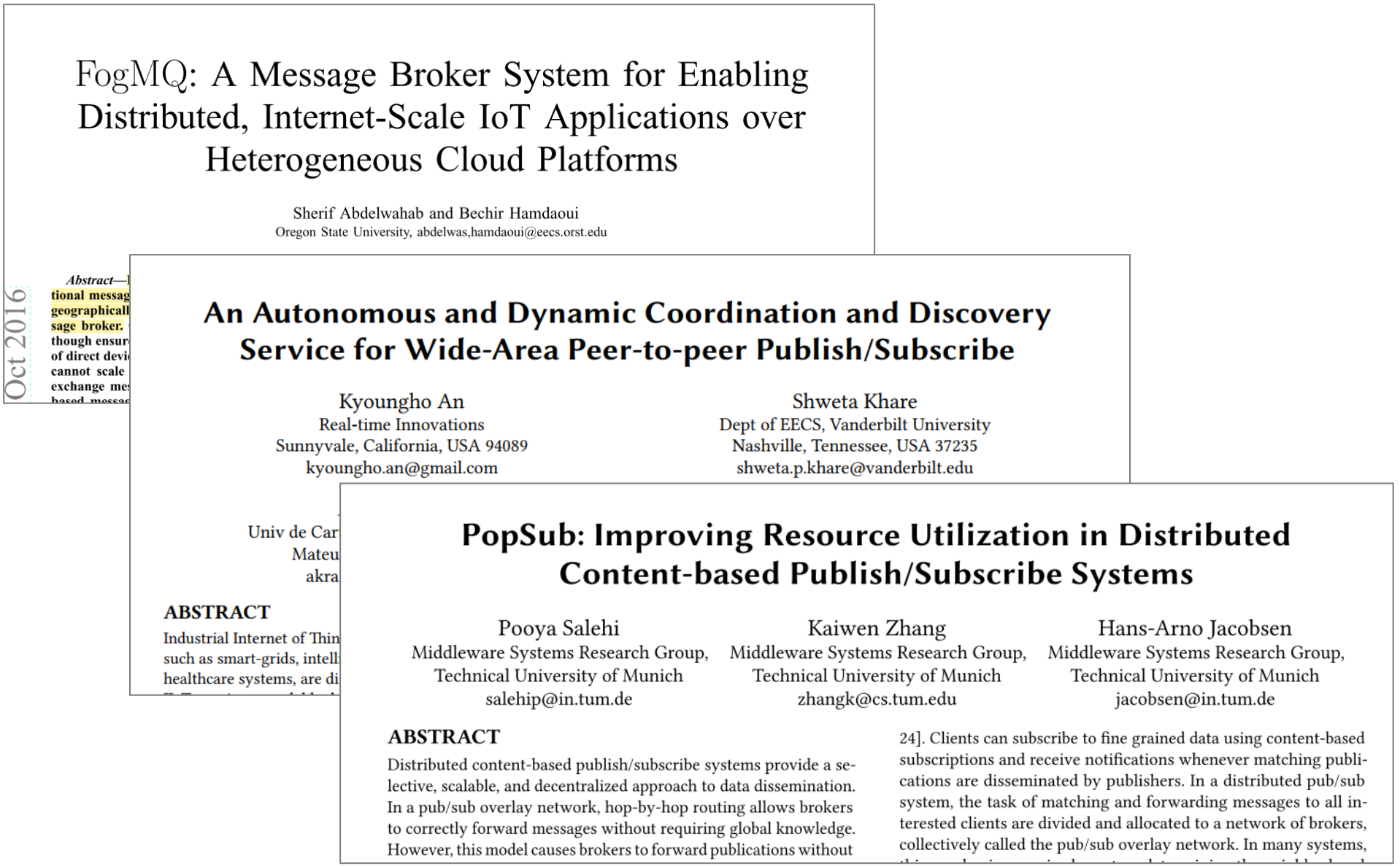
ABSTRACT

We investigate the problem of designing a scalable over-

Categories and Subject Descriptors

C.2.1 [**Computer-Communication Networks**]: Network

State of the Art – Research



FogMQ: A Message Broker System for Enabling Distributed, Internet-Scale IoT Applications over Heterogeneous Cloud Platforms

Sherif Abdelwahab and Bechir Hamdaoui
Oregon State University, abdelwas,hamdaoui@eecs.orst.edu

Oct 2016

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

Kyoungho An
Real-time Innovations
Sunnyvale, California, USA 94089
kyoungho.an@gmail.com

Shweta Khare
Dept of EECS, Vanderbilt University
Nashville, Tennessee, USA 37235
shweta.p.khare@vanderbilt.edu

ABSTRACT

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

Pooya Salehi
Middleware Systems Research Group,
Technical University of Munich
salehip@in.tum.de

Kaiwen Zhang
Middleware Systems Research Group,
Technical University of Munich
zhangk@cs.tum.edu

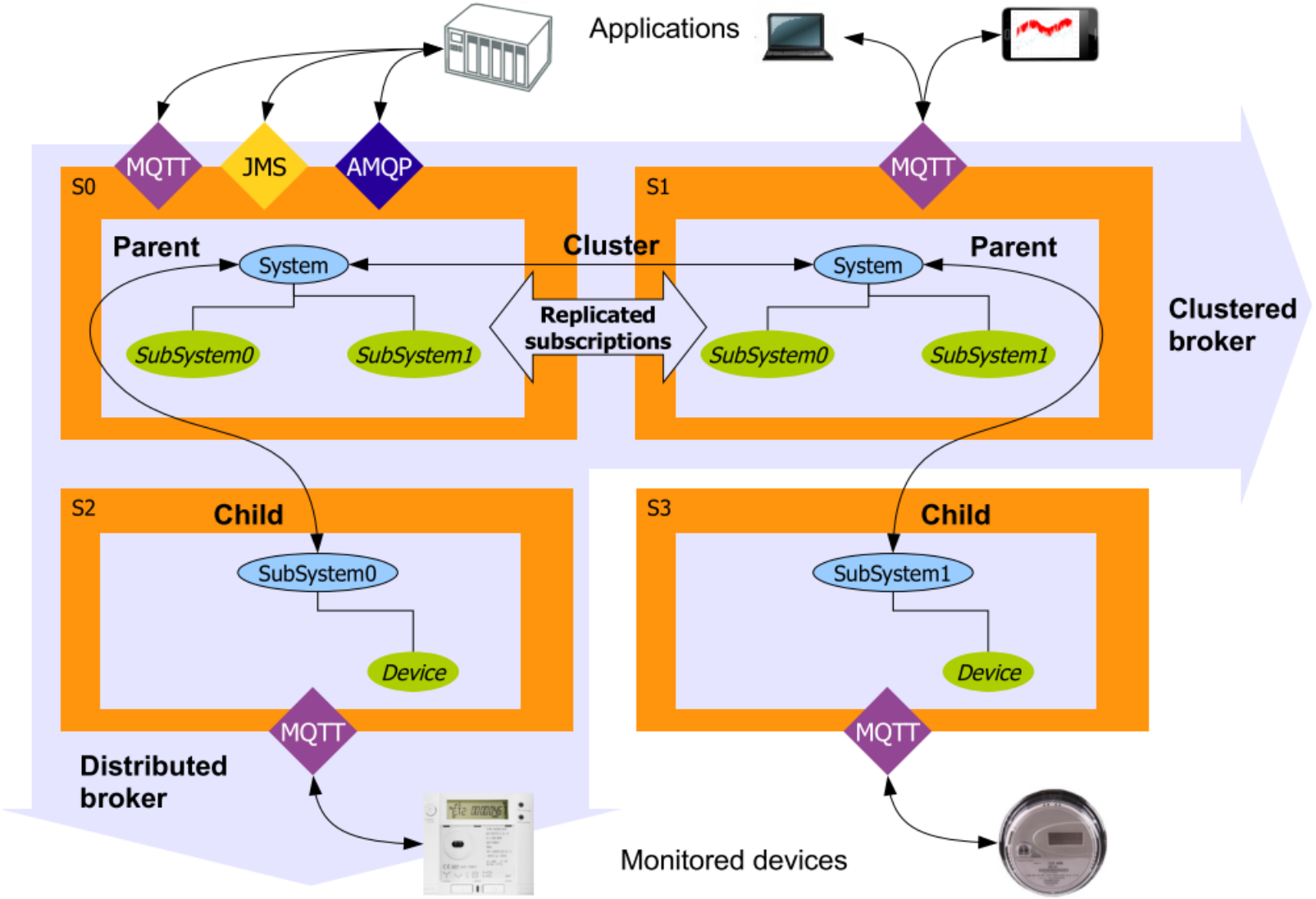
Hans-Arno Jacobsen
Middleware Systems Research Group,
Technical University of Munich
jacobsen@in.tum.de

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,

State of the Art – The Real World



ScalAgent. **JoramMQ, a distributed MQTT broker for the Internet of Things**. White paper. 2014.