

A large rocket, likely a SpaceX Falcon 9, is shown launching from a launch pad. The rocket is angled upwards towards the top left of the frame. It has two side boosters and a central core. A bright orange and yellow flame is visible at the base of the rocket. The background is a blue and white cloudy sky.

Build Your Own IoT Cloud

Christian Götz & Dominik Obermaier | dc-square

Who are we?



CHRISTIAN GÖTZ
@goetzchr



DOMINIK OBERMAIER
@dobermai

dc-square



HiveMQ



HiveMQ
Plugin Development



IoT Consulting



Workshops & Trainings

Goal of the Workshop

1. Learn components of an IoT platform
2. Implement your own platform

HTTP ?

IoT?

MQTT ?

Eclipse Paho ?

Dropwizard ?

HiveMQ ?

Development Environment

- Java JDK 7
- Eclipse JEE Luna
- Maven
- HiveMQ 2.1.0 Bundle installed & running
- MySQL database
- MySQL database viewer
- Current Web browser

Everybody should have

- Eclipse JEE running ✓
- Copied our prepared Maven Repo to `~/.m2` ✓
- HiveMQ running ✓
- MySQL database running ✓
- MySQL viewer installed ✓
- Current Web browser installed ✓

Clone our Repo



[https://github.com/dc-square/
build-your-own-iot-cloud-
workshop](https://github.com/dc-square/build-your-own-iot-cloud-workshop)

or

USB Drive from us

IoT Cloud Platform

Internet of Things

2020

20,000,000,000 devices

250 new devices every second

every person owns \approx 7 devices

<http://blogs.cisco.com/news/cisco-connections-counter/>
http://www.cisco.com/web/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf

WTF?

THINGS?



Consumer Goods



Industry Machines



objects in our everyday life



logistics has a lot of things...

Technology that connects
Devices
over wired or wireless
communication

How ???

Protocols?

Management?

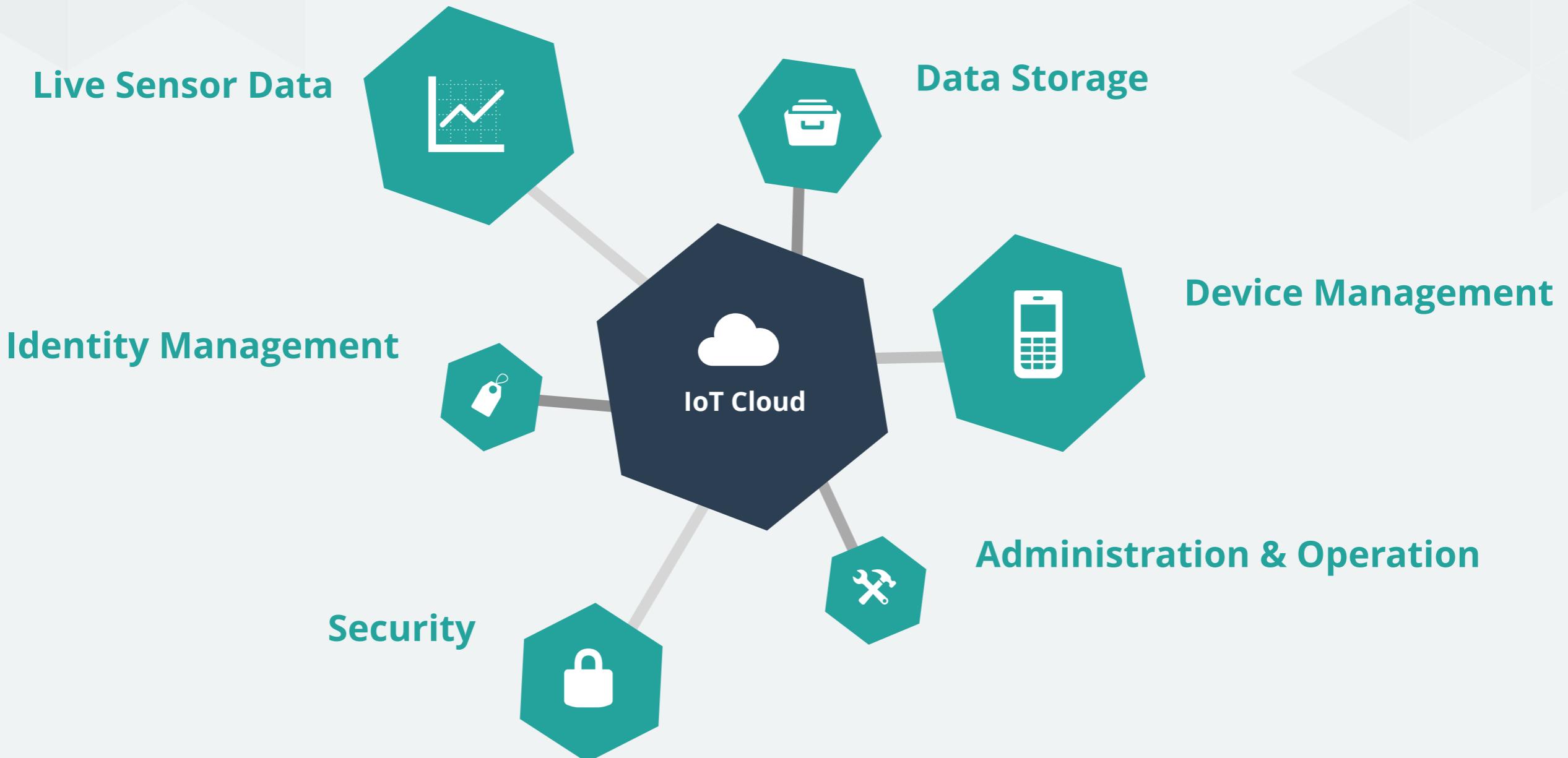
Live Data vs Historical Data?

Security?

Data Storage?

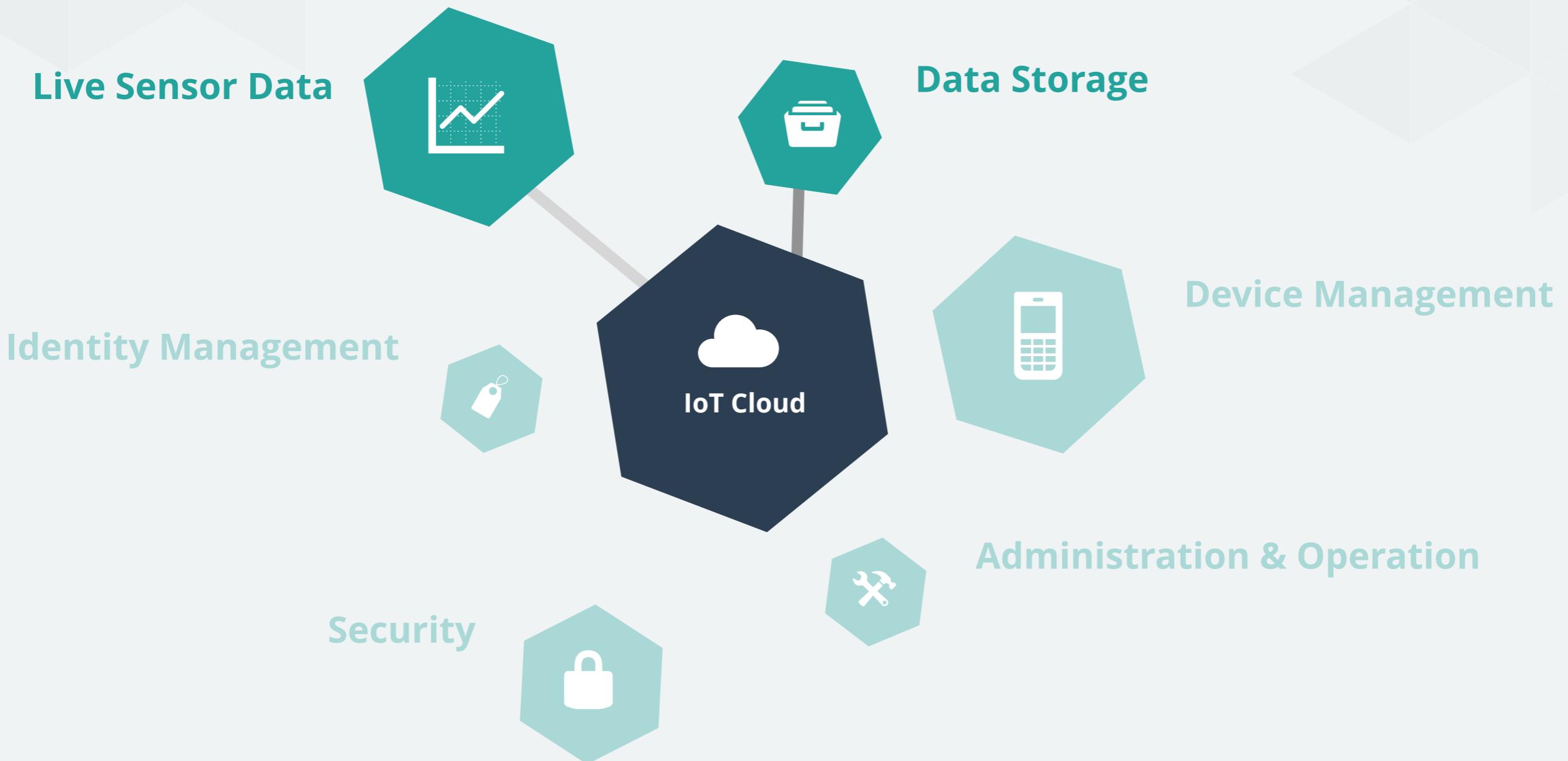
IoT Cloud Platform

Components



IoT Cloud Platform

Components that we implement today



Used Technology

Prototype



Eclipse Paho,
HTTP
Devices

HiveMQ
MQTT Broker



Dropwizard
REST API



HTML/JS
Web App

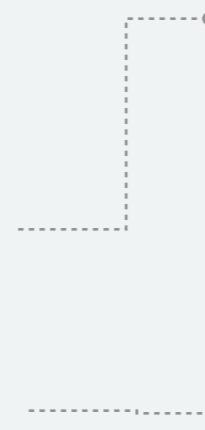


Used Technology

Devices



Eclipse Paho,
HTTP
Geräte



Weather Stations are sending Data (MQTT)

- Simulation of the Weather Stations with *Eclipse Paho*

- other devices only speak HTTP

Used Technology

HiveMQ



HiveMQ

HiveMQ
MQTT Broker

- **MQTT broker responsible for exchange of messages**

- **Persists Messages to Database**

Used Technology

Dropwizard



Dropwizard
REST API

- Provide Access to historical Data
- Sends ingoing data to HiveMQ

Used Technology

Web Dashboard



HTML/JS
Web App

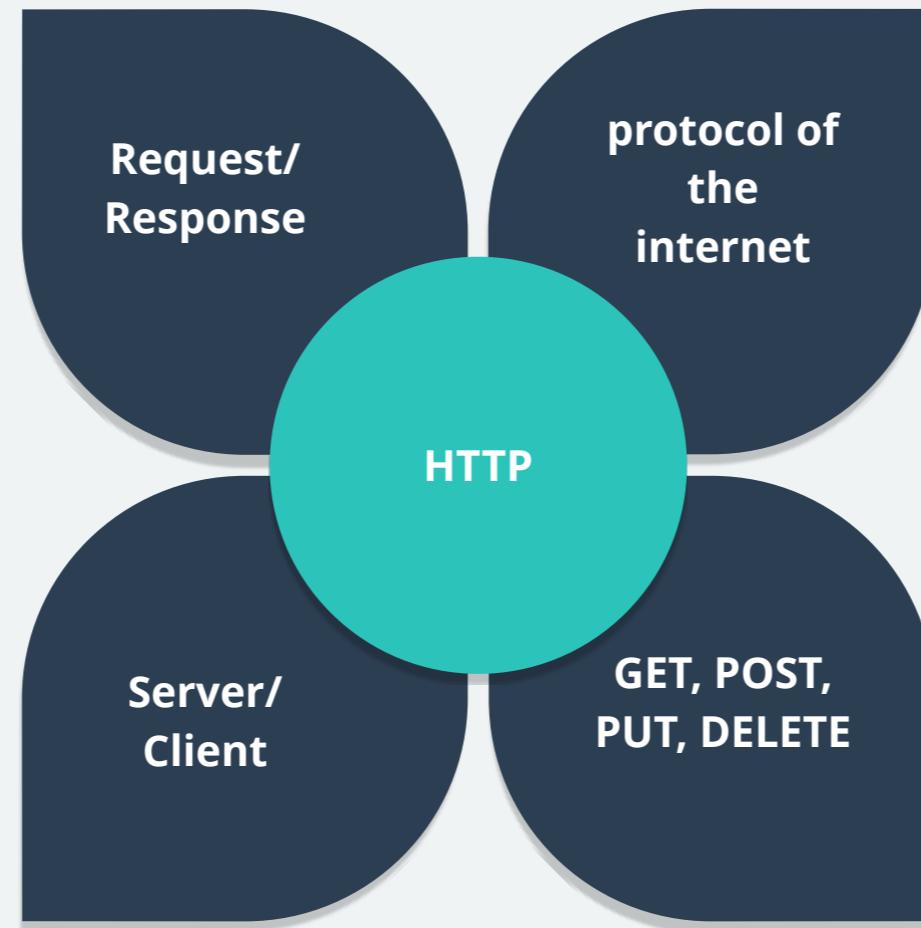
- Live Data from MQTT
- Historial Data over the REST API

Part 1: Devices

MQTT, HTTP

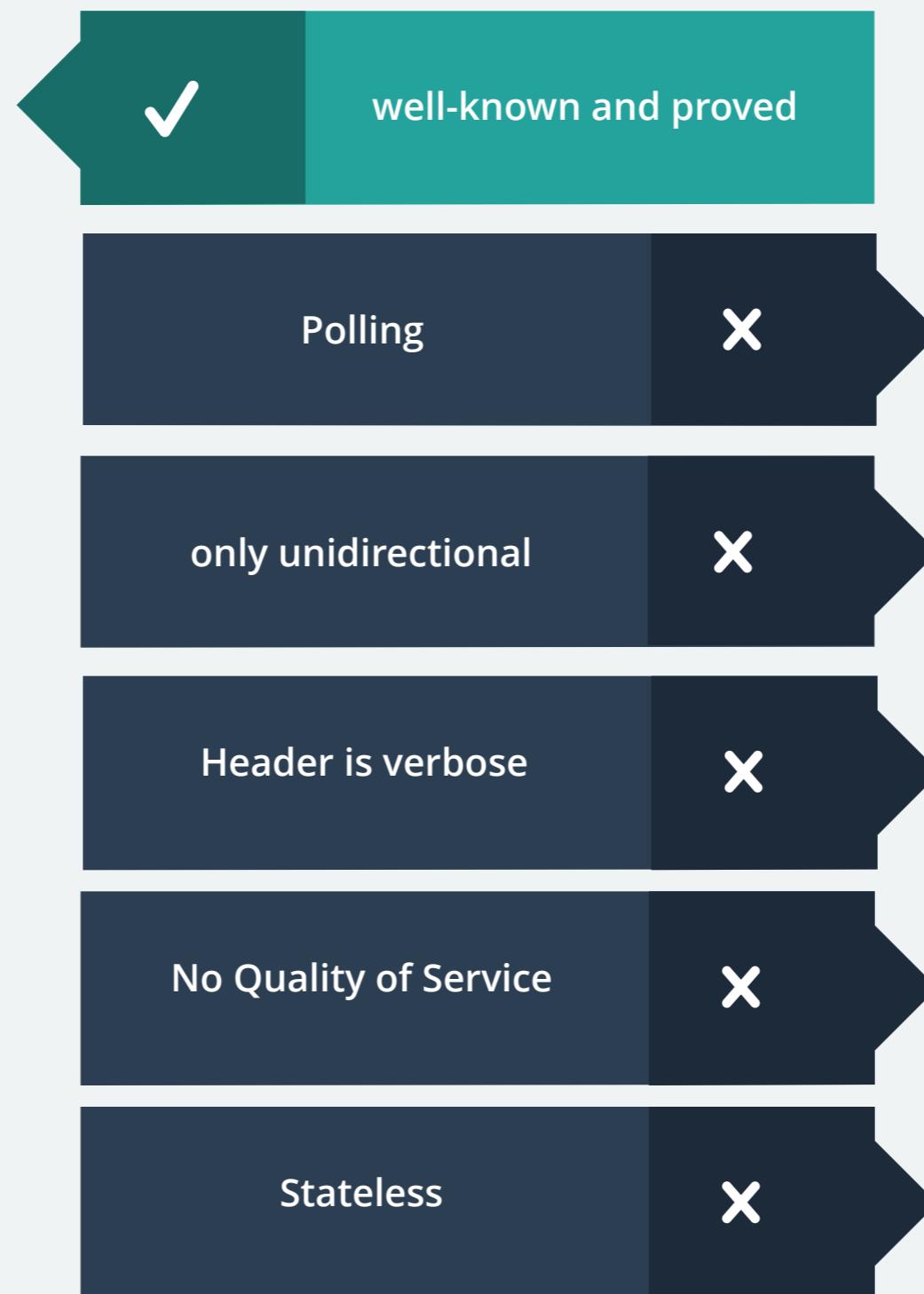
HTTP

Facts

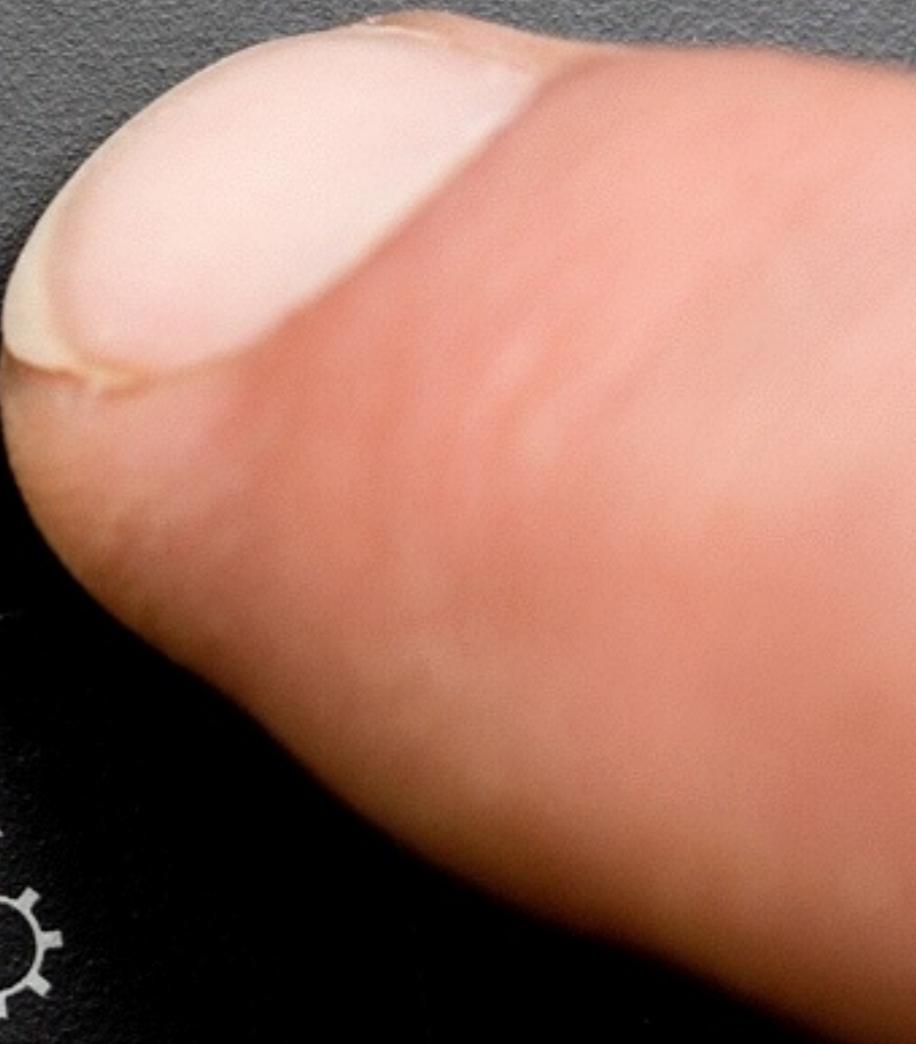


HTTP in the IoT

advantages/disadvantages



Paradigm shift





Subscribe

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semper iaculis at enim feugiat, scelerisque ullamco
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ante. Proin volutpat eros vitae nisi elementum sus
pellentesque adipiscing sed turpis consequat sus
pense. Fusce rhoncus ac ac nec facilisis. Aen
condimentum consequat elit, nec condimentum et.

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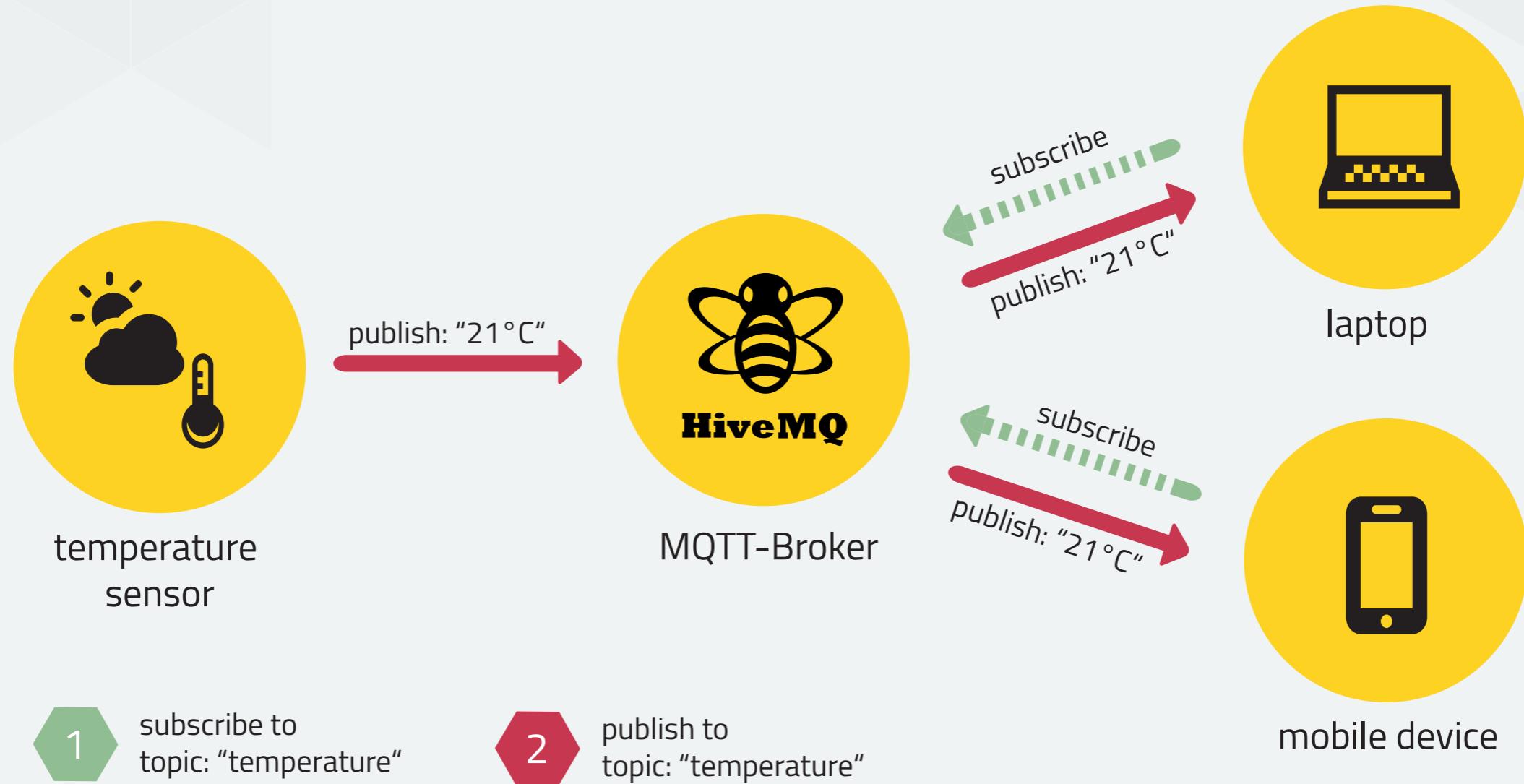
Publish



MQTT

MQTT

Publish/Subscribe



MQTT

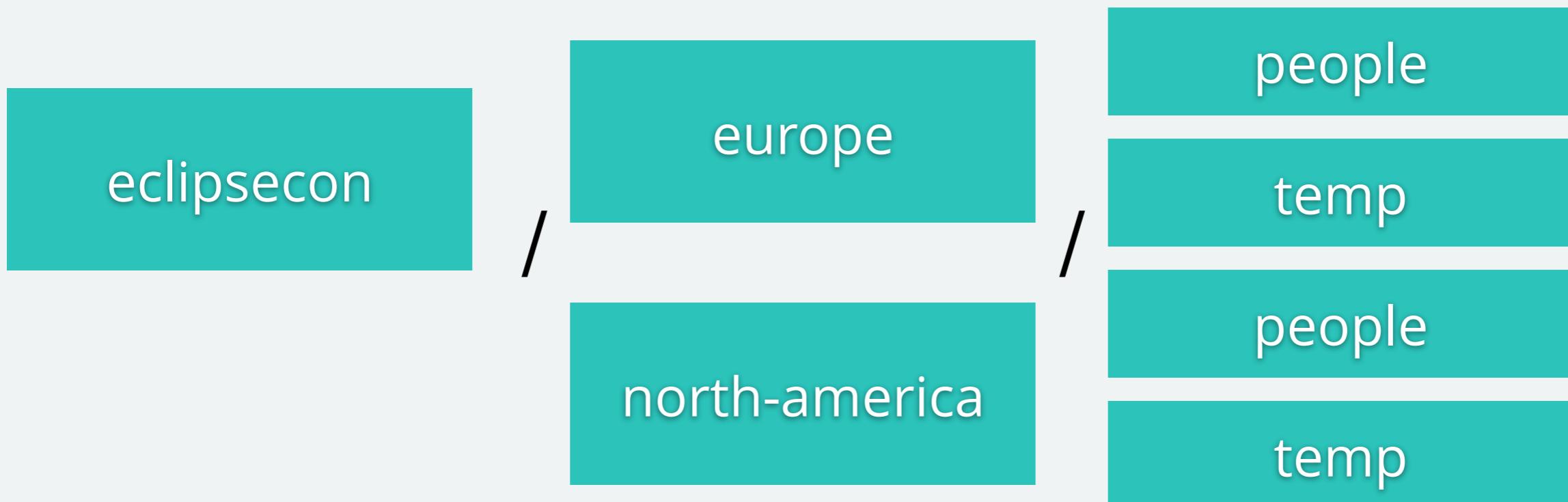
Topic Tree



MQTT

Simple Topic

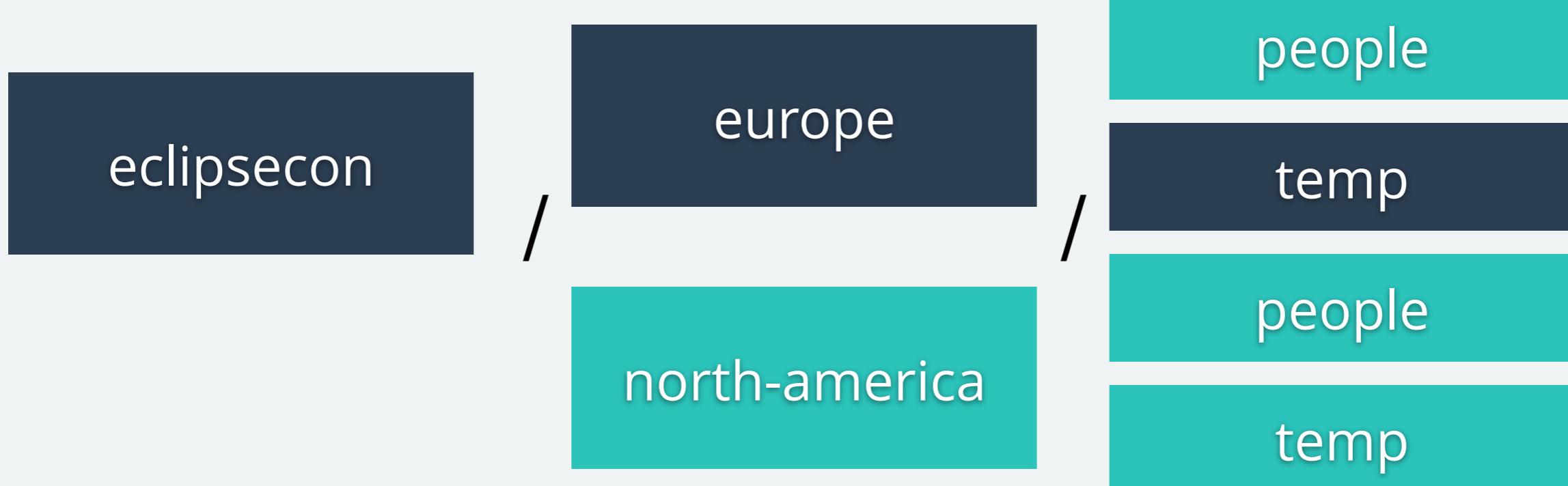
eclipsecon/europe/temp



MQTT

Simple Topic

eclipsecon/europe/temp



MQTT

Single Level Wildcard

eclipsecon/+temp



MQTT

Single Level Wildcard

eclipsecon/+temp



MQTT

Multilevel Wildcard

eclipsecon/#



MQTT

Multilevel Wildcard

eclipsecon/#



also possible is #

MQTT

at a glance

Easy

Connect, Publish, Subscribe, Unsubscribe,
Disconnect



based on TCP

Port 1883



Minimal Overhead

at best only 2 Bytes



Messaging Protocol

Exchange of Messages over Topics, Configurable
Queuing

Publish/Subscribe

Clients subscribe to topics, which clients are
publishing to

Made for unreliable networks

Individual guarantees for different clients

MQTT History

Timeline



1999

Invented by
IBM/Arccom



2013

Eclipse IoT



2015



2011

MQTT released
royalty free



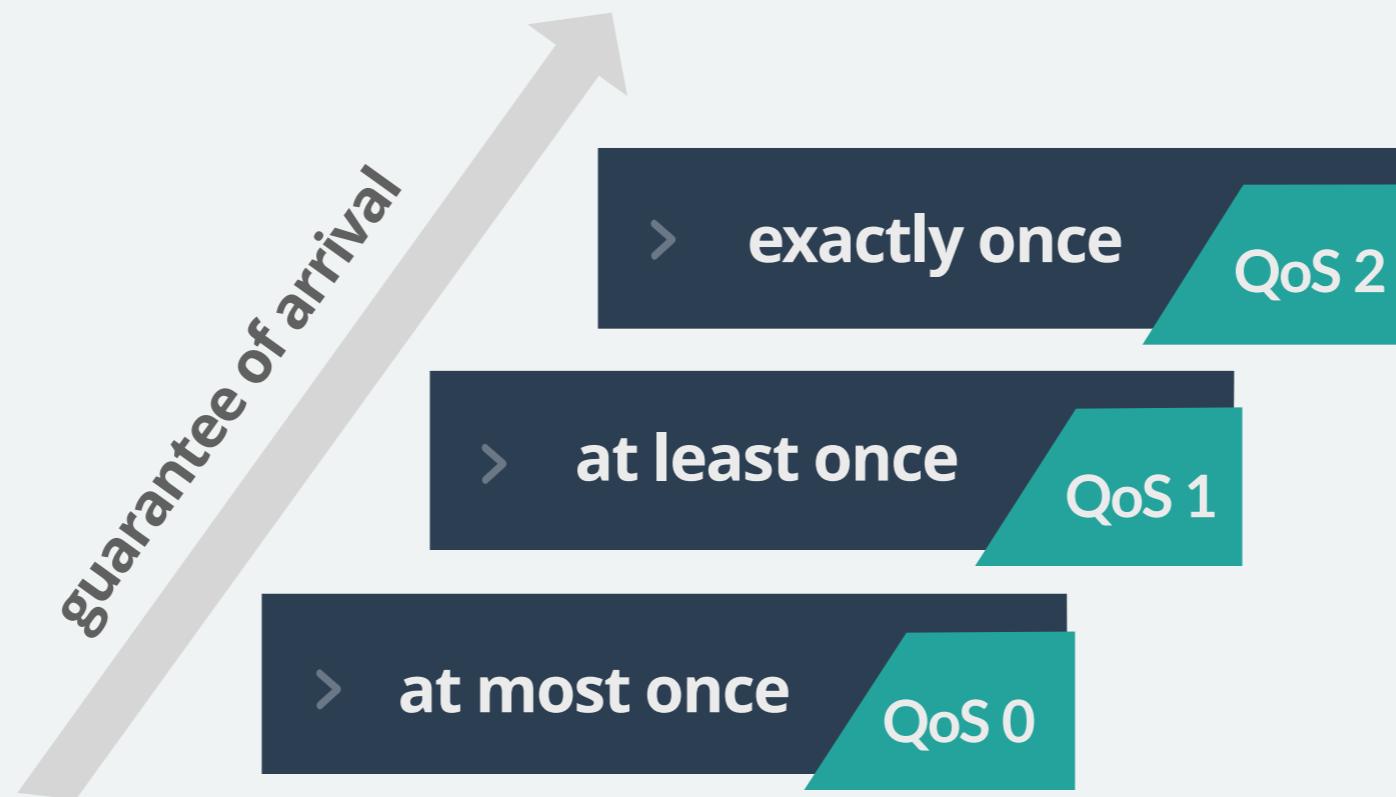
The Organization for the Advancement of Structured Information Standards

2014

Standard

MQTT - Quality of Service

Feature



MQTT - LWT

Feature

Device 1

- 1 **connect**
- 2 **connack**
- 3 **publish**
- 4 **offline**

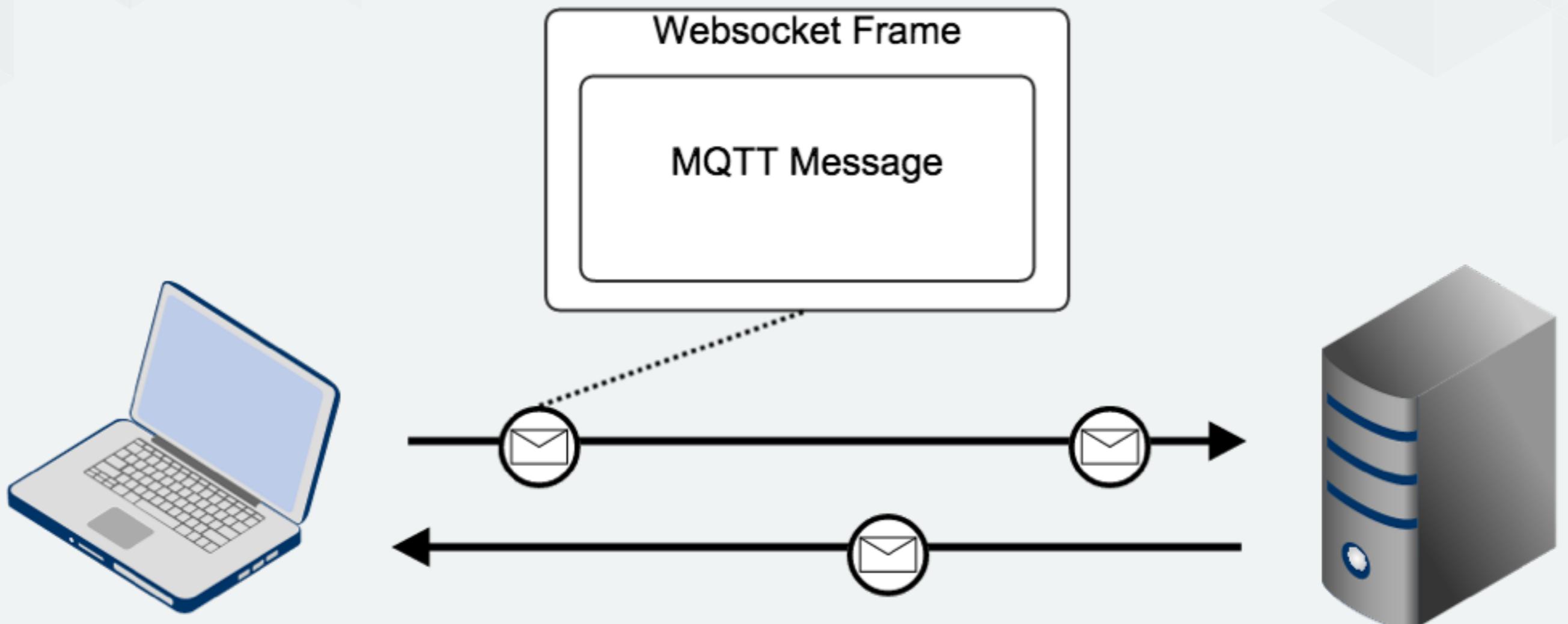
- > **LWT**
Topic: device1/status
Message: offline
- < **ok**
- > **Message**
Topic: device1/status
Message: offline

HiveMQ

-
-
-
- > **LWT Message**
Topic: device1/status
Message: offline

MQTT over Websockets

Feature



MQTT Broker

overview

Heart of MQTT



Distributing messages to subscribers



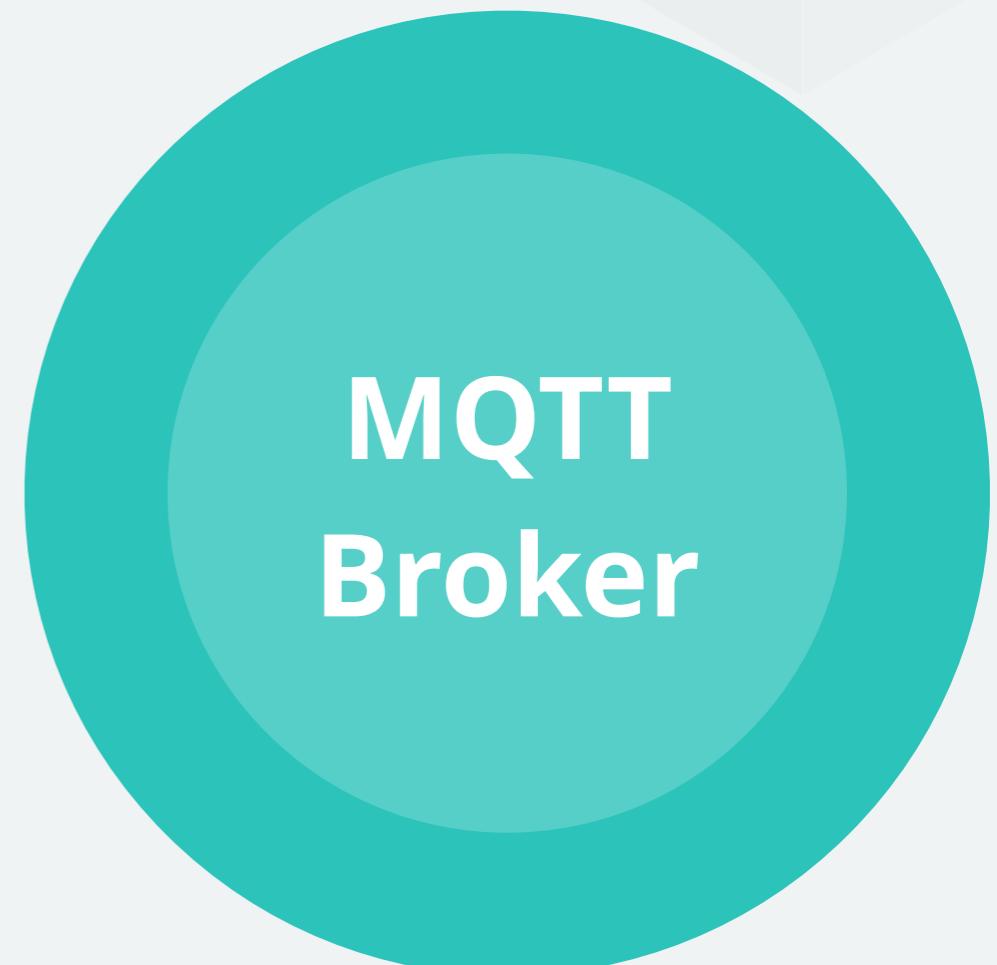
Uses Topics for Routing



Topics are lightweight

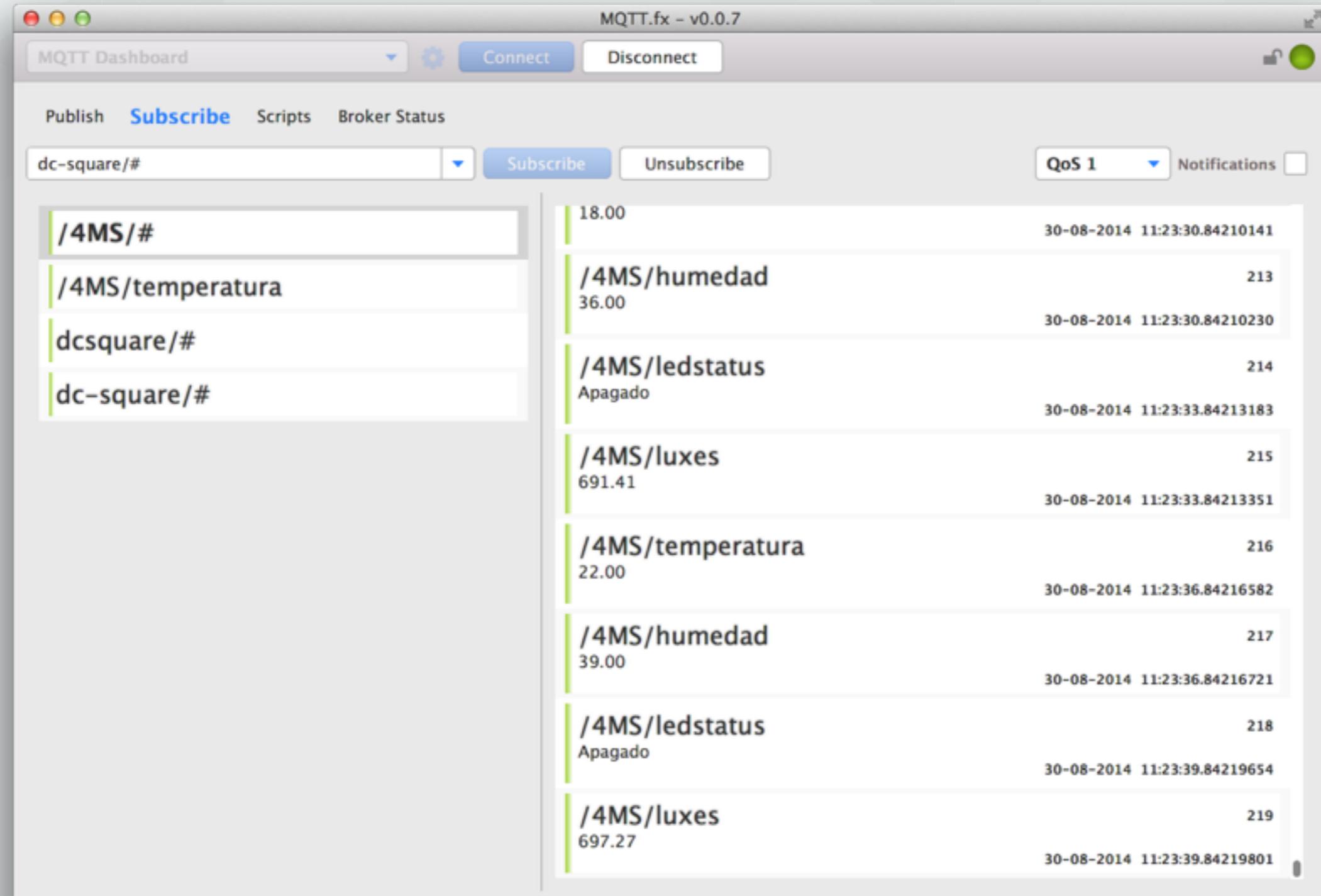


Custom Functionality



MQTT GUI Tools

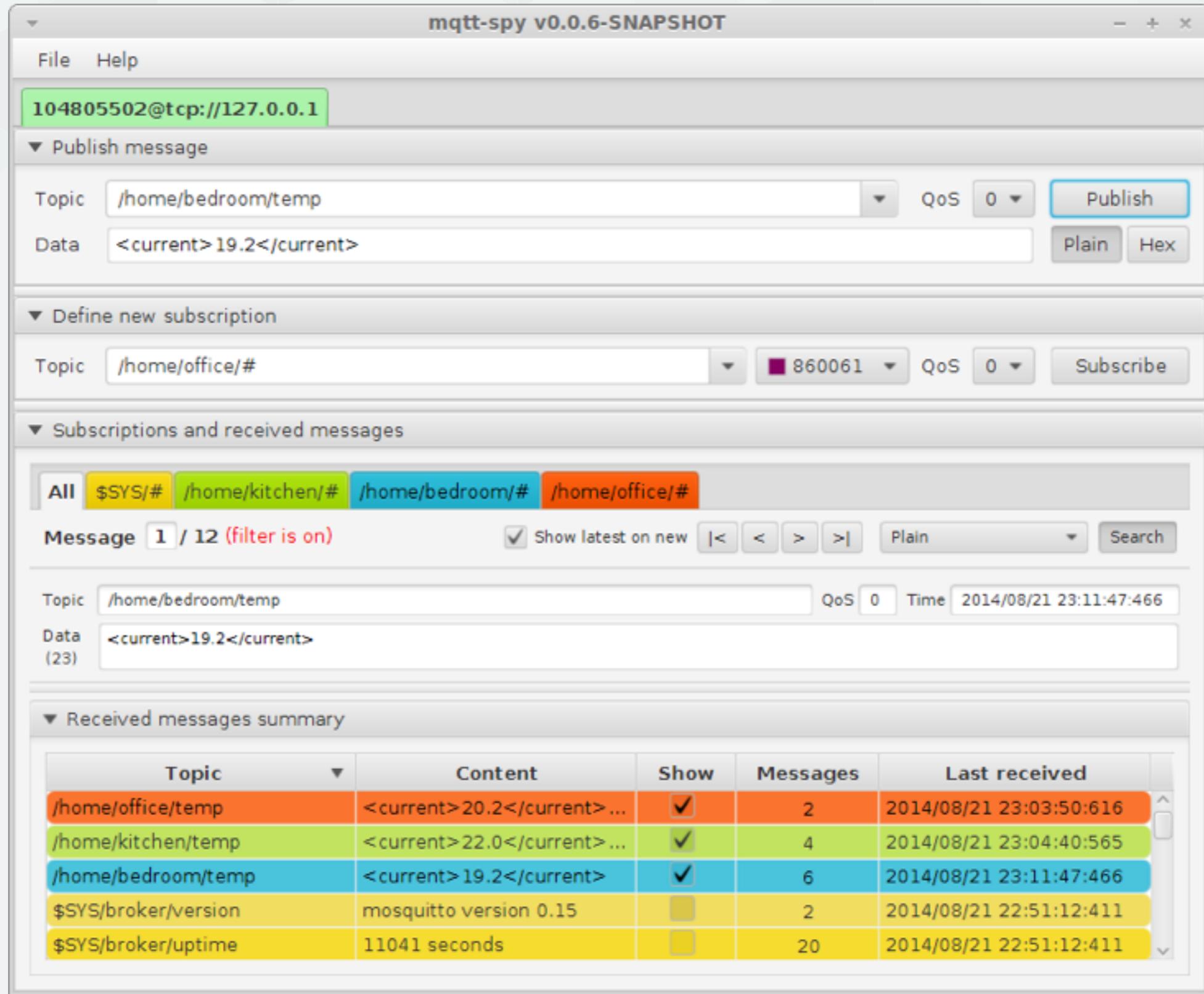
MQTT.fx 0.0.7



<http://www.jensd.de/wordpress/?p=1423>

MQTT GUI Tools

MQTT spy 0.0.6



<https://code.google.com/p/mqtt-spy/>

MQTT CMD Tools

`mosquitto_pub/_sub`

Mosquitto Clients

Publish/Subscribe

```
$ mosquitto_pub -h broker.mqttdashboard.com  
-t iotcloud/test -m "test" -q 1
```

http://mosquitto.org/man/mosquitto_pub-1.html

```
$ mosquitto_sub -h broker.mqttdashboard.com  
-t iotcloud/test
```

http://mosquitto.org/man/mosquitto_sub-1.html

MQTT Libraries

Eclipse Paho



Open Source

“Reference Implementation”

Many languages: Java, Javascript,
Lua, C, C++, Go, Python

Active Community

JS Library uses MQTT over
Websockets

MQTT Libraries

FuseSource MQTT Client



MQTT-Client

Open Source

3 API Styles

Automatic Reconnect

Maven Central

Less active Community

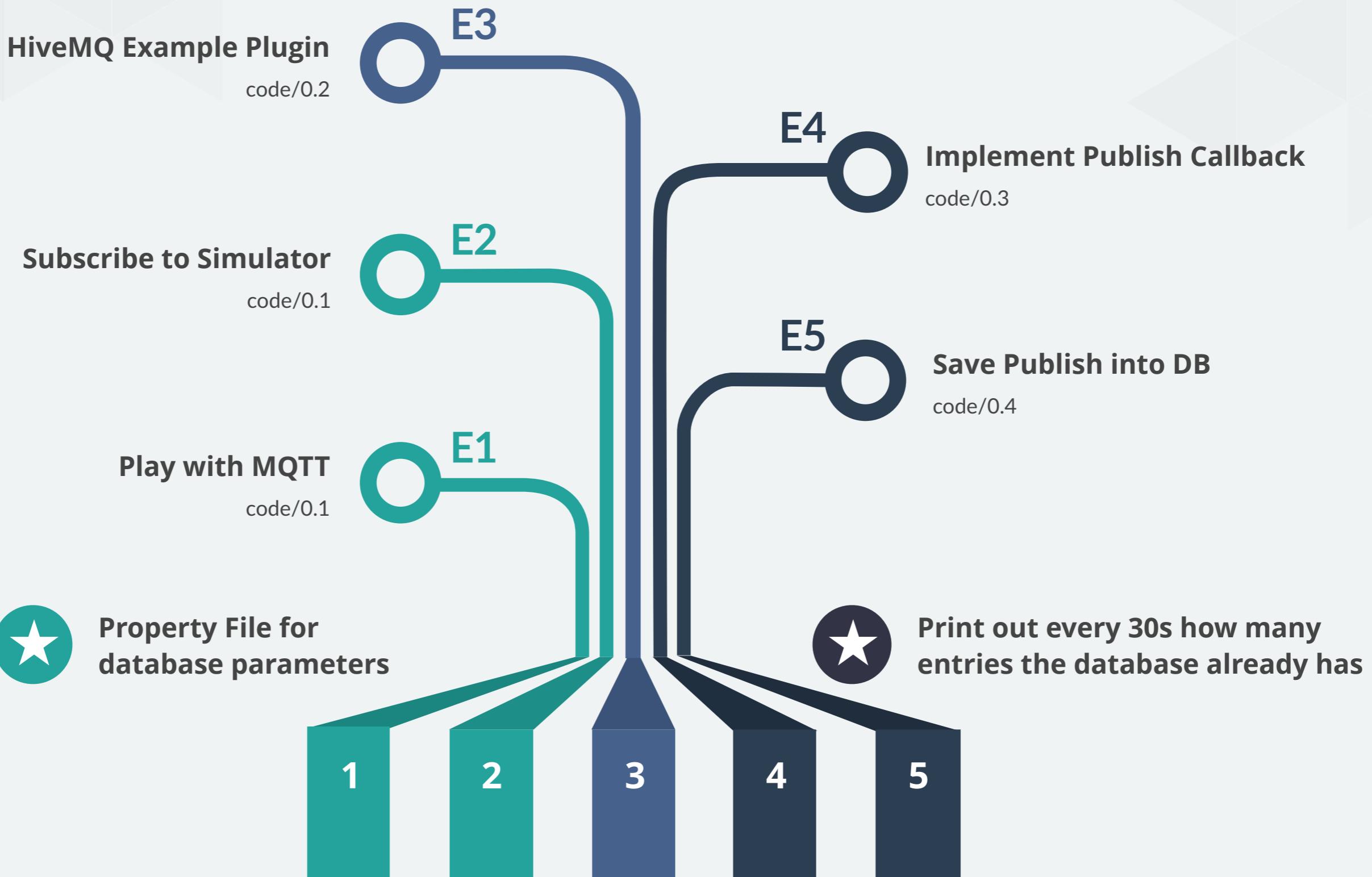


Ready for some code??

Let's get started :)

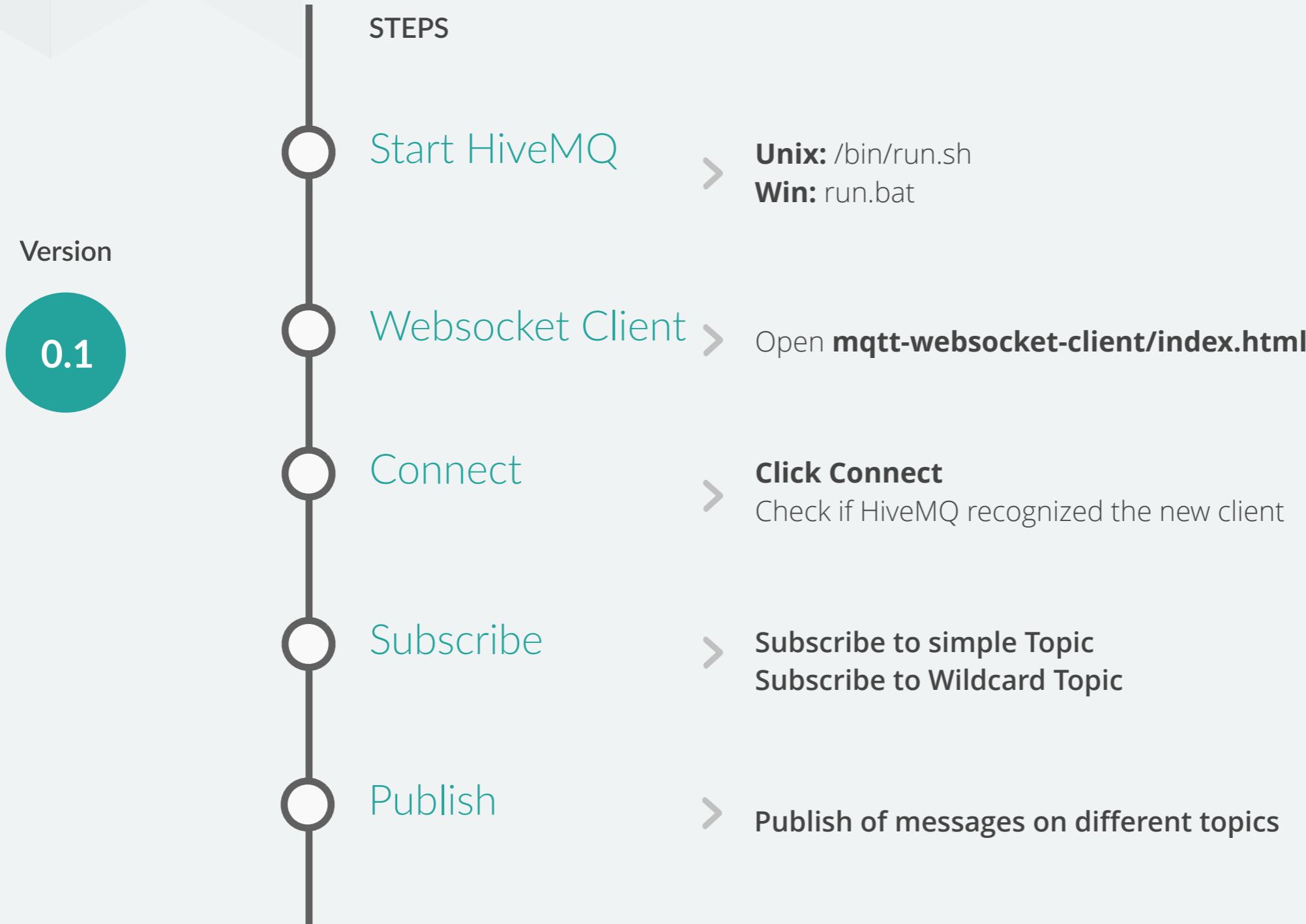
MQTT + HiveMQ

Hands-on



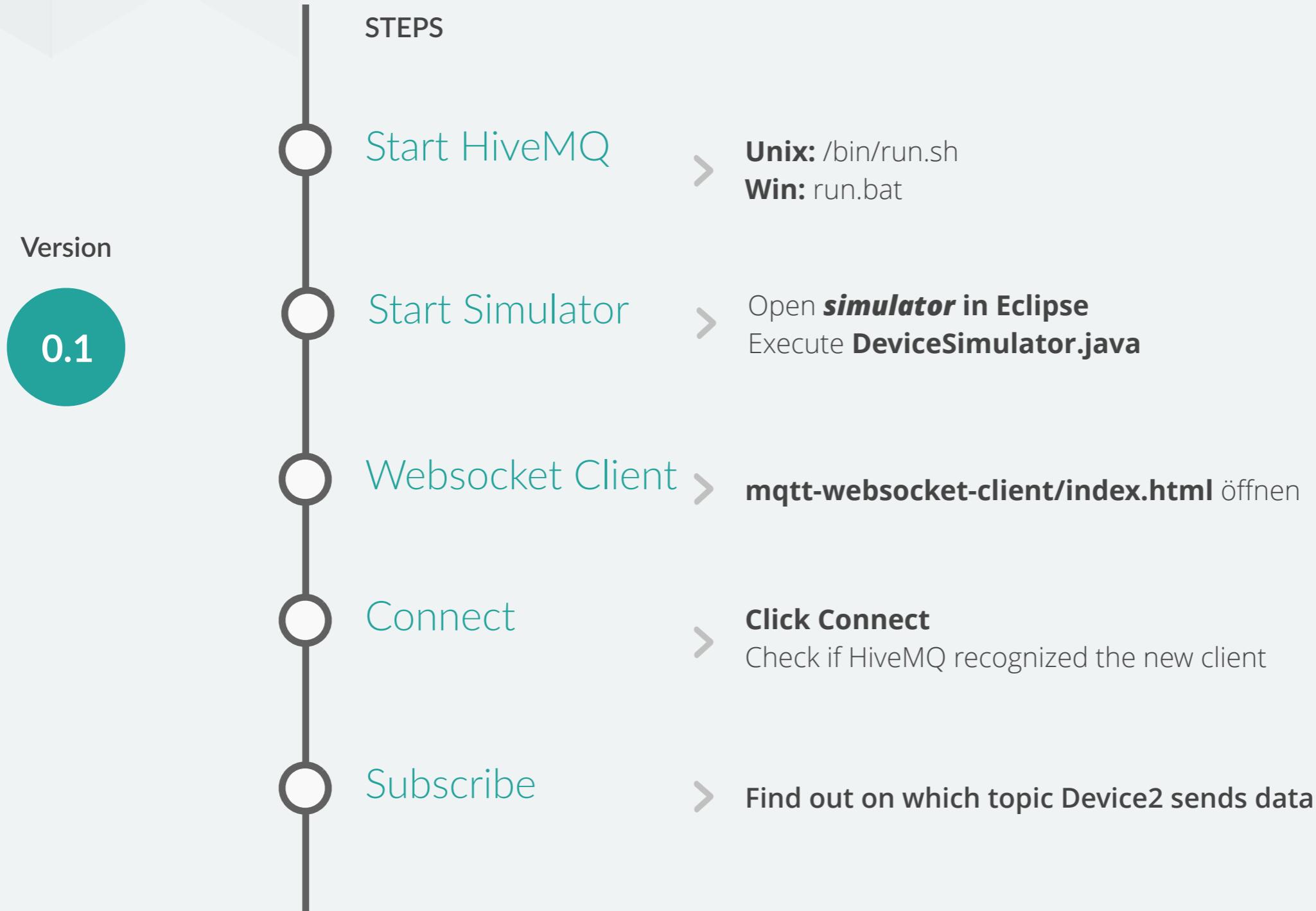
Exercise 1

Play with MQTT



Exercise 2

Use Simulator and find out Topic of Device2



Part 2: MQTT Broker

HiveMQ



MQTT Broker

Highly Scalable MQTT Broker

> 100.000 connections

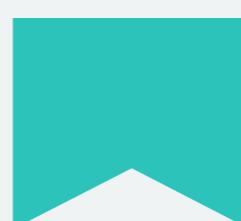


Open Plugin System

Implement custom logic on defined hooks

Cloud ready

Amazon Web Service, Microsoft Azure,
Own Datacenter

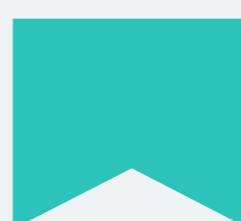


Rock Solid Implementation of MQTT Standard

Allows Hybrid mode for MQTT 3.1 and 3.1.1 clients.

Built-In Security

TLS Encryption, X.509 Certificates,
Custom Authentication and Authorization



Easy Handling and Operation

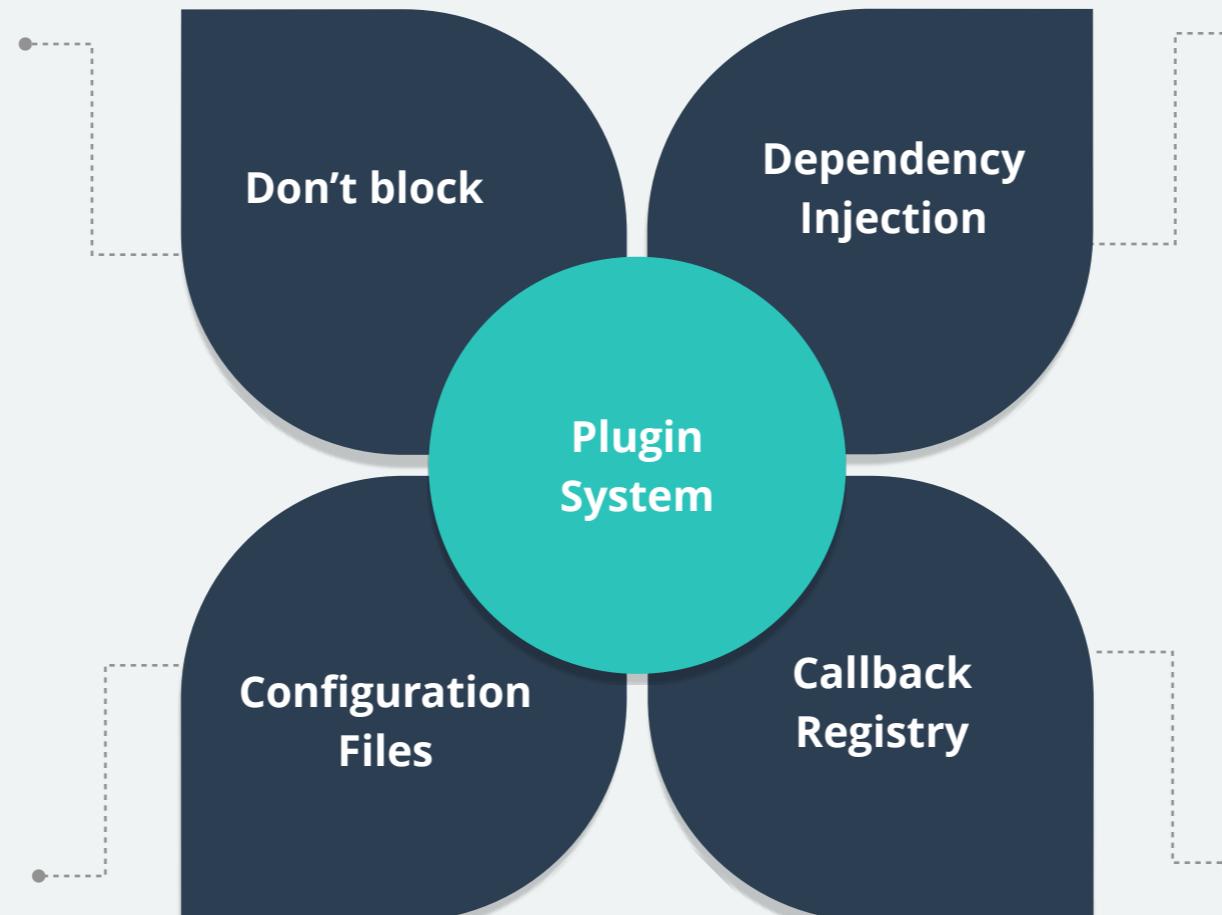
\$SYS Topics, Extensive Documentation, Monitoring
with JMX and Graphite

Plugin System

Hands-on

Don't block in a Plugin. Never.

Use other threads



Apache Configuration Support

Easy creation of Plugin Config Files
that reload themselves

Inject everything!

Awesome Testability.

Populate your Callback

Register your callback, otherwise it
won't be called.

Plugin Callbacks

Hooks for custom login



Plugin Development

Getting Started

- HiveMQ SPI
 - Service Provider Interface of HiveMQ
- Maven Plugin
 - Start HiveMQ with Plugin from within your IDE
 - Debug in Server/Client Mode
- Assembly Plugin
 - Create a shippable archive of the Plugin
- JavaDoc

Used Technology

HiveMQ

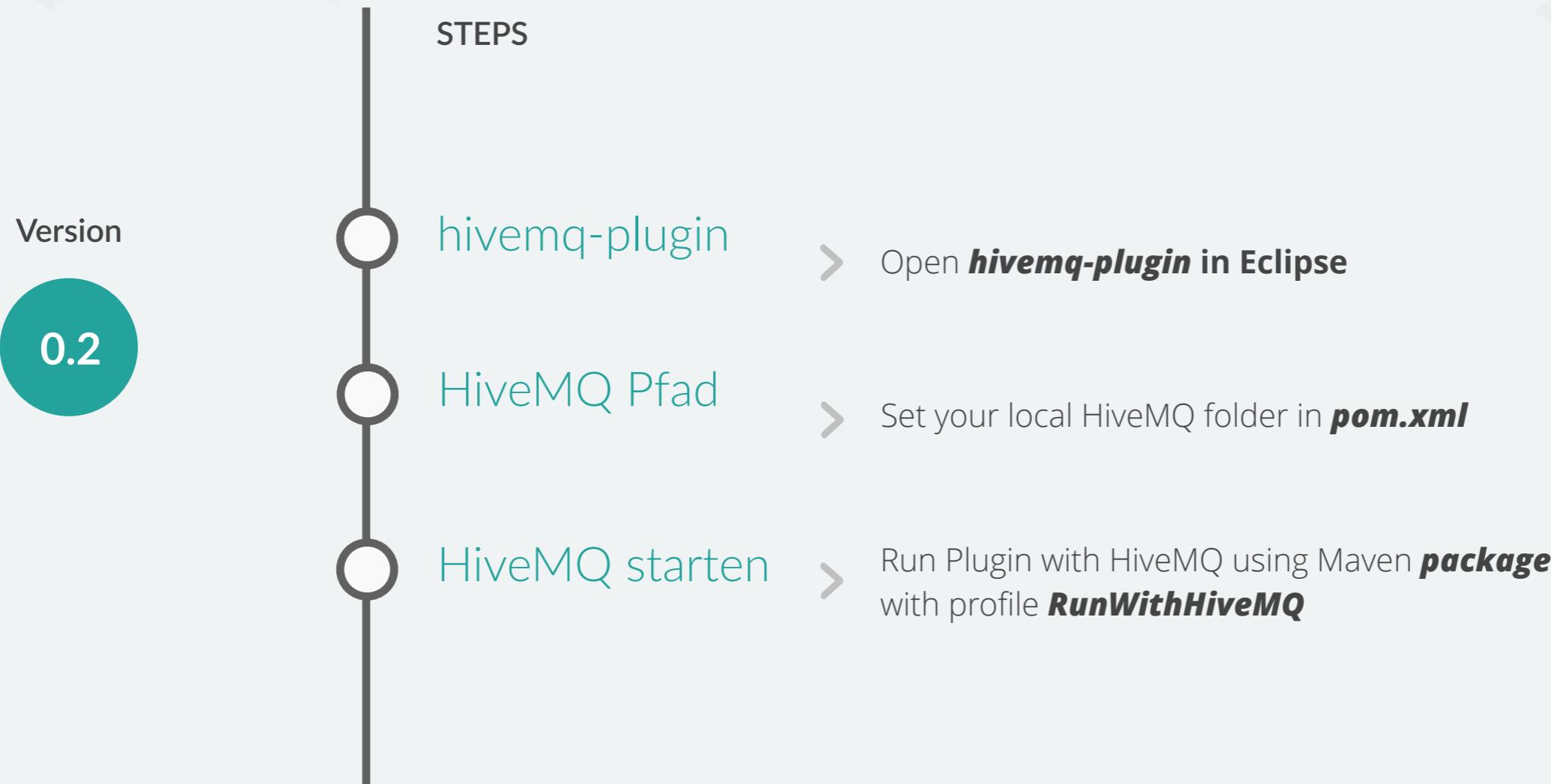


HiveMQ
MQTT Broker

- MQTT broker responsible for exchange of messages
- Persists Messages to Database

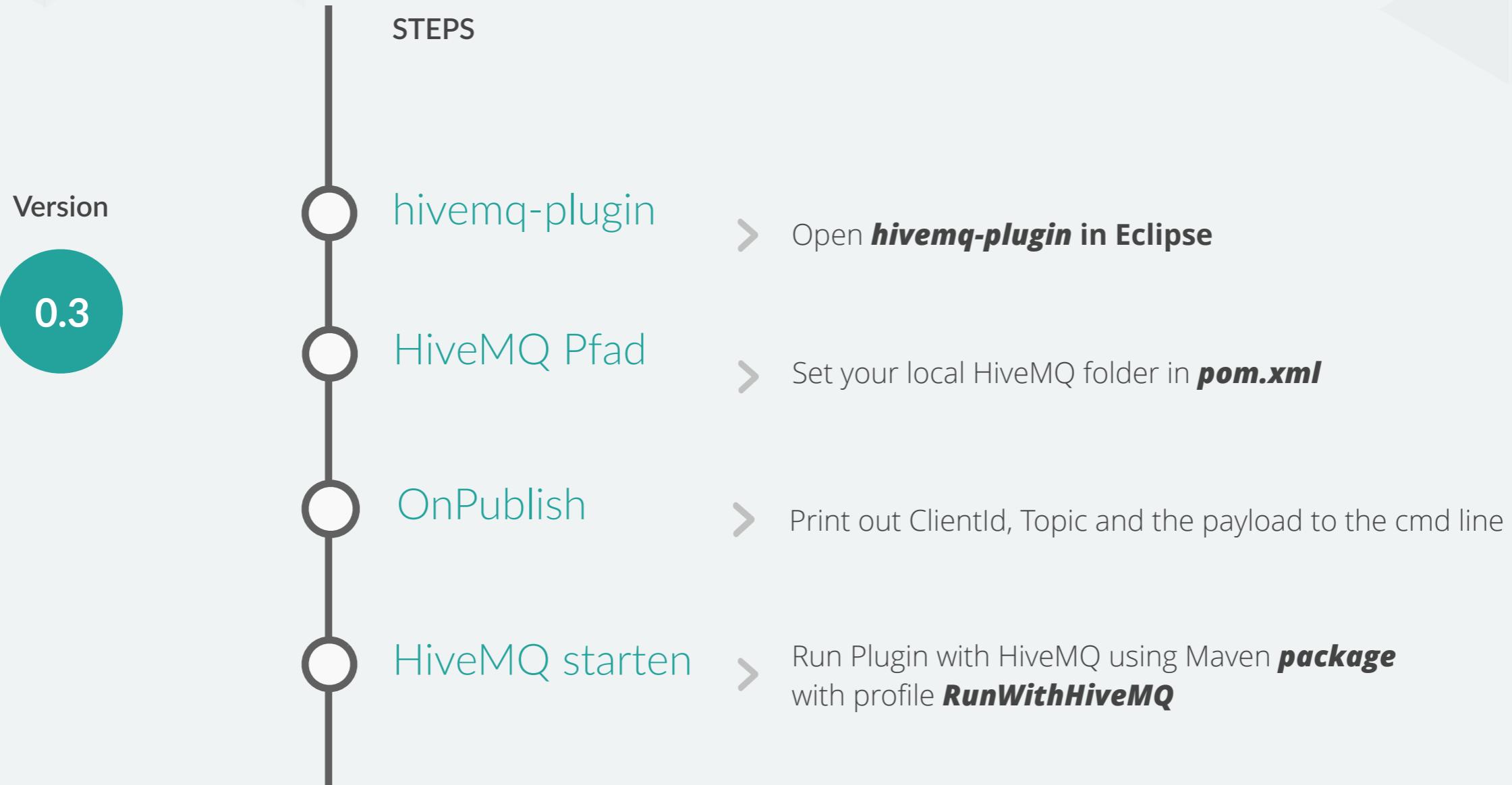
Übung 3

Plugin mit HiveMQ starten



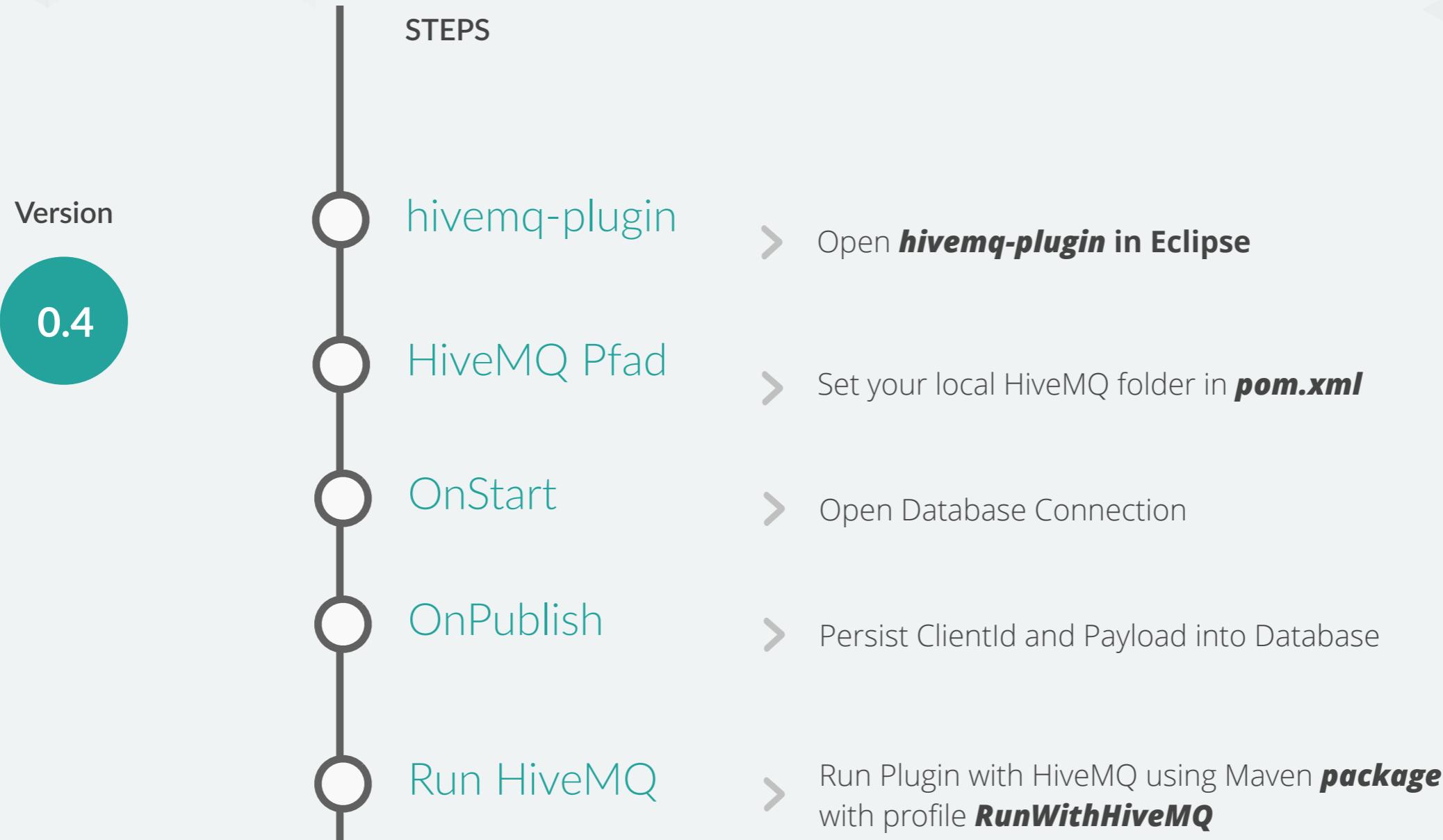
Exercise 4

Custom Publish Logic



Exercise 5

Write to Database



Improvements

HiveMQ Plugin

- Connection Pool for database connection
- Use ORM Framework
- Authentication and Authorization of clients
- Transport Encryption with TLS

Part 3: REST API

Dropwizard

Used Technology

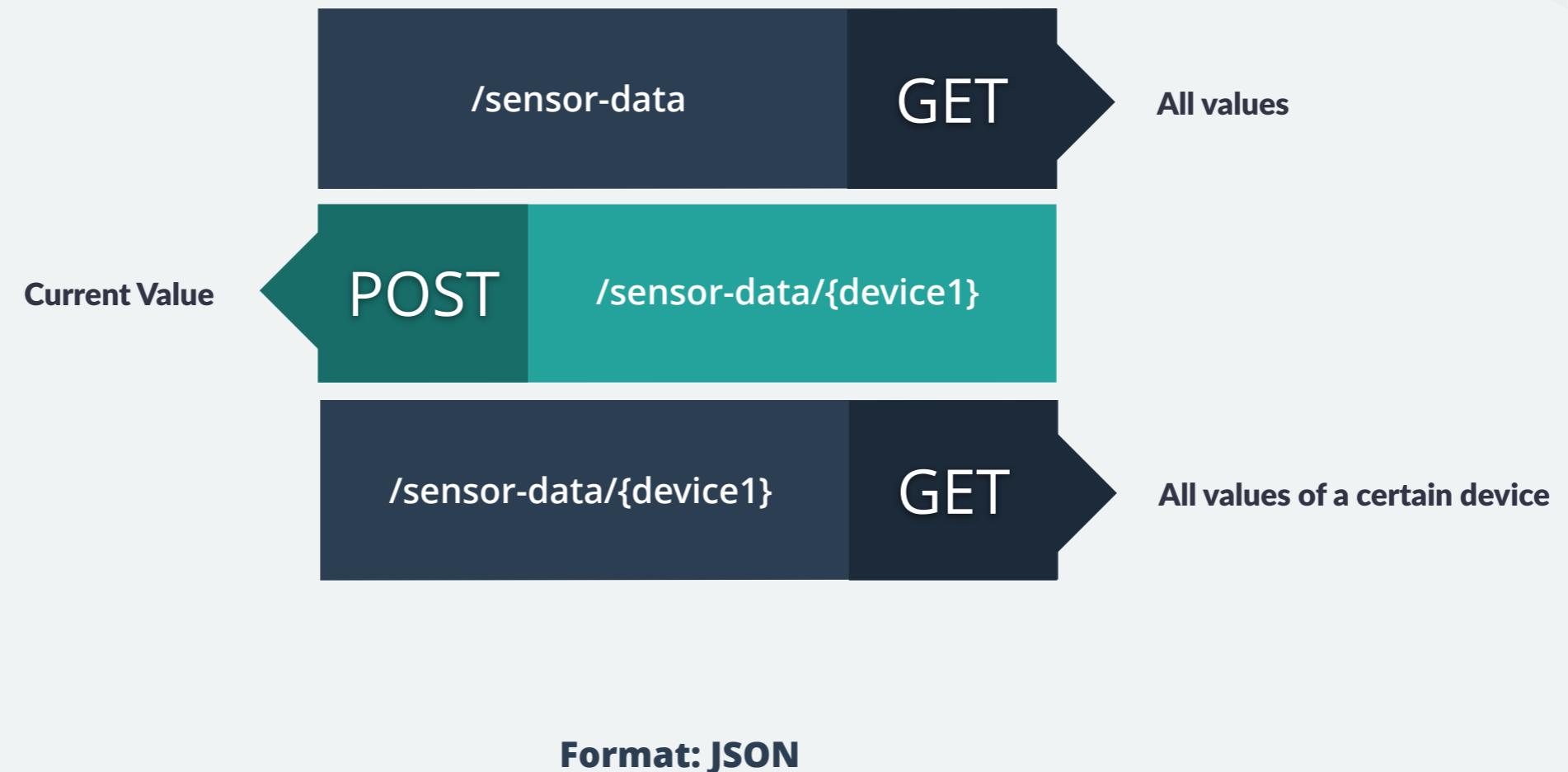
Dropwizard



- Provide Access to historical Data
- Sends ingoing data to HiveMQ

REST Ressourcen

IoTCloud



Dropwizard

overview



“Ready for Production and highly scalable **REST API**”

Easy operation and monitoring

Big Ecosystem with lots of Modules

Technologien

Dropwizard



HTTP



REST



JSON

metrics



powered by



Getting Started

Dropwizard

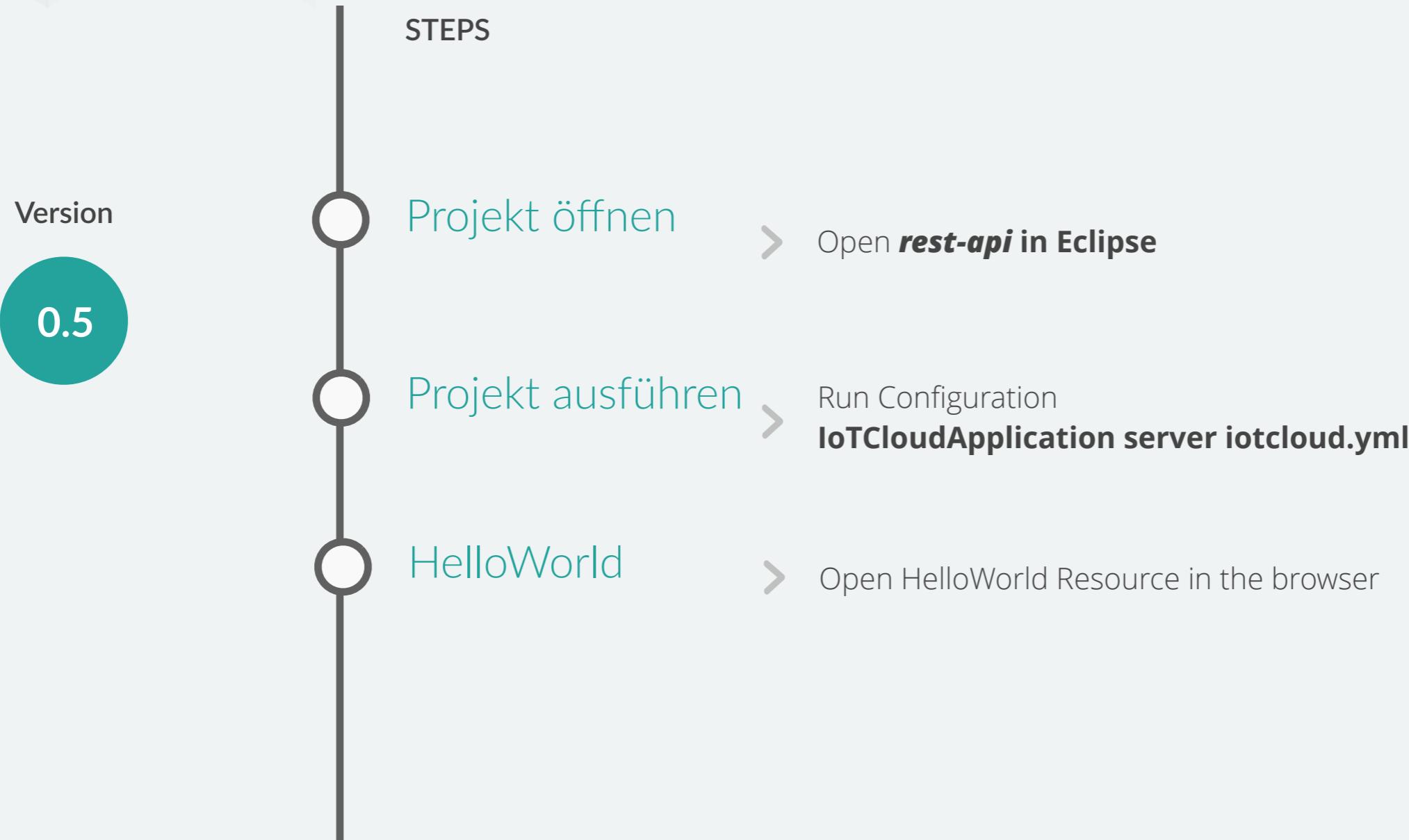
Configuration
yaml
+ class

Resources
classes

Start
server config.yml

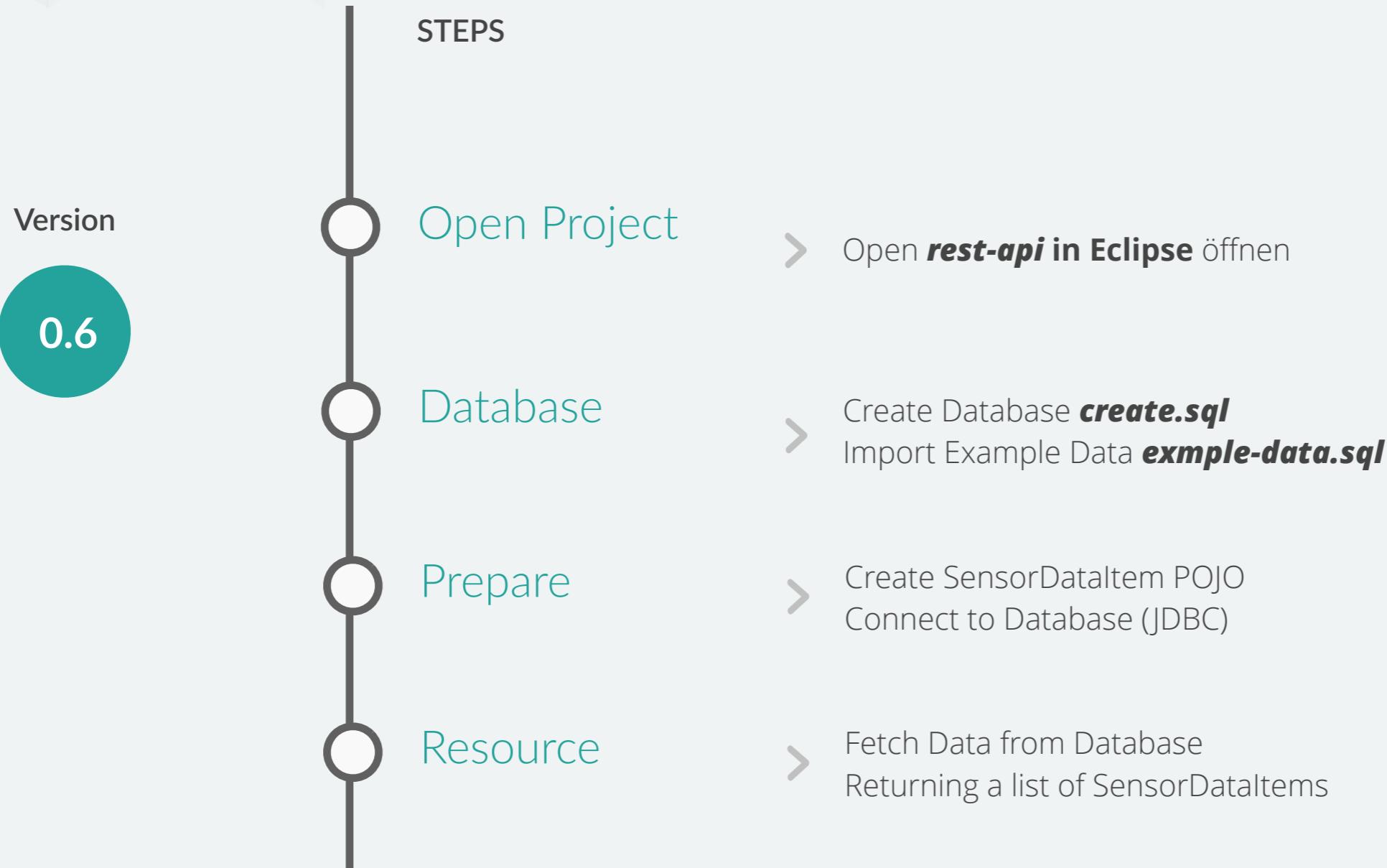
Exercise 6

First Dropwizard Project



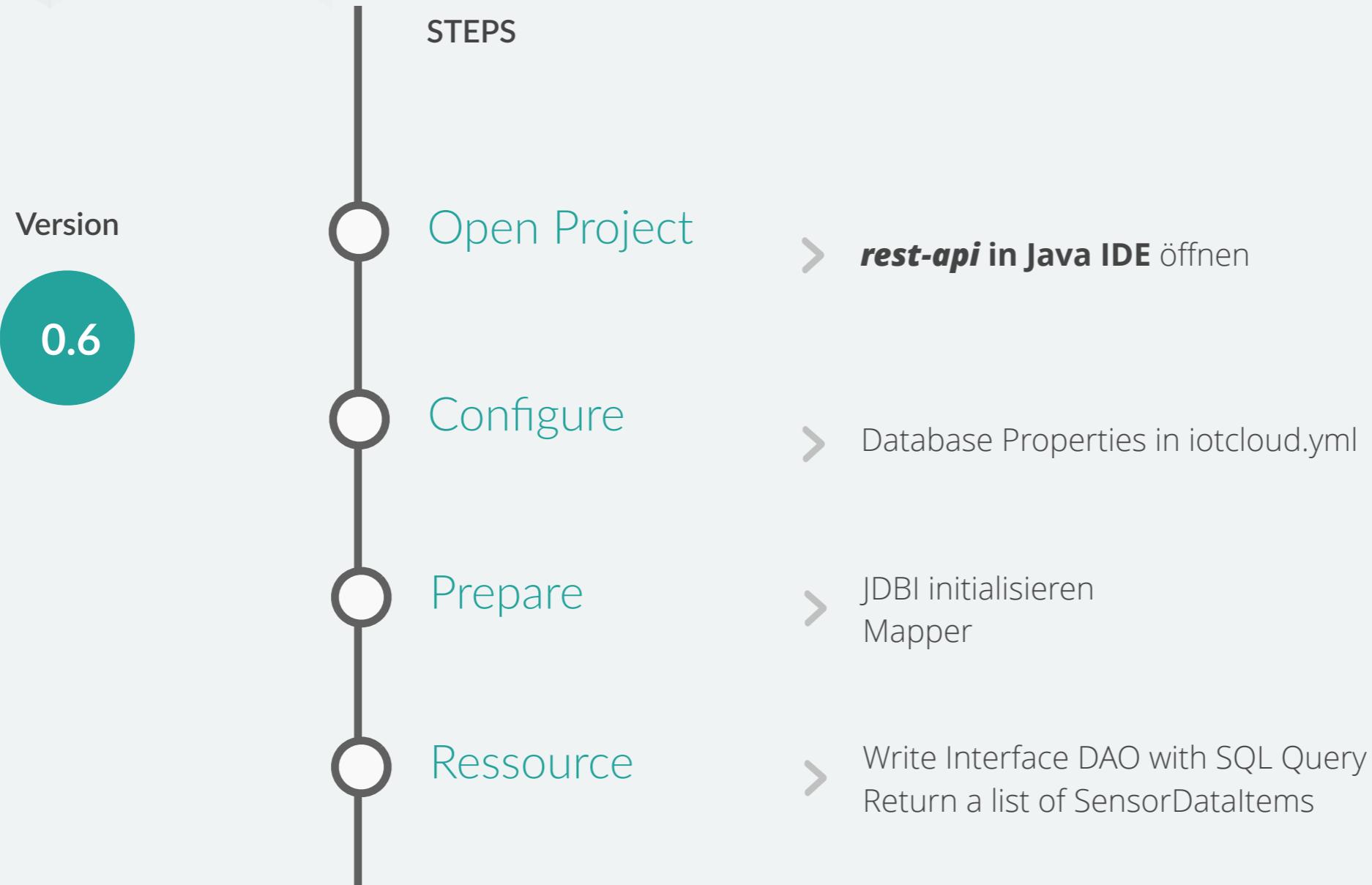
Exercise 7

GET /sensor-data



Exercise 8

JDBI instead of JDBC



Improvements

Dropwizard

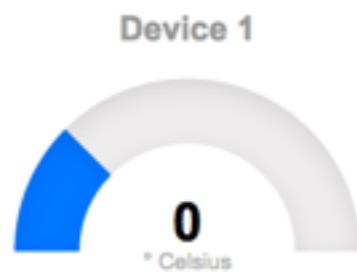
- Implementing Caching
- Use ConnectionPool for Database
- Use ORM Framework(JDBI, Hibernate)
- Authentication, Authorization
- Implement more REST Resources
- Transport Encryption TLS

Part 4: WebUI

Bringing all Parts together

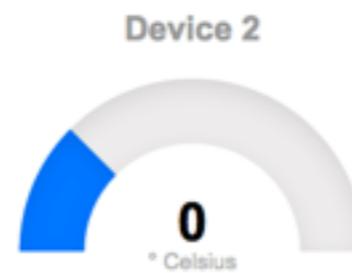
WebUI

Temperature 1



Show 10 entries

Temperature 2



Live Data over MQTT

Search:

| Id | Timestamp | Device ID | Value |
|----|-----------------|-----------|-------|
| 1 | 31.8.2014 04:22 | device1 | 0 °C |
| 2 | 31.8.2014 04:22 | device2 | 0 °C |
| 3 | 31.8.2014 04:22 | device1 | 0 °C |
| 4 | 31.8.2014 04:22 | | 3 °C |
| 5 | 31.8.2014 04:22 | device1 | 3 °C |
| 6 | 31.8.2014 04:22 | device2 | 6 °C |
| 7 | 31.8.2014 04:22 | device1 | 4 °C |
| 8 | 31.8.2014 04:22 | device2 | 9 °C |
| 9 | 31.8.2014 04:22 | device1 | 4 °C |

Historical Data over REST

Exercise 9

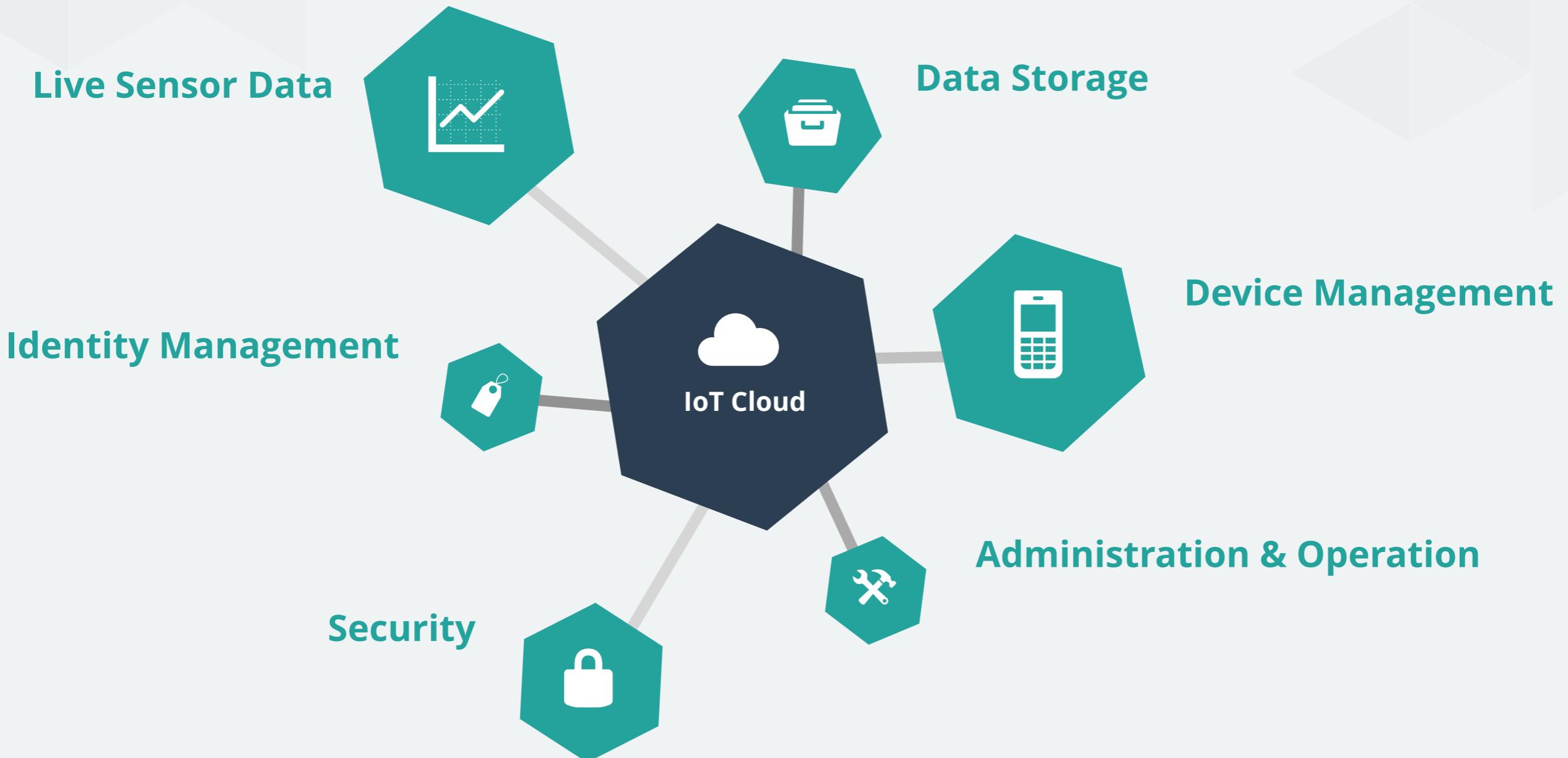
Ship the WebUI



Summary

IoT Cloud Platform

Components



IoT Cloud Prototype



Outlook

**High Scalability
High Availability**

**Device
Management**

**Support more
Protocols**

Security

Open Challenges

HiveMQ Special

HiveMQ Special



<http://www.hivemq.com/conference-special/>

Thanks!