



# MQTT in the Enterprise

How to successfully run an MQTT Message Broker

Arnold Bechtoldt  
(IT Legacy Optimization Advocate)

5 learnings from two years  
of ~~suffering~~ challenges!



Background



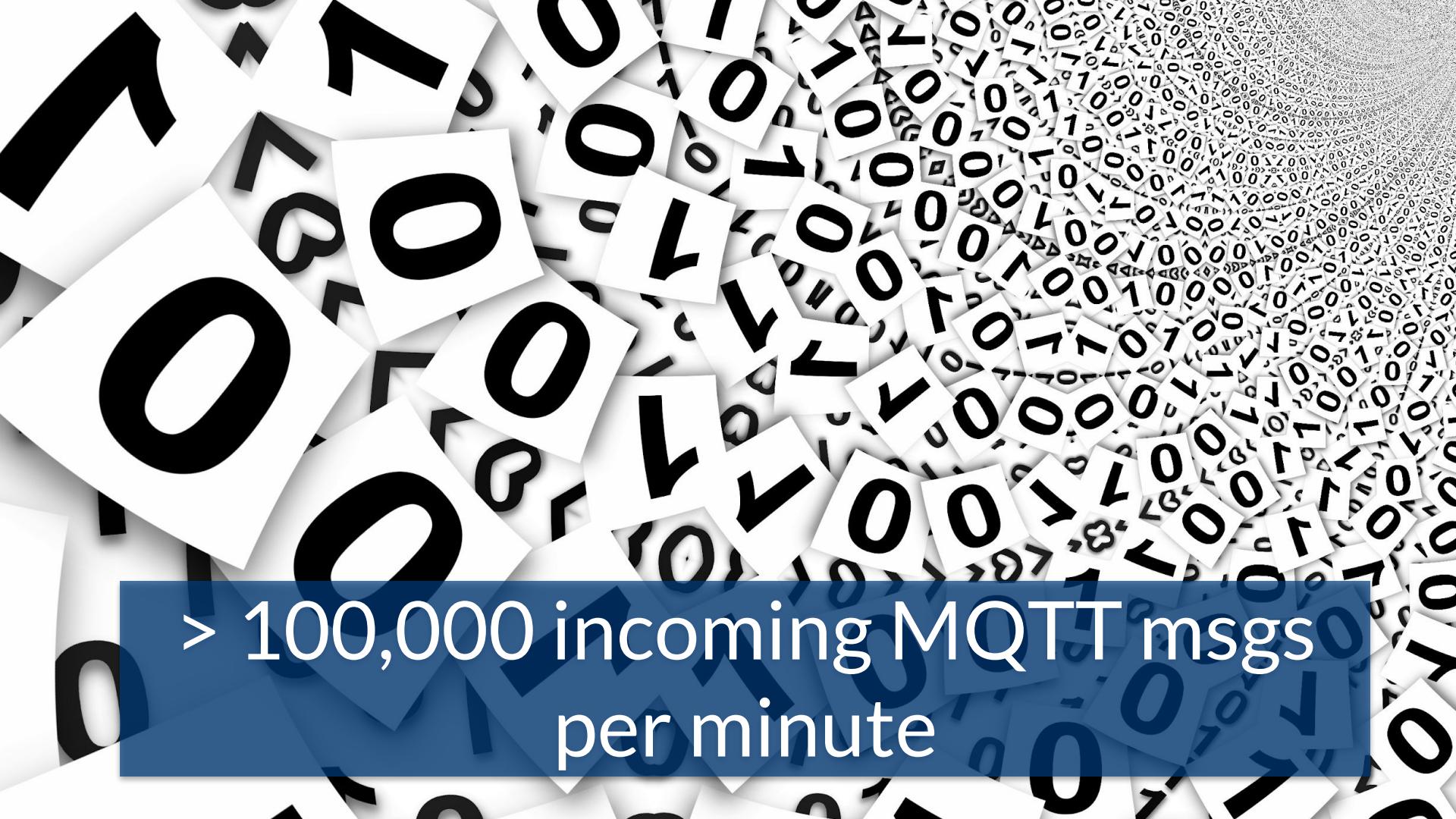
Cars



Many backend services



~ 40,000 MQTT sessions



> 100,000 incoming MQTT msgs  
per minute

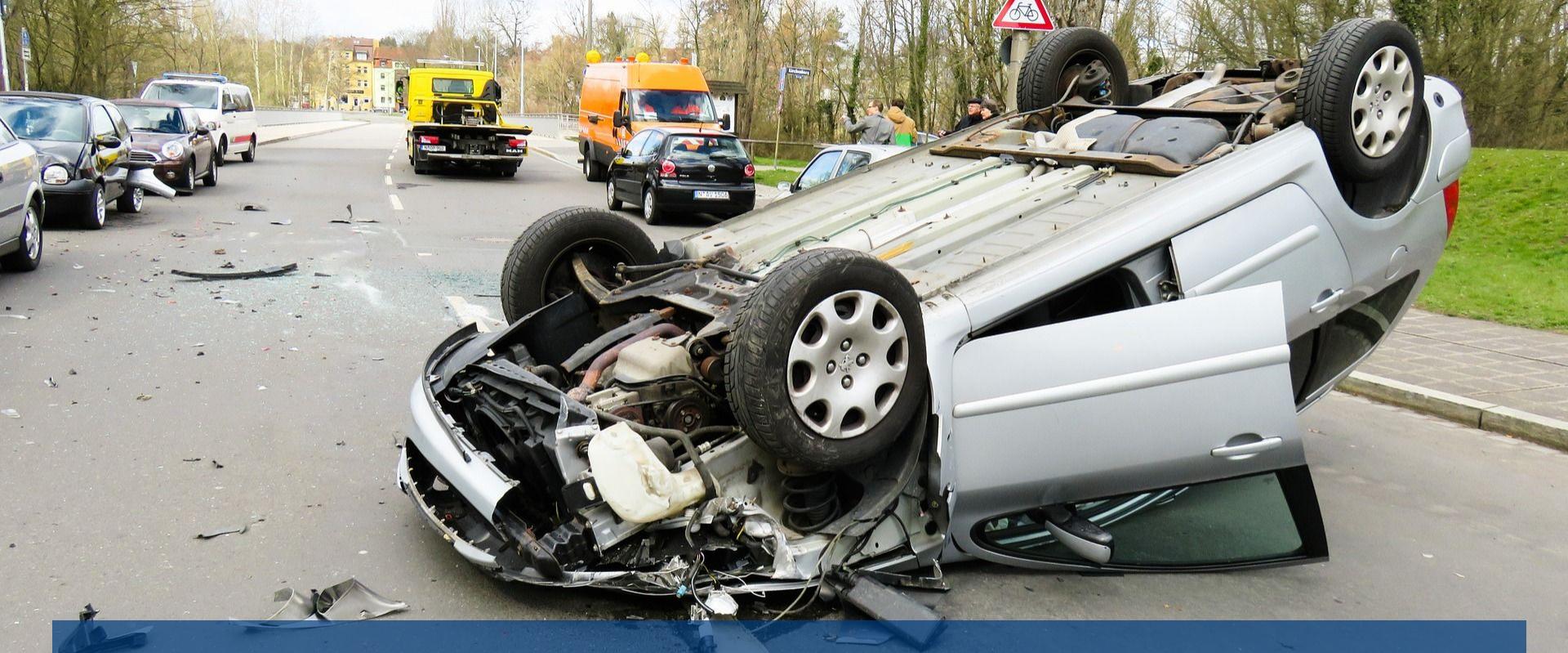
A traditional East Asian painting depicting a group of figures on horseback in a landscape. In the center, a man in a blue and orange robe and black helmet holds a sword aloft. To his left, another figure in a green robe and red sleeves raises their hand. The horses are rendered in various colors including brown, black, and white. The background features stylized trees and foliage.

> 1,000,000 customers



**HIVEMQ**  
ENTERPRISE MQTT BROKER

*Message Broker in the Middle (MITM)*



Our Mission:  
**Eliminate as few customers as possible!**



## Lesson #1

# MQTT: Things are different!

# MQTT: Things are different!

- Rules from HTTP world won't apply
- MQTT tooling support (was) missing
- "MQTT is simple." vs. "MQTT is hard."
- HiveMQ is a rather stateful application



## Lesson #2

# The(re is no) “I” in IoT!

# The(re is no) “I” in IoT!

- Clients with bad internet connection (GSM/UMTS)
- MQTT clients lack of (network) fault tolerance
- Many support tickets caused by *network issues*
- Comparing (MQTT) metrics helps on troubleshooting

# Lesson #3

## Monitor your (MQTT) clients...



# MQTT Broker Dashboard

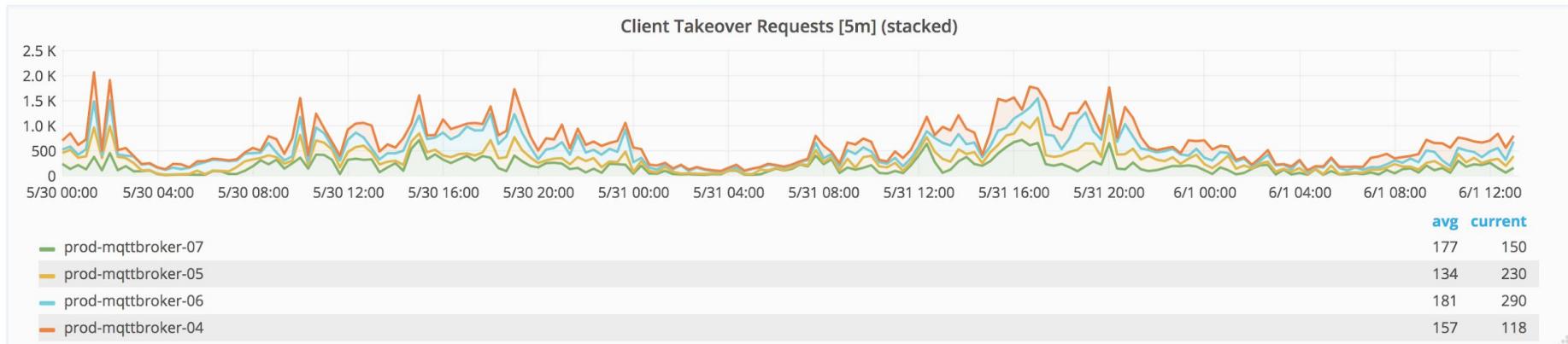


# HiveMQ Prometheus Metrics (> 1800)

```
metrics_com_hivemq_messages_dropped_before_publish_send_count_count 0.0
metrics_com_hivemq_messages_dropped_count_count 6092213.0
metrics_com_hivemq_messages_dropped_in_flight_window_count_count 835421.0
metrics_com_hivemq_messages_dropped_internal_error_count_count 0.0
metrics_com_hivemq_messages_dropped_not_connected_count_count 1238.0
metrics_com_hivemq_messages_dropped_not_writable_count_count 4775796.0
metrics_com_hivemq_messages_dropped_qos_0_queue_not_empty_count_count 479758.0
metrics_com_hivemq_messages_dropped_queue_full_count_count 0.0
metrics_com_hivemq_messages_dropped_rate_count 6092213.0
metrics_com_hivemq_messages_dropped_rate_fifteenminuterate 0.0026798488064779242
metrics_com_hivemq_messages_dropped_rate_fiveminuterate 0.003673811334623905
metrics_com_hivemq_messages_dropped_rate_meanrate 1.1690383860629943
metrics_com_hivemq_messages_dropped_rate_oneminuterate 0.0024693484286362477
metrics_com_hivemq_messages_incoming_connect_count_count 1.0997633E7
metrics_com_hivemq_messages_incoming_connect_rate_count 1.0997633E7
metrics_com_hivemq_messages_incoming_connect_rate_fifteenminuterate 2.695426446661923
metrics_com_hivemq_messages_incoming_connect_rate_fiveminuterate 2.846849980596273
metrics_com_hivemq_messages_incoming_connect_rate_meanrate 2.110342385291968
metrics_com_hivemq_messages_incoming_connect_rate_oneminuterate 2.890580707427736
metrics_com_hivemq_messages_incoming_disconnect_count_count 3926444.0
metrics_com_hivemq_messages_incoming_disconnect_rate_count 3926444.0
metrics_com_hivemq_messages_incoming_disconnect_rate_fifteenminuterate 0.8603151573544764
metrics_com_hivemq_messages_incoming_disconnect_rate_fiveminuterate 0.8937906297328476
metrics_com_hivemq_messages_incoming_disconnect_rate_meanrate 0.7534476952336496
metrics_com_hivemq_messages_incoming_disconnect_rate_oneminuterate 0.848894289974284
metrics_com_hivemq_messages_incoming_pingreq_count_count 1.6680187E8
```

# Visualizing Metrics (Grafana)

▼ Publishments/Queues/Monitoring



Graph

General

Metrics

Axes

Legend

Display

Alert

Time range

x

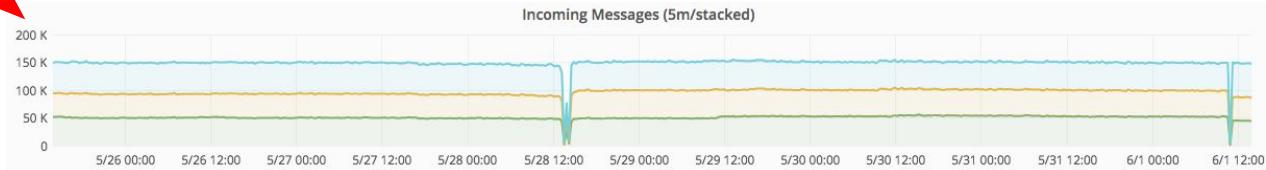
▲ A Query `increase(metrics_com_hivemq_cluster_sent_clienttakeoverrequest_count{group=\"$group",inst:`

Metric lookup metric name ☰ ⚡ 🗑

Legend format `{{instance_name}}` Step 10m ⓘ Resolution 1/2 ▾ ⟳

# Dev/Prod Parity

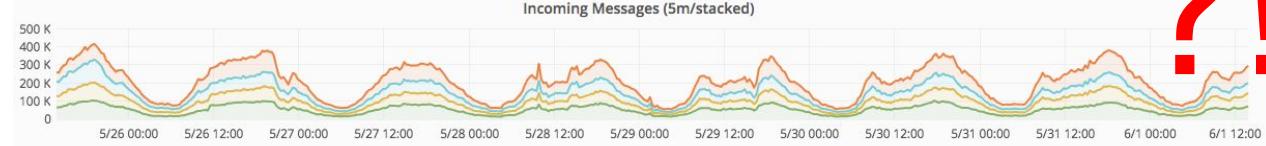
Testing



Integration



Production



? !



# Lesson #4

## Log everything

\*GDPR/DSGVO Disclaimer

## Unstructured logs as base ...

2018-06-01T18:25:30,737Z [hivemq-native-eventloop-child-15] DEBUG event.client-connected - Client ID: mqttlinkstatusaggregator, IP: , Clean  
2018-06-01T18:25:31,452Z [hivemq-native-eventloop-child-3] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefull  
2018-06-01T18:25:31,788Z [hivemq-native-eventloop-child-5] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefull  
2018-06-01T18:25:31,829Z [single-writer-9] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: was disconnected. re  
2018-06-01T18:25:31,830Z [hivemq-native-eventloop-child-15] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: l dis  
2018-06-01T18:25:33,453Z [hivemq-native-eventloop-child-7] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefull  
2018-06-01T18:25:33,790Z [hivemq-native-eventloop-child-9] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefull  
2018-06-01T18:25:34,016Z [hivemq-native-eventloop-child-10] DEBUG event.client-connected - Client ID: mqttlinkstatusaggregator, IP: , Clean  
2018-06-01T18:25:35,124Z [single-writer-9] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: : was disconnected. re  
2018-06-01T18:25:35,125Z [hivemq-native-eventloop-child-10] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: dis  
2018-06-01T18:25:35,455Z [hivemq-native-eventloop-child-15] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungraceful  
2018-06-01T18:25:35,791Z [hivemq-native-eventloop-child-1] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefull  
2018-06-01T18:25:36,218Z [hivemq-native-eventloop-child-2] DEBUG event.client-connected - Client ID: mqttlinkstatusaggregator, IP: , Clean  
2018-06-01T18:25:37,347Z [single-writer-14] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: ! was disconnected. r  
2018-06-01T18:25:37,348Z [hivemq-native-eventloop-child-2] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: disc  
2018-06-01T18:25:37,457Z [hivemq-native-eventloop-child-7] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefull  
2018-06-01T18:25:37,795Z [hivemq-native-eventloop-child-9] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefull  
2018-06-01T18:25:38,700Z [hivemq-native-eventloop-child-11] DEBUG event.client-connected - Client ID: test-mqttdbrokererlb-03-haproxy-healthchecker, IP:10  
2018-06-01T18:25:38,706Z [hivemq-native-eventloop-child-11] DEBUG event.client-disconnected - Client ID: test-mqttdbrokererlb-03-haproxy-healthchecker, IP  
2018-06-01T18:25:39,459Z [hivemq-native-eventloop-child-15] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungraceful  
2018-06-01T18:25:39,797Z [hivemq-native-eventloop-child-1] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefull  
2018-06-01T18:25:40,221Z [hivemq-native-eventloop-child-2] DEBUG event.client-disconnected - Client ID: vehic1 eMockListener1521022427024, IP ;  
2018-06-01T18:25:41,460Z [hivemq-native-eventloop-child-5] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefull  
2018-06-01T18:25:41,798Z [hivemq-native-eventloop-child-7] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefull  
2018-06-01T18:25:43,462Z [hivemq-native-eventloop-child-9] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefull  
2018-06-01T18:25:43,807Z [hivemq-native-eventloop-child-11] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefull  
2018-06-01T18:25:44,521Z [hivemq-native-eventloop-child-13] DEBUG event.client-connected - Client ID: test-mqttdbrokererlb-04-haproxy-healthchecker, IP:10  
2018-06-01T18:25:44,529Z [hivemq-native-eventloop-child-13] DEBUG event.client-disconnected - Client ID: test-mqttdbrokererlb-04-haproxy-healthchecker, IP  
2018-06-01T18:25:44,978Z [hivemq-native-eventloop-child-1] DEBUG event.client-connected - Client ID: mqttlinkstatusaggregator, IP: , Clean  
2018-06-01T18:25:45,464Z [hivemq-native-eventloop-child-5] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefull  
2018-06-01T18:25:45,808Z [hivemq-native-eventloop-child-7] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefull

# ... manipulated with Logstash

```
# fix a few inconsistencies in the original log format before offering the log line to kv for parsing
mutate {
    gsub => [
        "LOGMESSAGE", "connected\.$", "",
        "LOGMESSAGE", "\swas disconnected\.", "",",
        "LOGMESSAGE", "disconnected gracefully\?", ", reason: graceful_disconnect",
        "LOGMESSAGE", "disconnected ungracefully\?", ", reason: ungraceful_disconnect",
        "LOGMESSAGE", "An other client connected with the same client id.$", "clientID_in_new_connection",
        "LOGMESSAGE", "Another client connected with the same clientId.$", "clientID_in_new_connection",
        "LOGMESSAGE", "Client was idle for too long.$", "idle_timeout",
        "LOGMESSAGE", "Outgoing publish message was dropped\.", "",
        "LOGMESSAGE", "reason: Internal error\.$", "reason: internal_error",
        "LOGMESSAGE", "reason: No CONNECT sent in time.$", "reason: no_connect_sent_in_time",
        "LOGMESSAGE", "reason:", "event_reason:",
        "LOGMESSAGE", "\.$", ""
    ]
}

kv {
    source => "LOGMESSAGE"
    prefix => "mqtt_"
    field_split => ","
    value_split => ":"
    remove_char_value => " "
    remove_char_key => " "
    transform_key => "lowercase"
}
```

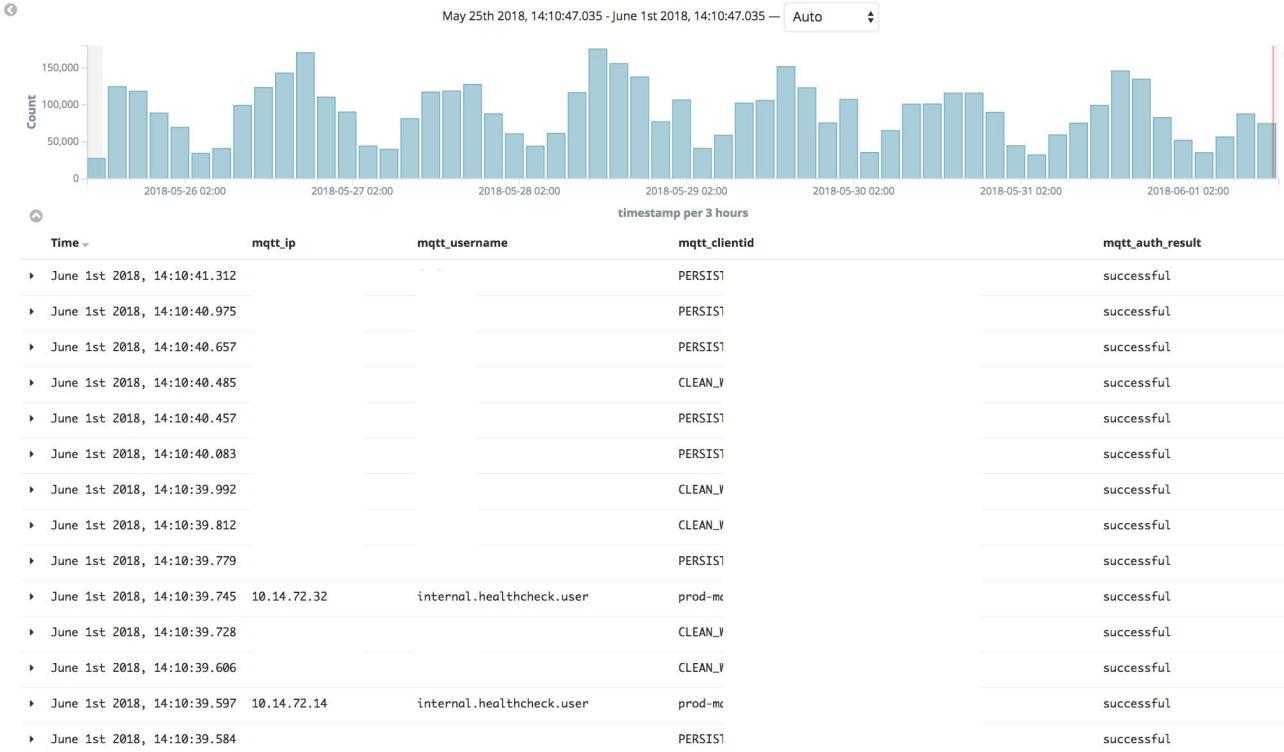
# Prepared for general use

## Quick Links

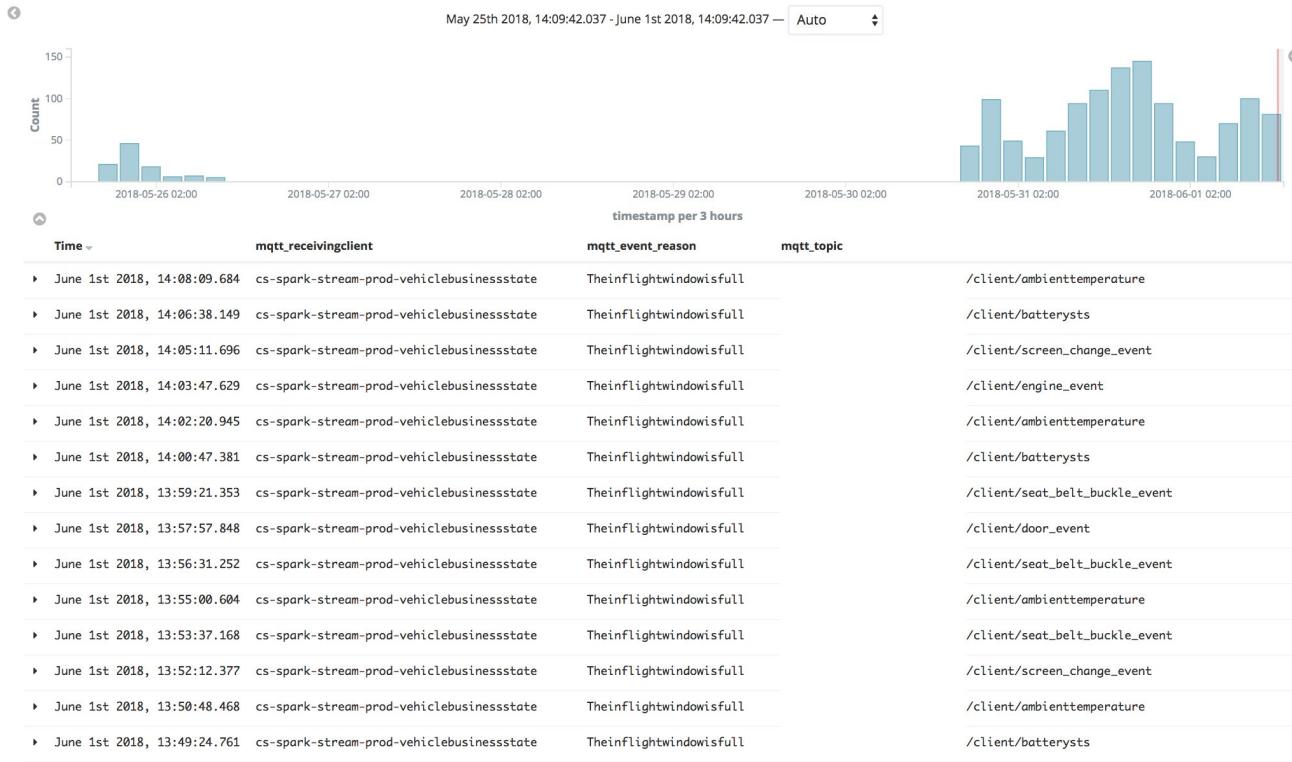
The following links help you to find some query examples. Open an example and modify to your own needs:

Use Case	Index	TEST	INT	PROD	Comment
Login details (after connect)	*-mqttbroker-authplugin-*	Kibana	Kibana	Kibana	(user abc)
Login details by VIN (after connect)	*-mqttbroker-authplugin-*	Kibana	Kibana	Kibana	(vehicle XYZ)
Connects/Disconnects by VIN	*-mqttbroker-events-*	Kibana	Kibana	Kibana	(vehicle XYZ)
Non-graceful disconnects	*-mqttbroker-events-*	Kibana	Kibana	Kibana	
MQTT Message Drops	*-mqttbroker-events-*		Kibana	Kibana	
HTTP IP Triggers	*-mqttbroker-restplugin-*	Kibana	Kibana	Kibana	
MQTT actions by VIN	*-mqttbroker-logs-*	Kibana	Kibana	Kibana	(vehicle XYZ)

# ... to show MQTT client login



# ... or dropped messages!





## Lesson #5

“S” in IoT stands for security!

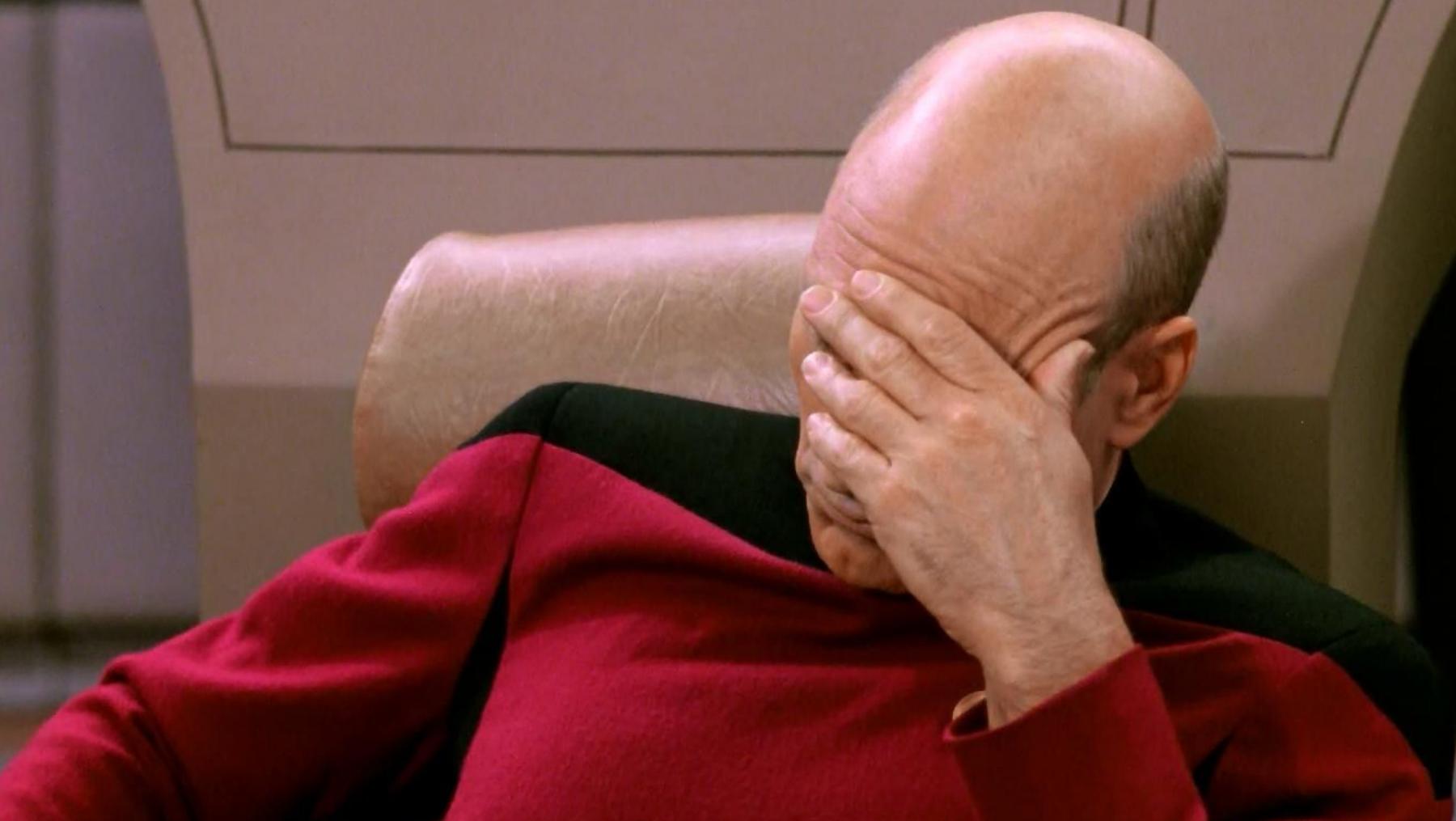
# “S” in IoT stands for security!

- MQTT security mechanisms exist
- “IoT security” is possible
- Fight for it!
- But often: *Problem Exists Between Chair And Keyboard* (PEBCAK)

# A PEBCAK example..

Do not ...

- forget authorization after implementing authentication (MQTT).
- use the password across ten thousands of clients.
- implement HW/SW with max password length of 8 chars.
- log them in plaintext into Elasticsearch.
- forget the firewall in front of your public Elasticsearch.
- publish *The Password™* on Github.



# Mission accomplished!

[...] die pragmatische, unkomplizierte und produktive Zusammenarbeit mit inovex positiv hervorzuheben, da [...] komplexe Problemstellungen [...] gemeinsam gelöst wurden [...].

Generell finde ich die Zusammenarbeit [...] schon ziemlich gut und v. a. auch pragmatisch. Auch dass sich alle [...] verantwortlich fühlen, dass die Dinge laufen/funktionieren.

Thank you to all [...] and giving us the chance to provide such a solution, from monitoring point of view it seems that we have the best MQTT connection ever.

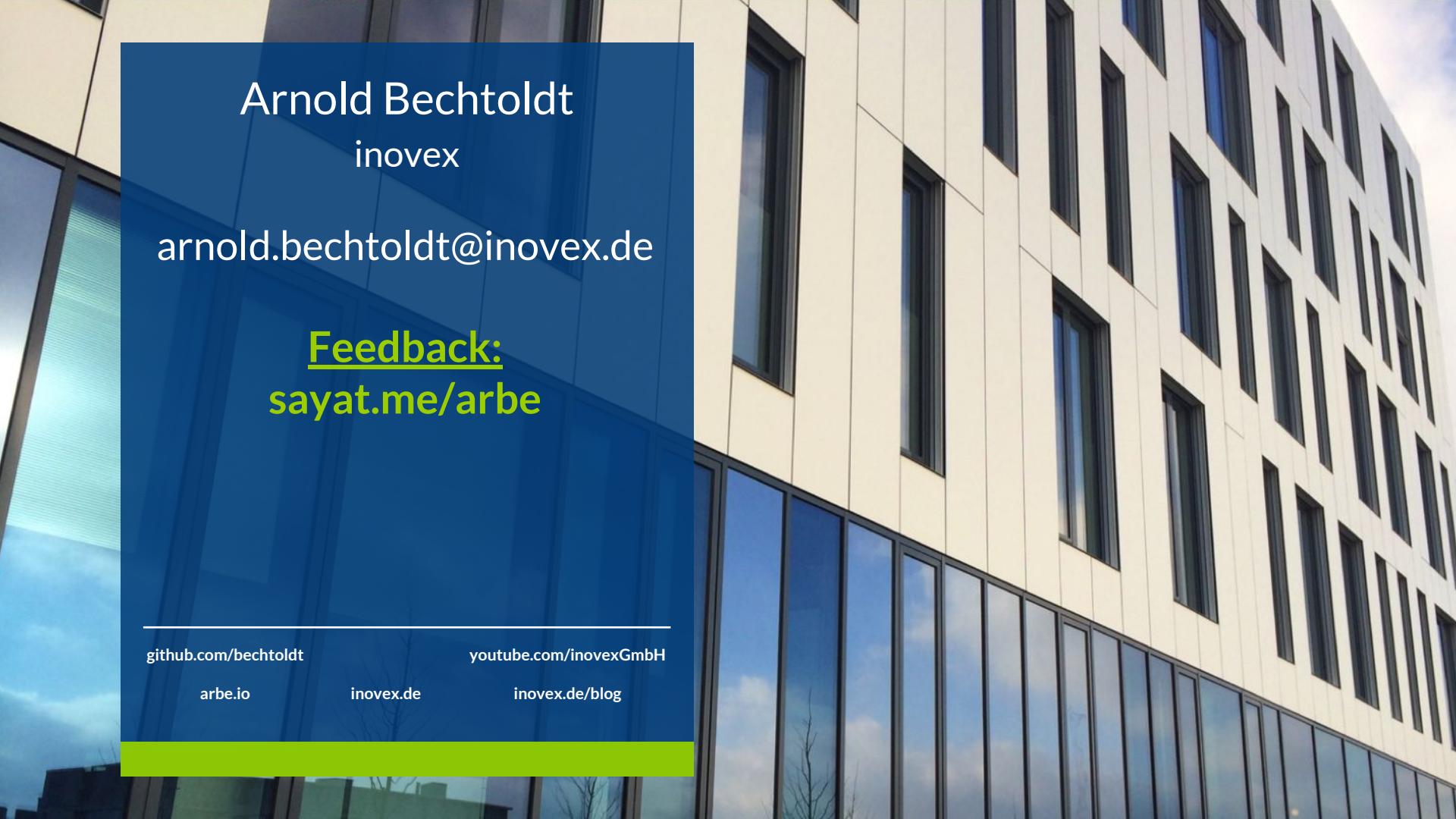
# Open Source now ...

- [github.com/inovex/mqtt-stresser](https://github.com/inovex/mqtt-stresser)
- [github.com/inovex/mqtt\\_blackbox\\_exporter](https://github.com/inovex/mqtt_blackbox_exporter)
- ... and more for beer!



# GitHub

**WE'RE  
HIRING!**  
[inovex.de/jobs](http://inovex.de/jobs)



Arnold Bechtoldt  
inovex

arnold.bechtoldt@inovex.de

Feedback:  
[sayat.me/arbe](http://sayat.me/arbe)

---

[github.com/bechtoldt](https://github.com/bechtoldt)

[youtube.com/inovexGmbH](https://youtube.com/inovexGmbH)

[arbe.io](https://arbe.io)

[inovex.de](https://inovex.de)

[inovex.de/blog](https://inovex.de/blog)