



MQTT in the Enterprise

How to successfully run an MQTT Message Broker

Arnold Bechtoldt
@arnisoph

Learnings from 2+ years of
solving challenges!

?
•



Background



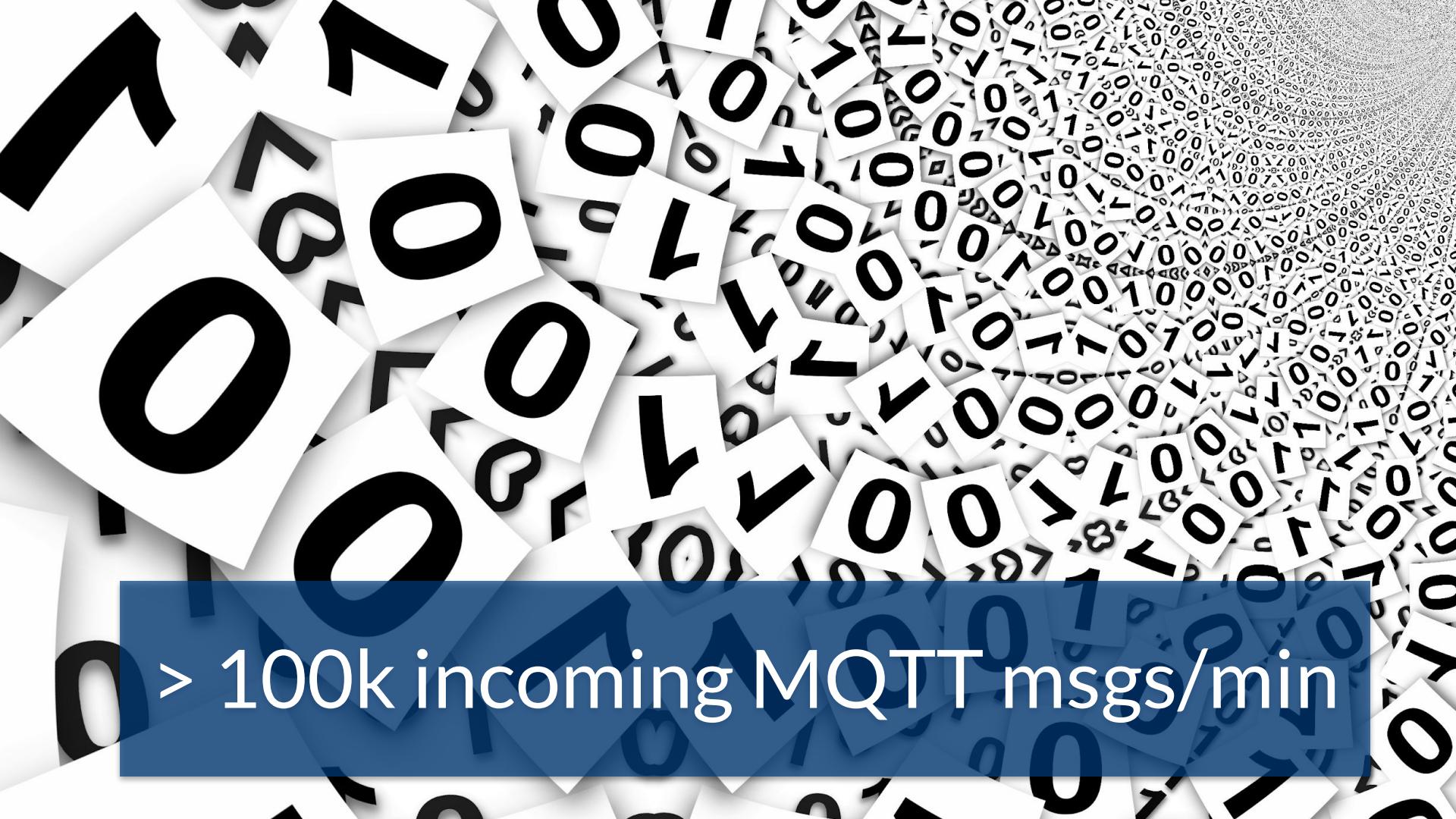
Cars. Many.



Backend Services



Even more MQTT sessions



> 100k incoming MQTT msgs/min



HIVEMQ
ENTERPRISE MQTT BROKER

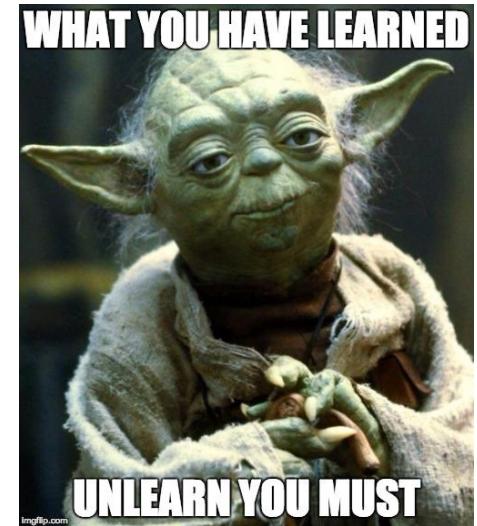
Our Message Broker in the Middle

Lesson #1

MQTT: Things are different!

MQTT: Things are different!

- Rules from HTTP world won't apply
- Lack of MQTT tooling (load testing, monitoring)
- Simple Protocol vs. Wrong Usage
- HiveMQ is a rather stateful app, deal with it!





Lesson #2

The(re is no) “I” in IoT!

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- Clients with bad internet connection (GSM/UMTS)
- MQTT clients lack of (network) fault tolerance
- Maaaaa(aaaa)ny support tickets caused by *network issues*
- Seek & Destroy with Monitoring!

Lesson #3

Monitor your (MQTT) clients...



MQTT Broker Dashboard

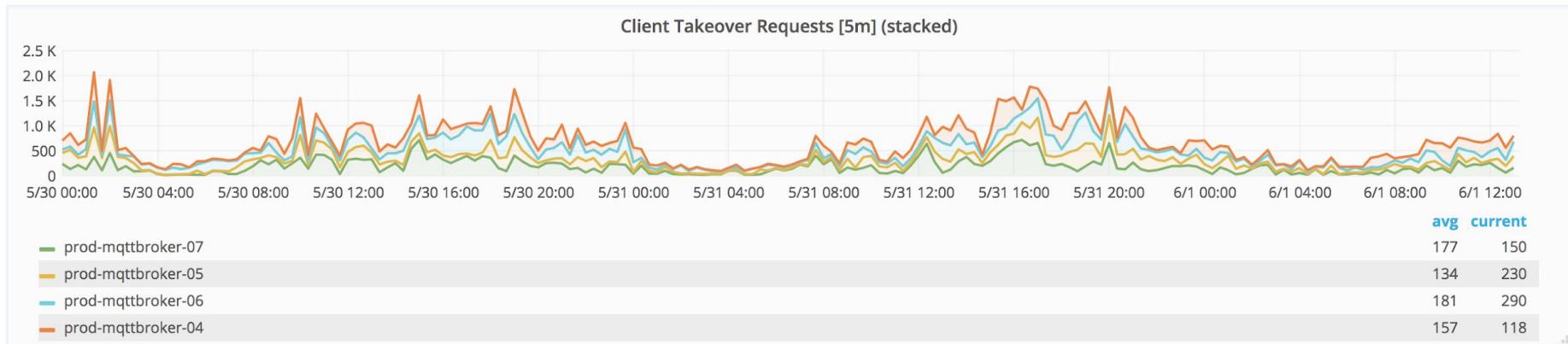


HiveMQ Prometheus Metrics (> 1800)

```
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

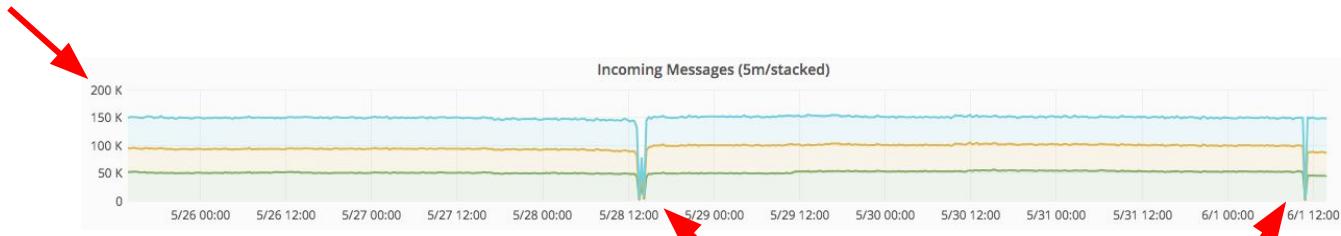
▲ A Query `increase(metrics_com_hivemq_cluster_sent_clienttakeoverrequest_count{group=\"$group",inst:`

Metric lookup metric name ☰ ⚡ 🗑

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

Problem: Dev/Prod Parity

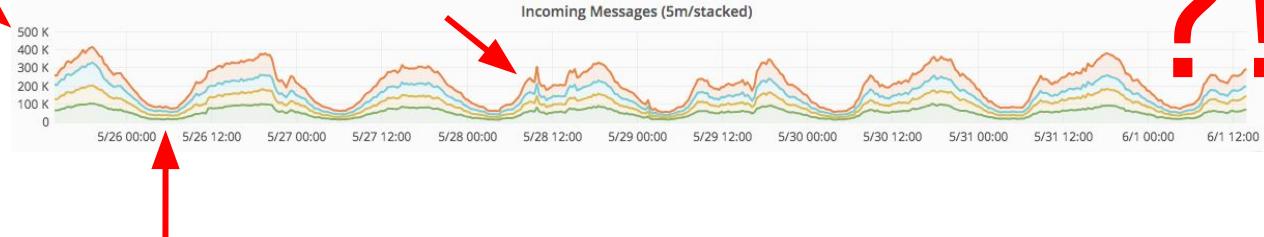
Testing



Integration



Production



? !

Lesson #4

Log everything*

```
7Z [hivemq-native-eventloop-child-15] DEBUG event.client-connected - Client ID: mqttlinkstatusaggregator, IP: , Cle
2Z [hivemq-native-eventloop-child-3] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefu
8Z [hivemq-native-eventloop-child-5] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefu
9Z [single-writer-9] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: was disconnected.
0Z [hivemq-native-eventloop-child-15] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: L d
3Z [hivemq-native-eventloop-child-7] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefu
0Z [hivemq-native-eventloop-child-9] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefu
6Z [hivemq-native-eventloop-child-10] DEBUG event.client-connected - Client ID: mqttlinkstatusaggregator, IP: , Cle
4Z [single-writer-9] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: : was disconnected.
5Z [hivemq-native-eventloop-child-10] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: a
5Z [hivemq-native-eventloop-child-15] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefu
1Z [hivemq-native-eventloop-child-1] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefu
8Z [hivemq-native-eventloop-child-2] DEBUG event.client-connected - Client ID: mqttlinkstatusaggregator, IP: , Cle
7Z [single-writer-14] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: ! was disconnected.
8Z [hivemq-native-eventloop-child-2] DEBUG event.client-disconnected - Client ID: mqttlinkstatusaggregator, IP: di
7Z [hivemq-native-eventloop-child-7] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefu
5Z [hivemq-native-eventloop-child-9] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefu
0Z [hivemq-native-eventloop-child-11] DEBUG event.client-connected - Client ID: test-mqttxxx-03-haproxy-healthchecker, IP:
6Z [hivemq-native-eventloop-child-11] DEBUG event.client-disconnected - Client ID: test-mqttxxx-03-haproxy-healthchecker,
9Z [hivemq-native-eventloop-child-15] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefu
7Z [hivemq-native-eventloop-child-1] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefu
1Z [hivemq-native-eventloop-child-2] DEBUG event.client-disconnected - Client ID: vehicl eMockListener1521022427024, IP
0Z [hivemq-native-eventloop-child-5] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefu
8Z [hivemq-native-eventloop-child-7] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefu
2Z [hivemq-native-eventloop-child-9] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefu
7Z [hivemq-native-eventloop-child-11] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefu
1Z [hivemq-native-eventloop-child-13] DEBUG event.client-connected - Client ID: test-mqttxxx-04-haproxy-healthchecker, IP:
9Z [hivemq-native-eventloop-child-13] DEBUG event.client-disconnected - Client ID: test-mqttxxx-04-haproxy-healthchecker,
8Z [hivemq-native-eventloop-child-1] DEBUG event.client-connected - Client ID: mqttlinkstatusaggregator, IP: !, Cle
4Z [hivemq-native-eventloop-child-5] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.25 disconnected ungracefu
8Z [hivemq-native-eventloop-child-7] DEBUG event.client-disconnected - Client ID: UNKNOWN, IP:10.9.54.31 disconnected ungracefu
17 Final size: 107 DEBUGS, total size: 107 Client ID: null Client IP: null Client Port: null Client Address: IP: 10.104.15.122
```

*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-mqttdbrokerlb-03-haproxy-healthchecker, IP:10
2018-06-01T18:25:38,706Z [hivemq-native-eventloop-child-11] DEBUG event.client-disconnected - Client ID: test-mqttdbrokerlb-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: vehicel 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-mqttdbrokerlb-04-haproxy-healthchecker, IP:10
2018-06-01T18:25:44,529Z [hivemq-native-eventloop-child-13] DEBUG event.client-disconnected - Client ID: test-mqttdbrokerlb-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"
}
```

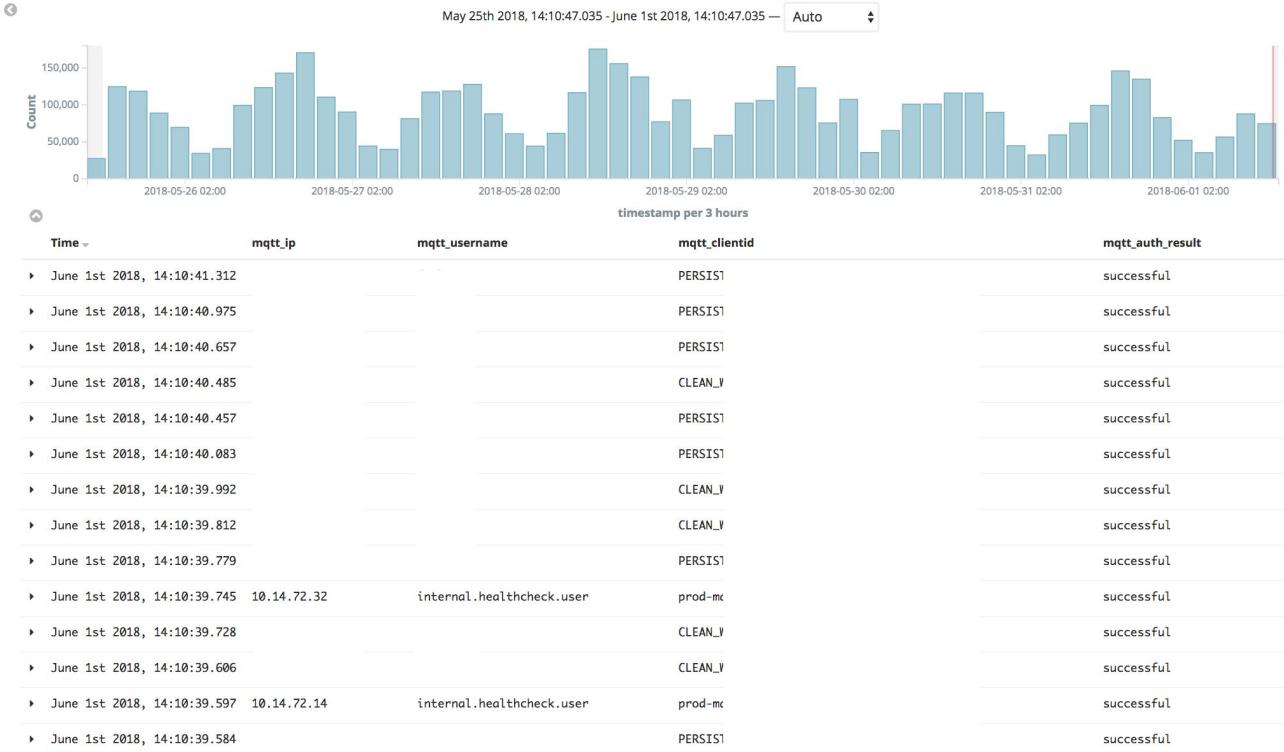
Prepared for general use

Quick Links

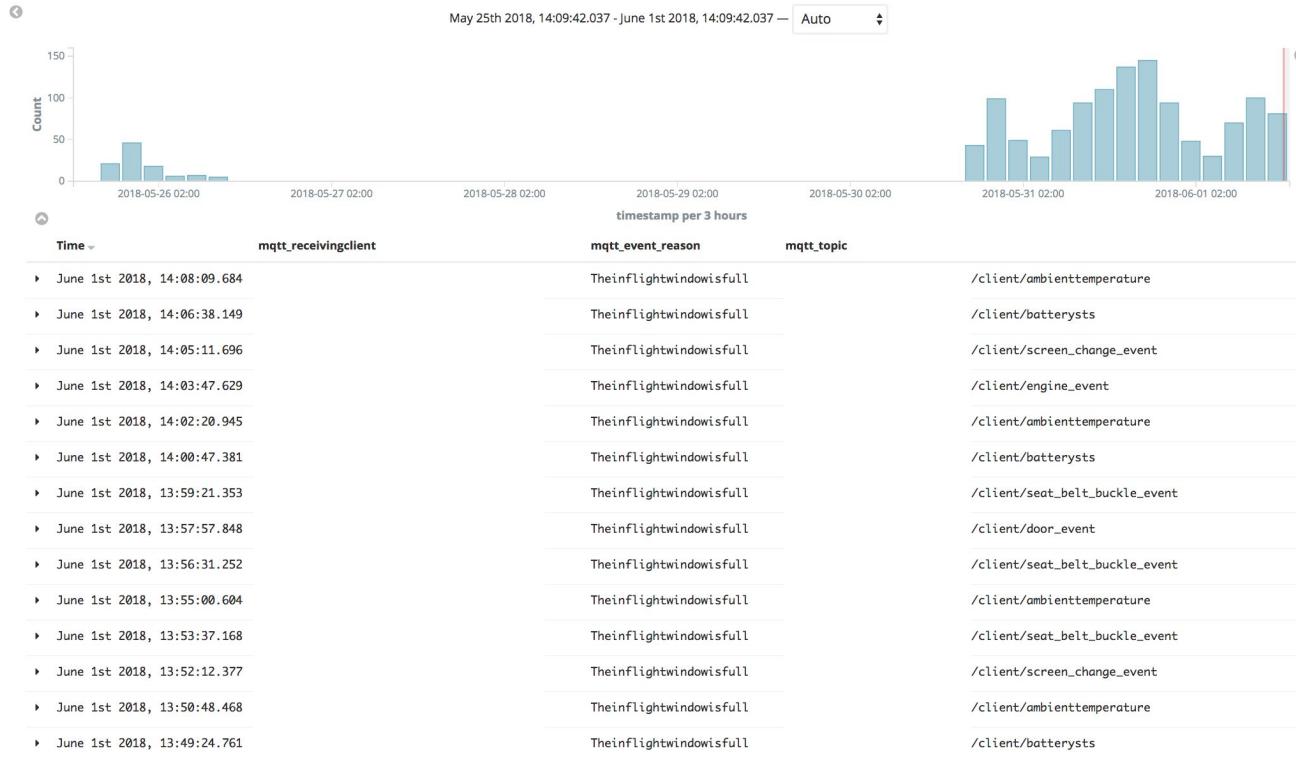
The following links help you to find some query examples. Open an example and modify to your own needs:

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!



Dropped Messages ...? Panic?!

Think Different™ + Do your homework!



Lesson #5

“S” in IoT stands for security!

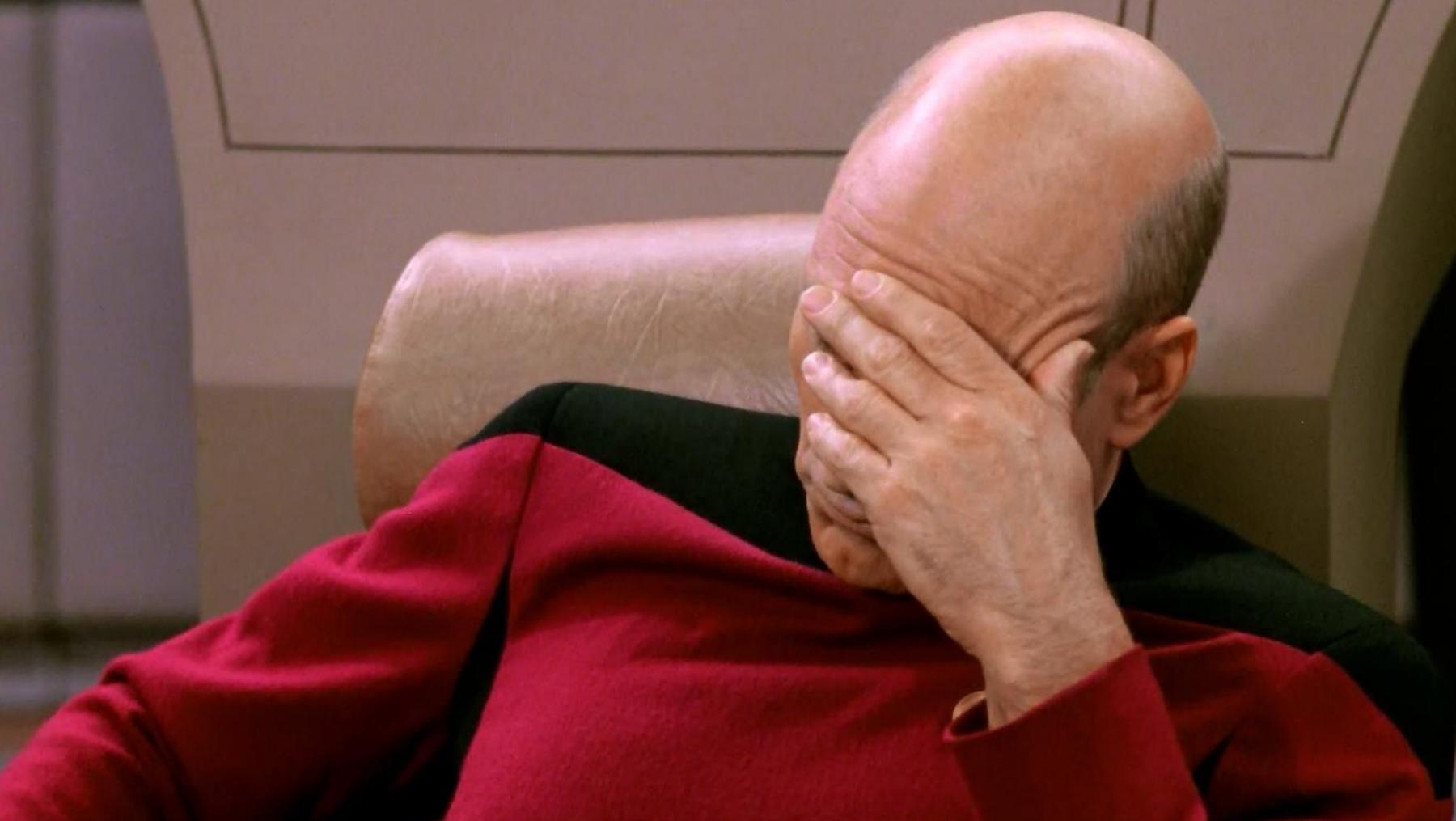
“S” in IoT stands for security!

- MQTT security mechanisms exist
- Security Batteries in HiveMQ (were) not included
- Fight for it!
- 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.



Open Source now ...

- github.com/inovex/mqtt-stresser
- github.com/inovex/mqtt_blackbox_exporter
- ... and more for beer!



GitHub

WE'RE
HIRING!
inovex.de/jobs

IT Engineering & Operations – Wir bauen Clouds

inovex ist seit vielen Jahren auf die Architektur, Realisierung und Betreuung von modernen IT-Infrastrukturen spezialisiert.

In unserer Unit „IT Engineering & Operations“ entstehen Cloud-Plattformen, die entweder komplett als Private Cloud oder als hybride Cloud im Zusammenspiel mit den großen Public Clouds (Amazon, Google, Microsoft) realisiert werden. Mit den „inovex Cloud Services“ unterhalten wir außerdem eine eigene Cloud-Plattform, auf der wir für Kunden digitale Lösungen im DevOps-Modus betreiben.

Für unser ITO-Team suchen wir *dich!* Du bist von Linux begeistert, hast einen Engineering Background und Lust, dich mit neuen Technologien zu beschäftigen? Dann bist du bei uns genau richtig! Was wir tun, wen wir suchen und wie es ist, bei uns zu arbeiten – das kannst du dir hier schon einmal ansehen. Und wenn du dann denkst, das könnte passen, freuen wir uns auf deine Bewerbung!

Dein ITO-Team bei inovex.

PS: Wir suchen für alle unsere Standorte neue Kolleg*innen. Ganz besonders allerdings für unser [Office in München](#). Wenn dich das interessiert – hier gibt es mehr Infos zu inovex München.



Wir bauen Clouds
Smarte Plattformen für die Digitale Transformation.



Engineeren statt administrieren
Es geht immer noch ein bisschen automatischer.



Der inovex Spirit
Wir machen unsere Kunden glücklich. Und uns selbst.

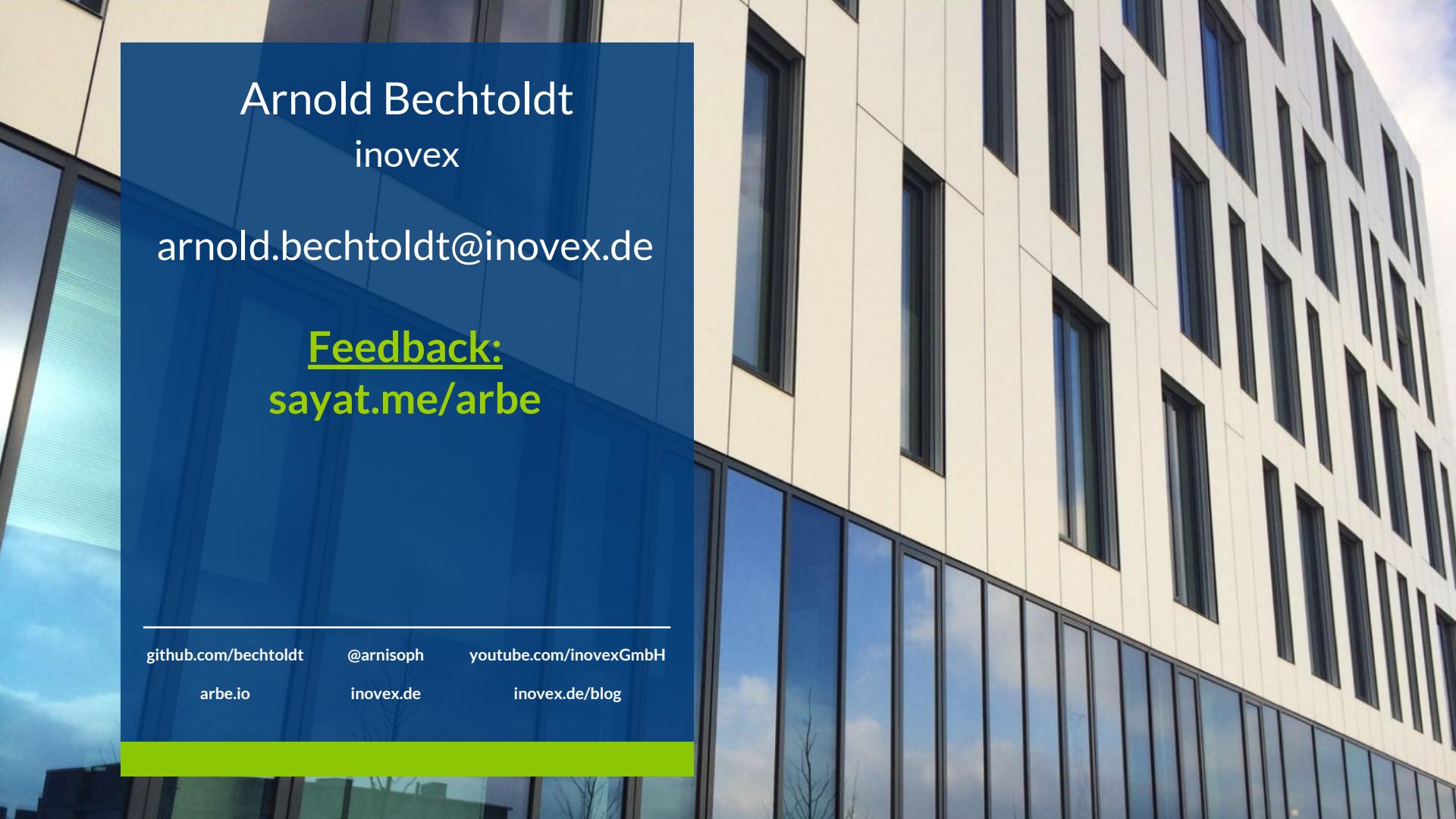


Wir leben DevOps
Cloud Engineering ist agile Software-Entwicklung.



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