



UNIVERSITY *of* LIMERICK
OLLSCOIL LUIM NIGH

Project Log

Spring Semester

Week 2

MEng Information & Network Security

Thomas Flynn

16117743

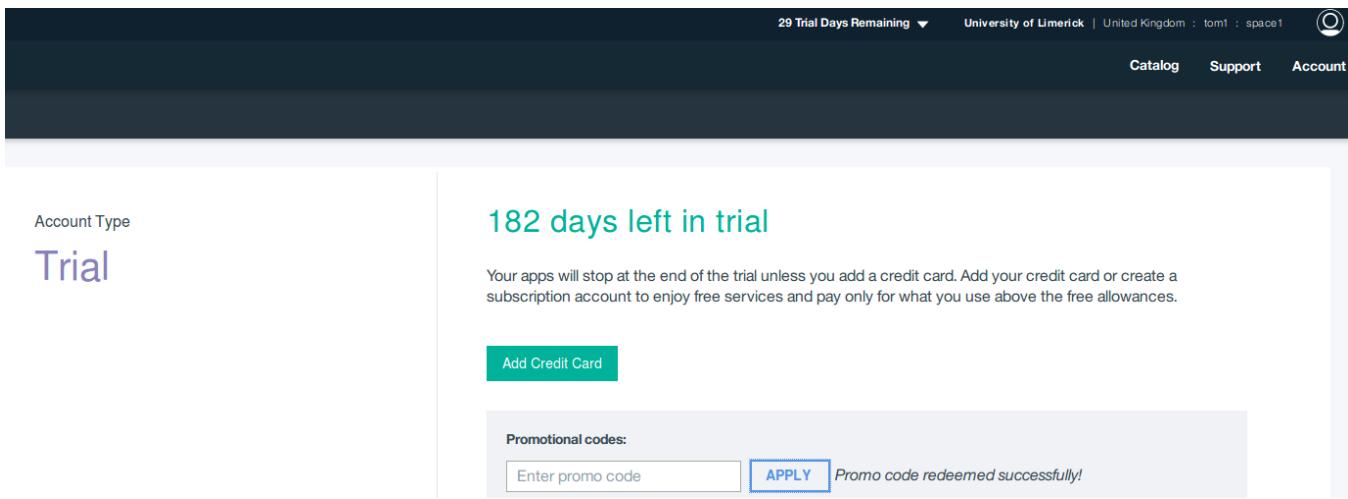
Project Supervisor: Sean McGrath

30/01/17- 05/02/17

1 Log Entries

1.1 Entry 30/01/17

Today I decided to create a new Bluemix account with my personal email. I then used the academic promo code that was associated with my college email on the new account. This solution avoided having to wait for the Bluemix support team to reply to me.



The screenshot shows the Bluemix trial dashboard. At the top, it displays "29 Trial Days Remaining" and the account information "University of Limerick | United Kingdom : tom1 : space1". Below this, there are links for "Catalog", "Support", and "Account". On the left, under "Account Type", it says "Trial". In the center, a large green box displays "182 days left in trial". Below this, a message states: "Your apps will stop at the end of the trial unless you add a credit card. Add your credit card or create a subscription account to enjoy free services and pay only for what you use above the free allowances." A green button labeled "Add Credit Card" is visible. At the bottom, there is a section for "Promotional codes:" with a text input field containing "Enter promo code", a blue "APPLY" button, and a message "Promo code redeemed successfully!".

I carried out the most intense session of research to date today. I worked on my project from 11am to 9pm, taking minor breaks. The summary of the areas researched can be seen in the toggl weekly log picture in section 5.

1.2 Entry 31/01/17

Today I gathered the most relevant links I have collected over the last few days and placed them in a “research-links-summary” document (which can be viewed in this repository). I plan to send this document to my supervisor once I’m happy with it.

1.3 Entry 03/02/17

Today I committed my research work to Github.

2 Tasks completed

- Creating new bluemix account for academic free trial
- IBM Container research
- IBM Container group research
- Amalgam8 research
- General research (jumping between mqtt brokers and bluemix links)
- MQTT container research
- Microservices from Theory to Practice (IBM document)
- Mosca research
- Questions & answers (self evaluation)
- Research links document for supervisor
- (rough) architectural diagram

3 GIT Repositories

3.1 INS-Thesis-Documentation

Commits on Jan 29, 2017



week 1 log

16117743 committed 2 days ago

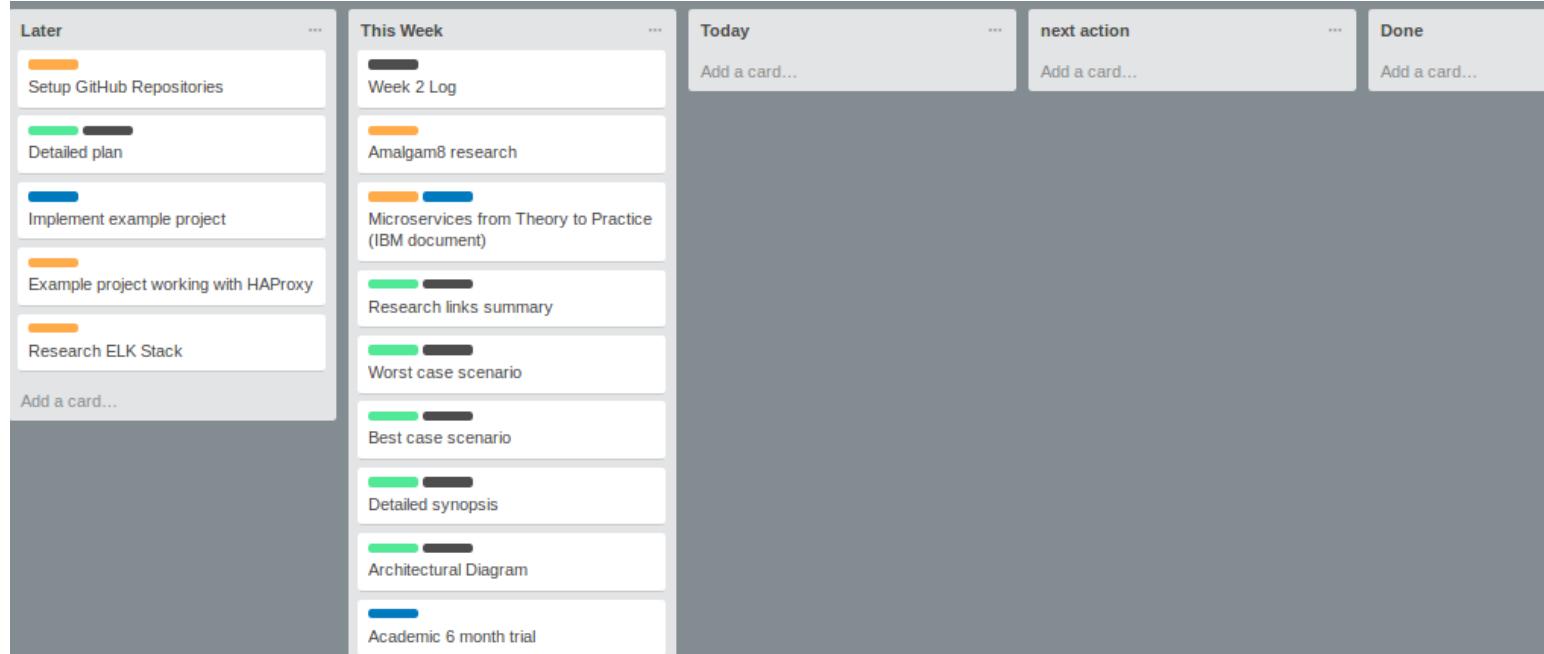


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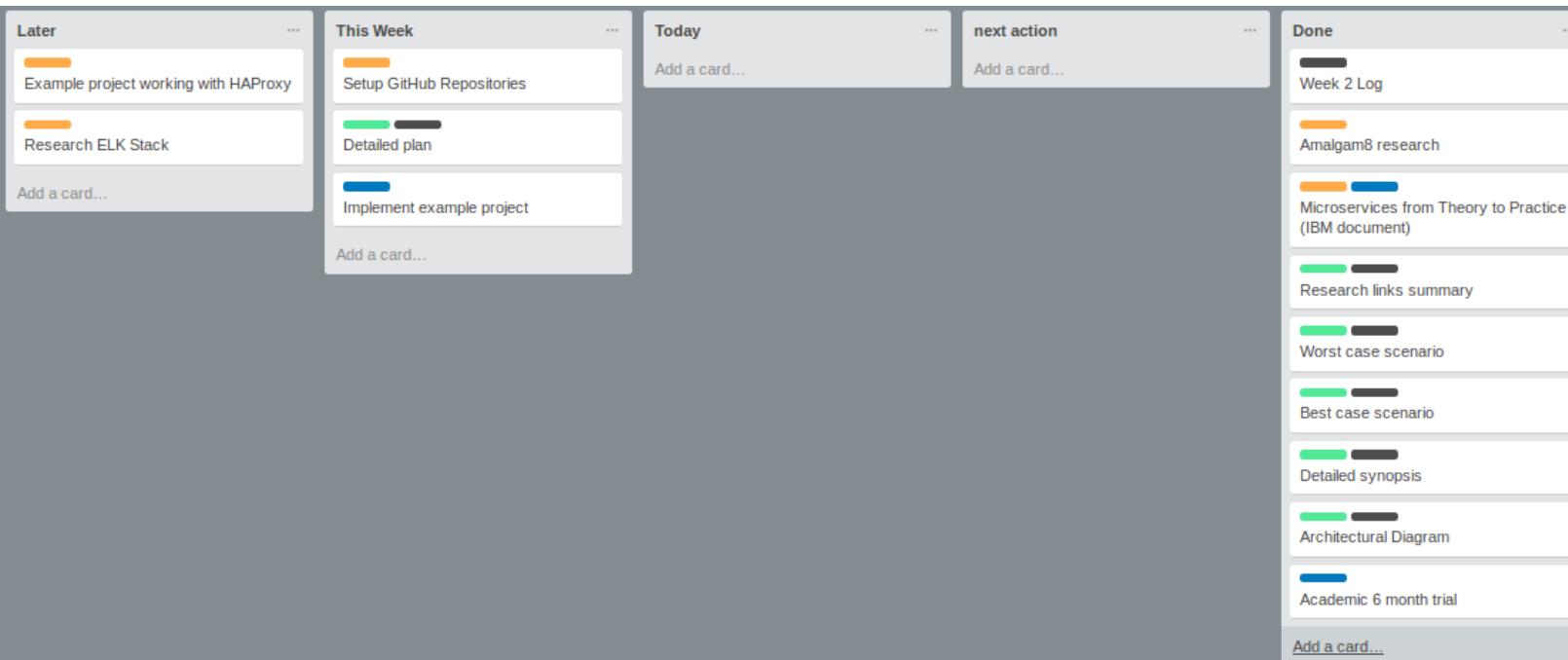


4 Trello boards

4.1 Board at the start of the week

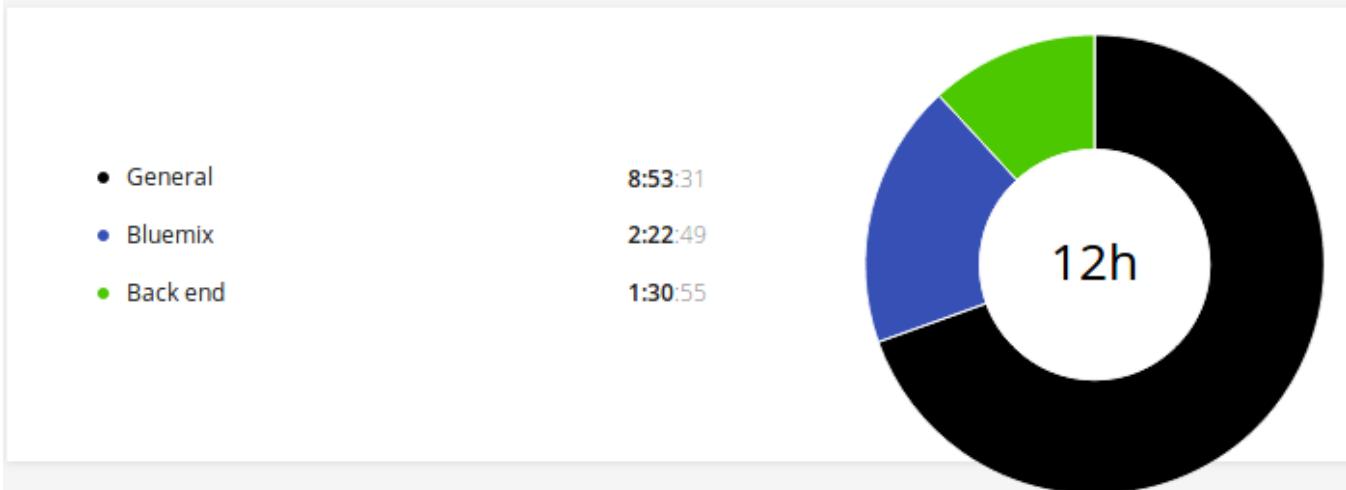
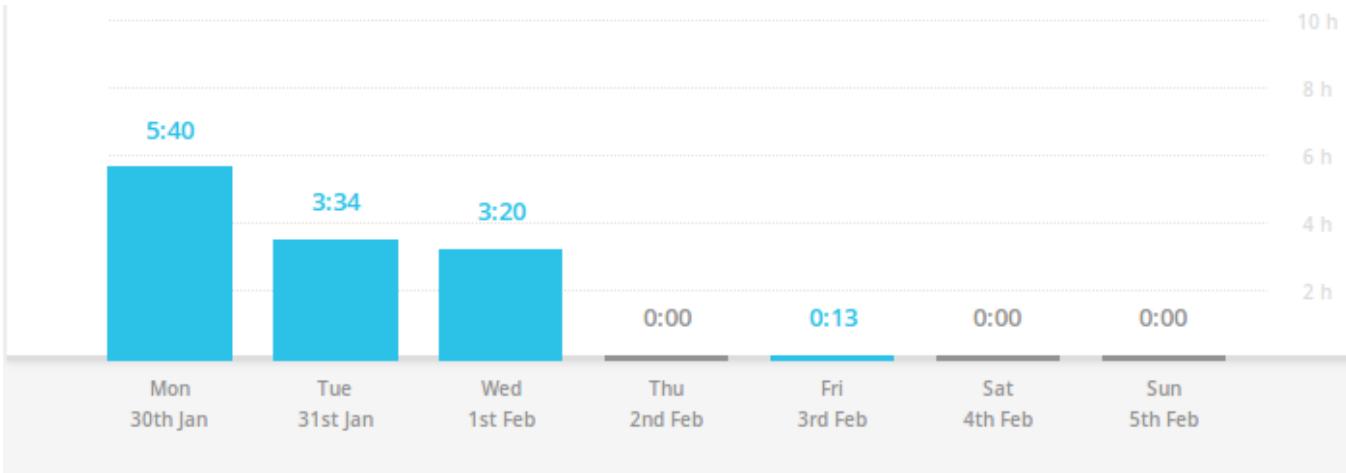


4.2 Board at the end of the week



5 Toggl Time Logs

5.1 Weekly time Log bar chart



5.2 Weekly time log

Fri, 3 Feb 0:13:00

Commit research work to Github ● General 0:13:00

Wed, 1 Feb 3:20:00

mini report ● General 3:20:00

Tue, 31 Jan 3:34:08

weekly log ● General 0:17:08

research links doc ● General 2:50:42

questions and answers (self) ● General 0:26:18
4:41 PM - 5:07 PM

Mon, 30 Jan

5:40:07

research links doc	● General	1:03:04
mosca research	● Back end	0:38:07
Microservices from Theory to Practice (IBM doc)	● Bluemix	0:58:21
mqtt container research	● Bluemix	0:31:43
general research	● General	0:43:19
Amalgam8 research	● Back end	0:52:48
IBM Container group research	● Bluemix	0:21:36
IBM Container service research	● Bluemix	0:22:29
Creating new Bluemix account	● Bluemix	0:08:40



6 Pictures

Q

load balancing considerations when 10K students on campus... and no one is using the mobile app UI.

Q

what is this number?

Q

what happens when 10K transmit in 1 sec?

Q

throughput?

Q

load balancing when 10K on campus and more than 10K using the mobile application?

Ans:

MQTT broker server is unaffected by these REST calls.

(Ideally) OpenWhisk will handle * requests through microservice black magic.

Q

what happens mqtt broker container during minimal load periods?

Ans:

Should only be charged for % of cpu time used.

Q

How many brokers/containers will you need for 1K, 5K, 10K users active?

Q

How will you handle failure?

Q

QoS?

what monitoring / feedback mechanisms will you implement?

ELK ^{stack} for debugging after the fact. (crash)

Q how will you roll out updates?

Ans Amalgam8 microservices framework for A/B testing, canary deployment.

how will Amalgam8 work with OpenWhisk?

Where does Node-Red come into this picture?
how will Node-Red be used for load balancing?

what are the costs for this application?

how big is a single payload from MQTT client?

How exactly does a mobile user get updated view of map?

time based trigger? how long? minimum? max?

what functions will open whisk be performing exactly?
what triggers?

why use an openwhisk microservice over Amalgam8 ms?

Q

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How will you handle failure?

Q

QoS?

Q 11

Q How will the backend differ for an embedded device? Will they be using REST on top of MQTT????!

Ans I think the device should post/subscribe to a topic like "car-iot" or something.

The "mobile-iot" topic would handle the mobile user, granting him/her (access?) to the REST API.

Q

So the only way a mobile user can gain access to the map UI app is if they successfully transmit their location through MQTT?

Q
Q

what happens to the MQTT ~~UI~~ protocol?

you're going to need it again in 15 mins

when the ~~mobile~~ client publishes their location again?

Ans

I'm not sure how REST works with MQTT

Q

why are you insisting on using REST?

Ans

In order to decouple front and backend, to allow for iOS and Android development.

Q

why not use REST for all communication?

Ans

The mobile application might as well use the MQTT framework that will be put in place for other IoT devices, anyway.

Q A

Q Is it a node.js backend for an Ionic (Angular) mobile application?

Ans → Yes
Q ↳ will all communication ~~be~~ that takes place between backend & front end use MQTT? (for APP UI)

Ans → maybe? I know I want to use REST anyway

Q ↳ will all other MQTT clients be notified when another one publishes?

Answer → I want the mobile clients to be updated once every 1 minute - 5 mins

Q updated on the data published?

Option 1: Yes, the client streams the published data, once every few minutes

Q what do you mean by stream?

The client does the hard work of interpreting each GeoJson object as it comes, and updates the UI after every... say 30 objects (Rendering)

Q How would account for error?

↳ Compare clients "total users" tally against DB
↳ Triggers microservice to do black magic if wrong

Q Will this option 1 drain battery? Ans: yes, yes it would.

Queues

- Stores each data payload in order received
- workers read the oldest item
- Redis/RabbitMQ "pushes" data onto workers
- Kafka → worker polls the queue for data.

PubSub channel

Same as above, but sends all the data to each consumer.

- workers don't share data, they all get a copy
- consumer must be connected in order to receive notification of incoming data (kafka exception)

Scaling clusters

You can only scale services that do not expose a public port as all container instances that are started for this service would try to use ~~same~~ port.

The "expose" parameter, publishes a port within your private container network only.

cmd "docker-compose scale the-app=2"

(i) add nginx service to docker-compose.yml

```
nginx:  
  image: nginx  
  ports:  
    - "492-168.0.1:80:80"  
  links:  
    - lets-chat-app
```

Questions

what is peak load?

↳ 10k msgs /per Sec

what size is average msg?

↳ Compressed
↳ unCompressed

what is Mosca?

↳ an effort to implement the MQTT protocol using node.js

Why Redis in Mosca?

↳ used as a pub/sub service in order to help
Mosca provide MQTT

All MQTT brokers share the same Redis store
solution → where sharing happens

VPN Service

↳ need VPN gateway device

Mosca

HAProxy Container

↳ Volume → SSL certificate

IBM container auto scaling

Scale up (when) $> 70\% \text{cpu}$ for (5 mins)

down $< 30\% \text{cpu}$ for (5 mins)

Space names

dev - tom

blue - uk

green - uk

REST - MQTT mirroring → monitoring
resources changed by other microservices are
tracked through MQTT events

malaria → tool for testing scalability & load
behaviour of MQTT environments.

Problems with scaling MQTT

Load balancing

↳ which broker to connect to?

↳ DNS load balancing

HA Proxy

QoS 1-2 msgs stored in Cassandra

↳ consistent hash ring

kafka → distributed by aggregation framework

Server to server

"smart" clients

Apache Zookeeper

kafka connector

↳ run in "distributed mode"

Can devise a topology that can...

↳ allows horizontal scaling

↳ parallel throughput

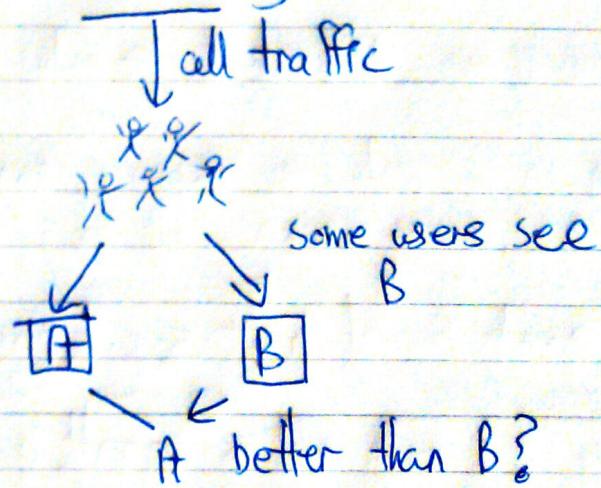
↳ high availability

Kafka client is too heavy weight to be a broker
client has to keep track of the "offset".

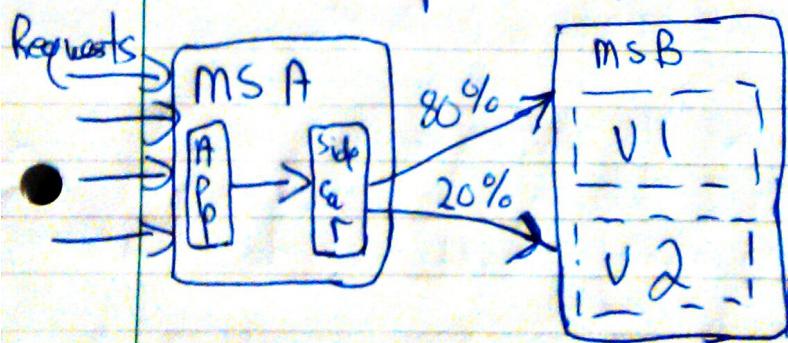
Amalgam 8 microservices architecture

① Canary Rollout

② A/B Testing



"Sidecar" responsible for routing between services



- Container Groups are bound to a public route that already includes an SSL certificate.
 - Can access group with HTTPS
- "Anti affinity" → these VMs are to run on different hosts
"Affinity rules" → these VMs are never migrated to other hosts.
- Container groups includes 2 or more containers that run the same image.

Auto recovery → attempts 3 times

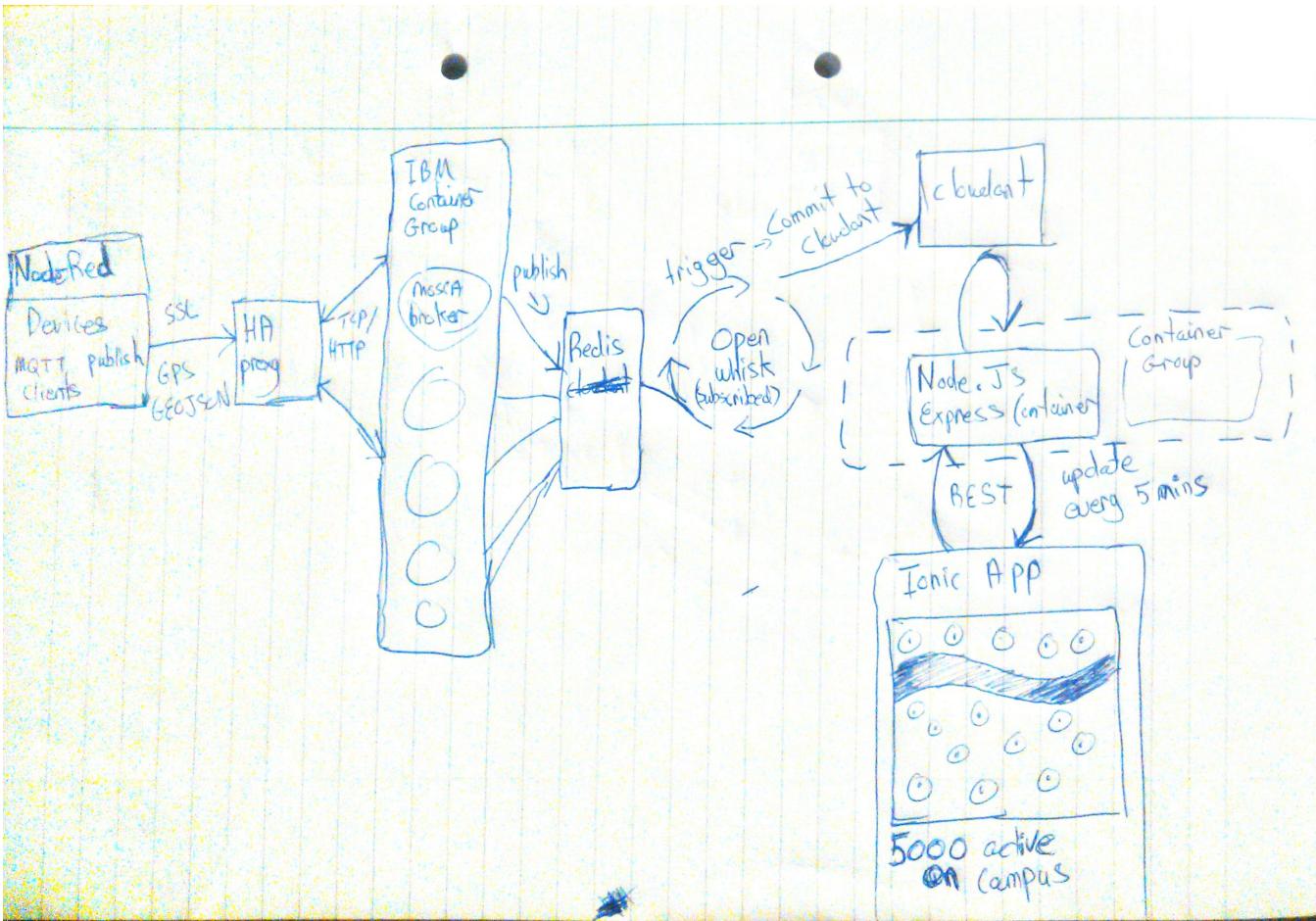
N+2 pattern → N = number of instances to handle requests

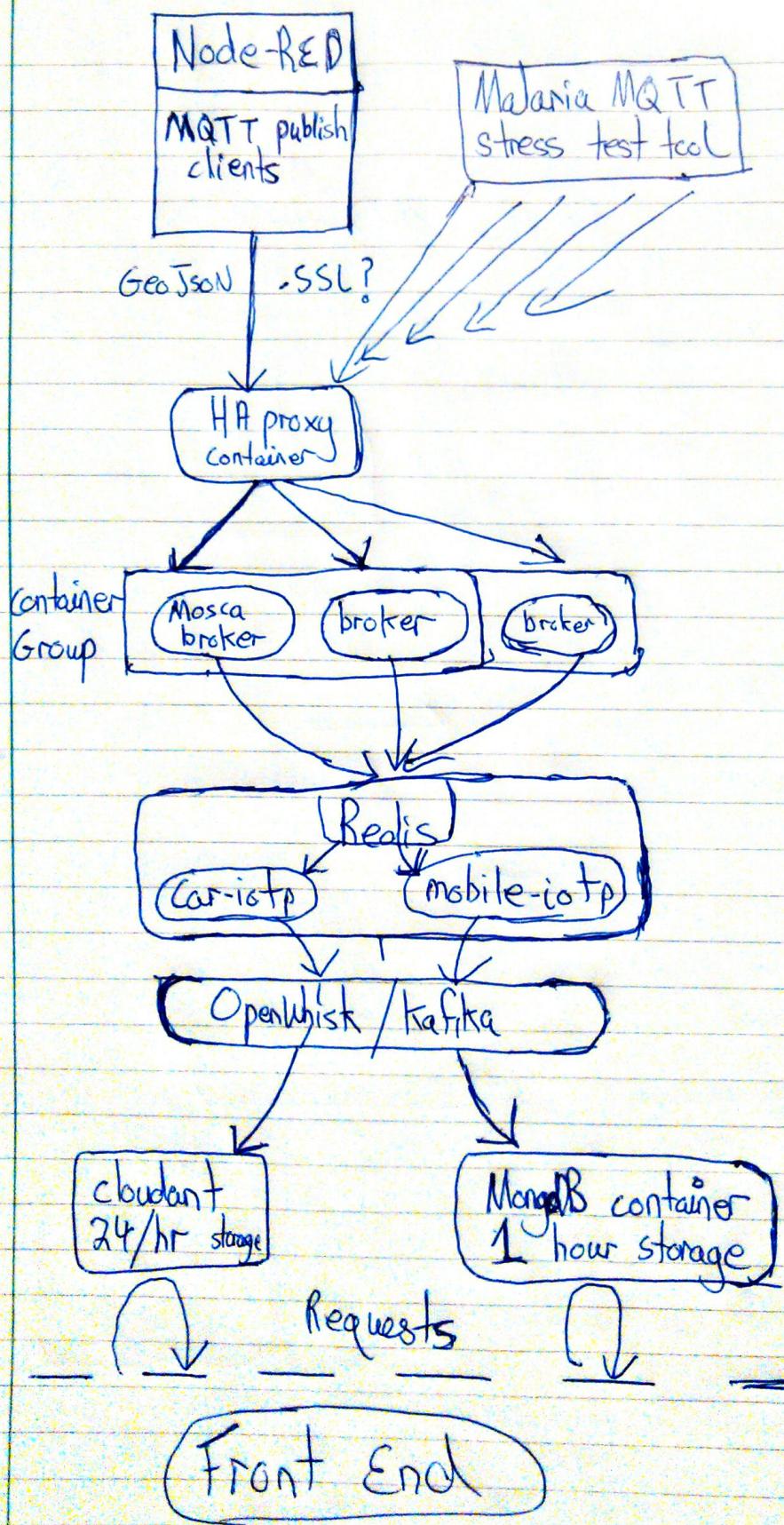
you can create multiple container groups that use the same route.

↳ if 1 group is unreachable, direct traffic to other

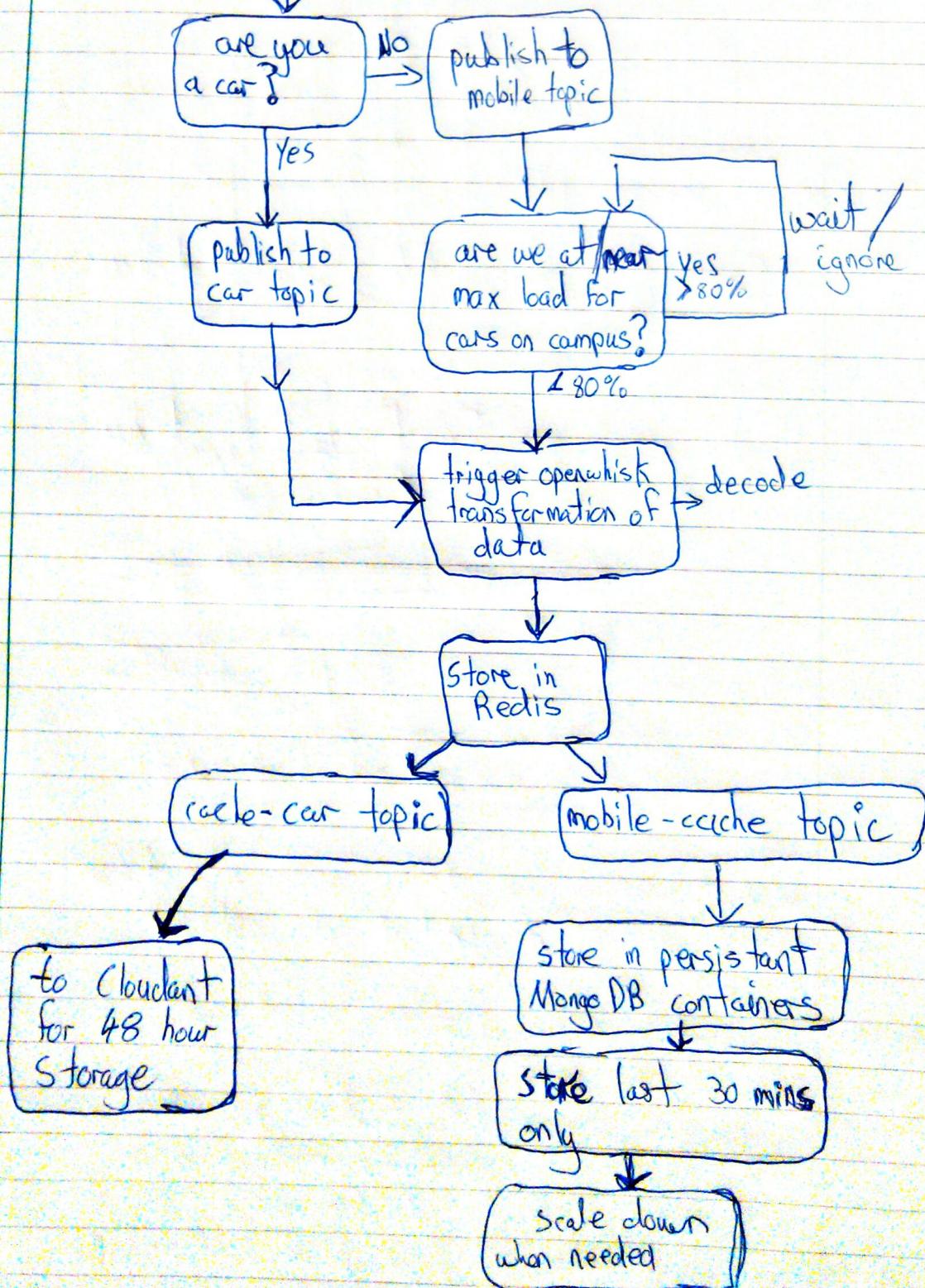
Single containers are to be used for short term processes and do not have built in high Availability capabilities like container groups.

- Create a 2nd container group
 - use different name
 - must use same host name as other group





After MQTT load balancing magic



Local balancing factor

- prioritize most clients who published ~~in the last 5mins~~ remove students who's velocity are leaving college bounds (presume leaving)

what issues could arise with this?

what about location?

- clients that were recorded entering the grounds get high priority

~~clients that are situated staff~~

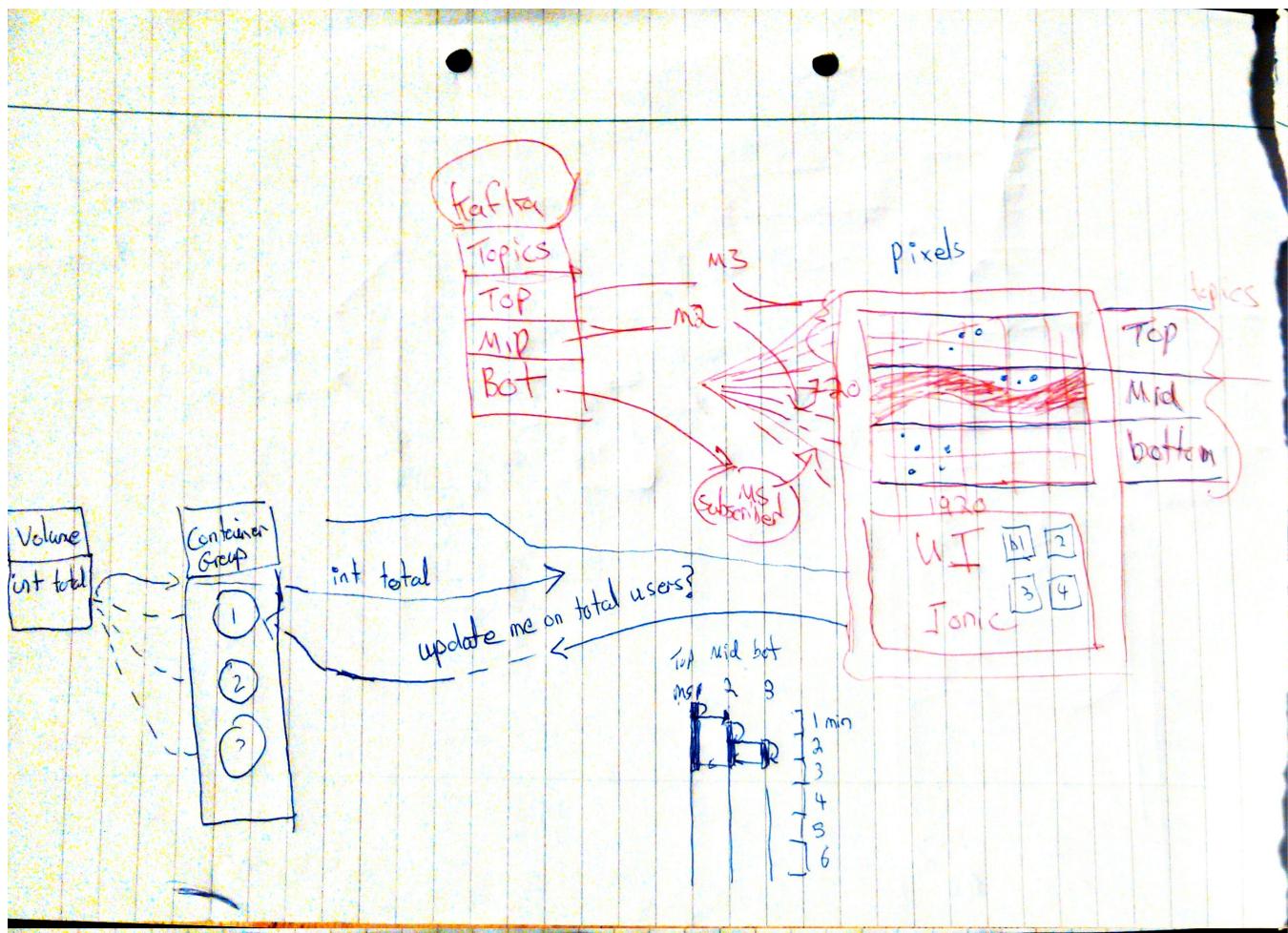
- clients publishing to "car-iotp" get higher priority than those who have recently published to "mobile-iotp"

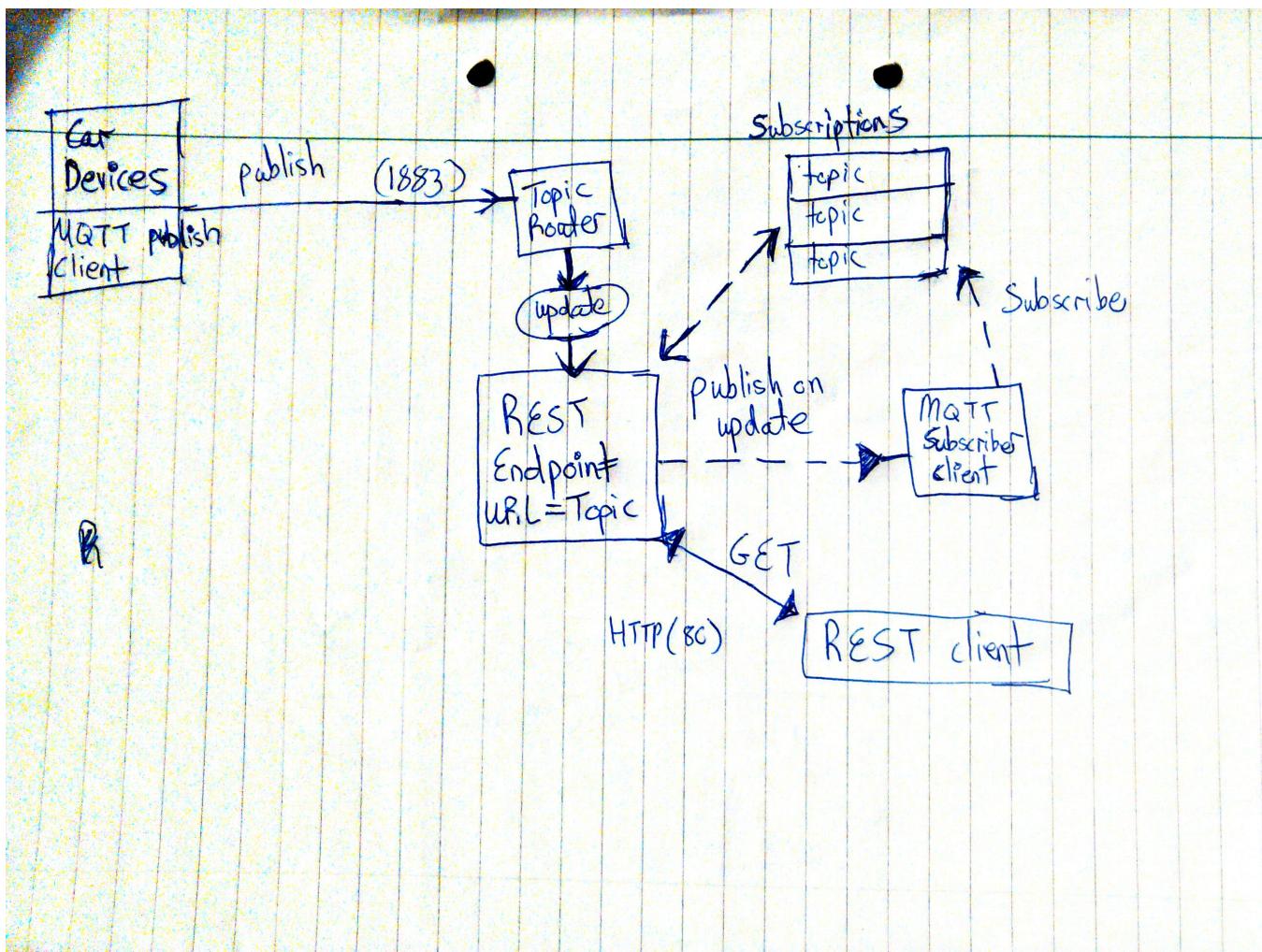
what microservice could you implement here in order to distinguish mobile app?

option A { Rewrite to a Node.js express container group

option B { Clients are authenticated to use various OpenWhisk services → including subscription to a "cache-mobile" topic

OpenWhisk will be in charge of ~~storing~~ reading/writing GPS





7 Bookmarks

<http://iot-datamodels.blogspot.ie/2013/05/event-models-for-restful-apis.html>

<https://dejanglozic.com/2014/05/06/rest-and-mqtt-yin-and-yang-of-micro-service-apis/>

<https://developer.ibm.com/clouddataservices/2015/10/15/analyze-website-metrics-and-visualize-with-d3/>

<https://developer.ibm.com/clouddataservices/2015/10/15/analyze-website-metrics-and-visualize-with-d3/>

https://console.ng.bluemix.net/docs/containers/container_compose_intro.html#container_compose_loadbalance

https://console.ng.bluemix.net/docs/containers/container_compose_intro.html#container_compose_scale

<http://colmsjo.com/mqtt>

https://console.ng.bluemix.net/docs/containers/container_compose_intro.html#container_compose_ov

https://console.ng.bluemix.net/docs/containers/container_compose_intro.html#container_compose_ov

<https://github.com/mqtt/mqtt.github.io/wiki/Server%20support>

<https://www.linkedin.com/pulse/iot-kafka-mqtt-bridge-using-mosca-robert-fuller>

<https://www.redbooks.ibm.com/redbooks/pdfs/sg248275.pdf>

<https://medium.com/@lelylan/how-to-build-an-high-availability-mqtt-cluster-for-the-internet-of-things-8011a06bd000#.ds9h70gb3>

https://console.eu-gb.bluemix.net/docs/containers/amalgam8/a8_solution_bluemix.html#a8_configure

