

AMIS SIG Introduction Microservice Choreography with Docker, Kubernetes Node.js and Kafka –Hands-on

1st June 2017

The ultimate goal of this workshop is to achieve microservice choreography. We will get there by implementing microservices as Dockerized Node.JS applications that run on Kubernetes and leverage microservice platform facilities such as a cache and an event bus. This event bus (Apache Kafka) provides the backbone for the choreography that will have microservices participate in a dance that no one orchestrates.

You will go through a number of steps in this workshop – that have you work with (and install) Docker, Kubernetes, Redis, Node.js, Apache Kafka and MongoDB.

You can get access to the sources for the practices from the GitHub repository:

<https://github.com/lucasjellema/microservices-choreography-kubernetes-workshop-june2017> .

1. Prepare a local Kubernetes and Docker environment

We will work with Docker in this workshop. You will be running multiple Docker Containers and have them interact. Subsequently, we will be using Kubernetes and its minikube cluster.

Installation

The installation we have to do before getting started with this workshop depends a little on your operating system – and of course the software you may already have set up on it. What we need to work with is at least:

- Docker
- VirtualBox
- Kubectl
- Minikube

On Windows and MacOS – without native support for Docker – we also need Docker Toolbox (or a VM running Linux).

Windows and MacOS: Docker Toolbox and VirtualBox

I will assume an older version of Windows or MacOS that does not have native Docker support. If that is your case, You need to:

- Download & Install the latest [Docker Toolbox](#) (this is not the same thing as just installing Docker)
- Download & install [VirtualBox](#) for Windows or OS X. Direct link to the binaries [here](#) (minikube relies on some of the drivers)

VirtualBox: go to the VirtualBox Downloads page: <https://www.virtualbox.org/wiki/Downloads> .
Download the latest installer for Windows or MacOS. Run the installer to install VirtualBox.

Docker Toolbox: https://docs.docker.com/toolbox/toolbox_install_windows/ or
https://docs.docker.com/toolbox/toolbox_install_mac/ (the steps: download the installer, run the installer, run the Docker Quickstart Terminal window to create the *default* machine)

- Windows: <http://storage.googleapis.com/kubernetes-release/release/v1.4.0/bin/windows/amd64/kubect.exe>
- minikube from <https://github.com/kubernetes/minikube/releases>

Some resources:

Tutorial : Getting Started with Kubernetes on your Windows Laptop with Minikube -

<https://rominirani.com/tutorial-getting-started-with-kubernetes-on-your-windows-laptop-with-minikube-3269b54a226>

<https://codefresh.io/blog/kubernetes-snowboarding-everything-intro-kubernetes/>

Minikube on Windows7: <https://quip.com/1TYDAdJowAgJ>

Running Kubernetes Locally via Minikube - <https://kubernetes.io/docs/getting-started-guides/minikube/>

Kubernetes Cheat Sheet: <https://kubernetes.io/docs/user-guide/kubect-cheatsheet/>

Run Minikube Single Node Cluster

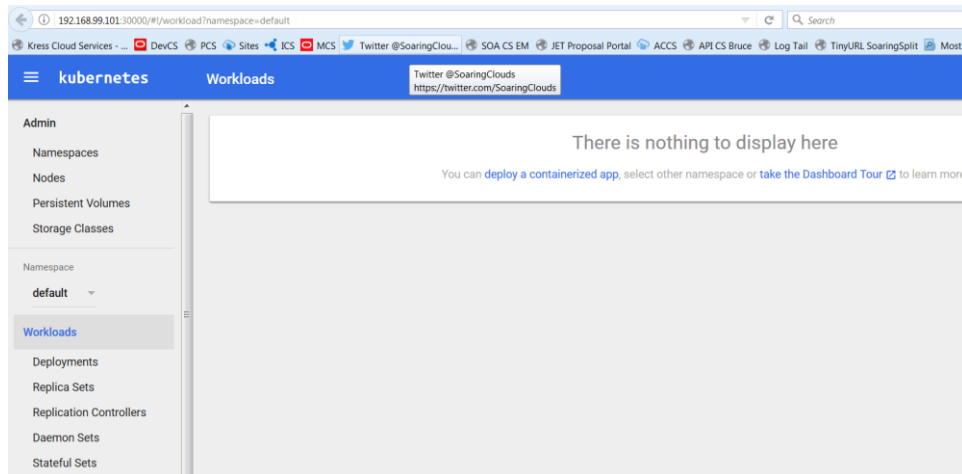
To run minikube – and have the one-node cluster initialized (in a VirtualBox VM):

minikube start

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>minikube.exe start
Starting local Kubernetes cluster...
Starting VM...
SSH-ing files into VM...
Setting up certs...
Starting cluster components...
Connecting to cluster...
Setting up kubeconfig...
Kubectl is now configured to use the cluster.
```

minikube dashboard --url=true

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>minikube dashboard --url=true
http://192.168.99.101:30000
```



minikube status

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>minikube status
minikubeVM: Running
localkube: Running
```

To get the IP address of the Minikube cluster:

```
minikube.exe ip
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>minikube.exe ip
192.168.99.101
```

To check on the nodes of the cluster, we can do:

```
kubectl.exe get nodes
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl.exe get nodes
NAME      STATUS    AGE       VERSION
minikube  Ready     7h        v1.6.0
```

Run Something on the MiniKube Cluster

Now in order to run a first [Docker container image in a Kubernetes] Pod on the cluster:

```
# deploy Docker container image nginx:
kubectl run my-nginx --image=nginx --replicas=2 --port=80
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl run my-nginx --image=nginx --replicas=2 --port=80
deployment "my-nginx" created
```

A Pod is started on the cluster with a single container based on the nginx Docker container image. Two replicas of the Pod will be kept running.

```
# as the result of the above, you will see pods and deployments
kubectl get pods
kubectl get deployments
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl get pods
NAME                                READY    STATUS    RESTARTS   AGE
my-nginx-858393261-3s0wg           1/1      Running   0           4m
my-nginx-858393261-5gnq3           1/1      Running   0           4m

C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl get deployments
NAME    DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
my-nginx 2         2         2             2           6m
```

In the Dashboard:

Name	Status	Restarts	Age
my-nginx-858393261-3s0wg	Running	0	-
my-nginx-858393261-5gnq3	Running	0	-

At this moment, the my-nginx containers cannot be accessed from outside the cluster. They need to be exposed through a Service:

```
# expose your deployment as a service
kubectl expose deployment my-nginx --type=NodePort
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl expose deployment my-nginx --type=NodePort
service "my-nginx" exposed
```

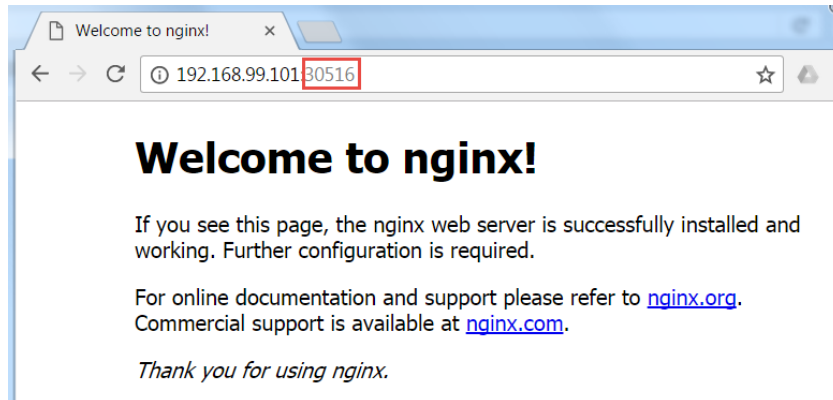
```
# check your service is there
kubectl get services
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl get services
NAME            CLUSTER-IP   EXTERNAL-IP   PORT(S)          AGE
kubernetes      10.0.0.1     <none>        443/TCP          7h
my-nginx        10.0.0.5     <nodes>       80:30516/TCP     43s
```

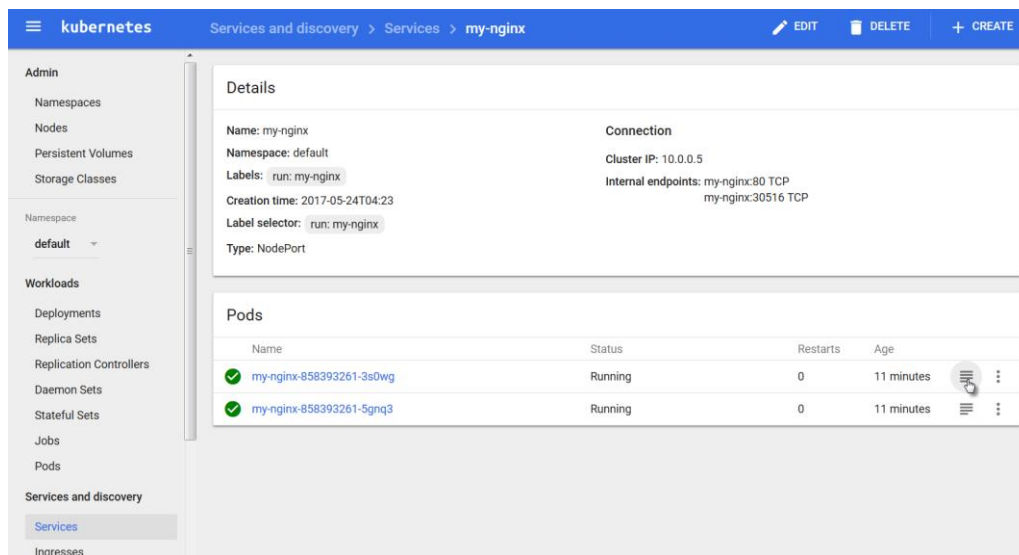
And in the Dashboard:

Name	Labels	Cluster IP	Internal endpoints	External endpoints
kubernetes	component: apiserver provider: kubernetes	10.0.0.1	kubernetes:443 TCP kubernetes:0 TCP	-
my-nginx	run: my-nginx	10.0.0.5	my-nginx:80 TCP my-nginx:30516 TCP	-

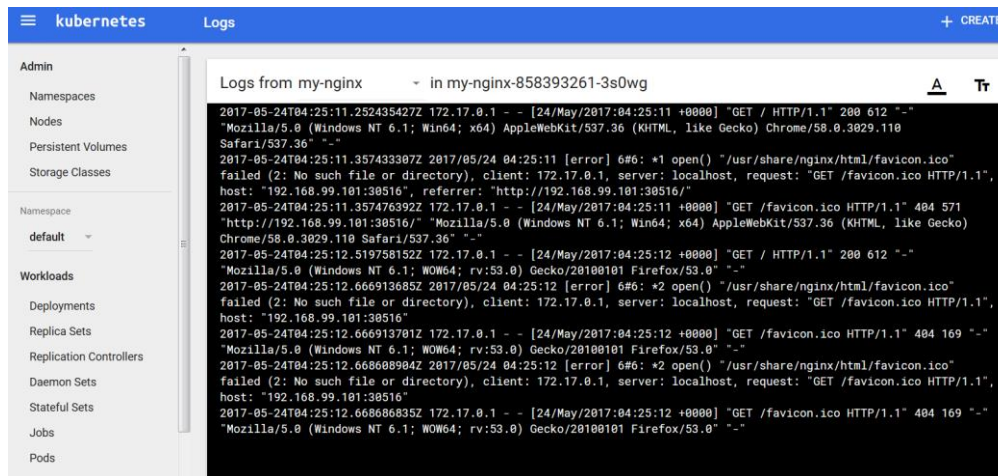
```
# Access your service from your default browser
minikube service my-nginx
```



If you are interested in the logging from one of the Pods, you can get to that logging in the dashboard. From the Services tab, drill down to a specific Service. Then click on the icon for the Pod that you are interested in:



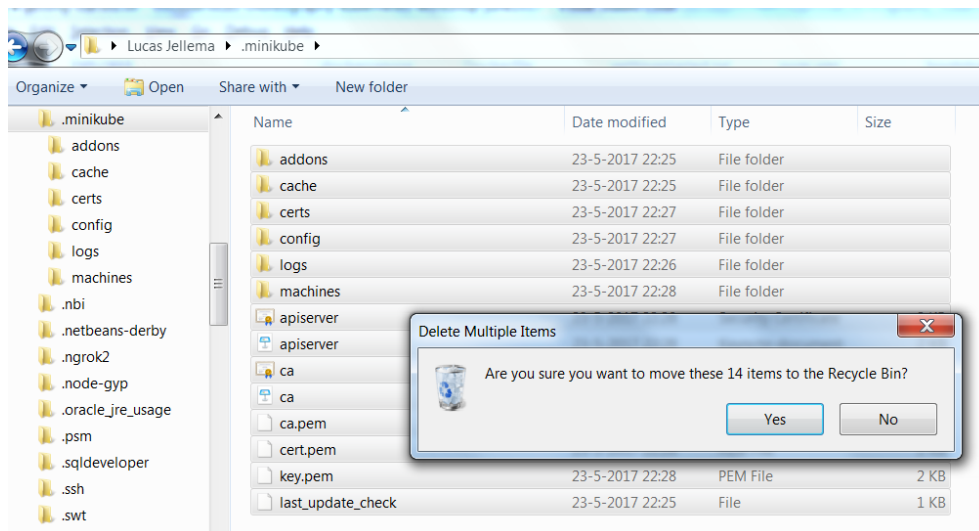
The logging will be shown:



At this point, you can remove the Deployment, Service and Pods for nginx.

Tip

Note: if you have trouble creating, running or restarting minikube, it may help to clear the directory `.minikube` under the current user directory:



2. Run your first Microservice

In this section, we will run a simple microservice. First as stand-alone Docker container, then in a Pod on the Kubernetes cluster. The microservice is implemented by a Node.js application – requestCounter – that accepts HTTP requests, counts request and returns the current count as the HTTP response.

Run RequestCounter in Docker

If you are using Docker Tools, then run the Docker Quickstart Terminal. On the command line in Docker Quickstart Terminal, run this command:

```
docker-machine ip default
```

It will return the IP address on your laptop assigned to the Docker VM that will run the Docker containers.

```
$ docker-machine ip default
192.168.99.100
```

On Docker command line – either in Linux server with Docker installed or in Docker Quickstart Terminal – run a container with the requestCounter.js Node.JS application:

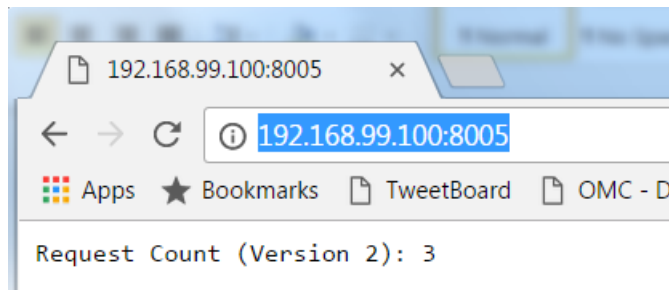
```
docker run -e "GIT_URL=https://github.com/lucasjellema/microservices-choreography-
kubernetes-workshop-june2017" -e "APP_PORT=8080" -p 8005:8080 -e "APP_HOME=part1" -e
"APP_STARTUP=requestCounter-2.js" lucasjellema/node-app-runner
```

```
efe6f7a9be92: Pull complete
Digest: sha256:02de5b7e9ff9111e8a8a76a91067d3061dd0d7b1fcddace5fe48965424420bcc
Status: Downloaded newer image for lucasjellema/node-app-runner:latest
switching node to version stable
node version: v7.10.0
Cloning into 'app'...
Application Home: part1
request-counter@0.0.2 /code/app/part1
+-- node-redis@0.1.7
`-- redis@2.7.1
   +-- double-ended-queue@2.1.0-0
   +-- redis-commands@1.3.1
   `-- redis-parser@2.6.0

Node.JS Server running on port 8080 for version 2 of requestCounter application.
```

When the microservice is running, it can be accessed on your laptop in the browser, at the IP address returned by docker-machine ip default and at port 8005 – the host port mapped to the container port 8080 in the docker run startup command.

<http://192.168.99.100:8005>



Execute the Docker run command again, with a small twist: change 8005 to 8006:

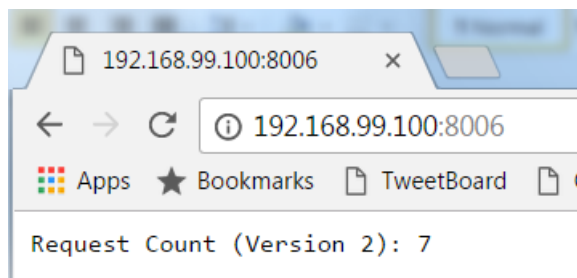
```
docker run -e "GIT_URL=https://github.com/lucasjellema/microservices-choreography-kubernetes-workshop-june2017" -e "APP_PORT=8080" -p 8006:8080 -e "APP_HOME=part1" -e "APP_STARTUP=requestCounter-2.js" lucasjellema/node-app-runner
```

A second container will be started for you, running the same application, listening at the same port – inside the container – and mapped to a different port at the host:

```
$ docker run -e "GIT_URL=https://github.com/lucasjellema/microservices-choreography-kubernetes-workshop-june2017" -e "APP_PORT=8080" -p 8006:8080 -e "APP_HOME=part1" -e "APP_STARTUP=requestCounter-2.js" lucasjellema/node-app-runner
switching node to version stable
node version: v7.10.0
Cloning into 'app'...
Application Home: part1
request-counter@0.0.2 /code/app/part1
+-- node-redis@0.1.7
`-- redis@2.7.1
   +-- double-ended-queue@2.1.0-0
   +-- redis-commands@1.3.1
   `-- redis-parser@2.6.0

Node.JS Server running on port 8080 for version 2 of requestCounter application.
```

<http://192.168.99.100:8006>



Use docker ps to check on the two containers currently running:

```
$ docker ps
```

CONTAINER ID	IMAGE NAMES	COMMAND	CREATED	STATUS	PORTS
c2dd31dd3d20	lucasjellema/node-app-runner	"/code/bootstrap.sh"	5 minutes ago	Up 5 minutes	0.0.0.
0:8006->8080/tcp	practical_vivesvaraya				
a13f8eae363	lucasjellema/node-app-runner	"/code/bootstrap.sh"	9 minutes ago	Up 8 minutes	0.0.0.
0:8005->8080/tcp	relaxed_bartik				

Stop these containers using

`docker stop <first three characters of container id>`

```
$ docker stop c2dd
lucas_j@14-311-267 MINGW64 ~
$ docker stop a13
lucas_j@14-311-267 MINGW64 ~
$ docker ps
```

CONTAINER ID	IMAGE	COMMAND
NAMES		

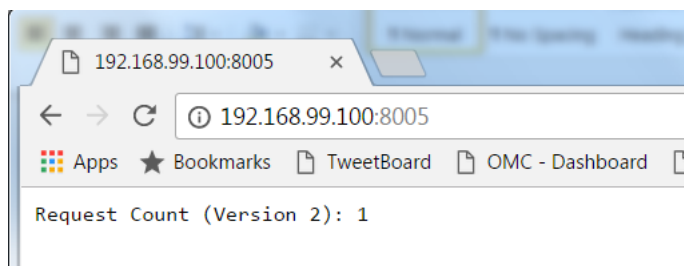
Then use `docker run` to start a fresh container :

```
docker run -e "GIT_URL=https://github.com/lucasjellema/microservices-choreography-
kubernetes-workshop-june2017" -e "APP_PORT=8080" -p 8005:8080 -e "APP_HOME=part1" -e
"APP_STARTUP=requestCounter-2.js" lucasjellema/node-app-runner
```

Access the microservice offered by this container once more.

<http://192.168.99.100:8005>

Verify the value returned by the request counter. Is it in line with the total number of calls you have made to the service?



Run and Expose the microservice on Kubernetes

Run one on Kubernetes

From workshop directory part1/kubernetes, run

```
kubectl create -f pod.yaml
```

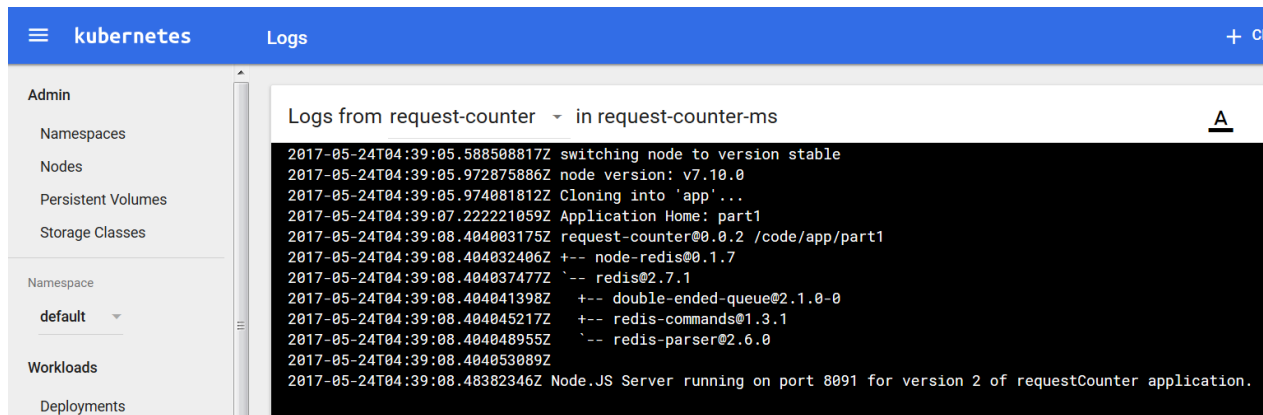
```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl create -f pod.yaml  
pod "request-counter-ms" created
```

This will create a Pod according to the specification in the file pod.yaml. Open this file and review the specification for the Pod. Crucial elements are the name of the Pod, the name of the underlying Docker Container Image and the values of the environment variables to be passed into the container.

Check on the Pod in the Dashboard (note: it will take up to a few minutes to get running for the first time because of the downloading of container images):

The screenshot shows the Kubernetes Dashboard interface. The top navigation bar is blue with the 'kubernetes' logo and a breadcrumb trail: 'Workloads > Pods > request-counter-ms'. On the right side of the top bar are buttons for 'EDIT', 'DELETE', and 'CREATE'. The left sidebar contains a menu with categories: 'Admin' (Namespaces, Nodes, Persistent Volumes, Storage Classes), 'Namespace' (a dropdown menu showing 'default'), 'Workloads' (Deployments, Replica Sets, Replication Controllers, Daemon Sets, Stateful Sets, Jobs, and 'Pods' which is highlighted), and 'Services and discovery' (Services). The main content area is divided into two sections. The 'Details' section shows metadata for the Pod 'request-counter-ms' in the 'default' namespace, with labels 'app: request-counter-ms', creation time '2017-05-24T04:36', status 'Running', and a 'View logs' link. It also shows network information: 'Node: minikube' and 'IP: 172.17.0.6'. The 'Containers' section shows details for the 'request-counter' container, including the image 'lucasjellema/node-app-runner', environment variables (GIT_URL, APP_PORT, APP_HOME, APP_STARTUP), and commands/args. A 'View logs' link is also present at the bottom of this section.

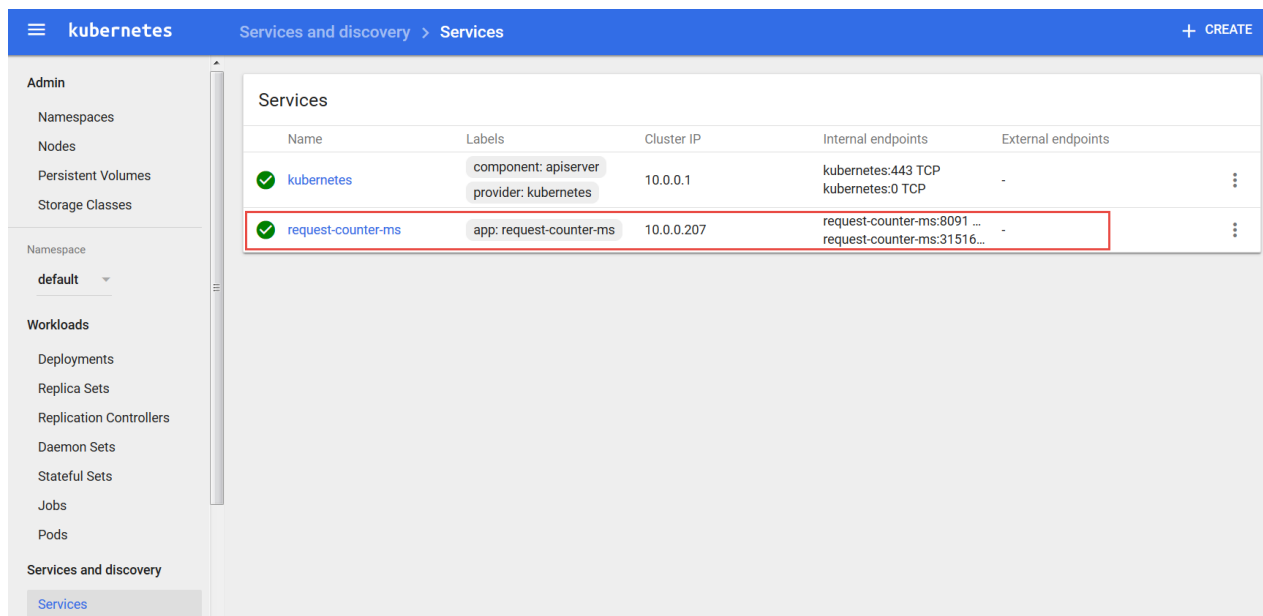
and verify the logging:



Expose the Pod using a Service to consumers outside the cluster:

```
kubect1.exe expose pod request-counter-ms --type=NodePort
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubect1.exe expose pod request-counter-ms --type=NodePort
service "request-counter-ms" exposed
```



Using kubect1 get services to inspect the service:

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubect1 get services
```

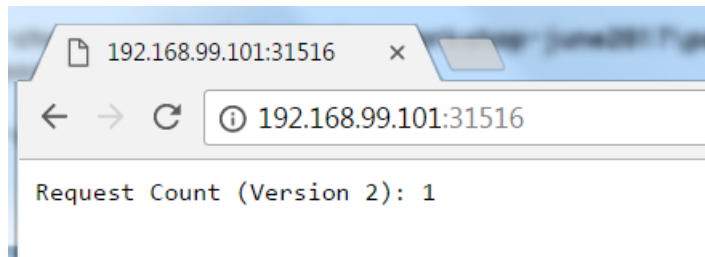
NAME	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
kubernetes	10.0.0.1	<none>	443/TCP	8h
request-counter-ms	10.0.0.207	<nodes>	8091:31516/TCP	1m

Also to get the url for accessing the service created for pod request-counter-ms:

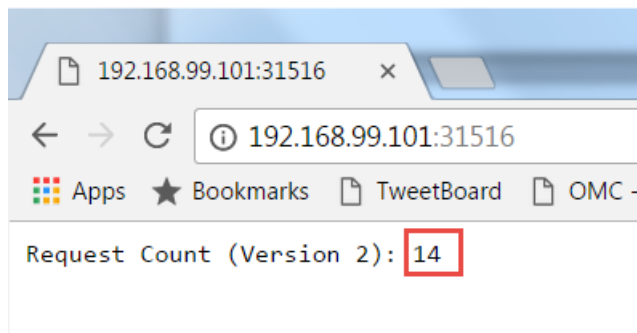
```
minikube.exe service --url=true request-counter-ms
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>minikube.exe service --url=true request-counter-ms
http://192.168.99.101:31516
```

Access the microservice at the URL retrieved (cluster ip: <port exposed for pod>):



Refresh the browser a few times. See how the counter value increases.



Delete the service and pod you have created for request-counter-ms:

Handle Scaling Up and Down

We will look at deployments on Kubernetes - you can run an application by creating a Kubernetes Deployment object, and you can describe a Deployment in a YAML file. Through Deployments, multiple replicas of a Pod can be started and managed by Kubernetes. These instances can be exposed under a single external IP, with Kubernetes taking care of routing incoming traffic to one of the Pods.

Let's run the request counter microservice again, through a deployment object – as described by file deployment.yaml.

```
kubectl create -f deployment.yaml
```

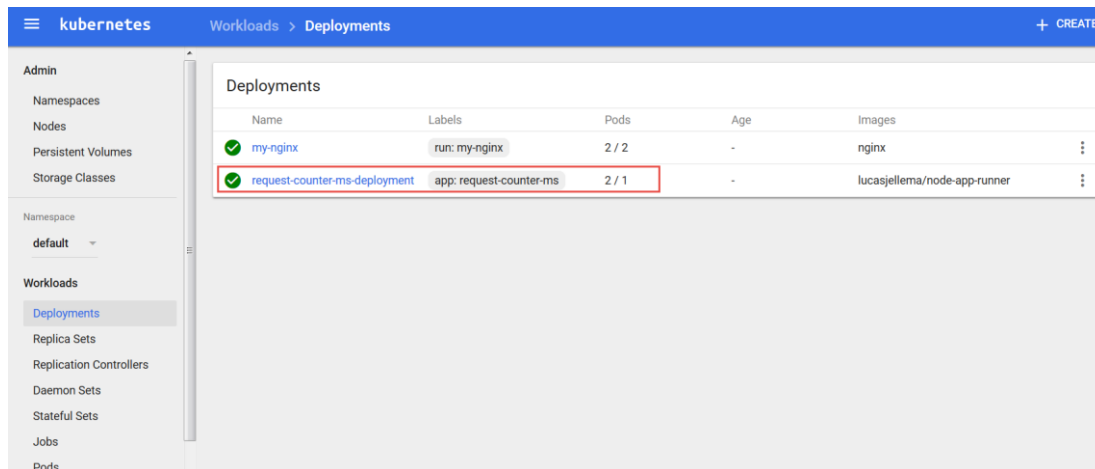
```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl create -f deployment.yaml
deployment "request-counter-ms-deployment" created
```

Display information about the Deployment:

```
kubectl describe deployment request-counter-ms-deployment
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl describe deployment request-counter-ms-deployment
Name: request-counter-ms-deployment
Namespace: default
CreationTimestamp: Wed, 24 May 2017 07:19:49 +0200
Labels: app=request-counter-ms
Annotations: deployment.kubernetes.io/revision=1
Selector: app=request-counter-ms
Replicas: 1 desired | 1 updated | 1 total | 1 available | 0 unavailable
StrategyType: RollingUpdate
MinReadySeconds: 0
RollingUpdateStrategy: 25% max unavailable, 25% max surge
Pod Template:
  Labels: app=request-counter-ms
  Containers:
    request-counter-ms:
      Image: lucasjellema/node-app-runner
      Port: 8091/TCP
      Environment:
        GIT_URL: https://github.com/lucasjellema/microservices-choreography-kubernetes-workshop-june2017
        APP_PORT: 8091
        APP_HOME: part1
        APP_STARTUP: requestCounter-2.js
      Mounts: <none>
      Volumes: <none>
  Conditions:
    Type          Status    Reason
    ----          -
    Available     True      MinimumReplicasAvailable
    Progressing   True      NewReplicaSetAvailable
OldReplicaSets: <none>
NewReplicaSet: request-counter-ms-deployment-2860362687 (1/1 replicas created)
Events:
  FirstSeen      LastSeen        Count   From              SubObjectPath  Type            Reason            Message
  ----
  17s            17s             1      deployment-controller  /              Normal          ScalingReplicaSet  Scaled up replica set request-c
t-2860362687 to 1
```

You can also check in the Dashboard for the Deployment, the Pods created as part of it and the Replica Set:



Instead of exposing a single Pod through a Service we can also expose the Deployment. Do so now, using:

```
kubectl expose deployment request-counter-ms-deployment --type=NodePort
```

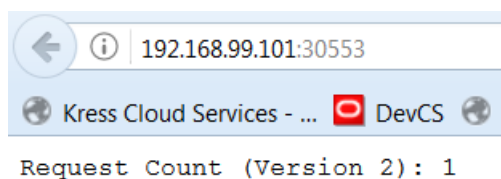
```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl.exe expose deployment request-counter-ms-deployment --type=NodePort
service "request-counter-ms-deployment" exposed
```

With kubectl get services:

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl get services
NAME                                CLUSTER-IP      EXTERNAL-IP      PORT(S)          AGE
kubernetes                          10.0.0.1         <none>           443/TCP          8h
request-counter-ms-deployment       10.0.0.189      <nodes>          8091:30553/TCP   1m
```

Access the microservice in the browser at the specified port (30553 in this case) or simply using:

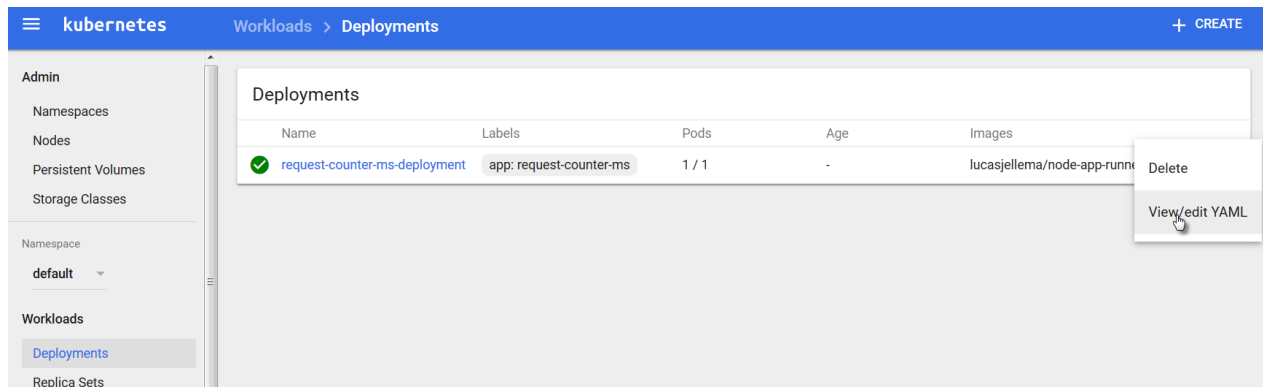
```
minikube.exe service request-counter-ms-deployment
```



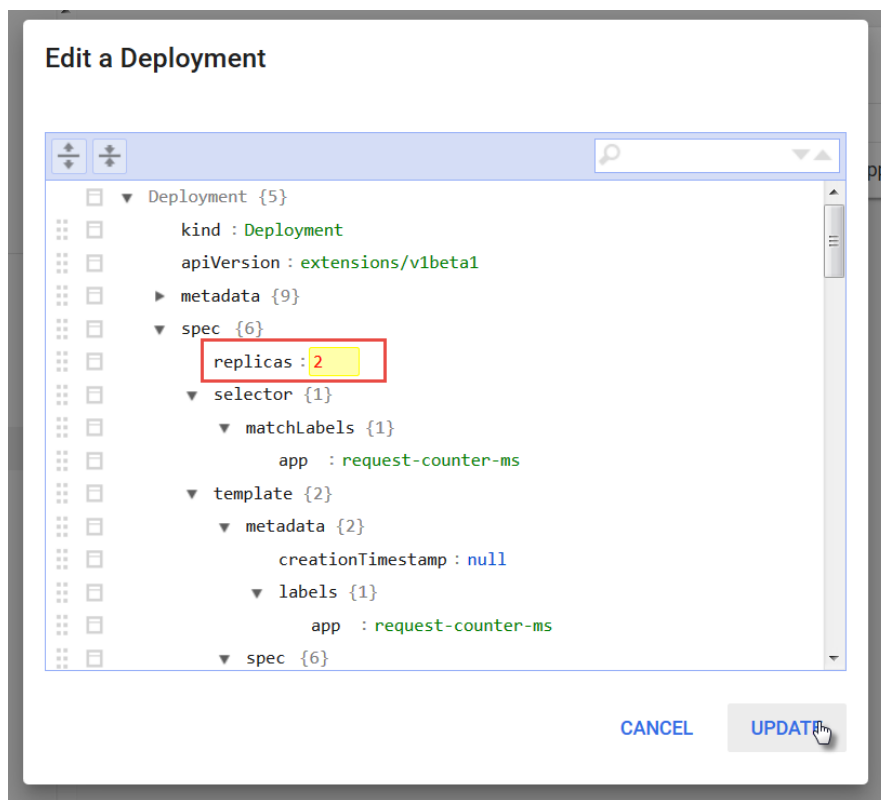
Hit the url a few more times, increasing the counter as you go.

Now we will scale up the number of replicas – i.e. the number of container instances that is running on the cluster. This can be done by editing the deployment.yaml file and using `kubectl apply -f deployment.yaml` – or through the Dashboard:

Click on the node Deployments in the navigator. Open the drop down menu for the deployment request-counter-ms-deployment and click on *View/edit YAML*.

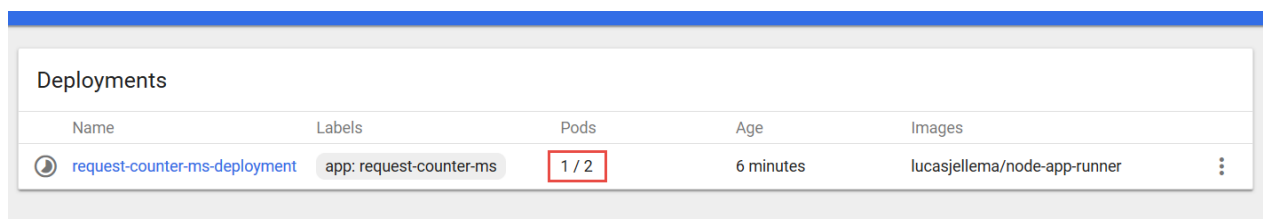


Change the value of the attribute replicas from 1 to 2:

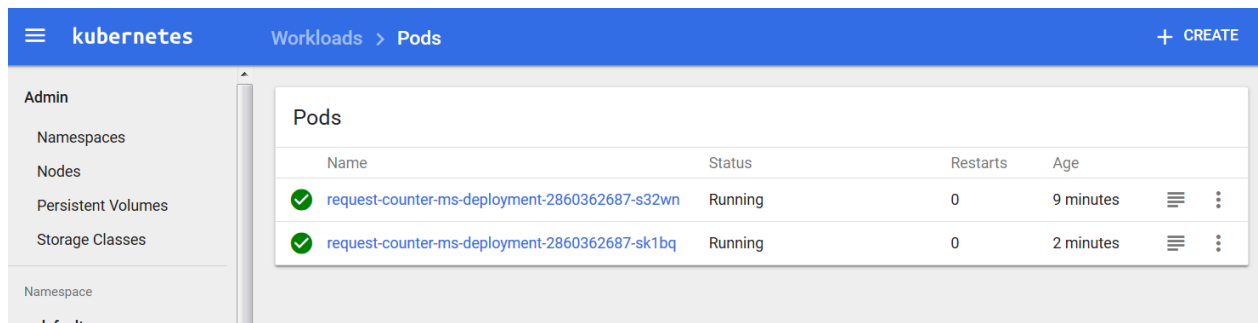


and click on Update.

You will see that the deployment has now 2 pods. The change is pending – as indicated by the icon on the left hand side.



After a little while, two pods are running:



The screenshot shows the Kubernetes dashboard with the 'Pods' tab selected. The left sidebar contains navigation links for Admin, Namespaces, Nodes, Persistent Volumes, Storage Classes, and Namespace. The main area displays a table of pods.

Name	Status	Restarts	Age
request-counter-ms-deployment-2860362687-s32wn	Running	0	9 minutes
request-counter-ms-deployment-2860362687-sk1bq	Running	0	2 minutes

You can access the microservice again from the browser, or you can do so using curl from the command line:

```
curl http://<ip of cluster>:<port exposed by service>
```

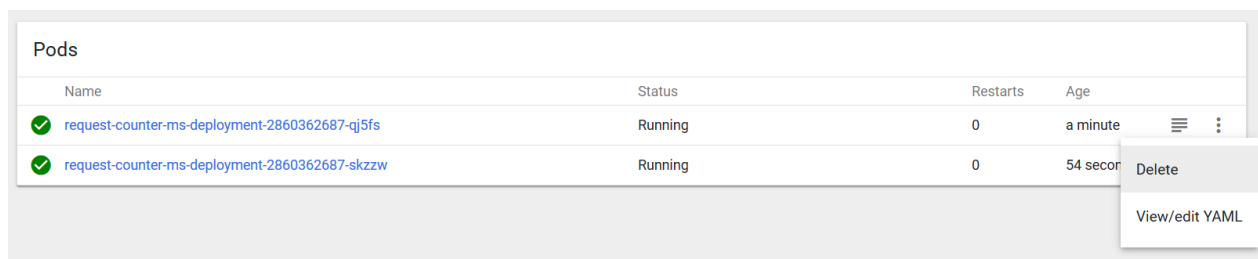
Your results will be similar to the following:

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 2): 1
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 2): 10
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 2): 2
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 2): 11
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 2): 3
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 2): 4
```

Instead of a smoothly increasing counter value, we see values that are not part of the same sequence and we even get duplicate values. If you look at the code of `/part1/requestCounter-2.js` – the application running in the pods – it is not hard to spot the flaw: these applications are not stateless and therefore do not support horizontal scaling.

Note how Kubernetes takes care of load balancing for us. We access a endpoint exposed from the cluster, and traffic is distributed over the available Pods.

Delete one of the pods, for example in the Dashboard:



The screenshot shows the Kubernetes dashboard with the 'Pods' tab selected. The left sidebar contains navigation links for Admin, Namespaces, Nodes, Persistent Volumes, Storage Classes, and Namespace. The main area displays a table of pods. A context menu is open over the second pod, showing 'Delete' and 'View/edit YAML' options.

Name	Status	Restarts	Age
request-counter-ms-deployment-2860362687-qj5fs	Running	0	a minute
request-counter-ms-deployment-2860362687-skzzw	Running	0	54 seconds

You will see a new Pod being created immediately. In the deployment definition we stated two replicas are required – and that is what Kubernetes ensures.

Now once more access the microservice a few times, for example using curl:

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/  
Request Count (Version 2): 1  
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/  
Request Count (Version 2): 12  
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/  
Request Count (Version 2): 2  
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/  
Request Count (Version 2): 3
```

The value 1 is obviously returned by the newly instantiated Pod.

Adding a Cache to the Microservices Platform and running a Stateless version of RequestCounter

Add a second pod with Redis in it

```
kubectl run redis-cache --image=redis --port=6379
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl run redis-cache --image=redis --port=6379  
deployment "redis-cache" created
```

Expose redis within cluster:

```
kubectl expose deployment redis-cache --type=ClusterIP
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl expose deployment redis-cache --type=ClusterIP  
service "redis-cache" exposed
```

From the command line we can inspect the services exposed on our minikube cluster:

```
kubectl get services
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl get services  
NAME                CLUSTER-IP    EXTERNAL-IP    PORT(S)          AGE  
kubernetes           10.0.0.1      <none>         443/TCP          10h  
redis-cache          10.0.0.55     <none>         6379/TCP         1m  
request-counter-ms-deployment  10.0.0.189    <nodes>        8091:30553/TCP   1h
```

This time, since redis-cache is exposed only inside the cluster, this command:

```
minikube.exe service redis-cache
```

produces no output.

Services and discovery > Services				
Services				
Name	Labels	Cluster IP	Internal endpoints	External endpoints
✓ kubernetes	component: apiserver provider: kubernetes	10.0.0.1	kubernetes:443 TCP kubernetes:0 TCP	-
✓ redis-cache	run: redis-cache	10.0.0.55	redis-cache:6379 TCP redis-cache:0 TCP	-
✓ request-counter-ms-deployment	app: request-counter-ms	10.0.0.189	request-counter-ms-deploymen... request-counter-ms-deploymen...	-

The hostname for the Redis cache service inside the cluster is redis-cache and the port is 6379 – at this endpoint, other pods in the cluster can access the service.

Upgrade deployment RequestCounter to version with Redis backing. V3: no lock, v4: optimistic lock

```
kubectl apply -f deployment-v2.yaml --record
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl apply -f deployment-v2.yaml --record
Warning: kubectl apply should be used on resource created by either kubectl create --save-config or kubectl apply
deployment "request-counter-ms-deployment" configured
```

Check on the status of the rollout of the change:

```
kubectl rollout status deployment request-counter-ms-deployment
```










```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl rollout status deployment request-counter-ms-deployment
deployment "request-counter-ms-deployment" successfully rolled out
```

We can inspect the history of a specific deployment and see which changes have been applied to it:

```
kubectl rollout history deployment request-counter-ms-deployment
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl rollout history deployment request-counter-ms-deployment
deployments "request-counter-ms-deployment"
REVISION      CHANGE-CAUSE
1              <none>
2              kubectl apply --filename=deployment-v2.yaml --record=true
```

In the dashboard, if we are quick we can see the pods being restarted. If we are not so fast, we can see both pods running (again) – having been restarted fairly recently:

Workloads > Pods + CREATE					
Pods					
Name	Status	Restarts	Age		
 redis-cache-3679063315-kr1lx	Running	0	21 hours		
 request-counter-ms-deployment-68346987-qxv6v	Running	0	2 minutes		
 request-counter-ms-deployment-68346987-zg8rj	Running	0	-		

Both Pods are running again, from the logs you can tell that both are running the new version of the application – powered by Redis.

kubernetes

Logs

+ CREATE

Admin

Namespaces

Nodes

Persistent Volumes

Storage Classes

Namespace

default

Workloads

Deployments

Replica Sets

Replication Controllers

Daemon Sets

Stateful Sets

Jobs

Pods

Logs from request-counter-ms in [request-counter-ms-deployment-68346987-qxv6v](#)

2017-05-25T04:25:19.163639616Z switching node to version stable

2017-05-25T04:25:19.398537346Z node version: v7.10.0

2017-05-25T04:25:19.392821771Z Cloning into 'app'...

2017-05-25T04:25:20.286580953Z Application Home: part1

2017-05-25T04:25:21.625460277Z request-counter@0.0.2 /code/app/part1

2017-05-25T04:25:21.625489197Z +-- node-redis@0.1.7

2017-05-25T04:25:21.625493373Z +-- redis@2.7.1

2017-05-25T04:25:21.625496958Z +-- double-ended-queue@2.1.0-0

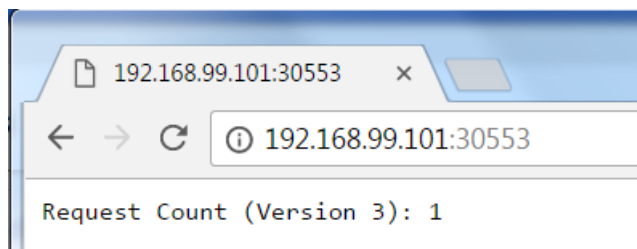
2017-05-25T04:25:21.625500518Z +-- redis-commands@0.1.3.1

2017-05-25T04:25:21.625503893Z +-- redis-parser@2.6.0

2017-05-25T04:25:21.625507536Z

2017-05-25T04:25:21.757802701Z Node.JS Server running on port 8091 for version 3 of requestCounter application, powered by Redis.

We can access the microservice (again) in the browser:



And from the command line we can do the curl thing a few times:

```
curl http://<ip of cluster>:<port exposed by service>
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3) 3
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3) 4
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3) 5
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3) 6
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3) 7
```













This time round, we do not get two counters incrementing in the background. Just a single incrementing value. And supposedly, that value is stored in the Redis cache where both instances access and manipulate it.

That should mean that we can stop and (re)start one or even both pods and then continue with the count as though nothing happened. Let's try that out. Stop one of the pods (note: get the name of the Pod in your case from either the command line using *kubectl get pods* or through the dashboard)










```
kubectl delete pod request-counter-ms-deployment-68346987-qxv6v --
grace-period=60
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl delete pod request-counter-ms-deployment-68346987-qxv6v --grace-period=60
pod "request-counter-ms-deployment-68346987-qxv6v" deleted
```

In the dashboard we can see how a new pod is started – because in the deployment we specified 2 replicas to always be running :

Workloads > Pods + CREATE					
Pods					
Name	Status	Restarts	Age		
 redis-cache-3679063315-kr1lx	Running	0	21 hours		
 request-counter-ms-deployment-68346987-dp2t8	Pending	0	0 seconds		
 request-counter-ms-deployment-68346987-qxv6v	Running	0	17 minutes		
 request-counter-ms-deployment-68346987-zg8rj	Running	0	14 minutes		

and a little bit later the Pod we asked to be deleted is gone:

Pods					
Name	Status	Restarts	Age		
 redis-cache-3679063315-kr1lx	Running	0	21 hours		
 request-counter-ms-deployment-68346987-dp2t8	Running	0	a minute		
 request-counter-ms-deployment-68346987-zg8rj	Running	0	16 minutes		

We can also delete our other pod, to be sure any state lingering in the original pods is gone:

```
kubectl delete pod request-counter-ms-deployment-68346987-zg8rj
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl delete pod request-counter-ms-deployment-68346987-zg8rj
pod "request-counter-ms-deployment-68346987-zg8rj" deleted
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl get pods
```

NAME	READY	STATUS	RESTARTS	AGE
redis-cache-3679063315-kr1lx	1/1	Running	0	21h
request-counter-ms-deployment-68346987-5w16v	1/1	Running	0	19s
request-counter-ms-deployment-68346987-dp2t8	1/1	Running	0	5m
request-counter-ms-deployment-68346987-zg8rj	1/1	Terminating	0	19m

Again, we see a new pod running and the old instance being terminated. At this point, both original pods are gone. If we access the request counter microservice, we will find that the counting continues where it had left off:

```
request-counter-ms-deployment-68346987-dp2t8 1/1 Running 0 5m
request-counter-ms-deployment-68346987-zg8rj 1/1 Terminating 0 19m
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 8
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 9
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 10
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 11
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 12
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 13
```

Of course now we have moved the burden of state to the Redis pod. If we restart that pod, we will get a reset in the counter value, because currently the cache is not persisted outside the container and its contents vanishes when the container dies. Note that we can have Redis be persisted to files outside container.

```
kubectl delete pod <name of redis-cache-... pod>
```

A new pod will be started after a few seconds and the old one terminated. When we then access the microservice requestcounter, the inevitable has happened: a counter reset. The old value was lost when the Redis cache pod was terminated:

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl delete pod redis-cache-3679063315-kr1lx
pod "redis-cache-3679063315-kr1lx" deleted
```

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>kubectl get pods
```

NAME	READY	STATUS	RESTARTS	AGE
redis-cache-3679063315-pxz02	1/1	Running	0	1m
request-counter-ms-deployment-68346987-5w16v	1/1	Running	0	7m
request-counter-ms-deployment-68346987-dp2t8	1/1	Running	0	12m

```
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 1
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 2
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 3
C:\data\microservices-choreography-kubernetes-workshop-june2017\part1\kubernetes>curl http://192.168.99.101:30553/
Request Count (Version 3): 4
```

Resources

See: <https://kubernetes.io/docs/concepts/services-networking/service/#publishing-services---service-types> on services in Kubernetes

Port forwarding from host to Redis Pod: <https://kubernetes.io/docs/tasks/access-application-cluster/port-forward-access-application-cluster/>

Rolling updates with K8s deployment: <https://tachingchen.com/blog/Kubernetes-Rolling-Update-with-Deployment/>

Graceful shutdown of pods: <https://pracucci.com/graceful-shutdown-of-kubernetes-pods.html>

3. Introducing the Event Bus Microservice into the Microservices Platform

Microservice orchestration through an event bus is one of the ultimate goals of this workshop. Let's add an event bus to our microservice platform – using Apache Kafka.

Note: there are many articles and resources for running Kafka & Zookeeper in Docker and in Kubernetes. Some resources are listed below. Unfortunately, none of these options really worked well for me. In the time I had available for preparation, I could not get a reproducible case to work as desired.

Therefore, you will work with a lean Virtual Machine that runs in VirtualBox.

A very interesting alternative is to work with Kafka in the Cloud. Various providers offer a Kafka PaaS service – for example IBM BlueMix and Oracle Event Hub. An interesting option is CloudKafka which offers a free tier and which is very easy to get going with. See <https://www.cloudkarafka.com/plans.html> for details - and the free Developer Duck Plan.

Getting started with the Kafka VM

Running the VM requires 2Gb of RAM and approximately 7Gb of free HD space

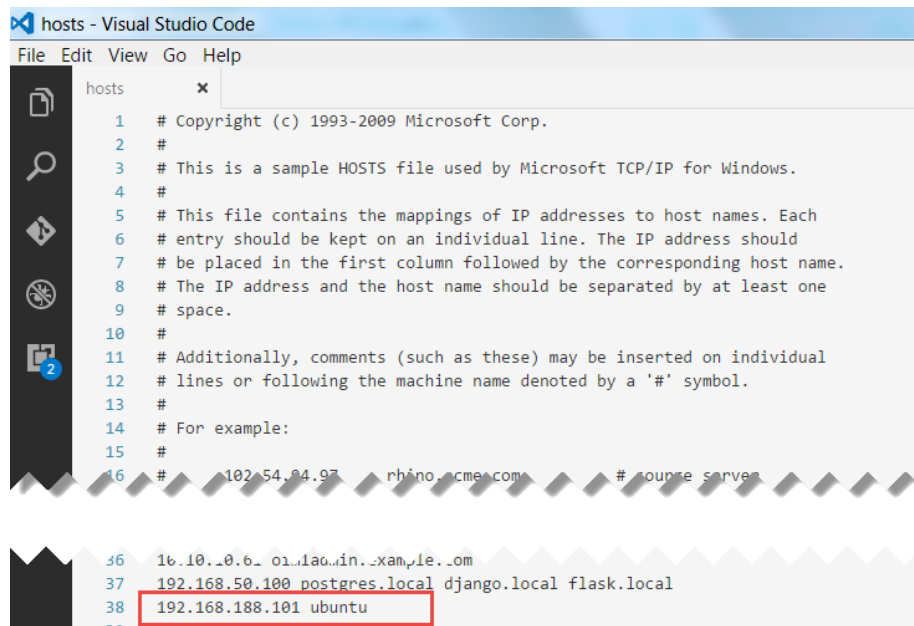
Start VirtualBox

Import the VM image – KafkaWorkshop.ova - by going to File, Import Virtual Appliance and browse to the image file. The VM requires 2Gb of RAM to run.

Configure Networking in VM

To access the Kafka instance running inside the VM from your laptop, you need to ensure that you enable network access to the VM. The instructions in this article (AMIS Technology Blog: <https://technology.amis.nl/2017/01/29/network-access-to-ubuntu-virtual-box-vm-from-host-laptop/>) show what you have to configure in order to be able to access the VM on its own IP address.

After arranging access to the VM, you may want to define a logical host name for the Virtual Machine – by adding an entry to the hosts file: C:\Windows\System32\drivers\etc\hosts, as shows below:

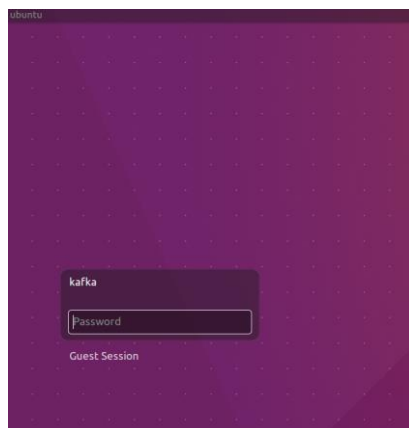


```
1 # Copyright (c) 1993-2009 Microsoft Corp.
2 #
3 # This is a sample HOSTS file used by Microsoft TCP/IP for Windows.
4 #
5 # This file contains the mappings of IP addresses to host names. Each
6 # entry should be kept on an individual line. The IP address should
7 # be placed in the first column followed by the corresponding host name.
8 # The IP address and the host name should be separated by at least one
9 # space.
10 #
11 # Additionally, comments (such as these) may be inserted on individual
12 # lines or following the machine name denoted by a '#' symbol.
13 #
14 # For example:
15 #
16 # 102.54.94.97 rhino.ncme.com # source server
17
18
19
20
21
22
23
24
25
26 16.10.10.61 olivia.in.example.com
27 192.168.50.100 postgres.local django.local flask.local
28 192.168.188.101 ubuntu
```

Note: *ubuntu* is the (advertised) host name of the Kafka in the VM; to play nice with Zookeeper it seems convenient to use that same name as the host name in our hosts file.

Start the VM

The VM will boot to a graphical login screen



The VM has two users: *root* and *kafka*. Both have password *Welcome01*.

The VM contains:

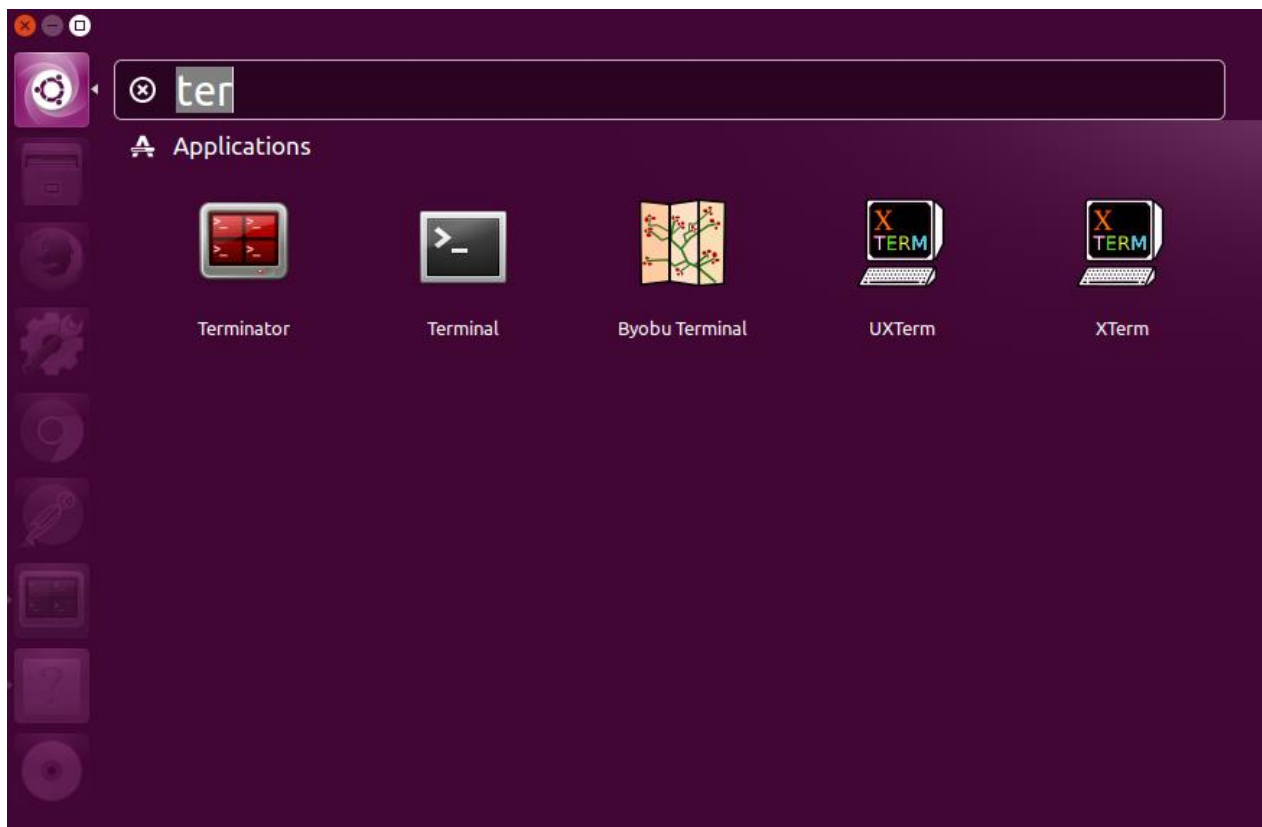
- Ubuntu 16.04 LTS
- Oracle JDK 8
- Eclipse Neon.2
- Node 7.4
- Zookeeper
- Firefox

- Chrome
- Postman
- confluent-platform-oss-2.11
- kafka-manager 1.3.2.1. When started runs on <http://localhost:9000>
- kafkatool 1.0.1

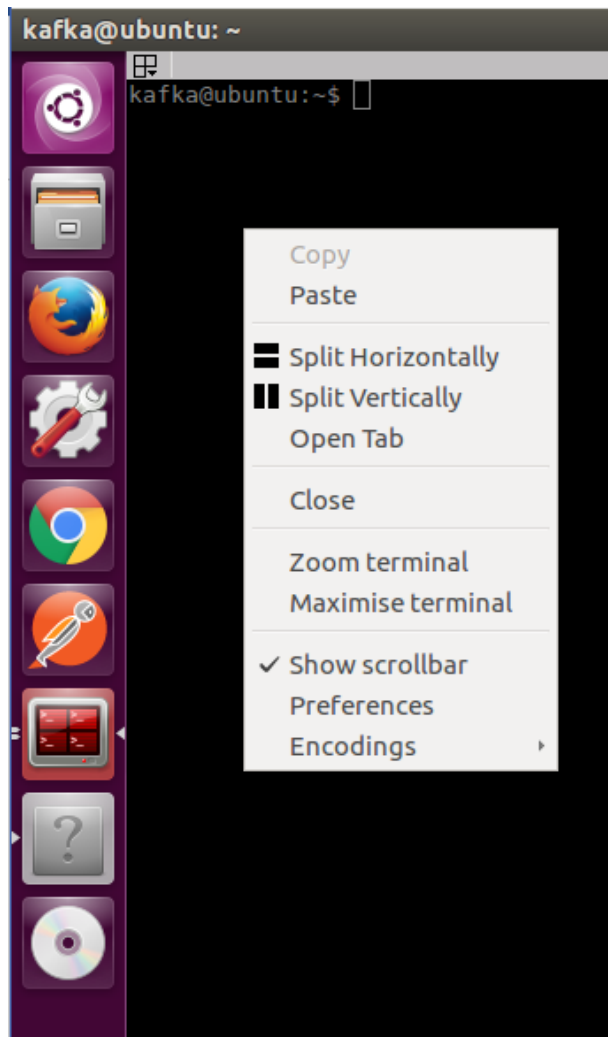
Getting to know the Kafka VM

Login to the VM: kafka/Welcome01

Start Terminator from the Unity menu



Split the screen horizontally – as shown in the next figure - and both screens vertically by right clicking in the window.



You will end up with four terminal windows.



In the first terminal window start a Kafka broker:

```
kafka-server-start /etc/kafka/server.properties
```

Start in the second terminal window start the kafka manager:

```
kafka-manager
```

Start kafkatoool in the third terminal window:

```
kafkatoool
```

Minimize the tool. You will use it at a later time.

Continue in the fourth terminal window

Create a topic

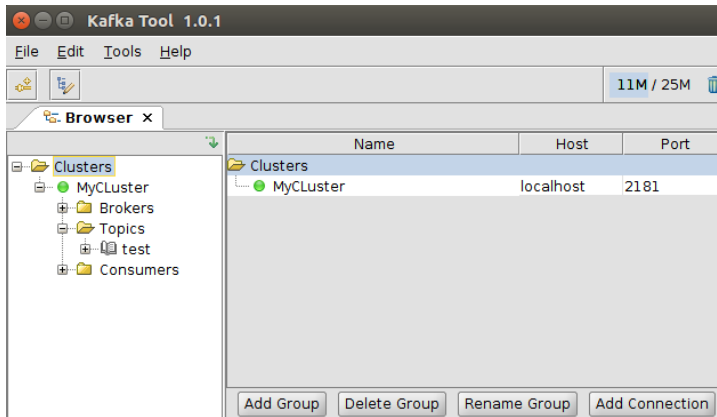
Create a topic:

```
kafka-topics --create --zookeeper localhost:2181 --replication-factor 1 --partitions 1 --topic test
```

Confirm the topic is created:

```
kafka-topics --list --zookeeper localhost:2181
```

Open kafkatoool and confirm the topic is created



Produce a message

Focus on the fourth terminal window again and type:

```
kafka-console-producer --broker-list localhost:9092 --topic test
```

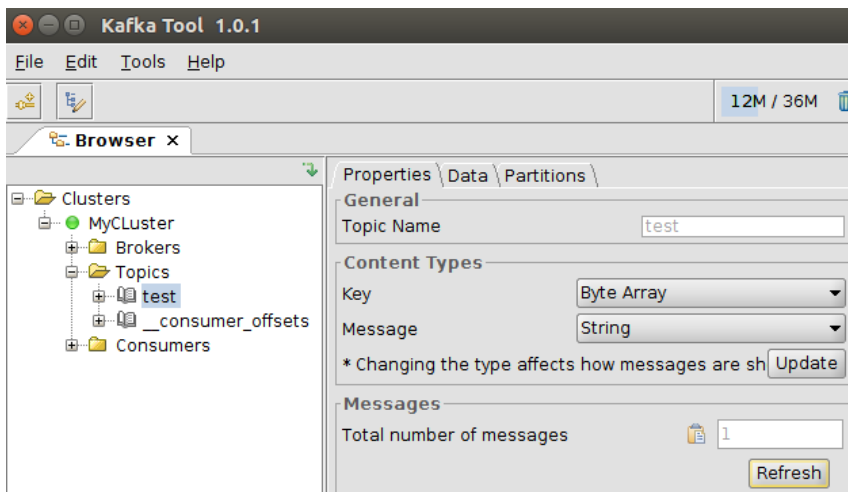
Press enter. No feedback appears; the cursor sits blinking and waiting for your input.

Type a message and press enter:

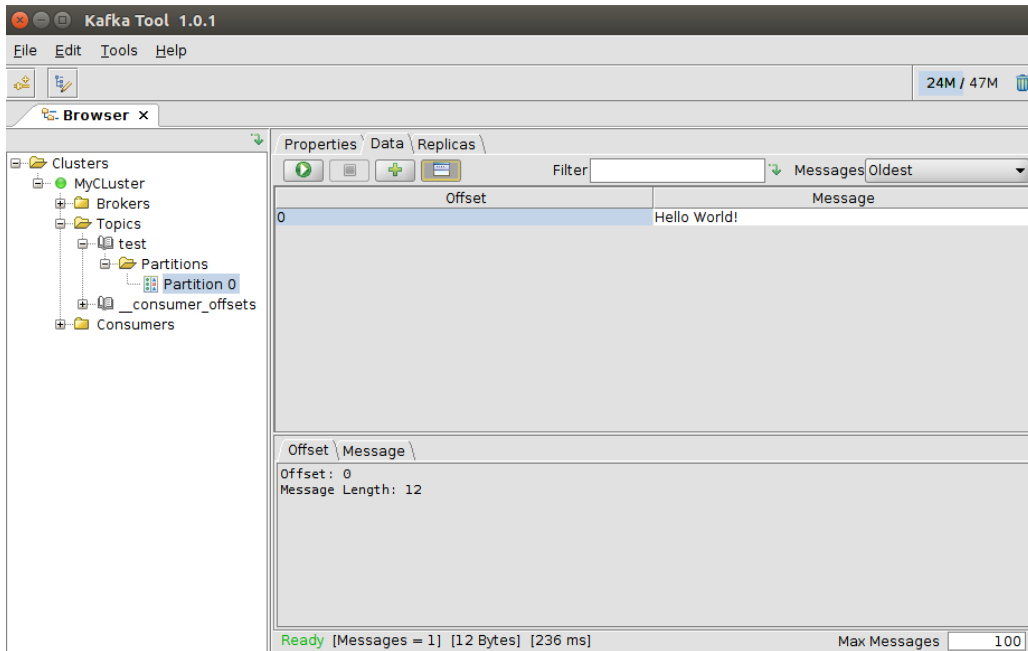
Hello World!

Check the message is created using kafka-manager and kafkatool.

Open kafkatool. Indicate the messages on the topic are string. Click the update button. Click the refresh button to view how many messages are present on the topic. Confirm the number is 1.



Open the partition under the test topic. Click the green play button. Confirm the Hello World! message has arrived.



Consume a message

Consume a message

```
kafka-console-consumer --bootstrap-server localhost:9092 --topic test --from-beginning
```

```
kafka@ubuntu:~$ kafka-console-consumer --bootstrap-server localhost:9092 --topic test --from-beginning
Hello World!
```

Confirm that the previously posted message has been consumed.

Run a Microservice with Kafka Interaction

In one of the terminal windows in your Kafka VM – determine the IP address that is assigned to the VM:

```
ifconfig
```

```
kafka@ubuntu:~$ ifconfig
enp0s3: Link encap:Ethernet HWaddr 08:00:27:86:d4:19
      inet addr:10.0.2.15 Bcast:10.0.2.255 Mask:255.255.255.0
      inet6 addr: fe80::a00:27ff:fe86:d419/64 Scope:Link
      UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
      RX packets:199 errors:0 dropped:0 overruns:0 frame:0
      TX packets:246 errors:0 dropped:0 overruns:0 carrier:0
      collisions:0 txqueuelen:1000
      RX bytes:61565 (61.5 KB) TX bytes:30803 (30.8 KB)

enp0s8: Link encap:Ethernet HWaddr 08:00:27:25:ec:80
      inet addr:192.168.188.101 Bcast:192.168.188.255 Mask:255.255.255.0
      inet6 addr: fe80::a00:27ff:fe25:ec80/64 Scope:Link
      UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
      RX packets:5342045 errors:0 dropped:0 overruns:0 frame:0
      TX packets:8251249 errors:0 dropped:0 overruns:0 carrier:0
      collisions:0 txqueuelen:1000
      RX bytes:539053379 (539.0 MB) TX bytes:682081625 (682.0 MB)

lo: Link encap:Local Loopback
      inet addr:127.0.0.1 Mask:255.0.0.0
      inet6 addr: ::1/128 Scope:Host
```

This is the address for the Kafka Host that we can use in applications that interact with Kafka. Take note of this IP address.

Create a new Kafka Topic called event-bus:

```
kafka-topics --create --zookeeper localhost:2181 --replication-factor 1 --partitions 1 --topic event-bus
```

```
kafka@ubuntu:~/bin$ kafka-topics --create --zookeeper localhost:2181 --replication-factor 1 --partitions 1 --topic event-bus
Created topic "event-bus".
```

Confirm the topic is created:

```
kafka-topics --list --zookeeper localhost:2181
```

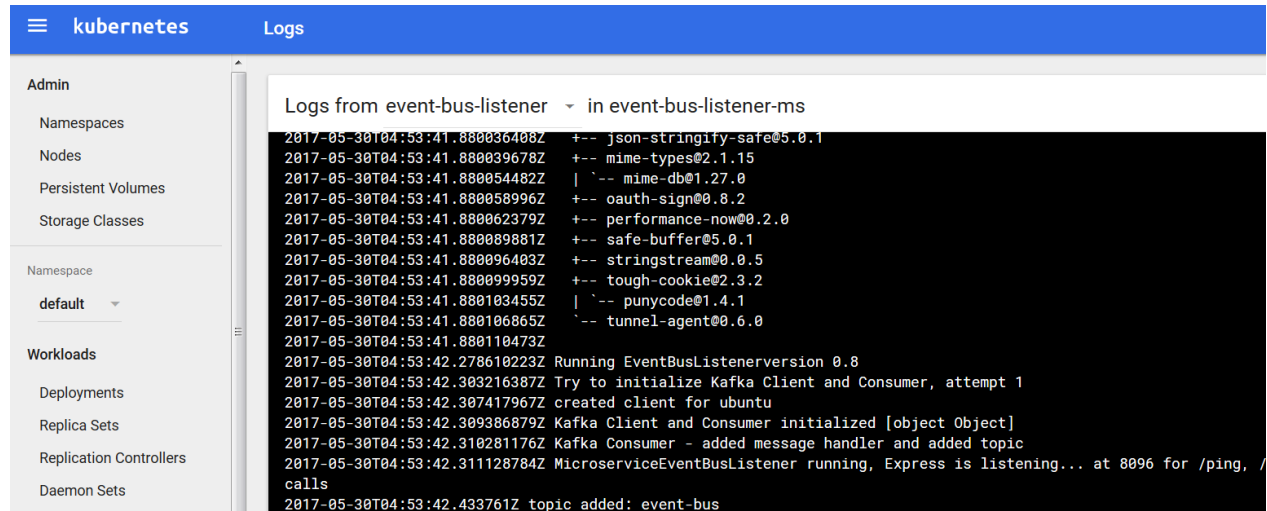
Run a Pod on Kubernetes that starts a Node.JS application that listens to the Event Bus topic on the Kafka Broker. You do this using the EventBusListener.yaml file in directory part3/event-bus-listener. Before you run the yaml file, check out its contents. Take note of the ports, the environment variables such as KAFKA_TOPIC (set to event-bus) and KAFKA_HOST. The *lifecycle* element in the yaml file ensures that the Kafka Host (the VM running the Kafka Broker) is known as a host inside the EventBusListener container. Ensure that the IP address used in the command executed is the correct one – that is: the IP address returned inside the Kafka Host using ifconfig.

```
EventBusListenerPod.yaml x package.json EventBusPublisherService.yaml EventBusListener.js (Index) E
3 metadata:
4   name: event-bus-listener-ms
5   labels:
6     app: event-bus-listener-ms
7 spec:
8   nodeName: minikube
9   containers:
10  - name: event-bus-listener
11    # get latest version of image
12    image: lucasjellema/node-app-runner
13    env:
14    - name: GIT_URL
15      value: "https://github.com/lucasjellema/microservices-choreography-kubernetes-w
16    - name: APP_PORT
17      value: "8096"
18    - name: APP_HOME
19      value: "part3/event-bus-listener"
20    - name: APP_STARTUP
21      value: "EventBusListener.js"
22    - name: KAFKA_HOST
23      value: "ubuntu"
24    - name: ZOOKEEPER_PORT
25      value: "2181"
26    - name: KAFKA_TOPIC
27      value: "event-bus"
28    ports:
29      # containerPort is the port exposed by the container (where nodejs express api is
30      - containerPort: 8096
31    lifecycle:
32      postStart:
33        exec:
34          # add advertised host (ubuntu) of VM running Kafka to hosts file - with the
35          command: ["sh", "-c", "echo 192.168.188.101 ubuntu > /etc/hosts"]
```


When the yaml file is correct, then run:

```
kubect1 create -f EventBusListenerPod.yaml -f
EventBusListenerService.yaml
```

You can check in the Kubernetes Dashboard whether the Pod has started running successfully and is now listening to a Kafka Topic:



Then, publish an event to topic event-bus from the command line in the VM running the Kafka Broker:

```
kafka-console-producer --broker-list localhost:9092 --topic event-bus
```

Press enter. No feedback appears; the cursor sits blinking and waiting for your input. Type a valid JSON message, something like:

```
{"Wish" : "Hello To World"}
```

```
kafka@ubuntu:~/bin$ kafka-console-producer --broker-list localhost:9092 --topic event-bus
{"Wish" : "Hello To World"}
```

If you check the logs in the Kubernetes Dashboard, you should find that the event has been received:

Logs

Logs from event-bus-listener ▾ in event-bus-listener-ms

```
2017-05-30T04:53:42.278610223Z Running EventBusListener version 0.8
2017-05-30T04:53:42.303216387Z Try to initialize Kafka Client and Consumer, attempt 1
2017-05-30T04:53:42.307417967Z created client for ubuntu
2017-05-30T04:53:42.309386879Z Kafka Client and Consumer initialized [object Object]
2017-05-30T04:53:42.310281176Z Kafka Consumer - added message handler and added topic
2017-05-30T04:53:42.311128784Z MicroserviceEventBusListener running, Express is listening... at 8096 for /ping, /abc
calls
2017-05-30T04:53:42.433761Z topic added: event-bus
2017-05-30T05:05:07.711534Z event received
2017-05-30T05:05:07.73216084Z actual event: { "a": "aaa" }
2017-05-30T05:16:58.806533218Z event received
2017-05-30T05:16:58.815491355Z received message { topic: 'event-bus',
2017-05-30T05:16:58.815680227Z   value: '{"Wish" : "Hello To World"}',
2017-05-30T05:16:58.815701308Z   offset: 6,
2017-05-30T05:16:58.815712297Z   partition: 0,
2017-05-30T05:16:58.815722764Z   highWaterOffset: 7,
2017-05-30T05:16:58.815767961Z   key: -1 }
2017-05-30T05:16:58.816293398Z received message object {"topic":"event-bus","value":{"Wish": "Hello To
World"}, "offset":6, "partition":0, "highWaterOffset":7, "key":-1}
```

Using the port assigned to service

```
c:\data\microservices-choreography-kubernetes-workshop-june2017\part3\event-bus-listener>kubectl get services
NAME                                CLUSTER-IP    EXTERNAL-IP    PORT(S)          AGE
eventbuslistenerservice            10.0.0.249    <nodes>        8096,32004/TCP   5m
```

You can access the event bus listener microservice from the browser on your laptop (using the IP address of the Docker machine) and get a list of all events consumed thusfar from topic event-bus:

192.168.99.100:32004/event-bus

JSON Raw Data Headers

Save Copy

```
{
  "topic": "event-bus",
  "events": [
    {
      "Wish": "Hello To World"
    }
  ]
}
```

Microservice on Kubernetes that Publishes Events

As a next step, we will run a microservice that takes input from you – the user – through simple HTTP requests and that turns each request into an event published on the event bus. The *event bus listener* microservice that we launched in the previous section will consume all those events and make them available through the browser. That means we realize communication between two microservices that are completely unaware of each other and only need to know about the common microservices platform event-bus capability.

Directory part3\event-bus-publisher contains the sources for this microservice.

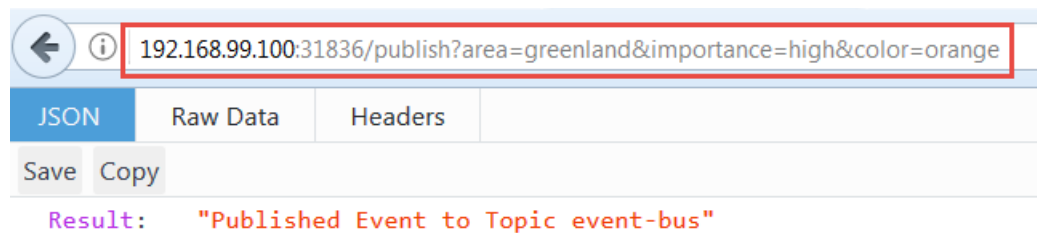
```
kubectl create -f EventBusPublisherPod.yaml -f
EventBusPublisherService.yaml
```

Check in Kubernetes Dashboard or through *kubernetes get pods* and *kubernetes get services* if the creation is complete – and what the port is that was assigned to the *EventBusPublisherService*.

```
c:\data\microservices-choreography-kubernetes-workshop-june2017\part3\event-bus-publisher>kubectl get services
NAME                                CLUSTER-IP   EXTERNAL-IP   PORT(S)                                AGE
eventbuslistenerservice            10.0.0.249   <nodes>       8096:32004/TCP                         59m
eventbuspublisherservice           10.0.0.172   <nodes>       8097:31836/TCP                         1m
```

With http requests from your browser - or using CURL or Postman – you can trigger the Event Bus Publisher microservice into publishing events to the Event Bus:

`http://<Docker Machine IP>:<port assigned to Kubernetes service>/publish?area=greenland&importance=high&color=orange`



The Event Bus Listener microservice is still running. Through the browser – or by looking at the logs for the Pod - you can check if it has consumed the event that was just published through the Event Bus Publisher microservice.



```
Logs from event-bus-listener ▾ in event-bus-listener-ms A Tr

2017-05-30T06:14:24.046228091Z event received
2017-05-30T06:14:24.050003936Z received message { topic: 'event-bus',
2017-05-30T06:14:24.050034921Z value: '{"meta":"Produced by EventBusPublisher (0.8.3) from an HTTP
Request","area":"greenland","importance":"high","color":"orange"}',
2017-05-30T06:14:24.050043188Z offset: 10,
2017-05-30T06:14:24.050102342Z partition: 0,
2017-05-30T06:14:24.050111979Z highWaterOffset: 11,
2017-05-30T06:14:24.050118086Z key: <Buffer 45 76 65 6e 74 42 75 73 45 76 65 6e 74> }
2017-05-30T06:14:24.050158029Z received message object {"topic":"event-bus","value":{"meta":"Produced by EventBusPublisher
(0.8.3) from an HTTP Request\\","area":"greenland\\","importance":"high\\","color":"orange
\\"},"offset":10,"partition":0,"highWaterOffset":11,"key":{"type":"Buffer","data":
[69,118,101,110,116,66,117,115,69,118,101,110,116]}}
2017-05-30T06:14:24.05016906Z actual event: {"meta":"Produced by EventBusPublisher (0.8.3) from an HTTP
Request","area":"greenland","importance":"high","color":"orange"}

Logs from 5/30/17 4:53 AM to 5/30/17 6:14 AM |< < > >|
```

When the HTTP Request to the Event Bus Publisher results in a message returned from the Event Bus Listener microservice, then we have succeeded. Microservice interaction in a most decoupled way. Time for some choreography!

Note: At this point, you can stop and delete all components currently running on Kubernetes. A quick way to tear all components down is:

```
kubectl delete po,svc,rc --all
```

4. Microservice Choreography – on Kubernetes and Kafa

In this section, a multi-step workflow is implemented using various microservices that dance together – albeit unknowingly. The choreography is laid down in a workflow prescription that each microservices knows how to participate in.

Note: directory part4 contains a Postman Collection: MicroServiceTestSet.postman_collection with a few simple test calls for the microservices that we run in this section.

Prepare Kafka Event Bus

The Kafka Event Bus was introduced in the previous section, using a Virtual Machine running on Virtual Box. We assume that this VM is (still) running. In this running VM, create two new topics (in a terminal window inside the VM):

```
kafka-topics --create --zookeeper localhost:2181 --replication-factor 1 --  
partitions 1 --topic workflowEvents
```

```
kafka-topics --create --zookeeper localhost:2181 --replication-factor 1 --  
partitions 1 --topic logTopic
```

The workflow choreography takes place through events published to and consumed from the first topic. Logging will be published to the second topic.

Startup Cache Capability

In addition to the Kafka Event Bus, our microservices platform also provides a cache facility to the microservices. This cache facility is provided through Redis, by executing these commands:

```
kubectl run redis-cache --image=redis --port=6379  
  
kubectl expose deployment redis-cache --type=NodePort
```

With these commands, a deployment is created on the Kubernetes Cluster with a pod based on Docker Image *redis* and exposing port 6379. This deployment is subsequently exposed as a service, available for other microservices on the same cluster and for consumers outside the cluster, so we can check on the contents of the cache if we want to. Type ClusterIP instead of NodePort is enough to allow access to other microservices (pods) on the cluster.

Run Microservice TweetReceiver

The microservice TweetReceiver exposes an API that expects HTTP Post Requests with the contents of a Tweet message. It will publish a workflow event to the Kafka Topic to report the tweet to the microservices cosmos to take care of.

In directory part4/TweetReceiver, run:

```
kubectl create -f TweetReceiverPod.yaml -f TweetReceiverService.yaml
```

With this command, a new Pod is launched that listens for HTTP Requests that report a Tweet. This can be done through a recipe from IFTTT or with a simple call from any HTTP client such as Postman.

Using *kubectl get services* you can inspect the service that is created and the port at which it is exposed.

Run Microservice Workflow Launcher

The Workflow Launcher listens to the Kafka Topic for events of type NewTweetEvent. Whenever it consumes one of those, it will compose a workflow event with a workflow choreography definition for that specific tweet. The data associated with the workflow is stored in the cache and thus made available to other microservices.

Run the Workflow Launcher with:

```
kubectl create -f WorkflowLauncherPod.yaml
```

Note: ensure that the KAFKA_HOST, ZOOKEEPER_PORT and REDIS_HOST and REDIS_PORT are correct in the yaml file.

This microservices does not expose an external service – all it does is listen to events on the Kafka Topic

When the microservice is running, it will listen for NewTweetEvents published by the TweetReceiver. If you check out the logs for WorkflowLauncher, you should find that any request send to TweetReceiver will now lead to activity in the WorkflowLauncher.

Run Microservice ValidateTweet

This

```
kubectl create -f ValidateTweetPod.yaml
```

Also to expose an API for this microservice:

```
kubectl create -f ValidateTweetService.yaml
```

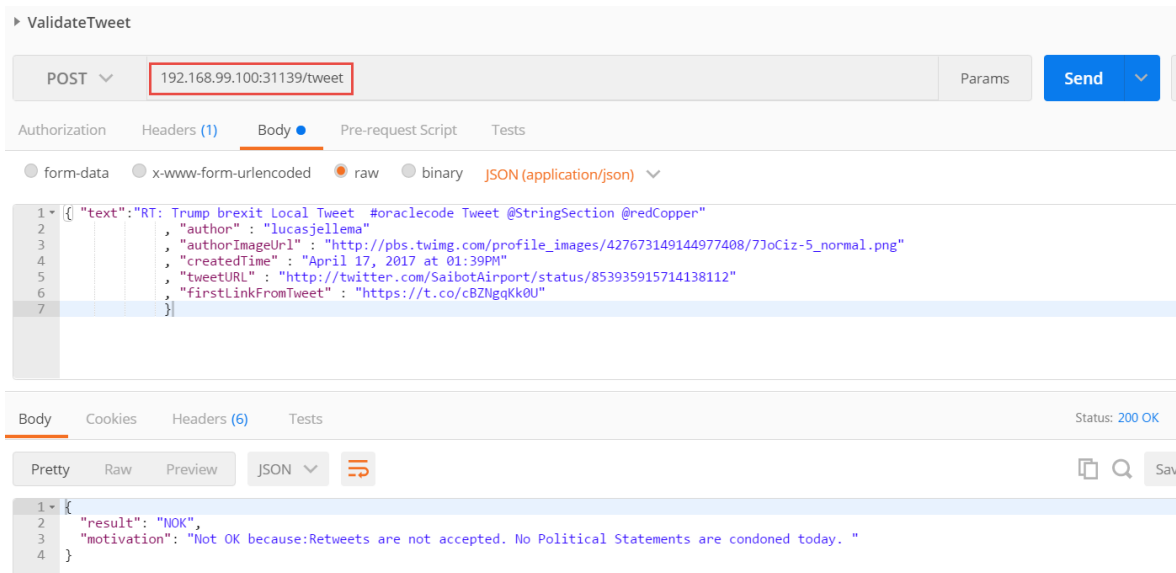
Using *kubectl get services* you can find out the port at which you can reach this microservice from your laptop. Using a simple curl, you can verify whether the microservices is running:

```
curl http://192.168.99.100:31139/about
```

```
c:\data\microservices-choreography-kubernetes-workshop-june2017\part4\ValidateTweet>curl http://192.168.99.100:31139/about
About TweetValidator API, Version 0.8Supported URLs:/ping (GET)
:/tweet (POST)NodeJS runtime version v8.0.0incoming headers{"user-agent":"curl/7.30.0","host":"192.168.99.100:31139","accept":"*/*"}

```

You can try out the functionality of this microservice with a simple POST request to the url:
[http:// 192.168.99.100:31139/tweet](http://192.168.99.100:31139/tweet):



Run Microservice to Enrich Tweet

This microservice takes the tweet and enriches it with information about the author, any acronyms and abbreviations, related tweets and many more details. Well, that was the intent. And could still happen. But for now all the enrichment that takes place is very limited indeed. Sorry about that. However, this microservice will play its designated role in the workflow execution, according to the choreography suggested by the workflow launcher.

Run the microservice from directory part4/ TweetEnricher:

```
kubectl create -f TweetEnricherPod.yaml
```

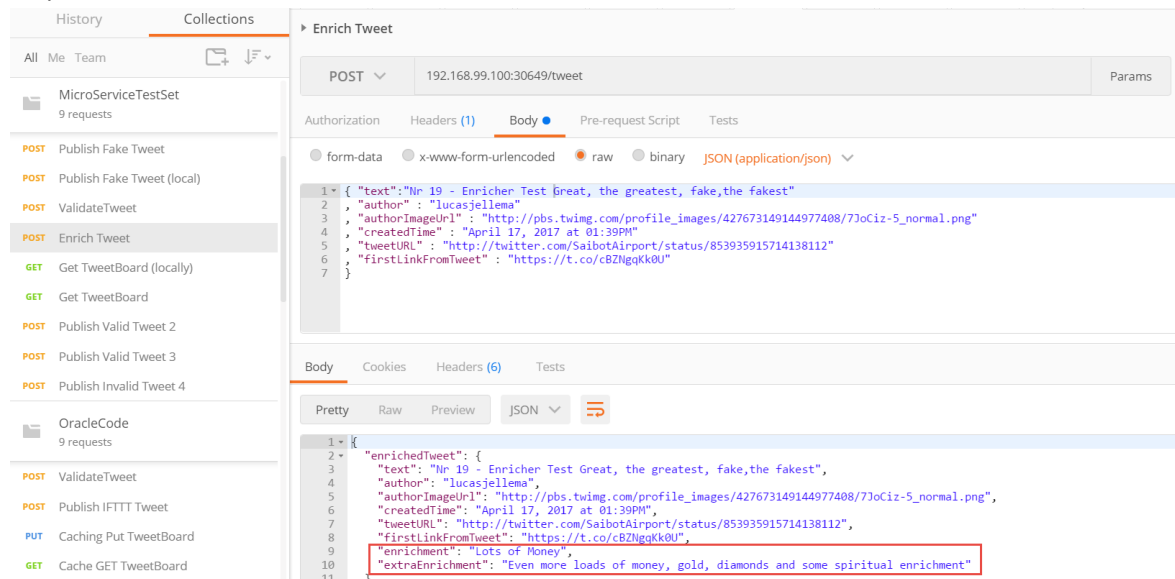
Also to expose an API for this microservice:

```
kubectl create -f TweetEnricherService.yaml
```

Using *kubectl get services* you can find out the port at which you can reach this microservice from your laptop. Using a simple curl, you can verify whether the microservices is running:

```
curl http://192.168.99.100:30649/about
```

You can try out the functionality of this microservice with a simple POST request to the url:
[http:// 192.168.99.100:31139/tweet](http://192.168.99.100:31139/tweet):



Run Microservice TweetBoard

The last microservice we discuss does two things:

1. it responds to events in the workflow topic of type `TweetBoardCapture` (by adding an entry for the tweet in the workflow document) and
2. it responds to HTTP Requests for the current tweet board [contents] by returning a JSON document with the most recent (maximum 25) Tweets that were processed by the workflow

This microservice is stateless. It uses the cache in the microservices platform to manage a document with the most recent tweets.

Run a Pod on Kubernetes with this microservice using this command in directory `part4/TweetBoard`:

```
kubectl create -f TweetBoardPod.yaml
```

and expose the microservice as a Service:

```
kubectl create -f TweetBoardService.yaml
```

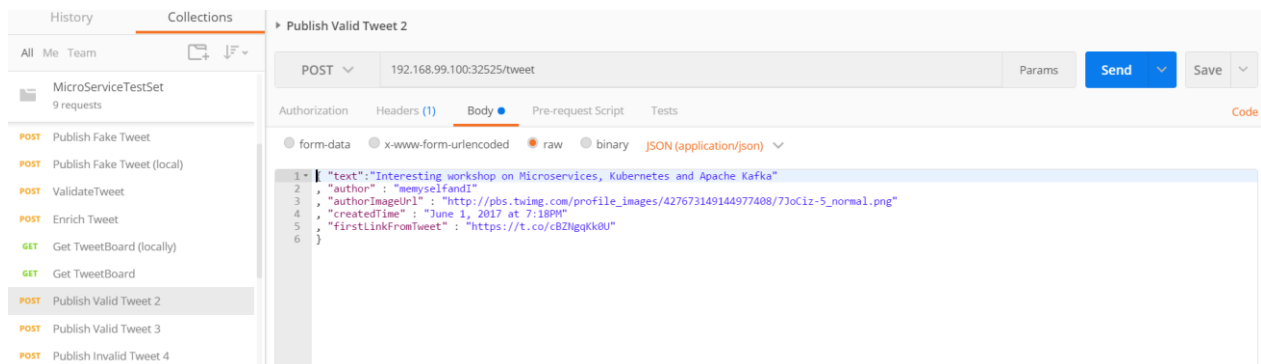
The Kubernetes Dashboard now lists the following Pods or Microservices:

kubernetes Workloads > Pods				
Pods				
Name	Status	Restarts	Age	
redis-cache-3679063315-8m9jl	Running	0	4 hours	
tweet-board-ms	Running	0	27 minutes	
tweet-enricher-ms	Running	0	an hour	
tweet-validator-ms	Running	0	2 hours	
tweetreceiver-ms	Running	0	4 hours	
workflow-launcher-ms	Running	0	3 hours	

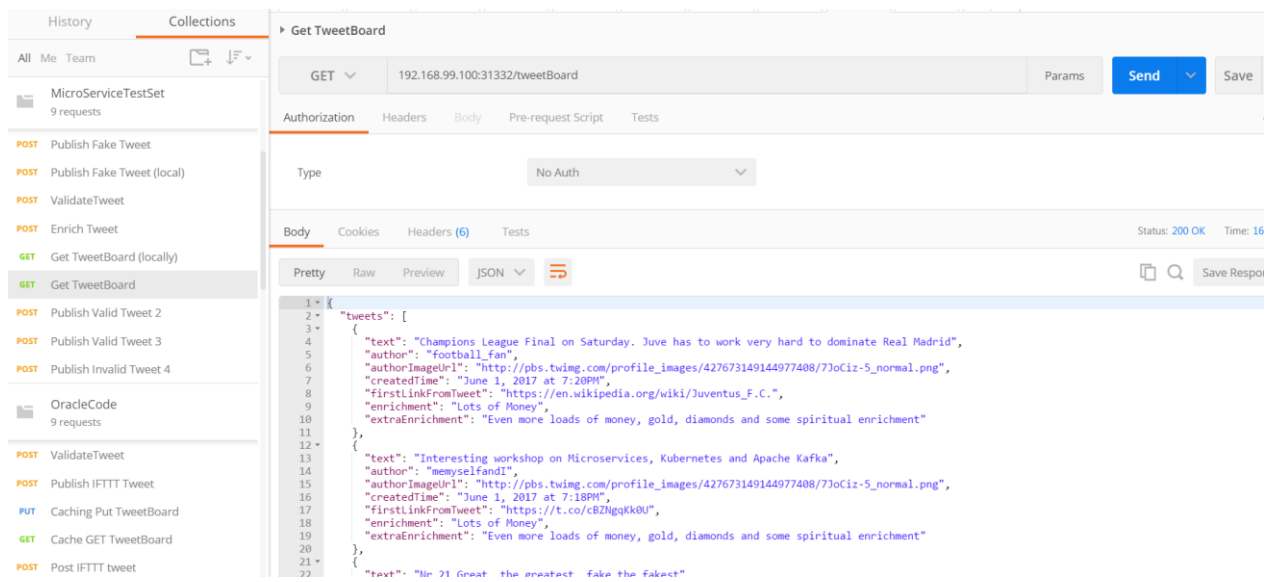
Inspect the port assigned to this microservice using *kubectl get services*. Then access the microservice at <http://<docker machine IP>:<assigned port>/tweetBoard>. You will not yet see any tweets on the tweet board.

However, as soon as you publish a valid tweet to the TweetReceiver micro service, the workflow is initiated and through the choreographed dance that involves Workflow Launcher, TweetValidator, TweetEnricher and TweetBoard, that tweet will make its appearance on the tweet board.

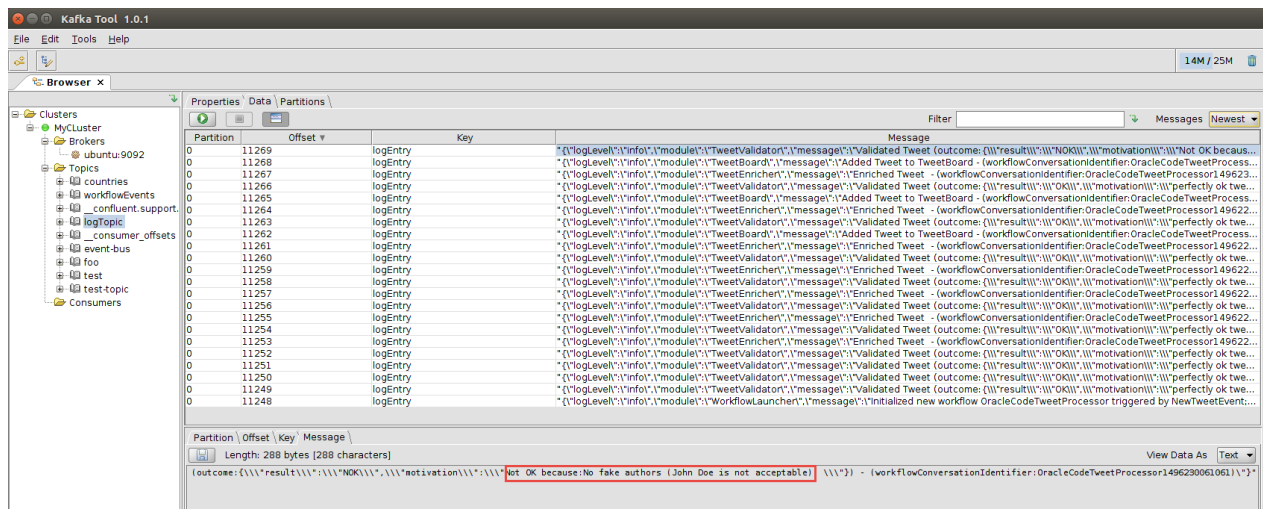
Publish a few tweets for TweetReceiver and inspect the tweet board again. You can use the test messages in the Postman collection:



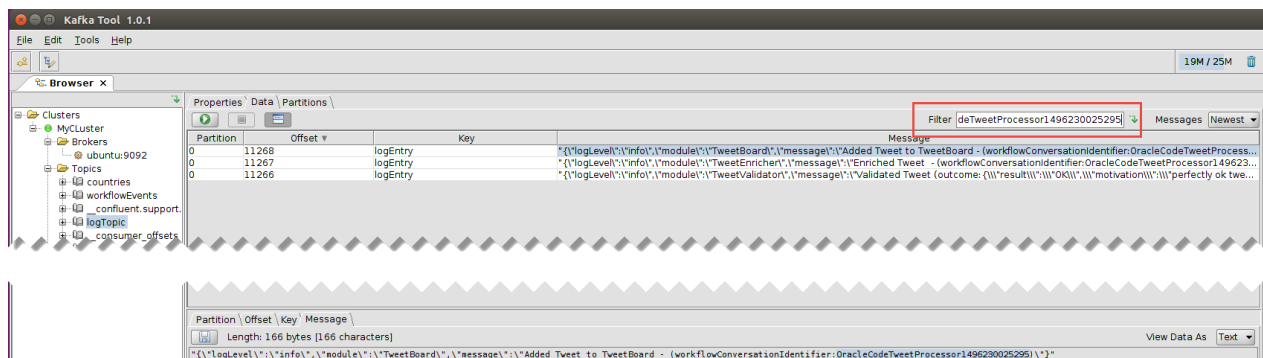
The Tweet Board looks like this:



By checking the topic logTopic in the Kafka tool in the VM running Kafka, we get a feel for the workflows that were executed – and for tweets that did not get through validation:



Note how you can filter events in this tool, for example by the workflow identifier:



Optional next steps

Some obvious next steps around this workflow implementation and the microservices platform used are listed below:

- Expose TweetReceiver to the public internet (for example using ngrok) and create an IFTTT recipe to invoke the TweetReceiver for selected tweets; this allows the workflow to act on real tweets
- Run multiple instances (replicas) of the Pods that participate in the workflow (note: they are all stateless and capable of horizontally scaling; however, here is not currently any (optimistic) locking implemented on cache access, so race conditions are although rare still possible!)
- Change the workflow
 - create a new workflow plan that for example changes the sequence of validation and enrichment or even allows them to be in parallel
- add a step to the workflow (and a microservice to carry out that step)
- Create microservice (or simple Node.js script) to check the contents of Redis Cache (for example the tweetboard document or the payload for a specific workflow instance)
- Retrieve Logging from Kafka Topic
- Run Kafka inside the Kubernetes cluster
- Implement one or more microservices on a cloud platform; that requires use of an event hub on the cloud (e.g. Kafka on the cloud, such as CloudKafka) and possibly (if the local Kafka is retained as well) a bridge between the local and the cloud based event bus.

Appendix: Running Apache Kafka and Zookeeper in Docker and in Kubernetes

<https://howtoprogram.xyz/2016/07/21/using-apache-kafka-docker/>

Using the instructions at <http://docs.confluent.io/current/cp-docker-images/docs/quickstart.html> and working either directly in Docker or through Docker Quickstart Terminal (on Windows or MacOS), we can get Apache Kafka (and Zookeeper) running, in two separate Docker containers.

```
docker run -d \
  --net=host \
  --name=zookeeper \
  -e ZOOKEEPER_CLIENT_PORT=32181 \
  confluentinc/cp-zookeeper:3.2.1
```

```
docker run -d \
  --net=host \
  --name=kafka \
  -e KAFKA_ZOOKEEPER_CONNECT=localhost:32181 \
  -e KAFKA_ADVERTISED_LISTENERS=PLAINTEXT://localhost:29092 \
  confluentinc/cp-kafka:3.2.1
```

```
docker run -d \
  --net=host \
  --name=schema-registry \
  -e SCHEMA_REGISTRY_KAFKASTORE_CONNECTION_URL=localhost:32181 \
  -e SCHEMA_REGISTRY_HOST_NAME=localhost \
  -e SCHEMA_REGISTRY_LISTENERS=http://localhost:8081 \
  confluentinc/cp-schema-registry:3.2.1
```

```
docker run -d \
  --name=kafka-rest4 \
  -p 8082:8082 \
  -e KAFKA_REST_ZOOKEEPER_CONNECT=localhost:32181 \
  -e KAFKA_REST_LISTENERS=http://localhost:8082 \
  -e KAFKA_REST_SCHEMA_REGISTRY_URL=http://localhost:8081 \
  -e KAFKA_REST_HOST_NAME=localhost \
  confluentinc/cp-kafka-rest:3.2.1
```

```
docker inspect --format '{{ .NetworkSettings.IPAddress }}' kafka-rest
```

to get ip address to access REST Proxy?

Alternative:

<https://howtoprogram.xyz/2016/07/21/using-apache-kafka-docker/>

Based on <https://github.com/CloudTrackInc/kubernetes-kafka> - we get Apache Kafka running on our minikube cluster.

From directory part3/kubernetes-kafka:

Zookeeper

```
kubectl apply -f zoo-rc.yaml --record
```

This should start a Pod based on the digitalwonderland/zookeeper image for Apache Zookeeper (<https://github.com/digital-wonderland/docker-zookeeper>).

Next, expose this Pod as a Service:

```
kubectl apply -f zoo-service.yaml --record
```

Run ReplicationController for Kafka

```
kubectl apply -f kafka-rc.yaml --record
```

And expose this Pod as a service:

```
kubectl apply -f kafka-service.yaml
```

Kafka Rest Proxy

<https://hub.docker.com/r/confluentinc/cp-kafka-rest/>

Run Kafka Rest Proxy - listening at port 8082, connecting to Zookeeper and from there to Kafka broker

```
kubectl apply -f kafka-rest-proxy-rc.yaml
```

And to expose the REST proxy outside the cluster

```
kubectl apply -f kafka-rest-proxy-service.yaml
```

An overview of the three services now running to implement the Event Bus platform service:

```
kubectl get services
```

```
c:\data\microservices-choreography-kubernetes-workshop-june2017\part3\kubernetes-kafka>kubectl get services
```

NAME	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE
kafka	10.0.0.42	<nodes>	9092:32124/TCP	50m
kafka-restproxy-svc	10.0.0.218	<nodes>	8082:32626/TCP	1m
kafka-zoo-svc	10.0.0.237	<nodes>	2181:30686/TCP,2888:32429/TCP,3888:32494/TCP	1h

To try out the Event Bus configuration – we can ask the Kafka Rest Proxy for a list of topics available on the Kafka Cluster:

```
curl "http://192.168.99.100:32626/topics"
```

The response:

```
c:\data\microservices-choreography-kubernetes-workshop-june2017\part3\kubernetes-kafka>curl "http://192.168.99.100:32626/topics"
["demo-topic"]
```

The fact that we get a response reveals that the Rest Proxy talked to Zookeeper and got in touch with the Kafka Broker. All three pods that constitute the Event Bus are in business.

```
curl "http://192.168.99.100:32626/topics/demo-topic"
```

In directory part3

```
kubectl apply -f kafka.yaml
```