Building Efficient Microservices Solutions With Kubernetes

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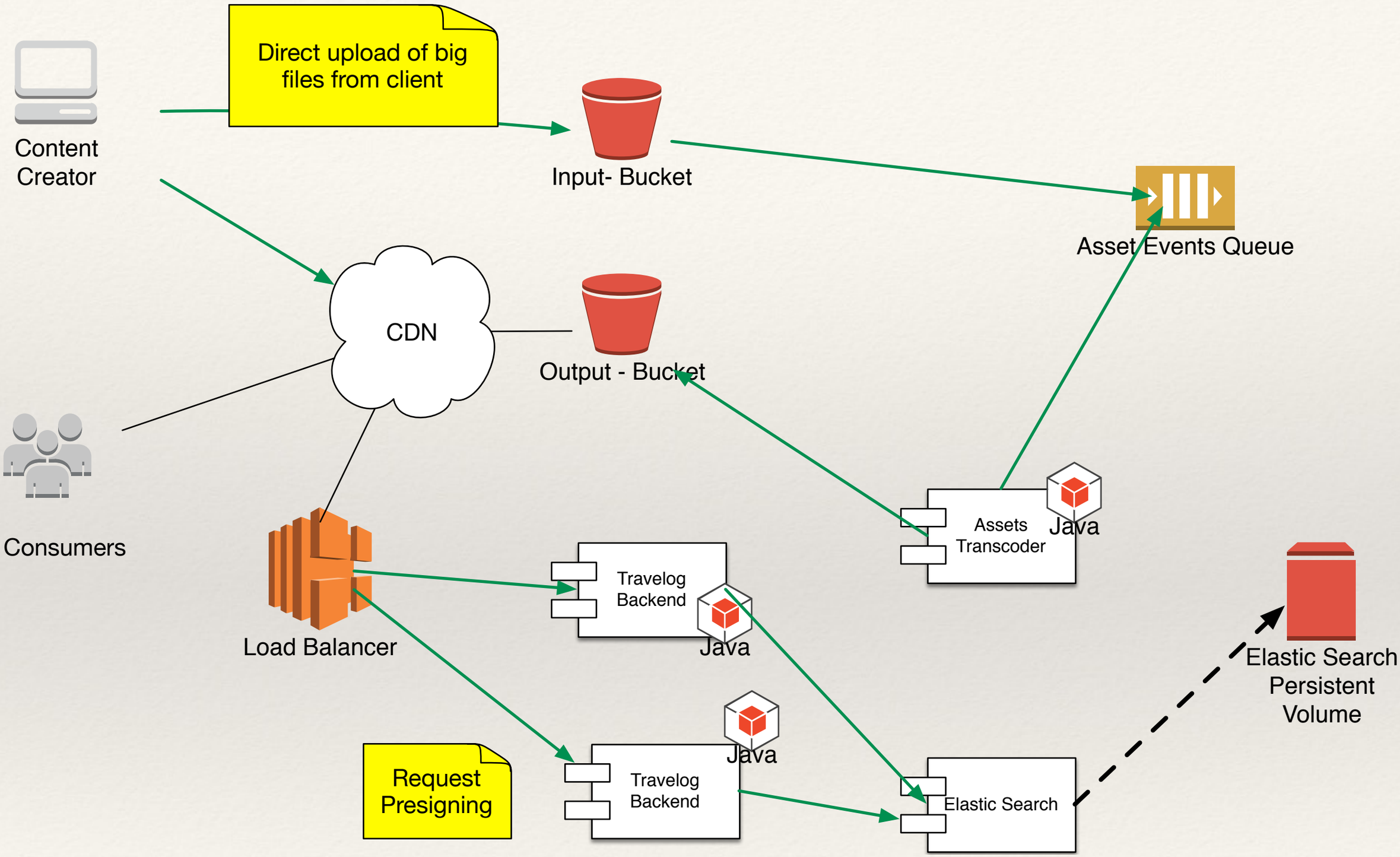
When we develop complex and important system we need to know how to:

- Ensure availability of a units at runtime;
- Configure units per env;
- Apply configuration changes;
- Have outage-less deployments;
- Troubleshoot;
- Protect secrets;
- Prevent unauthorized access;
- Manage storage;
- Scale;
- Use one micro-service from another;
- Configure SAS per environment;
- Develop and debug locally;
- Manage CPU and Memory resources;
- Have preferred targets (high CPU, or GPU, etc.)
- Run batch jobs;
- Expose service(s) for external clients;
- Collect logs;
- Know where things are;

Sample Application: Travelog



Discover exotic places »

Tell Your Travel Tale »

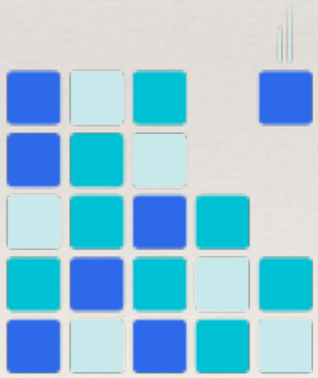
This example project shows how Kubernetes can facilitate micro-services based implementation of a travelog web site

Kubernetes is an open-source system for automating deployment, scaling, and management of containerized applications.

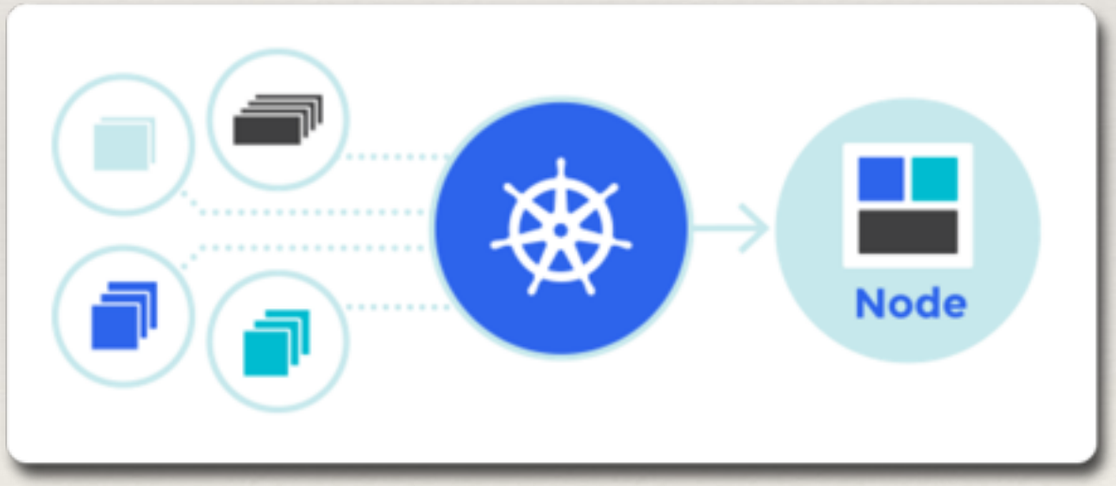
It groups containers that make up an application into logical units for easy management and discovery. Kubernetes builds upon 15 years of experience of running production workloads at Google, combined with best-of-breed ideas and practices from the community.

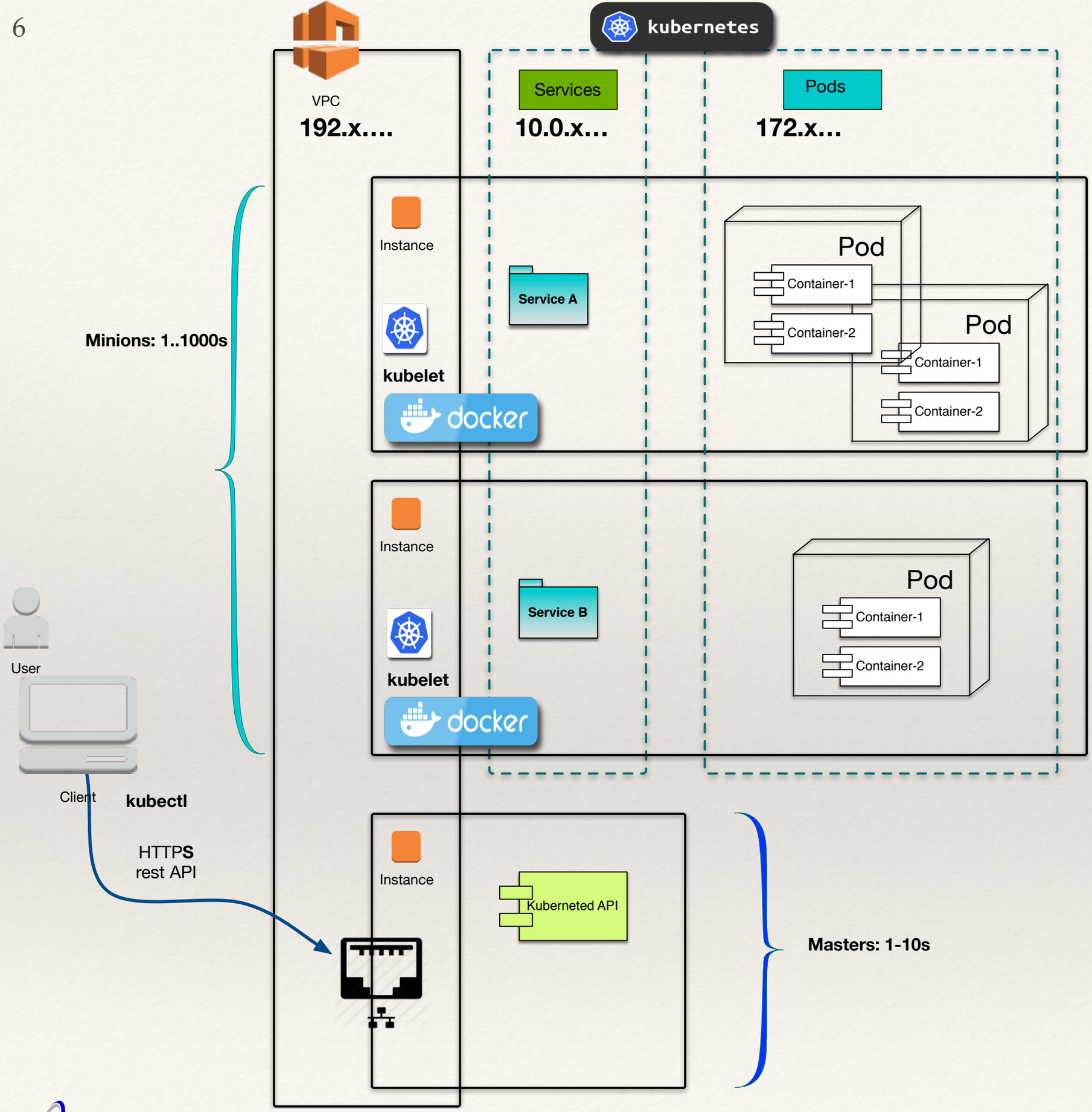
Planet Scale

Never Outgrow



Run Anywhere





Admin

Namespaces

Nodes

Persistent Volumes

Namespace

default

Workloads

Deployments

Replica Sets

Replication Controllers

Daemon Sets

Pet Sets

Jobs

Pods

Services and discovery.

Services

Ingress

Storage

Persistent Volume Claims

Config

Secrets

Config Maps

How to keep application working when something might fail:

kubernetes

ReplicationController

Ensures that we have requested number of replicas running at all times, and takes care of rolling updates when necessary.

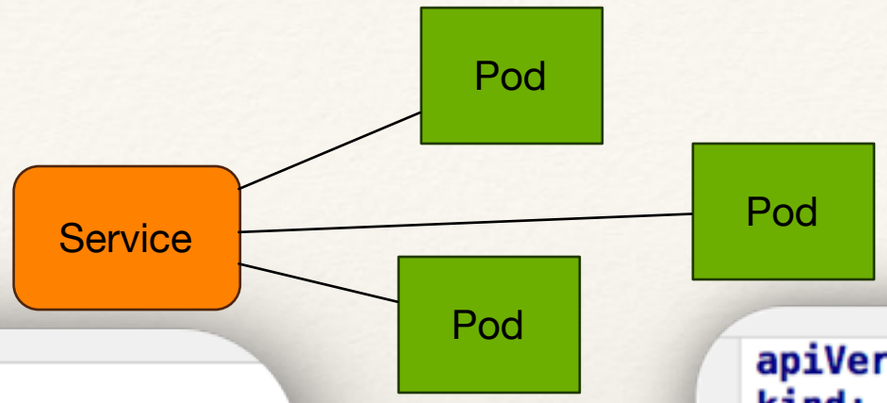
```yaml
apiVersion: v1
kind: ReplicationController
metadata:
  name: travelog-ws-rc
spec:
  replicas: 1
  template:
    metadata:
      name: travelog-ws-pod
      labels:
        app: travelog-ws-pod
    spec:
      containers:
      - name: travelog-ws-container
        image:  "kgignatyev/travelog-ws:2017-01-25-22-21-23"
        ports:
        - containerPort: 9100
        volumeMounts:
          - name: travel-properties
            mountPath: "/etc/travelog"
            readOnly: true
      volumes:
        - name: travel-properties
          secret:
            secretName: "travel-properties"
```

How to make our functionality available for client when pod-s come and go:

kubernetes

Service Service ≈ Internal Load Balancer

Ensures that clients have a permanent endpoint to call




```yaml
apiVersion: v1
kind: Service
metadata:
  name: travelog-ws-service
spec:
  selector:
    app: travelog-ws-pod

  ports:
    - port: 9100
      targetPort: 9100
```

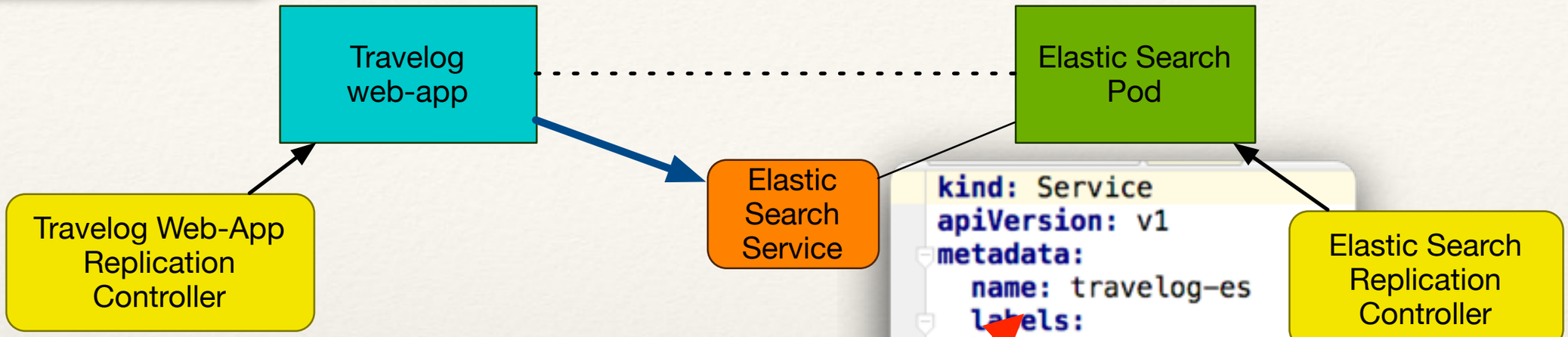
```yaml
apiVersion: v1
kind: ReplicationController
metadata:
  name: travelog-ws-rc
spec:
  replicas: 1
  template:
    metadata:
      name: travelog-ws-pod
      labels:
        app: travelog-ws-pod
    spec:
      containers:
      - name: travelog-ws-container
        image:  "kgignatyev/travelog-ws:
        ports:
        - containerPort: 9100
```

A Kubernetes `Service` is an abstraction which defines a logical set of `Pods` and a policy by which to access them - sometimes called a micro-service. The set of `Pods` targeted by a `Service` is (usually) determined by a `Label Selector` (see below for why you might want a `Service` without a selector).

How to make our functionality available for client when pod-s come and go:

kubernetes

Service




```
kind: Service
apiVersion: v1
metadata:
  name: travelog-es
  labels:
    name: travelog-es
spec:
  type: NodePort
  selector:
    name: es-rc-pod
  ports:
    - port: 9200
      name: "svc-port"
      targetPort: 9200
```

Note: env variables make it convenient for local development, but should not be relied upon in live cluster because it creates dependency on order of deployments

```
public class TravelogService {

    public String esBase() {
        String hostFromEnv = System.getenv( name: "TRAVELOG_ES_SERVICE_HOST");
        String res = "http://travelog-es:9200";
        if (hostFromEnv != null) {
            res = "http://" + hostFromEnv + ":" + System.getenv( name: "TRAVELOG_ES_PORT_9200_TCP_PORT");
        }
        return res;
    }
```

How to configure and apply configuration changes (slide 1)

kubernetes

ConfigMap, Secret

```
Properties context = readProperties( '../secrets/travel',env)

StringWriter sw = new StringWriter()

context.store(sw,"Generated for env:"+ env)

String confFileContent64 = Base64.getEncoder().encodeToString(sw

def out = "target/k8s/travel-secret." + env + ".yml"
processTemplate("src/secret.tmpl.yml",
        [secretName:'travel-properties',
         secretKey:'travel.properties',
         secretContent: confFileContent64], out)
```

```
Document 1/1  apiVersion:
apiVersion: v1
kind: Secret
metadata:
  name: travel-properties
type: Opaque
data:
  travel.properties: I0dlbmVyYXR
```

kubectl create -f infrastructure/target/k8s/travelog-secret.dev.yml

```
kgignatyev — bash
Konstantins-Mac-Pro:~ kgignatyev$ kubectl get secrets
NAME                    TYPE                                  DATA      AGE
default-token-m26lu     kubernetes.io/service-account-token   3         88d
fluentd-conf            Opaque                                1         7d
kgignatyev-registrykey  kubernetes.io/dockercfg               1         56d
mcytravel-properties    Opaque                                1         88d
mcytravel-ssl           Opaque                                2         54d
travel-properties       Opaque                                1         10d
Konstantins-Mac-Pro:~ kgignatyev$
```

How to configure and apply configuration changes (slide 2)

kubernetes

ConfigMap, Secret

```yaml
apiVersion: v1
kind: Secret
metadata:
  name: "travel-properties"
type: Opaque
data:
  travel.properties: I0dlbmVyY
```

```yaml
apiVersion: v1
kind: ReplicationController
metadata:
  name: assets-transcoder-rc
spec:
  replicas: 1
  template:
    metadata:
      name: assets-transcoder-pod
      labels:
        app: assets-transcoder-pod
    spec:
      containers:
      - name: assets-transcoder-container
        image:  "kgignatyev/assets-transcoder
        ports:
        - containerPort: 7200
        volumeMounts:
          - name: travel-properties
            mountPath: "/etc/travel"
            readOnly: true
      volumes:
        - name: travel-properties
          secret:
            secretName: "travel-properties"
```

```yaml
ion: v1
eplicationController
a:
  travelog-ws-rc
eplicas: 1
template:
  metadata:
    name: travelog-ws-pod
    labels:
      app: travelog-ws-pod
  spec:
    containers:
    - name: travelog-ws-container
      image:  "kgignatyev/travelog-ws:2017
      ports:
      - containerPort: 7100
      volumeMounts:
        - name: travel-properties
          mountPath: "/etc/travelog"
          readOnly: true
    volumes:
      - name: travel-properties
        secret:
          secretName: "travel-properties"
```

TravelogConfig

```
1   package kgi.presentations.k8s.travelog;
2
3   import ...
19
20  @Configuration
21  @PropertySource("file:/etc/travelog/travel.properties")
22  public class TravelogConfig {
23
24      @Bean
25      TravelConfigProperties configProperties() { return new TravelConfigProperties(); }
28  }
```

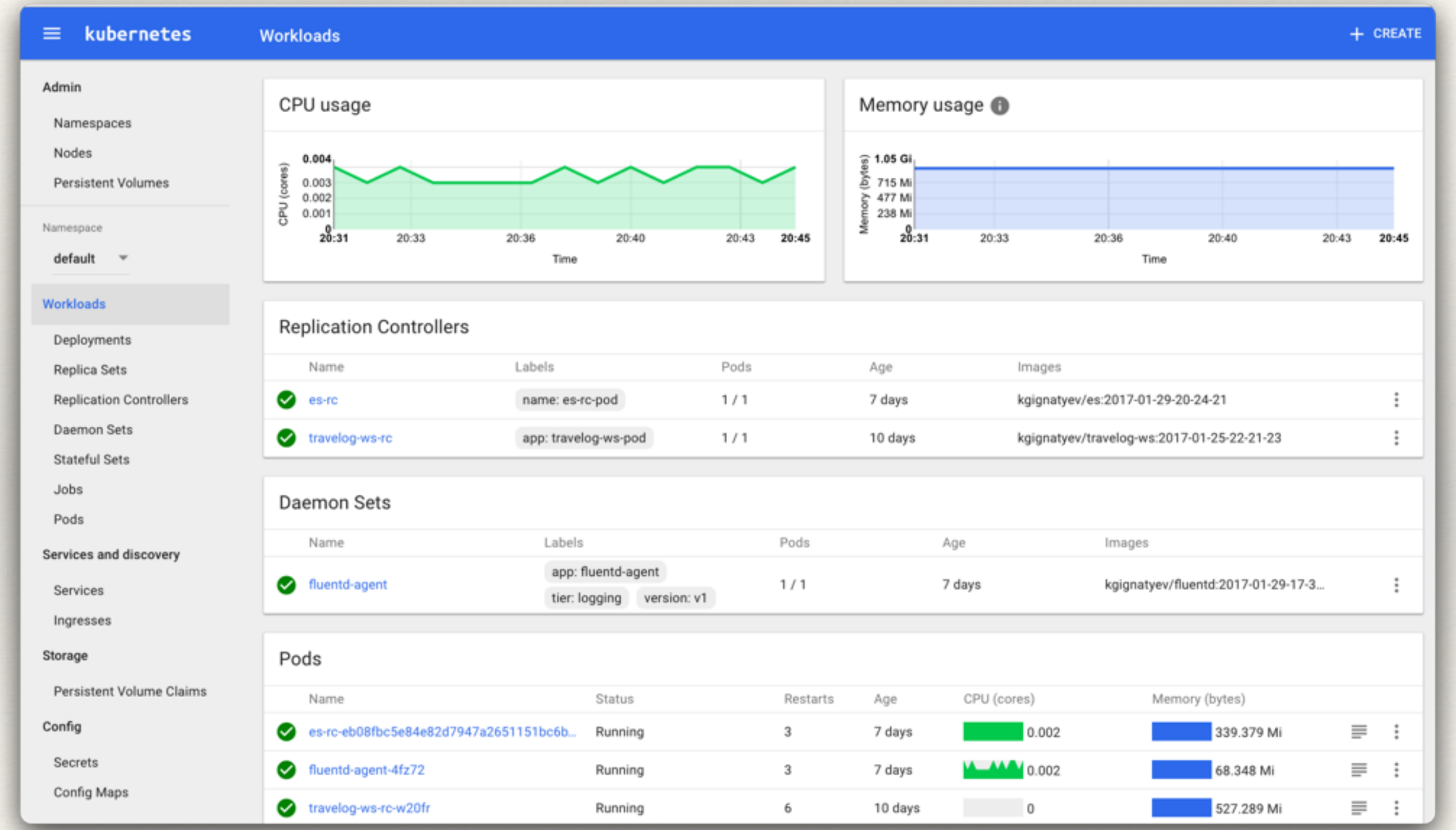
Dev9

Dev9

How to know where things are and what is going on:

kubernetes

Dashboard



How to know where things are and what is going on:

CLI: kubectl

```
Konstantins-Mac-Pro:~ kgignatyev$ kubectl get secrets
NAME                    TYPE                                  DATA      AGE
default-token-m26lu     kubernetes.io/service-account-token   3         88d
fluentd-conf            Opaque                                1         7d
kgignatyev-registrykey  kubernetes.io/dockercfg               1         56d
mcytravel-properties    Opaque                                1         88d
mcytravel-ssl           Opaque                                2         54d
travel-properties       Opaque                                1         10d
Konstantins-Mac-Pro:~ kgignatyev$ kubectl get pods
NAME                                    READY     STATUS    RESTARTS   AGE
es-rc-eb08fbc5e84e82d7947a2651151bc6b3-sj366   1/1       Running   3          7d
fluentd-agent-4fz72                     1/1       Running   3          7d
travelog-ws-rc-w20fr                    1/1       Running   6          10d
Konstantins-Mac-Pro:~ kgignatyev$ kubectl get services
NAME                CLUSTER-IP   EXTERNAL-IP   PORT(S)                         AGE
kubernetes          10.0.0.1     <none>        443/TCP                         89d
travelog-es         10.0.0.92    <nodes>       9200:31920/TCP,9300:31930/TCP   7d
travelog-ws-service 10.0.0.145   <none>        9100/TCP                        10d
Konstantins-Mac-Pro:~ kgignatyev$ kubectl get  rc
NAME            DESIRED   CURRENT   READY     AGE
es-rc           1         1         1         7d
travelog-ws-rc  1         1         1         10d
Konstantins-Mac-Pro:~ kgignatyev$
```

How to know where things are and what is going on:

kubernetes

SSH to a running pod and execute desired commands

kubectl exec -ti travelog-ws-rc-w20fr sh

```
Konstantins-Mac-Pro:~ kgignatyev$ kubectl exec -ti travelog-ws-rc-w20fr sh
/ # env
TRAVELOG_ES_PORT_9200_TCP_PORT=9200
KUBERNETES_SERVICE_PORT=443
KUBERNETES_PORT=tcp://10.0.0.1:443
TRAVELOG_ES_PORT_9300_TCP_PORT=9300
TRAVELOG_ES_PORT_9200_TCP_PROTO=tcp
TRAVELOG_ES_PORT_9300_TCP_PROTO=tcp
TRAVELOG_ES_SERVICE_HOST=10.0.0.92
HOSTNAME=travelog-ws-rc-w20fr
SHLVL=1
HOME=/root
JAVA_VERSION_BUILD=13
TRAVELOG_ES_PORT_9200_TCP=tcp://10.0.0.92:9200
TRAVELOG_ES_PORT=tcp://10.0.0.92:9200
TRAVELOG_ES_SERVICE_PORT=9200
TRAVELOG_ES_PORT_9300_TCP=tcp://10.0.0.92:9300
TRAVELOG_WS_SERVICE_PORT_9100_TCP_ADDR=10.0.0.145
JAVA_VERSION_MAJOR=8
TRAVELOG_WS_SERVICE_PORT_9100_TCP_PORT=9100
KUBERNETES_PORT_443_TCP_ADDR=10.0.0.1
TRAVELOG_WS_SERVICE_PORT_9100_TCP_PROTO=tcp
TRAVELOG_ES_SERVICE_PORT_SVC_PORT=9200
TRAVELOG_WS_SERVICE_SERVICE_HOST=10.0.0.145
PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/opt/jdk/bin
KUBERNETES_PORT_443_TCP_PORT=443
KUBERNETES_PORT_443_TCP_PROTO=tcp
```

UNIX

Where there is a shell, there is a way.

docker

How to scale :

kubernetes

Manually: kubectl --scale=x -f ...
Auto: Horizontal Pod Autoscale

Support for Horizontal Pod Autoscaler in kubectl

Horizontal Pod Autoscaler, like every API resource, is supported in a standard way by `kubectl`. We can create a new autoscaler using `kubectl create` command. We can list autoscalers by `kubectl get hpa` and get detailed description by `kubectl describe hpa`. Finally, we can delete an autoscaler using `kubectl delete hpa`.

In addition, there is a special `kubectl autoscale` command for easy creation of a Horizontal Pod Autoscaler. For instance, executing `kubectl autoscale rc foo --min=2 --max=5 --cpu-percent=80` will create an autoscaler for replication controller *foo*, with target CPU utilization set to `80%` and the number of replicas between 2 and 5. The detailed documentation of `kubectl autoscale` can be found here.

Support for custom metrics

Kubernetes 1.2 adds alpha support for scaling based on application-specific metrics like QPS (queries per second) or average request latency.

- `KUBE_ENABLE_CLUSTER_AUTOSCALER` - it enables cluster autoscaler if set to true.
- `KUBE_AUTOSCALER_MIN_NODES` - minimum number of nodes in the cluster.
- `KUBE_AUTOSCALER_MAX_NODES` - maximum number of nodes in the cluster.

How to have outage-less updates

kubernetes

Rolling updates

kubectl **rolling-update** -f travelog-webapp/target/k8s/travelog-ws-rc.yml --image=<new image>

k8s start new pods based on new image, reroutes traffic to them and then kills old pods.

Passing a configuration file

To initiate a rolling update using a configuration file, pass the new file to `kubectl rolling-update`:

```
$ kubectl rolling-update NAME -f FILE
```

How to have manage persistent volumes:

kubernetes

Persistent Volumes, Persistent Volume Claims

`PersistentVolume` types are in
plugins:

- GCEPersistentDisk
- AWSElasticBlockStore
- AzureFile
- AzureDisk
- FC (Fibre Channel)
- NFS
- iSCSI
- RBD (Ceph Block Device)
- CephFS
- Cinder (OpenStack block storage)
- Glusterfs
- VsphereVolume
- HostPath (single node testing only – local storage is no

```yaml
apiVersion: v1
kind: ReplicationController
metadata:
  name: es-rc
spec:
  replicas: 1
  template:
    metadata:
      name: es-rc-pod
      labels:
        name: es-rc-pod
    spec:
      containers:
      - name: es-rc-pod
        image: kgignatyev/es:2017-01-29-20-24-21
        volumeMounts:
        - mountPath: "/usr/share/elasticsearch/data"
          name: elastic-search-data
        ports:
        - containerPort: 9200
        - containerPort: 9300
      volumes:
      - name: elastic-search-data
        persistentVolumeClaim:
          claimName: "pvelastic.claim"
```

```yaml
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: pvelastic.claim
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 20Gi
  selector:
    matchLabels:
      name: "elastic-pv"
```

Local dev

Cloud

```yaml
kind: PersistentVolume
apiVersion: v1
metadata:
  name: elastic-pv
  labels:
    name: elastic-pv
spec:
  capacity:
    storage: 40Gi
  accessModes:
    - ReadWriteOnce
  hostPath:
     path: '/var/data/elastic'
```

```yaml
kind: PersistentVolume
apiVersion: v1
metadata:
  name: elastic-pv
  labels:
    name: elastic-pv
spec:
  capacity:
    storage: 20Gi
  accessModes:
    - ReadWriteOnce
  awsElasticBlockStore:
    volumeID: vol-ae8b5326
    fsType: ext4
```

How to have manage resource limits:

kubernetes

pod resource requests;

node selectors;

namespace limits

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: frontend
spec:
  containers:
  - name: db
    image: mysql
    resources:
      requests:
        memory: "64Mi"
        cpu: "250m"
      limits:
        memory: "128Mi"
        cpu: "500m"
  - name: wp
    image: wordpress
    resources:
      requests:
        memory: "64Mi"
        cpu: "250m"
      limits:
        memory: "128Mi"
        cpu: "500m"
```

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  labels:
    env: test
spec:
  containers:
  - name: nginx
    image: nginx
    imagePullPolicy: IfNotPresent
  nodeSelector:
    disktype: ssd
```

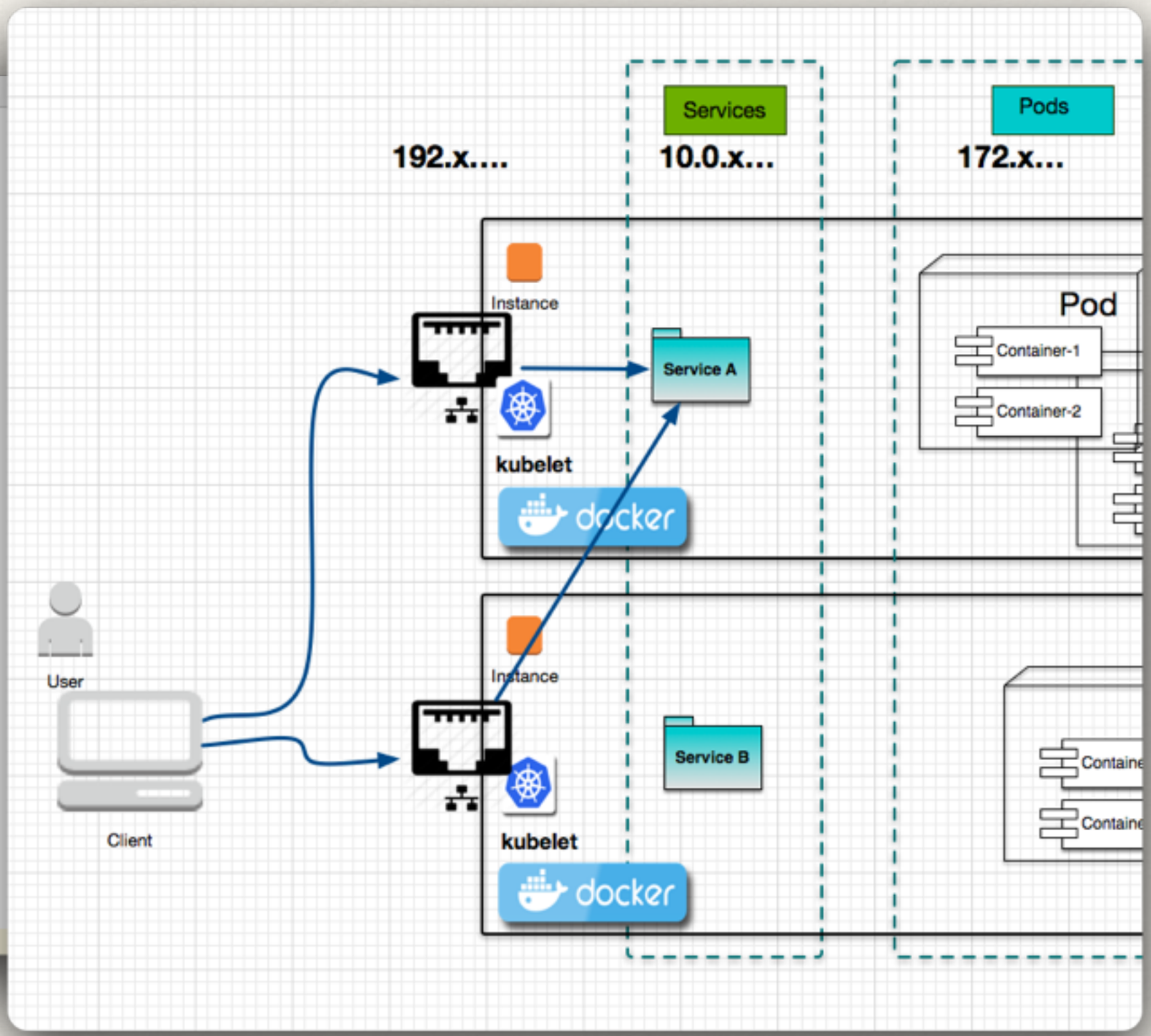
```
$ kubectl create namespace myspace

$ cat <<EOF > compute-resources.yaml
apiVersion: v1
kind: ResourceQuota
metadata:
  name: compute-resources
spec:
  hard:
    pods: "4"
    requests.cpu: "1"
    requests.memory: 1Gi
    limits.cpu: "2"
    limits.memory: 2Gi
EOF
$ kubectl create -f ./compute-resources.yaml --namespace=myspace
```

How to expose services for external clients:

NodePort, LoadBalancer, Ingress

```yaml
kind: Service
apiVersion: v1
metadata:
  name: travelog-es
  labels:
    name: travelog-es
spec:
  type: NodePort
  selector:
    name: es-rc-pod
  ports:
    - port: 9200
      name: "svc-port"
      targetPort: 9200
      nodePort: 31920
    - port: 9300
      name: "status-port"
      targetPort: 9300
      nodePort: 31930
```



kubernetes

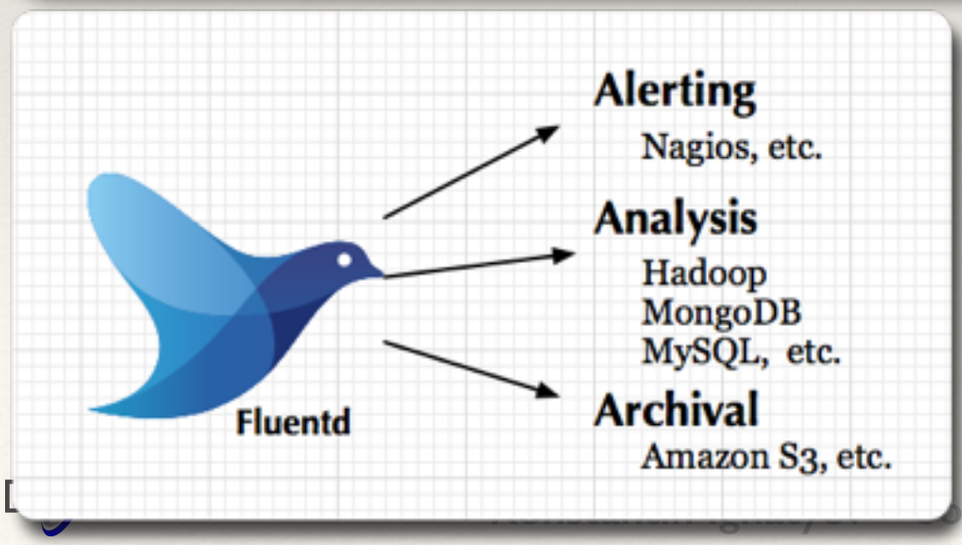
How to collect logs:

DaemonSet: guarantees that every (or selected) node run specified container, for example log collection daemon with k8s plugin to enhance container logs.

```
<source>
   type tail path
   /var/log/containers/*.log
   pos_file Fluentd-docker.pos
   time_format %Y-%m-%dT%H:%M:%S
   tag kubernetes.*
   format json
   read_from_head true
</source>

<filter kubernetes.var.lib.docker.containers.*.*.log>
   type kubernetes_metadata
</filter>

<match **>
   type stdout
</match>
```




```
apiVersion: extensions/v1beta1
kind: DaemonSet
metadata:
  name: fluentd-agent
  labels:
    tier: logging
    app: fluentd-agent
    version: v1
spec:
  template:
    metadata:
      labels:
        name: fluentd
    spec:
      hostPID: true
      hostIPC: true
      hostNetwork: true
      containers:
        - resources:
            requests:
              cpu: 0.15
          securityContext:
            privileged: true
          image: {{{image}}}
          name: fluentd
          volumeMounts:
            - name: logs
              mountPath: /var/log/containers/
              readOnly: true
            - name: mnt
              mountPath: /mnt/
            - name: config
              mountPath: /fluentd/etc/
      volumes:
        - name: config
          secret:
              secretName: "fluentd-conf"
        - name: logs
          hostPath:
              path: /var/log/containers/
        - name: mnt
          hostPath:
              path: /mnt/
```


Dev9

How to collect logs:

kubernetes

Log collectors have k8s aware plugins to enhance log messages with necessary details

Table | JSON | +/- 1 sec | 10 sec | 30 sec | 60 sec | Link to /logz-oxzrppltcfcihxkuwbxhbspjqckgbugz-170206_v2/ht

@timestamp	February 5th 2017, 23:30:51.000
t docker.container_id	8d29a3aca25dbd06da56ee2259c8ee3e9348679ccab8f532becdd4dcee735b09
t fluentd_tags	kubernetes.var.log.containers.kube-addon-manager-minikube_kube-system_kube-addon-manag e2259c8ee3e9348679ccab8f532becdd4dcee735b09.log
t kubernetes.container_name	kube-addon-manager
t kubernetes.host	minikube
t kubernetes.labels.component	kube-addon-manager
? kubernetes.labels.kubernetes_io/minikube-addons	addon-manager
t kubernetes.labels.version	v6.1
t kubernetes.namespace_name	kube-system
t kubernetes.pod_id	87ce0691-e5d2-11e6-a8a2-1af65948c45e
t kubernetes.pod_name	kube-addon-manager-minikube
t log	INFO: == Kubernetes addon update completed successfully at 2017-02-06T07:30:51+0000 ==
t stream	stdout
t tags	_logz_http_bulk_json_8070
t type	http-bulk

How to develop locally:

kubernetes

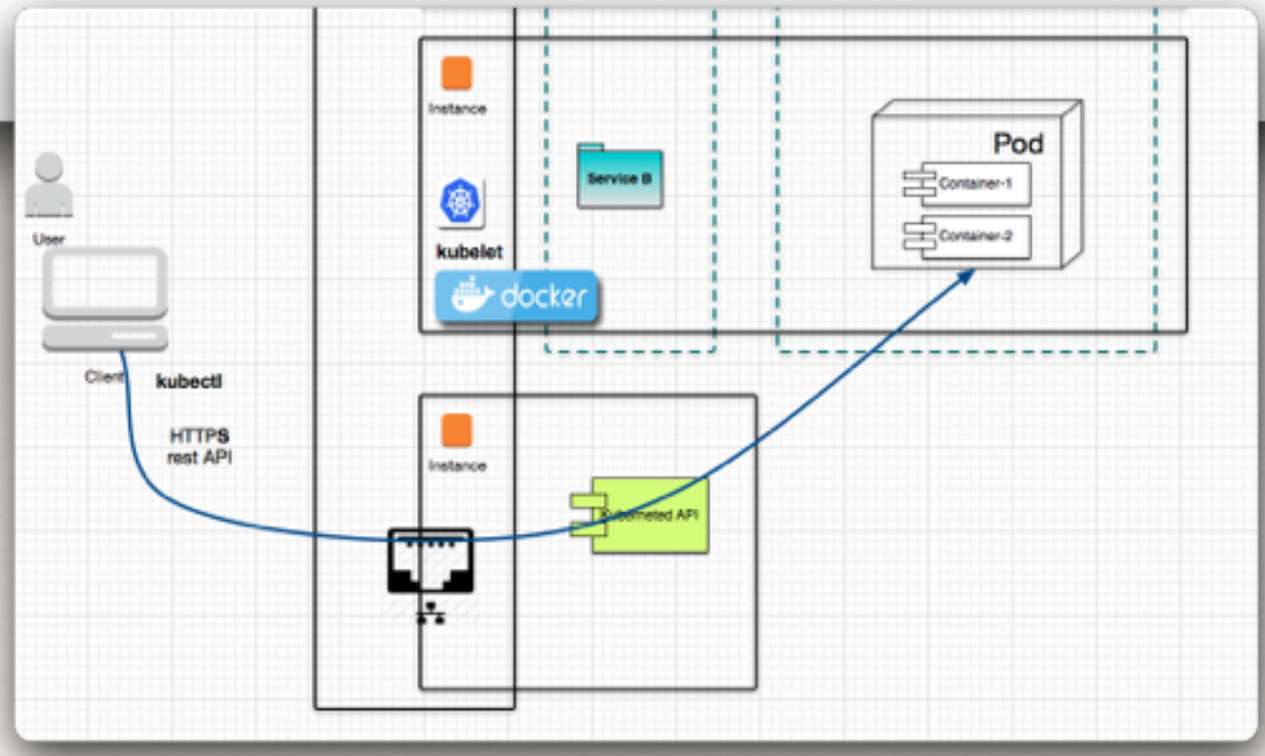
Port-forward

```
#!/usr/bin/env bash
echo "starting port forward to Elastic Search:"

podName=`kubectl get pods -l name=es-rc-pod -o=jsonpath='{$.items[0].metadata.name}'`
kubectl port-forward $podName  9200:9200
```

```
public class TravelogService {

    public String esBase() {
        String hostFromEnv = System.getenv( name: "TRAVELOG_ES_SERVICE_HOST");
        String res = "http://travelog-es:9200";
        if (hostFromEnv != null) {
            res = "http://" + hostFromEnv + ":" + System.getenv( name: "TRAVELOG_ES_PORT_9200_TCP_PORT");
        }
        return res;
    }
```



How to develop locally:

Minikube

build passing codecov 33%

What is Minikube?

Minikube is a tool that makes it easy to run Kubernetes locally. Minikube runs a single-node Kubernetes cluster inside a VM on your laptop for users looking to try out Kubernetes or develop with it day-to-day.

Features

- Minikube packages and configures a Linux VM, the container runtime, and all Kubernetes components, optimized for local development.
- Minikube supports Kubernetes features such as:
  - DNS
  - NodePorts
  - ConfigMaps and Secrets
  - Dashboards
  - Container Runtime: Docker, and rkt
  - Enabling CNI (Container Network Interface)

How to run batch and cron jobs:

BatchJob, CronJob, ‘naked’ pod

```yaml
apiVersion: batch/v1
kind: Job
metadata:
  name: pi
spec:
  template:
    metadata:
      name: pi
    spec:
      containers:
      - name: pi
        image: perl
        command: ["perl",  "-Mbignum=bpi", "-wle", "print bpi(2000)"]
      restartPolicy: Never
```

```yaml
apiVersion: batch/v2alpha1
kind: CronJob
metadata:
  name: hello
spec:
  schedule: "*/1 * * * *"
  jobTemplate:
    spec:
      template:
        spec:
          containers:
          - name: hello
            image: busybox
            args:
            - /bin/sh
            - -c
            - date; echo Hello from the Kubernetes cluster
          restartPolicy: OnFailure
```

Questions ?