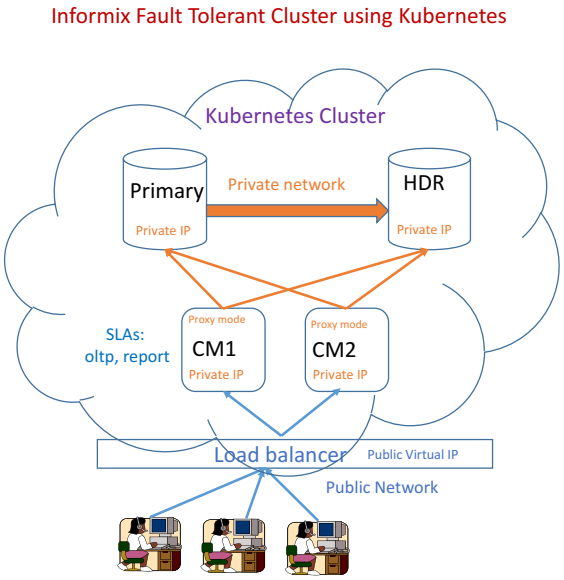
Instructions for setting up Informix Cluster in Kubernetes

This project helps to setup a fault tolerant Informix cluster along with Connection Manager in Kubernetes container service.

For details on Kubernetes, please refer to https://kubernetes.io/docs/home/

This document helps you build Docker images for Informix server and connection manager, and deploy fault tolerant Informix cluster within google cloud platform kubernetes container service. Even though google cloud platform container services was used for testing Informix Kubernetes cluster, the artifacts in this project helps you deploy Informix cluster in any of the public cloud Kubernetes Container Services.

End goal of this project is to build a fault tolerant Informix cluster environment as shown in this below picture:



Signup for Google Cloud Platform

1.Download google cloud sdk from here: https://cloud.google.com/sdk/downloads

2.Initialize google cloud sdk:

```
$ gcloud init
```

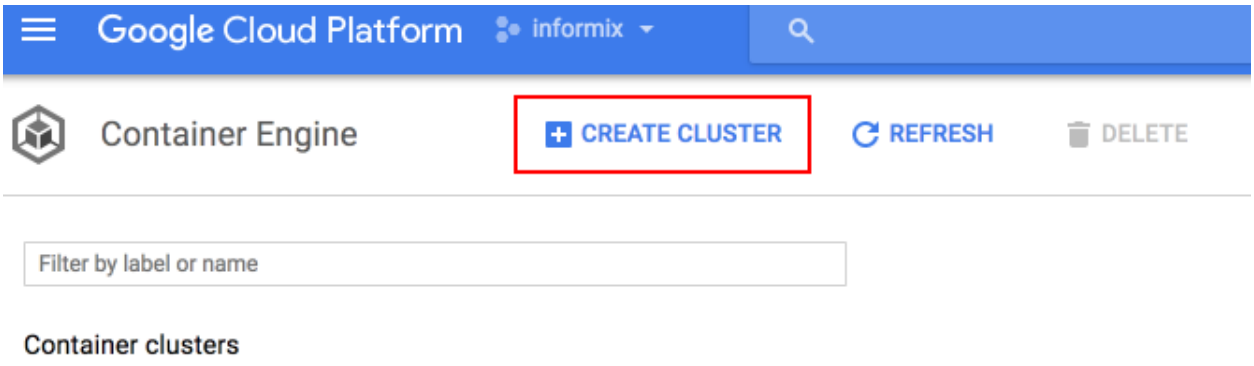
3.Install kubectl to control kubernetes cluster

gcloud components install kubectl

4.Login to Google Cloud Platform

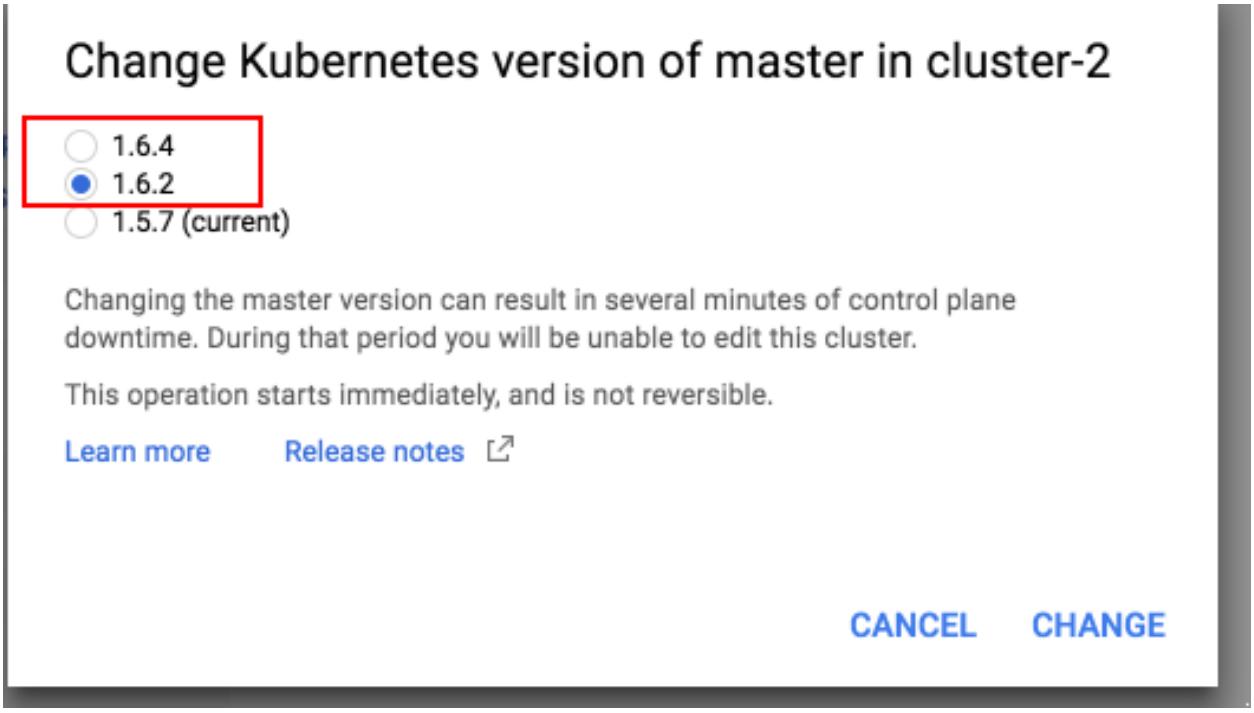
5.Create a new project called informix. Note down project id. Project id is of the format “fit-authority-#####”.

6.Click on “Container Engine” and create new cluster, and name the kubenetes cluster as informix-cluster.



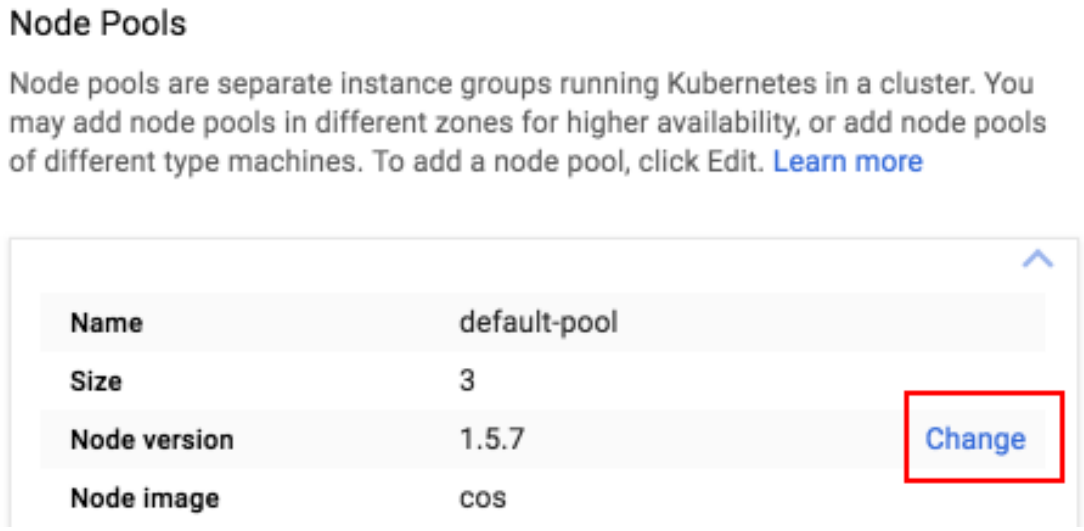
Important Note: After creating the cluster, make sure to upgrade all nodes in the cluster to 1.6.2 or higher version.
Note: In default and older versions below 1.6.x, reverse DNS lookup functionality do not work, this functionality is needed for trusted host configuration for Informix cluster nodes.

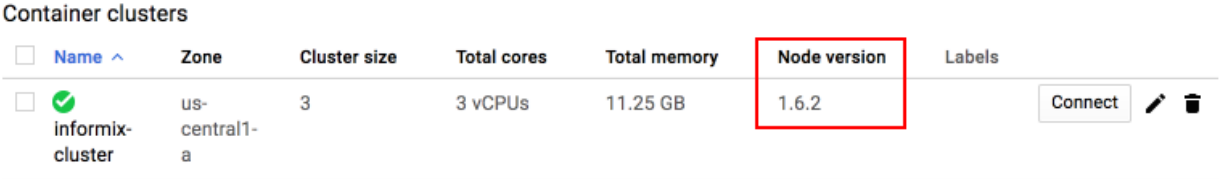
Screenshots on how to upgrade Kubernetes master and Node versions from google cloud platform console:



Select version 1.6.2 or above.

Upgrade Node pool version as well:





7.Note down the container cluster zone.

Configure your local host to connect to the kubernetes cluster:

8.Set default zone:

$ gcloud config set compute/zone us-central1-a

9.Get current configuration using this command:

```
$ gcloud config list
```

10.Ensure kubectl has authentication credentials:

$ gcloud auth application-default login

Connect to the kubernetes cluster

11.Configure kubectl command line access by running the following command:

$ gcloud container clusters get-credentials informix-cluster --zone us-central1-a --project fit-authority-167622

“Informix-cluster” is my kubernetes cluster name. us-central1-a is the google cloud platform zone. fit-authority-167622 is my project id.

12.Start proxy to connect to Kubernetes control plane:

$ Kubectl proxy
Starting to serve on 127.0.0.1:8001

13.Open dashboard by navigating to http:/localhost:8001/ui

14.Verify cluster by running hello-world program

$ kubectl run hello-node --image=gcr.io/google-samples/node-hello:1.0 --port=8080

$ kubectl expose deployment hello-node --type="LoadBalancer"

$ kubectl get service hello-node
NAME CLUSTER-IP EXTERNAL-IP PORT(S) AGE
  hello-node 10.107.246.252 104.197.98.97 8080:30075/TCP 45s

#open this below web page
http://104.197.98.97:8080

#delete service

$ kubectl delete service hello-node

15.Set project in your local host terminal:

$ PROJECT_ID="$(gcloud config get-value project)"

Verify project id.

$ echo $ PROJECT_ID
fit-authority-#####

16.Set default project id and zone.

$ gcloud config set project $PROJECT_ID

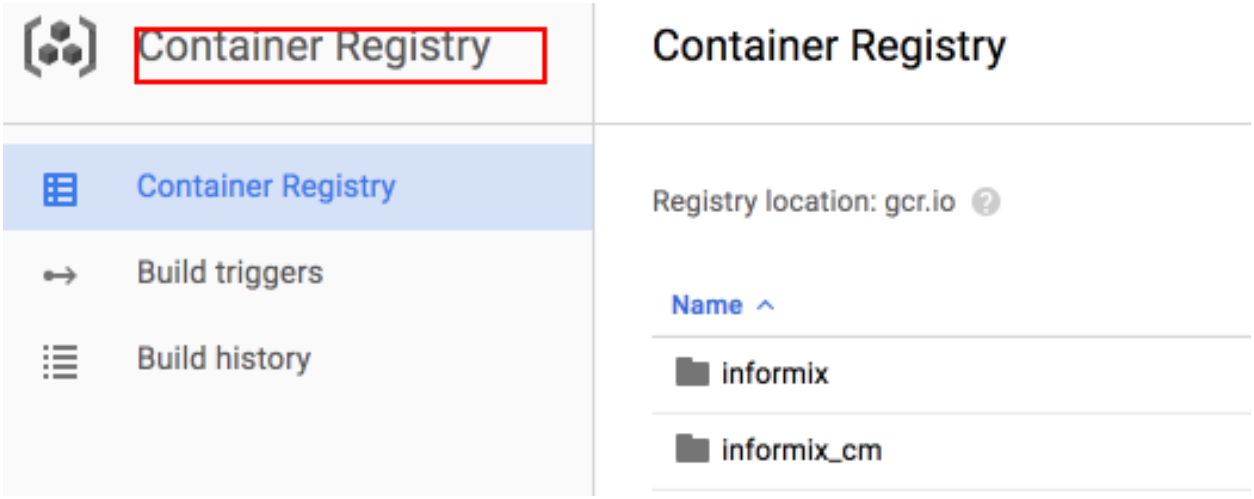
$ gcloud config set compute/zone us-central1-a

17.Install Docker

Open this URL and follow instructions to install Docker on your local host:
https://docs.docker.com/engine/installation/

18.Build Docker images

First sign up for “Container Registry” from google cloud platform web console:



19.Clone git project:

```
$ git clone https://github.com/nagaraju-inturi/kubernetes-informix-cluster.git
```

20.Build Docker images for Informix server:

```
$ cd kubernetes-informix-cluster/docker/server_ctx/
```

```
$ docker build -t gcr.io/${PROJECT_ID}/informix:v1 .
```

21. Push Informix server Docker image to google container registry:

```
$ gcloud docker -- push gcr.io/${PROJECT_ID}/informix:v1
```

22.Build Docker image for Informix Connection Manager:

```
$ cd kubernetes-informix-cluster/docker/cm_ctx/
```

```
$ docker build -t gcr.io/${PROJECT_ID}/informix_cm:v1 .
```

23. Push Connection Manager Docker image to Container registry:

```
$ gcloud docker -- push gcr.io/${PROJECT_ID}/informix_cm:v1
```

Build Informix cluster using below kubernetes YAML file:

24. Create SSL keystore files using IBM Global Security Kit:

```
$ cd kubernetes-informix-cluster/kubernetes/
```

Command to create keystore and SSL keys:

```
#Create keystore files
$ gsk8capicmd_64 -keydb -create -db informix.kdb -pw informix4k8 -type cms -expire 3650 -
stash

#create certificate
$ gsk8capicmd_64 -cert -create -db informix.kdb -pw informix4k8 -dn "CN=`hostname`" -size
2048 -label informix -default_cert yes
```

Informix.sth and Informix.kdb are required for SSL client connections.
For more details on IBM Global Security Kit, please refer to this URL:
https://www.ibm.com/support/knowledgecenter/SSGU8G_12.1.0/com.ibm.sec.doc/ids_ssl_006.htm

Alternatively, you can use the Informix.sth and Informix.kdb files from GIT repository for your test cluster. You cannot use these files for your production cluster.

If you do not want SSL configuration, update Informix-k8.yaml file and change `SSLCONFIG value to "false" for both Informix server and connection manager statefulsets, and create empty dummy files for Informix.sth and Informix.kdb files.`

25 (Important step) Create kubernetes secret for keystore files. Name secret object as ssl-key-secret

```
$ kubectl create secret generic ssl-key-secret --from-file=ssl-kdb=/kubernetes-informix-cluster/kubernetes//informix.kdb --from-file=ssl-sth=/kubernetes-informix-cluster/kubernetes//informix.sth
```

Note: Make sure to input correct path for Informix.kdb and Informix.sth for the above command.

26. Build Informix cluster using below kubernetes YAML file:

```
$ cd kubernetes-informix-cluster/kubernetes/

$ kubectl create -f informix-k8.yaml
```

Wait for up to 5 minutes and check the cluster status:

27. Check statefulsets

```
$ kubectl get statefulsets
NAME       DESIRED   CURRENT   AGE
cm         2         2         1d
informix   2         2         1d
```

28. List PODS

```
$ kubectl get pods
NAME         READY     STATUS    RESTARTS   AGE
cm-0         1/1       Running   0          1d
cm-1         1/1       Running   0          1d
informix-0   1/1       Running   0          1d
informix-1   1/1       Running   0          1d
```

29. List Persistent Volume Claims

```
$ kubectl get pvc
NAME              STATUS    VOLUME                                     CAPACITY   ACCESSMOD
ES   STORAGECLASS   AGE
data-informix-0   Bound     pvc-a20da4c9-4362-11e7-832e-
42010a80007f   10Gi       RWO           standard       1d
data-informix-1   Bound     pvc-c418adf9-4362-11e7-832e-
42010a80007f   10Gi       RWO           standard       1d
```

30. List Persistent Volumes

```
$ kubectl get pv
NAME                                       CAPACITY   ACCESSMODES   RECLAIMPOLICY   STATUS
  CLAIM                       STORAGECLASS   REASON    AGE
pvc-a20da4c9-4362-11e7-832e-
42010a80007f   10Gi       RWO           Delete          Bound     default/data-informix-
0   standard                1d
pvc-c418adf9-4362-11e7-832e-
42010a80007f   10Gi       RWO           Delete          Bound     default/data-informix-
1   standard                1d
```

31. List services to get external IP address for client connections:

```
$ kubectl get services
NAME          CLUSTER-IP      EXTERNAL-
IP      PORT(S)
              AGE
cm            None            <none>           50000/TCP,50001/TCP,50002/TCP,50003/TCP,5000
4/TCP,50005/TCP                                       1d
informix      None            <none>           60000/TCP,60001/TCP,60002/TCP
                                                      1d
informix-
cm   10.107.243.88   104.198.172.24   50000:32201/TCP,50001:31096/TCP,50002:32722/TCP,50003
:30588/TCP,50004:32642/TCP,50005:32267/TCP   1d
kubernetes    10.107.240.1    <none>           443/TCP
                                                      8d
```

Note down externa ip address from ‘kubectl get services’ command for “cm” service and connect to the Informix cluster.

32: External Port numbers for client connections:

Connection Manager SLA	PORT	Description
OLTP	50000	This port connects to current primary server
REPORT	50001	This port connects to any of the secondary servers
OLTP_SSL	50002	This SSL port connects to current primary server
REPORT_SSL	50003	This SSL port connects to any of the secondary servers
OLTP_DRDA	50004	This DRDA port connects to current primary server
REPORT_DRDA	50005	This DRDA port connects to any of the secondary servers

Note: For SSL port to work, you need to either copy Informix.sth to client.sth, Informix.kdb to client.kdp and copy these files to $INFORMIXDIR/etc/

Or

Create client.kdb and client.sth files by creating keystore using "`gsk8capicmd_64 –keydb –create`" `command`, extract public key from Informix.kdb file and import the key to client.kdb file.

Scaling up Connection manager statefulset instances/pods:

Run the following command increase number of connection manager pods:

```
$ kubectl scale ––replicas=3 statefulset cm
```

This above command makes sure that minimum three connection manager instances/pods running within the cluster.

```
$ kubectl get pods
NAME        READY    STATUS    RESTARTS   AGE
cm-0        1/1      Running   0          7m
cm-1        1/1      Running   0          7m
cm-2        0/1      Running   0          53s
informix-0  1/1      Running   0          7m
informix-1  1/1      Running   0          6m
```

Scaling up Informix server statefulset instances/pods:

```
$ kubectl scale ––replicas=3 statefulset informix
```

The above command creates new pod with Informix RSS server.

```
$ kubectl get pods
NAME        READY    STATUS    RESTARTS   AGE
cm-0        1/1      Running   0          7m
cm-1        1/1      Running   0          7m
cm-2        0/1      Running   0          3m
informix-0  1/1      Running   0          7m
informix-1  1/1      Running   0          6m
informix-2  1/1      Running   0          2m
```

Note: Current logic in Informix docker image boot.sh script only supports up to three nodes (Primary, HDR and RSS) for Informix cluster:

Verify fault tolerant nature of Kubernetes cluster:

Delete cm-1 pod from cm statefulset:

```
$ kubectl get pods
NAME          READY     STATUS    RESTARTS   AGE
cm-0          1/1       Running   0          1d
cm-1          1/1       Running   0          1d
informix-0    1/1       Running   0          1d
informix-1    1/1       Running   0          1d

$ kubectl delete pod cm-1
pod "cm-1" deleted
```

After few seconds verify pods again:

```
$ kubectl get pods
NAME          READY     STATUS        RESTARTS   AGE
cm-0          1/1       Running       0          1d
cm-1          0/1       Terminating   0          18s
informix-0    1/1       Running       0          1d
informix-1    1/1       Running       0          1d

$ kubectl get pods
NAME          READY     STATUS        RESTARTS   AGE
cm-0          1/1       Running       0          1d
cm-1          0/1       Running       0          50s
informix-0    1/1       Running       0          1d
informix-1    1/1       Running       0          1d
```

Kubernetes recreates the pod.

Same thing can be done for Informix statefulset as well.

Delete informix-1 and check what happens.

Note: Informix Kubernetes cluster do not automatically restart failed primary server as this may cause split brain situation, this operation requires DBA intervention. However, Informix Kubernetes cluster automatically restarts secondary server instance without DBA intervention.

Kubernetes Pods and Controllers for Informix cluster (Informix-k8.yaml file review):

Informix Kubernetes Cluster yaml file creates these following kubernetes pods and controllers:

Statefulsets: https://kubernetes.io/docs/concepts/workloads/controllers/statefulset/

Important Note on StatefulSets:

Kubernetes StatefulSets gets you predictable host names, and external storage(volumes) are bound to the pods(containers) in StatefulSets till the life of StatefulSets. These properties of StatefulSets helps build database cluster which require persistent state.

Host names within StatefulSets pods starts with <setname>-0, <setname>-1, <setname>-2 and so on.

Informix serve Docker image is constructed -- check logic with in boot.sh script -- to start primary server on informix-0, HDR on informix-1, and RSS on informix-2. Note: “informix” is the statefulset name for Informix cluster.

Pods: https://kubernetes.io/docs/concepts/workloads/pods/pod-overview/

Services: https://kubernetes.io/docs/concepts/services-networking/service/

Persistent Volumes: https://kubernetes.io/docs/concepts/storage/persistent-volumes/

Dynamic Provisioning for Persistent Volumes: http://blog.kubernetes.io/2016/10/dynamic-provisioning-and-storage-in-kubernetes.html

Secrets: https://kubernetes.io/docs/concepts/configuration/secret/

Informix statefulset with Informix server Docker image:

```
#
# StatefulSet for Informix cluster.
# Statefulsets gets predictable hostnames, and storage is bound
# to the life of the pods within the statefulsets.
# Replica count configures the number of Informix Server containers.
#
apiVersion: apps/v1beta1
kind: StatefulSet
metadata:
  name: informix
spec:
  serviceName: "informix"
  replicas: 2
  template:
    metadata:
      labels:
        app: informix
    spec:
      containers:
      - image: gcr.io/fit-authority-167622/informix:v3
        name: informix
        env:
        - name: SSLCONFIG
          value: "true"
        ports:
```

```
        - containerPort: 60000
          name: informix
        - containerPort: 60001
          name: informixssl
        - containerPort: 60002
          name: informixdrda
        volumeMounts:
        - name: data
          mountPath: /opt/ibm/data
        - name: vsslkeysecret
          mountPath: /etc/sslkeysecret
          readOnly: true
        livenessProbe:
          exec:
            command: ["/opt/ibm/chk4live.sh", "/tmp"]
            #command: ["ls", "/tmp"]
          initialDelaySeconds: 30
          timeoutSeconds: 5
        readinessProbe:
          exec:
            #command: ["/opt/ibm/chkinformix.sh", "/tmp"]
            command: ["ls", "/tmp"]
          initialDelaySeconds: 30
          timeoutSeconds: 30
      volumes:
      - name: data
        persistentVolumeClaim:
          claimName: data
      - name: vsslkeysecret
        secret:
          secretName: ssl-key-secret
          defaultMode: 256
  volumeClaimTemplates:
  - metadata:
      name: data
      annotations:
        volume.alpha.kubernetes.io/storage-class: anything
    spec:
      accessModes: ["ReadWriteOnce"]
      resources:
        requests:
          storage: 10Gi
```

Replicas specifies the number of pods/containers.
Containers section specify the docker image location for the pods.
VolumeMounts specifies details about the type of external disk being mounted and location of the mount point.

Volumes specify the details about kubenetes persistent volume claims.

volumeClaimTemplates refers to dynamic provisioning feature of kunbernetes clusters. For more details on this feature please refer to this web page:
http://blog.kubernetes.io/2016/10/dynamic-provisioning-and-storage-in-kubernetes.html

Connection manager (cm) statefulset with Informix connecton manager docker image:

```
#
# StatefulSet for Informix connection manager group.
# StatefulSet gets predictable hostnames, and storage is bound
# to the life of the pods within the statefulSets.
# Replica count configures the number of CM containers.
#
apiVersion: apps/v1beta1
kind: StatefulSet
metadata:
  name: cm
spec:
  serviceName: "cm"
  replicas: 2
  template:
    metadata:
      labels:
        app: cm
    spec:
      containers:
      - image: gcr.io/fit-authority-167622/informix_cm:v4
        name: cm
        env:
        - name: SSLCONFIG
          value: "true"
        ports:
        - containerPort: 50000
          name: oltp
        - containerPort: 50001
          name: report
        - containerPort: 50002
          name: oltpssl
        - containerPort: 50003
          name: reportssl
        - containerPort: 50004
          name: oltpdrda
        - containerPort: 50005
          name: reportdrda
        volumeMounts:
        - name: vsslkeysecret
          mountPath: /etc/sslkeysecret
          readOnly: true
        livenessProbe:
          exec:
            command: ["/opt/ibm/chk4live.sh", "/tmp"]
            #command: ["ls", "/tmp"]
          initialDelaySeconds: 30
          timeoutSeconds: 5
        readinessProbe:
          exec:
            #command: ["/opt/ibm/chkinformix.sh", "/tmp"]
            command: ["ls", "/tmp"]
          initialDelaySeconds: 30
          timeoutSeconds: 30
      volumes:
      - name: vsslkeysecret
        secret:
          secretName: ssl-key-secret
          defaultMode: 256
```

Headless services for Informix statefulset:

```
#
# Headless service for Informix cluster statefulset
# Headless service with clusterIP set to NULL
# create DNS records for Informix cluster hosts.
#
apiVersion: v1
kind: Service
metadata:
  name: informix
  labels:
    app: informix
spec:
  ports:
    - port: 60000
      name: informix
    - port: 60001
      name: informixssl
    - port: 60002
      name: informixdrda
  selector:
    app: informix
  clusterIP: None
  selector:
    app: informix
```

Headless service for connection manager statefulset:

```
#
# Connection manager servive along with loadbalancer.
# This service gets external ip address for applications
# to connect to Informix cluster over the internet.
#
#
# Headless service for Informix Connection Manager statefulset.
# Headless service with clusterIP set to NULL
# create DNS records for Informix Connection Manager hosts.
#
apiVersion: v1
kind: Service
metadata:
  name: cm
  labels:
    app: cm
spec:
  ports:
    - port: 50000
      name: oltp
    - port: 50001
      name: report
    - port: 50002
      name: oltpssl
    - port: 50003
      name: reportssl
    - port: 50004
      name: oltpdrda
    - port: 50005
```

```
    name: reportdrda
  selector:
    app: cm
  clusterIP: None
  selector:
    app: cm
```

Informix-cm service to get external IP address and to add load balancer for client connections:

```
#
# Connection manager client servive along with loadbalancer.
# This service gets external ip address for applications
# to connect to Informix cluster over the internet.
#
apiVersion: v1
kind: Service
metadata:
  name: informix-cm
  labels:
    app: cm
spec:
  ports:
  - name: oltp
    port: 50000
    targetPort: 50000
  - name: report
    port: 50001
    targetPort: 50001
  - name: oltpssl
    port: 50002
    targetPort: 50002
  - name: reportssl
    port: 50003
    targetPort: 50003
  - name: oltpdrda
    port: 50004
    targetPort: 50004
  - name: reportdrda
    port: 50005
    targetPort: 50005
  type: LoadBalancer
  selector:
    app: cm
```