

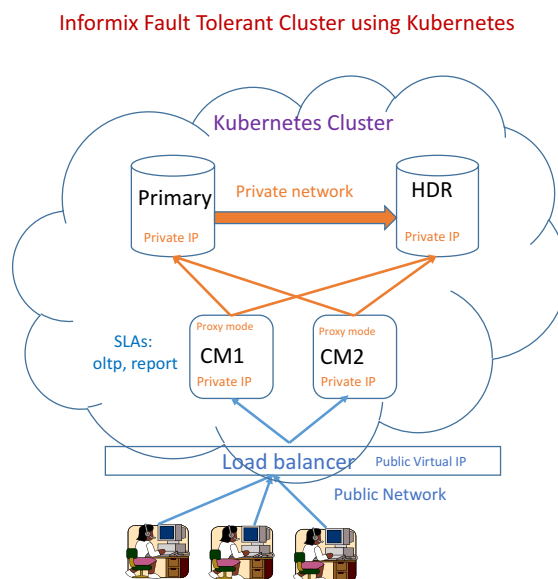
# Instructions for setting up Informix Cluster in Kubernetes

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
```

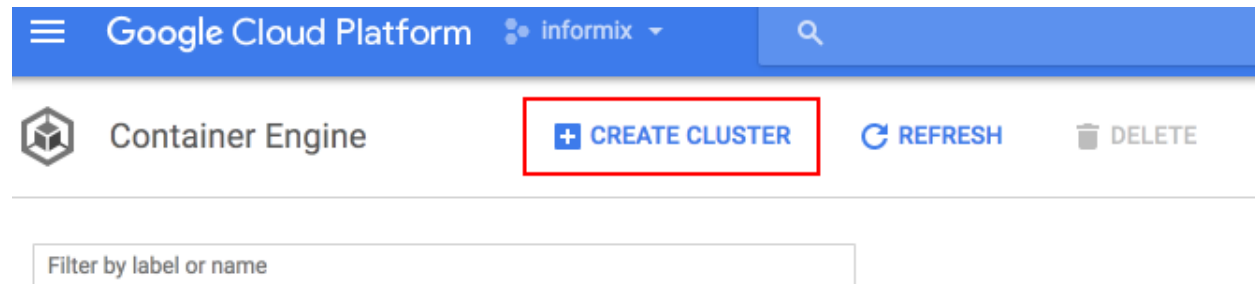
3.Install kubectl to control kubernetes cluster

```
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 kubernetes 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:

Cluster		
Master version	1.5.7	Upgrade available
Endpoint	35.184.112.95	Show credentials

## Change Kubernetes version of master in cluster-2

- ☐ 1.6.4  
☒ 1.6.2  
☐ 1.5.7 (current)

Changing the master version can result in several minutes of control plane downtime. During that period you will be unable to edit this cluster.

This operation starts immediately, and is not reversible.

[Learn more](#) [Release notes](#) [↗](#)

[CANCEL](#) [CHANGE](#)

Select version 1.6.2 or above.

Upgrade Node pool version as well:

### Node Pools

Node pools are separate instance groups running Kubernetes in a cluster. You may add node pools in different zones for higher availability, or add node pools of different type machines. To add a node pool, click Edit. [Learn more](#)

Name	default-pool
Size	3
Node version	1.5.7
Node image	COS

Change

#### Container clusters

<input type="checkbox"/> Name ^	Zone	Cluster size	Total cores	Total memory	Node version	Labels
<input checked="" type="checkbox"/> informix-cluster	us-central1-a	3	3 vCPUs	11.25 GB	1.6.2	<a href="#">Connect</a> <a href="#">✎</a> <a href="#">🗑</a>

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
```

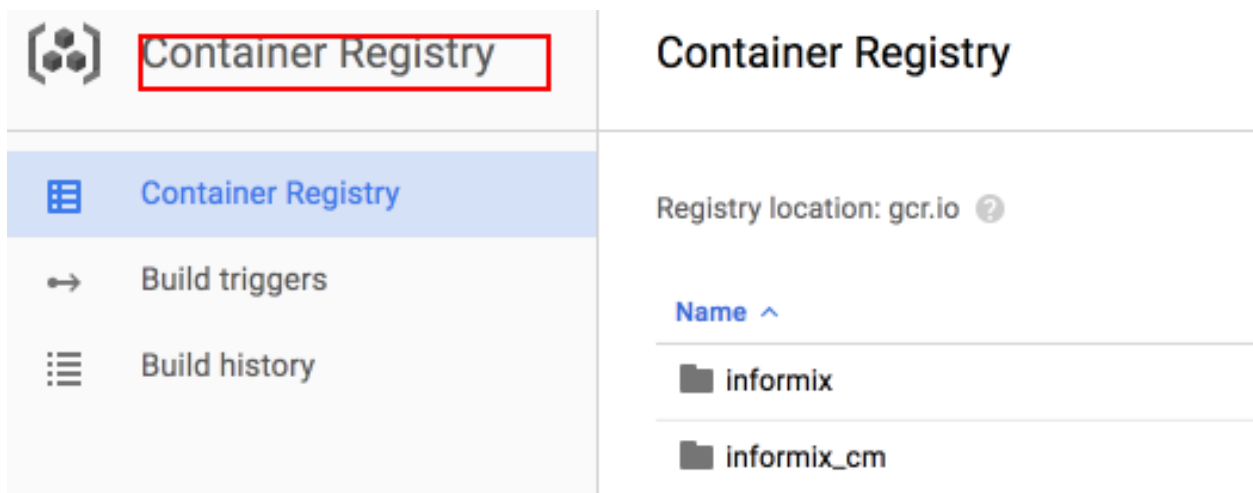
## 17. Install Docker

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](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	ACCESSMODE
data-informix-0	Bound	pvc-a20da4c9-4362-11e7-832e-42010a80007f	10Gi	RW0
data-informix-1	Bound	pvc-c418adf9-4362-11e7-832e-42010a80007f	10Gi	RW0

### 30. List Persistent Volumes

```
$ kubectl get pv
NAME                                CAPACITY  ACCESSMODES  RECLAIMPOLICY  STATUS
CLAIM                               STORAGECLASS  REASON      AGE
pvc-a20da4c9-4362-11e7-832e-      10Gi      RW0          Delete        Bound        default/data-informix-
42010a80007f                                1d
0  standard
pvc-c418adf9-4362-11e7-832e-      10Gi      RW0          Delete        Bound        default/data-informix-
42010a80007f                                1d
1  standard
```

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

```
$ kubectl get services
NAME                                CLUSTER-IP      EXTERNAL-IP      PORT(S)          AGE
cm                                  10.107.243.88   104.198.172.24   50000/TCP,50001/TCP,50002/TCP,50003/TCP,50004/TCP,50005/TCP 1d
informix                            10.107.240.1    <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 external 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.ssth to client.ssth, Informix.kdb to client.kdb and copy these files to \$INFORMIXDIR/etc/

Or

Create client.kdb and client.ssth 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
<b>cm-2</b>	<b>0/1</b>	<b>Running</b>	<b>0</b>	<b>53s</b>
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
<b>informix-2</b>	<b>1/1</b>	<b>Running</b>	<b>0</b>	<b>2m</b>

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.
# StatefulSet get predictable hostnames, and external storage is bound
# to the pods within StatefulSets for the life.
# Replica count configures 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 kubernetes persistent volume claims.

volumeClaimTemplates refers to dynamic provisioning feature of kubernetes 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.
# Replica count configures the number of CM containers/pods.
#
  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:

```
#
# 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 service 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
```