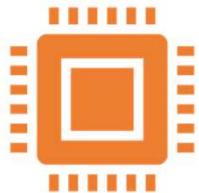


Lesson 1 : Application High Availability with Kubernetes

Describe how Kubernetes tries to keep applications running after failures.

Concepts of Deploying Highly Available Applications



Goal: make applications more robust and
resistant to runtime failures, and
subsequently disrupt business services / user
transactions



**In general, HA protect
application from failing due to**

- application bugs
- networking issues
- cluster resources exhausted
- memory leak

Writing Reliable Applications

- Cluster-level HA mitigates worst-case scenarios
- HA not substitution for fixing application-level issues
- Aim for reliability; application security is separate concern
- Applications work with k8s cluster to handle failure scenarios:
 - Tolerates restarts
 - Responds to health probes (startup, readiness, liveness probes)
 - Support multiple simultaneous instances
 - Has well-defined and well-behaved resources usage
 - Operate with restricted privileges
- Example 1: Most HTTP-based application provide endpoint to verify application health. Configure probe to observe this endpoint
- Example 2: Application respond with healthy status only when database is reachable.

Kubernetes Application Reliability

- Application crash → POD crash
- Application crash → POD still running
- POD running → Application not ready (delay, misconfigure)
- Application and POD still running, but missing important file/directory
- Kubernetes – HA technique to improve application reliability:
 - Restart policy: Never, Always, OnFailure
 - Probing: using health probes, cluster can check all the path-to-directory/IP/routing/permission is working
 - Horizontal scaling: when surge in demands, cluster can scale up number of replicas

Guided Exercise: Application High Availability with Kubernetes

You should be able to:

- Explore how the restartPolicy attribute affects crashing pods.
- Observe the behavior of a slow-starting application that has no configured probes.
- Use a deployment to scale the application, and observe the behavior of a broken pod.

Lesson 2 : Application Health Probes

Describe how Kubernetes uses health probes during deployment, scaling, and failover of applications.

Kubernetes Probes

- Enable cluster to determine status of application
- Repetitively probe for response
- Use case scenarios:
 - Crash mitigation by automatically attempting to restart failing pods
 - Failover and load balancing by sending requests only to healthy pods
 - Monitoring by determining whether and when pods are failing
 - Scaling by determining when new replica is needed to process increase requests

Authoring Probe Endpoints

- Endpoints determine health and status of application
- Application developers write code to generate health probe endpoint
 - `https://<application-name>:8080/healthz`
 - Application report successful health probe only if it can connect to configured database
- Endpoint best practice design
 - quick to perform
 - should not execute complex queries or
 - too many network calls

Probe Types

- **Readiness Probes** Determines whether the application is ready to serve requests.
- **Liveness Probes** Determine whether the application container is in a healthy state.
- **Startup Probes** Determines when an application's startup is completed.

Readiness Probes

- Called throughout lifetime of application.
- Determines whether the application is ready to serve requests.
- If the readiness probe fails, then Kubernetes remove the pod's IP address from the service resource.
- Help detect temporary issues that might affect your applications.

For example:

- application might be temporarily unavailable when it starts, because it must *establish initial network connections, load files in a cache, or perform initial tasks that take time to complete*.
- application might occasionally need to run long batch jobs, which make it temporarily unavailable to clients.

Liveness Probes

- Called after application's initial start process and throughout lifetime of application
- Determine whether the application container is in a healthy state.
- **If an application fails its liveness probe enough times, then the cluster restarts the pod** according to its restart policy

For example:

- Detect deadlock (application is running, but unable to make progress)
- Pod appear to be running, application code is not function correctly

Startup Probes

- Determines when an application's startup is completed.
- is not called after the probe succeeds.
- Liveness and readiness probes do not start until startup probe succeeds.
- **If the startup probe does not succeed** after a configurable timeout, then the **pod is restarted** based on its restartPolicy value.

For example:

- Applications with a long start time.

Type of Tests

When defining probe, must specify one of following types to perform the test

- **HTTP GET** Each time that the probe runs, the cluster sends a request to the specified HTTP endpoint. The test is considered a success if the request responds with an HTTP response code between **200 and 399**. Other responses cause the test to fail.
- **Container command** Each time that the probe runs, the cluster runs the specified command in the container. If the command exits with a **status code of 0**, then the test succeeds. Other status codes cause the test to fail.
- **TCP socket** Each time that the probe runs, the cluster attempts to open a socket to the container. The test succeeds only if the **connection is established**

Timings and Thresholds

- All probes include timing variables: periodSeconds and failureThreshold
- **periodSeconds** specifies the frequency of running probes in interval of seconds
- **failureThresholds** define how many failed attempts before probe considered failed

Example: failureThresholds: 3; periodSeconds: 5

- scenario 1: After 15 seconds, if all probes don't get response then probe considered failed
- scenario 2: After 10 seconds, if third probe get response then probe succeeded

- Too short period can cause resources wastage
- Too few probes: false alarm, or may not be accurately gauge the situation

Adding Probes using YAML manifest file

```
apiVersion: apps/v1
kind: Deployment
...output omitted...
spec:
...output omitted...
  template:
    spec:
      containers:
        - name: web-server
          ...output omitted...
          livenessProbe: ①
            failureThreshold: 6 ②
            periodSeconds: 10 ③
            httpGet:
              ④
                path: /health ⑤
                port: 3000 ⑥
```

1. Defines a liveness probe.
2. Specifies how many times the probe must fail before mitigating.
3. Defines how often the probe runs.
4. Sets the probe as an HTTP request and defines the request port and path.
5. Specifies the HTTP path to send the request to.
6. Specifies the port to send the HTTP request over.

Can add to individual pod or deployment

Adding Probes using oc set probe command

```
[user@host ~]$ oc set probe deployment/front-end \
--readiness \ ①
--failure-threshold 6 \ ②
--period-seconds 10 \ ③
--get-url http://:8080/healthz ④
```

1. Defines a readiness probe.
2. Sets how many times the probe must fail before mitigating.
3. Sets how often the probe runs.
4. Sets the probe as an HTTP request, and defines the request port and path.

Adding Probes using Web Console

1. Navigate to **Workloads**
2. Select **Deployments or Pods**
3. Actions → **Add Health Checks**

Project: metallb-system ▾

Deployments

Create Deployment

Name	Status	Labels	Pod selector
controller	1 of 1 pods	app=metallb app.kubernetes.io/managed-by=Helm app.kubernetes.io/version=v0.0.0 component=controller helm.sh/chart=metallb-0.0.0	app=metallb, component=controller
metallb-operator-controller-manager	1 of 1 pods	olm.deployment-spec-h...=55d7966... olm.o...=metallb-operator:4.12.0-202... olm.owner.kind=ClusterServiceVersion	control-plane=controller-manager

Project: metallb-system ▾

Deployments > Deployment details

D controller

Managed by metallb

Actions ▾

- Edit Pod count
- Add PodDisruptionBudget
- Pause rollouts
- Restart rollout
- Add Health Checks**
- Add storage
- Edit update strategy
- Edit resource limits
- Edit labels

Details Metrics YAML ReplicaSets Pods Environment Events

Deployment details

1 Pod

Name: controller

Update strategy: RollingUpdate

Guided Exercise: Application Health Probes

You should be able to:

- Observe potential issues with an application that is not configured with health probes.
- Configure startup, liveness, and readiness probes for the application.

Lab:
Deploy Managed and
Networked
Applications on
Kubernetes

You should be able to:

- Deploy a MySQL database from a container image.
- Deploy a web application from a container image.
- Configure environment variables for a deployment.
- Expose the web application for external access.

Quiz 1

Which method for creating container images is recommended by the containers community?

- a) Run commands inside a basic OS container, commit the container, and save or export it as a new container image.
- b) Run commands from a Dockerfile and push the generated container image to an image registry.
- c) Create the container image layers manually from tar files.
- d) Run the podman build command to process a container image description in YAML format.

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Quiz 2

What are two advantages of using the standalone S2I process as an alternative to Dockerfiles? (Choose two.)

- a) Requires no additional tools apart from a basic Podman setup.
- b) Creates smaller container images, having fewer layers.
- c) Reuses high-quality builder images.
- d) Automatically updates the child image as the parent image changes (for example, with security fixes).

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Quiz 3

What are two typical scenarios for creating a Dockerfile to build a child image from an existing image? (Choose two.)

- a) Adding new runtime libraries.
- b) Setting constraints to a container's access to the host machine's CPU.
- c) Adding internal libraries to be shared as a single image layer by multiple container images for different applications.
- d) Creates images compatible with OpenShift, unlike container images created from Docker tools.

Quiz 3

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- a) Creates images compatible with OpenShift, unlike container images created from Docker tools.

Layering Image

- Applicable to other INSTRUCTIONS

```
LABEL version="2.0" \
    description="This is an example container image" \
    creationDate="01-09-2017"
```

```
ENV MYSQL_ROOT_PASSWORD="my_password" \
    MYSQL_DATABASE "my_database"
```

```
EXPOSE 8080, 9090, 9191
```

Chapter Summary

In this chapter, you learned:



Dockerfile contains instructions that specify how to construct a container image.



The Source-to-Image (S2I) process provides an alternative to Dockerfiles. S2I implements a standardized container image build process for common technologies from application source code. This allows developers to focus on application development and not Dockerfile development.



Container images provided by Red Hat Container Catalog or Quay.io are a good starting point for creating custom images for a specific language or technology.



Building an image from a Dockerfile using a three-step process

You should be able to:

- Create network policies to control communication between pods.
- Verify ingress traffic is limited to pods.

You should be able to:

- Modify a secret to add htpasswd entries for new users.
- Configure a new project with role-based access controls and resource quotas.
- Use an OperatorHub operator to deploy a database.
- Create a deployment, service, and route for a web application.
- Troubleshoot an application using events and logs.

In this chapter, you learned:



The OpenShift web console provides a GUI for visualizing and managing OpenShift resources.



Some resources feature a specialized page that makes creating and editing resources more convenient than writing YAML by hand, such as the Edit Key/Value Secret editor, which automatically handles Base64 encoding and decoding.



You can install partner and community operators from the embedded OperatorHub page.



Cluster-wide metrics such as CPU, memory, and storage usage are displayed on the Dashboards page.



Project Details pages display metrics specific to the project, such as the top ten memory consumers by pod and the current resource quota usage.