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Deploying a Spring Boot microservice in Kubernetes using Helm charts

1. Roadmap

One of the things that I love most about programming is the feeling it causes to see how your creation comes to life when you run the program. We have gone through a process in which we have learned to develop the necessary tools at this point in order to bring our code to life.

In this article, the main objective is not to analyze in detail the concepts and main aspects of the technologies that are used, such as Kubernetes and Helm. I just hope that you have come up with a general idea of each one, we are going to show you the main issues that we are going to make use. In any case, we mention some sites and blogs that can be used to deepen your knowledge.

We are going to support on what we learned in the previous articles.

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Spring Boot: Enable Kubernetes probes endpoints
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2. Environment

The commands used in this article were executed a WSL 2 environment with an Ubuntu distribution. Here we can see the details of the OS version.

```
$ lsb_release -a
No LSB modules are available.
Distributor ID: Ubuntu
Description:    Ubuntu 20.04.3 LTS
```

kubectl

The Kubernetes command line tools, kubectl, will allow us execute commands against the cluster to deploy the applications, inspect and manage the cluster resources and view the logs. The client version used is v1.23.4 and the Kubernetes server version is v1.22.5.

Helm

Helm is a CNCF project, it works as Kubernetes package manager to install and update the most complex applications. In a simple and easy way we can maintain the definition of the application resources through YAML templates. A Helm chart is a bundle of all Kubernetes objects like Services, Deployments, Ingress and Persistent Volume Claims, with the necessary information to create an instance of a Kubernetes application. A *release* is an instance of a chart application.

Helm persists release metadata in Secrets (default) or ConfigMaps resources, stored in the Kubernetes cluster. Every time your release changes, it appends that to the existing data. This provides Helm with the capability to rollback to a previous release. Artifact Hub is an open source project where you can find a lot of chart repositories.

```
$ helm version --template 'Version:{{.Version}}, GoVersion:{{.GoVersion}}
Version:v3.8.0, GoVersion:go1.17.5
```

3. Helm chart

Lets start applying all these ideas to see how they work and interact with each other. The Helm chart is the first thing we need, the only parameter used is the name of the chart *springboot-starterkit-svc* and the new directory is created with the default directories and files structure.

```
$ helm create springboot-starterkit-svc
Creating springboot-starterkit-svc
```

Chart.yaml

This is a required file that contains the information about the chart like the API version, name, application version, dependencies, range of compatible Kubernetes version, etc.

Lets set the name of the chart application like *springboot-starterkit-svc* and the version of the chart to *0.1.2*. The appVersion value is reference in d*eployment.yaml* file as the image tag used to create the containers in the Kubernetes cluster.

```
apiVersion: v2

name: springboot-starterkit-svc

description: A Helm chart for Kubernetes

type: application

version: 0.1.2

appVersion: "latest"
```

values.yaml

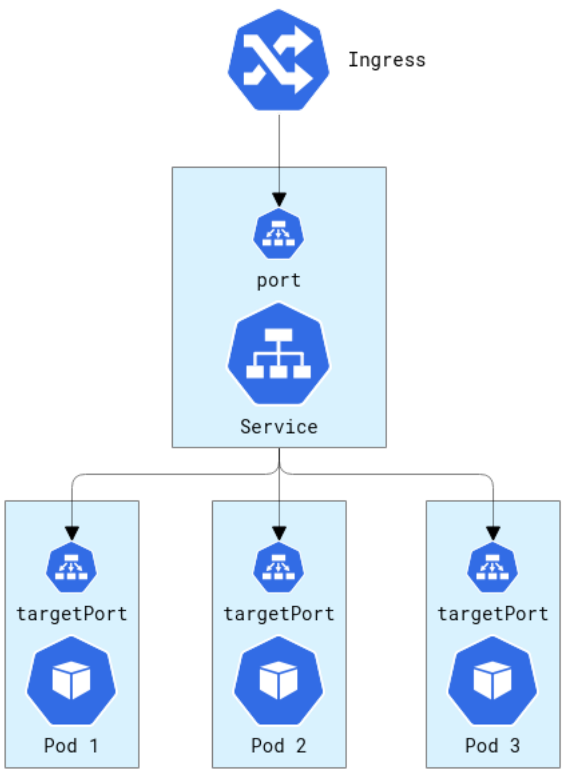
The default configuration values for the chart are declared here . Lets talk about the principal configurations of the chart below.

```
replicaCount: 3
image:
  repository: josephrodriguez/springboot-starterkit
  pullPolicy: Always
```

```
    targetPort: 8080

  ingress:
    enabled: true
    annotations:
      kubernetes.io/ingress.class: nginx
      kubernetes.io/tls-acme: "true"
    hosts:
      - host: springboot.starterkit.local
        paths:
        - path: /
          pathType: Prefix
          backend:
            serviceName: springboot-starterkit-svc
            servicePort: 80
```

- ***replicaCount***: Correspond to the number of pod instances to create for the application. Here the "one-container-per-Pod" model is used to create pods as wrapper around the single container. Helm will create a ReplicaSet resource on the Kubernetes cluster in order to keep a stable set of replica pods running at every time.
- ***image***: The source registry for the container image name and tag can be specified in this scope, also the Kubernetes pull policy. Every time that kubelet launches a container, queries to the image repository to resolve the image name to image digest. In case it does not contain a container image with that exact digest cached locally, kubelet pulls the image with the same digest, and use it to launch the container.
- ***service:*** Pods in Kubernetes are nonpermanent resources in the cluster, they are destroyed and created continually to match the cluster state. Kubernetes dynamically assigns each pod an IP address when it is created. Like the set of pods in an application can change over time, here is when enter the concept of Service. Service is a Kubernetes API object, it is an abstraction for a logical group of Pods. Clients in the cluster call the Service using the cluster IP address and the TCP port 80 specified in the *port* field in the manifest document. This request is forwarded to the *targetPort* of one Pod member of the service that match with the service selector. The selected pod have the container application instance that is listening on the port 8080.



Incoming requests to Service port is mapped to TCP targetPort of any Pod of the service endpoint 80 of the Service with name *springboot-starterkit-svc*.

deployment.yaml

Kubernetes Deployment resources are useful to declare the desire state for ReplicaSets and Pods. This is the first manifest template that we use on our application. Helm creates a Deployment resource with the specifications from this file.

The Pod Template define the structure of the pod, a single container is created with the image and tag values on *image.repository* and *Chart.AppVersion* respectively.

```
containers:
        - name: {{ .Chart.Name }}
          securityContext:
            {{- toYaml .Values.securityContext | nindent 12 }}
          image: "{{ .Values.image.repository }}:{{ .Values.image.tag | default .Chart.AppVersion }}"
          imagePullPolicy: {{ .Values.image.pullPolicy }}
          ports:
            - name: http
              containerPort: {{ .Values.service.targetPort }}
              protocol: TCP
          livenessProbe:
            httpGet:
              path: /actuator/health/liveness
              port: http
          readinessProbe:
            httpGet:
              path: /actuator/health/readiness
              port: http
          resources:
            {{- toYaml .Values.resources | nindent 12 }}
```

Now, we can understand how are used the exposed Kubernetes probes endpoints, like we see in this article. The kubelet use this liveness endpoint to know the status of the container and restart it if is needed. In the same way, the readiness endpoint is used to know when a container is ready to accept incoming traffic. A Pod will become ready when all of its containers are ready, for this application, the pod will become ready when its only container is.

4. GitHub Actions in action

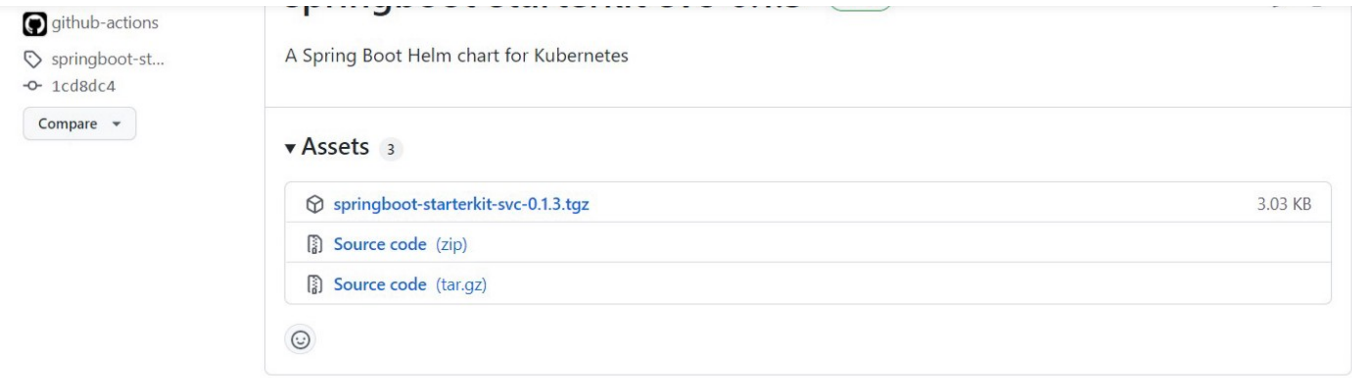
At this step, we have the Helm chart already configured for our deployment, so we created the springboot-helm-charts GitHub repository. You all know that I'm an open fan of the continuous integration and deployment with GitHub Actions, so it is valid to ask yourself: if I already have my Helm chart configured in a GitHub repository, will is there an GitHub Action that allows me create the Helm releases with a version update of the chart?

And the answer is: Yes!!!!!. I found Chart Releaser Action, excellent and easy to configure, allows us to achieve exactly what we need. This installation guide provides detailed information for its correct configuration, which goes through the following steps:

- Enable and configure GitHub Pages on the Helm charts repository.
- Ensure that charts definitions are under the /charts folder.
- Configure the GitHub workflow using helm/chart-releaser-action.
- Configure *dependabot* to keep using the latest version of the action. (Optional)

Only with the intention of testing if it works, lets update the version attribute on *Chart.yaml* file to 0.1.3 and voilá!!!!!, the GitHub Action does its magic. A new release is created for the Helm chart, you can see the complete log of the build here.

Each GitHub release artifact consists of two compressed files *Source code.zip* and *Source code.tar.gz* with the source code of the repository and the compressed chart release, in this case for example, springboot-starterkit-svc-0.1.3.tgz. You able to check the complete list of Helm releases here.



5. Install the Ingress controller

Install NGINX Ingress Controller to support the routing traffic from outside cluster to the deployed service. It is recommended to install the ingress controller in a different namespace than the one used to install the deployment's Kubernetes objects. Also you can use this guide using Helm or using YAML manifests with *kubectl apply* command.

Inspecting the namespace we can see the LoadBalancer service running and listening by 80 and 443 ports.

```
$ kubectl get service -n ingress-nginx
NAME                      TYPE          CLUSTER-IP      EXTERNAL-IP
ingress-nginx-controller  LoadBalancer  10.108.212.64   localhost
```

6. Helm in action

This is the moment we have been waiting for since the beginning of the article. These are the quick and easy steps to run the Spring Boot application with Helm, you won't believe it.

First, lets add the chart repository on Helm, the first parameter is the name of the repository and the second is the repository url.

```
$ helm repo add springboot https://josephrodriguez.github.io/springboot-helm-charts

"springboot" has been added to your repositories
```

There is a very useful option for this command, — *dry-run*, to simulate the install process rendering the full information of Kubernetes objects.

```
$ helm install springboot-starterkit-svc springboot/springboot-starterkit-svc --dry-run
```

We are ready to install the chart release archive built with Chart Releaser Action on GitHub. The first argument is the name *springboot-starterkit-svc* and the second is the chart using the repository name as part of the path.

```
$ helm install springboot-starterkit-svc springboot/springboot-starterkit-svc

NAME: springboot-starterkit-svc
LAST DEPLOYED: Mon Feb 28 20:12:46 2022
NAMESPACE: default
STATUS: deployed
REVISION: 1
TEST SUITE: None
NOTES:
1. Get the application URL by running these commands:   http://springboot.starterkit.local/
```

So far, everything is good

expected we have the three pod replicas.

```
$ kubectl get pods
NAME                                            READY   STATUS   RESTARTS springboot-starterkit-svc-7cd4657ddb-
514t4   1/1    Running   0        springboot-starterkit-svc-7cd4657ddb-7zxfq   1/1    Running   0
springboot-starterkit-svc-7cd4657ddb-9rl7r   1/1    Running   0
```

The output of the following commands was truncated only to show the relevant information that we need. Lets find the IP address of every pod instance.

```
$ kubectl describe pods/springboot-starterkit-svc-7cd4657ddb-514t4

Name:         springboot-starterkit-svc-7cd4657ddb-514t4
Namespace:    default
Status:       Running
IP:           10.1.0.213
IPs:
  IP:         10.1.0.213

$ kubectl describe pods/springboot-starterkit-svc-7cd4657ddb-7zxfq

Name:         springboot-starterkit-svc-7cd4657ddb-7zxfq
Namespace:    default
Status:       Running
IP:           10.1.0.212
IPs:
  IP:         10.1.0.212

$ kubectl describe pods/springboot-starterkit-svc-7cd4657ddb-9rl7r

Name:         springboot-starterkit-svc-7cd4657ddb-9rl7r
Namespace:    default
Status:       Running
IP:           10.1.0.214
IPs:
  IP:         10.1.0.214
```

There are three pods controlled by the same instance of *ReplicaSet* with IP addresses, 10.1.0.212, 10.1.0.213 and 10.1.0.214. Every one of them expose the HTTP port 8080 which is mapped to the container port inside the pod.

Lets search and inspect the Service instance in the cluster.

```
$ kubectl get service

NAME                        TYPE        CLUSTER-IP       PORT(S) kubernetes                ClusterIP
10.96.0.1         443/TCP springboot-starterkit-svc   ClusterIP   10.106.248.184    80/TCP

$ kubectl describe service/springboot-starterkit-svc

Name:              springboot-starterkit-svc
Namespace:         default
Type:              ClusterIP
IP Family Policy:  SingleStack
IP Families:       IPv4
IP:                10.106.248.184
IPs:               10.106.248.184
Port:              http  80/TCP
TargetPort:        http/TCP
Endpoints:         10.1.0.212:8080,10.1.0.213:8080,10.1.0.214:8080
```

The Service instance have IP address 10.106.248.184 and expose the HTTP port 80. It balance the incoming requests among the pod endpoints 10.1.0.212:8080, 10.1.0.213:8080, and 10.1.0.214:8080 as we can confirm in Endpoints property.

created pod, *springboot-starterkit-svc-7cd4657ddb-q6rl5* with IP address 10.1.0.215.

```
$ curl -v -H "Host: springboot.starterkit.local" localhost/status
*   Trying 127.0.0.1:80...
* TCP_NODELAY set
* Connected to localhost (127.0.0.1) port 80 (#0)

> GET /status HTTP/1.1
> Host: springboot.starterkit.local
> User-Agent: curl/7.68.0
> Accept: */*

< HTTP/1.1 200
< Date: Tue, 01 Mar 2022 04:43:10 GMT
< Content-Type: application/json
< Connection: keep-alive
< X-Server-IP: 10.1.0.215
< X-Server-Name: springboot-starterkit-svc-7cd4657ddb-q6rl5

{"status":"running","datetime":"2022-03-01T04:43:10.887"}
```

The next request was handled for the first pod, *springboot-starterkit-svc-7cd4657ddb-7zxfq* with IP address *10.1.0.212*.

```
$ curl -v -H "Host: springboot.starterkit.local" localhost/status
*   Trying 127.0.0.1:80...
* TCP_NODELAY set
* Connected to localhost (127.0.0.1) port 80 (#0)

> GET /status HTTP/1.1
> Host: springboot.starterkit.local
> User-Agent: curl/7.68.0
> Accept: */*

< HTTP/1.1 200
< Date: Tue, 01 Mar 2022 04:44:16 GMT
< Content-Type: application/json
< Connection: keep-alive
< X-Server-IP: 10.1.0.212
< X-Server-Name: springboot-starterkit-svc-7cd4657ddb-7zxfq

{"status":"running","datetime":"2022-03-01T04:44:16.553"}
```

8. Conclusions

Helm is an excellent tool to keep it very close to us, which we cannot take our eyes off of it. Its simple operation for create, package and deploy applications on Kubernetes cluster makes it an attractive tool to master in depth.

This is only an introduction to the topic, if you want to learn in depth, you can read a very extended and detailed version of this article in my personal blog entry.

Extended Article: Deploying a Spring Boot application in Kubernetes using Helm charts

References

- NGINX Ingress Controller
- Chart Releaser Action to Automate GitHub Page Charts
- Tutorial: Turning A GitHub Repo Into A Helm Chart Repo
- Helm Charts — Kubernetes