OpenShift Serverless Deep Dive

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What we'll
discuss today

What is serverless?

Why is serverless important

OpenShift Serverless

Knative

Knative Components

Installation

Serverless Flow

Kourier (Ingress)

Knative Serving

Autoscale, HPA, HA

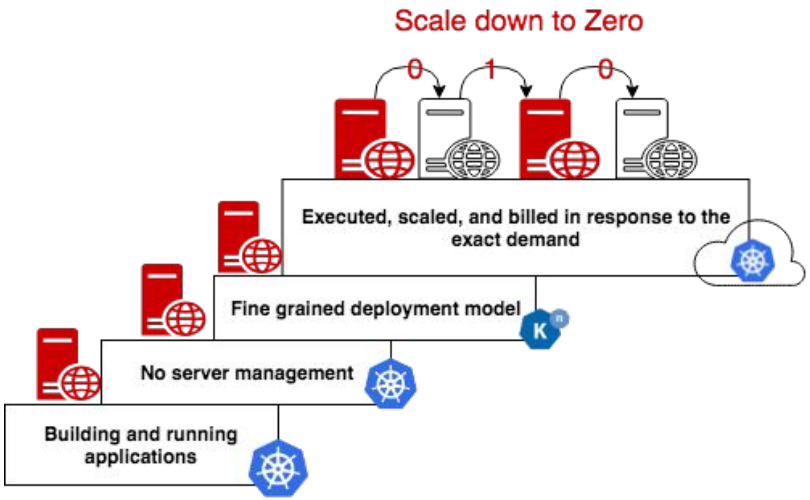
Traffic Splitting and Blue-Green Deployment

Knative Eventing

What is serverless?

Serverless is a deployment model that allows you to build and run applications without requiring deep insight into the underlying infrastructure. The idea is that the platform is ubiquitous and simply works. Developers can focus on writing code and determining where it needs to run without worrying about the infrastructure.

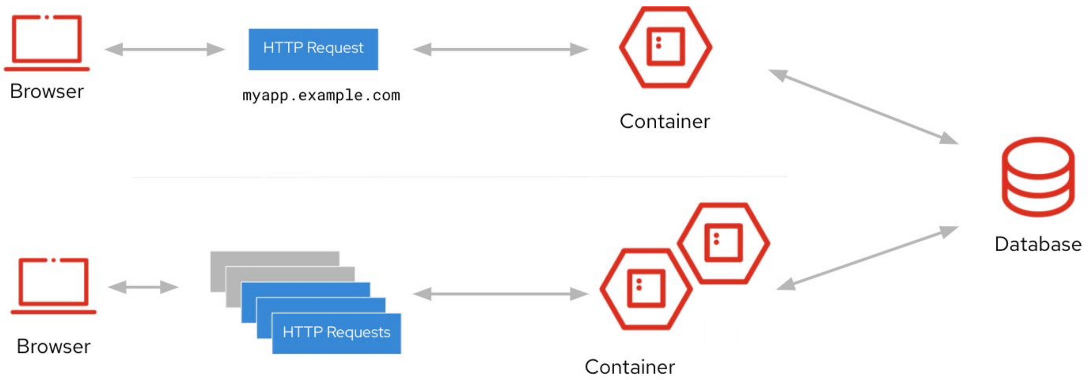
An event-driven serverless deployment makes it possible to run code and provision infrastructure only when necessary. That allows the application to be idle when it isn't needed. A serverless application will automatically scale up based on event-triggers in response to incoming demand, and is then able to scale to zero after use.

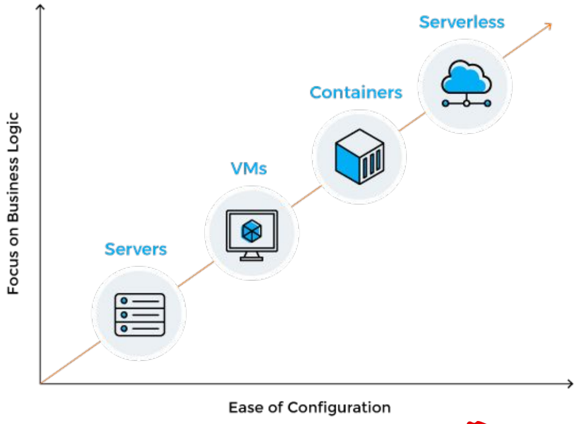


Why is serverless important?

The serverless model further unlocks the innovative power of Red Hat OpenShift. Serverless helps organizations innovate faster because the application is abstracted from the underlying infrastructure. Applications are packaged as OCI compliant containers that can be run anywhere, regardless of how they are written.

You can use any of these event triggers to run the application on demand. This structure makes it possible to deconstruct your monolithic application into individual containers, and let the application logic trigger each container, using incoming events to determine when to launch your application.





OpenShift Serverless

Developers can use Red Hat OpenShift Serverless to build, deploy and run event-driven applications that will start based on an event trigger, scale up resources as needed, then scale to zero after resource burst. With the power of Knative, Red Hat OpenShift Serverless applications can run anywhere Red Hat OpenShift is installed - on-premises, across multiple public cloud locations, or at the edge - all using the same interface.

OpenShift Serverless is based on the Knative project and supports almost any containerized application as it is designed to utilize many of the baseline features of OpenShift. Beyond auto-scaling for HTTP requests, you can trigger serverless containers from a variety of event sources and receive events such as Kafka messages, file upload to storage, timers for recurring jobs, and 100+ event sources like Salesforce, ServiceNow, email, etc, and is powered by Camel-K.

- deploying new application features or revisions
- performing canary
- A/B or blue-green testing with gradual traffic rollout

Knative

Knative is a Kubernetes-based platform to deploy and manage modern serverless workloads.

- Started as an **Open Source** Project mid-2018 by Google
- Community driven with a lot of vendor backing
  - https://knative.dev/
  - https://github.com/knative
  - https://slack.knative.dev/
  - Backed by Google, **Red Hat**, IBM and more
- Use Knative on **OpenShift**

  https://docs.openshift.com/container-platform/4.6/serverless/serverless-getting-started.html

Knative Components

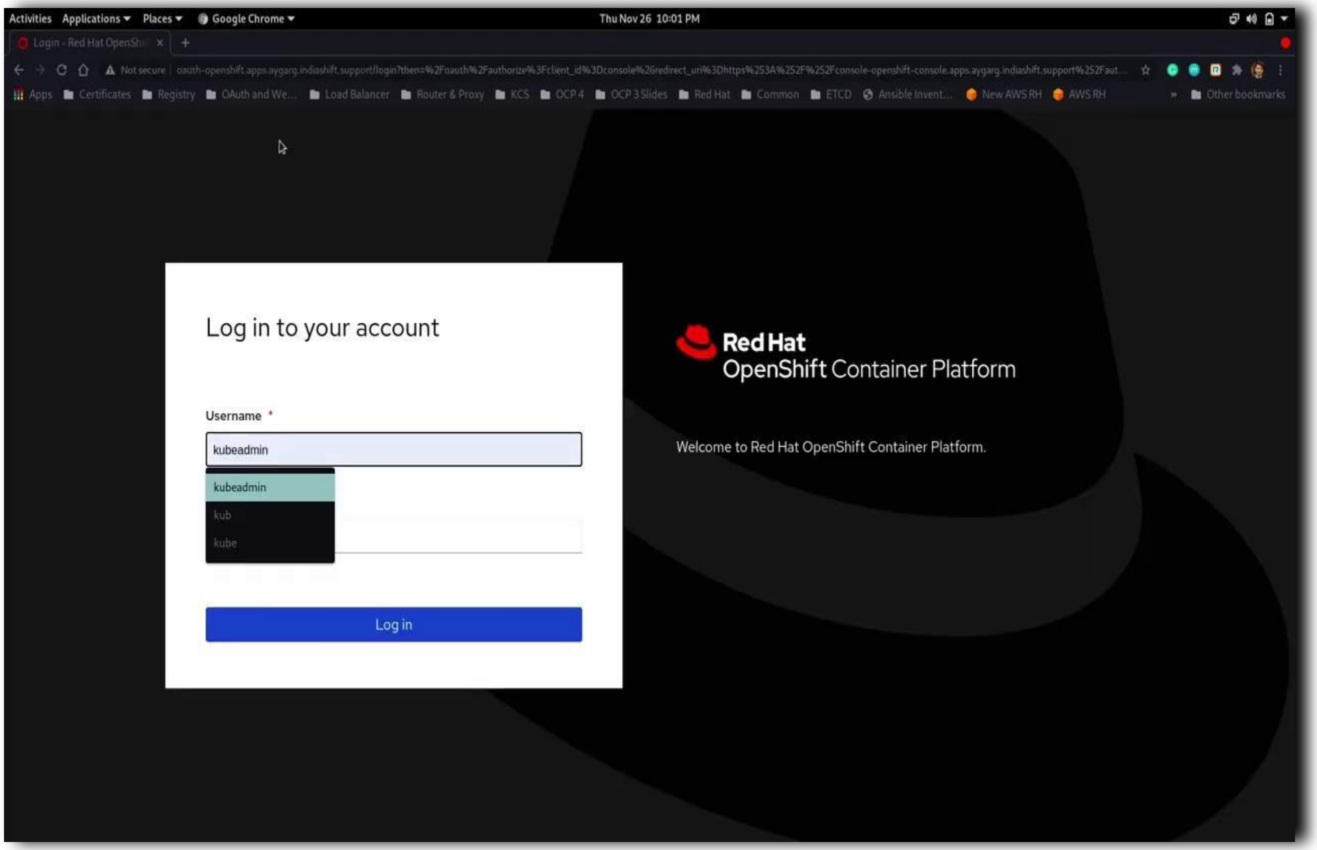
Serving

Run serverless containers on Kubernetes with ease, Knative takes care of the details of networking, autoscaling (even to zero), and revision tracking. You just have to focus on your core logic.

Eventing

Universal subscription, delivery, and management of events. Build modern apps by attaching compute to a data stream with declarative event connectivity and developer-friendly object model.

Installing OpenShift Serverless

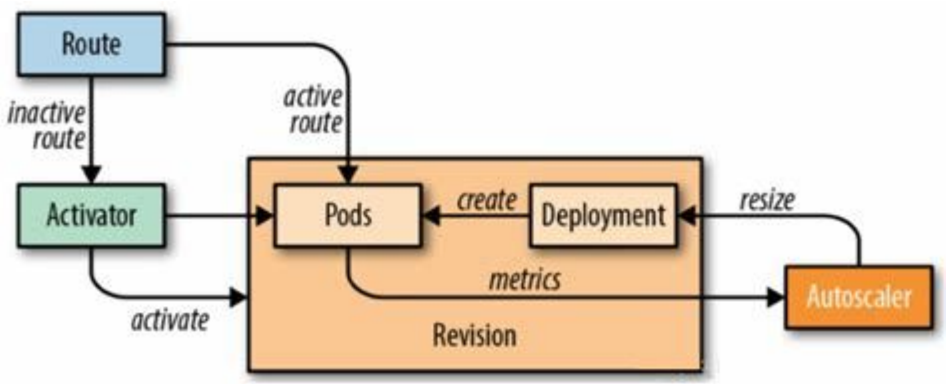


OpenShift Serverless Flow

After a defined time of idleness (called the stable-window) a revision is considered inactive, which causes a few things to happen. First off, all routes pointing to the now inactive revision will be pointed to the **activator**.

Its primary responsibilities are to receive and buffer requests for revisions that are inactive as well as report metrics to the autoscaler.

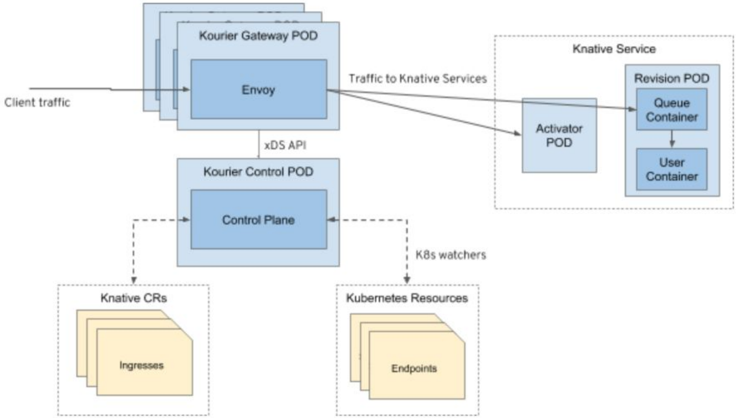
If we try to access the service while it is scaled to zero the activator will pick up the request(s) and buffer them until the Autoscaler is able to quickly create pods for the given revision.



Kourier: A lightweight Knative Serving ingress

Until recently, Knative Serving used Istio as its default networking component for handling external cluster traffic and service-to-service communication. Istio is a great service mesh solution, but it can add unwanted complexity and resource use to your cluster if you don’t need it. That’s why the Kourier: To simplify the ingress side of Knative Serving.

- **The Kourier gateway** is Envoy running with a base bootstrap configuration that connects back to the Kourier control plane.
- **The Kourier control plane** handles Knative ingress objects and keeps the Envoy configuration up to date.



When a new service is deployed in Knative Serving, it creates an Ingress object that contains information about how the service should be exposed.

Kourier subscribes to changes in ingresses that are managed by Knative Serving. Kourier is notified every time an ingress is created, deleted, or modified. When that happens, Kourier analyzes the information in the ingress and transforms the information into objects in an Envoy configuration.

```
bash
aygarg @ ayush-garg in ~ [06:34 PM]
$ oc get pod -n knative-serving-ingress
NAME                                        READY   STATUS    RESTARTS   AGE
3scale-kourier-control-685df54668-8vhs2     1/1     Running   0          41m
3scale-kourier-control-685df54668-h9tcq     1/1     Running   0          41m
3scale-kourier-gateway-7d49fc7d88-5rtk8     1/1     Running   0          3d20h
3scale-kourier-gateway-7d49fc7d88-jjqdw     1/1     Running   0          3d20h
aygarg @ ayush-garg in ~ [06:34 PM]
$
```

```
bash
aygarg @ ayush-garg in ~ [06:42 PM]
$ oc get cm/config-network -o yaml -n knative-serving | grep "ingress.class: kou
rier"
  ingress.class: kourier.ingress.networking.knative.dev
aygarg @ ayush-garg in ~ [06:42 PM]
$
```

Knative Serving Architecture

Knative Serving on OpenShift Container Platform enables developers to write cloud-native applications using serverless architecture. Serverless is a cloud computing model where application developers don't need to provision servers or manage scaling for their applications. These routine tasks are abstracted away by the platform, allowing developers to push code to production much faster than in traditional models.

Knative Serving supports deploying and managing cloud-native applications by providing a set of objects as Kubernetes Custom Resource Definitions (CRDs) that define and control the behavior of serverless workloads on an OpenShift Container Platform cluster. For more information about CRDs, see Extending the Kubernetes API with Custom Resource Definitions.

- Rapid deployment of serverless containers
- Automatic scaling up and down to zero
- Routing and network programming for Istio components
- Point-in-time snapshots of deployed code and configurations

Knative Serving CRDs

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- **Service:** The service.serving.knative.dev CRD automatically manages the life cycle of your workload to ensure that the application is deployed and reachable through the network. It creates a Route, a Configuration, and a new Revision for each change to a user created Service, or custom resource. Most developer interactions in Knative are carried out by modifying Services.
- **Revision:** The revision.serving.knative.dev CRD is a point-in-time snapshot of the code and configuration for each modification made to the workload. Revisions are immutable objects and can be retained for as long as necessary.
- **Route:** The route.serving.knative.dev CRD maps a network endpoint to one or more Revisions. You can manage the traffic in several ways, including fractional traffic and named routes.
- **Configuration:** The configuration.serving.knative.dev CRD maintains the desired state for your deployment. It provides a clean separation between code and configuration. Modifying a configuration creates a new Revision.

```
bash
aygarg @ ayush-garg in ~ [08:09 AM]
$ oc api-resources --api-group serving.knative.dev
NAME             SHORTNAMES      APIGROUP              NAMESPACED   KIND
configurations   config,cfg      serving.knative.dev   true         Configuration
revisions        rev             serving.knative.dev   true         Revision
routes           rt              serving.knative.dev   true         Route
services         kservice,ksvc   serving.knative.dev   true         Service
aygarg @ ayush-garg in ~ [08:10 AM]
$
```


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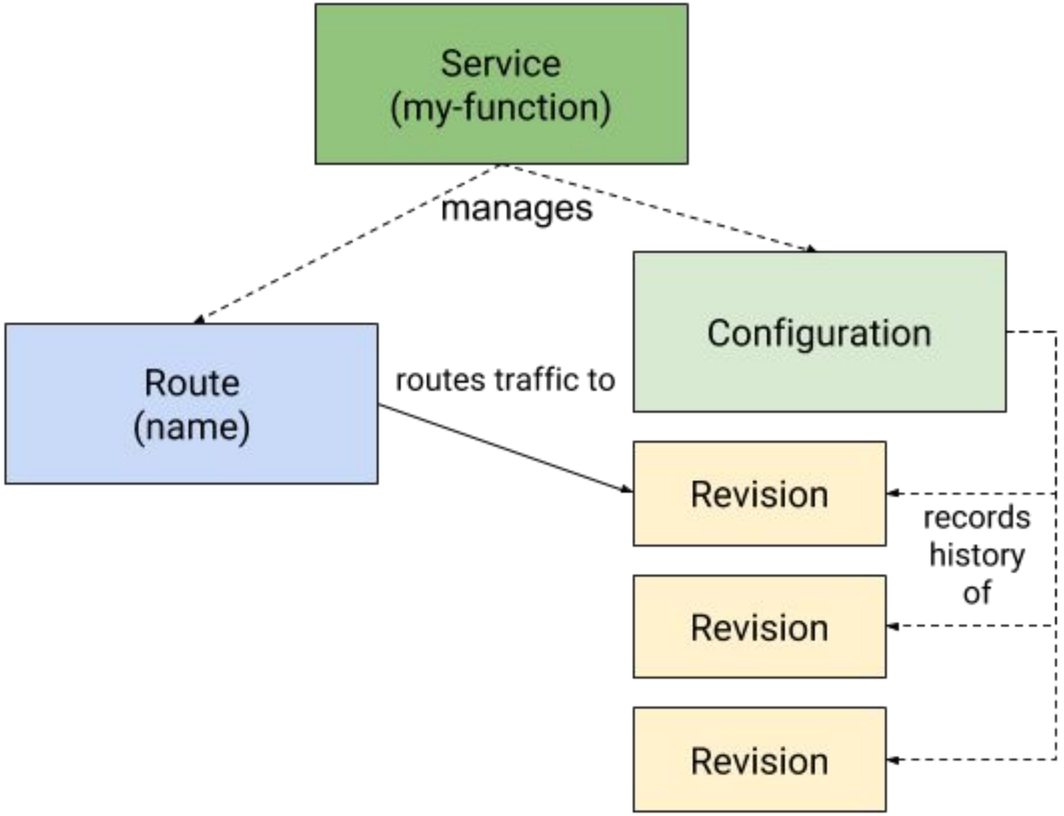
Service
(my-function)
manages
Route
(name)
routes traffic to
Configuration
Revision
records
history
of
Revision
Revision

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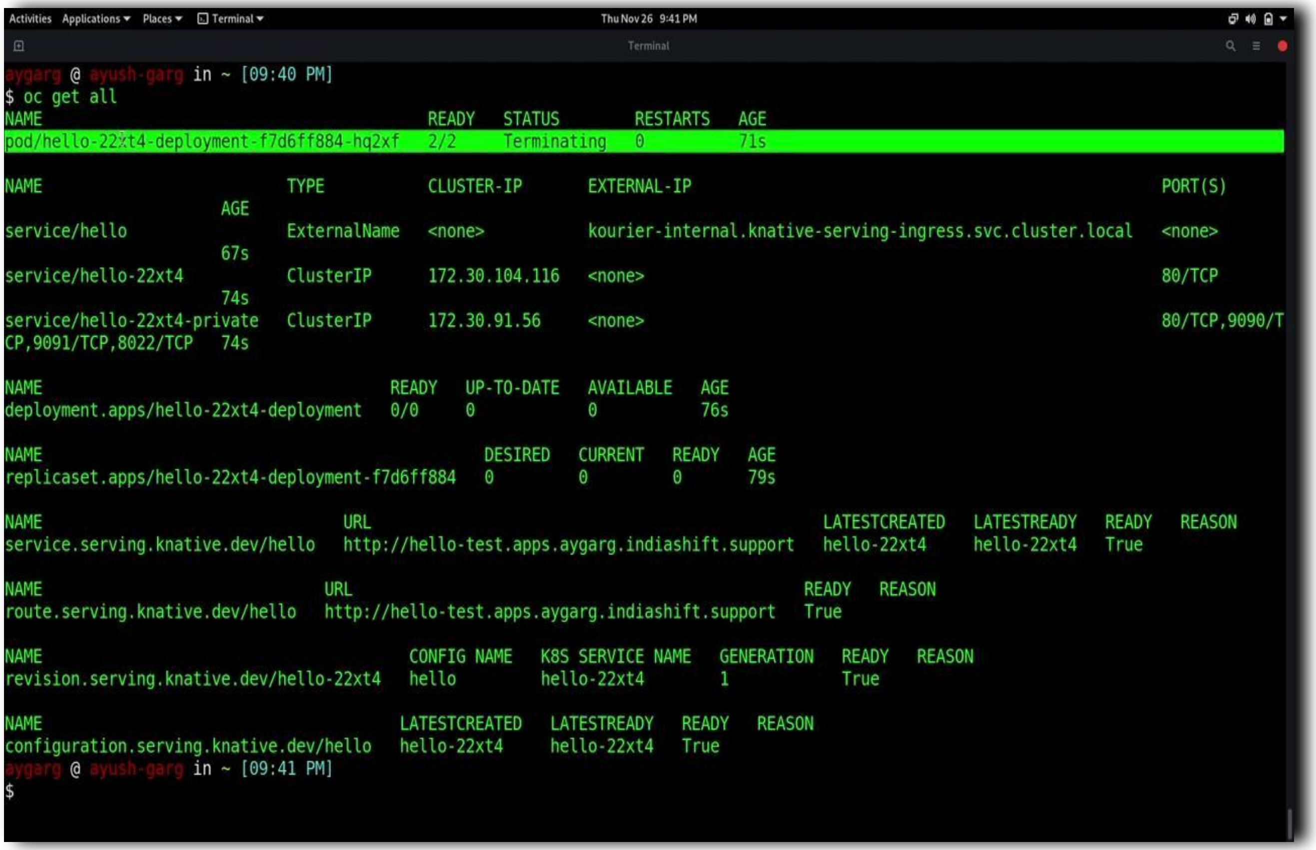
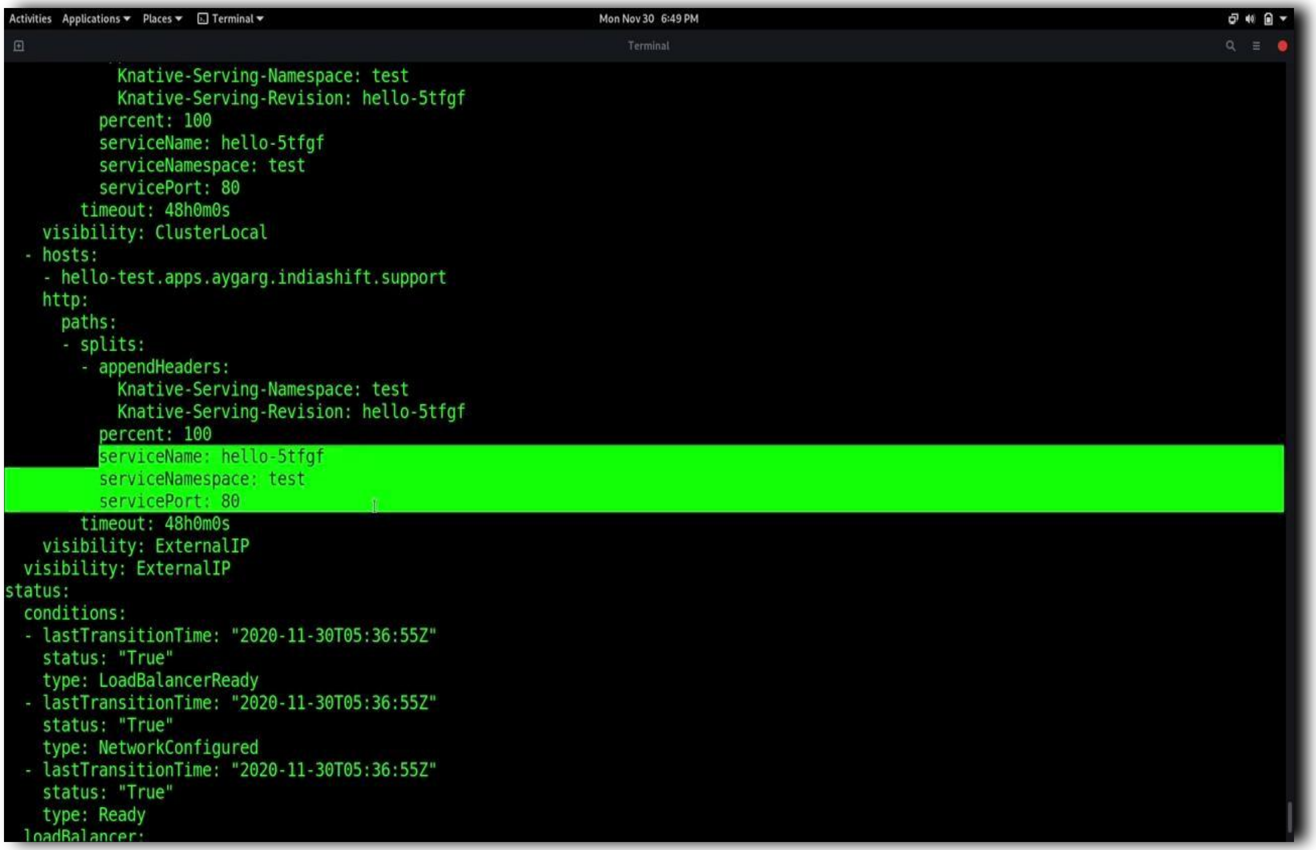
Hello-Serverless App



Knative Service Ingress Object



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Autoscaling

One of the main features of Knative is automatic scaling of replicas for an application to closely match incoming demand, including scaling applications to zero if no traffic is being received. Knative Serving enables this by default, using the Knative Pod Autoscaler (KPA). The Autoscaler component watches traffic flow to the application, and scales replicas up or down based on configured metrics.

Knative Pod Autoscaler (KPA)

- Part of the Knative Serving core and enabled by default once Knative Serving is installed.
- Supports scale to zero functionality.
- Does not support CPU-based autoscaling.

Horizontal Pod Autoscaler (HPA)

- Does not support scale to zero functionality.
- Supports CPU-based autoscaling.

Name	Status	Ready	Restarts	Owner	Memory	CPU	Created	
P autoscaler-6c64cc4b98-6xhs2	Running	1/1	0	RS autoscaler-6c64cc4b98	39.9 MiB	0.001 cores	Nov 26, 10:03 pm	⋮
P autoscaler-hpa-89698bf4d-nrfk8	Running	1/1	0	RS autoscaler-hpa-89698bf4d	26.3 MiB	0.000 cores	Nov 26, 10:03 pm	⋮
P autoscaler-hpa-89698bf4d-tm9mg	Running	1/1	0	RS autoscaler-hpa-89698bf4d	29.2 MiB	0.001 cores	Nov 26, 10:03 pm	⋮

Configuring the Autoscaler implementation

The type of Autoscaler implementation (KPA or HPA) can be configured by using the class annotation.

- **Global settings key:** `pod-autoscaler-class`
- **Per-revision annotation key:** `autoscaling.knative.dev/class`
- **Possible values:** `"kpa.autoscaling.knative.dev"` or `"hpa.autoscaling.knative.dev"`
- **Default:** `"kpa.autoscaling.knative.dev"`

Global (ConfigMaP)

```yaml
apiVersion: v1
kind: ConfigMap
metadata:
 name: config-autoscaler
 namespace: knative-serving
data:
 pod-autoscaler-class: "kpa.autoscaling.knative.dev"
```

Per Revision

```yaml
apiVersion: serving.knative.dev/v1
kind: Service
metadata:
  name: helloworld-go
  namespace: default
spec:
  template:
    metadata:
      annotations:
        autoscaling.knative.dev/class: "kpa.autoscaling.knative.dev"
    spec:
      containers:
        - image: gcr.io/knative-samples/helloworld-go
```

Metrics

The metric configuration defines which metric type is watched by the Autoscaler. For per-revision configuration, this is determined using the autoscaling.knative.dev/metric annotation. The possible metric types that can be configured per revision depend on the type of Autoscaler implementation you are using:

- The default KPA Autoscaler supports the `concurrency` and `rps` metrics.
- The HPA Autoscaler supports the `concurrency`, `rps` and `cpu` metrics.
- **Per-revision annotation key:** autoscaling.knative.dev/metric
- **Possible values:** `"concurrency"`, `"rps"` or `"cpu"`, depending on your Autoscaler type. The `cpu` metric is only supported on revisions with the HPA class.
- **Default:** `"concurrency"`

Per-revision concurrency configuration

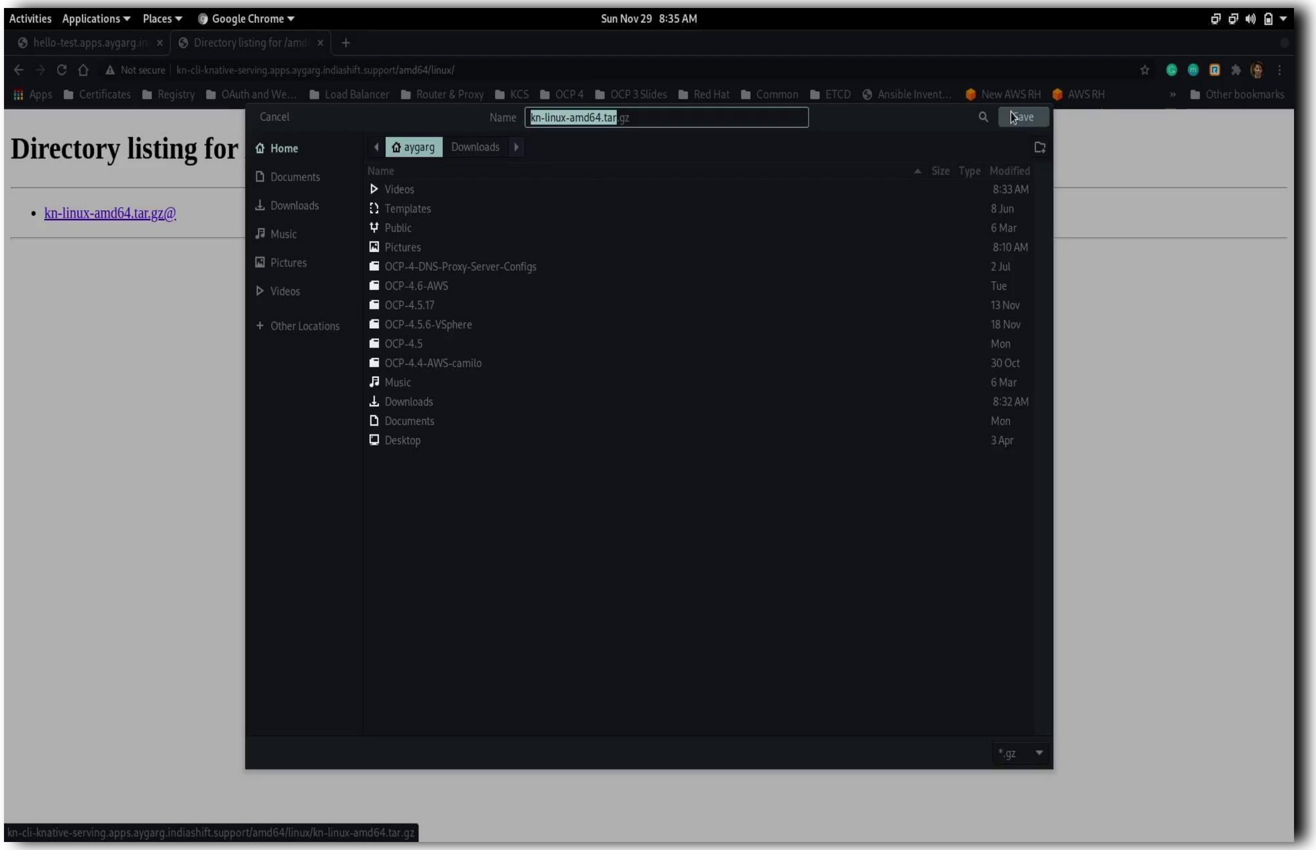
```yaml
apiVersion: serving.knative.dev/v1
kind: Service
metadata:
  name: helloworld-go
  namespace: default
spec:
  template:
    metadata:
      annotations:
        autoscaling.knative.dev/metric: "concurrency"
```

Per-revision cpu

```yaml
apiVersion: serving.knative.dev/v1
kind: Service
metadata:
  name: helloworld-go
  namespace: default
spec:
  template:
    metadata:
      annotations:
        autoscaling.knative.dev/metric: "cpu"
```

Autoscaler ConfigMap, Min-Max Pod, HPA and HA

Assigning Tag Revisions and Traffic Splitting



Setting up a custom domain

By default, Knative services have a fixed domain format:
→ <application_name>-<namespace>.<openshift_cluster_domain>

To change the default domain or add a new one, the “config-domain” CM needs to be modified.
→ $ oc edit cm config-domain --namespace knative-serving

```
apiVersion: v1
data:
  apps.aygarg.indiashift.support: ""
  custom.aygarg.indiashift.support: |
    selector:
      custom: domain
```

```
apiVersion: serving.knative.dev/v1
kind: Service
metadata:
  name: hello
  namespace: test
  labels:
    custom: domain
spec:
  template:
    spec:
      containers:
        - image: docker.io/openshift/hello-openshift
          env:
            - name: RESPONSE
              value: "Hello Serverless!"
```

Kourier Ingress LB

An ingress LB (loadbalancer type service) gets created for kourier inside the "knative-serving-ingress" namespace when the OpenShift Serverless operator is installed. However, the DNS records are not created for it and only "http" based traffic is accepted over it as no TLS certificates are there by default. Since the DNS records are not created for this LB, all the routes for serverless applications are served by the default OpenShift IngressController which sends the request to HAProxy pods first then to "kourier-gateway" pod.

Already deployed knative services can be accessed through that LB using the following curl command:

```
bash
aygarg @ ayush-garg in ~ [06:01 PM]
$ curl -H "Host: hello-test.apps.aygarg.indiashift.support" http://a090e7d10ea5
8438abd702454b5b7a09-383542004.us-east-1.elb.amazonaws.com
Hello Serverless!
aygarg @ ayush-garg in ~ [06:06 PM]
$
```

```
bash
$ oc get svc -n knative-serving-ingress
NAME                TYPE            CLUSTER-IP       EXTERNAL-IP
                                                 PORT(S)                     AGE
kourier             LoadBalancer    172.30.160.126   a090e7d10ea58438abd702454b5b
7a09-383542004.us-east-1.elb.amazonaws.com      80:30689/TCP,443:30210/TCP  18h
kourier-control     ClusterIP       172.30.18.104    <none>
                                                 18000/TCP                   18h
kourier-internal    ClusterIP       172.30.40.51     <none>
                                                 80/TCP                      18h
aygarg @ ayush-garg in ~ [06:01 PM]
$
```

Since the DNS records are not created for the kourier ingress LB and routes are served by default IngressController then the default HAProxy router pods become critical otherwise if the default OpenShift ingress goes down then the serverless routes won't be accessible.

As per the requirement, the DNS records can be created pointing to the new kourier ingress LB with respect to the cloud provider on which cluster is deployed. A wild-card DNS record can also be created pointing to the kourier ingress LB as the requests made by the routes to the LB contains the proper hostname in the host-header of the packet.

If the DNS record is created then the routes will be accessible over only the "http" protocol as there is no TLS certificate configured for the kourier ingress LB.

Configure TLS Certificate for Kourier Ingress

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```
$ openssl x509 -in ingress-cert/ayush.crt -text -noout
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            46:3e:f3:40:33:04:9a:d1:d2:db:3a:46:b6:91:32:d1:93:29:14:56
        Signature Algorithm: sha256WithRSAEncryption
        Issuer: CN = customCA
        Validity
            Not Before: Nov 29 13:59:12 2020 GMT
            Not After : Nov 29 13:59:12 2021 GMT
        Subject: CN = *.apps.aygarg.indiashift.support
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                RSA Public-Key: (2048 bit)
                Modulus:
                    00:df:81:dd:8d:75:da:58:36:d6:bb:38:1f:e6:55:
                    3c:61:0a:a0:03:f0:80:61:96:3c:7a:07:df:29:06:
                    3a:6a:b1:68:74:98:af:94:d5:3b:5f:e2:f6:d0:f4:
                    86:84:14:1b:d0:3a:88:1f:b7:96:4c:d2:5d:4e:a5:
                    6d:47:c3:cc:31:c8:d4:c0:93:85:82:f6:98:8e:de:
                    ff:94:2d:a3:15:d4:82:42:51:d8:aa:43:f9:a5:79:
                    17:ca:d4:0b:7c:5d:fb:73:fe:63:cb:a3:30:31:49:
                    95:3e:77:1c:89:00:85:89:1e:3a:80:98:85:80:83:
                    3f:0d:c1:77:e1:c4:e9:ae:fd:8d:81:32:78:30:cd:
                    70:f2:dd:56:1f:bc:c5:e4:ff:17:60:34:39:02:8f:
                    ba:3f:01:26:9e:4c:8f:bb:e2:7b:cc:ee:cd:ac:34:
                    85:13:3e:1d:79:25:b5:58:6a:45:92:99:3f:5c:6c:
                    8f:a6:5d:9c:a4:0a:c7:eb:75:44:63:ff:12:b8:6d:
                    8c:4a:b6:d0:ae:4a:7e:81:ad:d3:7a:9d:a9:2c:f5:
                    91:bc:3b:19:f9:b0:4b:bd:c3:b2:5e:34:01:76:54:
                    d9:4f:a6:2e:bf:20:34:64:2b:72:c9:cb:2b:8a:80:
                    b5:76:41:05:84:e5:c3:27:ec:cc:68:ee:74:5f:5d:
```


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Knative Eventing

Knative Eventing on OpenShift Container Platform enables developers to use an event-driven architecture with serverless applications. An event-driven architecture is based on the concept of decoupled relationships between event producers that create events, and event sinks, or consumers, that receive them.

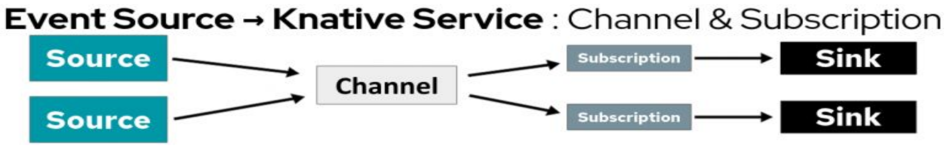
Knative Eventing uses standard HTTP POST requests to send and receive events between event producers and consumers. These events conform to the CloudEvents specifications, which enables creating, parsing, sending, and receiving events in any programming language.

OpenShift Serverless provides several mechanisms for building event-driven applications:

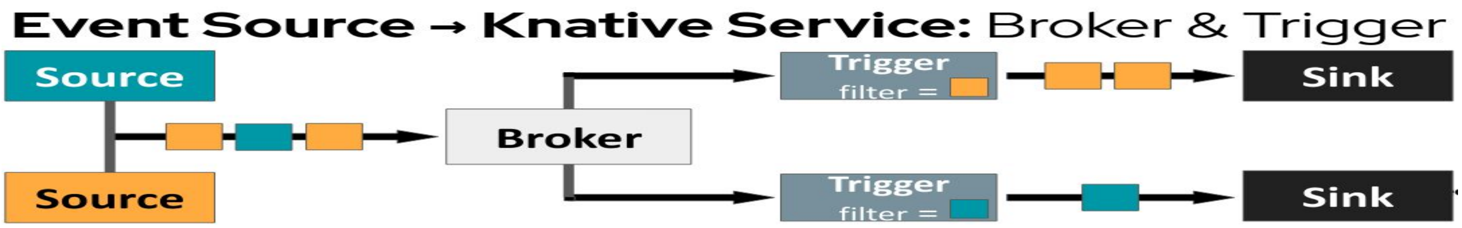
- Direct connections
- Channels and subscriptions
- Event filtering with brokers and triggers

Direct connections

Channels and subscriptions



Event brokers and triggers



Event Sources

An event source is an object that links an event producer with an event sink, or consumer. A sink can be a Knative service, channel, or broker that receives events from an event source.

- **ApiServerSource**
  Connects a sink to the Kubernetes API server.

- **PingSource**
  Periodically sends ping events with a constant payload. It can be used as a timer.

- **SinkBinding**
  Allows you to connect core Kubernetes resource objects such as a Deployment, Job, or StatefulSet with a sink.

- **KafkaSource**
  Connect a Kafka cluster to a sink as an event source.

PingSource Eventing Example

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```
Activities  Applications ▾  Places ▾  Terminal ▾          Mon Nov 30  11:46 PM
                                   Terminal
NAME                                         READY   STATUS    RESTARTS   AGE
event-display-d2tsv-deployment-67d84ff688-jsnqm   2/2     Running   0          22s
aygarg @ ayush-garg in ~ [11:44 PM]
$ oc get PingSource
NAME               SINK                                         AGE   READY   REASON
test-ping-source   http://event-display.test.svc.cluster.local   11s   True
aygarg @ ayush-garg in ~ [11:44 PM]
$ oc logs event-display-d2tsv-deployment-67d84ff688-jsnqm -c user-container
aygarg @ ayush-garg in ~ [11:45 PM]
$ oc logs -f event-display-d2tsv-deployment-67d84ff688-jsnqm -c user-container
rpc error: code = NotFound desc = could not find container "e587181335f003f30fefe862a3592bb34d0fea6b50c59d73b671e2f7d75d457a": container
 with ID starting with e587181335f003f30fefe862a3592bb34d0fea6b50c59d73b671e2f7d75d457a not found: ID does not existaygarg @ ayush-garg
in ~ [11:46 PM]
$ oc get pod
NAME                                              READY   STATUS        RESTARTS   AGE
event-display-d2tsv-deployment-67d84ff688-c564v   1/2     Running       0          5s
event-display-d2tsv-deployment-67d84ff688-jsnqm   0/2     Terminating   0          2m2s
aygarg @ ayush-garg in ~ [11:46 PM]
$ oc logs event-display-d2tsv-deployment-67d84ff688-c564v -c user-container
☁ cloudevents.Event
Validation: valid
Context Attributes,
  specversion: 1.0
  type: dev.knative.sources.ping
  source: /apis/v1/namespaces/test/pingsources/test-ping-source
  id: 33a6a500-14ee-4cd3-907c-4e34f6b72e0a
  time: 2020-11-30T18:16:00.000092805Z
  datacontenttype: application/json
Data,
  {
    "message": "Hello world!"
  }
aygarg @ ayush-garg in ~ [11:46 PM]
$
```


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