Alibaba Cloud Container Service for Kubernetes

Best Practices

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Generic conventions

Table -1: Style conventions

Style	Description	Example
•	This warning information indicates a situation that will cause major system changes, faults, physical injuries, and other adverse results.	Danger: Resetting will result in the loss of user configuration data.
	This warning information indicates a situation that may cause major system changes, faults, physical injuries, and other adverse results.	Warning: Restarting will cause business interruption. About 10 minutes are required to restore business.
	This indicates warning information, supplementary instructions, and other content that the user must understand.	Note: Take the necessary precautions to save exported data containing sensitive information.
	This indicates supplemental instructio ns, best practices, tips, and other content that is good to know for the user.	Note: You can use Ctrl + A to select all files.
>	Multi-level menu cascade.	Settings > Network > Set network type
Bold	It is used for buttons, menus, page names, and other UI elements.	Click OK .
Courier font	It is used for commands.	Run the cd /d C:/windows command to enter the Windows system folder.
Italics	It is used for parameters and variables.	bae log listinstanceid Instance_ID
[] or [a b]	It indicates that it is a optional value, and only one item can be selected.	ipconfig [-all/-t]
{} or {a b}	It indicates that it is a required value, and only one item can be selected.	<pre>swich {stand slave}</pre>

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1 Cluster

1.1 Update expired certificates of a Kubernetes cluster

When cluster certificates expire, communication with the cluster API server by using kubectl or calling APIs is disabled, and the expired certificates on cluster nodes cannot be updated automatically through template deployment. To update the certificates, you can log on to each cluster node and run the container stating commands, docker run.

Update the expired certificates on a Master node

- 1. Log on to a Master node with the root permission.
- **2.** Run the following command in any directory to update the expired certificates on the Master node:

```
$ docker run -it --privileged=true -v /:/alicoud-k8s-host --pid
host --net host \
  registry.cn-hangzhou.aliyuncs.com/acs/cert-rotate:v1.0.0 /renew/
upgrade-k8s.sh --role master
```

3. Repeat the preceding steps on each cluster Master node to update all the expired certificates.

Update the expired certificates on a Worker node

- 1. Log on to a Master node with the root permission.
- 2. Run the following command to obtain the cluster rootCA private key:

```
$ cat /etc/kubernetes/pki/ca.key
```

- **3.** Run either of the following commands to obtain the cluster root private key encoded through base64:
 - If the cluster rootCA private key has a blank line, run the following command:

\$ sed '1d' /etc/kubernetes/pki/ca.key| base64 -w 0

• If the cluster rootCA private key does not have any blank line, run the following command:

\$ cat /etc/kubernetes/pki/ca.key | base64 -w 0

- 4. Log on to a Worker node with the root permission.
- **5.** Run the following command in any directory to update the expired certificates on the Worker node.

```
\ docker run -it --privileged=true -v /:/alicoud-k8s-host --pid host --net host \setminus
```

```
registry.cn-hangzhou.aliyuncs.com/acs/cert-rotate:v1.0.0 /renew/
upgrade-k8s.sh --role node --rootkey ${base64CAKey}
```



In step 3, you have obtained \${base64CAKey}, which is the cluster root private key encoded through base64.

6. Repeat the preceding steps on each cluster Worker node to update all the expired certificates.

2 Application

3 Network

3.1 Deploy high-reliability Ingress Controller

In Kubernetes clusters, Ingress is a collection of rules that authorize the inbound access to the cluster and provide you with Layer-7 Server Load Balancer capabilities. You can provide the externally accessible URL, Server Load Balancer, SSL, and name-based virtual host. As the access layer of the cluster traffic, the high reliability of Ingress is important. This document introduces how to deploy a set of high-reliability Ingress access layer with good performance.

Prerequisites

- You have created a Kubernetes cluster. For more information, see *Create a Kubernetes cluster*.
- You have connected to the master node by using SSH. For more information, see *Access Kubernetes clusters by using SSH*.

High-reliability deployment architecture

To implement high reliability, the single point of failure must be solved first. Generally, the single point of failure is solved by deployment with multiple copies. Similarly, use the multi-node deployment architecture to deploy the high-reliability Ingress access layer in Kubernetes clusters. As Ingress is the access point of the cluster traffic, we recommend that you have the Ingress node exclusive to you to avoid the business applications and Ingress services from competing for resources.



As mentioned in the preceding deployment architecture figure, multiple exclusive Ingress instances form a unified access layer to carry the traffic at the cluster entrance and expand or contract the Ingress nodes based on the backend business traffic. If your cluster scale is not large in the early stage, you can also deploy the Ingress services and business applications in the hybrid mode, but we recommend that you limit and isolate the resources.



Instructions on deploying high-reliability Ingress access layer

- Ingress Server Load Balancer: The frontend Server Load Balancer instance of the Ingress access layer.
- Ingress node: The cluster node in which the Ingress pod is deployed.
- Ingress pod: The Ingress service.

The Ingress Server Load Balancer, Ingress node, and Ingress pod are associated based on the tag node-role.kubernetes.io/ingress=true:

- 1. The Ingress Server Load Balancer backend only mounts the cluster nodes with the tag noderole.kubernetes.io/ingress=true.
- The Ingress pod is only deployed to the cluster nodes with the tag node-role.kubernetes. io/ingress=true.

Step 1 Add a label for Ingress nodes

- 1. Log on to the Container Service console.
- 2. Under Kubernetes, click Clusters > Nodes in the left-side navigation pane.
- Select the cluster from the Cluster drop-down list. View the instance IDs of the worker nodes and then click Label Management in the upper-right corner.

Container Service	Node List					Refresh Label Manage	ment Scale Cluster	Add Existing Instance
Overview	Help: & Postpay instand	ce to Prepay				5		
Clusters	IP Address	Instance Type	Role	Instance ID/Name	Configuration	Operating System	Update Time	Action
Nodes 3	192.108.248.246	Alibaba Cloud Node	Master	Hellbehilldv60Lw68 km-for-ce-cadra	ecs.sn1ne.large	centos_7_04	05/10/2018,16:09:56	Monitor
 Application 	103.368.349.349	Alibaba Cloud Node	Worker	Hool dipugtamin villens 2009 kine für Kin-stad 73	ecs.sn1ne.large	centos_7_04	05/10/2018,16:09:56	Monitor
Deployment Pods	192.158.349.250	Alibaba Cloud Node	Worker	Hendpagkonnettaczógo: Miełan-co-cal/2	ecs.sn1ne.large	centos_7_04	05/10/2018,16:09:56	Monitor
Service Ingress	192.158.349.251	Alibaba Cloud Node	Worker	Hosdpuglommethicstigad kille-for-ca-cad??	ecs.sn1ne.large	centos_7_04	05/10/2018,16:09:56	Monitor
Release	202.268.249.248	Alibaba Cloud Node	Master	History (and the second	ecs.sn1ne.large	centos_7_04	05/10/2018,16:09:57	Monitor
 Store 	10.158349.247	Alibaba Cloud Node	Master	Hige accluding bit reference kite-for-ca-cad/3	ecs.sn1ne.large	centos_7_04	05/10/2018,16:09:57	Monitor

4. The Label Management page appears. Select the worker nodes and then click Add Tag. Add the label node-role.kubernetes.io/ingress : true to the worker nodes and then click OK.

Label Management 🔹 Back 🗷 Hide Default	Add		×		Refresh
Name	Name	node-role.kubernetes.io/ingress		IP Address	
Cn-hangzhou.i-bp://bigtacinity.est i.unit	Value	true		192.109.249.246	
Cn-hangzhou.i-bp12001aday560467807				130.158.349.247	
Cn-hangzhou.i-bpl.3cpltc978mma36hag			ose	982.158.248.348	
Cn-hanozhou.i-bp 100-unit managed				90.191.240.150	
Cn. Loui-bpl:da.gbmim@nocilgod				100.158.349.251	
Cn-hangzhou.i-bp				10.158.349.249	
Add Tag					

On the Label Management page, you can see the label is added to the worker nodes.

Label Management 🔄 ± Back Vert Hide Default			Refresh
Name	IP Address	Label	
Cn-hangzhou.i-bp:://doi.it.edu	192,065,249,248		
Cn-hangzhou.i-bp12:30480453761867	182.168.349.247		
Cn-hangzhou.i-bp	192.365.249.248		
cn-hangzhou.i-bp1 cn-hangzhou.i-bp1	183.168.349.230	node-role.kubernet : true 🛇	
cn-hangzhou.i-bp:	190.158.349.251	node-role.kubernet : true 🛇	
Cn-hangzhou.i-bp	201100.248.348	node-role.kubernet : true 🛇	
Add Tag			

You can also log on to the master node and run the command kubectl label no nodeID node-role.kubernetes.io/ingress=true to add the label to the worker nodes quickly.

Step 2 Create an Ingress service

- 1. Log on to the Container Service console.
- 2. Under Kubernetes, clickApplication > Deployment in the left-side navigation pane.
- Select the cluster from the Clusters drop-down list and kube-system from the Namespace drop-down list. Click **Delete** at the right of nginx-ingress-controller and then click OK in the displayed dialog box.

An Ingress Controller is deployed by default when the cluster is initialized. For more information, see *ingress-nginx*. You must delete the Ingress Controller deployed by default first and then deploy a new set of high-reliability Ingress Controller access layer.

Note:

The Ingress Controller deployed by default is associated with the nginx-ingress-lb service. Do not delete the associated service when deleting the deployment. The nginx-ingress-lb service is about to be updated later.

Container Service	Deployment				Create by image	Create by template	Refresh
Overview	Clusters test v Namespa	ce kube-system 🔻 🚺					
 Clusters 	Name	Tag	PodsQuantity	Time Created			Action
Clusters	alicloud-disk-controller	app:alicloud-disk-controller	1/1	05/10/2018,15:59:21		Details Update	e Delete
Nodes	default-http-backend	app:default-http-backend	1/1	05/10/2018,15:59:21		Details Update	e Delete
Storage Application	heapster	k8s-app:heapster task:monitoring	1/1	05/10/2018,15:59:21		Details Update	e Delete
Deployment	3 kube-dns	k8s-app:kube-dns	1/1	05/10/2018,15:59:14		Details Update	e Delete
Pods Service	monitoring-influxdb	k8s-app:influxdb task:monitoring	1/1	05/10/2018,15:59:21		Details Update	e 5 ete
Ingress	nginx-ingress-controller	app:ingress-nginx	1/1	05/10/2018,15:59:21		Details Update	e Delete
Release Config Maps	tiller-deploy	app:helm name:tiller	1/1	05/10/2018,15:59:23		Details Update	e Delete

4. Click Create by template in the upper-right corner.

Container Service	Deployment				Create by image Create by template Refresh
Overview	Clusters test • Namespace k	aube-system 🔻			
▼ Clusters	Name	Tag	PodsQuantity	Time Created	Action
Clusters	alicloud-disk-controller	app:alicloud-disk-controller	1/1	05/10/2018,15:59:21	Details Update Delete
Nodes	default-http-backend	app:default-http-backend	1/1	05/10/2018,15:59:21	Details Update Delete
Storage • Application	heapster	k8s-app:heapster task:monitoring	1/1	05/10/2018,15:59:21	Details Update Delete
Deployment	kube-dns	k8s-app:kube-dns	1/1	05/10/2018,15:59:14	Details Update Delete
Pods Service	monitoring-influxdb	k8s-app:influxdb task:monitoring	1/1	05/10/2018,15:59:21	Details Update Delete
Ingress Release	tiller-deploy	app:helm name:tiller	1/1	05/10/2018,15:59:23	Details Update Delete

 Select the cluster from the Clusters drop-down list and kube-system from the Namespace dropdown list. Select a sample template or Custom from the Resource Type drop-down list. Click DEPLOY.



In this example, redeploy the Ingress Controller to the target Ingress node in the DaemonSet method. You can also deploy the Ingress Controller by using deployment together with the affinity.

```
# nginx ingress pods
apiVersion: extensions/vlbetal
kind: DaemonSet
metadata:
   name: nginx-ingress-controller
   labels:
        app: ingress-nginx
   namespace: kube-system
   spec:
```

```
template:
     metadata:
       labels:
         app: ingress-nginx
     spec:
       nodeSelector:
         node-role.kubernetes.io/ingress: "true" ##Deploy the pod to
the corresponding node by using the label selector.
       serviceAccount: admin
       containers:
         - name: nginx-ingress-controller
           image: registry.cn-hangzhou.aliyuncs.com/acs/aliyun-
ingress-controller:aliyun-nginx-0.9.0-beta. 19.2
           args:
             - /nginx-ingress-controller
             - --default-backend-service=$(POD_NAMESPACE)/default-
http-backend
             - --configmap=$(POD_NAMESPACE)/nginx-configuration
             - --tcp-services-configmap=$(POD_NAMESPACE)/tcp-
services
             - --udp-services-configmap=$(POD_NAMESPACE)/udp-
services
             - -- annotations-prefix=nginx.ingress.kubernetes.io
             - --publish-service=$(POD_NAMESPACE)/nginx-ingress-lb
             - --v=2
           env:
             - name: POD NAME
               valueFrom:
                 fieldRef:
                   fieldPath: metadata.name
             - name: POD NAMESPACE
               valueFrom:
                 fieldRef:
                   fieldPath: metadata.namespace
           ports:
            - name: http
             containerPort: 80
           - name: https
             containerPort: 443
           livenessProbe:
             failureThreshold: 3
             httpGet:
               path: /healthz
               port: 10254
               scheme: HTTP
             initialDelaySeconds: 10
             periodSeconds: 10
             successThreshold: 1
             timeoutSeconds: 1
           readinessProbe:
             failureThreshold: 3
             httpGet:
               path: /healthz
               port: 10254
               scheme: HTTP
             periodSeconds: 10
             successThreshold: 1
             timeoutSeconds: 1
```

6. A message indicating the deployment status is displayed on the page after you click DEPLOY. After the successful deployment, click **Kubernetes Dashboard** in the message to go to the dashboard. Select kube-system as the namespace. Click **Daemon Sets** in the left-side navigation pane and view the nginx-ingress-controller.



7. Click Pods in the left-side navigation pane to view the pods of nginx-ingress-controller.



Step 3 Update Ingress Server Load Balancer service

- 1. Log on to the Container Service console.
- Under Kubernetes, clickApplication > Service in the left-side navigation pane. in the leftside navigation pane.
- Select the cluster from the Clusters drop-down list and kube-system from the Namespace dropdown list. Click Update.

An Ingress Server Load Balancer service is deployed by default when the cluster is initialized. For more information, see *ingress-nginx*. You must update the Ingress Server Loadbalancer service to automatically identify the ingress node that is mounted for marking.

Container Service	Service List		-				Create Refresh
Overview	Clusters test v Na	mespace kube-sys	tem 🔻 4				
 Clusters 	Name	Туре	Time Created	ClustersIP	internalendpoint	externalendpoint	Action
Clusters	default-http-backend	ClusterIP	05/10/2018,15:59:21	172.392.381	default-http-backend:80 TCP	-	Details Update Delete
Nodes	heapster	ClusterIP	05/10/2018,15:59:21	172/19/14/21	heapster:80 TCP	-	Details Update Delete
Storage	kube-dns	ClusterIP	05/10/2018,15:59:14	172.39.0.30	kube-dns:53 UDP kube-dns:53 TCP	-	Details Update Delete
Deployment	monitoring-influxdb	ClusterIP	05/10/2018,15:59:21	172.09.3.291	monitoring-influxdb:8086 TCP	-	Details Update Delete
Pods Service 3 = Ingress	nginx-ingress-lb	LoadBalancer	05/10/2018,15:59:21	172.19.12.202	nginx-ingress-lb:80 TCP nginx-ingress-lb:31092 TCP nginx-ingress-lb:443 TCP nginx-ingress-lb:32052 TCP	47.00.2.301:80 47.00.2.301:443	Details Update Delete
Release	tiller-deploy	ClusterIP	05/10/2018,15:59:24	172,194,04,138	tiller-deploy:44134 TCP	-	Details Update Delete

4. In the displayed dialog box, add the annotation service.beta.kubernetes.io/ alicloud-loadbalancer-backend-label "node-role.kubernetes.io/ingress= true", and then click OK.

You can also log on to the master node of the cluster and run the command kubectl apply -f https://acs-k8s-ingress.oss-cn-hangzhou.aliyuncs.com/nginx-ingress -slb-service.yml to update the nginx-ingress-lb service.



Then, you have deployed the high-reliability access layer of Ingress, which allows you to effectivel y deal with the challenges of single point of failure and business traffic, and quickly expand the Ingress access layer by adding tags.

4 Release

4.1 Implement Layer-4 canary release by using Alibaba Cloud Server Load Balancer in a Kubernetes cluster

In a Kubernetes cluster, Layer-7 Ingress cannot properly implement gray release for services accessed by using TCP/UDP. This document introduces how to implement Layer-4 canary release by using Server Load Balancer.

Prerequisites

- You have created a Kubernetes cluster. For more information, see #unique_12.
- You have connected to the master node by using SSH. For more information, see #unique_13.

Step 1 Deploy the old version of the service

- 1. Log on to the *Container Service console*.
- 2. Click Application > Deployment in the left-side navigation pane.
- 3. Click Create by template in the upper-right corner.
- Select the cluster and namespace from the Clusters and Namespace drop-down lists. Select a sample template or Custom from the Resource Type drop-down list. Click **DEPLOY**.

In this example, an nginx orchestration that exposes the service by using SLB.

```
apiVersion: extensions/vlbetal
kind: Deployment
metadata:
  labels:
    run: old-nginx
  name: old-nginx
spec:
  replicas: 1
   selector:
     matchLabels:
      run: old-nginx
   template:
     metadata:
       labels:
         run: old-nginx
         app: nginx
     spec:
       containers:
        image: registry.cn-hangzhou.aliyuncs.com/xianlu/old-nginx
         imagePullPolicy: Always
         name: old-nginx
         ports:
```

```
- containerPort: 80
           protocol: TCP
       restartPolicy: Always
apiVersion: v1
kind: Service
metadata:
   labels:
    run: nginx
  name: nginx
spec:
  ports:
   - port: 80
    protocol: TCP
     targetPort: 80
   selector:
    app: nginx
   sessionAffinity: None
   type: LoadBalancer ##Expose the service by using Alibaba Cloud
SLB.
```

- Click Application > Deployment and Application > Service in the left-side navigation pane to check the deployment and service.
- 6. Click the external endpoint at the right of the service to go to the Nginx default welcome page. In this example, old is displayed on the Nginx welcome page, which indicates that the currently accessed service corresponds to the backend old-nginx container.

To easily display the results of multiple releases , we recommend that you log on to the master node and execute the curl command to view the deployment results.

Step 2 Bring new deployment version online

- 1. Log on to the *Container Service console*.
- 2. Click Application > Deployment in the left-side navigation pane.
- 3. Click Create by template in the upper-right corner.

 Select the cluster and namespace from the Clusters and Namespace drop-down lists. Select a sample template or Custom from the Resource Type drop-down list. Click **DEPLOY**.

In this example, create a new version of nginx deployment that contains the app:nginx label. The label is used to use the same nginx service as that of the old version of deployment to bring the corresponding traffic.

The orchestration template in this example is as follows:

```
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  labels:
    run: new-nginx
  name: new-nginx
spec:
  replicas: 1
   selector:
     matchLabels:
      run: new-nginx
   template:
     metadata:
       labels:
         run: new-nginx
         app: nginx
     spec:
       containers:
       - image: registry.cn-hangzhou.aliyuncs.com/xianlu/new-nginx
         imagePullPolicy: Always
         name: new-nginx
         ports:
          - containerPort: 80
           protocol: TCP
       restartPolicy: Always
```

- Click **Deployment** in the left-side navigation pane. The deployment of new-nginx is displayed on the Deployment page.
- 6. Log on to the master node and execute the curl command to view the service access.

```
# bash
# for x in {1.. 10} ; do curl EXTERNAL-IP; done ##EXTERNAL-IP is the
    external endpoint of the service.
    new
    new
    new
    old
    new
    old
    new
    new
    old
```

old

You can see that the old service and new service are accessed for five times respectively. This is mainly because the service follows the Server Load Balancer policy of average traffic to process traffic requests, and the old deployment and new deployment are the same pod, which makes their traffic ratio as 1:1.

Step 3 Adjust traffic weight

You must adjust the number of pods in the backend to adjust the corresponding weight for the canary release based on Server Load Balancer. For example, to make the new service to have higher weight, you can adjust the number of new pods to four.



If the old application version and new application version coexist, the results returned after executing the curl command of a sample do not conform to the configured weight strictly. In this example, to obtain the approximate effect, execute the curl command for 10 times to observe more samples.

- 1. Log on to the Container Service console.
- 2. Under Kubernetes, click **Application** > **Deployment** in the left-side navigation pane.
- Select the cluster and namespace from the Clusters and Namespace drop-down lists. Click
 Update at the right of the deployment.
- 4. In the displayed dialog box, set the number of pods to four.

Note:

The default update method of Kubernetes deployment resources is rollingUpdate. Therefore, during the update process, the minimum number of containers that provide the service is guaranteed and this number can be adjusted in the template.

5. After the deployment, log on to the master node and execute the curl command to view the effect.

```
# bash
    # for x in {1.. 10} ; do curl EXTERNAL-IP; done ##EXTERNAL-IP is
the external endpoint of the service.
    new
    new
    new
    new
```

new old new new new old

You can see the new service is requested for eight times and the old service is requested twice among the 10 requests.

You can dynamically adjust the number of pods to adjust the weights of the new service and old service and implement the canary release.

5 Istio

5.1 Implement Istio distributed tracking in Kubernetes

Background

Microservice is a focus in the current era. More and more IT enterprises begin to embrace the microservices. The microservice architecture splits a complex system into several small services and each service can be developed, deployed, and scaled independently. As a heaven-made match, the microservice architecture and containers (Docker and Kubernetes) further simplify the microservice delivery and strengthen the flexibility and robustness of the entire system.

When monolithic applications are transformed to microservices, the distributed application architecture composed of a large number of microservices also increases the complexity of operation & maintenance, debugging, and security management. As microservices grow in scale and complexity, developers must be faced with complex challenges such as service discovery , Server Load Balancer, failure recovery, indicator collection, monitoring, A/B testing, throttling, access control, and end-to-end authentication, which are difficult to resolve.

In May 2017, Google, IBM, and Lyft published the open-source service network architecture Istio , which provides the connection, management, monitoring, and security protection of microservi ces. Istio provides an infrastructure layer for services to communicate with each other, decouples the issues such as version management, security protection, failover, monitoring, and telemetry in application logics and service access. Being unrelated to codes, Istio attracts enterprises to transform to microservices, which will make the microservice ecology develop fast.

Architecture principle of Istio

In Kubernetes, a pod is a collection of close-coupled containers, and these containers share the same network namespace. With the extension mechanism of Initializer in Kubernetes, an Envoy container is automatically created and started for each business pod, without modifying the deployment description of the business pod. The Envoy takes over the inbound and outbound traffic of business containers in the same pod. Therefore, the microservice governance functions , including the traffic management, microservice tracking, security authentication, access control, and strategy implementation, are realized by operating on the Envoy.

Overview	1	Help: & Create cluster & Scale cluste creation failures & Authorization manag	er 🔗 Connect to Kube ement	ernetes cluster via	a kubecti 🔗 Mai	nage applicatio	ins with com	mands 🔗 Cluster plan	ning 🔗 Create GPU clu:	sters 🔗 Troubleshoot cluster
✓ Clusters	L	Name 🔻								
Clusters	l	Cluster Name/ID	Cluster Type	Region (All)	Network Type	Cluster Status	Number of Nodes	Time Created	Kubernetes Version	Action
Volumes Namespace	IJ	k8s-test	Kubernetes	China East 1 (Hangzhou)	VPC vpc- bp1sr1al45z	Running	6	10/12/2018,16:24:34	1.11.2	Manage View Logs Dashboard Scale Cluster More -
 Application Deployment 		managed-cluster	ManagedKubernetes	China North 2 (Beijing)	VPC vpc- 2zef2e2y7vc	Running	3	10/09/2018,11:20:00	1.11.2	Delete Add Existing Instance Upgrade Cluster
StatefulSet Job		test-mia	Kubernetes	China East 1 (Hangzhou)	VPC vpc- bp1lkyevdjj	Running	7	09/17/2018,11:37:55	1.11.2	Automatic Scaling Addon Upgrade Deploy Istio
Pods										

An Istio service mesh is logically split into a data plane and a control plane.

- The data plane is composed of a collection of intelligent proxies (Envoys) deployed as sidecars that mediate and control all network communication between microservices.
- The control plane is used to manage and configure the proxies to route traffic, and enforce polices at the runtime.

An Istio is mainly composed of the following components:

- **Envoy:** The Envoy is used to mediate all the inbound and outbound traffic for all the services in the service mesh. Functions such as dynamic service discovery, Server Load Balancer, fault injection, and traffic management are supported. The Envoy is deployed as a sidecar to the pods of related services.
- **Pilot:** The Pilot is used to collect and verify the configurations and distribute the configurations to all kinds of Istio components.
- **Mixer:** The Mixer is used to enforce the access control and usage policies in the service mesh, and collect telemetry data from Envoy proxies and other services.
- Istio-Auth: Istio-Auth provides strong service-to-service and end user authentication.

For more information about Istio, see the Istio official document.

Install Istio

Use an Alibaba Cloud Container Service Kubernetes cluster as an example.

Alibaba Cloud Container Service has enabled the Initializers plug-in by default for Kubernetes clusters if the cluster version is later than 1.8. No other configurations are needed.



After you deploy the Istio, a sidecar is injected to each pod to take over the service communication. Therefore, we recommend that you verify this in the independent test environment.

Create a Kubernetes cluster

- 1. Log on to the Container Service console.
- 2. Under Kubernetes, click **Clusters** in the left-side navigation pane, and click **Create Kubernetes cluster** in the upper-right corner.
- **3.** Configure the parameters to create a cluster. For how to create a Kubernetes cluster, see *Create a Kubernetes cluster*.
- After the cluster is created, click Manage at the right of the cluster when the cluster status is changed to Running.

Container Service - Kubernetes +		Service	e List						Refresh Create
Overview	^	Help: 6	Cayer-4 canary release						
▼ Clusters	l	Clusters	k8s-istio 🔻	Namespace istio-system	•				
Clusters	L	Name		Туре	Time Created	ClustersIP	InternalEndpoint	ExternalEndpoint	Action
Nodes	l	grafana		ClusterIP	10/15/2018,10:26:35	172.19.9.0	grafana:3000 TCP		Details Update View YAML Delete
Volumes	l	istio-cita	adel	ClusterIP	10/15/2018,10:26:35	172.19.1.199	istio-citadel:8060 TCP istio-citadel:9093 TCP		Details Update View YAML Delete
Authorization	l	istio-egr	ressgateway	ClusterIP	10/15/2018,10:26:35	172.19.11.106	istio-egressgateway:80 TCP istio-egressgateway:443 TCP	-	Details Update View YAML Delete
Application	l	istio-gal	lley	ClusterIP	10/15/2018,10:26:34	172.19.15.222	istio-galley:443 TCP istio-galley:9093 TCP	-	Details Update View YAML Delete
Jepoyment StatefulSet Job Pods Service Ingress Volumes Claim Helm	11	istio-ing	resspiteway	LoadBalancer	10/15/2018,10:26:35	172.19.12.210	Into-Investigationary/80 TCP Into-Investigationary/100 TCP Into-Investigationary/1100 TCP Into-Investigationary/1100 TCP Into-Investigationary/1100 TCP Into-Investigationary/100 TCP	40 46 2140 46 2140 46 2500 48 2500 48 2503 49 1500 49 15001	Defails Update Wew YAML Delete

 On the cluster Basic Information page, you can configure the corresponding connection information based on the page information. You can connect to the cluster either by using *Connect to a Kubernetes cluster by using kubectl* or *Access Kubernetes clusters by using SSH*.

Container Service - Kubernetes - Overview Clusters Clusters Nodes	istio-ingressgateway	LoadBalancer	10/15/2018,10:26:35	172.19.12.210	isb-ngrespikewy:1390 TCP isb-ngrespikewy:1400 TCP isb-ngrespikewy:1400 TCP isb-ngrespikewy:1501 TCP isb-ngrespikewy:1501 TCP isb-ngrespikewy:1500 TCP isb-ngrespikewy:1500 TCP isb-ngrespikewy:1500 TCP isb-ngrespikewy:1500 TCP isb-ngrespikewy:1500 TCP isb-ngrespikewy:1500 TCP isb-ngrespikewy:1500 TCP isb-ngrespikewy:1500 TCP isb-ngrespikewy:1500 TCP	p 11400 12400 12010 12010 12010 12020 12020 15031	Details Update View Y2ML Delete
Volumes Namespace	istio-pilot	ClusterIP	10/15/2018,10:26:35	172.19.4.204	istio-pilot:15010 TCP istio-pilot:15011 TCP istio-pilot:8080 TCP istio-pilot:9093 TCP		Details Update View YAML Delete
Application	istio-policy	ClusterIP	10/15/2018,10:26:35	172.19.14.150	istio-policy:9091 TCP istio-policy:15004 TCP istio-policy:9093 TCP	-	Details Update View YAML Delete
Deployment	istio-sidecar-injector	ClusterIP	10/15/2018,10:26:35	172.19.1.255	istio-sidecar-injector:443 TCP		Details Update View YAML Delete
dot	istio-statsd-prom-bridge	ClusterIP	10/15/2018,10:26:35	172.19.14.221	istio-statsd-prom-bridge:9102 TCP istio-statsd-prom-bridge:9125 UDP	-	Details Update View YAML Delete
Pods Service	istio-telemetry	ClusterIP	10/15/2018,10:26:35	172.19.4.78	Istio-telemetry:9091 TCP Istio-telemetry:15004 TCP Istio-telemetry:9093 TCP Istio-telemetry:42422 TCP		Details Update View YAML Delete
Ingress Volumos Claim	prometheus	ClusterIP	10/15/2018,10:26:35	172.19.10.115	prometheus:9090 TCP		Details Update View YAML Delete
Helm	servicegraph	ClusterIP	10/15/2018,10:26:35	172.19.6.34	servicegraph:8088 TCP		Details Update View YAML Delete
Release Config Maps	tracing-on-sis-agent	ClusterIP	10/15/2018,10:26:35	172.19.10.85	tracing-on-sls-agent:5775 UDP tracing-on-sls-agent:6831 UDP tracing-on-sls-agent:6832 UDP tracing-on-sls-agent:5778 TCP		Details Update View YAML Delete
Secret • Store	tracing-on-sis-collector	ClusterIP	10/15/2018,10:26:35	172.19.3.201	tracing-on-sls-collector:14267 TCP tracing-on-sls-collector:14268 TCP tracing-on-sls-collector:9411 TCP		Details Update View YAML Delete
Docker Images	tracing-on-sis-query	LoadBalancer	10/15/2018,10:26:35	172.19.2.255	tracing-on-sls-query:80 TCP tracing-on-sls-query:30258 TCP	1:80	Details Update View YAML Delete

Deploy Istio release version

Log on to the master node and run the following command to get the latest Istio installation package.

```
curl -L https://git.io/getLatestIstio | sh -
```

Run the following command:

cd istio-0.4.0	##Change the working directory
to Istio	
export PATH=\$PWD/bin:\$PATH	##Add the istioctl client to
PATH environment variable	

Run the following command to deploy Istio.

```
kubectl apply -f install/kubernetes/istio.yaml
                                                            ## Deploy
Istio system components
kubectl apply -f install/kubernetes/istio-initializer.yaml
                                                                ##
Deploy Istio initializer plug-in
```

After the deployment, run the following command to verify if the Istio components are successfully

deployed.

```
$ kubectl get svc,pod -n istio-systemNAME TYPE CLUSTER-IP EXTERNAL-
IP PORT(S) AGEsvc/istio-ingress LoadBalancer 172.21.10.18 101.37.113
.231 80:30511/TCP,443:31945/TCP 1msvc/istio-mixer ClusterIP 172.21.
14.221 9091/TCP,15004/TCP,9093/TCP,9094/TCP,9102/TCP,9125/UDP,42422/
TCP 1msvc/istio-pilot ClusterIP 172.21.4.20 15003/TCP,443/TCP 1mNAME
READY STATUS RESTARTS AGEpo/istio-ca-55b954ff7-crsjq 1/1 Running 0
lmpo/istio-ingress-948b746cb-4t24c 1/1 Running 0 lmpo/istio-initialize
```

```
r-6c84859cd-8mvfj 1/1 Running 0 1mpo/istio-mixer-59cc756b48-tkx6c 3/3
Running 0 1mpo/istio-pilot-55bb7f5d9d-wc5xh 2/2 Running 0 1m
```

After all the pods are in the running status, the Istio deployment is finished.

Istio distributed service tracking case

Deploy and test the application BookInfo

BookInfo is an application similar to an online bookstore, which is composed of several independent microservices compiled by different languages. The application BookInfo is deployed in the container mode and does not have any dependencies on Istio. All the microservices are packaged together with an Envoy sidecar. The Envoy sidecar intercepts the inbound and outbound call requests of services to demonstrate the distributed tracking function of Istio service mesh.

For more information about BookInfo, see *Bookinfo guide*.

Clusters				
	τ			
Namespace				
istio-system				
Release Name				
istio				
Version				
1.0.3				
Enable Prometheus for m	netrics/logs collection			
🗹 Enable Grafana for metri	cs display			
✓ Enable automatic Istio Sidecar injection				
Enable the Kiali Visualization Service Grid				
Enable Log Service(SLS)	and Jaeger			
* Endpoint	cn-hangzhou.log.aliyuncs.com			
* Project				
* Logstore				
* AccessKeyID				
* AccessKeySecret				

Run the following command to deploy and test the application Bookinfo.

kubectl apply -f samples/bookinfo/kube/bookinfo.yaml

In the Alibaba Cloud Kubernetes cluster environment, every cluster has been configured with the Server Load Balancer and Ingress. Run the following command to obtain the IP address of Ingress.

\$ kubectl	get ingre	ess -o wide		
NAME	HOSTS	ADDRESS	PORTS	AGE
gateway	*	101.37.xxx.xxx	80	2m

If the preceding command cannot obtain the external IP address, run the following command to obtain the corresponding address.

```
export GATEWAY_URL=$(kubectl get ingress -o wide -o jsonpath={.items[0].status.loadBalancer.ingress[0].ip})
```

The application is successfully deployed if the following command returns 200.

```
curl -o /dev/null -s -w "%{http_code}\n" http://${GATEWAY_URL}/
productpage
```

You can open http://\${GATEWAY_URL}/productpage in the browser to access the

application. GATEWAY_URL is the IP address of Ingress.

Jaeger UI Lookup by Trace ID Search	Dependencies	About Jaeger 🗸
Find Traces Service (8) productpage	15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
Operation (4)	04.25.40 pm 04.35.00 pm 04.43.20 pm	Tic
Tags 💮 http.status_code=200 error=true	10 Traces	Sort: Most Recent
Lookback	productpage: productpage.default.svc.cluster.local:9080/productpage	45.89ms
Last Hour ×	Today 4:49:50 pm 8 minutes ago	
e.g. 1.2s, 100ms, 500us	productpage: productpage default.svc.cluster.local:9080/productpage	39.26ms
Max Duration	Today 4:49:49 pm 8 minutes ago	
Limit Results	productpage: productpage default svc.cluster local 9080/productpage	26.33ms
20	Today 4.49.48 pm 8 minutes ago	
Find Traces	productpage: productpage default.svc.cluster.local.9080/productpage	43.62ms
	Today 4:49:47 pm 8 minutes ago	

Deploy Jaeger tracking system

Distributed tracking system helps you observe the call chains between services and is useful when diagnosing performance issues and analyzing system failures.

Istio ecology supports different distributed tracking systems, including *Zipkin* and *Jaeger*. Use the Jaeger as an example.

Istio version 0.4 supports Jaeger. The test method is as follows.

```
kubectl apply -n istio-system -f https://raw.githubusercontent.com/
jaegertracing/jaeger-kubernetes/master/all-in-one/jaeger-all-in-one-
template.yml
```

After the deployment is finished, if you connect to the Kubernetes cluster by using kubectl, run the following command to access the Jaeger control panel by using port mapping and openhttp://localhost:16686 in the browser.

```
kubectl port-forward -n istio-system $(kubectl get pod -n istio-system
    -l app=jaeger -o jsonpath='{.items[0].metadata.name}') 16686:16686 &
```

If you connect to the Alibaba Cloud Kubernetes cluster by using SSH, run the following command to check the external access address of jaeger-query service.

```
$ kubectl get svc -n istio-system
NAME
                                                EXTERNAL-IP
                  TYPE
                                 CLUSTER-IP
PORT(S)
                                                                 AGE
jaeger-agent
                 ClusterIP
                                None
                                                <none>
5775/UDP,6831/UDP,6832/UDP
                                                                 1h
                                 172.21.10.187
jaeger-collector ClusterIP
                                                <none>
14267/TCP,14268/TCP,9411/TCP
                                                                 1h
                 LoadBalancer 172.21.10.197 114.55.82.11
                                                                 80:
jaeger-query
31960/TCP
             ##The external access address is 114.55.82.11:80.
zipkin
                  ClusterIP
                                None
                                                <none>
9411/TCP
```

Record the external access IP address and port of jaeger-query and then open the application in the browser.

By accessing the application BookInfo for multiple times and generating the call chain information, we can view the call chain information of services clearly.

✓ istio-ingressgateway: productpage.default.svc.cluster.local:9080/productpage									
Trace Start: October 15, 2018 4:18 PM Duration: 1.02s Services: 7 Depth: 10 Total Spans: 28									
Oms	254.04ms		508.08ms		762.13ms		1.02s		
Fx									
			_				Ϋ́,		
Service & Operation	Oms	254.04ms		508.08ms		762.13ms	1.02s		
v istio-ingressgateway productpage.default.svc.cluster.local									
productpage productpage.default.svc.cluster.local:9080									
v productpage async outbound[9091][istio-policy.istio	I 1.27ms								
V istio-policy Check	0.97ms								
V istio-mixer /istio.mixer.v1.Mixer/Check	I 0.23ms								
istio-mixer kubernetes:handler.kubernete	I 0.07ms								
productpage details.default.svc.cluster.local:9080/*	■ 6.46ms								
details details.default.svc.cluster.local:9080/*	5.66ms								
details async outbound[9091][istio-policy.istio	I 1.73ms								
v istio-policy Check	I 1ms								
 istio-mixer /istio.mixer.v1.Mixer/Check 	1 0.28ms								
istio-mixer kubernetes:handler.ku	1 0.07ms								
productpage reviews.default.svc.cluster.local:9080/*	ns 🗲								
reviews reviews.default.svc.cluster.local:9080/*	ns 🕻								
reviews async outbound[9091][istio-policy.isti	I 1.98ms								
V istio-policy Check	l 1.07ms								
istio-mixer /istio.mixer.v1.Mixer/Check	1 0.3ms								
istio-mixer kubernetes:handler.ku	0.08ms								
reviews ratings.default.svc.cluster.local:9080/*							7.4ms 🔳		
v ratings_ratings_default.svc.cluster.local:90							5.76ms 🛢		
 ratings async outbound/9091/listio-pol 							2.66ms I		
v istio-policy Check							1.71ms		
v istio-mixer /istio.mixer.v1.Mix							0.36ms		
istio-mixer kubernetes:ha							0.11ms I		

Click a specific Trace to view the details.



You can also view DAG.



Implementation principle of Istio distributed tracking

The kernel of Istio service mesh is the Envoy, which is a high-performance and open-source Layer -7 proxy and communication bus. In Istio, each microservice is injected with an Envoy sidecar and this instance is responsible for processing all the inbound and outbound network traffic. Therefore , each Envoy sidecar can monitor all the API calls between services, record the time required by each service call, and record whether each service call is successful or not.

Whenever a microservice initiates an external call, the client Envoy will create a new span. A span represents the complete interaction process between a collection of microservices, starting from a caller (client) sending a request to receiving the response from the server.

In the service interaction process, clients record the request start time and response receipt time, and the Envoy on the server records the request receipt time and response return time.

Each Envoy distributes their own span view information to the distributed tracking system. When a microservice processes requests, other microservices may need to be called, which causes the creation of a causally related span and then forms the complete trace. Then, an application must be used to collect and forward the following Headers from the request message:

- x-request-id
- x-b3-traceid
- x-b3-spanid
- x-b3-parentspanid
- x-b3-sampled
- x-b3-flags
- x-ot-span-context

Envoys in the communication links can intercept, process, and forward the corresponding Headers



For specific codes, see the Istio document *https://istio.io/docs/tasks/telemetry/distributed-tracing. html*.

Conclusion

Istio is accelerating the application and popularization of service mesh by using the good expansion mechanism and strong ecology. In addition to those mentioned in the preceding

sections, Weave Scope, Istio Dashboard, and Istio-Analytics projects provide abundant call link visualization and analysis capabilities.

6 DevOps