Container Service

Best Practices

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Best Practices

Swarm

Run TensorFlow-based AlexNet in Alibaba Cloud Container Service

AlexNet is a CNN network developed in 2012 by Alex Krizhevsky using five-layer convolution and three-layer ReLU layer, and won the ImageNet competition (ILSVRC). AlexNet proves the effectiveness in classification (15.3% error rate) of CNN, against the 25% error rate by previous image recognition tools. The emergence of this network marks a milestone for deep learning applications in the computer vision field.

AlexNet is also a common performance indicator tool for deep learning framework. TensorFlow provides the alexnet_benchmark.py tool to test GPU and CPU performance. This document uses AlexNet as an example to illustrate how to run a GPU application in Alibaba Cloud Container Service easily and quickly.

Prerequisite

Create a GN5 GPU cluster in Container Service console.

Procedure

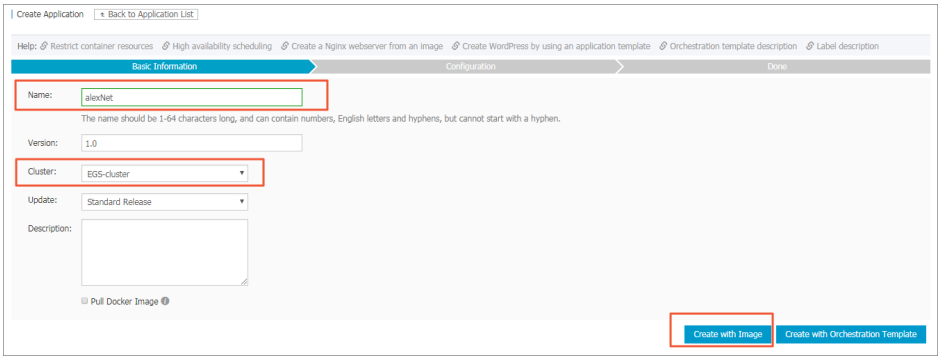
Log on to the Container Service console.

Click **Applications** in the left-side navigation pane.

Click **Create Application** in the upper-right corner.

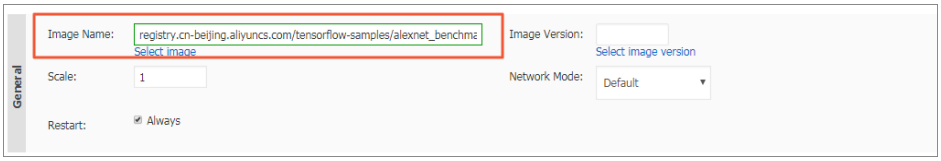
Complete the configurations. Enter the application name (**alexNet** in this example) in the

Name field and then select the created GN5 GPU cluster from the **Cluster** list.

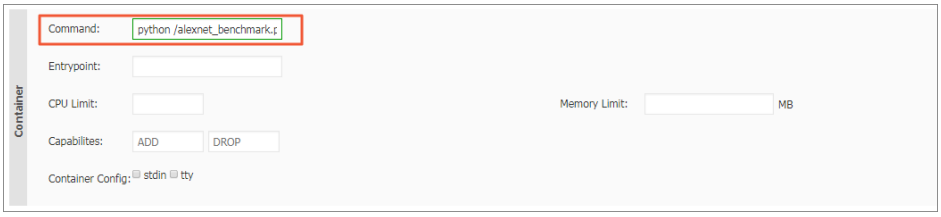


Click **Create with Image**.

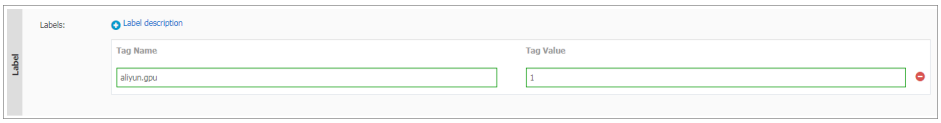
Enter **registry.cn-beijing.aliyuncs.com/tensorflow-samples/alexnet_benchmark:1.0.0-devel-gpu** in the **Image Name** field.



In the **Container** section, enter the command in the **Command** field. For example, enter python /alexnet_benchmark.py --batch_size 128 --num_batches 100.

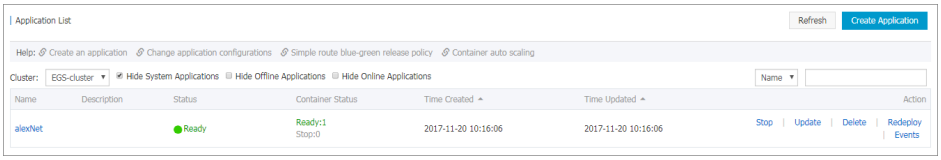


Click the button in the **Label** section. Enter the Alibaba Cloud gpu extension label. Enter **aliyun.gpu** in the **Tag Name** field, and the number of scheduling GPUs (**1** in this example) in the **Tag Value** field.



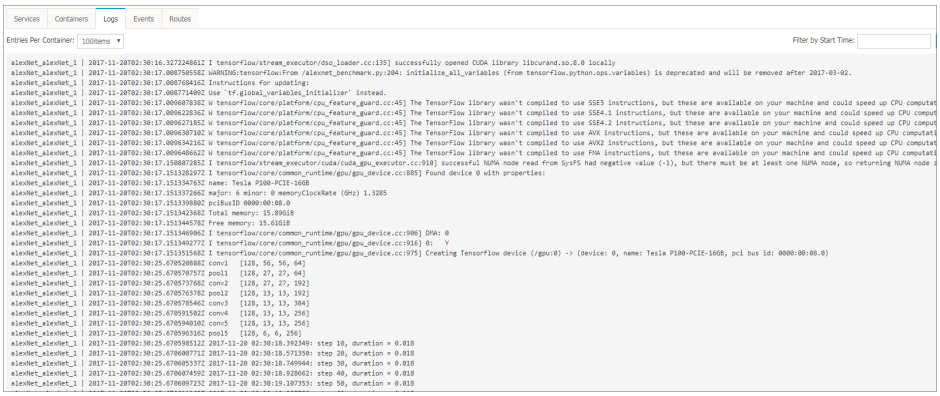
Click **Create** after configuring the application.

You can view the created **alexNet** application on the **Application List** page.



Click the application name **alexNet**.

Click the **Logs** tab.



In this way, you can check the performance of AlexNet on EGS by means of the container Log Service in Container Service console.

Minimalism serverless practices based on swarm mode

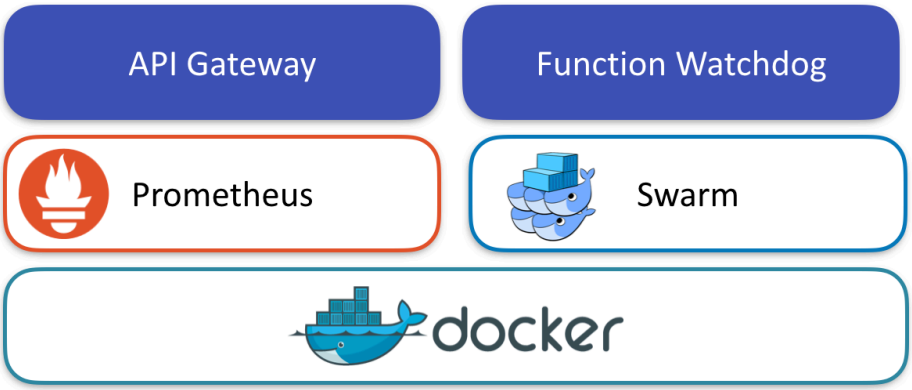
FaaS is currently the latest cloud service mode. Alibaba Cloud Container Service is based on the swarm mode clusters to implement a minimalism serverless framework, which supports using any Unix process as a function for external services.

Architecture principle

The FaaS prototype system contains the following models.

1. Any process can be converted to a function, packaged and delivered by using the Docker image.
2. Implement the scheduling capability of functions in a simple way by using the resource scheduling of Docker swarm mode clusters and the Server Load Balancer capability of routing mesh. Each function corresponds to one service in the Docker cluster.

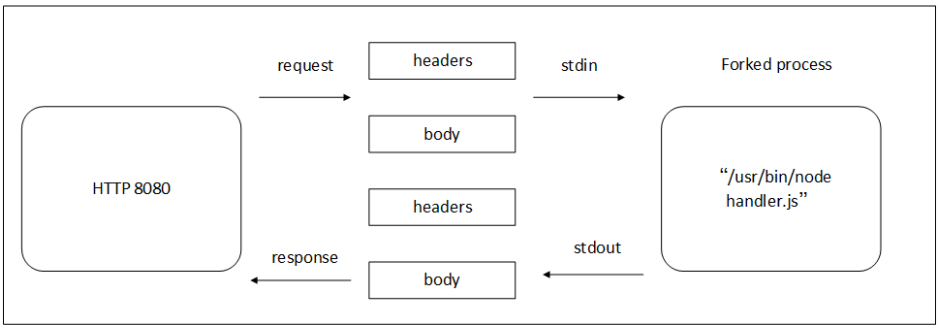
Function call monitoring and auto scaling are implemented by using Prometheus.



The design architecture is simple.

- The API Gateway is in charge of receiving service calls and routing requests to backend functions for implementation. It also collects service call indicators and sends the indicators to Prometheus. Prometheus calls back the API Gateway based on the number of service calls within a period of time to automatically scale the number of instances in the service container.

  Function Watchdog forwards HTTP requests as process calls, passes the requested data to the process by STDIN, and then returns the process STDOUT to the caller as the HTTP response result. Package the function process and Function Watchdog into a container image for deployment. The call process is as follows.



Install FaaS locally

Prepare a local Docker swarm mode cluster first. If no Docker swarm mode cluster is in place, you can install the latest Docker Engine and run the following command:

```
docker swarm init
```

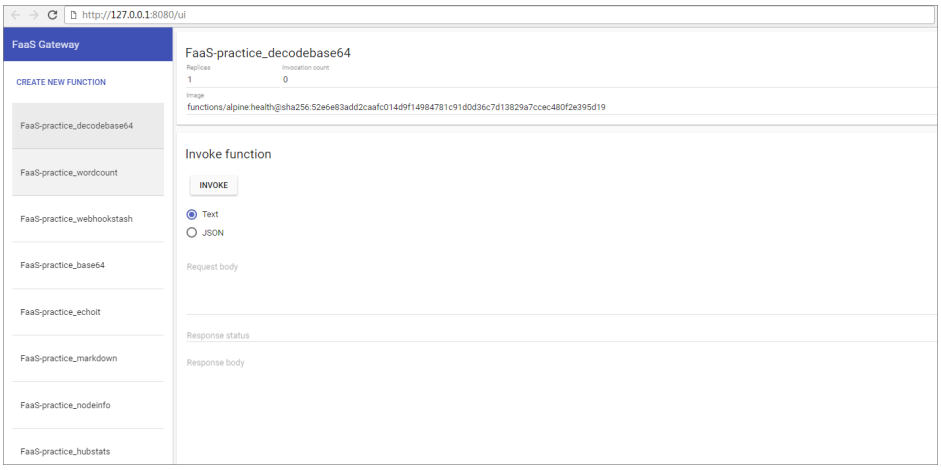
Run the following command to deploy FaaS:

```
git clone https://github.com/alexellis/faas
cd faas
./deploy_stack.sh
```

After the deployment, you can run the following command to check the FaaS status:

```
$ docker stack services func
ID NAME MODE REPLICAS IMAGE
1a8b2tb19ulk func_gateway replicated 1/1 functions/gateway:0.5.6
4jdexem6kppg func_webhookstash replicated 1/1 functions/webhookstash:latest
9ju4er5jur9l func_wordcount replicated 1/1 functions/alpine:health
e190suippx7i func_markdown replicated 1/1 alexellis2/faas-markdownrender:latest
l70j4c7kf99t func_alertmanager replicated 1/1 functions/alertmanager:latest
mgujgoa2u8f3 func_decodebase64 replicated 1/1 functions/alpine:health
o44asbnhqbda func_hubstats replicated 1/1 alexellis2/faas-dockerhubstats:latest
q8rx49ow3may func_echoit replicated 1/1 functions/alpine:health
t1ao5psnsj0s func_base64 replicated 1/1 functions/alpine:health
vj5z7rpdlo48 func_prometheus replicated 1/1 functions/prometheus:latest
xmwzd4z7l4dv func_nodeinfo replicated 1/1 functions/nodeinfo:latest
```

Then, access http://127.0.0.1:8080/ui FaaS in the browser.



Test FaaS in Alibaba Cloud

Limits

Make sure you have the conditions for creating a swarm mode cluster.

- By default, you can create at most 5 clusters in all regions, and add at most 20 nodes to each cluster. To create more clusters or add more nodes to a cluster, open a ticket.
- The Server Load Balancer instance created with the cluster only supports the Pay-As-You-Go billing method.

Procedure

Create a swarm mode cluster.
FaaS is deployed based on the Docker swarm mode cluster. Create a swarm mode cluster in Alibaba Cloud Container Service first.

Create an application by using an orchestration template. For more information, see Create an application by using an orchestration template.

The orchestration sample is as follows:

```
 version: "3"
services:

# Core API services are pinned, HA is provided for functions.
gateway:
volumes:
- "/var/run/docker.sock:/var/run/docker.sock"
ports:
- 8080:8080
labels:
aliyun.routing.port_8080: faas
image: functions/gateway:0.5.6
networks:
- functions
environment:
dnsrr: "true" # Temporarily use dnsrr in place of VIP while issue persists on PWD
deploy:
placement:
constraints: [node.role == manager]

prometheus:
image: functions/prometheus:latest # autobuild from Dockerfile in repo.
command: "-config.file=/etc/prometheus/prometheus.yml -storage.local.path=/prometheus -
storage.local.memory-chunks=10000 --alertmanager.url=http://alertmanager:9093"
ports:
- 9090:9090
depends_on:
- gateway
```

```
- alertmanager
labels:
aliyun.routing.port_9090: prometheus
environment:
no_proxy: "gateway"
networks:
- functions
deploy:
placement:
constraints: [node.role == manager]

alertmanager:
image: functions/alertmanager:latest # autobuild from Dockerfile in repo.
environment:
no_proxy: "gateway"
command:
- '-config.file=/alertmanager.yml'
networks:
- functions
ports:
- 9093:9093
deploy:
placement:
constraints: [node.role == manager]

# Sample functions go here.

# Service label of "function" allows functions to show up in UI on http://gateway:8080/
webhookstash:
image: functions/webhookstash:latest
labels:
function: "true"
depends_on:
- gateway
networks:
- functions
environment:
no_proxy: "gateway"
https_proxy: $https_proxy

# Pass a username as an argument to find how many images user has pushed to Docker Hub.
hubstats:
image: alexellis2/faas-dockerhubstats:latest
labels:
function: "true"
depends_on:
- gateway
networks:
- functions
environment:
no_proxy: "gateway"
https_proxy: $https_proxy

# Node.js gives OS info about the node (Host)
nodeinfo:
image: functions/nodeinfo:latest
```

```
labels:
function: "true"
depends_on:
- gateway
networks:
- functions
environment:
no_proxy: "gateway"
https_proxy: $https_proxy

# Uses `cat` to echo back response, fastest function to execute.
echoit:
image: functions/alpine:health
labels:
function: "true"
depends_on:
- gateway
networks:
- functions
environment:
fprocess: "cat"
no_proxy: "gateway"
https_proxy: $https_proxy

# Counts words in request with `wc` utility
wordcount:
image: functions/alpine:health
labels:
function: "true"
com.faas.max_replicas: "10"
depends_on:
- gateway
networks:
- functions
environment:
fprocess: "wc"
no_proxy: "gateway"
https_proxy: $https_proxy

# Calculates base64 representation of request body.
base64:
image: functions/alpine:health
labels:
function: "true"
depends_on:
- gateway
networks:
- functions
environment:
fprocess: "base64"
no_proxy: "gateway"
https_proxy: $https_proxy

# Decodes base64 representation of request body.
decodebase64:
image: functions/alpine:health
```

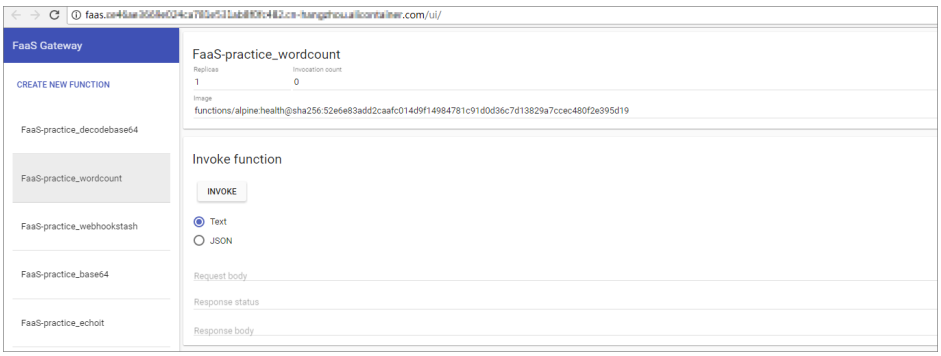
```
labels:
function: "true"
depends_on:
- gateway
networks:
- functions
environment:
fprocess: "base64 -d"
no_proxy: "gateway"
https_proxy: $https_proxy

# Converts body in (markdown format) -> (html)
markdown:
image: alexellis2/faas-markdownrender:latest
labels:
function: "true"
depends_on:
- gateway
networks:
- functions
environment:
no_proxy: "gateway"
https_proxy: $https_proxy

networks:
functions:
driver: overlay
```

Compared with the local deployment, only two labels are added, defining the routes of API Gateway and Prometheus.

- aliyun.routing.port_8080: Faas: Virtual domain name of the API Gateway.
- aliyun.routing.port_9090: Prometheus: Virtual domain name of the Prometheus service.

Click the application name on the **Application List** page and then click the **Routes** tab.

Click the route address to access the API Gateway and Prometheus service interfaces of Faas.



Subsequent operations

You can test the service scalability based on this method. For more information, see Open-source GitHub project address.

Best practices for restarting nodes

Restarting nodes directly might cause an exception in clusters. For example, for the Manager nodes in swarm mode clusters, if the number of healthy nodes is less than 2, the cluster might be incapable of self-cure and then become unavailable. In the context of Alibaba Cloud use cases, this document introduces the best practices for restarting nodes in the situations such as Container Service is actively operated and maintained.

Check the high availability configurations of business

Before restarting Container Service nodes, we recommend checking or modifying the following business configurations. In this way, restarting nodes cannot cause the exception of a single node and the business availability cannot be impaired.

Data persistence strategy of configurations

We recommend the data persistence for external volumes of important data configurations such as configurations of logs and business. In this way, after the container is restructured, deleting the former container cannot cause the data loss.

For how to use the Container Service data volumes, see Data volume management.

Restart strategy of configurations

We recommend configuring the restart: always restart strategy for the corresponding business services so that containers can be automatically pulled up after the nodes are

restarted.

High availability strategy of configurations

We recommend integrating with the product architecture to configure the affinity and mutual exclusion strategies, such as high availability scheduling (availability:az propery), specified node scheduling (affinity and constraint properties) , and specified nodes scheduling (constraint property), for the corresponding businesses. In this way, restarting nodes cannot cause the exception of a single node. For example, for the database business, we recommend the active-standby or multi-instance deployment, and integrating with the preceding characteristics to ensure the different instances are on different nodes and related nodes are not being restarted at the same time.

Best practices

We recommend checking the high availability configurations of business by reading the preceding introductions. Then, complete the following steps in sequence on each node.

Note: Do not perform on multiple nodes at the same time.

Back up snapshots

We recommend creating the latest snapshots for all the related disks of the nodes and then backing up the snapshots. In this way, when starting the shut-down nodes, the exception does not occur because the server is not restarted for a long time and the business availability is not impaired.

Verify the container configuration availability of business (ignore this step if the cluster is a swarm mode cluster)

For a non-swarm mode cluster, restarting the corresponding business containers on nodes ensures the containers can be pulled up again normally.

Note: The minimum control operation unit of swarm mode clusters is service. Therefore, you cannot directly process the business containers by starting or stopping Docker on swarm mode cluster nodes. Otherwise, an error occurs. The correct way is to perform automatic adjustment for business by readjusting the application replicas in Container Service console.

Modify node role (apply to swarm mode clusters)

If the corresponding node is a Manager node in the swarm mode cluster, set the node to a Worker node first.

Verify the running availability of Docker Engine

Try to restart Docker daemon and ensure the Docker Engine can be restarted normally.

Perform related operations and maintenance

Perform the related operations and maintenance in the plan, such as updating business codes, installing system patches, and adjusting system configurations.

Restarting nodes

Restart nodes normally in the console or system.

Check the status after the restart

Check the health status of the nodes and the running status of the business containers in Container Service console after restarting the nodes.

Call back node role (apply to swarm mode clusters)

If the corresponding node is a Manager node in the swarm mode cluster, set the node to a Manager node again.

Use OSSFS data volumes to share WordPress attachments

This document introduces how to share WordPress attachments across different containers by creating OSSFS data volumes in Alibaba Cloud Container Service.

Scenarios

Docker containers simplify WordPress deployment. With Alibaba Cloud Container Service, you can use an orchestration template to deploy WordPress with one click.

Note: For more information, see Create WordPress with an orchestration template.

In this example, the following orchestration template is used to create an application named **wordpress**.

```
web:
image: registry.aliyuncs.com/acs-sample/wordpress:4.3
ports:
- '80'
environment:
WORDPRESS_AUTH_KEY: changeme
WORDPRESS_SECURE_AUTH_KEY: changeme
WORDPRESS_LOGGED_IN_KEY: changeme
WORDPRESS_NONCE_KEY: changeme
WORDPRESS_AUTH_SALT: changeme
WORDPRESS_SECURE_AUTH_SALT: changeme
WORDPRESS_LOGGED_IN_SALT: changeme
WORDPRESS_NONCE_SALT: changeme
WORDPRESS_NONCE_AA: changeme
restart: always
links:
- 'db:mysql'
labels:
aliyun.logs: /var/log
aliyun.probe.url: http://container/license.txt
aliyun.probe.initial_delay_seconds: '10'
aliyun.routing.port_80: http://wordpress
aliyun.scale: '3'
db:
image: registry.aliyuncs.com/acs-sample/mysql:5.7
environment:
MYSQL_ROOT_PASSWORD: password
restart: always
labels:
aliyun.logs: /var/log/mysql
```

This application contains a MySQL container and three WordPress containers (aliyun.scale: '3' is the extension label of Alibaba Cloud Container Service, and specifies the number of containers. For more information about the labels supported by Alibaba Cloud Container Service, see Label description). The WordPress containers access MySQL by using a link. The aliyun.routing.port_80: http://wordpress label defines the load balancing among the three WordPress containers (for more information, see Simple routing - supports HTTP and HTTPS).

In this example, the application deployment is simple and the deployed application is of complete features. However, the attachments uploaded by WordPress are stored in the local disk, which means they cannot be shared across different containers or opened when requests are routed to other containers.

Solutions

This document introduces how to use OSSFS data volumes of Alibaba Cloud Container Service to

share WordPress attachments across different containers, without any code modifications.

OSSFS data volume, a third-party data volume provided by Alibaba Cloud Container Service, packages various cloud storages (such as Object Storage Service (OSS)) as data volumes and then directly mounts them to the containers. This means the data volumes can be shared across different containers and automatically re-mounted to the containers when the containers are restarted or migrated.

Procedure

Create OSSFS data volumes.

Log on to the Container Service console.

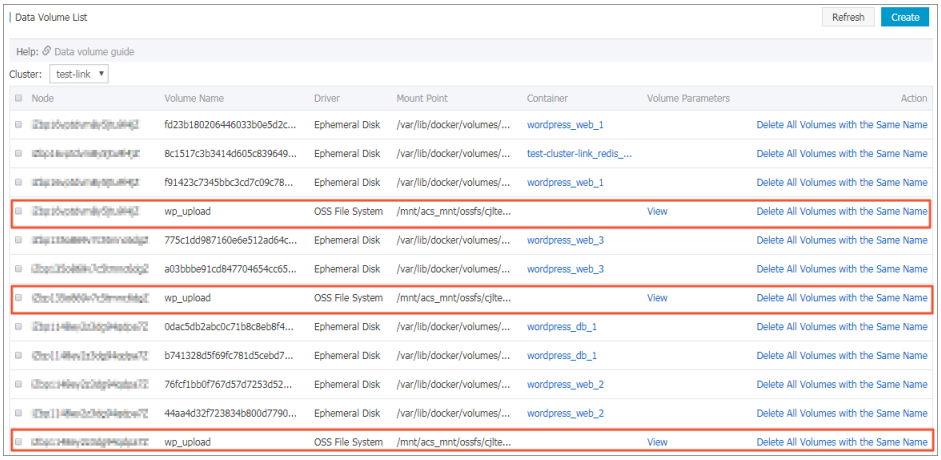
Click **Data Volumes** in the left-side navigation pane.

Select the cluster in which you want to create data volumes from the **Cluster** list.

Click **Create** in the upper-right corner to create the OSSFS data volumes.

For how to create OSSFS data volumes, see Create an OSSFS data volume.

In this example, the created OSSFS data volumes are named **wp_upload**. Container Service uses the same name to create data volumes on each node of a cluster.



Use the OSSFS data volumes.

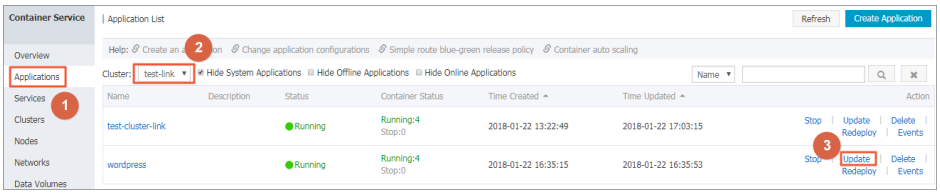
The WordPress attachments are stored in the /var/www/html/wp-content/uploads directory by default. In this example, map OSSFS data volumes to this directory and then an OSS bucket can be shared across different WordPress containers.

Log on to the Container Service console.

Click **Applications** in the left-side navigation pane.

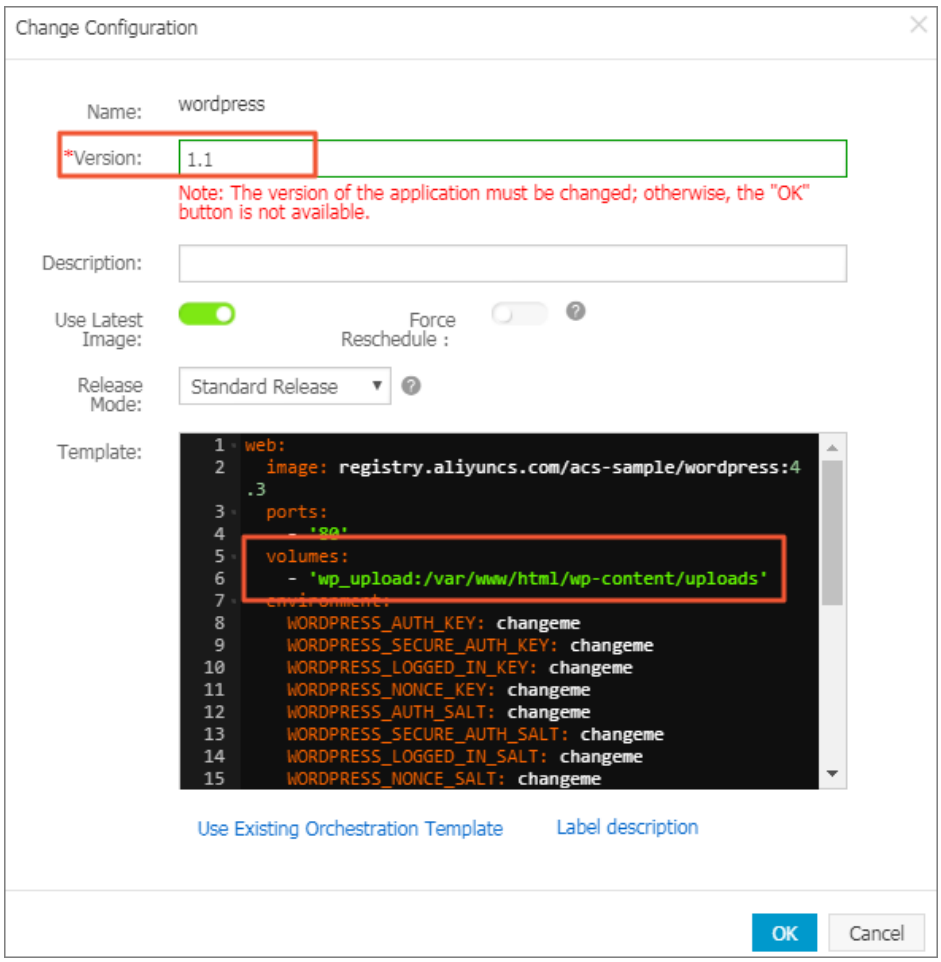
Select the cluster used in this example from the **Cluster** list.

Click **Update** at the right of the application **wordpress** created in this example.



In the **Template** field, add the mapping from OSSFS data volumes to the WordPress directory.

> **Note:** You must modify the **Version**. Otherwise, the application cannot be redeployed.



Click **OK** to redeploy the application.

Open WordPress and upload attachments. Then, you can see the uploaded attachments in the OSS bucket.

Use Docker Compose to test cluster network connectivity

This document provides a simple Compose file used to realize one-click deployment and you can test the container network connectivity by visiting the service access endpoint.

Scenarios

When deploying interdependent applications in a Docker cluster, you must make sure that the applications can access each other to realize cross-host container network connectivity. However, sometimes containers on different hosts cannot access each other due to network problems. If this happens, it is difficult to troubleshoot the problem. Therefore, an easy-to-use Compose file can be used to test the connectivity among cross-host containers within a cluster.

Solutions

Use the provided image and orchestration template to test the connectivity among containers.

```
 web:
image: registry.aliyuncs.com/xianlu/test-link
command: python test-link.py
restart: always
ports:
- 5000
links:
- redis
labels:
aliyun.scale: '3'
aliyun.routing.port_5000: test-link;
redis:
image: redis
restart: always
```

This example uses Flask to test the container connectivity.

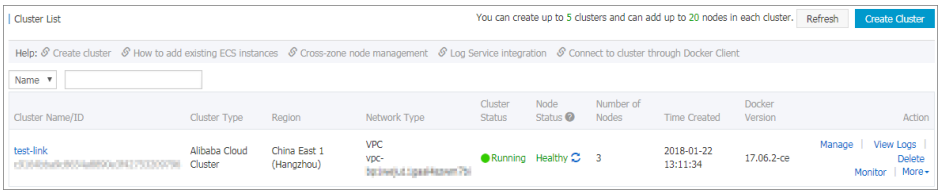
The preceding orchestration template deploys a Web service and a Redis service. The Web service contains three Flask containers and these three containers will be evenly distributed to three nodes when started. The three containers are on different hosts and the current network can realize cross-host container connectivity if the containers can ping each other. The Redis service runs on one of the three nodes. When started, each Flask container registers to the Redis service and reports the container IP address. The Redis service has the IP addresses of all the containers in the cluster after the three Flask containers are all started. When you access any of the three Flask containers, the container will send ping command to the other two containers and you can check the network connectivity of the cluster according to the ping command response.

Procedure

Create a cluster which contains three nodes.

In this example, the cluster name is **test-link**. For how to create a cluster, see Create a cluster.

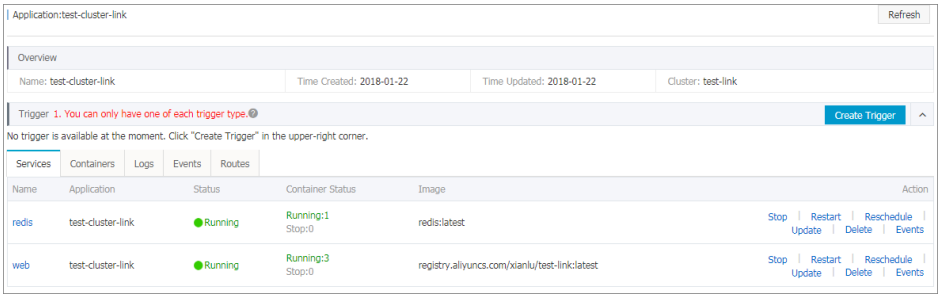
> **Note:** Select to create a Server Load Balancer instance when creating the cluster.



Use the preceding template to create an application (in this example, the application name is **test-cluster-link**) to deploy the **web** service and **redis** service.

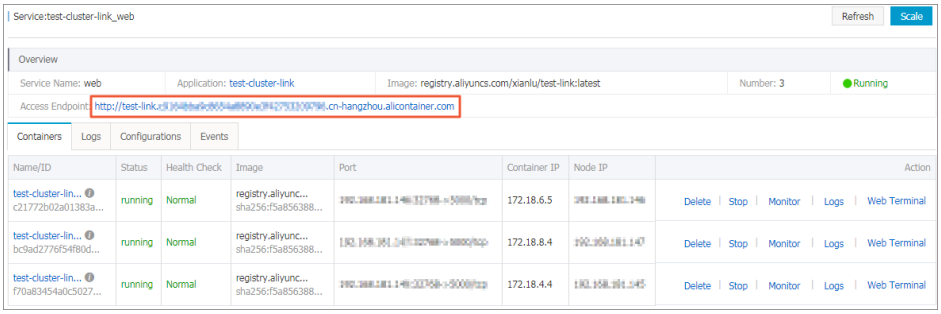
For how to create an application, see Create an application.

On the **Application List** page, click the application name to view the created services.



Click the name of the **web** service to enter the service details page.

You can see that the three containers (**test-cluster-link_web_1**, **test-cluster-link_web_2**, **test-cluster-link_web_3**) are all started and distributed on different nodes.



Visit the access endpoint of the **web** service.

As shown in the following figure, the container **test-cluster-link_web_1** can access the container **test-cluster-link_web_2** and container **test-cluster-link_web_3**.

Refresh the page. As shown in the following figure, the **container test-cluster-link_web_2** can access the container **test-cluster-link_web_1** and container **test-cluster-link_web_3**.

As the preceding results show, the containers in the cluster can access each other.

Log

Use ELK in Container Service

Background

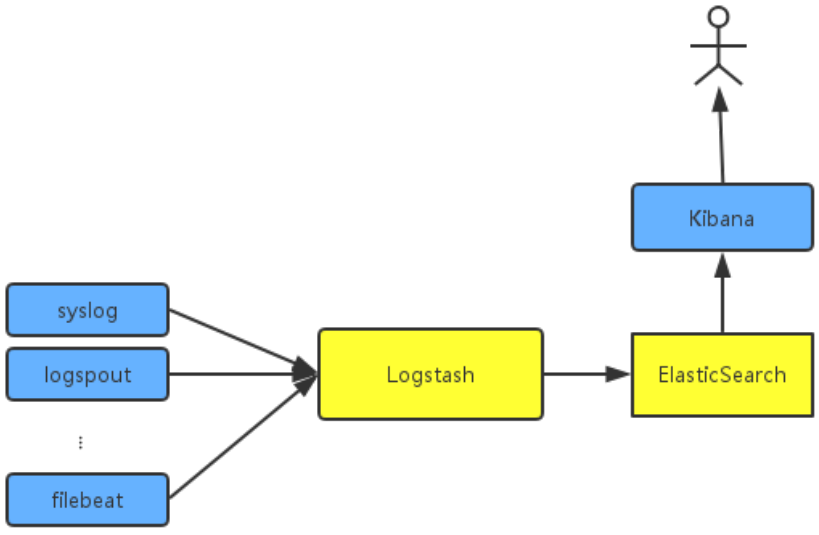
Logs are an important component of the IT system. They record system events and the time when the events occur. We can troubleshoot system faults according to the logs and make statistical analysis.

Logs are usually stored in the local log files. To view logs, log on to the machine and filter keywords by using grep or other tools. However, when the application is deployed on multiple machines, viewing logs in this way is inconvenient. To locate the logs for a specific error, you have to log on to all the machines and filter files one after another. That is why concentrated log storage has emerged. All the logs are collected in Log Service and you can view and search for logs in Log Service.

In the Docker environment, concentrated log storage is even more important. Compared with the traditional operation and maintenance mode, Docker usually uses the orchestration system to manage containers. The mapping between container and host is not fixed and containers might be constantly migrated between hosts. You cannot view the logs by logging on to the machine and the concentrated log becomes the only choice.

Container Service integrates with Alibaba Cloud Log Service and automatically collects container logs to Log Service by using declarations. However, some users might prefer the ELK (Elasticsearch+ Logstash+ Kibana) combination. This document introduces how to use ELK in Container Service.

Overall structure



An independent Logstash cluster needs to be deployed. Logstash is large and resource-consuming, so we do not run it on each machine, not to mention in every Docker container. To collect the

container logs, syslog, Logspout, and filebeat are used. You might also use other collection methods.

To try to fit the actual scenario, two clusters are created here: one is the **testelk** cluster for deploying ELK, and the other is the **app** cluster for deploying applications.

Procedure

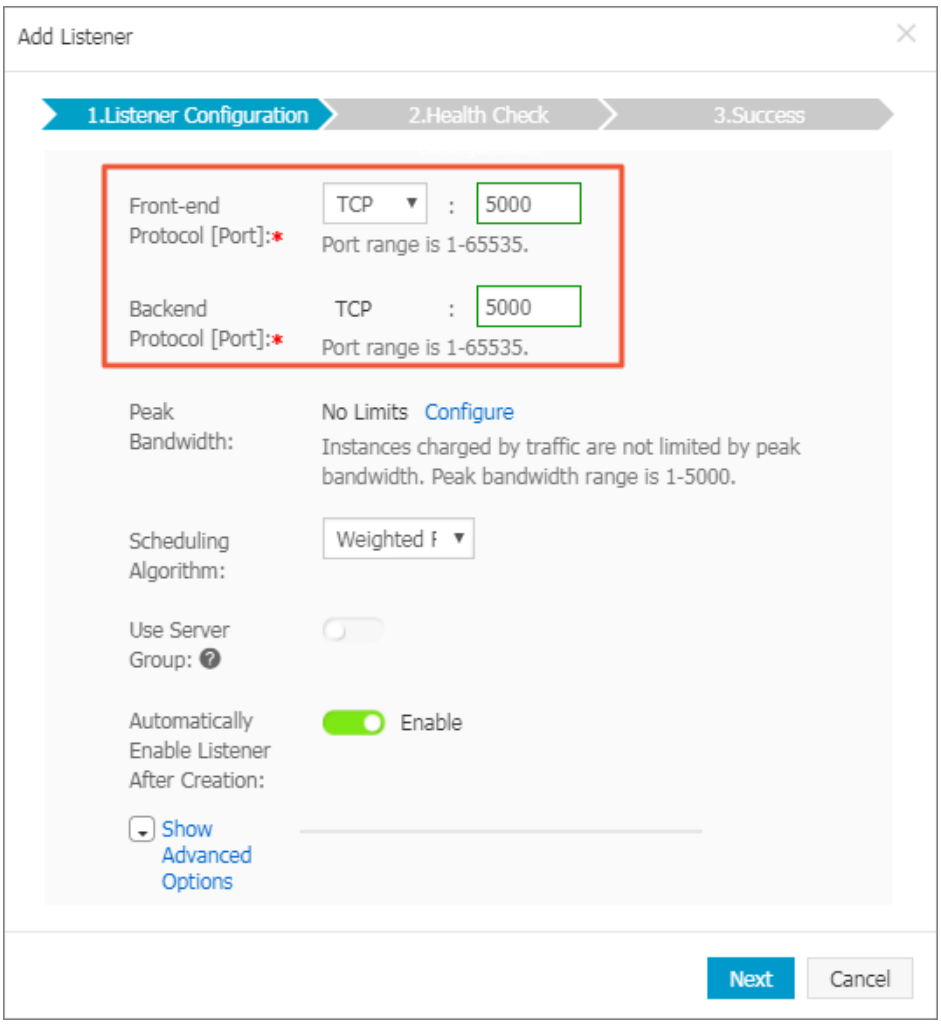
> **Note:** The clusters and Server Load Balancer instance created in this document must be in the same region.

Step 1. Create a Server Load Balancer instance

To enable other services to send logs to Logstash, create and configure a Server Load Balancer instance before configuring Logstash.

1. Log on to the Server Load Balancer console before creating an application.
2. Create a Server Load Balancer instance whose **Instance type** is **Internet**.

   Add 2 listeners for the created Server Load Balancer instance. The frontend and backend port mappings of the 2 listeners are 5000: 5000 and 5044: 5044 respectively, with no backend server added.



Step 2. Deploy ELK

Log on to the Container Service console.

Create a cluster named **testelk**. For how to create a cluster, see Create a cluster.

> **Note:** The cluster and the Server Load Balancer instance created in step 1 must be in the same region.

Bind the Server Load Balancer instance created in step 1 to this cluster.

On the **Cluster List** page, click **Manage** at the right of **testelk**. Click **Load Balancer Settings** in the left-side navigation pane. Click **Bind Server Load Balancer**. Select the created Server Load Balancer instance from the **Server Load Balancer ID** list and then click **OK**.

Deploy ELK by using the following orchestration template. In this example, an application named **elk** is created.

For how to create an application by using an orchestration template, see Create an application.

> **Note:** Replace ${SLB_ID} in the orchestration file with the ID of the Server Load Balancer instance created in step 1.

```
 version: '2'
services:
elasticsearch:
image: elasticsearch

kibana:
image: kibana
environment:
ELASTICSEARCH_URL: http://elasticsearch:9200/
labels:
aliyun.routing.port_5601: kibana
links:
- elasticsearch

logstash:
image: registry.cn-hangzhou.aliyuncs.com/acs-sample/logstash
hostname: logstash
ports:
- 5044:5044
- 5000:5000
labels:
aliyun.lb.port_5044: 'tcp://${SLB_ID}:5044' #Create a Server Load Balancer instance first.
aliyun.lb.port_5000: 'tcp://${SLB_ID}:5000'
links:
- elasticsearch
```

In this orchestration file, the official images are used for Elasticsearch and Kibana, with no changes made. Logstash needs a configuration file, so make an image on your own to include the configuration file. The image source codes can be found in demo-logstash.

The Logstash configuration file is as follows. This is a simple Logstash configuration. Two input formats, syslog and filebeats, are provided and their external ports are 5044 and 5000 respectively.

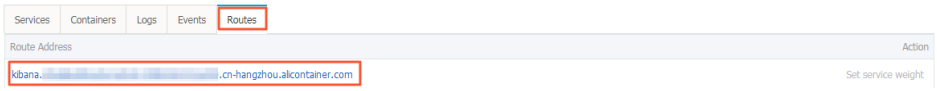
```
 input {
beats {
port => 5044
type => beats
}

tcp {
```

```
port => 5000
type => syslog
}

}

filter {
}

output {
elasticsearch {
hosts => ["elasticsearch:9200"]
}

stdout { codec => rubydebug }
}
```

Configure the Kibana index.

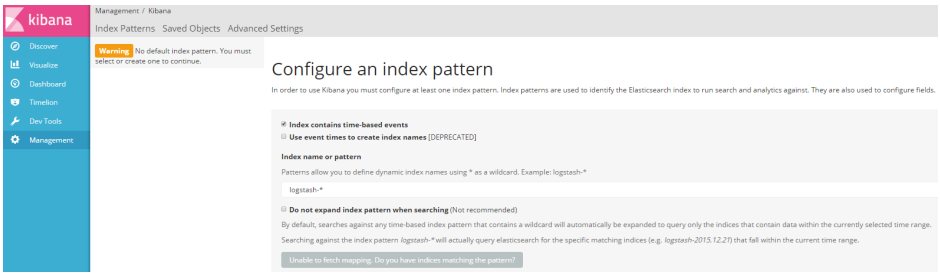
Access Kibana.

The URL can be found under the **Routes** tab of the application.
On the **Application List** page, click the application name **elk**. Click the **Routes** tab and then click the route address to access Kibana.



Create an index.

Configure the settings as per your needs and then click **Create**.



Step 3. Collect logs

In Docker, the standard logs adopt Stdout file pointer. The following example first demonstrates how to collect Stdout to ELK. If you are using file logs, you can use filebeat directly. WordPress is used for the demonstration. The following is the orchestration template of WordPress. An application **wordpress** is created in another cluster.

Log on to the Container Service console.

Create a cluster named **app**. For how to create a cluster, see Create a cluster.

> **Note:** The cluster and the Server Load Balancer instance created in step 1 must be in the same region.

Create the application **wordpress** by using the following orchestration template:

> **Note:** Replace ${SLB_IP} in the orchestration file with the IP address of the Server Load Balancer instance created in step 1.

```
 version: '2'
services:
mysql:
image: mysql
environment:
- MYSQL_ROOT_PASSWORD=password

wordpress:
image: wordpress
labels:
aliyun.routing.port_80: wordpress
links:
- mysql:mysql
environment:
- WORDPRESS_DB_PASSWORD=password
logging:
driver: syslog
options:
syslog-address: 'tcp://${SLB_IP}:5000'
```

After the application is deployed successfully, click the application name **wordpress** on the **Application List** page. Click the **Routes** tab and then click the route address to access the WordPress application.

On the **Application List** page, click the application name **elk**. Click the **Routes** tab and then click the route address to access Kibana and view the collected logs.

A new Docker log collection scheme: log-pilot

This document introduces a new log collection tool for Docker: log-pilot. Log-pilot is a log collection image we provide for you. You can deploy a log-pilot instance on each machine to collect all the Docker application logs.

> **Note:** Docker of Linux version is supported, while Docker of Windows or Mac version is not supported.

Log-pilot has the following features:

- A separate log process collects the logs of all the containers on the machine. No need to start a log process for each container.
- Log-pilot supports file logs and stdout logs. Docker log driver or Logspout can only process stdout, while log-pilot supports collecting the stdout logs and the file logs.
- Declarative configuration. When your container has logs to collect, log-pilot will automatically collect logs of the new container if the path of the log file to be collected is declared by using the label. No other configurations need to be changed.
- Log-pilot supports multiple log storage methods and can deliver the logs to the correct location for powerful Alibaba Cloud Log Service, popular ElasticSearch combination, or even Graylog.
- Open-source. Log-pilot is fully open-sourced. You can download the codes from log-pilot GitHub project. If the current features cannot meet your requirements, welcome to raise an issue.

Quick start

See a simple scenario as follows: start a log-pilot and then start a Tomcat container, letting log-pilot collect Tomcat logs. For simplicity, here Alibaba Cloud Log Service or ELK is not involved. To run locally, you only need a machine that runs Docker.

First, start log-pilot.

> **Note:** When log-pilot is started in this way, all the collected logs will be directly output to the console because no log storage is configured for backend use. Therefore, this method is mainly for debugging.

Open the terminal and enter the following commands:

```
docker run --rm -it \
-v /var/run/docker.sock:/var/run/docker.sock \
-v /:/host \
--privileged \
registry.cn-hangzhou.aliyuncs.com/acs-sample/log-pilot:0.1
```

You will see the startup logs of log-pilot.

```
bash-3.2$ docker run --rm -it \
>     -v /var/run/docker.sock:/var/run/docker.sock \
>     -v /:/host \
>     registry.cn-hangzhou.aliyuncs.com/acs-sample/fluentd-pilot:0.1
use default output

DEBU[0000] ad93dbee9691cc6a1ed1f9fab9ee365774d2f43262870425633940547 5de3515 has not log config, skip
WARN[0000] start fluentd
2017-02-08 14:09:24 +0000 [info]: reading config file path="/etc/fluentd/fluentd.conf"
2017-02-08 14:09:24 +0000 [info]: starting fluentd-0.12.32
2017-02-08 14:09:24 +0000 [info]: gem 'fluent-plugin-elasticsearch' version '1.9.2'
2017-02-08 14:09:24 +0000 [info]: gem 'fluentd' version '0.12.32'
2017-02-08 14:09:24 +0000 [info]: adding match pattern="**" type="stdout"
2017-02-08 14:09:24 +0000 [info]: using configuration file: <ROOT>
  <match **>
    @type stdout
  </match>
</ROOT>

DEBU[0108] Process container start event: f04e7fc992e5c17d5c18086831b2ce1a9af8815870d09b02833b372c1bf27860
INFO[0108] logs: [{catalina /host/var/lib/docker/containers/f04e7fc992e5c17d5c18086831b2ce1a9af8815870d09b02833b372c1bf27860 _ json f04e7fc992e5c17d5c18086831b2ce1a9af8815870d09b02833b372
on.log map[]} {access /host/var/lib/docker/volumes/424d96798c525540216 8df54806e1055884a8140389275703917 99aff176547f/_data /usr/local/tomcat/logs none localhost_access_log.*.txt map[]}]
```

Do not close the terminal. Open a new terminal to start Tomcat. The Tomcat image is among the few Docker images that use stdout and file logs at the same time, and is suitable for the demonstration here.

```
docker run -it --rm  -p 10080:8080 \
-v /usr/local/tomcat/logs \
--label aliyun.logs.catalina=stdout \
--label aliyun.logs.access=/usr/local/tomcat/logs/localhost_access_log.*.txt \
tomcat
```

Note:

- aliyun.logs.catalina=stdout tells log-pilot that this container wants to collect stdout logs.
- aliyun.logs.access=/usr/local/tomcat/logs/localhost_access_log.*.txt indicates to collect all log files whose names comply with the localhost_access_log.*.txt format under the /usr/local/tomcat/logs/ directory in the container. The label usage will be introduced in details later.

> **Note:** If you deploy Tomcat locally, instead of in the Alibaba Cloud Container Service, specify -v /usr/local/tomcat/logs. Otherwise, log-pilot cannot read log files. Container Service has implemented the optimization and you do not need to specify -v on your own.

Log-pilot will monitor the events in the Docker container. When it finds any container with aliyun.logs.xxx, it will automatically parse the container configuration and start to collect the corresponding logs. After you start Tomcat, you will find many contents are output immediately by the log-pilot terminal, including the stdout logs output at the Tomcat startup, and some debugging information output by log-pilot itself.

You can access the deployed Tomcat in the browser, and find that similar records are displayed on the log-pilot terminal every time you refresh the browser. The contents after message are the logs collected from /usr/local/tomcat/logs/localhost_access_log.XXX.txt.

Use ElasticSearch + Kibana

Deploy ElastichSearch + Kibana. See Use ELK in Container Service to deploy ELK in Alibaba Cloud Container Service, or deploy them directly on your machine by following the ElasticSearch/Kibana documents. This document assumes that you have deployed the two components.

If you are still running the log-pilot, close it first, and then start it again by using the following commands:

> **Note:** Before running the following commands, replace the two variables ELASTICSEARCH_HOST and ELASTICSEARCH_PORT with the actual values you are using. ELASTICSEARCH_PORT is generally 9200.

```
docker run --rm -it \
-v /var/run/docker.sock:/var/run/docker.sock \
-v /:/host \
--privileged \
-e FLUENTD_OUTPUT=elasticsearch \
-e ELASTICSEARCH_HOST=${ELASTICSEARCH_HOST} \
-e ELASTICSEARCH_PORT=${ELASTICSEARCH_PORT}
registry.cn-hangzhou.aliyuncs.com/acs-sample/log-pilot:0.1
```

Compared with the previous log-pilot startup method, here three environment variables are added:

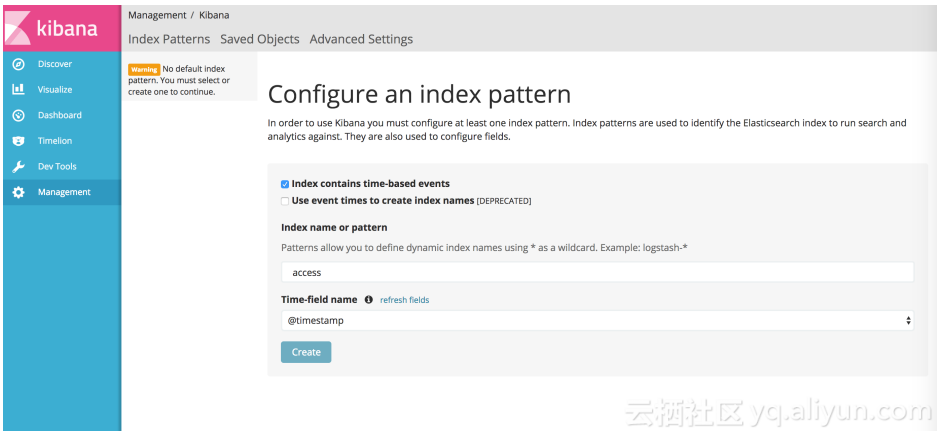
- FLUENTD_OUTPUT=elasticsearch: Send the logs to ElasticSearch.
- ELASTICSEARCH_HOST=${ELASTICSEARCH_HOST}: The domain name of ElasticSearch.
- ELASTICSEARCH_PORT=${ELASTICSEARCH_PORT}: The port number of ElasticSearch.

Continue to run the Tomcat started previously, and access it again to make Tomcat generate some logs. All these newly generated logs will be sent to ElasticSearch.

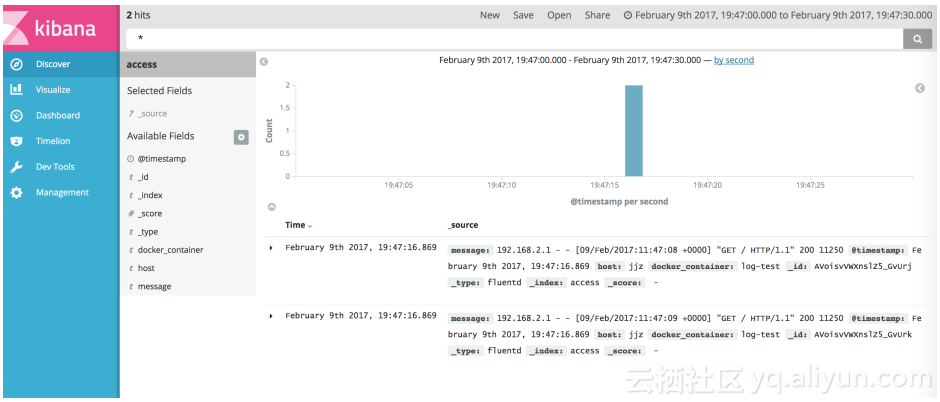
Open Kibana, and no new logs are visible yet. Create an index first. Log-pilot will write logs to the specific index of ElasticSearch. The rules are as follows:

If label aliyun.logs.tags is used in the application, and tags contains target, use target as the index of ElasticSearch. Otherwise, use XXX in the label aliyun.logs.XXX as the index.

In the previous example about Tomcat, the label aliyun.logs.tags is not used, so access and catalina are used by default as the index. First create the index access.



After the index is created, you can view the logs.



Use log-pilot in Alibaba Cloud Container Service

Container Service makes some special optimization for log-pilot, which adapts to running log-pilot best.

To run log-pilot in Container Service, create an application by using the following orchestration file. For how to create an application, see Create an application.

```
pilot:
image: registry.cn-hangzhou.aliyuncs.com/acs-sample/log-pilot:0.1
volumes:
- /var/run/docker.sock:/var/run/docker.sock
- /:/host
privileged: true
environment:
FLUENTD_OUTPUT: elasticsearch #Replace based on your requirements
ELASTICSEARCH_HOST: ${elasticsearch} #Replace based on your requirements
ELASTICSEARCH_PORT: 9200
labels:
aliyun.global: true
```

Then, you can use the aliyun.logs.xxx label on the application that you want to collect logs.

Label description

When Tomcat is started, the following two labels are declared to tell log-pilot the location of the container logs.

```
--label aliyun.logs.catalina=stdout
--label aliyun.logs.access=/usr/local/tomcat/logs/localhost_access_log.*.txt
```

You can also add more labels on the application container.

aliyun.logs.$name = $path

- The variable name is the log name and can only contain 0–9, a–z, A–Z, and hyphens (-).
- The variable path is the path of the logs to be collected. The path must specify the file, and cannot only be a directory. Wildcards are supported as part of the file name, for example, /var/log/he.log and /var/log/*.log are both correct. However, /var/log is not valid because the path cannot be only a directory. stdout is a special value, indicating standard output.

aliyun.logs.$name.format: The log format. Currently, the following formats are supported.

- none: Unformatted plain text.
- json: JSON format. One complete JSON string in each line.
- csv: CSV format.

aliyun.logs.$name.tags: The additional field added when the logs are reported. The format is k1=v1,k2=v2. The key-value pairs are separated by commas, for example, aliyun.logs.access.tags="name=hello,stage=test". Then, the logs reported to the storage will contain the name field and the stage field.

If ElasticSearch is used for log storage, the target tag will have a special meaning, indicating the corresponding index in ElasticSearch.

Log-pilot extension

For most users, the existing features of log-pilot can meet their requirements. If log-pilot cannot meet your requirements, you can:

- Submit an issue at https://github.com/AliyunContainerService/log-pilot.
- Directly change the codes and then raise the PR.

Health check mechanism of Docker containers

In a distributed system, the service availability needs to be frequently checked by using the health check mechanism to avoid exceptions when being called by other services. Docker introduced native health check implementation after version 1.12. This document introduces the health check mechanism of Docker containers and the new features in Docker swarm mode.

Process-level health check checks whether or not the process is alive and is the simplest health check for containers. Docker daemon automatically monitors the PID1 process in the container. If the docker run command specifies the restart policy, closed containers can be restarted automatically according to the restart policy. In practical use, process-level health check alone is far from enough. For example, if a container process is still alive, but cannot respond to user requests because of application deadlock, such problems cannot be discovered by process monitoring.

Kubernetes provides Liveness and Readness probes to check the health status of the container and its service respectively. Alibaba Cloud Container Service also provides a similar Service health check mechanism.

Docker native health check capability

Docker introduced the native health check implementation after version 1.12. The health check configurations of an application can be declared in the Dockerfile. The HEALTHCHECK instruction declares the health check command that can be used to determine whether the service status of the container master process is normal. This can reflect the real status of the container.

HEALTHCHECK instruction format:

- HEALTHCHECK [option] CMD <command>: The command that sets the container health check.
- HEALTHCHECK NONE: If the basic image has a health check instruction, this line can be used to block it.

> **Note:** The HEALTHCHECK can only appear once in the Dockerfile. If multiple HEALTHCHECK instructions exist, only the last one takes effect.

Images built by using Dockerfiles that contain HEALTHCHECK instructions can check the health status when instantiating Docker containers. Health check is started automatically after the container is started.

HEALTHCHECK supports the following options:

- --interval=<interval>: The time interval between two health checks. The default value is 30 seconds.
- --timeout=<interval>: The timeout time for running the health check command. The health check fails if it lasts longer than this time period. The default value is 30 seconds.
- --retries=<number of times>: When the health check fails continuously for a specified number of times, the container status is regarded as unhealthy. The default value is 3.
- --start-period=<interval>: The initialization time of application startup. Failed health check during the startup is not counted. The default value is 0 second (introduced from version 17.05).

The command after HEALTHCHECK [option] CMD follows the same format as ENTRYPOINT, in either the shell or the exec format. The returned value of the command determines the success or failure of the health check:

- 0: Success.
- 1: Failure.
- 2: Reserved value. Do not use.

After a container is started, the initial status is **Starting**. Docker Engine waits for a period of interval to regularly run the health check command. If the returned value of a single check is not **0** or the running lasts longer than the specified timeout time, the health check is considered as failed. If the health check fails continuously for retries times, the health status changes to **Unhealthy**.

- If the health check succeeds once, Docker will change the container status back to **Healthy**.
- When the container health status changes, Docker Engine issues a health_status event.

Assume that an image is a simple Web service. To enable health check to determine whether its Web service is working normally or not, curl can be used to help with the determination and the HEALTHCHECK instruction in its Dockerfile can be written as follows:

```
FROM elasticsearch:5.5
HEALTHCHECK --interval=5s --timeout=2s --retries=12 \
CMD curl --silent --fail localhost:9200/_cluster/health || exit 1


docker build -t test/elasticsearch:5.5 .
docker run --rm -d \
--name=elasticsearch \
test/elasticsearch:5.5
```

You can use docker ps. After several seconds, the Elasticsearch container changes from the **Starting** status to **Healthy** status.

```
$ docker ps
CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES
```

```
c9a6e68d4a7f test/elasticsearch:5.5 "/docker-entrypoin..." 2 seconds ago Up 2 seconds (health: starting) 9200/tcp, 9300/tcp elasticsearch
$ docker ps
CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES
c9a6e68d4a7f test/elasticsearch:5.5 "/docker-entrypoin..." 14 seconds ago Up 13 seconds (healthy) 9200/tcp, 9300/tcp elasticsearch
```

Another method is to directly specify the health check policy in the docker run command.

```
$ docker run --rm -d \
--name=elasticsearch \
--health-cmd="curl --silent --fail localhost:9200/_cluster/health || exit 1" \
--health-interval=5s \
--health-retries=12 \
--health-timeout=2s \
elasticsearch:5.5
```

To help troubleshoot the issue, all output results of health check commands (including stdout and stderr) are stored in health status and you can view them with the docker inspect command. Use the following commands to retrieve the health check results of the past five containers.

```
docker inspect --format='{{json .State.Health}}' elasticsearch
```

Or

```
docker inspect elasticsearch | jq ".[].State.Health"
```

The sample result is as follows:

```
{
"Status": "healthy",
"FailingStreak": 0,
"Log": [
{
"Start": "2017-08-19T09:12:53.393598805Z",
"End": "2017-08-19T09:12:53.452931792Z",
"ExitCode": 0,
"Output": "..."
},
...
}
```

We usually recommend that you declare the corresponding health check policy in the Dockerfile to facilitate the use of images because application developers know better about the application SLA. The application deployment and Operation & Maintenance personnel can adjust the health check policies as needed for deployment scenarios by using the command line parameters and REST API.

The Docker community provides some instance images that contain health checks. Obtain them in

the following project: https://github.com/docker-library/healthchec.

Note:

- Alibaba Cloud Container Service supports Docker native health check mechanism and Alibaba Cloud extension health check mechanism.
- Currently, Kubernetes does not support Docker native health check mechanism.

Health check capability for Docker swarm mode services

After Docker 1.13, health check policies are supported in the Docker swarm mode.

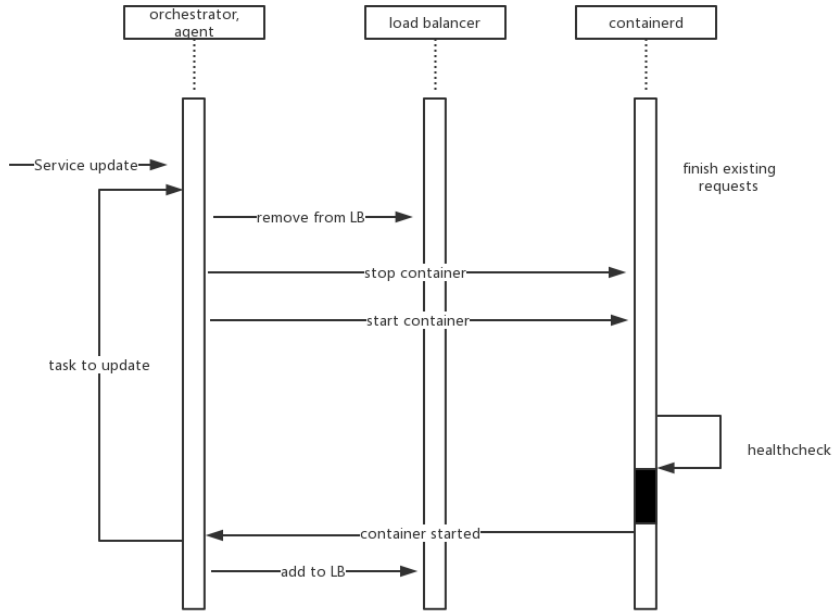
You can specify the health check policy in the docker service create command:

```
$ docker service create -d \
--name=elasticsearch \
--health-cmd="curl --silent --fail localhost:9200/_cluster/health || exit 1" \
--health-interval=5s \
--health-retries=12 \
--health-timeout=2s \
elasticsearch
```

In swarm mode, Swarm manager monitors the health status of service tasks. When a container enters the **Unhealthy** status, Swarm manager stops the container and starts a new container to replace the unhealthy one. The backend or DNS records of the Server Load Balancer (routing mesh) are automatically updated during this process to guarantee the service availability.

After version 1.13, health checks are supported in the service updating phase. In this way, the Server Load Balancer/DNS resolution do not send requests to a new container before it is fully started and enters the **Healthy** status, which makes sure that the requests will not be interrupted when applications are being updated.

The following is a sequence chart of the service updating process.



In a corporate production environment, reasonable health check settings can guarantee the application availability. Currently, many application frameworks are already built with monitoring and checking capabilities, such as Spring Boot Actuator. Integrated with the Docker built-in health check mechanism, you can implement application availability monitoring, automatic fault handling, and zero downtime updating in a concise manner.

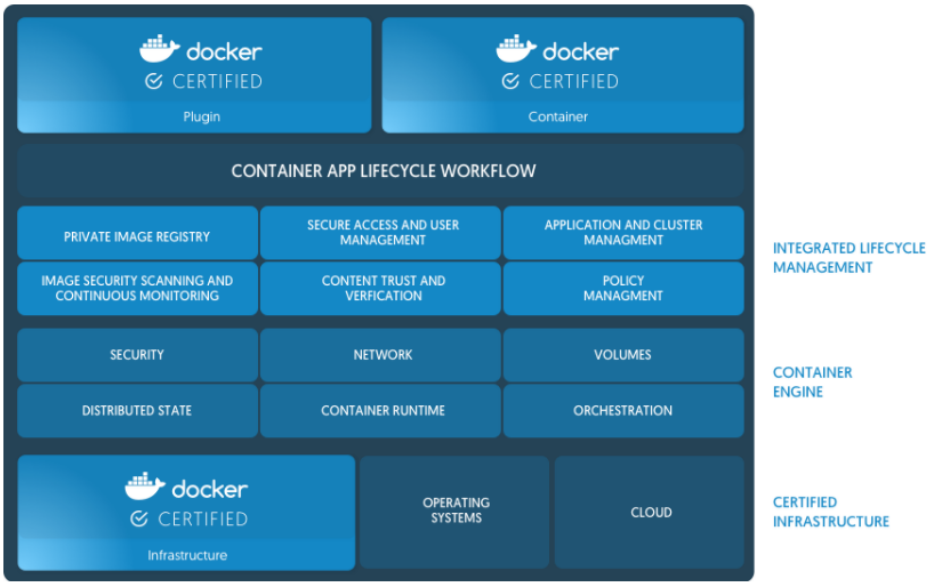
One-click deployment of Docker Datacenter

About DDC

Docker Datacenter (DDC) is an enterprise-level container management and service deployment package solution platform released by Docker. DDC is composed of the following three components:

- Docker Universal Control Plane (Docker UCP): A set of graphical management interfaces.
- Docker Trusted Registry (DTR): A trusted Docker image repository.
- Docker Engine enterprise edition: The Docker Engine providing technical support.

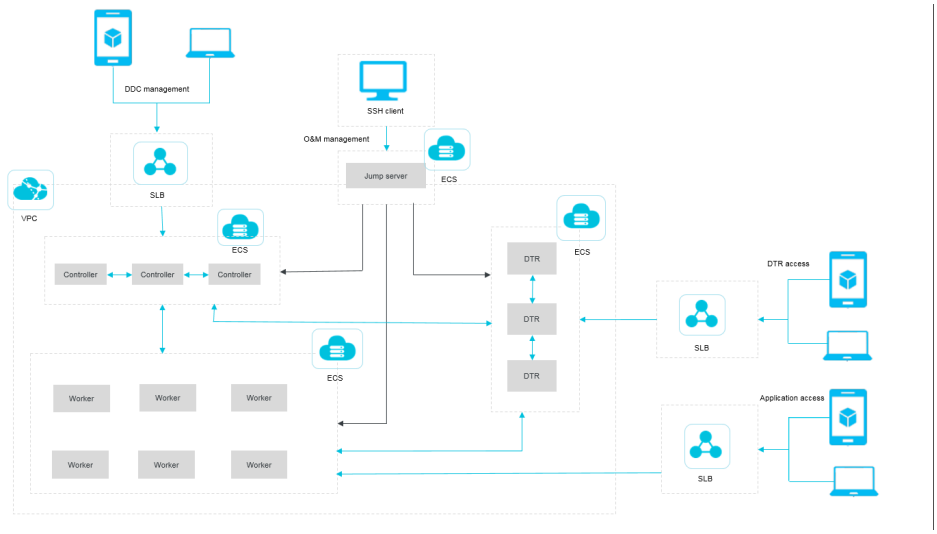
DDC is available on the Docker official website.



DDC is a counterpart of Docker Cloud, another online product of the Docker company. However, DDC primarily targets enterprise users for internal deployment. You can register your own Docker image to DTR and use UCP to manage the entire Docker cluster. Both components provide web interfaces.

You must purchase a license to use DDC, but the Docker company provides a free license for a one-month trial. You can download the trial license from the Docker official website after signing up.

DDC deployment architecture



In the preceding basic architecture figure, Controller primarily runs the UCP component, DTR runs the DTR component, and Worker primarily runs your own Docker service. The entire DDC environment is deployed on the Virtual Private Cloud (VPC) and all Elastic Compute Service (ECS) instances are in the same security group. Every component provides a Server Load Balancer instance for extranet access. Operations and maintenance are implemented by using the jump server. To enhance the availability, the entire DDC environment is deployed for high availability, meaning at least two Controllers and two DTRs exist.

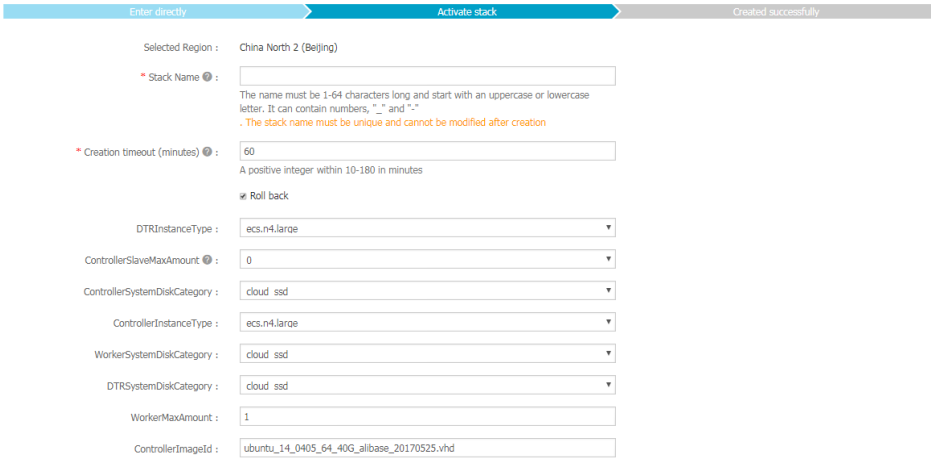
One-click deployment of DDC

You can use Alibaba Cloud Resource Orchestration Service (ROS) to deploy DDC in one click at the following link.

One-click deployment of DDC

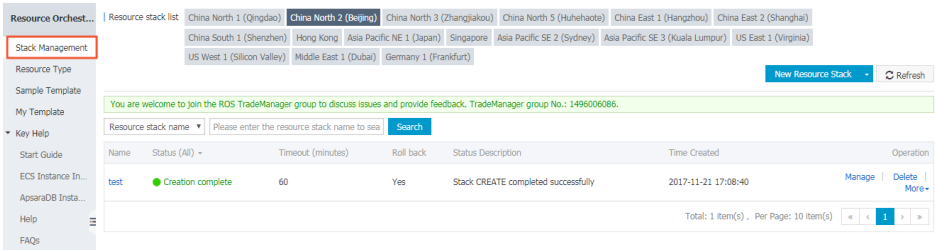
In the preceding orchestration template, DDC is deployed in the region China North 2 (Beijing) by default. To change the region for deployment, click **Back** in the lower-right corner of the page. Select your region and then click **Next**.

Complete the configurations. Click **Create** to deploy a set of DDC.



DDC access

After creating DDC successfully by using ROS, you can enter the ROS stack management page by clicking **Stack Management** in the left-side navigation pane. Find the created stack, and then click the stack name or **Manage** at the right of the stack. The **Stack Overview** page appears.



You can view the addresses used to log on to UCP and DTR in the **Output** section.

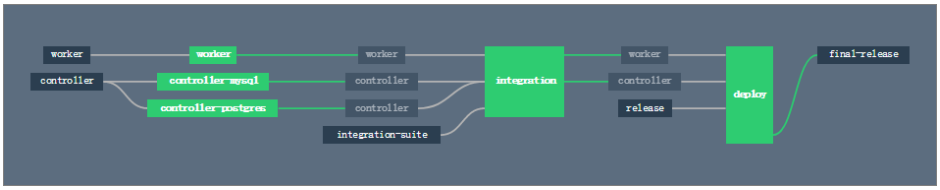
Enter the UCP address in the browser and the UCP access page appears. Enter the administrator account and password created when installing UCP and the system prompts you to import the license file. Import the license file and then enter the UCP control interface.

Kubernetes

Build Concourse CI in Container Service in an easy way

Concourse CI is a CI/CD tool, whose charm lies in the minimalist design and is widely applied to the CI/CD of each Cloud Foundry module. Concourse CI officially provides the standard Docker images and you can use Alibaba Cloud Container Service to deploy a set of Concourse CI applications rapidly.

Get to know the principle of Concourse if you are not familiar with the Concourse CI tool. For more information, see Concourse architecture.



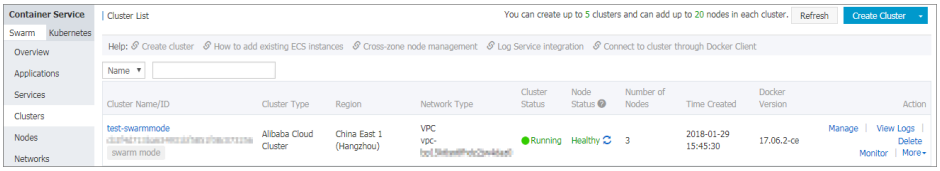
Create a swarm mode cluster

Log on to the Container Service console to create a cluster. In this example, create a swarm mode cluster with one node and whose network type is Virtual Private Cloud (VPC).

For how to create a cluster, see Create a cluster.

> **Note:** You must configure the external URL for Concourse, allowing you to access the web

service of Concourse from the current machine. Therefore, retain the public IP address or Elastic IP (IP) when creating a container cluster.



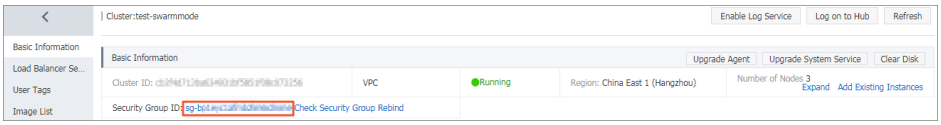
Configure security group rules

The Concourse component ATC monitors the port 8080 by default. Therefore, you must configure the inbound permissions of port 8080 for the cluster security group. For more information about the principle of Concourse, see Concourse architecture.

In the Container Service console, click **Clusters** in the left-side navigation pane under **Swarm** .

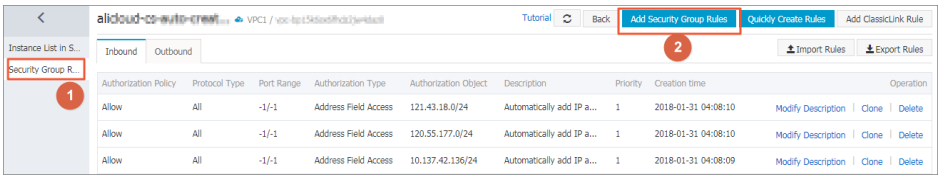
Click **Manage** at the right of the created cluster.

On the **Basic Information** page, click the security group ID.

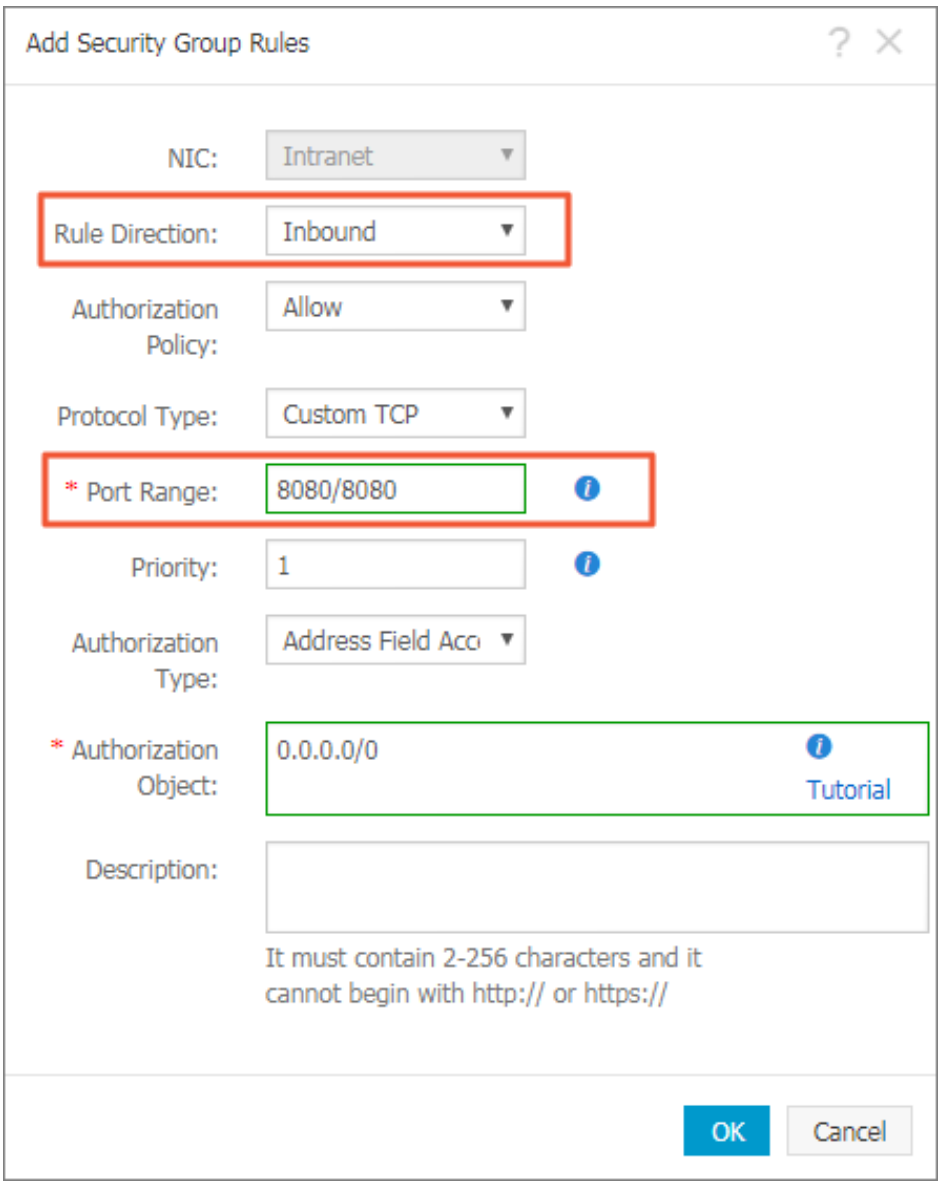


Click **Security Group Rules** in the left-side navigation pane.

Click **Add Security Group Rules**.



Configure the inbound permissions of port 8080 for the security group and then click **OK**.



Create keys in the ECS instance

You must generate three private keys for running Concourse safely. For the specific functions for these keys, see **Generating Keys** in the Standalone Binary.

Log on to the Elastic Compute Service (ECS) instance. In the root directory, create the directories keys/web and keys/worker. You can run the following command to create these two directories rapidly.

```
mkdir -p keys/web keys/worker
```

Run the following command to generate three private keys.

```
ssh-keygen -t rsa -f tsa_host_key -N ''
ssh-keygen -t rsa -f worker_key -N ''
ssh-keygen -t rsa -f session_signing_key -N ''
```

Copy the certificate to the corresponding directory.

```
cp ./keys/worker/worker_key.pub ./keys/web/authorized_worker_keys
cp ./keys/web/tsa_host_key.pub ./keys/worker
```

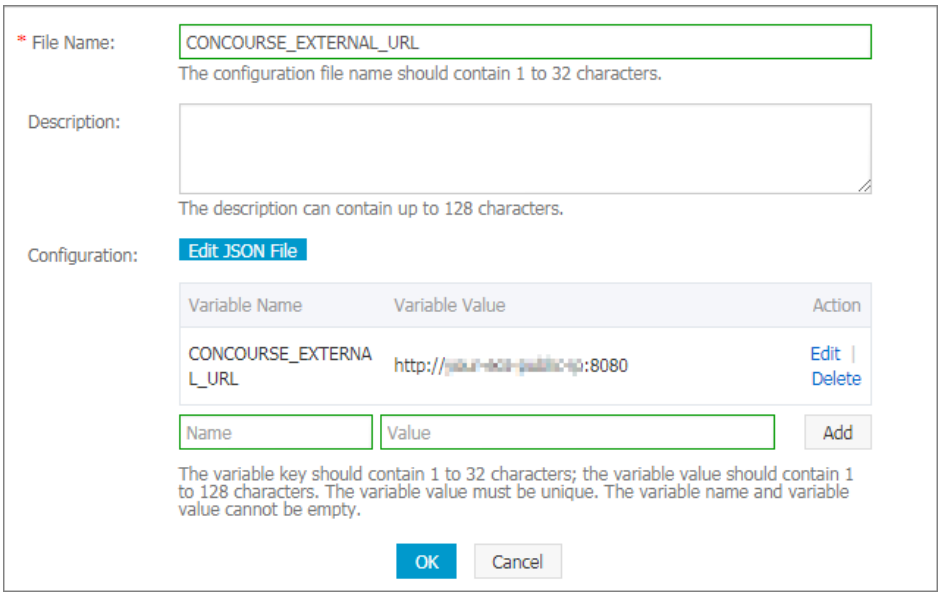
Deploy Concourse CI

Log on to the Container Service console.

Click **Configurations** in the left-side navigation pane under **Swarm**.

Click **Create** in the upper-right corner.

Enter **CONCOURSE_EXTERNAL_URL** as the **Variable Name** and http://your-ecs-public-ip:8080 as the **Variable Value**.



Click **Applications** in the left-side navigation pane.

Select the cluster used in this example from the **Cluster** list.

Click **Create Application** in the upper-right corner.

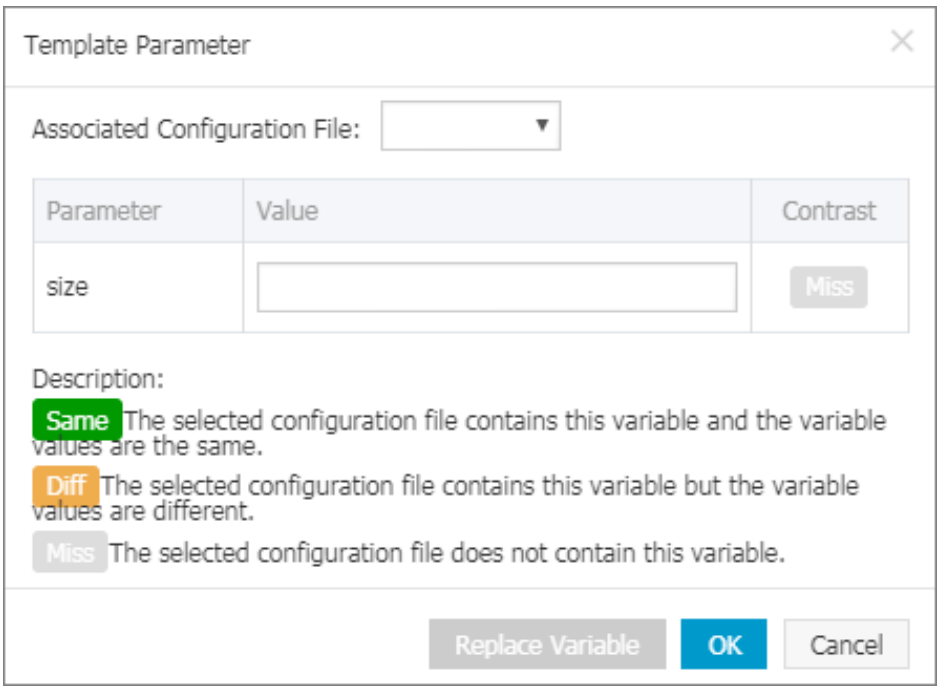
Enter the basic information for the application you are about to create.

Select **Create with Orchestration Template**.

Use the following template:

```
 version: '2'
services:
concourse-db:
image: postgres:9.5
privileged: true
environment:
POSTGRES_DB: concourse
POSTGRES_USER: concourse
POSTGRES_PASSWORD: changeme
PGDATA: /database
concourse-web:
image: concourse/concourse
links: [concourse-db]
command: web
privileged: true
depends_on: [concourse-db]
ports: ["8080:8080"]
volumes: ["/root/keys/web:/concourse-keys"]
restart: unless-stopped # required so that it retries until conocurse-db comes up
environment:
CONCOURSE_BASIC_AUTH_USERNAME: concourse
CONCOURSE_BASIC_AUTH_PASSWORD: changeme
CONCOURSE_EXTERNAL_URL: "${CONCOURSE_EXTERNAL_URL}"
CONCOURSE_POSTGRES_HOST: concourse-db
CONCOURSE_POSTGRES_USER: concourse
CONCOURSE_POSTGRES_PASSWORD: changeme
CONCOURSE_POSTGRES_DATABASE: concourse
concourse-worker:
image: concourse/concourse
privileged: true
links: [concourse-web]
depends_on: [concourse-web]
command: worker
volumes: ["/keys/worker:/concourse-keys"]
environment:
CONCOURSE_TSA_HOST: concourse-web
dns: 8.8.8.8
```

Click **Create and Deploy**. The **Template Parameter** dialog box appears.

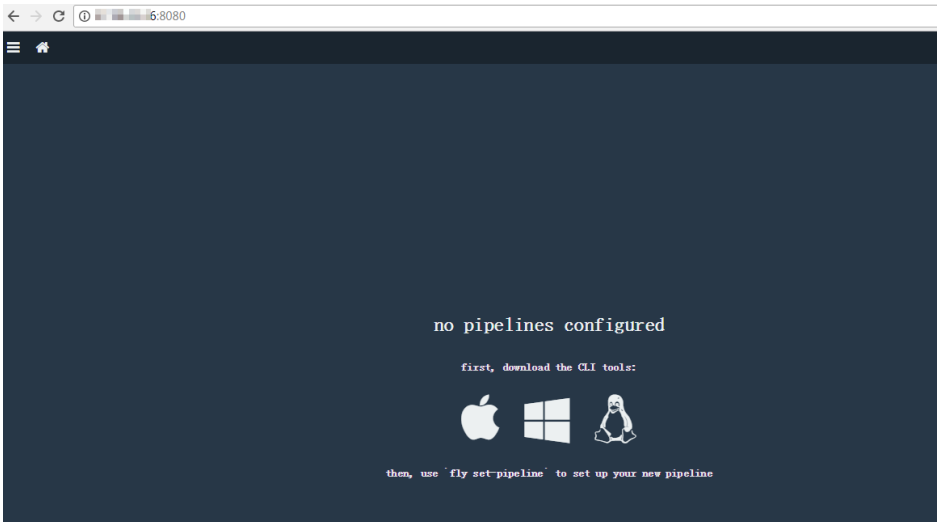


Select the configuration file to be associated with from the **Associated Configuration File** list.

Click **Replace Variable** and click **OK**.

After the application is created, the following three services are started: concourse-worker, concourse-db, and concourse-web.

Then, the Concourse CI deployment is finished. Open http://your-ecs-public-ip:8080 in the browser to access the Concourse CI.



Run a CI task (Hello world)

In the browser opened in the last section, download the CLI corresponding to your operating system and install the CLI client. Use ECS (Ubuntu16.04) as an example.

For Linux and Mac OS X systems, you must add the execution permissions to the downloaded FLY CLI file first. Then, install the CLI to the system and add it to $PATH.

```
chmod +x fly
install fly /usr/local/bin/fly
```

After the installation, you can check the version.

```
$fly -v
3.4.0
```

Connect to the target. The username and password are concourse and changeme by default.

```
$ fly -t lite login -c http://your-ecs-public-ip:8080
in to team 'main'
username: concourse
password:
saved
```

Save the following configuration template as hello.yml.

```
jobs:
- name: hello-world
plan:
- task: say-hello
config:
platform: linux
image_resource:
type: docker-image
source: {repository: ubuntu}
run:
path: echo
args: ["Hello, world!"]
```

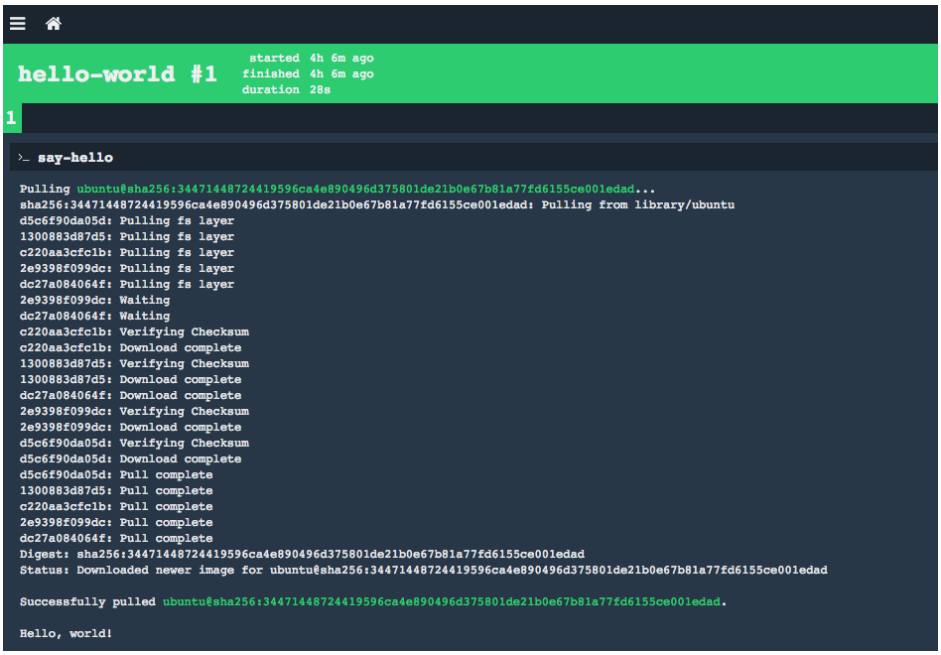
Register the task.

```
fly -t lite set-pipeline -p hello-world -c hello.yml
```

Start the task.

```
fly -t lite unpause-pipeline -p hello-world
```

The page indicating the successful execution is as follows:



For more information about the characteristics of Concourse CI, see Concourse CI project.

Implement Istio distributed tracking in Kubernetes

Background

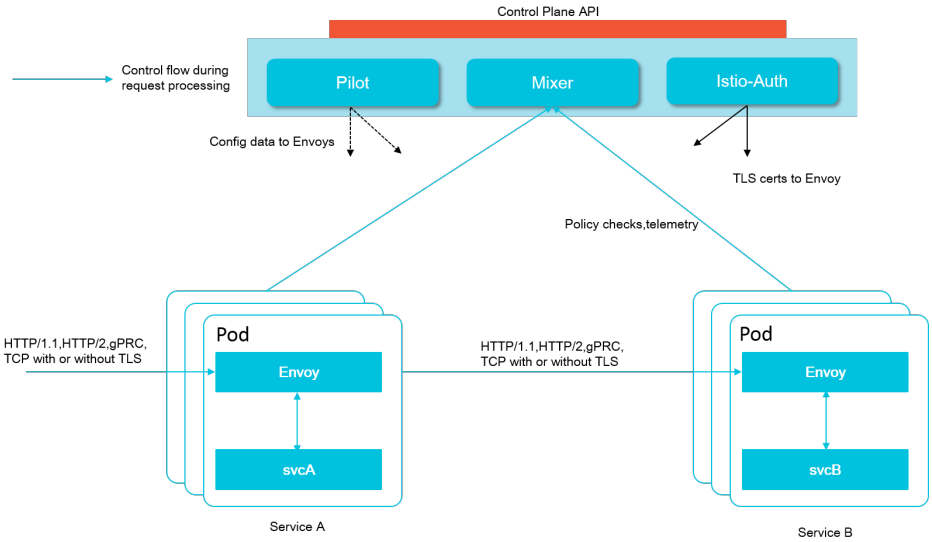
Microservice is a focus in the current era. More and more IT enterprises begin to embrace the microservices. The microservice architecture splits a complex system into several small services and each service can be developed, deployed, and scaled independently. As a heaven-made match, the microservice 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 microservices. 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.



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.

> **Note:** 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 Kubernetes clusters

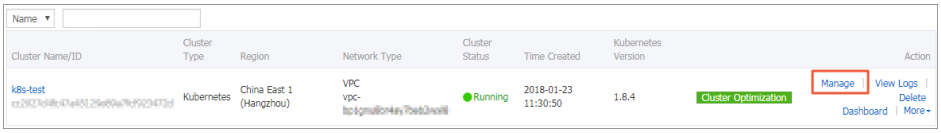
Log on to the Container Service console.

Click **Kubernetes** in the left-side navigation pane.

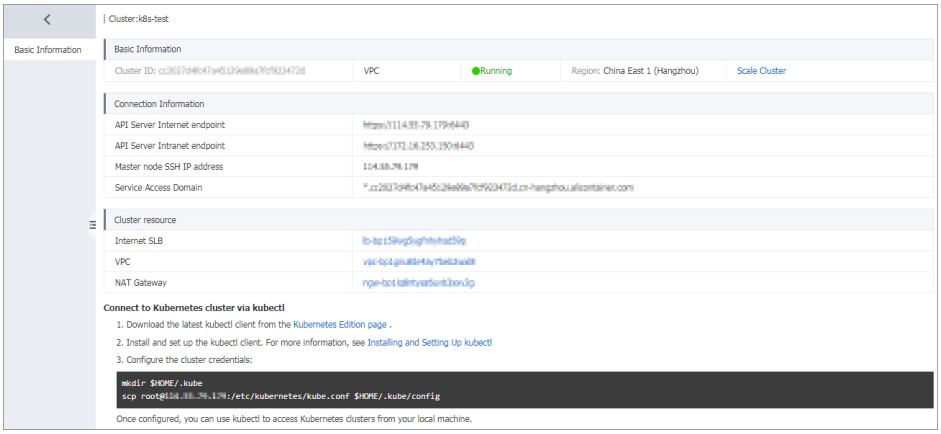
Click **Create Kubernetes Cluster** in the upper-right corner.

Configure the parameters to create a cluster. For how to create a Kubernetes cluster, see Create a cluster.

After the cluster is created, click **Manage** at the right of the cluster when the cluster status is changed to **Running**.



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 kubectl or SSH.



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-system
```

```
NAME TYPE CLUSTER-IP EXTERNAL-IP PORT(S) AGE
svc/istio-ingress LoadBalancer 172.21.10.18 101.37.113.231 80:30511/TCP,443:31945/TCP 1m
svc/istio-mixer ClusterIP 172.21.14.221 <none>
9091/TCP,15004/TCP,9093/TCP,9094/TCP,9102/TCP,9125/UDP,42422/TCP 1m
svc/istio-pilot ClusterIP 172.21.4.20 <none> 15003/TCP,443/TCP 1m

NAME READY STATUS RESTARTS AGE
po/istio-ca-55b954ff7-crsjq 1/1 Running 0 1m
po/istio-ingress-948b746cb-4t24c 1/1 Running 0 1m
po/istio-initializer-6c84859cd-8mvfj 1/1 Running 0 1m
po/istio-mixer-59cc756b48-tkx6c 3/3 Running 0 1m
po/istio-pilot-55bb7f5d9d-wc5xh 2/2 Running 0 1m
```

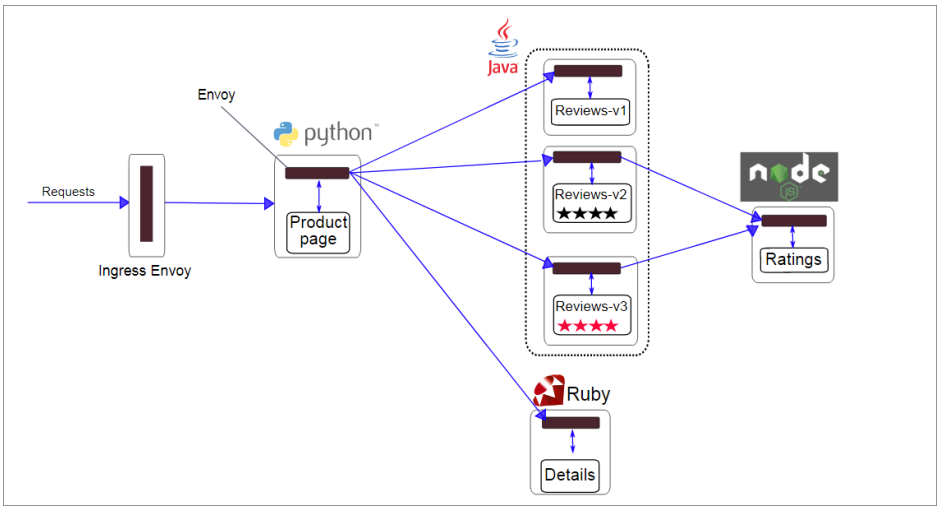
After all the pods are in the running status, the Istio deployment is finished.

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.



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 ingress -o wide
NAME HOSTS ADDRESS PORTS AGE
gateway * 101.37.xxx.xxx 80 2m
```

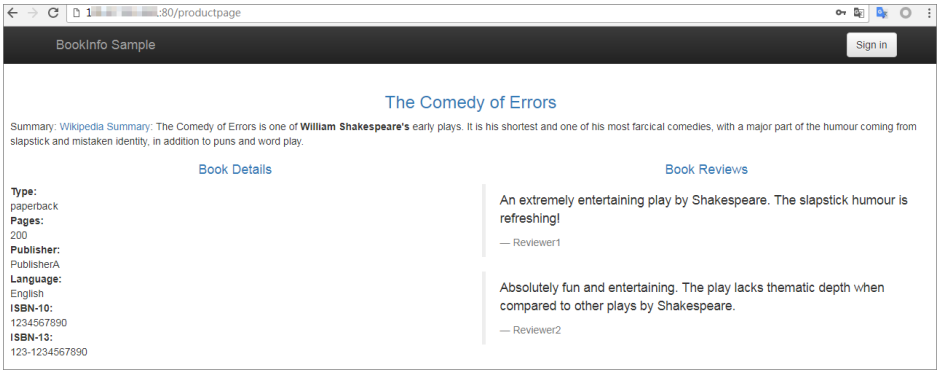
If the preceding command cannot obtain the external IP address, run the following command to obtain the corresponding address.

```
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.



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 open http://localhost:16686 in the browser.

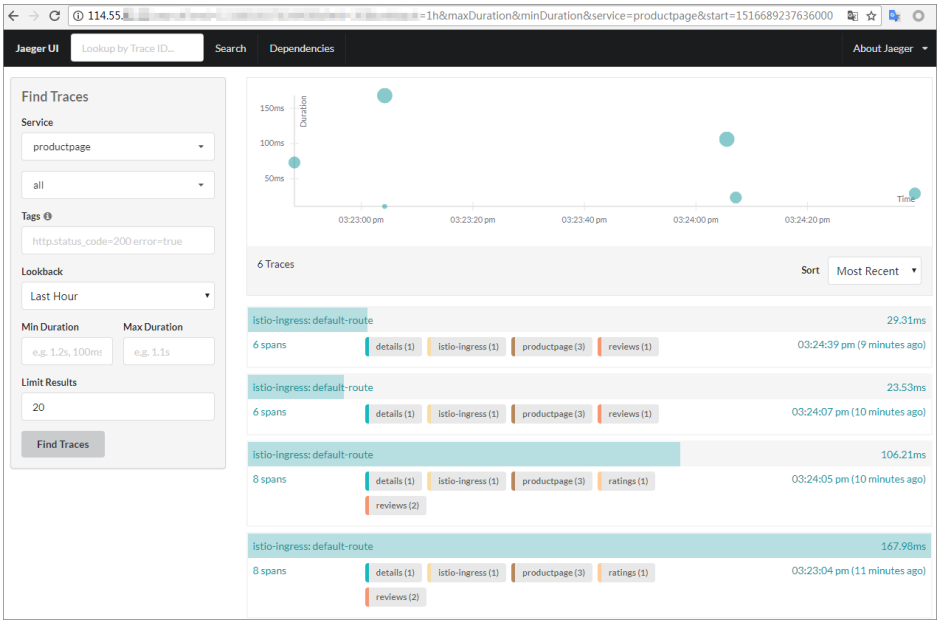
```
kubectl port-forward -n istio-system $(kubectl get pod -n istio-system -l app=jaeger -o jsonpath='{.items[0].metadata.name}') 16686:16686 &
```

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.

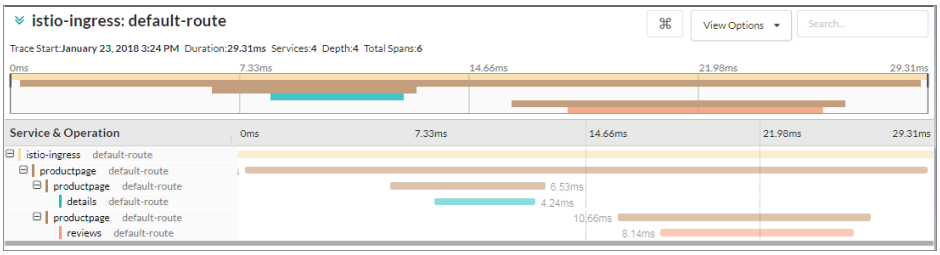
```
$ kubectl get svc -n istio-system
NAME TYPE CLUSTER-IP EXTERNAL-IP PORT(S) AGE
jaeger-agent ClusterIP None <none> 5775/UDP,6831/UDP,6832/UDP 1h
jaeger-collector ClusterIP 172.21.10.187 <none> 14267/TCP,14268/TCP,9411/TCP 1h
jaeger-query LoadBalancer 172.21.10.197 114.55.82.11 80:31960/TCP ##The external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

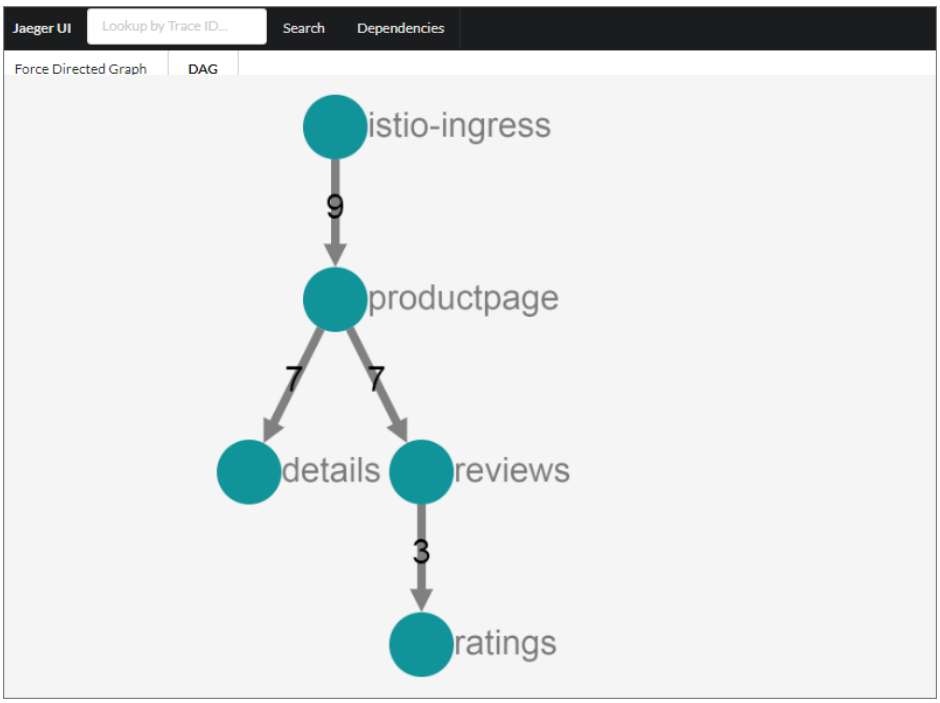
By accessing the application BookInfo for multiple times and generating the call chain information, we can view the call chain information of services clearly.



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.

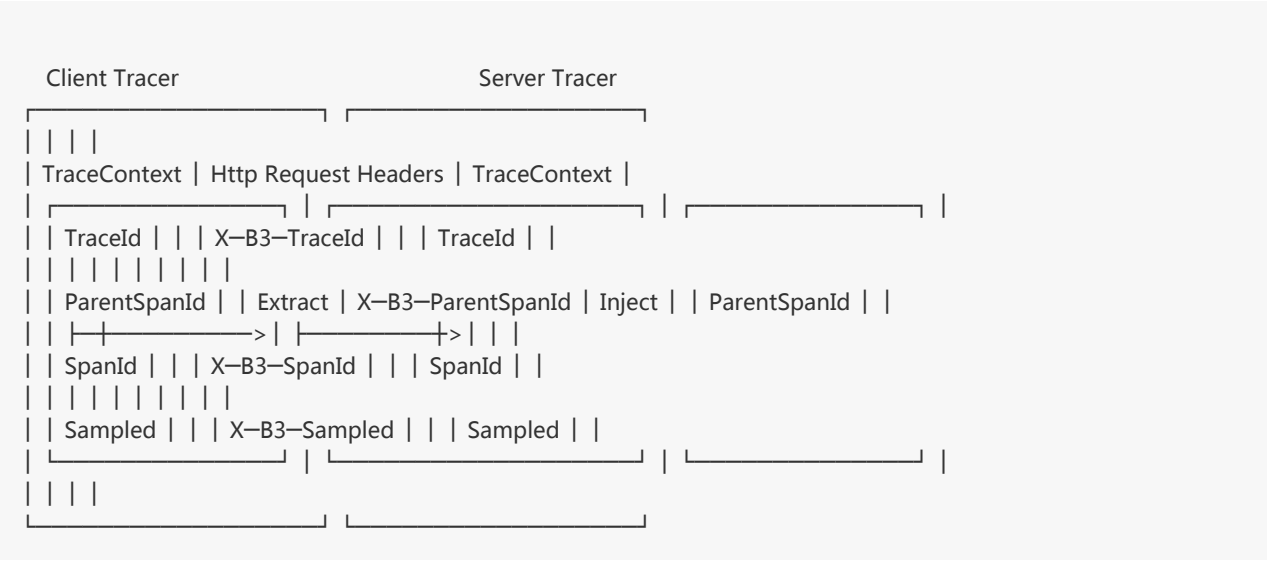
Whenever a microservice initiates an external call, the client Envoy will create a new span. A span represents the complete interaction process between a collection of microservices, starting from a caller (client) sending a request to receiving the response from the server.

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 might 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.

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.