FunctionGraph

User Guide

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Contents

1 Before You Start

1.1 Use of FunctionGraph

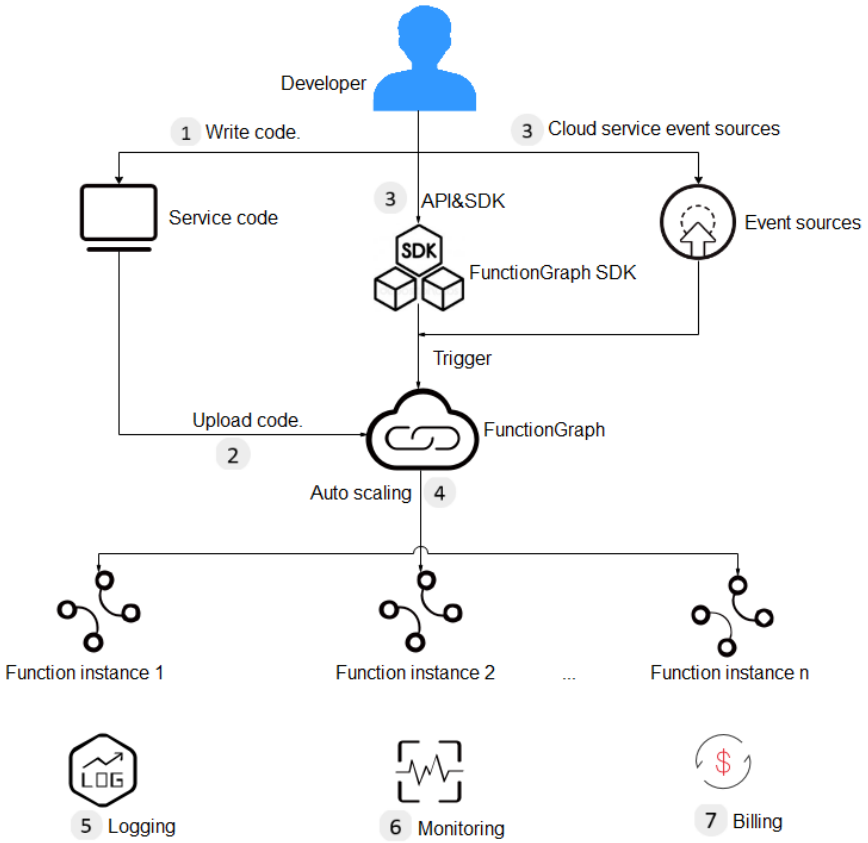
FunctionGraph allows you to run your code without provisioning or managing servers, while ensuring high availability and scalability. All you need to do is upload your code and set execution conditions, and FunctionGraph will take care of the rest. You pay only for what you use and you are not charged when your code is not running.

Process

Figure 1-1 shows the process of using functions.

1. Write code, package and upload it to FunctionGraph, and add event sources such as Simple Message Notification (SMN), Object Storage Service (OBS), and API Gateway (APIG) event sources to build applications.
2. Functions are triggered by RESTful API calls or event sources to achieve expected service purposes. During this process, FunctionGraph automatically schedules resources.
3. View logs and metrics. Note that you will be billed based on code execution duration.

Figure 1-1 Flowchart



The following shows the details:

1. Write code.

   Write code in Node.js, Python, Java, C#, PHP, or Go. For details, see the **FunctionGraph Developer Guide**.

2. Upload code.

   Edit code inline, upload a local ZIP or JAR file, or upload a ZIP file from OBS. For details, see **Creating a Deployment Package**.

3. Trigger functions by API calls or cloud service events.

   Functions are triggered by API calls or cloud service events. For details, see **Creating Triggers**.

4. Implement auto scaling.

   FunctionGraph implements auto scaling based on the number of requests. For details, see **Notes and Constraints**.

5. View logs.

   View run logs of function. FunctionGraph is interconnected with Log Tank Service (LTS). For details, see **Logs**.

6. View monitoring information.

   View graphical monitoring information. FunctionGraph is interconnected with Cloud Eye. For details, see **Metrics**.

7. Check your bills.

After function execution is complete, you will be billed based on the number of function execution requests and execution duration. For details, see .**Bills**.

Introduction to Dashboard

Log in to the FunctionGraph console and choose **Dashboard** in the navigation pane on the left.

- View your created functions/function quota, used storage/storage quota, and monthly invocations and resource usage.

  Figure 1-2 Monthly statistics

- View tenant-level metrics, including invocations, top 10 functions by invocation, errors, top 10 functions by error, duration, and throttles.

  Table 1-1 describes the function metrics.

  Table 1-1 Function metrics

Metric	Unit	Description
Invocations	Count	Total number of invocation requests, including invocation errors and throttled invocations. In case of asynchronous invocation, the count starts only when a function is executed in response to a request.
The 10 Functions with the Most Invocations	-	Top 10 functions by invocation in the last day, last 3 days, or a custom period.
Duration	ms	**Maximum duration**: the maximum duration all functions are executed at a time within a period. **Minimum duration**: the minimum duration all functions are executed at a time within a period. **Average duration**: the average duration all functions are executed at a time within a period.
Errors	Count	Number of times that your functions failed with error code **200** being returned. Errors caused by function syntax or execution are also included.

Metric	Unit	Description
The 10 Functions with the Most Errors	-	Top 10 functions by error in the last day, last 3 days, or a custom period.
Throttles	Count	Number of times that FunctionGraph throttles your functions due to the resource limit.

- View flow metrics, including the number of invocations, duration, number of errors, and number of running workflows.

Metric	Unit	Description
Invocations	Count	Total number of invocation requests, including successful, failed, and ongoing requests. In case of asynchronous invocation, the count starts only when a flow executes in response to a request.
Duration	ms	Average time taken to execute a flow in a specified period.
Errors	Count	Number of times that flows failed to be executed.
Running Workflows	Count	Number of ongoing flow executions.

1.2 Permissions Management

1.2.1 Creating a User and Granting Permissions

This section describes how to use **Identity and Access Management (IAM)** to implement fine-grained permissions control for your FunctionGraph resources. With IAM, you can:

- Create IAM users for employees based on the organizational structure of your enterprise. Each IAM user has their own security credentials for accessing FunctionGraph resources.
- Grant only the permissions required for users to perform a task.
- Entrust other accounts or cloud services to perform professional and efficient O&M on your FunctionGraph resources.

If your account does not need individual IAM users, then you may skip over this chapter.

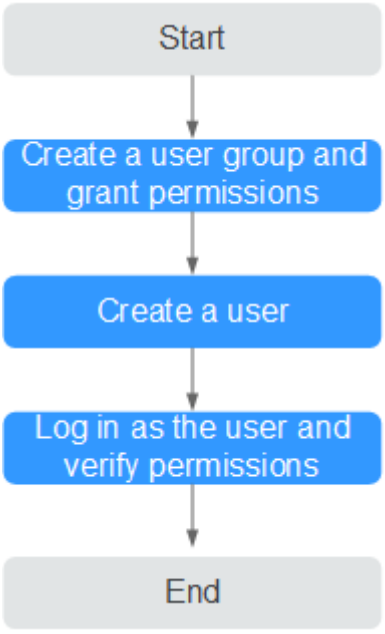
This section describes the procedure for granting permissions. For details, see **Figure 1-3**.

Prerequisites

Before assigning permissions to user groups, you should learn about the system permissions listed in **Permissions Management**. For the system policies of other services, see **System Permissions**.

Process

Figure 1-3 Process for granting FunctionGraph permissions



1. **Create a user group and assign permissions**.

   Create a user group on the IAM console, and assign the **FunctionGraph Invoker** role to the group.

2. **Create an IAM user and add it to the user group**.

   Create a user on the IAM console and add the user to the group created in **1**.

3. **Logging In as an IAM User** and Verifying Permissions

   Log in to the management console as the created user and check whether this user only has read permissions for FunctionGraph:

   - Choose **Service List** > **FunctionGraph** to access the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**. Then click **Create Function**. If a message appears indicating insufficient permissions to perform the operation, the **FunctionGraph Invoker** role has already taken effect.
   - Choose any other service in the **Service List**. If a message appears indicating insufficient permissions to access the service, the **FunctionGraph Invoker** role has already taken effect.

1.2.2 Creating a Custom Policy

Custom policies can be created as a supplement to the system policies of FunctionGraph.

You can create custom policies in either of the following ways:

- Visual editor: Select cloud services, actions, resources, and request conditions. This does not require knowledge of policy syntax.
- JSON: Edit JSON policies from scratch or based on an existing policy.

For details, see **Creating a Custom Policy**. This section introduces examples of common FunctionGraph custom policies.

Example Custom Policies

- Example 1: Authorizing a user to query function code and configuration

```
{
   "Version": "1.1",
   "Statement": [
      {
         "Effect": "Allow",
         "Action": [
            "functiongraph:function:list",
            "functiongraph:function:getConfig",
            "funcitongraph:function:getCode"
         ]
      }
   ]
}
```

- Example 2: Denying function deletion

  A policy with only "Deny" permissions must be used in conjunction with other policies to take effect. If both "Allow" and "Deny" permissions are assigned to a user, the "Deny" permissions take precedence over the "Allow" permissions.

  If you need to assign permissions of the **FunctionGraph FullAccess** policy to a user but prevent the user from deleting functions, create a custom policy for denying function deletion, and attach both policies to the group to which the user belongs. In this way, the user can perform all operations on FunctionGraph except deleting functions. The following is an example of a deny policy:

```
{
   "Version": "1.1",
   "Statement": [
      "Effect": "Deny",
      "Action": [
         "functiongraph:function:delete"
      ]
   ]
}
```

- Example 3: Configuring permissions for specific resources

  You can grant an IAM user permissions for specific resources. For example, to grant a user permissions for the **functionname** function in the **Default** application, set **functionname** to a specified resource path, that is, **FUNCTIONGRAPH:*:*:function:Default/functionname**.

NOTE

Specify function resources:

Format: **FUNCTIONGRAPH:*:*:function:** *application or function name*

For function resources, IAM automatically generates the resource path prefix **FUNCTIONGRAPH:*:*:function:**. You can specify a resource path by adding the application or function name next to the path prefix. Wildcards (*) are supported. For example, **FUNCTIONGRAPH:*:*:function:Default/*** indicates any function in the **Default** application.

```
{
    "Version": "1.1",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "functiongraph:function:list"
            ]
        },
        {
            "Effect": "Allow",
            "Action": [
                "functiongraph:function:listAlias",
                "functiongraph:function:listVersion",
                "functiongraph:function:getConfig",
                "functiongraph:function:getCode",
                "functiongraph:function:updateCode",
                "functiongraph:function:invoke",
                "functiongraph:function:updateConfig",
                "functiongraph:function:createVersion",
                "functiongraph:function:updateAlias",
                "functiongraph:function:createAlias"
            ],
            "Resource": [
                "FUNCTIONGRAPH:*:*:function:Default/*"
            ]
        }
    ]
}
```

1.3 Supported Programming Languages

1.3.1 Node.js

√: Supported. ×: Not supported.

Runtime	Supported	Development Guide
Node.js 6.10	√	For details about function syntax, SDK APIs, and function development, see **Developing Functions in Node.js**.
Node.js 8.10	√	
Node.js 10.16	√	
Node.js 12.13	√	
Node.js 14.18	√	
Node.js 16.17	√	
Node.js 18.15	√	

1.3.2 Python

√: Supported. ×: Not supported.

Runtime	Supported	Development Guide
Python 2.7	√	For details about function syntax, SDK APIs, and function development, see **Developing Functions in Python**.
Python 3.6	√	
Python 3.9	√	
Python 3.10	√	

1.3.3 Java

√: Supported. ×: Not supported.

Runtime	Supported	Development Guide
Java 8	√	For details about function syntax, SDK APIs, and function development, see **Developing Functions in Java**.
Java 11	√	

1.3.4 Go

√: Supported. ×: Not supported.

Runtime	Supported	Development Guide
Go 1.x	√	For details about function syntax, SDK APIs, and function development, see **Developing Functions in Go**.

1.3.5 C#

√: Supported. ×: Not supported.

Runtime	Supported	Development Guide
C# (.NET Core 2.1)	√	For details about function syntax, SDK APIs, and function development, see **Developing Functions in C#**.
C# (.NET Core 3.1)	√	

1.3.6 PHP

√: Supported. ×: Not supported.

Runtime	Supported	Development Guide
PHP 7.3	√	For details about function syntax, SDK APIs, and function development, see **Developing Functions in PHP**.

1.3.7 Custom Runtime

Scenarios

A runtime runs the code of a function, reads the handler name from an environment variable, and reads invocation events from the runtime APIs of FunctionGraph. The runtime passes event data to the function handler and returns the response from the handler to FunctionGraph.

FunctionGraph supports custom runtimes. You can use an executable file named **bootstrap** to include a runtime in your function deployment package. The runtime runs the function's handler method when the function is invoked.

Your runtime runs in the FunctionGraph execution environment. It can be a shell script or a binary executable file that is compiled in Linux.

NOTE

After programming, simply package your code into a ZIP file (Java, Node.js, Python, and Go) or JAR file (Java), and upload the file to FunctionGraph for execution. When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.

If you edit code in Go, zip the compiled file, and ensure that the name of the dynamic library file is consistent with the plug-in name of the handler. For example, if the name of the dynamic library file is **testplugin.so**, set the handler name to **testplugin.Handler**.

Runtime File bootstrap

If there is a file named **bootstrap** in your function deployment package, FunctionGraph executes that file. If the **bootstrap** file is not found or not executable, your function will return an error when invoked.

The runtime code is responsible for completing initialization tasks. It processes invocation events in a loop until it is terminated.

The initialization tasks run once for each instance of the function to prepare the environment for handling invocations.

Runtime APIs

FunctionGraph provides HTTP runtime APIs to receive function invocation events and returns response data in the execution environment.

- **Obtaining Invocation Event**

  Method – Get

  Path – http://$RUNTIME_API_ADDR/v1/runtime/invocation/request

  This API is used to retrieve an invocation event. The response body contains the event data. The following table describes additional data about the invocation contained in the response header.

  Table 1-2 Response header information

Parameter	Description
X-Cff-Request-Id	Request ID.
X-CFF-Access-Key	AK of the account. An agency must be configured for the function if this variable is used.
X-CFF-Auth-Token	Token of the account. An agency must be configured for the function if this variable is used.
X-CFF-Invoke-Type	Invocation type of the function.
X-CFF-Secret-Key	SK of the account. An agency must be configured for the function if this variable is used.
X-CFF-Security-Token	Security token of the account. An agency must be configured for the function if this variable is used.

- **Invocation Response**

  Method – POST

  Path – http://$RUNTIME_API_ADDR/v1/runtime/invocation/response/$REQUEST_ID

  This API is used to send a successful invocation response to FunctionGraph. After the runtime invokes the function handler, it publishes the response from the function to the invocation response path.

- **Invocation Error**

  Method – POST

  Path – http://$RUNTIME_API_ADDR/v1/runtime/invocation/error/$REQUEST_ID

  $REQUEST_ID is the value of variable **X-Cff-Request-Id** in the header of an event retrieval response. For more information, see **Table 1-2**.

  $RUNTIME_API_ADDR is a system environment variable. For more information, see **Table 1-3**.

  This API is used to send an error invocation response to FunctionGraph. After the runtime invokes the function handler, it publishes the response from the function to the invocation response path.

Runtime Environment Variables

You can use both custom and runtime environment variables in function code. The following table lists the runtime environment variables that are used in the FunctionGraph execution environment.

Table 1-3 Environment variables

Key	Description
RUNTIME_PROJECT_ID	Project ID
RUNTIME_FUNC_NAME	Function name
RUNTIME_FUNC_VERSION	Function version
RUNTIME_PACKAGE	App to which the function belongs
RUNTIME_HANDLER	Function handler
RUNTIME_TIMEOUT	Function timeout duration
RUNTIME_USERDATA	Value passed through an environment variable
RUNTIME_CPU	Number of allocated CPU cores
RUNTIME_MEMORY	Allocated memory
RUNTIME_CODE_ROOT	Directory that stores the function code
RUNTIME_API_ADDR	Host IP address and port of a custom runtime API

The value of a custom environment variable can be retrieved in the same way as the value of a FunctionGraph environment variable.

Example

This example contains one file called **bootstrap**. The file is implemented in Bash.

The runtime loads the function script from the deployment package by using two variables.

The **bootstrap** file is as follows:

```
#!/bin/sh
set -o pipefail
#Processing requests loop
while true
do
HEADERS="$(mktemp)"
  # Get an event
  EVENT_DATA=$(curl -sS -LD "$HEADERS" -X GET "http://$RUNTIME_API_ADDR/v1/runtime/invocation/
request")
  # Get request id from response header
  REQUEST_ID=$(grep -Fi x-cff-request-id "$HEADERS" | tr -d '[:space:]' | cut -d: -f2)
  if [ -z "$REQUEST_ID" ]; then
    continue
```



```
  fi
  # Process request data
  RESPONSE="Echoing request: hello world!"
  # Put response
  curl -X POST "http://$RUNTIME_API_ADDR/v1/runtime/invocation/response/$REQUEST_ID" -d
"$RESPONSE"
done
```

After loading the script, the runtime processes invocation events in a loop until it is terminated. It uses the API to retrieve invocation events from FunctionGraph, passes the events to the handler, and then sends responses back to FunctionGraph.

To obtain the request ID, the runtime saves the API response header in a temporary file, and then reads the request ID from the **x-cff-request-id** header field. The runtime processes the retrieved event data and sends a response back to FunctionGraph.

The following is an example of source code in Go. It can be executed only after compilation.

```
package main

import (
    "bytes"
    "encoding/json"
    "fmt"
    "io"
    "io/ioutil"
    "log"
    "net"
    "net/http"
    "os"
    "strings"
    "time"
)

var (
    getRequestUrl           = os.ExpandEnv("http://${RUNTIME_API_ADDR}/v1/runtime/invocation/
request")
    putResponseUrl          = os.ExpandEnv("http://${RUNTIME_API_ADDR}/v1/runtime/invocation/
response/{REQUEST_ID}")
    putErrorResponseUrl     = os.ExpandEnv("http://${RUNTIME_API_ADDR}/v1/runtime/
invocation/error/{REQUEST_ID}")
    requestIdInvalidError   = fmt.Errorf("request id invalid")
    noRequestAvailableError = fmt.Errorf("no request available")
    putResponseFailedError  = fmt.Errorf("put response failed")
    functionPackage         = os.Getenv("RUNTIME_PACKAGE")
    functionName            = os.Getenv("RUNTIME_FUNC_NAME")
    functionVersion         = os.Getenv("RUNTIME_FUNC_VERSION")

    client = http.Client{
        Transport: &http.Transport{
            DialContext: (&net.Dialer{
                Timeout: 3 * time.Second,
            }).DialContext,
        },
    }
)

func main() {
    // main loop for processing requests.
```



```
    for {
        requestId, header, payload, err := getRequest()
        if err != nil {
            time.Sleep(50 * time.Millisecond)
            continue
        }

        result, err := processRequestEvent(requestId, header, payload)
        err = putResponse(requestId, result, err)
        if err != nil {
            log.Printf("put response failed, err: %s.", err.Error())
        }
    }
}

// event processing function
func processRequestEvent(requestId string, header http.Header, evtBytes []byte) ([]byte, error) {
    log.Printf("processing request '%s'.", requestId)
    result := fmt.Sprintf("function: %s:%s:%s, request id: %s, headers: %+v, payload: %s",
functionPackage, functionName,
        functionVersion, requestId, header, string(evtBytes))

    var event FunctionEvent
    err := json.Unmarshal(evtBytes, &event)
    if err != nil {
        return (&ErrorMessage{ErrorType: "invalid event", ErrorMessage: "invalid json formated
event"}).toJsonBytes(), err
    }

    return (&APIGFormatResult{StatusCode: 200, Body: result}).toJsonBytes(), nil
}

func getRequest() (string, http.Header, []byte, error) {
    resp, err := client.Get(getRequestUrl)
    if err != nil {
        log.Printf("get request error, err: %s.", err.Error())
        return "", nil, nil, err
    }
    defer resp.Body.Close()

    // get request id from response header
    requestId := resp.Header.Get("X-CFF-Request-Id")
    if requestId == "" {
        log.Printf("request id not found.")
        return "", nil, nil, requestIdInvalidError
    }

    payload, err := ioutil.ReadAll(resp.Body)
    if err != nil {
        log.Printf("read request body error, err: %s.", err.Error())
        return "", nil, nil, err
    }

    if resp.StatusCode != 200 {
        log.Printf("get request failed, status: %d, message: %s.", resp.StatusCode, string(payload))
        return "", nil, nil, noRequestAvailableError
    }

    log.Printf("get request ok.")
    return requestId, resp.Header, payload, nil
}
```



```
func putResponse(requestId string, payload []byte, err error) error {
    var body io.Reader
    if payload != nil && len(payload) > 0 {
        body = bytes.NewBuffer(payload)
    }

    url := ""
    if err == nil {
        url = strings.Replace(putResponseUrl, "{REQUEST_ID}", requestId, -1)
    } else {
        url = strings.Replace(putErrorResponseUrl, "{REQUEST_ID}", requestId, -1)
    }

    resp, err := client.Post(strings.Replace(url, "{REQUEST_ID}", requestId, -1), "", body)
    if err != nil {
        log.Printf("put response error, err: %s.", err.Error())
        return err
    }
    defer resp.Body.Close()

    responsePayload, err := ioutil.ReadAll(resp.Body)
    if err != nil {
        log.Printf("read request body error, err: %s.", err.Error())
        return err
    }

    if resp.StatusCode != 200 {
        log.Printf("put response failed, status: %d, message: %s.", resp.StatusCode,
string(responsePayload))
        return putResponseFailedError
    }

    return nil
}

type FunctionEvent struct {
    Type string `json:"type"`
    Name string `json:"name"`
}

type APIGFormatResult struct {
    StatusCode      int               `json:"statusCode"`
    IsBase64Encoded bool              `json:"isBase64Encoded"`
    Headers         map[string]string `json:"headers,omitempty"`
    Body            string            `json:"body,omitempty"`
}

func (result *APIGFormatResult) toJsonBytes() []byte {
    data, err := json.MarshalIndent(result, "", "  ")
    if err != nil {
        return nil
    }

    return data
}

type ErrorMessage struct {
    ErrorType     string `json:"errorType"`
    ErrorMessage  string `json:"errorMessage"`
}

func (errMsg *ErrorMessage) toJsonBytes() []byte {
```



```
    data, err := json.MarshalIndent(errMsg, "", "  ")
    if err != nil {
        return nil
    }

    return data
}
```

Table 1-4 describes the environment variables used in the preceding code.

Table 1-4 Environment variables

Environment Variable	Description
RUNTIME_FUNC_NAME	Function name
RUNTIME_FUNC_VERSION	Function version
RUNTIME_PACKAGE	App to which the function belongs

2 Building Functions

2.1 Creating a Deployment Package

To create a function, you must create a deployment package which includes your code and all dependencies. You can create a deployment package locally or edit code on the FunctionGraph console. If you edit code inline, FunctionGraph automatically creates and uploads a deployment package for your function. FunctionGraph allows you to edit function code in the same way as managing a project. You can create and edit files and folders. After you upload a ZIP code package, you can view and edit the code on the console.

NOTE

- After programming, simply package your code into a ZIP file (Java, Node.js, Python, and Go) or JAR file (Java), and upload the file to FunctionGraph for execution.
- When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.
- If you edit code in Go, zip the compiled file, and ensure that the name of the dynamic library file is consistent with the plug-in name of the handler. For example, if the name of the dynamic library file is **testplugin.so**, set the handler name to **testplugin.Handler**.
- Java is a compiled language, which does not support editing code inline. If your function does not use any third-party dependencies, you can upload a function JAR file. If your function uses third-party dependencies, compress the dependencies and the function JAR file into a ZIP file, and then upload the ZIP file.

Table 2-1 lists the code entry modes supported by FunctionGraph for each runtime.

Table 2-1 Code entry modes

Runtime	Editing Code Inline	Uploading a ZIP File	Uploading a JAR File	Uploading a ZIP File from OBS
Node.js	Supported	Supported	Not supported	Supported

Runtime	Editing Code Inline	Uploading a ZIP File	Uploading a JAR File	Uploading a ZIP File from OBS
Python	Supported	Supported	Not supported	Supported
Java	Not supported	Supported	Supported	Supported
Go	Not supported	Supported	Not supported	Supported
C#	Not supported	Supported	Not supported	Supported
PHP	Supported	Supported	Not supported	Supported
Custom runtime	Supported	Supported	Not supported	Supported

NOTICE

If the code to be uploaded contains sensitive information (such as account passwords), encrypt the sensitive information to prevent leakage.

Table 2-2 Code entry modes

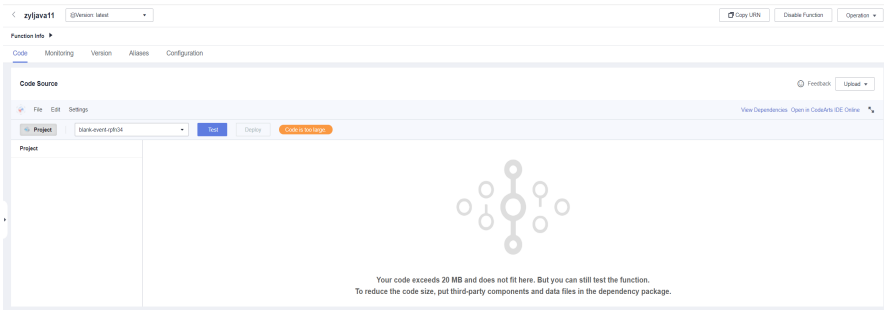
Code Entry Mode	Description
Edit code inline	FunctionGraph allows you to edit function code in the same way as managing a project. You can create and edit files and folders. After you upload a ZIP code package, you can edit the code on the **Code** tab of the function details page. • **File**: Create files and folders, save changes, and close all files. • **Edit**: Undo/redo typing; cut, copy, and paste code; find and replace content. • **Settings**: Set the font size, auto formatting, and theme color.
Upload ZIP file	1. On the **Code** tab of the function details page, choose **Upload** > **Local ZIP**. 2. Click **Select File** and upload a local code package to FunctionGraph. The size of the ZIP file cannot exceed 40 MB. For a larger file, upload it through OBS.

Code Entry Mode	Description
Upload file from OBS	1. On the **Code** tab of the function details page, choose **Upload** > **OBS ZIP**. 2. Click **Select File** and upload a local code package to FunctionGraph. **NOTE** After you update the code package in the OBS bucket, the code in the function is updated synchronously.

NOTE

If the size of the code you deploy is greater than 20 MB, the inline editor does not display the code, but you can still test your function.

Figure 2-1 Code not displayed in the editor



Node.js

Editing Code Inline

FunctionGraph provides an SDK for editing code in Node.js. If your custom code uses only the SDK library, you can edit code using the inline editor on the FunctionGraph console. After you edit code inline and upload it to FunctionGraph, the console compresses your code and the related configurations into a deployment package that FunctionGraph can run.

Uploading a Deployment Package

If your code uses other resources, such as a graphic library for image processing, first create a deployment package, and then upload the package to the FunctionGraph console. You can upload a Node.js deployment package in two ways.

NOTICE

- When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.
- The size of the decompressed source code cannot exceed 1.5 GB. If the code is too large, contact the customer service.

- Directly uploading a local deployment package

  After creating a ZIP deployment package, upload it to the FunctionGraph console. If the package size exceeds 40 MB, upload the package from OBS.

  For details about function resource restrictions, see **Notes and Constraints**.

- Uploading a deployment package using an OBS bucket

  After creating a ZIP deployment package, upload it to an OBS bucket in the same region as your FunctionGraph, and then paste the link URL of the OBS bucket into the function. The maximum size of the ZIP file that can be uploaded to OBS is 300 MB.

  For details about function resource restrictions, see **Notes and Constraints**.

Python

Editing Code Inline

FunctionGraph provides an SDK for editing code in Python. If your custom code uses only the SDK library, you can edit code using the inline editor on the FunctionGraph console. After you edit code inline and upload it to FunctionGraph, the console compresses your code and the related configurations into a deployment package that FunctionGraph can run.

Uploading a Deployment Package

If your code uses other resources, such as a graphic library for image processing, first create a deployment package, and then upload the package to the FunctionGraph console. You can upload a Python deployment package in two ways.

NOTICE

- When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.
- The size of the decompressed source code cannot exceed 1.5 GB. If the code is too large, contact the customer service.
- When you write code in Python, do not name your package with the same suffix as a standard Python library, such as **json**, **lib**, and **os**. Otherwise, an error indicating a module loading failure will be reported.

- Directly uploading a local deployment package

  After creating a ZIP deployment package, upload it to the FunctionGraph console. If the package size exceeds 40 MB, upload the package from OBS.

  For details about function resource restrictions, see **Notes and Constraints**.

- Uploading a deployment package using an OBS bucket

  After creating a ZIP deployment package, upload it to an OBS bucket in the same region as your FunctionGraph, and then paste the link URL of the OBS bucket into the function. The maximum size of the ZIP file that can be uploaded to OBS is 300 MB.

  For details about function resource restrictions, see **Notes and Constraints**.

Java

Java is a compiled language, which does not support editing code inline. You can only upload a local deployment package, which can be a ZIP or JAR file.

Uploading a JAR File

- If your function does not use any dependencies, directly upload a JAR file.
- If your function uses dependencies, upload them to an OBS bucket, set them during function creation, and upload the JAR file.

Uploading a ZIP File

If your function uses third-party dependencies, compress the dependencies and the function JAR file into a ZIP file, and then upload the ZIP file.

You can upload a Java deployment package in two ways.

NOTICE

- When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.
- The size of the decompressed source code cannot exceed 1.5 GB. If the code is too large, contact the customer service.

- Directly uploading a local deployment package

  After creating a ZIP deployment package, upload it to the FunctionGraph console. If the package size exceeds 40 MB, upload the package from OBS.

  For details about function resource restrictions, see **Notes and Constraints**.
- Uploading a deployment package using an OBS bucket

  After creating a ZIP deployment package, upload it to an OBS bucket in the same region as your FunctionGraph, and then paste the link URL of the OBS bucket into the function. The maximum size of the ZIP file that can be uploaded to OBS is 300 MB.

  For details about function resource restrictions, see **Notes and Constraints**.

Go

Uploading a Deployment Package

You can only upload a Go deployment package in ZIP format. There are two ways to upload it.

NOTICE

- When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.
- The size of the decompressed source code cannot exceed 1.5 GB. If the code is too large, contact the customer service.

- Directly uploading a local deployment package

  After creating a ZIP deployment package, upload it to the FunctionGraph console. If the package size exceeds 40 MB, upload the package from OBS.

  For details about function resource restrictions, see **Notes and Constraints**.

- Uploading a deployment package using an OBS bucket

  After creating a ZIP deployment package, upload it to an OBS bucket in the same region as your FunctionGraph, and then paste the link URL of the OBS bucket into the function. The maximum size of the ZIP file that can be uploaded to OBS is 300 MB.

  For details about function resource restrictions, see **Notes and Constraints**.

C#

Uploading a Deployment Package

You can only upload a C# deployment package in ZIP format. There are two ways to upload it.

NOTICE

- When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.
- The size of the decompressed source code cannot exceed 1.5 GB. If the code is too large, contact the customer service.

- Directly uploading a local deployment package

  After creating a ZIP deployment package, upload it to the FunctionGraph console. If the package size exceeds 40 MB, upload the package from OBS.

  For details about function resource restrictions, see **Notes and Constraints**.

- Uploading a deployment package using an OBS bucket

  After creating a ZIP deployment package, upload it to an OBS bucket in the same region as your FunctionGraph, and then paste the link URL of the OBS bucket into the function. The maximum size of the ZIP file that can be uploaded to OBS is 300 MB.

  For details about function resource restrictions, see **Notes and Constraints**.

PHP

Editing Code Inline

FunctionGraph provides an SDK for editing code in PHP. If your custom code uses only the SDK library, you can edit code using the inline editor on the FunctionGraph console. After you edit code inline and upload it to FunctionGraph, the console compresses your code and the related configurations into a deployment package that FunctionGraph can run.

Uploading a Deployment Package

If your code uses other resources, such as a graphic library for image processing, first create a deployment package, and then upload the package to the FunctionGraph console. You can upload a PHP deployment package in two ways.

NOTICE

- When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.
- The size of the decompressed source code cannot exceed 1.5 GB. If the code is too large, contact the customer service.

- Directly uploading a local deployment package

  After creating a ZIP deployment package, upload it to the FunctionGraph console. If the package size exceeds 40 MB, upload the package from OBS.

  For details about function resource restrictions, see **Notes and Constraints**.
- Uploading a deployment package using an OBS bucket

  After creating a ZIP deployment package, upload it to an OBS bucket in the same region as your FunctionGraph, and then paste the link URL of the OBS bucket into the function. The maximum size of the ZIP file that can be uploaded to OBS is 300 MB.

  For details about function resource restrictions, see **Notes and Constraints**.

Custom Runtime

Editing Code Inline

After you edit code inline and upload it to FunctionGraph, the console compresses your code and the related configurations into a deployment package that FunctionGraph can run.

Uploading a Deployment Package

If your code uses other resources, such as a graphic library for image processing, first create a deployment package, and then upload the package to the FunctionGraph console. You can upload a deployment package for a custom runtime in two ways.

NOTICE

- When creating a ZIP file, place the handler file under the **root** directory to ensure that your code can run normally after being decompressed.
- The size of the decompressed source code cannot exceed 1.5 GB. If the code is too large, contact the customer service.

- Directly uploading a local deployment package

  After creating a ZIP deployment package, upload it to the FunctionGraph console. If the package size exceeds 40 MB, upload the package from OBS.

  For details about function resource restrictions, see **Notes and Constraints**.

- Uploading a deployment package using an OBS bucket

  After creating a ZIP deployment package, upload it to an OBS bucket in the same region as your FunctionGraph, and then paste the link URL of the OBS bucket into the function. The maximum size of the ZIP file that can be uploaded to OBS is 300 MB.

  For details about function resource restrictions, see **Notes and Constraints**.

2.2 Creating a Function from Scratch

2.2.1 Creating an Event Function

Overview

A function is customized code for processing events. You can create a function from scratch and configure the function based on site requirements.

FunctionGraph manages the compute resources required for function execution. After editing code for your function, configure compute resources on the FunctionGraph console.

You can create a function from scratch or by using **a template** or **container image**.

NOTE

When creating a function from scratch, configure the basic and code information based on **Table 2-3**. The parameters marked with an asterisk (*) are mandatory.

Each FunctionGraph function runs in its own environment and has its own resources and file system.

Prerequisites

1. You must be familiar with the programming languages supported by FunctionGraph. For details, see **Supported Programming Languages**.
2. You have created a deployment package. For details, see **Creating a Deployment Package**.
3. (Optional) You have created an agency. For details, see **Configuring Agency Permissions**.

Procedure

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. On the **Function List** page, click **Create Function** in the upper right corner.
3. Click **Create from scratch** and configure the function information by referring to **Table 2-3**. The parameters marked with an asterisk (*) are mandatory.

Figure 2-2 Creating a function from scratch

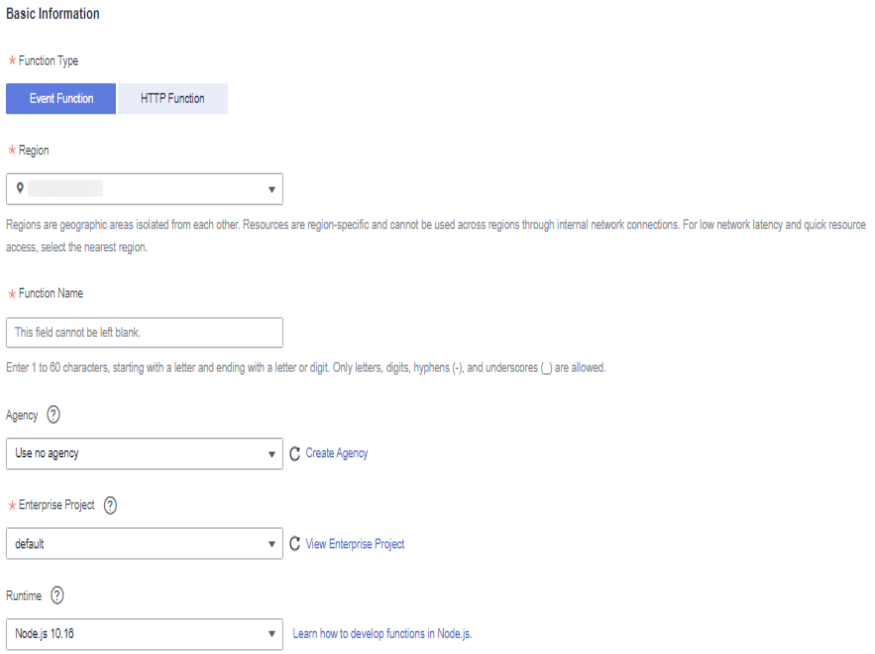


Table 2-3 Basic information

Parameter	Description
* Function Type	• Event functions: triggered by triggers. • HTTP functions: triggered once HTTP requests are sent to specific URLs. **NOTE** • HTTP functions do not distinguish between programming languages. The handler must be set in the **bootstrap** file. You can directly write the startup command, and allow access over port 8000. • HTTP functions support APIG and APIC triggers only. • For details about how to use HTTP functions, see **Creating an HTTP Function**.
*Region	Select a region where you will deploy your code.
*Function Name	Name of the function, which must meet the following requirements: • Consists of 1 to 60 characters, and can contain letters, digits, hyphens (-), and underscores (_). • Starts with a letter and ends with a letter or digit.
Agency	An agency is required if FunctionGraph accesses other cloud services. For details on how to create an agency, see **Configuring Agency Permissions**. No agency is required if FunctionGraph does not access any cloud services.

Parameter	Description
*Enterprise Project	Select a created enterprise project and add the function to it. By default, **default** is selected. **NOTE** If Enterprise Project Management Service (EPS) is not enabled, this parameter is unavailable. For details, see **Enabling the Enterprise Project Function**.
Runtime	Select a runtime to compile the function. **NOTICE** CloudIDE supports Node.js, PHP, and Python only.

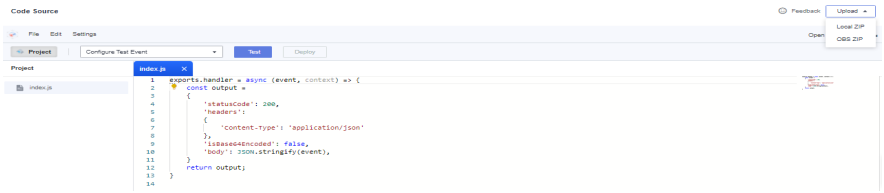
4. Click **Create Function**. On the displayed **Code** tab page, continue to configure the code.

Configuring Code

1. You can deploy the code based on the runtime you select. For details, see **Creating a Deployment Package**. After the deployment is complete, click **Deploy**.

   As shown in the following example, to deploy code in Node.js 10.16, you can edit code inline, upload a local ZIP file, or upload a ZIP file from OBS.

   Figure 2-3 Deploying code

2. You can modify the code and click **Deploy** to deploy the code again.

Viewing Code Information

1. View code attributes.

   Code attributes show the code size and the time the code was modified.

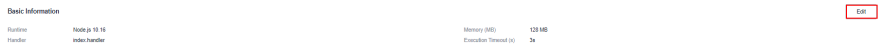
   Figure 2-4 Viewing code attributes

2. View basic information.

   Configuring Basic Settings shows the default memory and execution timeout in each runtime. You can click **Edit** to switch to the **Basic Settings** page and modify **Handler**, **Memory (MB)**, and **Execution Timeout (s)** as required. For details, see **Figure 2-5**.

   Figure 2-5 Editing basic information

NOTICE

Once a function is created, the runtime cannot be changed.

Table 2-4 Default basic information of each runtime

Runtime	Default Basic Information
Java	Memory (MB): 512 Handler: com.demo.TriggerTests.apigTest Execution Timeout (s): 15
Node.js	Memory (MB): 128 Handler: index.handler Execution Timeout (s): 3
Custom	Memory (MB): 128 Handler: bootstrap Execution Timeout (s): 3
PHP	Memory (MB): 128 Handler: index.handler Execution Timeout (s): 3
Python	Memory (MB): 128 Handler: index.handler Execution Timeout (s): 3
Go 1.x	Memory (MB): 128 Handler: handler Execution Timeout (s): 3

2.2.2 Creating an HTTP Function

Overview

HTTP functions are designed to optimize web services. You can send HTTP requests to URLs to trigger function execution. HTTP functions support APIG and APIC triggers only.

NOTE

- HTTP functions do not distinguish between programming languages. The handler must be set in the **bootstrap** file. You can directly write the startup command, and allow access over port 8000. The bound IP address is **127.0.0.1**.
- The **bootstrap** file is the startup file of the HTTP function. The HTTP function can only read **bootstrap** as the startup file name. If the file name is not **bootstrap**, the service cannot be started. For more information, see the **bootstrap file example**.
- HTTP functions support multiple programming languages.
- Functions must return a valid HTTP response.
- This section uses Node.js as an example. To use another runtime, simply change the runtime path. The code package path does not need to be changed. For the paths of other runtimes, see **Table 2-5**.
- For details about how to build a FunctionGraph HTTP function using Go, see **Building a FunctionGraph HTTP Function Using Go**.

Prerequisites

CAUTION

Before calling an API, ensure that the network of your service system can communicate with the API access domain name or address. This depends on where your service system is in relative to the ROMA Connect instance.

- The same VPC: Let the instance directly access the API.
- Two VPCs in the same region: Connect the instance and the service system with a peering connection. For details, see **VPC Peering Connection**.
- Two VPCs in two regions: Create a cloud connection and load the VPCs that need to communicate with each other. For details, see **Network Communications Among VPCs Across Regions**.
- Communication over the public network: Ensure that the instance must be bound with an EIP.

1. Prepare a Node.js script. A code example is as follows:

```
const http = require('http'); // Import Node.js core module

var server = http.createServer(function (req, res) {   //create web server
    res.writeHead(200, { 'Content-Type': 'text/html' });
    res.write('<html><body><h2>This is http function.</h2></body></html>');
    res.end();
});

server.listen(8000, '127.0.0.1'); //6 - listen for any incoming requests

console.log('Node.js web server at port 8000 is running..')
```

2. You have prepared a **bootstrap** file as the startup file of the HTTP function.

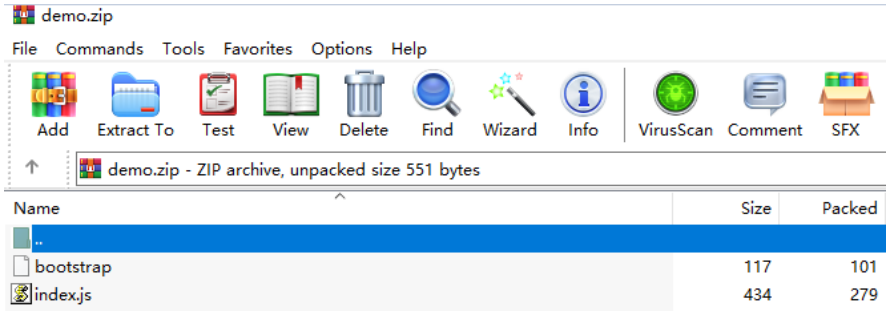
   Example

   The content of the **bootstrap** file is as follows:

```
/opt/function/runtime/nodejs12.13/rtsp/nodejs/bin/node $RUNTIME_CODE_ROOT/index.js
```

3. Compress the preceding two files into a ZIP package.

Figure 2-6 Compressing files into a ZIP package



NOTE

For HTTP functions in Python, add the **-u** parameter in the **bootstrap** file to ensure that logs can be flushed to the disk. Example:

```
/opt/function/runtime/python3.6/rtsp/python/bin/python3 -u $RUNTIME_CODE_ROOT/index.py
```

To use another runtime, change the runtime path by referring to **Table 2-5**. The code package path does not need to be changed.

Table 2-5 Paths for different runtimes

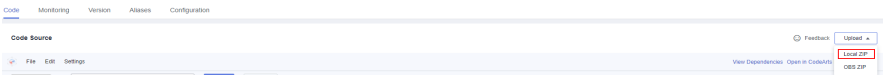
Runtime	Path
Java 8	/opt/function/runtime/java8/rtsp/jre/bin/java
Java 11	/opt/function/runtime/java11/rtsp/jre/bin/java
Node.js 6	/opt/function/runtime/nodejs6.10/rtsp/nodejs/bin/node
Node.js 8	/opt/function/runtime/nodejs8.10/rtsp/nodejs/bin/node
Node.js 10	/opt/function/runtime/nodejs10.16/rtsp/nodejs/bin/node
Node.js 12	/opt/function/runtime/nodejs12.13/rtsp/nodejs/bin/node
Node.js 14	/opt/function/runtime/nodejs14.18/rtsp/nodejs/bin/node
Node.js 16	/opt/function/runtime/nodejs16.17/rtsp/nodejs/bin/node
Node.js 18	/opt/function/runtime/nodejs18.15/rtsp/nodejs/bin/node
Python 2.7	/opt/function/runtime/python2.7/rtsp/python/bin/python
Python 3.6	/opt/function/runtime/python3.6/rtsp/python/bin/python3

Runtime	Path
Python 3.9	/opt/function/runtime/python3.9/rtsp/python/bin/python3
PHP 7.3	/opt/function/runtime/php7.3/rtsp/php/bin/php

Procedure

1. Create a function.
   a. Create an HTTP function. For details, see **Creating an Event Function**. Pay special attention to the following parameters:
      - **Function Type**: HTTP function
      - **Region**: Select a region where you will deploy your code.
   b. Choose **Upload** > **Local ZIP**, upload the ZIP package, and click **Deploy**.

      Figure 2-7 Uploading a ZIP file

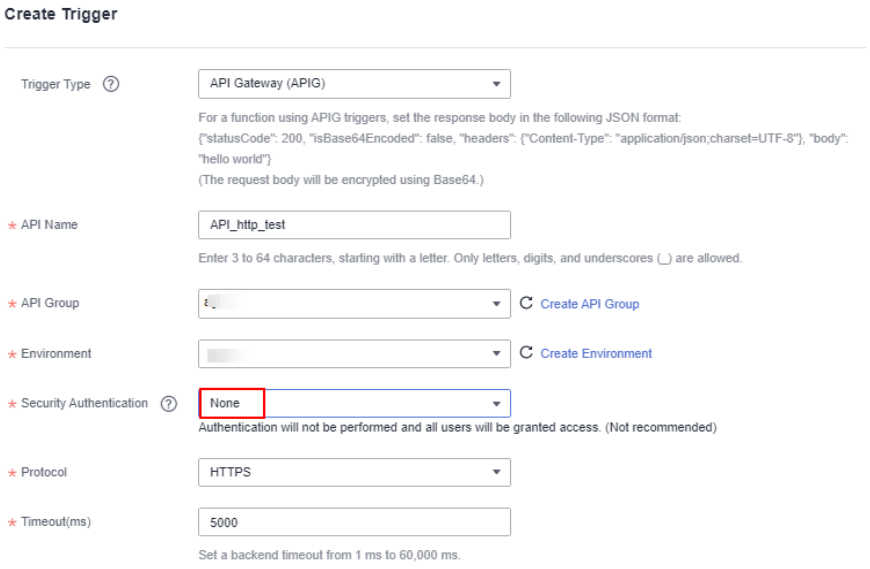
2. Create a trigger.

   NOTE

   HTTP functions support APIG and APIC triggers only.

   a. On the function details page, choose **Configuration** > **Triggers** and click **Create Trigger**.
   b. Set the trigger information. This step uses an APIG trigger as an example. For more information, see **Using an APIG Trigger**.

      Figure 2-8 Creating a trigger

NOTE

In this example, **Security Authentication** is set to **None**. You need to select an authentication mode based on site requirements.

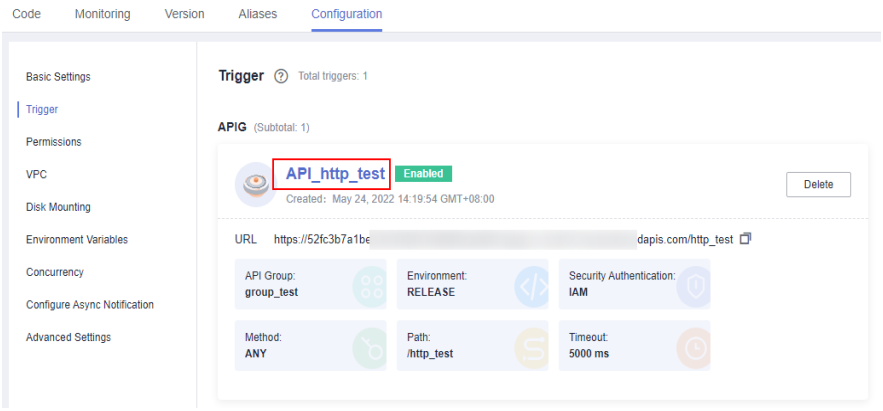
- **App**: AppKey and AppSecret authentication. This mode is of high security and is recommended.
- **IAM**: IAM authentication. This mode grants access permissions to IAM users only and is of medium security.
- **None**: No authentication. This mode grants access permissions to all users.

c. When the configuration is complete, click **OK**. After the trigger is created, **API_test_http** will be generated on the APIG console.

3. Publish the API.

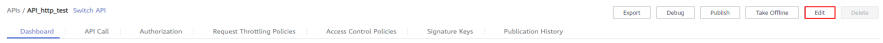
a. On the **Triggers** tab page, click an API name to go to the API overview page.

Figure 2-9 APIG trigger



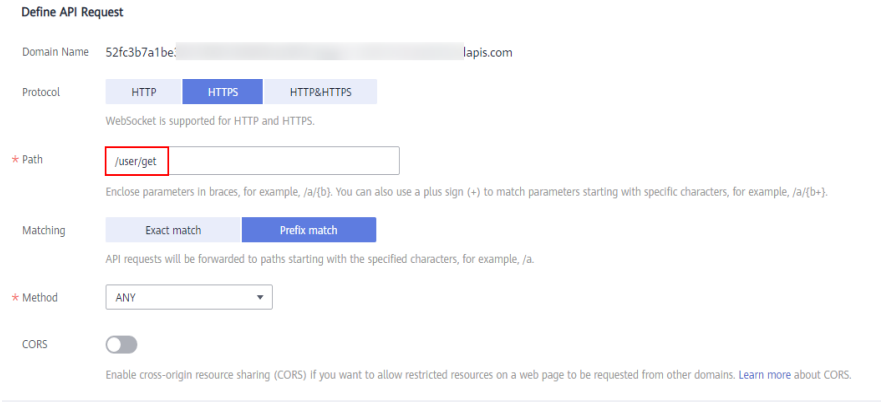
b. Click **Edit** in the upper right corner. The **Basic Information** page is displayed.

Figure 2-10 Editing an API



c. Click **Next**. On the **Define API Request** page that is displayed, change **Path** to **/user/get** and click **Finish**.

Figure 2-11 Defining an API request



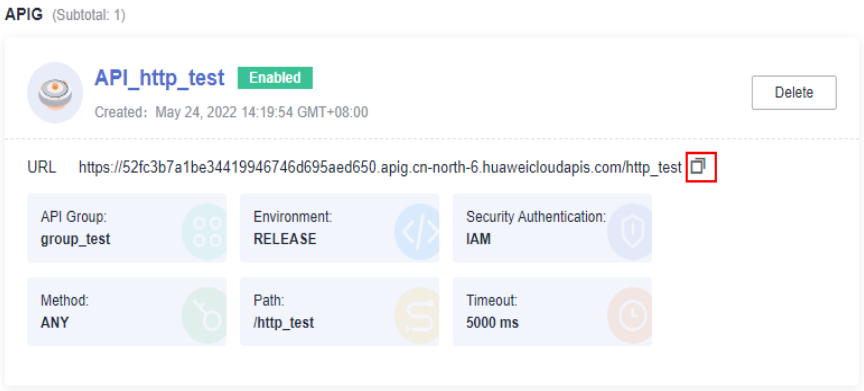
d. Click **Publish API**. On the displayed page, click **Publish**.

4. Trigger a function.

a. Go to the FunctionGraph console, choose **Functions** > **Function List** in the navigation pane, and click the created HTTP function to go to its details page.

b. Choose **Configuration** > **Triggers**, copy the URL, and access it using a browser.

Figure 2-12 Copying the URL



c. View the request result.

Figure 2-13 Viewing the request result

```
<html><body><h2>This is http function.</h2></body></html>
```

Common Function Request Headers

The following table lists the default request header fields of an HTTP function.

Table 2-6 Default request header fields

Field	Description
X-CFF-Request-Id	ID of the current request
X-CFF-Memory	Allocated memory
X-CFF-Timeout	Function timeout duration
X-CFF-Func-Version	Function version
X-CFF-Func-Name	Function name
X-CFF-Project-Id	Project ID
X-CFF-Package	App to which the function belongs
X-CFF-Region	Current region

2.3 Creating a Function Using a Template

Overview

FunctionGraph provides templates to automatically complete code, and running environment configurations when you create a function, helping you quickly build applications.

Creating a Function

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Templates**.
2. On the page that is displayed, select the **FunctionGraph** service, select the **context-class-introduction** template for Python 2.7, and click **Configure**.

   NOTE

   The **context-class-introduction** template for Python 2.7 is used as an example. You can also select other templates.
3. After you select a function template, the built-in code and configurations of the template are automatically loaded. The **Create Function** page is displayed.
4. Set **Function Name** to **context**, select a created agency, retain default values for other parameters, and click **Create Function**.

   NOTE

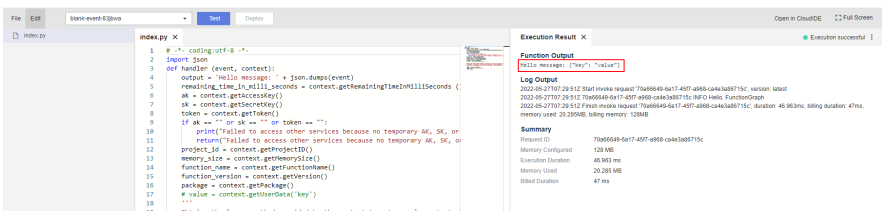
   If no agency is configured, the following message will be displayed when the function is triggered:

   ```
   Failed to access other services because no temporary AK, SK, or token has been obtained. Please set an agency.
   ```
5. Set the parameters based for your service requirements.

Triggering a Function

1. On the **Code** tab page of the **context** function, click **Test** in the upper right corner.
2. In the **Configure Test Event** dialog box, select **Blank Template** and click **Create**.
3. Click **Test**. After the test is complete, view the test result.

Figure 2-14 Successful execution result



2.4 Deploying a Function Using a Container Image

Introduction

Package your container images complying with the Open Container Initiative (OCI) standard, and upload them to FunctionGraph. The images will be loaded and run by FunctionGraph. Unlike the code upload mode, you can use a custom code package, which is flexible and reduces migration costs. You can create event and HTTP functions by using a custom image.

For details about how to develop and deploy an HTTP function using a container image, see **Developing an HTTP Function**.

For details about how to develop and deploy an event function using a container image, see **Developing an Event Function**.

The following features are supported:

- **Downloading images**

  Images are stored in SoftWare Repository for Container (SWR) and can only be downloaded by users with the **SWR Admin** permission. FunctionGraph will call the SWR API to generate and set temporary login commands before creating instances.

- **Setting environment variables**

  Encryption settings and environment variables are supported. For details, see **Configuring Environment Variables**.

- **Attaching external data disks**

  External data disks can be attached. For details, see **Configuring Disk Mounting**.

- **Billing**

  You will not be billed when you download images or wait for the images to be ready.

- **Reserved instances**

  For details, see the description about reserved instances.

NOTE

User containers will be started using UID 1003 and GID 1003, which are the same as other types of functions.

Prerequisites

You have created an agency with the **SWR Admin** permission by referring to **Configuring Agency Permissions**. Images are stored in SWR, and only users with this permission can invoke and pull images.

Procedure

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

2. On the **Function List** page, click **Create Function** in the upper right corner.
3. Select **Container Image**. For details, see **Table 2-7**.

Figure 2-15 Creating a function using a container image

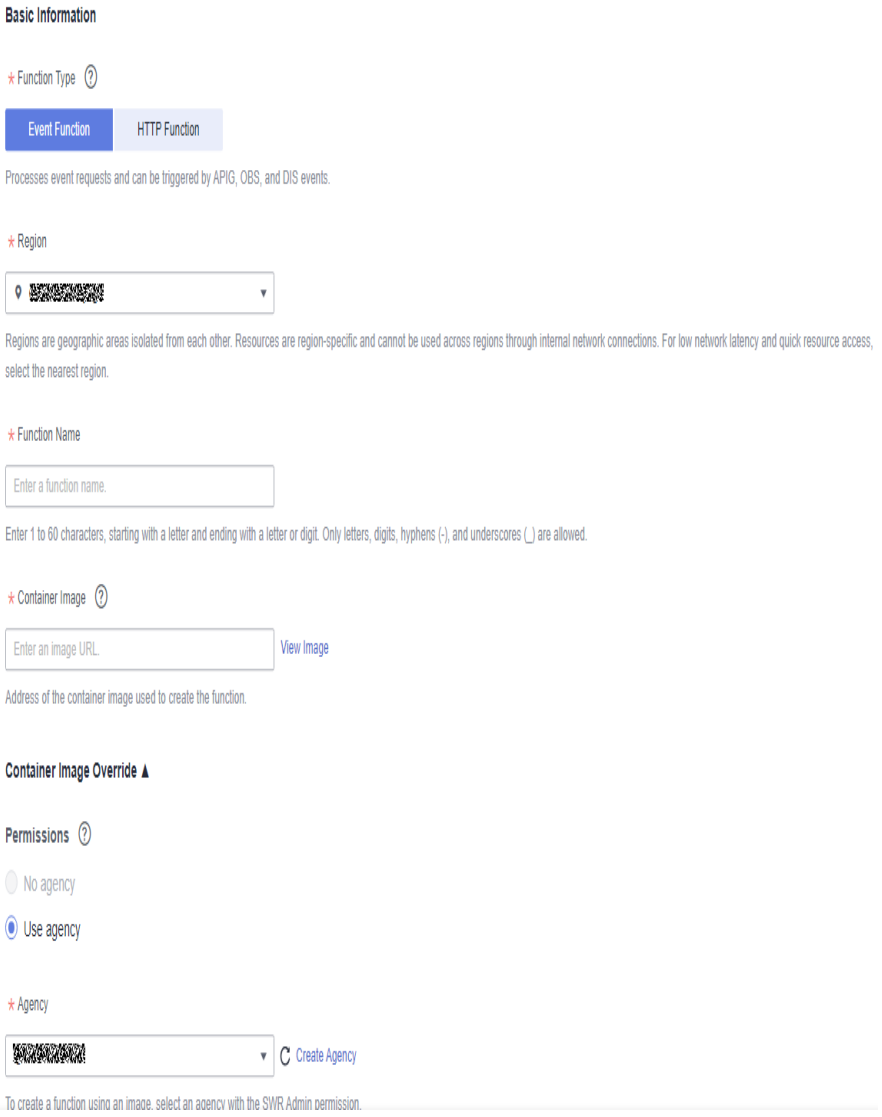


Table 2-7 Parameter description

Parameter	Description
*Function Type	Select a function type. **Event function**: triggered by triggers. **HTTP function**: triggered once HTTP requests are sent to specific URLs. **NOTE** • The custom container image must contain an HTTP server with listening port 8000. • HTTP functions support APIG and APIC triggers only. • When creating an event function, create an HTTP server to implement a handler (method: **POST**, path: **/invoke**) and an initializer (method: **POST**, path: **/init**). • When calling a function using APIG, **isBase64Encoded** is valued **true** by default, indicating that the request body transferred to FunctionGraph is encoded using Base64 and must be decoded for processing. • The function must return characters strings by using the following structure. `{ "isBase64Encoded": true|false, "statusCode": httpStatusCode, "headers": {"headerName":"headerValue",...}, "body": "..." }`
*Region	Select a region where you will deploy your code.
*Function Name	Name of the function, which must meet the following requirements: • Consists of 1 to 60 characters, and can contain letters, digits, hyphens (-), and underscores (_). • Starts with a letter and ends with a letter or digit.
*Enterprise Project	Select a created enterprise project and add the function to it. By default, **default** is selected. **NOTE** If EPS is not enabled, this parameter is unavailable. For details, see **Enabling the Enterprise Project Function**.
Container Image	Enter an image URL, that is, the location of the container image. You can click **View Image** to view private and shared images. For details about how to create an image, see **Creating an Image**. Image in SWR, for example, **swr.myhuaweicloud.com/my_group/my_image:latest**.

Parameter	Description
Container Image Override	• **CMD**: container startup command. Example: **/bin/sh**. If no command is specified, the entrypoint or CMD in the image configuration will be used. Enter one or more commands separated with commas (,). • **Args**: container startup parameter. Example: **-args,value1**. If no argument is specified, CMD in the image configuration will be used. Enter one or more arguments separated with commas (,). • **Working Dir**: working directory of the container. The folder path can only be **/** and cannot be created or modified. The path will be **/** by default if not specified. • **User ID**: user ID for running the image. If no user ID is specified, the default value **1003** will be used. • **Group ID**: user group ID. If no user group ID is specified, the default value **1003** will be used.
Agency	Select an agency with the **SWR Admin** permission. To create an agency, see **Creating an Agency**.

NOTE

- **Command**, **Args**, and **Working dir** can contain up to 5120 characters.
- When a function is executed at the first time, the image is pulled from SWR, and the container is started during cold start of the function, which takes a certain period of time. If there is no image on a node during subsequent cold starts, an image will be pulled from SWR.
- Public and private images are supported. For details, see **Setting Image Attributes**.
- The port of a custom container image must be 8000.
- The image package cannot exceed 10 GB. For a larger package, reduce the capacity. For example, mount the data of a question library to a container where the data was previously loaded through an external file system.
- FunctionGraph uses LTS to collect all logs that the container outputs to the console. These logs can be redirected to and printed on the console through standard output or an open-source log framework. The logs should include the system time, component name, code line, and key data, to facilitate fault locating.
- When an out of memory (OOM) error occurs, view the memory usage in the function execution result.
- Functions must return a valid HTTP response.

Sample Code

The following uses **Node.js Express** as an example. During function initialization, FunctionGraph uses the POST method to access the **/init** path (optional). Each time when a function is called, FunctionGraph uses the POST method to access the **/invoke** path. The function obtains **context** from **req.headers**, obtains **event** from **req.body**, and returns an HTTP response struct.


```
const express = require('express');
const app = express();
const PORT = 8000;

app.post('/init', (req, res) => {
  res.send('Hello init\n');
});

app.post('/invoke', (req, res) => {
  res.send('Hello invoke\n');
});

app.listen(PORT, () => {
  console.log(`Listening on http://localhost:${PORT}`);
});
```

2.5 Deploying a Function Using Terraform

2.5.1 Introduction

This section describes how to create a function using Terraform.

2.5.2 Prerequisites

2.5.2.1 Obtaining an Access Key

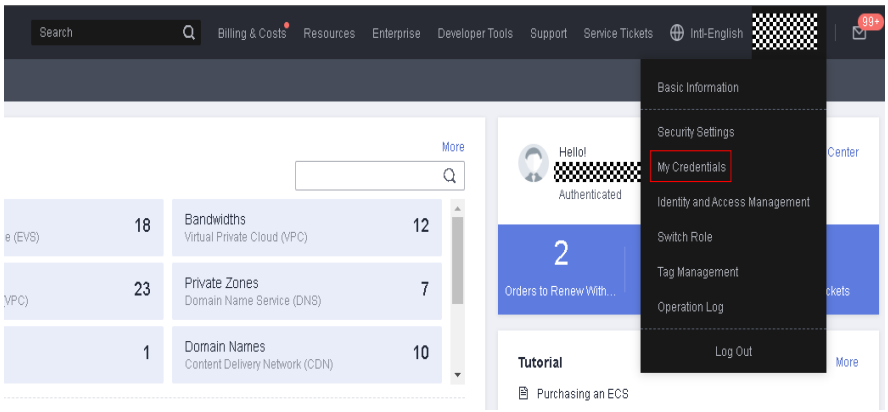
An access key comprises an access key ID (AK) and secret access key (SK), and is your long-term credential for accessing Huawei Cloud APIs.

Log in to Huawei Cloud, and click **Console** in the upper right corner.

Figure 2-16 Console

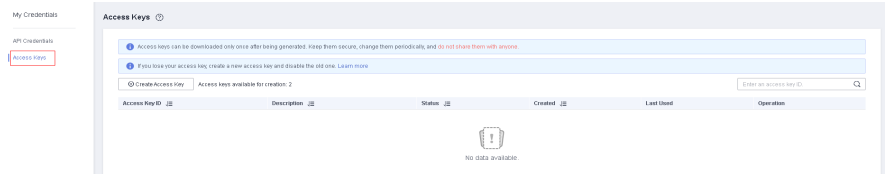
On the management console, hover over the username in the upper right corner and choose **My Credentials** from the drop-down list.

Figure 2-17 My Credentials



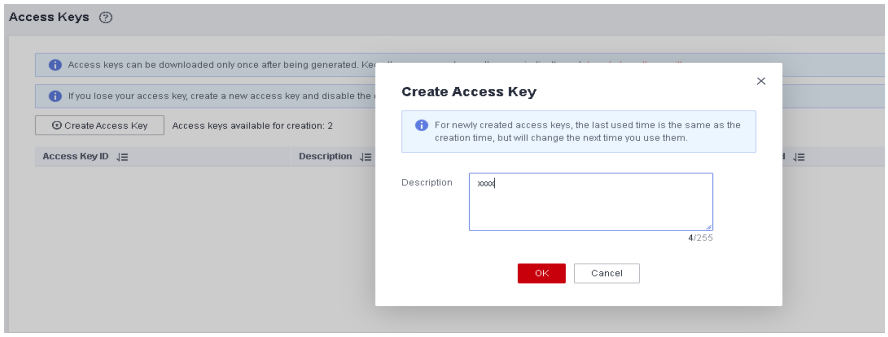
Choose **Access Keys** from the navigation pane.

Figure 2-18 Access Keys page



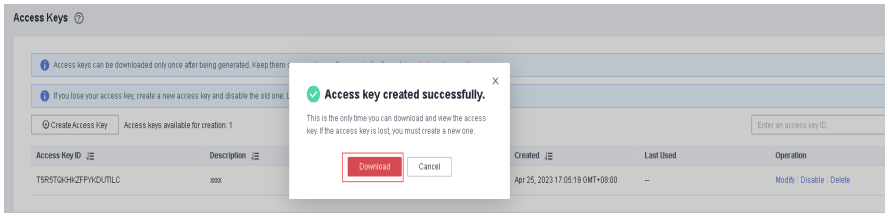
Click **Create Access Key**, and enter a description.

Figure 2-19 Creating an access key



Click **OK** to generate an access key, and download it.

Figure 2-20 Downloading the access key



View the AK in the access key list and the SK in the downloaded CSV file.

2.5.2.2 Preparing the Terraform Environment

Installing Terraform

Terraform provides installation packages for different environments. For details, see **https://developer.hashicorp.com/terraform/downloads**.

The following uses Linux CentOS (public access required) as an example to describe how to install Terraform.

Log in to the system as the **root** user, create the **/home/Terraform** directory, run the **cd** command to go to this directory, and then run the following commands:

```
sudo yum install -y yum-utils
sudo yum-config-manager --add-repo https://rpm.releases.hashicorp.com/RHEL/hashicorp.repo
sudo yum -y install terraform
```


Basic Terraform Commands

Run Terraform to view the command details.

```
Terraform
Usage: terraform [global options] <subcommand> [args]

The available commands for execution are listed below.
The primary workflow commands are given first, followed by
less common or more advanced commands.

Main commands:
  init          Prepare your working directory for other commands
  validate      Check whether the configuration is valid
  plan          Show changes required by the current configuration
  apply         Create or update infrastructure
  destroy       Destroy previously-created infrastructure

All other commands:
  console       Try Terraform expressions at an interactive command prompt
  fmt           Reformat your configuration in the standard style
  force-unlock  Release a stuck lock on the current workspace
  get           Install or upgrade remote Terraform modules
  graph         Generate a Graphviz graph of the steps in an operation
  import        Associate existing infrastructure with a Terraform resource
  login         Obtain and save credentials for a remote host
  logout        Remove locally-stored credentials for a remote host
  metadata      Metadata related commands
  output        Show output values from your root module
  providers     Show the providers required for this configuration
  refresh       Update the state to match remote systems
  show          Show the current state or a saved plan
  state         Advanced state management
  taint         Mark a resource instance as not fully functional
  untaint       Remove the 'tainted' state from a resource instance
  version       Show the current Terraform version
  workspace     Workspace management

Global options (use these before the subcommand, if any):
  -chdir=DIR    Switch to a different working directory before executing the
                given subcommand.
  -help         Show this help output, or the help for a specified subcommand.
  -version      An alias for the "version" subcommand.
```

For details about the commands, see **https://developer.hashicorp.com/terraform/cli**.

2.5.3 Basic Terraform Syntax

Terraform's configuration language is based on the HashiCorp Configuration Language (HCL) syntax. It is easy to configure and read and compatible with the JSON syntax. For details, see **https://developer.hashicorp.com/terraform/language**.

2.5.4 Writing a Function Resource Script

Huawei Cloud has registered with Terraform as a provider. You can mount your functions to the provider as resources. For details, see **https://registry.terraform.io/providers/huaweicloud/huaweicloud/latest/docs/resources/fgs_function**.

The following is an example.

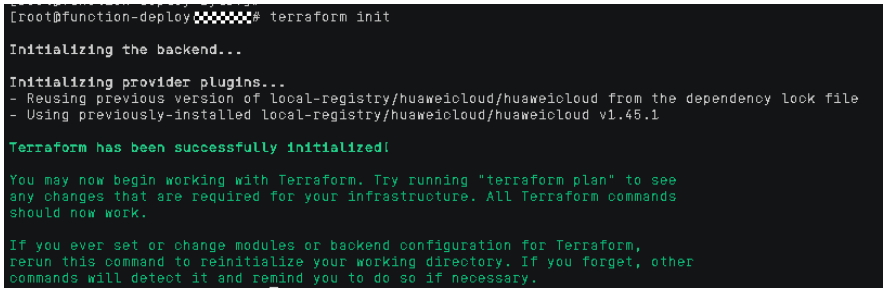
Create a **main.tf** file on the server, copy the following script to the file, and save it.


```
terraform {
  required_providers {
    huaweicloud = {
      source  = "huaweicloud/huaweicloud"
      version = ">= 1.40.0"
    }
  }
}

provider "huaweicloud" {
region = "cn-east-3" # Actual region
access_key = "*******" # Obtained key
secret_key = "*******" # Obtained key
}

resource "huaweicloud_fgs_function" "fgs_function" {
  name        = "test_func_rf"
  app         = "default"
  agency      = "function-admin"
  description = "function test"
  handler     = "index.handler"
  memory_size = 128
  timeout     = 3
  runtime     = "Python3.6"
  code_type   = "inline"
  func_code   =
"aW1wb3J0IGpzb24KZGVmIGhhbmRsZXIgKGV2ZW50LCBjb250ZXh0KToKICAgIG91dHB1dCA9ICdIZWxsbyBtZ
XNzYWdlOiAnICsganNvbi5kdW1wcyhldmVudCkKICAgIHJldHVybiBvdXRwdXQ=="
}
```

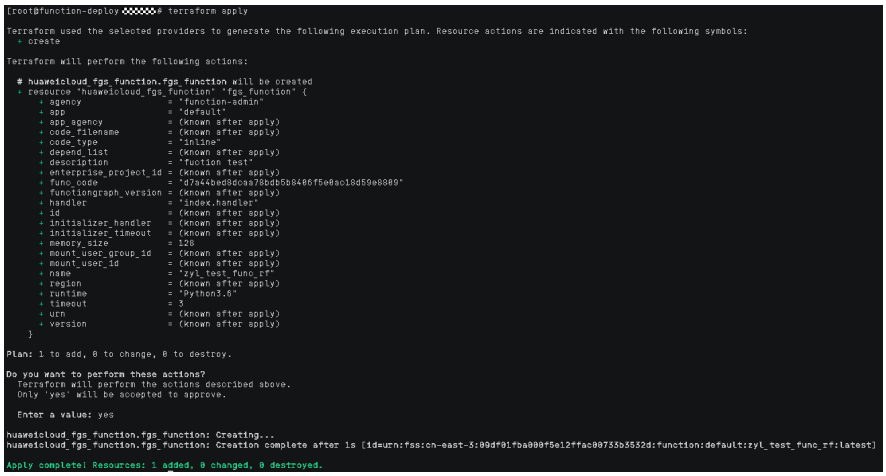
Replace **access_key** and **secret_key** with the AK/SK generated in **Obtaining an Access Key**.

2.5.5 Creating a Function by Running Terraform Commands

Go to the file path and run the **terraform init** command to initialize a working directory that contains the Terraform code.



Run the **terraform apply** command and enter **yes** after **Enter a value:**.



If the execution is successful, the function has been created.

3 Configuring Functions

3.1 Configuring Initialization

Overview

The initializer of a function is executed after an instance is started. The instance starts to process requests only after the initializer is executed. The initializer is executed only once during the lifecycle of a function instance. Initialization will be billed in the same way as function request processing.

Scenario

The service logic shared by multiple requests can be implemented in the initializer to reduce the latency. For example, the logic of loading a deep learning model with large specifications or building a connection pool for databases.

Prerequisites

You have created a function.

Initializing a Function

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Click the **Configuration** tab and choose **Advanced Settings**.

Figure 3-1 Enabling initialization

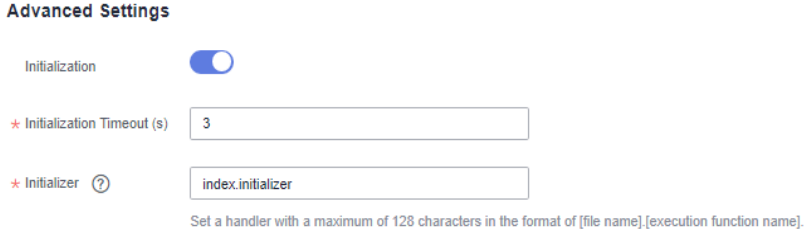


Table 3-1 Parameter configuration

Parameter	Description
Initialization	Enable initialization if needed.
Initialization Timeout (s)	Maximum duration the function can be initialized. Set this parameter if you enable function initialization. The value ranges from 1s to 300s.
Initializer	You can enable function initialization on the **Configuration** tab page. The initializer must be named in the same way as the handler. For example, for a Node.js or Python function, set an initializer name in the format of *[file name].[initialization function name]*. **NOTE** This parameter is not required if function initialization is disabled.

NOTE

- Set the initializer in the same way as the handler. For example, for a Node.js or Python function, set an initializer name in the format of *[file name].[initialization function name]*.
- For details about the function code configuration, see **Creating a Deployment Package**.

----End

3.2 Configuring Basic Settings

Introduction

After a function is created, **Memory (MB)**, **Handler**, and **Execution Timeout (s)** are automatically set based on your runtime. If needed, modify them based on this section.

Prerequisites

You have created a function.

Procedure

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. Choose **Configuration** > **Basic Settings** and configure parameters based on **Table 3-2**. Parameters marked with an asterisk (*) are mandatory.

Table 3-2 Basic settings

Parameter	Description
App	After a function is created, it is automatically categorized into the **default** app and cannot be switched to other apps. **NOTICE** An app acts like a folder. In the future, functions will be managed by label for better experience.
*Handler	• For a Node.js, Python, or PHP function, the handler must be named in the format of *[file name].[function name]*, which must contain a period (.). Example: **myfunction.handler** • For a Java function, the handler must be named in the format of *[package name].[class name].[execution function name]*. Example: **com.xxxxx.exp.Myfunction.myHandler** • For a Go function, the handler name must be the same as the executable file name in the uploaded code package. Example: If the executable file is **handler**, set this parameter to **handler**. • For a C# function, the handler must be named in the format of *[assembly]::[namespace].[class name]::[execution function name]*. Example: **HelloCsharp::Example.Hello::Handler**
*Enterprise Project	Select a created enterprise project and add the function to it. By default, **default** is selected. **NOTE** If EPS is not enabled, this parameter is unavailable. For details, see **Enabling the Enterprise Project Function**.
*Execution Timeout (s)	Maximum duration the function can be executed. You can set this parameter on the **Configuration** tab page. If the execution takes longer than 90s, use asynchronous invocation. The value ranges from 3s to 259,200s. **NOTE** The maximum duration for returning a result is 90s. If both the set timeout and the actual execution duration of a function exceed 90s, a message is displayed indicating that the function has timed out. However, the backend is still running. You can view the return result on the **Logs** tab page.
Memory (MB)	Memory of a function instance. Options: 128, 256, 512, 768, 1024, 1280, 1536, 1792, 2048, 2560, 3072, 3584, 4096, 8192, 10,240.

Parameter	Description
Description	Description of the function, which cannot exceed 512 characters.

4. Click **Save**.

3.3 Configuring Agency Permissions

Overview

FunctionGraph works with other cloud services in most scenarios. Create a cloud service agency so that FunctionGraph can perform resource O&M in other cloud services on your behalf.

Scenario

Before using FunctionGraph in the following scenarios, **create an agency**. Adjust the permissions granted to the agency to meet your service requirements. For example, grant the Admin permission in the development phase, and **change it to the fine-grained minimum permission in the product environment**. This ensures the required permissions while eliminating risks. Select the required action by referring to **Table 3-3**.

Table 3-3 Common actions

Scenario	Admin Permission	Fine-Grained Minimum Permission	Description
Using a custom image	SWR Admin	Unavailable	SWR Admin: administrator who has all permissions for the SoftWare Repository for Container (SWR) service. For details about how to create a custom image, see **Deploying a Function Using a Container Image**.

Scenario	Admin Permission	Fine-Grained Minimum Permission	Description
Mounting an SFS Turbo file system	SFS Administrator or Tenant administrator	sfsturbo:shares:getShare (Query details about a file system)	SFS Administrator: administrator who has all permissions for the Scalable File Service (SFS) service. Tenant administrator: administrator for all cloud services except IAM. This user can perform any operations on all cloud resources of the enterprise. sfsturbo:shares:getShare: permission for querying a file system in SFS. For details about how to mount an SFS Turbo file system, see **Mounting an SFS Turbo File System**.
Mounting an ECS shared directory	Tenant Guest and VPC Administrator	ecs:cloudServers:get (Query details about an ECS)	Tenant Guest: user with read-only permissions for all cloud services (except IAM) VPC Administrator: network administrator ecs:cloudServers:get: permission for querying an ECS. For details about how to mount an ECS shared directory, see **Mounting an ECS Shared Directory**.
Using a DIS trigger	DIS Administrator	Unavailable	Administrator who has all permissions for the DIS service. For details about how to create a DIS trigger, see **Using a DIS Trigger**.

Scenario	Admin Permission	Fine-Grained Minimum Permission	Description
Configuring cross-domain VPC access	VPC Administrator	vpc:ports:delete (Delete a port) vpc:ports:get (Query a port) vpc:ports:create (Create a port) vpc:vpcs:get (Query a VPC) vpc:subnets:get (Query a subnet)	Users with the **VPC Administrator** permissions can perform any operations on all cloud resources of the VPC. To configure cross-VPC access, specify an agency with VPC management permissions. Fine-grained minimum permission for VPC: permission for deleting, querying, or creating a port, or querying a VPC or subnet. For details about how to configure cross-domain VPC access, see **Configuring the Network**.
Reading DNS resources	DNS ReadOnlyAccess	dns:recordset:get (Query record sets) dns:zone:get (Query a tenant zone)	DNS ReadOnlyAccess: user with the permissions only to view DNS resources. To call a DNS API to resolve private domain names, specify an agency with the permissions to read DNS resources. Fine-grained minimum permission for DNS: permission for querying record sets or querying a tenant zone in DNS.
Creating an OBS bucket and trigger	OBS Administrator	obs:bucket:GetBucketLocation (Query a bucket location) obs:bucket:ListAllMyBuckets (Query buckets) obs:bucket:GetBucketNotification (Obtain the event notification configuration of a bucket) obs:bucket:PutBucketNotification (Configure event notifications for a bucket)	Fine-grained minimum permission for OBS: permission for querying a bucket location, buckets, or the event notification configuration of a bucket, or configuring event notifications for a bucket. For details about how to create an OBS trigger, see **Using an OBS Trigger**.

Creating an Agency

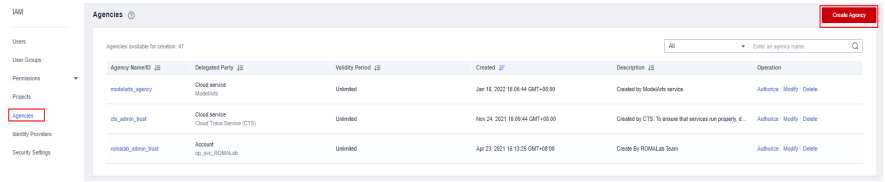
NOTE

In the following example, the **Tenant Administrator** permission is assigned to FunctionGraph and this setting takes effect only in the authorized regions.

Create an agency by referring to **Creating an Agency** and set parameters as follows:

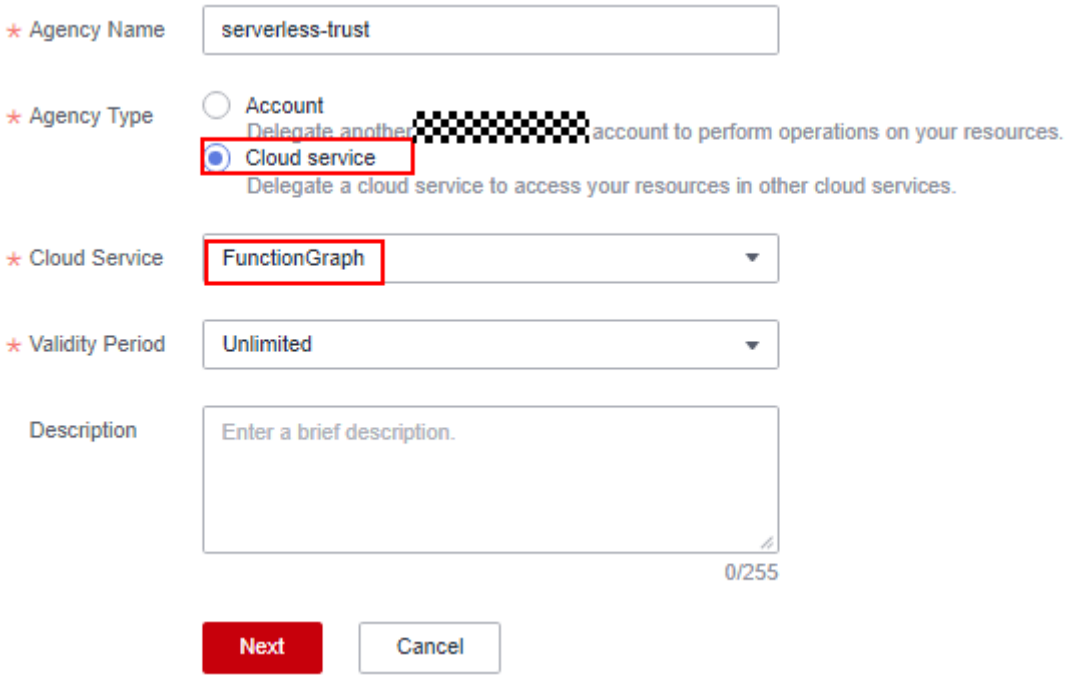
1. Log in to the IAM console.
2. On the IAM console, choose **Agencies** from the navigation pane, and click **Create Agency** in the upper right corner.

Figure 3-2 Creating an agency



3. Configure the agency.

Figure 3-3 Setting basic information



- For **Agency Name**, enter **serverless-trust**.
- For **Agency Type**, select **Cloud service**.
- For **Cloud Service**, select **FunctionGraph**.
- For **Validity Period**, select **Unlimited**.
- **Description**: Enter the description.

4. Click **Next**. On the displayed page, search for the permissions to be added in the search box on the right and select the permissions. The **Tenant Administrator** permission is used as an example.

Figure 3-4 Selecting policies

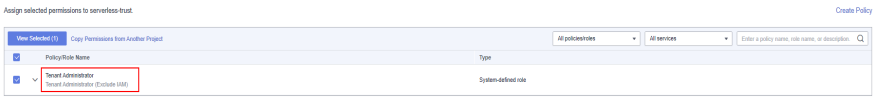


Table 3-4 Example of agency permissions

Policy Name	Scenario
Tenant Administrator	Administrator for all cloud services except IAM. This user can perform any operations on all cloud resources of the enterprise.

5. Click **Next** and select the scope, for example, **Region-specific project**.

Figure 3-5 Selecting the required permissions

Configuring an Agency

1. In the left navigation pane of the management console, choose **Compute** > **FunctionGraph**. On the FunctionGraph console, choose **Functions** > **Function List** from the navigation pane.
2. Click the function to be configured to go to the function details page.
3. Choose **Configuration** > **Permissions**, click **Create Agency**, and set an agency based on site requirements by referring to **2**–**5**.

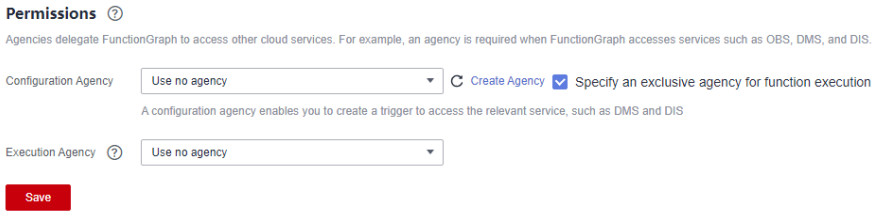
Table 3-5 Agency configuration parameters

Parameter	Description
Configuration Agency	Select a function that you have created.
Execution Agency	Mandatory if you select **Specify an exclusive agency for function execution**.

NOTE

- To ensure optimal performance, select **Specify an exclusive agency for function execution** and set different agencies for function configuration and execution. You can also use no agency or specify the same agency for both purposes. **Figure 3-6** shows the agency options.

  Figure 3-6 Setting agencies

- **Configuration Agency**: For example, to create Data Ingestion Service (DIS) triggers, first specify an agency with DIS permissions. If such an agency is not specified or the specified agency does not exist, no DIS triggers can be created.
- **Execution Agency**: This type of agency enables you to obtain a token and AK/SK from the context in the function handler for accessing other cloud services.

4. Click **Save**.

Modifying an Agency

Modifying an agency: You can modify the permissions, validity period, and description of an agency on the IAM console.

CAUTION

- After an agency is modified, it takes about 10 minutes for the modification (for example, **context.getToken**) to take effect.
- The agency information obtained using the **context** method is valid for 24 hours. Refresh it before it expires.

3.4 Configuring the Network

Public Access

By default, functions can access services on public networks. If the target public network service requires whitelist verification using a fixed IP address, **enable VPC access**, configure a public NAT gateway for the VPC, and bind an Elastic IP (EIP) to the gateway. For details, see **Configuring a Fixed Public IP Address**

Configuring VPC Access

Functions can access resources in a VPC bound to it. If a function needs both VPC and public access, configure a public NAT gateway for the VPC and bind an EIP to the gateway. For details, see **Configuring a Fixed Public IP Address**.

Required Permissions

Configure an agency by referring to **Configuring Agency Permissions**.

- Permissions for VPC access: an agency with the **VPC Administrator** permission or with the least permissions listed in **Table 3-6**

  Table 3-6 Least permissions required

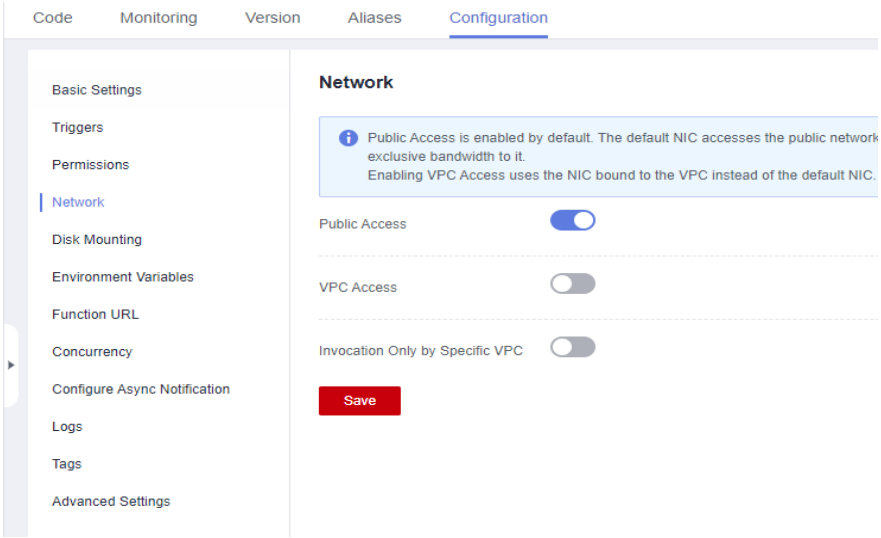
Permission	Action
Deleting a port	vpc:ports:delete
Querying a port	vpc:ports:get
Creating a port	vpc:ports:create
Querying a VPC	vpc:vpcs:get
Querying a subnet	vpc:subnets:get

- Permissions for private domain name resolution: an agency with the **DNS ReadOnlyAccess** permission

Procedure

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. Choose **Configuration** > **Network**, enable **VPC Access**, and specify a VPC and subnet.

Figure 3-7 Configuring VPC access



NOTE

1. For details on how to create a VPC and a subnet, see **Creating a VPC**.
2. Specify an agency with VPC administrator permissions for the function. For details, see **Configuring Agency Permissions**.
3. You can bind all functions in a project to up to four different subnets in any VPCs. (Each project has a unique 32-digit project ID, which is allocated when your account is created. The project IDs of your account and IAM user are the same.)

4. (Optional) Configure domain names.

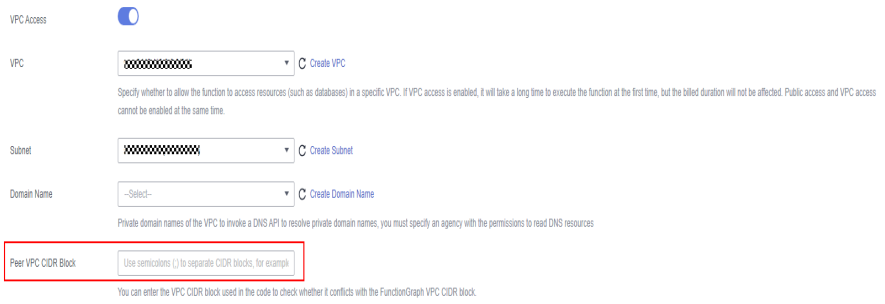
   Enter one or more private domain names of the VPC so that the function can use them to access resources in this VPC. See **Figure 3-7**.

   NOTE

   1. For details about how to create a private domain name, see **Creating a Private Zone**.
   2. Functions can resolve only domain names of the A record set type. For details about how to add a record set, see **Record Set Types and Configuration Rules**.

5. (Optional) Configure the VPC CIDR block.

   Figure 3-8 VPC CIDR block

   NOTE

   - You can enter the VPC CIDR block used in the code to check whether it conflicts with FunctionGraph's VPC CIDR block.
   - This feature is not available in **CN-Hong Kong**, **AP-Bangkok**, **AP-Singapore**, **AP-Jakarta**, **LA-Mexico City1**, **LA-Mexico City2**, **LA-Sao Paulo1**, and **LA-Santiago**.

6. Click **Save**.

Configuring a Fixed Public IP Address

If a function needs to access public network resources in a VPC or requires a fixed public IP address, configure a public NAT gateway for the VPC and bind an EIP to the gateway.

Prerequisites

1. You have created a VPC and a subnet according to **Creating a VPC**.
2. You have obtained an EIP according to **Assigning an EIP**.

Procedure

1. In the left navigation pane of the management console, choose **Network** > **NAT Gateway** to go to the NAT Gateway console. Then click **Buy Public NAT Gateway**.
2. On the displayed page, enter gateway information, select a VPC (for example, **vpc-01**) and subnet, and confirm and submit the settings. For details, see **Buying a Public NAT Gateway**.
3. Click the public NAT gateway name. On the details page that is displayed, click **Add SNAT Rule**, set the rule, and click **OK**.

Network Restrictions

FunctionGraph provides the following network access capabilities.

Parameter	Description
Public Access	The default public NAT access bandwidth is shared between tenants in testing scenarios that involve a small number of requests. In production scenarios that require high bandwidth, performance, and reliability, enable VPC access for your function, add a public NAT gateway, and bind an EIP with an exclusive bandwidth to it.
VPC Access	If this option is enabled, the default NIC is disabled and the NIC bound to the VPC will be used instead. Whether public access is supported depends on the VPC.
Invocation Only by Specific VPC	If this option is enabled, the function can be invoked only from the specified VPC instead of the public network.

3.5 Configuring Disk Mounting

Introduction

FunctionGraph allows you to mount file systems to your functions. Multiple functions can share the same file system. This greatly expands the function execution and storage space compared with the temporary disk space allocated to a function.

Scenarios

NOTICE

Before mounting file systems, enable access over the following ports:

1. 111, 445, 2049, 2051, 2052, and 20048
2. Another three ports for Ubuntu. To obtain the port numbers, run the following command:
   ```
   rpcinfo -p|grep mountd|grep tcp
   ```

For details, see **What Resources Does SFS Occupy?**

FunctionGraph supports the following types of file systems:

- SFS Turbo

  SFS Turbo supports the following storage classes: Standard (500 GB–32 TB), Standard-Enhanced (10 TB–320 TB), Performance (500 GB–32 TB), and Performance-Enhanced (10 TB–320 TB). SFS Turbo is expandable to 320 TB, and provides fully hosted shared file storage. It features high availability and durability, and supports massive quantities of small files and applications requiring low latency and high input/output operations per second (IOPS). SFS Turbo is suitable for high-performance websites, log storage, compression and decompression, DevOps, enterprise offices, and containerized applications. For details, see **SFS Service Overview**.

- ECS

  A directory on an ECS is specified as a shared file system (see **Mounting an ECS Shared Directory**) by using the network file system (NFS) service. The directory can then be mounted to a function in the same VPC as the ECS so that the function can read and write data in the directory. ECS file systems make it possible for dynamic expansion of compute resources. This type of file system is suitable for low service demand scenarios.

Benefits from using these file systems:

- The function execution space can be greatly expanded comparing with **/tmp**.
- A file system can be shared by multiple functions.
- ECS compute resources can be dynamically expanded and existing ECS storage capability can be used to achieve stronger computing performance.

  NOTE

  You can write temporary files in the **/tmp** directory. The total size of these files cannot exceed 10,240 MB.

Creating an Agency

Before adding file systems to a function, specify an agency with permissions for accessing the file system services for the function.

There is a limit on the maximum number of agencies you can create, and cloud service agencies cannot be modified. Therefore, you are advised to create an agency with high-level permissions, for example, **Tenant Administrator**, to allow

a function to access all resources in the selected region. For more information, see **Configuring Agency Permissions**.

Creating an SFS File System

Log in to the SFS console, and create an SFS or SFS Turbo file system. For details, see **Create a File System**.

Mounting an SFS Turbo File System

Setting an Agency

Before mounting an SFS Turbo file system to a function, specify an agency that has been granted **SFS Administrator** and **VPC Administrator** permissions for the function. If no agencies are available, create one in IAM.

Configuring VPC Access

An SFS Turbo file system is accessible only in the VPC where it has been created. Before mounting such a file system to a function, enable VPC access for the function.

1. On the SFS console, obtain the information about the VPC and subnet where a file system is to be mounted to your function. For details, see **File System Management**.
2. Enable VPC access by referring to **Configuring the Network** and enter the VPC and subnet obtained in **1**.

Mounting an SFS Turbo File System

SFS Turbo file systems can be mounted in the same way as SFS file systems. Select a file system and set the access path.

Mounting an ECS Shared Directory

Specifying an Agency

Before mounting an ECS shared directory to a function, specify an agency that has been granted **Tenant Guest** and **VPC Administrator** permissions for the function. If no agencies are available, create one in IAM. For details, see **Creating an Agency**.

Configuring VPC Access

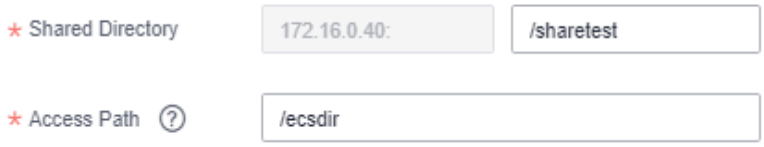
Before adding an ECS shared directory, specify the VPC where the ECS is deployed. View the VPC information on the details page of the ECS. Click the VPC name to go to the VPC details page, and view the subnet.

Set the acquired VPC and subnet for the function.

Mounting an ECS Directory

Enter a shared directory and function access path.

Figure 3-9 Setting the path



Follow-up Operations

A function can read and write data in an access path in the same way as in the mounted file system.

Function logs can be persisted by configuring the log path as a subdirectory in the access path.

Perform the following procedure to create a function using the "Web-Server-Access-Log-Statistics" template to analyze logs of a cloud server:

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Templates**.

Step 2 In the upper right corner of the **Templates** page, enter **Web-Server-Access-Log-Statistics** in the search box and press **Enter**.

Step 3 Click **Configure** next to the matched template (see **Figure 3-10**), and configure parameters as required.

Step 4 After parameter configuration is complete, click **Create Function**.

----End

Figure 3-10 Function template

Creating an NFS Shared Directory on ECS

1. **Linux**
   - CentOS, SUSE, EulerOS, Fedora, or openSUSE
     i. Configure a YUM repository.

     1. Create a file named **euleros.repo** in the **/etc/yum.repos.d** directory. Ensure that the file name must end with **.repo**.

     2. Run the following command to enter **euleros.repo** and edit the configuration:

     ```
     vi /etc/yum.repos.d/euleros.repo
     ```

     The EulerOS 2.0 SP3 YUM configuration is as follows:

     ```
     [base]
     name=EulerOS-2.0SP3 base
     baseurl=http://repo.huaweicloud.com/euler/2.3/os/x86_64/
     ```



```
enabled=1
gpgcheck=1
gpgkey=http://repo.huaweicloud.com/euler/2.3/os/RPM-GPG-KEY-EulerOS
```

The EulerOS 2.0 SP5 YUM configuration is as follows:

```
[base]
name=EulerOS-2.0SP5 base
baseurl=http://repo.huaweicloud.com/euler/2.5/os/x86_64/
enabled=1
gpgcheck=1
gpgkey=http://repo.huaweicloud.com/euler/2.5/os/RPM-GPG-KEY-EulerOS
```

NOTE

Parameter description:

name: repository name

baseurl: URL of the repository

- HTTP-based network address: **http://path/to/repo**
- Local repository address: **file:///path/to/local/repo**

gpgcheck: indicates whether to enable the GNU privacy guard (GPG) to check the validity and security of RPM package resources. **0**: The GPG check is disabled. **1**: The GPG check is enabled. If this option is not specified, the GPG check is enabled by default.

3. Save the configurations.

4. Run the following command to clear the cache:

```
yum clean all
```

ii. Run the following command to install nfs-utils:

```
yum install nfs-utils
```

iii. Create a shared directory.

When you open **/etc/exports** and need to create shared directory **/sharedata**, add the following configuration:

/sharedata 192.168.0.0/24(rw,sync,no_root_squash)

NOTE

The preceding configuration is used to share the **/sharedata** directory with other servers in the **192.168.0.0/24** subnet.

After the preceding command is run, run the **exportfs -v** command to view the shared directory and check whether the setting is successful.

iv. Run the following commands to start the NFS service:

```
systemctl start rpcbind
service nfs start
```

v. Create another shared directory.

For example, to create the **/home/myself/download** directory, add the following configuration to **/etc/exports**:

/home/myself/download 192.168.0.0/24(rw,sync,no_root_squash)

Restart the NFS service.

```
service nfs restart
```

Alternatively, run the following command without restarting the NFS service:

```
exportfs -rv
```

vi. (Optional) Enable automatic startup of the rpcbind service.

Run the following command:


```
systemctl enable rpcbind
```

- **Ubuntu**

  i. Run the following commands to install nfs-kernel-server:

  ```
  sudo apt-get update
  sudo apt install nfs-kernel-server
  ```

  ii. Create a shared directory.

  ```
  vim /etc/exports
  ```

  When you open **/etc/exports** and need to create shared directory **/sharedata**, add the following configuration:

  /sharedata 192.168.0.0/24(rw,sync,no_root_squash)

  NOTE

  The preceding configuration is used to share the **/sharedata** directory with other servers in the **192.168.0.0/24** subnet.

  iii. Start the NFS service.

  ```
  service nfs-kernel-server restart
  ```

  NOTE

  After the preceding command is run, run the **exportfs -v** command to view the shared directory and check whether the setting is successful.

  iv. Create another shared directory.

  For example, to create the **/home/myself/download** directory, add the following configuration to **/etc/exports**:

  /home/myself/download 192.168.0.0/24(rw,sync,no_root_squash)

  Restart the NFS service.

  ```
  service nfs restart
  ```

  Alternatively, run the following command without restarting the NFS service:

  ```
  exportfs -rv
  ```

2. **Windows**

1. Install the NFS server.

   Paid software: haneWIN. Download the software at the **haneWIN official website**.

   Free software: FreeNFS and WinNFSd. Download the software at the **SourceForge website**.

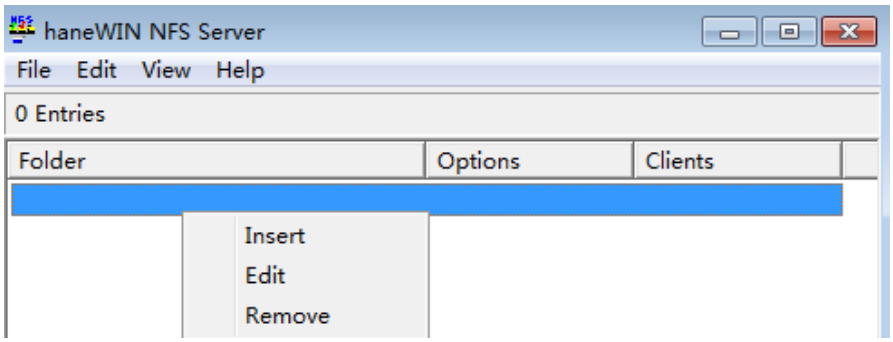
2. Enable the NFS function.

   - In the case of WinNFSd, see **WinNFSd configuration**.
   - In the case of haneWIN, perform the following steps:

     i. Run **nfsctl.exe** as the Windows administrator.

     ii. Right-click in the blank area and choose **Insert** from the shortcut menu.

Figure 3-11 Insert



3.6 Configuring Environment Variables

Overview

Environment variables allow you to pass dynamic parameters to a function without modifying code.

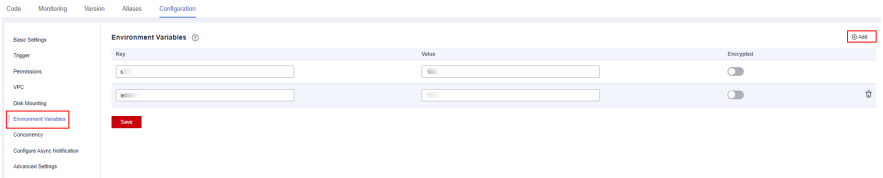
Scenario

- Environment distinguishing: Configure different environment variables for the same function logic. For example, use environment variables to configure testing and development databases.
- Configuration encryption: Configure encrypted environment variables to dynamically obtain authentication information (account, password, AK/SK) required to access other services.
- Dynamic configuration: Configure environment variables for parameters that need to be dynamically adjusted, including query period and timeout, in function logic.

Procedure

You can configure encryption settings and environment variables to dynamically pass settings to your function code and libraries without changing your code.

Figure 3-12 Adding environment variables



For example, for Node.js, encryption settings and environment variable values can be obtained from **getUserData(string key)** in **Context**. For details, see **Developing Functions in Node.js**.

WARNING

- Environment variables and encryption settings are user-defined key-value pairs that store function settings. Keys can contain letters, digits, and underscores (_), and must start with a letter.
- The total length of the key and value cannot exceed 4096 characters. (Available in these regions: ME-Riyadh, CN Southwest-Guiyang1, CN North-Ulanqab-Auto1, AF-Johannesburg, TR-Istanbul, CN North-Ulanqab1, LA-Sao Paulo1, CN-Hong Kong, AP-Singapore, CN East-Shanghai2, LA-Santiago, AP-Jakarta, CN Southwest-Guiyang201)
- When you define environment variables, FunctionGraph displays all your input information in plain text. For security purposes, do not include sensitive information.
- After encryption is enabled, key-value pairs are encrypted on the console and will remain encrypted during transmission.

Preset Parameters

The following lists preset parameters. Do not configure environment variables with the same names as any of these parameters.

Table 3-7 Preset parameters and description

Environment Variable	Description	Obtaining Method and Default Value
RUNTIME_PROJECT_ID	Project ID	Obtain the value from a Context interface or a system environment variable.
RUNTIME_FUNC_NAME	Function name	Obtain the value from a Context interface or a system environment variable.
RUNTIME_FUNC_VERSION	Function version	Obtain the value from a Context interface or a system environment variable.
RUNTIME_HANDLER	Handler	Obtain the value from a system environment variable.
RUNTIME_TIMEOUT	Execution timeout allowed for a function.	Obtain the value from a system environment variable.

Environment Variable	Description	Obtaining Method and Default Value
RUNTIME_USERDATA	Value passed through an environment variable	Obtain the value from a Context interface or a system environment variable.
RUNTIME_CPU	CPU usage of a function. The value is in proportion to **MemorySize**.	Obtain the value from a Context interface or a system environment variable.
RUNTIME_MEMORY	Memory size configured for a function	Obtain the value from a Context interface or a system environment variable. Unit: MB
RUNTIME_MAX_RESP_BODY_SIZE	Maximum size of a response body	Obtain the value from a system environment variable. Default value: 6,291,456 bytes
RUNTIME_INITIALIZER_HANDLER	Initializer	Obtain the value from a system environment variable.
RUNTIME_INITIALIZER_TIMEOUT	Initialization timeout of a function	Obtain the value from a system environment variable.
RUNTIME_ROOT	Runtime package path	Obtain the value from a system environment variable. Default value: **/home/snuser/runtime**
RUNTIME_CODE_ROOT	Path for storing code in a container	Obtain the value from a system environment variable. Default value: **/opt/function/code**
RUNTIME_LOG_DIR	Path for storing system logs in a container	Obtain the value from a system environment variable. Default value: **/home/snuser/log**

Example

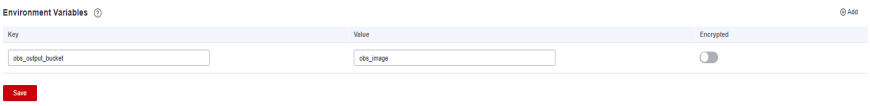
You can use environment variables to configure which directory to install files in, where to store outputs, and how to store connection and logging settings. These settings are decoupled from the application logic, so you do not need to update your function code when you change the settings.

In the following code snippet, **obs_output_bucket** is the bucket used for storing processed images.

```
def handler(event, context):
    srcBucket, srcObjName = getObsObjInfo4OBSTrigger(event)
    obs_address = context.getUserData('obs_address')
    outputBucket = context.getUserData('obs_output_bucket')
    if obs_address is None:
        obs_address = '{obs_address_ip}'
    if outputBucket is None:
        outputBucket = 'casebucket-out'

    ak = context.getAccessKey()
    sk = context.getSecretKey()

    # download file uploaded by user from obs
    GetObject(obs_address, srcBucket, srcObjName, ak, sk)

    outFile = watermark_image(srcObjName)

    # Upload converted files to a new OBS bucket.
    PostObject (obs_address, outputBucket, outFile, ak, sk)

    return 'OK'
```

Using environment variable **obs_output_bucket**, you can flexibly set the OBS bucket used for storing output images.

Figure 3-13 Environment variables



3.7 Configuring Asynchronous Execution Notification

Overview

Functions can be invoked synchronously or asynchronously. In asynchronous mode, FunctionGraph sends a response immediately after persisting a request. The request result cannot be known in real time. To retry when an asynchronous request fails or obtain asynchronous processing results, configure asynchronous settings.

Scenario

- Retry: By default, FunctionGraph does not retry if a function fails due to a code error. If your function needs retry, for example, if third-party services often fail to be invoked, configure retry to improve the success rate.

- Result notifications: FunctionGraph automatically notifies downstream services of the asynchronous execution result of a function for further processing. For example, storing execution failure information in OBS for cause analysis, or pushing execution success information to DIS or triggering the function again.

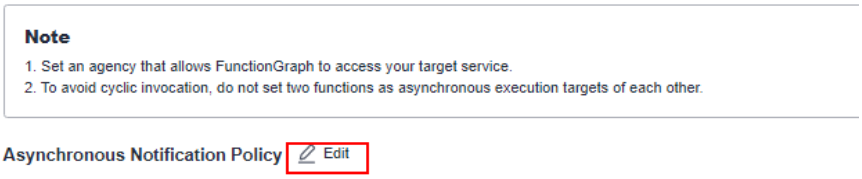
Procedure

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Configure Async Notification**. On the displayed page, click **Edit** next to **Asynchronous Notification Policy**.

Figure 3-14 Configuring an asynchronous notification policy



Step 4 Set parameters by referring to **Table 3-8**. For example, specify **FunctionGraph** for **Target Service**.

Figure 3-15 Setting parameters

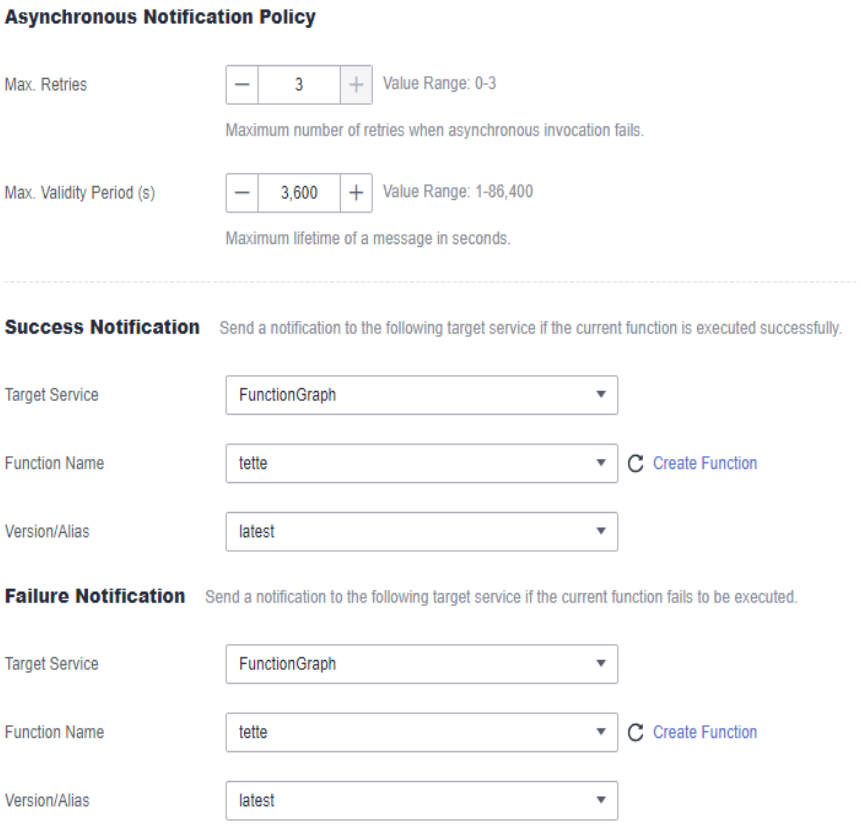


Table 3-8 Parameter description

Parameter	Description
Asynchronous Execution Notification Policy	• **Max. Retries**: maximum number of retries when asynchronous invocation fails. Value range: 0–3. Default value: **1**. • **Max. Validity Period (s)**: maximum lifetime of a message in seconds. Value range: 1–86,400.
Success Notification	**Target Service**: to which a notification will be sent if a function is executed successfully. 1. FunctionGraph 2. OBS 3. DIS 4. SMN
Failure Notification	**Target Service**: to which a notification will be sent if a function fails to be executed. 1. FunctionGraph 2. OBS 3. DIS 4. SMN

Step 5 Click **OK**.

NOTE

1. If a message indicating insufficient permissions is displayed when you configure asynchronous execution notification, add the **FunctionGraph Administrator** permission. For details, see **Creating a User and Granting Permissions**.
2. Set an agency that allows FunctionGraph to access the target service.
3. To avoid cyclic invocation, do not set two functions as asynchronous execution targets of each other.

----End

Configuration Description

For details about how to set the target for asynchronous invocation, see **Table 3-9**. The following shows an example:

```
{
      "timestamp": "2020-08-20T12:00:00.000Z+08:00",
   "request_context": {
         "request_id": "1167bf8c-87b0-43ab-8f5f-26b16c64f252",
         "function_urn": "urn:fss:xx-xxxx-x:xxxxxxx:function:xxxx:xxxx:latest",
         "condition": "",
         "approximate_invoke_count": 0
    },
      "request_payload": "",
      "response_context": {
         "status_code": 200,
         "function_error": ""
    },
```



```
    "response_payload": "hello world!"
}
```

Table 3-9 Parameter description

Parameter	Description
timestamp	Time when the invocation starts.
request_context	Request context.
request_context.request_id	ID of an asynchronous invocation request.
request_context. function_urn	URN of the function that is to be executed asynchronously.
request_context.condition	Invocation error type.
request_context. approximate_invoke_count	Number of asynchronous invocation times. If the value is greater than 1, function execution has been retried.
request_payload	Original request payload.
response_context	Response context.
response_context.statusCode	Code returned after function invocation. If the code is not 200, a system error occurred.
response_context.function_error	Invocation error information.
response_payload	Payload returned after function execution.

3.8 Configuring Single-Instance Multi-Concurrency

NOTE

This feature is supported only by FunctionGraph v2.

Overview

By default, each function instance processes only one request at a specific time. For example, to process three concurrent requests, FunctionGraph triggers three function instances. To address this issue, FunctionGraph has launched the single-instance multi-concurrency feature, allowing multiple requests to be processed concurrently on one instance.

Scenario

This feature is suitable for functions which spend a long time to initialize or wait for a response from downstream services. The feature has the following advantages:

- Fewer cold starts and lower latency: Usually, FunctionGraph starts three instances to process three requests, involving three cold starts. If you configure the concurrency of three requests per instance, only one instance is required, involving only one cold start.
- Shorter processing duration and lower cost: Normally, the total duration of multiple requests is the sum of each request's processing time. With this feature configured, the total duration is from the start of the first request to the end of the last request.

Comparison

If a function takes 5s to execute each time and you set the number of requests that can be concurrently processed by an instance to 1, three requests need to be processed in three instances, respectively. Therefore, the total execution duration is 15s.

When you set **Max. Requests per Instance** to **5**, if three requests are sent, they will be concurrently processed by one instance. The total execution time is 5s.

NOTE

If the maximum number of requests per instance is greater than 1, new instances will be automatically added when this number is reached. The maximum number of instances will not exceed **Max. Instances per Function** you set.

Table 3-10 Comparison

Comparison Item	Single-Instance Single-Concurrency	Single-Instance Multi-Concurrency
Log printing	-	To print logs, Node.js Runtime uses the **console.info()** function, Python Runtime uses the **print()** function, and Java Runtime uses the **System.out.println()** function. In this mode, current request IDs are included in the log content. However, when multiple requests are concurrently processed by an instance, the request IDs are incorrect if you continue to use the preceding functions to print logs. In this case, use **context.getLogger()** to obtain a log output object, for example, Python Runtime. log = context.getLogger() log.info("test")
Shared variables	Not involved.	Modifying shared variables will cause errors. Mutual exclusion protection is required when you modify non-thread-safe variables during function writing.

Comparison Item	Single-Instance Single-Concurrency	Single-Instance Multi-Concurrency
Monitoring metrics	Perform monitoring based on the actual situation.	Under the same load, the number of function instances decreases significantly.
Flow control error	Not involved.	When there are too many requests, the error code in the body is **FSS.0429**, the status in the response header is **429**, and the error message is **Your request has been controlled by overload sdk, please retry later**.

Configuring Single-Instance Multi-Concurrency

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. Choose **Configuration** > **Concurrency**.

   Set parameters by referring to **Table 3-11** and click **Save**.

Figure 3-16 Concurrency configuration

Table 3-11 Description

Parameter	Description
Max. Requests per Instance	Number of concurrent requests supported by a single instance. Value range: 1–1000.

Parameter	Description
Max. Instances per Function	Maximum number of instances in which a function can run. Default: **400**. Maximum: **1000**. **–1**: The function can run in any number of instances. **0**: The function is disabled. **NOTE** Requests that exceed the processing capability of instances will be discarded. Errors caused by excessive requests will not be displayed in function logs. You can obtain error details by referring to **Configuring Asynchronous Execution Notification**.

Configuration Constraints

- For Python functions, threads on an instance are bound to one core due to the Python Global Interpreter Lock (GIL) lock. As a result, concurrent requests can only be processed using the single core, not multiple cores. The function processing performance cannot be improved even if larger resource specifications are configured.
- For Node.js functions, the single-process single-thread processing of the V8 engine results in processing of concurrent requests only using a single core, not multiple cores. The function processing performance cannot be improved even if larger resource specifications are configured.

3.9 Managing Versions

Overview

FunctionGraph allows you to publish one or more versions throughout the development, test, and production processes to manage your function code. The code and environment variables of each version are saved as a snapshot. After the function code is published, you can modify settings as required.

After a function is created, the default version is latest. Each function has the latest version. After the function code is published, you can modify the version configuration as required.

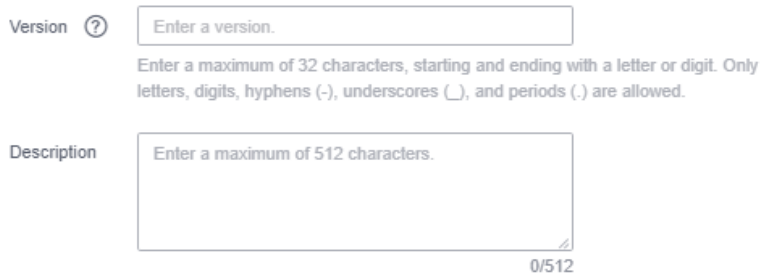
NOTE

A version is a snapshot of a function and corresponds to a tag in code. Each version contains the configuration and code of the function. By default, no trigger is bound to a new version. After a version is published, the configuration (such as environment variables) and code of the version cannot be updated, to ensure stability and traceability.

Publishing a Version

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. On the **Version** tab page, click **Publish new version**.

Figure 3-17 Parameters for publishing a new version



- **Version**: Enter a version number. If no version number is specified, the system automatically generates a version number based on the current date, for example, **v20220510-190658**.
- **Description**: Enter a description for the version. This parameter is optional.

4. Click **OK**. The system automatically publishes a version. Then you will be redirected to the new version.

NOTE

- You can publish up to 20 versions for a function.
- For a function whose latest version has been configured with reserved instances, the function configuration can be modified. By default, non-latest versions do not have reserved instances.
- No disk is attached to a new version created based on latest. Environment variables cannot be set if no trigger has been bound to the version.

Deleting a Version

1. Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. On the **Version** tab page of the latest version, select the version to delete.

Figure 3-18 Deleting a version

NOTE

- The latest version of a function cannot be deleted.
- If a function version associated with aliases is deleted, the aliases will also be deleted.

4. Click **OK** to delete the version.

WARNING

Deleting a version will permanently delete the associated code, configuration, alias, and event source mapping, but will not delete logs. Deleted versions cannot be recovered. Exercise caution when performing this operation.

3.10 Managing Aliases

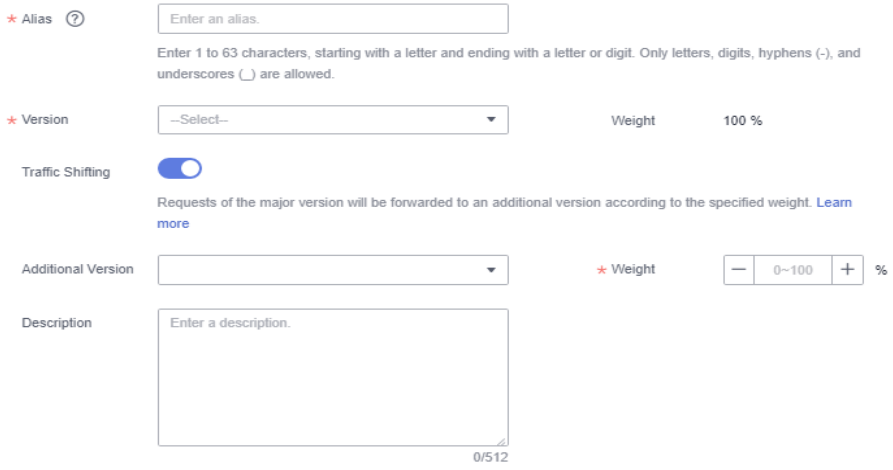
Overview

An alias points to a specific function version. Create an alias and expose it to clients, for example, bind a trigger to the alias instead of the corresponding version. Then your modification to the version for update or rollback will be imperceptible to the clients. An alias can point to up to two versions with different weights for dark launch.

Creating an Alias

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. On the **Aliases** tab page, click **Create Alias**.

Figure 3-19 Creating an alias



- **Alias**: Enter an alias.
- **Version**: Select a version to be associated with the alias.
- **Traffic Shifting**: Choose whether to enable traffic shifting. If this function is enabled, you can distribute a specific percentage of traffic to the additional version.
- **Additional Version**: Select an additional version to be associated. The latest version cannot be used as an additional version.
- **Weight**: Enter an integer from 0 to 100.

- **Description**: Enter a description for the alias.

4. Click **OK**.

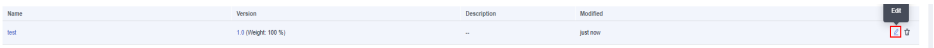
NOTE

You can create up to 10 aliases for a function.

Modifying an Alias

1. Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. On the **Aliases** tab page of the latest version, select the alias to modify.

Figure 3-20 Modifying an alias

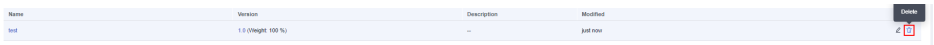


4. Modify the alias information, and click **OK**.

Deleting an Alias

1. Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. On the **Aliases** tab page of the latest version, select the alias to delete.

Figure 3-21 Deleting an alias



4. Click **OK** to delete the version.

3.11 Configuring Dynamic Memory

Overview

By default, a function is bound with only one resource specification. After enabling dynamic memory, you can configure a specification for request processing. If no specification is configured, the default one is used.

Scenario

Take video transcoding as an example. The size of a video file ranges from MB to GB. Different encoding formats and resolutions require different computing resources. To ensure performance, you usually need to configure a large resource specification, which however will result in a waste during low-resolution video (such as short video) processing. To solve this problem, implement the transcoding service with two functions: metadata obtaining and transcoding. Configure a specification for the transcoding function according to the metadata information to minimize the resources and cost.

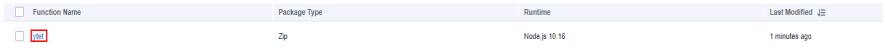
Prerequisites

You have created a function according to **Creating a Function from Scratch**.

Procedure

Step 1 Log in to the FunctionGraph console, choose **Functions** > **Function List** in the navigation pane, and click the name of the created function.

Figure 3-22 Selecting a created function

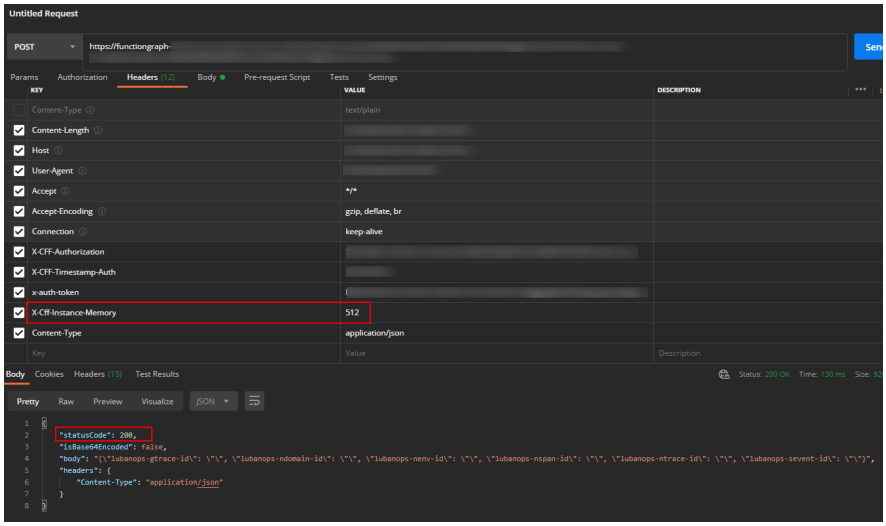


Step 2 On the function details page, choose **Configuration** > **Advanced Settings** and enable **Dynamic Memory**.

Step 3 Call the synchronous or asynchronous function execution API, add **X-Cff-Instance-Memory** to the request header, and set the value to **128**, **256**, **512**, **768**, **1024**, **1280**, **1536**, **1792**, **2048**, **2560**, **3072**, **3584**, **4096**, **8192**, or **10240**.

The following describes how to call an API using Postman. Add **X-Cff-Instance-Memory** to **Headers** and set the value to **512**. If the API is called successfully, error code 200 will be returned.

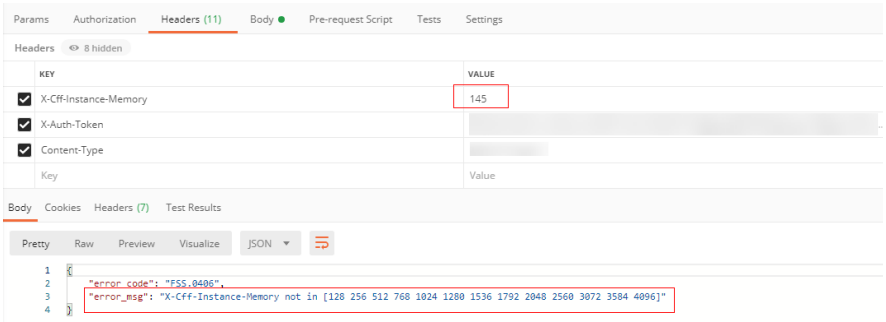
Figure 3-23 Adding a request header and calling the function



NOTE

- If **Dynamic Memory** is not enabled, the memory size set when the function is created will be used by default.
- If **Dynamic Memory** is enabled but the memory value has not been set, the memory size set when the function is created will be used by default. If the API is called successfully, error code 200 will be returned.
- If **Dynamic Memory** is enabled but the memory value is not **128**, **256**, **512**, **768**, **1024**, **1280**, **1536**, **1792**, **2048**, **2560**, **3072**, **3584**, **4096**, **8192**, or **10240**, error code FSS.0406 will be returned when the API is called. You only need to reset the memory value.

Figure 3-24 Invocation failure



----End

3.12 Configuring Heartbeat Function

Introduction

A heartbeat function detects the following exceptions of your functions:

- Deadlock
- Memory overflow
- Network errors

After you configure a heartbeat function, FunctionGraph sends a heartbeat request to your function instance every 5s. If the response is abnormal, FunctionGraph terminates the function instance.

The heartbeat request timeout is 3s. If no response is returned for six consecutive times, the function instance will be stopped.

Constraints

1. **Heartbeat detection is available for Java functions.**
2. The heartbeat function entry must be in the same file as your function handler.

   Java heartbeat function format:

   ```
   public boolean heartbeat() {
       // Custom detection logic
       return true
   ```

3. The heartbeat function has no input parameter and its return value is Boolean.

Procedure

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Click the **Configuration** tab and choose **Advanced Settings**.

Step 4 Enable **Heartbeat Function** and set the function entry.

Figure 3-25 Configuring a heartbeat function

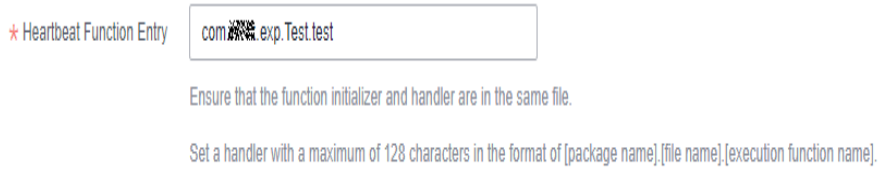


Table 3-12 Heartbeat function configuration

Parameter	Description
Heartbeat Function	If this option is enabled, FunctionGraph detects exceptions when your function is running.
Heartbeat Function Entry	The heartbeat function entry must be in the same file as your function handler. The value can contain a maximum of 128 characters in the format of "[package name].[class name].[execution function name]".

Step 5 Click **Save**.

----End

3.13 Configuring Tags

Introduction

Tags help you identify your cloud resources. When you have many cloud resources of the same type, you can use tags to classify them by dimension (for example, use, owner, or environment).

Add tags for a function on the **Configuration** tab page. Each function can have a maximum of 20 tags.

Scenario

Tags help you identify and manage your function resources. For example, you can define a set of tags for function resources in your account to track the owner and usage of each function resource.

Adding a Tag

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. Choose **Configuration** > **Tag**, and click **Add Tag**.
4. Add a tag key and value that meet the following rules:
   - Each tag consists of a key-value pair. Each key must be unique and have only one value.
   - Each function can have a maximum of 20 tags.

   NOTE

   If your organization has configured tag policies for FunctionGraph, add tags to functions based on the policies. If a tag does not comply with the tag policies, function creation may fail. Contact your administrator to learn more about tag policies.

   Table 3-13 Tag naming rules

Parameter	Rule
Key	• Cannot be empty. • Cannot start with _**sys**_ or a space, or end with a space. • Can contain UTF-8 letters, digits, spaces, and these characters: _.:=+-@ • Must be unique and cannot exceed 128 characters.
Value	• Can be an empty string. • Can contain UTF-8 letters, digits, spaces, and these characters: _.:/=+-@ • Max. 255 characters.

5. Click **Save**.

   Tag values can be modified but tag keys cannot.

Searching for Functions by Tag

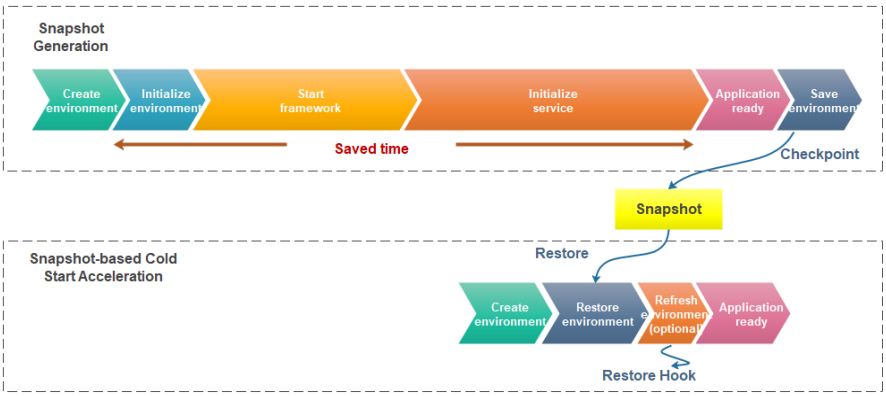
1. Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.
2. In the search box, select the **Tag** filter, and then select one or more key-value pairs.
3. (Optional) Add more filters, such as runtime and package type.
4. View the search result in the function list.

3.14 Configuring Snapshot-based Cold Start

Introduction

Huawei Cloud's snapshot-based cold start solution is a performance optimization service. It is free of charge and requires only simple configurations and a few code changes.

After cold start acceleration is enabled for a Java function, FunctionGraph executes the initialization code of the function, captures a snapshot of the context, and caches the snapshot after encryption. When the function scales with cold start, it **restores the execution environment from the snapshot** instead of repeating the initialization process, significantly increasing the startup speed.



Constraints

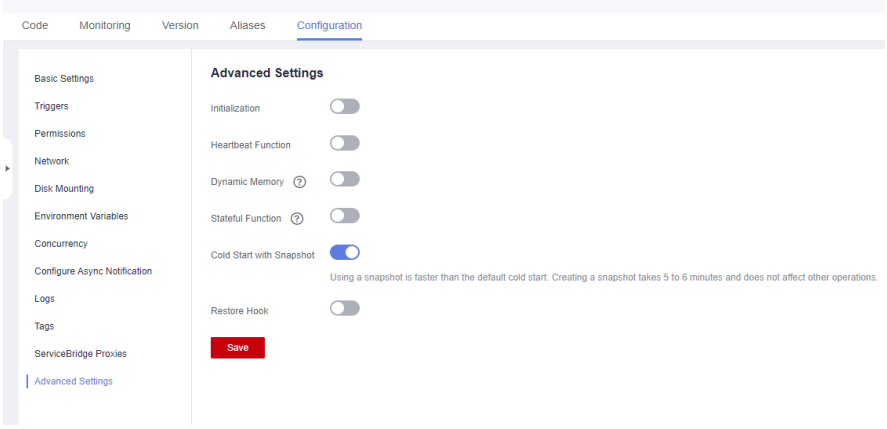
- Only Java functions are supported.
- For functions that strongly depend on states, consider using Restore Hook to refresh their states.
- For functions that strongly depend on CPU instruction sets, contact customer service.
- When functions that depend on hard-coded host environment variables (such as **hostname** and **hostip**) are migrated to other hosts, problems may occur. Do not use such variables if possible. Contact customer service.
- Currently, only applications developed using x86 machines are supported.

Prerequisites

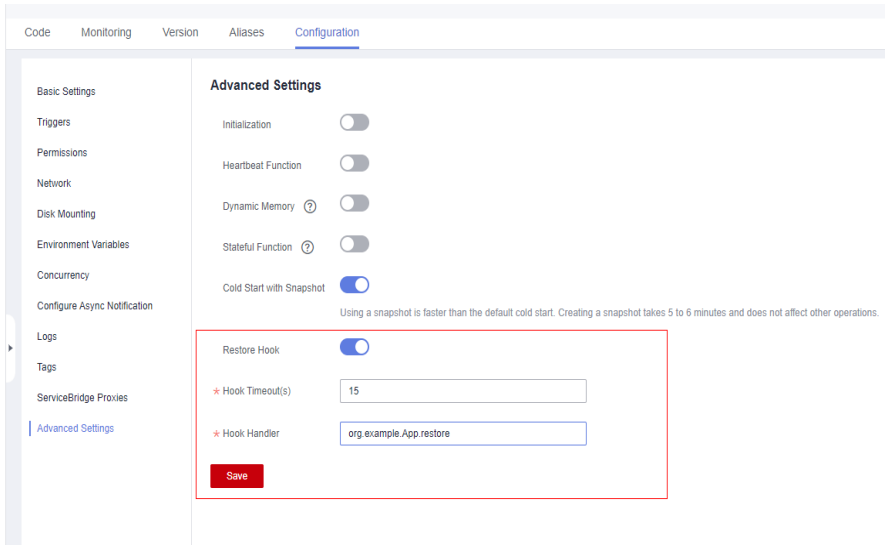
- A Java function has been created.

Procedure

1. Log in to the FunctionGraph console, configure a Java function, and enable **Cold Start with Snapshot**.



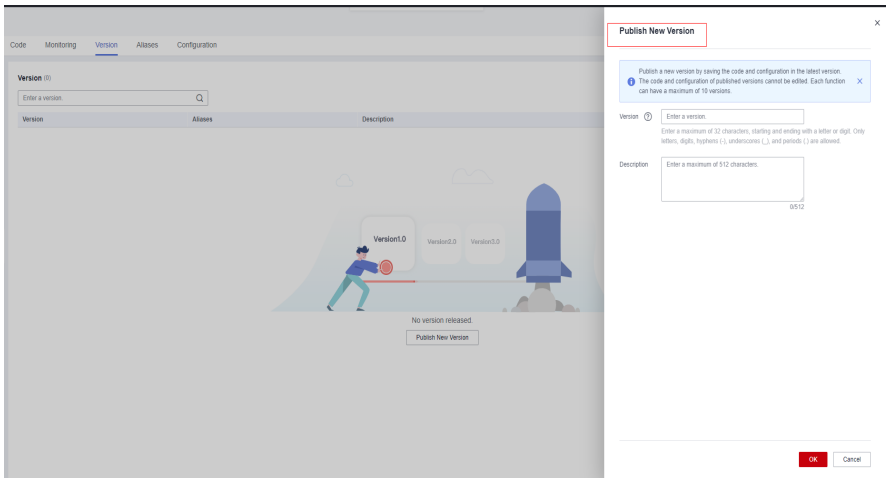
2. (Optional) Configure **Restore Hook** and implement the hook logic in the function code.



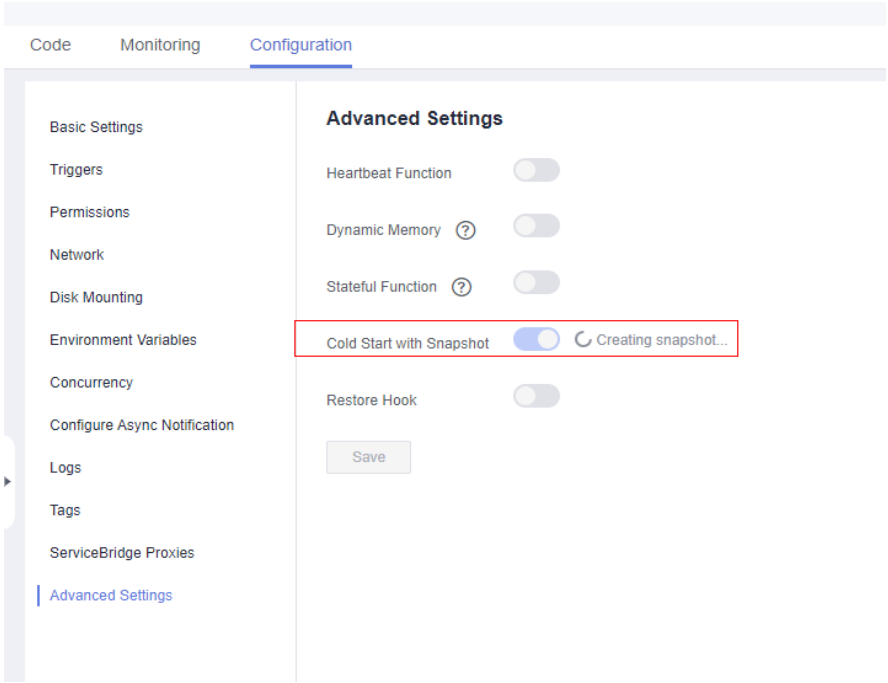
The following is an example of Restore Hook.

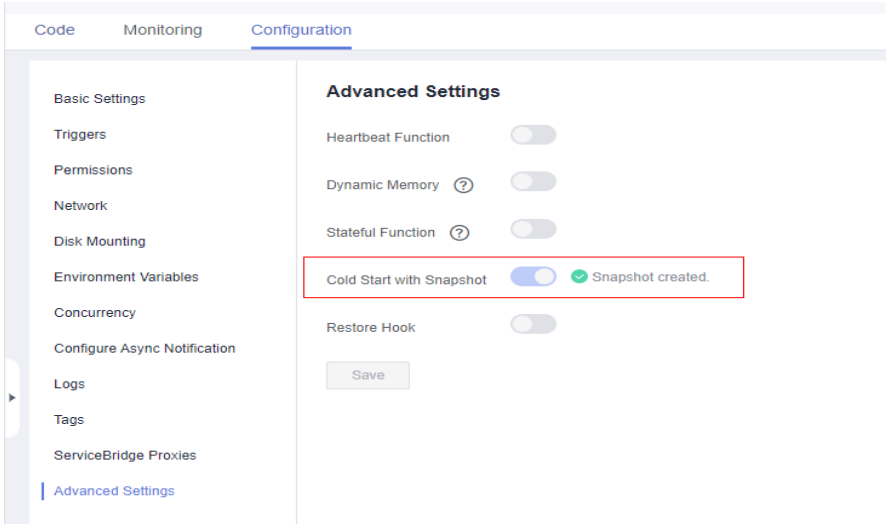
```
5 usages
public class App
{
    public void restore(Context context) {
        System.setProperty("myKey", "restoreValue");
    }

    public void init(Context context) {
        System.setProperty("myKey", "initValue");
    }

    2 usages
    public void print(APIGTriggerEvent event, Context context) {
        System.out.println("value: " + System.getProperty("myKey"));
    }
```

3. Publish a new version to trigger snapshot creation.



4. Wait until the snapshot is created (about 5 minutes).





5. Invoke the Java function to enjoy higher performance.

3.15 Configuring a Log Group and Log Stream

NOTE

This feature is supported only by FunctionGraph V2.

Introduction

You can bind a log group and log stream to a function to store its invocation logs. By default, the logs are stored in the log stream automatically created for the function. For details, see **Using LTS to Manage Function Logs**.

Prerequisites

You have created a log group and log stream on the LTS console.

Procedure

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. Choose **Configuration** > **Log**, and configure log collection according to **Table 3-14**.

Table 3-14 Log configuration parameters

Parameter	Description
Collect Logs	Enabled by default in FunctionGraph V2. This feature is unavailable for FunctionGraph V1.

Parameter	Description
Log Group	Select a log group for the function. The default log group **functiongraph.log.group.***xxx* cannot be selected. By default, the log group (starting with **functiongraph**) automatically generated by FunctionGraph is selected.
Log Stream	Select a log stream in the specified log group. By default, the log stream (starting with the function name) automatically generated for the function is selected.

4. Click **Save**.
5. After the function is invoked, **view logs** in the specified log group and log stream.

   NOTE

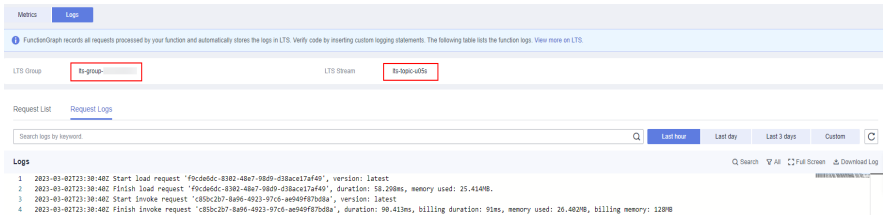
   You can change the log stream if needed.

Viewing Function Logs

View function logs in the specified log group and log stream.

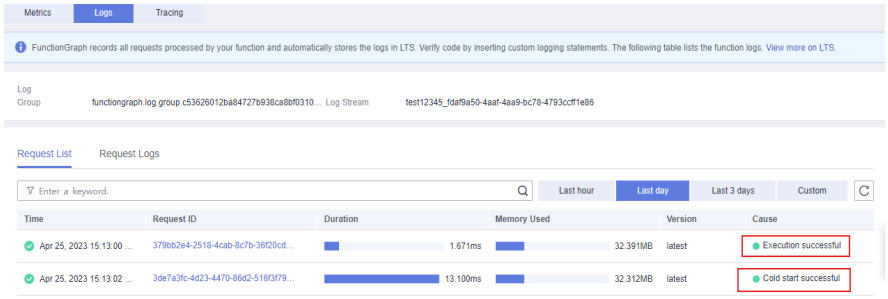
1. Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. Choose **Monitoring** > **Logs** and view the function logs.
   - As shown in **Figure 3-26**, logs of the function are generated in the specified log group and log stream.
   - If no custom log group and log stream are specified, the default log group (starting with **functiongraph**) and log stream are displayed.

     Figure 3-26 Viewing function logs

   - The following figure shows two successful requests. The request at the bottom took 13.100 ms, including the cold start time. The request at the top took only 1.671 ms, because no cold start was involved.

Figure 3-27 Logs



3.16 Stateful Functions

3.16.1 Introduction

State

In a narrow sense, states are data cyclically used during computing. For example, most model training algorithms in machine learning construct a proper loss function to calculate the gradient using chain rules, and then cyclically update existing model parameters in recursive mode. These model parameters are states cyclically used during training.

In FunctionGraph's kernel, states are process data generated during the invocation of functions in the same app by using the **invoke** API.

Stateful Function

Functions are classified into stateless and stateful functions. Stateful functions have their states stored in a FaaS service, and define the initial state methods and attributes.

Function Instance

Stateful function instances are logical. Different from ordinary function instances, stateful function instances can persist state data generated during execution and restore the state data for the next invocation.

Stateful function instances are identified by **InstanceID**, which is a unique 32-bit logical ID allocated by the system.

objRef

In FunctionGraph's kernel, objRef is an object which obtains the results of function invocation requests that have not yet been completed. objRef separates values from computing (function invocation) for flexibility and concurrency.

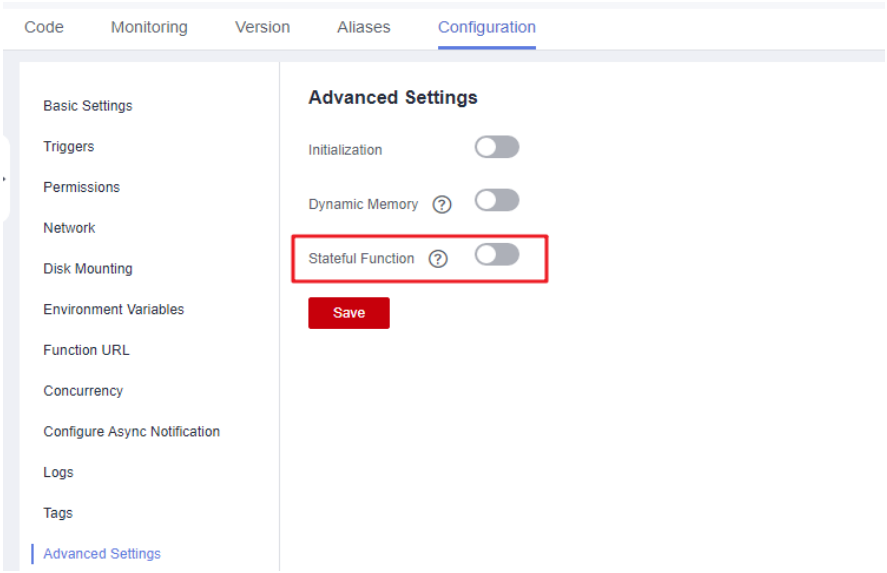
3.16.2 Development Instructions

Stateful functions can be in Java, Node.js, Python 3.6, and Python 3.9.

They are created, edited, and triggered in the same way as stateless functions, with only the following differences:

1. Enable **Stateful Function** on the configuration page.

   Figure 3-28 Stateful Function switch



2. Compile initialization code in your function using the template in the *FunctionGraph Developer Guide*.

State Management

- **Generating Function Instances**

  When a function instance invocation handle is created, the system generates a new state instance and loads it to the function for execution.

  For details about how to create such handles for different languages, see the demo template. The following uses Java as an example:

  a. **f = new Function (context, functionName)**: There is no need to specify a function instance name.

  b. **f = new Function (context, functionName, instanceName)**: Specify a new function instance name to invoke the relevant stateful function.

- **Restoring Function Instance Invocation Handles**

  Specify the function instance name with **instanceName** to restore invocation handles.

  f = new Function (context)

  f.getInstance (functionName, instanceName)

- **Accessing Function Instances**

  Use **context.state** to access the state data bound to function instances.

- **State Operations**

  – Before running a function, the system automatically loads the state data to **context.state** based on a function instance ID bound to the invocation handle.

- Use **context.state** to access the state data bound to a function instance.
- Use **f.saveState()** to save state data changes.
- If **f.saveState()** is called after a function is executed, the system automatically persists the function's state data. If **f.saveState()** is not called after a function is executed, the state data will not be saved.

objRef Operations

How Do I Create an objRef?

- Use **f.invoke()** to return objRef.

How Do I Use objRef?

- Use **objRef.get** to obtain the value of objRef.

3.16.3 Precautions

Constraints

1. A stateful function cannot recursively invoke itself.
2. Return values of Java functions can only be in JsonObject.
3. The size of a single state cannot exceed 256 KB. Each tenant can create a maximum of 100 stateful function instances.
4. State data is not encrypted during execution and persistence. Encrypt your sensitive data if any.
5. Stateful functions do not support reserved instances.
6. **instanceName** can contain 1 to 128 letters and digits.
7. Functions that access or are accessed by resources in a VPC must be in the same subnet as the resources.

Special init Method of Node.js

Node.js functions have an init() method for initialization and generating instance IDs.

To invoke a stateful function, use the following code:

```
const f = new Function(context, functionName, instanceName);
await f.init();
```


4 Online Debugging

Precautions

Event data is passed to the handler of your function as an input. After configuration, event data is persisted for later use. Each function can have a maximum of 10 test events.

Creating a Test Event

Step 1 Log in to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 Click the name of the desired function.

Step 3 On the function details page, select a version, and click **Test**.

Step 4 In the **Configure Test Event** dialog box, configure the test event information according to **Table 4-1**. The parameter marked with an asterisk (*) is mandatory.

Table 4-1 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.
Event Template	If you select **blank-template**, you can create a test event from scratch. If you select a template, the corresponding test event in the template is automatically loaded. For details about event templates, see **Table 4-2**.
*Event Name	The event name can contain 1 to 25 characters and must start with a letter and end with a letter or digit. Only letters, digits, underscores (_), and hyphens (-) are allowed. For example, **even-123test.**
Event data	Enter a test event.

Table 4-2 Event template description

Template Name	Description
API Gateway (APIG)	Simulates an APIG event to trigger your function.
API Gateway (Dedicated Gateway)	Simulates a dedicated APIG event to trigger your function.
Cloud Trace Service (CTS)	Simulates a CTS event to trigger your function.
Document Database Service (DDS)	Simulates a DDS event to trigger your function.
GaussDB(for Mongo)	Simulates a GaussDB(for Mongo) event to trigger your function.
Data Ingestion Service (DIS)	Simulates a DIS event to trigger your function.
Log Tank Service (LTS)	Simulates an LTS event to trigger your function.
Object Storage Service (OBS)	Simulates an OBS event to trigger your function.
Simple Message Notification (SMN)	Simulates an SMN event to trigger your function.
Timer	Simulates a timer event to trigger your function.
DMS (for Kafka)	Simulates a Kafka event to trigger your function.
Kafka (OPENSOURCEKAFKA)	Simulates an open-source Kafka event to trigger your function.
DMS (for RabbitMQ)	Simulates a RabbitMQ event to trigger your function.
Blank Template	The event is **{"key": "value"}**, which can be changed based on requirements.
Login Security Analysis	Serves as an input for the **loginSecurity-realtime-analysis-python** function template.
Image Classification	Serves as an input for the **image-tag** function template.
Pornographic Image Analysis	Serves as an input for the **porn-image-analysis** function template.

Template Name	Description
Speech Recognition	Serves as an input for the **voice-analysis** function template.

Step 5 Click **Create**.

----End

Testing a Function

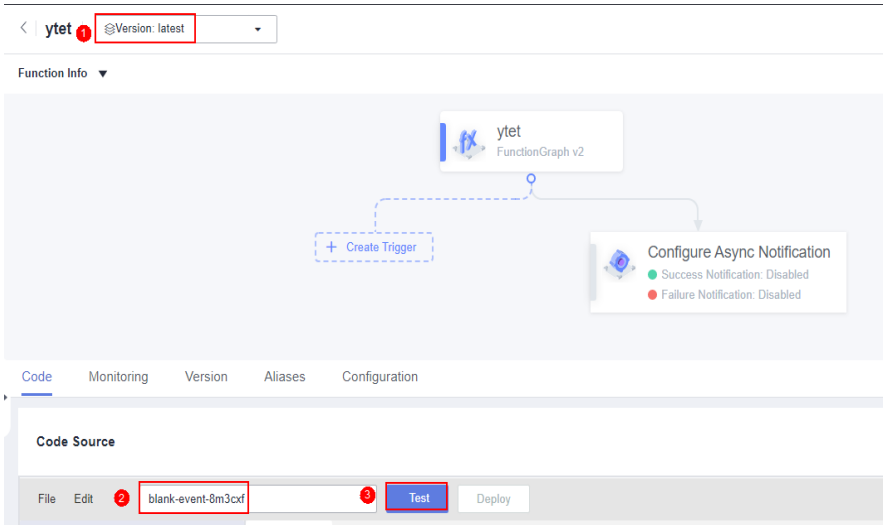
After creating a function, you can test it online to check whether it can run properly as expected.

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the name of the desired function.

Step 3 On the displayed function details page, select a version and test event, and click **Test**.

Figure 4-1 Selecting a test event



Step 4 Click **Test**. The function test result is displayed.

NOTE

The **Log Output** area displays a maximum of 2 KB logs. To view more logs, see **Managing Function Logs**.

----End

Modifying a Test Event

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the name of the desired function.

Step 3 On the displayed function details page, select a version and click **Configure Test Event**. The **Configure Test Event** dialog box is displayed.

Step 4 In the **Configure Test Event** dialog box, modify the test event information according to **Table 4-3**.

Table 4-3 Test event information

Parameter	Description
Create new test event	Create a test event.
Edit saved test event	Modify an existing test event.
Event data	Modify the test event code.

Step 5 Click **Save**.

----End

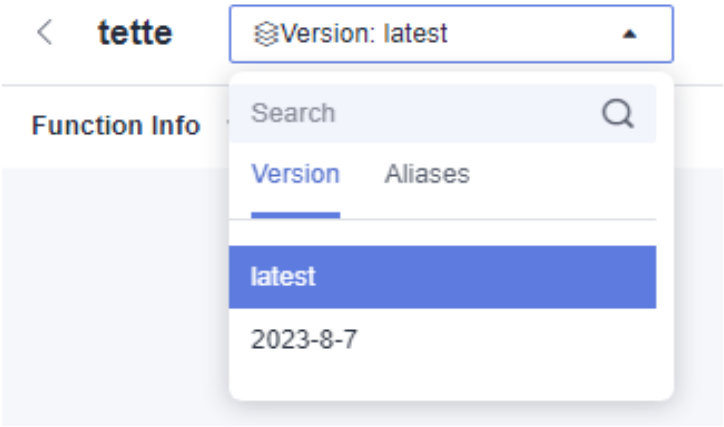
Deleting a Test Event

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the name of the desired function.

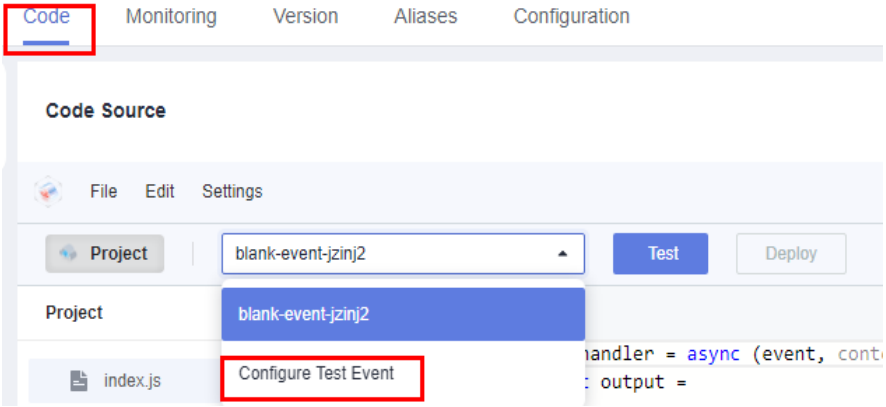
Step 3 On the function details page that is displayed, select a version, as shown in **Figure 4-2**.

Figure 4-2 Selecting a FunctionGraph version



Step 4 On the **Code** tab page, click **Configure Test Event**. The editing page is displayed, as shown in **Figure 4-3**.

Figure 4-3 Selecting Configure Test Event



Step 5 On the **Configure Test Event** page, select **Edit saved test event**. In the **Saved Test Events** list on the left, select the event to be deleted and click **Delete**.

Figure 4-4 Deleting a test event

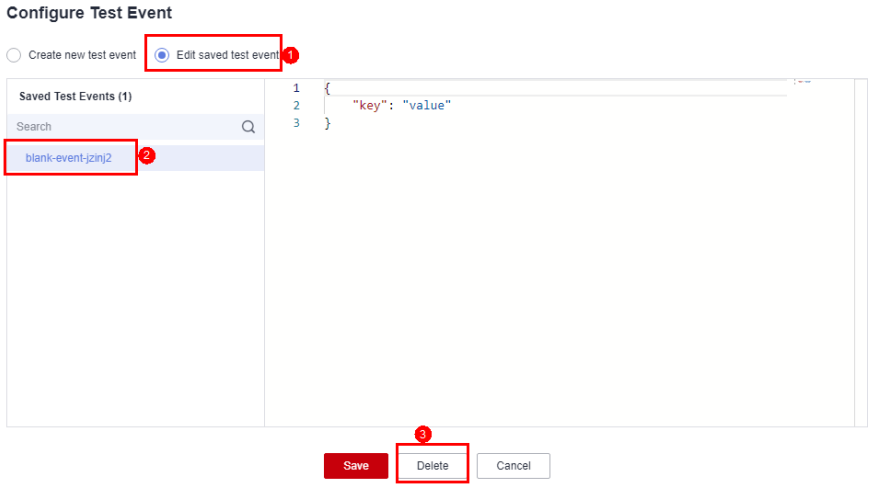


Table 4-4 Configuring test event information

Parameter	Description
Create new test event	Select a test event template.
Edit saved test event	Select the test event you want to delete.

----End

5 Creating Triggers

5.1 Managing Triggers

Enabling or Disabling a Trigger

You can enable or disable triggers as required. **Note that SMN, OBS and APIG triggers cannot be disabled and can only be deleted.**

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the name of the desired function.

Step 3 Choose **Configuration** > **Triggers**. On the displayed page, locate the row that contains the target trigger, and click **Disable** or **Enable**.

----End

Deleting a Trigger

You can delete triggers that will no longer be used.

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the name of the desired function.

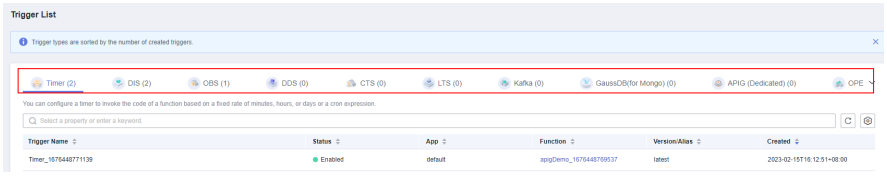
Step 3 Choose **Configuration** > **Triggers**. On the displayed page, locate the row that contains the target trigger and click **Delete**.

----End

NOTE

On the trigger list page, the type of trigger in use will be preferentially displayed.

Figure 5-1 Trigger display



5.2 Using a Timer Trigger

This section describes how to create a timer trigger to invoke your function based on a fixed rate or cron expression.

For details about the timer event source, see **Supported Event Sources**.

Prerequisites

You have created a function. For details, see **Creating a Function from Scratch**.

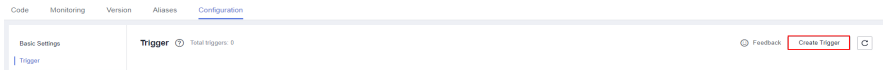
Creating a Timer Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-2 Creating a trigger



Step 4 Set the following parameters:

- **Trigger Type**: Select **Timer**.
- **Timer Name**: Enter a timer name, for example, **Timer**.
- **Rule**: Set a fixed rate or a cron expression.
  - **Fixed rate**: The function is triggered at a fixed rate of minutes, hours, or days. You can set a fixed rate from 1 to 60 minutes, 1 to 24 hours, or 1 to 30 days.
  - **Cron expression**: The function is triggered based on a complex rule. For example, you can set a function to be executed at 08:30:00 from Monday to Friday. For more information, see **Cron Expressions for a Function Timer Trigger**.
- **Enable Trigger**: Choose whether to enable the timer trigger.
- **Additional Information**: The additional information you configure will be put into the **user_event** field of the timer event source. For details, see **Supported Event Sources**.

Step 5 Click **OK**.

----End

Viewing the Execution Result

After the timer trigger is created, the function is executed every 1 minute. To view the function running logs, perform the following steps:

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click a function to go to the function details page.

Step 3 Choose **Monitoring** > **Logs** to query function running logs.

----End

5.3 Using an APIG (Dedicated) Trigger

This section describes how to create an APIG trigger and call an API to trigger a function.

For details about the APIG event source, see **Supported Event Sources**.

Prerequisites

You have created an API group, for example, **APIGroup_test**. For details, see **Creating an API Group**.

Creating an APIG Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 On the **Function List** page, click **Create Function** in the upper right corner.

Step 3 Set the following parameters:

- **Function Name**: Enter a function name, for example, **apig**.
- **Agency**: Select **Use no agency**.
- **Enterprise Project**: Select **default**.
- **Runtime**: Select **Python 2.7**.

Step 4 Click **Create**.

Step 5 On the **Code** tab page, copy the following code to the code window and click **Deploy**.

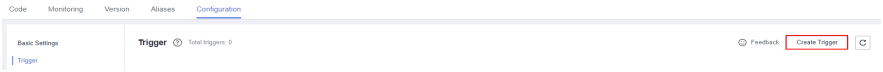
```
# -*- coding:utf-8 -*-
import json
def handler (event, context):
    body = "<html><title>Functiongraph Demo</title><body><p>Hello, FunctionGraph!</p></body></html>"
    print(body)
    return {
        "statusCode":200,
        "body":body,
```



```
    "headers": {
        "Content-Type": "text/html",
    },
    "isBase64Encoded": False
}
```

Step 6 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-3 Creating a trigger



Step 7 Configure the trigger information.

Table 5-1 Trigger information

Parameter	Description
Trigger Type	Select **API Gateway (Dedicated Gateway)**.
API Instance	Select an instance. If no instance is available, click **Create Instance**.
API Name	Enter an API name, for example, **API_apig**.
API Group	An API group is a collection of APIs. You can manage APIs by API group. Select **APIGroup_test**.
Environment	An API can be called in different environments, such as production, test, and development environments. APIG supports environment management, which allows you to define different request paths for an API in different environments. To ensure that the API can be called, select **RELEASE**.
Security Authentication	There are three authentication modes: • **App**: AppKey and AppSecret authentication. This mode is of high security and is recommended. For details, see **App Authentication**. • **IAM**: IAM authentication. This mode grants access permissions to IAM users only and is of medium security. For details, see **IAM Authentication**. • **None**: No authentication. This mode grants access permissions to all users. Select **None**.
Protocol	There are two types of protocols: • HTTP • HTTPS Select **HTTPS**.
Timeout (ms)	Enter **5000**.

Step 8 Click **OK**.

Figure 5-4 Creating a trigger

NOTE

1. **URL** indicates the calling address of the APIG trigger.
2. After the APIG trigger is created, an API named **API_apig** is generated on the APIG console. You can click the API name in the trigger list to go to the APIG console.

----End

Invoking the Function

Step 1 Enter the URL of the APIG trigger in the address bar of a browser, and press **Enter**.

Step 2 View the execution result, as shown in **Figure 5-5**.

Figure 5-5 Returned result

NOTE

1. The input for APIG invocation comes from an event template provided by the function. For details, see **Table 4-2**.
2. The function response for APIG invocation is encapsulated and must contain **body(String)**, **statusCode(int)**, **headers(Map)**, and **isBase64Encoded(boolean)**.

----End

Viewing the Execution Result

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click a function to go to the function details page.

Step 3 Choose **Monitoring** > **Logs** to query function running logs.

----End

5.4 Using an OBS Trigger

This section describes how to create an OBS trigger and upload an image package to a specified OBS bucket to trigger a function.

For details about the OBS event source, see **Supported Event Sources**.

Prerequisites

Before creating a trigger, ensure that you have prepared the following:

- You have created a function. For details, see **Creating a Function from Scratch**.
- You have created an OBS bucket, for example, **obs_cff**. For details, see **Creating a Bucket**.

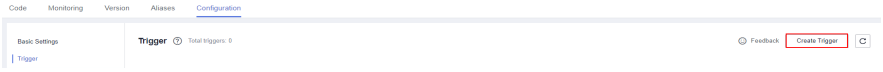
Creating an OBS Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-6 Creating a trigger



Step 4 Set the following parameters:

- **Trigger Type**: Select **Object Storage Service (OBS)**.
- **Bucket Name**: Specify the OBS bucket to be used as an event source, for example, **obs-cff**.
- **Events**: Select events that will trigger the function. In this example, select **Put**, **Post**, and **Delete**. When files in the **obs_cff** bucket are updated, uploaded, or deleted, the function is triggered.
- **Event Notification Name**: Specify the name of the event notification to be sent by SMN when an event occurs.
- **Prefix**: Enter a keyword for limiting notifications to those about objects whose names start with the matching characters. This limit can be used to filter the names of OBS objects.
- **Suffix**: Enter a keyword for limiting notifications to those about objects whose names end with the matching characters. This limit can be used to filter the names of OBS objects.

Step 5 Click **OK**.

----End

Triggering a Function

On the OBS console, upload an image ZIP package to the **obs-cff** bucket. For details, see **Uploading a File**.

NOTE

After the ZIP package is uploaded to the **obs-cff** bucket, the **HelloWorld** function is triggered.

Viewing the Execution Result

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click a function to go to the function details page.

Step 3 Choose **Monitoring** > **Logs** to query function running logs.

----End

5.5 Using a Kafka Trigger

This section describes how to create a Kafka trigger and configure a Kafka event to trigger a function.

After a Kafka trigger is used, FunctionGraph periodically polls for new messages in a specific topic in a Kafka instance and passes the messages as input parameters to invoke functions. For details about the DMS for Kafka event source, see **Supported Event Sources**.

NOTE

For details about the differences between DMS for Kafka and open-source Kafka, see **Comparing DMS for Kafka and Open-Source Kafka**.

Prerequisites

Before creating a trigger, ensure that you have prepared the following:

- You have created a function. For details, see **Creating a Function from Scratch**.
- You have enabled VPC access for the function. For details, see **Configuring the Network**.
- You have created a Kafka instance. For details, see **Buying an Instance**.
- You have created a topic under a Kafka instance. For details, see **Creating a Topic**.

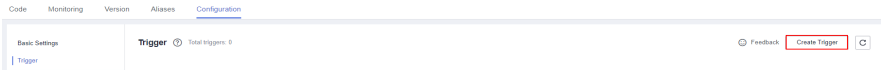
Creating a Kafka Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-7 Creating a trigger



Step 4 Set the following parameters:

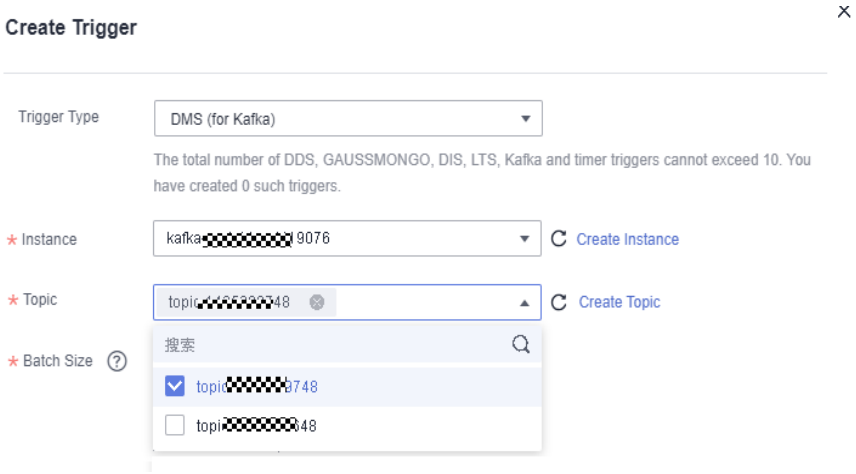
- **Trigger Type**: Select **DMS (for Kafka)**.
- **Instance**: Select a Kafka premium instance.
- **Topic**: Select a topic of the Kafka premium instance.
- **Batch Size**: Set the number of messages to be retrieved from a topic each time.
- **Username**: Enter the username of the instance if SSL has been enabled for it.
- **Password**: Enter the password of the instance if SSL has been enabled for it.

Step 5 Click **OK**.

NOTE

- After VPC access is enabled, you need to configure corresponding subnet permissions for the Kafka security group. For details about how to configure VPC access, see **Configuring the Network**.
- You can create a Kafka trigger with multiple topics. You do not need to create one such trigger for each topic in the same instance.

Figure 5-8 Selecting multiple topics



----End

Configuring a Kafka Event to Trigger the Function

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 On the function details page, select a version.

Step 4 On the **Code** tab page, click **Test**. The **Configure Test Event** dialog box is displayed.

Step 5 Set the parameters described in **Table 5-2** and click **Save**.

Table 5-2 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.
Event Template	Select **DMS (for Kafka)** to use the built-in Kafka event template.
Event Name	The event name can contain 1 to 25 characters and must start with a letter and end with a letter or digit. Only letters, digits, underscores (_), and hyphens (-) are allowed. For example, **kafka-123test**.
Event data	The system automatically loads the built-in Kafka event template, which is used in this example without modifications.

Step 6 Click **Test**. The function test result is displayed.

----End

5.6 Using a DIS Trigger

This section describes how to create a DIS trigger for a function, and configure a DIS event by using the built-in event template to trigger the function.

For details about the DIS event source, see **Supported Event Sources**.

Prerequisites

Before creating a trigger, ensure that you have prepared the following:

- You have created a function. For details, see **Creating a Function from Scratch**.
- You have created a DIS stream, for example, **dis-function**. For details, see **Creating a DIS Stream**.

Setting an Agency

Before creating a DIS trigger, set an agency to delegate FunctionGraph to access DIS. For details on how to create an agency, see **Configuring Agency Permissions**.

Since you did not specify an agency while creating the **HelloWorld** function, specify one first.

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Permissions**, and change the agency to **serverless-trust** created in **Configuring Agency Permissions**.

Step 4 Click **Save**.

----End

Creating a DIS Trigger

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Step 4 Set the following parameters:

- **Trigger Type**: Select **Data Ingestion Service (DIS)**.
- **Stream Name**: Select a DIS stream, for example, **dis-function**.
- **Starting Position**: Specify a position in the specified stream from which to start reading data.
  - **TRIM_HORIZON**: Data is read from the earliest valid records that are stored in the partition.
  - **LATEST**: Data is read just after the most recent record in the partition. This setting ensures that you always read the latest data.
- Data processing: **By Byte** and **By Batch**.

Table 5-3 Data Processing

Data processing mode	Description
By Byte	Configure **Max. Fetch Bytes** which indicates the maximum volume of data that can be fetched in each request. Only the records smaller than this value will be fetched. The value ranges from 0 KB to 4 MB.
By Batch	Configure **Batch Size** which indicates the maximum number of data records pulled at a time. Only the records smaller than this value will be fetched. The value ranges from 1 to 10,000. The total number of data records pulled at the same time cannot exceed 4 MB.

NOTE

By default, users do not have permission to use the **By Batch** mode. To use it, **submit a service ticket** to add a whitelist.

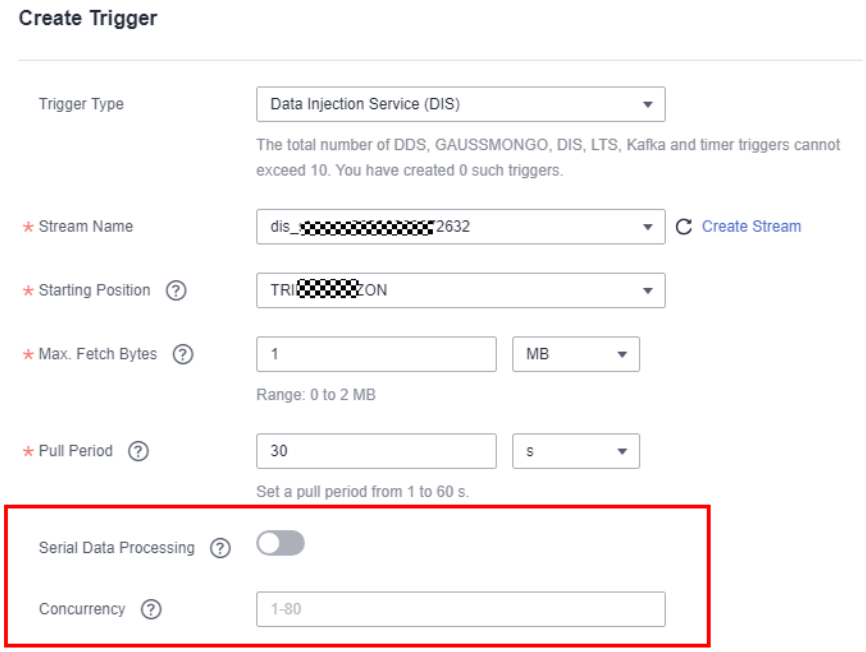
- **Pull Period**: Set a period for pulling data from the stream.

- **Serial Data Processing**: If this option is selected, FunctionGraph pulls data from the stream only after previous data is processed. If this option is not selected, FunctionGraph pulls data from the stream as long as the pull period ends.

  NOTE

  After **Serial Data Processing** is disabled, you can configure the concurrency (1–80) to limit the number of concurrent asynchronous invocation requests from a DIS trigger. This prevents a single DIS trigger with mass traffic from occupying the concurrency quota and affecting other DIS triggers. (Currently available only in CN North-Beijing4)

  Figure 5-9 Disabling serial data processing

Step 5 Click **OK**.

----End

Modifying a DIS Trigger

Some parameters of DIS triggers can be modified.

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers**, and click **Edit** next to a DIS trigger.

Step 4 Modify **Max. Fetch Bytes/Batch Size**, **Pull Period**, and **Serial Data Processing** as required, and click **OK**.

----End

Configuring a DIS Event to Trigger the Function

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 On the function details page, select a version.

Step 4 On the **Code** tab page, click **Test**. The **Configure Test Event** dialog box is displayed.

Step 5 Set the parameters described in **Table 5-4** and click **Save**.

Table 5-4 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.
Event Template	Select **Data Ingestion Service (DIS)** to use the built-in DIS event template.
Event Name	The event name can contain 1 to 25 characters and must start with a letter and end with a letter or digit. Only letters, digits, underscores (_), and hyphens (-) are allowed. For example, **dis-123test**.
Event data	The system automatically loads the built-in DIS event template, which is used in this example without modifications.

Step 6 Click **Test**. The function test result is displayed.

----End

5.7 Using an SMN Trigger

This section describes how to create an SMN trigger and publish a message to trigger a function.

For details about the SMN event source, see **Supported Event Sources**.

Prerequisites

- You have created an SMN topic, for example, **smn-test**. For details, see **Creating a Topic**.
- You have created a function. For details, see **Creating a Function from Scratch**.

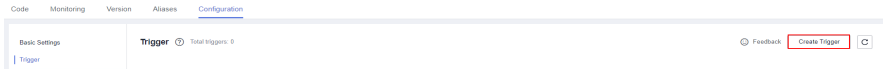
Creating an SMN Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-10 Creating a trigger



Step 4 Set the following parameters:

- **Trigger Type**: Select **Simple Message Notification (SMN)**.
- **Topic Name**: Select a topic, for example, **smn-test**.

Step 5 Click **OK**.

NOTE

After the SMN trigger is created, a subscription is generated for the corresponding topic on the SMN console.

----End

Publishing a Message to Trigger the Function

On the SMN console, publish a message to the **smn-test** topic. For details, see **Publishing a Text Message**.

Table 5-5 describes the parameters required for publishing a message.

Table 5-5 Parameters required for publishing a message

Parameter	Description
Subject	Enter **SMN-Test**.
Message Format	Select **Text**.
Message	Enter **{"message":"hello"}**.

NOTE

After a message is published, the function is triggered automatically. For details about example events, see **Supported Event Sources**.

Viewing the Execution Result

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click a function to go to the function details page.

Step 3 Choose **Monitoring** > **Logs** to query function running logs.

----End

5.8 Using an LTS Trigger

This section describes how to create an LTS trigger for a function, and invoke the function when log events occur.

For details about the timer event source, see **Supported Event Sources**.

Prerequisites

- You have created a function. For details, see **Creating a Function from Scratch**.
- You have created an agency with the **LTS FullAccess** permission. For details about how to create an agency, see **Configuring Agency Permissions**.
- You have created a log group, for example, **LogGroup1**. For details, see **Creating a Log Group**.
- You have created a log stream, for example, **LogTopic1**. For details, see **Creating a Log Stream**.

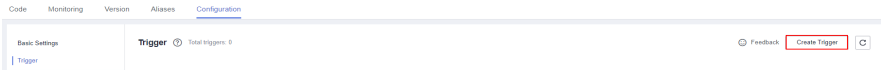
Creating an LTS Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-11 Creating a trigger



Step 4 Set the following parameters:

- **Trigger Type**: Select **Log Tank Service (LTS)**.
- **Log Group**: Select a log group, for example, **LogGroup1**.
- **Log Stream**: Select a log stream, for example, **LogStream1**.

Step 5 Click **OK**.

----End

Configuring an LTS Event to Trigger the Function

NOTE

When the size of an LTS event message exceeds 75 KB, it will be split into multiple messages by 75 KB to trigger the function.

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 On the function details page, select a version.

Step 4 On the **Code** tab page, click **Test**. The **Configure Test Event** dialog box is displayed.

Step 5 Set the parameters described in **Table 5-6** and click **Save**.

Table 5-6 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.
Event Template	Select **lts-event-template**.
Event Name	The event name can contain 1 to 25 characters and must start with a letter and end with a letter or digit. Only letters, digits, underscores (_), and hyphens (-) are allowed. For example, **lts-123test**.
Event data	The system automatically loads the built-in LTS event template, which is used in this example without modifications.

Step 6 Click **Test**. The function test result is displayed.

----End

5.9 Using a CTS Trigger

This section describes how to create a CTS trigger for a function, and invoke the function in response to cloud resource operations recorded by CTS.

For details about the CTS event source, see **Supported Event Sources**.

Prerequisites

You have created an agency on IAM. For details, see **Configuring Agency Permissions**.

Creating a CTS Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 On the **Function List** page, click **Create Function** in the upper right corner.

Step 3 Set the following parameters:

- **Function Name**: Enter a function name, for example, **HelloWorld**.

- **Agency**: Select **Use no agency**.
- **Enterprise Project**: Select **default**.
- **Runtime**: Select **Python 2.7**.

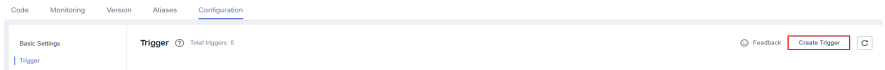
Step 4 Click **Create Function**.

Step 5 On the **Code** tab page, copy the following code to the code window and click **Deploy**.

```
# -*- coding:utf-8 -*-
'''
CTS trigger event:
{
  "cts":  {
        "time": "",
        "user": {
            "name": "userName",
            "id": "",
            "domain": {
                "name": "domainName",
                "id": ""
            }
        },
        "request": {},
        "response": {},
        "code": 204,
        "service_type": "FunctionGraph",
        "resource_type": "",
        "resource_name": "",
        "resource_id": {},
        "trace_name": "",
        "trace_type": "ConsoleAction",
        "record_time": "",
        "trace_id": "",
        "trace_status": "normal"
    }
}
'''
def handler (event, context):
    trace_name = event["cts"]["resource_name"]
    timeinfo = event["cts"]["time"]
    print(timeinfo+' '+trace_name)
```

Step 6 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-12 Creating a trigger



Step 7 Configure the trigger information.

Table 5-7 Trigger information

Parameter	Description
Trigger Type	Select **Cloud Trace Service (CTS)**.
Event Notification Name	Enter a notification name, for example, **Test**.
Service Type	Select **FunctionGraph**.

Parameter	Description
Resource Type	Resource types supported by the selected service, such as triggers, instances, and functions.
Trace Name	Operations that can be performed on the selected resource type, such as creating or deleting a trigger.

Step 8 Click **OK**.

----End

Configuring a CTS Event to Trigger the Function

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 On the function details page, select a version, and click **Test**. The **Configure Test Event** dialog box is displayed.

Step 4 Set the parameters described in **Table 5-8** and click **Save**.

Table 5-8 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.
Event Template	Select **cts-event-template**.
Event Name	Enter an event name, for example, **cts-test**.
Event data	The system automatically loads the event data in the CTS event template. You can modify the event data as required.

Step 5 Click **Test**. The function test result is displayed.

----End

5.10 Using a DDS Trigger

This section describes how to create a DDS trigger for a function, and invoke the function when a database table changes.

A function using a DDS trigger will be triggered every time a database table is updated. For details about the DDS event source, see **Supported Event Sources**.

Prerequisites

Before creating a trigger, ensure that you have prepared the following:

- You have created a function. For details, see **Creating a Function from Scratch**.
- You have enabled VPC access for the function. For details, see **Configuring the Network**.
- You have created a DDS DB instance.
- You have created a DDS database.

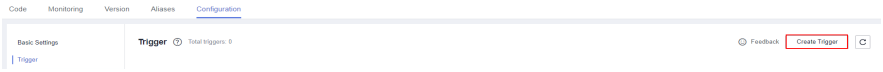
Creating a DDS Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-13 Creating a trigger



Step 4 Set the following parameters:

- **Trigger Type**: Select **Document Database Service (DDS)**.
- **DB Instance**: Select a DDS DB instance.
- **Password**: Enter the password of DDS DB instance administrator **rwuser**.
- **Database**: Enter the name of a database. Note that **admin**, **local**, and **config** are reserved database names and cannot be used here.
- **Collection**: Enter the name of a database collection.
- **Batch Size**: Set the number of records to be read from the database at a time.

Step 5 Click **OK**.

NOTE

After VPC access is enabled, you need to configure corresponding subnet permissions for the DDS security group. For details about how to configure VPC access, see **Configuring the Network**.

----End

Configuring a DDS Event to Trigger the Function

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 On the function details page, select a version, and click **Test**. The **Configure Test Event** dialog box is displayed.

Step 4 Set the parameters described in **Table 5-9** and click **Save**.

Table 5-9 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.
Event Template	Select **dds-event-template**.
Event Name	The event name can contain 1 to 25 characters and must start with a letter and end with a letter or digit. Only letters, digits, underscores (_), and hyphens (-) are allowed. For example, **dds-123test**.
Event data	The system automatically loads the built-in DDS event template, which is used in this example without modifications.

Step 5 Click **Test**. The function test result is displayed.

----End

5.11 Using a GaussDB(for Mongo) Trigger

This section describes how to create a GaussDB(for Mongo) trigger for a function.

A function using a GaussDB(for Mongo) trigger will be triggered every time a database table is updated. For details about the GaussDB(for Mongo) event source, see **Supported Event Sources**.

Prerequisites

Before creating a trigger, ensure that you have prepared the following:

- You have created a function. For details, see **Creating a Function from Scratch**.
- You have enabled VPC access for the function. For details, see **Configuring the Network**.
- You have created a GaussDB(for Mongo) instance. For details, see **Buying a Replica Set Instance**.

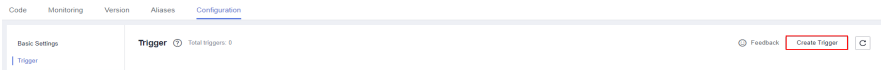
Creating a GaussDB(for Mongo) Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-14 Creating a trigger



Step 4 Set the following parameters:

- **Trigger Type**: Select **GaussDB(for Mongo)**.
- **GaussDB(for Mongo) Instance**: Select a GaussDB(for Mongo) instance.
- **Password**: Enter the password of the GaussDB(for Mongo) instance administrator **rwuser**.
- **Database**: Enter the name of a GaussDB(for Mongo) database. Note that **admin**, **local**, and **config** are reserved database names and cannot be used here.
- **Collection**: Enter the name of a database collection.
- **Batch Size**: Set the number of records to be read from the database at a time.

Step 5 Click **OK**.

NOTE

After VPC access is enabled, you need to configure corresponding subnet permissions for the GaussDB(for Mongo) security group. For details about how to configure VPC access, see **Configuring the Network**.

----End

Configuring a GaussDB(for Mongo) Event to Trigger the Function

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 On the function details page, select a version.

Step 4 On the **Code** tab page, click **Test**. The **Configure Test Event** dialog box is displayed.

Step 5 Set the parameters described in **Table 5-10** and click **Save**.

Table 5-10 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.
Event Template	Select **gaussmongo-event-template**.
Event Name	The event name can contain 1 to 25 characters and must start with a letter and end with a letter or digit. Only letters, digits, underscores (_), and hyphens (-) are allowed. For example, **gaussmongo-123test**.

Parameter	Description
Event data	The system automatically loads the built-in GaussDB(for Mongo) event template, which is used in this example without modifications.

Step 6 Click **Test**. The function test result is displayed.

----End

5.12 Using an APIG Trigger

This section describes how to create an APIG trigger and call an API to trigger a function.

For details about the APIG event source, see **Supported Event Sources**.

NOTE

APIG no longer provides shared gateways. Only customers who had registered before this feature was removed can continue using it.

Prerequisites

You have created an API group, for example, **APIGroup_test**. For details, see **Creating an API Group**.

Creating an APIG Trigger

Step 1 Log in to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 Click **Create Function**.

Step 3 Set the following parameters:

- **Function Name**: Enter a function name, for example, **apig**.
- **Agency**: Select **Use no agency**.
- **Enterprise Project**: Select **default**.
- **Runtime**: Select **Python 2.7**.

Step 4 Click **Create Function**.

Step 5 On the **Code** tab page, copy the following code to the code window and click **Deploy**.

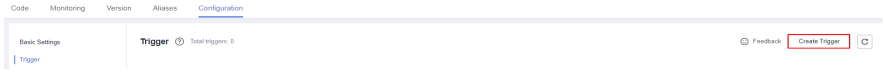
```
# -*- coding:utf-8 -*-
import json
def handler (event, context):
    body = "<html><title>Functiongraph Demo</title><body><p>Hello, FunctionGraph!</p></body></html>"
    print(body)
    return {
        "statusCode":200,
        "body":body,
        "headers": {
            "Content-Type": "text/html",
        },
```



```
    "isBase64Encoded": False
}
```

Step 6 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-15 Creating a trigger



Step 7 Configure the trigger information.

Table 5-11 Trigger information

Parameter	Description
Trigger Type	Select **API Gateway (APIG)**.
API Name	Enter an API name, for example, **API_apig**.
API Group	An API group is a collection of APIs. You can manage APIs by API group. Select **APIGroup_test**.
Environment	An API can be called in different environments, such as production, test, and development environments. APIG supports environment management, which allows you to define different request paths for an API in different environments. To ensure that the API can be called, select **RELEASE**.
Security Authentication	There are three authentication modes: • **App**: AppKey and AppSecret authentication. This mode is of high security and is recommended. For details, see **App Authentication**. • **IAM**: IAM authentication. This mode grants access permissions to IAM users only and is of medium security. For details, see **IAM Authentication**. • **None**: No authentication. This mode grants access permissions to all users. Select **None**.
Protocol	There are two types of protocols: • HTTP • HTTPS Select **HTTPS**.
Timeout (ms)	Enter **5000**.

Step 8 Click **OK**.

NOTE

1. The URL of the APIG trigger is **https://0ed9f61512d34982917a4f3cfe8ddd5d.apig.example.example.com/apig**.
2. After the APIG trigger is created, an API named **API_apig** is generated on the APIG console. You can click the API name in the trigger list to go to the APIG console.

----End

Invoking the Function

Step 1 Enter the URL of the APIG trigger in the address bar of a browser, and press **Enter**.

Step 2 After the function is executed, a result is returned.

----End

5.13 Using an APIC Trigger

This section describes how to create an APIC trigger and call an API to trigger a function. (This is only available in AP-Singapore.)

For details about the APIC event source, see **Supported Event Sources**.

Prerequisites

You have created an API group, for example, **APIConnect_test**. For details, see **Creating an API Group**.

Creating an APIC Trigger

Step 1 Log in to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 Click **Create Function**.

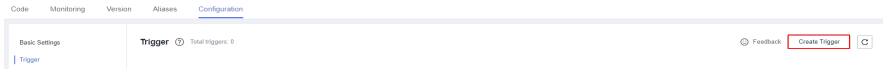
Step 3 Set the following parameters:

- **Function Name**: Enter a function name, for example, **apig**.
- **Agency**: Select **Use no agency**.
- **Enterprise Project**: Select **default**.
- For **Runtime**, select **Node.js 10.16**.

Step 4 Click **Create Function**.

Step 5 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-16 Creating a trigger



Step 6 Configure the trigger information.

Table 5-12 Trigger information

Parameter	Description
Trigger Type	Select **API Connect (APIC)**.
API Instance	Select an instance. If no instance is available, click **Create Instance**.
API Name	Enter an API name, for example, **API_apic**.
API Group	An API group is a collection of APIs. You can manage APIs by API group. Example: **DEFAULT**.
Environment	An API can be called in different environments, such as production, test, and development environments. APIG supports environment management, which allows you to define different request paths for an API in different environments. To ensure that the API can be called, select **RELEASE**.
Security Authentication	There are three authentication modes: • **App**: AppKey and AppSecret authentication. This mode is of high security and is recommended. For details, see **App Authentication**. • **IAM**: IAM authentication. This mode grants access permissions to IAM users only and is of medium security. For details, see **IAM Authentication**. • **None**: No authentication. This mode grants access permissions to all users. Select **None**.
Protocol	There are two types of protocols: • HTTP • HTTPS Select **HTTPS**.
Timeout (ms)	Enter **5000**.

Step 7 Click **OK**.

NOTE

After the trigger is created, an API named **API_apic** is generated on the APIG console. You can click the API name in the trigger list to go to the APIG console.

----End

Invoking the Function

Step 1 Log in to ROMA Connect, find the selected instance (for example, **Ac6-instance-NoDelete**), and view the public IP address.

Step 2 Enter the public IP address in the address box of the browser.

Step 3 After the function is executed, a result is returned.

----End

Viewing the Execution Result

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the name of the **nodejs-test** function.

Step 3 On the displayed function details page, click the **Logs** tab to query the function running logs.

Step 4 Click **View Context** in the same row as a log to view log details.

----End

5.14 Using a DMS (for RabbitMQ) Trigger

This section describes how to create a DMS (for RabbitMQ) trigger for a function. Currently, only the fan-out exchange mode is supported. After a DMS (for RabbitMQ) trigger is used, FunctionGraph periodically polls for new messages in a specific topic bound to the exchange of a RabbitMQ instance and passes the messages as input parameters to invoke functions. For details about the DMS (for RabbitMQ) event source, see **Supported Event Sources**.

Prerequisites

- You have created a function. For details, see **Creating a Function from Scratch**.
- You have enabled VPC access. For details, see **Configuring the Network**.
- A RabbitMQ instance has been created. For details, see **Buying an Instance**.
- The rules of the security group of the instance have been correctly configured.
  a. In the **Network** section on the **Basic Information** tab page, click the name of the security group.
  b. Click the **Inbound Rules** tab to view the inbound rules of the security group.
     i. SSL disabled

        For intra-VPC access, inbound access through port 5672 must be allowed.

        For public access, inbound access through port 15672 must be allowed.
     ii. SSL enabled

        For intra-VPC access, inbound access through port 5671 must be allowed.

        For public access, inbound access through port 15671 must be allowed.

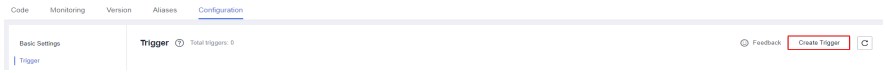
Creating a RabbitMQ Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-17 Creating a trigger



Step 4 Set the following parameters:

- **Trigger Type**: Select **DMS (for RabbitMQ)**.
- ***Instance**: Select a RabbitMQ instance.
- ***Password**: Enter the password of the RabbitMQ instance.
- ***Exchange**: Enter the name of the exchange to be used.
- **Virtual Host**: Enter a custom virtual host name.
- ***Batch Size**: Set the number of messages to be retrieved from a topic each time.

Step 5 Click **OK**.

----End

NOTE

After VPC access is enabled, you need to configure corresponding subnet permissions for the RabbitMQ security group. For details about how to configure VPC access, see **Configuring the Network**.

Configuring a DMS (for RabbitMQ) Event to Trigger the Function

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 On the function details page, select a version.

Step 4 On the **Code** tab page, click **Test**. The **Configure Test Event** dialog box is displayed.

Step 5 Set the parameters described in **Table 5-13** and click **Save**.

Table 5-13 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.

Parameter	Description
Event Template	Select **rabbitmq-event-template**.
Event Name	The event name can contain 1 to 25 characters and must start with a letter and end with a letter or digit. Only letters, digits, underscores (_), and hyphens (-) are allowed. For example, **kafka-123test**.
Event data	The system automatically loads the built-in RabbitMQ event template, which is used in this example without modifications.

Step 6 Click **Test**. The function test result is displayed.

----End

5.15 Using an Open-Source Kafka Trigger

This section describes how to create an open-source Kafka trigger and configure an event to trigger a function.

If you use an open-source Kafka trigger for a function, FunctionGraph periodically polls messages from a specific topic in Kafka and passes the messages as an input parameter to invoke the function.

NOTE

For details about the differences between DMS for Kafka and open-source Kafka, see **Comparing DMS for Kafka and Open-Source Kafka**.

Prerequisites

Before creating a trigger, ensure that you have prepared the following:

- You have created a function.
- You have enabled VPC access for the function. For details, see **Configuring the Network**.

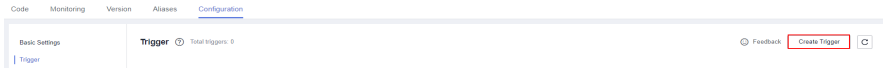
Creating an Open-Source Kafka Trigger

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 Choose **Configuration** > **Triggers** and click **Create Trigger**.

Figure 5-18 Creating a trigger



Step 4 Set the following parameters:

- **Trigger Type**: Select **Kafka (OPENSOURCEKAFKA)**.
- **Connection Address**: Addresses of brokers running Kafka. Separate the addresses with commas (,).
- **Topic**: Enter one or more topics.
- **Batch Size**: Maximum number of data records that can be processed by the function at a time.

Step 5 Click **OK**.

NOTE

The network configuration must be the same as that of the ECS where Kafka is deployed, including the VPC and subnet.

----End

Enabling a Kafka Trigger

By default, open-source Kafka triggers are disabled. To use such a trigger, click **Enable** on the **Trigger** page.

NOTE

If a trigger cannot be disabled, contact technical support.

Configuring a Kafka Event to Trigger the Function

Step 1 Return to the FunctionGraph console. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the function to be configured to go to the function details page.

Step 3 On the function details page, select a version.

Step 4 On the **Code** tab page, click **Test**. The **Configure Test Event** dialog box is displayed.

Step 5 Set the parameters described in **Table 5-14** and click **Save**.

Table 5-14 Test event information

Parameter	Description
Configure Test Event	You can choose to create a test event or edit an existing one. Use the default option **Create new test event**.
Event Template	Select **Kafka (OPENSOURCEKAFKA)** to use the built-in Kafka event template.
Event Name	The event name can contain 1 to 25 characters and must start with a letter and end with a letter or digit. Only letters, digits, underscores (_), and hyphens (-) are allowed. For example, **kafka-123test**.

Parameter	Description
Event data	The system automatically loads the built-in Kafka event template, which is used in this example without modifications.

Step 6 Click **Test**. The function test result is displayed.

----End

5.16 Cron Expressions for a Function Timer Trigger

You can configure a cron expression in the following formats for a function timer trigger:

- @every format

  The format is "@every *N* unit". *N* is a positive integer. **unit** can be ns, µs, ms, s, m, or h. An @every expression means to invoke a function every *N* time units, as shown in **Table 5-15**.

  Table 5-15 Example expressions

Expression	Meaning
@every 30m	Triggers a function every 30 minutes.
@every 1.5h	Triggers a function every 1.5 hours.
@every 2h30m	Triggers a function every 2.5 hours.

- Standard format

  The format is "*seconds minutes hours day-of-month month day-of-week*". *day-of-week* is optional. The fields must be separated from each other using a space. **Table 5-16** describes the fields in a standard cron expression.

  Table 5-16 Parameter description

Parameter	Mandatory	Value Range	Special Characters Allowed
CRON_TZ	No. If this parameter is not set, the region's time zone is used by default.	-	-
Seconds	Yes	0–59	, - * /
Minutes	Yes	0–59	, - * /

Parameter	Mandatory	Value Range	Special Characters Allowed
Hours	Yes	0–23	, - * /
Day-of-month	Yes	1–31	, - * ? /
Month	Yes	1–12 or Jan–Dec. The value is case-insensitive, as shown in **Table 5-17**.	, - * /
Day-of-week	No	0–6 or Sun–Sat. The value is case-insensitive, as shown in **Table 5-18**. **0** means Sunday.	, - * ? /

Table 5-17 Value description of the month field

Month	Digit	Abbreviation
January	1	Jan
February	2	Feb
March	3	Mar
April	4	Apr
May	5	May
June	6	Jun
July	7	Jul
August	8	Aug
September	9	Sep
October	10	Oct
November	11	Nov
December	12	Dec

Table 5-18 Value description of the day-of-week field

Day of Week	Digit	Abbreviation
Monday	1	Mon
Tuesday	2	Tue
Wednesday	3	Wed
Thursday	4	Thu
Friday	5	Fri
Saturday	6	Sat
Sunday	0	Sun

Table 5-19 describes the special characters that can be used in a cron expression.

Table 5-19 Special character description

Special Character	Meaning	Description
*	Used to specify all values within a field.	***** in the minutes field means every minute.
,	Used to specify multiple values, which can be discontinuous.	For example, "Jan,Apr,Jul,Oct" or "1,4,7,10" in the month field and "Sat,Sun" or "6,0" in the day-of-week field.
-	Used to specify a range.	For example, "0-3" in the minutes field.
?	Used to specify something in one of the two fields in which the character is allowed, but not the other.	You can specify something only in the day-of-month or day-of-week field. For example, if you want your function to be executed on a particular day (such as the 10th) of the month, but do not care what day of the week that is, then put "10" in the day-of-month field and "?" in the day-of-week field.

Special Character	Meaning	Description
/	Used to specify increments. The character before the slash indicates when to start, and the one after the slash represents the increment.	For example, "1/3" in the minutes field means to trigger the function every 3 minutes starting from 00:01:00 of the hour.

Table 5-20 describes several example cron expressions.

Table 5-20 Example cron expressions

Function Scheduling Example	Cron Expression (Beijing Time)
12:00 every day	CRON_TZ=Asia/Shanghai 0 0 12 * * *
12:30 every day	CRON_TZ=Asia/Shanghai 0 30 12 * * *
26th, 29th, and 33rd minutes of each hour	CRON_TZ=Asia/Shanghai 0 26,29,33 * * * *
12:30 from Monday to Friday	CRON_TZ=Asia/Shanghai 0 30 12 ? * MON-FRI
Every 5 minutes during 12:00 and 14:00 from Monday to Friday	CRON_TZ=Asia/Shanghai 0 0/5 12-14 ? * MON-FRI
12:00 every day from January to April	CRON_TZ=Asia/Shanghai 0 0 12 ? JAN,FEB,MAR,APR *

NOTE

If no cron expression is set, the region's time zone is used by default. If your task will run in a specific time zone, use **CRON_TZ** to specify the time zone. For example, to trigger your function at 04:00 on the first day of each month (Beijing time), use **CRON_TZ=Asia/Shanghai 0 0 4 1 * ***. The time zone expression varies depending on the region.

6 Invoking the Function

6.1 Synchronous Invocation

When triggering a function, clients wait for the result before proceeding. Currently, functions with APIG (shared), APIC, and APIG (dedicated) triggers are executed synchronously. Alternatively, you can use the API described in**Executing a Function Synchronously** to trigger a function synchronously. In this scenario, a function is executed for up to 15 minutes.

6.2 Asynchronous Invocation

When a client triggers a function, FunctionGraph persists the request and sends a response immediately to the client. The client proceeds without waiting for the execution result. You cannot know the result in real time. FunctionGraph queues the asynchronous requests and processes them when the server is idle. To obtain asynchronous processing results or to retry when an asynchronous request fails, **configure asynchronous settings**.

- The following triggers are invoked asynchronously by default and the invocation mode cannot be changed.

  Table 6-1 Invocation mode

Event Source	Invocation Mode
SMN	Asynchronous
OBS	Asynchronous
DIS	Asynchronous
Timer	Asynchronous
LTS	Asynchronous
DDS	Asynchronous

Event Source	Invocation Mode
DMS for Kafka	Asynchronous
DMS for RabbitMQ	Asynchronous
GaussDB(for Mongo)	Asynchronous

- APIG, APIG (dedicated), and APIC triggers can be configured for asynchronous invocation on their console. You can also use the API described in **Executing a Function Asynchronously** to trigger a function asynchronously. In this scenario, the maximum execution duration of a function is 12 hours (configured in the whitelist).

  NOTE

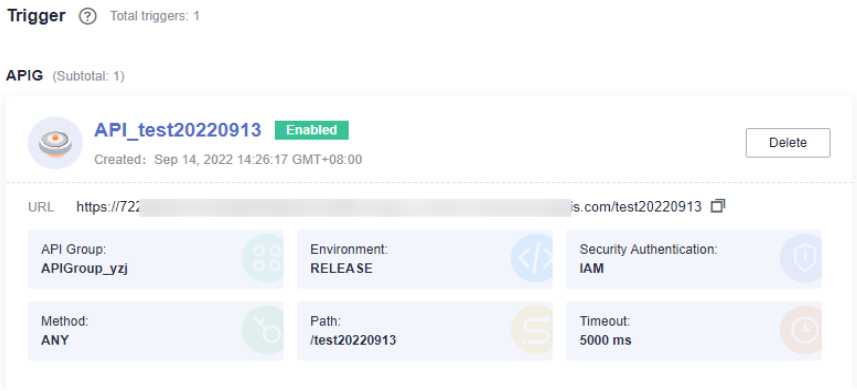
  If the E2E function execution latency exceeds 90s, asynchronous invocation is recommended. If synchronous invocation is used, no responses can be received after 90s due to gateway restrictions.

Example

The following procedure uses the APIG trigger of a function as an example.

1. Go to the function details page, and choose **Configuration** > **Triggers**.
2. Click the APIG trigger name to go to the APIG console.

   Figure 6-1 Clicking a trigger name

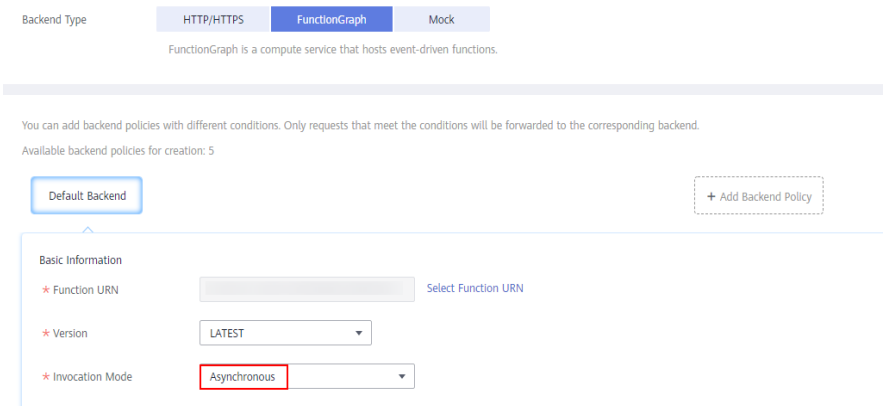


3. Click **Edit** in the upper right.

   Figure 6-2 Clicking Edit

4. Click **Next** until the **Define Backend Request** page is displayed. Then change **Invocation Mode** to **Asynchronous**.

Figure 6-3 Changing the invocation mode



5. Click **Finish** to save the settings.

6.3 Retry Mechanism

If synchronous or asynchronous invocation fails, do as follows:

- Synchronous invocation

  Try again.
- Asynchronous invocation

  You can set the maximum number of retries and the maximum message validity period (up to 24 hours) by referring to **Configuring Asynchronous Execution Notification**. FunctionGraph will retry a function based on these two parameters.

Idempotency

In programming, idempotency means that an application or component can identify duplicate events and prevent duplication, inconsistency, and data loss. If you want to keep a function idempotent, you need to design the function logic to correctly handle repeated events.

Idempotent function logic helps reduce the following problems:

- Unnecessary API calls
- Code processing time
- Data inconsistency
- Restrictions
- Latency

Ensure that your function code can process the same event multiple times without causing duplicate transactions or other unnecessary side effects in case of abnormal calls, retry of client, or retry within dependent functions.

7 Monitoring

7.1 Metrics

7.1.1 Function Monitoring

FunctionGraph is interconnected with Cloud Eye, allowing you to view function metrics without the need for any configurations.

Viewing Function Metrics

FunctionGraph collects function metrics and displays aggregated results. Switch to your target function version before viewing metrics.

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the function to be configured to go to the function details page.
3. Choose **Monitoring** > **Metrics**, select an interval (last day, last 3 days, or custom), and check the running status of the function.

   NOTE

   The following metrics are displayed: invocations, errors, duration (maximum, average, and minimum durations), throttles, and instance statistics.

Metric Description

Table 7-1 describes the function metrics.

Table 7-1 Function metrics

Metric	Unit	Description
Invocations	Count	Total number of invocation requests, including invocation errors and throttled invocations. In case of asynchronous invocation, the count starts only when a function is executed in response to a request.
Duration	ms	**Maximum Duration**: the maximum duration a function is executed within a period. **Minimum Duration**: the minimum duration a function is executed within a period. **Average Duration**: the average duration a function is executed within a period.
Errors	Count	Number of times that your functions failed with error code **200** being returned. Errors caused by function syntax or execution are also included.
Throttles	Count	Number of times that FunctionGraph throttles your functions due to the resource limit.
Instance Statistics	Count	Numbers of concurrent requests and reserved instances.

7.1.2 Function Metrics

Introduction

This section describes the FunctionGraph namespaces, function metrics, and dimensions reported to Cloud Eye. You can view function metrics and alarms by using the Cloud Eye console or calling APIs.

Namespaces

SYS.FunctionGraph

Function Metrics

Table 7-2 Function metrics

Metric ID	Metric Name	Description	Value Range	Monitored Object	Monitoring Period of Raw Data (Minute)
count	Invocations	Number of function invocations Unit: Count	≥ 0 counts	Functions	5
failcount	Errors	Number of invocation errors The following errors are included: • Function request error (causing an execution failure and returning error code 200) • Function syntax or execution error Unit: Count	≥ 0 counts	Functions	5
failRate	Error rate	Percentage of invocation errors to the total invocations Unit: %	0% ≤X≤ 100%	Functions	5
rejectcount	Throttles	Number of function throttles That is, the number of times that FunctionGraph throttles your functions due to the resource limit. Unit: Count	≥ 0 counts	Functions	5

Metric ID	Metric Name	Description	Value Range	Monitored Object	Monitoring Period of Raw Data (Minute)
concurrency	Number of concurrent requests	Maximum number of concurrent requests during function invocation. Unit: Count	≥ 0 counts	Functions	5
reservedinstancenum	Number of reserved instances	Number of reserved instances Unit: Count	≥ 0 counts	Functions	5
duration	Average duration	Average duration of function invocation Unit: ms	≥ 0 ms	Functions	5
maxDuration	Maximum duration	Maximum duration of function invocation Unit: ms	≥ 0 ms	Functions	5
minDuration	Minimum duration	Minimum duration of function invocation Unit: ms	≥ 0 ms	Functions	5
systemErrorCount	System errors	Number of 200 errors that cause a failure in executing function requests. Unit: Count	≥ 0	Functions	5
functionErrorCount	Function errors	Number of syntax and execution errors. Unit: Count	≥ 0	Functions	5
payPerUseInstance	Number of elastic instances.	Number of elastic instances. Unit: Count	≥ 0	Functions	5

Table 7-3 Flow metrics

Metric ID	Metric Name	Description	Value Range	Monitored Object	Monitoring Period of Raw Data (Minute)
toalCount	Invocations	Number of flow invocations Unit: Count	≥ 0 counts	Flows	1
errorCount	Errors	Number of invocation errors Unit: Count	≥ 0 counts	Flows	1
running	Running Workflows	Number of running flows Unit: Count	≥ 0 counts	Flows	1
rejectCount	Throttles	Number of flow throttles Unit: Count	≥ 0 counts	Flows	1
averageDuration	Average Duration	Average duration of flow invocation Unit: ms	≥ 0 ms	Flows	1

Dimensions

Key	Value
package-functionname	*App name-Function name* Example: default-myfunction_Python
graph_name	Flow name
projectId	Project ID of the tenant

7.1.3 Creating an Alarm Rule

After creating a function and trigger, you can monitor the invocation and running statuses of the function in real time.

Viewing Function Metrics

FunctionGraph differentiates the metrics of a function by version, allowing you to query the metrics of a specific function version.

Procedure

Create an alarm rule for a function to report metrics to Cloud Eye so that you can view monitoring graphs and alarm messages on the Cloud Eye console.

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

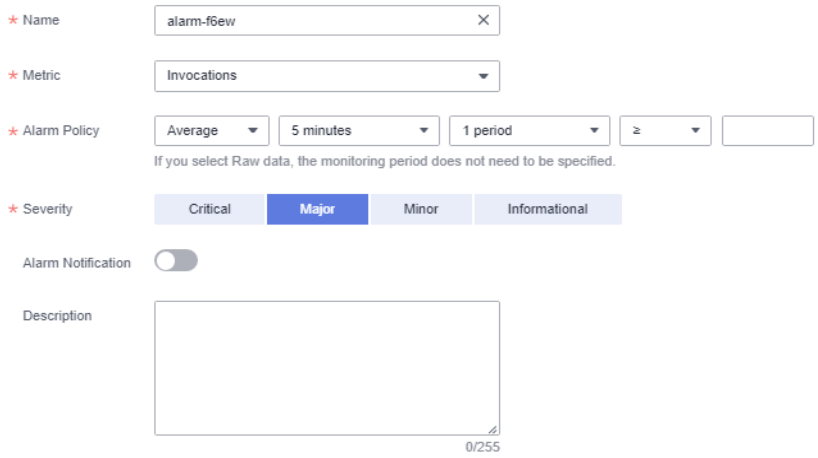
Step 2 Click the name of the desired function.

Step 3 On the displayed function details page, select a function version or alias, and choose **Monitoring** > **Metrics**.

Step 4 Click **Create Alarm Rule**.

Step 5 Set alarm parameters and click **Next** as shown in **Figure 7-1**.

Figure 7-1 Creating an alarm rule



Step 6 Enter a rule name and click **OK**.

----End

CAUTION

After a function is deleted, the alarm rules created for it will not be updated in real time on the Cloud Eye console and may continue to be displayed there for a maximum of seven days.

Function Metrics

Table 7-4 lists the function metrics that can be monitored by Cloud Eye.

Table 7-4 Function metrics

Metric	Display Name	Description	Unit	Upper Limit	Lower Limit	Recommended Threshold	Value Type	Dimension
count	Invocations	Number of function invocations	Count	-	0	-	int	package-functionname
failcount	Errors	Number of invocation errors	Count	-	0	-	int	package-functionname
rejectcount	Throttles	Number of function throttles	Count	-	0	-	int	package-functionname
duration	Average Duration	Average duration of function invocation	ms	-	0	-	int	package-functionname
maxDuration	Maximum Duration	Maximum duration of function invocation	ms	-	0	-	int	package-functionname
minDuration	Minimum Duration	Minimum duration of function invocation	ms	-	0	-	int	package-functionname

7.2 Logs

7.2.1 Querying Function Logs

FunctionGraph is interconnected with LTS, allowing you to view function logs without the need for any configurations.

Viewing Function Logs

On the FunctionGraph console, view function logs in the following ways:

- Viewing logs on the execution result page

  After creating a function, test it and view test logs on the execution result page. For details, see **Online Debugging**.

  The execution result page displays a maximum of 2 KB logs. To view more logs of the function, go to the **Logs** tab page.
- Viewing logs on the **Logs** tab page

  On the function details page, choose **Monitoring** > **Logs** to query log information. For details, see **Managing Function Logs**.

Downloading Logs

After querying the logs of a function version within a specified date range, you can download the logs for further analysis.

NOTE

- A maximum of 5000 logs can be downloaded at a time. When querying logs, select a proper time range to avoid log loss.
- The timestamp of logs is in UTC.

7.2.2 Managing Function Logs

NOTICE

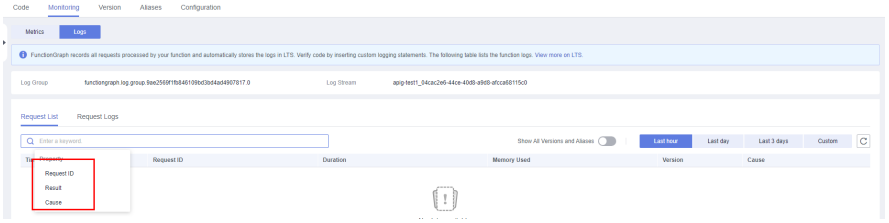
FunctionGraph v1 supports log management by using AOM or LTS.

FunctionGraph v2 supports log management by using LTS only.

- Using AOM to manage function logs

- Using LTS to manage function logs

Figure 7-2 Logs page



Using AOM to Manage Function Logs

Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the name of the desired function.

Step 3 Choose **Monitoring** > **Logs**. On the displayed page, enter search criteria.

NOTE

- You can:

  1. Enter a keyword for exact search. A keyword is a word between two adjacent delimiters.

  2. Enter a keyword with wildcards for fuzzy match. Example: ***ROR***, **ERR***, or **ER*OR**.

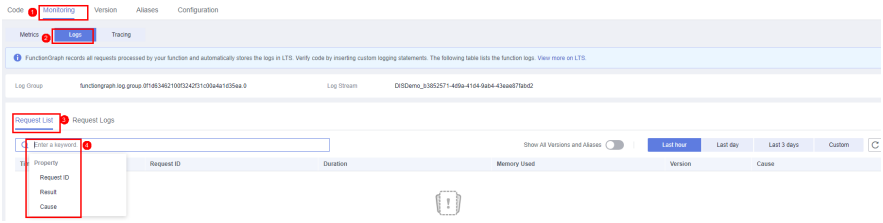
  3. Enter a phrase for exact search. Example: **Start to refresh alm Statistic**.

  4. Use AND (&&) or OR (||) to combine keywords to search. Example: **query&&logs** or **query||logs**.

- You can select **Last 30 minutes**, **Last hour**, **Last day**, and **Custom** (up to one month, for example, 2022/04/01 16:34:48–2022/05/01 16:34:48).
- You can query logs by version.

Step 4 Click  to search for logs.

Figure 7-3 Querying logs



NOTE

The log query result contains time, request ID, invocation result, duration, memory, and version.

Step 5 Perform the following operations if needed:

1. Search for logs by keyword.

2. Filter logs by status: **Error**, **Info**, **Error & Warning**, and **Error & Warning & Info**.

3. View logs in full screen.

4. **Download logs**.

Figure 7-4 Other operations

----End

Using LTS to Manage Function Logs

You can enable LTS to better manage function logs. After you enable LTS, FunctionGraph automatically creates a log group starting with **functiongraph**. When you create a function, a log stream starting with the function name is generated.

You can also bind a log group and log stream to a function to store its invocation logs. For details, see **Configuring a Log Group and Log Stream**.

NOTE

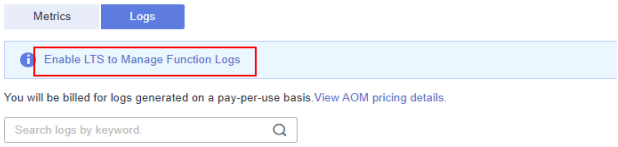
- By default, 20 log streams are created, which cannot be customized. On the **Logs** tab page of the function, press **F12** to find out the log stream ID of the **query** API, and then locate the corresponding log stream ID in LTS.

- Deleting a function log group by mistake on the LTS console will not be detected by FunctionGraph, and the historical log data can no longer be retrieved. To use a log group, modify the function description and save the changes. A new log group will be created.

Step 1 Enable LTS.

Enabling LTS in FunctionGraph v1: On the **Logs** tab page, click **Enable LTS to Manage Function Logs**.

Figure 7-5 Enabling LTS to manage function logs

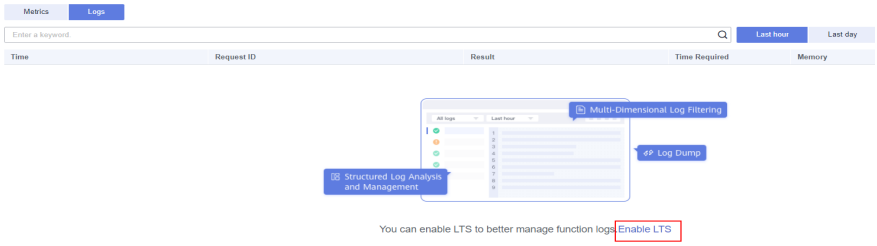


NOTE

In FunctionGraph v1, you can switch back to AOM. In that case, AOM will take over LTS to manage function logs. You will be billed for logs generated on a pay-per-use basis.

Enabling LTS in FunctionGraph v2: On the **Logs** tab page, click **Enable LTS**. Click **OK**. LTS is enabled successfully.

Figure 7-6 Enabling LTS to manage function logs



NOTE

In FunctionGraph v2, only LTS can be used to manage function logs.

Step 2 Set filter criteria.

- **Request List**: Filter requests by request ID, result (success or failure), or cause (initialization failed, load failed, system error, timed out, out of memory, out of disk space, or code error).
- **Request Log**: Filter logs by keyword, request ID, or instance ID.

Table 7-5 Invocation result

Result	Description
Execution successful	Log printed when a function is successfully executed.
Execution failed	Log printed when a function fails to be executed due to invocation timeout, memory or disk threshold exceeded, or code errors. To view the logs about invocation timeout, select **Invocation timed out** from the drop-down list. The methods for viewing the other three types of logs are the same.

Table 7-6 Cause analysis

Cause	Description
Initialization failed	Log printed when the function initialization fails.
Load failed	Log generated when the runtime fails to load your function file.
System error	Internal error.
Invocation timed out	Log printed when the function invocation period is longer than the preset limit.
Memory threshold exceeded	Log printed when the function memory size exceeds the preset limit.
Disk threshold exceeded	Log printed when the disk size exceeds the preset limit.
Code error	Log printed when a code error occurs.

NOTE

- You can view logs of the last hour, last day, last 3 days, or a custom time period.
- To manage function logs, go to the LTS console.
- Max. 10 MB logs can be retained for common instances during initialization. When this limit is reached, the latest logs replace the old ones.

----End

Downloading Logs

NOTICE

- Currently, logs can be downloaded only when you use AOM for log management.
- FunctionGraph v1 allows you to manage function logs using AOM.
- FunctionGraph v2 allows you to manage function logs using LTS, but does not support log download.

Step 1 Return to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 Click the name of the desired function.

Step 3 Click **Monitoring**.

Step 4 On the **Logs** page, select a version and time range, and click **Download Log**.

NOTE

A maximum of 5000 logs can be downloaded at a time. When querying logs, select a proper time range to avoid log loss.

----End

7.3 Tracing

NOTE

Currently, this feature is available only in CN East-Shanghai1 and CN North-Beijing4 regions.

Overview

After enabling tracing on the **Monitoring** tab, you can view details on the **Tracing** page, or go to the APM console and choose **Application Monitoring** > **Tracing**. This feature is available only for Java 8 and 11 functions.

Prerequisites

- Only functions with 512 MB or larger memory can be traced. For functions whose memory is less than 512 MB, increase the memory on the **Configuration** > **Basic Settings** page.

- You have obtained the permission to use APM. For details, see **APM Permissions Management**. If tracing is not enabled, no trace data can be obtained.

Enabling Tracing

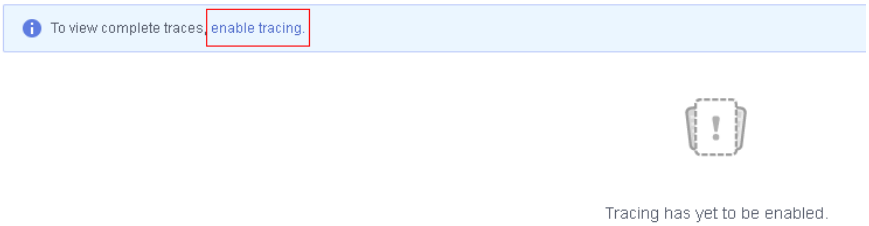
Step 1 Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.

Step 2 Click the name of the desired function.

Step 3 Choose **Monitoring** > **Tracing**.

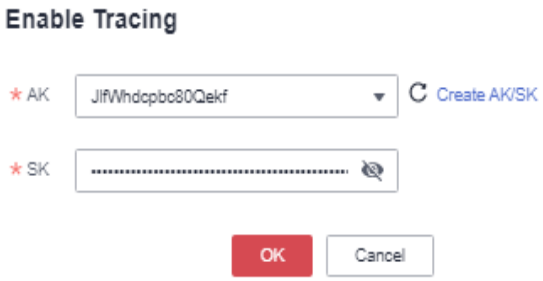
Step 4 Click **enable tracing**.

Figure 7-7 Enabling tracing



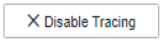
Step 5 The system automatically obtains an access key (AK/SK) from APM, as shown in **Figure 7-8**.

Figure 7-8 Obtaining an access key



- If an access key already exists, select an AK from the AK drop-down list and click **OK**.
- If you do not have an access key, click **Create AK/SK** to create one on the APM console. For details, see **Creating an Access Key**. Then the new AK/SK will be synchronized to the FunctionGraph console.

Step 6 Manage tracing.

- Click 

in the upper right corner. In this case, you cannot view function traces.

- If the AK/SK has been changed on the APM console, you need to go to the FunctionGraph console and click Update AK/SK in the upper right corner.

----End

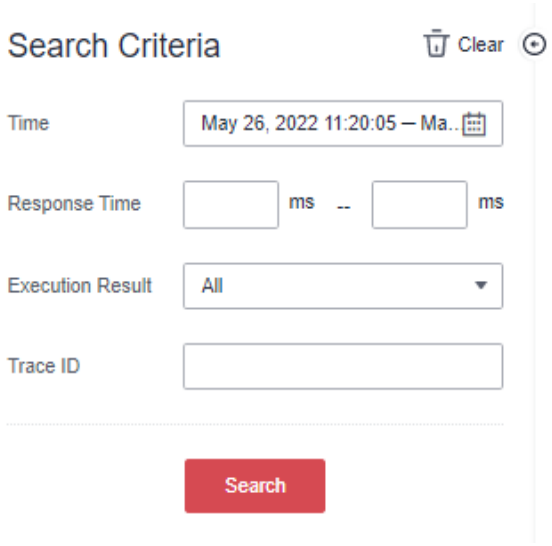
Querying Trace Details

Step 1 Return to the FunctionGraph console, choose **Functions** > **Function List** in the navigation pane, and click the name of a function with tracing enabled. The function details page is displayed.

Step 2 On the **Monitoring** tab page, choose **Tracing**.

Step 3 Set search criteria and click **Search**.

Figure 7-9 Setting search criteria



- **Time**: Set a time range to query traces. It can be up to 24 hours.
- **Response Time**: Set the response time.
- **Execution Result**: Select **All**, **Successful**, or **Failed**.
- **Trace ID**: If you specify this parameter, all other search criteria become invalid and only the trace with the specified ID will be searched.

Step 4 View the trace details on the right.

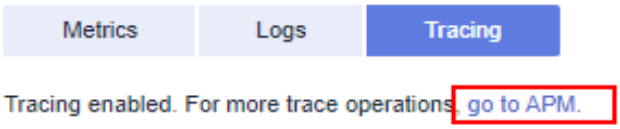
Viewing details about a trace: In the query result, click the trace name and view details on the APM console.

Figure 7-10 Clicking a trace name

Figure 7-11 Details about a trace

Viewing information about all traces: Click **go to APM** to perform complete path analysis and other operations.

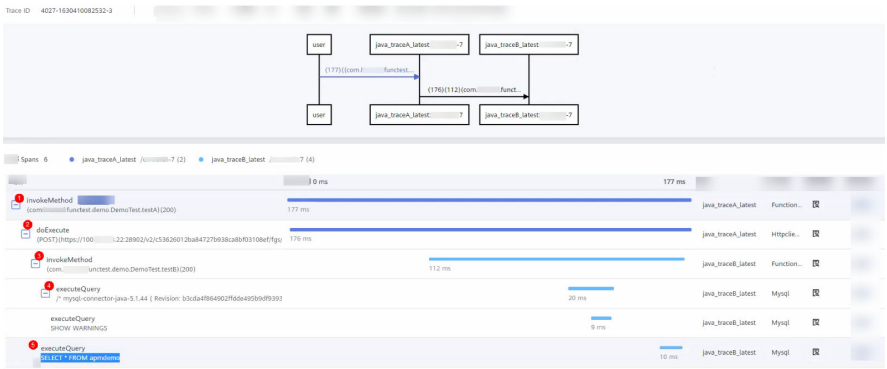
Figure 7-12 Going to APM



Example

1. The following shows how function A (**DemoTestA**) invokes function B (**DemoTestB**) by sending an HTTP request.

   Figure 7-13 Function invocation details

   1. Total time consumed by a method of function A
   2. Invoking function B by sending an HTTP request
   3. Accessing function B
   4. Executing **executeQuery**
   5. Executing a SELECT statement to query data

2. The following shows a complete function execution process that contains cold start.

   Spans are described as follows:

   - **load**: time for downloading and decompressing the function code package and dependency package
   - **preload**: time for loading function code and initializing the execution environment

- **init**: execution duration of the initializer. The initializer is executed only during cold start.
- **processInvoke**: execution duration of the function

NOTE

For more information, see section "Tracing".

----End

8 Function Management

Overview

Function is a combination of code, runtime, resources, and settings required to achieve a specific purpose. It is the minimum unit that can run independently. A function can be triggered by triggers and automatically schedule required resources and environments to achieve expected results.

Exporting a Function

You can export the functions that you created.

Step 1 Log in to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 Click a function name.

Step 3 On the displayed function details page, choose **Operation** > **Export Function** in the upper right corner.

NOTE

- A user can export only one function at a time.
- The exported function resource package cannot exceed 50 MB.
- The name of the exported function resource package is in the format of *function name*+*MD5 value of function code*.zip.
- The exported function resource package does not include alias information.
- If a function is disabled or enabled, all versions of the function will be disabled or enabled.

----End

Disabling a Function

Disabled functions can no longer be executed.

Step 1 Return to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 Click the name of the function you want to disable.

Step 3 On the displayed function details page, click **Disable Function** in the upper right corner.

Step 4 On the displayed page, click **Yes**. The function is disabled.

NOTE

- Only functions of the latest version can be disabled.
- Versions published based on the disabled latest version of a function are also disabled and can never be enabled.
- After disabling a function, you can modify its code but cannot execute the function.

----End

Enabling a Function

Disabled functions can be enabled again as required.

Step 1 Return to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 Click the name of the function you want to enable.

Step 3 On the displayed function details page, click **Enable Function** in the upper right corner.

----End

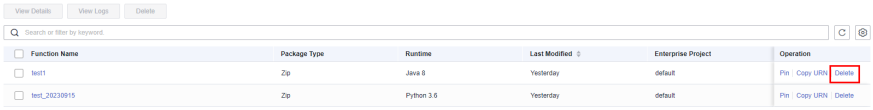
Deleting a Function

You can delete unused functions to release resources.

Step 1 Return to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 In the **Function List**, locate the row that contains the target function and click **Delete** in the operation column. In the displayed dialog box, enter **DELETE** and click **OK**.

Figure 8-1 Deleting a function



----End

9 Dependency Management

9.1 Configuring Dependency Packages

Overview

Generally, the code of a function consists of public libraries and service logic. The public libraries can be packaged as a dependency and shared among functions, reducing the size of the function code package for easy deployment and update.

FunctionGraph also provides some **public dependencies**, which are cached internally for quick loading. These dependencies are recommended.

FunctionGraph enables you to manage dependencies in a unified manner. You can upload dependencies from a local path, or through OBS if they are too large, and specify names for them. Dependencies can be iterated. Each dependency can have multiple versions.

For details, see **How Do I Create Function Dependencies?**

NOTE

- The name of each file in the dependency package cannot end with a tilde (~).
- A dependency package can contain up to 30,000 files.
- If your function uses a large private dependency, increase the execution timeout by choosing **Configuration** > **Basic Settings** on the function details page.

Creating a Dependency

Step 1 Log in to the FunctionGraph console, and choose **Functions** > **Dependencies** in the navigation pane.

Step 2 Click **Create Dependency**.

Step 3 Set the following parameters:

Table 9-1 Dependency configuration parameters

Parameter	Description
Name	Dependency name.
Code Entry Mode	Upload a ZIP file directly or upload a file from OBS. • **Upload ZIP**: Click **Select File** to upload one. • **Upload from OBS**: Specify an OBS link URL. For details about how to obtain the URL, see **Accessing an Object Using Its URL**.
Runtime	Select a runtime.
Description	Description of the dependency. This parameter is optional.

Step 4 Click **OK**. By default, a new dependency is version **1**.

Step 5 Click the dependency name, and view all versions and related information on the displayed page. Each dependency can have multiple versions.

- To create a dependency version, click **Create Version** in the upper right corner of the page.
- To view the address of a version, click the version.
- To delete a version, click the delete icon in the same row.

----End

Configuring Dependencies for a Function

Step 1 Return to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.

Step 2 Click the name of the desired function.

Step 3 On the displayed function details page, click the **Code** tab, click **Add** in the **Dependencies** area.

Step 4 On the displayed **Select Dependency** dialog box, select dependencies and click **OK**.

Table 9-2 Dependency configuration

Parameter	Description
Runtime	Runtime of this function. It cannot be changed.
Type	Add a **Public** or **Private** dependency.
Name	Select a dependency.
Version	Select a version to be added.

NOTE

- You can add a maximum of 20 dependencies for a function.
- Except your private dependencies, FunctionGraph provides some public dependencies, which you can choose when creating a function.

----End

Deleting a Dependency

To delete a dependency, just delete all of its versions.

Step 1 Return to the FunctionGraph console, and choose **Functions** > **Dependencies** in the navigation pane.

Step 2 Click the name of the target dependency to go to the **Versions** page.

Step 3 Click the delete icon in the row of a version. Repeat this operation if the dependency has multiple versions.

Figure 9-1 Deleting a dependency version

NOTE

Dependencies referenced by functions cannot be deleted.

----End

9.2 Dependent Libraries

Supported Dependent Libraries

FunctionGraph supports both standard and third-party libraries.

- Standard libraries

  When using standard libraries, you can import them to your inline code or package and upload them to FunctionGraph.

- Supported non-standard libraries

  FunctionGraph provides built-in third-party components listed in **Table 9-3** and **Table 9-4**. You can import these libraries to your inline code in the same way as you import standard libraries.

Table 9-3 Third-party components integrated with the Node.js runtime

Name	Usage	Version
q	Asynchronous method encapsulation	1.5.1
co	Asynchronous process control	4.6.0

Name	Usage	Version
lodash	Common tool and method library	4.17.10
esdk-obs-nodejs	OBS sdk	2.1.5
express	Simplified web-based application development framework	4.16.4
fgs-express	Provides a Node.js application framework for FunctionGraph and APIG to run serverless applications and REST APIs. This component provides an example of using the Express framework to build serverless web applications or services and RESTful APIs.	1.0.1
request	Simplifies HTTP invocation and supports HTTPS and redirection.	2.88.0

Table 9-4 Non-standard libraries supported by the Python runtime

Module	Usage	Version
dateutil	Date and time processing	2.6.0
requests	HTTP library	2.7.0
httplib2	httpclient	0.10.3
numpy	Mathematical computing	For pip 2.7, numpy==1.16.6. For pip 3.10, numpy==1.24.2. For pip 3.9, numpy==1.18.5. For pip 3.6, numpy==1.18.5.
redis	Redis client	2.10.5
obsclient	OBS client	-
smnsdk	SMN access	1.0.1

- Other third-party libraries (FunctionGraph has no built-in non-standard third-party libraries except those listed in the preceding table.)

  Package the dependency third-party libraries and upload them to an OBS bucket or on the function details page. These libraries will then be used in your function code.

Importing Dependent Libraries

Importing a dependency for Python:

```
from com.obs.client.obs_client import ObsClient
```

Importing a dependency for Node.js:

```
const ObsClient = require('esdk-obs-nodejs');
```

For standard libraries and supported non-standard libraries, you can directly use them in your function.

For non-standard third-party libraries that are not provided by FunctionGraph, you can use them by performing the following steps:

1. Package the dependent libraries into a ZIP file, upload the ZIP file to an OBS bucket, and obtain the OBS link URL.
2. Log in to the FunctionGraph console, and choose **Functions** > **Dependencies** in the navigation pane.
3. Click **Create Dependency**.
4. Set the dependency name and runtime, specify the OBS link URL, and click **OK**.

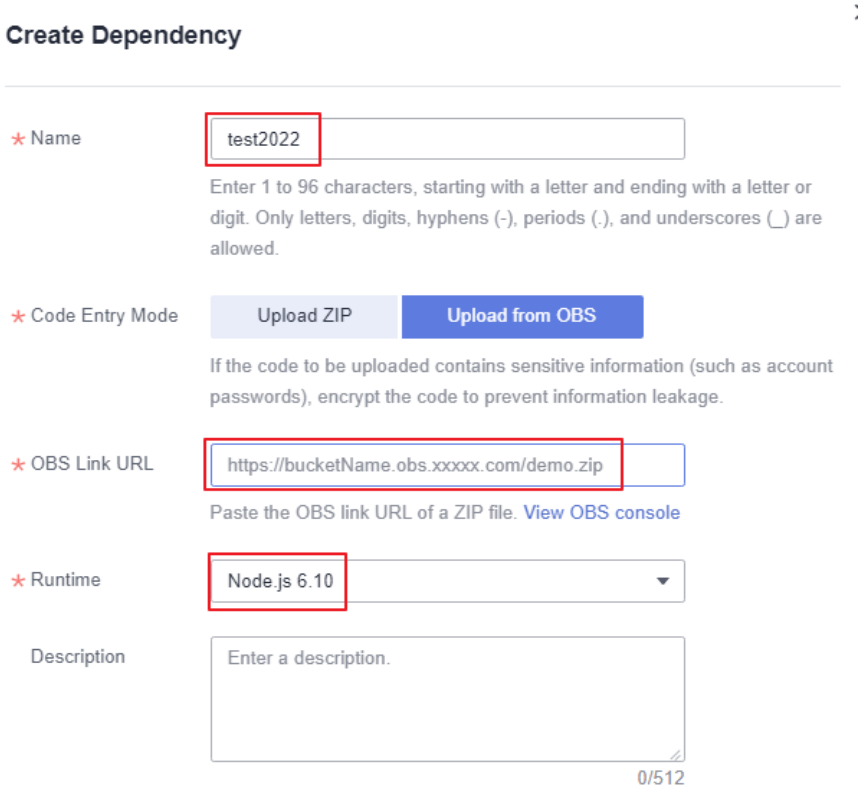
   NOTE

   For details about how to obtain the OBS link URL, see **Accessing an Object Using Its URL**. (The following figure is for reference only. Please use the actual URL of the uploaded file package.)

   Figure 9-2 Obtaining the OBS link URL

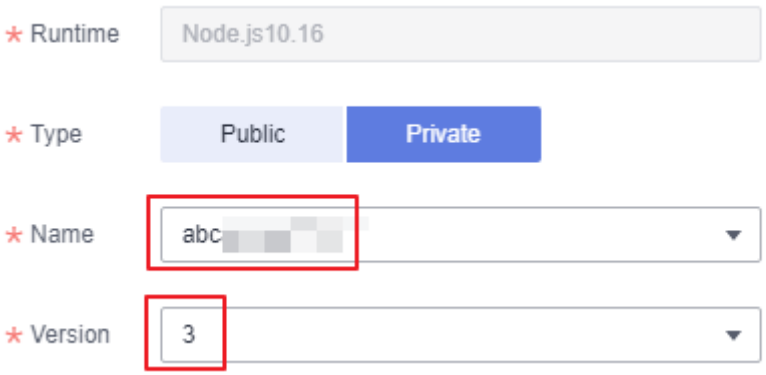
   

Figure 9-3 Setting the dependency



5. On the function details page, click the **Code** tab, click **Add** in the **Dependencies** area, select the dependency created in **4**, and click **OK**.

Figure 9-4 Selecting a dependency



WARNING

Each dependency package cannot contain a file with the same name as a code file. Otherwise, the two files may be incorrectly merged or overwritten. For example, if dependency package **depends.zip** contains a file named **index.py**, the handler of a function cannot be set to **index.handler**. Otherwise, a code file also named **index.py** will be generated.

9.3 Public Dependencies

9.3.1 What Is a Public Dependency?

Public dependencies are provided by Huawei Cloud. You can import them to your code on the function details page to implement service logic.

Public dependencies have the following advantages:

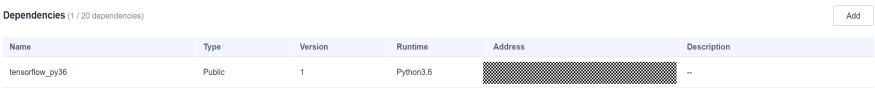
- They provide an out-of-the-box ecosystem, eliminating the need to build and upload dependencies. You can focus on your code and service logic without worrying about the running environment.
- FunctionGraph caches public dependencies for fast access. No network latency will be involved during cold start for accessing dependency files in storage services.
- Public dependencies either smaller or larger than 300 MB can be easily imported and deleted, while private dependencies larger than 300 MB must be split for upload.

9.4 Public Dependency Demos

9.4.1 Linear Regression with TensorFlow

Adding TensorFlow on Function Details Page

Figure 9-5 Adding TensorFlow



Importing TensorFlow to Code

```
import json
import random
# Import TensorFlow.
import tensorflow as tf
def handler (event, context):

    TRUE_W = random.randint(0,9)
    TRUE_b = random.randint(0,9)

    NUM_SAMPLES = 100

    X = tf.random.normal(shape=[NUM_SAMPLES, 1]).numpy()
    noise = tf.random.normal(shape=[NUM_SAMPLES, 1]).numpy()
    y = X * TRUE_W + TRUE_b + noise
    model = tf.keras.layers.Dense(units=1)

    EPOCHS = 20
    LEARNING_RATE = 0.002
    print("start training")
    for epoch in range(EPOCHS):
```

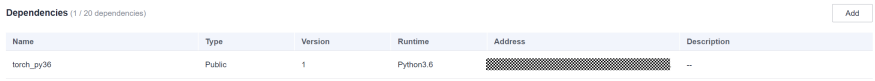


```
        with tf.GradientTape() as tape:
            y_ = model(X)
            loss = tf.reduce_sum(tf.keras.losses.mean_squared_error(y, y_))

        grads = tape.gradient(loss, model.variables)
        optimizer = tf.keras.optimizers.SGD(LEARNING_RATE)
        optimizer.apply_gradients(zip(grads, model.variables))

        print('Epoch [{}/{}], loss [{:.3f}]'.format(epoch, EPOCHS, loss))
    print("finished")
    print(TRUE_W,TRUE_b)
    print(model.variables)
    return {
        "statusCode": 200,
        "isBase64Encoded": False,
        "body": json.dumps(event),
        "headers": {
            "Content-Type": "application/json"
        }
    }

class Model(object):
    def __init__(self):
        self.W = tf.Variable(tf.random.uniform([1]))
        self.b = tf.Variable(tf.random.uniform([1]))
    def __call__(self, x):
        return self.W * x + self.b
```

9.4.2 Linear Regression with PyTorch

Adding Torch on Function Details Page

Figure 9-6 Adding Torch



Importing Torch to Code

```
# -*- coding:utf-8 -*-
import json
# Import Torch.
import torch as t
import numpy as np
def handler (event, context):
    print("start training!")
    train()
    print("finished!")
    return {
        "statusCode": 200,
        "isBase64Encoded": False,
        "body": json.dumps(event),
        "headers": {
            "Content-Type": "application/json"
        }
    }


def get_fake_data(batch_size=8):
    x = t.rand(batch_size, 1) * 20;
    y = x * 2 + (1 + t.randn(batch_size, 1)) * 3
    return x, y

def train():
    t.manual_seed(1000)
```

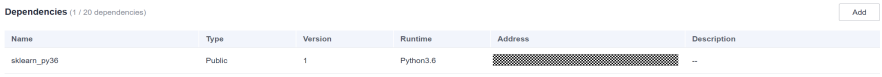


```
x, y = get_fake_data()

w = t.rand(1, 1)
b = t.zeros(1, 1)
lr = 0.001


for ii in range(2000):
    x, y = get_fake_data()
    y_pred = x.mm(w) + b.expand_as(y)
    loss = 0.5 * (y_pred - y) ** 2
    loss = loss.sum()

    dloss = 1
    dy_pred = dloss * (y_pred - y)

    dw = x.t().mm(dy_pred)
    db = dy_pred.sum()
    w.sub_(lr * dw)
    b.sub_(lr * db)


    if ii % 10 == 0:
        x = t.arange(0, 20).view(-1, 1)

        y = x.float().mm(w)+ b.expand_as(x)

        x2, y2 = get_fake_data(batch_size=20)

        print("w=",w.item(), "b=",b.item())
```

9.4.3 sklearn

Adding sklearn on Function Details Page

Figure 9-7 Adding sklearn



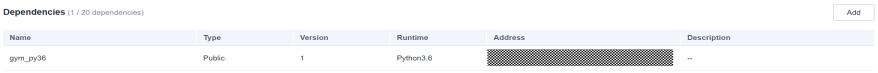
Importing sklearn to Code

```
# Import sklearn.
from sklearn import datasets
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
def handler (event, context):
    iris=datasets.load_iris()
    iris_X=iris.data
    iris_y=iris.target

    X_train,X_test,y_train,y_test=train_test_split(iris_X,iris_y,test_size=0.3)

    knn=KNeighborsClassifier()
    knn.fit(X_train,y_train)

    print(knn.predict(X_test))

    return y_test
```


9.4.4 Gym

Adding Gym on Function Details Page

Figure 9-8 Adding Gym



Importing Gym to Code

```
# Import Gym.
import gym
env = gym.make('CartPole-v0')
env.reset()

def handler(event,context):
    for _ in range(10):
        env.render()
        observation, reward, done, info, _ = env.step(env.action_space.sample()) # take a random action
        temp = env.step(env.action_space.sample()) # take a random action
        print('observation:{}, reward:{}, done:{}, info:{}'.format(observation, reward, done, info))
    env.close()
```


10 Reserved Instance Management (Old)

What Is a Reserved Instance?

FunctionGraph provides on-demand and reserved instances.

- On-demand instances are created and released by FunctionGraph based on actual function usage. When receiving requests to call functions, FunctionGraph automatically allocates execution resources to the requests.
- Reserved instances can be created and released by you as required. After you create reserved instances for a function, FunctionGraph preferentially forwards requests to the reserved instances. If the number of requests exceeds the processing capability of the reserved instances, FunctionGraph will forward the excessive requests to on-demand instances and automatically allocates execution resources to these requests.

  After reserved instances are created for a function, the code, dependencies, and initializer of the function are automatically loaded. Reserved instances are always alive in the execution environment, eliminating the influence of cold starts on your services.

  NOTE

  To use reserved instances, **submit a service ticket** to add your account to the whitelist.

You can directly create reserved instances or create them on the function configuration page. Differences between the two modes are described in the following table.

Table 10-1 Differences between the two modes

Mode	Advantage	Disadvantage
Directly creating reserved instances	You can create a reserved instance with just a few clicks.	Only a fixed number of reserved instances can be created. The reserved instances may be insufficient during peak hours and become idle during off-peak hours.
Creating reserved instances on the function configuration page	You can create different numbers of reserved instances for different periods, preventing waste of reserved instances during off-peak hours and ensuring enough reserved instances during peak hours.	The procedure is complex.

Directly Creating a Fixed Number of Reserved Instances

Ensure that the function, for example, **Objective-func**, for which you want to create reserved instances already exists on the FunctionGraph console.

1. Log in to the FunctionGraph console, and choose **Functions** > **Reserved Instances** in the navigation pane.
2. Click **Configure Reserved Instance**.
3. Set the following parameters:

   Table 10-2 Reserved instance information

Parameter	Description
App	Select the app to which the **Objective-func** function belongs.
Function	Select **Objective-func**.
Version	Select a version of the **Objective-func** function.
RI Quantity	Enter the number of reserved instances to be created. To determine how many reserved instances to create, view the number of used instances in the **Instance Statistics** area or check the usage of the **Objective-func** function.

4. Click **OK**.

   NOTE

   After creating reserved instances for a function, you can only change the reserved instance quantity.

Creating Reserved Instances on the Function Configuration Page

The number of function instances varies between different periods. To ensure enough reserved instances during peak hours and prevent waste of reserved instances during off-peak hours, you can create a timer for invoking the corresponding function with different number of reserved instances in different periods.

Ensure that the function, for example, **Objective-func**, for which you want to create reserved instances already exists on the FunctionGraph console.

1. Return to the FunctionGraph console, and choose **Functions** > **Function List** in the navigation pane.
2. Click **Create Function**.
3. Set the following information.

Parameter	Description
Template	Select **Create from scratch**.
Function Name	Enter a name to identify the function.
App	Select **default**.
Agency	Select **Use no agency**.
Description	Enter a description for the function. This parameter is optional.
Runtime	Select **Python 2.7**.
Handler	Enter **index.handler**.
Code Entry Mode	When creating a function, select **Default code**. On the **Configuration** tab page, select **Edit code inline** and enter the following code:

```
# -*- coding:utf-8 -*-
import json
import requests
def handler (event, context):
    domainId = "https://{Endpoint}"
    url = "/v2/{project_id}/fgs/functions/{func-urn}/reservedinstances"
    token = context.getToken()
    requrl = domainId + url
    headerdata = {"Content-Type":"application/json","x-auth-token":token}
    r = requests.put(requrl, data=event["user_event"], headers=headerdata,verify=False)
    return r.json
```

Replace the following parameters with the actual values:

- *Endpoint*: Endpoint of the **Objective-func** function. For details, see **Regions and Endpoints**.
- *project_id*: ID of the project to which the **Objective-func** function belongs. For details, see **Obtaining a Project ID**.
- *func-urn*: URN of the **Objective-func** function.

4. Click **Create Function**.
5. On the **Configuration** tab page, click **Create Agency**.
6. Create an agency and grant it the **FunctionGraph User** permission. For details, see **Configuring Agency Permissions**.
7. On the **Configuration** tab page, select the agency created in **6**, and click **Save**.
8. On the **Triggers** tab page, click **Create Trigger**.
9. Set the following information.

Parameter	Description
Trigger Type	Select **Timer**.
Timer Name	Enter a name to identify the timer.
Rule	Select **Cron expression** and enter a cron expression as required.
Enable Trigger	By default, this function is enabled. Retain the default setting.
Additional Information	Enter the number of reserved instances required in different periods based on the trigger rule.

Figure 10-1 Creating a timer trigger

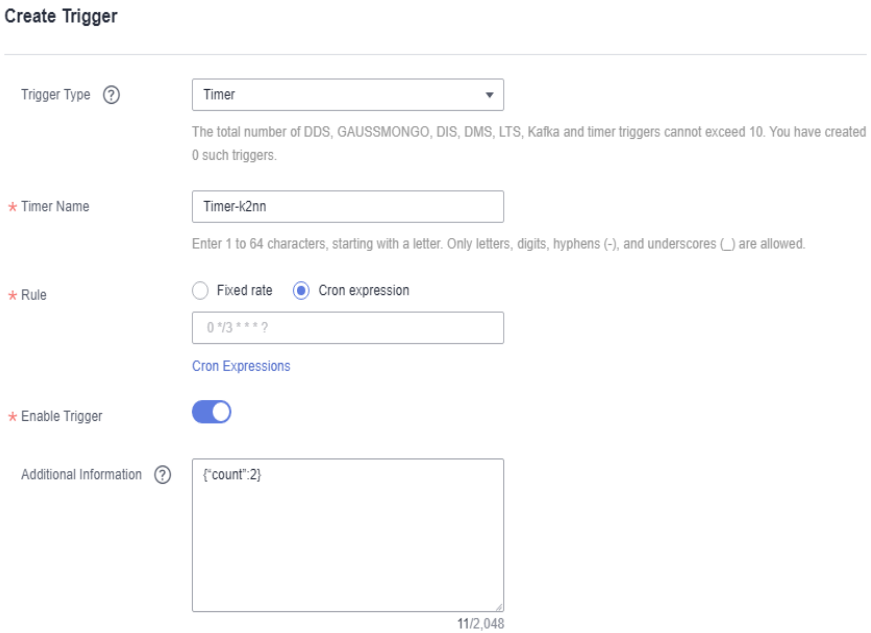


Figure 10-1 shows a timer trigger that requests FunctionGraph to create two reserved instances every 3 minutes.

10. Click **OK**.

After trigger creation, different numbers of reserved instances will be created for the **Objective-func** function in different periods based on the trigger rule.

11 Reserved Instance Management

Introduction

FunctionGraph provides on-demand and reserved instances.

- On-demand instances are created and released by FunctionGraph based on actual function usage. When receiving requests to call functions, FunctionGraph automatically allocates execution resources to the requests.
- Reserved instances can be created and released by you as required. After you create reserved instances for a function, FunctionGraph preferentially forwards requests to the reserved instances. If the number of requests exceeds the processing capability of the reserved instances, FunctionGraph will forward the excessive requests to on-demand instances and automatically allocates execution resources to these requests.

  After reserved instances are created for a function, the code, dependencies, and initializer of the function are automatically loaded. Reserved instances are always alive in the execution environment, eliminating the influence of cold starts on your services. (Do not execute one-time services using the initializer of reserved instances.)

  You can configure a fixed number of reserved instances or scheduled, metric, and intelligent recommendation policies.

  NOTE

  By default, you do not have permission to use the metric and intelligent recommendation policies. To use them, **submit a service ticket**.

Configuring a Fixed Number of Reserved Instances

Ensure that the function for which you want to create reserved instances already exists on the FunctionGraph console.

1. Log in to the **FunctionGraph console**. In the navigation pane, choose **Functions** > **Function List**.
2. Click the target function to go to the details page.
3. Choose **Configuration** > **Concurrency**, and click **Add**.

   Figure 11-1 Clicking Add

4. Set parameters by referring to **Table 11-1**.

   You can create a specified number of reserved instances for a function version or alias. This number cannot exceed the maximum number of requests per instance or the maximum number of instances per function.

Figure 11-2 Basic settings

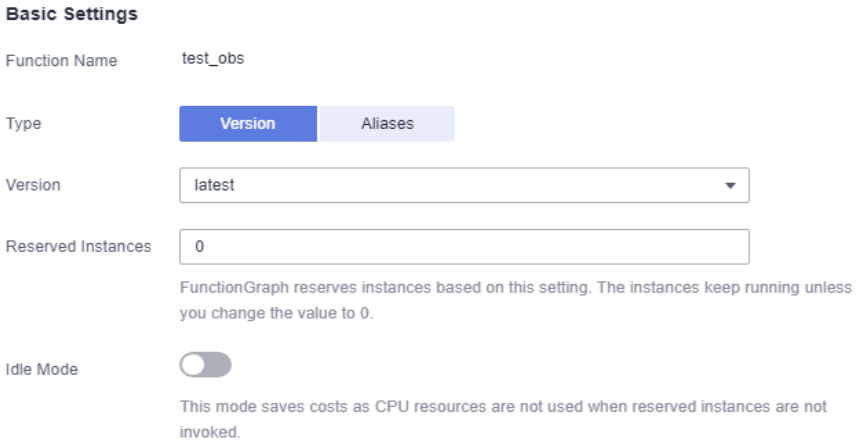


Table 11-1 Basic settings

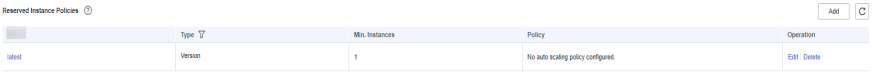
Parameter	Description
Function Name	Name of the current function.
Type	Select **Version** or **Aliases**.
Version	Set this parameter when you select **Version** for **Type**.
Alias	Set this parameter when you select **Aliases** for **Type**.
Min. Instances	Minimum number of instances. Max.: **1000**. FunctionGraph reserves the specified number of instances for the function. These instances will always run unless you change **Min. Instances** to **0**.
Idle Mode	This mode saves costs as CPU resources are not used when reserved instances are not invoked.

NOTE

- Reserved instances cannot be configured for both a function alias and the corresponding version. For example, if the alias of the latest version is 1.0 and reserved instances have been configured for this version, no more instances can be configured for alias 1.0.
- After the idle mode is enabled, reserved instances are initialized and the mode change needs some time to take effect. You will still be billed at the price of reserved instances for non-idle mode in this period.
- If the function concurrency is greater than the number of reserved instances, the excess requests will be allocated to on-demand instances, which involve a cold start.

5. Click **OK**. The new policy is displayed in the reserved instance policy list.

Figure 11-3 Policy list

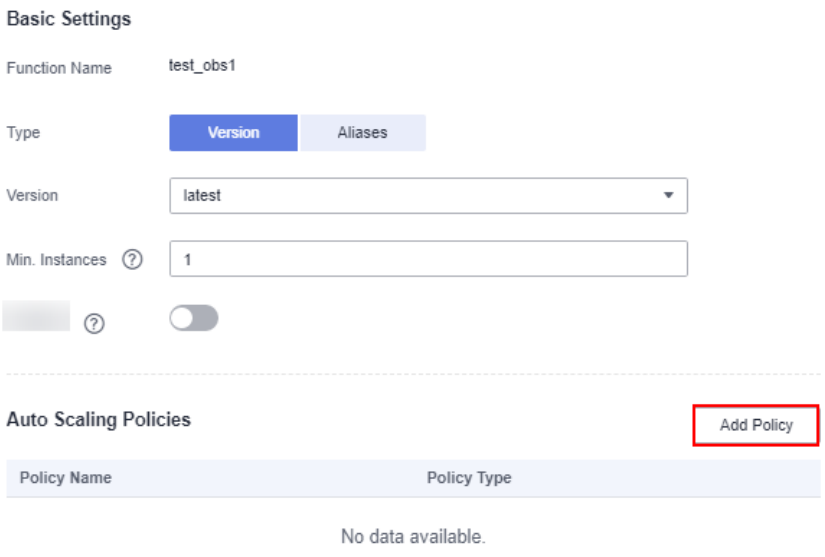


Configuring a Scheduled Scaling Policy

Configure the number of reserved instances that will run in a specified period and a cron expression. During this period, FunctionGraph adjusts the number of reserved instances based on the cron expression. When the period expires, the fixed number of instances will be reserved.

1. Configure the basic settings by referring to **Table 11-1**, and then click **Add Policy**.

Figure 11-4 Clicking Add Policy



2. Set parameters by referring to **Table 11-2**.

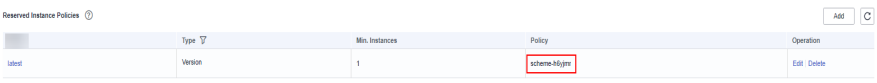
Figure 11-5 Adding a policy

Table 11-2 Scheduled scaling policy parameters

Parameter	Description
Policy Name	Policy name.
Cron Expression (UTC)	Set this parameter by referring to **Cron Expressions for a Function Timer Trigger**.
Validity	Local time when the cron expression is effective. The scheduled scaling policy is effective only during this validity period. In other time, the **Min. Instances** in the basic settings is used.
Min. Instances	The number of reserved instances to be created when the policy is effective. Set a number that meets your service requirements. **NOTE** The number must be greater than or equal to the **Min. Instances** in the basic settings.

3. Click **OK**. The new policy is displayed in the reserved instance policy list.

Figure 11-6 Policy list



4. To modify the reserved instance policy, click **Edit** in the **Operation** column. Then modify or add scheduled scaling policies.
5. To delete a reserved instance policy under a function version or alias, click **Delete** in the **Operation** column.
6. To view concurrent instances, click a quantifier in the reserved instance policy list, and click a scheduled scaling policy name.

NOTE

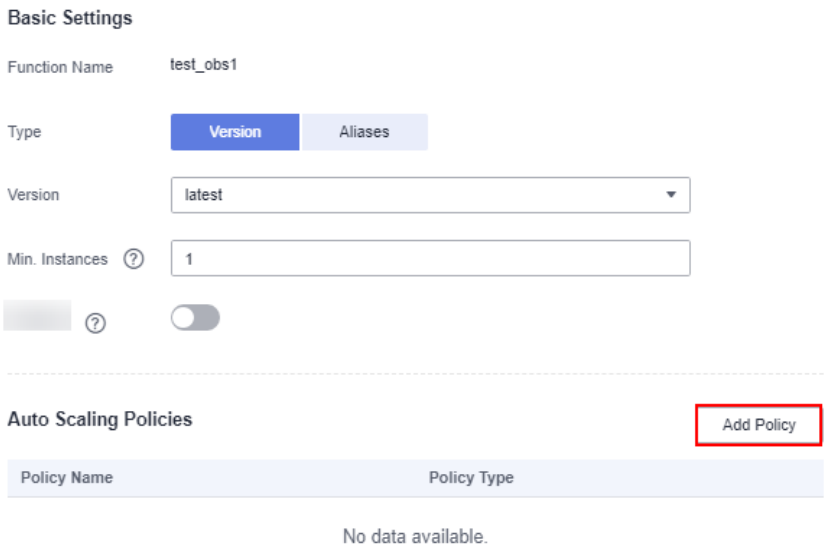
Multiple scheduled policies can be configured. For example, the number of reserved instances at 08:00 and 21:00 is updated to 100 and 10 respectively.

Configuring a Metric Scaling Policy

You can dynamically adjust the number of reserved instances based on service metrics (currently, only the number of concurrent users is supported). When configuring metric policies, you need to configure an agency that has permission to query AOM metrics and query and configure functions.

Step 1 Configure the basic settings by referring to **Table 11-1**, and then click **Add Policy**.

Figure 11-7 Adding a policy



Step 2 Set parameters by referring to **Table 11-3**.

Figure 11-8 Configuring a metric policy

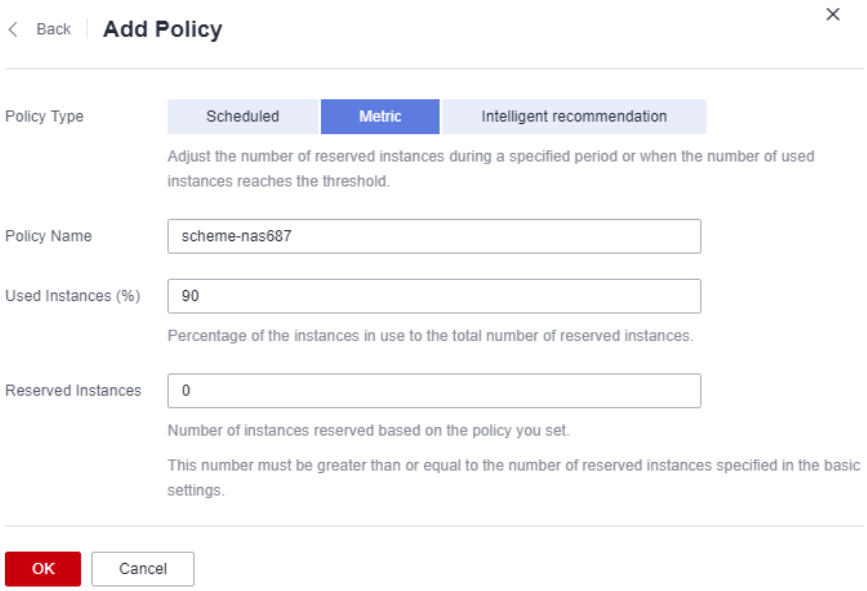


Table 11-3 Metric policy parameters

Parameter	Description
Policy Name	Policy name.
Used Instances (%)	The value ranges from 1 to 99, that is, the percentage of actually used reserved instances to the total number of reserved instances of the function. If the actual value is higher than the threshold, FunctionGraph gradually reduces the number of reserved instances. If the actual value is lower than the threshold, FunctionGraph directly creates the corresponding number of reserved instances every minute. (The metric is also generated every minute. Therefore, the adjustment will be delayed for 1 to 2 minutes.)
Reserved Instances	The number of reserved instances to be created when the threshold is not reached. It specifies the latest number of reserved instances based on the metric policy. For example, if only one reserved instance needs to be created based on the policy and the minimum number of reserved instances is set to **5**, five reserved instances will be created. **NOTE** The number must be greater than or equal to the **Min. Instances** in the basic settings.

Table 11-4 Configuring agency permissions

Service	Common Permission	Fine-Grained Permission
FunctionGraph	FunctionGraph ReadOnlyAccess	functiongraph:function:getConfig

Step 3 Click **OK**. The new policy is displayed in the reserved instance policy list.

Figure 11-9 Policy list

Step 4 To modify the reserved instance policy, click **Edit** in the **Operation** column. Then modify or add scheduled scaling policies.

Step 5 To delete a reserved instance policy under a function version or alias, click **Delete** in the **Operation** column.

Step 6 To view concurrent instances, click a quantifier in the reserved instance policy list, and click a scheduled scaling policy name.

NOTE

Scheduled policies and metric policies can be added together. When both policies are added, the minimum number of reserved instances for one of the policy types cannot be less than the latest number of reserved instances for the other policy type. For example, at 08:59, 9 reserved instances are updated by the metric policy, and 5 instances are configured for a scheduled policy at 10:00. Therefore, 9 reserved instances are updated at 10:00. If the next scheduled policy takes effect at 11:00, at least 5 reserved instances will be updated during10:00 and 11:00.

----End

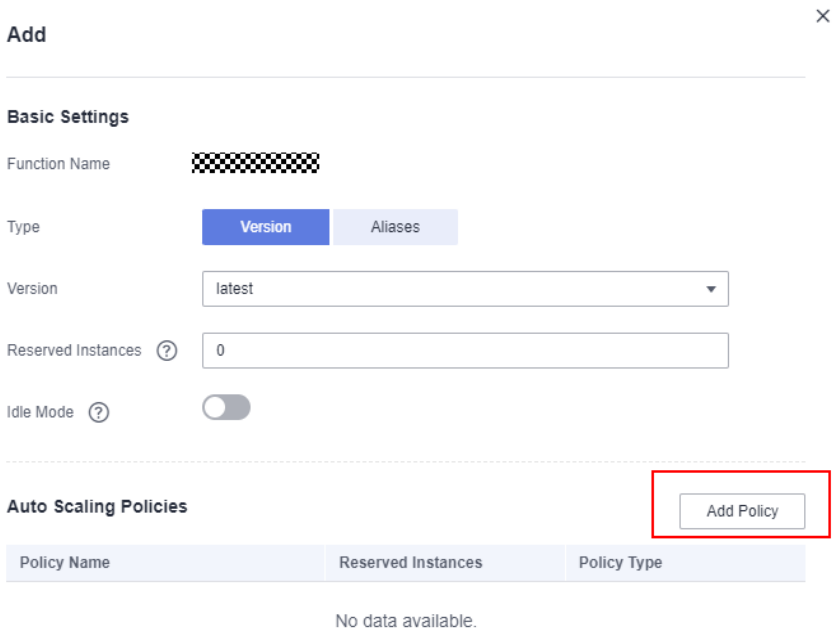
Configuring an Intelligent Recommendation Policy

Intelligent recommendation policies are based on feature profiling and load prediction technologies, dynamically adjusting reserved instances for peak and off-peak demands.

Intelligent recommendation policies are available in three options: high performance, balance, and low cost. The system dynamically adjusts the number of reserved instances based on load prediction to adapt to the peak and off-peak loads. The cost and performance of reserved instances are displayed. (Intelligent recommendation policies cannot coexist with other types of policies. A function version or alias can have only one such policy.)

1. Click **Add Policy**, as shown in the following figure.

Figure 11-10 Clicking Add Policy



2. Select **Intelligent recommendation**, and select any of **High performance**, **Balance**, and **Low cost** while referring to the performance and cost trends.

Figure 11-11 Intelligent recommendation

3. Click **OK**. The new policy is displayed in the reserved instance policy list.

Figure 11-12 Reserved Instance Policies

4. To view and modify a reserved instance policy, click **Edit** in the **Operation** column.
5. To delete a reserved instance policy under a function version or alias, click **Delete** in the **Operation** column.
6. Reserved instances are executed with the intelligent recommendation policy. To view the reserved instance costs and performance, click a quantifier in the policy list, and click a policy name.

12 Flow Management

12.1 Flow Overview

Flows are distributed serverless applications. Visually orchestrate multiple independent serverless functions into an application in sequential, branch, or parallel mode using Low Code technology. In addition, diagnose and debug your applications through a monitoring and management platform.

This section describes flow components, component orchestration rules, expression operators, and configuration examples.

Components

There are multiple types of components. Drag, drop, configure, and connect components to visually orchestrate flows. Before using flows, understand the components described in **Table 12-1**.

Table 12-1 Components

Category	Name	Description
Components	Function	FunctionGraph functions. For details, see **Creating a Function**.
	EG	EventGrid (EG) publishes events to a specified channel. For details about how to create resources, see the EG documentation.
Processors	Callback	Similar to manual review, this node blocks a function flow by conditions until the callback API is called to resume the flow.
	Subflow	A flow can be incorporated into another one as its subflow.

Category	Name	Description
	Parallel branch	A flow can have multiple parallel branches, which will be executed at the same time. You can determine the next step of each branch.
	Start	Start of a flow. A start node only has triggers, and each flow has one start node.
	Error handling	Determines the next step in case of an execution failure.
	Loop	Cyclically processes each element in an array. All subflows in a loop are executed each time.
	Wait	Determines when the next step will be executed after the previous step is finished.
	Service	Abstracts complex operations involving multiple functions and combines these functions into an atomic node for easy management.
	Conditional branch	Determines whether to execute the next branch based on specified conditions.
	Stop	Indicates the end of a flow.

Orchestration Rules

- A flow must be a directed acyclic graph (DAG). It has a start node followed only by one node (except the error handling and stop nodes) and ends after another node. You can end a flow in the following ways:
  a. Do not connect any conditional, parallel, or start node to the last node of the flow.
  b. Add a stop node as the last node of the flow.
- Component design rules

Table 12-2 Trigger, function, and EG

Type	Description	Mandatory
Trigger	• A flow can have a maximum of 10 triggers. • Triggers must be included in the start node. • Triggers cannot be connected to any other node.	No

Type	Description	Mandatory
Function	• A flow can have a maximum of 99 functions. • A function connected to an error handling node can be connected to another node that is not start or error handling. • A function that is not connected to an error handling node can be connected to only one non-start node.	No
EG	• A flow can have a maximum of 10 EG nodes. • An EG node connected to an error handling node can only be connected to another node that is not start or error handling. • An EG node that is not connected to an error handling node can be connected to only one non-start node.	No

Table 12-3 Processors

Type	Description	Mandatory
Callback	For details about the constraints of callback nodes, see the function parameter in **Table 12-2**. Callback nodes cannot be subnodes of a service node.	No
Subflow	A flow.	No
Parallel branch	• Indicates that the connected branches will be executed concurrently. • A parallel branch connects 1 to 20 nodes that are not error handling, start, or stop.	No
Start	• Indicates the start of a flow. Each flow has only one start node. • The start node must be followed by a node that is not stop or error handling.	Yes

Type	Description	Mandatory
Error handling	Can be connected to a maximum of 10 nodes that are not start, stop, or error handling.	No
Loop	Cyclically processes each element in an array. All subflows in a loop are executed each time. The subflows in a loop must satisfy the following rules: 1. Start with a function or wait node. 2. Only include function, wait, and error handling nodes.	No
Wait	Can be connected to zero or one node that is not start or error handling.	No
Service	Consists of multiple functions and can be connected to a stop node or an error handling node.	No
Conditional branch	Connects 2 to 20 nodes that are not start, stop, or error handling.	No
Stop	Not followed by any other node.	No

Expression Operators

The expression for an error handling or conditional branch node is in the format "[JsonPath] + [logical operator] + [value]". For example, **$.age >= 20**.

JsonPath Description

Operator	Supported	Description
$	Y	The root element to query. This starts all regular expressions.
@	Y	The current node being processed.
.	Y	Subnode.
[(,)]	Y	Array indexes.
[start:end]	Y	Array slice operator.
[?()]	Y	Filter expression, which must be evaluated to a Boolean value.

Examples

- Simple values: JSON data example

```
{
    "fruits": [ "apple", "orange", "pear" ],
    "vegetables": [{
    "veggieName": "potato",
    "veggieLike": true
     },
     {
         "veggieName": "broccoli",
         "veggieLike": false
     }]
}
```

  The **$.fruits** expression obtains all values under **fruits**.

  The result of **$.fruits** is **["apple","orange","pear"]**.

- Simple filtering: JSON data example

```
{
     "fruits": [ "apple", "orange", "pear" ],
     "vegetables": [{
     "veggieName": "potato",
     "veggieLike": true
     },
     {
         "veggieName": "broccoli",
         "veggieLike": false
     }]
}
```

  Expression: **$.vegetables[?(@.veggieLike == true)].veggieName**

  Meaning: Obtains all values of the key **vegetables** and outputs the value of **veggieName** whose **veggieLike** is **True**.

```
Result: [potato]
```

Logical Operators

The following data is used as input parameters in the examples:

```
{
  "name" : "apple",
  "weight": 13.4,
  "type": [3,4,6,8],
  "obj": {
        "a" : 1
   }
}
```

These are the supported operators.

Operator	Description	Example	Return Value	Remarks
==	Equal to	$.name == 'apple'	true	Supported data types: int, float, string, bool, and nil

Operator	Description	Example	Return Value	Remarks
!=	Not equal to	$.name != 'apple'	false	Supported data types: int, float, string, bool, and nil
<	Less than	$.weight < 12	false	Only numbers supported
>	Greater than	$.weight > 12	true	Only numbers supported
<=	Less than or equal to	$.weight <= 13.4	true	Only numbers supported
>=	Greater than or equal to	$.weight >= 13.4	true	Only numbers supported
'*'	Wildcard	$.weight == '*'	true	Must be used together with ==.
||	Or	$.name == 'apple' || $.weight < 12	true	Used together with () for complex AND/OR logic.
&&	And	$.name == 'apple' && $.weight < 12	false	Used together with () for complex AND/OR logic.

NOTE

- A string constant must be enclosed with quotation marks (''). For example, **'apple'**.
- JsonPath expressions cannot contain =, !=, <, >, |, or &.

Configuration Examples

Example 1: Parallel branch

1. Create three Python 3.9 functions with the following code:
   - Function 1: Returning the value of the event input

     ```
     import json
     def handler (event, context):
         input = event.get('input',0)
         return {
             "result": input
             }
     ```

   - Function 2: Returning the value of the event input plus 2

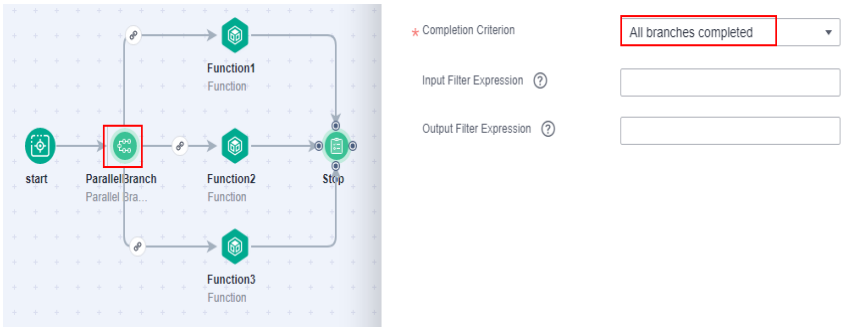

```
import json
def handler (event, context):
    input = event.get('input',0)
    return {
        "result": input+2
        }
```

- Function 3: Returning the square value of the event input

```
import json
def handler (event, context):
    input = event.get('input',0)
    return {
        "result": input*input
        }
```

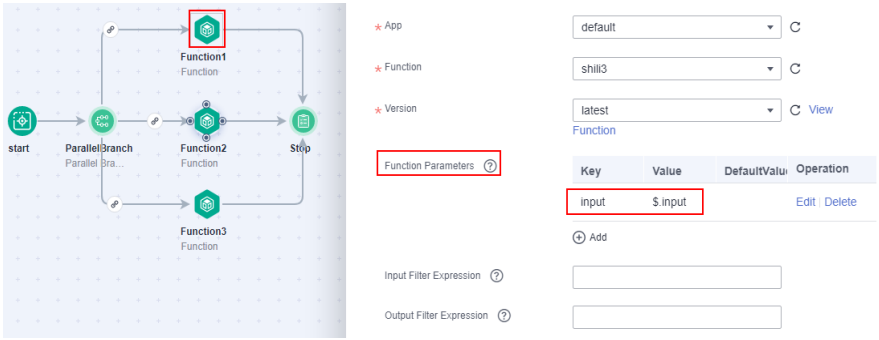
2. Add components to a flow by drag and drop and configure a parallel branch node according to the following figure.

Figure 12-1 Configuring a parallel branch node



3. Configure three function nodes by referring to **Table 12-2**.

Figure 12-2 Configuring function nodes

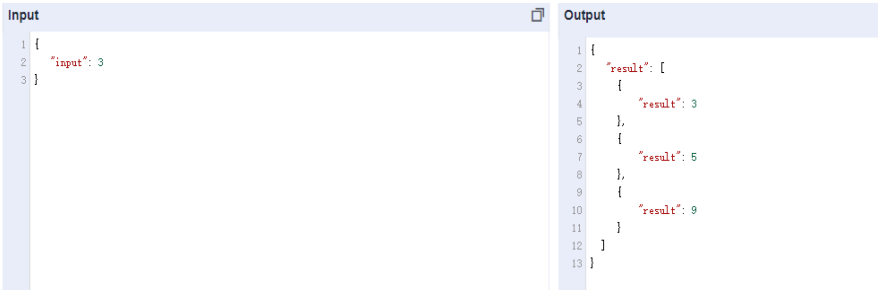


4. Save the flow. Then start execution with the following input:

```
{
  "input":3
}
```

5. Click the flow to view the execution result.

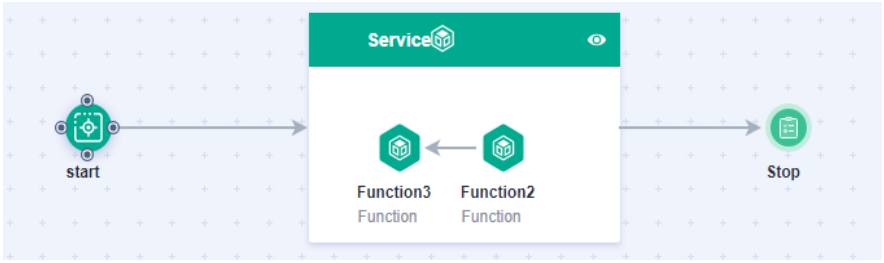
Figure 12-3 Execution result



Example 2: Service node in serial mode

1. Orchestrate components by drag and drop, and set the execution mode of the service node to **Serial**.

Figure 12-4 Configuring a service node



2. Add **function 2** and **function 3** to the service node and configure them according to the following figures.

Figure 12-5 Configuring function node 2

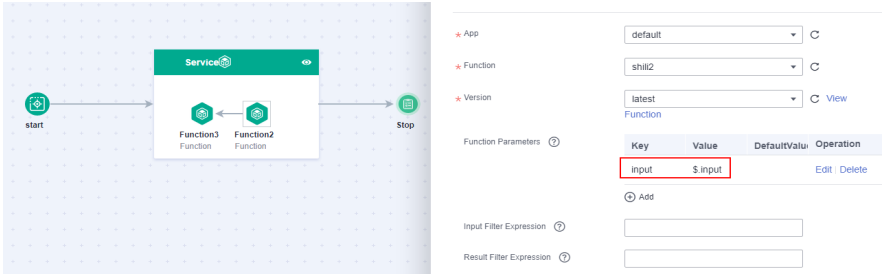
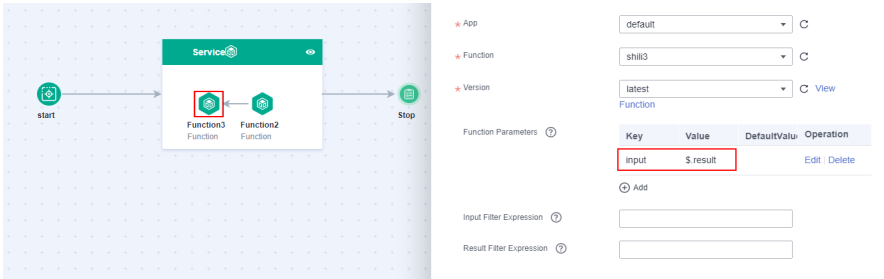


Figure 12-6 Configuring function node 3

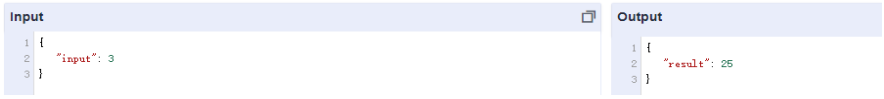


3. Save the flow. Then start execution with the following input:

```
{
  "input":3
}
```


4. Click the flow to view the execution result.

Figure 12-7 Execution result



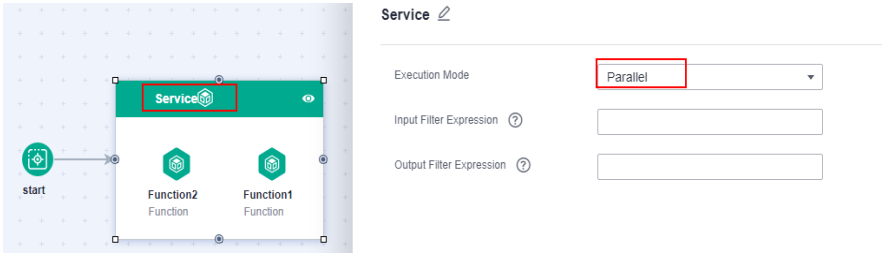
Example 3: Service node in parallel mode

1. Create two Python 3.9 functions with the following code:

```
import json
def handler (event, context):
    print(event)
    return {"result":"success"}
```

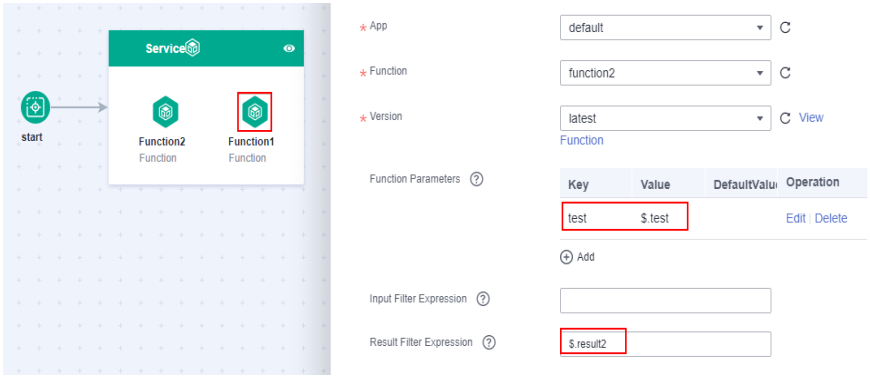
2. Add components to a flow by drag and drop and configure a service node according to the following figure.

Figure 12-8 Configuring a service node



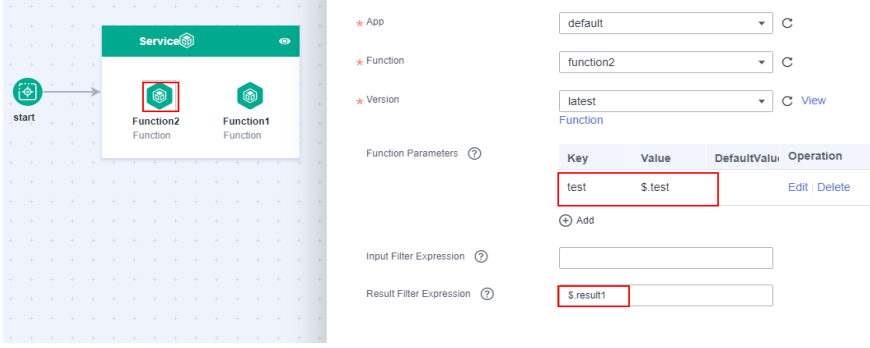
3. Configure function node 1.

Figure 12-9 Configuring function node 1



4. Configure function node 2.

Figure 12-10 Configuring function node 2



5. Save the flow. Then start execution with the following input:

```
{
  "test":123
}
```

6. Click the flow to view the execution result. Results of the two functions have been combined.

Figure 12-11 Execution result

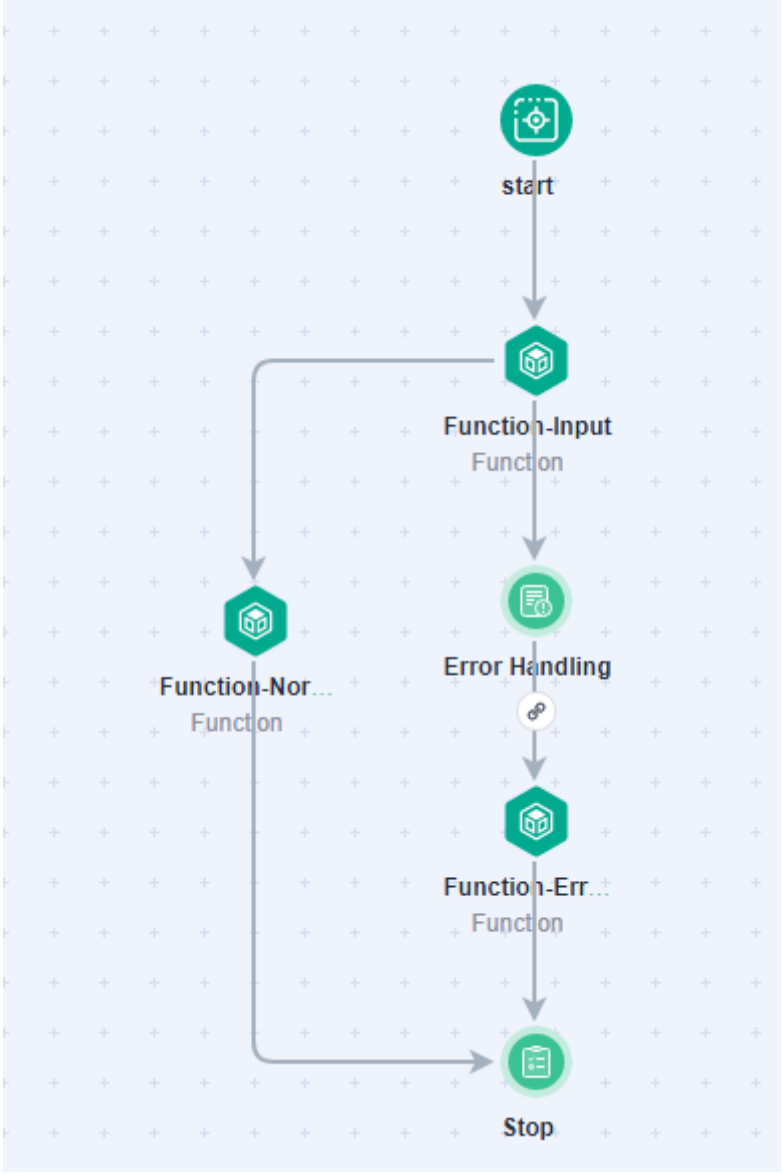
NOTE

If the result structures of the two functions are the same, only one result will be returned.

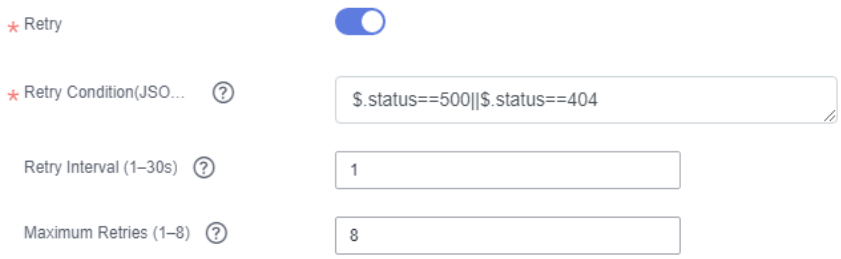
Example 4: Error handling

An error handling node determines whether to retry when the function it follows fails. There are two types of function failures: execution error and internal service error with an error code (**200**: success; **500** and **404**: failure).

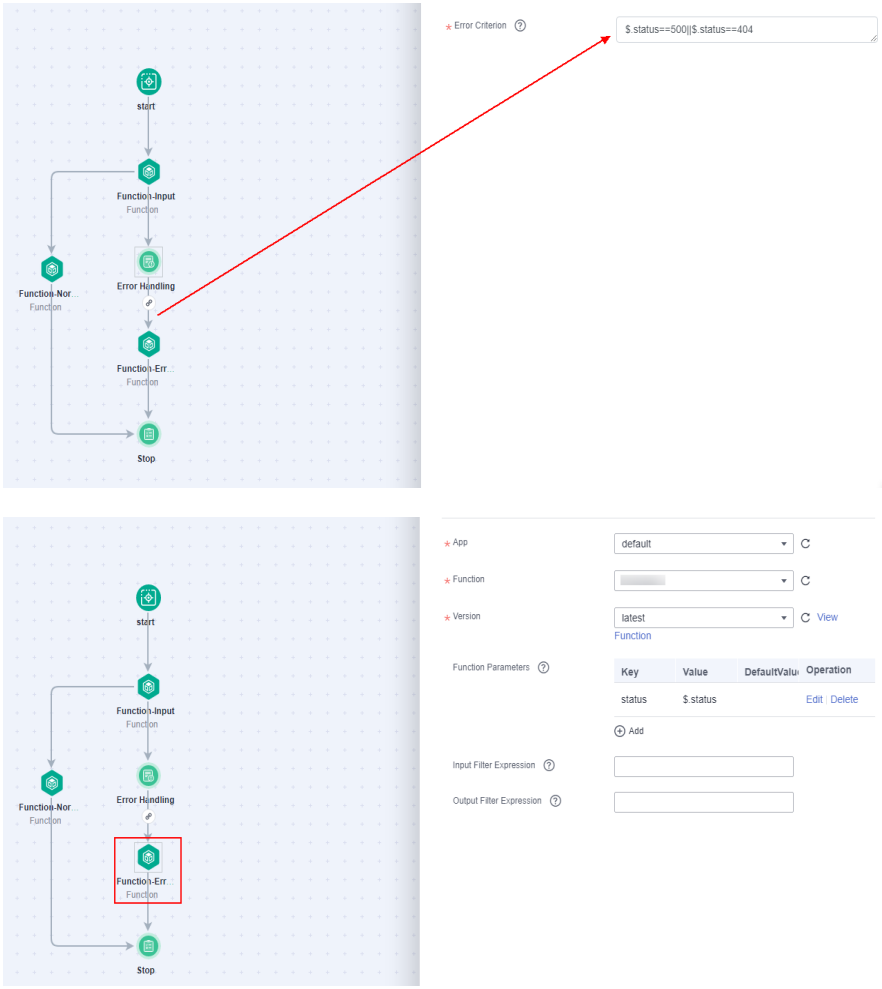
1. Add components to a flow by drag and drop and configure the following nodes:
   - **Function-Input**: Obtains the value of **input** from **event** and outputs it for **status**.
   - **ErrorHandling**: Retries the function when its status is **500** or **404**. This node retries for a maximum of eight times at an interval of 1s.
   - **Function-ErrorRecord**: Records an error if the status of the previous function is still **500** or **404** after eight retries.
   - **Function-NormalOutput**: Executed if the status of **Function-Input** is not **500** or **404**.



2. Configure the **Error Handling** node with retry condition **$.status==500|| $.status==404**.



3. Configure the **Function-ErrorRecord** node to be executed when all retries fail.

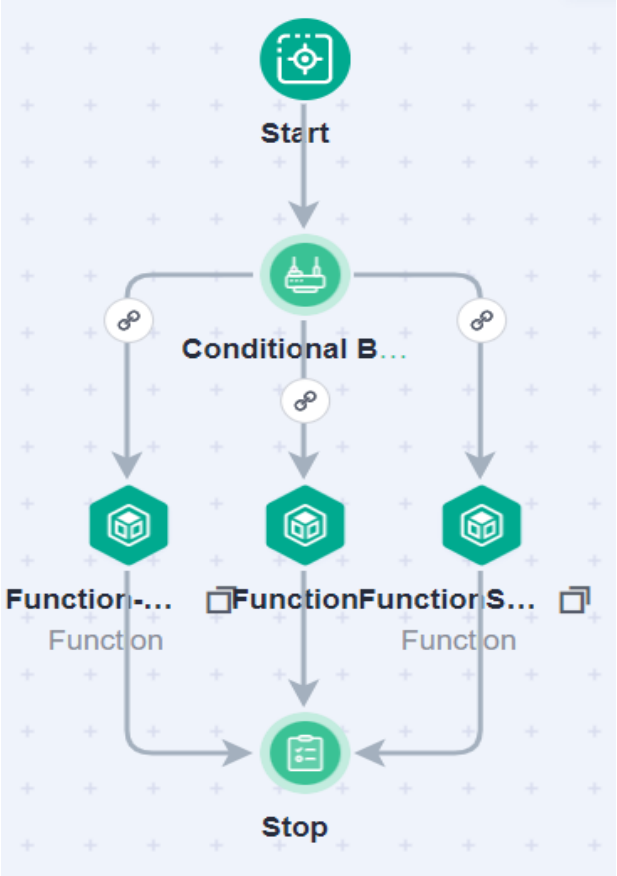


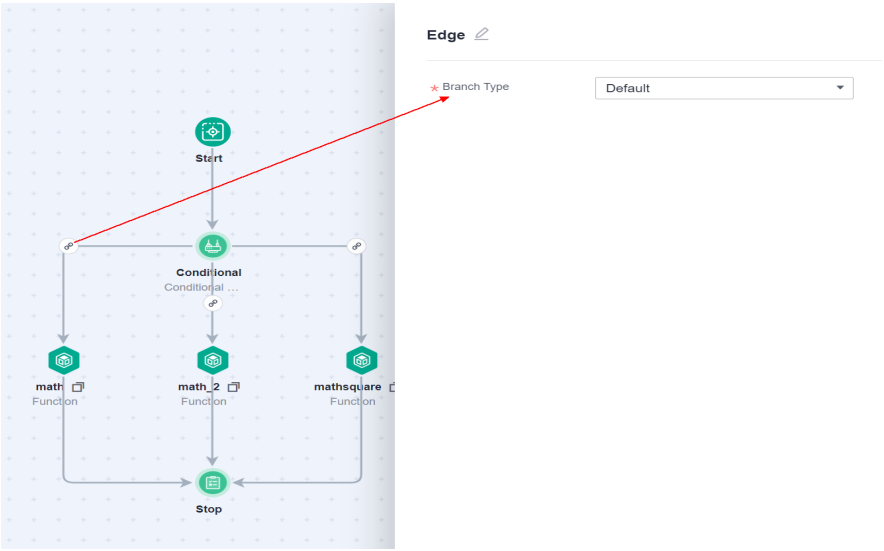
4. Enter **200**. The execution is successful.

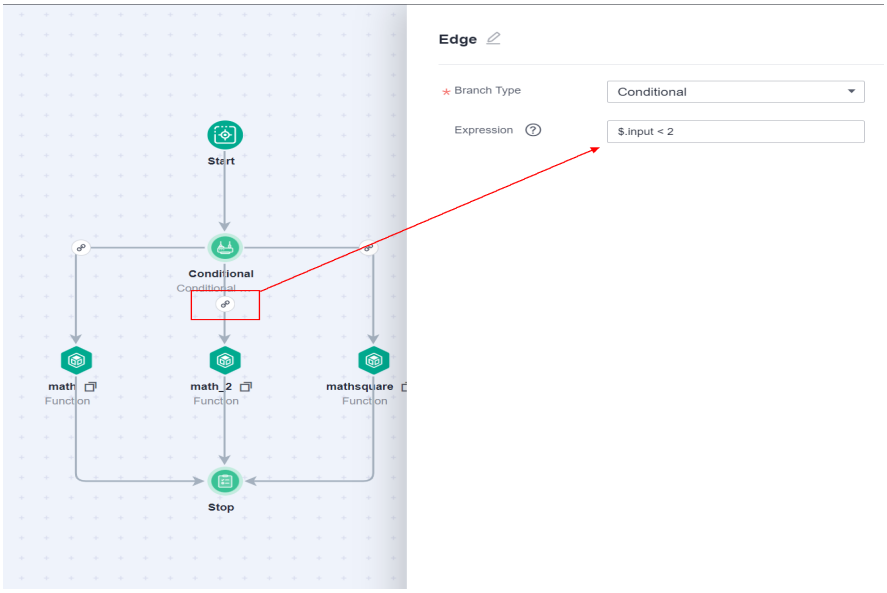
5. Enter **500**. The input function retries and an error is recorded.

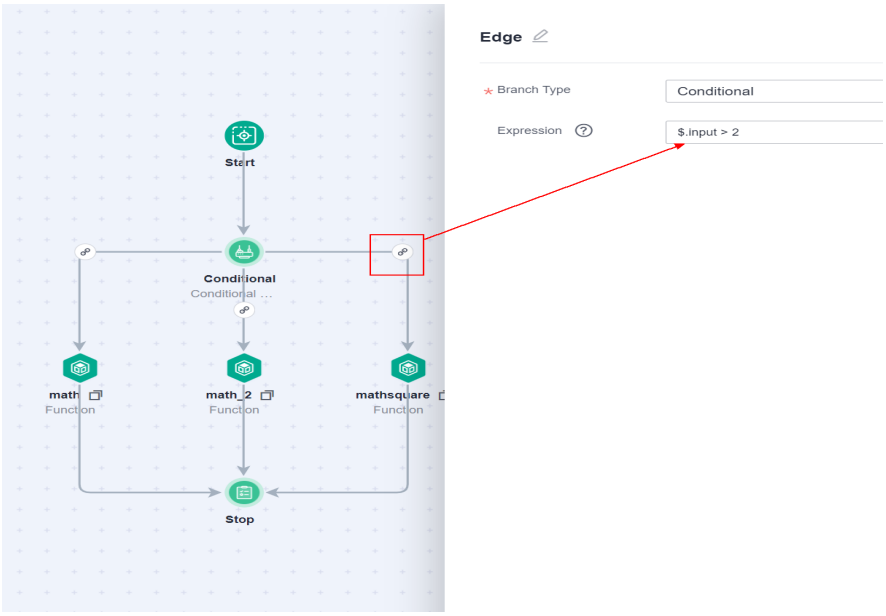
Example 5: Conditional branch

– Use the conditional branch to implement the following logic:
  Input value < 2: **result** is the input value plus 2.
  Input value > 2: **result** is 2 times the input value.
  Input value = 2: **result** is 2.
  The flow design is as follows:





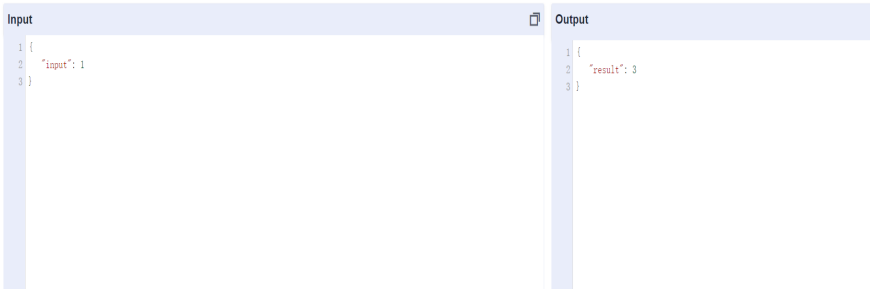




Input **3** to output the square of 3.

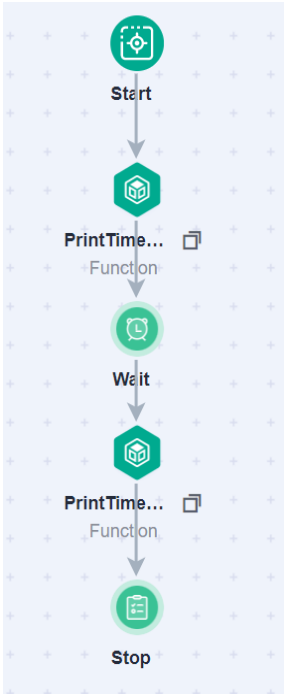
- Input **2** to output 2.

Input **1** to output 1 plus 2.

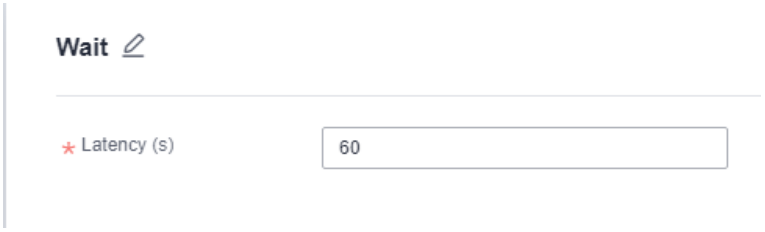


Example 6: Wait node

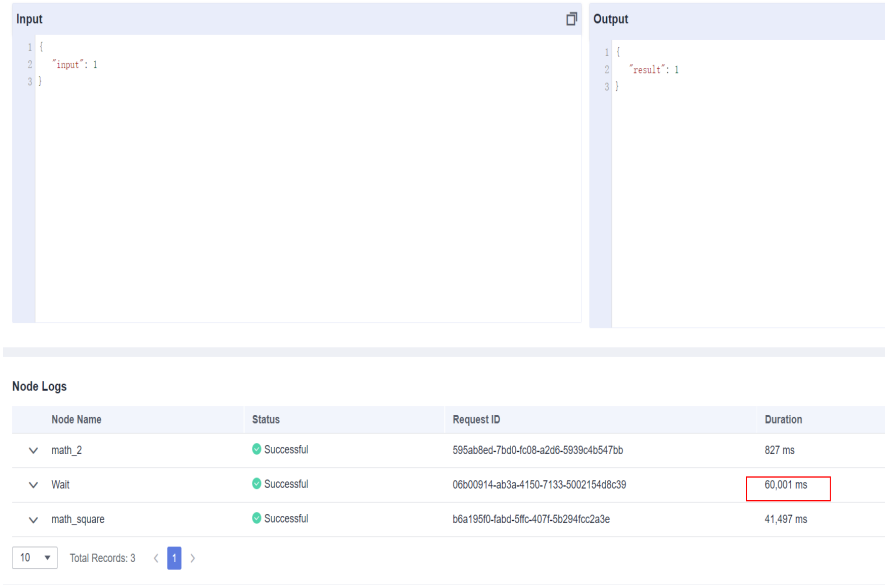
- Use the wait node to delay function invocation. The flow design is shown in the following figure.



- Set **Latency (s)** to **60**.



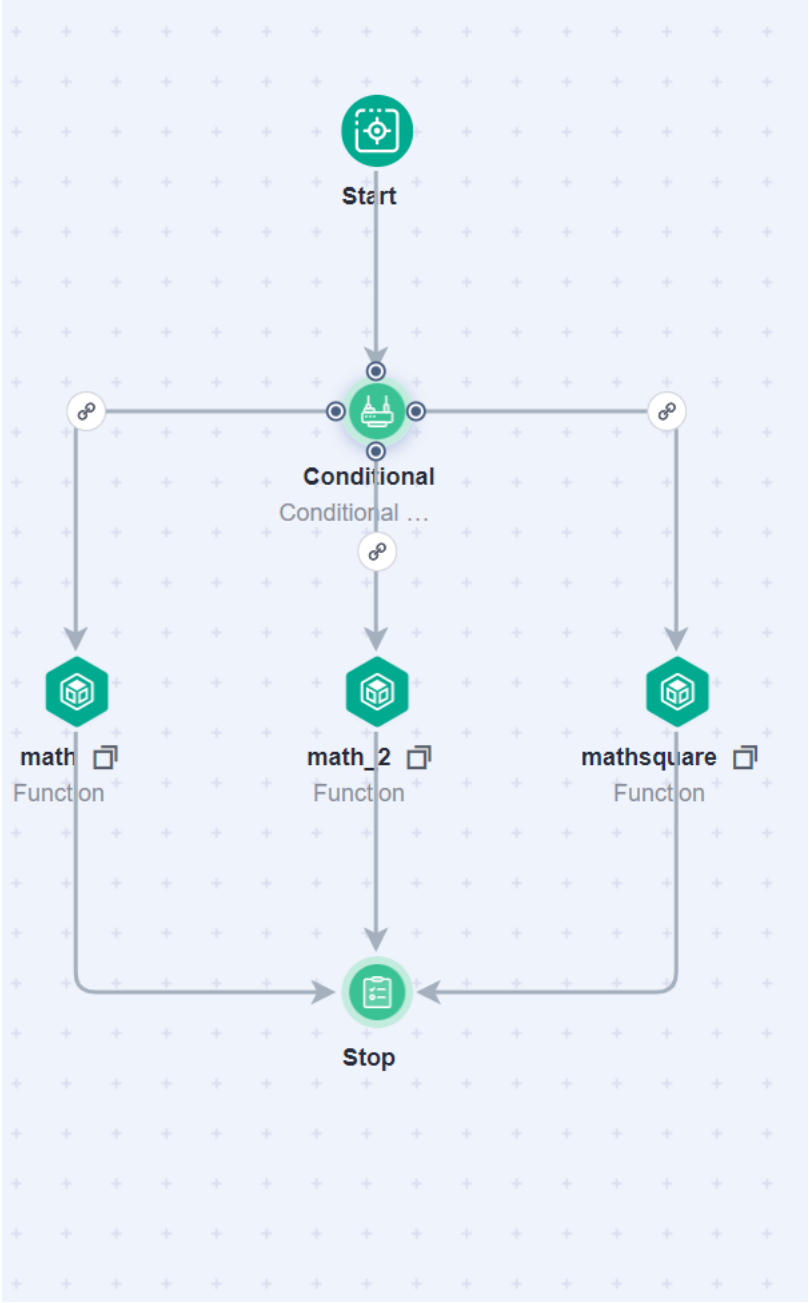
– View the execution result.

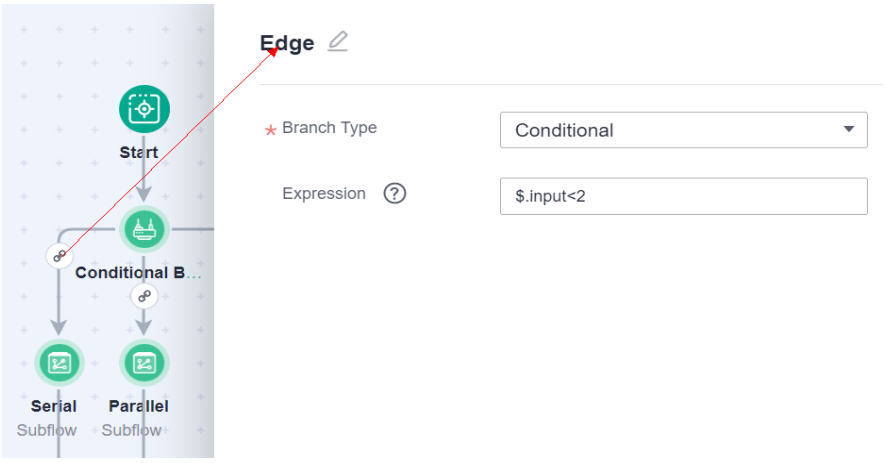


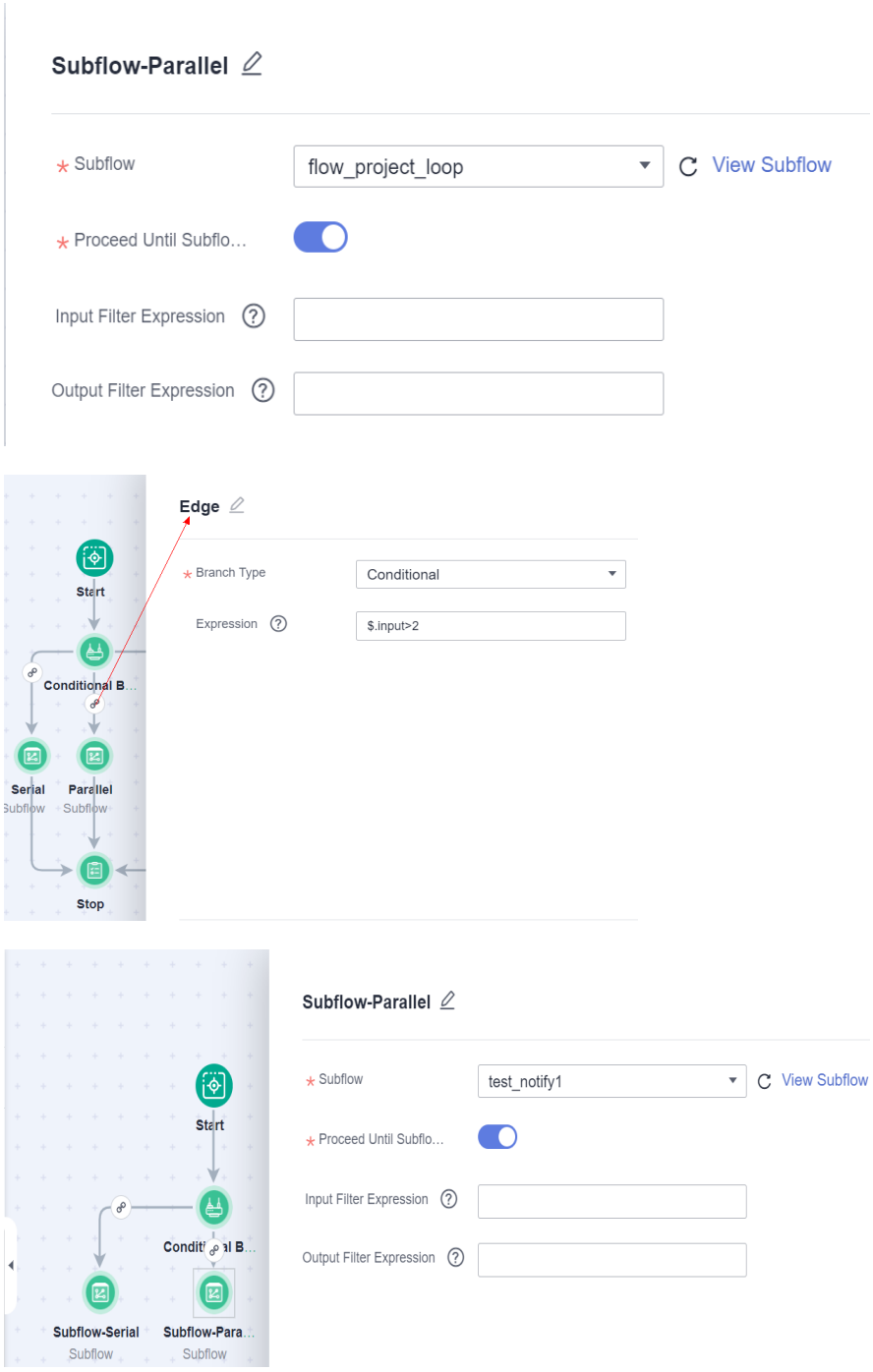
Example 7: Subflow

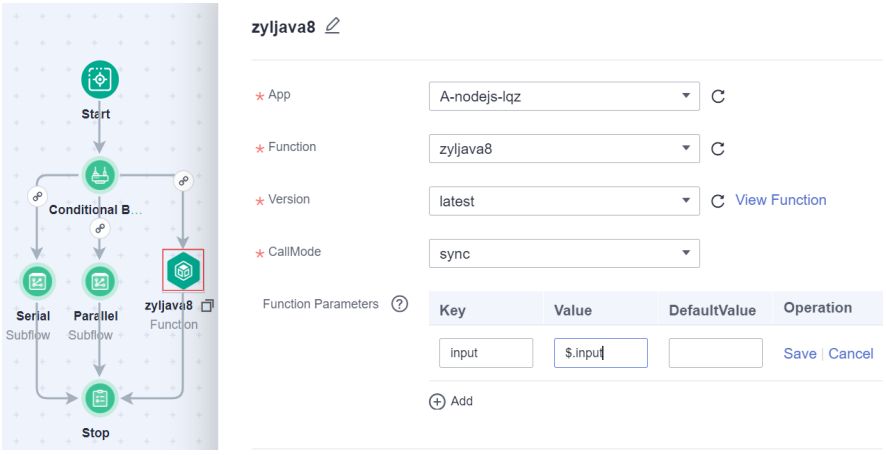
Multiple function flows can be combined as a new flow and reused to avoid repeated development.

- Design a function flow. **input** < 2: Execute the subflows in serial mode to output the input value plus 2 and then squared; **input** = 2: Execute the default branch to output the input value; **input** > 2: Execute the subflows in parallel mode to output the input value, the input value plus 2, and the square of the input value.









- Input **3** to execute the subflows in parallel mode and output the following result.

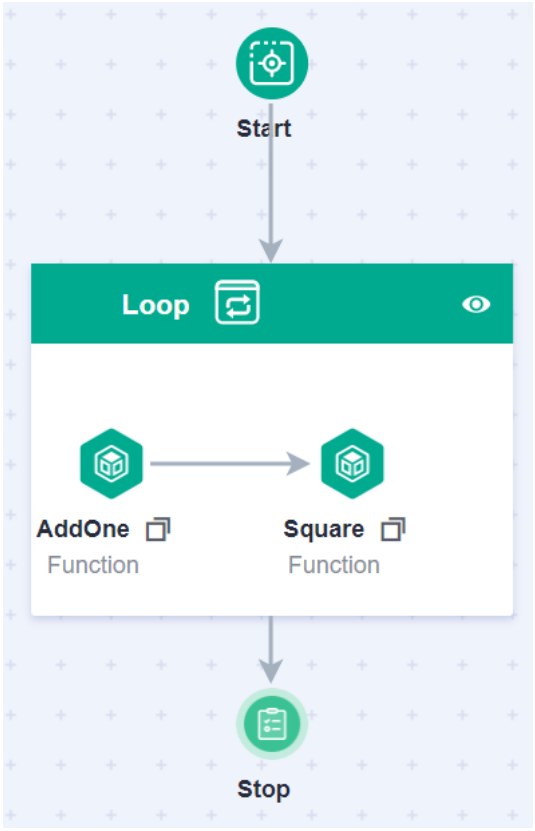
- Input **1** to execute the subflows in serial mode and output the following result.

- Input **2** to execute the default branch and output the input value, that is, **2**.

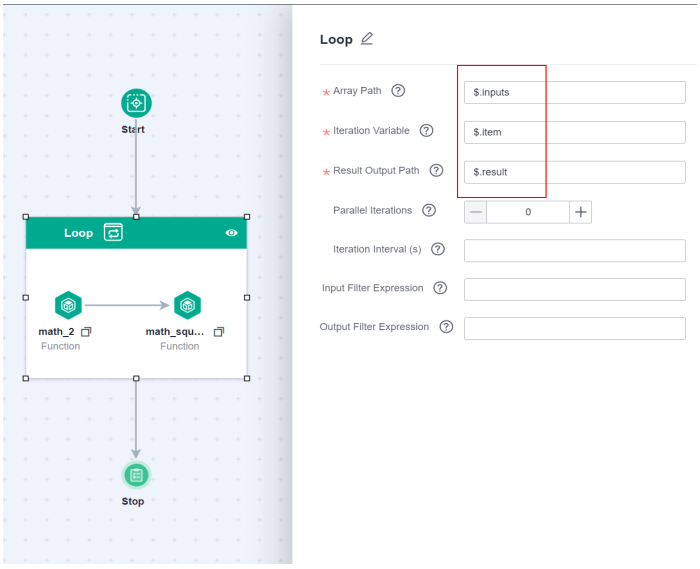
Example 8: Loop node

Use the loop node to cyclically process each element in an input array. All subflows in a loop are executed each time.

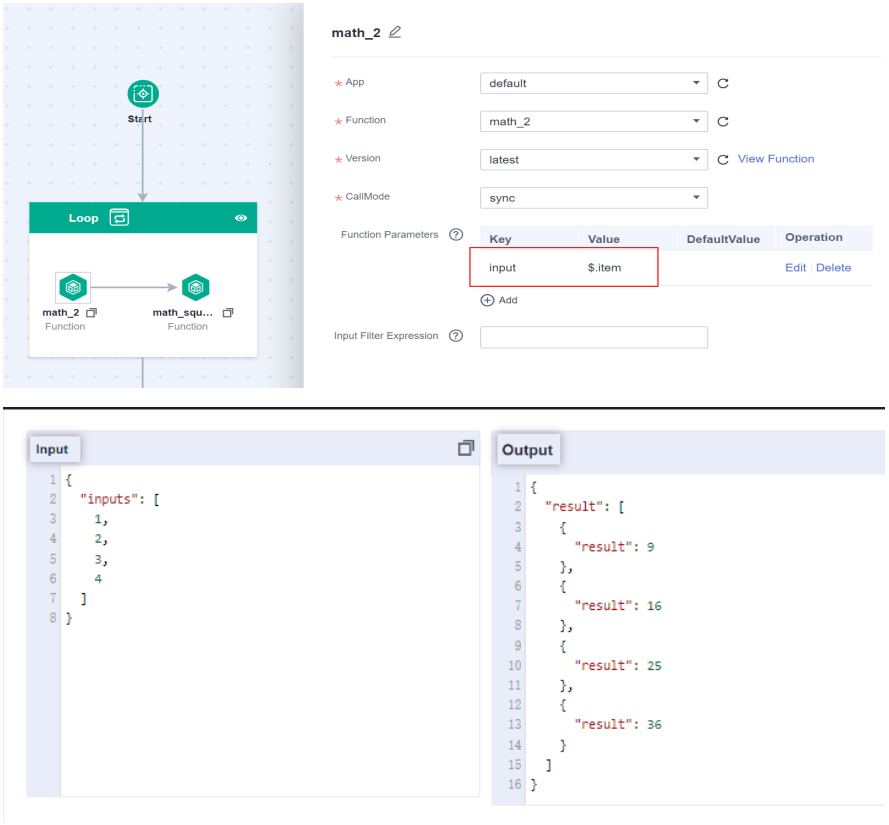
- Design a function flow with a loop node. The node cyclically adds **2** to each element in an integer array and then squares the sum. The flow is shown in the following figure.



- Set **Array Path** to **$.inputs** and **Iteration Variable** to **$.item**.



- Configure function **math_2** to output a result that is the input value plus 2. Ensure that the parameter value in **Function Parameters** is the same as the iteration variable in the loop node.



12.2 Creating a Flow

This section describes how to create and orchestrate a flow. You can create a standard or express flow for your service requirements.

- Standard flow: better for common services that take a long time to execute. Standard flows can only be invoked asynchronously, and their execution records are persisted for query.
- Express flow: better for services that take less than 5 minutes to execute and require ultimate performance. Express flows can be invoked synchronously or asynchronously, but their execution records (such as execution node history) are not persisted. The synchronous execution interface returns results, and the execution logs reported to LTS are displayed on the logs page.

NOTE

Express flows are available for free trial as a time-limited offer.

Prerequisites

- You have created a function. For details, see **Creating a Function from Scratch**.
- You have understood the **components**, **orchestration rules**, and **expression operators**.

Procedure

Step 1 Log in to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Function Flows** page, click **Create** next to **Standard Flow** or **Express Flow**.

NOTE

Function flows created on OBS DWR cannot be edited or deleted on the FunctionGraph console. If you need to do so, go to OBS DWR.

Step 3 Orchestrate a flow for your application.

1. Orchestrate the flow by dragging components.

   Take the flow in **Figure 12-12** as an example. Drag a start node, function, and stop node to the edit box, and connect them using lines.

   Figure 12-12 Orchestrating a flow

2. Click the function node to edit it. For details about the function parameters, see **Table 12-4**. Parameters marked with an asterisk (*) are mandatory.

   NOTE

   For the function node, select **function 2**, and configure this node by referring to **Figure 12-13**. The result will be the value of the event input plus 2.

   Figure 12-13 Configuring a function node

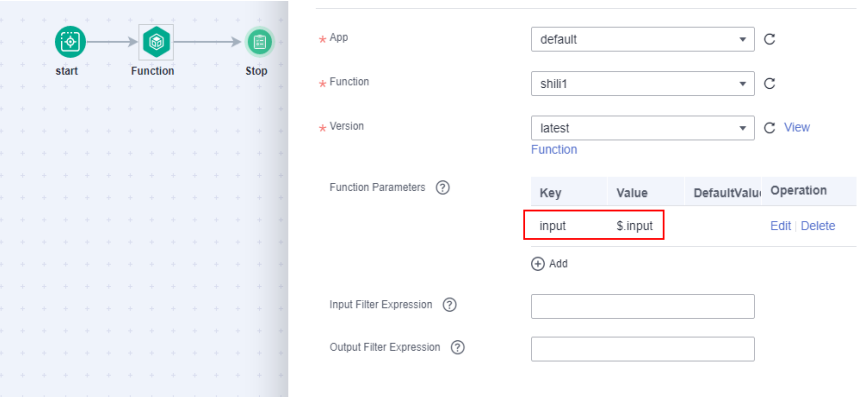
   

Table 12-4 Function parameters

Parameter	Description
* App	App to which the desired function belongs. You can create multiple functions under an app.

Parameter	Description
* Function	Function you want to use. **NOTE** – The data returned by the configured function must be in JSON format. Otherwise, it cannot be parsed. – Go functions can return stream data. To enable this feature, choose **Configuration** > **Advanced Settings** on the function details page, and select **Streaming Response**.
* Version	Function version you want to use.
* CallMode	By default, function nodes in a flow are invoked synchronously. **NOTE** – Synchronous invocation does not support long-term running functions and is max. 15 minutes. – Asynchronous invocation supports long-term running functions. The max. duration of a function node is the same as that supported by FunctionGraph.
Function Parameters	Parameters that will be passed in JSON format in the body. **Key**: parameter name **Value**: parameter value **DefaultValue**: used if no value is specified for the parameter **Operation**: Edit or delete the parameter.
Input Filter Expression	Selects part of the JSON output of the previous step to use it as the input of the current step.
Output Filter Expression	Selects part of the JSON output of the current step to pass it to the next step.

3. Click the EG node to edit it. For details about the EG parameters, see **Table 12-5**. Parameters marked with an asterisk (*) are mandatory.

   NOTE

   Before configuring an EG node, ensure that you have created an event source and channel on EG. For details, see **Figure 12-14**.

Figure 12-14 Configuring an EG node

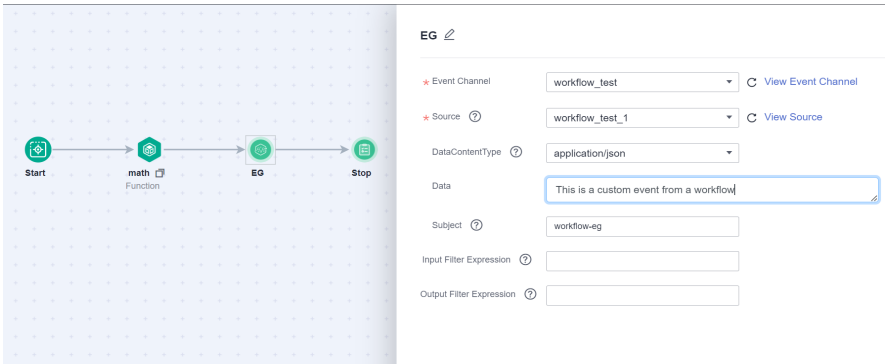


Table 12-5 EG node parameters

Parameter	Description
* Event Channel	Event channels receive events from event sources. Function flows support only custom event channels, which you create to receive events from custom sources. For details, see the event channel description in the EG documentation.
* Source	Event sources are applications that produce events. Function flows support only custom application event sources, which publish events to EG through a custom channel. For details, see the event source description in the EG documentation.
DataContentType	The format of **Data**, that is, event payload. **NOTE** Only **application/json** is supported.
Data	Event content.
Subject	A subject or object on which an event occurs.
Input Filter Expression	Selects part of the JSON output of the previous step to use it as the input of the current step.
Output Filter Expression	Selects part of the JSON output of the current step to pass it to the next step.

4. Configure processors by referring to **Table 12-6**. Parameters marked with an asterisk (*) are mandatory.

Table 12-6 Processor parameters

Category	Parameter	Description
Callback	* Callback timeout (min)	If no response is returned within the specified timeout, the node fails.
	* Callback Type	Type of the service node that can be called back by a function flow. **NOTE** Only function nodes are supported.
	* App	App to which the desired function belongs. You can create multiple functions under an app.
	* Function	Function you want to use. **NOTE** – The data returned by the configured function must be in JSON format. Otherwise, the data cannot be parsed. – Go functions can return stream data. To enable this feature, choose **Configuration** > **Advanced Settings** on the function details page, and select **Streaming Response**.
	* Version	Function version you want to use.
	* CallMode	By default, function nodes in a flow are invoked synchronously. **NOTE** – Synchronous invocation does not support long-term running functions and is max. 15 minutes. – Asynchronous invocation supports long-term running functions. The max. duration of a function node is the same as that supported by FunctionGraph.
	Function Parameters	Parameters that will be passed in JSON format in the body. **Key**: parameter name **Value**: parameter value **DefaultValue**: used if no value is specified for the parameter **Operation**: Edit or delete the parameter.
	Input Filter Expression	Selects part of the JSON output of the previous step to use it as the input of the current step.

Category	Parameter	Description
	Output Filter Expression	Selects part of the JSON output of the current step to pass it to the next step.
Subflow	Subflow	Select a flow.
	Proceed Until Subflow Completed	This option is enabled by default.
	Input Filter Expression	Selects part of the JSON output of the previous step to use it as the input of the current step.
	Output Filter Expression	Selects part of the JSON output of the current step to pass it to the next step.
Parallel Branch	* Completion Criterion	– **All branches completed**: suitable when there are two or more branches – **1 branch completed**: suitable when there is only one branch – **Set number of branches completed**: suitable for one of the two or more branches if possible
	Input Filter Expression	Selects part of the JSON output of the previous step to use it as the input of the current step.
	Output Filter Expression	Selects part of the JSON output of the current step to pass it to the next step.
	Set Branches	Set the number of branches that must be completed if you set **Completion Criterion** to **Set number of branches completed**.
	* Result Output Path	Path to which the result of this parallel branch will be output in the JSON format. The path is a key and the result is a value. If this parameter is not set, the default path is **result**.
Start	Triggers	Start of a flow. Each flow has only one start node. For details about how to create a trigger, see **Creating a Flow Trigger**.

Category	Parameter	Description
Error Handling	* Retry	Determines the next step in case of an execution failure. – **Retry Condition(JSONPath)**: Example: **$.status == 500** – **Retry Interval (1-30s)**: The default value is 1s. – **Maximum Retries (1-8)**: The default value is 3.
	* Retry Condition	A JSONPath expression. Result **true** indicates that an error is captured. The error handling node is executed then.
Loop	* Array Path	Path of the array variable to be traversed.
	* Iteration Variable	This variable will be replaced by the name of an element in the array during cyclic iteration.
	* Result Output Path	Output path of the result array for all iteration branches.
	Parallel Iterations	Number of iteration branches to be run concurrently. Value range: 0–100. **0** indicates unlimited.
	Iteration Interval (s)	Interval between parallel iterations.
	Input Filter Expression	Selects part of the JSON output of the previous step to use it as the input of the current step.
	Output Filter Expression	Selects part of the JSON output of the current step to pass it to the next step.
Wait	* Latency (s)	Default value: 1000s
Service	Execution Mode	Way that functions in this node will be executed. – **Serial**: Functions will be executed in the order they are connected. – **Parallel**: Functions will be executed concurrently.
	Input Filter Expression	JSONPath expression used to filter the input information of the node.
	Output Filter Expression	JSONPath expression used to filter the output information of the node.

Category	Parameter	Description
Conditional Branch	* Branch Type	– Conditional – Default If there is a conditional branch, a default branch is required.
	Expression	JSONPath expression required for a conditional branch. For details, see **Expression Operators**.
	Input Filter Expression	JSONPath expression used to filter the input information of the node.
	Output Filter Expression	JSONPath expression used to filter the output information of the node.
Stop	Stop	Not followed by any other node.

5. After configuring all nodes, click **Save** in the upper right corner.

   NOTE

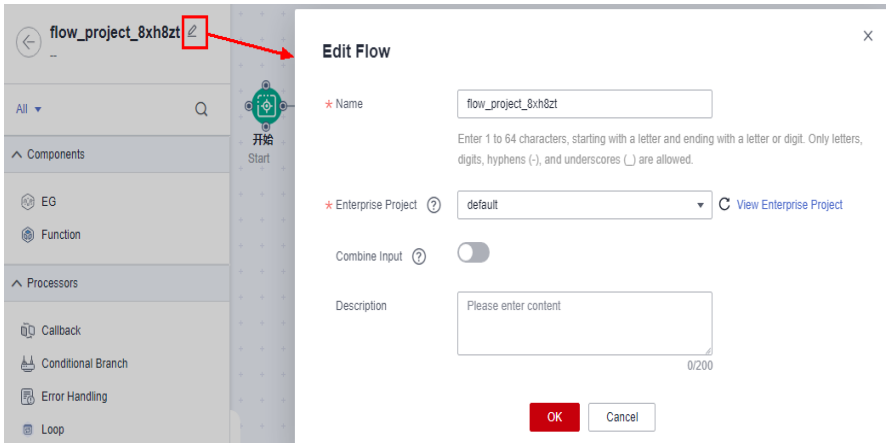
   If a node in the flow is modified, save the changes before starting the flow.

6. On the **Create Flow** page, click  on the right of the function flow name in the upper left corner, set parameters, and click **OK**.

Table 12-7 Configuration

Parameter	Description
* Name	Flow name.
* Enterprise Project	Select an enterprise project.
Combine Input	Whether to combine the previous node's output with the current node's input.
Description	Description about the flow.

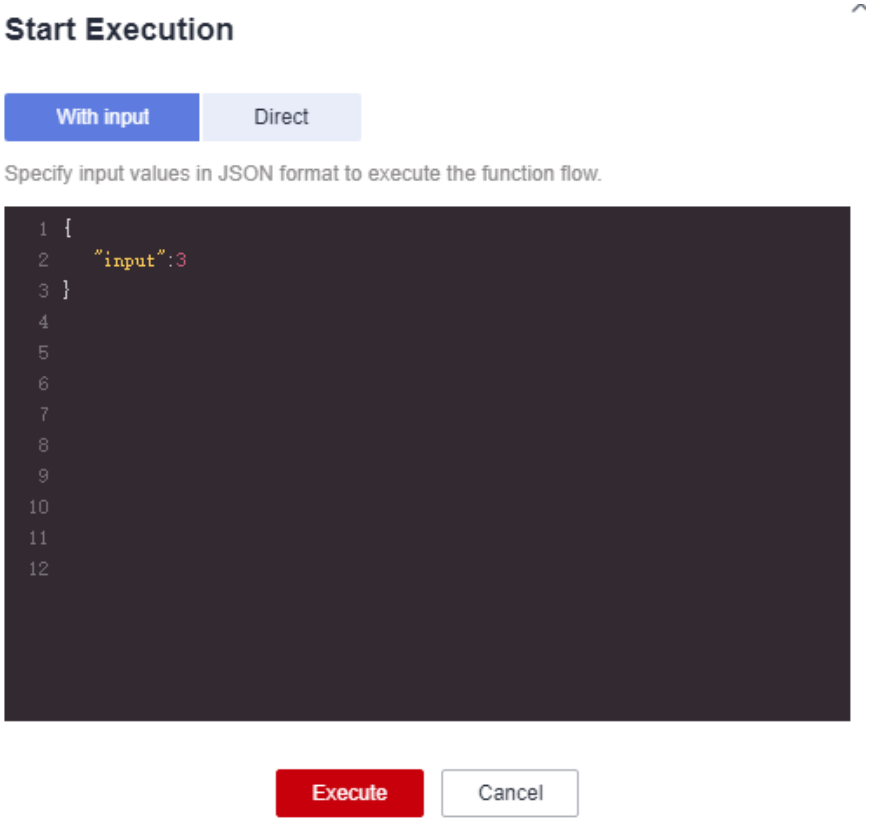
Figure 12-15 Editing a flow



7. Click **Start**. On the **Start Execution** page, specify input or start the flow directly. In this example, select **With input**.

```
{
  "input":3
}
```

Figure 12-16 Starting execution



NOTE

The input values must be in JSON format.

8. Click **Execute**. A message indicating that the flow is started successfully is displayed in the upper right corner.

9. Click the flow name to go to the details page and view the execution result.

----End

12.3 Managing Flow Executions

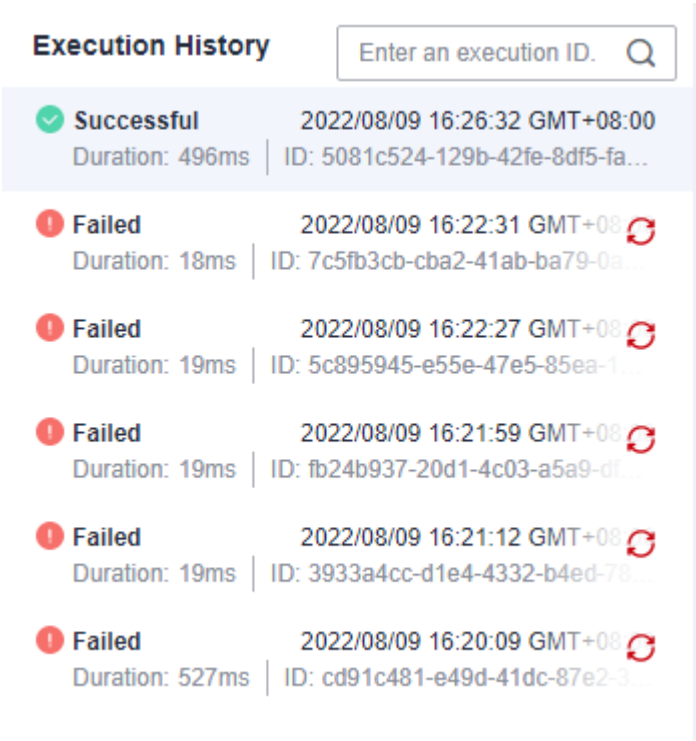
Viewing the Execution History of a Standard Flow

Step 1 Log in to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Flows** page, click the target flow to go to the details page.

Step 3 Click the **Executions** tab and view the executions.

Step 4 Search for an execution by ID. On the left shows the latest 100 executions of the flow.



- Click an execution. The execution result is displayed on the canvas in the middle. Nodes in green are successful, and nodes in red have failed.

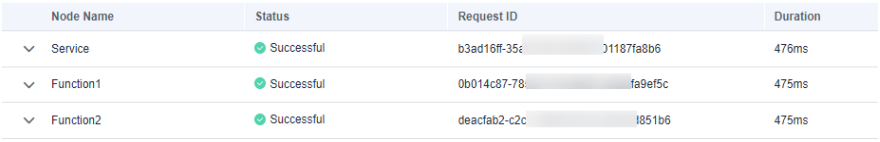
Figure 12-17 Execution failed

- Below the canvas is the input and output of this flow. Click a node on the canvas to view its input and output.

NOTE

Output fields with value **null** will not be displayed.

- The logs area in the bottom displays the execution records of all nodes.



----End

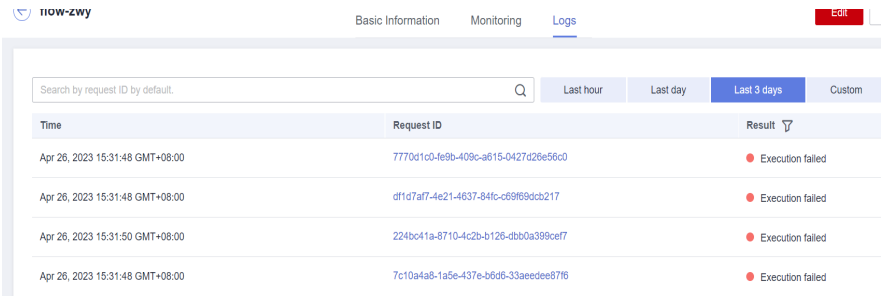
Viewing Execution Logs of an Express Flow

Step 1 Return to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Flows** page, click the target function flow to go to the **Basic Information** page.

Step 3 Click the **Logs** tab to view the execution logs.

Step 4 Filter logs by request ID or time range. Then click a request ID to view log details.



----End

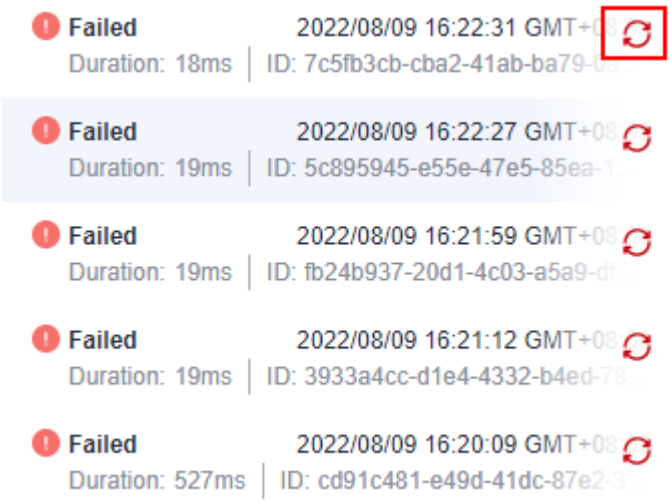
Retrying an Execution

Step 1 Return to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Flows** page, click the target flow to go to the details page.

Step 3 Click the **Executions** tab and view the executions.

Step 4 Click the retry icon on the right of a failed execution. If the retry is successful, a new record is generated.



----End

Stopping an Execution

Step 1 Return to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Flows** page, click the target flow to go to the details page.

Step 3 Click the **Executions** tab, and click the stop icon on the right of the target execution. After the execution is stopped, its status changes to **Cancel**.

----End

12.4 Creating a Flow Trigger

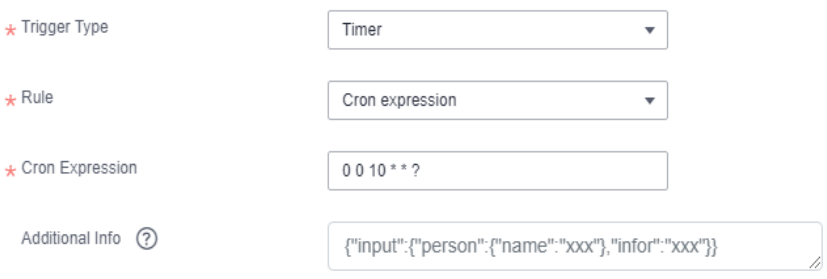
Flow trigger types include APIG, SMN, and timer.

Creating a Timer Trigger

Step 1 Log in to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Flows** page, find the target flow, and click **Edit**.

Step 3 Click the **Start** node. On the displayed page, click **Create Trigger** and set **Trigger Type** to **Timer**.



Step 4 Set the trigger information. As shown in **Table 12-8**, parameters with an asterisk (*) are mandatory.

Table 12-8 Timer trigger information

Parameter	Description
* Rule	Triggering rule of the timer. Currently, only cron expressions are supported.
* Cron Expression	Specifies the date and time when the flow will be scheduled. For details, see **Cron Expressions for a Function Timer Trigger**.
Additional Info	Must be in JSON format and contain an input. The value of input will be passed to the flow.

Step 5 Click **Create**.

----End

Creating an APIG (Shared) Trigger

NOTE

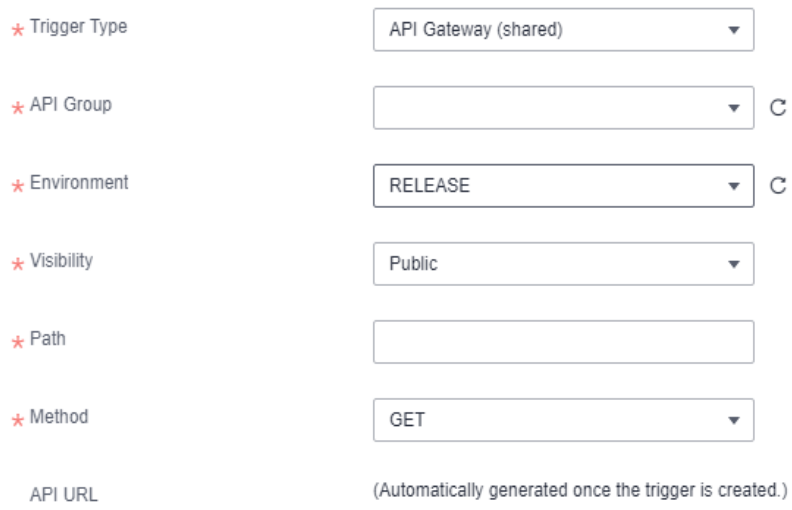
The shared gateway is no longer available. Only existing customers who previously used this feature can continue using it.

APIG flow triggers support only IAM authentication.

Step 1 Return to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Flows** page, find the target flow, and click **Edit**.

Step 3 Click the **Start** node. On the displayed page, click **Create Trigger** and set **Trigger Type** to **API Gateway (shared)**.



Step 4 Set the trigger information. As shown in **Table 12-9**, parameters with an asterisk (*) are mandatory.

Table 12-9 APIG (shared) trigger information

Parameter	Description
* API Group	An API group facilitates management of APIs used for the same service. In this example, select **APIGroup_test**.
* Environment	An API can be called in different environments, such as production, test, and development. APIG supports environment management, allowing you to define different request paths for an API in different environments. To ensure that the API can be called, select **RELEASE**.
* Visibility	Options: **Public** and **Private**.
* Path	Path for requesting the API. Format: **/users/projects**
* Method	The API calling method. Options: **GET**, **POST**, **DELETE**, **PUT**, **PATCH**, **HEAD**, **OPTIONS**, and **ANY**. **ANY** indicates that the API can be called using any request method.

Step 5 Click **Create**.

----End

Creating an APIG (Dedicated) Trigger

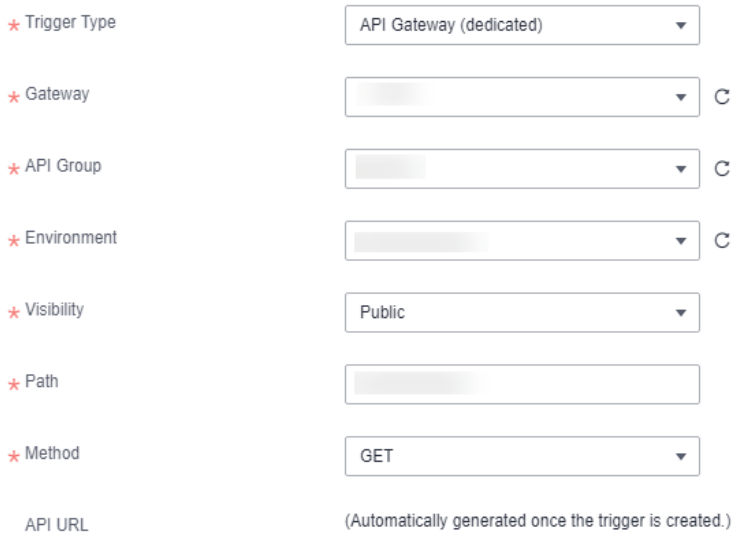
NOTE

- APIG flow triggers support only IAM authentication.
- Ensure that you have created a dedicated gateway before this operation. For details, see **Buying a Dedicated Gateway**.

Step 1 Return to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Flows** page, find the target flow, and click **Edit**.

Step 3 Click the **Start** node. On the displayed page, click **Create Trigger** and set **Trigger Type** to **API Gateway (dedicated)**.



Step 4 Set the trigger information. As shown in **Table 12-10**, parameters with an asterisk (*) are mandatory.

Table 12-10 APIG (dedicated) trigger information

Parameter	Description
* Gateway	Select a dedicated gateway.
* API Group	An API group facilitates management of APIs used for the same service. In this example, select **APIGroup_test**.
* Environment	An API can be called in different environments, such as production, test, and development. APIG supports environment management, allowing you to define different request paths for an API in different environments. To ensure that the API can be called, select **RELEASE**.
* Visibility	Options: **Public** and **Private**.
* Path	The path for requesting the API. Format: **/users/projects**
* Method	The API calling method. Options: **GET**, **POST**, **DELETE**, **PUT**, **PATCH**, **HEAD**, **OPTIONS**, and **ANY**. **ANY** indicates that the API can be called using any request method.

Step 5 Click **Create**.

----End

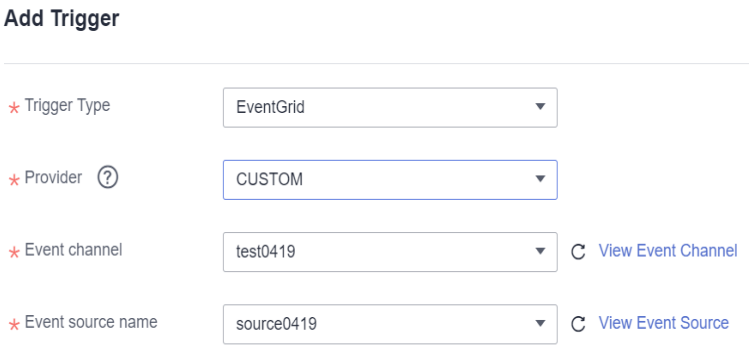
Creating an EG Trigger

Step 1 Return to the FunctionGraph console, and choose **Flows** in the navigation pane.

Step 2 On the **Flows** page, find the target flow, and click **Edit**.

Step 3 Click the **Start** node. On the displayed page, click **Create Trigger** and set **Trigger Type** to **EventGrid**.

Step 4 Select an event channel and source. Events from this source will trigger the flow.



Step 5 Set the trigger information, as shown in **Table 12-11**. Parameters with an asterisk (*) are mandatory.

Table 12-11 Timer trigger information

Parameter	Description
* Provider	EG event source provider. Huawei Cloud and custom event sources are supported.
* Event channel	Receives events from the specified source to trigger the function flow.
* Event source name	Event sources include Huawei Cloud services and custom applications. They produce events and publish them to EG.
Event types	Types of events that will trigger the function flow.

Step 6 Click **Create**.

----End

12.5 Processing Stream Files

This section describes how to use FunctionGraph to process large stream files. Create an express flow that meets your service requirements.

Background and Value

Serverless workflows feature orchestration, state management, persistence, visualized monitoring, error handling, and cloud service integration. They are suitable for many scenarios, including:

- Complex, abstract services, such as order management and CRM
- Services that require automatic interruption and recovery when manual intervention is involved among tasks, such as manual review and pipeline deployment
- Services that require manual interruption and recovery, such as data backup and restoration
- Task status monitoring
- Stream processing, such as log analysis and image/video processing

  Nowadays, most serverless workflow platforms focus more on control process orchestration rather than data flow orchestration and transmission. In scenarios similar to **Creating a Flow Trigger**, the data flow is simple and well supported by various platforms. However, they do not have a solution for ultra-large data stream processing scenarios, such as file transcoding. For these scenarios, Huawei Cloud FunctionGraph provides the serverless streaming solution, which responds to process files within milliseconds.

Principles

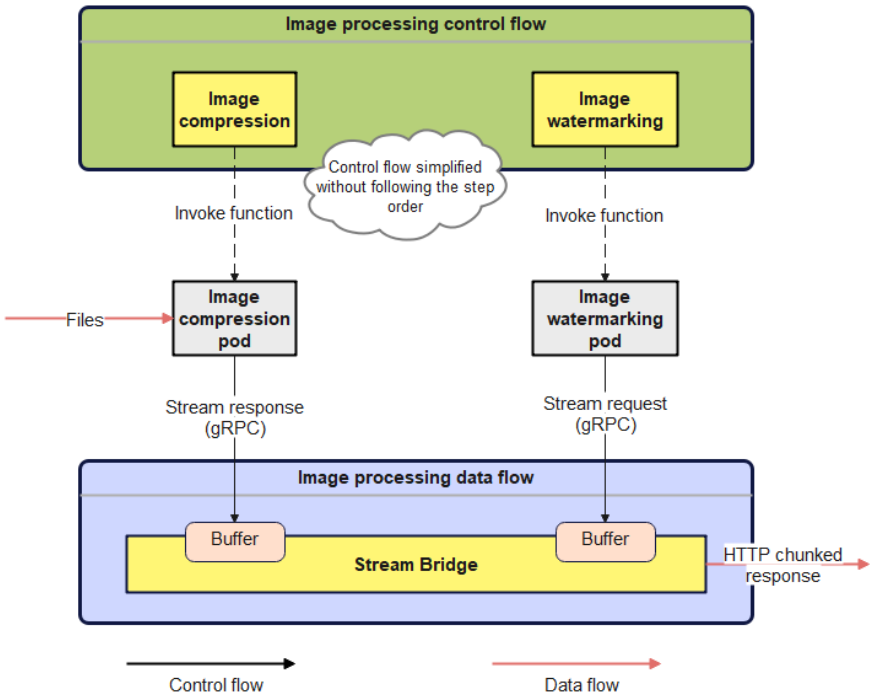
Huawei Cloud FunctionGraph provides the serverless streaming solution for file processing via orchestration. Steps are driven by data flows, which is easier to understand. This section uses image processing as an example to describe how this solution works.

A workflow system needs to process two parts:

- Control flow: Controls the flow between steps and the execution of serverless functions in the steps.
- Data flow: Controls the data flowing through the entire workflow. Generally, the output of a previous step serves as the input of the next step. For example, in the preceding image processing workflow, the image compression result is the input of the watermarking step.

In common service orchestration, the execution sequence of each service needs to be precisely controlled, so the control flow is the core of a workflow. However, streaming processing scenarios such as file processing do not require more on the control flow. For example, in the image processing scenario, large images can be processed by block. Image compression and watermarking are not necessarily completed in a specific sequence.

The following figure shows the architecture of Huawei Cloud FunctionGraph's serverless streaming solution.



Serverless streaming allows steps to be executed in parallel rather than in a specific sequence. Steps interact with each through data flows, which are controlled by the Stream Bridge component. The function SDKs include a streaming data API, which writes data into Stream Bridge in a gRPC stream. Stream Bridge then distributes the data flow into the function pod in the next step.

Procedure

Step 1 Create an image compression function, which uses **ctx.Write()** to return results as streaming data.

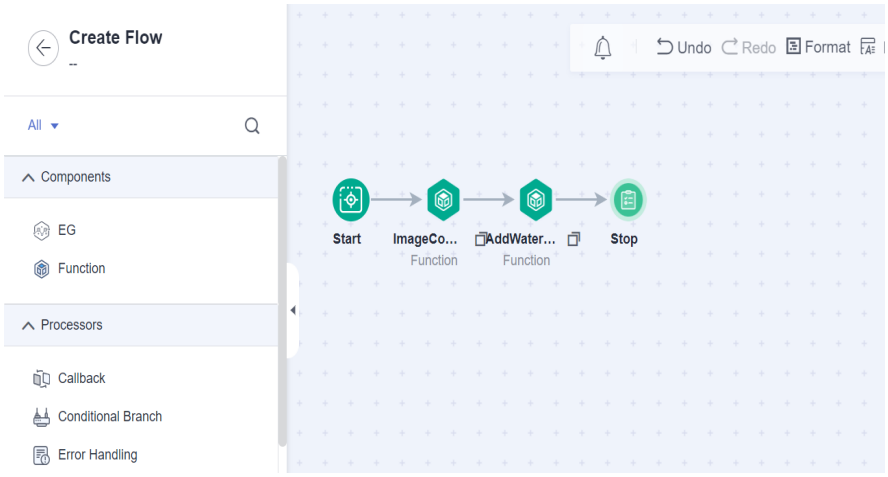
NOTE

Currently, only Go functions are supported.

```
func ImageTransform(payload []byte, ctx context.RuntimeContext) (interface{}, error) {
    reader, writer := io.Pipe()
    file, err := downloadOriginFile(ctx)
    if err != nil {
        return "nok", err
    }

    go func() {
        defer writer.Close()
        encodeImageFile(writer, file, ctx)
    }()

    defer reader.Close()
    // Write result stream back to client
    err = ctx.Write(reader)
    return "ok", err
}

// downloadOriginFile used to download the origin video file
func downloadOriginFile(ctx context.RuntimeContext) (*os.File, error) {
}

// encodeImageFile used to encode the origin image file to target resolution, result output will writes to writer stream
func encodeImageFile(writer io.Writer, originFile *os.File, ctx context.RuntimeContext)  {
}
```

FunctionGraph supports streaming response with **ctx.Write()**. Instead of focusing on network transmission, you only need to return the final results in a stream.

Step 2 Create a workflow on the FunctionGraph console.



Step 3 Invoke the synchronous flow execution API to obtain the file stream. The data is returned to the client in chunked streaming mode.

----End

13 Increasing Resource Quota

Overview

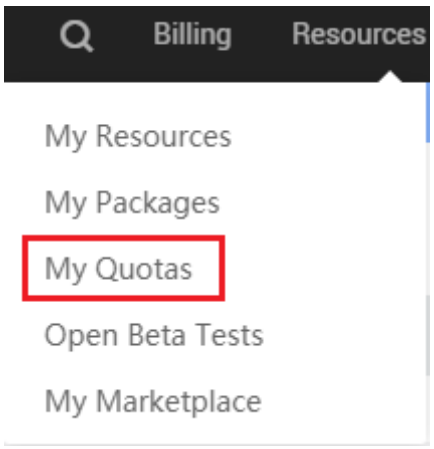
A quota is a limit on the quantity or capacity of a certain type of service resources that you can use. For example, the maximum number of ECSs or EVS disks that can be created.

If a quota cannot meet your needs, apply for a higher quota.

Viewing Quotas

1. Log in to the management console.
2. In the upper right corner of the page, choose **Resources** > **My Quotas**.

   Figure 13-1 Going to the Quotas page

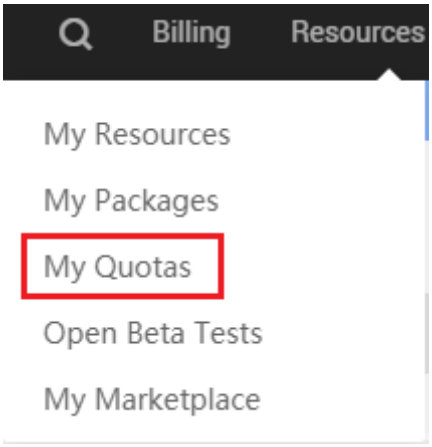
3. On the **Quotas** page, view the used and total quotas of resources.

   If a quota cannot meet your needs, apply for a higher quota by performing the following operations.

Increasing Quotas

1. Log in to the management console.
2. In the upper right corner of the page, choose **Resources** > **My Quotas**. The **Quotas** page is displayed.

Figure 13-2 Going to the Quotas page



3. Click **Increase Quota**.
4. On the **Create Service Ticket** page, set the parameters.

   In the **Problem Description** area, enter the required quota and reason for the adjustment.
5. Read the agreements and confirm that you agree to them, and then click **Submit**.

14 Audit

14.1 Operations Logged by CTS

Table 14-1 lists the FunctionGraph operations that can be logged by CTS.

Table 14-1 Operations logged by CTS

Operation	Resource Type	Event Name
Creating a function	Function	createFunction
Deleting a function	Function	deleteFunction
Modifying function information	Function	updateFunctionConfig
Publishing a function version	Function version	publishFunctionVersion
Deleting a function version alias	Function version alias	deleteVersionAlias
Deleting a function trigger	Trigger	deleteTrigger
Creating a function trigger	Trigger	createTrigger
Disabling a function trigger	Trigger	disableTrigger
Enabling a function trigger	Trigger	enableTrigger

14.2 Querying Real-Time Traces

Scenarios

After you enable CTS and the management tracker is created, CTS starts recording operations on cloud resources. After a data tracker is created, the system starts recording operations on data in OBS buckets. CTS stores operation records generated in the last seven days.

This section describes how to query and export operation records of the last seven days on the CTS console.

- **Viewing Real-Time Traces in the Trace List of the New Edition**
- **Viewing Real-Time Traces in the Trace List of the Old Edition**

Constraints

- Traces of a single account can be viewed on the CTS console. Multi-account traces can be viewed only on the **Trace List** page of each account, or in the OBS bucket or the **CTS/system** log stream configured for the management tracker with the organization function enabled.
- You can only query operation records of the last seven days on the CTS console. To store operation records for more than seven days, you must configure an OBS bucket to transfer records to it. Otherwise, you cannot query the operation records generated seven days ago.
- After performing operations on the cloud, you can query management traces on the CTS console 1 minute later and query data traces on the CTS console 5 minutes later.

Viewing Real-Time Traces in the Trace List of the New Edition

1. Log in to the management console.
2. Click  in the upper left corner and choose **Management & GovernanceManagement & Deployment** > **Cloud Trace Service**. The CTS console is displayed.
3. Choose **Trace List** in the navigation pane on the left.
4. On the **Trace List** page, use advanced search to query traces. You can combine one or more filters.
   - **Trace Name**: Enter a trace name.
   - **Trace ID**: Enter a trace ID.
   - **Resource Name**: Enter a resource name. If the cloud resource involved in the trace does not have a resource name or the corresponding API operation does not involve the resource name parameter, leave this field empty.
   - **Resource ID**: Enter a resource ID. Leave this field empty if the resource has no resource ID or if resource creation failed.
   - **Trace Source**: Select a cloud service name from the drop-down list.

- **Resource Type**: Select a resource type from the drop-down list.
- **Operator**: Select one or more operators from the drop-down list.
- **Trace Status**: Select **normal**, **warning**, or **incident**.
  - **normal**: The operation succeeded.
  - **warning**: The operation failed.
  - **incident**: The operation caused a fault that is more serious than the operation failure, for example, causing other faults.
- Time range: Select **Last 1 hour**, **Last 1 day**, or **Last 1 week**, or specify a custom time range.

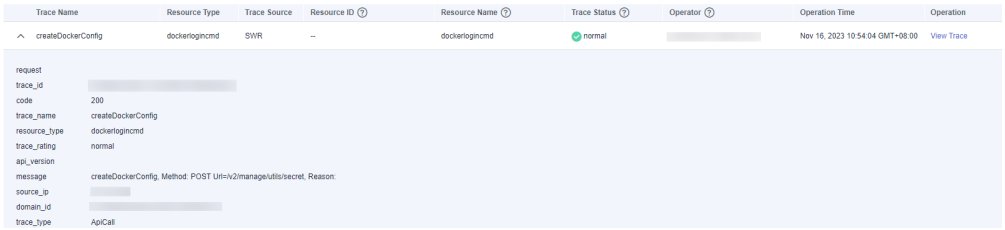
5. On the **Trace List** page, you can also export and refresh the trace list, and customize the list display settings.
   - Enter any keyword in the search box and click to filter desired traces.
   - Click **Export** to export all traces in the query result as an .xlsx file. The file can contain up to 5000 records.
   - Click to view the latest information about traces.
   - Click to customize the information to be displayed in the trace list. If **Auto wrapping** is enabled ( ), excess text will move down to the next line; otherwise, the text will be truncated. By default, this function is disabled.
6. For details about key fields in the trace structure, see **Trace Structure**section "Trace References" > "Trace Structure" and **Example Traces**section "Trace References" > "Example Traces".
7. (Optional) On the **Trace List** page of the new edition, click **Go to Old Edition** in the upper right corner to switch to the **Trace List** page of the old edition.

Viewing Real-Time Traces in the Trace List of the Old Edition

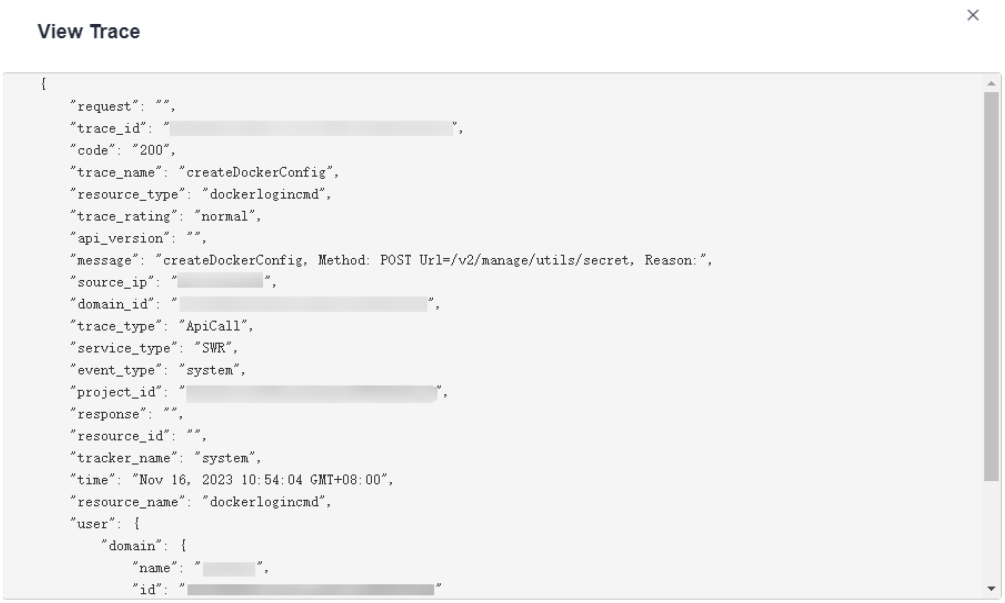
1. Log in to the management console.
2. Click in the upper left corner and choose **Management & GovernanceManagement & Deployment** > **Cloud Trace Service**. The CTS console is displayed.
3. Choose **Trace List** in the navigation pane on the left.
4. Each time you log in to the CTS console, the new edition is displayed by default. Click **Go to Old Edition** in the upper right corner to switch to the trace list of the old edition.
5. Set filters to search for your desired traces. The following filters are available:
   - **Trace Type**, **Trace Source**, **Resource Type**, and **Search By**: Select a filter from the drop-down list.
     - If you select **Resource ID** for **Search By**, specify a resource ID.
     - If you select **Trace name** for **Search By**, specify a trace name.
     - If you select **Resource name** for **Search By**, specify a resource name.

- **Operator**: Select a user.
- **Trace Status**: Select **All trace statuses**, **Normal**, **Warning**, or **Incident**.
- Time range: You can query traces generated during any time range in the last seven days.
- Click **Export** to export all traces in the query result as a CSV file. The file can contain up to 5000 records.

6. Click **Query**.
7. On the **Trace List** page, you can also export and refresh the trace list.
   - Click **Export** to export all traces in the query result as a CSV file. The file can contain up to 5000 records.
   - Click to view the latest information about traces.
8. Click on the left of a trace to expand its details.



9. Click **View Trace** in the **Operation** column. The trace details are displayed.



10. For details about key fields in the trace structure, see **Trace Structure**section "Trace References" > "Trace Structure" and **Example Traces**section "Trace References" > "Example Traces".
11. (Optional) On the **Trace List** page of the old edition, click **New Edition** in the upper right corner to switch to the **Trace List** page of the new edition.

