Data Encryption Workshop

Best Practice

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HUAWEI TECHNOLOGIES CO., LTD.

Security Declaration

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https://securitybulletin.huawei.com/enterprise/en/security-advisory

Contents

1 Key Management Service

1.1 Using KMS to Encrypt Offline Data

1.1.1 Encrypting or Decrypting Small Volumes of Data

Scenario

You can use online tools on the Key Management Service (KMS) console or call the necessary KMS APIs to directly encrypt or decrypt small-size data with a CMK, such as passwords, certificates, or phone numbers.

Restrictions

Currently, a maximum of 4 KB of data can be encrypted or decrypted in this way.

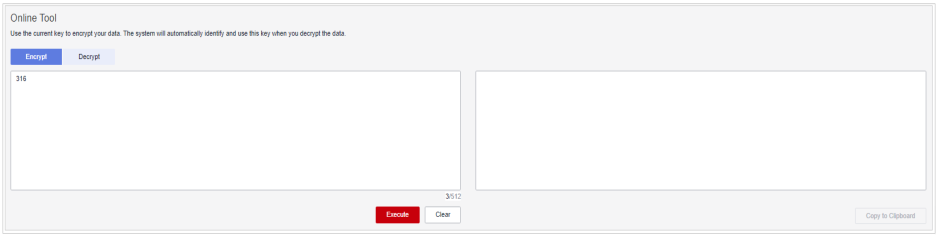
Encryption and Decryption Using Online Tools

- **Encrypting data**

Step 1 Click the alias of the target custom key to access the key details page. The **Tools** tab is displayed by default.

Step 2 Click **Encrypt**. In the text box on the left, enter the data to be encrypted, as shown in **Figure 1-1**.

Figure 1-1 Encrypting data


Online Tool
Use the current key to encrypt your data. The system will automatically identify and use this key when you decrypt the data.

316

3/512

Step 3 Click **Execute**. Ciphertext of the data is displayed in the text box on the right.

NOTE

- Use the current CMK to encrypt the data.
- You can click **Clear** to clear the entered data.
- You can click **Copy to Clipboard** to copy the ciphertext and save it in a local file.

- **Decrypting data**

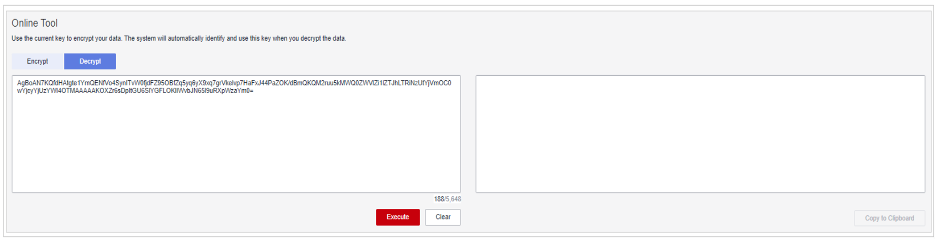
Step 4 You can click any non-default key in **Enabled** status to go to the encryption and decryption page of the online tool.

Step 5 Click **Decrypt**. In the text box on the left, enter the data to be decrypted. For details, see **Figure 1-2**.

NOTE

- The tool will identify the original encryption CMK and use it to decrypt the data.
- If the key has been deleted, the decryption will fail.

Figure 1-2 Decrypting data


Online Tool

Use the current key to encrypt your data. The system will automatically identify and use this key when you decrypt the data.

```
AgBoAN7KQfdHAtgte1YmQENfVo4SynlTvW0fjdFZ95OBfZq5yq6yX9xq7grVkelvp7HaFxJ44PaZOK/dBmQKQM2ruu5kMWQ0ZWVlZi1lZTJhLTRiNzUtYjVmOC0
wYjcyYjUzYWI4OTMAAAAAKOXZr6sDpltGU6SlYGFLOKlIWvbJN65l9uRXpWzaYm0=
```

188/5,648

Step 6 Click **Execute**. Plaintext of the data is displayed in the text box on the right.

NOTE

- You can click **Copy to Clipboard** to copy the plaintext and save it in a local file.
- Enter the plaintext on the console, the text will be encoded to Base64 format before encryption.

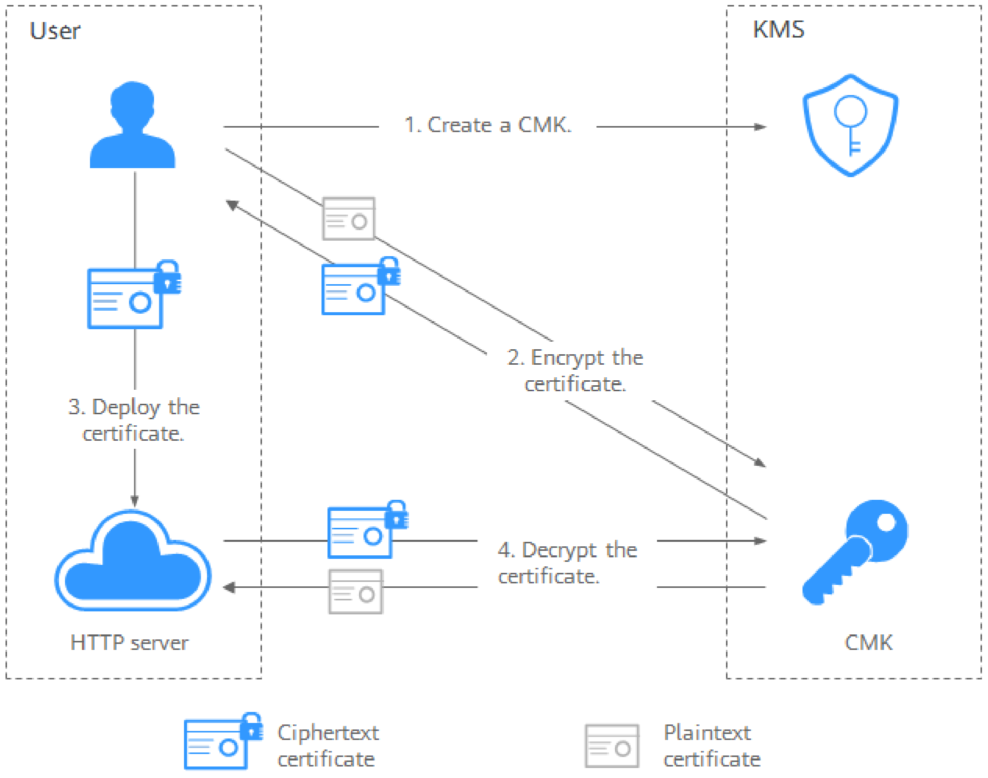
  The decryption result returned via API will be in Base64 format. Perform Base64 decoding to obtain the plaintext entered on the console.

----End

Calling APIs for Encryption and Decryption

Figure 1-3 shows an example about how to call KMS APIs to encrypt and decrypt an HTTPS certificate.

Figure 1-3 Encrypting and decrypting an HTTPS certificate


User
KMS
1. Create a CMK.
2. Encrypt the certificate.
3. Deploy the certificate.
4. Decrypt the certificate.
HTTP server
CMK
Ciphertext certificate
Plaintext certificate

The procedure is as follows:

1. Create a CMK on KMS.
2. Call the **encrypt-data** interface of KMS and use the CMK to encrypt the plaintext certificate.
3. Deploy the certificate onto a server.
4. The server uses the **decrypt-data** interface of KMS to decrypt the ciphertext certificate.

NOTE

If you enter and encrypt text on the console, the text will be encoded to Base64 format before being transferred to the backend for encryption. The decryption result returned via API will be in Base64 format. Text encrypted via API cannot be decrypted on the console, or garbled characters will be returned.

1.1.2 Encrypting or Decrypting a Large Amount of Data

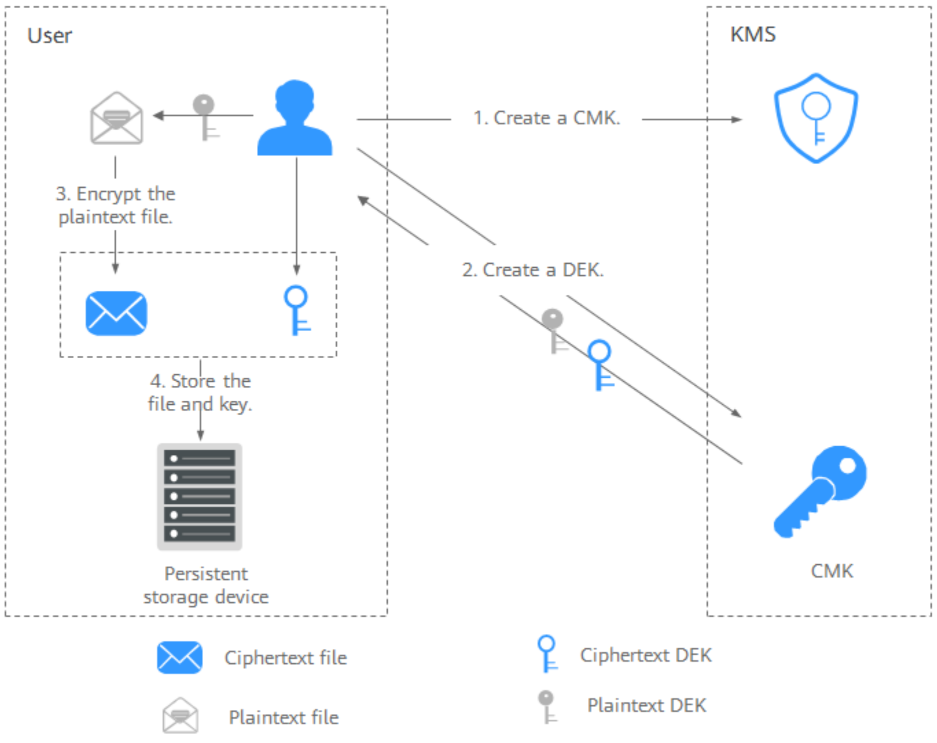
Scenario

If you want to encrypt or decrypt large volumes of data, such as pictures, videos, and database files, you can use envelope encryption, which allows you to encrypt and decrypt files without having to transfer a large amount of data over the network.

Encryption and Decryption Processes

- Large-size data encryption

Figure 1-4 Encrypting a local file



The process is as follows:

a. Create a CMK on KMS.

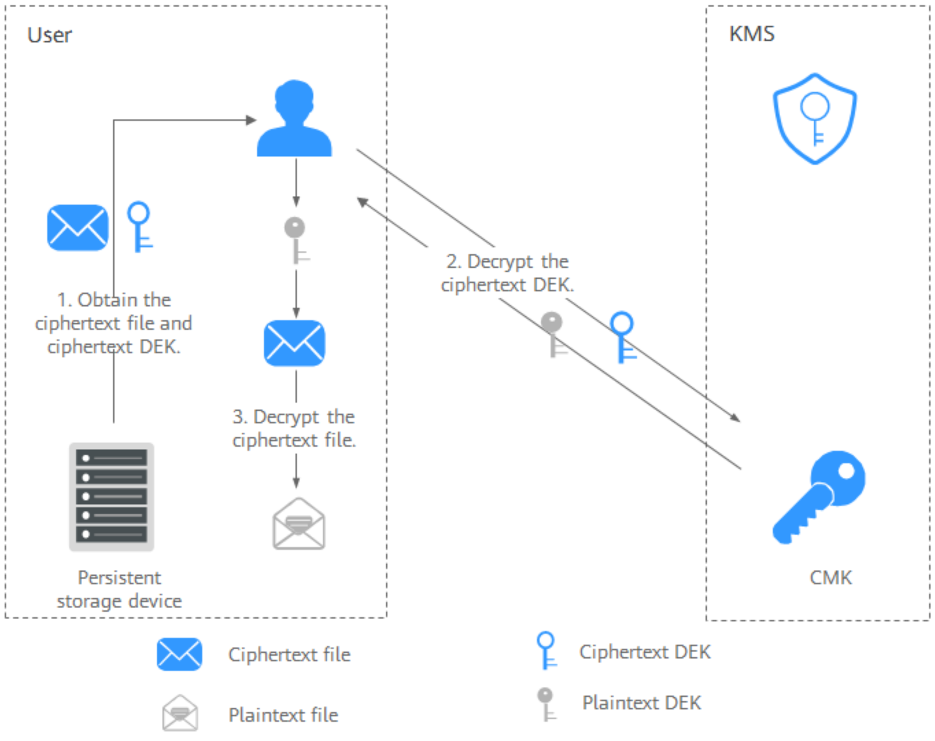
b. Call the **create-datakey** API of KMS to create a DEK. A plaintext DEK and a ciphertext DEK will be generated. The ciphertext DEK is generated when you use a CMK to encrypt the plaintext DEK.

c. Use the plaintext DEK to encrypt a plaintext file, generating a ciphertext file.

d. Store the ciphertext DEK and the ciphertext file together in a permanent storage device or a storage service.

- Large-size data decryption

Figure 1-5 Decrypting a local file


User
KMS
1. Obtain the ciphertext file and ciphertext DEK.
2. Decrypt the ciphertext DEK.
3. Decrypt the ciphertext file.
Persistent storage device
CMK
Ciphertext file
Plaintext file
Ciphertext DEK
Plaintext DEK

The process is as follows:

a. Read the ciphertext DEK and the ciphertext file from the permanent storage device or storage service.

b. Call the **decrypt-datakey** API of KMS and use the corresponding CMK (the one used for encrypting the DEK) to decrypt the ciphertext DEK. Then you get the plaintext DEK.

   If the CMK is deleted, the decryption will fail. Properly keep your CMKs.

c. Use the plaintext DEK to decrypt the ciphertext file.

APIs Related to Envelope Encryption

You can use the following APIs to encrypt and decrypt data.

API	Description
Creating a DEK	Create a DEK.
Encrypting a DEK	Encrypt a DEK with the specified master key.
Decrypting a DEK	Decrypt a DEK with the specified master key.

Encrypting a Local File

1. Create a CMK on the management console. For details, see **Creating a CMK**.
2. Prepare basic authentication information.
   - **ACCESS_KEY**: access key of the Huawei ID
   - **SECRET_ACCESS_KEY**: secret access key of the Huawei ID
   - **PROJECT_ID**: project ID of a HUAWEI CLOUD site. For details, see **Project**.
   - **KMS_ENDPOINT**: endpoint for accessing KMS. For details, see **Endpoints**.
   - There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
   - In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.
3. Encrypt a local file.

   Example code is as follows.
   - CMK is the ID of the key created on the HUAWEI CLOUD management console.
   - The plaintext data file is **FirstPlainFile.jpg**.
   - The data file generated after encryption is **SecondEncryptFile.jpg**.

```
import com.huaweicloud.sdk.core.auth.BasicCredentials;
import com.huaweicloud.sdk.kms.v1.KmsClient;
import com.huaweicloud.sdk.kms.v1.model.CreateDatakeyRequest;
import com.huaweicloud.sdk.kms.v1.model.CreateDatakeyRequestBody;
import com.huaweicloud.sdk.kms.v1.model.CreateDatakeyResponse;
import com.huaweicloud.sdk.kms.v1.model.DecryptDatakeyRequest;
import com.huaweicloud.sdk.kms.v1.model.DecryptDatakeyRequestBody;

import javax.crypto.Cipher;
import javax.crypto.spec.GCMParameterSpec;
import javax.crypto.spec.SecretKeySpec;
import java.io.BufferedInputStream;
import java.io.BufferedOutputStream;
import java.io.File;
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.io.IOException;
import java.nio.file.Files;
import java.security.SecureRandom;

/**
* Use a DEK to encrypt and decrypt files.
* To enable the assert syntax, add -ea to enable VM_OPTIONS.
 */
public class FileStreamEncryptionExample {

    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");
    private static final String PROJECT_ID = "<ProjectID>";
    private static final String KMS_ENDPOINT = "<KmsEndpoint>";

//Version of the KMS interface. Currently, the value is fixed to v1.0.
    private static final String KMS_INTERFACE_VERSION = "v1.0";

    /**
     * AES algorithm flags:
     * - AES_KEY_BIT_LENGTH: bit length of the AES256 key
      * - AES_KEY_BYTE_LENGTH: byte length of the AES256 key
     * - AES_ALG: AES256 algorithm. In this example, the Group mode is GCM and the padding
mode is PKCS5Padding.
     * - AES_FLAG: AES algorithm flag
     * - GCM_TAG_LENGTH: GCM tag length
     * - GCM_IV_LENGTH: length of the GCM initial vector
     */
    private static final String AES_KEY_BIT_LENGTH = "256";
    private static final String AES_KEY_BYTE_LENGTH = "32";
    private static final String AES_ALG = "AES/GCM/PKCS5Padding";
    private static final String AES_FLAG = "AES";
    private static final int GCM_TAG_LENGTH = 16;
    private static final int GCM_IV_LENGTH = 12;

    public static void main(final String[] args) {
        // ID of the CMK you created on the HUAWEI CLOUD management console
        final String keyId = args[0];

        encryptFile(keyId);
    }

    /**
     * Using a DEK to encrypt and decrypt a file
     *
     * @param keyId: user CMK ID
     */
    static void encryptFile(String keyId) {
        // 1. Prepare the authentication information for accessing HUAWEI CLOUD.
        final BasicCredentials auth = new
BasicCredentials().withAk(ACCESS_KEY).withSk(SECRET_ACCESS_KEY)
                .withProjectId(PROJECT_ID);

        // 2. Initialize the SDK and transfer the authentication information and the address for the
KMS to access the client.
        final KmsClient kmsClient =
KmsClient.newBuilder().withCredential(auth).withEndpoint(KMS_ENDPOINT).build();

        // 3. Assemble the request message for creating a DEK.
        final CreateDatakeyRequest createDatakeyRequest = new
CreateDatakeyRequest().withVersionId(KMS_INTERFACE_VERSION)
                .withBody(new
CreateDatakeyRequestBody().withKeyId(keyId).withDatakeyLength(AES_KEY_BIT_LENGTH));

        // 4. Create a DEK.
        final CreateDatakeyResponse createDatakeyResponse =
kmsClient.createDatakey(createDatakeyRequest);

        // 5. Receive the created DEK information.
        // It is recommended that the ciphertext key and key ID be stored locally so that the
plaintext key can be easily obtained for data decryption.
        // The plaintext key should be used immediately after being created. Before using it,
convert the hexadecimal plaintext key to a byte array.
        final String cipherText = createDatakeyResponse.getCipherText();
        final byte[] plainKey = hexToBytes(createDatakeyResponse.getPlainText());

        // 6. Prepare the file to be encrypted.
        // inFile: file to be encrypted
        // outEncryptFile: file generated after encryption

        final File inFile = new File("FirstPlainFile.jpg");
        final File outEncryptFile = new File("SecondEncryptFile.jpg");

        // 7. If the AES algorithm is used for encryption, you can create an initial vector.
        final byte[] iv = new byte[GCM_IV_LENGTH];
        final SecureRandom secureRandom = new SecureRandom();
        secureRandom.nextBytes(iv);

        // 8. Encrypt the file and store the encrypted file.
        doFileFinal(Cipher.ENCRYPT_MODE, inFile, outEncryptFile, plainKey, iv);
    }

    /**
     * Encrypting and decrypting a file
     *
     * @param cipherMode: Encryption mode. It can be Cipher.ENCRYPT_MODE or
Cipher.DECRYPT_MODE.
     * @param infile: file to be encrypted or decrypted
     * @param outFile: file generated after encryption and decryption
     * @param keyPlain: plaintext key
     * @param iv: initial vector
     */
    static void doFileFinal(int cipherMode, File infile, File outFile, byte[] keyPlain, byte[] iv) {

        try (BufferedInputStream bis = new BufferedInputStream(new FileInputStream(infile));
             BufferedOutputStream bos = new BufferedOutputStream(new
FileOutputStream(outFile))) {
            final byte[] bytIn = new byte[(int) infile.length()];
            final int fileLength = bis.read(bytIn);

            assert fileLength > 0;

            final SecretKeySpec secretKeySpec = new SecretKeySpec(keyPlain, AES_FLAG);
            final Cipher cipher = Cipher.getInstance(AES_ALG);
            final GCMParameterSpec gcmParameterSpec = new
GCMParameterSpec(GCM_TAG_LENGTH * Byte.SIZE, iv);
            cipher.init(cipherMode, secretKeySpec, gcmParameterSpec);
            final byte[] bytOut = cipher.doFinal(bytIn);
            bos.write(bytOut);
        } catch (Exception e) {
            throw new RuntimeException(e.getMessage());
        }
    }

}
```

Decrypting a Local File

1. Prepare basic authentication information.
   - **ACCESS_KEY**: access key of the Huawei ID
   - **SECRET_ACCESS_KEY**: secret access key of the Huawei ID
   - **PROJECT_ID**: project ID of a HUAWEI CLOUD site. For details, see **Project**.
   - **KMS_ENDPOINT**: endpoint for accessing KMS. For details, see **Endpoints**.
   - There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
   - In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.
2. Decrypt a local file.

   Example code is as follows.
   - CMK is the ID of the key created on the HUAWEI CLOUD management console.
   - The data file generated after encryption is **SecondEncryptFile.jpg**.
   - The data file generated after encryption and decryption is **ThirdDecryptFile.jpg**.

```
import com.huaweicloud.sdk.core.auth.BasicCredentials;
import com.huaweicloud.sdk.kms.v1.KmsClient;
import com.huaweicloud.sdk.kms.v1.model.CreateDatakeyRequest;
import com.huaweicloud.sdk.kms.v1.model.CreateDatakeyRequestBody;
import com.huaweicloud.sdk.kms.v1.model.CreateDatakeyResponse;
import com.huaweicloud.sdk.kms.v1.model.DecryptDatakeyRequest;
import com.huaweicloud.sdk.kms.v1.model.DecryptDatakeyRequestBody;

import javax.crypto.Cipher;
import javax.crypto.spec.GCMParameterSpec;
import javax.crypto.spec.SecretKeySpec;
import java.io.BufferedInputStream;
import java.io.BufferedOutputStream;
import java.io.File;
import java.io.FileInputStream;
import java.io.FileOutputStream;
import java.io.IOException;
import java.nio.file.Files;
import java.security.SecureRandom;

/**
* Use a DEK to encrypt and decrypt files.
* To enable the assert syntax, add -ea to enable VM_OPTIONS.
 */
public class FileStreamEncryptionExample {

    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");
    private static final String PROJECT_ID = "<ProjectID>";
    private static final String KMS_ENDPOINT = "<KmsEndpoint>";


//Version of the KMS interface. Currently, the value is fixed to v1.0.
    private static final String KMS_INTERFACE_VERSION = "v1.0";

    /**
     * AES algorithm flags:
     * - AES_KEY_BIT_LENGTH: bit length of the AES256 key
      * - AES_KEY_BYTE_LENGTH: byte length of the AES256 key
     * - AES_ALG: AES256 algorithm. In this example, the Group mode is GCM and the padding 
mode is PKCS5Padding.
     * - AES_FLAG: AES algorithm flag
     * - GCM_TAG_LENGTH: GCM tag length
     * - GCM_IV_LENGTH: length of the GCM initial vector
     */
    private static final String AES_KEY_BIT_LENGTH = "256";
    private static final String AES_KEY_BYTE_LENGTH = "32";
    private static final String AES_ALG = "AES/GCM/PKCS5Padding";
    private static final String AES_FLAG = "AES";
    private static final int GCM_TAG_LENGTH = 16;
    private static final int GCM_IV_LENGTH = 12;

    public static void main(final String[] args) {
        // ID of the CMK you created on the HUAWEI CLOUD management console
        final String keyId = args[0];
        // // Returned ciphertext DEK after DEK creation
        final String cipherText = args[1];

        decryptFile(keyId, cipherText);
    }

    /**
     * Using a DEK to encrypt and decrypt a file
     *
     * @param keyId: user CMK ID
     * @param cipherText: ciphertext data key
     */
    static void decryptFile(String keyId, String cipherText) {
        // 1. Prepare the authentication information for accessing HUAWEI CLOUD.
        final BasicCredentials auth = new 
BasicCredentials().withAk(ACCESS_KEY).withSk(SECRET_ACCESS_KEY)
```

```
                .withProjectId(PROJECT_ID);

        // 2. Initialize the SDK and transfer the authentication information and the address for the
KMS to access the client.
        final KmsClient kmsClient =
KmsClient.newBuilder().withCredential(auth).withEndpoint(KMS_ENDPOINT).build();

        // 3. Prepare the file to be encrypted.
        // inFile: file to be encrypted
        // outEncryptFile: file generated after encryption
        // outDecryptFile: file generated after encryption and decryption
        final File inFile = new File("FirstPlainFile.jpg");
        final File outEncryptFile = new File("SecondEncryptFile.jpg");
        final File outDecryptFile = new File("ThirdDecryptFile.jpg");

        // 4. Use the same initial vector for AES encryption and decryption.
        final byte[] iv = new byte[GCM_IV_LENGTH];

        // 5. Assemble the request message for decrypting the DEK. cipherText is the ciphertext
DEK returned after DEK creation.
        final DecryptDatakeyRequest decryptDatakeyRequest = new DecryptDatakeyRequest()
                .withVersionId(KMS_INTERFACE_VERSION).withBody(new
DecryptDatakeyRequestBody()
                        .withKeyId(keyId).withCipherText(cipherText).withDatakeyCipherLength(AES_KEY
_BYTE_LENGTH));

        // 6. Decrypt the DEK and convert the returned hexadecimal plaintext key into a byte array.
        final byte[] decryptDataKey =
hexToBytes(kmsClient.decryptDatakey(decryptDatakeyRequest).getDataKey());

        // 7. Decrypt the file and store the decrypted file.
// iv at the end of the statement is the initial vector created in the encryption example.
        doFileFinal(Cipher.DECRYPT_MODE, outEncryptFile, outDecryptFile, decryptDataKey, iv);

        // 8. Compare the original file with the decrypted file.
        assert getFileSha256Sum(inFile).equals(getFileSha256Sum(outDecryptFile));

    }

    /**
     * Encrypting and decrypting a file
     *
     * @param cipherMode: Encryption mode. It can be Cipher.ENCRYPT_MODE or
Cipher.DECRYPT_MODE.
     * @param infile: file to be encrypted or decrypted
     * @param outFile: file generated after encryption and decryption
     * @param keyPlain: plaintext key
     * @param iv: initial vector
     */
    static void doFileFinal(int cipherMode, File infile, File outFile, byte[] keyPlain, byte[] iv) {

        try (BufferedInputStream bis = new BufferedInputStream(new FileInputStream(infile));
             BufferedOutputStream bos = new BufferedOutputStream(new
FileOutputStream(outFile))) {
            final byte[] bytIn = new byte[(int) infile.length()];
            final int fileLength = bis.read(bytIn);

            assert fileLength > 0;

            final SecretKeySpec secretKeySpec = new SecretKeySpec(keyPlain, AES_FLAG);
            final Cipher cipher = Cipher.getInstance(AES_ALG);
            final GCMParameterSpec gcmParameterSpec = new
GCMParameterSpec(GCM_TAG_LENGTH * Byte.SIZE, iv);
            cipher.init(cipherMode, secretKeySpec, gcmParameterSpec);
            final byte[] bytOut = cipher.doFinal(bytIn);
            bos.write(bytOut);
        } catch (Exception e) {
            throw new RuntimeException(e.getMessage());
        }
    }

    /**
* Converting a hexadecimal string to a byte array
     *
     * @param hexString: a hexadecimal string
     * @return: byte array
     */
    static byte[] hexToBytes(String hexString) {
        final int stringLength = hexString.length();
        assert stringLength > 0;
        final byte[] result = new byte[stringLength / 2];
        int j = 0;
        for (int i = 0; i < stringLength; i += 2) {
            result[j++] = (byte) Integer.parseInt(hexString.substring(i, i + 2), 16);
        }
        return result;
    }

    /**
     * Calculate the SHA256 digest of the file.
     *
     * @param file
     * @return SHA256 digest
     */
     static String getFileSha256Sum(File file) {
        int length;
        MessageDigest sha256;
        byte[] buffer = new byte[1024];
        try {
            sha256 = MessageDigest.getInstance("SHA-256");
        } catch (NoSuchAlgorithmException e) {
            throw new RuntimeException(e.getMessage());
        }
        try (FileInputStream inputStream = new FileInputStream(file)) {
            while ((length = inputStream.read(buffer)) != -1) {
                sha256.update(buffer, 0, length);
            }
            return new BigInteger(1, sha256.digest()).toString(16);
        } catch (IOException e) {
            throw new RuntimeException(e.getMessage());
        }
    }
}
```

1.2 Using KMS to Encrypt and Decrypt Data for Cloud Services

1.2.1 Overview

KMS is a secure, reliable, and easy-to-use cloud service that helps users create, manage, and protect keys in a centralized manner.

After your cloud services are integrated with KMS, to encrypt data on cloud, you simply need to select a CMK managed by KMS for encryption.

You can select a Default Master Key (DMK) automatically created by a cloud service through KMS, or a key you created or imported to KMS. For details, see **Differences Between a CMK and a Default Master Key**.

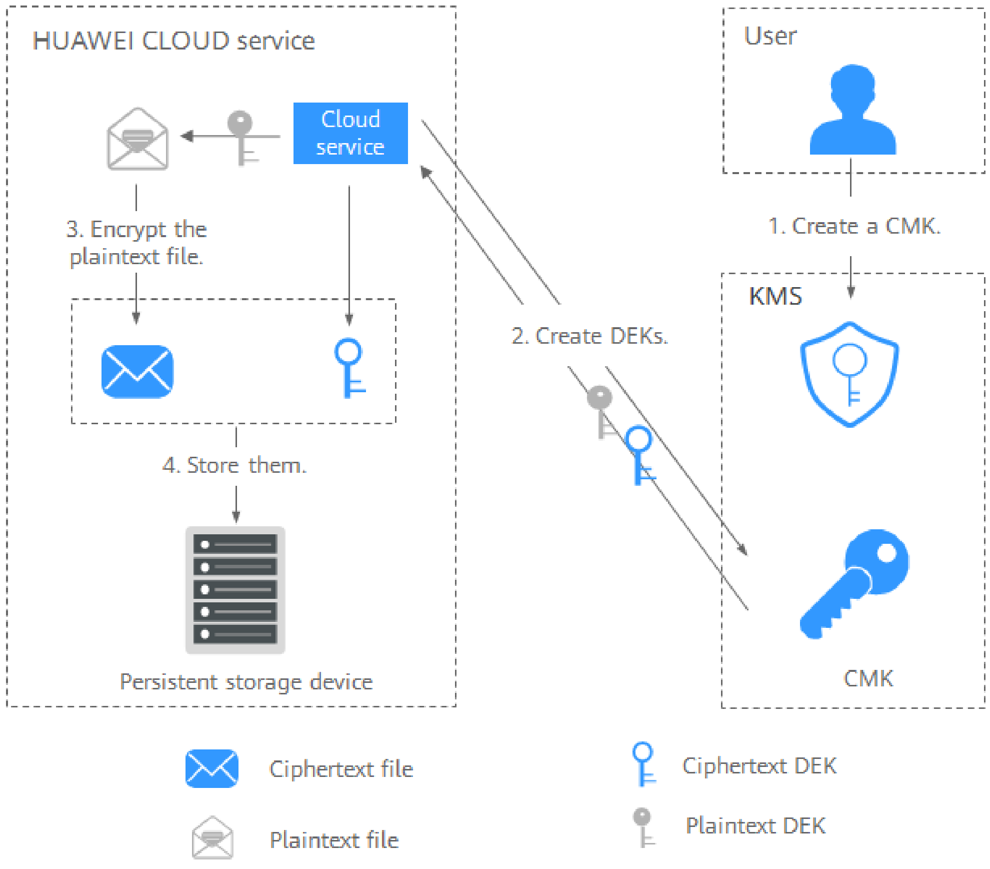
Table 1-1 Cloud services that use KMS encryption

Category	Service	Encryption Mode
Computing	Elastic Cloud Server (ECS)	You can encrypt an image or EVS disk in ECS. ● When creating an ECS, if you select an encrypted image, the system disk of the created ECS automatically has encryption enabled, with its encryption mode same as the image encryption mode. ● When creating an ECS, you can encrypt added data disks.
	Image Management Service (IMS)	**Encrypting Data in IMS**
Storage	Object Storage Service (OBS)	**Encrypting Data in OBS**
	Elastic Volume Service (EVS)	**Encrypting Data in EVS**
	Volume Backup Service (VBS)	VBS generally creates online backups for a single EVS disk (system or data disk) of the server. If it is encrypted, its backup data will be stored in encrypted mode.
	Cloud Server Backup Service (CSBS)	CSBS mainly creates consistency backups online for all EVS disks of the server. CSBS backups will also be displayed on the VBS page. If it is encrypted, its backup data will be stored in encrypted mode.
Database	RDS for MySQL	**Encrypting an RDS DB Instance**
	RDS for PostgreSQL	
	RDS for SQL Server	
	Document Database Service (DDS)	**Encrypting a DDS DB Instance**

Encryption Process

HUAWEI CLOUD services use the envelope encryption technology and call KMS APIs to encrypt service resources. Your CMKs are under your own management. With your grant, HUAWEI CLOUD services use a specific CMK of yours to encrypt data.

Figure 1-6 How Huawei Cloud uses KMS for encryption



The encryption process is as follows:

1. Create a CMK on KMS.
2. A HUAWEI CLOUD service calls the **create-datakey** API of the KMS to create a DEK. A plaintext DEK and a ciphertext DEK are generated.

   NOTE

   Ciphertext DEKs are generated when you use a CMK to encrypt the plaintext DEKs.
3. The HUAWEI CLOUD service uses the plaintext DEK to encrypt a plaintext file, generating a ciphertext file.
4. The HUAWEI CLOUD service saves the ciphertext DEK and the ciphertext file together in a permanent storage device or a storage service.

NOTE

When users download the data from the HUAWEI CLOUD service, the service uses the CMK specified by KMS to decrypt the ciphertext DEK, uses the decrypted DEK to decrypt data, and then provides the decrypted data for users to download.

1.2.2 Encrypting Data in ECS

Overview

KMS supports one-click encryption for ECS. The images and data disks of ECS can be encrypted.

- When creating an ECS, if you select an encrypted image, the system disk of the created ECS automatically has encryption enabled, with its encryption mode same as the image encryption mode.
- When creating an ECS, you can encrypt added data disks.

For details about how to encrypt an image, see **Encrypting Data in IMS**.

For details about how to encrypt a data disk, see **Encrypting Data in EVS**.

1.2.3 Encrypting Data in OBS

Overview

After server-side encryption is enabled, data of an object uploaded to Object Storage Service (OBS) is encrypted on the server before being stored. When the object is downloaded, data is decrypted on the server first.

KMS uses a third-party hardware security module (HSM) to protect keys, enabling you to create and manage encryption keys easily. Keys are not displayed in plaintext outside HSMs, which prevents key disclosure. With KMS, all operations on keys are controlled and logged, and usage records of all keys can be provided to meet regulatory compliance requirements.

Server-side encryption with KMS-managed keys (SSE-KMS) can be implemented for the objects to be uploaded. You need to create a key using KMS or use the default key provided by KMS. Then you can use the key to encrypt the object on the server when uploading the object to OBS.

Uploading Files in Server-side Encryption Mode (on the Console)

Step 1 In the bucket list on the OBS console, click a bucket to go to the **Overview** page.

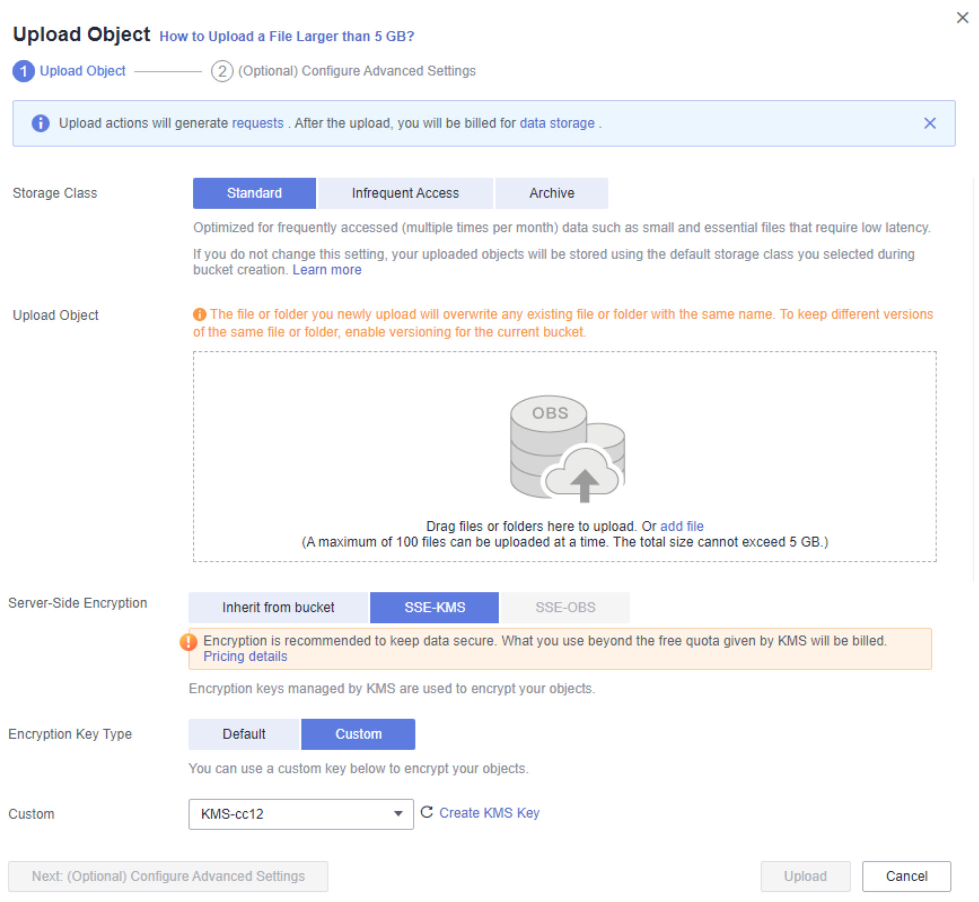
Step 2 In the navigation tree on the left, choose **Objects**.

Step 3 Click **Upload Object**. The **Upload Object** dialog box is displayed.

Step 4 Click **Add File**, select the file to be uploaded, and click **Open**.

Step 5 Set **Server-Side Encryption** to **SSE-KMS**, select the default key or a custom key, and click **Upload**.

Figure 1-7 Encrypting an object to be uploaded



Upload Object How to Upload a File Larger than 5 GB?

1 Upload Object —— 2 (Optional) Configure Advanced Settings

Upload actions will generate requests . After the upload, you will be billed for data storage .

Storage Class: Standard | Infrequent Access | Archive

Optimized for frequently accessed (multiple times per month) data such as small and essential files that require low latency.

If you do not change this setting, your uploaded objects will be stored using the default storage class you selected during bucket creation. Learn more

Upload Object: The file or folder you newly upload will overwrite any existing file or folder with the same name. To keep different versions of the same file or folder, enable versioning for the current bucket.

Drag files or folders here to upload. Or add file
(A maximum of 100 files can be uploaded at a time. The total size cannot exceed 5 GB.)

Server-Side Encryption: Inherit from bucket | SSE-KMS | SSE-OBS

Encryption is recommended to keep data secure. What you use beyond the free quota given by KMS will be billed. Pricing details

Encryption keys managed by KMS are used to encrypt your objects.

Encryption Key Type: Default | Custom

You can use a custom key below to encrypt your objects.

Custom: KMS-cc12 Create KMS Key

Key name: Name of the custom key. The key is created in DEW and is used for encrypted protection for data. OBS provides a default key **obs/default**. You can use the default key or create a key in DEW.

NOTE

Generally, the AES key is used when SSE-KMS is used. SM4 encryption keys can be used only in the CN North-Ulanqab1 region.

Step 6 After uploading the object, click it to view its encryption status.

NOTE

- The object encryption status cannot be changed.
- A key in use cannot be deleted. Otherwise, the object encrypted with this key cannot be downloaded.

----End

Uploading Files in Server-side Encryption Mode (Through an API)

You can call the required API of OBS to upload a file in SSE-KMS mode. For details, see *Object Storage Service API Reference*.

1.2.4 Encrypting Data in EVS

Overview

In case your services require encryption for the data stored on disks in Elastic Volume Service (EVS), EVS provides you with the encryption function. You can encrypt newly created EVS disks. Keys used by encrypted EVS disks are provided by KMS of DEW, secure and convenient. Therefore, you do not need to establish and maintain the key management infrastructure.

Disk encryption is used for data disks only. System disk encryption relies on the image. For details, see **Encrypting Data in IMS**.

Who Can Use the Disk Encryption Function?

- Security administrators (users having Security Administrator rights) can grant the KMS access rights to EVS for using disk encryption.
- When a common user who does not have the Security Administrator rights needs to use the disk encryption feature, the condition varies depending on whether the user is the first one ever in the current region or project to use this feature.
  - If the user is the first, the user must contact a user having the Security Administrator rights to grant the KMS access rights to EVS. Then, the user can use the disk encryption feature.
  - If the user is not the first, the user can use the disk encryption function directly.

From the perspective of a tenant, as long as the KMS access rights have been granted to EVS in a region, all users in the same region can directly use the disk encryption feature.

If there are multiple projects in the current region, the KMS access rights need to be granted to each project in this region.

Keys Used for EVS Disk Encryption

The keys provided by KMS for disk encryption include a Default Master Key and Customer Master Keys (CMKs).

- Default Master Key: A key that is automatically created by EVS through KMS and named **evs/default**.

  The Default Master Key cannot be disabled and does not support scheduled deletion.
- CMKs: Keys created by users. You can use existing CMKs or create one. For details, see **Creating a CMK**.

If disks are encrypted using a CMK, which is then disabled or scheduled for deletion, the disks can no longer be read from or written to, and data on these disks may never be restored. See **Table 1-2** for more information.

Table 1-2 Impact on encrypted disks after a CMK becomes unavailable

CMK Status	Impact on Encrypted Disks	Restoration Method
Disabled	• If an encrypted disk is then attached to an ECS, the disk can still be used, but normal read/write operations are not guaranteed permanently. • If an encrypted disk is then detached, re-attaching the disk will fail.	Enable the CMK. For details, see **Enabling One or More CMKs**.
Pending deletion		Cancel the scheduled deletion for the CMK. For details, see **Canceling the Scheduled Deletion of One or More CMKs**.
Deleted		Data on the disks can never be restored.

NOTICE

You will be charged for the CMKs you use. If basic keys are used, ensure that your account balance is sufficient. If professional keys are used, renew your order timely. Otherwise, your services may be interrupted and your data may never be restored as the encrypted disks become unreadable and unwritable.

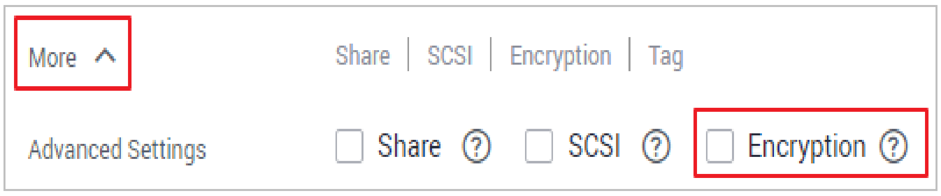
Using KMS to Encrypt a Disk (on the Console)

Step 1 On the EVS management console, click **Buy Disk**.

Step 2 Select the **Encryption** check box.

1. Click **More**. The **Encryption** check box is displayed.

Figure 1-8 More



2. Create an agency.

   Select **Encrypt**. If EVS is not authorized to access KMS, the **Create Agency** dialog box is displayed. In this case, click **Yes** to authorize it. After the authorization, EVS can obtain KMS keys to encrypt and decrypt disks.

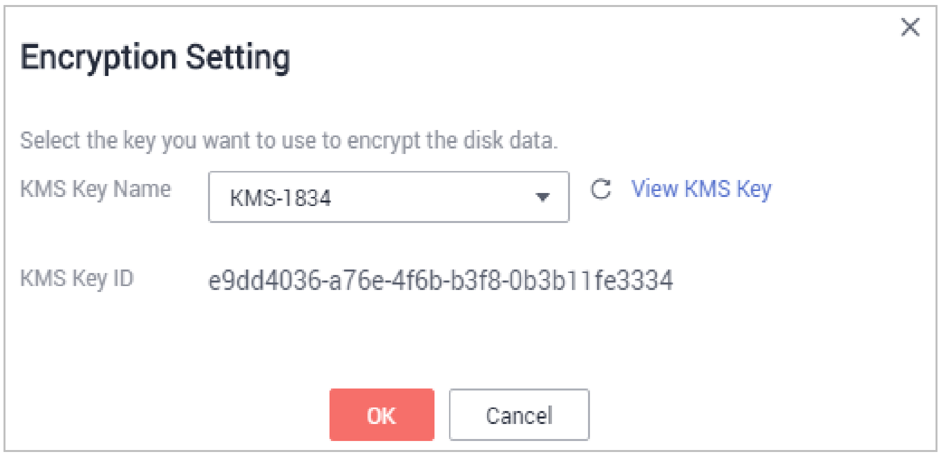
NOTE

Before you use the disk encryption function, KMS access rights need to be granted to EVS. If you have the right for granting, grant the KMS access rights to EVS directly. If you do not have the right, contact a user with the Security Administrator rights to grant the KMS access rights to EVS, then repeat the preceding operations.

3. Set encryption parameters.

   Select **Encrypt**. If the authorization succeeded, the encryption setting dialog box is displayed.

   Figure 1-9 Encryption settings



Encryption Setting

Select the key you want to use to encrypt the disk data.

KMS Key Name: KMS-1834

KMS Key ID: e9dd4036-a76e-4f6b-b3f8-0b3b11fe3334

   Select either of the following types of keys from the **KMS Key Name** drop-down list:

   – Default Master Key. After the KMS access rights have been granted to EVS, the system automatically creates a Default Master Key named **evs/default**.

   – An existing or new CMK. For details about how to create one, see **Creating a CMK**.

Step 3 Configure other parameters for the disk. For details about the parameters, see **Purchasing an EVS Disk**.

----End

Using KMS to Encrypt a Disk (Through an API)

You can call the required API of EVS to purchase an encrypted EVS disk. For details, see *Elastic Volume Service API Reference*.

1.2.5 Encrypting Data in IMS

You can create an encrypted image in Image Management Service (IMS) to securely store data.

Restrictions

- DEW must be enabled.

- An encrypted image cannot be shared with other users.
- An encrypted image cannot be published in the Marketplace.
- If an ECS has an encrypted system disk, the private image created using the ECS is also encrypted.
- The key used for encrypting an image cannot be changed.
- If the key used for encrypting an image is disabled or deleted, the image is unavailable.
- The system disk of an ECS created using an encrypted image is also encrypted, and its key is the same as the image key.

Using KMS to Encrypt a Private Image (on the Console)

You can create an encrypted image using an encrypted ECS or an external image file.

- Create an encrypted image using an encrypted ECS.

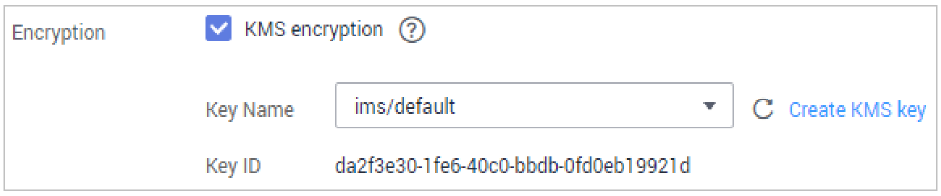
  When you use an ECS to create a private image, if the system disk of the ECS is encrypted, the private image created using the ECS is also encrypted. The key used for encrypting the image is the one used for creating the system disk.
- Create an encrypted image using an external image file.

  When you use an external image file that has been uploaded to an OBS bucket to create a private image, you can select KMS encryption when registering the image to encrypt the image.

  When uploading an image file, you can select **KMS encryption** and use a key provided by KMS to encrypt the uploaded file, as shown in **Figure 1-10**.

  a. On the IMS management console, click **Create Private Image**.
  b. Set **Type** to **System disk image**.
  c. Set **Source** to **Image File**.
  d. Select **KMS encryption**.

  Figure 1-10 Encrypting data in IMS

  Encryption ✓ KMS encryption
  Key Name ims/default
  Key ID da2f3e30-1fe6-40c0-bbdb-0fd0eb19921d

  Select either of the following types of keys from the **Key Name** drop-down list:

  - Default Master Key **ims/default** created by KMS
  - An existing or new CMK. For details about how to create one, see **Creating a CMK**.

  e. Configure other parameters. For details about the parameters, see **Registering an Image**.

Using KMS to Encrypt a Private Image (Through an API)

You can call the required API of IMS to encrypt the image file. For details, see *Image Management Service API Reference*.

1.2.6 Encrypting an RDS DB Instance

Overview

Relational Database Service (RDS) supports MySQL and PostgreSQL engines.

After encryption is enabled, disk data will be encrypted and stored on the server when you create a DB instance or expand disk capacity. When you download encrypted objects, the encrypted data will be decrypted on the server and displayed in plaintext.

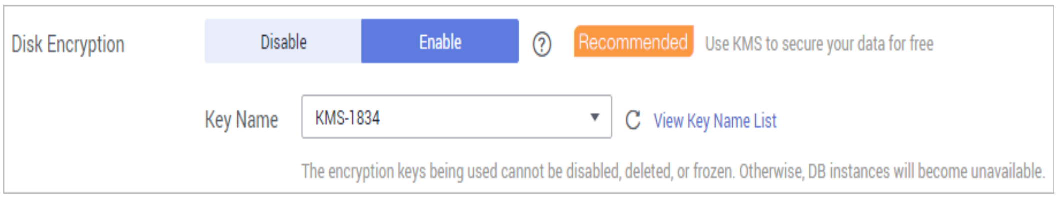
Restrictions

- The KMS Administrator right must be granted to the user in the region of RDS by using Identity and Access Management (IAM). For details about how to assign permissions to user groups, see "How Do I Manage User Groups and Grant Permissions to Them?" in *Identity and Access Management User Guide*.
- To use a user-defined key to encrypt objects to be uploaded, create a key using DEW. For details, see **Creating a CMK**.
- Once the disk encryption function is enabled, you cannot disable it or change the key after a DB instance is created. The backup data stored in OBS will not be encrypted.
- After an RDS DB instance is created, do not disable or delete the key that is being used. Otherwise, RDS will be unavailable and data cannot be restored.
- If you scale up a DB instance with disks encrypted, the expanded storage space will be encrypted using the original encryption key.

Using KMS to Encrypt a DB Instance (on the Console)

When a user purchases a database instance from Relational Database Service (RDS), the user can select **Disk encryption** and use the key provided by KMS to encrypt the disk of the database instance. For more information, see **Buy a MySQL DB Instance** and **Buy a PostgreSQL DB Instance**.

Figure 1-11 Encrypting data in RDS


Disk Encryption: Disable [✓ Enable] Recommended Use KMS to secure your data for free

Key Name: KMS-1834 View Key Name List

The encryption keys being used cannot be disabled, deleted, or frozen. Otherwise, DB instances will become unavailable.

Using KMS to Encrypt a DB Instance (Through an API)

You can also call the required API of RDS to purchase encrypted DB instances. For details, see *Relational Database Service API Reference*.

1.2.7 Encrypting a DDS DB Instance

Overview

After encryption is enabled, disk data will be encrypted and stored on the server when you create a DB instance or expand disk capacity. When you download encrypted objects, the encrypted data will be decrypted on the server and displayed in plaintext.

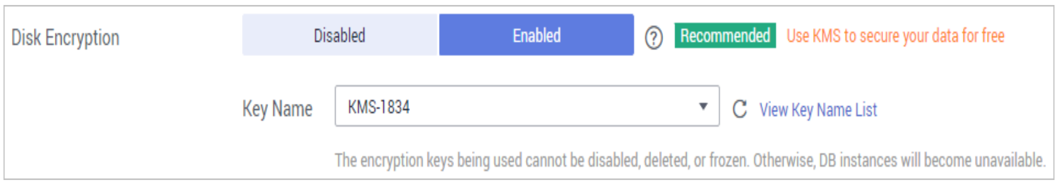
Restrictions

- The KMS Administrator right must be added in the region of RDS using IAM. For details about how to assign permissions to user groups, see "How Do I Manage User Groups and Grant Permissions to Them?" in *Identity and Access Management User Guide*.
- To use a user-defined key to encrypt objects to be uploaded, create a key using DEW. For details, see **Creating a CMK**.
- Once the disk encryption function is enabled, you cannot disable it or change the key after a DB instance is created. The backup data stored in OBS will not be encrypted.
- After a Document Database Service (DDS) DB instance is created, do not disable or delete the key that is being used. Otherwise, DDS will be unavailable and data cannot be restored.
- If you scale up a DB instance with disks encrypted, the expanded storage space will be encrypted using the original encryption key.

Using KMS to Encrypt a DB Instance (on the Console)

When you purchase a DB instance in DDS, you can set **Disk Encryption** to **Enable** and use the key provided by KMS to encrypt the disk of the DB instance. For more information, see **Buying a Cluster Instance**.

Figure 1-12 Encrypting data in DDS


Disk Encryption: Enabled
Key Name: KMS-1834

The encryption keys being used cannot be disabled, deleted, or frozen. Otherwise, DB instances will become unavailable.

Using KMS to Encrypt a DB Instance (Through an API)

You can also call the required API of DDS to purchase encrypted DB instances. For details, see *Document Database Service API Reference*.

1.3 Using the Encryption SDK to Encrypt and Decrypt Local Files

You can use certain algorithms to encrypt your files, protecting them from being breached or tampered with.

Encryption SDK is a client password library that can encrypt and decrypt data and file streams. You can easily encrypt and decrypt massive amounts of data simply by calling APIs. It allows you to focus on developing the core functions of your applications without being distracted by the data encryption and decryption processes.

NOTE

For more information, visit. For details, see **Details**.

Scenario

If large files and images are sent to KMS through HTTPS for encryption, a large number of network resources will be consumed and the encryption will be slow. This section describes how to quickly encrypt a large amount of data.

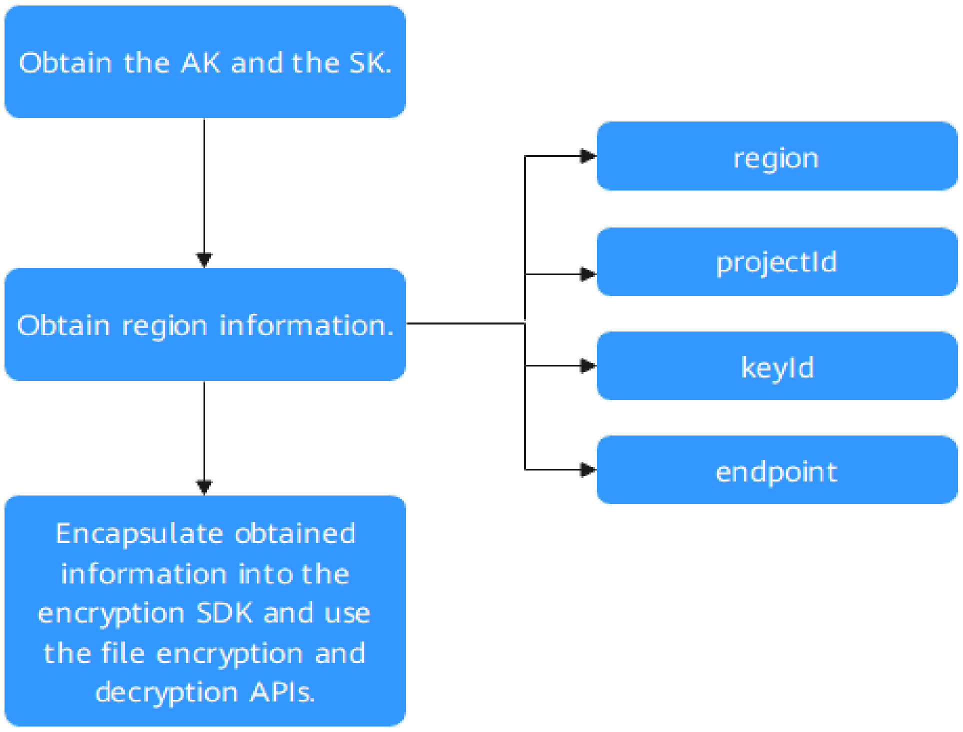
Solution

Encryption SDK performs envelope encryption on file streams segment by segment.

Data is encrypted within the SDK by using the DEK generated by KMS. Segmented encryption of files in the memory ensures the security and correctness of file encryption, because it does not require file transfer over the network.

The SDK loads a file to memory and processes it segment by segment. The next segment will not be read before the encryption or decryption of the current segment completes.

Process


Obtain the AK and the SK.
Obtain region information.
Encapsulate obtained information into the encryption SDK and use the file encryption and decryption APIs.
region
projectId
keyId
endpoint

Procedure

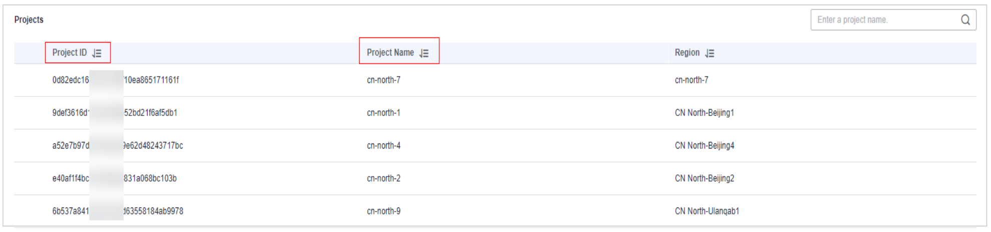
Step 1 Obtain the AK and the SK.

- ACCESS_KEY: Access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
- SECRET_ACCESS_KEY: Secret access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
- There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
- In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.

Step 2 Obtain region information.

1. **Log in to the management console**.
2. Hover over the username in the upper right corner and choose **My Credentials** from the drop-down list.
3. Obtain the **Project ID** and **Project Name**.

Figure 1-13 Obtaining the project ID and project name



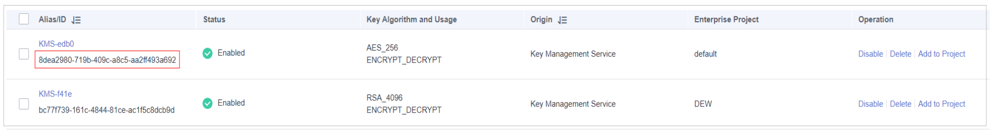
Projects

Enter a project name.

Project ID	Project Name	Region
0d82edc16[redacted]10ea865171161f	cn-north-7	cn-north-7
9def3616d[redacted]52bd21f6af5db1	cn-north-1	CN North-Beijing1
a52e7b97d[redacted]9e62d48243717bc	cn-north-4	CN North-Beijing4
e40af1f4bc[redacted]831a068bc103b	cn-north-2	CN North-Beijing2
6b537a841[redacted]d63558184ab9978	cn-north-9	CN North-Ulanqab1

4. Click ☰. Choose **Security & Compliance** > **Data Encryption Workshop**.
5. Obtain the ID of the CMK (**KEYID**) to be used in the current region.

Figure 1-14 Obtaining the CMK ID

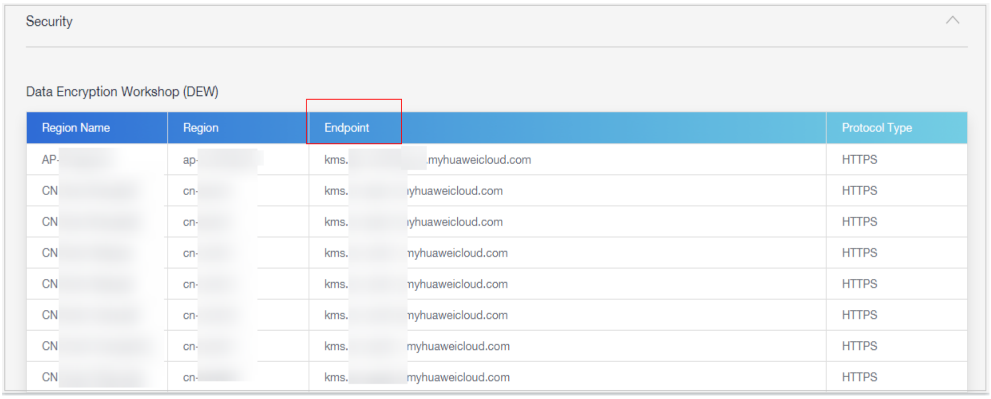


Alias/ID	Status	Key Algorithm and Usage	Origin	Enterprise Project	Operation
KMS-edb0 8dea2980-719b-409c-a8c5-aa2ff493a692	Enabled	AES_256 ENCRYPT_DECRYPT	Key Management Service	default	Disable | Delete | Add to Project
KMS-f41e bc77f739-161c-4844-81ce-ac1f5c8dcb9d	Enabled	RSA_4096 ENCRYPT_DECRYPT	Key Management Service	DEW	Disable | Delete | Add to Project

6. Obtain the endpoint (**ENDPOINT**) required by the current region.

   An endpoint is the **request address** for calling an API. Endpoints vary depending on services and regions. For the endpoints of all services, see **Regions and Endpoints**.

Figure 1-15 Obtaining an endpoint



Security

Data Encryption Workshop (DEW)

Region Name	Region	Endpoint	Protocol Type
AP-[redacted]	ap-[redacted]	kms.[redacted].myhuaweicloud.com	HTTPS
CN[redacted]	cn-[redacted]	kms.[redacted]yhuaweicloud.com	HTTPS
CN[redacted]	cn-[redacted]	kms.[redacted]yhuaweicloud.com	HTTPS
CN[redacted]	cn-[redacted]	kms.[redacted]myhuaweicloud.com	HTTPS
CN[redacted]	cn-[redacted]	kms.[redacted]myhuaweicloud.com	HTTPS
CN[redacted]	cn-[redacted]	kms.[redacted]myhuaweicloud.com	HTTPS
CN[redacted]	cn-[redacted]	kms.[redacted]myhuaweicloud.com	HTTPS
CN[redacted]	cn-[redacted]	kms.[redacted]myhuaweicloud.com	HTTPS

Step 3 Encrypt and decrypt a file.

```
public class KmsEncryptFileExample {

    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");
    private static final String PROJECT_ID = "<projectId>";
    private static final String REGION = "<region>";
    private static final String KEYID = "<keyId>";
    public static final String ENDPOINT = "<endpoint>";

    public static void main(String[] args) throws IOException {
        // Source file path
        String encryptFileInPutPath = args[0];
        // Path of the encrypted ciphertext file
        String encryptFileOutPutPath = args[1];
        // Path of the decrypted file
        String decryptFileOutPutPath = args[2];
        // Encryption context
        Map<String, String> encryptContextMap = new HashMap<>();
        encryptContextMap.put("encryption", "context");
        encryptContextMap.put("simple", "test");
        encryptContextMap.put("caching", "encrypt");
        // Construct the encryption configuration
        HuaweiConfig config = HuaweiConfig.builder().buildSk(SECRET_ACCESS_KEY)
                .buildAk(ACCESS_KEY)
                .buildKmsConfig(Collections.singletonList(new KMSConfig(REGION, KEYID, PROJECT_ID,
ENDPOINT)))
                .buildCryptoAlgorithm(CryptoAlgorithm.AES_256_GCM_NOPADDING)
                .build();
        HuaweiCrypto huaweiCrypto = new HuaweiCrypto(config);
        // Set the key ring.
        huaweiCrypto.withKeyring(new
KmsKeyringFactory().getKeyring(KeyringTypeEnum.KMS_MULTI_REGION.getType()));
        // Encrypt the file.
        encryptFile(encryptContextMap, huaweiCrypto, encryptFileInPutPath, encryptFileOutPutPath);
        // Decrypt the file.
        decryptFile(huaweiCrypto, encryptFileOutPutPath, decryptFileOutPutPath);
    }

    private static void encryptFile(Map<String, String> encryptContextMap, HuaweiCrypto huaweiCrypto,
                                    String encryptFileInPutPath, String encryptFileOutPutPath) throws IOException {
        // fileInputStream: input stream corresponding to the encrypted file
        FileInputStream fileInputStream = new FileInputStream(encryptFileInPutPath);
        // fileOutputStream: output stream corresponding to the source file
        FileOutputStream fileOutputStream = new FileOutputStream(encryptFileOutPutPath);
        // Encryption
        huaweiCrypto.encrypt(fileInputStream, fileOutputStream, encryptContextMap);
        fileInputStream.close();
        fileOutputStream.close();
    }
    private static void decryptFile(HuaweiCrypto huaweiCrypto, String decryptFileInPutPath, String
decryptFileOutPutPath) throws IOException {
        // in: input stream corresponding to the source file
        FileInputStream fileInputStream = new FileInputStream(decryptFileInPutPath);
        // out: output stream corresponding to the encrypted file
        FileOutputStream fileOutputStream = new FileOutputStream(decryptFileOutPutPath);
        // Decryption
        huaweiCrypto.decrypt(fileInputStream, fileOutputStream);
        fileInputStream.close();
        fileOutputStream.close();
    }
}
```

----End

1.4 Encrypting and Decrypting Data Through Cross-region DR

Scenario

If a fault occurs during encryption or decryption in a region, you can use KMS to implement cross-region DR encryption and decryption, ensuring service continuity.

Solution

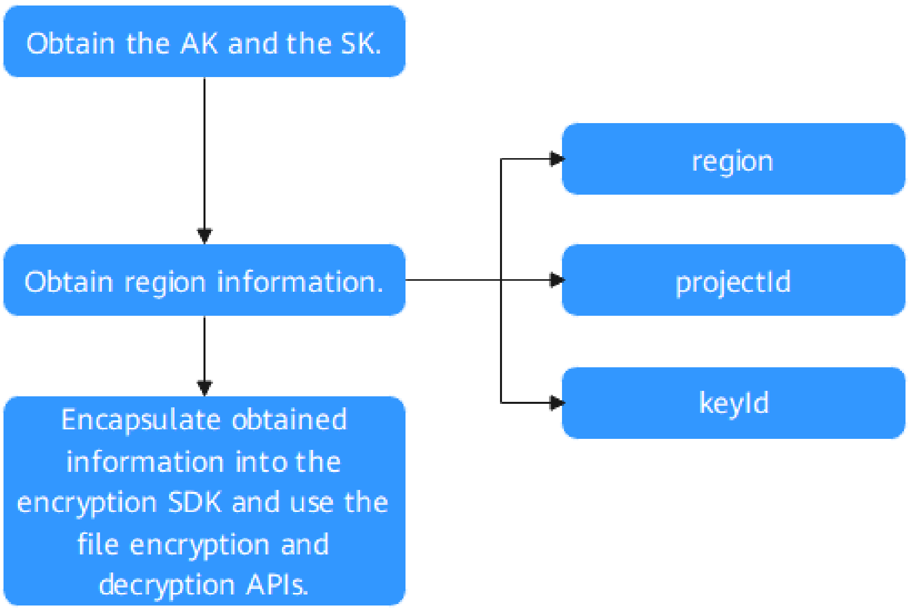
If KMS is faulty in one or multiple regions, encryption and decryption can be completed as long as a key in the key ring is available.

A cross-region key ring can use the CMKs of multiple regions to encrypt a piece of data and generate unique data ciphertext. To decrypt the data, you simply need to use a key ring that contains one or more available CMKs that were used for encrypting the data.

NOTE

For more information, see **Details**.

Process


Obtain the AK and the SK.
Obtain region information.
Encapsulate obtained information into the encryption SDK and use the file encryption and decryption APIs.
region
projectId
keyId

Procedure

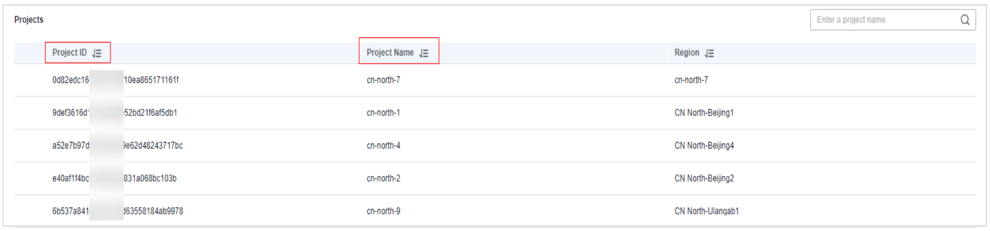
Step 1 Obtain the AK and the SK.

- ACCESS_KEY: Access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
- SECRET_ACCESS_KEY: Secret access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
- There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
- In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.

Step 2 Obtain region information.

1. **Log in to the management console**.
2. Hover over the username in the upper right corner and choose **My Credentials** from the drop-down list.
3. Obtain the **Project ID** and **Project Name**.

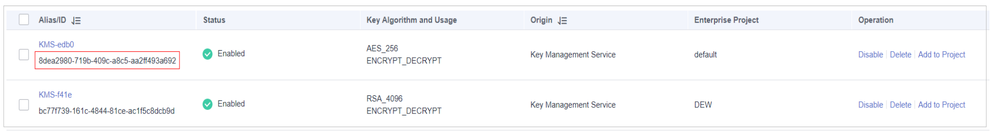
Figure 1-16 Obtaining the project ID and project name



Project ID	Project Name	Region
0d82edc16[redacted]10ea865171161f	cn-north-7	cn-north-7
9def3616d[redacted]52bd21f6af5db1	cn-north-1	CN North-Beijing1
a52e7b97d[redacted]9e62d48243717bc	cn-north-4	CN North-Beijing4
e40af1f4bc[redacted]831a068bc103b	cn-north-2	CN North-Beijing2
6b537a841[redacted]d63558184ab9978	cn-north-9	CN North-Ulanqab1

4. Click ☰. Choose **Security & Compliance** > **Data Encryption Workshop**.
5. Obtain the ID of the CMK (**KEYID**) to be used in the current region.

Figure 1-17 Obtaining the CMK ID



Alias/ID	Status	Key Algorithm and Usage	Origin	Enterprise Project	Operation
KMS-edb0 8dea2980-719b-409c-a8c5-aa2ff493a692	✓ Enabled	AES_256 ENCRYPT_DECRYPT	Key Management Service	default	Disable | Delete | Add to Project
KMS-f41e bc77f739-161c-4844-81ce-ac1f5c8dcb9d	✓ Enabled	RSA_4096 ENCRYPT_DECRYPT	Key Management Service	DEW	Disable | Delete | Add to Project

Step 3 Use the key ring for encryption and decryption.

```
public class KmsEncryptionExample {
    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");

    private static final String PROJECT_ID_1 = "<projectId1>";
    private static final String REGION_1 = "<region1>";
    private static final String KEYID_1 = "<keyId1>";

    public static final String PROJECT_ID_2 = "<projectId2>";
    public static final String REGION_2 = "<region2>";
    public static final String KEYID_2 = "<keyId2>";

    // Data to be encrypted
    private static final String PLAIN_TEXT = "Hello World!";

    public static void main(String[] args) {
        // CMK list
        List<KMSConfig> kmsConfigList = new ArrayList<>();
        kmsConfigList.add(new KMSConfig(REGION_1, KEYID_1, PROJECT_ID_1));
        kmsConfigList.add(new KMSConfig(REGION_2, KEYID_2, PROJECT_ID_2));
        // Construct encryption-related information.
        HuaweiConfig multiConfig = HuaweiConfig.builder().buildSk(SECRET_ACCESS_KEY)
                .buildAk(ACCESS_KEY)
                .buildKmsConfig(kmsConfigList)
                .buildCryptoAlgorithm(CryptoAlgorithm.AES_256_GCM_NOPADDING)
                .build();
        // Select a key ring.
        KMSKeyring keyring = new
KmsKeyringFactory().getKeyring(KeyringTypeEnum.KMS_MULTI_REGION.getType());
        HuaweiCrypto huaweiCrypto = new HuaweiCrypto(multiConfig).withKeyring(keyring);
        // Encryption context
        Map<String, String> encryptContextMap = new HashMap<>();
        encryptContextMap.put("key", "value");
        encryptContextMap.put("context", "encrypt");
        // Encryption
        CryptoResult<byte[]> encryptResult = huaweiCrypto.encrypt(new EncryptRequest(encryptContextMap,
PLAIN_TEXT.getBytes(StandardCharsets.UTF_8)));
        // Decryption
        CryptoResult<byte[]> decryptResult = huaweiCrypto.decrypt(encryptResult.getResult());
        Assert.assertEquals(PLAIN_TEXT, new String(decryptResult.getResult()));
    }
}
```

----End

1.5 Using KMS to Protect File Integrity

Scenario

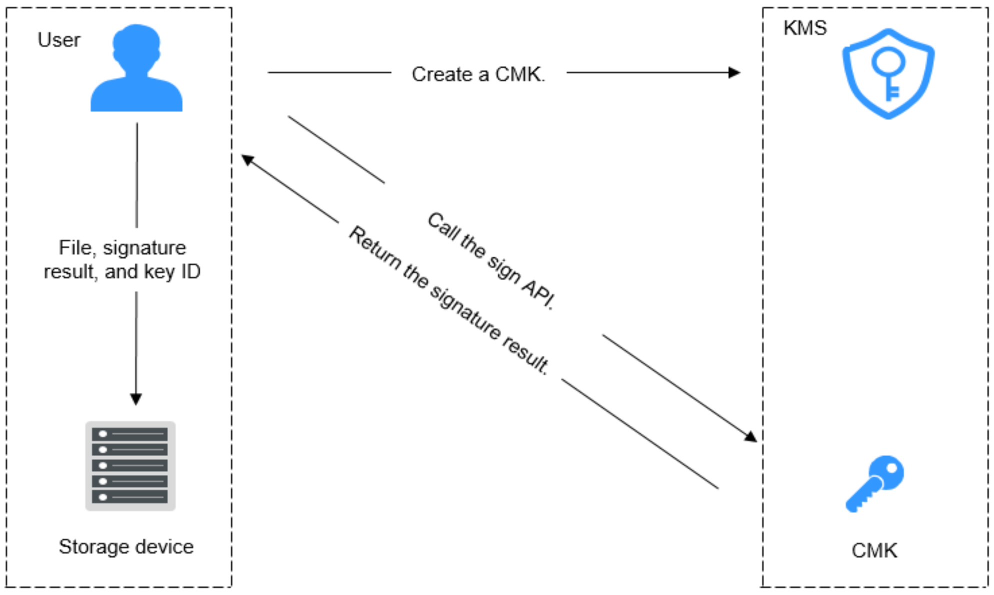
When a large amount of files (such as images, electronic insurance policies, and important files) need to be transmitted or stored securely, you can use KMS to sign the file digest. When the files are used again, you can recalculate the digest for signature verification. Ensure that files are not tampered with during transmission or storage.

Solution

Create a CMK on KMS.

Calculate the file digest and call the sign API of KMS to sign the digest. The signature result of the digest is obtained. Transmit or store the digest signature result, key ID, and the file together. The following figure shows the signature process.

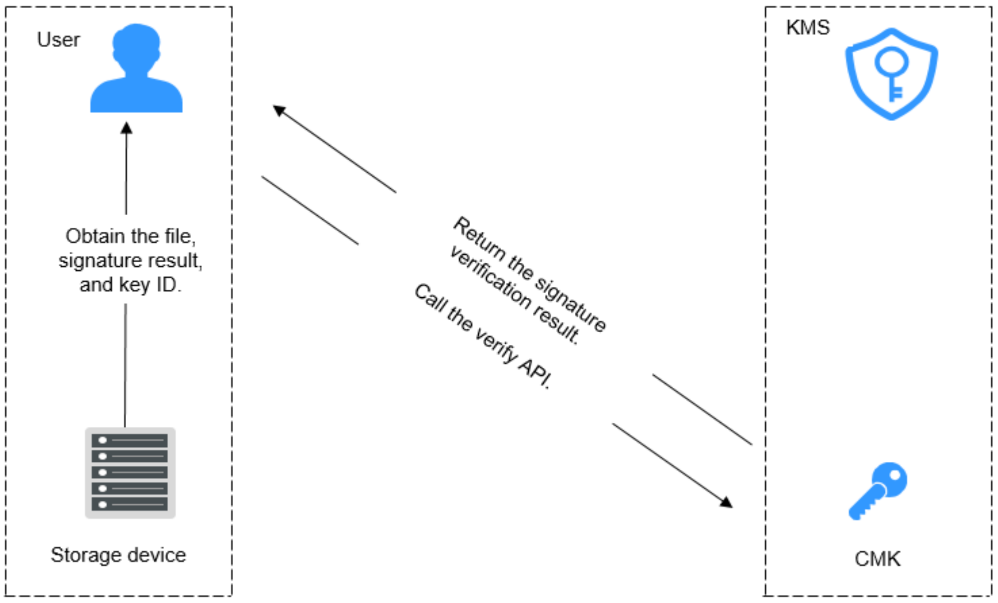
Figure 1-18 Signature process


User
Create a CMK.
KMS
Call the sign API.
Return the signature result.
File, signature result, and key ID
Storage device
CMK

Before using a file, you need to check the integrity of the file to ensure that the file is not tampered with.

Recalculate the file digest and call the verify API of KMS with the signature value to verify the signature for the digest. The signature verification result is obtained. If the signature is verified, the file has not been tampered with. The following figure shows the signature verification process.

Figure 1-19 Signature verification process.


User
Obtain the file, signature result, and key ID.
Storage device
KMS
CMK
Return the signature verification result.
Call the verify API.

Procedure

Step 1 Obtain the AK and the SK.

- ACCESS_KEY: Access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
- SECRET_ACCESS_KEY: Secret access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
- There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
- In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.

Step 2 Obtain region information.

- **Log in to the management console**.

Step 3 Use KMS to sign the file and verify the signature.

```
public class FileStreamSignVerifyExample {

    /**
     * Basic authentication information:
     * - ACCESS_KEY: access key of the Huawei Cloud account
     * - SECRET_ACCESS_KEY: secret access key of the Huawei Cloud account, which is sensitive information.
Store this in ciphertext.
     * - IAM_ENDPOINT: endpoint for accessing IAM. For details, see Regions and Endpoints.
     * - KMS_REGION_ID: regions supported by KMS. For details, see Regions and Endpoints.
     * - KMS_ENDPOINT: endpoint for accessing KMS. For details, see Regions and Endpoints.
     */
    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");
    private static final String IAM_ENDPOINT = "https://<IamEndpoint>";
    private static final String KMS_REGION_ID = "<RegionId>";
    private static final String KMS_ENDPOINT = "https://<KmsEndpoint>";

    public static void main(String[] args) {
        // CMK ID. Select a key whose usage contains SIGN_VERIFY.
        final String keyId = args[0];

        signAndVerifyFile(keyId);
    }

    /**
     * Use KMS to sign the file and verify the signature.
     *
     * @param keyId: CMK ID
     */
    static void signAndVerifyFile(String keyId) {
        // 1. Prepare the authentication information for accessing HUAWEI CLOUD.
        final BasicCredentials auth = new BasicCredentials()
                .withIamEndpoint(IAM_ENDPOINT).withAk(ACCESS_KEY).withSk(SECRET_ACCESS_KEY);

        // 2. Initialize the SDK and transfer the authentication information and the address for the KMS to
access the client.
        final KmsClient kmsClient = KmsClient.newBuilder()
                .withRegion(new Region(KMS_REGION_ID, KMS_ENDPOINT)).withCredential(auth).build();

        // 3. Prepare the file to be signed.
        // inFile File to be signed
        final File inFile = new File("FirstSignFile.iso");
        final String fileSha256Sum = getFileSha256Sum(inFile);

        // 4. Calculate the digest and select a proper signature algorithm based on the key type.
        final SignRequest signRequest = new SignRequest().withBody(
                new
SignRequestBody().withKeyId(keyId).withSigningAlgorithm(SignRequestBody.SigningAlgorithmEnum.RSASSA
_PSS_SHA_256)
                        .withMessageType(SignRequestBody.MessageTypeEnum.DIGEST).withMessage(fileSha256Su
m));

        final SignResponse signResponse = kmsClient.sign(signRequest);

        // 5. Verify the digest.
        final ValidateSignatureRequest validateSignatureRequest = new ValidateSignatureRequest().withBody(
                new
VerifyRequestBody().withKeyId(keyId).withMessage(fileSha256Sum).withSignature(signResponse.getSignatur
e())
                        .withSigningAlgorithm(VerifyRequestBody.SigningAlgorithmEnum.RSASSA_PSS_SHA_256)
                        .withMessageType(VerifyRequestBody.MessageTypeEnum.DIGEST));
        final ValidateSignatureResponse validateSignatureResponse =
kmsClient.validateSignature(validateSignatureRequest);

        // 6. Compare the digest result.
        assert validateSignatureResponse.getSignatureValid().equalsIgnoreCase("true");

    }

    /**
     * Calculate the SHA256 digest of the file.
     *
     * @param file
     * @return SHA256 digest in Base64 format
     */
    static String getFileSha256Sum(File file) {
        int length;
        MessageDigest sha256;
        byte[] buffer = new byte[1024];
        try {
            sha256 = MessageDigest.getInstance("SHA-256");
        } catch (NoSuchAlgorithmException e) {
            throw new RuntimeException(e.getMessage());
        }
        try (FileInputStream inputStream = new FileInputStream(file)) {
            while ((length = inputStream.read(buffer)) != -1) {
                sha256.update(buffer, 0, length);
            }
            return Base64.getEncoder().encodeToString(sha256.digest());
        } catch (IOException e) {
            throw new RuntimeException(e.getMessage());
        }
    }

}
```

----End

2 Cloud Secret Management Service

2.1 Using CSMS to Change Hard-coded Database Account Passwords

Generally, the secrets used for access are embedded in applications. To update a secret, you need to create a new secret and spend time updating your applications. If you have multiple applications using the same secret, you have to update all of them, or the applications you forgot to update will be unable to use the secret for login.

An easy-to-use, effective, and secure secret management tool will be helpful.

Cloud Secret Management Service (CSMS) has the following advantages:

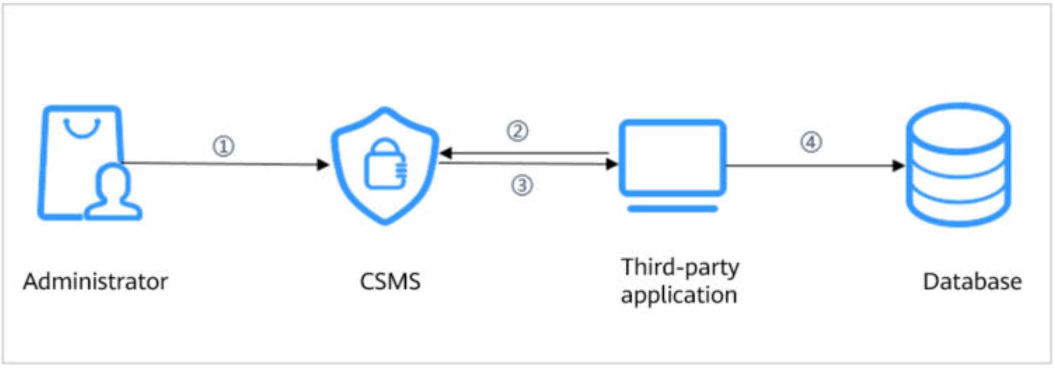
- You can host your secrets instead of using hardcoded secrets, improving the security of data and assets.
- Your services are not affected when you **manually rotate** secrets.
- Secure SDK access allows you to dynamically call your secrets.
- You can store many types of secrets. You can store service accounts, passwords, and database information, including but not limited to database names, IP addresses, and port numbers.

Logging In to a Database Using Secrets

You can create a secret and log in to your database by calling the secret via an API.

Ensure your account has the KMS Administrator or KMS CMKFullAccess permission. For details, see **DEW Permissions Management**.

Figure 2-1 Secret-based login process



The process is as follows:

Step 1 Create a secret on the **console** or via an **API** to store database information (such as the database address, port, and password).

Step 2 Use an application to access the database. CSMS will query the secret created in **1**.

Step 3 CSMS retrieves and decrypts the secret ciphertext and securely returns the information stored in the secret to the application through the secret management API.

Step 4 The application obtains the decrypted plaintext secret and uses it to access the database.

----End

Secret Creation and Query APIs

You can call the following APIs to create secrets, save their content, and query secret information.

API	Description
Creating a Secret	This API is used to create a secret and store the secret value in the initial secret version.
Querying a Secret	This API is used to query a secret.

Creating and Querying Secrets via APIs

1. Prepare basic authentication information.
   - **ACCESS_KEY**: Access key of the Huawei account
   - **SECRET_ACCESS_KEY**: Secret access key of the Huawei account
   - **PROJECT_ID**: project ID of a Huawei Cloud site. For details, see **Project**.
   - **CSMS_ENDPOINT**: endpoint for accessing CSMS. For details, see **Endpoints**.

- There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
- In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.

2. Create and query secret information.

   Secret name: **secretName**

   Secret value: **secretString**

   Secret version value: **LATEST_SECRET**

   Secret version: **versionId**

```
import com.huaweicloud.sdk.core.auth.BasicCredentials;
import com.huaweicloud.sdk.csms.v1.CsmsClient;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretRequest;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretRequestBody;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretResponse;
import com.huaweicloud.sdk.csms.v1.model.ShowSecretVersionRequest;
import com.huaweicloud.sdk.csms.v1.model.ShowSecretVersionResponse;

public class CsmsCreateSecretExample {
    /**
     * Basic authentication information:
     * - ACCESS_KEY: Access key of the Huawei account
     * - SECRET_ACCESS_KEY: Secret access key of the Huawei account
     * - PROJECT_ID: Huawei Cloud project ID. For details, see https://support.huaweicloud.com/intl/en-us/
productdesc-iam/iam_01_0023.html
* - CSMS_ENDPOINT: endpoint address for accessing CSMS. For details, see https://
support.huaweicloud.com/intl/en-us/api-dew/dew_02_0052.html.
     * - There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt
the AK/SK in the configuration file or environment variables for storage.
     * - In this example, the AK/SK stored in the environment variables are used for identity authentication.
Configure the environment variables HUAWEICLOUD_SDK_AK and HUAWEICLOUD_SDK_SK in the local
environment first.
     */
    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");
    private static final String PROJECT_ID = "<ProjectID>";
    private static final String CSMS_ENDPOINT = "<CsmsEndpoint>";

    //Version ID used to query the latest secret version details
    private static final String LATEST_SECRET = "latest";

    public static void main(String[] args) {
        String secretName = args[0];
        String secretString = args[1];

        //Create a secret.
        createSecret(secretName, secretString);

        //Query the content of the new secret based on the secret version latest or v1.
        ShowSecretVersionResponse latestVersion = showSecretVersion(secretName, LATEST_SECRET);
        ShowSecretVersionResponse firstVersion = showSecretVersion(secretName, "v1");

        assert latestVersion.equals(firstVersion);
        assert latestVersion.getVersion().getSecretString().equalsIgnoreCase(secretString);
    }

    /**
     * Create a secret.
     * @param secretName
     * @param secretString
     */
    private static void createSecret(String secretName, String secretString) {
        CreateSecretRequest secret = new CreateSecretRequest().withBody(
                new CreateSecretRequestBody().withName(secretName).withSecretString(secretString));

        CsmsClient csmsClient = getCsmsClient();

        CreateSecretResponse createdSecret = csmsClient.createSecret(secret);

        System.out.printf("Created secret success, secret detail:%s", createdSecret);
    }
    /**
     * Query secret version details based on the secret version ID.
     * @param secretName
     * @param versionId
     * @return
     */
    private static ShowSecretVersionResponse showSecretVersion(String secretName, String versionId) {
        ShowSecretVersionRequest showSecretVersionRequest = new
ShowSecretVersionRequest().withSecretName(secretName)
                .withVersionId(versionId);

        CsmsClient csmsClient = getCsmsClient();

        ShowSecretVersionResponse version = csmsClient.showSecretVersion(showSecretVersionRequest);

        System.out.printf("Query secret success. version id:%s",
version.getVersion().getVersionMetadata().getId());

        return version;
    }

    /**
     * Obtain the CSMS client.
     * @return
     */
    private static CsmsClient getCsmsClient() {
        BasicCredentials auth = new BasicCredentials()
                .withAk(ACCESS_KEY)
                .withSk(SECRET_ACCESS_KEY)
                .withProjectId(PROJECT_ID);

        return CsmsClient.newBuilder().withCredential(auth).withEndpoint(CSMS_ENDPOINT).build();
    }
}
```

Obtaining the Database Account Through an Application

1. Obtain the dependency statement of the CSMS SDK.

   Example:

```
<dependency>
            <groupId>mysql</groupId>
            <artifactId>mysql-connector-java</artifactId>
            <version>XXX</version>
        </dependency>
        <dependency>
            <groupId>com.google.code.gson</groupId>
            <artifactId>gson</artifactId>
            <version>2.8.9</version>
        </dependency>
        <dependency>
            <groupId>com.huaweicloud.sdk</groupId>
            <artifactId>huaweicloud-sdk-csms</artifactId>
            <version>3.0.79</version>
        </dependency>
```

2. Establish a database connection and obtain the account.

   Example:

```
import com.google.gson.Gson;
import com.google.gson.JsonObject;
import com.huaweicloud.sdk.csms.v1.model.ShowSecretVersionRequest;
import com.huaweicloud.sdk.csms.v1.model.ShowSecretVersionResponse;

import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.SQLException;

 // Obtain the specified database account based on the secret information.
    public static Connection getMySQLConnectionBySecret(String secretName, String jdbcUrl) throws
ClassNotFoundException, SQLException{
        Class.forName(MYSQL_JDBC_DRIVER);
        ShowSecretVersionResponse latestVersionValue = getCsmsClient().showSecretVersion(new
ShowSecretVersionRequest().withSecretName(secretName).withVersionId("latest"));
        String secretString = latestVersionValue.getVersion().getSecretString();
        JsonObject jsonObject = new Gson().fromJson(secretString, JsonObject.class);
        return DriverManager.getConnection(jdbcUrl, jsonObject.get("username").getAsString(),
jsonObject.get("password").getAsString());
    }
```

2.2 Using CSMS to Prevent AK and SK Leakage

CSMS is a secure, reliable, and easy-to-use credential hosting service. Users or applications can use CSMS to create, retrieve, update, and delete credentials in a unified manner throughout the credential lifecycle. CSMS can help you eliminate risks incurred by hardcoding, plaintext configuration, and permission abuse.

Scenario

Application secrets are stored and can be accessed temporarily to prevent AK and SK leakage.

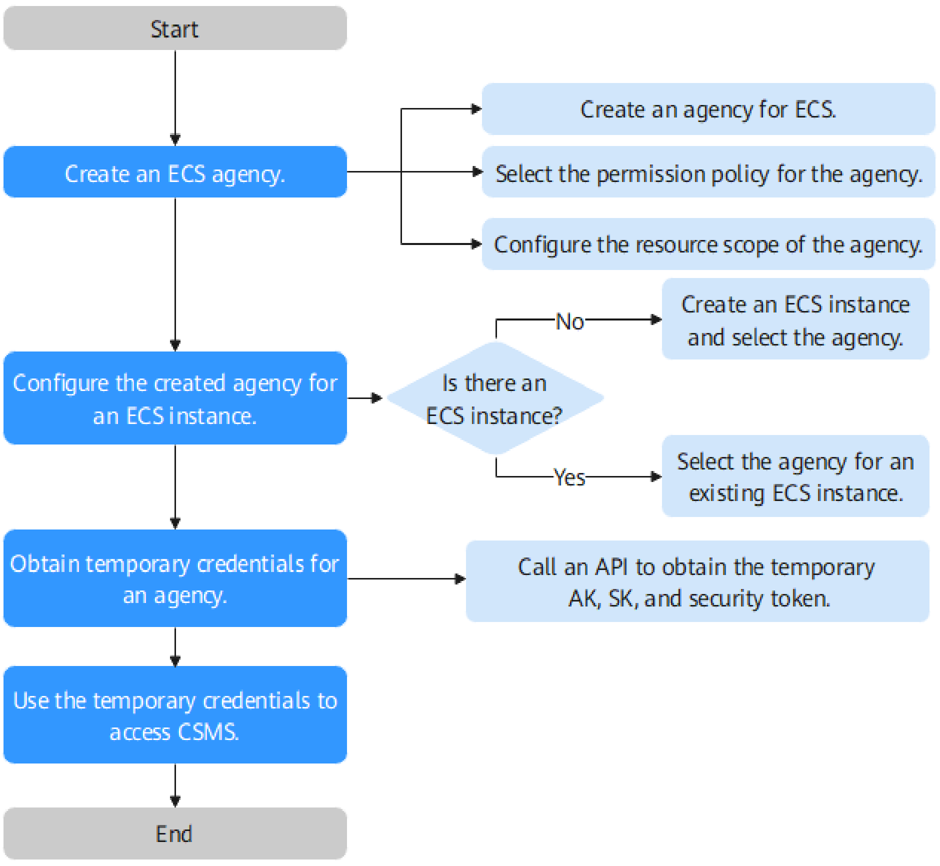
How It Works

You can use Identity and Access Management (IAM) to obtain temporary access keys for Elastic Cloud Server (ECS) to protect AKs and SKs.

Access secrets can be classified into permanent secrets and temporary secrets based on their validity periods. Permanent access secrets include usernames and passwords. Temporary access keys have a shorter validity period, are updated frequently, thus are more secure. You can assign an IAM agency to an ECS instance, so that applications in the ECS instance can use the temporary AK, SK, and security token to access CSMS. The temporary access keys are dynamically obtained every time they are required. They can also be cached in the memory and updated periodically.

Process Flow

Figure 2-2 ECS agency configuration process


Start
Create an ECS agency.
Create an agency for ECS.
Select the permission policy for the agency.
Configure the resource scope of the agency.
Configure the created agency for an ECS instance.
Is there an ECS instance?
No
Create an ECS instance and select the agency.
Yes
Select the agency for an existing ECS instance.
Obtain temporary credentials for an agency.
Call an API to obtain the temporary AK, SK, and security token.
Use the temporary credentials to access CSMS.
End

Constraint

Only the administrator or an IAM user with the ECS permission can configure an agency for an ECS instance.

Procedure

Step 1 Create an ECS agency on IAM.

1. **Log in to the management console**.
2. Click ☰ on the left of the page and choose **Management & Governance** > **Identity and Access Management**. The **Users** page is displayed.
3. In the navigation pane, choose **Agencies**.
4. Click **Create Agency** in the upper right corner.
5. Configure parameters in the **Create Agency** dialog box. For more information, see **Agency parameters**.

Figure 2-3 Creating an agency

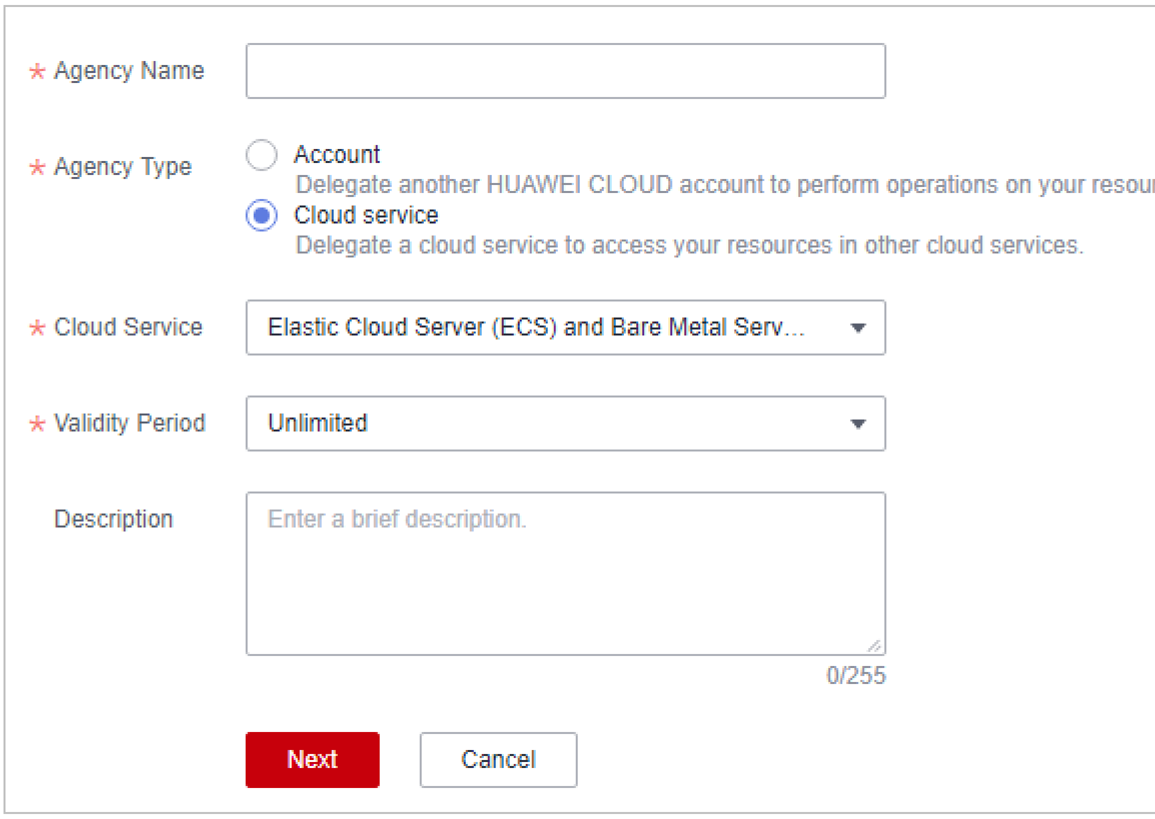
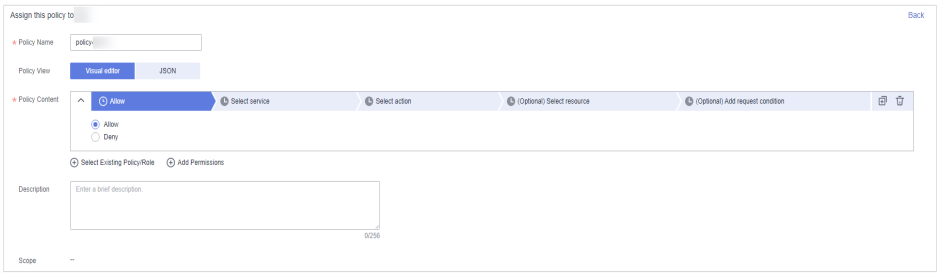

* Agency Name
* Agency Type
Account
Delegate another HUAWEI CLOUD account to perform operations on your resou
Cloud service
Delegate a cloud service to access your resources in other cloud services.
* Cloud Service: Elastic Cloud Server (ECS) and Bare Metal Serv...
* Validity Period: Unlimited
Description: Enter a brief description.
0/255

Table 2-1 Agency parameters

Parameter Name	Description
Agency Name	Enter an agency name. Example: **ECS_TO_CSMS**
Agency Type	Select **Cloud service**.
Cloud Service	Select **Elastic Cloud Server (ECS) and Bare Metal Server (BMS)**.
Validity Period	Select a duration. The value can be **Unlimited**, **1 day**, or **Custom**.
Description	(Optional) Enter agency description.

6. Click **Next** to go to the authorization page.
7. Click **Create Policy** in the upper right corner. If you already have a policy, skip this step.
   a. Configure policy parameters. For more information, see **Policy parameters**.

Figure 2-4 Creating a policy


Assign this policy to

Back

* Policy Name: policy-

Policy View: Visual editor | JSON

* Policy Content: Allow | Select service | Select action | (Optional) Select resource | (Optional) Add request condition

(● Allow) Deny

Select Existing Policy/Role
Add Permissions

Description: Enter a brief description.
0/256

Scope: --

Table 2-2 Policy parameters

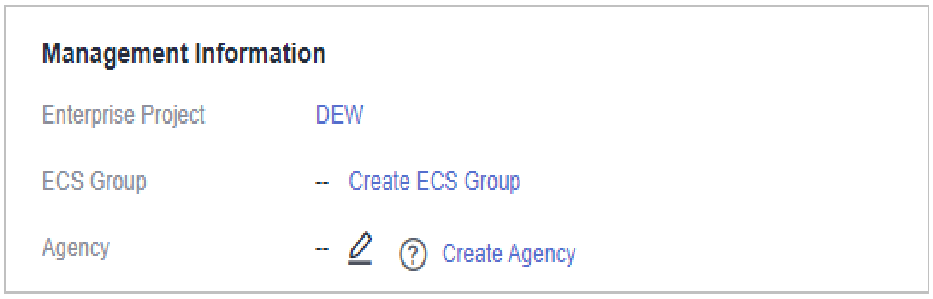
Parameter Name	Description
Policy Name	Enter a policy name.
Policy View	Select **Visual editor**.
Policy Content	▪ **Allow**: Select **Allow**. ▪ **Select service**: Select **Cloud Secret Management Service (CSMS)**. ▪ **Select action**: Select read and write permissions as required. ▪ **(Optional) Select resource**: Select the scope of resources. ○ **Specific**: Access specific secrets. **NOTE** You can select **Specify resource path**, and then click **Add Resource Path** to specify an accessible secret. ○ **All**: Access all secrets. ▪ **(Optional) Add request condition**: Click **Add Request Condition**, select a condition key and an operator, and enter values as required.
Description	(Optional) Enter policy description.

8. Select a policy for the agency. Click **Next**.
9. Select a scope and click **OK**.
   - **All resources**: IAM users will be able to use all resources, including those in enterprise projects, region-specific projects, and global services under your account based on assigned permissions.
   - **Enterprise projects**: The selected permissions will be applied to resources in the enterprise projects you select.
   - **Region-specific projects**: The selected permissions will be applied to resources in the region-specific projects you select.

Step 2 Assign an agency (for example, **ECS_TO_CSMS**) to an ECS instance.

- To create an ECS instance, perform the operations described in **Creating an ECS**. In **Step 3: Configure Advanced Settings**, select the new agency (for example, **ECS_TO_CSMS**).
- To use an existing ECS instance, perform the following steps:
  a. Click ☰ on the left of the page and choose **Management & Governance** > **Identity and Access Management**. Go to the ECS page.
  b. Click the name of an ECS instance to go to the **Summary** page.
  c. In the **Management Information** area, click ✎ and select an agency (for example, **ECS_TO_CSMS**).

Figure 2-5 Selecting an agency



Management Information

Enterprise Project	DEW
ECS Group	-- Create ECS Group
Agency	-- ✎ ? Create Agency

Step 3 In an application running on the ECS instance, call an API to obtain the temporary agency secrets, including the temporary AK, SK, and security token, to access CSMS.

1. Obtain the temporary AK and SK (in the **Security Key** directory). For details, see **Obtaining Metadata**.
   – URI
     /openstack/latest/securitykey
   – Method
     GET request
   – The following data is returned:

```
{
    "credential":{
       "access": "LDHZK30XXXXXXXXXXXXV",
       "secret":"gyqcdzVXXXXXXXXXXXXXXXXXXXXXXXMl6",
       "securitytoken": "El9FI2C65qXXXXXXXXXXXXXXXXXXXXXnkcaoV",
       "expires_at": "2022-07-14T12:09:24.147000Z"
            }
}
```

NOTE

- Extract the values of **access**, **secret**, and **securitytoken** to access CSMS.
- ECS automatically rotates temporary secrets to ensure that they are secure and valid.

2. Use the temporary AK, SK, and security token to access CSMS.
   – An example of the secret list is as follows. For details, see **Secret Management APIs**.

– Prepare basic authentication information.

  - ACCESS_KEY: Access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
  - SECRET_ACCESS_KEY: Secret access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
  - There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
  - In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.

```
package com.huaweicloud.sdk.test;

import com.huaweicloud.sdk.core.auth.ICredential;
import com.huaweicloud.sdk.core.auth.BasicCredentials;
import com.huaweicloud.sdk.core.exception.ConnectionException;
import com.huaweicloud.sdk.core.exception.RequestTimeoutException;
import com.huaweicloud.sdk.core.exception.ServiceResponseException;
import com.huaweicloud.sdk.csms.v1.region.CsmsRegion;
import com.huaweicloud.sdk.csms.v1.*;
import com.huaweicloud.sdk.csms.v1.model.*;

public class ListSecretsSolution {
    public static void main(String[] args) {
     * Basic authentication information:
     * - ACCESS_KEY: Access key of the Huawei account
     * - SECRET_ACCESS_KEY: Secret access key of the Huawei account
     * - PROJECT_ID: Huawei Cloud project ID. For details, see https://support.huaweicloud.com/
intl/en-us/productdesc-iam/iam_01_0023.html
* - CSMS_ENDPOINT: endpoint address for accessing CSMS. For details, see https://
support.huaweicloud.com/intl/en-us/api-dew/dew_02_0052.html.
     * - There will be security risks if the AK/SK used for authentication is directly written into
code. Encrypt the AK/SK in the configuration file or environment variables for storage.
     * - In this example, the AK/SK stored in the environment variables are used for identity
authentication. Configure the environment variables HUAWEICLOUD_SDK_AK and
HUAWEICLOUD_SDK_SK in the local environment first.
     */
    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");
    String securitytoken = "<YOUR SecurityToken>";

        String ak = System.getenv("CLOUD_SDK_AK");
        String sk = System.getenv("CLOUD_SDK_SK");

        ICredential auth = new BasicCredentials()
                .withAk(ak)
                .withSk(sk)
                .withSecurityToken(securitytoken);

         CsmsClient client = CsmsClient.newBuilder()
                .withCredential(auth)
                .withRegion(CsmsRegion.valueOf("cn-north-1"))
                .build();
         ListSecretsRequest request = new ListSecretsRequest();
         try {
             ListSecretsResponse response = client.listSecrets(request);
             System.out.println(response.toString());
         } catch (ConnectionException e) {
             e.getMessage();
         } catch (RequestTimeoutException e) {
             e.getMessage();
         } catch (ServiceResponseException e) {
             e.getMessage();
             System.out.println(e.getHttpStatusCode());
             System.out.println(e.getErrorCode());
             System.out.println(e.getErrorMsg());
         }
     }
}
```

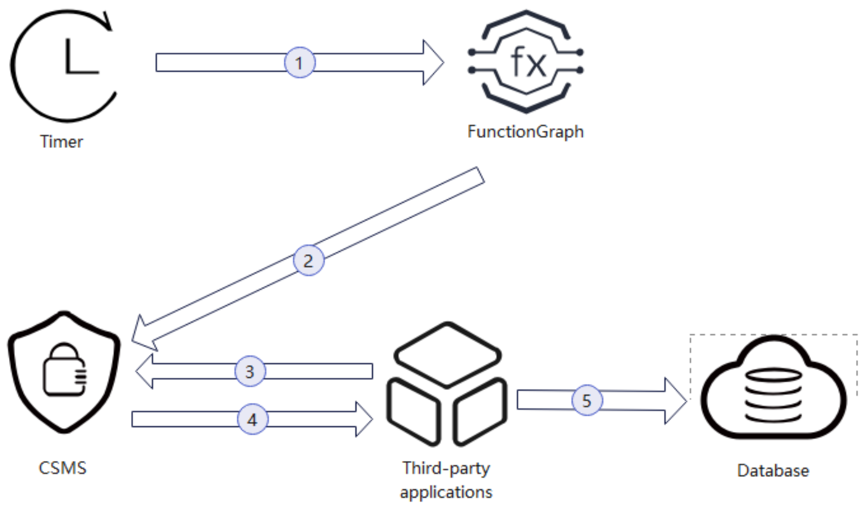
----End

2.3 Using CSMS to Automatically Rotate Security Passwords

This section describes how to use FunctionGraph and CSMS to generate and rotate strong secure passwords periodically, so that secure and compliant passwords can be generated, hosted, and automatically rotated.

Process

Figure 2-6 Password rotation



The process is as follows:

1. When a timer expires, a scheduled triggering event is published.
2. After receiving the event, FunctionGraph replaces the placeholder in the secret template with a new random password, and stores the password in the secret, which is considered as a new version of the secret.
3. Applications periodically call APIs or SDKs to obtain the latest secret version.
4. CSMS retrieves and decrypts the secret ciphertext and securely returns the information stored in the secret to the application through the secret management API.

5. After receiving the decrypted secret, applications use the new password for future access by using it to update the target object (such as the database or server).

Constraints

- CSMS is available in the region.
- FunctionGraph is available in the region.

Creating an Agency

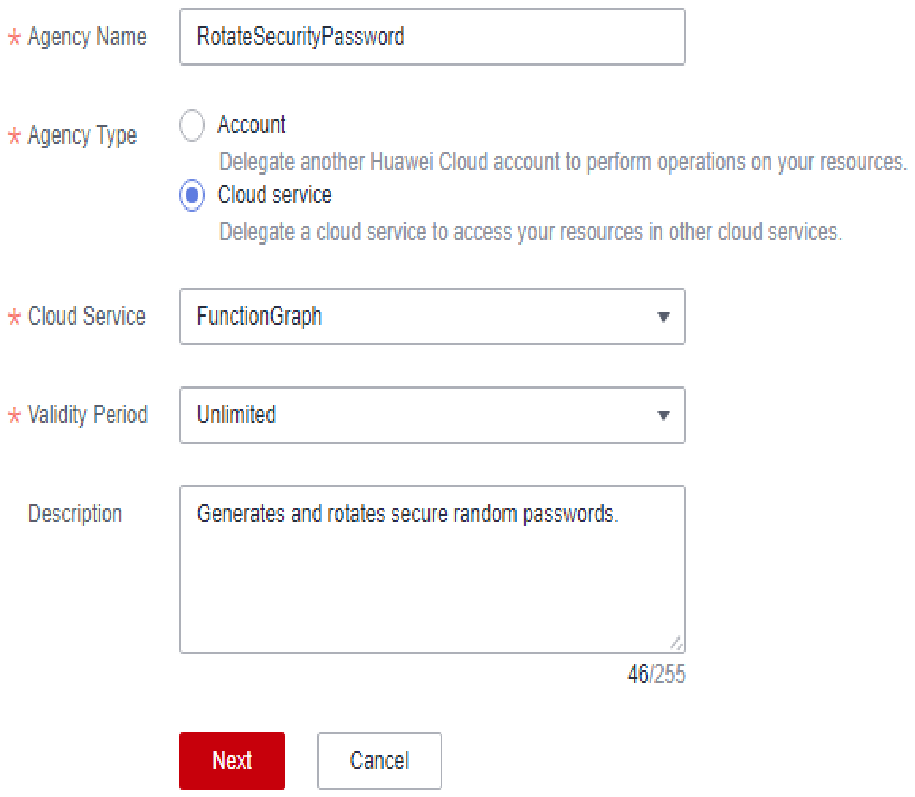
Step 1 Log in to the management console.

Step 2 Click ☰ on the left and choose **Management & Governance** > **Identity and Access Management** to access the **Users** page.

Step 3 In the navigation pane one the left, choose **Agencies**.

Step 4 Click **Create Agency** and configure the parameters as shown in **Figure 2-7**. **Table 2-3** describes the parameters.

Figure 2-7 Creating an agency



* Agency Name	RotateSecurityPassword
* Agency Type	Account: Delegate another Huawei Cloud account to perform operations on your resources. [✓ Cloud service: Delegate a cloud service to access your resources in other cloud services.]
* Cloud Service	FunctionGraph
* Validity Period	Unlimited
Description	Generates and rotates secure random passwords. 46/255

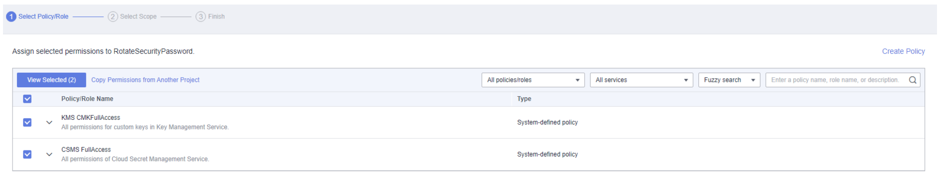
Table 2-3 Agency parameters

Parameter	Description
Agency Name	Set this parameter as required.
Agency Type	Select **Cloud service**.
Cloud Service	Choose **FunctionGraph**.
Validity Period	Set this parameter based on the application scenario of the function. If the function needs to be executed for a long time, choose **Unlimited**.
Description	Set this parameter as needed.

Step 5 Click **Next**.

Step 6 Select **CSMS FullAccess** and **KMS CMKFullAccess**.

Figure 2-8 Selecting permissions

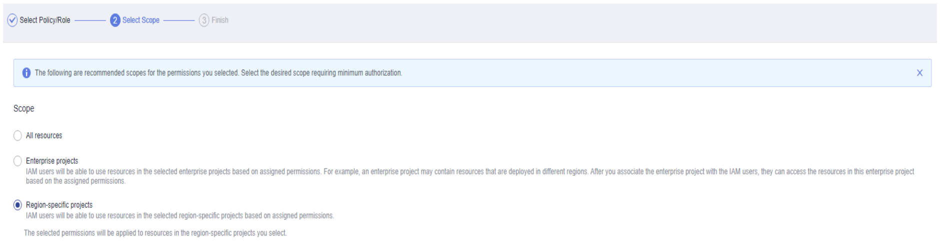


Assign selected permissions to RotateSecurityPassword.

	Policy/Role Name	Type
✓	KMS CMKFullAccess All permissions for custom keys in Key Management Service.	System-defined policy
✓	CSMS FullAccess All permissions of Cloud Secret Management Service.	System-defined policy

Step 7 Click **Next** and select a scope based on your service requirements.

Figure 2-9 Selecting a scope



The following are recommended scopes for the permissions you selected. Select the desired scope requiring minimum authorization.

Scope

- ○ All resources
- ○ Enterprise projects
  IAM users will be able to use resources in the selected enterprise projects based on assigned permissions. For example, an enterprise project may contain resources that are deployed in different regions. After you associate the enterprise project with the IAM users, they can access the resources in this enterprise project based on the assigned permissions.
- ● Region-specific projects
  IAM users will be able to use resources in the selected region-specific projects based on assigned permissions.

The selected permissions will be applied to resources in the region-specific projects you select.

Step 8 Click **OK**.

----End

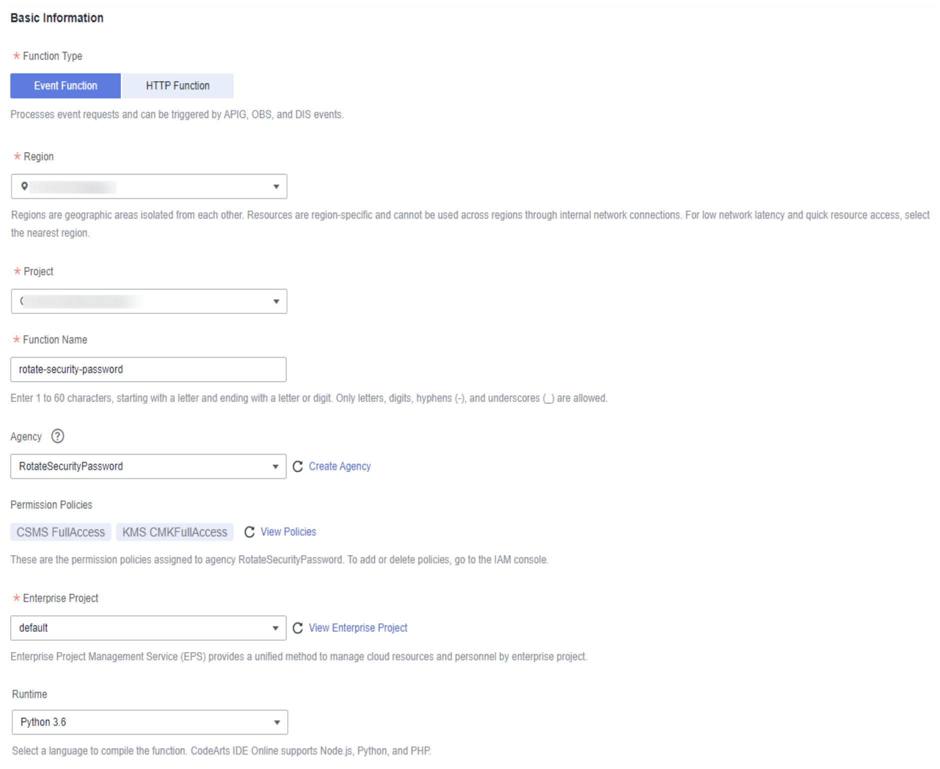
Creating a Password Rotation Function

Step 1 Log in to the management console.

Step 2 Click ☰ on the left and choose **Compute** > **FunctionGraph**.

Step 3 Click **Create Function** in the upper right corner and configure the parameters as shown in **Figure 2-10**. **Table 2-4** describes the parameters.

Figure 2-10 Creating a function



Basic Information

* Function Type

Event Function | HTTP Function

Processes event requests and can be triggered by APIG, OBS, and DIS events.

* Region

[redacted]

Regions are geographic areas isolated from each other. Resources are region-specific and cannot be used across regions through internal network connections. For low network latency and quick resource access, select the nearest region.

* Project

[redacted]

* Function Name

rotate-security-password

Enter 1 to 60 characters, starting with a letter and ending with a letter or digit. Only letters, digits, hyphens (-), and underscores (_) are allowed.

Agency

RotateSecurityPassword

Create Agency

Permission Policies

CSMS FullAccess KMS CMKFullAccess View Policies

These are the permission policies assigned to agency RotateSecurityPassword. To add or delete policies, go to the IAM console.

* Enterprise Project

default

View Enterprise Project

Enterprise Project Management Service (EPS) provides a unified method to manage cloud resources and personnel by enterprise project.

Runtime

Python 3.6

Select a language to compile the function. CodeArts IDE Online supports Node.js, Python, and PHP.

Table 2-4 Basic parameters

Parameter	Description
Region	Select the region where the function is deployed.
Project	Select the project where the function is deployed.
Function Name	Enter a custom function name.
Agency	Enter the name set in **Creating an Agency**.
Enterprise Project	If you have enabled enterprise projects, select one for you to add a function to it. If you have not enabled enterprise projects, this parameter will not be displayed. Skip this step. For details about how to enable an enterprise project, see **Enabling Enterprise Center**.
Runtime	Select a language for writing the function. Currently, Python is supported. **NOTE** Only Python 3.6, 3.9, and 3.10 are supported.

Step 4 Click **Create Function**.

Step 5 Choose the **Configuration** tab. In the navigation pane on the left, choose **Environment Variables**. Click **Add** and add environment variables in the variable configuration row. **Table 2-4** describes the parameters. Then, click **Save**.

Table 2-5 Environment variables

Parameter	Description	Example
region	Project name which is based on the region, for example, if the region is CN North-Beijing4, the project name should be **cn-north-4**. To obtain your region, click your username in the upper right corner of the page, and choose **My Credentials** from the drop-down list.	cn-north-4
secret_name	Name of the secret to be rotated **NOTE** A secret must have been created. For details, see **Creating a Secret**.	rds-functionGraph-rotate
secret_conte nt	Secret template which is specified using braces ({}), for example, the secret template is **{"password":"password_placeholder"}**. In this case, **password_placeholder** is the placeholder, which will be replaced by a secure password after the function is executed. The new content will be saved in the secret after the replacement. **NOTE** If multiple placeholders exist in a template, more than one password will be generated and replaced in sequence.	{"password":"password_placeholder"}
password_le ngth	Password length. The value ranges from **8** to **128**. The default value is **16**.	16
password_fo rmat	Password format. The default value is **2**. Possible values are as follows: 1. Digits and letters 2. Digits, letters, and special characters (~!@#%^*-_=+?) 3. Only digits 4. Only letters	2

Step 6 Choose the **Code** tab, add the following password rotation function to the editing window, and click **Deploy**.

```
# -*- coding:utf-8 -*-
import json
import secrets
import string
import requests
import inspect

def handler (event, context):
    global secret_content
    global password_length
    global password_format
    global kms_endpoint
    global region
    global secret_name
    global headers
    region = context.getUserData('region')
    secret_name = context.getUserData('secret_name')
    password_length = 16 if context.getUserData('password_length') is None else
int(context.getUserData('password_length'))
    password_format = 2 if context.getUserData('password_format') is None else
int(context.getUserData('password_format'))
    secret_content = context.getUserData('secret_content')
    headers = {
        'Content-Type': 'application/json',
        'x-Auth-Token': context.getToken()
    }
    try:
        new_content = replace_old_content(secret_content)
        # check region, if pass, return kms endpoint
        kms_endpoint = check_region(region)
        return update(context, new_content)
    except Exception as e:
        print("ERROR: %s" % e)
        return 'FAILED'

# replace "password_placeholder" in secret_content by new password
def replace_old_content(content):
    while content.find("password_placeholder") != -1:
        password = generate_password()
        while password.find("password_placeholder") != -1:
            password = generate_password()
        content = content.replace("password_placeholder", password, 1)
    return content

def generate_password():
    special_chars = "~!@#%^*-_=+?"
    # password format(default is 2):
    # 1.support letters and digits; 2.support letters, digits and special chars(~!@#%^*-_=+?);
    # 3.only support digits; 4.only support letters
    format_mapping = {
        1: string.ascii_letters + string.digits,
        2: string.ascii_letters + string.digits + special_chars,
        3: string.digits,
        4: string.ascii_letters
    }
    if password_length < 8 or password_length > 128:
        raise Exception("invalid password_length: %s, the password length range must be between 8-128." %
password_length)
    try:
        support_chars = format_mapping[password_format]
        password = ''.join([secrets.choice(support_chars) for _ in range(password_length)])
        return password
    except:
        raise Exception("invalid password_format: %s." % password_format)

def check_region(region):
    endpoint_mapping = {
        'cn-north-1': 'cn-north-1.myhuaweicloud.com',
        'cn-north-2': 'cn-north-2.myhuaweicloud.com',
        'cn-north-4': 'cn-north-4.myhuaweicloud.com',
        'cn-north-7': 'cn-north-7.myhuaweicloud.com',
        'cn-north-9': 'cn-north-9.myhuaweicloud.com',
        'cn-east-2': 'cn-east-2.myhuaweicloud.com',
        'cn-east-3': 'cn-east-3.myhuaweicloud.com',
        'cn-south-1': 'cn-south-1.myhuaweicloud.com',
        'cn-south-2': 'cn-south-2.myhuaweicloud.com',
        'cn-southwest-2': 'cn-southwest-2.myhuaweicloud.com',
        'ap-southeast-1': 'ap-southeast-1.myhuaweicloud.com',
        'ap-southeast-2': 'ap-southeast-2.myhuaweicloud.com',
        'ap-southeast-3': 'ap-southeast-3.myhuaweicloud.com',
        'af-south-1': 'af-south-1.myhuaweicloud.com',
        'la-north-2': 'la-north-2.myhuaweicloud.com',
        'la-south-2': 'la-south-2.myhuaweicloud.com',
        'na-mexico-1': 'na-mexico-1.myhuaweicloud.com',
        'sa-brazil-1': 'sa-brazil-1.myhuaweicloud.com'
    }
    try:
        endpoint = endpoint_mapping[region]
        kms_endpoint = '%s.%s' % ('kms', endpoint)
        return kms_endpoint
    except:
        raise Exception("invalid region: %s" % region)

def check_csms_resp(resp):
    if resp.status_code in (200, 201, 204):
        return
    caller_function_name = inspect.stack()[1].function
    json_resp = json.loads(resp.text)
    if 'error_msg' in json_resp:
        error_message = 'function:%s , reason: %s' % (
            caller_function_name, json_resp['error_msg'])
        raise Exception(error_message)
    error_message = 'function:%s , reason: %s' % (
        caller_function_name, resp.text)
    raise Exception(error_message)

def update(context, new_content):
    project_id = context.getProjectID()
    url = 'https://%s/v1/%s/secrets/%s/versions' % (kms_endpoint, project_id, secret_name)
    payload = {'secret_string': new_content}
    payload = json.dumps(payload)
    resp = requests.post(url, headers=headers, data=payload)
    check_csms_resp(resp)
    return 'SUCCESS'
```

----End

Debugging

Debug the created FunctionGraph. For details, see **Online Debugging**.

Creating a Trigger

Create a trigger. For details, see **Using a Timer Trigger**.

Viewing a Secret

Step 1 **Log in to the management console**.

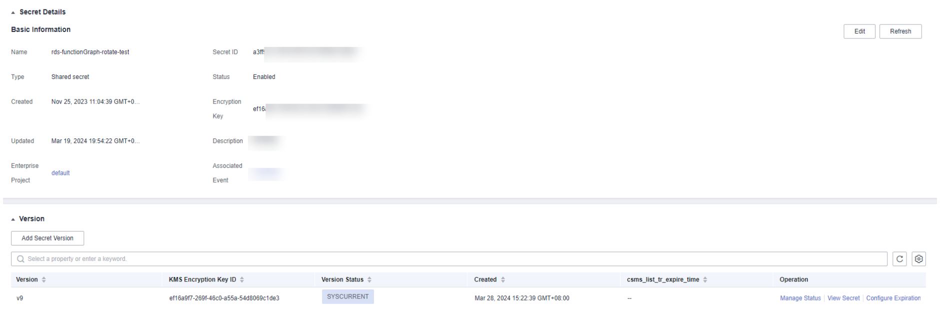
Step 2 Click ☰. Choose **Security & Compliance** > **Data Encryption Workshop**.

Step 3 In the navigation pane, choose **Cloud Secret Management Service**.

Step 4 Search for the secret created in **Creating a Password Rotation Function**.

Step 5 Click the secret to view its details, including current and historical versions.

Figure 2-11 Viewing secret details


Secret Details

Basic Information

Edit | Refresh

Name	rds-functionGraph-rotate-test	Secret ID	a3ff[redacted]
Type	Shared secret	Status	Enabled
Created	Nov 25, 2023 11:04:39 GMT+0...	Encryption Key	ef16[redacted]
Updated	Mar 19, 2024 19:54:22 GMT+0...	Description	[redacted]
Enterprise Project	default	Associated Event	[redacted]

Version

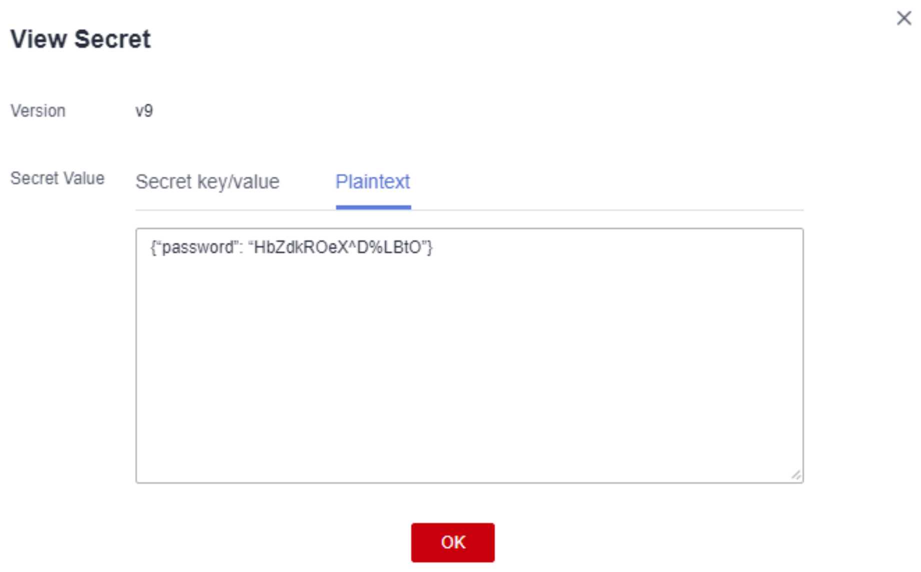
Add Secret Version

Select a property or enter a keyword.

Version	KMS Encryption Key ID	Version Status	Created	csms_list_tr_expire_time	Operation
v9	ef16a9f7-269f-46c0-a55a-54d8069c1de3	SYSCURRENT	Mar 28, 2024 15:22:39 GMT+08:00	--	Manage Status | View Secret | Configure Expiration

Step 6 In the **Version**, locate the secret, and click **View Secret** in the **Operation** column to view the password.

Figure 2-12 Viewing a secret value


View Secret

Version v9

Secret Value: Secret key/value | Plaintext

```
{"password": "HbZdkROeX^D%LBtO"}
```

OK

----End

2.4 Rotating Secrets

2.4.1 Overview

If you have not updated secrets for a long time, important information (such as important passwords, tokens, certificates, SSH keys, and API keys) protected by these secrets are exposed to leakage risks. Periodically rotating secrets improves the security of protected plaintext information.

HUAWEI CLOUD provides two secret rotation policies:

- **Rotating a Secret for a User**
- **Rotating a Secret for a Two Users**

You can select a rotation policy as needed.

Procedure

1. The administrator adds a secret version and updates its content on the **console** or via an **API**.
2. The application calls a CSMS API to obtain the latest secret version or the secret of a specified version status, and then rotate the secret.
3. Regularly repeat steps **1** and **2** to rotate secrets.

2.4.2 Rotating a Secret for a User

Overview

You can update the information of a user in a secret.

This is the most commonly used secret rotation policy.

Example:

- For database access, a database connection is not deleted during secret rotation. After the rotation, new connections use the new secrets.
- A user can create an account, for example, using an email address as the username. Generally, users can change passwords as needed, but cannot create other users or change usernames.
- Temporary users are created at the moment they are needed.
- Passwords are entered by users, not retrieved from CSMS by applications. These users do not need to change their usernames or passwords.

Constraints

Ensure your account has the KMS Administrator or KMS CMKFullAccess permission. For details, see **DEW Permissions Management**.

Secret Rotation APIs

You can call the following APIs to rotate secrets locally.

API	Description
Creating a Secret Version	Create a secret version.
Querying the Secret Version and Value	Query the information about a specified secret version and the plaintext secret value in the version.

Example of Single Account Secret Rotation

1. Create a secret on the HUAWEI CLOUD console. For details, see **Creating a Secret**.
2. Prepare basic authentication information.
   - **ACCESS_KEY**: Access key of the Huawei account

- **SECRET_ACCESS_KEY**: Secret access key of the Huawei account
- **PROJECT_ID**: project ID of a HUAWEI CLOUD site. For details, see **Project**.
- **CSMS_ENDPOINT**: endpoint for accessing CSMS. For details, see **Endpoints**.
- There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
- In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.

3. Rotation the secret of a user.

   In the example code,

   - **secretName** indicates the name of the secret created on the Huawei Cloud console.
   - **secretString** indicates the value saved in the secret created on the Huawei Cloud console.
   - **versionId** indicates the secret ID automatically generated after a secret is created on the Huawei Cloud console.
   - **LATEST_VERSION** indicates the secret version.

```
import com.huaweicloud.sdk.core.auth.BasicCredentials;
import com.huaweicloud.sdk.csms.v1.CsmsClient;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretVersionRequest;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretVersionRequestBody;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretVersionResponse;
import com.huaweicloud.sdk.csms.v1.model.ShowSecretVersionRequest;
import com.huaweicloud.sdk.csms.v1.model.ShowSecretVersionResponse;

public class CsmsSingleAccountExample {
    /**
     * Basic authentication information:
     * - ACCESS_KEY: Access key of the Huawei account
     * - SECRET_ACCESS_KEY: Secret access key of the Huawei account
     * - PROJECT_ID: Huawei Cloud project ID. For details, see https://support.huaweicloud.com/
intl/en-us/productdesc-iam/iam_01_0023.html
* - CSMS_ENDPOINT: endpoint address for accessing CSMS. For details, see https://
support.huaweicloud.com/intl/en-us/api-dew/dew_02_0052.html.
     * - There will be security risks if the AK/SK used for authentication is directly written into
code. Encrypt the AK/SK in the configuration file or environment variables for storage.
     * - In this example, the AK/SK stored in the environment variables are used for identity
authentication. Configure the environment variables HUAWEICLOUD_SDK_AK and
HUAWEICLOUD_SDK_SK in the local environment first.
     */
    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");
    private static final String PROJECT_ID = "<ProjectID>";
    private static final String CSMS_ENDPOINT = "<CsmsEndpoint>";
    //Version ID used to query the latest secret version details.
    private static final String LATEST_VERSION = "latest";
    public static void main(String[] args) {
        String secretName = args[0];
        String secretString = args[1];
        singleAccountRotation(secretName, secretString);
    }

    /**
     * Example: secret rotation for a single account
     *
     * @param secretName   Secret name
     * @param secretString Secret content
     */
    private static void singleAccountRotation(String secretName, String secretString) {
        //Host the new secret in CSMS.
        createNewSecretVersion(secretName, secretString);
        //Query the secret of the latest version based on the secret version latest.
        ShowSecretVersionResponse secretResponseByLatest =
showSecretVersionDetail(secretName, LATEST_VERSION);
        assert secretResponseByLatest.getVersion().getSecretString().equals(secretString);
    }

    /**
     * Example of creating a secret
     * If a secret version is added without version status, the program points the SYSCURRENT
version status to the version by default.
     *
     * @param secretName   Secret name
     * @param secretString Secret content
     * @return
     */
    private static CreateSecretVersionResponse createNewSecretVersion(String secretName,
String secretString) {
        CsmsClient csmsClient = getCsmsClient();

        CreateSecretVersionRequest createSecretVersionRequest = new
CreateSecretVersionRequest()
                .withSecretName(secretName)
                .withBody(new CreateSecretVersionRequestBody().withSecretString(secretString));

        CreateSecretVersionResponse secretVersion =
csmsClient.createSecretVersion(createSecretVersionRequest);

        System.out.printf("Created new version success, version id:%s",
secretVersion.getVersionMetadata().getId());
        return secretVersion;
    }
    /**
     * Query the secret of a specified version.
     *
     * @param secretName Secret name
     * @param versionId  Secret_version_ID
     * @return
     */
    private static ShowSecretVersionResponse showSecretVersionDetail(String secretName, String
versionId) {
        ShowSecretVersionRequest showSecretVersionRequest = new
ShowSecretVersionRequest().withSecretName(secretName)
                .withVersionId(versionId);
        CsmsClient csmsClient = getCsmsClient();
        ShowSecretVersionResponse secretDetail =
csmsClient.showSecretVersion(showSecretVersionRequest);
        System.out.printf("Query latest version success. version id:%s",
secretDetail.getVersion().getVersionMetadata().getId());
        return secretDetail;
    }
    /**
     * Obtain the CSMS client.
     *
     * @return
     */
    private static CsmsClient getCsmsClient() {
        BasicCredentials auth = new BasicCredentials()
                .withAk(ACCESS_KEY)
                .withSk(SECRET_ACCESS_KEY)
                .withProjectId(PROJECT_ID);
        return
CsmsClient.newBuilder().withCredential(auth).withEndpoint(CSMS_ENDPOINT).build();
    }
}
```

2.4.3 Rotating a Secret for Two Users

Overview

You can update the information of two users in a secret.

For example, if your application requires high availability and you perform single-user rotation, you may fail to access the application when changing the user password and updating the secret content. In this case, you need to use the multi-user secret rotation policy.

You must have an account, for example, **Admin**, that has the permission to create and change the passwords of **user1** and **user2**. First, create a secret, create and save the account and password of **user1**, and record them as **user1/password1**. Then, create **user2** by adding secret version **v2**, and save the password of **user2** as **user2/password2**. If you change the password of **user1**, you need to add secret version **v3** and record it as **user1/password3**. When the secret version **v3** is being created, the application uses the existing secret version **v2** to obtain information. Once **v3** is ready, the temporary storage tag will be changed, and the application can use **v3** to obtain information.

Constraints

Ensure your account has the KMS Administrator or KMS CMKFullAccess permission. For details, see **DEW Permissions Management**.

Secret Rotation APIs

You can call the following APIs to rotate secrets locally.

API	Description
Creating a Secret Version	Create a secret version.
Querying the Secret Version and Value	Query the information about a specified secret version and the plaintext secret value in the version.
Updating the Version Status of a Secret	Update the version status of a secret.
Querying the Status of a Secret Version	Query the status of a specified secret version.

Example of Dual-Account Secret Rotation

1. Create a secret on the HUAWEI CLOUD console as the administrator. For details, see **Creating a Secret**.
2. Prepare basic authentication information.
   - **ACCESS_KEY**: Access key of the Huawei account
   - **SECRET_ACCESS_KEY**: Secret access key of the Huawei account

- **PROJECT_ID**: project ID of a HUAWEI CLOUD site. For details, see **Project**.
- **CSMS_ENDPOINT**: endpoint for accessing CSMS. For details, see **Endpoints**.
- There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
- In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables **HUAWEICLOUD_SDK_AK** and **HUAWEICLOUD_SDK_SK** in the local environment first.

3. Rotate the secret for two users.

   In the example code,

   - **secretName** indicates the name of the secret created on the Huawei Cloud console.
   - **secretString** indicates the value saved in the secret created on the Huawei Cloud console.
   - **versionId** indicates the secret ID automatically generated after a secret is created on the Huawei Cloud console.
   - **LATEST_VERSION** indicates the secret version.

```
import com.huaweicloud.sdk.core.auth.BasicCredentials;
import com.huaweicloud.sdk.csms.v1.CsmsClient;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretVersionRequest;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretVersionRequestBody;
import com.huaweicloud.sdk.csms.v1.model.CreateSecretVersionResponse;
import com.huaweicloud.sdk.csms.v1.model.ListSecretStageRequest;
import com.huaweicloud.sdk.csms.v1.model.ListSecretStageResponse;
import com.huaweicloud.sdk.csms.v1.model.ShowSecretVersionRequest;
import com.huaweicloud.sdk.csms.v1.model.ShowSecretVersionResponse;
import com.huaweicloud.sdk.csms.v1.model.UpdateSecretStageRequest;
import com.huaweicloud.sdk.csms.v1.model.UpdateSecretStageRequestBody;

import java.util.Collections;
import java.util.List;

public class CsmsDualAccountExample {
    /**
     * Basic authentication information:
     * - ACCESS_KEY: Access key of the Huawei account
     * - SECRET_ACCESS_KEY: Secret access key of the Huawei account
     * - PROJECT_ID: Huawei Cloud project ID. For details, see https://support.huaweicloud.com/
intl/en-us/productdesc-iam/iam_01_0023.html
* - CSMS_ENDPOINT: endpoint address for accessing CSMS. For details, see https://
support.huaweicloud.com/intl/en-us/api-dew/dew_02_0052.html.
     * - There will be security risks if the AK/SK used for authentication is directly written into
code. Encrypt the AK/SK in the configuration file or environment variables for storage;
     * - In this example, the AK/SK stored in the environment variables are used for identity
authentication. Configure the environment variables HUAWEICLOUD_SDK_AK and
HUAWEICLOUD_SDK_SK in the local environment first.
     */
    private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");
    private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");
    private static final String PROJECT_ID = "<ProjectID>";
    private static final String CSMS_ENDPOINT = "<CsmsEndpoint>";

    //Version ID used to query the latest secret version details.
    private static final String LATEST_VERSION = "latest";
    private static final String HW_CURRENT_STAGE = "SYSCURRENT";
    private static final String HW_PENDING_STAGE = "HW_PENDING";

    public static void main(String[] args) {
        String secretName = args[0];
        String secretString = args[1];

        dualAccountRotation(secretName, secretString);
    }

    /**
     * Example: secret rotation for two accounts
     *
     * @param secretName
     * @param secretString
     */
    private static void dualAccountRotation(String secretName, String secretString) {
        // Create a new secret version with a custom version status. Assume that the secret 
content is the account password of service A.
        CreateSecretVersionResponse newSecretVersion = 
createNewSecretVersionWithStage(secretName,
                secretString, Collections.singletonList(HW_PENDING_STAGE));
        String versionId = newSecretVersion.getVersionMetadata().getId();

        // Before rotation, check whether the pending state is modified.
        ListSecretStageResponse listSecretStageResponse = showSecretStage(secretName, 
HW_PENDING_STAGE);
        assert listSecretStageResponse.getStage().getVersionId().equals(versionId);

        // After the account and password of service A are updated, the version status of the new 
secret is updated to SYSCURRENT. The old secret is still stored in the service and cannot be 
accessed by specifying latest.
        updateSecretStage(secretName, versionId, HW_CURRENT_STAGE);

        // Query the secret of the latest version by specifying latest to complete the dual-account 
secret rotation.
        ShowSecretVersionResponse secretResponse = showVersionDetail(secretName, 
LATEST_VERSION);

        assert secretResponse.getVersion().getSecretString().equals(secretString);
    }

    /**
     * Example of creating a secret
     * If you add a secret version by customizing the version status, the program will not point 
the SYSCURRENT version status to this version.
     *
     * @param secretName
     * @param newSecretVersionText
     * @param stageList
     * @return
     */
    private static CreateSecretVersionResponse createNewSecretVersionWithStage(String 
secretName,
                                                                               String newSecretVersionText,
                                                                               List<String> stageList) {
        CsmsClient csmsClient = getCsmsClient();

        //Host the new secret in CSMS.
        CreateSecretVersionRequest createSecretVersionRequest = new 
CreateSecretVersionRequest()
                .withSecretName(secretName)
                .withBody(new CreateSecretVersionRequestBody()
                        .withSecretString(newSecretVersionText)
                        .withVersionStages(stageList));

        CreateSecretVersionResponse secretVersion = 
csmsClient.createSecretVersion(createSecretVersionRequest);

        System.out.printf("Created new version success, version id: %s", 
secretVersion.getVersionMetadata().getId());

        return secretVersion;
    }

    /**
     * Point the input version state to the specified secret version.
     * @param secretName
     * @param versionId
     * @param newStageName
     */
    private static void updateSecretStage(String secretName, String versionId, String
newStageName) {
        UpdateSecretStageRequest updateSecretStageRequest = new
UpdateSecretStageRequest().withSecretName(secretName)
                .withStageName(newStageName).withBody(new
UpdateSecretStageRequestBody().withVersionId(versionId));

        CsmsClient csmsClient = getCsmsClient();

        csmsClient.updateSecretStage(updateSecretStageRequest);

        System.out.printf("Version stage update success. version id:%s, new stage name:%s",
versionId, newStageName);
    }

    /**
     * Query the secret of a specified version.
     * @param secretName
     * @param versionId
     * @return
     */
    private static ShowSecretVersionResponse showVersionDetail(String secretName, String
versionId) {
        ShowSecretVersionRequest showSecretVersionRequest = new
ShowSecretVersionRequest().withSecretName(secretName)
                .withVersionId(versionId);

        CsmsClient csmsClient = getCsmsClient();
        ShowSecretVersionResponse secretDetail =
csmsClient.showSecretVersion(showSecretVersionRequest);

        System.out.printf("Query latest version success. version id:%s",
 secretDetail.getVersion().getVersionMetadata().getId());
        return secretDetail;
    }

    /**
     * Query the status of a specified version.
     * @param secretName
     * @param stageName
     * @return
     */
    private static ListSecretStageResponse showSecretStage(String secretName, String
stageName) {
        ShowSecretStageRequest showSecretStageRequest = new ShowSecretStageRequest()
                .withSecretName(secretName).withStageName(stageName);
        CsmsClient csmsClient = getCsmsClient();
        return csmsClient.showSecretStage(showSecretStageRequest);
    }

    /**
     * Obtain the CSMS client.
     *
     * @return
     */
    private static CsmsClient getCsmsClient() {
        BasicCredentials auth = new BasicCredentials()
                .withAk(ACCESS_KEY)
                .withSk(SECRET_ACCESS_KEY)
                .withProjectId(PROJECT_ID);
        return
```

```
CsmsClient.newBuilder().withCredential(auth).withEndpoint(CSMS_ENDPOINT).build();
    }
}
```

2.4.4 Rotating IAM Secrets Using FunctionGraph

Scenario

This section describes how to rotate IAM secrets through KMS using a FunctionGraph template.

Constraints

- Only IAM member accounts can be rotated. IAM master accounts cannot be rotated.
- The IAM member account to be rotated must have at least one group of secrets.
- CSMS is available in the region.

Procedure

Create an agency.

Step 1 Log in to the management console.

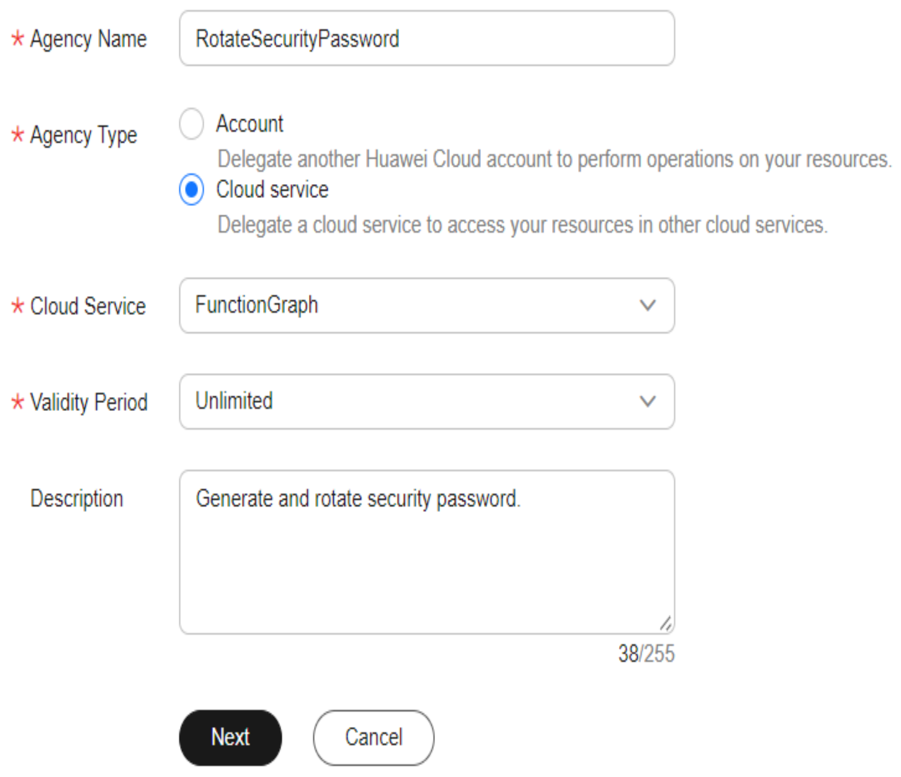
Step 2 Click ● in the upper left corner of the management console and select a region or project.

Step 3 Click ☰ in the upper left corner of the page and choose **Management & Governance** > **Identity and Access Management**.

Step 4 In the navigation pane one the left, choose **Agencies**. Click **Create Agency** in the upper right corner.

Step 5 Configure the parameters, as shown in the following figure. **Table 2-6** lists the parameters.

Figure 2-13 Creating an agency



* Agency Name	RotateSecurityPassword
* Agency Type	○ Account Delegate another Huawei Cloud account to perform operations on your resources. ● Cloud service Delegate a cloud service to access your resources in other cloud services.
* Cloud Service	FunctionGraph
* Validity Period	Unlimited
Description	Generate and rotate security password. 38/255

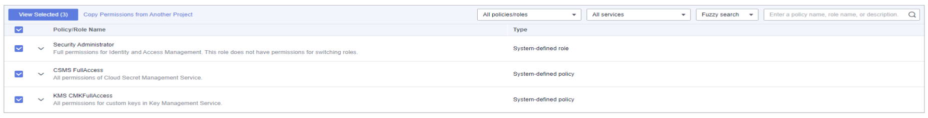
Table 2-6 Parameters for creating an agency

Parameter	Description
Agency Name	Enter a custom agency name, for example, **test**.
Agency Type	Select **Cloud service**.
Cloud Service	Choose **FunctionGraph**.
Validity Period	Set this parameter based on the actual scenario. If the function needs to be executed for a long time, choose **Unlimited**.
Description	Set this parameter as needed.

Step 6 Click **Next**.

Step 7 Select **Security Administrator**, **CSMS FullAccess**, and **KMS CMKFullAccess**, as shown in the following figure.

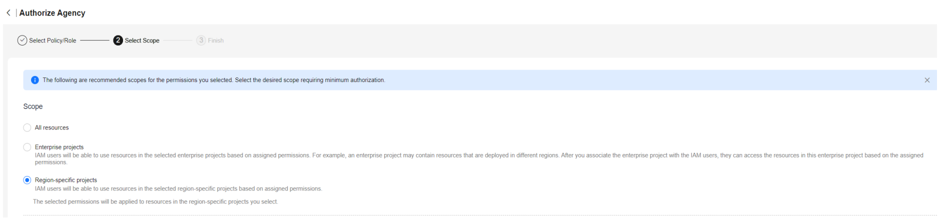
Figure 2-14 Assigning permissions


View Selected (3)
Copy Permissions from Another Project
All policies/roles
All services
Fuzzy search
Enter a policy name, role name, or description.

✓	Policy/Role Name	Type
✓	Security Administrator Full permissions for Identity and Access Management. This role does not have permissions for switching roles.	System-defined role
✓	CSMS FullAccess All permissions of Cloud Secret Management Service.	System-defined policy
✓	KMS CMKFullAccess All permissions for custom keys in Key Management Service.	System-defined policy

Step 8 Click **Next** and choose an authorization scope, as shown in the following figure.

Figure 2-15 Authorization scope



The following are recommended scopes for the permissions you selected. Select the desired scope requiring minimum authorization.

Scope

- All resources
- Enterprise projects
  IAM users will be able to use resources in the selected enterprise projects based on assigned permissions. For example, an enterprise project may contain resources that are deployed in different regions. After you associate the enterprise project with the IAM users, they can access the resources in this enterprise project based on the assigned permissions.
- [✓ Region-specific projects]
  IAM users will be able to use resources in the selected region-specific projects based on assigned permissions.

The selected permissions will be applied to resources in the region-specific projects you select.

Step 9 Click **OK**.

----End

Create a function template and a function.

Step 1 Log in to the management console.

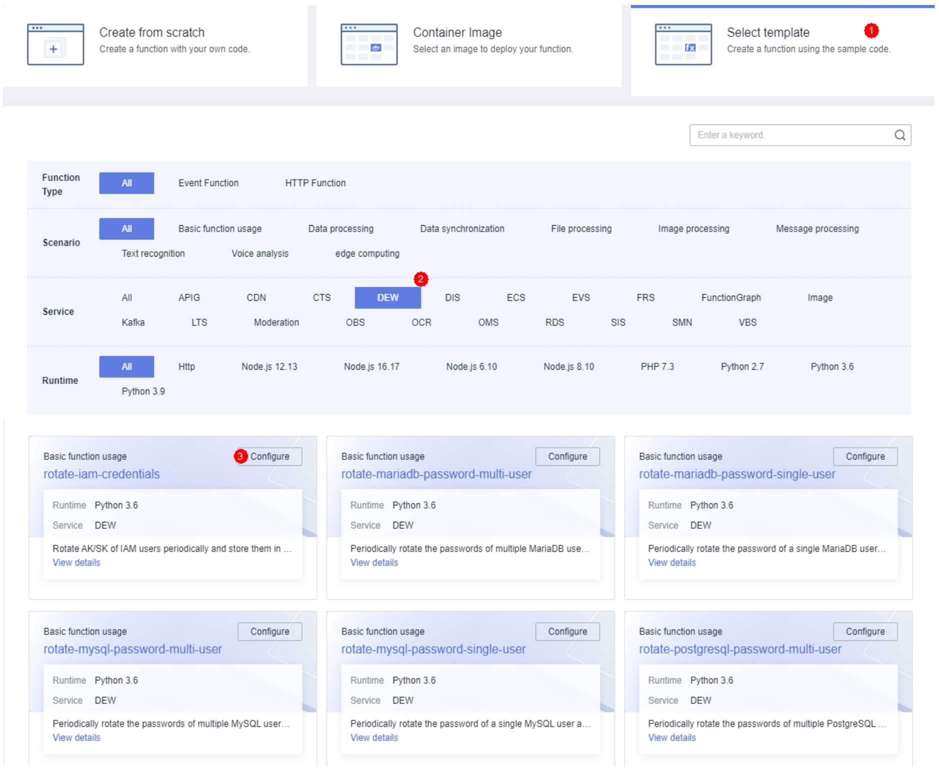
Step 2 Click in the upper left corner of the management console and select a region or project.

Step 3 Click in the upper left corner of the page and choose **Compute** > **FunctionGraph**.

Step 4 Click **Create Function** in the upper right corner.

Step 5 Click **Select template**. In the **Service** area, click **DEW**, locate **rotate-iam-credentials** in the below, and click **Configure** in the upper right corner of the box, as shown in the following figure.

Figure 2-16 Creating a function



Create from scratch
Create a function with your own code.

Container Image
Select an image to deploy your function.

Select template 1
Create a function using the sample code.

Enter a keyword.

Function Type	All Event Function HTTP Function
Scenario	All Basic function usage Data processing Data synchronization File processing Image processing Message processing Text recognition Voice analysis edge computing
Service	All APIG CDN CTS DEW 2 DIS ECS EVS FRS FunctionGraph Image Kafka LTS Moderation OBS OCR OMS RDS SIS SMN VBS
Runtime	All Http Node.js 12.13 Node.js 16.17 Node.js 6.10 Node.js 8.10 PHP 7.3 Python 2.7 Python 3.6 Python 3.9

Basic function usage 3 Configure
rotate-iam-credentials
Runtime Python 3.6
Service DEW
Rotate AK/SK of IAM users periodically and store them in ...
View details

Basic function usage Configure
rotate-mariadb-password-multi-user
Runtime Python 3.6
Service DEW
Periodically rotate the passwords of multiple MariaDB use...
View details

Basic function usage Configure
rotate-mariadb-password-single-user
Runtime Python 3.6
Service DEW
Periodically rotate the password of a single MariaDB user...
View details

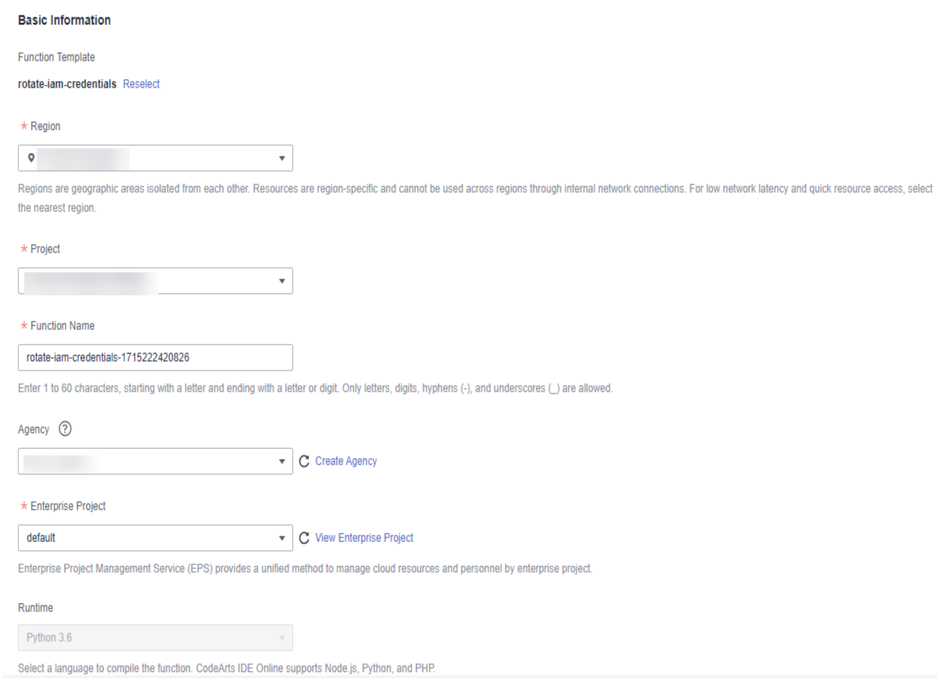
Basic function usage Configure
rotate-mysql-password-multi-user
Runtime Python 3.6
Service DEW
Periodically rotate the passwords of multiple MySQL user...
View details

Basic function usage Configure
rotate-mysql-password-single-user
Runtime Python 3.6
Service DEW
Periodically rotate the password of a single MySQL user a...
View details

Basic function usage Configure
rotate-postgresql-password-multi-user
Runtime Python 3.6
Service DEW
Periodically rotate the passwords of multiple PostgreSQL ...
View details

Step 6 Configure the parameters, which are described in **Table 2-7**.

Figure 2-17 Basic function information



Basic Information

Function Template
rotate-iam-credentials Reselect

* Region
[redacted]
Regions are geographic areas isolated from each other. Resources are region-specific and cannot be used across regions through internal network connections. For low network latency and quick resource access, select the nearest region.

* Project
[redacted]

* Function Name
rotate-iam-credentials-1715222420826
Enter 1 to 60 characters, starting with a letter and ending with a letter or digit. Only letters, digits, hyphens (-), and underscores (_) are allowed.

Agency
[redacted]
Create Agency

* Enterprise Project
default
View Enterprise Project
Enterprise Project Management Service (EPS) provides a unified method to manage cloud resources and personnel by enterprise project.

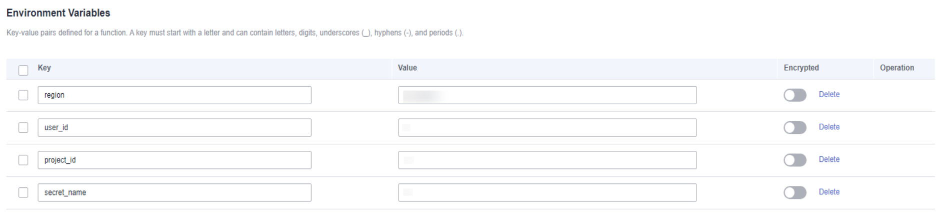
Runtime
Python 3.6
Select a language to compile the function. CodeArts IDE Online supports Node.js, Python, and PHP.

Table 2-7 Basic parameters

Parameter	Description
Region	Select the region where the function is to be deployed.
Project	Select the project where the function is to be deployed.
Function Name	Enter a custom function name.
Agency	Select an agency.
Enterprise Project	If you have enabled enterprise projects, select one for you to add a function to it. If you have not enabled an enterprise project, this parameter will be unavailable. Skip this step.

Step 7 Configure the environment variables, which are described in **Table 2-8**.

Figure 2-18 Environment variables



Environment Variables

Key-value pairs defined for a function. A key must start with a letter and can contain letters, digits, underscores (_), hyphens (-), and periods (.).

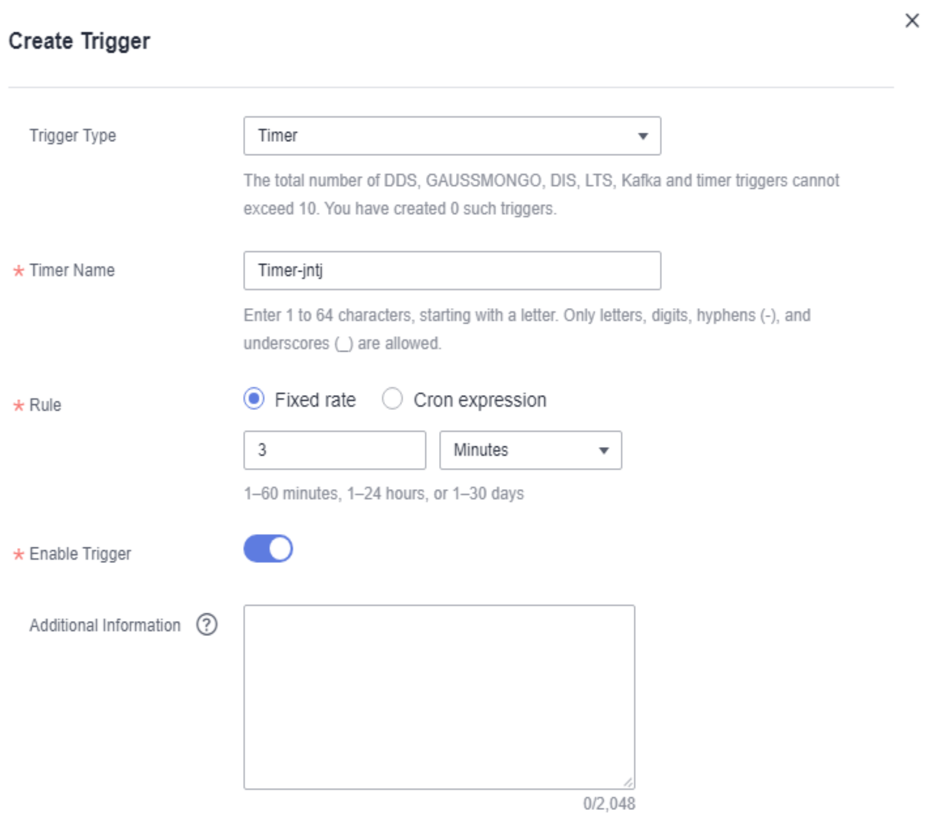
Key	Value	Encrypted	Operation
region			Delete
user_id			Delete
project_id			Delete
secret_name			Delete

Table 2-8 Environment variables

Parameter	Description
region	Project, for example, if the region is CN North-Beijing4, the project name should be **cn-north-4**. **NOTE** To obtain the project, hover the mouse over the username, and choose **My Credentials** from the drop-down list. The projects are displayed.
user_id	Enter the ID of the IAM user to be rotated. **NOTE** To obtain the IAM user ID, hover the mouse over the username, and choose **My Credentials** from the drop-down list. The ID is displayed.
project_id	Enter the project ID. **NOTE** To obtain the IAM user ID, hover the mouse over the username, and choose **My Credentials** from the drop-down list. The IDs of the projects are displayed.
secret_name	Enter the name of the secret to be created, which cannot be the same as an existing secret name.

Step 8 Configure trigger variables, which are described in **Table 2-9**.

Figure 2-19 Trigger variables


Create Trigger

Trigger Type: Timer

The total number of DDS, GAUSSMONGO, DIS, LTS, Kafka and timer triggers cannot exceed 10. You have created 0 such triggers.

* Timer Name: Timer-jntj

Enter 1 to 64 characters, starting with a letter. Only letters, digits, hyphens (-), and underscores (_) are allowed.

* Rule: [✓ Fixed rate] Cron expression

3 Minutes

1–60 minutes, 1–24 hours, or 1–30 days

* Enable Trigger: ✓

Additional Information

0/2,048

Table 2-9 Trigger variables

Parameter	Description
Timer Name	Custom
Rule	Configured as required
Enable Trigger	Configured as required

Step 9 Click **Create Function**.

----End

Debug.

For details about debugging a function workflow, see **Online Debugging**.

View the secret.

Step 1 **Log in to the management console**.

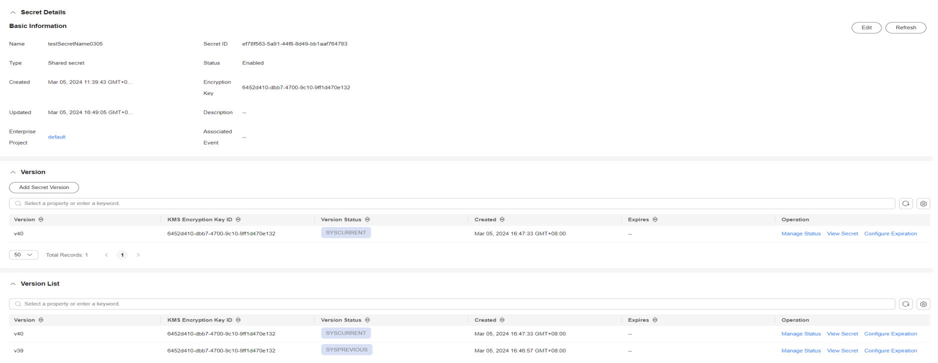
Step 2 Click in the upper left corner of the management console and select a region or project.

Step 3 Click ☰. Choose **Security & Compliance** > **Data Encryption Workshop**.

Step 4 In the navigation pane, choose **Cloud Secret Management Service**.

Step 5 Query the specified secret in **Step 7**. Click it to view the details. The current valid secret, historical secrets, and other information are displayed.

Figure 2-20 Secret details



Basic Information

Name	testSecretName0305	Secret ID	ef78f563-5a91-44f8-8d49-bb1aaf764783
Type	Shared secret	Status	Enabled
Created	Mar 05, 2024 11:39:43 GMT+0...	Encryption Key	6452d410-dbb7-4700-9c10-9ff1d470e132
Updated	Mar 05, 2024 16:49:05 GMT+0...	Description	--
Enterprise Project	default	Associated Event	--

Version	KMS Encryption Key ID	Version Status	Created	Expires	Operation
v40	6452d410-dbb7-4700-9c10-9ff1d470e132	SYSCURRENT	Mar 05, 2024 16:47:33 GMT+08:00	--	Manage Status View Secret Configure Expiration

50 Total Records: 1 < 1 >

Version	KMS Encryption Key ID	Version Status	Created	Expires	Operation
v40	6452d410-dbb7-4700-9c10-9ff1d470e132	SYSCURRENT	Mar 05, 2024 16:47:33 GMT+08:00	--	Manage Status View Secret Configure Expiration
v39	6452d410-dbb7-4700-9c10-9ff1d470e132	SYSPREVIOUS	Mar 05, 2024 16:46:57 GMT+08:00	--	Manage Status View Secret Configure Expiration

Step 6 Locate the latest version of the secret, click **View Secret** in the **Operation** column to check the AK/SK.

----End

3 General

3.1 Retrying Failed DEW Requests by Using Exponential Backoff

Scenario

If you receive an error message when calling an API, you can use exponential backoff to retry the request.

How It Works

If consecutive errors (such as traffic limiting errors) are reported by the service side, continuous access will keep causing conflicts. Exponential backoff can help you avoid such errors.

Constraints

The current account has an enabled key.

Example

1. Prepare basic authentication information.
   - ACCESS_KEY: Access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
   - SECRET_ACCESS_KEY: Secret access key of the Huawei account. For details, see **How Do I Obtain an Access Key (AK/SK)?**
   - PROJECT_ID: site project ID. For details, see **Obtaining a Project ID**.
   - **KMS_ENDPOINT**: endpoint for accessing KMS. For details, see **Endpoints**.
   - There will be security risks if the AK/SK used for authentication is directly written into code. Encrypt the AK/SK in the configuration file or environment variables for storage.
   - In this example, the AK/SK stored in the environment variables are used for identity authentication. Configure the environment variables

HUAWEICLOUD_SDK_AK and **HUAWEICLOUD_SDK_SK** in the local environment first.

2. Code for exponential backoff:

```
import com.huaweicloud.sdk.core.auth.BasicCredentials;
 import com.huaweicloud.sdk.core.auth.ICredential;
 import com.huaweicloud.sdk.core.exception.ClientRequestException;
 import com.huaweicloud.sdk.kms.v2.model.EncryptDataRequest;
 import com.huaweicloud.sdk.kms.v2.model.EncryptDataRequestBody;
 import com.huaweicloud.sdk.kms.v2.KmsClient;

 public class KmsEncryptExample {

     private static final String ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_AK");

     private static final String SECRET_ACCESS_KEY = System.getenv("HUAWEICLOUD_SDK_SK");

     private static final String KMS_ENDPOINT = "xxxx";

     private static final String KEY_ID = "xxxx";

     private static final String PROJECT_ID = "xxxx";


     private static KmsClient KmsClientInit() {
         ICredential auth = new BasicCredentials()
                 .withAk(ACCESS_KEY)
                 .withSk(SECRET_ACCESS_KEY)
                 .withProjectId(PROJECT_ID);
         return KmsClient.newBuilder()
                 .withCredential(auth)
                 .withEndpoint(KMS_ENDPOINT)
                 .build();
     }

     public static long getWaitTime(int retryCount) {
         long initialDelay = 200L;
         return (long) (Math.pow(2, retryCount) * initialDelay);
     }

     public static void encryptData(KmsClient client, String plaintext) {
         EncryptDataRequest request = new EncryptDataRequest().withBody(
                 new EncryptDataRequestBody()
                         .withKeyId(KEY_ID)
                         .withPlainText(plaintext));
         client.encryptData(request);
     }

     public static void main(String[] args) {
         int maxRetryTimes = 6;
         String plaintext = "plaintext";
         String errorMsg = "The throttling threshold has been reached";

         KmsClient client = KmsClientInit();
         for (int i = 0; i < maxRetryTimes; i++) {
             try {
                 encryptData(client, plaintext);
                 return;
             } catch (ClientRequestException e) {
                 if (e.getErrorMsg().contains(errorMsg)) {
                     try {
                         Thread.sleep(getWaitTime(i));
                     } catch (InterruptedException ex) {
                         throw new RuntimeException(ex);
                     }
                 }
             }
         }
```

```
    }
}
```