Developer Guide

Amazon S3 Encryption Client

Amazon S3 Encryption Client: Developer Guide

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What is the Amazon S3 Encryption Client?

Note

This documentation describes the Amazon S3 Encryption Client version 3.*x* and newer, which is an independent library. For information about previous versions of the Amazon S3 Encryption Client, see the AWS SDK Developer Guide for your programming language.

The Amazon S3 Encryption Client is a client-side encryption library that enables you to encrypt an object locally to ensure its security before passing it to Amazon Simple Storage Service (Amazon S3). Amazon S3 receives your object already encrypted; it does not play a role in encrypting or decrypting it. After you instantiate the Amazon S3 Encryption Client, your objects are automatically encrypted and decrypted as part of your Amazon S3 `PutObject` and `GetObject` requests. The Amazon S3 Encryption Client is provided free of charge under the Apache 2.0 license.

The Amazon S3 Encryption Client is supported in the following programming languages and platforms. This guide focuses on version 4.x of the Amazon S3 Encryption Client for Java and Amazon S3 Encryption Client for Go. For more information on the remaining language implementations, see their respective AWS SDK Developer Guides.

- AWS SDK for C++
- AWS SDK for Go
- AWS SDK for Java
- AWS SDK for .NET
- AWS SDK for Ruby
- AWS SDK for PHP

The Amazon S3 Encryption Client provides:

A default implementation that adheres to cryptography best practices

By default, the Amazon S3 Encryption Client generates a unique data key for each object that it encrypts. This follows the cryptography best practice of using unique data keys for each encryption operation.

The Amazon S3 Encryption Client encrypts your objects using a secure, authenticated, symmetric key algorithm.

A framework for protecting data keys with wrapping keys

The Amazon S3 Encryption Client protects the data keys that encrypt your objects by encrypting them under a wrapping key. With the Amazon S3 Encryption Client, you define a wrapping key by passing the key to the Amazon S3 Encryption Client, which it uses to optimize its settings.

Amazon S3 Encryption Client concepts

Note

This documentation describes the Amazon S3 Encryption Client version 3.*x* and newer, which is an independent library. For information about previous versions of the Amazon S3 Encryption Client, see the AWS SDK Developer Guide for your programming language.

This topic introduces the concepts and terminology used in the Amazon S3 Encryption Client. It's designed to help you understand how the Amazon S3 Encryption Client works and the terms we use to describe it.

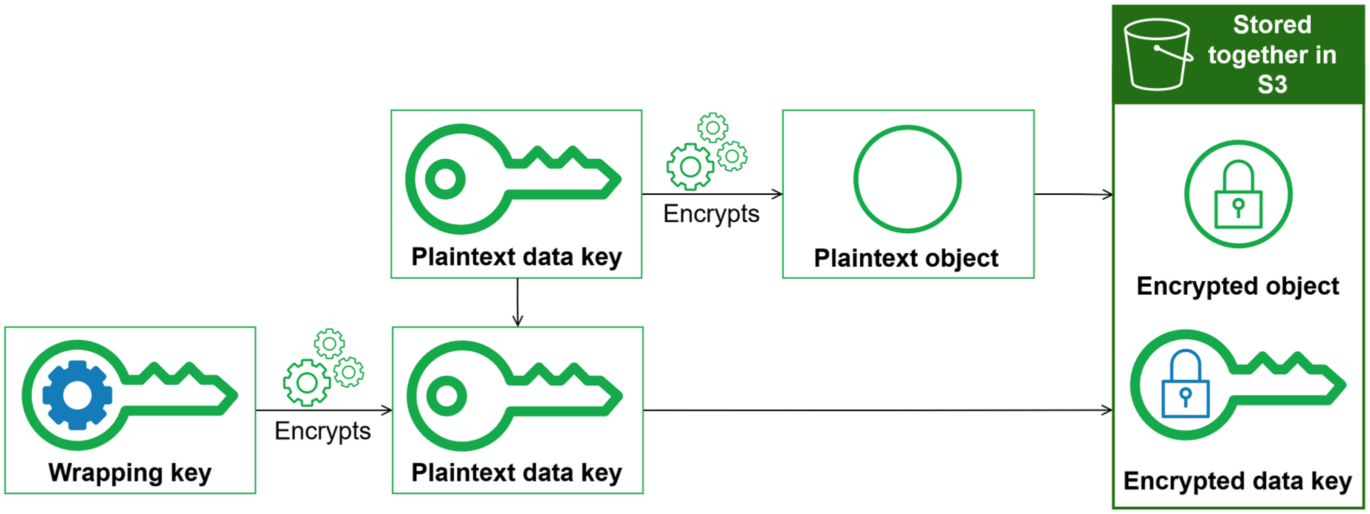
Topics

Envelope encryption

The security of your encrypted object depends in part on protecting the data key that can decrypt it. One accepted best practice for protecting the data key is to encrypt it. To do this, you need another encryption key, known as a *key-encryption key* or wrapping key. The practice of using a wrapping key to encrypt data keys is known as *envelope encryption*.

Protecting data keys

The Amazon S3 Encryption Client encrypts each object with a unique data key. Then it encrypts the data key under the wrapping key you specify. It stores the encrypted data key with the encrypted object that the `PutObject` request uploads to Amazon S3.



Combining the strengths of multiple algorithms

To encrypt your object, by default, the Amazon S3 Encryption Client uses a sophisticated algorithm suite with AES-GCM symmetric encryption. To encrypt the data key, you can specify a symmetric or asymmetric encryption algorithm appropriate to your wrapping key.

In general, symmetric key encryption algorithms are faster and produce smaller ciphertexts than asymmetric or *public key encryption*. But public key algorithms provide inherent separation of roles and easier key management. To combine the strengths of each, you can encrypt your object with symmetric key encryption, and then encrypt the data key with public key encryption.

Data key

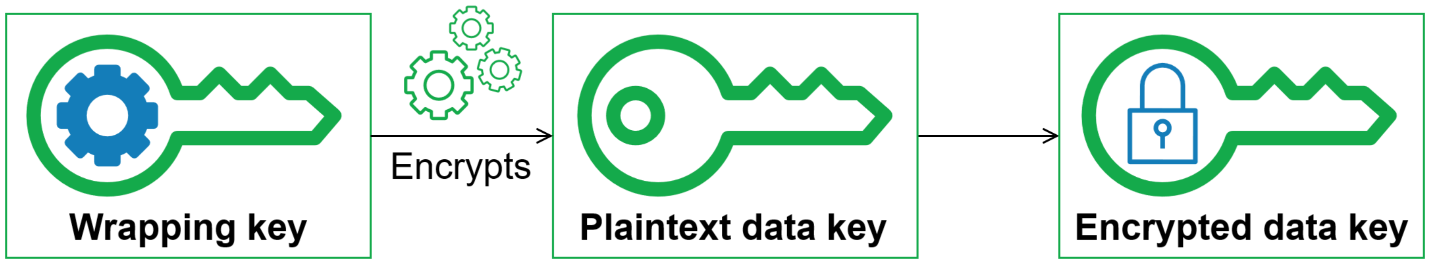
A *data key* is an encryption key that the Amazon S3 Encryption Client uses to encrypt your object. Each data key is a byte array that conforms to the requirements for cryptographic keys. The Amazon S3 Encryption Client uses a unique data key to encrypt each object.

You don't need to specify, generate, implement, extend, protect or use data keys. The Amazon S3 Encryption Client does that work for you.

To protect your data keys, the Amazon S3 Encryption Client encrypts them under a *key-encryption key* known as a wrapping key. When you call `PutObject`, the Amazon S3 Encryption Client uses your plaintext data key to encrypt your object, then removes it from memory as soon as possible. The Amazon S3 Encryption Client encrypts the data key with the wrapping key you provide. Then the Amazon S3 Encryption Client stores the encrypted data key with the encrypted object that the `PutObject` request uploads to Amazon S3. For more information, see How the Amazon S3 Encryption Client works.

Wrapping key

A *wrapping key* is a key-encryption key that the Amazon S3 Encryption Client uses to encrypt the data key that encrypts your object. You specify the wrapping key that is used to protect your data keys when you instantiate your Amazon S3 Encryption Client. Version 3.*x* of the Amazon S3 Encryption Client uses the wrapping key you specify and one of the fully supported wrapping algorithms to encrypt and decrypt data keys.



The Amazon S3 Encryption Client supports several commonly used wrapping keys, such as symmetric AWS KMS keys, Raw AES-GCM (Advanced Encryption Standard/Galois Counter Mode) keys, and Raw RSA keys.

Note

Version 3.*x* of the Amazon S3 Encryption Client for Go does not support Raw AES-GCM or Raw RSA wrapping keys.

When you use envelope encryption, you need to protect your wrapping keys from unauthorized access. You can do this in any of the following ways:

- Use a web service designed for this purpose, such as AWS Key Management Service (AWS KMS).
- Use a hardware security module (HSM) such as those offered by AWS CloudHSM.
- Use other key management tools and services.

If you don't have a key management system, we recommend AWS KMS. The Amazon S3 Encryption Client integrates with AWS KMS to help you protect and use your wrapping keys.

Keyrings

To specify the wrapping keys you use for encryption and decryption, you use a keyring You can use the keyrings that the Amazon S3 Encryption Client provides or design your own implementations. The Amazon S3 Encryption Client provides keyrings that are compatible with each other subject to language constraints.

A *keyring* generates, encrypts, and decrypts data keys. When you define a keyring, you can specify the wrapping keys that encrypt your data keys. Most keyrings specify at least one wrapping key or a service that provides and protects wrapping keys. You can also define a keyring with no wrapping keys or a more complex keyring with additional configuration options.

For details about specifying wrapping keys, see the examples topic of your programming language.

Supported encryption algorithms

An *algorithm suite* is a collection of cryptographic algorithms and related values. Cryptographic systems use the algorithm implementation to generate the ciphertext message.

To encrypt each Amazon S3 object, the Amazon S3 Encryption Client uses a unique 256-bit symmetric data encryption key and an Advanced Encryption Standard (AES) with Galois/Counter Mode (GCM) algorithm suite. This algorithm suite uses AES-GCM for authenticated encryption with a 12-byte initialization vector, and a 16-byte AES-GCM authentication tag. It does not support a key derivation function.

For information on legacy encryption algorithms, see Supported encryption algorithms.

Cryptographic materials manager

The cryptographic materials manager (CMM) assembles the cryptographic materials that are used to encrypt and decrypt data. The *cryptographic materials* include plaintext and encrypted data keys, and an optional message signing key. You never interact with the CMM directly. The encryption and decryption methods handle it for you.

You can use the default CMM that the Amazon S3 Encryption Client provides or write a custom CMM. You can specify a CMM, but it's not required. When you specify a keyring, the Amazon S3 Encryption Client creates a default CMM for you. The default CMM gets the encryption or decryption materials from the keyring that you specify. This might involve a call to a cryptographic service, such as AWS Key Management Service(AWS KMS).

Because the CMM acts as a liaison between the Amazon S3 Encryption Client and a keyring, it is an ideal point for customization and extension, such as support for policy enforcement and caching.

Encryption context

If you use a symmetric AWS KMS key as your wrapping key, you can include an encryption context in all requests to encrypt data. Using an encryption context is optional, but it is a cryptographic best practice that we recommend.

An *encryption context* is a set of name-value pairs that contain arbitrary, non-secret additional authenticated data. The encryption context can contain any data you choose, but it typically consists of data that is useful in logging and tracking, such as data about the file type, purpose, or ownership. When you encrypt data, the encryption context is cryptographically bound to the encrypted data so that the same encryption context is required to decrypt the data. The Amazon S3 Encryption Client stores the encryption context in plaintext in the metadata of the encrypted object that it uploads to Amazon S3. The Amazon S3 Encryption Client also uses the encryption context to provide additional authenticated data (AAD) in your AWS KMS calls.

Note

We strongly recommend using only US-ASCII characters in your encryption contexts. Including non-US-ASCII characters can result in availability and compatibility errors.

The following example demonstrates how to specify an encryption context in your cryptographic operations.

1. Specify a KMS key as your wrapping key by instantiating your client with the `kmsKeyId` builder parameter.

   ```
   // v4

   class v4KMSKeyExample {
       public static void main(String[] args) {
           S3Client v4Client = S3EncryptionClient.builderV4()
                   .kmsKeyId(kmsKeyId)
                   .build();
       }
   }
   ```

2. Use the `overrideConfiguration` builder parameter to specify the encryption context within your `PutObject` request.

   ```
   // v4

   class v4EncryptExample {
       public static void main(String[] args) {
           s3Client.putObject(PutObjectRequest.builder()
                           .bucket(bucket)
                           .key(objectKey)

    .overrideConfiguration(withAdditionalConfiguration(encryptionContext))
                           .build(), RequestBody.fromString(objectContent));
       }
   }
   ```

3. Include the same encryption context in your `GetObject` request.

   ```
   // v4
   ```

```
class v4DecryptExample {
    public static void main(String[] args) {
        ResponseBytes<GetObjectResponse> objectResponse =
 s3Client.getObjectAsBytes(builder -> builder
                .bucket(bucket)
                .key(objectKey)

 .overrideConfiguration(withAdditionalConfiguration(encryptionContext)));
        String output = objectResponse.asUtf8String();
    }
}
```

Instruction files

An *instruction file* is a separate Amazon S3 object that stores encryption metadata for an encrypted object. When you encrypt an object using the Amazon S3 Encryption Client, the client needs to store metadata about the encryption operation, including the encrypted data key, the encryption algorithm used, and other cryptographic information required to decrypt the object.

The Amazon S3 Encryption Client supports two methods for storing this encryption metadata:

Object metadata storage (default)

Encryption metadata is stored in the object's metadata headers. This is the most common and convenient method as all encryption information is stored with the object itself. When you retrieve the encrypted object, the Amazon S3 Encryption Client reads the encryption metadata from the object's headers and uses it to decrypt the object.

Instruction file storage

Encryption metadata is stored in a separate Amazon S3 object called an instruction file. The instruction file has the same key as the encrypted object with the suffix `.instruction` appended. For example, if your encrypted object has the key `mydata.txt`, the instruction file will have the key `mydata.txt.instruction`.

When to use each storage method:

- **Use object metadata storage** for most scenarios. It simplifies object management since encryption metadata travels with the object. This is the default storage method and is recommended unless you have specific requirements that necessitate instruction files.
- **Use instruction file storage** when object metadata size is a concern or when you need to separate encryption metadata from the encrypted object. Note that using instruction files requires managing two Amazon S3 objects (the encrypted object and its instruction file) instead of one. When you delete an encrypted object that uses instruction file storage, you must also delete the instruction file separately.

Key commitment

The Amazon S3 Encryption Client supports *key commitment* (sometimes known as *robustness*), a security property that guarantees that each ciphertext can be decrypted only to a single plaintext. To do this, key commitment guarantees that only the data key that encrypted your object will be used to decrypt it.

Most modern symmetric ciphers (including AES) encrypt a plaintext under a single secret key, such as the unique data key that the Amazon S3 Encryption Client uses to encrypt each plaintext object. Decrypting this data with the same data key returns a plaintext that is identical to the original. Decrypting with a different key will usually fail. However, it's possible to decrypt a ciphertext under two different keys. In rare cases, it is feasible to find a key that can decrypt a few bytes of ciphertext into a different, but still intelligible, plaintext.

The Amazon S3 Encryption Client always encrypts each plaintext object under one unique data key. It might encrypt that data key under multiple wrapping keys but the wrapping keys always encrypt the same data key.

Typically, the Amazon S3 Encryption Client only supports one data key per object. However, this data key can be changed over time. Some Amazon S3 Encryption Client implementations support the use of multiple data keys for a single object when using instruction files with custom suffixes. For example, if one user decrypts the encrypted object with the default instruction file, it returns 0x0 (false) while another user decrypting with a custom instruction file for the same encrypted object gets 0x1 (true).

For objects encrypted using the default Object Metadata storage (not instruction files), it is not possible to change the encrypted data key associated with the object without changing the object. Object Metadata in S3 is immutable, so changing the metadata is equivalent to changing the object itself.

To prevent this scenario, the Amazon S3 Encryption Client supports key commitment when encrypting and decrypting. When the Amazon S3 Encryption Client encrypts an object with key commitment, it cryptographically binds the unique data key that produced the ciphertext to the *key commitment string*, a non-secret data key identifier. Then it stores the key commitment string in the metadata of the encrypted object. When it decrypts a message with key commitment, the Amazon S3 Encryption Client verifies that the data key is the one and only key for that encrypted message. If data key verification fails, the decrypt operation fails.

Support for key commitment is introduced in the latest minor versions of 3.*x* for Java, Go, .NET, 2.*x* for Ruby, PHP, and C++. These languages can decrypt objects with key commitment, but won't encrypt with key commitment. You can use this version to fully deploy the ability to decrypt ciphertext with key commitment.

Supported languages include full support for key commitment. By default, it encrypts and decrypts only with key commitment. This is an ideal configuration for applications that don't need to decrypt ciphertext encrypted by earlier versions of the Amazon S3 Encryption Client.

Although encrypting and decrypting with key commitment is a best practice, we let you decide when it's used, and let you adjust the pace at which you adopt it. The Amazon S3 Encryption Client supports a commitment policy that sets the default algorithm suite and limits the algorithm suites that may be used. This policy determines whether your data is encrypted and decrypted with key commitment.

Key commitment results in a slightly larger (+ 56 bytes) encrypted message and takes more time to process. If your application is very sensitive to size or performance, you might choose to opt out of key commitment. But do so only if you must.

For more information about migrating to the latest version, including their key commitment features, see the migration guide for your programming language.

Commitment policy

A *commitment policy* is a configuration setting that determines whether your application encrypts and decrypts with key commitment.

Commitment policy has three values:

Value	Encrypts with key commitment	Encrypts without key commitment	Decrypts with key commitment	Decrypts without key commitment
`ForbidEncryptAllowDecrypt`	never	always	yes	yes
`RequireEncryptAllowDecrypt`	always	never	yes	yes
`RequireEncryptRequireDecrypt`	always	never	yes	never

The commitment policy setting is introduced in minor versions of supported languages. It's valid in all supported programming languages.

`ForbidEncryptAllowDecrypt`

This policy decrypts with or without key commitment, but it won't encrypt with key commitment. This value is designed to prepare all hosts running your application to decrypt with key commitment before they ever encounter a ciphertext encrypted with key commitment.

`RequireEncryptAllowDecrypt`

This policy always encrypts with key commitment. It can decrypt with or without key commitment. This value lets you start encrypting with key commitment, but still decrypt ciphertexts without key commitment.

`RequireEncryptRequireDecrypt`

This policy encrypts and decrypts only with key commitment. Use this value when you are certain that all of your ciphertexts are encrypted with key commitment.

The commitment policy setting determines which algorithm suites you can use. If you specify an algorithm suite that conflicts with your commitment policy, the Amazon S3 Encryption Client returns an error.

The Amazon S3 Encryption Client supports encryption using key commitment in major version 4.x for Java, Go, and .NET, and major version 3.x for Ruby, PHP, and C++.

For help setting your commitment policy, see the migration guide for your programming language.

How the Amazon S3 Encryption Client works

Note

This documentation describes the Amazon S3 Encryption Client version 3.*x* and newer, which is an independent library. For information about previous versions of the Amazon S3 Encryption Client, see the AWS SDK Developer Guide for your programming language.

The Amazon S3 Encryption Client is designed specifically to protect the data that you store in Amazon S3. The workflows in this section explain how the Amazon S3 Encryption Client encrypts and decrypts your objects.

The Amazon S3 Encryption Client uses envelope encryption to protect your objects. It encrypts each Amazon S3 object under a unique data encryption key. Then it encrypts the data encryption key with a wrapping key that you specify.

Need help with the terminology we use in the Amazon S3 Encryption Client? See the section called "Terms and concepts".

Encrypt and decrypt with the Amazon S3 Encryption Client

The Amazon S3 Encryption Client works as an intermediary between you and Amazon S3 by encrypting your object as you upload it, and decrypting your object as you download it. The following walkthrough specifies an RSA key pair as the wrapping key. For detailed code examples, see the *Examples* topic of your preferred programming language.

1. Specify your wrapping key and create a keyring when you instantiate your client.
2. Encrypt your plaintext object by calling `PutObject`.

    a. The Amazon S3 Encryption Client provides the encryption materials: one plaintext data key and one copy of that data key encrypted by your wrapping key.

    b. The Amazon S3 Encryption Client uses the plaintext data key to encrypt your object, and then discards the plaintext data key.

    c. The Amazon S3 Encryption Client uploads the encrypted data key and the encrypted object to Amazon S3 as part of the `PutObject` call.

3. Decrypt your encrypted object by calling `GetObject`.

    a. The Amazon S3 Encryption Client uses your wrapping key to decrypt the encrypted data key.

    b. The Amazon S3 Encryption Client uses the plaintext data key to decrypt the object, discards the plaintext data key, and returns the plaintext object as part of the `GetObject` call.

Client-side and server-side encryption

Note

This documentation describes the Amazon S3 Encryption Client version 3.*x* and newer, which is an independent library. For information about previous versions of the Amazon S3 Encryption Client, see the AWS SDK Developer Guide for your programming language.

The Amazon S3 Encryption Client supports *client-side encryption*, where you encrypt your objects before you send them to Amazon S3. Amazon S3 provides server-side encryption options that encrypt your objects at their destination before they are saved in Amazon S3.

The tools that you choose depend on your security requirements and the sensitivity of your data. You can use both the Amazon S3 Encryption Client and Amazon S3 server-side encryption. When you send encrypted objects to Amazon S3, Amazon S3 doesn't recognize the objects as being encrypted, it just detects typical objects.

Server-side encryption

Amazon S3 supports encryption at rest with three mutually exclusive server-side encryption options. Amazon S3 encrypts your data at the object level as it writes it to disks in its data centers and decrypts it for you when you access it.

Amazon S3 Encryption Client

Client-side encryption provides end-to-end protection for your object, in transit and at rest, from its source to storage in Amazon S3.

- Your data is protected in transit and at rest. It is never exposed to any third party, including AWS.
- You choose how your cryptographic keys are protected. You specify the wrapping key used to protect the data keys that encrypt your objects.
- Your objects are all encrypted with a unique data key. The Amazon S3 Encryption Client does not use or interact with bucket keys, even if you specify a KMS key as your wrapping key.

Amazon S3 Encryption Client programming languages

The Amazon S3 Encryption Client is supported in the following programming languages and platforms. This guide focuses on version 3.*x* of the Amazon S3 Encryption Client for Java and Amazon S3 Encryption Client for Go. For more information on the remaining language implementations, see their respective AWS SDK Developer Guides.

- Java
- Go
- C++ (AWS SDK for C++)
- .NET (v2) (AWS SDK for .NET)
- Ruby (v2) (AWS SDK for Ruby)
- PHP (v3) (AWS SDK for PHP)

Amazon S3 Encryption Client for Java

Note

This documentation describes the Amazon S3 Encryption Client version 3.*x* and newer, which is an independent library. For information about previous versions of the Amazon S3 Encryption Client, see the AWS SDK Developer Guide for your programming language.

This topic explains how to install and use the Amazon S3 Encryption Client for Java. For details about programming with the Amazon S3 Encryption Client for Java, see the amazon-s3-encryption-client-java repository on GitHub.

Topics

- Prerequisites
- Installation
- Amazon S3 Encryption Client for Java examples
- Asynchronous programming in the Amazon S3 Encryption Client for Java
- S3 Encryption Client Migration (V3 to V4)

- S3 Encryption Client Migration (V2 to V3)

Prerequisites

Before you install the Amazon S3 Encryption Client for Java, be sure you have the following prerequisites.

A Java development environment

You will need Java 8 or later. On the Oracle website, go to Java SE Downloads, and then download and install the Java SE Development Kit (JDK).

If you use the Oracle JDK, you must also download and install the Java Cryptography Extension (JCE) Unlimited Strength Jurisdiction Policy Files.

AWS SDK for Java 2.x

The Amazon S3 Encryption Client for Java requires the Amazon S3 and AWS KMS modules of the AWS SDK for Java 2.x. You can install the entire SDK or just the Amazon S3 and AWS KMS modules.

For information about updating your version of the AWS SDK for Java, see Migrating from version 1.x to 2.x of the AWS SDK for Java.

To install the AWS SDK for Java, use Apache Maven.

- To import the entire AWS SDK for Java as a dependency, declare it in your `pom.xml` file.
- To create a dependency for the Amazon S3 module in the AWS SDK for Java, follow the instructions for specifying particular modules. Set the `groupId` to `software.amazon.awssdk` and the `artifactID` to `s3`.
- To create a dependency for the AWS KMS module in the AWS SDK for Java, follow the instructions for specifying particular modules. Set the `groupId` to `software.amazon.awssdk` and the `artifactId` to `kms`.

Installation

You can install the latest version of the Amazon S3 Encryption Client for Java in the following ways.

Manually

To install the Amazon S3 Encryption Client for Java, clone or download the amazon-s3-encryption-client-java GitHub repository.

Using Apache Maven

The Amazon S3 Encryption Client for Java is available through Apache Maven with the following dependency definition. Install the latest version offered.

```
<dependency>
  <groupId>software.amazon.encryption.s3</groupId>
  <artifactId>amazon-s3-encryption-client-java</artifactId>
  <version>4.x</version>
</dependency>
```

Optional dependencies

Multipart upload (high-level API)

To perform multipart uploads with the high-level API, create dependencies for the AWS CRT-based Amazon S3 client. For help creating these dependencies, see Add dependencies to use the AWS CRT-based Amazon S3 client in the *AWS SDK for Java 2.x Developer Guide*.

For more information on multipart uploads in the Amazon S3 Encryption Client, see Multipart upload.

Amazon S3 Encryption Client for Java examples

The following examples show you how to use the Amazon S3 Encryption Client for Java to encrypt and decrypt Amazon S3 objects. These examples show how to use version 4.*x* of the Amazon S3 Encryption Client for Java. For more detailed examples, see the amazon-s3-encryption-client-java GitHub repository.

Topics

Instantiating the Amazon S3 Encryption Client

After installing the Amazon S3 Encryption Client for Java, you are ready to instantiate your client and begin encrypting and decrypting your Amazon S3 objects. If you have encrypted objects under a previous version of the Amazon S3 Encryption Client, you may need to enable legacy decryption modes when you instantiate the updated client. For more information, see Migrating to version 3.*x* of the Amazon S3 Encryption Client for Java.

With version 3.*x* or later of the Amazon S3 Encryption Client for Java, you can instantiate your client specifying the builder parameter that identifies your wrapping key. The Amazon S3 Encryption Client supports the following wrapping keys: symmetric AWS KMS keys, Raw AES-GCM keys, and Raw RSA keys. Then, the Amazon S3 Encryption Client automatically configures a keyring based on the wrapping key type with default settings and a default cryptographic materials manager (CMM). If you want to customize your client, you can also manually configure your keyring.

Note

If you use Raw RSA or Raw AES-GCM wrapping keys, you are responsible for generating, storing, and protecting the key material, preferably in a hardware security module (HSM) or key management system.

The following examples instantiate the Amazon S3 Encryption Client with the default decryption mode. This means that all objects will be decrypted using the fully supported buffered decryption mode. For more information, see Decryption modes (Version 3.*x* and later).

Topics

AWS KMS wrapping key

To specify a KMS key as your wrapping key, instantiate your client with the `kmsKeyId` builder parameter.

To use a KMS key as your wrapping key, you need kms:GenerateDataKey and kms:Decrypt permissions on the KMS key. The value of the `kmsKeyId` parameter can be any valid KMS key identifier. For details, see Key identifiers in the *AWS Key Management Service Developer Guide*.

```
// v4

class v4KMSKeyExample {
    public static void main(String[] args) {
        S3Client v4Client = S3EncryptionClient.builderV4()
                .kmsKeyId(kmsKeyId)
                .build();
    }
}
```

Raw AES wrapping key

To specify a Raw AES key (`javax.crypto.SecretKey`) as your wrapping key, instantiate your client with the `aesKey` builder parameter.

```
// v4

class v4AESKeyExample {
    public static void main(String[] args) {
        S3Client v4Client = S3EncryptionClient.builderV4()
                .aesKey(aesKey)
                .build();
    }
}
```

Raw RSA wrapping key

To specify a Raw RSA key (`java.security.KeyPair`) as your wrapping key, instantiate your client with the `rsaKeyPair` builder parameter. You can specify an entire RSA key pair or a partial RSA key pair. The value of the `rsaKeyPair` parameter must include both the public and private keys in the key pair to perform both encrypt and decrypt operations. You can specify the public key to enable the Amazon S3 Encryption Client to perform encrypt operations, or the private key to enable decrypt operations as needed. By specifying a partial key pair you can limit the exposure of your keys. For examples using a partial key pair, see the amazon-s3-encryption-client-java GitHub repository.

RSA key pair

To instantiate version 3.*x* of the client to perform both encrypt and decrypt operations, specify both the public and private keys of your key pair.

```
// v4

class v4RSAKeyPairExample {
    public static void main(String[] args) {
        S3Client v4Client = S3EncryptionClient.builderV4()
                .rsaKeyPair(rsaKeyPair)
                .build();
    }
}
```

Public key

To instantiate the client to encrypt only, specify the **public key**. If you specify the public key alone, all `GetObject` calls will fail because the private key is required to decrypt.

```
// v4

class v4RSAKeyPairExample {
    public static void main(String[] args) {
        S3Client v4Client = S3EncryptionClient.builderV4()
                .rsaKeyPair(new PartialRsaKeyPair(null, rsaKeyPair.getPublic()))
                .build();
    }
}
```

Private key

To instantiate the client to decrypt only, specify the **private key**. If you specify the private key alone, all `PutObject` calls will fail because the public key is required to encrypt.

```
// v4

class v4RSAKeyPairExample {
    public static void main(String[] args) {
        S3Client v4Client = S3EncryptionClient.builderV4()
                .rsaKeyPair(new PartialRsaKeyPair(rsaKeyPair.getPrivate(), null))
                .build();
    }
}
```

Manually instantiate the client

If you want to customize your client, you can manually configure your own keyring and cryptographic materials manager (CMM). The following example manually configures an AWS KMS keyring using a symmetric encryption AWS KMS wrapping key and passes the custom AWS KMS client to the Amazon S3 Encryption Client.

```
// v4
class v4CustomKeyringExample {
    public static void main(String[] args) {
        KmsKeyring keyring = KmsKeyring.builder()
            .wrappingKeyId(KMS_KEY_ID)
            .kmsClient(customKmsClient)
            .build();

        CryptographicMaterialsManager cmm = DefaultCryptoMaterialsManager.builder()
            .keyring(keyring)
            .build();

        S3Client v4Client = S3EncryptionClient.builderV4()
            .cryptoMaterialsManager(cmm)
            .build();
    }
}
```

Encrypting and decrypting Amazon S3 objects

The following example shows you how to use the Amazon S3 Encryption Client for Java to encrypt and decrypt Amazon S3 objects.

This example uses a Raw RSA wrapping key and instantiates the Amazon S3 Encryption Client with the default decryption mode.

1. Specify your wrapping key by passing it to the Amazon S3 Encryption Client when you instantiate your client. The Amazon S3 Encryption Client for Java automatically configures a keyring based on the wrapping key you specify.

    ```
    // v4
    ```

```
class v4RSAKeyPairExample {
    public static void main(String[] args) {
        S3Client v4Client = S3EncryptionClient.builderV4()
                .rsaKeyPair(rsaKeyPair)
                .build();
    }
}
```

2. Encrypt your plaintext object by calling `PutObject`.

   a. The Amazon S3 Encryption Client provides the encryption materials: one plaintext data key and one copy of that data key encrypted by your wrapping key.

   b. The Amazon S3 Encryption Client uses the plaintext data key to encrypt your object, and then discards the plaintext data key.

   c. The Amazon S3 Encryption Client uploads the encrypted data key and the encrypted object to Amazon S3 as part of the `PutObject` call.

```
// v4

class v4EncryptExample {
    public static void main(String[] args) {
        s3Client.putObject(PutObjectRequest.builder()
                        .bucket(bucket)
                        .key(objectKey)
                        .build(), RequestBody.fromString(objectContent));
    }
}
```

3. Decrypt your encrypted object by calling `GetObject`.

   a. The Amazon S3 Encryption Client uses your wrapping key to decrypt the encrypted data key.

   b. The Amazon S3 Encryption Client uses the plaintext data key to decrypt the object, discards the plaintext data key, and returns the plaintext object as part of the `GetObject` call.

```
// v4
```

```
class v4DecryptExample {
    public static void main(String[] args) {
        ResponseBytes<GetObjectResponse> objectResponse =
 s3Client.getObjectAsBytes(builder -> builder
                .bucket(bucket)
                .key(objectKey));
        String output = objectResponse.asUtf8String();
    }
}
```

Note

The default decryption mode cannot decrypt objects larger than 64 MB. This decryption mode automatically buffers stream contents into memory to prevent the release of unauthenticated objects. If you attempt to decrypt an object larger than 64 MB, you will receive an exception directing you to enable the delayed authentication decryption mode. For more information, see Decryption modes.

4. Optional: verify that the decrypted object matches the original plaintext object that you uploaded.

```
assert output.equals(objectContent);
```

5. The Amazon S3 Encryption Client implements the `AutoClosable` interface, which automatically calls `close()` when you exit a `try-with-resources` block for which the object has been declared in the resource specification header. As a best practice, you should either use `try-with-resources` or explicitly call the `close()` method.

```
s3Client.close();
```

Ranged GET requests

With Amazon S3, you can download a specific part of an object by performing a ranged GET request. In version 3.*x* and later of the Amazon S3 Encryption Client, you must explicitly enable the unauthenticated legacy decryption mode to perform ranged requests.

By default, version 4.*x* of the Amazon S3 Encryption Client encrypts and decrypts your objects using the AES-GCM with key commitment algorithm suite. However, you can enable it to use the legacy AES-CTR algorithm to partially decrypt your object during a ranged GET request. The

Amazon S3 Encryption Client cannot use AES-GCM for ranged gets because it is an authenticated scheme that appends an authentication tag to the encrypted object. When you request a partial object, the client cannot read the entire object stream to reach the authenticated tag. This means that the partial object is not authenticated.

Specifying a range

You can include the `Range` parameter in your `GetObject` request to download and decrypt a specific byte-range from an object. The start and end indices of the byte range are included in the partial object. The byte-range you specify should reflect to the following format:

```
range("bytes=startIndex-endIndex")
```

The following list details how the Amazon S3 Encryption Client responds to ranged requests that specify an invalid byte-range. For more detailed examples, see the amazon-s3-encryption-client-java GitHub repository.

- When the start index is within object range but the end index is greater than the object's total length, the Amazon S3 Encryption Client returns the object from the start index to the end of the original plaintext object.
- When the start index is greater than the end index, the Amazon S3 Encryption Client returns the entire object.
- When the range is specified with an invalid format, the Amazon S3 Encryption Client returns the entire object.

  For example, if the range was specified as `range("10-20")`, instead of `range("bytes=10-20")`, then the Amazon S3 Encryption Client will return the entire object.
- When both the start and end indicies are greater than the original plaintext object's total length, but still within the same cipher block, the Amazon S3 Encryption Client returns an empty object.
- When both the start and end indicies are greater than the original plaintext object's total length, and are outside of the object's cipher block, the `GetObject` request fails.

Performing a ranged request

The following walkthrough explains how to perform a ranged request when using version 4.*x* of the Amazon S3 Encryption Client.

1. Enable ranged gets by specifying the `enableLegacyUnauthenticatedModes` parameter when you instantiate your client.

   The following example specifies a raw AES key as the wrapping key.

   ```
   // v4

   class v4EnableRangedGetsExample {
       public static void main(String[] args) {
           S3Client v4Client = S3EncryptionClient.builderV4()
                   .aesKey(aesKey)
                   .enableLegacyUnauthenticatedModes(true)
                   .build();
       }
   }
   ```

2. Partially decrypt your encrypted object by specifying the byte-range in your GetObject request.

   The following example specifies a start index at byte 10 and end index at byte 20.

   ```
   // v4

   class v4RangedGetExample {
       public static void main(String[] args) {
           ResponseBytes<GetObjectResponse> objectResponse =
    v4Client.getObjectAsBytes(builder -> builder
                   .bucket(bucket)
                   .range("bytes=10-20")
                   .key(objectKey));
           String output = objectResponse.asUtf8String();
       }
   }
   ```

3. Optional: verify that the decrypted partial object matches the original plaintext object that you uploaded at the same range.

   ```
   assert output.equals(objectContent);
   ```

4. The Amazon S3 Encryption Client implements the `AutoClosable` interface, which automatically calls `close()` when you exit a `try-with-resources` block for which the

object has been declared in the resource specification header. As a best practice, you should either use `try-with-resources` or explicitly call the `close()` method.

```
s3Client.close();
```

Multipart upload

Amazon S3 allows you to upload a single object as a set of parts using multipart uploads. Amazon S3 recommends that when your object size reaches 100 MB, you should consider using multipart uploads. In version 3.*x* or later of the Amazon S3 Encryption Client, you can perform multipart uploads with the low-level API or the high-level API. Use the low-level API when you need to vary part sizes during the upload or require more control over the multipart upload process. Use the high-level API to simplify the multipart upload process by enabling the Amazon S3 Encryption Client to automatically perform multipart uploads.

Multipart Upload (high-level API)

When you use the high-level API, the Amazon S3 Encryption Client automatically performs multipart uploads for all objects larger than 5 MB. The Amazon S3 Encryption Client encrypts the object locally and then calls the AWS CRT-based Amazon S3 client to perform the multipart upload to Amazon S3.

Note

If your permissions to access required Amazon S3 resources or KMS keys are revoked during a multipart upload using the high-level API, the in-progress request may upload successfully. Subsequent multipart upload requests will fail.

To enable automatic multipart uploads with the high-level API, you must add dependencies for the AWS CRT-based Amazon S3 client to your Maven project file and specify the `enableMultipartPutObject` parameter when you instantiate your client.

Add dependencies

To use the AWS CRT-based Amazon S3 client with the Amazon S3 Encryption Client, add the following two dependencies. For more information on creating dependencies and installing the Amazon S3 Encryption Client, see Installing the Amazon S3 Encryption Client for Java.

```
<dependency>
  <groupId>software.amazon.awssdk</groupId>
  <artifactId>s3</artifactId>
  <version>2.19.3
<dependency>
  <groupId>software.amazon.awssdk.crt</groupId>
  <artifactId>aws-crt</artifactId>
  <version>0.21.5</version>
</dependency>
```

Enable multipart upload

To enable the Amazon S3 Encryption Client to automatically perform multipart uploads, specify the `enableMultipartPutObject` parameter when you instantiate your client.

The following example specifies a raw AES key as the wrapping key.

```
// v4

class v4EnableMultipartUploadExample {
    public static void main(String[] args) {
        S3Client v4Client = S3EncryptionClient.builderV4()
                .aesKey(aesKey)
                .enableMultipartPutObject(true)
                .build();
    }
}
```

Multipart Upload (low-level API)

The Amazon S3 Encryption Client does not require any additional configuration to use the low-level API. Use the following API calls to generate a multipart upload request with version 4.*x* of the Amazon S3 Encryption Client.

1. Start the multipart upload process by calling `CreateMultipartUpload`.
2. Call `UploadPart` to upload each part of your object. When you upload the final part, you must specify `isLastPart` for the Amazon S3 Encryption Client to be able to call `cipher.doFinal()`

```
// v4
```

```
class v4UploadFinalPartExample {
    public static void main(String[] args) {
         UploadPartRequest uploadPartRequest = UploadPartRequest.builder()
                    .bucket(bucket)
                    .key(objectKey)
                    .uploadId(initiateResult.uploadId())
                    .partNumber(partsSent)
                    .overrideConfiguration(isLastPart(true))
                    .build();
    }
}
```

3. Call `CompleteMultipartUpload` to finish the process.

Asynchronous programming in the Amazon S3 Encryption Client for Java

Version 3.*x* and later of the Amazon S3 Encryption Client provides a nonblocking asynchronous client that implements high concurrency across a few threads. The asynchronous client enables you to perform requests sequentially without waiting to view results between each request.

The default Amazon S3 Encryption Client uses synchronous methods that block your thread's execution until the client receives a response from Amazon S3. The asynchronous client returns immediately, giving control back to the calling thread without waiting for a response. Because an asynchronous method returns before a response is available, you need a way to get the response when it's ready. The methods in version 4.*x* of the Amazon S3 Encryption Client return *CompletableFuture objects* that allow you to access the response when it's ready.

Topics

Instantiating the asynchronous client

To use the asynchronous client, you must specify the `S3AsyncEncryptionClient` builder and the builder parameter that identifies your wrapping key when you instantiate your client. The Amazon S3 Encryption Client supports the following wrapping keys: symmetric AWS KMS keys, raw AES-GCM keys, and raw RSA keys.

Note

If you use Raw RSA or Raw AES-GCM wrapping keys, you are responsible for generating, storing, and protecting the key material, preferably in a hardware security module (HSM) or key management system.

The following examples instantiate the asynchronous Amazon S3 Encryption Client with the default decryption mode. This means that all objects will be decrypted using the fully supported buffered decryption mode. For more information, see Decryption modes (Version 3.*x* and later).

KMS key

To specify a KMS key as your wrapping key, instantiate your client with the `kmsKeyId` builder parameter. The value of the `kmsKeyId` parameter can be any valid KMS key identifier. For details, see Key identifiers in the *AWS Key Management Service Developer Guide*.

```
// v4

class v4KMSKeyExample {
    public static void main(String[] args) {
        S3AsyncClient v4Client = S3AsyncEncryptionClient.builderV4()
                .kmsKeyId(kmsKeyId)
                .build();
    }
}
```

Raw AES key

To specify a raw AES key (`javax.crypto.SecretKey`) as your wrapping key, instantiate your client with the `aesKey` builder parameter.

```
// v4

class v4AESKeyExample {
    public static void main(String[] args) {
        S3AsyncClient v4Client = S3AsyncEncryptionClient.builderV4()
                .aesKey(aesKey)
                .build();
    }
}
```

Raw RSA key

To specify a raw RSA key (`java.security.KeyPair`) as your wrapping key, instantiate your client with the `rsaKeyPair` builder parameter. You can specify an entire RSA key pair or a partial RSA key pair. The value of the `rsaKeyPair` parameter must include both the public and private keys in the key pair to perform both encrypt and decrypt operations. You can specify the public key to enable the Amazon S3 Encryption Client to perform encrypt operations, or the private key to enable decrypt operations as needed. By specifying a partial key pair you can limit the exposure of your keys. For examples using a partial key pair, see the amazon-s3-encryption-client-java GitHub repository.

To instantiate version 4.*x* of the client to perform both encrypt and decrypt operations, specify both the public and private keys of your key pair.

```
// v4

class v4RSAKeyPairExample {
    public static void main(String[] args) {
        S3AsyncClient v4Client = S3AsyncEncryptionClient.builderV4()
                .rsaKeyPair(rsaKeyPair)
                .build();
    }
}
```

To instantiate the client to encrypt only, specify the **public key**. If you specify the public key alone, all `GetObject` calls will fail because the private key is required to decrypt.

```
// v4

class v4RSAKeyPairExample {
    public static void main(String[] args) {
        S3AsyncClient v4Client = S3AsyncEncryptionClient.builderV4()
                .rsaKeyPair(new PartialRsaKeyPair(null, rsaKeyPair.getPublic()))
                .build();
    }
}
```

To instantiate the client to decrypt only, specify the **private key**. If you specify the private key alone, all `PutObject` calls will fail because the public key is required to encrypt.

```
// v4
```

```
class v4RSAKeyPairExample {
    public static void main(String[] args) {
        S3AsyncClient v4Client = S3AsyncEncryptionClient.builderV4()
                .rsaKeyPair(new PartialRsaKeyPair(rsaKeyPair.getPrivate(), null))
                .build();
    }
}
```

You can customize your asynchronous client by specifying different builder parameters to enable the features you need. By default, version 4.*x* of the Amazon S3 Encryption Client does not support legacy decryption, ranged 'GET' requests, or multipart uploads (via the high-level API).

For example, if you need to decrypt data keys that were encrypted with a legacy wrapping algorithm, specify the `enableLegacyWrappingAlgorithms` parameter when you instantiate your client. The following example specifies a raw AES key as the wrapping key.

```
// v4

class v4EnableLegacyModesAsyncClientExample {
    public static void main(String[] args) {
        S3AsyncClient v4Client = S3AsyncEncryptionClient.builderV4()
                .aesKey(AES_KEY)
                .enableLegacyWrappingAlgorithms(true)
                .build();
    }
}
```

Encrypt and decrypt with the asynchronous client

The following walkthrough demonstrates how encrypt and decrypt asynchronously with version 4.*x* of the Amazon S3 Encryption Client.

1. Instantiate your asynchronous client with the `S3AsyncEncryptionClient` builder.

   The following example specifies a raw AES key as the wrapping key.

   ```
   // v4

   class v4EnableAsyncClientExample {
       public static void main(String[] args) {
   ```

```
        S3AsyncClient v4Client = S3AsyncEncryptionClient.builderV4()
                .aesKey(AES_KEY)
                .build();
    }
}
```

2. Call PutObject to encrypt a plaintext object and upload it to Amazon S3.

   The asynchronous client stores the response to confirm that the `PutObject` request completed when you call `GetObject` in the future.

```
// v4

class v4PutObjectAsyncClientExample {
    public static void main(String[] args) {
        CompletableFuture<PutObjectResponse> futurePut =
 v4AsyncClient.putObject(builder -> builder
                .bucket(bucket)
                .key(objectKey)
                .build(), AsyncRequestBody.fromString(objectContent));
        // Block on completion of the futurePut
        futurePut.join();
    }
}
```

3. Call GetObject to download and decrypt the encrypted object.

```
// v4

class v4GetObjectAsyncClientExample {
    public static void main(String[] args) {
         CompletableFuture<ResponseBytes<GetObjectResponse>> futureGet =
 v4AsyncClient.getObject(builder -> builder
                .bucket(bucket)
                .key(objectKey)
                .build(), AsyncResponseTransformer.toBytes());
        // Wait for the future to complete
        ResponseBytes<GetObjectResponse> getResponse = futureGet.join();
    }
}
```

4. Optional: verify that the decrypted object matches the original plaintext object that you uploaded.

```
assert output.equals(objectContent);
```

5. The Amazon S3 Encryption Client implements the `AutoClosable` interface, which automatically calls `close()` when you exit a `try-with-resources` block for which the object has been declared in the resource specification header. As a best practice, you should either use `try-with-resources` or explicitly call the `close()` method.

```
s3Client.close();
```

Note

The default decryption mode cannot decrypt objects larger than 64 MB. This decryption mode automatically buffers stream contents into memory to prevent the release of unauthenticated objects. If you attempt to decrypt an object larger than 64 MB, you will receive an exception directing you to enable the delayed authentication decryption mode. For more information, see Decryption modes.

S3 Encryption Client Migration (V3 to V4)

Version 4.*x* of the Amazon S3 Encryption Client introduces AES GCM with Key Commitment (ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY) and Commitment Policies to enhance security by protecting against data key tampering in Instruction Files. This migration guide explains how to safely upgrade from 3.*x* to 4.*x* while maintaining backward compatibility during the transition.

Migration Overview

Migrating to version 4.*x* of the Amazon S3 Encryption Client requires a two-phase approach to ensure compatibility and security. The migration path depends on your current version.

Migrate 2.x to 3.x

If you're using 2.*x*, you must first migrate to 3.*x* before migrating to 4.*x*. Version 3.*x* introduces significant API changes, including a simplified client builder interface that replaces the `EncryptionMaterialsProvider` pattern used in 2.*x*. For detailed instructions on upgrading from 2.*x* to 3.*x* and understanding these API changes, see S3 Encryption Client Migration (V2 to V3). After upgrading to 3.*x*, follow the migration path below to migrate to 4.*x*.

Note

Direct migration from 2.*x* to 4.*x* is possible but not recommended. To avoid data access issues and ensure data accessibility across your entire infrastructure, follow the detailed migration steps in Migrate to 4.*x*.

Migrate 3.x to 4.x

If you're using 3.*x*, follow the two-phase approach below to migrate to 4.*x*.
Version 4.*x* introduces Commitment Policies and AES GCM with Key Commitment (ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY) to enhance security. The client builder interface remains consistent with 3.*x*, but you will need to configure the appropriate Commitment Policy for your use case. Ensure you're using Amazon S3 Encryption Client version 3.6.0 or greater before starting Phase 1.

1. **Phase 1: Update existing 3.*x* clients to read 4.*x* formats**

   Update all existing 3.*x* clients in your environment to Amazon S3 Encryption Client version 3.6.0 or greater. This version can read objects encrypted with 4.*x* algorithms and commitment policies. This ensures that when you start encrypting with 4.*x*, your existing applications can still decrypt the new objects.

2. **Phase 2: Migrate encryption and decryption clients to 4.*x***

   After all clients can read 4.*x* formats, migrate your encryption and decryption operations to use 4.*x* clients with the appropriate Commitment Policy. This phase introduces the enhanced security features while maintaining backward compatibility with existing encrypted objects through three progressive steps.

This phased approach prevents compatibility issues and ensures that all encrypted objects remain accessible throughout the migration process.

Understanding V4 Concepts

Version 4.*x* introduces two key security concepts that enhance protection against data tampering:

Commitment Policy

Commitment Policy controls how the encryption client handles key commitment during encryption and decryption operations. 4.*x* provides three policy options to support different migration scenarios and security requirements:

`FORBID_ENCRYPT_ALLOW_DECRYPT` (Default for 3.*x* transitional versions)

> **Encryption behavior:** Encrypts objects without key commitment, using the same algorithms as 3.*x*.
>
> **Decryption behavior:** Allows decryption of objects encrypted with and without key commitment.
>
> **Security implications:** This policy does not enforce key commitment and may allow tampering with the encrypted data key in Instruction Files. Use this policy only during the initial migration phase when you need 3.*x* clients to read newly encrypted objects.
>
> **Version Compatibility:** Objects encrypted with this policy can be read by any 3.*x* or 4.*x* client. This is the default (and only) policy for 3.*x* clients.

`REQUIRE_ENCRYPT_ALLOW_DECRYPT`

> **Encryption behavior:** Encrypts objects with key commitment using the ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY algorithm.
>
> **Decryption behavior:** Allows decryption of both objects encrypted with key commitment and objects encrypted without key commitment.
>
> **Security implications:** This policy provides strong security for newly encrypted objects while maintaining backward compatibility for reading older objects. This is the recommended policy for most migration scenarios.
>
> **Version Compatibility:** Objects encrypted with this policy can only be read by 3.*x* clients (version 3.6.0 or greater) and 4.*x* clients.

`REQUIRE_ENCRYPT_REQUIRE_DECRYPT` (Default for 4.*x*)

> **Encryption behavior:** Encrypts objects with key commitment using the ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY algorithm.
>
> **Decryption behavior:** Only allows decryption of objects encrypted with key commitment. Rejects objects encrypted without key commitment.

Security implications: This policy provides the highest level of security by enforcing key commitment for all operations. Use this policy only after all objects have been re-encrypted with key commitment and you no longer need to read legacy 3.*x* encrypted objects.

Version Compatibility: Objects encrypted with this policy can only be read by 3.*x* clients (version 3.6.0 or greater) and 4.*x* clients. This policy will reject objects encrypted without key commitment during decryption.

Migration considerations: During migration, start with `FORBID_ENCRYPT_ALLOW_DECRYPT` if you need 3.*x* clients to read new objects, then move to `REQUIRE_ENCRYPT_ALLOW_DECRYPT` once all clients are upgraded to 3.*x* (version 3.6.0 or greater) or 4.*x*. Finally, consider `REQUIRE_ENCRYPT_REQUIRE_DECRYPT` only after all legacy objects have been re-encrypted.

AES GCM with Key Commitment

AES GCM with Key Commitment (ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY) is the new encryption algorithm suite introduced in version 4.*x* that protects against data key tampering in Instruction Files by cryptographically binding the key to its intended use.

Instruction File impact: The ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY algorithm only impacts Instruction Files, which are separate S3 objects that store encryption metadata including the encrypted data key. Objects that store encryption metadata in object metadata (the default storage method) are not affected by this algorithm change.

Protection against tampering: The ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY algorithm protects against data key tampering by cryptographically binding the encrypted data key to the encryption context. This prevents attackers from substituting a different encrypted data key in the Instruction File, which could potentially lead to decryption with an unintended key.

Version Compatibility: Objects encrypted with ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY can only be decrypted by 3.*x* clients (version 3.6.0 or greater) or 4.*x* clients. Earlier 3.*x* clients cannot read these objects.

Important

Important: Before enabling encryption with the ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY algorithm (by using `REQUIRE_ENCRYPT_ALLOW_DECRYPT` or `REQUIRE_ENCRYPT_REQUIRE_DECRYPT` commitment policies), you must ensure that all clients that will read these objects have been upgraded to 3.*x* (version 3.6.0 or greater) or 4.*x*. Failure to upgrade all readers first will result in decryption failures for newly encrypted objects.

Update existing 3.*x* clients to read 4.*x* formats

Before migrating to 4.*x* encryption, you must first update all existing 3.*x* clients to a version that can read 4.*x* encrypted objects. This ensures compatibility when you begin encrypting with 4.*x*.

Build and install the latest S3EC version

Update your Maven or Gradle dependencies to use the latest version of the Amazon S3 Encryption Client 3.*x* that includes support for reading 4.*x* messages:

Maven (pom.xml):

```
<dependency>
    <groupId>software.amazon.encryption.s3</groupId>
    <artifactId>amazon-s3-encryption-client-java</artifactId>
    <version>3.6.0</version>
</dependency>
```

Gradle (build.gradle):

```
dependencies {
    implementation 'software.amazon.encryption.s3:amazon-s3-encryption-client-
java:3.6.0'
}
```

Build, Install, and Deploy Applications

After updating your dependencies, rebuild and deploy your applications:

1. **Clean and rebuild:**

   ```
   mvn clean install
   ```

   or for Gradle:

   ```
   gradle clean build
   ```

2. **Run your tests:**

   ```
   mvn test
   ```

   or for Gradle:

   ```
   gradle test
   ```

3. **Deploy updated applications:** Deploy the updated applications to all environments where S3 Encryption Client is used. Ensure all applications can successfully decrypt existing 3.*x* encrypted objects before proceeding to Phase 2.

Migrate encryption and decryption clients to 4.*x*

After all clients in your environment can read 4.*x* formats, you can migrate your encryption and decryption operations to use 4.*x* clients. The following examples demonstrate the transition from 3.*x* to 4.*x* clients using different Commitment Policies during the transition.

Client Migration Examples

The following examples show how to migrate from 3.*x* to 4.*x* clients using different Commitment Policies during the transition:

Pre-migration (3.x Client)

```
// V3 Client (Prior 3.x versions)
// Uses default algorithm without key commitment (ALG_AES_256_GCM_IV12_TAG16_NO_KDF)
S3Client v3Client = S3EncryptionClient.builder()
        .kmsKeyId(kmsKeyId)
        .build();

// V3 Client (Latest 3.x version - 3.6.0 or greater)
// Prepare for V4 migration with FORBID_ENCRYPT_ALLOW_DECRYPT
// This allows reading both committed and non-committed objects
S3Client v3Client = S3EncryptionClient.builderV4()
        .kmsKeyId(kmsKeyId)
        .encryptionAlgorithm(AlgorithmSuite.ALG_AES_256_GCM_IV12_TAG16_NO_KDF)
        .commitmentPolicy(CommitmentPolicy.FORBID_ENCRYPT_ALLOW_DECRYPT)
        .build();
```

During Migration (4.*x* Client with FORBID_ENCRYPT_ALLOW_DECRYPT Policy)

Update your Maven or Gradle dependencies to use the latest version of the Amazon S3 Encryption Client 4.*x*:

Maven (pom.xml):

```
<dependency>
    <groupId>software.amazon.encryption.s3</groupId>
    <artifactId>amazon-s3-encryption-client-java</artifactId>
    <version>4.x</version>
</dependency>
```

Gradle (build.gradle):

```
dependencies {
    implementation 'software.amazon.encryption.s3:amazon-s3-encryption-client-java:4.x'
}
```

After updating your dependencies, make code changes as described below. This should result in no functional changes to your application.

```
// V4 Client with FORBID_ENCRYPT_ALLOW_DECRYPT
// This maintains V2/V3 compatibility during migration
// Uses non-committing algorithm to maintain compatibility with V2/V3 clients
S3Client v4Client = S3EncryptionClient.builderV4()
        .kmsKeyId(kmsKeyId)
        .encryptionAlgorithm(AlgorithmSuite.ALG_AES_256_GCM_IV12_TAG16_NO_KDF)
        .commitmentPolicy(CommitmentPolicy.FORBID_ENCRYPT_ALLOW_DECRYPT)
        .build();
```

During migration (4.*x* Client with REQUIRE_ENCRYPT_ALLOW_DECRYPT Policy)

After deploying the FORBID_ENCRYPT_ALLOW_DECRYPT changes, make code changes as described below. This will cause your application to start writing objects encrypted with key commitment.

```
// V4 Client with REQUIRE_ENCRYPT_ALLOW_DECRYPT
// This encrypts with commitment but can read objects with or without commitment
// Uses committing algorithm to protect against data key tampering
S3Client v4Client = S3EncryptionClient.builderV4()
        .kmsKeyId(kmsKeyId)
        .commitmentPolicy(CommitmentPolicy.REQUIRE_ENCRYPT_ALLOW_DECRYPT)
        .build();
```

Post-migration (4.*x* Client with default commitment policy)

After deploying the REQUIRE_ENCRYPT_ALLOW_DECRYPT changes, make code changes as described below. This will cause your application to stop reading objects encrypted without key commitment. Before deploying this change, ensure any existing objects are now encrypted with key commitment.

```
// V4 Client with default REQUIRE_ENCRYPT_REQUIRE_DECRYPT policy
// This encrypts with commitment and only reads objects with commitment (most secure)
// Uses committing algorithm by default
S3Client v4Client = S3EncryptionClient.builderV4()
        .kmsKeyId(kmsKeyId)
        .build();
```

Enable Legacy Decryption Modes

If you need to decrypt objects or data keys that were encrypted by earlier versions of the Amazon S3 Encryption Client, you need to explicitly enable this behavior when you instantiate the client.

The `enableLegacyUnauthenticatedModes` parameter of the `builderV4()` method enables the Amazon S3 Encryption Client to decrypt content encrypted with legacy unauthenticated encryption algorithms (such as AES-CBC) and to perform ranged GET requests on encrypted objects.

The `enableLegacyWrappingAlgorithms` parameter of the `builderV4()` method enables the Amazon S3 Encryption Client to decrypt data keys that were wrapped with legacy V2 wrapping algorithms.

If your `v4Client` doesn't include the necessary settings, and it encounters an object or data key encrypted with a legacy algorithm, it throws `S3EncryptionClientException`.

For example, this code builds a `v4Client` object with a user-provided raw AES wrapping key. This client always encrypts only with fully supported algorithms. However, it can decrypt objects and data keys encrypted with fully supported or legacy algorithms.

```
// v4
```

```
class v4EnableLegacyDecryptionModesExample {
    public static void main(String[] args) {
        S3Client v4Client = S3EncryptionClient.builderV4()
                .aesKey(aesKey)
                .commitmentPolicy(CommitmentPolicy.REQUIRE_ENCRYPT_ALLOW_DECRYPT)
                .enableLegacyUnauthenticatedModes(true)
                .enableLegacyWrappingAlgorithms(true)
                .build();
    }
}
```

The legacy decryption modes are designed to be a temporary fix. After you've re-encrypted all of your objects with fully supported algorithms, you can eliminate it from your code.

S3 Encryption Client Migration (V2 to V3)

Note

If you're using S3 Encryption Client V3 and want to migrate to V4, see S3 Encryption Client Migration (V3 to V4).

The `v3Client` constructor does not use the `EncryptionMaterialsProvider` that was required in versions 1.*x* and 2.*x* of the Amazon S3 Encryption Client. Instead, you use a parameter of the `v3Client` builder to specify your wrapping key. The Amazon S3 Encryption Client supports the following wrapping keys: AWS Key Management Service (AWS KMS) symmetric AWS KMS keys, raw AES-GCM (Advanced Encryption Standard/Galois Counter Mode) keys, and raw RSA keys. The Amazon S3 Encryption Client optimizes its settings based on the wrapping key type.

When updating from earlier versions of the Amazon S3 Encryption Client to version 3.*x*, you need to update your client builder code to use the new, simpler interface for the `v3Client`. If you're decrypting ciphertext that was encrypted by earlier versions of the Amazon S3 Encryption Client, you might also need to allow the Amazon S3 Encryption Client to decrypt legacy encryption algorithms.

To update to Amazon S3 Encryption Client version 3.*x*, delete the code that instantiates the `EncryptionMaterialsProvider`. Then replace the code that calls the `v1Client` or `v2Client` builder with code that calls the `v3Client` builder. Use a parameter of the `v3Client` builder to specify your wrapping key.

The following examples show the equivalent code required to specify a KMS key as the wrapping key in versions 1.*x*, 2.*x*, and 3.*x* of the Amazon S3 Encryption Client.

Version 1.*x*

In Amazon S3 Encryption Client version 1.*x*, you instantiate an `EncryptionMaterialsProvider` with your wrapping key, and then specify that materials provider when instantiating the `v1Client` object.

```
// v1

class v1KMSKeyExample {
    public static void main(String[] args) {

        EncryptionMaterialsProvider materialsProvider = new
 KMSEncryptionMaterialsProvider(kmsKeyId);
        AmazonS3Encryption v1Client = AmazonS3EncryptionClient.encryptionBuilder()
                .withEncryptionMaterialsProvider(materialsProvider)
                .build();
    }
}
```

Version 2.*x*

In Amazon S3 Encryption Client version 2.*x*, you instantiate an `EncryptionMaterialsProvider` with your wrapping key, and then specify that materials provider when instantiating the `v2Client` object.

```
// v2

class v2KMSKeyExample {
    public static void main(String[] args) {

        EncryptionMaterialsProvider materialsProvider = new
 KMSEncryptionMaterialsProvider(kmsKeyId);
        AmazonS3EncryptionV2 v2Client =
 AmazonS3EncryptionClientV2.encryptionBuilder()
                .withEncryptionMaterialsProvider(materialsProvider)
                .build();
    }
}
```

Version 3.*x*

In Amazon S3 Encryption Client version 3.*x*, the `v3Client` constructor requires only a parameter that identifies the wrapping key. For a KMS key, use the `kmsKeyId` parameter. The value of the `kmsKeyId` parameter can be any valid KMS key identifier. For details, see Key identifiers in the *AWS Key Management Service Developer Guide*. 3.*x* clients use the default algorithm suite (ALG_AES_256_GCM_IV12_TAG16_NO_KDF) which does not support key commitment and is maintained for backward compatibility. Content encrypted with this algorithm can be read by any 2.*x*, 3.*x*, or 4.*x* client.

```
// v3

class v3KMSKeyExample {
    public static void main(String[] args) {
        // Uses default algorithm without key commitment
 (ALG_AES_256_GCM_IV12_TAG16_NO_KDF)
        S3Client v3Client = S3EncryptionClient.builder()
                .kmsKeyId(kmsKeyId)
                .build();
    }
}
```

If you're using Amazon S3 Encryption Client version 3.*x* and planning to migrate to 4.*x*, use the latest 3.*x* version (3.6.0 or greater) with the following configuration:

```
// 3.x (Latest 3.x version - 3.6.0 or greater for 4.x migration)

class v3TransitionalKMSKeyExample {
    public static void main(String[] args) {
        // Explicitly set your commitment policy to FORBID_ENCRYPT_ALLOW_DECRYPT
        S3Client v3Client = S3EncryptionClient.builderV4()
                .kmsKeyId(kmsKeyId)

 .encryptionAlgorithm(AlgorithmSuite.ALG_AES_256_GCM_IV12_TAG16_NO_KDF)
                // This will allow your writers to continue writing messages without
 commitment
                // while being able to read messages with or without commitment.
                .commitmentPolicy(CommitmentPolicy.FORBID_ENCRYPT_ALLOW_DECRYPT)
                .build();
    }
}
```

Key API Changes in Versions 3.6.0 and Greater

If you're using Amazon S3 Encryption Client version 3.*x* and planning to migrate to 4.*x*, you need to be aware of key API changes introduced in versions 3.6.0 and greater. These versions introduce new builder methods and parameters to support commitment policies and algorithm suite configuration in preparation for 4.*x*.

Key API Changes:

- `builderV4()` method: Use this method when configuring commitment policies and algorithm suites for 4.*x* migration. The standard `builder()` method is marked as deprecated and will be removed in 4.*x*.
- `encryptionAlgorithm()` parameter: Explicitly specify the encryption algorithm suite. For transitional versions, use `AlgorithmSuite.ALG_AES_256_GCM_IV12_TAG16_NO_KDF` (AES-256-GCM without key derivation function or key commitment) to maintain backward compatibility with earlier 3.*x* clients.
- `commitmentPolicy()` parameter: Set the commitment policy for your use case. For transitional versions, use `CommitmentPolicy.FORBID_ENCRYPT_ALLOW_DECRYPT` to allow your writers to continue writing messages without commitment while being able to read messages with or without commitment.

The standard `builder()` method remains available in versions 3.6.0 and greater for backward compatibility, but it is marked as deprecated and will be removed in 4.*x*. To prepare for the upgrade to 4.*x*, migrate your code to use `builderV4()` with the appropriate commitment policy configuration.

The `builderV4()` method implements a subset of the functionality found in the 4.*x* client, but the behavior is the same. See Migrating to 4.*x* for more information on migrating from 3.*x* to 4.*x*.

Enable Legacy Decryption Modes

If you need to decrypt objects or data keys that were encrypted by earlier versions of the Amazon S3 Encryption Client, you need to explicitly enable this behavior when you instantiate the client.

The `enableLegacyUnauthenticatedModes` parameter of the `builderV4()` method enables the Amazon S3 Encryption Client to decrypt content encrypted with legacy unauthenticated encryption algorithms (such as AES-CBC) and to perform ranged GET requests on encrypted objects.

The `enableLegacyWrappingAlgorithms` parameter of the `builderV4()` method enables the Amazon S3 Encryption Client to decrypt data keys that were wrapped with legacy V2 wrapping algorithms.

If your `v3Client` doesn't include the necessary settings, and it encounters an object or data key encrypted with a legacy algorithm, it throws `S3EncryptionClientException`.

For example, this code builds a `v3Client` object with a user-provided raw AES wrapping key. This client always encrypts only with fully supported algorithms. However, it can decrypt objects and data keys encrypted with fully supported or legacy algorithms.

```
// v3

class v3EnableLegacyDecryptionModesExample {
    public static void main(String[] args) {
        S3Client v3Client = S3EncryptionClient.builderV4()
                .aesKey(aesKey)
                .encryptionAlgorithm(AlgorithmSuite.ALG_AES_256_GCM_IV12_TAG16_NO_KDF)
                .commitmentPolicy(CommitmentPolicy.FORBID_ENCRYPT_ALLOW_DECRYPT)
                .enableLegacyUnauthenticatedModes(true)
                .enableLegacyWrappingAlgorithms(true)
                .build();
    }
}
```

The legacy decryption modes are designed to be a temporary fix. After you've re-encrypted all of your objects with fully supported algorithms, you can eliminate it from your code.

Amazon S3 Encryption Client for Go

Note

This documentation describes the Amazon S3 Encryption Client version 3.*x* and newer, which is an independent library. For information about previous versions of the Amazon S3 Encryption Client, see the AWS SDK Developer Guide for your programming language.

This topic explains how to install and use the Amazon S3 Encryption Client for Go. For details about programming with the Amazon S3 Encryption Client for Go, see the amazon-s3-encryption-client-go repository on GitHub.

Topics

Prerequisites

Before you install the Amazon S3 Encryption Client for Go, be sure you have the following prerequisites.

A Go development environment

The Amazon S3 Encryption Client for Go requires Go 1.24 or later, but we recommend that you use the latest version.

You can view your current version of Go by running the following command.

```
go version
```

AWS SDK for Go 2.x

The Amazon S3 Encryption Client for Go requires the Amazon S3 and AWS KMS service clients of the AWS SDK for Go 2.x. Service clients can be constructed using either the `NewFromConfig` or `New` function. For more information, see Using the AWS SDK for Go V2 with AWS services in the *AWS SDK for Go Developer Guide*.

For information about updating your version of the AWS SDK for Go, see Migration to the AWS SDK for Go V2 in the *AWS SDK for Go Developer Guide*.

Installation

To install the Amazon S3 Encryption Client for Go and its dependencies, run the following Go command.

```
go get github.com/aws/amazon-s3-encryption-client-go
```

Amazon S3 Encryption Client for Go examples

The following examples show you how to use the Amazon S3 Encryption Client for Go to encrypt and decrypt Amazon S3 objects. These examples show how to use version 4.*x* of the Amazon S3 Encryption Client for Go.

Note

The Amazon S3 Encryption Client for Go does not support asynchronous programming, multipart uploads, or ranged GET requests. To use these features of the Amazon S3 Encryption Client, you must use the Amazon S3 Encryption Client for Java.

Topics

Instantiating the Amazon S3 Encryption Client

After installing the Amazon S3 Encryption Client for Go, you are ready to instantiate your client and begin encrypting and decrypting your Amazon S3 objects. If you have encrypted objects under a previous version of the Amazon S3 Encryption Client, you may need to enable legacy decryption modes or configure a commmitment policy when you instantiate the updated client. For more information, see Migrating to version 4.*x* of the Amazon S3 Encryption Client for Go.

The Amazon S3 Encryption Client for Go supports keyrings that use symmetric encryption KMS keys as the wrapping key. The Amazon S3 Encryption Client for Go does not support keyrings that use Raw AES-GCM or Raw RSA wrapping keys. To use Raw AES-GCM or Raw RSA wrapping keys, you must use the Amazon S3 Encryption Client for Java. For more information, see Instantiating the Amazon S3 Encryption Client for Java.

To use a KMS key as your wrapping key, you need kms:GenerateDataKey and kms:Decrypt permissions on the KMS key. To specify a KMS key, use any valid KMS key identifier. For details, see Key identifiers in the *AWS Key Management Service Developer Guide*.

The following example instantiates the Amazon S3 Encryption Client with the default decryption mode. This means that all objects will be decrypted using the fully supported buffered decryption mode. For more information, see Decryption modes (Version 3.*x* and later).

```
import (
   ...
   // Import the materials and client package
   "github.com/aws/amazon-s3-encryption-client-go/client/v4"
   "github.com/aws/amazon-s3-encryption-client-go/materials/v4"
   ...
)
s3EncryptionClient, err := client.New(s3Client, cmm)

// Create the keyring and cryptographic materials manager (CMM)
cmm, err :=
 materials.NewCryptographicMaterialsManager(materials.NewKmsKeyring(kmsClient, kmsKeyArn,
 func(options *materials.KeyringOptions) {
  options.EnableLegacyWrappingAlgorithms = false
}))
if err != nil {
 t.Fatalf("error while creating new CMM")
}

s3EncryptionClient, err := client.New(s3Client, cmm)
```

Encrypting and decrypting Amazon S3 objects

The following example shows you how to use the Amazon S3 Encryption Client for Go to encrypt and decrypt Amazon S3 objects.

1. Create a keyring with a KMS key as your wrapping key when you instantiate your client.

    ```
    s3Client = s3.NewFromConfig(cfg)
    kmsClient := kms.NewFromConfig(cfg)
    cmm, err :=
     materials.NewCryptographicMaterialsManager(materials.NewKmsKeyring(kmsClient, kmsKeyArn,
     func(options *materials.KeyringOptions) {
        options.EnableLegacyWrappingAlgorithms = false
    }))
    if err != nil {
        t.Fatalf("error while creating new CMM")
    }
    ```

2. Encrypt your plaintext object by calling `PutObject`. To include an optional material description, add an `EncryptionContext` value to the `context` and supply this value to the `PutObject` request.

   a. The Amazon S3 Encryption Client provides the encryption materials: one plaintext data key and one copy of that data key encrypted by your wrapping key.

   b. The Amazon S3 Encryption Client uses the plaintext data key to encrypt your object, and then discards the plaintext data key.

   c. The Amazon S3 Encryption Client uploads the encrypted data key and the encrypted object to Amazon S3 as part of the `PutObject` call.

```
ctx := context.Background()
...
encryptionContext := context.WithValue(ctx, "EncryptionContext",
 map[string]string{"ec-key": "ec-value"})

s3EncryptionClient, err := client.New(s3Client, cmm)
_, err = s3EncryptionClient.PutObject(encryptionContext, &s3.PutObjectInput{
    Bucket: aws.String(bucket),
    Key:    aws.String(objectKey),
    Body:   bytes.NewReader([]byte(plaintext)),
})

if err != nil {
    t.Fatalf("error while encrypting: %v", err)
}
```

3. Decrypt your encrypted object by calling `GetObject`.

   a. The Amazon S3 Encryption Client uses your wrapping key to decrypt the encrypted data key.

   b. The Amazon S3 Encryption Client uses the plaintext data key to decrypt the object, discards the plaintext data key, and returns the plaintext object as part of the `GetObject` call.

```
result, err := s3EncryptionClient.GetObject(ctx, &s3.GetObjectInput{
  Bucket: aws.String(bucket),
  Key:    aws.String(objectKey),
 })
 if err != nil {
  return fmt.Errorf("error while decrypting: %v", err)
 }
```

```
decryptedPlaintext, err := io.ReadAll(result.Body)
if err != nil {
 return fmt.Errorf("failed to read decrypted plaintext into byte array")
}
```

4. Optional: verify that the decrypted object matches the original plaintext object that you uploaded.

```
if e, a := []byte(plaintext), decryptedPlaintext; !bytes.Equal(e, a) {
  return fmt.Errorf("expect %v text, got %v", e, a)
 }
```

S3 Encryption Client Migration (3.*x* to 4.*x*)

Note: If you're using version 2.*x* of the Amazon S3 Encryption Client for Go and want to migrate to version 4.*x*, you must first migrate to version 3.*x*. See the section called "Migrate from 2.*x* to 3.*x*".

Version 4.*x* of the Amazon S3 Encryption Client for Go introduces AES GCM with Key Commitment (ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY) and Commitment Policies to enhance security by protecting against data key tampering in Instruction Files. This migration guide explains the two-phase approach to safely upgrade from 3.*x* to 4.*x* while maintaining backward compatibility during the transition.

Migration Overview

Migrating from version 3.*x* to version 4.*x* of the Amazon S3 Encryption Client for Go requires a two-phase approach to ensure compatibility and security:

1. **Phase 1: Update existing 3.*x* clients to read 4.*x* formats**

   First, update all existing 3.*x* clients in your environment to a version that can read objects encrypted with 4.*x* algorithms and commitment policies (Amazon S3 Encryption Client for Go version 3.2.0 or greater). This ensures that when you start encrypting with 4.*x*, your existing applications can still decrypt the new objects.
2. **Phase 2: Migrate encryption and decryption clients to 4.*x***

   After all clients can read 4.*x* formats, migrate your encryption and decryption operations to use 4.*x* clients with the appropriate Commitment Policy. This phase introduces the enhanced security features while maintaining backward compatibility with existing encrypted objects.

This phased approach prevents compatibility issues and ensures that all encrypted objects remain accessible throughout the migration process.

Understanding 4.*x* Concepts

Version 4.*x* introduces two key security concepts that enhance protection against data key tampering:

Commitment Policy

Commitment Policy controls how the encryption client handles key commitment during encryption and decryption operations. There are three Commitment Policies:

`FORBID_ENCRYPT_ALLOW_DECRYPT`

> **Encryption:** Encrypts without commitment.
>
> **Decryption:** Allows decryption of both committing and non-committing objects.
>
> **Security:** Does not enforce commitment and may allow for tampering of data keys in Instruction Files. Use only during migration for backward compatibility.
>
> **Version Compatibility:** Objects encrypted with this policy can be read by 2.*x*, 3.*x*, and 4.*x* clients.

`REQUIRE_ENCRYPT_ALLOW_DECRYPT`

> **Encryption:** Encrypts with commitment (uses ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY algorithm).
>
> **Decryption:** Allows decryption of both committing and non-committing objects.
>
> **Security:** New objects are protected against tampering in Instruction Files. Old objects remain readable, but are not protected against data key tampering.
>
> **Version Compatibility:** Objects encrypted with this policy can only be read by 3.*x* clients (Amazon S3 Encryption Client for Go version 3.2.0 or greater) and 4.*x* clients.

`REQUIRE_ENCRYPT_REQUIRE_DECRYPT` (Default for 4.*x*)

> **Encryption:** Encrypts with commitment (uses ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY algorithm).
>
> **Decryption:** Only allows decryption of objects encrypted with key commitment.

Security: Strict commitment enforcement provides protection against tampered data keys.

Version Compatibility: Objects encrypted with this policy can only be read by 3.*x* clients (version 3.2.0 or greater) and 4.*x* clients. This policy will reject non-committing objects during decryption.

AES GCM with Key Commitment

AES GCM with Key Commitment (ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY) is the new encryption algorithm suite introduced in version 4.*x* that protects against data key tampering in Instruction Files by cryptographically binding the key to its intended use.

Version Compatibility: Objects encrypted with ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY can only be decrypted by 3.*x* clients (version 3.2.0 or greater) or 4.*x* clients. 2.*x* and earlier 3.*x* clients (v3.1.0 and earlier) cannot read these objects.

Update Existing Clients

Before migrating to 4.*x* encryption, you must first update all existing 3.*x* clients to a version that can read 4.*x* encrypted objects. This ensures compatibility when you begin encrypting with 4.*x*.

Build and Install the Latest SDK Version

Update your Go module dependencies to use the latest version of the Amazon S3 Encryption Client for Go 3.*x* that includes support for reading 4.*x* messages:

Update Go modules:

```
go get github.com/aws/amazon-s3-encryption-client-go/v3@latest
```

Update your go.mod file if needed:

```
module your-application

go 1.24

require (
    // The `x`s must be replaced with the specific latest version
    github.com/aws/amazon-s3-encryption-client-go/v3 v3.x.x
    // Add other dependencies as needed
)
```

Build, Install, and Deploy Applications

After updating your dependencies, rebuild and deploy your applications:

1. **Clean and rebuild:**

   ```
   go mod tidy
   go build ./...
   ```

2. **Run your tests:**

   ```
   go test ./...
   ```

3. **Deploy updated applications:** Deploy the updated applications to all environments where S3 Encryption Client is used. Ensure all applications can successfully decrypt existing V3 encrypted objects before proceeding to the next phase.

Migrate to V4

After all clients in your environment can read 4.*x* formats, you can migrate your encryption and decryption operations to use 4.*x* clients. The following examples demonstrate the transition from 3.*x* to 4.*x* clients.

Client Migration Examples

The following examples show how to migrate from 3.*x* to 4.*x* clients using different Commitment Policies during the transition:

Pre-migration (3.*x* Client)

```
import (
 "context"
 "fmt"
 "strings"

 "github.com/aws/aws-sdk-go-v2/aws"
 "github.com/aws/aws-sdk-go-v2/config"
 "github.com/aws/aws-sdk-go-v2/service/kms"
 "github.com/aws/aws-sdk-go-v2/service/s3"

 // V3 S3 Encryption Client imports
 "github.com/aws/amazon-s3-encryption-client-go/v3/client"
```

```
 "github.com/aws/amazon-s3-encryption-client-go/v3/materials"
)

func V3EncryptionExample() error {
 ctx := context.Background()

 // Load AWS configuration
 cfg, err := config.LoadDefaultConfig(ctx, config.WithRegion("us-west-2"))
 if err != nil {
  return fmt.Errorf("failed to load config: %v", err)
 }

 // Create KMS and S3 clients
 kmsClient := kms.NewFromConfig(cfg)
 s3Client := s3.NewFromConfig(cfg)

 // Create V3 encryption materials
 kmsKeyId := "arn:aws:kms:us-
west-2:123456789012:key/12345678-1234-1234-1234-123456789012"
 cmm, err := materials.NewCryptographicMaterialsManager(
  materials.NewKmsKeyring(kmsClient, kmsKeyId))
 if err != nil {
  return fmt.Errorf("failed to create CMM: %v", err)
 }

 // Create V3 S3 encryption client
 s3EncryptionClient, err := client.New(s3Client, cmm)
 if err != nil {
  return fmt.Errorf("failed to create encryption client: %v", err)
 }

 // Encrypt and upload object
 encryptionContext := map[string]string{
  "purpose": "example",
  "department": "engineering",
 }

 _, err = s3EncryptionClient.PutObject(ctx, &s3.PutObjectInput{
  Bucket: aws.String("my-bucket"),
  Key:    aws.String("my-object"),
  Body:   strings.NewReader("Hello, World!"),
  Metadata: encryptionContext,
 })
 return err
}
```

During Migration (4.*x* Client with FORBID_ENCRYPT_ALLOW_DECRYPT Policy)

Update your Go module dependencies to use the latest version of the Amazon S3 Encryption Client for Go 4.*x*:

Upgrade Go modules:

```
go get github.com/aws/amazon-s3-encryption-client-go/v4@latest
```

Update your go.mod file if needed:

```
module your-application

go 1.24

require (
    // The `x`s must be replaced with the specific latest version
    github.com/aws/amazon-s3-encryption-client-go/v4 v4.x.x
    // Add other dependencies as needed
)
```

After updating your dependencies, make code changes as described below. This should result in no functional changes to your application.

```
import (
 "context"
 "fmt"
 "strings"

 "github.com/aws/aws-sdk-go-v2/aws"
 "github.com/aws/aws-sdk-go-v2/config"
 "github.com/aws/aws-sdk-go-v2/service/kms"
 "github.com/aws/aws-sdk-go-v2/service/s3"

 // V4 S3 Encryption Client imports
 "github.com/aws/amazon-s3-encryption-client-go/v4/client"
 "github.com/aws/amazon-s3-encryption-client-go/v4/commitment"
 "github.com/aws/amazon-s3-encryption-client-go/v4/materials"
)
```

```
func V4ForbidAllowExample() error {
 ctx := context.Background()

 // Load AWS configuration
 cfg, err := config.LoadDefaultConfig(ctx, config.WithRegion("us-west-2"))
 if err != nil {
  return fmt.Errorf("failed to load config: %v", err)
 }

 // Create KMS and S3 clients
 kmsClient := kms.NewFromConfig(cfg)
 s3Client := s3.NewFromConfig(cfg)

 // Create V4 encryption materials with KMS keyring
 kmsKeyId := "arn:aws:kms:us-
west-2:123456789012:key/12345678-1234-1234-1234-123456789012"
 cmm, err := materials.NewCryptographicMaterialsManager(
  materials.NewKmsKeyring(kmsClient, kmsKeyId))
 if err != nil {
  return fmt.Errorf("failed to create CMM: %v", err)
 }

 // Create V4 S3 encryption client with FORBID_ENCRYPT_ALLOW_DECRYPT policy
 // This maintains V3 compatibility during migration
 s3EncryptionClient, err := client.New(s3Client, cmm, func(options
 *client.EncryptionClientOptions) {
  // This MUST be explicitly configured to FORBID_ENCRYPT_ALLOW_DECRYPT.
  // While FORBID_ENCRYPT_ALLOW_DECRYPT is the default for v3 clients,
  // v4 clients default to REQUIRE_ENCRYPT_REQUIRE_DECRYPT.
  // This configuration ensures identical behavior to a v3 client.
  options.CommitmentPolicy = commitment.FORBID_ENCRYPT_ALLOW_DECRYPT
 })
 if err != nil {
  return fmt.Errorf("failed to create V4 encryption client: %v", err)
 }

 // Encrypt and upload object (uses legacy algorithms for V3 compatibility)
 encryptionContext := map[string]string{
  "purpose": "example",
  "department": "engineering",
 }

 _, err = s3EncryptionClient.PutObject(ctx, &s3.PutObjectInput{
  Bucket: aws.String("my-bucket"),
  Key:    aws.String("my-object"),
  Body:   strings.NewReader("Hello, World!"),
  Metadata: encryptionContext,
 })

 return err
}
```

During migration (4.*x* Client with REQUIRE_ENCRYPT_ALLOW_DECRYPT Policy)

After deploying the FORBID_ENCRYPT_ALLOW_DECRYPT changes, make code changes as described below. This will cause your application to start writing objects encrypted with key committing algorithms.

```
import (
 "context"
 "fmt"
 "io"
 "strings"

 "github.com/aws/aws-sdk-go-v2/aws"
 "github.com/aws/aws-sdk-go-v2/config"
 "github.com/aws/aws-sdk-go-v2/service/kms"
 "github.com/aws/aws-sdk-go-v2/service/s3"

 // V4 S3 Encryption Client imports
 "github.com/aws/amazon-s3-encryption-client-go/v4/client"
    "github.com/aws/amazon-s3-encryption-client-go/v4/commitment"
 "github.com/aws/amazon-s3-encryption-client-go/v4/materials"
)

func V4RequireAllowExample() error {
 ctx := context.Background()

 // Load AWS configuration
 cfg, err := config.LoadDefaultConfig(ctx, config.WithRegion("us-west-2"))
 if err != nil {
  return fmt.Errorf("failed to load config: %v", err)
 }

 // Create KMS and S3 clients
 kmsClient := kms.NewFromConfig(cfg)
 s3Client := s3.NewFromConfig(cfg)

 // Create V4 encryption materials with KMS keyring
 kmsKeyId := "arn:aws:kms:us-
west-2:123456789012:key/12345678-1234-1234-1234-123456789012"
 cmm, err := materials.NewCryptographicMaterialsManager(
  materials.NewKmsKeyring(kmsClient, kmsKeyId))
 if err != nil {
  return fmt.Errorf("failed to create CMM: %v", err)
 }

 // Create V4 S3 encryption client with REQUIRE_ENCRYPT_ALLOW_DECRYPT commitment policy
 // Uses REQUIRE_ENCRYPT_ALLOW_DECRYPT to ensure new messages are encrypted with key
 commitment
 s3EncryptionClient, err := client.New(s3Client, cmm, func(options
 *client.EncryptionClientOptions) {
  // Migration note: The commitment policy has been updated to
 REQUIRE_ENCRYPT_ALLOW_DECRYPT.
  // This change causes the client to start writing objects encrypted with key
 committing algorithms.
  // The client will continue to be able to read objects encrypted with either
  // key committing or non-key committing algorithms.
  options.CommitmentPolicy = commitment.REQUIRE_ENCRYPT_ALLOW_DECRYPT
 })
 if err != nil {
  return fmt.Errorf("failed to create V4 encryption client: %v", err)
 }

 // Encrypt and upload object (uses AES_GCM_KC with key commitment)
 encryptionContext := map[string]string{
  "purpose": "example",
  "department": "engineering",
 }

 _, err = s3EncryptionClient.PutObject(ctx, &s3.PutObjectInput{
  Bucket: aws.String("my-bucket"),
  Key:    aws.String("my-object"),
  Body:   strings.NewReader("Hello, World!"),
  Metadata: encryptionContext,
 })
 if err != nil {
  return fmt.Errorf("failed to put object: %v", err)
 }
 // Decrypt and download object
 result, err := s3EncryptionClient.GetObject(ctx, &s3.GetObjectInput{
  Bucket: aws.String("my-bucket"),
  Key:    aws.String("my-object"),
 })
 if err != nil {
  return fmt.Errorf("failed to get object: %v", err)
 }
 defer result.Body.Close()

 // Read decrypted content
 body, err := io.ReadAll(result.Body)
 if err != nil {
  return fmt.Errorf("failed to read body: %v", err)
 }

 fmt.Printf("Decrypted content: %s\n", string(body))
 return nil
}
```

Post-migration (4.*x* Client with default commitment policy)

After deploying the REQUIRE_ENCRYPT_ALLOW_DECRYPT changes, make code changes as described below. This will cause your application to stop reading objects encrypted without key committing algorithms. Before deploying this change, ensure all existing objects are now encrypted with key commiting algorithms.

```
import (
 "context"
 "fmt"
 "io"
 "strings"

 "github.com/aws/aws-sdk-go-v2/aws"
 "github.com/aws/aws-sdk-go-v2/config"
 "github.com/aws/aws-sdk-go-v2/service/kms"
 "github.com/aws/aws-sdk-go-v2/service/s3"

 // V4 S3 Encryption Client imports
 "github.com/aws/amazon-s3-encryption-client-go/v4/client"
 "github.com/aws/amazon-s3-encryption-client-go/v4/materials"
)
```

```
func V4KeyCommitmentExample() error {
 ctx := context.Background()

 // Load AWS configuration
 cfg, err := config.LoadDefaultConfig(ctx, config.WithRegion("us-west-2"))
 if err != nil {
  return fmt.Errorf("failed to load config: %v", err)
 }

 // Create KMS and S3 clients
 kmsClient := kms.NewFromConfig(cfg)
 s3Client := s3.NewFromConfig(cfg)

 // Create V4 encryption materials with KMS keyring
 kmsKeyId := "arn:aws:kms:us-
west-2:123456789012:key/12345678-1234-1234-1234-123456789012"
 cmm, err := materials.NewCryptographicMaterialsManager(
  materials.NewKmsKeyring(kmsClient, kmsKeyId))
 if err != nil {
  return fmt.Errorf("failed to create CMM: %v", err)
 }

 // Create V4 S3 encryption client with default commitment policy
 (REQUIRE_ENCRYPT_REQUIRE_DECRYPT)
 // Uses REQUIRE_ENCRYPT_ALLOW_DECRYPT to ensure all messages read or written are
 encrypted with key commitment
 s3EncryptionClient, err := client.New(s3Client, cmm)
 if err != nil {
  return fmt.Errorf("failed to create V4 encryption client: %v", err)
 }

 // Encrypt and upload object (uses AES_GCM_KC with key commitment)
 encryptionContext := map[string]string{
  "purpose": "example",
  "department": "engineering",
 }

 _, err = s3EncryptionClient.PutObject(ctx, &s3.PutObjectInput{
  Bucket: aws.String("my-bucket"),
  Key:    aws.String("my-object"),
  Body:   strings.NewReader("Hello, World!"),
  Metadata: encryptionContext,
 })
 if err != nil {
  return fmt.Errorf("failed to put object: %v", err)
 }

 // Decrypt and download object
 result, err := s3EncryptionClient.GetObject(ctx, &s3.GetObjectInput{
  Bucket: aws.String("my-bucket"),
  Key:    aws.String("my-object"),
 })
 if err != nil {
  return fmt.Errorf("failed to get object: %v", err)
 }
 defer result.Body.Close()

 // Read decrypted content
 body, err := io.ReadAll(result.Body)
 if err != nil {
  return fmt.Errorf("failed to read body: %v", err)
 }

 fmt.Printf("Decrypted content: %s\n", string(body))
 return nil
}
```

Additional Examples

The following examples demonstrate specific 4.*x* configuration scenarios for different migration and operational needs.

Enable Legacy Support for Reading 1.*x*/2.*x* Objects

During migration, you may need to read objects encrypted with legacy algorithms. Configure your 4.*x* client to support backward compatibility:

```
import (
 "context"
 "fmt"

 "github.com/aws/aws-sdk-go-v2/aws"
 "github.com/aws/aws-sdk-go-v2/config"
 "github.com/aws/aws-sdk-go-v2/service/kms"
 "github.com/aws/aws-sdk-go-v2/service/s3"

 // V4 S3 Encryption Client imports
 "github.com/aws/amazon-s3-encryption-client-go/v4/client"
 "github.com/aws/amazon-s3-encryption-client-go/v4/commitment"
 "github.com/aws/amazon-s3-encryption-client-go/v4/materials"
)

func V4WithLegacySupportExample() error {
 ctx := context.Background()

 // Load AWS configuration
 cfg, err := config.LoadDefaultConfig(ctx, config.WithRegion("us-west-2"))
 if err != nil {
  return fmt.Errorf("failed to load config: %v", err)
 }

 // Create KMS and S3 clients
 kmsClient := kms.NewFromConfig(cfg)
 s3Client := s3.NewFromConfig(cfg)

 // Create encryption materials
 kmsKeyId := "arn:aws:kms:us-
west-2:123456789012:key/12345678-1234-1234-1234-123456789012"
 cmm, err := materials.NewCryptographicMaterialsManager(
  materials.NewKmsKeyring(kmsClient, kmsKeyId, func(options *materials.KeyringOptions)
 {
   // Enable legacy wrapping algorithms for V2/V3 compatibility
   options.EnableLegacyWrappingAlgorithms = true
  }))
 if err != nil {
  return fmt.Errorf("failed to create CMM: %v", err)
 }

 // Create V4 client with legacy support enabled
 s3EncryptionClient, err := client.New(s3Client, cmm, func(options
 *client.EncryptionClientOptions) {
  // Allow reading objects encrypted with legacy algorithms
  options.EnableLegacyUnauthenticatedModes = true
  // Use REQUIRE_ENCRYPT_ALLOW_DECRYPT to encrypt with commitment but read legacy
 objects
  options.CommitmentPolicy = commitment.REQUIRE_ENCRYPT_ALLOW_DECRYPT
 })
 if err != nil {
  return fmt.Errorf("failed to create encryption client: %v", err)
 }
 // This client can now read objects encrypted with legacy algorithms and encrypt new
 objects with commitment
 result, err := s3EncryptionClient.GetObject(ctx, &s3.GetObjectInput{
  Bucket: aws.String("my-bucket"),
  Key:    aws.String("legacy-encrypted-object"),
 })
 if err != nil {
  return fmt.Errorf("failed to decrypt legacy object: %v", err)
 }
 defer result.Body.Close()

 return nil
}
```

S3 Encryption Client Migration (2.*x* to 3.*x*)

Note: If you're using version 3.*x* of the Amazon S3 Encryption Client for Go and want to migrate to version 4.*x*, see the section called "Migrate from 3.*x* to 4.*x*".

With version 3.*x* of the Amazon S3 Encryption Client for Go, you create one client for both encryption and decryption. Version 3.*x* replaces the cipher data generators with the cryptographic materials manager (CMM), and replaces the KMS key providers, `NewKMSContextKeyGenerator`, with the `NewKmsKeyring`.

When updating from earlier versions of the Amazon S3 Encryption Client to version 3.*x*, you need to update your client builder code to use the new, simpler client. If you're decrypting ciphertext that was encrypted by earlier versions of the Amazon S3 Encryption Client, you might also need to allow the Amazon S3 Encryption Client to decrypt legacy encryption algorithms.

The following examples show the equivalent code required to specify a KMS key provider with a KMS key ID in versions 1.*x*, 2.*x*, and 3.*x* of the Amazon S3 Encryption Client.

Version 1.*x*

In version 1.*x*, you use the `NewKMSKeyGeneratorWith` function to construct the `cipherDataGenerator`.

```
sess := session.Must(session.NewSession())
kmsClient := kms.New(sess)
cmkID := "1234abcd-12ab-34cd-56ef-1234567890ab"
```

```
cipherDataGenerator := s3crypto.NewKMSKeyGenerator(kmsClient, kmsKeyID)
```

Version 2.*x*

In version 2.*x*, you use the `NewKMSContextKeyGenerator` function to construct the `cipherDataGenerator`.

```
sess := session.Must(session.NewSession())
kmsClient := kms.New(sess)
cmkID := "1234abcd-12ab-34cd-56ef-1234567890ab"
var matDesc s3crypto.MaterialDescription

// changed NewKMSKeyGenerator to NewKMSContextKeyGenerator
cipherDataGenerator := s3crypto.NewKMSContextKeyGenerator(kmsClient, kmsKeyID,
 matDesc)
```

Version 3.*x*

In version 3.*x*, you use the `NewKmsKeyring` function to construct your cryptographic materials manager (CMM).

```
s3Client := s3.NewFromConfig(cfg)
kmsClient := kms.NewFromConfig(cfg)
cmm, err :=
 materials.NewCryptographicMaterialsManager(materials.NewKmsKeyring(kmsClient, kmsKeyID))
 if err != nil {
  return fmt.Errorf("error while creating new CMM")
 }
```

Migrating from version 2.*x*

The following example demonstrates how to migrate a version 2.*x* application that uses the `NewKMSContextKeyGenerator` KMS key provider with a material description and `AESGCMContentCipherBuilderV2` content cipher to version 3.*x* of the Amazon S3 Encryption Client for Go.

```
import (
 "bytes"
 "context"
 "fmt"
 "log"
 // AWS SDK for Go v1 (for V2 S3EC)
 awsV1 "github.com/aws/aws-sdk-go/aws"
 sessionV1 "github.com/aws/aws-sdk-go/aws/session"
 kmsV1 "github.com/aws/aws-sdk-go/service/kms"
 s3V1 "github.com/aws/aws-sdk-go/service/s3"
 s3cryptoV2 "github.com/aws/aws-sdk-go/service/s3/s3crypto"

 // AWS SDK for Go v2 (for V3 S3EC)
 "github.com/aws/aws-sdk-go-v2/aws"
 "github.com/aws/aws-sdk-go-v2/config"
 "github.com/aws/aws-sdk-go-v2/service/kms"
 "github.com/aws/aws-sdk-go-v2/service/s3"

 // V3 S3 Encryption Client imports
 "github.com/aws/amazon-s3-encryption-client-go/v3/client"
 "github.com/aws/amazon-s3-encryption-client-go/v3/materials"
)

func KmsContextV2toV3GCMExample() error {
 bucket := LoadBucket()
 kmsKeyAlias := LoadAwsKmsAlias()

 objectKey := "my-object-key"
 region := "us-west-2"
 plaintext := "This is an example.\n"

 // Create an S3EC Go v2 encryption client
 // using the KMS client from AWS SDK for Go v1
 sessKms, err := sessionV1.NewSession(&awsV1.Config{
  Region: aws.String(region),
 })

 kmsSvc := kmsV1.New(sessKms)
 handler := s3cryptoV2.NewKMSContextKeyGenerator(kmsSvc, kmsKeyAlias,
 s3cryptoV2.MaterialDescription{})
 builder := s3cryptoV2.AESGCMContentCipherBuilderV2(handler)
 encClient, err := s3cryptoV2.NewEncryptionClientV2(sessKms, builder)
 if err != nil {
  log.Fatalf("error creating new v2 client: %v", err)
 }

 // Encrypt using KMS+Context and AES-GCM content cipher
 _, err = encClient.PutObject(&s3V1.PutObjectInput{
  Bucket: aws.String(bucket),
  Key:    aws.String(objectKey),
  Body:   bytes.NewReader([]byte(plaintext)),
 })
 if err != nil {
  log.Fatalf("error calling putObject: %v", err)
 }
 fmt.Printf("successfully uploaded file to %s/%s\n", bucket, key)

 // Create an S3EC Go v3 client
 // using the KMS client from AWS SDK for Go v2
 ctx := context.Background()
 cfg, err := config.LoadDefaultConfig(ctx,
  config.WithRegion(region),
 )

 kmsV2 := kms.NewFromConfig(cfg)
 cmm, err := materials.NewCryptographicMaterialsManager(materials.NewKmsKeyring(kmsV2,
 kmsKeyAlias))
 if err != nil {
  t.Fatalf("error while creating new CMM")
 }

 s3V2 := s3.NewFromConfig(cfg)
 s3ecV3, err := client.New(s3V2, cmm)

 result, err := s3ecV3.GetObject(ctx, &s3.GetObjectInput{
  Bucket: aws.String(bucket),
  Key:    aws.String(objectKey),
 })
 if err != nil {
  t.Fatalf("error while decrypting: %v", err)
 }
}
```

Enable legacy decryption modes

If you need to decrypt objects or data keys that were encrypted with a legacy algorithm, or you need to partially decrypt an AES-GCM encrypted object when performing a ranged request, you need to explicitly enable this behavior when you instantiate the client.

Version 3.*x* of the Amazon S3 Encryption Client encrypts only with fully supported algorithms. It will never encrypt with a legacy algorithm. By default, it decrypts only with fully supported algorithms, but you can enable it to decrypt with both fully supported and legacy algorithms. For more information, see Decryption modes (Amazon S3 Encryption Client for Java version 3.*x* and later).

The `enableLegacyUnauthenticatedModes` flag enables the Amazon S3 Encryption Client to decrypt encrypted objects with a fully supported or legacy encryption algorithm.

Version 3.*x* of the Amazon S3 Encryption Client uses one of the fully supported wrapping algorithms and the wrapping key you specify to encrypt and decrypt the data keys. The `enableLegacyWrappingAlgorithms` flag enables the Amazon S3 Encryption Client to decrypt encrypted data keys with a fully supported or legacy wrapping algorithm.

If your client doesn't include the necessary legacy decryption mode with a value of `true`, and it encounters an object encrypted with a legacy algorithm, it throws `S3EncryptionClientException`.

The following example enables the `enableLegacyUnauthenticatedModes` and `enableLegacyWrappingAlgorithms` flags. This client always encrypts only with fully supported algorithms. However, it can decrypt objects and data keys encrypted with fully supported or legacy algorithms.

```
cmm, err :=
 materials.NewCryptographicMaterialsManager(materials.NewKmsKeyring(kmsClient, ,
 func(options *materials.KeyringOptions) {
    options.EnableLegacyWrappingAlgorithms = true
})

if err != nil {
 t.Fatalf("error while creating new CMM")
}

client, err := client.New(s3Client, cmm, func(clientOptions
 *client.EncryptionClientOptions) {
  clientOptions.EnableLegacyUnauthenticatedModes = true
})

if err != nil {
 // handle error
}
```

The legacy decryption modes are designed to be a temporary fix. After you've re-encrypted all of your objects with fully supported algorithms, you can eliminate it from your code.

Supported encryption algorithms

Note

This documentation describes the Amazon S3 Encryption Client version 3.*x* and newer, which is an independent library. For information about previous versions of the Amazon S3 Encryption Client, see the AWS SDK Developer Guide for your programming language.

The Amazon S3 Encryption Client supports industry-standard algorithms for encrypting objects and data keys. As our knowledge evolves, we adjust our support for encryption algorithms to ensure that your sensitive data is protected. The following topic provides context on which encryption algorithms are fully supported and the different decryption modes supported in version 3.*x* of the Amazon S3 Encryption Client.

Topics

Encryption algorithms (Version 3.*x* and later)

In versions 3.*x* and later, the Amazon S3 Encryption Client will use fully supported algorithms to encrypt and decrypt objects and data keys. You can enable the Amazon S3 Encryption Client to decrypt objects and data keys with a legacy encryption algorithm, but it will not encrypt with a legacy encryption algorithm. It encrypts only with a fully supported encryption algorithm.

The following tables list the object encryption algorithms and wrapping algorithms that are supported in version 3.*x* of the Amazon S3 Encryption Client. Use these tables to determine if any of your objects or data keys were encrypted with an algorithm that is no longer supported. If you need to decrypt objects or data keys that were encrypted with a legacy algorithm, see Enable Legacy Decryption Modes.

Encrypting objects — The following table lists the fully supported (Full) and previously supported (Legacy) encryption algorithms that are used to encrypt objects.

Algorithm	Algorithm Suite	Support
AES-GCM	ALG_AES_256_GCM_IV12_TAG16_NO_KDF	Full
AES-GCM with key commitment	ALG_AES_256_GCM_HKDF_SHA512_COMMIT_KEY	Full
AES-CBC	ALG_AES_256_CBC_IV16_NO_KDF	Legacy

AES-GCM with key commitment is an enhanced version of the standard AES-GCM algorithm that provides additional security through Key commitment. This algorithm ensures that each encrypted object can only be decrypted to a single plaintext, protecting against attacks where an adversary attempts to decrypt data under multiple keys. The key commitment algorithm adds a cryptographic commitment to the data key in the object's encryption metadata, which is verified during decryption. This provides robustness guarantees that prevent key substitution attacks when reading instruction files. Note that encryption using AES-GCM with key commitment is only available in version V4 and later of the Amazon S3 Encryption Client, and objects encrypted with this algorithm can only be decrypted by V4 and the latest 3.*x* clients.

Encrypting data keys — The following table lists the fully supported (Full) and previously supported (Legacy) wrapping algorithms that are used to encrypt the data keys that encrypt your objects. Version 3.*x* of the Amazon S3 Encryption Client uses one of the fully supported wrapping algorithms and the wrapping key you specify to encrypt and decrypt the data keys.

Algorithm	Support
AES-GCM	Full
AWS KMS (with an encryption context)	Full
RSA-OAEP-MGF1 and SHA-1	Full
AES	Legacy
AESWrap	Legacy
AWS KMS (without an encryption context)	Legacy

Algorithm	Support
RSA-OAEP-MGF-1 and SHA-256	Legacy
RSA	Legacy

Commitment policy encryption support — The following table shows which algorithm suites support encryption operations based on commitment policy settings. The commitment policy determines whether encryption operations require key commitment.

Algorithm Suite	FORBID_ENCRYPT_ALLOW_DECRYPT	REQUIRE_ENCRYPT_ALLOW_DECRYPT	REQUIRE_ENCRYPT_REQUIRE_DECRYPT
AES-GCM	Yes	No	No
AES-GCM with key commitment	No	Yes	Yes

Decryption modes (version 3.*x* and later)

Version 3.*x* of the Amazon S3 Encryption Client defines four modes of support for decryption that you can use to enable the client to decrypt objects and data keys with either fully supported or legacy algorithms.

Fully supported

By default, version 3.*x* of the Amazon S3 Encryption Client encrypts and decrypts your objects using the AES-GCM algorithm suite. AES-GCM is an authenticated scheme. This means that an authentication tag is appended to the encrypted object. The default behavior for versions 1.*x* and 2.*x* allowed streaming decryption of AES-GCM encrypted objects. Because authentication happens at the end of the decryption process, the entire object must be read before the cipher can validate the integrity of it. This allows plaintext objects to be released and used before the authentication tag is validated.

Version 3.*x* of the Amazon S3 Encryption Client supports streaming decryption of AES-GCM encrypted objects, but we recommend using the default decryption mode to prevent the release of unauthenticated plaintext objects.

Buffered (default)

By default, version 3.*x* of the Amazon S3 Encryption Client automatically buffers the stream contents into memory as the decrypted object is read to prevent the release of unauthenticated objects. If the client reaches the end of the stream, and the authentication fails, your `GetObject` request will throw an exception and the unauthenticated object will not be returned.

When you use the buffered decryption mode with the Amazon S3 Encryption Client for Java, the default maximum object size that can be decrypted is 64 MB. However, you can use the optional `setBufferSize` parameter to customize the maximum object size that the mode will buffer. You can use the `setBufferSize` parameter to specify any integer between 16 bytes and 64 GB as the maxiumum object size.

The following Java example instantiates the client with a raw AES wrapping key and a maximum object size of 32 MiB.

```
S3Client s3Client = S3EncryptionClient.builderV4()
        .aesKey(aesKey)
        .setBufferSize(32 * 1024 * 1024) // OPTIONAL
        .build();
```

When you use the buffered decryption mode with the Amazon S3 Encryption Client for Go, the default maximum object size that can be decrypted is 63 GiB. You cannot set a custom buffer size with the Amazon S3 Encryption Client for Go. As a result, the buffered decryption mode does not require any additional configuration when you instatiate your client with the Amazon S3 Encryption Client for Go.

We recommend that you use the buffered decryption mode whenever possible. Since this is the default mode, you do not need to specify the buffered decryption mode when you instantiate your client.

Delayed authentication

Note

The Amazon S3 Encryption Client for Go does not support the delayed authentication mode. To decrypt objects under the delayed authentication mode, you must use the Amazon S3 Encryption Client for Java.

The delayed authentication mode also supports streaming decryption of AES-GCM encrypted objects, but it does not buffer or interrupt the stream to prevent unauthenticated objects from being returned. We recommend using the Buffered (default) decryption mode whenever possible. However, you might want to use the delayed authentication mode if you established your own method of buffering the stream while using versions 1.*x* and 2.*x* of the client.

If you use the delayed authentication mode and are processing the plaintext data from the stream before reading to the end, you must account for the *delayed* authentication. Read the entire object to the end before you start using the decrypted object. When using this decryption mode, the Amazon S3 Encryption Client will not authenticate any object until it reaches the end of the stream. You will need to manually roll back any data from the stream if an exception is thrown at the end of the stream.

To enable the delayed authentication mode, specify the `enableDelayedAuthenticationMode` parameter when you instantiate the client.

The following example specifies a raw AES key as the wrapping key. This client only encrypts with fully supported algorithms and decrypts using the delayed authentication mode.

```
S3Client s3Client = S3EncryptionClient.builderV4()
        .aesKey(aesKey)
        .commitmentPolicy(CommitmentPolicy.REQUIRE_ENCRYPT_ALLOW_DECRYPT)
        .enableDelayedAuthenticationMode(true)
        .build();
```

Legacy

Legacy wrapping algorithms

By default, the Amazon S3 Encryption Client uses the wrapping key you specify and one of the fully supported wrapping algorithms to encrypt and decrypt the data keys that encrypt your objects. If you need to decrypt data keys that were encrypted with a legacy wrapping algorithm, you must specify the `enableLegacyWrappingAlgorithms` parameter when you instantiate your client.

Java

The following example specifies a raw AES key as the wrapping key. This client only encrypts with fully supported wrapping algorithms. However, it can decrypt data keys encrypted with fully supported or legacy wrapping algorithms.

```
S3Client s3Client = S3EncryptionClient.builderV4()
        .aesKey(aesKey)
        .commitmentPolicy(CommitmentPolicy.REQUIRE_ENCRYPT_ALLOW_DECRYPT)
        .enableLegacyWrappingAlgorithms(true)
        .build();
```

Go

The following example creates a keyring that uses a KMS key as the wrapping key and only encrypts with fully supported wrapping algorithms. However, it can decrypt data keys encrypted with fully supported or legacy wrapping algorithms.

```
cmm, err :=
 materials.NewCryptographicMaterialsManager(materials.NewKmsKeyring(kmsClient, kmsKeyArn,
 func(options *materials.KeyringOptions) {
    options.EnableLegacyWrappingAlgorithms = true
})
```

Unauthenticated legacy object encryption algorithms

If you need to decrypt objects that were encrypted with a legacy algorithm, or you need to partially decrypt an AES-GCM encrypted object by performing a ranged request, you need to use the unauthenticated legacy mode. The Amazon S3 Encryption Client will decrypt objects with a legacy encryption algorithm, but will use the fully supported AES-GCM algorithm to encrypt any objects that you upload to Amazon S3. The decryption of AES-CBC encrypted objects and ranged requests are considered *unauthenticated* because the algorithms do not provide any form of authentication to ensure the integrity of the object.

To enable the unauthenticated legacy mode, specify the `enableLegacyUnauthenticatedModes` parameter when you instantiate the client.

Java

The following example specifies an AES key as the wrapping key. This client only encrypts with fully supported algorithms. However, it can decrypt objects encrypted with fully supported or legacy algorithms.

```
S3Client s3Client = S3EncryptionClient.builderV4()
        .aesKey(aesKey)
        .commitmentPolicy(CommitmentPolicy.REQUIRE_ENCRYPT_ALLOW_DECRYPT)
        .enableLegacyUnauthenticatedModes(true)
        .build();
```

Go

The following example creates a cryptographic materials manager that only encrypts with fully supported wrapping algorithms. However, it can decrypt objects encrypted with fully supported or legacy algorithms.

```
client, err := NewS3EncryptionClientV3(s3Client, cmm, func(clientOptions
 *client.EncryptionClientOptions) {
  clientOptions.EnableLegacyUnauthenticatedModes = true
 })
 if err != nil {
  // handle error
 }
```

The `enableLegacyModes` parameter is designed to be a temporary fix. After you've re-encrypted all of your objects with fully supported algorithms, you can remove it from your code.

Commitment policy decryption support

The following tables show which algorithm suites support decryption operations based on commitment policy settings and the `enableLegacyUnauthenticatedModes` parameter. The commitment policy determines whether decryption operations require key commitment.

Decryption support with enableLegacyUnauthenticatedModes=false — The following table shows decryption support when legacy unauthenticated modes are disabled (default behavior).

Algorithm Suite	FORBID_ENCRYPT_ALLOW_DECRYPT	REQUIRE_ENCRYPT_ALLOW_DECRYPT	REQUIRE_ENCRYPT_REQUIRE_DECRYPT
AES-CBC	No	No	No
AES-CTR	No	No	No
Committing AES-CTR	No	No	No
AES-GCM	Yes	Yes	No
Committing AES-GCM	Yes	Yes	Yes

Decryption support with enableLegacyUnauthenticatedModes=true — The following table shows decryption support when legacy unauthenticated modes are enabled.

Algorithm Suite	FORBID_ENCRYPT_ALLOW_DECRYPT	REQUIRE_ENCRYPT_ALLOW_DECRYPT	REQUIRE_ENCRYPT_REQUIRE_DECRYPT
AES-CBC	Yes	Yes	No
AES-CTR	Yes	Yes	No
AES-CTR with key commitment	Yes	Yes	Yes
AES-GCM	Yes	Yes	No
AES-GCM with key commitment	Yes	Yes	Yes

Encryption algorithms (Version 2.*x* and earlier)

The following tables list the object encryption and wrapping algorithms that are supported in versions 2.*x* and earlier of the Amazon S3 Encryption Client. Versions 1.x and 2.x of the Amazon S3 Encryption Client are included in the following AWS SDKs.

Encrypting objects — The following table lists encryption algorithms that are used to encrypt objects.

Algorithm	C++	Go	Java	.NET	PHP v3	Ruby v2
AES-GCM	Full	Full	Full	Full	Full	Full
AES-CBC	Legacy	Legacy	Legacy	No	No	Legacy

Encrypting data keys — The following table lists encryption algorithms that are used to encrypt the data keys that were used to encrypt objects.

Algorithm	C++	Go	Java	.NET	PHP v3	Ruby v2
AES-ECB	No	No	Legacy	Legacy	No	Legacy
AES-GCM	Full	No	Full	Full	No	Full
AESWrap	Legacy	No	Legacy	Legacy	No	Legacy
KMS	Legacy	Legacy	Legacy	Legacy	Legacy	Legacy
KMS +context	Full	Full	Full	Full	Full	Full
RSA	No	No	Legacy	No	No	Legacy
RSA-OAEP-SHA1	No	No	Full	Full	No	Full

Document history for the Amazon S3 Encryption Client Developer Guide

The following table describes significant changes to the Amazon S3 Encryption Client Developer Guide. In addition to these major changes, we also update the documentation frequently to improve the descriptions and examples, and to address the feedback that you send to us.

Change	Description	Date
Amazon S3 Encryption Client V4 Documentation	Added V3-to-V4 migration guides for Java and Go, updated Terms and Concepts with key commitment, commitment policy, and instruction file definitions, added AES-GCM with key commitment to supported algorithms.	December 16, 2025
Amazon S3 Encryption Client for Go version 3.*x*	Added and updated documentation for version 3.*x* of the Amazon S3 Encryption Client for Go.	November 16, 2023
Initial release	The initial release of this documentation describes version 3.*x* of the Amazon S3 Encryption Client for Java.	April 5, 2023