

# 1.6 Storage Services

In this course, I will:

- Explore Amazon Simple Storage Service (S3), Amazon S3 Glacier, Amazon Elastic Block Store (EBS), Amazon Elastic File System (EFS), and Amazon Backup
- Cover Amazon S3 and the .NET SDK to work with S3 buckets and objects
- Work with vaults and archives using Amazon S3 Glacier, and use Amazon EFS to store files

## Amazon Simple Storage Service (S3)

- Object storage
- Storage, protection and management

### Amazon S3 Storage Classes

- Different use cases
- Access tiers

### Amazon S3 Storage Management

- S3 Lifecycle
- S3 Object Lock
- S3 Replication
- S3 Batch Operation

### Amazon S3 Access Management

- S3 Block Public Access
- AWS Identity and Access Management (IAM): recommended
- Bucket Policies
- S3 Access Points
- Access Control List (ACLs): granular control
- S3 Object Ownership

- Access Analyzer for S3

#### Amazon S3 Data Processing

- S3 Object Lambda: filtering, automatic imagery sizing, redactions, and more
- Event notification: most implemented service

## Amazon S3 Storage Logging and Monitoring

Automated	Manual
Amazon CloudWatch metrics for Amazon S3	Server access monitoring
AWS CloudTrail	AWS Trusted Advisor

#### Amazon S3 Analytics and Insights

- Amazon S3 Storage Lens
- Storage Class Analysis
- S3 Inventory with Inventory Reports

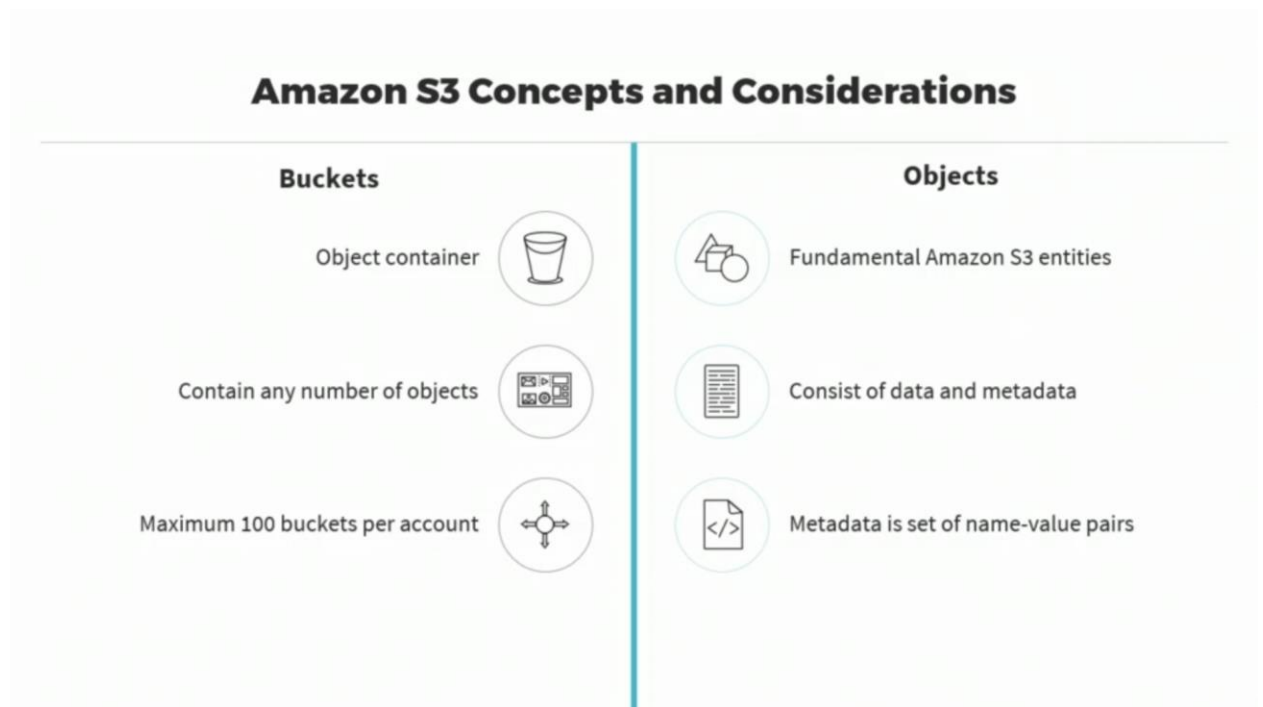
#### Amazon S3 Strong Consistency

- Read-after-write consistency for PUT and DELETE requests
- Strongly consistent read operations

#### S3

- Now within S3, there are two main components: buckets and objects.
- buckets contain objects. They are a means of isolation.
- don't think of them as directories on a hard drive. Instead, think of buckets as the hard drive itself. That's how isolated they are from each other.
- objects are the fundamental S3 entities.
- consider the objects as the files and directories inside the bucket.
- Buckets can contain any number of objects, like a limitless hard drive, and objects consist of data and metadata.

- So, if the data is the file content, then the metadata is the information about the file, like its size, type, ACLs and so on.
- So, for buckets you can have a maximum of 100 buckets per AWS account, and object metadata is limited to name-value pairs.
- Keys: A key is the unique identifier for an object within a bucket. A key doesn't have to be globally unique. It just has to be unique within a bucket.



#### Amazon S3 Concepts and Considerations

- Keys
- Versioning
- Version ID
- Bucket policy
- S3 Access Points
- Access Control Lists (ACLs)
- Regions

## Amazon S3 Security

### Amazon S3 Data Protection

- Durable infrastructure

- Redundant Storage
- Auto-healing
- Versioning
- IAM
- FIPS endpoint for FIPS 140-2 validation

#### Amazon S3 Encryption

- Client side
- Server side

#### Amazon S3 Client-Side Encryption

- Customer Master Key (CMK)
- Option to store key in app
- AWS encryption SDK (Software Development Kit): recommended

#### Amazon S3 Server-Side Encryption

- Key types
  1. S3 managed keys (SSE-S3): unique key
  2. Server-side encryption with customer master keys (SSE-KMS): customer provided key
  3. Server-side encryption with customer-provided keys (SSE-C): customer provided key

#### AWS Identity and Access Management (IAM)

- Private by default
- Resource-based policy
- User-based policy

#### Amazon S3 Access Management

- Who can access
- What resources can be accessed
- Type of actions

#### Amazon S3 Logging and Monitoring

- Amazon CloudWatch Alarms

- AWS CloudTrail logs
- Amazon S3 access logs
- AWS Trusted advisor

## **Amazon S3 Development**

### Amazon S3 Requests

- REST service
- REST API or AWS SDK
- Transactions authenticated or anonymous
- Libraries generate a signature
- REST API calls require code to be written

### Amazon S3 Requests and IPv6

- S3 buckets
- IAM policies
- Testing
- Dual-stack endpoints

### Amazon S3 dual-stack endpoints

- IPv4 or IPv6
- REST API and endpoint URI
- Accessing S3 buckets
- Region must be specified
- URI be like: s3.dualstack.yourregion.amazonaws.com

### Amazon S3 requests and AWS SDK

- AWS account
- IAM credentials
- IAM user temporary credentials
- Federated user temporary credentials

### Amazon S3 requests and REST API

- Construct hostnames
- Virtual hosted and path requests
- Request to dual-stack endpoints
- URI: mybucket.s3.dualstack.yourregion.amazonaws.com

- URI: s3.yourregion.amazonaws.com/mybucket (if don't have dual-stack endpoints)

#### Request Redirection and REST API

- HTTP user agents
- 100-continue

#### Amazon S3 Bucket Virtual Hosting

- First slash-delimited part of Request-URI path
- HTTP host header

### **Amazon S3 Glacier**

- Archiving and backup
- Secure and durable
- Long-term storage
- Offload administrative overhead
- Expose RESTful web service
- Called via HTTP/S
- Communicate via JavaScript Object Notation (JSON)
- Request to S3 glacier web service API

#### Amazon S3 Glacier Archive Storage Classes

- S3 Glacier Instant Retrieval: within seconds
- S3 Glacier Flexible Retrieval: takes up to 5min to 12 hours
- S3 Glacier Deep Archive: can do any time and take 12 hours

#### Amazon S3 Glacier Objects

- Vault: A vault is a partition within S3 Glacier and inside a vault you would store archives.
- Archive: archives go into vaults, designed for long-term storage. They have an archive ID and not much else. There isn't really directories or metadata or anything like that
- Jobs: A job is any action that you perform on an archive. So, if you wanted to upload or download an archive, you'd have to create a job to do that. And asking for data could take hours, so obviously you'd want to kick off a job and then come back later when it's done.
- Notifications: the signal that you get back when the jobs are completed.

#### Amazon S3 Glacier Regions and Endpoints

- Vaults are region specific
- Vault requests require specified regions

### Creating Vaults

- Maximum 1000 per AWS region
- Naming convention: have unique name within that region

### Retrieving Vault Metadata

- API calls
- ASCII values
- Maximum 1000 vaults
- Additional requests

### Amazon S3 Glacier Archives

- Unique ID
- Optional description

### Uploading Archives

- Single operation up to 4 GB
- Parts total limit of 40 TB

### Downloading Archives

- Not available through management console
- Use AWS CLI, REST API or Amazon SDK

### Amazon S3 Glacier and Amazon SDKs

- Wrap S3 Glacier API
- AWS security credentials
- Libraries map to REST API and provide objects

### Amazon S3 Shared Responsibility

- Security of the cloud
- Security in the cloud

## Amazon Elastic Block Store (EBS)

- Block-level volumes for EC2 instances
- Mounted as devices
- Exposed as storage volumes
- Independent persistence
- File system on top of volumes
- Block devices
- Dynamic configuration changes

### Working with Amazon EBS Volumes

- Dynamically increase size
- Change IOPS capacity
- Change volume type

### Amazon EBS Volume Types

- Solid state drives (SSDs): great performance and considered best volume type for using. Bit costly
- Hard disk drives (HDDs): better for large data, cheaper
- Previous generation (unoptimized): if no upper req., can use this

### Amazon EBS Volume Limitations

- Storage capacity
- Service: limit only 64 TB
- Partitioning: 32 bit or 64-bit, limit of 64 zettabyte capacity
- Data block size: bigger the volume, bigger the block

### Amazon EBS Snapshots

- Data backup
- Incremental
- Restore from any snapshot

### Amazon EBS Data Services

- Amazon EBS Elastic Volumes
- Amazon EBS encryption
- Amazon EBS fast snapshot restore (FSR)

### Amazon EBS and NVMe on Linux

- Nitro system



- NVMe device names
- Block device driver

#### Amazon EBS-optimized Instances

- Optimized configuration stack
- Dedicated amazon EBS I/O capacity
- Dedicated bandwidth
- Superior performance

### **Amazon Elastic File System (EFS)**

- Serverless
- Scale on demand
- Web services interface
- AWS managed infrastructure
- NFS v. 4.1 and 4.0
- Multiple compute instances
- Pay-per-use

#### Amazon EFS Storage Classes

- Many options
- Standard storage classes
- One zone storage classes

#### How Amazon EFS Works

- Amazon EC2 and compute instances
- AWS direct connect and AWS managed VPN
- AWS backup
- Authentication and access control
- Data consistency
- Storage classes and lifecycle management

#### Working with Amazon EFS

- Create file system
- Create mount targets
- Create security groups

#### Amazon Resource IDs

- Unique resource ID
- Command-line tools and EFS API
- Resource ID length

#### File Systems and Amazon EFS

- EC2 instance
- NFS permissions
- Only root user has R-W-X (Read Write Execute) access by default
- Single root directory

#### Mounting Amazon EFS File Systems

- Numerous options
- EFS mount helper

### **How AWS Backup Works**

- Data protection service
- Fully managed
- Centralization and automation

#### AWS Backup Features

- Backup policies
- Activity monitoring
- Task automation
- No scripts or intervention required

#### How AWS Backup Works

- Other AWS services: EC2, EFS, EBS, DynamoDB, S3
- Metering and pricing: EFS has different pricing model

#### AWS Backup Plan Management

- Create plan
- Assign resources
- Delete a plan
- Update a plan

#### Backup Vaults

- Backup containers

- AWS Key Management Service (AWS KMS)
- Multiple vaults

### Working with Backups

- each backup you create is a snapshot in time of your individual resources.
- Recovery points
- Unique ID
- AWS resource types

### AWS Backup Security

- Data protection
- IAM
- Compliance validation
- Resilience
- Infrastructure security

### AWS Backup Data Protection

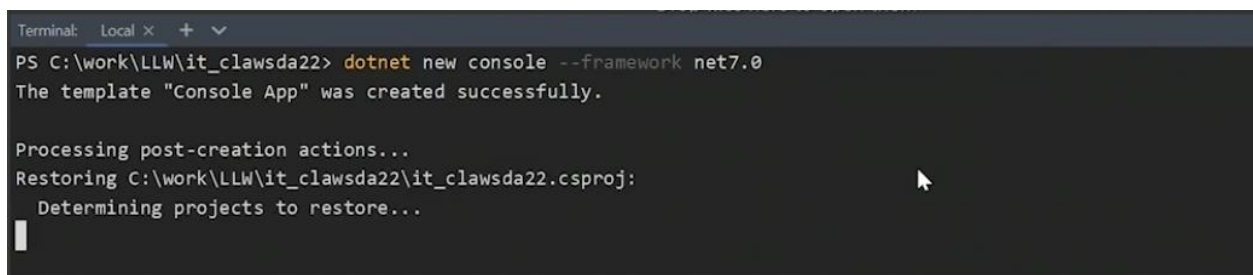
- IAM: no one has access of backup, have to grant explicit permission
- MFA, SSL/TLS, encryption

### Backup Encryption

- Default AWS KMS key
- Customer-managed key

## Using Amazon S3

### Creating Amazon S3 Bucket



```
Terminal: Local x + v
PS C:\work\LLW\it_clawsda22> dotnet new console --framework net7.0
The template "Console App" was created successfully.

Processing post-creation actions...
Restoring C:\work\LLW\it_clawsda22\it_clawsda22.csproj:
  Determining projects to restore...
  
```

In vs Code terminal

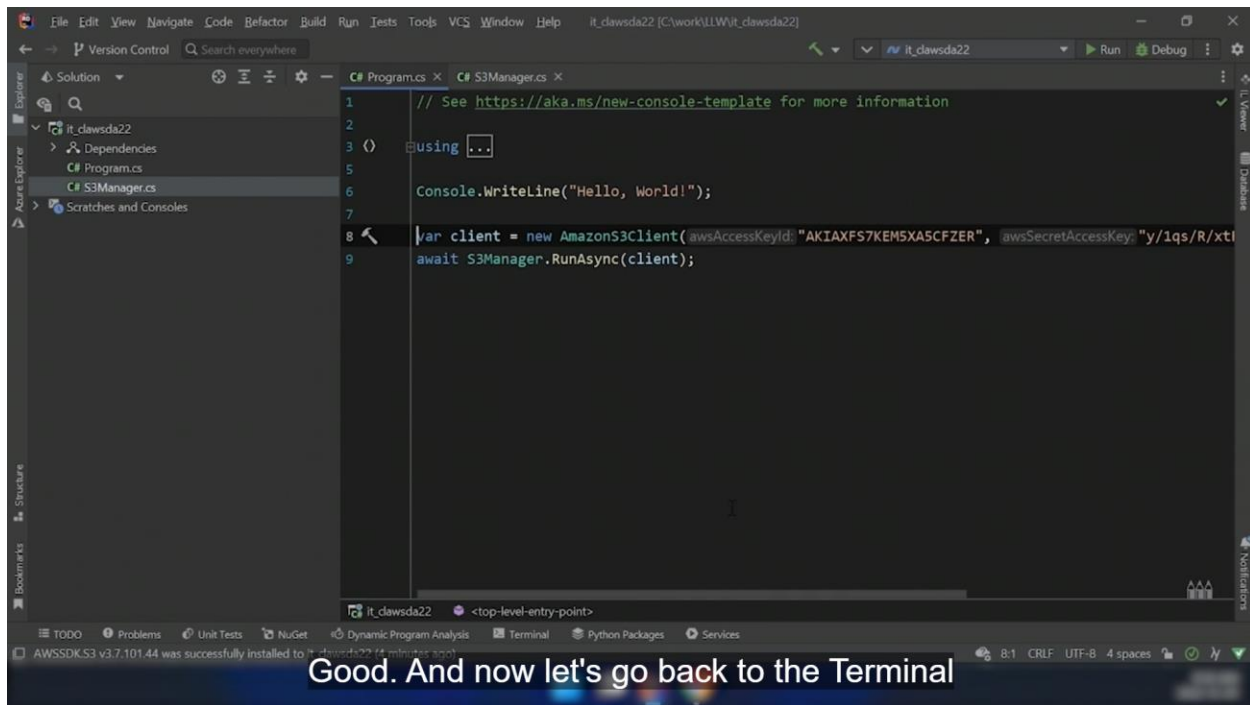
```
Terminal: Local x + v

A new PowerShell stable release is available: v
Upgrade now, or check out the release page at:
https://aka.ms/PowerShell-Release?tag=v7.3.1

PS C:\work\LLW\it_clawsda22> dotnet run
Hello, World!
PS C:\work\LLW\it_clawsda22>
```

```
File Edit View Navigate Code Refactor Build Run Tests Tools VCS Window Help it_clawsda22 [C:\work\LLW\it_clawsda22]
P Version Control Search everywhere
Solution Explorer
  it_clawsda22
    Dependencies
    Program.cs
    S3Manager.cs
    Scratches and Consoles
S3Manager.cs
1 using Amazon.S3;
2
3 namespace it_clawsda22;
4
5 public class S3Manager
6 {
7     public static async Task RunAsync(IAmazonS3 client)
8     {
9     }
10
11     private static async Task CreateBucketAsync(IAmazonS3 client, string bucketName)
12     {
13         Console.WriteLine("Creating bucket: {0}", bucketName);
14         var request = new PutBucketRequest
15         {
16             BucketName = bucketName,
17             UseClientRegion = true
18         };
19     }
20 }
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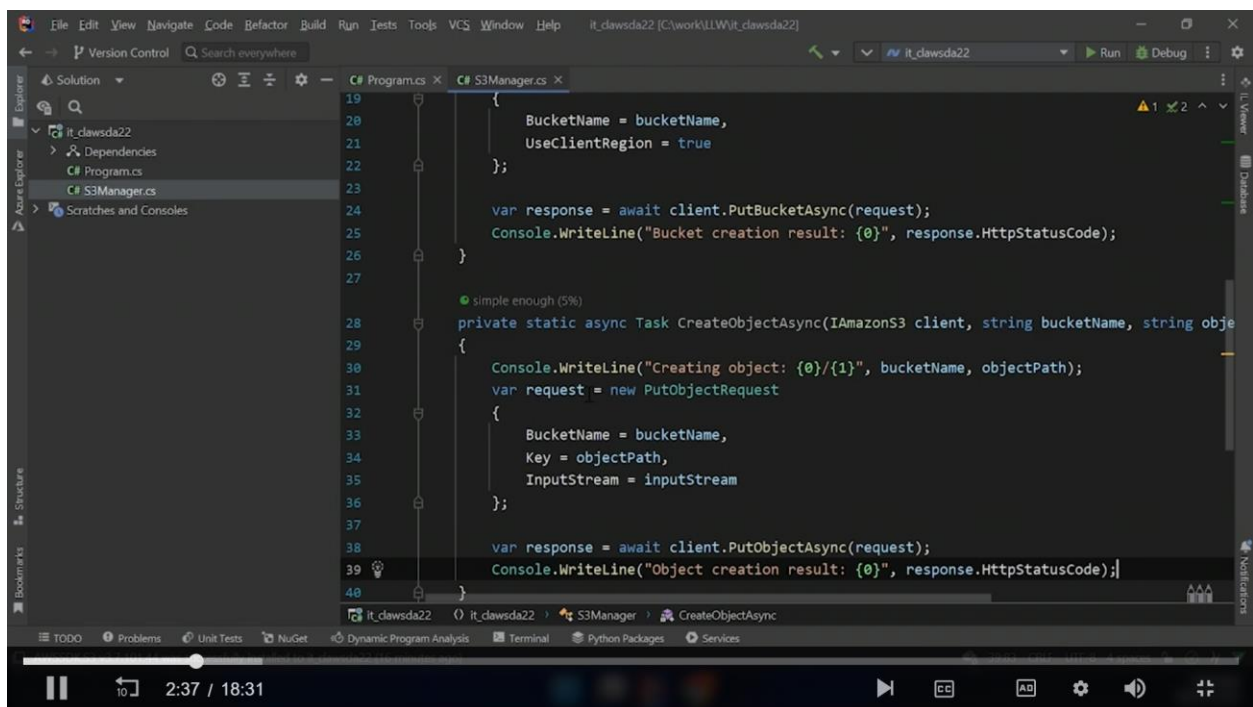
```
Terminal: Local x
PS C:\work\LLW\it_clawsda22> dotnet run
Hello, World!
PS C:\work\LLW\it_clawsda22> dotnet run
Hello, World!
Creating bucket: sbdemo0610
Bucket creation result: OK
```

```
simple enough (5%)
private static async Task DeleteBucketAsync(IAmazonS3 client, string bucketName)
{
    Console.WriteLine("Deleting bucket: {0}", bucketName);
    var request = new DeleteBucketRequest
    {
        BucketName = bucketName
    };

    var response = await client.DeleteBucketAsync(request);
    Console.WriteLine("Bucket deletion result: {0}", response.HttpStatusCode);
}

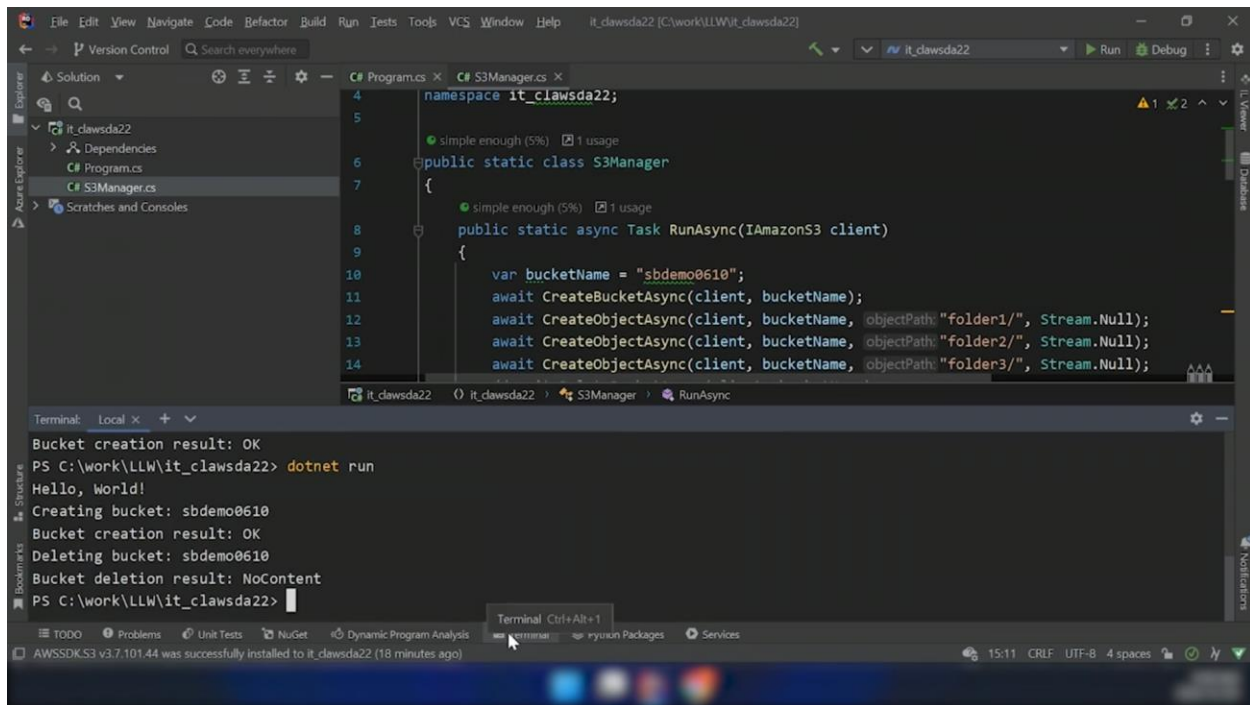
public static async Task RunAsync(IAmazonS3 client)
{
    var bucketName = "sbdemo0610";
    await CreateBucketAsync(client, bucketName);
    await DeleteBucketAsync(client, bucketName);
}
```

## Creating Amazon S3 Object

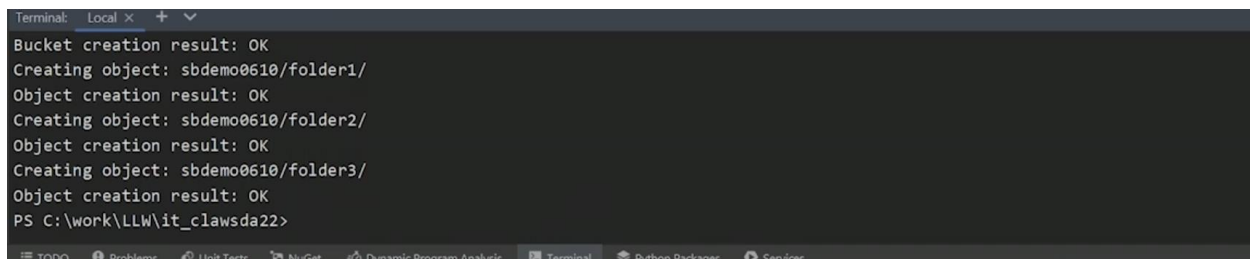


The screenshot shows the Visual Studio IDE with the file `S3Manager.cs` open. The code defines two asynchronous methods: `CreateBucketAsync` and `CreateObjectAsync`. The `CreateObjectAsync` method is highlighted with a green dot and the text "simple enough (5%)". The code uses the `IAmazonS3` interface to interact with Amazon S3. The `CreateObjectAsync` method takes an `IAmazonS3` client, a bucket name, an object path, and an input stream as parameters. It creates a `PutObjectRequest` object with the bucket name, key (object path), and input stream, and then calls `PutObjectAsync` on the client. The result is printed to the console.

```
19         BucketName = bucketName,
20         UseClientRegion = true
21     };
22
23     var response = await client.PutBucketAsync(request);
24     Console.WriteLine("Bucket creation result: {0}", response.HttpStatusCode);
25 }
26
27
28 simple enough (5%)
29 private static async Task CreateObjectAsync(IAmazonS3 client, string bucketName, string objectPath, Stream inputStream)
30 {
31     Console.WriteLine("Creating object: {0}/{1}", bucketName, objectPath);
32     var request = new PutObjectRequest
33     {
34         BucketName = bucketName,
35         Key = objectPath,
36         InputStream = inputStream
37     };
38
39     var response = await client.PutObjectAsync(request);
40     Console.WriteLine("Object creation result: {0}", response.HttpStatusCode);
41 }
```

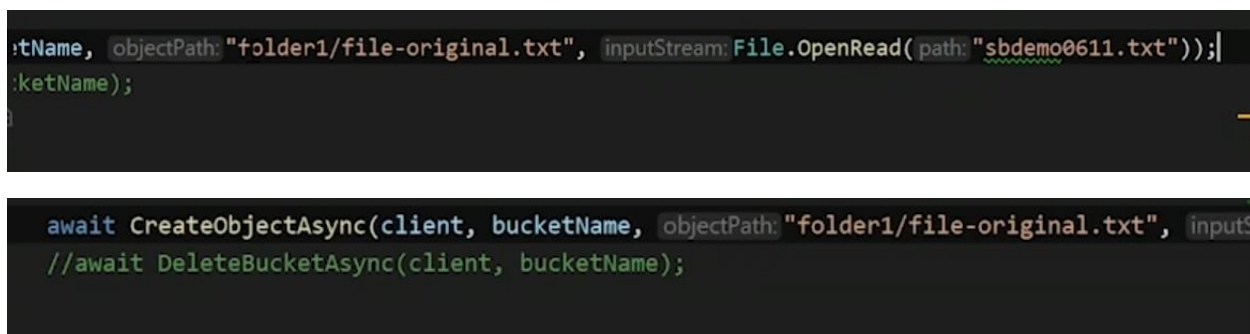


Comment delete await



Uploading file in folder

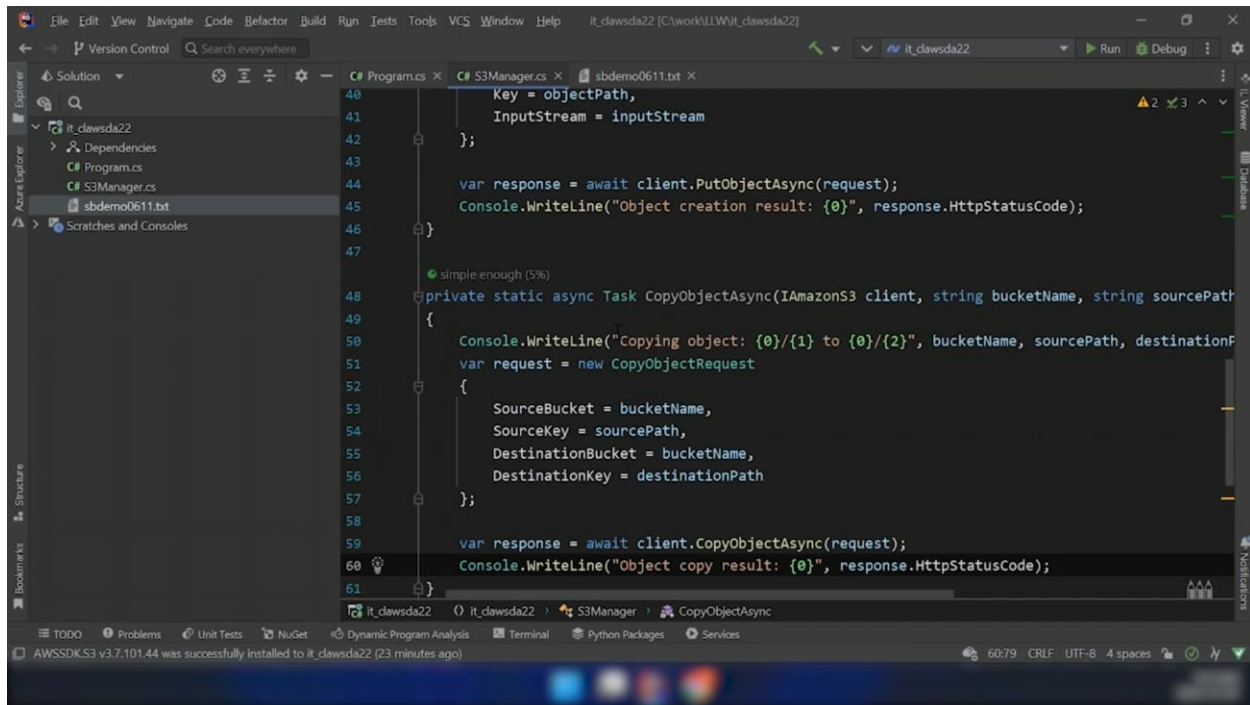
➔ Create a txt file with some content





```
Creating object: sbdemo0610/folder1/file-original.txt
Object creation result: OK
PS C:\work\LLW\it_clawsda22>
```

## Copy file



The screenshot shows the Visual Studio Code editor with the `S3Manager.cs` file open. The `CopyObjectAsync` method is visible, which takes an `IAmazonS3` client, a bucket name, and source/destination paths. The method logs the copy operation and returns the result. The `Program.cs` file is also open, showing the `CopyObjectAsync` method being called.

```
40 Key = objectPath,
41 InputStream = inputStream
42 };
43
44 var response = await client.PutObjectAsync(request);
45 Console.WriteLine("Object creation result: {0}", response.HttpStatusCode);
46
47
48 simple enough (5%)
49 private static async Task CopyObjectAsync(IAmazonS3 client, string bucketName, string sourcePath
50 {
51     Console.WriteLine("Copying object: {0}/{1} to {0}/{2}", bucketName, sourcePath, destinationPath);
52     var request = new CopyObjectRequest
53     {
54         SourceBucket = bucketName,
55         SourceKey = sourcePath,
56         DestinationBucket = bucketName,
57         DestinationKey = destinationPath
58     };
59     var response = await client.CopyObjectAsync(request);
60     Console.WriteLine("Object copy result: {0}", response.HttpStatusCode);
61 }
```

```
ent, bucketName, sourcePath: "folder1/file-origina.txt", destinationPath: "folder2/file-copied.txt");|
(client, bucketName);
```

```
await CopyObjectAsync(client, bucketName, sourcePath: "folder1/file-origina.txt", |
//await DeleteBucketAsync(client, bucketName);
}
```

## Delete file

```
simple enough (5%)
private static async Task DeleteObjectAsync(IAmazonS3 client, string bucketName, string objectPath)
{
    Console.WriteLine("Deleting object: {0}/{1}", bucketName, objectPath);
    var request = new DeleteObjectRequest
    {
        BucketName = bucketName,
        Key = objectPath
    };

    var response = await client.DeleteObjectAsync(request);
    Console.WriteLine("Object delete result: {0}", response.HttpStatusCode);
}

await DeleteObjectAsync(client, bucketName, objectPath: "folder3/file-renamed.txt");
//await DeleteBucketAsync(client, bucketName);
```

Move object file

```
private static async Task MoveObjectAsync(IAmazonS3 client, string bucketName, string sourcePath, string destinationPath)
{
    Console.WriteLine("Moving object: {0}/{1} to {0}/{2}", bucketName, sourcePath, destinationPath);
    await CopyObjectAsync(client, bucketName, sourcePath, destinationPath);
    await DeleteObjectAsync(client, bucketName, sourcePath);
}

await MoveObjectAsync(client, bucketName, sourcePath: "folder2/file-copied.txt", destinationPath: "folder3/file-moved.txt");

await MoveObjectAsync(client, bucketName, sourcePath: "folder2/file-copied.txt", destinationPath: "folder3/file-moved.txt");
await MoveObjectAsync(client, bucketName, sourcePath: "folder3/file-moved.txt", destinationPath: "folder3/file-renamed.txt");

await MoveObjectAsync(client, bucketName, sourcePath: "folder2/file-copied.txt", destinationPath: "folder3/file-moved.txt");
await MoveObjectAsync(client, bucketName, sourcePath: "folder3/file-moved.txt", destinationPath: "folder3/file-renamed.txt");
```

Download file

```
simple enough (5%)
private static async Task DownloadObjectAsync(IAmazonS3 client, string bucketName, string objectPath)
{
    Console.WriteLine("Downloading object: {0}/{1}", bucketName, objectPath);
    var request = new GetObjectRequest
    {
        BucketName = bucketName,
        Key = objectPath
    };

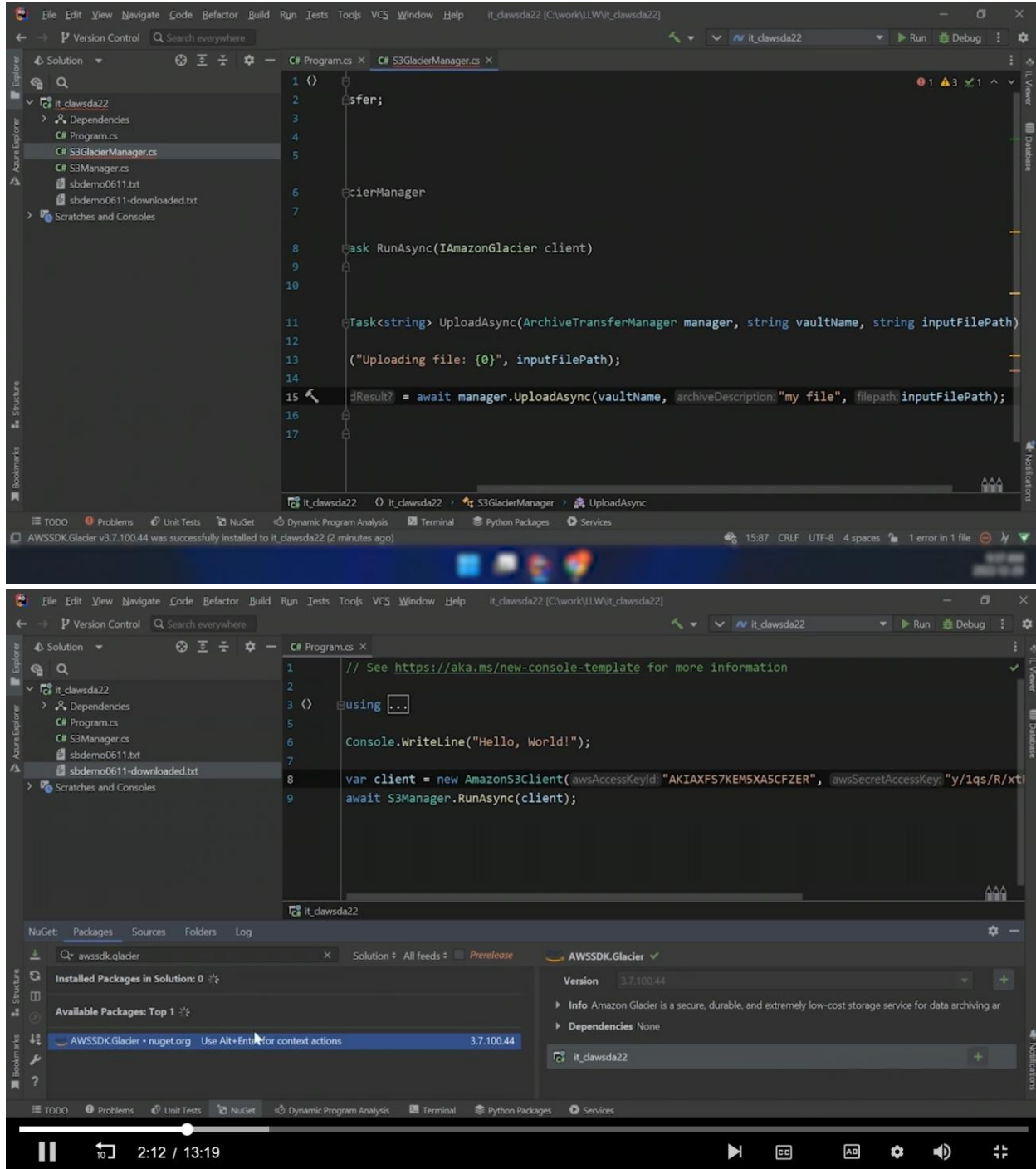
    using var response = await client.GetObjectAsync(request);
    Console.WriteLine("Object download result: {0}", response.HttpStatusCode);
    await response.WriteResponseStreamToFileAsync(downloadPath, append: true, CancellationTo
}

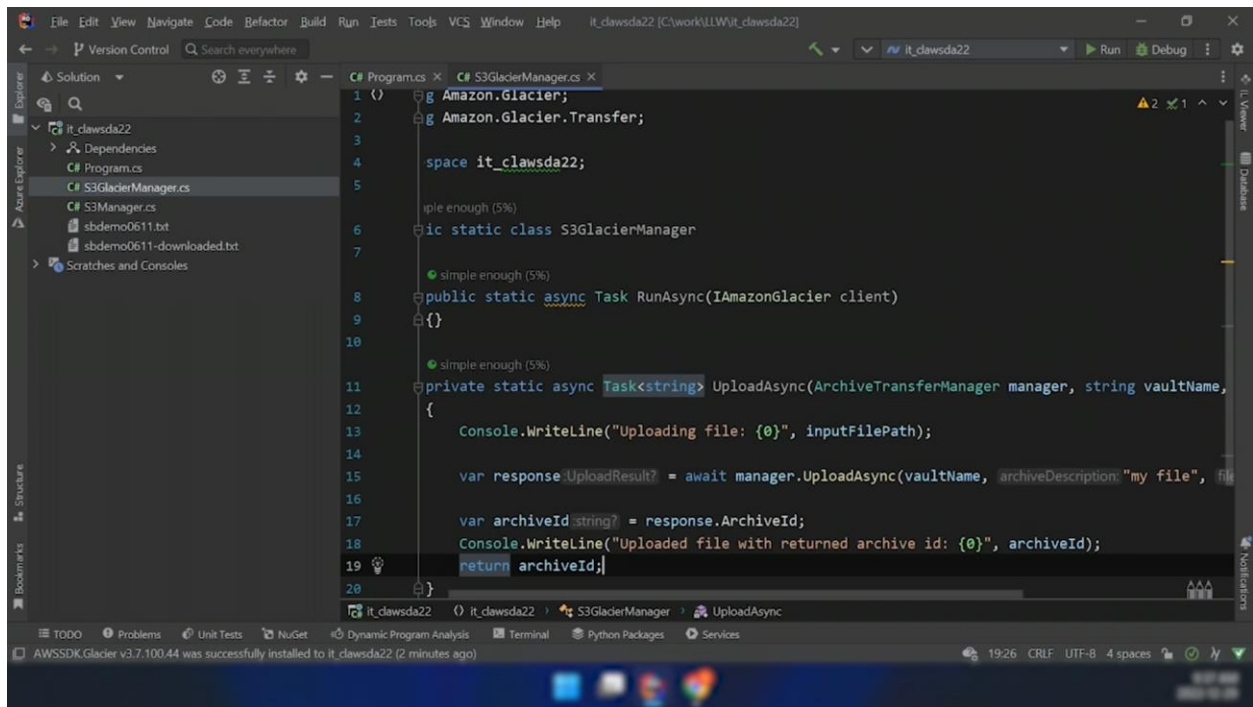
await DownloadObjectAsync(client, bucketName, objectPath: "folder3/file-renamed.txt",
bucketName, objectPath: "folder3/file-renamed.txt", downloadPath: ".\\sbdemo0611-downloaded.txt");
```

```
Terminal: Local x + v
Object copy result: OK
Deleting object: sbdemo0610/folder3/file-moved.txt
Object delete result: NoContent
Downloading object: sbdemo0610/folder3/file-renamed.txt
Object download result: OK
Deleting object: sbdemo0610/folder3/file-renamed.txt
Object delete result: NoContent
PS C:\work\LLW\it_clawsda22>
```

dotnet run = run command on terminal

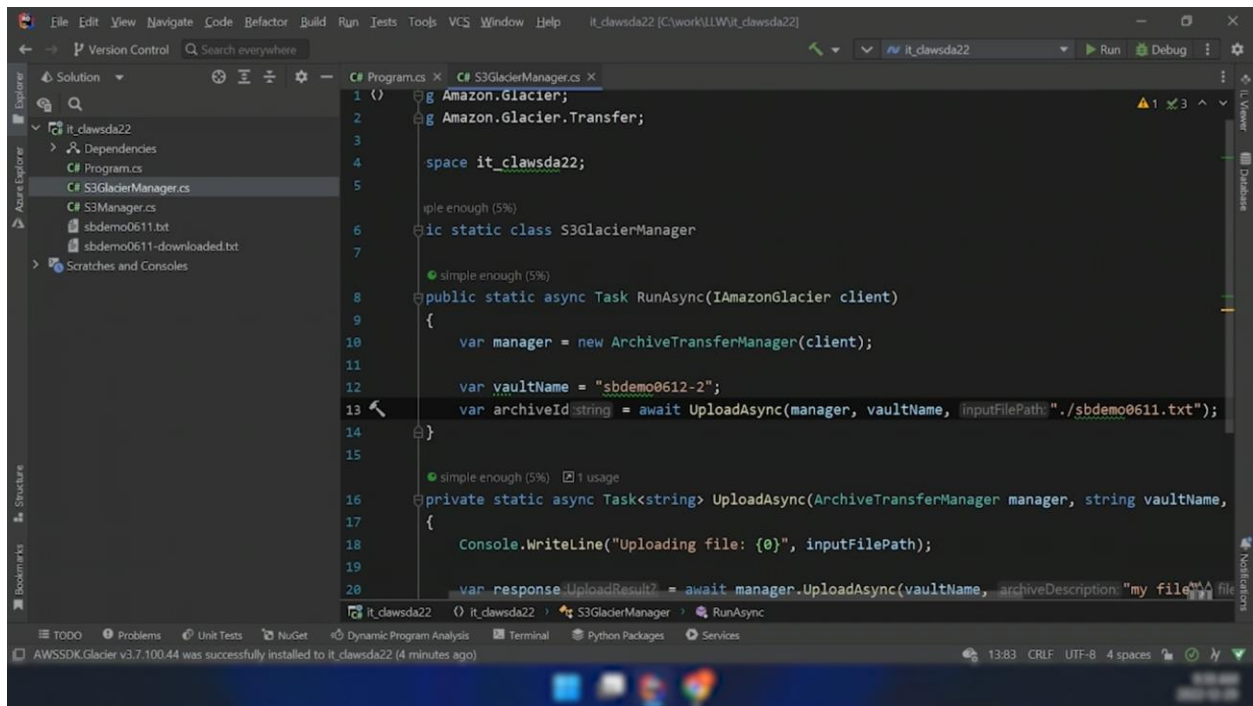
## Working With Amazon S3 Glacier





```
1 {}
2 g Amazon.Glacier;
3 g Amazon.Glacier.Transfer;
4
5 space it_clawsda22;
6
7 //simple enough (5%)
8 public static class S3GlacierManager
9 {
10 //simple enough (5%)
11 public static async Task RunAsync(IAmazonGlacier client)
12 {}
13
14 //simple enough (5%)
15 private static async Task<string> UploadAsync(ArchiveTransferManager manager, string vaultName,
16 {
17     Console.WriteLine("Uploading file: {0}", inputFilePath);
18
19     var response UploadResult? = await manager.UploadAsync(vaultName, archiveDescription: "my file", file
20
21     var archiveId string? = response.ArchiveId;
22     Console.WriteLine("Uploaded file with returned archive id: {0}", archiveId);
23     return archiveId;
24 }
```

AWSSDK.Glacier v3.7.100.44 was successfully installed to it\_clawsda22 (2 minutes ago)



```
1 {}
2 g Amazon.Glacier;
3 g Amazon.Glacier.Transfer;
4
5 space it_clawsda22;
6
7 //simple enough (5%)
8 public static class S3GlacierManager
9 {
10 //simple enough (5%)
11 public static async Task RunAsync(IAmazonGlacier client)
12 {
13     var manager = new ArchiveTransferManager(client);
14
15     var vaultName = "sbdemo0612-2";
16     var archiveId string? = await UploadAsync(manager, vaultName, inputFilePath: ".\\sbdemo0611.txt");
17 }
18
19 //simple enough (5%) 1 usage
20 private static async Task<string> UploadAsync(ArchiveTransferManager manager, string vaultName,
21 {
22     Console.WriteLine("Uploading file: {0}", inputFilePath);
23
24     var response UploadResult? = await manager.UploadAsync(vaultName, archiveDescription: "my file", file
```

AWSSDK.Glacier v3.7.100.44 was successfully installed to it\_clawsda22 (4 minutes ago)

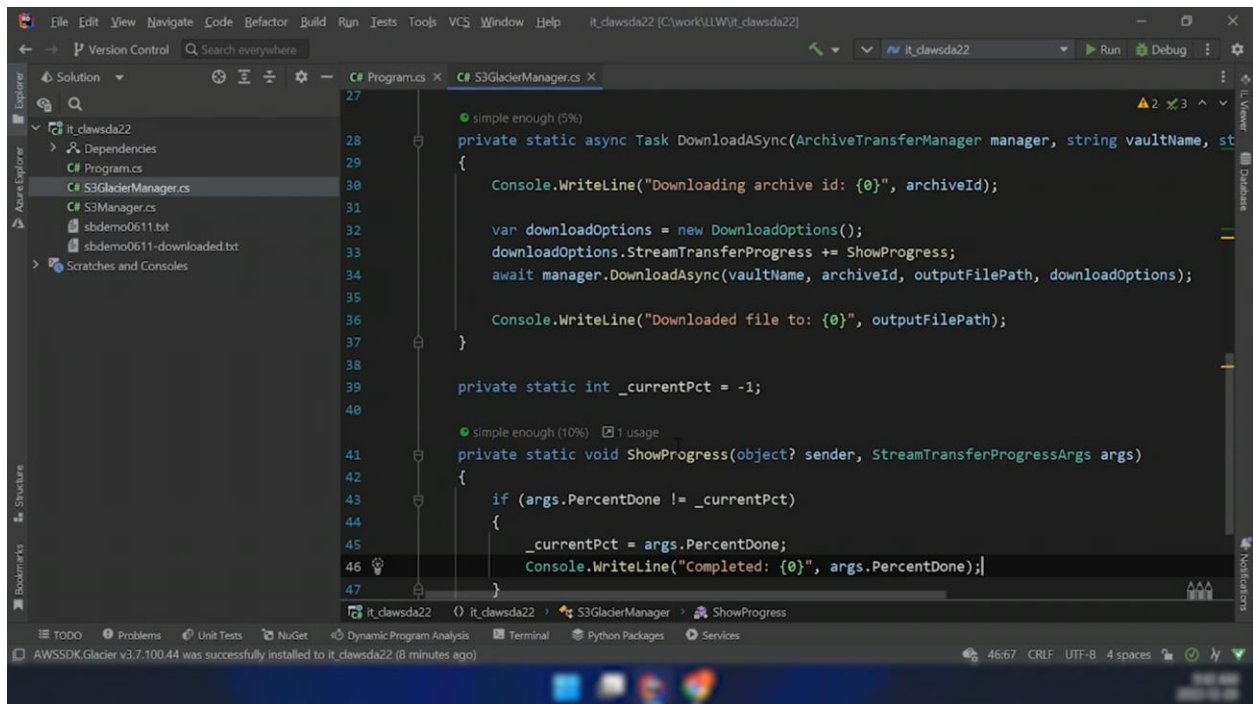


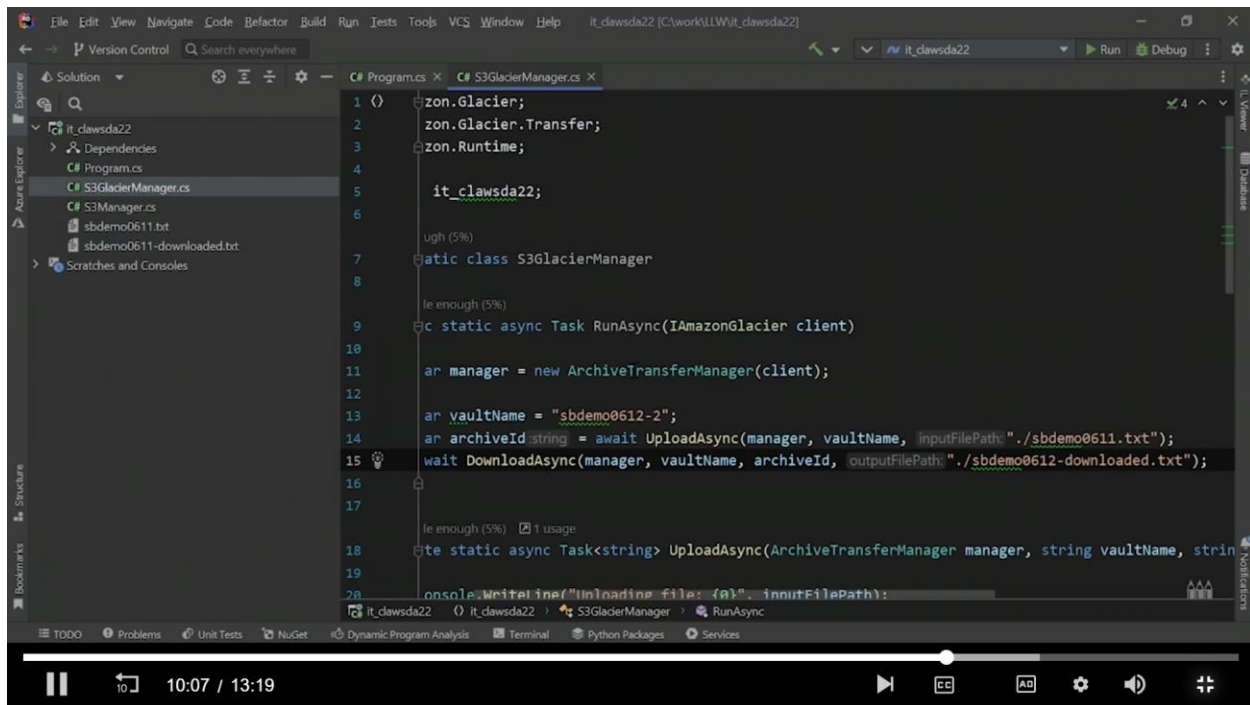
• simple enough (5%)

```
private static async Task DownloadASync(ArchiveTransferManager manager, string vaultName, string archiveId, string outputPath)
{
    Console.WriteLine("Downloading archive id: {0}", archiveId);

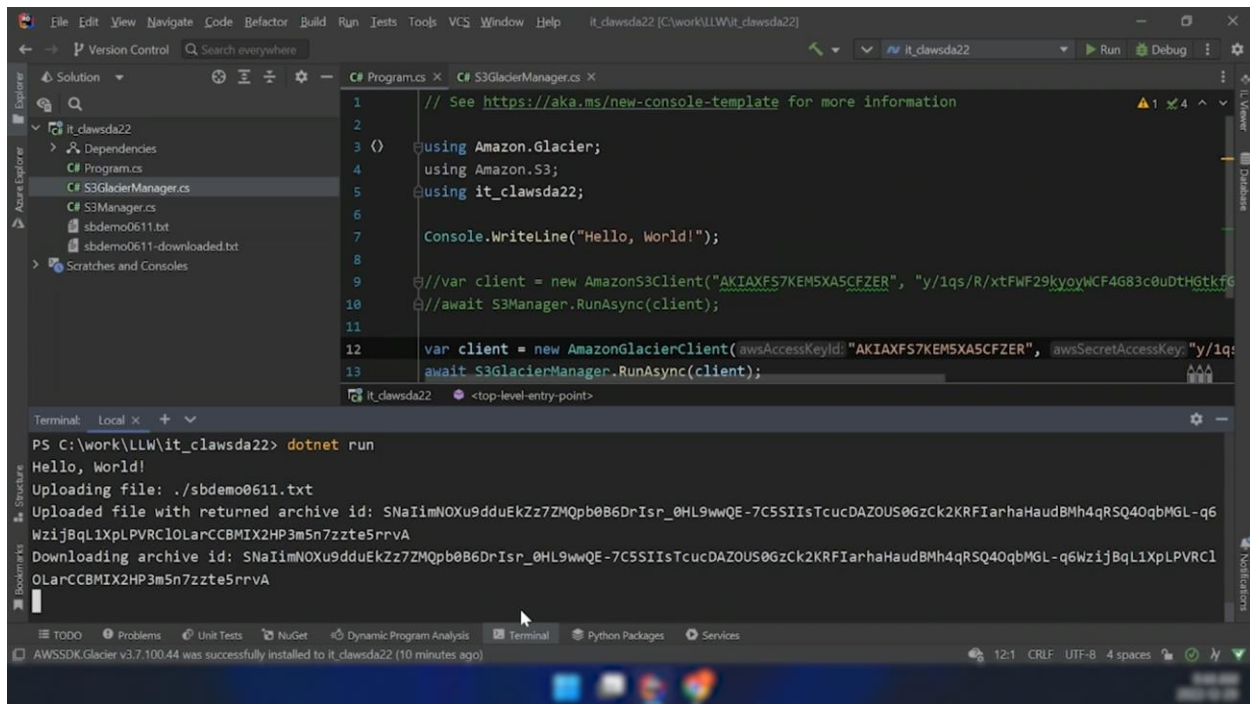
    var downloadOptions = new DownloadOptions();
    downloadOptions.StreamTransferProgress += ShowProgress;
    await manager.DownloadAsync(vaultName, archiveId, outputPath, downloadOptions);

    Console.WriteLine("Downloaded file to: {0}", outputPath);
}
```





```
1 1()
2  {
3      zon.Glacier;
4      zon.Glacier.Transfer;
5      zon.Runtime;
6
7      it_clawsda22;
8
9      ough (5%)
10
11  static class S3GlacierManager
12  {
13      le enough (5%)
14      ic static async Task RunAsync(IAmazonGlacier client)
15      {
16          ar manager = new ArchiveTransferManager(client);
17
18          ar vaultName = "sbdemo0612-2";
19          ar archiveId string = await UploadAsync(manager, vaultName, inputFilePath "./sbdemo0611.txt");
20          wait DownloadAsync(manager, vaultName, archiveId, outputFilePath "./sbdemo0612-downloaded.txt");
21      }
22
23      le enough (5%) 1 usage
24      te static async Task<string> UploadAsync(ArchiveTransferManager manager, string vaultName, string inputFilePath)
25      {
26          onsole.WriteLine("Uploading file: {0}. inputFilePath: {1}", vaultName, inputFilePath);
27      }
28  }
```

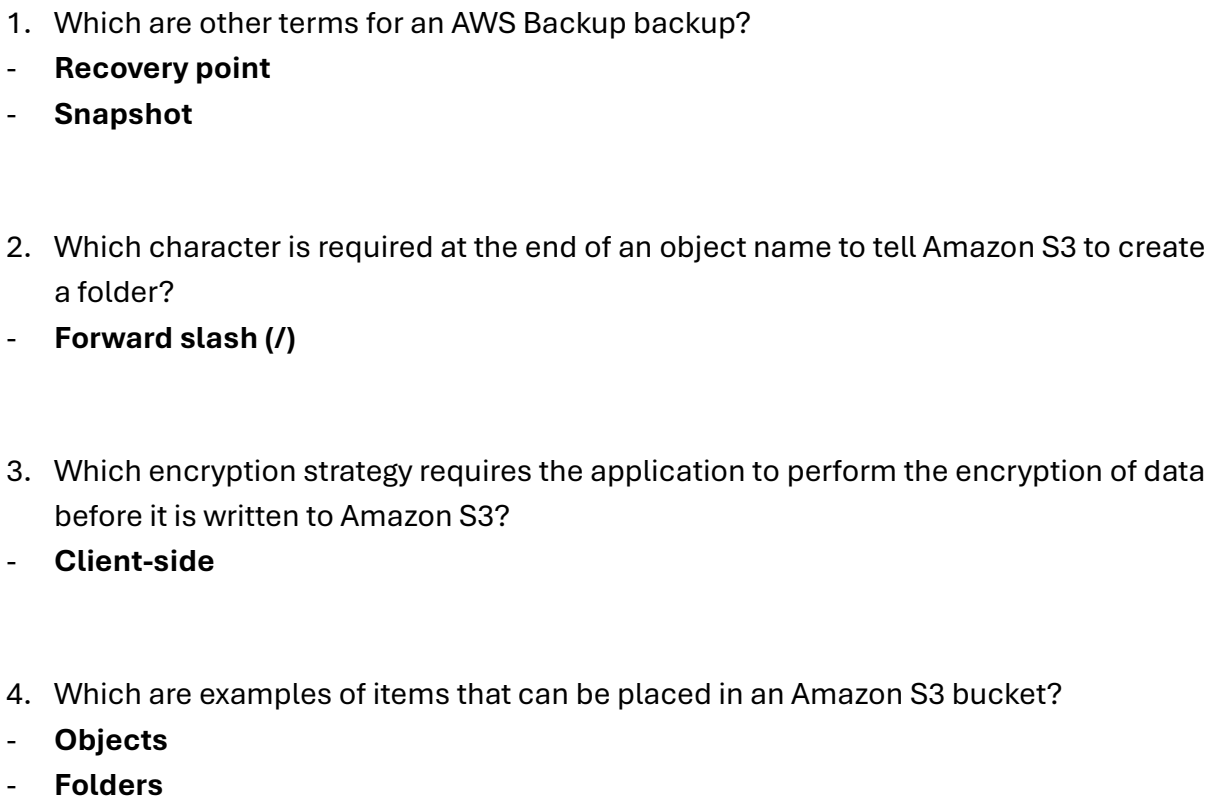


```
1 // See https://aka.ms/new-console-template for more information
2
3 using Amazon.Glacier;
4 using Amazon.S3;
5 using it_clawsda22;
6
7 Console.WriteLine("Hello, World!");
8
9 //var client = new AmazonS3Client("AKIAFS7KEM5XACFZER", "y/1qs/R/xtFWF29kyoyWCF4G83c0uDthGtKfG");
10 //await S3Manager.RunAsync(client);
11
12 var client = new AmazonGlacierClient(awsAccessKeyId: "AKIAFS7KEM5XACFZER", awsSecretAccessKey: "y/1qs/R/xtFWF29kyoyWCF4G83c0uDthGtKfG");
13 await S3GlacierManager.RunAsync(client);
14
```

```
PS C:\work\LLW\it_clawsda22> dotnet run
Hello, World!
Uploading file: ./sbdemo0611.txt
Uploaded file with returned archive id: SNaIimNOXu9dduEkZz7ZMQpb0B6DrIsr_0HL9wwQE-7C5SIIIsTcucDAZOUS0GzCk2KRFIarhaHaudBMh4qRSQ40qbMGL-q6WzjBqL1XpLPVRC1OLarCCBMIX2HP3m5n7zzte5rrvA
Downloading archive id: SNaIimNOXu9dduEkZz7ZMQpb0B6DrIsr_0HL9wwQE-7C5SIIIsTcucDAZOUS0GzCk2KRFIarhaHaudBMh4qRSQ40qbMGL-q6WzjBqL1XpLPVRC1OLarCCBMIX2HP3m5n7zzte5rrvA
```

## Creating an Amazon EFS File System

SSH client should be installed in pc that comes along with windows 11 and you have to enable it





5. Which IP protocols are supported by dual-stack endpoints?

- **IPv4**
- **IPv6**

6. Which is the top-level component of Amazon S3?

- **Buckets**

7. Which Amazon S3 Glacier tier supports choosing between paying for access to archives within 1-5 minutes or free access between 5-12 hours?

- **S3 Glacier Flexible Retrieval**

8. Which Amazon EFS storage class takes advantage of multiple availability zones to offer high availability and self-healing?

- **Standard storage classes**

9. By default, which location is an EFS file system mounted to a Linux EC2 system?

- **/mnt/efs/fs1**

10. Which two credential values are required when establishing a connection to AWS using the AWS SDK?

- **Key ID**
- **Secret value**

11. Which Amazon EBS volume type has the highest performance?

- **Solid state drives (SSDs)**

12. Which value is required to interact with an archive after it has been created?

- **Archive ID**