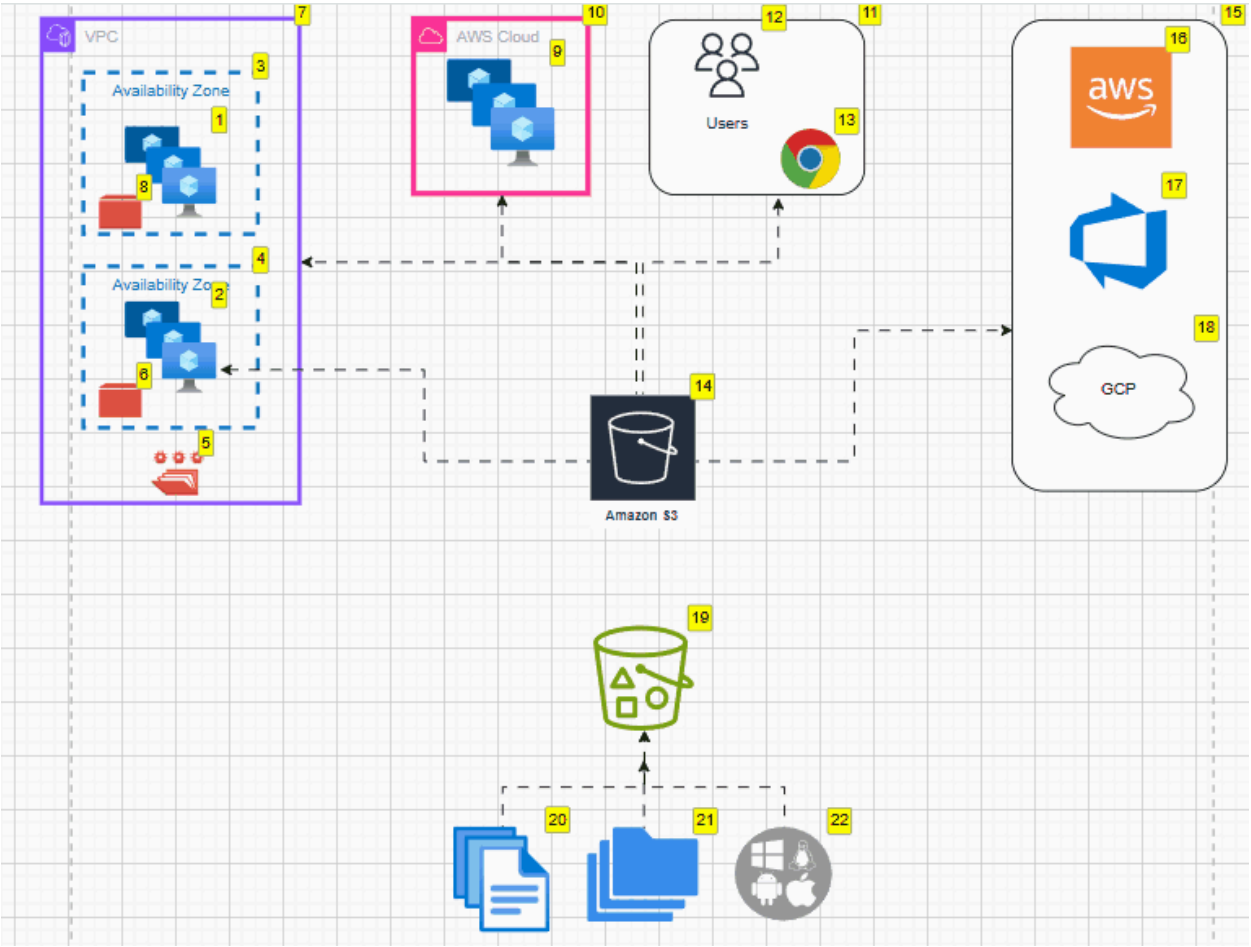
Amazon S3 (Simple Storage Service) is a **scalable object storage service** provided by Amazon Web Services (AWS). It allows users to store and retrieve **any amount of data at any time**, from anywhere on the web. S3 is designed for **durability, availability**, and **scalability**, making it ideal for backup, archival, big data analytics, static websites, and more.

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### 🔍 Core Concepts and Components of Amazon S3

Here's a breakdown of the main components and features of S3:

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#### 1. Buckets

##### 🪣 What is an S3 Bucket?

An **Amazon S3 Bucket** is a **container for storing data** (called objects) in Amazon S3. Think of it like a **folder** on your computer, but in the cloud. Every object (file) you store in S3 must reside in a bucket.

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### 🔍 Key Characteristics of an S3 Bucket

#### 1. Globally Unique Name

- Every bucket name must be **unique across all AWS accounts and regions**.
- Example: my-company-logs-2025

#### 2. Region-Specific

- Buckets exist in a specific **AWS region** (e.g., us-east-1, ap-south-1).
- You choose the region at bucket creation to optimize for **latency, compliance, or cost**.

#### 3. Flat Structure

- Buckets do **not have a folder hierarchy**, but you can simulate folders using **object key prefixes**.
- Example: images/cats/kitty.jpg is just a key, not a folder structure.

#### 4. Unlimited Storage

- Each bucket can store an **unlimited number of objects**.
- The only limit is object size: each object can be up to **5 TB**.

#### 5. Access Control

You can control who can access your bucket using:

- **Bucket Policies** (JSON-based rules)
- **IAM Policies**
- **Access Control Lists (ACLs)**
- **Public access settings** (you can block public access at bucket or account level)

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### 🧰 Bucket Features

| Feature | Description |
| --- | --- |
| **Versioning** | Enable to keep multiple versions of an object. |
| **Lifecycle Rules** | Automatically transition or delete objects over time. |
| **Replication** | Copy objects to another bucket (same or different region). |
| **Event Notifications** | Trigger events when objects are uploaded, deleted, etc. |
| **Logging** | Track requests made to the bucket (access logs). |
| **Static Website Hosting** | Serve static websites directly from S3. |

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## 2. Objects

### 📦 What is an S3 Object?

An **object** in Amazon S3 is the **fundamental unit of storage**. It represents **a file and its metadata** stored inside an S3 bucket. Every file you upload to S3 becomes an object.

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### 🔍 Components of an S3 Object

Each object in S3 is made up of the following parts:

**1. Key**

- The **unique identifier** for the object within a bucket.
- It acts like a **file path**.
- Example: images/cats/kitty.jpg

**2. Value (Data)**

- The actual **content** of the object (e.g., a photo, video, document, backup).
- Can be up to **5 TB** in size.
- For files larger than 5 GB, **multipart upload** is recommended.

**3. Metadata**

- Information about the object.
- Two types:
    - **System-defined metadata**: Created by AWS (e.g., Content-Type, Last-Modified)
    - **User-defined metadata**: You can add custom key-value pairs when uploading.

**4. Version ID *(if versioning is enabled)***

- A unique identifier for different versions of the same object.
- Helps with data recovery and rollback.

**5. ETag (Entity Tag)**

- A hash of the object's content, often used for **integrity checks**.
- Not always an MD5 hash (especially for multipart uploads).

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**3. Keys**

- A **key** is the unique identifier for an object within a bucket (like a filename).
- Example: In mybucket/images/cat.jpg, "images/cat.jpg" is the key.

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**4. Regions**

- Buckets are created in specific **AWS regions** (e.g., us-east-1).
- Data stored in a region stays in that region unless explicitly moved.

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**5. Storage Classes**

S3 offers multiple storage classes optimized for different use cases:

- **S3 Standard**: General-purpose, frequently accessed data.
- **S3 Intelligent-Tiering**: Moves objects between tiers based on access patterns.
- **S3 Standard-IA**: Infrequent access, lower cost.
- **S3 One Zone-IA**: Infrequent access, but stored in a single AZ.
- **S3 Glacier / Glacier Deep Archive**: For archival, low-cost, long-term storage.

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**6. Versioning**

- Allows storing **multiple versions** of an object in a bucket.
- Useful for backups, data recovery, and undoing changes.

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**7. Lifecycle Policies**

- Automatically transition objects between storage classes or **delete** them after a set period.

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**8. Access Control**

S3 offers several ways to manage access:

- **Bucket Policies**: JSON-based rules applied at the bucket level.
- **IAM Policies**: Control access at the AWS user or role level.
- **Access Control Lists (ACLs)**: Fine-grained access control for individual objects or buckets.

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**9. Encryption**

S3 supports encryption for data at rest and in transit:

- **SSE-S3**: Server-side encryption using AWS-managed keys.
- **SSE-KMS**: Server-side encryption with AWS Key Management Service.
- **SSE-C**: Server-side encryption with customer-provided keys.
- **Client-side encryption** is also supported.

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**10. Data Consistency**

- **Strong read-after-write consistency**: Immediately read the latest version after writing or updating an object.

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**11. Event Notifications**

- You can configure S3 to send **notifications** to services like:
    - Amazon SNS
    - Amazon SQS
    - AWS Lambda

- Useful for workflows like processing new uploads.

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**12. Static Website Hosting**

- S3 can host static websites (HTML, CSS, JS).
- Supports **custom error pages**, **index documents**, and **public access**.

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**13. Cross-Origin Resource Sharing (CORS)**

- Allows web applications in one domain to access resources in S3 from another domain.

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**14. Replication**

- **Cross-Region Replication (CRR)**: Automatically copy objects to a bucket in a different region.
- **Same-Region Replication (SRR)**: Useful for compliance and backup within the same region.

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**15. S3 Access Logs**

- Store access logs in another bucket to analyze access patterns or for auditing purposes.

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**16. S3 Select & Glacier Select**

- Retrieve **only a subset of data** from an object using SQL-like queries (without downloading the whole object).

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