

CLOUD COMPUTING

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Module VI

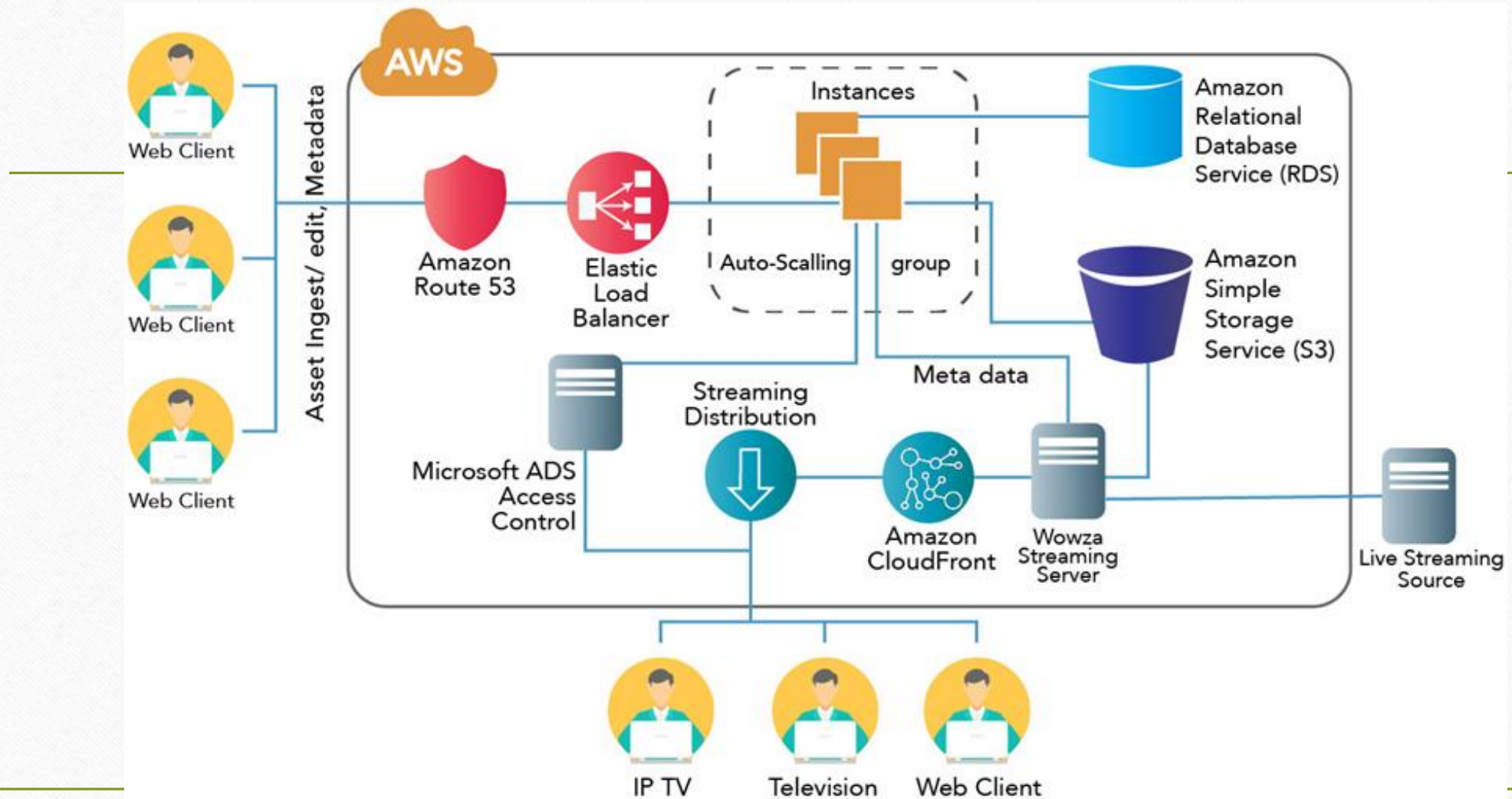
Amazon Web Services (AWS)

- In 2006, **Amazon Web Services (AWS)** started to offer IT services to the market in the form of web services, which is nowadays known as **cloud computing**.
- With this cloud, we need not plan for servers and other IT infrastructure which takes up much of time in advance.
- Instead, these services can instantly spin up hundreds or thousands of servers in minutes and deliver results faster.
- We pay only for what we use with no up-front expenses and no long-term commitments, which makes AWS cost efficient.
- Today, AWS provides a highly reliable, scalable, low-cost infrastructure platform in the cloud that powers multitude of businesses in 190 countries around the world.

History of AWS

- 2002- AWS services launched
- 2006- Launched its cloud products
- 2012- Holds first customer event
- 2015- Reveals revenues achieved of \$4.6 billion
- 2016- Surpassed \$10 billion revenue target
- 2016- Release snowball and snowmobile
- 2019- Offers nearly 100 cloud services
- 2021- AWS comprises over 200 products and services

AWS Architecture



AWS Architecture

- EC2 is also called Elastic Compute cloud which will allow the clients or else the users of using various configurations in their own project or method as per their requirement.
- There are also different amazing options such as pricing options, individual server mapping, configuration server, etc.
- S3 which is present in the AWS architecture is called Simple Storage Services.
- By using this S3, users can easily retrieve or else store data through various data types using Application Programming Interface calls.
- There will be no computing element for the services as well.

Importance of AWS Architecture

- AWS Architecture also makes sure to provide incredible services based on the web technologies, uploading and unloading of virtual servers, the selection service and the service of transferring messages, etc.
- Moreover, the resources of AWS can be available worldwide and can also be able to deploy solutions exactly where the customers are required of them.
- Here are the main benefits of AWS Architecture and its uses:
 - It has a wide range of benefits from the massive economies of the scale
 - It also helps to stop guessing capacity and can easily achieve higher economic rates which can easily translate from the lower prices to the upper prices.
 - It can easily enhance the agility and the speed that can reduce the time to complete a task.

AWS Architecture Components

- Key Components of AWS Architecture:

- **Load Balancing:**

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- The load balancing component in the AWS architecture helps to enhance the application and the server's efficiency in the right way.
 - According to the diagrammatic representation of AWS architecture, this Hardware load balancer is mostly used as the common network appliance and helps to perform skills in the architectures of the traditional web applications.
 - It also makes sure to deliver the Elastic Load Balancing Service, AWS takes the traffic gets distributed to EC2 instances across the various available sources. Along with this, it also distributes the traffic to dynamic addition and the Amazon EC2 hosts removals from the load-balancing rotation.

AWS Architecture Components

- **Elastic Load Balancing:** can dynamically grow and shrink the load-balancing capacity to adjust to traffic demands and also support sticky sessions to address more advanced routing needs.
- **Amazon Cloud Front:** is mostly used for the delivery of content that is directly used for website delivery. The content in the Amazon Cloud Front can also be the type of content such as static, dynamic as well as streaming content that can also take the usage of global network locations as well. From the user end, the content can be requested in an automatic way based on the nearest location that also shows the diverse effect on the performance which will be enhanced in the right way. There will be no commitments in the monthly wise and the contracts.

AWS Architecture Components

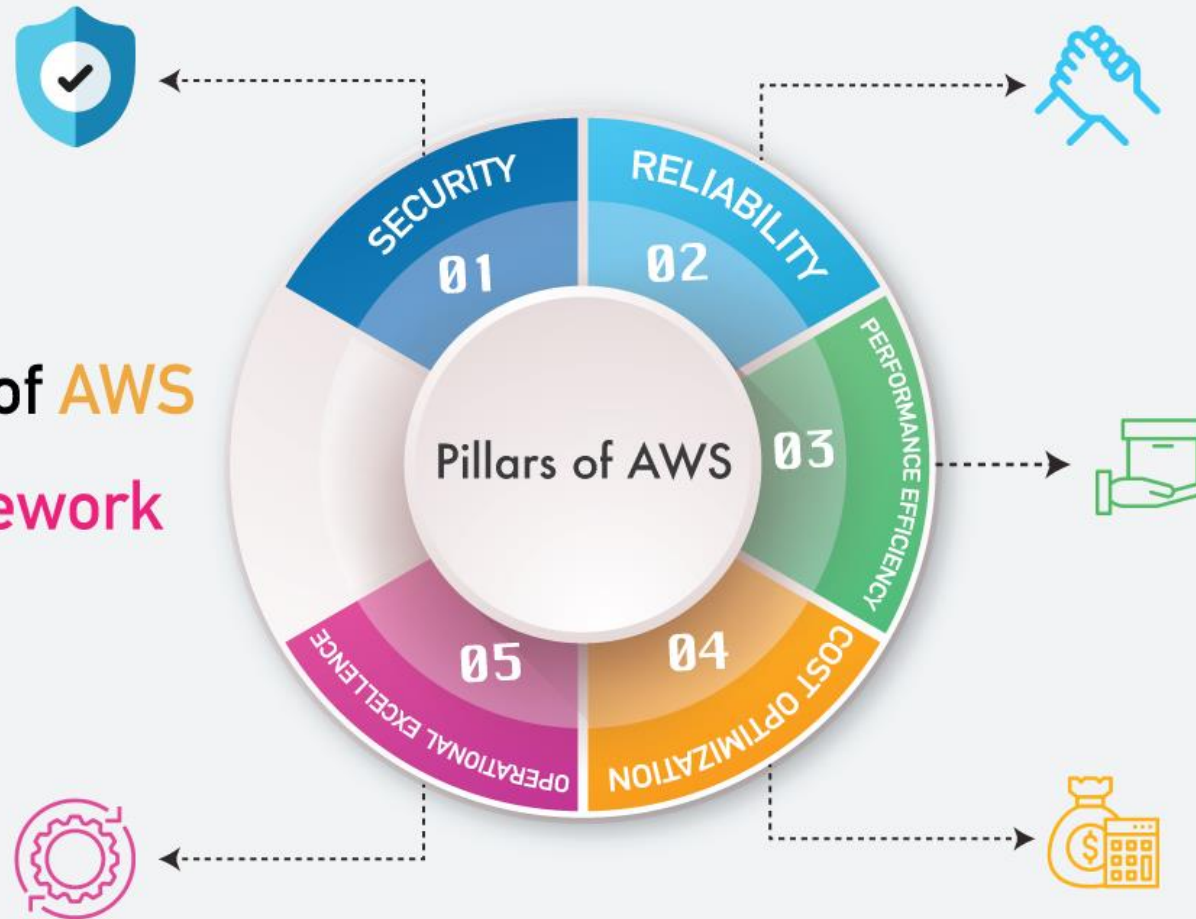
- **Elastic Load Balancer:** is mainly used to deliver the required traffic to the web servers and it also helps to improve the performance in a large manner. This Elastic Load Balancing can easily have growth in a dynamic way and also the load-balancing capacity can be shrunk based on certain traffic conditions.
- **Security Management:** It also makes sure to provide a security feature namely known as security groups. It will also work the same as the inbound network firewall and will also have to specify the ports, protocols, and also source IP ranges where all these can be reached to the EC2 instances. With the help of specific subnets or else IP addresses, the security groups can be configured that can also limit the access to EC2 instances effectively.

AWS Architecture Components

- **Amazon Elastic Cache:** is an efficient web service where the memory cache can be managed in the cloud with ease. This cache plays a vital role in terms of memory management and will also help to reduce the service's load in a reliable manner. It also makes sure to enhance the performance along with the scalability on the tier of the database by caching the information which is used in a frequent manner.
- **Amazon Relational Database Service (ADS):** helps to deliver the same access that is similar to the MySQL, Microsoft SQL Server database engine or else Microsoft SQL. These applications, queries, and tools will be useful in the Amazon RDS as well.

5 pillars of AWS Architecture

The 5 Pillars of **AWS**
Architected Framework



5 pillars of AWS Architecture

1. Security

- Security is the basic thing that matters a lot in AWS Technology. It is entirely an infra design that can easily serve complete data protection, infrastructure protection, privilege Management of all AWS accounts and identifying the security breach with certain detective controls reliably. Basically, it follows certain design principles that are:
 - One can apply security at every level
 - Implementation of Principle of Least Privilege
 - Enable Traceability
 - Secured System Applications, data, and OS Level
 - Automate Security Best practices

5 pillars of AWS Architecture

2. Reliability

- AWS is a good architecture that has come up with well-planned foundations and monitoring in place with various mechanism rates to handle demand rates as per requirements. The system can easily detect the failure and must come out with an optimized solution. The design principles are in the given way like:
 - Test Recovery Procedures
 - Usage of Horizontal Scalability in an increment of system availability
 - Recovery from failure in an automatic way
 - Add or else Removing resources
 - Manage Changes in the automation

5 pillars of AWS Architecture

3. Performance Efficiency

- Performance Efficiency is kept the focus on the efficient use of computing resources to meet the given requirements in a reliable manner. It is also to maintain efficiency as demand changes and technology evolves. The design principles go in the given way:
 - Democratize advanced Technologies
 - Globally Deploying of the given system at a minimal cost of lower latency
 - To keep aside of operational burden, use a serverless architecture
 - Various comparative testing and configurations for better performance

5 pillars of AWS Architecture

4. Cost Optimization

- It is one of the main pillars of AWS Architecture that is completely optimizing costs, unused, elimination or else sub-optimal resources. It is most probably considered with the matching supply with demand and being aware of expenditure and optimizes over costs. The following design principles are delivered in the cost optimization are,
 - Adopting of consumption model
 - High benefits values from economies of scale
 - Stop investing in Data Center Operations
 - Analyzing and Attribute Expenditure
 - Usage of Well Managed services for reducing some cost of ownership

5 pillars of AWS Architecture

5. Operational Excellence

- Generally, this Operational Excellence of the product is checked for reliability, agility, and performance. The most optimized way is to standardize and manage workflows in an efficient manner. It mostly suggests various principles like
 - Performing Operations with code
 - Making of some regular incremental changes
 - Test for certain responses to unexpected events
 - Learning new from the events and failures of certain operations
 - Operations Procedures are always kept current

Amazon EC2 instances

- **Amazon EC2 (Elastic Compute Cloud)** is a web service interface that provides resizable compute capacity in the AWS cloud.
- It is designed for developers to have complete control over web-scaling and computing resources.
- EC2 instances can be resized and the number of instances scaled up or down as per our requirement.
- These instances can be launched in one or more geographical locations or regions, and **Availability Zones (AZs)**.
- Each region comprises of several AZs at distinct locations, connected by low latency networks in the same region.

Amazon EC2 instances

- EC2 Components:

- **Operating System Support:** Amazon EC2 supports multiple OS in which we need to pay additional licensing fees like: Red Hat Enterprise, SUSE Enterprise and Oracle Enterprise Linux, UNIX, Windows Server, etc. These OS needs to be implemented in conjunction with Amazon Virtual Private Cloud (VPC).
- **Security:** Users have complete control over the visibility of their AWS account. In AWS EC2, the security systems allow create groups and place running instances into it as per the requirement. You can specify the groups with which other groups may communicate, as well as the groups with which IP subnets on the Internet may talk.
- **Pricing:** AWS offers a variety of pricing options, depending on the type of resources, types of applications and database. It allows the users to configure their resources and compute the charges accordingly.

Amazon EC2 instances

- **Fault tolerance:** Amazon EC2 allows the users to access its resources to design fault-tolerant applications. EC2 also comprises geographic regions and isolated locations known as availability zones for fault tolerance and stability. It doesn't share the exact locations of regional data centers for security reasons. When the users launch an instance, they must select an AMI that's in the same region where the instance will run. Instances are distributed across multiple availability zones to provide continuous services in failures, and Elastic IP (EIPs) addresses are used to quickly map failed instance addresses to concurrent running instances in other zones to avoid delay in services.
- **Migration:** This service allows the users to move existing applications into EC2. It costs \$80.00 per storage device and \$2.49 per hour for data loading. This service suits those users having large amount of data to move.

Features of EC2

- **Reliable** – Amazon EC2 offers a highly reliable environment where replacement of instances is rapidly possible. Service Level Agreement commitment is 99.9% availability for each Amazon EC2 region.
- **Designed for Amazon Web Services** – Amazon EC2 works fine with Amazon services like Amazon S3, Amazon RDS, Amazon DynamoDB, and Amazon SQS. It provides a complete solution for computing, query processing, and storage across a wide range of applications.
- **Secure** – Amazon EC2 works in Amazon Virtual Private Cloud to provide a secure and robust network to resources.
- **Flexible Tools** – Amazon EC2 provides the tools for developers and system administrators to build failure applications and isolate themselves from common failure situations.
- **Inexpensive** – Amazon EC2 wants us to pay only for the resources that we use. It includes multiple purchase plans such as On-Demand Instances, Reserved Instances, Spot Instances, etc. which we can choose as per our requirement.

Create and Manage EC2

- Sign-in to AWS account and open IAM console by using the following link <https://console.aws.amazon.com/iam/>.
- **Step 2** – In the navigation Panel, create/view groups and follow the instructions.
- **Step 3** – Create IAM user. Choose users in the navigation pane. Then create new users and add users to the groups.
- **Step 4** – Create a Virtual Private Cloud using the following instructions.
 - Open the Amazon VPC console by using the following link – <https://console.aws.amazon.com/vpc/>
 - Select VPC from the navigation panel. Then select the same region in which we have created key-pair.
 - Select start VPC wizard on VPC dashboard.
 - Select VPC configuration page and make sure that VPC with single subnet is selected. Then choose Select.
 - VPC with a single public subnet page will open. Enter the VPC name in the name field and leave other configurations as default.
 - Select create VPC, then select Ok.

Create and Manage EC2

- **Step 5** – Create WebServerSG security groups and add rules using the following instructions.
 - On the VPC console, select Security groups in the navigation panel.
 - Select create security group and fill the required details like group name, name tag, etc.
 - Select your VPC ID from the menu. Then select yes, create button.
 - Now a group is created. Select the edit option in the inbound rules tab to create rules.
- **Step 6** – Launch EC2 instance into VPC using the following instructions.
 - Open EC2 console by using the following link – <https://console.aws.amazon.com/ec2/>
 - Select launch instance option in the dashboard.
 - A new page will open. Choose Instance Type and provide the configuration. Then select Next: Configure Instance Details.
 - A new page will open. Select VPC from the network list. Select subnet from the subnet list and leave the other settings as default.
 - Click Next until the Tag Instances page appears

Create and Manage EC2

- **Step 7** – On the Tag Instances page, provide a tag with a name to the instances. Select Next: Configure Security Group.
- **Step 8** – On the Configure Security Group page, choose the Select an existing security group option. Select the WebServerSG group that we created previously, and then choose Review and Launch.
- **Step 9** – Check Instance details on Review Instance Launch page then click the Launch button.
- **Step 10** – A pop up dialog box will open. Select an existing key pair or create a new key pair. Then select the acknowledgement check box and click the Launch Instances button.

EBS Volume

- An Amazon EBS volume is a durable, block-level storage device that you can attach to your instances.
 - After you attach a volume to an instance, you can use it as you would use a physical hard drive. EBS volumes are flexible.
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- For current-generation volumes attached to current-generation instance types, you can dynamically increase size, modify the provisioned IOPS capacity, and change volume type on live production volumes.
 - You can use EBS volumes as primary storage for data that requires frequent updates, such as the system drive for an instance or storage for a database application.
 - You can also use them for throughput-intensive applications that perform continuous disk scans.
 - EBS volumes persist independently from the running life of an EC2 instance.

EBS Volume

- You can attach multiple EBS volumes to a single instance.
- The volume and instance must be in the same Availability Zone.
- Depending on the volume and instance types, you can use Multi-Attach to mount a volume to multiple instances at the same time.

EBS Volume

- EBS Volume Type:
 - General Purpose SSD (gp2 and gp3),
 - Provisioned IOPS SSD (io1 and io2),
 - Throughput Optimized HDD (st1),
 - Cold HDD (sc1),
 - and Magnetic (standard).
- They differ in performance characteristics and price, allowing you to tailor your storage performance and cost to the needs of your applications.

Benifits of using EBS Volume

- **Data availability**: it is automatically replicated within its Availability Zone to prevent data loss due to failure of any single hardware component.
- **Data persistence**: It is off-instance storage that can persist independently from the life of an instance. You continue to pay for the volume usage as long as the data persists.
- **Data encryption**: you can create encrypted EBS volumes with the Amazon EBS encryption feature. Amazon EBS encryption uses 256-bit Advanced Encryption Standard algorithms (AES-256) and an Amazon-managed key infrastructure.
- **Data security**: Amazon EBS volumes are presented to you as raw, unformatted block devices. These devices are logical devices that are created on the EBS infrastructure and the Amazon EBS service ensures that the devices are logically empty (that is, the raw blocks are zeroed or they contain cryptographically pseudorandom data) prior to any use or re-use by a customer.
- **Snapshots**: Amazon EBS provides the ability to create snapshots (backups) of any EBS volume and write a copy of the data in the volume to Amazon S3, where it is stored redundantly in multiple Availability Zones.
- **Flexibility**: EBS volumes support live configuration changes while in production. You can modify volume type, volume size, and IOPS capacity without service interruptions.

Simple Storage Service (S3)

- Amazon Simple Storage Service (Amazon S3) is an object storage service that offers industry-leading scalability, data availability, security, and performance.
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- Customers of all sizes and industries can use Amazon S3 to store and protect any amount of data for a range of use cases, such as data lakes, websites, mobile applications, backup and restore, archive, enterprise applications, IoT devices, and big data analytics.
 - Amazon S3 provides management features so that you can optimize, organize, and configure access to your data to meet your specific business, organizational, and compliance requirements.

S3 Terminology

- **Bucket:** Data, in S3, is stored in containers called *buckets*.
 - Each bucket will have its own set of policies and configuration. This enables users to have more control over their data.
 - Bucket Names must be unique.

- Can be thought of as a parent folder of data.
- There is a limit of 100 buckets per AWS accounts. But it can be increased if requested from AWS support.
- **Bucket Owner:** The person or organization that owns a particular bucket is its *bucket owner*.
- **Import/Export Station:** A machine that uploads or downloads data to/from S3.
- **Key:** Key, in S3, is a unique identifier for an object in a bucket. For example in a bucket 'ABC' your *GFG.java* file is stored at *javaPrograms/ GFG.java* then '*javaPrograms/ GFG.java*' is your object key for *GFG.java*.
 - It is important to note that 'bucketName+key' is unique for all objects.
 - This also means that there can be only one object for a key in a bucket. If you upload 2 files with the same key. The file uploaded latest will overwrite the previously contained file.

S3 Terminology

➤ **Versioning:** Versioning means to always keep a record of previously uploaded files in S3. Points to note:

- Versioning is not enabled by default. Once enabled, it is enabled for all objects in a bucket.
- Versioning keeps all the copies of your file, so, it adds cost for storing multiple copies of your data. For example, 10 copies of a file of size 1GB will have you charged for using 10GBs for S3 space.
- Versioning is helpful to prevent unintended overwrites and deletions.
- Note that objects with the same key can be stored in a bucket if versioning is enabled (since they have a unique version ID).

➤ **null Object:** Version ID for objects in a bucket where versioning is suspended is null. Such objects may be referred to as null objects.

- For buckets with versioning enabled, each version of a file has a specific version ID.

S3 Terminology

- **Object:** Fundamental entity type stored in AWS S3.
- **Access Control Lists (ACL):** A document for verifying the access to S3 buckets from outside your AWS account. Each bucket has its own ACL.
- **Bucket Policies:** A document for verifying the access to S3 buckets from within your AWS account, this controls which services and users have what kind of access to your S3 bucket. Each bucket has its own Bucket Policies.
- **Lifecycle Rules:** This is a cost-saving practice that can move your files to AWS Glacier (The AWS Data Archive Service) or to some other S3 storage class for cheaper storage of old data or completely delete the data after the specified time.

S3 Features

- **Durability:** AWS claims Amazon S3 to have a 99.999999999% of durability (11 9's). This means the possibility of losing your data stored on S3 is one in a billion.
- **Availability:** AWS ensures that the up-time of AWS S3 is 99.99% for standard access.

- Note that availability is related to being able to access data and durability is related to losing data altogether.
- **Server-Side-Encryption (SSE):** AWS S3 supports three types of SSE models:
 - **SSE-S3:** AWS S3 manages encryption keys.
 - **SSE-C:** The customer manages encryption keys.
 - **SSE-KMS:** The AWS Key Management Service (KMS) manages the encryption keys.
- **File Size support:** AWS S3 can hold files of size ranging from 0 bytes to 5 terabytes. A 5TB limit on file size should not be a blocker for most of the applications in the world.

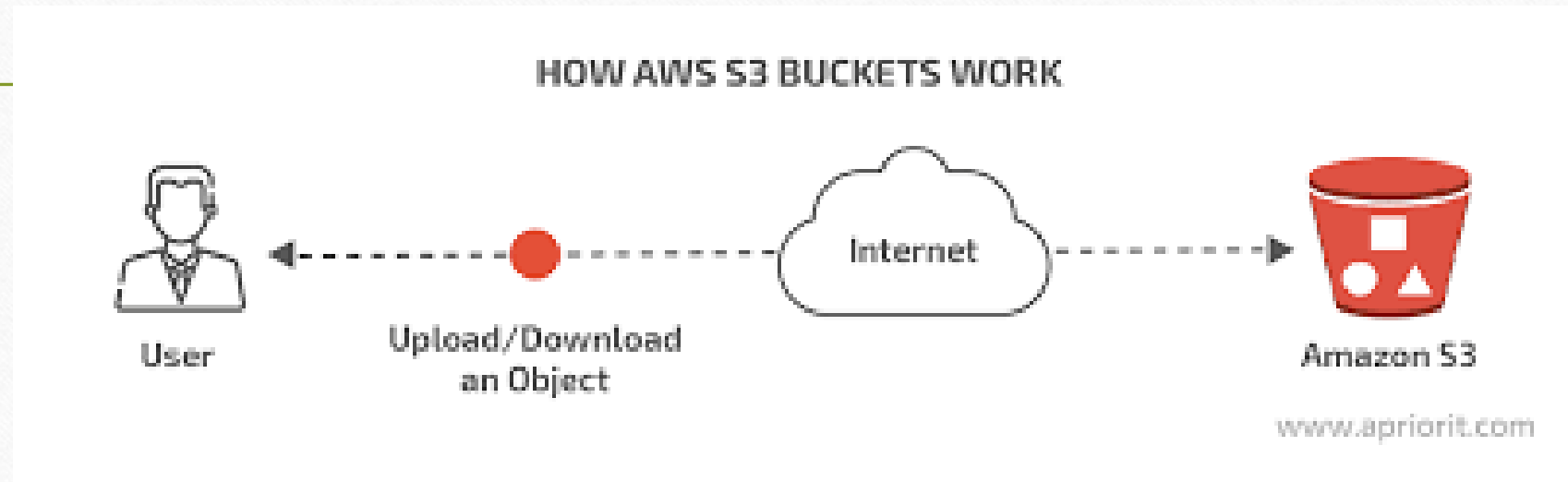
S3 Features

- **Infinite storage space:** Theoretically AWS S3 is supposed to have infinite storage space. This makes S3 infinitely scalable for all kinds of use cases.
- **Pay as you use:** The users are charged according to the S3 storage they hold.
- **AWS-S3** is region-specific.

S3 storage Classes

- **Standard:** Suitable for frequently accessed data, that needs to be highly available and durable.
- **Standard Infrequent Access (Standard IA):** This is a cheaper data-storage class and as the name suggests, this class is best suited for storing infrequently accessed data like log files or data archives. Note that there may be a per GB data retrieval fee associated with Standard IA class.
- **Intelligent Tiering:** This service class classifies your files automatically into frequently accessed and infrequently accessed and stores the infrequently accessed data in infrequent access storage to save costs. This is useful for unpredictable data access to an S3 bucket.
- **One Zone Infrequent Access (One Zone IA):** All the files on your S3 have their copies stored in a minimum of 3 Availability Zones. One Zone IA stores this data in a single availability zone. It is only recommended to use this storage class for infrequently accessed, non-essential data. There may be a per GB cost for data retrieval.
- **Reduced Redundancy Storage (RRS):** All the other S3 classes ensure the durability of 99.999999999%. RRS only ensures a 99.99% durability. AWS no longer recommends RRS due to its less durability. However, it can be used to store non-essential data.

How S3 Works?



How S3 Works?

- Amazon S3 is an object storage service that stores data as objects within buckets. An *object* is a file and any metadata that describes the file.
 - A *bucket* is a container for objects.
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- To store your data in Amazon S3, you first create a bucket and specify a bucket name and AWS Region.
 - Then, you upload your data to that bucket as objects in Amazon S3.
 - Each object has a *key* (or *key name*), which is the unique identifier for the object within the bucket.
 - S3 provides features that you can configure to support your specific use case.
 - Buckets and the objects in them are private and can be accessed only if you explicitly grant access permissions.
 - You can use bucket policies, AWS Identity and Access Management (IAM) policies, access control lists (ACLs), and S3 Access Points to manage access.