AWS Certified Solutions Architect Associate and Professional – Exam Guide

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Chapter 1 - Introduction to Cloud Computing

The History of the Enterprise Network and Data Center

Ever since computing resources provided a competitive advantage, organizations have been investing in their computing resources. Over time technology became not only a competitive advantage but also a necessary resource to be competitive in today's business environment. Since technology can bring extreme advances in productivity, sales, marketing, communication, and collaboration, organizations have invested more and more resources into technology. Organizations, therefore, built large and complex data centers and connected those data centers to an organization's users with specialized networking, security, and computing hardware resources. Enterprise data centers became huge networks, often requiring thousands of square feet of space; incredible amounts of power; cooling; hundreds, if not thousands, of servers, switches, routers; and many other technologies. Effectively, the enterprise and especially the global enterprise environments became massive networks—just like a cloud computing environment. The net result was a powerful private cloud environment.

Global enterprise data centers and high-speed networks work well. However, these networks come with a high cost and require a high level of expertise to manage these environments. Network and data center technology is not simple, and it requires a significant staff of expensive employees to design, operate, maintain, and fix these environments. Some large enterprise technology environments take billions of dollars to create and operate.

Global enterprise networks and data centers still have merit for high security, ultrahigh-performance environments requiring millisecond-level latency, and ultrahigh network and computing performance. An example environment that benefits from this traditional model is the global financial environment, where shaving milliseconds off network, server, and application performance can equate to a significant competitive advantage. However, for many customers, the costs of procuring and operating the equipment are just too costly.

Recent advances in network, virtualization, and processing power make the transition to cloud computing feasible.

Why Now Is the Optimal Time for Cloud Computing

Let's first look at virtualization, as it is the key enabling technology of cloud computing. Server performance has increased dramatically in recent years. It is no longer necessary to have a server or multiple servers for every application. Since today's servers are so powerful, they can be partitioned into multiple logical servers in a physical server, reducing the need for so many servers. This reduces space, power, and cooling requirements. Additionally, virtualization makes it simple to move, add, or change server environments. Previously, any time you wanted to make a server change, you had to buy a new server, which could take weeks or months, install the operating system and all the applications' dependencies, and then find a time to upgrade the server when it wasn't being used. This process was lengthy, as changes to any part of an IT environment can effect many other systems and users. With virtualization, to upgrade a server, you have to copy only the server file to another machine, and it's up and running.

Server virtualization became so critical in improving hardware resource utilization for computing that soon organizations explored moving the network to virtualized servers. Now routing, firewalling, and many other functions can be shifted to virtualized services with software-defined networking. For several years organizations have migrated their traditional data centers to virtualized enterprise data centers, and it has worked well. However, network speed (bandwidth) has made significant gains, while the cost of this high-performance networking has decreased substantially.

Therefore, it is now possible to move the data center to a cloud computing environment and still achieve high performance with lower total costs. With the ability to purchase multiple 10-gigabit-per-second links to AWS, it's now feasible to connect an organization to a cloud provider at almost the same speed as if the application is in the local data center, but with the benefits of a cloud computing environment.

Types of Cloud Environments

Hybrid Cloud

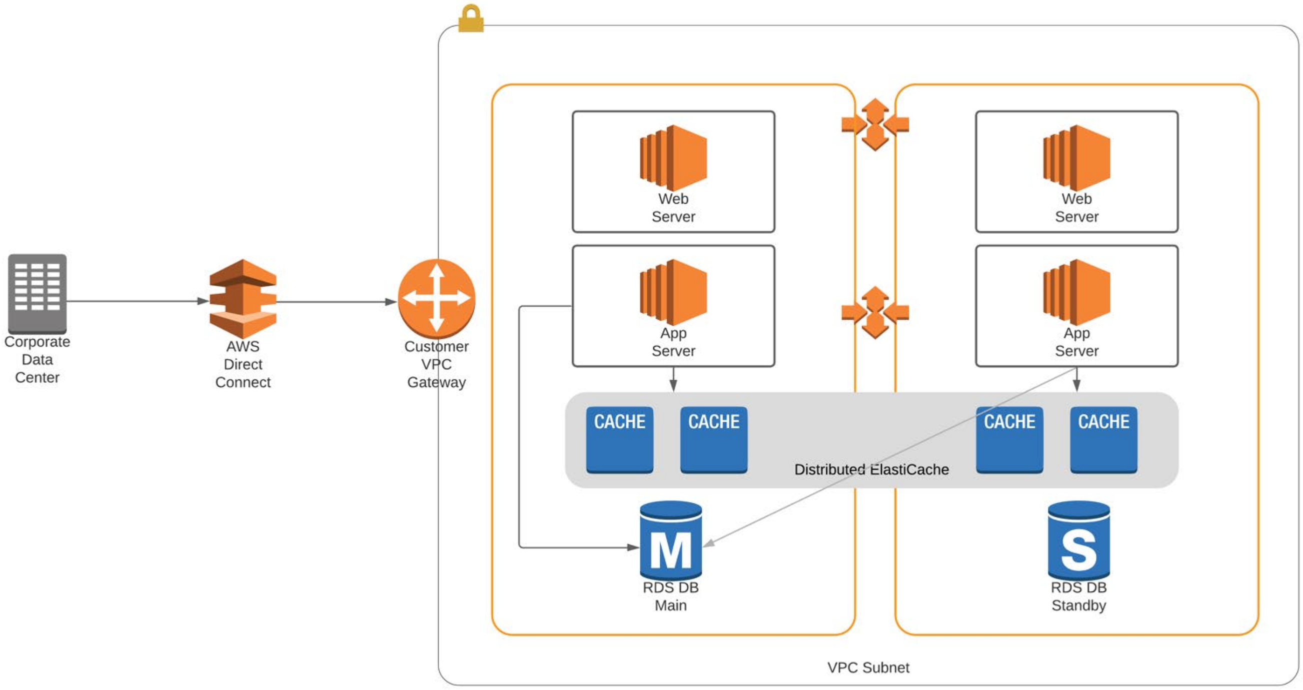
A hybrid cloud combines a standard data center with outsourced cloud computing. For many organizations, the hybrid cloud is the perfect migration to the cloud. In a hybrid architecture, the organization can run its applications and systems in its local data center and offload part of the computing to the cloud. This provides an opportunity for the organization to leverage its investment in its current technology while moving to the cloud. Hybrid clouds provide an opportunity to learn and develop the optimal cloud or hybrid architecture.

Applications for hybrid cloud include:

- Disaster recovery – Run the organization computing locally, with a backup data center in the cloud.
- On-demand capacity – Prepare for spikes in application traffic by routing extra traffic to the cloud.
- High performance – Some applications benefit from the reduced latency and higher network capacity available on premises, and all other applications can be migrated to the cloud to reduce costs and increase flexibility.
- Specialized workloads – Move certain workflows to the cloud that require substantial development time, i.e., machine learning, rendering, transcoding.

- Backup – The cloud provides an excellent means to back up to a remote and secure location.

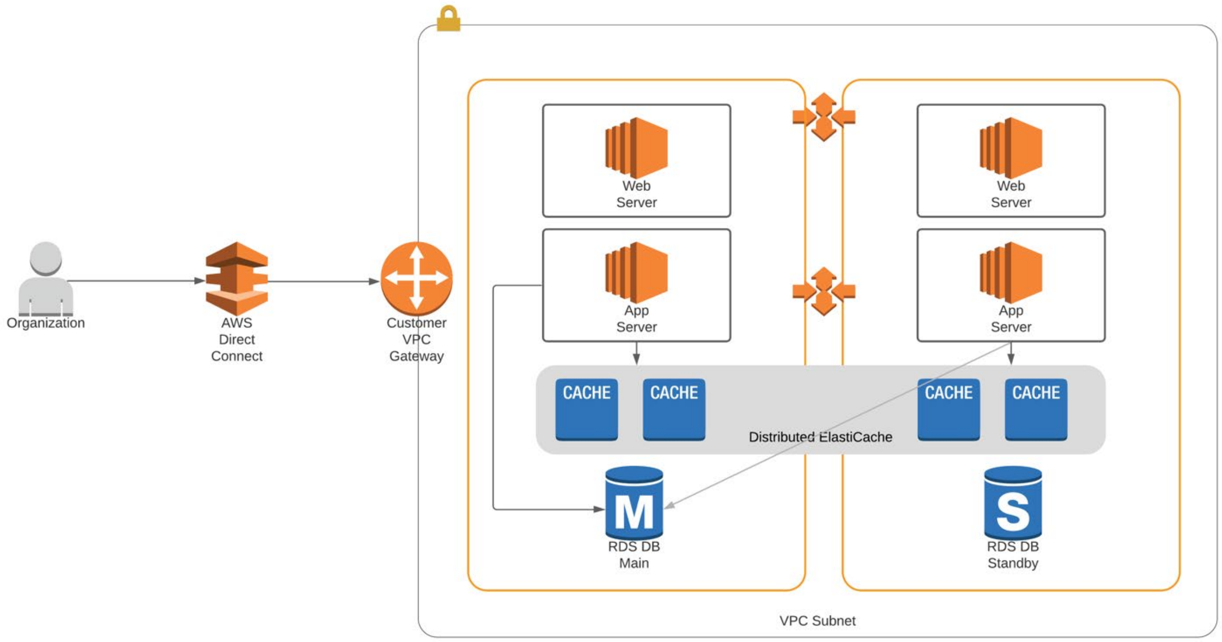
The diagram below shows an example of a hybrid cloud computing environment:



Pure Cloud Computing Environment

In a pure cloud computing environment, all computing resources are in the cloud. This means servers, storage, applications, databases, and load balancers are all in the cloud. The organization is connected to the cloud with a direct connection or a VPN connection. The speed and reliability of the connection to the cloud provider will be the key determinant of the performance of this environment.

The diagram below shows an example of a pure cloud computing environment on the AWS platform:



A pure cloud computing environment has several advantages:

- Scalability – The cloud provides incredible scalability.
- Agility – Adding computing resources can occur in minutes versus weeks in a traditional environment.
- Pay-as-you-go pricing – Instead of purchasing equipment for maximum capacity, which may be idle 90 percent of the time, exactly what is needed is purchased when needed. This can provide tremendous savings.
- Professional management – Managing data centers is very complicated. Space, power, cooling, server management, database design, and many other components can easily overwhelm most IT organizations. With the cloud, most of these are managed for you by highly skilled individuals, which reduces the risk of configuration mistakes, security problems, and outages.
- Self-healing – Cloud computing can be set up with health checks that can remediate problems before they have a significant effect on users.
- Enhanced security – Most cloud organizations provide a highly secure environment. Most enterprises would not have access to this level of security due to the costs of the technology and the individuals to manage it.

Multi-Cloud Environment

Organizations are now leveraging multiple cloud providers. This enables an organization to obtain the best benefits from each cloud provider. For example, cloud provider 1 has the best artificial intelligence/machine learning tools, and cloud provider 2 has the best infrastructure. Additionally, a multi-cloud environment protects an organization from an outage in a single cloud provider.

Multi-cloud environments also provide the following benefits:

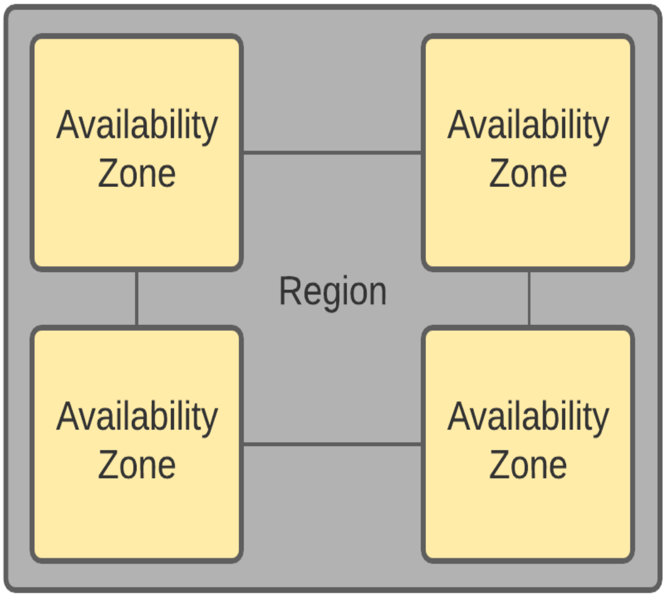
- High-availability – A single cloud provider is a single point of failure.
- Vendor lock-in – Being on multiple clouds protects the customer from a provider raising their rates, etc. It gives the customer negotiation power on pricing and services.

The AWS Cloud and How It's Organized

The AWS cloud is organized into regions, availability zones, local zones, and edge locations. Each of these components performs a specific function in delivering cloud services to AWS clients.

The main components of the AWS cloud are **regions** and **availability zones**. A region is a large geographic area, i.e. a continent or part of a continent. An availability zone is simply a data center. A geographic region will have many data centers called availability zones.

Please see the diagram below:



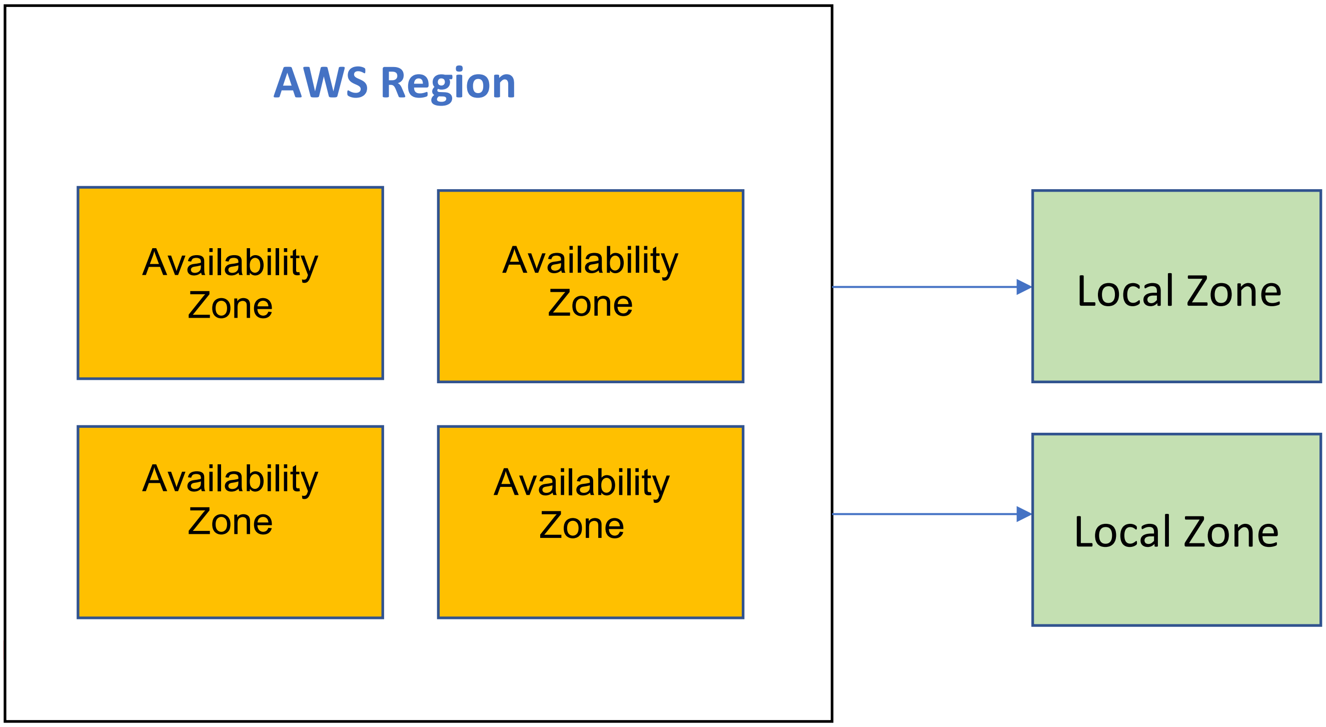
Local Zones

Cloud computing often occurs at a significant distance from the customer's location. Sending and receiving data over a long distance can contribute to high levels of latency. High levels of latency can affect user experience as well as application performance. To that end, AWS offers the **local zone**. The local zone is an extension of the region. Effectively it's a data center closer to the user. Organizations place systems that require low latency in these local zones.

Things to note about local zones:

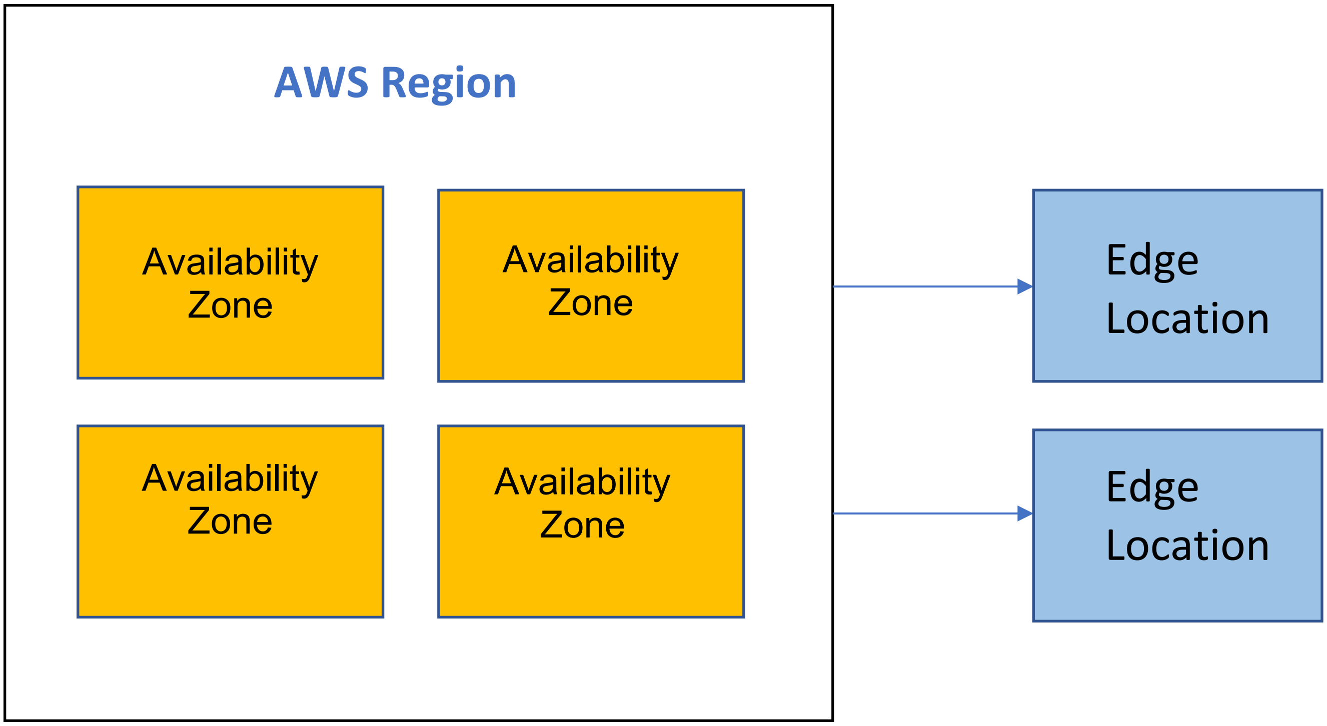
- To use a local zone, first opt into using local zones.
- Create a subnet in the local zone.
- Place systems in the local zone.

This diagram shows how the local zone is an extension of the region for low-latency computing:



Edge Locations

Edge locations are used by the CloudFront content delivery network. Edge locations provide access to the CloudFront content delivery network in most major cities. Edge locations are used by CloudFront to improve internet performance and improve website security and scalability. CloudFront will be discussed in depth in the CloudFront section of this book.



How to Access and Manage Resources in the Cloud

There are three ways to manage cloud computing resources on AWS. The methods to configure AWS cloud computing resources are the AWS Management Console, the command-line interface, and connecting via an API through the software development kit.

AWS Management Console

The AWS Management Console is a simple-to-use, browser-based method to manage configurations. There are numerous options, with guidance and help functions. Most users will use this platform.

AWS CLI (Command Line Interface)

The AWS Command Line Interface (CLI) enables you to manage computing resources via Linux commands and JavaScript Object Notation (JSON) scripting. This is efficient but requires more knowledge and training, and organizations need to know exactly what is needed and how to configure properly. With the CLI, there is no guidance as in the AWS Management Console.

AWS SDK (Software Development Kit)

The AWS Software Development Kit (SDK) provides a highly effective method to modify and provision AWS resources on demand. This can be automated and can provide the ultimate scalability. This will require sophisticated knowledge to build the programming resources and is recommended for experts.

Chapter 2 - Connecting to the Cloud

If an organization moves its computing environment to the cloud, then the connections to the cloud become critical. If the connection to the cloud fails, then the organization can no longer access cloud resources. The performance needs and an organization's dependency on IT will determine the connection requirements to the cloud.

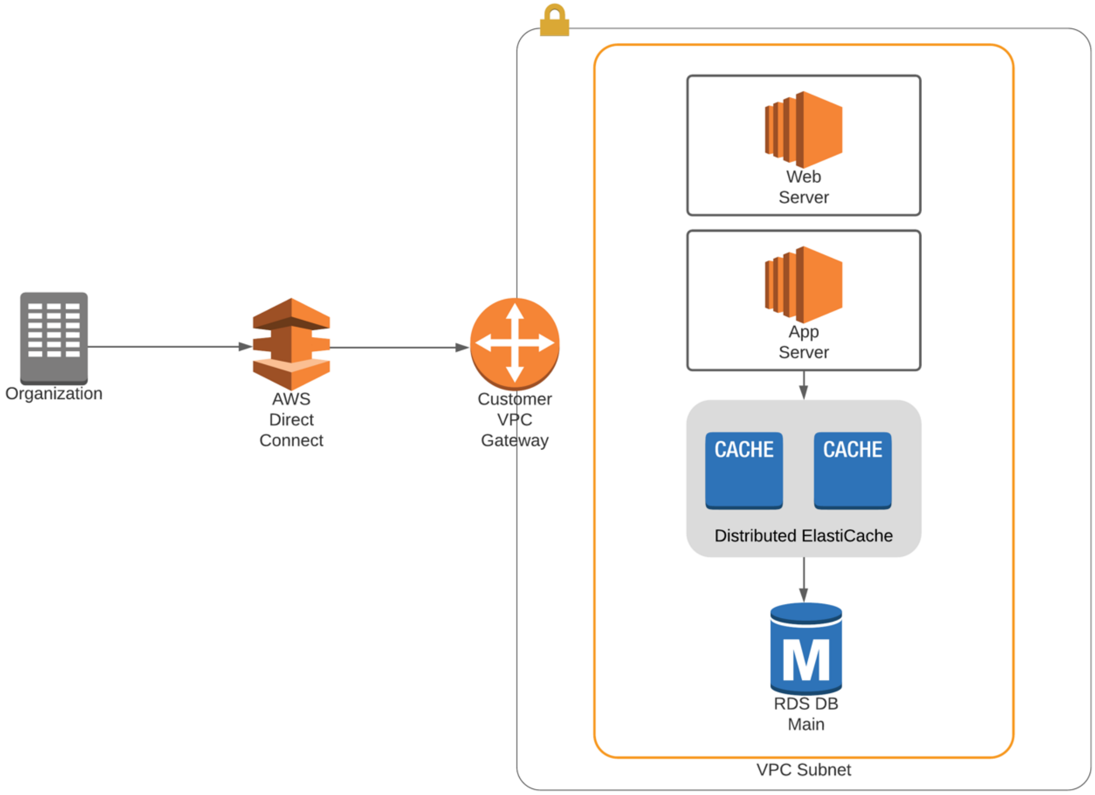
For most organizations, getting a "direct" connection to the cloud will be the preferred method. A direct connection is analogous to a private line in the networking world because it is effectively a wire that connects the organization to the cloud. This means guaranteed performance, bandwidth, and latency. As long as the connection is available, performance is excellent. This is unlike a VPN connection over the internet, where congestion anywhere on the internet can negatively affect performance.

Since network connections can fail, a direct connection is generally combined with a VPN backup over the internet. A VPN can send the data securely over the internet to AWS. A VPN provides data security via encryption and permits the transfer of routing information and the use of private address space. VPNs work by creating an IP security (IPsec) tunnel over the internet.

Direct Connect

Organizations have two options when connecting to the cloud: a dedicated network connection or a VPN connection. An AWS direct connection is the equivalent of a private line between a customer's on-premises data center and the AWS network. A private line is analogous to a wire between the organization's data center and the AWS cloud. Since the private line is effectively a wire, there will be consistent speed and latency. The ability to get a guaranteed speed and consistent latency makes a direct connection the best option when an organization needs guaranteed or consistent network performance.

The diagram below shows a high-level logical view of the AWS direct connection.



Key Underlying Technologies

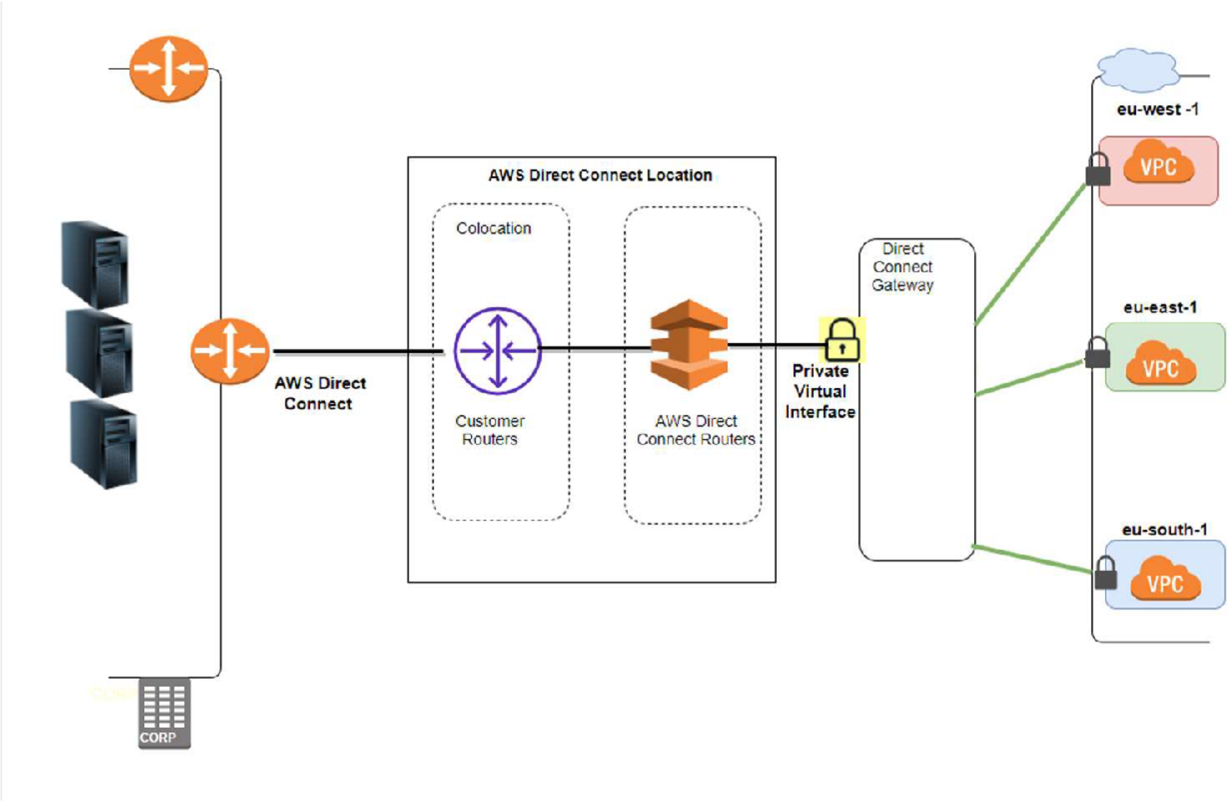
The concept of a direct connection is based on Ethernet WAN (wide area network) technologies that provide dedicated point-to-point network connectivity between multiple locations. Key components include a fiber-optic router with a fiber-optic Ethernet port and, of course, a single-mode fiber-optic connection. Speeds available for the AWS Direct Connect include 1 Gbps, 10 Gbps, and 100 Gbps Ethernet. If additional bandwidth is desired, up to four connections can be bundled into a *link aggregation group*. The link aggregation group (LAG) will be covered in another section.

In addition, Bidirectional Forwarding Detection (BFD) is supported to help make sure traffic is only sent on healthy, fully active connections.

How Does a Direct Connection Work?

On the surface, AWS Direct Connect gives the illusion of a wired connection, but several actions occur behind the scenes. The customer buys a connection from their data center to an AWS Direct Connect location. From there, a connection is made from the customer router in the direct connection location to the AWS switch. This occurs by connecting a cable between the customer router and the AWS switch. This cable connection is called a *cross-connect*. Traffic is then backhauled over the AWS backbone network to the VPC. Customers can access the AWS Direct Connect console to build virtual interfaces when the network connection is established.

The diagram below shows the actual technology involved in a direct connection:



Direct Connect Requirements

Direct Connect requires a virtual local area network (VLAN) tag on a direct connection. Each VLAN is tagged with an 802.1q tag. The 802.1q tag keeps customers' traffic separated on the layer 2 connections back to AWS.

All direct connection routers must support Border Gateway Protocol (BGP). BGP is used to build routing tables (network layer reachability information) which are used for traffic forwarding decisions. Additionally, the BGP implementation must support BGP Message Digest 5 (MD5) authentication via a customer authentication key or an AWS-generated key. It is recommended to use Bidirectional Forwarding Detection (BFD) so that traffic will fail over to a secondary circuit in the event of a failure.

Letter of Authorization

To connect the customer network to the AWS network, a Letter of Authorization – Connecting Facility Assignment (LOA-CFA) must be granted. A LOA-CFA gives an internet service provider

authority to act on behalf of a customer. An LOA-CFA application must be submitted via the management console, API, or CLI, identifying the Direct Connect region. Once complete, AWS will provision a switchport to the Direct Connect Location. Finally, the letter is submitted to the service provider to establish a cross-connect.

AWS Direct Connect Partners

A Direct Connect Partner is an authorized service provider that provisions the direct connection from an on-premises data center to a customer's AWS Virtual Private Cloud (VPC). Direct Connect Partners can provide sub-Gbps connections if full-speed ports are not needed. Sub-Gbps connections drastically reduce the cost over full-speed ports. Once a port speed is determined, the Direct Connect Partner will establish a rate limiting policy. This is useful for organizations that only need partial speeds. In most cases a direct connect partner will be more expensive per GB of data transferred but cost less overall for organizations not needing full link speed.

Public and Private Virtual Interfaces (VIF)

The direct connection offers access to both public and private interfaces. Public and private virtual interfaces (VIF) provide customers with the opportunity to connect to both public and private VIFs. A private VIF is used to securely access a VPC using private IP addresses, and a public VIF can access all public services using public IP addresses. AWS allows customers to connect to multiple VPCs in any AWS Region.

Public VIFs can be used to reach AWS services like S3, DynamoDB, and public subnets, whereas private VIFs are used to connect to virtual gateways (VGW). AWS allows customers to advertise up to one hundred routes over a BGP peering session but will not permit more than one thousand routes per customer. AWS will not readvertise routes, so customers can't become a transit ISP.

Direct Connect Gateway

Direct Connect gateway (DCG) is a service built over top Direct Connect and provides the ability to connect VPCs in multiple availability zones (AZ) or Regions. Once connected to a DCG, a logical private connection is created between a customer's VPC in the selected AZ. Afterward, BGP peering is set up and connected to the gateway, and CIDR addresses will not overlap.

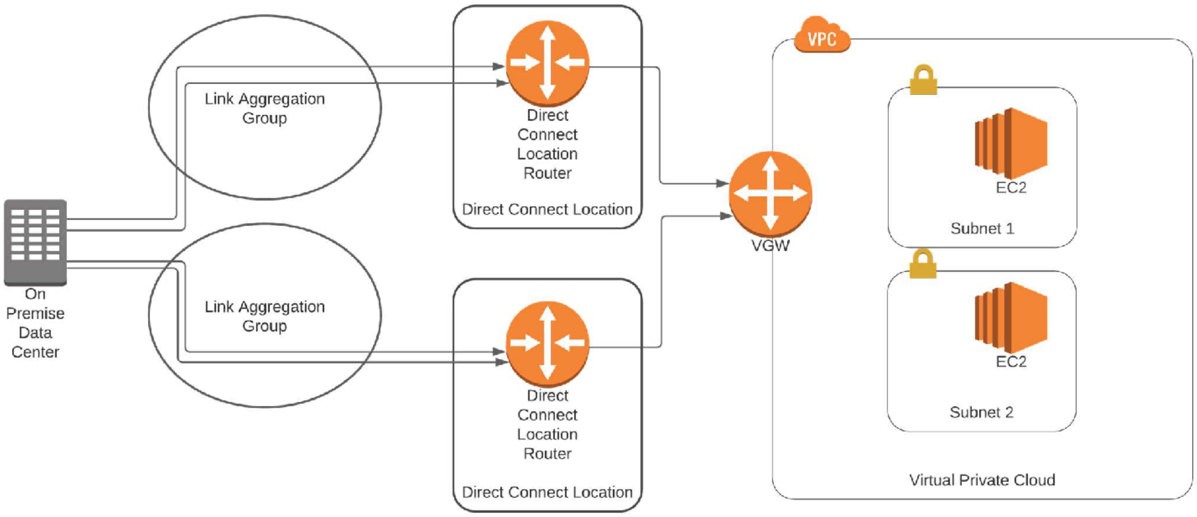
Link Aggregation Groups (LAG)

Some organizations need high-speed access to the cloud, which can't be achieved through a single direct connection. **Link aggregation groups** (LAGs) allow customers to combine multiple Ethernet links into a single logical connection, increasing throughput and fault tolerance.

AWS supports LAGs that enable the combination of up to four 1 GB or 10 GB connections into a single logical port. All links must be the same type, speed, and latency. These requirements can best be achieved by using the same service provider.

By default, the LAG will be active for as long as the connections are available, adding speed and redundancy. However, this can be disabled if there is a need for a higher-performance backup solution. If an organization needs serious high-speed access, then it will likely need a redundant LAG connection.

An example of redundant LAGs can be seen below:



Bidirectional Forwarding Detection

AWS supports Bidirectional Forwarding Detection (BFD), a network protocol that detects faults between two routers or switches within milliseconds or even microseconds. With fiber-optic network connections, there are two connections, a *send link* and a *receive link*. If the send link is up and the receive link is down, the network devices may not notice the down connection. BFD looks for any link failures (send or receive) and shuts down a non-fully functional link. It provides low-overhead detection of link failures, even on physical devices that do not support failure detection. BFD essentially notifies BGP of a broken connection, and BGP reroutes the traffic to a secondary (failover) circuit, if available.

Billing

AWS Direct Connect has three separate charges that determine pricing: capacity, port hours, and data transfer out (DTO). There are no setup charges, and services can be canceled at any time. As with any other AWS service, data transfers into AWS via Direct Connect are free; however, services provided by AWS Direct Connect Partners may have additional terms or restrictions that apply.

Capacity is the maximum rate that data can be transported through a network connection.

Pricing of ports is dependent on per port hours consumed for each port type. Partial port hours consumed are billed as full hours and charged to the AWS account that owns the port. Hours will still be charged even if data is not passing through the port.

Data Transfer Out (DTO) is determined by the AWS Region and the AWS Direct Connect location. Consider the cost of the private circuit from the data center to the AWS location.

Virtual Private Networks (VPNs)

The alternative to a direct connection is a virtual private network (VPN). A virtual private network is the creation of a secure connection inside of a public network. There are multiple types of VPN technologies: IPsec, L2TP, GRE, even multiprotocol BGP with virtual routing and forwarding. VPNs that are used to connect to AWS are based upon IPsec.

VPN Connection to AWS

The simplest and cheapest means to connect to AWS is a VPN. A VPN provides a means to "tunnel" traffic over the internet in a secure manner. Modern VPNs use IPSec or SSL technologies. The VPN technology used to connect to AWS is an IPsec tunnel. Encryption is provided by IPsec, which provides a means to provide encryption (privacy), authentication (identifying the user), data authenticity (meaning the data has not been changed), and nonrepudiation (meaning, the user can't say they didn't send the message after the fact).

VPN Performance

VPNs are inherently flexible, as all that is needed is internet access on both sides of the connection. However, the problem with VPN connections is that while the connection speed to the internet is guaranteed, there is no control of what happens on the internet. Because of this, there can be substantial performance degradation based upon the availability, routing, and congestion on the internet. VPN-only connections are ideal for remote workers and small branches of a few workers; where if they lose connectivity, there will not be significant costs to the organization.

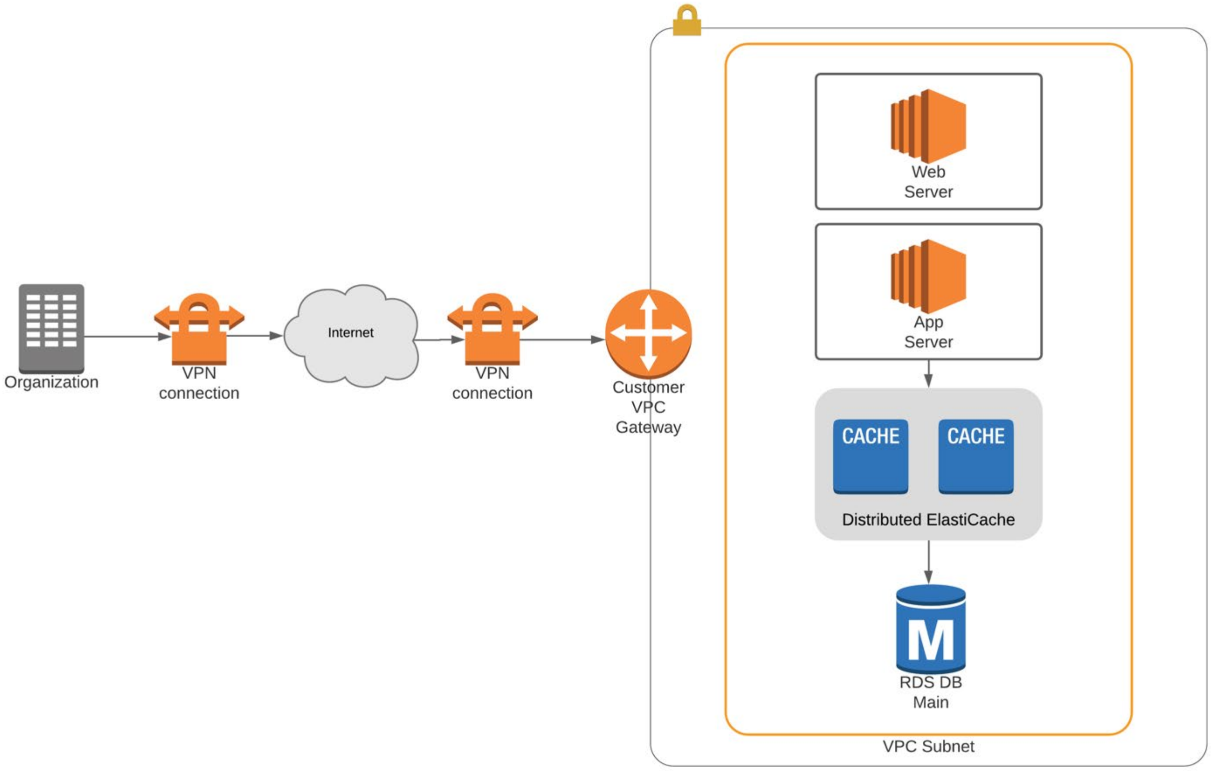
Advantages of using VPNs can be seen below:

- Cost – generally less expensive than direct connections
- Speed – can be set up in minutes
- Simplicity and flexibility – simple to create remote connections

Disadvantages of using VPNs for remote access:

- Lower performance than direct connections.
- Internet performance not consistent.
- Inconsistent bandwidth and latency.
- Dependent upon the routing of multiple ISPs.
- Once your data gets to the internet it is best effort – no delivery of message delivery.

The diagram below shows an example of a VPN connecting to the AWS platform.

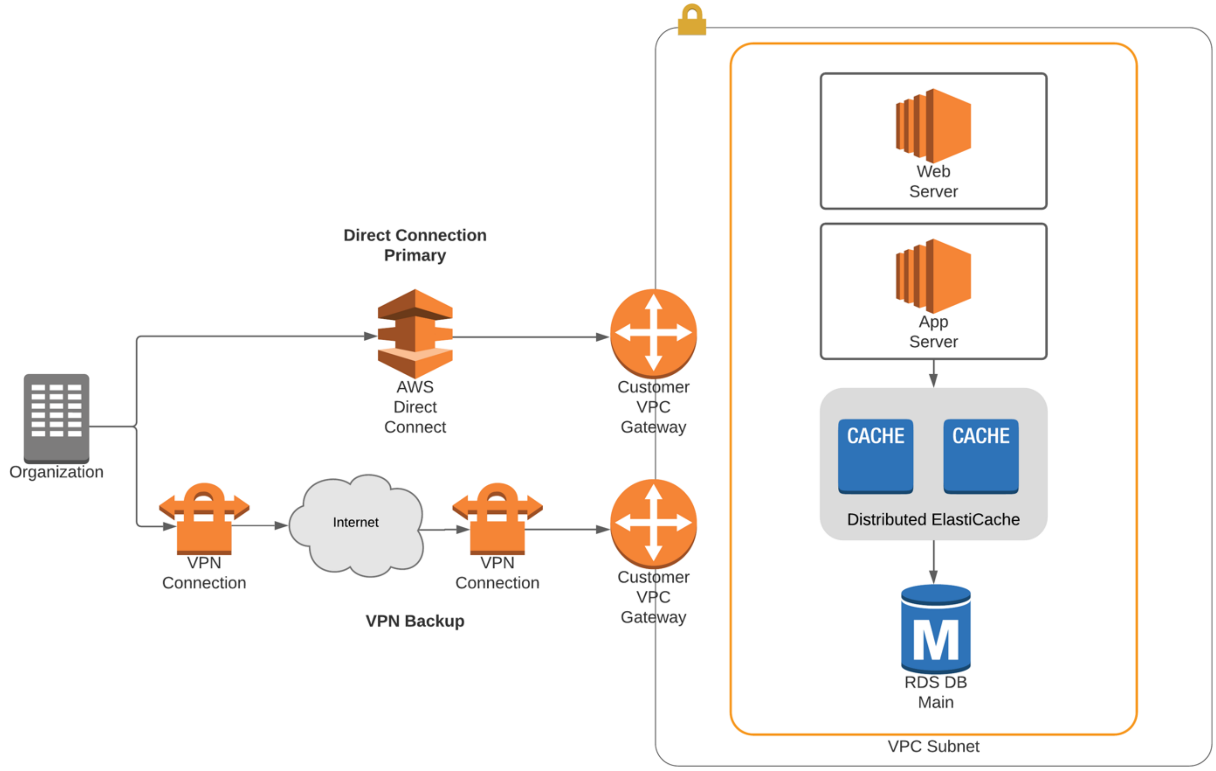


High-Availability Connections

Connecting to the cloud with high availability is essential when an organization depends upon technology.

The highest-availability architectures will include at least two direct connections to the cloud. Ideally, each connection is with a separate service provider and a dedicated router, and each router is connected to different power sources. This configuration provides redundancy to the network connection, power failures, and the routers connecting to the cloud. For organizations that need 99.999 percent availability, this type of configuration is essential. For even higher availability, there can be a VPN connection as a backup to the other direct connections.

The diagram below shows an example of a high availability connection to the AWS platform.



High Availability at Lower Costs

A lower cost means to achieve high availability is to have a dedicated connection and a VPN backup to the cloud. This will work well for most organizations, assuming they can tolerate reduced performance when using the backup environment.

Chapter 3 - Storage Options on the AWS Cloud Platform

There are several storage options available to AWS cloud computing customers. These are AWS Simple Storage Service (S3), Elastic Block Store, Elastic File System, Storage Gateway, and WorkDocs.

In traditional data centers, there are three kinds of storage—block storage, object storage and file storage. Block storage is used to store data files on storage area networks (SANs) or cloud-based storage environments. It is excellent for computing situations where there is a need for fast, efficient, and reliable data transportation. File storage is stored on local systems, servers, or network file systems. Object storage is often used for backup, archival, and big data environments.

AWS Primary Storage Options

In the AWS cloud environment, there are three types of storage: *block storage*, *object storage*, and *file storage*.

Block Storage

Block storage is a type of network storage that feels and functions like a hard drive in a computer. Block storage places data into blocks and then stores those blocks as separate pieces. Each block has a unique identifier. This type of storage places those blocks of data wherever they are most efficient. This enables incredible scalability and works well with numerous operating systems. Block storage is hierarchical, meaning files are stored in nested folders like a traditional desktop operating system.

Object Storage

Object-based storage differs from block storage. Object storage breaks data files into pieces called *objects*. It then stores those objects in a single place that can be used by multiple systems that have network access to the storage. Since each object will have a unique ID, it's easy for computing resources to access data on file-based storage. Additionally, each object has metadata or information about the data to make it easier to find when needed. This metadata allows for powerful search functions such as SQL queries to be run on the data. Object storage is "flat" or non-hierarchical, meaning all files are stored in a single folder or "bucket." Due to the metadata, object storage is often used in big data environments and data lakes.

File Storage

File storage is traditional storage. It can be used for a systems operating system and network file systems. Examples of this are NTFS-based volumes for Windows systems and NFS volumes for Linux/UNIX systems. These volumes can be mounted and directly accessed by numerous computing resources simultaneously.

AWS Object Storage

The AWS platform provides an efficient platform for object storage with Amazon Simple Storage Service, otherwise known as S3.

Amazon Simple Storage Service (S3)

Amazon S3 provides high-security, high-availability, durable, and scalable object-based storage. S3 has 99.999999999 percent durability and 99.99 percent availability. *Durability* refers to a file getting lost or deleted. Availability is the ability to access the system when you need access to your data. This means data stored on S3 is highly likely to be available when you need it.

Since S3 is object-based storage, it provides a perfect opportunity to store files, backups, and even static website hosting. Computing systems cannot boot from object-based storage block-based storage. Therefore, S3 cannot be used for the computing platform's operating system. Since block-based storage is effectively decoupled from the server's operating system, it has near limitless storage capabilities.[1]

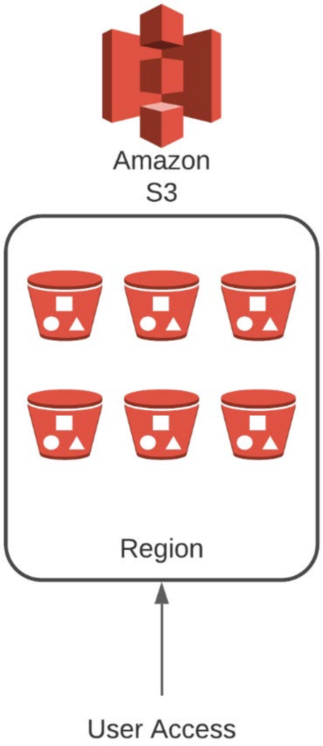
S3 is typically used for these applications:

- Backup and archival for an organization's data
- Static website hosting
- Distribution of content, media, or software
- Disaster recovery planning
- Big data analytics
- Internet application hosting

Amazon S3 is organized into buckets. Each bucket is a container for files stored on S3. Buckets create a top-level name space, meaning they must be globally unique and can be accessed by their DNS name. An example of this address can be seen below:

http://mybucketname.s3.amazonaws.com/file.html

The diagram below shows the organizational structure of S3:



Since the buckets use DNS-type addressing, it is best to use names that follow standard DNS naming conventions. Bucket names can have up to sixty-three characters, including letters, numbers, hyphens, and periods. It's noteworthy that the path you use to access the files on S3 is not necessarily the location where the file is stored. The URL used to access your file is really a pointer to the database where your files are stored. S3 functions a lot like a database behind the scenes, which enables you to do incredible things with data stored on S3 like SQL queries. An organization can have up to one hundred buckets per account without requesting a bucket limit increase from AWS.

Buckets are placed in different geographic regions. When creating the bucket, to achieve the highest performance, place the bucket in a region that is closest. Additionally, this will decrease data transfer changes across the AWS network. For global enterprises, it may be necessary to place buckets in multiple geographic regions. AWS S3 provides a means for buckets to be replicated automatically between regions. This is called *cross-region replication*.

S3 Is Object-Based Storage

S3 is used with many services within the AWS cloud platform. Files stored in S3 are called *objects*. AWS allows most objects to be stored in S3. Every object stored in an S3 bucket has a unique identifier, also known as a *key*. A key can be up to 1,024 bytes, which are comprised of Unicode characters and can include slashes, backslashes, dots, and dashes.

Single files can be as small as 0 bytes, all the way to 5 TB per file. This provides ultimate flexibility. Objects in S3 can have metadata (information about the data), which can make S3 extremely flexible and can assist with searching for data. The metadata is stored in a name-value pair environment, much like a database. Since metadata is placed in a name-value pair, S3 provides a SQL-based method to perform SQL-based queries of your data stored in S3. To promote scalability, AWS S3 uses an eventually consistent system. While this promotes scalability, it is possible that after you delete an object, it may be available for a short period.

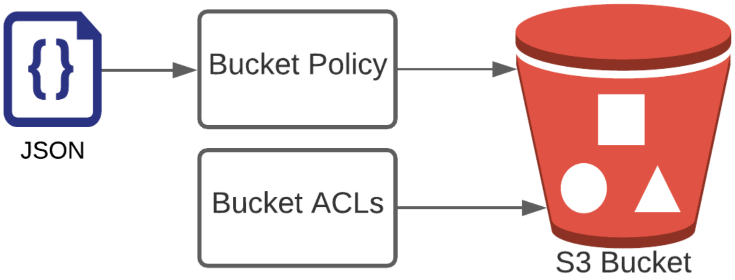
Securing Data in S3

The security of your data is paramount, and S3 storage is no exception. S3 is secured via the bucket's policy and user policies. Both methods are written in JSON access-based policy language.

Bucket policies are generally the preferred method to secure your data in S3. Bucket policies allow for granular control of the security of your digital assets stored in S3. Bucket policies are based on IAM users and roles. S3 bucket policies are similar to the way Microsoft authenticates users and grants access to certain resources based upon the user's role, permissions, and groups in Active Directory.[2]

S3 also allows for using ACLs (Access Control Lists) to secure your data. However, the control afforded to your data via an ACL is much less sophisticated than with IAM policies. ACL-based permissions are essentially *read*, *write*, or *full control*.

The diagram below shows how ACL and bucket policies are used with AWS S3:



S3 Storage Tiers

AWS S3 offers numerous storage classes to best suit an organization's availability and financial requirements. The main storage classes can be seen below:

- Amazon S3 Standard
- Amazon S3 Infrequent Access (Standard-IA)
- Amazon S3 Infrequent Access (Standard-IA) – One Zone
- Amazon S3 Intelligent-Tiering
- Amazon S3 Glacier

Amazon S3 Standard

Amazon S3 Standard provides high-availability, high-durability, high-performance, and low-latency object storage. Given the performance of S3, it is well suited for storage of frequently accessed data. For most general-purpose storage requirements, S3 is an excellent choice.

Amazon S3 Infrequent Access (Standard-IA)

Amazon S3 Infrequent Access provides the same high-availability, high-durability, high-performance, and low-latency object storage as standard S3. The major difference is the cost, which is substantially lower. However, with S3 Infrequent Access, you pay a retrieval fee every time data is accessed. This makes S3 extremely cost-effective for long-term storage of data not frequently accessed. However, access fees might make it cost-prohibitive for frequently accessed data.

Amazon S3 Infrequent Access (Standard-IA) – One Zone

Amazon S3 Infrequent Access provides the same service as Amazon S3-IA but with reduced durability. This is great for backups of storage due to its low cost.

Amazon S3 Intelligent-Tiering

Amazon S3 Intelligent-Tiering provides an excellent blend of S3 and S3-IA. Amazon keeps frequently accessed data on S3 Standard and effectively moves your infrequently accessed data to S3-IA, so you have the best and most cost-effective access to your data.

Additionally, S3 Intelligent-Tiering facilitates further cost optimization by enabling an organization to automatically archive information that was not accessed in a period. This semi-automated lifecycle policy can help an organization reduce its storage costs. The way this works is data that was not accessed in a period of 90 days will be moved to the archive access tier, which presents performance equivalent to the S3 Glacier storage class. Additionally, items that have not been accessed for a period of 180 days to the Deep Archive Access tier, which is equivalent to the S3 Deep Archive.

Amazon S3 Glacier

Amazon Glacier offers secure, reliable, and very low-cost storage for data that does not require instant access. This storage class is perfect for data archival or backups. Access to data must be requested; after three to five hours, the data becomes available. Data can be accessed sooner by paying for expedited retrievals. Glacier also has a feature called Vault Lock. Vault Lock can be used for archives that require compliance controls, i.e., medical records. With Vault Lock, data cannot be modified but can be read when needed. Glacier, therefore, provides immutable data access, meaning it can't be changed while in Glacier.

Managing Data in S3

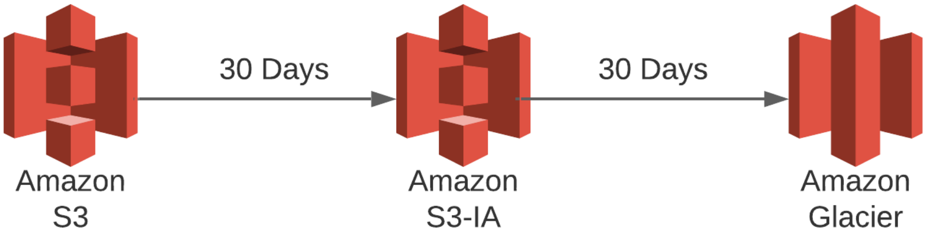
This next section describes how to manage and protect your data on S3.

S3 Lifecycle Management

The storage tiers provided by S3 provide an excellent means to have robust access to data with a variety of pricing models. S3 lifecycle management provides an effective means to automatically transition data to the best S3 tier for an organization's storage needs.

For example, let's say you need access to your data every day for thirty days, then infrequently access your data for the next thirty days, and you may never access your data again but want to maintain it for archival purposes. You can set up a lifecycle policy to automatically move your data to the optimal location.

You can store your data in S3, then after thirty days, have your data automatically moved to S3-IA, and after thirty days, the data can be moved to Glacier for archival purposes. This can be seen in the diagram below:



That's the power of lifecycle policies.

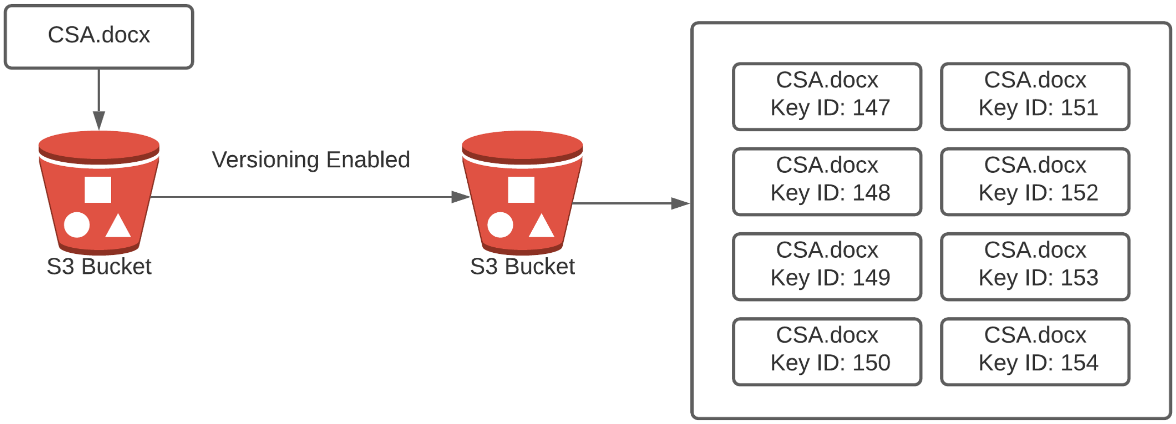
Lifecycle policies can be configured to be attached to the budget or specific objects as specified by an S3 prefix.

S3 Versioning

To help secure S3 data from accidental deletion, *S3 versioning* is the AWS solution.

Amazon S3 versioning protects data against accidental or malicious deletion by keeping multiple versions of each object in the bucket, identified by a unique version ID. Therefore, multiple copies of objects are stored in S3 when versioning is enabled. Every time there is a change to the object, S3 will store another version of that object. Versioning allows users to preserve, retrieve, and restore every version of every object stored in their Amazon S3 bucket. If a user makes an accidental change or even maliciously deletes an object in your S3 bucket, you can restore the object to its original state simply by referencing the version ID along with the bucket and object key. Versioning is turned on at the bucket level. Once enabled, versioning cannot be removed from a bucket; it can be suspended only.

The diagram below shows how S3 versioning maintains a copy of all previous versions by using a Key ID:



Multifactor Authentication Delete

To provide additional protection from data deletion, S3 supports multifactor authentication to delete an object from S3. When an attempt to delete an object from S3 is made, S3 will request an authentication code. The authentication code will be a one-time password that changes every few seconds. This one-time authentication code can be provided from a hardware key generator or a software-based authentication solution, i.e., Google Authenticator.

Organizing Data in S3

As previously discussed, S3 storage is very similar to a database. Essentially the data is stored as a flat arrangement in a bucket. While this scales well, it is not necessarily the most organized structure for end users. S3 allows the user to specify a prefix and delimiter parameter so the user can organize their data in what feels like a folder. Essentially the user could use a slash (/) or backslash (\) as a delimiter. This will make S3 storage look and feel like a traditional Windows or Linux file system organized by folders.[3] For example:

- mike/2020/awsvideos/storage/S3.mp4
- mike/2020/awsvideos/compute/ec2.mp4
- mike/2020/awsvideos/database/dynamo.mp4

Encrypting Your Data

S3 supports a variety of encryption methods to enhance the security of your data. Generally, all data containing sensitive or organization proprietary data should be encrypted. Ideally, you encrypt your data on the way to S3, as well as when the data is stored (or resting) on S3. A simple way to encrypt data on the way to S3 is to use https, which uses SSL to encrypt your data on its way to the S3 bucket. Encrypting data on S3 can be performed using client-side encryption or server-side encryption.[4, 5]

Client-Side Encryption

Client-side encryption means encrypting the data files prior to sending to AWS. This means the files are already encrypted when transferred to S3 and will stay encrypted when stored on S3. To encrypt files using client-side encryption, there are two options available to use. Files can be encrypted with a client-side master key or a client master key using the AWS key management system (KMS). When using client-side encryption, you maintain total control of the encryption process, including the encryption keys.

Server-Side Encryption

Alternatively, S3 supports *server-side encryption*. Server-side encryption is performed using S3 and KMS. Amazon S3 automatically will encrypt when storing and decrypt when accessing your data on S3. There are several methods to perform server-side encryption and key management. These options are discussed below.

SSE-KMS (Customer-Managed Keys with AWS KMS)

The SSE-KMS is a complete key management solution. The user manages their own master key, but the key management system manages the data key. This solution provides extra security by having separate permissions for using a customer-managed key, which provides added protection against unauthorized access of your data in Amazon S3. Additionally, SSE-KMS helps with auditing by providing a trail of how, by whom, and when your data was accessed.

SSE-S3 (AWS-Managed Keys)

SSE-S3 is a fully integrated encryption solution for data in your S3 bucket. AWS performs all key management and provides secure storage of your encryption keys. Using SSE-S3, every object is encrypted with a unique encryption key. All object keys are then encrypted by a separate master key. AWS automatically generates new encryption keys and automatically rotates them monthly.

SSE-C (Customer-Provided Keys)

SSE-C is used in environments when you want total autonomy over key management. When using SSE-C, AWS S3 will perform all encryption and decryption of your data, but you have total control of your encryption keys.

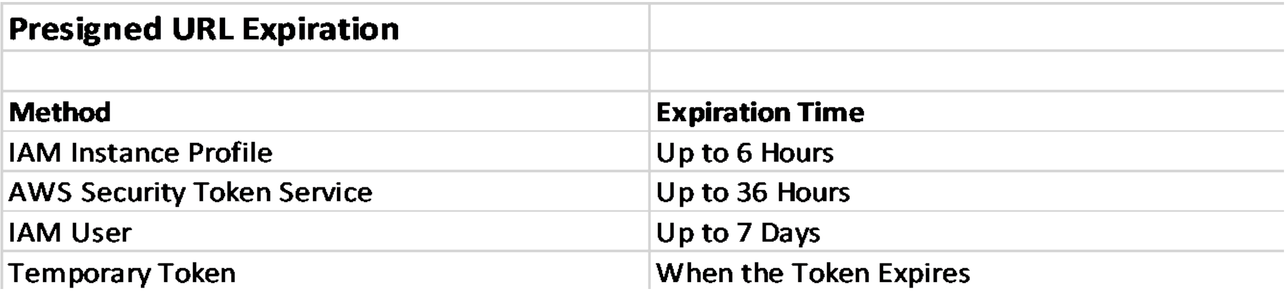
Tuning S3 for Your Needs

There are a few tuning options to make S3 perform even better. They are covered below:

Presigned URLs

All objects stored in S3 are private by default, meaning only the owner has access to the objects in their bucket. Therefore, to share a file with another user or organization, you need to provide access to the object. You can generate a presigned URL to share an S3-based object with others. When you generate the presigned URL, the owner's encryption key is used to sign the URL, which allows the receiver temporary access to the object.

You can use the following authentication options to generate a presigned URL. Each method has a different expiration to the authorization provided by the presigned URL. These options can be seen in the table below:



Presigned URL Expiration	
Method	**Expiration Time**
IAM Instance Profile	Up to 6 Hours
AWS Security Token Service	Up to 36 Hours
IAM User	Up to 7 Days
Temporary Token	When the Token Expires

Multipart Uploads

AWS S3 allows for objects of up to 5 TB in size to be stored. However, when trying to upload large files, many things can go wrong and interrupt the file transmission. The largest file that can be uploaded as a single object is 5 GB. It is best practice to send files larger than 100 MB as a multipart upload. In a multipart upload, the file is broken into pieces, and each piece is sent to S3. When all the pieces are received, S3 puts the pieces back together into a single file. This helps dramatically if anything goes wrong with the transmission; only a part of the file needs to be resent instead of the whole file. This improves both the speed and reliability of transferring large files to S3.

Range Gets

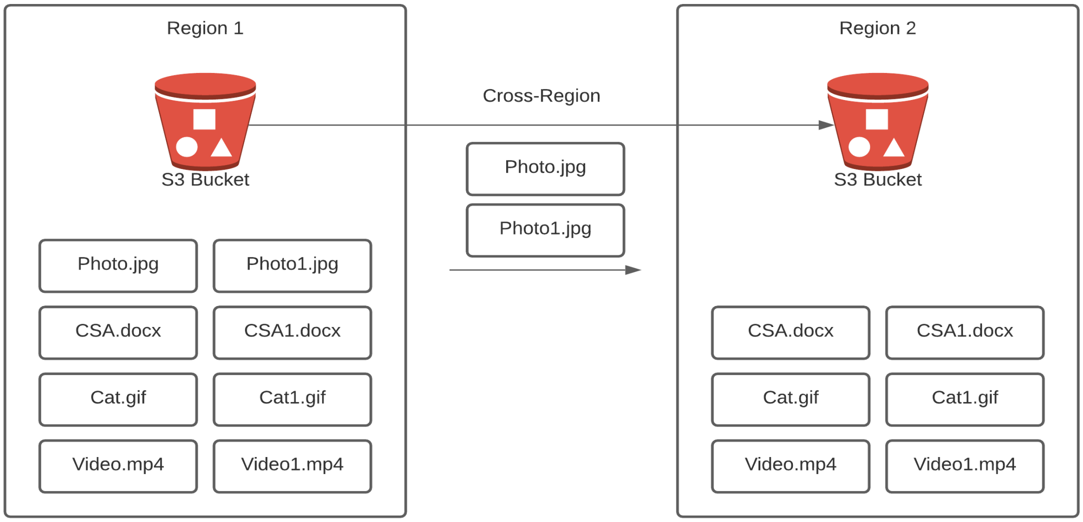
S3 supports large files. Sometimes you need access to some of the data in the file, but not the entire object. A *range get* allows you to request a portion of the file. This is highly useful when dealing with large files or when on a slow connection, i.e., mobile network.

Cross-Region Replication

S3 cross-region replication automatically copies the objects in an S3 bucket to another region. Therefore, all S3 buckets will be synchronized. After cross-region replication is turned on, all new files will be copied to the region for which cross-region replication has been enabled. Objects in the bucket before turning on cross-region replication will need to be manually copied to the new bucket.

Cross-region replication is especially useful when hosting a global website’s backend on S3. If website users experience latency due to the distance of the users to the website, the website can be hosted locally off a local S3 bucket. An example would be a US company with a website hosted in New York that suddenly gets a large customer base in Japan. The S3 bucket can be manually copied to a bucket in Asia. With cross-region replication enabled, any future changes to the website’s main bucket in New York will be automatically copied to the S3 bucket in Asia. This can dramatically reduce latency and provide a disaster recovery backup of the main website.

The diagram below shows cross-region replication copying files from one region to another region:



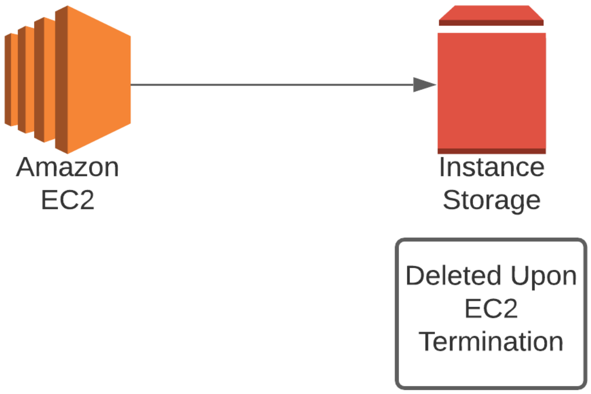
Storage for Computing Resources

The next class of storage is storage directly available to computing platforms. These include instance storage, elastic block storage, and elastic file systems.

Instance Storage

Instance storage is essentially a transient storage platform for an elastic computing instance. It is temporary in that when the instance is stopped, the volume is automatically deleted. This will be covered in much more depth when we discuss the EC2 platform.

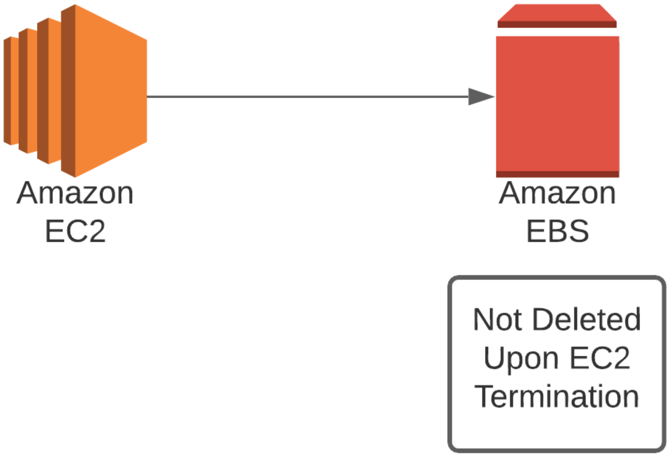
The diagram below shows how EC2 instance storage is used within the AWS platform. Note the instance storage is deleted upon EC2 termination.



Elastic Block Storage (EBS)

Elastic block storage is a high-performance block storage platform for using EC2 instances and AWS databases. An EBS volume can be mounted and used by EC2 instances, and the data on an EBS volume is not deleted on an EC2 instance termination. EBS volumes are designed for high throughput and high-transaction workloads. This storage is ideal for databases, enterprise applications, containers, and big data applications. EBS is scalable and can scale to multiple petabytes of data. EBS is highly available, with availability of 99.999 percent, so it's perfect for mission-critical use. EBS functions like a virtual hard drive. EBS is automatically backed up to another availability zone to protect against any device failure.[6]

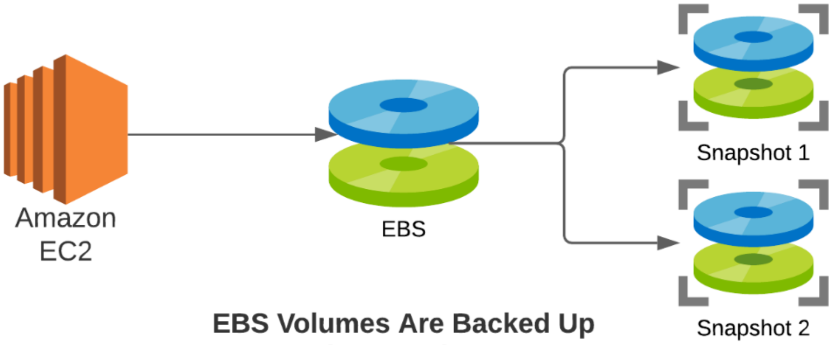
The diagram below shows how EBS instances are attached to an EC2 instance:



Backing Up EBS Volumes

EBS volumes can be backed up to other regions in the form of EBS snapshots. An *EBS snapshot* is a point-in-time copy of your data. A snapshot can be shared with other users and can be copied to other regions. Snapshots can be versioned, and multiple versions can be maintained. Therefore, you can restore your data to any previous snapshots. EBS snapshots are incrementally backed up to optimize speed and storage space. Unlike with traditional incremental backups, you can delete some backups and still make a complete restore of current data stored on EBS volumes.[7]

The diagram below shows how EBS volumes are backed up using snapshots:



EBS Volumes Are Backed Up
Via Snapshots

EBS Volume Types

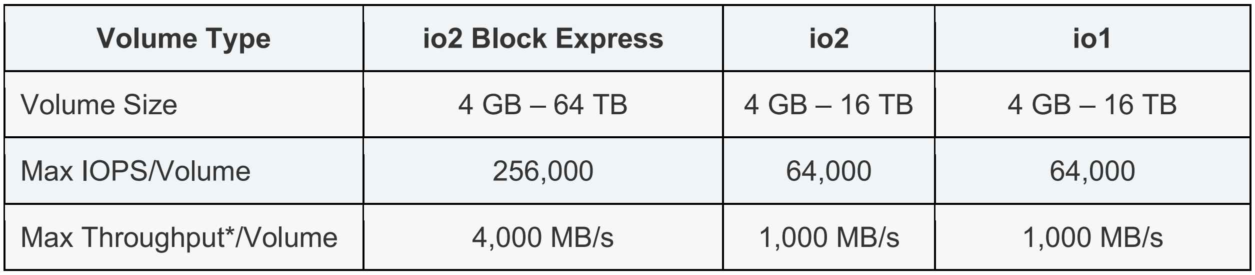
There are several types of EBS volumes available. Choosing the right volume type can make a substantial difference in the performance of your system. This next section describes the EBS volumes available and how to choose the right EBS volume type to meet the systems requirements. The four types of EBS volumes are EBS Provisioned IOPS (io1), EBS General Purpose SSD (gp2), EBS Throughput Optimized HDD (st1), and EBS Cold HDD (sc1).

EBS Provisioned IOPS (io1)

EBS-provisioned IOPS is the highest-performance SSD storage available on the EBS platform. This platform enables the user to purchase guaranteed speed of read and write performance, in terms of inputs and outputs per second (IOPS). EBS-provisioned IOPS is optimal for applications that require high disk input and output performance (IO). It’s designed for databases or other applications requiring low latency. There are three types of provisioned IOPS volumes. Each

PIOPS version has different speeds.

EBS Provisioned IOPS has three options which are io1, io2, and io2 Block Express. Io2 Block Express is the highest performance SSD volume designed for business-critical, latency-sensitive, and transactional workloads. The throughput speeds provided by io2 Block Express volumes are up to 4,000 MB/second.



Volume Type	io2 Block Express	io2	io1
Volume Size	4 GB – 64 TB	4 GB – 16 TB	4 GB – 16 TB
Max IOPS/Volume	256,000	64,000	64,000
Max Throughput*/Volume	4,000 MB/s	1,000 MB/s	1,000 MB/s

Io2 Block Express is the highest performance SSD volume designed for business-critical, latency-sensitive, and transactional workloads. The throughput speeds provided by io2 Block Express volumes are up to 4,000 MB/second. Io1 and io2 are both pre-provisioned volumes but operate at a much lower speed than io2 Block Express, as you can see in the table above.

EBS General Purpose SSD (gp2)

EBS general purpose SSD (gp2) is an SSD-based storage solution. It provides a good balance of price and performance. Gp2 is an excellent platform for a boot volume, as it has good performance and does not get erased upon EC2 instance shutdown. Gp2 is great for transactional workloads. It is great for dev and test environments that require low latency, at a much lower cost than PIOPS-based volumes used in production environments.

Throughput Optimized HDD (st1)

EBS Throughput Optimized HDD (st1) is low-cost magnetic storage. St1 is designed for frequently accessed workloads. It supports a fairly significant throughput of 500 MB/second but with higher latency than SSD-based volumes. St1 is designed for situations that require a low-cost option to store substantial data. It works well with applications that have sequential read and writes to the disk.

EBS Cold HDD (sc1)

EBS Cold HDD (sc1) is the lowest-cost option for EBS volumes. Sc1 is for workloads that do not require frequent disk access but still need a reliable storage platform.

The diagram below lists the speed and performance of the various EBS volumes.

	SSD					HDD	
Volume Type	**General Purpose SSD**		**Provisioned IOPS SSD**			**Throughput Optimized HDD**	**Cold HDD**
	gp3	gp2	io2 Block Express	io2	io1	st1	sc1
Volume Size	1GB–16TB	4GB–16TB	4GB–64TB	4GB–16 TB	4GB–16 TB	125GB–16TB	125GB–16TB
Max IOPS/Volume	16,000	16,000	256,000	64,000	64,000	500	250
Max Throughput/Volume	1,000 MB/s	250 MB/s	4,000 MB/s	1,000 MB/s	1,000 MB/s	500 MB/s	250 MB/s
Performance Attribute	IOPS					MB/second	

*Volume throughput is calculated as MB = 1024^2 bytes.

Choosing the Correct EBS Volume Type

Choosing the correct EBS volume type can make the difference between optimal performance and performance problems within the system. The primary determination of volume selection is whether the application requires high throughput, low latency, or both.

For applications requiring high throughput and low latency, choose EBS-provisioned IOPS. Applications that require moderate throughput, but low latency will perform well on EBS General Purpose SSD volumes. For applications that require high throughput but are less sensitive to latency, EBS Throughput Optimized HDD are a great option, especially if the application performs sequential read and writes of data. Lastly, EBS Cold HDD is perfect for storing a large amount of infrequently accessed data that is not sensitive to higher latencies than SSD volumes.

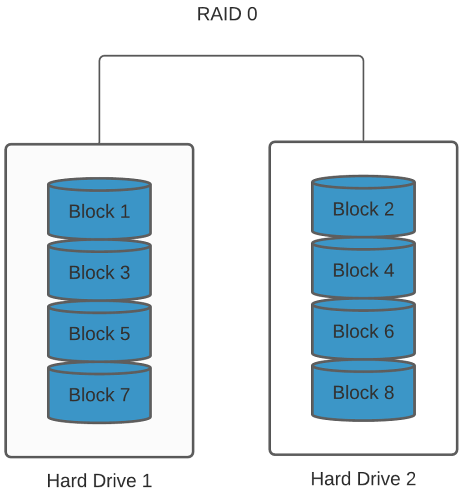
RAID

When even higher throughput and lower latencies are required, RAID volumes can be configured. RAID volumes are an array of disks that can increase disk performance, capacity, and/or reliability. Since EBS volumes are virtual hard drives automatically backed up to another availability zone, EBS volumes will have even more flexibility than traditional RAID volumes. The next section will describe the primary RAID options.[8]

RAID 0

RAID 0 is the fastest option for storage. RAID 0 places data on all hard drives in the array. Therefore, the speed and capacity are increased incrementally by every hard drive placed in the system. For example, a RAID array in RAID 0 with four hard drives each with 2 TB capacity will have a total capacity of 8 TB. If each disk has a 200 MB/second throughput, then four disks will provide effectively 800 MB/second of data throughput. The problem with RAID 0 is that there is no fault tolerance. If a single drive fails, then all data on the RAID array is lost. When RAID 0 volumes are used, an excellent backup strategy should be in place. RAID 0 is less of a problem with EBS volumes than traditional disks. Since AWS volumes are virtual disks that are automatically backed up to another availability zone, it is less risky than with traditional hard drives. Still, RAID 0 is often considered too risky to be used in a production environment due to lack of fault tolerance.

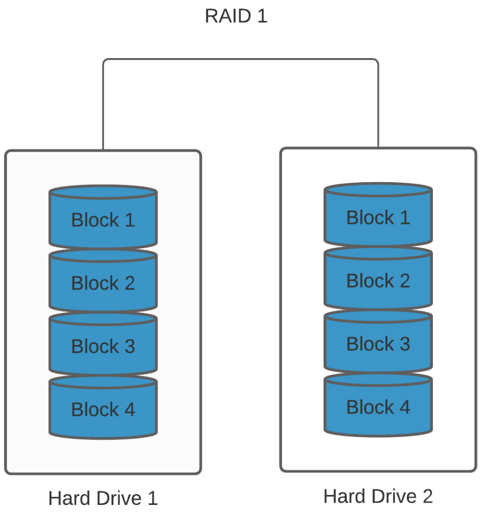
The diagram below shows an example of RAID 0:



RAID 1

RAID 1 is a highly fault-tolerant form of RAID. RAID 1 is also known as *disk mirroring*. In RAID 1, a second disk or set of disks “mirrors,” or copies, the data from the primary drive to the secondary drive. This option does not increase speed or capacity. However, if a disk fails, all that is necessary is to “break” the mirror and failover to the other disk or disks in the array. This is an excellent option when rapid recovery of a hard drive failure is required. Generally, it’s one of the most expensive and lowest-performing RAID options, as it requires double the storage, one for the data and another drive or set of drives to back up the data in real time.

The diagram below shows an example of RAID 1:



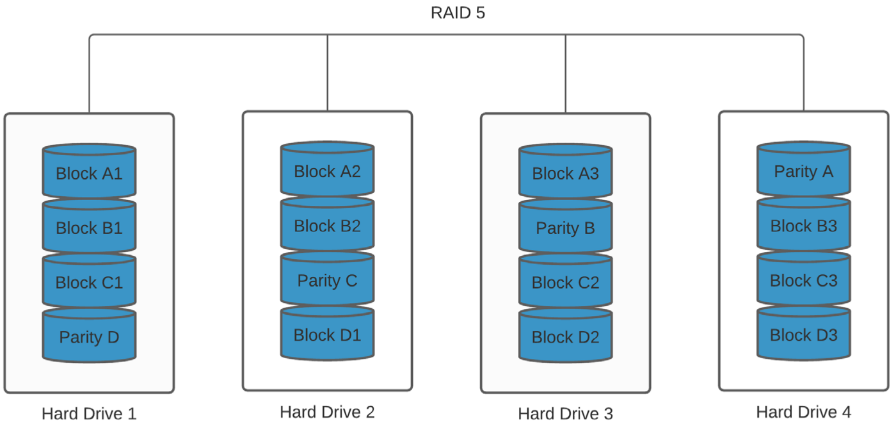
RAID 5

RAID 5 is a very common form of RAID storage. It is not recommended by AWS but is widely used in enterprise computing, so we will describe it for informational purposes.

RAID 5 provides a good balance of speed and redundancy. A RAID 5 array requires at least three disks. Like RAID 0, the data is striped across all disks. Unlike RAID 0, parity or recovery information is also striped across the drives. Since parity information is striped across the drives, a percentage of the storage will be dedicated to writing parity data. This means with a three-disk RAID 5 array, there will only be the capacity of two disks. Additionally, there is overhead associated with writing parity data to the disks, which decreases potential disk performance. The good news is that if an individual disk fails, the data in the array can be rebuilt by installing a new disk, and the array copies the data to the new disk from the stored parity information.

RAID 5 provides greater speed than a single drive but is slower than RAID 0. Some version of RAID 5 is used in most enterprise computing environments.

The diagram below shows an example of RAID 5:

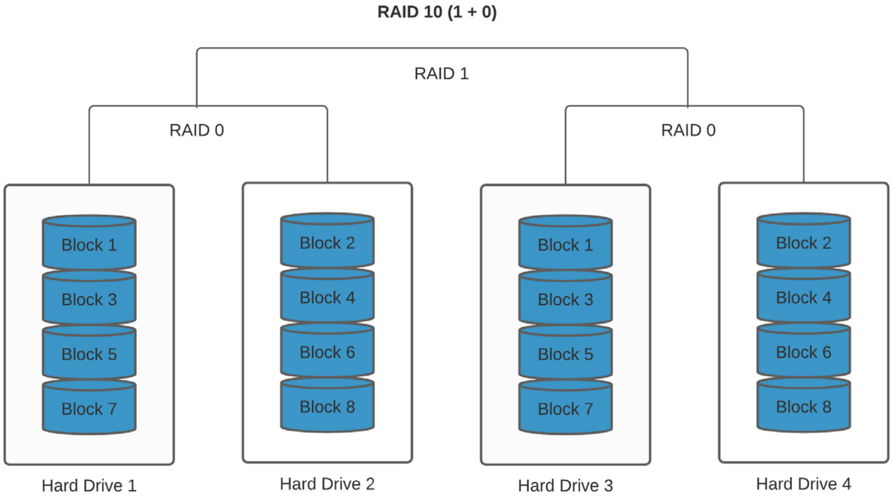


RAID 10

RAID 10 is the highest-performing and highest-redundancy option available. RAID 10 is essentially a combination of RAID 0 and RAID 1. RAID 10 works by configuring two RAID 0 arrays and then configuring the second RAID array to mirror the primary RAID array. This enables the speed of RAID 0 with the redundancy of RAID 1.

The drawback of a RAID 10 array is it requires double the disks with no increase in storage capacity. So if ten disks are configured in RAID 0, another ten disks will be required to mirror the primary array. This makes it the highest-cost option for RAID arrays. This option is becoming increasingly popular, as higher disk speeds are increasingly needed, but with fault tolerance.

The diagram below shows an example of RAID 10:



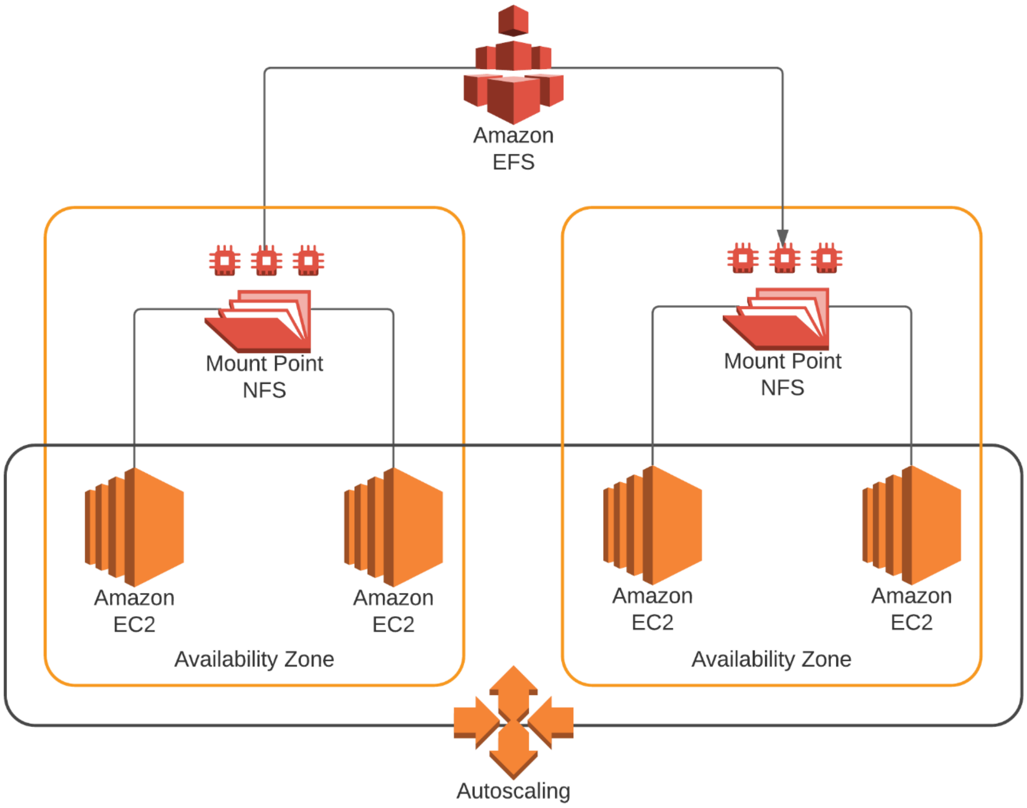
Elastic File System (EFS)

The next storage for AWS is the Elastic File System (EFS). EFS is a high-performance, highly scalable file system for networked computers. It is essentially the AWS version of the network file system (NFS) originally invented by Sun Microsystems. Since EFS is a network file system, it can be accessed simultaneously by many computing instances. EFS is best used when a high-performance network file system is required. Think of corporate file shares or multiple servers needing access to the same files simultaneously.

There are two versions of EFS available. The two versions of EFS are standard and infrequent access. *Standard EFS* is the normal version and the highest performance option. *EFS Infrequent access* is a lower-cost option for files not accessed frequently. EFS has numerous benefits:

- Scalable – High throughput, high IOPS, high capacity, and low latency.
- Elastic – EFS will automatically adjust sizing to meet the required storage capacity.
- Pricing – Pay for what is used.
- POSIX compatible – This enables access from standard file servers both on premises and on the cloud. Works with traditional NFS-based file permissions and directories.

The diagram below shows how EFS is mounted and used by multiple EC2 instances on the AWS platform:



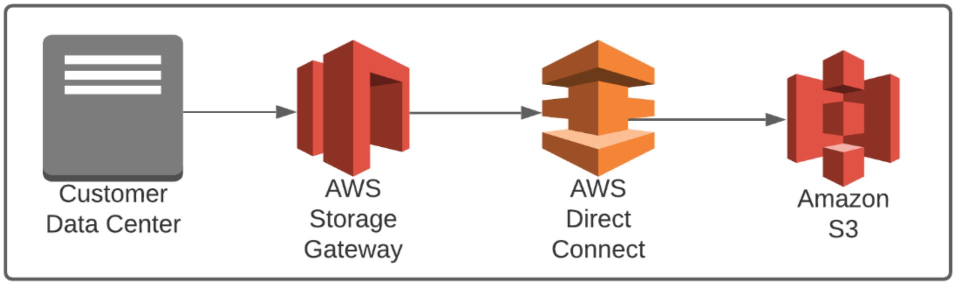
AWS Storage Gateway

Connecting on-premises environments to the cloud and achieving optimal performance often requires some tuning. This is especially true when connecting servers to object-based storage on S3. A great option to connect the on-premises data center to S3-based storage is with a storage gateway. This makes the storage look and feel like a network file system to the on-premises computing systems.[9]

A storage gateway is a virtual machine that runs in the data center. It is a prebuilt virtual machine from AWS available in VMware, Hyper V, or KVM. This virtual machine acts as a virtual file server. The on-premises computing resources read and write to the storage gateway, which then synchronizes to S3. You can access the storage gateway with SMB or NFS based shares. SMB is optimal for Windows devices, while NFS is optimal for Linux machines.

Three types of storage gateways are available for different applications. They are *volume gateways*, both *cached volumes* and *stored volumes*; and *tape gateways*.

The diagram below shows an example of a storage gateway on the AWS platform:



Storage Gateway Cached Volume

In a storage gateway cached volume, the organization's data is stored on S3. The cache volume maintains frequently accessed data locally on the volume gateway. This provides low-latency file access for frequently accessed files to the on-premises systems.

Storage Gateway Stored Volume

In a storage gateway stored volume, the on-premises systems store your files to the storage gateway, just like any other file server. The storage gateway then asynchronously backs up your data to S3. The data is backed up to S3 via point-in-time snapshots. Since the data is on S3 via a snapshot, these snapshots can be used by EC2 instances should something happen to the on-premises data center. This provides an excellent and inexpensive offsite disaster recovery option.

Tape Gateway

The tape gateway provides a cloud backup solution. It essentially replaces backup tapes used by some enterprise environments for deep archival purposes. Since it is virtual, there is no need to maintain physical tapes and the infrastructure to support a tape-based backup solution. With the tape gateway, data is copied to Glacier or Deep Archive.

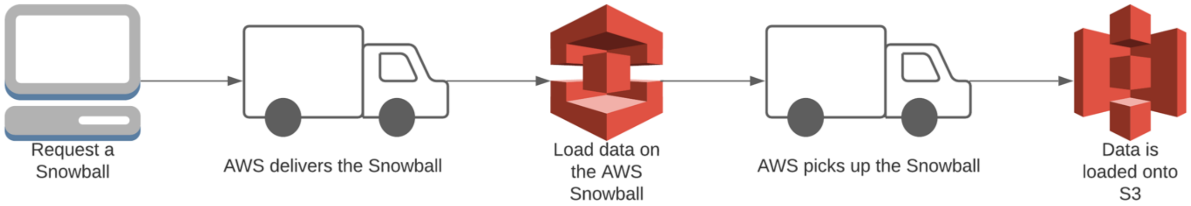
Migrating Data to AWS

Moving an organization's data center to the cloud involves setting up the cloud infrastructure as well as moving an organization's data to AWS. Data can be copied to the cloud over a VPN or a direct connection. But if there is a tremendous amount of data or rapid timelines to move to the cloud, it might be necessary to move files to the cloud in a more efficient manner. Additionally, it might be cheaper to send data directly to S3, as opposed to adding additional high-performance, high-capacity direct connections to AWS. To that end, there are multiple methods of sending data directly to AWS and they are listed below.

AWS Snowball

The AWS Snowball is a rugged computer with substantial storage that can be rented from AWS. AWS ships the Snowball to the customer. The customer places the Snowball on their network and copies the files they want to move to AWS. The files on the Snowball are encrypted. The organization then ships the Snowball to AWS. Once the Snowball is received by AWS, AWS employees move the data from the Snowball to the organization's cloud computing environment.

The diagram below shows an example of an AWS Snowball:


Request a Snowball
AWS delivers the Snowball
Load data on the AWS Snowball
AWS picks up the Snowball
Data is loaded onto S3

AWS Snowball Edge

The Snowball Edge is a more powerful snowball that includes compute capabilities and a 100 terabyte (100TB) storage capacity. Snowball Edge can run Lambda functions, provide durable local storage on premises, and transfer files through NFS. Snowball Edge essentially allows for storage and compute power on the go.

Snowball Edge offers two types of configurations—*Storage Optimized* or *Compute Optimized*. Each configuration includes additional options such as increased compute functionality or an attached GPU.

The diagram/picture below shows an example of an AWS Snowball Edge device:

Photo from AWS - AWS Snowcone - https://aws.amazon.com/blogs/aws/aws-snowball-edge-more-storage-local-endpoints-lambda-functions/

The AWS Snowcone is a small data transfer device with a rugged exterior weighing roughly 4.5 lbs. (2.1 kg). Snowcone provides 8 TB of available storage that supports data transfer from on-premises Windows, Linux, and macOS systems, including file-based applications via Network File System (NFS).

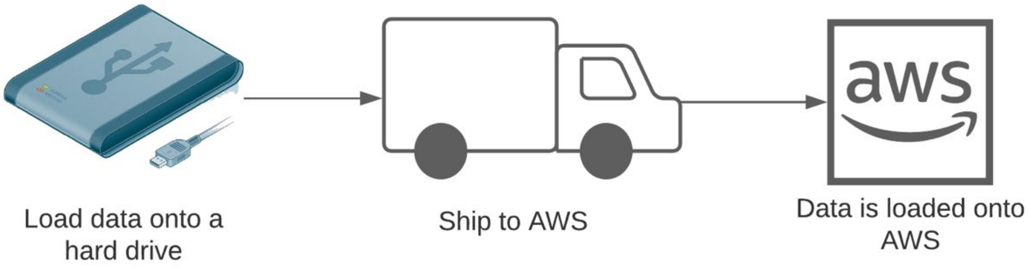
The diagram/picture below shows an example of an AWS Snowcone:

Photo from AWS - https://aws.amazon.com/snow/

AWS Import/Export Service

The import-export service is essentially a means to ship data to AWS. Essentially, you copy your data to a hard drive or hard drives. The organization then ships the hard drives to AWS. Once the hard drives are received by AWS, they move the data from the hard drives to your cloud computing environment.[10]

The diagram below shows how the AWS Import/Export service is used to quickly move large amounts of data to AWS:



AWS Snowmobile

The AWS Snowmobile is a forty-five-foot-long semi-trailer truck that can securely transport vast amounts of data to AWS efficiently and inexpensively. This exabyte-scale data transfer service allows customers to deliver petabytes of data in weeks instead of months. Each truck has 100 petabytes (100 PB) of storage capacity and is protected by 24/7 video surveillance.

Once the Snowmobile is dispatched to your site, AWS personnel configure your network for file transfer to perform high-speed data migration using a removable network switch. After successful data transfer, the Snowmobile is taken back to AWS for importation to the cloud.

The diagram/picture below shows an example of an AWS Snowmobile:

Storage for Collaboration

In recent years there has been a significant move to cloud storage for collaboration. This is especially useful for working on creative projects, documents, or presentations. AWS has created Amazon WorkDocs for this purpose.

Amazon WorkDocs

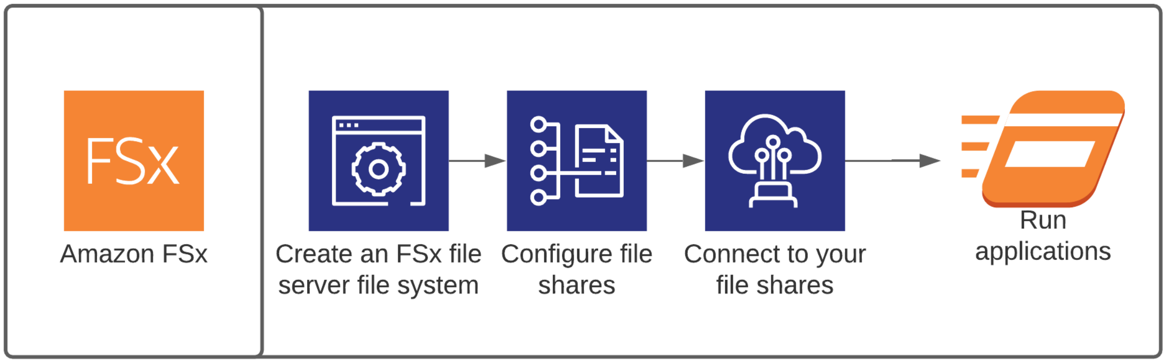
Amazon WorkDocs is a fully managed, secure content creation, storage, and collaboration service. It is similar in functionality to Google Drive or Dropbox. WorkDocs enables collaboration across projects and facilitates things like shared document editing. It is a simple solution with pay-as-you-go pricing. WorkDocs can be accessed with a web interface or with client software. Client software is available for Windows and macOS clients. This is secure storage and meets all main forms of compliance standards, i.e., HIPAA, PCI, and ISO.[11]

Amazon FSx for Windows

Some organizations heavily utilize the Windows platform for many critical services. Organizations that need native windows file servers can use Amazon FSx. Amazon FSx's are hosted Microsoft Windows file servers. FSx is a Windows server; therefore it supports Microsoft features such as storage quotas and active directory integration. As a Windows file server, it uses the Server Message Block (SMB) protocol. Windows-based SMB file shares can be accessed by Windows, macOS, and Linux hosts.

FSx is a high-availability service with high-availability single and multiple availability zone options. FSx provides data protection through encryption, both in transit and at rest. Additionally, to protect against data loss, FSx provides fully managed backups.

The diagram below shows an example of AWS FSx being used for Windows hosts:


FSx
Amazon FSx
Create an FSx file server file system
Configure file shares
Connect to your file shares
Run applications

FSx for Lustre

FSx for Lustre is high-performance storage based upon the Luster parallel file system. FSx for Lustre has sub millisecond latency. FSx for Lustre has excellent throughput—hundreds of gigabytes per second. Additionally, this is very-low-latency storage with millions of IOPS. FSx for Lustre can be used with S3 to allow the S3 objects to be accessed as if they were files in a network-attached storage (NAS) or elastic file system (EFS).

Chapter 4 - Computing on the AWS Platform (EC2)

This chapter describes the computing options available within the AWS Platform. AWS provides numerous computing options that can be sized based upon an organization's needs. Sizing compute resources are similar to sizing virtual machines in a traditional data center. Servers should be configured based upon the CPU, memory, storage (size and performance), graphics processing unit (GPU), and network performance requirements.[12]

AWS's primary computing platform is called Elastic Compute Cloud (EC2). EC2 servers are virtual machines launched on the AWS platform. EC2 servers are called *instances*. EC2 instances are sized like any virtualized server environment. AWS has numerous options to meet an organization's needs. Instance types should be chosen based upon the need for the following computing options:

- CPU cores (virtual CPUs)
- Memory (DRAM)
- Storage (capacity and performance)
- Network performance

Instances are available in a wide range of sizes and configurations to provide a means to perfectly size a system based upon an organization's needs. AWS has a multitude of possible server configurations to assist the organization with properly sizing their computing instances.[13]

A summary of the EC2 instance types is below:

EC2 Instance Types	**Specialty**	**Use Case**
A1	Arm-Based Workloads	Web Servers
C5	Compute Optimized	Batch Processing, Media Transcoding
G3	GPU Based Workloads	Machine Learning
I3	High Speed Storage	Data Warehousing, High Performance Databases
M5	General Purpose	Databases
M6	General Purpose	Application Servers, Gaming Servers
R5	Memory Optimized	Caches, High Performance Databases
T3	Burstable Computing Platform	Web apps, Test Environments
X1	Lowest Pricing Per GB DRAM	Bid Data Processing Engines, In-Memory Databases

Every instance type can be ordered in various sizes. Check with AWS for sizing, as sizes are subject to change.

EC2 instances support Windows and Linux operating systems. An organization can build its own virtual machines or can start with a prebuilt virtual machine. A prebuilt virtual machine is called an Amazon Machine Image (AMI). It is important to note that AMIs will need a storage volume for the instance. The storage volume may be an instance volume or an EBS volume. It is essential to choose the correct storage volume type. Standard instance volumes will be deleted upon instance reboot or termination. EBS volumes are persistent, and data will be available after reboot or instance termination.

Amazon Machine Images (AMI)

Since the AMI is the basis for the virtual machine, it's important to choose the correct AMI. AMIs can be obtained from the following sources:

- **Published by AWS** – These images are prebuilt by Amazon for a variety of needs. They are available in a variety of operating systems.

- **AWS Marketplace** – These are prebuilt machines by AWS partners. These machines are generally created for specific uses (i.e., licensed software from a third party).

- **AMIs from existing instances** – These are generally customer-created AMIs. They are created from an existing server. They enable a full machine copy, with all applications and package dependencies installed.

- **AMIs from uploaded servers** – An AMI can be created from a physical server to virtual machine conversion. Additionally, an AMI can be imported from a virtual machine conversion (i.e., VMware or VirtualBox virtual machine).

A complete AMI has several components:

- Operating system from one of the four AMI sources.
- Launch permissions for the instance.
- A block device mapping of storage volumes in the system.

Automating the First Boot for EC2 Instances

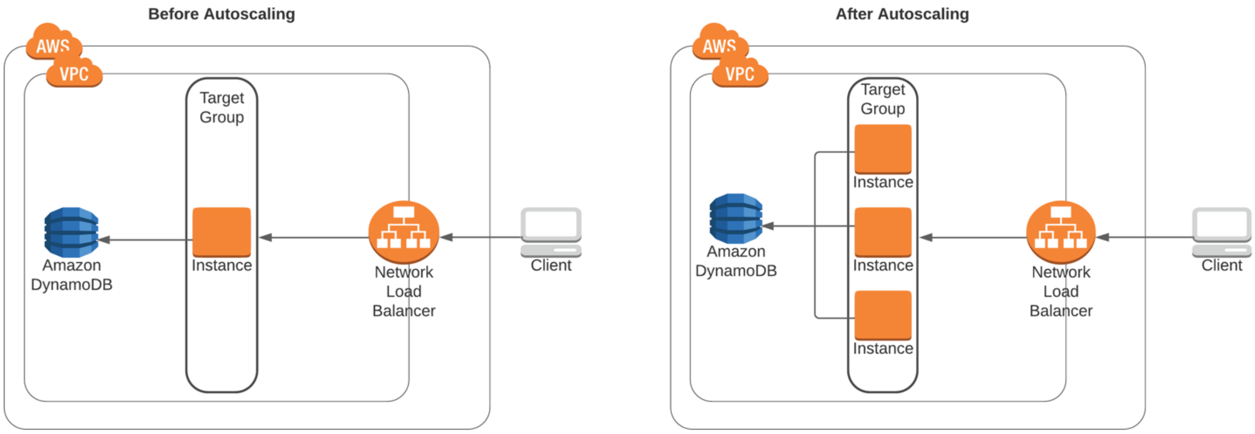
Starting with a full AMI is a great way to launch an EC2 instance. It is fast and efficient. However, the base AMI may not have all the necessary services installed and may need the latest software patches. There are two possible ways to take an AMI and configure it for an organization's use. The first option is to launch the EC2 instance with the premade AMI. After the instance boots, manually update the operating system and then install necessary services. Alternatively, the instance can be automatically updated upon boot with a bootstrap script. Bootstrap scripts for Linux can be as simple as a basic shell script. Windows systems can be bootstrapped with a power shell script.

Autoscaling

One of the key drivers to the move to the cloud is *autoscaling*. In the traditional environment, servers are configured for peak demand plus a growth factor to meet increased demand over time. With traditional servers, capacity must always exceed demand, because if demand were to increase beyond the server's capacity, either the site would become unavailable, or business could be lost. Oversizing can become very expensive, causing the organization to pay for resources they may never use.

Autoscaling completely changes the computing paradigm. Autoscaling enables an organization to size its computing resources based upon average demand. If demand for computing resources increases, autoscaling can spin up another instance as needed. Therefore, an organization will have almost unlimited computing capacity while paying for only what is used. Many solutions architects consider autoscaling one of the best features of the cloud.

The diagram below shows how autoscaling increases compute instances to handle increased load:



Instance Purchasing Options

AWS has numerous options for purchasing computing instances. Each type of instance is optimized for different computing requirements. The type of computing instances available can be seen below:

- On-demand instances
- Reserved instances
- Scheduled reserved instances
- Spot instances

- Dedicated hosts

On-Demand Instances

On-demand computing instances are computing instances that are available when needed. On-demand instances are charged by either the second or hour of use and facilitate autoscaling. On-demand instances are optimal when reliable computing capacity is needed without complete knowledge of how long the application will be used or its capacity requirements.

Reserved Instances

A *reserved instance* is an instance where an organization commits to purchase a specified compute capacity for a specified period of time. It is essentially a contract to purchase a computing instance and can be for one to three years. By purchasing instances based upon long-term use, the organization can receive substantial savings over on-demand pricing. Reserved instances are optimal when an organization knows how long the application will be used and its capacity requirements.

Scheduled Reserved Instances

A *scheduled reserved instance* is a special type of reserved instance. This type of instance is optimal when you have a need for a specific amount of computing power on a scheduled basis. For example, if an organization has a mission-critical batch job that runs every Saturday and Sunday.

Spot Instances

A *spot instance* is an instance that is pulled from unused AWS capacity. Spot instances are sold in an auction-like manner in which an organization places a bid. If the bid price is equal to or greater than the spot price, a spot instance is purchased. Spot instances are deeply discounted and can be a great option. The drawback of spot instances is that they can be terminated if the spot price goes above the price that was bid on the instances. Spot instances are ideal when an organization needs extra computing capacity at a great price for non-mission-critical use.

Dedicated Hosts

A *dedicated host* is a dedicated server. Dedicated hosts are bare metal servers. A bare metal server is a physical server without an operating system or applications installed. With a dedicated host, the organization can install any operating system or application required. Dedicated hosts are optimal when an organization needs access to system-level information, such as actual CPU usage. Dedicated hosts are an excellent option when an application has a license that is dedicated to a physical machine.

Tenancy Options

After the computing platform is chosen, it is necessary to determine the tenancy of the computing platform. The *tenancy*, or where the instances are located, can make a substantial impact on performance and availability. The tenancy options are:

- Shared tenancy
- Dedicated instances
- Dedicated hosts
- Placement groups

Shared Tenancy

This is the standard tenancy for EC2 instances. With shared tenancy, the physical server hosted at AWS will contain virtual machines for several customers.

Dedicated Instance

This is a server that is completely dedicated to a single customer. This server can house multiple virtual machines. All virtual machines on the dedicated instance belong to the single customer who owns the instance.

Dedicated Host

As previously described, this is a bare metal server and is dedicated to a single customer.

Placement Groups

AWS uses the concept of placement groups. Placement groups are where the computing instances are located. There are three options for placement groups. The options below are covered in the VPC section:

- Clustered
- Spread
- Partitioned

Securing EC2 Access

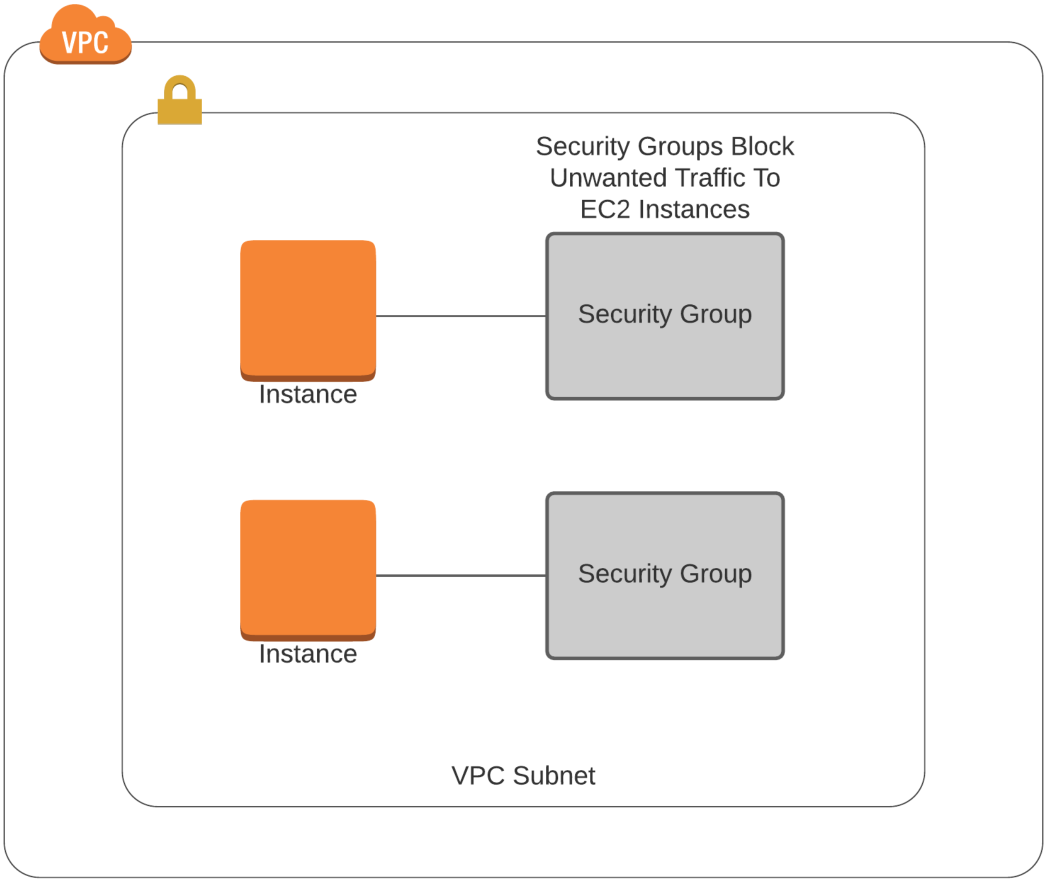
Keeping an organization’s technology secure requires an end-to-end security posture. EC2 instances are no exception, and they should be kept as secure as possible. Keeping the instance patched with the latest security updates and turning off unnecessary services is a major part of securing EC2 instances. AWS provides a security feature called *security groups*. Security groups can dramatically help in locking down EC2 services. Note that security groups are an essential part of many AWS services. Security groups will be covered in depth in the security section of this book.

Security Groups

A security group is a virtual firewall that lets an organization configure what network traffic is allowed into the server or AWS service. There are several key concepts with security groups:

- The default security policy is to deny traffic. An organization must explicitly permit desired traffic for the security group, or all traffic will be denied.
- Security groups include the source and destination IP address, protocol TCP/UDP, and port numbers.
- The security group is only as effective as its configuration. Be as specific as possible and allow only the traffic necessary into the system. Block all other traffic.

The diagram below shows how security groups protect compute instances by keeping unwanted traffic out of the server:


VPC
Security Groups Block Unwanted Traffic To EC2 Instances
Security Group
Instance
Security Group
Instance
VPC Subnet

IP Addresses for EC2 Instances

For an EC2 instance to function on a network, the instance must have an IP address. EC2 instances can have a private IP address, public IP address, or both. Instances also come with a fully qualified domain name assigned by AWS that can be used to connect to an EC2 instance. There are several key components to addressing EC2 instances:

- IP addresses are assigned to network interfaces and not computing systems.
- Depending upon the instance type, an instance can have multiple network interfaces.
- Each network instance must be on a different subnet, then other interfaces on the EC2 instance.
- Each IP address assigned to an interface must be unique within the VPC.
- IP addresses can be IPv4 or IPv6.
- All interfaces are automatically assigned an IPv6 globally unique address, which can be manually disabled.
- EC2 instances with public IP addresses with an internet gateway are reachable from the internet.
- EC2 instances with private IP addresses are not reachable from the internet unless a NAT instance and an internet gateway is used.
- EC2 instances with private IP addresses and a NAT gateway without an internet gateway will not be reachable from the internet but will be able to connect to the internet for operating system patches and other needed connectivity.

Note the section on VPCs discusses networking and IP addressing in much more depth.

Accessing EC2 Instances

Accessing and managing EC2 instances are critically important to maintaining a high-availability architecture. EC2 instances can be accessed via the following methods:

- Directly from the EC2 console.
- Via Secure Shell (SSH) for Linux machines.
- Via Remote Desktop Protocol (RDP) for Windows systems.
- Some management can be configured over the API using the AWS SDK.

Chapter 5 - Introduction to Databases

What Is a Database?

A *database* is a repository of structured/unstructured information, or data, stored in a computer system. A database is usually controlled by a database management system (DBMS). The data and the DBMS, along with the applications that integrate with them, are referred to as a database.

Data in databases is commonly presented in rows and columns. This data can be managed by using SQL, which is a special language written to manipulate databases.

In the modern application environment, most web applications and many enterprise applications integrate with databases for information storage, management, and access to information. AWS has four forms of databases.

Databases have become such a critical component of modern information systems. But what exactly is a database and why are databases used? Databases are applications that allow for storage of large amounts of information. Databases can help an organization find key performance metrics from their data in order to make strategic business decisions.

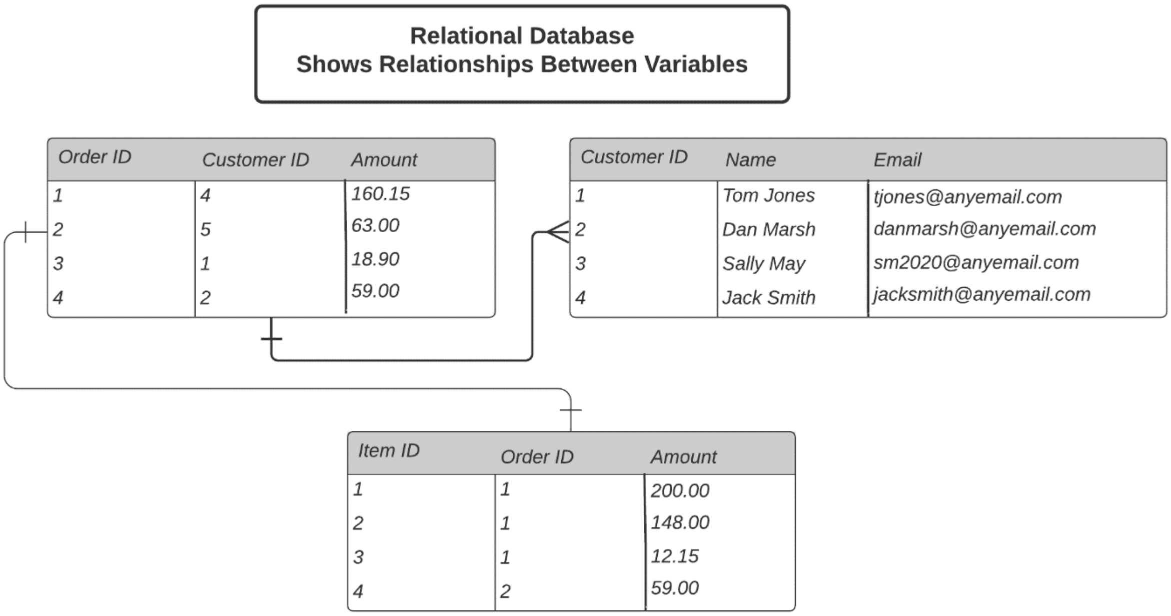
In the modern application environment, most web applications and many enterprise applications integrate with databases for information storage, management, and access to information. AWS has four forms of databases:

- Relational databases
    - Amazon Aurora
    - MariaDB
    - Microsoft SQL Server
    - MySQL
    - Oracle Database
    - PostgreSQL
- NoSQL databases
    - Amazon DynamoDB
    - Amazon DocumentDB
    - Cassandra
- Data warehousing databases
    - Amazon Redshift
- Data lakes – Data lakes allow an organization to store virtually any type of data at an almost unlimited scale. Unlike a database, a data lake can store data in its native format until it is needed by another application.

Relational Databases

Relational databases are the most common type of database and are best for structured data. Relational databases help organizations find the relationships between different aspects of their business by showing how data is related to each other. Relational databases store data in a manner that is very similar to a spreadsheet, with columns and rows.[13]

The diagram below shows how relational databases help show the relationship between different variables:



Relational Database
Shows Relationships Between Variables

Order ID	Customer ID	Amount
1	4	160.15
2	5	63.00
3	1	18.90
4	2	59.00

Customer ID	Name	Email
1	Tom Jones	tjones@anyemail.com
2	Dan Marsh	danmarsh@anyemail.com
3	Sally May	sm2020@anyemail.com
4	Jack Smith	jacksmith@anyemail.com

Item ID	Order ID	Amount
1	1	200.00
2	1	148.00
3	1	12.15
4	2	59.00

With relational databases, as soon as data is written, it will be immediately available for query. The instant consistency is based upon relational databases following the ACID model.[17] More information on the ACID model can be seen below:

- Atomic – Transactions are all or nothing.
- Consistent – Data is consistent immediately after writing to the database.
- Isolated – Transactions do not affect each other.
- Durable – Data in the database will not be lost.

In the AWS environment, multiple relational databases are supported, including:

- Amazon Aurora
- MariaDB

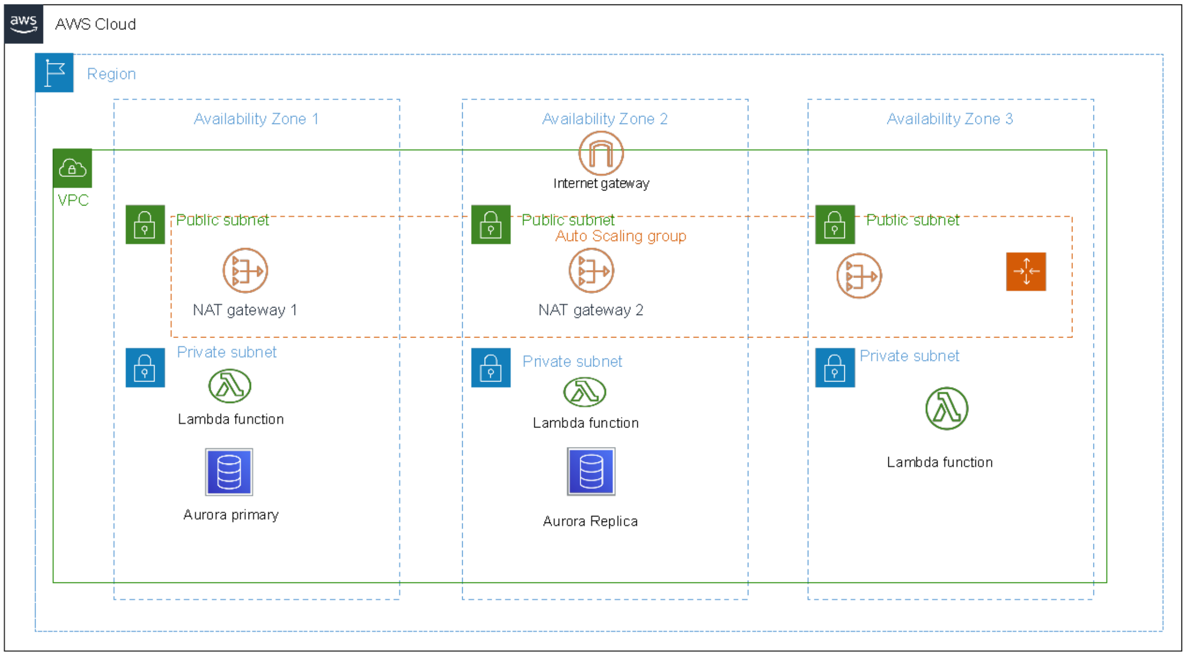
- Microsoft SQL Server
- MySQL
- Oracle Database
- PostgreSQL

Amazon Aurora

Amazon Aurora is an Amazon-branded relational database. It is a cloud-native relational database that combines much of the performance and feature set of traditional enterprise databases with the cost-effectiveness of open source databases.

Amazon Aurora is the Amazon-branded relational database service. It is a fully managed database service. Aurora is MySQL- and PostgreSQL-compatible database. Aurora is a high-performance database with speeds up to five times faster than MySQL and three times faster than PostgreSQL databases.

Amazon Aurora is a distributed, fault-tolerant database that autoscales up to ~100TB per database instance. Aurora is highly scalable and can leverage up to 15 read replicas. Additionally, Aurora provides point-in-time recovery, continuous backup to Amazon S3, and replication across three availability zones.



MariaDB

MariaDB is an open-source relational database. It was created by the developers of the MySQL database. MariaDB has additional features and advanced functionality when compared to

MySQL. MariaDB supports a larger connection pool and is comparatively faster than MySQL but doesn’t support data masking and dynamic columns.

Microsoft SQL Server

Microsoft SQL Server is the Microsoft-branded relational database solution. AWS supports multiple versions of Microsoft SQL:

- SQL Server 2008
- SQL Server 2012
- SQL Server 2014

Microsoft SQL Server enables organizations to bring their Windows-based workflows to the cloud. Microsoft SQL Server offers tools including the SQL Server Management Studio to help manage the infrastructure. Microsoft SQL Server supports high-availability clustering and failover options, but in a different manner than other relational databases. Please check Microsoft documentation for the most up-to-date information when configuring Microsoft SQL databases.

AWS supports four versions of the Microsoft SQL databases:

- Enterprise
- Express
- Standard
- Web

MySQL

MySQL is one of the original open-source relational databases and has been around since 1995. MySQL is extremely popular and is used in a wide variety of web applications.

Oracle Databases

Oracle is one of the most popular relational databases in the world. It has an extensive feature set and functionality. Unlike open-source databases, oracle databases are developed, licensed, and managed by Oracle. AWS RDS for Oracle supports multiple versions of the Oracle database:

- Standard
- Standard One
- Enterprise

Each of these supported versions of AWS RDS for Oracle has different performance, flexibility, and scalability options. AWS offers two licensing options with the AWS:

- **License included** – In this version the database is licensed to AWS. Two license options are available for this option:
    - Standard Edition One
    - Standard Edition Two
- **Bring your own license** – You have a license for Oracle, and you host your database on AWS. This provides much more license flexibility and is available with these license options:
    - Standard
    - Enterprise
    - Standard Edition One
    - Standard Edition Two

PostgreSQL Database

PostgreSQL is an open-source relational database. It has a very advanced feature set and enhanced functionality when compared to MySQL.

Amazon RDS

This is an AWS-managed relational database service. You can use this service to manage and maintain your relational databases. It is not a database. It supports:

- MySQL
- Amazon Aurora
- MariaDB
- Oracle
- Microsoft SQL Server
- PostgreSQL

AWS databases run on virtual machines (EC2 instances). So, when creating an RDS database instance, you have to choose an instance type. Instance type are of similar size and name to an EC2 instance. Running on an EC2 instance gives RDS the ability to autoscale (scale vertically and scale horizontally on demand).

In addition to the built-in authentication of the supported databases, RDS can use AWS Identity and Access Management (IAM) to set permissions and control who can log into the database.

RDS works across availability zones (AZs) (multi-AZ). This is a good model for disaster recovery.

You can have the primary database in one AZ and the standby in another AZ. If the primary database fails, you can fail over to the standby database in the other AZ.

RDS supports synchronous replication to the standby. This means that data is copied over to the standby simultaneously as it is being written to the storage of the primary database. RDS also supports read replicas. Read replicas can span multiple regions. If there is a problem, you can manually promote read replicas to be a stand-alone write-able database.

Amazon Timestream

Amazon Timestream is a fully managed (serverless), AWS cloud native SQL Relational Database. Amazon Timestream specializes in storing and querying trackable data variables that change over time, known as "time series data", from user data, IoT, and operational applications. Amazon Timestream is capable of ingesting trillions of events over a time interval for measuring events that change over time.

Amazon Timestream is an autoscaling, distributed fault-tolerant database. Users only pay for what they ingest, store and query. According to official AWS web documentation, "It is 1,000 times faster and 1/100th the cost of a relational database."

Amazon Timestream is used to ingest data from various device sensors to identify the time ranges without change. IoTs such as smart devices, motion cameras, light sensors, temperature sensors, and health equipment analyze variations, performance metrics, and health metrics data from the device sensors and alert consumers to take some action.

An example would be a sports analysis software application that ingests trillions of American Football data point metrics from sensors related to games played which analyze individual player performance, team performance, offensive, and defensive statistical data points, and much more data points that changes over a time period. Amazon Timestream SQL query engine can provide dynamic data for real-time dashboards that provide real-time analytical information to teams that are playing, including fantasy users who handicap the game, based on changing real-time information.

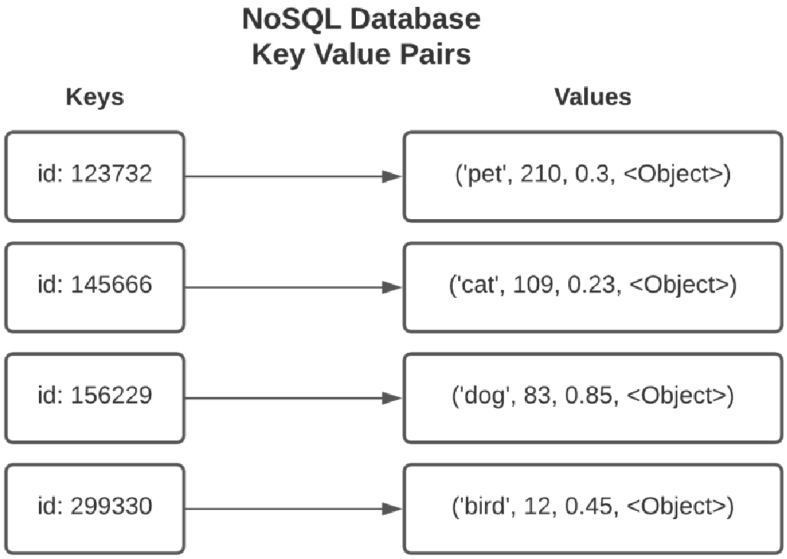
Amazon Timestream is capable of ingesting and storing trillions of events over a 24-hour period. Amazon Timestream automates complex data storage tiering lifecycle policy and management that can reduce storage costs. Amazon Timestream identifies trends, patterns, and anomalies with a built-in SQL query engine that provides a rapid point-in-memory store for lower throughput and fast analytical queries through its magnetic store. Amazon Timestream uses AWS Key Management System (KMS) to encrypt all data in transit, and at rest using customer-managed keys (CMK).

No SQL Databases

A NoSQL database stands for “not only SQL”. NoSQL databases facilitate enhanced flexibility and scalability by allowing a more flexible database schema. NoSQL databases can handle structured and nonstructured data. Being able to work with structured and unstructured data can allow NoSQL databases to scale far beyond relational databases.14 NoSQL databases are optimal under the following circumstances:

- When you need to store large amounts of unstructured data.
- When the database schema may change.
- When you need flexibility.
- When an organization needs rapid deployment of the database.

The diagram below shows how NoSQL databases work with key value pairs.


NoSQL Database
Key Value Pairs
Keys
Values
id: 123732
('pet', 210, 0.3, <Object>)
id: 145666
('cat', 109, 0.23, <Object>)
id: 156229
('dog', 83, 0.85, <Object>)
id: 299330
('bird', 12, 0.45, <Object>)

DynamoDB

Many enterprises require a database with near-unlimited scalability and flexibility beyond what can be achieved with a relational database. AWS offers a fully managed NoSQL database called DynamoDB for organizations that need the scalability and flexibility of a NoSQL database.

DynamoDB is a fully managed, high-availability NoSQL database service. DynamoDB has multiple advantages:

- Fully managed by AWS, so there is less management for the organization.
- Because it is serverless, there is near unlimited scalability, as the database is not bound to the capacity of a physical server or servers. Additionally, AWS manages servers, operating systems, and security.
- High availability – By default, DynamoDB is placed in multiple availability zones.
- High-performance storage – DynamoDB uses high-performance SSD storage.

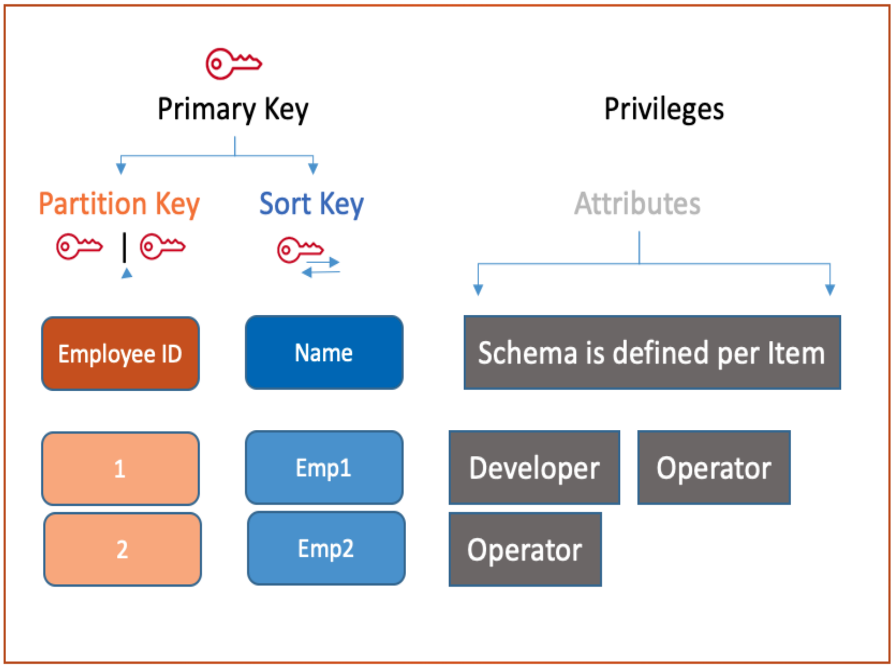
- Data protection – All data is encrypted by default in DynamoDB.
- Low latency – DynamoDB can be configured for sub-millisecond latency when used with DynamoDB Accelerator (which is an in-memory cache for DynamoDB).
- Backups – DynamoDB can be backed up with minimal or no effect on database performance.

Key Things to Know about DynamoDB

DynamoDB has a very flexible schema, as it is not bound to the same table and column scheme used by relational databases. This flexibility allows for significant customization and scalability. DynamoDB works best with name/value pairs in the primary index. DynamoDB can also have secondary indexes, which allow applications to use additional query patterns over traditional SQL databases.

DynamoDB secondary indexes can be global or local. Global indexes can span across all database partitions. Secondary partitions have virtually unlimited capacity. The only real limitation is a key value cannot exceed 10 gigabytes (GB). Local secondary indexes have the same partition key as the base table.

The diagram below shows an example of the DynamoDB key value pair architecture:



DynamoDB, by default, does not follow the ACID model used by SQL databases, which helps increase its scalability.

DynamoDB by default uses the BASE model:

- Basically Available – The system should be available for queries.
- Soft State – Data in the database may change over time.
- Eventually Consistent – Writes to the database are eventually consistent. This means that a database read immediately after a write may not be available, but will be over time.

DynamoDB with the default configuration follows the eventually consistent model. However, DynamoDB can be configured to have strongly consistent reads if needed.

DynamoDB Pricing

DynamoDB is priced based on throughput. To achieve the best performance and pricing, it is necessary to provision read and write capacity. Read and write capacity are provisioned prior to use and should be set to accommodate the organization's needs.

Autoscaling can also be used with DynamoDB. Autoscaling will watch the databases and scale up as needed, but it will not scale down. Since DynamoDB autoscaling does not scale back down, this method can lead to higher long-term costs.

When to Use DynamoDB

DynamoDB is the optimal choice when near unlimited database scalability and low latency are required. Additionally, DynamoDB is an excellent choice when storing data from a large number of devices, such as Internet of Things (IoT).

Some common DynamoDB use cases are:

- Gaming applications
    - Storing game states
    - Player data stores
    - Leaderboards
- Financial applications
    - Storing a large number of user transactions
- E-commerce applications
    - Shopping carts
    - Inventory tracking
    - Customer profiles and accounts

Amazon DynamoDB Accelerator (DAX)

Amazon DynamoDB Accelerator (DAX) is a managed service that provides high availability and high performance in memory cache for Amazon DynamoDB. DynamoDB Accelerator offers sub-microsecond latency. DynamoDB Accelerator can handle up about a million requests per second.

Document DB

DocumentDB is a fully managed MongoDB-compatible database. DocumentDB is highly scalable and will autoscale up to 64 TB.

Key points to note about Document can be seen below:

- Fully managed
- MongoDB compatible
- Offers extreme performance
- Highly secure
- Industry compliant
- Highly available

Apache Cassandra

Apache Cassandra is an open-source NoSQL distributed database. As a NoSQL database, it is extremely scalable. Apache Cassandra is designed for high performance and availability. In fact, Apache Cassandra is designed to be run across a large number of commodity servers, increasing performance and availability.

Key points of Apache Cassandra can be seen below:

- Distributed across multiple servers
- Highly scalable
- Fault tolerant
- Tunable consistency

Amazon Keyspaces (for Apache Cassandra)

Amazon Keyspaces (for Apache Cassandra) is a serverless, fully managed AWS Apache Cassandra–compatible database service. Amazon Keyspaces is used to migrate, run, and scale Apache Cassandra workloads. Apache Cassandra is an open-standards, NoSQL database. As a NoSQL database, Apache Cassandra is a highly scalable environment that enables working with large amounts of data (semi-structured and structured) across many servers.

Being fully managed, AWS Keyspaces enables users to not worry about provisioning, patching, or managing servers. Amazon Keyspaces is deployed without any underlying infrastructure requirement or software installation.

AWS Keyspaces offers two throughput capacity modes for reads and writes:

1. **On-demand mode** is the default choice, where you only pay for the reads and writes that your application performs. You do not need to specify your table's throughput capacity in advance. Amazon Keyspaces accommodates your application traffic instantly as it ramps up or down. It is a smart choice for unpredictable traffic.
2. **Provisioned capacity mode** is suited for predictable application traffic and can forecast your table's capacity requirements. You can specify the number of reads and writes per second that you expect your application to perform with provisioned capacity mode. You can increase and decrease the provisioned capacity for your table automatically with automatic scaling.

Amazon Keyspaces (for Apache Cassandra) duplicates three copies of your data in multiple Availability Zones for durability and high availability. It enables encryption at rest automatically when you create a new Amazon Keyspaces table and all client connections require Transport Layer Security (TLS).

It allows organizations to run a standards-based NoSQL database without having to worry about the underlying technology. This enables a more cost-effective environment by having lower operational overhead and simpler administration, therefore businesses can deploy applications better, faster, and cheaper leading to better options. When organizations focus on running the business instead of managing the technology, companies can concentrate on growing and increasing profits.

Amazon Quantum Ledger Database

A ledger database is a NoSQL (Not Only SQL) database that provides an immutable record of database transactions or changes in a data stream. It records changes in the database and maintains data integrity using cryptographic hashing. Cryptographic hashing involves ingesting plain data into an algorithm (hash function) that produces a unique enciphered text (hash value) that identifies data. Therefore, cryptographic hashing is the critical component that makes data integrity possible.

Since every piece of data recorded produces a unique hash value, the records kept by a ledger database are immutable. To verify data validity, the data is subjected to the same hashing function. The data is valid if the hash values produced are the same as those recorded in the ledger. If not, the data has been tampered with!

The Amazon Quantum Ledger Database (QLDB) is a fully managed and serverless centralized ledger database that automatically scales with applications. Being serverless eliminates the worry or need for provisioning server capacity. It uses tables and indexes to query the stored historical data. Unlike traditional databases with non-immutable record-keeping audit logs, for example, AWS Relational Database (SQL) or AWS DynamoDB (NoSQL), AWS Quantum Ledger Database (QLDB) does not permit any “Add”, “Update”, or “Delete” operations to heavily maintain the integrity of data inserted onto the QLDB.

QLDB tracks data changes by storing all changes made inside a transaction log, known as a “journal”. The data stored in the QLDB journal is immutable and cryptographically verifiable, meaning that data cannot be altered, modified, or tampered with once inserted into the ledger database. The benefit of the QLDB’s journal is that it increases the data’s verifiable integrity and improves its security.

Amazon QLDB can track all changes made to any application, while simultaneously providing a verifiable change history. QLDB is also ACID-compliant, which is an additional attribute that QLDB contributes to the secured validity and durability of its database transactions, regardless of network failures or disruptions.

ACID compliance stands for the following:

- Atomicity: either all transaction operations successfully go through or they’re all entirely halted
- Consistency: all data inserted into the database is valid
- Isolation: transaction operations work independently of each other, eliminating any worries of interference
- Durability: successful transaction operations can survive any network failures

NOTE: QLDB’s ledger differs from the blockchain ledger in that its ledger is centralized while blockchain uses distributed ledgers.

Because QLDB is centralized, it can execute its transactions without the need for consensus, unlike blockchain. This means there is no requirement for various parties to agree with each other before permitting transactions to the ledger database, hence QLDB being faster than blockchains. The benefit of QLDB not needing consensus is that this attribute makes it easier to manage QLDB and cost-effective due to reduced compute overhead.

How Amazon Quantum Ledger Database works

QLDB has the ability to record a completely immutable transaction log of all change history inside of its journal. Because QLDB is an “append-only” ledger table, it only allows for data to be inserted and will never permit any updates or deletions to any records – hence its immutability. The data records stored in the immutable journal are referred to as “blocks”.

These blocks are sequenced and chained together using the Secure Hash Algorithm 256-bit (SHA-256) cryptographic hash function that securely confirms the validity of the data’s integrity. Because QLDB blocks are sequenced and chained together, old data isn’t replaced with new data during a database update. Instead, new record versions are created and stored in the QLDB journal. Therefore, data can never be overwritten.

Each QLDB block entry contains the following:

- **Document-based data**: Data stored as Amazon Ion documents. Amazon Ion is an open-source document-based data format. The data stored is therefore consistent and searchable. Amazon Ion is beneficial because of its data storing and processing flexibility of semi-structured, structured, and nested data in the NoSQL QLDB.
- **Metadata**: Includes the document’s hash value, transactional information, and journal attributes. (Remember: Metadata is simply data about your data.)
- **PartiQL statements involved**: These are queries that are run during the transaction. PartiQL is an SQL-compatible query language that works with Amazon Ion. It allows you to insert data, manage inserted data, and query the database.

Each revision of an Ion document is recorded as a new document version with a unique document ID. QLDB has two types of data storage:

- **Journal storage**: The disk space used up by the journal
- **Index storage**: The disk space used up by the ledger’s tables and indexes

Common Use Cases for Amazon Quantum Ledger Database

QLDB is ideal when a repository of sequenced, accurate, verifiable, and immutable historical records of events is a critical regulatory business requirement. It is beneficial in the following use cases:

- Preserving the authentic legal documentation of vehicle ownership, i.e, vehicle title ownership, approved vehicle registration
- Recording financial transactions for auditing purposes. For example, financial debit and credit transactions
- Fraud detection and forensic analysis of records
- Recording employee history, for example, payroll, employee benefits

Data Warehousing on AWS

Data warehouses are designed to assist with business intelligence and analytics. Data warehouses are designed to perform analysis on large amounts of historical business data. A data warehouse is comprised of the following components:

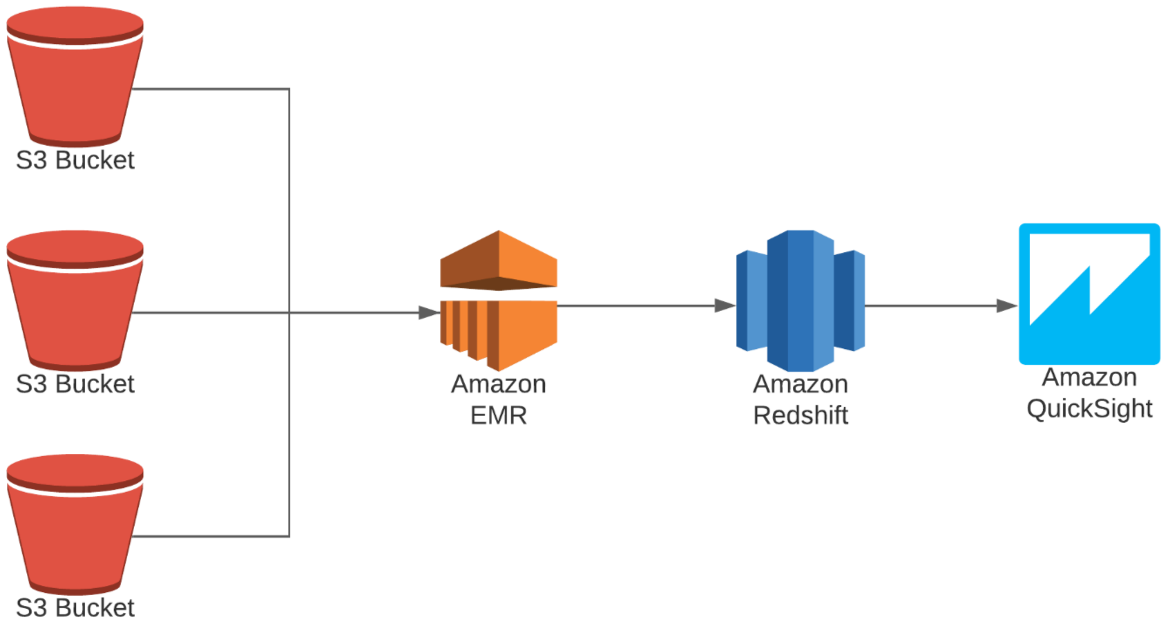
- Database to store data.
- Tools for visualizing the data.
- Tool for prepping and loading data.

Redshift

Data warehousing is becoming a critical business tool. Data warehouses enable businesses to get actionable insights from their data. The AWS data warehousing solution is called Amazon Redshift. Amazon Redshift is a fast, powerful, and fully managed data warehouse solution. Amazon Redshift supports petabyte-scale data warehousing. Amazon Redshift is based upon PostgreSQL and supports SQL queries. Additionally, Redshift will work with many applications that perform SQL queries.[22]

Redshift is a highly scalable platform. The Redshift architecture is built around clusters of computing nodes. The primary node is considered a *leader node*, with supporting nodes called *compute nodes*. Compute nodes support the leader node. Queries are directed to the leader node.

The diagram below shows how data warehousing is performed with Amazon Redshift and other AWS services:



Scaling Amazon Redshift Performance

Scaling Amazon Redshift is achieved by adding additional nodes. Amazon offers two types of nodes:

- Dense compute nodes – Dense compute nodes are based upon high-speed SSD RAID arrays.
- Dense storage nodes – Dense storage nodes are based upon magnetic disk RAID arrays.

Generally speaking, SSD-based arrays have higher throughput than magnetic arrays. SSD-based arrays have much higher IOPS than magnetic-based RAID arrays and perform much better in applications that require high input/output (IO) performance.

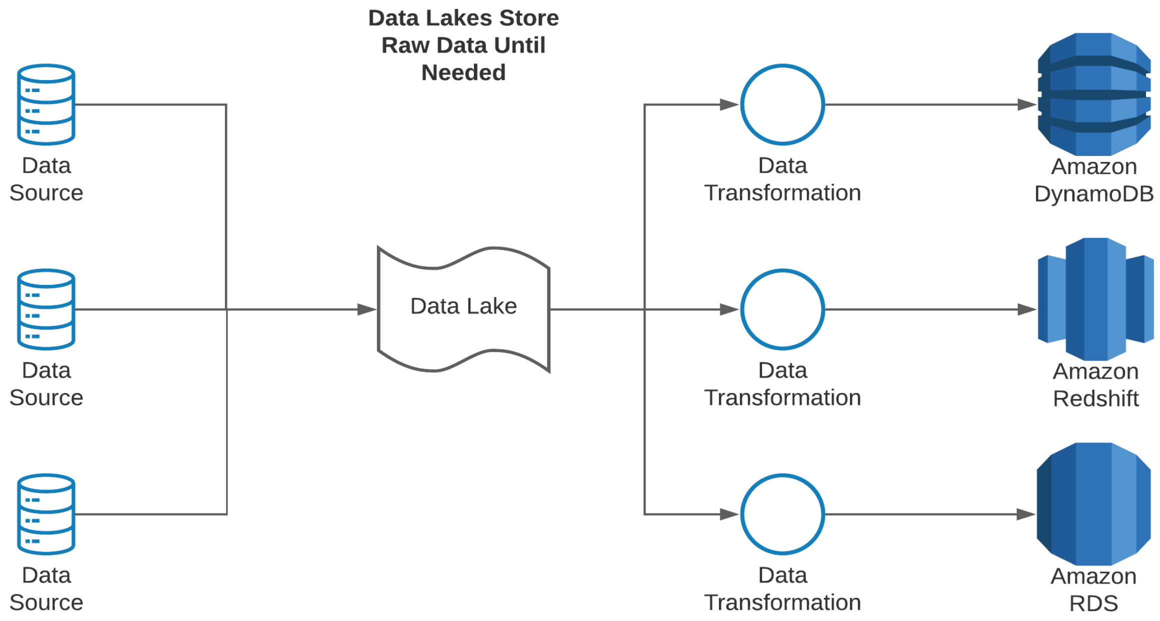
Data Lakes

A data lake is not exactly a database, but it includes database elements, so it’s included in the database section of this book.[15, 16]

What Is a Data Lake?

A data lake is a repository that allows an organization to store structured and unstructured data in the same place. Data lakes allow an organization to store and analyze extremely large amounts of data.

The diagram below shows an example of a data lake on the AWS platform:



Benefits of a Data Lake

Data lakes allow an organization to store virtually any type of data at an almost unlimited scale. Unlike a database, a data lake can store data in its native format until it is needed by another application. In a data lake, the data can be queried and searched for relevant data and solutions to current problems. Data lakes are highly adaptable and can be changed at any time to meet an organization's requirements.

AWS Lake Formation

AWS Lake Formation is a managed service that facilitates the rapid deployment of data lakes. A data lake is a repository that holds large volumes of unprocessed and processed data in the same location. The information captured comes from various sources.

Unprocessed data is captured quickly and in raw format. Metadata tagging is used to provide useful information about the raw data. Conversely, processed data is assigned to tables, fields, or other elements before storage. This results in slower data capture speeds. The outcome is an environment that stores unlimited data in various formats.

Data Lakes provide quick accessibility to analytical and machine learning tools resulting in actionable data. Data lakes are also customizable, secure, and scalable.

Organizations leverage AWS Lake Formation to increase profits, create cost savings, and improve database management efficiency. Actionable data allows organizations to gain competitive advantages and improve market share through consumer data analysis. Business performance data helps to improve operations efficiency. Lastly, the creation and deployment of data lakes is task intensive and takes months. AWS Lake Formation service reduces data lake creation and deployment time to days.

Database Storage Options

After determining the optimal database for an organization's needs, it is necessary to determine the proper storage options for the database. AWS databases are stored on EBS volumes, and the database storage options are:

- Previsioned IOPS (PIOPS)
    - Highest performance
    - Lowest latency
    - Highest throughput
- General Purpose SSD
    - High performance
    - Lower latency
    - Moderate throughput

- Magnetic storage
    - Moderate performance
    - Moderate throughput
    - Lowest cost
    - Highest latency
    - Designed for light IO requirements

Database Management and Optimizations

There are many components to successfully architecting and scaling an enterprise-wide database. This section will cover the following topics:

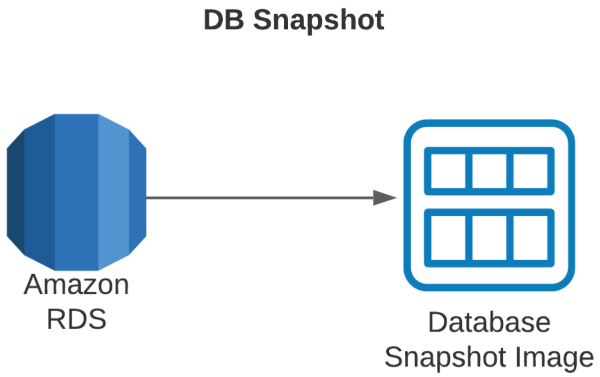
- Backing up the database.
- Scaling the database.
- Designing for high availability.
- Protection of data with encryption.
- Extraction, transforming, and loading tools (ETL).

Backing Up the Database

Databases are automatically backed up by AWS. Database backups copy the entire server, not just the data stored on the database. Backups can be retained for up to thirty-five days, which is configurable from one to thirty-five days. Automated backups happen at a defined window each day. While the database is being backed up, it may be unavailable or have significantly degraded performance.[23]

Databases can also be backed up manually. Manual backups are in the form of a DB snapshot. DB snapshots are a point-in-time copy of the database's EBS volume. DB snapshots are maintained until manually deleted.

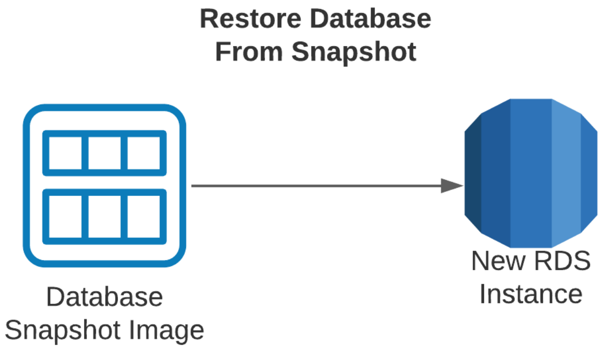
The diagram below shows how a database is manually backed up on the AWS platform:



Restoring a Database Backup

Databases can easily be restored from backups. When an organization needs to restore a database, a new database instance is created. Since a new database is created, it will have a new IP address and DNS name. Therefore, if a database is restored, it may be necessary to update other applications with the new IP address or DNS name.

The diagram below shows how a database is restored from a snapshot image:



Scaling the Database

Databases are mission-critical applications for many enterprises. As a mission-critical application, the database must scale to meet an organization's needs. There are several methods to increase the scalability of the database. Often it will take a combination of scaling methods to meet an organization's needs.

The first scaling method refers to scaling up versus scaling out. *Scaling up* refers to simply increasing the capacity of the server housing the database. At some point scaling up is not feasible, as a database can exceed the capacity of even the most powerful servers. Scaling out, by comparison, involves adding additional compute instances. Scaling out has two options: partitioning for NoSQL databases and read replicas for relational databases.

Scaling Out for Relational Databases

Relational databases are scaled out by adding additional servers. With relational databases, the additional servers are called *read replicas*. A read replica is a read-only copy of the main database instance. Read replicas are synchronized in near real time. Read replicas are used to decrease the load on the main database server by sending read requests to read replicas as opposed to the primary server. This reduces CPU, memory, and disk IO on the main server. AWS supports up to five read replicas. Read replicas are helpful in the following scenarios:

- When there is a lot of read activity.
- To increase performance, but read replicas are for performance and not disaster recovery.
- When query traffic is slowing things down.

- For more capacity, as offloading read requests from the main database can save valuable resources.

Scaling Out for NoSQL Databases

Partitioning the database involves chopping the database into multiple logical pieces called *shards*. The database has the intelligence to know how to route the data and the requests to the correct shard. Effectively, sharding breaks down the database into smaller, more manageable pieces. Partitioning the database is effective for NoSQL databases like DynamoDB and Cassandra.

Database Caching

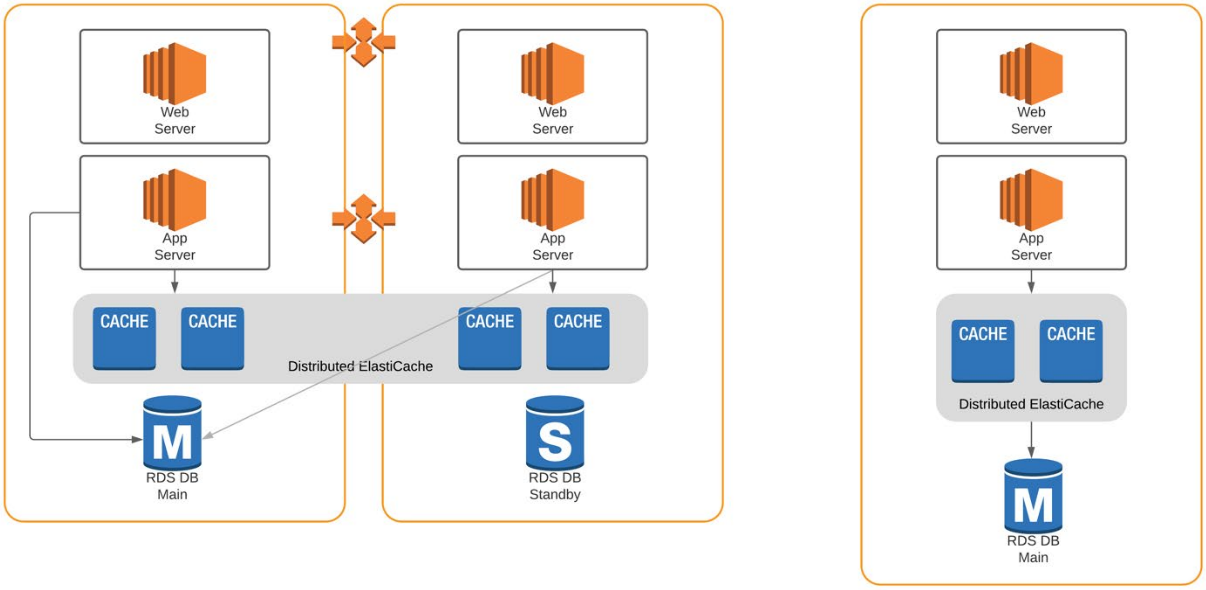
Database caching is another means to increase the scalability of a database. Caching is a method that takes frequently accessed information and places it in memory, so the request does not need to be forwarded to the database server.

Caching works by taking the first request for information to the database server. The server then responds to the request, and the cache temporarily stores the results of the request in memory. Future requests for the same information will be responded to by the cache and will not be sent to the database server. Future requests for information not stored in the cache will be sent to the server.

Caching data reduces requests to the server, freeing up server resources. To prevent stale data, the cache will not keep information in memory forever. Instead, the cache has a timeout to expire old data and make room for fresh data. This timeout, referred to as the *time to live* (TTL), can be configured based upon an organization’s needs.

AWS supports two caching types. These are ElastiCache for Memcached and ElastiCache for Redis. Memcached is designed for simplicity. ElastiCache for Redis has a substantial feature set and functionality. Caching is an excellent method to increase scalability. Caching is beneficial only when there are frequent requests for the same information, or queries, as if all requests are for new information, they will all be sent to the main server, mitigating any benefit to the cache.

The diagram below shows an example of database caching on the AWS platform:



Database Queueing

Database queueing can make a significant improvement in increasing the write performance of a database. Additionally, queueing can significantly help reduce CPU usage and other resources in the database. AWS has a queueing services called Simple Queue Service (SQS). Using SQS effectively decouples the database writes from the actual database.[24] The database works in the following manner:

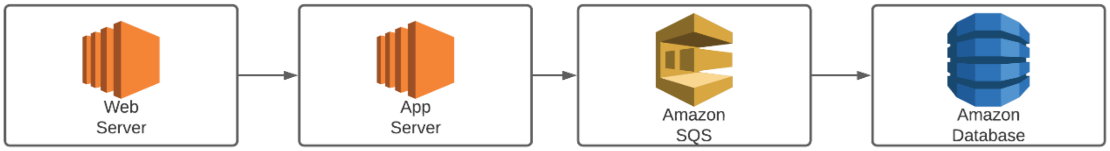
1. Data is sent to the SQS queue.
2. The queue looks at the database.
3. If the database is free, the message is sent from the queue to the database and removed from the queue.
4. If the database is busy or unavailable, the message waits in the queue until the database is available.
5. When the database is available, the message is sent to the database and removed from the SQS queue.

AWS offers two versions of the SQS queue:

- **AWS standard SQS queue** – This is a simple queue to temporarily store messages prior to being written to the database. With Standard SQS queues, there is no guarantee of the order of messages leaving the queue. This is the default option.

- **First in, first out (FIFO)** – This option guarantees that the messages will exit the queue in the order that they were received

The diagram below shows an example of an SQS queue on the AWS platform:



How Does SQS Help?

SQS helps by reducing write contention to the database. SQS helps with availability as well; if the database is temporarily down, messages can be retained in the queue. Since messages are retained in the queue until the database is ready, it can dramatically smooth CPU, memory, and disk IO performance. Additionally, the number of messages in the SQS queue can be used to scale out the database or computing service using the SQS queue.

When to Use SQS

SQS is optimal to use in the following circumstances:

- To increase scalability when there are a lot of write requests to the system.
- To decrease the load on the database behind the SQS queue.
- When it's not known exactly how much performance is needed but the organization wants to be able to account for large spikes in traffic.
- When extra insurance is desired that critical messages won't be lost.
- When you want to decouple your application to increase availability, modularity, and scalability.

AWS Glue

Databases provide an excellent means to store data. As explained in this chapter, there are many types of databases, and each has its strengths and weaknesses. It is often necessary to take data from one database and place it in another database.

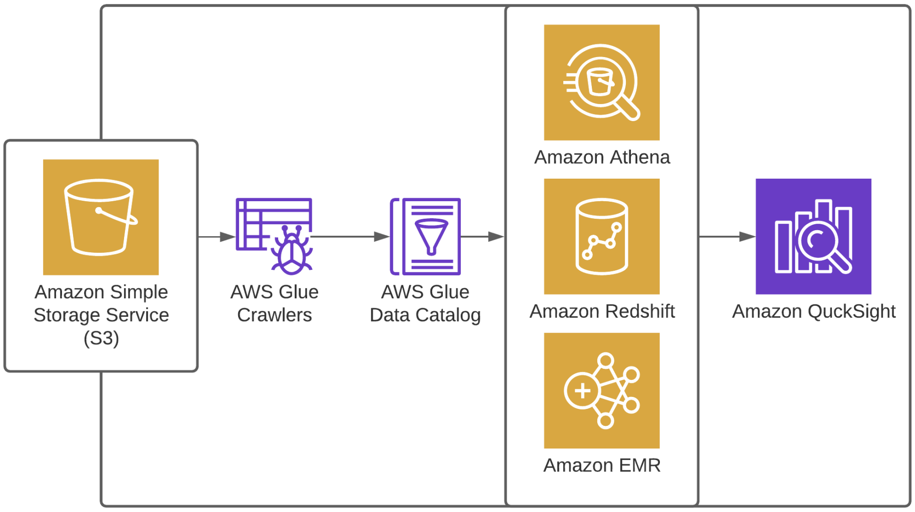
For example, an organization may use RDS for relational database purposes and have data stored on S3, and may want to start using Amazon Redshift. Taking the data from the RDS database and S3 may take some transformation prior to loading into the data warehouse. Transforming data is typically accomplished with extraction, transformation, and loading tools (ETL).

AWS has a fully managed and serverless ETL tool called Amazon Glue. Amazon Glue helps organizations by providing a service to take their data from all sources and load the data to the ultimate destination.[25]

AWS Glue Highlights

- Point AWS Glue to the location of the data stored on AWS.
- Glue will automatically discover the data and create a metadata catalog.
- After the data is cataloged, it is searchable and queryable.
- The data can be queried directly or loaded into a database or data warehouse.

The diagram below shows an example of using AWS Glue:



AWS Database Migration Tools

Moving the Database to the Cloud

Migrating to the cloud often involves migrating a database from the data center to the cloud. Relational Databases can be migrated to the AWS platform using native tools such as Microsoft SQL Server Migration Assistant or AWS tools such as the *Database Migration Service* and the *Schema conversion tool*. These tools help simplify moving the database to the cloud.

Database migration falls under two main categories: homogeneous migration and heterogeneous migration. A homogeneous database migration involves moving to the same database (i.e., MySQL from the data center to a MySQL server on the cloud). A heterogeneous migration involves migrating to a different kind of database (i.e., MySQL in the data center and Amazon Aurora in the cloud).

Database Migration Service

To assist customers in migrating their databases to the cloud, AWS provides the Database Migration Service (DMS). The DMS helps clients migrate their databases to the AWS platform with zero downtime. The DMS can capture live data; in fact the DMS can run while the database is fully operational. The net effect is a migration with zero downtime.

AWS Schema Conversion Tool

AWS Schema Conversion Tool (AWS SCT) is an AWS-managed service that simplifies the moving of one database engine to another. It does so by converting the source database schema to match your target database.

When migrating a database to AWS, the schema of the source database (OLTP/OLAP) must be converted to a format that is compatible with your target database. The AWS SCT offers a graphical user interface to automatically do these schema conversions. These conversions could be the transformation of a custom code to a format that is compatible with the target database.

Once the conversion is complete, AWS SCT provides an assessment report of the database showing any essential steps to be manually performed by the client to complete the migration process. If the schema from the source database cannot be converted automatically, the AWS SCT offers steps on how to create a corresponding schema in the target database.

AWS SCT can be used for migration between heterogeneous databases and to convert source database schema. AWS SCT is essential for converting relational OLTP schema or data warehouse schema, application codes, and SQL procedures. This tool is great for creating and managing Data Migration Service endpoints and data extraction agents. It performs extraction, transformation, and load (ETL) processes as well as optimizes existing Redshift.

Designing a High-Availability Database Architecture

Given the crucial nature of databases in the enterprise computing environment, making sure the database is available when needed is of utmost importance. The key to all high-availability designs is to avoid any single point of failure.

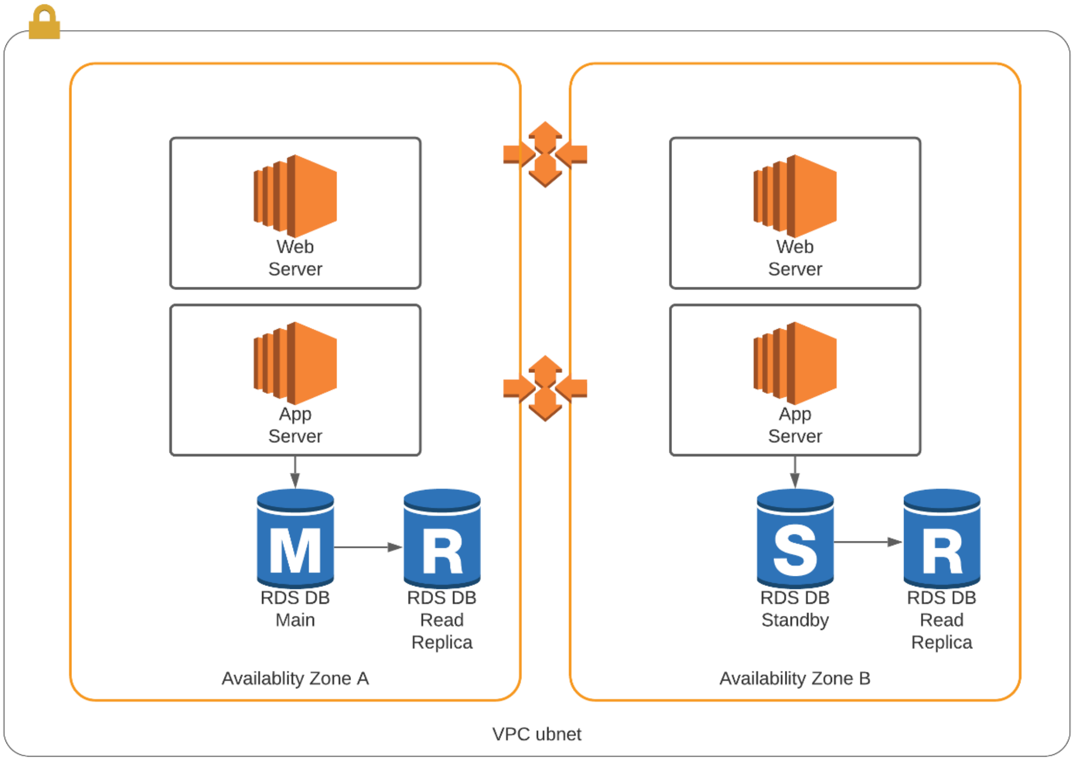
As a reminder, the AWS network is divided into regions and zones. Regions are large geographic areas, while an availability zone (AZ) is really a data center inside of a region. Regions may have many availability zones.

A high-ability database architecture will have database instances placed in multiple availability zones (multi-AZ). In a multi-AZ environment, there are multiple copies of the database, one in every availability zone. It is important to note that multi-AZ environments do not increase database performance. Multi-AZ environments are for redundancy to enhance availability purposes.

In a multi-AZ environment, data from the primary (master) database is synchronously copied to the backup database in the other AZ. If the primary database were to fail, the database instance in the other AZ would take over. A failover to the backup database will be triggered in the following circumstances:

- The primary database instance fails.
- There is an outage in an availability zone.
- The database instance type is changed.
- The primary database is under maintenance (i.e., patching an operating system).
- A manual failover has been initiated (i.e., reboot with failover).

The diagram below shows a high-availability application and database architecture:

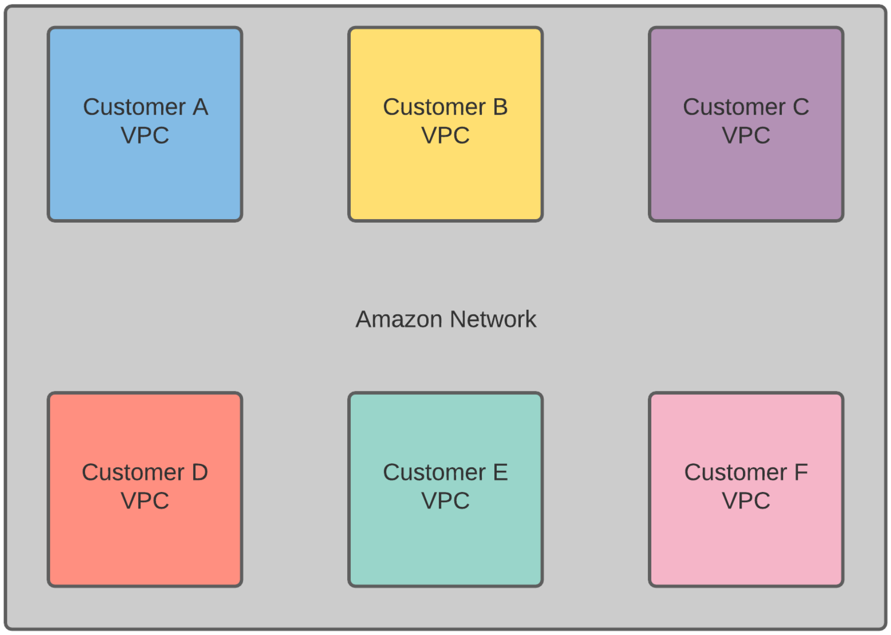

Web
Server
App
Server
M
RDS DB
Main
R
RDS DB
Read
Replica
Availablity Zone A
Web
Server
App
Server
S
RDS DB
Standby
R
RDS DB
Read
Replica
Availability Zone B
VPC ubnet

Chapter 6 - The AWS Virtual Private Cloud (VPC)

What Is the AWS VPC?

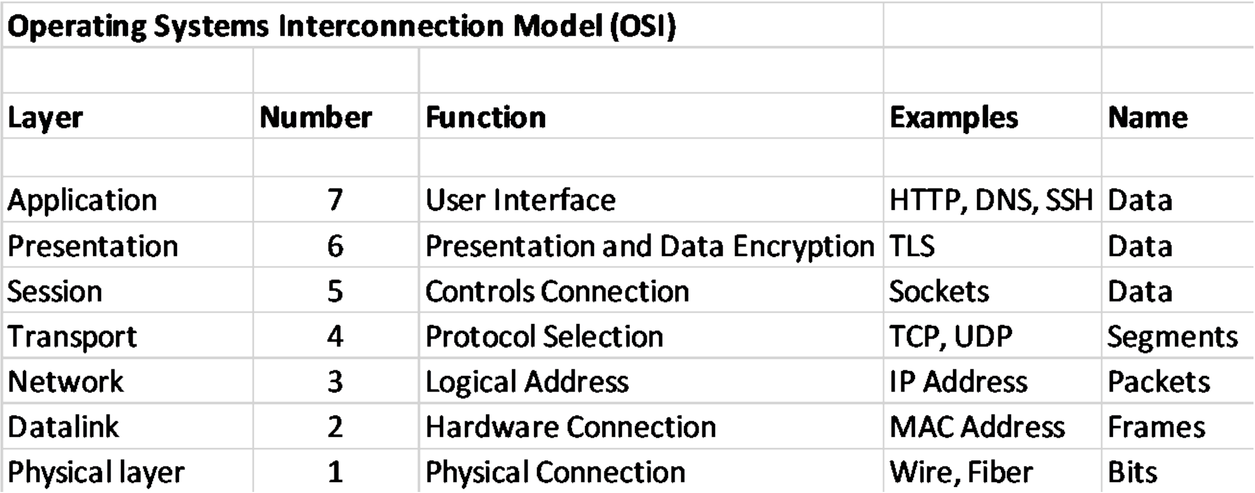
The AWS VPC is essentially a private virtual network inside the AWS network. While AWS is physically a shared network, each VPC is logically isolated from other AWS customers. The AWS network supports private and public addresses for each of its customers. Since AWS customers are logically separated, there is no contention for IP address space between VPCs. Each VPC will have its own routing table that is responsible for directing traffic. As with any network, a proper IP addressing scheme is essential for scalability.[26]

The diagram below shows an example of logically isolated customer VPCs on the AWS platform:



The OSI Model

Throughout this book, especially the VPC section, we often reference the open systems interconnect (OSI) model. The OSI model divides network communications into seven layers. Each layer of this model has specific functions for network communication. Knowledge of the OSI model can be helpful in troubleshooting and understanding the components of network communication. The table below shows the seven layers of the OSI model and the associated functionality at each level.[27]



Operating Systems Interconnection Model (OSI)

Layer	Number	Function	Examples	Name
Application	7	User Interface	HTTP, DNS, SSH	Data
Presentation	6	Presentation and Data Encryption	TLS	Data
Session	5	Controls Connection	Sockets	Data
Transport	4	Protocol Selection	TCP, UDP	Segments
Network	3	Logical Address	IP Address	Packets
Datalink	2	Hardware Connection	MAC Address	Frames
Physical layer	1	Physical Connection	Wire, Fiber	Bits

IP Addressing

An IP address is a logical address assigned to a computing device that identifies that device on the network. An IP address is similar to an address on a home. For mail to be delivered, the house must have a unique address so that the postal service can identify the correct home and deliver the mail. Every address must be unique, even if the only thing that separates similar-looking addresses is the postal code. IP addresses are no different. For any device to talk to another device on an IP network, their addresses must be unique. There are two versions of IP addresses:

- **IPv4** – Original IP address used in networking that has been in use since the 1970s and is still the dominant address space.
- **IPv6** – Newer IP addressing model designed to overcome the limitations of IPv4.

IP addresses operate at layer 3 of the OSI model. IP addresses are logical addresses, in that they are assigned to a network interface. IP addresses are not hard coded, like a MAC address (layer 2), that is permanently assigned to an Ethernet interface.

IP addresses are 32-bit addresses, which was perfect when the internet was formed. However, the internet grew far beyond what anyone expected, and there were not enough public IP addresses. The Internet Engineering Task Force (IETF) came up with two solutions to the IP address space shortage.[28, 29] The first solution is to provide private IP address space as specified by the Request for Comments (RFC) 1918 and the second solution is IPv6 addresses. Private IP addresses are to be used on internal networks and are not globally routable. Private IP addresses are available in the following address space:

- 10.0.0.0/8

- 172.16.0.0/16 through 172.31.0.0/16
- 192.168.0.0/16

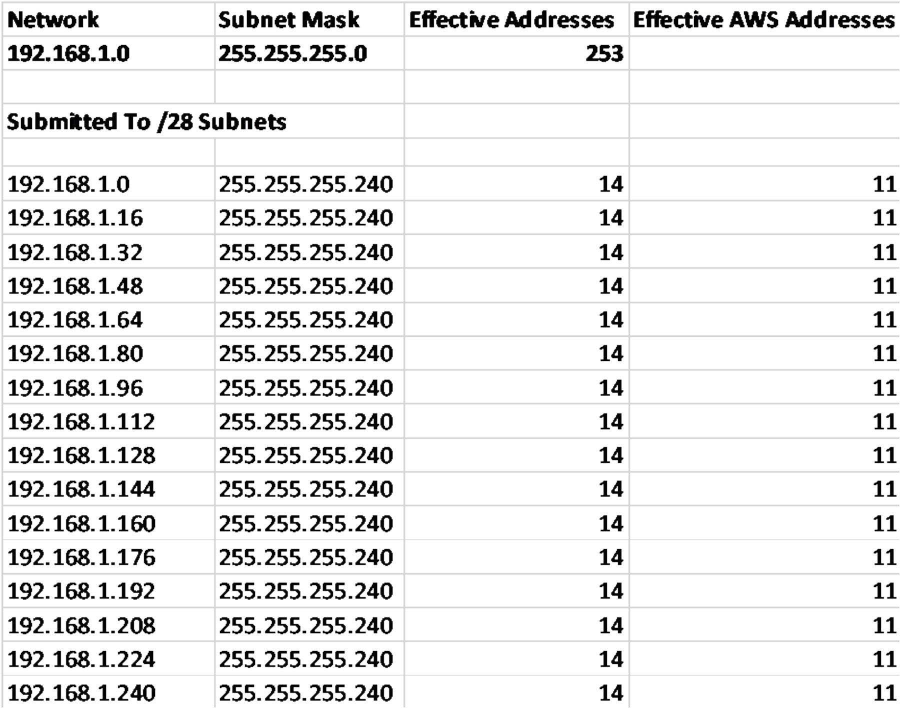
IP Address Classes

IPv4 has five classes of IP address space. Address classes are legacy, and not really used in today's modern environment. IP address classes are covered for historical purposes and so the reader can better understand *classless interdomain routing* (CIDR). Classful addresses are not used anymore since there is a shortage of IP addresses. Instead, subnetting is used to optimize IP address usage and availability.

- Class A addresses
    - 1.0.0.0- 126.255.255.255/8
- Class B addresses
    - 128.0.0.0- 191.255.255.255/16
- Class C addresses
    - 192.0.0.0- 223.255.255.255/24
- Class D addresses (Multicast)
    - 224.0.0.0- 239.255.255.255
- Class E addresses (Experimental)
    - 240.0.0.0- 255.255.255.255

Subnetting and Supernetting

Since there are a limited number of IP addresses, it's essential to use IP addresses carefully. One way to make use of an organization's IP address space is with subnetting. Subnetting is effectively taking an IP network and chopping it into smaller networks. Please see the graphic below:



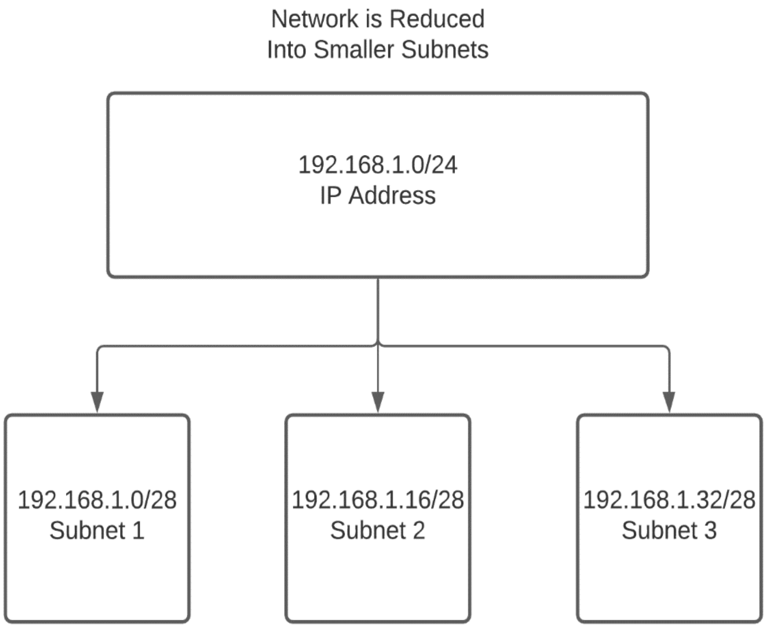
Network	Subnet Mask	Effective Addresses	Effective AWS Addresses
192.168.1.0	255.255.255.0	253	
Submitted To /28 Subnets			
192.168.1.0	255.255.255.240	14	11
192.168.1.16	255.255.255.240	14	11
192.168.1.32	255.255.255.240	14	11
192.168.1.48	255.255.255.240	14	11
192.168.1.64	255.255.255.240	14	11
192.168.1.80	255.255.255.240	14	11
192.168.1.96	255.255.255.240	14	11
192.168.1.112	255.255.255.240	14	11
192.168.1.128	255.255.255.240	14	11
192.168.1.144	255.255.255.240	14	11
192.168.1.160	255.255.255.240	14	11
192.168.1.176	255.255.255.240	14	11
192.168.1.192	255.255.255.240	14	11
192.168.1.208	255.255.255.240	14	11
192.168.1.224	255.255.255.240	14	11
192.168.1.240	255.255.255.240	14	11

In this table, the 192.168.1.0/24 network has been submitted into sixteen /28 subnets. Subnetting is critical for two reasons. The first reason is that every interface on a system needs to be on a different network or subnet. The second reason is there is a practical limitation of how many hosts can be on a subnet due to system broadcasts.

All interfaces need to be on a different subnet. Imagine a router with thirty interfaces. Each interface needs to communicate only with the router on the far end of the connection. In practicality, only two IP addresses are needed—one on each side of the connection. If the network 192.168.1.0/24 were attached to both sides of a WAN link, instead of only using two addresses, this link would use up all 253 addresses available on that subnet. By comparison, subnetting from a /24 to a /28 would allow for sixteen subnets available that would each support eleven hosts. Note that this is a reduction from the fourteen available addresses that would be present with a /28 subnet mask. This is because AWS reserves the first three IP addresses and the broadcast address space. An additional point to remember is that the smallest subnet supported by the AWS platform is a /28.

The second key reason that subnetting is essential and is related to constraining broadcast traffic. Host systems often identify each other by sending broadcast traffic to the local subnet. Broadcast traffic is different than traditional traffic. With traditional traffic, a system sends a message to another system. With broadcast traffic, when a host sends a broadcast, every host on the subnet sees and must process the broadcast. Additionally, network switches forward broadcast traffic out of every port except the port where the broadcast was sent. Broadcast traffic can easily overwhelm computing and network hardware. So, limiting the size of broadcast domains is essential. Limiting the reach of broadcasts is achieved by using smaller subnets and routing traffic between subnets.

The diagram below shows an example of a network being partitioned into smaller subnets:



Supernetting

Supernets are the exact opposite of subnets. *Supernets* combine multiple smaller subnets into a larger network called a supernet. As we have previously stated, optimizing performance often involves reducing the size of broadcast domains with effective subnetting. Therefore, supernetting is generally used more to optimize routing than for addressing computer systems.

Supernetting to Optimize Routing

Routers distribute traffic across the network by building a map of all available subnets. These subnets are subsets of the full class A, B, or C networks. Therefore, modern routing is called *classless interdomain routing* (CIDR). Routers often have memory and CPU limitations that limit the number of routes the router can support. As an example, AWS permits only one hundred routes in a VPC. To minimize the number of routes in the routing table while maintaining full reachability, it is often necessary to summarize routes. Route summarization is effectively taking several subnets and supernetting them into a single network. A full discussion of routing, switching, and IP addressing is beyond the scope of this book. For those interested in detailed routing and switching information, we recommend the book *Routing TCP/IP* by Jeff Doyle and Jennifer Dehaven Carroll.

How It Works

Let’s look at this section of a VPC routing table:

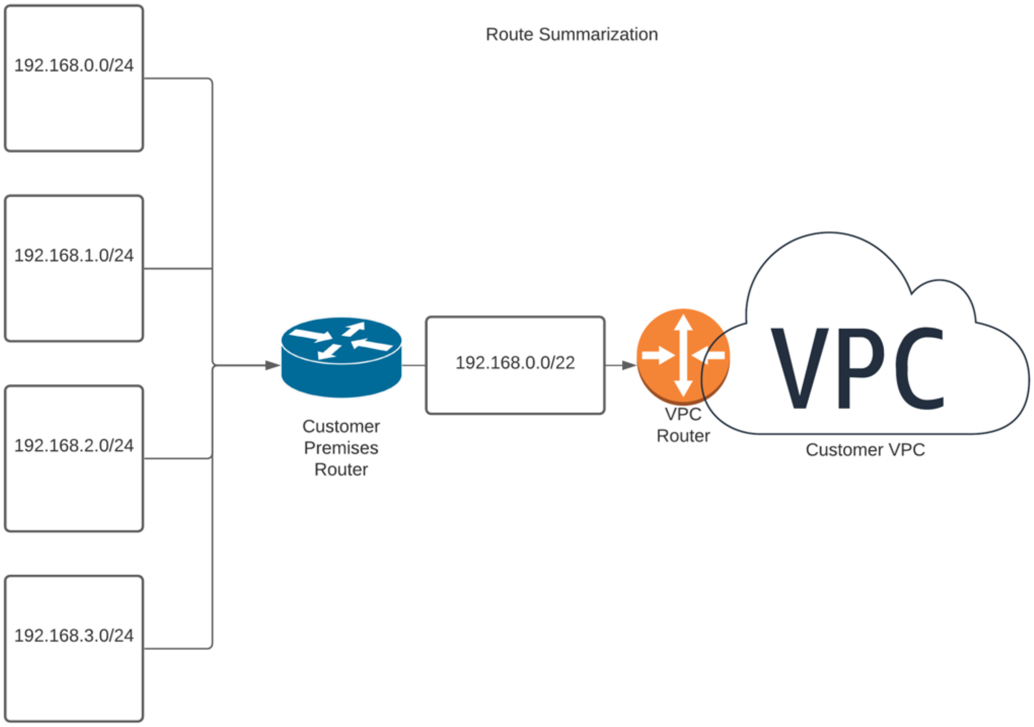
- Destination 192.168.0.0/24 target igw-123456789098765
- Destination 192.168.1.0/24 target igw-123456789098765
- Destination 192.168.2.0/24 target igw-123456789098765
- Destination 192.168.3.0/24 target igw-123456789098765

Instead of putting all these routes in a routing table, the subnets can be supernetted and summarized into the following route:

- Destination 192.168.0.0/22 target igw-123456789098765

As you can see, we have taken four routes and converted them into a single summarized route. This provides full reachability while saving valuable resources in the routing tables. With AWS allowing only one hundred routes, every route counts. So it's best to use an IP addressing scheme that can be summarized and to use route summarization whenever possible. This can also be used for traffic engineering on AWS. To learn more about traffic engineering using the BGP routing protocol that is supported by AWS, we recommend the book *Internet Routing Architectures* by Sam Halabi.

The diagram below shows an example of route summarization with supernetting:



IPv6 Addresses

When IPv4 was invented, no one could have imagined the growth of the internet. Very quickly the internet would be out of addresses, and something more scalable would be needed. The Internet Engineering Task Force invented a new version of the internet protocol to overcome the weaknesses with IPv4. This new protocol was IPv6. To overcome the address shortage, the 32-bit binary address used with IPv4 was changed to a 128-bit hexadecimal address. This provides infinitely more address space and scalability. Realistically speaking, IPv6 address capacity is likely sufficient to provide every internet-enabled device an IP address.

While IPv6 is the future, IPv4 is still the main IP addressing scheme in use today. IPv6 addresses are becoming more popular. In modern times, most mobile phones have an IPv6 address. AWS automatically assigns an IPv6 address to every interface.

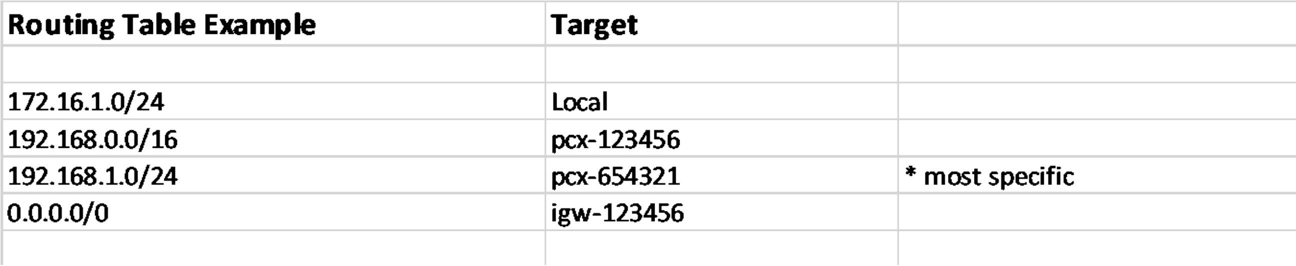
Components of a VPC

Now that we have reviewed the basic elements of IP addressing, it’s time to discuss the AWS-specific components of a VPC. The key components of a VPC can be seen below. This section will cover these VPC components in detail:

- VPC routing tables
- Internet gateways
- Egress-only internet gateways
- NAT instances and NAT gateways
- Elastic IP addresses (EIPs)
- VPC endpoints
- VPC peering connections
- Network access control lists
- Security groups

Routing Tables and Routing

All VPCs effectively have a virtual router provided by AWS. The virtual router is used to direct traffic to its ultimate destination. Routers determine how to make traffic forwarding decisions based upon their routing tables. A sample routing table can be seen below:



Routing Table Example	Target	
172.16.1.0/24	Local	
192.168.0.0/16	pcx-123456	
192.168.1.0/24	pcx-654321	* most specific
0.0.0.0/0	igw-123456	

In the routing table above, it’s clearly visible that the routing table has a destination subnet and a destination interface/gateway to forward traffic. The destination is referred to as the *target* in AWS. Note that if there are multiple paths to a destination, the most specific route will be chosen.

How Routing Tables Work

Routers build a map of the network. The map of the network will show which interface to use to send traffic to its ultimate destination. Traffic will then be sent to the next router, which will have its map of the network. Packets are forwarded from router to router until they reach their ultimate destination.

The map of the network is called a *routing table*. Routing tables can be built statically or dynamically. Static routes are user configured, where dynamic routes are dynamically learned via a routing protocol. Static routes are ideal when there are very few paths to reach the ultimate destination. Dynamic routes are learned, which is excellent for large networks. Additionally, dynamic routing enables high availability, as the routers can reroute traffic to a backup path if needed. Dynamic routing can reroute traffic by detecting when a router or link is down and calculating an alternate path. Most, if not all, large enterprise networks use routing protocols as part of their high-availability architecture. There are essentially two kinds of routing protocols, and they can be seen below:

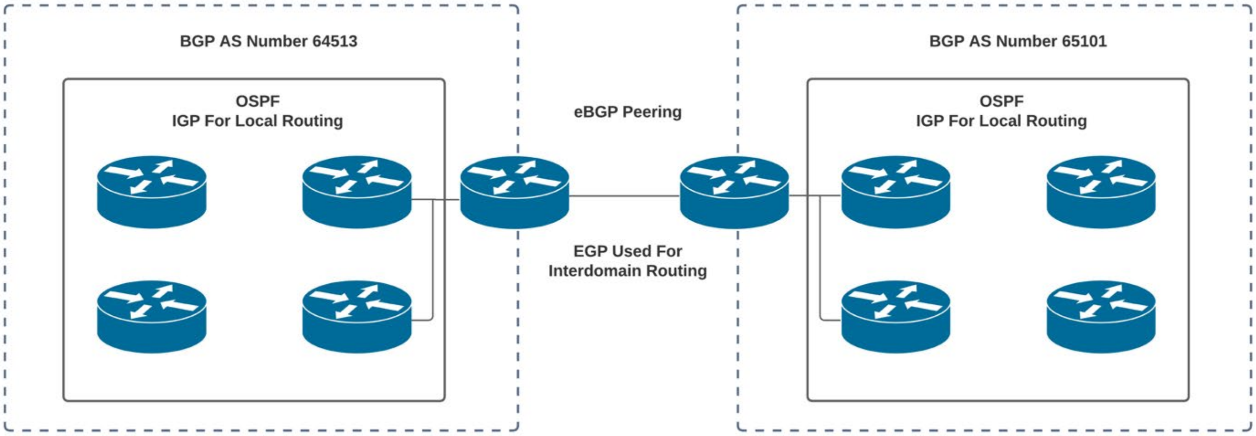
Interior Gateway Protocols (IGP)

- Interior gateway protocols are used to exchange routing information inside of an organization.
- Interior gateway protocols provide a very detailed map of the organization's routes.
- Interior gateway protocols can detect outages and reroute traffic very quickly.
- Interior gateway protocols are tuned for performance at the expense of scalability.
- Some examples of interior gateway routing protocols include OSPF, IS-IS, and EIGRP.

Exterior Gateway Protocols (EGP)

- Exterior gateway protocols are used to exchange routing information across organizations.
- Exterior gateway protocols provide extensive tuning tools, providing the means to engineer traffic and filter routes for scalability, security, and proper routing.
- Exterior gateway protocols are slower to reroute traffic, as they are designed for scalability and tunability.
- Border Gateway Protocol (BGP) is the exterior gateway protocol used by the internet and AWS.
- Exterior gateway protocols are tuned to be able to store an enormous number of routes (assuming the routers have sufficient memory and CPU capacity). At the time of this writing, the internet routing table has over eight hundred thousand routes.[30]

The diagram below shows how an IGP is used for internal routing and an EGP is used for interdomain routing:

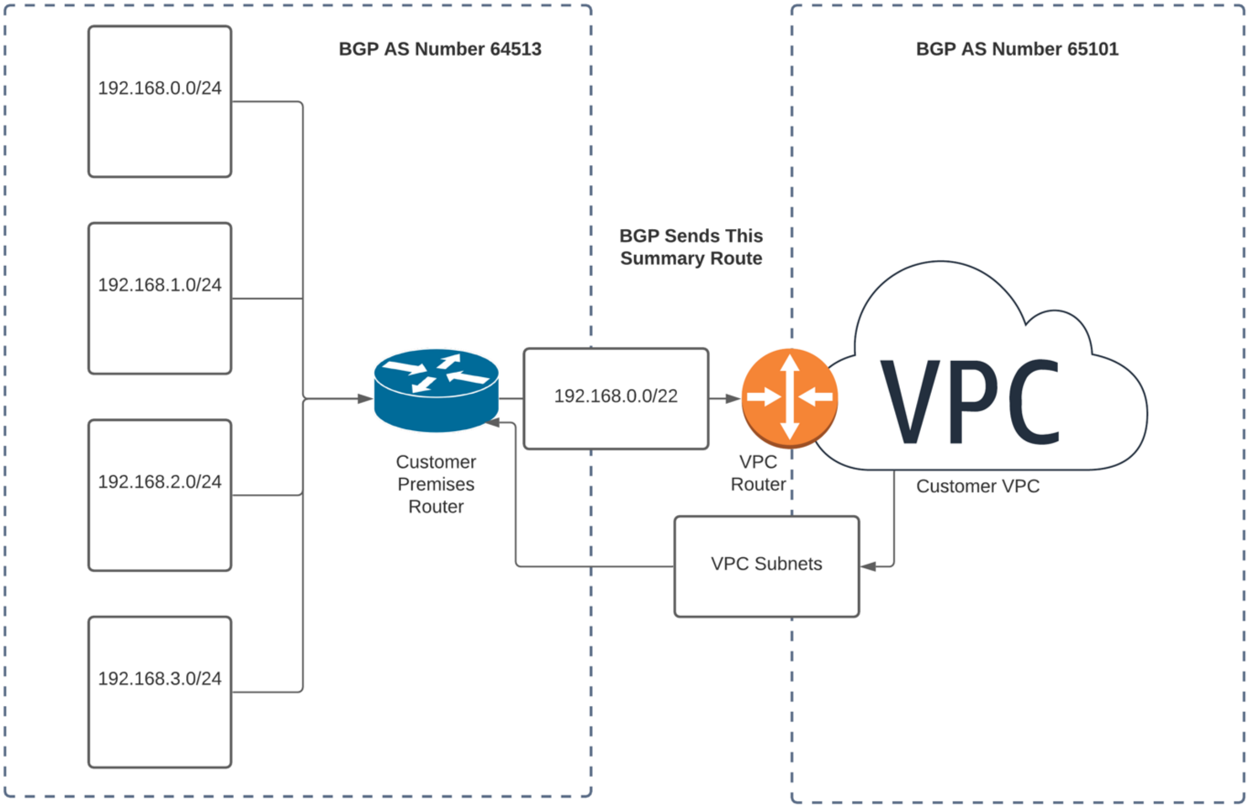


Dynamic Routing with AWS

AWS supports connecting an organization to AWS with BGP. BGP is a highly tunable and scalable exterior gateway routing protocol. BGP runs on TCP port 179. It is essential when using BGP to connect to AWS that firewalls and network ACLs allow TCP port 179. BGP enables an organization to have multiple connections to the internet or AWS and load share across these connections. As with all BGP routing, an autonomous system number is required to identify an organization to the AWS network.

BGP is required when using a direct connection to connect to AWS. AWS supports some of the available BGP tuning options, like communities. AWS BGP implementation supports the well-known community “no export,” which prevents a VPC from becoming a transit autonomous system for the internet. (This means you won’t become an accidental internet service provider and have parts of the internet connecting through your VPC.) AWS has a light BGP implementation when compared to core internet routers. AWS supports a maximum of one hundred routes learned from BGP; therefore an IP addressing scheme capable of route summarization is necessary. AWS supports some of the BGP tuning options, such as weight, local preference, and Autonomous System path (AS path). Please see below for an example of a system connecting with BGP to share routing information via BGP to AWS.

The diagram below shows how an organization would use BGP to connect to AWS to share routing information:



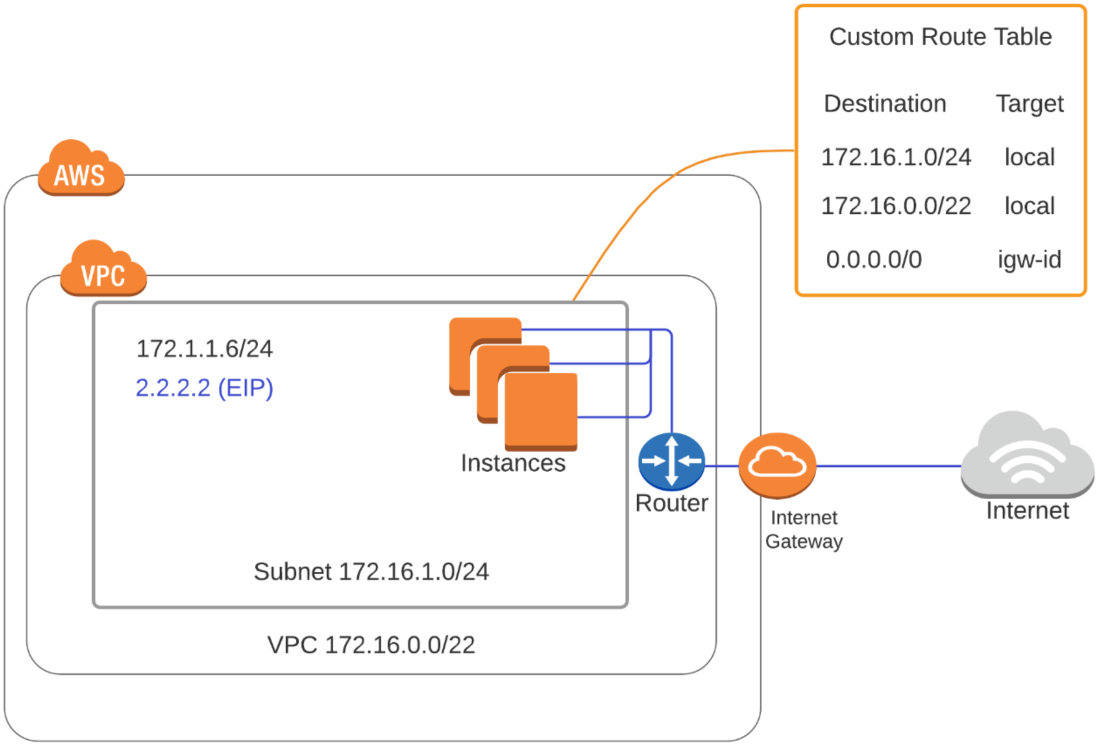
Internet Gateways (IGW)

In order to connect to the internet, an internet connection and an internet gateway must be configured. The internet gateway is a router with an internet service provider connection. AWS provides internet service to VPC customers when the customer sets up an internet gateway. The AWS internet gateway is a high-availability, redundant internet router. When using the internet gateway, it will have a route to all internet destinations or a default route to an upstream provider.

An internet gateway is created in the following manner:

1. Attach an IGW to the VPC.
2. Create a default route to send all internet-destined traffic to the internet gateway.
3. Assign a public IP address to the gateway.
4. Configure security. Systems will be reachable from the internet, so it is essential that systems are patched for security vulnerabilities and firewalls; network ACLs and security groups are configured.

The diagram below shows an example of an internet gateway on the AWS platform:



Custom Route Table

Destination	Target
172.16.1.0/24	local
172.16.0.0/22	local
0.0.0.0/0	igw-id

Egress-Only Internet Gateways

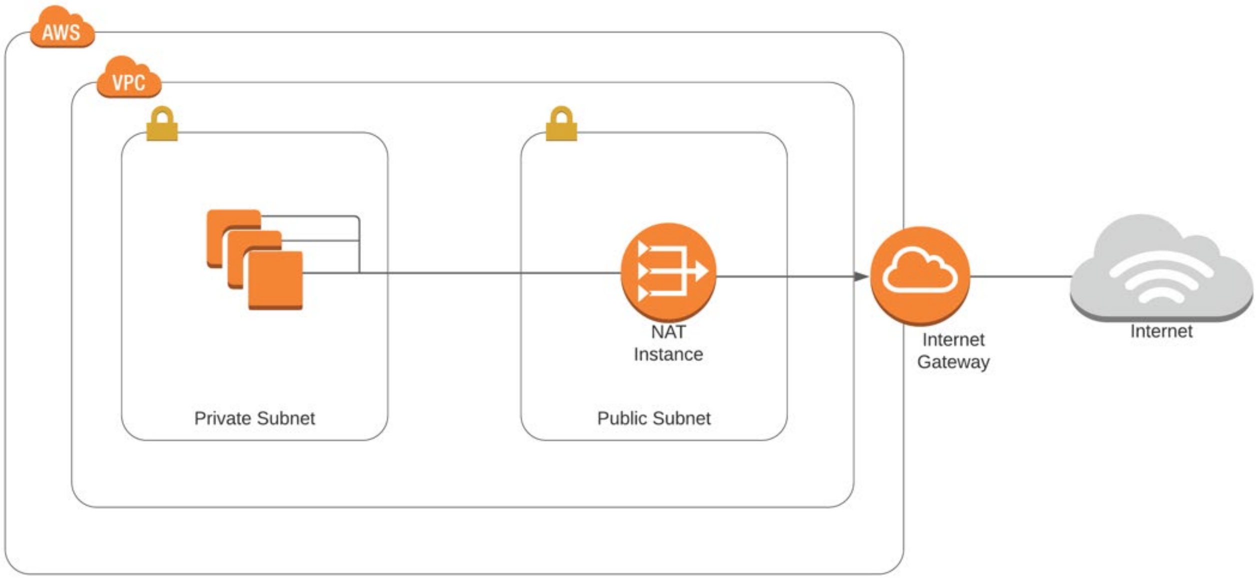
Egress-only internet gateways allow internet connectivity to IPv6 systems. IPv6 does not really use private address space. So essentially all IPv6 addresses are unique and globally routable. Therefore, IPv6 systems do not need NAT to connect to the internet, as there is no need to translate an internal address into an external address.

When using an egress-only internet gateway, systems will not be reachable from the internet. This type of internet gateway is stateful and allows traffic established by internal hosts to return to the AWS VPC. This allows internal systems to download software patches and upgrades from the internet while keeping outsiders from connecting into the AWS VPC from the internet. This is very similar in function to the NAT gateway without an internet gateway in IPv4.[32]

NAT Instances

A *NAT instance* is a custom AWS virtual machine that translates private IP addresses into public IP addresses. The NAT instance is available as an AMI, and it runs on an EC2 instance. A NAT instance must be in a public subnet with a route to the internet gateway. This type of setup is used for egress only, meaning internal systems can connect to the internet, but systems on the internet will not be able to connect to systems in the VPC. Additionally, the VPC routing table must have a default route to the internet gateway. This is really a legacy product and has largely been replaced with the AWS NAT gateway.[33]

The diagram below shows an example of a NAT instance on the AWS platform:

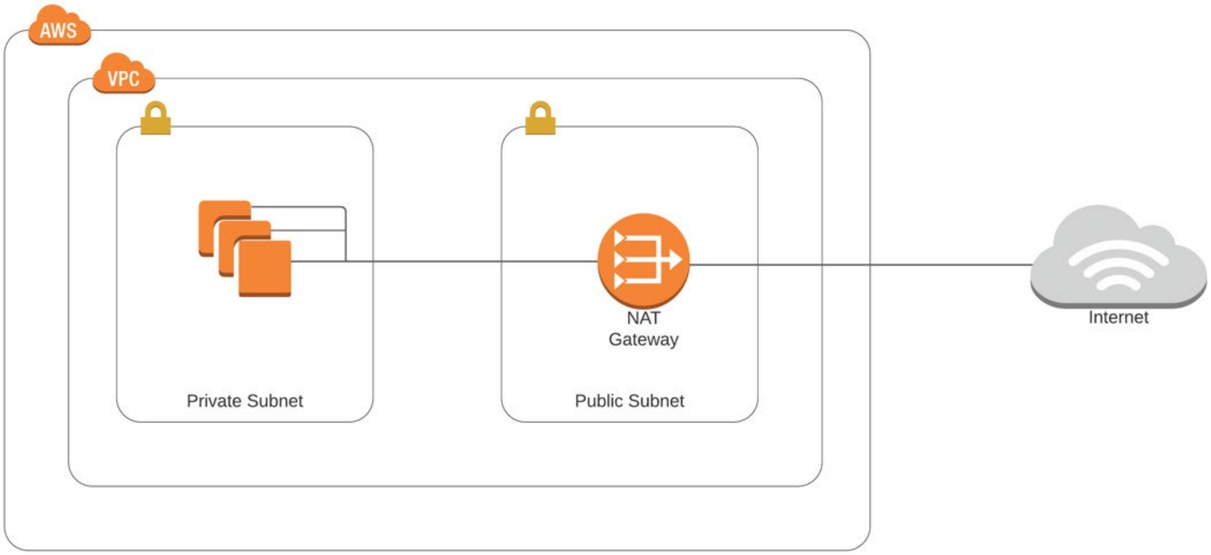


NAT Gateway

A *NAT gateway* is a fully managed NAT service. The NAT gateway is highly available and redundant inside of an availability zone. A NAT gateway provides egress-only internet connectivity, similar to a NAT instance. This means that inbound connections from the internet will be refused, but internal hosts will be able to connect to the internet. A NAT gateway is optimal when hosts need to connect to the internet to download software patches but desire to keep their systems off the public internet for security reasons.[34]

The NAT gateway is configured in a public subnet. Then a default route must be created to send internet-destined traffic to the NAT gateway. Note that the NAT gateway will use an elastic IP for the life of the NAT gateway.

The diagram below shows an example of a NAT gateway on the AWS platform:



Elastic Network Interfaces (ENIs)

A network interface is what connects a system to the network. AWS's version of this is called the Elastic network interface. *Elastic Network Interfaces* (ENIs) are virtual network interface cards, which are generally attached to EC2 instances. By default, there is an ENI created when you launch an EC2 instance. The default ENI is eth0. Systems can be placed on two subnets (dual-homed) or multiple subnets by creating multiple ENIs and attaching those ENIs to an EC2 instance. Multiple ENIs are commonly used for system management—for example, on a web server, the public side open will be open to http/https, and the private ENI will be open to port 22 for SSH.

Elastic IP Addresses (EIPs)

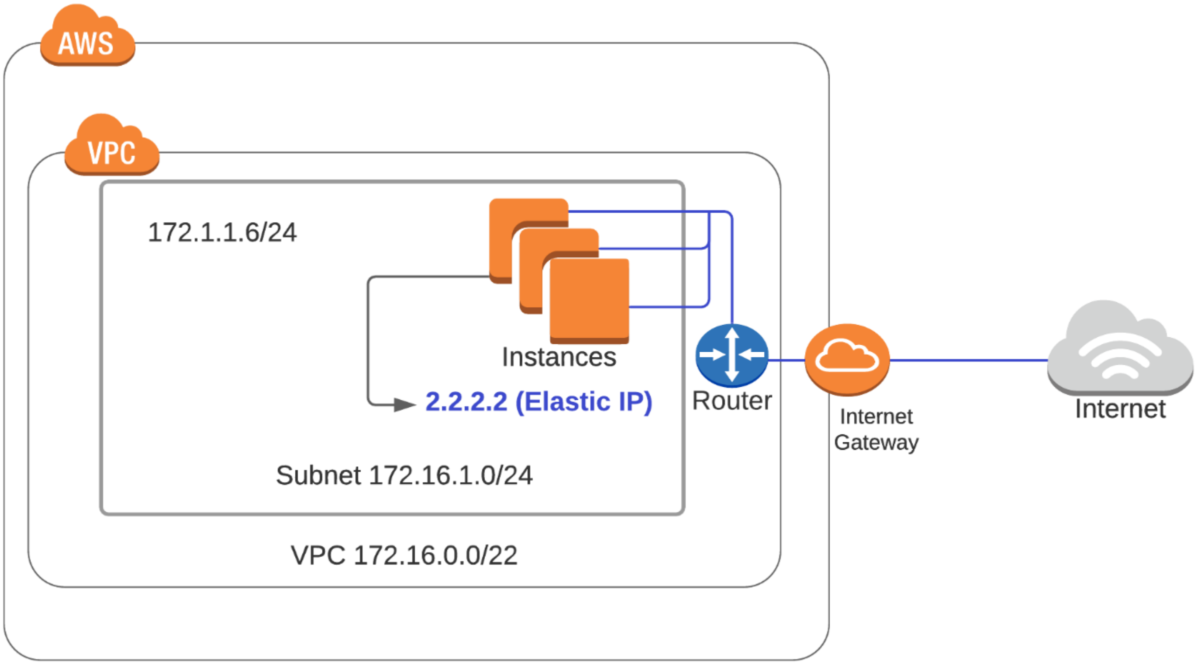
AWS maintains a pool of public IP addresses for their customers to use on the internet. These public IP addresses are called Elastic IP addresses. Elastic IP addresses work in the following manner: [35]

1. When an organization needs a public address, it sets up an Elastic IP address.

2. The EIP is taken from the AWS public address pool and dedicated to the customer's Elastic IP address.
3. The customer can keep this EIP as long as they are using the address.
4. When the customer no longer needs the EIP address, the customer closes the EIP, and the address is sent back to the AWS pool for future customer use.

An EIP can have a single public address that is mapped to multiple private IP addresses, with the main address being the primary address and the additional addresses being secondary addresses. Secondary IP addresses are useful during IP address migrations, as they allow for connectivity while IP addresses are changed. Secondary addresses are often used when an organization merges with another organization, and IP addresses need to be modified to allow for full connectivity. This often occurs when both organizations are using the same private IP address space.

The diagram below shows an example of using an Elastic IP address on the AWS platform:



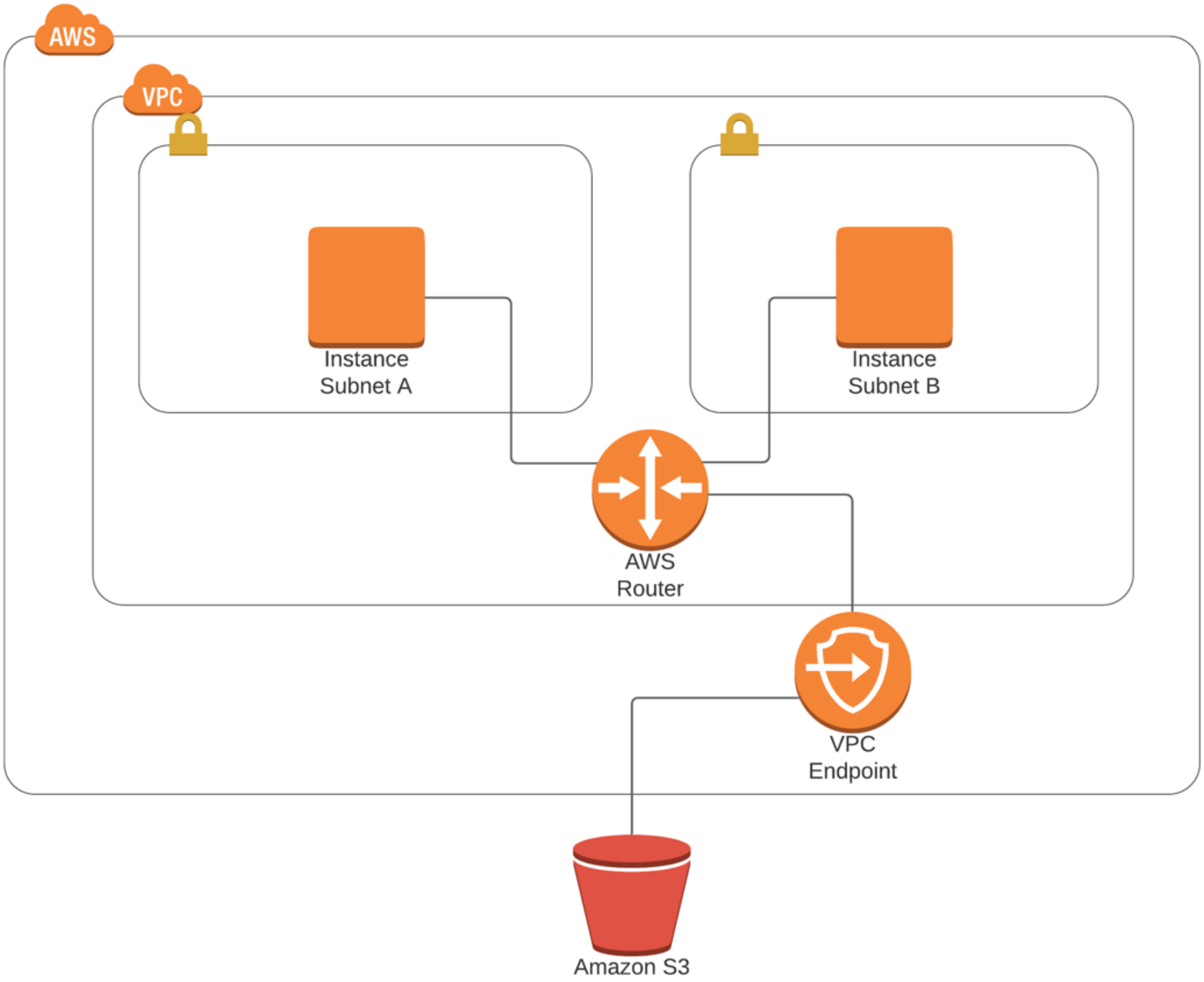
Endpoints

Internet gateways and NAT gateways offer a solution to connect a customer VPC to the public internet. While it's possible to connect to many AWS services over the public internet, it's not the preferred method. Connecting to the AWS services over the Amazon network can offer significant benefits, especially when connecting to other services or VPCs on the AWS platform. Connecting to another AWS service is performed with the creation of a VPC endpoint. When connecting with VPC endpoints, the connectivity is established over the AWS high-speed network backbone.[36] This can offer the following benefits:

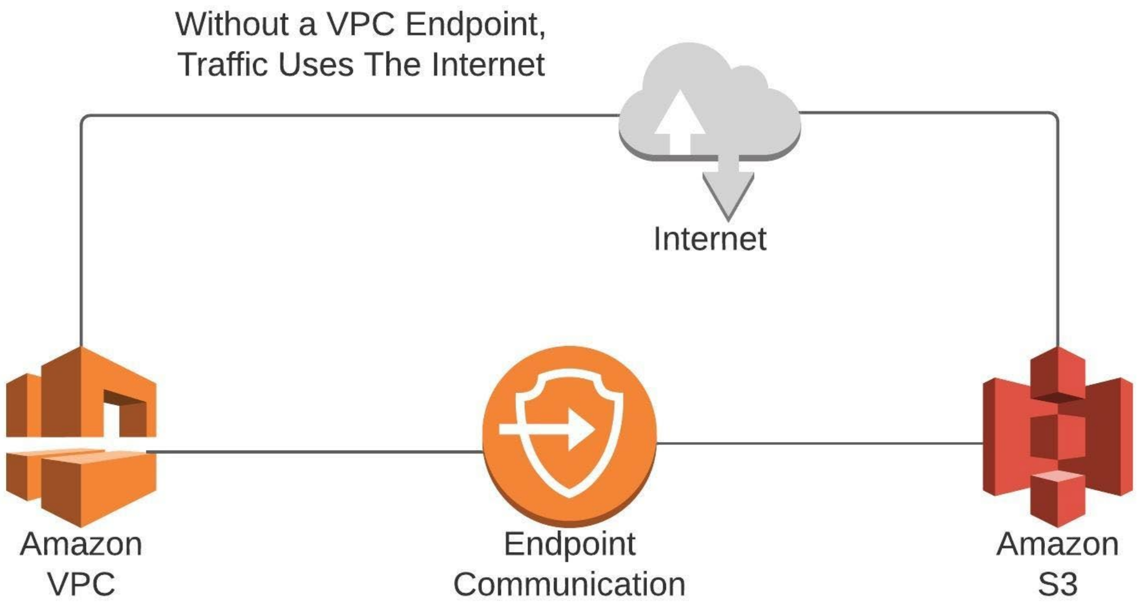
- **Privacy and security** – Sending data over the AWS network is much more private and secure than the internet.
- **Performance** – Internet gateway speeds often lower performance then sending data directly over the AWS network.
  - The AWS network is fully managed by AWS. Therefore it can have lower latency and lower congestion than the public internet. The internet has no performance guarantees across autonomous systems.
- **Cost control** – AWS charges for internet use. Sending data over the AWS network will cost less than internet use.
- **Simplicity** – VPC endpoints do not require a public IP address, internet gateway, or NAT gateway.

The way to connect your organization's VPC to AWS without traversing the internet is with a VPC endpoint. VPC endpoints are virtual devices used for routing within the AWS network. There are two types of VPC endpoints: interface endpoints and gateway endpoints.

The diagram below shows an example of a VPC endpoint on the AWS platform:



Here is an example showing how without the end point, traffic would need to use the internet:



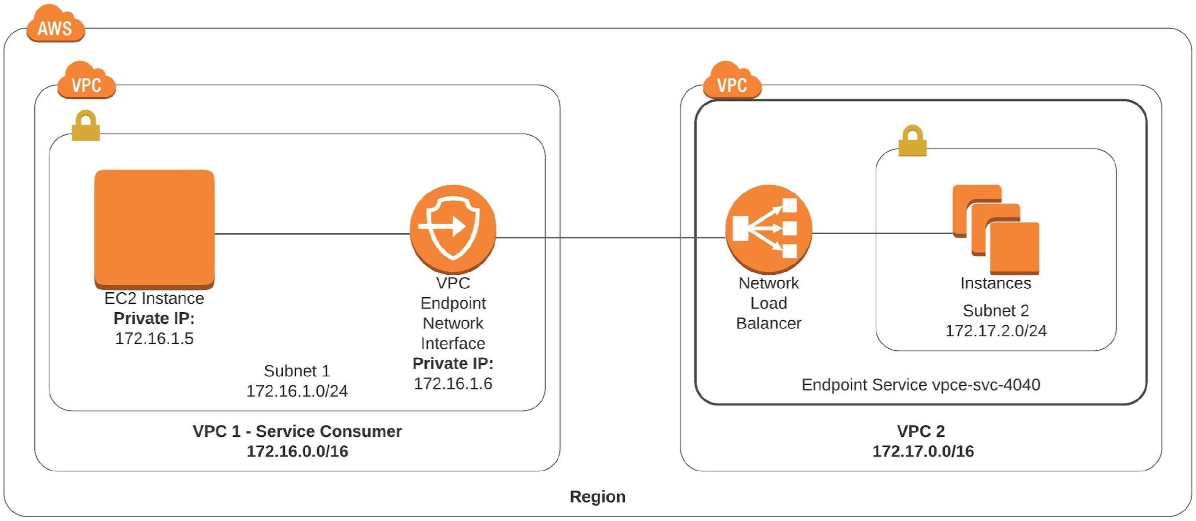
Interface Endpoints

An *interface endpoint* is a means to connect to AWS services or external organizations or services. Certain AWS services are accessed via interface endpoints such as EC2 Systems Manager and Kinesis. External VPCs are also connected via interface endpoints. Interface endpoints automatically create an elastic network interface that uses a private address from the VPCs address pool. The interface endpoint serves as an entry point from your organization to supported services. Supported services include AWS services and other VPCs. Interface endpoints use the AWS PrivateLink service. The PrivateLink service restricts all access between VPCs or AWS services. Interface endpoints are compatible with most VPC services.[37]

Interface endpoints work differently than gateway endpoints. With a gateway endpoint, there is a route in the routing table created to access the external endpoint. Interface endpoints, on the other hand, are effectively a network interface. You can control the traffic destined to the endpoint with a security group.

After creation of the interface endpoint, AWS creates an ENI in your subnets that you specify to use the interface endpoint. After the creation of an endpoint, AWS will generate an AWS endpoint-specific DNS name so you can connect to the endpoint via its DNS name interface endpoints—private link.

The diagram below shows an example of an interface endpoint:



Gateway Endpoints

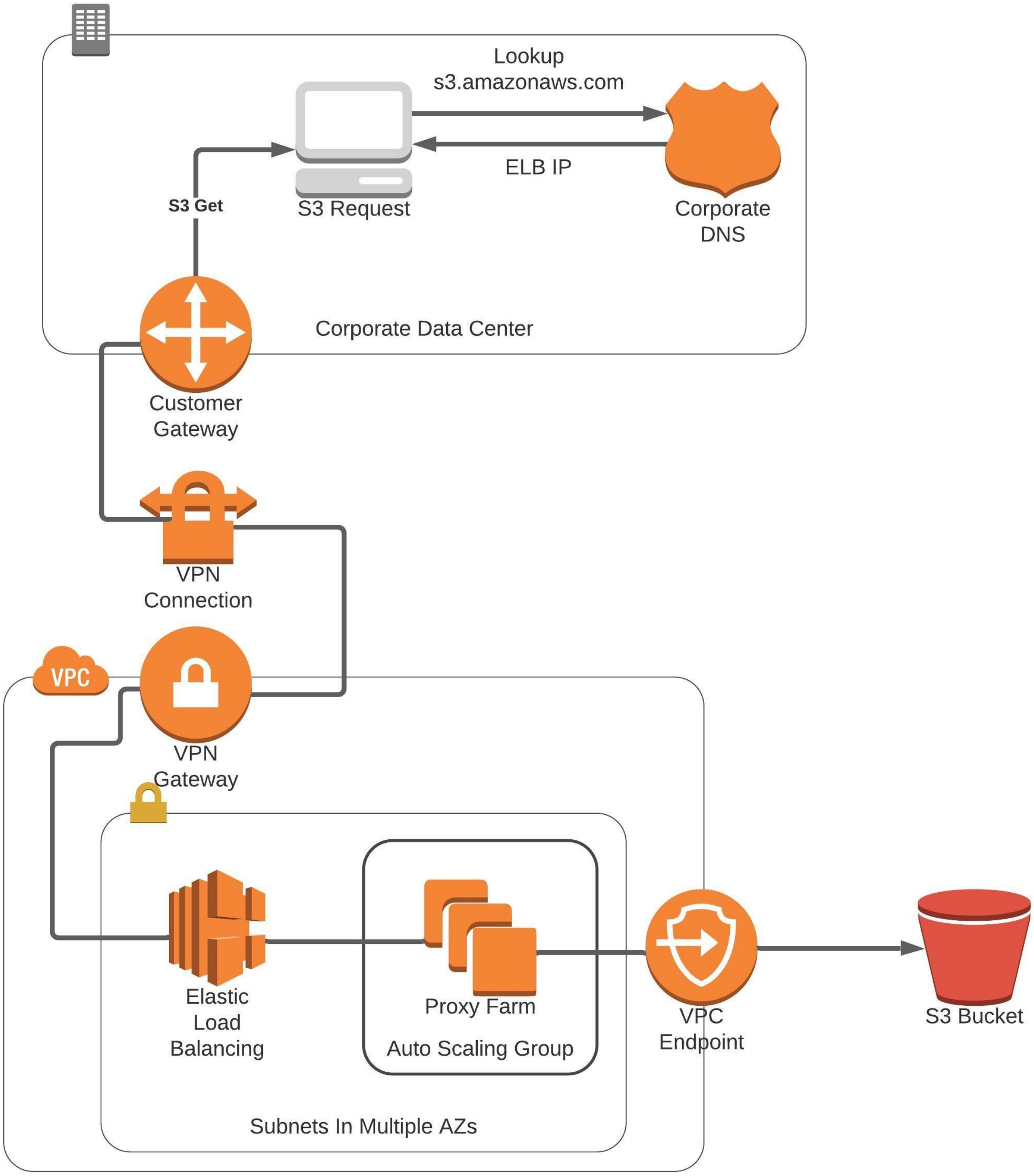
A gateway endpoint is a private endpoint that provides high-security access to an AWS service. It effectively places a route in the VPC's routing table for traffic destined to the AWS service. An example of a gateway endpoint is connecting Amazon S3 to DynamoDB.[38]

A gateway endpoint enables an organization to create multiple endpoints in a single VPC. Gateway endpoints allow private access from VPC to a public AWS service such as S3 or DynamoDB. For example, when an endpoint is created for S3, a prefix list and VPC endpoint are created for the VPC. The prefix list will adhere to this naming convention—pl-xxxxxxxx—and can be seen in the routing table. The routing table will show for route/prefix pl-xxxxxxxx. The route to the VPC endpoint will be in the routing table.

Gateway endpoints support IPv4 only. A gateway endpoint can only be linked to a single VPC. DNS resolution must be enabled in your VPC to ensure all the IP addresses maintained by AWS correctly resolved.

Gateway endpoints can be accessed over a direct connection or VPN location.

The graphic below shows how an organization can use a VPN connection to access an endpoint on the AWS cloud:



Gateway Load Balancer Endpoints

A Gateway Load Balancer endpoint is a managed service used to deploy multiple network or security appliances. Gateway Load Balancer endpoints are used to securely exchange traffic across VPC boundaries. Gateway Load Balancer endpoints provide private connectivity between virtual appliances i.e., marketplace firewalls. You deploy the Gateway Load Balancer in the same VPC as you would use a network load balancer to load balance virtual appliances.

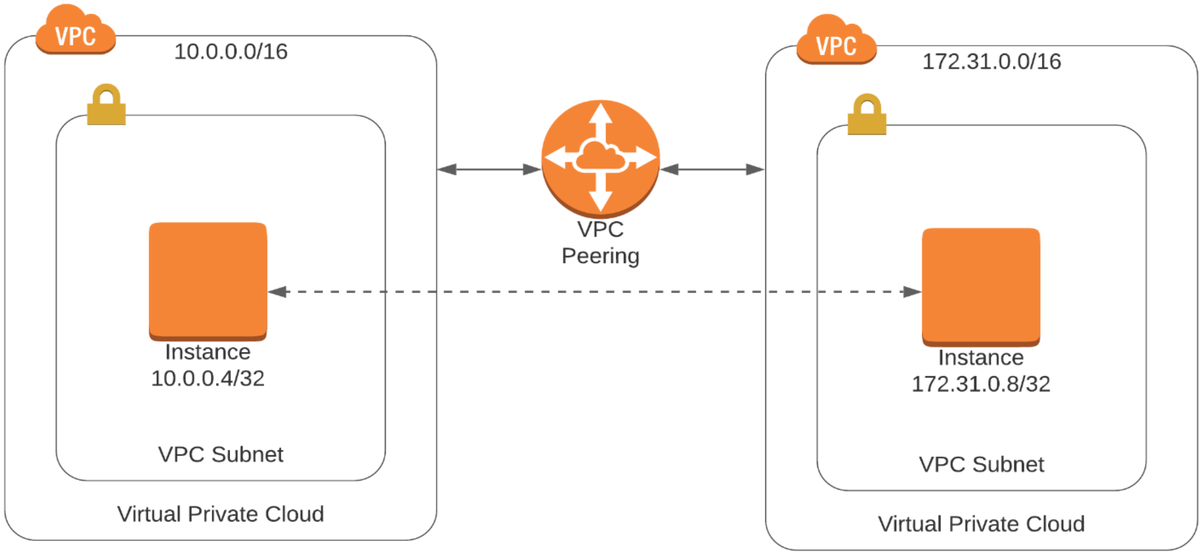
VPC Peering

VPC peering is a technique to connect one or more VPCs without traversing the public internet. VPC peering also mitigates the need for direct or VPN connections between organizations that are hosted on the AWS network. VPC peering provides high-speed, high-availability connectivity by leveraging the AWS backbone for connectivity.[39, 40]

Some key things to know about VPC peering:

- VPC peering provides a nontransitive connection. This means that while VPC peering facilitates connectivity between VPCs, it does not facilitate routing traffic through a VPC to connect to another VPC.
- VPC peering uses the AWS network backbone, so there is a need for internet connections, internet gateways, NAT gateways, or public IP addresses.
- Inter-region VPC traffic is encrypted for data privacy.

The diagram below shows an example of a VPC peering on the AWS platform:

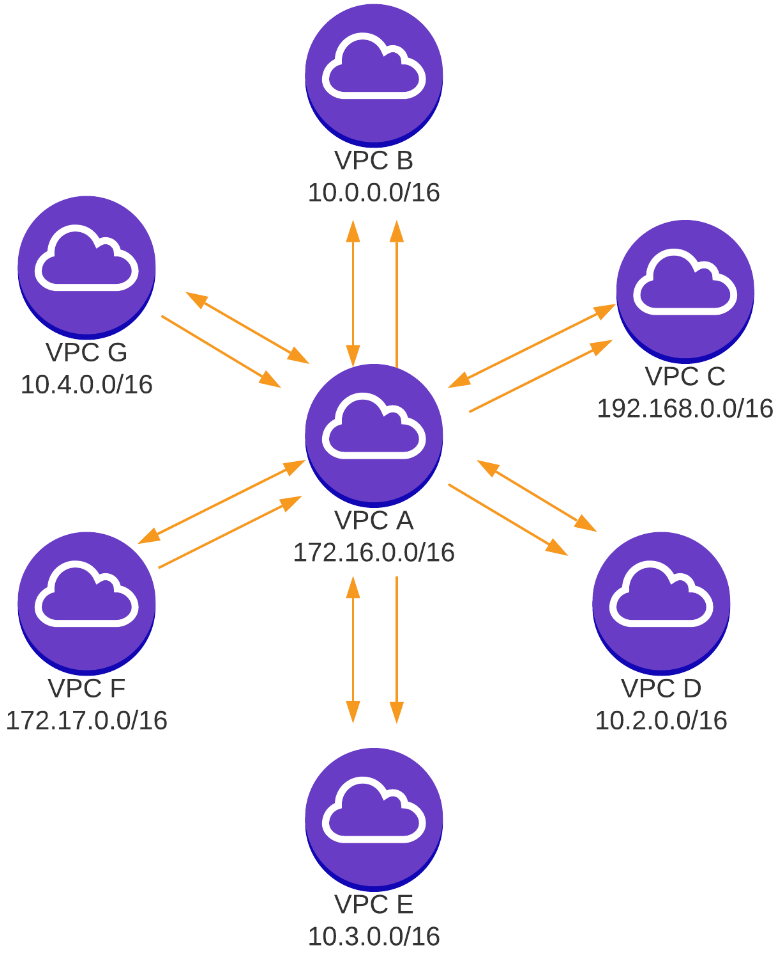


There are essentially two primary architectures for VPC peering: hub and spoke, and fully meshed.

Hub and Spoke

In a hub-and-spoke environment, a hub is created with connections to all remote VPCs. This enables the hub to communicate with each remote VPC or spoke. However, since VPC peering is not transitive, VPCs will not be able to communicate with each other since communication is limited to hub-and-spoke VPCs.

The diagram below shows an example of hub-and-spoke VPC peering on the AWS platform:



Fully Meshed

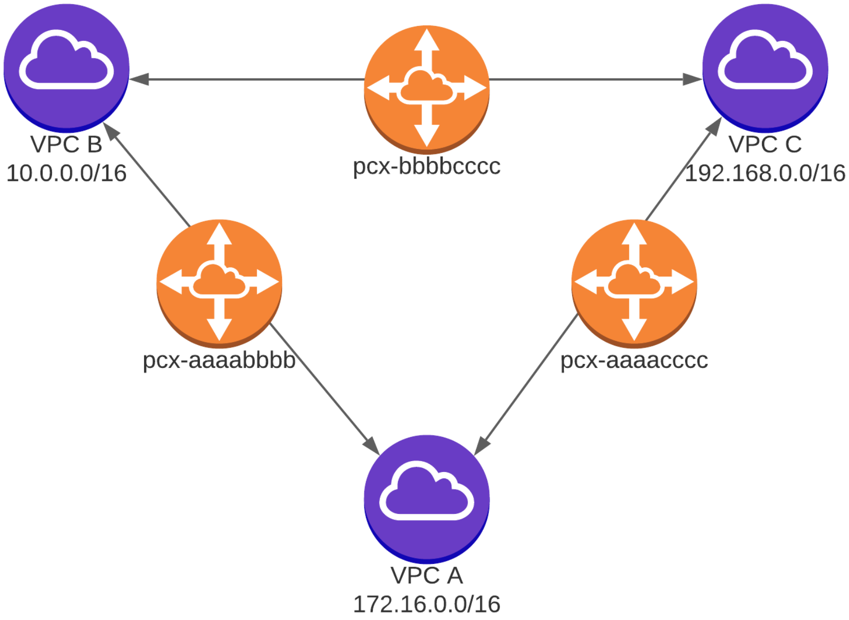
When all VPCs need to communicate with each other, every VPC will require peering to every other VPC. This is referred to as a *fully meshed environment*. Fully meshed architectures are required because VPC peering is not transitive. While fully meshed VPC peering works well, it is challenging from a scalability perspective. Scalability is challenged as the number of connections grows very rapidly as additional sites are added. The number of connections can be calculated with this formula: N*(N-1) /2, where N is the number of nodes or VPCs.

Let's examine how fast VPC connections grow in the fully meshed environment.

- With three VPCs, six connections are required:
    - 3 * (3-1) /2 = 6 connections
- With ten VPCs, forty-five connections are required:
    - 10 * (10-1) /2 = 45 connections
- With twenty VPCs, only 190 connections are required:
    - 20 * (20-1) /2 = 190 connections
- With thirty VPCs, 435 connections are required:
    - 30 * (30-1) /2 = 435 connections

Fully meshed environments are excellent when a small number of VPCs require connectivity. However, fully meshed environments do not scale when a large number of VPCs require connectivity with each other. A solution to help create a more scalable VPC peering environment is with AWS CloudHub and Transit Gateway.

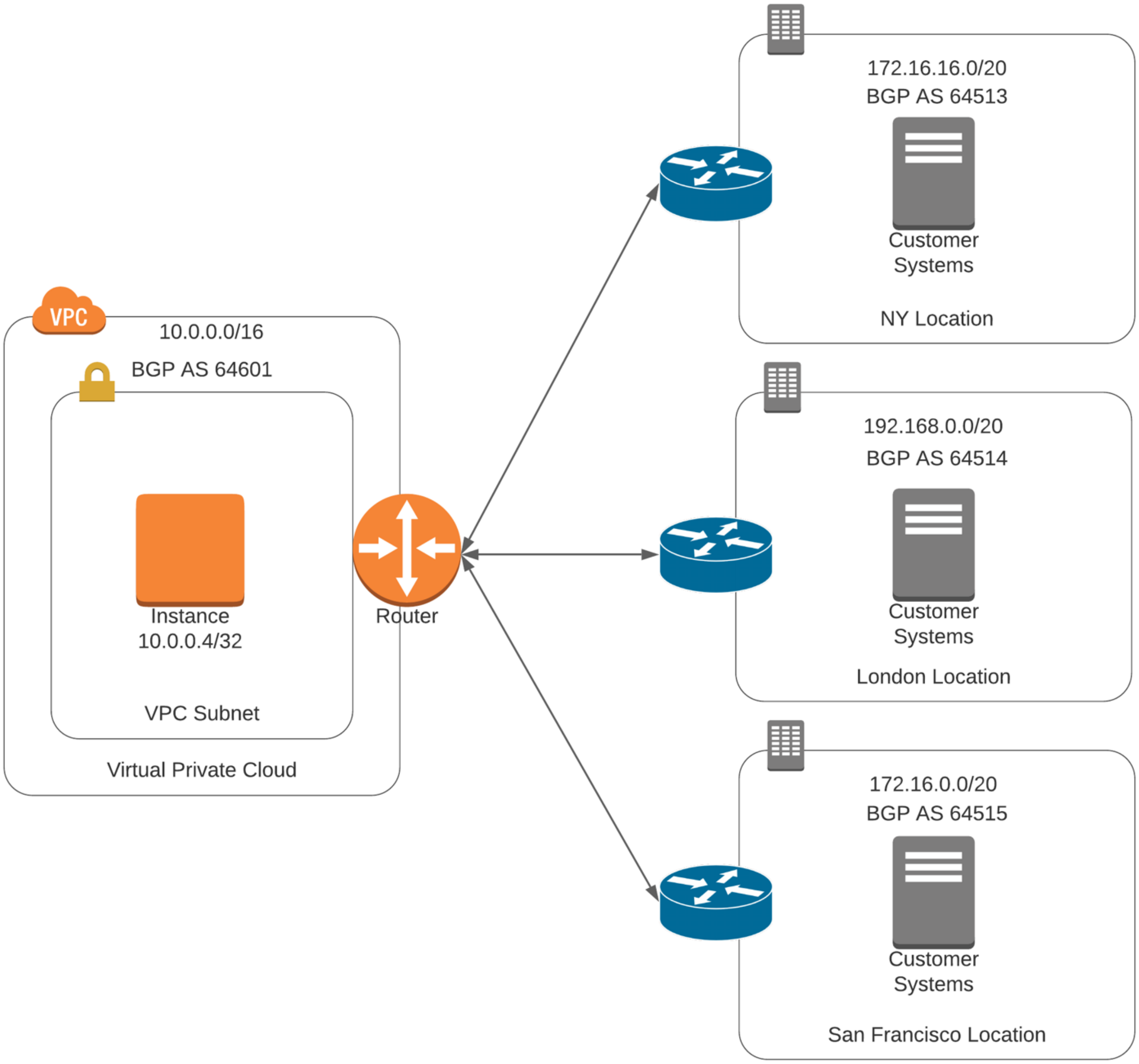
The diagram below shows an example of fully meshed VPC peering on the AWS platform:



AWS CloudHub

When it's necessary to establish connectivity between a VPC and a large number of remote sites, CloudHub simplifies the process of VPC peering. CloudHub enables an organization to have transitive VPC connections in a hub-and-spoke environment. CloudHub uses BGP, specifically eBGP, to connect and share routing information across VPCs. Routing information is propagated via BGP, which provides network reachability to all remote locations or connected VPCs. Since all remote locations have knowledge of all subnets across organizations and VPCs, full communication across VPCs is established. Since BGP is used for route sharing, connectivity can be limited to only desired resources by using route filters, access lists, and firewalls.[41]

The diagram below shows an example of using CloudHub to simplify VPC peering on the AWS platform:



Transit Gateway

Transit Gateway is a service designed to facilitate communication between multiple VPCs. It is very similar to CloudHub, but CloudHub only supports VPNs. Since the default behavior of the AWS VPC peering is nontransitive, Transit Gateway provides the ability to share routing across multiple VPCs.

Transit Gateway can share routes through both VPN connections and Direct Connect. Transit Gateway supports VPC peering across availability zones and regions. Transit Gateway ensures that all traffic traverses the AWS backbone and not the internet. Additionally, to further enhance security, all data remains encrypted, providing an additional layer of security. Transit Gateway supports near-unlimited scalability, allowing an organization to scale without having to worry about the capabilities of their Transit Gateway(s).

External resources can be connected to Transit Gateway through attachments. Transit Gateway supports the following **attachments.**

A connection to one or more:

1. VPCs
2. VPN connections
3. AWS Direct Connect gateways
4. AWS Transit Gateway Connect or third-party software-defined WAN appliances (SD-WAN)
5. Connections to other Transit Gateway(s) (Transit Gateway peering)

When sending a message across multiple VPCs, the VPCs must use the same Transit Gateway. This is because transit gateways do not share flow state information.

VPC Peering vs. PrivateLink

Both VPC peering and PrivateLink can be used to connect two separate organizations (VPCs). However, there are some significant differences between VPC peering and PrivateLink. Knowing which of these services to choose is essential to deliver the best solution.

When VPC Peering Is Best

VPC peering is best when an organization wants complete connectivity between organizations. VPC peering allows access to all the services an organization allows. VPC peering requires non-overlapping address space. So, if there is full communication between VPCs and non-overlapping IP address space, VPC peering is the best option.

When PrivateLink Is Best

PrivateLink is much more scalable than VPC peering. VPC peering has a limitation of 125 connections. Therefore, if many connections are needed PrivateLink, is the best option. PrivateLink allows overlapping address space between organizations, as PrivateLink provides NAT by default. PrivateLink is inherently more secure than VPC peering. PrivateLink allows access to only one service. To further enhance security, PrivateLink connections are unidirectional, meaning if you want connections in and out of your VPC, you must enable bi-directional communication.

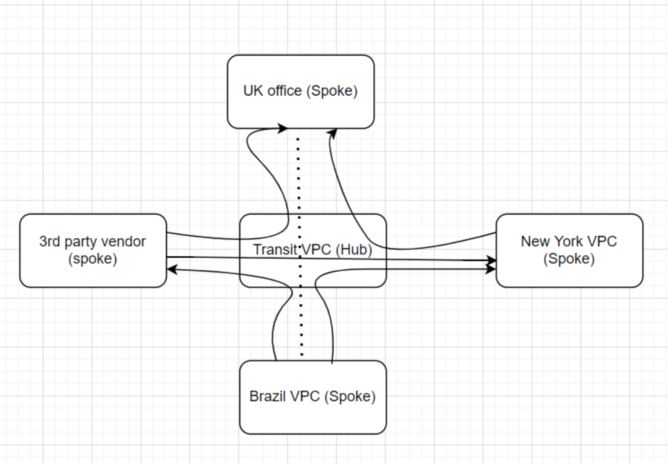
Enhancing the VPC Security Posture

AWS provides numerous options to enhance the security of a VPC. Two fundamental options to enhance the security of a VPC include network access control lists and security groups.

AWS Transit VPC

What is the AWS transit VPC?

A Transit VPC is a VPC that facilitates hub and spoke networking in the cloud. It is a strategy used to connect multiple VPCs and remote networks by using the Transit VPC as a hub and allowing them to tunnel traffic through the AWS global network as if it were a virtual private line. The Transit VPC acts as an intermediary allowing two or more VPCs to connect to themselves through it and obtain network services. The individual VPCs only need to connect to the Transit VPC via a virtual private network, then data is routed from one VPC to the other through the transit VPC. It is essentially a way to use the cloud as a conduit from VPCs. This networking connection method on the cloud allows users to connect various VPCs irrespective of their location or AWS account through a central VPC. This eliminates the need to have direct connections (peering) from each VPC to the other, simplifying the management of the networks. This architecture is like a dynamic VPN solution where the Transit VPC is the central point of focus while all other VPCs connecting through it are the spokes.



How does AWS Transit work?

The AWS Transit VPC acts like a cloud router and directs traffic to and from one VPC/branch to the other allowing users to monitor traffic flow. The Transit VPC has all the spokes connecting directly to it and uses an external gateway routing protocol (EGRP) called border gateway protocol (BGP) to route traffic between the different VPCs. It keeps the data flowing through it privately by automatic encryption of data. It can also use access control lists to filter traffic further enforcing security. The data is never routed through the public Internet but via the AWS global cloud network. This “cloud router” also can perform network address translation (NAT) so that 2 or more VPCs with the same IP address subnet ranges can still be connected through the transit VPC without any problems.

Why do we use AWS Transit?

Organizations can use Transit VPCs when they need to connect branch offices and/or VPCs scattered across different locations and get the look and feel of a private network over the cloud. In addition, routing traffic through a Transit VPC eliminates the need for multiple sets of routers as well as private lines across VPCs which will help optimize cost for an organization because it only needs one connection per VPC to the transit VPC to achieve full interconnectivity. The Transit VPC also allows for shared connectivity between multiple VPCs. This can help to quickly scale resources when there is an urgent need.

Network Access Control List (NACL)

The NACL is a means to enhance security by keeping unwanted traffic out of a subnet. NACLs block or permit traffic in a manner similar to an access control list on a router or a stateless firewall.[42] There are some key things to understand about NACLs in order to use them effectively:

- Rules are created to determine what traffic is allowed or denied.
- The accept or deny rules must be written in a specific order.
- The rules are processed in order. Therefore, if you explicitly deny something, it won't be possible to permit something that is denied by a previous statement.
- The order is determined by the number attached to the rule statement.
- Lower numbers in the rule statement are processed prior to higher numbers.
- Network ACLs have an implicit deny, so you must specify any traffic that you want to allow, or it will all be blocked when you add a network ACL. The allowed traffic must be sequenced before any rule that denies the desired traffic.
- NACLs are written in both inbound and outbound rules. Inbound rules determine what's allowed into a subnet; outbound rules determine what traffic is permitted to leave a subnet.
- Remember, NACLs are stateless, so inbound rules and outbound rules need to match. If SSL is allowed in, then it must be allowed back to the requester. NACLs are stateless; therefore, there is no means to allow return traffic like a stateful firewall.

The order of the rules in the NACL are important. Below are two examples of network ACLs, one with the proper technique, and the other with an incorrect technique.

Proper NACL Structure – Do This!

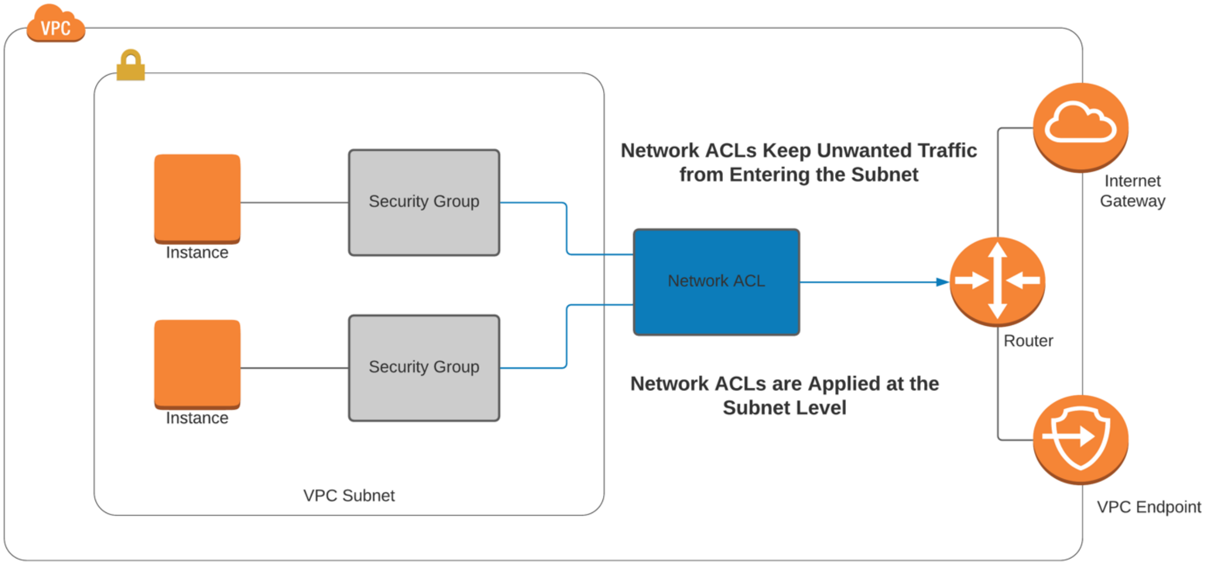
Inbound
Rule 110 Allow TCP Port 80 Source any
Outbound
Rule 110 Allow TCP Port 80 Destination any

Improper NACL Structure – Don't Do This!

Inbound
Rule 100 – Deny all traffic
Rule 110 Allow TCP Port 80 Source any

Note that in the above example with improper technique, all traffic is blocked by the first rule in the NACL; therefore all traffic is blocked. This reinforces the need to use the correct order in NACL rule statements.

The diagram below shows how network ACLs keep unwanted traffic out of the subnet:

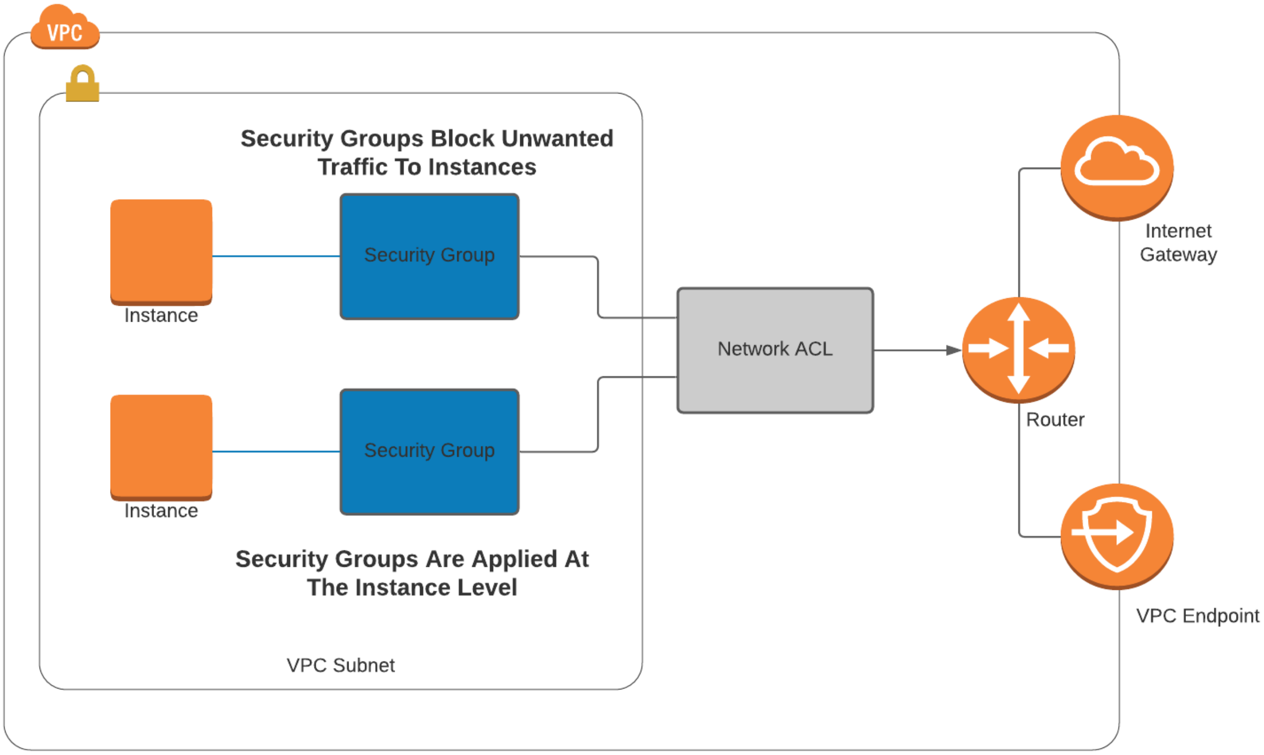

VPC
Instance
Security Group
Instance
Security Group
VPC Subnet
Network ACLs Keep Unwanted Traffic from Entering the Subnet
Network ACL
Network ACLs are Applied at the Subnet Level
Internet Gateway
Router
VPC Endpoint

Security Groups

A security group is essentially a stateful access control list (like a firewall) that is applied to a computing instance or AWS service. This is different than an NACL, which is applied to a subnet. Realistically speaking, a good security architecture will include NACLs at the subnet and security groups attached to the server.

Security groups have an implicit deny, so only permit statements are required. All that is necessary is configuring the permit statements to allow the desired traffic into the server. Since security groups are stateful, it is only necessary to permit inbound traffic, as outbound return traffic will be permitted. Security groups evaluate all rules prior to permitting or denying traffic, so the order of rules in a security group is not as critical as with NACLs.[43]

The diagram below shows how security groups keep unwanted traffic out of the instance:



Chapter 7 - AWS Network Performance Optimizations

There are three components of AWS networking that can have a substantial impact on performance and availability: *placement groups, Route 53*, and *load balancers*.

Placement Groups

Placement groups are simply where an organization places their equipment, such as servers (EC2 instances). Where an organization places its equipment can have a profound effect on performance and availability. There are three options for placement groups: *clustered*, *partitioned*, and *spread groups*.[44]

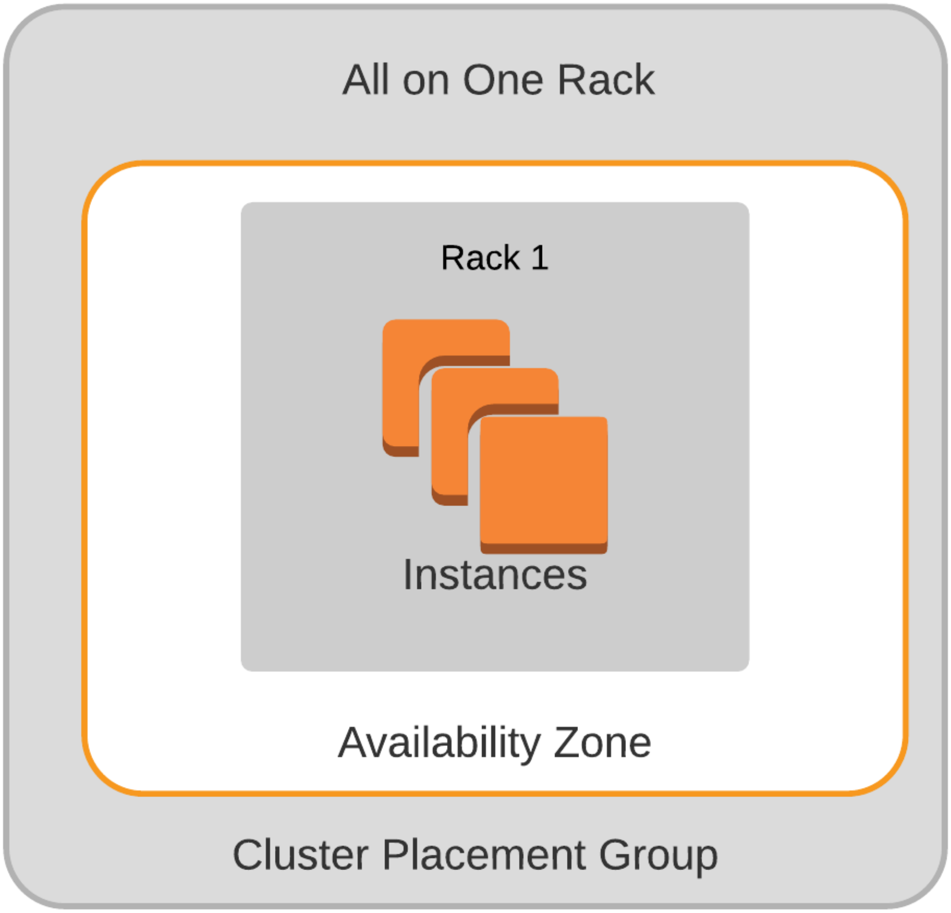
Clustered Placement Groups

A *clustered placement group* offers the best performance at the expense of availability. A clustered placement group means placing an organization's servers extremely close to each other to reduce latency and optimize performance.[45] Some key tenants of placement groups are as follows:

- Proximity – Instances are very close in physical proximity.
- Instances are often in the same rack.
- Instances are often on the same physical server.
- Since devices are often on the same rack, on the same network switch, and on the same server, this offers the absolute best network performance

Clustered placement groups have a major drawback when it comes to availability. Since everything is close together, often on the same server, rack, switch, and power source, there are many single points of failure when compared with other architectures. This architecture is perfect for applications that are not tolerant of latency.

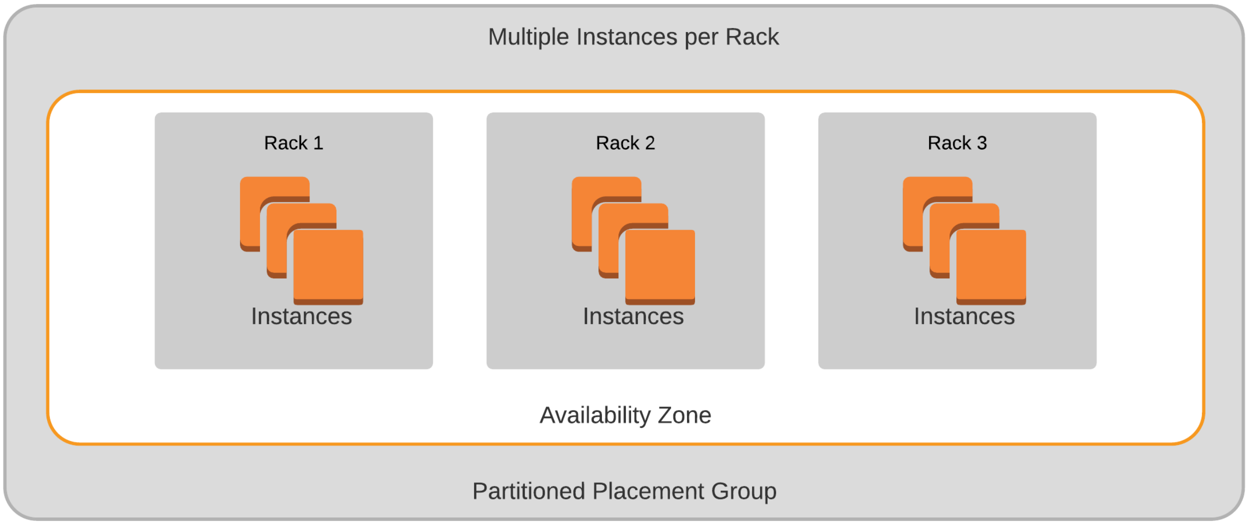
The diagram below shows an example of a clustered placement group:



Partitioned Placement Groups

Partitioned placement groups provide a high level of performance, low latency, and with higher availability than a clustered placement group. Partitioned placement groups place all components in a single AZ (data center). However, the instances are grouped into partitions and spread across data center racks. Spreading the load across a data center minimizes the risk that a single server, power outage, or network switch failure will bring the entire system down.[46]

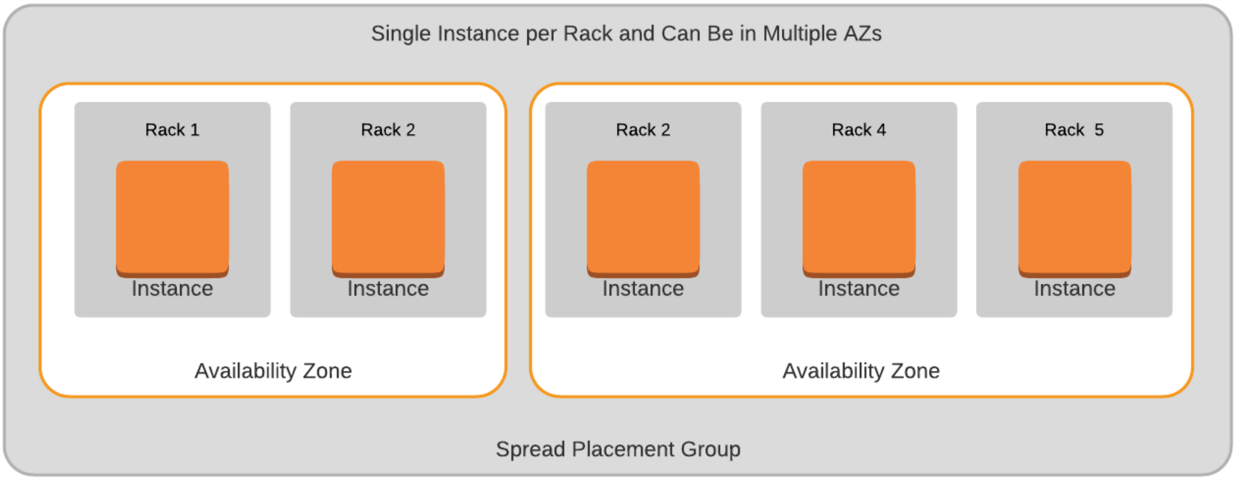
The diagram below shows an example of a partitioned placement group:



Spread Placement Groups

A spread placement group is optimal when a high-availability design is required. In spread placement groups, instances are spread across hardware, racks, physical servers, power distribution units, and other system components. Groups can be spread across multiple availability zones. This design offers high availability, but with higher latency and lower network performance than clustered and partitioned placement groups.[47]

The diagram below shows an example of a spread placement group:



Elastic Fabric Adapter

The Amazon Elastic Fabric Adapter (EFA) is a type of network interface offering high performance and throughput. The Elastic Network Adapter (ENA) was designed for high-performance computing (HPC) applications.

It is essentially a newer and faster form of a network interface, an interface that has been designed to support speeds of 100 Gbps.

The Elastic Fabric Adapter is a custom-built interface that bypasses the operating system to enhance the performance of inter-instance communications, which is critical to scaling of high-performance applications.

The Elastic Network Adapter can be attached to EC2 instances to accelerate high-performance computing and machine learning applications.

The Elastic Fabric Adapter works with the most commonly used interfaces, APIs, and libraries for inter-node communications. The Elastic Fabric Adapter can be used with little or no modifications in the organization's applications.

Single-Root Input/Output Virtualization (SR-IOV)

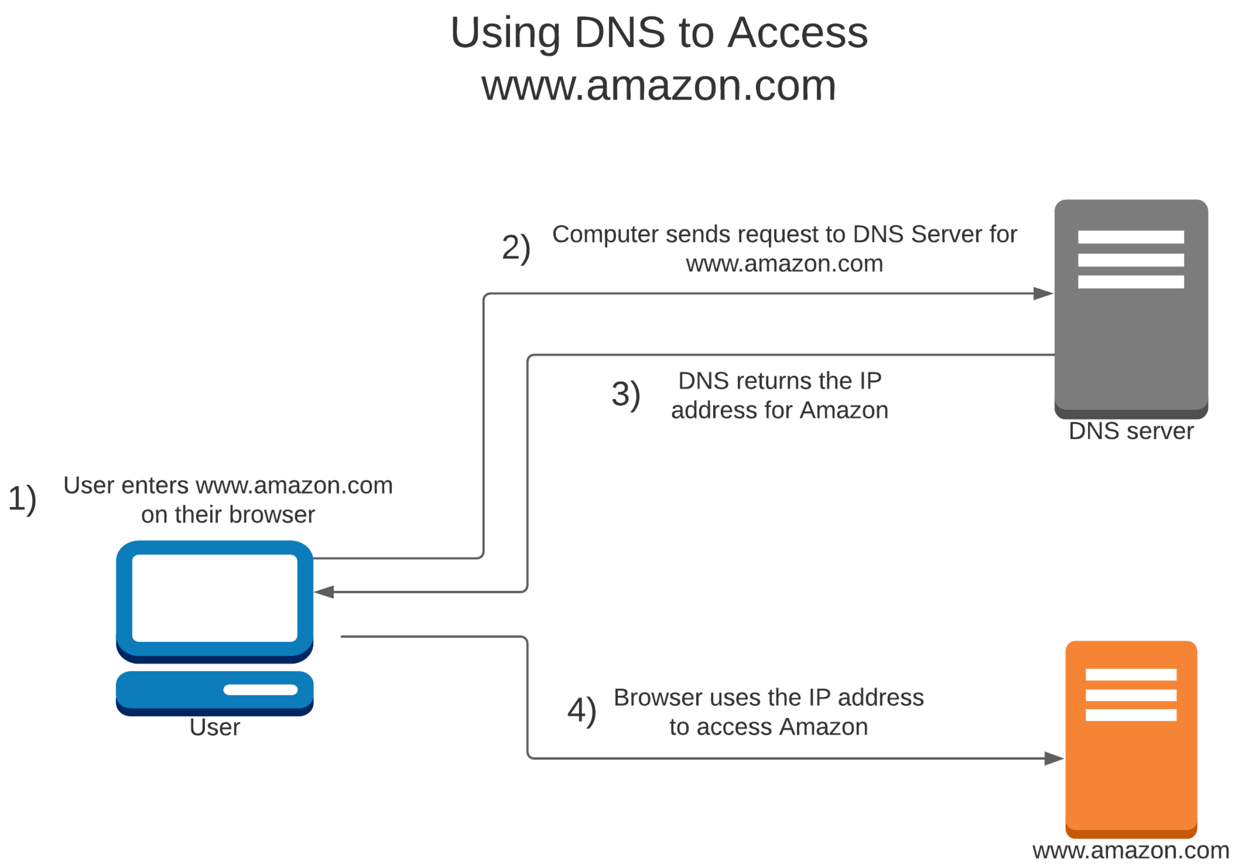
Servers in the cloud are virtual machines. That means virtualized network cards, video cards, and other virtual hardware components. Under normal circumstances this works fine, but when an organization requires high performance, virtual hardware is often not enough.

Often an organization needs the performance of actual hardware, a physical graphics processing unit or a physical network adapter. Enter the world of SR-IOV. *Single root I/O virtualization* is placing a physical network card in a virtual machine, essentially passing a PCIE card into the virtual machine.

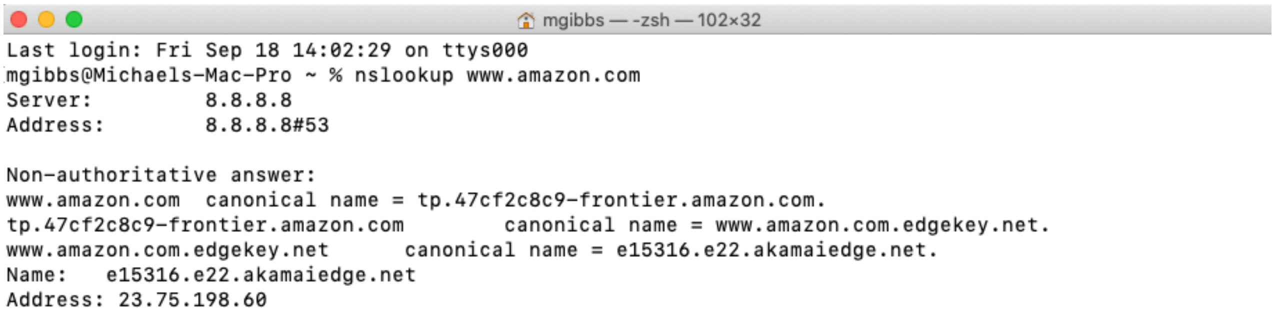
By passing the physical network card into the virtual machine, the virtual machine will have full hardware performance. SR-IOV is a way to combine the flexibility of virtualization with bare metal server networking performance.

Amazon Route 53

Every device on the network requires an IP address. While it's possible to connect directly to every system using just the device's IP address, it's infeasible to remember every system's IP address. Imagine remembering the IP address of every website on the internet. The solution that was developed to this challenge was the Domain Name System (DNS). The DNS maps a name with an address. Amazon Route 53 is Amazon's implementation of the DNS.[48]
The diagram below shows an example of DNS mapping a name to an IP address:


Using DNS to Access www.amazon.com
2) Computer sends request to DNS Server for www.amazon.com
3) DNS returns the IP address for Amazon
DNS server
1) User enters www.amazon.com on their browser
User
4) Browser uses the IP address to access Amazon
www.amazon.com

For example, it’s very easy to remember www.amazon.com. When we enter www.amazon.com, our systems ask the DNS server what the IP address is for this website. Then our request is forwarded to the IP address of the Amazon website. You can see the name to address mapping on any UNIX/Linux and Windows systems with the nslookup command:



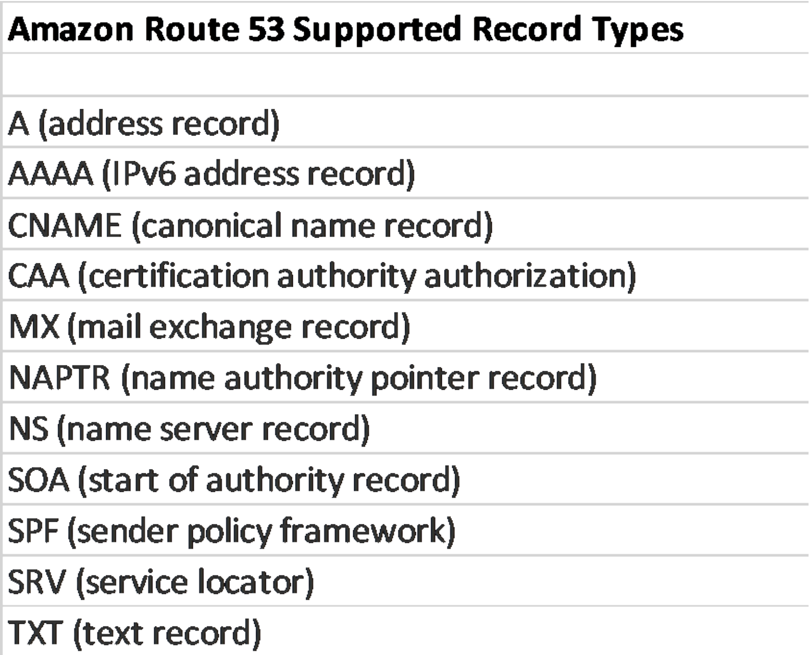
```
Last login: Fri Sep 18 14:02:29 on ttys000
mgibbs@Michaels-Mac-Pro ~ % nslookup www.amazon.com
Server:         8.8.8.8
Address:        8.8.8.8#53

Non-authoritative answer:
www.amazon.com  canonical name = tp.47cf2c8c9-frontier.amazon.com.
tp.47cf2c8c9-frontier.amazon.com        canonical name = www.amazon.com.edgekey.net.
www.amazon.com.edgekey.net      canonical name = e15316.e22.akamaiedge.net.
Name:   e15316.e22.akamaiedge.net
Address: 23.75.198.60
```

Some key points to know about AWS Route 53:

- Route 53 provides name to IP address mappings just like any other DNS platform.
- Route 53 is a high-availability platform for DNS services.
- Route 53 is highly scalable platform for DNS services and server health checks.
- AWS uses anycast services, for which there are multiple servers with the same address placed over the internet.
- Anycast provides extremely high availability and low latency. As a host, it will connect to the closest DNS server based upon its IP address. If a DNS server were to become unavailable, the host will connect to the next closest anycast address of the DNS server
- Route 53 supports most of the available DNS record types.
- Route 53 uses TCP and UDP port 53.
- Route 53 works with health checks and can be used to create a high-availability solution.
- Route 53 supports most DNS record types.
- Route 53 has numerous options to optimize a web-based environment.

AWS supports the following DNS record types:



Amazon Route 53 Supported Record Types
A (address record)
AAAA (IPv6 address record)
CNAME (canonical name record)
CAA (certification authority authorization)
MX (mail exchange record)
NAPTR (name authority pointer record)
NS (name server record)
SOA (start of authority record)
SPF (sender policy framework)
SRV (service locator)
TXT (text record)

While a deep understanding of DNS is beyond the scope of this book, there are some DNS records that are so foundational we recommend learning them. These key record types are as follows:

A – Record

- The most fundamental DNS record.
- A record mapping a name to an IP address.
- The IPv6 equivalent is an AAAA record.

CNAME – Record

- This is a record that maps a domain to another domain.
- It can map to another CNAME Record or an A record.
- CNAME records effectively redirect a request for one domain to another domain.
- i.e., map www.a.com to www.b.com.

NS – Record

- Identifies the DNS servers that are responsible for your DNS zone.
- These authoritative name servers propagate an organization's official DNS information to the DNS servers across the internet.
- NS records can be several entities.

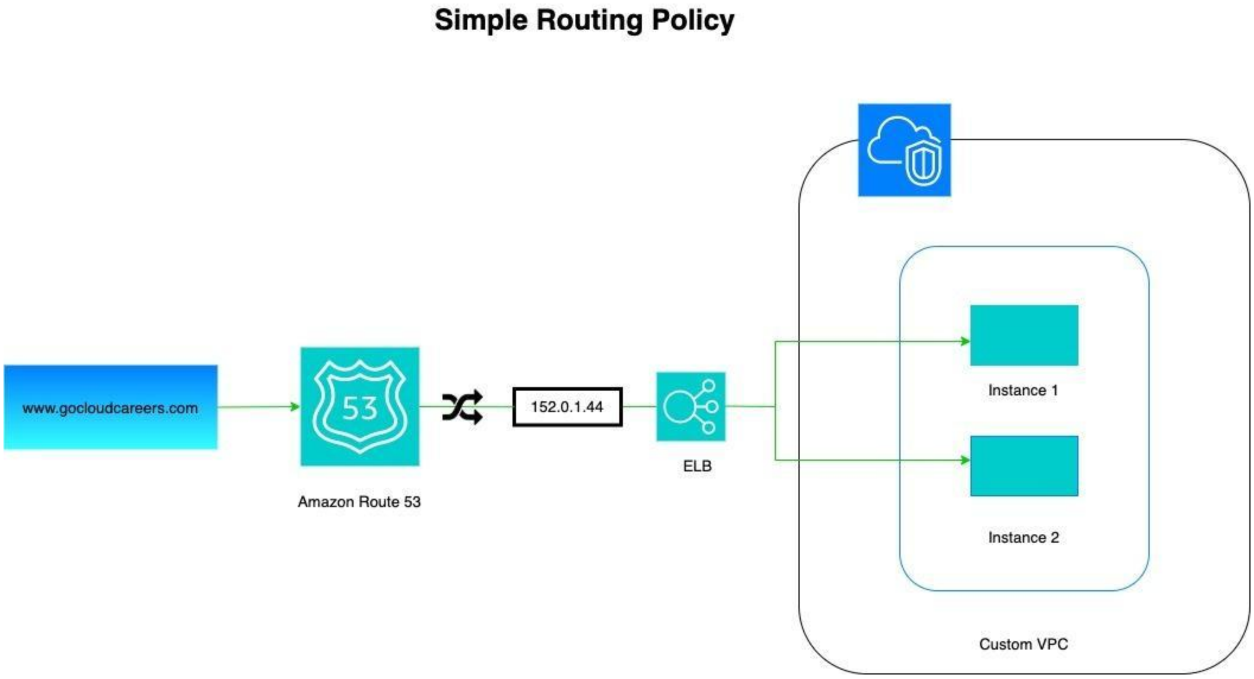
MX – Record

- An MX record specifies which mail servers can accept mail for your domain.
- MX records are necessary to be able to receive email.

Policy Based Routing Options

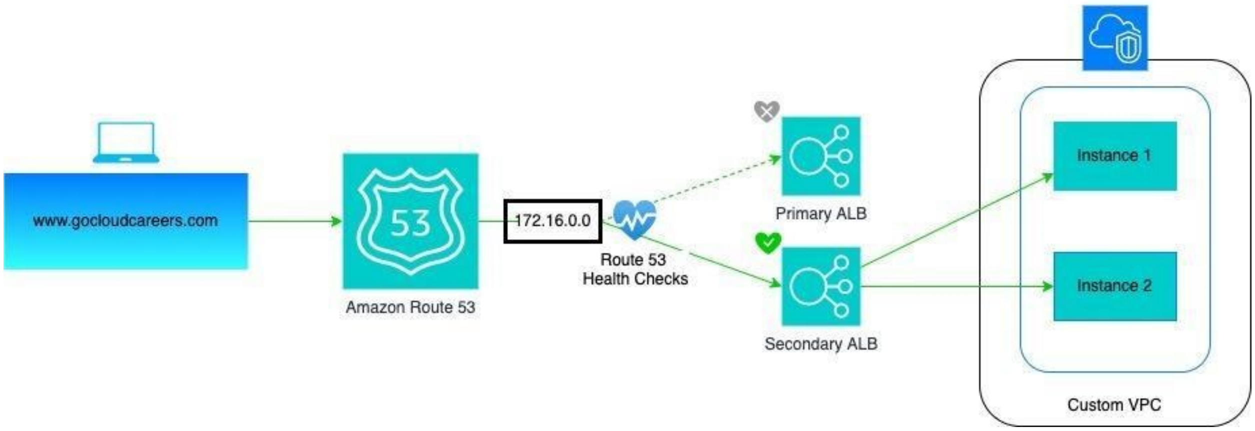
AWS has several policy-based routing options for Route 53. These policies can be as simple as mapping a name to an IP address to finding the sever with the lowest latency. The AWS Route 53 policies and their functions are as follows:

Simple routing – Basic DNS that maps a domain name to a single location. This is the default policy, which is perfect with a single server for a domain. An example of this policy can be seen below:

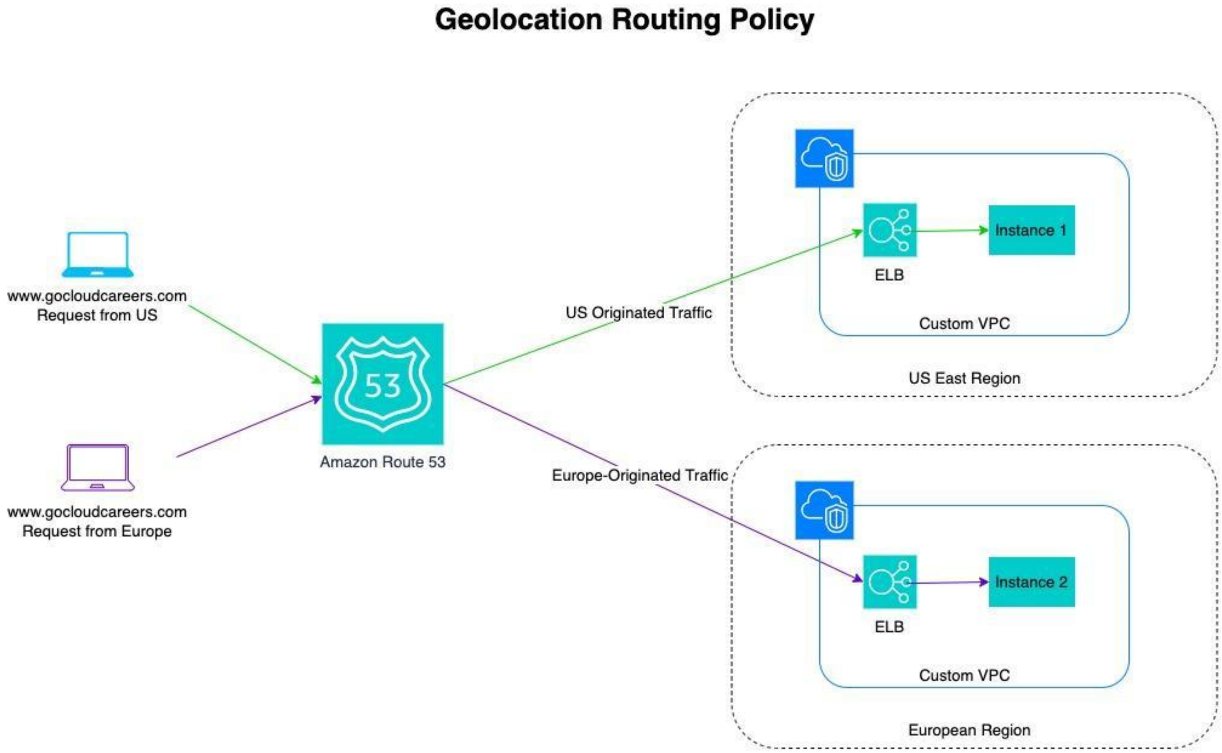


Failover routing – Sends the traffic to the main server. If that is not available, it sends traffic to a backup server. An example of this policy can be seen below:

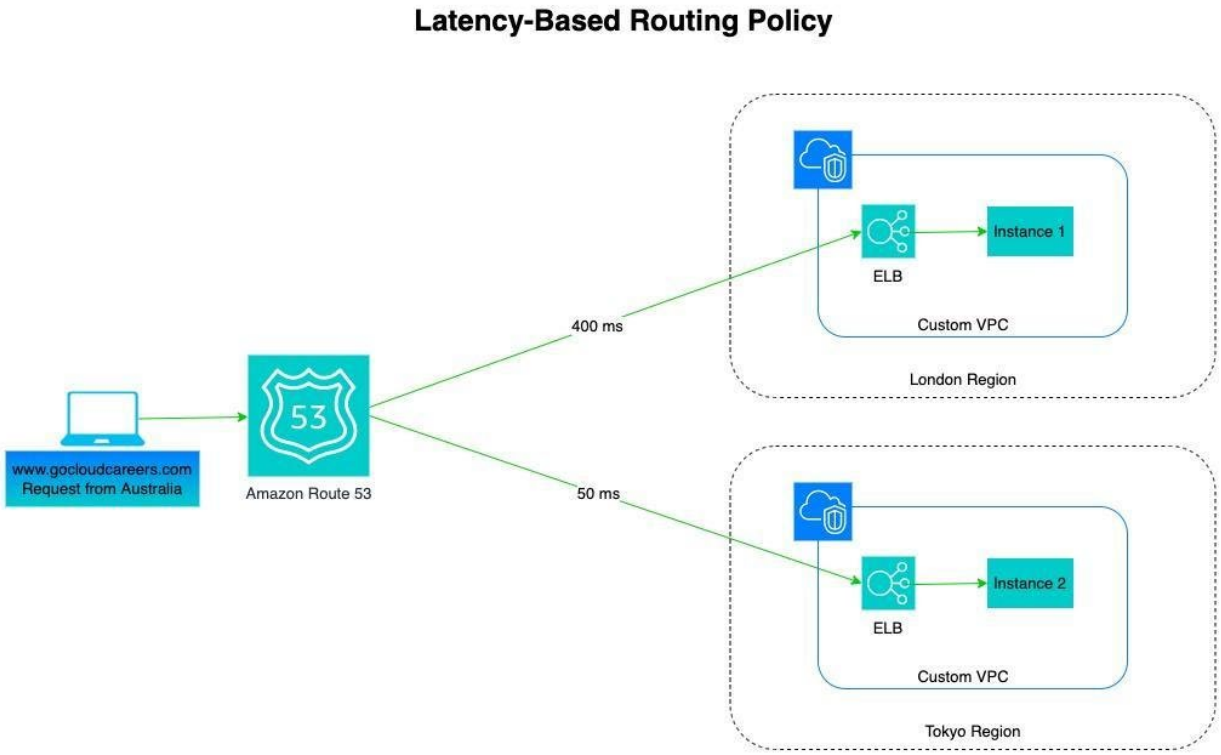
Failover Routing Policy



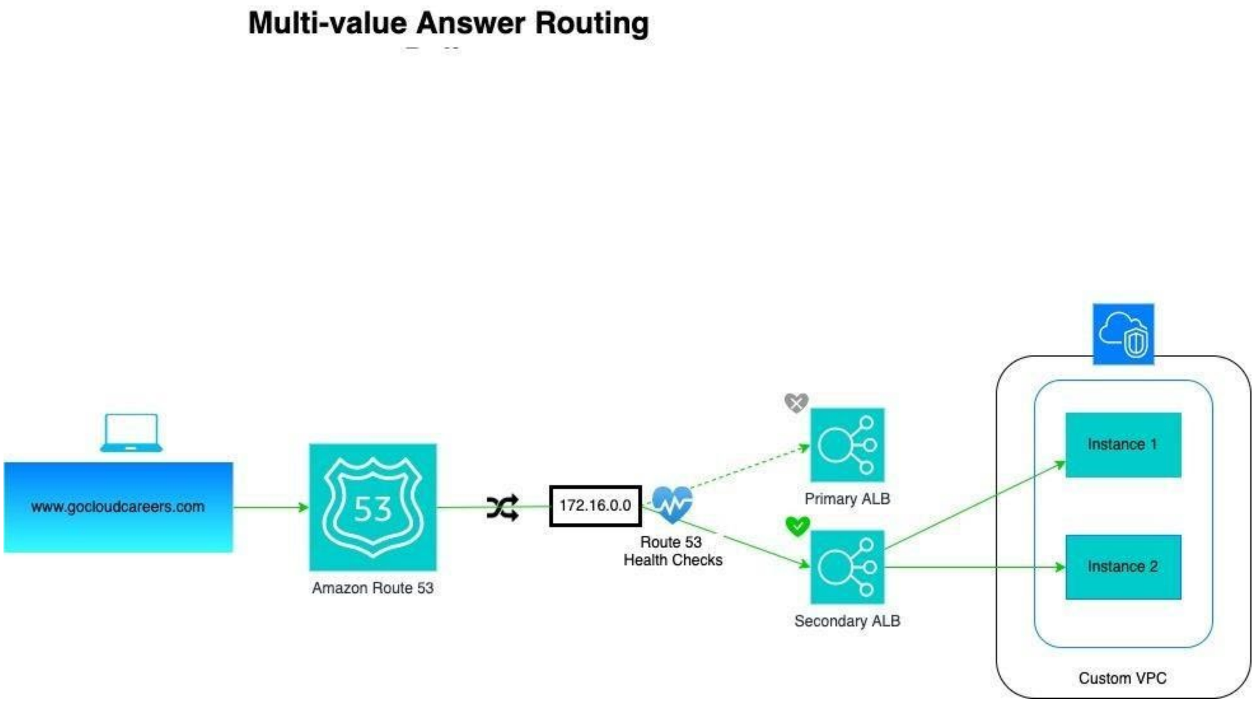
Geolocation routing – Used when there are servers in several regions. To optimize performance, geolocation routing will look at the source IP address of the user (which will ultimately provide their location) and route them to the closest region so they have the best performance. An example of this policy can be seen below:



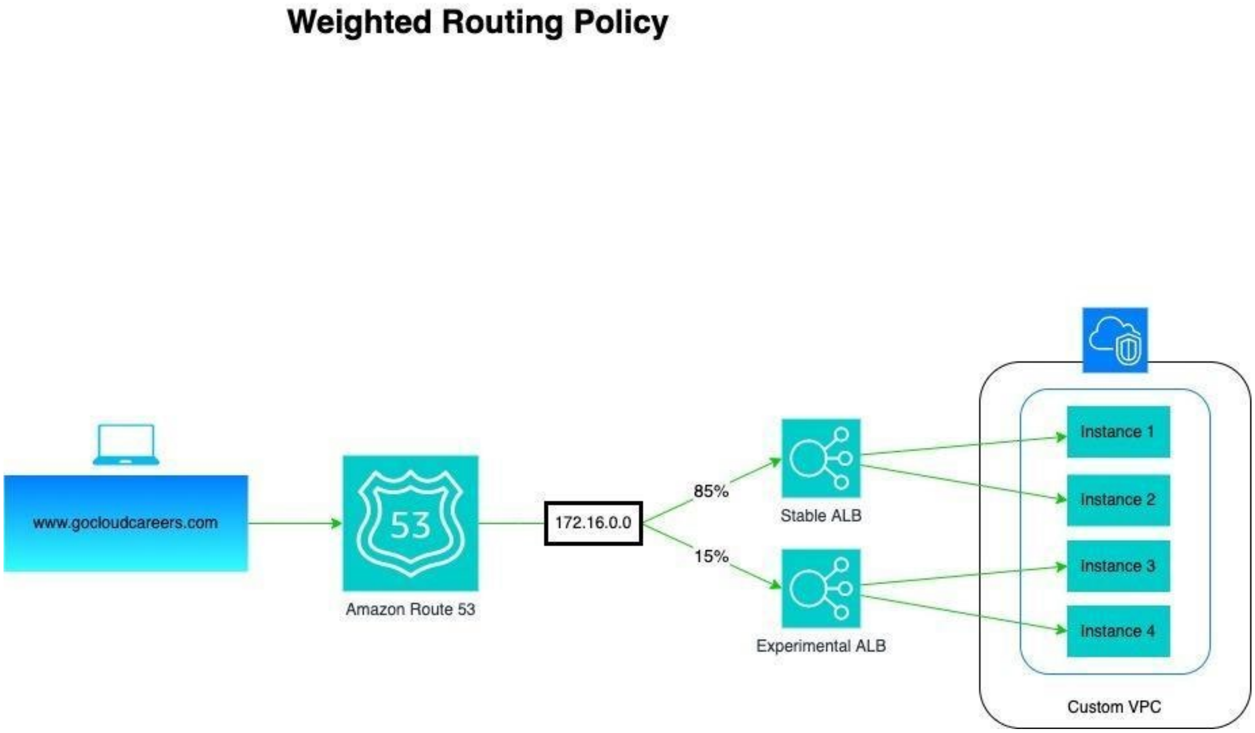
Latency-based routing – Will send to the server with the lowest latency to optimize performance. Ideal when the website is in multiple availability zones or regions. It provides the optimal experience to the user. An example of this policy can be seen below:



Multivalue answer – Route to any available server. An example of this policy can be seen below:



Weighted Routing – Provides a means to share traffic between servers at a percentage you chose, i.e., 75 percent to server *a*, and 25 percent to server *b*. It is a great option to test an application's functionality. Think of a CI/CD pipeline and blue-green deployments. Send most of the traffic to the old website for testing and a percentage to the new website. When the new site is tested, move the traffic to the new server. An example of this policy can be seen below:



Geoproximity routing – Used when an organization has servers in multiple availability zones. Geoproximity routing will send the requestor to the closest availability zone. There is also the ability to route traffic in a specific manner by using bias. Bias makes the geographic region larger or smaller.

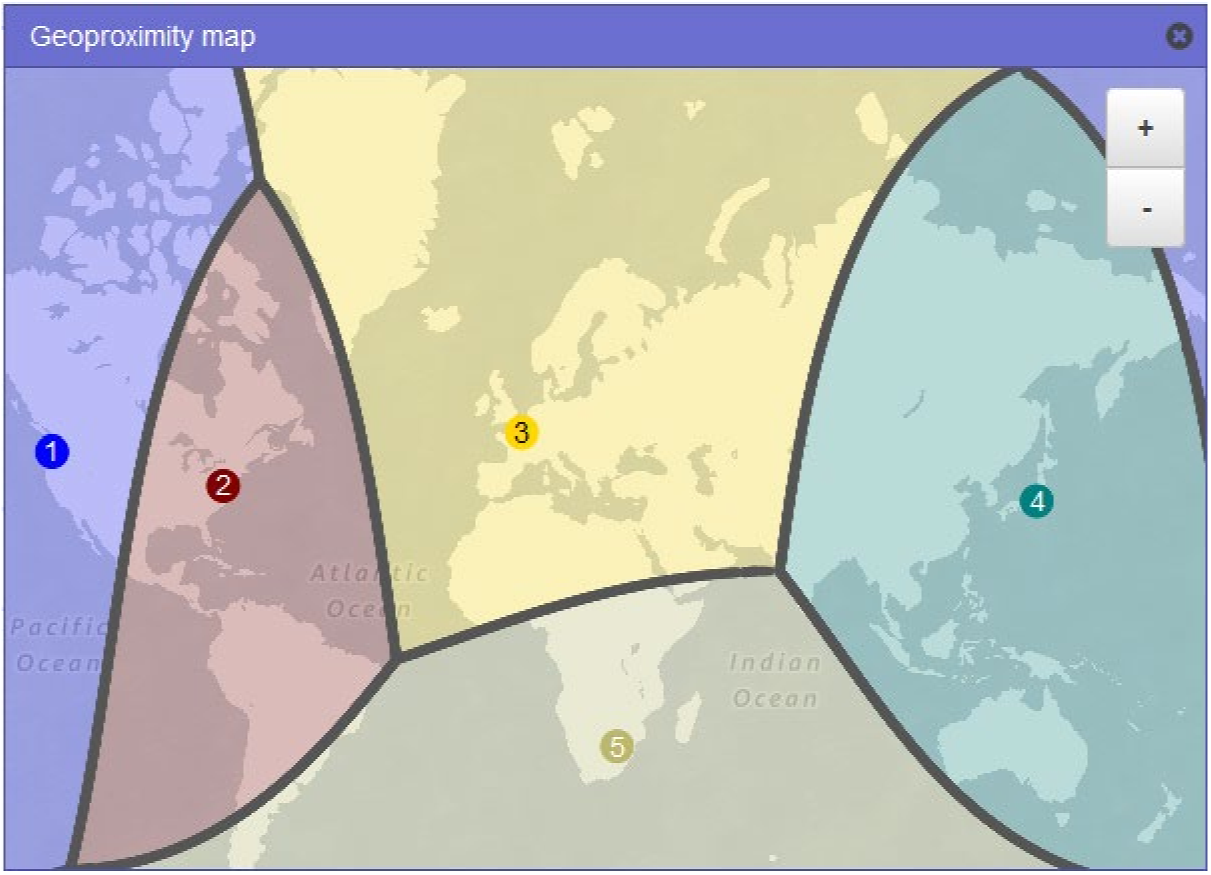


Image source [*https://docs.aws.amazon.com/Route53/latest/DeveloperGuide/routing-policy.html#routing-policy-geoproximity*](https://docs.aws.amazon.com/Route53/latest/DeveloperGuide/routing-policy.html#routing-policy-geoproximity)

Load Balancers

Load balancers are network devices that facilitate load sharing across servers. Load balancers can help greatly with scalability by allowing the application to be deployed across multiple servers. Load balancers can also increase availability by allowing multiple servers to be used simultaneously, removing single points of failure. Additionally, load balancers can use health checks to remove unhealthy servers from being used, which further enhances application availability.[49]

Since load balancers facilitate load sharing among servers, they can facilitate scaling out applications across multiple servers. Scaling out servers substantially increases performance.

There are some key concepts when working with AWS load balancers. These key concepts are listeners, targets, target groups, and sticky sessions.

Listeners

Load balancers have a *listener* which waits for connection requests. Application load balancers look at http, https requests, and ports 1–65535. Network load balancers look at protocol and port numbers, specifically TCP, UDP, TLS, and TCP_UDP ports 1–65535.

Targets

Load balancers distribute their traffic to a target. A *target* is a server, a container, or whatever is providing the service. Targets can be an EC2 instance or an IP address. When the target is an IP address, it must be from the private address space (RFC 1918) or the shared address space (RFC 6598):

- 10.0.0.0/8 (RFC 1918)
- 172.16.0.0/12 (RFC 1918)
- 192.168.0.0/16 (RFC 1918)
- 100.64.0.0/10 (RFC 6598) – shared address space

Target Groups

Target groups enable the systems administrator to group multiple targets together. For example, a target group can be used to group multiple EC2 instances together.

Sticky Sessions

A *sticky session* is keeping the session open between the client and a single server. By default, AWS network load balancers will keep a session active between the client and a single server. This is based on the way a network load balancer functions.

Application load balancers do not maintain a session between the client and server. However, the application load balancer can be set up to maintain a session between the client and the server. This occurs with enabling the application load balancer to use a cookie to track and manage the connection.

Types of Load Balancers

There are essentially four kinds of load balancers: classic load balancers, network load balancers, application load balancers, and gateway load balancers.

Network Load Balancers

Network load balancers operate at the transport layer (layer 4) of the OSI model. Network load balancers work with either the TCP or UDP transport protocol.

Application Load Balancers

Application load balancers operate at the application layer (layer 7) of the OSI model. Application load balancers typically work with the http or https protocol.[50]

The AWS implementation of a load balancer is called an Elastic Load Balancer. There are four options for Elastic Load Balancers. These options are Application Load Balancers, Network Load Balancers, Gateway Load Balancers, and Classic Load Balancers. There are some key things to know about Elastic Load Balancers:

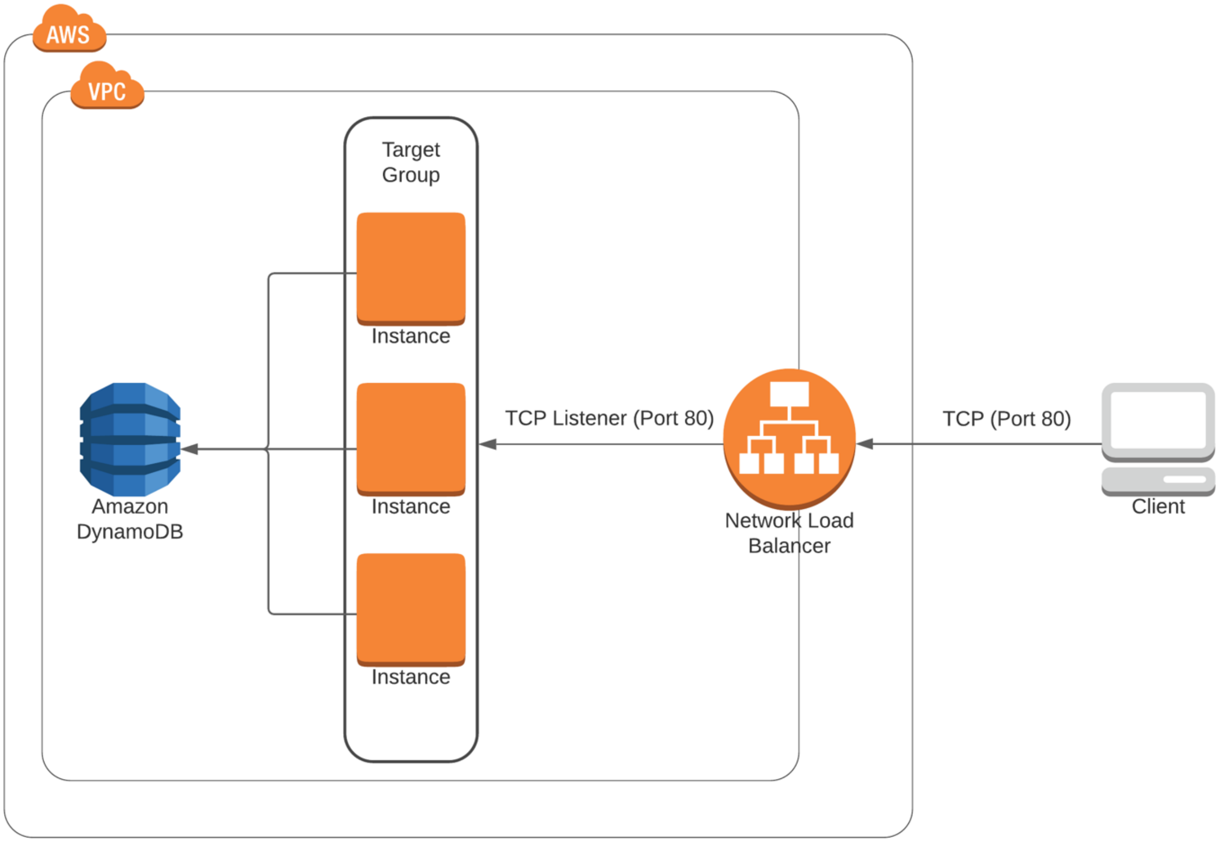
- Elastic Load Balancers automatically distribute traffic to multiple targets (i.e., EC2 instances, Lambda).
- Elastic Load Balancers can facilitate autoscaling. Load balancers can assist in the autoscaling of more instances if necessary to meet the application's performance needs.
- Elastic Load Balancers use an IP address, and if autoscaling occurs, multiple IP addresses will be used.
    - Plan your addressing scheme carefully so you don't run out of addresses.
    - Remember, AWS reserves the first four IP addresses (network and first three usable addresses) and the last (broadcast) IP address of the subnet.
- Elastic Load Balancers can load balance across availability zones.
- Elastic Load Balancers support health checks so nonfunctioning servers can be removed from use.
- Elastic Load Balancers can terminate SSL connections, which can reduce the load on servers.

Elastic Load Balancer – Network Load Balancer

The Network Load Balancer operates at the transport layer (layer 4) of the OSI model. Network load balancers work with either the TCP or UDP transport protocol. Network Load Balancers perform routing based upon the destination port of the traffic they receive. Network Load Balancers are extremely fast and are an excellent option when ultimate speed is needed. Network Load Balancers can handle millions of requests per second and excel with rapidly changing traffic patterns.

The Elastic Load Balancer network version is stateful. This means that once a connection is established between the host and the server, the connection is maintained until the session is completed. The Network Load Balancer keeps state by maintaining sticky sessions that have a mapping of the source and destination of the connections.[51]

The diagram below shows an example of an Elastic Network Load Balancer:



Elastic Load Balancer – Application Load Balancer

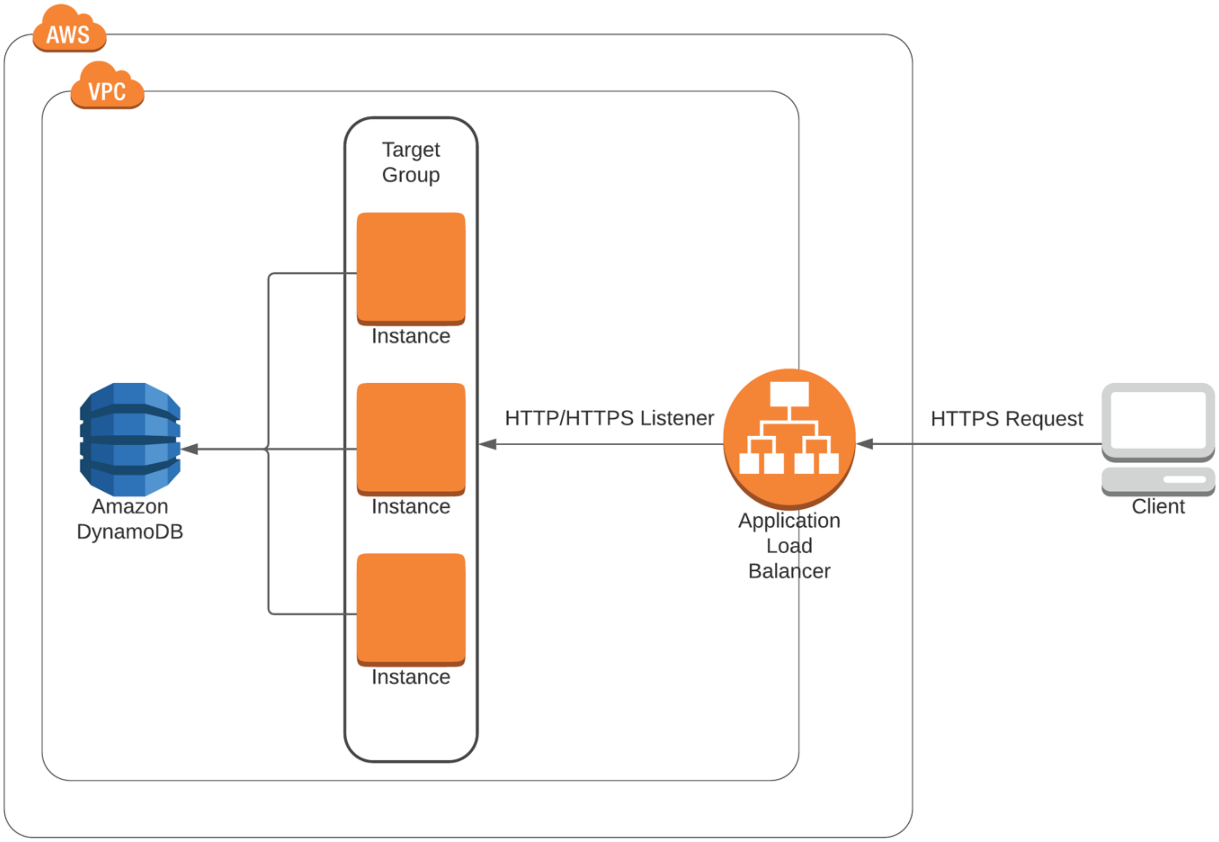
The Application Load Balancer operate at the application layer (layer 7) of the OSI model. Application load balancers typically work with the http or https protocol.[50] The application ELB can route traffic based upon many options and is ideal for web traffic. Application Load Balancers are an excellent means to load balance requests to microservices and container-based applications. Application ELBs can even load balance between a VPC and an on-premises data center.

Application Load Balancers are stateful. Once a connection is established between the host and the server, the connection is maintained until the session is completed. The Application Load Balancer keeps state by maintaining sticky sessions that have a mapping of the source and destination addresses of the connections.

Application ELBs make forwarding decisions based upon the following factors:

- Domain name
- Path provided by the URL
- Elements in the http, https header
- Http method-based routing (i.e., put or get)
- Source address

The diagram below shows an example of an Elastic Application Load Balancer:



Gateway Load Balancers

The AWS Gateway Load Balancer can be used to load balance third-party virtual appliances. Examples would include marketplace firewall solutions. The Gateway Load Balancer is used to provide redundancy—as there is no redundancy in a virtual appliance. Gateway Load Balancers are designed to replace the Network Load Balancer function when load balancing network devices. Gateway Load Balancers provide both layer 3 and layer 4 load balancing functions.

- Provide high availability by removing single points of failure with third-party appliances
- Can help increase network performance

Classic Load Balancers

The AWS Classic Load Balancer can be network based or application based. This is a legacy platform and can work with both EC2-classic and VPCs.[52] Classic Load Balancers have been deprecated and will be retired by August 20, 2022. Classic Load Balancers are characterized by the following:

- Have autoscaling capabilities
- Can support single or multiple availability zones
- Can terminate SSL connections to reduce server load
- Are stateful by using sticky sessions
- Provide logs to analyze traffic flows and can be used with CloudTrail for auditing

Chapter 8 - Security

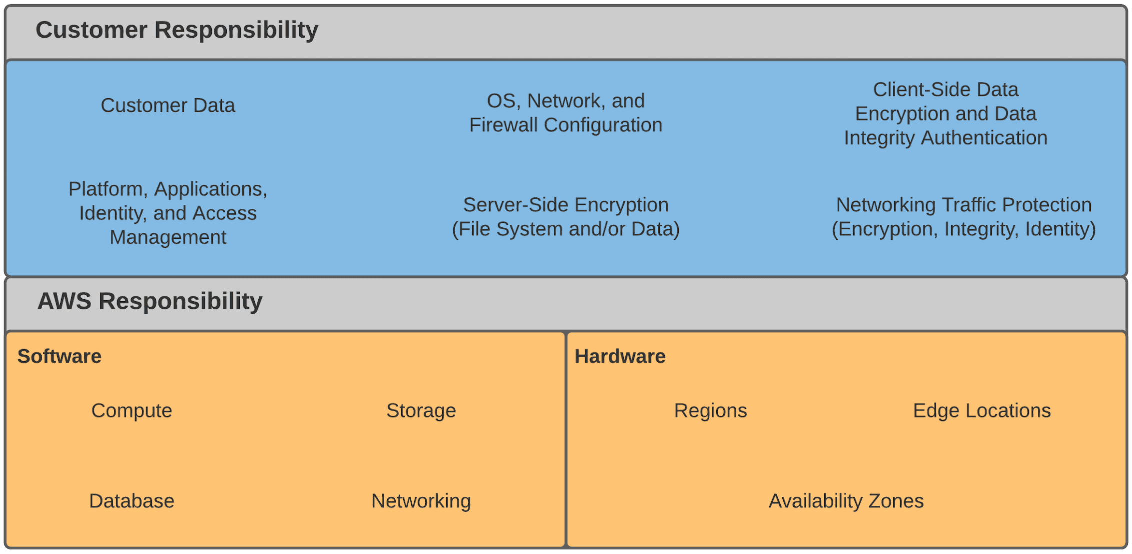
Security is a critical component for the success of any organization. A complete guide to full security architectures is beyond the scope of this book and should be explored by any organization that would face serious consequences if a security breach occurred. This chapter breaks down security into the following components:

- Who is responsible for what parts of the VPC
- Principle of least privilege
- Industry compliance
- Identity and access management
- Multiple account strategies
- Network ACLs, security groups, WAF
- Intrusion detection and prevention
- Distributed denial of service attacks and prevention
- Service catalogs
- Systems manager parameter store

AWS Shared Security Model

While outsourcing the data center to the cloud can help with costs, agility, scalability, and even security, there is still a substantial amount of security that must be performed by the customer. When outsourcing an organization’s data center to AWS, security and compliance responsibilities are shared between AWS and the customer. This is called the *shared security model*. In the shared security model, AWS maintains the security of the cloud, and the customer maintains the security of their VPC.[53]

The diagram below shows the AWS shared responsibility model:


Customer Responsibility
Customer Data
OS, Network, and Firewall Configuration
Client-Side Data Encryption and Data Integrity Authentication
Platform, Applications, Identity, and Access Management
Server-Side Encryption (File System and/or Data)
Networking Traffic Protection (Encryption, Integrity, Identity)
AWS Responsibility
Software
Compute
Storage
Database
Networking
Hardware
Regions
Edge Locations
Availability Zones

Securing the Cloud

AWS manages keeping the cloud secure. Keeping the cloud secure is really about managing the following functions:

- Principle of least privilege – The principle of least privilege is a best practice for limiting who from AWS can manage assets in the cloud by granting only the permissions required to complete a task.
- Physical security – Keeping the facility locked, keeping unauthorized users out of the AWS data centers.
- Security of the cloud – Keeping the cloud secure (firewalls, system patching, routing, IDS/IPS, change management)
- Follow industry regulations (accepted international security standards such as ISO 27001 and the National Institute of Standards and Technology (NIST), as Europe's General Data Protection Regulation (GDPR) and HIPAA.
- Keeping all AWS applications secure with patching and maintaining the underlying components of serverless applications offered by AWS.
- Keeping the AWS network secure with secure routing, VLANs, route filtering, firewalls, and intrusion prevention and detection (IDS/IPS).

Securing the VPC

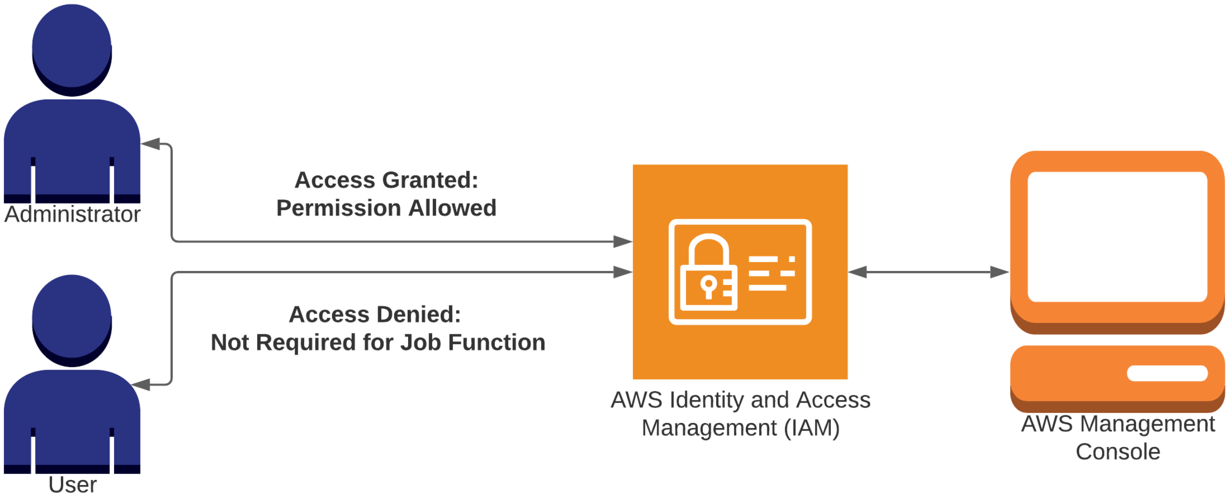
The customer is responsible for securing all aspects of their VPC. This means the customer is responsible for the following security components:

- Identity and access management – Determine who is allowed in the VPC and define their functions.
- Principle of least privilege – Grant the least privileges necessary for employees and partners to perform their functions effectively.
- Data security – Manage encryption.
- Maintenance of customer-designed applications.
- Management of the VPC routing tables.
- Managing traffic allowed into the VPC – Firewalls, NACLs, security groups.
- Maintenance of the operating systems and applications stored on EC2 compute instances.
- Physical security – Keep the devices that connect to the cloud secure from unauthorized users.

Principle of Least Privilege

One of the most critical components of security is the principle of least privilege. The *principle of least privilege* is really about making sure individuals and systems using the cloud can access only the functions necessary to perform their role effectively. Granting more than the minimal level of privileges can enable users or hackers to intentionally or accidentally damage the VPC. Additionally, privileges should be revoked when no longer needed, i.e., when an employee leaves the company.[54]

The diagram below shows the principle of least privilege by allowing access to the management console only to individuals who need access for their job function:



Industry Compliance

Many industries throughout the world are highly regulated. Often these industries have a legal requirement that requires a level of security, data retention, and auditing policies. AWS supports many international compliance requirements.[55]

Some key compliance standards are as follows:

- PCI DSS – for payment cards
- ISO 9001. 27001, 27017, 27018
- Fed ramp
- HIPAA – US health care privacy

A full list can be seen at https://aws.amazon.com/compliance/programs/.

Identity and Access Management

Identity and access management is a key component of any security architecture. Identity and access management is about identifying the user and giving the user access to the resources necessary to perform their functions.[56] Identity and access management is also referred to as AAA. The key components of AAA are as follows:

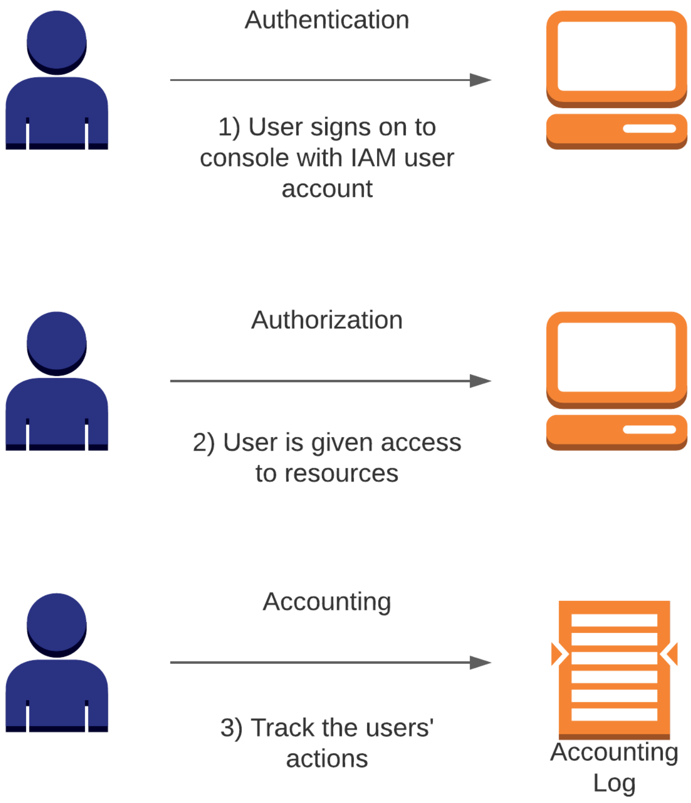
- Authentication – Identifying the user.
- Authorization – Determining if the user is allowed to access the resource.
- Accounting – The ability to see what the user has done.

AWS Identity and Access Management (IAM) enables granular management of access control of any organization's systems on AWS. IAM enables the ability to specify who has access to which services and resources and under what circumstances. IAM policies enable secure access to specific AWS services, i.e. APIs. This enables an organization to control access and use of their systems.

AWS divides IAM into users and roles. An *IAM user* is a person accessing the AWS cloud. Generally speaking, an *IAM role* is used by an AWS service to access another service, i.e., EC2 accessing DynamoDB.

AWS has some specific components of its IAM systems. AWS uses the concept of *principals*. In AWS a principal is an IAM entity that is permitted to access AWS resources. AWS further breaks down the principal concept into root users, IAM users, and roles.

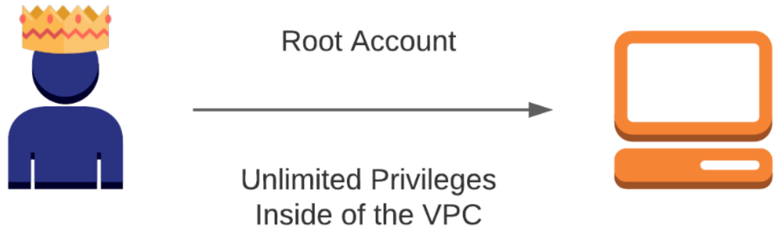
The diagram below shows the functions of authentication, authorization, and accounting:


Authentication
1) User signs on to console with IAM user account
Authorization
2) User is given access to resources
Accounting
3) Track the users' actions
Accounting Log

Root User

The root user is the person who created the AWS account. The root user has full system access. The root user can access the console and has programmatic access to AWS resources. Since the root user can do anything, including deletion of the VPC, it's best to use the root account to set up the VPC and then immediately create an IAM user with appropriate access to the VPC. This is similar in practice to not using the root account to log in to a UNIX or Linux system to prevent accidental system damage.

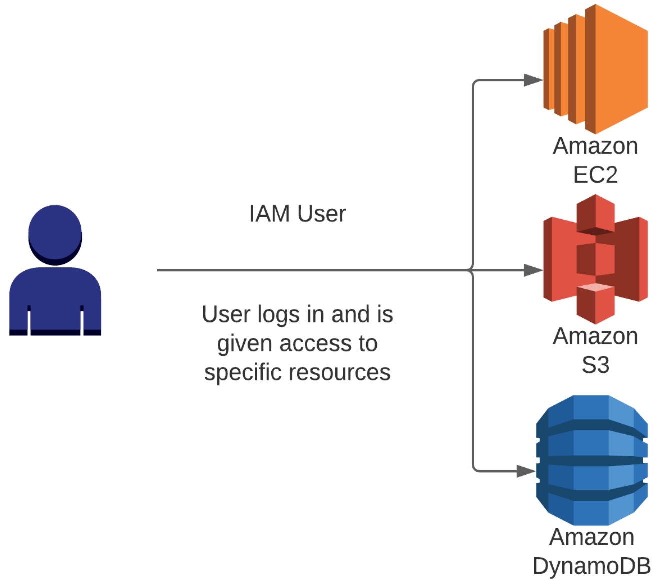
The diagram below shows an example of the root user privileges:



IAM Users

IAM users are identities that have permissions to interact with AWS resources. IAM users are created by principals with administrative access. IAM users can be created with the AWS Management Console, CLI, or SDKs. IAM users are permanent unless deleted by an administrator.

The diagram below shows provides an IAM user accessing an AWS VPC:



Roles and Security Tokens

Roles are used to provide access to AWS services. There are three types of roles in the AWS environment:

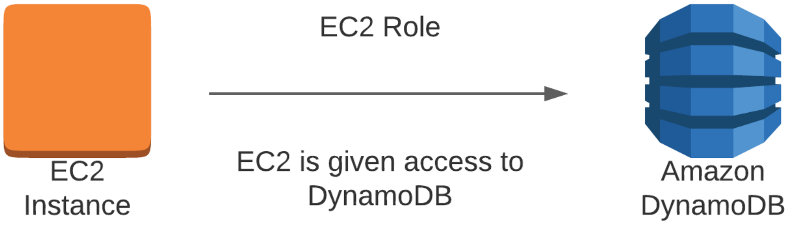
- EC2 roles
- Cross-account roles
- Identity federations

EC2 Roles

EC2 roles enable EC2 computing instances to access AWS services, i.e., S3 and DynamoDB. To set up an EC2 Role, an IAM role is created and then applied to the EC2 instance. By creating the EC2 role, there is no need to store AWS credentials on the EC2 instance, which further enhances security.[57] Here is how EC2 roles work:

1. An EC2 role is created.
2. The EC2 role is applied to an EC2 instance.
3. When the EC2 instance attempts to access AWS services, a temporary token is provided to allow access.
4. The AWS service recognizes the tokens and grants access.
5. As temporary tokens expire, new tokens are generated frequently.
6. By rotating tokens, security is enhanced as no password (key) needs to be passed to the application.
7. This greatly enhances security. If an EC2 instance were to be hacked, no passwords would be given to the hacker. Since the tokens expire and are rotated frequently, even if hackers were to gain access to a token, it could not be used for long.

The diagram below shows an example of an EC2 instance accessing DynamoDB with an EC2 role:

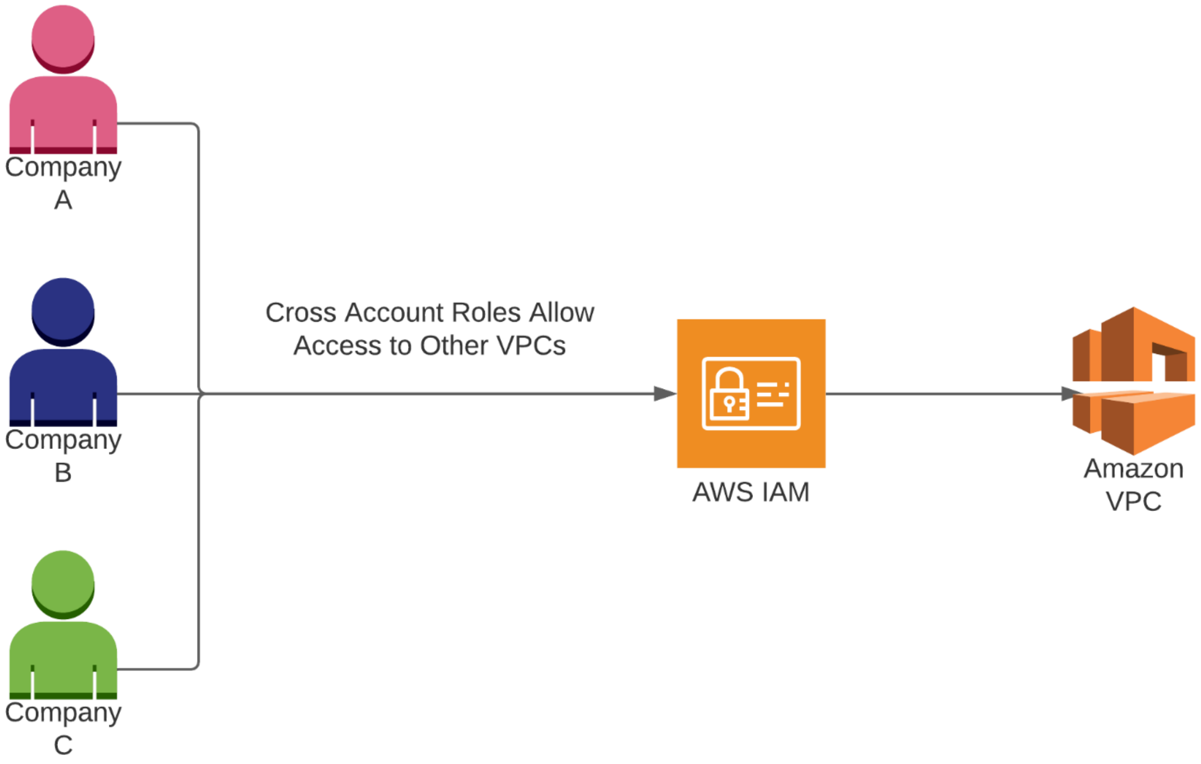


Cross-Account Roles

In the modern technology environment, it is frequently necessary for an organization to share resources with other business partners. To connect with organizations outside the VPC, cross-account roles are used. Connecting to other organizations can create significant business opportunities, but that connectivity also brings security challenges. The partner company may need access to certain resources but should not have access to any resource that could compromise the organization if lost or stolen. While it's always essential to provide access with the principle of least privilege, nowhere is it more critical than with connecting to external organizations.[58, 59] Therefore, be very strategic in assigning permissions to cross-account roles. Cross-account roles work in the following manner:

1. A role is created for the external user.
2. The external user connects to the AWS Secure Token Service (STS) and receives a temporary token.
3. The external user then provides the temporary token to AWS and is authorized to access the VPC.

The diagram below shows a cross-account role being used to access external VPCs.

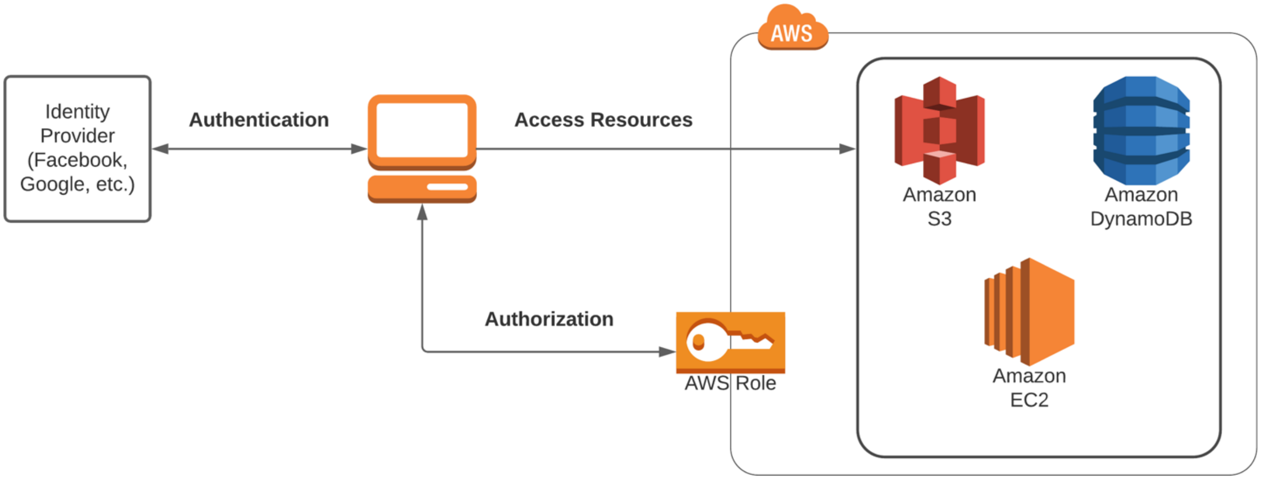


Identity Federations

IAM is such a critical function for organizational security. As organizations grow in size and complexity, IAM can become challenging to manage. Often the best way to scale IAM systems is to connect (federate) with an identity provider. A VPC can connect to an identity provider and use its IAM database within AWS. Connections with an identity provider are built by building a trust relationship with the identity provider. After the trust relationship is established, a connection is made with OpenID connect (OIDC) or Security Assertion Markup Language 2.0 (SAML).[60]

Identity providers can be an organization's active directory or LDAP systems, or external providers such as Google, Amazon, Facebook, Twitter, or LinkedIn. AWS has three choices for authentication with identity providers: single sign-on, Federated IAM, and AWS Cognito.

The diagram below shows how identity federations work with the AWS platform.

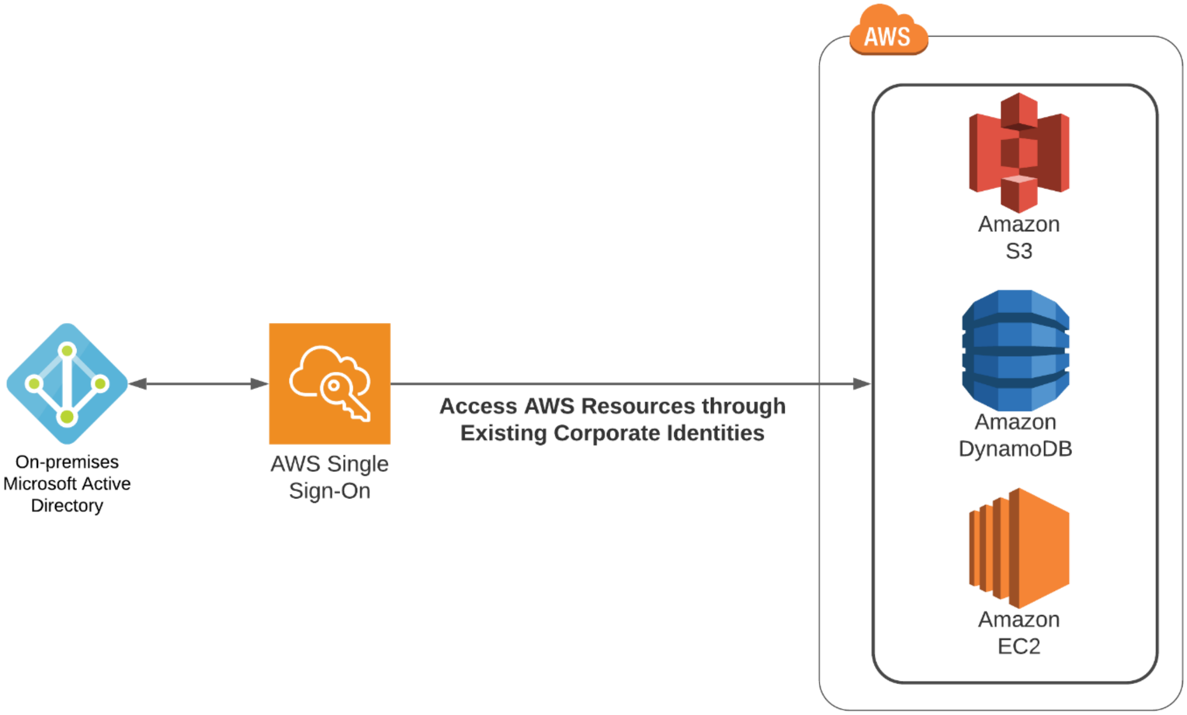


AWS Single Sign-On

AWS Single Sign-On enables the user to authenticate once to the identity provider, and then they will not need to sign on to access AWS services.[61] It works in the following manner:

1. The user signs on to the identity provider.
2. The user is authenticated by the identity provider.
3. The identity provider determines what group (permissions) to give the user.
4. The user is given permissions and is authenticated and authorized to use AWS services.

The diagram below shows how Single Sign-On works with the AWS platform:


AWS
Amazon S3
Amazon DynamoDB
Amazon EC2
On-premises Microsoft Active Directory
AWS Single Sign-On
Access AWS Resources through Existing Corporate Identities

Federated IAM

Federated IAM provides a means to authenticate with an external identity provider. Federated IAM enables significant and granular control over user functions. Federated IAM works in the following manner:

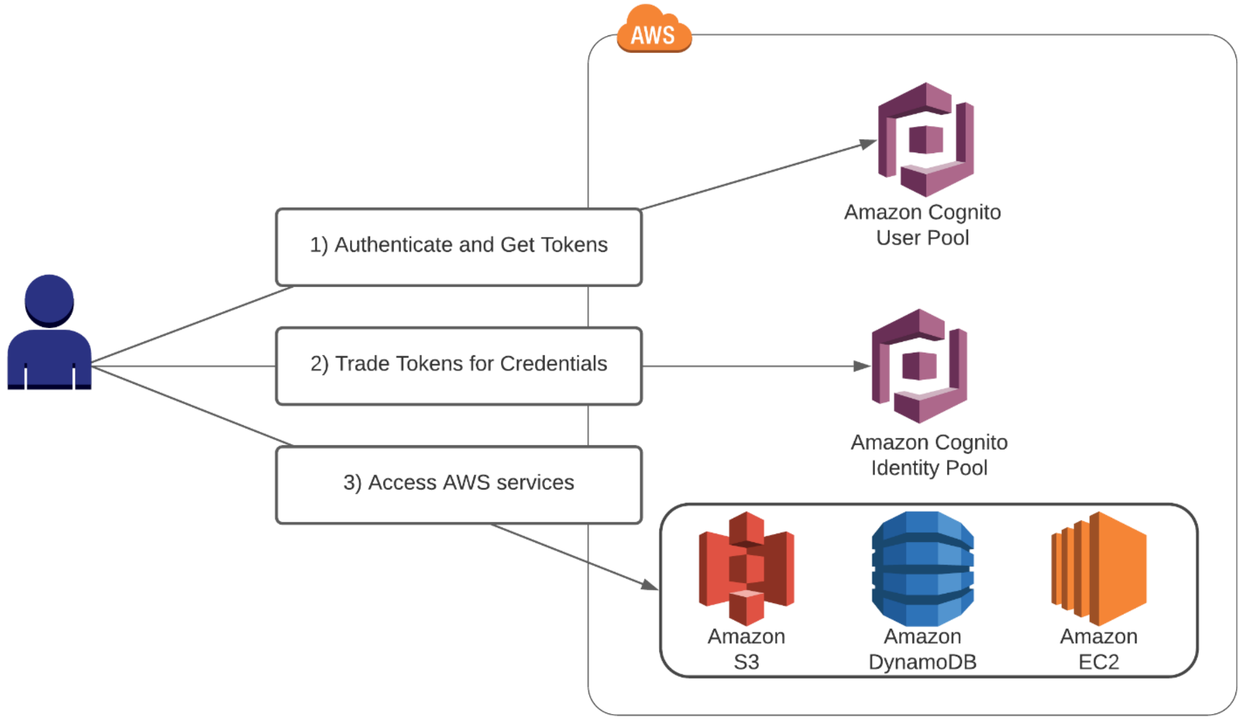
1. A user attempts authentication.
2. The request is forwarded to the identity provider.
3. The identity provider authenticates the users.
4. The identity provider determines the user's privileges.
5. The identity provider grants privileges based upon job role, the organization's cost center, and other factors.

AWS Cognito

AWS Cognito is an identity and data synchronization service. AWS Cognito enables organizations to synchronize identity management and data across mobile devices. Cognito provides authentication, authorization, and user management for web and mobile apps. AWS Cognito users can sign in directly with a username and password, or with a third-party identity provider such as Facebook or Google.[62] AWS Cognito is simple and efficient. Cognito works in the following manner:

1. The user attempts to authenticate against Cognito.
2. Cognito authenticates the user.
3. Cognito provides a token for the user.
4. The user device trades token for credentials.
5. The credentials are then used to access AWS services.

The diagram below shows how AWS Cognito is used to authenticate mobile devices to access the AWS platform.

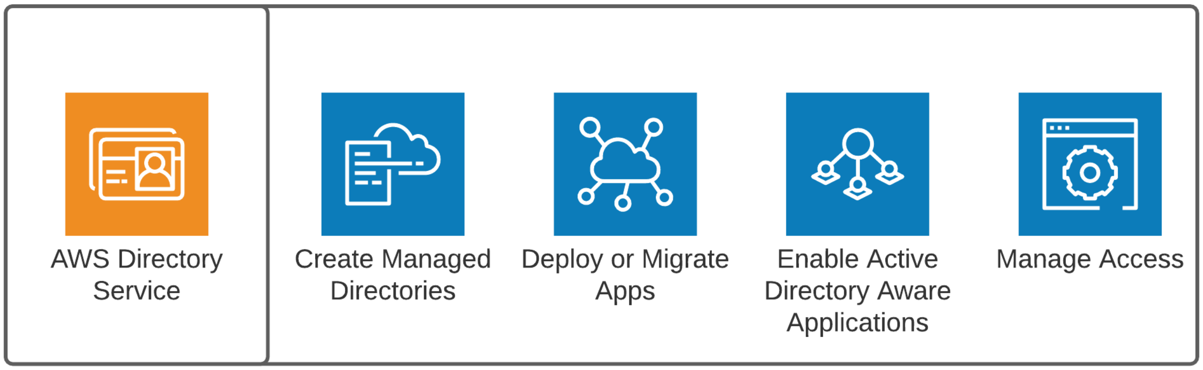

AWS
Amazon Cognito User Pool
1) Authenticate and Get Tokens
2) Trade Tokens for Credentials
Amazon Cognito Identity Pool
3) Access AWS services
Amazon S3
Amazon DynamoDB
Amazon EC2

AWS Directory Service

Another means to create a scalable IAM solution is with the AWS Directory Service. The AWS Directory Service provides hosted, dedicated tenant, Windows Active Directory (AD) servers. These are high-availability servers spread across two availability zones with the default configuration. The AD servers are actual Microsoft AD servers hosted by AWS. Being actual Microsoft AD servers, Microsoft-dependent workloads can function in the AWS VPC.[63]

AWS Directory Service can also be integrated with customers' on-premises Microsoft AD domain controllers. AWS Directory Service can also be used by AWS services such as EC2, RDS for SQL server, end-user computing, and AWS WorkSpaces for IAM functions. The hosted AD servers can also be used by EC2, RDS for SQL Server, AWS End User Computing, and AWS workspaces for IAM functions.

The diagram below shows how AWS Directory Service is used to facilitate Microsoft applications in the AWS environment.


AWS Directory Service
Create Managed Directories
Deploy or Migrate Apps
Enable Active Directory Aware Applications
Manage Access

Authentication Process

Now that we have discussed the available IAM options, it is necessary to understand how the authentication process works under the different options.

Username and Password

1. User logs in to the console with username and password.
2. AWS verifies the user's identity.
3. AWS provides an authorization based upon the user's privileges.

Access Key

An *access key* is a combination of a twenty-character key ID and forty-character secret. The access key is used for authentication and facilitates connections to AWS via an API. This is generally performed with the Software Development Kit (SDK).

Access Key and Security Token

When an IAM authentication needs to occur for an assumed role, a secure token is provided to the requesting application. The secure token, along with the access key, is used for authentication. This provides additional security over other methods.

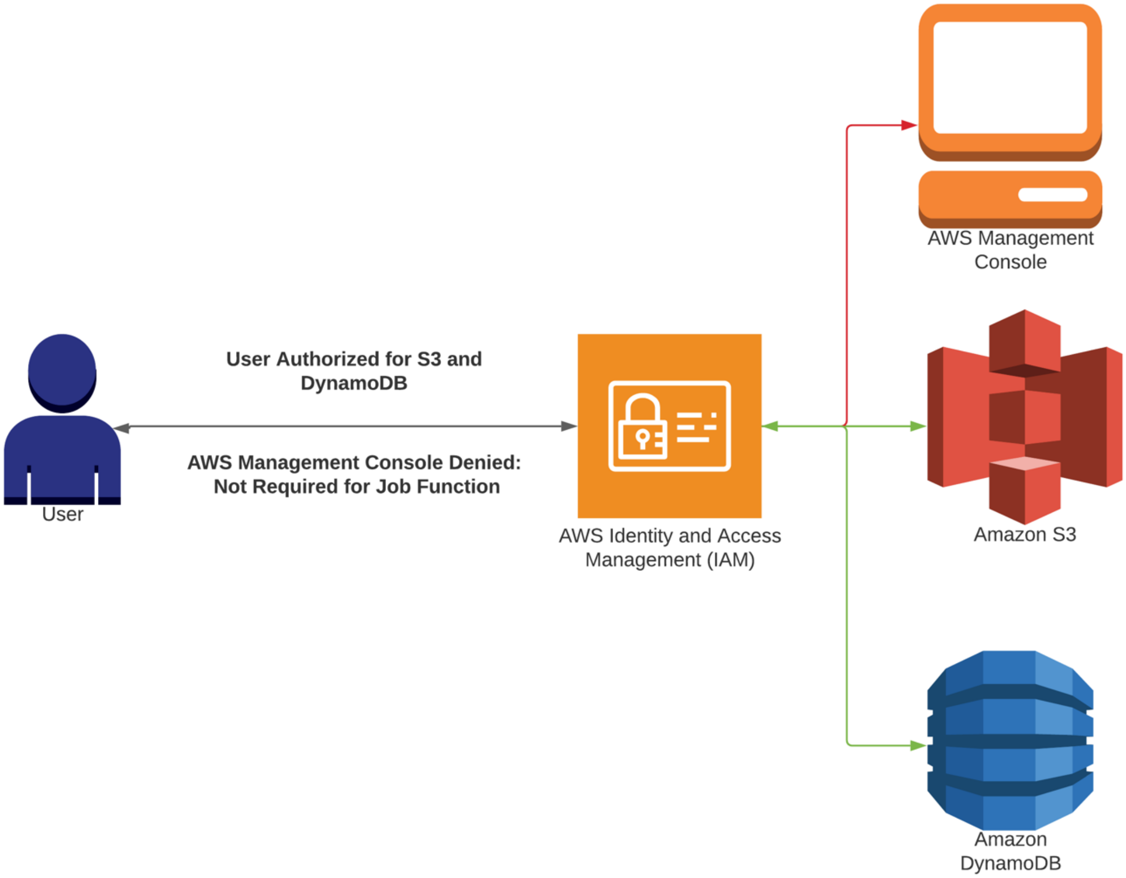
Authorization

After authentication, it is necessary to authorize the user to perform whatever functions are necessary for their job function. To keep the VPC secure, the default policy is to deny access to all services. Authorization is really about granting permissions to necessary services that have been defined in the IAM policy.

IAM policy documents are written in JavaScript Object Notation (JSON). A policy document defines the following attributes:

- Effect – Allow or deny.
- Service – What service is being requested.
- Resource – What resource is being made available. This is the full Amazon Resource Name.
- Action – Determines the permissions of the user, i.e., read only, read/write.
- Condition – The condition component of IAM is optional. It enables very granular controls, i.e., to allow access from a specific IP subnet, time of day.

The diagram below shows the user authorization on the AWS platform:


AWS Management Console
User Authorized for S3 and DynamoDB
AWS Management Console Denied: Not Required for Job Function
User
AWS Identity and Access Management (IAM)
Amazon S3
Amazon DynamoDB

Creating IAM Policies

IAM policies determine who is allowed into the VPC and what actions they can perform. When creating an IAM policy, permissions can be applied to a specific resource or all resources. Providing access to specific resources is based upon the Amazon Resource Name (ARN). Providing access to all resources is accomplished with an asterisks (*) wildcard. There are two types of policies available in AWS: AWS-managed policies and customer-managed policies.[64]

AWS Managed Policies

AWS-managed policies are standalone policies created by AWS. These policies have several key attributes:

- Provide permission for services and functions within AWS.
- Are optimized for common use cases.
- Can be attached and moved to different entities and accounts in AWS.
- Can be based on job role to provide different levels of access.
- Have two major predefined roles: administrator access and power user.
- Administrator access provides full access to every service.
- Power users essentially have full access with the exception of IAM and organization management.

Customer-Managed Policies

Customer-managed policies are managed by the customer for their account. These policies have several key attributes. They:

- Are not visible outside the customer's organization.
- Are custom made for the organization's specific needs.
- Can be attached to entities within the AWS account.

How to Create an IAM Policy

There are several ways to create an IAM policy. To make an IAM policy from the console, perform the following steps:

1. Sign in to the IAM console from a user account with administrator privileges – https://console.aws.amazon.com/iam/.
2. In the navigation pane, choose Policies.
3. You will see a list of AWS-managed policies. These are simple to use, updated by AWS as needed, and can help avoid configuration errors.

4. Alternatively, you choose to create a customer-managed policy starting with an AWS policy and then customize and use the policy generator. Or you can create one from scratch.

Copying an AWS-Managed Policy

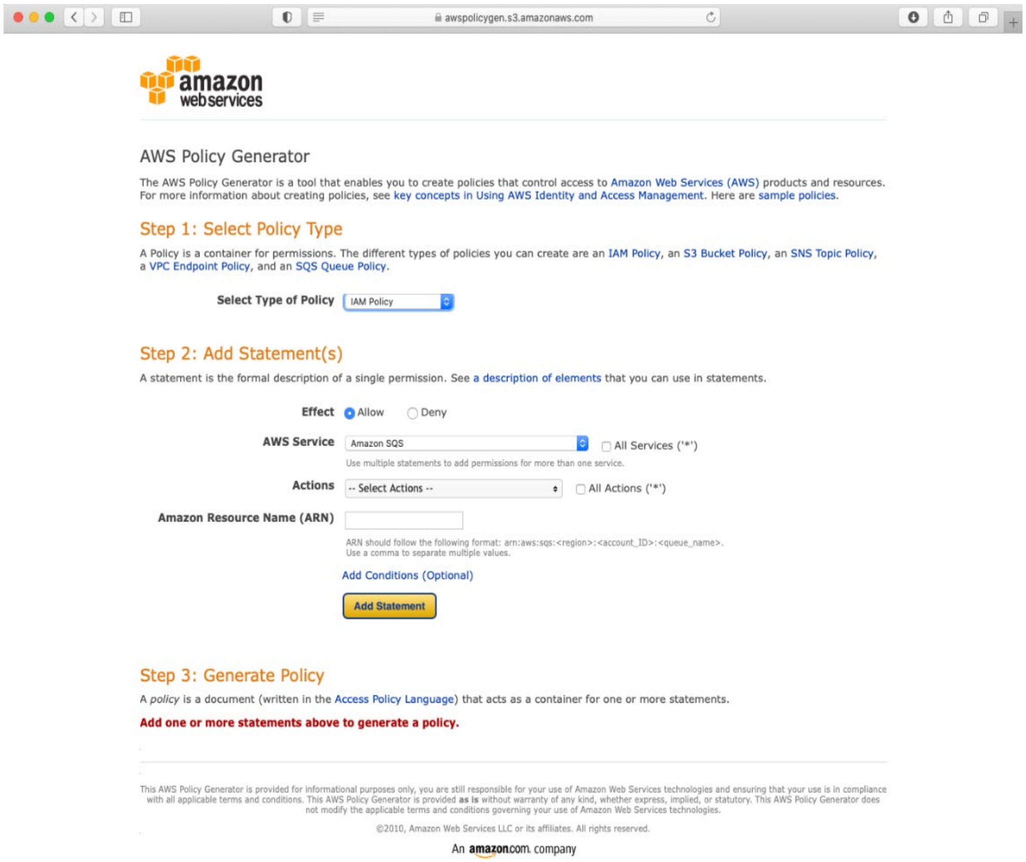
If an organization elects to create its own policy, the easiest method is to copy an AWS-managed policy and customize. This is the simplest method, and it helps to avoid configuration errors by starting with a known good configuration.

AWS Policy Generator

The AWS Policy Generator is an easy-to-use questionnaire that will generate an IAM policy.[65] The policy generator works as follows:

1. Go to the policy generator page.
2. Answer the questions.
3. Assign permissions to specific resources. Multiple permissions can be created as statements.
4. A policy document is then created that can be edited.

The diagram below shows how the AWS Policy Generator can be used to create custom IAM policies:



AWS Policy Generator

The AWS Policy Generator is a tool that enables you to create policies that control access to Amazon Web Services (AWS) products and resources. For more information about creating policies, see key concepts in Using AWS Identity and Access Management. Here are sample policies.

Step 1: Select Policy Type

A Policy is a container for permissions. The different types of policies you can create are an IAM Policy, an S3 Bucket Policy, an SNS Topic Policy, a VPC Endpoint Policy, and an SQS Queue Policy.

Select Type of Policy: IAM Policy

Step 2: Add Statement(s)

A statement is the formal description of a single permission. See a description of elements that you can use in statements.

Effect ● Allow ○ Deny

AWS Service: Amazon SQS □ All Services ('*')

Use multiple statements to add permissions for more than one service.

Actions: -- Select Actions -- □ All Actions ('*')

Amazon Resource Name (ARN):

ARN should follow the following format: arn:aws:sqs:<region>:<account_ID>:<queue_name>.
Use a comma to separate multiple values.

Add Conditions (Optional)

Add Statement

Step 3: Generate Policy

A *policy* is a document (written in the Access Policy Language) that acts as a container for one or more statements.

Add one or more statements above to generate a policy.

This AWS Policy Generator is provided for informational purposes only, you are still responsible for your use of Amazon Web Services technologies and ensuring that your use is in compliance with all applicable terms and conditions. This AWS Policy Generator is provided **as is** without warranty of any kind, whether express, implied, or statutory. This AWS Policy Generator does not modify the applicable terms and conditions governing your use of Amazon Web Services technologies.

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Create an IAM Policy from Scratch

IAM policies can be generated from scratch in JSON format. When creating an IAM policy, it is essential to make sure to use the proper grammar and syntax. Creating an IAM policy from scratch is ideal for organizations that have individuals with JSON programming expertise and require significant policy customization.

Sample IAM Policy

Now that we have discussed the methods to create an IAM policy, let’s evaluate a sample policy. A sample policy can be seen below:

```
{
 "Version": "2020-09-01",
 "Statement": [
   {
    "Effect": "Allow",
    "Action": [
      "ec2:AttachVolume",
      "ec2:DetachVolume"
    ],
    "Resource": [
      "arn:aws:ec2:*:*:volume/*",
      "arn:aws:ec2:*:*:instance/*"
    ],
    "Condition": {
      "ArnEquals": {"ec2:SourceInstanceARN": "arn:aws:ec2:*:*:instance/instance-id"}
    }
   }
 ]
}
```

Now let’s evaluate this IAM policy.

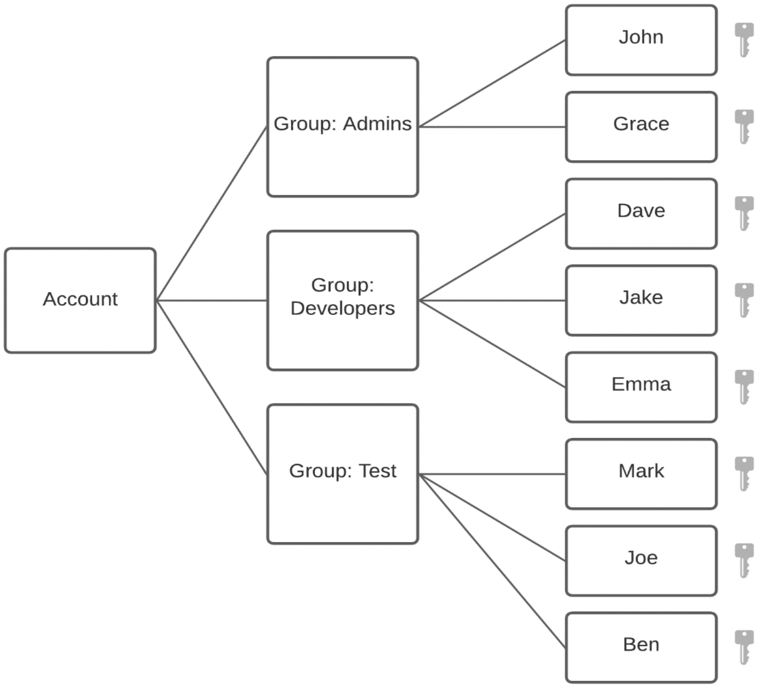
1. The “version” and “date” explain when the policy was created.
2. The first string allows mounting and unmounting of a volume on EC2.
3. The next statement provides the locations of the volumes.
4. The third line specifies conditional elements that allow the policy to be in effect and is optional.

Applying the IAM Policies

After the IAM policies are created, they need to be applied in order to function. IAM policies can be applied in several manners. Policies can be applied as a user policy, managed policy, or group policy.

> **User policy** – A user policy is applied to individual users. This works well but quickly becomes unscalable when many users exist in an organization. Imagine configuring individual policies for two hundred thousand employees.
>
> **Managed policy** – With managed policies, a policy is created and exists independently of the user. The policy can then be attached to users or groups (collections of users). This method is effective and scalable.
>
> **Group policy** – An organization can create a policy for a certain set of individuals. This is known as *role-based access control*. In role-based access control, users are put into groups.
>
> For example, systems administrators all need the same access, so a policy is created for the group “systems administrators.” Then, a policy is applied to that group that provides access to the resources necessary to perform their jobs. This can be used for any group of users accounting, finance, etc. Users are then added to groups and inherit the policy from the group. This is a highly effective and scalable method for IAM policies.

The diagram below shows how group policies are used for IAM with the AWS platform:



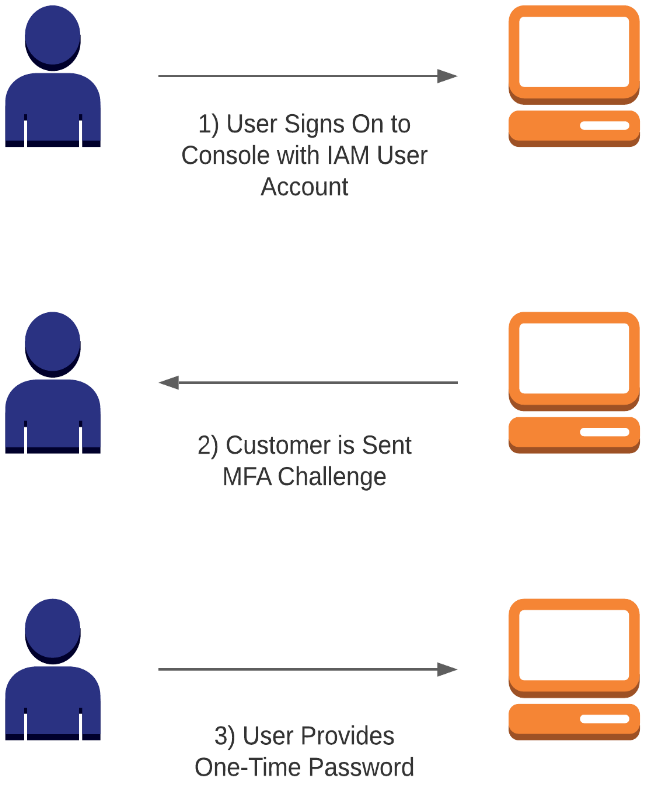
Further Securing IAM with Multifactor Authentication

Organizations looking for enhanced security around IAM can use *multifactor authentication* (MFA). MFA applies to the security concept of something you have and something you know. A perfect example is a debit card. To access money in your account, you need the card (something you have) and a pin number (something you know). This combination greatly enhances the security posture. MFA works in the following manner:

1. The organization sets up an authenticator app or device with a key.
2. The authenticator device creates a one-time password that changes every few seconds.
3. When the user logs in with their username and password, AWS will provide a challenge asking for the one-time password.
4. If the user provides the correct one-time password, they will be authenticated into the system.

This setup provides substantial security. Even if a hacker were to obtain the username and password, they would not be allowed into the system without knowing the constantly changing one-time passwords.

The diagram below shows how multifactor authentication is used in the AWS platform:

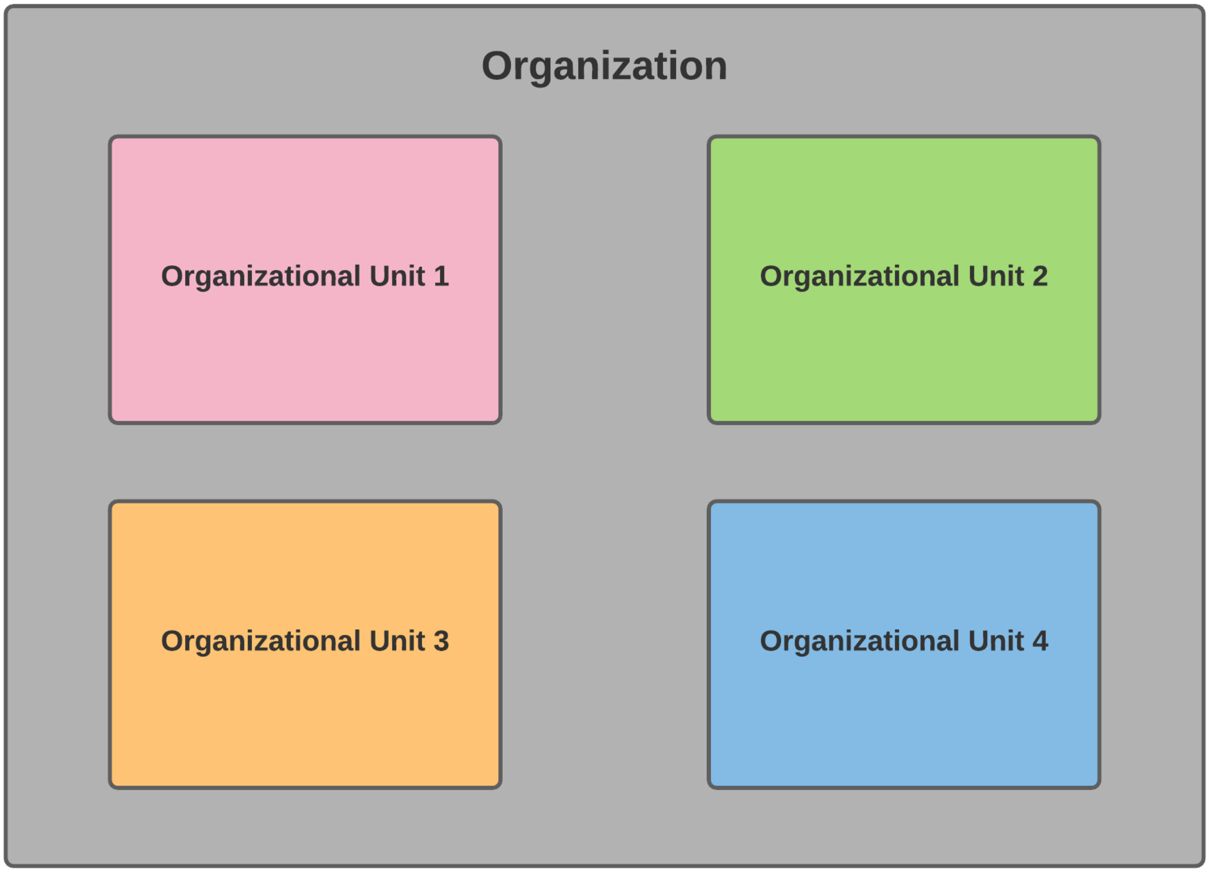

1) User Signs On to Console with IAM User Account
2) Customer is Sent MFA Challenge
3) User Provides One-Time Password

Multi-Account Strategies

Another method to increase the security of the VPC is to partition the organization into multiple small accounts and share information between accounts. Each small account will be placed into a single billing unit called an *organization unit* (OU). Since all organization units are placed into a single billing organization, the organization can still benefit from volume discounts on the total services they consume.[66] Multi-account strategies are especially beneficial from a security perspective because of the following security enhancements:

- Isolation between organizational units.
- The ability to share only the necessary information between units.
- The ability to reduce the visibility of workloads between organizations.
- The ability to reduce the blast radius (meaning that if a problem happens in a single OU, it won't affect other OUs).
- The ability to truly compartmentalize data.

The diagram below shows an example of a multi-account strategy on the AWS platform:



Securing Access Between Organizational Units

Access between organizational units is restricted by using a service control policy. Service Control Policies (SCP) provide IAM-like functionality across organizational units. SCPs allow the ability to “whitelist” or “blacklist” services or actions.

Service control policies are the heart of the control between organizational units. Service control polices help with the following:

- Access control – SCPs help manage access across the organization’s accounts using IAM.
- Encryption – Integration of AWS KMS helps to meet security requirements.
- Auditing – SCP integrated with CloudTrail. This provides the ability to track changes and discover any malicious activities.
- Automation – Ability to apply policies to the entire organization (i.e., HIPPA compliance for healthcare).

Restricting Network Access

A strong security posture involves allowing traffic needed for business operations while keeping all unwanted traffic out of the network and services. Traffic filtering is accomplished with network ACLS, security groups, and firewalls. Network ACLs and security groups are covered in depth in the networking section of this book.

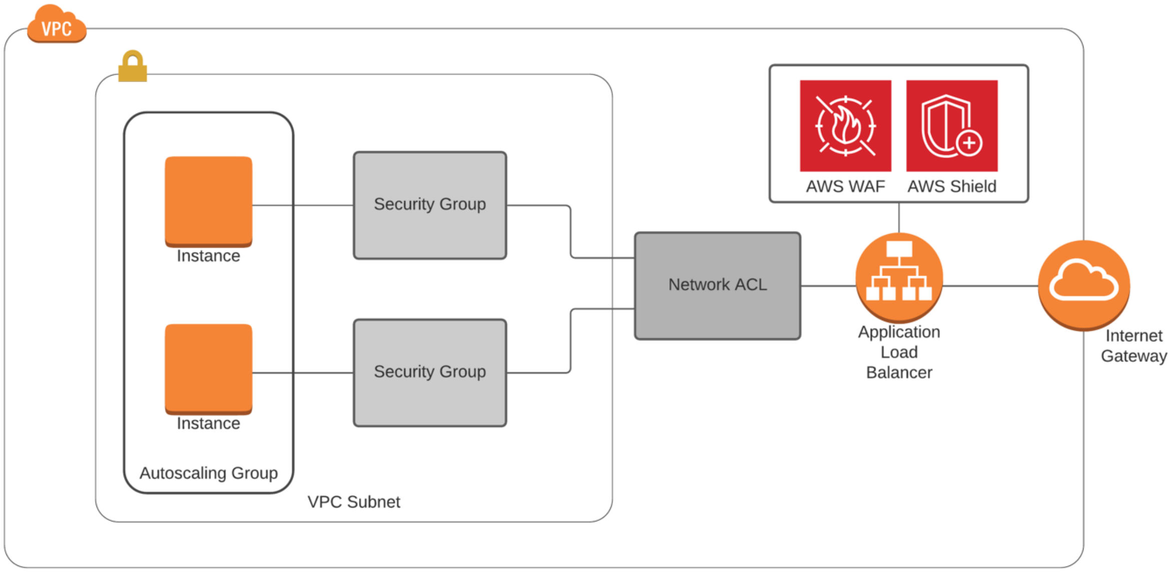
Firewalls are widely used in enterprise networking. Traditional firewalls keep unwanted traffic out of the network like a network ACL does, but firewalls are stateful. Since firewalls are stateful, they know the state of every connection that has passed through the firewall. Being stateful, firewall default policies block all incoming traffic but allow return traffic initiated by internal users that pass through the firewall. Modern firewalls can recognize common attack patterns and stop them by dynamically applying new firewall rules. AWS has a modern firewall solution that can be used with CloudFront, Application Load Balancers, and API gateways.

Preventing Distributed Denial of Service Attacks

Distributed denial of service (DDoS) attacks are a common assault against an organization's systems. A DDoS attack is designed to interrupt the normal function of a server, application, or network by overwhelming the service or its surrounding infrastructure. A DDoS attack is implemented by flooding traffic or server requests from multiple computers on the internet. Preventing a DDoS attack takes a full security posture. The key elements of DDoS prevention within AWS are as follows:

- Block unwanted traffic with network ACLs, which reduces the options the attacker can use to attack the network or server.
- Keep unwanted traffic out of servers and AWS services with security groups.
- Use a firewall. Adding AWS Web Application Firewall (WAF) can recognize common attacks and can dynamically apply polices to mitigate these attacks.
- Leverage AWS Shield, which provides enhanced DDoS protection. There are two versions of AWS Shield—Standard and Advanced. AWS Shield Standard is provided at no additional cost for organizations using AWS WAF. AWS Shield Advanced is an enhanced option at an additional cost that provides protection to EC2, ELB, CloudFront distributions, Route 53, and AWS Global Accelerator.
- Leverage autoscaling. Since the goal of a DDoS attack is to overwhelm the network or computing platform, autoscaling can help mitigate against DDOS attacks. During a DDoS attack, autoscaling can help increase compute capacity to offset the loss of computing capacity from the attacker

The diagram below shows how multiple network security measures are combined to thwart a distributed denial of service attack.



Amazon Web Application Firewall (WAF)

WAF protects applications and sites from common Web attacks that could otherwise negatively affect application performance and availability such as DDoS, including ”Man-in-the-Middle” attacks.

WAF protects applications and sites from common Web attacks that could otherwise negatively affect application performance and availability such as DDoS, SQL, injection, cross-site scripting, and ”Man-in-the-Middle” attacks.

Developers can customize security rules to allow, block or monitor Web requests. For example, Amazon CloudFront receives a request from an end-user and forwards that request to WAF for inspection. WAF responds to either block or allows the request accordingly.

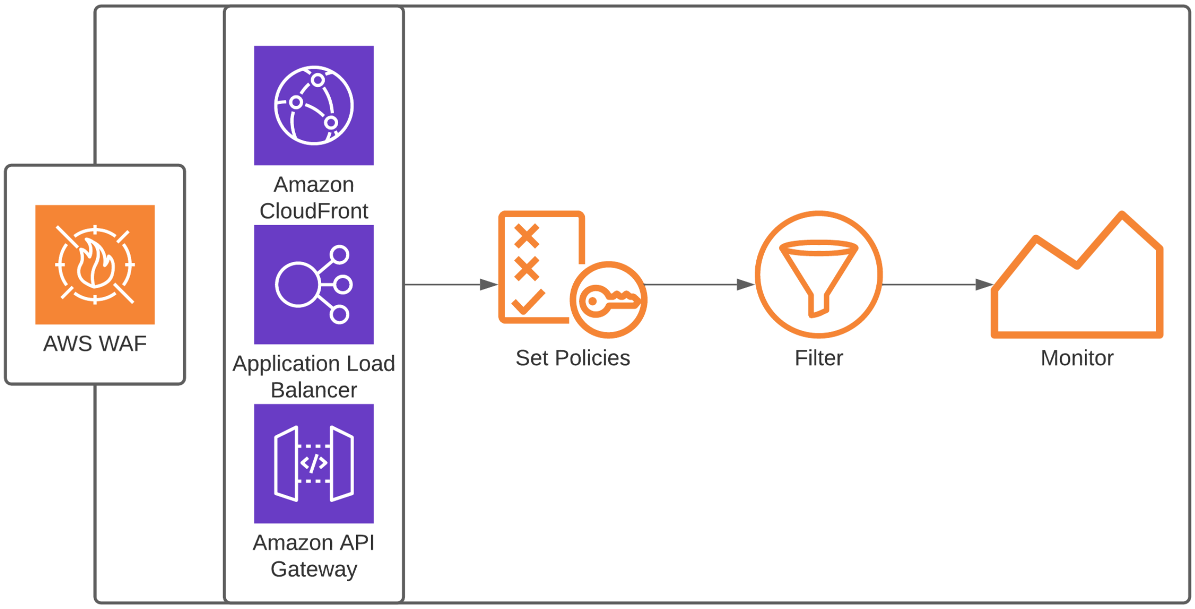
AWS WAF is managed rules configured by the customer and is an application layer. Standard network firewalls usually operate at layers 3 and 4 of the OSI model and typically have IP protection, access control lists (ACL), port protection, etc. An intrusion or a client accesses a web application by IP address or desertion port number (ex. The network firewall blocks them or allows them according to the organization’s policies.

The standard layer 3 and 4 network firewalls are suitable for handling web application access at this level. With AWS WAF, making intelligent decisions based on the request that comes in, it protects users from Distributed Denial of Service (DDoS). It gives an extra layer to filter web traffic based on conditions that include IP address HTTP headers and body or custom URIs. Additionally, the AWS Shield provides expanded DDoS attack protection for AWS resources. Users can also get 24/7 support from the DDoS response team and detailed visibility into DDoS events (this service is additional).

Setting up and using WAF is performed in the following manner:

1. Enable WAF on the application or device.
2. Create a policy that filters access to the application.
3. WAF analyzes the traffic depending on the policies created.
4. WAF will permit or deny the traffic depending on the traffic's adherence to the WAF policy.
5. If an attack occurs, new rules can be created to mitigate the attack.
6. WAF integrates with CloudWatch to provide increased visibility into network traffic and potential or actual attacks.

The diagram below shows how the AWS Web Application Firewall functions in the AWS environment.



The firewall protects all your networks, serves as a border between trusted and untrusted networks, and is typically placed on the network's edge.

WAF protects against the Open Web Application Security Project (OWASP) top 10 attacks and has protection against cross-site scripting attacks. Dedicated Web Application Firewall technology is needed to deal with these attacks. The Next-Gen should be the primary firewall. It can identify application traffic regardless of where it comes in from, use packets, and be application aware. It can be used with Microsoft Active Directory (AD) to add useful information for traffic and policies.

And WAF will inspect traffics at the application layer (L7), which can protect web application and is its primary function, from OWASP vulnerabilities as well as application and content-aware.

WAF is a web application firewall used to filter through data and monitor and block or allow traffic from or going to the application and placed before applications and servers, offering protection from any type of threats that attack servers. WAF mainly focuses on threats aimed at HTTP and HTTPS applications and servers. In some cases, enterprises need to use both solutions for maximum protection.

AWS WAF works by continuously analyzing Hypertext Transfer Protocol (HTTP) requests using the set of user-configured managed rules to determine which aspects of network communication(s) are safe and harmful. AWS WAF usually scrutinizes HTTP communications by focusing on the GET and POST requests. The GET requests are used to retrieve data from the server, while POST requests are used in sending data to a server to change its state. AWS WAF can use either whitelisting or blacklisting or a hybrid combination of both approaches. For Whitelisting, this approach entails AWS WAF will, by default, deny all incoming requests but only request from known trusted sources.

AWS Firewall Manager

AWS Firewall Manager is a security management service that allows users to centrally set up and control AWS WAF rules, Shield Advanced protection, security groups, Network Firewall rules, DNS Firewall rules, and AWS Marketplace third-party firewall rules for your Amazon VPC throughout multiple AWS accounts through its integration with AWS Organization which is an AWS policy management tool.

AWS Firewall Manager makes sure any new user or application automatically operates under established procedures and guidelines. An administrator can apply rules across an entire organization, but the service also can limit policies to a single user, a group of users, or to specific applications.

How does it Work?

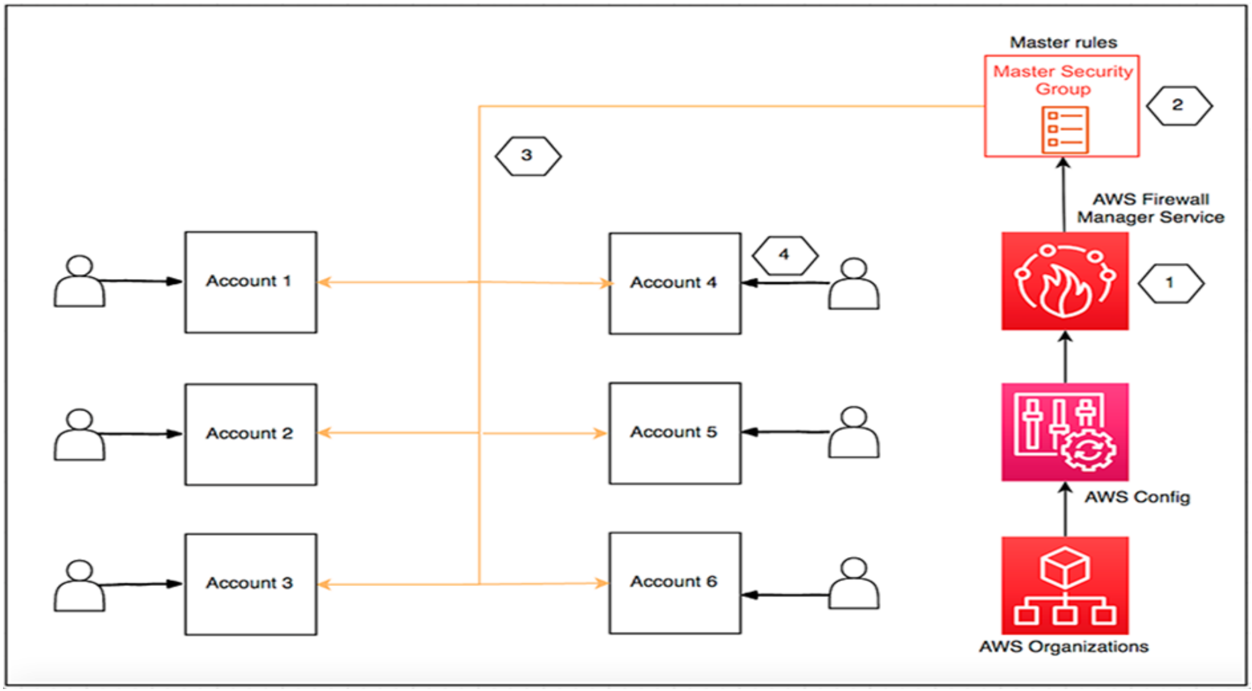
Users set up their protections just once, and the service automatically applies them across your accounts and resources, even as you add new accounts and resources.

Firewall Manager can be used by companies operating in highly regulated industries such as healthcare and finance that must comply with national and/or international data protection codes. It is also intended for organizations that need to manage policies for workloads and users across multiple geographies centrally.

Additionally, the service integrates with AWS WAF-managed rules to protect your applications from eventual common vulnerabilities. Developers can use their AWS Firewall Manager to automatically patch and protect web apps and APIs from threats. Integration with other AWS security tools allows AWS Firewall Manager to send alerts so users can react to potential attacks as they occur.

A developer can access her AWS Firewall Manager from the AWS Management Console and only use it with her AWS account and application. Users must set up an administrator account with access to all AWS Organizations' features. The administrator must also enable their AWS Config for all members of her accounts and each applicable region if a developer wants to protect their CloudFront infrastructure using their AWS Firewall Manager, the CloudFront in the US. East 1 will be hosted.

The service also has default limits on the number of policies and accounts that can be managed, but organizations can request increases to some of these limits. However, the organization cannot exceed 10 rules per group or a 2:1 ratio of rule groups to policies.



Why use Firewall Manager

- Streamline management of firewall rules throughout the account
- Ensure compliance with current and new application
- Effortlessly deploy managed rules across accounts
- Centrally deploy protection for VPCs
- Safeguard resources across accounts
- Automatically adds protection to resources that are added to the account
- Allows users to use their own rules, or buy managed rules from AWS Marketplace

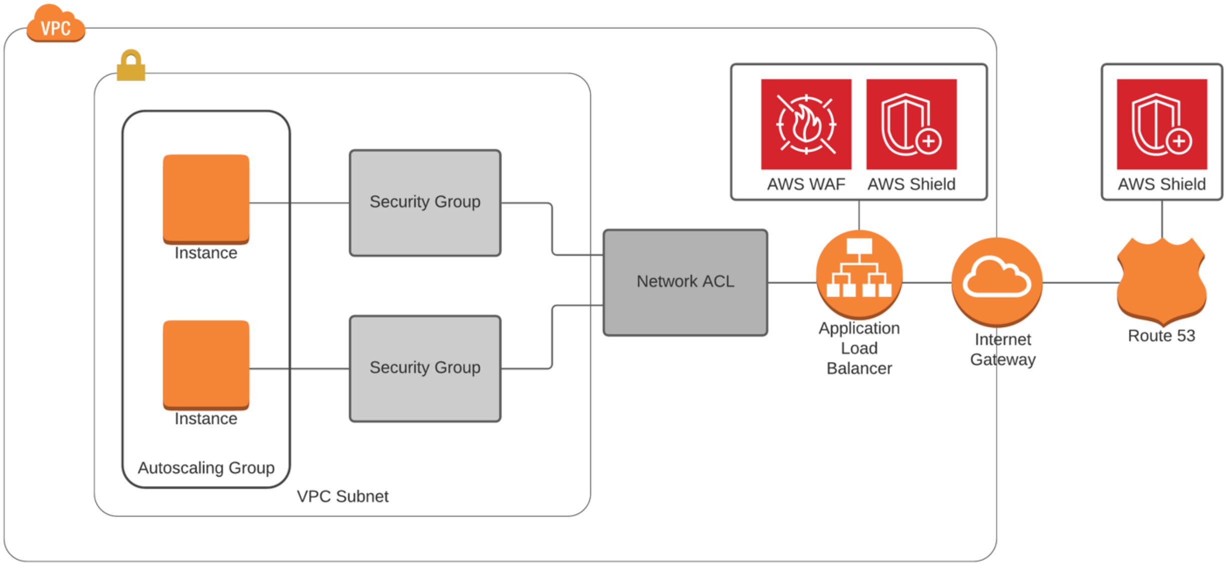
AWS Shield

AWS Shield is an AWS service to protect against DDoS attacks. AWS Shield is available in two versions: AWS Shield Standard and AWS Shield Advanced.[68]

AWS Shield Standard

AWS Shield Standard is a free DDoS protection service for AWS customers using WAF. AWS Shield Standard protects against the most common attacks. According to AWS, Shield Standard blocks against 96 percent of the most common attacks, including SYN/ACK floods, reflection attacks, and http slow reads. AWS Shield Standard works based on the logic contained in its policy.

The diagram below shows how AWS Shield is used to defend against distributed denial of service attacks:



AWS Shield Advanced

AWS Shield Advanced is a paid DDoS protection service for AWS customers. It has many advantages and additional features above AWS Shield Standard. AWS Shield Advanced has a rich feature set and functionality, including:

- Additional protection for volumetric attacks by adding intelligent attack detection and mitigation tools.
- Dynamic solution that can look at traffic patterns to determine if an attack is occurring.
- Ability to detect an attack and can automatically deploy ACLs to mitigate the attack.

- Visibility and notification for layer 3/4/7 attacks.
- 24/7 access to a DDoS response team, assuming the customer is a member of the business or enterprise support.
- Protection for ELBs, EC2 instances, CloudFront distributions, Route 53, and AWS Global Accelerator.

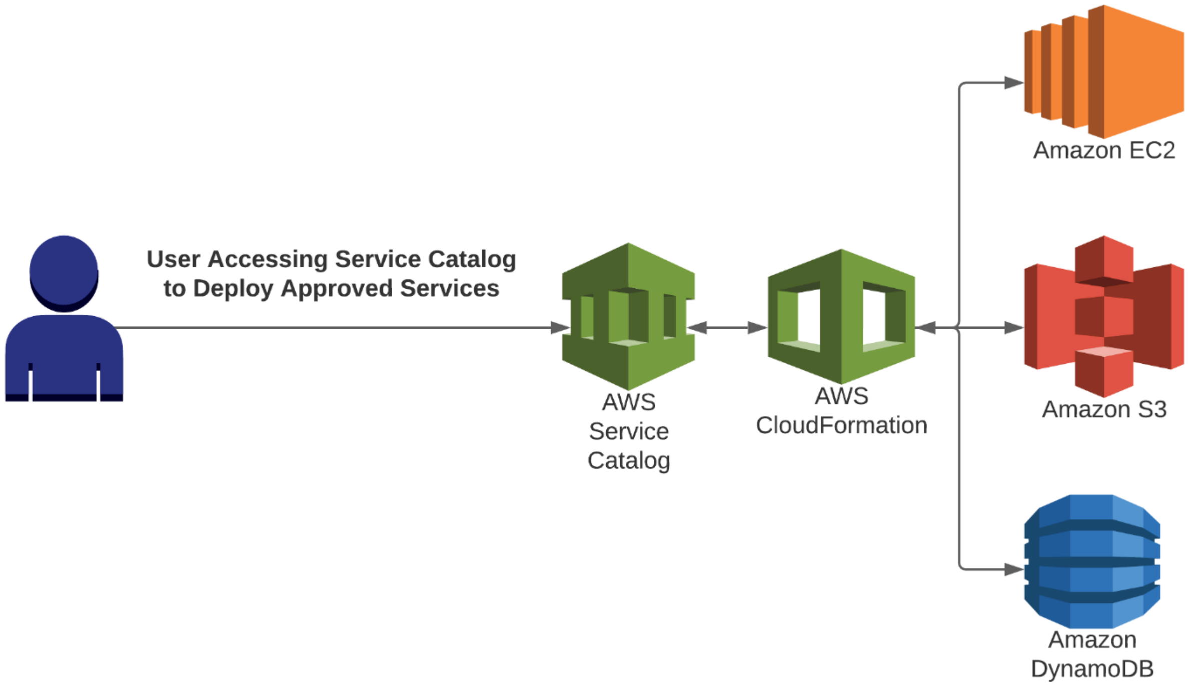
AWS Service Catalog

As previously discussed, a full security posture includes physical security, access lists, security groups, firewalls, DDoS protection, IDS/IPS, and controlling and optimizing what is placed on the network. While there are many ways to control what is placed on the network, AWS makes it easier with the use of the AWS Service Catalog.

A service catalog is a means to create a list of approved services. The service catalog is defined by the customer, so they can allow what services they desire on the organization's network. The service catalog can include specific AMIs, servers, software, databases, and multitier application architectures. Therefore, the service catalog can help ensure compliance with corporate security standards by limiting what system admins can place on the network.

For example, the service catalog can be configured to allow only security-hardened AMIs on the network (fully pathed, disabling unnecessary services, etc.). AWS Service Catalog simplifies deployments, as administrators can allow only approved and compliant services.[69]

The diagram below shows how the service catalog is used to select and deploy approved services.

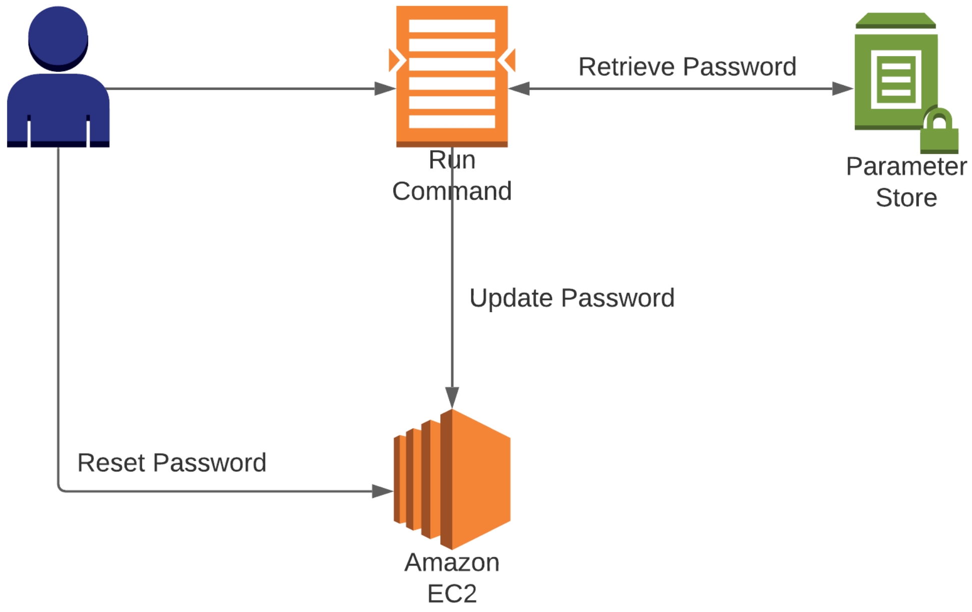


AWS Systems Manager Parameter Store

Another component of an overall security posture is the secure management of passwords, database strings, and other critical components. Proper management of passwords is essential for a secure environment. If passwords are compromised, the organization would be open to attacks by hackers. Stolen passwords can lead to serious data loss and exploitation by hackers. AWS provides a solution for securely storing passwords, which is the AWS Systems Manager Parameter Store, which increases the security posture by separating an organization's code from their secret information.[70, 71]

The AWS Systems Manager Parameter Store provides secure, hierarchical storage for configuration data management and secrets management. It scans your managed instances and will report any policy violations detected. The AWS Systems Manager Parameter Store is a scalable, hosted, serverless environment optimized for storing passwords, database strings, license codes, and API keys. For extremely sensitive information, it's advisable to encrypt data in the store. It provides a means to encrypt sensitive data and provides an excellent means to track password use, as well as audit who has been accessing the system.

The diagram below shows how the Systems Manager Parameter Store can be used for secure password storage and maintenance.



Amazon Macie

Amazon Macie is a fully managed service to enhance an organization's security. Amazon Macie uses machine learning and pattern matching to find and alert an organization if private data becomes publicly available. Most specifically, the alerts are based upon private information in S3 buckets becoming publicly available, or does not meet with compliance standards, i.e., unencrypted S3 bucket.

Macie provides an inventory of buckets that are encrypted, publicly accessible, and shared with other AWS accounts. Macie's findings can be searched and filtered through the AWS Management Console and relayed through the Amazon Event Bridge.

Macie integrates with event management systems, workflows, or AWS Step Functions to automate security remediation actions.

Amazon Macie, in combination with AWS Services, can help regulate for the General Data Privacy Regulation (GDPR), Health Insurance Portability, and Accountability Act (HIPAA).

Amazon GuardDuty

Amazon GuardDuty is a threat-monitoring service to protect your AWS accounts, workloads, and data stored on AWS S3. GuardDuty monitors for malicious activity and provides detailed security findings. GuardDuty uses machine learning for pattern matching and detection of threats. GuardDuty can be set up to help remediate threats. Threats can be mitigated by the initiation of a Lambda function or by sending alerts to systems administrators.

GuardDuty protects against unusual data access on AWS S3, API requests from known malicious IP addresses, and compromised security credentials. GuardDuty provides detailed reporting that can be accessed in the AWS Management Console. Additionally, GuardDuty integrates with event management and workflow systems to help optimize an organization's security.

Amazon Inspector

Amazon Inspector is a security service that provides an automated assessment of applications to uncover security vulnerabilities. Inspector looks for vulnerabilities such as deviations from security best practices, which are predefined rules that are regularly updated by AWS security personnel.

Once Inspector completes the assessment, the findings are placed in a report, ordered by level of severity. This report assists the organization in securing their systems by making systems administrators aware of known vulnerabilities. Some examples of the types of vulnerabilities identified by Inspector include checking to see if private systems are reachable from the internet, remote root login is enabled, or vulnerable software versions are installed.

AWS SECURITY HUB

AWS Security Hub is a service that provides users with a broad scope or extensive view of a user's security posture in AWS and facilitates the AWS environment's compliance with security industry standards and best practices.

AWS Security Hub simplifies how users understand and improve their cloud security posture with automated security best practice checks, by collecting and prioritizing security data from across AWS accounts, AWS services, and third-party partner products.

This provides a central view of security and compliance posturing. AWS Security Hub is primarily an aggregated and analytical tool that works across AWS services, accounts, and some third-party tools It collects, organizes, and analyzes data on all resources and services you consume. The tool checks data against best practice standards, to identify oversights or trends and then provide actionable results.

Chapter 9 - AWS Applications and Services

AWS has several key services that can be used to enhance VPC-based applications and services. This chapter will cover these key AWS services:

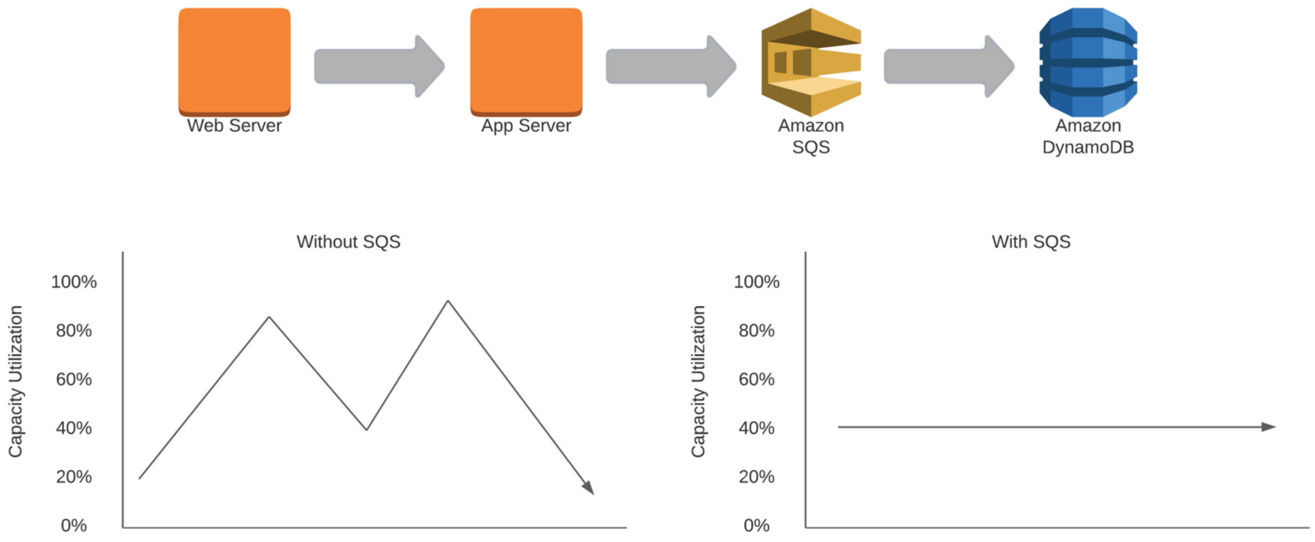
- Simple Queue Service (SQS)
- Simple Notification Service (SNS)
- Simple Workflow Service (SWF)
- Elastic Map Reduce (EMR)
- Kinesis
- Elastic Compute Service (ECS)
- Elastic Kubernetes Service (EKS)
- Elastic Beanstalk
- CloudWatch
- Config
- CloudTrail
- CloudFront
- Lambda
- Lambda@Edge
- Step Functions
- Rekognition
- CloudFormation
- AWS Certificate Manager (ACM)

AWS Simple Queue Service (SQS)

To design a highly available and scalable application, it is sometimes necessary to decouple the components of an application's architecture. By decoupling the application's architecture, it is possible to minimize system bottlenecks and optimize the performance of the entire system. A great option for decoupling application architectures is the Amazon Simple Queue Service (SQS).[72]

SQS is a message queuing service that provides temporary message storage prior to the message being transmitted to its ultimate destination. SQS enhances application availability by providing a way to retain messages when a part of the application's architecture is busy or unavailable. Since SQS can hold messages on the way to the destination, the organization can optimally size its architecture. If a traffic spike occurs, SQS will store and deliver the message when it's ready.

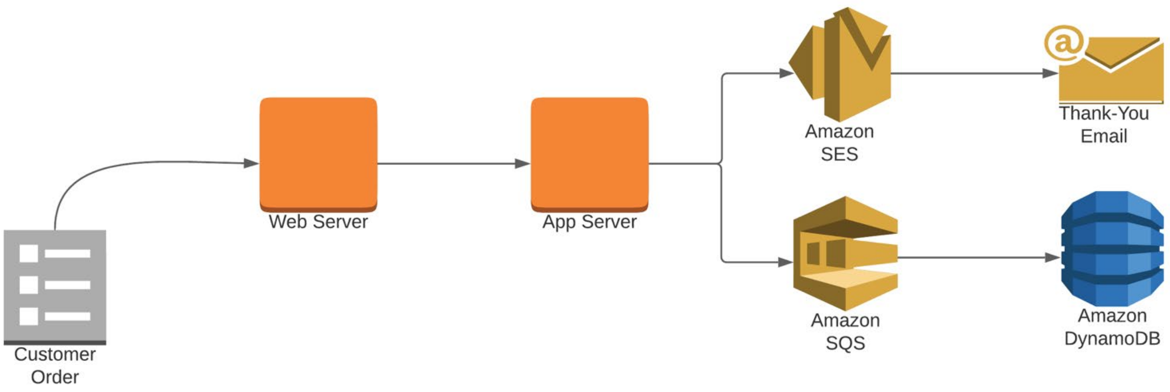
The diagram below shows how SQS can optimize performance and help promote scalability:



Utilization can be optimized with SQS

SQS is used to decouple application architecture components, which promotes scalability. SQS can further increase scalability and elasticity of services when SQS is used to autoscale instances based on the message's depth in the SQS queue. SQS can take the place of messaging middleware in multitiered applications. SQS is highly available, and multiple copies of every message are stored redundantly. SQS has integration with KMS to allow for end-to-end encryption. SQS is highly tunable transient storage. The SQS message queue retention period can be adjusted for up to fourteen days, with the default storage time being four days.

The diagram below shows how SQS queues are used to decouple application architecture components:



SQS can be configured for standard queues (the default), first in, first out (FIFO) queues, and dead-letter queues. The key attributes of these queue types are:

Standard Queues

- Super-fast and support a nearly unlimited number of requests per second.
- Offers the fastest throughput and message delivery.
- Every message is delivered at least once.
- Best-effort delivery, and messages may be delivered out of order.

First In, First Out Queues

- High throughput but much slower than standard queues.
- First in, first out delivery guarantees the messages will be processed once and in the order they are received.
- Since messages are sent in the order they are received, it is possible the FIFO queue will increase latency because all new messages will be waiting for the previous message to be processed.

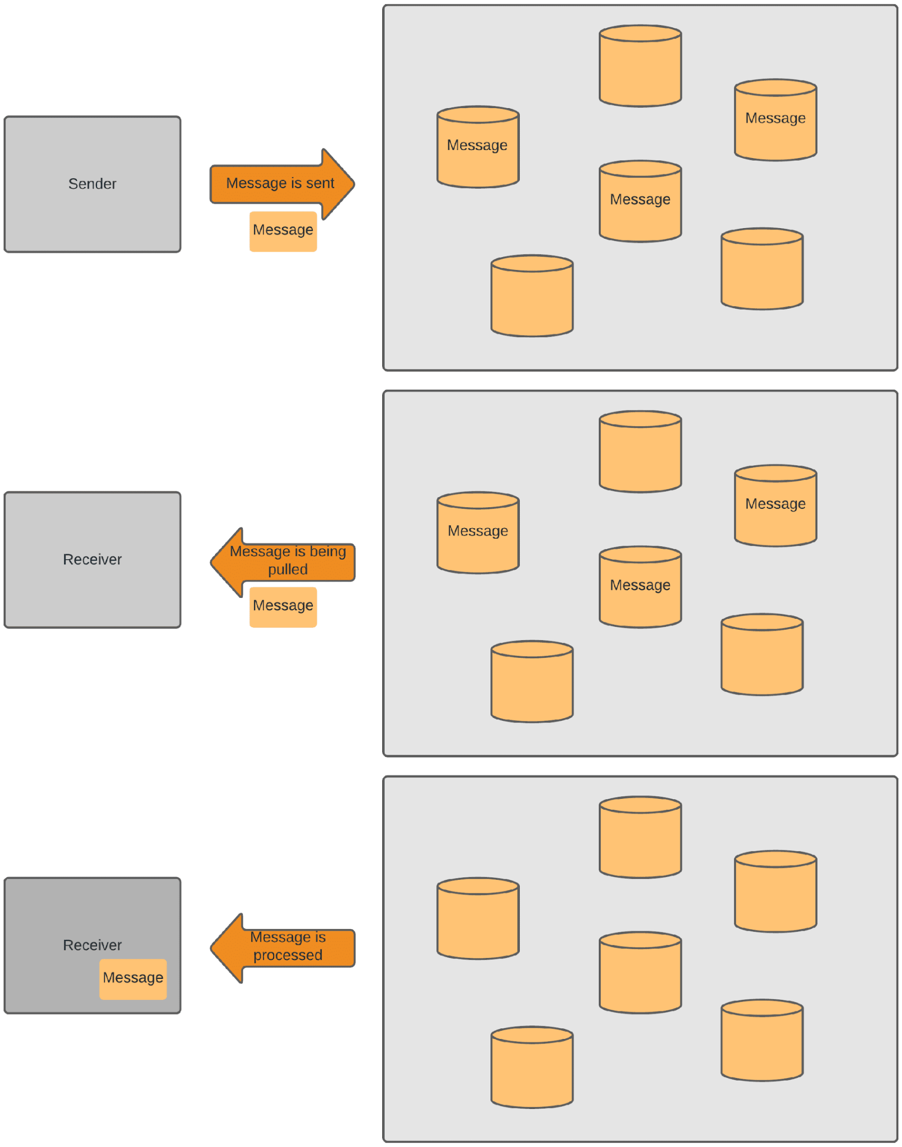
Dead-Letter Queues

- Dead-letter queues (DLQ) can be set up to retain undeliverable messages if an error occurs in the system.

How SQS Works

1. Messages are sent from the computing platform to the queue as a step to their ultimate destination.
2. After the message is inside the queue, it can be scheduled for delivery based upon the capacity of the ultimate destination for the message.
3. If the ultimate destination is busy, the message can stay in the queue until it is processed or times out. The message can stay in the queue for up to fourteen days based on the SQS configuration.
4. The message is pulled from the queue to be processed.
5. After the message is completely processed, the message is deleted from the queue.

The diagram below shows how SQS is used to reliably deliver messages to their ultimate destination:



When to Use SQS

SQS can be extremely beneficial in designing a highly-available and scalable architecture. Some key situations where SQS can make a notable difference are as follows:

- With capacity planning and application scalability.
- To make sure messages (orders) are not lost if part of the system is overloaded (i.e., database on multitiered application).
- For cost optimization, as it offers the ability to right-size the instances supporting an application.

- For autoscaling, with its ability to trigger autoscaling based up queue depth, as opposed to a less direct metrics, i.e., CPU utilization.
- To support an application's ability to handle large spikes in traffic without having to scale or make changes to the platform
- To handle increased traffic destined for databases, often without the need to increase write capacity on the database.

AMAZON MQ

AWS describes Amazon MQ as a fully managed open-source message broker service for Apache ActiveMQ and RabbitMQ. Amazon MQ makes it easy to set up and operate message brokers in the cloud, so you can migrate your messaging and applications without rewriting code.

To fully understand how Amazon MQ works and when to use it, we first need to understand what a message broker service is and how a message queue works.

A Message Broker service allows different software systems to use other programming languages on various platforms to communicate and exchange information.

Think of the message broker as a translator; if two people were attempting to have a conversation but spoke different languages, a *"translator"* would be required as a go-between to interpret the discussion. This is effectively the job of the message brokers; the only difference is that instead of translating human language, a message broker translates computer languages between different software and platforms. When a producer wants to send information to the end consumer, a message broker works to interpret the data and ensures the consumer understands what the producer is trying to say.

A Message Queue is temporary storage to help process requests and avert message loss. An easy way to look at a queue would be to think of it as an email. When we send an email to a friend, the message sits in an inbox (the *queue* or *holding area*) until the recipient takes action to open the message and save or delete it.

Amazon has a proprietary message queueing system called Amazon Simple Queueing Service (SQS). It is a fully managed, highly scalable service that Amazon maintains, patches, and runs. SQS also gives users unlimited scalability without losing messaging. However, as a proprietary service, a business cannot migrate its content into or out of SQS or forward it to a different company.

Let's imagine we own an eCommerce company and use a message broker system that runs off a small server initially purchased to run a business. Once the business starts growing, we need more servers to keep the site from crashing, so instead, the decision was made to move to the cloud. In this scenario, an open-source message broker system allows the organization to move data into the cloud. Open source gives businesses more control, added agility, and further flexibility. It will enable the company to keep or move its data from one location to another, so it's never locked into a single proprietary software provider.

How does Amazon MQ work?

Amazon MQ uses industry-standard APIs and protocols for messaging like JMS, NMS, AMQP 1.0, STOMP, or WebSocket, for naming a few. Thus, it is easy for applications from any message broker that uses these standards onto the Amazon platform without rewriting code. Lastly, creating, managing, and deleting brokers using the AWS Management Console is simple.

When to use Amazon MQ

Enterprise-level customers benefit the most from using MQ because they no longer have to re-engineer applications to use SQS in Amazon. Now a business can migrate their message broker and have Amazon manage the maintenance, security, updates, monitoring, and troubleshooting.

An added benefit for anyone using MQ is that it integrates with other AWS services like CloudWatch to monitor the health of the message broker, set alarms, and send notifications when something goes wrong. It also integrates with other AWS auto-scaling services, so if a random traffic spike occurs on the website, the servers automatically scale so more messages can be processed. MQ will also integrate with IAM for authentication and authorization service.

Amazon MQ offers pay-as-you-go pricing, meaning users only pay for the time the message broke instance runs per hour; however, the storage is billed monthly. AWS calculates the GB used for each hour and divides it by the number of hours in the month. This results in a value of "GB-Months," with data transfer fees charged separately.

Amazon explains the Data transfer fee: "For traffic forwarded between brokers across availability zones in the same region, you will be charged at $0.01/GB in each direction. AWS will charge for bandwidth out of each area for cross-region networks according to the EC2 pricing schedule.

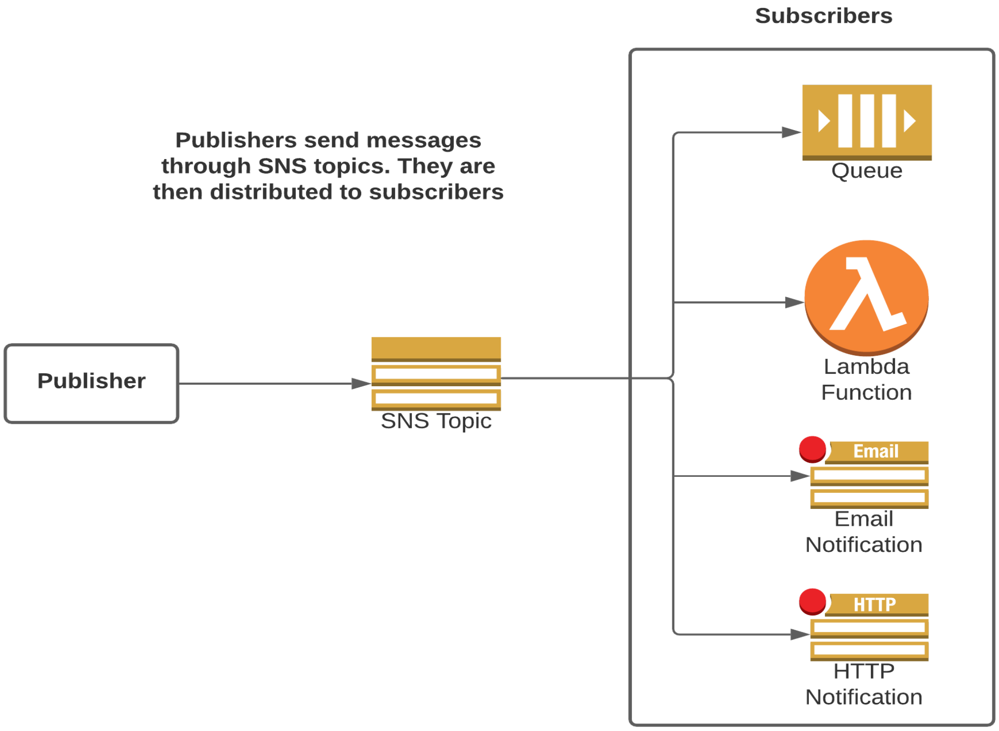
There are no additional charges for Amazon MQ for ActiveMQ Networks of Brokers. Users of the service are charged for each broker in the network, plus any data transfer fees for network traffic between availability zones or regions.

AWS Simple Notification Service (SNS)

Amazon Simple Notification Service is a managed messaging service to deliver messages between systems, or between systems and individuals. SNS is used to decouple messages between microservice applications. SNS is also used to send SMS, email and push messages to devices.[73]

SNS facilitates communication between senders and recipients via a publish-subscribe model. The publish-subscribe (pub-sub) messaging model enables notifications to be delivered to clients using a push mechanism. Push notifications notify clients of message updates. SNS consists of publishers and subscribers. Publishers communicate by sending a message to a topic. A subscriber subscribes to a topic and receives messages that have been published to the topic. It functions like an email list — you subscribe to the list and receive messages the sender (publisher) sends to the list.

The diagram below shows how the SNS publisher/subscriber model works for message delivery:



SNS is a highly available platform that by default runs across multiple availability zones. SNS can be used to fan out messages to a large number of subscriber systems or customer endpoints. Endpoints can be many things; some examples are SQS queues and Lambda functions. SNS allows message filtering through policies so that only desired notifications are received. SNS encrypts messages immediately to protect from unauthorized access.

SNS can be used in a variety of situations. Some common SNS use cases can be seen below:

Application and System Alerts

- SNS can send a notification when a predefined event occurs (i.e., a limit is passed).
- For example: When a CPU’s utilization goes over 80 percent, notify system administrators.

Email and Text Messages

- SNS can push notifications to people’s emails and/or send them text messages.
- For example: a company’s CEO is going to be on TV, and a broadcast link is sent to employees’ emails and phones.

Mobile Notifications

- SNS can send push notifications directly to mobile applications.
- For example: notify a customer of a flash sale on your app.

AWS Simple Workflow Service (SWF)

SWF is a workflow management solution. SWF enables the coordination of tasks across distributed application components. SWF enables you to create a workflow of tasks that take multiple steps for completion. SWF then coordinates the execution of tasks across the platform. Normally it would take substantial application development to coordinate tasks across multiple systems. As SWF is a prebuilt workflow management solution, all that’s necessary is to tell SWF the necessary workflow steps, and SWF manages all coordination of steps until completion.[74]

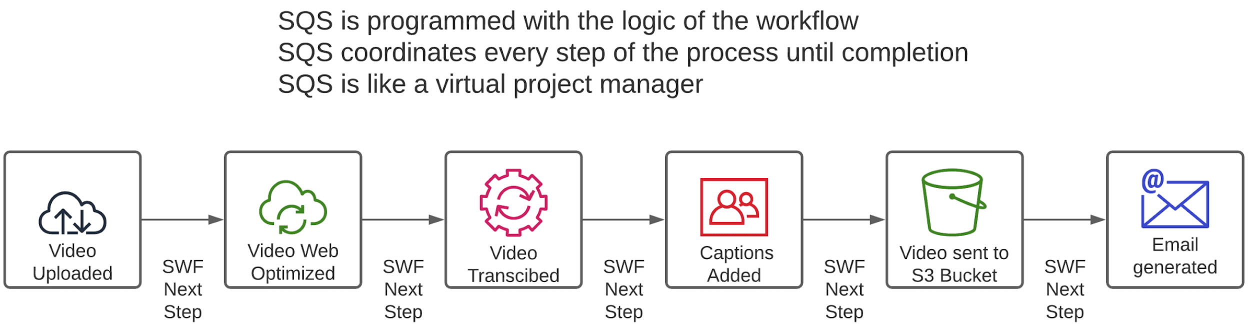
SWF manages workflows using workers that carry out the steps. These workers are programmed to perform, process, and confirm the completion of each step. Workers can be deployed using EC2 or Lambda, or on a local system.

SWF controls the flow of tasks using *deciders* to keep track of the workflow. The decider receives decision tasks from SWF and then determines and schedules the next step to complete the task.

Let’s explore a common multistep workflow that would benefit from SWF:

1. Video is uploaded.
2. Video is processed and converted to an optimized format.
3. After formatting, the video is transcribed.
4. After transcription, the video’s transcriptions are added as subtitles.
5. After final processing, the video is stored on a server.
6. After the video is stored on the server, the user gets a notification that their video is ready for download.

The diagram below shows how SWF can be used in the above multistep workflow.



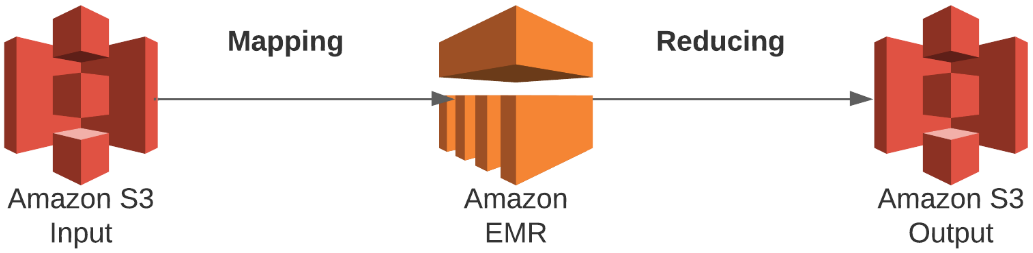
Without SWF, it would be necessary to develop software to manage the coordination of all steps. With SWF, all that is necessary is to configure the workflow in SWF. SWF will manage the process from the time the video is uploaded until the time the user gets notified that the video is ready for download.

AWS Elastic Map Reduce (EMR)

Elastic Map Reduce is an AWS application for processing and analyzing large amounts of data. EMR acts as a managed cluster that manages big data frameworks. Typically, big data management requires specialty servers. These specialty servers must be provisioned and require operating system installation, application installation, and configuration. AWS EMR provides an alternative to this by offering a prebuilt system that facilitates big data analysis and processing without the need for server management, application installation, and configuration.[75]

EMR is a managed service that takes a lot of complexity out of big data management. EMR uses tools such as Apache Spark, Apache Hive, Apache HBase, Apache Flink, Apache Hudi, and Presto. EMR takes advantage of these tools in order to offer greater performance than traditional solutions, at a lower overall cost.

The diagram below shows how AWS EMR is used to analyze large amounts of data:



AWS Kinesis

Amazon Kinesis is an AWS service for collecting, processing, and analyzing streaming data. Amazon Kinesis can collect and analyze streaming data in real time from sources including video, audio, logs, website clickstreams, and Internet of Things (IoT) devices. Unlike traditional environments where you collect, store, and then analyze the data, Kinesis can do this in real time. By analyzing data in real time, the organization can receive a competitive advantage by not having to wait for data storage and processing to obtain actionable insights.[76]

Why Use Kinesis?

Kinesis is ideal for situations when large amounts of streaming data need to be rapidly moved and processed. Some application examples include the following:

- Weather sensors located across the globe that report current conditions every five minutes.
- A fleet of airplanes sending information about their status every few minutes.

These applications generate a large volume of streaming information, and Kinesis makes managing these types of data streams in real time feasible.

Kinesis Platforms

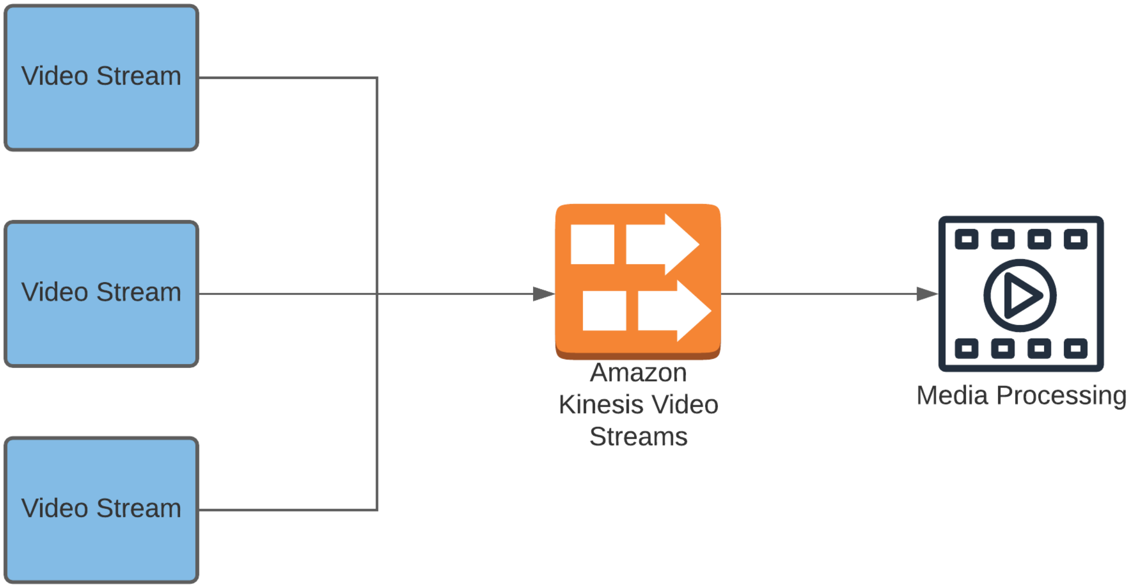
There are four Kinesis platforms:

- Kinesis Video Streams
- Kinesis Data Streams
- Kinesis Data Firehose
- Kinesis Data Analytics

AWS Kinesis Video Streams

Kinesis Video Streams is a Kinesis application specifically for video data. Kinesis Video Streams enables the collection of videos from multiple sources, as well as providing ingestion, storage, and indexing of multiple streams. The videos obtained by Kinesis streams can be sent for media processing or used by machine learning applications.

The diagram below shows how AWS Kinesis Video Streams is used to capture large amounts of real-time streaming data.



What Amazon Kinesis Video stream does

Video streaming services and platforms like Netflix, use a video streaming service to enable their platforms to perform better. One of the advantages of streaming through a platform is that users can collect data, save, process, analyze and help users make better business decisions.
Amazon Kinesis Video Streams is AWS's interpretation of video streaming technology. It saves, sets procedures, and evaluates incoming data to get an understanding of it. It streams data in real time and allows users to stream any amount of video streaming data from any source. Further, it automatically scales and handles any amount of data. It's utilized by analysts, artificial intelligence, machine learning, and many other business cases.

How Amazon Kinesis Video Streams works

Every connected device such as smart cars, smartphones, security cameras, smart cities, and any video/camera securely captures the data to AWS using the Kinesis Video streams. It then takes the incoming data and safely stores, converts, and encrypts the data and sets it up for real-time access and analytics.

Why use Amazon Kinesis Video Streams

When using the service, users have access to real-time data to analyze for machine learning, data analytics, and monitoring capacity. Video Streams can also increase the storage area of the databases responsible for storing your data, from any number of video streaming sources with no restriction or limit and it is very fast. Managed Service means users don't have to worry about the difficulties involved in setting up their own networks and storage infrastructures/datacenter.

AWS Kinesis Data Streams

Kinesis Data Streams is highly scalable platform for real-time data. Kinesis Data Streams can capture gigabytes per second of data from hundreds or thousands of sources. This includes financial transactions, location tracking, database event streams, and other streaming data. Kinesis Data Streams can ingest an organization's data and provide meaningful insights using business intelligence tools.

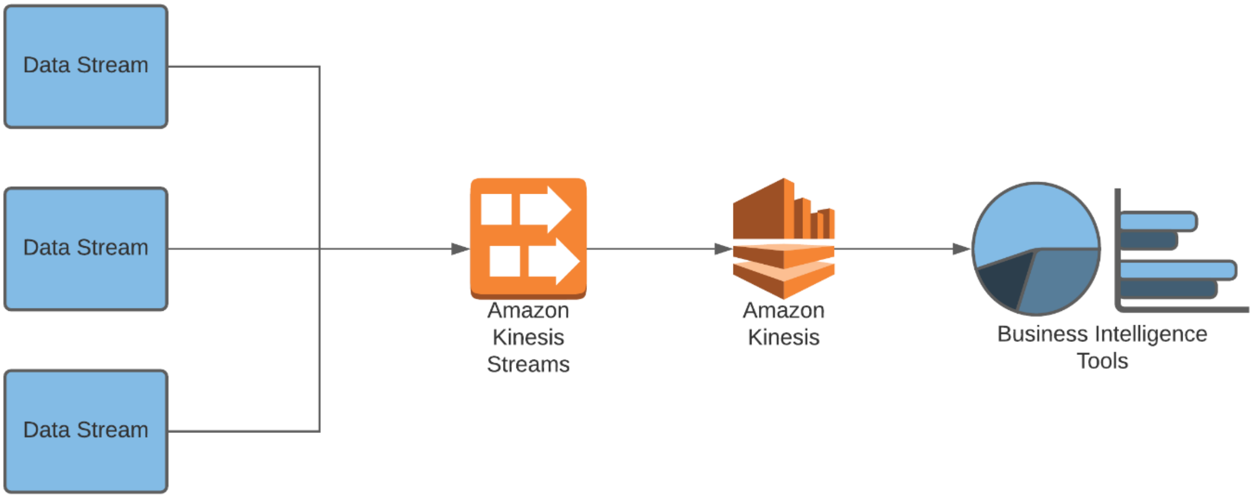
Kinesis Data Streams can be used in a variety of situations. Some common use cases are:

- Large event data collection.
- Real-time data analytics.
- Capturing gaming data.
- Capturing mobile data.

How It Works

1. Steaming data is captured by AWS Kinesis Streams.
2. Streaming data is then sent for processing via EC2 and/or Kinesis Data Analytics.
3. After data is processed, the data can be sent to business intelligence tools.

The diagram below shows how AWS Kinesis Data Streams are used to capture large amounts of real-time streaming data.



AWS Kinesis Data Firehose

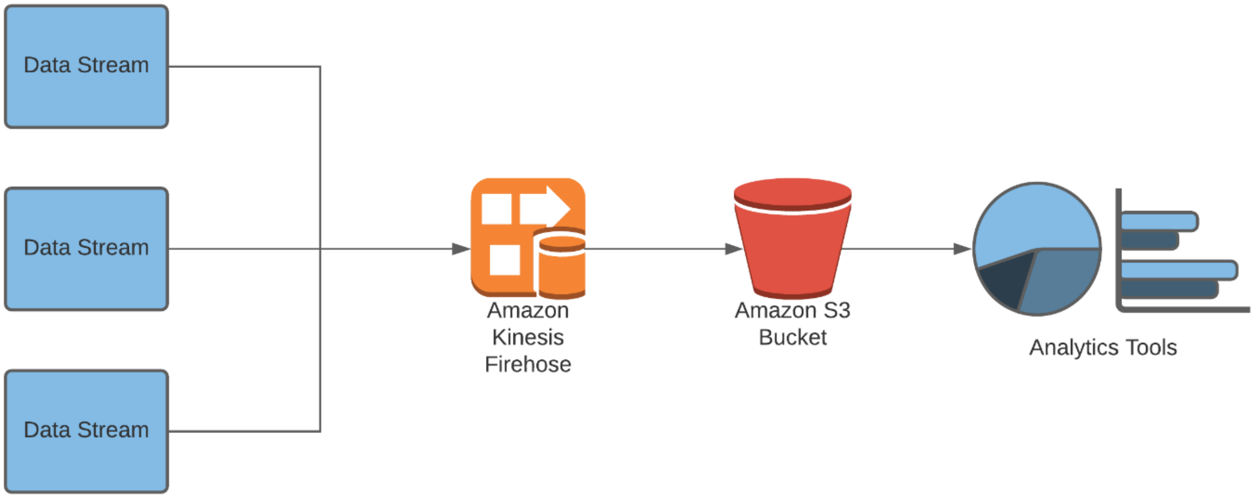
Amazon Kinesis Data Firehose is a managed service to load streaming data into data stores, data lakes, and data analytics services. Amazon Kinesis Data Firehose can capture streaming data and put it in S3 and Redshift, as well as other services. Amazon Kinesis Data Firehose scales to match the throughput of your data and supports autoscaling and data monitoring.

Amazon Kinesis Data Firehose pricing is based on throughput. Throughput is based on the number of shards. A *shard* is a throughput unit, with a capacity of 1 megabit per second. During setup, the administrator configures the capacity by the number of shards. Shards are increased as capacity requirements increase. A policy can be set up to autoscale the number of shards based upon utilization—up to ten shards per region, per account can be created. If additional shards are required, they can be obtained by contacting AWS support.

How It Works

1. Steaming data is captured by AWS Kinesis Data Firehose.
2. Streaming data is sent for storage, i.e., S3.
3. Stored data can be analyzed with analytics tools.

The diagram below shows how AWS Kinesis Data Firehose is used to capture large amounts of real-time streaming data and store the data in S3.



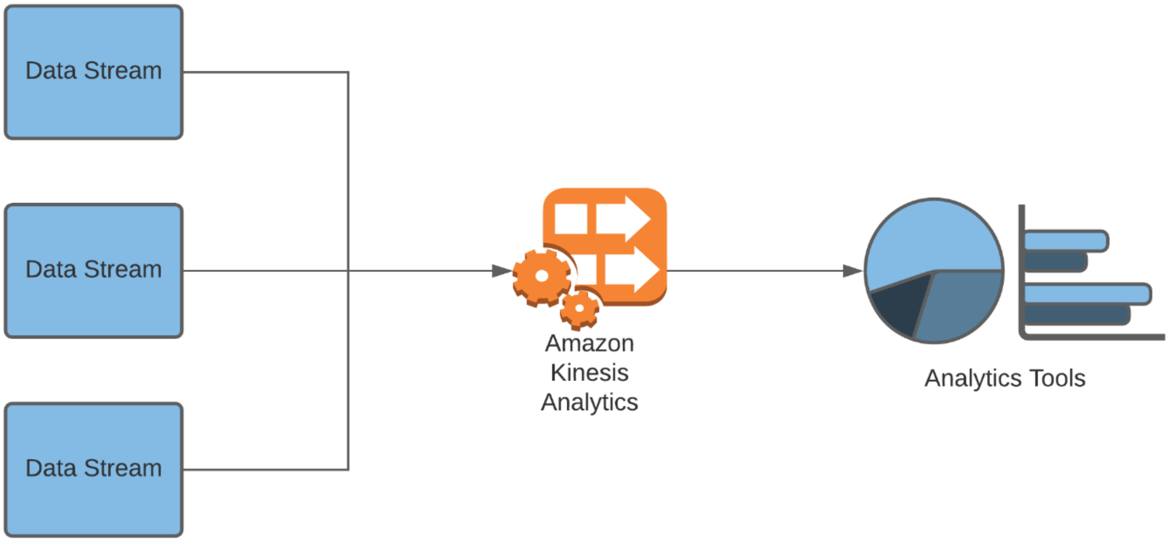
AWS Kinesis Data Analytics

Kinesis Data Analytics is a managed service to transform and analyze streaming data in real time. Kinesis Data Analytics uses Apache Flink to process data streams. Kinesis Data Analytics can autoscale to meet an organization's needs. Kinesis Data Analytics can be queried with standard SQL queries.

How It Works

1. Streaming data is captured by Amazon Kinesis Data Streams, Firehouse, Elasticsearch, S3, DynamoDB, and other data sources.
2. Amazon Kinesis Data Analytics analyzes data in real time.
3. Amazon Kinesis Data Analytics sends processed data to analytics tools.

The diagram below shows how AWS Kinesis Data Analytics is used to capture and process large amounts of data in real time.



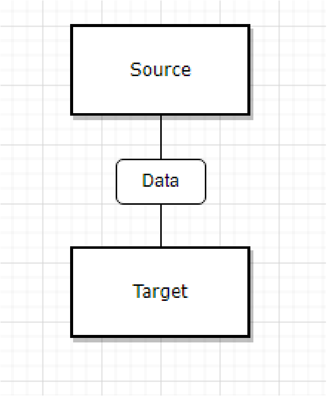
Amazon Managed Streaming for Apache Kafka

Amazon Managed Streaming for Apache Kafka (MSK) is a fully managed service that allows users to build and run applications that then use Apache Kafka to process streaming data in AWS.

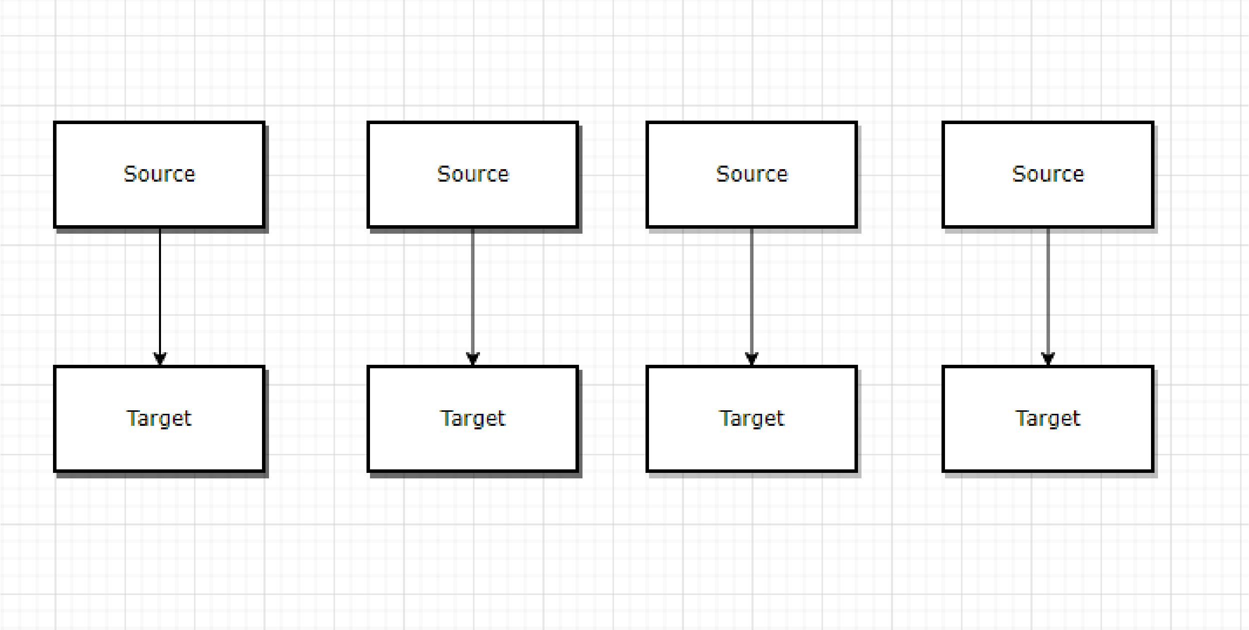
MSK is a fast, scalable, durable, and fault-tolerant streaming platform. It provides a unified, high-throughput distributed messaging system, and a low-latency platform for handling real-time data feeds.

MSK is also a distributed, partitioned, replicated commit log service. It provides a publish-subscribe message bus that can be used to build real-time data pipelines and streaming applications. MSK is a distributed streaming platform designed to handle large amounts of data. It can be used to store and process data in real-time.

Users have a source and target system that need to exchange data, on the surface that seems quite simple. You need an integration piece that ties both the source and target system together.



What eventually happens is companies end up with having many sources and target systems that need to exchange data and it becomes very complicated.

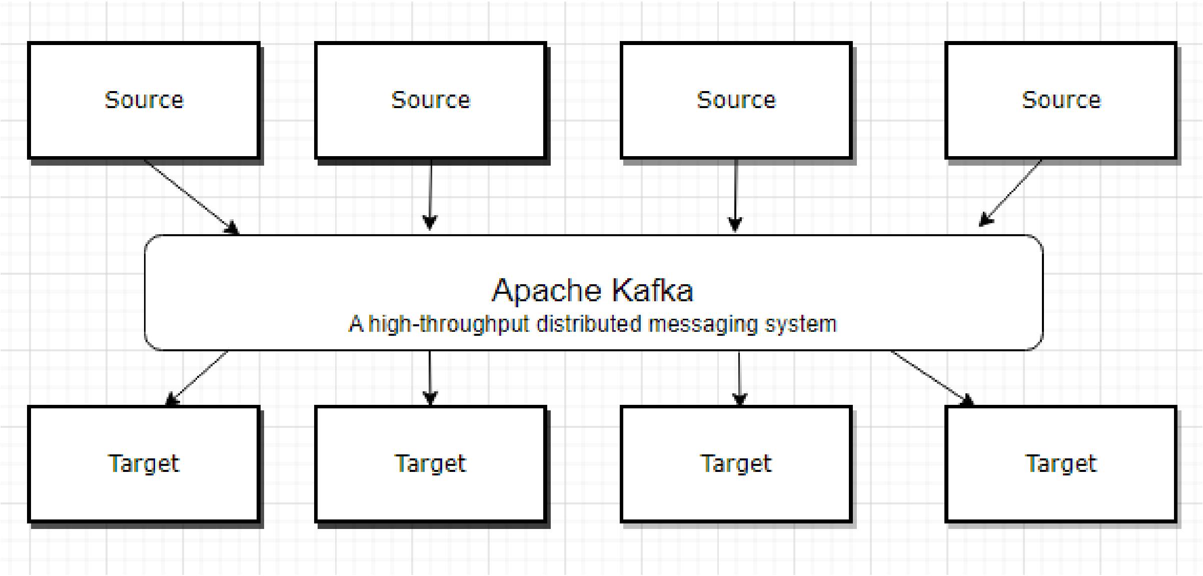


Problems organizations face with the above architecture is that if organizations have four source systems and six target systems well, they'll require twenty-four integrations to write, and each integration comes with a lot of difficulties.

These difficulties stem from the protocol, how the data is transported (TCP, HTTP, REST, FTP, JDBC, etc.), then the Data format how that data is parsed (Binary, CSV, JSON, etc.), and the Data schema and evolution, how the data is shaped that may change in the future.

Additionally, when users integrate a source system with a target system there would be an increased load on the connections. So, how is this problem solved?

Apache Kafka and how it works



Apache Kafka allows users to decouple data streams and systems. The source systems would have their data end up in Apache Kafka while the target system would source their data from Apache Kafka. Decoupling is a benefit of using Apache Kafka. Also, users may have any data stream they have including website events, pricing data, financial transactions, user interactions, and lots more. Likewise, users may put it in any target system such as analytics, email systems, audit, etc.

What is the business case for Apache Kafka?

Apache Kafka provides a high-throughput, low-latency, fault-tolerant messaging service that allows for the processing of millions of messages per second. Meaning Apache Kafka can scale with organizational needs and can handle any amount of data thrown at it.

Useful in the following cases:

- When there is a need to process data records in real-time
- When there is a need to handle high volumes of data
- When there is a need to process both batch and streaming data

In summary Apache Kafka

- It allows the decoupling of data streams and systems
- Distributed, resilient architecture, fault-tolerant
- Horizontal scalability
- Can scale to 100s of brokers
- Can scale to millions of messages per second
- High performance (latency of less than 10ms) - real-time
  - Used by thousands of firms including Airbnb, LinkedIn, UBER, NETFLIX, Walmart

Amazon OpenSearch

Amazon OpenSearch is an open-source service that allows users to search, analyze and monitor large volumes of data from multiple sources. It also incorporates visualization tools that provide insights into unstructured and semi-structured data. In addition, OpenSearch integrates well with analytics, machine learning, and other database mining tools.

How does Amazon OpenSearch work?

When data is captured and loaded into Amazon OpenSearch, it uses in-built services, such as Kibana Full-text Querying, Autocomplete, or Scroll Search, to search, visualize, and analyze logs to get real-time insights into the data. This data can be log files, messages, metrics, or documents. OpenSearch also allows users to automate alerts if there are underperformance and availability issues with information or website and can detect anomalies in real-time using machine learning.

Why use Amazon OpenSearch?

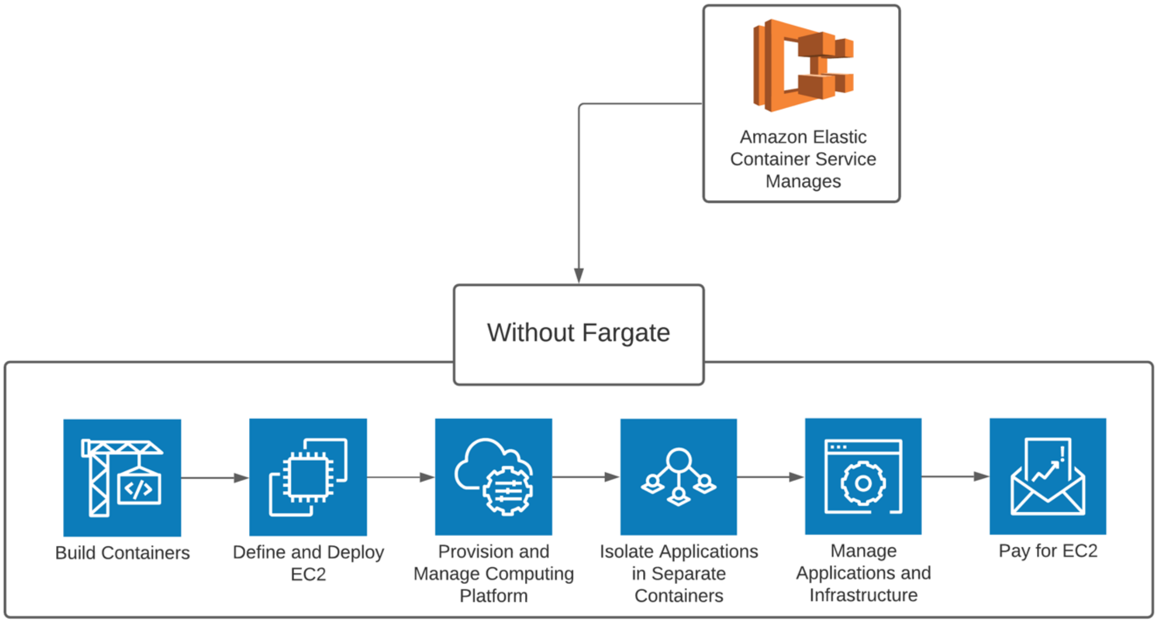
There are many benefits to OpenSearch. Such as It eliminates operational overhead and reduces costs to businesses. By utilizing automation provisioning, software installation, patching, and storage tiering integration. Also, being 100% open source saves your Research and Development costs when users need to modify, extend, monetize, and resell products. It’s pretty secure, and the functionality is very innovative and time-saving. The service is built on top of the open-source Apache Lucene search engine. It offers many of the same features and benefits, including full-text search, hit highlighting, faceted search, and dynamic clustering—safe, fast, versatile fully modifiable equals company bottom-line savings.

AWS Elastic Container Service (ECS)

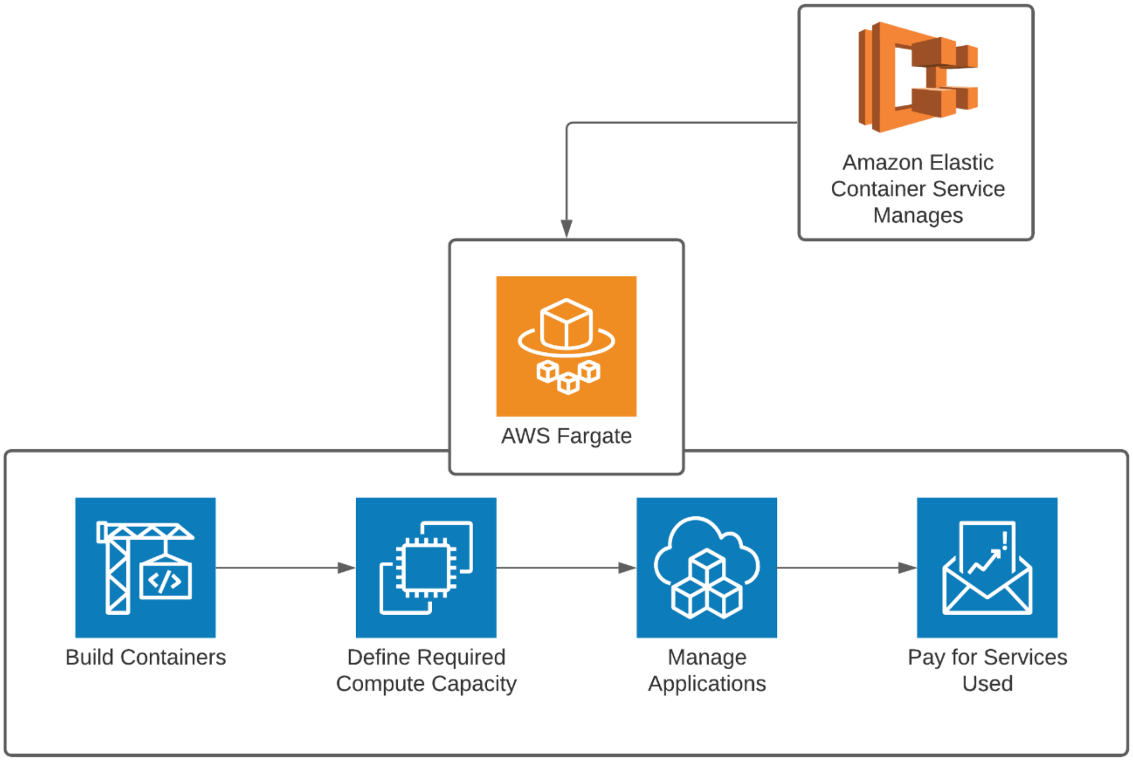
AWS Elastic Container Service (ECS) is a fully managed container management service. ECS is a high-availability (99.99 percent) and high-security container management solution. ECS is deployed in a VPC, which facilitates using AWS security features like network ACLs and security groups. ECS works to manage containers on EC2 or AWS Fargate.

ECS is often used with AWS Fargate, which is a serverless computing engine for containers. This enables ECS and Fargate to create a completely serverless container platform. ECS is used with Fargate, where ECS provides orchestration and management of the Fargate container service. When using ECS with Fargate, there is no need to configure computing instances, install, and manage operating systems, or manage computing instances. Since Fargate is serverless, there is almost limitless scalability.

The diagram below shows how AWS ECS is used to manage containers on the EC2 platform:


Amazon Elastic Container Service Manages
Without Fargate
Build Containers
Define and Deploy EC2
Provision and Manage Computing Platform
Isolate Applications in Separate Containers
Manage Applications and Infrastructure
Pay for EC2

The diagram below shows how AWS ECS is used to manage Fargate containers:

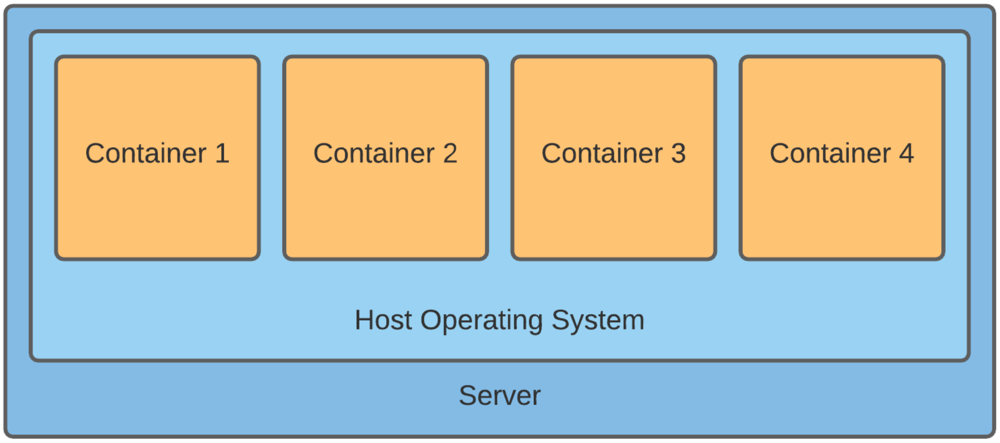

Amazon Elastic Container Service Manages
AWS Fargate
Build Containers
Define Required Compute Capacity
Manage Applications
Pay for Services Used

What Is a Container?

A container is a lightweight, self-contained software package that acts as a modern version of a virtual machine. Virtual machines have a lot of overhead, as they require an entire copy of an operating system to run. By comparison, a container contains just enough of an operating system for the application in the container to run. Since the container runs only a small percentage of operating system packages, a container requires much less memory and CPU resources than a virtual machine. Therefore, many more containers can run at higher performance than virtual machines on a server.[77, 78]

Container images are logically isolated from each other, promoting a secure environment. The host of the containers can support only clients that use the host's operating system. This means Linux containers are hosted on a Linux host and Windows containers are hosted on a Windows host. With the new Windows Subsystem for Linux, Windows systems can now support Linux containers. The reason containers must be on the same operating system is that containers depend on packages from the host operating system.

The diagram below shows how a server can support numerous containers in a logically isolated manner:



Choosing Between EC2 and Fargate for Containers

As discussed, containers can be hosted on EC2 instances or Fargate. Both approaches have their merit. Choosing the right host is dependent upon an organization's requirements. Please see the list below for guidance on choosing the best container approach:

- If complete control over the device hosting the container is needed, choose EC2.
- If there are specialized requirements and specific customization options required, choose EC2.

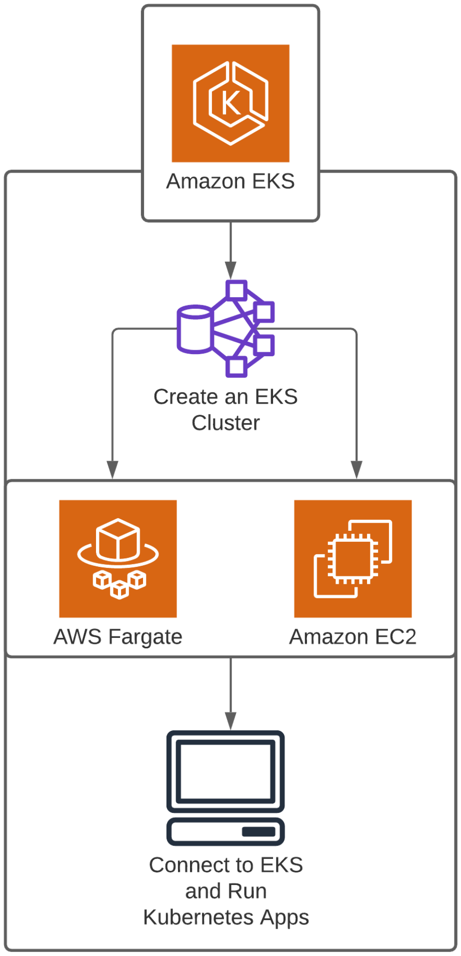
- If a highly scalable platform with minimal management overhead is desired, choose Fargate.
- If near limitless scalability is required, choose Fargate.
- Overall, Fargate is likely a better solution for most customers' needs.

AWS Elastic Kubernetes Service (EKS)

AWS Elastic Kubernetes Service (EKS) is a fully managed Kubernetes container management service. EKS is a full Kubernetes service, which means Kubernetes containers can be moved to EKS without modification. Kubernetes is an open-source container management service and is the industry standard for containerized applications.[79]

EKS is extremely similar to ECS, but it uses the Kubernetes container platform. Like ECS, EKS is often used with AWS Fargate, creating a completely serverless container platform. EKS can also be used with EC2 in the same manner that ECS can be used with EC2.

The diagram below shows how AWS EKS is used to manage Kubernetes containers:



Amazon EKS Distro

EKS Distro is a service that enables users to run containerized applications in their data center in the same way you run them in AWS. A container is a ready-to-run software that runs on any server without the need to install and configure the application components. These containers run on servers called "nodes" which can be clustered for performance and availability.

Matching Kubernetes configuration in AWS and your Data Center

As Kubernetes is a technology that automatically monitors node clusters and restarts them if they go down. Duplicating the same Kubernetes configuration users have in AWS in their data center is a cumbersome task because they must match the same versions of components and security patches. EKS Distro is Amazon's answer to this challenge by publishing pre-configured software components that users can download as-is to their own data center thus alleviating them from having to configure and match Amazon's environment. Amazon EKS Distro enables users to create Kubernetes clusters with the *exact* version of Kubernetes used in their AWS EKS. The main difference between EKS and EKS Distro is that EKS is a fully managed Kubernetes service on AWS whereas EKS Distro is available to download and install in any environment, including a data center.

With AWS EKS-D users can deploy Kubernetes clusters that match their AWS EKS clusters without having to focus on:

- Tracking compatibility across the Kubernetes versions in AWS and your data centers
- Performing application regression testing in your data center Kubernetes clusters each time AWS releases a new version of EKS and you need your data center to be at the same version.
- Security risks from older Kubernetes versions by extending support 14 months after community support ends.

Use Cases

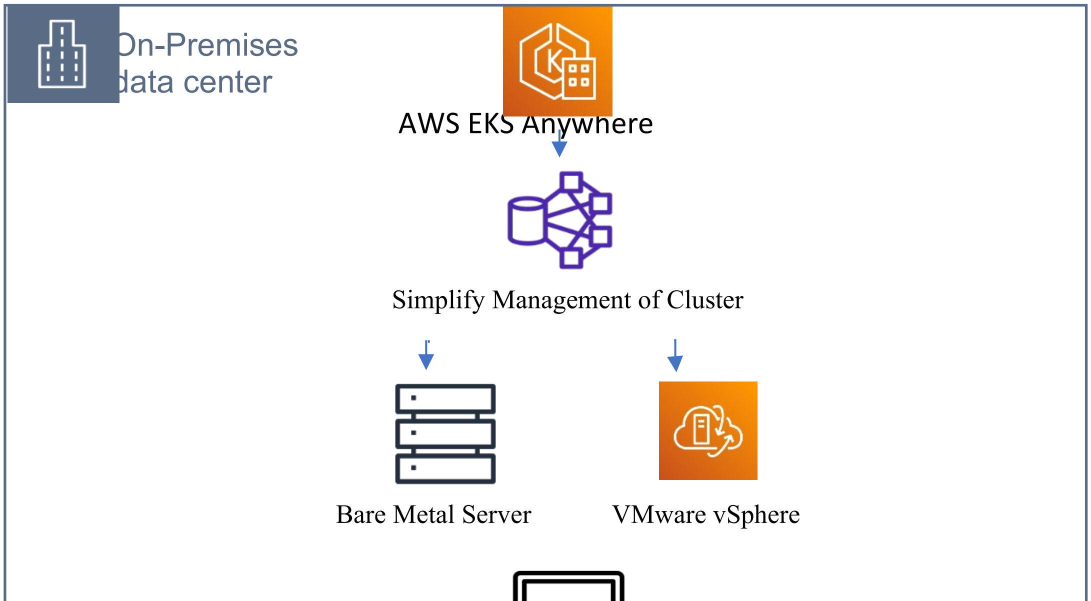
- Hybrid clusters – when users want Kubernetes clusters that span their data center and AWS cloud. For example, when a user's data center requires more capacity, additional nodes from AWS are added to the cluster.
- Disaster Recovery - when users want to set up AWS EKS to be the backup data center if their own data center goes down.

AWS EKS Anywhere

AWS EKS Anywhere is a customer-managed service that allows users to create and manage Kubernetes clusters with optional support from AWS. Kubernetes is a container orchestration platform that allows automation of the deployment, management, and scaling of containerized applications.

How does AWS EKS Anywhere work?

It is deployed as an installable software package that simplifies the creation and operation of Kubernetes clusters. It then automates the management of these clusters on-premises and self-heals. This enables reduced support costs and maintenance of redundant third-party tools. It can be deployed on both physical servers such as bare metal and VMware. It can be installed in any environment including multi-cloud & on-premises.



When to use AWS EKS Anywhere

AWS EKS Anywhere simplifies users' on-premises Kubernetes cluster management via default configurations, provides autoscaling, and is self-healing.
It offers a consistent and reliable Kubernetes cluster environment on-premises over a self-managed environment. It also reduces your support costs and avoids the maintenance of redundant third-party application tools and makes Governance easy for the clusters.

Use Cases

AWS EKS Anywhere is a multi-cloud if users are in a location without internet connectivity, AWS EKS Anywhere enables them to deploy and operate Kubernetes clusters that are highly available and with the same power as Amazon EKS on AWS.

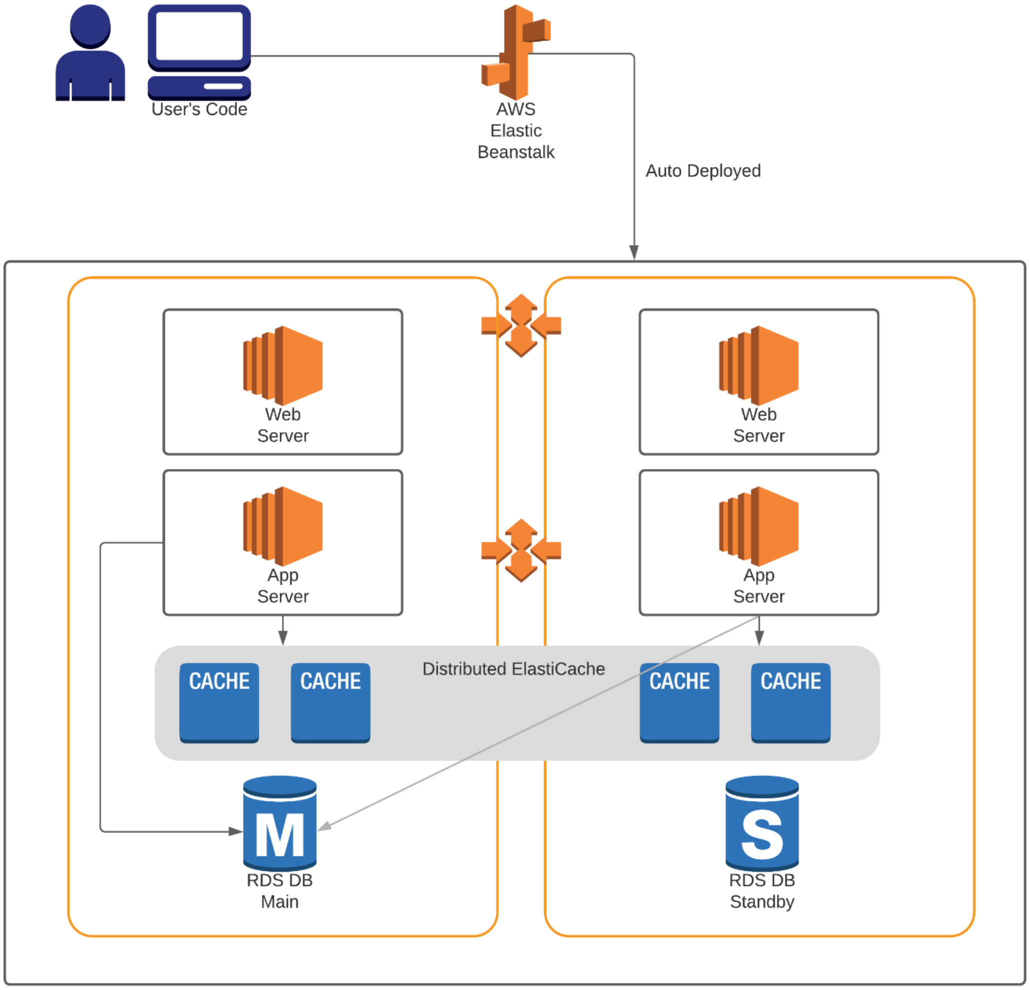
AWS Elastic Beanstalk

AWS Elastic Beanstalk is a service for provisioning, deploying, and scaling web applications and services. When using Elastic Beanstalk, the administrator simply uploads the code, and Elastic Beanstalk automatically deploys the necessary infrastructure (EC2, containers, load balancers). All infrastructure deployed by Elastic Beanstalk is autoscaling, so it grows with customer requirements. Additionally, infrastructure deployed from Elastic Beanstalk is automatically load balanced.[80]
Elastic Beanstalk provides the necessary tools for web deployment and automatically applies them to the customer, enabling the customer to focus on code development and not infrastructure management. Elastic Beanstalk supports the following programming languages:

- Go
- Java

- .NET
- Node.js
- PHP
- Python
- Ruby

Elastic Beanstalk provisions and manages the environment while allowing the administrator to manage the environment if desired after the computing platform is deployed. Elastic Beanstalk monitors application health and is integrated with CloudWatch logs for performance monitoring. The diagram below shows AWS Elastic Beanstalk automatically deploying the application environment based upon inputting the organization's code:



Amazon Elastic Container Registry (Amazon ECR)

Amazon Elastic Container Registry (ECR) stores, manages, and deploys Docker images. Additionally, ECR allows AWS developers to save configurations and quickly move them into a production environment, thus reducing overall workloads.

Amazon ECR provides command-line interface (CLI) and APIs to manage repositories and integrated services like Amazon ECS that takes these files and actively uses them in the deployment of applications.

A developer uses the Docker CLI to push or pull container images to or from an AWS region. Amazon ECR can be used wherever a Docker container service is running, including on-premises environments. AWS Elastic Beanstalk also supports Amazon ECR for multi-container environments.

Amazon ECR works with Amazon Simple Storage Service (S3) and private repositories like GitHub, and resource-based permission using AWS Identity and Access Management (IAM) and allows administrators to use AWS IAM to create restrictions that limit access to each repository. ECR also supports public container image repositories.

Attributes of Amazon ECR

Amazon ECR contains the following attributes:

- Registry: Each account has an Amazon ECR private registry, used to create repositories and store images in different versions.
- Authorization token: users authenticate to Amazon ECR registries before images can be pushed and pulled.
- Repository: It contains Docker images, Open Container Initiative (OCI) images, and OCI-compatible artifacts.
- Repository Policy: users can create IAM policies that control who has access to their repositories and their images.
- Images: container images can be pushed and pulled into repositories. These images can be tagged and used locally on development systems.

ECR Encryption

Container images can be encrypted in transit using HTTPS transfer and automatically at rest using Amazon S3 server-side encryption.

When would you Amazon Elastic Containers Registry (Amazon ECR)?

Amazon Elastic Container Registry makes it simpler to manage and deploy containers. It can be used to deploy application images and artifacts anywhere.

- Microservices

- Websites
- Video rendering services
- Machine learning

AWS CloudWatch

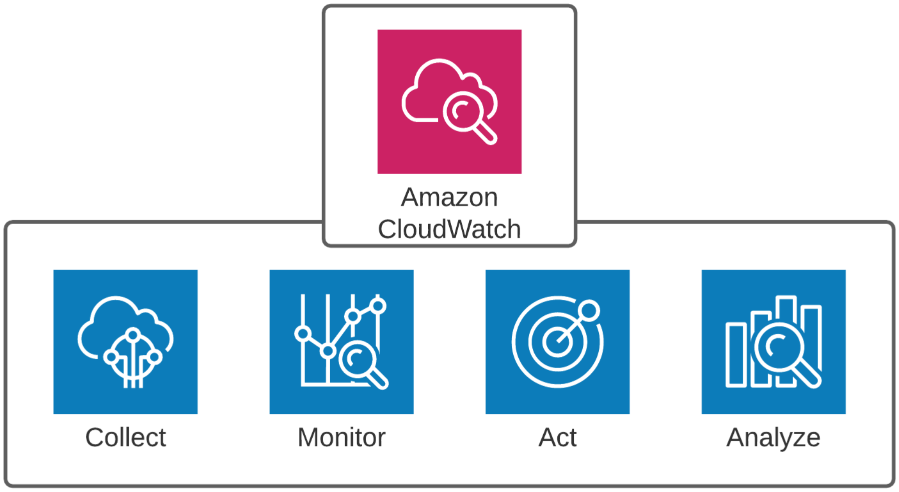
CloudWatch is a monitoring service to monitor AWS resources and applications deployed on AWS. CloudWatch provides metrics to monitor performance and troubleshoot issues.[81, 82]

CloudWatch can work with built-in metrics and custom metrics. CloudWatch has several built-in default metrics, which include CPU utilization, disk utilization, and network utilization. CloudWatch custom metrics can be set up to monitor factors critical to the application's performance, such as memory utilization, API performance, or other metrics.

CloudWatch has a notification service that notifies the organization when certain metrics have been reached. Organizations can set custom metrics and alert notifications. CloudWatch events can also be used to trigger autoscaling, Lambda functions, SNS notifications, actions on containers, and many other functions.

AWS CloudWatch is available in two versions for EC2 instances: basic monitoring and advanced. Basic monitoring automatically provides information every five minutes at no charge. Detailed monitoring provides information every one minute at an additional cost. When using detailed monitoring, it must be enabled at the EC2 instance. As pricing is subject to change, please reference the AWS website for current pricing information for CloudWatch services at https://aws.amazon.com/cloudwatch/pricing/.

The diagram below shows AWS CloudWatch can be used for VPC monitoring and optimization:



AWS Config

AWS Config is a service that enables assessment, auditing, and evaluation of configurations in AWS. AWS Config provides a means to see what changes were made and who made these changes in the VPC. AWS Config provides monitoring of any changes that have occurred. When a change is made, AWS config can send an SNS alert to systems administrators.

AWS Config also provides constant monitoring of configurations and checks configurations against an organization's policies. If a change is made that violates the organization's policy, an SNS alert is sent, and a CloudWatch event will occur.

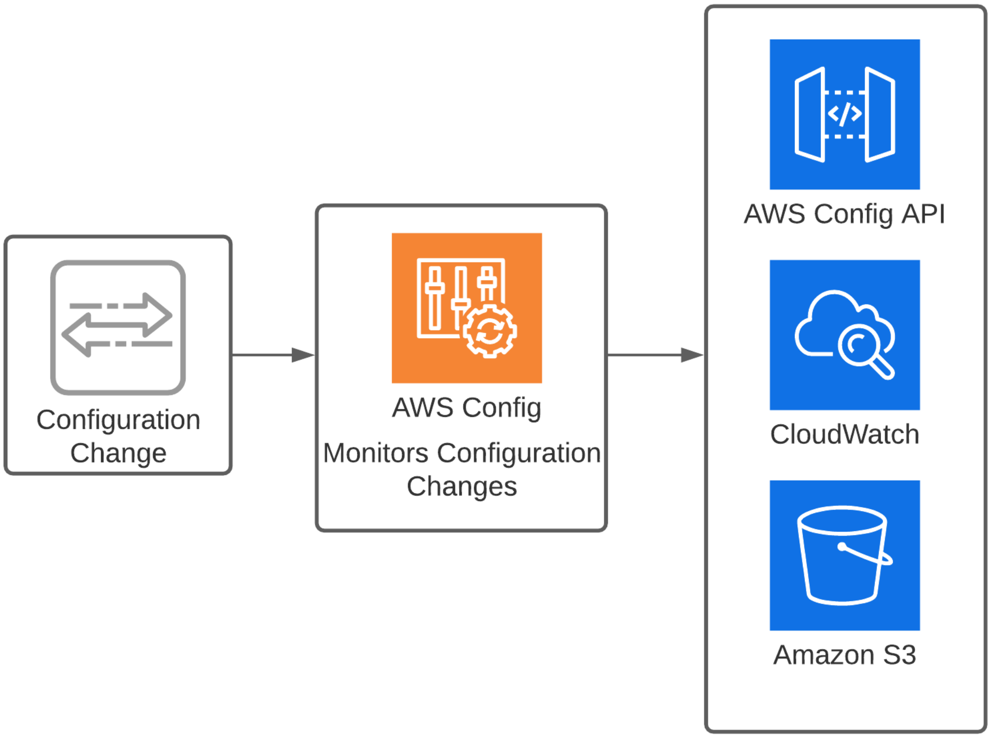
AWS Config provides a means to assist with change management. Config can track relationships between resources, so if changes are made, it will be easy to determine which systems will be affected by the changes. AWS Config can help with troubleshooting, as it can integrate with CloudTrail and track changes made. In this manner, if a configuration change causes a problem, AWS config will show which changes should be reverted to go back to a fully functional environment.

How It Works

1. A configuration change is made.
2. AWS Config notes the change and records the change in a consistent format.
3. AWS Config will then check the change against an organization's policies.

4. AWS Config will notify the services that can notify the system administrator of configuration changes. Notifications can be sent as a CloudWatch event, SNS, or other AWS service.

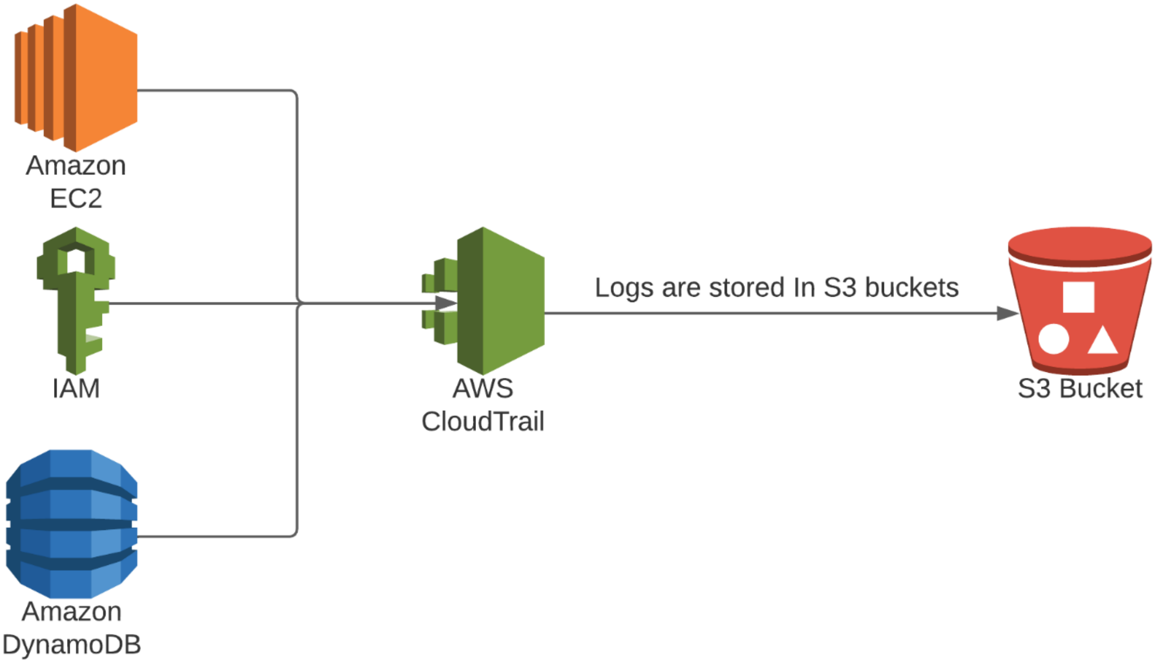
The diagram below shows how AWS Config monitors for configuration changes:



AWS CloudTrail

CloudTrail is an AWS service that assists with the auditing process. CloudTrail provides an audit log that supports risk management and compliance endeavors. CloudTrail provides a means to track changes made to an AWS account by a user, role, or AWS service.[83]

The diagram below shows how AWS CloudTrail is used for logging and auditing of an organization's VPC:



CloudTrail is enabled when the AWS account is created. To start using CloudTrail, create a trail with the CloudWatch console, CLI, or CloudTrail API. CloudTrail records events, and these events are visible in the CloudTrail console under Event History. The CloudTrail event history shows events that have occurred in the last ninety days. Additionally, CloudTrail can be configured to store logs in an S3 bucket for long-term storage.

Two types of CloudTrail trails can be created, and they can be seen below:

Local Trail

A *local trail* is tied to a single region trail. CloudTrail logs are put into a single bucket. This is the default option when CloudTrail is configured by the CLI or API.

A Trail that Applies to All Regions

A CloudTrail can be set up to monitor all regions. This provides the most comprehensive logging and auditing options available. This provides a record of all events that occur inside an organization’s infrastructure. This type of trail can help correlate events across an organization’s global infrastructure and provide insight on fixing problems.

CloudTrail and Compliance Audits

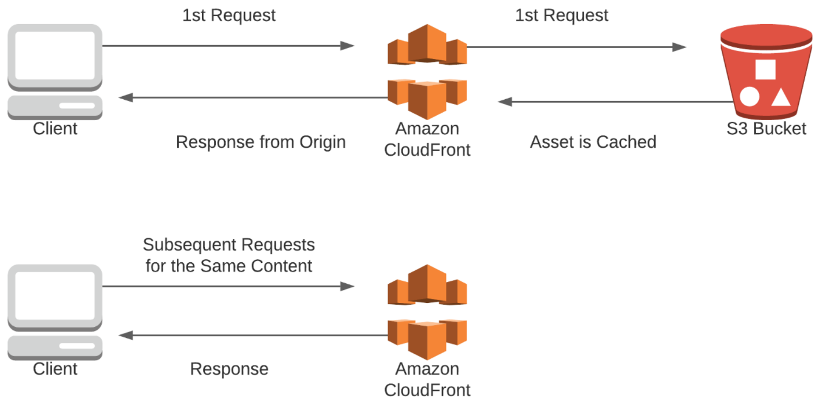
Many industries are highly regulated and have specialized data storage, protection, privacy, and auditing requirements. CloudTrail can be very beneficial in highly regulated environments, as CloudTrail can help show how the organization is adhering to legal requirements.

AWS CloudFront

AWS CloudFront is an Amazon-branded content delivery network. CloudFront can dramatically improve web hosting and is integrated with numerous AWS services. Effectively, CloudFront is a network of caching servers spread throughout the world. When a request is made to a webpage, its location is determined, and the web request is sent to the closest CloudFront server. Local CloudFront servers cache website content and speed the delivery to remote locations throughout the world.[84, 85, 86] The caching server works in the following manner:

1. The web request is sent to the CloudFront caching server.
2. If the website has been requested prior to the cache timeout, the content is sent straight to the user.
3. If the website data is not stored on the cache, the cache reaches out to the original website.
4. When the data is received, the information is stored on the cache until the cache’s expiration, and the data is sent to the requestor.

The diagram below shows how CloudFront caching can be used to improve the scalability and performance of web applications:



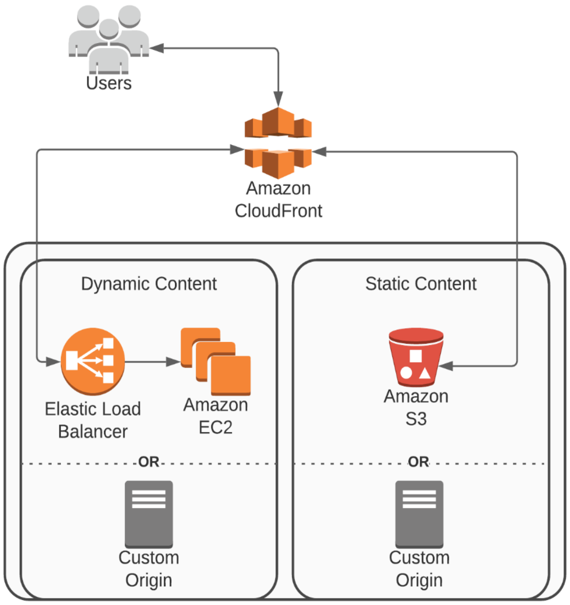
Caching can assist with website scalability and performance by offloading frequent requests to the cache instead of the actual website. Caching is very helpful for frequently requested content. If the content is very dynamic and user requests are all for new data, then the caching server will not help to improve performance or scalability.

CloudFront integrates with numerous AWS services, including S3, EC2, Elastic Load Balancers, and Route 53. CloudFront is typically used as a front end to static websites stored on S3. CloudFront can also be a front end to an EC2-based website as long as an Elastic Load Balancer is part of the architecture.

CloudFront can help website performance through the following mechanisms:

- Cached content – The request does not need to go to the web server because it is cached.
- Global reach – There are over 217 points of presence for CloudFront. So CloudFront can get content much closer to the user's location.
- Routing efficiency – When CloudFront is used, requests that go to the original source (i.e., S3 bucket) traverse the AWS backbone and not the public internet. Therefore, performance can be enhanced, as AWS can manage their network for lower latency than when traversing an unknown number of internet service providers.
- Persistent connections – CloudFront maintains connections to the source. This minimizes the number of connections required on the web server, which reduces server load.

The diagram below shows how AWS CloudFront can be used to enhance the performance of a web application with static and dynamic content:



CloudFront can also make a significant impact on an organization's security.

CloudFront Integrates with Web Application Firewall (WAF)

- WAF adds firewalling capabilities to protect against common web attacks.

CloudFront Can Help Prevent Distributed Denial of Service Attacks

- CloudFront distributes requests through multiple points of presence.
- CloudFront forwards only legitimate http/https requests to the server that aren't already in the cache. This means the attacker cannot launch a DDoS by sending a large number of invalid requests to the server.
- AWS Shield Standard is included with CloudFront to provide additional layers of DDoS protection.

CloudFront Can Provide Encryption in Transit

- CloudFront can enforce SSL/TLS protocols.
- CloudFront integrates with the AWS Certificate Manager.
- CloudFront supports Server Name Identification (SNI) as well as custom certificates.

Tuning CloudFront

CloudFront is highly tunable to meet an organization's needs. CloudFront can be modified by changing the *time to live* (TTL) for objects in the cache. The minimum, maximum, and default TTL for objects are configurable options. If problems occur in the cache, it is possible to clear the cache. Clearing the cache is performed via the API or with the command line with the following command structure:

- aws cloudfront create-invalidation --distribution-iddistribution_ID --paths "/*".

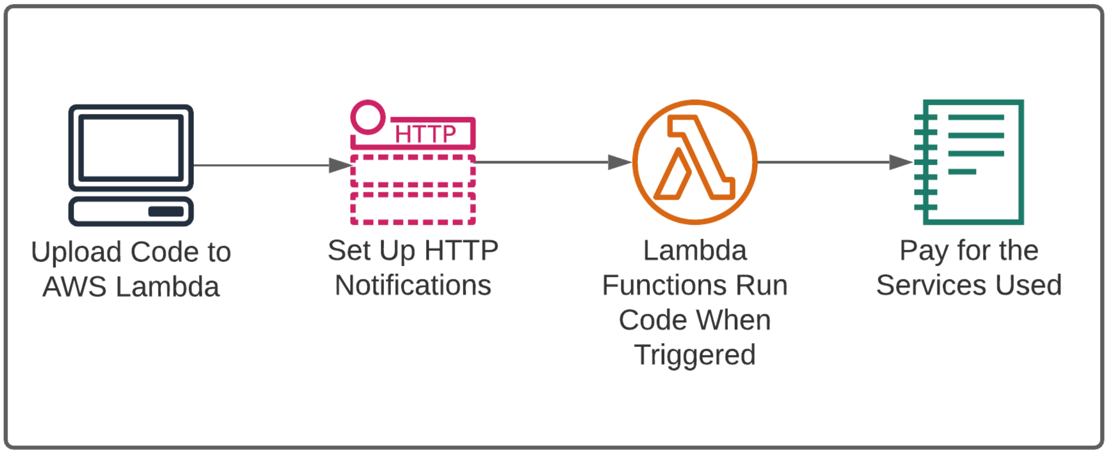
AWS Lambda

AWS Lambda is a serverless computing service to enable automation across an organization's infrastructure. AWS Lambda is useful in many situations where automation can increase the efficiency of technology by decreasing manual intervention. Some examples of automation with the Lambda platform include processing data across multiple systems, patching operating systems, and remediation of security events.[87]

Using Lambda functions is much simpler than deploying custom automation applications. To get started using Lambda, just upload the code for the Lambda function. Since Lambda is serverless, there is no need to manage servers and operating systems. Lambda supports the following programming languages:

- C#
- Go
- Java
- Node.js
- Python
- PowerShell
- Ruby

The diagram below shows how Lambda functions are deployed on the AWS platform:

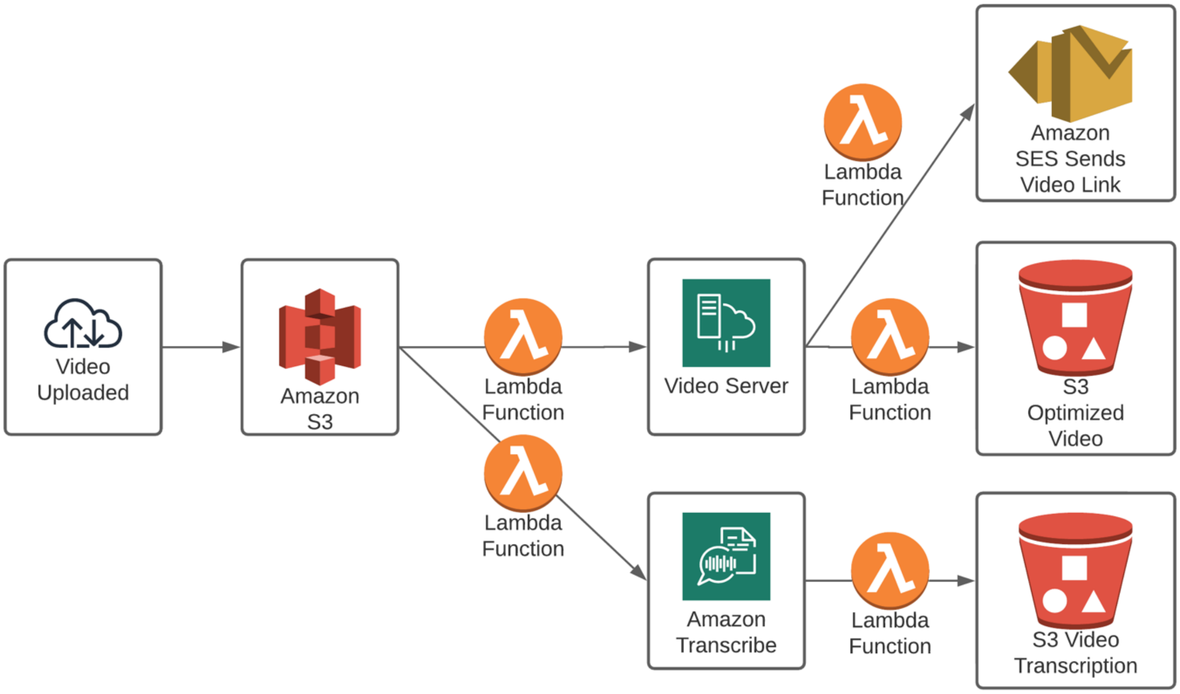

HTTP
Upload Code to AWS Lambda
Set Up HTTP Notifications
Lambda Functions Run Code When Triggered
Pay for the Services Used

Lambda is stateless, meaning that once the function is performed, the function has been completed. If additional functions are needed, it will be necessary to set up additional Lambda functions. Lambda functions can be run in response to events in a VPC. A sample video optimization using Lambda can be seen below:

In this example, there is a video-processing application that optimizes and transcribes a video after being uploaded into S3 using Lambda functions.

1. A new video is uploaded into S3.
2. When S3 detects a new video, a Lambda function is triggered to inform the transcription application that a new video is ready to be transcribed.
3. The video gets transcribed.
4. After the video is transcribed, a Lambda function triggers AWS SNS/SES.
5. An email is then sent to the customer, telling them their video is ready for download.

The diagram below shows how AWS Lambda can be used to automate workflows on the AWS platform:

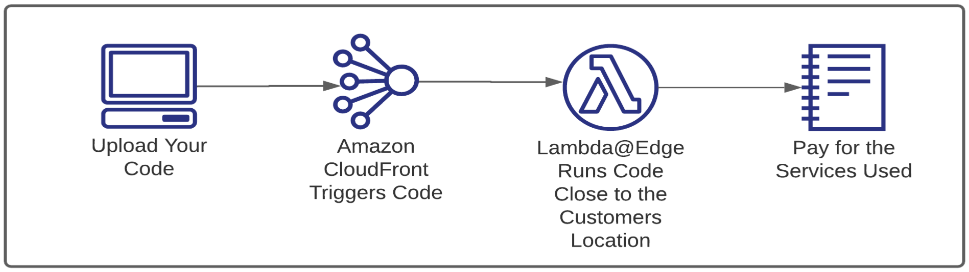


AWS Lambda@Edge

AWS Lambda@Edge is a serverless CloudFront feature. Lambda@Edge works with the CloudFront content delivery network. Lambda@Edge enables the content to be closer to the customer and achieve higher performance. Additionally, Lambda@Edge allows for running Lambda functions closer to the user. Setting up is a matter of the following:

1. Upload code to a Lambda function.
2. Set up the Lambda function to be triggered by CloudFront.
3. The Lambda@Edge code is run where your users are located.

The diagram below shows how AWS Lambda@Edge can be used to perform functions close to the customer's location:


Upload Your Code
Amazon CloudFront Triggers Code
Lambda@Edge Runs Code Close to the Customers Location
Pay for the Services Used

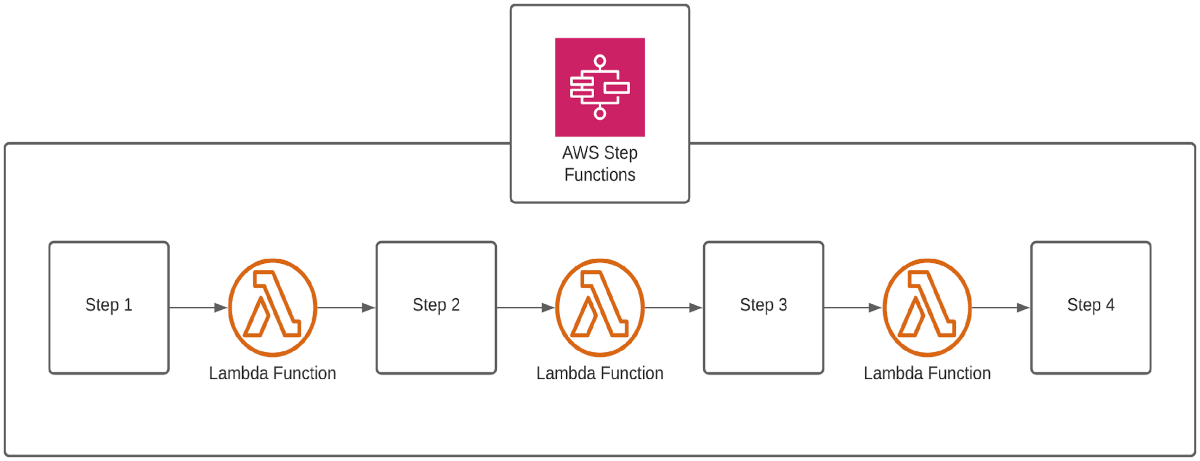
AWS Step Functions

AWS Step Functions provide a means to sequence multiple Lambda functions. AWS Step Functions are serverless, just like AWS Lambda. Step Functions help facilitate a multiple-step workflow. For example, if a file is uploaded to S3, a Lambda function can send the file to an EC2 instance for processing. After processing is completed, a Lambda function can send the processed data to DynamoDB.[88]

Step Functions are simple to design. The process to set up AWS Step Functions is as follows:

1. Design the steps of the application.
2. Create the individual Lambda functions.
3. Configure the workflow in the Step Functions.
4. Connect the workflow components to individual tasks specified in the Lambda functions.
5. Execute the Step Functions in normal use.
6. Optimize and evolve the Lambda and Step Functions as needs change.

The diagram below shows how AWS Step Functions can be used to automate multistep workflows:



Amazon Forecast

Amazon Forecast is a machine learning tool to assist with business forecasts. It works on time-based data analysis of older data first to the newest data to help businesses review historical data to make better predictions for the future.

It is designed and geared toward those with little or no experience with forecasting or machine learning. Amazon Forecast was built based on the same technology used at Amazon to do their own forecasting.

How Amazon Forecast Works

Amazon forecast works by using a machine learning algorithm to combine historical time series data with other variables to build accurate forecasts, with the aim of predicting business outcomes accurately. To create a forecasting project in Amazon, users work with the following resources.

- **Importing Datasets**:
    - Upload datasets which are collections of input Data containing complementary information relevant to the use case.

- **Training Predictors**
    - Custom models trained on their data are called *predictors*. Users train predictors by selecting a pre-built algorithm or selecting the AutoML option to have Amazon forecast pick the best algorithm for the project.

- **Generating Forecasts**
    - Using the customized forecasting model, Amazon Forecast generates forecasts for the time-series data which can be visualized in the console, exported as a CSV file, and viewed in custom applications with the help of Amazon forecast API.

Why we use Amazon Forecast

Amazon Forecast is used when users want to predict business outcomes accurately. It is useful in multiple fields like Healthcare, Finance, Retail, and Hospitality. The following use cases for Amazon Forecast are:

- **Operational planning**

    - Supports business options to better predict amounts of web traffic, AWS usage, and IoT sensor usage.

- **Supply chain planning**

    - Allows businesses to predict the number of fresh goods, services, or other inputs required by the business.

- **Retail demand planning**
    - Gives businesses a better way to predict product demand by combining historical sales and associated data, allowing you to accurately adjust inventory and pricing at different store locations.
- **Resource planning**
    - Allows businesses to predict requirements for staffing, energy utilization, marketing, and server capacity.

AWS Rekognition

Rekognition is a way to analyze videos and images using machine learning. Rekognition can be helpful in analyzing video content.[89] Some examples of using AWS Rekognition are:

- Identification of individuals in a video.
- Analysis of emotional state based upon facial expressions.
- Identification of unwanted content in videos.
- Ability to search a video for a certain person.
- Labeling of images, logos, or objects found inside of a video.
- Detecting anomalies and unwanted content within an organization's videos.

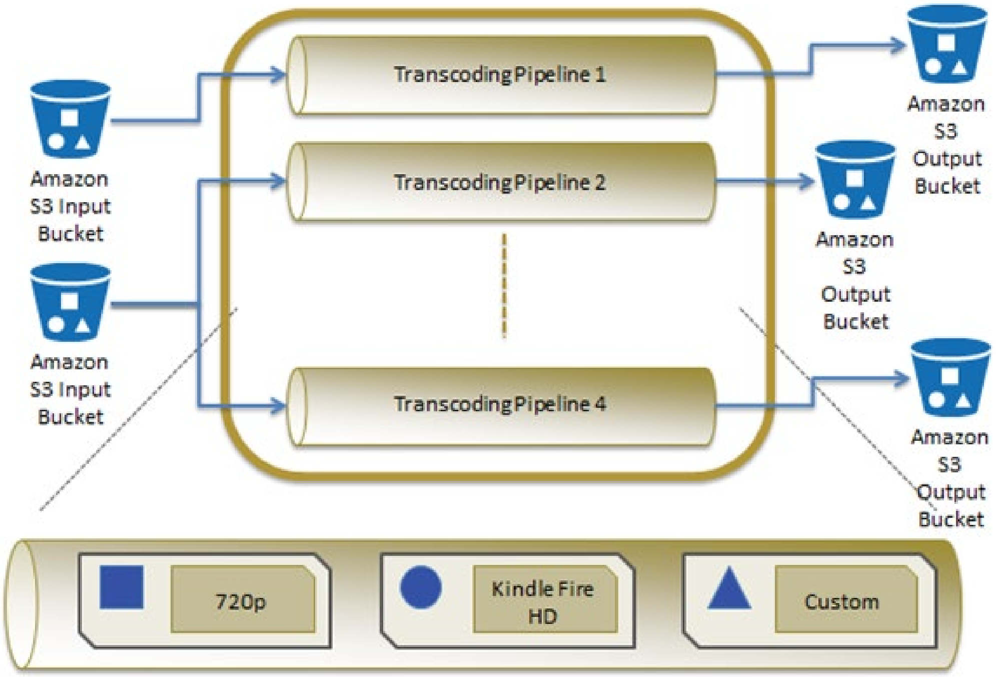
Amazon Elastic Transcoder

Amazon Elastic Transcoder is a service for converting video between various, digital media formats in the cloud. It is easy to use, cost-effective, and highly scalable way to transcode videos that users store in Amazon Simple Storage Service (S3) in versions that work on smartphones, tablets, and PCs. Elastic Transcoder is architected to handle high-volume, complex transcoding jobs in parallel using multiple transcoding pipelines.

What does Elastic Transcoder do?

Transcoding is highly computationally intensive and requires generous amounts of system resources like Random Access Memory (RAM), higher-end Central Processing Units (CPUs), and Graphical Processing Units (GPUs). Especially when transcoding 4k videos into different formats. Therefore, organizations may select to do their transcoding needs in the cloud.

Amazon Elastic Transcoder is easy to use because it has a clear workflow and predefined video formats that can be selected for many output devices. Amazon Elastic Transcoder is available in different AWS Regions, and users can transcode where they store content. There is no contract or monthly commitment for using Amazon Elastic Transcoder. Users pay based only on the minutes needed to transcode videos and the resolution of the content transcoded.



When to use Elastic Transcoder?

Users can convert large, high-quality digital media files into formats that users can play back on mobile devices, tablets, web browsers, and connected televisions.

Amazon Textract

Amazon Textract is a machine learning (ML) service that extracts text, handwriting, and data from scanned documents. These scanned document(s) could be single or multi-page documents and could be in any of these formats: JPEG, PNG, PDF, or TIFF format. This Textract service, developed by Amazon’s computer vision scientists, is based on a proven, highly scalable, and deep learning technology to analyze billions of images and videos daily. The most common way that companies and businesses, both in the private and public sectors, adopt to identify, understand, and extract data from forms and tables is by implementing a manual configuration of a simple OCR (optical character recognition) software that requires regular updates whenever there is a change in form to both the tables and forms. This manual configuration and update as it pertains to extracting data from scanned documents is quite a tedious and expensive process. However, using Amazon Textract, it is easy to add document text detection and analysis to your applications and overall, this reduces the timeframe of extracting data to minutes, instead of hours or days.

How does Amazon Textract work?

Amazon Textract works by reading and processing documents using machine learning (ML) which is a combination of various Application Programming Interfaces (APIs). After reading documents, Textract can extract text, numbers, handwriting, and query response from tables and images. Amazon Textract automates document workflows using AWS Lambda functions to make API calls. Extracted data can then be sent directly to object storage when it consists of structurally extracted data or to the AWS Comprehend service for analysis, and then to object storage after being processed. Textract uses optical character recognition (OCR) to detect handwriting, numbers, and printed text from documents but also goes beyond standard OCR by being able to match key-value pairs in images and tables while keeping the context of their relational value. Using traditional OCR methods, key-value pairs are captured as simple text that unlinks them but by using machine learning, Amazon Textract avoids erasing their associated value. A key-value pair is a set of linked data items, for instance in a document, you could have a field named "first name" as the key and the corresponding value pair as "James". This makes it a lot easier to import the extracted data about the key-value pair into a database.

Amazon Textract uses machine learning (ML) to perform a variety of functions, for instance, it makes use of Document Analysis API to extract text, forms, and tables from documents that have a structured form. Also, Amazon Textract makes use of AnalyzeExpense API to process invoices and receipts, and AnalyzeID API to process documents issued by the U.S government such as passports and driver's licenses. Furthermore, with Amazon Textract there are no minimum fees or upfront costs. Users only pay for what they use, in other words, for each document analyzed using Textract.

Why should you use Amazon Textract?

Using Amazon Textract makes it easy for companies/businesses that deal with a lot of documents daily to automate the process of extracting critical data from scanned documents in an easy and cost-efficient manner.
The most common use cases for Amazon Textract include the following:

1. Designing an intelligent search index.
   - **Financial services:** Textract is especially useful when it comes to accurately extracting critical business data such as applicants' names, mortgage rates, and invoice totals from loans and mortgage applications.
   - **Public sector:** Textract is useful in accurately extracting relevant data from forms such as Federal tax forms and State-specific business loan and mortgage forms.
2. Capturing data automatically from different forms and tables.
3. Speeds up the capture and standardization of data from various sources.

By using Amazon Textract, the following advantages are derived:

- Document analysis is scalable because millions of documents can be analyzed rapidly, and critical data extracted for relevant decision-making.

- Cost-effective as it does not require minimum fees or upfront commitments. It also uses a tiered-pricing model which essentially means different pricing categories tailored to best meet customers' needs.
    - Makes it possible to incorporate document detection into your apps.

AWS Comprehend

Natural Language Processing is an artificial intelligence service that gives computers the ability to interpret text and speech in a similar way to what humans do.

With AWS Comprehend, human language is dissected into pieces so that the grammatical structure of sentences and the meaning of words can be evaluated and recognized by machine learning. From there, it extracts the critical elements from the data. Comprehend also identifies the patterns as well as recognizes the sentiments of the content.

With the intelligence to mimic the human ability in understanding language context, Comprehend helps businesses save costs and innovate by automating the process of:

- Recognizing client behavior and preference through voice mails and text.
- Mining data from various sources.
- Making it easier to extract useful business information, so that businesses can have a better understanding of the insights and improves their ways of serving the customers.
- Dissect the meaning of videos to see if there is any negative content needed to be flagged.
- Categorizing documents by topics.

AWS Translate

This is a service that provides translation of 25 languages from one form to another in text form. It uses artificially intelligent technology, efficiently and accurately as possible in real-time as demand permits. Also, people of different languages can communicate despite their language barriers with this service. It supports multiple languages using data of supported languages and language codes as an enabler.

How does AWS Translate Work?

It uses Neural networks that identify and intelligently translate languages it supports. This helps in converting from one language audience to another language audience in a text format. The service uses both a combination of supported languages and a language of codes to carry out its process.

The translation service is a model with two components - the encoder and the decoder. The encoder reads through the whole text word by word to intelligently process the meaning of the whole text verbatim. It is aided by a neural network code called "Attention Mechanism" to both understand the context. The decoder uses the semantic meaning to translate word for word the text in the intended output language.

The service also has a feature that can automatically detect an input source language and tells the user what language it is using by the aid of Amazon Comprehend – a natural language processing service. If an unsupported language is requested as a source or intended language, the service returns as an *UnsupportedLanguagePairException*.

How to use AWS Translate

Use AWS translate for the following:
To enable multilingual user experience in your application by integration. Translate company–authored content, such as meeting minutes, technician reports, knowledge-based articles, and posts.
Translate interpersonal communications like emails, in-game chat, and computer service chat.

1. Process and manage your company's incoming data:
    - Analyze text, such as social media, and news feeds, in many languages.
    - Search for information like eDiscovery cases in many languages.
2. Enable language-independent processing by integrating AWS translate with other AWS services.
    - Extract named entities, sentiments, and key phrases from unstructured text, such as social media streams with Amazon Comprehend.
    - Make subtitles and live captioning available in many languages with Amazon Transcribe.
    - Translate documents repository in the following databases: Amazon DynamoDB, Amazon Aurora, and Amazon Redshift.

Amazon Polly

Amazon Polly is a cloud service that transforms text into lifelike speech. Dozens of voices available in many different countries and languages give the user the ability to create webpages and applications with realistic speech functionality.

How does Amazon Polly work?

Amazon Polly's "Text-to-speech" technology uses artificial intelligence to create natural-sounding human speech. "Neural Text-to-speech" is a service that improves the quality even further with advanced speaking styles.

Why use Amazon Polly?

Amazon Polly can be used to help people read through a document at a faster pace or even narrate an email, book, or document while on the go. This can vastly improve productivity.

Amazon Polly can return audio as a real-time stream. This makes it ideal for call centers as it can be used for reactions to prompts during phone calls to deliver automated responses or real-time information such as service status, billing, etc. Therefore, reducing a call center's manual workload and running costs.

Amazon Polly can be used as an announcer for public transportation systems, giving up-to-date schedule information that would be most beneficial for the visually impaired.

Amazon Polly can be used in games and interactive media to react with tailored responses based on the user's input. This can save costs on voice acting while still giving a more immersive experience.

AWS Kendra

AWS Kendra is a fully managed search service powered by Machine Learning (ML). Kendra lets users search through both structured and unstructured data. Kendra uses natural language processing (NLP) to understand the context of a user's query and find relevant answers.

How does Kendra work?

Kendra indexes documents whether it's unstructured text such as HTML files, Microsoft PowerPoint presentations, Microsoft Word documents, Plain text documents, or PDFs. Kendra is also capable of indexing structured text, for example, "Frequently asked questions and answers."

Document attributes can be used to filter responses, and queries as well. Document attributes must be mapped to an index field before they can be used in a query. Custom attributes can be added to documents as well to use very specific searches. Queries can be weighted towards more relevant results by increasing or decreasing the importance of individual fields in the index. If users were to add more weight to the importance of the highest replies and views, users could see postings that are more popular or hot on forums. You can even add additional boosts.

Data sources are a repository of all your numerous documents indexed and located in one place. Data sources can be automatically synchronized with Kendra Indexes. That way if a change or deletion happens in one it will happen in the other. Kendra supports a wide range of data sources from Amazon's S3 buckets and RDS, Salesforce, Slack, GitHub, Microsoft and google drives, custom drives, and many more.

Benefits of Kendra

Every query for something and the result was too literal or not very relevant to what users are thinking of? Kendra solves that problem using NLP to give search results a human touch instead of a robotic and literal answer.

AWS Amplify

AWS Amplify is a service used for the quick development and deployment of full-stack web and mobile applications. Full-stack applications are made up of a front end which is the user interface and the back end which refers to the servers, code, and databases that make the app work. A developer can create their application without needing to manage AWS services including virtual machines, storage, and databases. Amplify includes three main tools for development and hosting. They are AWS Amplify Studio, Amplify CLI and Amplify Hosting.

AWS Amplify Studio

- Amplify Studio is a web browser-based visual development interface. It allows for a simplified drag-and-drop configuration of the application's front-end and back-end Amplify Studio enables mobile and front-end web developers to set up and build secure and scalable back ends automatically - without coding.
- *User Interface (UI) - App Front End*

  Ready to use UI templates streamline the creation of the screen(s) the user sees (called the front-end).

  Users can also customize these templates using a software tool named Figma. Figma is a graphic tool that lets you select the device type (Figure 2), design the layout of each screen, and choose what happens when a user clicks on a button on that screen. It simulates how your application *looks* to a user and how to navigate to each screen from a user's perspective.

  AWS Amplify is compatible with popular platforms such as iOS, Android, Flutter, and JS and integrates popular web frameworks like Vue, React, Next.js, and more.
- *Server-side/AWS Services - App Back End*

  AWS Amplify also enables users to quickly implement what happens to the information created by the user (called the back-end). This is the design of *how* the information is processed (logic) and *where* it is stored (data). You can add these functions and features to your application by simply selecting common AWS services from the navigator list.
  - Authentication - Manage users
  - Data storage - Databases
  - File storage - Images, videos, and other files
  - Libraries - Prewritten code
  - Artificial Intelligence/Machine Learning
  - Web hosting

AWS Amplify CLI

If a developer needs more tools than are provided in Amplify Studio, they can use Amplify CLI.

Amplify CLI allows command line development of the application back-end. The developer can choose from up to 175 other AWS services to build and support their application just by writing a few lines of code.

AWS Amplify Hosting

Amplify Hosting is a web and mobile app hosting service. It can update and push new, updated applications to the internet. Code is retrieved from a Git repository or Amplify Studio interface and deployed using AWS Cloud Front's content delivery network. The content delivery network brings the application to edge locations around the world and thus closer to the users for lower latency. Hosted applications send data metrics to AWS Cloud Watch for real-time monitoring. User-defined alarms can be set to various metrics and notify developers when they are set off.

Pricing

Pricing for Amplify is based on which AWS services are provisioned for the application and for static Web Hosting.

Pay-as-you-go pricing for static web hosting.

- **Build & Deploy**
  - $0.01 per build minute

- **Hosting**
  - $0.023 per GB stored per month
  - $0.15 per GB served

When to use AWS Amplify

AWS Amplify is used for the rapid creation of an application without needing to code. It gives a non-technical developer the agility and scalability of the cloud to take their app ideas from paper to reality in hours.

AWS CloudFormation

CloudFormation is a means to template known good configurations of an organization's services. For example, if an organization has a common application that requires the configuration of several servers with specific patches, a CloudFormation template can make sure all new servers are properly configured. CloudFormation therefore helps you provision applications in a safe and repeatable manner.

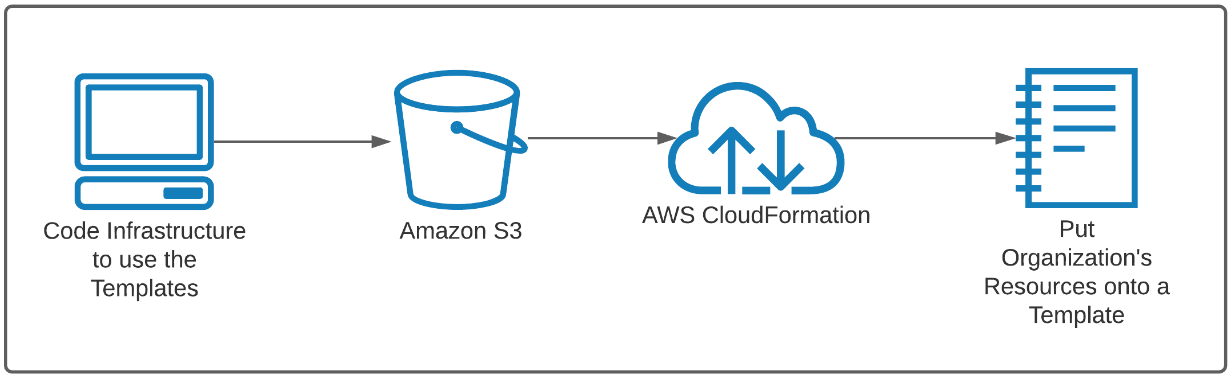
CloudFormation templates can be made with simple text files or via supported programming languages. AWS Cloud Formation templates are available through a multitude of options.

CloudFront can deploy your templates across your infrastructure by rebuilding applications or building new ones.[90]

How It Works

1. Develop the code for the organization's infrastructure.
2. The code can be made from a template or from scratch in either JSON or YAML format.
3. Store your code either locally or on S3.
4. Use CloudFormation with the customized code either with the CloudFormation console, CLI, or API.
5. CloudFront will then provision your systems.

The diagram below shows an example of CloudFormation used to template an organization's services.


Code Infrastructure to use the Templates
Amazon S3
AWS CloudFormation
Put Organization's Resources onto a Template

AWS Proton

AWS Proton is a service aimed at Infrastructure-as-code (IaaS) and uses CloudFormation and Terraform. This service separates the infrastructure and code. AWS Proton enables effective collaboration between infrastructure teams and development teams so they can simplify infrastructure provisioning, code deployments, monitoring, and updates. Users have full capacity to manage, update, and troubleshoot as required.

What does AWS Proton do?

AWS Proton standardized infrastructure and deployment tooling for developers and their serverless and container-based applications. This is a deployment workflow tool for modern applications that helps platform and DevOps engineers achieve organizational agility.

Proton introduces two entities in its setup:

- **Service**
    - It is an AWS resource or set of resources that are usually focused on business logic and contains custom developer code. Repeatable items within an AWS application are considered to be a Proton service instance. y pipeline and webhook established during the creation of a service instance, so custom code will be automatically built and deployed to a service instance. Proton service instances are exclusive to a Proton environment. Also, the Proton service instance may have its own CodeDeploy
- **Environment**
    - AWS Environment is a shared set of resources and policies that are shared across service instances that are created in this environment (common DB, API Gateway, VPC, etc.).
    - Both AWS Service and AWS Environment are created from Proton templates — it is a proton-specific file structure that uses CloudFormation and Terraform to define resources for an environment (environment template), service (service template), and code pipeline for service (optional, included into service template).

AWS Proton benefits:

This service gives users complete flexibility to operate their infrastructure as they choose. Developers can use the AWS Proton self-service interface to deploy their applications with minimal configuration.

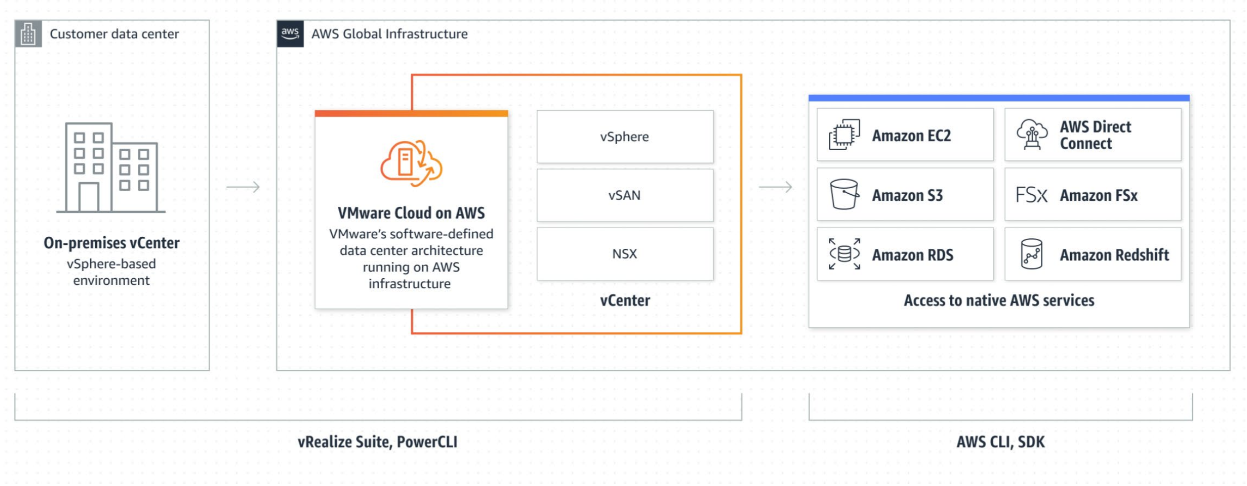
VMWare Cloud on AWS

VMware Cloud on AWS is an environment on AWS that uses the same VMware servers, VMware vSphere, VMware Virtual SAN, and VMware NSX virtualization technologies used in data centers now can be used on AWS cloud. VMware Cloud on AWS enables Enterprise IT and Operations teams to continue to add value to their business in the AWS cloud, while maximizing their VMware investments, without the need to buy new hardware. This allows no changes on virtual machines and simplifies migration. This service is optimized to run on dedicated, elastic, bare-metal AWS infrastructure. This offering enables customers to quickly and confidently scale up or down capacity without change or friction for any workload with access to native cloud services.

What VMware Cloud does

VMware Cloud on AWS is an Infrastructure as a Service (IaaS) solution that offers the complete Software-Defined-Datacenter (SDDC) stack in the cloud on Amazon bare-metal servers. It removes the upfront costs related to acquiring the hardware, licenses, and labor. Users only pay for the resources they use and can scale up and down according to the demand (CAPEX -> OPEX). Other Software-as-a-Service (SaaS) and Platform-as-a-Service (PaaS) services are available such as disaster recovery, app modernization, and Virtual Desktop Infrastructure (VDI).

VMware Cloud on AWS is based on the VMware Cloud Foundation (VCF) framework which includes computing, storage, networking, and management. The vSphere hosts in AWS run on bare-metal hardware, owned, and operated by Amazon. The cloud vCenter can be linked to a user's on-premises environment to achieve Software-Defined-Datacenter (SDDC) hybridity. A user becomes a user of the environment and no longer needs to worry about operations such as patching or upgrading.



Use Cases for VMware Cloud on AWS

Simplified Data Center Migration

- VMware Cloud on AWS is to accelerate and simplify the migration process for businesses by reducing migration efforts and complexity between on-premises environments and the cloud. Once in the cloud, users can leverage VMware and AWS services to modernize applications and run mission-critical applications quickly with VMware availability and performance combined with the elastic global scale of AWS.

Rapid Disaster Recovery Service to Your Environment

- One offering available on VMware Cloud on AWS is VMware's Site Recovery: on-demand disaster recovery as a service, optimized for VMware Cloud on AWS to reduce risk without the need to maintain a secondary on-premises site. You can securely replicate resources to VMware Cloud on AWS so you can quickly start up on-demand in AWS when disaster strikes.

Flexible Dev/Test Environment

- Users can use VMware SDDC-consistent dev/test environments that can integrate with modern Continuous Integration / Continuous Deployment (CI/CD) automation tools and access native AWS services seamlessly. You can create an entire VMware SDDC in under two hours and scale host capacity in minutes.

Data Center extension to the Cloud with your existing skill set

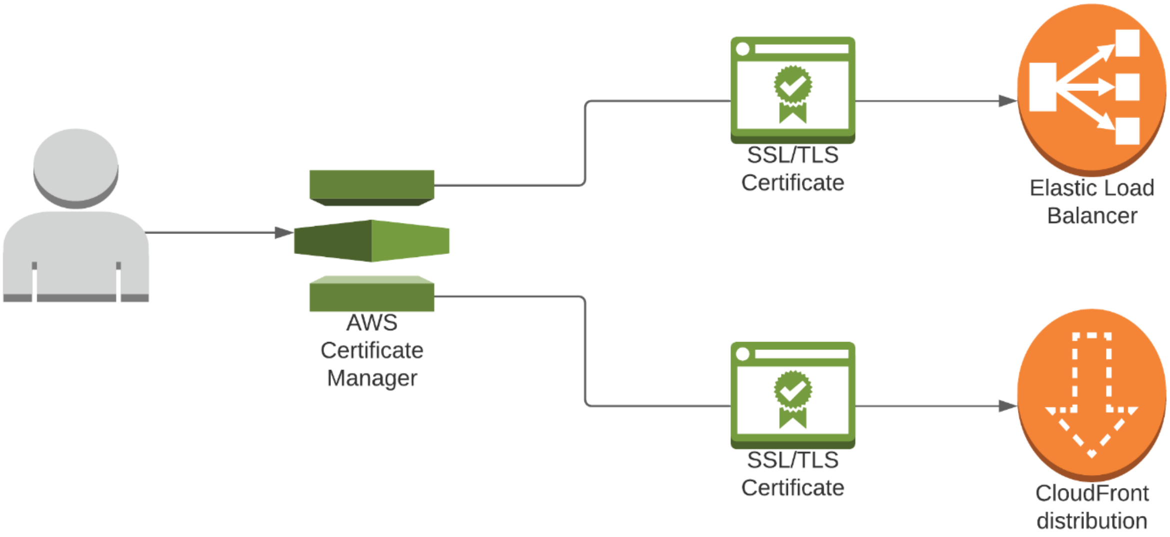
- This offering lets users who are familiar with VMware keep a consistent and similar environment on the cloud. Since VMware Cloud on AWS doesn't require re-tooling or re-educating, IT teams can continue to deliver consistently on vSphere-based infrastructure and operations that are already implemented in existing on-premises data centers and have the ability to link to their existing VMware environment.

AWS Certificate Manager (ACM)

AWS Certificate Manager is a service for SSL/TLS certificates. AWS Certificate Manager makes it easy to provision, manage, and deploy certificates either publicly or privately. It allows users to deploy certificates on AWS resources quickly and effectively. It provides free public and private certificates to AWS services such as ELBs and API Gateways.

AWS Certificate Manager provides a means to obtain certificates to websites, promoting safe and secure connections. AWS Certificate Manager is a platform to manage all of your certificates in the AWS cloud centrally.[91, 92] There are two options when deploying certificates: the default certificate manager and ACM private CA.

The diagram below shows how the certificate manager can be used to obtain SSL/TLS certificates:



Default AWS Certificate Manager (ACM)

AWS Certificate Manager is for customers who want encryption and security using TLS. The certificates are deployed through ELBs, CloudFront, and API Gateways to make communication secure.

ACM Private CA

Private CA is for communication within the organization. Private CA can issue certificates for users, computers, applications, services, servers, and more devices throughout the organization. Private CA certificates are for use internally and not on the internet. Private certificates also come at an additional cost.

AWS App Discovery

AWS application discovery is a service that helps enterprises migrate and optimize on-prem applications to the AWS cloud. This service reveals data about business case creation and application migration planning. Business case data includes:

- The cost of operating in the Cloud vs on-prem
- The cost of migrating to the Cloud
- The cost of leaving your current infrastructure
- Benefits of being in the Cloud
- The cost of doing nothing

AWS App discovery makes migration easier by allowing enterprises to make better decisions around the specifics of migrating each application. From this data, companies can rapidly organize, track and shift applications to the cloud in the most cost-efficient way.

AWS APP Discovery how it works:

AWS application discovery service collects server information like CPU, disk space/ performance, and network usage/ performance from a customer’s on-prem data center.

Captured network data can be used for analyzation of network efficiencies/deficiencies between servers in the network. From this, selected applications can be organized into groups (on servers) for fast and efficient cloud migrations.

Captured CPU and disk performance data can be examined to determine efficiencies/deficiencies for virtual application requirements—and which would be the most optimal and cost-effective.

AWS APP discovery gathers and reveals data using one of the following AWS services:

- Agentless discovery
- Agent-based discovery

AWS Agentless discovery

When using Agentless discovery virtual CPU, RAM, and disk IOPS data is collected and can be analyzed for peak utilization. In addition, Agentless Discovery collects configuration data such as Ip addresses, resource usage, server hostnames, mac addresses, and disk resources.

AWS agent-based discovery

AWS application discovery agent must be installed on each physical server and VM. It can only be installed using Windows or Linux operating systems. AWS agent-based discovery retrieves detailed data i.e., processes that are running, inbound and outbound network connections, static configuration data, and time-series performance information.

AWS Application Discovery works in conjunction with third-party application discovery solutions in the AWS (APN) partner network. This allows you to extract and import data about your on-prem environment. The information can be examined and imported using public APIs. From this data, applications can then be grouped with their respective servers for migration tracking.

AWS App Discovery What Is It Used for:

AWS App Discovery is used to collect detailed information about an enterprise’s on-prem data center. It uses this information to form the most efficient and cost-effective migration strategy to the AWS cloud. From this data, enterprises can determine TCO (total cost of ownership) and other benefits of migrating to AWS.

App Discovery saves time and increases staff productivity i.e., improved automation and backup process with managed services. Captured network data allows companies to properly allocate network resources. Organizations can use this data to achieve operational resiliency (high availability) when migrating to AWS. AWS app discovery can also accelerate the innovation pipeline with rapid experimentation. Organizations can quickly test various migration strategies to determine which solution would be optimal.

AWS App Discovery is a service that allows enterprises to quickly discover, assess, and then migrate their on-prem applications to the AWS cloud.

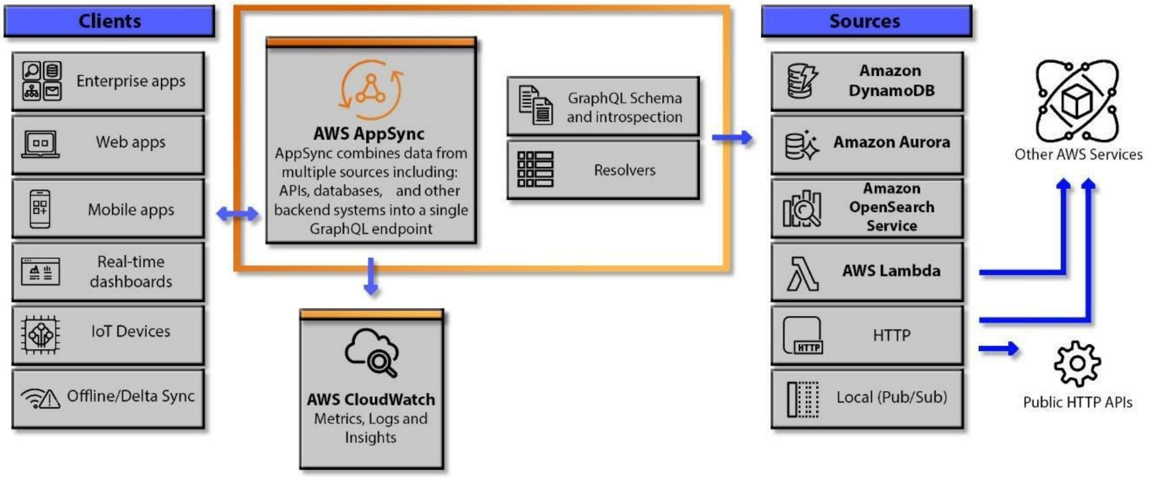
AWS AppSync

Appsync is a simple solution that enables multiple applications to be connected and synchronized with data from multiple sources including databases, Lambda functions, and OpenSearch, etc. in real-time. Appsync automatically manages and updates the data in web and mobile applications in real time and updates the data for offline users as soon as they connect. In addition, it combines all the data from multiple applications and simplifies the process of transforming data to the cloud.

How does Appsync work?

Appsync uses a publish and subscribe (pub and sub) method to push or pull data from multiple sources. A template is created to define what data is pulled from the sources and in what form that data is then passed to the user. For example, a chat application wants to access messages, media, and user details that are all stored in separate databases.

The application connects to Appsync, which then draws the data from each database and sends it in a neat package back to the user. If the user updates their details, Appsync sends only the updated details back to the relevant databases.



AWS AppSync provides the requested data that needs to be available in real-time by using GraphQL. GraphQL is the query language that enables requests for specific data from multiple sources.

Why use Appsync?

Amazon Appsync supports offline access. This allows users to continue working on their applications while offline and automatically update all necessary databases as soon as the connection is back. This results in a more seamless uninterrupted workflow. Amazon Appsync simplifies the setup of backend services and data sources which gives developers more time to focus on other tasks.

Appsync's ability to synchronize across applications and data in real-time can help businesses view up-to-date analytical data from multiple sources on any compatible device.
Amazon Appsync is fully scalable which gives high availability and with its built-in caching and its serverless nature, it also increases performance for real-time applications.

Amazon AppFlow

AWS AppFlow is a bi-directional service that moves and synchronizes data from 3rd party applications, SaaS (software as a service), such as Salesforce® and Slack® with AWS services without having to write code. All that is needed is to configure your data transfer requirements and Appflow will take care of moving the data between the SaaS application to the AWS service.

What does Appflow do?

Appflow adds value by providing tighter integration between different applications and services that are used in businesses and AWS services. By aggregating the data from multiple sources, companies can make observations, create hypotheses, and draw conclusions based on the information consumed. It helps determine the total amount of money a customer is expected to spend on a user's business, or on its products, during their lifetime. This is an important figure to know because it helps companies make decisions about how much money to invest in creating new products, acquiring new customers, and retaining existing ones.

Appflow improves operational efficiencies by connecting applications, services, processes, and devices to automate workflows, reducing manual work errors while reducing the overall cost of doing business. It also modernizes data governance and clarifies the movement of your data between these applications.

Creating AppFlow:

It only takes minutes to create an AppFlow. Using AppFlow's user interface users can select the data source and destination, and specify the data flow trigger based on events, scheduled or on-demand. Map the fields from the source to the destination, then add filters for validation and transformation.

Filters that can be used:

- Filter records
- Mask sensitive fields

- Combine fields to create new ones
- Validate fields
- Truncate fields

The next step is to activate your flow or run it with just a click of a button.

AppFlow also automates the creation of PrivateLink endpoints for supported SaaS applications. This ensures that data never gets exposed to the internet.

- AWS PrivateLink is a technology that provides private connectivity between VPCs and services.

When to use Appflow

- Integrate with just a few clicks
  - Anyone can use AppFlow to integrate applications in a few minutes – no more waiting days or weeks to code custom connectors. Features like data pagination, error logging, and network connection retries are included by default so there's no coding or management. With Appflow, data flow quality is built in, a user can enrich the flow of data through mapping, merging, masking, filtering, and validation as part of the flow itself.
- Transfer data at a massive scale
  - AppFlow easily scales up without the need to plan or provision resources, so users can move large volumes of data without breaking it down into multiple batches. AppFlow can run up to 100 GB per flow, which enables users to easily transfer millions of records all while running a single flow.
- Automate data security
  - All data flowing through AppFlow is encrypted at rest and in transit, and users can encrypt data with AWS keys, or they can bring their own custom keys. With AppFlow, they can use their existing Identity and Access Management (IAM) policies to enforce permissions, rather than creating new policies. For SaaS integrations with AWS PrivateLink enabled, data is secured from the public internet by default.

AWS Cloud9

AWS Cloud9 is a cloud-based integrated development environment (IDE) software that pulls together common tools used to build applications under one graphical user interface (GUI). IDE usually consists of a source code editor which is a text editor for code writing, local build automation to help automate repeating tasks, and a program to help display any bugs in the code (debugger). AWS Cloud9 provides developers with an environment with the tools necessary to build, run, test, debug, and release software. True to the nature of an IDE, Cloud9 supports over 40 programming languages and has an inbuilt terminal, and runtime debuggers. The environment can be modified to our predilections by switching color themes, and syntax colors amongst others.

What does AWS Cloud9 do?

Cloud9 allows users to run a development environment on any Linux server. Cloud9 offers users the ability to develop, deploy, and debug applications using a browser without the need to install an IDE. It has a terminal with a browser-based shell where a developer can add commands, install additional software, do a git push, or share the development environment with others. This service allows for real-time collaboration and chatting from within the Cloud9 environment. The environment comes preconfigured with libraries, plug-ins, and SDKs for server or serverless development, testing, and debugging.
AWS cloud9 terminal has sudo privileges for EC2-hosted environments and pre-authenticated AWS Command Line Interface (CLI), which all create easy access to AWS services. Using a cloud9 IDE via a web browser to access the cloud9 environment, a compute resource (EC2, Linux server, or any other supported server) connects to the Cloud9 environment. After the work is completed, the application is then stored in a remote repository like the Amazon CodeCommit repository.

How is AWS Cloud9 beneficial?

IDE helps save time in developing new applications as the required tools don't need to be configured separately or learn how to use each of the tools. They also have automated code generation and intelligent code completion features that help cut down on the time it takes to type out every character. Cloud9 also identifies bugs in real-time, highlights syntax, and developers do not have to switch between tools as they are all in one GUI. These features enable developers to have an organized workflow and solve problems as they arise. AWS Cloud9 is offered at no additional cost, however, if the Cloud9 environment is hosted on an EC2 instance, then fees for computing and storage apply.

AWS Code Artifacts

Is a fully managed service that enables users to store software packages used during application development. The software packages are stored in a repository (ex. GitHub) so that they can be accessed for future reuse. The packages can be in the form of simple files, reports, or logs.

How AWS Code Artifacts works

Before a package is added to a repository, a package manager is configured to use the repository endpoint. This means a Uniform Reference Locator (URL) is added to it. The package manager then stores it in the repository. Repositories are organized into a domain. A domain is protected with an encryption key. It is then connected to a development environment. It can also be connected to an external repository which then fetches and stores packages when requested by a package manager.

Why use AWS CodeArtifact

It reduces delivery time by encouraging code reuse. Also, CodeArtifact is a fully managed service by AWS, so it takes the stress off your management. There is no limit to the number of packages that can be stored.

Use it to securely store and share software packages used during software development. It can also be used to review, access, or terminate AWS Security and Compliance agreements for all accounts, e.g., Payment Card Industry reports or AWS System and Organization Control reports.

AWS CodeStar

CodeStar is a service assisting in the creation, managing, and deploying of software applications. This service facilitates a central console used to assign project team members specific roles needed by them to access certain tools and resources by using a centralized console.

Benefits of CodeStar

Software development and deployment involve so many processes like writing, building, testing, and deployment. CodeStar offers a single dashboard that integrates software development tools thereby making it easier for managers, developers, and team members to collaborate simultaneously on projects, they can use the console to track software developments and view the next task. It saves users, time, and effort and reduces operational costs. Further, CodeStar has various defined project templates available to choose from that can be customized to fit the purpose, saving much-needed resources and errors.

CodeStar Pricing

Usage does not attract any additional charge. Users simply pay for resources such as Amazon EC2 instances, AWS Lambda executions, Amazon Elastic Block Store volumes, or Amazon S3 buckets that are provisioned in projects. Users only pay for what they use as needed without any upfront commitments or minimum fees.

AWS Data Exchange

AWS Data Exchange is a data subscription service that allows the exchange of data between organizations. Through AWS Data Exchange, customers can subscribe to various published data through the console. Data can be used for data-driven decisions using analytics and machine learning services.

How Does AWS Data Exchange Work?

On AWS Data Exchange, data providers can host various data such as payroll information, debit card transactions, healthcare, and demographic data for the user. Data providers process, store, and collect valuable data for their customers. This data is provided as a data product that the customers can subscribe to in AWS Data Exchange Console or marketplace.

Users can gain access to the AWS Data Exchange console with appropriate IAM user permissions. IAM users can access and subscribe to thousands of data products from approved data providers through the console. Once subscribed, users can store this data in an S3 bucket or access it through a signed URL. All subscription charges are billed to the AWS account. A data product is divided into three parts:

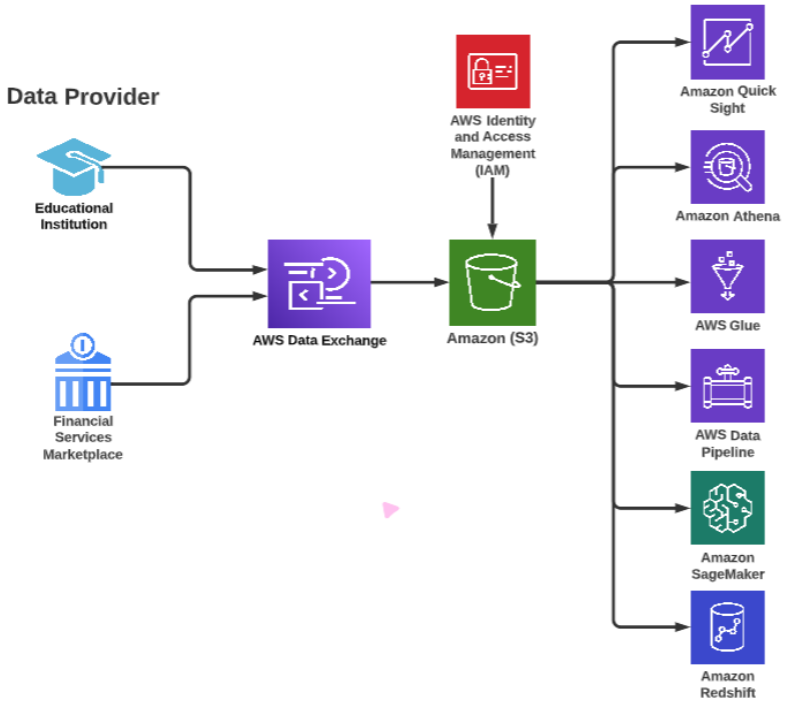
- Product detail
    - It contains a description of the data with customer support contact information.
- Product offers
    - It contains terms and conditions for the data product
- Data sets
    - Data sets are a set of data with different versions for data revision.
      Users can decide which version to be published.

Users can create, view, manage, and access data sets through the AWS Data Exchange console or API. Once subscribed, users can apply data sets with AWS analytics and machine learning services, such as Amazon Athena, Amazon Quicksight, and Amazon Redshift.

Data in AWS Data Exchange is organized in three ways.

- **Assets** – A piece of data
- **Revisions** – A container for one or more assets
- **Data sets** – A series of one or more revisions

Data can be managed and edited through the AWS Data Exchange console or the AWS Command Line Interface (AWS CLI).



Why Use AWS Data Exchange?

AWS Data Exchange builds a bridge between AWS users and third-party providers. AWS customers can utilize this service to access data from multiple data sources to make data-driven business decisions using AWS analytics and machine learning services. AWS Data Exchange assists data providers and customers by providing a managed data delivery service that reduces operational overhead in a secure and reliable process.
Data exchange also allows users to migrate to the cloud with existing subscriptions by approved third-party data providers. Through AWS Data Exchange's Bring Your Own Subscription (BYOS) offers, customers can migrate and fulfill existing subscriptions with data providers at no additional cost. AWS Data Exchange provides seamless integration of third-party data subscriptions into AWS architectures.

AWS Device Farm

AWS Device Farm allows developers to test their applications using Virtual devices available on the service without the need to buy physical devices like mobile phones for the testing. These virtual devices cut across different platforms and operating systems including iOS, Android, and other Web apps.

What does it do and how does it work?

AWS Device Farm allows testers and developers to test their applications in the following ways:

- *Automated App Testing*

    - Users can upload and choose the application to test, select devices, operating system versions, and the number of devices to be used for the test, then run the test and get the result. Users can select as many virtual devices as possible, different variety of operating systems, and states to get the desired outcome or confirm the application works well.
- *Remote access interaction*
    - Users can set up a virtual device and interact with it remotely while achieving real-time outcomes from the virtual device.

When to use Device Farm

AWS Device Farm enables simplistic and increased efficiency testing. It allows for the following

- Enables the testers to use multiple devices for testing without purchasing the physical devices.
- The virtual devices used for testing are secure and updated with the latest patches.
- It allows for testing with different varieties of products and operating systems.

AWS Global Accelerator

Global Accelerator is an AWS-managed service that optimizes global communication and data transfer between two devices or endpoints. It provides an optimal pathway for data exchange between an end-user and the application device endpoint (the point where the host organization grants access).

How AWS Global Accelerator works

The AWS Global Accelerator brings the application closer to the user on the public Internet. It uses anycast, receives incoming requests from users, and routes the traffic to the nearest data center or edge location closest to the user. When the request arrives at the AWS Global Accelerator, it routes traffic through the AWS private network over the public Internet. This creates high availability and optimized routing to provide the user with the lowest latency and highest throughput.

To avoid a single point of failure, AWS Global Accelerator uses a built-in health check system to check the health status of the application endpoints on a network. Once the health check identifies the endpoint as unhealthy, it redirects traffic to the next available one closest to the user.

Why do we use AWS Global Accelerator?

Organizations leverage AWS Global Accelerator to achieve improved speed and performance for the end-user. The result is better user experiences which contribute to return customers, improved brand reputation, and increased profits.

AWS License Manager

AWS License Manager provides the convenience of managing one's software licenses. It can accommodate a variety of software license vendors such as IBM, Microsoft, Oracle, and SAP. Once License Manager is enabled, administrators can visualize and manage the usage of all software licenses across a hybrid environment. With the ability to create limits by configuring licensing rules and enforcing them to be applied, it then tracks the usage to report results.

How does it work?

With the License Manager application, users can set up licensing rules, attach them to the launches, and keep track of usage. Users can adjust license-consuming resources without additional work. License Manager determines resource inventory needs, supervises license procurement, and drives compliant license usage.

Why do we use it?

You have control over your usage: With the License Manager application, administrators can create custom licensing rules, provisions, and track licenses across multiple accounts on proprietary licenses and on-premises environments.

- **Cost Reduction**
  - License Manager saves costs that would otherwise be lost to license violations.
- **Mitigates risk of non-compliance**
  - License Manager gives administrators the ability to set limits for license usage. When license usage exceeds these limits, License Manager sends an alert to administrators.

Tracking an organization's licensing usage and rule compliance can be difficult if done manually. Licensing managers assist by allowing users to set license restrictions and monitor their enforcement, lowering the number of launches that do not follow the rules. License managers can automatically discover existing licenses to manage their usage and switch between licenses without interruption. This allows an organization to save time and effort in managing and reporting licenses.

AWS Managed Grafana

Grafana is a common open-source analytic platform that is used to visualize, query, and understand metrics stored anywhere in your production and data environment.

Amazon Managed Grafana is a serverless and secure data visualization service. With Amazon Managed Grafana, you can instantly query, correlate, and visualize operational metrics, logs, and traces from multiple data sources.

Amazon-managed Grafana is therefore the proprietary service offered to enhance productivity while making use of Grafana applications by taking away the burden of self-management thereby allowing users to focus on other important tasks. Amazon Managed Grafana leverages existing security features like AWS IAM Identity Center (formerly single sign-on), data access control, and audit reporting and has the potential to create, explore and share observability dashboards in the production environment.

Advantages of AWS Managed Grafana over Common Grafana

- Highly scalable and available, removing the burden of constant upgrades and management.
- Provides a single dashboard containing all integrated resources and tools.
- Highly interactive data visualization for effective real-time monitoring and data operation.
- Allows easy integration with open-source, AWS data sources, third-party, and other common cloud data sources.
- Supports Security Assertion Markup Language (SAML) making it simple to use and operate.
- It is highly secured, assuring data protection and privacy.
- It eases the stress of licensing and periodic renewal as obtained with regular Grafana.

Managed Grafana pricing

Users pay for what they use, based on an active workspace, and are billed monthly. Grafana requires no upfront fees or commitments.

AWS Wavelength

AWS wavelength is an infrastructure deployment zone that is embedded in the telecommunication provider facility using the 5G network. This can be compared to a local zone that works just like any AWS Availability Zone but with very low latency. Prior to AWS Wavelength, application traffics had to travel from the device to a cell tower, then to a metro aggregation location, and then on to the Internet before it could reach resources running on the AWS cloud. These network hops could add milliseconds of latency to the traffic. Using wavelength makes it possible to avoid buffering on uplinks and downlinks which is particularly useful for large objects and streaming video data.

How does AWS Wavelength work?

AWS Wavelength zone typically exits outside of AWS data centers. Users can create and AWS EC2 instances, Amazon Elastic Block Storage, Amazon virtual private cloud, subnets in AWS Wavelength. You can also use services that orchestrate such as Amazon Elastic Kubernetes services and Amazon Elastic cluster services in AWS wavelength. Infrastructures are deployed on 5G communication service provider networks

When to use AWS Wavelength

AWS Wavelength is extremely useful for situations where low latency is needed such as interactive applications, and streaming data demands that users have good latency for optimum performance. AWS Wavelength can solve latency issues for gaming, smart cars, and connected cards enabling capabilities such as improved road safety. AWS Wavelength also provides the ultra-low latency needed for streaming high-resolution video and high-fidelity audio as well as embedding interactive experiences into live video streams.

AWS Well-Architected Tool

AWS Well-Architected Tool is a free cloud service that provides general guidelines and best practices for measuring and improving workloads (running resources). It assists in documenting choices about the architecture and highlights areas for potential improvements. The AWS Well-Architected Tool helps users plan and create better workloads and monitor to improve existing workloads by getting advice, recommendations, and actions based on the AWS Well-Architected Framework's five pillars: (Operational Excellence, Security, Reliability, Performance, Efficiency, Cost Optimization). A user reviews and investigates the suggestions and recommendations to decide on the next steps.

IT professionals may use the AWS Well-Architected Tool by first defining the workload with priorities and tradeoffs regarding security, performance, and cost. Then, document the current state by answering a questionnaire aligned with best practices. Third, review the outcome to identify the areas of improvement and risks associated. Finally, drive a continuous process of making improvements. It is critical to pay attention while answering the questions to better measure the architecture in terms of operational excellence, reliability, security, efficiency, and cost-effectiveness.

Why do we use AWS Well-Architected Tool?

The AWS Well-Architected Tool reviews workloads based on the guidelines and best practices.

It also highlights potential issues across your portfolio while providing guidance and suggestions for making improvements. The Well-Architected Tool tags each workload and assigns the metadata to each resource to facilitate resource management. It creates custom lenses and shares them for collaboration with other AWS accounts. The tool also provides APIs to extend AWS's Well-Architected functionality and best practices. Finally, the tool supports architecture governance for processes, applications, and workflows.

AWS Compute Optimizer

AWS Compute Optimizer is a management tool that recommends AWS resources to increase efficiency and reduce user costs.

How does AWS Compute Optimizer work?

AWS Compute Optimizer is a free service on AWS. Compute Optimizer reviews previous resource activity to distinguish use patterns, (ex. how frequently or infrequently a stored file is accessed). Compute Optimizer compares the user’s activities to similar activities on suggested resources (AWS “what-if'' scenario). Through the AWS user interface, AWS Compute Optimizer takes this comparison, presents graphical data explaining recommended resources to optimize performance, reduce costs, and manage risk. Clients are given the option to use the look-back option to review three months of long-term data history. The user is free to deny or implement the recommended resources.

Why would we use AWS Compute Optimizer?

AWS Compute Optimizer helps recommend ways to optimize the use of a user’s AWS resources and workloads best suited to your business.
Having too many resources (overprovisioned) equates to unnecessary additional expenses. Not having enough resources (under-provisioned) equates to reduced performance. Compute Optimizer provides recommendations best suited to optimize AWS resources such as AWS Lambda, Elastic Block Storage, Scaling Groups, and AWS Elastic Compute Cloud (EC2).
Leveraging AWS Compute Optimizer enables users to utilize resources that reduce costs and improve performance. When users enable these suggestions, AWS configures the resources to deliver optimal performance that meets the business needs.

AWS Outpost

AWS Outpost is a fully managed service that uses an EC2 instance or a series of EC2 instances configured as a VPC in an AWS-supplied appliance. The AWS Outpost is a physical appliance that is shipped directly to the customer and plugged into the customer's on-premises data center to reduce physical latency. The AWS Outpost appliance acts as an AWS virtual private cloud which is physically placed closer to the customer's physical equipment located in the data center. It is used to lower latency between physical infrastructure. AWS Outpost is tied to the customer's existing AWS account and extends the VPC components to the AWS Region.

How does AWS outpost work?

The customer logs into their AWS Management console to configure their EC2 instances type and size, along with resources, such as RDS instances, ECS Clusters, EBS volumes, or EMR Instances, like any other VPC. After shipping, the customer simply connects to the device into their data center network. AWS Outpost can use either the customer’s existing Direct Connect or VPN connection back to AWS Cloud provider. The AWS Outpost appliance with EC2 instances appears in the customer's existing AWS account as a VPC and is accessible by the AWS Management Console. AWS Outpost EC2 instance subnets communicate with other instances in the same AWS Region using private IP addresses, all within the same VPC.
This AWS Outpost appliance does not run as part of the customer’s on-premise data center network. It runs as an extension of the AWS network. The AWS Outpost should be thought of as another subnet VPC that maps to your existing AWS VPC cloud environment.

Why should AWS Outpost be used?

AWS Outpost allows the customer to run AWS EC2 instances locally in their own data center. The main use case for using AWS Outpost is for applications that need to reduce latency connections by physically connecting closer to the data source. Additional examples include running data-intensive workloads to process data locally and cutting back on expensive and wasteful data transmissions to and from the cloud. Utilizes machine learning (ML) and analytics services so health management systems that can make use of low-latency processing with local data storage. Closes the gap between the factory floor equipment and executed functions through edge computing. Also runs manufacturing execution systems and supervisory control and acquisition systems on the AWS-managed device.

AWS X-Ray

AWS X-Ray is a tool that is used to troubleshoot and identify root causes of performance issues and errors in a user’s AWS services. X-Ray looks at API requests as they travel through your application and produce a map of your application. Developers can use AWS X-Ray to analyze and debug their applications. AWS X-Ray provides a full-view picture of the requests passing through user services via a service map. X-Ray helps users see who made the request to the service, when the request was made, and when the reply came back.

How does AWS X-Ray work?

AWS X-Ray works by collecting data from the applications or services running in the system. It then aggregates or combines the data to form traces for each application or service. Next, it creates a service map or visual representation that can be used to trace or debug or troubleshoot each service. With this data, users can further drill down on each service to see the root cause of any issue facing their applications.

When to use AWS X-Ray?

Use AWS X-ray for auditing purposes, to trace requests made to a user's applications. X-Ray can also create a detailed service map of the applications running in their system to find to locate all the bottlenecks in the architecture and improve performance Additionally, X-Ray can help improve the security posture of applications by always encrypting all trace data at rest.

AWS Service Quotas

Service quotas give users the ability to view, log and set limits on several services that integrate within the AWS dashboard. Using Service Quotas also helps to scale various services as workloads increase. Depending on business needs, users can adjust service quotas values and monitor them by setting up alerts to inform users of impending limits. This keeps users from having unintentional spending increases that negatively impact the company's overhead cost.

How Service Quota Works

Each resource type has a default quota. Users can increase these limits by requesting a quota increase. The default limit for Amazon EC2 instances is twenty instances per region, but users can increase this to two hundred per region. This is an excellent resource because it allows users to look up logs and determine the need for service increases in a particular area.

What is Service Quota used for?

Use Service Quotas to help control costs, optimize performance, and improve the availability of resources. Users also use Service Quotas to request an increase in resource limits. If users need additional Instances than the current limit allows, they can submit a Service Quota increase request. Service Quotas are integrated with other AWS services so that users can view and manage their resource limits in one place. Pay only for the resources used combined with other AWS services, making this service extremely convenient.

Alexa for Business

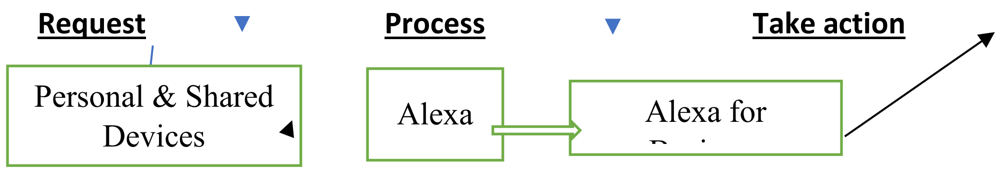
Amazon's Alexa for Business service aims to improve the usability of your conference rooms and office by providing a more streamlined method of accessing your company's schedule, tasks, and information.

Alexa serves as a smart assistant in the office, thus alleviating time spent on mundane tasks. Alexa for Business provides centralized administration of Alexa hardware, user enrollment, and skill distribution. Using the Alexa Skills Kit and the Alexa for Business APIs, users can create custom voice skills that are aware of their surroundings and make them available internally. Using Alexa for Business, it's simple to give customers voice-enabled versions of your products and services that take advantage of their surroundings.

How it works

Alexa for Business utilizes information about the devices, user accounts, and skills within an organization. When a team member asks Alexa a question, Alexa uses the information to respond or perform the requested action. When a participant verbalizes “Alexa, start the meeting” in a meeting, Alexa uses the device location, the calendar information for the location, and the type of video conferencing equipment available, all stored in the Alexa for Business account, to begin the meeting.

By subscribing to the Alexa for Business service, businesses gain access to the SaaS middleware required to integrate Alexa with partner platforms such as Microsoft and Cisco, as well as management and deployment tools.



Why should Alexa for business be used?

Alexa for Business dashboard serves as the central hub for managing and configuring all Alexa for Business devices, allowing you to do things like designate a device's physical location, select which skills to enable, and configure huddle room preferences.
Users who have been invited to enroll their personal Alexa accounts with a user’s Alexa for Business account are called "enrolled users." This grants them access to any custom skills made available through Alexa for Business, in addition to the Alexa features and skills they have already enabled on their account. They can use these with any Alexa device linked to their account, whether at home, in the office, or on their mobile device using the Alexa app.
By utilizing Alexa for Business, companies can develop Alexa skills catered to their staff or clientele. Alexa for Business enables IT to centrally manage and deploy Alexa devices for use by employees in shared spaces like meeting rooms, private offices, and common areas.

Using voice commands, Alexa for Business can perform tasks such as:

- Research upcoming activities
- Make time for things
- Handle your to-do list
- Check and answer your email.
- Install alarms
- Locate a vacant conference room.
- Tentatively reserve conference rooms

- Explain how to get to the meeting room
- Make first contact in meeting spaces.
- Attend online conferences
- Manage the technology in the meeting space
- Please inform building maintenance of the issue you are experiencing.
- Raise an issue with technology to the attention of IT.
- Get some office stuff
- Inquire into files and reports
- Look at the most recent numbers for sales
- Warehouse stock should be checked.

Alexa for Business is compatible with a variety of third-party solutions, such as:

- Tones from the Amazon
- Cisco
- Polycom
- WebEx
- Zoom
- BlueJeans
- Skype for Enterprise
- The New Microsoft Office 365
- Microsoft Exchange
- G-Suite by Google
- Salesforce
- Concur

AWS IoT Device Management

AWS IoT Device Management is a device inventory and management service for Internet-connected devices. Organizations using AWS IoT Device Management can easily register device information and configurations, organize their device inventory, monitor, and remotely update device software and firmware.

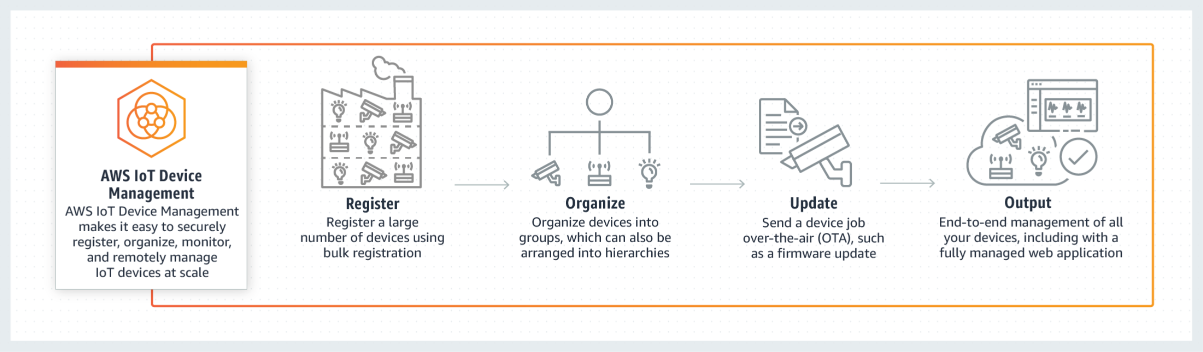
What does AWS IoT Device Management do?

Teams use device managers during IoT lifecycle phases for efficiency and effort during IoT deployment, monitoring, and maintenance. The service helps to track, monitor, and manage the connected device fleet, ensuring that all IoT devices work properly and securely after they've been deployed. A device manager provides access securely to device health monitorization, detects, and remotely troubleshoots problems while managing any software and firmware updates.

IoT deployments can include thousands, or even millions, of devices that range from simple sensors to complex computing devices. Multiple devices are referred to as fleets. Given the scale and diversity of connected device fleets, tracking, monitoring, and managing devices are challenging. It is crucial for:

- Onboarding and organizing your devices into flexible hierarchies to streamline fleet maintenance and workflow updates.

- Saving time by filtering a device search based on specific attributes to make informed decisions.
- Remotely monitor device fleet health status, analyze trends, troubleshoot, and push updates at scale
- Use Fleet Hub, to visualize the fleet health status and remotely perform real-time actions, such as firmware updates and device reboots.


AWS IoT Device Management
AWS IoT Device Management makes it easy to securely register, organize, monitor, and remotely manage IoT devices at scale
Register
Register a large number of devices using bulk registration
Organize
Organize devices into groups, which can also be arranged into hierarchies
Update
Send a device job over-the-air (OTA), such as a firmware update
Output
End-to-end management of all your devices, including with a fully managed web application

Why do organizations use IoT Device Management?

IoT Device Management provides remote device fleet monitoring and monitors a user’s equipment metadata while setting policy changes with service alerts to stay informed about device configuration or unusual behaviors. Device Management performs bulk updates, controls the deployment velocity of over-the-air updates (such as firmware and bug fixes) and defines steady jobs for automatic updates. Organizations can create logical groups of devices, such as all sensors in a specific area, to organize and target their fleet for remote actions with a few clicks. Device Management indexes metadata to understand the device state and optimizes the search.

AWS IoT Core

AWS IoT Core is a cloud service that acts as a communication gateway, message broker, device/application interface for internet-connected IoT devices, and AWS cloud-based services. AWS IoT Core is the foundation for Amazon’s comprehensive solution when deploying, managing, analyzing, and maintaining an IoT architecture with minimum to no infrastructure support from the system owner.

What does AWS IoT Core do?

AWS IoT Core provides a scalable and AWS-maintained solution that supplies secure connectivity to and from devices, rule-based IoT data traffic manipulation, and IoT command and control (C2) interface to enable backend cloud services interaction with data gathered from the IoT device fleet. AWS IoT Core can reduce the operational burden for IoT devices by providing a platform that supports communication and management of an IoT architecture since the infrastructure is managed by AWS engineers. This service facilitates communication from device to cloud services, applications, and other devices. There are other features of this service such as it has built-in Authentication Authorization (AA), RESTful application programmable interface (API) for command-and-control capability, multiple IoT communication protocol support, ACL (Access Control List) implementation, and a device registry for optional device state data collection.

When would AWS IoT Core be used?

This service would be beneficial to any scenario where there is a need to connect an IoT fleet of devices to backend AWS cloud services. This access can give the end users the ability to process, analyze, and make actionable decisions from the IoT data quickly within the millisecond timeframe. This service can handle a device fleet count ranging from a single device to billions of devices and handle trillions of messages from those devices.

AWS IoT Analytics

AWS IoT Analytics is a fully managed service that allows users to securely connect, manage, and ingest data from millions of globally dispersed devices. It provides a complete solution for collecting, processing, analyzing, and visualizing IoT data in real time to support improved operational efficiency.

IoT data is highly unstructured, making it challenging to analyze with traditional analytics and business intelligence tools designed to process structured data.
This data typically comes from devices that process data such as temperature, motion, or sound. AWS IoT Analysis helps enterprises and device manufacturers quickly and easily gain operational insights by collecting, filtering, and transforming the data before analysis can occur.

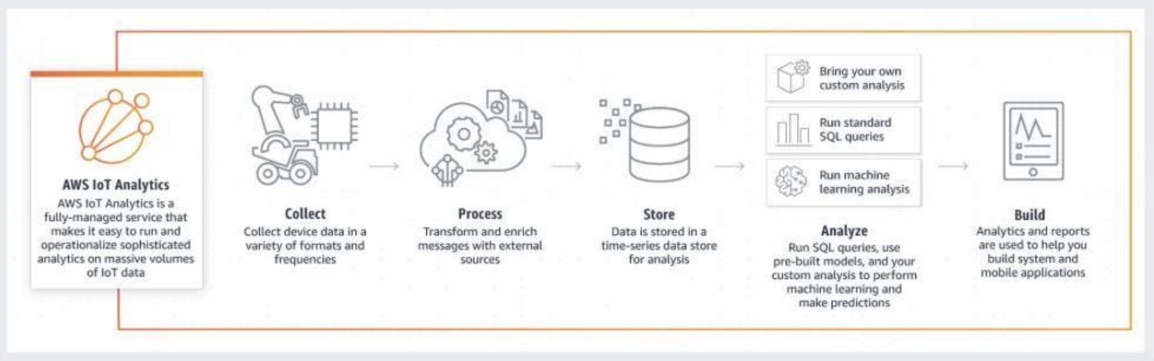
How does it work?

AWS IoT works in three major steps.

1. Collect: Aws IoT analytics prepares data analytics by using channels to listen to devices. Users define a channel and select the data they want to store and analyze.

2. Process: Once the channel is set up, you configure pipelines to process your data. A pipeline is a web service that reliably processes and moves data between different compute environments, storage services, and on-premises data sources. After the pipeline processes the data, AWS IoT Analytics stores it in a data store for analysis.

3. Analyze: It helps users gain insights from their data. Data is queried using the built-in SQL query engine. AWS IoT can be used with visualization tools such as Quick insight and Tableau.


AWS IoT Analytics
AWS IoT Analytics is a fully-managed service that makes it easy to run and operationalize sophisticated analytics on massive volumes of IoT data
Collect
Collect device data in a variety of formats and frequencies
Process
Transform and enrich messages with external sources
Store
Data is stored in a time-series data store for analysis
Bring your own custom analysis
Run standard SQL queries
Run machine learning analysis
Analyze
Run SQL queries, use pre-built models, and your custom analysis to perform machine learning and make predictions
Build
Analytics and reports are used to help you build system and mobile applications

IoT Analytics benefits:

1. Data storage optimized: the data store is optimized to deliver a fast response time on IoT queries.
2. The data prepared is easily processed and analyzed.
3. It is a managed pay-as-you-go service that scales automatically.

Why do we use it?

1. It predicts maintenance models and applies them to your fleet. Like predicting when a service is about to fail or needs maintenance.
2. It helps build an application that monitors inventories in real-time.
3. With IoT, you can monitor the efficiency of different processes and act for improvement.

AWS IoT Events

IoT Events is a cloud base service that continuously monitors data from applications and equipment for any changes in daily operations. If an event occurs, it will trigger the right response. IoT events run serverless so there is no host. IoT events monitor ongoing data from IoT device sensors and applications to integrate with other services like IoT core and AWS IoT analytics, for early detection. This will help you gain insight and act against the data. This service manages the state of each device and its processes.

How does IoT Events work?

IoT Events monitors equipment or devices for failures or changes in operation, then triggers an action when events occur. Users can take inputs from multiple sources. Users are able to move device data from using IoT Core or collect results of analytics from IoT analytics and take the input data from IoT Greengrass devices running on the edge. Users can also route sensor data to IoT events. IoT events are consistent with processing messages and consistent in reporting. Actions take place in near real-time. IoT events simultaneously monitor multiple applications and sensors to detect events in a critical state. It also makes it easy to detect and respond to events that happen across multiple IoT devices, equipment systems, and applications. IoT events will assess the behavior and performance of the devices, and identify issues based on the industry it is being used in.

Why should I use it

IoT events help enterprises understand the conditions of the equipment. It takes more than a single sensor to get all context required to reduce the cost of maintenance. IoT events learn new insights that will help automate operations faster to cut costs and increase revenue to be more profitable. Helps with root cause analysis of IoT events device sensors and applications. IoT events will allow organizations to focus on business operations without worrying about state management consistency.

AWS IoT Graph

AWS IoT Things Graph is a service enabling non-developers to visually create workflows between physical sensors, physical assets, and web services for building networked solutions across physical and virtual things.

What does AWS IoT Graph do?

AWS IoT Things Graph works with IoT devices like sensors and actuators along with web services to build applications that can be deployed in AWS Cloud or Edge Locations. Deploying at edge locations that are using AWS IoT Greengrass (defined in another section of the book) can bring the devices closer to AWS which will increase performance and reduce latency which helps applications work as designed.

When to use AWS IoT Graph:

Agricultural businesses use the IoT Things Graph with moisture sensors to enable or disable watering devices, turn cameras on, send alerts when certain thresholds have been maxed, and turn on other needed equipment to help the produce grow bigger, better, stronger crops.
For business safety, using IoT Things Graph when an unrecognized person is detected on camera in a secure area, devices can be used to lock the door, shut off certain lights, alert authorities, and call or message company personnel.
With a supply chain business, IoT Things Graph can start when a product is received and tracks the progress while in the building, alerts go out if it is missing or not picked up, update the customer at the time of delivery and track actual delivery to their door and confirm delivery to the business.

Chapter 10 - DevOps

DevOps is a hybrid of software development and operations combined. DevOps is a set of practices designed to increase software release speed and quality. Additionally, DevOps practices are used to automate deployments in the form of infrastructure as code. DevOps is a collaborative process designed to deliver code changes more frequently and reliably by breaking the cycle into manageable segments.

DevOps uses a continuous integration and continuous delivery (CI/CD) method, which refers to automating all stages of the software development process. By enforcing automation in all phases of software development, companies can better enhance business goals and customer needs.

DevOps is not architecture. But cloud architects and solutions architects should be familiar with DevOps practices. This section will cover AWS DevOps tools.

AWS provides native CI/CD tools, including AWS CodePipeline, AWS CodeCommit, AWS CodeBuild, and AWS CodeDeploy.

AWS CodePipeline

AWS CodePipeline is a continuous delivery service that quickly automates the software release process without upfront costs or long-term commitments. CodePipeline can integrate with third-party services like GitHub and many Amazon services, including Amazon S3, AWS Code Commit, and Amazon ECR.

The software release process can be modeled using the CLI, CloudFormation, and SDKs. CodePipeline can deploy software faster, increasing cost savings that come from a more efficient workflow.

AWS CodeCommit

AWS CodeCommit is a managed source code management (SCM) service that securely hosts Git repositories. AWS CodeCommit provides a highly available and scalable architecture that supports all Git tools and plugins. Source code is encrypted in transit and at rest.

SCM is a critical component of the DevOps lifecycle, enabling teams to seamlessly track and improve code modifications during the entire development process. Using a fully-managed repository improves performance by eliminating the need to build the underlying infrastructure.

AWS CodeBuild

AWS CodeBuild is a predesigned build environment where customers can test code with continuous scaling (on a pay-per-minute basis). Compatible programming languages and automation tools include but are not limited to Python, Go, Apache Maven, and Gradle. With the help of continuous integration tools, the creation of applications is faster and more consistent (or reliable). Sustainable software development improves quality and reduces risk.

AWS CodeBuild can be used on the AWS CodePipeline console to run tests and produce software packages. AWS CodeBuild can be used on the AWS Command Line Interface (AWS CLI) or the AWS SDKs.

AWS CodeDeploy

AWS CodeDeploy is a service that helps automate code and software deployments quickly by eliminating errors from manual operations. CodeDeploy can be used on premises and with Amazon EC2, AWS Fargate, and AWS Lambda. Additionally, CodeDeploy can scale to match software deployment needs.

CodeDeploy can track the status of application deployments and provide detailed reports via the AWS Management Console or the AWS Command Line Interface (CLI). Push notifications can be created to view live updates of deployments.

These are the AWS native CI/CD tools. There are other tools used by DevOps engineers. A comprehensive list of DevOps tools and what those tools perform can be seen at the link below:

https://www.gentelli.com/thought-leadership/insights/devops-tools

Chapter 11 - Cost Optimization

Financial Differences Between Traditional Data Centers and Cloud Computing

Migrating from the data center to the cloud can have a profound effect on an organization's technology costs. In most scenarios a move to the cloud will have a lower total cost of ownership than with traditional data centers. This is because traditional data centers have high costs to purchase equipment, build data centers, and manage staff of the data center and IT systems. These are heavy capital expenditures (CAPEX) with a moderate degree of operational expenses (OPEX). The list below shows the typical capital and operational expenses with traditional data centers. With a traditional data center, the organization purchases the following equipment (CAPEX):

- Physical servers
- Routers
- Switches
- Firewalls
- Load balancers
- Racks
- Power distribution units
- Generators
- Uninterruptible power supplies (UPS)
- Data center cooling

Additionally, there are moderate OPEX costs associated with traditional data centers. The primary OPEX costs are:

- Large IT staff
- Electric bills
- WAN connections
- Internet connections

Optimizing Technology Costs on the AWS Cloud

Moving to the cloud changes the cost structure completely. In the cloud computing environment, there is minimal to purchase, so CAPEX is very low. However, the organization pays every time cloud services are used, and usage can get quite expensive. Therefore, with cloud computing, while CAPEX is low, OPEX is high. Generally speaking, moving to the cloud will have a lower total cost of ownership than with traditional data centers. Furthermore, the better the cloud architecture is designed, the lower the total costs for cloud computing. There are five steps to lowering the cost of cloud computing:

Step One

- Provision only the resources needed, as you pay for all resources used.
- Monitor your systems to get insights into the proper size of compute and network resources.

Step Two

- Properly size resources.
- Plan and size equipment based upon average use and not peak usage. Cloud computing allows autoscaling, so you don't need to overprovision in advance as in a traditional data center.
- Leverage means to decouple systems in the architecture when possible. For example, an SQS queue can dramatically decrease the spikes in the system, allowing for less expensive resources to be used in the architecture.

Step Three

- Purchase the right computing platform. Know when it's best to use On-Demand Instances, Reserved Instances, and Spot Instances, as they can have a dramatic effect on costs. These options are discussed below:

  On-Demand Instances

  - Are the most expensive at a pure pricing level.
  - Provide instant access to computing power.
  - Are ideal when you don't know the exact amount of computing power required but need flexible options.
  - Are highly reliable, in that on-demand instances won't be terminated like a spot instance when AWS pricing changes.
  - Promote scalability by facilitating autoscaling.
  - Ideal for situations when you have a temporary application or when you don't know how long the application will be used.

  Spot Instances

  - Are the lowest-cost option for computing power within the AWS platform.

- Let the customer bid for unused computing power in AWS.
- Have constant pricing changes based upon AWS capacity and current bids by other organizations using the AWS platform.
- Are not for critical workloads, as they can be shut down by AWS if the price for spot instances changes.
- Are optimal for batch jobs that are not critical and have a means to restart the processing if the system is shut down.

Reserved Instances

- Offer discounted service when an organization makes a guaranteed purchase of computing capacity for a period of time.
- Provide pricing based on a contract—the longer the contract, the greater the discount.
- Are ideal for an application with a known capacity and a known duration for which the organization will use the computing platform.

There are three types of reserved instances.

Standard Reserved Instances

- Are the lowest-cost option.
- Are optimal for a long-running application.

Convertible Reserved Instances

- Convertible reserved instances are reserved instances with the flexibility to change the size of computing instances.
- With convertible reserved instances, an organization purchases a computing platform based upon need. If the organization needs to resize its computing instances, it has the flexibility to change.
- Convertible reserved instances offer flexibility but with higher costs than standard reserved instances.

Scheduled Reserved Instances

- Scheduled reserved instances are reserved instances for computing platforms that are used by organizations with frequent and periodic needs for computing power.
- Scheduled reserved instances are optimal for critical workloads that happen periodically, for example, a batch job that needs to run uninterrupted every weekend for forty-eight hours straight.

    - Scheduled reserved instances cost more than standard reserved instances, but they enable discounted pricing for periodic workloads.

  To optimize costs for computing instances, purchase the computing platform that will be most cost-effective based on the organization’s needs. Costs can be best optimized by using a combination of on-demand, reserved, and spot instances based on an organization’s needs.

Step Four

- Leverage managed services and serverless options to minimize time and costs spent managing computing instances.

Step Five

Step five is about managing data transfer costs.

- AWS charges for data sent between regions. Being mindful of cross-region data charges can make a big difference in an organization’s costs. S3 cross-region replication can assist with data transfer costs when there is a large amount of data being requested across regions.
- Leverage CloudFront to reduce data transfer costs between regions, as content will be cached and served locally.
- Use the right connection to AWS. Data in and out of a VPC over a direct connection can be lower cost than VPN if large amounts of data are being transferred.

AWS Budgets

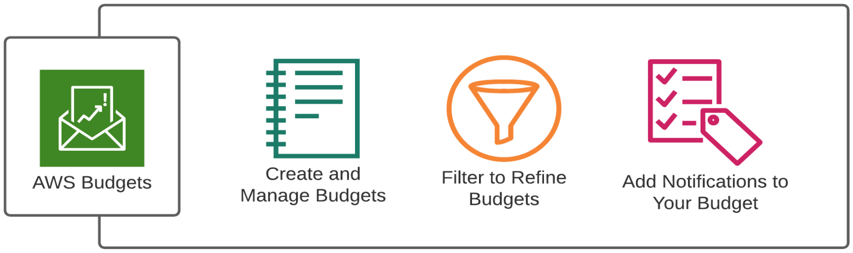
Another means to control costs is to create a budget and stick to that budget. AWS budgets help the organization stick to a budget with budget notifications.[93]

How AWS Budgets Work

- The organization creates a budget and sets custom alerts.
- The budget is created in the AWS Management Console or within the AWS Billing Console.
- When an organization gets close to exceeding its budget, an alert is sent.

This can ensure that an organization adheres to its budget. Additionally, the budget alarms can help an organization plan for future optimizations of their network. For example, an organization may find that due to use, reserved instances may enable large cost savings. This enables the organization to optimize cloud computing expenses.

The diagram below shows how AWS budgets can be used to help an organization manage its AWS cloud computing expenses.



AWS Trusted Advisor

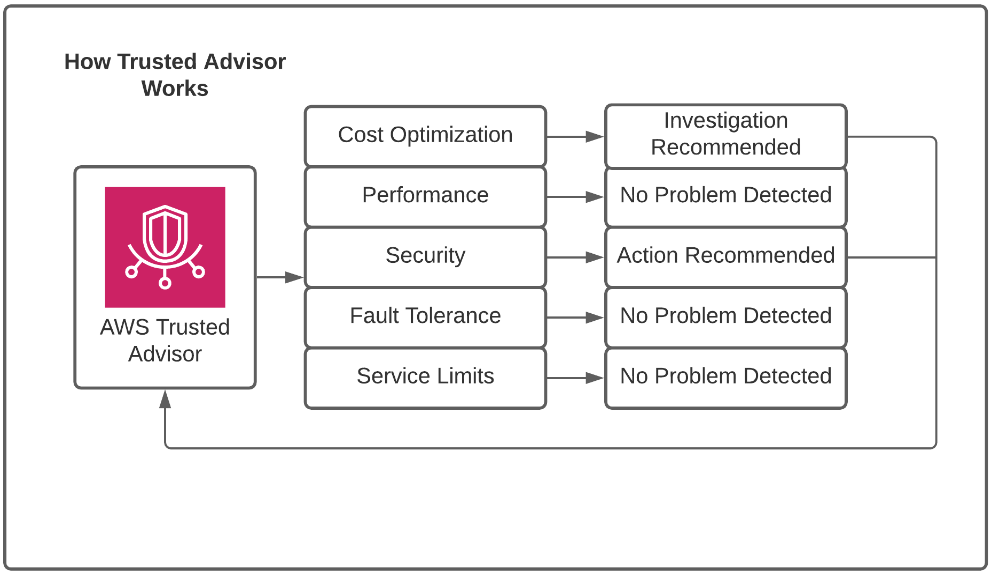
AWS Trusted Advisor is an online tool to help an organization optimize its spending on the AWS platform.[94]

How AWS Trusted Advisor Works

1. AWS Trusted Advisor scans and evaluates an organization’s infrastructure.
2. AWS Trusted Advisor compares an organization’s infrastructure to AWS best practices and provides recommendations. These recommendations can improve performance, security, availability, and system costs.
3. The organization evaluates the Trusted Advisor recommendations.
4. The organization implements the appropriate recommendations from AWS Trusted Advisor.
5. This should reduce costs and/or improve system performance.

There are two versions of Trusted Advisor for clients, the Developer Support Plans and Business Support Plans. Organizations with AWS Basic and Developer Support Plans have access to six security checks and fifty service limit checks with Trusted Advisor. Organizations with Business Support Plans or AWS Enterprise Support Plans receive fifteen Trusted Advisor checks (fourteen cost optimization, seventeen security, twenty-four fault tolerance, ten performance, and fifty service limits).

The diagram below shows how AWS Trusted Advisor is used to help an organization optimize its AWS infrastructure:



Chapter 12 - Building High-Availability Architectures

What Is Availability?

Availability refers to the service being available for use when you need it. A high-availability infrastructure is highly likely to be ready when needed. Designing for high availability can become extremely expensive, depending upon the availability required.[95]

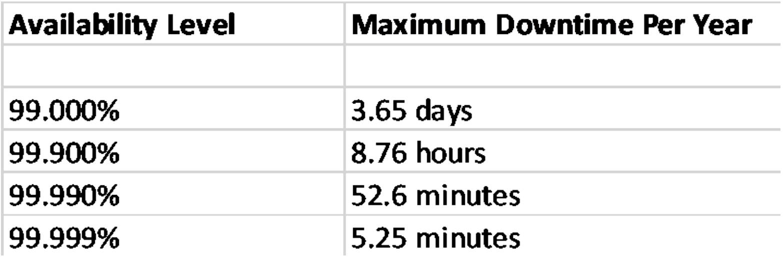
In general, there are four levels of availability:

- 99.0 percent

- 99.9 percent
- 99.99 percent
- 99.999 percent

Most people would consider levels of availability of 99.9 percent or greater to be a highly available network. Many organizations require much higher levels of availability. For example, service providers, banks, health care organizations, and other organizations that are completely dependent upon technology—with serious consequences if the systems are not operational—require 99.999 percent or greater availability.

The diagram below shows the typical availability metrics and associated downtime per year:



Availability Level	Maximum Downtime Per Year
99.000%	3.65 days
99.900%	8.76 hours
99.990%	52.6 minutes
99.999%	5.25 minutes

Building a High-Availability Network

Building a high-availability network is based upon the key tenant of no single points of failure. This means complete redundancy is required in all aspects of the computing environment. Necessary redundant services are as follows:

- Redundant power
- Redundant cooling for servers
- Redundant network connections
- Redundant service providers
- Redundant routers
- Redundant switches
- Redundant servers
- Redundant load balancers
- Redundant DNS
- Redundant storage
- Redundant locations
- Redundant applications, i.e., databases

Change Management

A strong change management program is required for high-availability systems. Configuration changes can have a major impact on system performance, especially if configuration mistakes occur. Therefore, prior to making any changes across an organization’s systems, all stakeholders need to be notified of prospective changes. All stakeholders need to evaluate that any changes made will not affect the systems they manage. Additionally, all stakeholders need to agree on a time for configuration changes. Configuration changes should be made at a time when the system is minimally used—ideally a time when user access and system utilization are at their lowest levels.

High Availability in the Cloud

Building a high-availability system in the cloud is much simpler than with the traditional data center. This is because AWS maintains the key elements of high availability in the architecture, including:

- Redundant power
- Redundant cooling
- Redundant connections to the internet and across the backbone
- Redundant routers and switches

Since AWS natively performs many of the parts of a high-availability architecture, only a subset of redundancy is required, and those elements can be seen below. Whenever possible, place the platform in multiple availability zones. These elements include the following:

- EC2 compute instances
- Databases
- Elastic Load Balancers
- DNS or Route 53
- NAT gateways
- Storage

Another key component of high-availability design is the connections from the organization to the AWS VPC. For most clients this will include a direct connection to AWS and a VPN backup. Organizations requiring even higher levels of availability and performance might have a primary direct connection, a backup direction connection, and a VPN backup to the direct connections. Ideally all connections to AWS are across multiple service providers, so that if a service provider were to have an outage, the backup connections would remain intact. Furthermore, on the customer end, redundant connections should be placed on redundant routers.

High Availability Requires High Security

High-availability environments require a strong security posture. A strong security posture is required because if security is compromised, it can have a major impact on system performance and availability. Key components of high security for high-availability architecture are below:

Principle of Least Privilege

- Allow users access to only the systems they need to perform their job.
- Use strong IAM policies to limit the users to the minimum services necessary.

Containing Problems

- Limit blast radius of an application by using AWS Organizations.

Keep Unwanted Traffic Out

- Keep unwanted network traffic out using network ACLs.
- Configure services with security groups so that only desired traffic is allowed.
- Use Amazon WAF for firewall, AWS Shield for DDoS, and IDS/IPS for intrusion protection.

Physical Security

- Equipment accessing the AWS network should be secured to prevent unauthorized access.

Passwords and Authentication

- Allow only strong passwords to be used and rotate them frequently.
- Use multifactor authentication.
- Use temporary passwords or tokens whenever possible.

Data Privacy

- Encrypt data to ensure its privacy from unauthorized users.
- Encrypt data both at rest and in transit.

Logging and Monitoring

There should be constant monitoring of the systems for the following:

- System alerts

- Security breaches
- Usage
- Performance

Other Essential Security Components

- Disable all unused and unnecessary services on systems.
- Allow only approved services to be used.
- Template known configurations with CloudFormation to be sure new systems meet security requirements.

Additional Means to Increase Availability

There are some additional methods for increasing availability. Using systems and services that are designed to enhance availability is one method. DNS and load balancers with health checks are purposely designed to enhance availability and performance. Elasticity and autoscaling features help to make sure applications are always usable and don't become unstable with high demand.

Availability can also be increased by decoupling applications using services like SQS. Decoupling components of the architecture can promote system integrity and availability by enabling functionality when one or more parts of the system are unavailable. For example, adding an SQS queue in front of a database can keep the system functioning and not lose messages during a database outage. Additionally, use services designed to lower overall system load so the systems will be available and not busy when needed. An example is using redundant caching in front of web servers.

Chapter 13 - AWS Labs – Getting Hands-On

In this section we showcase some hands-on training. Labs will follow the flow of the chapters in this book whenever possible.

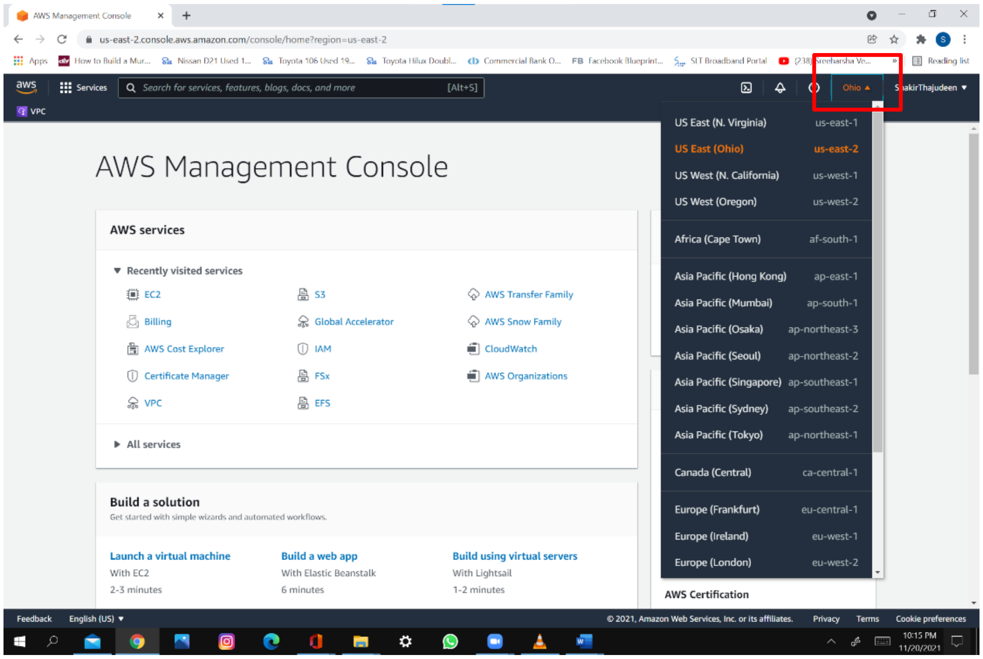
Chapter 1 Labs

Creating a virtual machine (EC2 instance) and remotely accessing that virtual machine with SSH.

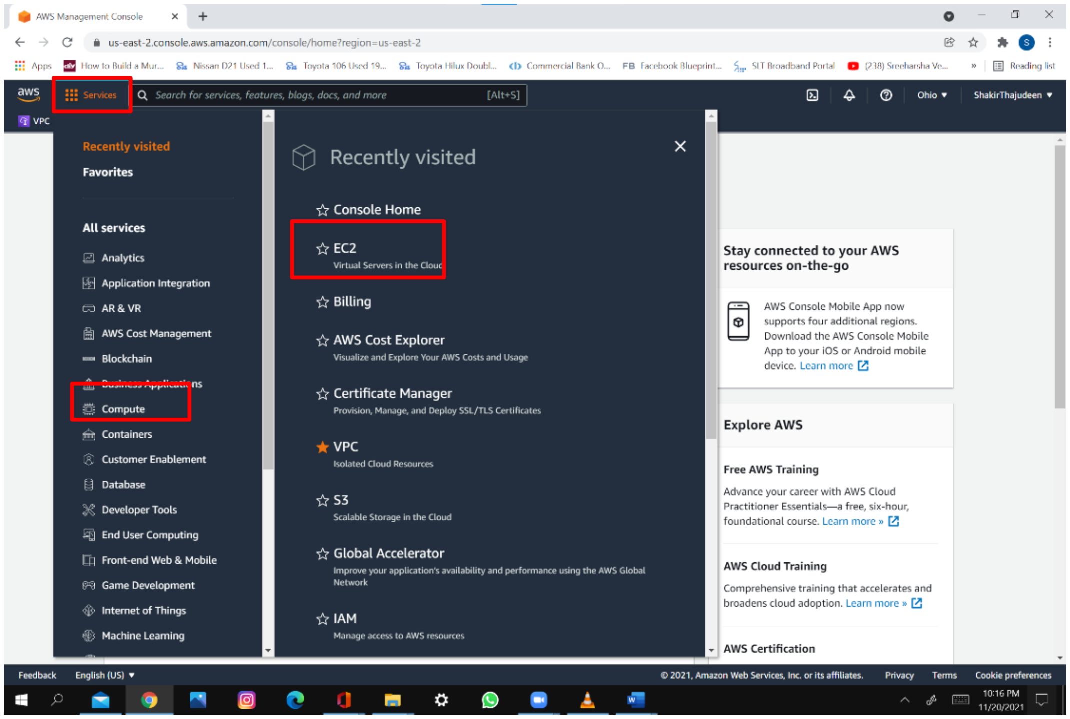
Lab: Create an EC2 Instance

The objective of this lab is to create a virtual machine, which is called an EC2 instance in AWS cloud.

Log in to the **AWS Management Console** and select the region where the EC2 instance should be created:


AWS Management Console
us-east-2.console.aws.amazon.com/console/home?region=us-east-2
Services
Search for services, features, blogs, docs, and more [Alt+S]
Ohio
ShakirThajudeen
VPC
AWS Management Console
AWS services
Recently visited services
EC2
S3
AWS Transfer Family
Billing
Global Accelerator
AWS Snow Family
AWS Cost Explorer
IAM
CloudWatch
Certificate Manager
FSx
AWS Organizations
VPC
EFS
All services
Build a solution
Get started with simple wizards and automated workflows.
Launch a virtual machine
With EC2
2-3 minutes
Build a web app
With Elastic Beanstalk
6 minutes
Build using virtual servers
With Lightsail
1-2 minutes
US East (N. Virginia) us-east-1
US East (Ohio) us-east-2
US West (N. California) us-west-1
US West (Oregon) us-west-2
Africa (Cape Town) af-south-1
Asia Pacific (Hong Kong) ap-east-1
Asia Pacific (Mumbai) ap-south-1
Asia Pacific (Osaka) ap-northeast-3
Asia Pacific (Seoul) ap-northeast-2
Asia Pacific (Singapore) ap-southeast-1
Asia Pacific (Sydney) ap-southeast-2
Asia Pacific (Tokyo) ap-northeast-1
Canada (Central) ca-central-1
Europe (Frankfurt) eu-central-1
Europe (Ireland) eu-west-1
Europe (London) eu-west-2
AWS Certification
Feedback
English (US)
© 2021, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms
Cookie preferences
10:15 PM
11/20/2021

Click on **Services**, then **Compute**, and finally click on **EC2**:

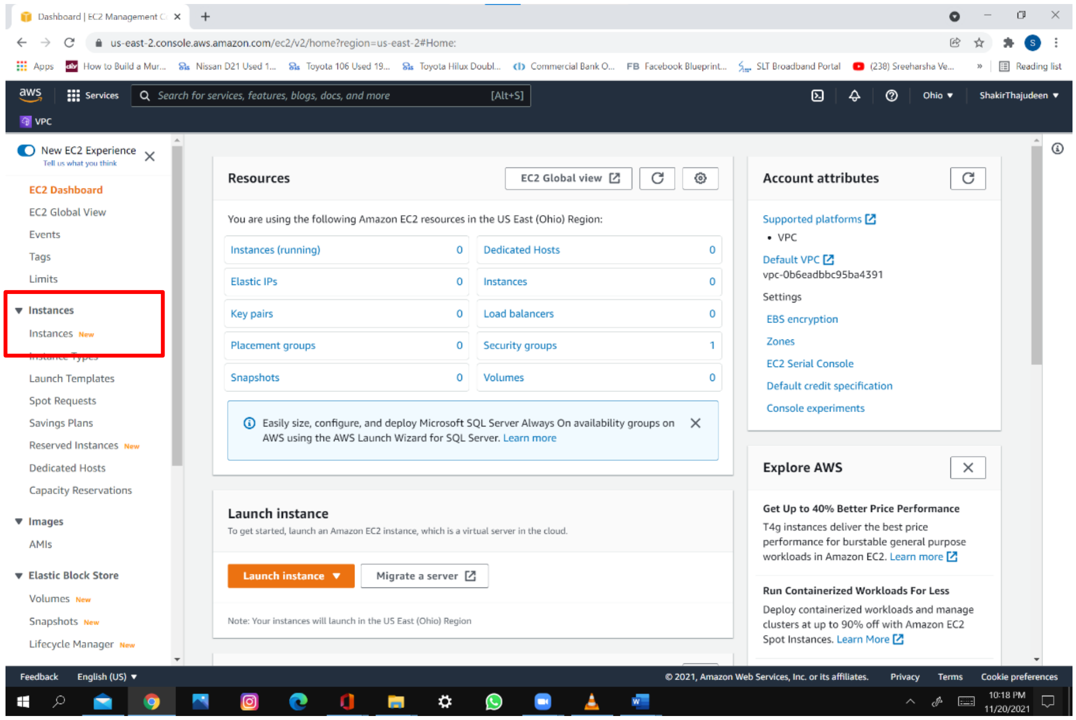


AWS Console Mobile App now supports four additional regions. Download the AWS Console Mobile App to your iOS or Android mobile device. Learn more

Advance your career with AWS Cloud Practitioner Essentials—a free, six-hour, foundational course. Learn more »

Comprehensive training that accelerates and broadens cloud adoption. Learn more »

In the **EC2 Dashboard** , select **Instances** under **Instances**:



You are using the following Amazon EC2 resources in the US East (Ohio) Region:

Instances (running)	0	Dedicated Hosts	0
Elastic IPs	0	Instances	0
Key pairs	0	Load balancers	0
Placement groups	0	Security groups	1
Snapshots	0	Volumes	0

Easily size, configure, and deploy Microsoft SQL Server Always On availability groups on AWS using the AWS Launch Wizard for SQL Server. Learn more

To get started, launch an Amazon EC2 instance, which is a virtual server in the cloud.

Note: Your instances will launch in the US East (Ohio) Region

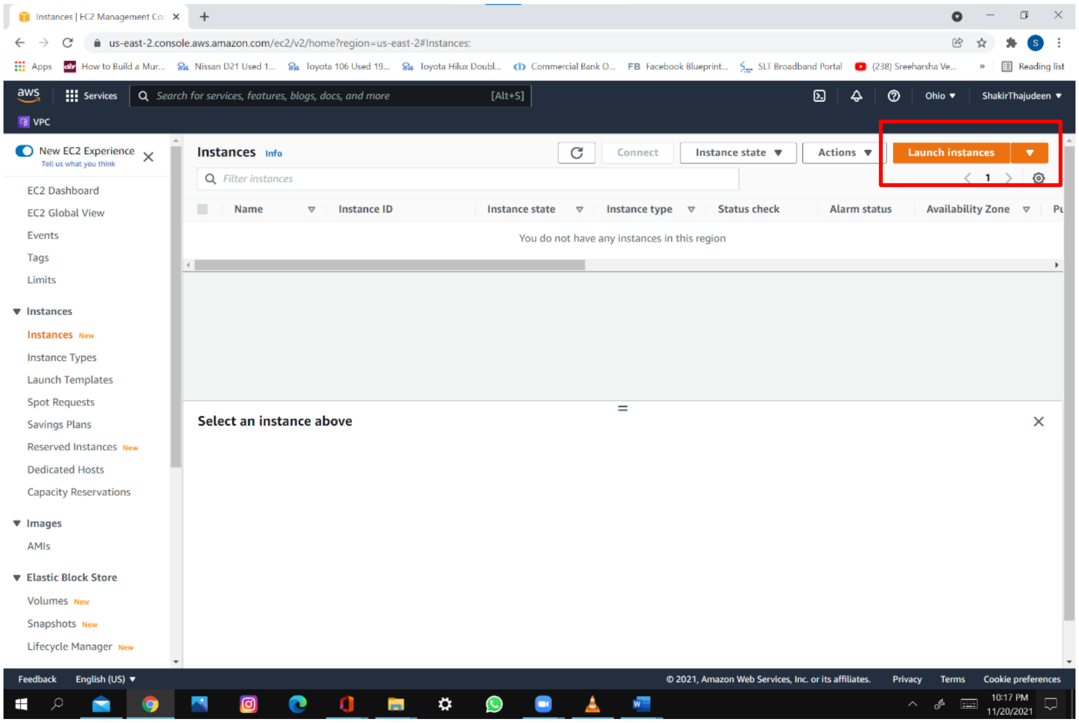
Get Up to 40% Better Price Performance

T4g instances deliver the best price performance for burstable general purpose workloads in Amazon EC2. Learn more

Run Containerized Workloads For Less

Deploy containerized workloads and manage clusters at up to 90% off with Amazon EC2 Spot Instances. Learn More

Click on **Launch Instances**:



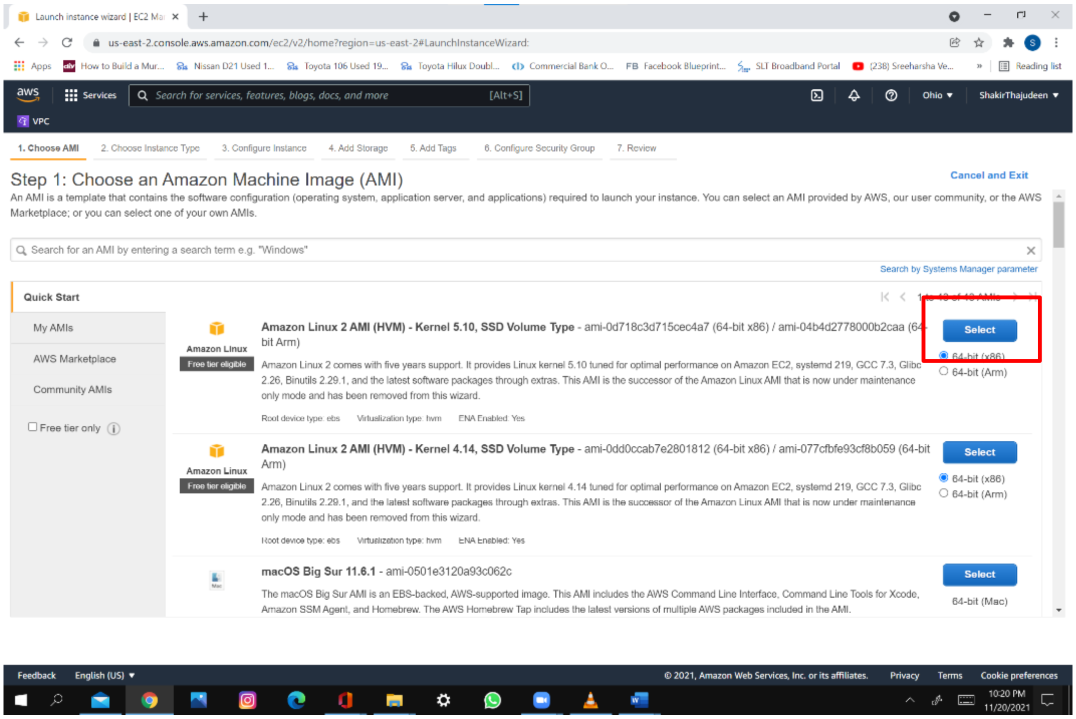
Instances Info

Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Pu

You do not have any instances in this region

Select an instance above

Select an **AWS Machine Image** (AMI):


Launch instance wizard | EC2 Ma
us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Ohio
ShakirThajudeen
VPC
1. Choose AMI
2. Choose Instance Type
3. Configure Instance
4. Add Storage
5. Add Tags
6. Configure Security Group
7. Review
Cancel and Exit
Search for an AMI by entering a search term e.g. "Windows"
Search by Systems Manager parameter
Quick Start
My AMIs
AWS Marketplace
Community AMIs
□ Free tier only
1 to 43 of 43 AMIs
Amazon Linux
Free tier eligible
Select
Feedback
English (US)
© 2021, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms
Cookie preferences
10:20 PM
11/20/2021

Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type - ami-0d718c3d715cec4a7 (64-bit x86) / ami-04b4d2778000b2caa (64-bit Arm)

Amazon Linux 2 comes with five years support. It provides Linux kernel 5.10 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is now under maintenance only mode and has been removed from this wizard.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86)
○ 64-bit (Arm)

Amazon Linux 2 AMI (HVM) - Kernel 4.14, SSD Volume Type - ami-0dd0ccab7e2801812 (64-bit x86) / ami-077cfbfe93cf8b059 (64-bit Arm)

Amazon Linux 2 comes with five years support. It provides Linux kernel 4.14 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is now under maintenance only mode and has been removed from this wizard.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

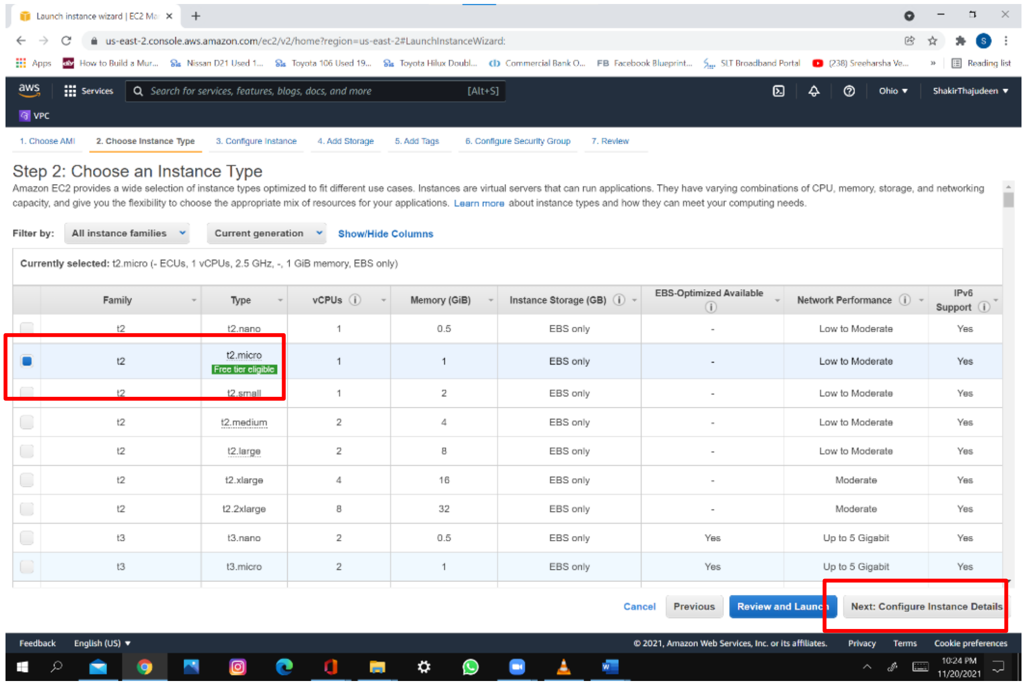
● 64-bit (x86)
○ 64-bit (Arm)

macOS Big Sur 11.6.1 - ami-0501e3120a93c062c

The macOS Big Sur AMI is an EBS-backed, AWS-supported image. This AMI includes the AWS Command Line Interface, Command Line Tools for Xcode, Amazon SSM Agent, and Homebrew. The AWS Homebrew Tap includes the latest versions of multiple AWS packages included in the AMI.

64-bit (Mac)

Select the **t2.micro** instance type and click **Next**:



1. Choose AMI | 2. Choose Instance Type | 3. Configure Instance | 4. Add Storage | 5. Add Tags | 6. Configure Security Group | 7. Review

Step 2: Choose an Instance Type

Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have varying combinations of CPU, memory, storage, and networking capacity, and give you the flexibility to choose the appropriate mix of resources for your applications. Learn more about instance types and how they can meet your computing needs.

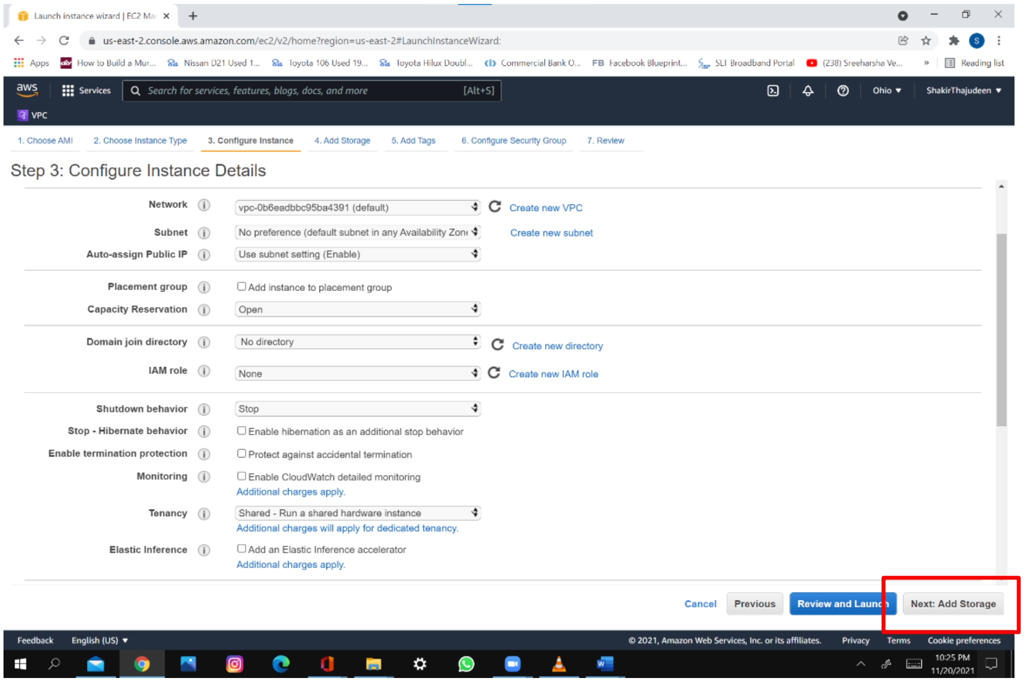
Filter by: All instance families | Current generation | Show/Hide Columns

Currently selected: t2.micro (- ECUs, 1 vCPUs, 2.5 GHz, -, 1 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance	IPv6 Support
□	t2	t2.nano	1	0.5	EBS only	-	Low to Moderate	Yes
■	t2	t2.micro Free tier eligible	1	1	EBS only	-	Low to Moderate	Yes
□	t2	t2.small	1	2	EBS only	-	Low to Moderate	Yes
□	t2	t2.medium	2	4	EBS only	-	Low to Moderate	Yes
□	t2	t2.large	2	8	EBS only	-	Low to Moderate	Yes
□	t2	t2.xlarge	4	16	EBS only	-	Moderate	Yes
□	t2	t2.2xlarge	8	32	EBS only	-	Moderate	Yes
□	t3	t3.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes
□	t3	t3.micro	2	1	EBS only	Yes	Up to 5 Gigabit	Yes

Cancel
Previous
Review and Launch
Next: Configure Instance Details
Feedback
English (US)
© 2021, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms
Cookie preferences

Configure instance details and click **Next**:



1. Choose AMI | 2. Choose Instance Type | 3. Configure Instance | 4. Add Storage | 5. Add Tags | 6. Configure Security Group | 7. Review

Step 3: Configure Instance Details

Network: vpc-0b6eadbbc95ba4391 (default) — Create new VPC

Subnet: No preference (default subnet in any Availability Zon — Create new subnet

Auto-assign Public IP: Use subnet setting (Enable)

Placement group: □ Add instance to placement group

Capacity Reservation: Open

Domain join directory: No directory — Create new directory

IAM role: None — Create new IAM role

Shutdown behavior: Stop

Stop - Hibernate behavior: □ Enable hibernation as an additional stop behavior

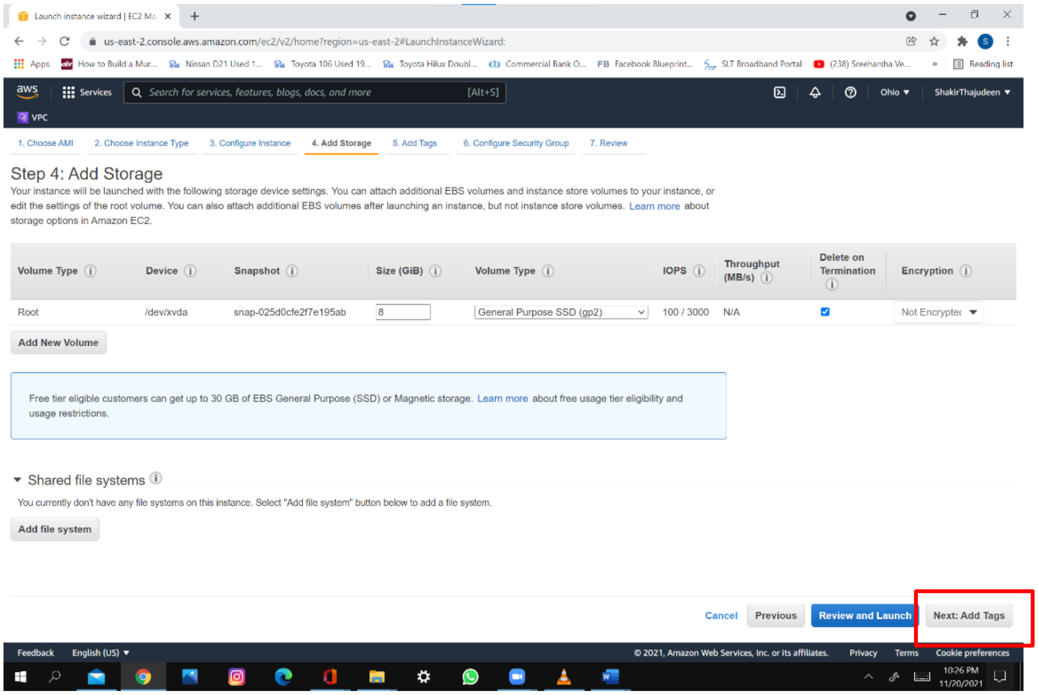
Enable termination protection: □ Protect against accidental termination

Monitoring: □ Enable CloudWatch detailed monitoring
Additional charges apply.

Tenancy: Shared - Run a shared hardware instance
Additional charges will apply for dedicated tenancy.

Elastic Inference: □ Add an Elastic Inference accelerator
Additional charges apply.

Select Storage or just click **Next** to use the default settings:



Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. Learn more about storage options in Amazon EC2.

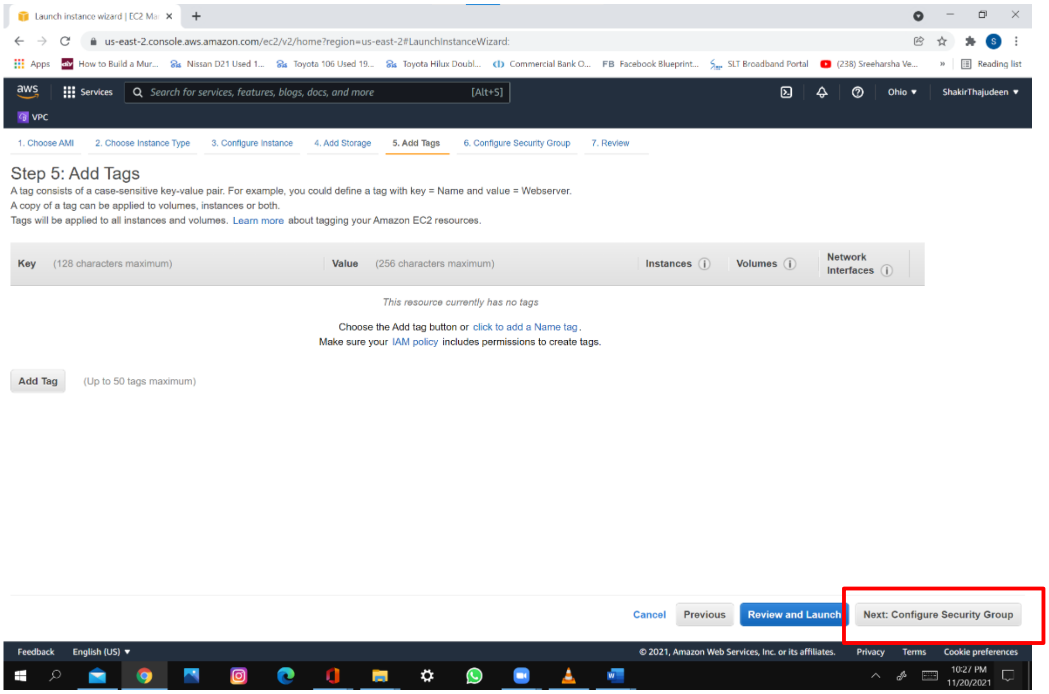
Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encryption
Root	/dev/xvda	snap-025d0cfe2f7e195ab	8	General Purpose SSD (gp2)	100 / 3000	N/A	☑	Not Encrypted

Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. Learn more about free usage tier eligibility and usage restrictions.

Shared file systems

You currently don't have any file systems on this instance. Select "Add file system" button below to add a file system.

Add tags and click **Next**:


Launch instance wizard | EC2 Ma
us-east-2.console.aws.amazon.com/ec2/v2/home?region=us-east-2#LaunchInstanceWizard:
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Ohio
ShakirThajudeen
VPC
1. Choose AMI
2. Choose Instance Type
3. Configure Instance
4. Add Storage
5. Add Tags
6. Configure Security Group
7. Review
Add Tag
(Up to 50 tags maximum)
Cancel
Previous
Review and Launch
Next: Configure Security Group
Feedback
English (US)
© 2021, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms
Cookie preferences

Step 5: Add Tags

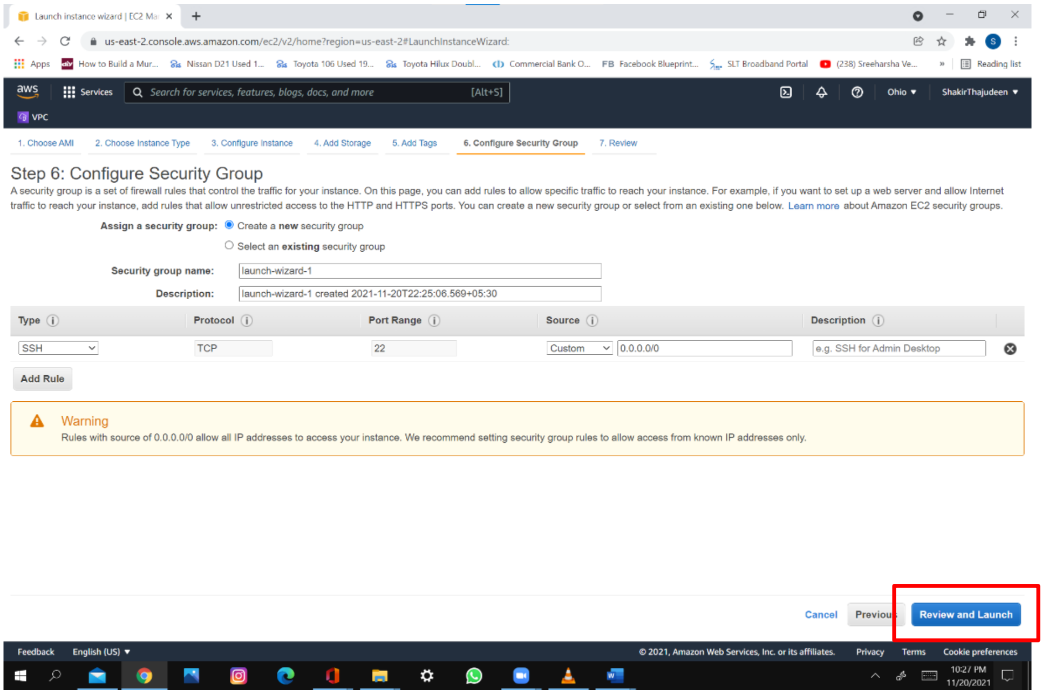
A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver.
A copy of a tag can be applied to volumes, instances or both.
Tags will be applied to all instances and volumes. Learn more about tagging your Amazon EC2 resources.

Key (128 characters maximum)	Value (256 characters maximum)	Instances	Volumes	Network Interfaces

This resource currently has no tags

Choose the Add tag button or click to add a Name tag.
Make sure your IAM policy includes permissions to create tags.

Configure security group and click **Review and Launch**:



Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. Learn more about Amazon EC2 security groups.

Assign a security group: ● Create a **new** security group
○ Select an **existing** security group

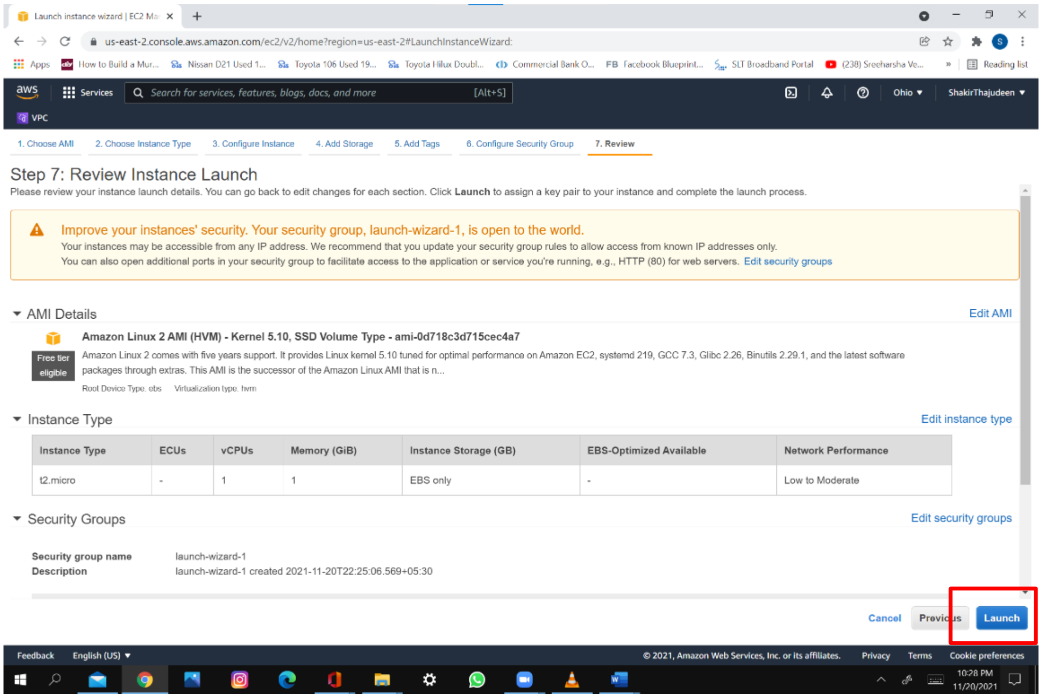
Security group name: launch-wizard-1

Description: launch-wizard-1 created 2021-11-20T22:25:06.569+05:30

Type	Protocol	Port Range	Source		Description
SSH	TCP	22	Custom	0.0.0.0/0	e.g. SSH for Admin Desktop

Warning
Rules with source of 0.0.0.0/0 allow all IP addresses to access your instance. We recommend setting security group rules to allow access from known IP addresses only.

Review the instance configuration. When ready, click **Launch**:



Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

Improve your instances' security. Your security group, launch-wizard-1, is open to the world.
Your instances may be accessible from any IP address. We recommend that you update your security group rules to allow access from known IP addresses only.
You can also open additional ports in your security group to facilitate access to the application or service you're running, e.g., HTTP (80) for web servers. Edit security groups

AMI Details — Edit AMI

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type - ami-0d718c3d715cec4a7

Free tier eligible

Amazon Linux 2 comes with five years support. It provides Linux kernel 5.10 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is n...

Root Device Type: ebs   Virtualization type: hvm

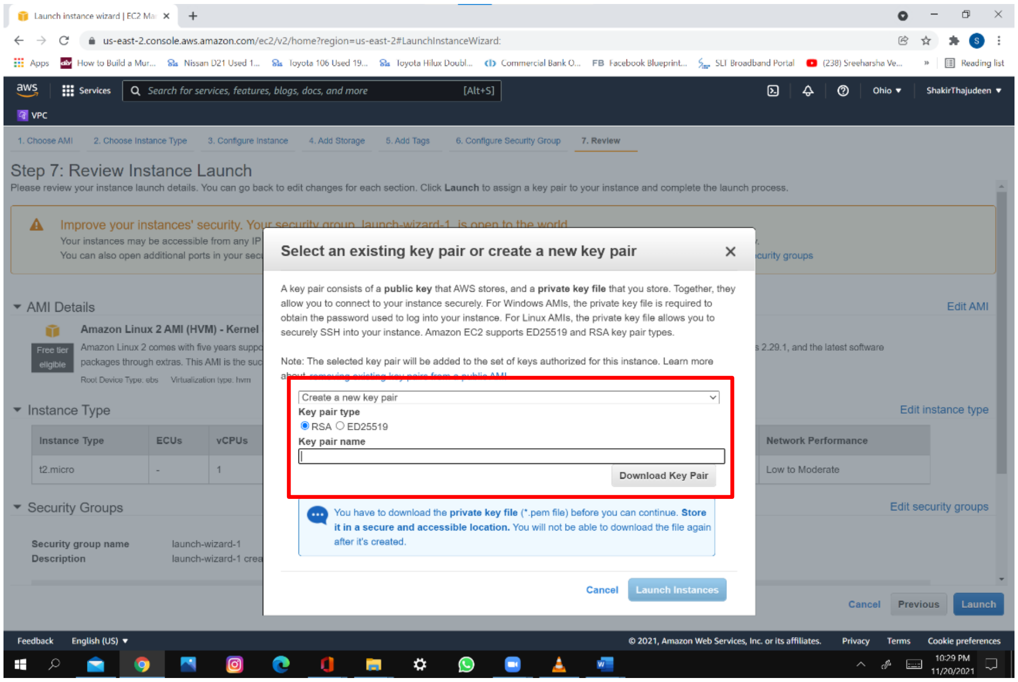
Instance Type — Edit instance type

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
t2.micro	-	1	1	EBS only	-	Low to Moderate

Security Groups — Edit security groups

Security group name launch-wizard-1
Description launch-wizard-1 created 2021-11-20T22:25:06.569+05:30

Create a new key pair and download the file:



Step 7: Review Instance Launch

Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance. Amazon EC2 supports ED25519 and RSA key pair types.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about removing existing key pairs from a public AMI.

Create a new key pair

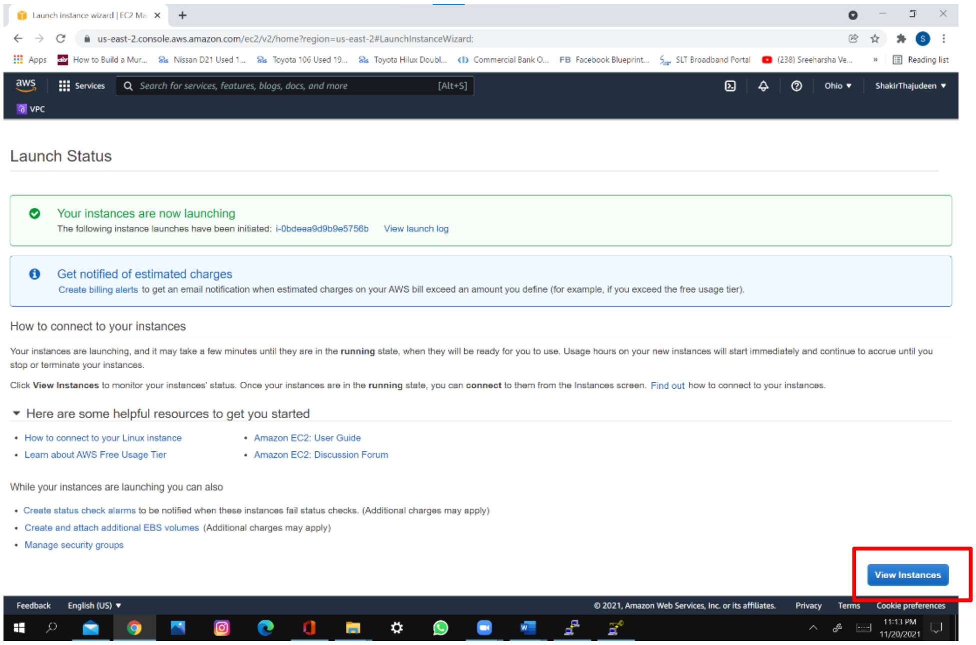
Key pair type

● RSA ○ ED25519

Key pair name

You have to download the **private key file** (*.pem file) before you can continue. **Store it in a secure and accessible location.** You will not be able to download the file again after it's created.

Launch status. Click **View Instances**:



Launch Status

Your instances are now launching

The following instance launches have been initiated: i-0bdeea9d9b9e5756b View launch log

Get notified of estimated charges

Create billing alerts to get an email notification when estimated charges on your AWS bill exceed an amount you define (for example, if you exceed the free usage tier).

How to connect to your instances

Your instances are launching, and it may take a few minutes until they are in the **running** state, when they will be ready for you to use. Usage hours on your new instances will start immediately and continue to accrue until you stop or terminate your instances.

Click **View Instances** to monitor your instances' status. Once your instances are in the **running** state, you can **connect** to them from the Instances screen. Find out how to connect to your instances.

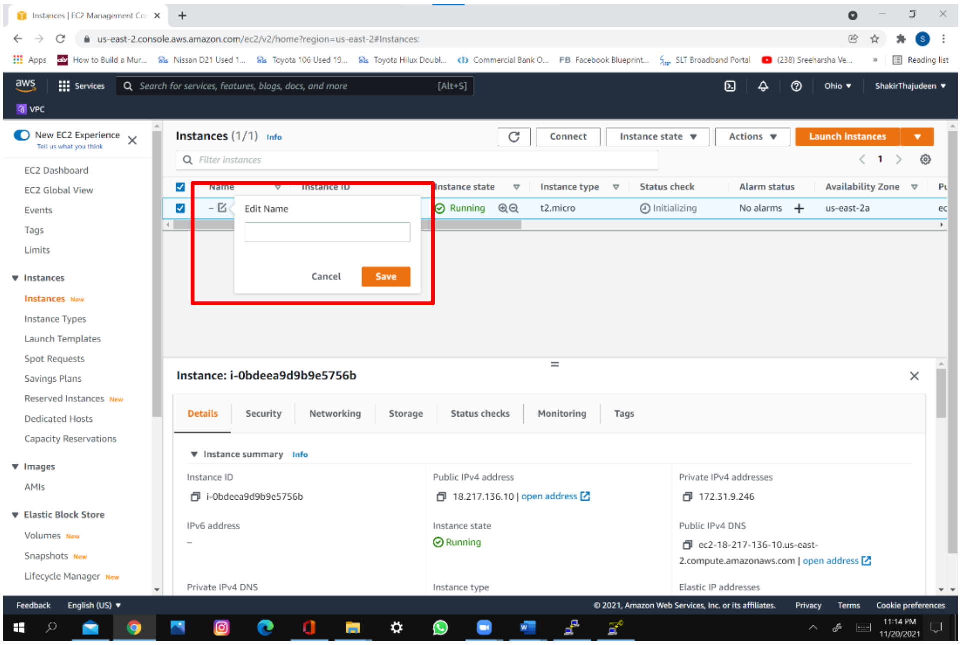
Here are some helpful resources to get you started

- How to connect to your Linux instance
- Learn about AWS Free Usage Tier
- Amazon EC2: User Guide
- Amazon EC2: Discussion Forum

While your instances are launching you can also

- Create status check alarms to be notified when these instances fail status checks. (Additional charges may apply)
- Create and attach additional EBS volumes (Additional charges may apply)
- Manage security groups

Launch instance – status. You can edit the instance name:



Instance: i-0bdeea9d9b9e5756b

Instance ID: i-0bdeea9d9b9e5756b

Public IPv4 address: 18.217.136.10 | open address

Private IPv4 addresses: 172.31.9.246

IPv6 address: –

Instance state: Running

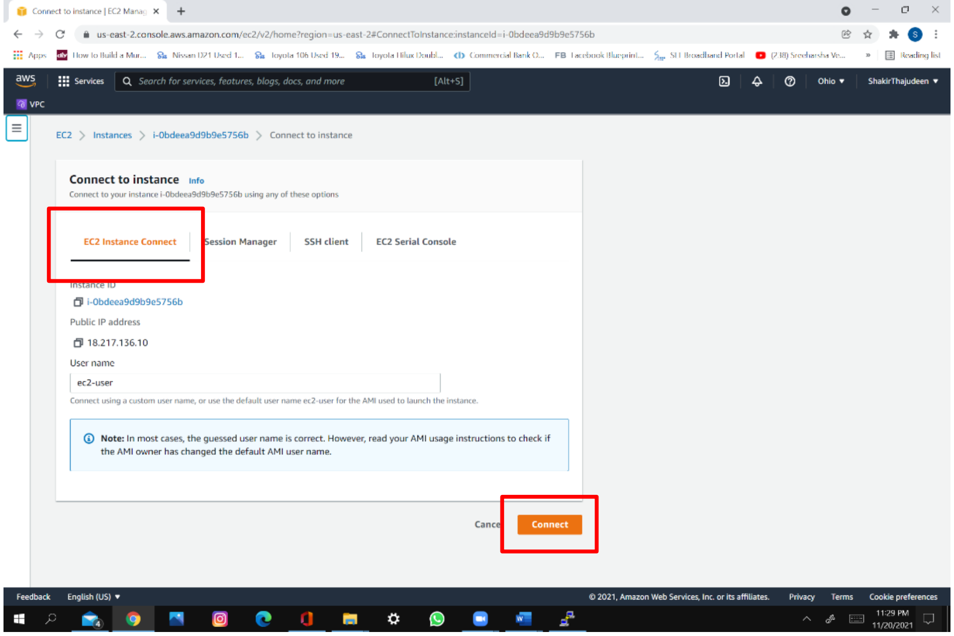
Public IPv4 DNS: ec2-18-217-136-10.us-east-2.compute.amazonaws.com | open address

Private IPv4 DNS

Instance type

Elastic IP addresses

Select the instance, then click **Connect**. Select **EC2 Instance Connect** and click **Next**:



Connect to instance Info

Connect to your instance i-0bdeea9d9b9e5756b using any of these options

Instance ID: i-0bdeea9d9b9e5756b

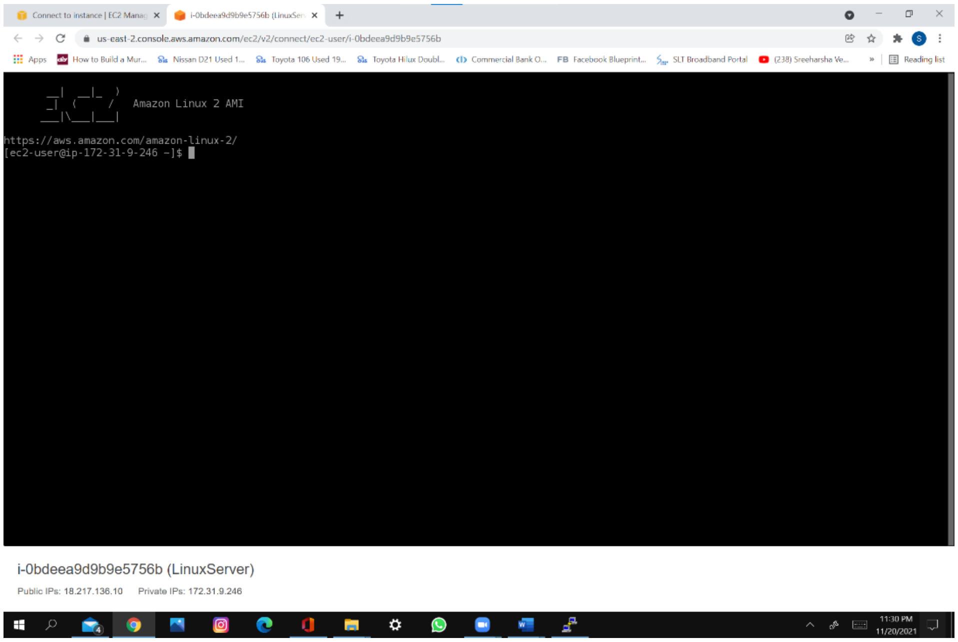
Public IP address: 18.217.136.10

User name: ec2-user

Connect using a custom user name, or use the default user name ec2-user for the AMI used to launch the instance.

Note: In most cases, the guessed user name is correct. However, read your AMI usage instructions to check if the AMI owner has changed the default AMI user name.

A new browser tab will open with the EC2's Command Line Interface (CLI):



Connect to instance | EC2 Manag
i-0bdeea9d9b9e5756b (LinuxSer
us-east-2.console.aws.amazon.com/ec2/v2/connect/ec2-user/i-0bdeea9d9b9e5756b

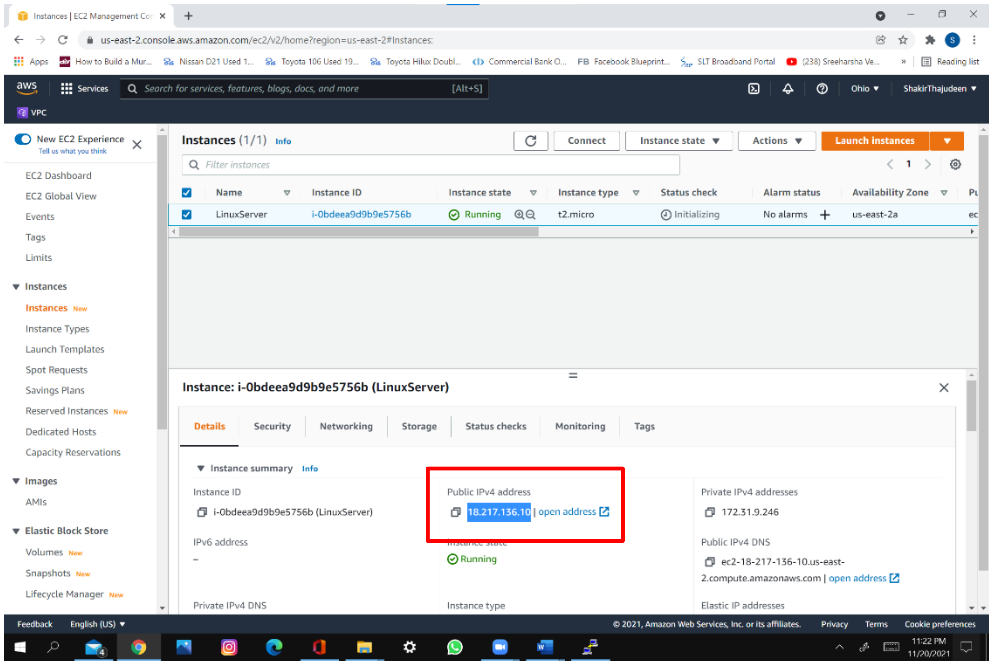
```
       __|  __|_  )
       _|  (     /   Amazon Linux 2 AMI
      ___|\___|___|

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-172-31-9-246 ~]$ 
```

i-0bdeea9d9b9e5756b (LinuxServer)

Public IPs: 18.217.136.10   Private IPs: 172.31.9.246

To connect to a LINUX EC2 instance from Windows, an SSH client like PuTTY is needed. From the EC2 Instance details page, copy its public IP address:



Instances (1/1) Info

☑	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Pu
☑	LinuxServer	i-0bdeea9d9b9e5756b	Running	t2.micro	Initializing	No alarms	us-east-2a	ec

Instance: i-0bdeea9d9b9e5756b (LinuxServer)

Instance summary Info

Instance ID
i-0bdeea9d9b9e5756b (LinuxServer)

Public IPv4 address
18.217.136.10 | open address

Private IPv4 addresses
172.31.9.246

IPv6 address
–

Instance state
Running

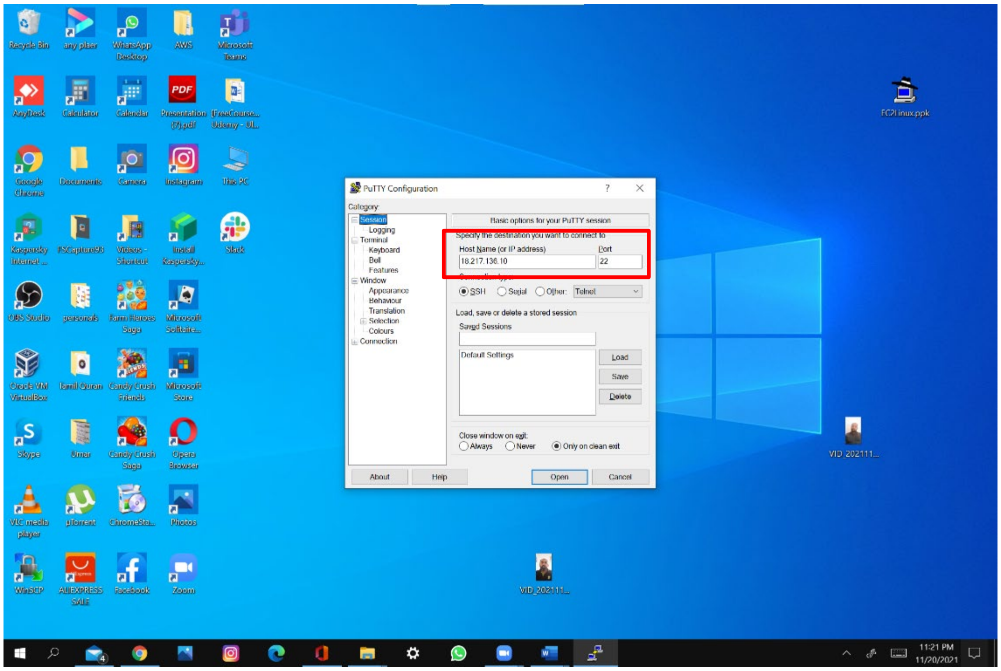
Public IPv4 DNS
ec2-18-217-136-10.us-east-2.compute.amazonaws.com | open address

Private IPv4 DNS

Instance type

Elastic IP addresses

Paste that address in **PuTTY**'s **Host Name (or IP address)** field:



PuTTY Configuration

Category:

Basic options for your PuTTY session

Specify the destination you want to connect to

Host Name (or IP address): 18.217.136.10

Port: 22

Connection type: ● SSH ○ Serial ○ Other: Telnet

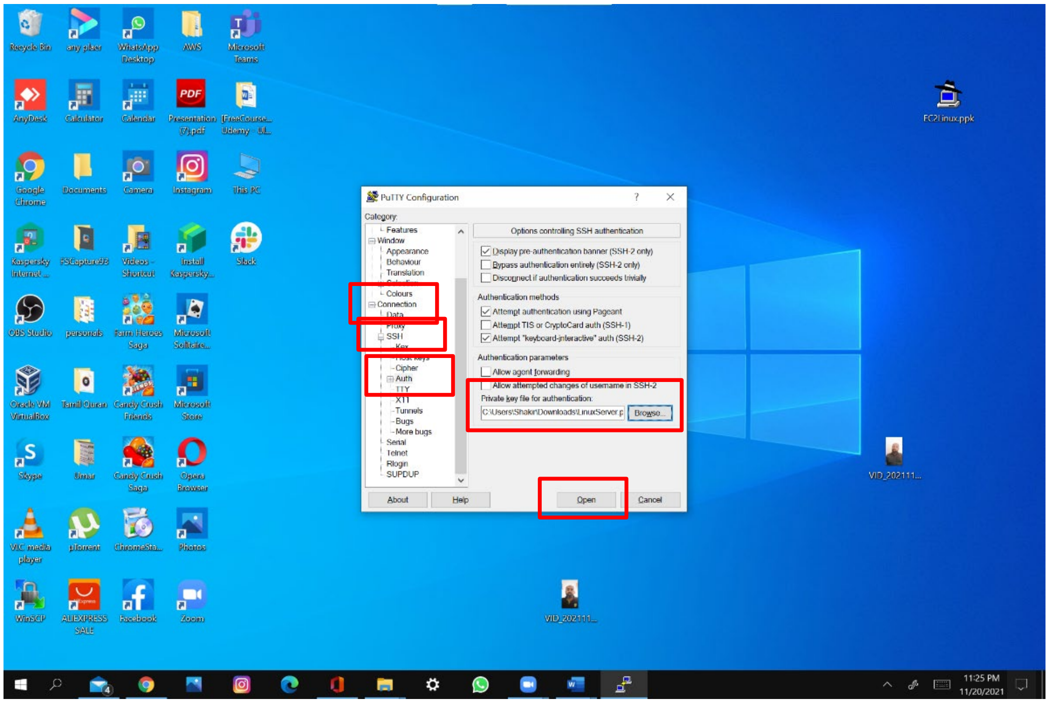
Load, save or delete a stored session

Saved Sessions

Default Settings

Close window on exit: ○ Always ○ Never ● Only on clean exit

From the left panel, select Connection, then select **SSH**, and finally select **Auth**. Click **Browse** and locate the downloaded putty .ppk key. Click Open:



PuTTY Configuration

Category:

Options controlling SSH authentication

☑ Display pre-authentication banner (SSH-2 only)

□ Bypass authentication entirely (SSH-2 only)

□ Disconnect if authentication succeeds trivially

Authentication methods

☑ Attempt authentication using Pageant

□ Attempt TIS or CryptoCard auth (SSH-1)

☑ Attempt "keyboard-interactive" auth (SSH-2)

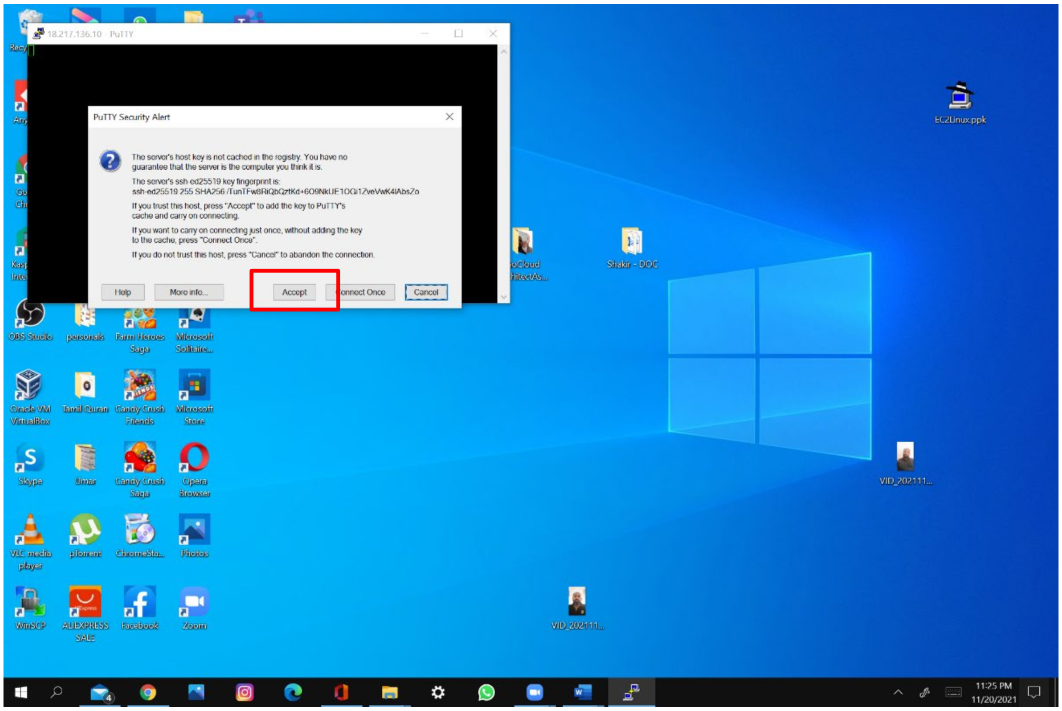
Authentication parameters

□ Allow agent forwarding

□ Allow attempted changes of username in SSH-2

Private key file for authentication: C:\Users\Shakir\Downloads\LinuxServer.p

A **PuTTY Security Alert** will pop up. Accept it:



The server's host key is not cached in the registry. You have no guarantee that the server is the computer you think it is.

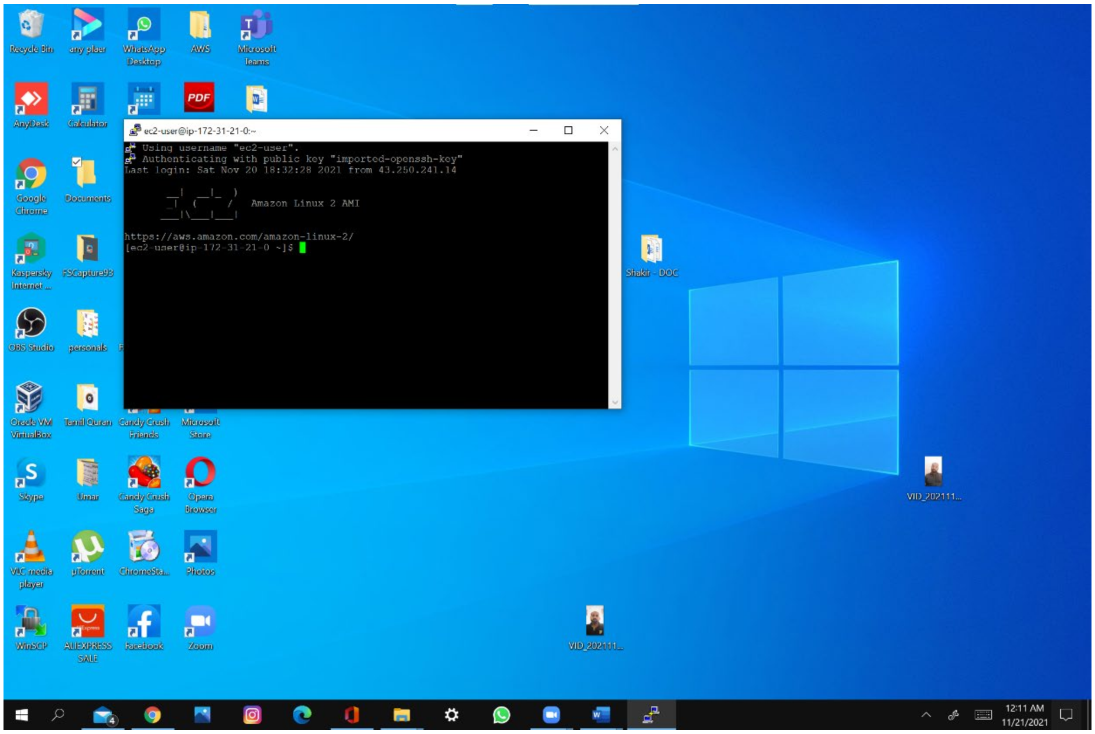
The server's ssh-ed25519 key fingerprint is:
ssh-ed25519 255 SHA256:/TunTFw8RiQbQztKd+6O9NkUE1OGi1ZveVwK4lAbsZo

If you trust this host, press "Accept" to add the key to PuTTY's cache and carry on connecting.

If you want to carry on connecting just once, without adding the key to the cache, press "Connect Once".

If you do not trust this host, press "Cancel" to abandon the connection.

The access to the EC2 instance CLI is ready:



```
Using username "ec2-user".
Authenticating with public key "imported-openssh-key"
Last login: Sat Nov 20 18:32:28 2021 from 43.250.241.14

       __|  __|_  )
       _|  (     /   Amazon Linux 2 AMI
      ___|\___|___|

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-172-31-21-0 ~]$
```

Chapter 3 Labs

Lab: Create an S3 Bucket

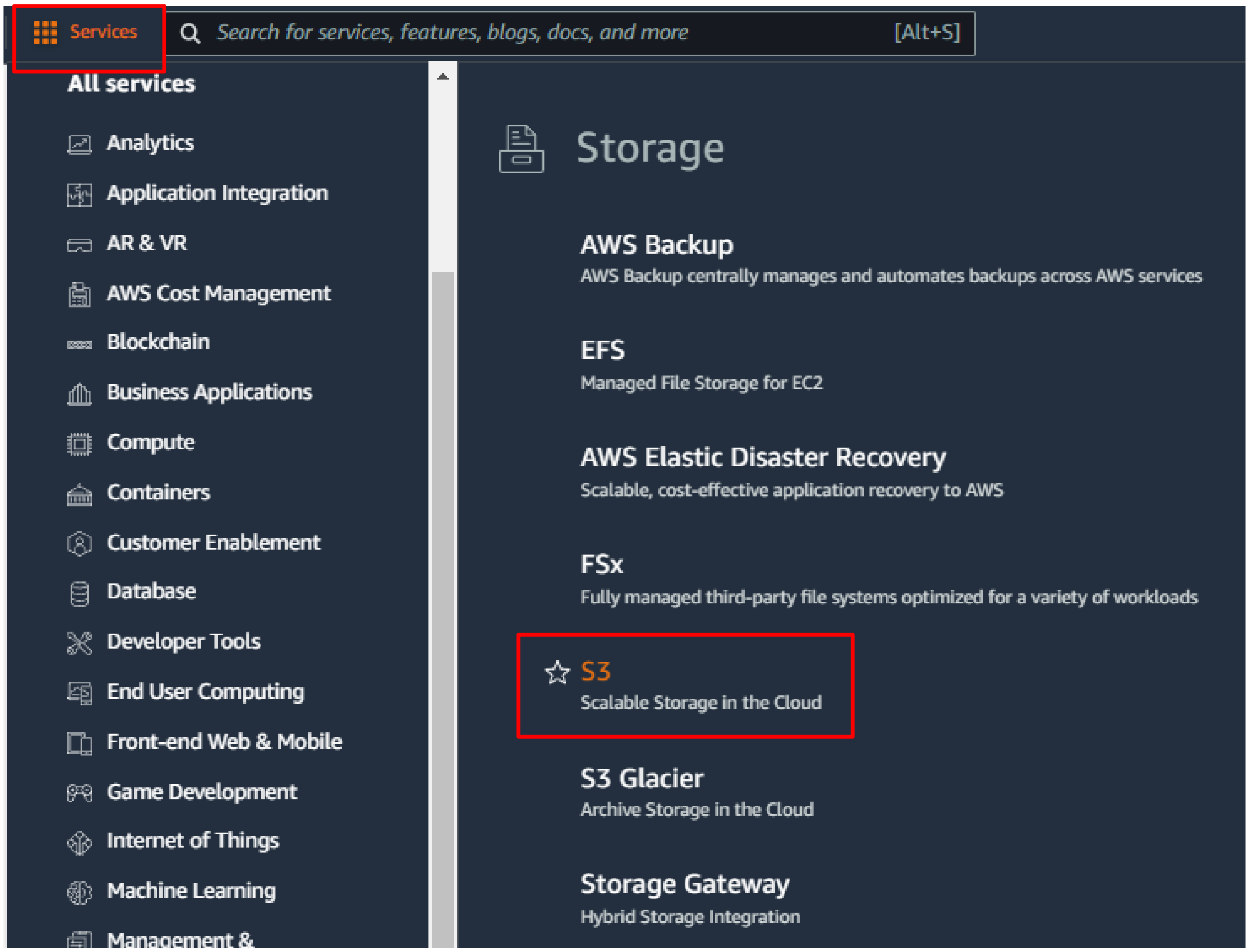
The objective of this lab is to create an S3 bucket.

There are three ways to create an Amazon S3 bucket, via the management console, CLI, or API.

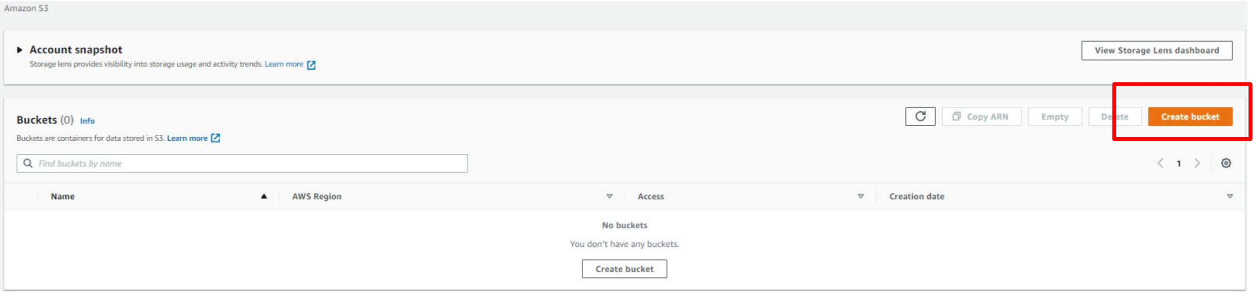
Remember bucket names should be unique for each AWS partition, and once a bucket is created, bucket name or region cannot be changed.

Create an S3 bucket using the S3 console

Sign in to the AWS Management Console and click on **Services**. The S3 option is found under the **Storage** section in the AWS console:


Services
Search for services, features, blogs, docs, and more
[Alt+S]
All services
Analytics
Application Integration
AR & VR
AWS Cost Management
Blockchain
Business Applications
Compute
Containers
Customer Enablement
Database
Developer Tools
End User Computing
Front-end Web & Mobile
Game Development
Internet of Things
Machine Learning
Management &
Storage
AWS Backup
AWS Backup centrally manages and automates backups across AWS services
EFS
Managed File Storage for EC2
AWS Elastic Disaster Recovery
Scalable, cost-effective application recovery to AWS
FSx
Fully managed third-party file systems optimized for a variety of workloads
S3
Scalable Storage in the Cloud
S3 Glacier
Archive Storage in the Cloud
Storage Gateway
Hybrid Storage Integration

Click **Create bucket**:



Storage lens provides visibility into storage usage and activity trends. Learn more

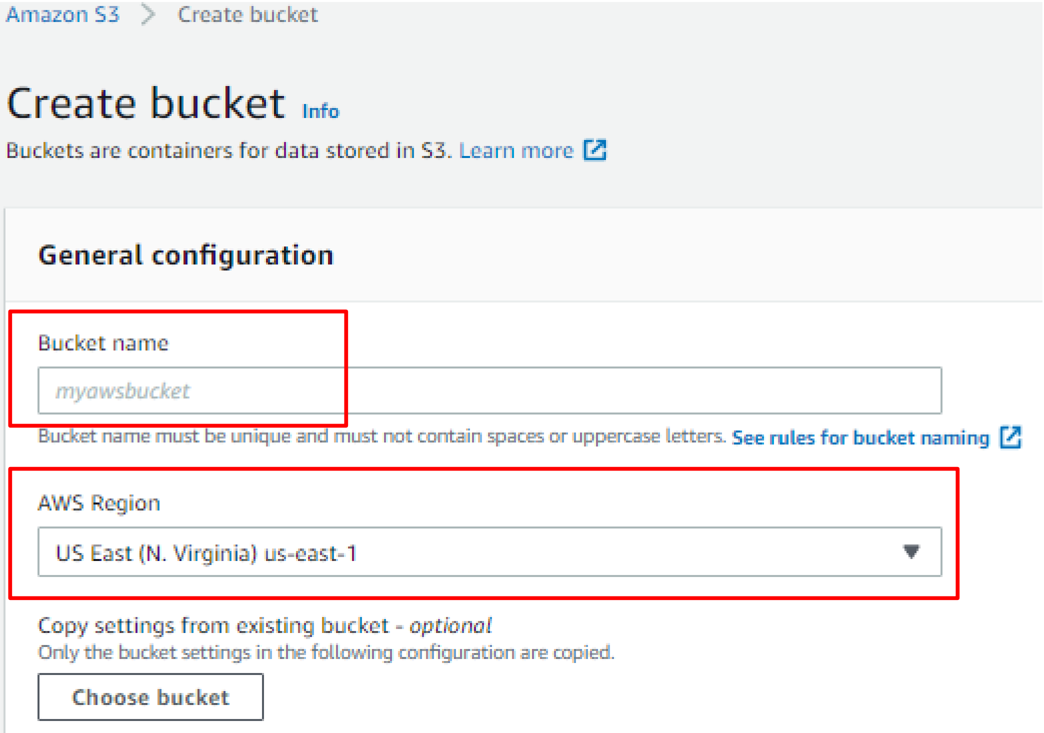
Buckets are containers for data stored in S3. Learn more

No buckets

You don't have any buckets.

The Create bucket wizard opens.

Enter a name for the Bucket, select the region in which the bucket should be created:



Buckets are containers for data stored in S3. Learn more

Bucket name: myawsbucket

Bucket name must be unique and must not contain spaces or uppercase letters. See rules for bucket naming

AWS Region: US East (N. Virginia) us-east-1

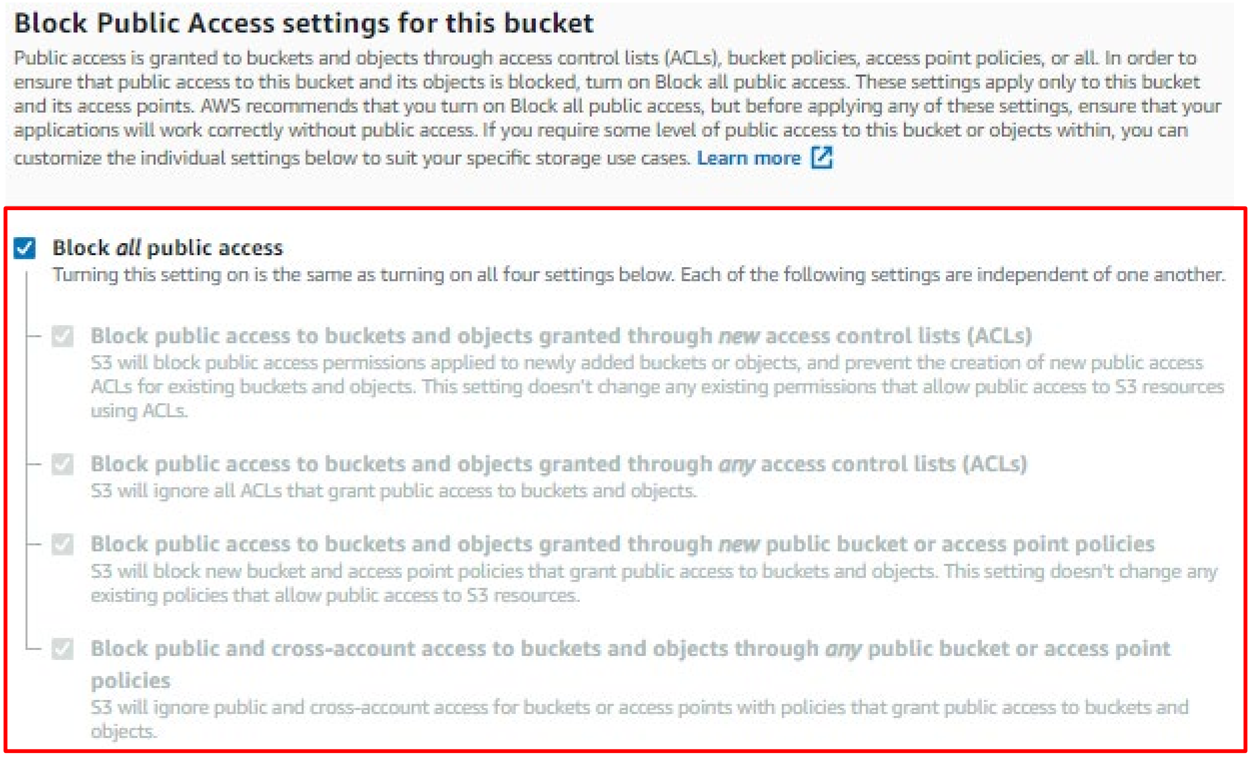
Copy settings from existing bucket - *optional*

Only the bucket settings in the following configuration are copied.

The bucket name is visible in the URLs that point to the objects in the bucket. So avoid including sensitive information in the bucket name.

Choose a Region that minimizes latency and costs and addresses regulatory requirements.

Choose the Block Public Access settings that you want to apply to the bucket:



Block Public Access settings for this bucket

Public access is granted to buckets and objects through access control lists (ACLs), bucket policies, access point policies, or all. In order to ensure that public access to this bucket and its objects is blocked, turn on Block all public access. These settings apply only to this bucket and its access points. AWS recommends that you turn on Block all public access, but before applying any of these settings, ensure that your applications will work correctly without public access. If you require some level of public access to this bucket or objects within, you can customize the individual settings below to suit your specific storage use cases. Learn more

☑ **Block *all* public access**
Turning this setting on is the same as turning on all four settings below. Each of the following settings are independent of one another.

- ☑ **Block public access to buckets and objects granted through *new* access control lists (ACLs)**
  S3 will block public access permissions applied to newly added buckets or objects, and prevent the creation of new public access ACLs for existing buckets and objects. This setting doesn't change any existing permissions that allow public access to S3 resources using ACLs.
- ☑ **Block public access to buckets and objects granted through *any* access control lists (ACLs)**
  S3 will ignore all ACLs that grant public access to buckets and objects.
- ☑ **Block public access to buckets and objects granted through *new* public bucket or access point policies**
  S3 will block new bucket and access point policies that grant public access to buckets and objects. This setting doesn't change any existing policies that allow public access to S3 resources.
- ☑ **Block public and cross-account access to buckets and objects through *any* public bucket or access point policies**
  S3 will ignore public and cross-account access for buckets or access points with policies that grant public access to buckets and objects.

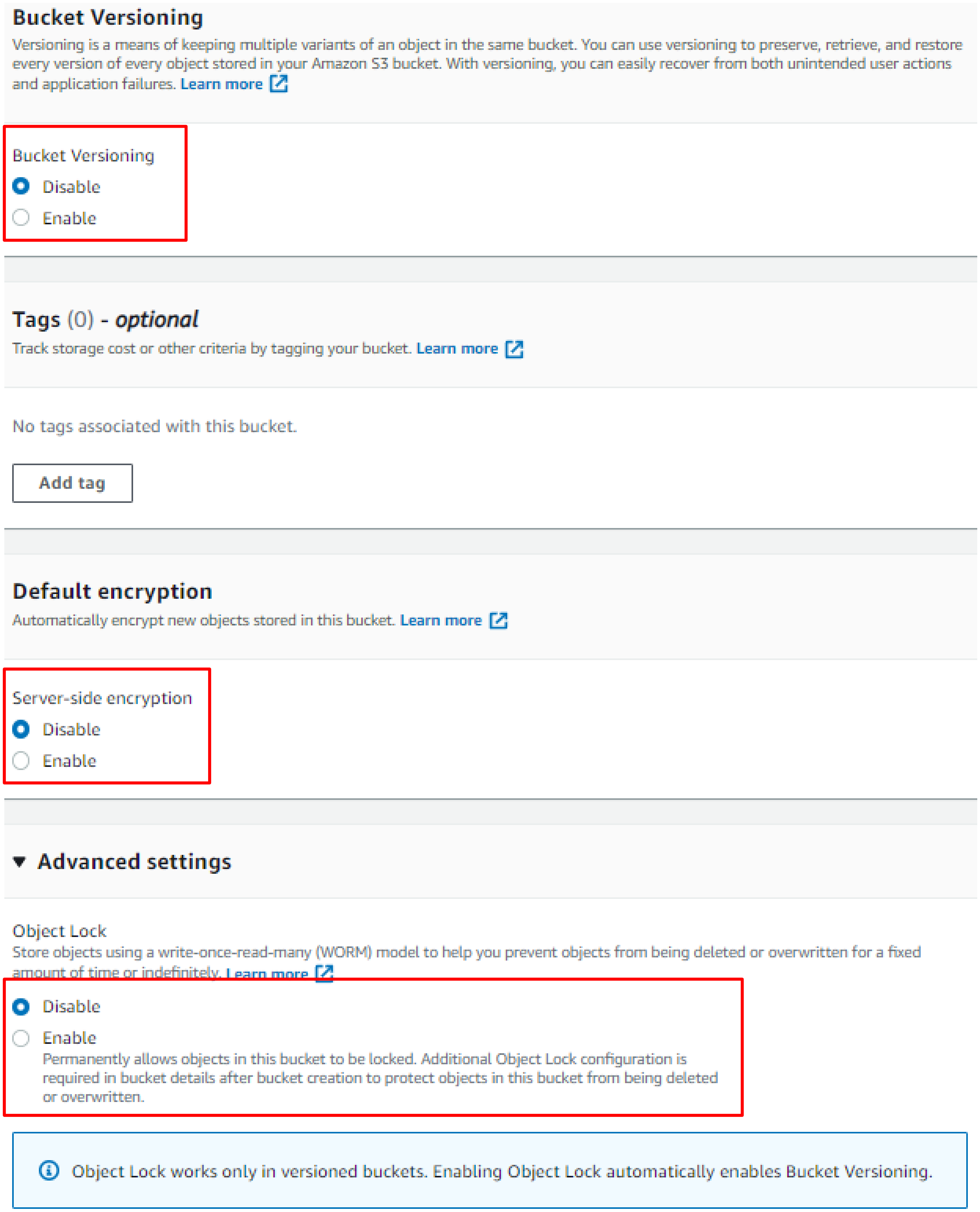
By default, **Block *all* public access** is enabled. This can be changed for specific case types. Block Public Access settings that you enable for the bucket are also enabled for all access points that you create on the bucket.

For this lab we will not use versioning nor encryption, so leave the default settings selected.

From **Object Lock**, select **Disable**.

If Object Lock is required, some permissions need to be addressed:

- s3:CreateBucket,
- s3:PutBucketVersioning, and
- s3:PutBucketObjectLockConfiguration.



Bucket Versioning

Versioning is a means of keeping multiple variants of an object in the same bucket. You can use versioning to preserve, retrieve, and restore every version of every object stored in your Amazon S3 bucket. With versioning, you can easily recover from both unintended user actions and application failures. Learn more

Bucket Versioning

● Disable

○ Enable

Tags (0) - ***optional***

Track storage cost or other criteria by tagging your bucket. Learn more

No tags associated with this bucket.

Default encryption

Automatically encrypt new objects stored in this bucket. Learn more

Server-side encryption

● Disable

○ Enable

▼ **Advanced settings**

Object Lock

Store objects using a write-once-read-many (WORM) model to help you prevent objects from being deleted or overwritten for a fixed amount of time or indefinitely. Learn more

● Disable

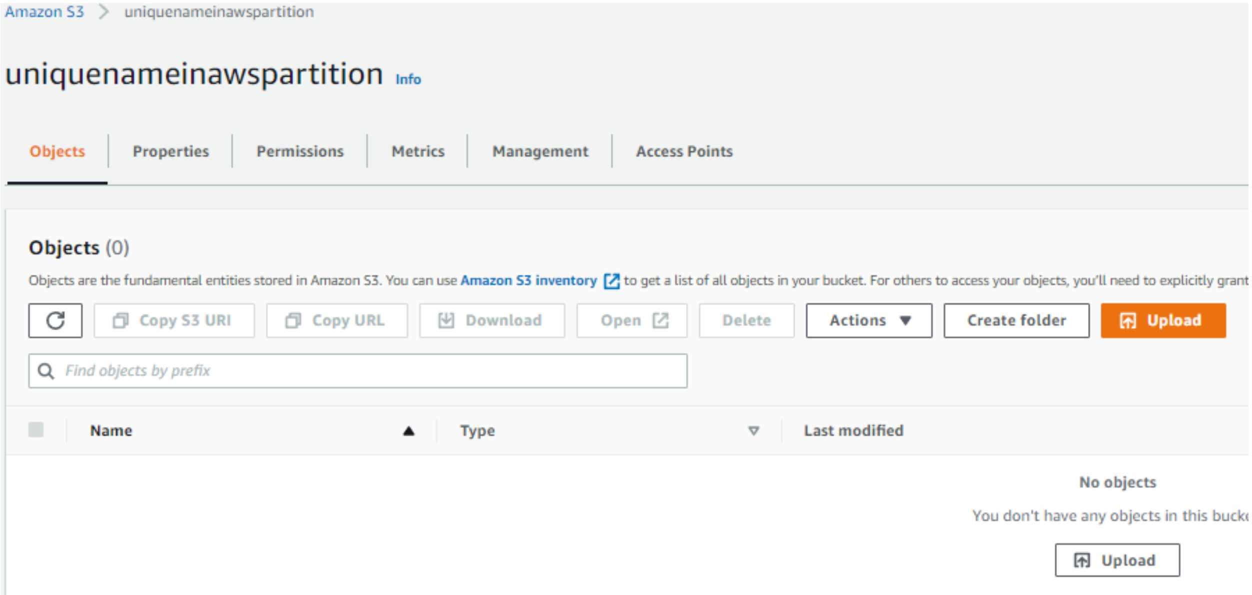
○ Enable

Permanently allows objects in this bucket to be locked. Additional Object Lock configuration is required in bucket details after bucket creation to protect objects in this bucket from being deleted or overwritten.

Object Lock works only in versioned buckets. Enabling Object Lock automatically enables Bucket Versioning.

Once all the options are selected, click **Create bucket**.

Once the bucket is created, click on it to show its details:



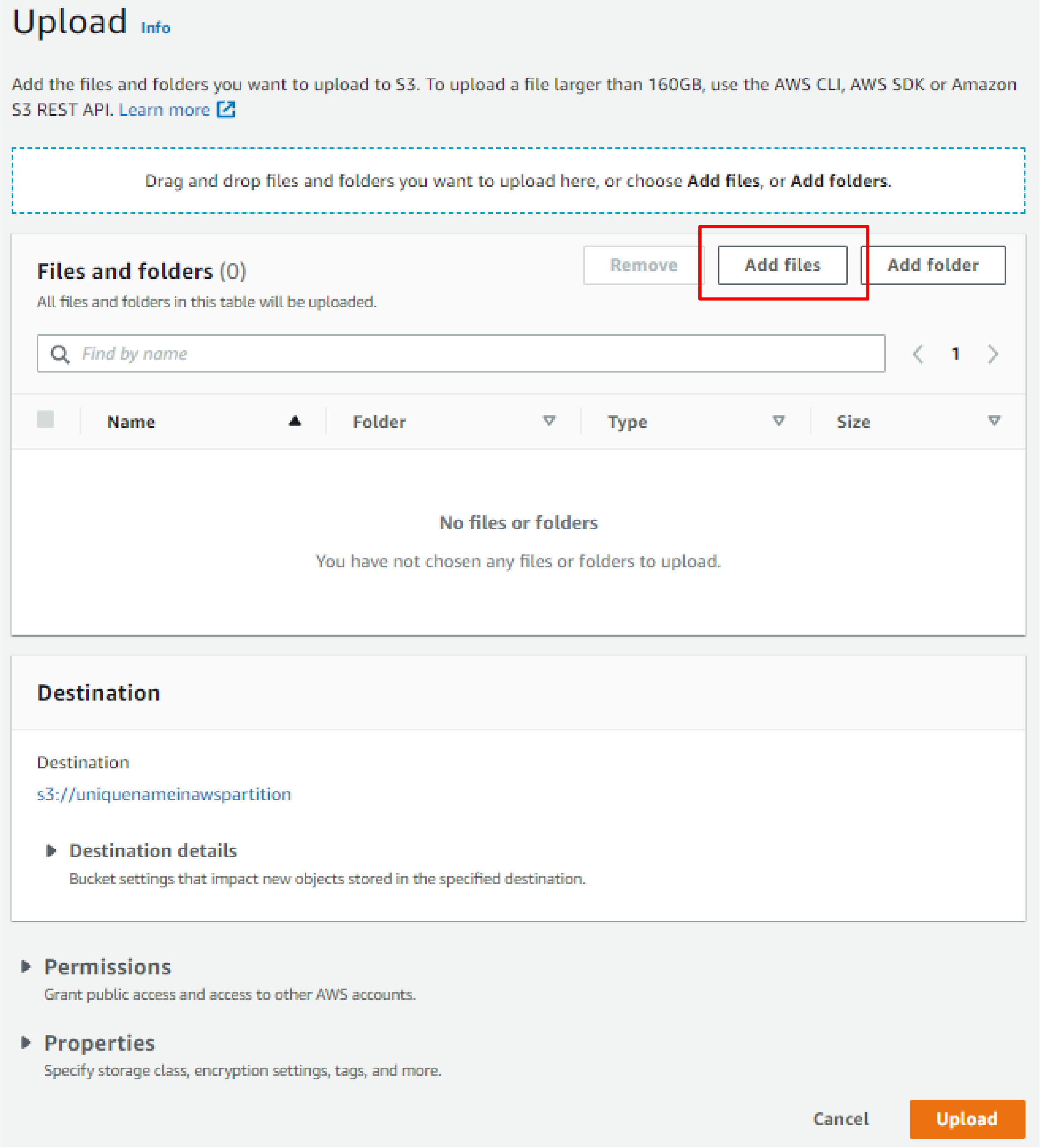
Objects (0)

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant

No objects

You don't have any objects in this buck

To upload a file, click on the **Upload** button. Then click **Add files** to locate the file or files to be uploaded:



Upload Info

Add the files and folders you want to upload to S3. To upload a file larger than 160GB, use the AWS CLI, AWS SDK or Amazon S3 REST API. Learn more

Drag and drop files and folders you want to upload here, or choose **Add files**, or **Add folders**.

Files and folders (0)

All files and folders in this table will be uploaded.

□	Name ▲	Folder ▽	Type ▽	Size ▽

No files or folders

You have not chosen any files or folders to upload.

Destination

Destination

s3://uniquenameinawspartition

Destination details

Bucket settings that impact new objects stored in the specified destination.

Permissions

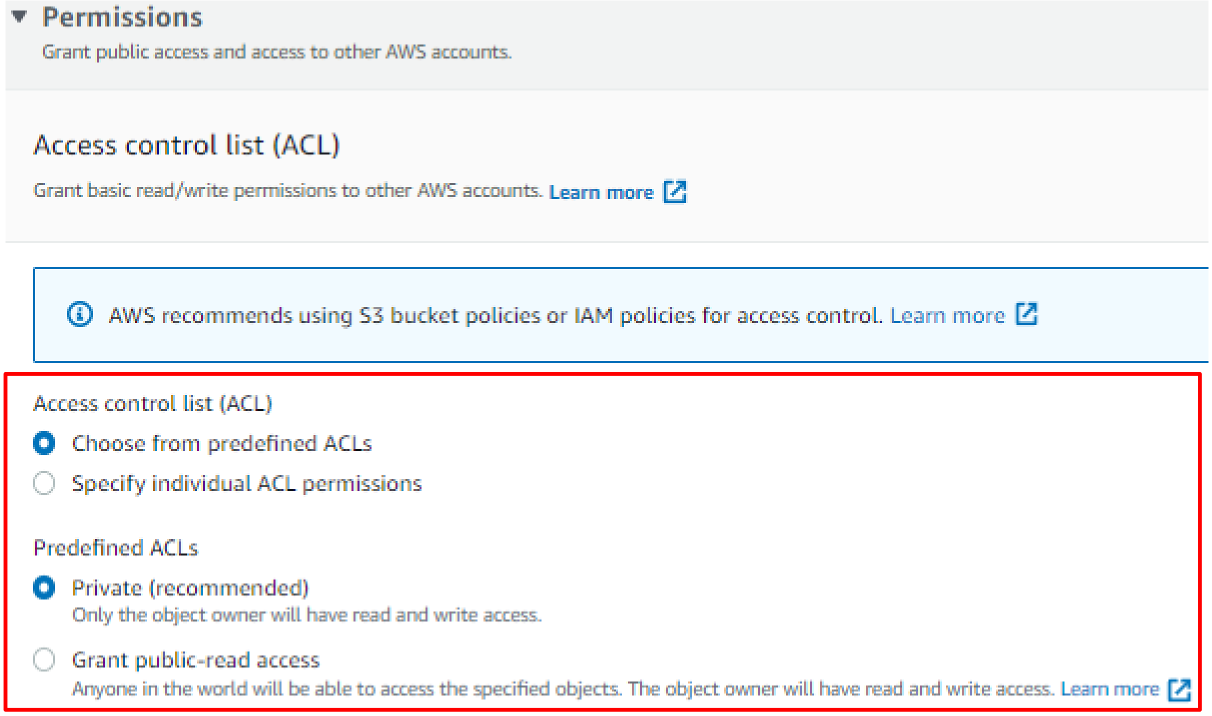
Grant public access and access to other AWS accounts.

Properties

Specify storage class, encryption settings, tags, and more.

Properties like *storage class*, *encryption*, *object permissions*, *tags*, and *metadata* can be configured on a file-by-file basis before they are uploaded to the S3 bucket.

Under Permissions, leave the default options selected:



▼ Permissions

Grant public access and access to other AWS accounts.

Access control list (ACL)

Grant basic read/write permissions to other AWS accounts. Learn more

AWS recommends using S3 bucket policies or IAM policies for access control. Learn more

Access control list (ACL)

● Choose from predefined ACLs

○ Specify individual ACL permissions

Predefined ACLs

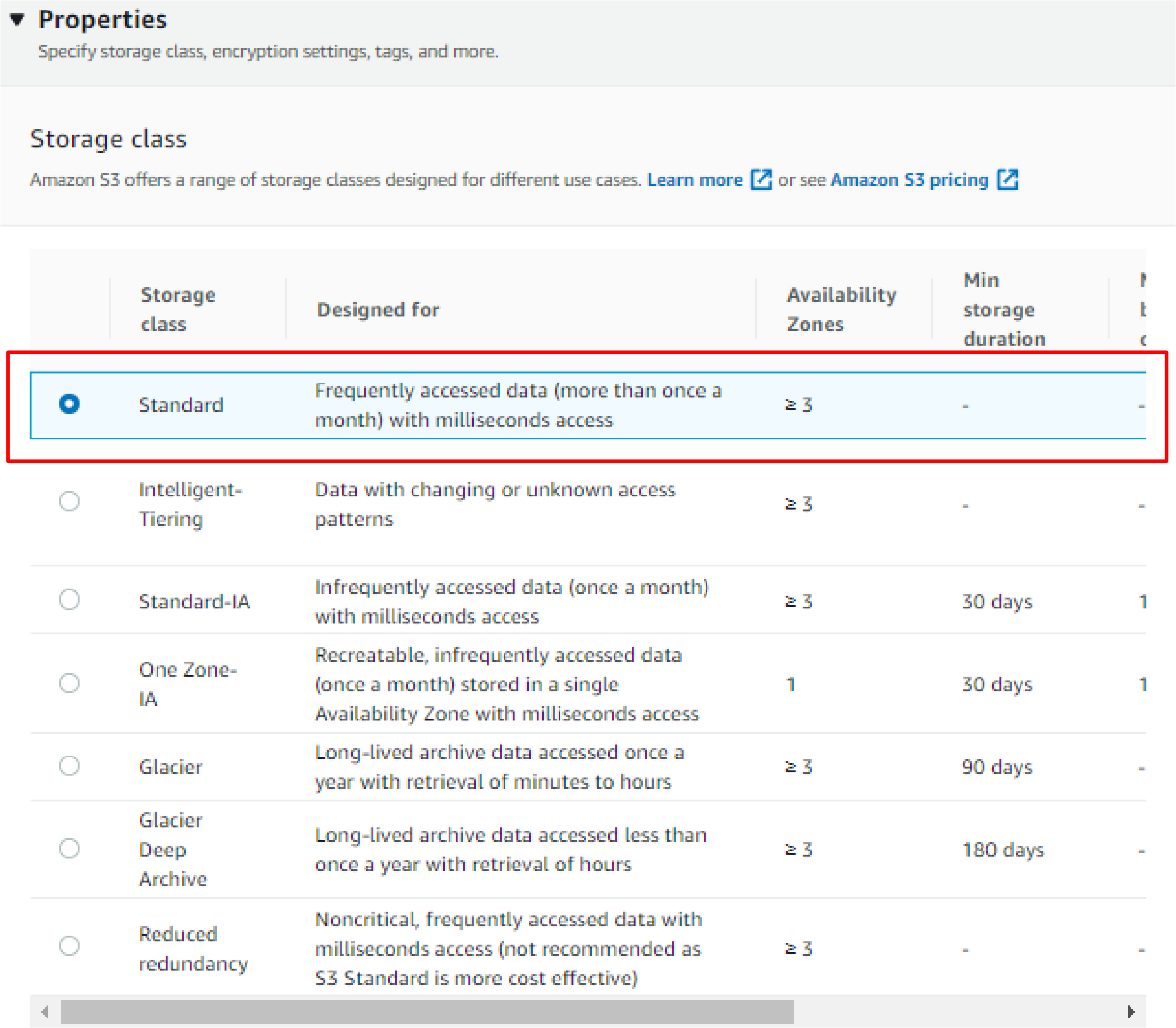
● Private (recommended)

Only the object owner will have read and write access.

○ Grant public-read access

Anyone in the world will be able to access the specified objects. The object owner will have read and write access. Learn more

Under **Properties**, selected the **Standard** Storage class:



▼ **Properties**

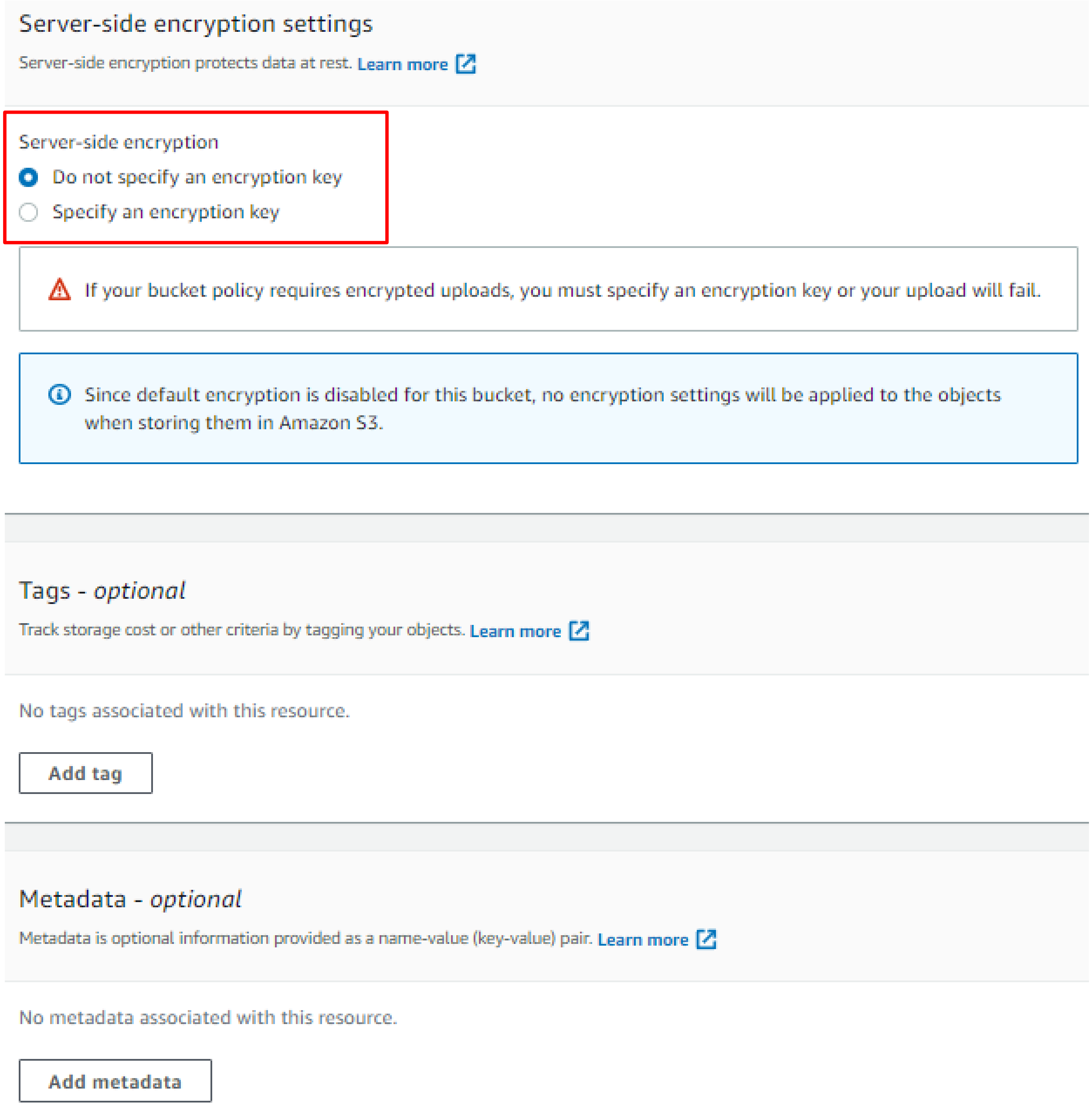
Specify storage class, encryption settings, tags, and more.

Storage class

Amazon S3 offers a range of storage classes designed for different use cases. **Learn more** or see **Amazon S3 pricing**

	Storage class	Designed for	Availability Zones	Min storage duration	M b c
●	Standard	Frequently accessed data (more than once a month) with milliseconds access	≥ 3	-	-
○	Intelligent-Tiering	Data with changing or unknown access patterns	≥ 3	-	-
○	Standard-IA	Infrequently accessed data (once a month) with milliseconds access	≥ 3	30 days	1
○	One Zone-IA	Recreatable, infrequently accessed data (once a month) stored in a single Availability Zone with milliseconds access	1	30 days	1
○	Glacier	Long-lived archive data accessed once a year with retrieval of minutes to hours	≥ 3	90 days	-
○	Glacier Deep Archive	Long-lived archive data accessed less than once a year with retrieval of hours	≥ 3	180 days	-
○	Reduced redundancy	Noncritical, frequently accessed data with milliseconds access (not recommended as S3 Standard is more cost effective)	≥ 3	-	-

Under **Server-side encryption settings**, select **Do not specify an encryption key**:



Server-side encryption settings

Server-side encryption protects data at rest. Learn more

Server-side encryption

● Do not specify an encryption key

○ Specify an encryption key

If your bucket policy requires encrypted uploads, you must specify an encryption key or your upload will fail.

Since default encryption is disabled for this bucket, no encryption settings will be applied to the objects when storing them in Amazon S3.

Tags - *optional*

Track storage cost or other criteria by tagging your objects. Learn more

No tags associated with this resource.

Metadata - *optional*

Metadata is optional information provided as a name-value (key-value) pair. Learn more

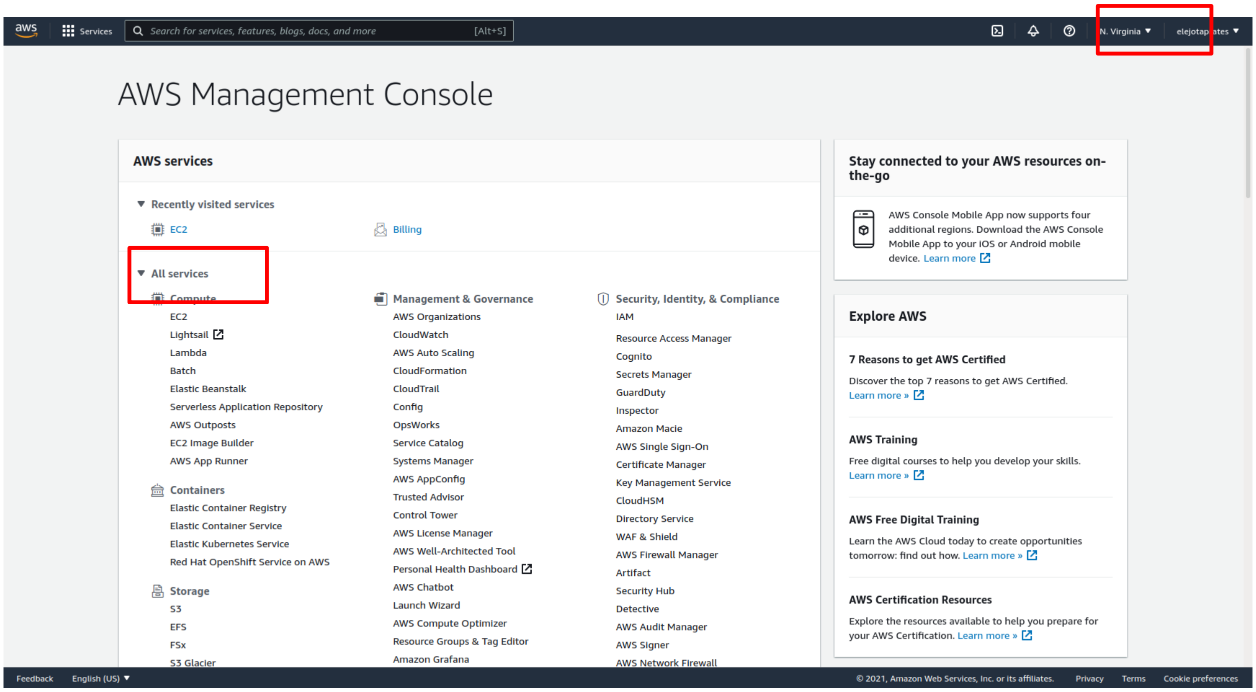
No metadata associated with this resource.

When all the configurations are done, click on the **Upload** button.

Lab: Create an Elastic Block Store (EBS) Volume

The objective of this lab is to create an empty Elastic Block Store (EBS) volume.

From the management console, select the Region (top right of the screen) where you want to create your resources. Then select EC2 under the Compute service group.



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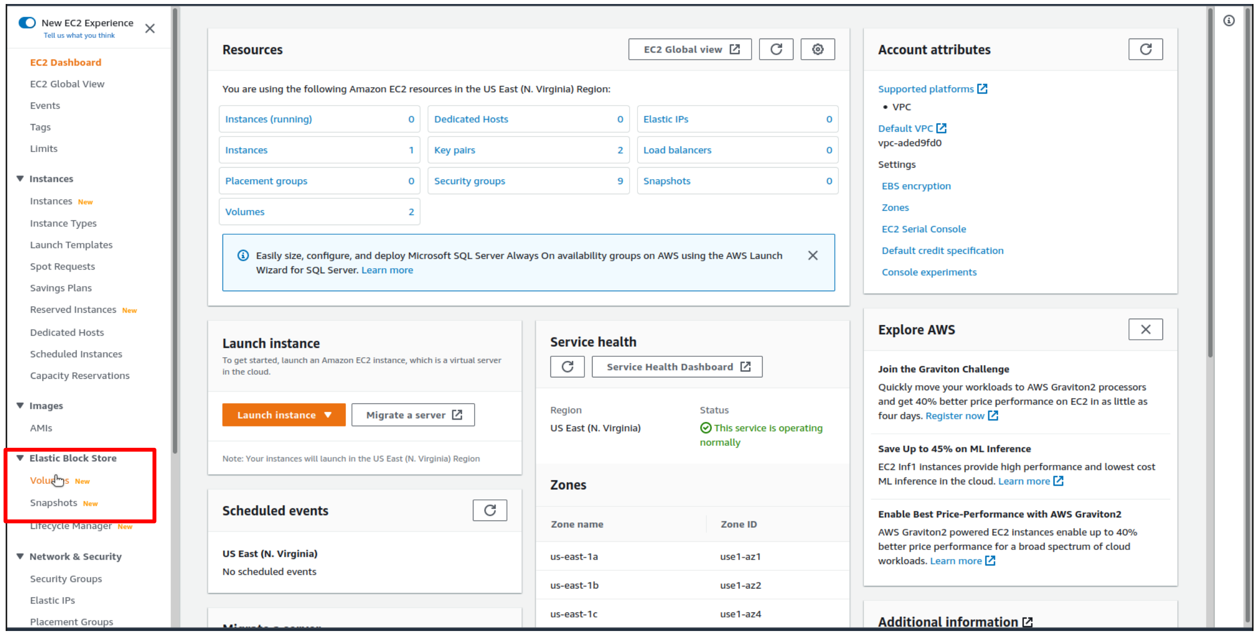
In the EC2 dashboard, select Volumes under Elastic Block Store:



New EC2 Experience
Tell us what you think

EC2 Dashboard
EC2 Global View
Events
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▼ Instances
Instances New
Instance Types
Launch Templates
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Reserved Instances New
Dedicated Hosts
Scheduled Instances
Capacity Reservations

▼ Images
AMIs

▼ Elastic Block Store
Volumes New
Snapshots New
Lifecycle Manager New

▼ Network & Security
Security Groups
Elastic IPs
Placement Groups

Resources

EC2 Global view

You are using the following Amazon EC2 resources in the US East (N. Virginia) Region:

Instances (running)	0	Dedicated Hosts	0	Elastic IPs	0
Instances	1	Key pairs	2	Load balancers	0
Placement groups	0	Security groups	9	Snapshots	0
Volumes	2				

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Account attributes

Supported platforms
- VPC

Default VPC
vpc-aded9fd0

Settings
EBS encryption
Zones
EC2 Serial Console
Default credit specification
Console experiments

Launch instance

To get started, launch an Amazon EC2 instance, which is a virtual server in the cloud.

Launch instance ▼ Migrate a server

Note: Your instances will launch in the US East (N. Virginia) Region

Service health

Service Health Dashboard

Region: US East (N. Virginia)
Status: This service is operating normally

Zones

Zone name	Zone ID
us-east-1a	use1-az1
us-east-1b	use1-az2
us-east-1c	use1-az4

Scheduled events

US East (N. Virginia)
No scheduled events

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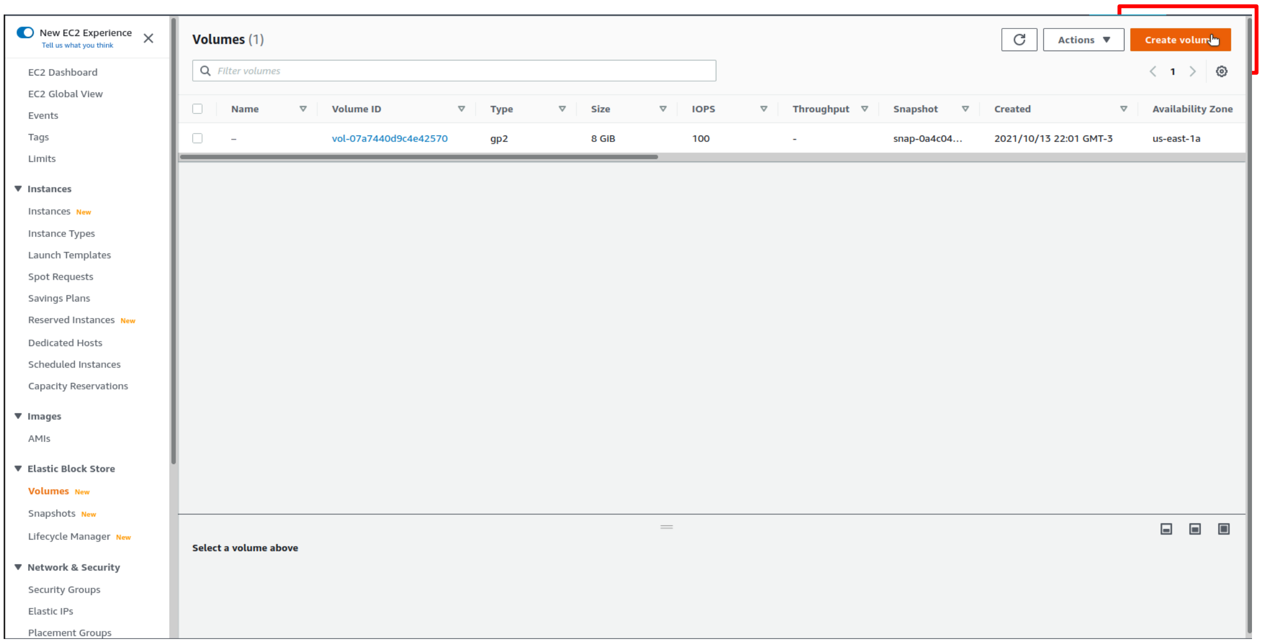
Additional information

Click on the Create volume button to start the creation process:



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Instances New
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Scheduled Instances
Capacity Reservations

▼ Images
AMIs

▼ Elastic Block Store
Volumes New
Snapshots New
Lifecycle Manager New

▼ Network & Security
Security Groups
Elastic IPs
Placement Groups

Volumes (1)

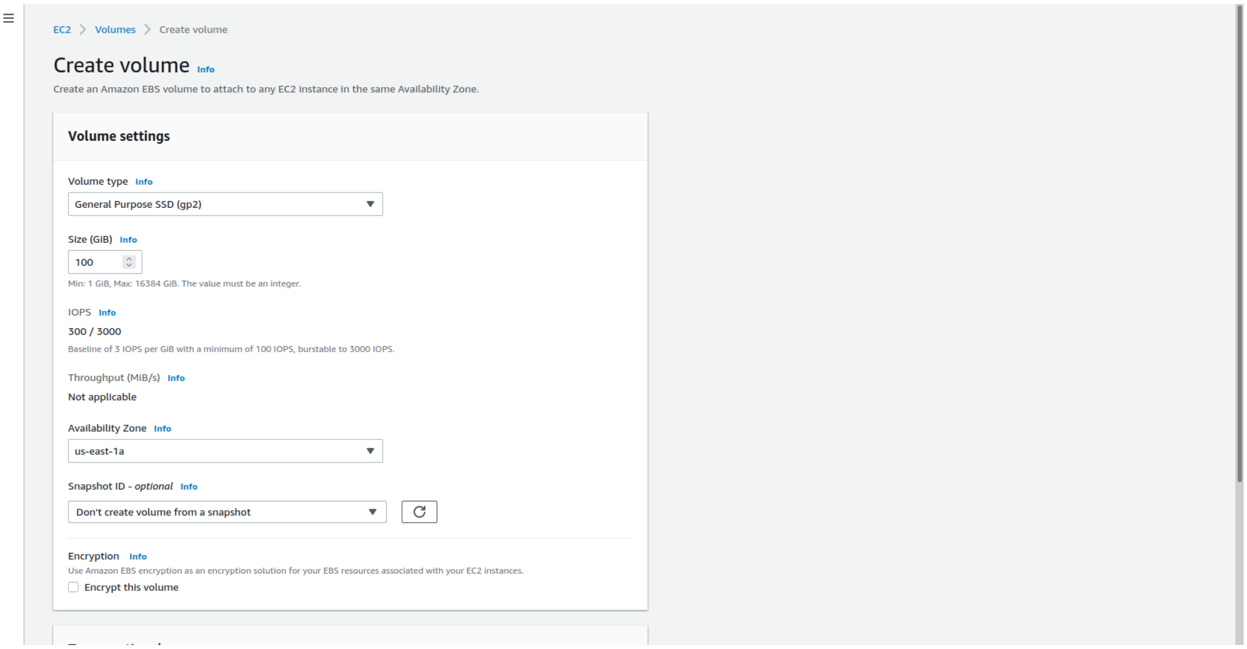
Actions ▼ Create volume

Filter volumes

□	Name	Volume ID	Type	Size	IOPS	Throughput	Snapshot	Created	Availability Zone
□	–	vol-07a7440d9c4e42570	gp2	8 GiB	100	-	snap-0a4c04…	2021/10/13 22:01 GMT-3	us-east-1a

Select a volume above

The new screen shows the options for the volume creation:



EC2 > Volumes > Create volume

Create volume Info

Create an Amazon EBS volume to attach to any EC2 instance in the same Availability Zone.

Volume settings

Volume type Info

General Purpose SSD (gp2)

Size (GiB) Info

100

Min: 1 GiB, Max: 16384 GiB. The value must be an integer.

IOPS Info

300 / 3000

Baseline of 3 IOPS per GiB with a minimum of 100 IOPS, burstable to 3000 IOPS.

Throughput (MiB/s) Info

Not applicable

Availability Zone Info

us-east-1a

Snapshot ID - *optional* Info

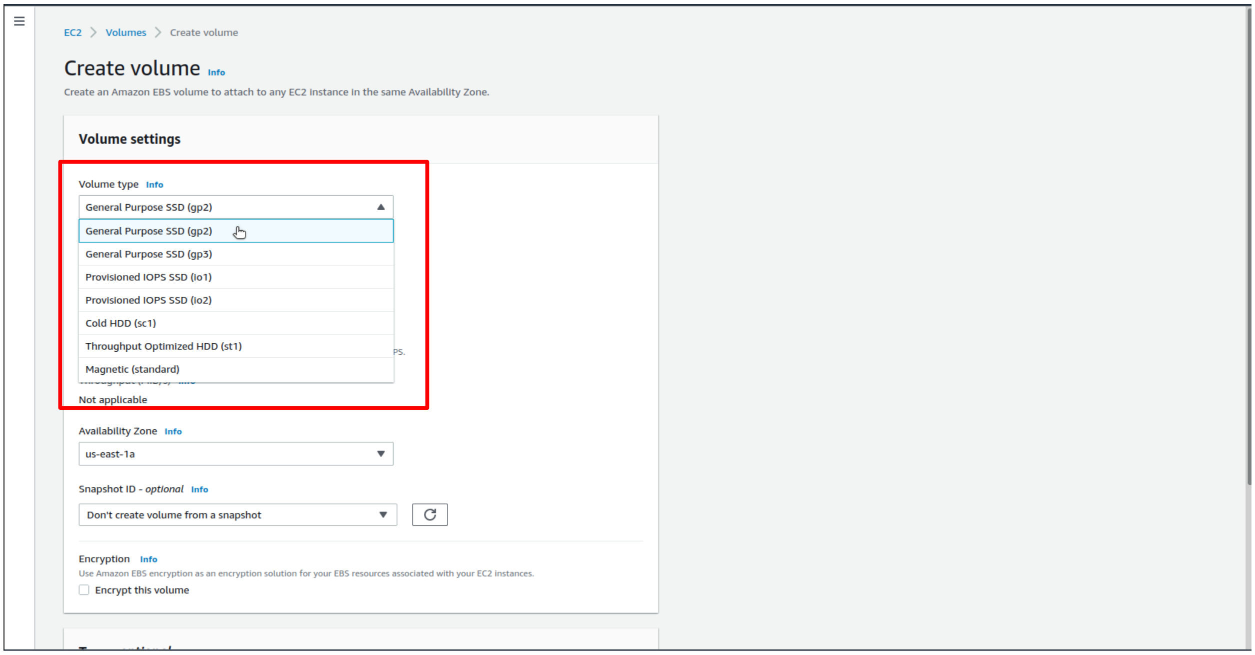
Don't create volume from a snapshot

Encryption Info

Use Amazon EBS encryption as an encryption solution for your EBS resources associated with your EC2 instances.

□ Encrypt this volume

For this lab, select a General Purpose SSD (gp2) volume type:



EC2 > Volumes > Create volume

Create volume Info

Create an Amazon EBS volume to attach to any EC2 instance in the same Availability Zone.

Volume settings

Volume type Info

General Purpose SSD (gp2)

General Purpose SSD (gp2)
General Purpose SSD (gp3)
Provisioned IOPS SSD (io1)
Provisioned IOPS SSD (io2)
Cold HDD (sc1)
Throughput Optimized HDD (st1)
Magnetic (standard)

Not applicable

Availability Zone Info

us-east-1a

Snapshot ID - *optional* Info

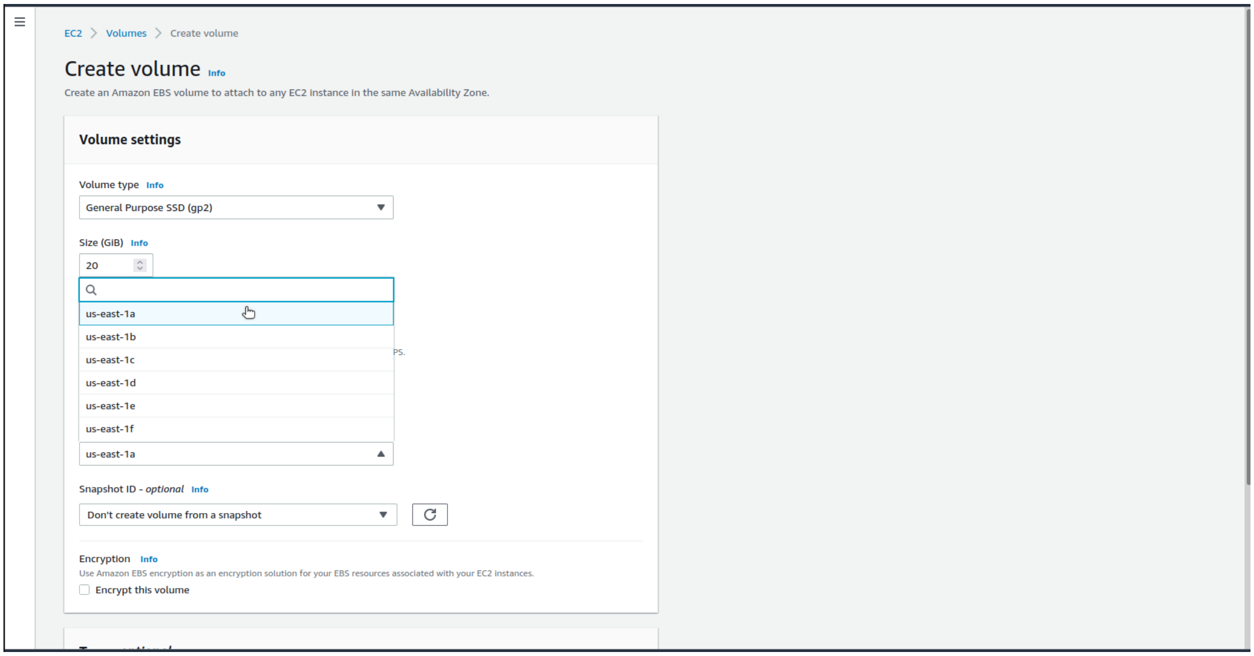
Don't create volume from a snapshot

Encryption Info

Use Amazon EBS encryption as an encryption solution for your EBS resources associated with your EC2 instances.

□ Encrypt this volume

Set the size of the volume to 20GB and select one Availability Zone from the selection box:



EC2 > Volumes > Create volume

Create volume Info

Create an Amazon EBS volume to attach to any EC2 instance in the same Availability Zone.

Volume settings

Volume type Info

General Purpose SSD (gp2)

Size (GiB) Info

20

- us-east-1a
- us-east-1b
- us-east-1c
- us-east-1d
- us-east-1e
- us-east-1f

us-east-1a

Snapshot ID - *optional* Info

Don't create volume from a snapshot

Encryption Info

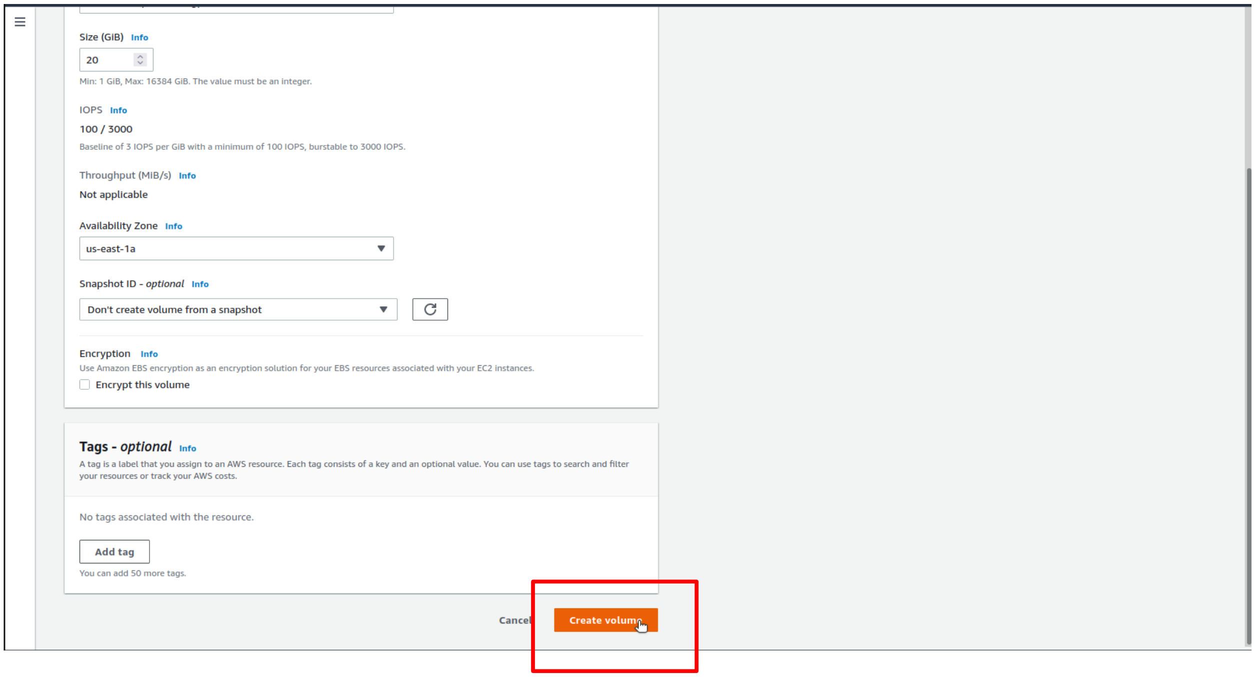
Use Amazon EBS encryption as an encryption solution for your EBS resources associated with your EC2 instances.

□ Encrypt this volume

It is important to note that volumes can only be attached to EC2 instances that belong to the same Availability Zone.

In this lab, we are creating an empty volume, so leave the option Snapshot ID as *Don't create volume from a snapshot*. Leave the Encryption option unchecked, since we will not deal with encryption in this lab.

When all the settings are done, click on the Create volume button:



Size (GiB) Info

20

Min: 1 GiB, Max: 16384 GiB. The value must be an integer.

IOPS Info

100 / 3000

Baseline of 3 IOPS per GiB with a minimum of 100 IOPS, burstable to 3000 IOPS.

Throughput (MiB/s) Info

Not applicable

Availability Zone Info

us-east-1a

Snapshot ID - *optional* Info

Don't create volume from a snapshot

Encryption Info

Use Amazon EBS encryption as an encryption solution for your EBS resources associated with your EC2 instances.

□ Encrypt this volume

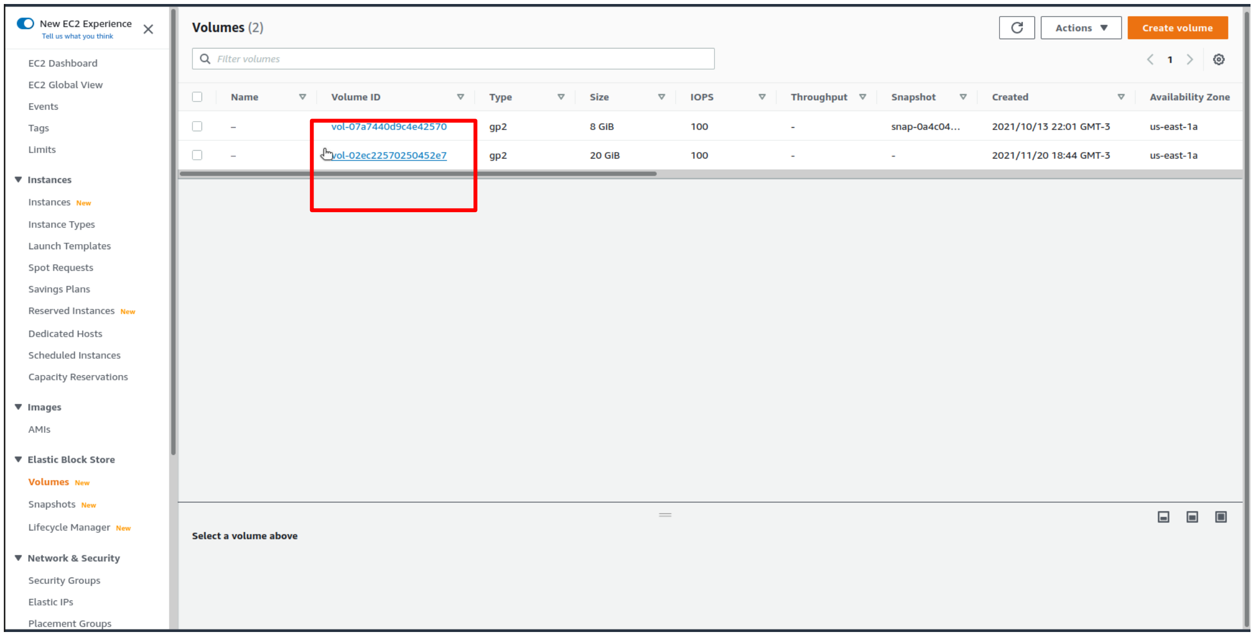
Tags - *optional* Info

A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter your resources or track your AWS costs.

No tags associated with the resource.

You can add 50 more tags.

The window will update and show the new volume. Click on the name of the volume to show its details:

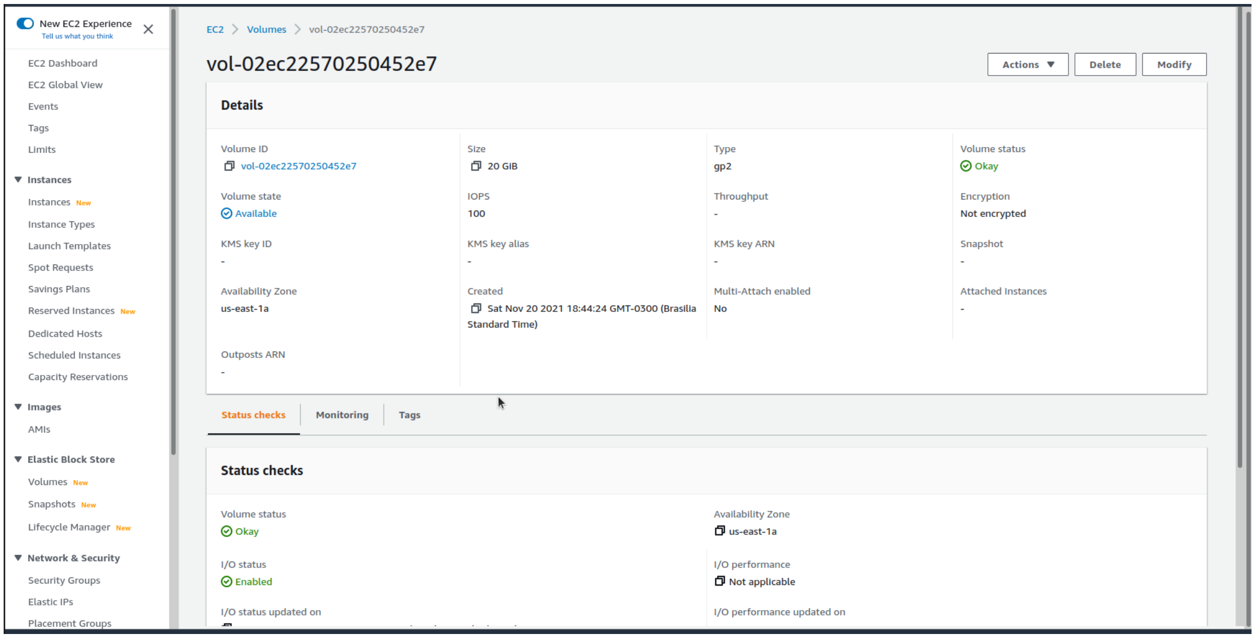


Volumes (2)

□	Name	Volume ID	Type	Size	IOPS	Throughput	Snapshot	Created	Availability Zone
□	–	vol-07a7440d9c4e42570	gp2	8 GiB	100	-	snap-0a4c04...	2021/10/13 22:01 GMT-3	us-east-1a
□	–	vol-02ec22570250452e7	gp2	20 GiB	100	-	-	2021/11/20 18:44 GMT-3	us-east-1a

Select a volume above

Volume details:



vol-02ec22570250452e7

Details

Volume ID: vol-02ec22570250452e7
Size: 20 GiB
Type: gp2
Volume status: Okay
Volume state: Available
IOPS: 100
Throughput: -
Encryption: Not encrypted
KMS key ID: -
KMS key alias: -
KMS key ARN: -
Snapshot: -
Availability Zone: us-east-1a
Created: Sat Nov 20 2021 18:44:24 GMT-0300 (Brasilia Standard Time)
Multi-Attach enabled: No
Attached Instances: -
Outposts ARN: -

Status checks

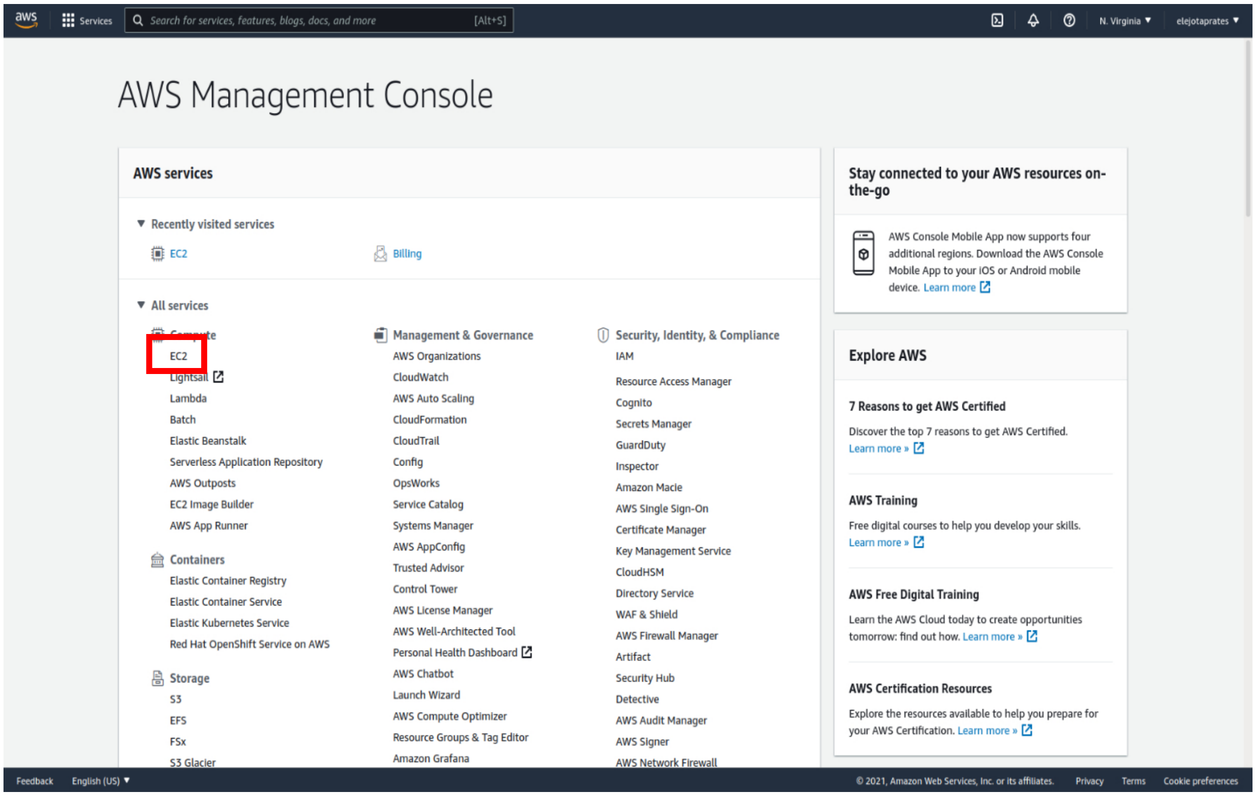
Volume status: Okay
Availability Zone: us-east-1a
I/O status: Enabled
I/O performance: Not applicable
I/O status updated on
I/O performance updated on

The empty EBS volume is ready.

Lab: Create an EC2 Instance and Mount an EBS Volume

The objective of this lab is to attach an Elastic Block Store (EBS) volume to an EC2 instance (virtual machine).

First create the instance. From the management console, select the **Region** (top right of the screen) where the resources were created. Select **EC2** under the **Compute** service group, from the **AWS Management Console**:



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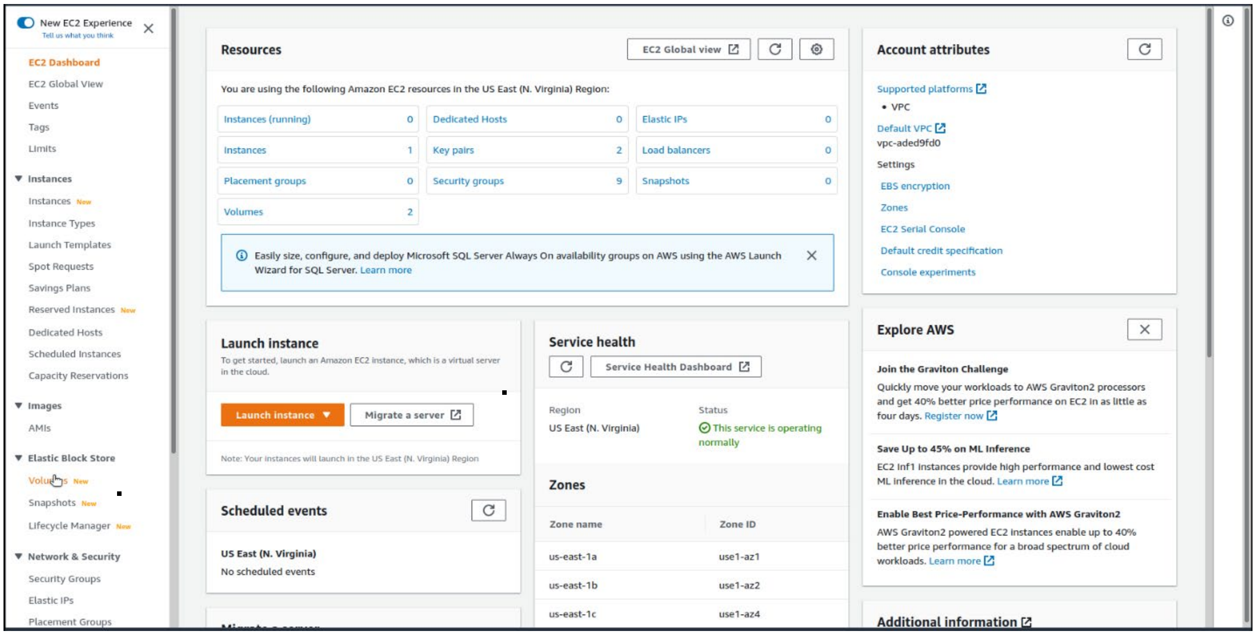
Using the left-side panel from the EC2 dashboard, select **Volumes** under **Elastic Block Store** to access the volumes dashboard:



Resources

You are using the following Amazon EC2 resources in the US East (N. Virginia) Region:

Instances (running)	0	Dedicated Hosts	0	Elastic IPs	0
Instances	1	Key pairs	2	Load balancers	0
Placement groups	0	Security groups	9	Snapshots	0
Volumes	2				

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Account attributes

Supported platforms
- VPC

Default VPC
vpc-aded9fd0

Settings
EBS encryption
Zones
EC2 Serial Console
Default credit specification
Console experiments

Launch instance

To get started, launch an Amazon EC2 instance, which is a virtual server in the cloud.

Note: Your instances will launch in the US East (N. Virginia) Region

Service health

Region: US East (N. Virginia)
Status: This service is operating normally

Zones

Zone name	Zone ID
us-east-1a	use1-az1
us-east-1b	use1-az2
us-east-1c	use1-az4

Scheduled events

US East (N. Virginia)
No scheduled events

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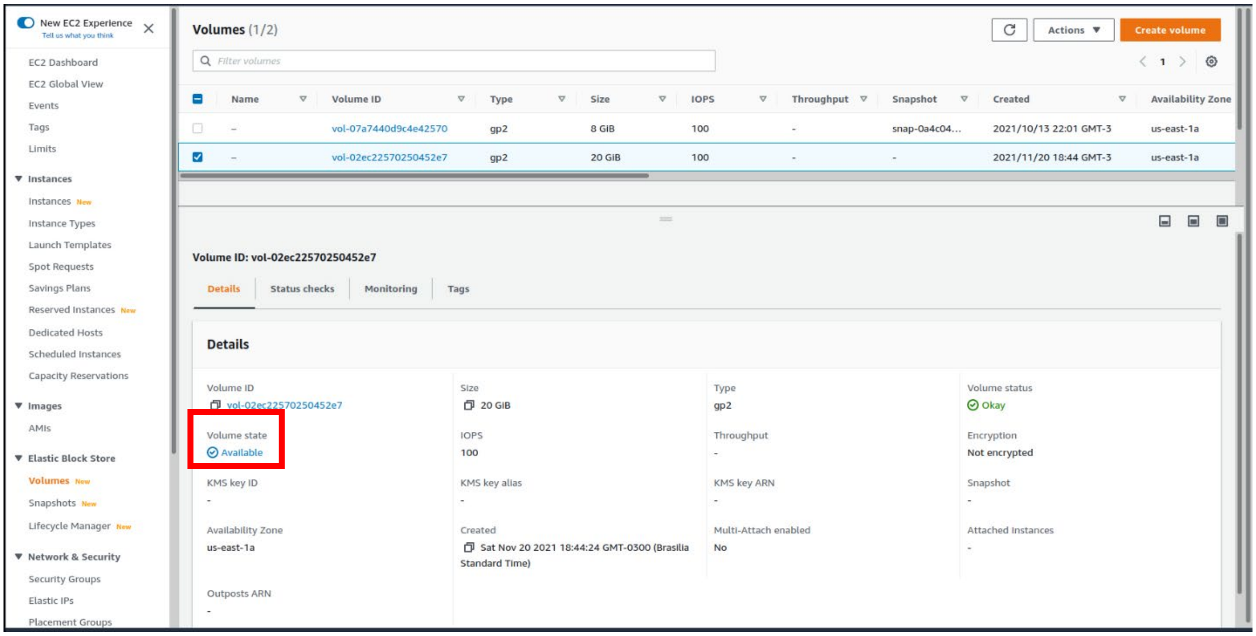
Additional information

Check the selection box of the volume to show its details. Notice that the **Volume state** shows **Available**:



Volumes (1/2)

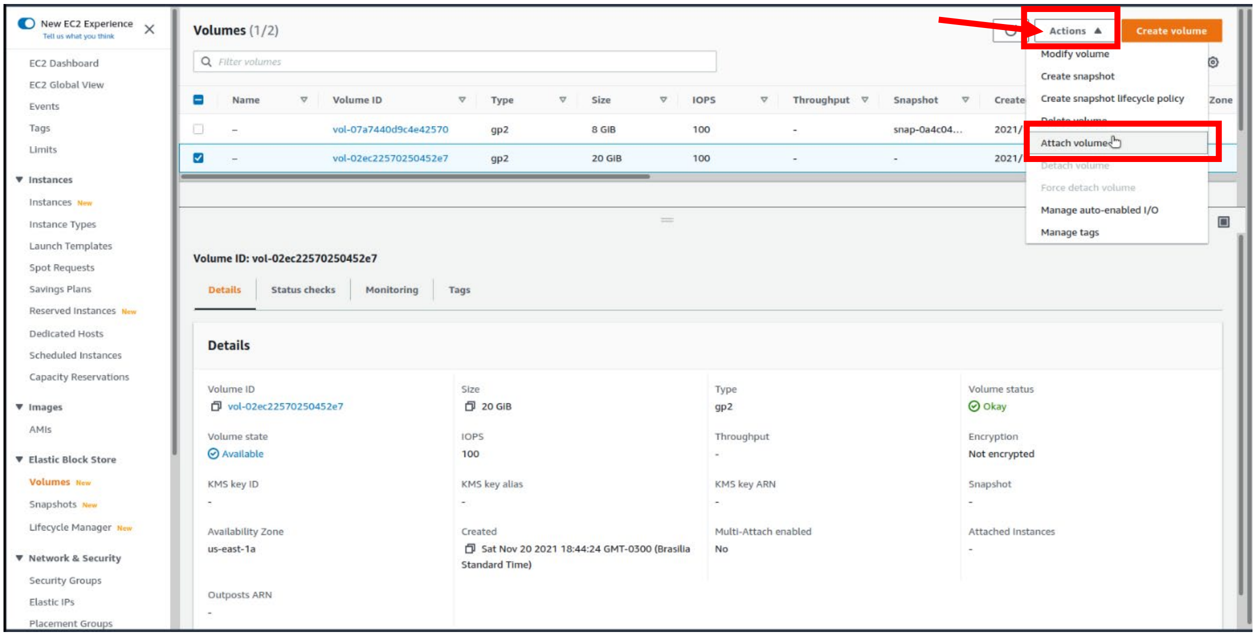
	Name	Volume ID	Type	Size	IOPS	Throughput	Snapshot	Created	Availability Zone
□	–	vol-07a7440d9c4e42570	gp2	8 GiB	100	-	snap-0a4c04...	2021/10/13 22:01 GMT-3	us-east-1a
☑	–	vol-02ec22570250452e7	gp2	20 GiB	100	-	-	2021/11/20 18:44 GMT-3	us-east-1a

Volume ID: vol-02ec22570250452e7

Details

Volume ID vol-02ec22570250452e7	Size 20 GiB	Type gp2	Volume status Okay
Volume state Available	IOPS 100	Throughput -	Encryption Not encrypted
KMS key ID -	KMS key alias -	KMS key ARN -	Snapshot -
Availability Zone us-east-1a	Created Sat Nov 20 2021 18:44:24 GMT-0300 (Brasilia Standard Time)	Multi-Attach enabled No	Attached Instances -
Outposts ARN -			

Click on the **Actions** button and select **Attach volume**:



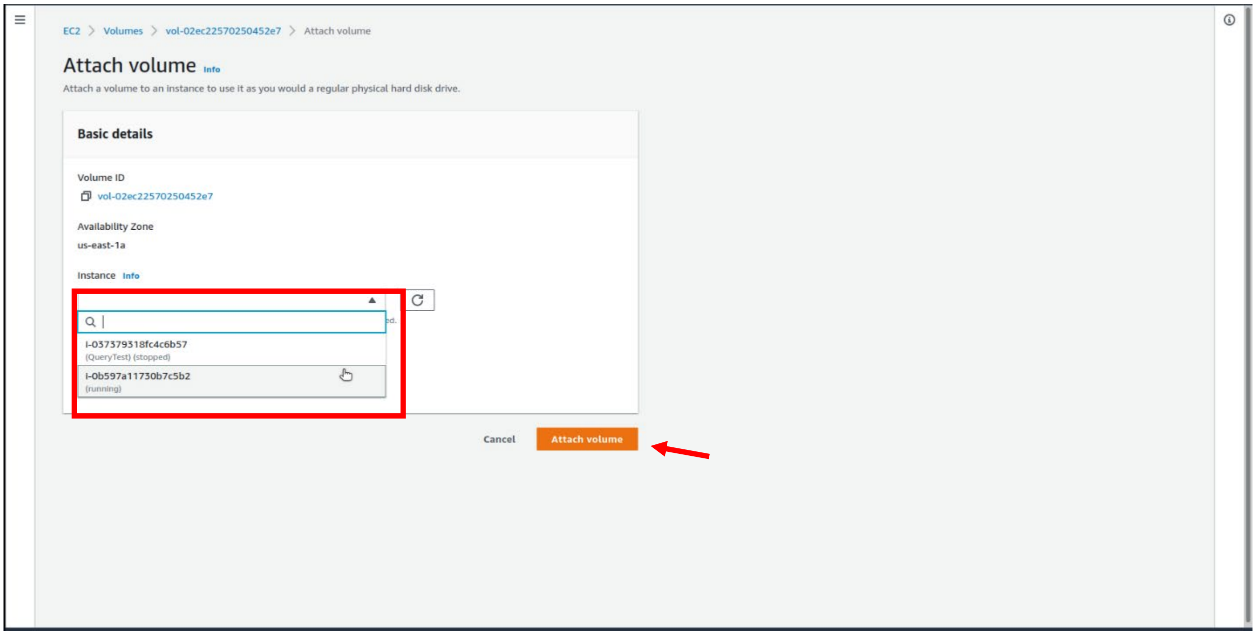
	Name	Volume ID	Type	Size	IOPS	Throughput	Snapshot	Create	Zone
□	–	vol-07a7440d9c4e42570	gp2	8 GiB	100	-	snap-0a4c04...	2021/	
☑	–	vol-02ec22570250452e7	gp2	20 GiB	100	-	-	2021/	

Volume ID: vol-02ec22570250452e7

Details

Volume ID: vol-02ec22570250452e7
Size: 20 GiB
Type: gp2
Volume status: Okay
Volume state: Available
IOPS: 100
Throughput: -
Encryption: Not encrypted
KMS key ID: -
KMS key alias: -
KMS key ARN: -
Snapshot: -
Availability Zone: us-east-1a
Created: Sat Nov 20 2021 18:44:24 GMT-0300 (Brasilia Standard Time)
Multi-Attach enabled: No
Attached instances: -
Outposts ARN: -

Using the selection box, select the EC2 instance where the volume should be attached. Click on the **Attach volume** button:



Attach volume

Attach a volume to an instance to use it as you would a regular physical hard disk drive.

Basic details

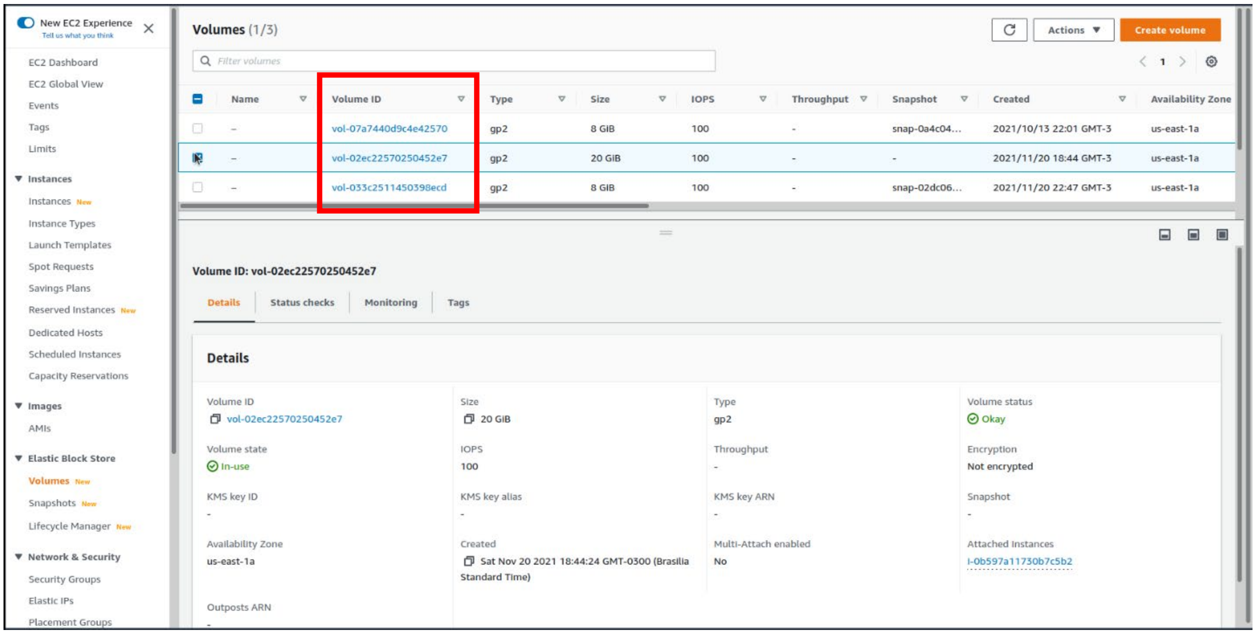
Volume ID: vol-02ec22570250452e7

Availability Zone: us-east-1a

Instance:

- i-037379318fc4c6b57 (QueryTest) (stopped)
- i-0b597a11730b7c5b2 (running)

The updated window shows the volumes. Select the volume to show its details. Notice that the **Volume state** changed to **In-use**:



Volumes (1/3)

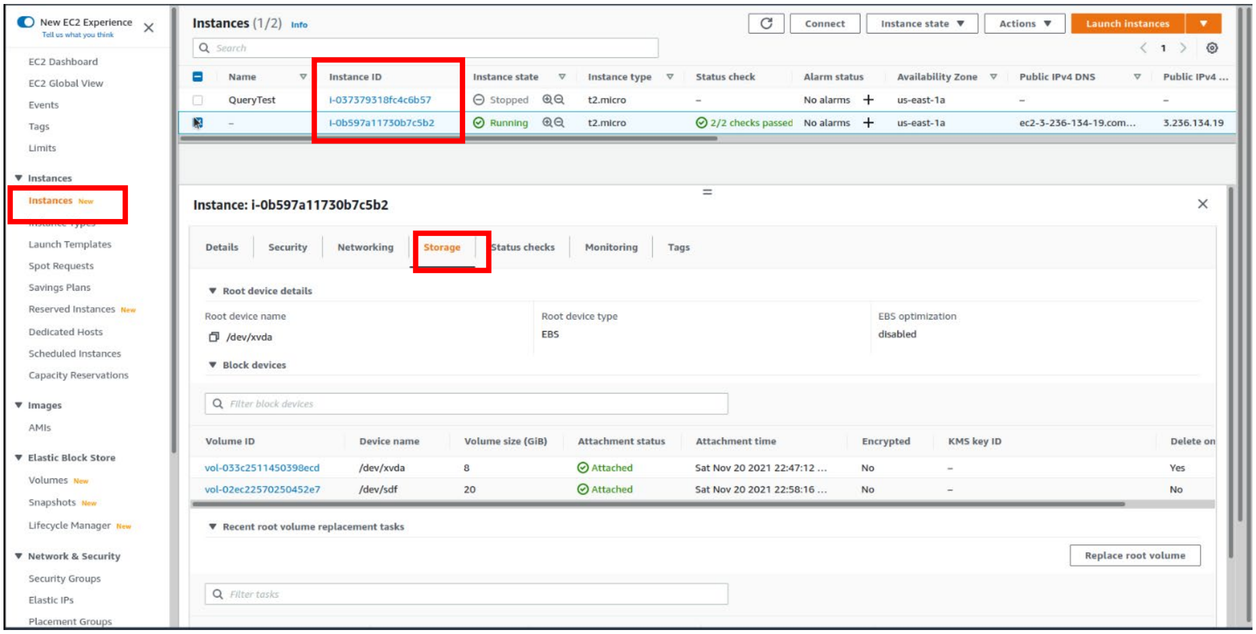
	Name	Volume ID	Type	Size	IOPS	Throughput	Snapshot	Created	Availability Zone
□	–	vol-07a7440d9c4e42570	gp2	8 GiB	100	-	snap-0a4c04...	2021/10/13 22:01 GMT-3	us-east-1a
☑	–	vol-02ec22570250452e7	gp2	20 GiB	100	-	-	2021/11/20 18:44 GMT-3	us-east-1a
□	–	vol-033c2511450398ecd	gp2	8 GiB	100	-	snap-02dc06...	2021/11/20 22:47 GMT-3	us-east-1a

Volume ID: vol-02ec22570250452e7

Details

Volume ID vol-02ec22570250452e7	Size 20 GiB	Type gp2	Volume status Okay
Volume state In-use	IOPS 100	Throughput -	Encryption Not encrypted
KMS key ID -	KMS key alias -	KMS key ARN -	Snapshot -
Availability Zone us-east-1a	Created Sat Nov 20 2021 18:44:24 GMT-0300 (Brasilia Standard Time)	Multi-Attach enabled No	Attached Instances i-0b597a11730b7c5b2
Outposts ARN -			

Using the left-side panel, select **Instances** under **Instances.** Check the selection box of the instance, then select the **Storage** tab:



Instances (1/2)

	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IPv4 ...
□	QueryTest	i-037379318fc4c6b57	Stopped	t2.micro	–	No alarms +	us-east-1a	–	–
☑	–	i-0b597a11730b7c5b2	Running	t2.micro	2/2 checks passed	No alarms +	us-east-1a	ec2-3-236-134-19.com...	3.236.134.19

Instance: i-0b597a11730b7c5b2

▼ Root device details

Root device name /dev/xvda	Root device type EBS	EBS optimization disabled

▼ Block devices

Volume ID	Device name	Volume size (GiB)	Attachment status	Attachment time	Encrypted	KMS key ID	Delete on
vol-033c2511450398ecd	/dev/xvda	8	Attached	Sat Nov 20 2021 22:47:12 ...	No	–	Yes
vol-02ec22570250452e7	/dev/sdf	20	Attached	Sat Nov 20 2021 22:58:16 ...	No	–	No

▼ Recent root volume replacement tasks

The EC2 instance has two EBS volumes attached to it.

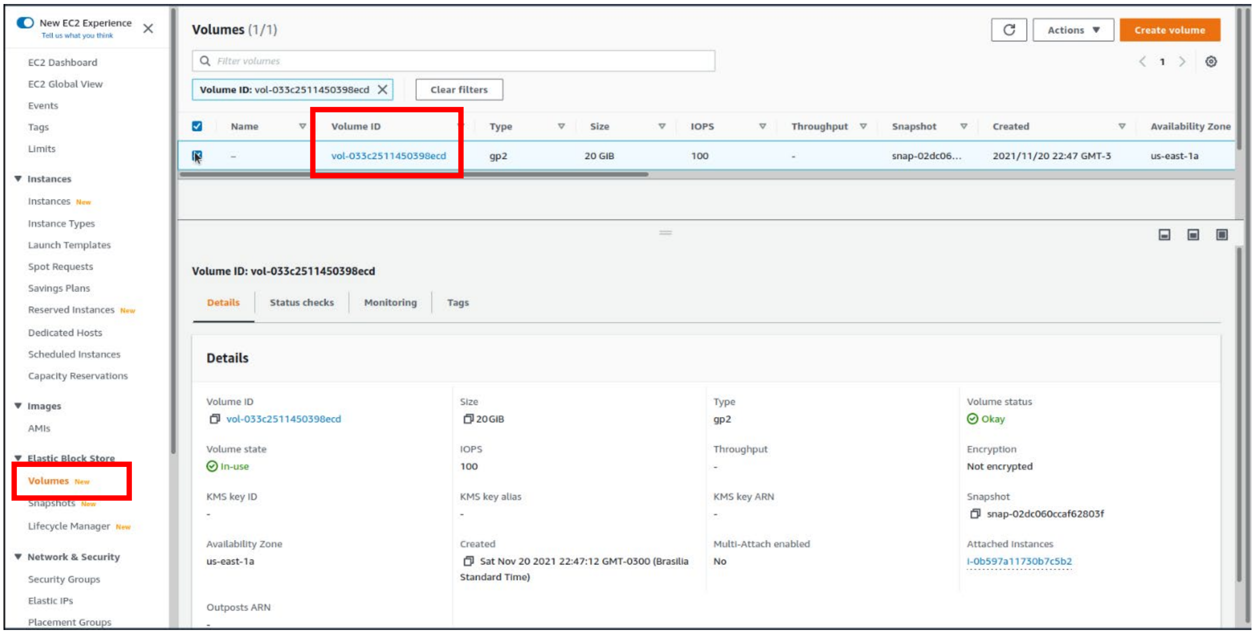
The newly attached volume can be formatted and mounted to the EC2 instance, but this is not in the scope of this lab.

Removing a volume from an EC2 instance

The root volume of an EC2 instance is where the operating system is installed. Detaching the root volume should be done only under special circumstances. Otherwise it will make the instance unusable.

Detaching an additional volume that was previously attached to the instance can be done while the instance is running, but the mount point of the volume could be lost. If the volume is not needed in that instance anymore, it is a safe procedure.

Using the left-side panel, open the **Volumes** dashboard. Select the volume you want to detach from the instance:



Volumes (1/1)

Volume ID: vol-033c2511450398ecd

☑	Name	Volume ID	Type	Size	IOPS	Throughput	Snapshot	Created	Availability Zone
☑	–	vol-033c2511450398ecd	gp2	20 GIB	100	-	snap-02dc06...	2021/11/20 22:47 GMT-3	us-east-1a

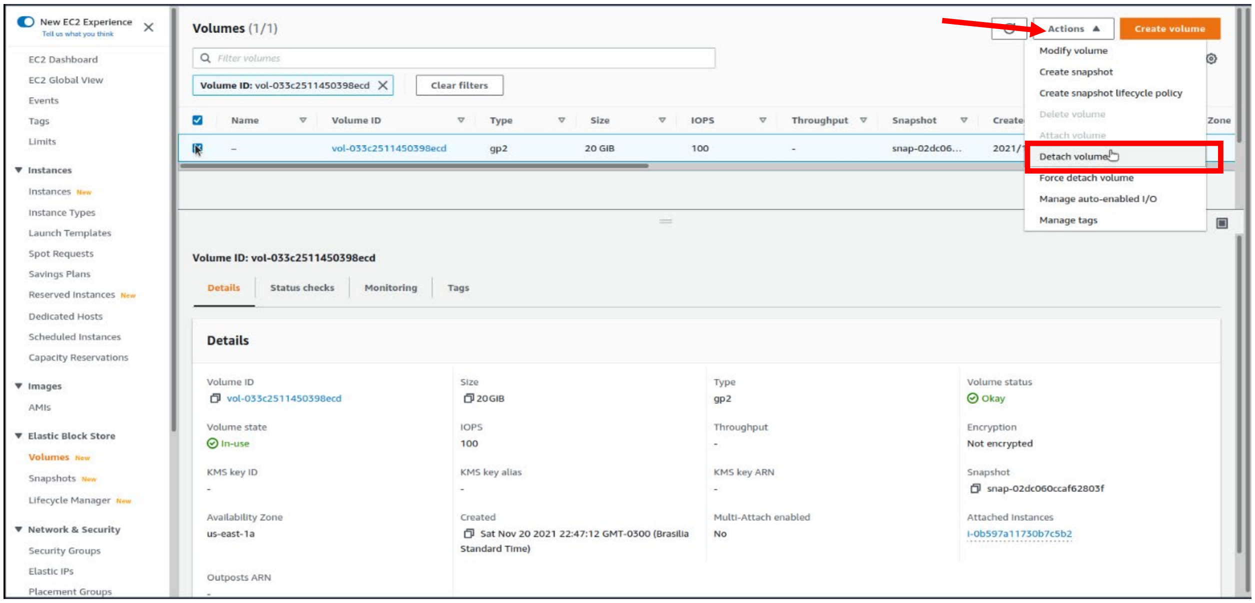
Volume ID: vol-033c2511450398ecd

Details | Status checks | Monitoring | Tags

Details

Volume ID: vol-033c2511450398ecd
Size: 20GIB
Type: gp2
Volume status: Okay
Volume state: In-use
IOPS: 100
Throughput: -
Encryption: Not encrypted
KMS key ID: -
KMS key alias: -
KMS key ARN: -
Snapshot: snap-02dc060ccaf62803f
Availability Zone: us-east-1a
Created: Sat Nov 20 2021 22:47:12 GMT-0300 (Brasilia Standard Time)
Multi-Attach enabled: No
Attached Instances: i-0b597a11730b7c5b2
Outposts ARN: -

Click on the **Actions** button and select **Detach volume**:



Volume ID: vol-033c2511450398ecd

Name	Volume ID	Type	Size	IOPS	Throughput	Snapshot	Create	Zone
–	vol-033c2511450398ecd	gp2	20 GIB	100	-	snap-02dc06...	2021/	

Volume ID: vol-033c2511450398ecd

Details

Volume ID
vol-033c2511450398ecd

Size
20GIB

Type
gp2

Volume status
Okay

Volume state
In-use

IOPS
100

Throughput
-

Encryption
Not encrypted

KMS key ID
-

KMS key alias
-

KMS key ARN
-

Snapshot
snap-02dc060ccaf62803f

Availability Zone
us-east-1a

Created
Sat Nov 20 2021 22:47:12 GMT-0300 (Brasilia Standard Time)

Multi-Attach enabled
No

Attached Instances
i-0b597a11730b7c5b2

Outposts ARN
-

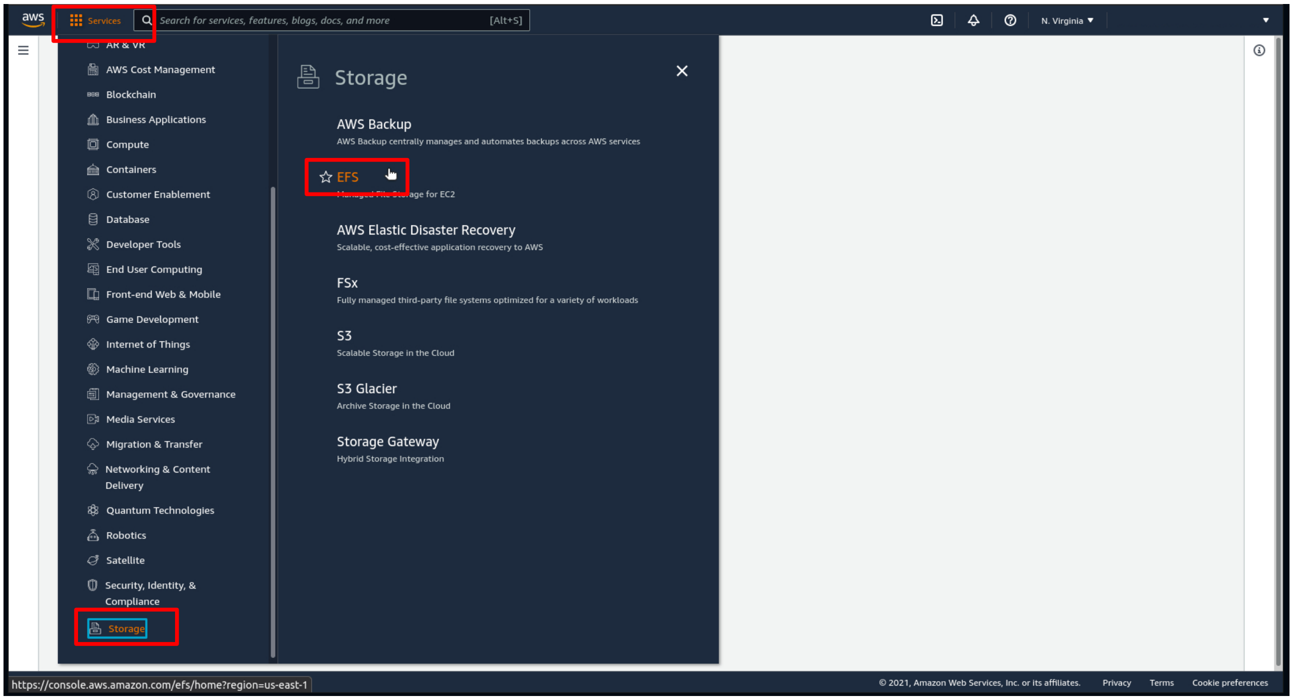
Confirm the detachment.

The EC2 instance has only the Root volume now.

Lab: Create an Elastic File System (EFS)

The objective of this lab is to create an EFS File System that can be accessed by Linux and Unix systems.

From the management console, select the **Region** (top right of the screen) where the file system should be created. Click on the Services button on the top left of the screen to show all services groups. Select **Storage** from the list; then select **EFS**:


aws
Services
Search for services, features, blogs, docs, and more
[Alt+S]
N. Virginia
AR & VR
AWS Cost Management
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Machine Learning
Management & Governance
Media Services
Migration & Transfer
Networking & Content Delivery
Quantum Technologies
Robotics
Satellite
Security, Identity, & Compliance
Storage
Storage
AWS Backup
AWS Backup centrally manages and automates backups across AWS services
EFS
Managed File Storage for EC2
AWS Elastic Disaster Recovery
Scalable, cost-effective application recovery to AWS
FSx
Fully managed third-party file systems optimized for a variety of workloads
S3
Scalable Storage in the Cloud
S3 Glacier
Archive Storage in the Cloud
Storage Gateway
Hybrid Storage Integration
https://console.aws.amazon.com/efs/home?region=us-east-1
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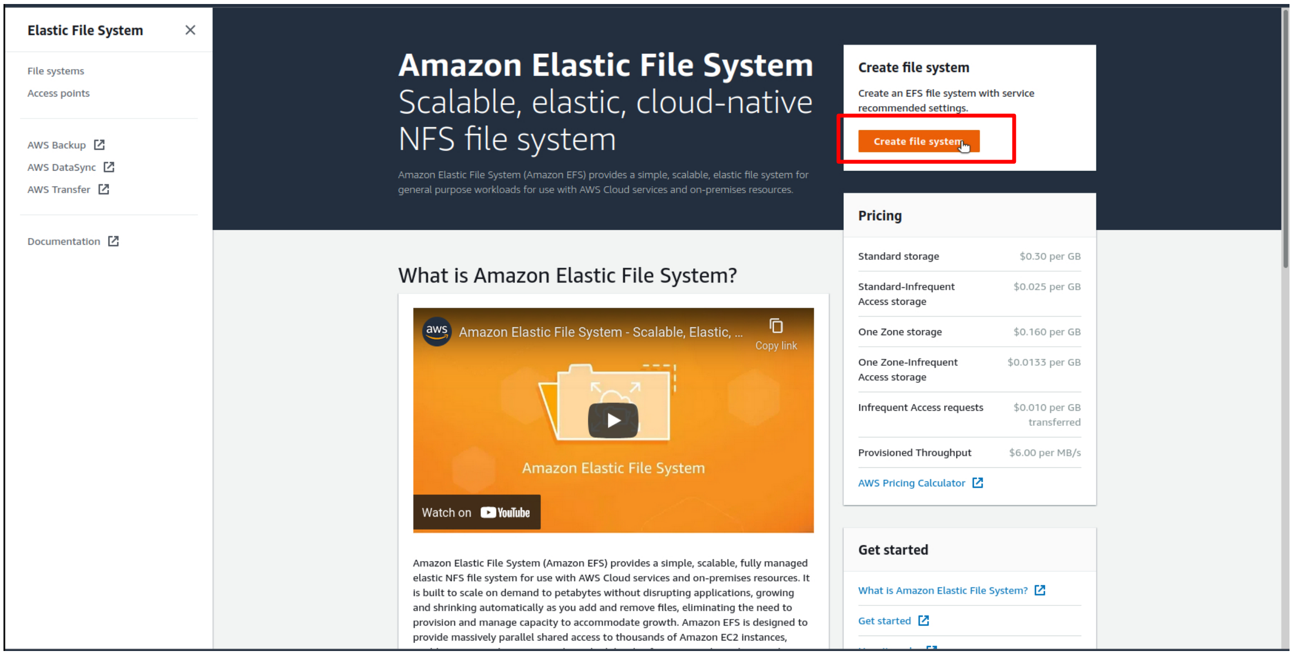
Click on the **Create file system** button:



Amazon Elastic File System
Scalable, elastic, cloud-native NFS file system

Amazon Elastic File System (Amazon EFS) provides a simple, scalable, elastic file system for general purpose workloads for use with AWS Cloud services and on-premises resources.

Create file system

Create an EFS file system with service recommended settings.

Pricing

Standard storage	$0.30 per GB
Standard-Infrequent Access storage	$0.025 per GB
One Zone storage	$0.160 per GB
One Zone-Infrequent Access storage	$0.0133 per GB
Infrequent Access requests	$0.010 per GB transferred
Provisioned Throughput	$6.00 per MB/s

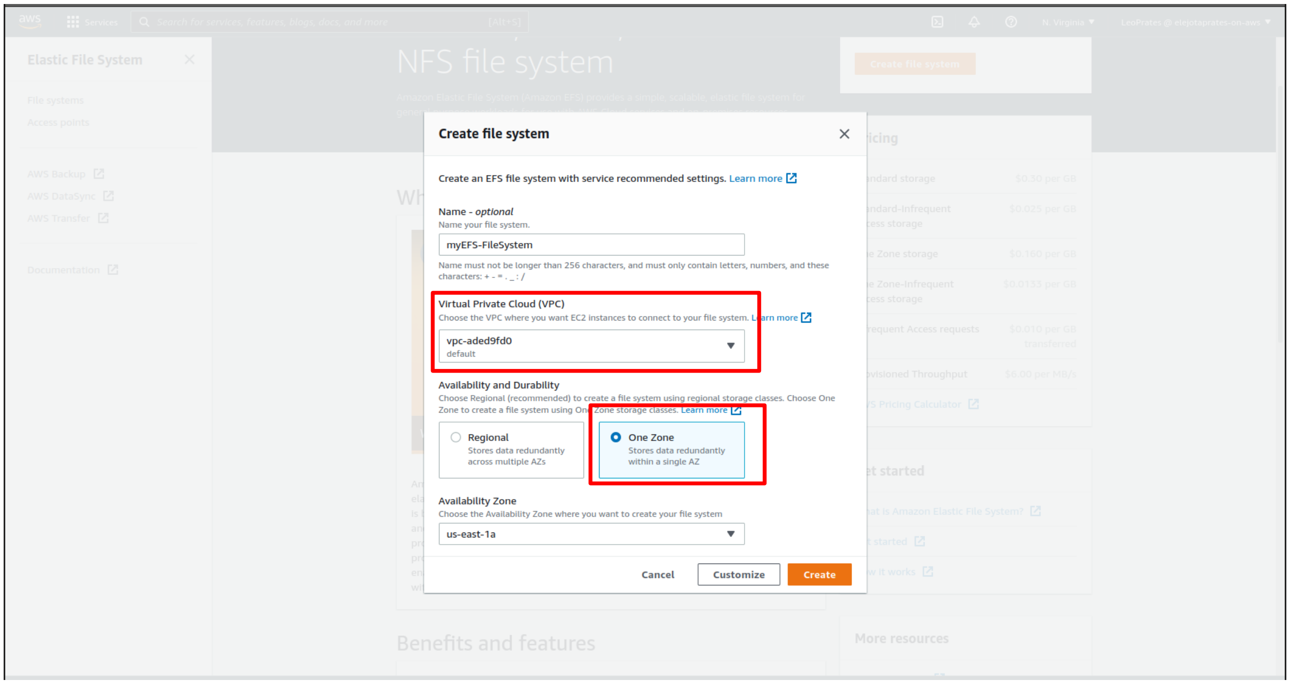
What is Amazon Elastic File System?

Amazon Elastic File System - Scalable, Elastic, ...
Copy link
Amazon Elastic File System
Watch on YouTube

Amazon Elastic File System (Amazon EFS) provides a simple, scalable, fully managed elastic NFS file system for use with AWS Cloud services and on-premises resources. It is built to scale on demand to petabytes without disrupting applications, growing and shrinking automatically as you add and remove files, eliminating the need to provision and manage capacity to accommodate growth. Amazon EFS is designed to provide massively parallel shared access to thousands of Amazon EC2 instances,

Get started

Enter a name for the file system, select the VPC, and choose the redundancy. For this lab we will choose One Zone:



Create file system

Create an EFS file system with service recommended settings. Learn more

Name - *optional*
Name your file system.
myEFS-FileSystem
Name must not be longer than 256 characters, and must only contain letters, numbers, and these characters: + - = . _ : /

Virtual Private Cloud (VPC)
Choose the VPC where you want EC2 instances to connect to your file system. Learn more
vpc-aded9fd0
default

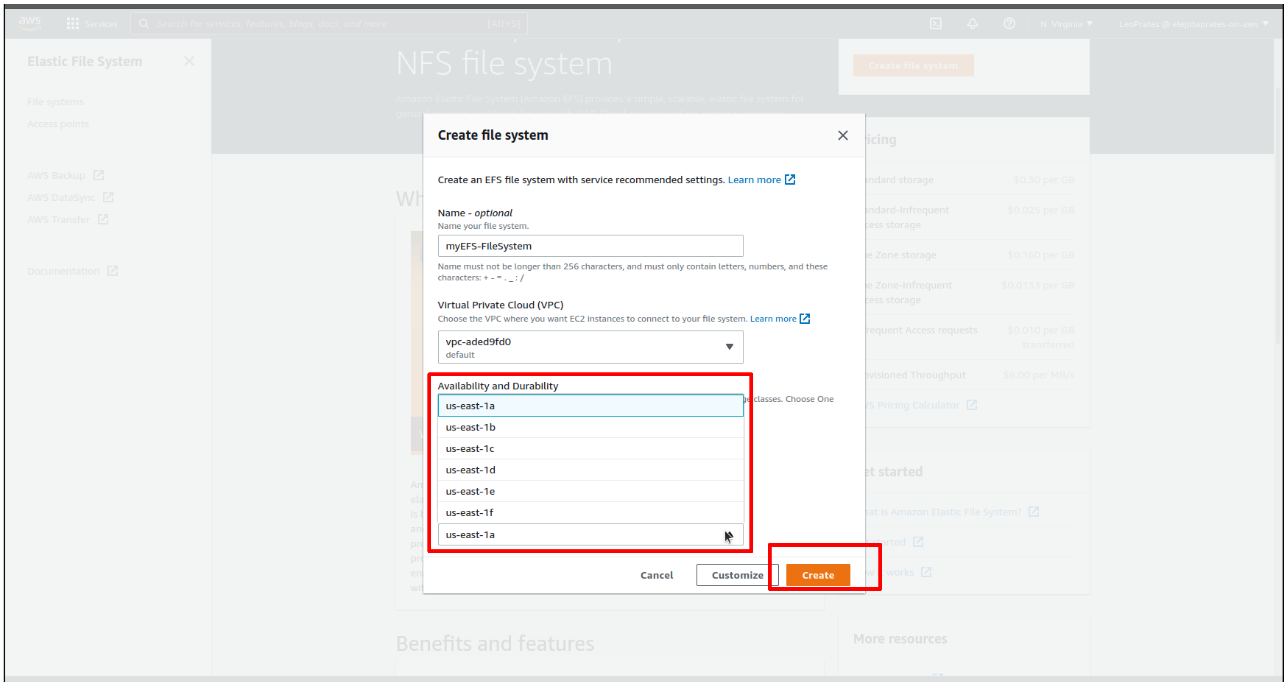
Availability and Durability
Choose Regional (recommended) to create a file system using regional storage classes. Choose One Zone to create a file system using One Zone storage classes. Learn more

○ Regional
Stores data redundantly across multiple AZs

● One Zone
Stores data redundantly within a single AZ

Availability Zone
Choose the Availability Zone where you want to create your file system
us-east-1a

Select the Availability Zone, and click on the **Create** button:



NFS file system

Create file system

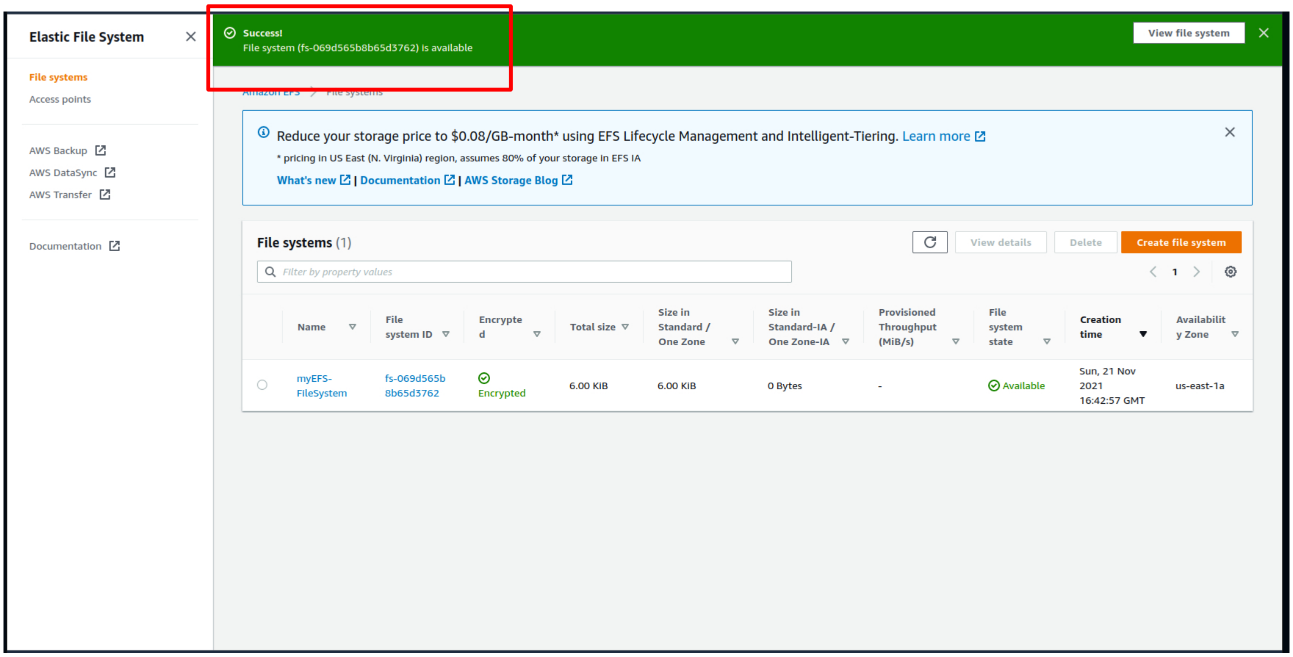
Create an EFS file system with service recommended settings. Learn more

Name - *optional*
Name your file system.
myEFS-FileSystem
Name must not be longer than 256 characters, and must only contain letters, numbers, and these characters: + - = . _ : /

Virtual Private Cloud (VPC)
Choose the VPC where you want EC2 instances to connect to your file system. Learn more
vpc-aded9fd0
default

Availability and Durability
us-east-1a
us-east-1b
us-east-1c
us-east-1d
us-east-1e
us-east-1f
us-east-1a

It could take some time. Then the window will update and show the status of the file system:



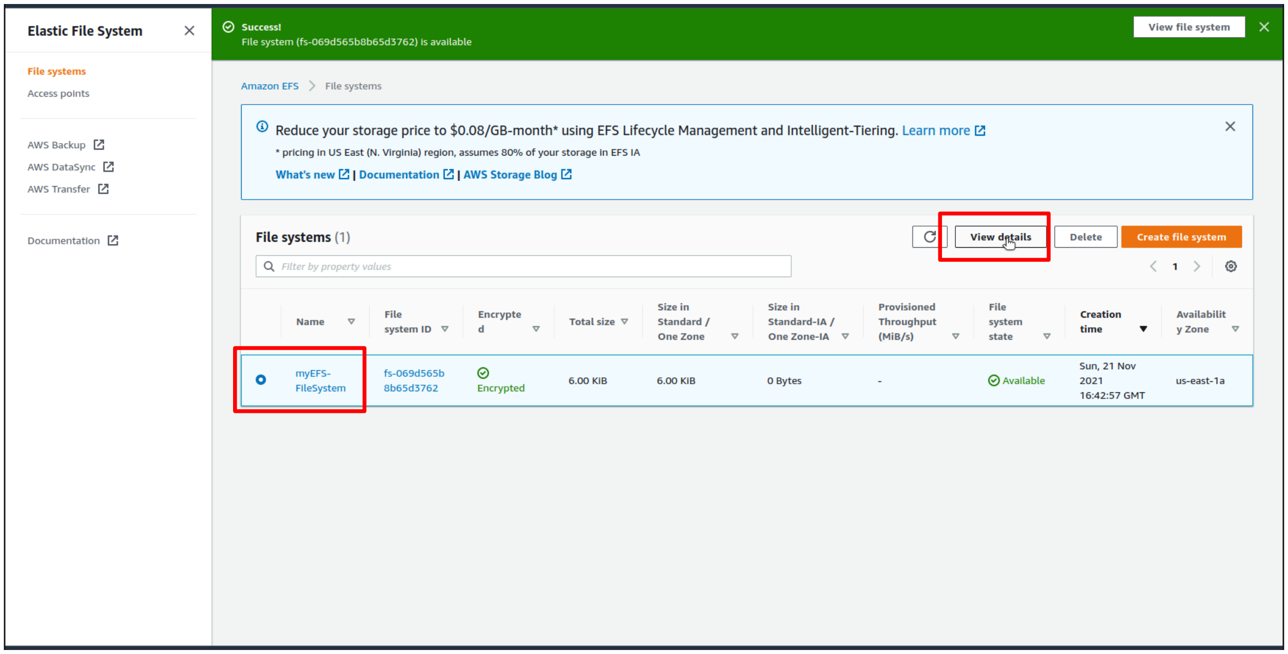
Success!
File system (fs-069d565b8b65d3762) is available

Reduce your storage price to $0.08/GB-month* using EFS Lifecycle Management and Intelligent-Tiering. Learn more
* pricing in US East (N. Virginia) region, assumes 80% of your storage in EFS IA
What's new | Documentation | AWS Storage Blog

File systems (1)

	Name	File system ID	Encrypted	Total size	Size in Standard / One Zone	Size in Standard-IA / One Zone-IA	Provisioned Throughput (MiB/s)	File system state	Creation time	Availability Zone
○	myEFS-FileSystem	fs-069d565b8b65d3762	✓ Encrypted	6.00 KiB	6.00 KiB	0 Bytes	-	✓ Available	Sun, 21 Nov 2021 16:42:57 GMT	us-east-1a

Select the file system and click on the **View details** button:



Success!
File system (fs-069d565b8b65d3762) is available

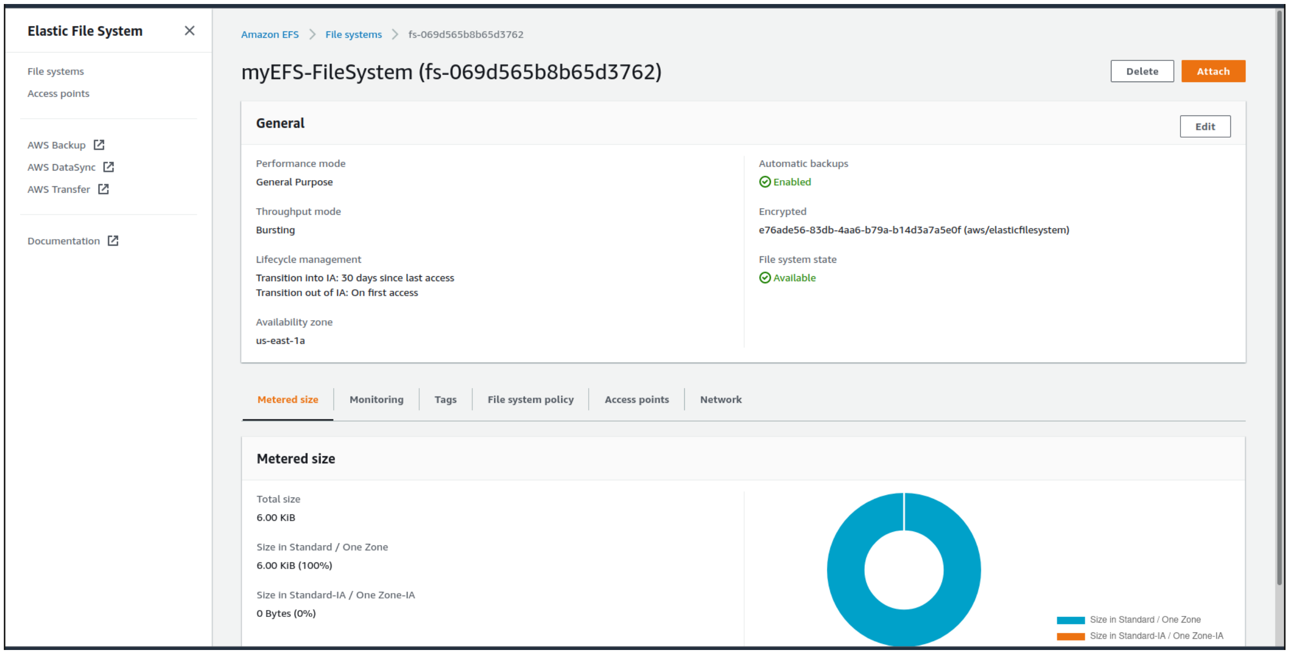
Reduce your storage price to $0.08/GB-month* using EFS Lifecycle Management and Intelligent-Tiering. Learn more

* pricing in US East (N. Virginia) region, assumes 80% of your storage in EFS IA

File systems (1)

	Name	File system ID	Encrypted	Total size	Size in Standard / One Zone	Size in Standard-IA / One Zone-IA	Provisioned Throughput (MiB/s)	File system state	Creation time	Availability Zone
●	myEFS-FileSystem	fs-069d565b8b65d3762	✓ Encrypted	6.00 KiB	6.00 KiB	0 Bytes	-	✓ Available	Sun, 21 Nov 2021 16:42:57 GMT	us-east-1a

File system details:



myEFS-FileSystem (fs-069d565b8b65d3762)

General

Performance mode
General Purpose

Throughput mode
Bursting

Lifecycle management
Transition into IA: 30 days since last access
Transition out of IA: On first access

Availability zone
us-east-1a

Automatic backups
✓ Enabled

Encrypted
e76ade56-83db-4aa6-b79a-b14d3a7a5e0f (aws/elasticfilesystem)

File system state
✓ Available

Metered size

Total size
6.00 KiB

Size in Standard / One Zone
6.00 KiB (100%)

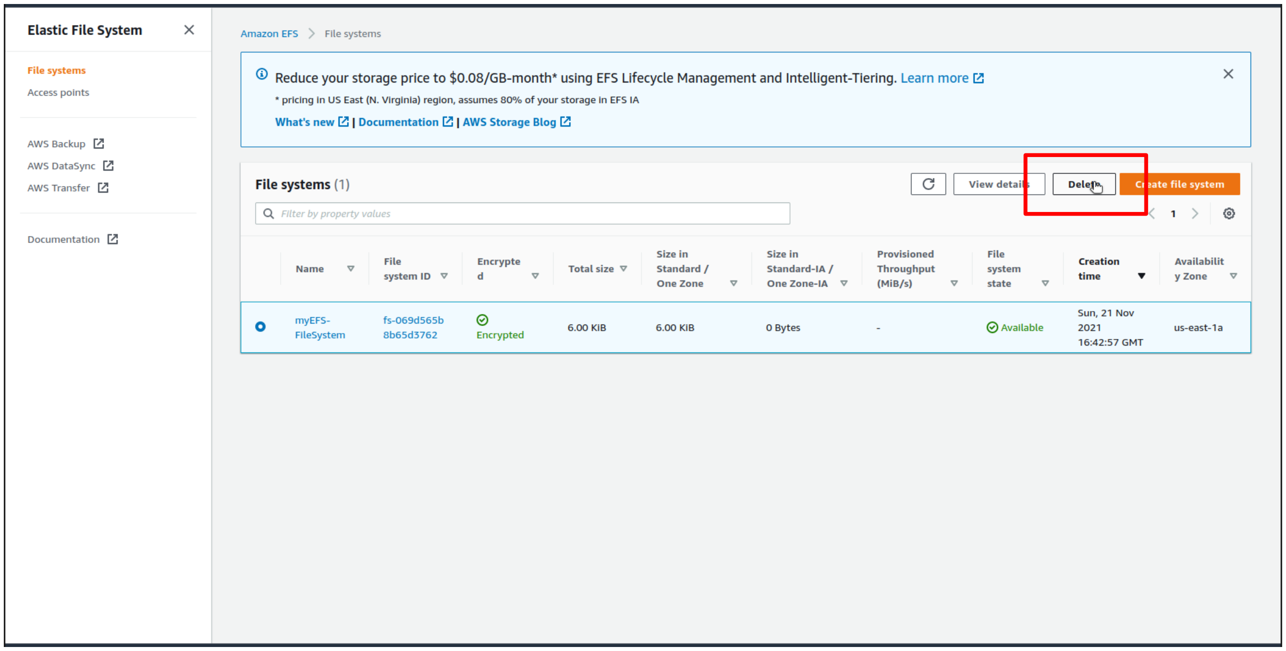
Size in Standard-IA / One Zone-IA
0 Bytes (0%)

Size in Standard / One Zone
Size in Standard-IA / One Zone-IA

Removing an EFS File System

Before removing an EFS file system, it must be unmounted from the EC2 instances. This is done from inside the EC2 instance Command Line Interface – CLI.

To remove an EFS File System, select the file system. Then click the **Delete** button:



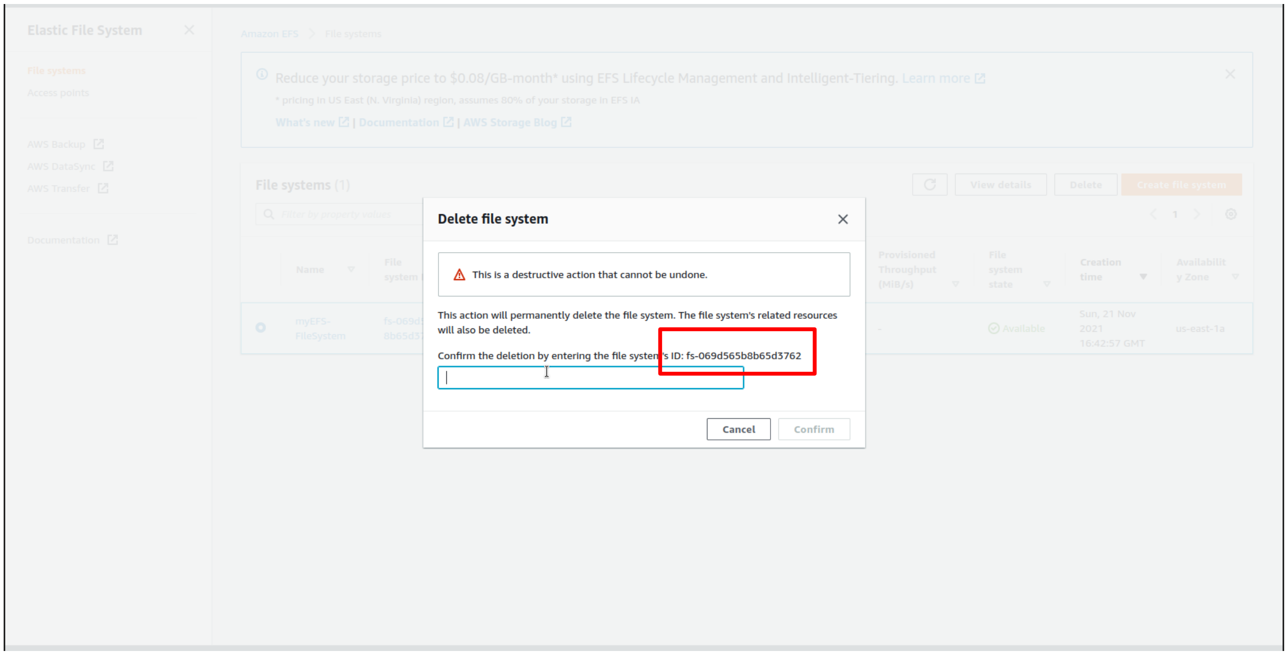
Reduce your storage price to $0.08/GB-month* using EFS Lifecycle Management and Intelligent-Tiering. Learn more

* pricing in US East (N. Virginia) region, assumes 80% of your storage in EFS IA

What's new | Documentation | AWS Storage Blog

	Name	File system ID	Encrypted	Total size	Size in Standard / One Zone	Size in Standard-IA / One Zone-IA	Provisioned Throughput (MiB/s)	File system state	Creation time	Availability Zone
●	myEFS-FileSystem	fs-069d565b8b65d3762	✓ Encrypted	6.00 KiB	6.00 KiB	0 Bytes	-	✓ Available	Sun, 21 Nov 2021 16:42:57 GMT	us-east-1a

It will show the ID of the file system. Copy that and paste into the box:



Reduce your storage price to $0.08/GB-month* using EFS Lifecycle Management and Intelligent-Tiering. Learn more

* pricing in US East (N. Virginia) region, assumes 80% of your storage in EFS IA

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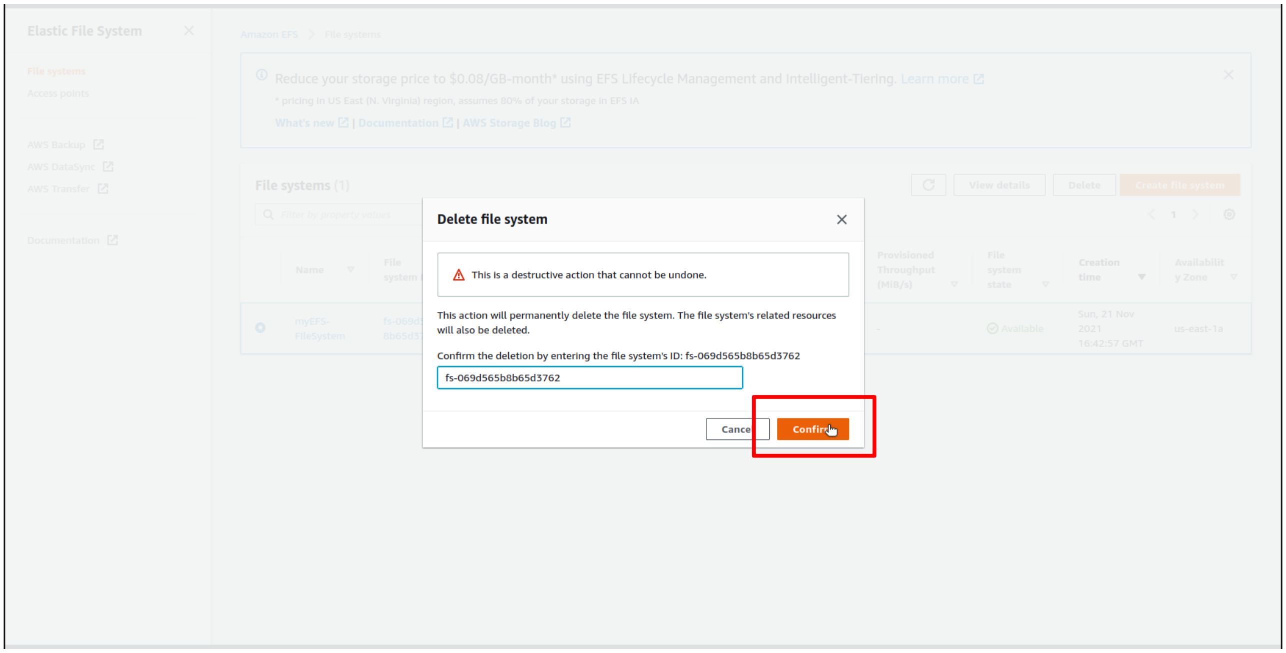
Delete file system

This is a destructive action that cannot be undone.

This action will permanently delete the file system. The file system's related resources will also be deleted.

Confirm the deletion by entering the file system's ID: fs-069d565b8b65d3762

After pasting the ID in the box, click on the Confirm button:



Reduce your storage price to $0.08/GB-month* using EFS Lifecycle Management and Intelligent-Tiering. Learn more

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What's new | Documentation | AWS Storage Blog

Delete file system

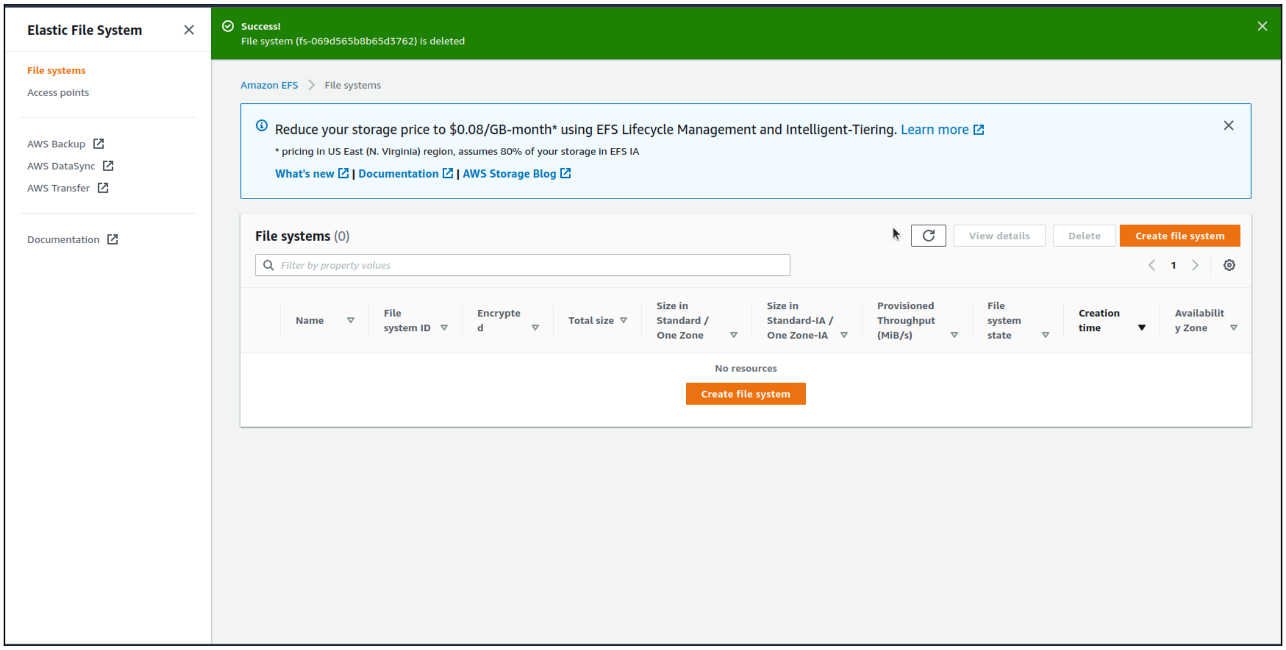
This is a destructive action that cannot be undone.

This action will permanently delete the file system. The file system's related resources will also be deleted.

Confirm the deletion by entering the file system's ID: fs-069d565b8b65d3762

fs-069d565b8b65d3762

After some time, a green banner will appear on the top of the window informing the file system has been successfully deleted:



Success!
File system (fs-069d565b8b65d3762) is deleted

Reduce your storage price to $0.08/GB-month* using EFS Lifecycle Management and Intelligent-Tiering. Learn more

* pricing in US East (N. Virginia) region, assumes 80% of your storage in EFS IA

What's new | Documentation | AWS Storage Blog

File systems (0)

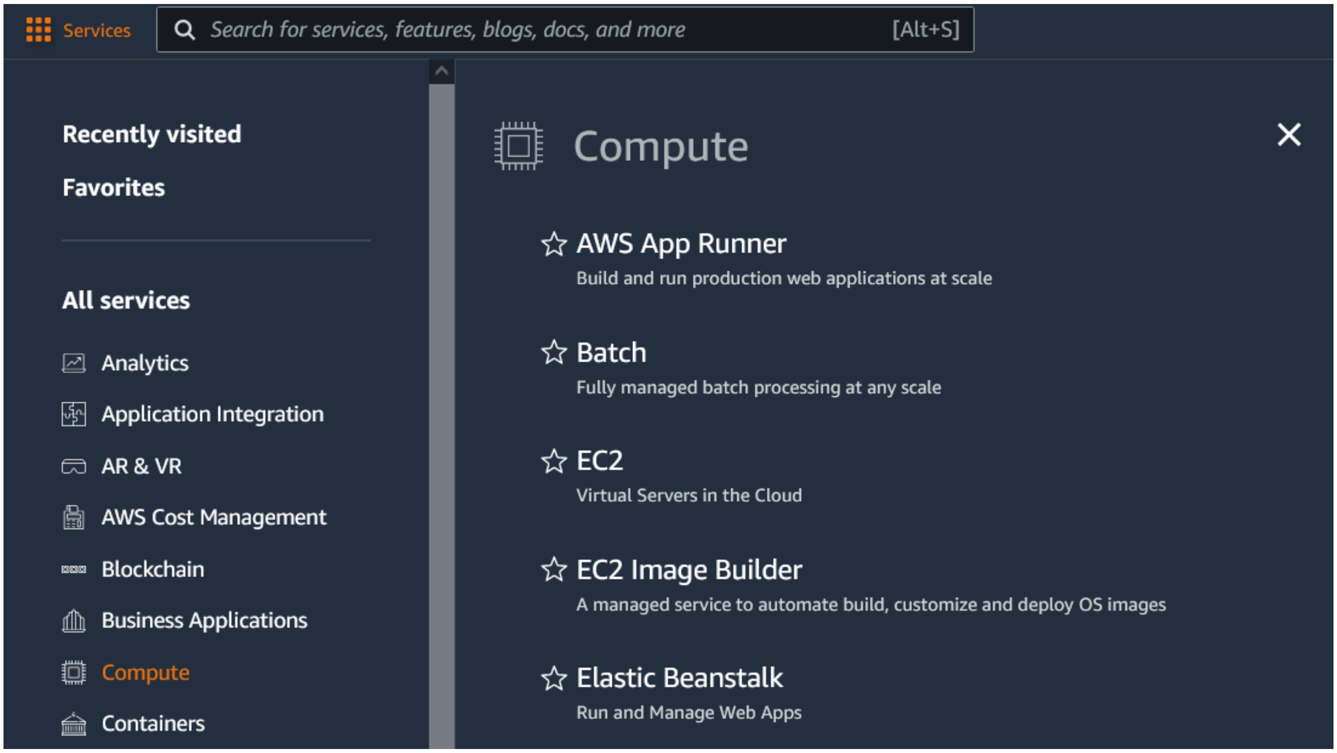
Name	File system ID	Encrypted	Total size	Size in Standard / One Zone	Size in Standard-IA / One Zone-IA	Provisioned Throughput (MiB/s)	File system state	Creation time	Availability Zone

No resources

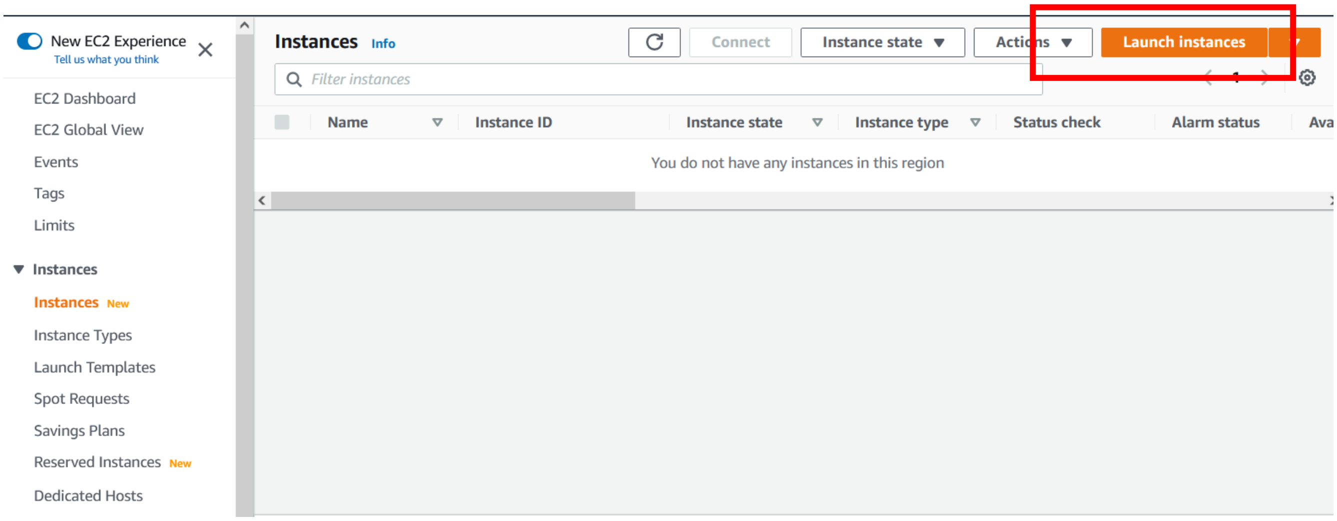
Chapter 4 Labs

Lab: Launch a Linux EC2 Instance and Set Up Linux, Apache, MySQL, PHP (LAMP) Stack

Log in to the AWS Management Console. Go to Services > Compute > EC2

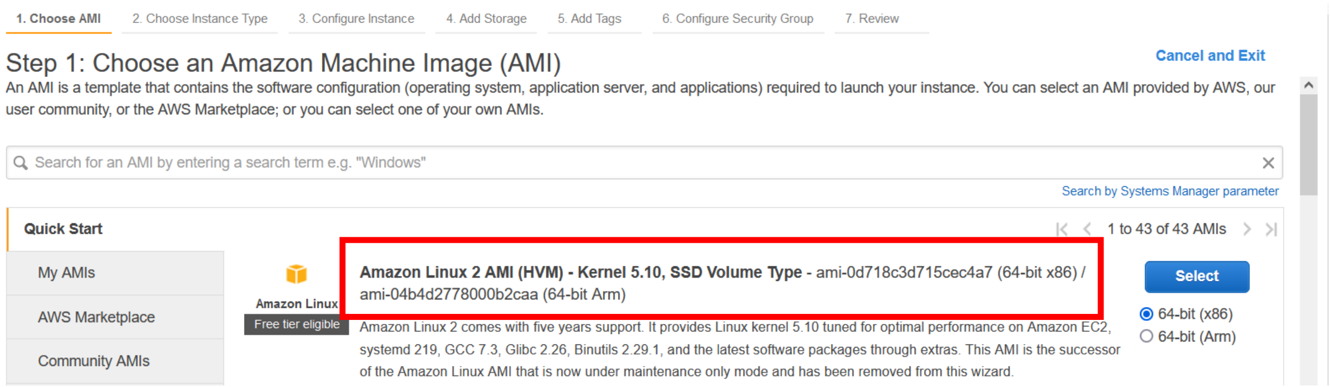


Click on **Launch instance**:



You do not have any instances in this region

Select Amazon Linux 2:



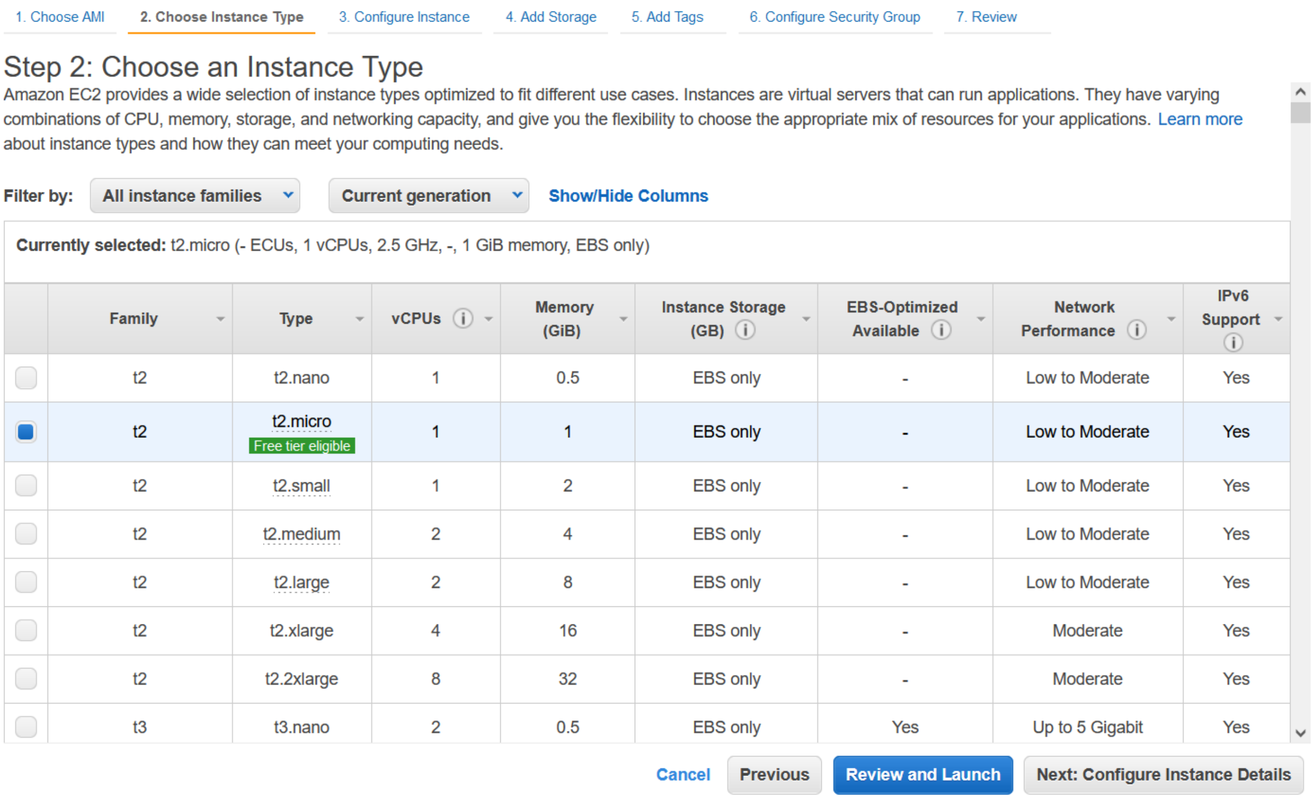
Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type - ami-0d718c3d715cec4a7 (64-bit x86) / ami-04b4d2778000b2caa (64-bit Arm)

Amazon Linux 2 comes with five years support. It provides Linux kernel 5.10 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is now under maintenance only mode and has been removed from this wizard.

Select a free tier eligible instance type; click Review and Launch.



Step 2: Choose an Instance Type

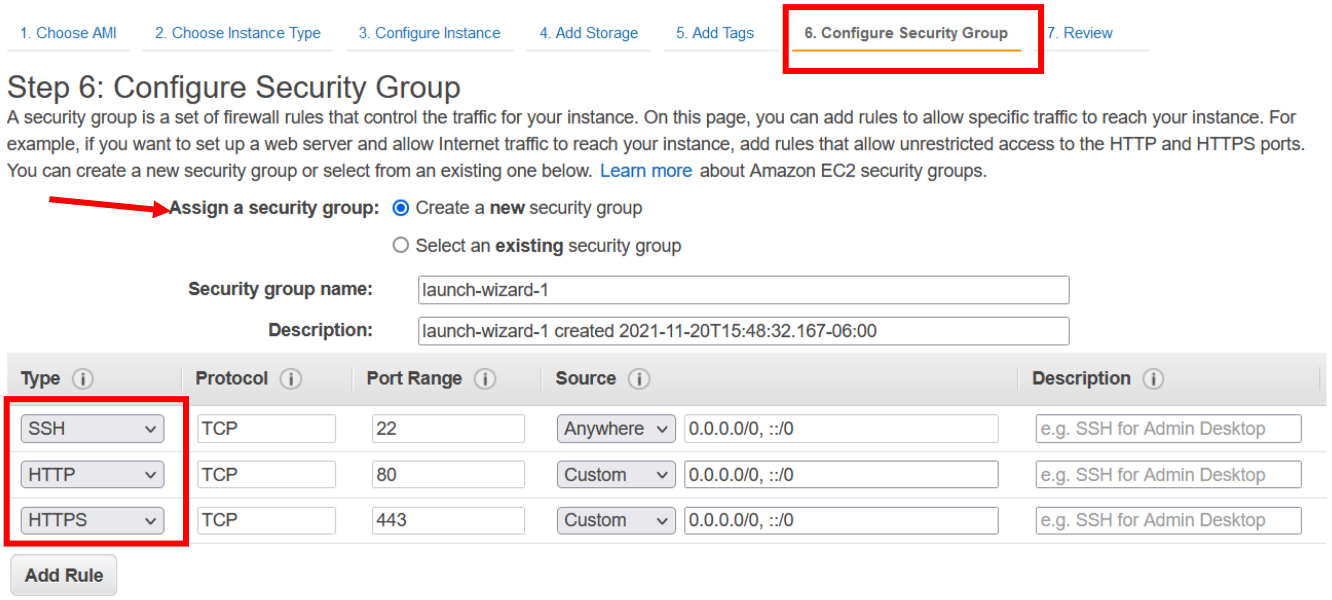
Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have varying combinations of CPU, memory, storage, and networking capacity, and give you the flexibility to choose the appropriate mix of resources for your applications. Learn more about instance types and how they can meet your computing needs.

Filter by: All instance families | Current generation | Show/Hide Columns

Currently selected: t2.micro (- ECUs, 1 vCPUs, 2.5 GHz, -, 1 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance	IPv6 Support
□	t2	t2.nano	1	0.5	EBS only	-	Low to Moderate	Yes
■	t2	t2.micro Free tier eligible	1	1	EBS only	-	Low to Moderate	Yes
□	t2	t2.small	1	2	EBS only	-	Low to Moderate	Yes
□	t2	t2.medium	2	4	EBS only	-	Low to Moderate	Yes
□	t2	t2.large	2	8	EBS only	-	Low to Moderate	Yes
□	t2	t2.xlarge	4	16	EBS only	-	Moderate	Yes
□	t2	t2.2xlarge	8	32	EBS only	-	Moderate	Yes
□	t3	t3.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes

Click on “6. Configure Security Group,” and add SSH, http, and https rules to the policy. Click Review.



Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. Learn more about Amazon EC2 security groups.

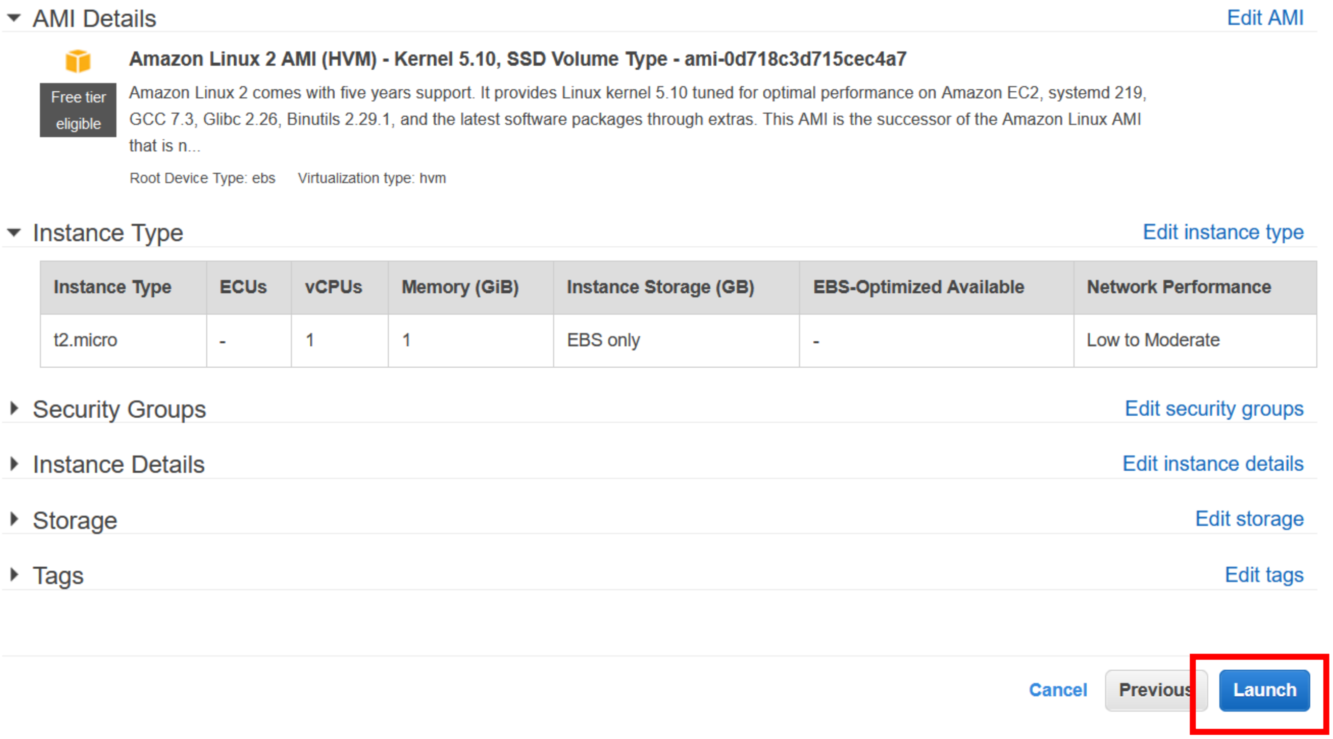
Assign a security group: ● Create a **new** security group
○ Select an **existing** security group

Security group name: launch-wizard-1

Description: launch-wizard-1 created 2021-11-20T15:48:32.167-06:00

Type	Protocol	Port Range	Source		Description
SSH	TCP	22	Anywhere	0.0.0.0/0, ::/0	e.g. SSH for Admin Desktop
HTTP	TCP	80	Custom	0.0.0.0/0, ::/0	e.g. SSH for Admin Desktop
HTTPS	TCP	443	Custom	0.0.0.0/0, ::/0	e.g. SSH for Admin Desktop

Click Launch.



AMI Details

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type - ami-0d718c3d715cec4a7

Free tier eligible

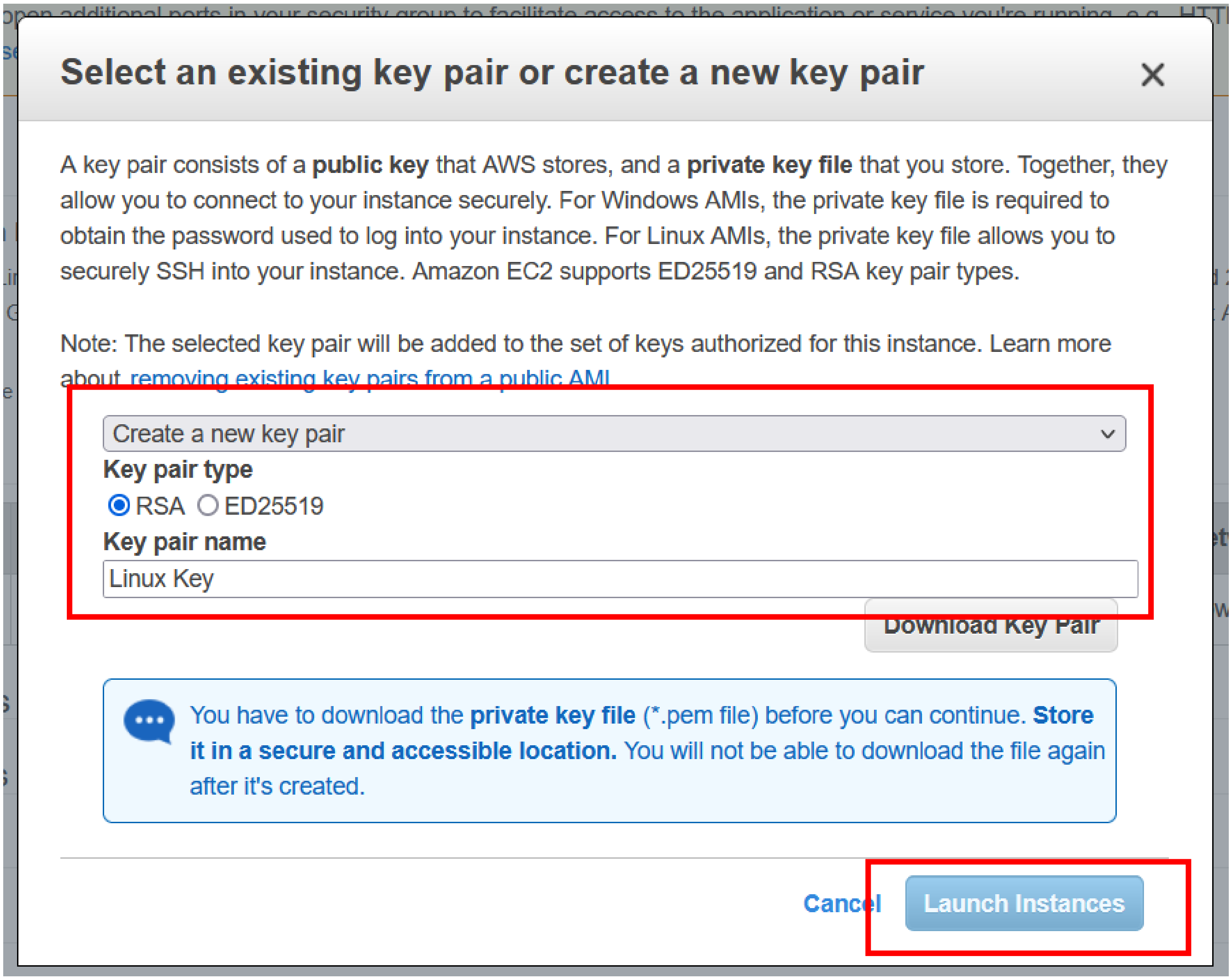
Amazon Linux 2 comes with five years support. It provides Linux kernel 5.10 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is n...

Root Device Type: ebs Virtualization type: hvm

Instance Type

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
t2.micro	-	1	1	EBS only	-	Low to Moderate

Create a new security key pair and download the key. Make sure you save it! Then click Launch Instance.



Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance. Amazon EC2 supports ED25519 and RSA key pair types.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about removing existing key pairs from a public AMI

Create a new key pair

Key pair type

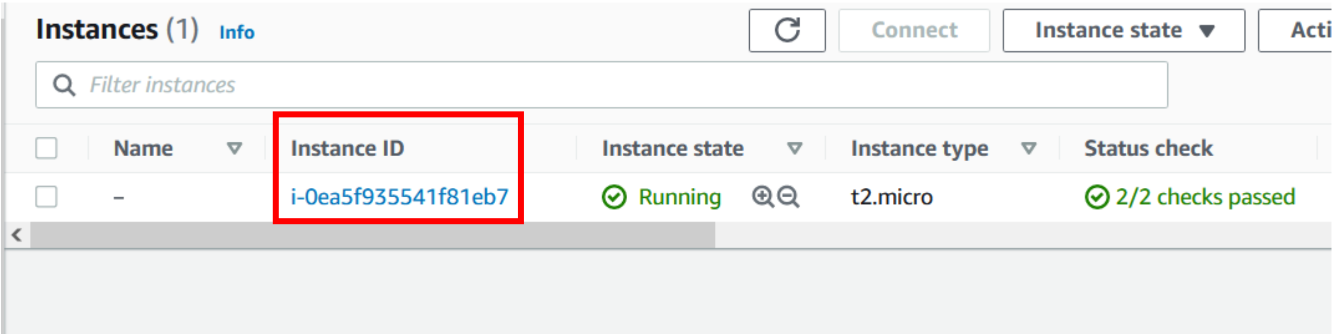
● RSA ○ ED25519

Key pair name

Linux Key

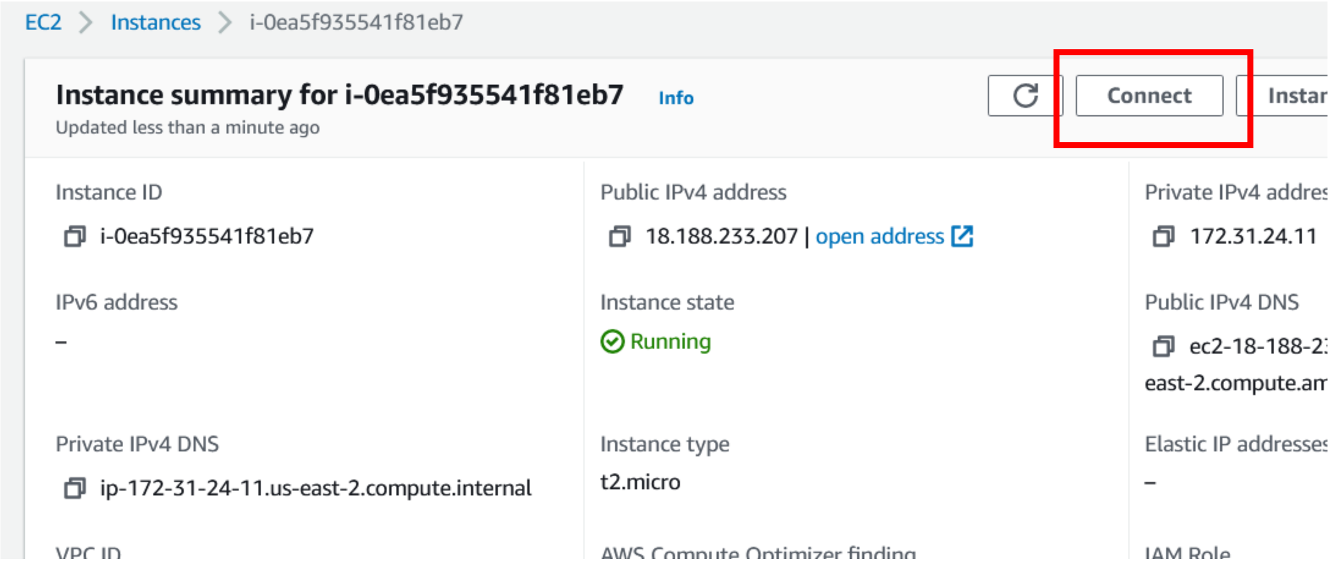
You have to download the **private key file** (*.pem file) before you can continue. **Store it in a secure and accessible location.** You will not be able to download the file again after it's created.

On the main EC2 page, click on the Instance ID, then click Connect, and click Connect again.



Instances (1) Info

□	Name	Instance ID	Instance state	Instance type	Status check
□	–	i-0ea5f935541f81eb7	✓ Running	t2.micro	✓ 2/2 checks passed



Instance summary for i-0ea5f935541f81eb7

Updated less than a minute ago

Instance ID: i-0ea5f935541f81eb7

Public IPv4 address: 18.188.233.207 | open address

Private IPv4 addres: 172.31.24.11

IPv6 address: –

Instance state: Running

Public IPv4 DNS: ec2-18-188-2: east-2.compute.am

Private IPv4 DNS: ip-172-31-24-11.us-east-2.compute.internal

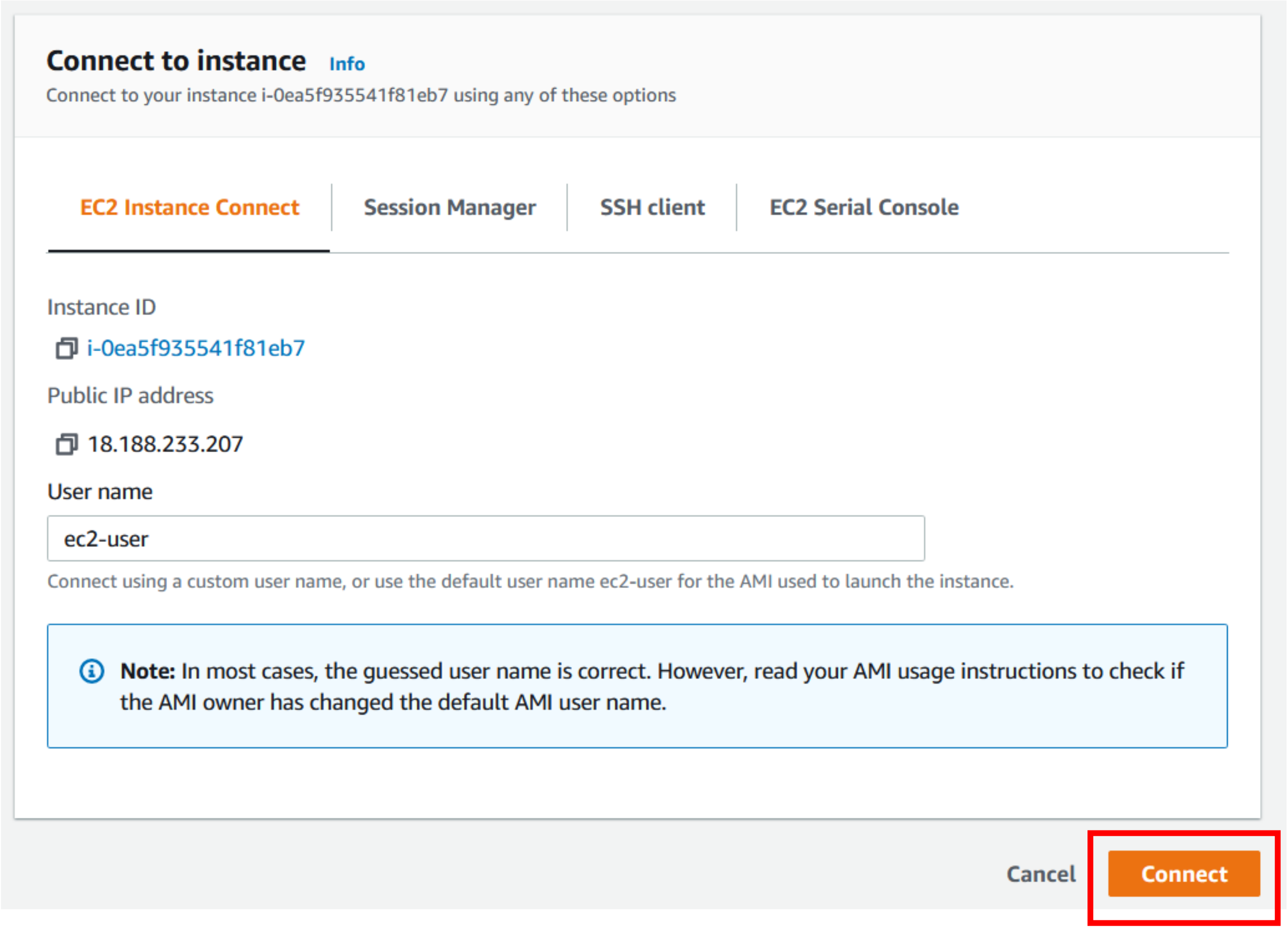
Instance type: t2.micro

Elastic IP addresses: –

VPC ID

AWS Compute Optimizer finding

IAM Role



Connect to instance

Connect to your instance i-0ea5f935541f81eb7 using any of these options

Instance ID: i-0ea5f935541f81eb7

Public IP address: 18.188.233.207

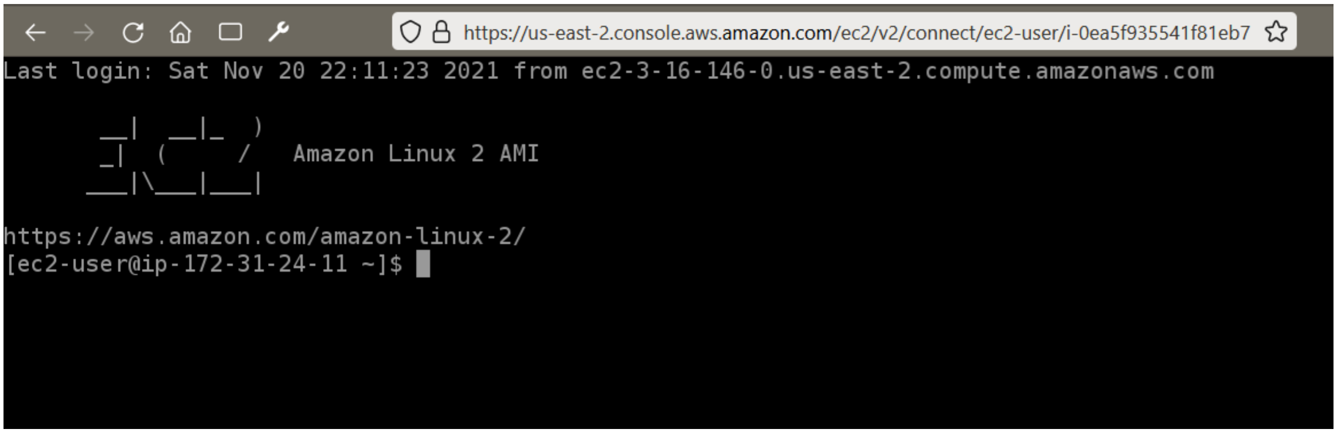
User name: ec2-user

Connect using a custom user name, or use the default user name ec2-user for the AMI used to launch the instance.

Note: In most cases, the guessed user name is correct. However, read your AMI usage instructions to check if the AMI owner has changed the default AMI user name.

Congratulations! You've created an EC2 instance.

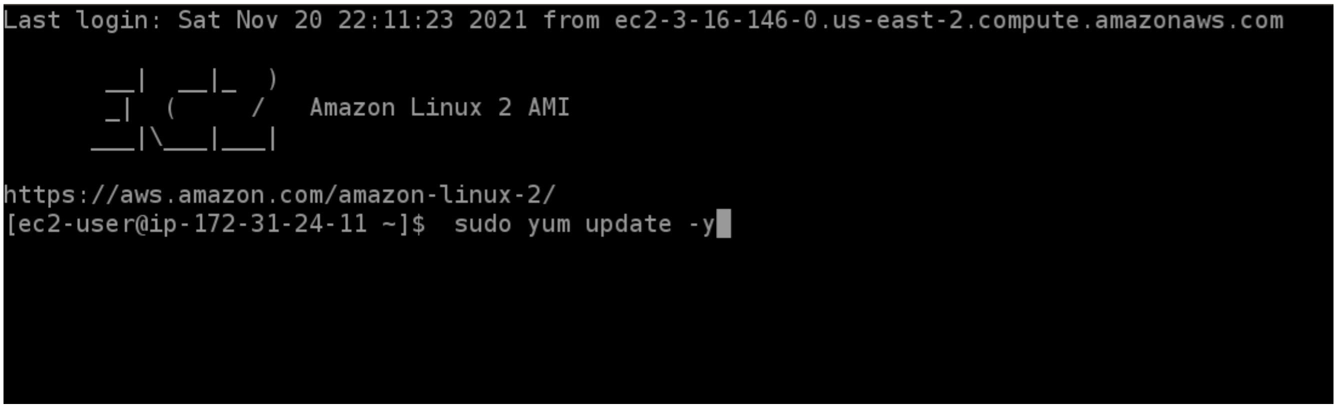
Go to the Linux command line.



https://us-east-2.console.aws.amazon.com/ec2/v2/connect/ec2-user/i-0ea5f935541f81eb7

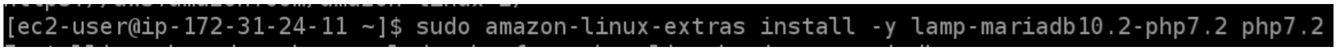
```
Last login: Sat Nov 20 22:11:23 2021 from ec2-3-16-146-0.us-east-2.compute.amazonaws.com

       __|  __|_  )
       _|  (     /   Amazon Linux 2 AMI
      ___|\___|___|

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-172-31-24-11 ~]$
```

Make sure all software packages are up to date.
Type the following at the command prompt:
sudo yum update -y



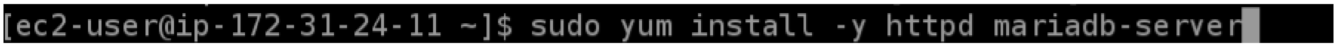
```
Last login: Sat Nov 20 22:11:23 2021 from ec2-3-16-146-0.us-east-2.compute.amazonaws.com

       __|  __|_  )
       _|  (     /   Amazon Linux 2 AMI
      ___|\___|___|

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-172-31-24-11 ~]$  sudo yum update -y
```

Install MariaDB (Substituted for MySQL) and PHP Amazon Linux Extras repositories.
Type the following at the command prompt:
sudo amazon-linux-extras install -y lamp-mariadb10.2-php7.2 php7.2



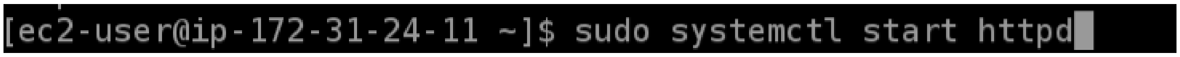
```
[ec2-user@ip-172-31-24-11 ~]$ sudo amazon-linux-extras install -y lamp-mariadb10.2-php7.2 php7.2
```

Install the Apache, MariaDB, and PHP software packages.
Type the following at the command prompt:
yum install -y httpd mariadb-server



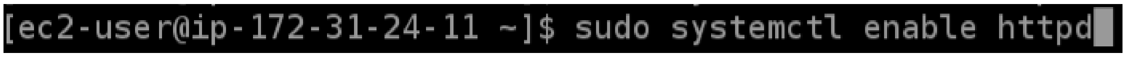
```
[ec2-user@ip-172-31-24-11 ~]$ sudo yum install -y httpd mariadb-server
```

Start the Apache web server.
Type the following at the command prompt:
sudo systemctl start httpd



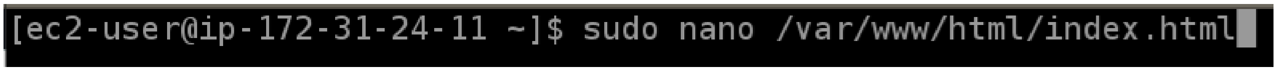
```
[ec2-user@ip-172-31-24-11 ~]$ sudo systemctl start httpd
```

Set Apache to automatically start after a reboot
Type the following at the command prompt:
sudo systemctl enable httpd



```
[ec2-user@ip-172-31-24-11 ~]$ sudo systemctl enable httpd
```

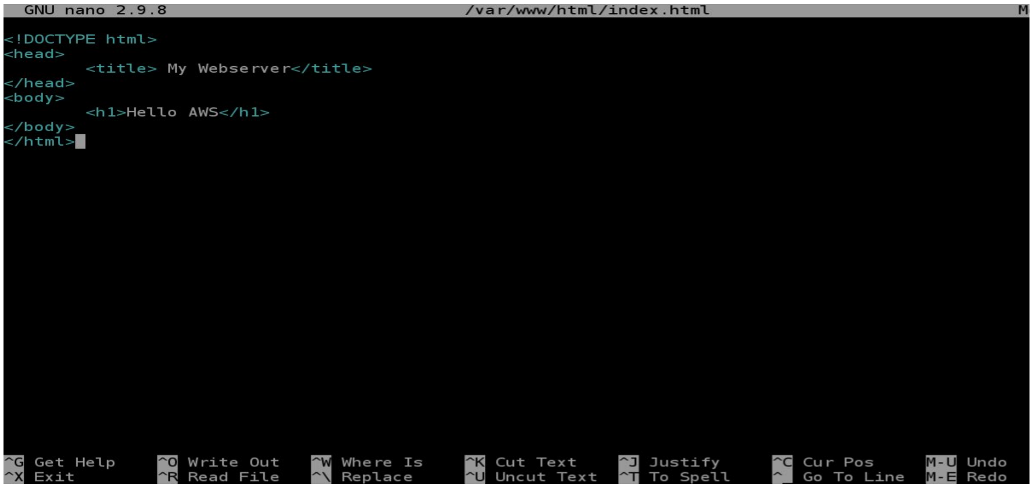
Create an index.html file for the homepage of the website.
Type the following at the command prompt:
sudo nano /var/www/html/index.html



```
[ec2-user@ip-172-31-24-11 ~]$ sudo nano /var/www/html/index.html
```

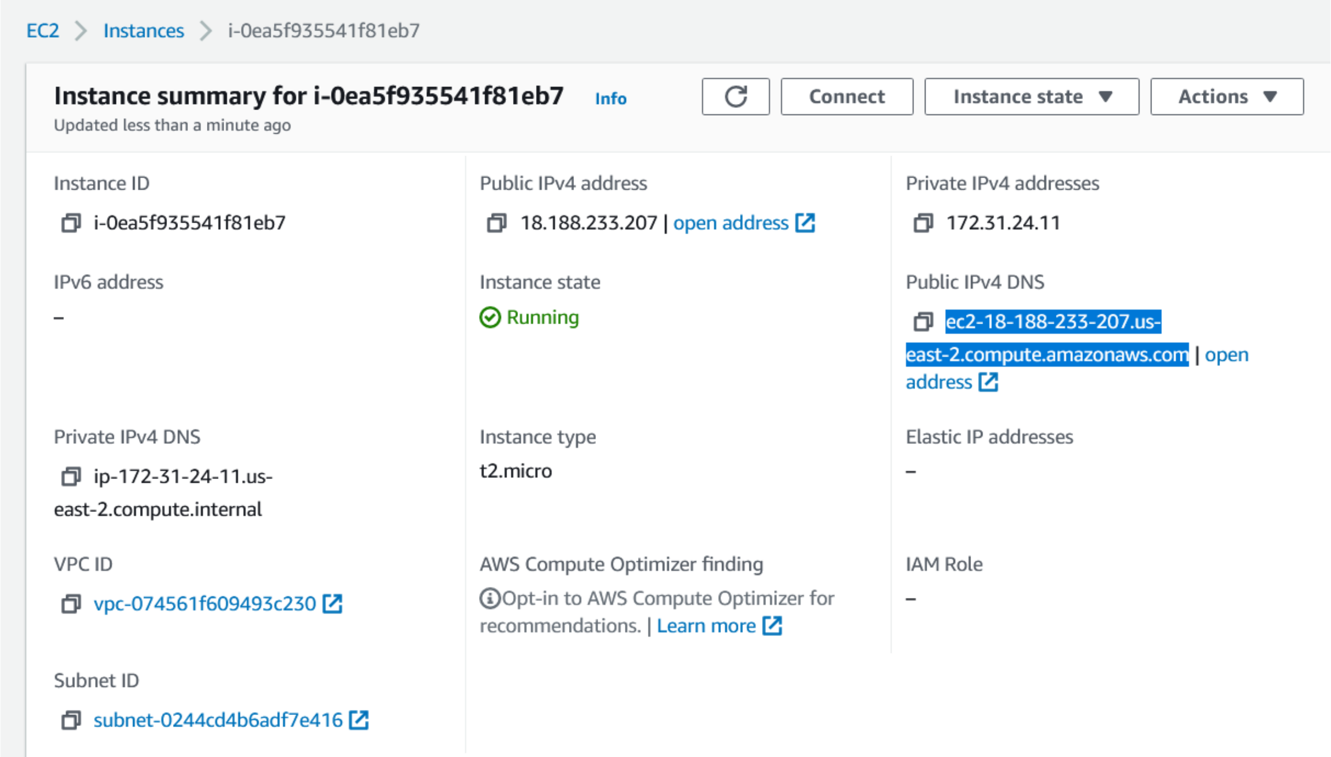
Insert the following and save the file with Control+O. Exit nano with Control+X.

```
<!DOCTYPE html>
<head>
	<title>My Web server</title>
</head>
<body>
	<h1>Hello AWS</h1>
</body>
</html>
```



```
<!DOCTYPE html>
<head>
        <title> My Webserver</title>
</head>
<body>
        <h1>Hello AWS</h1>
</body>
</html>
```

Navigate to the public DNS record for your server.



Instance summary for i-0ea5f935541f81eb7 Info

Updated less than a minute ago

Instance ID: i-0ea5f935541f81eb7

Public IPv4 address: 18.188.233.207 | open address

Private IPv4 addresses: 172.31.24.11

IPv6 address: –

Instance state: Running

Public IPv4 DNS: ec2-18-188-233-207.us-east-2.compute.amazonaws.com | open address

Private IPv4 DNS: ip-172-31-24-11.us-east-2.compute.internal

Instance type: t2.micro

Elastic IP addresses: –

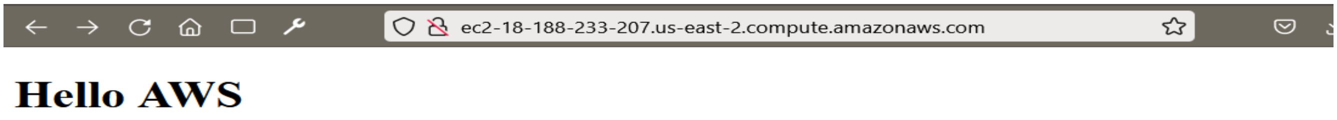
VPC ID: vpc-074561f609493c230

AWS Compute Optimizer finding: Opt-in to AWS Compute Optimizer for recommendations. | Learn more

IAM Role: –

Subnet ID: subnet-0244cd4b6adf7e416

Congratulations, you’ve set up a LAMP server on an EC2 instance.

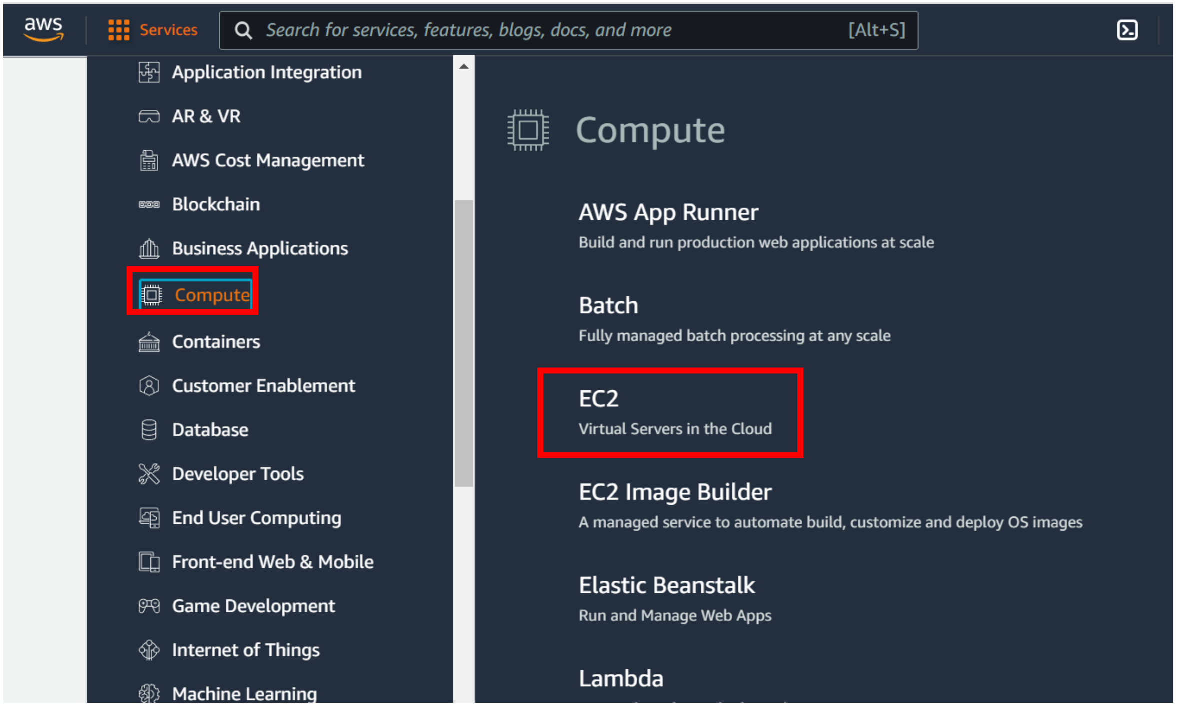


ec2-18-188-233-207.us-east-2.compute.amazonaws.com

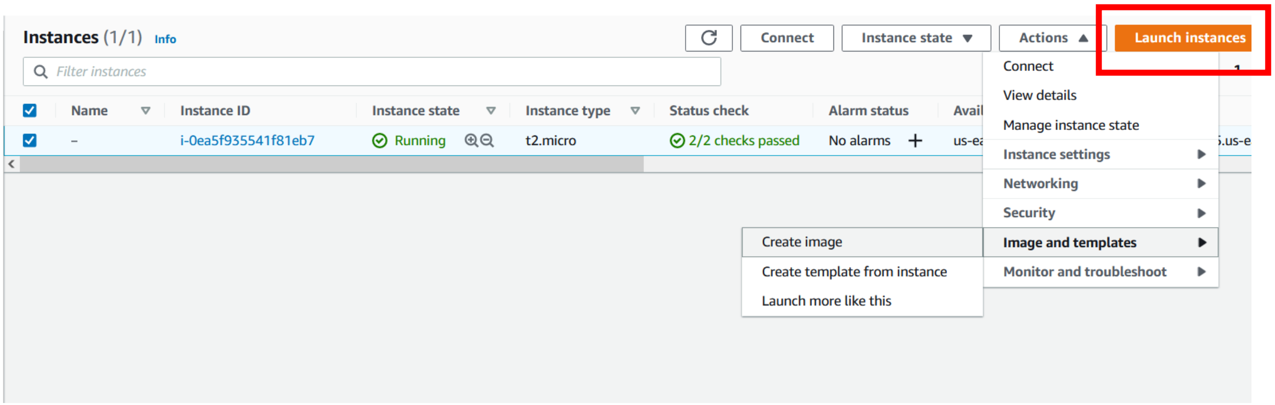
Hello AWS

Lab: Create an Amazon Machine Image (AMI) of Our Linux Web Server

Log in to the AWS Console, Go to Services > Compute > EC2.

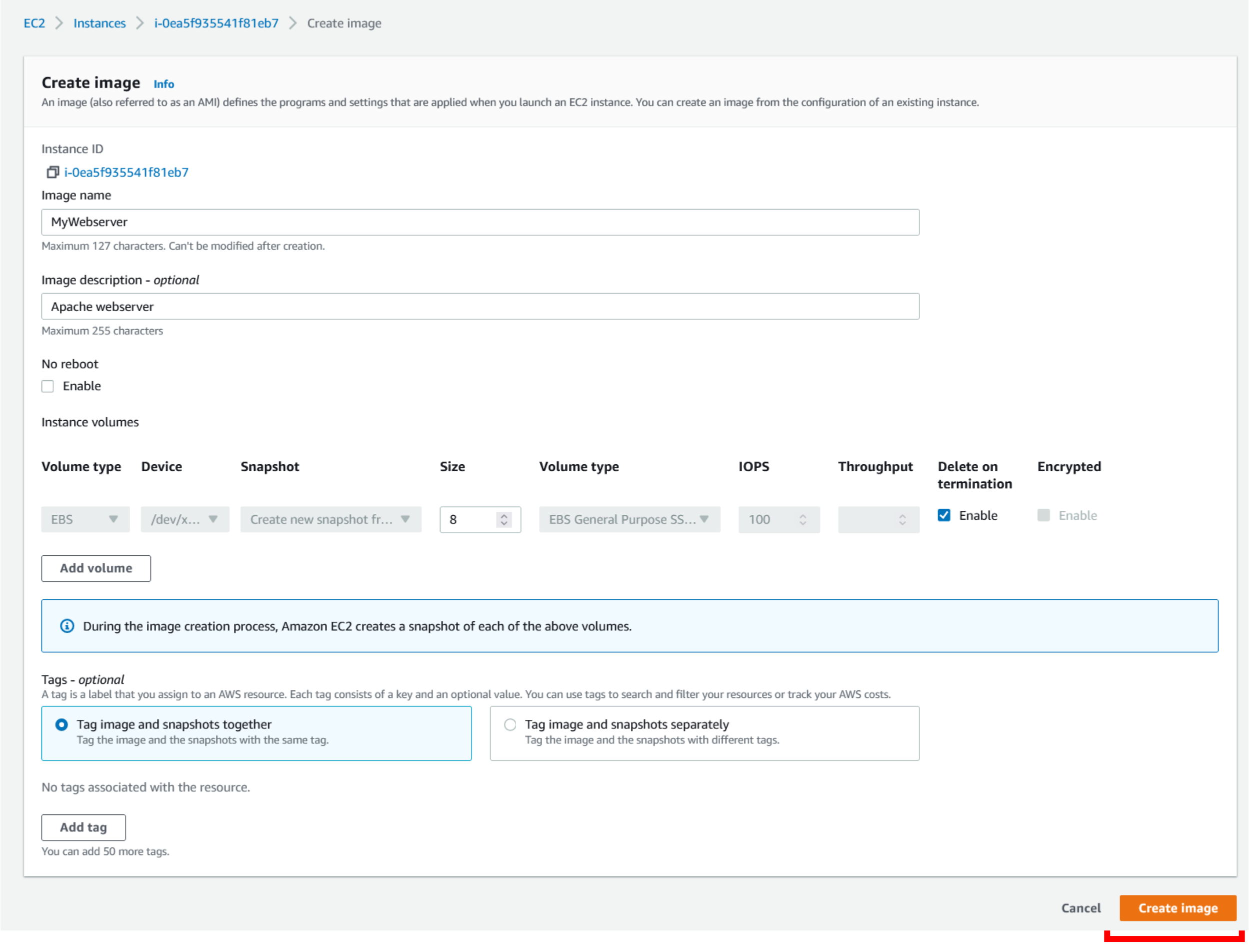


Select the server and click on Actions > Image and templates > Create Image



☑	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Avail
☑	–	i-0ea5f935541f81eb7	Running	t2.micro	2/2 checks passed	No alarms +	us-ea

Give the AMI a name and description. Then click **Create Image.**



EC2 > Instances > i-0ea5f935541f81eb7 > Create image

Create image Info

An image (also referred to as an AMI) defines the programs and settings that are applied when you launch an EC2 instance. You can create an image from the configuration of an existing instance.

Instance ID

i-0ea5f935541f81eb7

Image name

MyWebserver

Maximum 127 characters. Can't be modified after creation.

Image description - *optional*

Apache webserver

Maximum 255 characters

No reboot

□ Enable

Instance volumes

Volume type	Device	Snapshot	Size	Volume type	IOPS	Throughput	Delete on termination	Encrypted
EBS	/dev/x...	Create new snapshot fr...	8	EBS General Purpose SS...	100		☑ Enable	□ Enable

Add volume

During the image creation process, Amazon EC2 creates a snapshot of each of the above volumes.

Tags - *optional*

A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter your resources or track your AWS costs.

● Tag image and snapshots together
Tag the image and the snapshots with the same tag.

○ Tag image and snapshots separately
Tag the image and the snapshots with different tags.

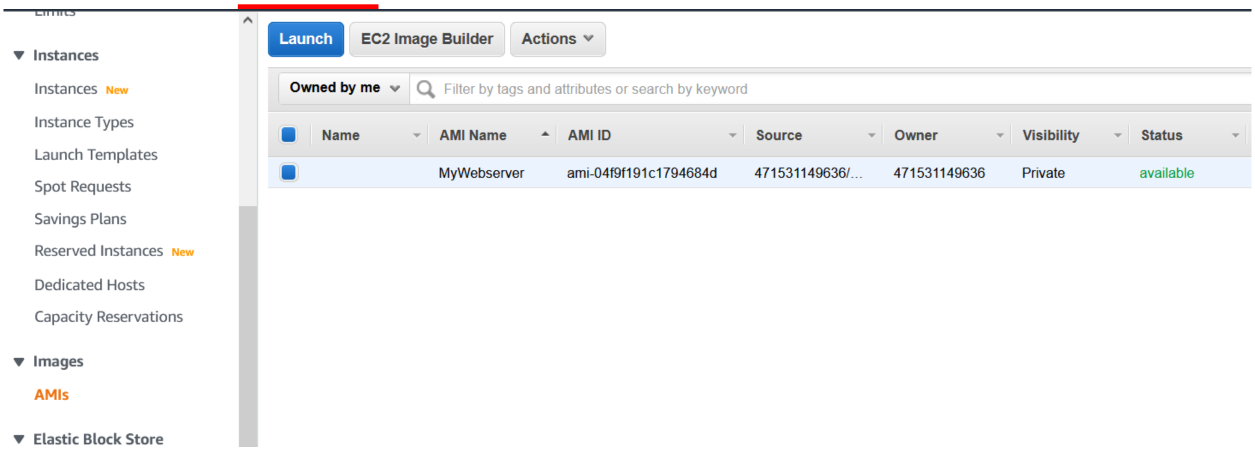
No tags associated with the resource.

Add tag

You can add 50 more tags.

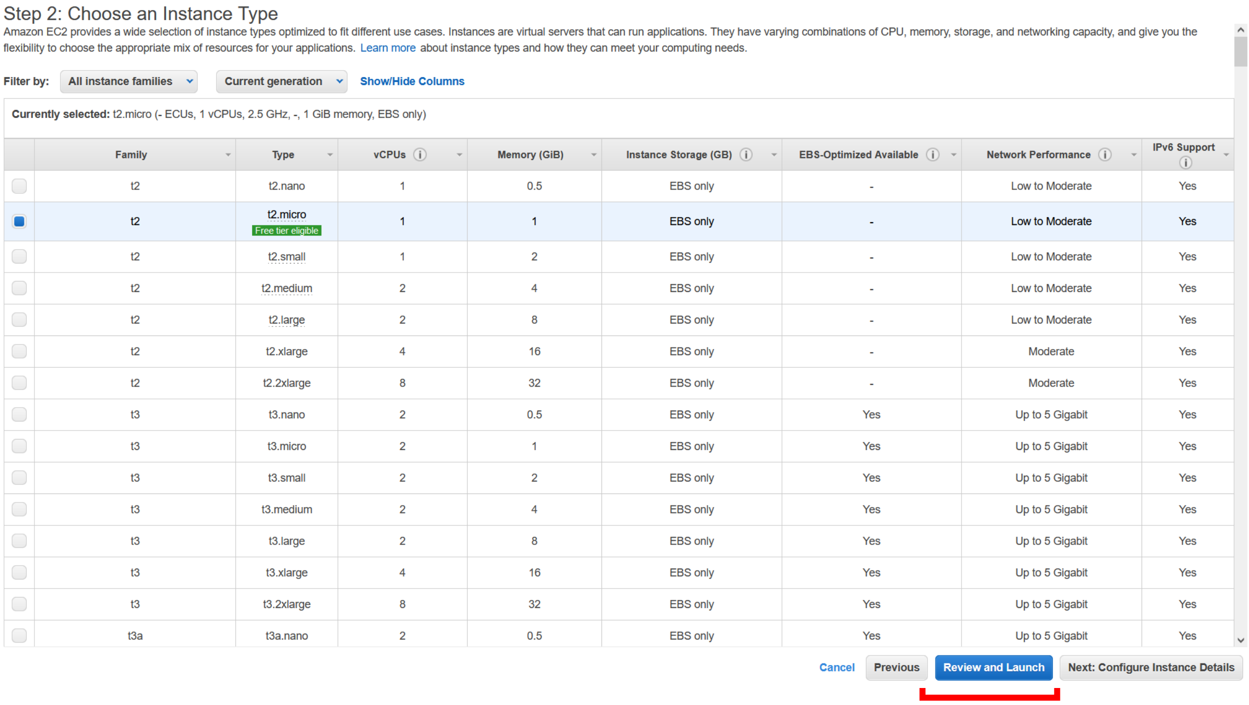
Cancel | Create image

Go to the AMIs page. It may take a few minutes for the AMI to go from ‘pending’ to ‘available.’ Select the AMI and click **Launch**.



■	Name	AMI Name	AMI ID	Source	Owner	Visibility	Status
■		MyWebserver	ami-04f9f191c1794684d	471531149636/...	471531149636	Private	available

Choose a Free Tier Eligible Instance type. Click **Review and Launch.**



Step 2: Choose an Instance Type

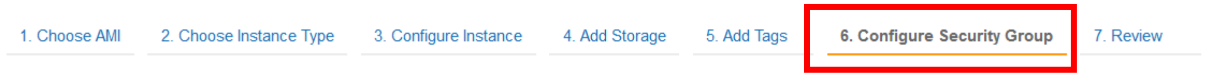
Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have varying combinations of CPU, memory, storage, and networking capacity, and give you the flexibility to choose the appropriate mix of resources for your applications. Learn more about instance types and how they can meet your computing needs.

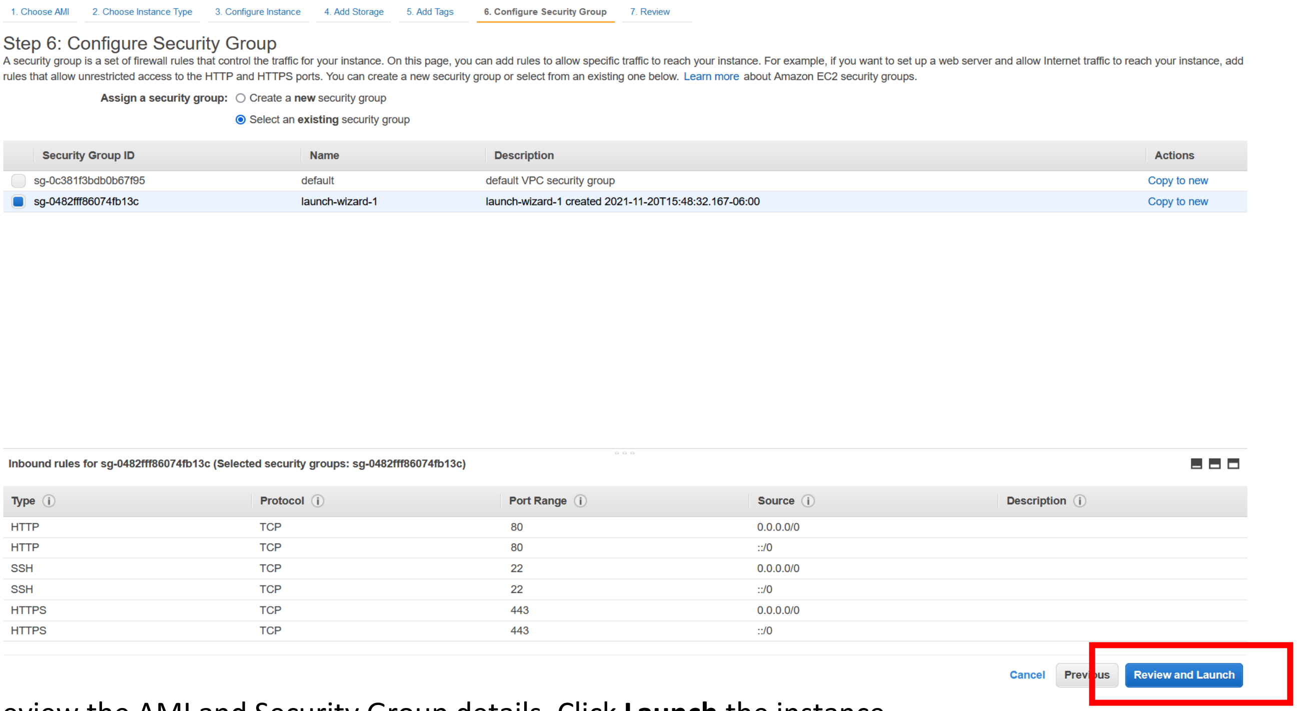
Filter by: All instance families | Current generation | Show/Hide Columns

Currently selected: t2.micro (- ECUs, 1 vCPUs, 2.5 GHz, -, 1 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance	IPv6 Support
□	t2	t2.nano	1	0.5	EBS only	-	Low to Moderate	Yes
■	t2	t2.micro Free tier eligible	1	1	EBS only	-	Low to Moderate	Yes
□	t2	t2.small	1	2	EBS only	-	Low to Moderate	Yes
□	t2	t2.medium	2	4	EBS only	-	Low to Moderate	Yes
□	t2	t2.large	2	8	EBS only	-	Low to Moderate	Yes
□	t2	t2.xlarge	4	16	EBS only	-	Moderate	Yes
□	t2	t2.2xlarge	8	32	EBS only	-	Moderate	Yes
□	t3	t3.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes
□	t3	t3.micro	2	1	EBS only	Yes	Up to 5 Gigabit	Yes
□	t3	t3.small	2	2	EBS only	Yes	Up to 5 Gigabit	Yes
□	t3	t3.medium	2	4	EBS only	Yes	Up to 5 Gigabit	Yes
□	t3	t3.large	2	8	EBS only	Yes	Up to 5 Gigabit	Yes
□	t3	t3.xlarge	4	16	EBS only	Yes	Up to 5 Gigabit	Yes
□	t3	t3.2xlarge	8	32	EBS only	Yes	Up to 5 Gigabit	Yes
□	t3a	t3a.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes

Click on **6. Configure Security Group** and select the existing security group for the previously created web server. *Note: Use default values for "3. Configure Instance, 4. Add Storage, and 5. Add Tags".* **Click Review and Launch.**





Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. Learn more about Amazon EC2 security groups.

Assign a security group: ○ Create a **new** security group

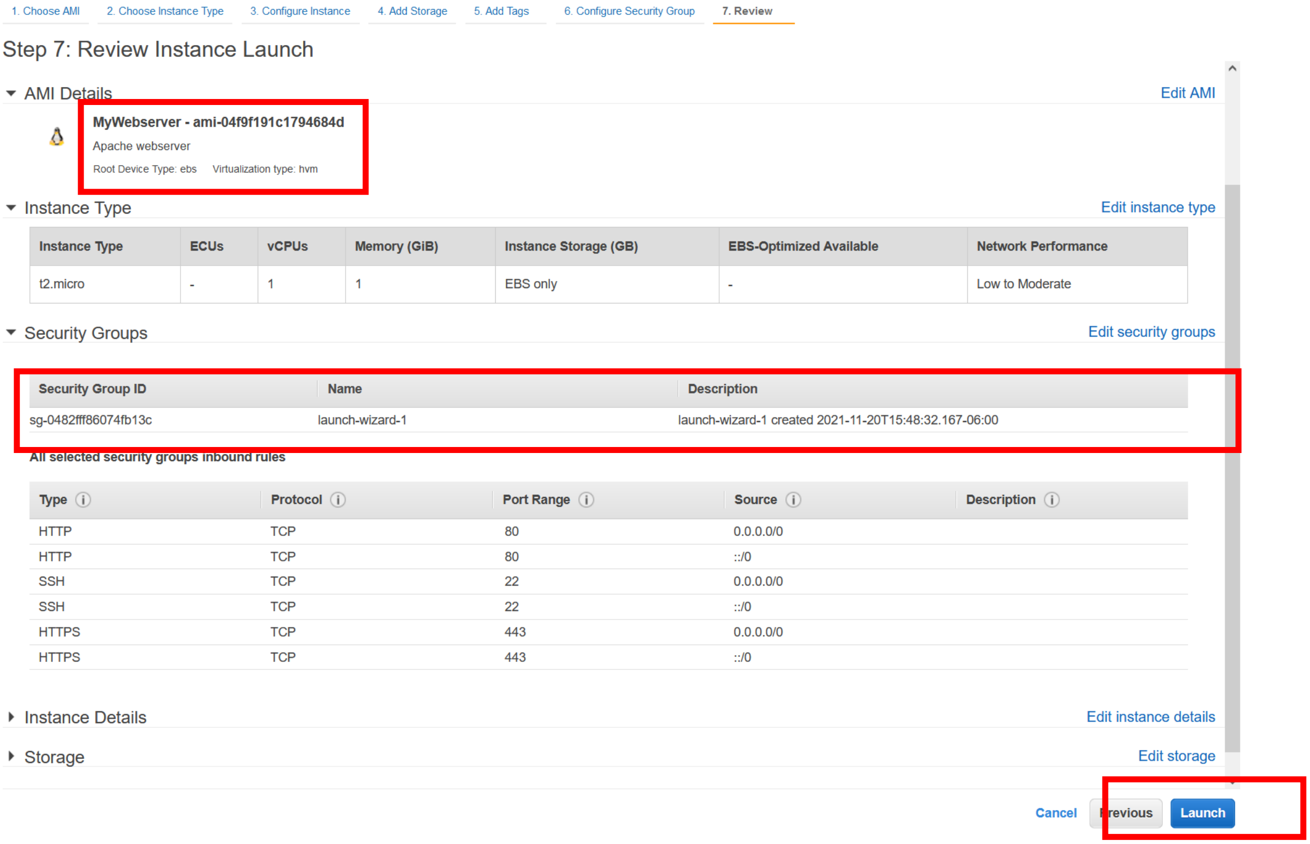
● Select an **existing** security group

	Security Group ID	Name	Description	Actions
☐	sg-0c381f3bdb0b67f95	default	default VPC security group	Copy to new
■	sg-0482fff86074fb13c	launch-wizard-1	launch-wizard-1 created 2021-11-20T15:48:32.167-06:00	Copy to new

Inbound rules for sg-0482fff86074fb13c (Selected security groups: sg-0482fff86074fb13c)

Type	Protocol	Port Range	Source	Description
HTTP	TCP	80	0.0.0.0/0	
HTTP	TCP	80	::/0	
SSH	TCP	22	0.0.0.0/0	
SSH	TCP	22	::/0	
HTTPS	TCP	443	0.0.0.0/0	
HTTPS	TCP	443	::/0	

Review the AMI and Security Group details. Click **Launch** the instance.



Step 7: Review Instance Launch

AMI Details — Edit AMI

MyWebserver - ami-04f9f191c1794684d

Apache webserver

Root Device Type: ebs Virtualization type: hvm

Instance Type — Edit instance type

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
t2.micro	-	1	1	EBS only	-	Low to Moderate

Security Groups — Edit security groups

Security Group ID	Name	Description
sg-0482fff86074fb13c	launch-wizard-1	launch-wizard-1 created 2021-11-20T15:48:32.167-06:00

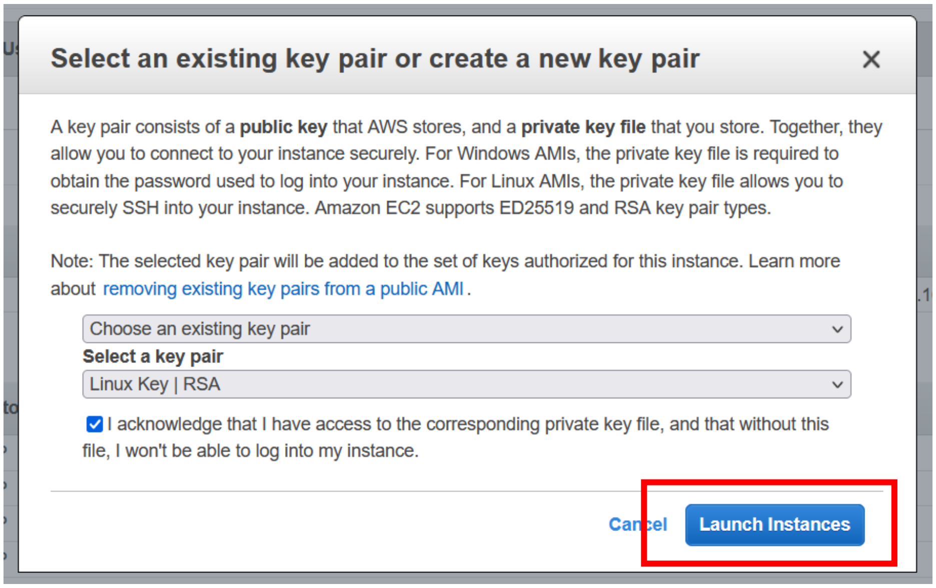
All selected security groups inbound rules

Type	Protocol	Port Range	Source	Description
HTTP	TCP	80	0.0.0.0/0	
HTTP	TCP	80	::/0	
SSH	TCP	22	0.0.0.0/0	
SSH	TCP	22	::/0	
HTTPS	TCP	443	0.0.0.0/0	
HTTPS	TCP	443	::/0	

Instance Details — Edit instance details

Storage — Edit storage

Make sure you have the key pair downloaded from the previous lab, or create a new key pair. Click Launch Instances.



Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance. Amazon EC2 supports ED25519 and RSA key pair types.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about removing existing key pairs from a public AMI .

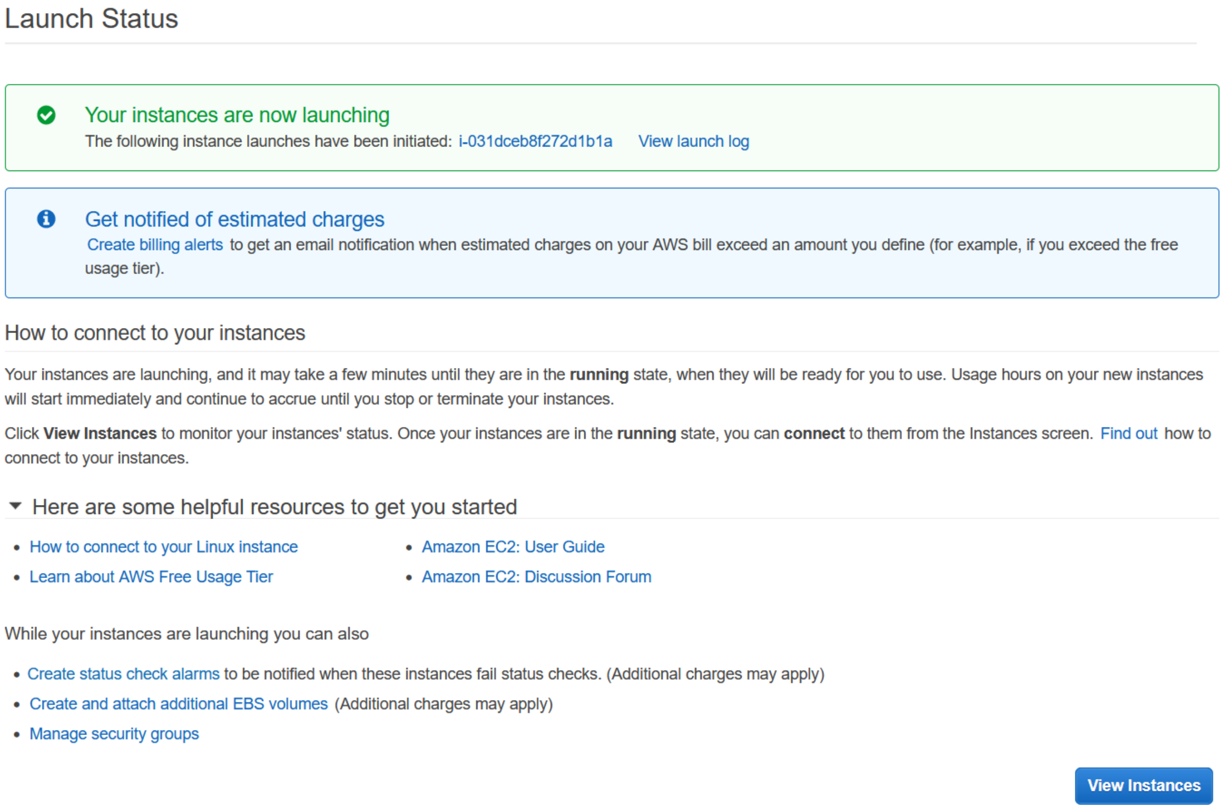
Choose an existing key pair

Select a key pair

Linux Key | RSA

☑ I acknowledge that I have access to the corresponding private key file, and that without this file, I won't be able to log into my instance.

Congratulations! You've created and launched an AMI. You can check the status and view the instances.



Launch Status

Your instances are now launching

The following instance launches have been initiated: i-031dceb8f272d1b1a View launch log

Get notified of estimated charges

Create billing alerts to get an email notification when estimated charges on your AWS bill exceed an amount you define (for example, if you exceed the free usage tier).

How to connect to your instances

Your instances are launching, and it may take a few minutes until they are in the **running** state, when they will be ready for you to use. Usage hours on your new instances will start immediately and continue to accrue until you stop or terminate your instances.

Click **View Instances** to monitor your instances' status. Once your instances are in the **running** state, you can **connect** to them from the Instances screen. Find out how to connect to your instances.

Here are some helpful resources to get you started

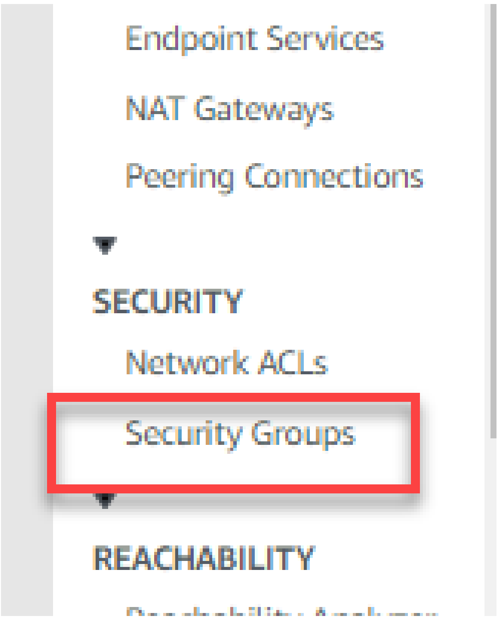
- How to connect to your Linux instance
- Learn about AWS Free Usage Tier
- Amazon EC2: User Guide
- Amazon EC2: Discussion Forum

While your instances are launching you can also

- Create status check alarms to be notified when these instances fail status checks. (Additional charges may apply)
- Create and attach additional EBS volumes (Additional charges may apply)
- Manage security groups

Lab: Create a Security Group for an EC2 Instance

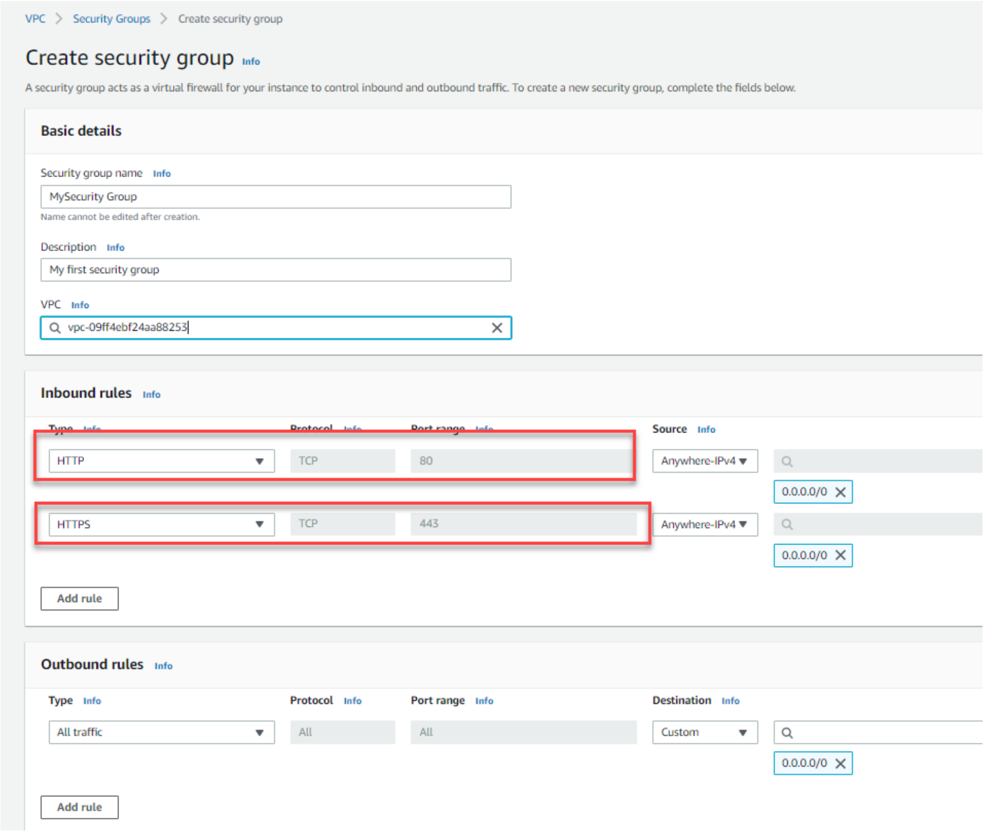
From the management console, navigate to the VPC console.
Open the Amazon VPC console at https://console.aws.amazon.com/vpc/.
Choose **Security Groups** in the navigation pane.



Choose **Create security group**.
Specify a name and description for the security group.

Note: Once created, security group names and descriptions cannot be changed. Choose the target VPC from **VPC**.

Security group inbound and outbound **Rules** can be added now or later.



VPC > Security Groups > Create security group

Create security group Info

A security group acts as a virtual firewall for your instance to control inbound and outbound traffic. To create a new security group, complete the fields below.

Basic details

Security group name Info
MySecurity Group
Name cannot be edited after creation.

Description Info
My first security group

VPC Info
vpc-09ff4ebf24aa88253

Inbound rules Info

Type Info	Protocol Info	Port range Info	Source Info	
HTTP	TCP	80	Anywhere-IPv4	0.0.0.0/0
HTTPS	TCP	443	Anywhere-IPv4	0.0.0.0/0

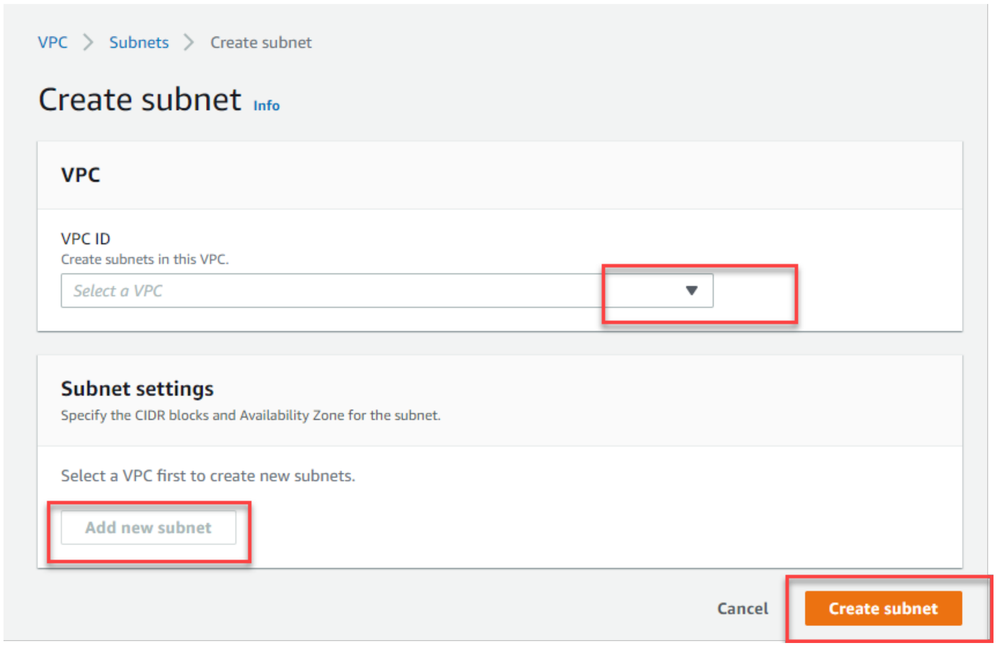
Add rule

Outbound rules Info

Type Info	Protocol Info	Port range Info	Destination Info	
All traffic	All	All	Custom	0.0.0.0/0

Add rule

Tags can be added now or later. Choose **Add new tag** and enter the tag key and value. Choose **Create security group**.



VPC > Subnets > Create subnet

Create subnet Info

VPC

VPC ID
Create subnets in this VPC.
Select a VPC

Subnet settings
Specify the CIDR blocks and Availability Zone for the subnet.

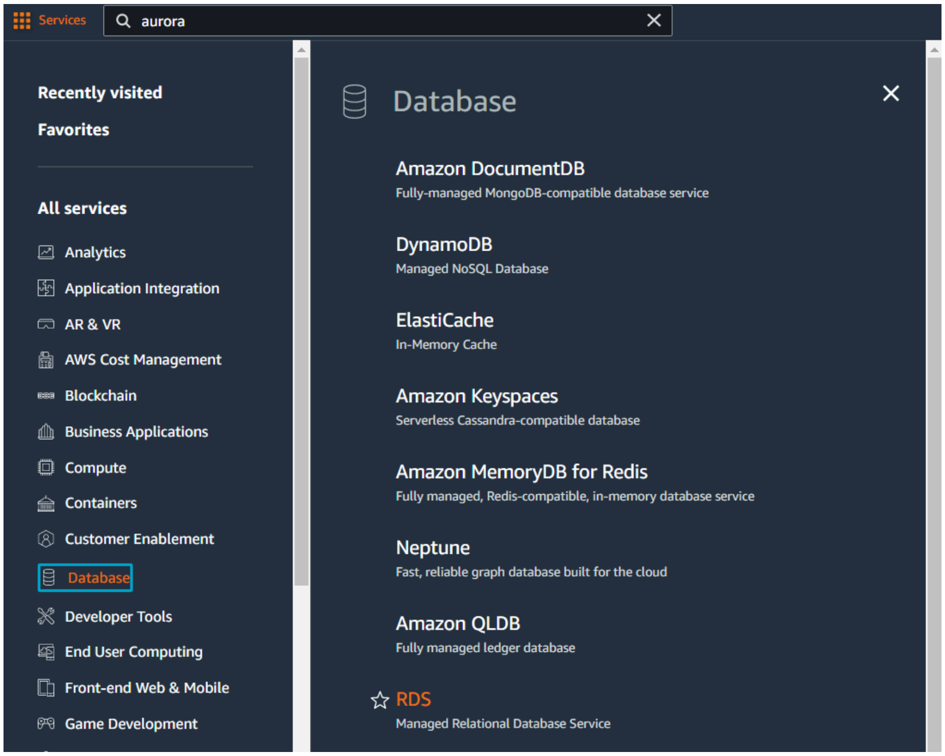
Select a VPC first to create new subnets.

Select the newly created VPC (MYVPC).

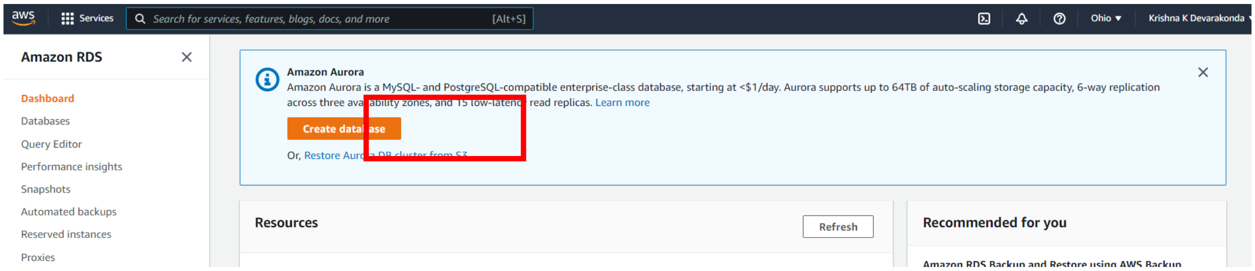
Chapter 5 Labs

Lab: Create an Amazon Aurora (Relational Database)

Log in to AWS Management Console.
Navigate to Services Database RDS databases as shown below:



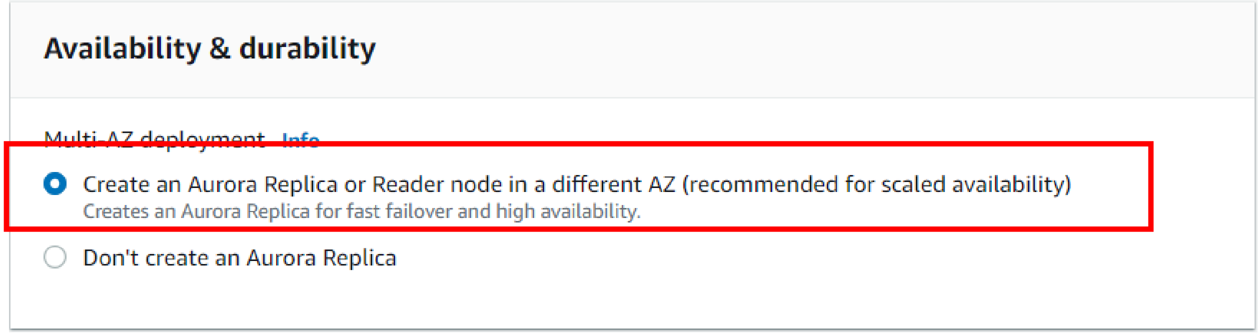
Click on Create Database under Amazon Aurora.



Amazon Aurora
Amazon Aurora is a MySQL- and PostgreSQL-compatible enterprise-class database, starting at <$1/day. Aurora supports up to 64TB of auto-scaling storage capacity, 6-way replication across three availability zones, and 15 low-latency read replicas. Learn more

Or, Restore Aurora DB cluster from S3

Pick defaults for everything except for Availability & Durability.



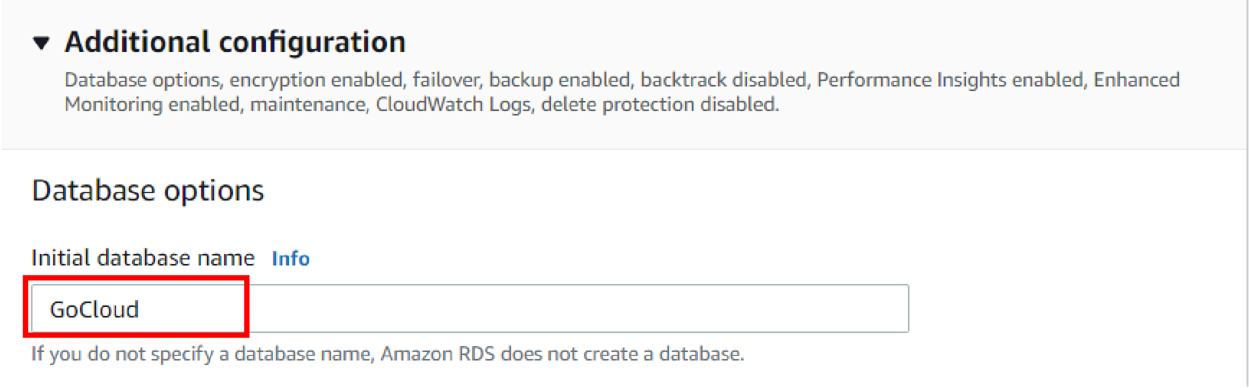
Availability & durability

Multi-AZ deployment Info

● Create an Aurora Replica or Reader node in a different AZ (recommended for scaled availability)
Creates an Aurora Replica for fast failover and high availability.

○ Don't create an Aurora Replica

Under Advanced configuration, enter “Initial database name”,



▼ Additional configuration
Database options, encryption enabled, failover, backup enabled, backtrack disabled, Performance Insights enabled, Enhanced Monitoring enabled, maintenance, CloudWatch Logs, delete protection disabled.

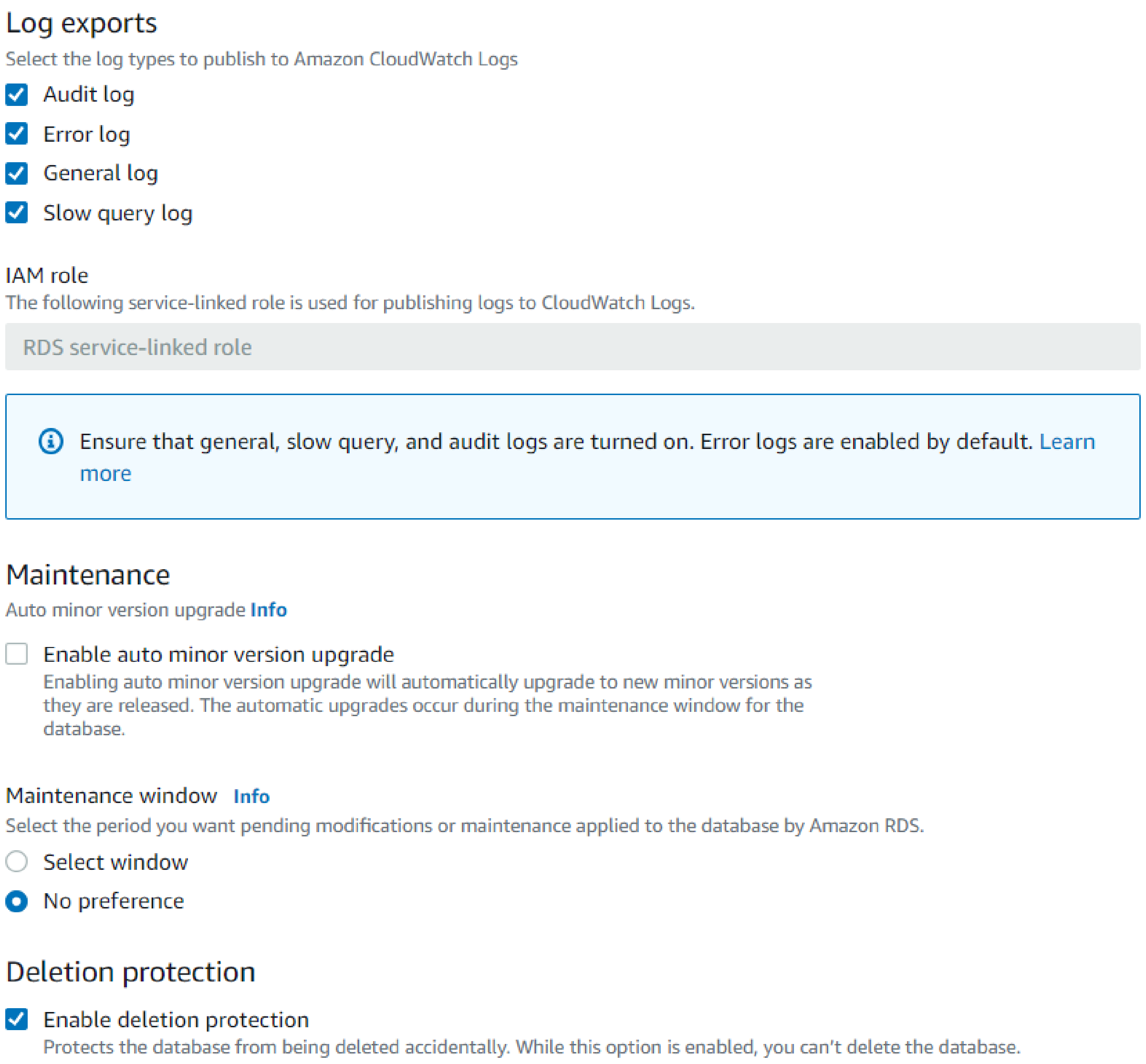
Database options

Initial database name Info

GoCloud

If you do not specify a database name, Amazon RDS does not create a database.

Check “Log exports” as needed, check “Deletion protection”.



Log exports

Select the log types to publish to Amazon CloudWatch Logs

☑ Audit log

☑ Error log

☑ General log

☑ Slow query log

IAM role

The following service-linked role is used for publishing logs to CloudWatch Logs.

RDS service-linked role

Ensure that general, slow query, and audit logs are turned on. Error logs are enabled by default. Learn more

Maintenance

Auto minor version upgrade Info

☐ Enable auto minor version upgrade

Enabling auto minor version upgrade will automatically upgrade to new minor versions as they are released. The automatic upgrades occur during the maintenance window for the database.

Maintenance window Info

Select the period you want pending modifications or maintenance applied to the database by Amazon RDS.

○ Select window

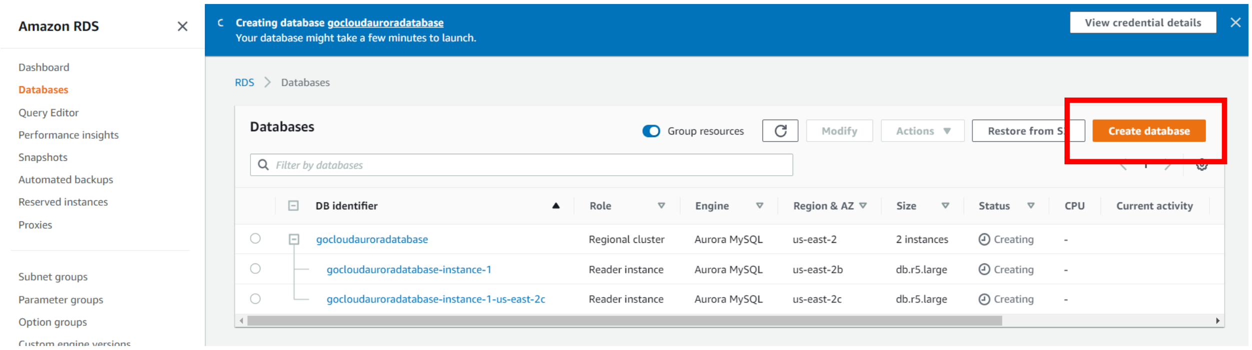
● No preference

Deletion protection

☑ Enable deletion protection

Protects the database from being deleted accidentally. While this option is enabled, you can't delete the database.

Click on “Create Database” and you will land on RDS Databases dashboard with “Creating” status



Creating database gocloudauroradatabase

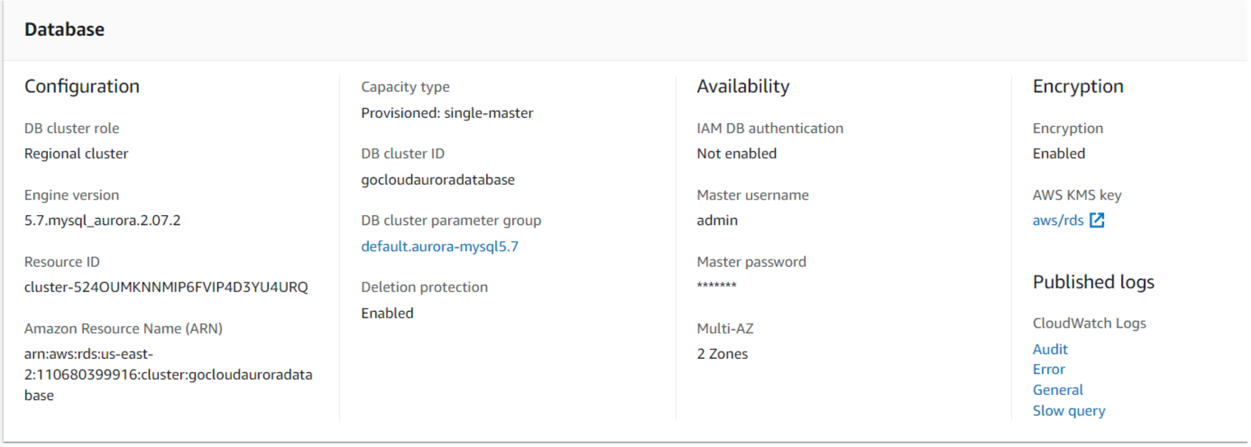
Your database might take a few minutes to launch.

RDS > Databases

Databases

	DB identifier	Role	Engine	Region & AZ	Size	Status	CPU	Current activity
○	gocloudauroradatabase	Regional cluster	Aurora MySQL	us-east-2	2 instances	Creating	-	
○	gocloudauroradatabase-instance-1	Reader instance	Aurora MySQL	us-east-2b	db.r5.large	Creating	-	
○	gocloudauroradatabase-instance-1-us-east-2c	Reader instance	Aurora MySQL	us-east-2c	db.r5.large	Creating	-	

Click on the database, and navigate to “Configuration” tab to view the configuration of your database.



Database

Configuration

DB cluster role
Regional cluster

Engine version
5.7.mysql_aurora.2.07.2

Resource ID
cluster-524OUMKNNMIP6FVIP4D3YU4URQ

Amazon Resource Name (ARN)
arn:aws:rds:us-east-2:110680399916:cluster:gocloudauroradatabase

Capacity type
Provisioned: single-master

DB cluster ID
gocloudauroradatabase

DB cluster parameter group
default.aurora-mysql5.7

Deletion protection
Enabled

Availability

IAM DB authentication
Not enabled

Master username
admin

Master password
****

Multi-AZ
2 Zones

Encryption

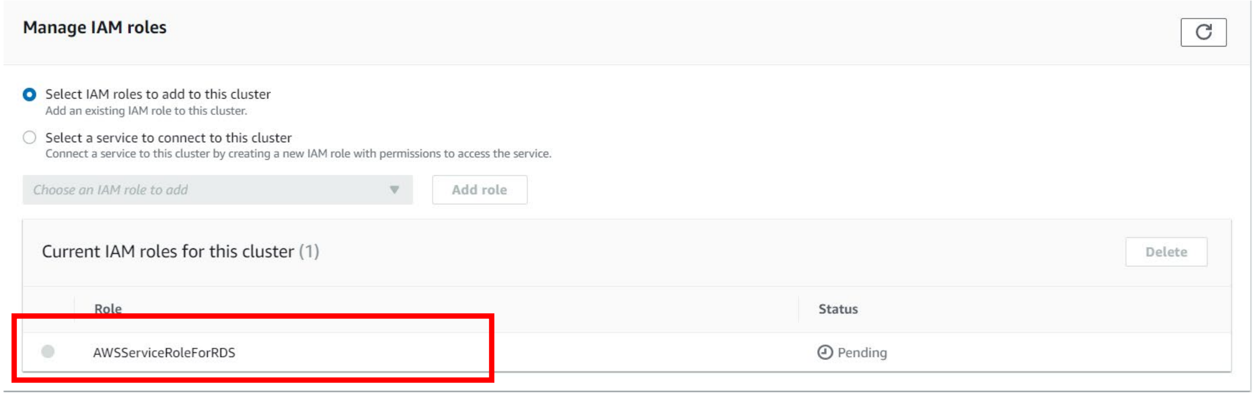
Encryption
Enabled

AWS KMS key
aws/rds

Published logs

CloudWatch Logs
Audit
Error
General
Slow query

On the “Connectivity & security” tab, under “Manage IAM roles”, check “Select IAM roles to add to this cluster” option and choose “AWSServiceRoleForRDS”. Click on “Add Role”.



Manage IAM roles

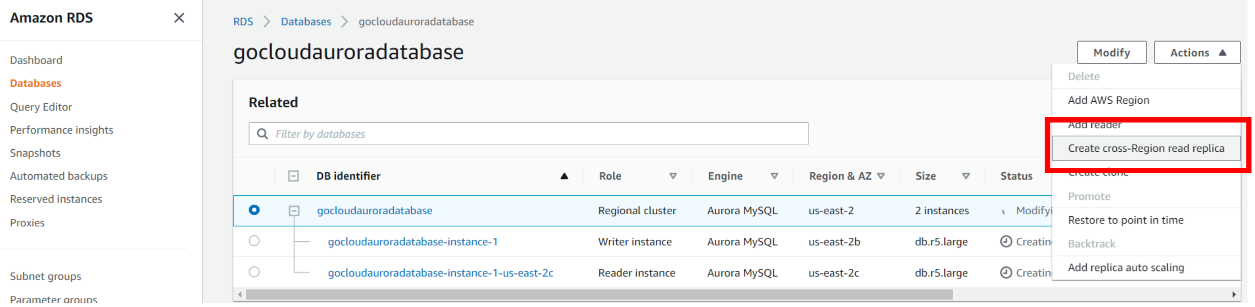
● Select IAM roles to add to this cluster
Add an existing IAM role to this cluster.

○ Select a service to connect to this cluster
Connect a service to this cluster by creating a new IAM role with permissions to access the service.

Current IAM roles for this cluster (1)

Role	Status
AWSServiceRoleForRDS	Pending

To Create database across multiple regions, we can choose the below option.

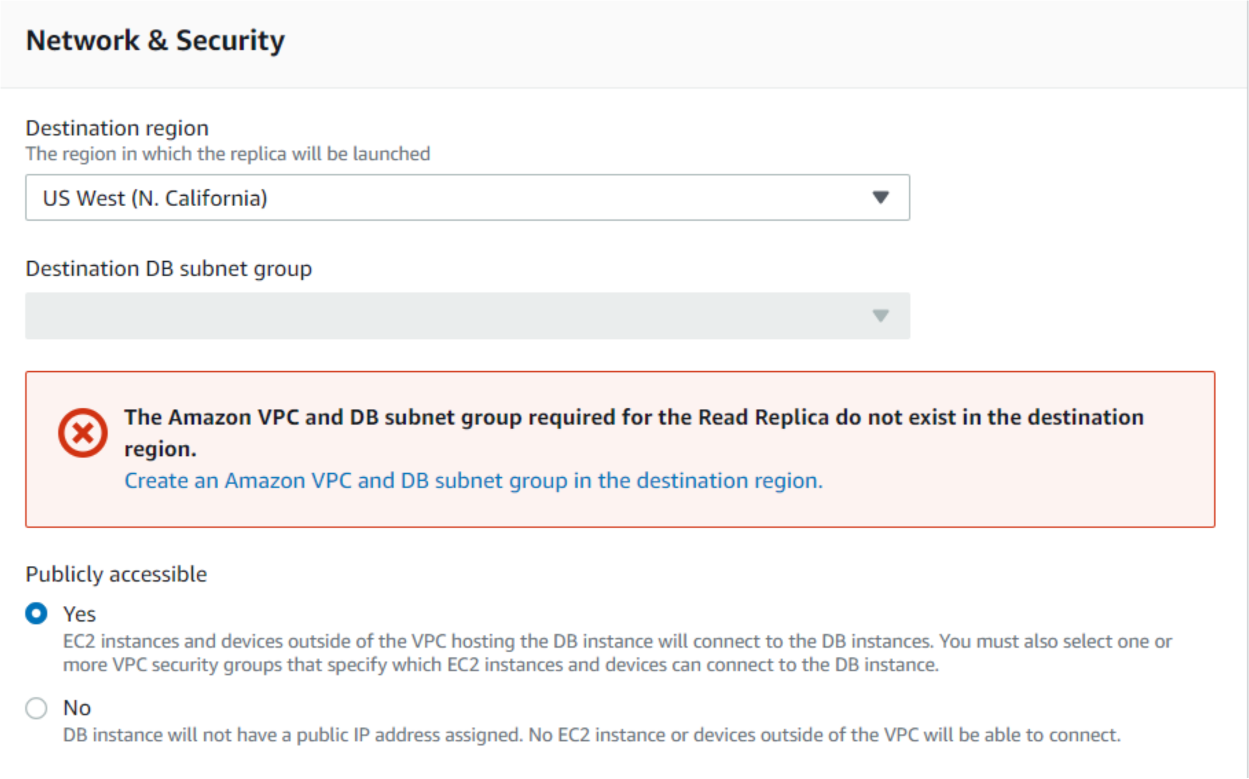


gocloudauroradatabase

Related

DB identifier	Role	Engine	Region & AZ	Size	Status
gocloudauroradatabase	Regional cluster	Aurora MySQL	us-east-2	2 instances	Modifyi
gocloudauroradatabase-instance-1	Writer instance	Aurora MySQL	us-east-2b	db.r5.large	Creatin
gocloudauroradatabase-instance-1-us-east-2c	Reader instance	Aurora MySQL	us-east-2c	db.r5.large	Creatin

If you run into DB Subnet group error, follow steps 11 to 14. Otherwise, skip to step 15.



Network & Security

Destination region
The region in which the replica will be launched

US West (N. California) ▼

Destination DB subnet group

▼

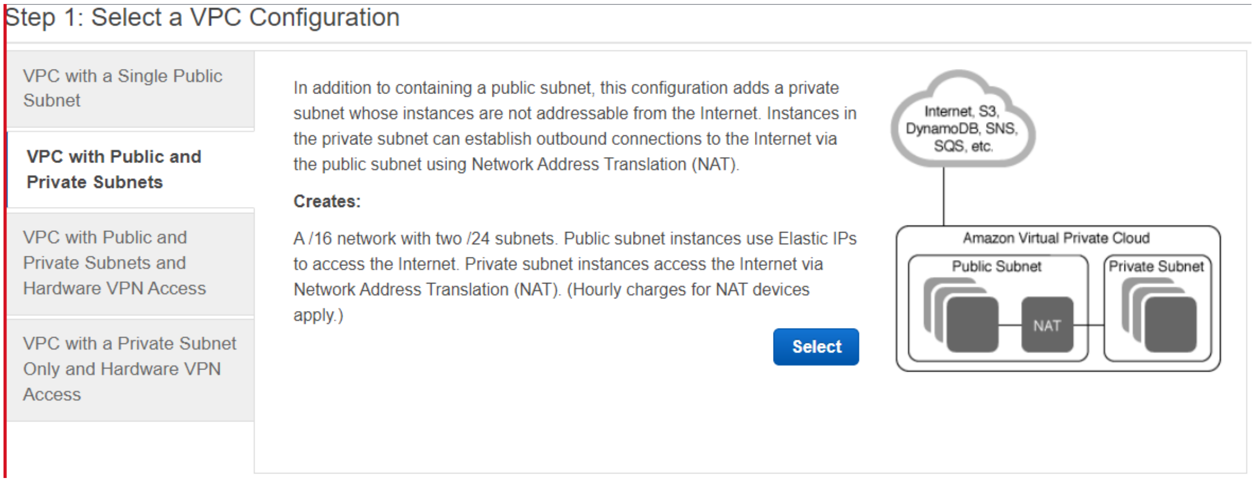
The Amazon VPC and DB subnet group required for the Read Replica do not exist in the destination region.
Create an Amazon VPC and DB subnet group in the destination region.

Publicly accessible

● Yes
EC2 instances and devices outside of the VPC hosting the DB instance will connect to the DB instances. You must also select one or more VPC security groups that specify which EC2 instances and devices can connect to the DB instance.

○ No
DB instance will not have a public IP address assigned. No EC2 instance or devices outside of the VPC will be able to connect.

Create new VPC under cross regions (here we picked us-west).



Step 1: Select a VPC Configuration

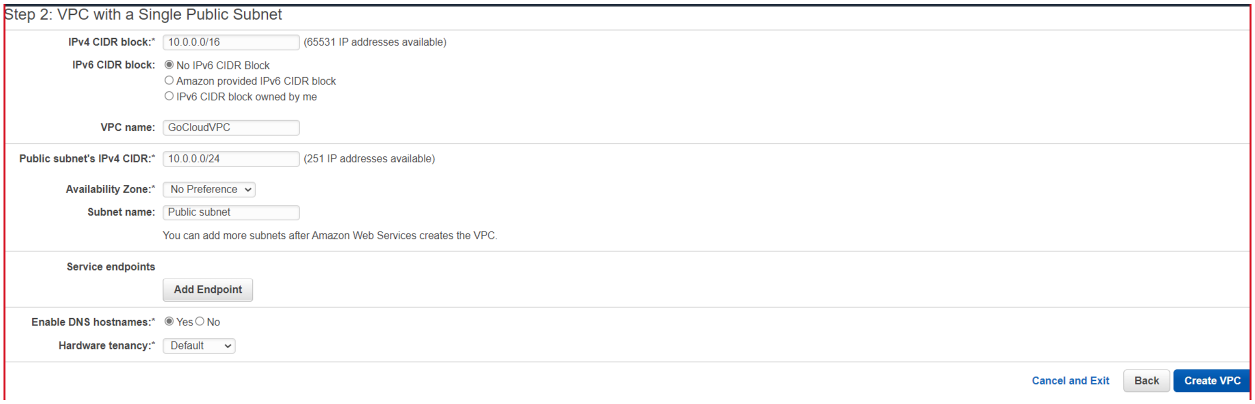
- VPC with a Single Public Subnet
- **VPC with Public and Private Subnets**
- VPC with Public and Private Subnets and Hardware VPN Access
- VPC with a Private Subnet Only and Hardware VPN Access

In addition to containing a public subnet, this configuration adds a private subnet whose instances are not addressable from the Internet. Instances in the private subnet can establish outbound connections to the Internet via the public subnet using Network Address Translation (NAT).

Creates:

A /16 network with two /24 subnets. Public subnet instances use Elastic IPs to access the Internet. Private subnet instances access the Internet via Network Address Translation (NAT). (Hourly charges for NAT devices apply.)

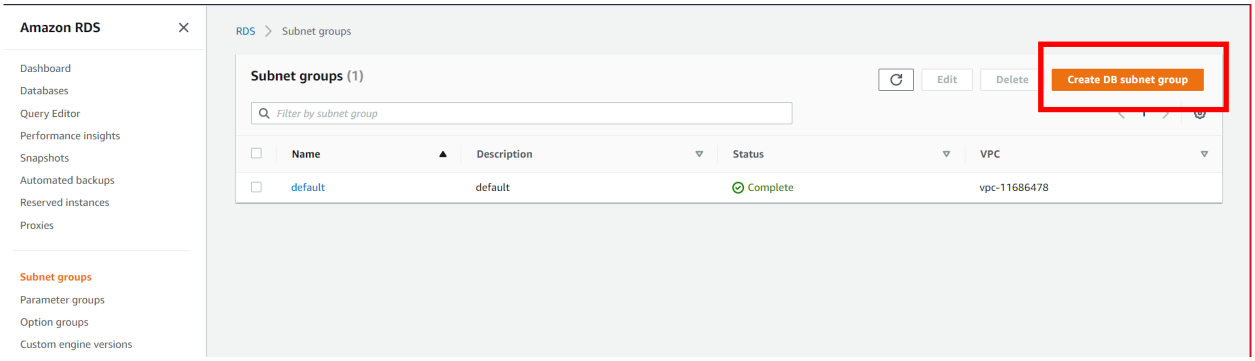
Select
Internet, S3, DynamoDB, SNS, SQS, etc.
Amazon Virtual Private Cloud
Public Subnet
NAT
Private Subnet



Step 2: VPC with a Single Public Subnet

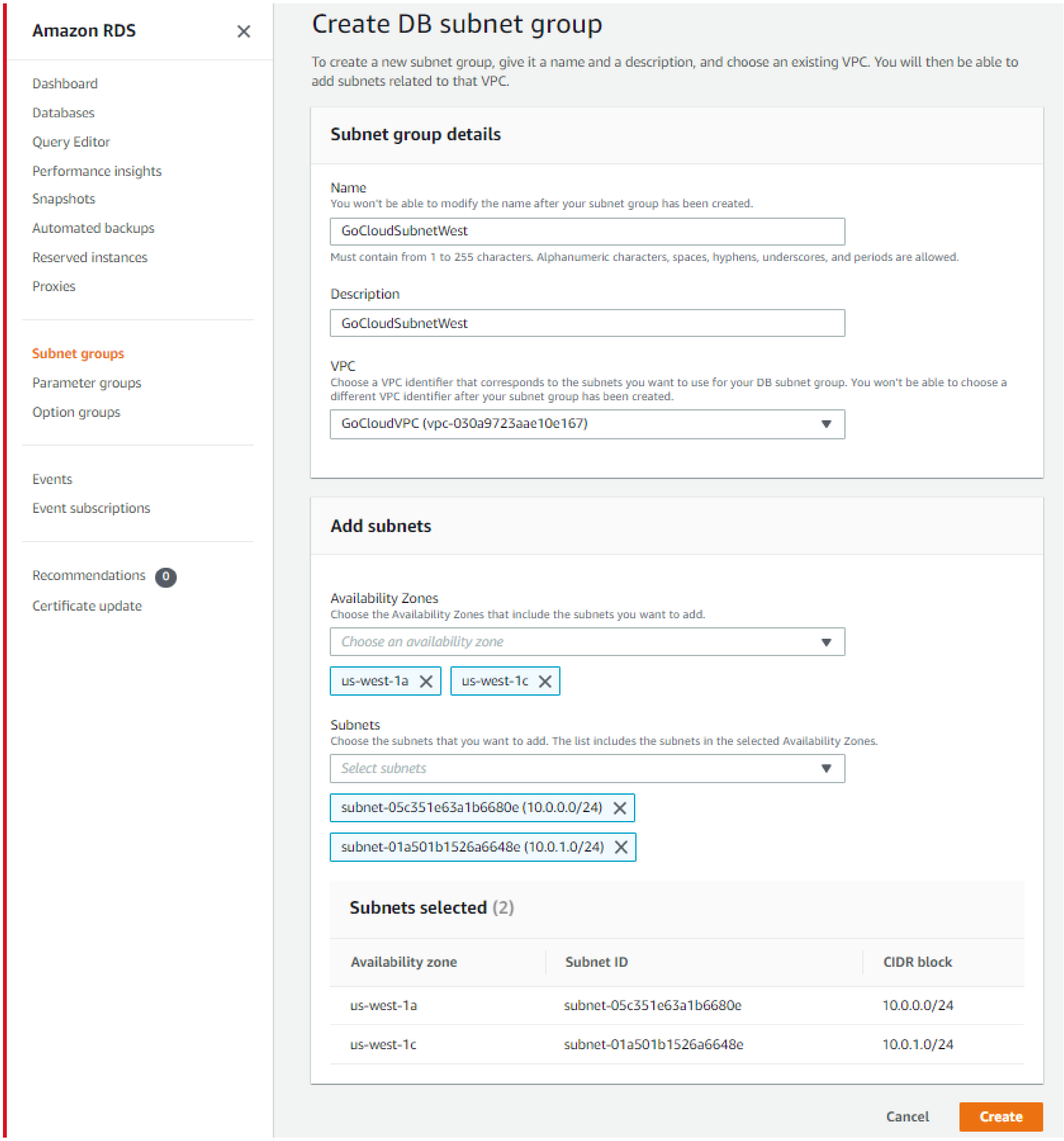
IPv4 CIDR block:*	10.0.0.0/16 (65531 IP addresses available)
IPv6 CIDR block:	● No IPv6 CIDR Block ○ Amazon provided IPv6 CIDR block ○ IPv6 CIDR block owned by me
VPC name:	GoCloudVPC
Public subnet's IPv4 CIDR:*	10.0.0.0/24 (251 IP addresses available)
Availability Zone:*	No Preference
Subnet name:	Public subnet
	You can add more subnets after Amazon Web Services creates the VPC.
Service endpoints	
Enable DNS hostnames:*	● Yes ○ No
Hardware tenancy:*	Default

Create a new DB subnet group.



Subnet groups (1)

□	Name	Description	Status	VPC
□	default	default	✓ Complete	vpc-11686478



Create DB subnet group

To create a new subnet group, give it a name and a description, and choose an existing VPC. You will then be able to add subnets related to that VPC.

Subnet group details

Name
You won't be able to modify the name after your subnet group has been created.
GoCloudSubnetWest
Must contain from 1 to 255 characters. Alphanumeric characters, spaces, hyphens, underscores, and periods are allowed.

Description
GoCloudSubnetWest

VPC
Choose a VPC identifier that corresponds to the subnets you want to use for your DB subnet group. You won't be able to choose a different VPC identifier after your subnet group has been created.
GoCloudVPC (vpc-030a9723aae10e167)

Add subnets

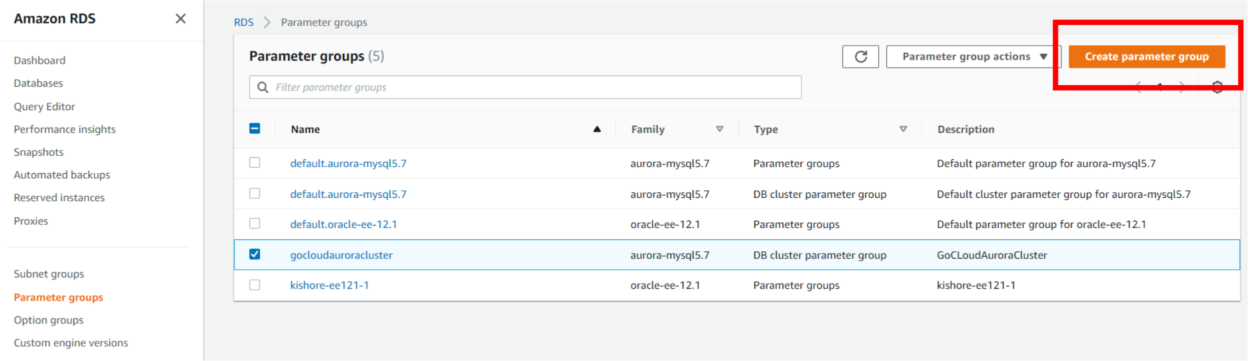
Availability Zones
Choose the Availability Zones that include the subnets you want to add.
Choose an availability zone
us-west-1a
us-west-1c

Subnets
Choose the subnets that you want to add. The list includes the subnets in the selected Availability Zones.
Select subnets
subnet-05c351e63a1b6680e (10.0.0.0/24)
subnet-01a501b1526a6648e (10.0.1.0/24)

Subnets selected (2)

Availability zone	Subnet ID	CIDR block
us-west-1a	subnet-05c351e63a1b6680e	10.0.0.0/24
us-west-1c	subnet-01a501b1526a6648e	10.0.1.0/24

Create DB cluster group.

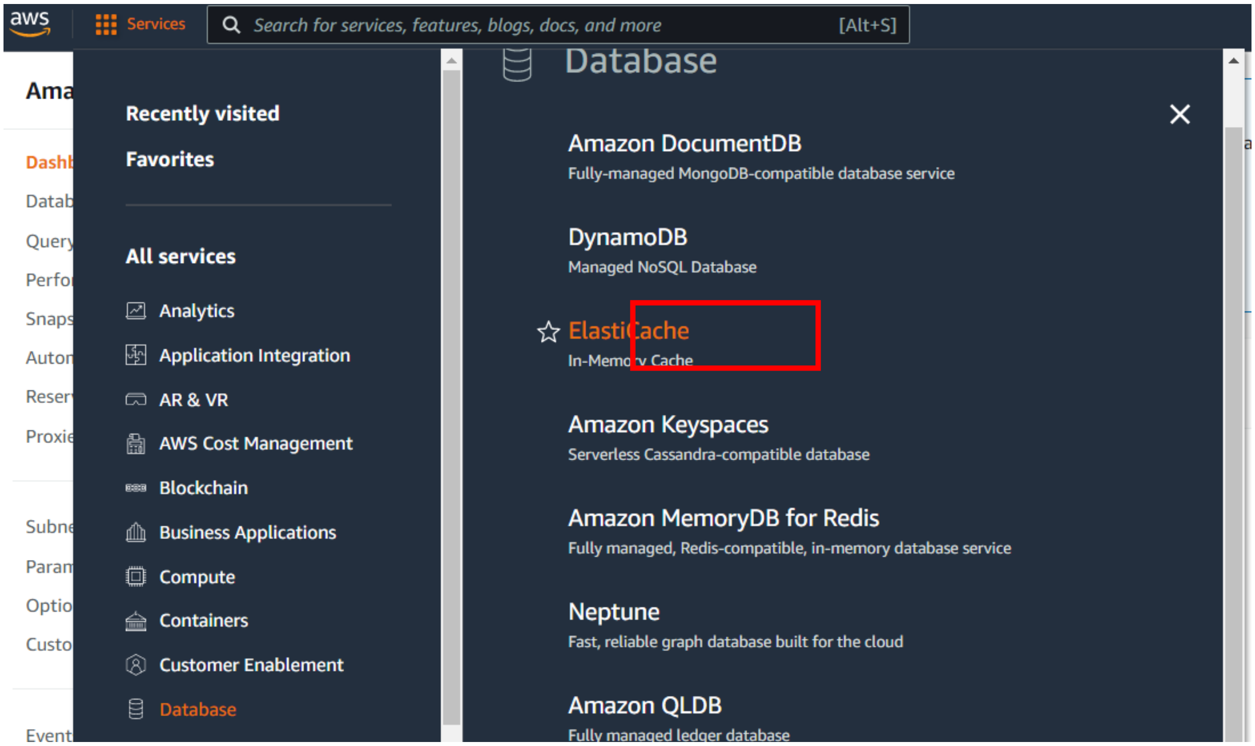


Parameter groups (5)

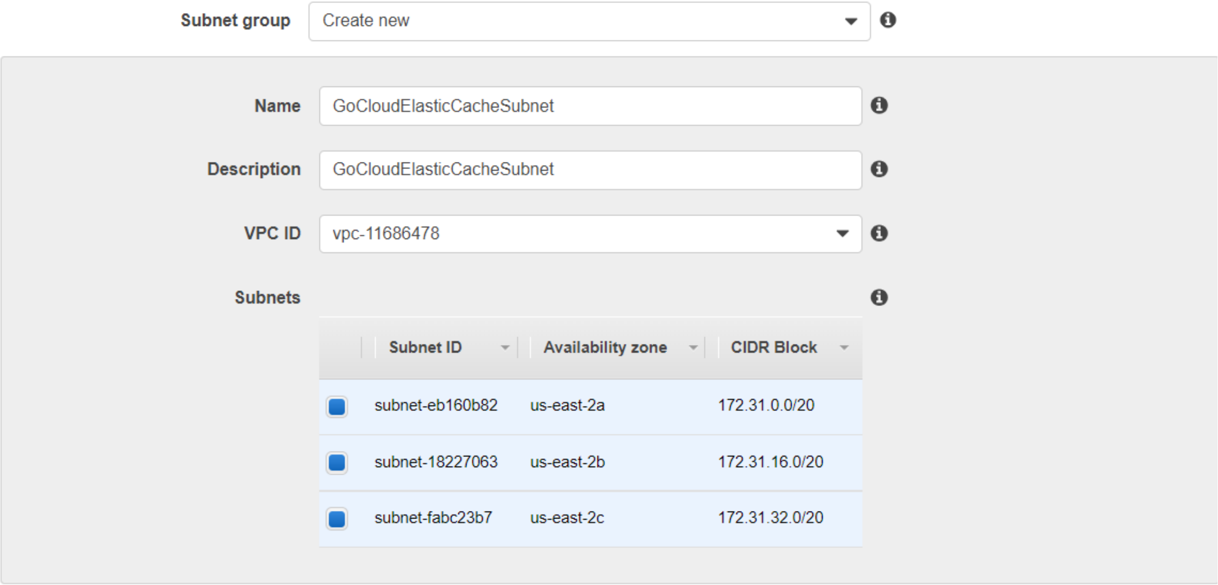
	Name	Family	Type	Description
□	default.aurora-mysql5.7	aurora-mysql5.7	Parameter groups	Default parameter group for aurora-mysql5.7
□	default.aurora-mysql5.7	aurora-mysql5.7	DB cluster parameter group	Default cluster parameter group for aurora-mysql5.7
□	default.oracle-ee-12.1	oracle-ee-12.1	Parameter groups	Default parameter group for oracle-ee-12.1
☑	gocloudauroracluster	aurora-mysql5.7	DB cluster parameter group	GoCLoudAuroraCluster
□	kishore-ee121-1	oracle-ee-12.1	Parameter groups	kishore-ee121-1

Modify the Aurora Database configuration to use the new DB cluster group. Stop & Start the RDS main cluster instance after modifying the configuration for synchronizing before creating the “Cross-region Replica”.

Lab: Set Up Elastic Cache For Database Caching



Create a new subnet group with the existing subnets in that AZ.



Subnet group: Create new

Name: GoCloudElasticCacheSubnet

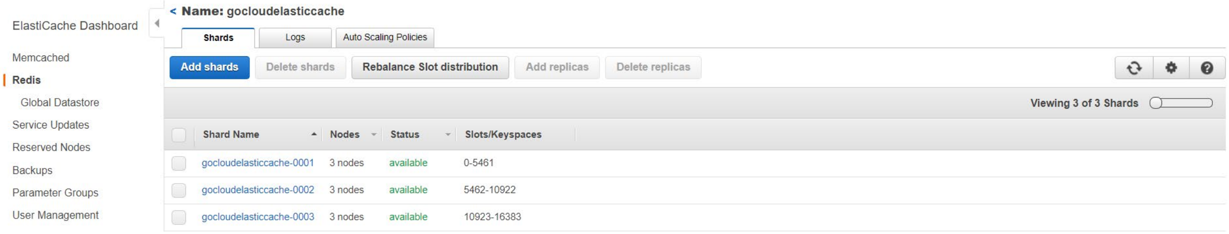
Description: GoCloudElasticCacheSubnet

VPC ID: vpc-11686478

Subnets

	Subnet ID	Availability zone	CIDR Block
■	subnet-eb160b82	us-east-2a	172.31.0.0/20
■	subnet-18227063	us-east-2b	172.31.16.0/20
■	subnet-fabc23b7	us-east-2c	172.31.32.0/20

Once created, it should look like this:



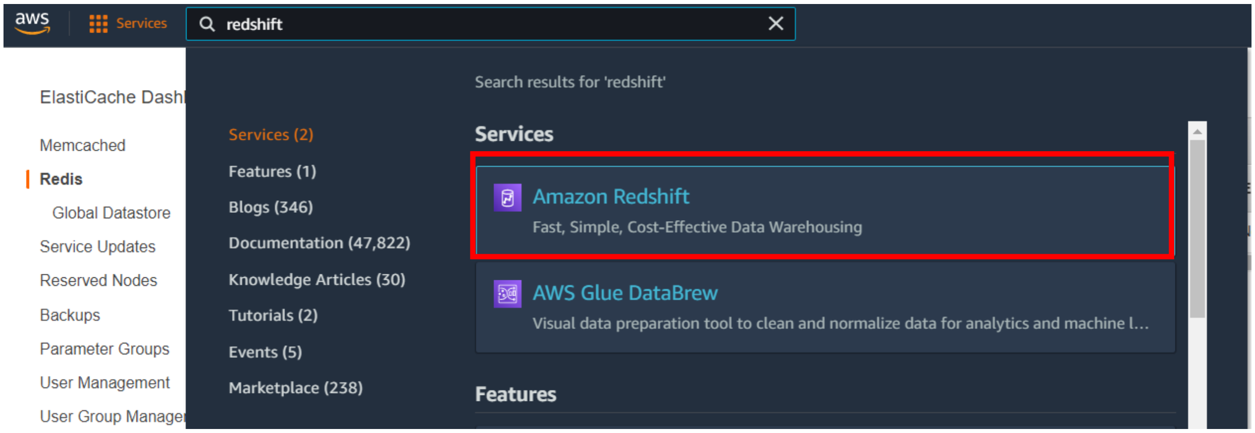
< **Name:** gocloudelasticcache

Viewing 3 of 3 Shards

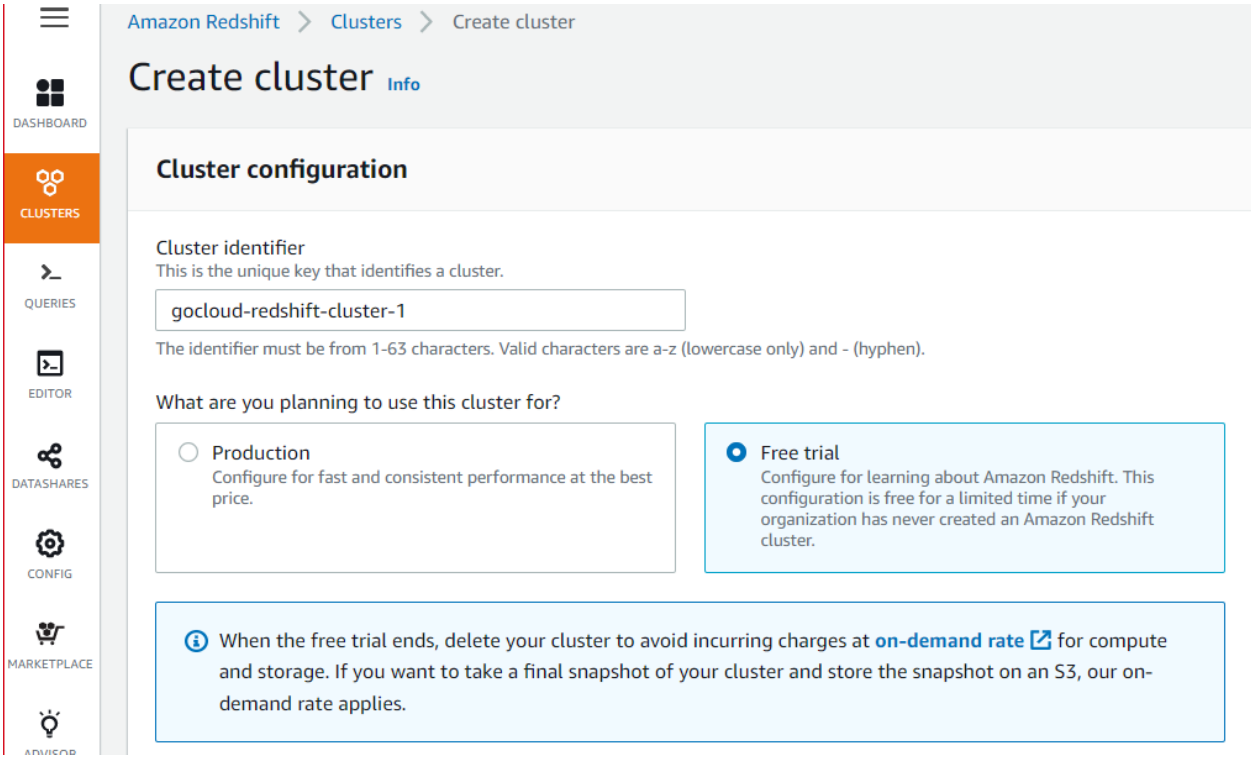
Shard Name	Nodes	Status	Slots/Keyspaces
gocloudelasticcache-0001	3 nodes	available	0-5461
gocloudelasticcache-0002	3 nodes	available	5462-10922
gocloudelasticcache-0003	3 nodes	available	10923-16383

Lab: Set up an Amazon Redshift Data Warehouse

Select Redshift service.



Create Cluster by specifying a username and password.



Create cluster Info

Cluster configuration

Cluster identifier
This is the unique key that identifies a cluster.

gocloud-redshift-cluster-1

The identifier must be from 1-63 characters. Valid characters are a-z (lowercase only) and - (hyphen).

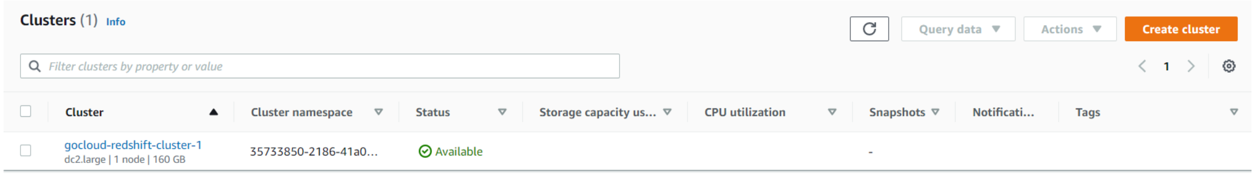
What are you planning to use this cluster for?

○ Production
Configure for fast and consistent performance at the best price.

● Free trial
Configure for learning about Amazon Redshift. This configuration is free for a limited time if your organization has never created an Amazon Redshift cluster.

ⓘ When the free trial ends, delete your cluster to avoid incurring charges at **on-demand rate** for compute and storage. If you want to take a final snapshot of your cluster and store the snapshot on an S3, our on-demand rate applies.

Once RedShift is created, it should look like this:

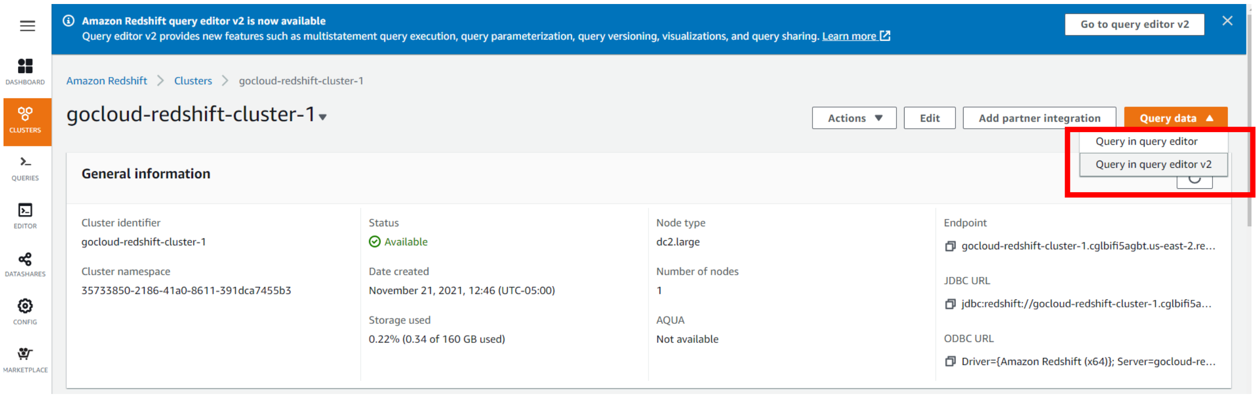


Clusters (1) Info

Filter clusters by property or value

Cluster	Cluster namespace	Status	Storage capacity us...	CPU utilization	Snapshots	Notificati...	Tags
gocloud-redshift-cluster-1 dc2.large | 1 node | 160 GB	35733850-2186-41a0...	Available			-		

To Connect to the database and run queries, choose "Query in query editor v2" option.



Amazon Redshift query editor v2 is now available
Query editor v2 provides new features such as multistatement query execution, query parameterization, query versioning, visualizations, and query sharing. Learn more

Amazon Redshift > Clusters > gocloud-redshift-cluster-1

gocloud-redshift-cluster-1

General information

Cluster identifier
gocloud-redshift-cluster-1

Cluster namespace
35733850-2186-41a0-8611-391dca7455b3

Status
Available

Date created
November 21, 2021, 12:46 (UTC-05:00)

Storage used
0.22% (0.34 of 160 GB used)

Node type
dc2.large

Number of nodes
1

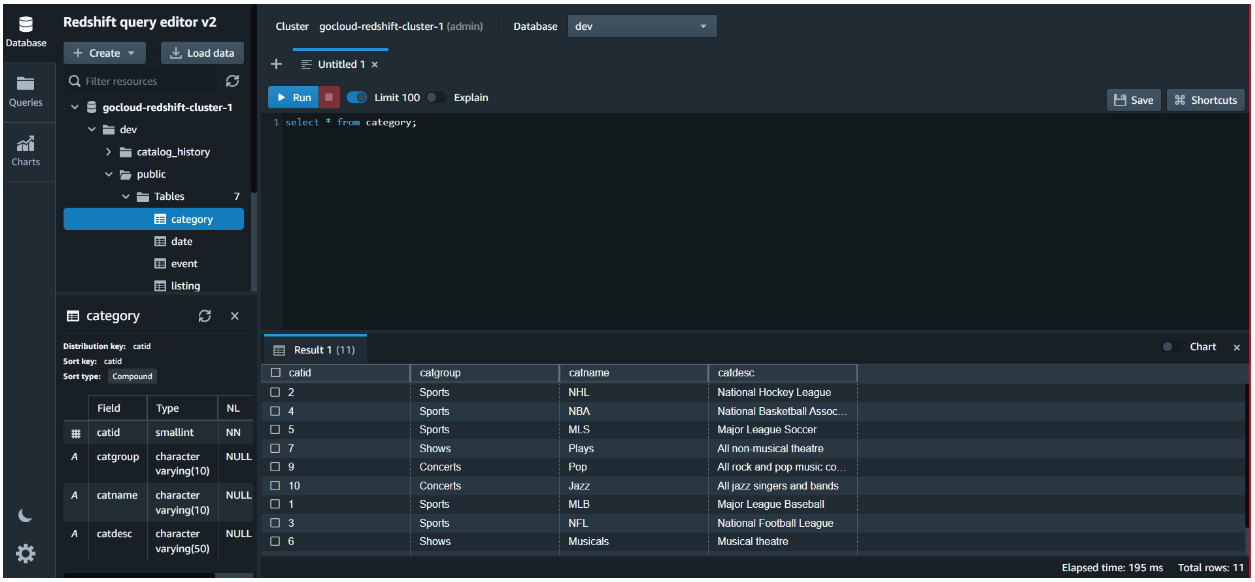
AQUA
Not available

Endpoint
gocloud-redshift-cluster-1.cglbifi5agbt.us-east-2.re...

JDBC URL
jdbc:redshift://gocloud-redshift-cluster-1.cglbifi5a...

ODBC URL
Driver={Amazon Redshift (x64)}; Server=gocloud-re...

Querying the database using V2 editor.



Redshift query editor v2

Cluster gocloud-redshift-cluster-1 (admin) Database dev

Untitled 1

Limit 100

```
select * from category;
```

category

Distribution key: catid
Sort key: catid
Sort type: Compound

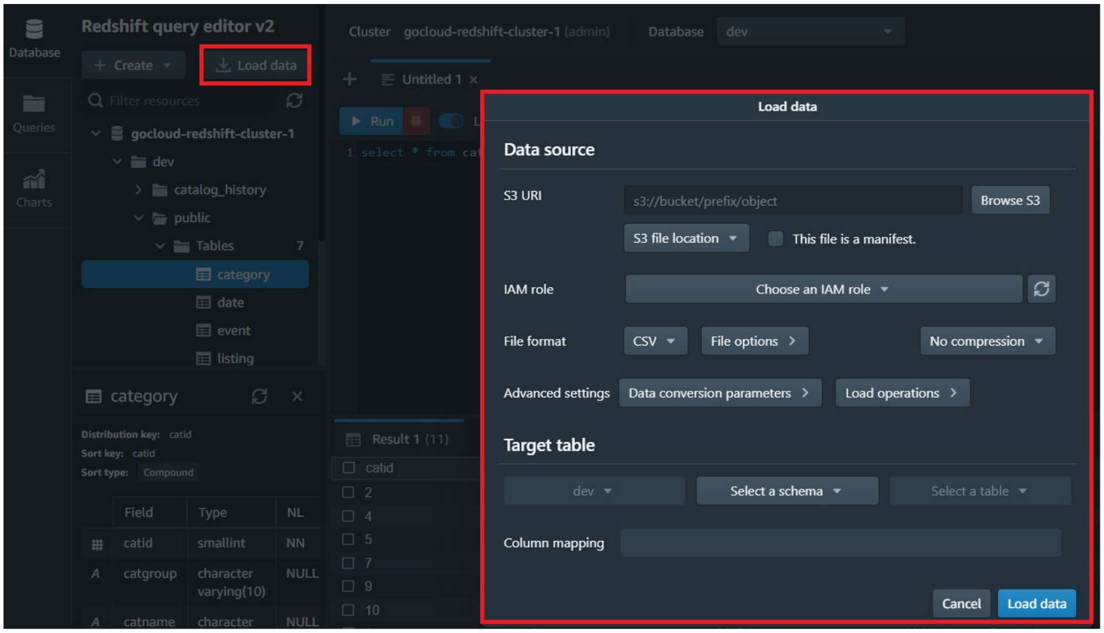
	Field	Type	NL
#	catid	smallint	NN
A	catgroup	character varying(10)	NULL
A	catname	character varying(10)	NULL
A	catdesc	character varying(50)	NULL

Result 1 (11)

catid	catgroup	catname	catdesc
2	Sports	NHL	National Hockey League
4	Sports	NBA	National Basketball Assoc...
5	Sports	MLS	Major League Soccer
7	Shows	Plays	All non-musical theatre
9	Concerts	Pop	All rock and pop music co...
10	Concerts	Jazz	All jazz singers and bands
1	Sports	MLB	Major League Baseball
3	Sports	NFL	National Football League
6	Shows	Musicals	Musical theatre

Elapsed time: 195 ms Total rows: 11

To load data into Redshift, select a data source



Load data

Data source

S3 URI: s3://bucket/prefix/object — Browse S3

S3 file location — □ This file is a manifest.

IAM role: Choose an IAM role

File format: CSV — File options — No compression

Advanced settings: Data conversion parameters — Load operations

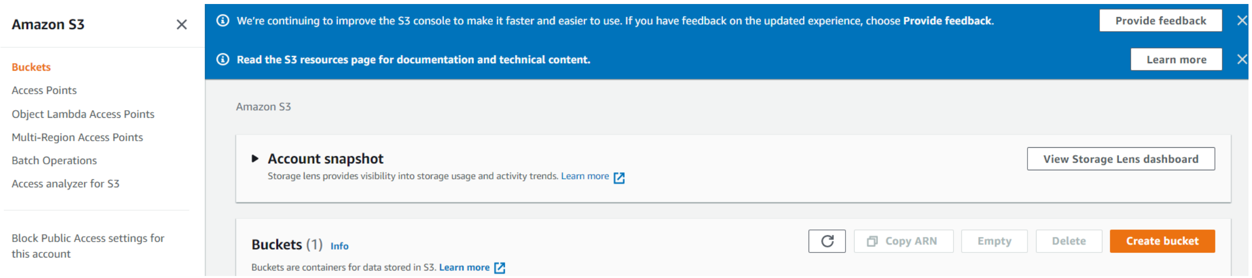
Target table

dev — Select a schema — Select a table

Column mapping

Cancel — Load data

Create S3 bucket – Uncheck "Block all public access" for the DEMO purpose only. Enable Bucket versioning as needed.



We're continuing to improve the S3 console to make it faster and easier to use. If you have feedback on the updated experience, choose **Provide feedback**.

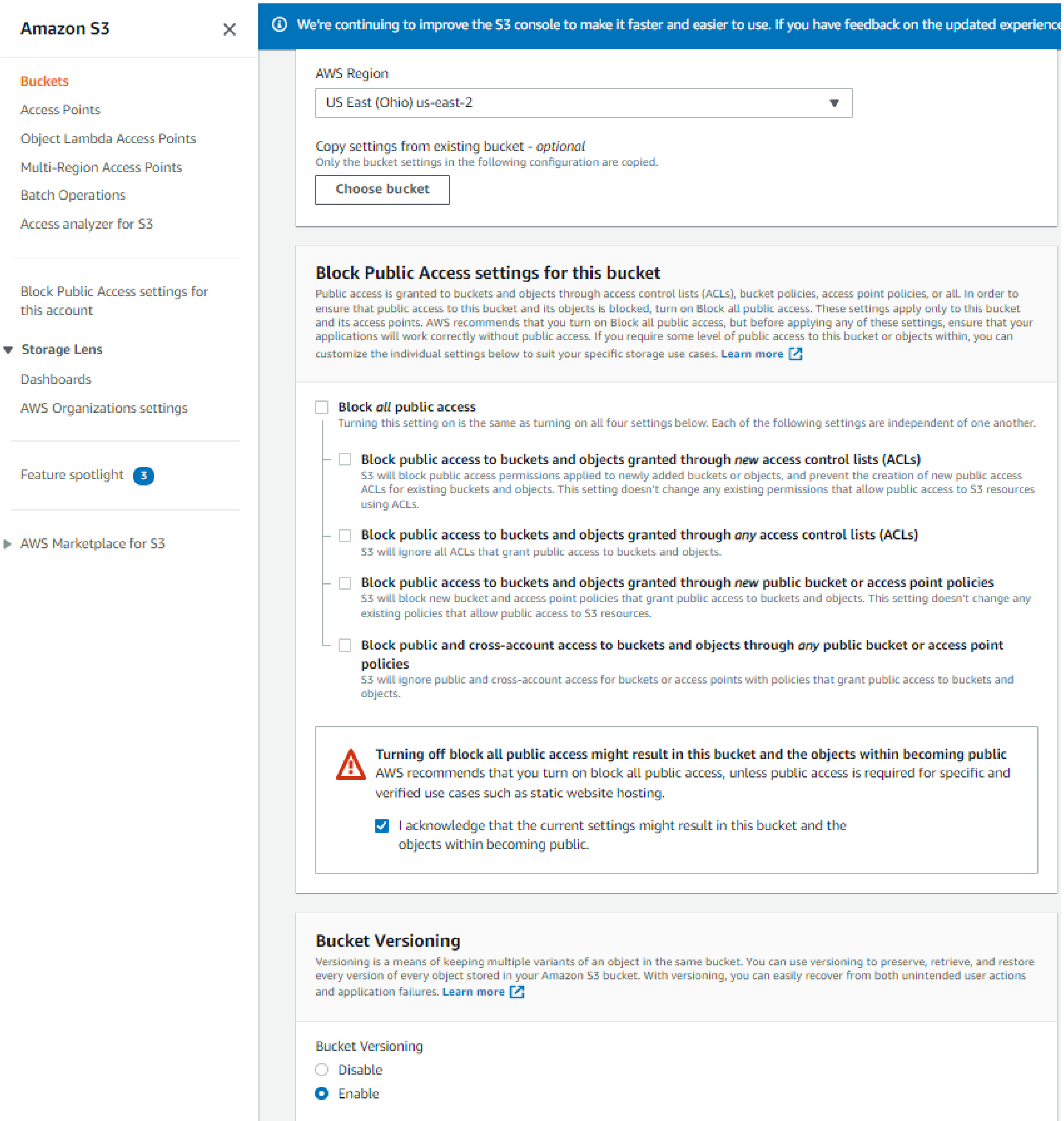
Read the S3 resources page for documentation and technical content.

Account snapshot

Storage lens provides visibility into storage usage and activity trends. Learn more

Buckets (1) Info

Buckets are containers for data stored in S3. Learn more



We're continuing to improve the S3 console to make it faster and easier to use. If you have feedback on the updated experienc

AWS Region

US East (Ohio) us-east-2 ▼

Copy settings from existing bucket - *optional*

Only the bucket settings in the following configuration are copied.

Block Public Access settings for this bucket

Public access is granted to buckets and objects through access control lists (ACLs), bucket policies, access point policies, or all. In order to ensure that public access to this bucket and its objects is blocked, turn on Block all public access. These settings apply only to this bucket and its access points. AWS recommends that you turn on Block all public access, but before applying any of these settings, ensure that your applications will work correctly without public access. If you require some level of public access to this bucket or objects within, you can customize the individual settings below to suit your specific storage use cases. Learn more

□ **Block *all* public access**

Turning this setting on is the same as turning on all four settings below. Each of the following settings are independent of one another.

- □ **Block public access to buckets and objects granted through *new* access control lists (ACLs)**
  S3 will block public access permissions applied to newly added buckets or objects, and prevent the creation of new public access ACLs for existing buckets and objects. This setting doesn't change any existing permissions that allow public access to S3 resources using ACLs.
- □ **Block public access to buckets and objects granted through *any* access control lists (ACLs)**
  S3 will ignore all ACLs that grant public access to buckets and objects.
- □ **Block public access to buckets and objects granted through *new* public bucket or access point policies**
  S3 will block new bucket and access point policies that grant public access to buckets and objects. This setting doesn't change any existing policies that allow public access to S3 resources.
- □ **Block public and cross-account access to buckets and objects through *any* public bucket or access point policies**
  S3 will ignore public and cross-account access for buckets or access points with policies that grant public access to buckets and objects.

Turning off block all public access might result in this bucket and the objects within becoming public

AWS recommends that you turn on block all public access, unless public access is required for specific and verified use cases such as static website hosting.

☑ I acknowledge that the current settings might result in this bucket and the objects within becoming public.

Bucket Versioning

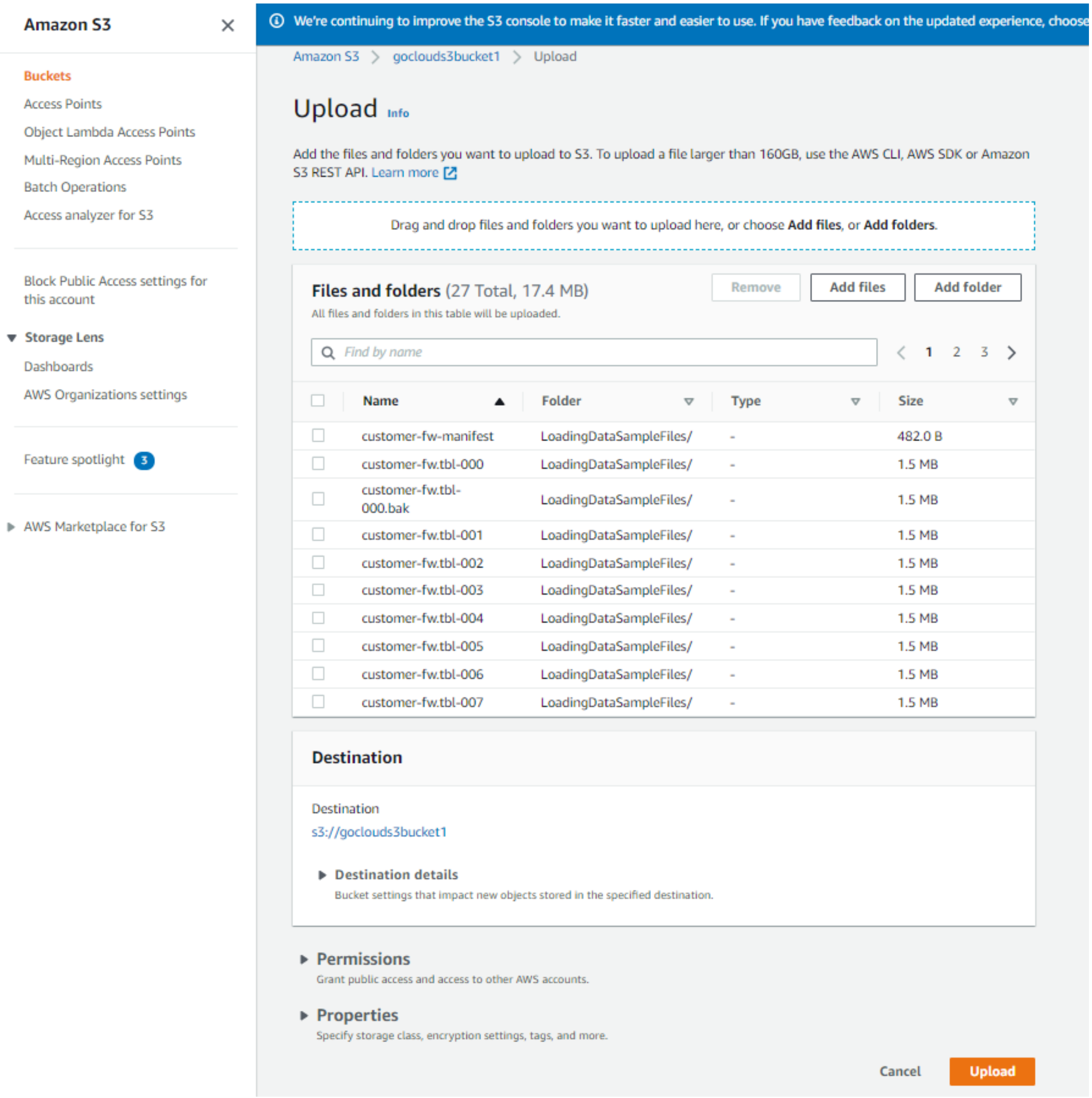
Versioning is a means of keeping multiple variants of an object in the same bucket. You can use versioning to preserve, retrieve, and restore every version of every object stored in your Amazon S3 bucket. With versioning, you can easily recover from both unintended user actions and application failures. Learn more

Bucket Versioning

○ Disable

● Enable

For this lab, download files from this AWS link and upload to S3 bucket you created above.



We're continuing to improve the S3 console to make it faster and easier to use. If you have feedback on the updated experience, choose

Amazon S3 > goclouds3bucket1 > Upload

Upload Info

Add the files and folders you want to upload to S3. To upload a file larger than 160GB, use the AWS CLI, AWS SDK or Amazon S3 REST API. Learn more

Drag and drop files and folders you want to upload here, or choose **Add files**, or **Add folders**.

Files and folders (27 Total, 17.4 MB)

All files and folders in this table will be uploaded.

□	Name	Folder	Type	Size
□	customer-fw-manifest	LoadingDataSampleFiles/	-	482.0 B
□	customer-fw.tbl-000	LoadingDataSampleFiles/	-	1.5 MB
□	customer-fw.tbl-000.bak	LoadingDataSampleFiles/	-	1.5 MB
□	customer-fw.tbl-001	LoadingDataSampleFiles/	-	1.5 MB
□	customer-fw.tbl-002	LoadingDataSampleFiles/	-	1.5 MB
□	customer-fw.tbl-003	LoadingDataSampleFiles/	-	1.5 MB
□	customer-fw.tbl-004	LoadingDataSampleFiles/	-	1.5 MB
□	customer-fw.tbl-005	LoadingDataSampleFiles/	-	1.5 MB
□	customer-fw.tbl-006	LoadingDataSampleFiles/	-	1.5 MB
□	customer-fw.tbl-007	LoadingDataSampleFiles/	-	1.5 MB

Destination

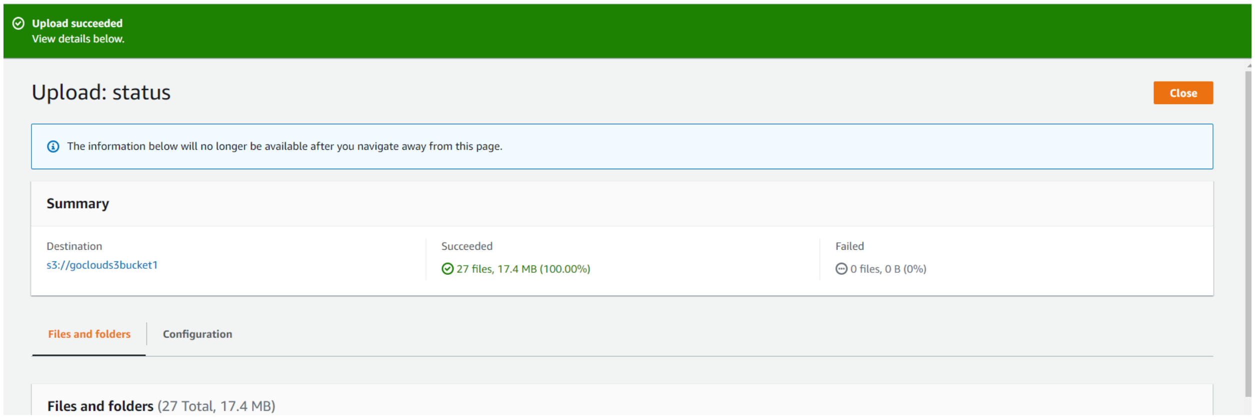
Destination
s3://goclouds3bucket1

▸ **Destination details**
Bucket settings that impact new objects stored in the specified destination.

▸ **Permissions**
Grant public access and access to other AWS accounts.

▸ **Properties**
Specify storage class, encryption settings, tags, and more.

After files are uploaded, you should see upload complete status.



Upload succeeded
View details below.

Upload: status

The information below will no longer be available after you navigate away from this page.

Summary

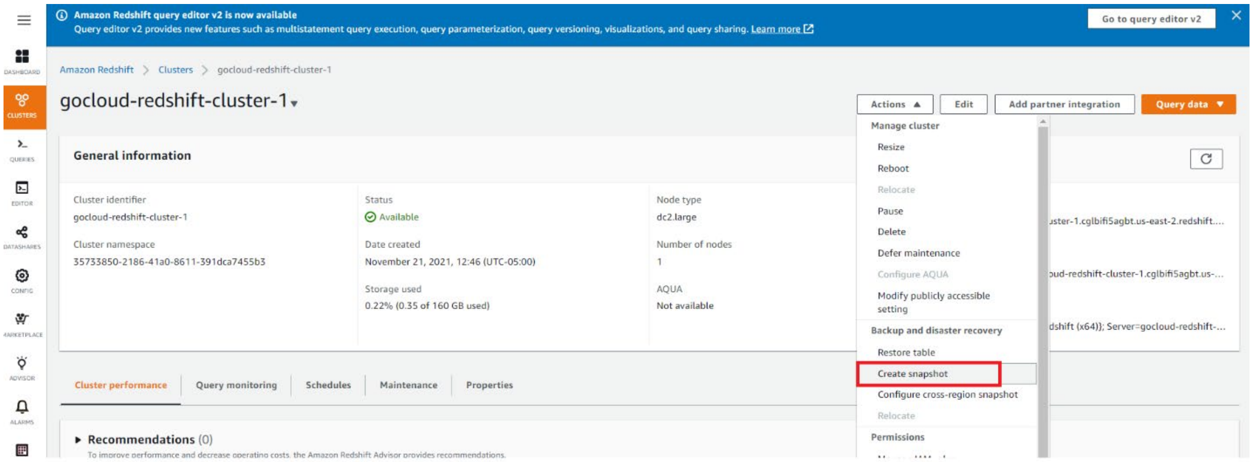
Destination
s3://goclouds3bucket1

Succeeded
27 files, 17.4 MB (100.00%)

Failed
0 files, 0 B (0%)

Files and folders (27 Total, 17.4 MB)

Back up Database by creating a snapshot.



Amazon Redshift query editor v2 is now available
Query editor v2 provides new features such as multistatement query execution, query parameterization, query versioning, visualizations, and query sharing. Learn more

Amazon Redshift > Clusters > gocloud-redshift-cluster-1

gocloud-redshift-cluster-1

General information

Cluster identifier
gocloud-redshift-cluster-1

Cluster namespace
35733850-2186-41a0-8611-391dca7455b3

Status
Available

Date created
November 21, 2021, 12:46 (UTC-05:00)

Storage used
0.22% (0.35 of 160 GB used)

Node type
dc2.large

Number of nodes
1

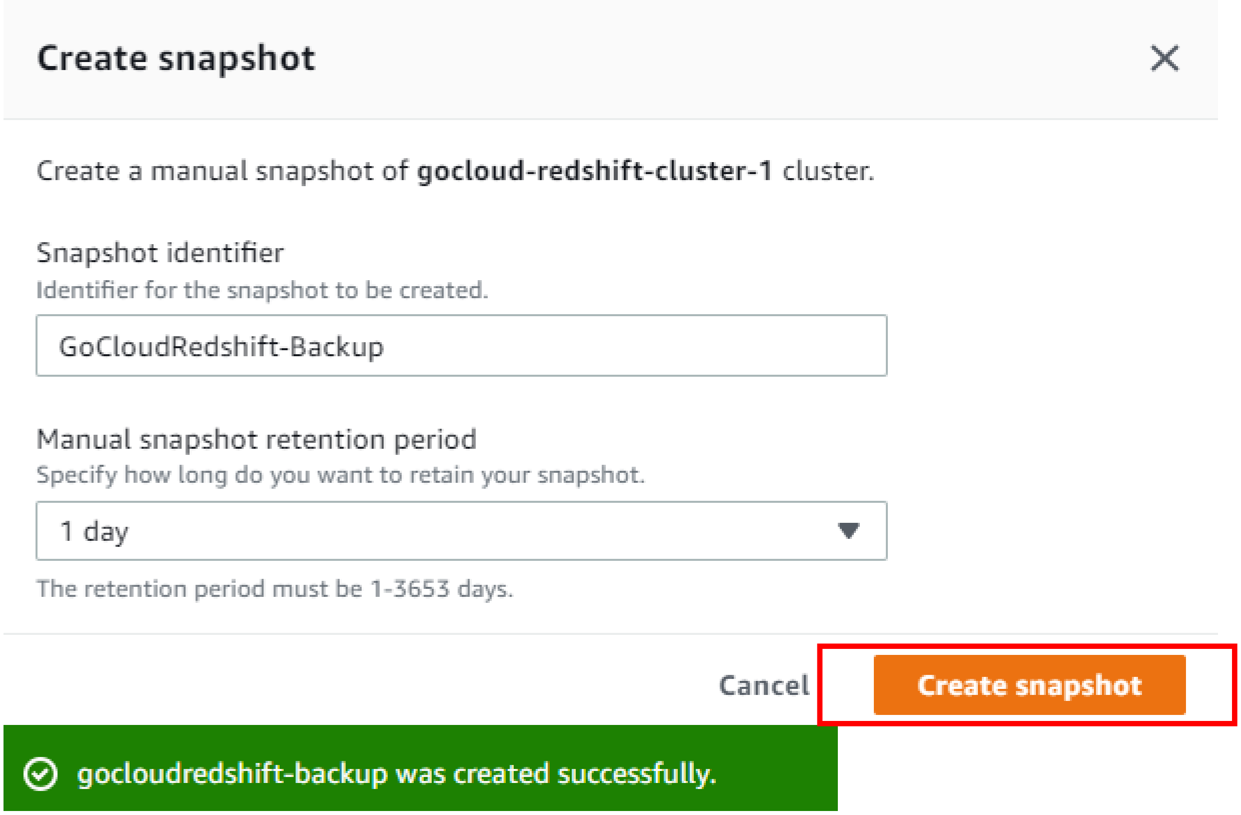
AQUA
Not available

uster-1.cglbifi5agbt.us-east-2.redshift....

oud-redshift-cluster-1.cglbifi5agbt.us-...

dshift (x64)); Server=gocloud-redshift-...

Recommendations (0)
To improve performance and decrease operating costs, the Amazon Redshift Advisor provides recommendations.



Create snapshot

Create a manual snapshot of **gocloud-redshift-cluster-1** cluster.

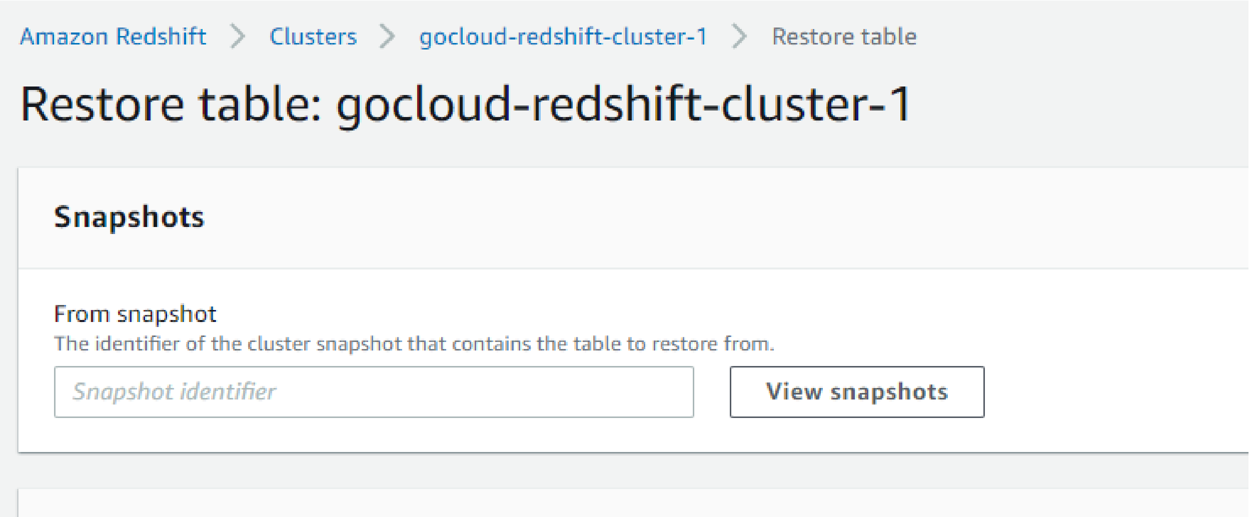
Snapshot identifier
Identifier for the snapshot to be created.
GoCloudRedshift-Backup

Manual snapshot retention period
Specify how long do you want to retain your snapshot.
1 day ▼
The retention period must be 1-3653 days.

gocloudredshift-backup was created successfully.

Restore Snapshot from backup.

a) Restore.



Amazon Redshift > Clusters > gocloud-redshift-cluster-1 > Restore table

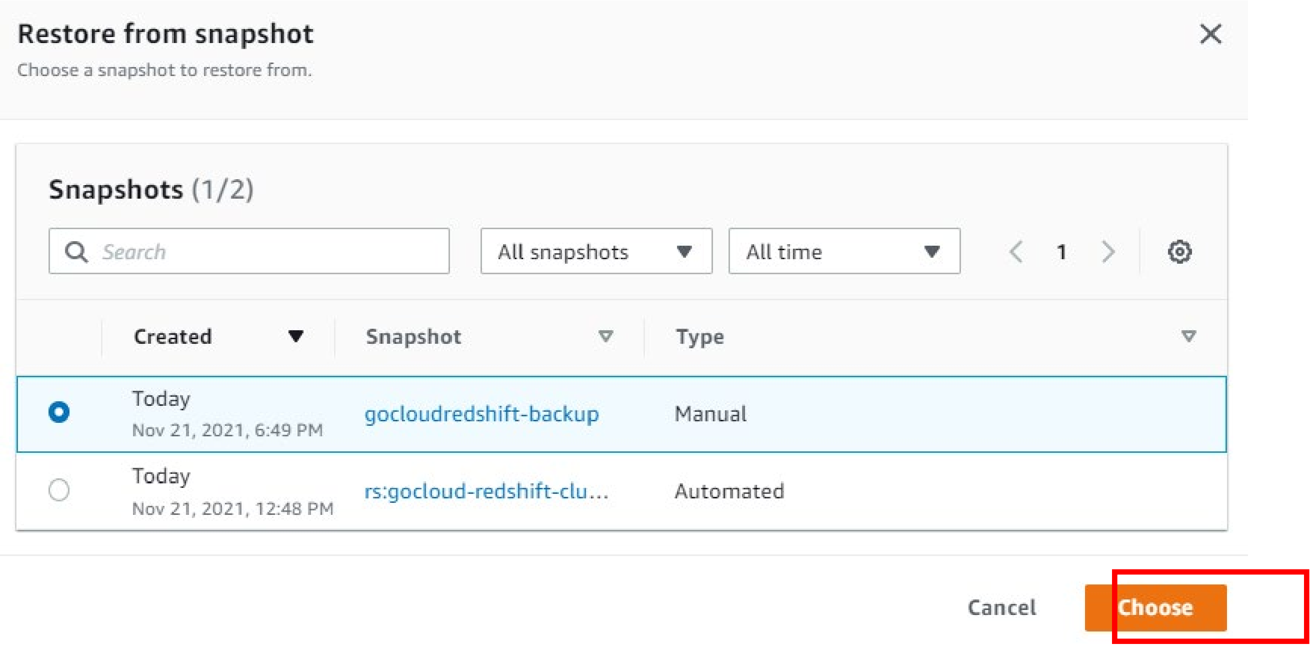
Restore table: gocloud-redshift-cluster-1

Snapshots

From snapshot
The identifier of the cluster snapshot that contains the table to restore from.
Snapshot identifier

b) Choose the backup from “View Snapshots” to retrieve existing snapshots.

c)



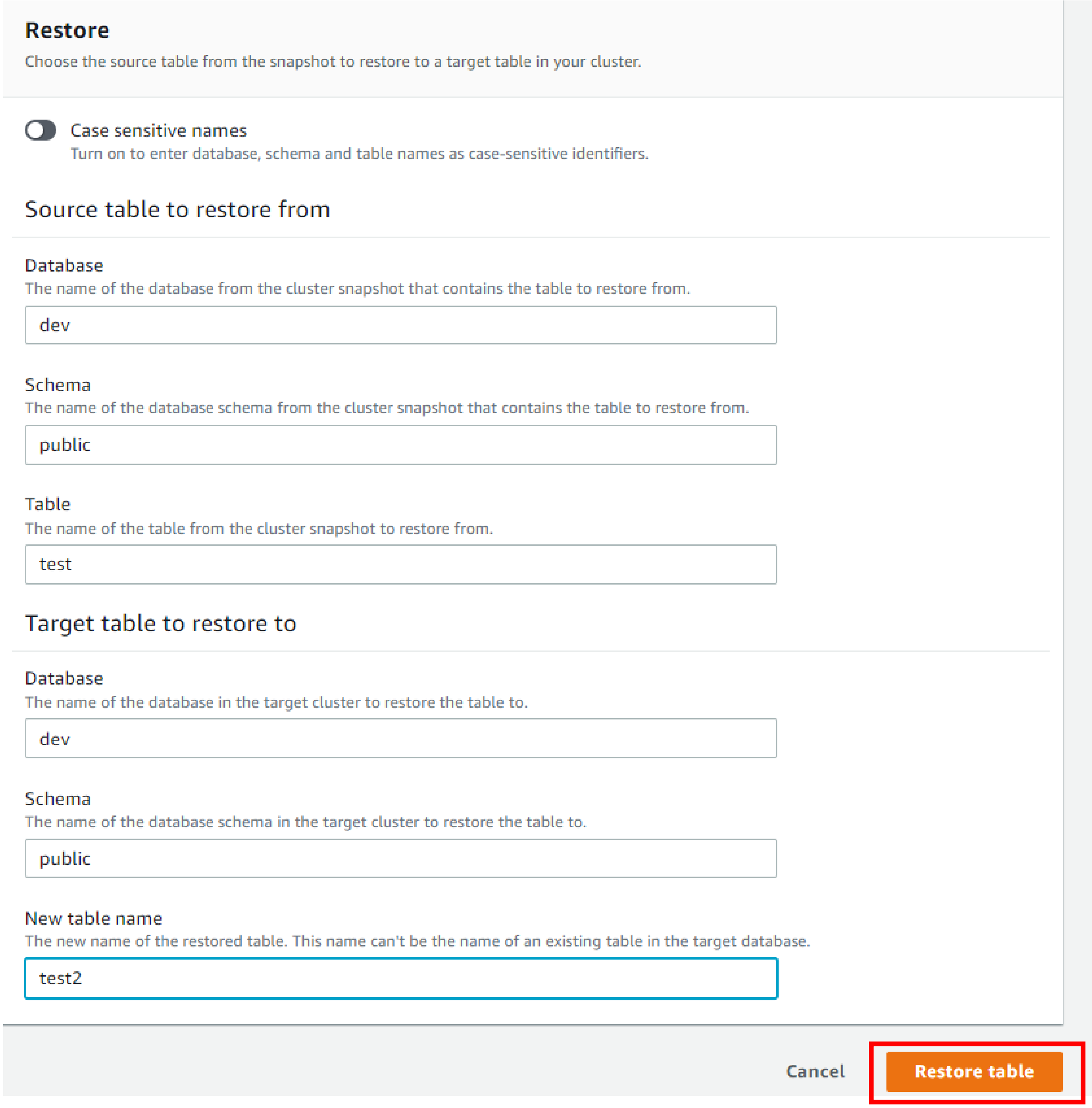
Restore from snapshot

Choose a snapshot to restore from.

Snapshots (1/2)

	Created	Snapshot	Type
●	Today Nov 21, 2021, 6:49 PM	gocloudredshift-backup	Manual
○	Today Nov 21, 2021, 12:48 PM	rs:gocloud-redshift-clu…	Automated

d) Enter restore information.



Restore

Choose the source table from the snapshot to restore to a target table in your cluster.

Case sensitive names

Turn on to enter database, schema and table names as case-sensitive identifiers.

Source table to restore from

Database

The name of the database from the cluster snapshot that contains the table to restore from.

dev

Schema

The name of the database schema from the cluster snapshot that contains the table to restore from.

public

Table

The name of the table from the cluster snapshot to restore from.

test

Target table to restore to

Database

The name of the database in the target cluster to restore the table to.

dev

Schema

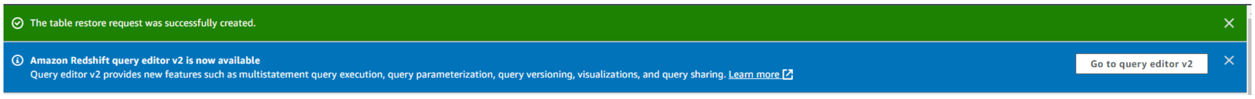
The name of the database schema in the target cluster to restore the table to.

public

New table name

The new name of the restored table. This name can't be the name of an existing table in the target database.

test2



The table restore request was successfully created.

Amazon Redshift query editor v2 is now available

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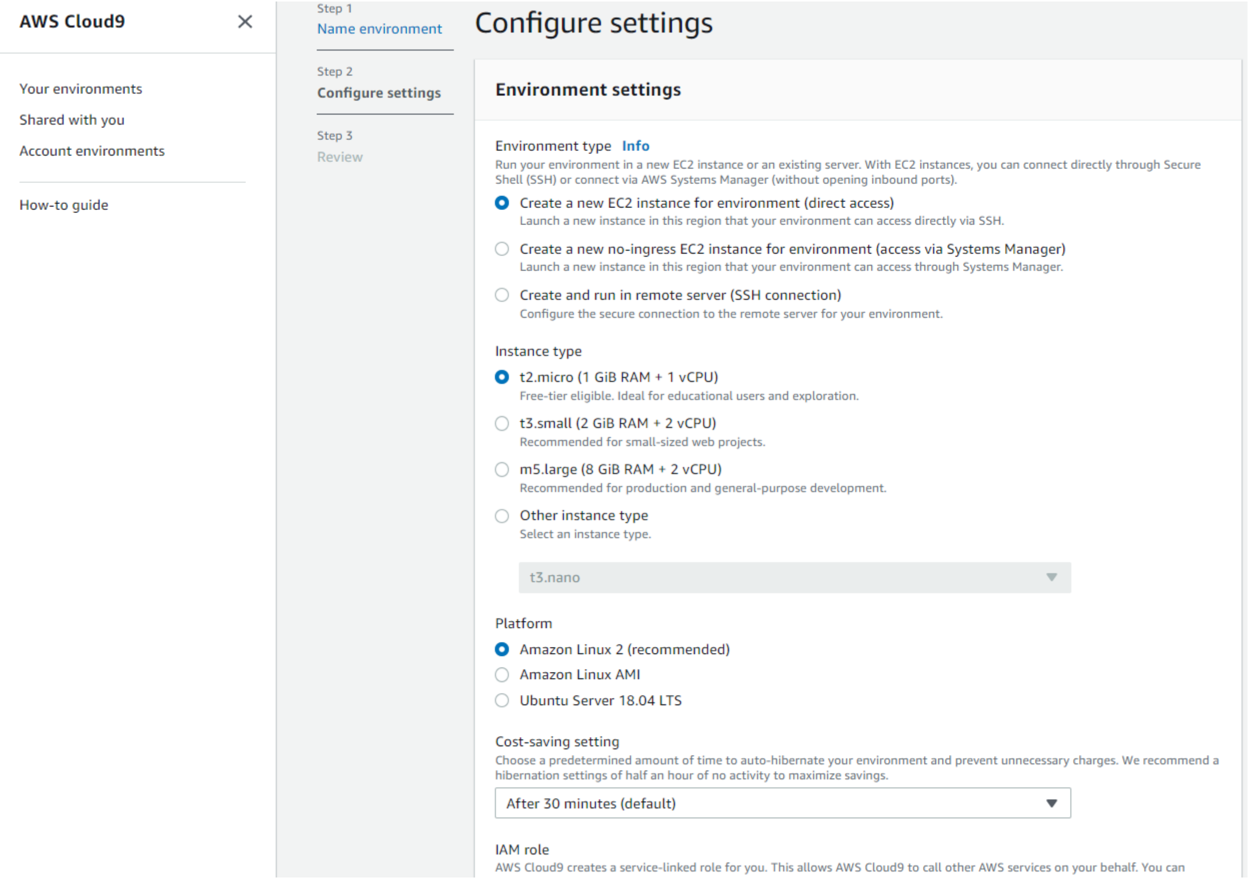
Lab: Set Up Amazon ElastiCache with Amazon Aurora Serverless

Create Cloud9 IDE environment by searching “Cloud9” and selecting the service.



Configure settings

Environment settings

Environment type Info

Run your environment in a new EC2 instance or an existing server. With EC2 instances, you can connect directly through Secure Shell (SSH) or connect via AWS Systems Manager (without opening inbound ports).

● Create a new EC2 instance for environment (direct access)
Launch a new instance in this region that your environment can access directly via SSH.

○ Create a new no-ingress EC2 instance for environment (access via Systems Manager)
Launch a new instance in this region that your environment can access through Systems Manager.

○ Create and run in remote server (SSH connection)
Configure the secure connection to the remote server for your environment.

Instance type

● t2.micro (1 GiB RAM + 1 vCPU)
Free-tier eligible. Ideal for educational users and exploration.

○ t3.small (2 GiB RAM + 2 vCPU)
Recommended for small-sized web projects.

○ m5.large (8 GiB RAM + 2 vCPU)
Recommended for production and general-purpose development.

○ Other instance type
Select an instance type.

t3.nano

Platform

● Amazon Linux 2 (recommended)
○ Amazon Linux AMI
○ Ubuntu Server 18.04 LTS

Cost-saving setting

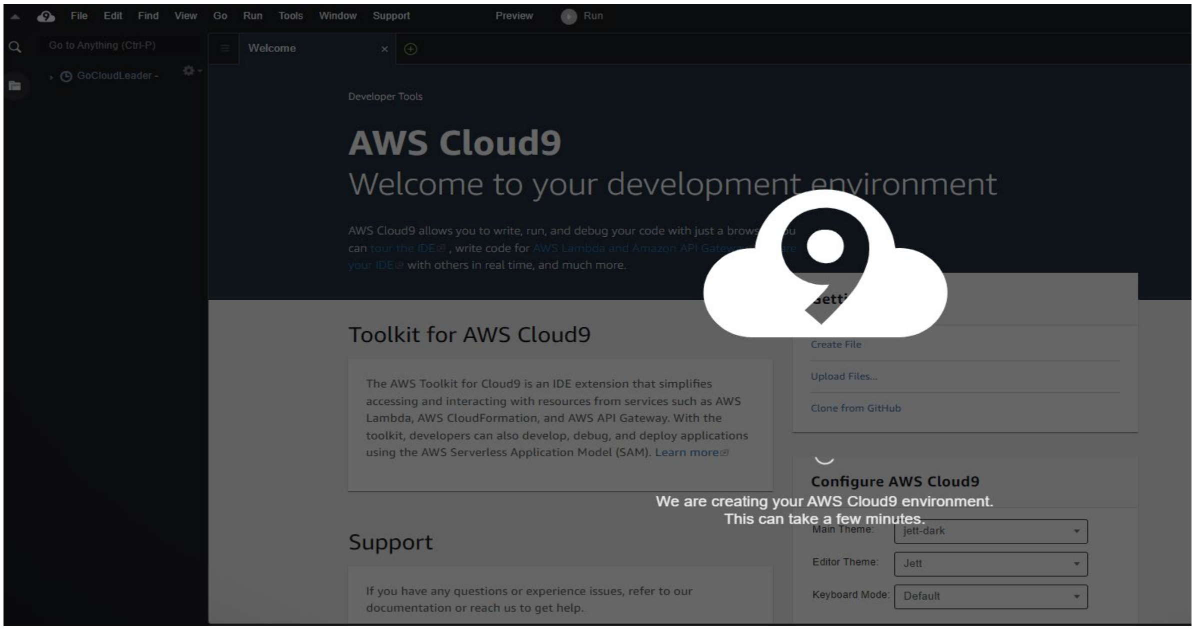
Choose a predetermined amount of time to auto-hibernate your environment and prevent unnecessary charges. We recommend a hibernation settings of half an hour of no activity to maximize savings.

After 30 minutes (default)

IAM role

AWS Cloud9 creates a service-linked role for you. This allows AWS Cloud9 to call other AWS services on your behalf. You can

The following screen is displayed during creation.



AWS Cloud9
Welcome to your development environment

AWS Cloud9 allows you to write, run, and debug your code with just a brows... you can tour the IDE, write code for AWS Lambda and Amazon API Gatew... are your IDE with others in real time, and much more.

Toolkit for AWS Cloud9

The AWS Toolkit for Cloud9 is an IDE extension that simplifies accessing and interacting with resources from services such as AWS Lambda, AWS CloudFormation, and AWS API Gateway. With the toolkit, developers can also develop, debug, and deploy applications using the AWS Serverless Application Model (SAM). Learn more

Support

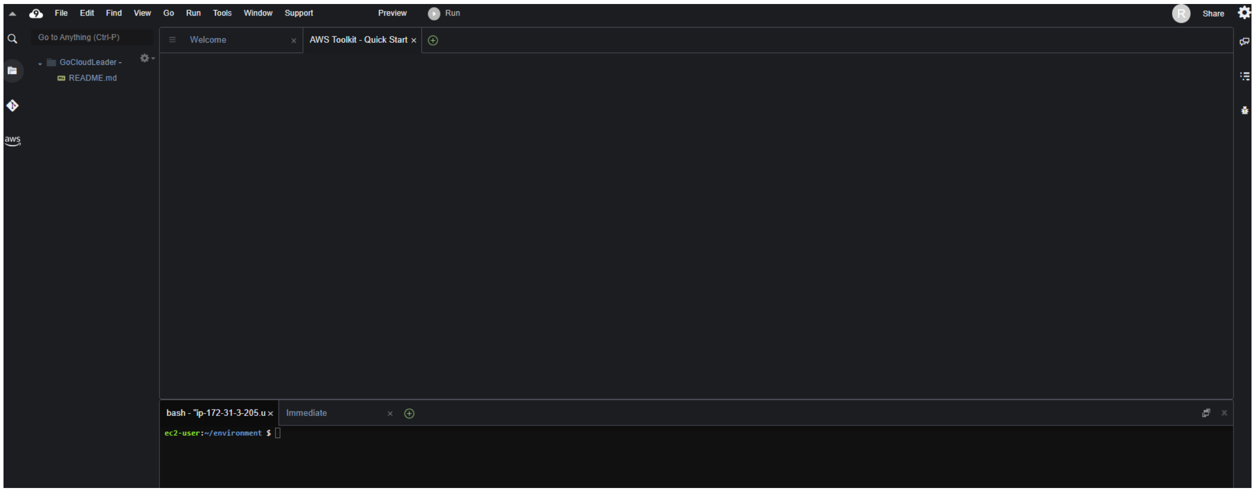
If you have any questions or experience issues, refer to our documentation or reach us to get help.

Configure AWS Cloud9

Main Theme: jett-dark
Editor Theme: Jett
Keyboard Mode: Default

We are creating your AWS Cloud9 environment.
This can take a few minutes.

Once connected, you should see a bash prompt connected to the EC2 instance.

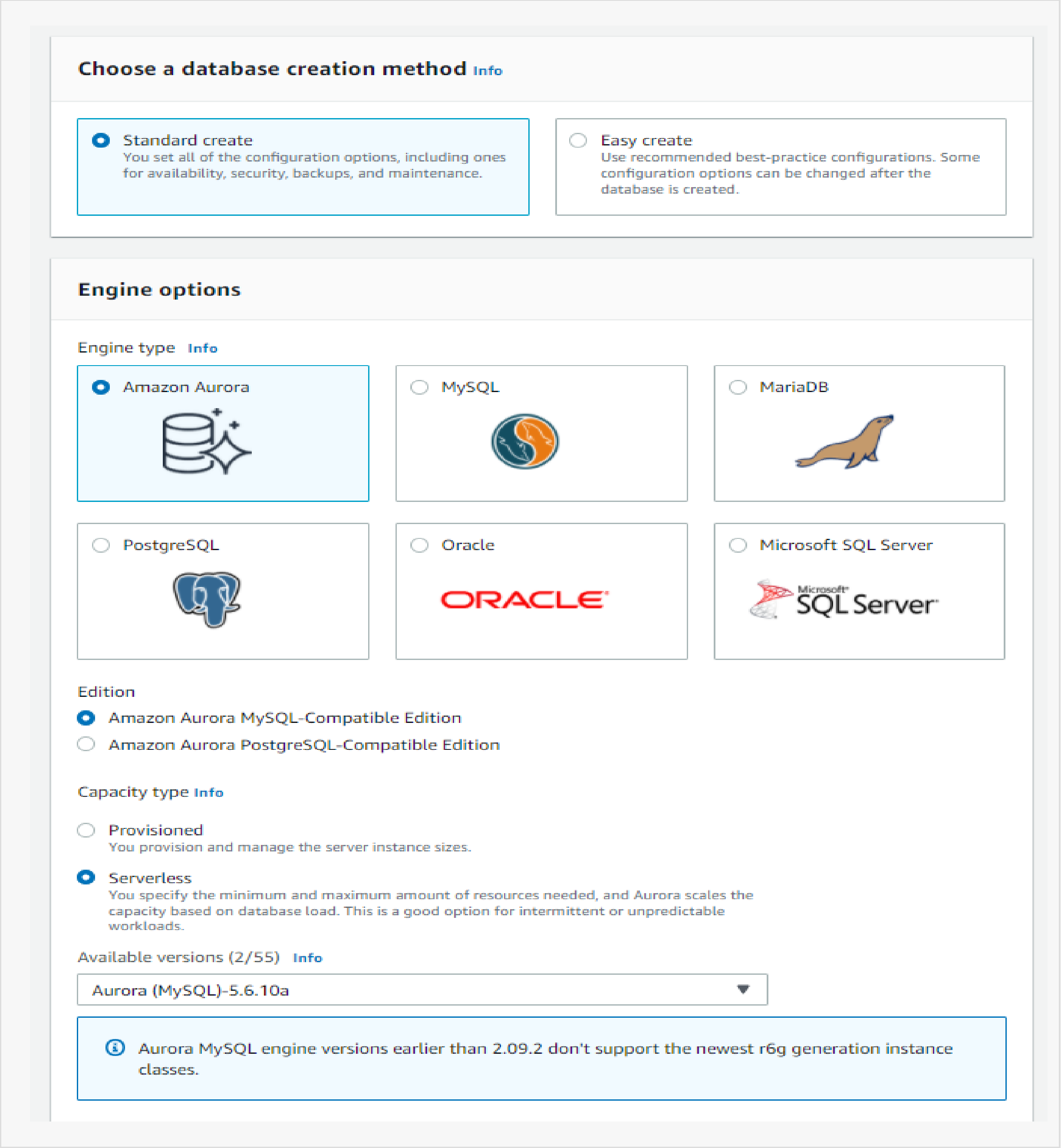


```
ec2-user:~/environment $
```

Run the following commands:

- cd ~/environment
- curl –sL http://d118jxrmrxsq90.cloudfront.net/leaderboard.tar | tar -xv
- ls
- npm install --prefix scripts/ && npm install --prefix application
- echo "export AWS_REGION=us-east-2" >> env.sh && source env.sh
- source env.sh

Type X.



Choose a database creation method Info

● Standard create
You set all of the configuration options, including ones for availability, security, backups, and maintenance.

○ Easy create
Use recommended best-practice configurations. Some configuration options can be changed after the database is created.

Engine options

Engine type Info

● Amazon Aurora

○ MySQL

○ MariaDB

○ PostgreSQL

○ Oracle

○ Microsoft SQL Server

Edition

● Amazon Aurora MySQL-Compatible Edition

○ Amazon Aurora PostgreSQL-Compatible Edition

Capacity type Info

○ Provisioned
You provision and manage the server instance sizes.

● Serverless
You specify the minimum and maximum amount of resources needed, and Aurora scales the capacity based on database load. This is a good option for intermittent or unpredictable workloads.

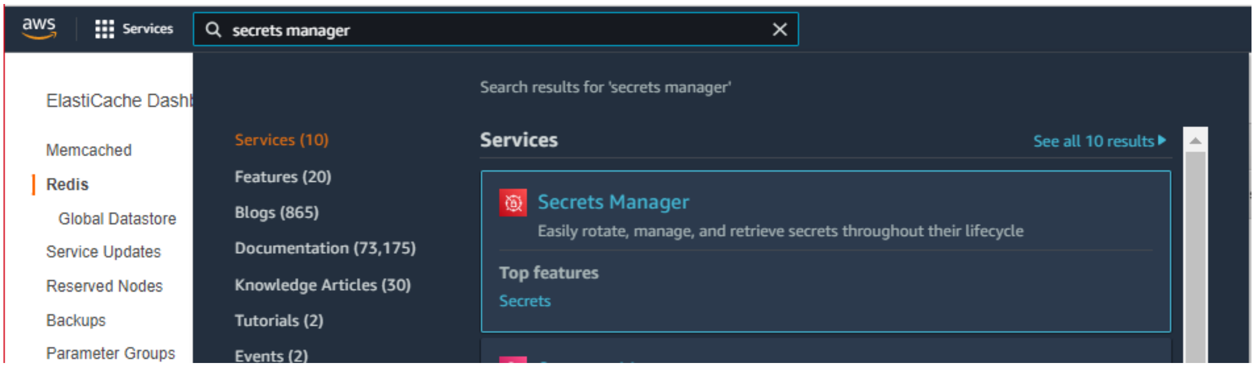
Available versions (2/55) Info

Aurora (MySQL)-5.6.10a ▼

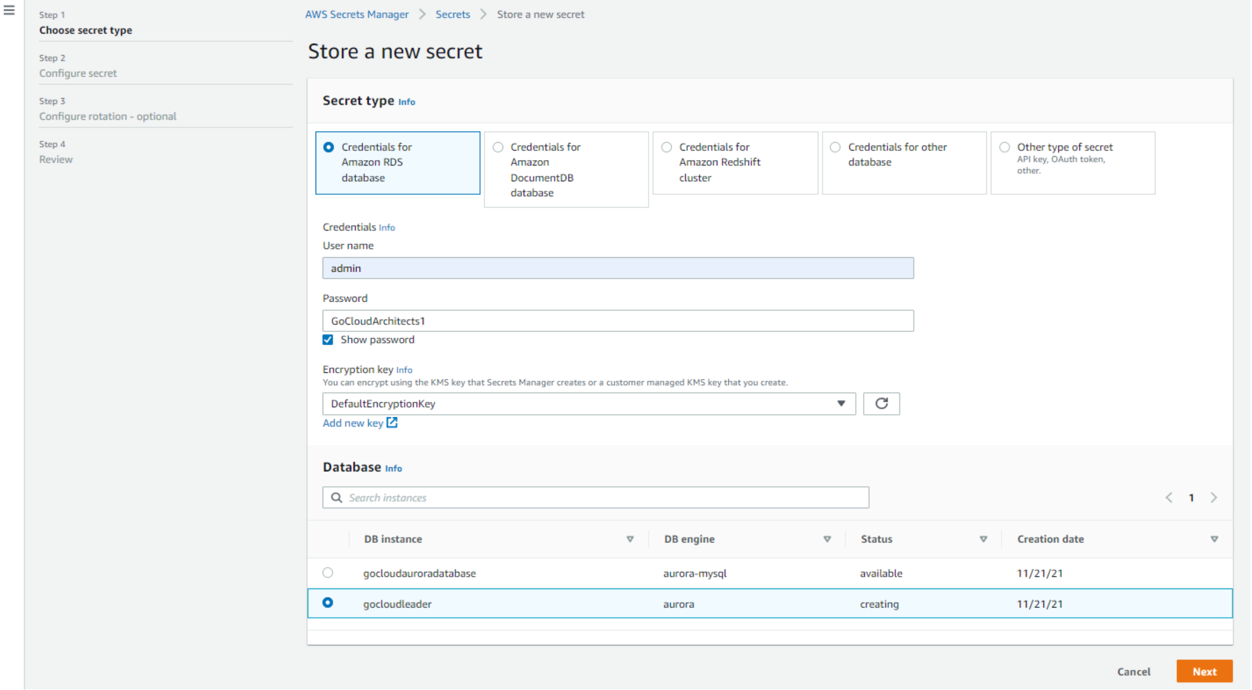
ⓘ Aurora MySQL engine versions earlier than 2.09.2 don't support the newest r6g generation instance classes.

Choose default configurations but check “Data API” under Connectivity and uncheck “Deletion Protection” under Additional Configuration.

Secrets manager Store a new Secret.



Create and enter secret name as “gocloudsecret” ⍰ Disable automatic rotation.



Step 1
Choose secret type
Step 2
Configure secret
Step 3
Configure rotation - optional
Step 4
Review
AWS Secrets Manager > Secrets > Store a new secret

Store a new secret

Secret type Info

● Credentials for Amazon RDS database
○ Credentials for Amazon DocumentDB database
○ Credentials for Amazon Redshift cluster
○ Credentials for other database
○ Other type of secret API key, OAuth token, other.

Credentials Info

User name: admin

Password: GoCloudArchitects1

☑ Show password

Encryption key Info

You can encrypt using the KMS key that Secrets Manager creates or a customer managed KMS key that you create.

DefaultEncryptionKey

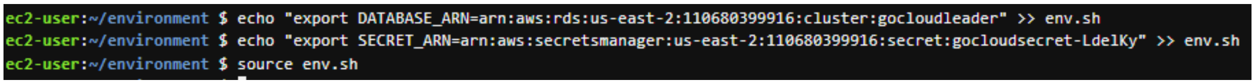
Add new key

Database Info

Search instances

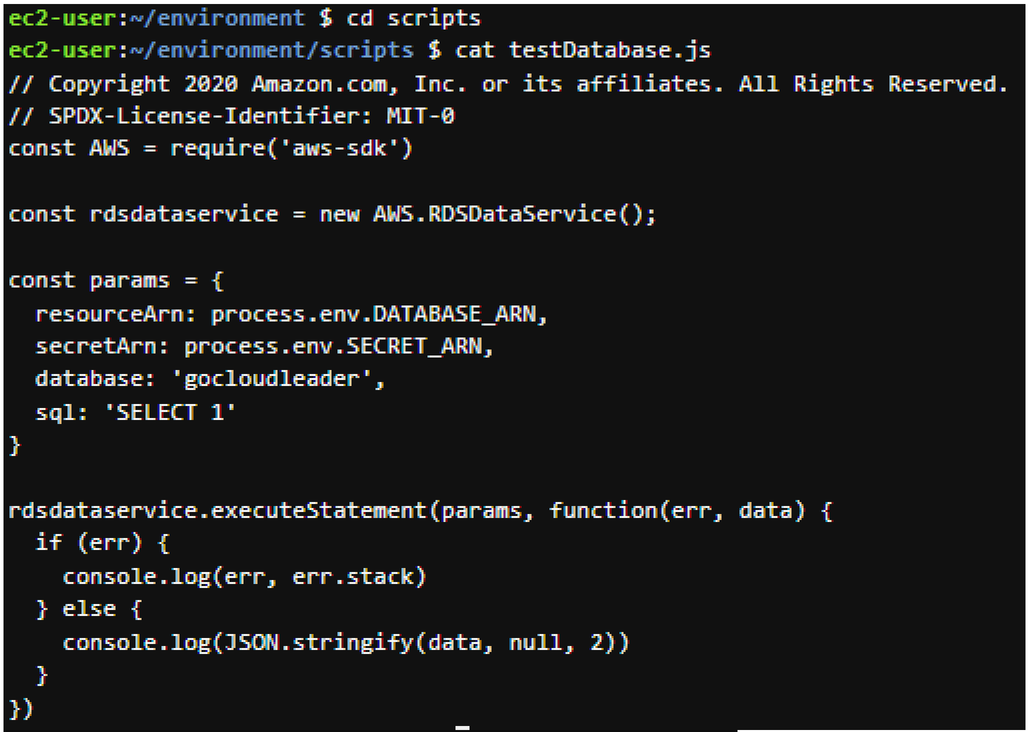
	DB instance	DB engine	Status	Creation date
○	gocloudauroradatabase	aurora-mysql	available	11/21/21
●	gocloudleader	aurora	creating	11/21/21

Edit env file.

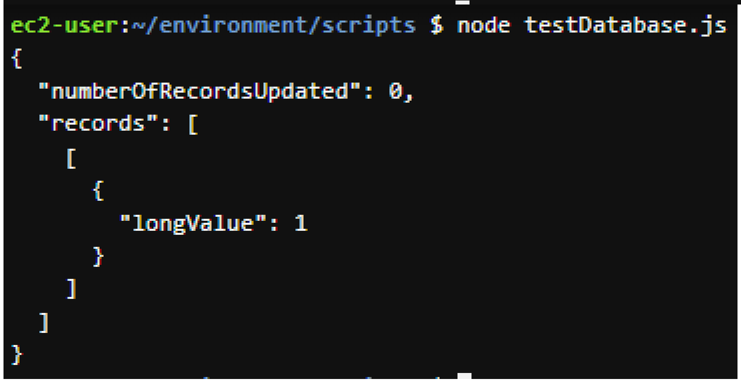


```
ec2-user:~/environment $ echo "export DATABASE_ARN=arn:aws:rds:us-east-2:110680399916:cluster:gocloudleader" >> env.sh
ec2-user:~/environment $ echo "export SECRET_ARN=arn:aws:secretsmanager:us-east-2:110680399916:secret:gocloudsecret-LdelKy" >> env.sh
ec2-user:~/environment $ source env.sh
```

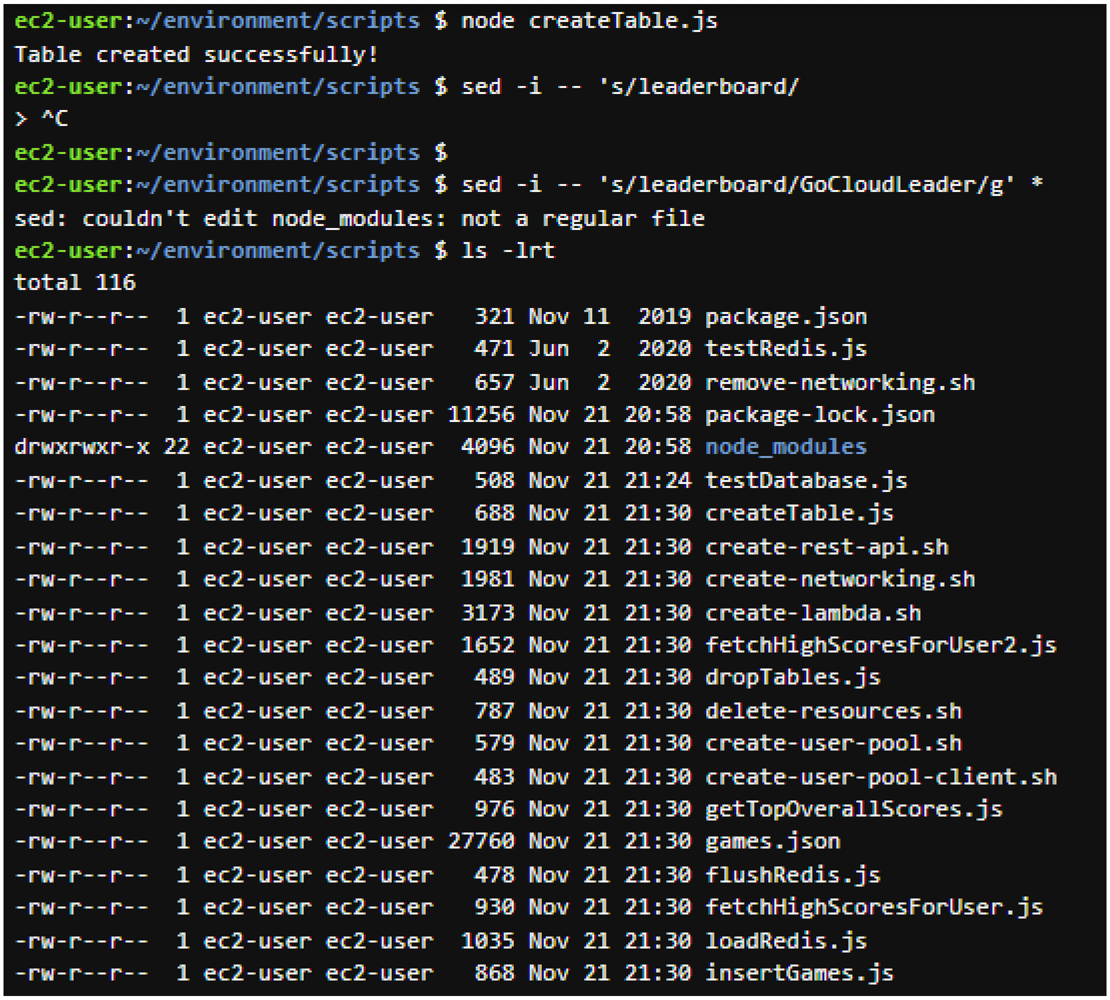
Edit testDatabase.js and update the database name.



```
ec2-user:~/environment $ cd scripts
ec2-user:~/environment/scripts $ cat testDatabase.js
// Copyright 2020 Amazon.com, Inc. or its affiliates. All Rights Reserved.
// SPDX-License-Identifier: MIT-0
const AWS = require('aws-sdk')

const rdsdataservice = new AWS.RDSDataService();

const params = {
  resourceArn: process.env.DATABASE_ARN,
  secretArn: process.env.SECRET_ARN,
  database: 'gocloudleader',
  sql: 'SELECT 1'
}

rdsdataservice.executeStatement(params, function(err, data) {
  if (err) {
    console.log(err, err.stack)
  } else {
    console.log(JSON.stringify(data, null, 2))
  }
})
```

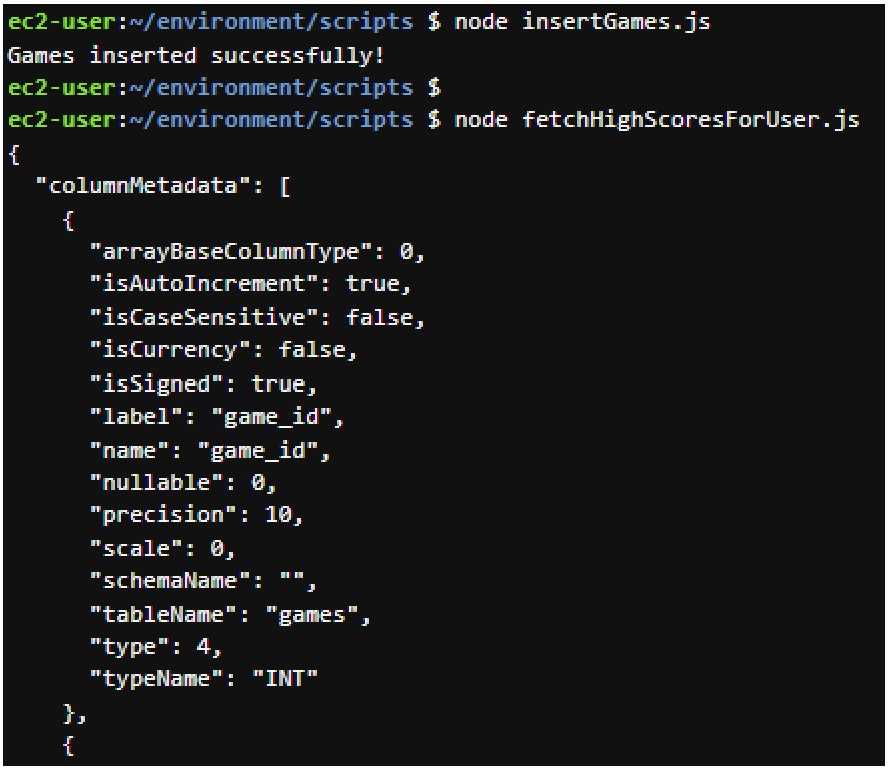


```
ec2-user:~/environment/scripts $ node testDatabase.js
{
  "numberOfRecordsUpdated": 0,
  "records": [
    [
      {
        "longValue": 1
      }
    ]
  ]
}
```



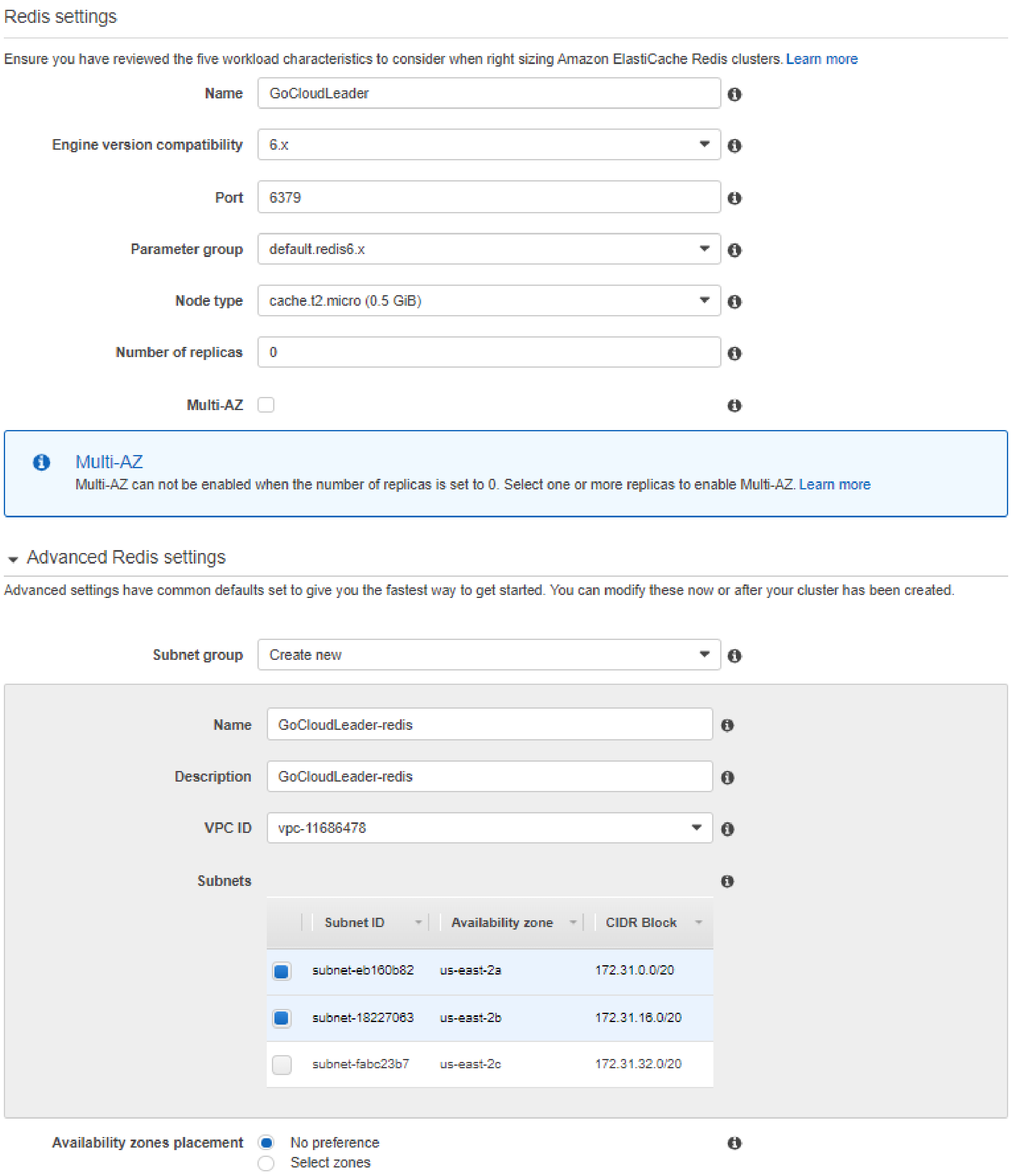
```
ec2-user:~/environment/scripts $ node createTable.js
Table created successfully!
ec2-user:~/environment/scripts $ sed -i -- 's/leaderboard/
> ^C
ec2-user:~/environment/scripts $
ec2-user:~/environment/scripts $ sed -i -- 's/leaderboard/GoCloudLeader/g' *
sed: couldn't edit node_modules: not a regular file
ec2-user:~/environment/scripts $ ls -lrt
total 116
-rw-r--r--  1 ec2-user ec2-user   321 Nov 11  2019 package.json
-rw-r--r--  1 ec2-user ec2-user   471 Jun  2  2020 testRedis.js
-rw-r--r--  1 ec2-user ec2-user   657 Jun  2  2020 remove-networking.sh
-rw-r--r--  1 ec2-user ec2-user 11256 Nov 21 20:58 package-lock.json
drwxrwxr-x 22 ec2-user ec2-user  4096 Nov 21 20:58 node_modules
-rw-r--r--  1 ec2-user ec2-user   508 Nov 21 21:24 testDatabase.js
-rw-r--r--  1 ec2-user ec2-user   688 Nov 21 21:30 createTable.js
-rw-r--r--  1 ec2-user ec2-user  1919 Nov 21 21:30 create-rest-api.sh
-rw-r--r--  1 ec2-user ec2-user  1981 Nov 21 21:30 create-networking.sh
-rw-r--r--  1 ec2-user ec2-user  3173 Nov 21 21:30 create-lambda.sh
-rw-r--r--  1 ec2-user ec2-user  1652 Nov 21 21:30 fetchHighScoresForUser2.js
-rw-r--r--  1 ec2-user ec2-user   489 Nov 21 21:30 dropTables.js
-rw-r--r--  1 ec2-user ec2-user   787 Nov 21 21:30 delete-resources.sh
-rw-r--r--  1 ec2-user ec2-user   579 Nov 21 21:30 create-user-pool.sh
-rw-r--r--  1 ec2-user ec2-user   483 Nov 21 21:30 create-user-pool-client.sh
-rw-r--r--  1 ec2-user ec2-user   976 Nov 21 21:30 getTopOverallScores.js
-rw-r--r--  1 ec2-user ec2-user 27760 Nov 21 21:30 games.json
-rw-r--r--  1 ec2-user ec2-user   478 Nov 21 21:30 flushRedis.js
-rw-r--r--  1 ec2-user ec2-user   930 Nov 21 21:30 fetchHighScoresForUser.js
-rw-r--r--  1 ec2-user ec2-user  1035 Nov 21 21:30 loadRedis.js
-rw-r--r--  1 ec2-user ec2-user   868 Nov 21 21:30 insertGames.js
```

Fetch High scores.



```
ec2-user:~/environment/scripts $ node insertGames.js
Games inserted successfully!
ec2-user:~/environment/scripts $
ec2-user:~/environment/scripts $ node fetchHighScoresForUser.js
{
  "columnMetadata": [
    {
      "arrayBaseColumnType": 0,
      "isAutoIncrement": true,
      "isCaseSensitive": false,
      "isCurrency": false,
      "isSigned": true,
      "label": "game_id",
      "name": "game_id",
      "nullable": 0,
      "precision": 10,
      "scale": 0,
      "schemaName": "",
      "tableName": "games",
      "type": 4,
      "typeName": "INT"
    },
    {
```

Create ElastiCache – Redis from services with t2.micro and new subnet group.



Redis settings

Ensure you have reviewed the five workload characteristics to consider when right sizing Amazon ElastiCache Redis clusters. Learn more

Name	GoCloudLeader
Engine version compatibility	6.x
Port	6379
Parameter group	default.redis6.x
Node type	cache.t2.micro (0.5 GiB)
Number of replicas	0
Multi-AZ	□

Multi-AZ

Multi-AZ can not be enabled when the number of replicas is set to 0. Select one or more replicas to enable Multi-AZ. Learn more

Advanced Redis settings

Advanced settings have common defaults set to give you the fastest way to get started. You can modify these now or after your cluster has been created.

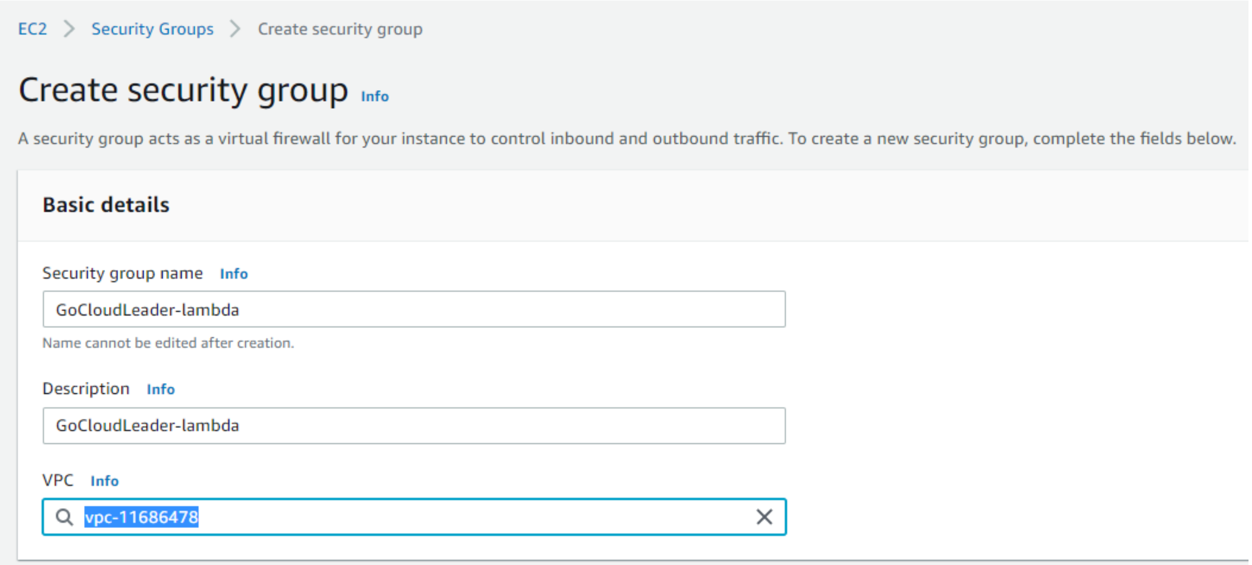
Subnet group	Create new
Name	GoCloudLeader-redis
Description	GoCloudLeader-redis
VPC ID	vpc-11686478

Subnets

	Subnet ID	Availability zone	CIDR Block
☑	subnet-eb160b82	us-east-2a	172.31.0.0/20
☑	subnet-18227063	us-east-2b	172.31.16.0/20
□	subnet-fabc23b7	us-east-2c	172.31.32.0/20

Availability zones placement ● No preference
○ Select zones

Create Lambda security group.



EC2 > Security Groups > Create security group

Create security group Info

A security group acts as a virtual firewall for your instance to control inbound and outbound traffic. To create a new security group, complete the fields below.

Basic details

Security group name Info

GoCloudLeader-lambda

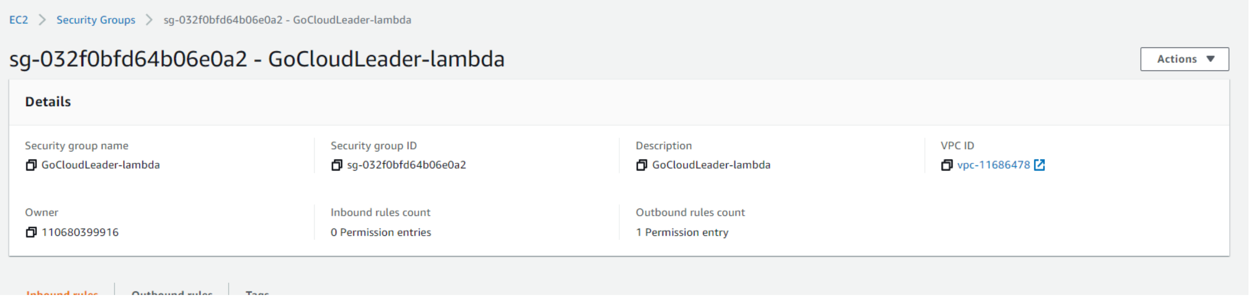
Name cannot be edited after creation.

Description Info

GoCloudLeader-lambda

VPC Info

vpc-11686478

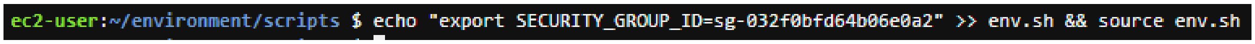


EC2 > Security Groups > sg-032f0bfd64b06e0a2 - GoCloudLeader-lambda

sg-032f0bfd64b06e0a2 - GoCloudLeader-lambda

Details

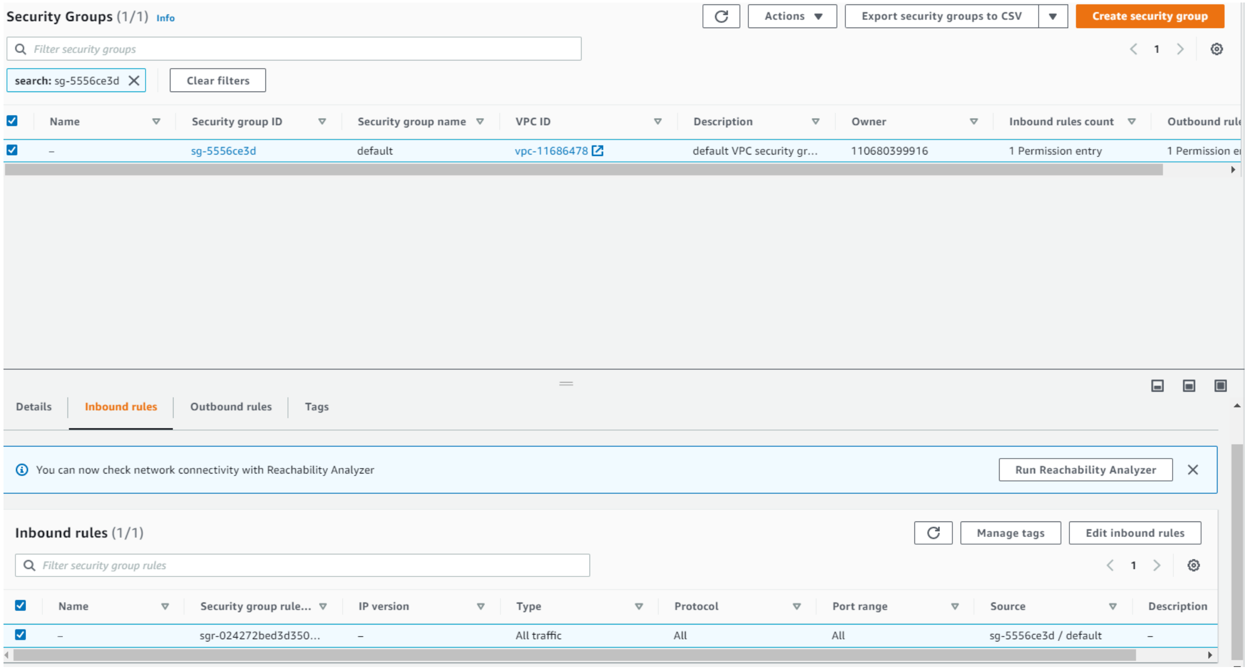
Security group name GoCloudLeader-lambda	Security group ID sg-032f0bfd64b06e0a2	Description GoCloudLeader-lambda	VPC ID vpc-11686478
Owner 110680399916	Inbound rules count 0 Permission entries	Outbound rules count 1 Permission entry	



```
ec2-user:~/environment/scripts $ echo "export SECURITY_GROUP_ID=sg-032f0bfd64b06e0a2" >> env.sh && source env.sh
```

Amazon ElastiCache instances must be provisioned in a VPC in a private subnet.

a. Edit Inbound rules in Security Group. Use the security group from ElastiCache dashboard by expanding the Redis cache we created.

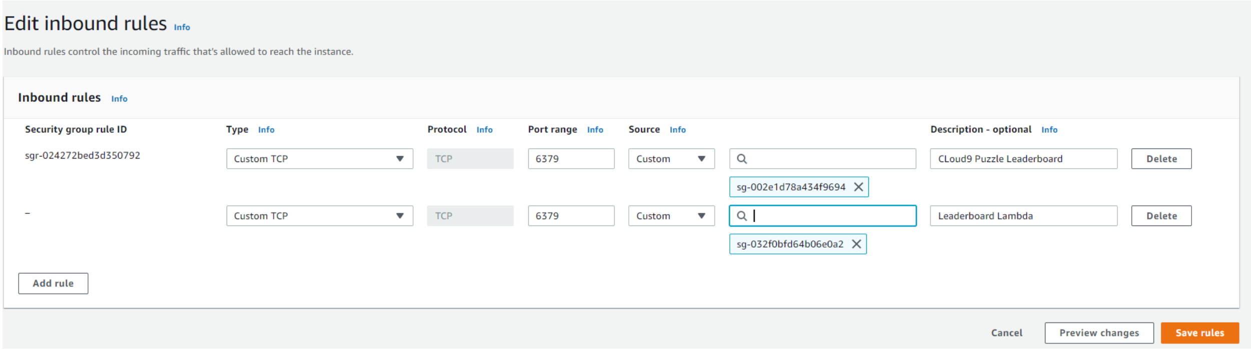

Security Groups (1/1) Info
Actions
Export security groups to CSV
Create security group
Filter security groups
search: sg-5556ce3d
Clear filters

☑	Name	Security group ID	Security group name	VPC ID	Description	Owner	Inbound rules count	Outbound rul
☑	–	sg-5556ce3d	default	vpc-11686478	default VPC security gr…	110680399916	1 Permission entry	1 Permission e

Details
Inbound rules
Outbound rules
Tags
You can now check network connectivity with Reachability Analyzer
Run Reachability Analyzer
Inbound rules (1/1)
Manage tags
Edit inbound rules
Filter security group rules

☑	Name	Security group rule...	IP version	Type	Protocol	Port range	Source	Description
☑	–	sgr-024272bed3d350…	–	All traffic	All	All	sg-5556ce3d / default	–

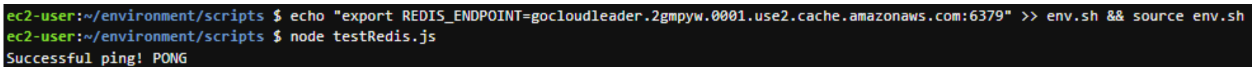
Add Inbound rules for the traffic from Cloud9 instance.


Edit inbound rules Info
Inbound rules control the incoming traffic that's allowed to reach the instance.
Inbound rules Info

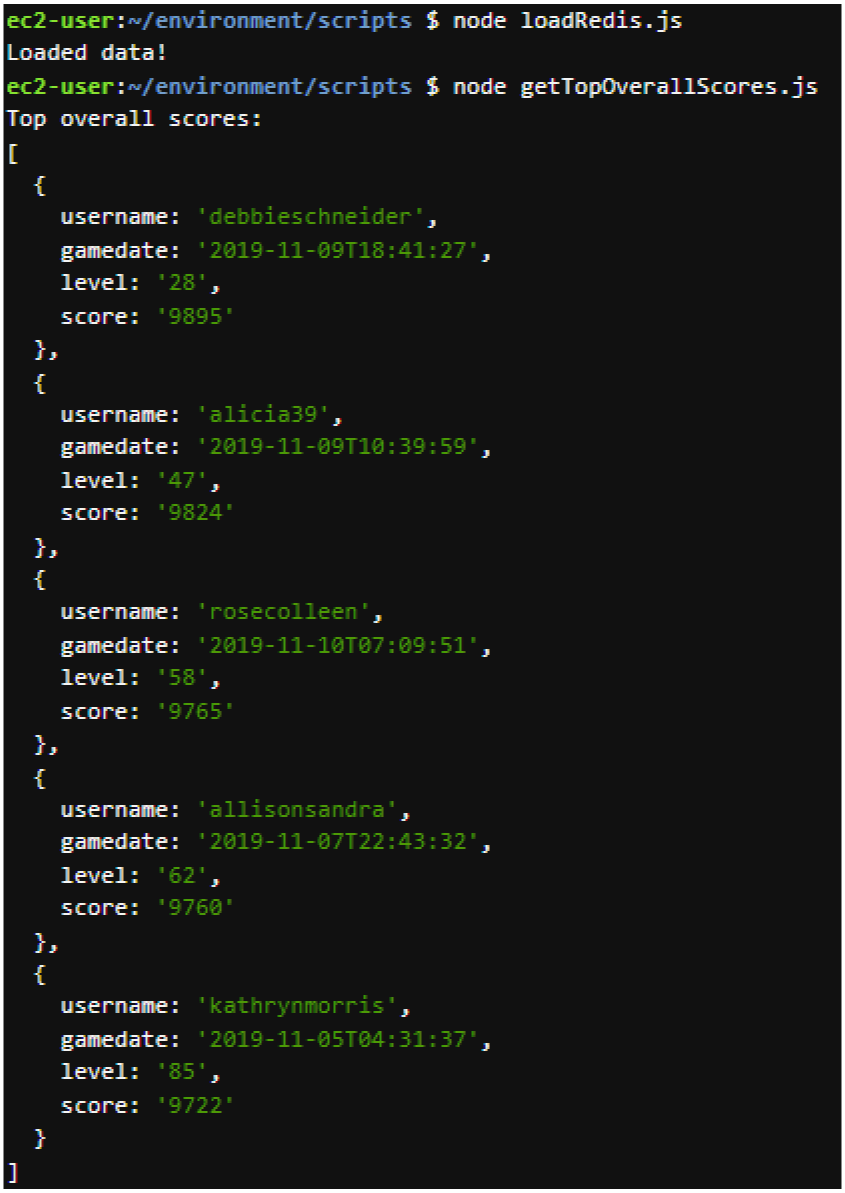
Security group rule ID	Type	Protocol	Port range	Source		Description - optional	
sgr-024272bed3d350792	Custom TCP	TCP	6379	Custom	sg-002e1d78a434f9694	CLoud9 Puzzle Leaderboard	Delete
–	Custom TCP	TCP	6379	Custom	sg-032f0bfd64b06e0a2	Leaderboard Lambda	Delete

Add rule
Cancel
Preview changes
Save rules

Ping Redis instance.

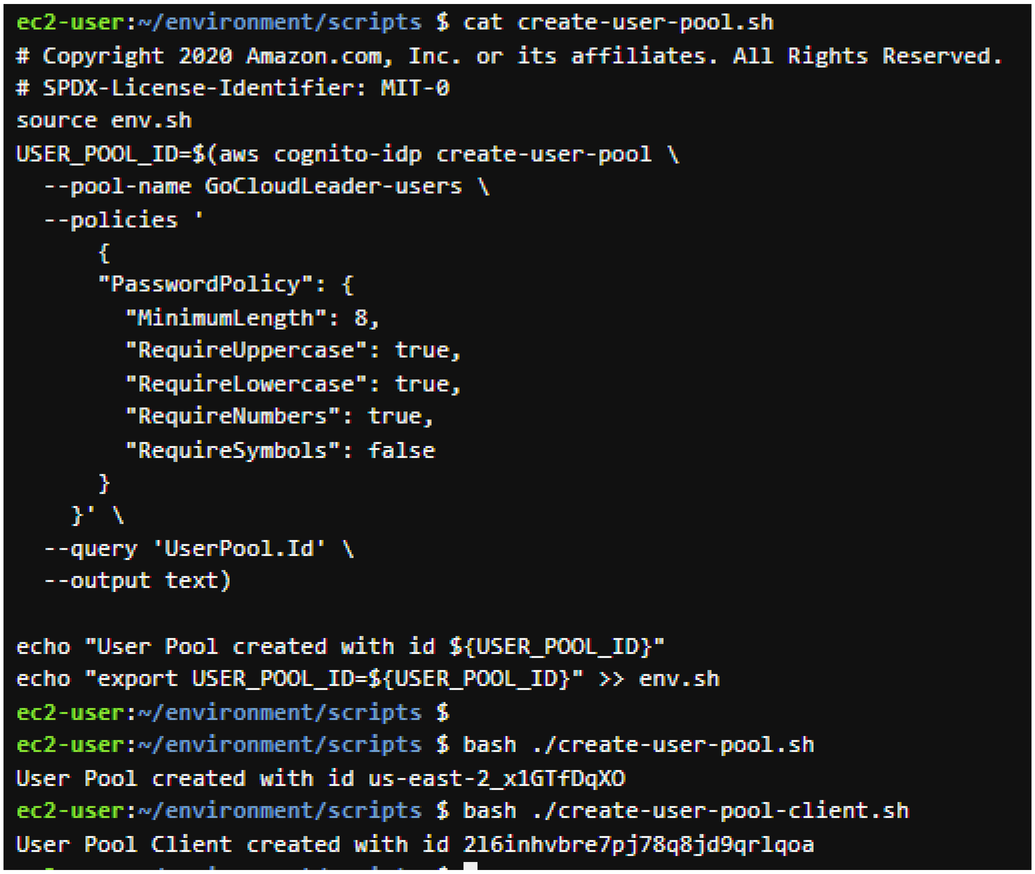

```
ec2-user:~/environment/scripts $ echo "export REDIS_ENDPOINT=gocloudleader.2gmpyw.0001.use2.cache.amazonaws.com:6379" >> env.sh && source env.sh
ec2-user:~/environment/scripts $ node testRedis.js
Successful ping! PONG
```

Load sample data into Redis and read top scores.



```
ec2-user:~/environment/scripts $ node loadRedis.js
Loaded data!
ec2-user:~/environment/scripts $ node getTopOverallScores.js
Top overall scores:
[
  {
    username: 'debbieschneider',
    gamedate: '2019-11-09T18:41:27',
    level: '28',
    score: '9895'
  },
  {
    username: 'alicia39',
    gamedate: '2019-11-09T10:39:59',
    level: '47',
    score: '9824'
  },
  {
    username: 'rosecolleen',
    gamedate: '2019-11-10T07:09:51',
    level: '58',
    score: '9765'
  },
  {
    username: 'allisonsandra',
    gamedate: '2019-11-07T22:43:32',
    level: '62',
    score: '9760'
  },
  {
    username: 'kathrynmorris',
    gamedate: '2019-11-05T04:31:37',
    level: '85',
    score: '9722'
  }
]
```

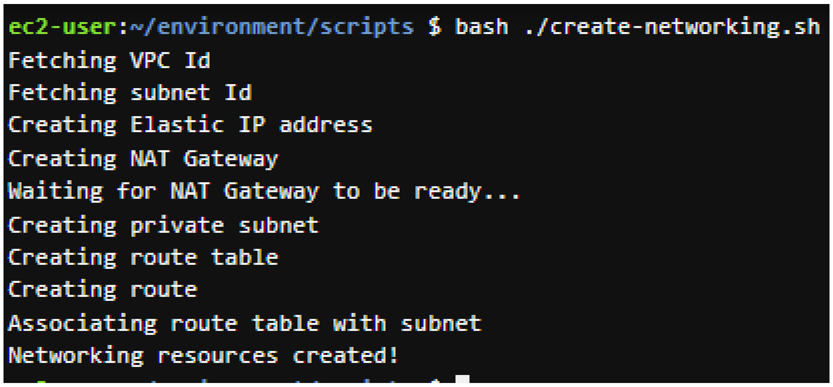
Amazon Cognito user pool.



```
ec2-user:~/environment/scripts $ cat create-user-pool.sh
# Copyright 2020 Amazon.com, Inc. or its affiliates. All Rights Reserved.
# SPDX-License-Identifier: MIT-0
source env.sh
USER_POOL_ID=$(aws cognito-idp create-user-pool \
  --pool-name GoCloudLeader-users \
  --policies '
      {
      "PasswordPolicy": {
        "MinimumLength": 8,
        "RequireUppercase": true,
        "RequireLowercase": true,
        "RequireNumbers": true,
        "RequireSymbols": false
      }
    }' \
  --query 'UserPool.Id' \
  --output text)

echo "User Pool created with id ${USER_POOL_ID}"
echo "export USER_POOL_ID=${USER_POOL_ID}" >> env.sh
ec2-user:~/environment/scripts $
ec2-user:~/environment/scripts $ bash ./create-user-pool.sh
User Pool created with id us-east-2_x1GTfDqXO
ec2-user:~/environment/scripts $ bash ./create-user-pool-client.sh
User Pool Client created with id 216inhvbre7pj78q8jd9qrlqoa
```

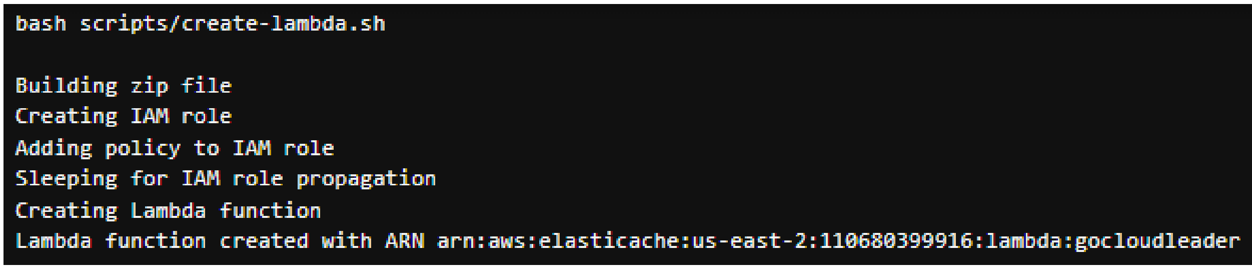
Deploy your application.

Create network resources.



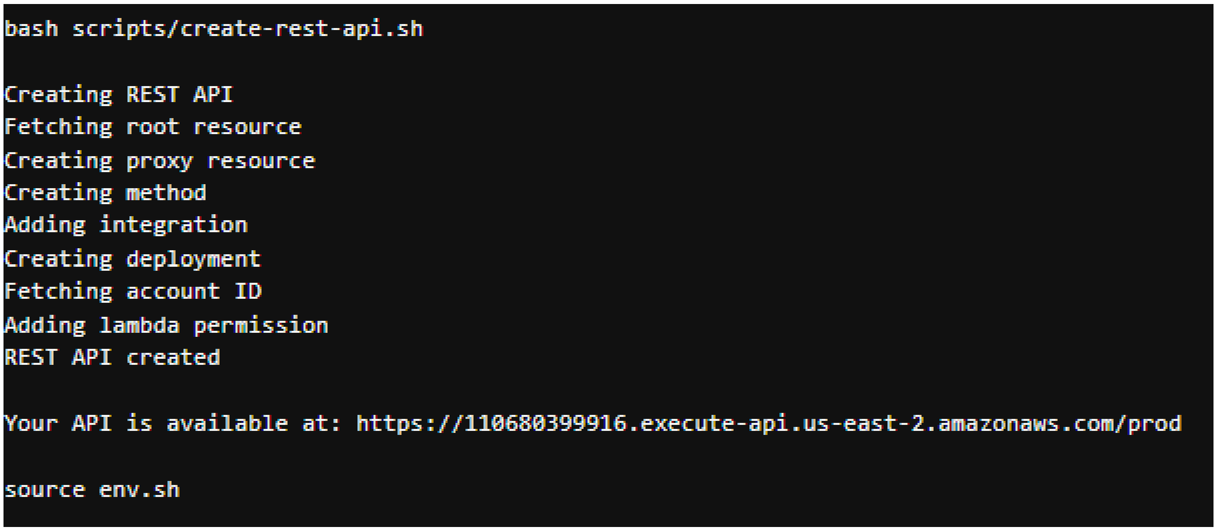
```
ec2-user:~/environment/scripts $ bash ./create-networking.sh
Fetching VPC Id
Fetching subnet Id
Creating Elastic IP address
Creating NAT Gateway
Waiting for NAT Gateway to be ready...
Creating private subnet
Creating route table
Creating route
Associating route table with subnet
Networking resources created!
```

Create Lambda function.



```
bash scripts/create-lambda.sh

Building zip file
Creating IAM role
Adding policy to IAM role
Sleeping for IAM role propagation
Creating Lambda function
Lambda function created with ARN arn:aws:elasticache:us-east-2:110680399916:lambda:gocloudleader
```

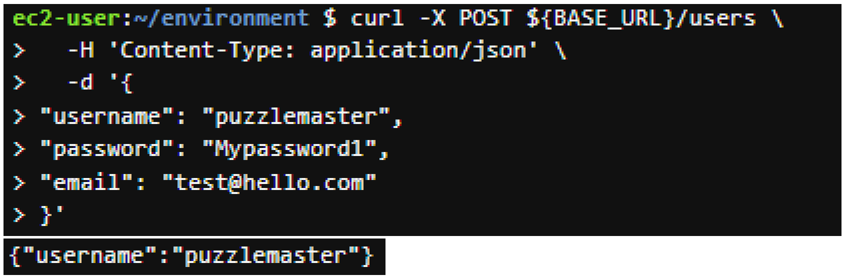
Create REST API.



```
bash scripts/create-rest-api.sh

Creating REST API
Fetching root resource
Creating proxy resource
Creating method
Adding integration
Creating deployment
Fetching account ID
Adding lambda permission
REST API created

Your API is available at: https://110680399916.execute-api.us-east-2.amazonaws.com/prod

source env.sh
```

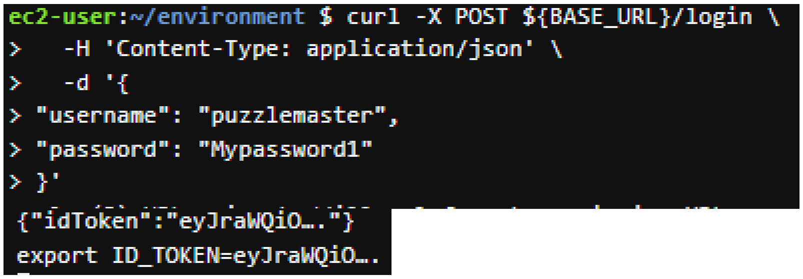
Testing the Application

Register new user.



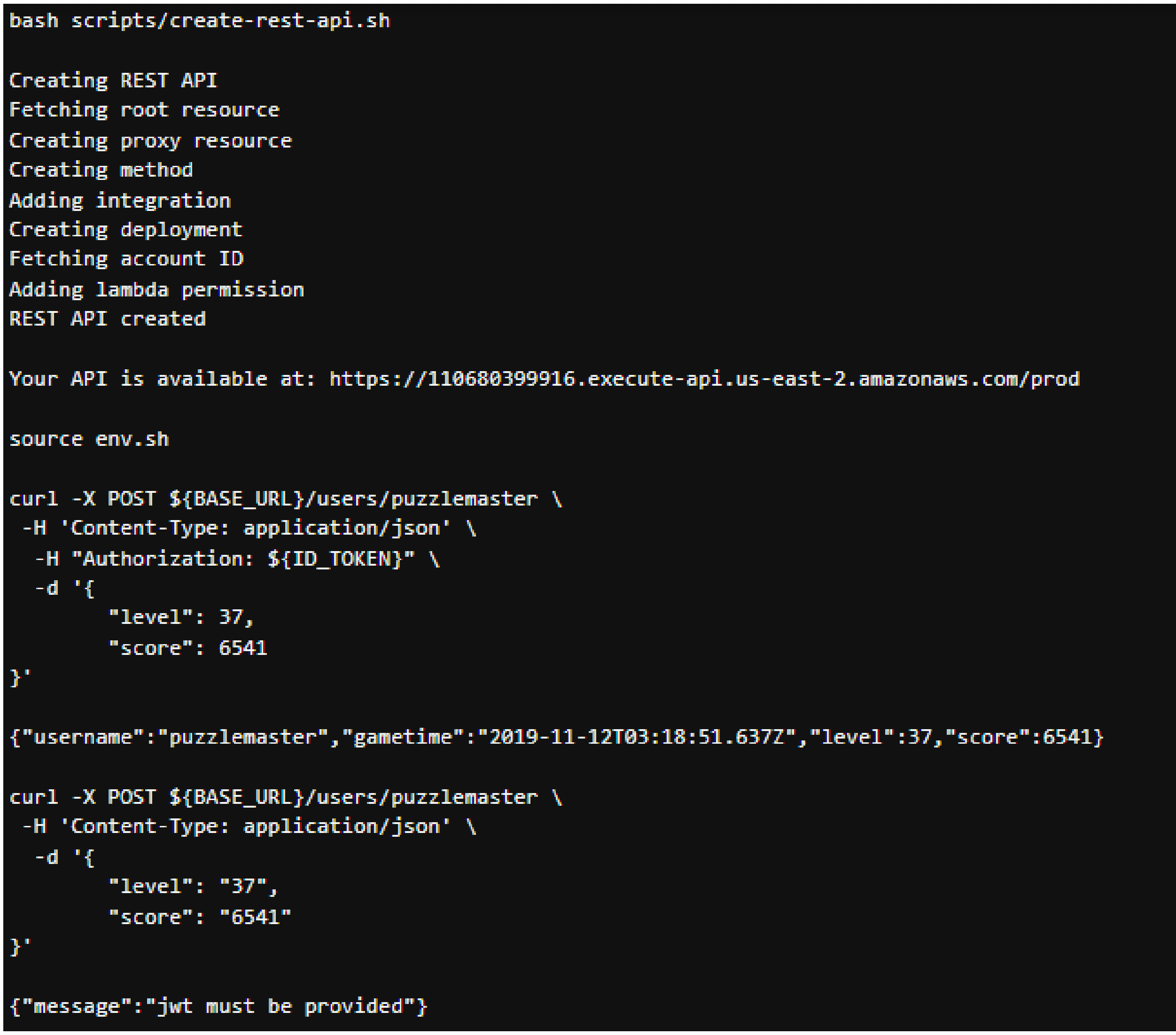
```
ec2-user:~/environment $ curl -X POST ${BASE_URL}/users \
>   -H 'Content-Type: application/json' \
>   -d '{
> "username": "puzzlemaster",
> "password": "Mypassword1",
> "email": "test@hello.com"
> }'
{"username":"puzzlemaster"}
```

Log in to fetch user credentials.



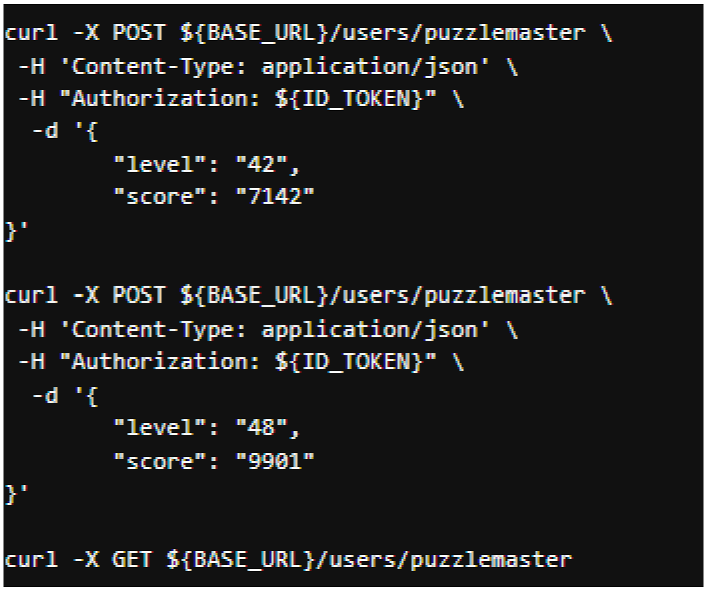
```
ec2-user:~/environment $ curl -X POST ${BASE_URL}/login \
>   -H 'Content-Type: application/json' \
>   -d '{
> "username": "puzzlemaster",
> "password": "Mypassword1"
> }'
{"idToken":"eyJraWQiO…."}
export ID_TOKEN=eyJraWQiO….
```

Create REST API and add data.

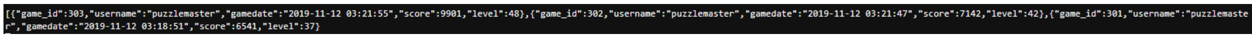


```
bash scripts/create-rest-api.sh

Creating REST API
Fetching root resource
Creating proxy resource
Creating method
Adding integration
Creating deployment
Fetching account ID
Adding lambda permission
REST API created

Your API is available at: https://110680399916.execute-api.us-east-2.amazonaws.com/prod

source env.sh

curl -X POST ${BASE_URL}/users/puzzlemaster \
 -H 'Content-Type: application/json' \
  -H "Authorization: ${ID_TOKEN}" \
  -d '{
        "level": 37,
        "score": 6541
}'

{"username":"puzzlemaster","gametime":"2019-11-12T03:18:51.637Z","level":37,"score":6541}

curl -X POST ${BASE_URL}/users/puzzlemaster \
 -H 'Content-Type: application/json' \
  -d '{
        "level": "37",
        "score": "6541"
}'

{"message":"jwt must be provided"}
```

Add more data and get the scores.



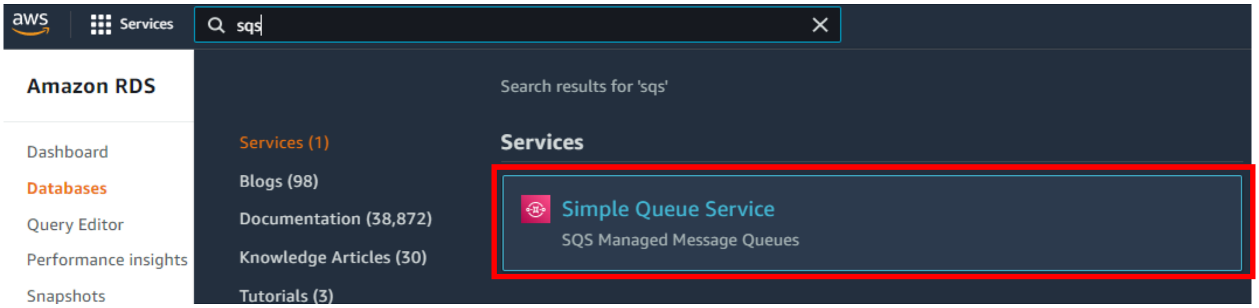
```
curl -X POST ${BASE_URL}/users/puzzlemaster \
 -H 'Content-Type: application/json' \
 -H "Authorization: ${ID_TOKEN}" \
  -d '{
        "level": "42",
        "score": "7142"
}'

curl -X POST ${BASE_URL}/users/puzzlemaster \
 -H 'Content-Type: application/json' \
 -H "Authorization: ${ID_TOKEN}" \
  -d '{
        "level": "48",
        "score": "9901"
}'

curl -X GET ${BASE_URL}/users/puzzlemaster
```



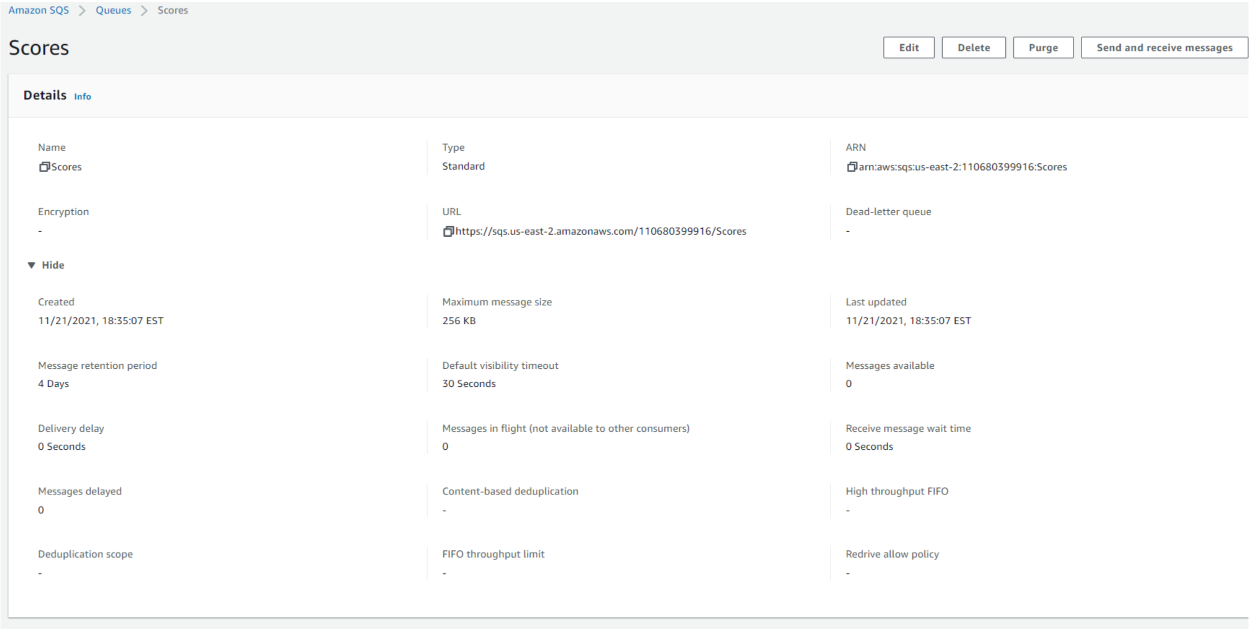
```
[{"game_id":303,"username":"puzzlemaster","gamedate":"2019-11-12 03:21:55","score":9901,"level":48},{"game_id":302,"username":"puzzlemaster","gamedate":"2019-11-12 03:21:47","score":7142,"level":42},{"game_id":301,"username":"puzzlemaste
r","gamedate":"2019-11-12 03:18:51","score":6541,"level":37}
```

Labs: Amazon Simple Queue Service (SQS)

Choose SQS service.

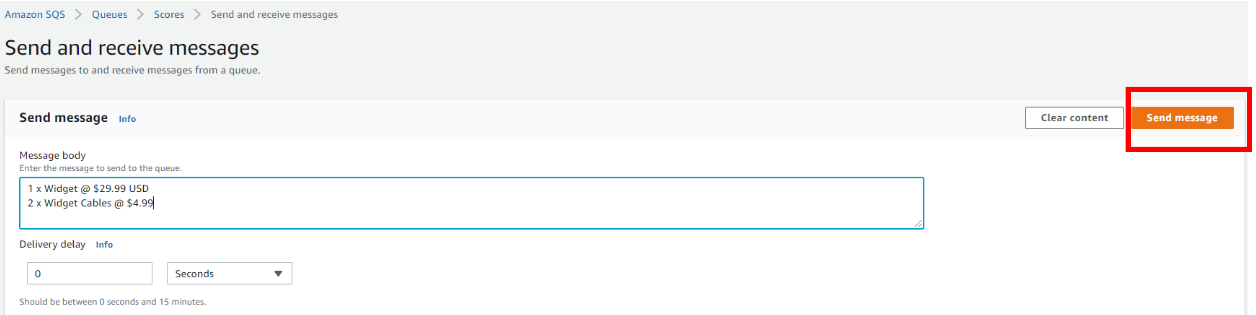


Create queue. Once created, the following screen should appear:



Name Scores	Type Standard	ARN arn:aws:sqs:us-east-2:110680399916:Scores
Encryption -	URL https://sqs.us-east-2.amazonaws.com/110680399916/Scores	Dead-letter queue -
Created 11/21/2021, 18:35:07 EST	Maximum message size 256 KB	Last updated 11/21/2021, 18:35:07 EST
Message retention period 4 Days	Default visibility timeout 30 Seconds	Messages available 0
Delivery delay 0 Seconds	Messages in flight (not available to other consumers) 0	Receive message wait time 0 Seconds
Messages delayed 0	Content-based deduplication -	High throughput FIFO -
Deduplication scope -	FIFO throughput limit -	Redrive allow policy -

Send messages to the queue using "Send and receive messages" button.


Amazon SQS > Queues > Scores > Send and receive messages
Send and receive messages
Send messages to and receive messages from a queue.
Send message Info
Clear content
Send message
Delivery delay Info
Seconds

Message body

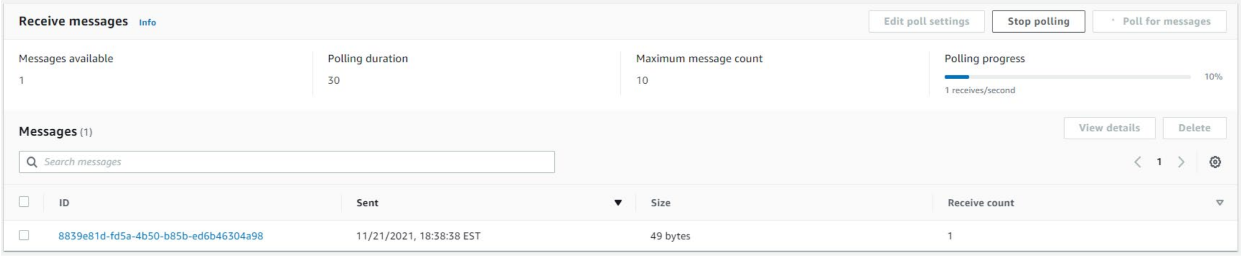
Enter the message to send to the queue.

```
1 x Widget @ $29.99 USD
2 x Widget Cables @ $4.99
```

Delivery delay: 0 Seconds

Should be between 0 seconds and 15 minutes.

Receive messages by polling.



Receive messages Info

Messages available: 1

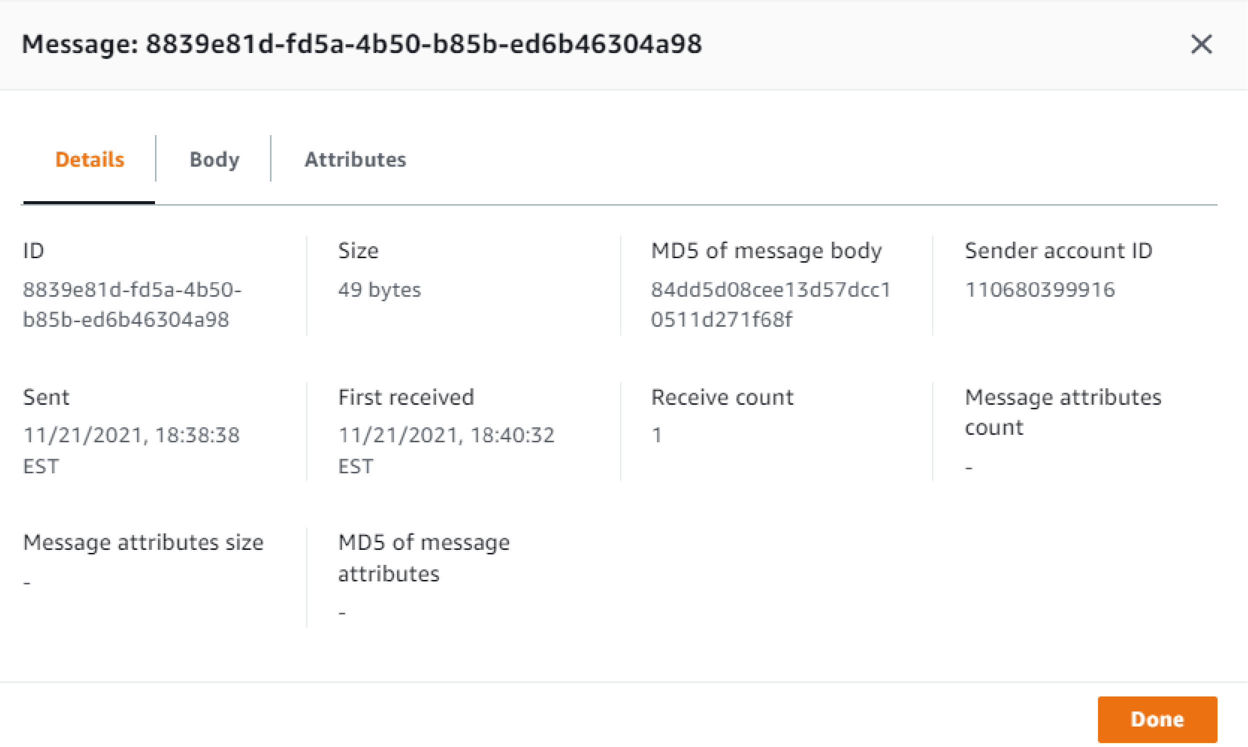
Polling duration: 30

Maximum message count: 10

Polling progress: 10%
1 receives/second

Messages (1)

ID	Sent	Size	Receive count
8839e81d-fd5a-4b50-b85b-ed6b46304a98	11/21/2021, 18:38:38 EST	49 bytes	1



Message: 8839e81d-fd5a-4b50-b85b-ed6b46304a98

ID: 8839e81d-fd5a-4b50-b85b-ed6b46304a98

Size: 49 bytes

MD5 of message body: 84dd5d08cee13d57dcc10511d271f68f

Sender account ID: 110680399916

Sent: 11/21/2021, 18:38:38 EST

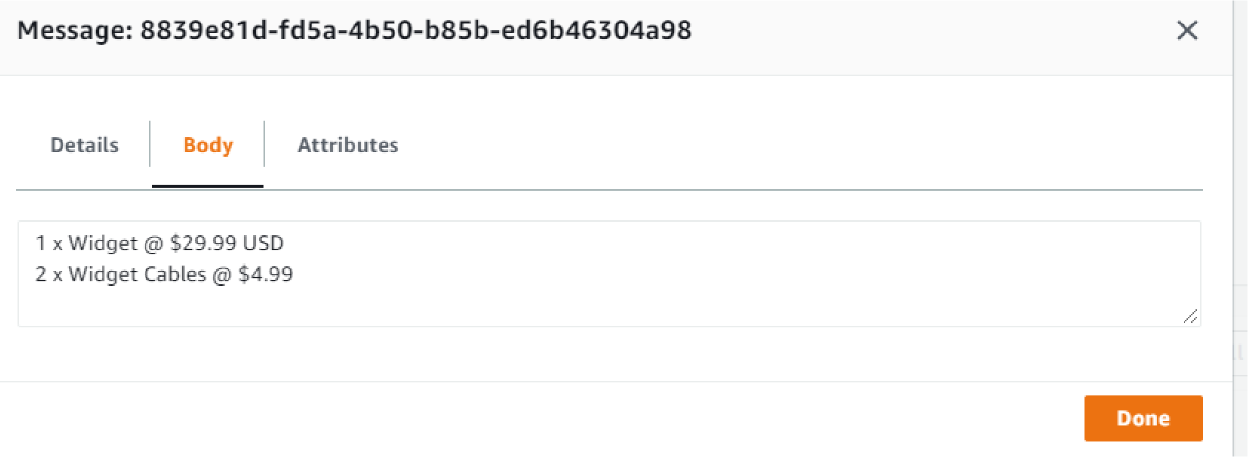
First received: 11/21/2021, 18:40:32 EST

Receive count: 1

Message attributes count: -

Message attributes size: -

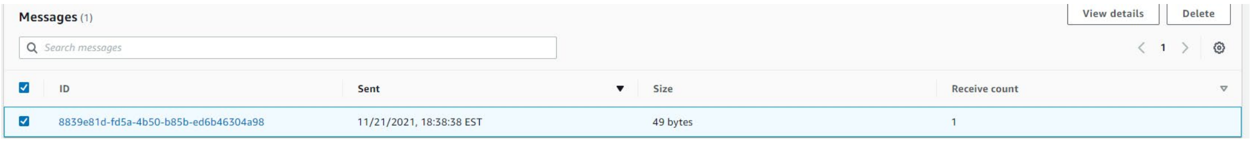
MD5 of message attributes: -



Message: 8839e81d-fd5a-4b50-b85b-ed6b46304a98

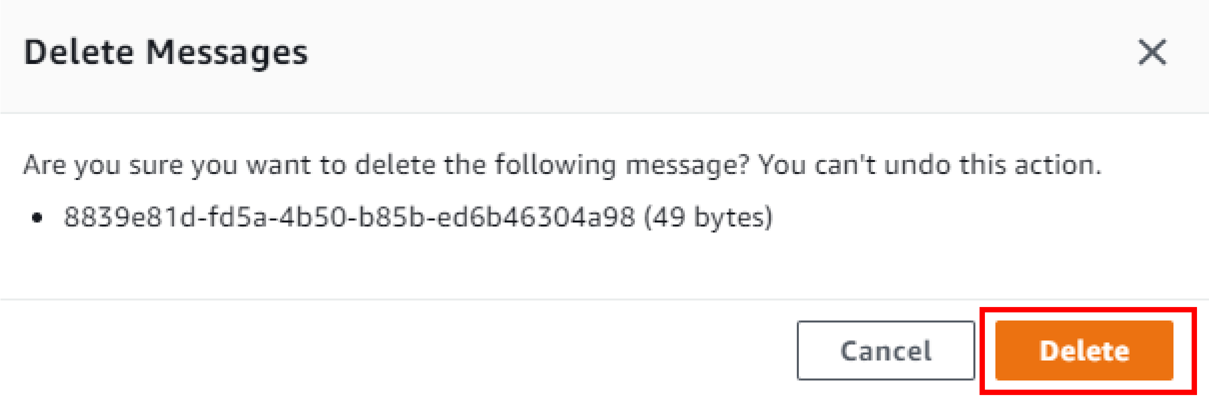
```
1 x Widget @ $29.99 USD
2 x Widget Cables @ $4.99
```

Delete messages from queue.



Messages (1)

☑	ID	Sent	Size	Receive count
☑	8839e81d-fd5a-4b50-b85b-ed6b46304a98	11/21/2021, 18:38:38 EST	49 bytes	1



Delete Messages

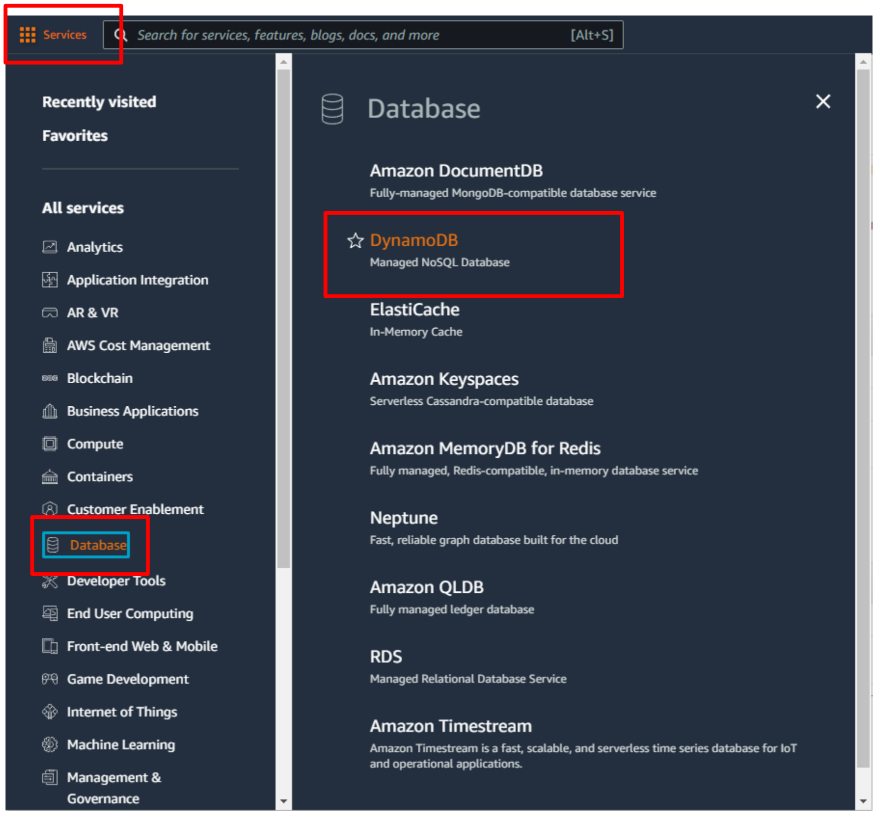
Are you sure you want to delete the following message? You can't undo this action.

- 8839e81d-fd5a-4b50-b85b-ed6b46304a98 (49 bytes)

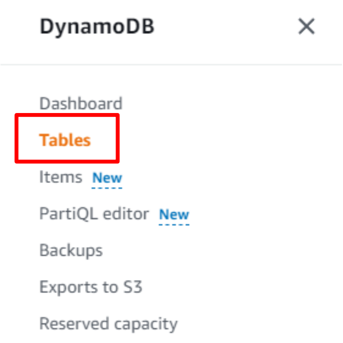
Lab: Create a Table in DynamoDB Using the AWS Management Console

The objective of this lab is to create a table in DynamoDB using the AWS Management Console.

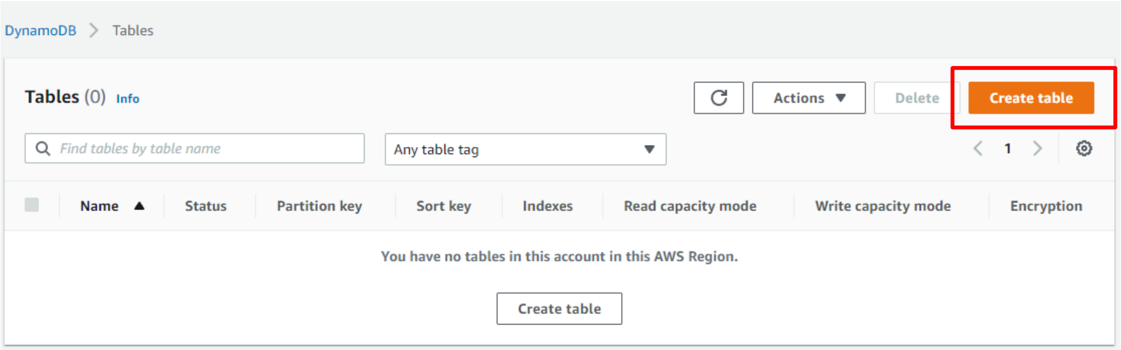
Start by logging in to the AWS Management Console at <https://aws.amazon.com>.
Click on **Services** (top left), **Database** (left column), and **DynamoDB** (right column):


Services
Search for services, features, blogs, docs, and more
[Alt+S]
Recently visited
Favorites
All services
Analytics
Application Integration
AR & VR
AWS Cost Management
Blockchain
Business Applications
Compute
Containers
Customer Enablement
Database
Developer Tools
End User Computing
Front-end Web & Mobile
Game Development
Internet of Things
Machine Learning
Management & Governance
Database
Amazon DocumentDB
Fully-managed MongoDB-compatible database service
DynamoDB
Managed NoSQL Database
ElastiCache
In-Memory Cache
Amazon Keyspaces
Serverless Cassandra-compatible database
Amazon MemoryDB for Redis
Fully managed, Redis-compatible, in-memory database service
Neptune
Fast, reliable graph database built for the cloud
Amazon QLDB
Fully managed ledger database
RDS
Managed Relational Database Service
Amazon Timestream
Amazon Timestream is a fast, scalable, and serverless time series database for IoT and operational applications.

Click **Tables.**



Click the **Create Table** button.

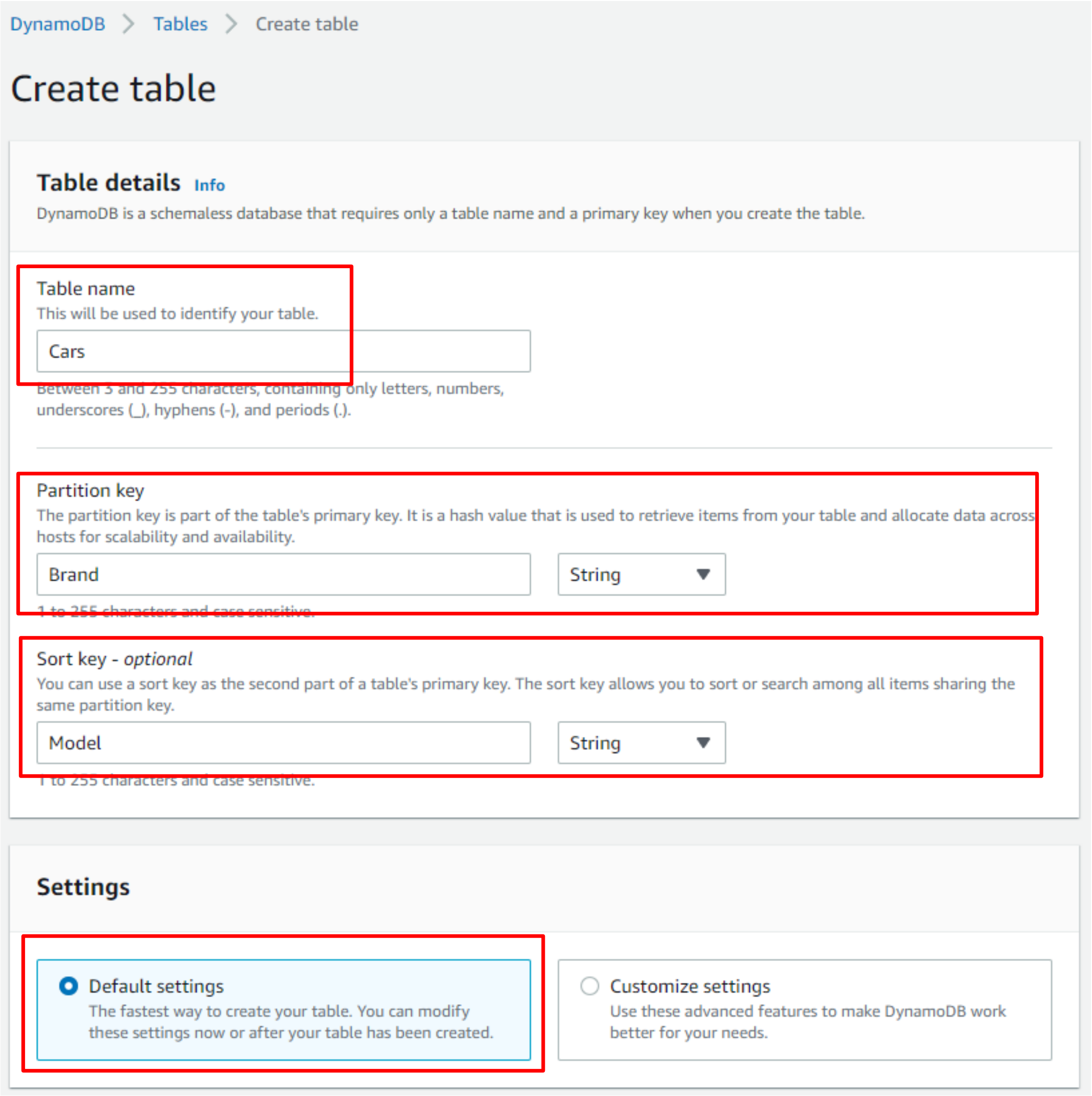


	Name ▲	Status	Partition key	Sort key	Indexes	Read capacity mode	Write capacity mode	Encryption

You have no tables in this account in this AWS Region.

Enter the table details as follows:

For the **Table name**, type “Cars”.
For the **Partition key**, type “Brand”.
Type “Model” as the **Sort key – optional**.
Leave **Default settings** selected.



Create table

Table details Info

DynamoDB is a schemaless database that requires only a table name and a primary key when you create the table.

Table name
This will be used to identify your table.
Cars
Between 3 and 255 characters, containing only letters, numbers, underscores (_), hyphens (-), and periods (.).

Partition key
The partition key is part of the table's primary key. It is a hash value that is used to retrieve items from your table and allocate data across hosts for scalability and availability.
Brand | String ▼
1 to 255 characters and case sensitive.

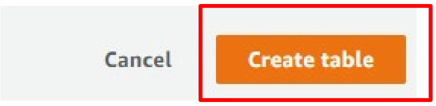
Sort key - *optional*
You can use a sort key as the second part of a table's primary key. The sort key allows you to sort or search among all items sharing the same partition key.
Model | String ▼
1 to 255 characters and case sensitive.

Settings

● Default settings
The fastest way to create your table. You can modify these settings now or after your table has been created.

○ Customize settings
Use these advanced features to make DynamoDB work better for your needs.

Scroll to bottom, Click **Create table** button.



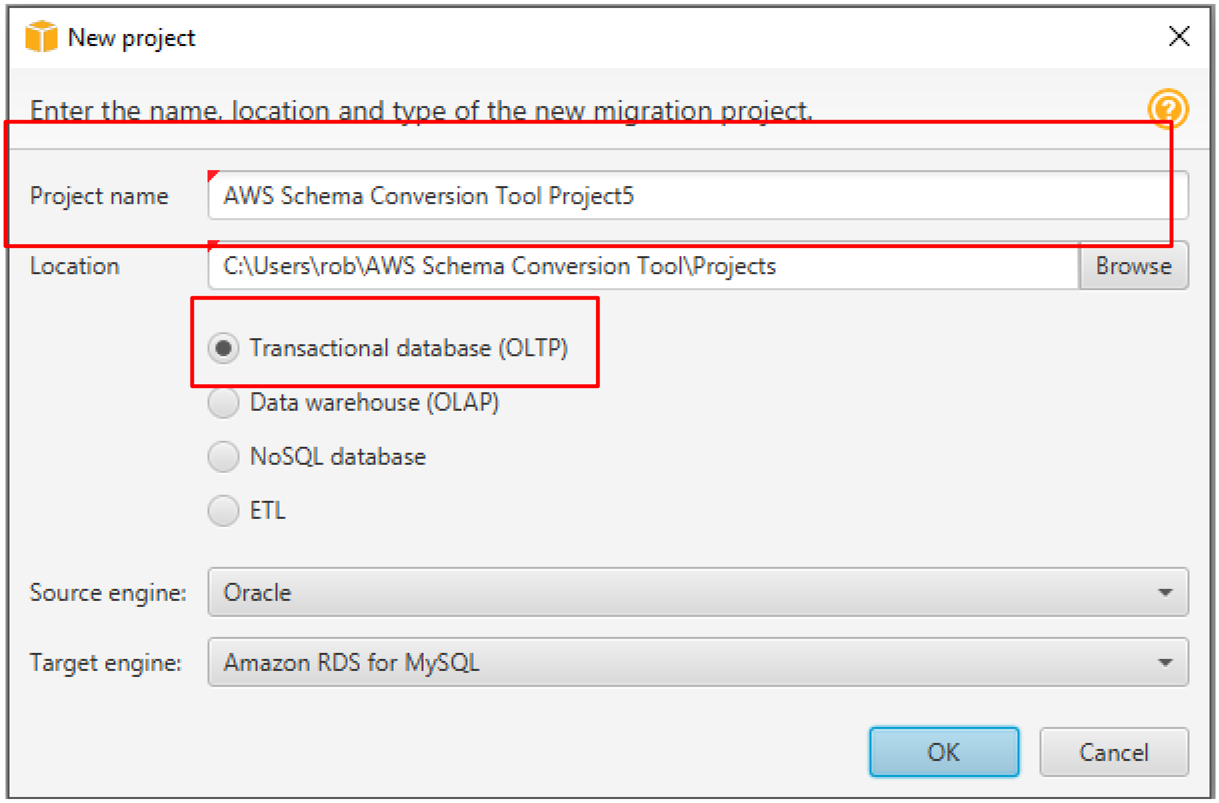
Lab: Using the Database Migration Service and the Schema Conversion Tool

In this lab will use the DMS and SCT to migrate a database to AWS.

The following high-level steps can be used for a heterogeneous migration of an Oracle Database (OLTP) to an AWS RDS Postgres database using a combination of native tools like Oracle Data Pump and AWS SCT and DMS.

Record the SCN of the Oracle Database, take a backup. Next create a user on the source (ORACLE) database and grant them the necessary privileges per AWS Guidelines.

Now download and start the SCT client.
Enter a project Name.
Choose OLTP.



New project

Enter the name, location and type of the new migration project.

Project name: AWS Schema Conversion Tool Project5

Location: C:\Users\rob\AWS Schema Conversion Tool\Projects

● Transactional database (OLTP)
○ Data warehouse (OLAP)
○ NoSQL database
○ ETL

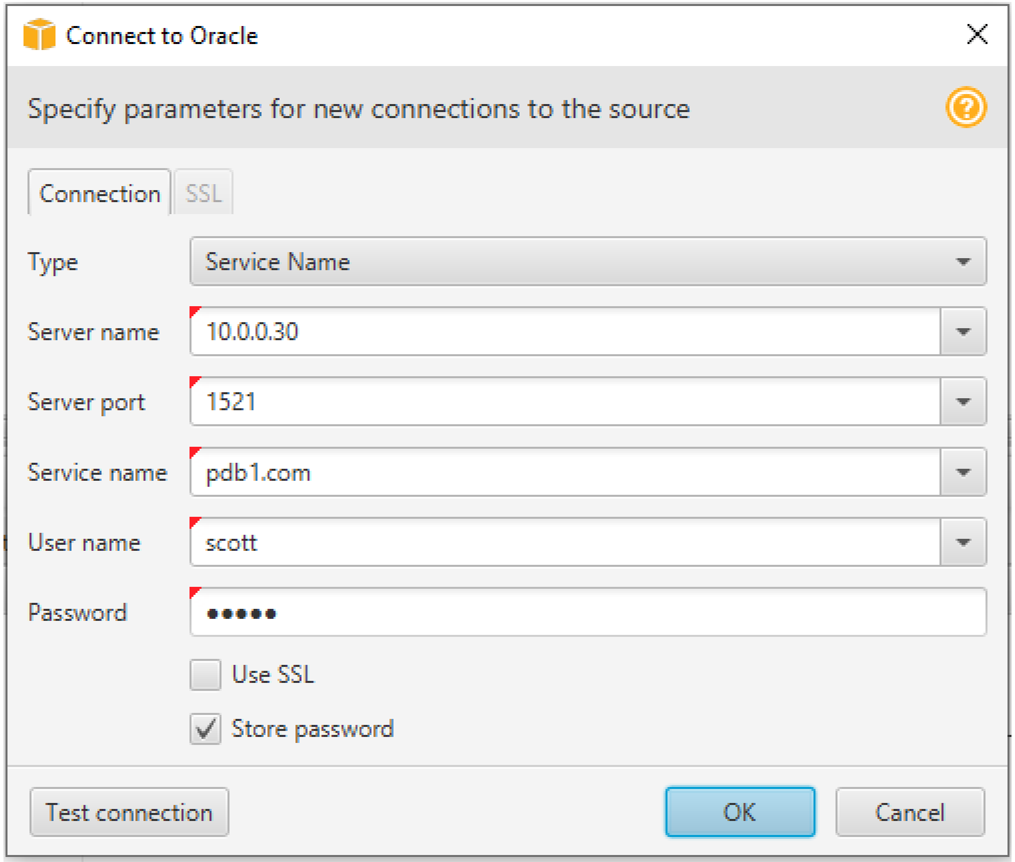
Source engine: Oracle

Target engine: Amazon RDS for MySQL

Enter source and target engines as Oracle and Postgres.

In the connect to dialog box, connect Oracle and fill in the necessary details. The user should be the same user created in step II and Test connection.

Connect to Amazon RDS for PostgreSQL. Repeat the above steps above.



Connect to Oracle

Specify parameters for new connections to the source

Type: Service Name

Server name: 10.0.0.30

Server port: 1521

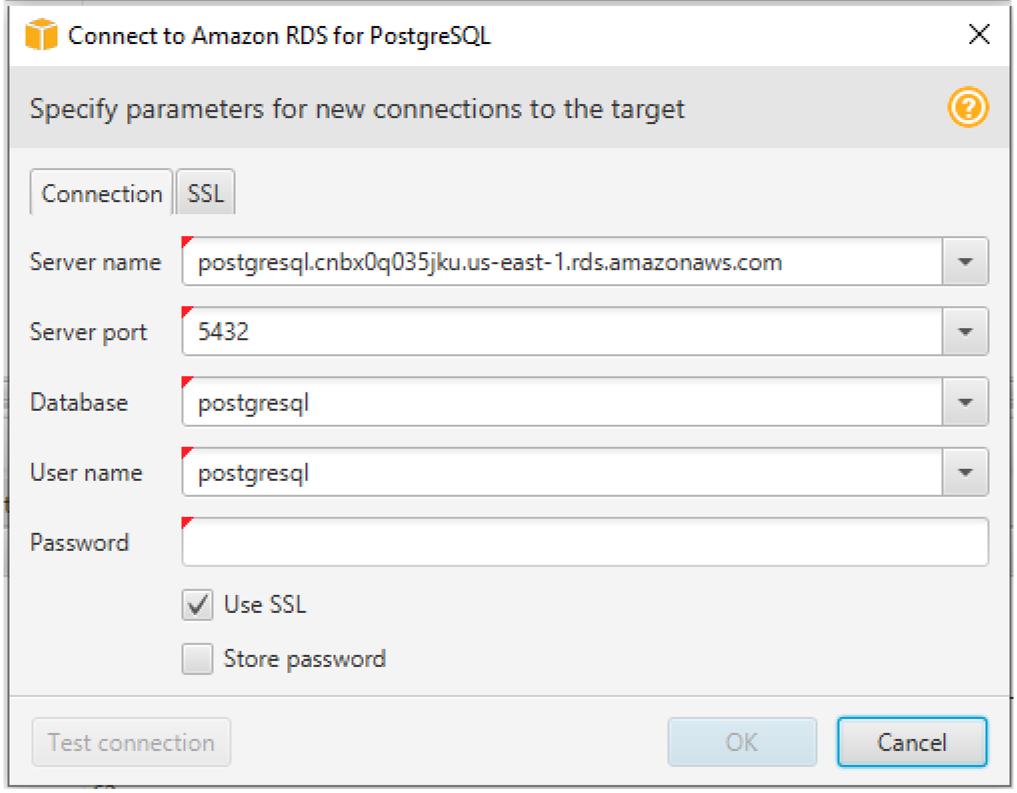
Service name: pdb1.com

User name: scott

Password: •••••

☐ Use SSL

☑ Store password



Connect to Amazon RDS for PostgreSQL

Specify parameters for new connections to the target

Server name: postgresql.cnbx0q035jku.us-east-1.rds.amazonaws.com

Server port: 5432

Database: postgresql

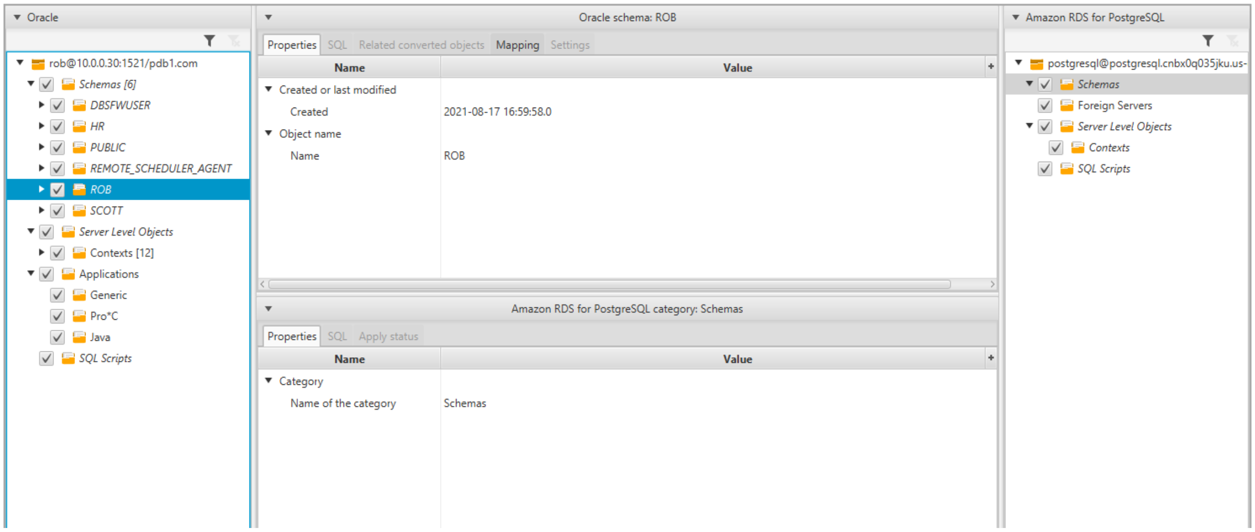
User name: postgresql

Password:

☑ Use SSL

☐ Store password

Click to convert schema.



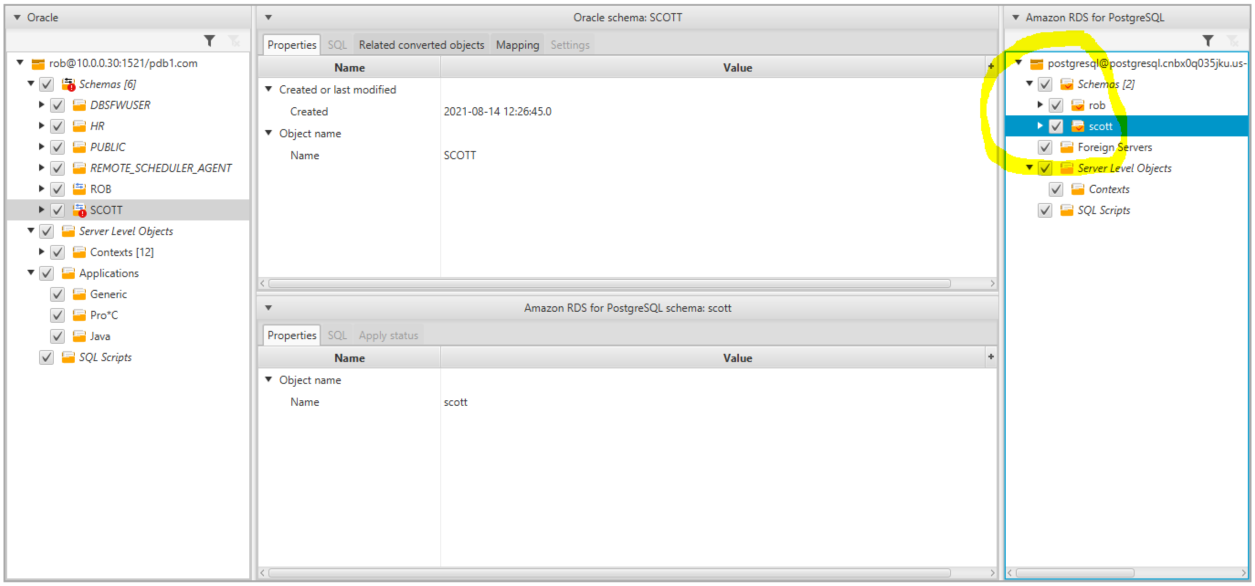
Oracle schema: ROB

Name	Value
Created or last modified	
Created	2021-08-17 16:59:58.0
Object name	
Name	ROB

Amazon RDS for PostgreSQL category: Schemas

Name	Value
Category	
Name of the category	Schemas

Right click on the target and apply.



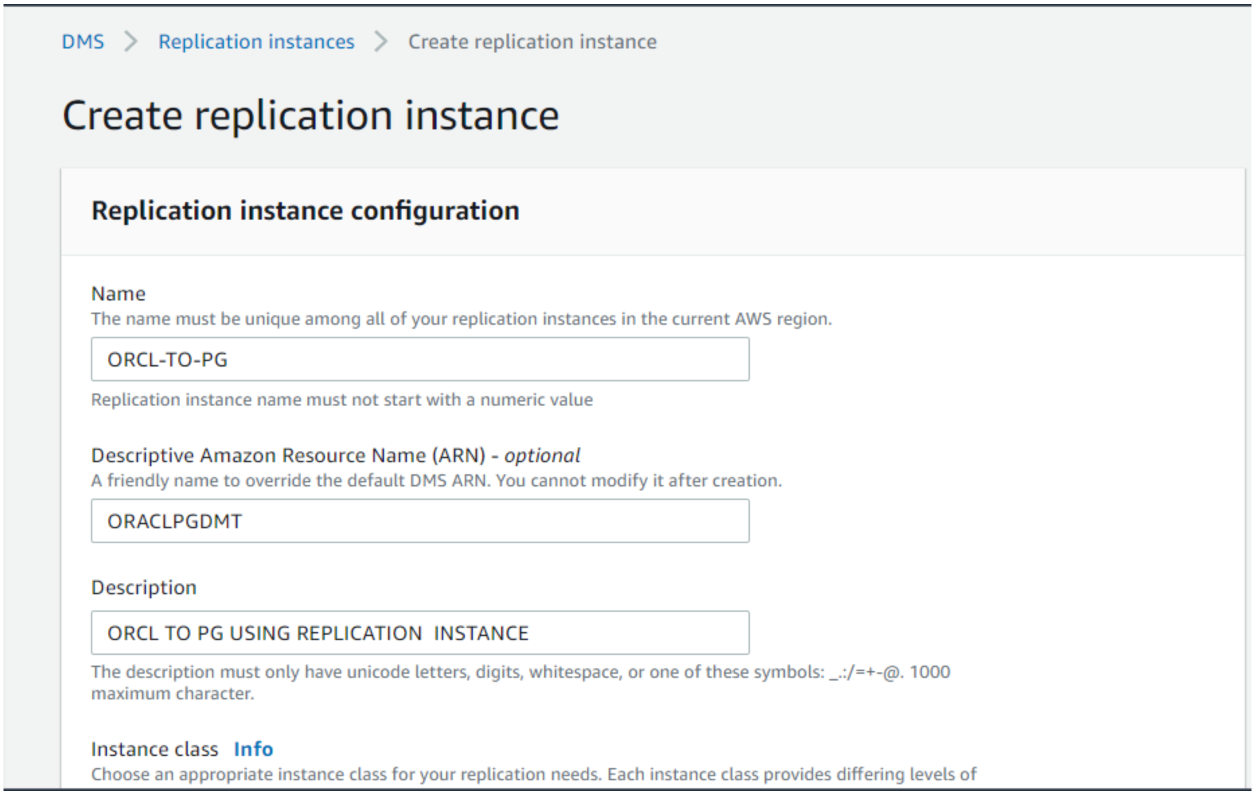
Oracle schema: SCOTT

Name	Value
Created or last modified	
Created	2021-08-14 12:26:45.0
Object name	
Name	SCOTT

Amazon RDS for PostgreSQL schema: scott

Name	Value
Object name	
Name	scott

Create a replication instance using the AWS DMS console.



Create replication instance

Replication instance configuration

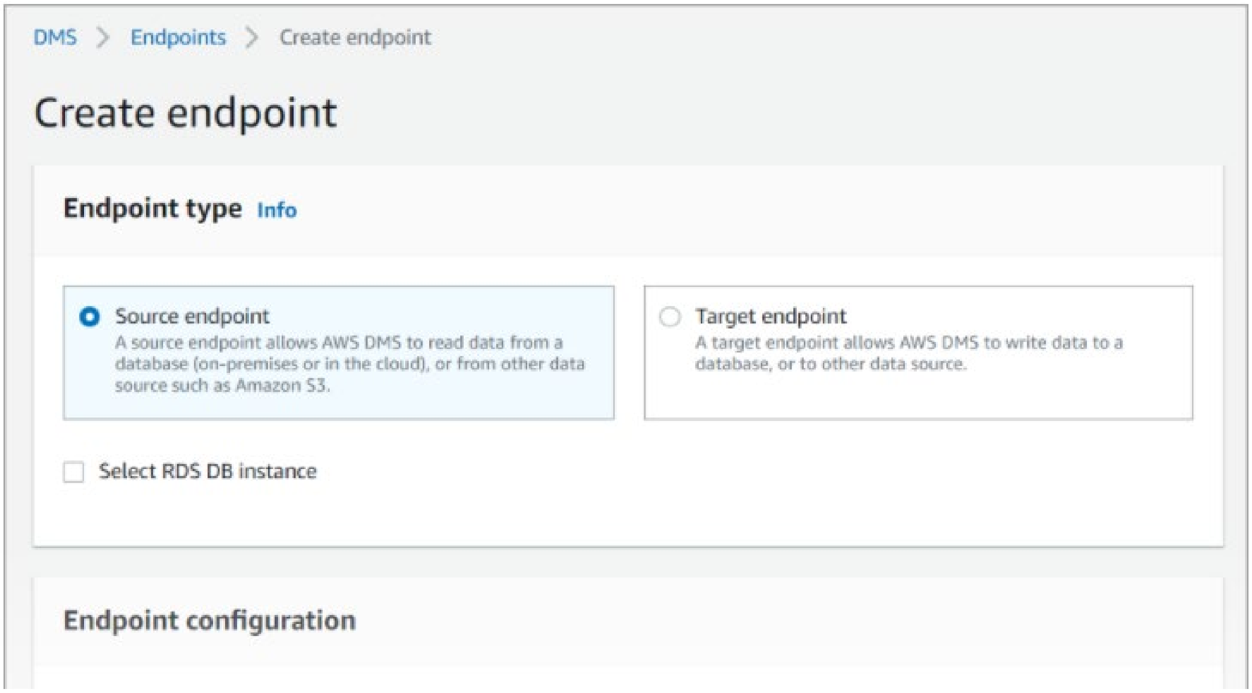
Name
The name must be unique among all of your replication instances in the current AWS region.
ORCL-TO-PG
Replication instance name must not start with a numeric value

Descriptive Amazon Resource Name (ARN) - *optional*
A friendly name to override the default DMS ARN. You cannot modify it after creation.
ORACLPGDMT

Description
ORCL TO PG USING REPLICATION INSTANCE
The description must only have unicode letters, digits, whitespace, or one of these symbols: _.:/=+-@. 1000 maximum character.

Instance class
Choose an appropriate instance class for your replication needs. Each instance class provides differing levels of

Specify source and target endpoints.



Create endpoint

Endpoint type

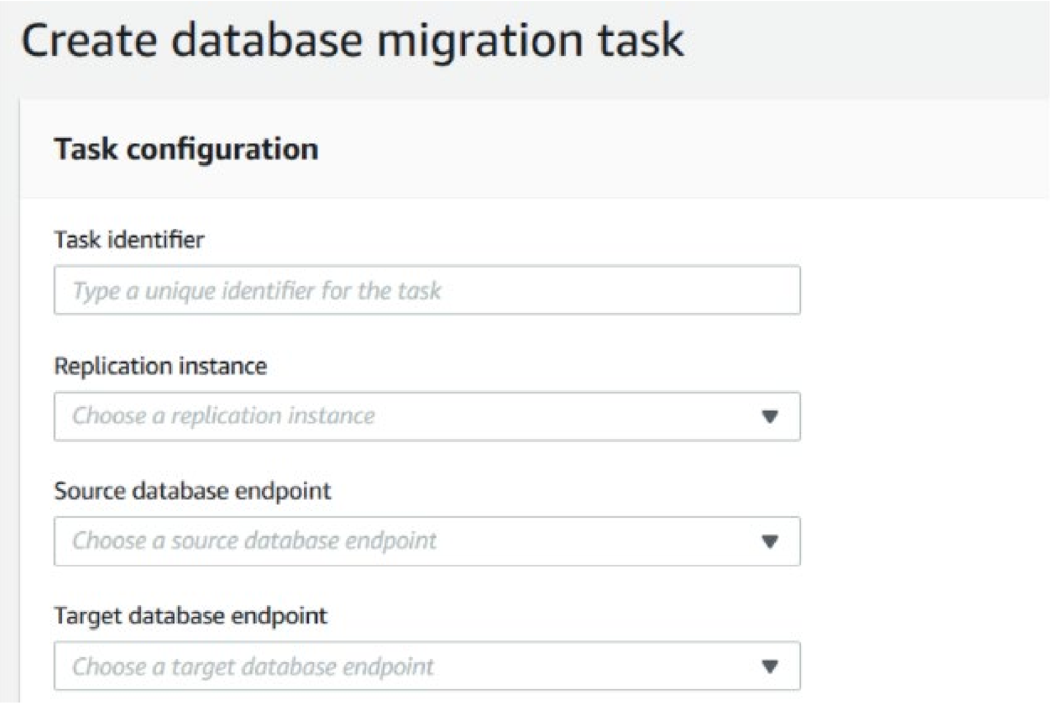
● Source endpoint
A source endpoint allows AWS DMS to read data from a database (on-premises or in the cloud), or from other data source such as Amazon S3.

○ Target endpoint
A target endpoint allows AWS DMS to write data to a database, or to other data source.

□ Select RDS DB instance

Endpoint configuration

Create a task and migrate data.



Create database migration task

Task configuration

Task identifier

Type a unique identifier for the task

Replication instance

Choose a replication instance ▼

Source database endpoint

Choose a source database endpoint ▼

Target database endpoint

Choose a target database endpoint ▼

To test replication:

Make sure that your database migration task shows a status of running but your initial database replication, started in the previous step, isn’t complete.

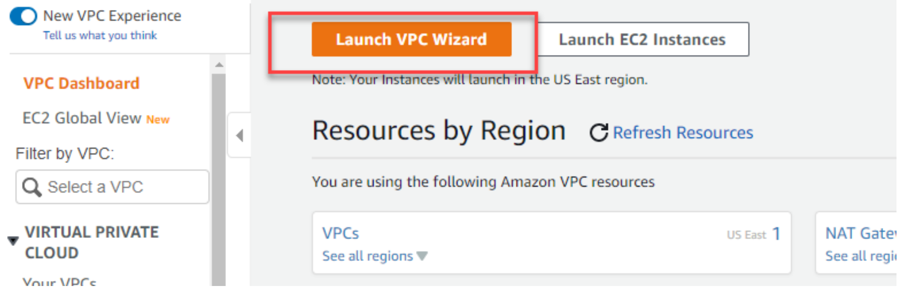
Chapter 6 Labs

Lab: Create a VPC

Open the VPC console at https://console.aws.amazon.com/vpc/.

The VPC will be created in a specific AWS Region. Take note of the region, found in the top right of the navigation bar. Ensure this region is selected for the entirety of this exercise.

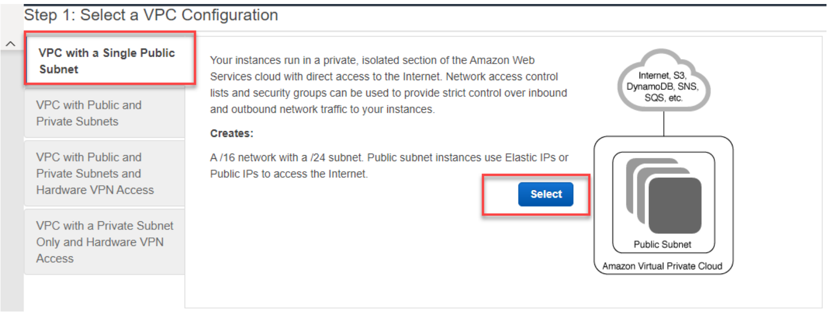
Launch the VPC Wizard, from the **VPC Dashboard** located in the navigation pane.



Note: Your Instances will launch in the US East region.

You are using the following Amazon VPC resources

Next, follow this path: **VPC with a Single Public Subnet** > **Select**


Step 1: Select a VPC Configuration
VPC with a Single Public Subnet
VPC with Public and Private Subnets
VPC with Public and Private Subnets and Hardware VPN Access
VPC with a Private Subnet Only and Hardware VPN Access
Select
Internet, S3, DynamoDB, SNS, SQS, etc.
Public Subnet
Amazon Virtual Private Cloud

Your instances run in a private, isolated section of the Amazon Web Services cloud with direct access to the Internet. Network access control lists and security groups can be used to provide strict control over inbound and outbound network traffic to your instances.

Creates:

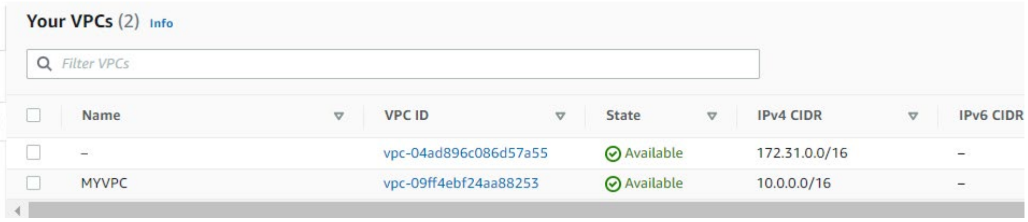
A /16 network with a /24 subnet. Public subnet instances use Elastic IPs or Public IPs to access the Internet.

Configure the VPC. Type a name for the VPC in the **VPC Name** field; also enter a name for the subnet in the field titled **Subnet Name**.

This will aid in identifying each in the Amazon VPC console. Leave all other configurations as is for the purposes of this exercise. Then choose **Create VPC**.

A status window will show the creation progress. Once completed, close the status window by clicking **OK**.

The newly created VPC will be found on the **Your VPCs** page along with a default VPC. The **Default VPC** column will display **No** for the new VPC as it is considered nondefault.



Your VPCs (2) Info

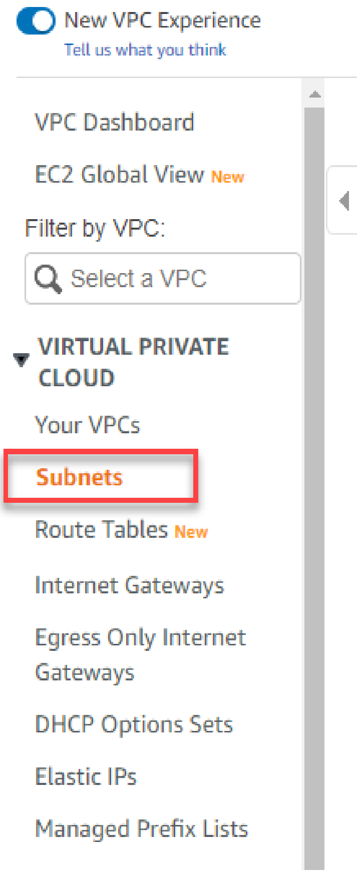
Filter VPCs

□	Name	VPC ID	State	IPv4 CIDR	IPv6 CIDR
□	–	vpc-04ad896c086d57a55	Available	172.31.0.0/16	–
□	MYVPC	vpc-09ff4ebf24aa88253	Available	10.0.0.0/16	–

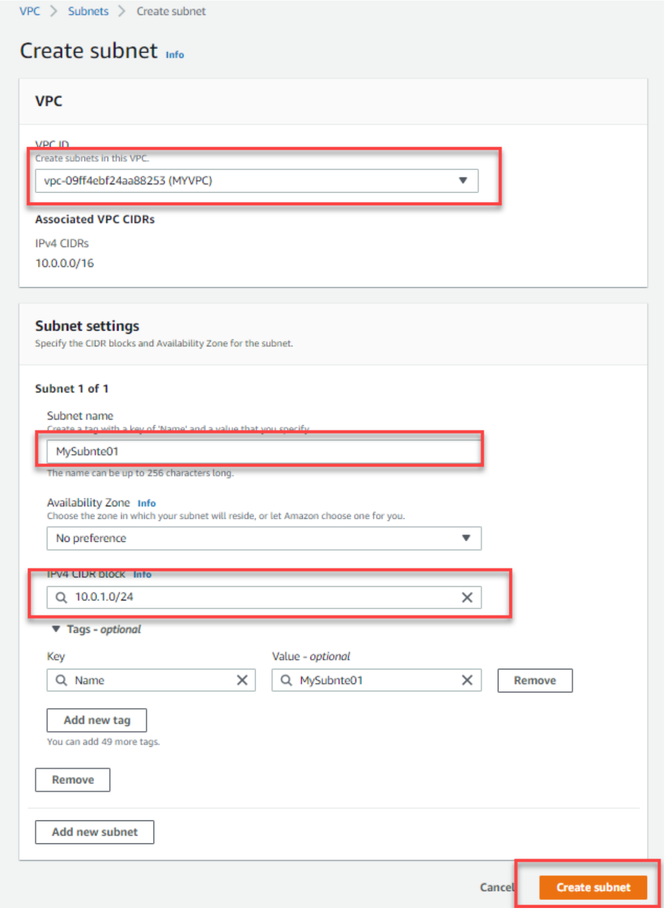
Create a Subnet for the VPC

An IPv4 CIDR block must first be selected from the newly created VPC's range and Availability Zone specified. There may be multiple subnets within the same zone. If an IPv6 CIDR block is associated with your VPC, an IPv6 block may be specified for the subnet.

Navigate to the Amazon VPC console: https://console.aws.amazon.com/vpc/.
Choose **Subnets** > **Create subnet** from the navigation pane.



Enter subnet specifications as necessary. Choose **Create** and then select the VPC for which you created the subnet.



VPC > Subnets > Create subnet

Create subnet Info

VPC

VPC ID
Create subnets in this VPC.
vpc-09ff4ebf24aa88253 (MYVPC)

Associated VPC CIDRs
IPv4 CIDRs
10.0.0.0/16

Subnet settings
Specify the CIDR blocks and Availability Zone for the subnet.

Subnet 1 of 1

Subnet name
Create a tag with a key of 'Name' and a value that you specify.
MySubnte01
The name can be up to 256 characters long.

Availability Zone Info
Choose the zone in which your subnet will reside, or let Amazon choose one for you.
No preference

IPv4 CIDR block Info
10.0.1.0/24

Tags - *optional*

Key: Name
Value - *optional*: MySubnte01

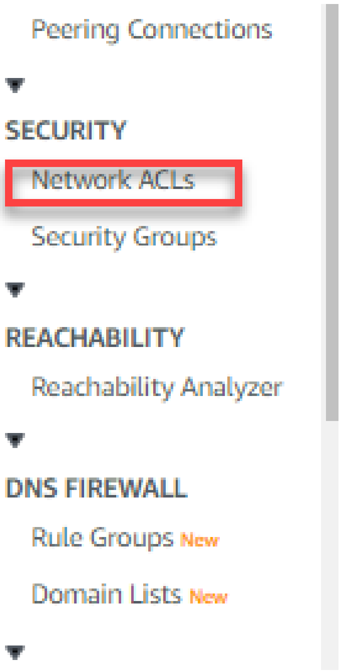
You can add 49 more tags.

Lab: Create Network Access Control Lists (NACL)

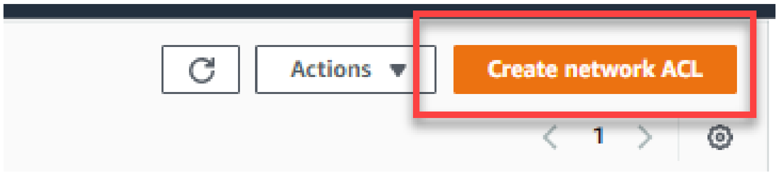
The objective of this lab is to create an access list to protect a subnet.

Open the Amazon VPC console at https://console.aws.amazon.com/vpc/.

Choose **Network ACLs** in the navigation pane.



Choose **Create network ACL.**



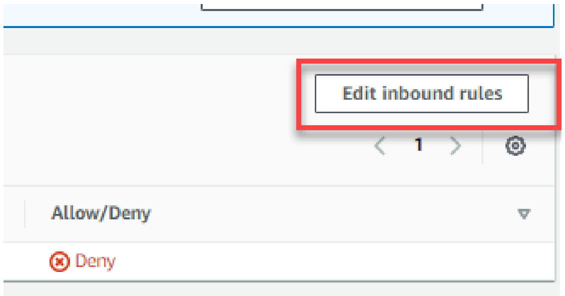
Name your network ACL, if desired, in the **Create Network ACL** dialog box. Then select the VPC ID from the **VPC** list and choose **Yes > Create**.

Add and Delete Rules

Open the Amazon VPC console at https://console.aws.amazon.com/vpc/.

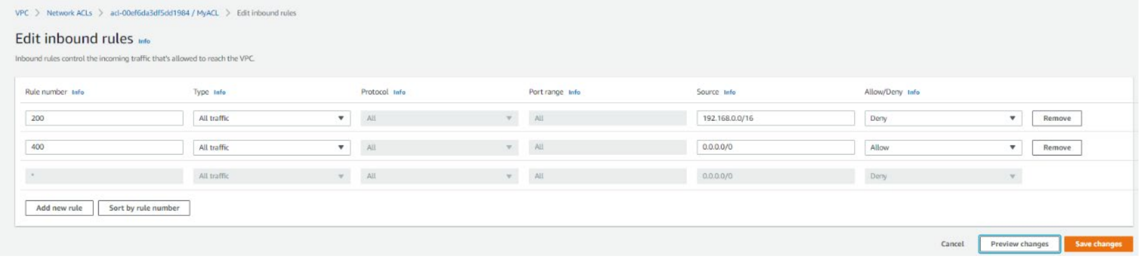
Choose **Network ACLs**.

Edit inbound rules in the details pane.



Choose **Add new rule**.

In this example, we will block any incoming traffic from the CIDR range 192.168.0.0/16 from entering the subnet:


VPC > Network ACLs > acl-00ef6da3df5dd1984 / MyACL > Edit inbound rules

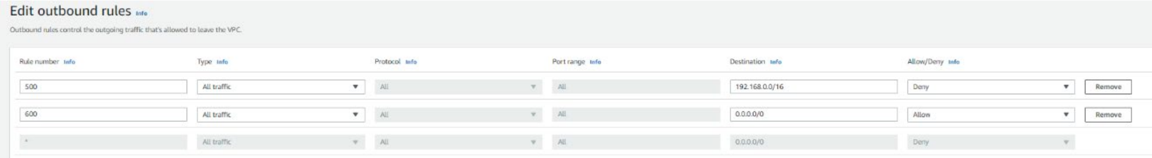
Edit inbound rules Info

Inbound rules control the incoming traffic that's allowed to reach the VPC.

Rule number	Type	Protocol	Port range	Source	Allow/Deny	
200	All traffic	All	All	192.168.0.0/16	Deny	Remove
400	All traffic	All	All	0.0.0.0/0	Allow	Remove
*	All traffic	All	All	0.0.0.0/0	Deny	

Add new rule
Sort by rule number
Cancel
Preview changes
Save changes

Now, we will block any outgoing traffic destined to CIDR range 192.168.0.0/16:



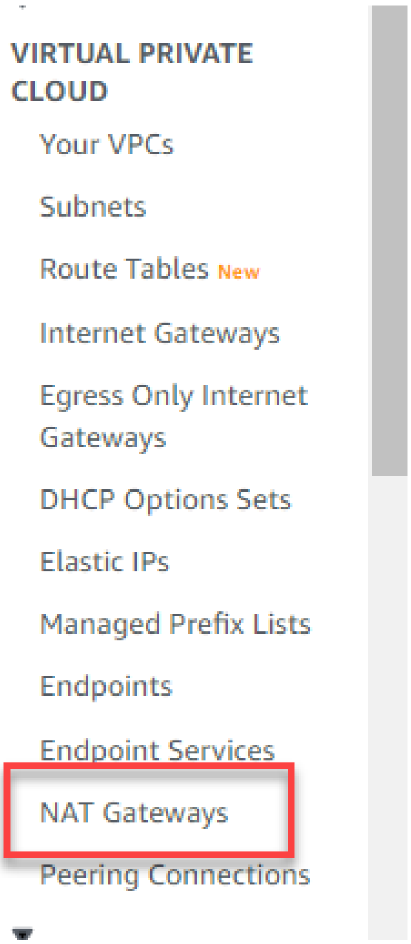
Edit outbound rules Info

Outbound rules control the outgoing traffic that's allowed to leave the VPC.

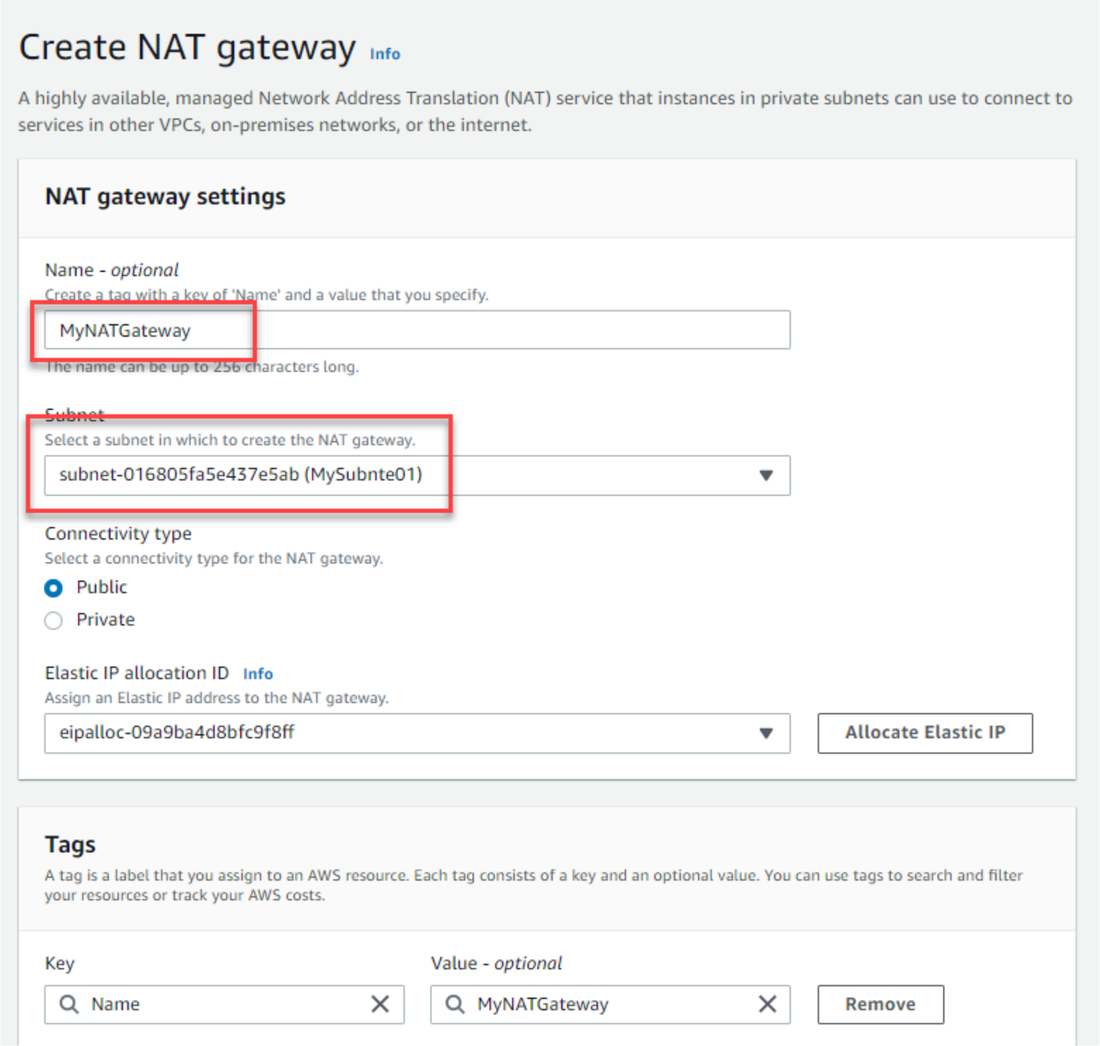
Rule number	Type	Protocol	Port range	Destination	Allow/Deny	
500	All traffic	All	All	192.168.0.0/16	Deny	Remove
600	All traffic	All	All	0.0.0.0/0	Allow	Remove
*	All traffic	All	All	0.0.0.0/0	Deny	

Lab: Create A NAT Gateway

Open the Amazon VPC console at https://console.aws.amazon.com/vpc/.



Choose **NAT Gateways** in the navigation pane, and then do the following:



Create NAT gateway Info

A highly available, managed Network Address Translation (NAT) service that instances in private subnets can use to connect to services in other VPCs, on-premises networks, or the internet.

NAT gateway settings

Name - *optional*
Create a tag with a key of 'Name' and a value that you specify.
MyNATGateway
The name can be up to 256 characters long.

Subnet
Select a subnet in which to create the NAT gateway.
subnet-016805fa5e437e5ab (MySubnte01)

Connectivity type
Select a connectivity type for the NAT gateway.
● Public
○ Private

Elastic IP allocation ID Info
Assign an Elastic IP address to the NAT gateway.
eipalloc-09a9ba4d8bfc9f8ff

Tags

A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter your resources or track your AWS costs.

Key	Value - *optional*
Name	MyNATGateway

Specify a name for the NAT gateway. This is optional. **Note:** Key is “Name” and Value is the name specified.

Select a target subnet in which to place the NAT gateway.

Connectivity type: AWS defaults to a **Public** gateway. Select **Private** to create a private NAT gateway if preferred.

> *Note For Public NAT gateway only: For **Elastic IP allocation ID**, select an Elastic IP address to associate with the NAT gateway.

(Optional) Choose **Add new tag** and enter the key name and value if additional tags are desired.

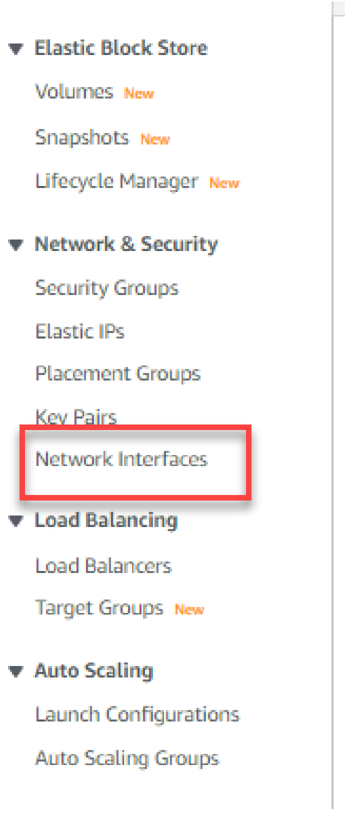
Choose **Create a NAT Gateway.**

Lab: Create Elastic Network Interface

In this lab we will create an Elastic Network Interface.

Open the Amazon EC2 Console at https://console.aws.amazon.com/ec2/.

Choose **Network Interfaces** from the navigation pane.



Choose **Create network interface**.

Enter a **Description** name (optional).

Select the **Subnet** that was created.

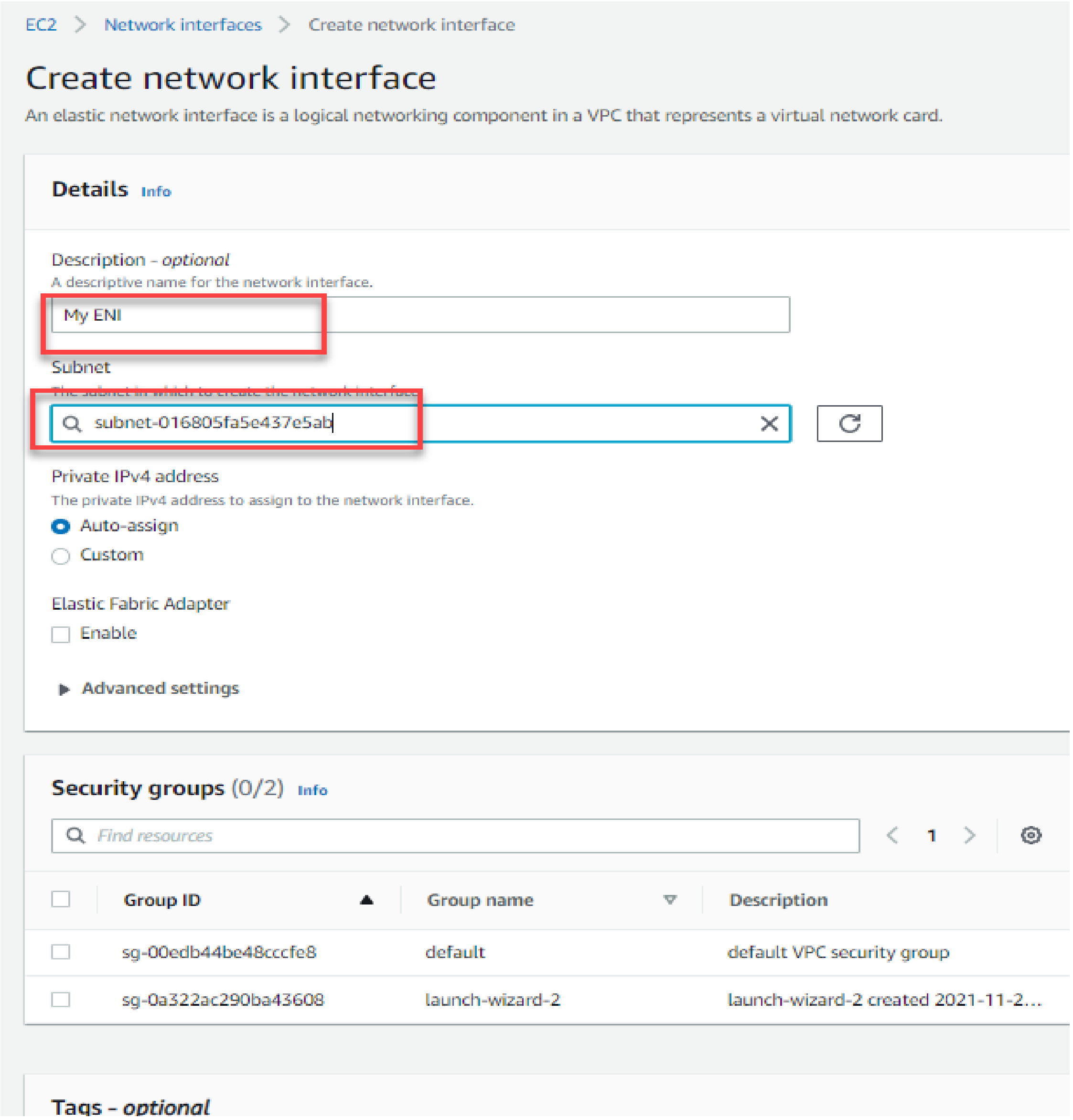
For Private IPv4 address:

Choose **Auto-assign**, or

Choose **Custom** and enter an IPv4 address selected from the subnet.

Select one or more **Security Groups**, and if desired, **Add New Tag**.

Then **Create network interface**.



EC2 > Network interfaces > Create network interface

Create network interface

An elastic network interface is a logical networking component in a VPC that represents a virtual network card.

Details Info

Description - *optional*

A descriptive name for the network interface.

My ENI

Subnet

The subnet in which to create the network interface.

subnet-016805fa5e437e5ab

Private IPv4 address

The private IPv4 address to assign to the network interface.

● Auto-assign

○ Custom

Elastic Fabric Adapter

□ Enable

▶ Advanced settings

Security groups (0/2) Info

Find resources

□	Group ID	Group name	Description
□	sg-00edb44be48cccfe8	default	default VPC security group
□	sg-0a322ac290ba43608	launch-wizard-2	launch-wizard-2 created 2021-11-2...

Tags - *optional*

Attach Elastic Network Interface (ENI)

An interface can be attached to any instance in the same Availability Zone. To do so, do the following:

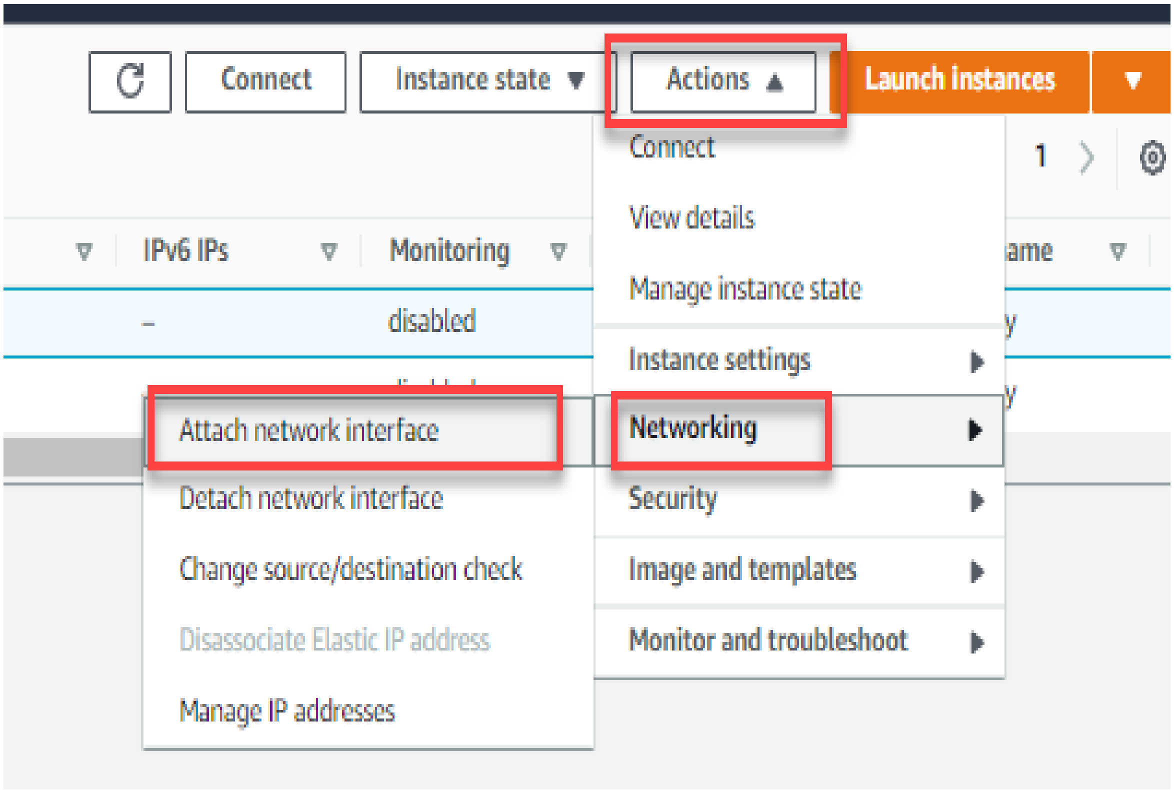
Open the Amazon EC2 console, https://console.aws.amazon.com/ec2/.

Choose **Instances.**

Select the checkbox next to the Instance, then
Actions > **Networking** > **Attach network interface**.

Select desired network interface. Network cards may also be chosen if the instance supports them.

Choose **Attach**.

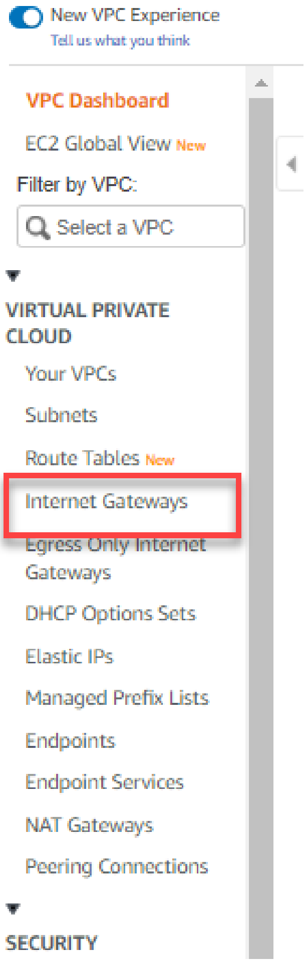


Lab: Create an Internet Gateway

The objective of this lab is to create an internet gateway.

Open the Amazon VPC console https://console.aws.amazon.com/vpc/.

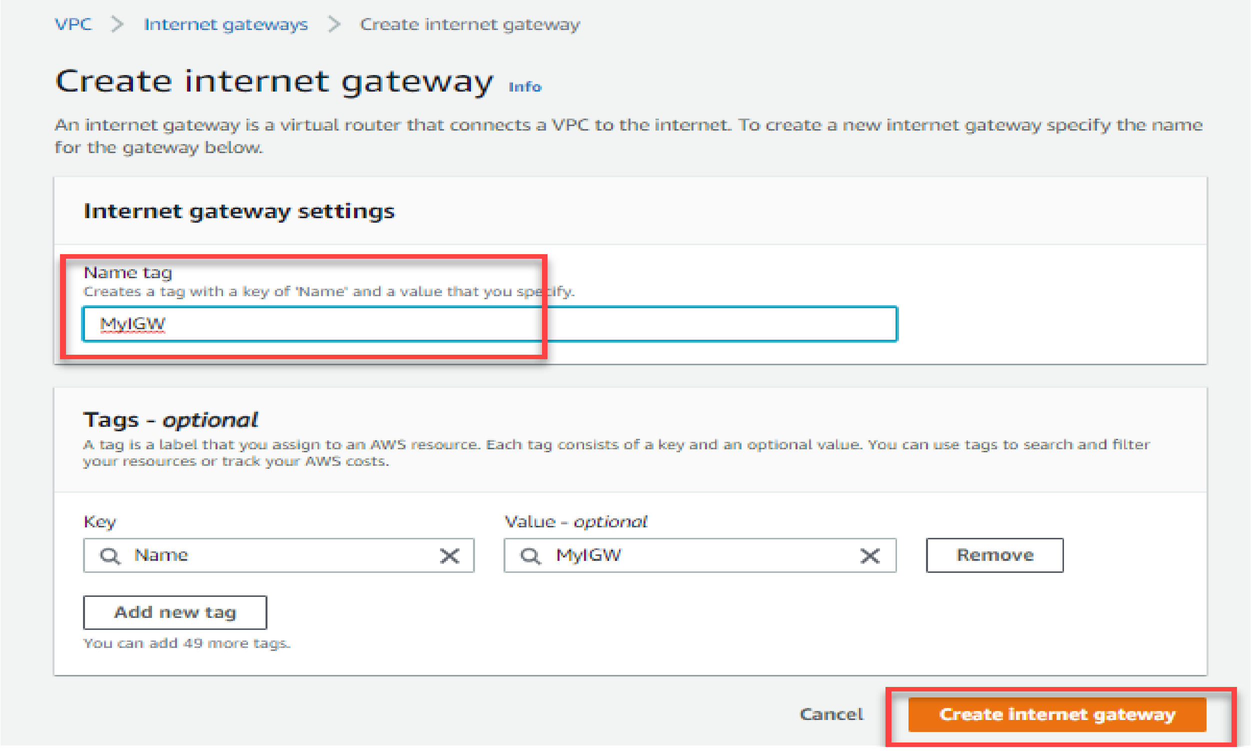
Choose **Internet Gateways** > **Create internet gateway** from the navigation pane.



Name the gateway (optional).

Add or Remove Tag (optional).

Click **Create internet gateway**.



VPC > Internet gateways > Create internet gateway

Create internet gateway Info

An internet gateway is a virtual router that connects a VPC to the internet. To create a new internet gateway specify the name for the gateway below.

Internet gateway settings

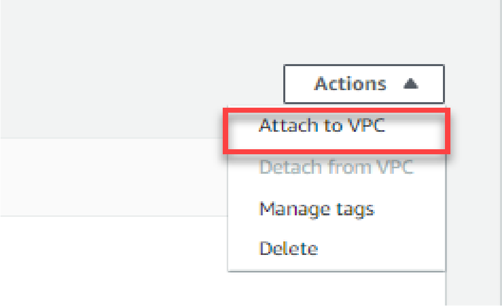
Name tag
Creates a tag with a key of 'Name' and a value that you specify.
MyIGW

Tags - *optional*
A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter your resources or track your AWS costs.

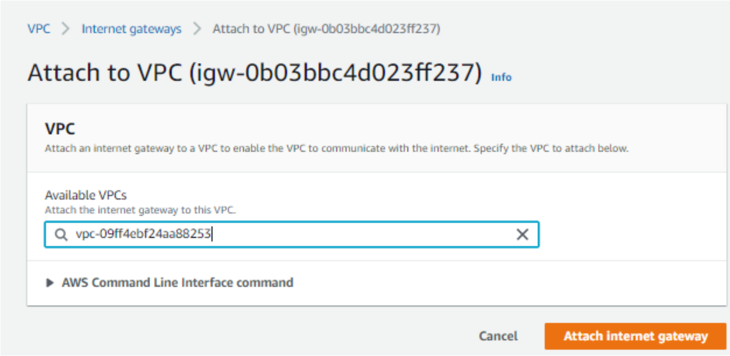
Key	Value - *optional*
Name	MyIGW

You can add 49 more tags.

Select the just-created internet gateway Then follow **Actions** > **Attach to VPC**.



Select the target VPC from the list, and then choose **Attach internet gateway**.



VPC > Internet gateways > Attach to VPC (igw-0b03bbc4d023ff237)

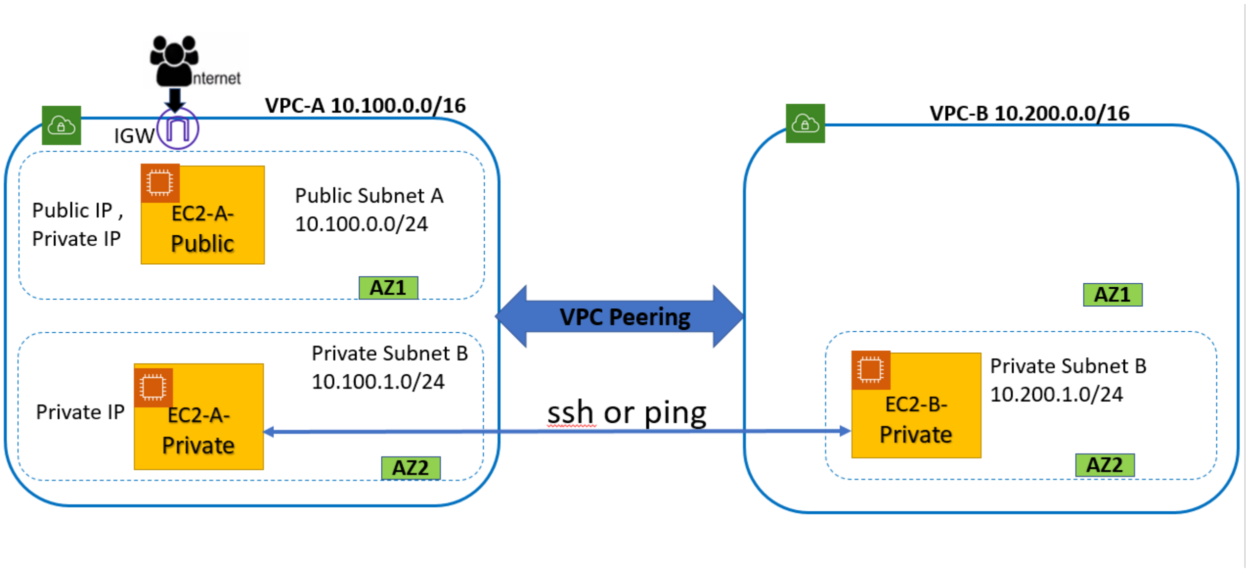
Attach to VPC (igw-0b03bbc4d023ff237) Info

VPC
Attach an internet gateway to a VPC to enable the VPC to communicate with the internet. Specify the VPC to attach below.

Available VPCs
Attach the internet gateway to this VPC.
vpc-09ff4ebf24aa88253

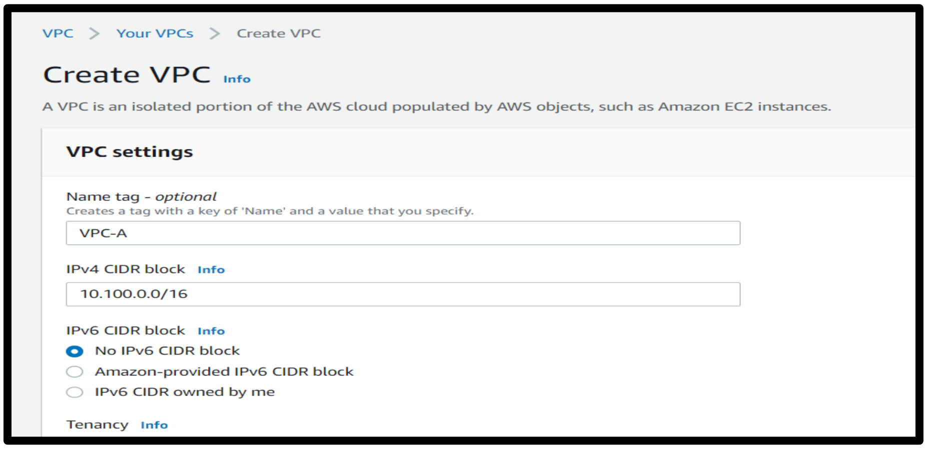
Lab: AWS VPC Peering

In this lab we will set up VPC peering. First, we will create the VPCs, and then we will establish VPC peering.



Create the first VPC:

VPC-A (IP address 10.100.0.0/16).



Create VPC Info

A VPC is an isolated portion of the AWS cloud populated by AWS objects, such as Amazon EC2 instances.

VPC settings

Name tag - *optional*
Creates a tag with a key of 'Name' and a value that you specify.
VPC-A

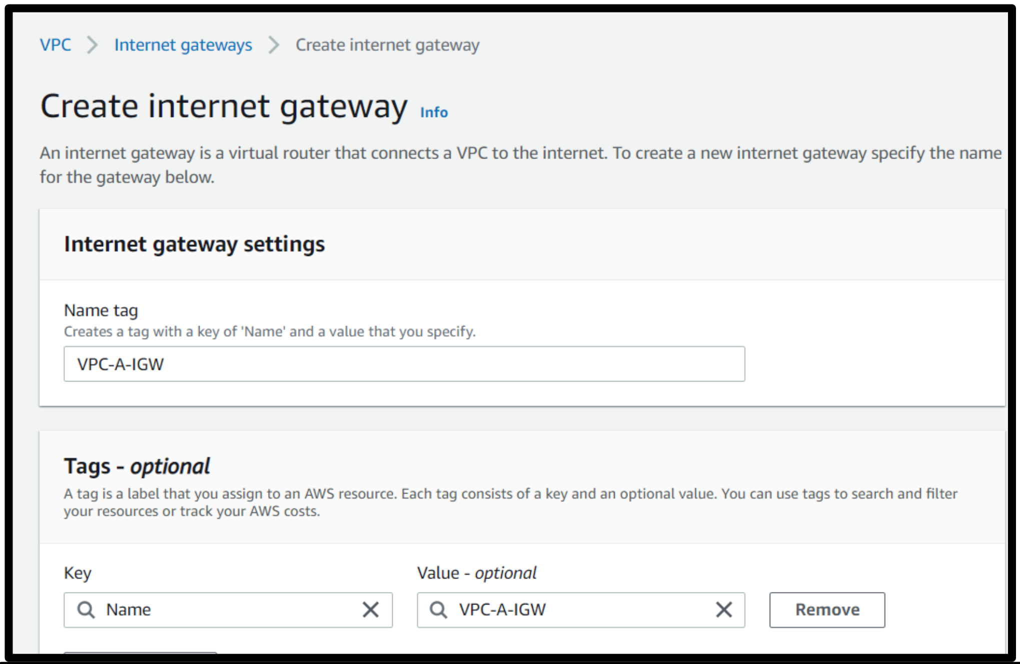
IPv4 CIDR block Info
10.100.0.0/16

IPv6 CIDR block Info
● No IPv6 CIDR block
○ Amazon-provided IPv6 CIDR block
○ IPv6 CIDR owned by me

Tenancy Info

Most VPCs will have an internet gateway, so we will create one here:

Create Internet Gateways(VPC-A-IGW) and Attach it to VPC-A.



VPC > Internet gateways > Create internet gateway

Create internet gateway

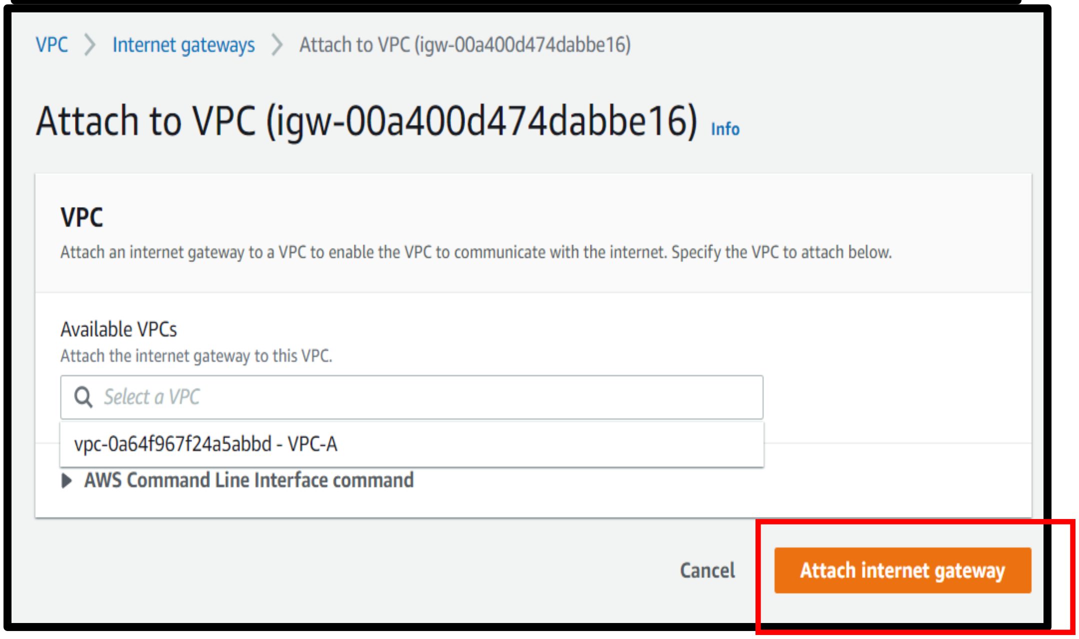
An internet gateway is a virtual router that connects a VPC to the internet. To create a new internet gateway specify the name for the gateway below.

Internet gateway settings

Name tag
Creates a tag with a key of 'Name' and a value that you specify.
VPC-A-IGW

Tags - *optional*
A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter your resources or track your AWS costs.

Key	Value - *optional*
Name	VPC-A-IGW



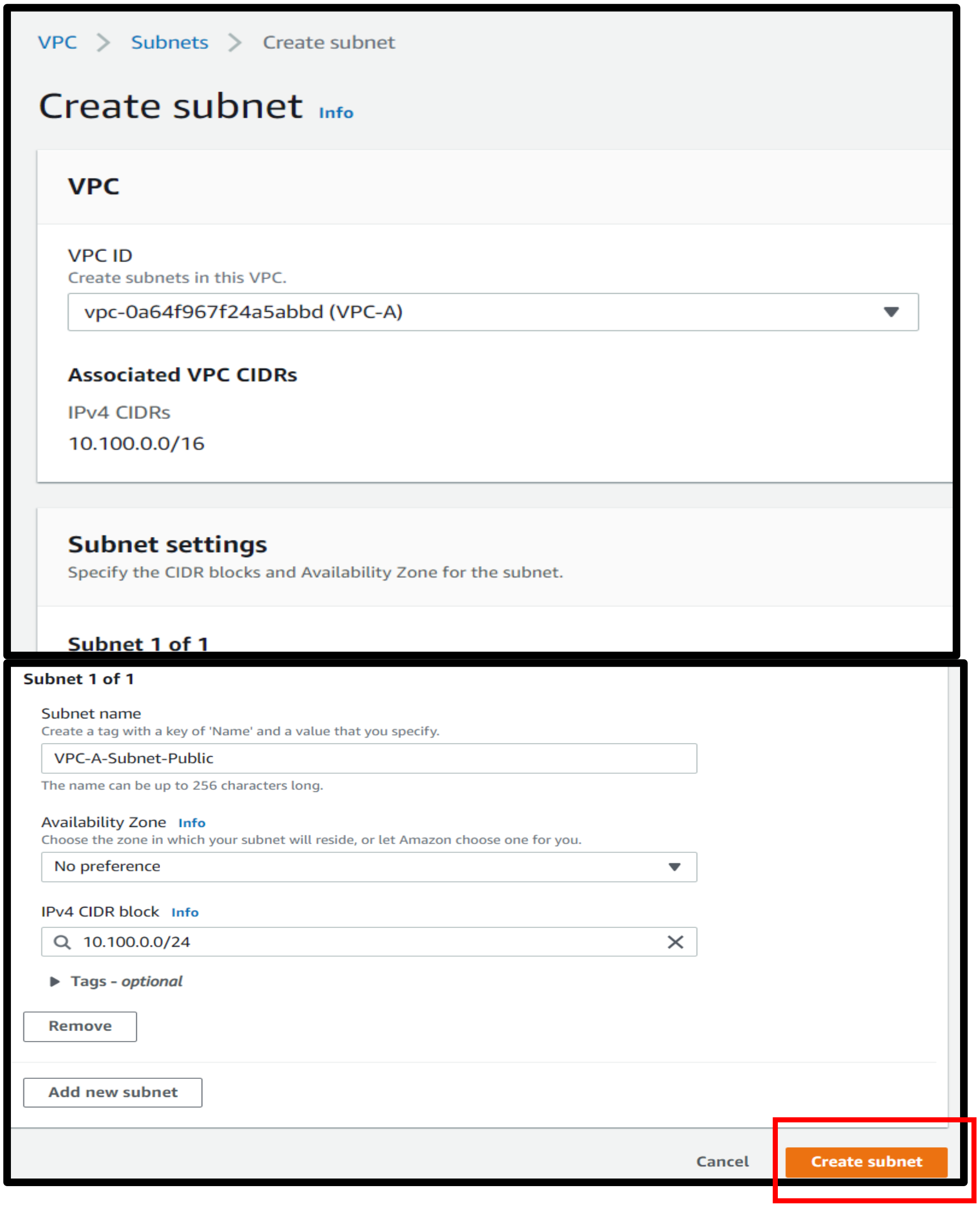
VPC > Internet gateways > Attach to VPC (igw-00a400d474dabbe16)

Attach to VPC (igw-00a400d474dabbe16)

VPC
Attach an internet gateway to a VPC to enable the VPC to communicate with the internet. Specify the VPC to attach below.

Available VPCs
Attach the internet gateway to this VPC.
Select a VPC
vpc-0a64f967f24a5abbd - VPC-A

Create public subnets (10.100.0.0/24) inside VPC-A. This is for demo purposes.



VPC > Subnets > Create subnet

Create subnet Info

VPC

VPC ID
Create subnets in this VPC.
vpc-0a64f967f24a5abbd (VPC-A)

Associated VPC CIDRs

IPv4 CIDRs
10.100.0.0/16

Subnet settings
Specify the CIDR blocks and Availability Zone for the subnet.

Subnet 1 of 1

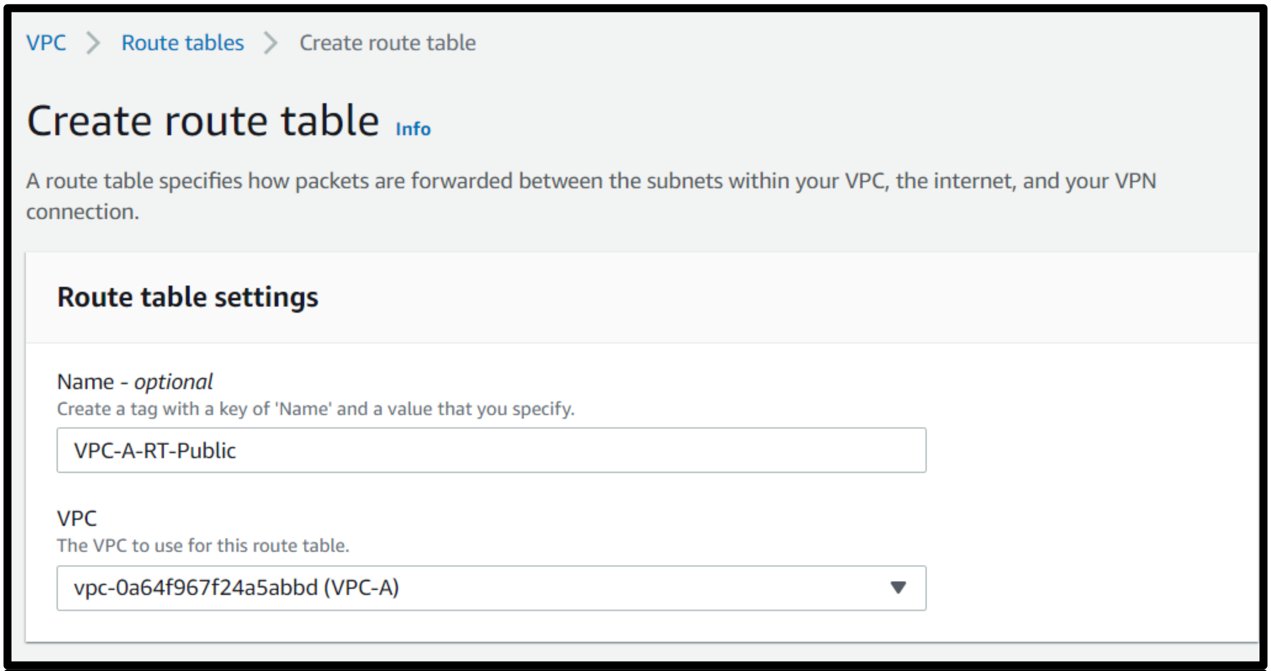
Subnet 1 of 1

Subnet name
Create a tag with a key of 'Name' and a value that you specify.
VPC-A-Subnet-Public
The name can be up to 256 characters long.

Availability Zone Info
Choose the zone in which your subnet will reside, or let Amazon choose one for you.
No preference

IPv4 CIDR block Info
10.100.0.0/24

Create Public Route table then add internet route (destination :0.0.0.0.0/0 & target igw) and associate with Public Subnet of VPC-A.



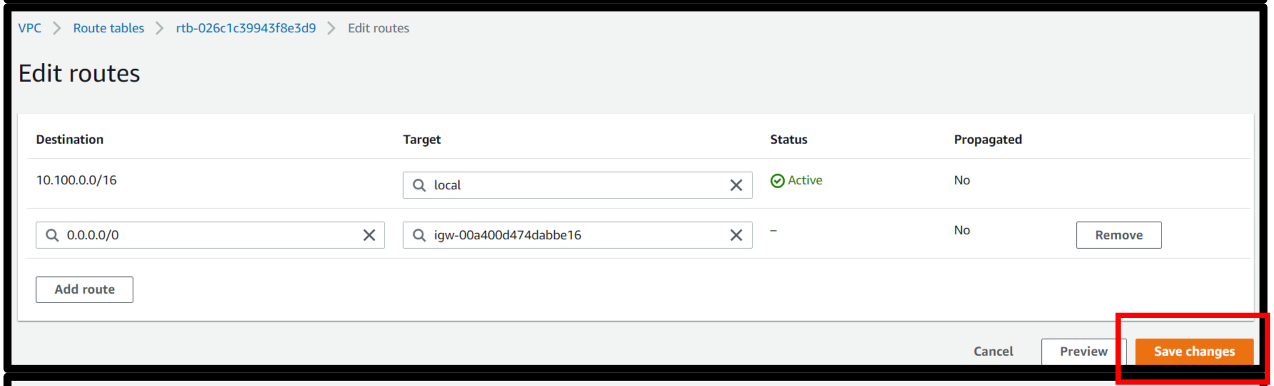
Create route table

A route table specifies how packets are forwarded between the subnets within your VPC, the internet, and your VPN connection.

Route table settings

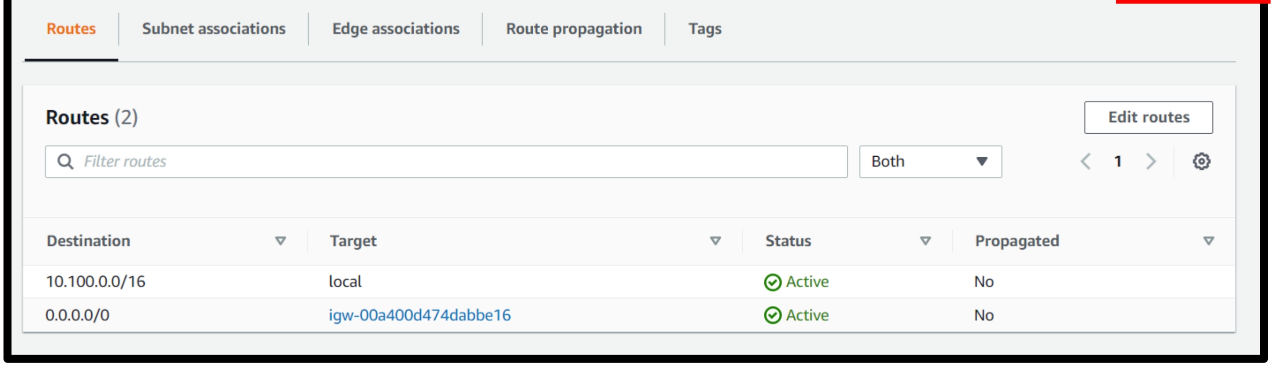
Name - *optional*
Create a tag with a key of 'Name' and a value that you specify.
VPC-A-RT-Public

VPC
The VPC to use for this route table.
vpc-0a64f967f24a5abbd (VPC-A)



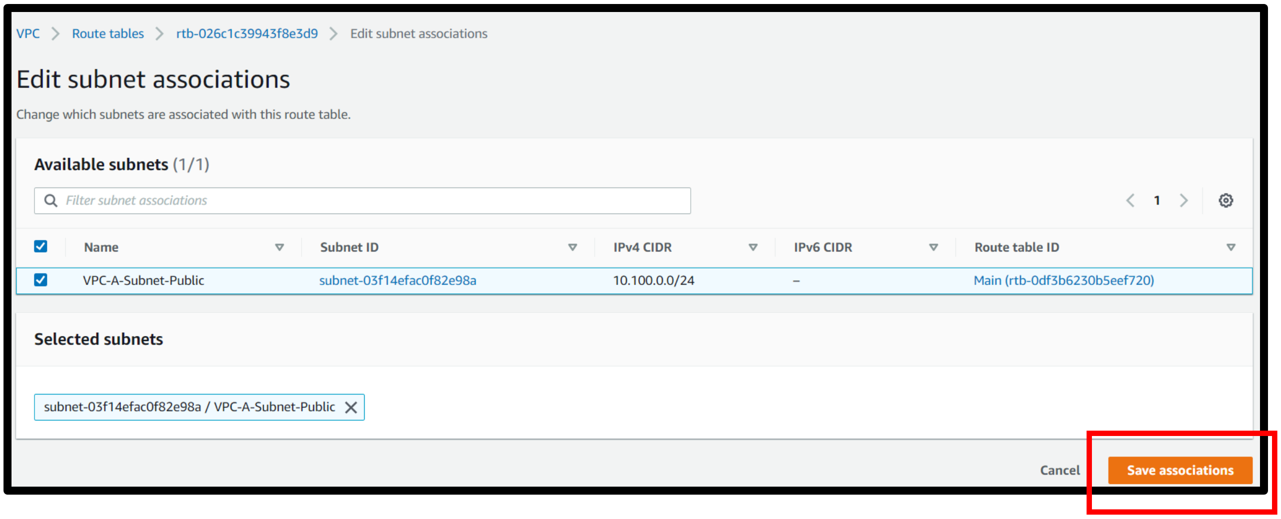
Edit routes

Destination	Target	Status	Propagated	
10.100.0.0/16	local	Active	No	
0.0.0.0/0	igw-00a400d474dabbe16	-	No	Remove



Routes (2)

Destination	Target	Status	Propagated
10.100.0.0/16	local	Active	No
0.0.0.0/0	igw-00a400d474dabbe16	Active	No



VPC > Route tables > rtb-026c1c39943f8e3d9 > Edit subnet associations

Edit subnet associations

Change which subnets are associated with this route table.

Available subnets (1/1)

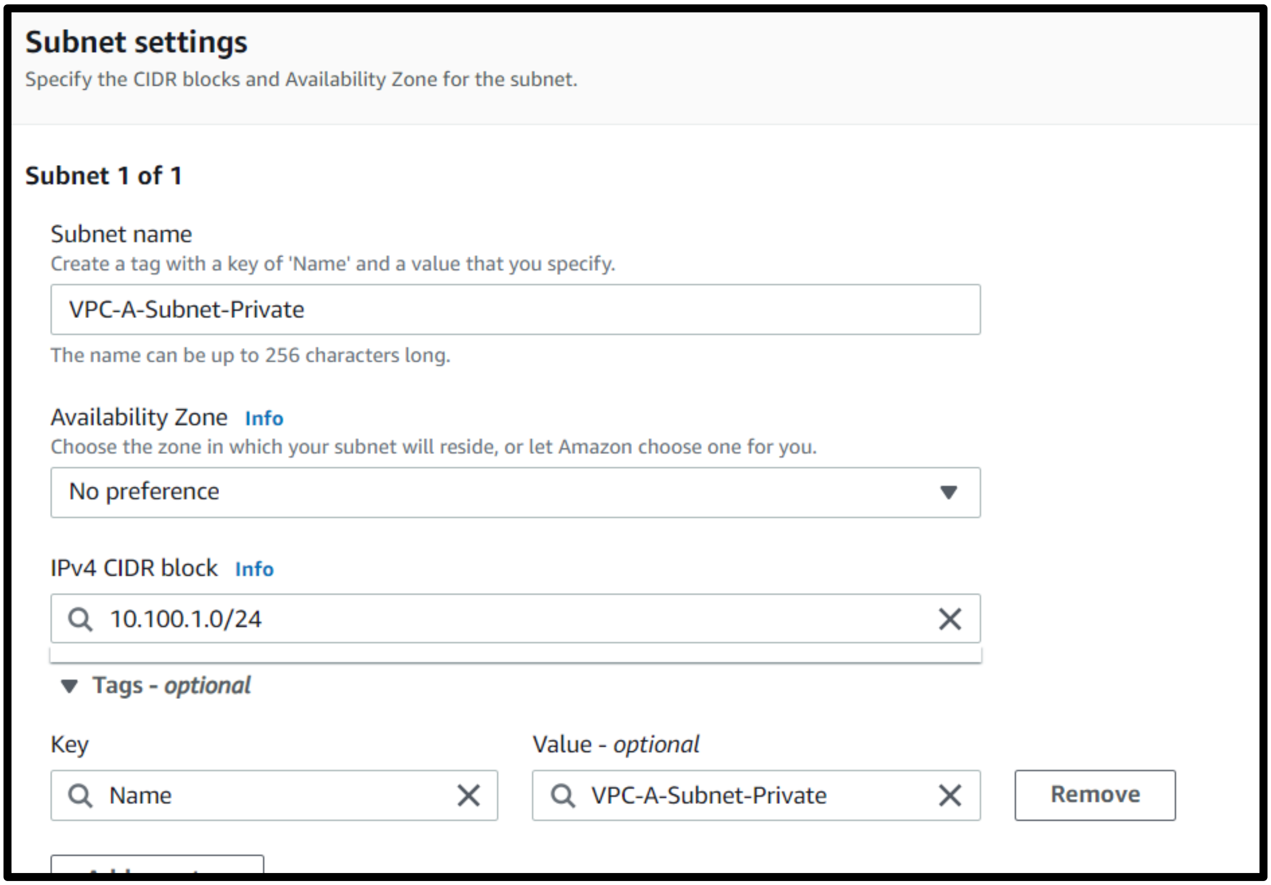
Filter subnet associations

☑	Name	Subnet ID	IPv4 CIDR	IPv6 CIDR	Route table ID
☑	VPC-A-Subnet-Public	subnet-03f14efac0f82e98a	10.100.0.0/24	–	Main (rtb-0df3b6230b5eef720)

Selected subnets

subnet-03f14efac0f82e98a / VPC-A-Subnet-Public ✕

Create Private Subnets (10.100.1.0/24) inside VPC-A.



Subnet settings

Specify the CIDR blocks and Availability Zone for the subnet.

Subnet 1 of 1

Subnet name

Create a tag with a key of 'Name' and a value that you specify.

VPC-A-Subnet-Private

The name can be up to 256 characters long.

Availability Zone Info

Choose the zone in which your subnet will reside, or let Amazon choose one for you.

No preference

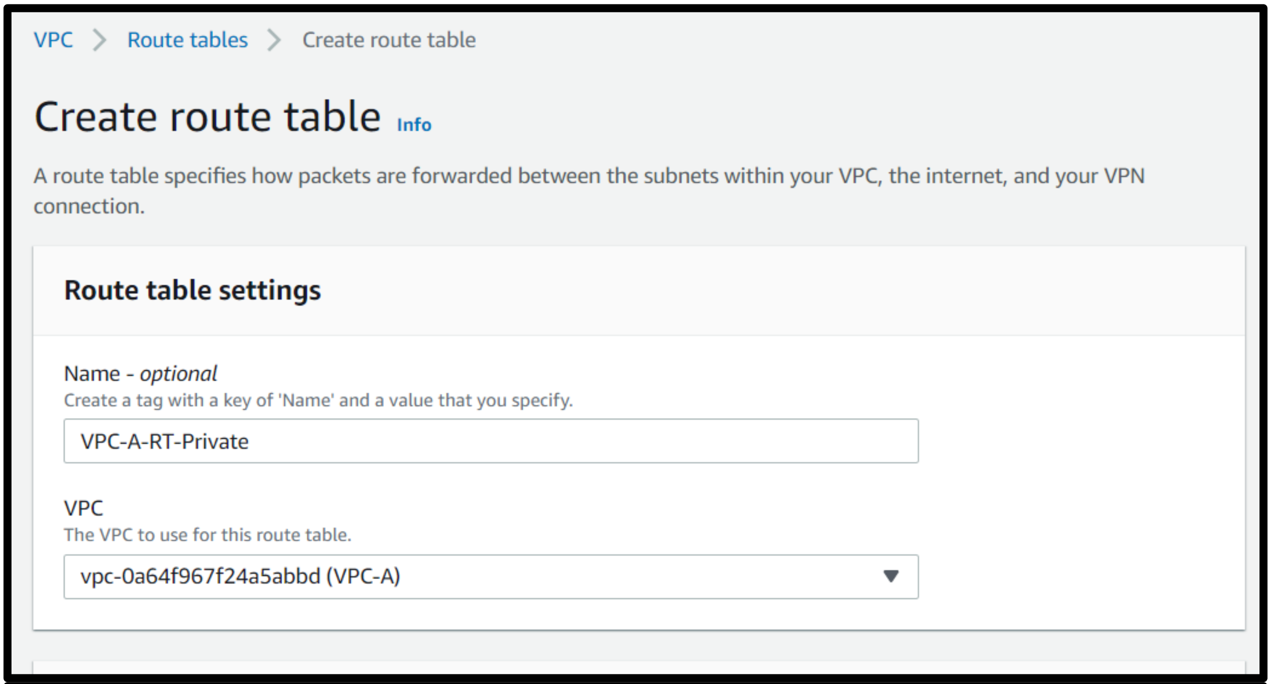
IPv4 CIDR block Info

10.100.1.0/24

▼ Tags - *optional*

Key	Value - *optional*	
Name	VPC-A-Subnet-Private	Remove

Create Private Route table (no need to connect to internet) and associate with private subnet of VPC-A.



VPC > Route tables > Create route table

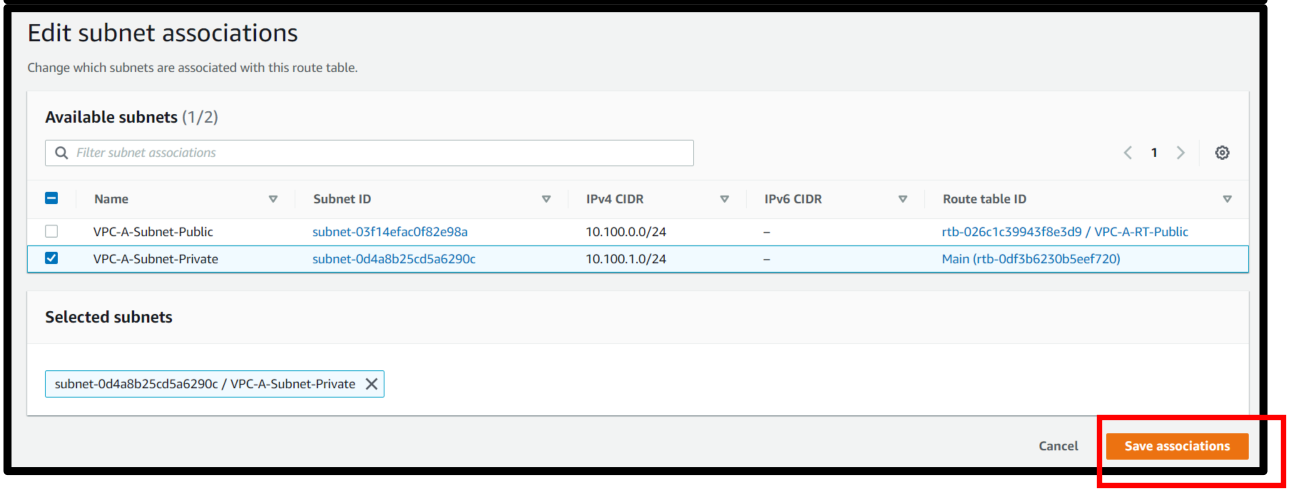
Create route table Info

A route table specifies how packets are forwarded between the subnets within your VPC, the internet, and your VPN connection.

Route table settings

Name - *optional*
Create a tag with a key of 'Name' and a value that you specify.
VPC-A-RT-Private

VPC
The VPC to use for this route table.
vpc-0a64f967f24a5abbd (VPC-A)



Edit subnet associations

Change which subnets are associated with this route table.

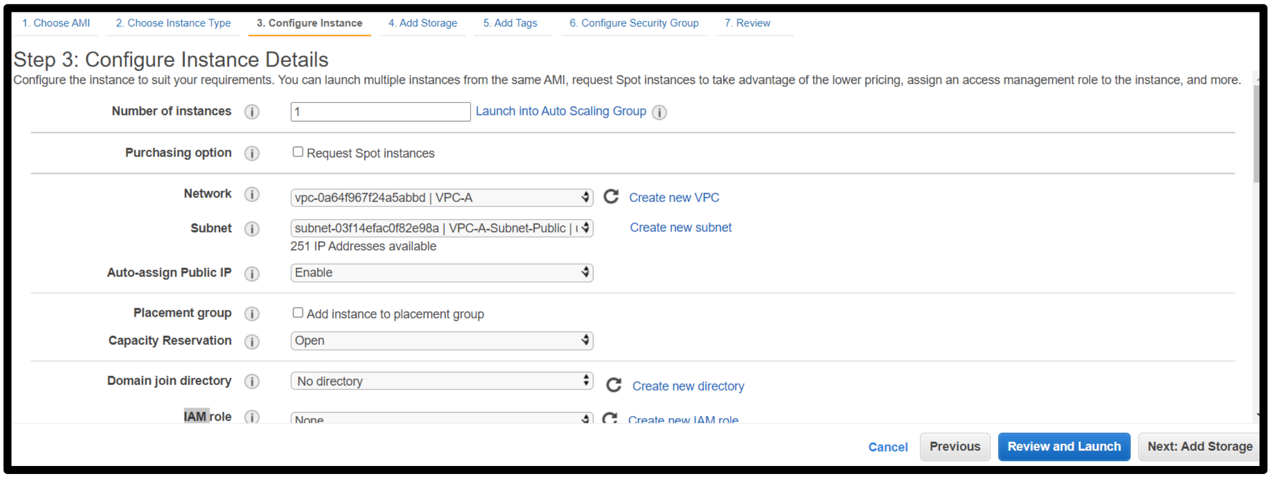
Available subnets (1/2)

	Name	Subnet ID	IPv4 CIDR	IPv6 CIDR	Route table ID
☐	VPC-A-Subnet-Public	subnet-03f14efac0f82e98a	10.100.0.0/24	–	rtb-026c1c39943f8e3d9 / VPC-A-RT-Public
☑	VPC-A-Subnet-Private	subnet-0d4a8b25cd5a6290c	10.100.1.0/24	–	Main (rtb-0df3b6230b5eef720)

Selected subnets

subnet-0d4a8b25cd5a6290c / VPC-A-Subnet-Private

Launch Public EC2-A inside Public Subnet of VPC-A.



Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances: 1 Launch into Auto Scaling Group

Purchasing option: □ Request Spot instances

Network: vpc-0a64f967f24a5abbd | VPC-A Create new VPC

Subnet: subnet-03f14efac0f82e98a | VPC-A-Subnet-Public | Create new subnet
251 IP Addresses available

Auto-assign Public IP: Enable

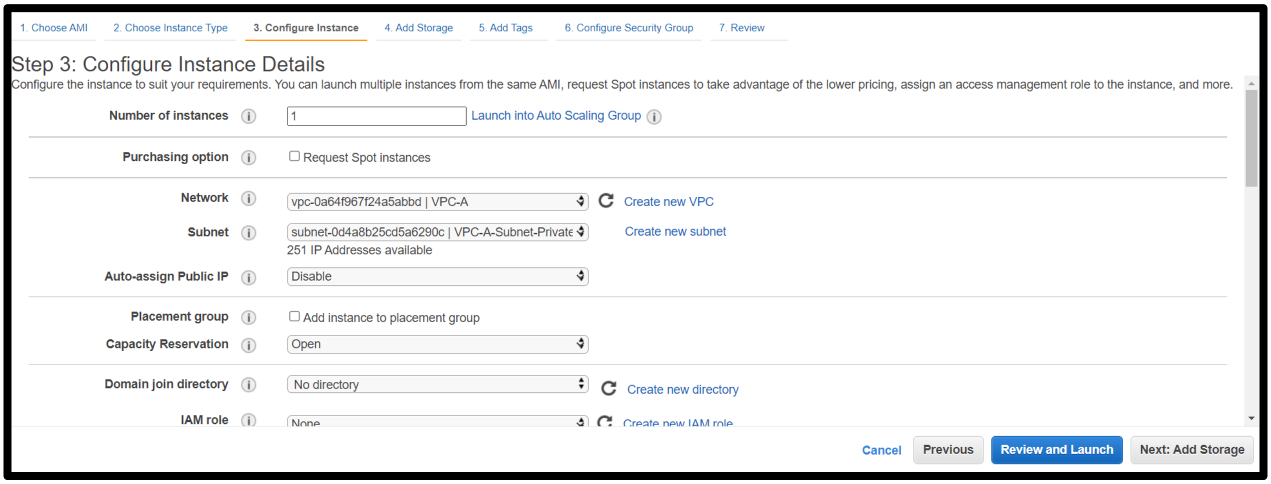
Placement group: □ Add instance to placement group

Capacity Reservation: Open

Domain join directory: No directory Create new directory

IAM role: None Create new IAM role

Launch Private EC2-A Inside Private Subnet of VPC-A.



Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances: 1 Launch into Auto Scaling Group

Purchasing option: □ Request Spot instances

Network: vpc-0a64f967f24a5abbd | VPC-A Create new VPC

Subnet: subnet-0d4a8b25cd5a6290c | VPC-A-Subnet-Private Create new subnet
251 IP Addresses available

Auto-assign Public IP: Disable

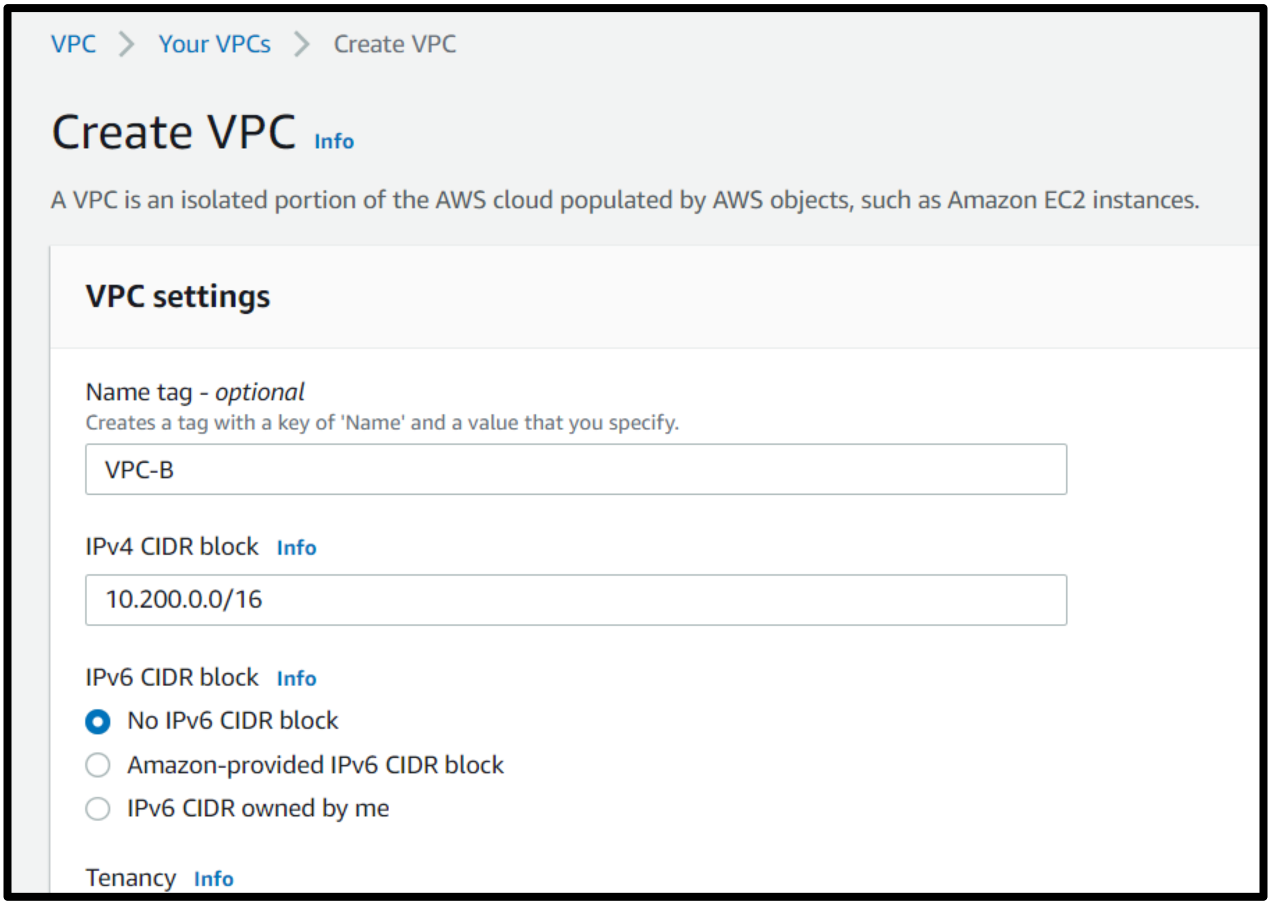
Placement group: □ Add instance to placement group

Capacity Reservation: Open

Domain join directory: No directory Create new directory

IAM role: None Create new IAM role

Create second VPC: VPC-B.



VPC > Your VPCs > Create VPC

Create VPC Info

A VPC is an isolated portion of the AWS cloud populated by AWS objects, such as Amazon EC2 instances.

VPC settings

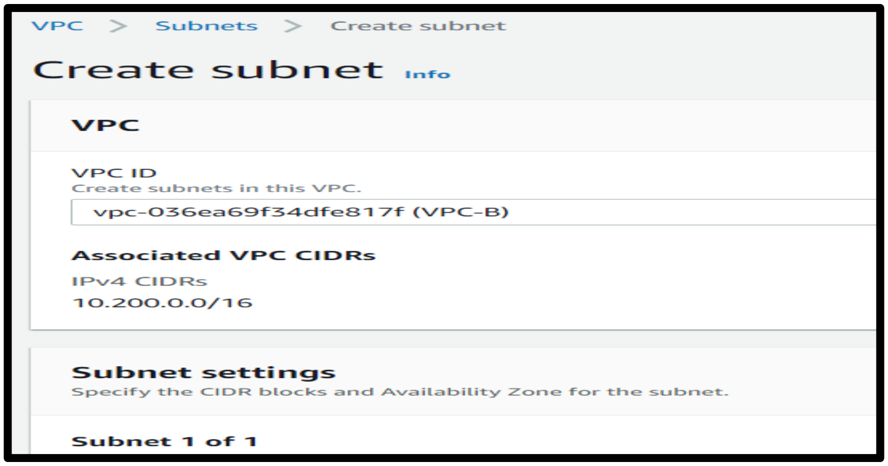
Name tag - *optional*
Creates a tag with a key of 'Name' and a value that you specify.
VPC-B

IPv4 CIDR block Info
10.200.0.0/16

IPv6 CIDR block Info
● No IPv6 CIDR block
○ Amazon-provided IPv6 CIDR block
○ IPv6 CIDR owned by me

Tenancy Info

Create Private Subnets (10.200.1.0/24) inside VPC-B.



VPC > Subnets > Create subnet

Create subnet Info

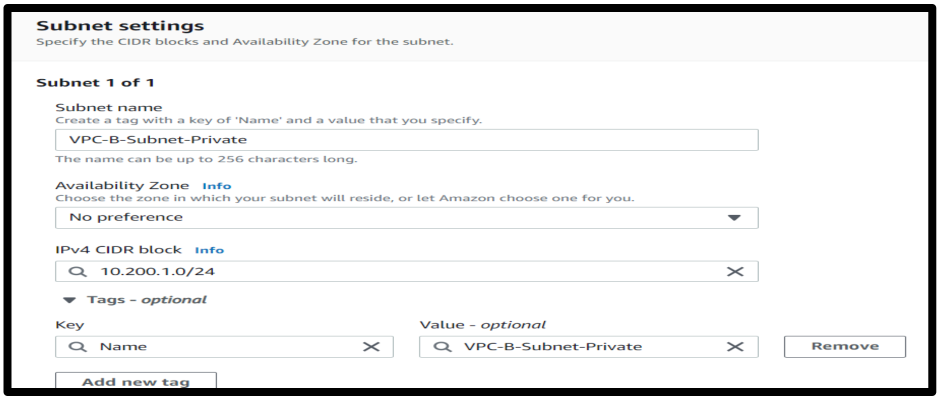
VPC

VPC ID
Create subnets in this VPC.
vpc-036ea69f34dfe817f (VPC-B)

Associated VPC CIDRs
IPv4 CIDRs
10.200.0.0/16

Subnet settings
Specify the CIDR blocks and Availability Zone for the subnet.

Subnet 1 of 1



Subnet settings

Specify the CIDR blocks and Availability Zone for the subnet.

Subnet 1 of 1

Subnet name

Create a tag with a key of 'Name' and a value that you specify.

VPC-B-Subnet-Private

The name can be up to 256 characters long.

Availability Zone Info

Choose the zone in which your subnet will reside, or let Amazon choose one for you.

No preference ▼

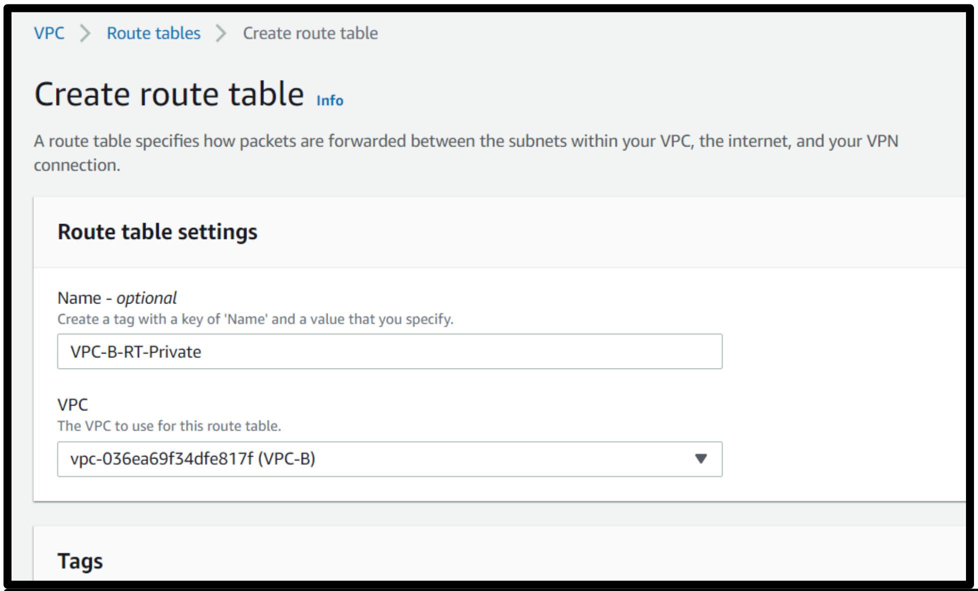
IPv4 CIDR block Info

10.200.1.0/24

▼ Tags - *optional*

Key	Value - *optional*	
Name	VPC-B-Subnet-Private	Remove

Create Private Route table (no need to connect to internet) and associate with private subnet.



VPC > Route tables > Create route table

Create route table Info

A route table specifies how packets are forwarded between the subnets within your VPC, the internet, and your VPN connection.

Route table settings

Name - *optional*

Create a tag with a key of 'Name' and a value that you specify.

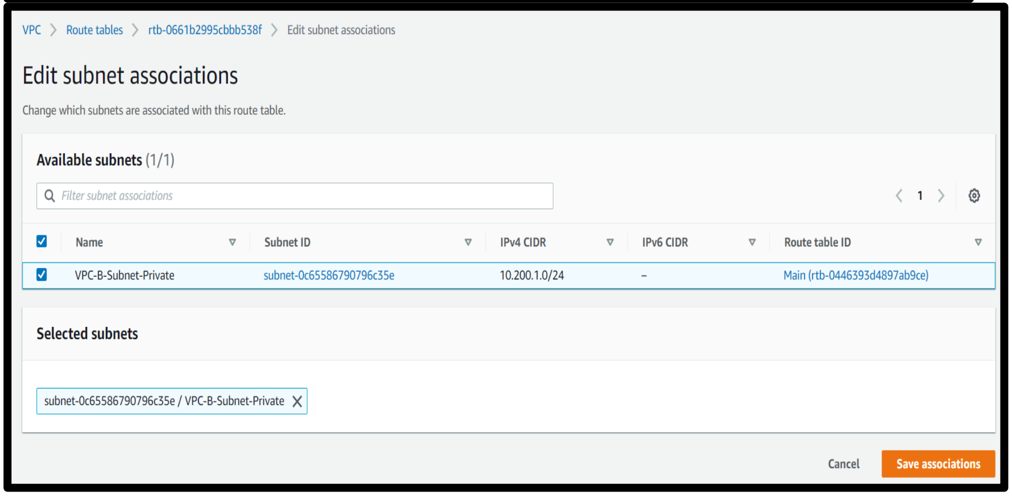
VPC-B-RT-Private

VPC

The VPC to use for this route table.

vpc-036ea69f34dfe817f (VPC-B) ▼

Tags



VPC > Route tables > rtb-0661b2995cbbb538f > Edit subnet associations

Edit subnet associations

Change which subnets are associated with this route table.

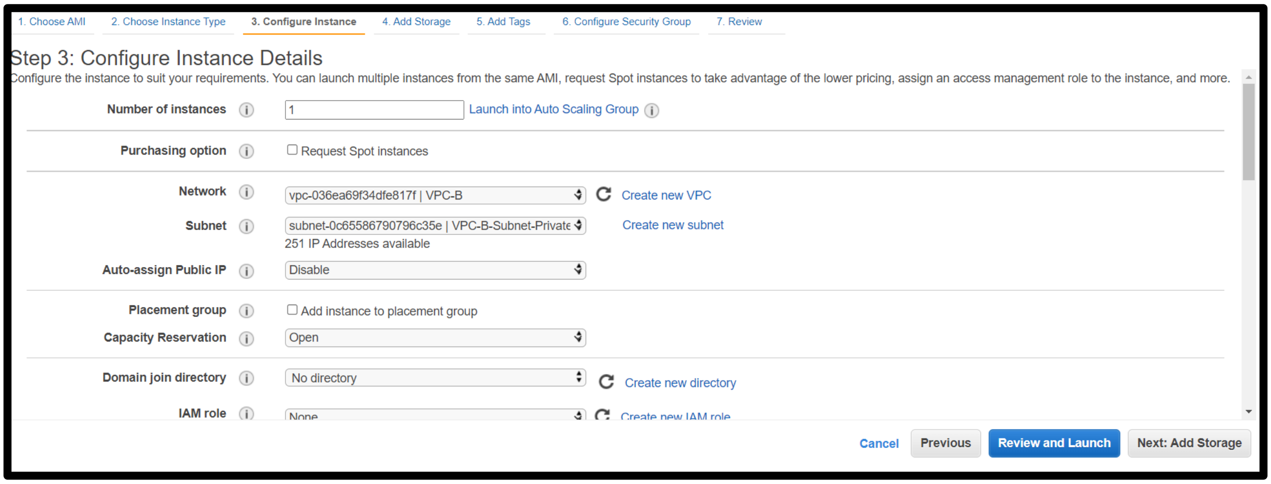
Available subnets (1/1)

☑	Name	Subnet ID	IPv4 CIDR	IPv6 CIDR	Route table ID
☑	VPC-B-Subnet-Private	subnet-0c65586790796c35e	10.200.1.0/24	–	Main (rtb-0446393d4897ab9ce)

Selected subnets

subnet-0c65586790796c35e / VPC-B-Subnet-Private

Launch Private EC2-A inside Private Subnet of VPC-B.



Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances: 1 — Launch into Auto Scaling Group

Purchasing option: □ Request Spot instances

Network: vpc-036ea69f34dfe817f | VPC-B — Create new VPC

Subnet: subnet-0c65586790796c35e | VPC-B-Subnet-Private — Create new subnet
251 IP Addresses available

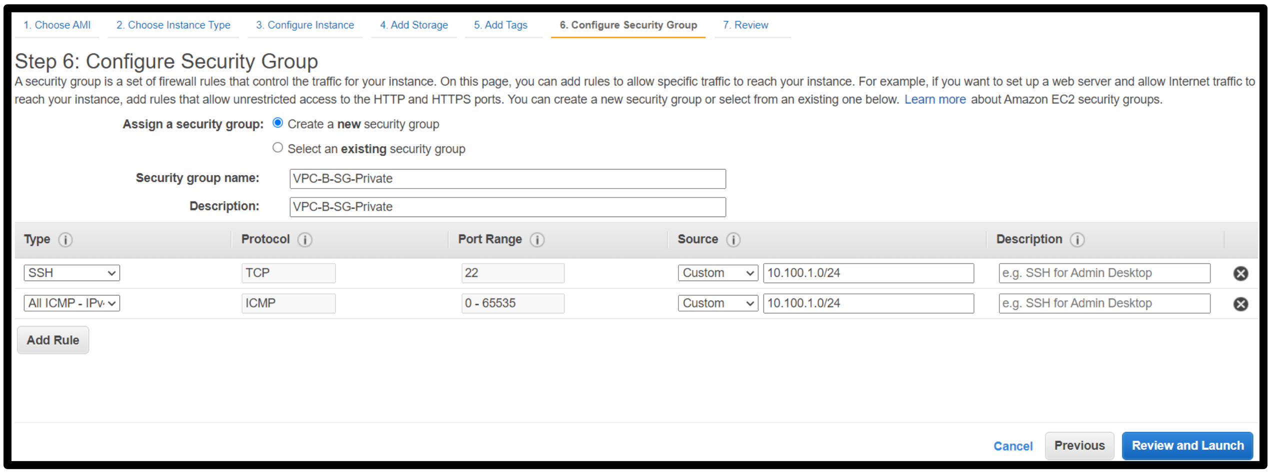
Auto-assign Public IP: Disable

Placement group: □ Add instance to placement group

Capacity Reservation: Open

Domain join directory: No directory — Create new directory

IAM role: None — Create new IAM role



Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. Learn more about Amazon EC2 security groups.

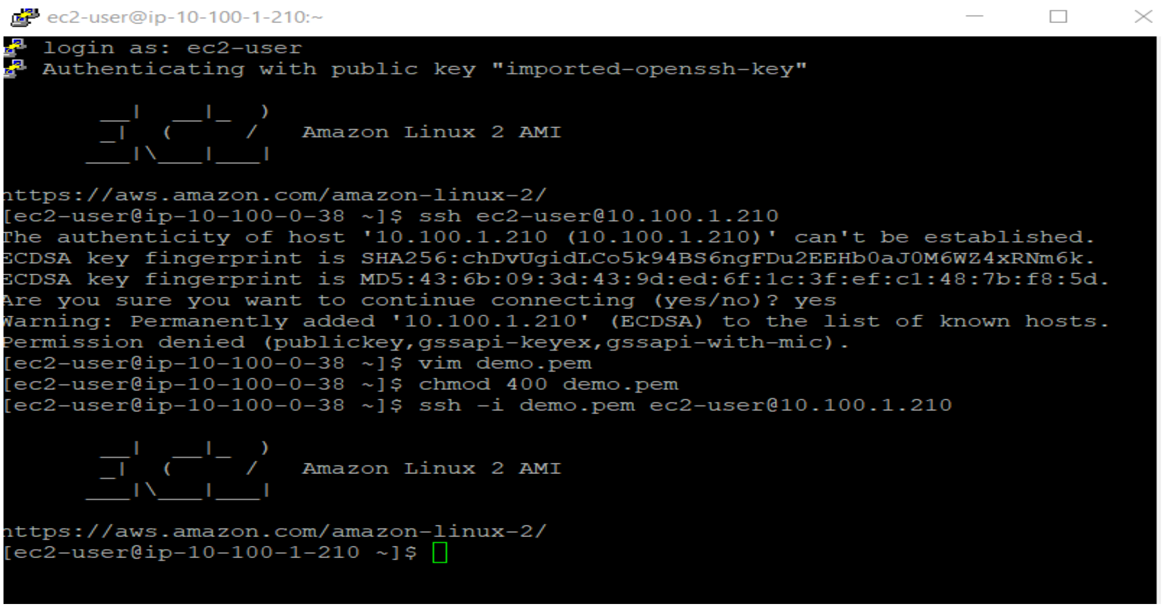
Assign a security group: ● Create a **new** security group
○ Select an **existing** security group

Security group name: VPC-B-SG-Private

Description: VPC-B-SG-Private

Type	Protocol	Port Range	Source		Description
SSH	TCP	22	Custom	10.100.1.0/24	e.g. SSH for Admin Desktop
All ICMP - IPv4	ICMP	0 - 65535	Custom	10.100.1.0/24	e.g. SSH for Admin Desktop

Connect Public subnet EC2 with Private subnet EC2 of VPC-A.

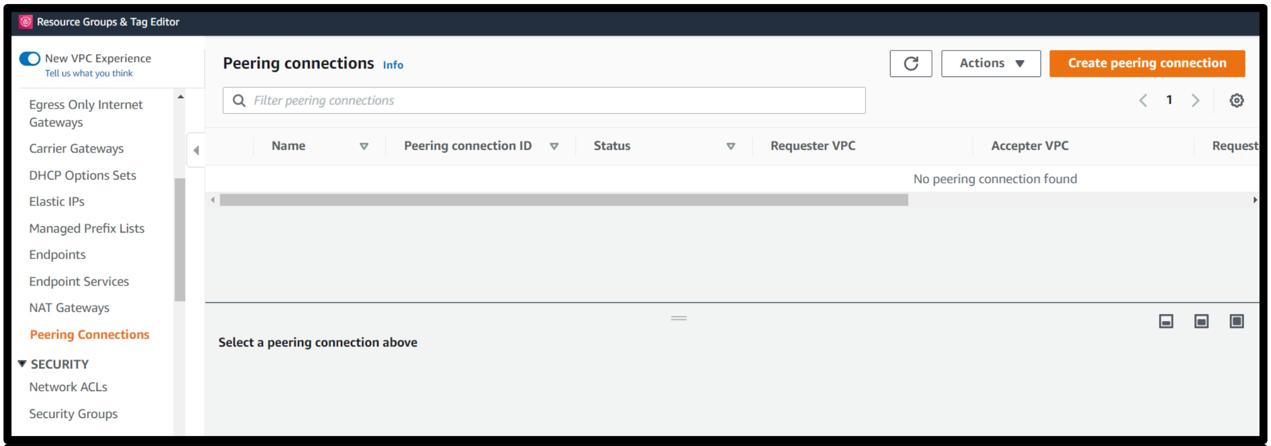


ec2-user@ip-10-100-1-210:~

```
login as: ec2-user
Authenticating with public key "imported-openssh-key"

       __|  __|_  )
       _|  (     /   Amazon Linux 2 AMI
      ___|\___|___|

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-10-100-0-38 ~]$ ssh ec2-user@10.100.1.210
The authenticity of host '10.100.1.210 (10.100.1.210)' can't be established.
ECDSA key fingerprint is SHA256:chDvUgidLCo5k94BS6ngFDu2EEHb0aJ0M6WZ4xRNm6k.
ECDSA key fingerprint is MD5:43:6b:09:3d:43:9d:ed:6f:1c:3f:ef:c1:48:7b:f8:5d.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.100.1.210' (ECDSA) to the list of known hosts.
Permission denied (publickey,gssapi-keyex,gssapi-with-mic).
[ec2-user@ip-10-100-0-38 ~]$ vim demo.pem
[ec2-user@ip-10-100-0-38 ~]$ chmod 400 demo.pem
[ec2-user@ip-10-100-0-38 ~]$ ssh -i demo.pem ec2-user@10.100.1.210

       __|  __|_  )
       _|  (     /   Amazon Linux 2 AMI
      ___|\___|___|

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-10-100-1-210 ~]$ 
```

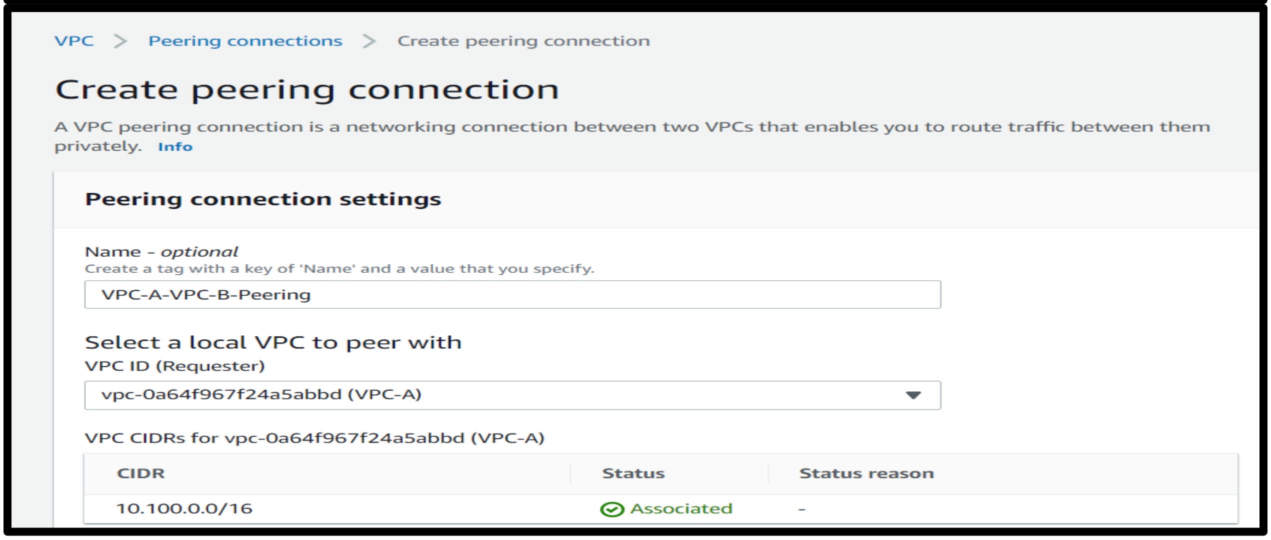
VPCs Peering

Connect Private subnet EC2 of VPC-A to Private subnet EC2 of VPC-B.



Name	Peering connection ID	Status	Requester VPC	Accepter VPC	Request
			No peering connection found		

Select a peering connection above



Create peering connection

A VPC peering connection is a networking connection between two VPCs that enables you to route traffic between them privately. Info

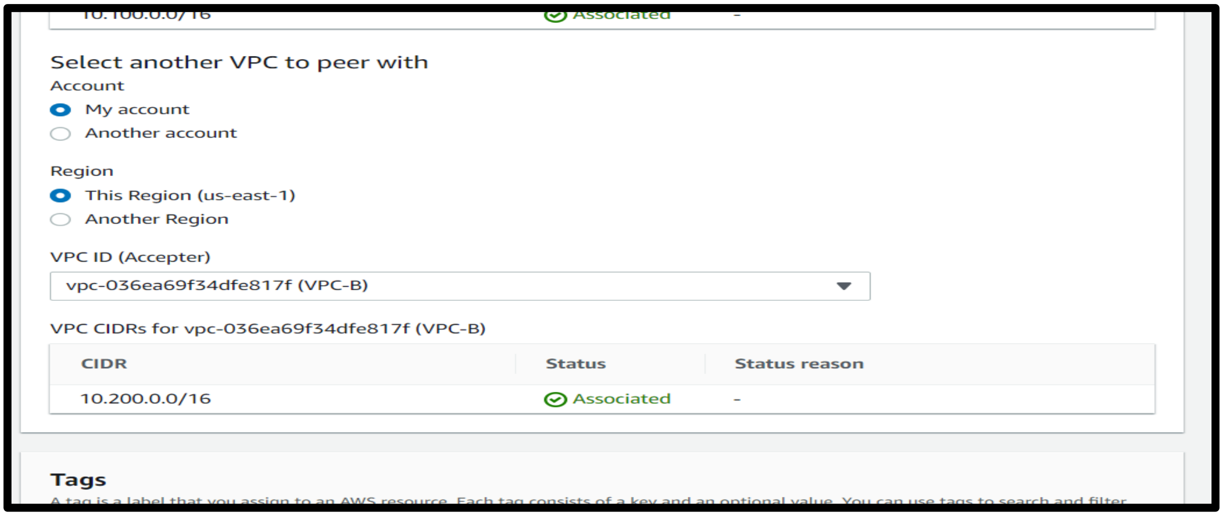
Peering connection settings

Name - *optional*
Create a tag with a key of 'Name' and a value that you specify.
VPC-A-VPC-B-Peering

Select a local VPC to peer with
VPC ID (Requester)
vpc-0a64f967f24a5abbd (VPC-A)

VPC CIDRs for vpc-0a64f967f24a5abbd (VPC-A)

CIDR	Status	Status reason
10.100.0.0/16	Associated	-



10.100.0.0/16 ✓ Associated -

Select another VPC to peer with

Account

● My account

○ Another account

Region

● This Region (us-east-1)

○ Another Region

VPC ID (Accepter)

vpc-036ea69f34dfe817f (VPC-B)

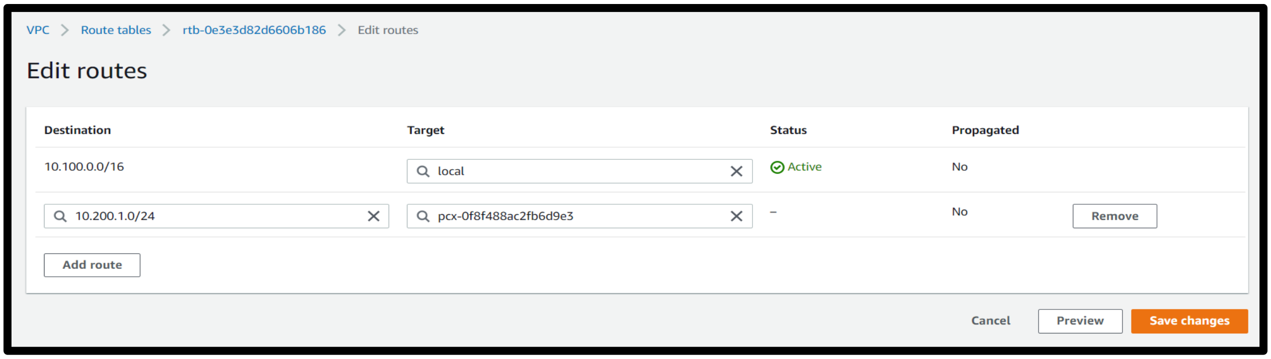
VPC CIDRs for vpc-036ea69f34dfe817f (VPC-B)

CIDR	Status	Status reason
10.200.0.0/16	✓ Associated	-

Tags

A tag is a label that you assign to an AWS resource. Each tag consists of a key and an optional value. You can use tags to search and filter

Set up routing table for VPC-A-RT-Private.

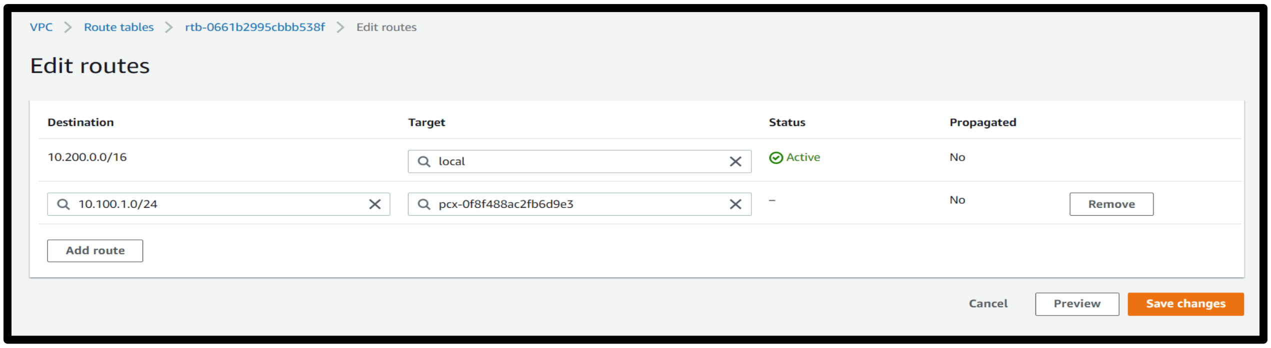


VPC > Route tables > rtb-0e3e3d82d6606b186 > Edit routes

Edit routes

Destination	Target	Status	Propagated	
10.100.0.0/16	local	✓ Active	No	
10.200.1.0/24	pcx-0f8f488ac2fb6d9e3	-	No	Remove

Set up the routing table for VPC-B-RT-Private.

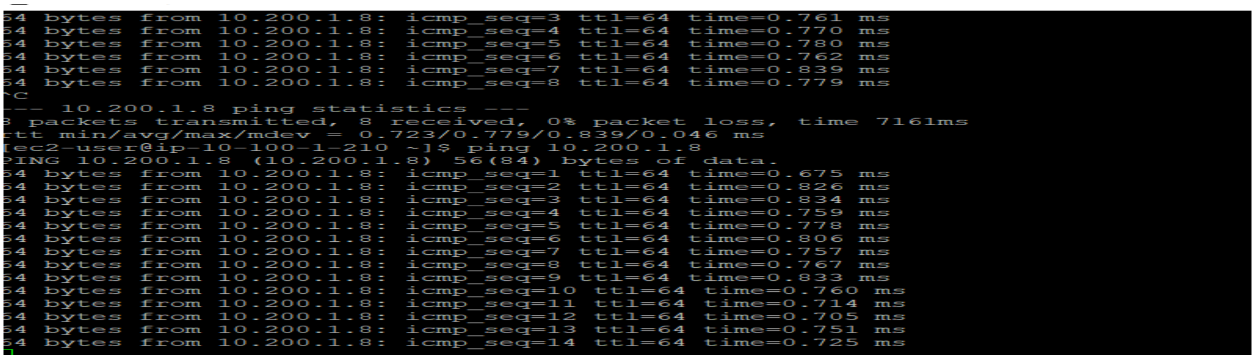


VPC > Route tables > rtb-0661b2995cbbb538f > Edit routes

Edit routes

Destination	Target	Status	Propagated	
10.200.0.0/16	local	✓ Active	No	
10.100.1.0/24	pcx-0f8f488ac2fb6d9e3	-	No	Remove

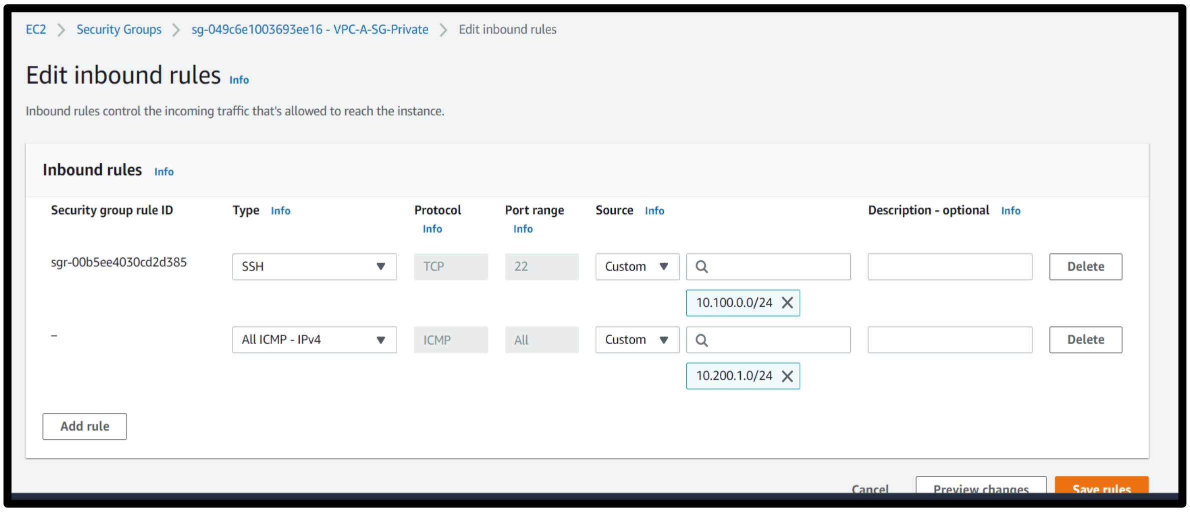
Testing connectivity. Pinging from private EC2 of VPC-A ------private EC2 of VPC-B.



```
64 bytes from 10.200.1.8: icmp_seq=3 ttl=64 time=0.761 ms
64 bytes from 10.200.1.8: icmp_seq=4 ttl=64 time=0.770 ms
64 bytes from 10.200.1.8: icmp_seq=5 ttl=64 time=0.780 ms
64 bytes from 10.200.1.8: icmp_seq=6 ttl=64 time=0.762 ms
64 bytes from 10.200.1.8: icmp_seq=7 ttl=64 time=0.839 ms
64 bytes from 10.200.1.8: icmp_seq=8 ttl=64 time=0.779 ms
^C
--- 10.200.1.8 ping statistics ---
8 packets transmitted, 8 received, 0% packet loss, time 7161ms
rtt min/avg/max/mdev = 0.723/0.779/0.839/0.046 ms
[ec2-user@ip-10-100-1-210 ~]$ ping 10.200.1.8
PING 10.200.1.8 (10.200.1.8) 56(84) bytes of data.
64 bytes from 10.200.1.8: icmp_seq=1 ttl=64 time=0.675 ms
64 bytes from 10.200.1.8: icmp_seq=2 ttl=64 time=0.826 ms
64 bytes from 10.200.1.8: icmp_seq=3 ttl=64 time=0.834 ms
64 bytes from 10.200.1.8: icmp_seq=4 ttl=64 time=0.759 ms
64 bytes from 10.200.1.8: icmp_seq=5 ttl=64 time=0.778 ms
64 bytes from 10.200.1.8: icmp_seq=6 ttl=64 time=0.806 ms
64 bytes from 10.200.1.8: icmp_seq=7 ttl=64 time=0.757 ms
64 bytes from 10.200.1.8: icmp_seq=8 ttl=64 time=0.767 ms
64 bytes from 10.200.1.8: icmp_seq=9 ttl=64 time=0.833 ms
64 bytes from 10.200.1.8: icmp_seq=10 ttl=64 time=0.760 ms
64 bytes from 10.200.1.8: icmp_seq=11 ttl=64 time=0.714 ms
64 bytes from 10.200.1.8: icmp_seq=12 ttl=64 time=0.705 ms
64 bytes from 10.200.1.8: icmp_seq=13 ttl=64 time=0.751 ms
64 bytes from 10.200.1.8: icmp_seq=14 ttl=64 time=0.725 ms
```

Edit Security group private EC2 of VPC-A.

Testing connectivity. Pinging from private EC2 of VPC-B------private EC2 of VPC-A.



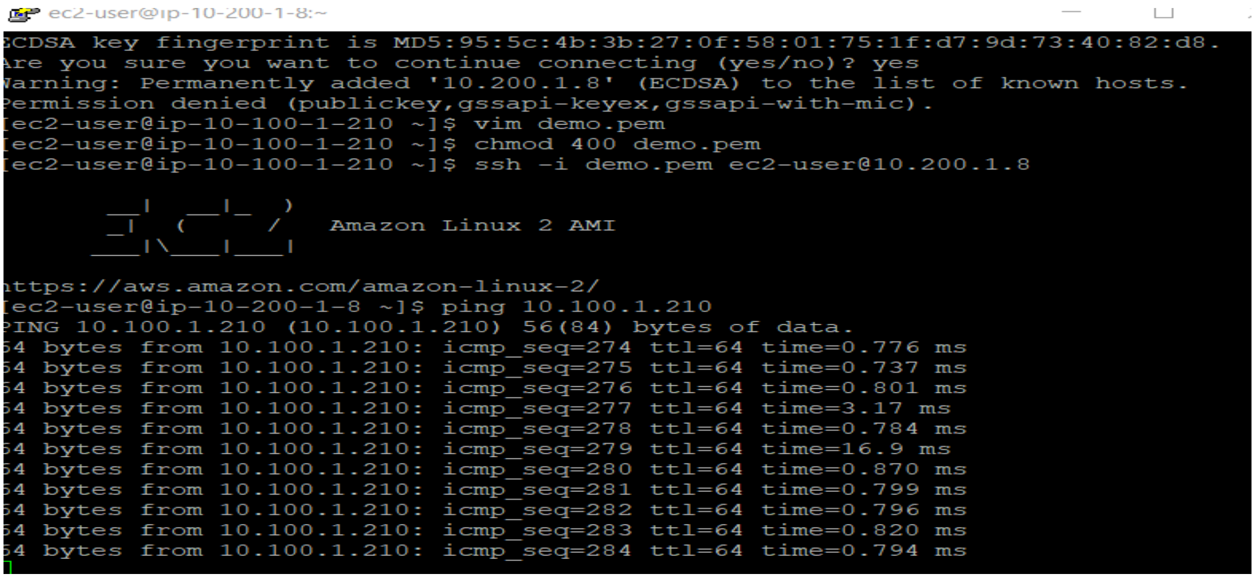
EC2 > Security Groups > sg-049c6e1003693ee16 - VPC-A-SG-Private > Edit inbound rules

Edit inbound rules Info

Inbound rules control the incoming traffic that's allowed to reach the instance.

Inbound rules Info

Security group rule ID	Type	Protocol	Port range	Source	Description - optional
sgr-00b5ee4030cd2d385	SSH	TCP	22	Custom 10.100.0.0/24	
–	All ICMP - IPv4	ICMP	All	Custom 10.200.1.0/24	



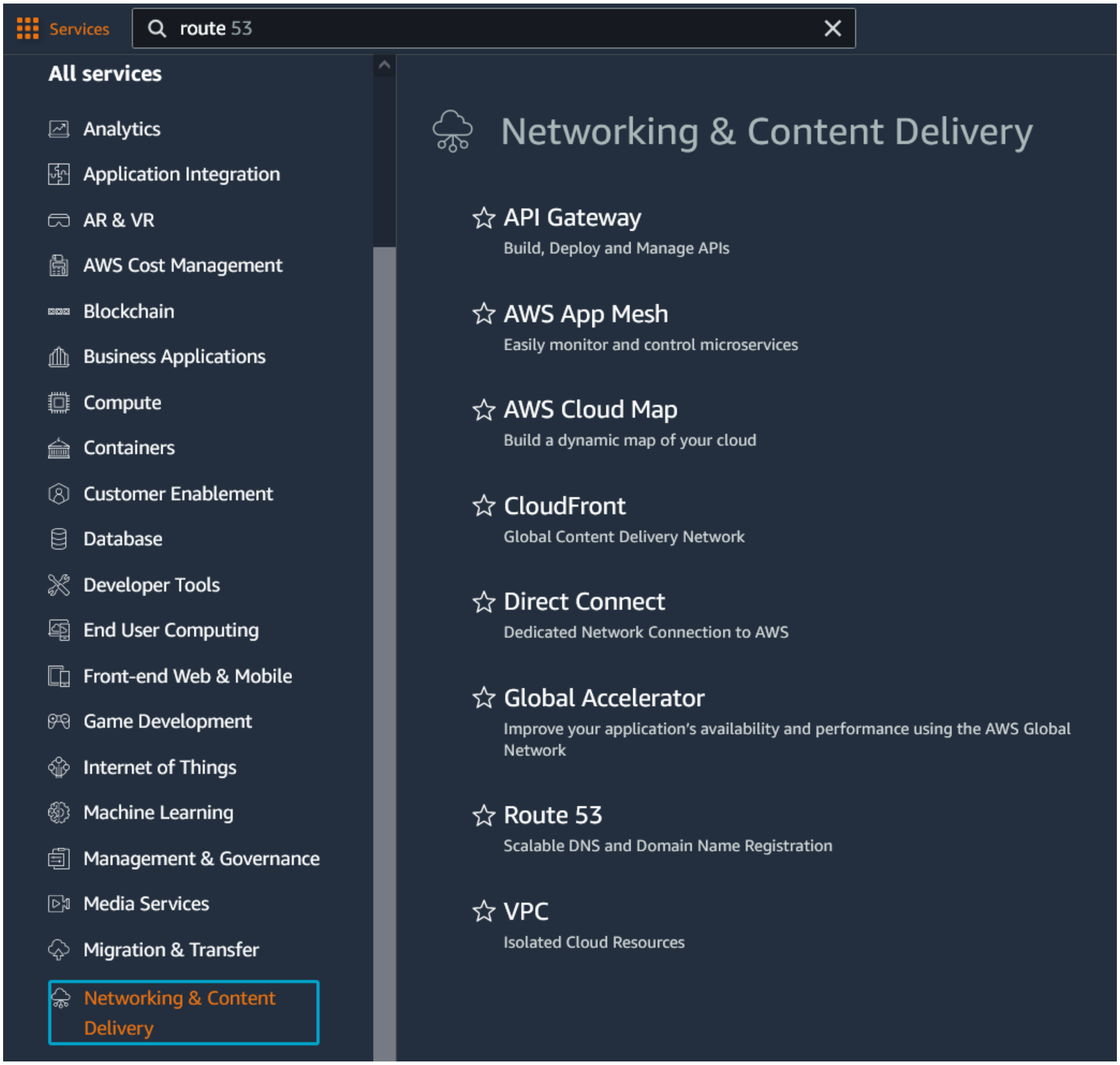
```
ECDSA key fingerprint is MD5:95:5c:4b:3b:27:0f:58:01:75:1f:d7:9d:73:40:82:d8.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.200.1.8' (ECDSA) to the list of known hosts.
Permission denied (publickey,gssapi-keyex,gssapi-with-mic).
[ec2-user@ip-10-100-1-210 ~]$ vim demo.pem
[ec2-user@ip-10-100-1-210 ~]$ chmod 400 demo.pem
[ec2-user@ip-10-100-1-210 ~]$ ssh -i demo.pem ec2-user@10.200.1.8

       __|  __|_  )
       _|  (     /   Amazon Linux 2 AMI
      ___|\___|___|

https://aws.amazon.com/amazon-linux-2/
[ec2-user@ip-10-200-1-8 ~]$ ping 10.100.1.210
PING 10.100.1.210 (10.100.1.210) 56(84) bytes of data.
64 bytes from 10.100.1.210: icmp_seq=274 ttl=64 time=0.776 ms
64 bytes from 10.100.1.210: icmp_seq=275 ttl=64 time=0.737 ms
64 bytes from 10.100.1.210: icmp_seq=276 ttl=64 time=0.801 ms
64 bytes from 10.100.1.210: icmp_seq=277 ttl=64 time=3.17 ms
64 bytes from 10.100.1.210: icmp_seq=278 ttl=64 time=0.784 ms
64 bytes from 10.100.1.210: icmp_seq=279 ttl=64 time=16.9 ms
64 bytes from 10.100.1.210: icmp_seq=280 ttl=64 time=0.870 ms
64 bytes from 10.100.1.210: icmp_seq=281 ttl=64 time=0.799 ms
64 bytes from 10.100.1.210: icmp_seq=282 ttl=64 time=0.796 ms
64 bytes from 10.100.1.210: icmp_seq=283 ttl=64 time=0.820 ms
64 bytes from 10.100.1.210: icmp_seq=284 ttl=64 time=0.794 ms
```

Chapter 7 Labs

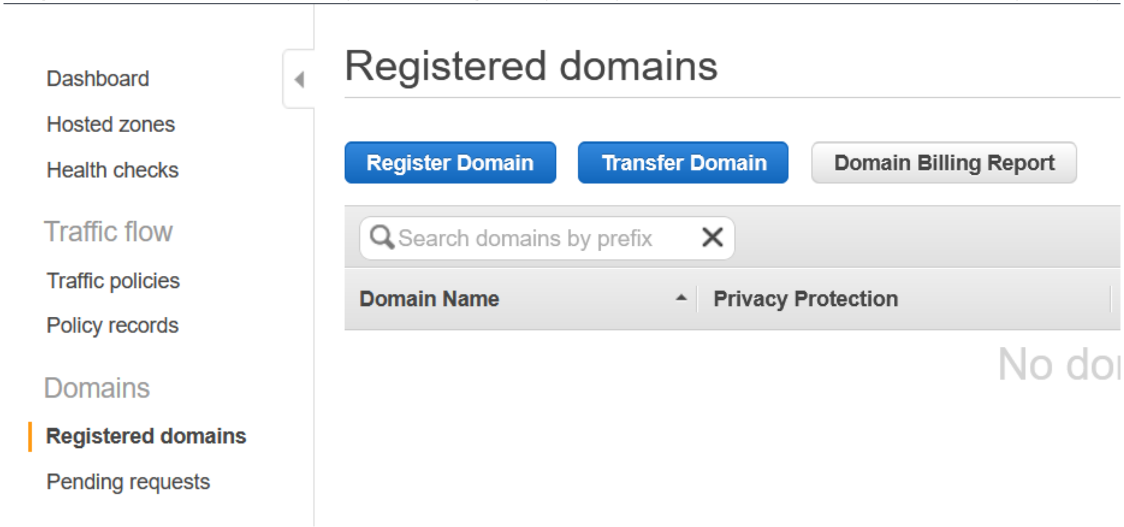
Lab: Create a Route 53 Hosted Zone

In this lab we will create a public hosted DNS zone using AWS Route 53. Note, you will need to purchase a domain name through AWS.

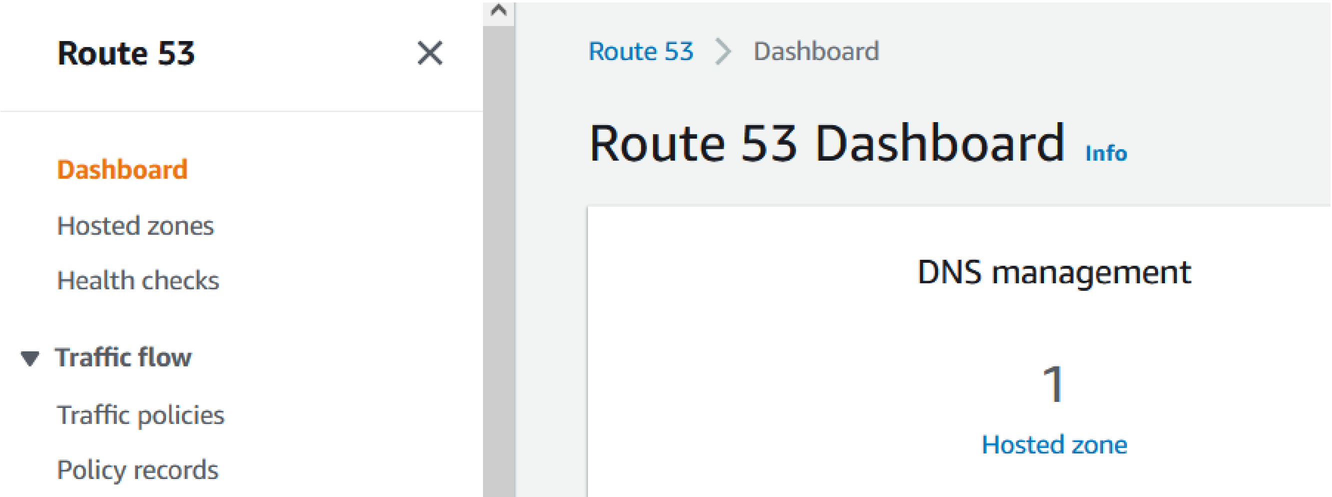
From the management console, Go to Services > Networking > Route 53.

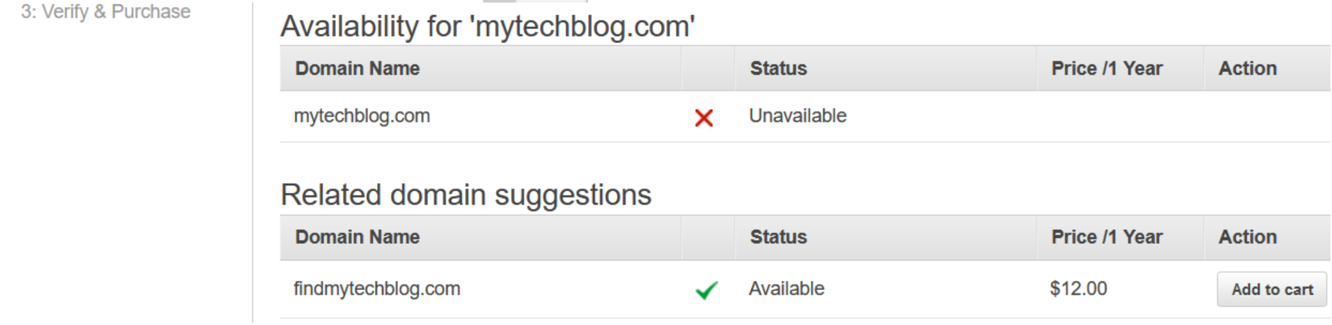


Register a domain name by following the prompts. Make sure to leave Whois privacy enabled.



AWS has automatically created a Hosted Zone for the domain name. Go back to the main Route 53 dashboard and click "Hosted Zone" to view it.





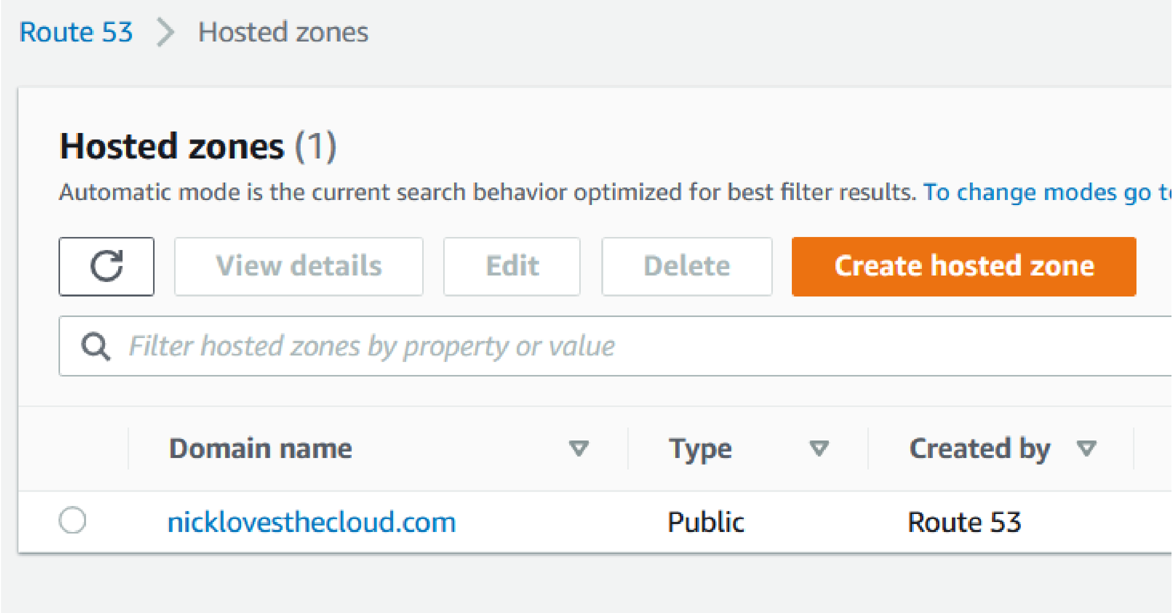
Availability for 'mytechblog.com'

Domain Name		Status	Price /1 Year	Action
mytechblog.com	✗	Unavailable		

Related domain suggestions

Domain Name		Status	Price /1 Year	Action
findmytechblog.com	✓	Available	$12.00	Add to cart

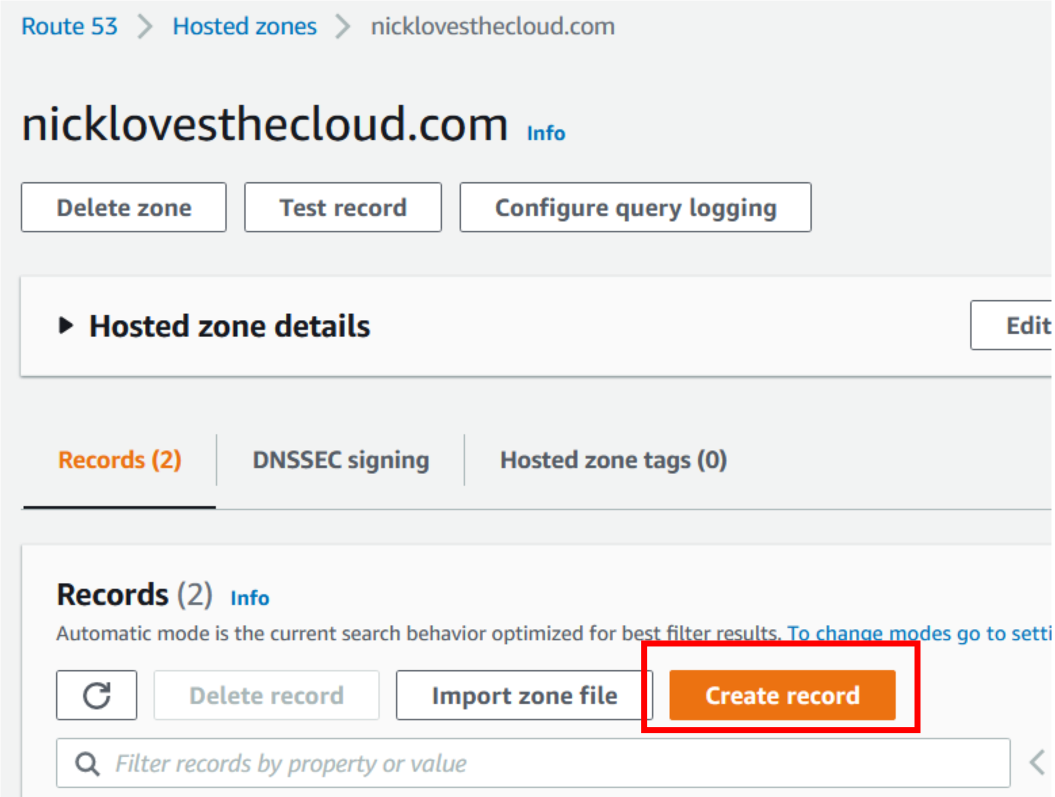
Click on your domain.



Automatic mode is the current search behavior optimized for best filter results. To change modes go t

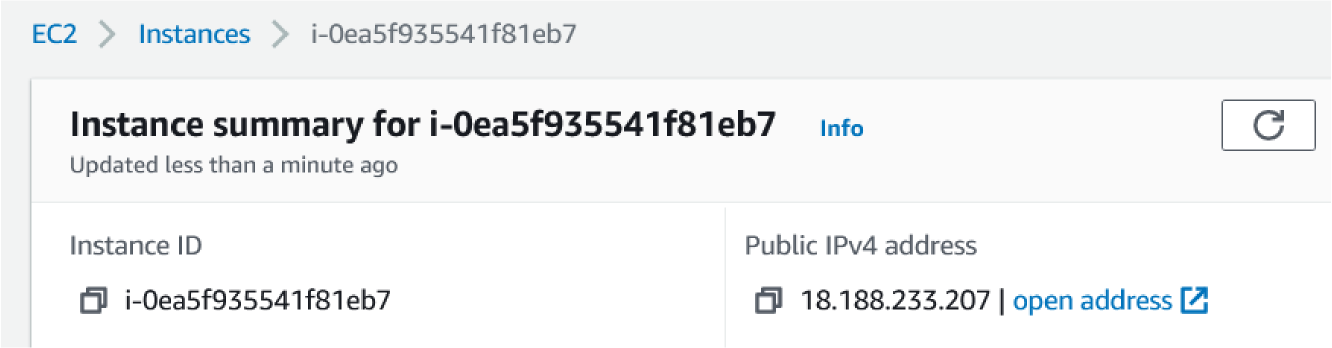
	Domain name	Type	Created by
○	nicklovesthecloud.com	Public	Route 53

On the Hosted Zones page, click **Create record**.



Automatic mode is the current search behavior optimized for best filter results. To change modes go to setti

Find the Public IPv4 address of your web server and copy it to the value box. Make sure to select a DNS “A” record from the dropdown. Then click **Create record**.



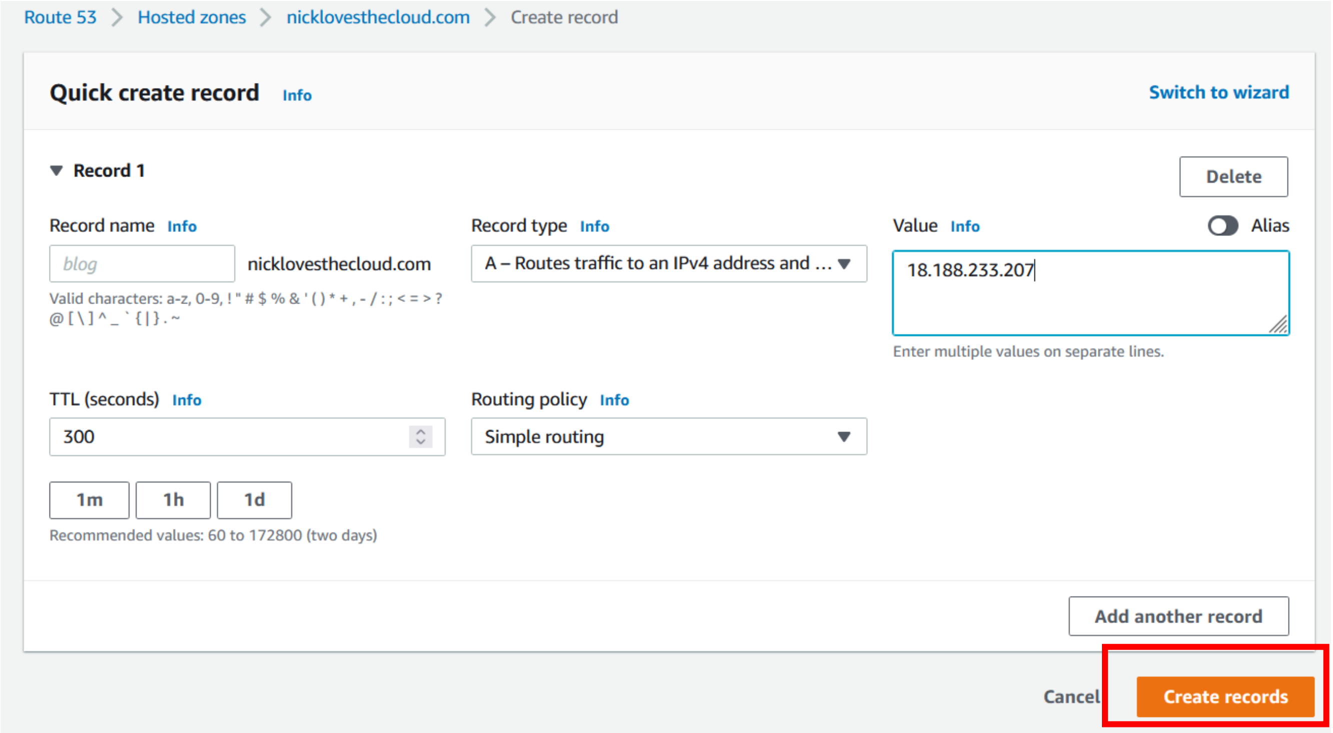
EC2 > Instances > i-0ea5f935541f81eb7

Instance summary for i-0ea5f935541f81eb7 Info

Updated less than a minute ago

Instance ID: i-0ea5f935541f81eb7

Public IPv4 address: 18.188.233.207 | open address



Route 53 > Hosted zones > nicklovesthecloud.com > Create record

Quick create record Info

Record 1

Record name Info: blog nicklovesthecloud.com

Valid characters: a-z, 0-9, ! " # $ % & ' ( ) * + , - / : ; < = > ? @ [\ ] ^ _ ` { | } . ~

Record type Info: A – Routes traffic to an IPv4 address and ...

Value Info: 18.188.233.207

Alias

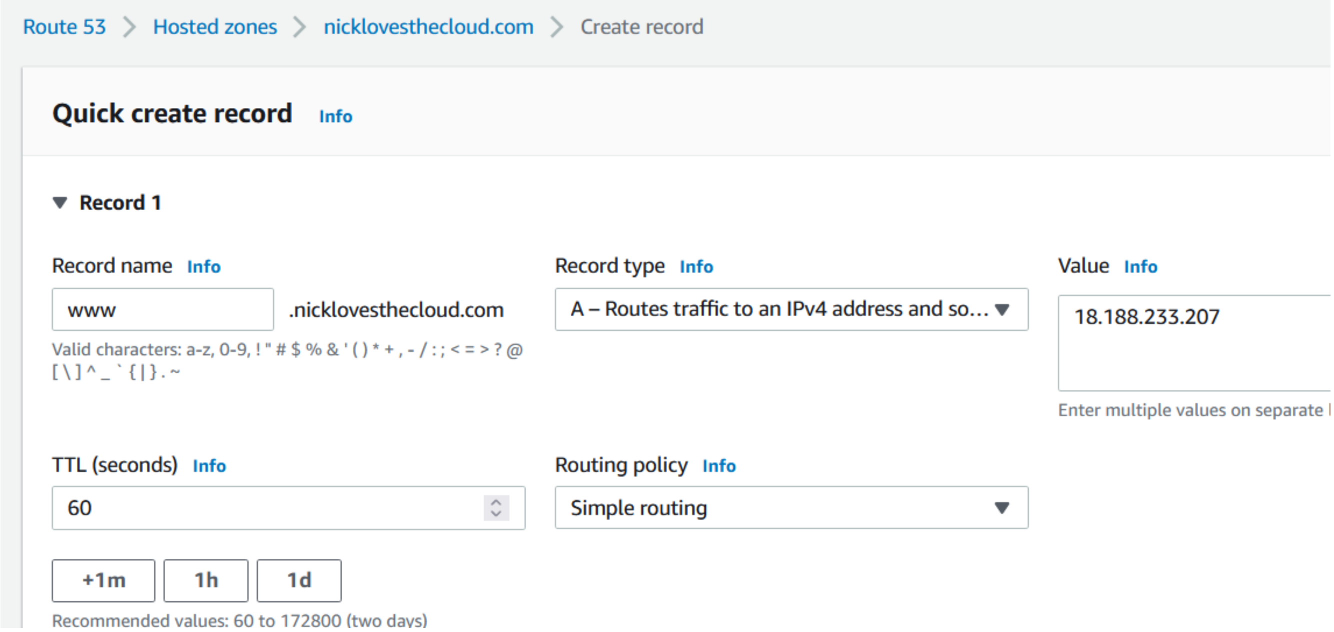
Enter multiple values on separate lines.

TTL (seconds) Info: 300

Recommended values: 60 to 172800 (two days)

Routing policy Info: Simple routing

Create a second record as follows.



Route 53 > Hosted zones > nicklovesthecloud.com > Create record

Quick create record Info

▼ Record 1

Record name Info: www .nicklovesthecloud.com

Valid characters: a-z, 0-9, ! " # $ % & ' ( ) * + , - / : ; < = > ? @ [\ ] ^ _ ` { | } . ~

Record type Info: A – Routes traffic to an IPv4 address and so...

Value Info: 18.188.233.207

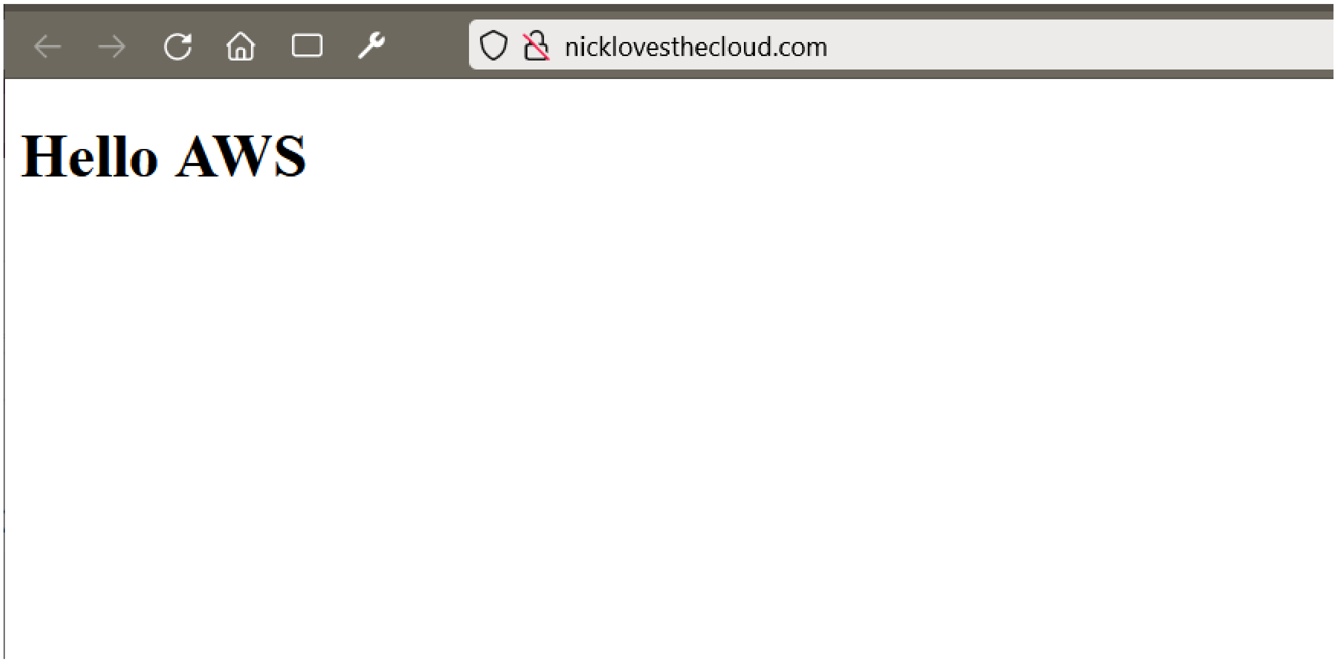
Enter multiple values on separate l

TTL (seconds) Info: 60

Recommended values: 60 to 172800 (two days)

Routing policy Info: Simple routing

Your web server should now be reachable by going to your domain name.



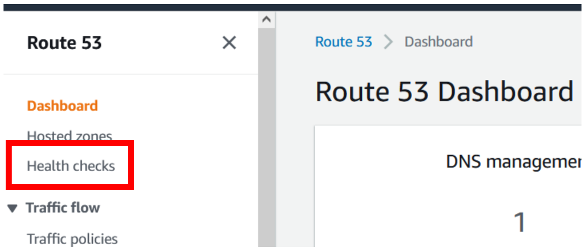
nicklovesthecloud.com

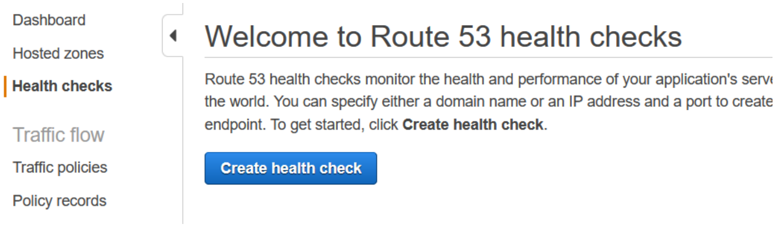
Hello AWS

Lab: Create a DNS Health Check Using Route 53

From the management console, navigate to the Route 53 dashboard.

On the Route 53 dashboard click on “Health Checks”, then click “Create Health Check.”

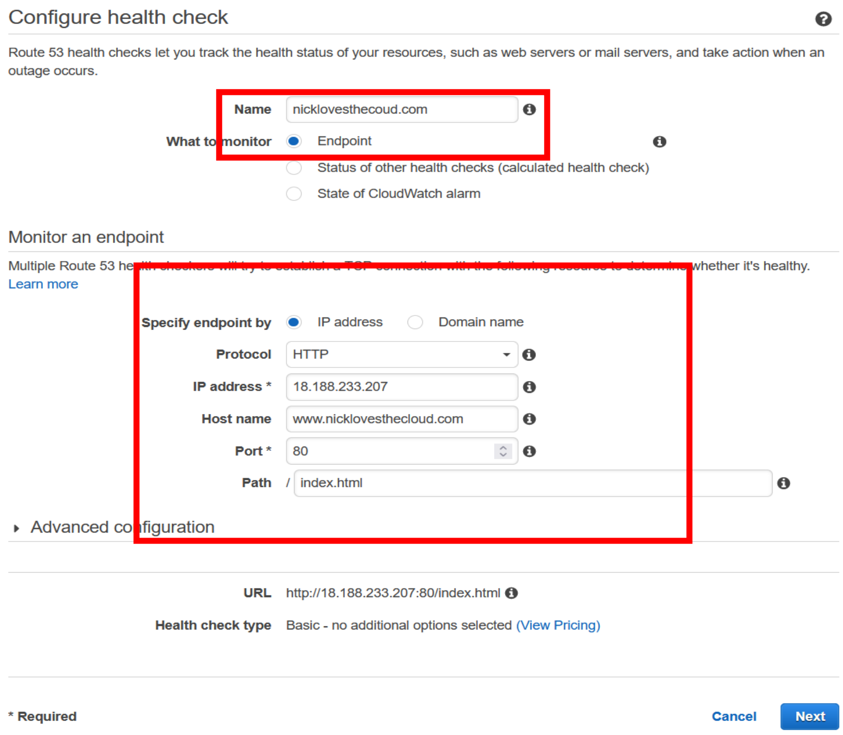




Welcome to Route 53 health checks

Route 53 health checks monitor the health and performance of your application's serv the world. You can specify either a domain name or an IP address and a port to create endpoint. To get started, click **Create health check**.

Configure the health check with your domain name.



Configure health check

Route 53 health checks let you track the health status of your resources, such as web servers or mail servers, and take action when an outage occurs.

Name nicklovesthecoud.com

What to monitor ● Endpoint ○ Status of other health checks (calculated health check) ○ State of CloudWatch alarm

Monitor an endpoint

Multiple Route 53 health checkers will try to establish a TCP connection with the following resource to determine whether it's healthy. Learn more

Specify endpoint by ● IP address ○ Domain name

Protocol HTTP

IP address * 18.188.233.207

Host name www.nicklovesthecloud.com

Port * 80

Path / index.html

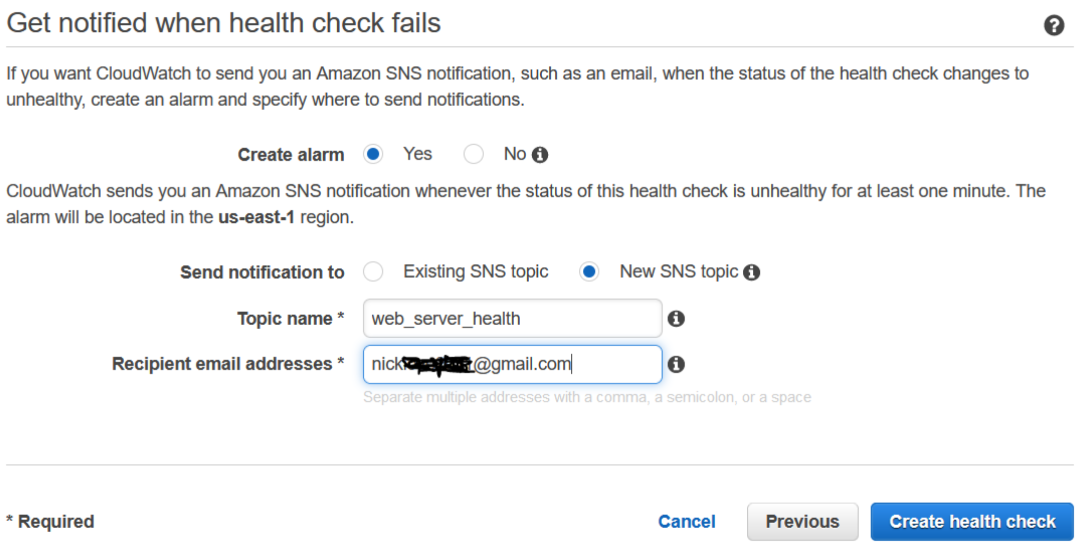
Advanced configuration

URL http://18.188.233.207:80/index.html

Health check type Basic - no additional options selected (View Pricing)

* **Required**

Set up SNS notifications for the health check.



Get notified when health check fails

If you want CloudWatch to send you an Amazon SNS notification, such as an email, when the status of the health check changes to unhealthy, create an alarm and specify where to send notifications.

Create alarm ● Yes ○ No

CloudWatch sends you an Amazon SNS notification whenever the status of this health check is unhealthy for at least one minute. The alarm will be located in the **us-east-1** region.

Send notification to ○ Existing SNS topic ● New SNS topic

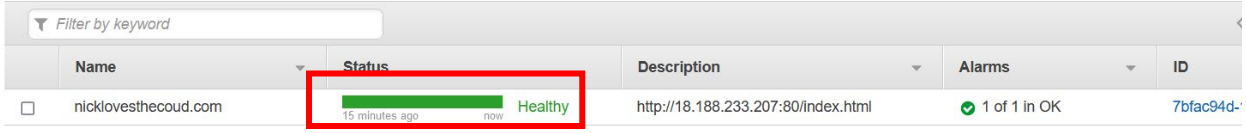
Topic name * web_server_health

Recipient email addresses * nick[redacted]@gmail.com

Separate multiple addresses with a comma, a semicolon, or a space

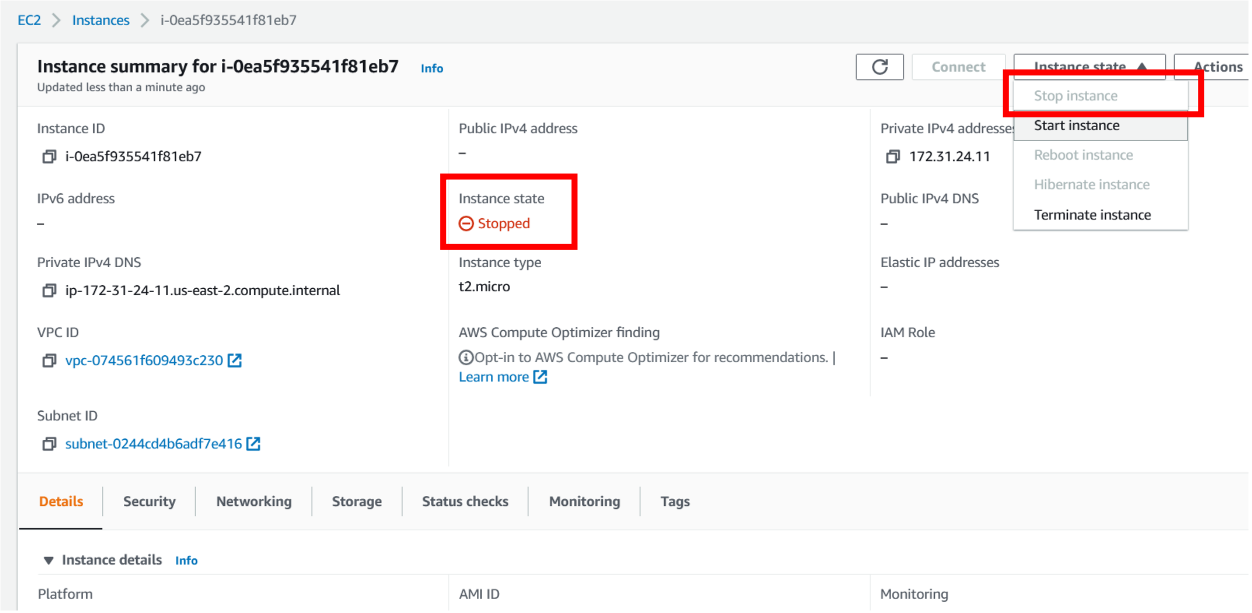
* Required

Congratulations, you've created a health check. Notice that the Status reads "Healthy".



	Name	Status	Description	Alarms	ID
□	nicklovesthecoud.com	15 minutes ago now Healthy	http://18.188.233.207:80/index.html	✓ 1 of 1 in OK	7bfac94d-

Test the health check by stopping the web server.



EC2 > Instances > i-0ea5f935541f81eb7

Instance summary for i-0ea5f935541f81eb7 Info
Updated less than a minute ago

Instance ID: i-0ea5f935541f81eb7

Public IPv4 address: –

Private IPv4 addresses: 172.31.24.11

IPv6 address: –

Instance state: Stopped

Public IPv4 DNS: –

Private IPv4 DNS: ip-172-31-24-11.us-east-2.compute.internal

Instance type: t2.micro

Elastic IP addresses: –

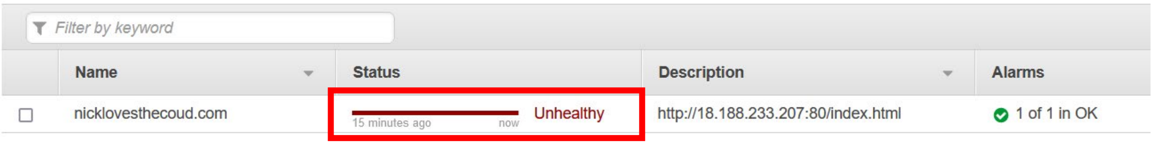
VPC ID: vpc-074561f609493c230

AWS Compute Optimizer finding: Opt-in to AWS Compute Optimizer for recommendations. | Learn more

IAM Role: –

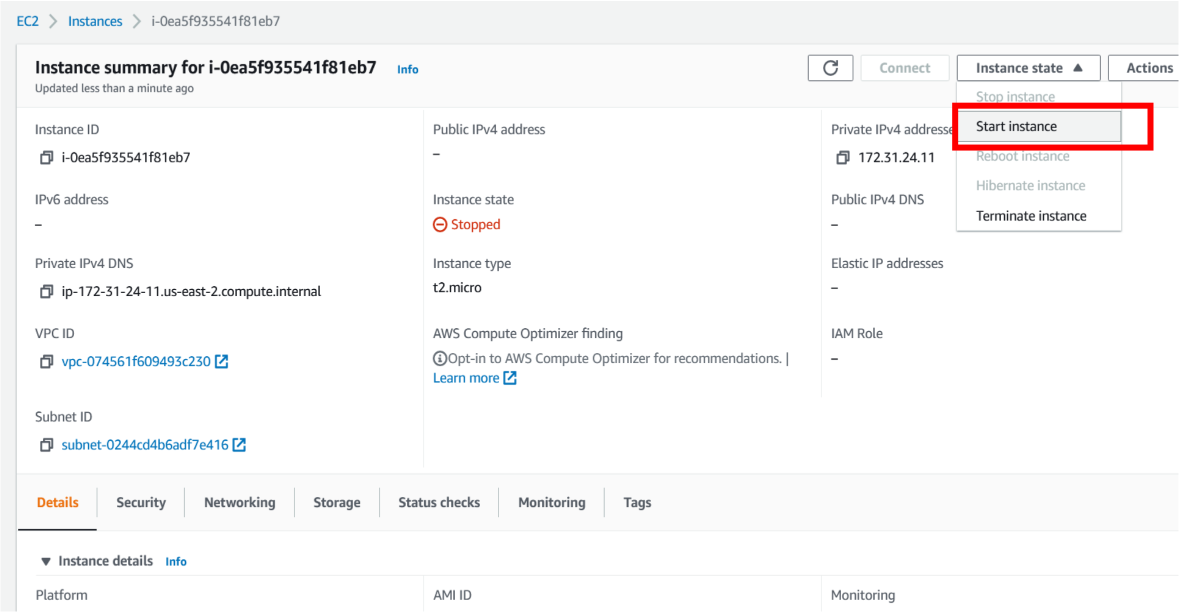
Subnet ID: subnet-0244cd4b6adf7e416

The health check should fail because the server is unreachable.



	Name	Status	Description	Alarms
□	nicklovesthecoud.com	15 minutes ago now Unhealthy	http://18.188.233.207:80/index.html	✓ 1 of 1 in OK

Following the health check, restart the web server.



Instance summary for i-0ea5f935541f81eb7 Info

Updated less than a minute ago

Instance ID: i-0ea5f935541f81eb7

IPv6 address: –

Private IPv4 DNS: ip-172-31-24-11.us-east-2.compute.internal

VPC ID: vpc-074561f609493c230

Subnet ID: subnet-0244cd4b6adf7e416

Public IPv4 address: –

Instance state: Stopped

Instance type: t2.micro

AWS Compute Optimizer finding: Opt-in to AWS Compute Optimizer for recommendations. | Learn more

Private IPv4 addresse: 172.31.24.11

Public IPv4 DNS: –

Elastic IP addresses: –

IAM Role: –

▼ Instance details Info

Platform

AMI ID

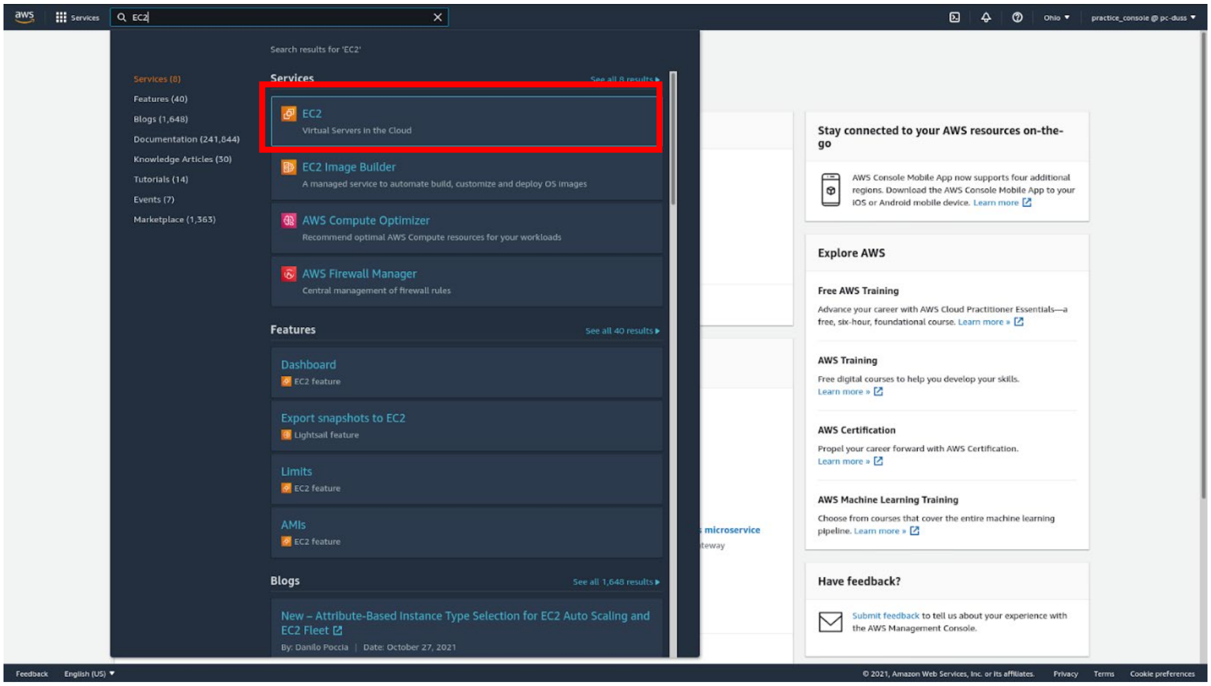
Monitoring

Lab: Set Up an Application Load Balancer & Target Groups

In this lab we will set up an application load balancer that will distribute traffic to a target group. Load balancing can play a major role in high-availability applications

Configure Your Target Groups

Before we create our load balancer, we need to include our instances in a Target Group. From the management console, navigate to the **EC2** console.



A managed service to automate build, customize and deploy OS images

Recommend optimal AWS Compute resources for your workloads

Central management of firewall rules

New – Attribute-Based Instance Type Selection for EC2 Auto Scaling and EC2 Fleet

By: Danilo Poccia | Date: October 27, 2021

AWS Console Mobile App now supports four additional regions. Download the AWS Console Mobile App to your iOS or Android mobile device. Learn more

Advance your career with AWS Cloud Practitioner Essentials—a free, six-hour, foundational course. Learn more »

Free digital courses to help you develop your skills. Learn more »

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Choose from courses that cover the entire machine learning pipeline. Learn more »

Submit feedback to tell us about your experience with the AWS Management Console.

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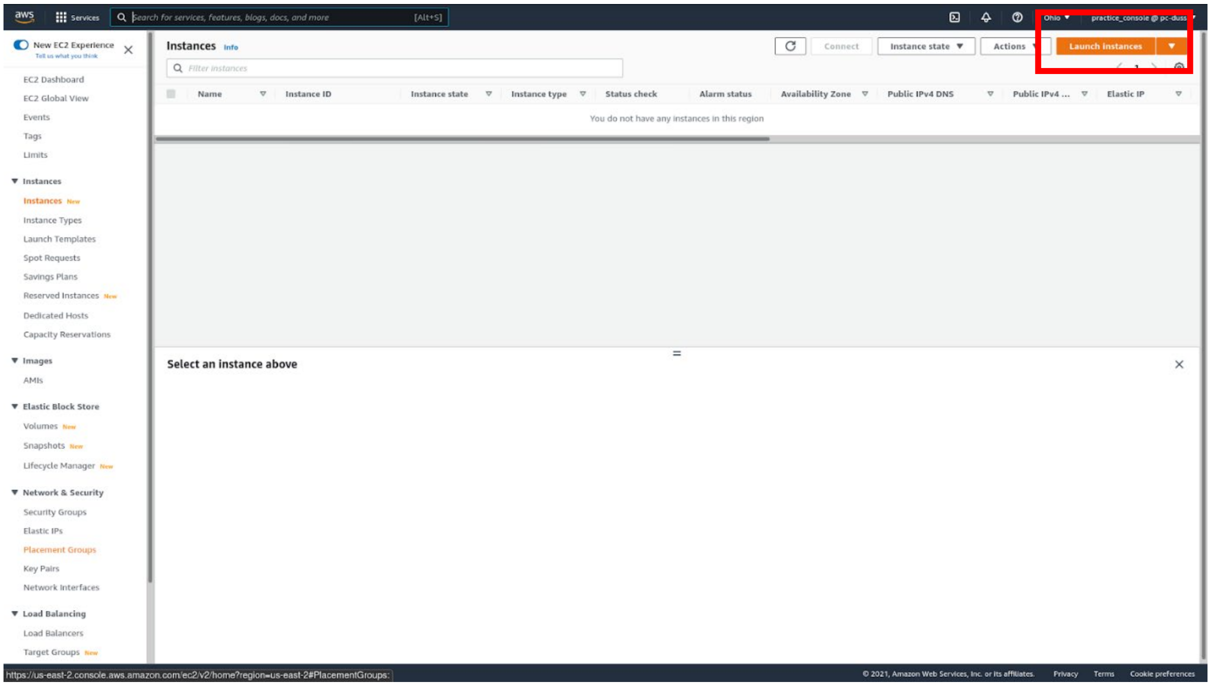
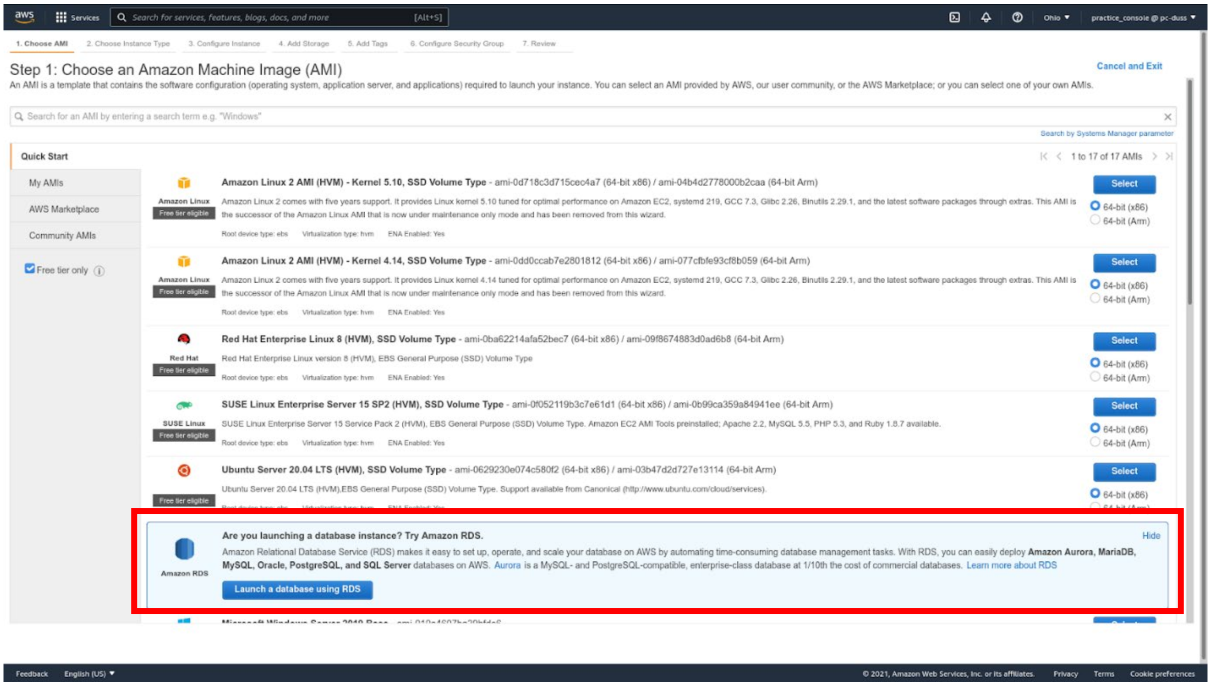
Navigate to the **Instances** section in the sidebar. Click on **Launch instances**.



You do not have any instances in this region

Select an instance above

Select the Free Tier image of your choice. We will choose Amazon Linux.



Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type - ami-0d718c3d715cec4a7 (64-bit x86) / ami-04b4d2778000b2caa (64-bit Arm)

Amazon Linux 2 comes with five years support. It provides Linux kernel 5.10 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is now under maintenance only mode and has been removed from this wizard.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

Amazon Linux 2 AMI (HVM) - Kernel 4.14, SSD Volume Type - ami-0dd0ccab7e2801812 (64-bit x86) / ami-077cfbfe93cf8b059 (64-bit Arm)

Amazon Linux 2 comes with five years support. It provides Linux kernel 4.14 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is now under maintenance only mode and has been removed from this wizard.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-0ba62214afa52bec7 (64-bit x86) / ami-09f8674883d0ad6b8 (64-bit Arm)

Red Hat Enterprise Linux version 8 (HVM), EBS General Purpose (SSD) Volume Type

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

SUSE Linux Enterprise Server 15 SP2 (HVM), SSD Volume Type - ami-0f052119b3c7e61d1 (64-bit x86) / ami-0b99ca359a84941ee (64-bit Arm)

SUSE Linux Enterprise Server 15 Service Pack 2 (HVM), EBS General Purpose (SSD) Volume Type. Amazon EC2 AMI Tools preinstalled; Apache 2.2, MySQL 5.5, PHP 5.3, and Ruby 1.8.7 available.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

Ubuntu Server 20.04 LTS (HVM), SSD Volume Type - ami-0629230e074c580f2 (64-bit x86) / ami-03b47d2d727e13114 (64-bit Arm)

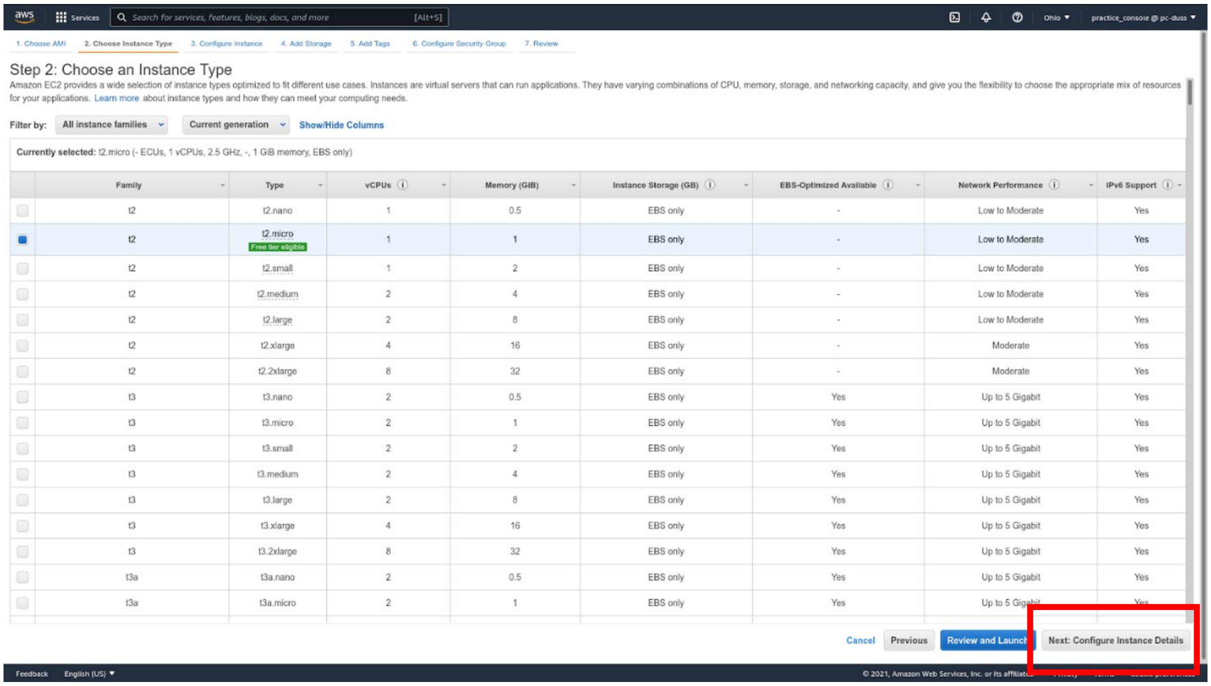
Ubuntu Server 20.04 LTS (HVM),EBS General Purpose (SSD) Volume Type. Support available from Canonical (http://www.ubuntu.com/cloud/services).

● 64-bit (x86)

Are you launching a database instance? Try Amazon RDS.

Amazon Relational Database Service (RDS) makes it easy to set up, operate, and scale your database on AWS by automating time-consuming database management tasks. With RDS, you can easily deploy **Amazon Aurora, MariaDB, MySQL, Oracle, PostgreSQL, and SQL Server** databases on AWS. Aurora is a MySQL- and PostgreSQL-compatible, enterprise-class database at 1/10th the cost of commercial databases. Learn more about RDS

Select **t2.micro**. Click **Next: Configure Instance Details**.


aws
Services
Search for services, features, blogs, docs, and more [Alt+S]
Ohio ▾
practice_console @ pc-duss ▾
1. Choose AMI
2. Choose Instance Type
3. Configure Instance
4. Add Storage
5. Add Tags
6. Configure Security Group
7. Review
Cancel
Previous
Review and Launch
Next: Configure Instance Details
Feedback
English (US) ▾
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Step 2: Choose an Instance Type

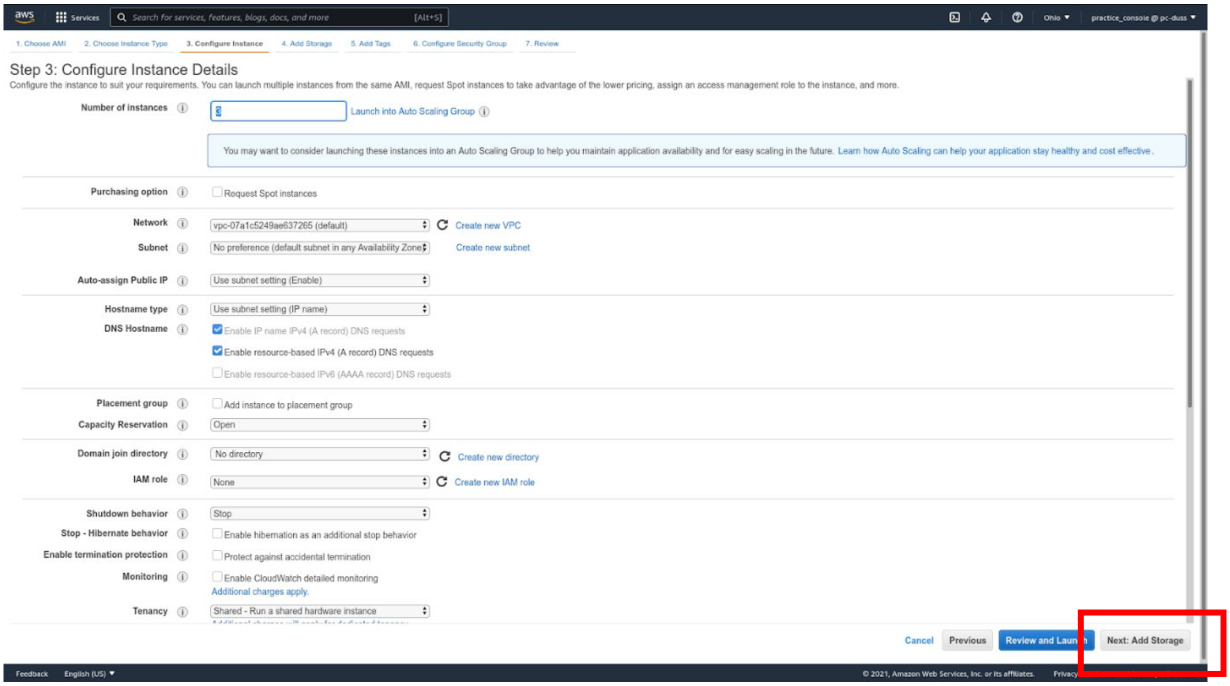
Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have varying combinations of CPU, memory, storage, and networking capacity, and give you the flexibility to choose the appropriate mix of resources for your applications. Learn more about instance types and how they can meet your computing needs.

Filter by: All instance families ▾ Current generation ▾ Show/Hide Columns

Currently selected: t2.micro (- ECUs, 1 vCPUs, 2.5 GHz, -, 1 GiB memory, EBS only)

	Family	Type	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance	IPv6 Support
☐	t2	t2.nano	1	0.5	EBS only	-	Low to Moderate	Yes
☑	t2	t2.micro Free tier eligible	1	1	EBS only	-	Low to Moderate	Yes
☐	t2	t2.small	1	2	EBS only	-	Low to Moderate	Yes
☐	t2	t2.medium	2	4	EBS only	-	Low to Moderate	Yes
☐	t2	t2.large	2	8	EBS only	-	Low to Moderate	Yes
☐	t2	t2.xlarge	4	16	EBS only	-	Moderate	Yes
☐	t2	t2.2xlarge	8	32	EBS only	-	Moderate	Yes
☐	t3	t3.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes
☐	t3	t3.micro	2	1	EBS only	Yes	Up to 5 Gigabit	Yes
☐	t3	t3.small	2	2	EBS only	Yes	Up to 5 Gigabit	Yes
☐	t3	t3.medium	2	4	EBS only	Yes	Up to 5 Gigabit	Yes
☐	t3	t3.large	2	8	EBS only	Yes	Up to 5 Gigabit	Yes
☐	t3	t3.xlarge	4	16	EBS only	Yes	Up to 5 Gigabit	Yes
☐	t3	t3.2xlarge	8	32	EBS only	Yes	Up to 5 Gigabit	Yes
☐	t3a	t3a.nano	2	0.5	EBS only	Yes	Up to 5 Gigabit	Yes
☐	t3a	t3a.micro	2	1	EBS only	Yes	Up to 5 Gigabit	Yes

Set the **Number of Instances** to 3. Click **Next: Add Storage**.



Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances: 3 Launch into Auto Scaling Group

You may want to consider launching these instances into an Auto Scaling Group to help you maintain application availability and for easy scaling in the future. Learn how Auto Scaling can help your application stay healthy and cost effective.

Purchasing option: ☐ Request Spot instances

Network: vpc-07a1c5249ae637265 (default) Create new VPC

Subnet: No preference (default subnet in any Availability Zone) Create new subnet

Auto-assign Public IP: Use subnet setting (Enable)

Hostname type: Use subnet setting (IP name)

DNS Hostname: ☑ Enable IP name IPv4 (A record) DNS requests

☑ Enable resource-based IPv4 (A record) DNS requests

☐ Enable resource-based IPv6 (AAAA record) DNS requests

Placement group: ☐ Add instance to placement group

Capacity Reservation: Open

Domain join directory: No directory Create new directory

IAM role: None Create new IAM role

Shutdown behavior: Stop

Stop - Hibernate behavior: ☐ Enable hibernation as an additional stop behavior

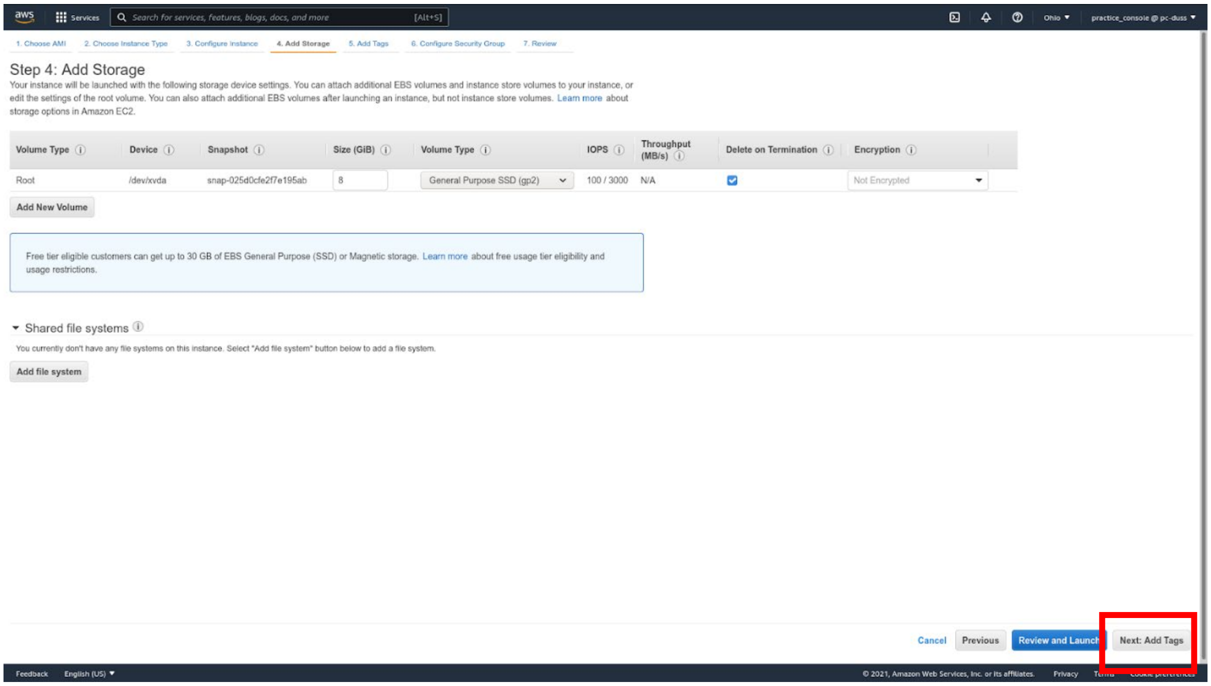
Enable termination protection: ☐ Protect against accidental termination

Monitoring: ☐ Enable CloudWatch detailed monitoring

Additional charges apply.

Tenancy: Shared - Run a shared hardware instance

Click **Next: Add Tags**.



aws
Services
Search for services, features, blogs, docs, and more [Alt+S]
Ohio
practice_console @ pc-duss
1. Choose AMI
2. Choose Instance Type
3. Configure Instance
4. Add Storage
5. Add Tags
6. Configure Security Group
7. Review

Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. Learn more about storage options in Amazon EC2.

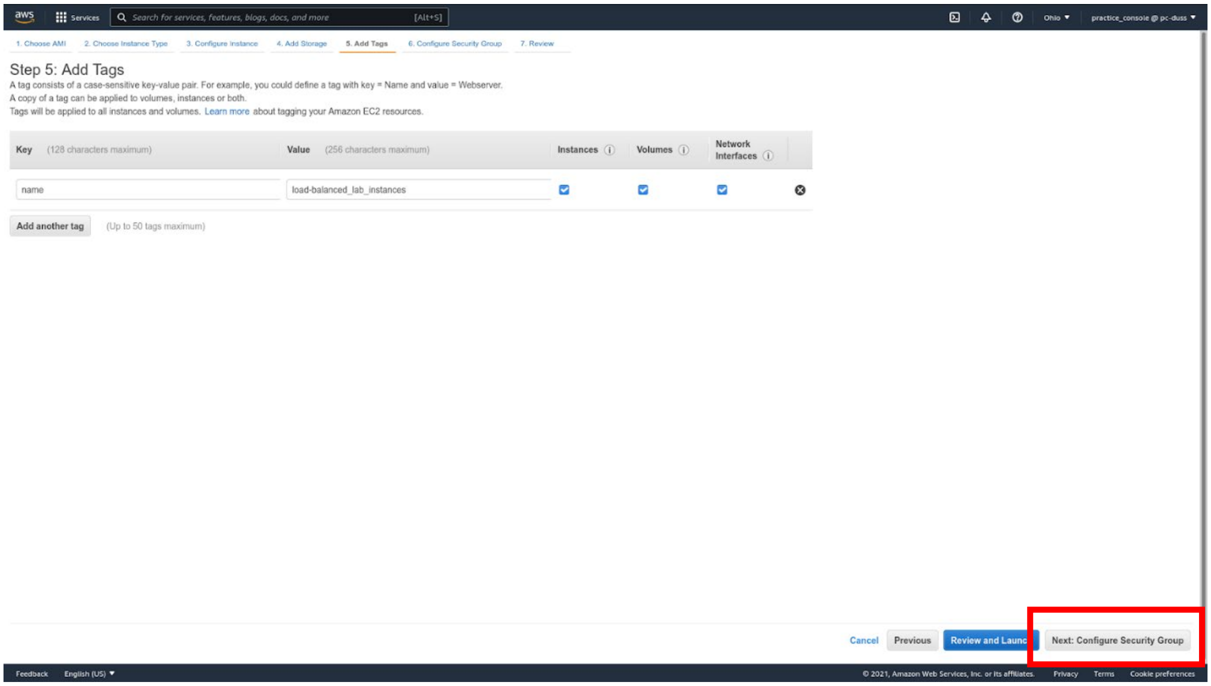
Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encryption
Root	/dev/xvda	snap-025d0cfe2f7e195ab	8	General Purpose SSD (gp2)	100 / 3000	N/A	☑	Not Encrypted

Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. Learn more about free usage tier eligibility and usage restrictions.

Shared file systems

You currently don't have any file systems on this instance. Select "Add file system" button below to add a file system.

Add a name tag and give it a value. Click **Next: Configure Security Group**.



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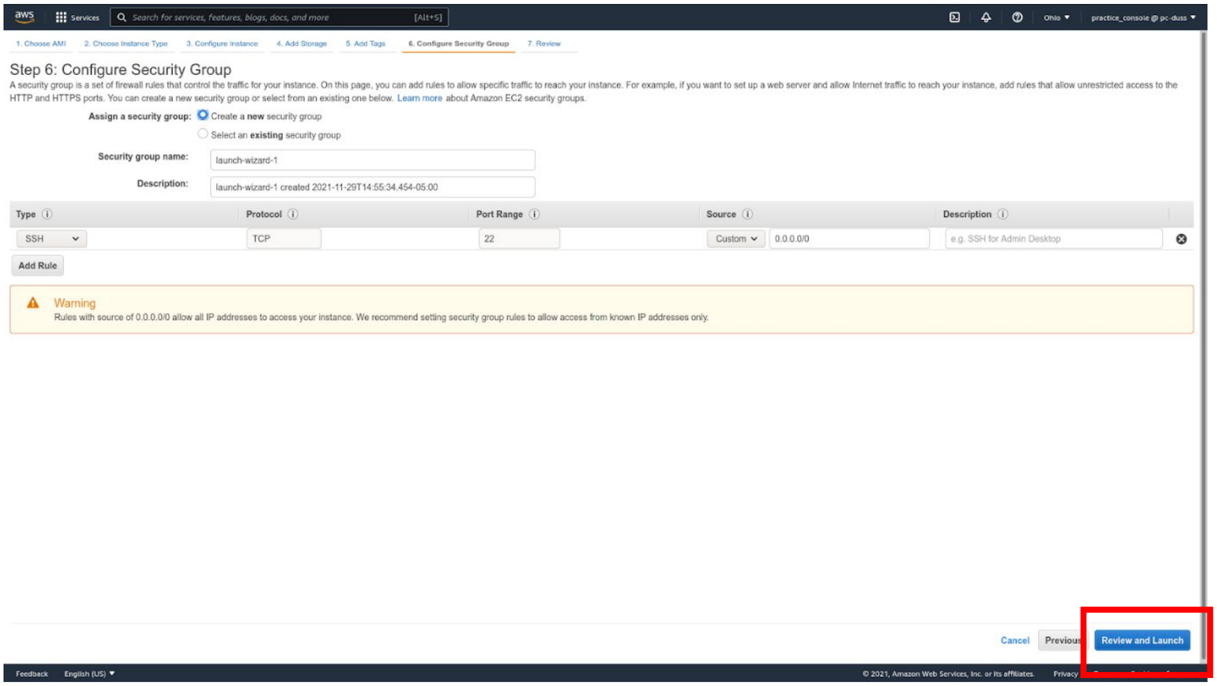
Ohio
practice_console @ pc-duss
1. Choose AMI
2. Choose Instance Type
3. Configure Instance
4. Add Storage
5. Add Tags
6. Configure Security Group
7. Review

Step 5: Add Tags

A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver.
A copy of a tag can be applied to volumes, instances or both.
Tags will be applied to all instances and volumes. Learn more about tagging your Amazon EC2 resources.

Key (128 characters maximum)	Value (256 characters maximum)	Instances	Volumes	Network Interfaces
name	load-balanced_lab_instances	☑	☑	☑

You can leave this at the defaults or use an existing Security Group. Click **Review and Launch**.



Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. Learn more about Amazon EC2 security groups.

Assign a security group: ● Create a **new** security group
○ Select an **existing** security group

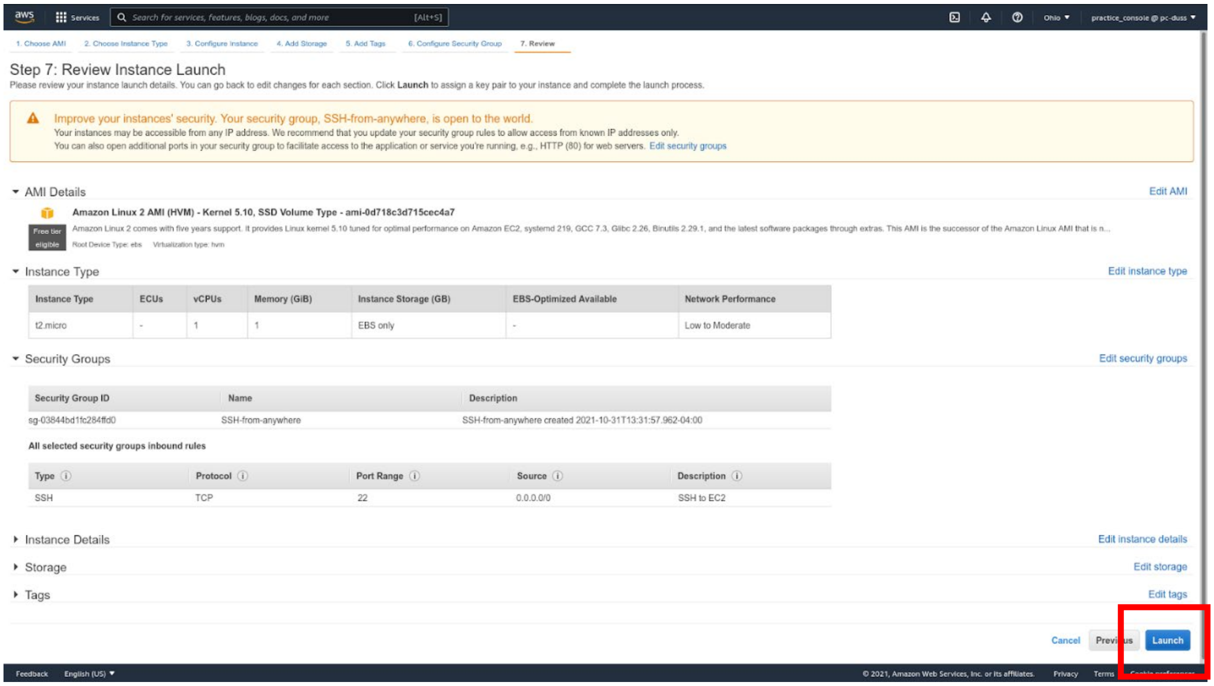
Security group name: launch-wizard-1

Description: launch-wizard-1 created 2021-11-29T14:55:34.454-05:00

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	Custom 0.0.0.0/0	e.g. SSH for Admin Desktop

Warning
Rules with source of 0.0.0.0/0 allow all IP addresses to access your instance. We recommend setting security group rules to allow access from known IP addresses only.

When you are ready, click **Launch**.



Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

Improve your instances' security. Your security group, SSH-from-anywhere, is open to the world.
Your instances may be accessible from any IP address. We recommend that you update your security group rules to allow access from known IP addresses only.
You can also open additional ports in your security group to facilitate access to the application or service you're running, e.g., HTTP (80) for web servers. Edit security groups

AMI Details

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type - ami-0d718c3d715cec4a7
Amazon Linux 2 comes with five years support. It provides Linux kernel 5.10 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is n...
Root Device Type: ebs Virtualization type: hvm

Instance Type

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
t2.micro	-	1	1	EBS only	-	Low to Moderate

Security Groups

Security Group ID	Name	Description
sg-03844bd1fc284ffd0	SSH-from-anywhere	SSH-from-anywhere created 2021-10-31T13:31:57.962-04:00

All selected security groups inbound rules

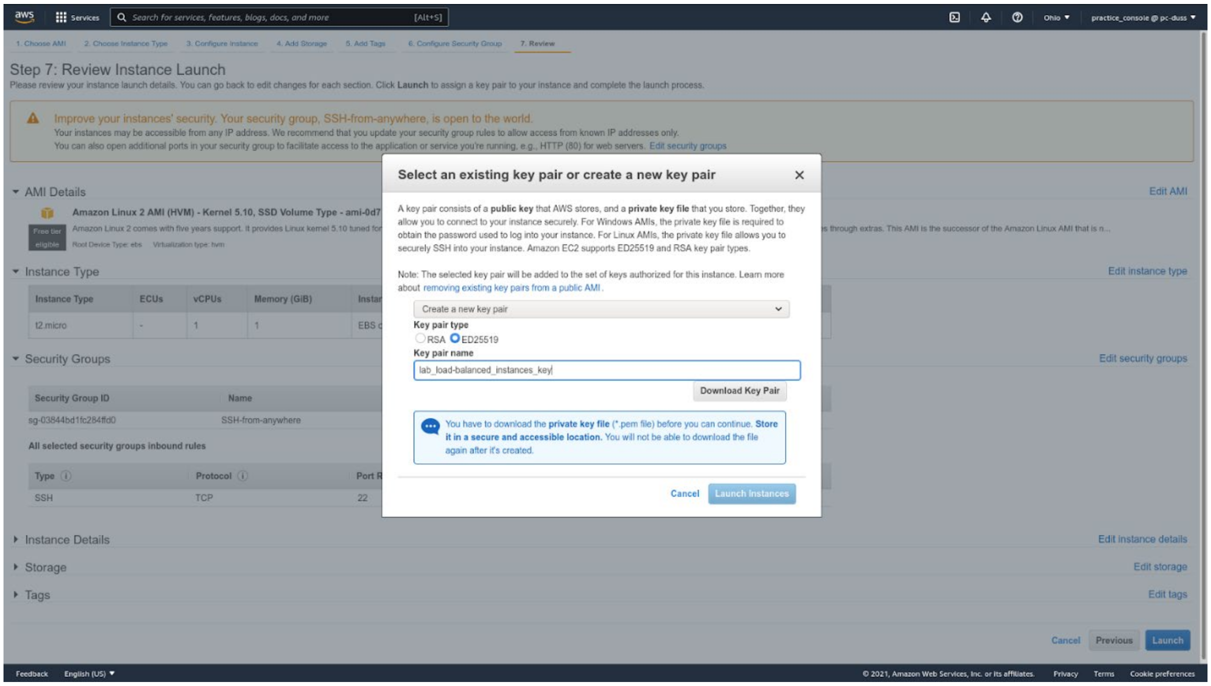
Type	Protocol	Port Range	Source	Description
SSH	TCP	22	0.0.0.0/0	SSH to EC2

Instance Details

Storage

Tags

Give a name to the SSH key. Make sure to download the SSH key. When you have, click **Launch Instances**.



Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

Improve your instances' security. Your security group, SSH-from-anywhere, is open to the world.

Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance. Amazon EC2 supports ED25519 and RSA key pair types.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about removing existing key pairs from a public AMI .

Create a new key pair

Key pair type

○ RSA ● ED25519

Key pair name

lab_load-balanced_instances_key

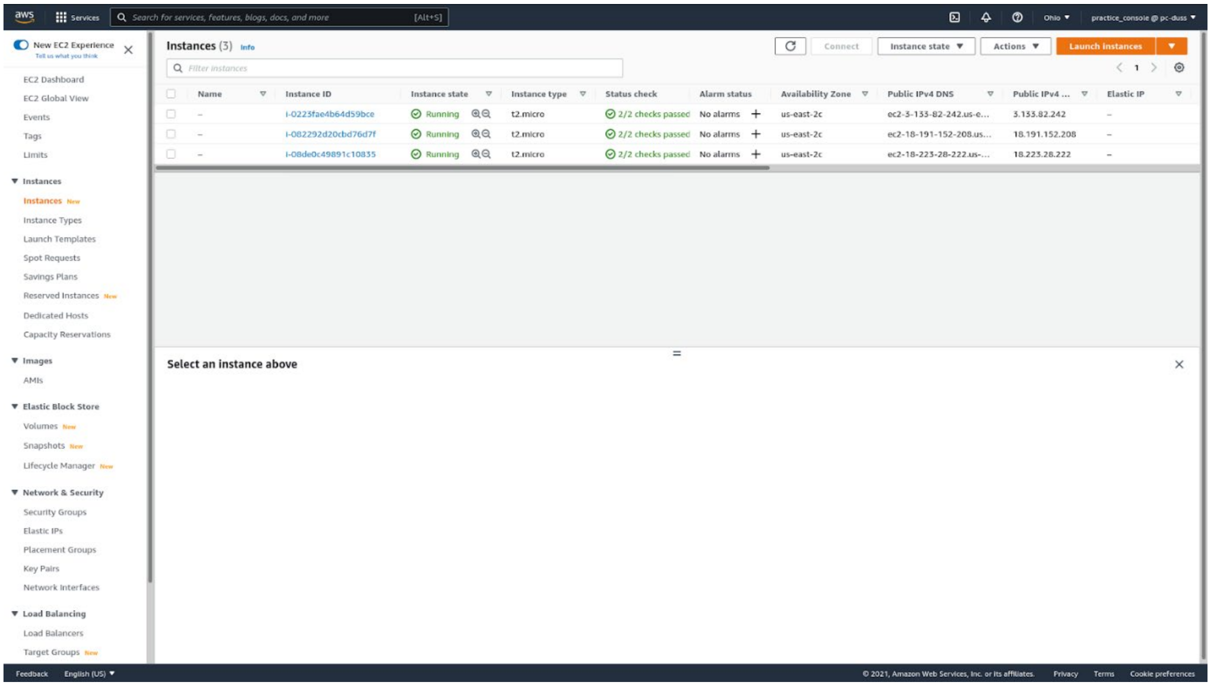
Download Key Pair

You have to download the **private key file** (*.pem file) before you can continue. **Store it in a secure and accessible location.** You will not be able to download the file again after it's created.

Cancel Launch Instances

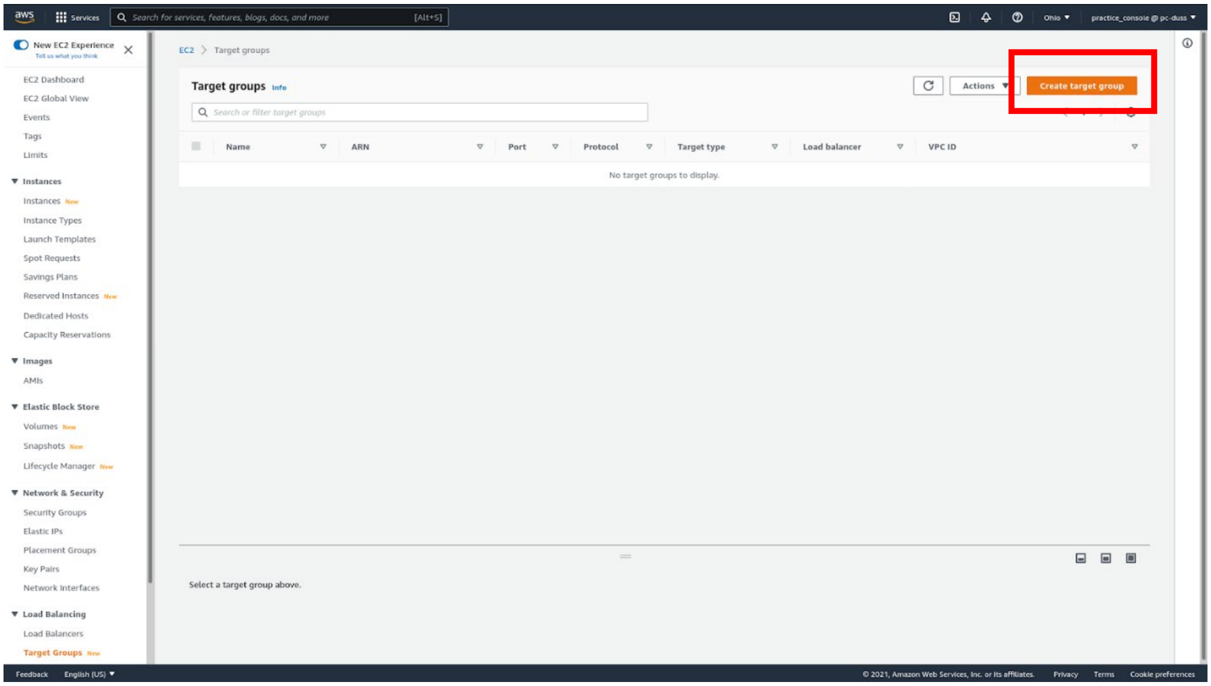
Now, let’s go back to Target Groups.

From the main EC2 console, in the sidebar, under **Load Balancing**, select **Target Groups**. If you can't see it, scroll down within the sidebar.



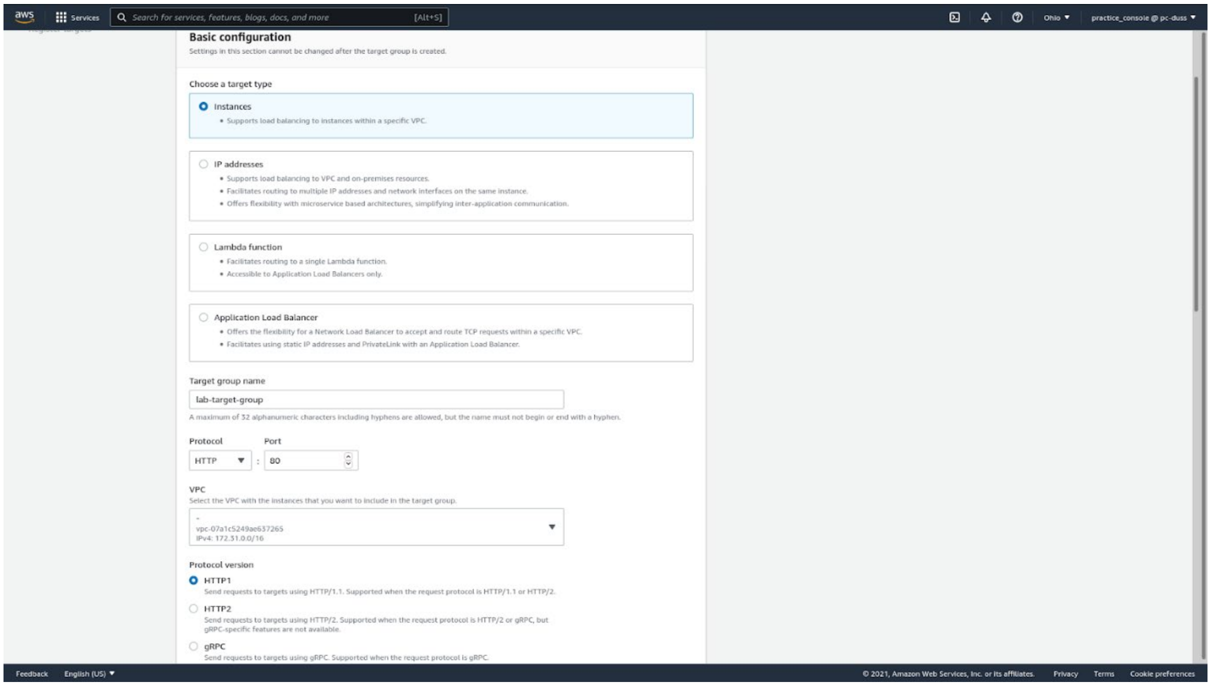
Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IPv4 ...	Elastic IP
–	i-0223fae4b64d59bce	Running	t2.micro	2/2 checks passed	No alarms	us-east-2c	ec2-3-133-82-242.us-e...	3.133.82.242	–
–	i-082292d20cbd76d7f	Running	t2.micro	2/2 checks passed	No alarms	us-east-2c	ec2-18-191-152-208.us...	18.191.152.208	–
–	i-08de0c49891c10835	Running	t2.micro	2/2 checks passed	No alarms	us-east-2c	ec2-18-223-28-222.us-...	18.223.28.222	–

Click **Create target group**.



Name	ARN	Port	Protocol	Target type	Load balancer	VPC ID
No target groups to display.						

Leave everything at default. Make sure the VPC is the one in which you want to place the load balancer. Give a name to your Target Group.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Basic configuration

Settings in this section cannot be changed after the target group is created.

Choose a target type

● Instances
- Supports load balancing to instances within a specific VPC.

○ IP addresses
- Supports load balancing to VPC and on-premises resources.
- Facilitates routing to multiple IP addresses and network interfaces on the same instance.
- Offers flexibility with microservice based architectures, simplifying inter-application communication.

○ Lambda function
- Facilitates routing to a single Lambda function.
- Accessible to Application Load Balancers only.

○ Application Load Balancer
- Offers the flexibility for a Network Load Balancer to accept and route TCP requests within a specific VPC.
- Facilitates using static IP addresses and PrivateLink with an Application Load Balancer.

Target group name: lab-target-group

A maximum of 32 alphanumeric characters including hyphens are allowed, but the name must not begin or end with a hyphen.

Protocol: HTTP ▼ : Port: 80

VPC

Select the VPC with the instances that you want to include in the target group.

-
vpc-07a1c5249ae637265
IPv4: 172.31.0.0/16

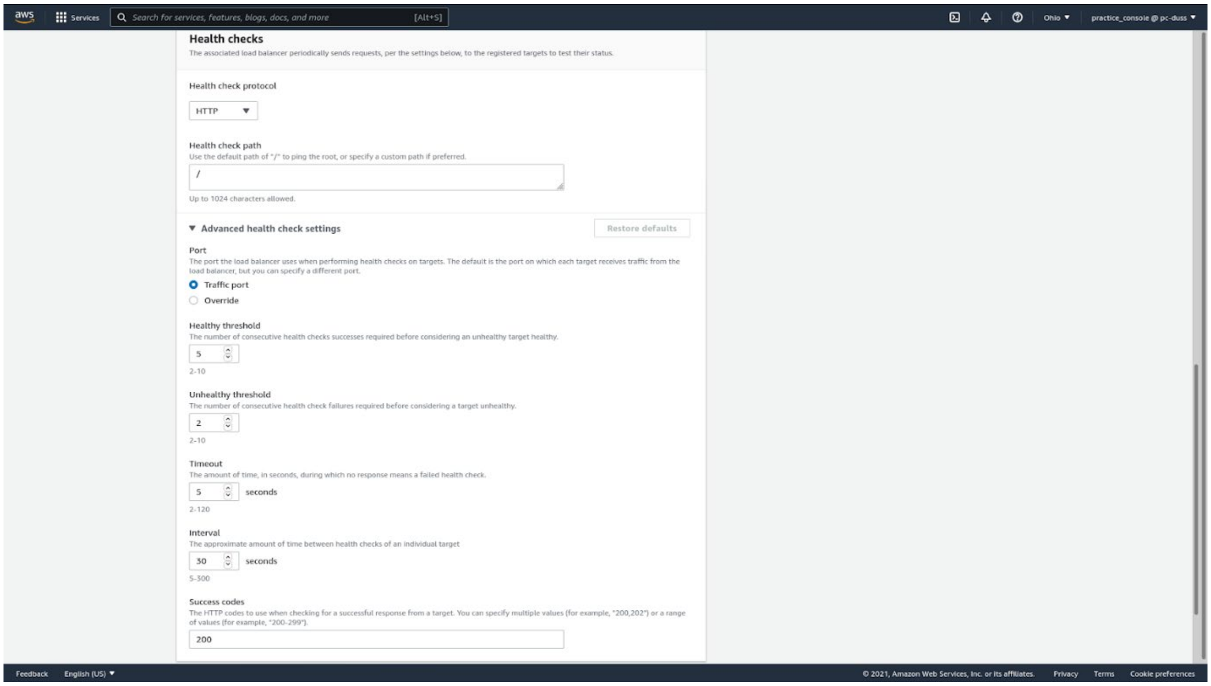
Protocol version

● HTTP1
Send requests to targets using HTTP/1.1. Supported when the request protocol is HTTP/1.1 or HTTP/2.

○ HTTP2
Send requests to targets using HTTP/2. Supported when the request protocol is HTTP/2 or gRPC, but gRPC-specific features are not available.

○ gRPC
Send requests to targets using gRPC. Supported when the request protocol is gRPC.

Click on **Advanced health check settings**. Leave everything at default but look at the sections and their values. This will help you understand how the health check system works to keep tabs on the status of your instances.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Health checks

The associated load balancer periodically sends requests, per the settings below, to the registered targets to test their status.

Health check protocol: HTTP ▼

Health check path

Use the default path of "/" to ping the root, or specify a custom path if preferred.

/

Up to 1024 characters allowed.

▼ Advanced health check settings

Port

The port the load balancer uses when performing health checks on targets. The default is the port on which each target receives traffic from the load balancer, but you can specify a different port.

● Traffic port
○ Override

Healthy threshold

The number of consecutive health checks successes required before considering an unhealthy target healthy.

5

2-10

Unhealthy threshold

The number of consecutive health check failures required before considering a target unhealthy.

2

2-10

Timeout

The amount of time, in seconds, during which no response means a failed health check.

5 seconds

2-120

Interval

The approximate amount of time between health checks of an individual target

30 seconds

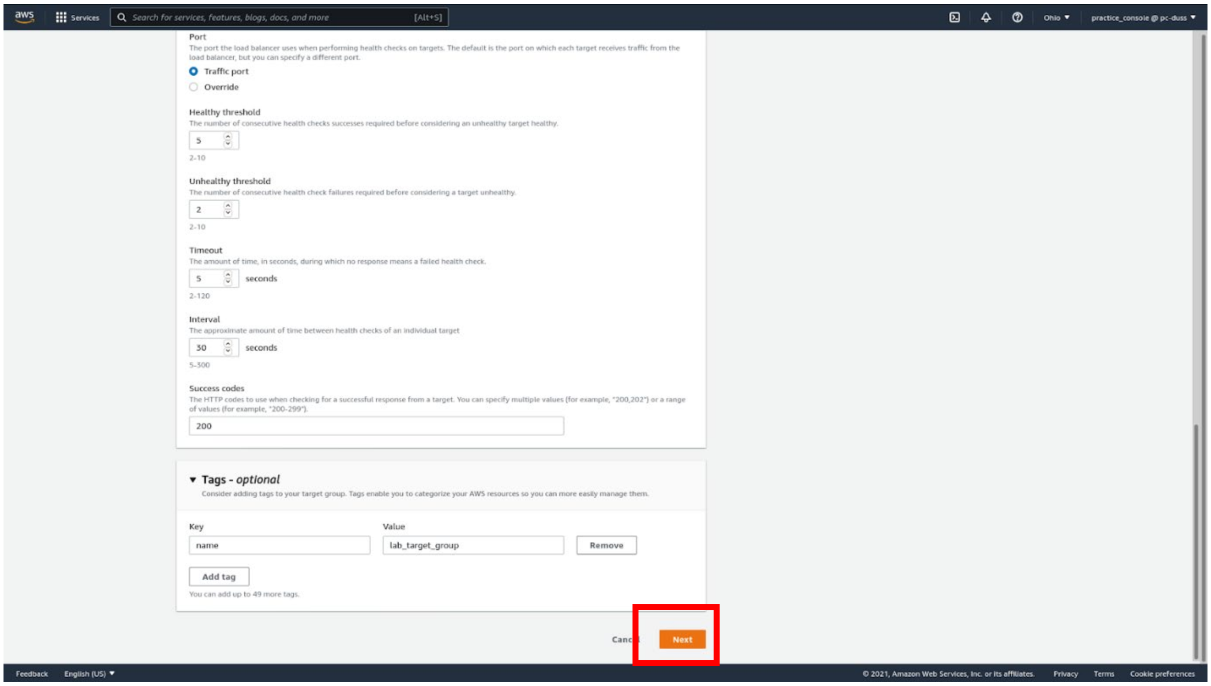
5-300

Success codes

The HTTP codes to use when checking for a successful response from a target. You can specify multiple values (for example, "200,202") or a range of values (for example, "200-299").

200

Add a name tag. Give it a value. Click **Next**.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Port
The port the load balancer uses when performing health checks on targets. The default is the port on which each target receives traffic from the load balancer, but you can specify a different port.

● Traffic port
○ Override

Healthy threshold
The number of consecutive health checks successes required before considering an unhealthy target healthy.
5
2-10

Unhealthy threshold
The number of consecutive health check failures required before considering a target unhealthy.
2
2-10

Timeout
The amount of time, in seconds, during which no response means a failed health check.
5 seconds
2-120

Interval
The approximate amount of time between health checks of an individual target
30 seconds
5-300

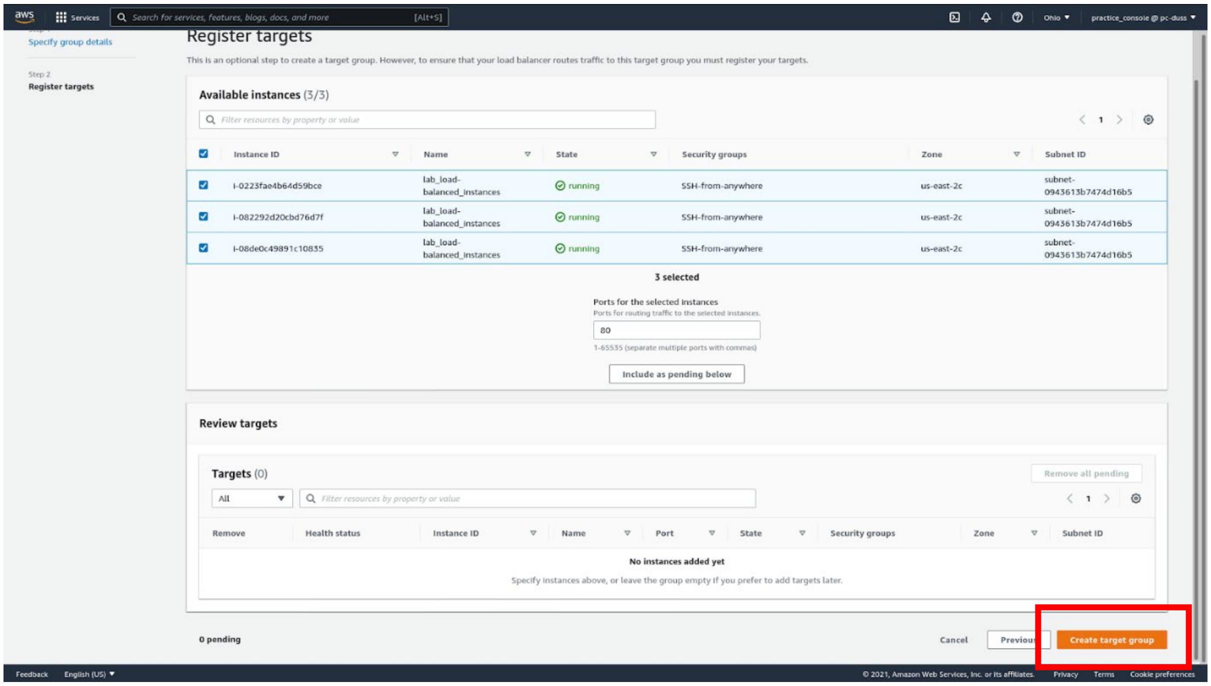
Success codes
The HTTP codes to use when checking for a successful response from a target. You can specify multiple values (for example, "200,202") or a range of values (for example, "200-299").
200

▼ Tags - *optional*
Consider adding tags to your target group. Tags enable you to categorize your AWS resources so you can more easily manage them.

Key	Value	
name	lab_target_group	Remove

Add tag
You can add up to 49 more tags.

Select the three instances created before and click **Include as pending below**. Click **Create target group**.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Specify group details
Step 2
Register targets

Register targets

This is an optional step to create a target group. However, to ensure that your load balancer routes traffic to this target group you must register your targets.

Available instances (3/3)

☑	Instance ID	Name	State	Security groups	Zone	Subnet ID
☑	i-0223fae4b64d59bce	lab_load-balanced_instances	✓ running	SSH-from-anywhere	us-east-2c	subnet-0943613b7474d16b5
☑	i-082292d20cbd76d7f	lab_load-balanced_instances	✓ running	SSH-from-anywhere	us-east-2c	subnet-0943613b7474d16b5
☑	i-08de0c49891c10835	lab_load-balanced_instances	✓ running	SSH-from-anywhere	us-east-2c	subnet-0943613b7474d16b5

3 selected

Ports for the selected instances
Ports for routing traffic to the selected instances.
80
1-65535 (separate multiple ports with commas)

Include as pending below

Review targets

Targets (0)

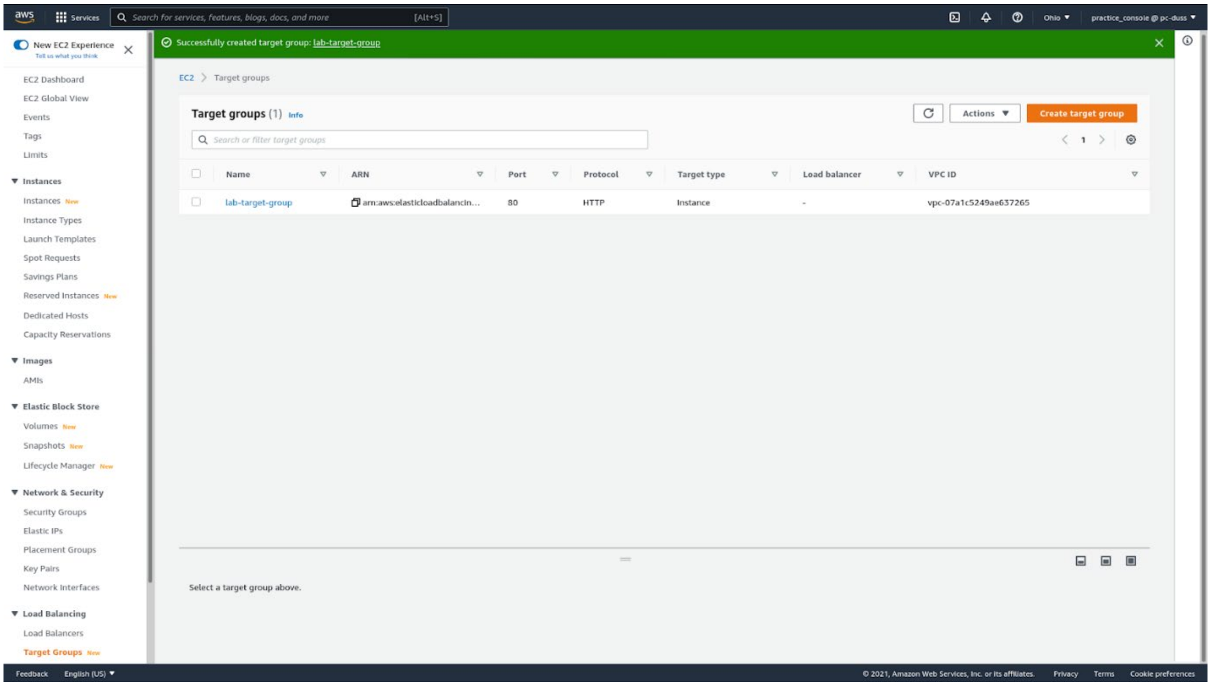
Remove all pending

Remove	Health status	Instance ID	Name	Port	State	Security groups	Zone	Subnet ID

No instances added yet
Specify instances above, or leave the group empty if you prefer to add targets later.

0 pending

You have successfully created your Target Group to be used by a load balancer.



Successfully created target group: lab-target-group

EC2 > Target groups

Target groups (1)

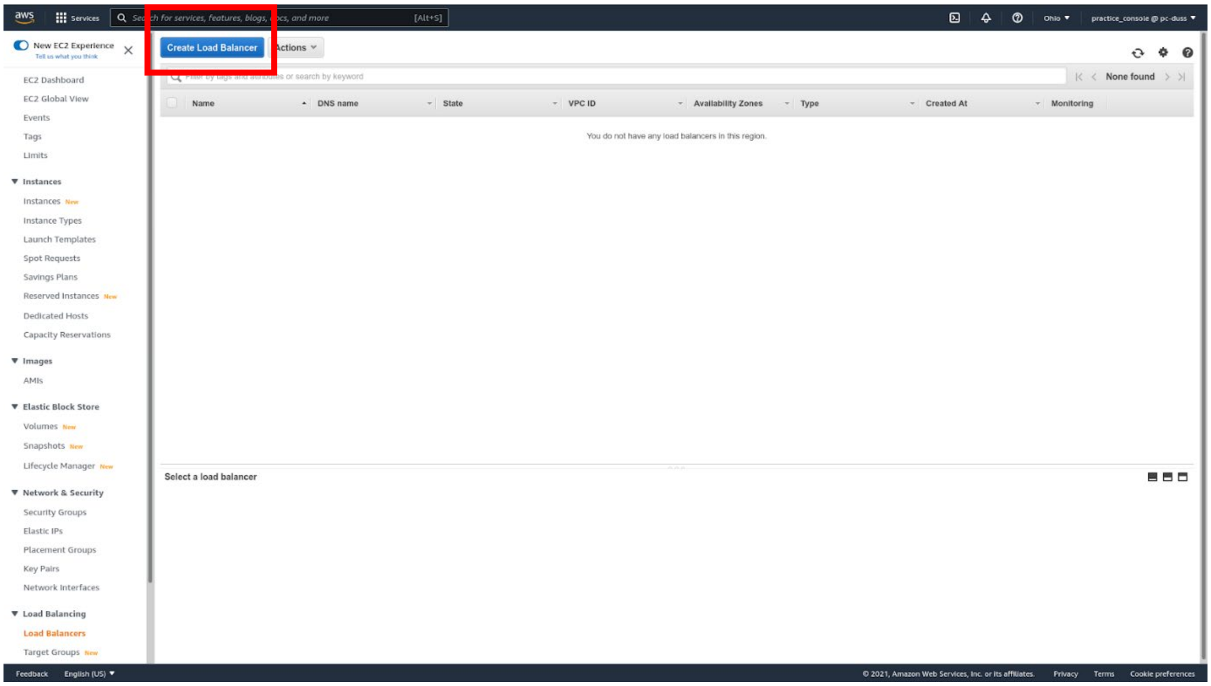
	Name	ARN	Port	Protocol	Target type	Load balancer	VPC ID
□	lab-target-group	arn:aws:elasticloadbalancin...	80	HTTP	Instance	-	vpc-07a1c5249ae637265

Select a target group above.

Creating the Application Load Balancer

Application load balancers provide intelligence based on Application layer logic in http/https protocols.

Select **Load Balancers** from the sidebar, just above Target Groups. Click **Create Load Balancer**.

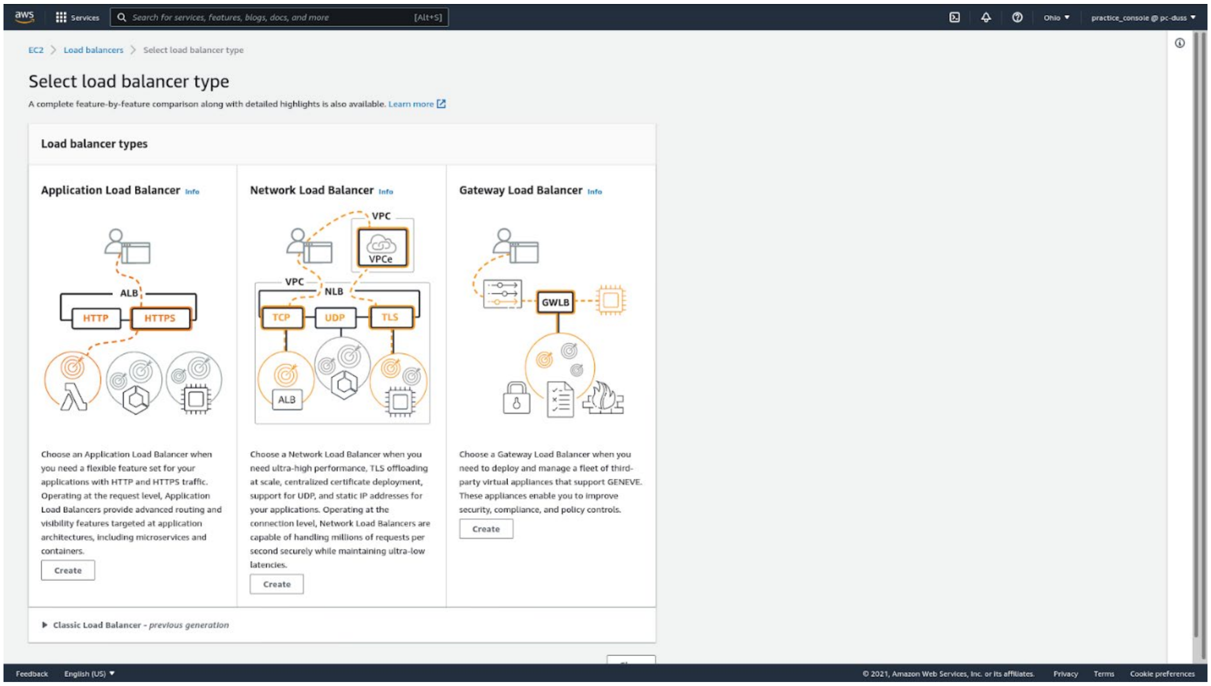


	Name	DNS name	State	VPC ID	Availability Zones	Type	Created At	Monitoring

You do not have any load balancers in this region.

Select a load balancer

Select **Create** in **Application Load Balancer**.



EC2 > Load balancers > Select load balancer type

Select load balancer type

A complete feature-by-feature comparison along with detailed highlights is also available. Learn more

Load balancer types

Application Load Balancer Info

Choose an Application Load Balancer when you need a flexible feature set for your applications with HTTP and HTTPS traffic. Operating at the request level, Application Load Balancers provide advanced routing and visibility features targeted at application architectures, including microservices and containers.

Create

Network Load Balancer Info

Choose a Network Load Balancer when you need ultra-high performance, TLS offloading at scale, centralized certificate deployment, support for UDP, and static IP addresses for your applications. Operating at the connection level, Network Load Balancers are capable of handling millions of requests per second securely while maintaining ultra-low latencies.

Create

Gateway Load Balancer Info

Choose a Gateway Load Balancer when you need to deploy and manage a fleet of third-party virtual appliances that support GENEVE. These appliances enable you to improve security, compliance, and policy controls.

Create

▶ Classic Load Balancer - *previous generation*

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TLS
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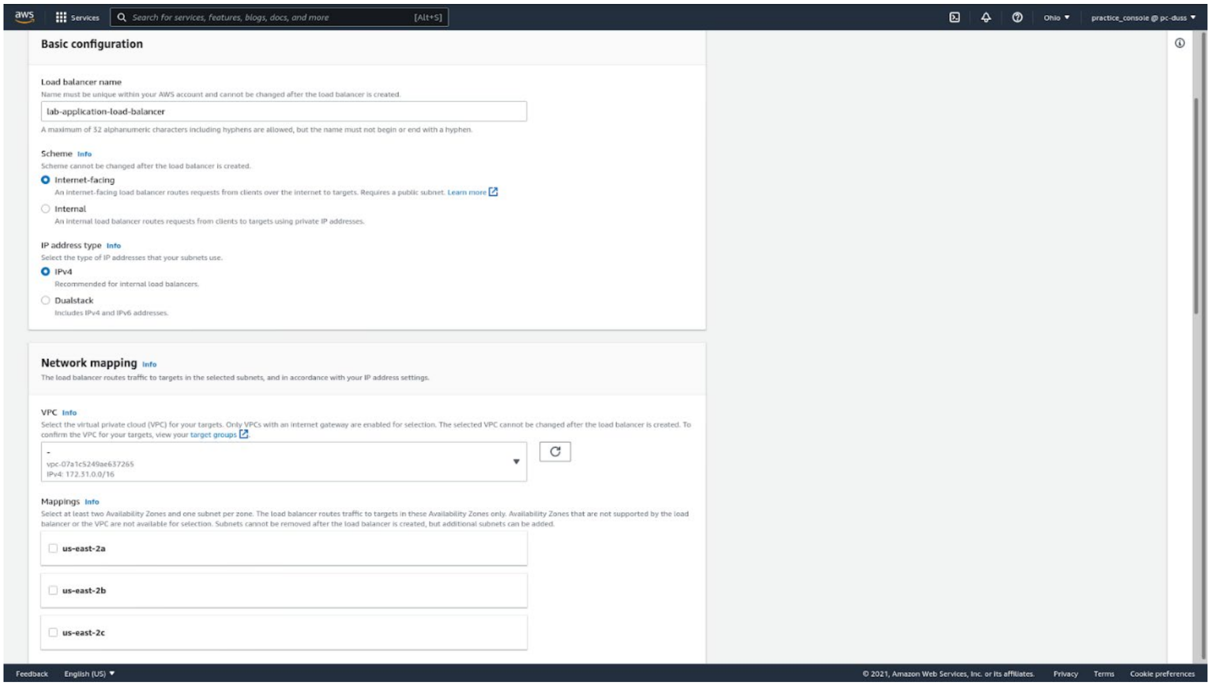
Give a name to your application load balancer. Leave the rest of Basic Configuration at their default.



Basic configuration

Load balancer name

Name must be unique within your AWS account and cannot be changed after the load balancer is created.

lab-application-load-balancer

A maximum of 32 alphanumeric characters including hyphens are allowed, but the name must not begin or end with a hyphen.

Scheme Info

Scheme cannot be changed after the load balancer is created.

● Internet-facing

An internet-facing load balancer routes requests from clients over the internet to targets. Requires a public subnet. Learn more

○ Internal

An internal load balancer routes requests from clients to targets using private IP addresses.

IP address type Info

Select the type of IP addresses that your subnets use.

● IPv4

Recommended for internal load balancers.

○ Dualstack

Includes IPv4 and IPv6 addresses.

Network mapping Info

The load balancer routes traffic to targets in the selected subnets, and in accordance with your IP address settings.

VPC Info

Select the virtual private cloud (VPC) for your targets. Only VPCs with an internet gateway are enabled for selection. The selected VPC cannot be changed after the load balancer is created. To confirm the VPC for your targets, view your target groups.

-
vpc-07a1c5249ae637265
IPv4: 172.31.0.0/16

Mappings Info

Select at least two Availability Zones and one subnet per zone. The load balancer routes traffic to targets in these Availability Zones only. Availability Zones that are not supported by the load balancer or the VPC are not available for selection. Subnets cannot be removed after the load balancer is created, but additional subnets can be added.

□ us-east-2a

□ us-east-2b

□ us-east-2c

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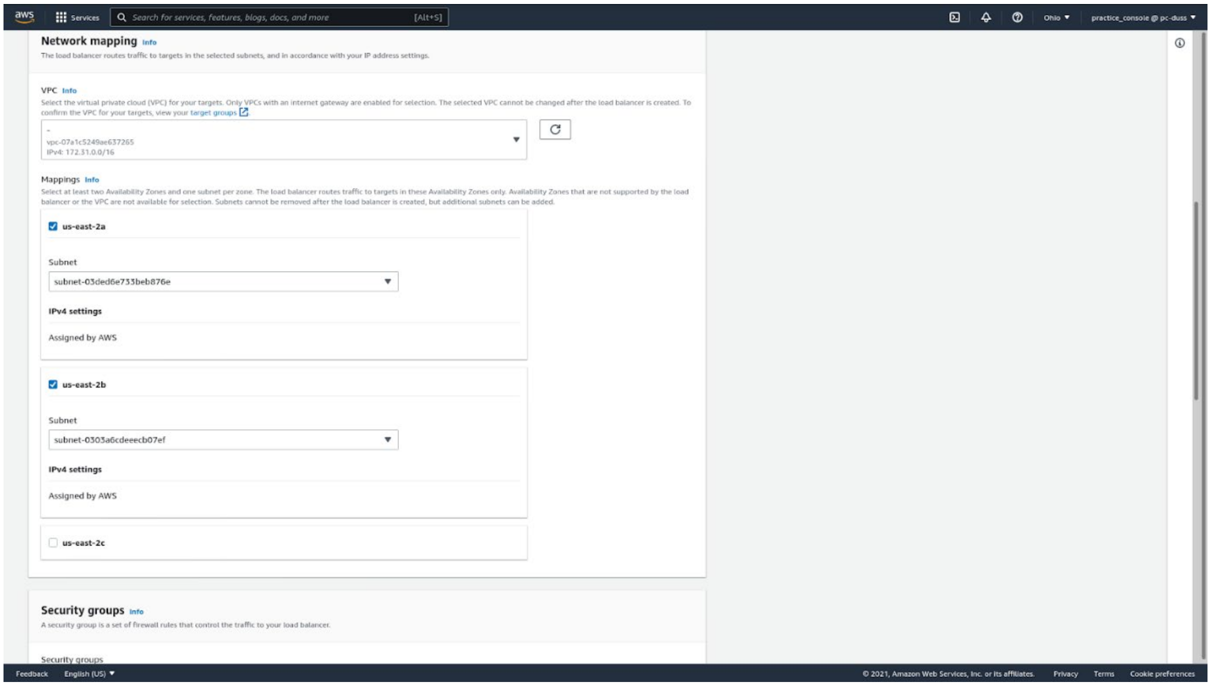
In Network mapping, make sure you have selected the desired VPC. Select two Availability Zones (AZ) of your choice for this VPC. Then select a subnet for each AZ.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Network mapping Info

The load balancer routes traffic to targets in the selected subnets, and in accordance with your IP address settings.

VPC Info

Select the virtual private cloud (VPC) for your targets. Only VPCs with an internet gateway are enabled for selection. The selected VPC cannot be changed after the load balancer is created. To confirm the VPC for your targets, view your target groups.

-
vpc-07a1c5249ae637265
IPv4: 172.31.0.0/16

Mappings Info

Select at least two Availability Zones and one subnet per zone. The load balancer routes traffic to targets in these Availability Zones only. Availability Zones that are not supported by the load balancer or the VPC are not available for selection. Subnets cannot be removed after the load balancer is created, but additional subnets can be added.

☑ us-east-2a

Subnet: subnet-03ded6e733beb876e

IPv4 settings: Assigned by AWS

☑ us-east-2b

Subnet: subnet-0303a6cdeeecb07ef

IPv4 settings: Assigned by AWS

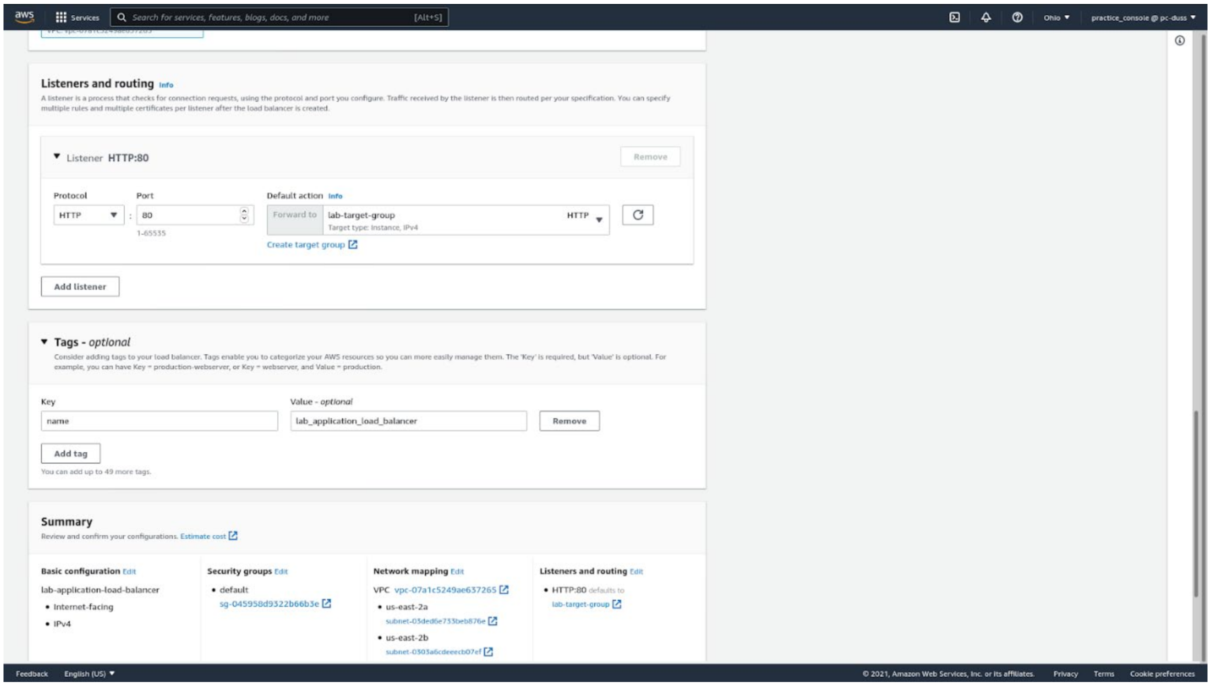
□ us-east-2c

Security groups Info

A security group is a set of firewall rules that control the traffic to your load balancer.

Security groups

Leave Listener to http at port 80. Select your target group from just before.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Add listener
Add tag
Remove
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Listeners and routing Info

A listener is a process that checks for connection requests, using the protocol and port you configure. Traffic received by the listener is then routed per your specification. You can specify multiple rules and multiple certificates per listener after the load balancer is created.

▼ Listener HTTP:80

Protocol: HTTP

Port: 80 (1-65535)

Default action Info: Forward to lab-target-group HTTP
Target type: Instance, IPv4

Create target group

▼ Tags - *optional*

Consider adding tags to your load balancer. Tags enable you to categorize your AWS resources so you can more easily manage them. The 'Key' is required, but 'Value' is optional. For example, you can have Key = production-webserver, or Key = webserver, and Value = production.

Key: name

Value - *optional*: lab_application_load_balancer

You can add up to 49 more tags.

Summary

Review and confirm your configurations. Estimate cost

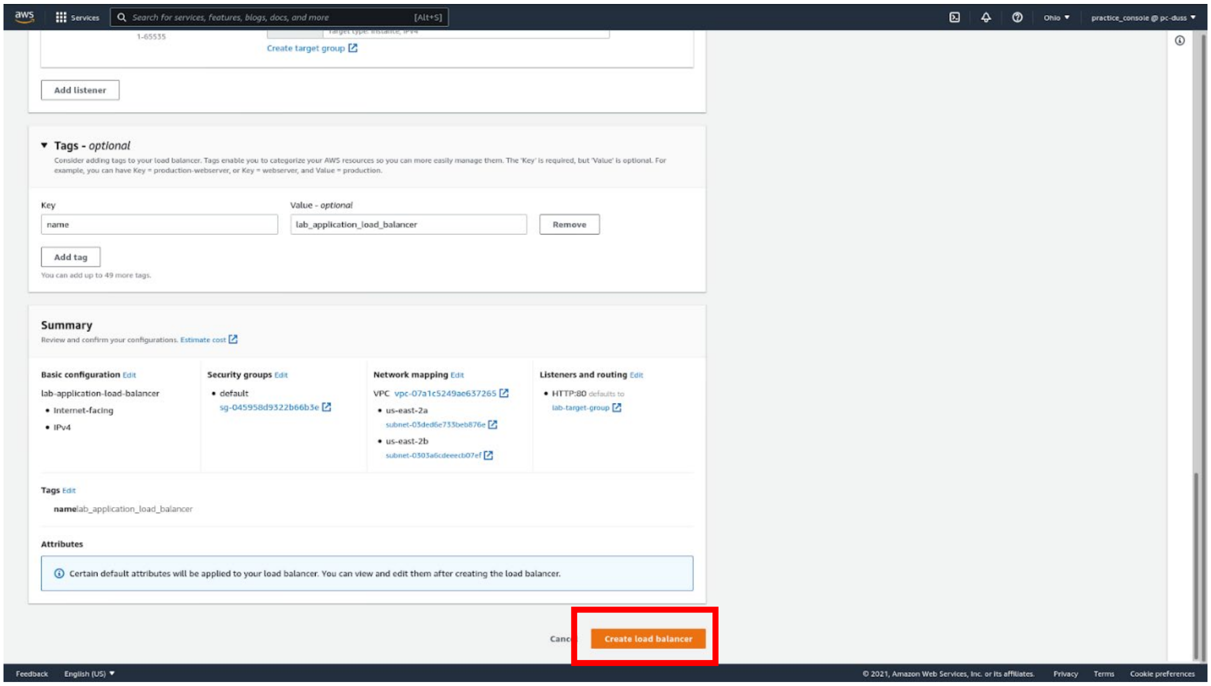
Basic configuration Edit
lab-application-load-balancer
- Internet-facing
- IPv4

Security groups Edit
- default
  sg-045958d9322b66b3e

Network mapping Edit
VPC vpc-07a1c5249ae637265
- us-east-2a
  subnet-03ded6e733beb876e
- us-east-2b
  subnet-0303a6cdeeecb07ef

Listeners and routing Edit
- HTTP:80 defaults to
  lab-target-group

Add a name tag. Give it a value. Click **Create load balancer**.



Tags - *optional*

Consider adding tags to your load balancer. Tags enable you to categorize your AWS resources so you can more easily manage them. The 'Key' is required, but 'Value' is optional. For example, you can have Key = production-webserver, or Key = webserver, and Value = production.

Key: name

Value - *optional*: lab_application_load_balancer

You can add up to 49 more tags.

Summary

Review and confirm your configurations.

Basic configuration
lab-application-load-balancer
- Internet-facing
- IPv4

Security groups
- default
  sg-045958d9322b66b3e

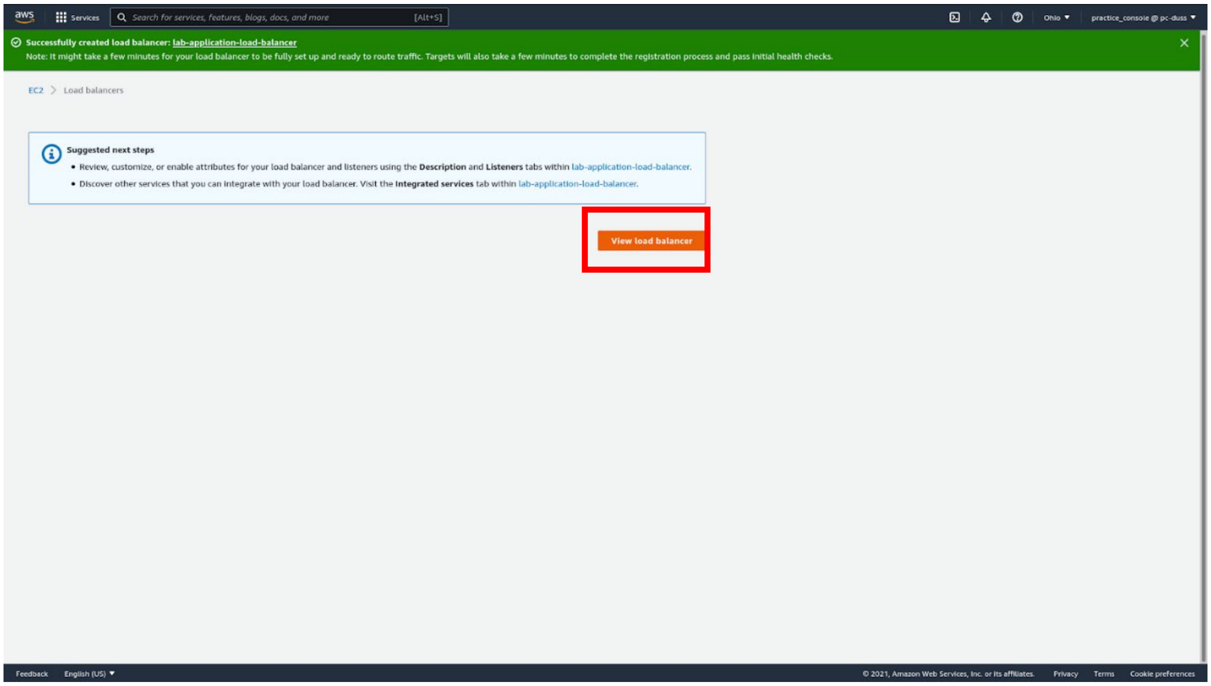
Network mapping
VPC vpc-07a1c5249ae637265
- us-east-2a
  subnet-03ded6e733beb876e
- us-east-2b
  subnet-0303a6cdeeecb07ef

Listeners and routing
- HTTP:80 defaults to lab-target-group

Tags
namelab_application_load_balancer

Attributes
Certain default attributes will be applied to your load balancer. You can view and edit them after creating the load balancer.

You have successfully created your first application load balancer. Click **View load balancer** to return to the dashboard.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EC2 > Load balancers
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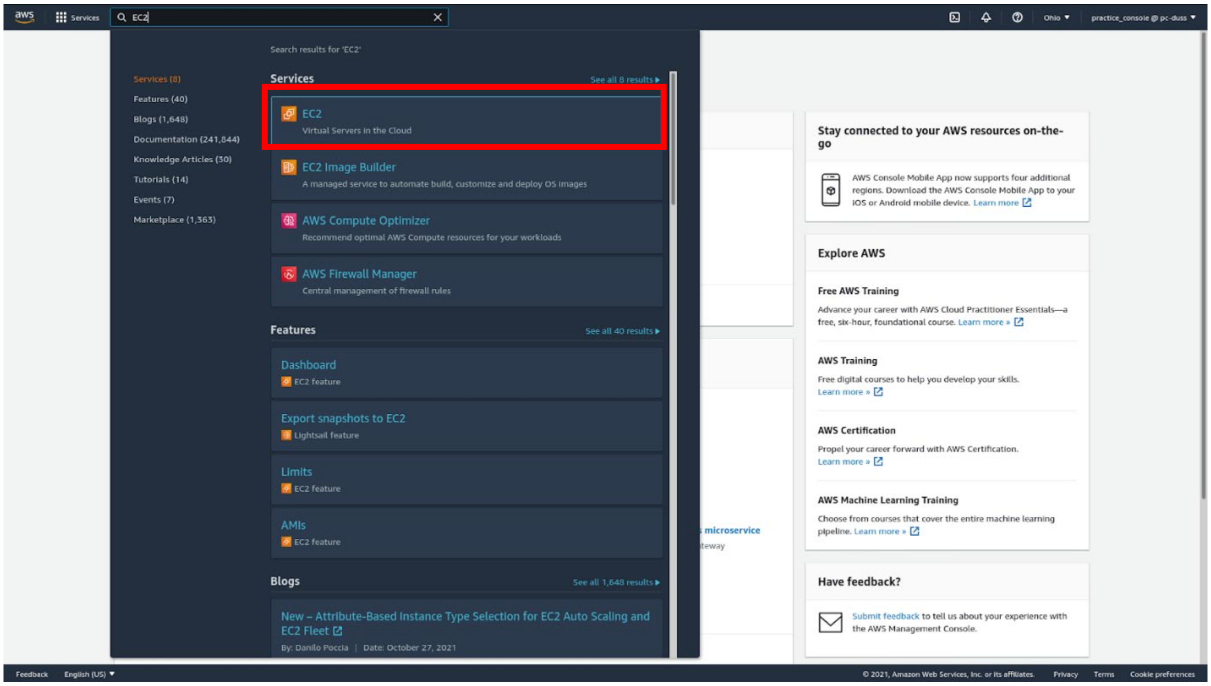
Successfully created load balancer: lab-application-load-balancer
Note: It might take a few minutes for your load balancer to be fully set up and ready to route traffic. Targets will also take a few minutes to complete the registration process and pass initial health checks.

Suggested next steps
- Review, customize, or enable attributes for your load balancer and listeners using the **Description** and **Listeners** tabs within lab-application-load-balancer.
- Discover other services that you can integrate with your load balancer. Visit the **Integrated services** tab within lab-application-load-balancer.

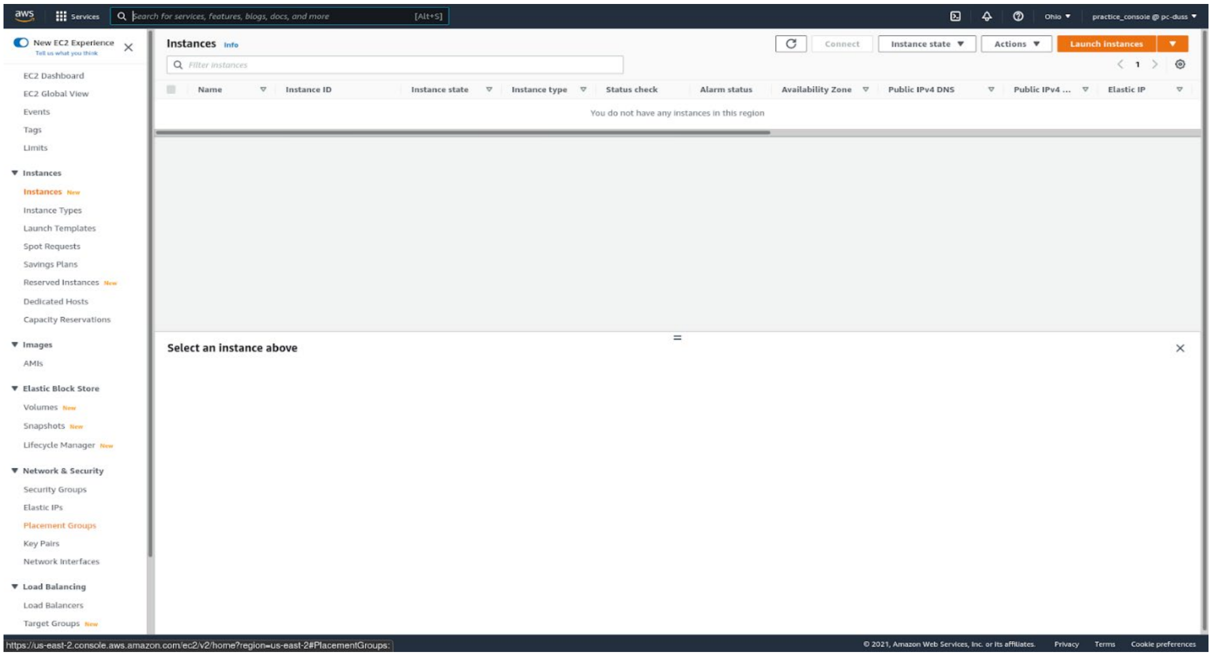
Lab: Create a Cluster Placement Group

In this lab, we will set up a cluster placement group. Then we will place some virtual machines into the cluster placement group.

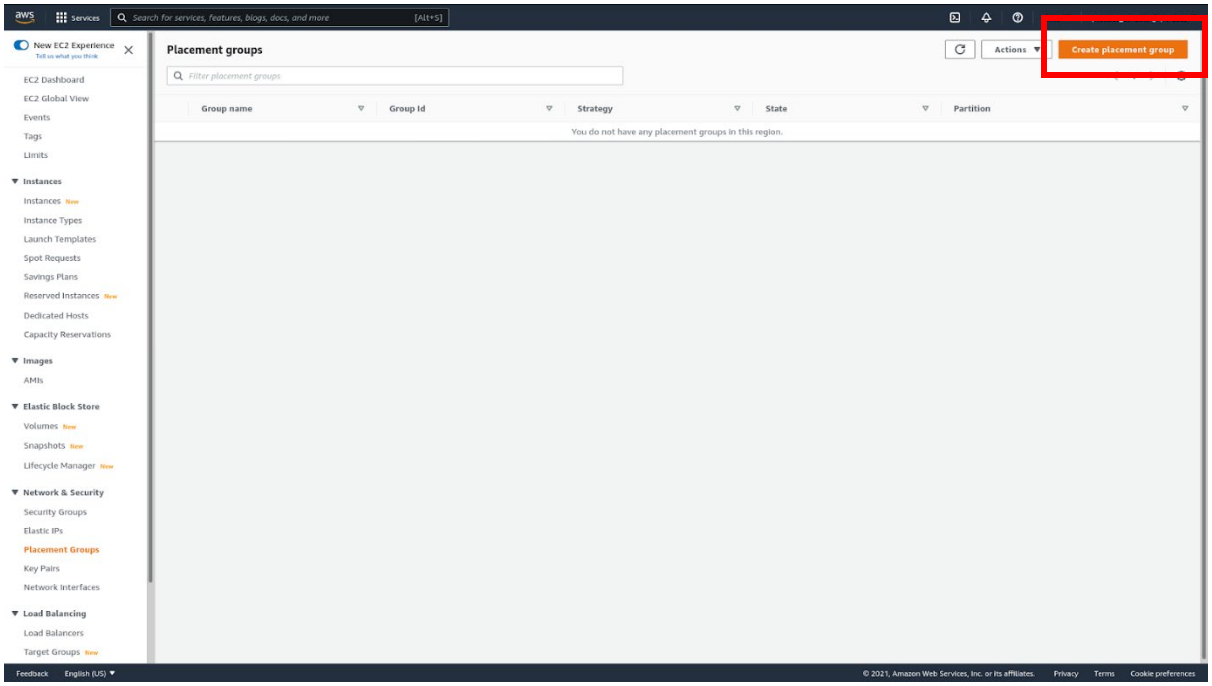
From the management console, start by navigating to the **EC2 console**.


EC2
Search results for 'EC2'
Services (8)
Features (40)
Blogs (1,648)
Documentation (241,844)
Knowledge Articles (30)
Tutorials (14)
Events (7)
Marketplace (1,363)
Services
See all 8 results
EC2
Virtual Servers in the Cloud
EC2 Image Builder
A managed service to automate build, customize and deploy OS images
AWS Compute Optimizer
Recommend optimal AWS Compute resources for your workloads
AWS Firewall Manager
Central management of firewall rules
Features
See all 40 results
Dashboard
EC2 feature
Export snapshots to EC2
Lightsail feature
Limits
EC2 feature
AMIs
EC2 feature
Blogs
See all 1,648 results
New – Attribute-Based Instance Type Selection for EC2 Auto Scaling and EC2 Fleet
By: Danilo Poccia | Date: October 27, 2021
Stay connected to your AWS resources on-the-go
AWS Console Mobile App now supports four additional regions. Download the AWS Console Mobile App to your iOS or Android mobile device. Learn more
Explore AWS
Free AWS Training
Advance your career with AWS Cloud Practitioner Essentials—a free, six-hour, foundational course. Learn more »
AWS Training
Free digital courses to help you develop your skills. Learn more »
AWS Certification
Propel your career forward with AWS Certification. Learn more »
AWS Machine Learning Training
Choose from courses that cover the entire machine learning pipeline. Learn more »
Have feedback?
Submit feedback to tell us about your experience with the AWS Management Console.
Ohio
practice_console @ pc-duss
Feedback
English (US)
© 2021, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms
Cookie preferences

In the sidebar on the left, scroll down and locate **Placement Groups**.



Click on **Create placement group**.

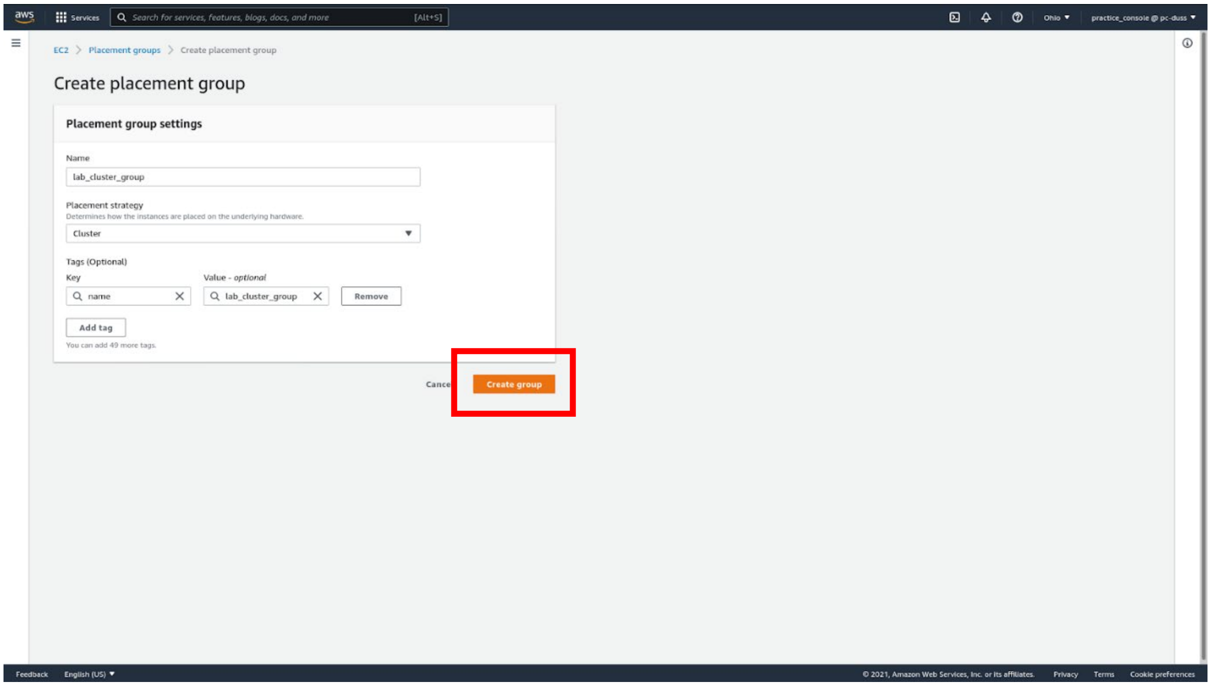


Placement groups

Group name	Group Id	Strategy	State	Partition

You do not have any placement groups in this region.

Choose a name for your cluster placement group. In **Placement strategy**, select **Cluster**. Add a name tag for your new group and give it a value. Click **Create group**.



Create placement group

Placement group settings

Name: lab_cluster_group

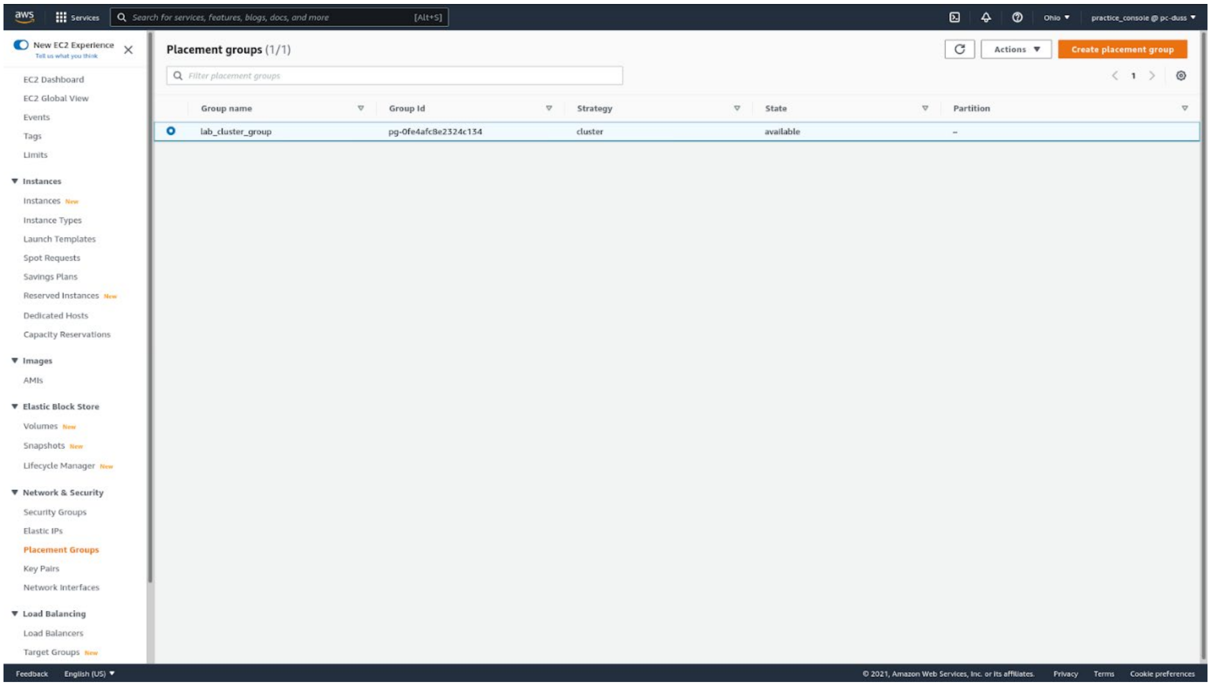
Placement strategy
Determines how the instances are placed on the underlying hardware.
Cluster

Tags (Optional)

Key	Value - *optional*
name	lab_cluster_group

You can add 49 more tags.

And there you go, you have successfully created your first cluster placement group.

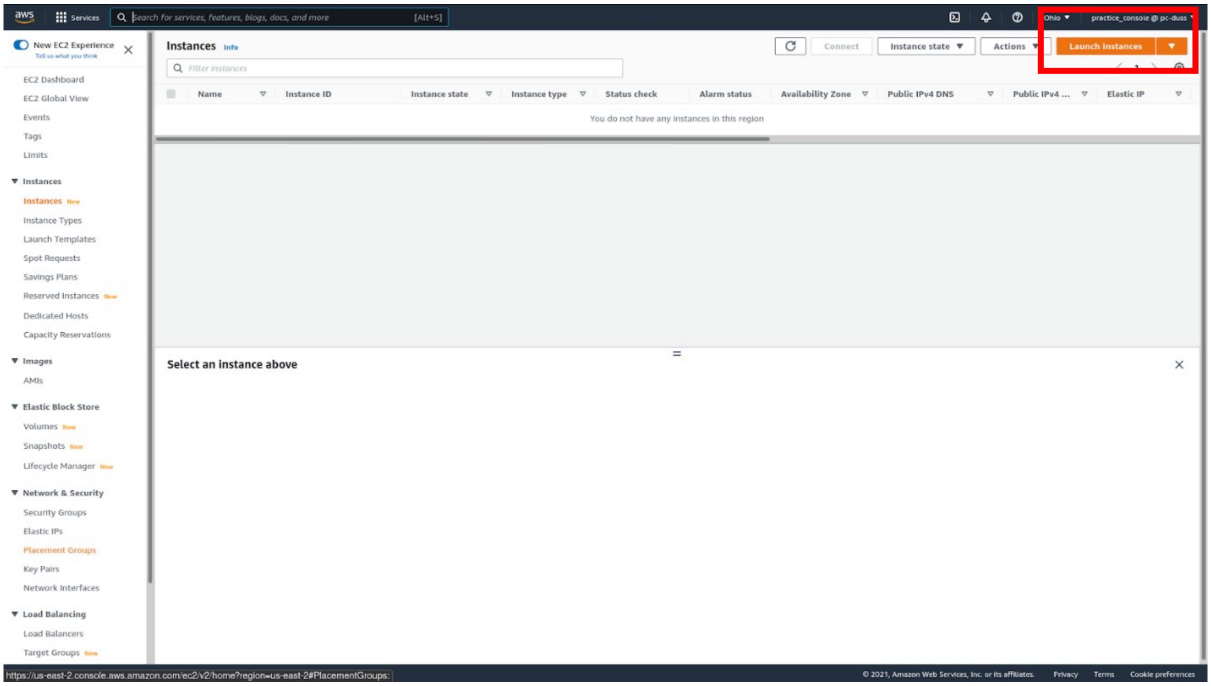


Placement groups (1/1)

	Group name	Group Id	Strategy	State	Partition
●	lab_cluster_group	pg-0fe4afc8e2324c134	cluster	available	–

Next, we put the virtual machines into the cluster placement group

Navigate to the **Instances** subsection of the EC2 console.

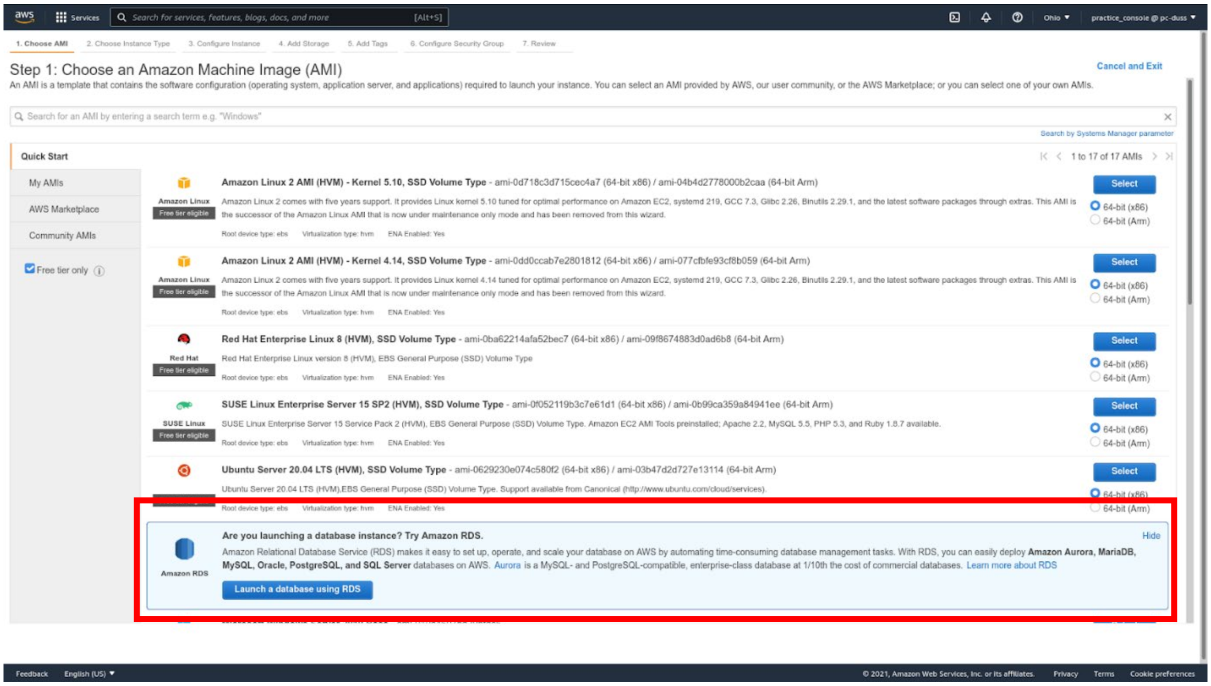


□	Name	Instance ID	Instance state	Instance type	Status check	Alarm status	Availability Zone	Public IPv4 DNS	Public IPv4 ...	Elastic IP

You do not have any instances in this region

Select an instance above

Select the **Amazon Linux** image.



Step 1: Choose an Amazon Machine Image (AMI)

An AMI is a template that contains the software configuration (operating system, application server, and applications) required to launch your instance. You can select an AMI provided by AWS, our user community, or the AWS Marketplace; or you can select one of your own AMIs.

Search for an AMI by entering a search term e.g. "Windows"

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type - ami-0d718c3d715cec4a7 (64-bit x86) / ami-04b4d2778000b2caa (64-bit Arm)

Amazon Linux 2 comes with five years support. It provides Linux kernel 5.10 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is now under maintenance only mode and has been removed from this wizard.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

Amazon Linux 2 AMI (HVM) - Kernel 4.14, SSD Volume Type - ami-0dd0ccab7e2801812 (64-bit x86) / ami-077cfbfe93cf8b059 (64-bit Arm)

Amazon Linux 2 comes with five years support. It provides Linux kernel 4.14 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is now under maintenance only mode and has been removed from this wizard.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

Red Hat Enterprise Linux 8 (HVM), SSD Volume Type - ami-0ba62214afa52bec7 (64-bit x86) / ami-09f8674883d0ad6b8 (64-bit Arm)

Red Hat Enterprise Linux version 8 (HVM), EBS General Purpose (SSD) Volume Type

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

SUSE Linux Enterprise Server 15 SP2 (HVM), SSD Volume Type - ami-0f052119b3c7e61d1 (64-bit x86) / ami-0b99ca359a84941ee (64-bit Arm)

SUSE Linux Enterprise Server 15 Service Pack 2 (HVM), EBS General Purpose (SSD) Volume Type. Amazon EC2 AMI Tools preinstalled; Apache 2.2, MySQL 5.5, PHP 5.3, and Ruby 1.8.7 available.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

Ubuntu Server 20.04 LTS (HVM), SSD Volume Type - ami-0629230e074c580f2 (64-bit x86) / ami-03b47d2d727e13114 (64-bit Arm)

Ubuntu Server 20.04 LTS (HVM),EBS General Purpose (SSD) Volume Type. Support available from Canonical (http://www.ubuntu.com/cloud/services).

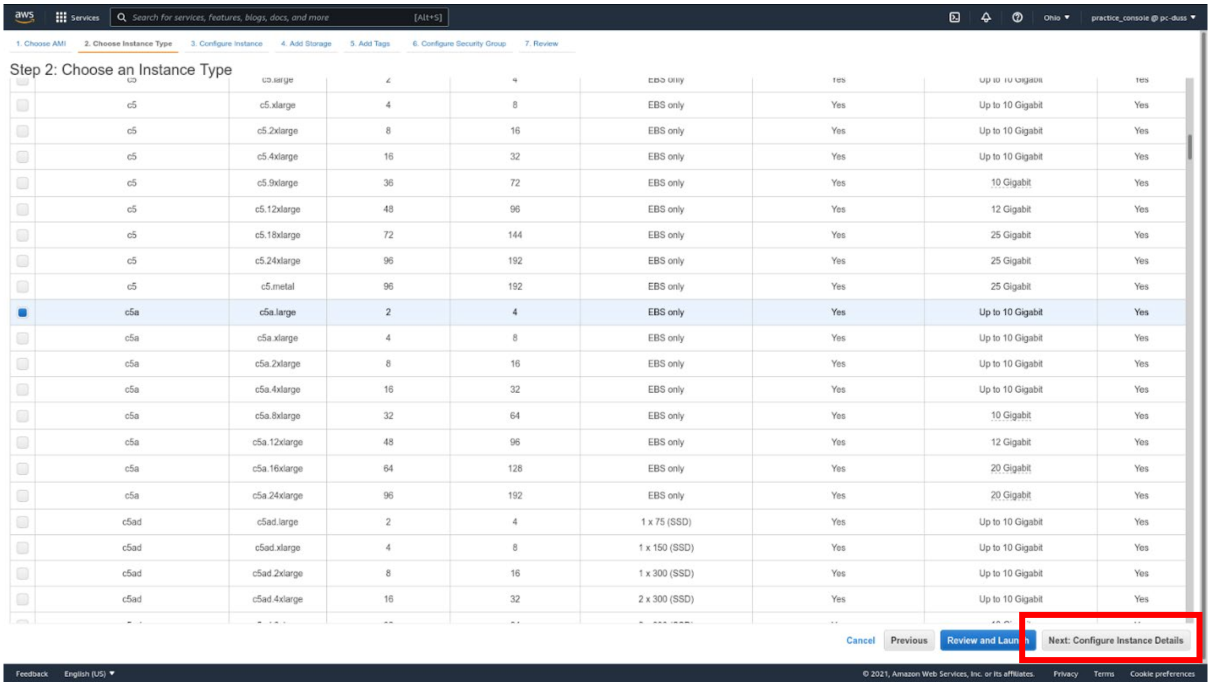
Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

● 64-bit (x86) ○ 64-bit (Arm)

Are you launching a database instance? Try Amazon RDS.

Amazon Relational Database Service (RDS) makes it easy to set up, operate, and scale your database on AWS by automating time-consuming database management tasks. With RDS, you can easily deploy **Amazon Aurora, MariaDB, MySQL, Oracle, PostgreSQL, and SQL Server** databases on AWS. Aurora is a MySQL- and PostgreSQL-compatible, enterprise-class database at 1/10th the cost of commercial databases. Learn more about RDS

Select the **c5a.large** instance type. This is the least expensive instance type that supports cluster placement groups. You can delete as soon as the lab is over to save on costs. Click **Next: Configure Instance Details**.


aws
Services
Search for services, features, blogs, docs, and more [Alt+S]
Ohio ▼
practice_console @ pc-duss ▼
1. Choose AMI
2. Choose Instance Type
3. Configure Instance
4. Add Storage
5. Add Tags
6. Configure Security Group
7. Review
Cancel
Previous
Review and Launch
Next: Configure Instance Details
Feedback
English (US) ▼
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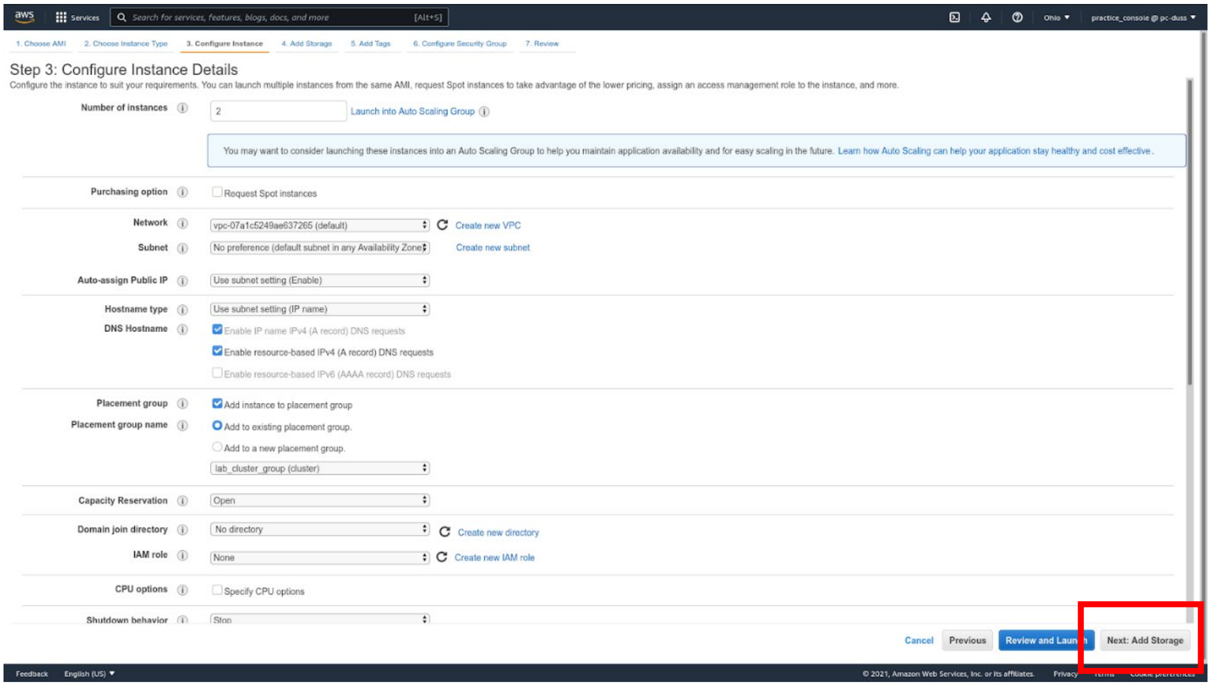
Terms
Cookie preferences

Step 2: Choose an Instance Type

□	c5	c5.large	2	4	EBS only	Yes	Up to 10 Gigabit	Yes
□	c5	c5.xlarge	4	8	EBS only	Yes	Up to 10 Gigabit	Yes
□	c5	c5.2xlarge	8	16	EBS only	Yes	Up to 10 Gigabit	Yes
□	c5	c5.4xlarge	16	32	EBS only	Yes	Up to 10 Gigabit	Yes
□	c5	c5.9xlarge	36	72	EBS only	Yes	10 Gigabit	Yes
□	c5	c5.12xlarge	48	96	EBS only	Yes	12 Gigabit	Yes
□	c5	c5.18xlarge	72	144	EBS only	Yes	25 Gigabit	Yes
□	c5	c5.24xlarge	96	192	EBS only	Yes	25 Gigabit	Yes
□	c5	c5.metal	96	192	EBS only	Yes	25 Gigabit	Yes
■	c5a	c5a.large	2	4	EBS only	Yes	Up to 10 Gigabit	Yes
□	c5a	c5a.xlarge	4	8	EBS only	Yes	Up to 10 Gigabit	Yes
□	c5a	c5a.2xlarge	8	16	EBS only	Yes	Up to 10 Gigabit	Yes
□	c5a	c5a.4xlarge	16	32	EBS only	Yes	Up to 10 Gigabit	Yes
□	c5a	c5a.8xlarge	32	64	EBS only	Yes	10 Gigabit	Yes
□	c5a	c5a.12xlarge	48	96	EBS only	Yes	12 Gigabit	Yes
□	c5a	c5a.16xlarge	64	128	EBS only	Yes	20 Gigabit	Yes
□	c5a	c5a.24xlarge	96	192	EBS only	Yes	20 Gigabit	Yes
□	c5ad	c5ad.large	2	4	1 x 75 (SSD)	Yes	Up to 10 Gigabit	Yes
□	c5ad	c5ad.xlarge	4	8	1 x 150 (SSD)	Yes	Up to 10 Gigabit	Yes
□	c5ad	c5ad.2xlarge	8	16	1 x 300 (SSD)	Yes	Up to 10 Gigabit	Yes
□	c5ad	c5ad.4xlarge	16	32	2 x 300 (SSD)	Yes	Up to 10 Gigabit	Yes

In **Number of instances**, enter 2. In **Placement group**, tick **Add instance to placement group**. In **Placement group name**, select the placement group you created just previously. Click **Next: Add Storage**.



Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing, assign an access management role to the instance, and more.

Number of instances: 2 — Launch into Auto Scaling Group

You may want to consider launching these instances into an Auto Scaling Group to help you maintain application availability and for easy scaling in the future. Learn how Auto Scaling can help your application stay healthy and cost effective.

Purchasing option: □ Request Spot instances

Network: vpc-07a1c5249ae637265 (default) — Create new VPC

Subnet: No preference (default subnet in any Availability Zone) — Create new subnet

Auto-assign Public IP: Use subnet setting (Enable)

Hostname type: Use subnet setting (IP name)

DNS Hostname:
☑ Enable IP name IPv4 (A record) DNS requests
☑ Enable resource-based IPv4 (A record) DNS requests
□ Enable resource-based IPv6 (AAAA record) DNS requests

Placement group: ☑ Add instance to placement group

Placement group name:
● Add to existing placement group.
○ Add to a new placement group.
lab_cluster_group (cluster)

Capacity Reservation: Open

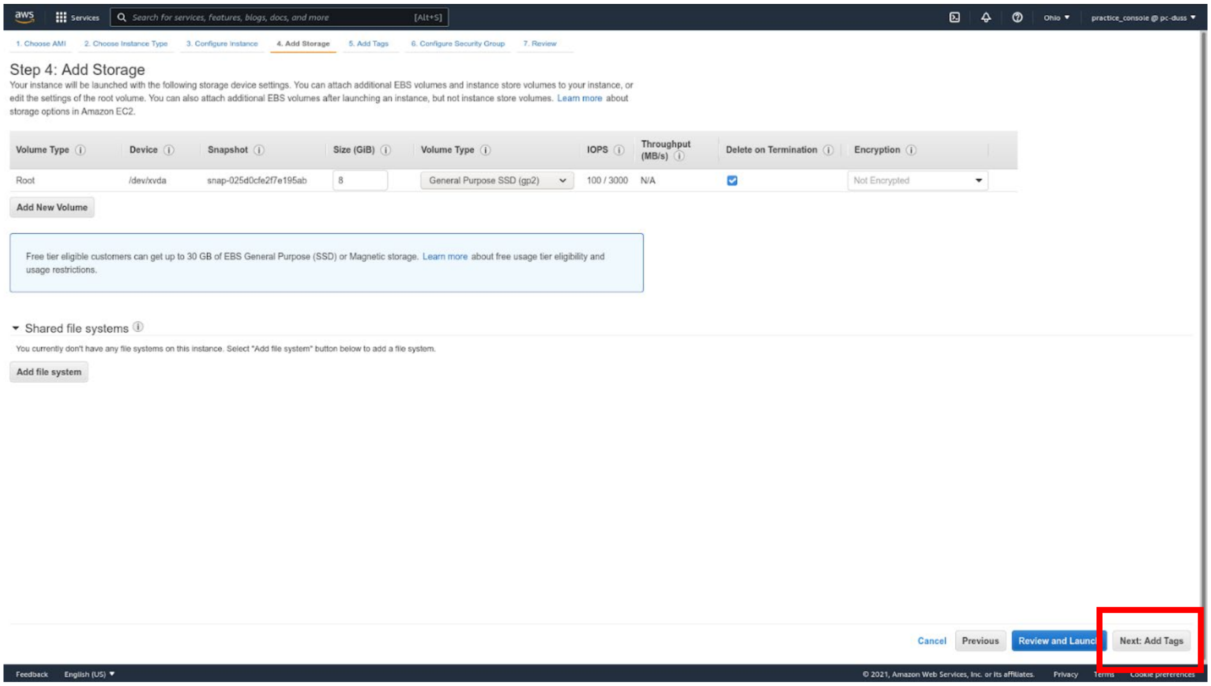
Domain join directory: No directory — Create new directory

IAM role: None — Create new IAM role

CPU options: □ Specify CPU options

Shutdown behavior: Stop

Click **Next: Add Tags**.



Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance, or edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. Learn more about storage options in Amazon EC2.

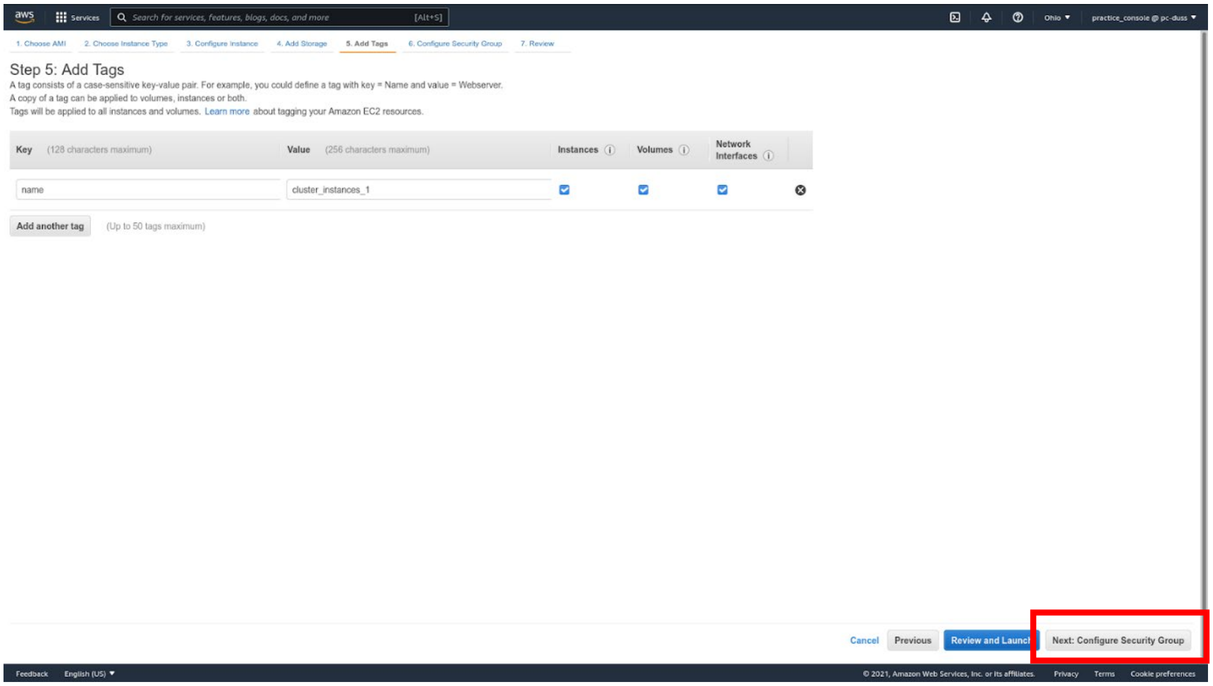
Volume Type	Device	Snapshot	Size (GiB)	Volume Type	IOPS	Throughput (MB/s)	Delete on Termination	Encryption
Root	/dev/xvda	snap-025d0cfe2f7e195ab	8	General Purpose SSD (gp2)	100 / 3000	N/A	☑	Not Encrypted

Free tier eligible customers can get up to 30 GB of EBS General Purpose (SSD) or Magnetic storage. Learn more about free usage tier eligibility and usage restrictions.

Shared file systems

You currently don't have any file systems on this instance. Select "Add file system" button below to add a file system.

Add a name tag. Give it a value. Click **Next: Configure Security Group**.

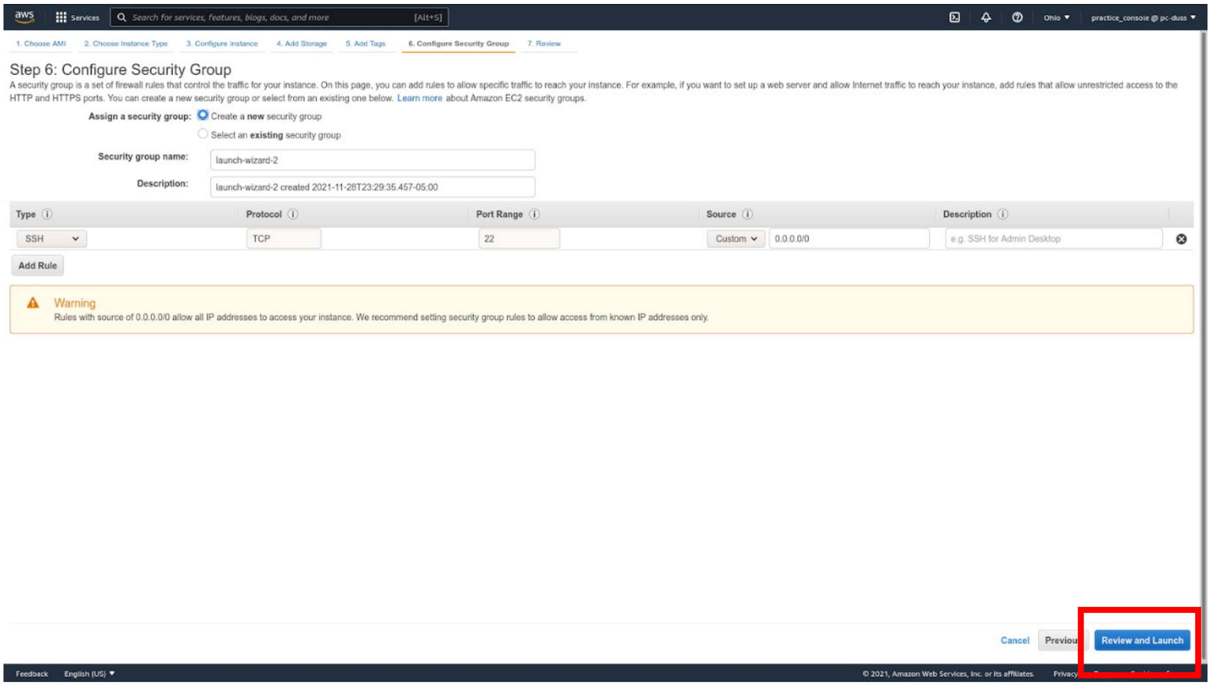


Step 5: Add Tags

A tag consists of a case-sensitive key-value pair. For example, you could define a tag with key = Name and value = Webserver.
A copy of a tag can be applied to volumes, instances or both.
Tags will be applied to all instances and volumes. Learn more about tagging your Amazon EC2 resources.

Key (128 characters maximum)	Value (256 characters maximum)	Instances	Volumes	Network Interfaces
name	cluster_instances_1	☑	☑	☑

You can leave the security group to its default or use an existing one if you already have one set up. Click **Review and Launch**.



Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. Learn more about Amazon EC2 security groups.

Assign a security group: ● Create a **new** security group
○ Select an **existing** security group

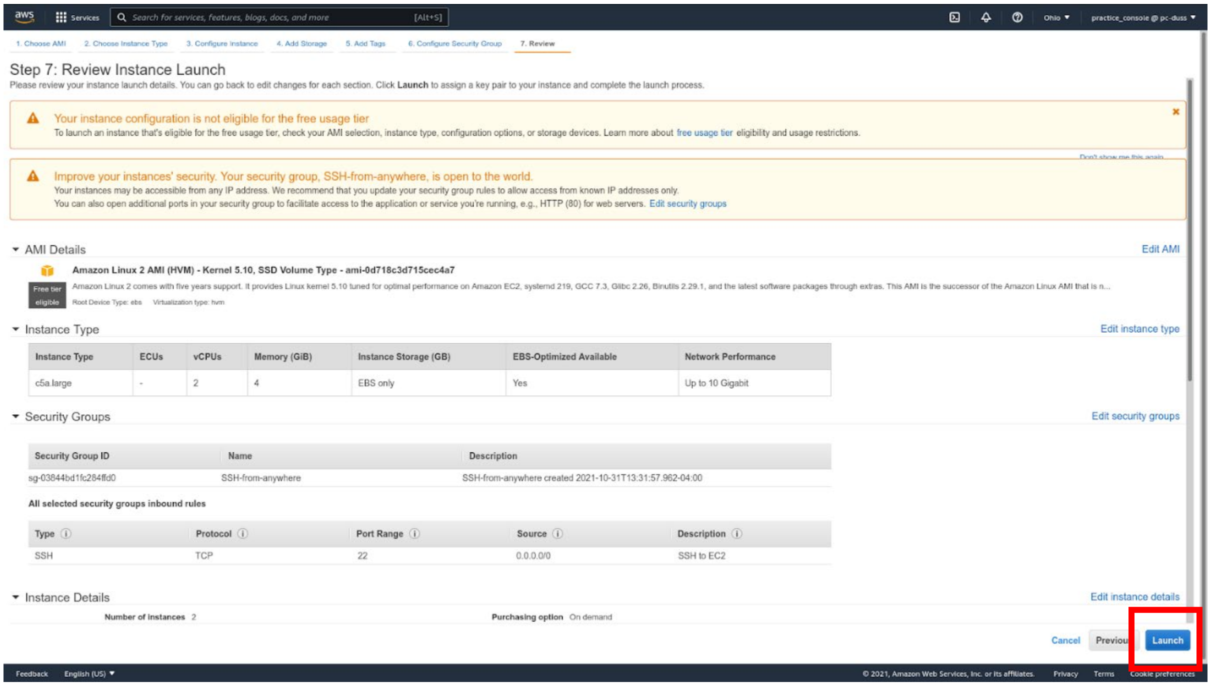
Security group name: launch-wizard-2

Description: launch-wizard-2 created 2021-11-28T23:29:35.457-05:00

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	Custom 0.0.0.0/0	e.g. SSH for Admin Desktop

Warning
Rules with source of 0.0.0.0/0 allow all IP addresses to access your instance. We recommend setting security group rules to allow access from known IP addresses only.

When you are ready, click **Launch**.



Step 7: Review Instance Launch

Please review your instance launch details. You can go back to edit changes for each section. Click **Launch** to assign a key pair to your instance and complete the launch process.

Your instance configuration is not eligible for the free usage tier

To launch an instance that's eligible for the free usage tier, check your AMI selection, instance type, configuration options, or storage devices. Learn more about free usage tier eligibility and usage restrictions.

Improve your instances' security. Your security group, SSH-from-anywhere, is open to the world.

Your instances may be accessible from any IP address. We recommend that you update your security group rules to allow access from known IP addresses only.

You can also open additional ports in your security group to facilitate access to the application or service you're running, e.g., HTTP (80) for web servers. Edit security groups

AMI Details

Amazon Linux 2 AMI (HVM) - Kernel 5.10, SSD Volume Type - ami-0d718c3d715cec4a7

Amazon Linux 2 comes with five years support. It provides Linux kernel 5.10 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras. This AMI is the successor of the Amazon Linux AMI that is n...

Root Device Type: ebs   Virtualization type: hvm

Instance Type

Instance Type	ECUs	vCPUs	Memory (GiB)	Instance Storage (GB)	EBS-Optimized Available	Network Performance
c5a.large	-	2	4	EBS only	Yes	Up to 10 Gigabit

Security Groups

Security Group ID	Name	Description
sg-03844bd1fc284ffd0	SSH-from-anywhere	SSH-from-anywhere created 2021-10-31T13:31:57.962-04:00

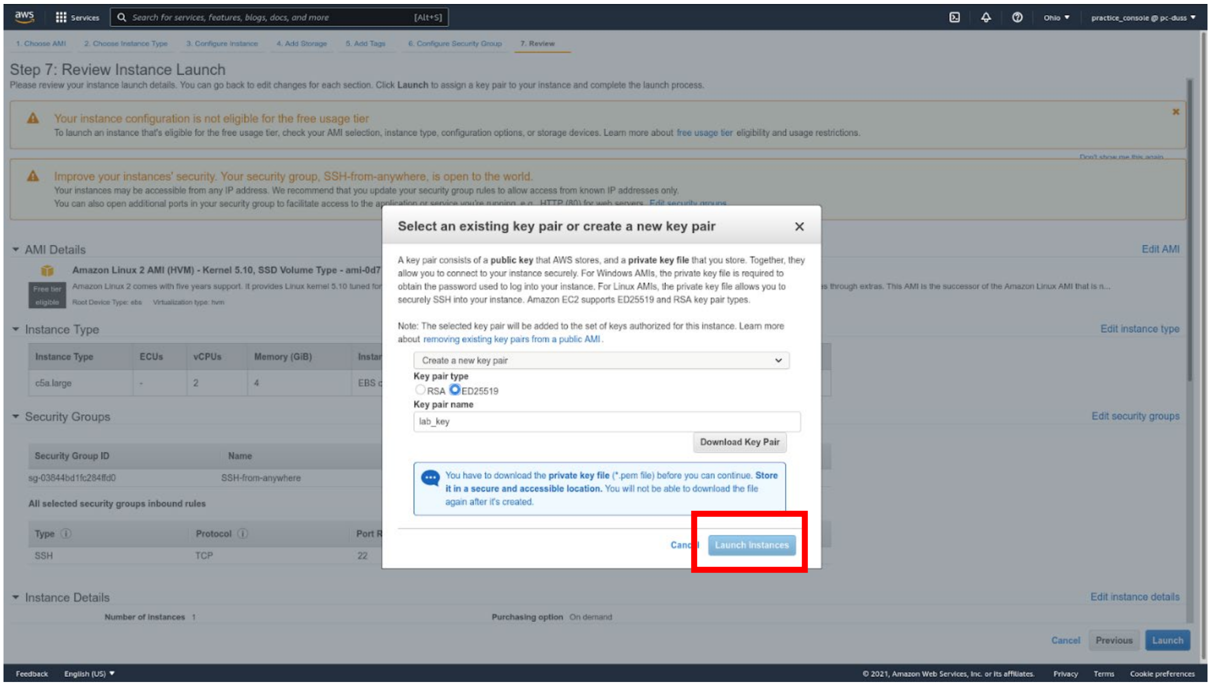
All selected security groups inbound rules

Type	Protocol	Port Range	Source	Description
SSH	TCP	22	0.0.0.0/0	SSH to EC2

Instance Details

Number of instances 2   **Purchasing option** On demand

Enter a name for your SSH key. Make sure to download the key. When you have, click **Launch Instances**.



Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance. Amazon EC2 supports ED25519 and RSA key pair types.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about removing existing key pairs from a public AMI.

Create a new key pair

Key pair type

○ RSA ● ED25519

Key pair name

lab_key

You have to download the **private key file** (*.pem file) before you can continue. **Store it in a secure and accessible location.** You will not be able to download the file again after it's created.

Number of instances 1   **Purchasing option** On demand

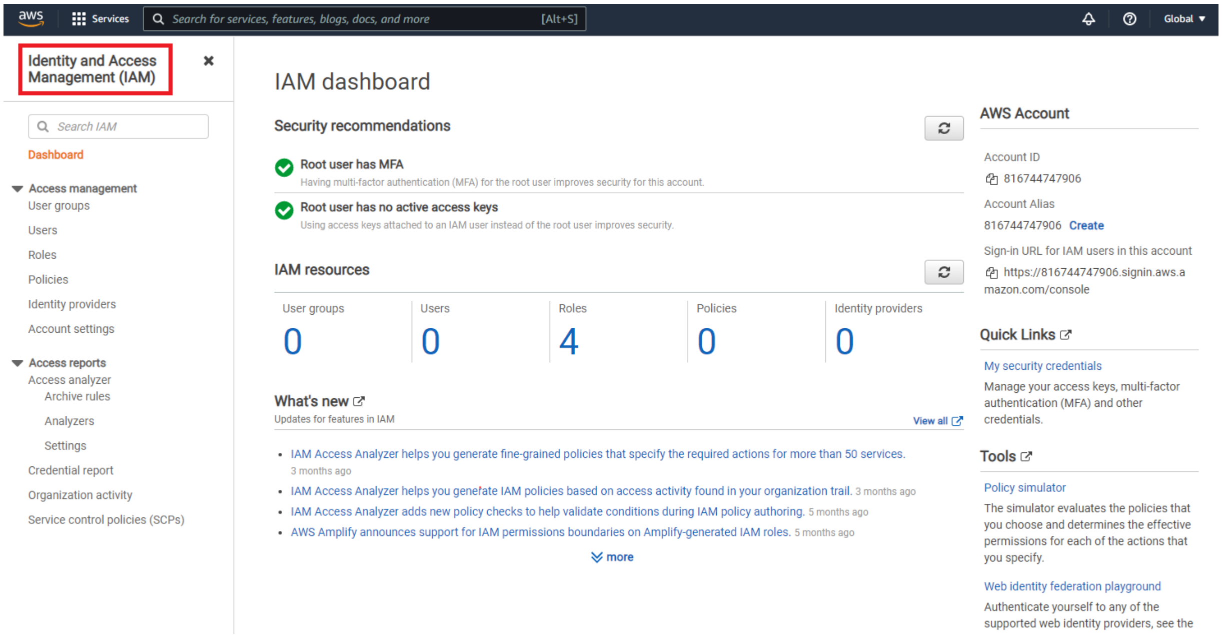
Chapter 8 Labs

Lab: Create an Identity and Access Management (IAM) User

Create an IAM User

From the AWS console, follow these steps to create an IAM user:

Sign in and open the **IAM console** at https://console.aws.amazon.com/iam/.



IAM dashboard

Security recommendations

Root user has MFA
Having multi-factor authentication (MFA) for the root user improves security for this account.

Root user has no active access keys
Using access keys attached to an IAM user instead of the root user improves security.

IAM resources

User groups	Users	Roles	Policies	Identity providers
0	0	4	0	0

What's new
Updates for features in IAM
View all

- IAM Access Analyzer helps you generate fine-grained policies that specify the required actions for more than 50 services. 3 months ago
- IAM Access Analyzer helps you generate IAM policies based on access activity found in your organization trail. 3 months ago
- IAM Access Analyzer adds new policy checks to help validate conditions during IAM policy authoring. 5 months ago
- AWS Amplify announces support for IAM permissions boundaries on Amplify-generated IAM roles. 5 months ago

more

AWS Account

Account ID
816744747906

Account Alias
816744747906 Create

Sign-in URL for IAM users in this account
https://816744747906.signin.aws.amazon.com/console

Quick Links

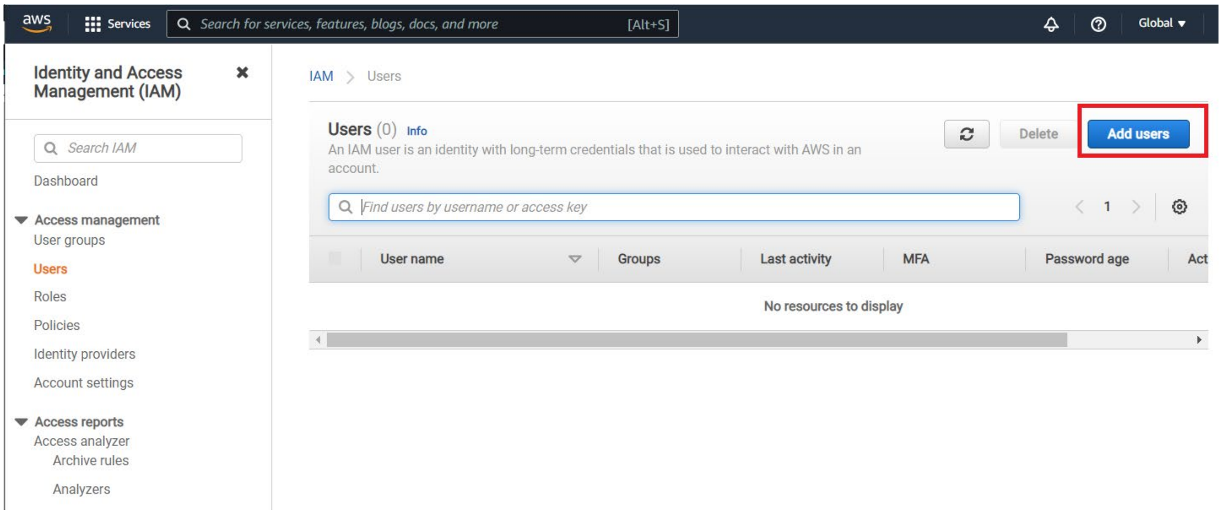
My security credentials
Manage your access keys, multi-factor authentication (MFA) and other credentials.

Tools

Policy simulator
The simulator evaluates the policies that you choose and determines the effective permissions for each of the actions that you specify.

Web identity federation playground
Authenticate yourself to any of the supported web identity providers, see the

Choose **Users** in the navigation pane and select **Add Users**.

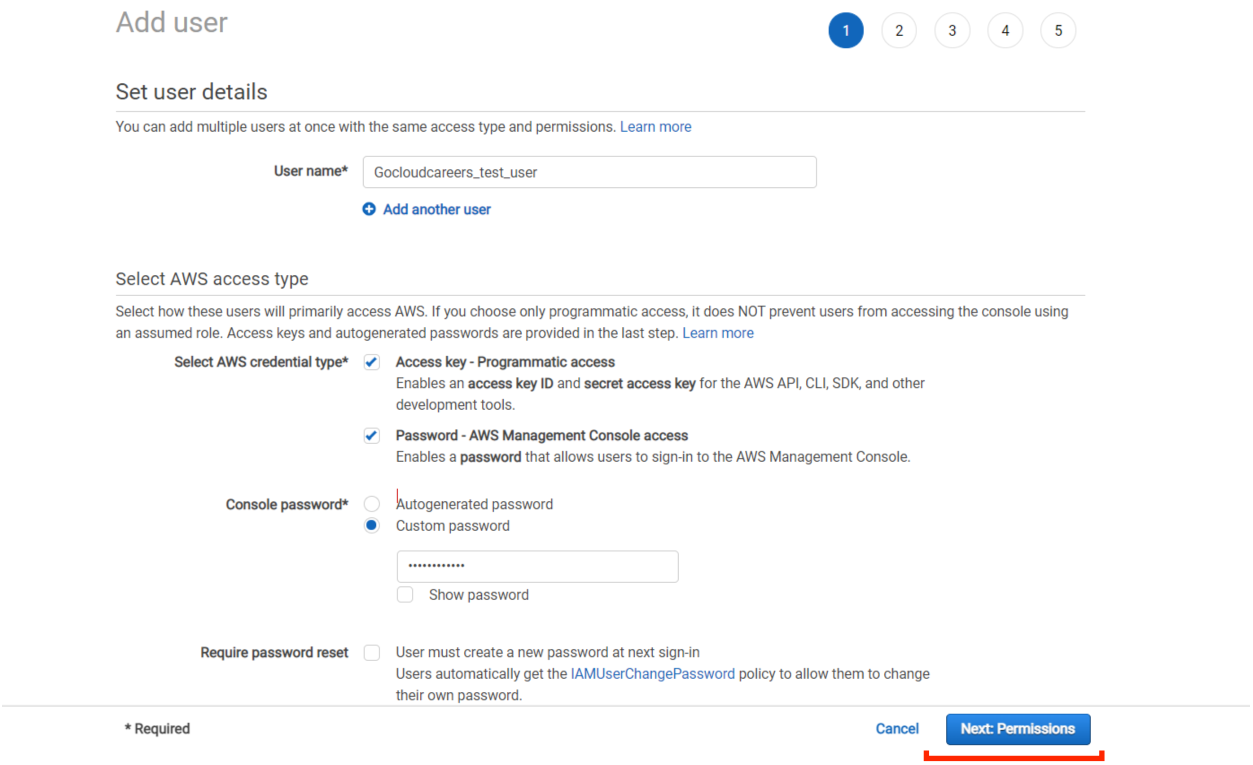


Users (0) Info
An IAM user is an identity with long-term credentials that is used to interact with AWS in an account.

User name	Groups	Last activity	MFA	Password age	Act

No resources to display

Enter the user's name in **User name** field, and select the type of access the user should have (Programmatic or AWS Management Console Access). Click **Next: Permissions**.



Add user

Set user details

You can add multiple users at once with the same access type and permissions. Learn more

User name* Gocloudcareers_test_user

Select AWS access type

Select how these users will primarily access AWS. If you choose only programmatic access, it does NOT prevent users from accessing the console using an assumed role. Access keys and autogenerated passwords are provided in the last step. Learn more

Select AWS credential type*

☑ **Access key - Programmatic access**
Enables an **access key ID** and **secret access key** for the AWS API, CLI, SDK, and other development tools.

☑ **Password - AWS Management Console access**
Enables a **password** that allows users to sign-in to the AWS Management Console.

Console password*

○ Autogenerated password
● Custom password

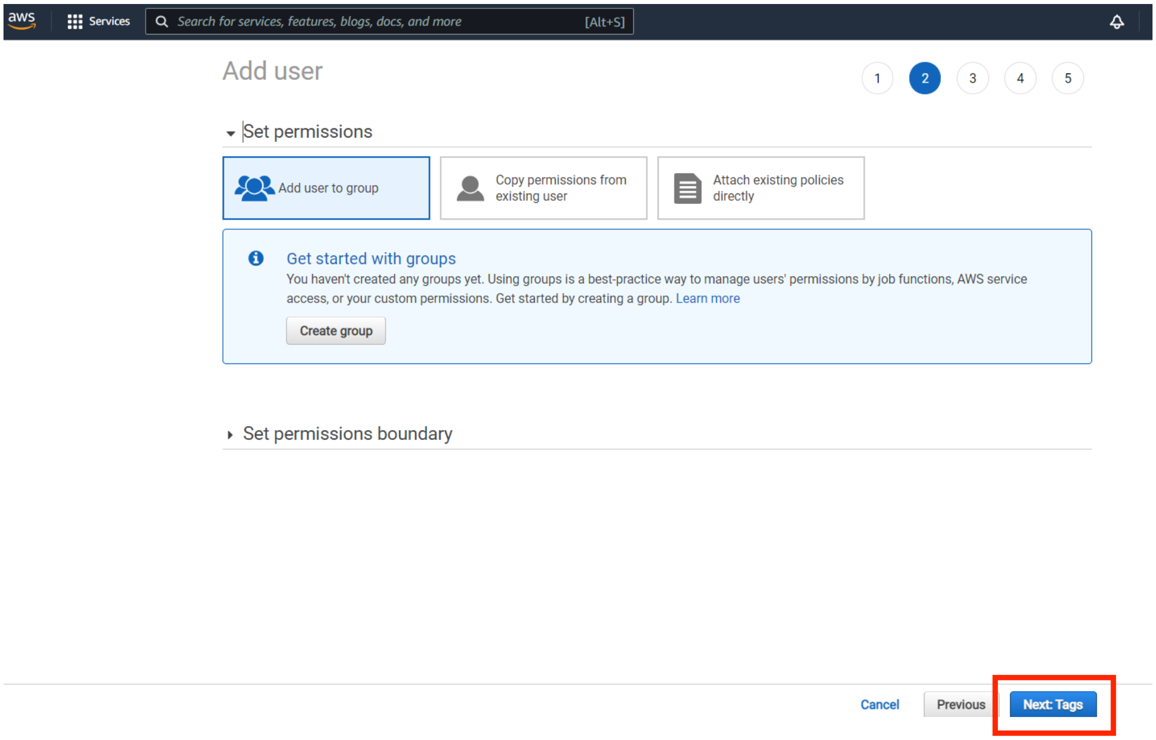
············

□ Show password

Require password reset □ User must create a new password at next sign-in
Users automatically get the IAMUserChangePassword policy to allow them to change their own password.

* Required

On the **Set Permissions** page, add user to the target group. Permissions can be copied from an existing user, or the existing policies of the specified group may be attached directly. **Click Next: Tags**.



aws
Services
Search for services, features, blogs, docs, and more
[Alt+S]

Add user

Set permissions

Add user to group
Copy permissions from existing user
Attach existing policies directly

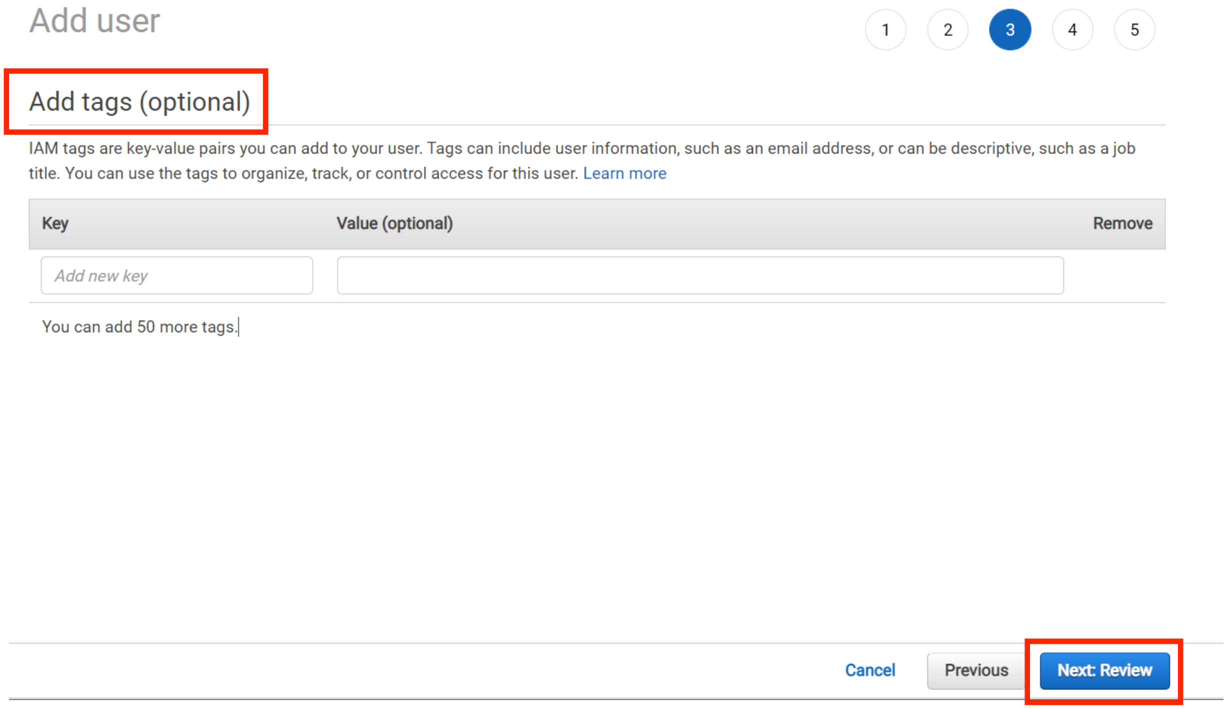
Get started with groups

You haven't created any groups yet. Using groups is a best-practice way to manage users' permissions by job functions, AWS service access, or your custom permissions. Get started by creating a group. Learn more

Set permissions boundary

Cancel
Previous
Next: Tags

Add tags, if desired, entering a Key and Value. Click **Next: Review**.



Add user

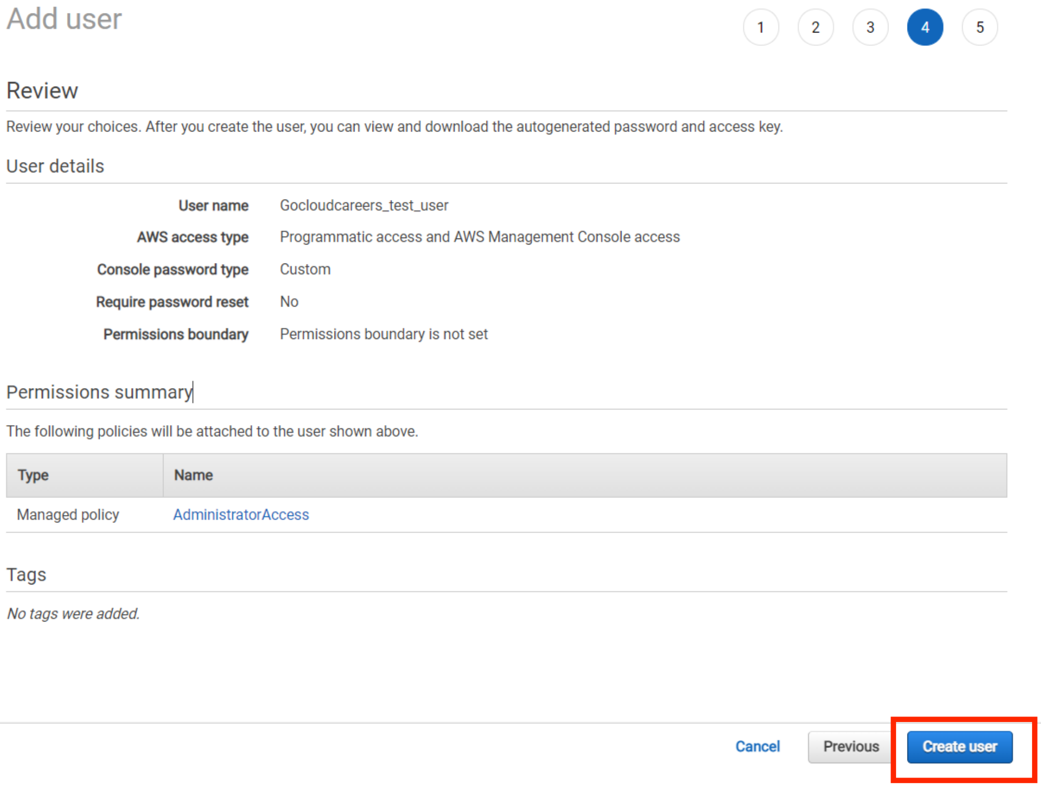
Add tags (optional)

IAM tags are key-value pairs you can add to your user. Tags can include user information, such as an email address, or can be descriptive, such as a job title. You can use the tags to organize, track, or control access for this user. Learn more

Key	Value (optional)	Remove
Add new key		

You can add 50 more tags.

Review and verify the **User details**, then click **Create user**.



Review

Review your choices. After you create the user, you can view and download the autogenerated password and access key.

User details

User name	Gocloudcareers_test_user
AWS access type	Programmatic access and AWS Management Console access
Console password type	Custom
Require password reset	No
Permissions boundary	Permissions boundary is not set

Permissions summary

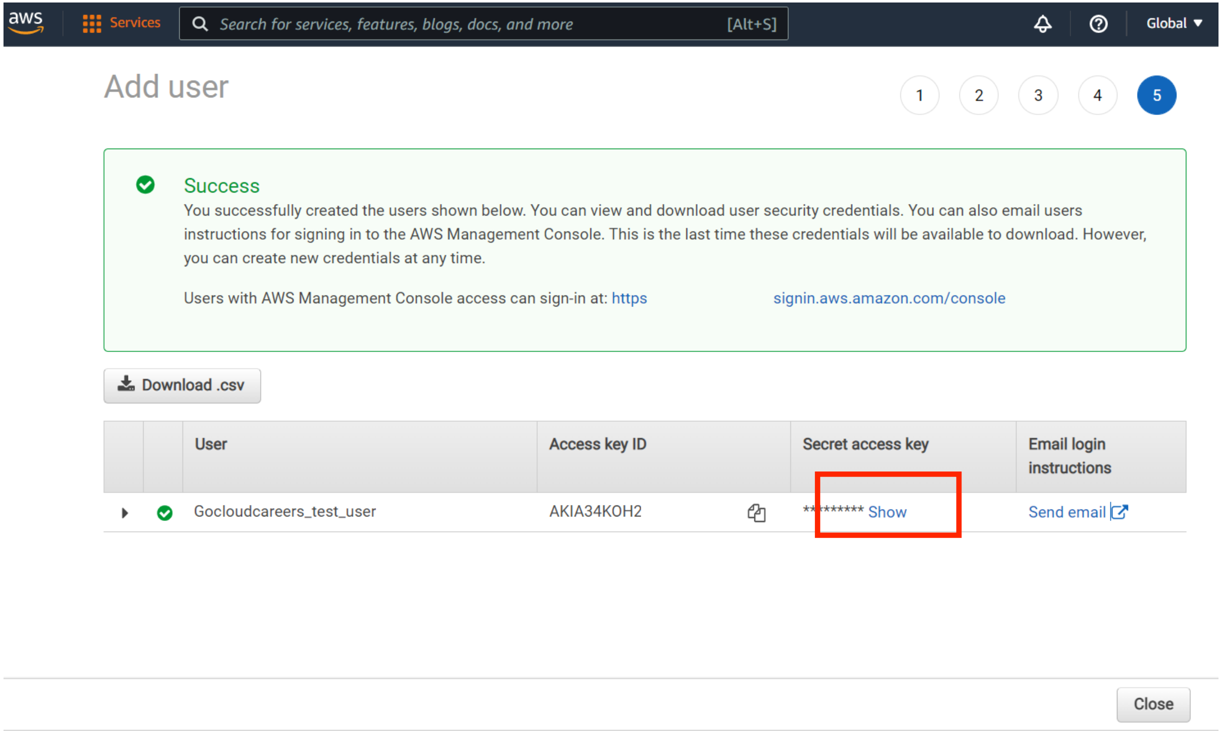
The following policies will be attached to the user shown above.

Type	Name
Managed policy	AdministratorAccess

Tags

No tags were added.

Choose **Show** to view users' **Secret access keys**. Access keys may be downloaded to a .csv file as well. Choose **Download.csv** then save the file to a safe location. **Note -** Access to the secret access keys will **not** be available after this step. Click **Close**.



Add user

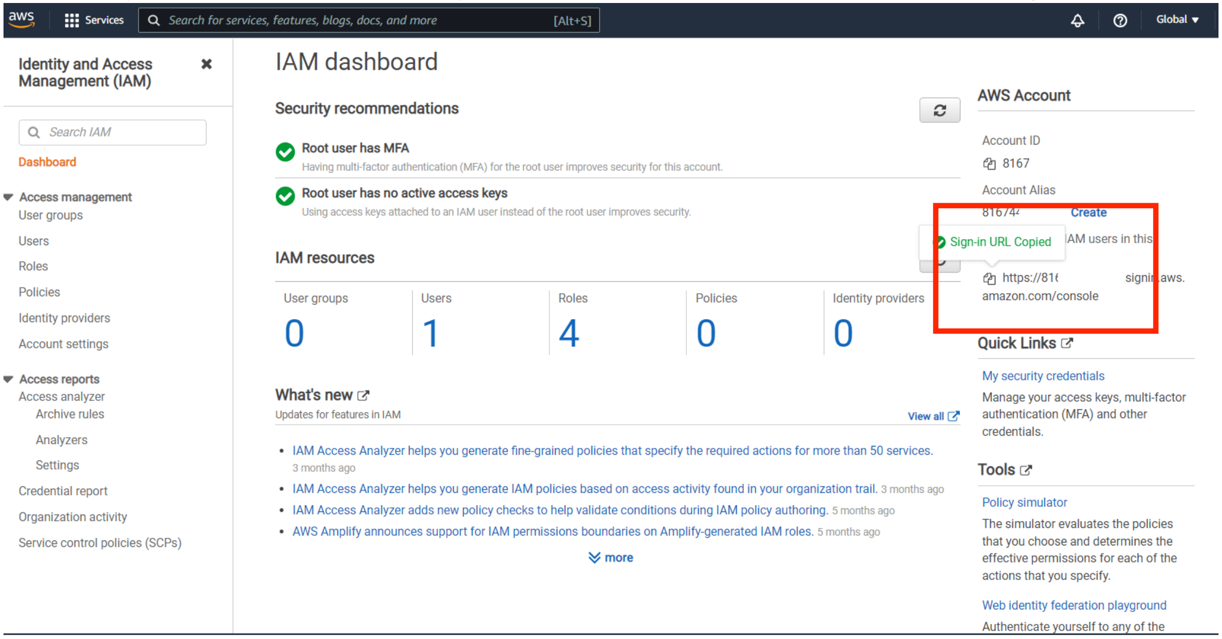
Success

You successfully created the users shown below. You can view and download user security credentials. You can also email users instructions for signing in to the AWS Management Console. This is the last time these credentials will be available to download. However, you can create new credentials at any time.

Users with AWS Management Console access can sign-in at: https signin.aws.amazon.com/console

		User	Access key ID	Secret access key	Email login instructions
▸	✓	Gocloudcareers_test_user	AKIA34KOH2	********* Show	Send email

Use newly created User name and password for the new user account in the **Sign-in URL**.



IAM dashboard

Security recommendations

Root user has MFA
Having multi-factor authentication (MFA) for the root user improves security for this account.

Root user has no active access keys
Using access keys attached to an IAM user instead of the root user improves security.

IAM resources

User groups	Users	Roles	Policies	Identity providers
0	1	4	0	0

What's new
Updates for features in IAM
View all

- IAM Access Analyzer helps you generate fine-grained policies that specify the required actions for more than 50 services. 3 months ago
- IAM Access Analyzer helps you generate IAM policies based on access activity found in your organization trail. 3 months ago
- IAM Access Analyzer adds new policy checks to help validate conditions during IAM policy authoring. 5 months ago
- AWS Amplify announces support for IAM permissions boundaries on Amplify-generated IAM roles. 5 months ago

more

AWS Account

Account ID
8167

Account Alias
81674 Create

Sign-in URL Copied
AM users in this
https://81 signi aws.amazon.com/console

Quick Links
My security credentials
Manage your access keys, multi-factor authentication (MFA) and other credentials.

Tools
Policy simulator
The simulator evaluates the policies that you choose and determines the effective permissions for each of the actions that you specify.

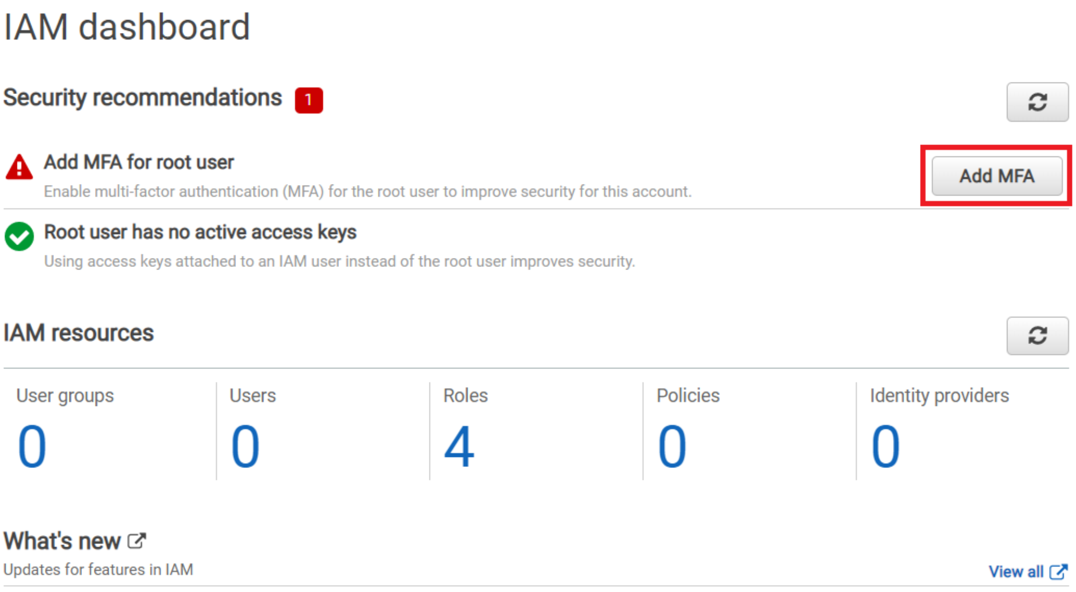
Web identity federation playground
Authenticate yourself to any of the

LAB: Setting Up Multi-Factor Authentication (MFA) for the AWS Account Root User

In this lab we will set up multifactor authentication for the root user. This is a security best practice.

Sign in to the AWS Management Console and open the IAM console at https://console.aws.amazon.com/iam/.

Click **Add MFA**.



IAM dashboard

Security recommendations 1

Add MFA for root user

Enable multi-factor authentication (MFA) for the root user to improve security for this account.

Root user has no active access keys

Using access keys attached to an IAM user instead of the root user improves security.

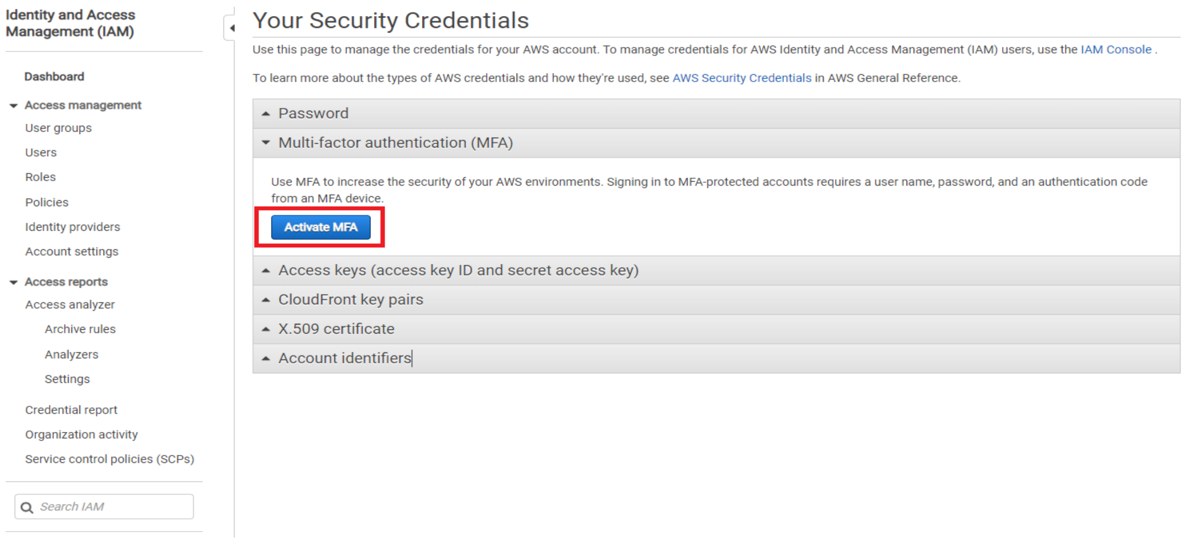
IAM resources

User groups	Users	Roles	Policies	Identity providers
0	0	4	0	0

What's new

Updates for features in IAM

Click **Activate MFA**.



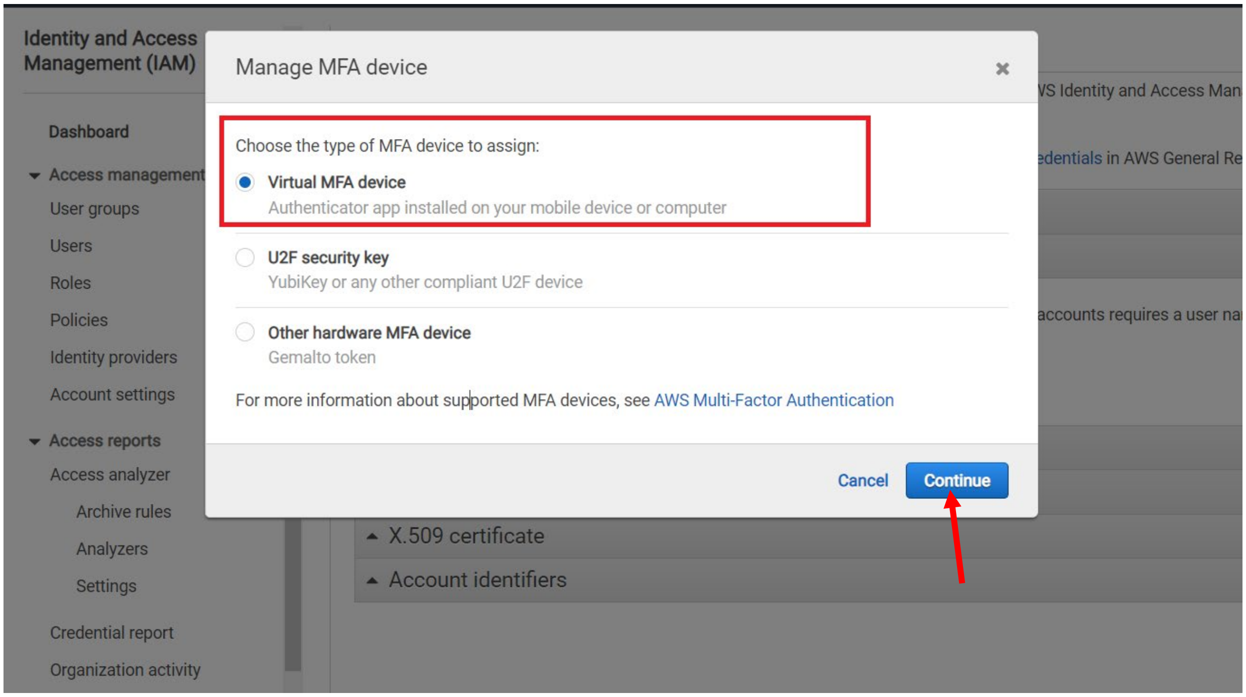
Your Security Credentials

Use this page to manage the credentials for your AWS account. To manage credentials for AWS Identity and Access Management (IAM) users, use the IAM Console .

To learn more about the types of AWS credentials and how they're used, see AWS Security Credentials in AWS General Reference.

Use MFA to increase the security of your AWS environments. Signing in to MFA-protected accounts requires a user name, password, and an authentication code from an MFA device.

Choose **Virtual MFA devices** and click **Continue**.



Manage MFA device

Choose the type of MFA device to assign:

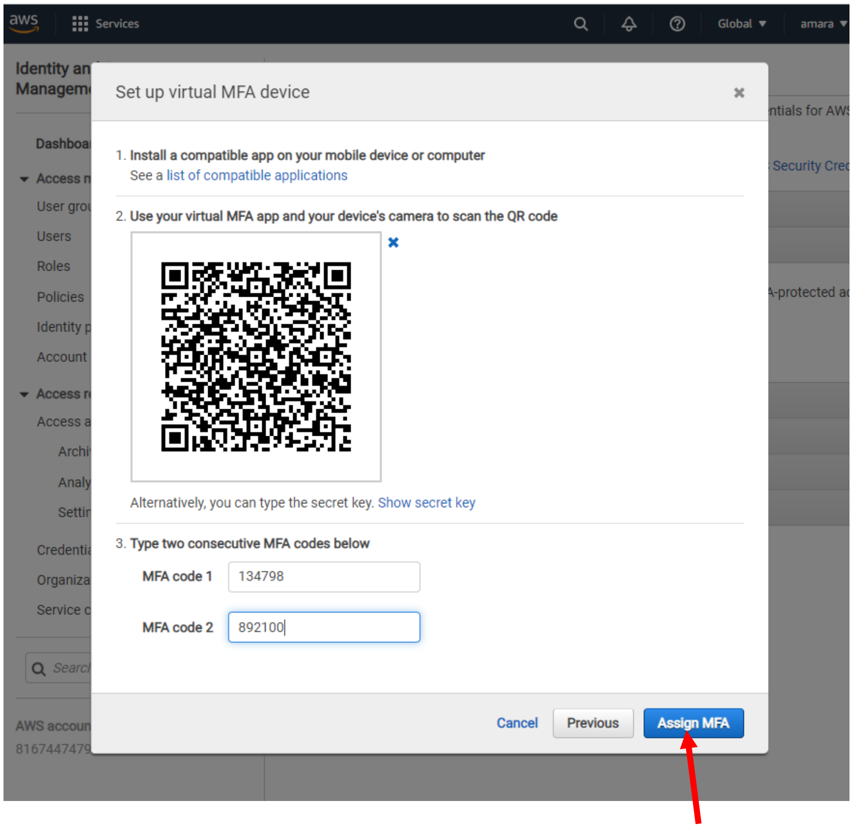
● Virtual MFA device
Authenticator app installed on your mobile device or computer

○ U2F security key
YubiKey or any other compliant U2F device

○ Other hardware MFA device
Gemalto token

For more information about supported MFA devices, see AWS Multi-Factor Authentication

Install one of the compatible application Authenticators on your device (E.g.: Google Authenticator), scan the QR code, enter two MFA codes, click **Assign MFA**.



Set up virtual MFA device

1. Install a compatible app on your mobile device or computer
See a list of compatible applications

2. Use your virtual MFA app and your device's camera to scan the QR code

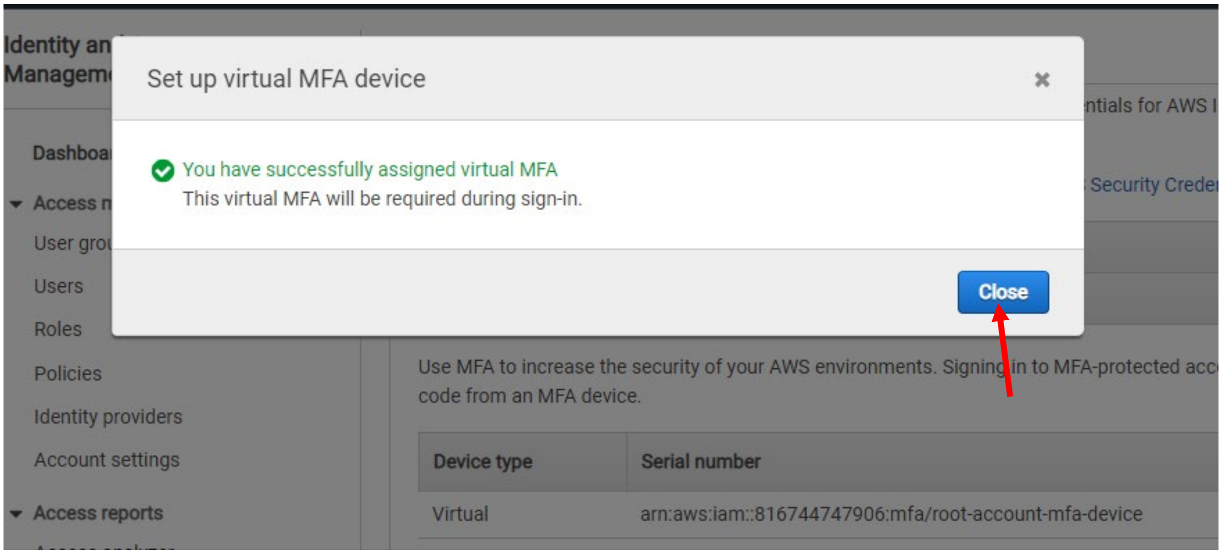
Alternatively, you can type the secret key. Show secret key

3. Type two consecutive MFA codes below

MFA code 1: 134798

MFA code 2: 892100

After successfully assigned MFA, click **Close**.



Set up virtual MFA device

✓ You have successfully assigned virtual MFA
This virtual MFA will be required during sign-in.

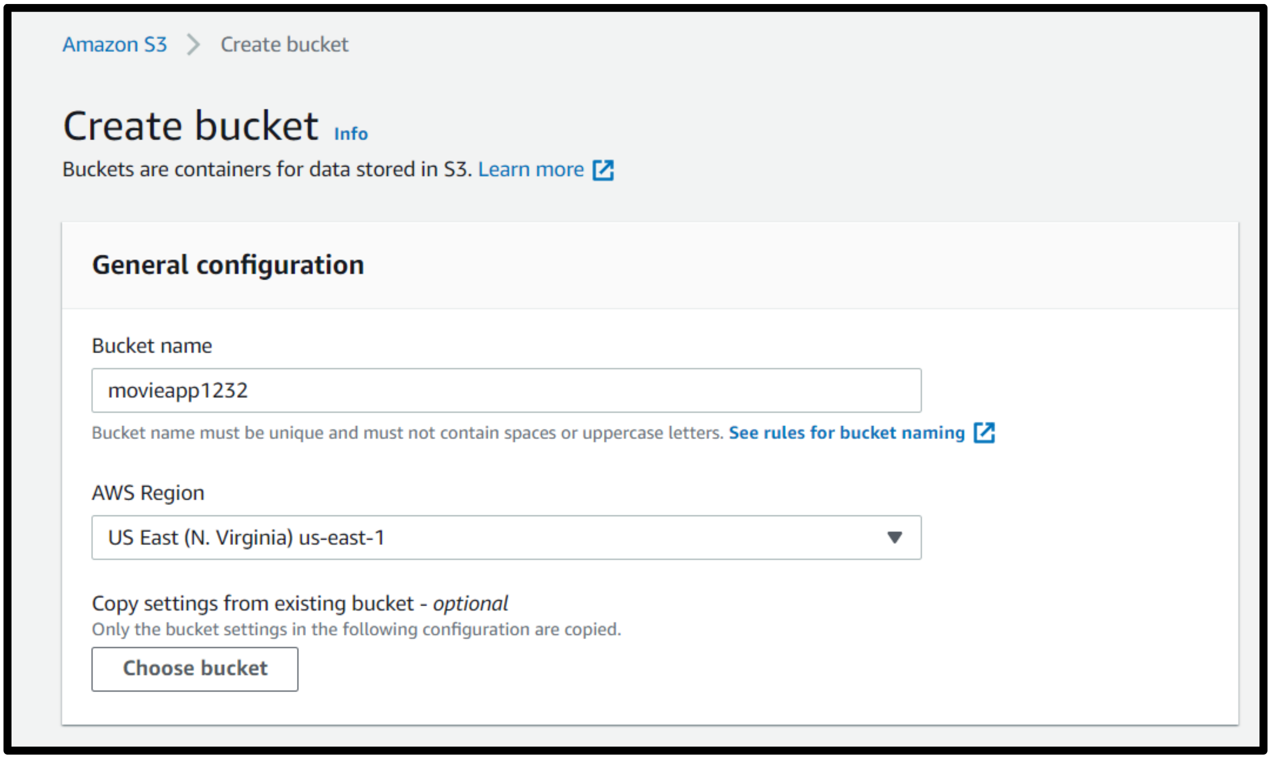
Use MFA to increase the security of your AWS environments. Signing in to MFA-protected acc
code from an MFA device.

Device type	Serial number
Virtual	arn:aws:iam::816744747906:mfa/root-account-mfa-device

Lab: Set Up a Static Website and Connect It with CloudFront

In this lab we will set up a static website on S3 and serve that website from the CloudFront content delivery network.

Create an S3 bucket.



Amazon S3 > Create bucket

Create bucket Info

Buckets are containers for data stored in S3. Learn more

General configuration

Bucket name

movieapp1232

Bucket name must be unique and must not contain spaces or uppercase letters. See rules for bucket naming

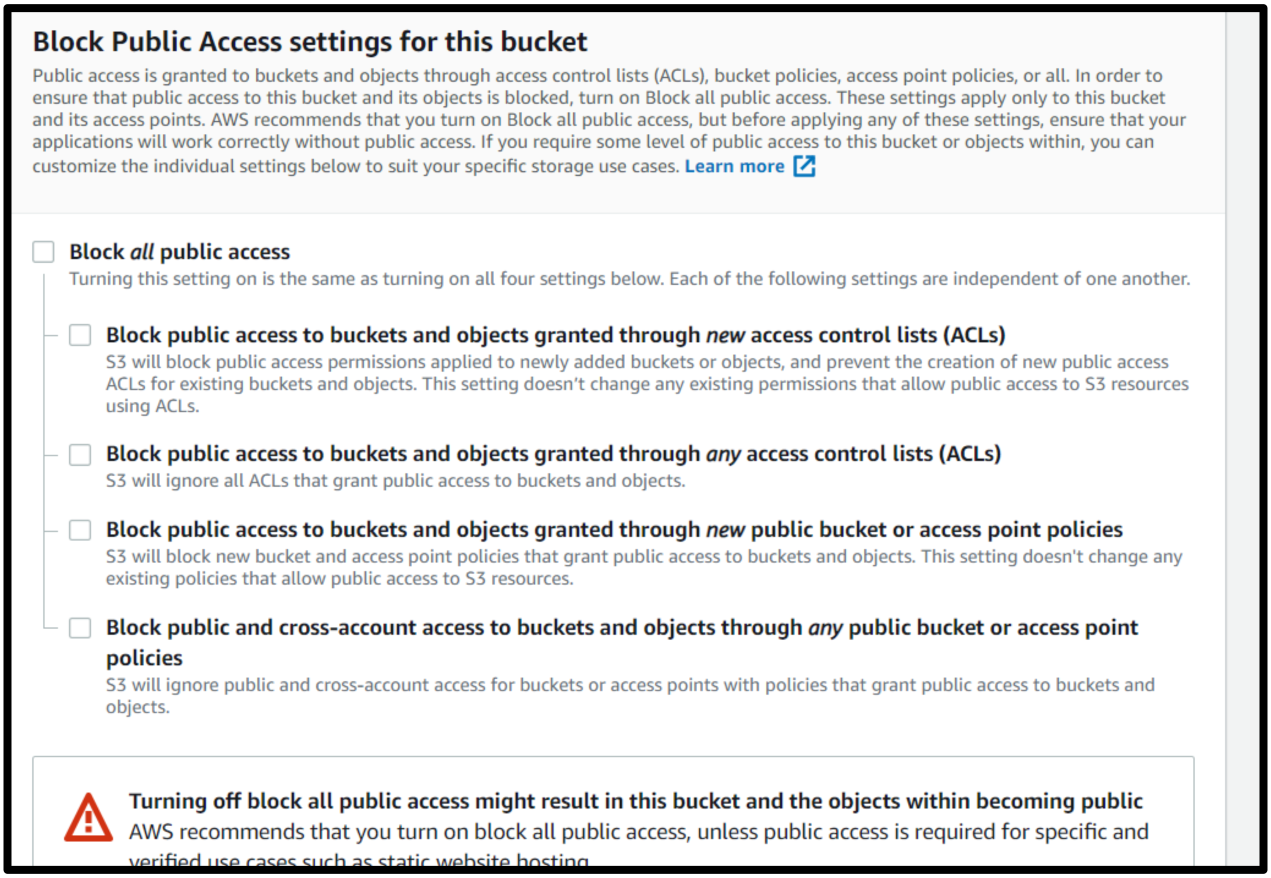
AWS Region

US East (N. Virginia) us-east-1

Copy settings from existing bucket - *optional*

Only the bucket settings in the following configuration are copied.

Make the bucket public.



Block Public Access settings for this bucket

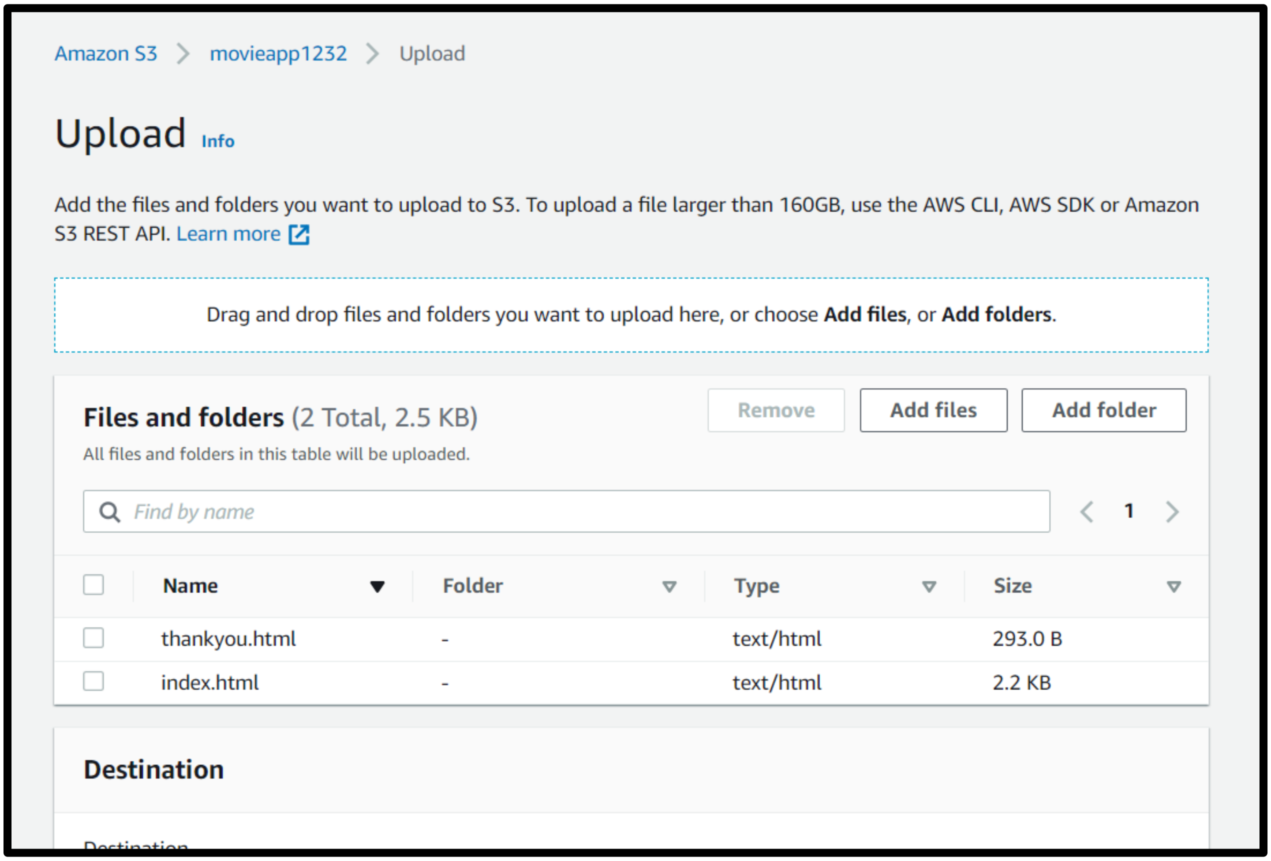
Public access is granted to buckets and objects through access control lists (ACLs), bucket policies, access point policies, or all. In order to ensure that public access to this bucket and its objects is blocked, turn on Block all public access. These settings apply only to this bucket and its access points. AWS recommends that you turn on Block all public access, but before applying any of these settings, ensure that your applications will work correctly without public access. If you require some level of public access to this bucket or objects within, you can customize the individual settings below to suit your specific storage use cases. Learn more

□ **Block *all* public access**
Turning this setting on is the same as turning on all four settings below. Each of the following settings are independent of one another.

- □ **Block public access to buckets and objects granted through *new* access control lists (ACLs)**
  S3 will block public access permissions applied to newly added buckets or objects, and prevent the creation of new public access ACLs for existing buckets and objects. This setting doesn't change any existing permissions that allow public access to S3 resources using ACLs.
- □ **Block public access to buckets and objects granted through *any* access control lists (ACLs)**
  S3 will ignore all ACLs that grant public access to buckets and objects.
- □ **Block public access to buckets and objects granted through *new* public bucket or access point policies**
  S3 will block new bucket and access point policies that grant public access to buckets and objects. This setting doesn't change any existing policies that allow public access to S3 resources.
- □ **Block public and cross-account access to buckets and objects through *any* public bucket or access point policies**
  S3 will ignore public and cross-account access for buckets or access points with policies that grant public access to buckets and objects.

Turning off block all public access might result in this bucket and the objects within becoming public
AWS recommends that you turn on block all public access, unless public access is required for specific and verified use cases such as static website hosting

Upload content.



Upload Info

Add the files and folders you want to upload to S3. To upload a file larger than 160GB, use the AWS CLI, AWS SDK or Amazon S3 REST API. Learn more

Drag and drop files and folders you want to upload here, or choose **Add files**, or **Add folders**.

Files and folders (2 Total, 2.5 KB)

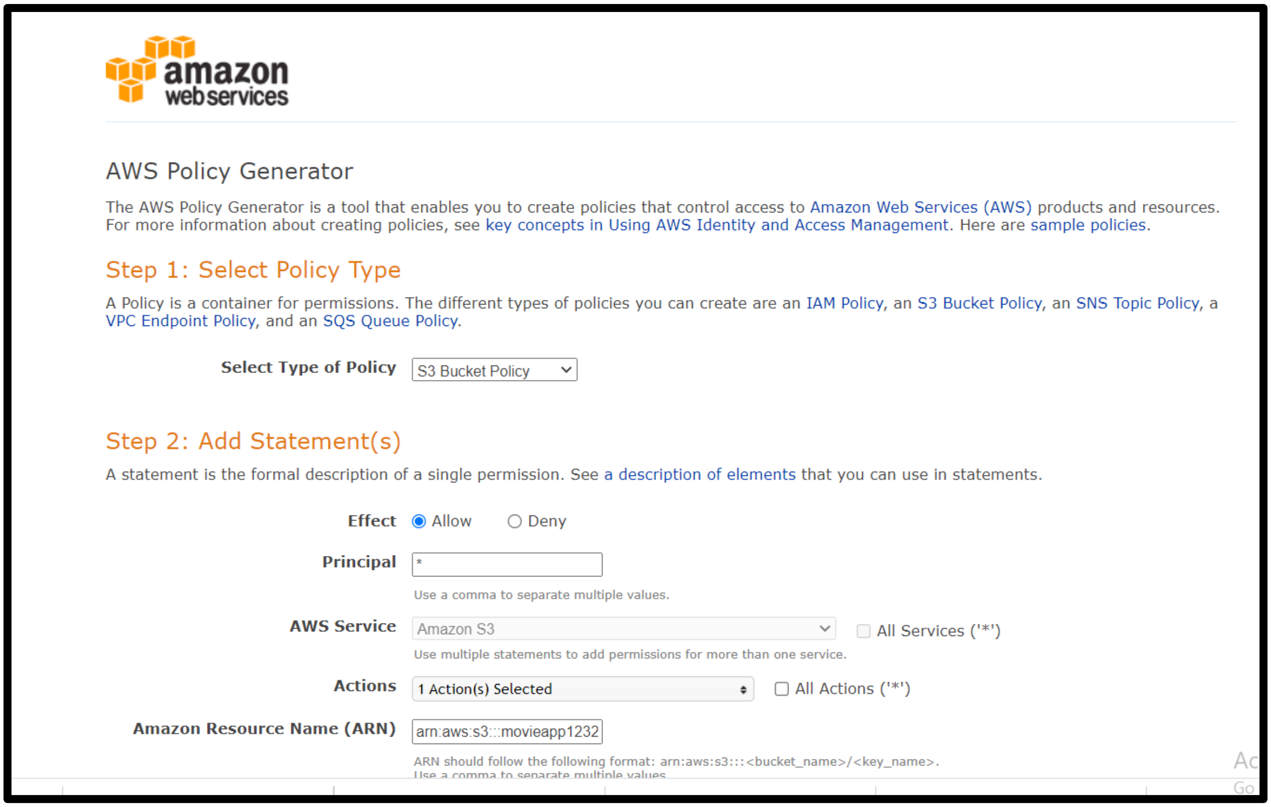
All files and folders in this table will be uploaded.

□	Name	Folder	Type	Size
□	thankyou.html	-	text/html	293.0 B
□	index.html	-	text/html	2.2 KB

Destination

Destination

Create bucket policy.



AWS Policy Generator

The AWS Policy Generator is a tool that enables you to create policies that control access to Amazon Web Services (AWS) products and resources. For more information about creating policies, see key concepts in Using AWS Identity and Access Management. Here are sample policies.

Step 1: Select Policy Type

A Policy is a container for permissions. The different types of policies you can create are an IAM Policy, an S3 Bucket Policy, an SNS Topic Policy, a VPC Endpoint Policy, and an SQS Queue Policy.

Select Type of Policy S3 Bucket Policy

Step 2: Add Statement(s)

A statement is the formal description of a single permission. See a description of elements that you can use in statements.

Effect ● Allow ○ Deny

Principal *

Use a comma to separate multiple values.

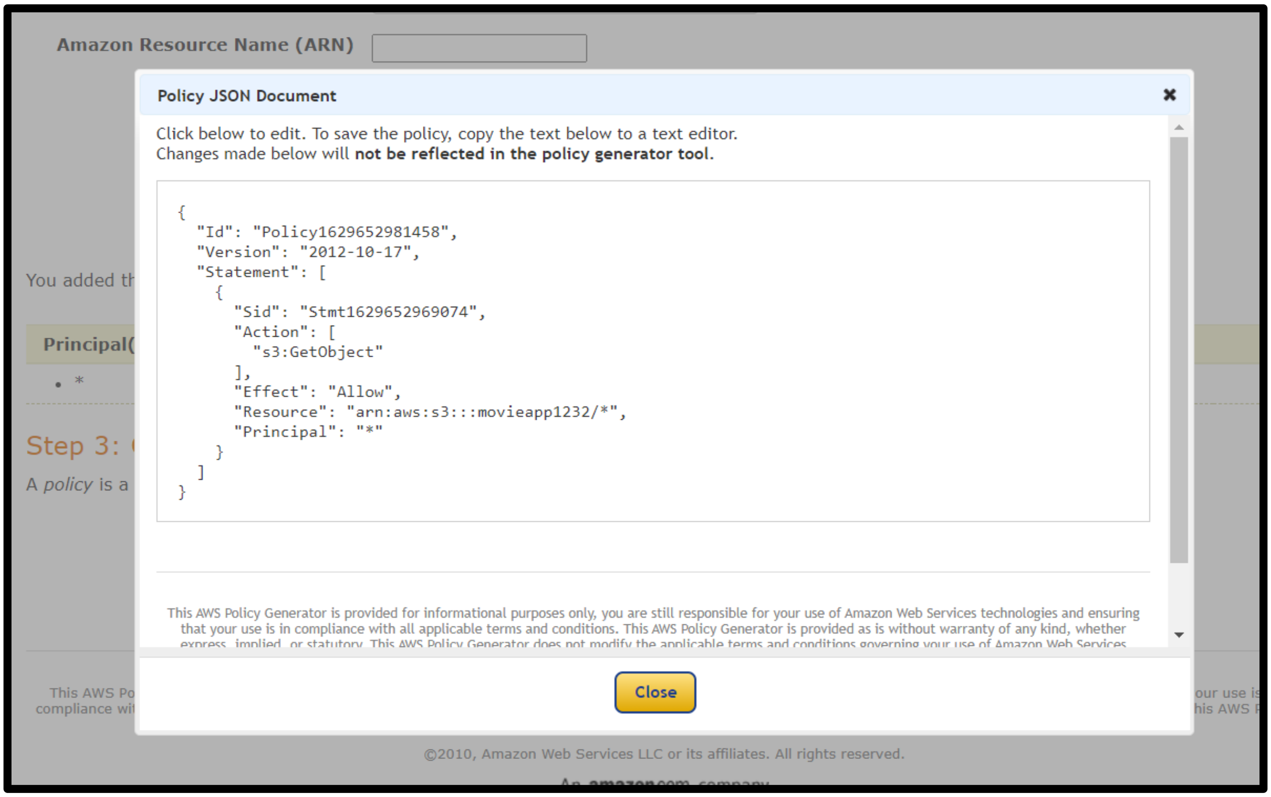
AWS Service Amazon S3 □ All Services ('*')

Use multiple statements to add permissions for more than one service.

Actions 1 Action(s) Selected □ All Actions ('*')

Amazon Resource Name (ARN) arn:aws:s3:::movieapp1232

ARN should follow the following format: arn:aws:s3:::<bucket_name>/<key_name>.
Use a comma to separate multiple values.



Amazon Resource Name (ARN)

Policy JSON Document

Click below to edit. To save the policy, copy the text below to a text editor.
Changes made below will **not be reflected in the policy generator tool.**

```
{
  "Id": "Policy1629652981458",
  "Version": "2012-10-17",
  "Statement": [
    {
      "Sid": "Stmt1629652969074",
      "Action": [
        "s3:GetObject"
      ],
      "Effect": "Allow",
      "Resource": "arn:aws:s3:::movieapp1232/*",
      "Principal": "*"
    }
  ]
}
```

This AWS Policy Generator is provided for informational purposes only, you are still responsible for your use of Amazon Web Services technologies and ensuring that your use is in compliance with all applicable terms and conditions. This AWS Policy Generator is provided as is without warranty of any kind, whether express, implied, or statutory. This AWS Policy Generator does not modify the applicable terms and conditions governing your use of Amazon Web Services

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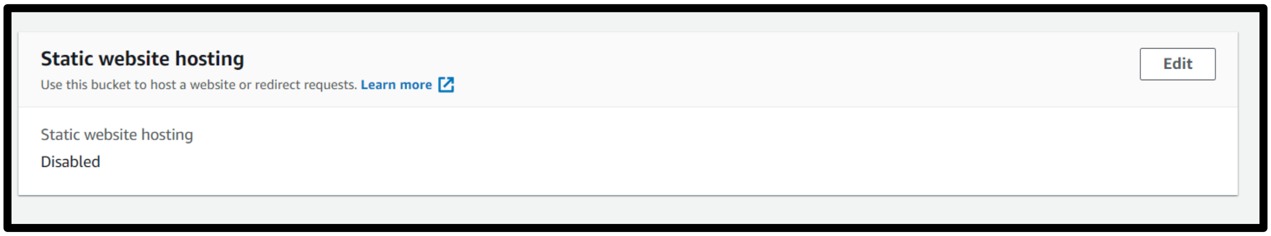
Enable static website hosting.

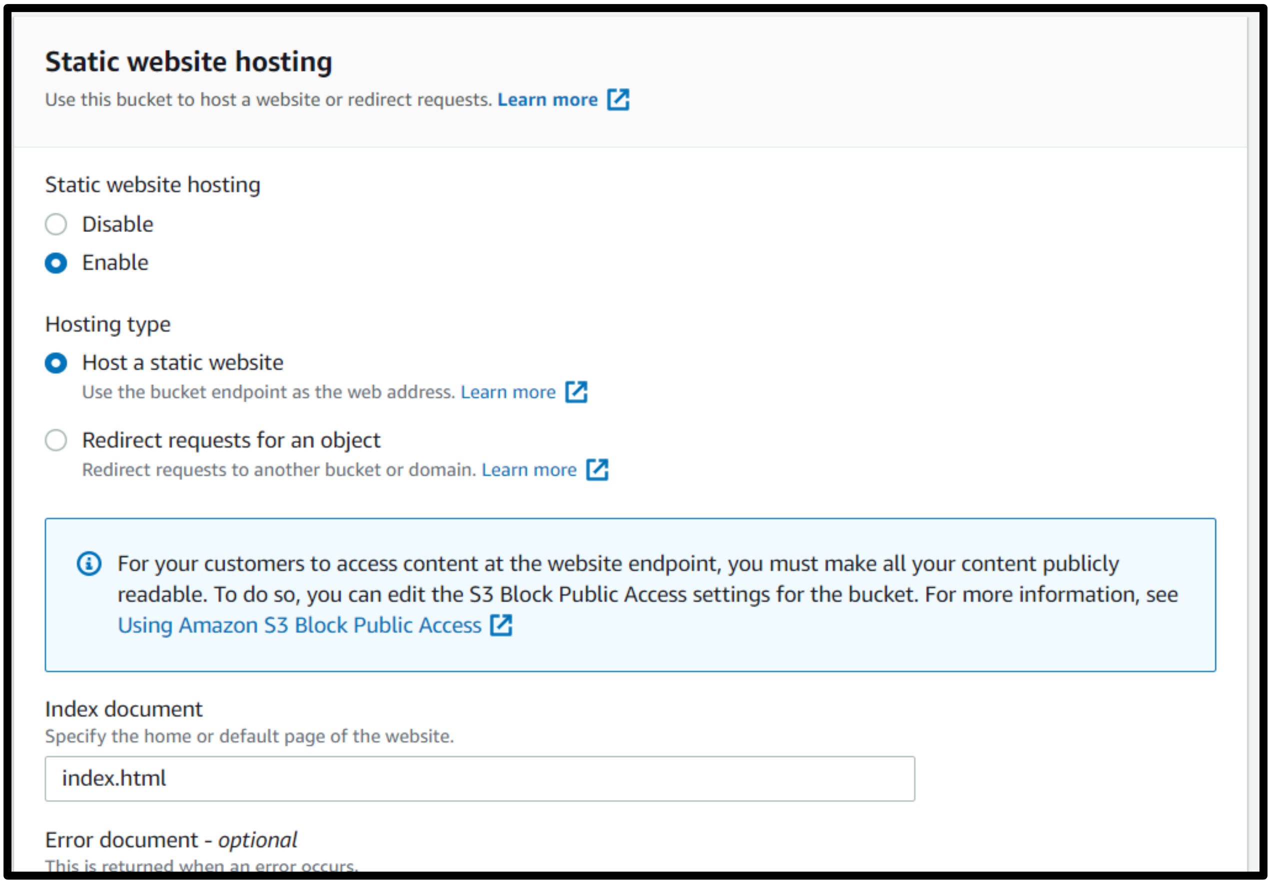


Static website hosting

Use this bucket to host a website or redirect requests. Learn more

Static website hosting

Disabled



Static website hosting

Use this bucket to host a website or redirect requests. Learn more

Static website hosting

○ Disable

● Enable

Hosting type

● Host a static website

Use the bucket endpoint as the web address. Learn more

○ Redirect requests for an object

Redirect requests to another bucket or domain. Learn more

For your customers to access content at the website endpoint, you must make all your content publicly readable. To do so, you can edit the S3 Block Public Access settings for the bucket. For more information, see Using Amazon S3 Block Public Access

Index document

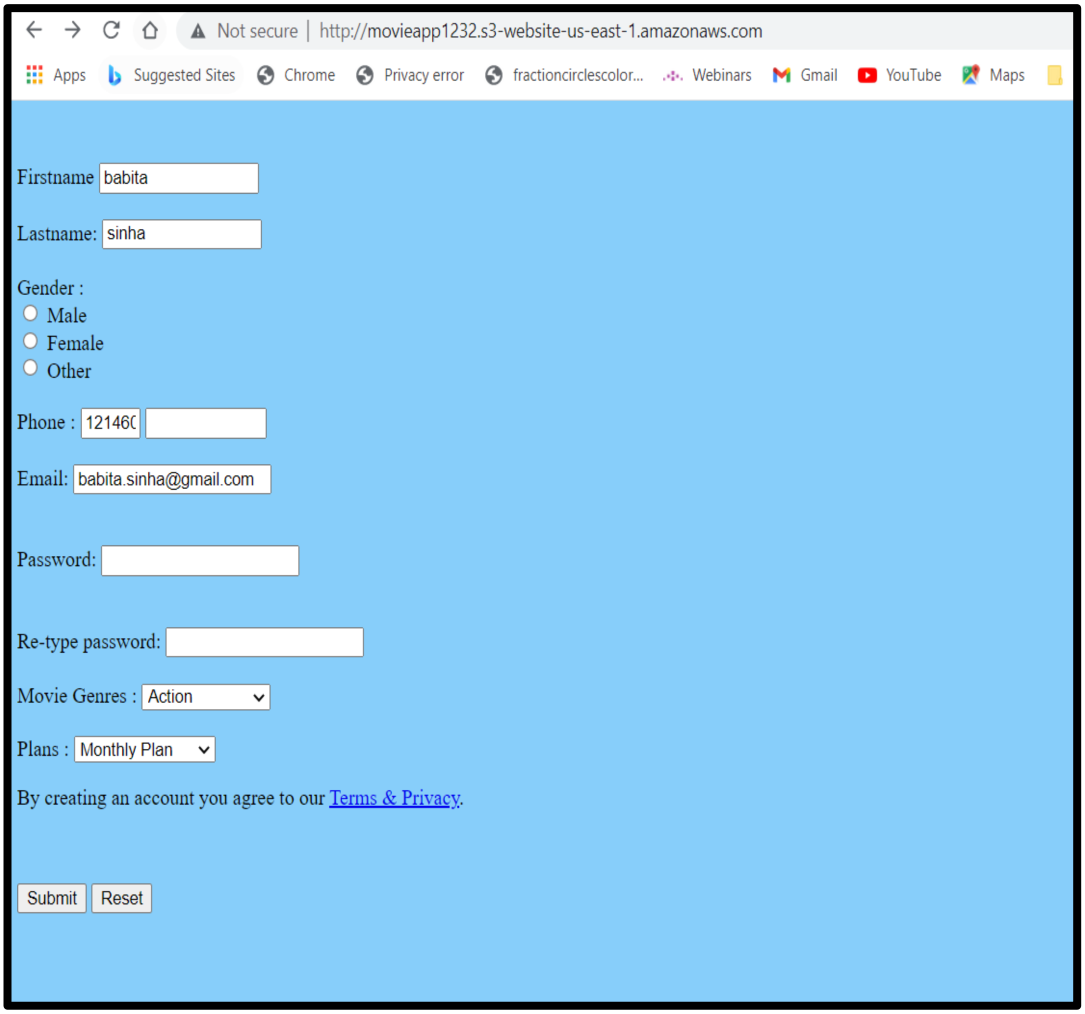
Specify the home or default page of the website.

index.html

Error document - *optional*

This is returned when an error occurs.

Verify website.



Firstname babita

Lastname: sinha

Gender :
○ Male
○ Female
○ Other

Phone : 12146(

Email: babita.sinha@gmail.com

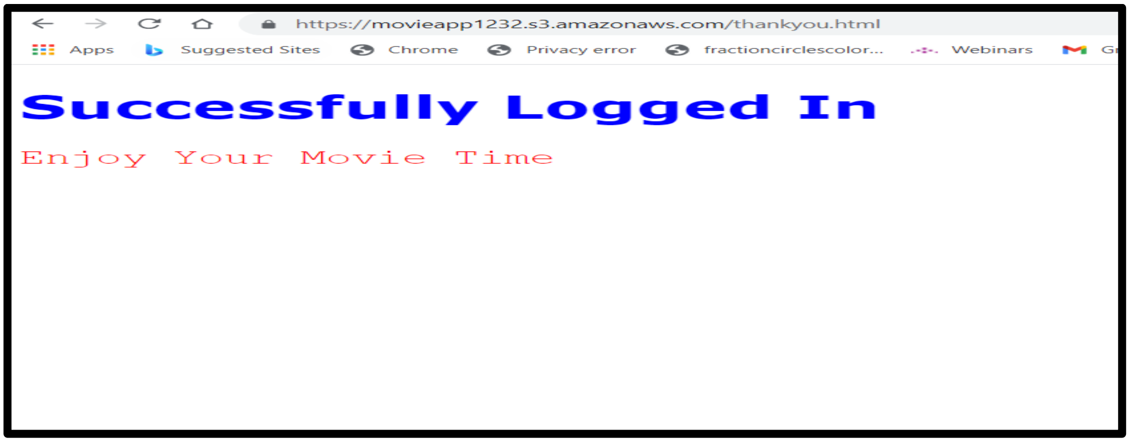
Password:

Re-type password:

Movie Genres : Action

Plans : Monthly Plan

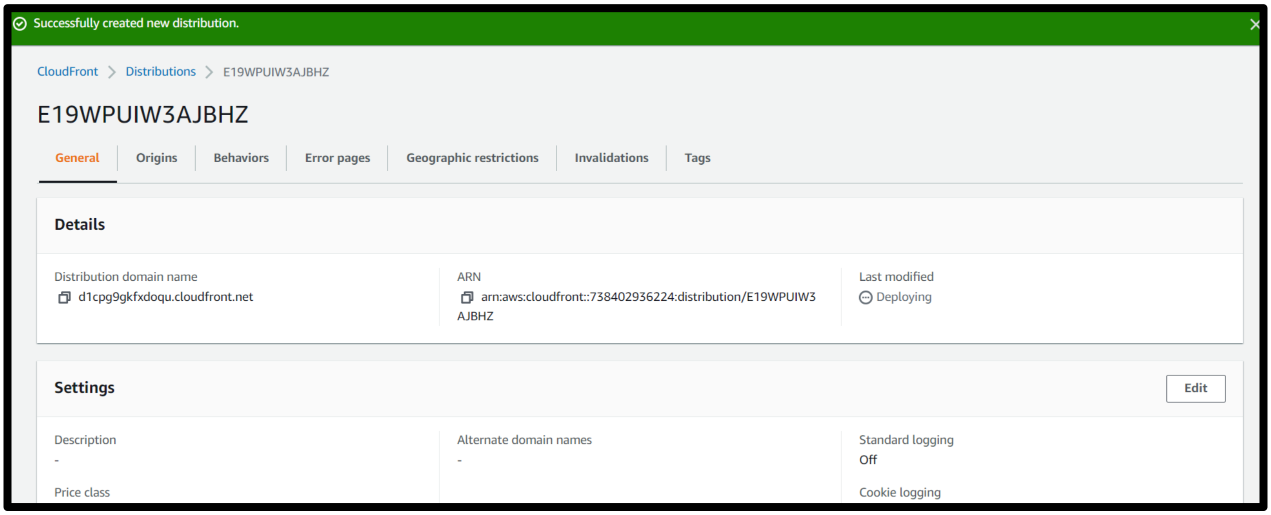
By creating an account you agree to our Terms & Privacy.



Successfully Logged In

Enjoy Your Movie Time

Add the CloudFront distribution.


Successfully created new distribution.

CloudFront > Distributions > E19WPUIW3AJBHZ

E19WPUIW3AJBHZ

Details

Distribution domain name
d1cpg9gkfxdoqu.cloudfront.net

ARN
arn:aws:cloudfront::738402936224:distribution/E19WPUIW3AJBHZ

Last modified
Deploying

Settings

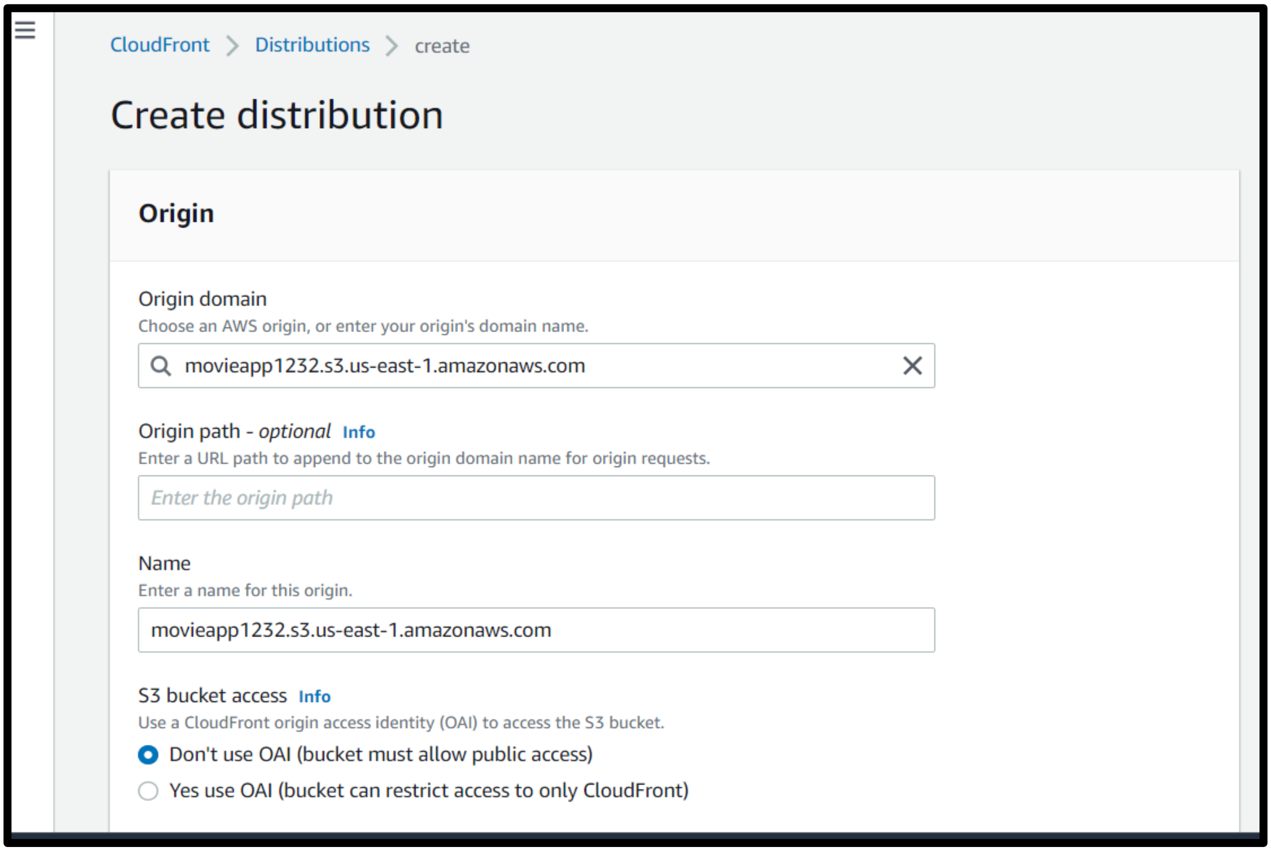
Description
-

Alternate domain names
-

Standard logging
Off

Price class

Cookie logging


CloudFront > Distributions > create

Create distribution

Origin

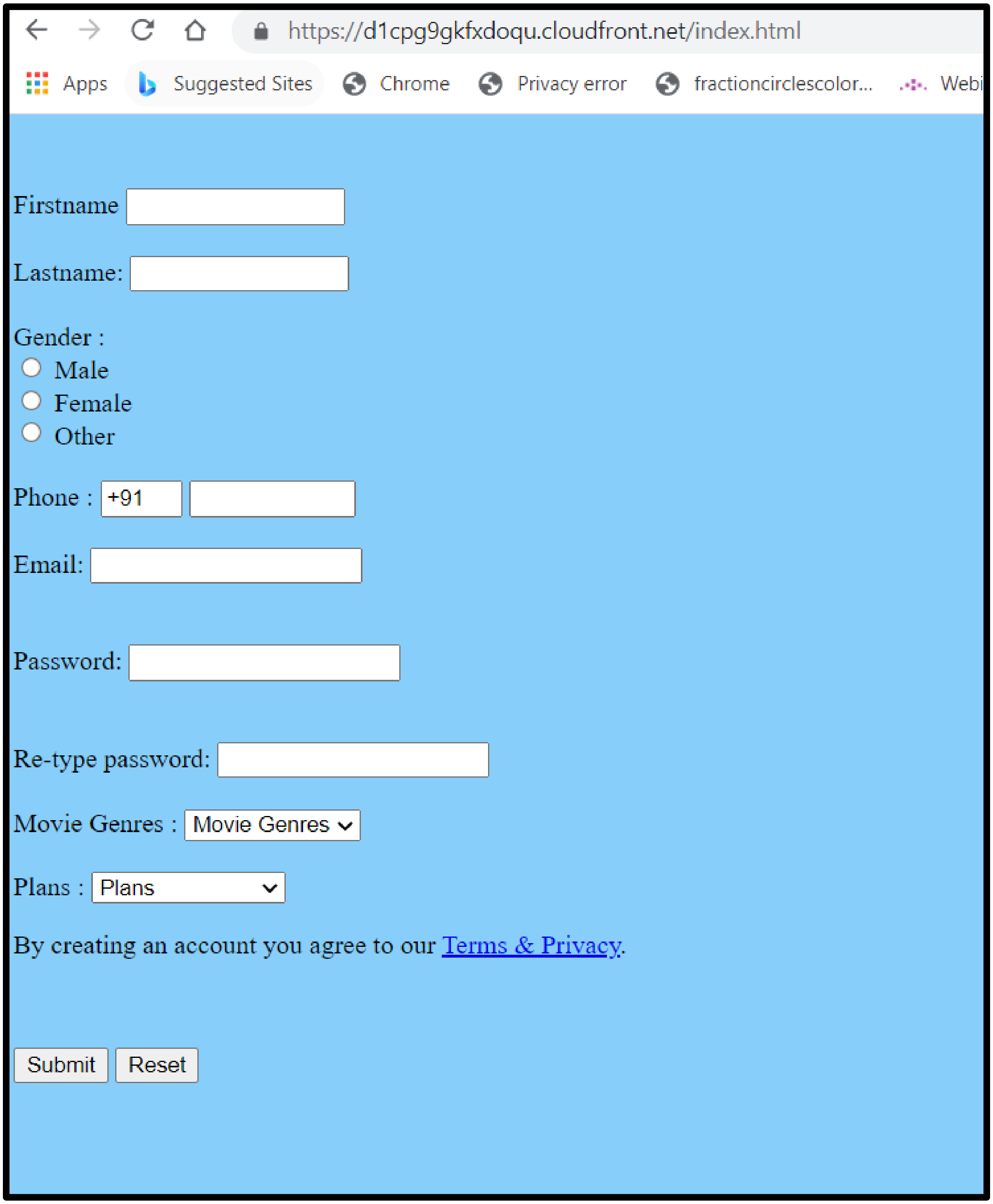
Origin domain
Choose an AWS origin, or enter your origin's domain name.
movieapp1232.s3.us-east-1.amazonaws.com

Origin path - *optional* Info
Enter a URL path to append to the origin domain name for origin requests.
Enter the origin path

Name
Enter a name for this origin.
movieapp1232.s3.us-east-1.amazonaws.com

S3 bucket access Info
Use a CloudFront origin access identity (OAI) to access the S3 bucket.
● Don't use OAI (bucket must allow public access)
○ Yes use OAI (bucket can restrict access to only CloudFront)

Verify website after CloudFront.



https://d1cpg9gkfxdoqu.cloudfront.net/index.html

Firstname

Lastname:

Gender :
○ Male
○ Female
○ Other

Phone : +91

Email:

Password:

Re-type password:

Movie Genres : Movie Genres

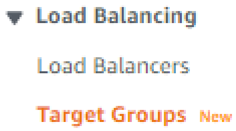
Plans : Plans

By creating an account you agree to our Terms & Privacy.

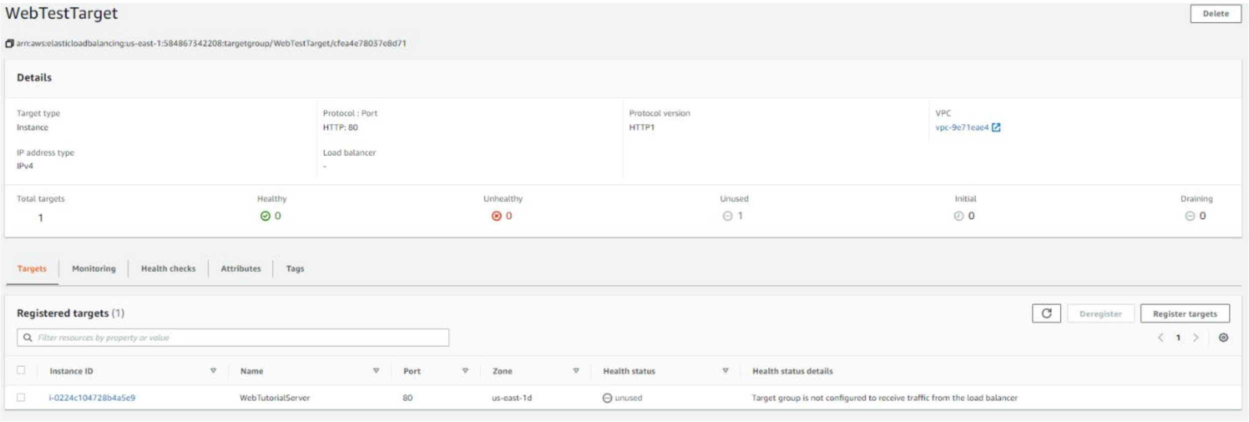
Lab: Setting Up WAF, Shield, and CloudFront

In this lab we will set up CloudFront, WAF, and Shield.

Starting from the management console, navigate to load balancers and set up a target group with an EC2-based web server.



Create a Target Group with your web server EC2 instance as a registered target. EC2 instances can only work with CloudFront when a load balancer is used.



WebTestTarget

Delete

arn:aws:elasticloadbalancing:us-east-1:584867342208:targetgroup/WebTestTarget/cfea4e78037e8d71

Details

Target type: Instance

IP address type: IPv4

Protocol : Port: HTTP: 80

Load balancer: -

Protocol version: HTTP1

VPC: vpc-9e71eae4

Total targets	Healthy	Unhealthy	Unused	Initial	Draining
1	0	0	1	0	0

Targets | Monitoring | Health checks | Attributes | Tags

Registered targets (1)

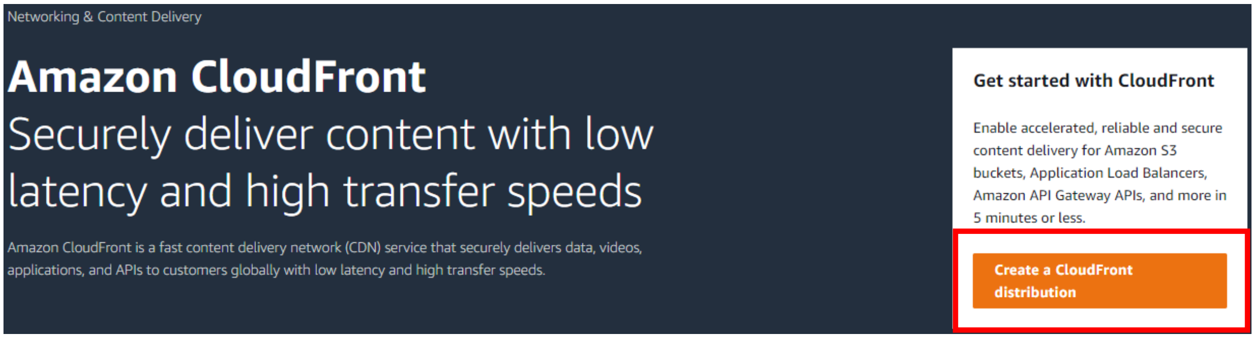
Filter resources by property or value

Deregister | Register targets

□	Instance ID	Name	Port	Zone	Health status	Health status details
□	i-0224c104728b4a5e9	WebTutorialServer	80	us-east-1d	unused	Target group is not configured to receive traffic from the load balancer

Set up CloudFront Distribution.

From the management console, navigate to CloudFront. Then create a CloudFront distribution.



Networking & Content Delivery

Amazon CloudFront

Securely deliver content with low latency and high transfer speeds

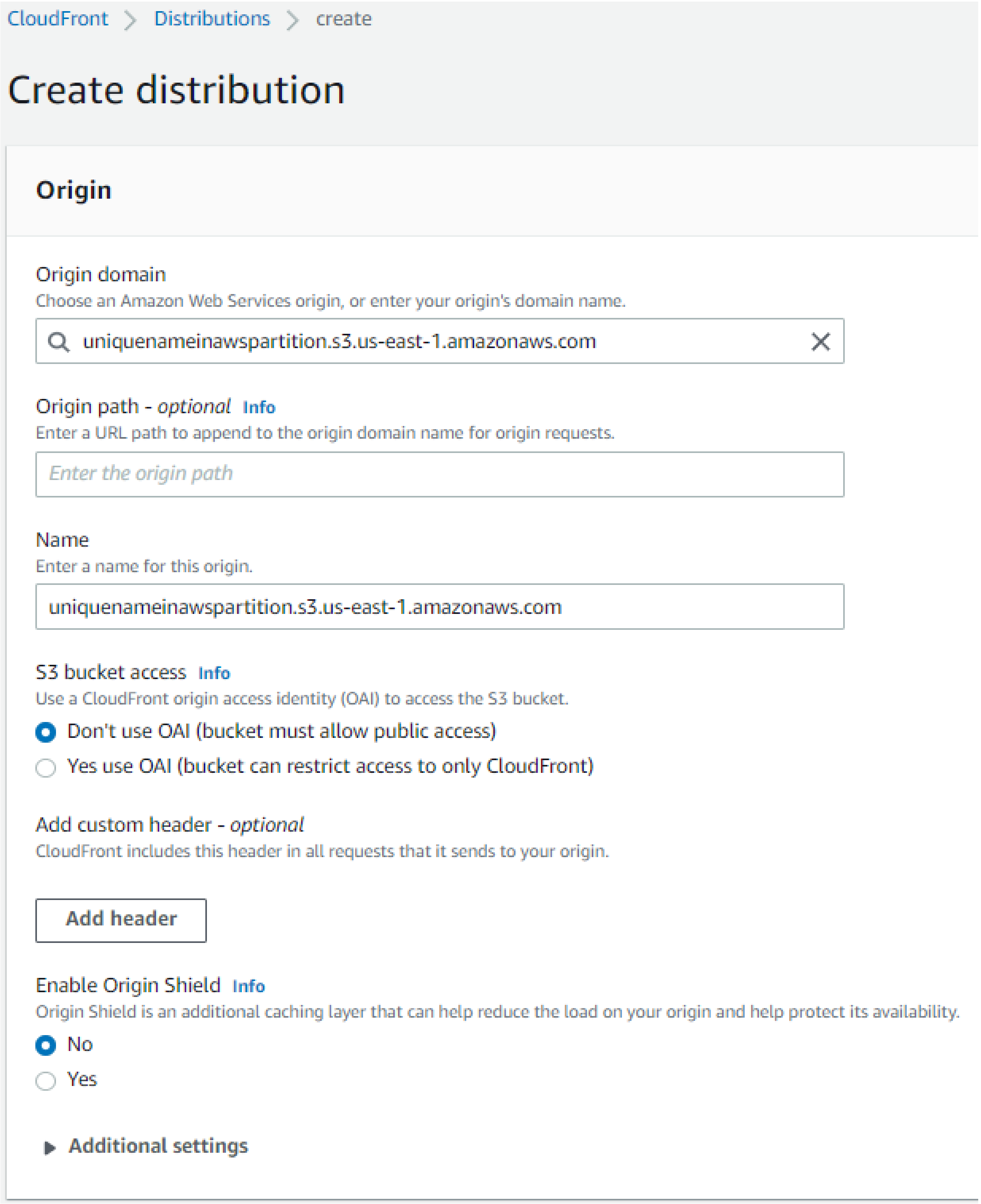
Amazon CloudFront is a fast content delivery network (CDN) service that securely delivers data, videos, applications, and APIs to customers globally with low latency and high transfer speeds.

Get started with CloudFront

Enable accelerated, reliable and secure content delivery for Amazon S3 buckets, Application Load Balancers, Amazon API Gateway APIs, and more in 5 minutes or less.

Create a CloudFront distribution

Select the S3 distribution you created. For this test, we will not enable Origin Shield.



Create distribution

Origin

Origin domain
Choose an Amazon Web Services origin, or enter your origin's domain name.
uniquenameinawspartition.s3.us-east-1.amazonaws.com

Origin path - *optional* Info
Enter a URL path to append to the origin domain name for origin requests.
Enter the origin path

Name
Enter a name for this origin.
uniquenameinawspartition.s3.us-east-1.amazonaws.com

S3 bucket access Info
Use a CloudFront origin access identity (OAI) to access the S3 bucket.

● Don't use OAI (bucket must allow public access)
○ Yes use OAI (bucket can restrict access to only CloudFront)

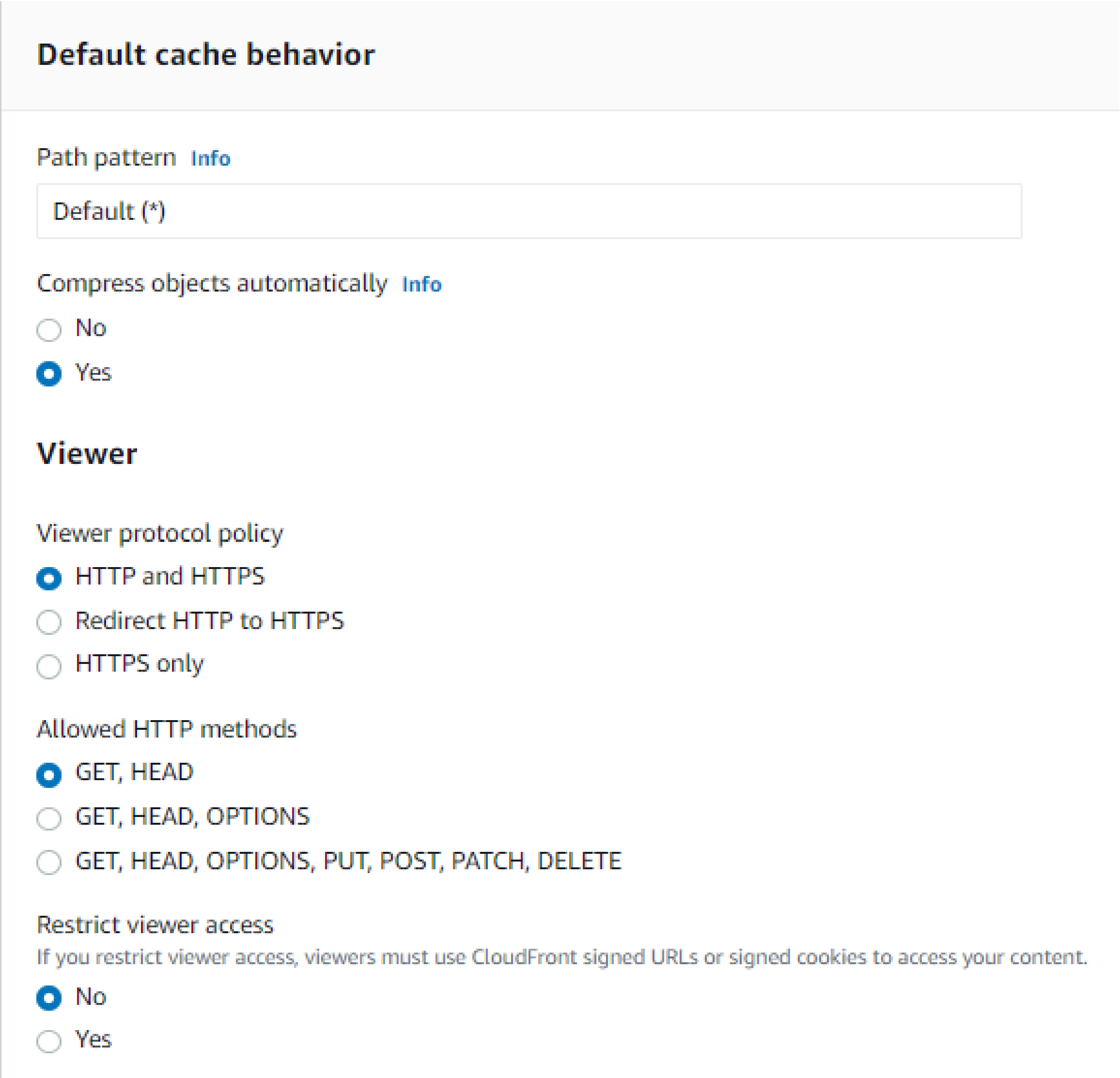
Add custom header - *optional*
CloudFront includes this header in all requests that it sends to your origin.

Enable Origin Shield Info
Origin Shield is an additional caching layer that can help reduce the load on your origin and help protect its availability.

● No
○ Yes

For this lab, we are only interested in the http and https protocols.

For this lab, we will not restrict viewer access.



Default cache behavior

Path pattern Info

Default (*)

Compress objects automatically Info

○ No
● Yes

Viewer

Viewer protocol policy

● HTTP and HTTPS
○ Redirect HTTP to HTTPS
○ HTTPS only

Allowed HTTP methods

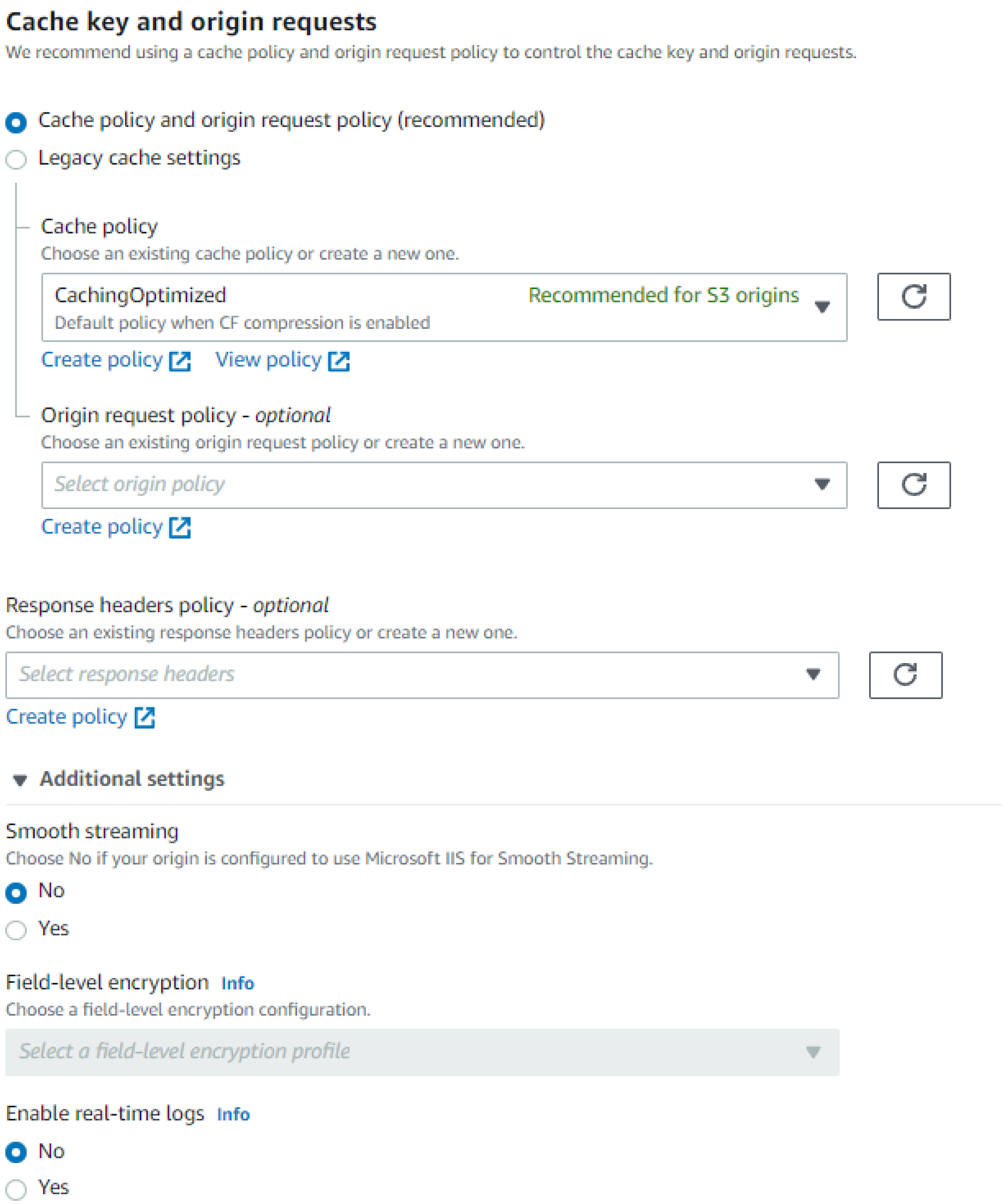
● GET, HEAD
○ GET, HEAD, OPTIONS
○ GET, HEAD, OPTIONS, PUT, POST, PATCH, DELETE

Restrict viewer access
If you restrict viewer access, viewers must use CloudFront signed URLs or signed cookies to access your content.

● No
○ Yes

We have kept most of the default options on the next few screens, which are geared toward optimizing performance.

Click Create Distribution.



Cache key and origin requests

We recommend using a cache policy and origin request policy to control the cache key and origin requests.

● Cache policy and origin request policy (recommended)

○ Legacy cache settings

Cache policy

Choose an existing cache policy or create a new one.

CachingOptimized — Recommended for S3 origins ▼

Default policy when CF compression is enabled

Create policy   View policy

Origin request policy - *optional*

Choose an existing origin request policy or create a new one.

Select origin policy ▼

Create policy

Response headers policy - *optional*

Choose an existing response headers policy or create a new one.

Select response headers ▼

Create policy

▼ **Additional settings**

Smooth streaming

Choose No if your origin is configured to use Microsoft IIS for Smooth Streaming.

● No

○ Yes

Field-level encryption **Info**

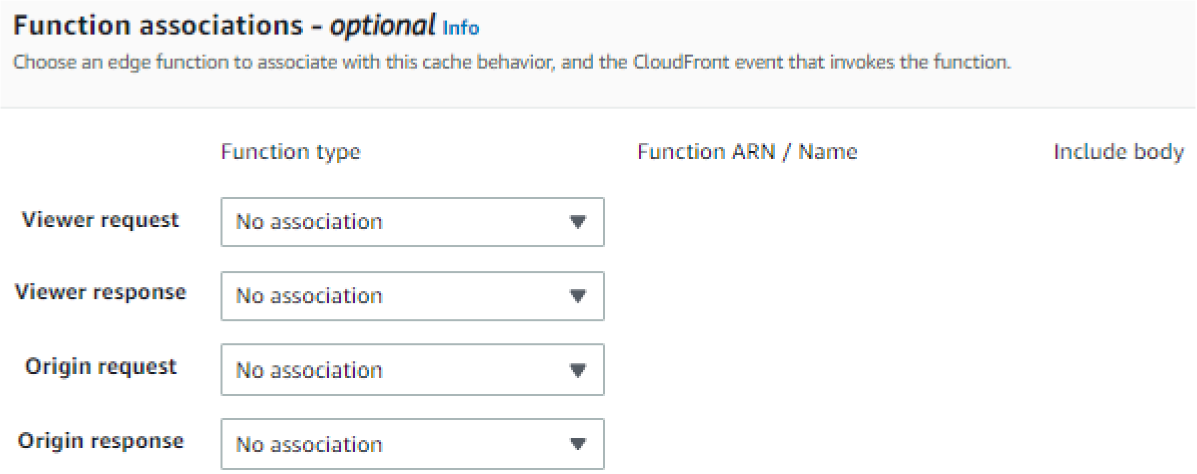
Choose a field-level encryption configuration.

Select a field-level encryption profile ▼

Enable real-time logs **Info**

● No

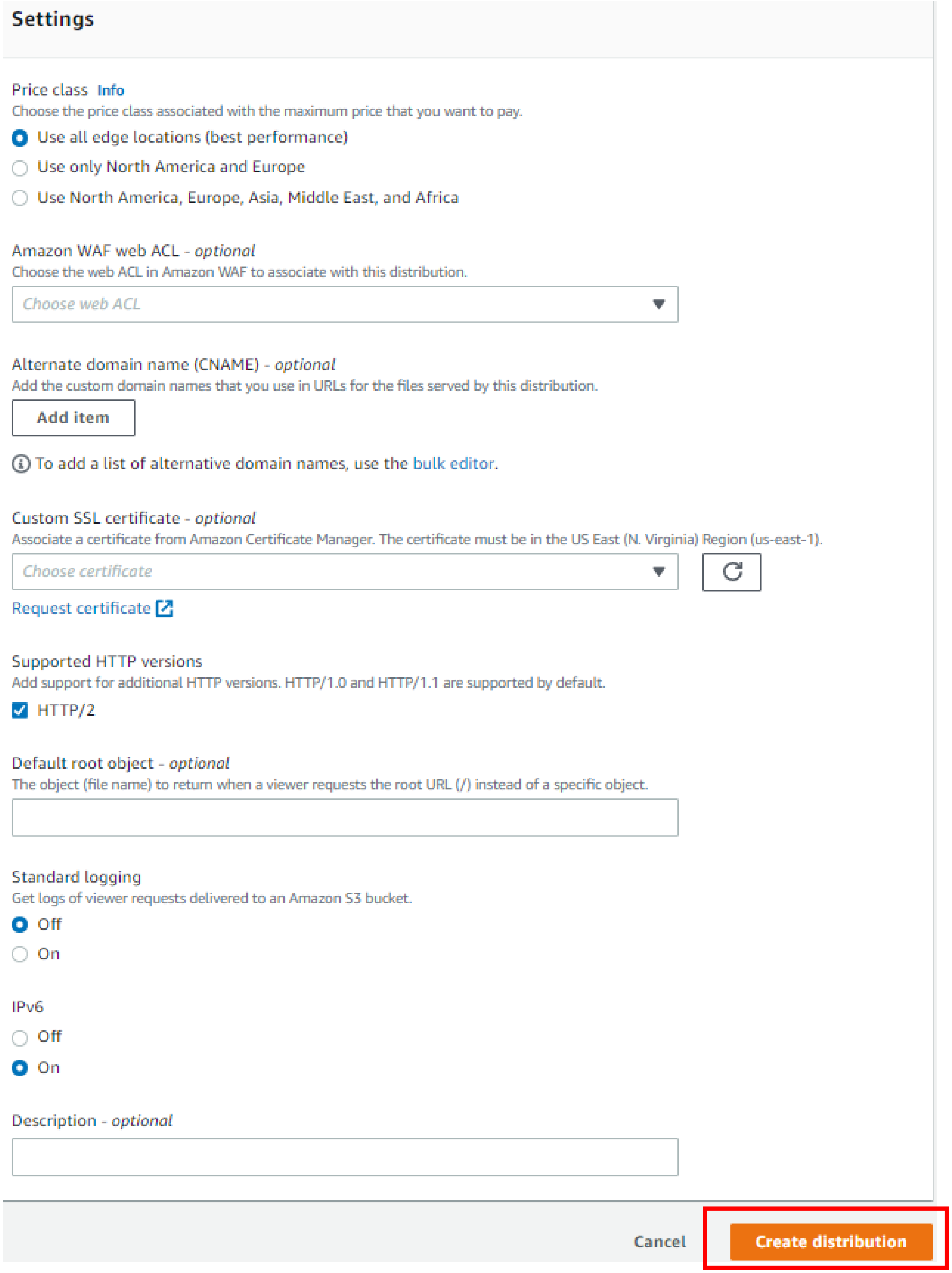
○ Yes



Function associations - *optional* Info

Choose an edge function to associate with this cache behavior, and the CloudFront event that invokes the function.

	Function type	Function ARN / Name	Include body
Viewer request	No association ▼		
Viewer response	No association ▼		
Origin request	No association ▼		
Origin response	No association ▼		



Settings

Price class Info

Choose the price class associated with the maximum price that you want to pay.

● Use all edge locations (best performance)

○ Use only North America and Europe

○ Use North America, Europe, Asia, Middle East, and Africa

Amazon WAF web ACL - *optional*

Choose the web ACL in Amazon WAF to associate with this distribution.

Choose web ACL ▼

Alternate domain name (CNAME) - *optional*

Add the custom domain names that you use in URLs for the files served by this distribution.

Add item

ⓘ To add a list of alternative domain names, use the bulk editor.

Custom SSL certificate - *optional*

Associate a certificate from Amazon Certificate Manager. The certificate must be in the US East (N. Virginia) Region (us-east-1).

Choose certificate ▼

Request certificate

Supported HTTP versions

Add support for additional HTTP versions. HTTP/1.0 and HTTP/1.1 are supported by default.

☑ HTTP/2

Default root object - *optional*

The object (file name) to return when a viewer requests the root URL (/) instead of a specific object.

Standard logging

Get logs of viewer requests delivered to an Amazon S3 bucket.

● Off

○ On

IPv6

○ Off

● On

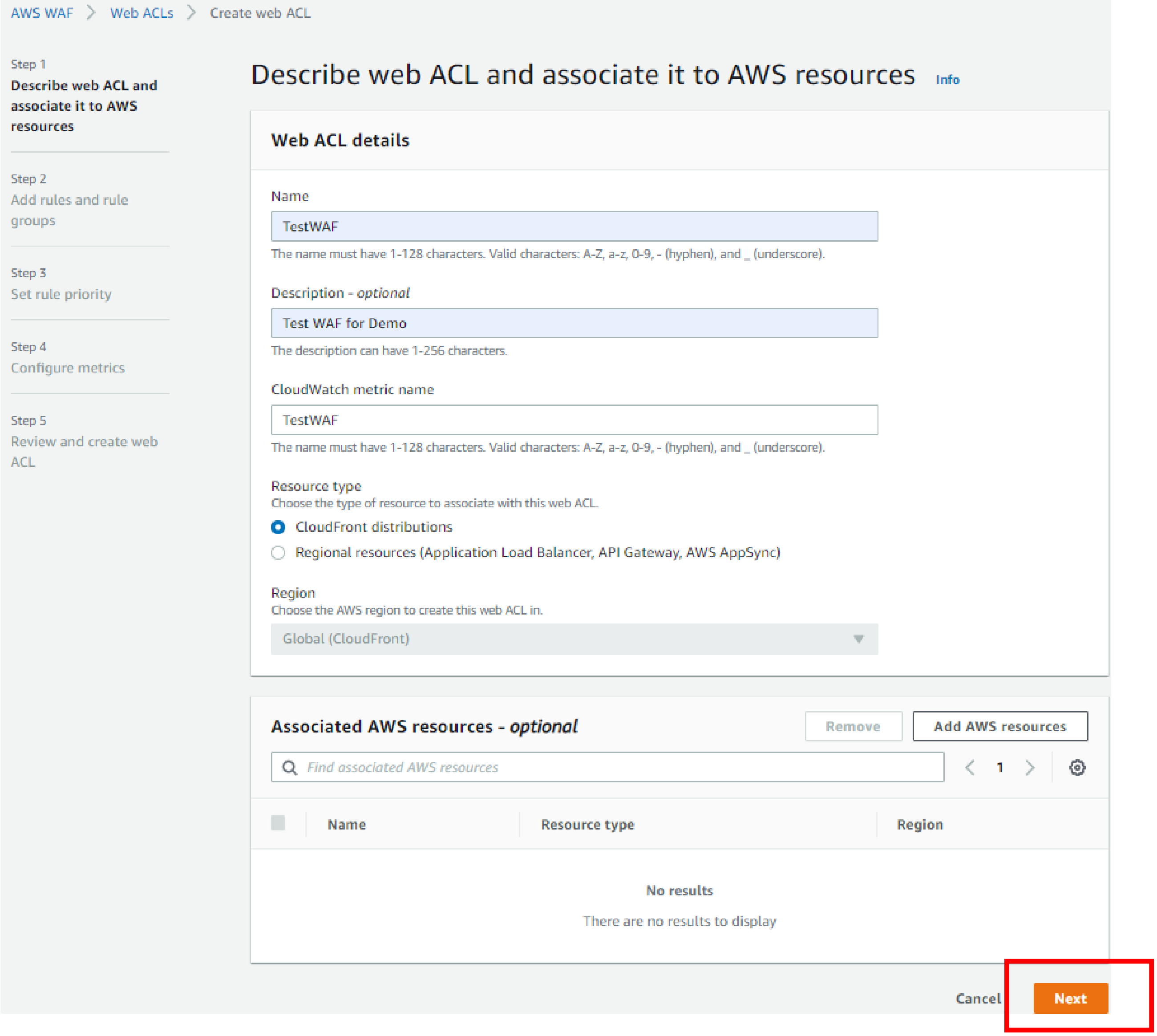
Description - *optional*

Lab: Create a Web Access Firewall (WAF)

In this lab, we have selected CloudFront distribution as the resource type..

The associated resource (CloudFront Distribution Name) can be added in this section, or you can add it later after the WAF has been created.

Click next:



AWS WAF > Web ACLs > Create web ACL

Step 1
Describe web ACL and associate it to AWS resources

Step 2
Add rules and rule groups

Step 3
Set rule priority

Step 4
Configure metrics

Step 5
Review and create web ACL

Describe web ACL and associate it to AWS resources Info

Web ACL details

Name
TestWAF
The name must have 1-128 characters. Valid characters: A-Z, a-z, 0-9, - (hyphen), and _ (underscore).

Description - *optional*
Test WAF for Demo
The description can have 1-256 characters.

CloudWatch metric name
TestWAF
The name must have 1-128 characters. Valid characters: A-Z, a-z, 0-9, - (hyphen), and _ (underscore).

Resource type
Choose the type of resource to associate with this web ACL.
● CloudFront distributions
○ Regional resources (Application Load Balancer, API Gateway, AWS AppSync)

Region
Choose the AWS region to create this web ACL in.
Global (CloudFront)

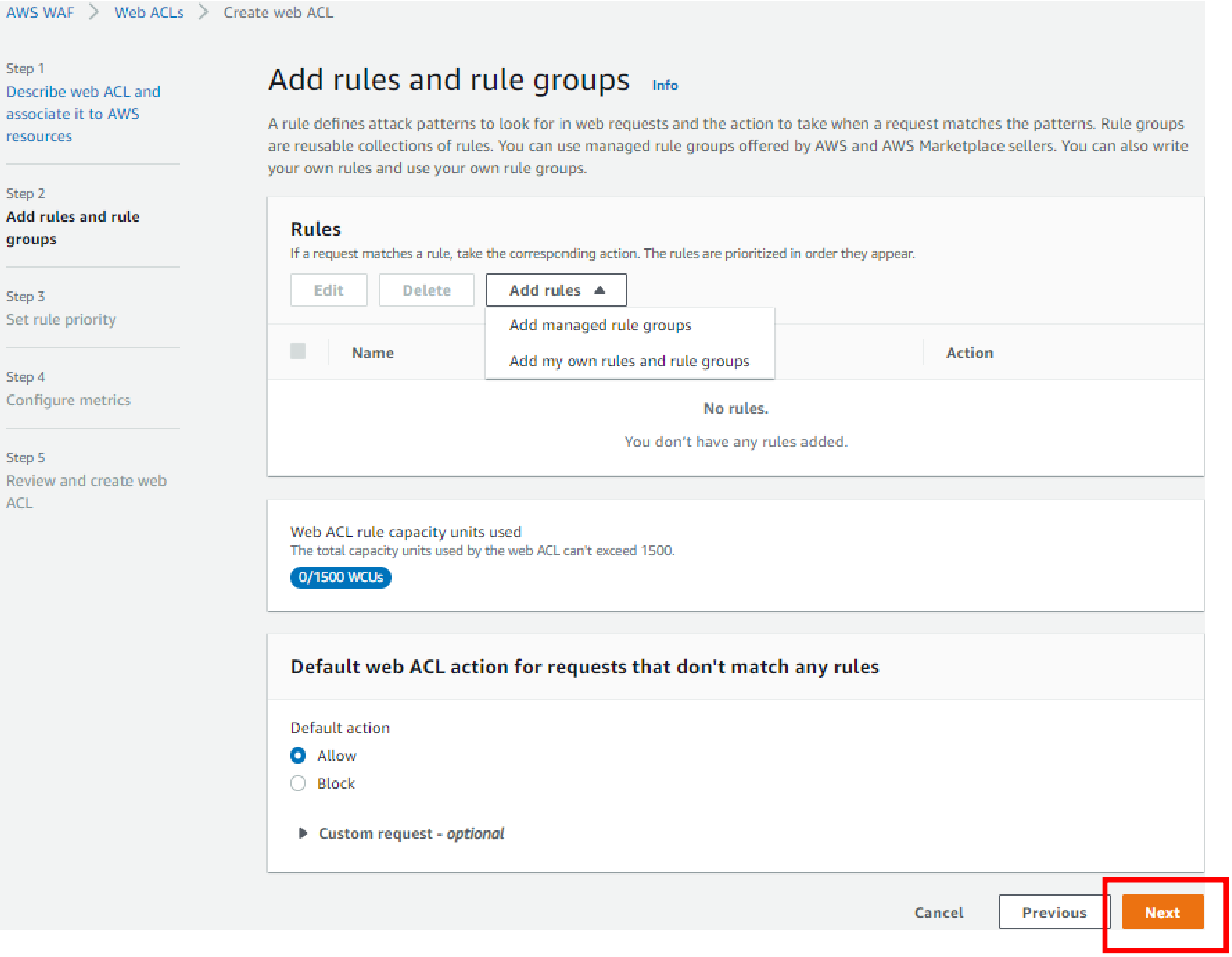
Associated AWS resources - *optional*

Name	Resource type	Region

No results
There are no results to display

In this lab, we have opted not to add any custom rules and will use the defaults.

Click next:



AWS WAF > Web ACLs > Create web ACL

Step 1
Describe web ACL and associate it to AWS resources

Step 2
Add rules and rule groups

Step 3
Set rule priority

Step 4
Configure metrics

Step 5
Review and create web ACL

Add rules and rule groups Info

A rule defines attack patterns to look for in web requests and the action to take when a request matches the patterns. Rule groups are reusable collections of rules. You can use managed rule groups offered by AWS and AWS Marketplace sellers. You can also write your own rules and use your own rule groups.

Rules

If a request matches a rule, take the corresponding action. The rules are prioritized in order they appear.

No rules.

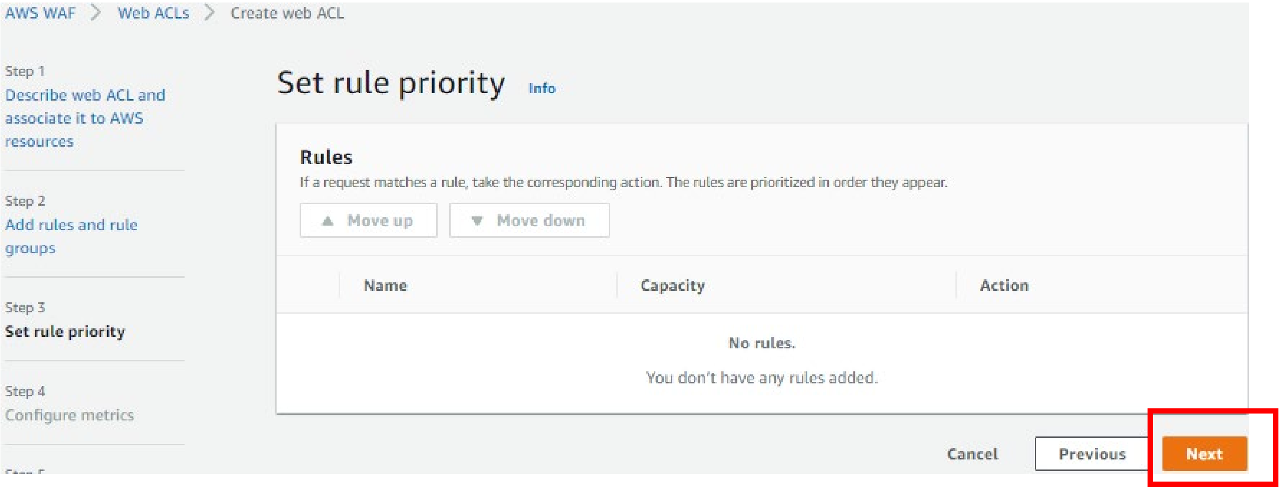
You don't have any rules added.

Web ACL rule capacity units used
The total capacity units used by the web ACL can't exceed 1500.
0/1500 WCUs

Default web ACL action for requests that don't match any rules

Default action
● Allow
○ Block

▸ Custom request - *optional*


AWS WAF > Web ACLs > Create web ACL

Step 1
Describe web ACL and associate it to AWS resources

Step 2
Add rules and rule groups

Step 3
Set rule priority

Step 4
Configure metrics

Set rule priority

Info

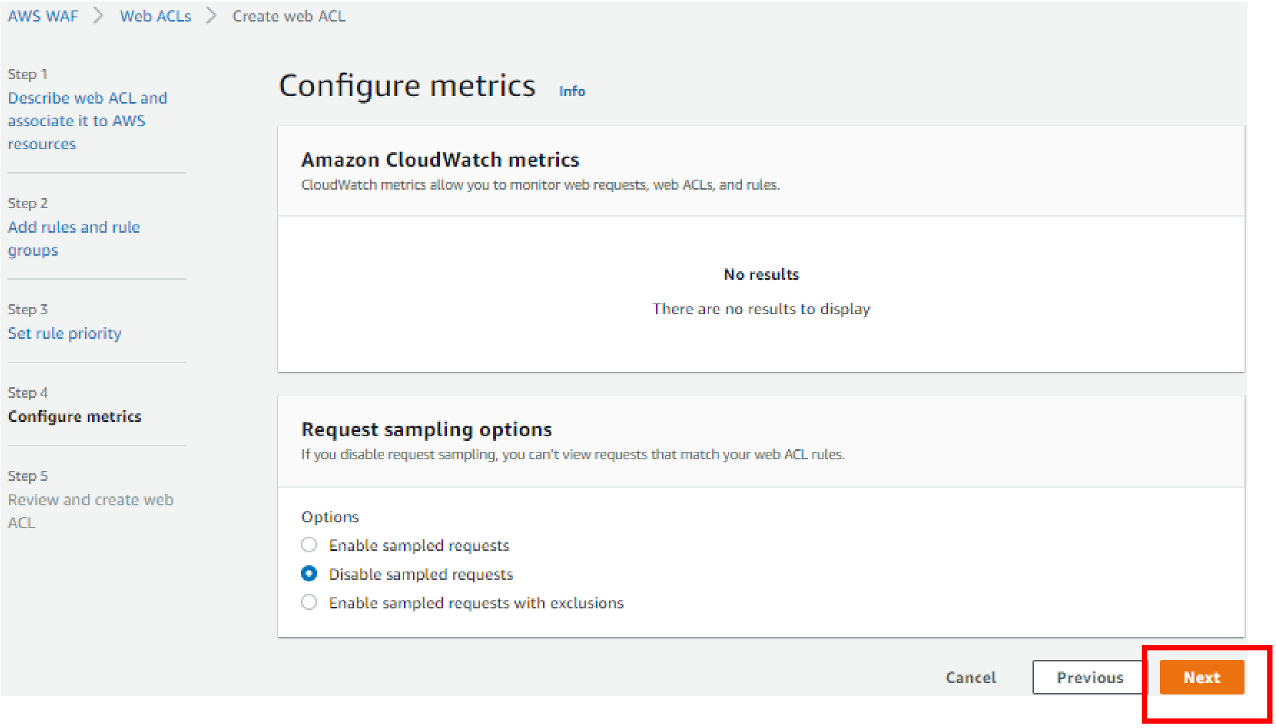
Rules

If a request matches a rule, take the corresponding action. The rules are prioritized in order they appear.

Name	Capacity	Action

No rules.

You don't have any rules added.


AWS WAF > Web ACLs > Create web ACL

Step 1
Describe web ACL and associate it to AWS resources

Step 2
Add rules and rule groups

Step 3
Set rule priority

Step 4
Configure metrics

Step 5
Review and create web ACL

Configure metrics

Info

Amazon CloudWatch metrics

CloudWatch metrics allow you to monitor web requests, web ACLs, and rules.

No results

There are no results to display

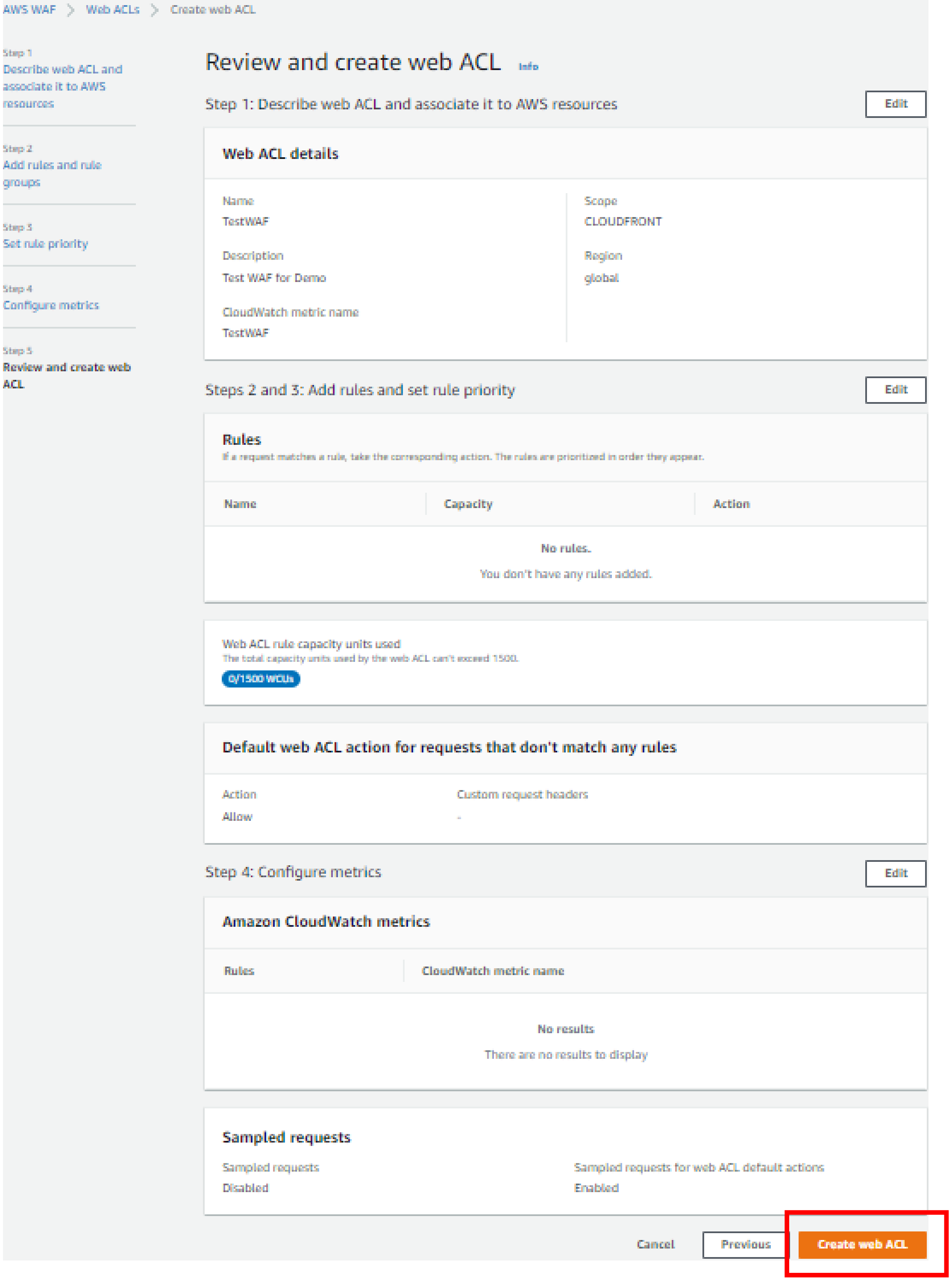
Request sampling options

If you disable request sampling, you can't view requests that match your web ACL rules.

Options

○ Enable sampled requests
● Disable sampled requests
○ Enable sampled requests with exclusions

Review all the options selected and click on “Create Web ACL”.


AWS WAF > Web ACLs > Create web ACL
Step 1
Describe web ACL and associate it to AWS resources
Step 2
Add rules and rule groups
Step 3
Set rule priority
Step 4
Configure metrics
Step 5
Review and create web ACL
Info
Edit
Edit
Edit
Cancel
Previous
Create web ACL

Review and create web ACL

Step 1: Describe web ACL and associate it to AWS resources

Web ACL details

Name TestWAF	Scope CLOUDFRONT
Description Test WAF for Demo	Region global
CloudWatch metric name TestWAF	

Steps 2 and 3: Add rules and set rule priority

Rules

If a request matches a rule, take the corresponding action. The rules are prioritized in order they appear.

Name	Capacity	Action

No rules.

You don't have any rules added.

Web ACL rule capacity units used

The total capacity units used by the web ACL can't exceed 1500.

0/1500 WCUs

Default web ACL action for requests that don't match any rules

Action	Custom request headers
Allow	-

Step 4: Configure metrics

Amazon CloudWatch metrics

Rules	CloudWatch metric name

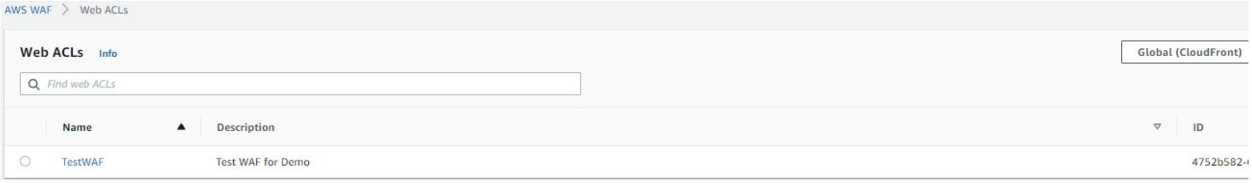
No results

There are no results to display

Sampled requests

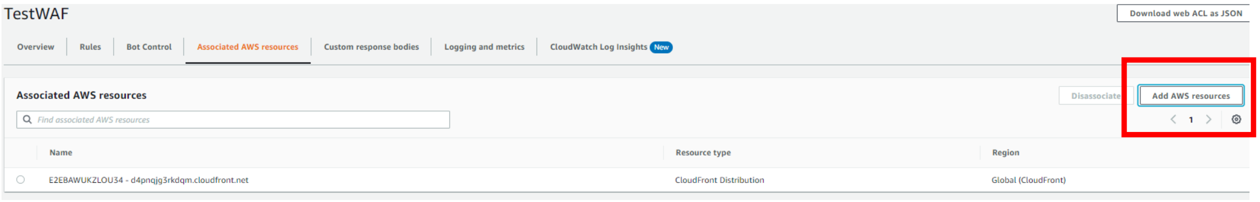
Sampled requests	Sampled requests for web ACL default actions
Disabled	Enabled

Once the ACL has been created, it can be associated with the CloudFront distribution.

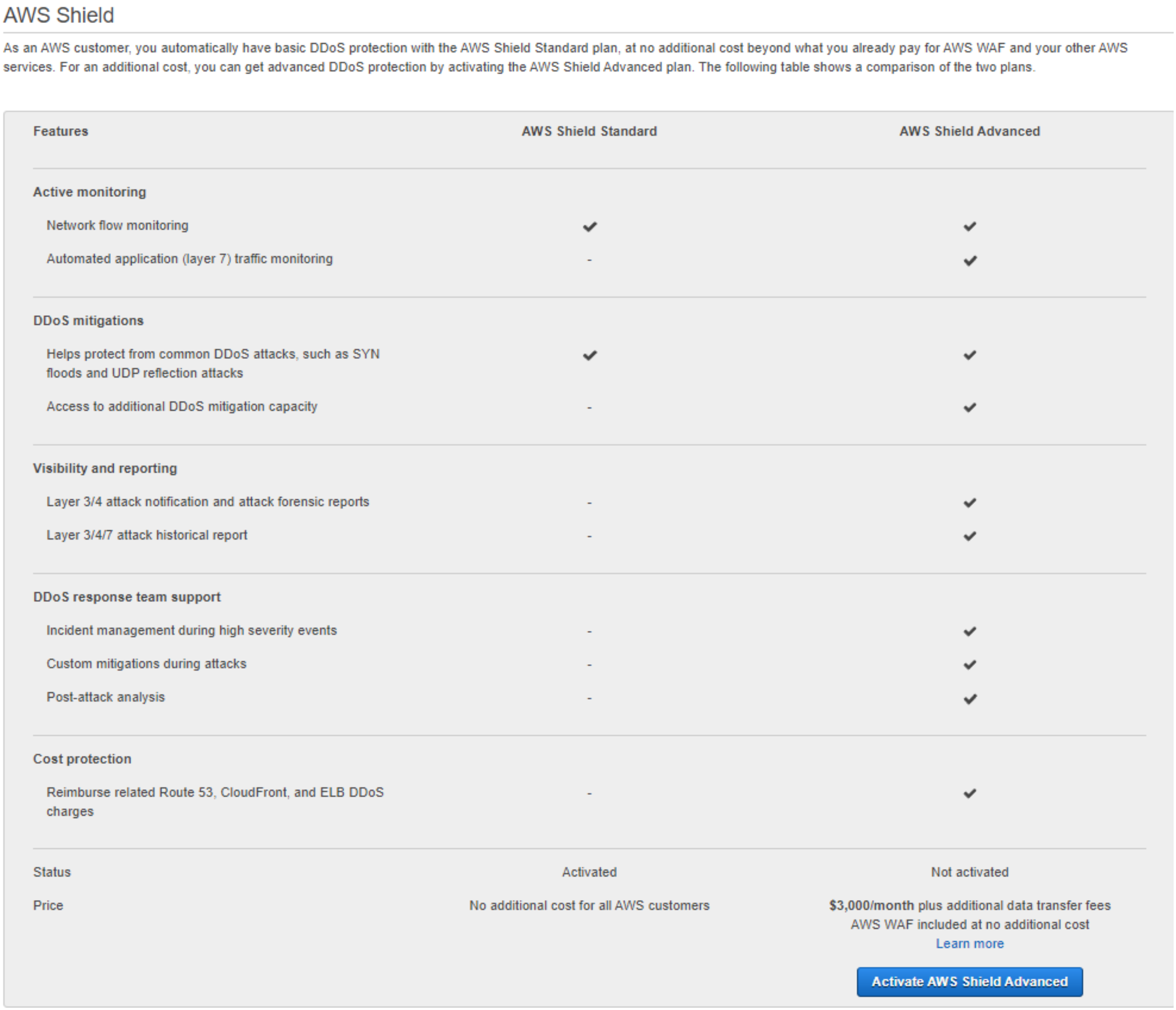


	Name ▲	Description	ID
○	TestWAF	Test WAF for Demo	4752b582-(

For all CloudFront Distributions, AWS Shield will be automatically enabled.



	Name	Resource type	Region
○	E2EBAWUKZLOU34 - d4pnqjg3rkdqm.cloudfront.net	CloudFront Distribution	Global (CloudFront)



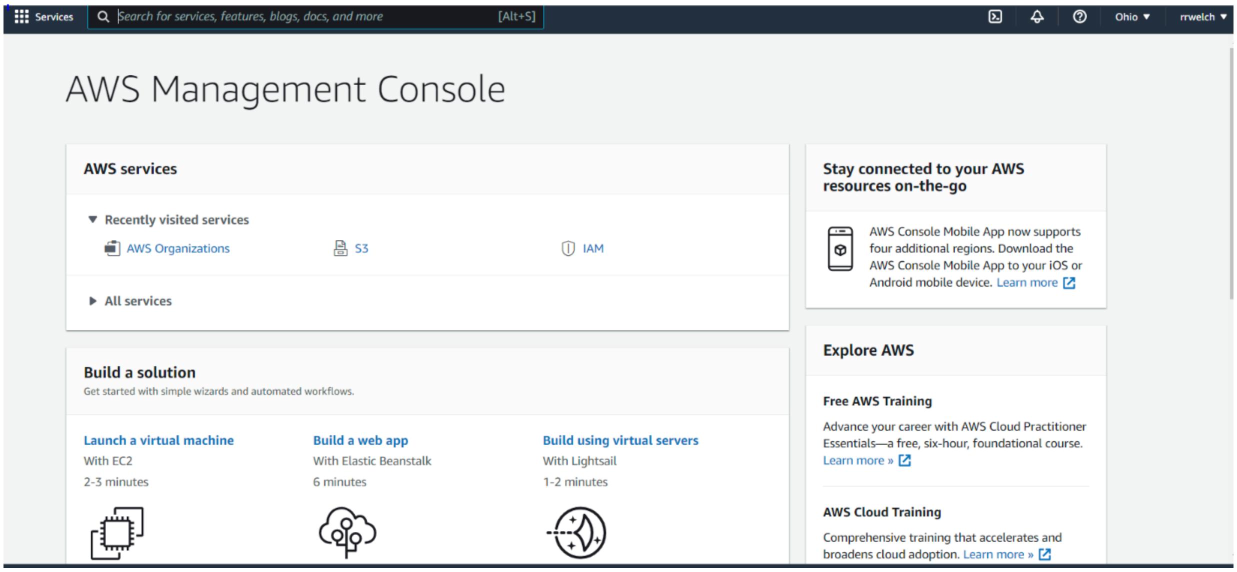
AWS Shield

As an AWS customer, you automatically have basic DDoS protection with the AWS Shield Standard plan, at no additional cost beyond what you already pay for AWS WAF and your other AWS services. For an additional cost, you can get advanced DDoS protection by activating the AWS Shield Advanced plan. The following table shows a comparison of the two plans.

Features	AWS Shield Standard	AWS Shield Advanced
Active monitoring		
Network flow monitoring	✓	✓
Automated application (layer 7) traffic monitoring	-	✓
DDoS mitigations		
Helps protect from common DDoS attacks, such as SYN floods and UDP reflection attacks	✓	✓
Access to additional DDoS mitigation capacity	-	✓
Visibility and reporting		
Layer 3/4 attack notification and attack forensic reports	-	✓
Layer 3/4/7 attack historical report	-	✓
DDoS response team support		
Incident management during high severity events	-	✓
Custom mitigations during attacks	-	✓
Post-attack analysis	-	✓
Cost protection		
Reimburse related Route 53, CloudFront, and ELB DDoS charges	-	✓
Status	Activated	Not activated
Price	No additional cost for all AWS customers	$3,000/month plus additional data transfer fees AWS WAF included at no additional cost Learn more

Lab: Creating an AWS Organization with AWS Management Console

In this lab we will be setting up AWS organizations. From the AWS Management Console, click on your username (upper right) to access a drop-down menu.

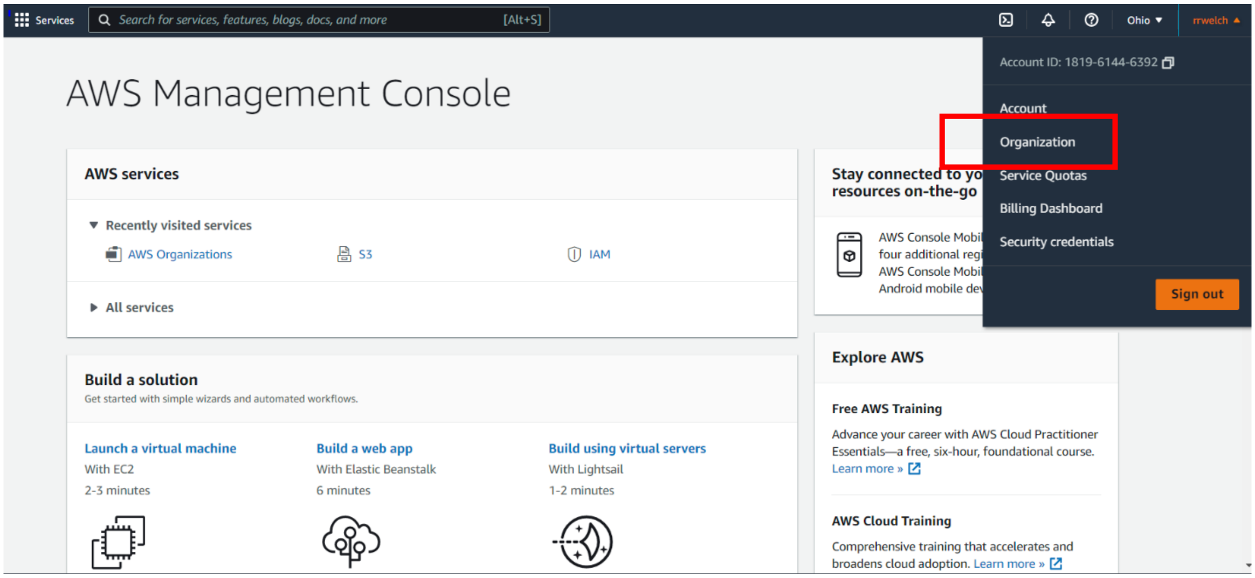


AWS Console Mobile App now supports four additional regions. Download the AWS Console Mobile App to your iOS or Android mobile device. Learn more

Advance your career with AWS Cloud Practitioner Essentials—a free, six-hour, foundational course. Learn more »

Comprehensive training that accelerates and broadens cloud adoption. Learn more »

Select Organization in the drop-down menu.

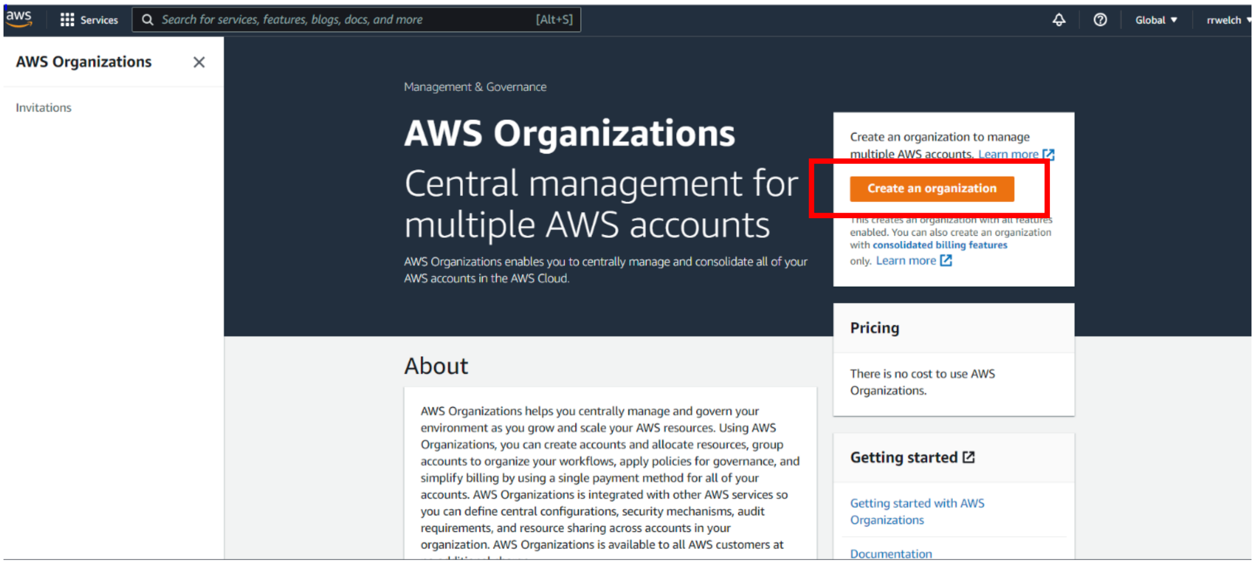


AWS Console Mobi
four additional regi
AWS Console Mobi
Android mobile dev

Advance your career with AWS Cloud Practitioner Essentials—a free, six-hour, foundational course. Learn more »

Comprehensive training that accelerates and broadens cloud adoption. Learn more »

Click Create an organization:



Management & Governance

AWS Organizations

Central management for multiple AWS accounts

AWS Organizations enables you to centrally manage and consolidate all of your AWS accounts in the AWS Cloud.

Create an organization to manage multiple AWS accounts. Learn more

Create an organization

This creates an organization with all features enabled. You can also create an organization with **consolidated billing features** only. Learn more

Pricing

There is no cost to use AWS Organizations.

About

AWS Organizations helps you centrally manage and govern your environment as you grow and scale your AWS resources. Using AWS Organizations, you can create accounts and allocate resources, group accounts to organize your workflows, apply policies for governance, and simplify billing by using a single payment method for all of your accounts. AWS Organizations is integrated with other AWS services so you can define central configurations, security mechanisms, audit requirements, and resource sharing across accounts in your organization. AWS Organizations is available to all AWS customers at

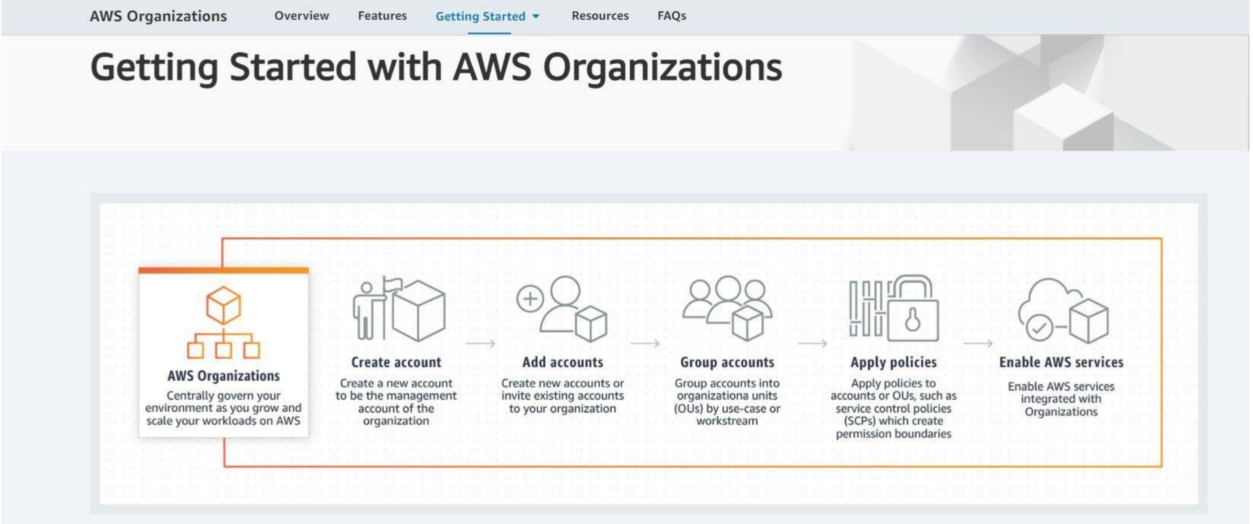
Getting started

Getting started with AWS Organizations

Documentation

Creating an organization is a simple process:

1. Create the organization.
2. Create and add a new account.
3. Group accounts.
4. Apply policies.
5. Enable services.



Getting Started with AWS Organizations

AWS Organizations
Centrally govern your environment as you grow and scale your workloads on AWS

Create account
Create a new account to be the management account of the organization

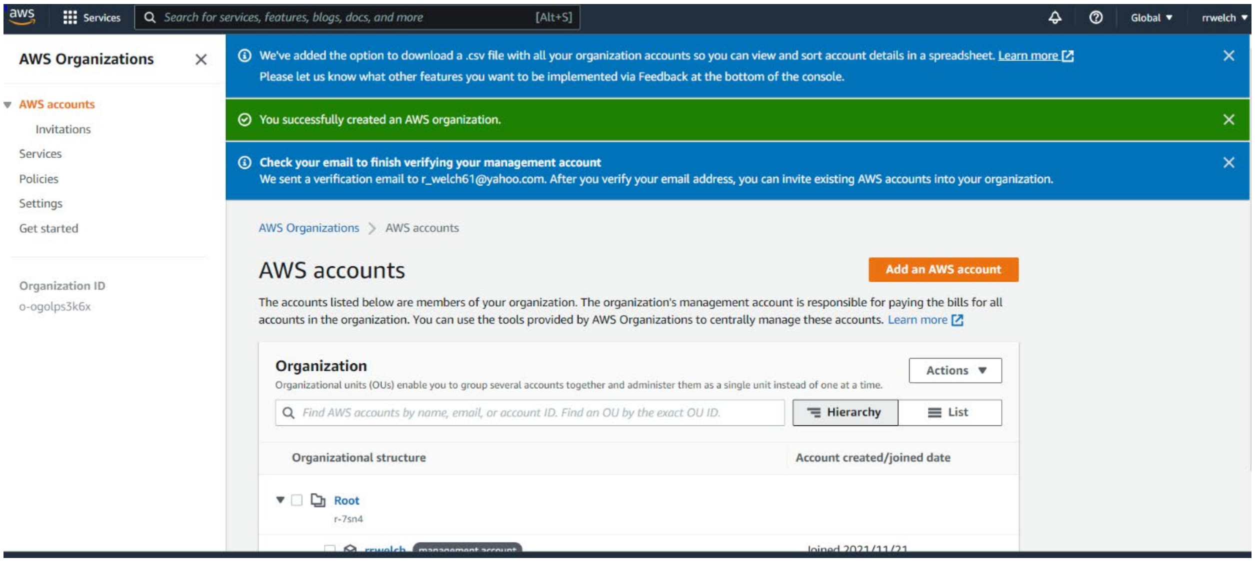
Add accounts
Create new accounts or invite existing accounts to your organization

Group accounts
Group accounts into organizationa units (OUs) by use-case or workstream

Apply policies
Apply policies to accounts or OUs, such as service control policies (SCPs) which create permission boundaries

Enable AWS services
Enable AWS services integrated with Organizations

An email will be sent to the user to verify that you have created an organization. Once you verify, you will be able to add accounts.



Organization ID
o-ogolps3k6x

We've added the option to download a .csv file with all your organization accounts so you can view and sort account details in a spreadsheet. Learn more
Please let us know what other features you want to be implemented via Feedback at the bottom of the console.

You successfully created an AWS organization.

Check your email to finish verifying your management account
We sent a verification email to r_welch61@yahoo.com. After you verify your email address, you can invite existing AWS accounts into your organization.

AWS Organizations > AWS accounts

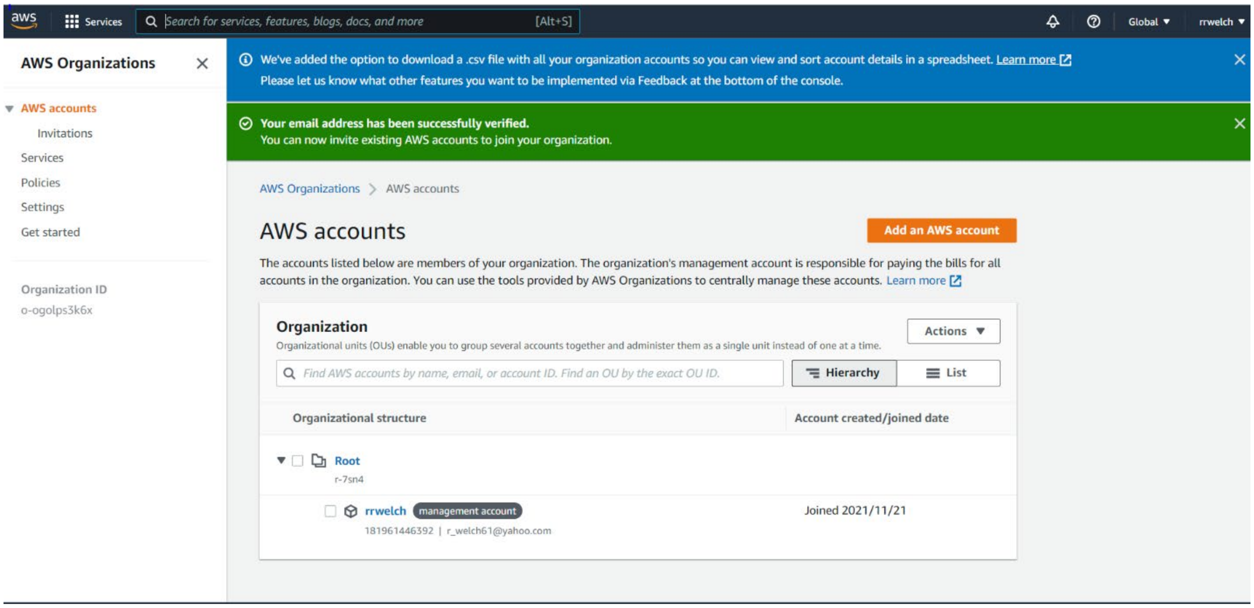
AWS accounts

The accounts listed below are members of your organization. The organization's management account is responsible for paying the bills for all accounts in the organization. You can use the tools provided by AWS Organizations to centrally manage these accounts. Learn more

Organization
Organizational units (OUs) enable you to group several accounts together and administer them as a single unit instead of one at a time.

Organizational structure	Account created/joined date
▼ □ Root r-7sn4	
□ rrwelch management account	Joined 2021/11/21

The accounts listed below are members of your organization. The organization's management account is responsible for paying the bills for all accounts in the organization. You can use the tools provided by AWS Organizations to centrally manage these accounts.



Organization ID
o-ogolps3k6x

We've added the option to download a .csv file with all your organization accounts so you can view and sort account details in a spreadsheet. Learn more
Please let us know what other features you want to be implemented via Feedback at the bottom of the console.

Your email address has been successfully verified.
You can now invite existing AWS accounts to join your organization.

AWS Organizations > AWS accounts

AWS accounts

The accounts listed below are members of your organization. The organization's management account is responsible for paying the bills for all accounts in the organization. You can use the tools provided by AWS Organizations to centrally manage these accounts. Learn more

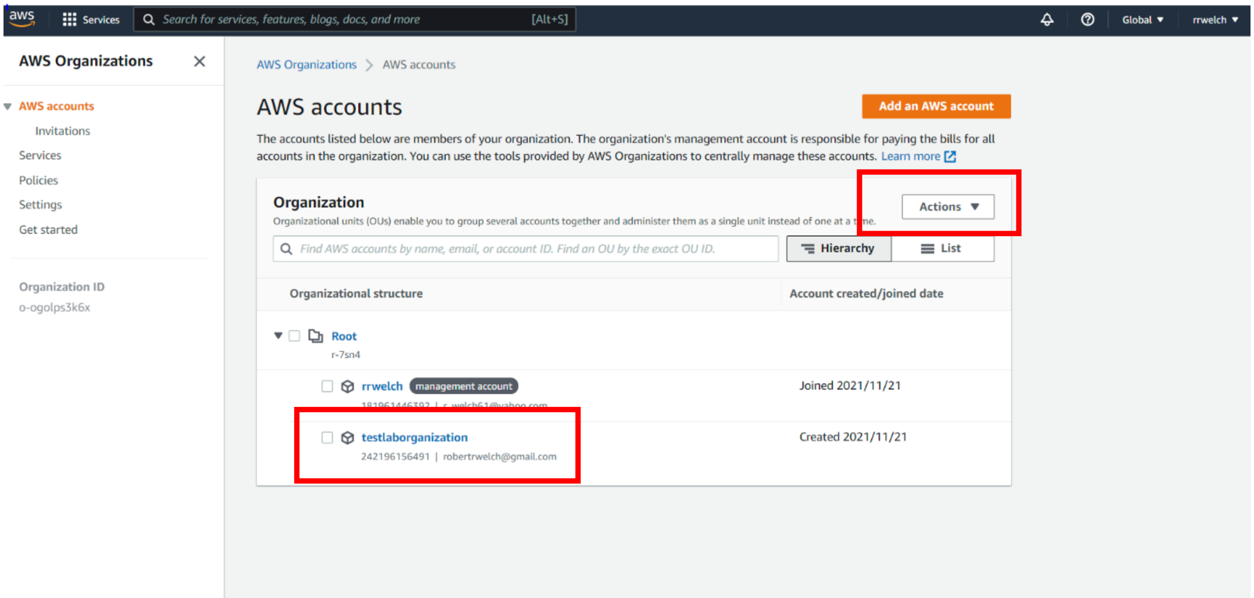
Organization
Organizational units (OUs) enable you to group several accounts together and administer them as a single unit instead of one at a time.

Organizational structure	Account created/joined date
▼ □ Root r-7sn4	
□ rrwelch management account 181961446392 | r_welch61@yahoo.com	Joined 2021/11/21

Create a new AWS group under your organization.

It may take some time to create a new account.

Click on Root and then select the action drop-down and create a new organizational group.



AWS Organizations > AWS accounts

AWS accounts

The accounts listed below are members of your organization. The organization's management account is responsible for paying the bills for all accounts in the organization. You can use the tools provided by AWS Organizations to centrally manage these accounts. Learn more

Organization

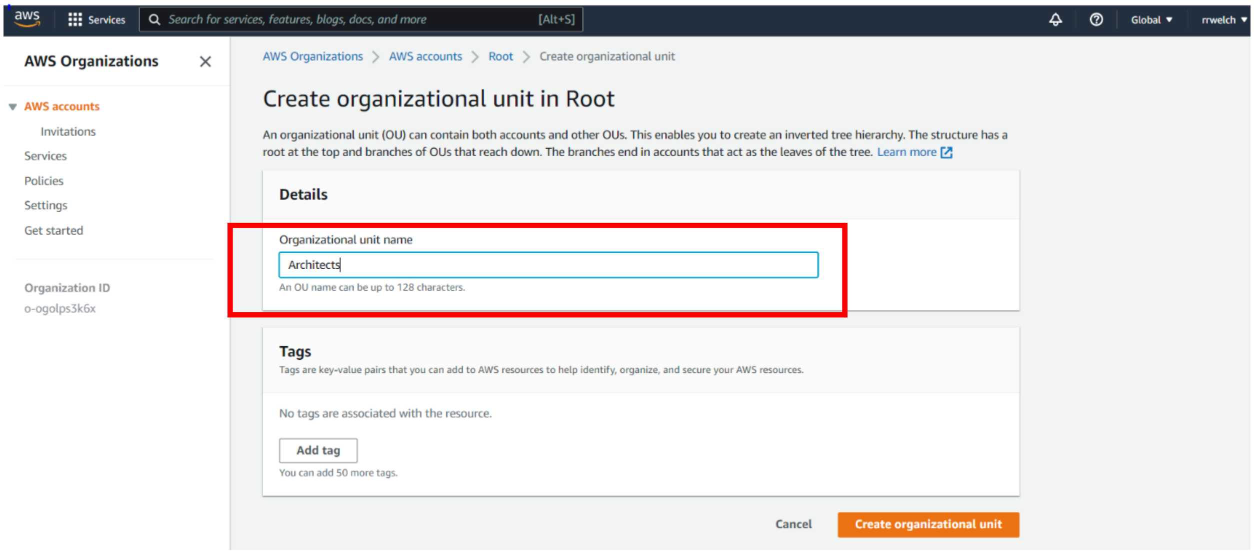
Organizational units (OUs) enable you to group several accounts together and administer them as a single unit instead of one at a time.

Find AWS accounts by name, email, or account ID. Find an OU by the exact OU ID.

Organizational structure	Account created/joined date
▼ □ Root r-7sn4	
□ rrwelch management account 181961446392 | r_welch61@yahoo.com	Joined 2021/11/21
□ testlaborganization 242196156491 | robertrwelch@gmail.com	Created 2021/11/21

Organization ID
o-ogolps3k6x

Enter a name:



AWS Organizations > AWS accounts > Root > Create organizational unit

Create organizational unit in Root

An organizational unit (OU) can contain both accounts and other OUs. This enables you to create an inverted tree hierarchy. The structure has a root at the top and branches of OUs that reach down. The branches end in accounts that act as the leaves of the tree. Learn more

Details

Organizational unit name: Architects

An OU name can be up to 128 characters.

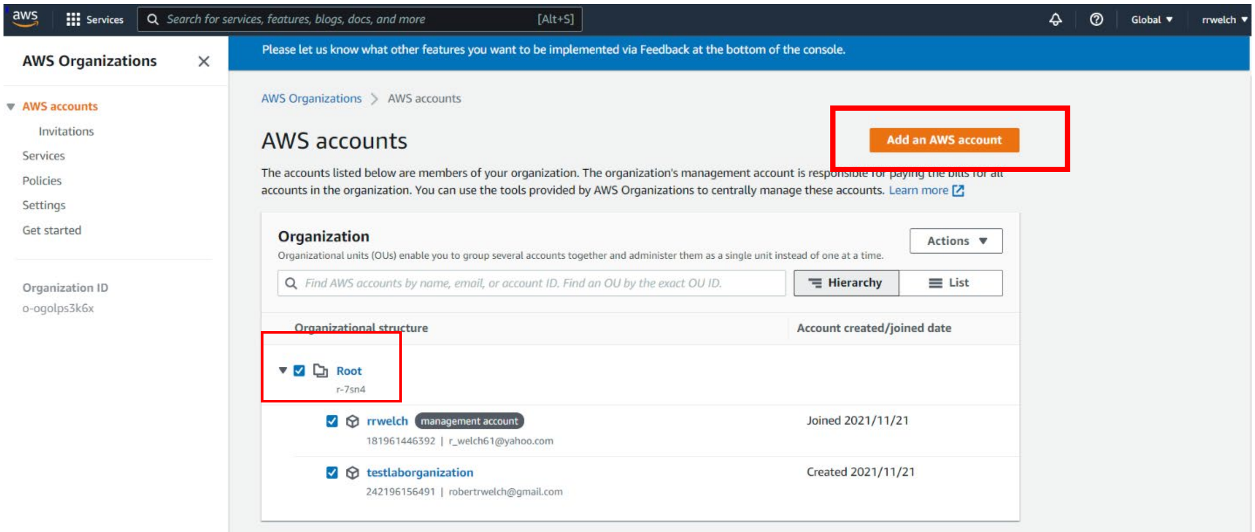
Tags

Tags are key-value pairs that you can add to AWS resources to help identify, organize, and secure your AWS resources.

No tags are associated with the resource.

You can add 50 more tags.

Organization ID
o-ogolps3k6x


aws
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Global ▼
rrwelch ▼
AWS Organizations
AWS accounts
Invitations
Services
Policies
Settings
Get started
AWS Organizations > AWS accounts
Add an AWS account
Actions ▼
Find AWS accounts by name, email, or account ID. Find an OU by the exact OU ID.
Hierarchy
List

Please let us know what other features you want to be implemented via Feedback at the bottom of the console.

AWS accounts

The accounts listed below are members of your organization. The organization's management account is responsible for paying the bills for all accounts in the organization. You can use the tools provided by AWS Organizations to centrally manage these accounts. Learn more

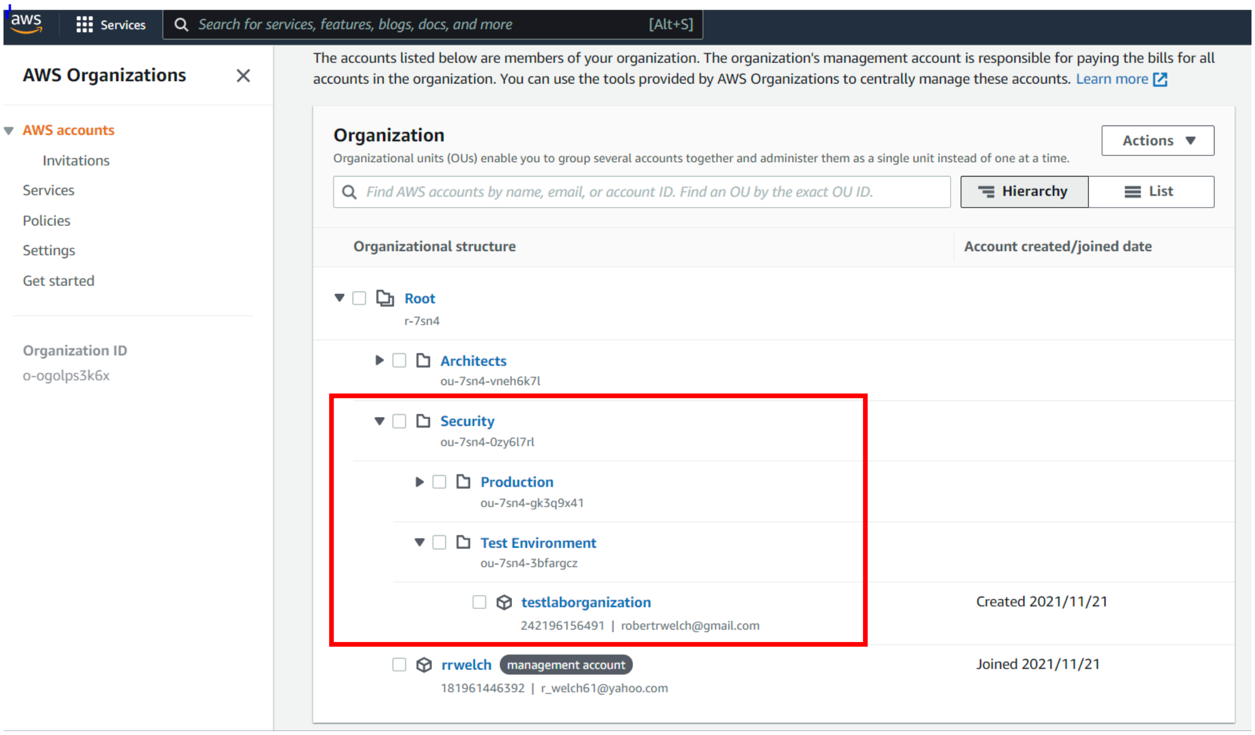
Organization ID
o-ogolps3k6x

Organization

Organizational units (OUs) enable you to group several accounts together and administer them as a single unit instead of one at a time.

Organizational structure	Account created/joined date
☑ Root r-7sn4	
☑ rrwelch management account 181961446392 | r_welch61@yahoo.com	Joined 2021/11/21
☑ testlaborganization 242196156491 | robertrwelch@gmail.com	Created 2021/11/21

Now let’s move the new user under the Security Organization by selecting the name and the Actions drop-down. “Move” then select the organization you wish to place them in. Best Practice: prior to creating organizational hierarchies, think about how the company is structured and design to meet their needs.


aws
Services
Search for services, features, blogs, docs, and more
[Alt+S]
AWS Organizations
AWS accounts
Invitations
Services
Policies
Settings
Get started
Actions ▼
Find AWS accounts by name, email, or account ID. Find an OU by the exact OU ID.
Hierarchy
List

The accounts listed below are members of your organization. The organization's management account is responsible for paying the bills for all accounts in the organization. You can use the tools provided by AWS Organizations to centrally manage these accounts. Learn more

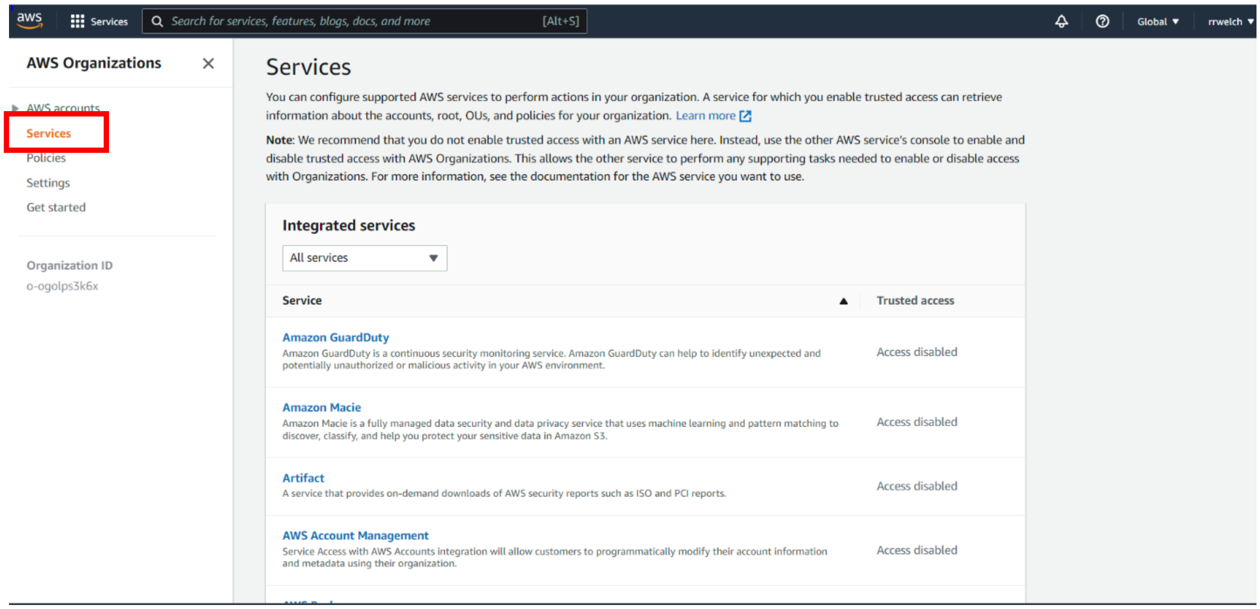
Organization ID
o-ogolps3k6x

Organization

Organizational units (OUs) enable you to group several accounts together and administer them as a single unit instead of one at a time.

Organizational structure	Account created/joined date
▼ □ Root r-7sn4	
▶ □ Architects ou-7sn4-vneh6k7l	
▼ □ Security ou-7sn4-0zy6l7rl	
▶ □ Production ou-7sn4-gk3q9x41	
▼ □ Test Environment ou-7sn4-3bfargcz	
□ testlaborganization 242196156491 | robertrwelch@gmail.com	Created 2021/11/21
□ rrwelch management account 181961446392 | r_welch61@yahoo.com	Joined 2021/11/21

Select the services you wish to assign each user or organization.
Note: Prior to selecting a service, check the pricing before you do so to avoid any unexpected costs.
Note: The organization's "management account" is responsible for paying the bills for all accounts in the organization.



Organization ID
o-ogolps3k6x

Services

You can configure supported AWS services to perform actions in your organization. A service for which you enable trusted access can retrieve information about the accounts, root, OUs, and policies for your organization. Learn more

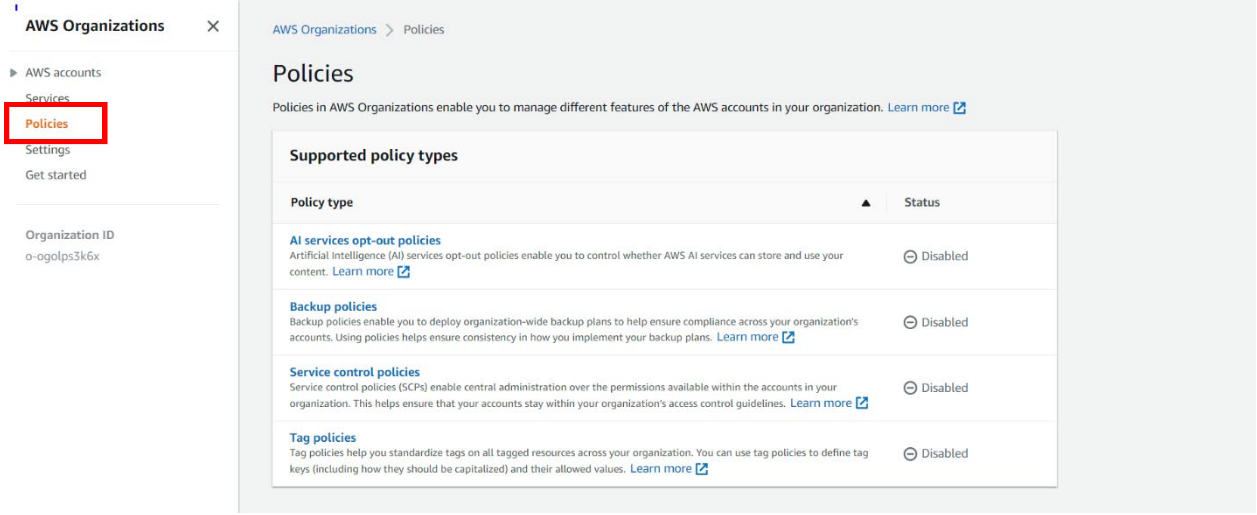
Note: We recommend that you do not enable trusted access with an AWS service here. Instead, use the other AWS service's console to enable and disable trusted access with AWS Organizations. This allows the other service to perform any supporting tasks needed to enable or disable access with Organizations. For more information, see the documentation for the AWS service you want to use.

Integrated services

All services ▾

Service ▲	Trusted access
Amazon GuardDuty Amazon GuardDuty is a continuous security monitoring service. Amazon GuardDuty can help to identify unexpected and potentially unauthorized or malicious activity in your AWS environment.	Access disabled
Amazon Macie Amazon Macie is a fully managed data security and data privacy service that uses machine learning and pattern matching to discover, classify, and help you protect your sensitive data in Amazon S3.	Access disabled
Artifact A service that provides on-demand downloads of AWS security reports such as ISO and PCI reports.	Access disabled
AWS Account Management Service Access with AWS Accounts integration will allow customers to programmatically modify their account information and metadata using their organization.	Access disabled

Additionally, you can add policies such as "Service and Control" policies to only allow access to certain applications or other information that a user within this organization is allowed to see or use.



Organization ID
o-ogolps3k6x

Policies

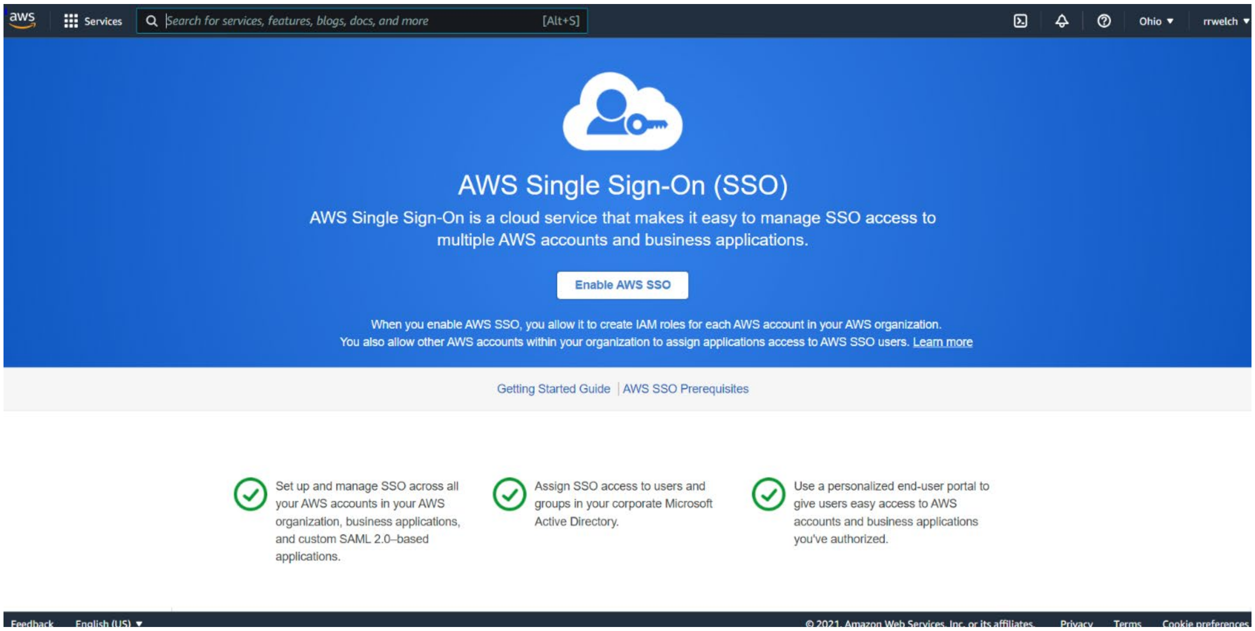
Policies in AWS Organizations enable you to manage different features of the AWS accounts in your organization. Learn more

Supported policy types

Policy type ▲	Status
AI services opt-out policies Artificial Intelligence (AI) services opt-out policies enable you to control whether AWS AI services can store and use your content. Learn more	⊖ Disabled
Backup policies Backup policies enable you to deploy organization-wide backup plans to help ensure compliance across your organization's accounts. Using policies helps ensure consistency in how you implement your backup plans. Learn more	⊖ Disabled
Service control policies Service control policies (SCPs) enable central administration over the permissions available within the accounts in your organization. This helps ensure that your accounts stay within your organization's access control guidelines. Learn more	⊖ Disabled
Tag policies Tag policies help you standardize tags on all tagged resources across your organization. You can use tag policies to define tag keys (including how they should be capitalized) and their allowed values. Learn more	⊖ Disabled

AWS single sign-on: This step may be needed if it has not been enabled.

Make sure to enable Single Sign-on.


aws
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Ohio ▼
rrwelch ▼
Enable AWS SSO
Getting Started Guide | AWS SSO Prerequisites
Feedback
English (US) ▼
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Terms
Cookie preferences

AWS Single Sign-On (SSO)

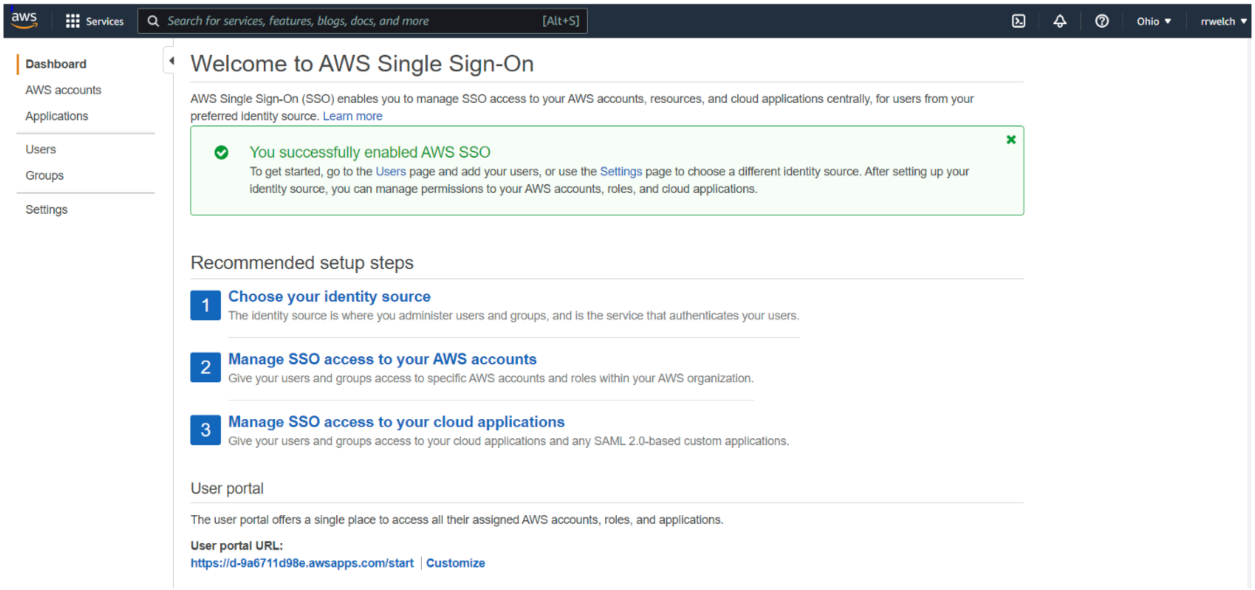
AWS Single Sign-On is a cloud service that makes it easy to manage SSO access to multiple AWS accounts and business applications.

When you enable AWS SSO, you allow it to create IAM roles for each AWS account in your AWS organization. You also allow other AWS accounts within your organization to assign applications access to AWS SSO users. Learn more

✓ Set up and manage SSO across all your AWS accounts in your AWS organization, business applications, and custom SAML 2.0–based applications.

✓ Assign SSO access to users and groups in your corporate Microsoft Active Directory.

✓ Use a personalized end-user portal to give users easy access to AWS accounts and business applications you've authorized.



Welcome to AWS Single Sign-On

AWS Single Sign-On (SSO) enables you to manage SSO access to your AWS accounts, resources, and cloud applications centrally, for users from your preferred identity source. Learn more

✓ You successfully enabled AWS SSO

To get started, go to the Users page and add your users, or use the Settings page to choose a different identity source. After setting up your identity source, you can manage permissions to your AWS accounts, roles, and cloud applications.

Recommended setup steps

1 Choose your identity source
The identity source is where you administer users and groups, and is the service that authenticates your users.

2 Manage SSO access to your AWS accounts
Give your users and groups access to specific AWS accounts and roles within your AWS organization.

3 Manage SSO access to your cloud applications
Give your users and groups access to your cloud applications and any SAML 2.0-based custom applications.

User portal

The user portal offers a single place to access all their assigned AWS accounts, roles, and applications.

User portal URL:
https://d-9a6711d98e.awsapps.com/start | Customize

You may delete an organization by selecting Settings.

Chapter 9 Labs

Lab: Container Clusters in AWS Using ECS/EKS

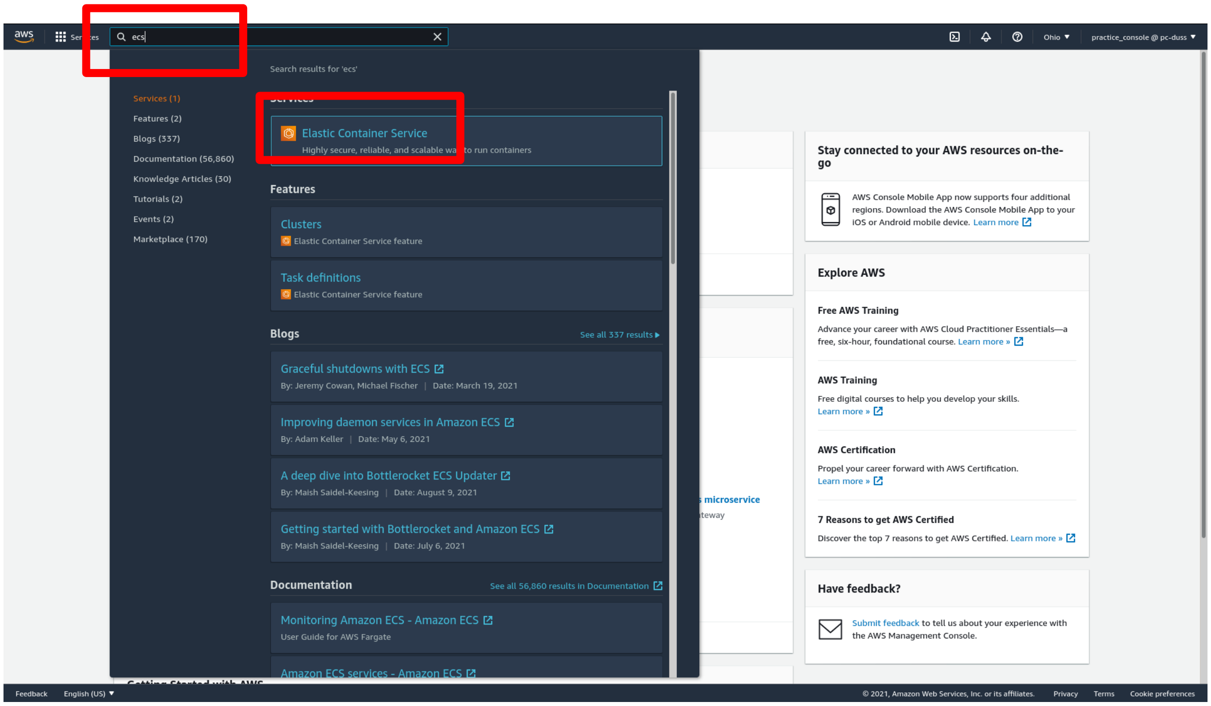
Description:

In this lab section we will focus on containers. We will be creating container clusters using the AWS Elastic Container Service and Elastic Kubernetes Service.

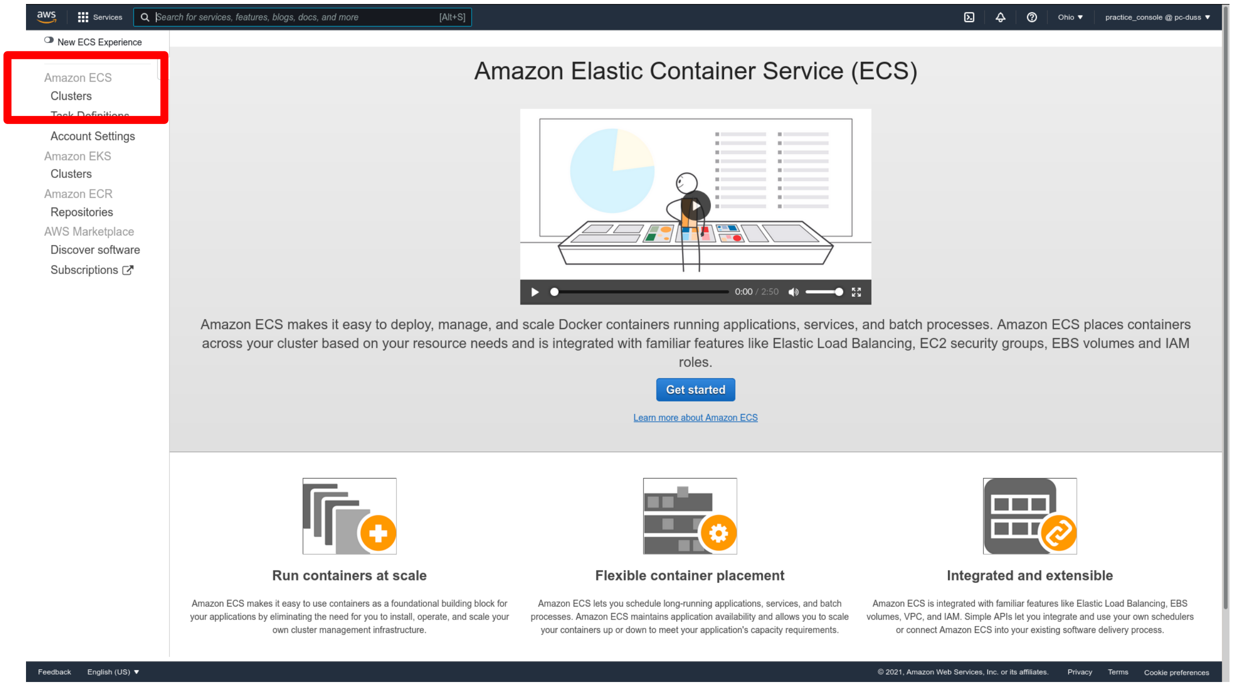
First, we will begin by setting up Elastic Container Service. Second, we will create Kubernetes clusters with Elastic Kubernetes Service.

ECS Cluster (Elastic Container Service)

From the Management Console, go to the **Elastic Container Service** dashboard.


ecs
Search results for 'ecs'
Services (1)
Features (2)
Blogs (337)
Documentation (56,860)
Knowledge Articles (30)
Tutorials (2)
Events (2)
Marketplace (170)
Elastic Container Service
Highly secure, reliable, and scalable way to run containers
Features
Clusters
Elastic Container Service feature
Task definitions
Elastic Container Service feature
Blogs
See all 337 results
Graceful shutdowns with ECS
By: Jeremy Cowan, Michael Fischer | Date: March 19, 2021
Improving daemon services in Amazon ECS
By: Adam Keller | Date: May 6, 2021
A deep dive into Bottlerocket ECS Updater
By: Maish Saidel-Keesing | Date: August 9, 2021
Getting started with Bottlerocket and Amazon ECS
By: Maish Saidel-Keesing | Date: July 6, 2021
Documentation
See all 56,860 results in Documentation
Monitoring Amazon ECS - Amazon ECS
User Guide for AWS Fargate
Amazon ECS services - Amazon ECS
Ohio
practice_console @ pc-duss
Stay connected to your AWS resources on-the-go
AWS Console Mobile App now supports four additional regions. Download the AWS Console Mobile App to your iOS or Android mobile device. Learn more
Explore AWS
Free AWS Training
Advance your career with AWS Cloud Practitioner Essentials—a free, six-hour, foundational course. Learn more »
AWS Training
Free digital courses to help you develop your skills. Learn more »
AWS Certification
Propel your career forward with AWS Certification. Learn more »
7 Reasons to get AWS Certified
Discover the top 7 reasons to get AWS Certified. Learn more »
Have feedback?
Submit feedback to tell us about your experience with the AWS Management Console.
Feedback
English (US)
© 2021, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms
Cookie preferences

Click on the **Clusters** section, under **Amazon ECS**.



Amazon Elastic Container Service (ECS)

Amazon ECS makes it easy to deploy, manage, and scale Docker containers running applications, services, and batch processes. Amazon ECS places containers across your cluster based on your resource needs and is integrated with familiar features like Elastic Load Balancing, EC2 security groups, EBS volumes and IAM roles.

Run containers at scale

Amazon ECS makes it easy to use containers as a foundational building block for your applications by eliminating the need for you to install, operate, and scale your own cluster management infrastructure.

Flexible container placement

Amazon ECS lets you schedule long-running applications, services, and batch processes. Amazon ECS maintains application availability and allows you to scale your containers up or down to meet your application's capacity requirements.

Integrated and extensible

Amazon ECS is integrated with familiar features like Elastic Load Balancing, EBS volumes, VPC, and IAM. Simple APIs let you integrate and use your own schedulers or connect Amazon ECS into your existing software delivery process.

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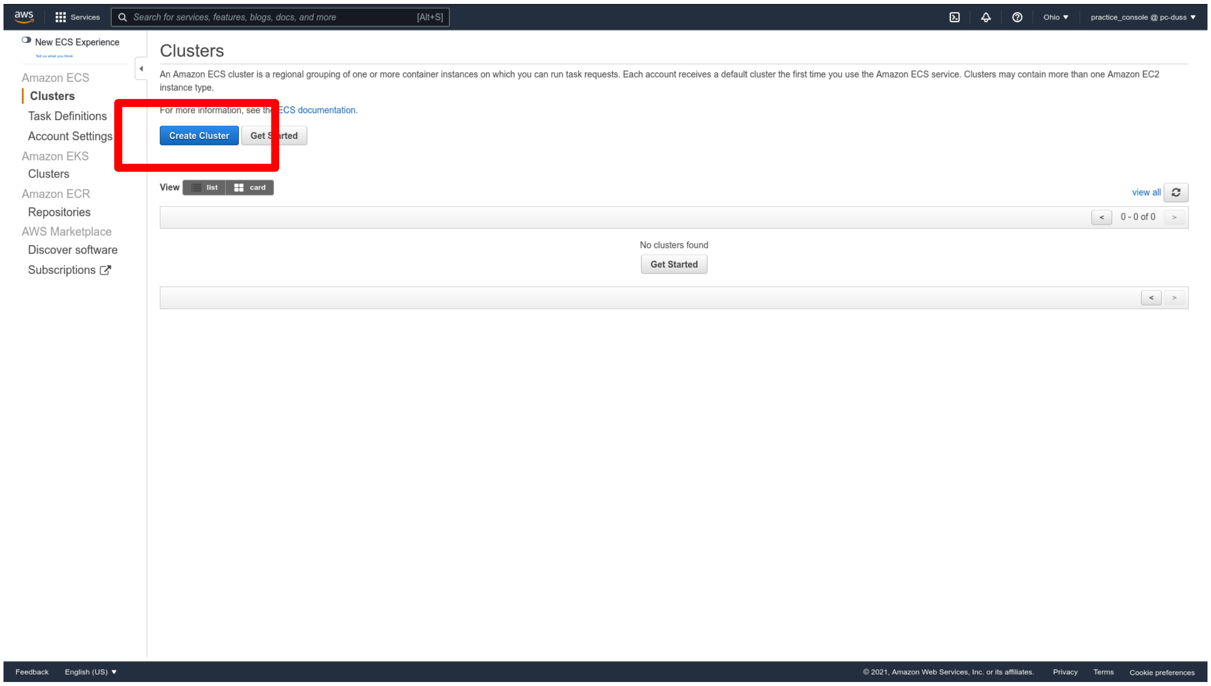
Click on **Create Cluster**.



Clusters

An Amazon ECS cluster is a regional grouping of one or more container instances on which you can run task requests. Each account receives a default cluster the first time you use the Amazon ECS service. Clusters may contain more than one Amazon EC2 instance type.

For more information, see the ECS documentation.

No clusters found

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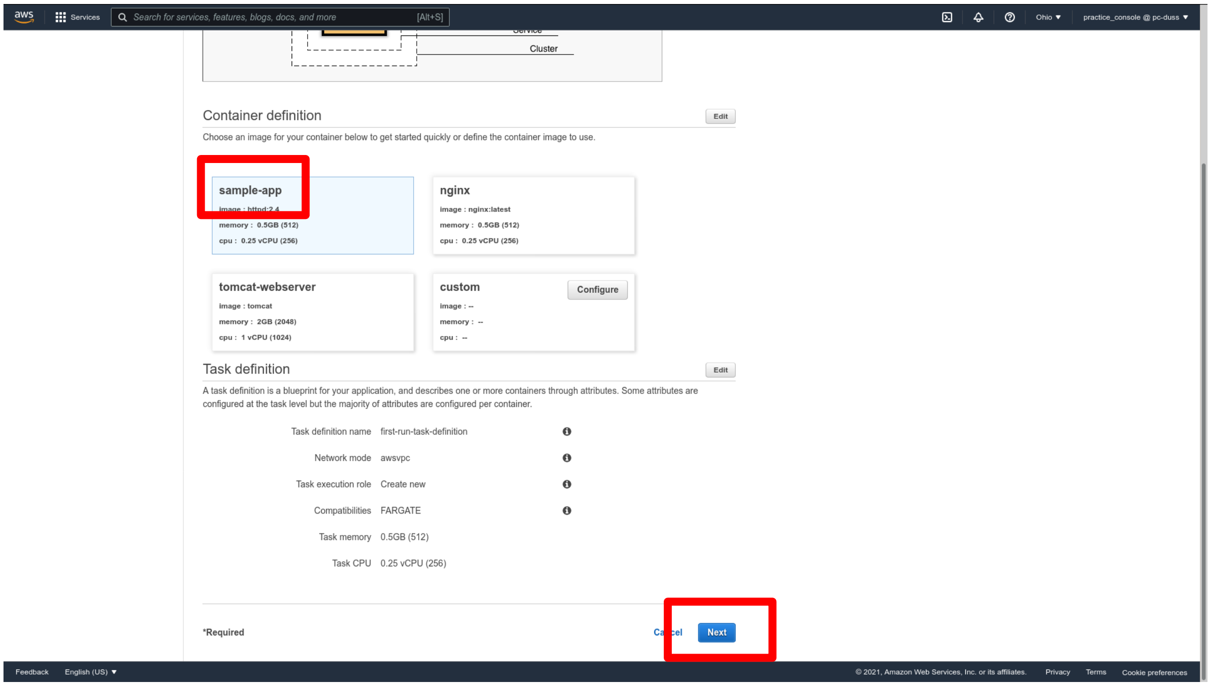
Leave the container image on **sample-app** and click **Next**.



Container definition

Choose an image for your container below to get started quickly or define the container image to use.

sample-app
image : httpd:2.4
memory : 0.5GB (512)
cpu : 0.25 vCPU (256)

nginx
image : nginx:latest
memory : 0.5GB (512)
cpu : 0.25 vCPU (256)

tomcat-webserver
image : tomcat
memory : 2GB (2048)
cpu : 1 vCPU (1024)

custom
image : --
memory : --
cpu : --

Task definition

A task definition is a blueprint for your application, and describes one or more containers through attributes. Some attributes are configured at the task level but the majority of attributes are configured per container.

Task definition name	first-run-task-definition
Network mode	awsvpc
Task execution role	Create new
Compatibilities	FARGATE
Task memory	0.5GB (512)
Task CPU	0.25 vCPU (256)

*Required

aws
Services
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Service
Cluster
Edit
Configure
Edit
Ca cel
Next
Feedback
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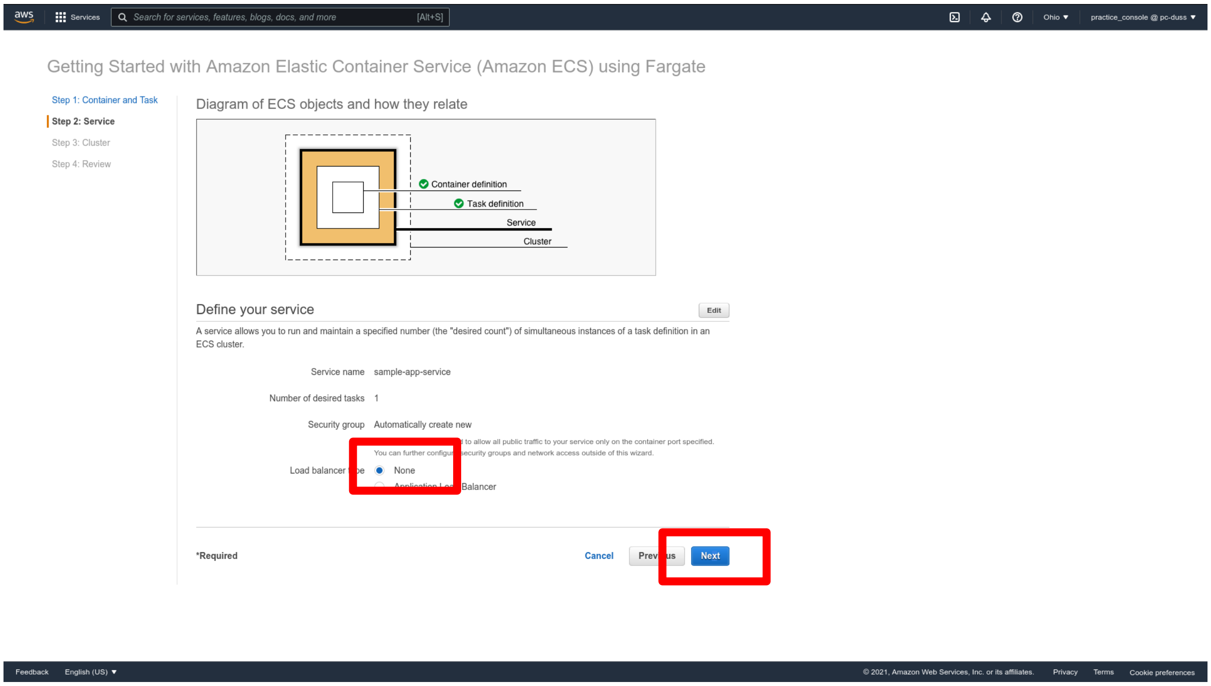
Leave the service as default. For this lab select **None** in the **Load balancer type**. Click **Next**.



Getting Started with Amazon Elastic Container Service (Amazon ECS) using Fargate

Diagram of ECS objects and how they relate

Define your service

A service allows you to run and maintain a specified number (the "desired count") of simultaneous instances of a task definition in an ECS cluster.

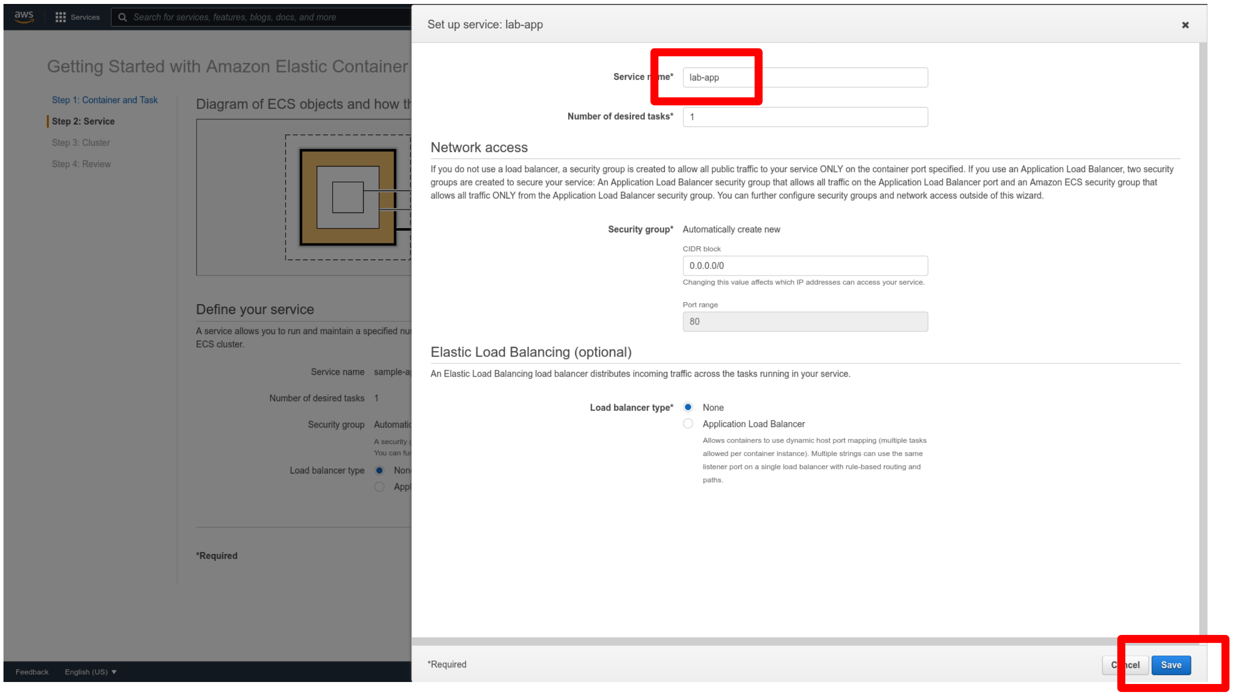
Service name	sample-app-service
Number of desired tasks	1
Security group	Automatically create new

d to allow all public traffic to your service only on the container port specified.
You can further configur security groups and network access outside of this wizard.

Load balancer t pe ● None
○ Application Lo Balancer

*Required

This sidebar will appear. Give a descriptive name to your service. Leave the other settings at their default. Click **Save**.


aws
Services
Search for services, features, blogs, docs, and more
Getting Started with Amazon Elastic Container
Step 1: Container and Task
Step 2: Service
Step 3: Cluster
Step 4: Review
Diagram of ECS objects and how th
Define your service
Feedback
English (US) ▼
×
Cancel
Save

Set up service: lab-app

Service name* lab-app

Number of desired tasks* 1

Network access

If you do not use a load balancer, a security group is created to allow all public traffic to your service ONLY on the container port specified. If you use an Application Load Balancer, two security groups are created to secure your service: An Application Load Balancer security group that allows all traffic on the Application Load Balancer port and an Amazon ECS security group that allows all traffic ONLY from the Application Load Balancer security group. You can further configure security groups and network access outside of this wizard.

Security group* Automatically create new

CIDR block 0.0.0.0/0

Changing this value affects which IP addresses can access your service.

Port range 80

Elastic Load Balancing (optional)

An Elastic Load Balancing load balancer distributes incoming traffic across the tasks running in your service.

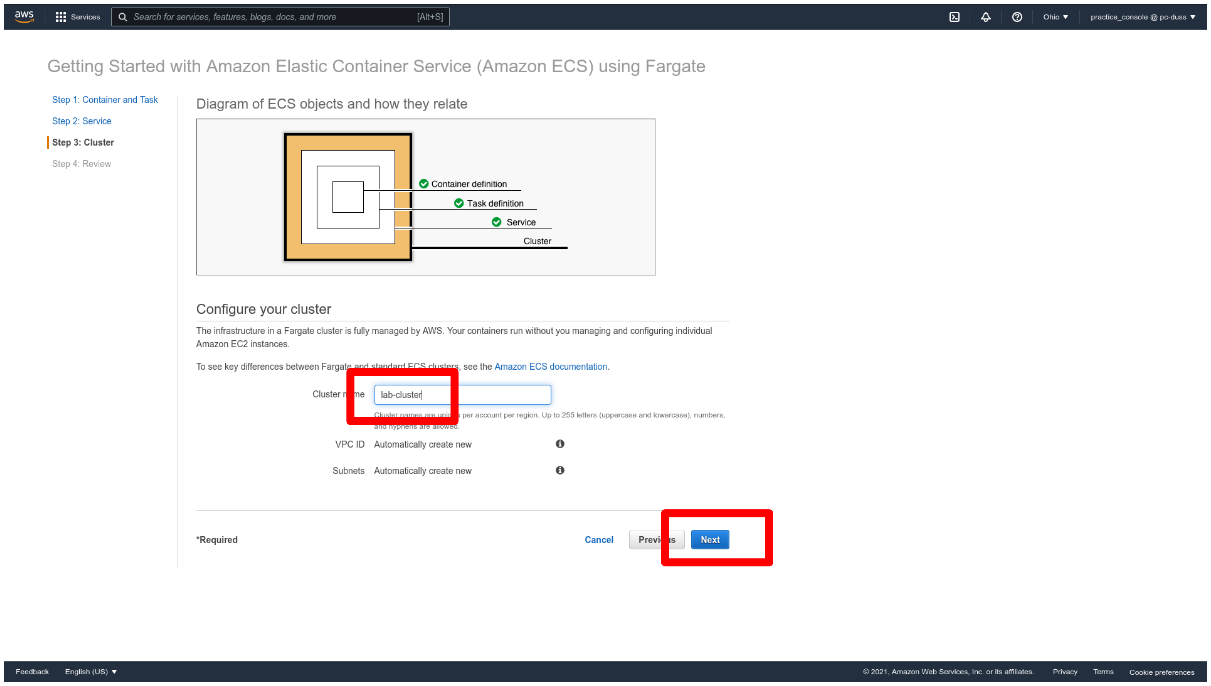
Load balancer type* ● None

○ Application Load Balancer

Allows containers to use dynamic host port mapping (multiple tasks allowed per container instance). Multiple strings can use the same listener port on a single load balancer with rule-based routing and paths.

*Required

Give a descriptive name for your cluster. Click **Next**.



Getting Started with Amazon Elastic Container Service (Amazon ECS) using Fargate

Diagram of ECS objects and how they relate

Configure your cluster

The infrastructure in a Fargate cluster is fully managed by AWS. Your containers run without you managing and configuring individual Amazon EC2 instances.

To see key differences between Fargate and standard ECS clusters, see the Amazon ECS documentation.

Cluster name lab-cluster

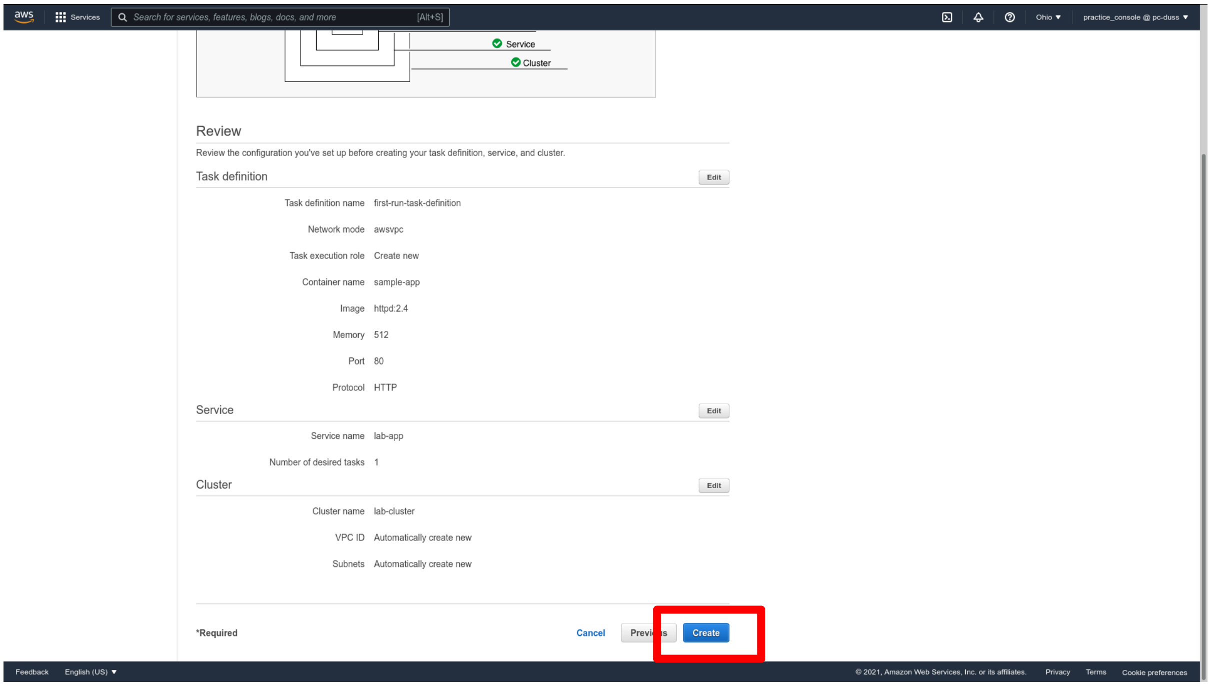
Cluster names are unique per account per region. Up to 255 letters (uppercase and lowercase), numbers, and hyphens are allowed.

VPC ID Automatically create new

Subnets Automatically create new

*Required

Review the settings. When you are ready, click **Create**.


aws
Services
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Ohio ▼
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Service
Cluster
Edit
Cancel
Previous
Create
Feedback
English (US) ▼
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Review

Review the configuration you've set up before creating your task definition, service, and cluster.

Task definition

Task definition name	first-run-task-definition
Network mode	awsvpc
Task execution role	Create new
Container name	sample-app
Image	httpd:2.4
Memory	512
Port	80
Protocol	HTTP

Service

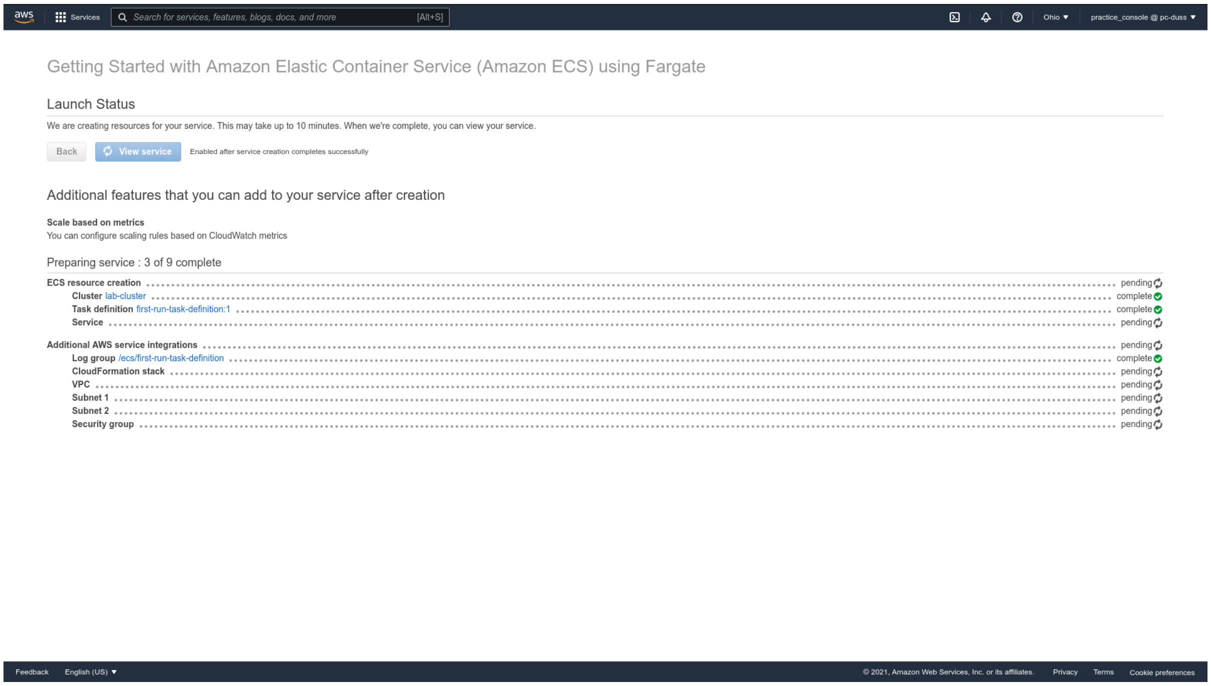
Service name	lab-app
Number of desired tasks	1

Cluster

Cluster name	lab-cluster
VPC ID	Automatically create new
Subnets	Automatically create new

*Required

This page will show the creation process for your cluster. Allow it to complete.


aws
Services
Search for services, features, blogs, docs, and more [Alt+S]
Ohio ▼
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Back
View service
Feedback
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Getting Started with Amazon Elastic Container Service (Amazon ECS) using Fargate

Launch Status

We are creating resources for your service. This may take up to 10 minutes. When we're complete, you can view your service.

Enabled after service creation completes successfully

Additional features that you can add to your service after creation

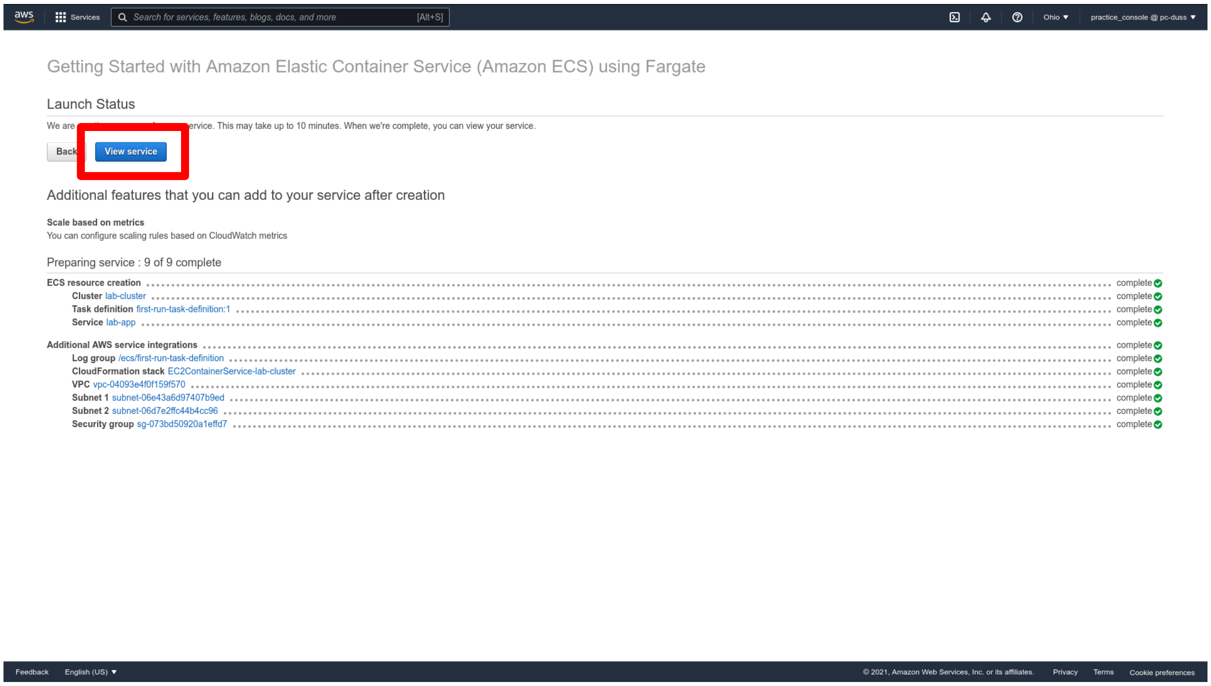
Scale based on metrics

You can configure scaling rules based on CloudWatch metrics

Preparing service : 3 of 9 complete

```
ECS resource creation ........................................ pending
    Cluster lab-cluster ...................................... complete ✓
    Task definition first-run-task-definition:1 .............. complete ✓
    Service .................................................. pending
Additional AWS service integrations .......................... pending
    Log group /ecs/first-run-task-definition ................. complete ✓
    CloudFormation stack ..................................... pending
    VPC ...................................................... pending
    Subnet 1 ................................................. pending
    Subnet 2 ................................................. pending
    Security group ........................................... pending
```

When all is complete, click on **View service** to view your new cluster.



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Ohio ▼
practice_console @ pc-duss ▼

Getting Started with Amazon Elastic Container Service (Amazon ECS) using Fargate

Launch Status

We are ... ervice. This may take up to 10 minutes. When we're complete, you can view your service.

Additional features that you can add to your service after creation

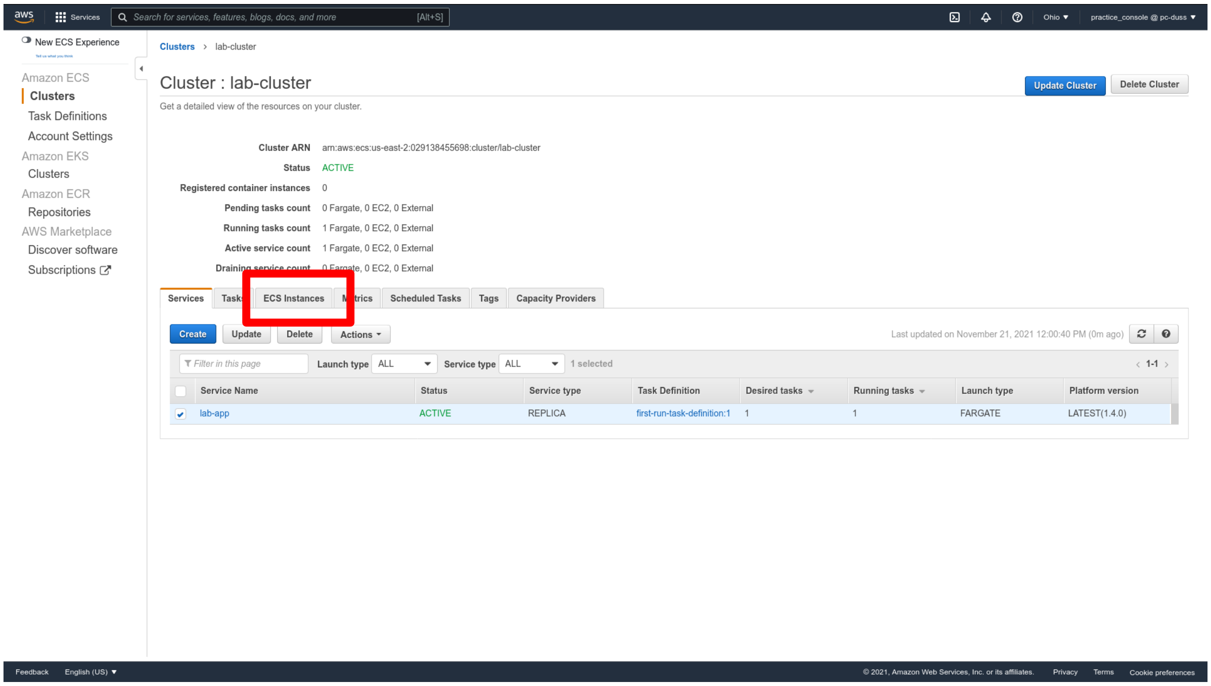
Scale based on metrics
You can configure scaling rules based on CloudWatch metrics

Preparing service : 9 of 9 complete

```
ECS resource creation ........................................ complete ✓
    Cluster lab-cluster ...................................... complete ✓
    Task definition first-run-task-definition:1 .............. complete ✓
    Service lab-app .......................................... complete ✓

Additional AWS service integrations .......................... complete ✓
    Log group /ecs/first-run-task-definition ................. complete ✓
    CloudFormation stack EC2ContainerService-lab-cluster ..... complete ✓
    VPC vpc-04093e4f0f159f570 ................................ complete ✓
    Subnet 1 subnet-06e43a6d97407b9ed ........................ complete ✓
    Subnet 2 subnet-06d7e2ffc44b4cc96 ........................ complete ✓
    Security group sg-073bd50920a1effd7 ...................... complete ✓
```

Here is the summary for your cluster. Container instances will be in the ECS Instances tab. You can also edit or delete your cluster from here.



Cluster : lab-cluster

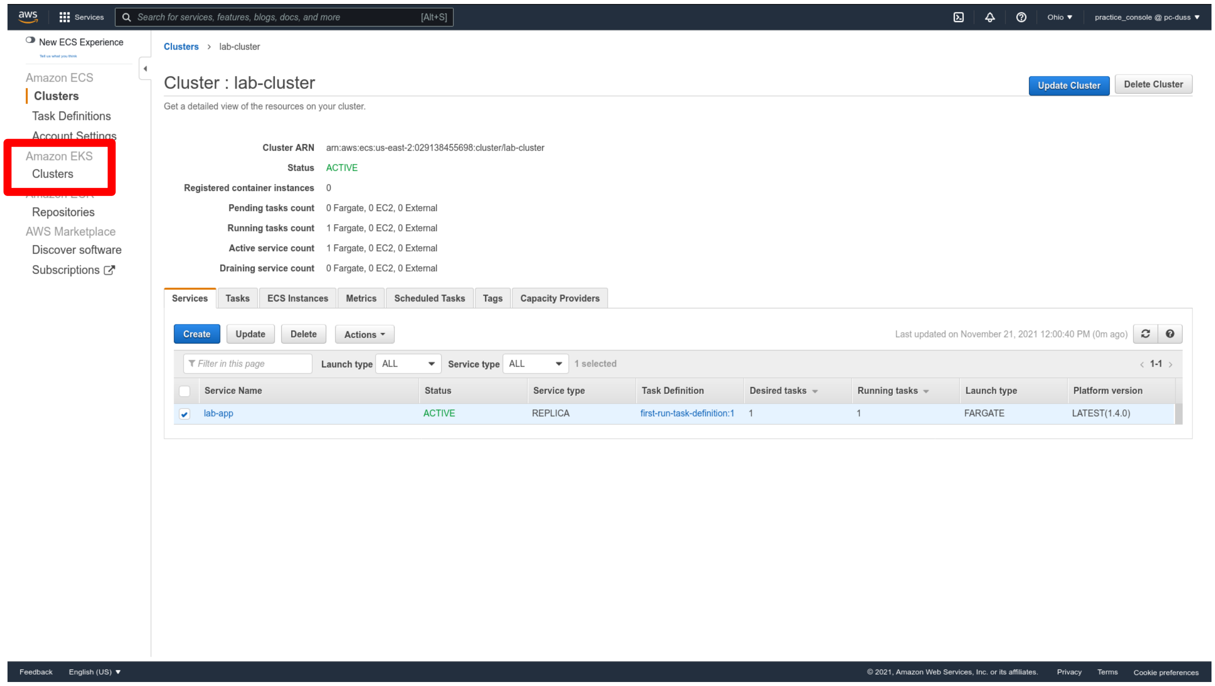
Get a detailed view of the resources on your cluster.

Cluster ARN	arn:aws:ecs:us-east-2:029138455698:cluster/lab-cluster
Status	ACTIVE
Registered container instances	0
Pending tasks count	0 Fargate, 0 EC2, 0 External
Running tasks count	1 Fargate, 0 EC2, 0 External
Active service count	1 Fargate, 0 EC2, 0 External
Draining service count	0 Fargate, 0 EC2, 0 External

☐	Service Name	Status	Service type	Task Definition	Desired tasks	Running tasks	Launch type	Platform version
☑	lab-app	ACTIVE	REPLICA	first-run-task-definition:1	1	1	FARGATE	LATEST(1.4.0)

EKS Cluster (Kubernetes)

Now, let’s create a Kubernetes cluster. Click on **Clusters** under the **Amazon EKS** section.



Cluster : lab-cluster

Get a detailed view of the resources on your cluster.

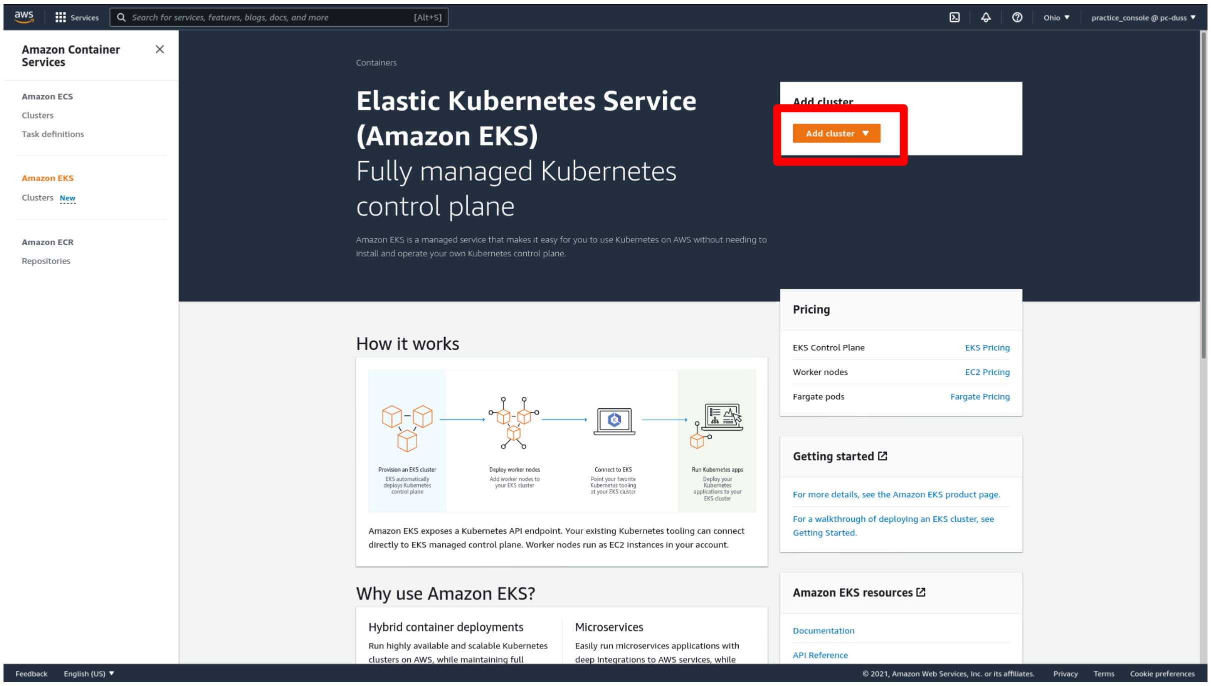
Cluster ARN arn:aws:ecs:us-east-2:029138455698:cluster/lab-cluster
Status ACTIVE
Registered container instances 0
Pending tasks count 0 Fargate, 0 EC2, 0 External
Running tasks count 1 Fargate, 0 EC2, 0 External
Active service count 1 Fargate, 0 EC2, 0 External
Draining service count 0 Fargate, 0 EC2, 0 External

Last updated on November 21, 2021 12:00:40 PM (0m ago)

Launch type ALL Service type ALL 1 selected 1-1

	Service Name	Status	Service type	Task Definition	Desired tasks	Running tasks	Launch type	Platform version
☑	lab-app	ACTIVE	REPLICA	first-run-task-definition:1	1	1	FARGATE	LATEST(1.4.0)

Click on **Add cluster**.


aws
Services
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Ohio
practice_console @ pc-duss
Amazon Container Services
Amazon ECS
Clusters
Task definitions
Amazon EKS
Clusters New
Amazon ECR
Repositories
Containers
Add cluster
Add cluster
Provision an EKS cluster
EKS automatically deploys Kubernetes control plane
Deploy worker nodes
Add worker nodes to your EKS cluster
Connect to EKS
Point your favorite Kubernetes tooling at your EKS cluster
Run Kubernetes apps
Deploy your Kubernetes applications to your EKS cluster
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Elastic Kubernetes Service (Amazon EKS)

Fully managed Kubernetes control plane

Amazon EKS is a managed service that makes it easy for you to use Kubernetes on AWS without needing to install and operate your own Kubernetes control plane.

How it works

Amazon EKS exposes a Kubernetes API endpoint. Your existing Kubernetes tooling can connect directly to EKS managed control plane. Worker nodes run as EC2 instances in your account.

Why use Amazon EKS?

Hybrid container deployments

Run highly available and scalable Kubernetes clusters on AWS, while maintaining full

Microservices

Easily run microservices applications with deep integrations to AWS services, while

Pricing

EKS Control Plane	EKS Pricing
Worker nodes	EC2 Pricing
Fargate pods	Fargate Pricing

Getting started

For more details, see the Amazon EKS product page.

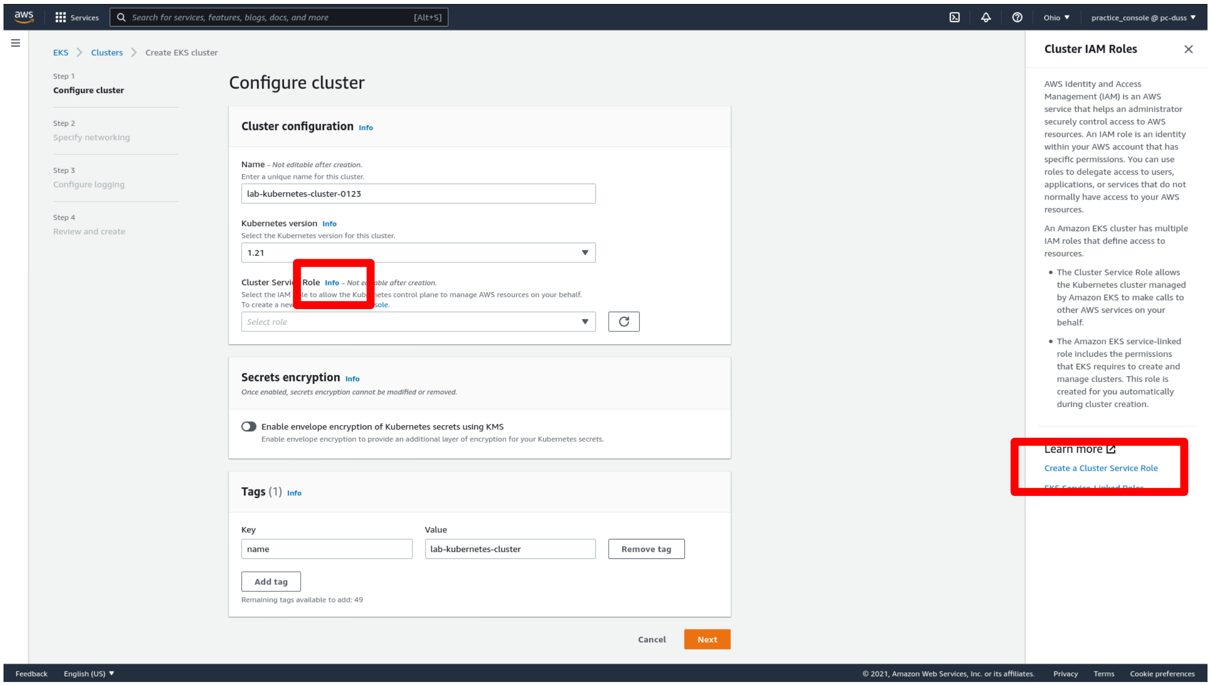
For a walkthrough of deploying an EKS cluster, see Getting Started.

Amazon EKS resources

Documentation

API Reference

Don’t start filling out the form yet. First, we need to create an IAM role for Kubernetes clusters, as there is none set up for you by default. Click on **Info** next to Cluster Service Role. Then, a sidebar should appear. Briefly read the provided description. When done, click **Create a Cluster Service Role**. This will send us to the **Roles** section of the IAM Console.



Configure cluster

Cluster configuration

Name - *Not editable after creation.*
Enter a unique name for this cluster.
lab-kubernetes-cluster-0123

Kubernetes version
Select the Kubernetes version for this cluster.
1.21

Cluster Servi Role Info - *Not e able after creation.*
Select the IAM le to allow the Kub netes control plane to manage AWS resources on your behalf.
To create a new sole.
Select role

Secrets encryption
Once enabled, secrets encryption cannot be modified or removed.

Enable envelope encryption of Kubernetes secrets using KMS
Enable envelope encryption to provide an additional layer of encryption for your Kubernetes secrets.

Tags (1)

Key	Value
name	lab-kubernetes-cluster

Remaining tags available to add: 49

Cluster IAM Roles

AWS Identity and Access Management (IAM) is an AWS service that helps an administrator securely control access to AWS resources. An IAM role is an identity within your AWS account that has specific permissions. You can use roles to delegate access to users, applications, or services that do not normally have access to your AWS resources.

An Amazon EKS cluster has multiple IAM roles that define access to resources.

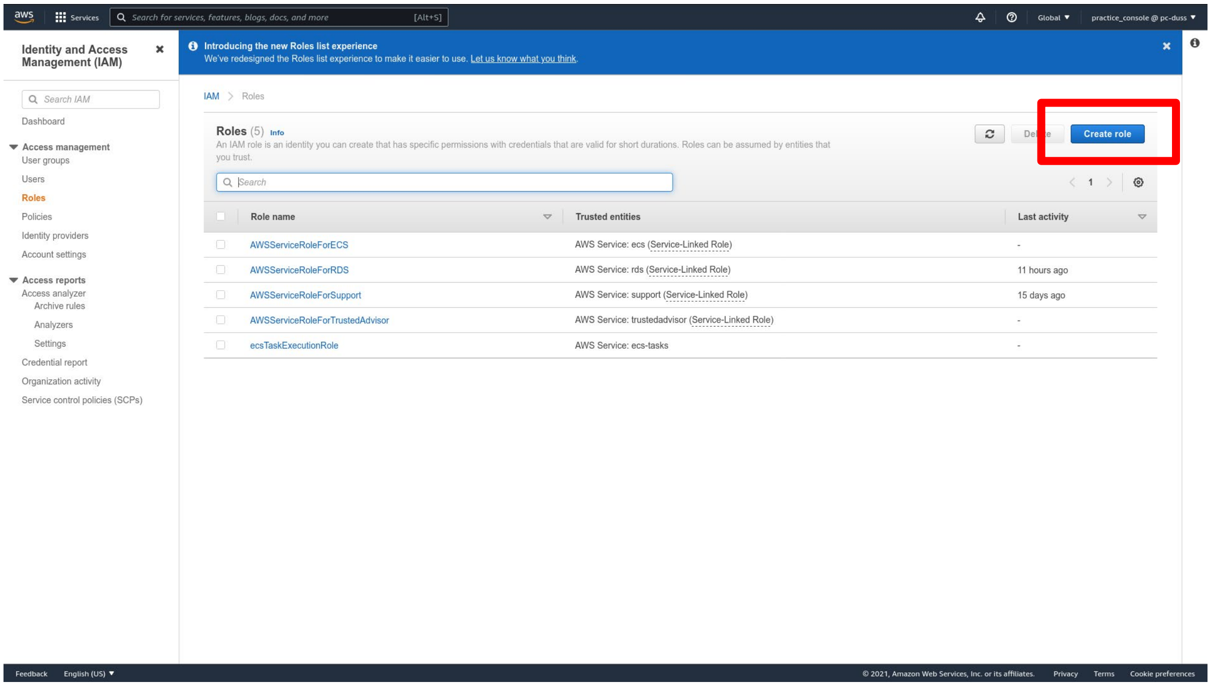
- The Cluster Service Role allows the Kubernetes cluster managed by Amazon EKS to make calls to other AWS services on your behalf.
- The Amazon EKS service-linked role includes the permissions that EKS requires to create and manage clusters. This role is created for you automatically during cluster creation.

Learn more

Create a Cluster Service Role

EKS Service-Linked Roles

Click **Create role**.

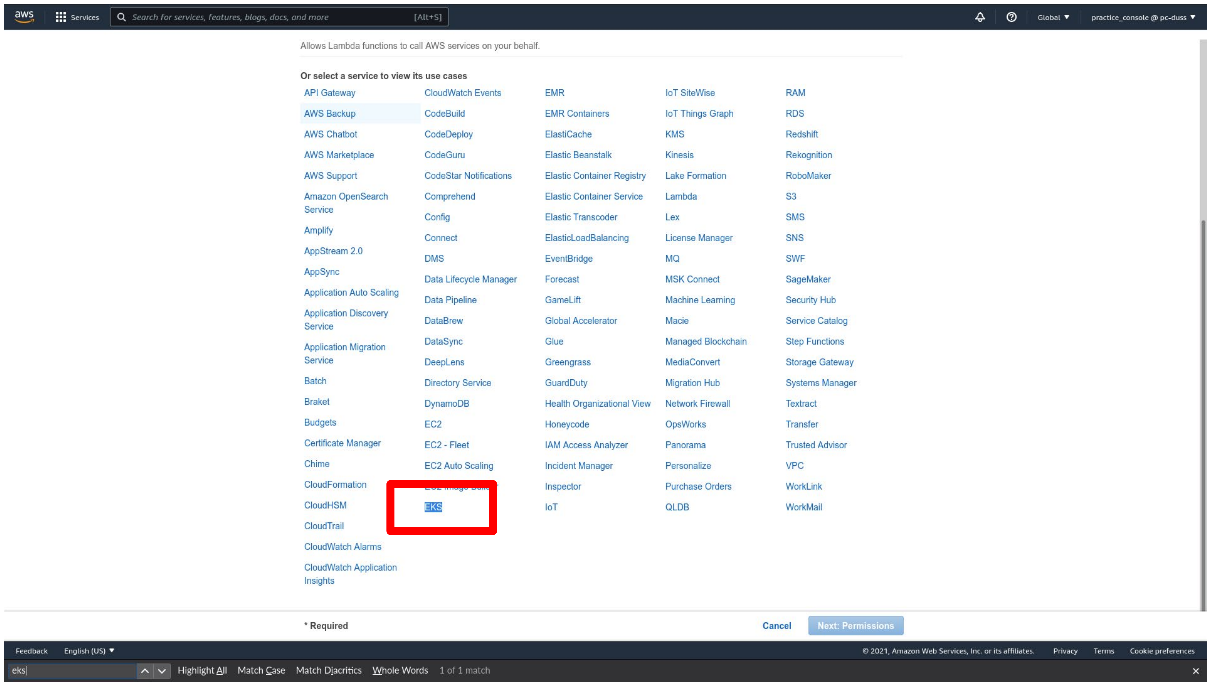


Introducing the new Roles list experience
We’ve redesigned the Roles list experience to make it easier to use. Let us know what you think.

Roles (5)
An IAM role is an identity you can create that has specific permissions with credentials that are valid for short durations. Roles can be assumed by entities that you trust.

Role name	Trusted entities	Last activity
AWSServiceRoleForECS	AWS Service: ecs (Service-Linked Role)	-
AWSServiceRoleForRDS	AWS Service: rds (Service-Linked Role)	11 hours ago
AWSServiceRoleForSupport	AWS Service: support (Service-Linked Role)	15 days ago
AWSServiceRoleForTrustedAdvisor	AWS Service: trustedadvisor (Service-Linked Role)	-
ecsTaskExecutionRole	AWS Service: ecs-tasks	-

Search for the term **EKS** and click on it.

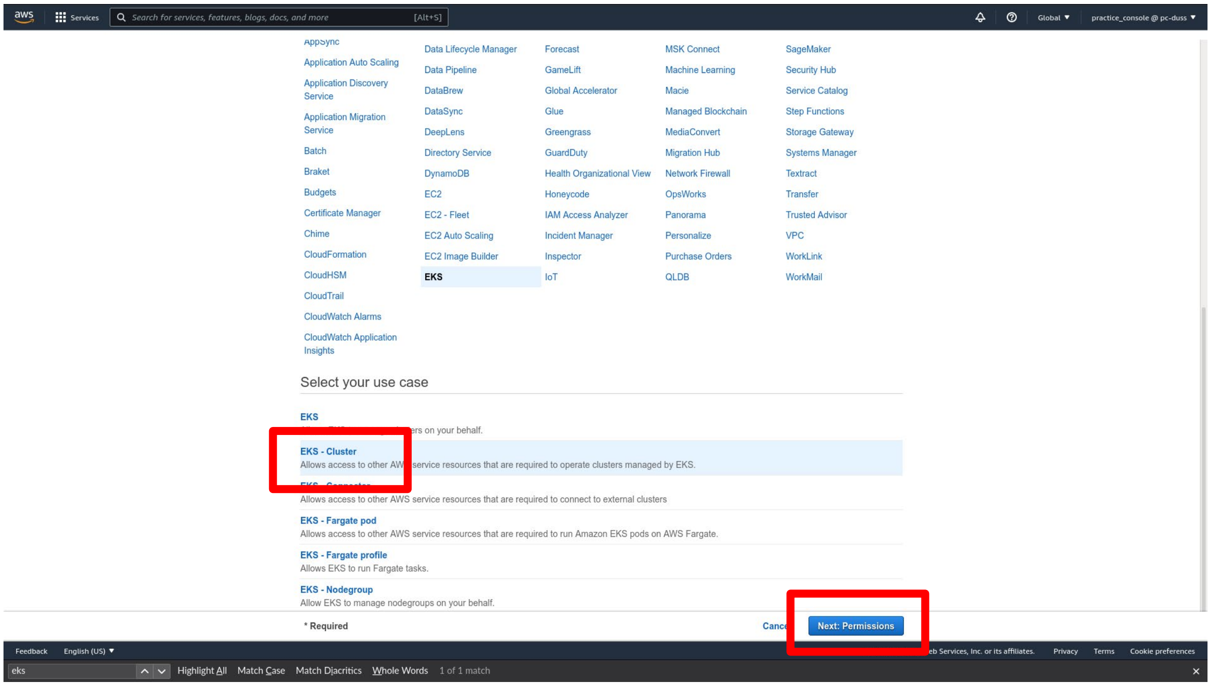


Allows Lambda functions to call AWS services on your behalf.

Or select a service to view its use cases

* Required

Select **EKS-Cluster**. Click **Next: Permissions**.



Select your use case

EKS
rs on your behalf.

EKS - Cluster
Allows access to other AW service resources that are required to operate clusters managed by EKS.

Allows access to other AWS service resources that are required to connect to external clusters

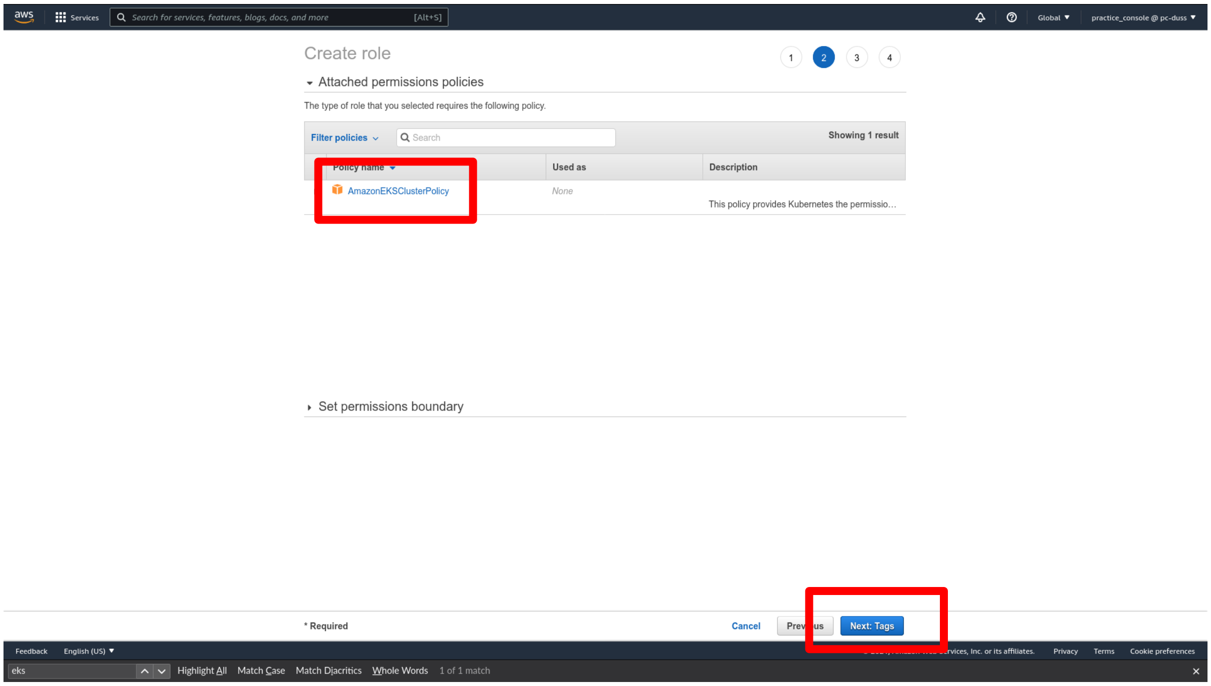
EKS - Fargate pod
Allows access to other AWS service resources that are required to run Amazon EKS pods on AWS Fargate.

EKS - Fargate profile
Allows EKS to run Fargate tasks.

EKS - Nodegroup
Allow EKS to manage nodegroups on your behalf.

* Required

Select **AmazonEKSClusterPolicy** to attach this policy to your new IAM role. Click **Next: Tags**.



Create role

Attached permissions policies

The type of role that you selected requires the following policy.

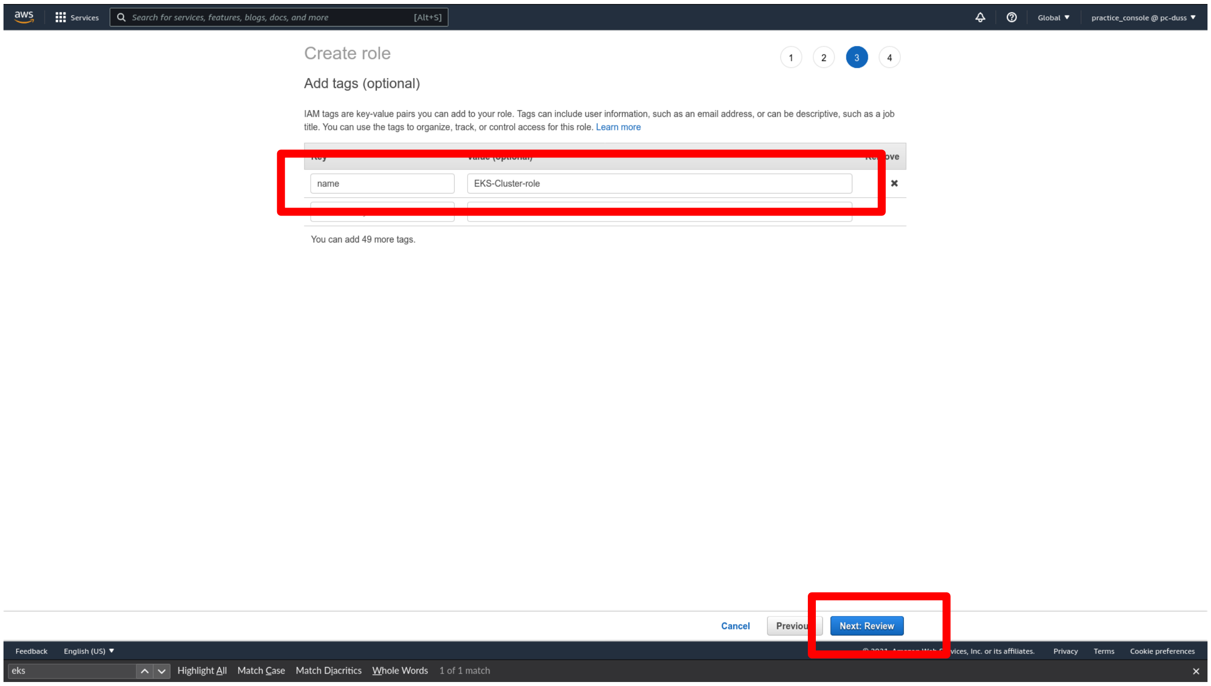
Showing 1 result

Policy name	Used as	Description
AmazonEKSClusterPolicy	None	This policy provides Kubernetes the permissio…

Set permissions boundary

* Required

Add a “name” **tag**, and give it a descriptive name. Click **Next: Review**.



Create role

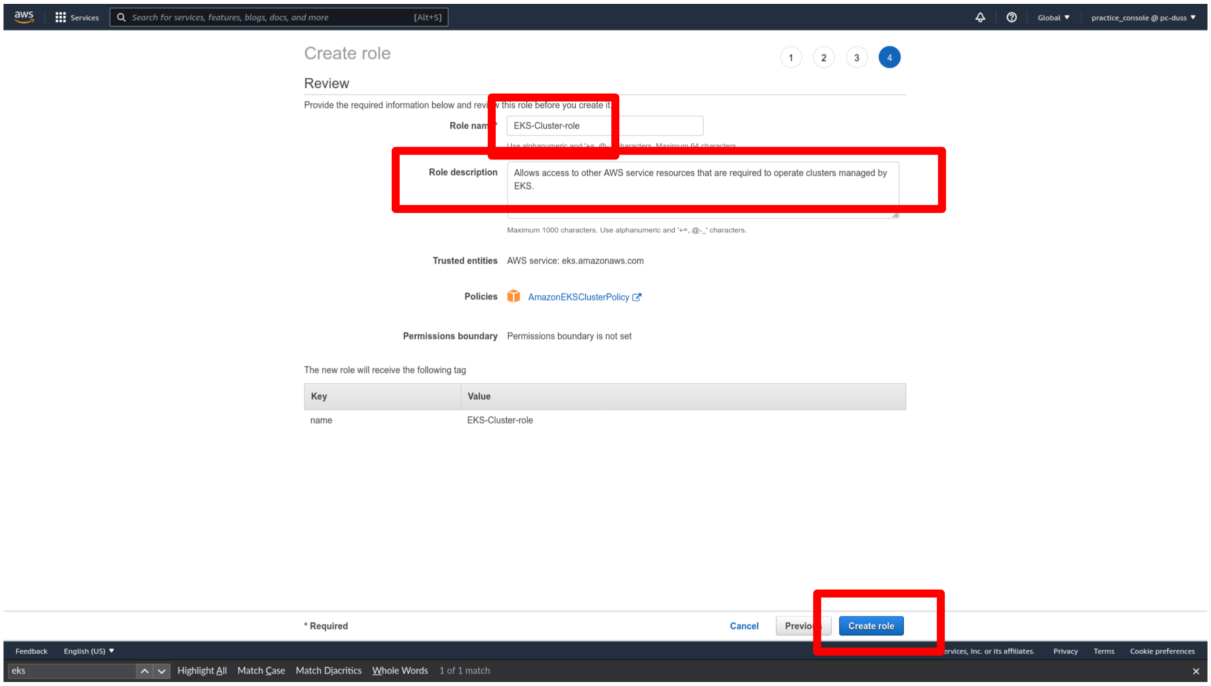
Add tags (optional)

IAM tags are key-value pairs you can add to your role. Tags can include user information, such as an email address, or can be descriptive, such as a job title. You can use the tags to organize, track, or control access for this role. Learn more

Key	Value (optional)	Remove
name	EKS-Cluster-role	✖

You can add 49 more tags.

Give a descriptive name to your Kubernetes cluster role. Provide a description for others to understand its purpose. When you are ready, click **Create role**. This will be your new IAM role to handle Kubernetes clusters.



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Global
practice_console @ pc-duss

Create role

Review

Provide the required information below and review this role before you create it.

Role name* EKS-Cluster-role

Use alphanumeric and '+=,.@-_' characters. Maximum 64 characters.

Role description: Allows access to other AWS service resources that are required to operate clusters managed by EKS.

Maximum 1000 characters. Use alphanumeric and '+=,.@-_' characters.

Trusted entities: AWS service: eks.amazonaws.com

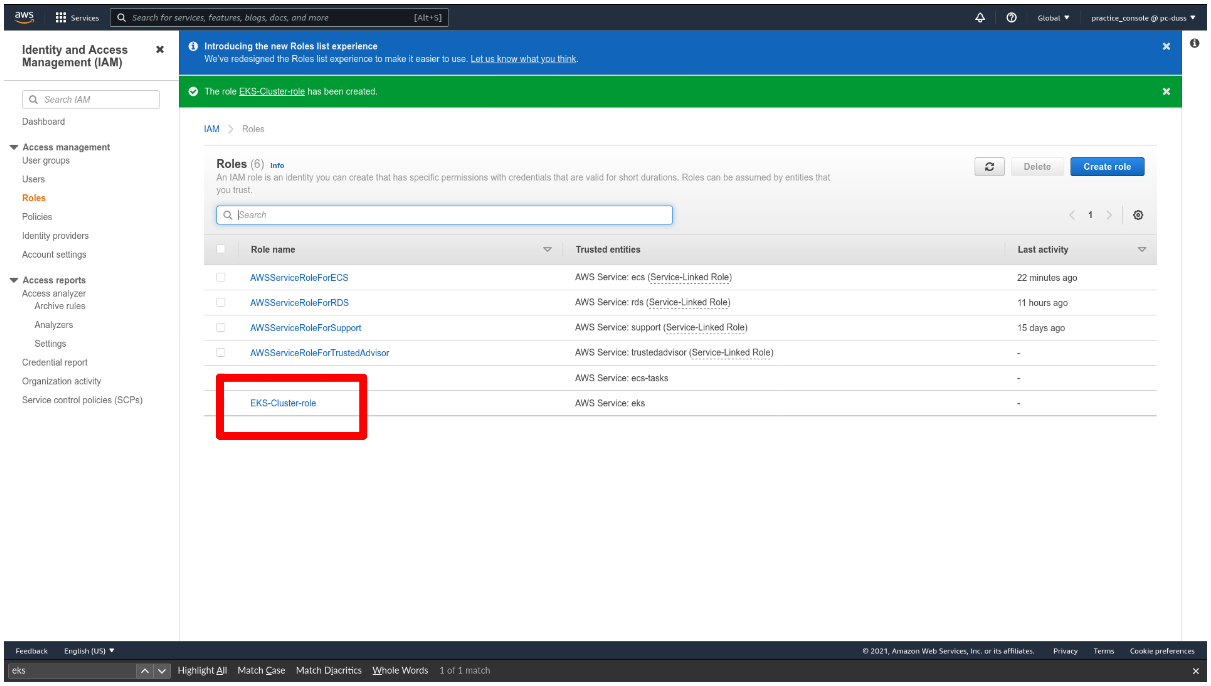
Policies: AmazonEKSClusterPolicy

Permissions boundary: Permissions boundary is not set

The new role will receive the following tag

Key	Value
name	EKS-Cluster-role

We can see the new role has been added. You can attribute this role to users you want to give access to EKS Cluster management. Our work here is done. Let's go back to the main page for EKS (scroll back up if you do not remember how). There, you can restart the process of creating a cluster (by clicking **Add cluster**).



Introducing the new Roles list experience
We've redesigned the Roles list experience to make it easier to use. Let us know what you think.

The role EKS-Cluster-role has been created.

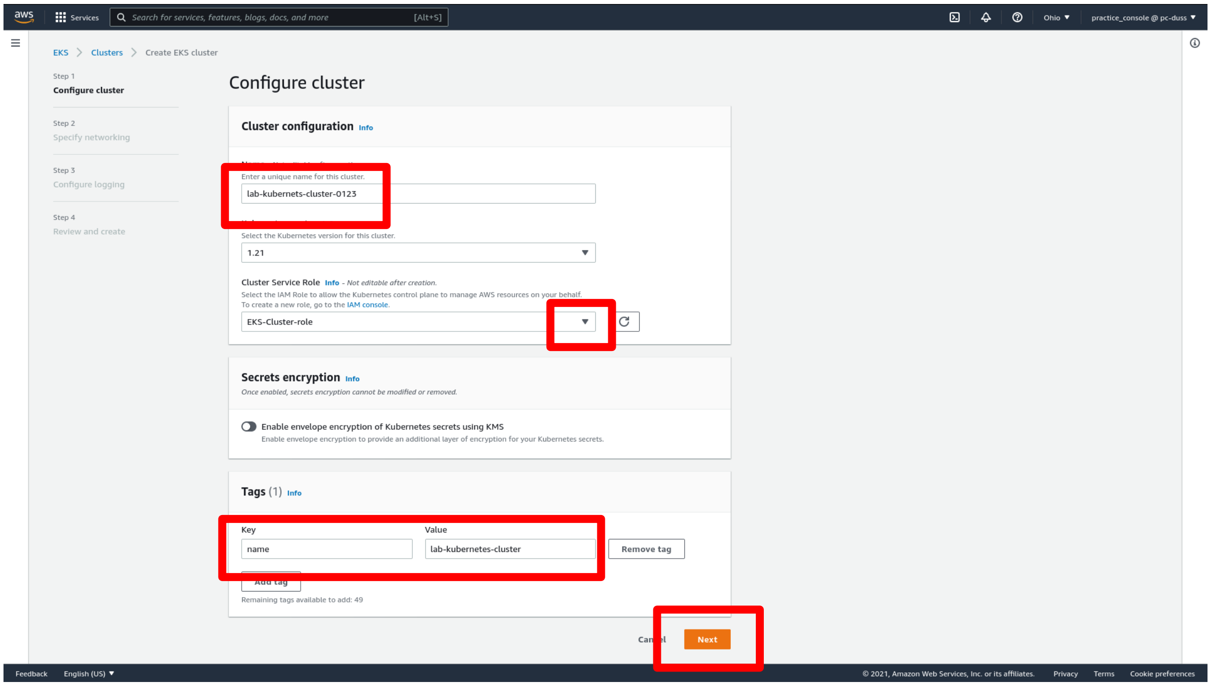
Roles (6)

An IAM role is an identity you can create that has specific permissions with credentials that are valid for short durations. Roles can be assumed by entities that you trust.

□	Role name	Trusted entities	Last activity
□	AWSServiceRoleForECS	AWS Service: ecs (Service-Linked Role)	22 minutes ago
□	AWSServiceRoleForRDS	AWS Service: rds (Service-Linked Role)	11 hours ago
□	AWSServiceRoleForSupport	AWS Service: support (Service-Linked Role)	15 days ago
□	AWSServiceRoleForTrustedAdvisor	AWS Service: trustedadvisor (Service-Linked Role)	-
		AWS Service: ecs-tasks	-
	EKS-Cluster-role	AWS Service: eks	-

Now that we are back, choose a **unique** name/identifier for this cluster. Leave the Kubernetes version to the default. In the Cluster Service Role box, select your newly created role. Now, you know what this box is for.

We won’t be enabling encryption for this lab, but know that it is possible to do so. Add a “name” **tag** for your Kubernetes cluster, and give it a descriptive name. Click **Next**.



EKS > Clusters > Create EKS cluster

Step 1
Configure cluster

Step 2
Specify networking

Step 3
Configure logging

Step 4
Review and create

Configure cluster

Cluster configuration Info

Enter a unique name for this cluster.
lab-kubernetes-cluster-0123

Select the Kubernetes version for this cluster.
1.21

Cluster Service Role Info - *Not editable after creation.*
Select the IAM Role to allow the Kubernetes control plane to manage AWS resources on your behalf.
To create a new role, go to the IAM console.
EKS-Cluster-role

Secrets encryption Info
Once enabled, secrets encryption cannot be modified or removed.

Enable envelope encryption of Kubernetes secrets using KMS
Enable envelope encryption to provide an additional layer of encryption for your Kubernetes secrets.

Tags (1) Info

Key	Value
name	lab-kubernetes-cluster

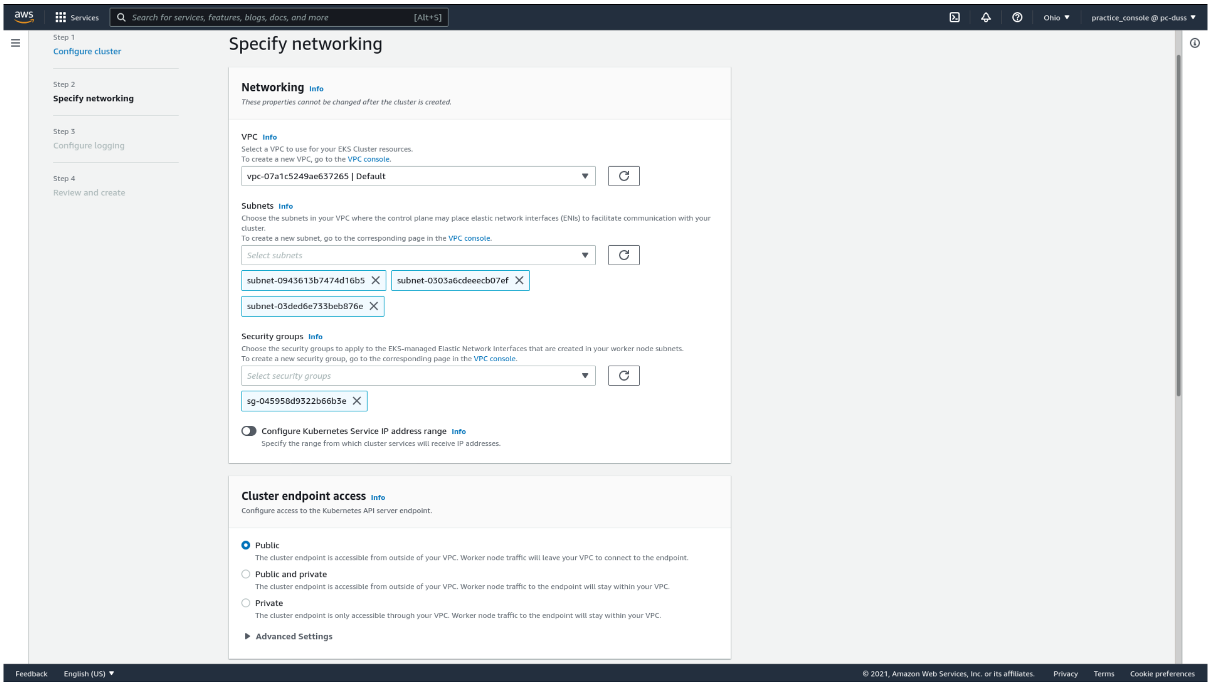
Remove tag

Add tag

Remaining tags available to add: 49

Cancel Next

You can specify a specific **VPC** for your cluster. In this lab, we will leave it on the default VPC. We will also leave all the **subnets** of the default VPC enabled, but know that you can restrict the cluster to only certain subnets. We will also be leaving the default **security group**. Scroll down.



Step 1
Configure cluster

Step 2
Specify networking

Step 3
Configure logging

Step 4
Review and create

Specify networking

Networking Info
These properties cannot be changed after the cluster is created.

VPC Info
Select a VPC to use for your EKS Cluster resources.
To create a new VPC, go to the VPC console.
vpc-07a1c5249ae637265 | Default

Subnets Info
Choose the subnets in your VPC where the control plane may place elastic network interfaces (ENIs) to facilitate communication with your cluster.
To create a new subnet, go to the corresponding page in the VPC console.
Select subnets
subnet-0943613b7474d16b5
subnet-0303a6cdeeecb07ef
subnet-03ded6e733beb876e

Security groups Info
Choose the security groups to apply to the EKS-managed Elastic Network Interfaces that are created in your worker node subnets.
To create a new security group, go to the corresponding page in the VPC console.
Select security groups
sg-045958d9322b66b3e

Configure Kubernetes Service IP address range Info
Specify the range from which cluster services will receive IP addresses.

Cluster endpoint access Info
Configure access to the Kubernetes API server endpoint.

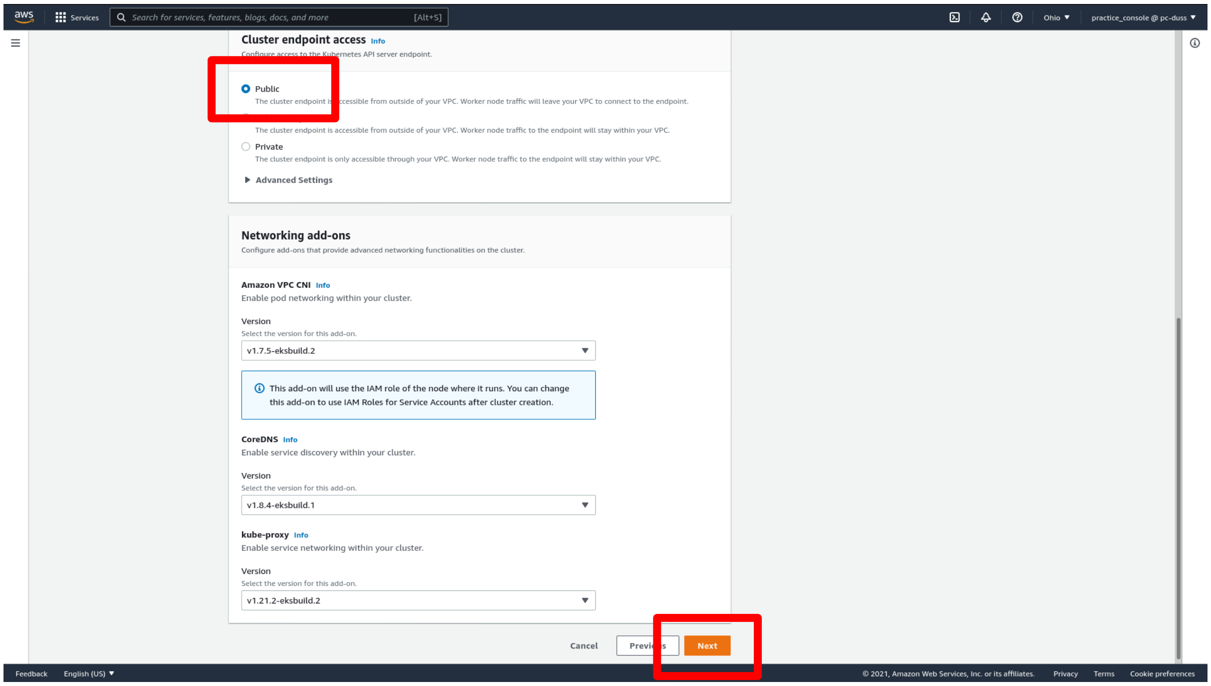
● Public
The cluster endpoint is accessible from outside of your VPC. Worker node traffic will leave your VPC to connect to the endpoint.

○ Public and private
The cluster endpoint is accessible from outside of your VPC. Worker node traffic to the endpoint will stay within your VPC.

○ Private
The cluster endpoint is only accessible through your VPC. Worker node traffic to the endpoint will stay within your VPC.

▶ Advanced Settings

For this lab, we will allow **Public** access to the cluster. This means your Kubernetes workers will be accessible from the internet. Here, it says the worker traffic will leave the VPC to connect to an endpoint. Note, however, that it does not leave Amazon's internal network (it does not use the public internet). Leave the version numbers at their default. Click **Next**.



aws
Services
Search for services, features, blogs, docs, and more [Alt+S]
Ohio ▼
practice_console @ pc-duss ▼

Cluster endpoint access Info

Configure access to the Kubernetes API server endpoint.

● Public
The cluster endpoint is accessible from outside of your VPC. Worker node traffic will leave your VPC to connect to the endpoint.

The cluster endpoint is accessible from outside of your VPC. Worker node traffic to the endpoint will stay within your VPC.

○ Private
The cluster endpoint is only accessible through your VPC. Worker node traffic to the endpoint will stay within your VPC.

▶ Advanced Settings

Networking add-ons

Configure add-ons that provide advanced networking functionalities on the cluster.

Amazon VPC CNI Info
Enable pod networking within your cluster.

Version
Select the version for this add-on.
v1.7.5-eksbuild.2 ▼

This add-on will use the IAM role of the node where it runs. You can change this add-on to use IAM Roles for Service Accounts after cluster creation.

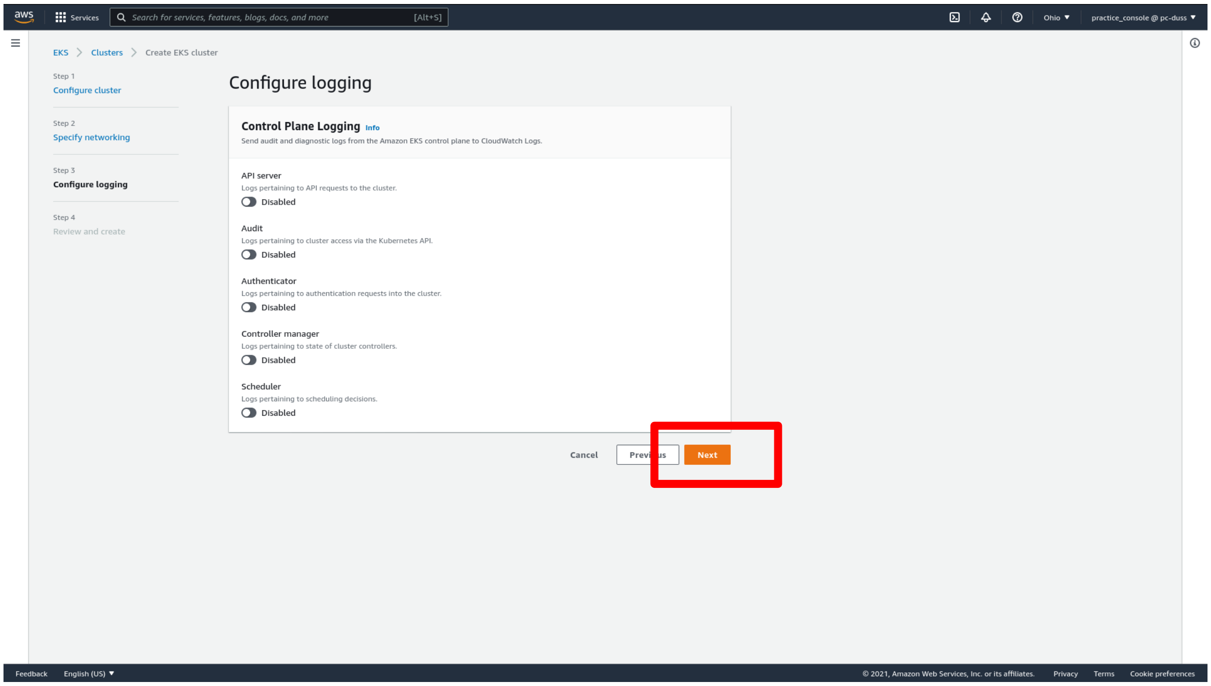
CoreDNS Info
Enable service discovery within your cluster.

Version
Select the version for this add-on.
v1.8.4-eksbuild.1 ▼

kube-proxy Info
Enable service networking within your cluster.

Version
Select the version for this add-on.
v1.21.2-eksbuild.2 ▼

You can configure logs for your Kubernetes cluster. For now, you can simply click **Next**.



aws
Services
Search for services, features, blogs, docs, and more [Alt+S]
Ohio ▼
practice_console @ pc-duss ▼
EKS > Clusters > Create EKS cluster
Step 1
Configure cluster
Step 2
Specify networking
Step 3
Configure logging
Step 4
Review and create

Configure logging

Control Plane Logging Info

Send audit and diagnostic logs from the Amazon EKS control plane to CloudWatch Logs.

API server
Logs pertaining to API requests to the cluster.
Disabled

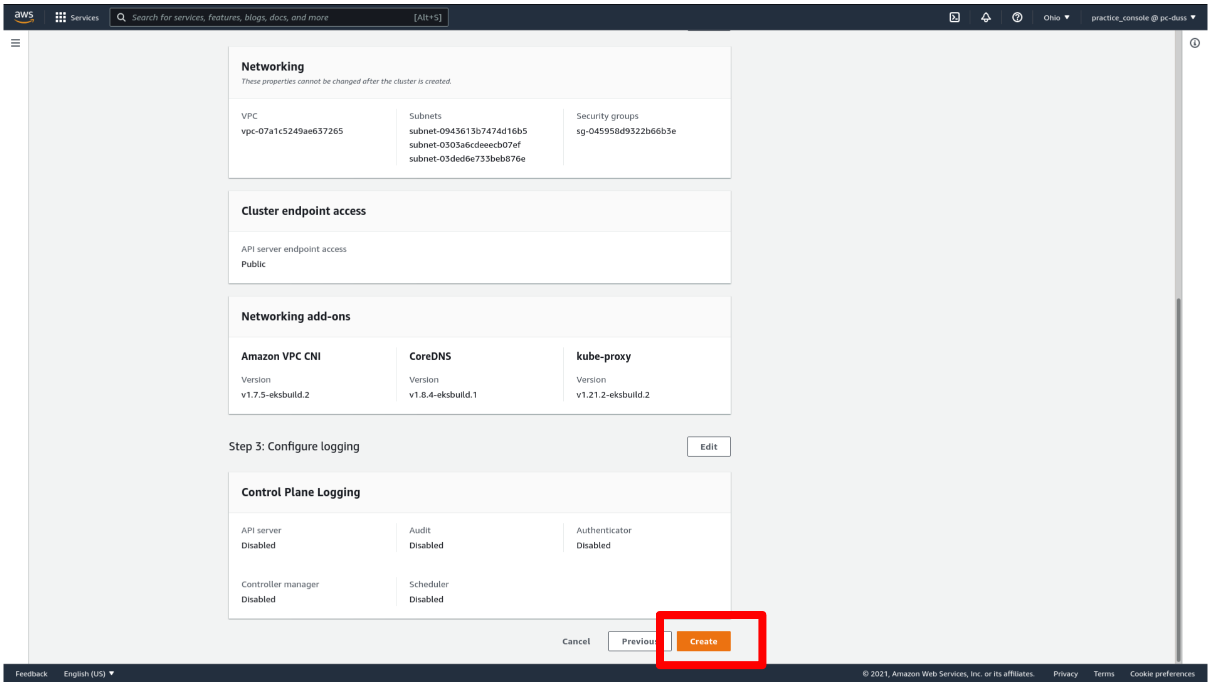
Audit
Logs pertaining to cluster access via the Kubernetes API.
Disabled

Authenticator
Logs pertaining to authentication requests into the cluster.
Disabled

Controller manager
Logs pertaining to state of cluster controllers.
Disabled

Scheduler
Logs pertaining to scheduling decisions.
Disabled

Review the settings for the Kubernetes cluster. When you are ready, click **Create**.


aws
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Ohio
practice_console @ pc-duss

Networking

These properties cannot be changed after the cluster is created.

VPC	Subnets	Security groups
vpc-07a1c5249ae637265	subnet-0943613b7474d16b5 subnet-0303a6cdeeecb07ef subnet-03ded6e733beb876e	sg-045958d9322b66b3e

Cluster endpoint access

API server endpoint access
Public

Networking add-ons

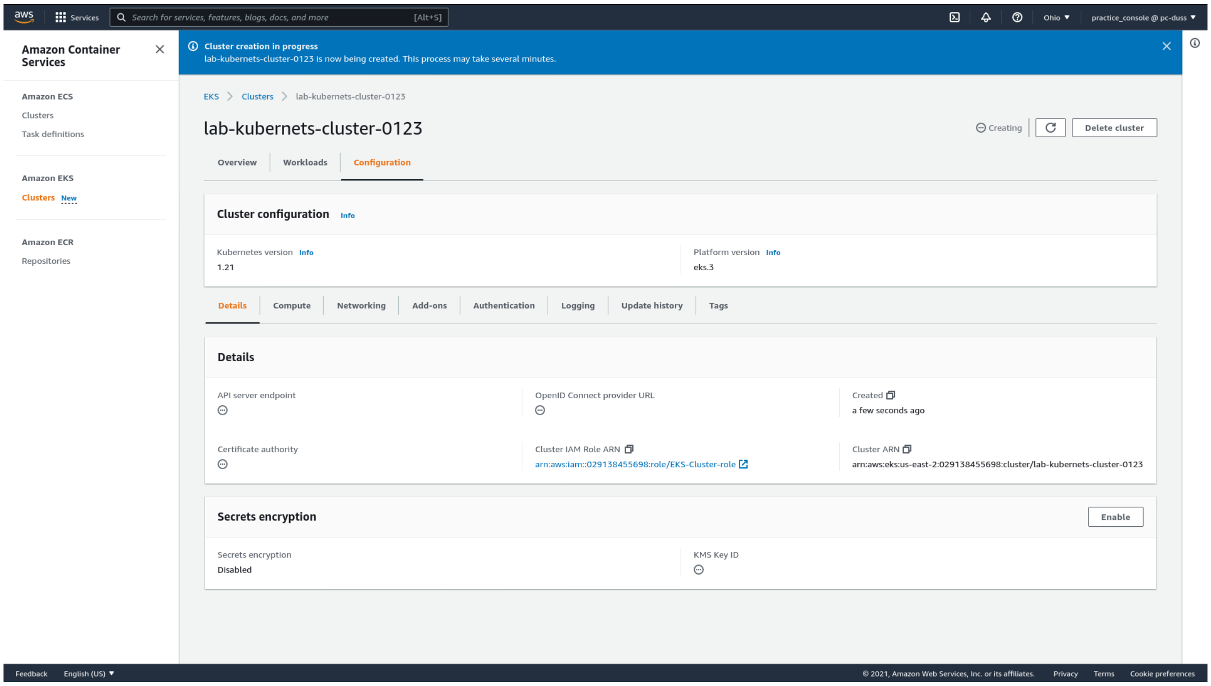
Amazon VPC CNI	CoreDNS	kube-proxy
Version	Version	Version
v1.7.5-eksbuild.2	v1.8.4-eksbuild.1	v1.21.2-eksbuild.2

Step 3: Configure logging

Control Plane Logging

API server	Audit	Authenticator
Disabled	Disabled	Disabled
Controller manager	Scheduler	
Disabled	Disabled	

Your Kubernetes cluster will now begin the creation process. You can stay here or come back, and it will complete in the background. You can use this page to view information regarding your Kubernetes cluster, or to **delete** it.



Cluster creation in progress
lab-kubernets-cluster-0123 is now being created. This process may take several minutes.

lab-kubernets-cluster-0123

Cluster configuration Info

Kubernetes version	Platform version
1.21	eks.3

Details

API server endpoint	OpenID Connect provider URL	Created
⊖	⊖	a few seconds ago
Certificate authority	Cluster IAM Role ARN	Cluster ARN
⊖	arn:aws:iam::029138455698:role/EKS-Cluster-role	arn:aws:eks:us-east-2:029138455698:cluster/lab-kubernets-cluster-0123

Secrets encryption

Secrets encryption	KMS Key ID
Disabled	⊖

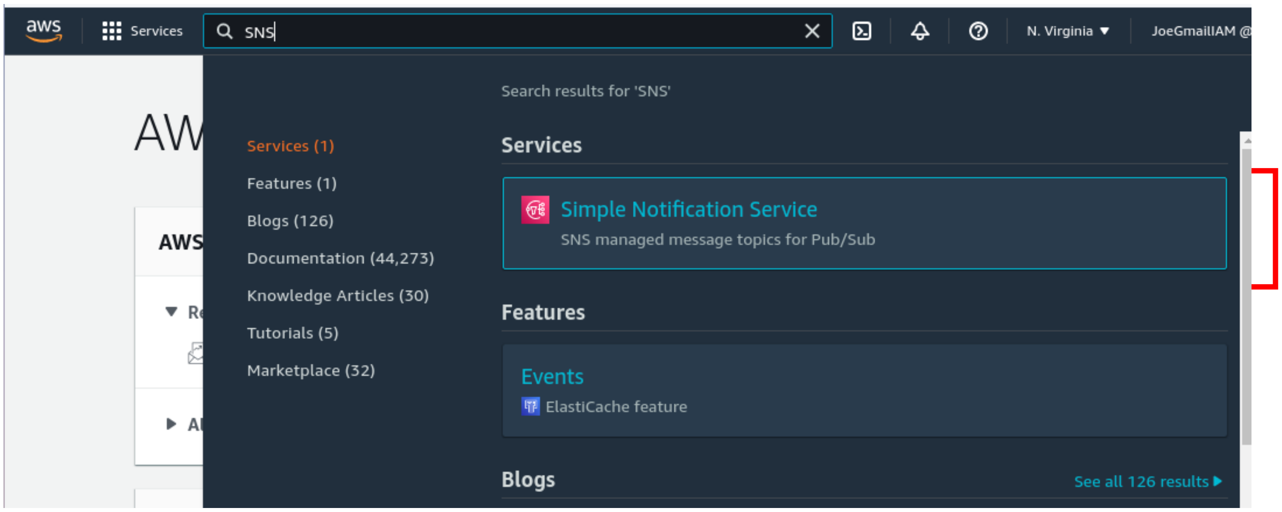
Lab: Create AWS SNS Topic and Get Email Notifications

In this lab we are going to set up an AWS SNS Topic to alert us about the Budget we have set up on our account.

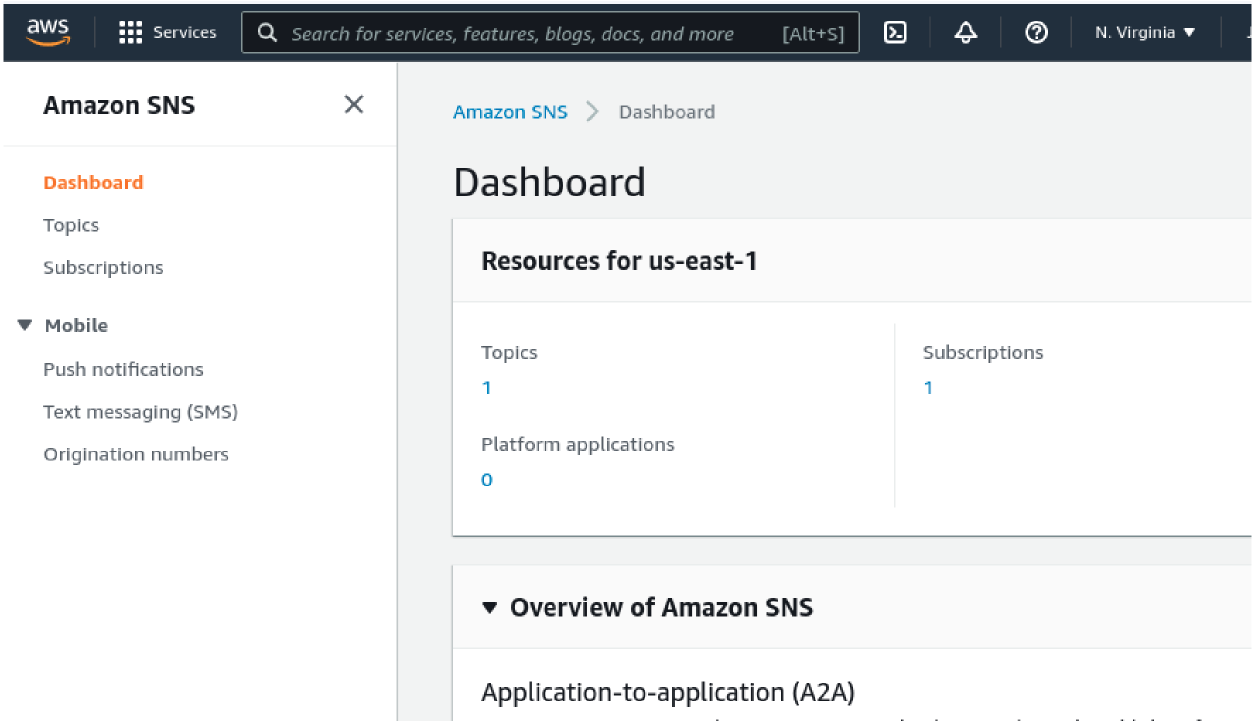
Creating an AWS SNS Topic

At the AWS Management Console, in the search box at the top left-hand corner, type **SNS**.

From the results, click **Simple Notification Service**.



From the resulting dashboard, click on **Topics**.



Dashboard

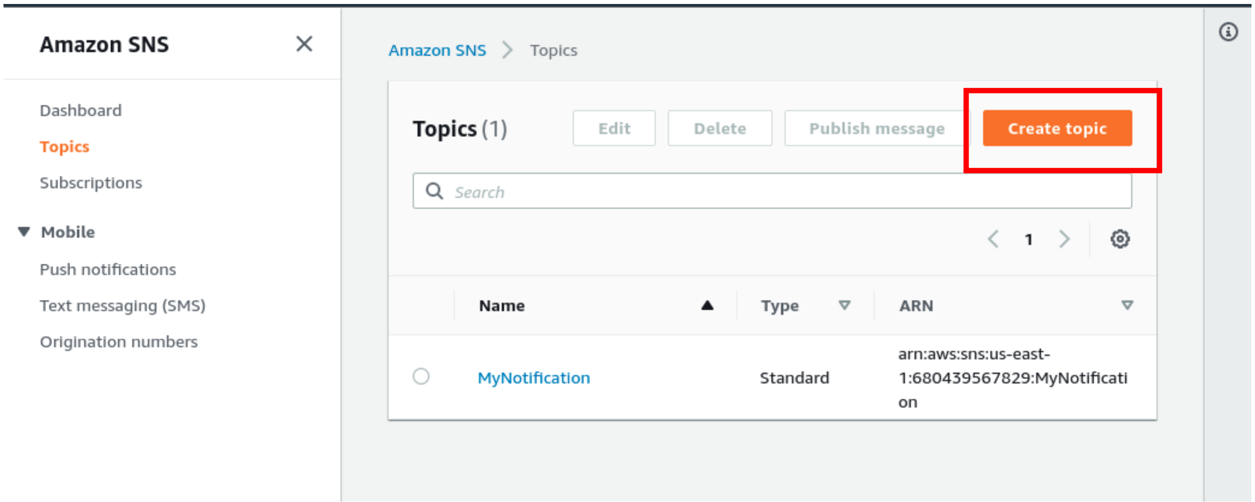
Resources for us-east-1

Topics 1	Subscriptions 1
Platform applications 0	

Overview of Amazon SNS

Application-to-application (A2A)

Click on the **Create Topic** button.



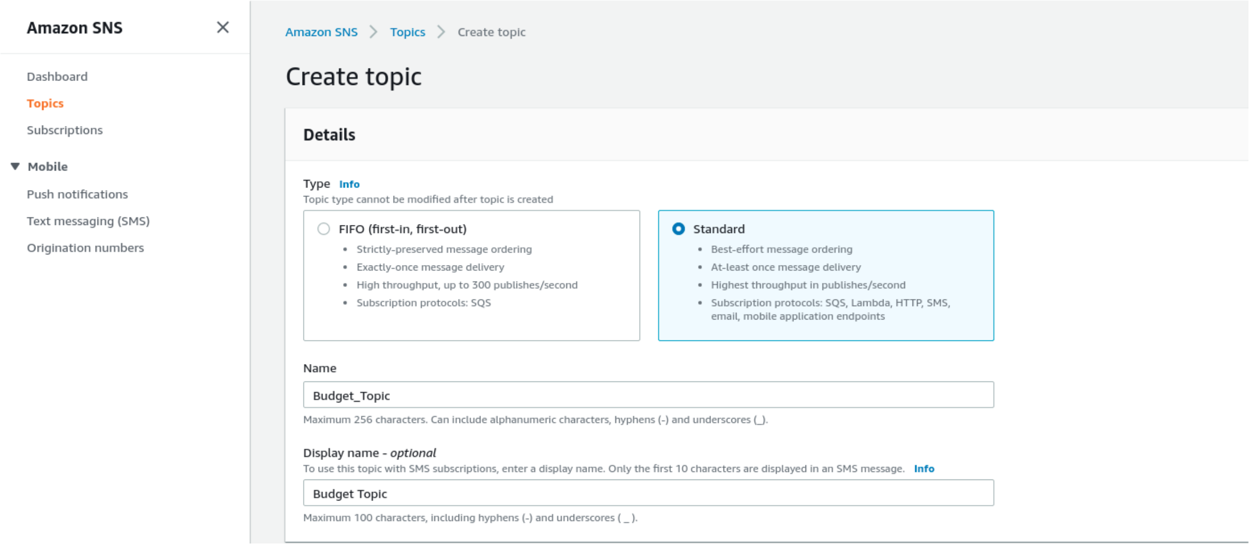
Topics (1)

	Name	Type	ARN
○	MyNotification	Standard	arn:aws:sns:us-east-1:680439567829:MyNotification

We will choose the type of SNS topic. For example, if we were setting up a topic to publish to an SQS FIFO queue, we would choose FIFO. As we are setting up email, we will choose the **Standard** type.

Type in a recognizable name. We have filled this field with **Budget_Topic**.

Type in a Display name. This is optional, but we have input **Budget Topic**.



Create topic

Details

Type Info

Topic type cannot be modified after topic is created

○ FIFO (first-in, first-out)

- Strictly-preserved message ordering
- Exactly-once message delivery
- High throughput, up to 300 publishes/second
- Subscription protocols: SQS

● Standard

- Best-effort message ordering
- At-least once message delivery
- Highest throughput in publishes/second
- Subscription protocols: SQS, Lambda, HTTP, SMS, email, mobile application endpoints

Name

Budget_Topic

Maximum 256 characters. Can include alphanumeric characters, hyphens (-) and underscores (_).

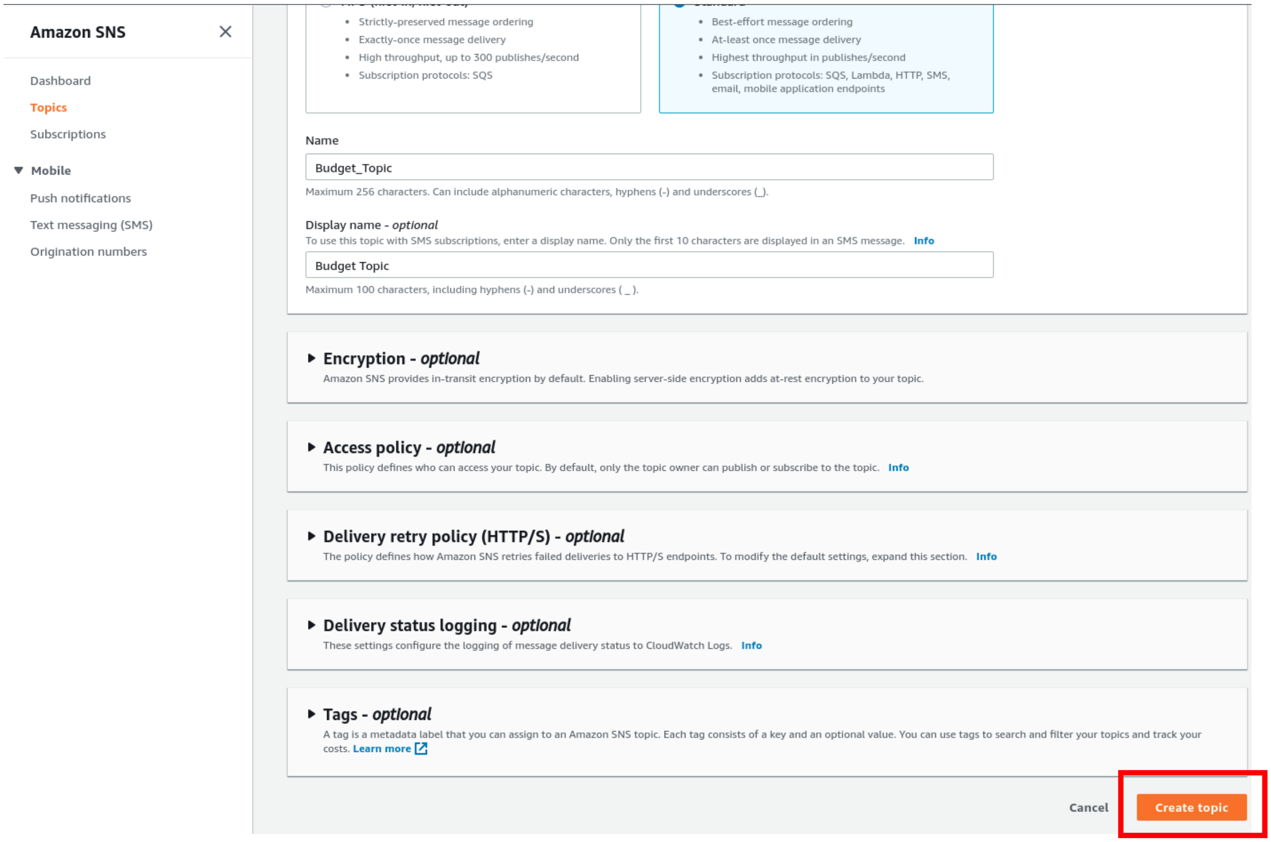
Display name - *optional*

To use this topic with SMS subscriptions, enter a display name. Only the first 10 characters are displayed in an SMS message. Info

Budget Topic

Maximum 100 characters, including hyphens (-) and underscores (_).

Accept the default configurations in optional sections and click **Create Topic**.



Amazon SNS

- Dashboard
- Topics
- Subscriptions

▼ Mobile

- Push notifications
- Text messaging (SMS)
- Origination numbers

○

- Strictly-preserved message ordering
- Exactly-once message delivery
- High throughput, up to 300 publishes/second
- Subscription protocols: SQS

●

- Best-effort message ordering
- At-least once message delivery
- Highest throughput in publishes/second
- Subscription protocols: SQS, Lambda, HTTP, SMS, email, mobile application endpoints

Name

Budget_Topic

Maximum 256 characters. Can include alphanumeric characters, hyphens (-) and underscores (_).

Display name - *optional*

To use this topic with SMS subscriptions, enter a display name. Only the first 10 characters are displayed in an SMS message. Info

Budget Topic

Maximum 100 characters, including hyphens (-) and underscores (_).

▶ **Encryption - *optional***

Amazon SNS provides in-transit encryption by default. Enabling server-side encryption adds at-rest encryption to your topic.

▶ **Access policy - *optional***

This policy defines who can access your topic. By default, only the topic owner can publish or subscribe to the topic. Info

▶ **Delivery retry policy (HTTP/S) - *optional***

The policy defines how Amazon SNS retries failed deliveries to HTTP/S endpoints. To modify the default settings, expand this section. Info

▶ **Delivery status logging - *optional***

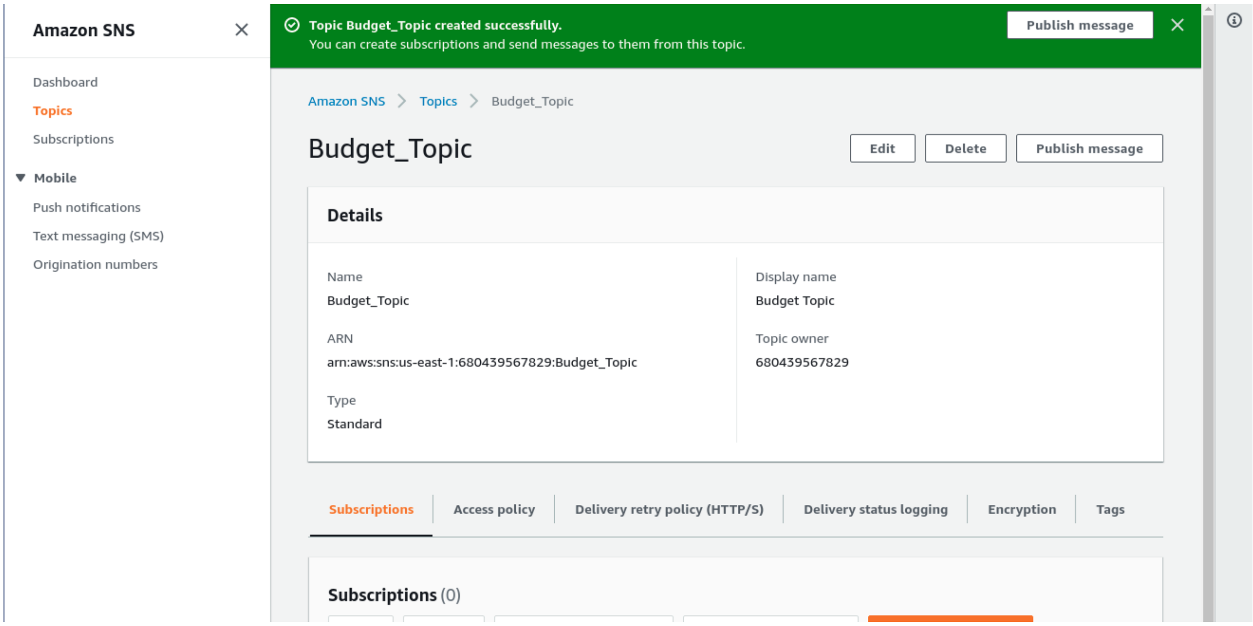
These settings configure the logging of message delivery status to CloudWatch Logs. Info

▶ **Tags - *optional***

A tag is a metadata label that you can assign to an Amazon SNS topic. Each tag consists of a key and an optional value. You can use tags to search and filter your topics and track your costs. Learn more

Cancel | Create topic

As we see here, the topic has been created.



Topic Budget_Topic created successfully.
You can create subscriptions and send messages to them from this topic.

Amazon SNS > Topics > Budget_Topic

Budget_Topic

Details

Name
Budget_Topic

ARN
arn:aws:sns:us-east-1:680439567829:Budget_Topic

Type
Standard

Display name
Budget Topic

Topic owner
680439567829

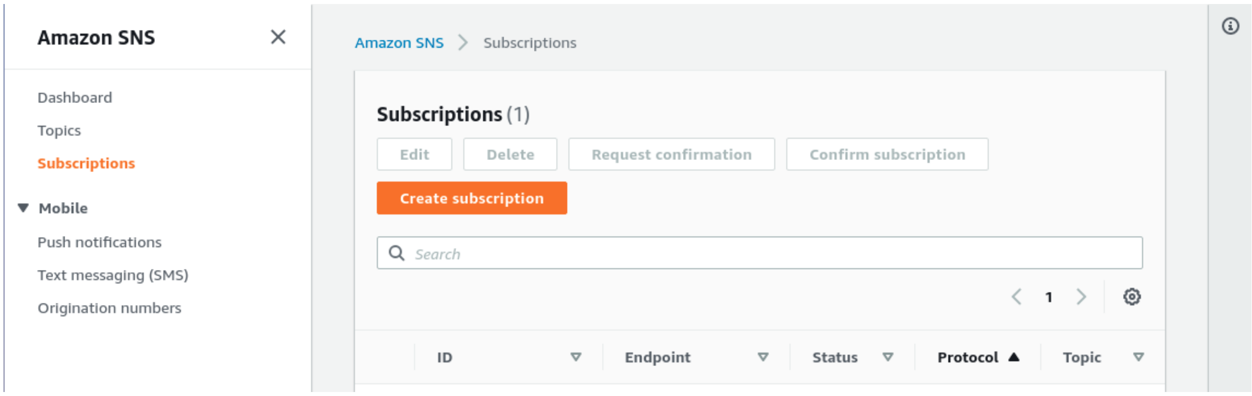
Subscriptions (0)

Now that the topic is created, services can subscribe to the topic to receive notifications. We will subscribe to this topic with “Budget” and be notified by email.

How to Subscribe to a Topic

Repeat Steps 1 and 2 to get to the Amazon SNS page, if you are not already there. Click on **Subscriptions.**

Click the **Create Subscriptions** button.

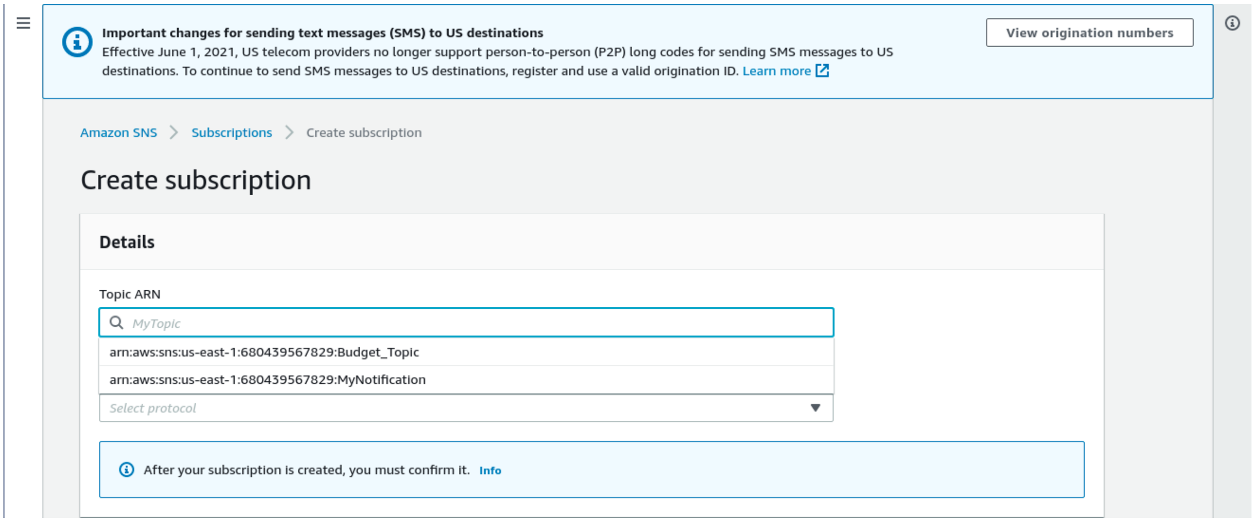


Amazon SNS > Subscriptions

Subscriptions (1)

ID	Endpoint	Status	Protocol ▲	Topic

Click inside the textbox. From the drop-down menu, identify the Amazon Resource Name (ARN) of the topic you would like to subscribe to. You will recognize this number because the name you gave the topic will be at the end of this number.



Important changes for sending text messages (SMS) to US destinations
Effective June 1, 2021, US telecom providers no longer support person-to-person (P2P) long codes for sending SMS messages to US destinations. To continue to send SMS messages to US destinations, register and use a valid origination ID. Learn more

Amazon SNS > Subscriptions > Create subscription

Create subscription

Details

Topic ARN

MyTopic

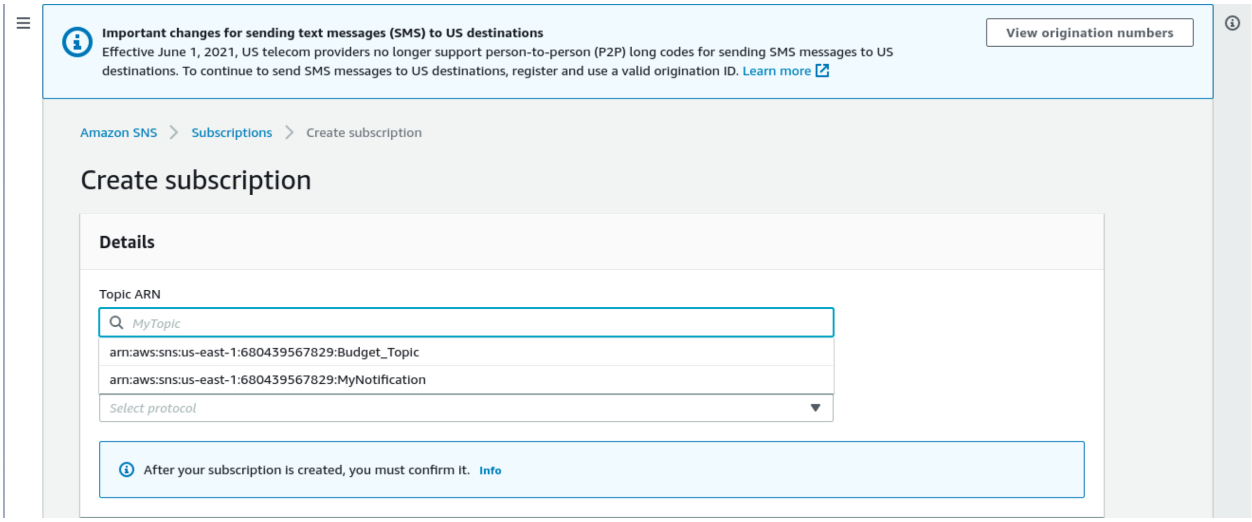
arn:aws:sns:us-east-1:680439567829:Budget_Topic

arn:aws:sns:us-east-1:680439567829:MyNotification

Select protocol

After your subscription is created, you must confirm it. Info

When you click the desired ARN, the textbox will be populated with your choice.



Important changes for sending text messages (SMS) to US destinations
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Amazon SNS > Subscriptions > Create subscription

Create subscription

Details

Topic ARN

MyTopic

arn:aws:sns:us-east-1:680439567829:Budget_Topic

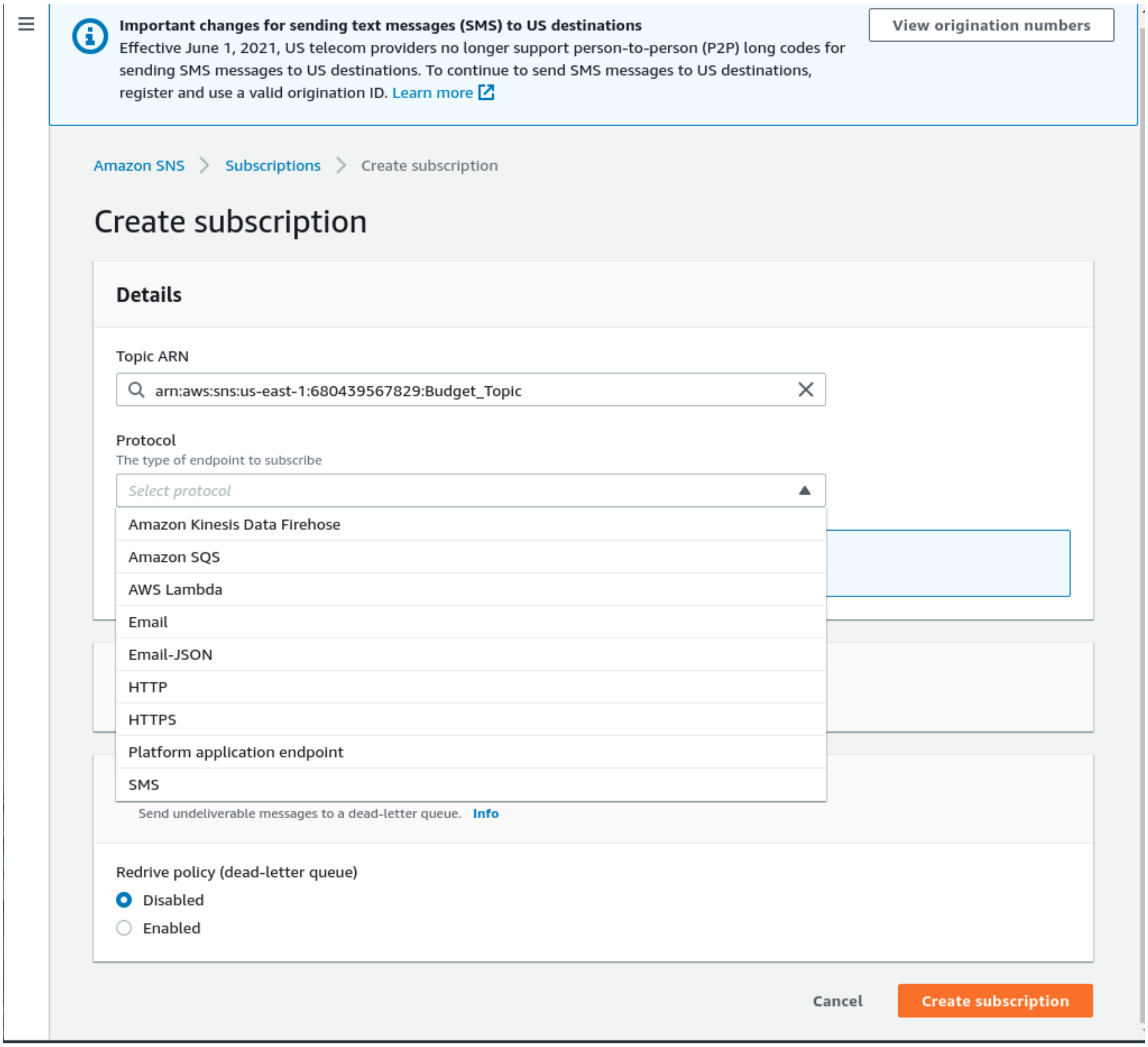
arn:aws:sns:us-east-1:680439567829:MyNotification

Select protocol

After your subscription is created, you must confirm it. Info

Click inside the textbox for Protocol.

As we would like to be notified by email, Select **Email** from the drop-down list.



Important changes for sending text messages (SMS) to US destinations
Effective June 1, 2021, US telecom providers no longer support person-to-person (P2P) long codes for sending SMS messages to US destinations. To continue to send SMS messages to US destinations, register and use a valid origination ID. Learn more

Amazon SNS > Subscriptions > Create subscription

Create subscription

Details

Topic ARN: arn:aws:sns:us-east-1:680439567829:Budget_Topic

Protocol
The type of endpoint to subscribe

Select protocol

- Amazon Kinesis Data Firehose
- Amazon SQS
- AWS Lambda
- Email
- Email-JSON
- HTTP
- HTTPS
- Platform application endpoint
- SMS

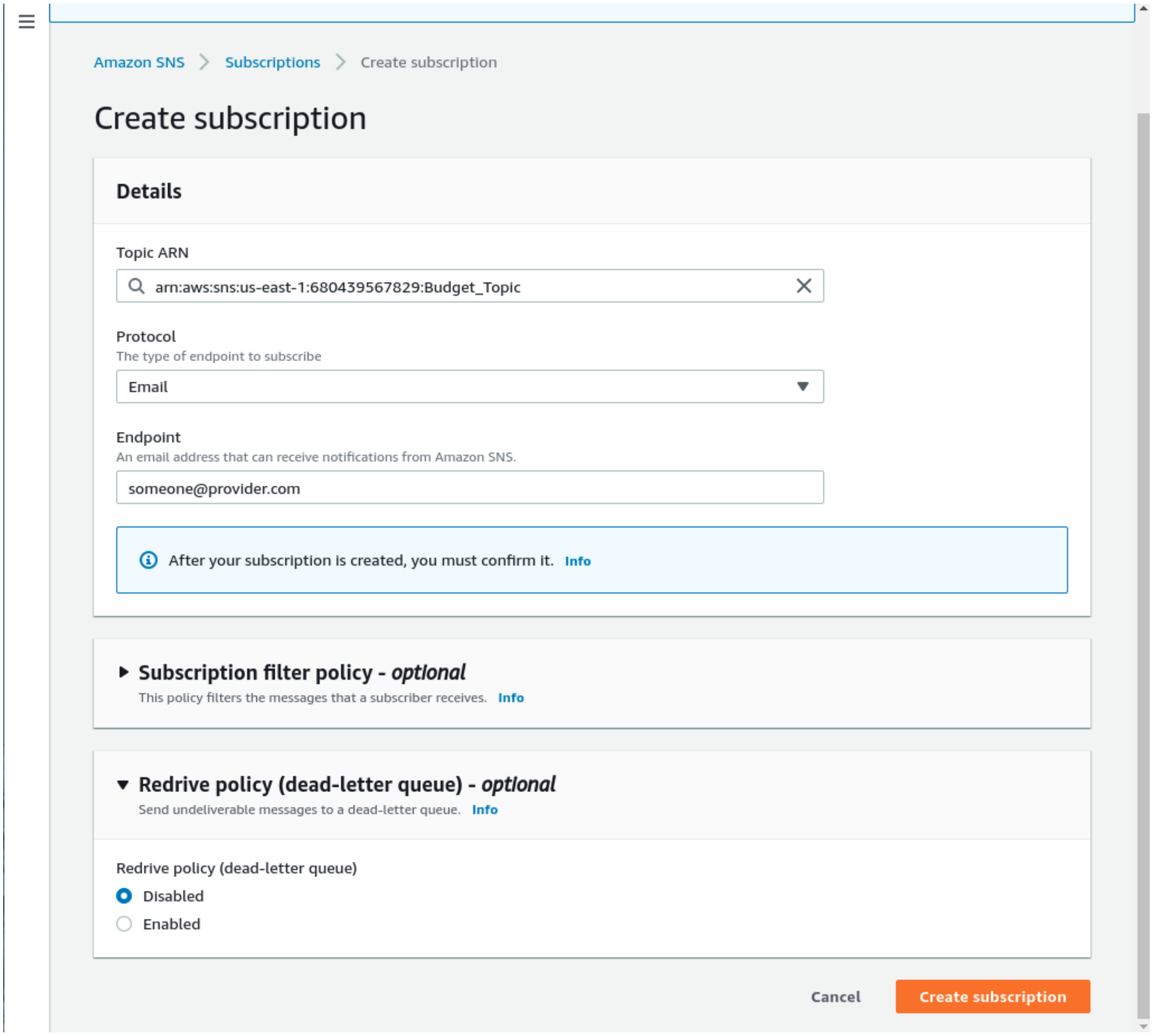
Send undeliverable messages to a dead-letter queue. Info

Redrive policy (dead-letter queue)

● Disabled
○ Enabled

The Text box will now be populated with your choice.

Your email address will be the endpoint for the topic. Fill this in, accept the defaults in the optional sections, and click the **Create subscription** button.



Create subscription

Details

Topic ARN

arn:aws:sns:us-east-1:680439567829:Budget_Topic

Protocol

The type of endpoint to subscribe

Email

Endpoint

An email address that can receive notifications from Amazon SNS.

someone@provider.com

After your subscription is created, you must confirm it. Info

Subscription filter policy - *optional*

This policy filters the messages that a subscriber receives. Info

Redrive policy (dead-letter queue) - *optional*

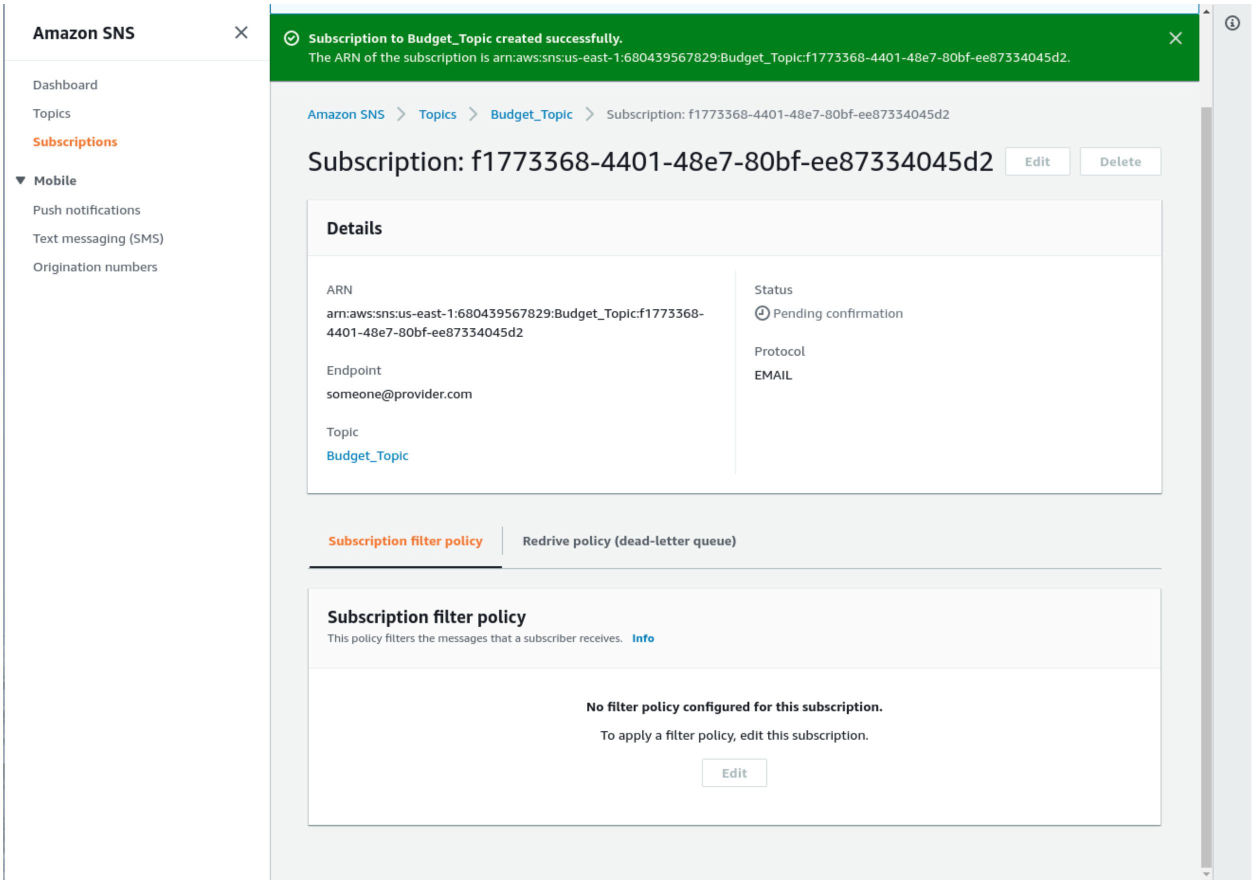
Send undeliverable messages to a dead-letter queue. Info

Redrive policy (dead-letter queue)

● Disabled

○ Enabled

Here, we see that the subscription has been created.



Subscription to Budget_Topic created successfully.
The ARN of the subscription is arn:aws:sns:us-east-1:680439567829:Budget_Topic:f1773368-4401-48e7-80bf-ee87334045d2.

Amazon SNS > Topics > Budget_Topic > Subscription: f1773368-4401-48e7-80bf-ee87334045d2

Subscription: f1773368-4401-48e7-80bf-ee87334045d2

Details

ARN
arn:aws:sns:us-east-1:680439567829:Budget_Topic:f1773368-4401-48e7-80bf-ee87334045d2

Endpoint
someone@provider.com

Topic
Budget_Topic

Status
Pending confirmation

Protocol
EMAIL

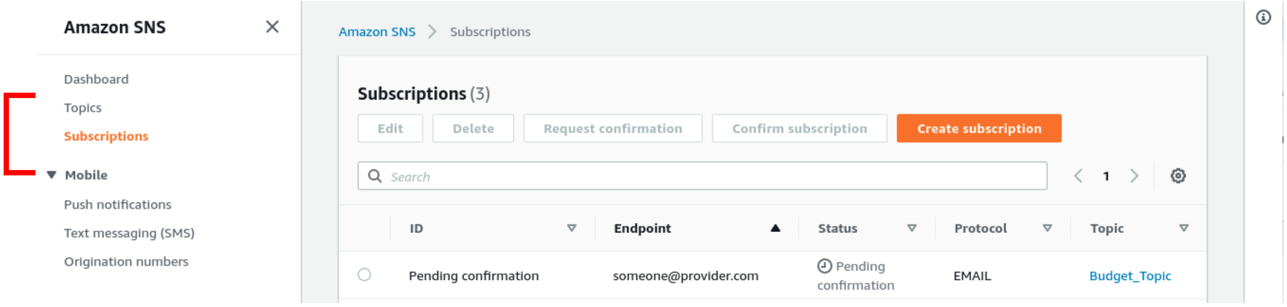
Subscription filter policy
Redrive policy (dead-letter queue)

Subscription filter policy
This policy filters the messages that a subscriber receives. Info

No filter policy configured for this subscription.

To apply a filter policy, edit this subscription.

From the left-hand panel, click **Subscriptions**. You will notice your email under the heading **Endpoint**. The Status will be “pending confirmation”.

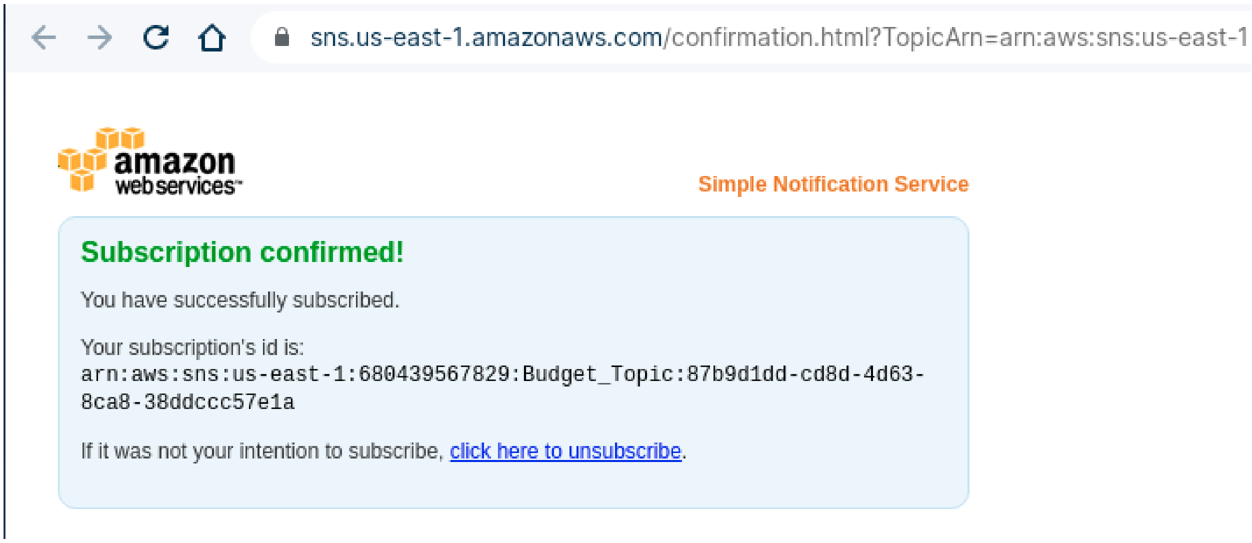


Subscriptions (3)

	ID	Endpoint	Status	Protocol	Topic
○	Pending confirmation	someone@provider.com	Pending confirmation	EMAIL	Budget_Topic

You will receive an email, most likely with the subject line “AWS Notification – Subscription Confirmation”. Open the email and click on the “Confirm Submission” link.

You will be greeted by this screen in your browser:



sns.us-east-1.amazonaws.com/confirmation.html?TopicArn=arn:aws:sns:us-east-1

amazon webservices

Simple Notification Service

Subscription confirmed!

You have successfully subscribed.

Your subscription's id is:

```
arn:aws:sns:us-east-1:680439567829:Budget_Topic:87b9d1dd-cd8d-4d63-
8ca8-38ddccc57e1a
```

If it was not your intention to subscribe, click here to unsubscribe.

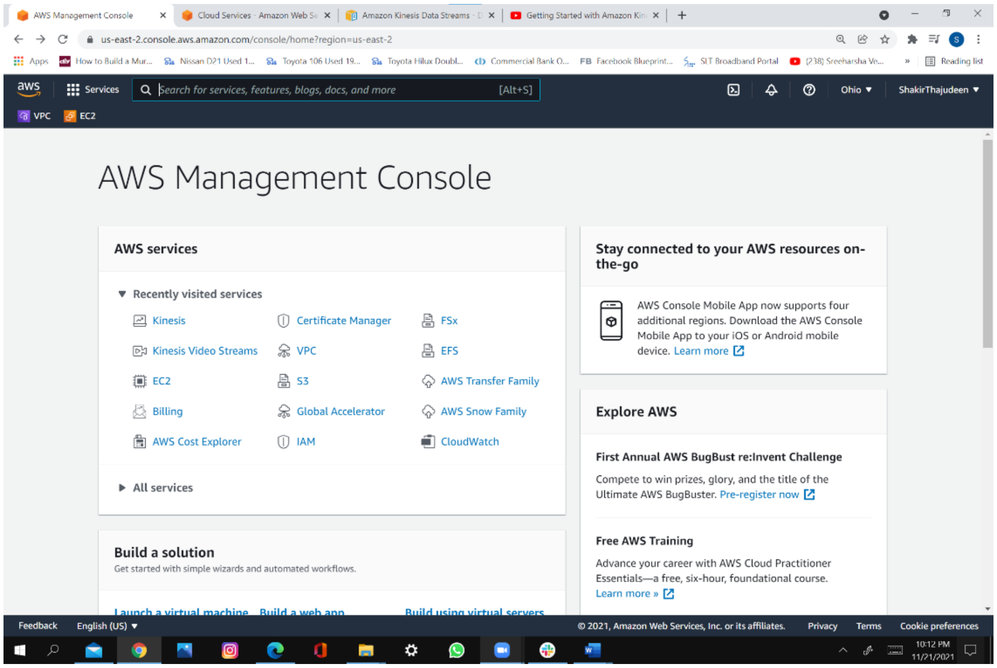
Back in the console, repeat steps 1 and 2 if you are not on the Amazon SNS dashboard. On the Amazon SNS dashboard, click **Subscriptions**.

You will notice that your Status has changed from “pending confirmation” to “confirmed”.

Lab: Set Up Amazon Kinesis Streams

In this lab we will create a Kinesis Data Stream**. Here we are using the Kinesis Data Streams console**.

Select the AWS management console and then select the kinesis data stream console.



AWS Management Console

Stay connected to your AWS resources on-the-go

AWS Console Mobile App now supports four additional regions. Download the AWS Console Mobile App to your iOS or Android mobile device. Learn more

Explore AWS

First Annual AWS BugBust re:Invent Challenge

Compete to win prizes, glory, and the title of the Ultimate AWS BugBuster. Pre-register now

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Build a solution

Get started with simple wizards and automated workflows.

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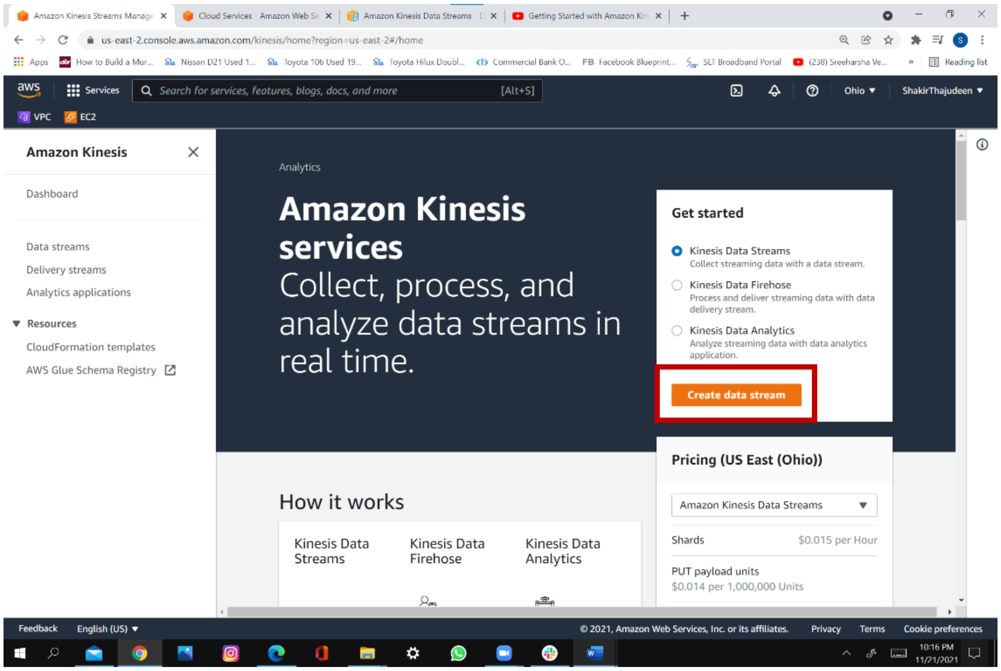

Amazon Kinesis services

Collect, process, and analyze data streams in real time.

Get started

● Kinesis Data Streams
Collect streaming data with a data stream.

○ Kinesis Data Firehose
Process and deliver streaming data with data delivery stream.

○ Kinesis Data Analytics
Analyze streaming data with data analytics application.

Create data stream

Pricing (US East (Ohio))

Shards	$0.015 per Hour
PUT payload units	$0.014 per 1,000,000 Units

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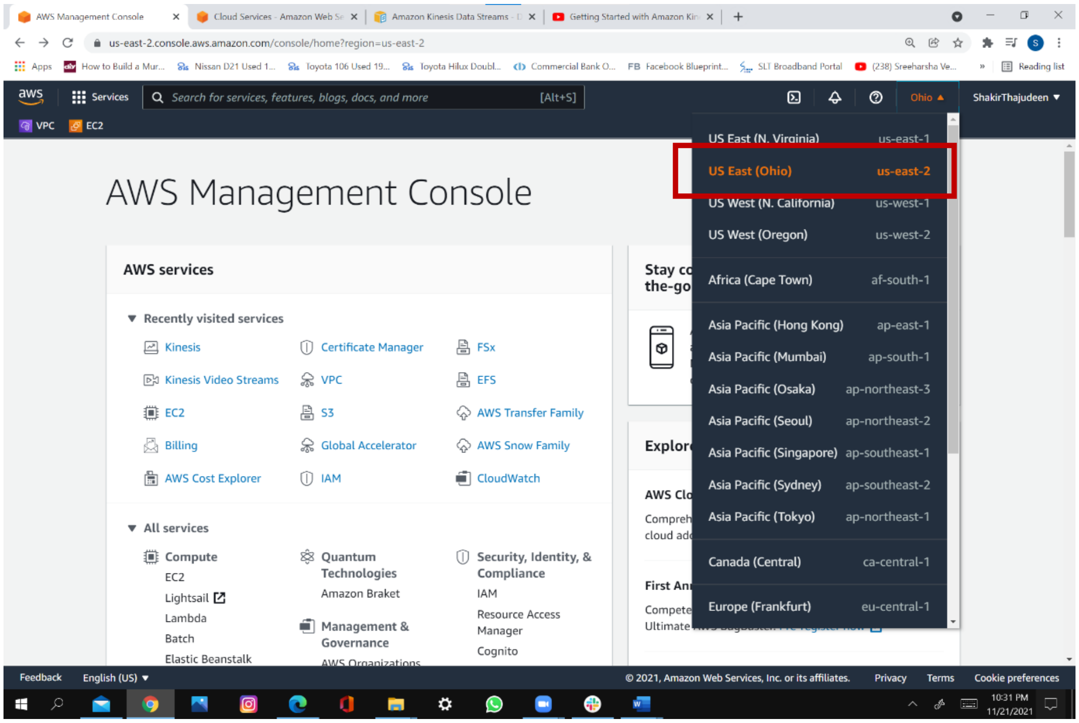
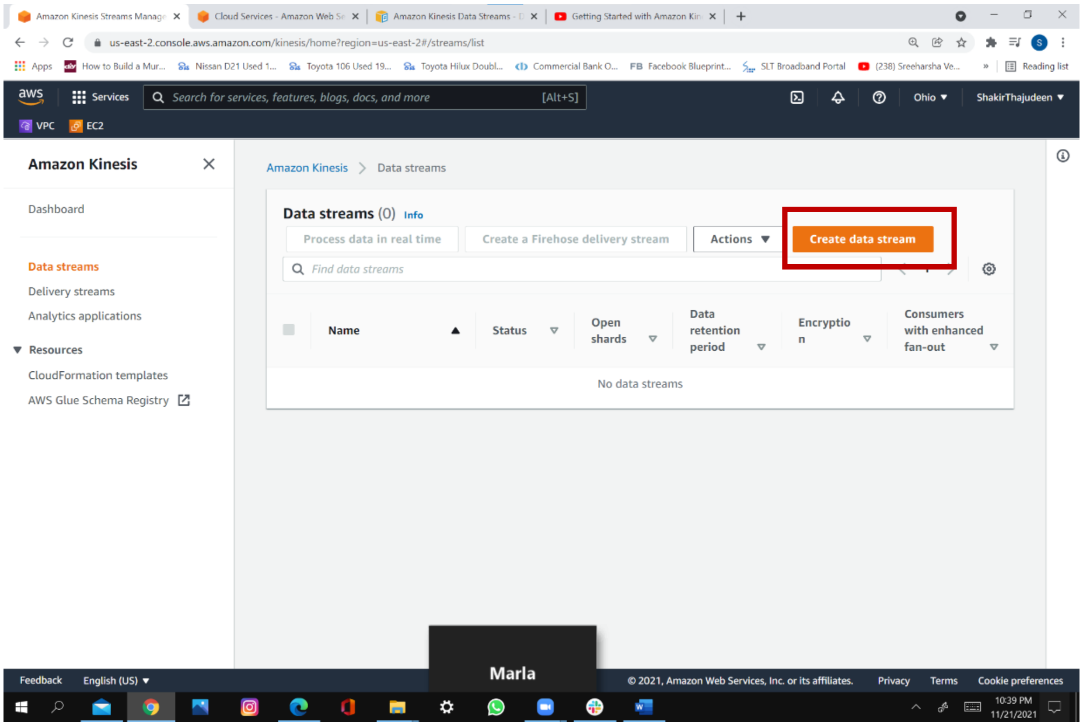
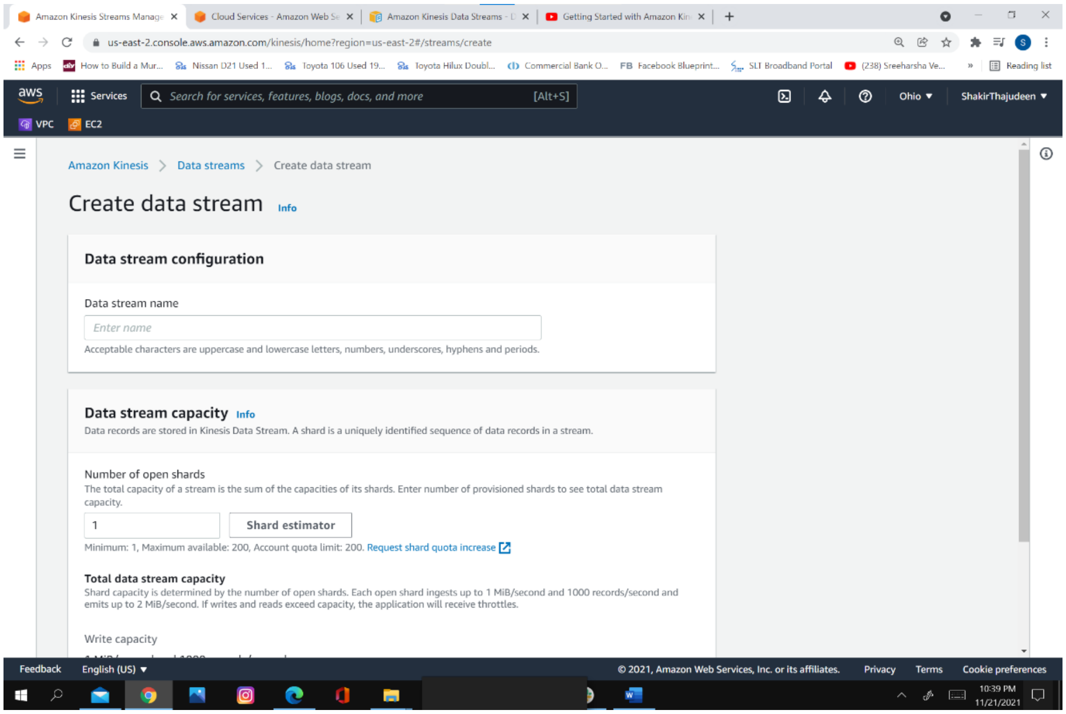
Select the region from the navigation bar.


us-east-2.console.aws.amazon.com/console/home?region=us-east-2
Services
Search for services, features, blogs, docs, and more
Ohio
ShakirThajudeen
AWS Management Console
AWS services
Recently visited services
Kinesis
Certificate Manager
FSx
Kinesis Video Streams
VPC
EFS
EC2
S3
AWS Transfer Family
Billing
Global Accelerator
AWS Snow Family
AWS Cost Explorer
IAM
CloudWatch
All services
US East (N. Virginia) us-east-1
US East (Ohio) us-east-2
US West (N. California) us-west-1
US West (Oregon) us-west-2
Africa (Cape Town) af-south-1
Asia Pacific (Hong Kong) ap-east-1
Asia Pacific (Mumbai) ap-south-1
Asia Pacific (Osaka) ap-northeast-3
Asia Pacific (Seoul) ap-northeast-2
Asia Pacific (Singapore) ap-southeast-1
Asia Pacific (Sydney) ap-southeast-2
Asia Pacific (Tokyo) ap-northeast-1
Canada (Central) ca-central-1
Europe (Frankfurt) eu-central-1

Click create data stream.



Create data stream.


us-east-2.console.aws.amazon.com/kinesis/home?region=us-east-2#/streams/create
Services
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ShakirThajudeen
VPC
EC2
Feedback
English (US)
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10:39 PM
11/21/2021

Amazon Kinesis > Data streams > Create data stream

Create data stream Info

Data stream configuration

Data stream name

Enter name

Acceptable characters are uppercase and lowercase letters, numbers, underscores, hyphens and periods.

Data stream capacity Info

Data records are stored in Kinesis Data Stream. A shard is a uniquely identified sequence of data records in a stream.

Number of open shards

The total capacity of a stream is the sum of the capacities of its shards. Enter number of provisioned shards to see total data stream capacity.

1 | Shard estimator

Minimum: 1, Maximum available: 200, Account quota limit: 200. Request shard quota increase

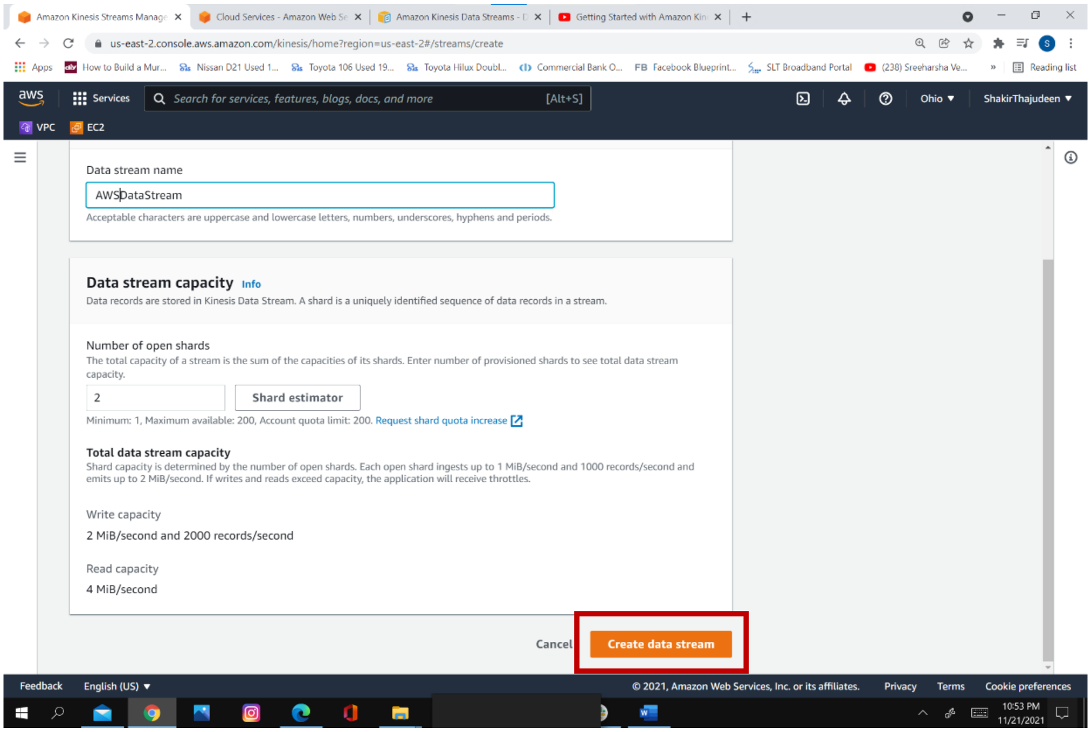
Total data stream capacity

Shard capacity is determined by the number of open shards. Each open shard ingests up to 1 MiB/second and 1000 records/second and emits up to 2 MiB/second. If writes and reads exceed capacity, the application will receive throttles.

Write capacity

Enter stream name and the number of shards.

Click **Create data stream.**


us-east-2.console.aws.amazon.com/kinesis/home?region=us-east-2#/streams/create
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Ohio
ShakirThajudeen
VPC
EC2
Feedback
English (US)
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Cookie preferences
10:53 PM
11/21/2021

Data stream name

AWSDataStream

Acceptable characters are uppercase and lowercase letters, numbers, underscores, hyphens and periods.

Data stream capacity Info

Data records are stored in Kinesis Data Stream. A shard is a uniquely identified sequence of data records in a stream.

Number of open shards

The total capacity of a stream is the sum of the capacities of its shards. Enter number of provisioned shards to see total data stream capacity.

2 | Shard estimator

Minimum: 1, Maximum available: 200, Account quota limit: 200. Request shard quota increase

Total data stream capacity

Shard capacity is determined by the number of open shards. Each open shard ingests up to 1 MiB/second and 1000 records/second and emits up to 2 MiB/second. If writes and reads exceed capacity, the application will receive throttles.

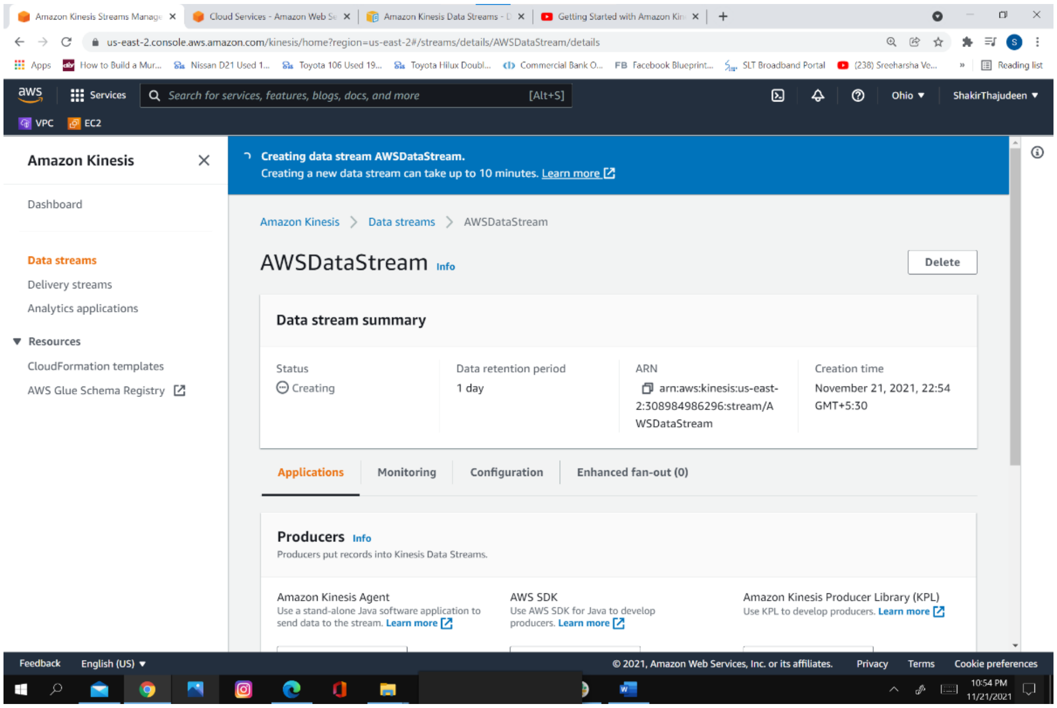
Write capacity

2 MiB/second and 2000 records/second

Read capacity

4 MiB/second

Cancel | Create data stream


Amazon Kinesis Streams Manage
Cloud Services - Amazon Web Se
Amazon Kinesis Data Streams
Getting Started with Amazon Kin
us-east-2.console.aws.amazon.com/kinesis/home?region=us-east-2#/streams/details/AWSDataStream/details
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Ohio
ShakirThajudeen
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EC2
Amazon Kinesis
Dashboard
Data streams
Delivery streams
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Cookie preferences
10:54 PM
11/21/2021

Creating data stream AWSDataStream.
Creating a new data stream can take up to 10 minutes. Learn more

Amazon Kinesis > Data streams > AWSDataStream

AWSDataStream Info

Delete

Data stream summary

Status	Data retention period	ARN	Creation time
Creating	1 day	arn:aws:kinesis:us-east-2:308984986296:stream/AWSDataStream	November 21, 2021, 22:54 GMT+5:30

Applications | Monitoring | Configuration | Enhanced fan-out (0)

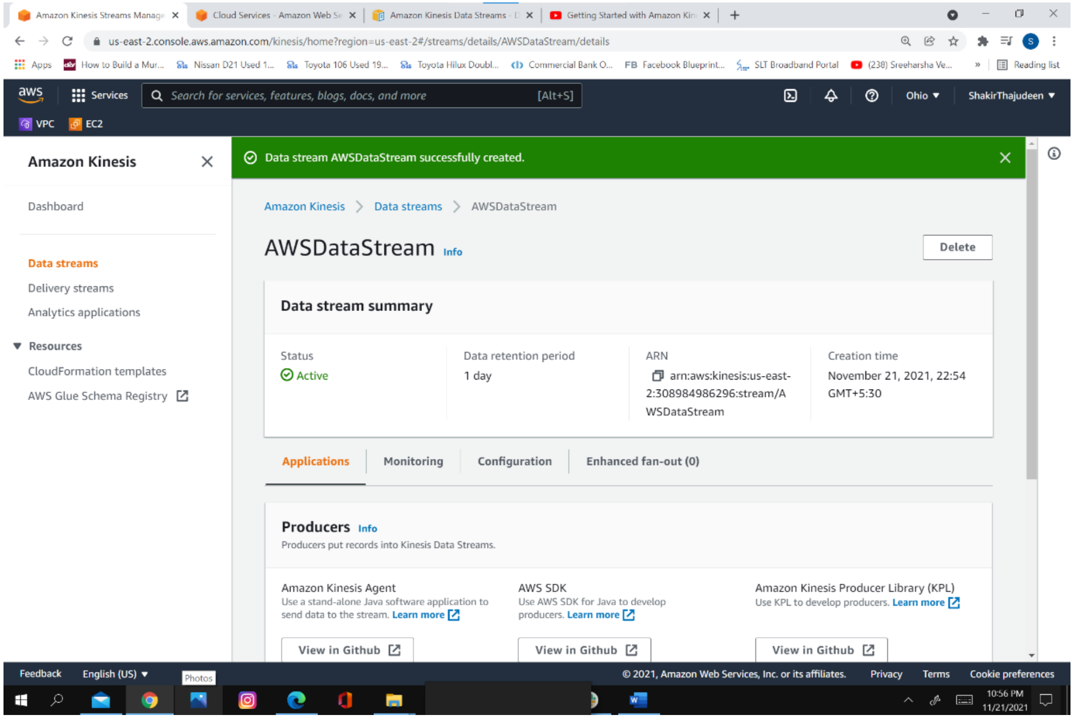
Producers Info
Producers put records into Kinesis Data Streams.

Amazon Kinesis Agent
Use a stand-alone Java software application to send data to the stream. Learn more

AWS SDK
Use AWS SDK for Java to develop producers. Learn more

Amazon Kinesis Producer Library (KPL)
Use KPL to develop producers. Learn more

When created, status will change to active.


Amazon Kinesis Streams Manage
Cloud Services - Amazon Web Se
Amazon Kinesis Data Streams
Getting Started with Amazon Kin
us-east-2.console.aws.amazon.com/kinesis/home?region=us-east-2#/streams/details/AWSDataStream/details
Services
Search for services, features, blogs, docs, and more
[Alt+S]
Ohio
ShakirThajudeen
VPC
EC2
Amazon Kinesis
Dashboard
Data streams
Delivery streams
Analytics applications
Resources
CloudFormation templates
AWS Glue Schema Registry
Feedback
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10:56 PM
11/21/2021

Data stream AWSDataStream successfully created.

Amazon Kinesis > Data streams > AWSDataStream

AWSDataStream Info

Delete

Data stream summary

Status	Data retention period	ARN	Creation time
Active	1 day	arn:aws:kinesis:us-east-2:308984986296:stream/AWSDataStream	November 21, 2021, 22:54 GMT+5:30

Applications | Monitoring | Configuration | Enhanced fan-out (0)

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View in Github

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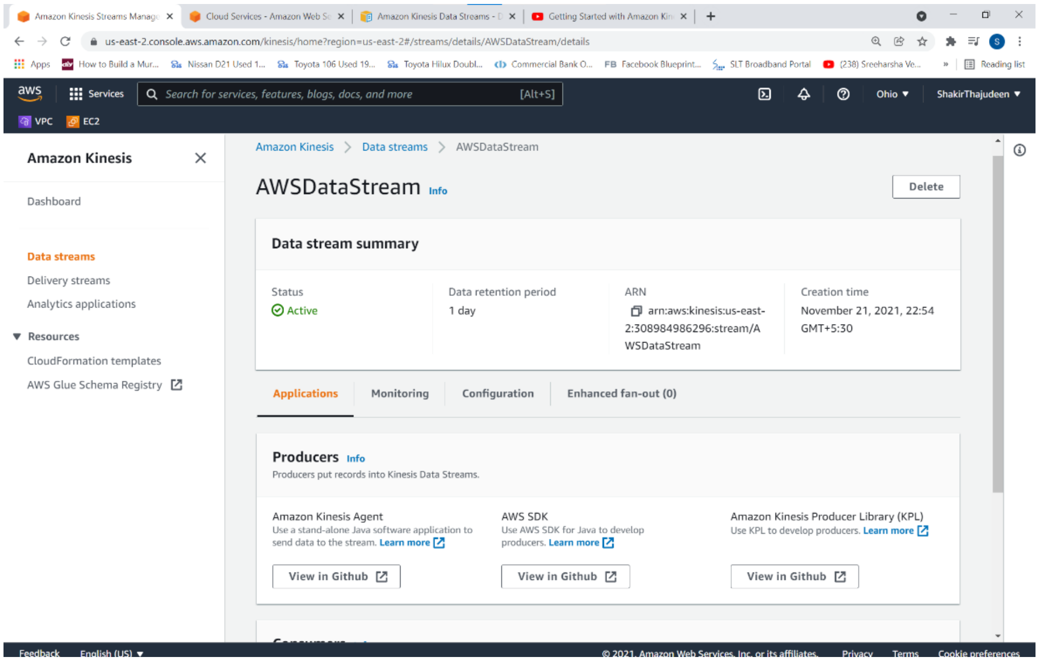
View in Github

Amazon Kinesis Producer Library (KPL)
Use KPL to develop producers. Learn more
View in Github

The stream details page displays a summary of your stream configuration.



AWSDataStream Info

Data stream summary

Status	Data retention period	ARN	Creation time
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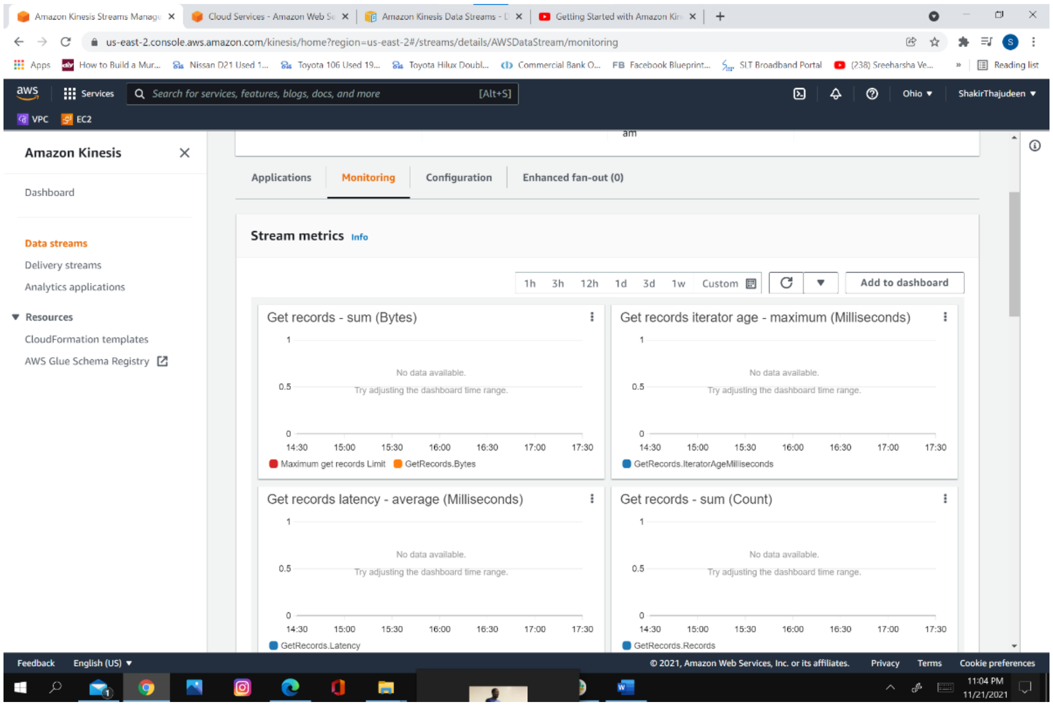
Use KPL to develop producers. Learn more

By selecting the tabs, you can see the Monitoring, Configuration, and Enhanced fan-out.



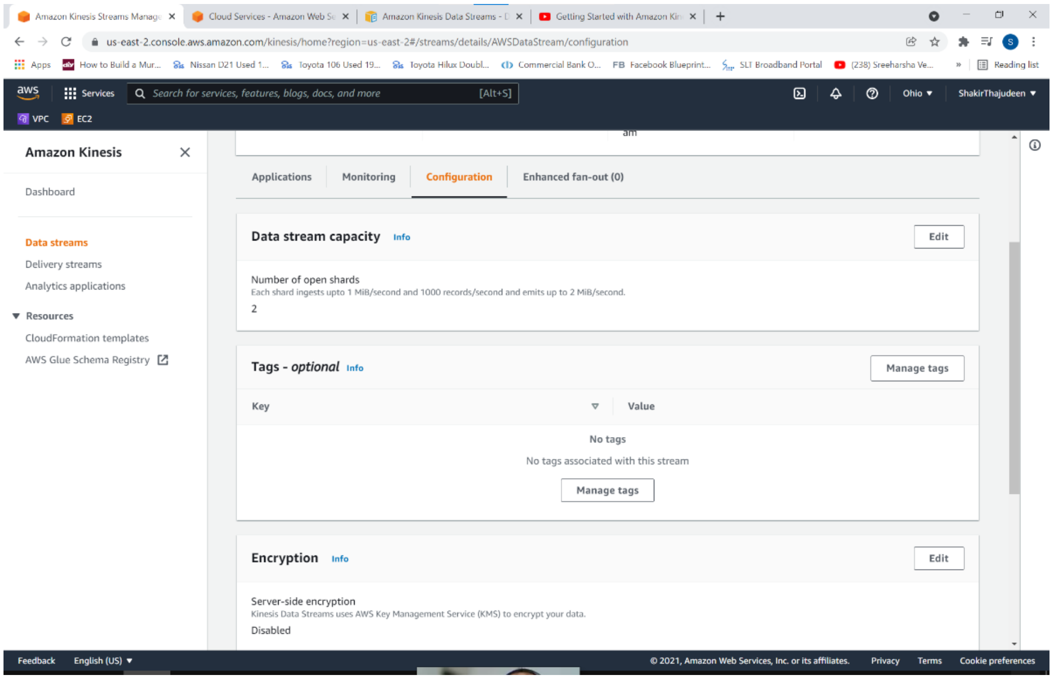
Stream metrics Info

Get records - sum (Bytes)
No data available.
Try adjusting the dashboard time range.
Maximum get records Limit
GetRecords.Bytes

Get records iterator age - maximum (Milliseconds)
No data available.
Try adjusting the dashboard time range.
GetRecords.IteratorAgeMilliseconds

Get records latency - average (Milliseconds)
No data available.
Try adjusting the dashboard time range.
GetRecords.Latency

Get records - sum (Count)
No data available.
Try adjusting the dashboard time range.
GetRecords.Records



us-east-2.console.aws.amazon.com/kinesis/home?region=us-east-2#/streams/details/AWSDataStream/configuration

am

Data stream capacity Info

Number of open shards
Each shard ingests upto 1 MiB/second and 1000 records/second and emits up to 2 MiB/second.
2

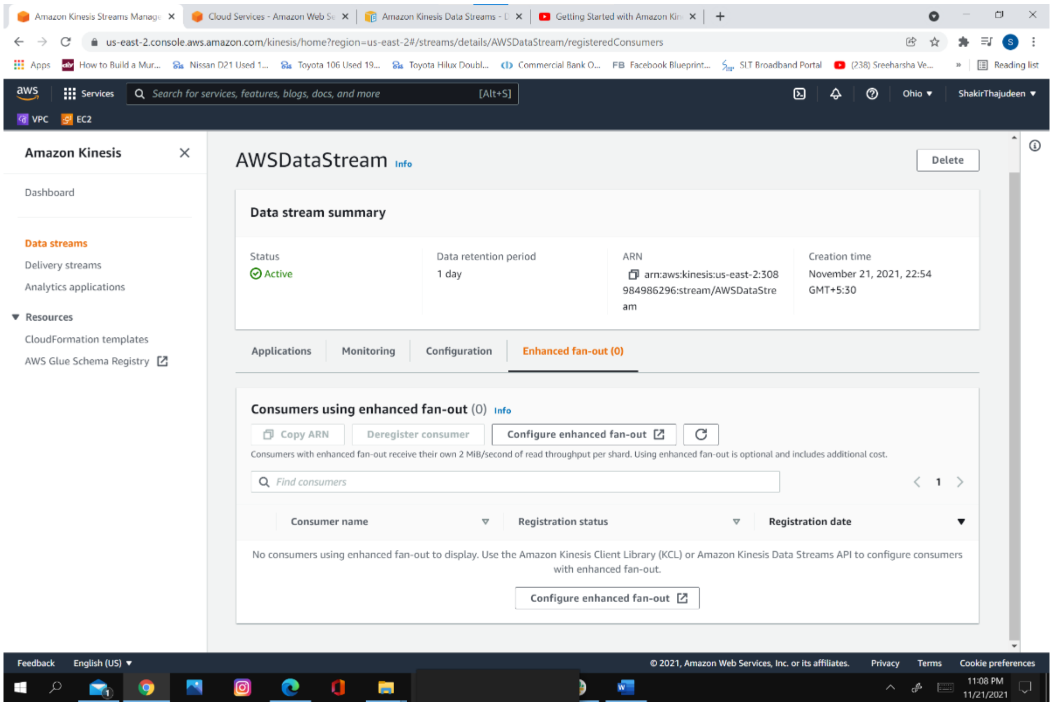
Tags - *optional* Info

Key	Value

No tags
No tags associated with this stream

Encryption Info

Server-side encryption
Kinesis Data Streams uses AWS Key Management Service (KMS) to encrypt your data.
Disabled



us-east-2.console.aws.amazon.com/kinesis/home?region=us-east-2#/streams/details/AWSDataStream/registeredConsumers

AWSDataStream Info

Data stream summary

Status	Data retention period	ARN	Creation time
Active	1 day	arn:aws:kinesis:us-east-2:308984986296:stream/AWSDataStream	November 21, 2021, 22:54 GMT+5:30

Consumers using enhanced fan-out (0) Info

Consumers with enhanced fan-out receive their own 2 MiB/second of read throughput per shard. Using enhanced fan-out is optional and includes additional cost.

Consumer name	Registration status	Registration date

No consumers using enhanced fan-out to display. Use the Amazon Kinesis Client Library (KCL) or Amazon Kinesis Data Streams API to configure consumers with enhanced fan-out.

Chapter 14 Passing the AWS Exam

The AWS Certified Solutions Architect Exams

AWS exams can be quite challenging, as there is a lot of material covered in the exams. It is our experience that these exams can cover an incredibly wide range of topics. Therefore, we advise strong preparation, so you are in the best position to answer challenging questions. There are some key elements of AWS questions that make them challenging to answer, including the following:

- Questions can be extremely wordy and challenging to understand. Don't be surprised if you need to read the questions two or three times each to understand the question.
- There may not be a correct answer among the options presented in the question. Choose what feels like the best answer.
- The questions frequently do not provide sufficient information to answer them without a lot of guessing and interpretation.
- Don't overthink the questions. If you have an extensive IT background, when you read the questions, you will see multiple options that could be right because there are many ways to accomplish the same goals. For the exam, forget past experiences and remember the AWS way. It is an AWS test, so think in terms of AWS.
- Sometimes the answers to the questions differ by only one word, so read very carefully.
- Sometimes AWS questions have *NOT* in them. For example, *Which one of these options is* not *required under these circumstances?* Read carefully so you don't miss the *NOT*.
- Don't spend too much time on each question, as you can go back to them and may find the answer elsewhere on the exam.

Recommendations

We have several recommendations to help you pass the exam.

Read this book in its entirety. We spent a lot of time putting the materials in a short and easy-to-read format. Since we wrote for readability, even small sections of the book may contain a lot of information.

Look very carefully at the diagrams contained in this book. We designed those diagrams to help explain AWS concepts.

Read the AWS white papers. In our experience, a lot of AWS questions are taken from information contained in AWS white papers.

Use practice tests. We feel that knowledge is only part of passing the AWS exams. A lot of passing the AWS exam is learning to read and understand the complexity of AWS questions. Practice tests are a great way to assess your knowledge, reinforce tricky concepts, and get you used to the way AWS asks questions. When you can score 95 percent or better on a practice test, we recommend scheduling the exam.

Avoid brain dumps. We strongly advise against using services that claim to have actual exam questions with answers. First, it is cheating and unethical. Second, when we find AWS questions on the internet, often the answers provided are incorrect. Additionally, if AWS suspects someone of cheating, AWS can pull any certifications they receive.

Don't cram the day of the exam. If you have prepared properly, you will have the tools necessary to pass the exam. We believe that for many, the biggest challenge is actually reading and understanding the questions. If you are tired from cramming, the questions may be challenging, if not impossible, to understand.

The Day Before the Exam

The day before the exam, make every effort to get a good night's sleep so you will have the energy and concentration for a three-hour exam. Eat healthy foods the day before and the day of the exam so you will be at your best. Avoid alcohol or any substance that can affect thinking or judgment, unless prescribed by your physician for a health condition.

The Day of the Exam

We recommend taking it easy on the day of the exam. As we have previously stated, the AWS questions are very challenging to understand, so it's best to arrive feeling refreshed and not fatigued. Arrive early for the exam, whether it's online or in person. Online exams can take time to set up, as there are photos to be taken and many other setup components. This can take thirty minutes or more in certain situations. When taking an in-person exam, there can be traffic problems, parking problems, or tech problems, so be early so you don't lose valuable exam time. Remember to have a valid photo ID when you take the exam.

Thank You

Thank you for reading this book. We are excited for your journey into the world of cloud computing. We are always excited when our students pass a new certification exam. Please let us know about your success by sending an email to elitetechcareers@gmail.com.

Practice Exam

Below is a sample practice exam. Please note that not all questions are grammatically perfect. This is intentional to make the questions feel more like the actual exam. As stated in the book, we strongly recommend purchasing additional practice exams and scheduling your exam when you can c3onsistently score above 95 percent.

1. An organization has an application in their on-premises data center that stores multiple 5GB files per day in S3. Recently many of these uploads have been failing. The customer's data center is geographically close to the S3 region where they store their data. What can the organization do to increase the reliability of data transfers to AWS without incurring substantial costs?

   A) Upload data to S3 using transfer acceleration

   B) Upload data as part of a multipart upload

   C) Upload data to glacier and then copy to S3

   D) Upgrade to a faster connection to the internet

2. An organization has users who upload a large number of files (each file is about 30MB) each day to S3. Recently, many of these uploads have been very slow. The organization's employees are spread throughout the world. What can the organization do to increase the performance of these transfers to S3?

   A) Upload data to S3 using transfer acceleration

   B) Upload data as part of a multipart upload

   C) Upload data to Glacier and then copy to S3

   D) Upgrade to a faster connection to the internet

3. You have deployed a three-tier architecture in a VPC with a CIDR block of 172.16.1.0/28. The initial deployment has two web servers, two application servers, two database servers, and a custom server deployed on an EC2 instance. All web, application servers, and database servers are spread across two availability zones. Additionally, there is an

ELB and DNS using Route 53. Demand for the application grows, and autoscaling is not able to keep up with demand, as autoscaling stops after adding two additional servers.

Why did autoscaling stop adding instances? Choose two:

A) AWS reserves the first four and last IP addresses, so there are not enough addresses to launch additional instances.

B) There should be 15 usable addresses in a /28 subnet, so there must be a configuration error.

C) Autoscaling is configured improperly.

D) The customer needs a larger subnet, i.e. a /27 instead of a /28.

4. When using IAM, a group is regarded as a:

   A) Collection of AWS accounts

   B) Collection of AWS users

   C) Collection of computing instances

   D) Link between a database and a compute instance

5. You have set up an autoscaling policy to scale in and out. You would like to control which instances are stopped first. How would you configure this?

   A) IAM Role

   B) A termination policy

   C) Route 53

   D) DynamoDB

6. What are characteristics of VPC subnets? Choose 3:

   A) Each subnet maps to a single availability zone.

   B) Subnets are spread across availability zones.

C) Instances in a private subnet can access the internet if they have an elastic IP.

D) The smallest subnet on AWS is a /28.

E) With the default configuration all subnets can route between each other in a VPC.

7. In a CloudFormation template, each identified resource includes the following:

A) An operating system and AMI

B) A dedicated host and hypervisor

C) Logical ID, resource type, and resource properties

D) Physical ID, resource type, and resource properties

8. Every time you attempt to delete an SSL certificate from the IAM certificate store, you keep getting the error "Certificate: <certificate-id> is being used by CloudFront". What is the most likely reason for this error?

A) SSL certificates cannot be deleted.

B) You do not have sufficient IAM permissions.

C) CloudFront is not set up properly.

D) Prior to deleting the SSL certificate, its necessary to rotate SSL certificates or revert to the default CloudFront certificate.

9. You plan on launching a new product. There is tremendous buzz and enthusiasm around the product launch, but you don't know exactly the demand. Orders will be sent to the database, so it's critical that writes to the database will not be lost. What is the best way to be sure orders are not lost when being written to the database?

A) Use a Microsoft SQL server cluster.

B) Use DynamoDB with the max write capacity.

C) Use an Amazon Simple Queue Service (SQS) to store orders until written to the database.

D) Add additional read replicas.

10. An organization wants autoscaling to scale out at 65 percent CPU utilization and scale in at 35 percent. How can the organization make sure this occurs?

    A) Use auto-scaling with the default policy.

    B) Use autoscaling with a policy.

    C) Use CloudWatch alarms to send an SNS message to autoscale.

    D) It is not possible to scale at these CPU levels.

11. Which of the following EBS volume types is ideal for applications with light or burst I/O requirements?

    A) Provisioned IOPS

    B) EBS General Purpose SSD (gp2)

    C) EBS Throughput Optimized HDD (st1)

    D) EBS Cold HDD (sc1)

12. Which of the following EBS volume types is ideal for applications requiring the lowest latency possible?

    A) Provisioned IOPS

    B) EBS General Purpose SSD (gp2)

    C) EBS Throughput Optimized HDD (st1)

    D) EBS Cold HDD (sc1)

13. Your company is getting ready to make a major public announcement about a highly anticipated new product. The website is running on EC2 instances deployed across

multiple Availability Zones with a Multi-AZ RDS MySQL Extra Large DB Instance. There are a large number of read and writes on the database. After examination you discover that there is read contention on RDS MySQL. How can you best scale in this environment?

A) Deploy ElastiCache in-memory cache running in each availability zone.

B) Add an SQS queue in front of the RDS MySQL database.

C) Increase the RDS MySQL instance size and implement provisioned IOPS.

D) Add an RDS MySQL read replica in each availability zone.

14. An organization has a requirement for the highest-throughput and lowest-latency storage option. The organization is willing to trade redundancy for performance. What is the best RAID option for this situation?

A) Raid 0

B) Raid 1

C) Raid 5

D) Raid 10

15. An organization has a requirement for the highest-throughput and lowest-latency storage option with complete redundancy. What is the best RAID option for this situation?

A) Raid 0

B) Raid 1

C) Raid 5

D) Raid 10

16. An organization requires a solution that provides complete redundancy. Speed is not a concern. What is the best RAID option?

A) Raid 0

B) Raid 1

C) Raid 5

D) Raid 10

17. Your company is developing a next-generation wearable device that collects health information to assist individuals with adopting healthy lifestyles. The sensor will push 25 KB of health data in JSON format every 2 seconds. The data should be processed and analyzed, and information should be sent to the individual's primary care provider.

    The application must provide the ability for real-time analytics of the inbound health data. The health data must be highly durable. The results of the analytic processing should persist for data mining.

    Which architecture outlined below will meet the initial requirements for the collection platform?

    A) Use S3 to collect the inbound sensor data analyze the data with Amazon Athena.

    B) Use Amazon Kinesis to collect the inbound sensor data, analyze the data with Kinesis clients, and save the results to a Redshift cluster using EMR.

    C) Send data to SNS to collect the inbound sensor data and save the results to AWS RDS Multi-AZ.

    D) Send the data to SQS, which then sends to DynamoDB.

18. A new reality game show is being created. During the show users will vote for their favorite contestant. It is expected that millions of users will be voting. The votes must be collected into a durable, scalable, and highly available location. Which service should you use?

    A) Amazon DynamoDB

    B) Amazon Redshift

    C) Microsoft SQL Server

    D) AWS S3

19. You are tasked with creating a solution to analyze a customer's clickstream data on a website to analyze user behavior. The analysis must provide the sequence of pages that are clicked by websites users. This data will be used in real time to optimize the website's performance in terms of page stickiness and advertising click-through rates. Which is the best option to capture and analyze user behavior in real time?

    A) Send web clicks data to Amazon S3, and then analyze and analyze behavior using Amazon Athena.

    B) Push web clicks data to Amazon Kinesis and analyze behavior using Kinesis workers.

    C) Write web clicks directly to DynamoDB.

    D) Write web clicks directly to Amazon RDS for Oracle.

20. An application provides data transformation services. Data to be transformed is uploaded to Amazon S3 and then transformed by a fleet of spot EC2 instances. VIP customers should have their files transformed before other customers. How should you implement a system that services VIP customers first?

    A) This cannot be performed, as the apposition process messages in the order they are received.

    B) Use an ELB to distribute VIP traffic first and then generic traffic to the spot fleet of transformation instances.

    C) Set up two SQS queues, priority queue for VIP customers and a second queue with default priority for everyone else. Have the transformation instances first poll the high-priority queue; if there is no message, then poll the default priority queue.

    D) Use SNS to send a message to administrators to manually send VIP customers data for immediate transformation.

21. An organization is planning on setting up a bastion host to help manage systems on their VPC. The bastion host must be reachable from all internet addresses. The bastion host must also be able to access the internal network and should only be open to SSH traffic from a small CIDR range of addresses. How can the bastion host be configured for this purpose?

A) This cannot be performed, as the host is on a public subnet.

B) Create two network interfaces on two different subnets. Assign security groups to allow external traffic on the public interface and SSH traffic on the internal network interface.

C) Create two network interfaces with the same subnets. Assign security groups to allow external traffic on the public interface and SSH traffic on the internal network interface.

D) Separate the services. Put the web server on an EC2 instance and set up a second server for SSH traffic.

22. _____________ pricing offers a significant discount over on-demand pricing. This pricing approach works well for mission-critical applications with known capacity utilization and known duration of use.

A) Discount voucher

B) Reserved instance

C) AWS coupon code

D) Spot instance

23. An organization's security policy requires encryption of sensitive data at rest. The data is stored on an EBS volume which is attached to an EC2 instance. Which options would facilitate encrypting your data at rest? (Choose 3):

A) Leverage third-party volume encryption tools.

B) Move data from EBS to S3.

C) Encrypt data prior to storing on EBS.

D) Encrypt data using native data encryption drivers at the file system level.

E) Unnecessary, as all data on AWS is encrypted.

24. What does the PollForTask action perform when it’s called by a task runner in AWS Data Pipeline?

    A) It retrieves the pipeline definition.

    B) It sends an SNS message to AWS administrators.

    C) It sends the data to the next application in the task.

    D) It performs the next task to perform from AWS Data Pipeline.

25. Which of the following are customer responsibilities under the shared security model? Choose 3.

    A) Security groups

    B) ACLs

    C) Patch management of the serverless operating system

    D) IAM credentials

    E) Managing the underlying hardware of an EC2 instance

26. An organization has three separate divisions (VPCs), and they are main, autos, and auto parts. The main organization needs access to auto and auto parts. How can the main organization access the VPCs of autos and auto parts?

    A) Set up VPC peering between main and autos and auto parts.

    B) Open NACLs to allow for full communication.

    C) Make sure the security groups allow for the CIDR ranges of all VPCs.

    D) This is not possible, as VPCs cannot communicate with each other.

27. A company has 500 TB of business-critical data. The company had a fire at their facility and is in immediate need to move their data center to the AWS cloud. The company needs to perform this within 7 business days. The company has a 1-Gig direct

connection to AWS, which is running at near full capacity. How can you get the system fully operational within the short timeframe?

A) Request multiple Snowball devices from AWS. Load data on the Snowball device. Have AWS download data to an S3 bucket.

B) Order a 10GB direct connection and send over that link.

C) Upload to S3 over the existing 1GB internet connection with multipart uploads.

D) Use the AWS import/export service. Load data on the hard drives. Have AWS download data to an S3 bucket.

28. An organization is using ElastiCache in front of Amazon RDS database which has four read replicas deployed. The database CPU is at 65 percent with the ElastiCache and cannot meet current capacity if the ElastiCache Fails. The server has very limited write use and is mostly limited by read contention. What is a solution to mitigate the impact of an ElastiCache failure?

A) Spread memory and capacity over a smaller number of larger cache nodes.

B) Spread memory and capacity over a larger number of smaller cache nodes.

C) Implement an SQS queue to assist with write capacity.

a. Use AWS SNS messenger to alert team of cache failures.

29. What indicates that an object is successfully stored when put in S3?

A) An http 404 code is received.

B) An http 300 code is received.

C) Cloud watch logs show put was successful.

D) An http 200 code is received, along with an MD5 hash.

30. What is the maximum number of VPCs per region?

A) 10

B) 50

C) 100

D) 5

31. S3 bucket policies are written in what language?

A) JavaScript

B) C++

C) JSON

D) Python

32. A global organization is hosting a website on S3. The company is experiencing large data charges for cross-region sharing from the S3 bucket. What changes can be made to reduce costs?

A) VPC peering

B) S3 cross-region replication

C) Move the website off S3 and onto an EC2 instance

D) CloudHub

33. An organization has been storing their data on instance storage. The server was patched for security vulnerability, and when it was rebooted, all data stored was gone. Why did this happen?

A) Malware infection

B) Not enough information is provided to troubleshoot

C) Instance storage is deleted upon termination or reboot

D) None of the above

34. An organization is using an AWS RDS database. The database is currently running on EBS general purpose storage. At times read and write latency is too high for the organization's needs. How can this be easily remedied?

    A) Upgrade the EBS volume to previsioned OPS

    B) Change storage type to EBS throughput optimized

    C) Change storage location to an EFS volume

    D) Change to high-speed instance storage

35. Relational databases follow the BASE model (Basically Available, Soft State, and Eventually Consistent).

    A) True

    B) False

36. An organization has noticed the CPU on their RDS database is consistently at 85%. When looking at the database, there is heavy read activity from frequent SQL queries from the finance department. What can the organization do to improve the performance and scalability of the database? Choose 2:

    A) Add a read replica and point the finance department's SQL queries to the read replica

    B) Add an ElastiCache to reduce read contention for frequently accessed information

    C) Add an SQS queue to reduce read contention

    D) Set up Multi-AZ for the RDS database

37. An organization has set up a high-availability database architecture using a Multi-AZ environment. If the primary database fails, which of the following will cause the database to failover to the backup database? Choose 4:

    A) The primary database instance fails.

B) There is an outage in an availability zone.

C) The database instance type is changed.

D) The primary database is under maintenance (i.e., patching an operating system).

E) The database is busy, with a CPU utilization of 90%.

38. An organization has a web server in a private subnet that is connected to the internet with an NAT gateway. External users cannot access the web server. What changes can the organization make to have this server reachable from the internet? Choose 3:

A) Put the web server on a public subnet.

B) Use a NAT instance with an internet gateway.

C) Put an ELB in a public subnet and keep the web server in a private subnet.

D) There must be a configuration error, as the server can ping addresses on the public internet.

39. An organization has noticed that when users connect to S3 their traffic is traversing the public internet. The organization is experiencing low performance and high internet costs. What can the organization do to increase the performance, privacy, and scalability of the solution?

A) Create an endpoint for S3 and connect to the endpoint.

B) S3 always uses the internet, so increase the internet connection speed and encrypt with a VPN.

C) Set a routing policy to have the organization connect to S3 via the AWS network.

D) Set up VPC peering to S3.

40. An organization has three VPCs, VPC A, VPC B, and VPC C. VPC A is peered with VPC B and VPC C. VPC A can reach VPC B and C. But VPC B and VPC C cannot communicate with each other. Why can’t these VPCs communicate with each other?

A) A firewall is blocking connectivity.

B) There is a misconfigured ACL policy.

C) A configuration error occurred.

D) VPC peering is not transitive, and this is normal.

41. An organization has set up an NACL to increase the security of their VPC. The organization wants to allow web traffic, TCP Port 80, into the subnet where the web servers reside. They apply the NACL, but no web requests are making it to the web server. Why could this be happening? The ACL can be seen below:

Rule 110 – Deny all traffic
Rule 110 – Inbound Allow TCP Port 80 Source 192.168.1.1
Rule 120 – Outbound Allow TCP Port 80 Source 192.168.1.1

A) The ACL is property configured. There must be another problem.

B) The order is incorrect, as all traffic is denied prior to being permitted by rules 110 and 120.

C) It is not possible to have a deny statement in an ACL.

D) The security group on the web server is improperly configured.

42. With NACL, both an inbound and outbound policy are necessary. Why are security groups only configured for an inbound policy?

A) Security groups are stateful, so they allow outbound return traffic.

B) Security groups require both an inbound and outbound policy.

C) It’s an inconsistency in the AWS Cloud.

D) Security groups don’t allow outbound traffic.

43. If an organization is looking to maximize performance for specific applications but doesn’t need high availability for this application, what would be the best option in terms of placement groups?

A) Spread placement group.

B) Partition placement group.

C) Cluster placement group.

D) Placement groups don’t affect performance.

44. Your organization requires encryption of all data at rest. What can you do to encrypt and protect data on the EBS volume that is mounted by an EC2 instance? Which of these options would allow you to encrypt your data at rest? Choose 2:

A) Leverage third party volume encryption tools

B) Use SSH to encrypt data

C) Encrypt data prior to storing it on EBS

D) Use an EFS instance instead of EBS

45. You are designing internet connectivity for your organization’s VPC. The organization has web servers with private addresses that must be reachable from the internet. The web servers must be highly available. What can you use to ensure the web servers are highly available and reachable from the internet? Choose 2:

A) Configure an NAT instance in your VPC. Place web servers behind the NAT instance.

B) Configure CloudFront and place it in front of your web servers. Put CloudFront on a public subnet.

C) Assign EIPs to all web servers. Configure a Route 53 failover policy attached to the EIPs. Use Route 53 with health checks.

D) Put web servers in multiple availability zones. Create a DNS A record for all EIPs.

E) Put all web servers behind an ELB. Configure a Route 53 CNAME record that points to the ELB DNS name.

46. An organization is looking to implement an intrusion detection and prevention system into their VPC. This platform should have the ability to scale to meet the needs of a global enterprise organization. How should they design their VPC to achieve scalable IDS/IPS?

    A) Call AWS support and ask them to put a switch port in SPAN mode and attach a packet sniffer to the SPAN.

    B) Set up a proxy server and send all internet requests through the proxy server.

    C) Deploy IDS/IPS onto the organization's firewall.

    D) Put an agent on all servers that sends network traffic to the IDS/IPS for inspection and management.

47. An organization has been using a domain name for their business. The company hired a marketing firm that suggested they change their domain name to something more indicative of their brand. What can the organization do to use a new domain name while not losing its current customers using the old domain name?

    A) Migrate to the new domain. Set up a DNS CNAME record that redirects current users to the new URL.

    B) Set up a new website with the domain name and keep the old website operational.

    C) Migrate to the new domain. Set up a DNS A record that redirects current users to the new URL.

    D) Migrate to the new domain. Set up a DNS NS record that redirects current users to the new URL.

48. An organization is looking to use a load balancer to increase performance and availability of their website. The organization has tens of millions of customers and is looking for the highest speed load balancer available on the AWS platform. Which is the best option when speed is of utmost importance?

    A) Elastic Load Balancer – Application

    B) Elastic Load Balancer – Network

    C) Classic Load Balancer – Application

D) Route 53 with policy routing instead of a load balancer

49. An organization has configured an IAM role for a user. The user cannot seem to access any information on the VPC. What could be wrong in this situation?

    A) The IAM role was configured in a manner that blocks access to all resources.

    B) IAM roles are not for users. They are created for systems to access other systems in a VPC.

    C) The IAM role was not properly applied to the user.

    D) There is not enough information provided to answer this question.

50. Using the IAM concept of AAA (Authentication, Authorization, and Accounting), which component determines whether a user is allowed access to a resource?

    A) Authentication

    B) Authorization

    C) Accounting

51. An organization desires to connect its on-premise Microsoft Active Directory services with AWS for easier IAM management. How can the organization federate to the organization's Microsoft AD servers?

    A) This is not possible.

    B) Use the AWS AD migration tool.

    C) Build a connection using SAML 2.0.

    D) Leverage AWS directory services and have them peer with on-premise AD servers.

52. An organization wants to give several developers access to all AWS resources except IAM. What access should the developers have to support their jobs?

A) Administrator

B) Developer

C) Power User

D) Sys Admin

53. An organization is looking for a means to store critical information such as passwords and software licenses. Which is the best and most secure option?

A) Store passwords on an encrypted database

B) Store passwords in a hidden folder in the root account of an EC2 instance

C) Store passwords and licenses in the Systems Manager Parameter Store

D) Store passwords in a spreadsheet, which is inside an encrypted folder on the CEOs computer

54. An organization is setting up a platform for managing and analyzing extremely large amounts of data. The organization is looking to use a serverless environment. What would be the easiest option to deploy and manage a big data framework for this customer?

A) Set up an EC2 instance and install Apache Hadoop

B) Use AWS EMR

C) Build a custom big data management platform and place on a Fargate container

D) Use DynamoDB

55. An organization wants to use CloudWatch to monitor memory utilization in an application with large memory demands. The organization would like updates every 1 minute. How should the organization set this up?

A) No setup is required. CloudWatch performs this service automatically.

B) Leverage CloudWatch detailed monitoring and set a CloudWatch custom metric.

C) Leverage CloudTrail and not CloudWatch for this purpose.

D) Set up a Lambda function that will use SNS to notify systems administrators when memory utilization goes over 80 percent.

56. Lambda functions can be set up in which of the following programming languages? Choose 3:

A) Node.js

B) Visual basic

C) Python

D) C#

E) C++

F) Pascal

57. An organization wants to restrict access to information stored on S3. Which of the below options can be used for access control?

A) ACLs

B) IAM policies

C) Bucket policies

D) All of the above

58. Your organization stores a substantial amount of data on S3. The files stored on S3 are very large, most over 1 GB. You are traveling and in a part of the world with slow internet access. You only need some of the data in the file but not the entire file. What options, if any, can you use to work more efficiently?

A) Find a location with better internet access.

B) Use a range get.

C) There is nothing you can do, so be patient.

D) Use a Python script to download files overnight.

59. In order to maintain the integrity of autoscaling, autoscaling requests are signed with a hash based upon the user's private key. What hashing algorithm is used to calculate the hash?

    A) SHA-256

    B) HMAC-SHA1

    C) X11

    D) X11Gost

60. AWS uses the term *elastic* for many of their services. What does the Amazon definition of elastic mean?

    A) Bursting capabilities

    B) The ability to create instances easily

    C) The ability to scale resources up and down with minimal challenges

    D) The speed of deployment compared to a traditional data center

61. When restoring a database from a DB snapshot, which of the following occurs? Choose 2:

    A) A new instance is created.

    B) It restores the original instance.

    C) All information, including the operating system, database, and all data, is restored to the new instance.

    D) All information, including the operating system, database, and all data is restored to the old instance.

62. An organization is creating a machine learning application on the AWS platform. Which is the best type of instance for this application?

    A) C5

    B) T3

    C) M5

    D) G3

63. When connecting to AWS via a direct connection, what routing protocol is used to exchange routing information for network layer reachability?

    A) OSPF

    B) EIGRP

    C) BGP

    D) RIP V2

64. An organization is using an application that requires physical access to the underlying hardware of the server. Which is the best type of tenancy on the AWS platform?

    A) Shared tenancy

    B) Dedicated instance

    C) Dedicated host

    D) Placement group

65. An organization that creates video games is launching a new game. They expect this application to have tens of millions of global users. What is the best database option to store game state?

    A) Microsoft SQL

    B) MySQL

C) DynamoDB

D) Amazon Aurora

66. An organization is moving to the cloud. The organization is looking for a way to be more efficient and is willing to modify its current processes. The organization needs a relational database and a data warehouse. The organization has currently been using a custom-developed and problematic ETL tool to exchange information between databases and storage. What can the organization do to replace the current ETL tool?

A) AWS Glue

B) DynamoDB

C) ElastiCache

D) VPC endpoint

67. An organization is looking to set up a mail server on an EC2 instance. What type of DNS record should be set up in Route 53?

A) A record

B) CNAME record

C) MX record

D) NS record

68. An organization wants to set up a scalable IAM solution for mobile phones. The organization wants to authenticate via Facebook and other identity providers. What solution is recommended in this use case?

A) Set up IPsec between the VPC and Facebook

B) Set up VPC peering with Facebook

C) Use Amazon Cognito

D) Use the AWS Directory service

69. When setting up an IAM policy, which statements are not required? Choose 2:

    A) Action

    B) Resource

    C) Condition

    D) Shield

70. It’s often necessary to fan out messages to multiple systems for distributed workflows. Which AWS service is designed for this purpose?

    A) EMR

    B) ECS

    C) SNS

    D) EKS

71. An organization has been recently attacked by a hacker. The organization is looking for a means to find systems that do not comply with the organization’s policies (operating system, patch level, security groups, etc.). What is the simplest method for the organization to find systems that do not meet organizational standards?

    A) AWS CloudWatch

    B) AWS CloudTrail

    C) AWS Config

    D) AWS CloudFront

72. An organization uses a substantial number of videos in its digital marketing campaigns. The organization would like to ensure that there is no content that could be potentially offensive to some customers. What would be the simplest means to achieve this on the AWS platform?

A) Set up an EC2 G3 instance, with a Python script using a machine algorithm to identify suspect content

B) Use AWS Rekognition to identify suspect content

C) Use AWS Mechanical Turk to identify suspect content

D) Use the AWS Content Manager to identify suspect content

73. A migration from a traditional data center to the cloud can have a profound effect on the organization's technology expenses. A CFO is asking what type of effect a migration to the cloud would have on their technology costs. How would you describe the financial impact to the CFO? Choose 2 below:

A) Cloud computing has lower capital expenses (CAPEX) and higher operational expenses (OPEX).

B) Cloud computing has lower capital expenses (OPEX) and higher operational expenses (CAPEX).

C) The total cost of ownership is likely more expensive, but there is increased business agility.

D) The total cost of ownership is likely less expensive, and there is increased business agility.

74. Creating a full security posture involves which of the following? Choose all that apply:

A) NACLs

B) IAM

C) DDoS prevention

D) Firewalls

E) Linux only

75. An organization is looking for a means to sequence multiple Lambda functions. What is the simplest way to do this on the AWS platform?

A) Lambda@Edge

B) Python script

C) Step Functions

D) Glue

Answer Key

1. B
2. A
3. A, D
4. B
5. B
6. A, D, E
7. C
8. D
9. C
10. B
11. D
12. A
13. D
14. A
15. D
16. B
17. B
18. A
19. B
20. C
21. B
22. B
23. A, C, D
24. A
25. A, B, D
26. A
27. A
28. B
29. D
30. D
31. C
32. B
33. C
34. A
35. B
36. A, B
37. A, B, C, D
38. A, B, C
39. A
40. D
41. B
42. A

43. C
44. A, C
45. C, E
46. D
47. A
48. B
49. B
50. B
51. C
52. C
53. C
54. B
55. B
56. A, C, D,
57. D
58. B
59. A
60. C
61. A, C
62. D
63. C
64. C
65. C
66. A
67. C
68. C
69. C, D
70. C
71. C
72. B
73. A, D
74. A, B, C, D
75. C

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