Caltech | Center for Technology & Management Education

Post Graduate Program in Cloud

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Cloud

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AWS Certified SysOps Administrator – Associate Level

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Deployment, Provisioning, and Automation

Learning Objectives

By the end of this lesson, you will be able to:

- Launch a virtual server with the required configuration
- Create, manage, deploy customized, secure, and up-to-date server images
- Visualize and control the entire AWS infrastructure
- Automate AWS services by creating templates
- Deploy and scale web applications

A Day in the Life of an AWS Administrator

You work as Administrator for a company that is considering moving to a cloud-based environment so that they may concentrate on their projects rather than infrastructure. They'd like you to propose a few AWS solutions for the following requirements:

- They want to manage any workload remotely while maintaining a simple and Secure Shell connection to the server.
- They want to remotely and securely manage the configuration of any managed server.
- They also want a deployment solution that will help them model and set up their AWS resources, so they can spend less time managing them and more time focusing on the AWS apps.
- Additionally, getting a solution that allows them to develop and manage applications in the AWS Cloud without having to learn about the infrastructure that supports them will be advantageous.

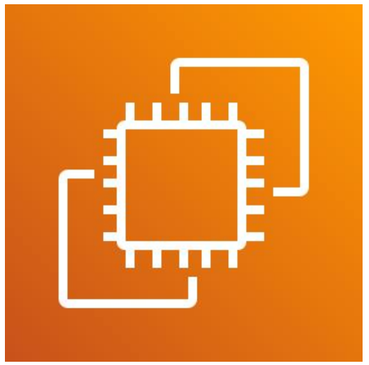
To achieve all the above along with some additional features, you will be learning a few concepts in this lesson that will help you find solutions for the above-given scenario.

EC2 and EBS Volume

Elastic Compute Cloud (EC2)

Amazon Elastic Compute Cloud (Amazon EC2) provides scalable computing capacity in the Amazon Web Services (AWS) Cloud.

- Eliminates the need to invest in hardware up-front, allowing a user to develop and deploy apps more quickly
- Used to create as many or as few virtual servers as needed, handle security and networking, and storage
- Allows you to scale up or down in response to variations in demand or popularity spikes, removing the need to forecast traffic



Features of EC2

- Virtual computing environments, known as instances
- Preconfigured templates for your instances, known as Amazon Machine Images (AMIs)
- Various configurations of CPU, memory, storage, and networking capacity for your instances, known as instance types
- Secure login information for your instances using key pairs
- Storage volumes for temporary data, known as *instance store volumes*
- Persistent storage volumes for your data, known as Amazon EBS volumes

Features of EC2

- Multiple physical locations for your resources, known as Regions and Availability Zones
- A firewall that enables you to specify the protocols, ports, and source IP ranges that can reach your instances using security groups
- Static IPv4 addresses for dynamic cloud computing, known as Elastic IP addresses
- Metadata, known as tags, that you can create and assign to your Amazon EC2 resources
- Virtual networks, known as virtual private clouds (VPCs)

Assisted Practice

EC2 instance Connect

Duration: 10 Min.

Problem Statement:

You are given the task of launching an EC2 instance, which is a secure and resizable cloud compute service that allows users to remotely manage any workload. You must also provide a simple and Secure Shell connection to your instances (SSH).

Assisted Practice: Guidelines

Steps to create AWS EC2 instance and connect to it:

1. Login to your Amazon Management console.
2. Open the Amazon EC2 console.
3. Configure an EC2 Instance and launch your instance.
4. Use the Connect tab present on the EC2 Dashboard to connect to your instance

EC2 Launch Issues

Two major issues that can occur while launching or creating an EC2 instance are given below:

InstanceLimitExceeded error:

- This error occurs when you have reached the limit of the number of instances that you are allowed to launch within a region.
- By default, this limit is set to 20 by AWS.

```
An error occurred (InstanceLimitExceeded) when calling the RunInstances
operation: Your quota allows for 2 more running instance(s). You request
ed at least 5
```

EC2 Launch Issues

InsufficientInstanceCapacity error:

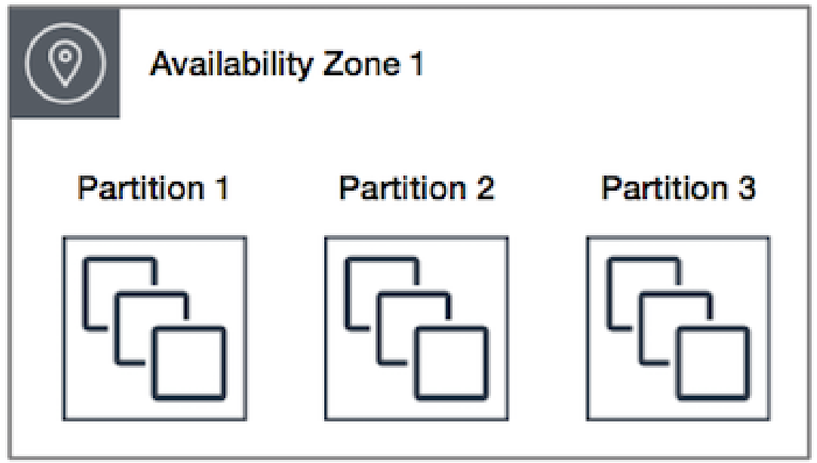
- This error means that AWS is out of the number of a type of instances (on-demand) that you have requested to launch.
- However, this is a rare issue that can occur and can be solved by requesting less instances, selecting another type of instance, changing zones, and purchasing reserved instances.
- Example: This error can occur if you request more than twenty **t2.micro** instances at once.

Placement Groups

Placement groups help users control how the instances are deployed.

- Placement groups help in getting low latency, high network throughput, and high computing power.
- There are three types of placement groups:

1. Cluster: All instances are created in one availability zone
2. Partition: Instances are created in segments called partitions with each present in a different rack with separate power and network resources
3. Spread: Every instance has a different rack and an independent power and network setup

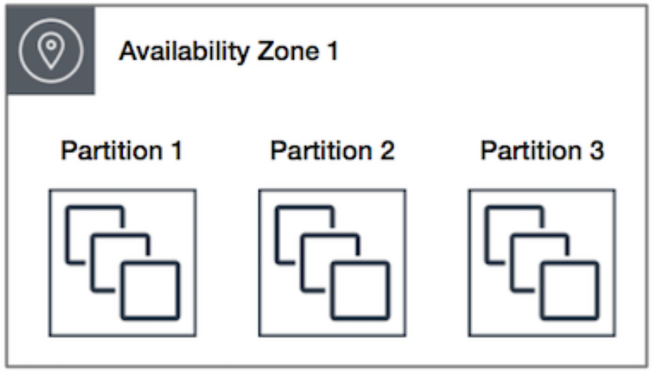


Cluster Placement Group

- A cluster placement group is a grouping of instances in one availability zone.
- User can span peered VPCs in the same region.
- Instances have a throughput limit of 10 Gbps for TCP/IP traffic.
- Instances are placed in the same high bisection bandwidth segment of the network.
- Cluster placement groups are recommended for applications that benefit from low network latency, high network throughput, or both.
- It is recommended to have a single launch request for all instances and also to keep same instance types in one cluster.
- There are, however, chances of reaching the instance limit when trying to add more instances.

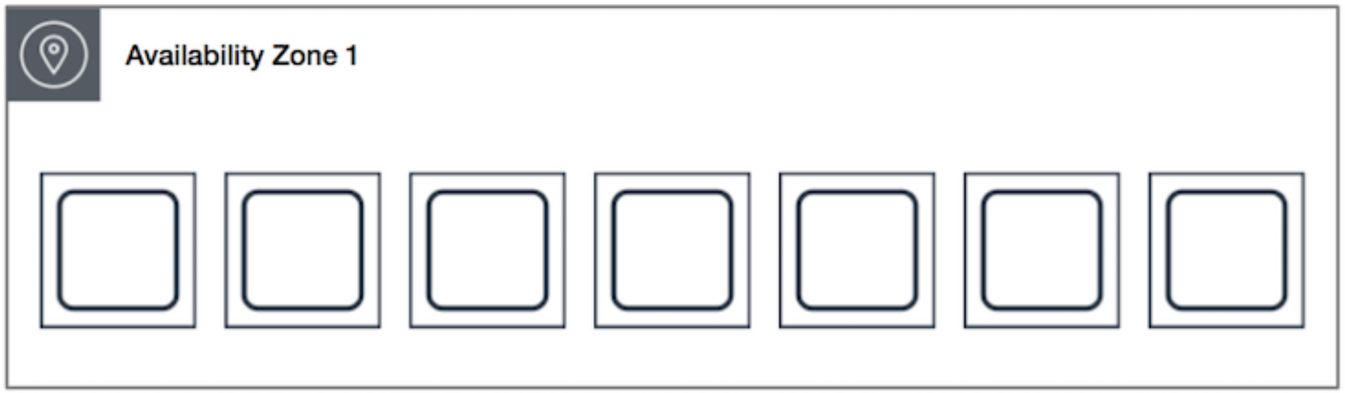
Partition Placement Group

- In partition placement groups, Amazon EC2 divides each group into segments called partitions.
- Each partition within a placement group has a separate set of racks.
- Each rack has a separate network and power source.
- It allows user to isolate and mitigate the impact of hardware failure.
- It can be used to deploy large workloads like HDFS and Cassandra across distinct racks.
- By default, AWS distributes instances across partitions. However, one can also decide where the instances should be launched.
- If there is insufficient unique hardware to fulfill the request during instance startup, the request fails.



Spread Placement Group

- A spread placement group is a one-instance-per-rack arrangement with distinct power and network sources for each instance.
- It is used for applications having a small number of critical instances that should be kept separate from each other.
- Launching instances reduces the risk of simultaneous failures.
- A spread placement group can span multiple availability zones in the same region with a maximum of seven running instances per availability zone per group.



EBS Volumes and IOPS

Elastic Block Store (EBS) is a storage volume that can be attached with an EC2 instance.

- These volumes appear similar to disk space on the instances.
- These volumes can be used to create file systems and databases, run operating systems, and perform other functions.
- SSD-backed storage is a type of EBS volume used quite often.
- SSD can be used to run operating systems and databases which are majorly I/O-intensive tasks.

EBS Volumes and IOPS

gp2 and **io1** are two types of EBS SSD volumes.

- IOPS stands for Input/Output Operations Per Second and is used to provide standard values to the performance capacity of the volume.

- **gp2** stands for General Purpose which is mostly used as boot volumes.

- **io1** is the Provisioned IOPS used for I/O-intensive tasks, databases, and latency-sensitive workloads.

- IOPS capability depends on the size of the volume:
  - **gp2** volumes: 3 IOPS/GB up to 16k IOPS
  - **io1** volumes: 50 IOPS/GB up to 64k IOPS

EBS Volumes and IOPS

IOPS issues:

- There are cases when a user might reach the IOPS limit or exceed the number of requests.
- If the limit is reached, the user starts getting requests queuing.
- The application becomes slow depending on its sensitivity to IOPS.

Solutions:

1. User can increase the size of the volume. However, if it is already 5.2TB, then there is a high possibility that it has reached the 16k IOPS limit.
2. If more than 16k IOPS is needed, it is advised to change the volume type to Provisioned IOPS.

Amazon Machine Image (AMI)

What Is an AMI?

Amazon Machine Image (AMI) is used to provide the information required to launch an instance. A single AMI can be used to launch multiple instances with the same configuration.

What Is an AMI?

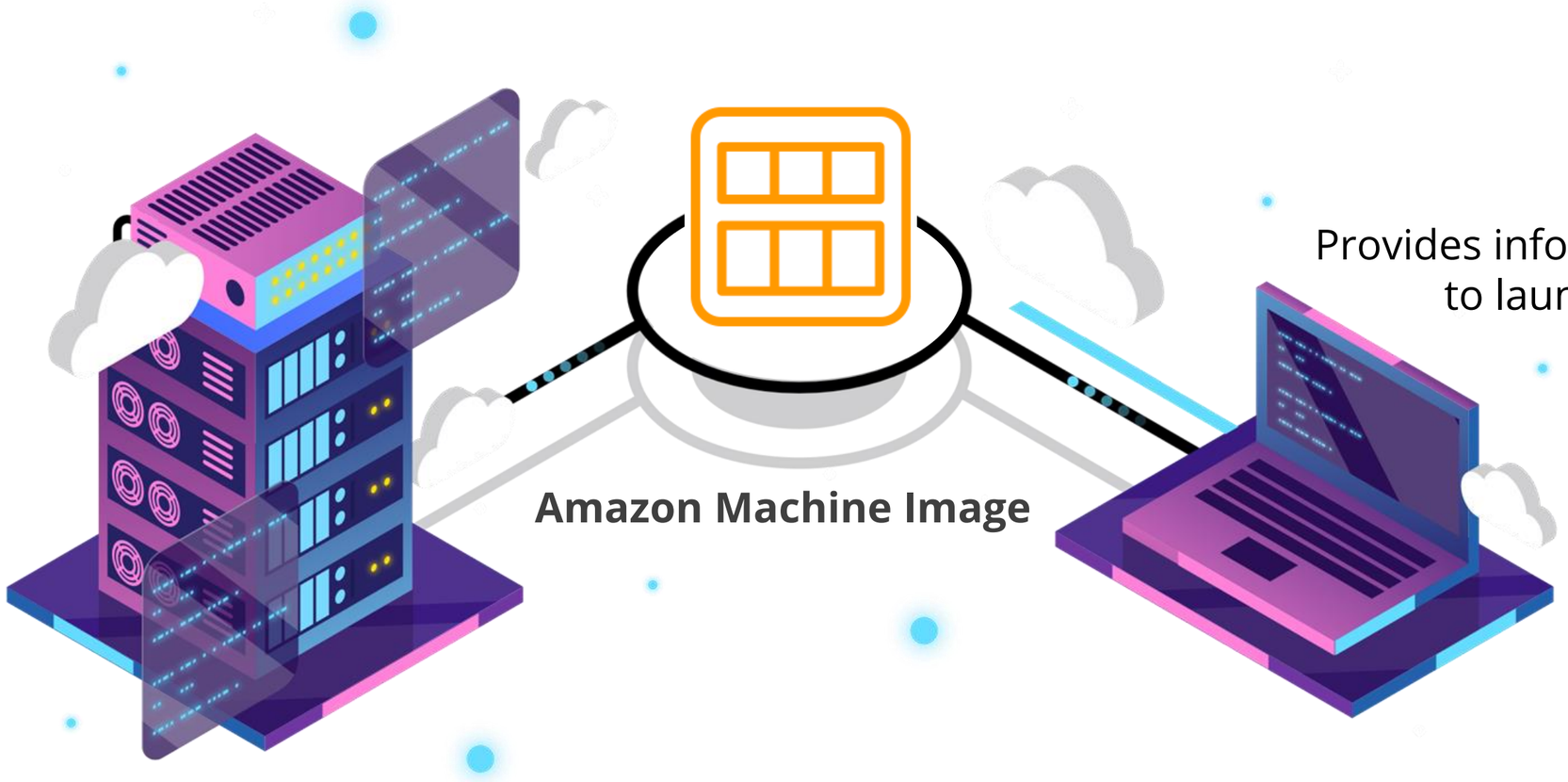
An AMI includes the following:

One or more EBS snapshots for instance-store-backed AMIs

A block device mapping that specifies the volumes to attach to the instance when it's launched

Launching permissions that control which AWS accounts can use the AMI to launch instances

What Is an AMI?



Provides information required to launch EC2 instances

Comprises preconfigured templates for the creation of virtual servers (EC2 instances) in the AWS environment

AMI Types

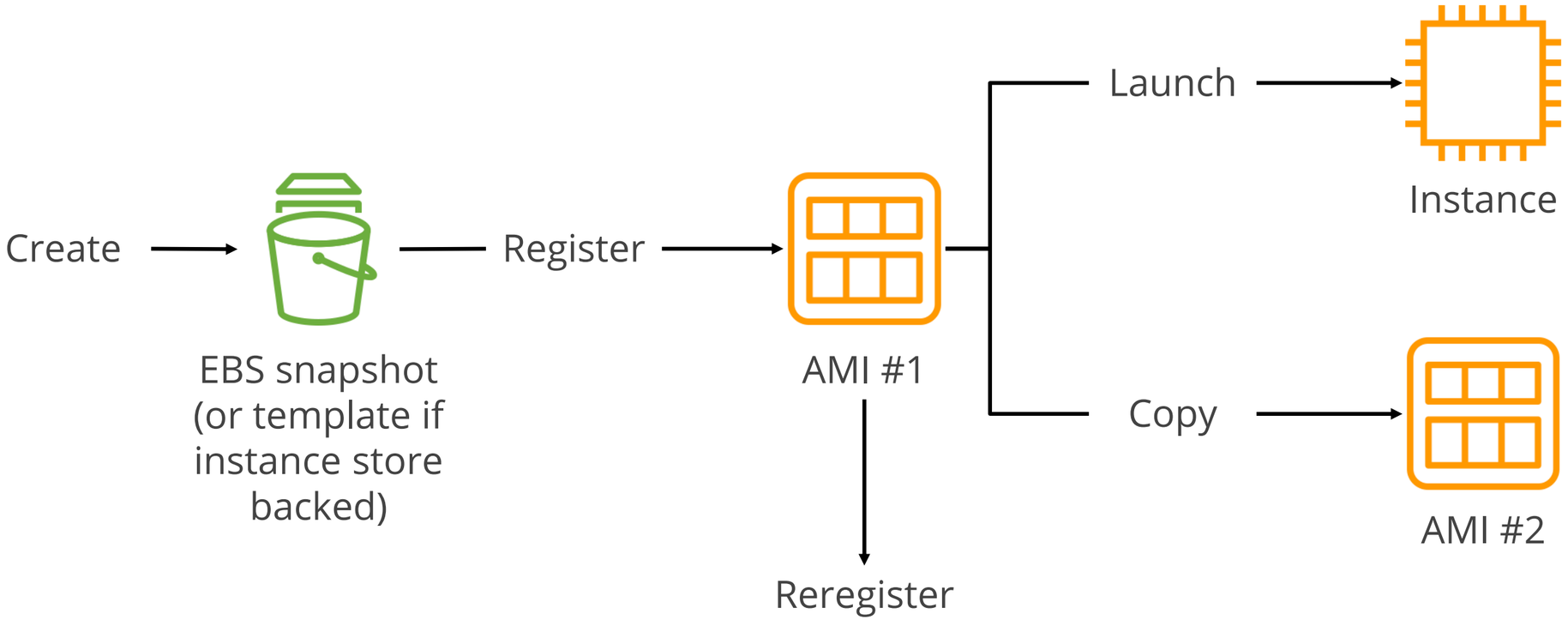
AWS-managed AMIs

Private and custom AMIs created by users

Public custom AMIs: Provided by community

Private AMIs: Shared with you but are created by other AWS accounts

AMI Lifecycle



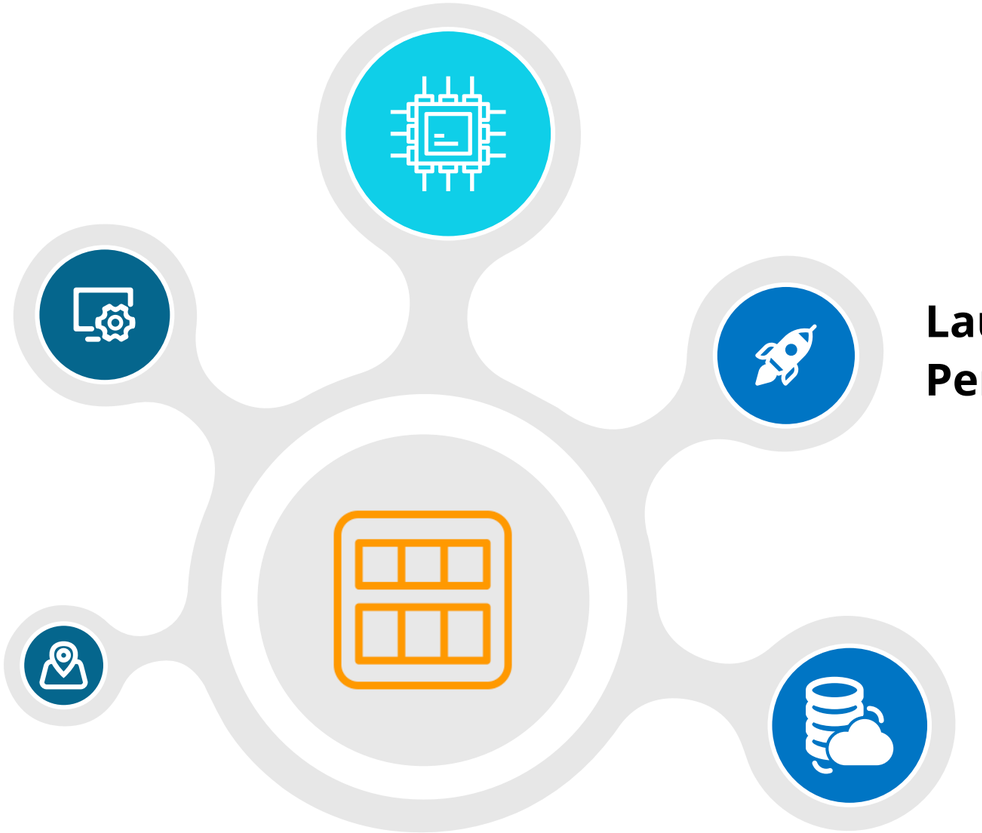
AMI: Characteristics

An AMI can be selected based on the following characteristics:

Architecture (32-bit or 64-bit)

Operating Systems: Linux, Windows, and Ubuntu

Launch Permissions: Define who has access to the AMI



Region: AMIs are region specific

Storage: For the root device

Customizing and Configuring AMIs

It can improve provisioning when an instance is launched.

Configuration files can be used to configure and customize the environment quickly and consistently.

It is possible to create a custom AMI instead of the standard AMI included in the platform.

Customizing and Configuring AMIs

Below are the benefits of custom AMI:

Allows us to make changes in the low-level components

Improves the provisioning time

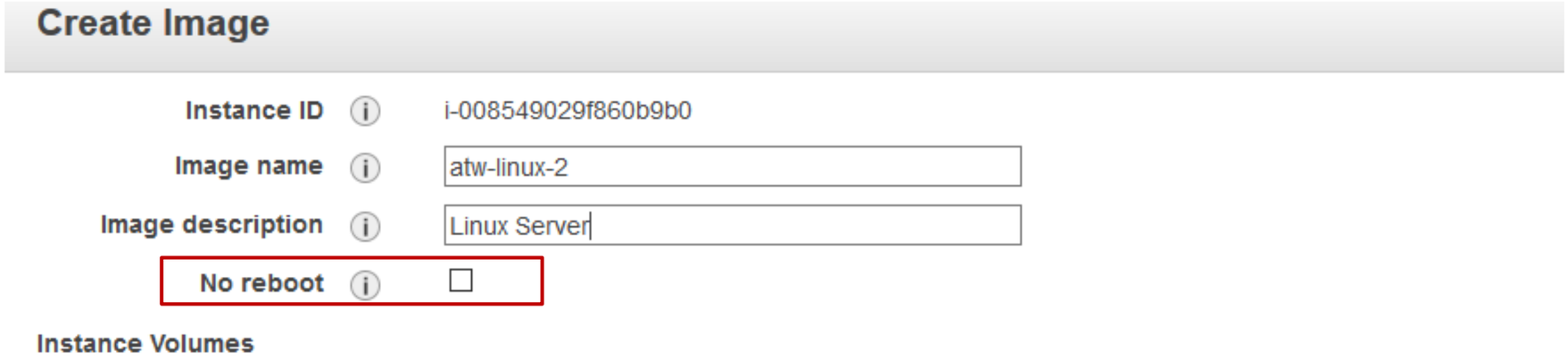
Reduces the time taken for the configuration server

Shared AMIs

- AMIs created by a developer and made available for another developer are called shared AMIs.
- The best approach for using EC2 is to use shared AMI that has components and custom content required.
- AMIs can be created and shared with others.

AMI No Reboot Options

AMI No Reboot Option is not selected by default. Amazon EC2 restarts the instance after shutting it down, taking snapshots of any associated volumes, creating and registering the AMI, and rebooting the instance.



Select **No reboot** to avoid having the instance shut down.

EC2 Migration Using AMIs

The AWS Windows AMIs are set up with the same default settings as the Microsoft installation media, with a few modifications.

These are the two cases when migrating to Nitro-based instances:

- If you are launching instances from custom Windows AMIs
- If you are launching instances from Windows AMIs provided by Amazon that were created before 2018

Drivers and settings enable the latest generation of instance types, and instances built on the Nitro System, such as an M5 or C5, are among the modifications.

EC2 Image Builder

EC2 Image Builder is an AWS fully managed service that makes creating, managing, deploying customized, secure, and up-to-date server images easier.

A user can use the AWS Management Console, AWS CLI, or APIs to create custom images in your AWS account.

EC2 Image Builder

The following are some of the features offered by EC2 Image Builder:

- Increase productivity and reduce operations for building compliant and up-to-date images
- Increase service uptime
- Raise the security bar for deployments
- Centralize enforcement and lineage tracking
- Simplify sharing of resources across AWS accounts

EC2 Image Builder: Supported Operating Systems

Image Builder supports the following operating systems:

- Amazon Linux 2
- Windows Server 2019/2016/2012 R2
- Windows Server version 1909
- Red Hat Enterprise Linux (RHEL) 8 and 7
- CentOS 8 and 7
- Ubuntu 18 and 16
- SUSE Linux Enterprise Server (SUSE) 15

EC2 Image Builder: Components

The terms listed below are essential for understanding and using the EC2 Image Builder.

- **AMI**
- **Managed image**
- **Image pipeline**
- **Image recipe**
- **Container recipe**
- **Source image**

EC2 Image Builder: Components

The terms listed below are essential for understanding and using the EC2 Image Builder.

- **Component document**
- **Components**
- **Configuration phases**
- **Runtime stages**

Systems Manager

Systems Manager

AWS Systems Manager is a tool that provides visibility and control of the entire AWS infrastructure to the user.

- It integrates with Cloudwatch which allows user to view the dashboard, operational date, or reporting bugs.
- It also includes Run command to automate operational tasks such as security patching.
- It also organizes the inventory by grouping resources by application or environment.

Run Command

Run command allows the user to run predefined commands on one or more EC2 instances.

Some of the basic tasks that can be executed using the Run command:

1. Stop, restart, terminate, and resize instances
2. Attach or detach an instance
3. Create snapshots
4. DynamoDB backup
5. Apply updates and system patches
6. Run scripts

Assisted Practice

SSM And Run Command

Duration: 10 Min.

Problem Statement:

Demonstrate how AWS System Manager allows a user to manage the configuration of any managed instances remotely and securely.

Assisted Practice: Guidelines

Steps to demonstrate SSM And Run Command:

1. Selecting S3 bucket
2. Setting up run command

AWS CloudFormation

What Is CloudFormation?

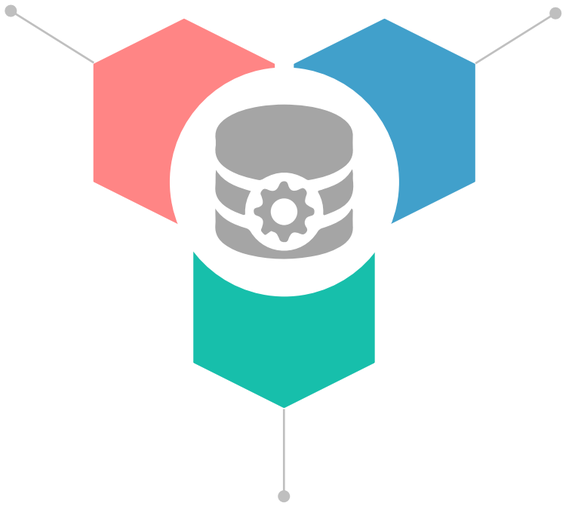
AWS CloudFormation is a service that helps an end user automate AWS services by creating templates.

- A user can create a template describing a resource, and AWS CloudFormation handles provisioning and configuration for it.
- AWS CloudFormation eliminates the process of individual configuration of AWS resources and their dependencies.
- CloudFormation interprets a template and makes API calls to create resources defined by the user.
- Apart from the UI, CloudFormation supports YAML and JSON formats for defining resources.

What Is AWS CloudFormation?

Managing the infrastructure

A single template can contain information of services, and other configurations are done by AWS.



Replicating the infrastructure

A user can replicate the same infrastructure for multiple regions for dealing with service failures using rollback operations.

Tracking changes in the infrastructure

AWS describes what changes happened in resources that got provisioned, thus helping in easy logging of activities.

CloudFormation Template

- CloudFormation template is either a JSON or a YAML text file.
- AWS CloudFormation uses these templates as reference for building resources.
- Example: A template contains information about an EC2 instance, such as the instance type, AMI ID, block device mappings, and key-pair name.
- A user can also upload a template to CloudFormation using S3.
- The resource created using the template is called a **stack.**

Template: Components

1. **Data tables:** Static configuration values, such as AMI names
1. **Outputs:** URL to a web application
1. **Parameters:** Input values provided while creating stacks
1. **Resources:** Names and configurations of services to be added
1. **Conditions:** Actions to be taken based on the conditional statements, such as equals
1. **Mappings:** Set values based on a region, such as AMIs
1. **Transform:** Includes snippets from outside the main template

Template: Example

The sample template given below shows how to create an EC2 instance:

```
AWSTemplateFormatVersion: "2010-09-09"
Description: A sample template
Resources:
  MyEC2Instance:
    Type: "AWS::EC2::Instance"
    Properties:
      ImageId: "ami-0ff8a91507f77f867"
      InstanceType: t2.micro
      KeyName: testkey
      BlockDeviceMappings:
        -
          DeviceName: /dev/sdm
          Ebs:
            VolumeType: io1
            Iops: 200
            DeleteOnTermination: false
            VolumeSize: 20
```

Assisted Practice

CloudFormation

Duration: 10 Min.

Problem Statement:

You are asked to demonstrate AWS CloudFormation that will help your organization model and set up their AWS resources so that they can spend less time managing those resources and more time focusing on the applications that run in AWS. Your company only needs to create a template that describes all the AWS resources it requires and CloudFormation will take care of provisioning and configuring those resources for them.

Assisted Practice: Guidelines

Steps to create a stack with S3 bucket using AWS CloudFormation:

1. Login to your AWS lab
2. Select **CloudFormation** from **Services**
3. Design a template with S3
4. Render the template

AWS CloudFormation StackSets

AWS CloudFormation StackSets enhance the capabilities of stacks by allowing a user to build, update, or delete stacks across multiple accounts and regions with a single operation.

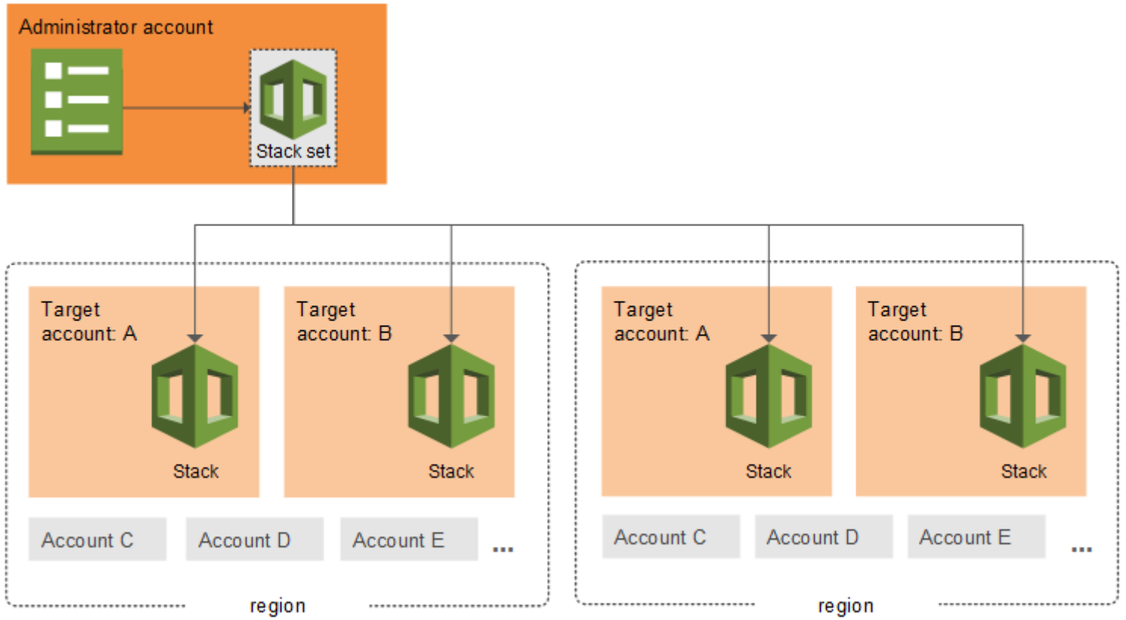


Image source: docs.aws.com

AWS CloudFormation StackSets: Concepts

A user must understand the following concepts to utilize StackSets.

- Administrator and target accounts
- Stack sets
- Permission models for stack sets
- Stack instances
- Stack set operations
- Stack set operation options
- Tags
- Stack set and stack instance status codes

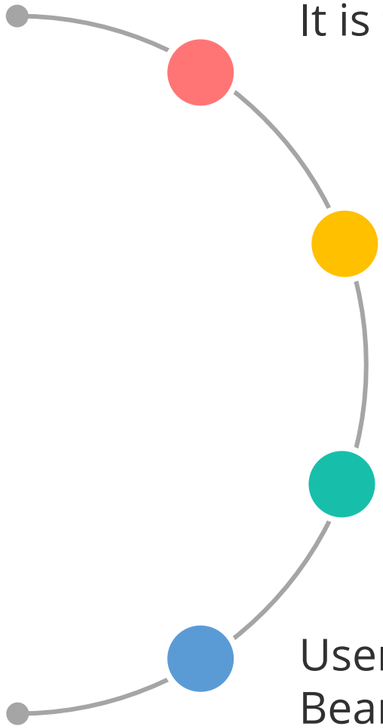
Elastic Beanstalk

What Is Elastic Beanstalk?

AWS Elastic Beanstalk is a service used to deploy and scale web applications developed in various languages, such as Java, .NET, PHP, Python, and Ruby on servers, such as Apache.

- The infrastructure supporting the application is managed by AWS.
- There is no additional installation required, such as Java or .NET.
- On uploading the code, Elastic Beanstalk handles the deployment, load balancing, and auto scaling it.
- The user has full control over the application and the resources used to run it.

Benefits of Elastic Beanstalk



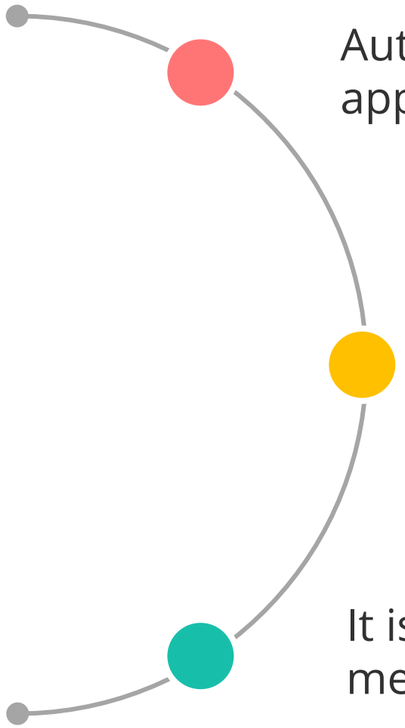
It is the fastest and simplest way to deploy an application on AWS.

Auto scaling is done automatically for an application.

Users can choose the most suitable EC2 instance for an application.

Users have the flexibility to handle all resources, or they can also let Elastic Beanstalk take care of them.

Benefits of Elastic Beanstalk



Automatic platform updates are performed on the OS for the tools used for an application, such as Java.

It provides a dashboard to manage the application health.

It is integrated with CloudWatch and X-Ray for logging performance data and metrics.

Assisted Practice

Elastic Beanstalk

Duration: 10 Min.

Problem Statement:

You work as an architect for a startup organization that is not familiar with AWS and the services it provides. The organization is developing a .NET application. As an architect, you've been requested to demonstrate Elastic Beanstalk, which will allow your company to quickly deploy and manage the application in the AWS Cloud without having to learn about the infrastructure that runs those applications.

Assisted Practice: Guidelines

Steps to create a web application using Elastic Beanstalk:

1. Login to your AWS lab
2. Select **Elastic Beanstalk** from **Services**
3. Upload an HTML page for rendering
4. Select the platform and language

Automation Scheduling Tools

AWS OpsWorks

AWS OpsWorks is a service that allows users to automate server configuration on Chef or Puppet.

- It allows you to use code to automate configurations of your servers.
- It uses managed instances of Chef or Puppet.
- It allows you to manage configurations of operating systems and applications.
- OpsWorks maintains a server by automatically patching, updating, and backing it up.

Amazon EventBridge

Amazon EventBridge is a serverless event bus service that allows a user to connect applications to data from various sources.

EventBridge delivers real-time data from a user's apps, software as a service (SaaS) apps, AWS services to AWS Lambda functions, HTTP invocation endpoints with API destinations, and event buses in other AWS accounts.

Key Takeaways

- Elastic Block Store (EBS) is a storage volume that can be attached with an EC2 instance.
- Multiple physical locations for your resources, known as Regions and Availability Zones.
- Placement groups help users control how the instances are deployed.
- EC2 Image Builder makes creating, managing, deploying customized, secure, and up-to-date server images easier.
- Systems Manager organizes an inventory by grouping resources by application or environment.

Lesson-End Project

Duration: 60 min.

Deploy Elastic Beanstalk using CLI

Problem Statement:
Create and configure an Amazon Elastic Beanstalk, add a user with the attached policy, and deploy the app.

Background of the problem statement:
Your manager has assigned you a task where you have to deploy Elastic Beanstalk (EB) using CLI to add a policy of EB with full access to the user.