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Amazon Elastic Compute Cloud

What you will learn

At the core of the lesson

You will learn how to:

- Explain the features and uses of Amazon Elastic Compute Cloud (Amazon EC2)
- Launch an EC2 instance
- Describe the pricing options for Amazon EC2

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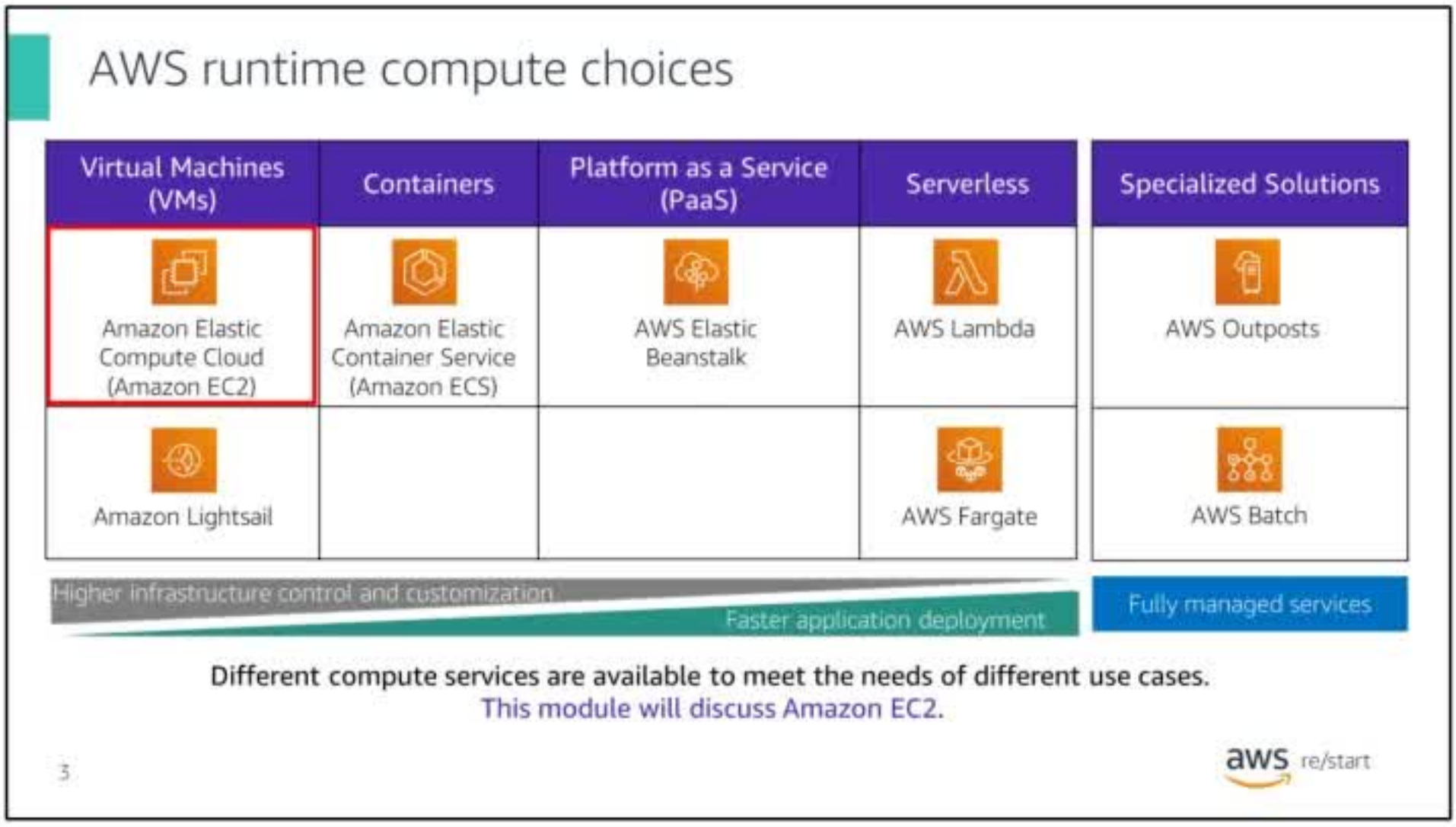
Amazon Web Services (AWS) provides multiple services to build a solution. Some of those services provide the foundation to all solutions, which are also known as the **core services**. This module provides insight into the offerings of each service category and looks at the first group of services, compute.

You will first get an overview of compute services. Then, you will learn about Amazon Elastic Compute Cloud (or Amazon EC2).

Whether you want to build mobile apps or run massive clusters to sequence the human genome, building and running your business starts with compute. AWS has a broad catalog of compute services. It offers everything from simple application services to flexible virtual servers, and even serverless computing.



AWS offers several compute options to meet different needs. When you consider the service to use for a given type of workload, it's important that you understand the available compute options. As the diagram shows, the key runtime compute choices can be grouped into four categories of cloud-computing models: *virtual machines (VMs); containers; platform as a service*, which is also known as *PaaS*; and *serverless*. In addition, you can use *specialized solutions* to address specific compute use cases.

In the *virtual machines* category, AWS offers two core services. The first service is *Amazon Elastic Compute Cloud (Amazon EC2)*. It provides secure and resizable virtual servers in the cloud. The second service is Amazon Lightsail. It provides virtual private servers to run simple workloads in a cost-effective way.

In the containers category, AWS offers *Amazon Elastic Container Service (Amazon ECS)*. It enables you to run Docker container applications on AWS.

The *PaaS* category includes *AWS Elastic Beanstalk*. It's a solution that runs web applications and services that are developed in languages such as Java, .NET, PHP, Node.js, Python, Ruby, Go, and Docker.

The *serverless* category includes *AWS Lambda*, which is a serverless compute solution that runs Java, Go, PowerShell, Node.js, C#, Python, or Ruby code. This category also includes *AWS Fargate*, which provides a serverless compute

platform for containers.

For specialized solutions, *AWS Outposts* provides a way to run AWS infrastructure and services on-premises, and *AWS Batch* is a service that runs batch jobs at any scale.

When you select an AWS compute runtime for your workload, consider that virtual machines and container-based services provide more control over your infrastructure and enable higher degrees of customization. PaaS and serverless services enable you to focus more on your application and less on infrastructure. They also enable quick deployment. The services in the specialized solutions category address specific types of workloads, or *hybrid cloud* and *batch*. These specialized services work well for these use cases because they are also fully managed by AWS.

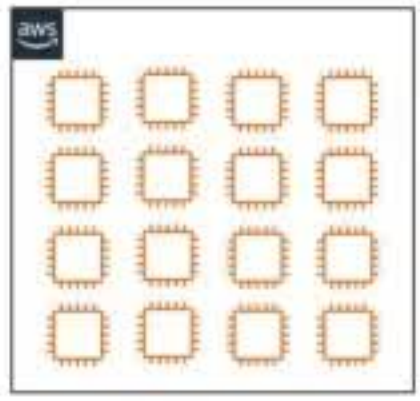
Amazon EC2 is one of the core AWS services and is the focus of this module.

Amazon EC2

On-premises servers

Example uses of EC2 instances

- ✓ Application server
- ✓ Web server
- ✓ Database server
- ✓ Game server
- ✓ Mail server
- ✓ Media server
- ✓ Catalog server
- ✓ File server
- ✓ Computing server
- ✓ Proxy server



EC2 instances

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Running on-premises servers is an expensive undertaking. Hardware must be procured, and this procurement can be based on project plans instead of on the reality of how the servers are used. Data centers are expensive to build, staff, and maintain. Organizations also need to permanently provision a sufficient amount of hardware to handle traffic spikes and peak workloads. After traditional on-premises deployments are built, server capacity might be unused and idle for a significant portion of the time that the servers are running, which is wasteful.

Amazon EC2 provides virtual machines where you can host the same kinds of applications that you might run on a traditional on-premises server. It provides secure, resizable compute capacity in the cloud. EC2 instances can support a variety of workloads. Common uses for EC2 instances include:

- Application servers
- Web servers
- Database servers
- Game servers
- Mail servers
- Media servers
- Catalog servers
- File servers

- Computing servers
- Proxy servers

Amazon EC2 overview

- Amazon Elastic Compute Cloud (Amazon EC2)
  - Provides virtual machines—referred to as EC2 instances—in the cloud
  - Gives you *full control* over the guest operating system (OS), either Microsoft Windows or Linux, on each instance
- You can launch instances of any size into an Availability Zone anywhere in the world.
  - Launch instances from Amazon Machine Images (AMIs)
  - Launch instances with a few clicks or a line of code, and they are ready in minutes
- You can control traffic to and from instances

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The **EC2** in Amazon EC2 stands for **Elastic Compute Cloud**:

- **Elastic** refers to the fact that you can easily increase or decrease the number of servers that you run to support an application automatically. You can also increase or decrease the size of existing servers.
- **Compute** refers to reason why most users run servers—to host running applications or process data. These actions require compute resources, including processing power (CPU) and memory (RAM).
- **Cloud** refers to the fact that the EC2 instances that you run are hosted in the cloud.

Amazon EC2 provides virtual machines in the cloud and gives you full administrative control over the Microsoft Windows or Linux operating system that runs on the instance. Most server operating systems are supported, including: Windows 2008, 2012, 2016, and 2019, Red Hat, SuSE, Ubuntu, and Amazon Linux.

An operating system (OS) that runs on a virtual machine is often called a *guest OS* to distinguish it from the host OS. The host OS is directly installed on any server hardware that hosts one or more virtual machines.

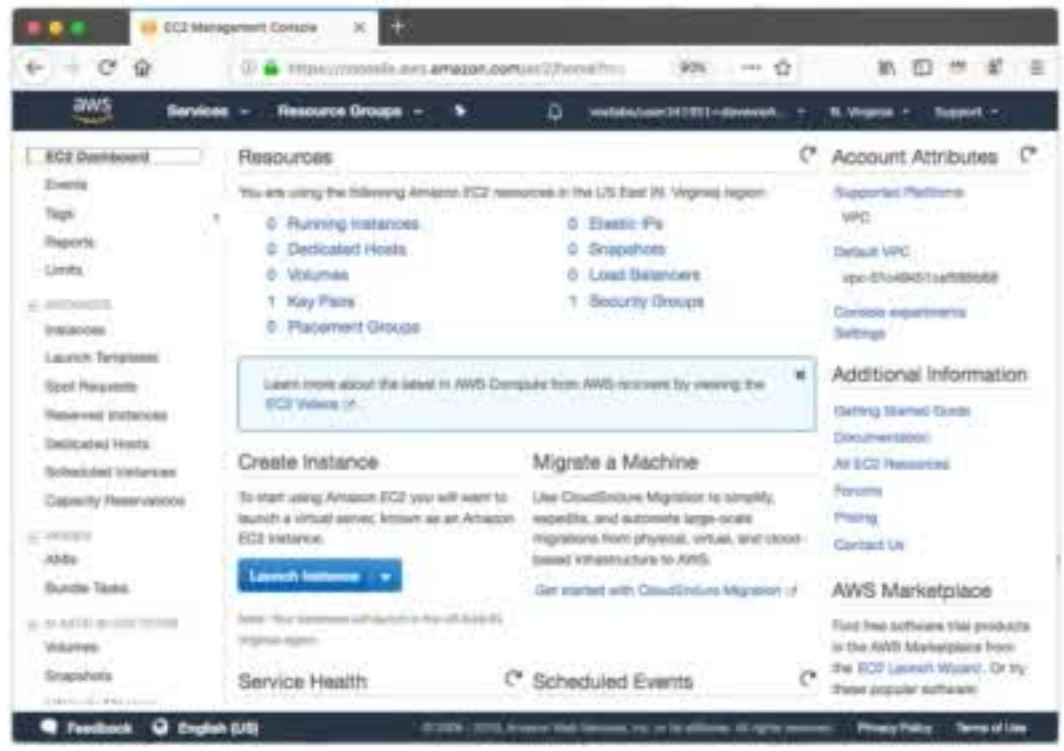
With Amazon EC2, you can launch any number of instances of any size into any Availability Zone anywhere in the world in minutes. Instances launch from **Amazon Machine Images (AMIs)**, which are effectively virtual machine templates. AMIs are discussed in more detail later in this module.

You can control traffic to and from instances by using security groups. Also, because the servers run in the AWS Cloud, you can build solutions that use multiple AWS services.

Launching an EC2 instance

This section of the module walks through nine key decisions to make when you create an EC2 instance by using the AWS Management Console Launch Instance Wizard.

- Along the way, essential Amazon EC2 concepts will be explored.



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The first time that you launch an EC2 instance, you will likely use the *AWS Management Console Launch Instance Wizard*. An example of this process is shown in the demonstration at the end of this section.

The **Launch Instance Wizard** makes it easy to launch an instance. For example, if you choose to accept all the default settings, you can skip most of the steps that are provided by the wizard and launch an EC2 instance in a few clicks.

However, for most deployments, you will want to modify the default settings so that the servers you launch are deployed in a way that matches your specific needs.

The next series of slides introduce you to the essential choices that you must make when you launch an instance. The slides cover essential concepts that are good to know when you make these choices. You learn about these concepts to help you understand the options that are available, and the effects of the decisions that you make.

1. Select an AMI

Choices made using the Launch Instance Wizard:

1. AMI
2. Instance Type
3. Network settings
4. IAM role
5. User data
6. Storage options
7. Tags
8. Security group
9. Key pair

- Amazon Machine Image (AMI)
  - Is a template that is used to create an EC2 instance (which is a virtual machine, or VM, that runs in the AWS Cloud)
  - Contains a Windows or Linux operating system
  - Often also has some software pre-installed
- AMI choices:
  - Quick Start – *Linux and Windows AMIs that are provided by AWS*
  - My AMIs – *Any AMIs that you created*
  - AWS Marketplace – *Pre-configured templates from third parties*
  - Community AMIs – *AMIs shared by others; use at your own risk*

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An **Amazon Machine Image (AMI)** provides information that is needed to launch an EC2 instance. You must specify a source AMI when you launch an instance. You can use different AMIs to launch different types of instances. For example, you can choose one AMI to launch an instance that will become a web server and another AMI to deploy an instance that will host an application server. You can also launch multiple instances from a single AMI.

An AMI includes the following components:

- A **template for the root volume** of the instance. A root volume typically contains an OS and everything that was installed in that OS (applications, libraries, and so on). Amazon EC2 copies the template to the root volume of a new EC2 instance, and then starts it.
- **Launch permissions** that control which AWS accounts can use the AMI.
- A **block device mapping** that specifies the volumes to attach to the instance (if any) when it is launched.

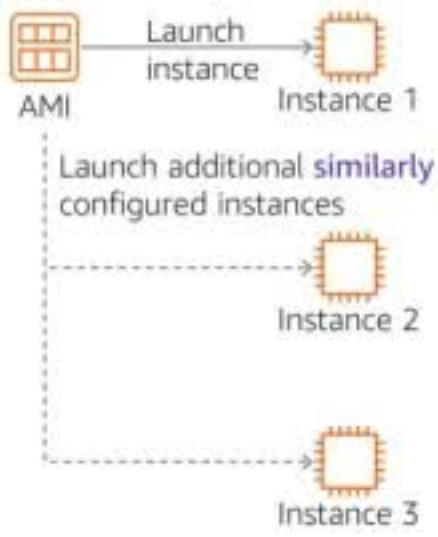
You can choose many AMIs:

- Quick Start – AWS offers a number of pre-built AMIs for launching your instances. These AMIs include many Linux and Windows options.
- My AMIs – These AMIs are AMIs that you created.
- AWS Marketplace – The AWS Marketplace offers a digital catalog that lists thousands of software solutions. These AMIs can offer specific use cases to

help you get started quickly.

- Community AMIs – These AMIs are created by people all around the world. These AMIs are not checked by AWS, so use them at your own risk. Community AMIs can offer many different solutions to various problems, but use them with care. Avoid using them in any production or corporate environment.

AMI benefits



- **Repeatability**
  - Use an AMI to launch instances repeatedly, with efficiency and precision
- **Reusability**
  - Instances that are launched from the same AMI are identically configured
- **Recoverability**
  - You can create an AMI from a configured instance as a restorable backup
  - You can replace a failed instance by launching a new instance from the same AMI

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An AMI provides the information that is needed to launch an instance. The benefits of using an AMI include *repeatability*, *reusability*, and *recoverability*.

AMIs enable *repeatability* because an AMI packages the full configuration and content of an EC2 instance. As such, it can be used repeatedly to launch multiple instances with efficiency and precision.

AMIs promote *reusability* because instances that are launched from the same AMI are exact replicas of each other. This design makes it easier to build clusters of similar instances or recreate compute environments.

AMIs also facilitate *recoverability*. If an instance fails, you can replace it by launching a new instance from the same AMI that you used to launch the original instance. In addition, AMIs provide a way to back up a complete EC2 instance configuration, which you can use to launch a replacement instance if there is a failure.

2. Select an instance type

Choices made using the Launch Instance Wizard:

1. AMI
2. Instance Type
3. Network settings
4. IAM role
5. User data
6. Storage options
7. Tags
8. Security group
9. Key pair

- Consider your use case
  - How will the EC2 instance you create be used?
- The instance type that you choose determines –
  - Memory (RAM)
  - Processing power (CPU)
  - Disk space and disk type (Storage)
  - Network performance
- Instance type categories –
  - General purpose
  - Compute-optimized
  - Memory-optimized
  - Storage-optimized
  - Accelerated computing
- Instance types offer *family*, *generation*, and *size*

After you choose the AMI for launching the instance, you must choose on an instance type.

Amazon EC2 provides a selection of *instance types* that optimized to fit different use cases. Instance types comprise varying combinations of CPU, memory, storage, and networking capacity. The different instance types give you the flexibility to choose the appropriate mix of resources for your applications. Each instance type includes one or more instance sizes, which enable you to scale your resources to the requirements of your target workload.

Instance type categories include general purpose, compute-optimized, memory-optimized, storage-optimized, and accelerated computing instances. Each instance type category offers many instance types to choose from.

EC2 instance type naming and sizes

Instance type naming

- Example: t3.large
  - T is the family name
  - 3 is the generation number
  - Large is the size

Example instance sizes

Instance Name	vCPU	Memory (GB)	Storage
t3.nano	2	0.5	EBS-Only
t3.micro	2	1	EBS-Only
t3.small	2	2	EBS-Only
t3.medium	2	4	EBS-Only
t3.large	2	8	EBS-Only
t3.xlarge	4	16	EBS-Only
t3.2xlarge	8	32	EBS-Only

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The name of an EC2 instance type has several parts. For example, consider the T type.

T is the *family name*, which is then followed by a number. Here, that number is 3.

The number is the *generation number* of that type. So, a t3 instance is the third generation of the T family. In general, instance types in a higher-number generation are more powerful and provide a better value for the price.

The next part of the name is the *size* portion of the instance. When you compare sizes, it's important to note the coefficient portion of the size category.

For example, a *t3.2xlarge* has twice the vCPU and memory of a *t3.xlarge*. The t3.xlarge has, in turn, twice the vCPU and memory of a t3.large.

It is also important to note that *network bandwidth* is also tied to the size of the EC2 instance. If you run jobs that are network-intensive, you might need to increase the instance specifications to meet your needs.

Instance type use cases

	General Purpose	Compute Optimized	Memory Optimized	Accelerated Computing	Storage Optimized
Instance Types	a1, m4, m5, t2, t3	c4, c5	r4, r5, x1, z1	f1, g3, g4, p2, p3	d2, h1, i3
Use Case	Broad	High performance	In-memory databases	Machine learning	Distributed file systems

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Instance types vary in several ways, including CPU type, CPU or core count, storage type, storage amount, memory amount, and network performance. The chart provides a high-level view of the different instance categories, and which instance type families and generation numbers fit into each category type. Consider a few of the instance types in more detail:

- **T3** instances provide burstable performance *general purpose* instances that provide a baseline level of CPU performance with the ability to burst above the baseline. Use cases for this type of instance include websites and web applications, development environments, build servers, code repositories, microservices, test and staging environments, and line-of-business applications.

- **C5** instances are optimized for *compute-intensive* workloads, and deliver cost-effective high performance at a low price per compute ratio. Use cases include scientific modeling, batch processing, ad serving, highly scalable multiplayer gaming, and video encoding.

- **R5** instances are optimized for *memory-intensive* applications. Use cases include high-performance databases, data mining and analysis, in-memory databases, distributed web-scale in-memory caches, applications that perform real-time processing of unstructured big data, Apache Hadoop or

Apache Spark clusters, and other enterprise applications.

To learn more about each instance type, see the Amazon EC2 Instance Types documentation.

Instance types networking features

- The network bandwidth (Gbps) varies by instance type
  - See Amazon EC2 Instance Types to compare
- To maximize networking and bandwidth performance of your instance type:
  - If you have interdependent instances, launch them into a **cluster placement group**
  - Enable enhanced networking
- Enhanced networking types are supported on most instance types
  - See the Networking and Storage Features documentation for details
- Enhanced networking types –
  - **Elastic Network Adapter (ENA):** Supports network speeds of up to 100 Gbps
  - **Intel 82599 Virtual Function interface:** Supports network speeds of up to 10 Gbps

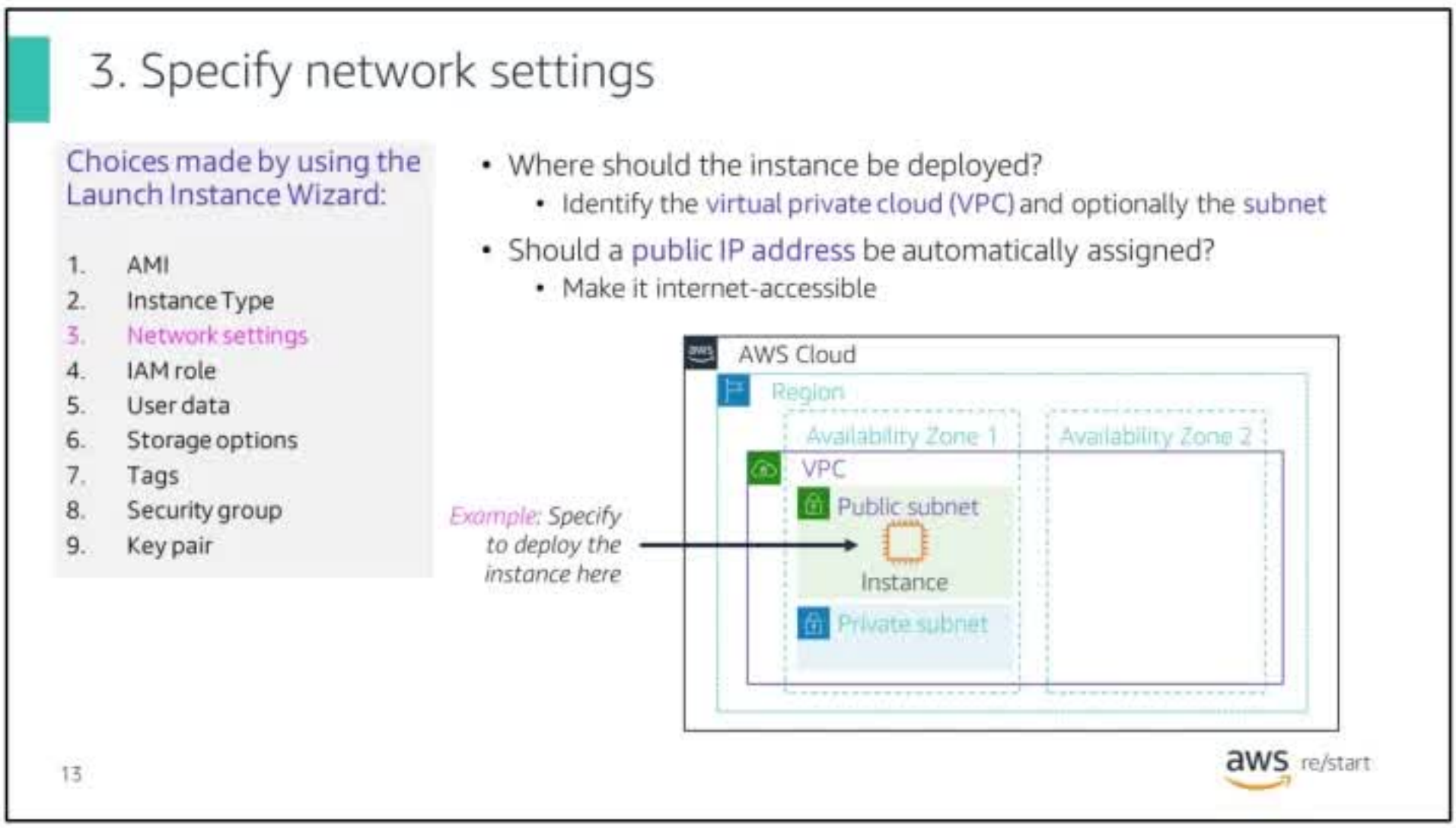
In addition to considering the CPU, RAM, and storage needs of your workloads, it's also important to consider your network bandwidth requirements.

Each instance type provides a documented network performance level. For example, an a1.medium instance will provide up to 10 Gbps, but a p3dn.24xlarge instance provides up to 100 Gbps. Choose an instance type that meets your requirements.

When you launch multiple new EC2 instances, Amazon EC2 attempts to place the instances so that they are spread out across the underlying hardware by default. It does so to minimize correlated failures. However, if you want to specify placement criteria, you can use *placement groups* to influence the placement of a group of *interdependent* instances to meet the needs of your workload. For example, you might specify that three instances should all be deployed in the same Availability Zone to ensure lower network latency and higher network throughput between instances. Refer to the Placement Group documentation for details.

Many instance types also enable you to configure enhanced networking to get significantly higher packet per second (PPS) performance, lower delay variation in the arrival of packets over the network (network jitter), and lower latencies. See the Elastic Network Adapter (ENA) Elastic Network Adapter (ENA)

documentation for details.



After you choose an AMI and an instance type, you must specify the network location where the EC2 instance will be deployed. You must choose the *Region* before you start the Launch Instance Wizard. Verify that you are in the correct Region page of the Amazon EC2 console before you choose **Launch Instance**.

When you launch an instance in a *default virtual private cloud (VPC)*, AWS will assign it a *public IP address* by default. When you launch an instance into a *nondefault VPC*, the subnet has an attribute that determines whether instances that are launched into that subnet receive a public IP address from the public IPv4 address pool. By default, AWS will not assign a public IP address to instances that are launched in a nondefault subnet. You can control whether your instance receives a public IP address in two ways. First, you can modify the public IP addressing attribute of your subnet. Second, you can also enable or disable the public IP addressing feature during launch (which overrides the subnet's public IP addressing attribute).

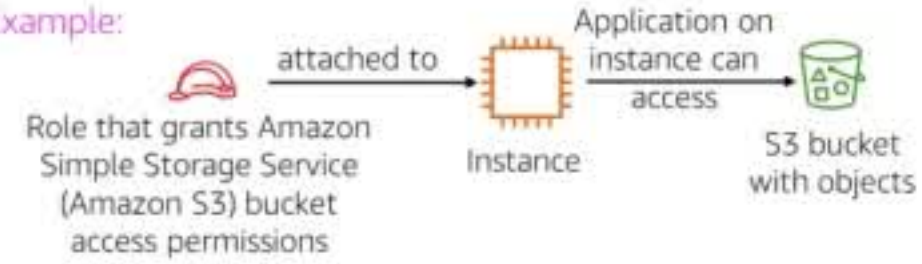
4. Attach IAM role (optional)

Choices made by using the Launch Instance Wizard:

1. AMI
2. Instance Type
3. Network settings
4. IAM role
5. User data
6. Storage options
7. Tags
8. Security group
9. Key pair

- Does software on the EC2 instance need to interact with other AWS services?
  - If yes, attach an appropriate IAM Role
- An AWS Identity and Access Management (IAM) role that is attached to an EC2 instance is kept in an instance profile
- You are *not* restricted to attaching a role only at instance launch
  - You can also attach a role to an instance that already exists

Example:



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It's common to use EC2 instances to run an application that must make secure application programming interface (API) calls to other AWS services. To support these use cases, AWS enables you **to attach an AWS Identity and Access Management (IAM) role to an EC2 instance**. Without this feature, you might be tempted to place AWS credentials on an EC2 instance for an application on that instance to use. However, you should never store AWS credentials on an EC2 instance. This practice is highly insecure. Instead, attach an IAM role to the EC2 instance. The IAM role then grants permissions to make API requests to the applications that run on the EC2 instance.

An **instance profile** is a container for an IAM role. If you use the AWS Management Console to create a role for Amazon EC2, the console automatically creates an instance profile and gives it the same name as the role. When you use the Amazon EC2 console to launch an instance with an IAM role, you can select a role to associate with the instance. In the console, the list that displays is actually a list of instance profile names.

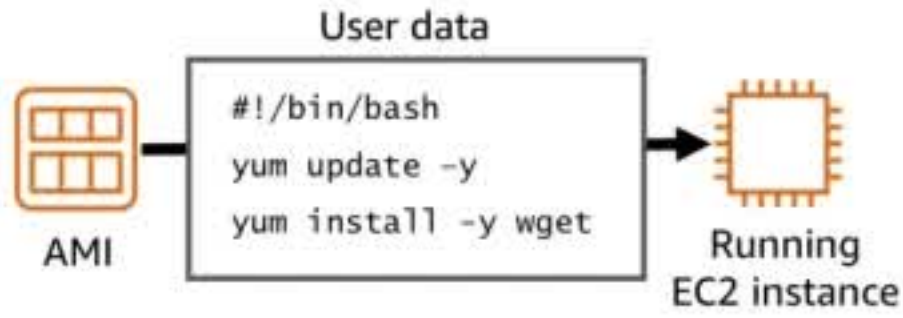
In the example, an IAM role is used to grant permissions to an application that runs on an EC2 instance. The application must access a bucket in Amazon Simple Storage Service (Amazon S3).

You can attach an IAM role when you launch the instance, but you can also attach a role to an already-running EC2 instance. When you define a role that can be used by an EC2 instance, you define which accounts or AWS services can assume the role. You also define which API actions and resources the application can use after it assumes the role. If you change a role, the change is propagated to all instances that have the role attached to them.

5. User data script (optional)

Choices made by using the Launch Instance Wizard:

1. AMI
2. Instance Type
3. Network settings
4. IAM role
5. User data
6. Storage options
7. Tags
8. Security group
9. Key pair



- Optionally specify a user data script at instance launch
- Use user data scripts to customize the runtime environment of your instance
  - Script runs the first time the instance starts
- Can be used strategically
  - For example, reduce the number of custom AMIs that you build and maintain

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When you create your EC2 instances, you have the option of passing *user data* to the instance. User data can automate the completion of installations and configurations at instance launch. For example, a user data script might patch and update the instance's operating system, fetch and install software license keys, or install additional software.

In the example user data script, you see a simple three-line Linux Bash shell script. The first line indicates that the script should be run by the Bash shell. The second line invokes the Yellowdog Updater, Modified (YUM) utility, which is commonly used in many Linux distributions—such as Amazon Linux, CentOS, and Red Hat Linux—to retrieve software from an online repository and install it. In line two of the example, that command tells YUM to update all installed packages to the latest versions that are known to the software repository that it's configured to access. Line three of the script indicates that the Wget utility should be installed. Wget is a common utility for downloading files from the web.

For a Microsoft Windows instance, the user data script should be written in a format that's compatible with a Command Prompt window (batch commands) or with Windows PowerShell. Refer to the Windows User Data Scripts documentation for details.

When the EC2 instance is created, *the user data script will run with AWS account root user privileges* during the final phases of the boot process. On Linux instances, it's run by the cloud-init service. On Microsoft Windows instances, it's run by the EC2Config or EC2Launch utility. *By default, user data only runs the first time that the instance starts*. However, if you would like your user data script to run every time the instance is booted, you can create a Multipurpose Internet Mail Extensions (MIME) multipart file user data script (this process isn't common).

6. Specify storage

Choices made by using the Launch Instance Wizard:

1. AMI
2. Instance Type
3. Network settings
4. IAM role
5. User data
6. Storage options
7. Tags
8. Security group
9. Key pair

- Configure the root volume
  - Where the guest operating system is installed
- Attach additional storage volumes (optional)
  - AMI might already include more than one volume
- For each volume, specify:
  - The size of the disk (in GB)
  - The volume type
    - Different types of solid state drives (SSDs) and hard disk drives (HDDs) are available
  - If the volume will be deleted when the instance is terminated
  - If encryption should be used

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When you launch an EC2 instance, you can configure storage options. For example, you can configure the size of the root volume where the guest OS is installed. You can also attach additional storage volumes when you launch the instance. Some AMIs are also configured to launch more than one storage volume by default to provide storage that is separate from the root volume.

For each volume that your instance will have, you can specify the size of the disks, the volume types, and whether the storage will be retained if the instance is terminated. You can also specify if encryption should be used.

Amazon EC2 storage options

- Amazon Elastic Block Store (Amazon EBS) –
  - Durable, block-level storage volumes
  - You can stop the instance and start it again, and the data will still be there
- Amazon EC2 Instance Store –
  - Ephemeral storage is provided on disks that are attached to the host computer where the EC2 instance is running
  - If the instance stops, data that's stored here is deleted
- Other options for storage (not for the root volume) –
  - Mount an Amazon Elastic File System (Amazon EFS) file system
  - Connect to Amazon Simple Storage Service (Amazon S3)

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Amazon Elastic Block Store (Amazon EBS) is an easy-to-use, high-performance **durable block storage** service that's designed to be used with Amazon EC2 for both throughput-intensive and transaction-intensive workloads. With Amazon EBS, you can choose from four different volume types to balance the optimal price and performance. You can change volume types or increase volume size without disrupting your critical applications, so you can have cost-effective storage when you need it.

Amazon EC2 Instance Store provides ephemeral (or temporary) block-level storage for your instance. This storage is located on disks that are physically attached to the host computer. Instance Store works well when you must temporarily store information that changes frequently, such as buffers, caches, scratch data, and other temporary content. You can also use Instance Store for data that's replicated across a fleet of instances, such as a load balanced pool of web servers. If the instances are stopped—either because of user error or a malfunction—the data on the instance store will be deleted.

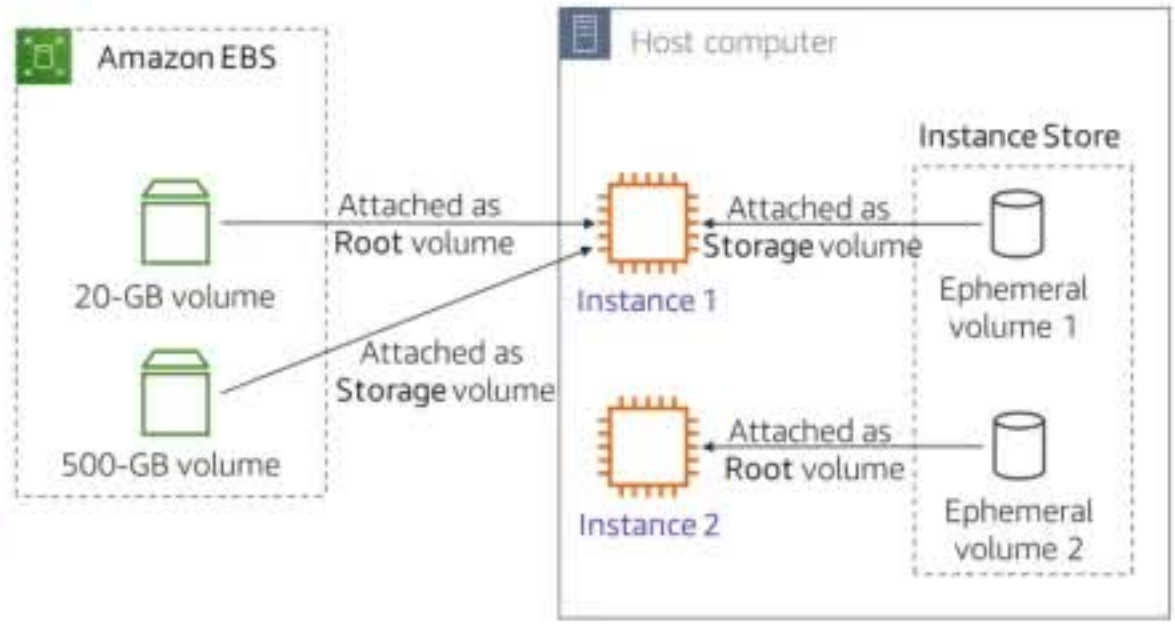
Amazon Elastic File System (Amazon EFS) provides a simple, scalable, fully managed elastic Network File System (NFS) file system for use with AWS Cloud services and on-premises resources. It's built to scale on-demand to petabytes without disrupting applications. It grows and shrinks automatically as you add and remove files, which reduces the need to provision and manage capacity to

accommodate growth.

Amazon Simple Storage Service (Amazon S3) is an object storage service that offers scalability, data availability, security, and performance. You can store and protect any amount of data for a variety of use cases, such as websites, mobile apps, backup and restore, archive, enterprise applications, Internet of Things (IoT) devices, and big data analytics.

Example storage options

- Instance 1 characteristics –
  - It has an **EBS** *root volume* type for the OS.
  - What happens if the instance is stopped and then started again?
- Instance 2 characteristics –
  - It has an **Instance Store** *root volume* type for the OS.
  - What happens if the instance stops (because of user error or a system malfunction)?



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These two examples illustrate two different storage configurations for EC2 instances.

The **Instance 1** example shows that the root volume—which contains the OS and possibly other data—is stored on Amazon EBS. This instance also has two attached volumes. One volume is a 500-GB EBS storage volume, and the other volume is an Instance Store volume. **If this instance was stopped and then started again**, the OS would survive. Any data that was stored on either the 20-GB EBS volume or the 500-GB EBS volume would remain intact. However, any data that was stored on *Ephemeral volume 1* would be permanently lost. Recall that the Instance Store works well for temporarily storing information that changes frequently (such as buffers, caches, scratch data, and other temporary content).

The **Instance 2** example shows that the root volume is on an instance store (*Ephemeral volume 2*). **An instance with an Instance Store root volume can't be stopped by an Amazon EC2 API call. It can only be terminated.** However, it could be stopped from within the instance's OS (for example, by issuing a shutdown command). It could also stop because of OS or disk failure, which would cause the instance to be terminated. If the instance is terminated, all the data that was stored on *Ephemeral volume 2* would be lost, including the OS. You wouldn't be able to start the instance again. Thus, don't rely on Instance Store for valuable, long-term data. Instead, use more durable data storage, such as Amazon EBS, Amazon EFS, or Amazon S3.

If an instance *reboots* (intentionally or unintentionally), data on the instance store root volume does persist.

7. Add tags

Choices made by using the Launch Instance Wizard:

1. AMI
2. Instance Type
3. Network settings
4. IAM role
5. User data
6. Storage options
7. Tags
8. Security group
9. Key pair

- A tag is a label that you can assign to an AWS resource
  - Consists of a *key* and an optional *value*
- Tagging is how you can attach metadata to an EC2 instance
- Potential benefits of tagging—Filtering, automation, cost allocation, and access control

Example:

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A tag is a label that you assign to an AWS resource. Each tag consists of a *key* and an optional *value*, both of which you define. Tags enable you to categorize AWS resources (such as EC2 instances) in different ways. For example, you might tag instances by purpose, owner, or environment.

You can use tagging to attach metadata to an EC2 instance.

Tag keys and tag values are case-sensitive. For example, a commonly used tag for EC2 instances is a tag key that's called *Name* and a tag value that describes the instance, such as *My Web Server*. The *Name* tag is exposed by default in the Amazon EC2 console **Instances** page. However, if you create a key that's called *name* (with lower-case *n*), it won't appear in the **Name** column for the list of instances. (However, it will still appear in the instance details panel in the **Tags** tab).

It's a best practice to develop Tagging strategies. A consistent set of tag keys makes it easier for you to manage your resources. You can also search and filter the resources based on the tags that you add.

8. Security group settings

Choices made by using the Launch Instance Wizard:

1. AMI
2. Instance Type
3. Network settings
4. IAM role
5. User data
6. Storage options
7. Tags
8. Security group
9. Key pair

- A security group is a set of firewall rules that control traffic to the instance
  - It exists *outside* of the instance's guest OS
- Create rules that specify the source and which ports that network communications can use
  - Specify the port number and the protocol, such as Transmission Control Protocol (TCP), User Datagram Protocol (UDP), or Internet Control Message Protocol (ICMP)
  - Specify the source (for example, an IP address or another security group) that's allowed to use the rule

Type	Protocol	Port Range	Source
SSH	TCP	22	My IP 72.21.198.67/32

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A **security group** acts as a virtual firewall that controls network traffic for one or more instances. When you launch an instance, you can specify one or more security groups. Otherwise, the default security group is used.

You can add **rules** to each security group. Rules allow traffic to or from its associated instances. You can modify the rules for a security group at any time. The new rules will be automatically applied to all instances that are associated with the security group. When AWS decides whether to allow traffic to reach an instance, all the rules from all the security groups that are associated with the instance are evaluated. When you launch an instance in a virtual private cloud (VPC), you must either create a new security group or use one that already exists in that VPC. After you launch an instance, you can change its security groups.

When you **define a rule**, you can specify the allowable source of the network communication (inbound rules) or destination (outbound rules). The **source** can be an IP address, an IP address range, another security group, a gateway VPC endpoint, or anywhere (which means that all sources will be allowed). By default, a **security group** includes an **outbound rule** that allows all **outbound** traffic. You can remove the **rule** and add **outbound rules** that only allow specific **outbound** traffic. If your **security group** has no **outbound rules**, no **outbound** traffic that originates from your instance is allowed.

In the example rule, the rule allows Secure Shell (SSH) traffic over Transmission Control Protocol (TCP) port 22 if the source of the request is *My IP*. The *My IP* IP address is calculated when you define the rule by determining the IP address that you are using to connect to the AWS Cloud.

Network access control lists (network ACLs) can also be used are firewalls to protect subnets in a VPC.

9. Identify or create the key pair

Choices made by using the Launch Instance Wizard:

1. AMI
2. Instance Type
3. Network settings
4. IAM role
5. User data
6. Storage options
7. Tags
8. Security group
9. Key pair

- At instance launch, you specify an existing key pair *or* create a new key pair
- A key pair consists of –
  - A public key that AWS stores
  - A private key file that you store
- It enables secure connections to the instance
- For Windows AMIs –
  - Use the private key to obtain the administrator password that you need to log in to your instance
- For Linux AMIs –
  - Use the private key to use SSH to securely connect to your instance

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After you specify all the required configurations to launch an EC2 instance—and after you customize any optional EC2 launch wizard configuration settings—the **Review Instance Launch** window opens. If you then choose **Launch**, a dialog box asks you to choose an existing key pair, proceed without a key pair, or create a new key pair before you can choose **Launch Instances** and create the EC2 instance.

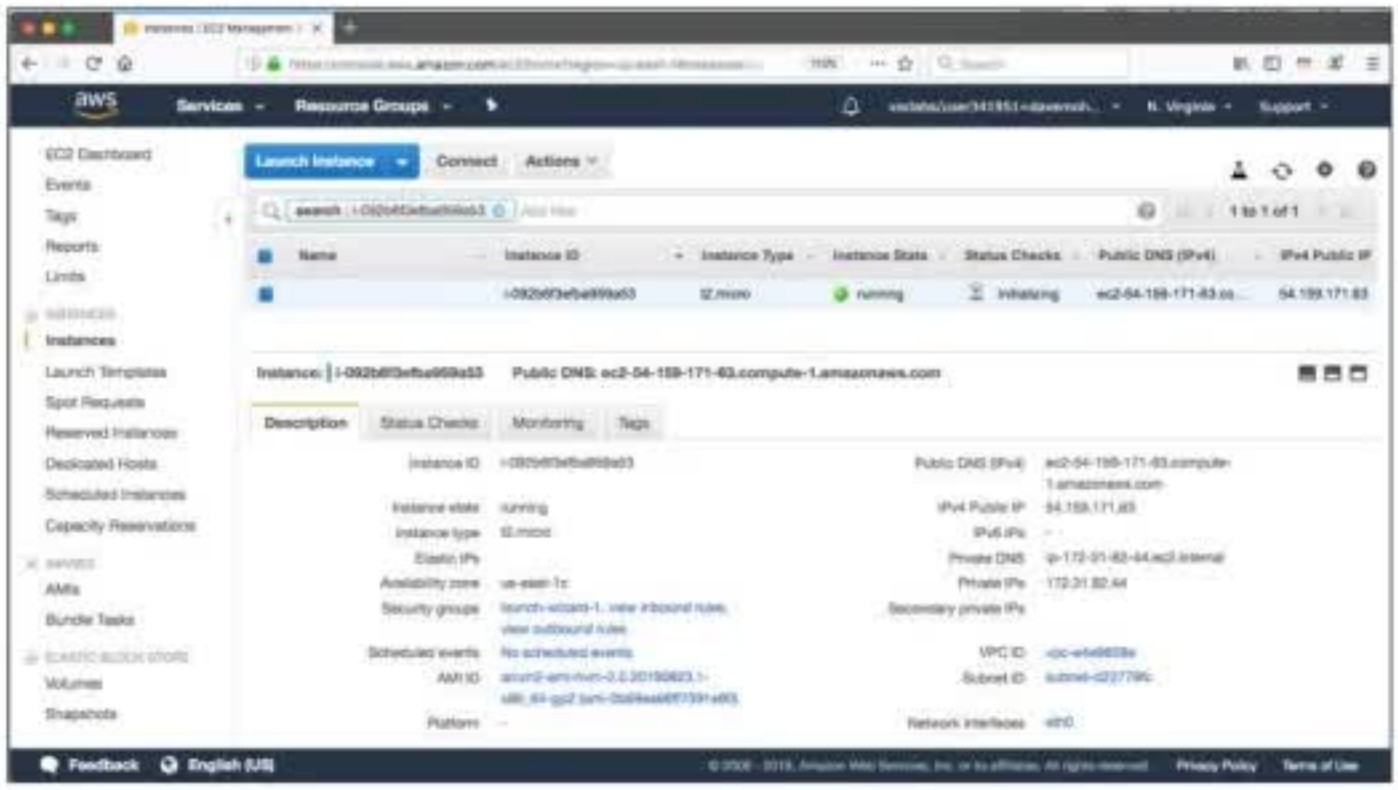
Amazon EC2 uses public key cryptography to encrypt and decrypt login information. The technology uses a **public key** to encrypt a piece of data. Then, the recipient uses the private key to decrypt the data. The public and private keys are known as a **key pair**. Public key cryptography enables you to securely access your instances by using a private key instead of a password.

When you launch an instance, you specify a key pair. You can specify an existing key pair or a new key pair that you create at launch. If you create a new key pair, download it and save it in a safe location. This opportunity is the only chance that you get to save the private key file.

To connect *to* a **Microsoft Windows** instance, use the private key to obtain the administrator password, and then log in to the EC2 instance's Windows Desktop by using Remote Desktop Protocol (RDP). To establish an SSH connection *from* a Windows machine to an EC2 instance, you can use a tool such as PuTTY, which will require the same private key.

With **Linux** instances, the **public key** content is placed on the instance at boot time. An entry is created in in `~/.ssh/authorized_keys`. To log in to your Linux instance (for example, by using SSH), you must provide the **private key** when you establish the connection.

Amazon EC2 console view of a running EC2 instance



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After you choose **Launch Instances** and then choose **View Instances**, a screen opens. It looks similar to the example.

Many of the settings that you specified during launch are in the **Description** panel.

Information about the available instance includes IP address and DNS address information, the instance type, the unique instance ID that was assigned to the instance, the AMI ID of the AMI that you used to launch the instance, the VPC ID, the subnet ID, and more.

Many of these details provide hyperlinks. You can choose them to learn more information about the instance's resources.

Launch an EC2 instance with the AWS Command Line Interface

- EC2 instances can also be created programmatically.

AWS Command Line Interface (AWS CLI)

- This example shows how simple the command can be.
  - This command assumes that the key pair and security group already exist.
  - More options could be specified. See the AWS CLI Command Reference for details.

Example command:

```
aws ec2 run-instances \
--image-id ami-1a2b3c4d \
--count 1 \
--instance-type c3.large \
--key-name MyKeyPair \
--security-groups MySecurityGroup \
--region us-east-1
```


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You can also launch EC2 instances programmatically, either by using the AWS Command Line Interface (AWS CLI) or one of the AWS software development kits (SDKs).

In the example AWS CLI command, you see a single command that specifies the minimal information that is needed to launch an instance. The command includes the following information:

- **`aws`** – Specifies an invocation of the *aws* command line utility.
- **`ec2`** – Specifies an invocation of the *ec2* service command.
- **`run-instances`** – Is the subcommand that is being invoked.

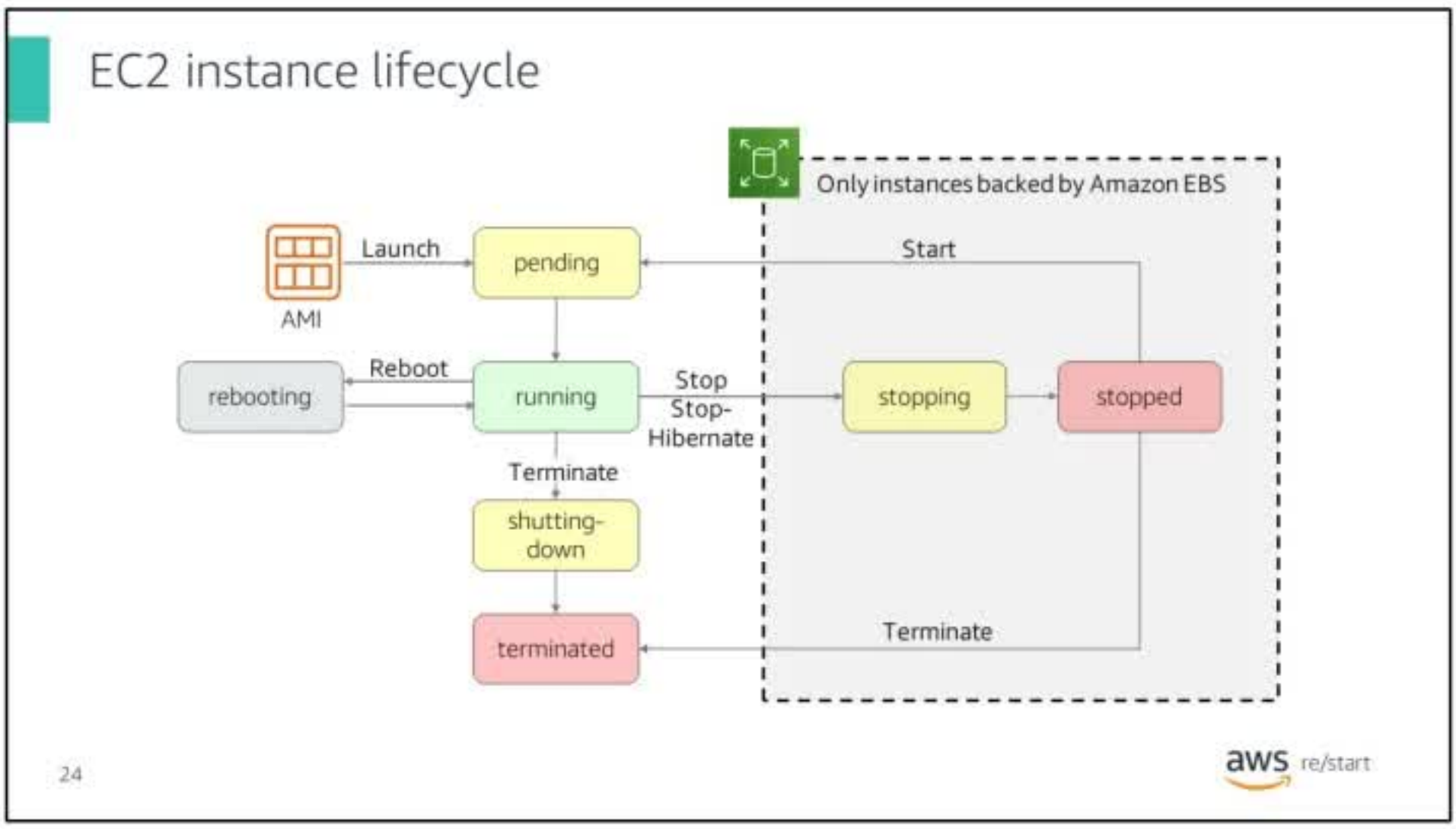
The rest of the command specifies several parameters, including:

- **`image-id`** – This parameter is followed by an AMI ID. All AMIs have a unique AMI ID.
- **`count`** – You can specify more than one.
- **`instance-type`** – You can specify the instance type to create (for example) a c3.large instance
- **`key-name`** – In the example, assume that *MyKeyPair* already exists.
- **`security-groups`** - In this example, assume that *MySecurityGroup* already exists.
- **`region`** - AMIs exist in an AWS Region, so you must specify the Region where the AWS CLI will find the AMI and launch the EC2 instance.

The command should successfully create an EC2 instance if:

- The command is properly formed
- The resources that the command needs already exist
- You have sufficient permissions to run the command
- You have sufficient capacity in the AWS account

If the command is successful, the API responds to the command with the instance ID and other relevant data for your application to use in subsequent API requests.



This diagram illustrates the lifecycle of an instance. The arrows show **actions** that you can take. The boxes show the **state** the instance will enter after that action. An instance can be in one of the following states:

- **Pending** – When an instance is first launched from an AMI, or when you start a stopped instance, it enters the *pending* state when the instance is booted and deployed to a host computer. The instance type that you specified at launch determines the hardware of the host computer for your instance.
- **Running** – When the instance is fully booted and ready, it exits the *pending* state and enters the *running* state. You can connect over the internet to your running instance.
- **Rebooting** – Instead of invoking a reboot from the instance's guest OS, AWS recommends you reboot the instance by using the Amazon EC2 console, the AWS Command Line Interface (AWS CLI), or AWS software development kits (SDKs). A rebooted instance stays on the same physical host, and it maintains the same public DNS name and public IP address. If the instance has **instance store** volumes, it retains the data on those volumes.
- **Shutting down** – This state is an intermediate state between *running* and *terminated*.
- **Terminated** – A terminated instance remains in the Amazon EC2 console for

some time before the virtual machine is deleted. However, you can't connect to or recover a terminated instance.

- **Stopping** – Instances that are backed by Amazon EBS can be stopped. They enter the *stopping* state before they attain the fully *stopped* state.
- **Stopped** – A *stopped* instance doesn't incur the same cost as a *running* instance. Starting a *stopped* instance puts it back into the *pending* state, which moves the instance to a new host machine.

Amazon EC2 pricing models

On-Demand Instances

- Pay by the hour
- No long-term commitments
- Eligible for the AWS Free Tier

Dedicated Hosts

- A physical server with EC2 instance capacity that's fully dedicated to your use

Dedicated Instances

- Instances that run in a VPC on hardware that's dedicated to a single customer

Reserved Instances

- Full, partial, or no upfront payment for the instance that you reserve
- Discount on hourly charge for that instance
- 1-year or 3-year term

Scheduled Reserved Instances

- Purchase a capacity reservation that's available on a recurring schedule you specify
- 1-year term

Spot Instances

- Instances run as long as they are available and your bid is above the Spot Instance price
- They can be interrupted by AWS with a 2-minute notification
- Interruption options include terminated, stopped, or hibernated
- Prices can be significantly less expensive compared to On-Demand Instances
- Good choice when you have flexibility in when your applications can run

Per-second billing is available for On-Demand Instances, Reserved Instances, and Spot Instances that run Amazon Linux or Ubuntu.

aws re/start

Amazon offers different pricing models to choose from when you want to run EC2 instances.

- **Per-second billing** is only available for On-Demand Instances, Reserved Instances, and Spot Instances that run Amazon Linux or Ubuntu.
- **On-Demand Instances** are eligible for the AWS Free Tier. They have the lowest upfront cost and the most flexibility, with no upfront commitments or long-term contracts. They are a good choice for applications with short-term, spiky, or unpredictable workloads.
- **Dedicated Hosts** are physical servers with instance capacity that's dedicated to your use. They enable you to use your existing per-socket, per-core, or per-VM software licenses, such as for Microsoft Windows or Microsoft SQL Server.
- **Dedicated Instances** are instances that run in a VPC on hardware that's dedicated to a single customer. They are physically isolated from instances that belong to other AWS accounts at the level of the host hardware.
- **Reserved Instances** enable you to reserve computing capacity for 1-year or 3-year term, with lower hourly running costs. The discounted usage price is fixed for as long as you own the Reserved Instance. If you expect consistent and heavy use, they can provide substantial savings compared to On-Demand Instances.

- **Scheduled Reserved Instances** enable you to purchase capacity reservations that recur on a daily, weekly, or monthly basis—with a specified duration—for a 1-year term. You pay for the time that the instances are scheduled, even if you don't use them.
- **Spot Instances** enable you to bid on unused EC2 instances, which can lower your costs. The hourly price for a Spot Instance fluctuates depending on supply and demand. Your Spot Instance runs whenever your bid exceeds the current market price.

Amazon EC2 pricing models: Benefits




On-Demand Instances	Spot Instances	Reserved Instances	Dedicated Hosts
• Offers low cost and flexibility	• Use for large-scale, dynamic workloads	• Offers predictability, which ensures that compute capacity is available when needed	• Saves money on licensing costs • Helps meet compliance and regulatory requirements

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Each Amazon EC2 pricing model provides a different set of benefits.

On-Demand Instances offer the most flexibility, with no long-term contract and low rates.

Spot Instances provide large scale at a significantly discounted price.

Reserved Instances are a good choice if you have predictable or steady-state compute needs (for example, an instance that you know you want to keep running most or all of the time for months or years).

Dedicated Hosts are a good choice when you have licensing restrictions for the software you want to run on Amazon EC2, or when you have specific compliance or regulatory requirements that prevent you from using the other deployment options.

Amazon EC2 pricing models: Use cases

Spiky Workloads

Time-Insensitive Workloads

Steady-State Workloads

Highly Sensitive Workloads

On-Demand Instances	Spot Instances	Reserved Instances	Dedicated Hosts
• Short-term, spiky, or unpredictable workloads • Application development or testing	• Applications with flexible start and end times • Applications that are only feasible at very low compute prices • Users with urgent computing needs for large amounts of additional capacity	• Steady state or predictable usage workloads • Applications that require reserved capacity, including disaster recovery (DR) • Users able to make upfront payments to reduce total computing costs even further	• Bring your own license (BYOL) • Compliance and regulatory restrictions • Usage and licensing tracking • Ability to control instance placement

Here is a review of some use cases for the various pricing options.

On-Demand Instance pricing works well for spiky workloads, or if you only need to test or run an application for a short time (for example, during application development or testing). Sometimes, your workloads are unpredictable, and On-Demand Instances are a good choice for these cases.

Spot Instances are a good choice if your applications can tolerate interruption with a 2-minute warning notification. By default, instances are terminated, but you can configure them to stop or hibernate instead. Common use cases include fault-tolerant applications such as web servers, API backends, and big data processing. Workloads that constantly save data to persistent storage (such as Amazon S3) are also good candidates.

Reserved Instances are a good choice when you have long-term workloads with predictable usage patterns, such as servers that you want to run in a consistent way over many months.

Dedicated Hosts are a good choice when you have existing per-socket, per-core, or per-VM software licenses, or when you must address specific corporate compliance and regulatory requirements.

Key takeaways

- **Amazon EC2** enables you to run Microsoft Windows and Linux **virtual machines** in the cloud.
- An **Amazon Machine Image (AMI)** provides the information that's needed to launch an EC2 instance
- An **EC2 instance type** defines a configuration of CPU, memory, storage, and network performance characteristics
- When you launch an Amazon EC2 instance, you must choose an **AMI** and an **instance type**. You must also specify key configuration parameters, including **network**, **security**, **storage**, and **user data** settings.
- Amazon EC2 pricing models include **On-Demand Instances**, **Reserved Instances**, **Savings Plans**, **Spot Instances**, and **Dedicated Hosts**.

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Some key takeaways from this lesson include:

- Amazon EC2 enables you to run Microsoft Windows and Linux virtual machines in the cloud.
- An Amazon Machine Image (AMI) provides the information that's needed to launch an EC2 instance.
- An EC2 instance type defines a configuration of CPU, memory, storage, and network performance characteristics.
- When you launch an EC2 instance, you must choose an AMI and an instance type. You must also specify key configuration parameters, including network, security, storage, and user data settings.
- Amazon EC2 pricing models include On-Demand Instances, Reserved Instances, Savings Plans, Spot Instances, and Dedicated Hosts.