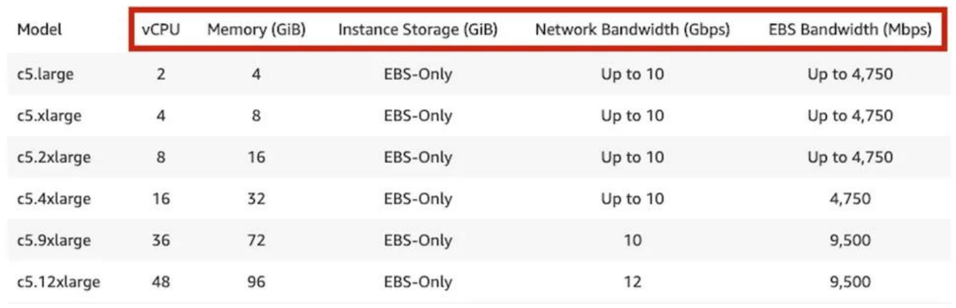
Reading 2.25: Amazon EC2 Instance Lifecycle

Now that you know how to select an operating system for your EC2 instance, it’s time to choose other configurations to create your EC2 instance, such as the instance type, network, and storage. For an application like the employee directory application, you need instances with enough capacity to run web servers and process incoming customer requests. Your instance sizing will depend on both the demands of your application and the anticipated size of your user base. Forecasting server capacity for an on-premises application requires difficult decisions involving significant up-front capital spending, while changes to the allocation of your cloud-based services can be made with a simple API call. Because of AWS’s pay-as-you-go model, you can match your infrastructure capacity to your application’s demand, instead of the other way around.

What Makes Up an EC2 Instance?

EC2 instances are a combination of virtual processors (vCPUs), memory, network, and in some cases, instance storage and graphics processing units (GPUs). When you create an EC2 instance, you need to choose how much you need of each of these components.



Model	vCPU	Memory (GiB)	Instance Storage (GiB)	Network Bandwidth (Gbps)	EBS Bandwidth (Mbps)
c5.large	2	4	EBS-Only	Up to 10	Up to 4,750
c5.xlarge	4	8	EBS-Only	Up to 10	Up to 4,750
c5.2xlarge	8	16	EBS-Only	Up to 10	Up to 4,750
c5.4xlarge	16	32	EBS-Only	Up to 10	4,750
c5.9xlarge	36	72	EBS-Only	10	9,500
c5.12xlarge	48	96	EBS-Only	12	9,500

AWS offers a variety of instances that differ based on performance. Some instances provide you with more capacity and others provide less. To get an overview of the capacity details for a particular instance, you should look at the instance type. Instance types consist of a prefix identifying the type of workloads they’re optimized for, followed by a size. For example, the instance type c5.large can be broken down into the following elements.

- **c5** determines the instance family and generation number. Here, the instance belongs to the fifth generation of instances in an instance family that’s optimized for generic computation.
- **large**, which determines the amount of instance capacity.

What Are Instance Families?

Instance Family	Description	Use Cases
General purpose	Provides a balance of compute, memory, and networking resources, and can be used for a variety of workloads.	Scale-out workloads such as web servers, containerized microservices, caching fleets, distributed data stores, and development environments.
Compute optimized	Ideal for compute-bound applications that benefit from high-performance processors.	High-performance web servers, scientific modeling, batch processing, distributed analytics, high-performance computing (HPC), machine/deep learning, ad serving, highly scalable multiplayer gaming.

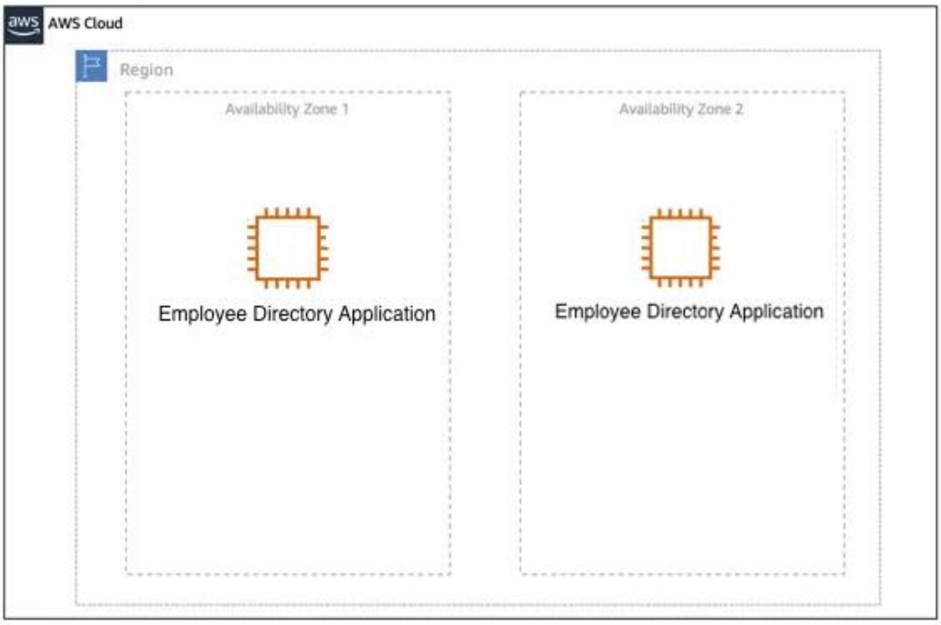
Memory optimized	Designed to deliver fast performance for workloads that process large data sets in memory.	Memory-intensive applications such as high-performance databases, distributed web-scale in-memory caches, mid-size in-memory databases, real-time big-data analytics, and other enterprise applications.
Accelerated computing	Use hardware accelerators or co-processors to perform functions such as floating-point number calculations, graphics processing, or data pattern matching more efficiently than is possible with conventional CPUs.	3D visualizations, graphics-intensive remote workstations, 3D rendering, application streaming, video encoding, and other server-side graphics workloads.
Storage optimized	Designed for workloads that require high, sequential read and write access to large data sets on local storage. They are optimized to deliver tens of thousands of low-latency random I/O operations per second (IOPS) to applications that replicate their data across different instances.	NoSQL databases, such as Cassandra, MongoDB, and Redis, in-memory databases, scale-out transactional databases, data warehousing, Elasticsearch, and analytics.

Where Does Your EC2 Instance Live?

By default, your EC2 instances are placed in a network called the default Amazon Virtual Private Cloud (VPC). This network was created so that you can easily get started with Amazon EC2 without having to learn how to create and configure a VPC. Any resource you put inside the default VPC will be public and accessible by the internet, so you shouldn’t place any customer data or private information inside of it. Once you get more comfortable with networking on AWS, you should change this default setting to choose your own custom VPCs and restrict access with additional routing and connectivity mechanisms.

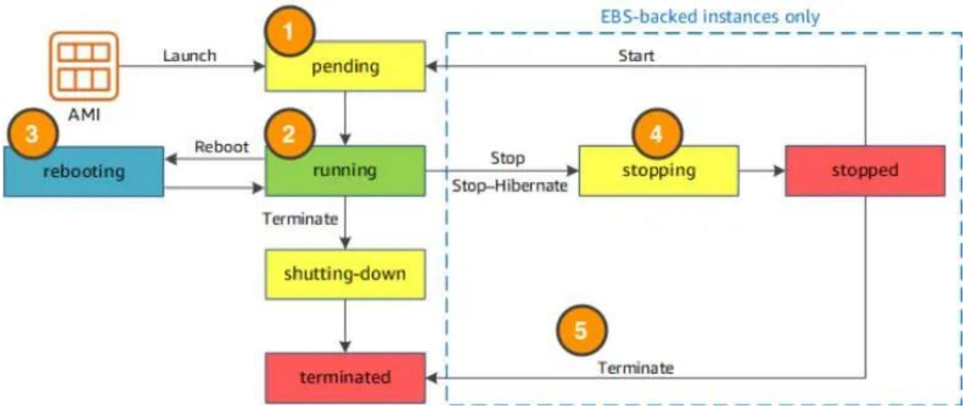
Architect for High Availability

Inside this network, your instance resides in an Availability Zone of your choice. AWS services that are scoped at the Availability Zone level must be architected with high availability in mind. While EC2 instances are typically reliable, two is better than one, and three is better than two. Specifying the instance size gives you an advantage when designing your architecture because you can use more smaller instances instead of a few larger ones. If your frontend only has a single instance and that instance fails, your application goes down. On the other hand, if your workload is distributed across 10 instances and one fails, you lose only 10 percent of your fleet and your application availability is hardly affected. When architecting any application for high availability, consider using at least two EC2 instances in two separate Availability Zones. --


AWS Cloud
Region
Availability Zone 1
Availability Zone 2
Employee Directory Application
Employee Directory Application

Explore the EC2 Instance Lifecycle

An EC2 instance transitions between different states from the moment you create it all the way through to its termination.



When you launch an instance, it enters the pending state (1). When the instance is pending, billing has not started. At this stage, the instance is preparing to enter the running state. Pending is where AWS performs all actions needed to set up an instance, such as copying the AMI content to the root device and allocating the necessary networking components. When your instance is *running* (2), it's ready to use. This is also the stage where billing begins. As soon as an instance is running, you are then able to take other actions on the instance, such as *reboot*, *terminate*, *stop*, and *stop-hibernate*. When you reboot an instance (3), it’s different than performing a stop action and then a start action. Rebooting an instance is equivalent to rebooting an operating system. The instance remains on the same host computer and maintains its public and private IP address, and any data on its instance store. It typically takes a few minutes for the reboot to complete. When you stop and start an instance (4), your instance may be placed on a new underlying physical server. Therefore, you lose any data on the instance store that were on the previous host computer. When you stop an instance, the instance gets a new public IP address but maintains the same private IP address. When you *terminate* an instance (5), the instance store are erased, and you lose both the public IP address and private IP address of the machine. Termination of an instance means you can no longer access the machine.

What Is the Difference Between Stop and Stop-Hibernate?

When you stop your instance, it enters the *stopping* state, and then the *stopped* state. AWS does not charge usage or data transfer fees for your instance after you stop it, but storage for any Amazon EBS volumes is still charged. While your instance is in the stopped state, you can modify some attributes, like the instance type. When you stop your instance, the data stored in memory (RAM) is lost. When you *stop-hibernate* your instance, AWS signals the operating system to perform hibernation (suspend-to-disk), which saves the contents from the instance memory (RAM) to the Amazon EBS root volume. Consider a scenario where you build a standard three tier application, where you have web servers, application servers and database servers. Turns out, the application you built becomes extremely popular. To relieve some stress on the database that supports your application, you want to implement a custom backend layer that caches database information in memory (RAM). You decide to run this custom backend caching solution on Amazon EC2. In this scenario, the stop-hibernate feature would be instrumental in persisting storage. It would prevent you from having to manually create scripts to save this RAM data before shutting down the server.

What Makes Up the Pricing?

To understand EC2 pricing, let's decouple the instance price from other services attached to it, such as storage and networking costs. In this unit we refer to the instance cost as the cost associated with the instance in terms of specifications and not the total blended cost of running an instance. Once an instance is launched in your AWS account, the billing usually accrues on a per-second basis. For simplicity of calculation, prices are stated per-hour. For example, if you have an instance running for 5 minutes and 38 seconds during a given month, you only pay for 338 seconds of utilization at the end of the month. One exception to this pricing convention may be third-party AMIs purchased from the AWS Marketplace, which may have a minimum billing of 1 hour. For more details, check out the resources section of this unit.

What Are the EC2 Pricing Options?

One of the ways to reduce costs with Amazon EC2 is to choose the right pricing option for the way your applications run. There are three main purchasing options for EC2 instances: on-demand, reserved, and spot instances.

Pay As You Go with On-Demand Instances

With *On-Demand* instances, you pay for compute capacity with no long-term commitments. Billing begins whenever the instance is running, and billing stops when the instance is in a stopped or terminated state. The price per second for a running On-Demand instance is fixed. For applications that require servers to be running all the time, you are less likely to benefit from the On-Demand pricing model, simply because there is no situation where you will need to turn servers off. For example, you might want the web server hosting the frontend of your corporate directory application to be running 24/7 so that users can access the website at any time. Even if there are no users connected to your website, you don't want to shut down the servers supporting the site in case of potential user activity. In the case when servers cannot be stopped, consider using a Reserved Instance to save on costs.

Reserve Capacity with Reserved Instances (RIs)

RIs provide you with a significant discount compared to On-Demand instance pricing. RIs provide a discounted hourly rate and an optional capacity reservation for EC2 instances. You can choose between three payment options: *All Upfront*, *Partial Upfront*, or *No Upfront*. You can select either a 1-year or 3-year term for each of these options. Depending on which option you choose, you are discounted differently.

- All Upfront offers a higher discount than Partial Upfront instances.
- Partial Upfront instances offer a higher discount than No Upfront.
- No Upfront offers a higher discount than On-Demand.

On-Demand and *No Upfront* are similar since both do not require any upfront payment. However, there is a major difference. When you choose an On-Demand instance, you stop paying for the instance when you stop or terminate the instance. When you stop an RI, you still pay for it because you committed to a 1-year or 3-year term. Reserved Instances are associated with an instance type and an Availability Zone depending on how you reserve it. The discount applied by a Reserved Instance purchase is not directly associated with a specific instance ID, but with an instance type.

Save on Costs with Spot Instances

Another way of paying for EC2 instances is by using *Spot Instances*. Amazon EC2 Spot Instances allow you to take advantage of unused EC2 capacity in the AWS Cloud. They are available at up to a 90% discount compared to *On-Demand* prices. With Spot Instances, you set a limit on how much you would like to pay for the instance hour. This is compared against the current Spot price that AWS determines. If the amount you pay is more than the current Spot price and there is capacity, then you will receive an instance. While they are very promising from the billing perspective, there are some architectural considerations you will need to consider in order to use them effectively. One consideration is that your spot instance may be interrupted. For example, if AWS determines that capacity is no longer available for a particular spot instance or if the Spot price exceeds how much you are willing to pay, AWS will give you a 2-minute warning before it interrupts your instance. That means any application or workload that runs on a Spot instance must be able to be interrupted. Because of this unique consideration, inherently fault-tolerant workloads are typically good candidates to use with Spot instances. These include big data, containerized workloads, continuous integration/continuous delivery (CI/CD), web servers, high-performance computing (HPC), image and media rendering, or other test and development workloads.