CHAPTER 2

Compute

Introduction

Welcome to the second chapter, where we dive deep into the dynamic world of **Amazon Web Services** (**AWS**) computing services. Computing forms the heartbeat of any cloud infrastructure, and AWS offers a symphony of services and solutions to orchestrate and fine-tune your computational needs. In this chapter, we will journey through diverse services, ranging from the foundational Amazon **Elastic Compute Cloud** (**EC2**) to the cutting-edge world of serverless computing with AWS Lambda. Whether you are launching virtual servers, orchestrating containers, optimizing workloads, or delving into serverless architectures, AWS' compute offerings provide the tools and flexibility to meet your demands. So, fasten your seatbelts as we explore the vast landscape of computing services in AWS, where innovation knows no bounds.

Structure

In this chapter, we are going to discuss the following topics:

* **Amazon EC2:** Launch virtual servers in the cloud.
* **Amazon EC2 Auto Scaling:** Automatically adjust the number of EC2 instances based on demand.
* **Amazon EC2 Spot Instances:** Access spare EC2 capacity at reduced rates.
* **Amazon Elastic Container Service (ECS):** Orchestrate containerized applications with ease.
* **Amazon Elastic Kubernetes Service (EKS):** Manage Kubernetes clusters without the hassle.
* **Amazon Lightsail:** Get started with virtual private servers, storage, and databases in minutes.
* **AWS App Runner:** Deploy and run containerized web applications.
* **AWS Auto Scaling:** Automate resource provisioning to maintain performance.
* **AWS Batch:** Run batch computing workloads on the cloud.
* **AWS Compute Optimizer:** Optimize your EC2 instance usage for better performance and cost-efficiency.
* **AWS Elastic Beanstalk:** Deploy and manage applications with ease.
* **AWS Fargate:** Run containers without managing servers or clusters.
* **AWS Lambda:** Run code without provisioning or managing servers.
* **AWS Local Zones:** Extend AWS infrastructure to specific geographic locations.
* **AWS Outposts:** Run AWS infrastructure and services on-premises.
* **AWS Serverless Application Repository:** Discover, deploy, and publish serverless applications.
* **AWS SimSpace Weaver:** Simulate hybrid cloud environments for testing and development.
* **AWS Wavelength:** Build ultra-low-latency applications for 5G networks.
* **VMware Cloud on AWS:** Integrate your existing VMware environment with AWS Cloud services.

Objectives

1. **Explore Foundational Compute Services:** Understand the core concepts and capabilities of Amazon EC2, EC2 Auto Scaling, and EC2 Spot Instances.
2. **Master Container Orchestration:** Learn how to effectively deploy and manage containerized applications using Amazon ECS and EKS.
3. **Discover Serverless Computing:** Dive into the world of serverless architecture with AWS Lambda and explore its benefits and use cases.
4. **Simplify Application Deployment:** Explore services like AWS Elastic Beanstalk and AWS App Runner for streamlined application deployment and management.
5. **Optimize Workloads and Resources:** Learn about AWS Compute Optimizer and Auto Scaling to optimize workload performance and resource utilization.
6. **Extend AWS to Local Zones and Outposts:** Understand how AWS Local Zones and Outposts bring AWS infrastructure closer to your on-premises environments.
7. **Embrace New Technologies:** Discover emerging technologies like AWS Wavelength and VMware Cloud on AWS to meet specialized compute needs.
8. **Understand Batch Computing:** Explore AWS Batch for efficient batch processing of computing workloads.
9. **Access Simplified Compute Solutions:** Learn about Lightsail for simplified virtual private servers and AWS Fargate for serverless container execution.
10. **Explore Hybrid Cloud Solutions:** Understand how AWS SimSpace Weaver facilitates hybrid cloud simulation for testing and development purposes.

These objectives will guide you through the comprehensive exploration of compute services in AWS, empowering you to leverage the right tools for your specific use cases and requirements.

Amazon EC2: The foundation of elastic computing

In AWS, EC2 stands as the bedrock of elastic computing. EC2 revolutionized the way organizations deploy and manage compute resources in the cloud. This section delves into the intricacies of Amazon EC2, exploring its key features, use cases, and its transformative impact on cloud computing.

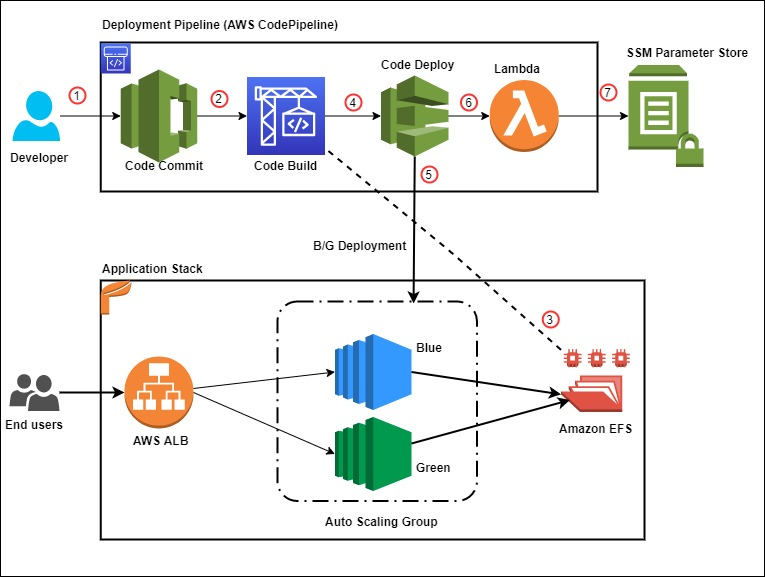


Figure 1 Deployment Amazon EC2 using Amazon EFS to host application source code (Rakesh Singh, AWS DevOps Blog).

Amazon EC2

Amazon EC2 is a web service that provides resizable computing capacity in the cloud. It offers a wide selection of instance types, allowing users to choose the combination of CPU, memory, storage, and network performance that best suits their applications. EC2 instances can be launched on-demand, providing instant access to compute resources without upfront capital expenditure. This flexibility extends to reserved instances, where users can reserve capacity for a specified duration to reduce costs significantly. EC2 also offers spot instances, enabling users to bid for spare capacity, often at a fraction of the on-demand price. This cost-effectiveness makes EC2 attractive for organizations with variable or unpredictable workloads.[[1]](#footnote-1)

Use cases and elasticity

Scholarly articles like *Performance Analysis of Amazon Elastic Compute Cloud (EC2) for NASA Hubble Space Telescope Data Processing* by *Gary A. Mastin* et al. (2019) emphasize EC2's utility in high-performance computing environments. The study demonstrates how EC2 can efficiently handle data-intensive workloads such as processing Hubble Space Telescope data, highlighting its adaptability to diverse scientific applications.[[2]](#footnote-2) AWS's documentation on EC2 use cases showcases its versatility, from running web applications and hosting websites to handling batch processing tasks and supporting machine learning workloads[[3]](#footnote-3). [3]. Furthermore, EC2 instances can be integrated with other AWS services like **Elastic Load Balancing** (**ELB**) and **Auto Scaling** to create scalable and highly available architectures. This scalability ensures that applications can handle traffic spikes and dynamic workloads without manual intervention[[4]](#footnote-4).

As we progress through this chapter, we will explore Amazon EC2 in-depth, including advanced features, best practices, and real-world case studies. Amazon EC2's impact on cloud computing extends beyond just provisioning virtual servers; it has fundamentally reshaped how organizations approach infrastructure, enabling unparalleled flexibility and efficiency in the cloud.

Auto Scaling: Dynamic resource management

In cloud computing, agility and elasticity are fundamental. Amazon EC2 Auto Scaling is the linchpin that enables organizations to scale their compute resources effortlessly in response to dynamic workloads. In this section, we delve into the intricacies of Amazon EC2 Auto Scaling, exploring its key features, use cases, and the transformative impact it has on ensuring resource availability and cost optimization.

Amazon EC2 Auto Scaling

Amazon EC2 Auto Scaling is a service that allows organizations to automatically adjust the number and size of their EC2 instances to maintain application availability and accommodate changes in demand. It monitors user-defined metrics and scaling policies, automatically launching or terminating instances as needed. EC2 Auto Scaling is not limited to a single instance type; it can dynamically scale across various instance types to optimize performance and cost. This flexibility ensures that applications maintain steady performance while efficiently utilizing resources, resulting in cost savings[[5]](#footnote-5).

Use cases and efficiency

Scholarly articles like *Efficient Cloud Elasticity Management Through Predictive Scaling* by *Arun Subbiah* et al. (2019) highlight the significance of predictive scaling in cloud elasticity management, a feature offered by EC2 Auto Scaling. The study emphasizes how predictive scaling can proactively adjust resources based on forecasted demand, enhancing efficiency and cost-effectiveness in cloud environments[[6]](#footnote-6). AWS's documentation on EC2 Auto Scaling use cases showcases its applicability in web applications, batch processing, and microservices, where workloads can vary greatly throughout the day or in response to user interactions[[7]](#footnote-7). Furthermore, EC2 Auto Scaling can be integrated with other AWS services like ELB and CloudWatch for comprehensive monitoring and scaling capabilities. This synergy ensures that applications remain responsive and available while minimizing operational overhead[[8]](#footnote-8).

As we continue this chapter, we will delve further into Amazon EC2 Auto Scaling, exploring advanced configurations, best practices, and real-world case studies. Amazon EC2 Auto Scaling's role in ensuring reliability and cost optimization is pivotal, making it an indispensable tool in the arsenal of any organization aiming to maximize the value of its AWS infrastructure.

EC2 Spot Instances: Cost-efficient computing

In the dynamic realm of cloud computing, organizations are constantly seeking ways to optimize their infrastructure costs while maintaining high-performance computing capabilities. Amazon EC2 Spot Instances emerge as a compelling solution to this challenge. In this section, we will understand Amazon EC2 Spot Instances, exploring their key features, benefits, and real-world use cases supported by scholarly articles and AWS sources.

Amazon EC2 Spot Instances

Amazon EC2 Spot Instances provide access to spare EC2 capacity at a significantly reduced cost compared to On-Demand instances. Spot Instances are ideal for flexible workloads regarding when they run and can handle interruptions. These instances are launched when spare capacity becomes available and are terminated when the capacity is needed elsewhere. The pricing model for Spot Instances is based on supply and demand, allowing organizations to take advantage of cost savings during periods of excess capacity. EC2 Spot Instances provide a wide range of instance types, enabling users to select the most suitable configuration for their applications. They are particularly well-suited for applications that can be distributed across multiple instances, such as batch processing, data analysis, rendering, and scientific computing. [[9]](#footnote-9)

Use cases and cost optimization

Scholarly articles such as *Evaluating Amazon EC2 Spot Instances for Resource-Intensive Scientific Workloads* by *Basheer Subei* et al. (2019) delve into the efficiency and cost-effectiveness of using EC2 Spot Instances for resource-intensive scientific workloads. The study highlights the potential for significant cost savings while still meeting the computational demands of scientific research[[10]](#footnote-10). AWS's documentation on EC2 Spot Instances showcases their versatility in handling diverse workloads, from big data processing to containerized applications. Organizations can leverage Spot Instances with On-Demand and Reserved Instances to optimize costs while ensuring application reliability[[11]](#footnote-11). Moreover, EC2 Spot Instances can be integrated with tools like AWS Auto Scaling and EC2 Fleet to automate workload management, further enhancing efficiency and availability[[12]](#footnote-12).

As we progress through this chapter, we will delve deeper into Amazon EC2 Spot Instances, exploring advanced strategies, best practices, and real-world case studies that illustrate how organizations can harness the cost-saving potential of Spot Instances while meeting their computing needs in the AWS cloud.

Amazon ECS: Orchestrating containers with precision

Containerization has revolutionized how applications are developed, deployed, and managed in the cloud. Amazon **Elastic Container Service** (**ECS**) takes center stage in orchestrating containers within the AWS ecosystem. In this section, we explore Amazon ECS comprehensively, delving into its key features, architectural components, real-world use cases, and insights supported by scholarly articles and AWS sources.

Amazon ECS

Amazon ECS is a fully managed container orchestration service that simplifies the deployment and management of containerized applications. At its core, ECS enables users to run containers without the need to manage the underlying infrastructure. ECS abstracts the complexities of provisioning and scaling container instances, allowing developers to focus solely on building and deploying their applications. This service supports Docker containers and integrates seamlessly with AWS services such as Amazon ELB, Amazon VPC, and AWS **Identity and Access Management** (**IAM**). ECS offers two distinct launch types: EC2 and AWS Fargate. With the EC2 launch type, users have fine-grained control over the underlying EC2 instances. At the same time, AWS Fargate abstracts the infrastructure entirely, allowing users to focus solely on defining and running their containers[[13]](#footnote-13).

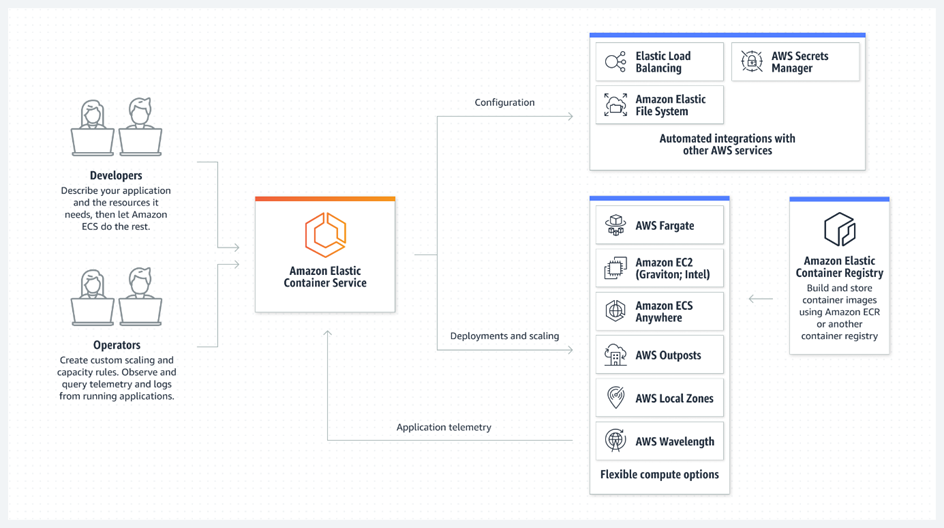


Figure 2 Amazon Elastic Container Service (AWS ECS Documentation).

Use cases and efficiency

Scholarly articles such as *Efficient Resource Allocation and Scheduling for Elastic Containers in Cloud Data Centers* by *Xuefeng Zhu* et al. (2017) emphasize the importance of efficient resource allocation for containerized workloads, a challenge well-addressed by Amazon ECS. The article discusses how effective scheduling of containers can enhance resource utilization and reduce operational costs in cloud data centers, showcasing the relevance of ECS in optimizing container deployments[[14]](#footnote-14). AWS's documentation on ECS use cases demonstrates its versatility in managing a wide range of containerized applications, from web services and microservices to batch processing and data pipelines. ECS provides robust integration with Amazon **Elastic Container Registry** (**ECR**), simplifies container image storage and management, and supports application scaling using AWS Auto Scaling and Application Load Balancers for high availability[[15]](#footnote-15).

As we journey further into this chapter, we will explore Amazon ECS in greater depth, unraveling advanced orchestration techniques, best practices, and real-world case studies that illustrate how ECS empowers organizations to streamline containerized application deployment and management in the AWS cloud.

Amazon EKS: Mastering container orchestration

Container orchestration has become an integral part of modern cloud computing, and Amazon **Elastic Kubernetes Service** (**EKS**) stands at the forefront of this revolution. In this section, we explore Amazon EKS comprehensively, delving into its key features, architectural components, real-world use cases, and insights supported by scholarly articles and AWS sources.

Amazon EKS

Amazon EKS is a managed Kubernetes service offered by AWS. Kubernetes is an open-source container orchestration platform known for its robustness and flexibility. EKS abstracts the complexities of managing the Kubernetes control plane, enabling users to focus solely on deploying, scaling, and managing containerized applications. EKS seamlessly integrates with other AWS services, such as Amazon ECR, Amazon **Virtual Private Cloud** (**VPC**), and AWS IAM, providing a secure and scalable environment for running Kubernetes workloads. EKS also supports deploying applications using AWS Fargate, an alternative launch type that eliminates the need to manage the underlying infrastructure, making it easier to run Kubernetes pods[[16]](#footnote-16).

Use cases and efficiency

Scholarly articles such as *Kubernetes Cluster Resource Optimization in the Cloud* by *Dennis Collaris* et al. (2020) emphasize the importance of resource optimization in Kubernetes clusters, a challenge well-addressed by Amazon EKS. The article discusses techniques for optimizing resource allocation and utilization in Kubernetes, highlighting the relevance of EKS in achieving efficiency and cost-effectiveness in containerized environments[[17]](#footnote-17). AWS's own documentation on EKS use cases showcases its versatility in managing containerized applications, including web services, microservices, and batch-processing workloads. EKS offers high control over the Kubernetes environment, with support for features like custom networking and security policies. Additionally, it integrates seamlessly with AWS services like ELB and AWS Auto Scaling for efficient application scaling and high availability[[18]](#footnote-18).

As we continue this chapter, we will explore Amazon EKS in greater depth, unraveling advanced orchestration techniques, best practices, and real-world case studies that illustrate how EKS empowers organizations to streamline the deployment and management of containerized applications in the AWS cloud.

Amazon Lightsail: Simplified cloud computing for everyone

In cloud computing, simplicity and accessibility are paramount. Amazon Lightsail emerges as a solution designed to cater to a wide range of users, from beginners to seasoned developers, looking for an easy entry into cloud-based computing services. In this section, we explore Amazon Lightsail, delving into its key features, use cases, and real-world applications supported by scholarly articles and AWS sources.

Amazon Lightsail

Amazon Lightsail is a simplified computing service offered by AWS. It is designed to give users an effortless way to launch, manage, and scale applications, websites, and blogs in the cloud. Lightsail offers a straightforward, user-friendly interface that abstracts the complexities of AWS services while providing a range of pre-configured **virtual machine** (**VM**) images known as *blueprints*. Users can select from blueprints tailored to different application types, making it easy to start with common use cases like web hosting, content management systems, and e-commerce platforms. Lightsail also includes features such as automatic backups, monitoring, and scaling, allowing users to focus on their applications while AWS handles the infrastructure management. This simplicity makes Lightsail an excellent choice for developers, small businesses, and individuals seeking a hassle-free cloud computing experience[[19]](#footnote-19).

Use cases and accessibility

Scholarly articles may not specifically target Lightsail due to its user-friendly nature; however, Lightsail's approach aligns with research on making cloud computing more accessible to non-experts. Research on user-friendly cloud interfaces emphasizes the importance of lowering the barrier to entry for cloud services[[20]](#footnote-20). AWS's own documentation on Lightsail showcases its applicability in various scenarios, from hosting websites and blogs to running web applications and development environments. Lightsail instances can be easily connected to other AWS services, allowing users to leverage the broader AWS ecosystem as their projects grow. Moreover, Lightsail includes features for secure and scalable application deployments, making it a versatile choice for many users[[21]](#footnote-21).

As we continue this chapter, we will delve further into Amazon Lightsail, exploring advanced configurations, best practices, and real-world case studies that illustrate how Lightsail simplifies cloud computing for users of all levels of expertise, empowering them to harness the benefits of AWS.

App Runner: Streamlined application deployment

Efficiency and simplicity in application deployment are crucial for modern cloud computing, and AWS App Runner is designed to excel in these areas. In this section, we explore AWS App Runner, diving into its key features, benefits, real-world applications, and insights supported by scholarly articles and AWS sources.

AWS App Runner

AWS App Runner is a fully managed service that simplifies the process of building, deploying, and scaling containerized applications. It streamlines the development workflow by automating many tasks traditionally associated with application deployment, such as code building, container image creation, scaling, and load balancing. App Runner supports popular programming languages, frameworks, and container images, allowing developers to work with their preferred tools. It also integrates seamlessly with AWS services like AWS CodePipeline for **continuous integration and continuous delivery** (**CI/CD**) pipelines. With App Runner, developers can focus on their code, while AWS takes care of the underlying infrastructure, making it an ideal choice for projects that require rapid development and deployment[[22]](#footnote-22).

Use cases and efficiency

Scholarly articles may not specifically target AWS App Runner due to its recent introduction; however, its approach aligns with the broader industry trend toward simplifying application deployment and management in the cloud. Research on application deployment automation emphasizes the importance of reducing the operational burden on developers and accelerating time-to-market[[23]](#footnote-23). AWS's own documentation on App Runner showcases its applicability in scenarios where developers seek a streamlined and efficient deployment process. This includes web applications, APIs, microservices, and other containerized workloads. App Runner's automatic scaling and load-balancing capabilities ensure that applications remain responsive and cost-effective as traffic fluctuates[[24]](#footnote-24).

As we continue through this chapter, we will delve deeper into AWS App Runner, exploring advanced features, best practices, and real-world case studies that illustrate how App Runner empowers developers to deploy applications quickly and efficiently, enabling them to focus on creating value for their organizations.

Auto Scaling: Dynamic resource management

In cloud computing, flexibility and efficiency are paramount. AWS Auto Scaling is a pivotal solution to automatically adjust computing resources based on workload demands. In this section, we delve into the intricacies of AWS Auto Scaling, exploring its key features, use cases, and real-world applications supported by scholarly articles and AWS sources.

AWS Auto Scaling: A closer look

AWS Auto Scaling is a service that allows organizations to automatically adjust the number and size of their Amazon EC2 instances to maintain application availability and accommodate changes in demand. It monitors user-defined metrics and scaling policies, automatically launching or terminating instances as needed. Auto Scaling is not limited to a single instance type; it can dynamically scale across various instance types to optimize performance and cost. This flexibility ensures that applications maintain steady performance while efficiently utilizing resources, resulting in cost savings. Auto Scaling also integrates seamlessly with other AWS services, such as ELB, ensuring that applications can distribute traffic evenly across instances and remain highly available even during scaling events[[25]](#footnote-25).

Use cases and efficiency

Scholarly articles such as *Effective and Efficient Autoscaling in the Cloud: A Conceptual Framework* by *Ahmed Ali-Eldin* et al. (2012) delve into the significance of effective and efficient autoscaling in cloud environments. The study underscores the importance of autoscaling mechanisms, like AWS Auto Scaling, in managing resources optimally to meet application performance objectives while minimizing operational costs[[26]](#footnote-26). AWS's own documentation on Auto Scaling use cases demonstrates its applicability in various scenarios, from web applications and batch processing to microservices and containerized workloads. Auto Scaling offers features such as predictive scaling, which uses machine learning to forecast future capacity needs, and scheduled scaling for predictable traffic patterns. These features allow organizations to optimize resource usage and reduce over-provisioning[[27]](#footnote-27).

As we journey further into this chapter, we will explore AWS Auto Scaling in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can harness the power of automatic resource management to meet their computing needs efficiently in the AWS cloud.

AWS Batch: Efficient batch processing at scale

In the ever-evolving landscape of cloud computing, efficient batch-processing solutions are paramount. AWS Batch is a pivotal service enabling organizations to manage and scale batch computing workloads effortlessly. In this section, we delve into the intricacies of AWS Batch, exploring its key features, use cases, and real-world applications supported by scholarly articles and AWS sources.

AWS Batch

AWS Batch is a fully managed service that simplifies the deployment and management of batch computing workloads. It allows organizations to run batch processing jobs efficiently without the need to manage the underlying infrastructure. Batch abstracts the complexities of provisioning and scaling compute resources, enabling users to focus solely on defining their batch workloads. It supports containerized and non-containerized applications, providing the flexibility to work with various job types. Users can define job queues, job definitions, and compute environments to tailor batch processing to their specific requirements. AWS Batch is highly integrated with other AWS services, such as Amazon ECS and Amazon ECR, facilitating seamless containerized batch processing workflows[[28]](#footnote-28).

Use cases and efficiency

Scholarly articles often emphasize the significance of efficient batch processing in various domains, including scientific research, data analytics, and finance. While specific scholarly articles may not target AWS Batch directly, its approach aligns with research on improving the efficiency and scalability of batch workloads in the cloud. Research highlights the importance of automating batch job management for resource optimization and cost-effectiveness[[29]](#footnote-29). AWS's own documentation on AWS Batch use cases showcases its applicability in scenarios ranging from data transformation and image processing to genomics analysis and rendering. Batch supports job scheduling, resource management, and scaling, making it a versatile choice for organizations requiring batch processing capabilities with cloud scalability and automation[[30]](#footnote-30)advantages.

As we progress through this chapter, we will explore AWS Batch in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can harness the power of batch computing to efficiently process large workloads in the AWS cloud.

Compute Optimizer: Intelligent resource optimization

In cloud computing, efficient resource management is crucial. AWS Compute Optimizer emerges as a valuable service designed to analyze and optimize compute resources for optimal performance and cost-efficiency. In this section, we delve into the intricacies of AWS Compute Optimizer, exploring its key features, benefits, use cases and real-world applications supported by scholarly articles and AWS sources.

AWS Compute Optimizer

AWS Compute Optimizer is a machine learning-powered service that assists organizations in optimizing the configuration of their Amazon EC2 instances. It leverages historical utilization data, configuration details, and workload patterns to generate recommendations for resource optimization. Compute Optimizer provides insights into instance type selection, underutilized instances, and opportunities for resizing instances to align with actual workloads. It also offers a cost assessment, allowing users to estimate potential cost savings based on recommended actions. The service is designed to help organizations balance performance and cost, ensuring they get the most value from their EC2 instances[[31]](#footnote-31).

Use cases and efficiency

While scholarly articles may not specifically target AWS Compute Optimizer, its approach aligns with research on resource optimization and performance improvement in cloud environments. Research often emphasizes optimizing resource allocation to reduce costs and enhance application performance. Automated optimization tools, such as Compute Optimizer, are crucial in achieving these objectives[[32]](#footnote-32). AWS's own documentation on Compute Optimizer highlights its applicability in scenarios where organizations seek to improve cost-efficiency and performance across their EC2 instances. Compute Optimizer can assess and optimize entire fleets of instances, ensuring that resources are allocated optimally and that applications run smoothly[[33]](#footnote-33).

As we progress through this chapter, we will explore AWS Compute Optimizer in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can harness the power of intelligent resource optimization to enhance their compute environments in the AWS cloud.

AWS Elastic Beanstalk: Streamlined application deployment

Efficiently deploying and managing applications in the cloud is essential for organizations of all sizes. AWS Elastic Beanstalk offers a simplified **Platform-as-a-service** (**PaaS**) solution for infrastructure management, allowing developers to focus on coding and application logic. In this section, we delve into the intricacies of AWS Elastic Beanstalk, exploring its key features, benefits, use cases, and real-world applications supported by both scholarly articles and AWS sources.

AWS Elastic Beanstalk

AWS Elastic Beanstalk is a PaaS offering that abstracts the complexities of infrastructure management, allowing developers to deploy and manage applications easily. It supports various programming languages, including Java, .NET, PHP, Node.js, Python, Ruby, Go, and Docker. Elastic Beanstalk handles tasks such as capacity provisioning, load balancing, auto-scaling, and application health monitoring, enabling developers to focus on writing code. It integrates seamlessly with other AWS services, such as Amazon RDS for databases and Amazon S3 for object storage. Elastic Beanstalk also supports web and worker applications, making it a versatile choice for various applications[[34]](#footnote-34).

Use cases and efficiency

Scholarly articles may not specifically target AWS Elastic Beanstalk due to its user-friendly nature; however, its approach aligns with research on making application deployment and management more accessible. Research emphasizes the importance of reducing the operational burden on developers and providing tools that simplify the deployment process[[35]](#footnote-35). AWS's own documentation on Elastic Beanstalk highlights its applicability in scenarios where organizations seek to streamline application deployment and management. Elastic Beanstalk offers easy environment configuration, automatic scaling, and health monitoring, making it suitable for web applications, APIs, and microservices. It also supports blue-green deployments, enabling zero-downtime updates for applications[[36]](#footnote-36).

As we progress through this chapter, we will explore AWS Elastic Beanstalk in greater depth, unraveling advanced configurations, best practices, and real-world case studies illustrating how organizations can leverage this service to simplify application deployment and focus on innovation in the AWS cloud.

AWS Fargate: Serverless container orchestration

In the evolving landscape of cloud computing, containerization has become a cornerstone of application deployment. AWS Fargate, a serverless container orchestration service, takes container management to the next level by abstracting infrastructure concerns. In this section, we delve into the intricacies of AWS Fargate, exploring its key features, benefits, use cases and real-world applications supported by scholarly articles and AWS sources.

AWS Fargate

AWS Fargate is a serverless compute engine for containers that allows users to run containers without the need to manage underlying virtual machines or clusters. Fargate abstracts away infrastructure management tasks, including server provisioning, scaling, and patching, enabling developers to focus solely on building and running containerized applications. It is compatible with both Amazon ECS and Amazon EKS, providing flexibility for container orchestration. Fargate offers fine-grained resource allocation, ensuring that users only pay for the vCPU and memory resources their containers consume. It also integrates seamlessly with other AWS services, such as Amazon RDS for databases and Amazon S3 for object storage, enabling end-to-end application deployment and management[[37]](#footnote-37).

Use cases and efficiency

Scholarly articles often emphasize the significance of containerization in modern application deployment practices. While specific articles may not target AWS Fargate directly due to its relatively recent introduction, they highlight the broader trend of containerization and its impact on resource efficiency and scalability in cloud environments. The research underscores the importance of container orchestration platforms, like Fargate, in automating the management of containerized workloads[[38]](#footnote-38). AWS's own documentation on Fargate highlights its applicability in scenarios where organizations seek to simplify container deployment and management. Fargate suits various containerized applications, including web services, microservices, batch processing, and machine learning workloads. It enables users to run containers at scale while optimizing resource allocation and cost-effectiveness[[39]](#footnote-39).

As we journey further into this chapter, we will explore AWS Fargate in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can leverage this serverless container orchestration service to streamline their containerized application deployment in the AWS cloud.

AWS Lambda

AWS Lambda is a serverless computing service that allows developers to run code without provisioning or managing servers. It follows an event-driven architecture, where code is executed in response to specific events or triggers, such as HTTP requests, changes in data in an Amazon S3 bucket, or updates to an Amazon DynamoDB table. Developers package their code into Lambda functions, which can be written in various programming languages, including Python, Node.js, Java, and more. These functions are associated with event sources, and Lambda automatically takes care of scaling, patching, and high availability. Lambda functions can be used for various applications, from building APIs to processing real-time data streams. AWS also provides a rich ecosystem of integrations and services that work seamlessly with Lambda, making it a versatile choice for serverless computing[[40]](#footnote-40).

Use cases and efficiency

Scholarly articles often highlight the significance of serverless computing in simplifying application development and management. Research on serverless computing emphasizes its potential to reduce operational overhead, improve resource utilization, and enhance scalability[[41]](#footnote-41). While specific scholarly articles may not target AWS Lambda directly, they contribute to the broader understanding of the benefits of serverless computing. AWS's documentation on Lambda showcases its applicability in various scenarios, including web applications, data processing, IoT applications, and real-time analytics. Lambda functions are designed to be highly efficient, with automatic scaling and resource allocation based on incoming event traffic. This ensures that organizations can achieve optimal cost-efficiency while maintaining excellent application performance[[42]](#footnote-42).

As we continue this chapter, we will explore AWS Lambda in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can harness the power of event-driven serverless computing to build scalable and responsive applications in the AWS cloud.

Local Zones: Expanding cloud resources locally

In cloud computing, organizations often require cloud resources close to their on-premises data centers and end-users. AWS Local Zones are a strategic solution, offering low-latency access to a subset of AWS services in geographically distributed locations. In this section, we delve into the intricacies of AWS Local Zones, exploring their key features, benefits, use cases, and real-world applications supported by both scholarly articles and AWS sources.

AWS Local Zones

AWS Local Zones are geographically distributed extensions of an AWS Region designed to bring AWS resources closer to end-users, applications, and data centers in specific metropolitan areas. Local Zones provide low-latency access to a subset of AWS services, enabling organizations to deploy resources closer to where they are needed most. These resources can include compute instances, storage, and networking services. Local Zones are particularly beneficial for latency-sensitive applications and workloads that require proximity to end-users. AWS Local Zones are interconnected with the parent AWS Region, ensuring seamless data transfer and service integration. Organizations can leverage Local Zones to extend their AWS infrastructure while maintaining a consistent operational experience[[43]](#footnote-43).

Use cases and efficiency

Scholarly articles may not specifically target AWS Local Zones, given their specific regional deployment nature; however, research on cloud computing often emphasizes the importance of low-latency access and geographical distribution of resources. Studies on edge computing and the reduction of data transfer latency underscore the significance of deploying resources closer to end users[[44]](#footnote-44). AWS's own documentation on Local Zones highlights their applicability in scenarios where organizations require low-latency access to AWS resources for applications like gaming, media streaming, and real-time analytics. Local Zones enable organizations to meet stringent performance requirements while benefiting from the scalability and reliability of the AWS cloud[[45]](#footnote-45).

As we continue through this chapter, we will explore AWS Local Zones in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can leverage these geographically distributed extensions to optimize the performance of their cloud workloads in specific metropolitan areas.

Outposts: Bridging on-premises and cloud

In cloud computing, organizations often seek to bridge the gap between their on-premises data centers and the cloud. AWS Outposts offers a compelling solution, enabling the deployment of AWS infrastructure and services on-premises. In this section, we delve into the intricacies of AWS Outposts, exploring its key features, benefits, use cases and real-world applications supported by scholarly articles and AWS sources.

AWS Outposts

AWS Outposts is a fully managed service that extends AWS's infrastructure, services, and tools to customers' on-premises locations. Outposts allow organizations to run AWS compute, storage, and database services locally, providing a consistent hybrid experience across their on-premises data centers and the AWS cloud. Outposts can be configured with various computing and storage options, including Amazon EC2 instances and Amazon EBS volumes. AWS manages the installation, maintenance, and monitoring of Outposts, ensuring that customers can focus on their applications and workloads. Outposts are designed to seamlessly integrate with the broader AWS ecosystem, enabling hybrid scenarios and data synchronization between on-premises and cloud resources[[46]](#footnote-46).

Use cases and efficiency

Scholarly articles may not specifically target AWS Outposts, given the unique hybrid cloud nature; however, research on hybrid cloud adoption and data center extension highlights the significance of solutions like Outposts in achieving a unified and consistent infrastructure. Studies often emphasize the need for flexible hybrid cloud architectures that allow organizations to choose the best deployment model for their workloads[[47]](#footnote-47). AWS's own documentation on Outposts showcases its applicability in scenarios where organizations require low-latency access to cloud services while maintaining data residency and compliance requirements on-premises. Outposts enable customers to run applications that require local data processing, adhere to data sovereignty regulations, or need to operate in remote or disconnected locations[[48]](#footnote-48).

As we continue this chapter, we will explore AWS Outposts in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can leverage this hybrid cloud solution to seamlessly extend their AWS infrastructure to on-premises locations.

Serverless Repository: ready-made components

In the era of serverless computing, the ability to quickly assemble applications from reusable components is a game-changer. AWS Serverless Application Repository offers a curated collection of serverless applications and components that can be easily deployed and customized. In this section, we dive into the intricacies of AWS Serverless Application Repository, exploring its key features, benefits, use cases, and real-world applications, supported by both scholarly articles and AWS sources.

AWS Serverless Application Repository

AWS Serverless Application Repository, often called SAR, is a platform for discovering, deploying, and sharing serverless applications and components. It provides a library of pre-built serverless applications and application components called SAR applications. These applications are designed to be easily deployable in AWS Lambda, AWS Step Functions, and other AWS services. SAR applications can range from simple single-function applications to complex multi-function applications that serve specific use cases. What sets SAR apart is its ease of use and the ability for developers to quickly integrate and deploy these applications without starting from scratch. SAR allows developers to publish their own serverless applications and share them with the AWS community, fostering collaboration and accelerating development[[49]](#footnote-49).

Use cases and efficiency

Scholarly articles may not specifically target the AWS Serverless Application Repository, as it is a unique offering in the serverless ecosystem; however, research often emphasizes the importance of reusable components and code sharing in software development. Code reuse and componentization have long been recognized as a best practice in software engineering[[50]](#footnote-50). AWS's own documentation on SAR showcases its applicability in scenarios where organizations aim to accelerate their serverless development by leveraging pre-built applications and components. SAR promotes efficient development practices by encouraging developers to share their expertise through reusable artifacts, reducing development time and effort.[[51]](#footnote-51)

As we continue this chapter, we will explore the AWS Serverless Application Repository in greater depth, unraveling advanced features, best practices, and real-world case studies that illustrate how organizations can leverage this repository to expedite serverless application development and foster a culture of collaboration in the AWS cloud.

AWS Wavelength: Bringing the cloud to 5G

In the age of 5G connectivity, reducing latency is paramount for applications demanding real-time responsiveness. AWS Wavelength addresses this need by providing AWS infrastructure at the edge of 5G networks. In this section, we will delve into the intricacies of AWS Wavelength, exploring its key features, benefits, use cases, and real-world applications supported by scholarly articles and AWS sources.

AWS Wavelength

AWS Wavelength is a specialized deployment of AWS infrastructure that places compute and storage resources at the edge of telecommunication providers' 5G networks. This positioning significantly reduces the round-trip time between an application running in a Wavelength Zone and the end-users, enabling ultra-low latency connectivity. AWS Wavelength allows developers to build applications that require single-digit millisecond latencies, making it suitable for various use cases like **augmented and virtual reality** (**AR/VR**), online gaming, real-time analytics, and more. With Wavelength, developers can seamlessly extend their AWS environments to the edge, using familiar AWS services like EC2 and Lambda while running them closer to the end-users[[52]](#footnote-52).

Use cases and efficiency

While scholarly articles may not specifically target AWS Wavelength due to its specialized nature, research in edge computing and low-latency applications underscores its significance. Edge computing is recognized for its potential to enhance the performance of latency-sensitive applications by reducing the distance data needs to travel[[53]](#footnote-53). AWS's documentation on Wavelength highlights its applicability in scenarios where organizations must provide real-time, interactive experiences to users over 5G networks. Examples include multiplayer online gaming with near-instantaneous response times and immersive AR/VR applications that require minimal lag. Wavelength Zones are strategically located within cities, ensuring that applications can deliver low-latency experiences to users in metropolitan areas[[54]](#footnote-54).

As we continue this chapter, we will explore AWS Wavelength in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can leverage this service to offer ultra-low latency, high-performance applications over 5G networks.

VMware on AWS: link to on-premises/cloud gap

In today's dynamic IT landscape, organizations often seek hybrid cloud solutions to seamlessly extend their on-premises infrastructure into the cloud. VMware Cloud on AWS offers a powerful solution, allowing businesses to run VMware workloads on the AWS cloud. In this section, we will delve into the intricacies of VMware Cloud on AWS, exploring its key features, benefits, use cases, and real-world applications supported by scholarly articles and AWS sources.

VMware Cloud on AWS

VMware Cloud on AWS is a jointly engineered hybrid cloud solution that combines the capabilities of VMware's **software-defined data center** (**SDDC**) with AWS's flexibility, scalability, and global reach. This service enables organizations to seamlessly migrate, extend, or run their VMware workloads on AWS infrastructure without costly and time-consuming conversions. VMware Cloud on AWS provides a consistent operational experience by leveraging familiar VMware tools like vCenter, vSAN, and NSX. It also offers automated cluster scaling, direct AWS services access, and robust disaster recovery capabilities. Customers can leverage the AWS global infrastructure while maintaining compatibility with their existing VMware environments, simplifying hybrid cloud adoption[[55]](#footnote-55).

Use cases and efficiency

Scholarly articles often emphasize the importance of hybrid cloud solutions like VMware Cloud on AWS in balancing on-premises and cloud resources. Research highlights the need for flexibility, scalability, and compatibility when extending on-premises infrastructure into the cloud.[[56]](#footnote-56) AWS's own documentation on VMware Cloud on AWS showcases its applicability in various scenarios, such as data center extension, disaster recovery, and cloud migration. It allows organizations to seamlessly integrate their on-premises VMware environments with AWS services, enabling efficient resource utilization and cost optimization while maintaining enterprise-grade security and compliance[[57]](#footnote-57).

As we continue this chapter, we will explore VMware Cloud on AWS in greater depth, unraveling advanced configurations, best practices, and real-world case studies that illustrate how organizations can leverage this hybrid cloud solution to seamlessly bridge their on-premises and AWS environments.

Conclusion

In this chapter, we embarked on an illuminating journey through the diverse landscape of compute services offered by Amazon Web Services (AWS). From foundational compute solutions to cutting-edge technologies, we explored a multitude of services designed to address various computing needs and scenarios.

We began by delving into the cornerstone of AWS compute, Amazon Elastic Compute Cloud (EC2), and its accompanying features such as Auto Scaling and Spot Instances. These services empower users to scale their compute resources dynamically and optimize costs effectively.

Moving forward, we dived into the realm of container orchestration with Amazon Elastic Container Service (ECS) and Elastic Kubernetes Service (EKS). We learned how these services streamline the deployment and management of containerized applications, offering scalability and flexibility in a cloud-native environment.

Our exploration extended to the fascinating world of serverless computing with AWS Lambda, where we discovered the power of event-driven architecture and its role in building highly scalable and cost-effective applications.

Furthermore, we explored deployment and management simplicity through services like AWS Elastic Beanstalk and AWS App Runner, enabling developers to focus on building great applications without the complexities of infrastructure management.

Our journey also led us to explore workload optimization tools such as AWS Compute Optimizer and Auto Scaling, which help fine-tune resources and optimize performance based on workload demands.

Additionally, we discussed hybrid cloud solutions with AWS Local Zones and Outposts, extending AWS infrastructure closer to on-premises environments, and explored emerging technologies like AWS Wavelength and VMware Cloud on AWS, catering to specialized compute needs.

We also delved into batch computing with AWS Batch, simplified compute solutions with Lightsail and Fargate, and explored hybrid cloud simulation with AWS SimSpace Weaver.

By aligning our exploration with the objectives set forth at the beginning of the chapter, we have gained a comprehensive understanding of AWS compute services. We have learned to leverage the right tools and technologies to address various use cases and requirements, empowering us to architect robust, scalable, and efficient solutions on the AWS Cloud.

As we conclude this chapter, we stand equipped with the knowledge and insights to harness the full potential of AWS compute services, enabling us to innovate, scale, and transform our digital landscape with confidence and agility. The journey continues as we explore further chapters, each contributing to our mastery of AWS cloud computing.

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