Practical Serverless Applications with AWS

Harnessing the Power of Serverless Cloud Applications

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Apoorva Prakash
Shaik Inthiyaz Basha

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To my father, ***Dr. Om Prakash Srivastava,*** *to whom I owe everything and who inspired me but is not here to read this. Yes, life is like that sometimes!*

—Apoorva Prakash

To my parents ***Shaik Alla Basha*** *and* ***Shaik Sabira Begum****. They sacrificed their dreams to fulfill ours. Parents are the architects of our future, laying the foundation of our dreams. My father retired from the APSRTC on June 1, 2024, after a 35-year career.*

—Shaik Inthiyaz Basha

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About the Authors

Apoorva Prakash is a distinguished IT professional and technical writer with a stellar 14-year track record of success across diverse roles. Currently serving as an Engineering Manager at Schneider Electric Pvt Ltd., India, Apoorva leads a dynamic team involved in multifaceted projects encompassing various cutting-edge technologies, notably specializing in AWS-based serverless cloud applications developed in Node.js and Python.

Apoorva's expertise extends to the meticulous architecture and implementation design of numerous portals, including expansive employee portals and ecommerce platforms, APIs showcasing his mastery in Liferay, Kubernetes, and data engineering and processing. As a Liferay-certified professional with over a decade of immersion in the platform, he coauthored the acclaimed book *Hands-On Liferay DXP* (Apress, 2022), solidifying his authority in the field.

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Shaik Inthiyaz Basha currently serves as a Platform Architect and Technical Expert at Schneider Electric Pvt Ltd., India. In this role, he is responsible for leading a team dedicated to developing serverless applications. Inthiyaz is recognized for his expertise in content management systems (CMS), Amazon Web Services (AWS), and other cloud platforms. He is a coauthor of the *Hands-On Liferay DXP* book and has demonstrated his proficiency through successful implementations of various Liferay components. In addition, he holds certifications such as Liferay Backend Developer (DXP).

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- Mr. Ashutosh Naik, Director, Digital Strategy & Governance, Schneider Electric Pvt. Ltd.

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- Our families

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Introduction

Welcome to *Practical Serverless Applications with AWS: Harnessing the Power of Serverless Cloud Applications*.

In today's rapidly evolving technological landscape, cloud computing has become an indispensable part of modern software development. Among the various cloud providers, Amazon Web Services (AWS) stands out as a leader, offering a comprehensive suite of tools and services that empower developers to build scalable, efficient, and cost-effective applications. This book is your gateway to mastering serverless application development using AWS, providing you with the knowledge and hands-on experience needed to excel in this exciting field.

Why Serverless?

Serverless computing represents a paradigm shift in how we approach application development and deployment. By abstracting away the complexities of server management, serverless architectures allow developers to focus solely on writing code that delivers business value. AWS's serverless offerings provide automatic scaling, reduced operational overhead, and a pay-per-use model that can significantly optimize costs.

What You'll Learn

This book is structured to take you on a comprehensive journey through the AWS ecosystem, focusing on serverless technologies and best practices. Here's what you can expect:

1. We'll start by laying a solid foundation with an introduction to AWS, covering its core concepts, architecture, and essential services.
2. You'll then dive into frontend development and integration, learning how to leverage AWS services to create responsive and scalable user interfaces.
3. Our exploration of data engineering will equip you with the tools and knowledge to build robust data pipelines and processing systems.
4. The backend development section will delve deep into serverless computing, showcasing how to create powerful, event-driven applications using AWS Lambda and related services.
5. We'll cover cloud DevOps practices, ensuring you can implement continuous integration and deployment pipelines for your serverless applications.
6. Finally, you'll put theory into practice by building your first end-to-end serverless application, consolidating all the knowledge gained throughout the book.

Whom This Book Is For

This book is designed for developers, architects, and technology enthusiasts who want to harness the power of AWS for serverless application development. Whether you're new to cloud computing or looking to expand your existing AWS skills, you'll find valuable insights and practical examples to guide your learning journey.

By the end of this book, you'll have the confidence and expertise to design, develop, and deploy serverless applications on AWS, opening up new possibilities for your projects and career.

Let's embark on this exciting journey into the world of serverless computing with AWS!

CHAPTER 1

Introduction to AWS

As you begin on your expedition into the world of serverless computing on Amazon Web Services (AWS), it is crucial to have a solid understanding of the fundamental concepts that underpin this powerful platform. In this chapter, you will delve into the fundamentals of cloud computing, explore the AWS architecture and services, and unravel the intricacies of regions, availability zones, and identity management. You will then dive into the world of infrastructure as code (IaC) by examining CloudFormation and the Cloud Development Kit (CDK), which enable us to create, manage, and provision your resources efficiently. To ensure the health and performance of your applications, we will introduce CloudWatch, AWS's comprehensive monitoring and observability service. Finally, you will explore the essential networking concepts within AWS, including Virtual Private Cloud (VPC), Internet Gateways, subnets, and NAT Gateways, which provide the foundation for secure and scalable networking in the cloud. At the conclusion of this chapter, you will have a deep knowledge of the core components and services that form the backbone of serverless computing on AWS, empowering you to build robust and scalable applications that harness the power of the cloud.

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Cloud Computing Refresher

The on-demand availability of computer system resources is called cloud computing. It is the delivery of services including storage, servers (physical and virtual), databases, software, development tools, and networking capabilities over the Internet without direct active management by the user.

Growth of Cloud Computing

The term cloud computing was initially introduced in the 1950s to detail Internet-related services and their growth, as shown in Figure 1-1, from distributed systems to the advanced technology known as *cloud computing*.

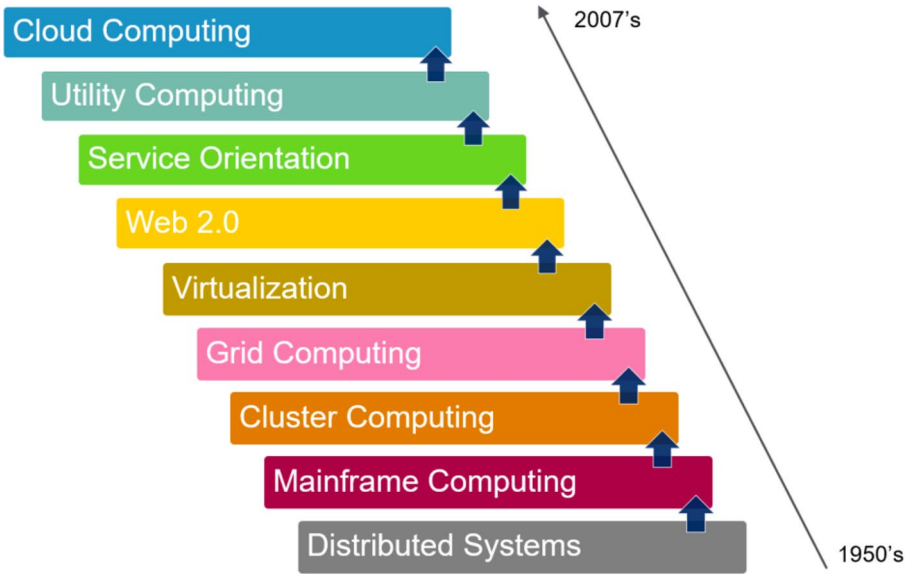

Figure 1-1. *Cloud computing growth*

1. **Distributed Systems:** A distributed system spreads tasks across independent computers but presents a single point of access for users.
2. **Mainframe Computing:** It was introduced in 1951. It refers to incredibly powerful and reliable computers, handling massive amounts of data and complex input/output tasks. But these were awfully expensive.
3. **Cluster Computing:** It emerged as a counterpoint to mainframe computing to reduce the cost up to some extent associated with mainframe computing in the 1980s. In cluster computing, the connection between each machine is by a network with high bandwidth.
4. **Grid Computing:** The groundwork for grid computing was laid in the 1990s. In grid computing, systems were dispersed across various locations, and the connections between these systems are via the Internet.
5. **Virtualization:** Virtualization creates a software layer on top of physical hardware, allowing users to run multiple independent systems (like operating systems) at the same time. It is a key technology powering cloud computing.
6. **Web 2.0:** Web 2.0 is an interface that transforms static web pages into dynamic and interactive experiences. It is the reason you can interact with and contribute to websites, not just passively view them. Web 2.0, which boomed around 2004, revolutionized how you connect and engage online. This shift toward user-generated content and collaboration fostered the rise of social media platforms like Google Maps, Facebook, and Twitter.

7. **Service Orientations:** Service orientation is the architectural foundation for cloud computing. It allows for building applications that are flexible, scalable, and cost-effective. With this approach, two key concepts were introduced: QoS (Quality of Service) and SaaS (Software as a Service).

8. **Cloud Computing:** Cloud computing shifts data and software from local storage to remote servers, accessible through an Internet connection. Cloud computing is a technology where resources are provided as a service through the Internet. The data stored in the cloud can include files, images, documents, and other storable content. This is also sometimes referred to as utility computing.

Types of Cloud Computing

Major types of cloud computing services are listed below:

1. **IaaS (Infrastructure as a Service):** It provides scalable and customizable computing resources as needed such as virtual machines, storage, and networking, allowing organizations to outsource their IT infrastructure.

2. **PaaS (Platform as a Service):** It provides a comprehensive platform for entire application lifecycle, for developing, testing, deploying, and managing applications, providing the necessary infrastructure and tools, allowing developers to concentrate on building applications without any distraction about the underpinning hardware and software.

3. **SaaS (Software as a Service):** It provides access to software applications over the Internet, eliminating the need for organizations to install and maintain the software on their own devices, making it a convenient and scalable solution.

Cloud Computing Model Types

Major types of cloud computing models are listed below:

1. **Public Cloud:** Public cloud services are delivered by independent providers and are available to the public over the Internet, offering a cost-effective and scalable solution for organizations.
2. **Private Cloud:** Private cloud resources are isolated for a specific organization, providing more control, security, and customization options, but typically requiring a higher upfront investment.
3. **Hybrid Cloud:** Hybrid cloud integrates public and private cloud services, enabling organizations to balance the benefits of both models, including scalability, cost-effectiveness, and data security.

Figure 1-2 illustrates various components and services interconnected through cloud computing. It highlights how cloud computing integrates with private clouds, public clouds, hybrid computing, databases, storage, servers, applications, and mobile devices. It emphasizes the versatility and connectivity of cloud-based solutions.

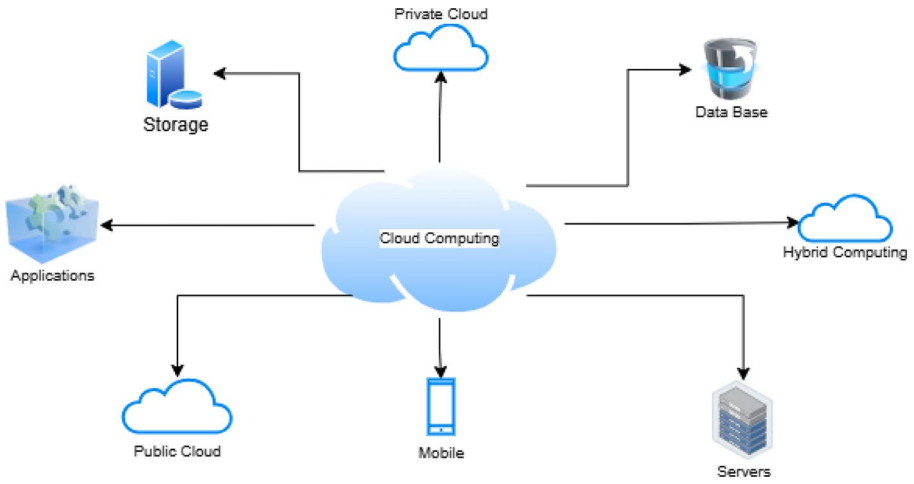

Figure 1-2. *Cloud computing*

Upsides and Downsides of Cloud Computing

In recent years, cloud computing has experienced substantial growth, delivering a multitude of benefits with some potential drawbacks. Let us explore the pros and cons of this technology.

Pros of Cloud Computing

1. **Cost Saving:** Cloud computing discards the necessity for businesses to invest in costly hardware and software, as well as the associated maintenance and IT support costs. Instead, businesses can reach computing resources on demand, paying only for what they utilized.
2. **Data Redundancy:** Cloud providers typically maintain multiple copies of data across distinct locations, ensuring that your information is protected against hardware failures or natural disasters.

3. **Data Replication:** Cloud services automatically replicate and back up your data, reducing the risk of data loss and providing an additional layer of protection.
4. **Malware Protection:** Cloud providers often have powerful security measures in place, including advanced malware protection, to safeguard your data from cyber threats.
5. **Flexibility:** Cloud computing allows you to extend your computing resources up or down as needed, adapting to changing business requirements.
6. **Reliability:** Cloud providers typically have robust infrastructure and redundancy measures in place, confirming high availability and uptime for your applications and data.
7. **High Accessibility:** Cloud-based services can be accessed remotely through an Internet connection, facilitating distributed work and teamwork.
8. **Scalable:** Cloud computing allows you to easily scale your computing resources to meet increasing demands, without the need for costly hardware upgrades.

Cons of Cloud Computing

1. **Internet Dependency:** Cloud computing requires a reliable and stable Internet connection to access your data and applications. Disruptions in Internet service can impact your ability to work.

2. **Limitations of Control:** When using cloud services, you have reduced control over your data and infrastructure compared to in-house solutions. This can be a concern for businesses with specific compliance or regulatory requirements.
3. **Issues in Privacy and Security:** While cloud providers maintain rigorous security protocols, there are still concerns about the potential for certificate thefts or unauthorized access to sensitive information.
4. **Data Breaches:** Cloud services can be vulnerable to data breaches, which can have grave consequences for businesses and their customers.

AWS Architecture and Services

AWS (Amazon Web Services) is a comprehensive, evolving cloud computing platform provided by Amazon. It is like a one-stop shop for businesses and individuals to access a variety of services online. These services fall into three main categories: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). AWS provides compute power, storage, and content delivery tools. It started with internal infrastructure for Amazon's retail operations in 2002. In 2006, AWS introduced its defining IaaS services. AWS pioneered the pay-as-you-go cloud model, offering scalable resources on demand.

AWS offers a variety of tools and products for enterprises and software developers in around 245 countries and territories. AWS services are widely used by government agencies, education institutions, and private organizations across the globe.

Importance of AWS

AWS (Amazon Web Services) boasts over 200 services, making it a one-stop shop for building virtually any application imaginable. This vast range of services caters to individuals, public sector agencies, and private companies alike.

1. **Cost-Effective Cloud Solutions:** AWS offers a broad spectrum of services, all delivered through the cloud, which translates to potentially lower costs compared to traditional IT infrastructure.
2. **Language and Network Agnostic:** No matter your preferred programming language or network setup, AWS integrates seamlessly, making it adaptable to various development environments.
3. **Open Collaboration:** AWS plays well with others! It allows you to connect and integrate with services from competing cloud providers, fostering a flexible and open ecosystem.
4. **Global Reach and Proven Track Record:** As the forerunner in cloud services, AWS benefits from a vast global network of data centers and a well-established customer base, making it a reliable choice for organizations worldwide.

AWS Architecture

AWS architecture refers to the way you design and configure various AWS services to build and run your applications on the AWS cloud platform. There is no single architecture that fits all, but there are some core principles and components to consider:

1. **Architectural Styles:** There are different architectural styles you can employ within AWS, like a simple three-tier web application structure or a more complex microservices architecture.
2. **Scalability:** AWS allows you to easily scale your resources up or down as your needs change. This means you can handle spikes in traffic or data storage without having to worry about infrastructure limitations.
3. **Flexibility:** AWS offers an extensive variety of services that can be used to build and run a variety of applications. This flexibility allows businesses to choose the tools that are ideally suited to their requirements.
4. **Security:** AWS is a secure platform that offers a variety of features to help businesses protect their data. These features include encryption, access controls, and monitoring.
5. **Reliability:** AWS is an exceptionally reliable platform that offers an elevated level of uptime and performance. This means that businesses can be confident that their applications will be available to users when they need them.
6. **Best Practices:** AWS provides a framework called AWS Well-Architected to help you build secure, high-performing, resilient, and cost-effective architectures. It includes best practices for designing and deploying systems on AWS.