Cloud Native Microservices Cookbook

Master the art of microservices in the cloud with over 100 practical recipes

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Dedicated to

My beloved parents:

Krishan Kumar Yadav

and

Manju Yadav

Your nurturing guidance and unwavering support have shaped me into the person I am today. With your love and wisdom, you have empowered me to confidently navigate life's journey and make conscientious decisions. Thank you for providing me with a foundation to stand tall and pursue my dreams.

And to my loving wife:

Neha Yadav

Your enduring companionship and intense faith in my abilities have served as my steadfast source of strength and inspiration. I express my deepest gratitude for being my pillar of support and my greatest source of joy.

About the Author

Varun Yadav, a seasoned Computer Science Engineer with nearly two decades of rich expertise spanning Enterprise Architecture, Solution Architecture, Cloud Computing, Microservices, and DevOps. Combining technical acumen with strategic vision, he holds an MBA in Information Management and Strategy, complemented by a Post Graduate Diploma in AI and Machine Learning. With a career deeply rooted in the BFSI domain, Varun has been a driving force behind innovation, actively participating in Proof of Concepts (POCs), leading Idea Generation initiatives, and igniting creativity in Hackathons. Notably, Varun believes in leading by example, having successfully helmed large-scale teams through intricate projects and endeavors. With an unwavering commitment to staying ahead of the curve in technology, he embodies a blend of expertise and foresight, consistently delivering transformative solutions that redefine industry standards. Whether forging innovative approaches or fostering collaborative environments, he stands as a beacon of excellence, guiding teams toward unparalleled success in the ever-evolving landscape of technology.

About the Reviewers

- **Kumar Gaurav**, with over 12 years of experience in software engineering, is currently serving as an Architect at LTI-Mindtree, where he leads digital transformation initiatives. Specializing in open-source solutions and cloud-native technologies, he ensures the implementation of industry best practices in infrastructure setup, development, deployment, and monitoring for large enterprises. Kumar's expertise encompasses Kubernetes, OpenShift, Docker, Git, Java, Microservices, API Gateway, ESB, WSO2, DevOps MySQL, Linux, tool based development and more.

  Certified in WSO2 & Oracle middleware technologies, Kumar excels in on-premise and cloud-based implementations, with proficiency in Amazon Web Services, Google Cloud, and Oracle Cloud. He has played a pivotal role in end-to-end project implementation and post-implementation support across various domains such as Finance, Railways, Healthcare, Power sector, and Business Intelligence.

  Driven by a passion for innovation and fostering seamless communication between systems, Kumar actively seeks networking and collaboration opportunities within the realm of modern digital architecture.

- **Sumit Baja**j, a seasoned Engineering Leader and Integration Solution Architect with 20 years of rich experience in designing and developing software products to solve complex business problems. A creative problem solver and solution-oriented professional, dedicated to improving business operations and meeting client technical needs. With proven leadership characteristics, he drives enterprise-grade solutions from conception to completion, consistently delivering exceptional project outcomes.

Acknowledgement

I am deeply indebted to my wife, Neha, whose constant backing made it possible for me to dedicate countless hours to the creation of this book. Thank you for your patience, and encouragement, and for being my pillar of strength throughout this journey. Your love and belief in me mean everything.

I extend my sincere gratitude to all my managers who have been more than just colleagues; they have been mentors, guides, and friends. Special thanks to Marul Mehta for his invaluable support and confidence in me during the formative stages of my career, and to Rakesh Mahajan for his encouragement to embark on this writing journey. Your belief in my abilities and encouragement has been instrumental in making this book a reality.

I would also like to express my heartfelt appreciation to BPB Publications for giving me the opportunity to write this book. It has been an honor to collaborate with such a reputable publishing house, and I am grateful for the trust they have placed in me.

Preface

Welcome to the preface of this book, where I am thrilled to share my journey and passion for technology with you. From the very beginning, I have been captivated by the wonders of technology, finding immense joy in seeing my contributions come to life and being used by people. It has been an exhilarating ride dedicating my entire career to crafting and delivering technology solutions, particularly in the BFSI domain.

What drove me to write this book? Well, it is simple. I have always craved the full picture – the complete lifecycle, the entire technology stack. That burning curiosity inspired me to embark on this writing journey. This book is not just a collection of recipes; it is a meticulously planned expedition through the intricate world of designing and architecting microservices from scratch, all the way to harnessing the boundless potential of the cloud.

Think of it as your guide to launching microservices in the cloud – a comprehensive roadmap that covers every aspect, from the nitty-gritty of developing microservices to the intricacies of hosting and administrating them in the cloud. Through real-world insights and practical examples, I aim to demystify the complexities of proficient system architectures, equipping you with the tools and know-how to navigate this exciting terrain with confidence.

Chapter breakdown:

Chapter 1: Microservices and Cloud - Discover the foundational concepts of microservice architecture and cloud elasticity. Delve into the importance of Java frameworks and learn to configure cloud services and setup cloud infra for optimal performance.

Chapter 2: Developing Microservices and Test Cases - Establish a solid foundation for microservice development, starting with environment setup and the API-first approach. Explore practical examples and running code snippets to kickstart your journey.

Chapter 3: Externalize Application Configurations - Learn to externalize application configurations for enhanced flexibility and seamless deployment across different environments. Dive into Spring Cloud Config Server and Spring Actuator for efficient configuration management.

Chapter 4: Implementing Dynamic Services - Explore the need for service discovery and various approaches to achieve seamless communication between dynamically changing microservices.

Chapter 5: Containerization Using Docker - Unlock the agility and efficiency of containerization with Docker. Master the process of wrapping applications in lightweight images and deploying them to AWS ECR.

Chapter 6: Pipeline Automation for CI/CD - Streamline your development process with automated CI/CD pipelines. Discover best practices for code quality checks, test case execution, and security assessments.

Chapter 7: Microservices Orchestration - Centralize control and management of containerized applications with microservices orchestration. Learn to set up orchestrators, fetch from registries, and scale your applications seamlessly.

Chapter 8: Auto Scalability, High Availability, and Disaster Recovery - Ensure high availability and scalability of your applications in the AWS cloud. Explore strategies for disaster recovery and handle scale-out and scale-in events effectively.

Chapter 9: Cloud Security - Prioritize security considerations for your microservices in the cloud. Discover techniques to safeguard your applications using available cloud security offerings.

Chapter 10: Observability - Gain insights into the internal state of your applications with observability. Learn to set up logs, metrics, and tracing for better understanding and critical observations about the application behavior.

Chapter 11: Infrastructure Automation with IaC - Simplify infrastructure setup with Infrastructure as Code (IaC). Explore automation techniques for creating and managing infrastructure across different environments.

So, buckle up, dear reader, as we embark on this thrilling adventure together. Let us dive deep into the world of microservices and cloud technologies, and uncover the secrets to building robust, scalable solutions that stand the test of time.

Happy reading and hands-on exploring!

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Chapter 1
Microservices and Cloud

Introduction

This is an era in which all greenfield application developments are done using microservice architecture, and going cloud is the strategic direction every organization is moving towards.

In this chapter, we will learn the importance of microservice architecture and how cloud elasticity is the go-to technology for leveraging the maximum benefits out of a microservice and the importance of Java frameworks in building enterprise grade microservices.

Structure

In this chapter, we will discuss following topics:

- Importance of microservices
- Importance of cloud
- Using the Java programming language
- Java frameworks for microservices
- Configuring cloud services

Objectives

By the end of this chapter, we will learn the benefits of developing an application using microservice architecture compared to a monolithic architecture, as well as the features provided by cloud infrastructure and how they overcome the challenges that are present in the on-premise deployments. We will also learn the importance of Java as a programming language for developing enterprise grade software applications, the Java frameworks available in the market for developing microservices and why Spring Boot is the most preferred option amongst them. In the end, we will learn how to configure different AWS services that will be required to begin the development of the microservices discussed in detail in later chapters of this book.

Importance of microservices

Microservices have evolved to overcome the issues and challenges faced by the monolithic applications, be it in any phase of the software development lifecycle, development, testing, build, deployment, or maintenance. Although microservices require some extra efforts, they provide many advantages in the larger extent.

The word **micro** means granular, that is, breaking the complete large requirement into small parts and then developing, building, and deploying them as services independent of each other, eventually orchestrating them in tandem to fulfill the complete business requirement. Here, granularity is a subjective term and how granular a service should be, is dependent on case-to-case basis and on the actual business functionality. In most of the cases, the functionality that is subject to change together in the future, should be part of the same microservice.

Figure 1.1 illustrates the difference between a monolithic application and microservices:

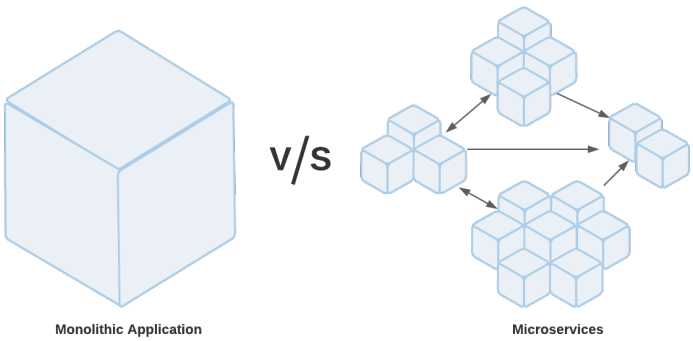

***Figure 1.1**: Monolithic versus Microservices*

The benefits of developing an application using a microservice architecture compared with the overwork that needs to be done in different phases of **software delivery life cycle (SDLC)**, are explained as follows.

Development

The benefits and overwork in the development phase are as follows.

Benefits:

- Every microservice can be developed independently of each other.
- Different teams can work together to develop different microservices.
- If required, the microservices can be developed using different technology stacks.

Overwork:

- Multiple code repositories are to be created and maintained, one for each microservice.

Testing

The benefits and overwork in the testing phase are as follows:

Benefits:

- Every microservice can be independently tested by the testing team.
- Test cases can be easily created, since the scope of a microservice is limited compared to the complete functionality.

Overwork:

- Separate integration tests are to be created to test the overall business functionality.
- Multiple test environments might have to be created, if required.

Deployment

The benefits and overwork in the deployment phase are as follows:

Benefits:

- Build pipelines are simple and can be created independently for each microservice.
- Can leverage container and cloud infrastructure.
- **Independent Infrastructure as Code** (**IaC**) scripts can be created, which are simple and can reuse common templates.

Overwork:

- Microservices need to be carefully version controlled to resolve the interdependence on each other.

- Complex orchestration is required to build coordination between multiple microservices.

Management

The benefits and overwork in the management phase are as follows:

Benefits:

- Individual microservices can be upgraded or modified without impacting other services.
- Easier to debug and troubleshoot.
- Application health can be monitored at a microservice level.

Overwork:

- As more than one instance of each microservice can be live at a time, there is a need for complex observability patterns to get the complete insight of the whole application.

Additional advantages of application development using microservice architecture are:

- The design is highly scalable, and more microservices can be easily added later if required.
- Faster time-to-market as microservices are be independently developed, tested, and deployed and the activities can be done in parallel.
- A microservice can be shared with different business modules, which makes it reusable.
- An individual microservice can be scaled in case of heavy load, without impacting others, which has a straight cost and performance benefit.

Thus, the benefits of a microservice architecture are huge compared to the overwork that is required to be done.

It is crucial to acknowledge that adopting a microservices architecture introduces new complexities. Communication between microservices becomes paramount, necessitating the implementation of robust and efficient mechanisms such as REST, gRPC APIs or message queues. Monitoring and managing the entire ecosystem of microservices demand more sophisticated tools and strategies such as service mesh In conclusion, the microservices architecture is a powerful paradigm that addresses the limitations of monolithic applications. It promotes flexibility, scalability, and agility in software development. While it does present additional challenges, the benefits it provides, especially in handling large and complex systems, make it a preferred choice for modern application development.

Importance of cloud

Going cloud is the new norm; every agile company is either migrating their applications to cloud or building new applications in a cloud native way. Adopting cloud allows the enterprises to focus on their core competencies or businesses without bothering about any of the following:

- Hardware infrastructure
- Software licenses
- Security
- Patching
- Backups
- Disaster recovery, and so on.

Everything is taken care of by the cloud provider.

Apart from offloading the preceding tedious and tardy activities from the shoulders of an enterprise, cloud infrastructure provides them with the flexibility to choose from various options of compute and services, depending on their business needs and workloads. In return, enterprises also save costs, as they are only paying for services as per their usage, and there is no need to incur huge costs during off business hours or at the time of lean workloads.

There are multiple cloud providers in the market. Following are the ones that have majority of the market share:

- Amazon Web Services
- Microsoft Azure
- Google Cloud
- Oracle Cloud

Figure 1.2 features some of the cloud provider options:

***Figure 1.2**: Cloud providers*