

DBA Essentials for 21c

Installing Oracle Database 21c on OCI Compute

Divit Gupta



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First published: 2024

Published by BPB Online

WeWork

119 Marylebone Road

London NW1 5PU

UK | UAE | INDIA | SINGAPORE

ISBN 978-93-55516-299

www.bpbonline.com

Dedicated to

*To my mother, **Shashi Gupta**, and in the memory of my father,
Pritipal Gupta; for their sacrifices and for exemplifying
the power of determination.*

*To my wife **Khushbu** and sons **Yash** and **Darsh** who
made me understand true love.*

Foreword

It is with great enthusiasm that I can say, that it is a privilege for me to provide a preface for this remarkable book on artificial intelligence, skillfully crafted by my esteemed colleague, Divit. Our collaborative endeavors during our tenure at Oracle, coupled with my involvement in his insightful podcast series, have enabled me the opportunity to witness firsthand the depth of Divit's expertise, the expansiveness of his vision, and the unwavering passion he dedicates to the realms of Oracle Database and Cloud Technology.

Divit possesses a distinctive ability to seamlessly integrate profound knowledge of the AI landscape with a keen understanding of optimizing narratives for search—an unequivocal manifestation of his commitment to delivering excellence in this dynamic field. This book stands as a testament to his unyielding pursuit of knowledge, characterized by an insatiable thirst for data and a dedication to experimentation, all of which significantly contribute to advancing the discourse on Oracle Database and Cloud Technology.

Throughout our shared experiences, I have witnessed Divit's exceptional leadership qualities. Beyond his impressive technical acumen, he embodies the attributes of a visionary leader in the domain of Oracle Database and Cloud Technology. Divit's capacity to assimilate diverse ideas, coupled with his decisiveness in making bold and strategic choices, sets him apart. In the intricate landscape of Cloud Technology, he stands as a results-oriented architect, leading by example and demonstrating unparalleled dedication to overcoming challenges.

As you delve into the pages of this book, guided by Divit's expertise, I encourage you to absorb the wealth of knowledge and insights he imparts. It is a journey led by a seasoned professional who not only comprehends the intricate nuances of Cloud Technology but is also committed to sharing that understanding for the benefit of all. May this book illuminate and inspire enthusiasts, researchers, and professionals alike in the realm of Oracle Database and Cloud Technology.

Eleanor Meritt
Vice President
Oracle America

About the Author

Divit Gupta is working as Principal Architect at Oracle Corp USA and aspires to transform the landscape of Cloud Computing, AI, and Data Science by guiding a fresh cohort of professionals. As a Sr. Member of IEEE, his objective is to equip over a million individuals worldwide with advanced expertise in analytics, machine learning, and AI within the next five years, thus raising the global benchmark for tech proficiency. In alignment with the insights of influential thinkers, Divit contends that true accomplishment extends beyond personal success, emphasizing the importance of uplifting others and actively contributing to their pursuit of excellence. His overarching mission is to shape a future in the tech realm that is both skilled and inclusive.

As an accomplished IT professional with a career spanning over two decades, he is widely recognized as a prominent speaker and thought leader in the realm of emerging technologies. Hosting popular podcasts like “Tech Talk with Divit,” “Live Labs with Divit,” and “Cloud Bites with Divit,” he provides a platform to showcase technological initiatives and leadership. With roles including Oracle TV’s correspondent for Cloud World and a recognized expert, Divit presented on Oracle Database technology at Oracle Cloud World FY 2023.

Beyond his podcast endeavors, Divit is deeply passionate about knowledge-sharing, evident in his participation in international conference talks, technical blogs, Whitepapers, and the authorship of multiple books on emerging technologies. His expertise has gained visibility in leading newspapers and technology magazines worldwide. As a highly skilled technologist, Divit holds professional certifications from Microsoft, Oracle, AWS, Databricks, and has earned a post-graduate certificate from Harvard Business School Online.

About the Reviewer

Isha Khamesra, is a seasoned IT Professional with 14 years of industry expertise, who excels in Technical and Functional initiatives and providing global solutions. With a global impact, she drives implementation, defines team, and improves business processes.

A dynamic and highly motivated team leader, she possesses exceptional analytical and problem-solving skills. With effective communication and interpersonal finesse, she thrives in managing multiple assignments and inspiring teams. Known for her quick learning and adaptability to new technologies, she is a productive thinker and action-oriented individual. Beyond her professional prowess, she excels in user training, combining her leadership with a commitment to personal growth. Holding over 18 certifications with Oracle, Automation Anywhere, she remains at the forefront of technology. She also has a master's degree in Business Analytics.

Acknowledgement

From the depths of my heart, I express profound gratitude to my cherished family and friends. Their unwavering support and encouragement fueled me through the long journey of writing this book.

My deepest appreciation goes to BPB Publications for their invaluable guidance and expertise in transforming this manuscript into a tangible reality. This book's journey to fruition wouldn't have been possible without the remarkable contributions of reviewers, technical experts, and editors. Their dedicated efforts and insightful feedback significantly shaped and strengthened this work.

I also extend my heartfelt thanks to my esteemed colleagues and co-workers in the tech industry. Their invaluable teachings and insightful feedback over the years have empowered me to write this book.

Finally, my deepest gratitude goes to all the readers who have taken an interest in this work and supported its realization. Your encouragement has served as a potent fuel, driving me forward at every step.

Preface

In the fast-evolving landscape of cloud computing, artificial intelligence, and data science, the quest for knowledge is relentless. This book, crafted by Divit Gupta, an esteemed Sr. Member of IEEE and a seasoned IT professional, stands as a beacon for those eager to master the intricacies of Oracle 21c on OCI Compute. With over two decades of expertise, Divit not only imparts technical wisdom but also transforms complex concepts into accessible narratives. From installation essentials to advanced configurations, this guide promises a comprehensive journey through Oracle's latest database technology. Whether you're a seasoned professional or a curious learner, embark on this adventure and unlock the full potential of Oracle 21c with a trusted guide.

The book adopts a hands-on approach, providing step-by-step tutorials and practical examples to guide readers through the installation process. Visual aids, real-world scenarios, and user-friendly instructions ensure an engaging and effective learning experience, suitable for both beginners and experienced professionals.

Chapter 1: Introduction to Oracle Database 21c – This chapter serves as a gateway to the world of Oracle Database 21c installation. Readers are introduced to the fundamental concepts of Oracle Database, gaining insights into the significance of cloud computing with a focus on OCI Compute basics. The chapter sets the stage by outlining key considerations for a successful installation and establishes the foundation for the subsequent exploration of Oracle Database Setup Wizard and Configuration Assistant.

Chapter 2: Introduction to Oracle Cloud Infrastructure – This chapter delves into the essentials of Oracle Cloud Infrastructure (OCI) Compute, providing readers with a solid understanding of OCI Compute services. Topics include the creation and configuration of compute instances, as well as networking essentials crucial for deploying Oracle Database on OCI. By grasping these fundamental concepts, readers gain the necessary groundwork for the practical deployment covered in subsequent chapters.

Chapter 3: OCI Essentials and Key Features – In this chapter, readers are guided through the intricacies of the Oracle Database Setup Wizard, also known as the Database Installer. The chapter explores the tool's interface, providing a step-by-step walkthrough of the pre-installation considerations and system requirements. By the end, readers will have a solid grasp of navigating and utilizing the Setup Wizard for a seamless and efficient Oracle Database 21c installation.

Chapter 4: OCI Compute Basics – This chapter demystifies the role and functionality of Oracle Database Configuration Assistant (DBCA). Readers explore the guided configuration and customization options offered by DBCA, gaining insights into best practices for leveraging this essential tool. By the end of the chapter, readers will be equipped to efficiently configure and customize Oracle databases using DBCA, ensuring optimal performance and adherence to industry standards.

Chapter 5: Oracle Database Setup Wizard – This chapter is a practical guide through the installation process of Oracle Database 21c. Readers will navigate the pre-installation checks, understand system prerequisites, and follow a step-by-step approach to install the database. Post-installation tasks and validation procedures are also covered, ensuring readers gain the expertise to deploy and verify Oracle Database 21c installations successfully.

Chapter 6: Oracle Database Configuration Assistant – This chapter delves into the nuanced process of creating and configuring Oracle Database. Readers will explore various database creation options and types, understand configuration parameters, and delve into advanced settings for performance and security. By the end of the chapter, readers will be adept at tailoring Oracle Database 21c to meet specific requirements, ensuring a robust and optimized database configuration.

Chapter 7: Oracle Database 21c Installation: Part 1 – This chapter sets the stage for a comprehensive exploration of the installation process for Oracle Database 21c. This chapter dives into the essential preparatory steps, guiding readers through the necessary checks and prerequisites to ensure a smooth installation experience. From validating hardware requirements to confirming software availability, each step is meticulously explained. The focus then shifts to the installation of Database 21c in the Desktop Class, offering a step-by-step walkthrough that includes insightful screenshots. This chapter serves as a foundational pillar for readers, providing the knowledge needed to embark on their journey of installing Oracle Database 21c with confidence.

Chapter 8: Oracle Database 21c Installation: Part 2 – This chapter delves deeper into the installation process, focusing on specific aspects relevant to the Server Class environment. The chapter meticulously outlines the prerequisites essential for a successful installation, ensuring that readers have a clear understanding of the requirements for a robust Oracle Database 21c setup. With a keen eye on the Server Class installation, the chapter guides readers through each step, providing detailed insights and practical guidance. By the end of this chapter, readers will have gained a comprehensive understanding of the prerequisites

and procedures necessary for a seamless Oracle Database 21c installation in a Server Class environment.”

Chapter 9: Create Container Database – The chapter is a pivotal exploration of Oracle Database creation modes, focusing on a comprehensive recap of Oracle Database Configuration Assistant (DBCA) and its various modes. Readers will navigate through the nuanced process of creating a Container Database, beginning with the Typical Mode for a quick setup and moving on to the Advanced Mode for more tailored configurations. This chapter ensures a thorough understanding of both modes, equipping readers with the knowledge to efficiently create and configure Container Databases in Oracle Database 21c.

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CHAPTER 1

Introduction to Oracle Database 21c

Introduction

In the ever-evolving landscape of information management, organizations continually seek powerful and reliable solutions to store and process their critical data. **Oracle Database 21c** stands as a pinnacle in the realm of relational database management systems, offering cutting-edge features and capabilities. As we delve into the intricacies of installing Oracle Database 21c, it becomes paramount to comprehend the essence and significance of this latest iteration.

Oracle Database 21c builds upon a rich legacy of database technology, introducing advancements that cater to the dynamic needs of modern enterprises. Whether it is about efficiently managing vast amounts of data or ensuring high availability in a cloud environment, Oracle Database 21c emerges as a robust solution.

Oracle Database 21c is used by organizations of all sizes and industries to power their mission-critical applications. It is a trusted and reliable database platform that can help businesses to improve their efficiency, productivity, and profitability.

Structure

This chapter will cover the following topics:

- Overview of Oracle Database 21c
- New with Oracle Database 21c

Objectives

This chapter will provide you with a comprehensive overview of Oracle Database 21c. We will discuss the key concepts that you need to understand, such as Oracle Database architecture, database basics, database components, key features and what is new with Oracle database 21c.

By the end of this chapter, you will be able to understand the overview of Oracle Database 21c and key features of Oracle database 21c.

Overview of Oracle Database 21c

Oracle Database 21c is the innovation release of Oracle's converged database. It offers a wide range of new features and enhancements that can help customers to improve the performance, scalability, security, and manageability of their database workloads.

Some of the key features of Oracle Database 21c include:

- **Performance enhancements:** Oracle Database 21c includes several performance enhancements, such as improved query optimization, faster parallel processing, and more efficient memory management. These enhancements can help customers to improve the performance of their database workloads by up to 20%.
- **Scalability enhancements:** Oracle Database 21c can now scale to support even the most demanding workloads. It can support up to 100 trillion rows in a single table and up to 1000 petabytes of data in a single database.
- **Security enhancements:** Oracle Database 21c includes a number of security enhancements, such as data encryption at rest and in transit, user authentication and authorization, and audit logging. These enhancements can help customers to protect their data from unauthorized access, use, or disclosure.
- **Manageability enhancements:** Oracle Database 21c includes a number of manageability enhancements, such as simplified database administration, improved monitoring and diagnostics, and automated self-tuning. These enhancements can help customers to reduce the cost and complexity of managing their database environments.

In addition to these key features, Oracle Database 21c also includes a number of other enhancements, such as support for new data types, new machine learning capabilities, and new cloud-native features.

Oracle Database 21c is a powerful and versatile database that can help customers to meet the most demanding data management requirements. It is an ideal choice for businesses of all sizes, from small businesses to large enterprises.

Here are some specific examples of how Oracle Database 21c can be used to improve business outcomes:

- A retail company can use Oracle Database 21c to improve the performance of its e-commerce platform, which can lead to increased sales and customer satisfaction.
- A financial services company can use Oracle Database 21c to improve the risk management capabilities of its trading systems, which can help to reduce losses and improve profitability.
- A healthcare organization can use Oracle Database 21c to improve the quality of patient care by providing doctors and nurses with access to real-time patient data.
- A manufacturing company can use Oracle Database 21c to improve the efficiency of its production processes by optimizing inventory management and supply chain planning.

Overall, Oracle Database 21c is a powerful and versatile database that can help businesses of all sizes to improve their performance, scalability, security, and manageability.

Before we proceed further let us discuss the key components of Database system and architecture, we will discuss the basic terms used in the database world, it will be a refresher for Database professionals.

Oracle Database architecture

Within the Oracle Database server framework, a fundamental structure is comprised of a database and, at the minimum, one database instance—an entity often colloquially known as an instance. Let us have a comprehensive Oracle 21c Database architecture in *Figure 1.1* below:

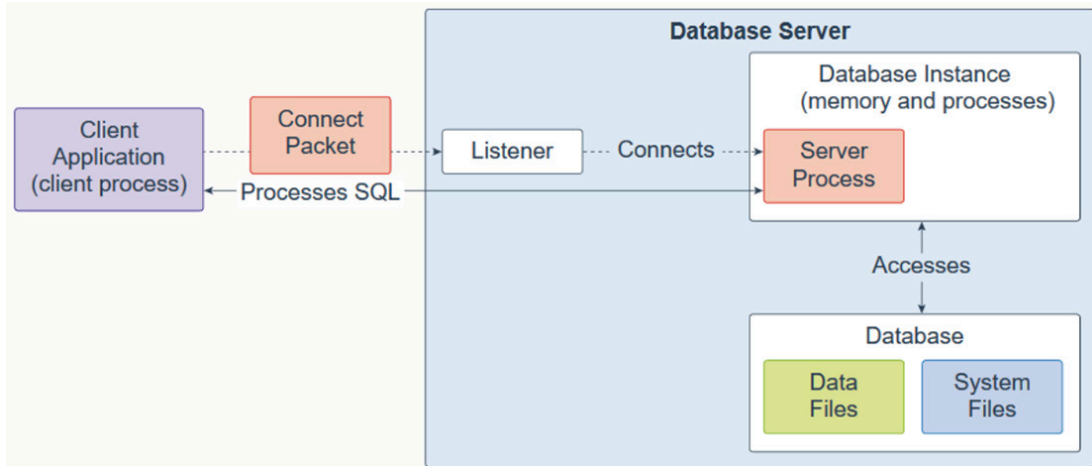


Figure 1.1: Architecture diagram of Oracle Database 21c depicting the interaction between the client application and the database system.

(Source: <https://docs.oracle.com/en/database/>)

Given the intimate connection between an instance and a database, the term **Oracle database** occasionally encapsulates both the instance and the database. To delineate with precision, in the most stringent interpretation, the terms hold distinct meanings:

Database server

An Oracle Database comprises, at minimum, a database instance, and a database. The database instance manages memory and processes. Within the multitenant container database, physical files known as data files constitute a fundamental component. Throughout its operation, an Oracle Database relies on various database system files.

In the context of a single-instance database architecture, a singular database instance and a corresponding database form the foundational structure. This architecture establishes a direct one-to-one relationship between the database and its associated instance. Notably, it allows for the installation of multiple single-instance databases on a single server machine. Each database operates within its distinct database instance. This configuration proves particularly advantageous when there is a need to concurrently run diverse versions of Oracle Database on the same machine.

The architecture of an **Oracle Real Application Clusters (Oracle RAC)** database comprises multiple instances operating on distinct server machines, all concurrently accessing the same database. This collective cluster of server machines presents itself as a unified entity on one side, while on the other, end users and applications interact with what appears to be a singular server. This intricate setup is meticulously designed to deliver high availability, scalability, and optimal performance.

The listener, a pivotal component in this framework, serves as a database server process. Its primary functions involve receiving client requests, establishing a connection with the database instance, and subsequently transitioning the client connection to the server process. The listener has the flexibility to operate either locally on the database server or remotely, with the prevailing trend in typical Oracle RAC environments being remote deployment. This strategic configuration ensures an agile and responsive system that caters to the dynamic demands of high-performance and scalable database operations.

Database

A database, in essence, is a compilation of files residing on disk, serving as the repository for user data. These data files, with their own autonomous existence, can be separate entities irrespective of a database instance. In the evolving landscape of Oracle Database 21c, the term **database** is now specifically attributed to the data files associated with a multitenant **container database (CDB)**, **pluggable database (PDB)**, or an application container. This refined definition underscores the nuanced structure and versatility of databases in the latest Oracle iteration.

Multitenant architecture

The adoption of a multitenant architecture empowers an Oracle database to function as a container database.

In the Oracle database paradigm, there is a requisite interrelationship where each database must either encompass or have the capability to be encompassed by another. For instance, a CDB accommodates **pluggable databases (PDBs)**, and an application container houses application PDBs. The relationship unfolds with a PDB being housed within a CDB or application container, and an application container being nested within a CDB.

With the inception of Oracle Database 21c, the exclusive and supported architecture is the multitenant container database. In contrast, in previous releases, Oracle endorsed **non-container databases (Non-CDBs)**. This shift underscores a strategic move towards a more consolidated and versatile multitenant structure in the latest Oracle Database iterations.

CDBs

Within a container database, multiple user-created pluggable databases and application containers find their accommodation.

On a tangible level, a CDB is delineated by a collection of files comprising the control file, online redo log files, and data files. The orchestration of these files is under the purview of the database instance, which effectively manages the constituent elements forming the CDB.

The accompanying illustration offers a visual representation of a CDB along with its associated database instance.

Pluggable databases

A Pluggable Database represents a transportable assembly encompassing schemas, schema objects, and nonschema elements, presenting itself to an application as an independent database entity.

On the physical plane, each PDB is endowed with a distinct set of data files, serving as repositories for the PDB's specific data. The **container database (CDB)** comprehensively integrates all data files associated with the encapsulated PDBs, along with a dedicated set of system data files designed to store metadata specific to the CDB itself.

For the purpose of relocation or archival actions involving a PDB, a process known as **unplugging** comes into play. When unplugged, a PDB comprises its data files and an accompanying metadata file. It is noteworthy that an unplugged PDB remains non-operational until it undergoes the "plugging in" process, effectively reconnecting it to a CDB. This distinctive maneuverability and encapsulation provide a versatile means of managing and relocating pluggable databases within the Oracle Database environment.

Application containers

An application container serves as an elective, user-initiated compartment housed within a container database, designed to store both data and metadata pertinent to one or more applications.

In the framework of an application container, an **application**, alternatively known as the master application definition, manifests as a distinct, versioned collection of shared data and metadata residing in the application root. This encompasses comprehensive definitions such as tables, views, user accounts, and PL/SQL packages, all of which are universally applicable across a set of PDBs.

Conceptually, the application container operates akin to an application-specific container database within a CDB. Much like the overarching CDB, an application container is equipped to encompass multiple Application PDBs, fostering seamless sharing of both metadata and data among these PDBs. On the tangible plane, an application container maintains its own set of data files, mirroring the structural elements present in a PDB.

Consider a **Software as a Service (SaaS)** scenario, where an array of Application PDBs can be utilized, each dedicated to a distinct customer. These PDBs collaboratively share application metadata and data. As exemplified in the presented scenario, the **sales_app** is the overarching application model residing in the application root. The individual Application PDBs, such as **cust1_pdb** and **cust2_pdb**, specifically cater to sales data for Customer 1 and Customer 2, respectively. This intricate architecture facilitates various PDB-level operations, including plugging, unplugging, cloning, and more, all accessible at the

granular level of individual customer-specific PDBs. In essence, the application container offers a sophisticated and adaptable infrastructure for managing diverse applications within the overarching Oracle Database environment.

An application container is a discretionary, user-generated component within a container database responsible for storing data and metadata for one or more application back ends. A CDB may encompass zero or more application containers. Within an application container, an **application** refers to a named and versioned collection of common data and metadata residing in the application root. In this context, the term application denotes a master application definition, encompassing elements like table definitions, views, and packages.

To illustrate, one could establish multiple sales related pluggable databases within a single application container, sharing an application that includes common tables and their definitions. Similarly, distinct HR-related PDBs could be stored in a separate application container, each with its own set of common tables and definitions.

The creation of the application root, and consequently, the application container itself, is implicitly carried out by the **CREATE PLUGGABLE DATABASE** statement with the **AS APPLICATION CONTAINER** clause. Initially devoid of PDBs, the application container requires connection to the application root for the execution of the **CREATE PLUGGABLE DATABASE** statement, wherein a container name (identical to the application root name) must be specified, ensuring uniqueness within the CDB and across CDB instances reachable through a specific listener. Each application container is associated with a default service bearing the same name as the application container.

In certain aspects, an application container operates akin to a CDB tailored for a specific application within an overarching CDB. Much like the CDB, an application container has the capacity to incorporate multiple PDBs, fostering the sharing of metadata and data among these PDBs. The application root serves as the facilitator for application PDBs to collaborate on a shared application—a term encompassing a designated and versioned collection of common metadata and data. An ordinary application installation involves the inclusion of application common users, metadata-linked common objects, and data-linked common objects.

Sharding architecture

Oracle Sharding represents a strategic database scaling method rooted in the horizontal partitioning of data across multiple **pluggable databases (PDBs)**. From the perspective of applications, this array of PDBs seamlessly coalesces into a unified and coherent logical database.

The advantages inherent in sharding for **Online Transaction Processing (OLTP)** applications are manifold. Firstly, Oracle Sharding offers the invaluable benefit of linear scalability, ensuring that as the database workload increases, the system's capacity expands

proportionally. This is particularly crucial in dynamically evolving environments where rapid scaling is imperative.

Another notable advantage is fault containment, whereby the impact of any potential system failures or disruptions is confined to the specific shard affected, preventing widespread outages. Geographical data distribution is a third key benefit, allowing data to be strategically distributed across different shards based on geographic locations. This not only enhances data accessibility but also facilitates compliance with data residency regulations.

Oracle Sharding finds a highly compatible deployment environment in the Oracle Cloud, leveraging the cloud's inherent capabilities for scalability and resource optimization. Unlike NoSQL data stores that implement sharding, Oracle Sharding distinguishes itself by providing the advantages of sharding without compromising the comprehensive capabilities of an enterprise **Relational Database Management System (RDBMS)**. This distinction is pivotal, particularly for organizations seeking the benefits of sharding without sacrificing the robust features and reliability associated with an enterprise-grade RDBMS. In essence, Oracle Sharding emerges as a scalable, fault-tolerant, and geographically distributed solution that seamlessly integrates into the Oracle Cloud environment, positioning itself as a formidable choice for organizations with dynamic and evolving database needs.

Within a sharding architecture, each container database resides on its dedicated server, equipped with localized resources such as CPU, memory, flash, or disk. In this framework, the flexibility is evident as a Pluggable Database can be explicitly designated as a shard. The orchestration unfolds as PDB shards, originating from distinct CDBs, collectively form a unified and coherent logical entity known as a sharded database.

A crucial constraint to note is that two shards originating from the same CDB cannot coexist within the same sharded database. However, within a singular CDB, a PDB has the flexibility to be a part of one sharded database, while another PDB within the same CDB can contribute to a completely different sharded database. This nuanced architecture allows for intricate and customized management of shards within the same overarching container database.

The essence of horizontal partitioning is integral to sharding, involving the distribution of a database table across shards. Each shard houses a version of the table with identical columns but a distinct subset of rows. This partitioning strategy defines what is commonly known as a sharded table. The illustrative figure demonstrates the horizontal partitioning of a sharded table across three shards, where each shard is a Pluggable Database situated within a separate container database. This methodology not only enhances the scalability and flexibility of data management but also provides a granular view of how sharded tables are distributed and organized across different shards within the Oracle Database architecture.