

# Oracle Database Introduction

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# What is Oracle Database?

## Definition:

- Oracle's flagship product
- Advanced Relational Database Management System (RDBMS)
- Developed by Oracle Corporation
- First commercially available SQL-based database (1979)

## Key Characteristics:

- Handles multiple data types
- Manages large amounts of data
- Operates on both traditional and cloud environments
- Uses SQL for data access and management



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# About Relational Databases

## What is a Database?

- Organized collection of information treated as a unit
- Purpose: collect, store, and retrieve related information
- Used by database applications

## Evolution:

- First generation: Hierarchical and Network databases
- Modern standard: Relational Model (E.F. Codd, 1970)

## Relational Model Components:

- Structures: Well-defined objects to store/access data
- Operations: Actions to manipulate data and structures
- Integrity rules: Govern operations on data and structures



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# Database Management System (DBMS)

**Definition:** Software that controls storage, organization, and retrieval of data

## Key Elements:

1. **Kernel code:** Manages memory and storage
2. **Repository of metadata:** Data dictionary
3. **Query language:** Enables applications to access data

## RDBMS vs Traditional DBMS:

- Distinguishes between logical and physical operations
- Physical operations are transparent to applications
- Implements the relational model



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# Oracle Database History

## Major Milestones:

**1977:** Software Development Laboratories founded

- Founders: Larry Ellison, Bob Miner, Ed Oates
- Later became Oracle Corporation (1983)

**1979:** Oracle V2 released

- First commercially available SQL-based RDBMS

**1983:** Oracle Version 3

- First relational database on mainframes, minicomputers, and PCs
- Written in C for portability



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## Oracle Database Evolution (Continued)

**Version 4:** Multiversion read consistency

**Version 5 (1985):** Client/server computing and distributed databases

**Version 6:** Enhanced disk I/O, row locking, scalability, backup/recovery

- Introduced PL/SQL language

**Oracle7 (1992):** PL/SQL stored procedures and triggers

**Oracle8 (1997):** Object-relational database, partitioning

**Oracle8i (1999):** Internet protocols, server-side Java support



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# Oracle Database Evolution (Modern Era)

## Oracle9i (2001):

- Oracle Real Application Clusters (RAC)
- Oracle XML Database (XML DB)

## Oracle Database 10g (2003):

- Grid computing
- Oracle Automatic Storage Management (ASM)
- Self-managing and self-tuning capabilities

## Oracle Database 11g (2007):

- Enhanced manageability, diagnosability, and availability
- Simplified information infrastructure

## Oracle Database 12c (2013):

- Designed for the Cloud
- Multitenant architecture
- In-Memory column store
- JSON document support



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# Oracle Database Release Types

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- **Long Term Support Release**

- 5 years of Premier support followed by 3 years of Extended Support
- Recommended for production databases
- Currently is 19c ( PS ends April 30, 2024)
- The next one is scheduled to be 23c

- **Innovation Release**

- 2 year of Premier Support, no Extended Support
- Recommended for studying the new features in development environments
- Examples: 12c, 18c, and 21c



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# Oracle Database Editions

## Enterprise Edition:

- For large organizations
- Supports high-volume OLTP and data warehousing
- Advanced analytics, security, and functionality options

## Standard Edition:

- Basic Oracle functionality
- Suited for workgroup, department-level, or web applications

## Personal Edition:

- Single-use development environments
- Nearly all Enterprise Edition components
- Cost-effective for developers

## Express Edition:

- Free entry-level edition
- Simple to install and manage
- Easy upgrade path to advanced products



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# Schema Objects

## What is a Schema?

- Collection of logical data structures (schema objects)
- Owned by database user
- Has same name as the user

## Important Schema Objects:

- **Tables:** Most important schema object
- **Indexes:** Second most important schema object
- Other objects: Views, sequences, procedures, etc.

**Key Point:** Schema objects are user-created structures that directly refer to database data

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# Tables

**Definition:** Describes an entity (e.g., employees)

**Components:**

- **Table name:** Identifies the entity
- **Columns:** Attributes of the entity
- **Rows:** Instances of the entity

**Column Properties:**

- Name
- Data type
- Width

**Integrity Constraints:**

- Rules for columns (e.g., NOT NULL)
- Force specific values or behaviors

**Example:** Employees table with columns: employee\_id, first\_name, last\_name

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# Indexes

## Purpose:

- Optional data structure on table columns
- Increase performance of data retrieval

## Characteristics:

- Logically and physically independent of data
- Can be dropped and created without affecting tables
- No impact on applications when modified

## When to Use:

- Applications frequently query specific rows
- Applications query range of rows
- Need to locate requested rows efficiently



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# Data Access - SQL

## Structured Query Language (SQL):

- ANSI standard language for relational databases
- Set-based declarative language
- Nonprocedural: describes what should be done, not how

## SQL vs Procedural Languages:

- Procedural (C): Describes HOW things should be done
- SQL: Describes WHAT should be done

## SQL Capabilities:

- Query data
- Insert, update, delete rows
- Create, alter, drop objects
- Control database access
- Guarantee consistency and integrity



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# SQL Statement Example

## Basic SQL Structure:

```
SELECT first_name, last_name  
FROM employees;
```

## Key Features:

- Simple but powerful
- String of SQL text
- Users specify result wanted, not how to derive it

## Oracle SQL:

- Implementation of ANSI standard
- Supports numerous extended features beyond standard SQL



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# PL/SQL and Java

## PL/SQL:

- Procedural extension to Oracle SQL
- Integrated with Oracle Database
- Controls flow of SQL programs
- Uses variables and error-handling procedures

## Benefits:

- Store application logic in database
- Built-in functionality deployed anywhere
- Server-side programming

## Java Support:

- Store Java program units in database
- Java stored procedures published to SQL
- Call PL/SQL from Java and vice versa



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# Transaction Management

## What is a Transaction?

- Logical, atomic unit of work
- Contains one or more SQL statements
- Either all committed or all rolled back

## Example: Funds Transfer

1. Decrease savings account
2. Increase checking account
3. Record transaction in journal

**All or Nothing Principle:** Oracle Database ensures all operations succeed or fail as a unit

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# Why Transactions Matter

## Database vs File System:

- File system: Partial updates can leave inconsistent state
- Oracle Database: Moves from one consistent state to another

## Transaction Principles:

- Atomic operation
- Succeeds or fails as a whole
- Maintains data consistency

**RDBMS Requirement:** Must group SQL statements for commit or rollback

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# Data Concurrency

**Definition:** Simultaneous access of same data by multiple users

**Challenge:** Multiple users updating same data simultaneously

**Without Concurrency Controls:**

- Users could change data improperly
- Compromises data integrity
- Destructive interactions possible

**Goal:** Reduce or eliminate wait time while preventing destructive interactions

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# Oracle Locking Mechanism

## What are Locks?

- Mechanism preventing destructive interaction between transactions
- Controls concurrent access to shared resources

## Benefits:

- Ensures data integrity
- Allows maximum concurrent access to data

## How It Works:

- Oracle Database uses locks automatically
- Prevents improper data changes
- Maintains consistency during concurrent access



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# Data Consistency

**Requirement:** Each user must see a consistent view of data

**Consistency Includes:**

- Visible changes from user's own transactions
- Committed transactions from other users

**Problems Prevented:**

- Lost update problem
- Uncommitted changes visible to others

**Oracle Enforcement:** Always enforces statement-level read consistency

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# Read Consistency Levels

## Statement-Level Read Consistency:

- Data returned by single query is committed and consistent
- For a single point in time
- When statement was opened

## Transaction-Level Read Consistency:

- All queries in transaction see data from same point in time
- Point in time = when transaction began

## Oracle Flashback Query:

- Enables explicit specification of point in time
- Advanced data recovery feature



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# Oracle Database Architecture Overview

## Database Server Purpose:

- Reliably manages large amounts of data
- Multiuser environment
- Concurrent access to same data
- Prevents unauthorized access
- Provides failure recovery solutions

**Key Concept:** Database and instance work together but are distinct entities

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# Database vs Instance

## Database:

- Set of files located on disk
- Store data
- Can exist independently of instance

## Instance:

- Set of memory structures managing database files
- System Global Area (SGA): shared memory
- Background processes
- Can exist independently of database files

**Oracle Database:** Term sometimes refers to both instance and database together



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# Instance and Database Components

## Client Process:

- Runs application for each user connection
- Associated with server process

## Server Process:

- Has private session memory
- Program Global Area (PGA)

## Memory Structures:

- SGA: Shared memory area for instance
- PGA: Private memory for server processes

**Physical Structure:** Database files store actual data on disk

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# Multitenant Architecture

## Container Database (CDB):

- Single physical database
- Contains zero, one, or many pluggable databases

## Pluggable Database (PDB):

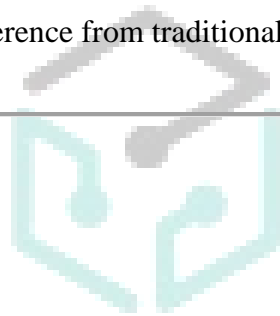
- Portable collection of schemas and schema objects
- Appears as non-CDB to Oracle Net client

## Non-CDB:

- Traditional Oracle database
- Cannot contain PDBs

**Key Innovation:** Architectural difference from traditional databases

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# Multitenant Architecture - Problems Solved

## Traditional Challenges:

- Hundreds/thousands of databases on different platforms
- Multiple physical servers
- Databases using only fraction of hardware capacity
- Wasted hardware and human resources

**Solution:** Consolidate multiple physical databases into single database on single computer

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# Multitenant Architecture Benefits (Part 1)

## Cost Benefits:

- Reduced hardware costs
- More efficient resource utilization
- Consolidated infrastructure

## Operational Benefits:

- Easier data and code movement
- Simplified management and monitoring
- Separation of data and code

## Administrative Benefits:

- PDB administrator: manages assigned PDBs only
- CDB administrator: manages entire CDB
- Clear separation of duties



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# Multitenant Architecture Benefits (Part 2)

## Manageability Benefits:

- Easier upgrades by unplugging/plugging PDBs
- Simplified testing in development PDBs
- Individual PDB flashback capability
- Performance limits at PDB level (memory, I/O)

## Application Management:

- Application containers for master definitions
- Set of PDBs with common application root
- Install, upgrade, manage applications centrally



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# Sharding Architecture

**Purpose:** Handle massive distributed databases

**Key Features:**

- Single logical database across multiple physical databases
- Horizontal partitioning
- Enhanced scalability

**Use Cases:**

- Very large datasets
- Global distribution requirements
- High-performance needs



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# Oracle Database Platform Support

## Operating Systems:

- Linux
- Microsoft Windows
- Other major operating systems

## Benefits of Cross-Platform Support:

- Flexibility in deployment
- Harness strengths of each OS
- Stable and efficient operations
- Easier management for administrators

**Compatibility:** Seamless integration across diverse IT environments



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# Key Features of Oracle Database

## Advanced Analytics:

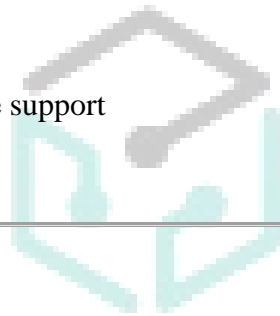
- Big data support
- Predictive analytics
- Automated systems
- Quick data processing

## High Data Availability:

- Data replication
- Backup capabilities
- Server clustering
- Minimal downtime

## Scalability:

- Single server deployment
- Massive distributed database support
- Grows with business needs



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# Security Features

## Multi-Layered Security:

- Advanced data encryption (at rest and in transit)
- Robust user authentication
- Comprehensive access controls
- Security risk monitoring

## Protection Against:

- Unauthorized access
- Potential breaches
- Threats and vulnerabilities

**Integration:** Security measures at every layer from storage to application



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# Oracle Real Application Clusters (RAC)

**Definition:** Multiple instances accessing single database simultaneously

**Benefits:**

- Fault tolerance
- Scalability
- High availability
- Load balancing
- Failover capabilities

**Use Case:** Mission-critical applications requiring uninterrupted service

**Redundancy:** Protects against single point of failure



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# Backup and Recovery

**Importance:** Essential for protecting data and maintaining integrity

## Oracle Capabilities:

- Real-time data backups
- Swift disaster recovery
- Full backups
- Incremental backups

## Business Benefits:

- Maintains trustworthiness
- Minimizes impact of data disruptions
- Ensures business continuity
- Prepares for unforeseen data loss



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# Structured Query Language (SQL) in Oracle

**Role:** Powerful language for precise data management

**Capabilities:**

- Data manipulation
- Data retrieval
- Complex query execution
- High performance and accuracy

**Administrator Benefits:**

- Efficient database operations
- Robust data handling
- Precise control over data



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# Oracle Cloud Integration

## Oracle Cloud Infrastructure (OCI):

- Supports traditional and modern applications
- AI and machine learning support
- Multicloud, public, hybrid, and dedicated options

## Benefits:

- Scalable and secure environment
- Reduced physical hardware overhead
- Focus on growth and innovation
- Dynamic resource allocation

**Tools:** Application deployment, data analysis, secure storage



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## Oracle Database Cloud Services

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- **User Manager:** client is responsible for updating the OS, installing, upgrading, and patching Oracle database software.
- **Co-Managed:** Oracle database software comes pre-installed in the machines. Oracle provides tools to facilitate taking database backups, patching database software, upgrading database software, and providing disaster recovery.
- **Autonomous:** fully automated database service that uses machine-learning (ML) for automatically tuning, scaling, and patching Oracle databases.



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# Key Oracle Products - Cloud Applications

## Oracle Fusion Cloud Application Suite:

- Software-as-a-Service (SaaS) applications
- Specific business use cases

## Components:

- Fusion ERP: Financials, project management, compliance
- SCM: Supply chain and manufacturing
- HCM: Human capital management
- Sales platforms
- Industry-specific add-ons

**Oracle E-Business Suite:** Simplifies data entry and management with prebuilt templates



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# Key Oracle Products - Hardware

## Engineered Systems:

- Built for scale
- x86 and SPARC-based servers
- Java application systems
- Storage and networking solutions

## Oracle Exadata:

- Developed specifically for Oracle Database
- Combines database servers, storage, and networking
- Optimized performance
- Engineered system approach



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# Key Oracle Products - Middleware

## Oracle Fusion Middleware:

- Family of tools for enterprise applications
- Data integration
- Business intelligence
- Content management

## Oracle Application Express (APEX):

- Low-code web app builder
- Rapid development

## Additional Capabilities:

- IoT functionality
- Big data integration
- Content management



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# Key Oracle Products - Software

## PeopleSoft:

- ERP for HR, financial management, campus solutions

## Oracle E-Business Suite:

- Order management, logistics, business functions

## Oracle Business Intelligence (OBIEE):

- Reporting and analysis

## Oracle Enterprise Manager:

- Advanced DevOps data operations
- Large-scale organization management



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## Oracle Database Options and Technologies

Requirement	Database Option/Technology
Hardware failure tolerance (active-active)	Real Application Cluster (RAC)
Hardware failure tolerance (active-passive)	RAC One Node
Disaster recovery (DR)	Data Guard
Disaster recovery (DR) with accessible Standby	Active Data Guard
Replication	Oracle GoldenGate (separate product)
Storage Management (HDD failure tolerance)	Automatic Storage Management (ASM)



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# Oracle Database Use Cases - Business Operations

## Business Applications:

- Enterprise Resource Planning (ERP)
- Customer Relationship Management (CRM)
- Human Resources Management (HRM)

## Benefits:

- Interactive insights
- Up-to-date information
- Day-to-day operations support
- Real-time data access



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# Oracle Database Use Cases - Data Management

## Data Warehousing:

- Central repository for structured data
- Vast data storage
- Analysis and reporting facilitation

## E-Commerce Platforms:

- Product catalog management
- Inventory tracking
- Transaction data handling
- Back-office solutions



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# Oracle Database Use Cases - Critical Industries

## Financial and Insurance Services:

- Secure, encrypted database
- Payment management
- Transaction tracking
- Risk auditing

## Government and Nonprofits:

- Secure public records management
- Classified information handling
- Used by Department of Defense
- Public sector applications



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# Oracle Database Use Cases - Healthcare and OLTP

## Healthcare Services:

- Streamlined operations
- Data integrity maintenance
- Workflow optimization
- Predictive insights

## Online Transaction Processing (OLTP):

- Large numbers of database transactions
- Real-time execution
- Multiple concurrent users
- E-commerce, banking, telecommunications



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# Database Components - Tablespaces

## Logical Storage:

- Data stored logically in tablespaces
- Flexible structure management

## Physical Storage:

- Data files on disk

## Administrator Flexibility:

- Manage structure without affecting user access
- Separate logical from physical concerns



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# Database Architectures

## Configuration Options:

### Single-Instance Database:

- One instance accessing one database
- Suitable for smaller deployments

### RAC Environment:

- Multiple instances accessing single database
- High availability and scalability
- Fault tolerance

### Choice Based On:

- Organization needs
- Scale requirements
- Availability requirements



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# Performance Optimization

## Oracle Database Strengths:

- Handles demanding database applications
- High performance under strenuous conditions
- Supports vast data types and volumes

## Optimization Features:

- Works in on-premises and cloud settings
- Scales with business growth
- Manages fluctuating workloads
- Maintains performance during expansion



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# Continuous Updates and Improvements

## Oracle's Approach:

- Regular updates
- Security improvements
- Efficiency enhancements
- Proactive maintenance

## Benefits:

- Maintained operational efficiency
- Enhanced security posture
- Adaptation to technological advances
- Reduced downtime

**Focus:** Keeping Oracle Database at forefront of database technology



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# Tools and Strategies for Efficiency

## Comprehensive Suite:

- SQL for data management
- PL/SQL for procedural extensions
- Oracle Cloud for scalability
- RAC for high availability

## Advanced Tools:

- Optimize physical structures
- Optimize logical structures
- Enhance performance
- Reduce downtime

**Result:** Streamlined database operations and enhanced productivity



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# Database Administrator Role

## Responsibilities:

- Setting up database environment
- Managing database structures
- Optimizing performance
- Ensuring security

## Resources:

- Oracle Support
- Structured Query Language (SQL)
- PL/SQL programming
- Advanced Oracle tools

**Focus:** Smooth database management operations



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# Client-Server Model

## Architecture:

- Database on server
- User interactions through client machines

## Benefits:

- Scalable data management
- Flexible deployment
- Multiple user support
- Centralized data control

## Support:

- Multiple concurrent connections
- Efficient resource utilization
- Distributed access



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# Why Oracle Database Matters

## Fundamental Pillar:

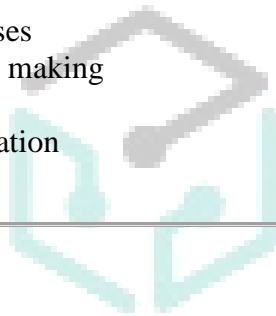
- More than just a technological tool
- Underpins critical business processes worldwide
- Essential for large organizations

## Core Strengths:

- Manages large data volumes
- Provides easy access
- Ensures high availability
- Maintains strong security

## Business Impact:

- Crucial resource for enterprises
- Enables data-driven decision making
- Supports business continuity
- Facilitates growth and innovation



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# Summary: Oracle Database at a Glance

**What It Is:** Advanced RDBMS by Oracle Corporation, first commercial SQL database

## Key Capabilities:

- Handles multiple data types and large volumes
- SQL and PL/SQL support
- Multi-platform deployment
- Cloud and on-premises operation

## Major Features:

- Scalability and high performance
- Advanced security and encryption
- High availability with RAC
- Comprehensive backup and recovery

**Why It Matters:** Essential tool for enterprise data management, supporting critical business operations across industries worldwide

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# Oracle Database Administrator Common Tasks

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- Plan the Database Design
- Install Oracle database and Grid Infrastructure Software
- Create Oracle Databases
- Backup the database
- Control database security
- Tune Oracle database performance
- Implement Database Disaster Recovery (DR) plan
- Migrate the on-prem databases to the Cloud
- Patching database and grid infrastructure



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## Oracle Database Administrator Common Tasks

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- Upgrade Oracle databases
- Create and Manage Oracle clusters (RAC)
- Clone databases
- Monitor database resources growth and determine future demands
- Perform database health check
- Oracle database options and licenses
- Diagnosing and troubleshooting Oracle databases



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## Oracle DBA Demand in the Job Market

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- Bull sources:
  - The introduction of Autonomous Databases in 2018
  - High cost of professional DBAs
  - The introduction of alternative solutions like MySQL and PostgreSQL
  - Cloud services provide easy to use tools
- Push sources:
  - Not all the systems can migrate their databases to Autonomous Database
  - Other cloud database services still need DBAs
  - More IT Systems are being deployed
- IT Recruitment websites demonstrate that DBAs are still required



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