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|  |  | **TECNOLÓGICO DE ESTUDIOS SUPERIORES DE JOCOTITLÁN**      **Database Migration from Oracle 19c to MySQL 8.0**      **Alumno: Andrés López Piña (2022150480607)**  **Materia: Base de Datos**  **Profesor: Marcial Jesús Martínez Blas**          **Jocotitlán, Estado de México, 20 de junio de 2025** |

# **Introduction**

Database migration represents one of the most critical operations in enterprise IT infrastructure management. The transition from Oracle 19c to MySQL 8.0 involves complex considerations including data integrity preservation, schema compatibility, performance optimization, and minimal downtime requirements. This research provides a systematic approach to executing such migrations on Oracle Linux 8 platform.

Oracle Database 19c, being Oracle's current long-term support release, offers robust enterprise features but comes with significant licensing costs. MySQL 8.0, with its enhanced performance characteristics, JSON support, and cost-effectiveness, presents an attractive alternative for many organizations seeking to optimize their database infrastructure investments.

The migration process involves multiple phases including assessment, planning, schema conversion, data transfer, application adaptation, testing, and deployment. Each phase requires careful consideration of technical constraints, business requirements, and risk mitigation strategies.

# Theoretical Framework

## 2.1 Database Migration Fundamentals

Database migration encompasses the transfer of data, schema objects, and associated metadata from one database management system to another. The process involves several key components:

* Schema Translation: Converting database objects such as tables, indexes, views, and constraints from Oracle's SQL dialect to MySQL's syntax
* Data Type Mapping: Translating Oracle-specific data types to MySQL equivalents while preserving data integrity
* Procedural Logic Conversion: Adapting stored procedures, functions, and triggers to MySQL's syntax and capabilities
* Performance Optimization: Ensuring migrated databases maintain or improve performance characteristics

## 2.2 Oracle 19c Architecture Overview

Oracle 19c implements a multitenant architecture supporting both container databases (CDB) and pluggable databases (PDB). Key architectural components include:

* System Global Area (SGA): Shared memory region containing database buffers, shared pool, and redo log buffers
* Program Global Area (PGA): Private memory areas for individual server processes
* Oracle Processes: Background processes managing database operations including SMON, PMON, LGWR, and DBWR
* Storage Structures: Tablespaces, data files, control files, and redo log files

## 2.3 MySQL 8.0 Architecture Fundamentals

MySQL 8.0 introduces significant architectural improvements including:

* InnoDB Storage Engine Enhancements: Improved performance, atomic DDL operations, and enhanced security
* Document Store Capabilities: Native JSON data type support and X Protocol for NoSQL operations
* Resource Groups: CPU resource management for workload prioritization
* Invisible Indexes: Index management without affecting query optimizer behavior

## 3. Objectives

### 3.1 General Objective

To develop and document a comprehensive methodology for migrating Oracle 19c databases to MySQL 8.0 on Oracle Linux 8, ensuring data integrity, optimal performance, and minimal business disruption.

### 3.2 Specific Objectives

1. Assessment and Planning Objective: Establish systematic procedures for evaluating existing Oracle 19c database environments and determining migration feasibility and requirements.
2. Schema Conversion Objective: Develop standardized processes for converting Oracle database schemas to MySQL-compatible structures while preserving functional equivalency.
3. Data Migration Objective: Implement reliable data transfer mechanisms ensuring complete data integrity and consistency throughout the migration process.
4. Performance Optimization Objective: Define tuning strategies for migrated MySQL 8.0 databases to achieve comparable or superior performance relative to source Oracle systems.
5. Testing and Validation Objective: Create comprehensive testing frameworks to validate migration success, data accuracy, and application functionality post-migration. 4. Migration

## Methodology

### 4.1 Pre-Migration Assessment

#### 4.1.1 Environment Analysis

# Oracle 19c Database Information Gathering sqlplus / as sysdba << EOF

SELECT banner FROM v\$version;

SELECT name, open\_mode FROM v\$database;

SELECT tablespace\_name, bytes/1024/1024 MB FROM dba\_data\_files;

SELECT owner, object\_type, COUNT(\*) FROM dba\_objects GROUP BY owner, object\_type;

EXIT;

EOF

# System Resource Assessment cat /proc/meminfo | grep MemTotal cat /proc/cpuinfo | grep processor | wc -l df -h

#### 4.1.2 Compatibility Assessment

* Identify Oracle-specific features requiring conversion or replacement
* Catalog stored procedures, functions, and packages
* Document application dependencies and interfaces
* Assess data volume and complexity metrics

### 4.2 MySQL 8.0 Installation and Configuration

#### 4.2.1 System Preparation on Oracle Linux 8 # Update system packages sudo dnf update -y

# Install required dependencies sudo dnf install -y wget gcc gcc-c++ cmake ncurses-devel openssl-devel

# Configure system limits echo "mysql soft nofile 65536" >> /etc/security/limits.conf echo "mysql hard nofile 65536" >> /etc/security/limits.conf

# Create MySQL user and group sudo groupadd mysql sudo useradd -r -g mysql -s /bin/false mysql **4.2.2 MySQL 8.0 Installation**

# Download MySQL 8.0 repository package wget https://dev.mysql.com/get/mysql80-community-release-el8-1.noarch.rpm

# Install repository package sudo rpm -Uvh mysql80-community-release-el8-1.noarch.rpm

# Install MySQL server sudo dnf install -y mysql-community-server # Start and enable MySQL service sudo systemctl start mysqld sudo systemctl enable mysqld

# Retrieve temporary root password sudo grep 'temporary password' /var/log/mysqld.log

# Secure MySQL installation mysql\_secure\_installation

**4.2.3 MySQL Configuration Optimization** # Edit MySQL configuration file sudo vi /etc/my.cnf

# Add performance optimizations

[mysqld] innodb\_buffer\_pool\_size = 4G innodb\_log\_file\_size = 512M innodb\_flush\_log\_at\_trx\_commit = 2 query\_cache\_type = 0 query\_cache\_size = 0 max\_connections = 500 thread\_cache\_size = 50 table\_open\_cache = 4000 innodb\_open\_files = 4000

# Restart MySQL service sudo systemctl restart mysqld

### 4.3 Schema Migration Process

#### 4.3.1 Oracle Schema Export

# Export Oracle schema using Data Pump

expdp system/password DIRECTORY=data\_pump\_dir

DUMPFILE=schema\_export.dmp \

SCHEMAS=target\_schema CONTENT=METADATA\_ONLY

# Traditional export for compatibility

exp system/password FILE=schema\_export.dmp OWNER=target\_schema ROWS=N

#### 4.3.2 Schema Conversion Using MySQL Workbench

* # Launch MySQL Workbench Migration Wizard
* mysql-workbench
* # Migration steps in Workbench:
* # 1. Database > Migrate
* # 2. Configure source connection (Oracle)
* # 3. Configure target connection (MySQL)
* # 4. Schema selection and conversion
* # 5. Review and edit converted objects
* # 6. Create target database

#### 4.3.3 Manual Schema Conversion Commands

-- Example Oracle to MySQL table conversion

-- Oracle table:

CREATE TABLE employees ( emp\_id NUMBER(10) PRIMARY KEY, emp\_name VARCHAR2(100), hire\_date DATE, salary NUMBER(10,2)

);

-- MySQL equivalent: CREATE TABLE employees ( emp\_id INT AUTO\_INCREMENT PRIMARY KEY, emp\_name VARCHAR(100), hire\_date DATE, salary DECIMAL(10,2)

);

### 4.4 Data Migration Implementation 4.4.1 Oracle Data Export

# Full data export using Data Pump

|  |  |
| --- | --- |
| expdp system/password  DUMPFILE=data\_export.dmp \ | DIRECTORY=data\_pump\_dir |

SCHEMAS=target\_schema CONTENT=DATA\_ONLY

# CSV export for specific tables sqlplus system/password << EOF

SET COLSEP ','

SET PAGESIZE 0

SET TRIMSPOOL ON

SET HEADSEP OFF

SET LINESIZE 1000

SPOOL /tmp/employees.csv

SELECT \* FROM employees;

SPOOL OFF

EXIT;

EOF

**4.4.2 MySQL Data Import** # Import CSV data using MySQL LOAD DATA mysql -u root -p << EOF

USE target\_database;

LOAD DATA INFILE '/tmp/employees.csv'

INTO TABLE employees

FIELDS TERMINATED BY ','

ENCLOSED BY '"'

LINES TERMINATED BY '\n';

EOF

# Import using mysqlimport utility mysqlimport --local --fields-terminated-by=, \ --user=root --password=password \ target\_database /tmp/employees.csv

**4.4.3 ETL Process Using Custom Scripts** #!/usr/bin/env python3 import cx\_Oracle import mysql.connector from datetime import datetime

# Oracle connection oracle\_conn = cx\_Oracle.connect('user/password@localhost:1521/ORCL') oracle\_cursor = oracle\_conn.cursor()

# MySQL connection mysql\_conn = mysql.connector.connect(

host='localhost', user='root', password='password', database='target\_db'

)

mysql\_cursor = mysql\_conn.cursor()

# Data migration with batch processing batch\_size = 1000 oracle\_cursor.execute("SELECT COUNT(\*) FROM source\_table") total\_rows = oracle\_cursor.fetchone()[0]

for offset in range(0, total\_rows, batch\_size): oracle\_cursor.execute(f"""

SELECT \* FROM (

SELECT a.\*, ROWNUM rnum FROM source\_table a

WHERE ROWNUM <= {offset + batch\_size}

) WHERE rnum > {offset}

""")

batch\_data = oracle\_cursor.fetchall()

mysql\_cursor.executemany(

"INSERT INTO target\_table VALUES (%s, %s, %s, %s)", batch\_data

)

mysql\_conn.commit()

print(f"Processed {min(offset + batch\_size, total\_rows)} of {total\_rows} rows") # Close connections oracle\_conn.close() mysql\_conn.close()

### 4.5 Application Adaptation

#### 4.5.1 SQL Syntax Modifications -- Oracle DUAL table usage

SELECT SYSDATE FROM DUAL;

-- MySQL equivalent

SELECT NOW();

-- Oracle DECODE function

SELECT DECODE(status, 'A', 'Active', 'I', 'Inactive', 'Unknown') FROM table;

-- MySQL equivalent

SELECT CASE

WHEN status = 'A' THEN 'Active'

WHEN status = 'I' THEN 'Inactive'

ELSE 'Unknown'

END FROM table;

-- Oracle NVL function

SELECT NVL(column\_name, 'Default') FROM table;

-- MySQL equivalent

SELECT IFNULL(column\_name, 'Default') FROM table;

#### 4.5.2 Stored Procedure Conversion

-- Oracle procedure example

CREATE OR REPLACE PROCEDURE get\_employee\_count( p\_department IN VARCHAR2, p\_count OUT NUMBER

) AS

BEGIN

SELECT COUNT(\*) INTO p\_count

FROM employees

WHERE department = p\_department;

END;

-- MySQL equivalent

DELIMITER //

CREATE PROCEDURE get\_employee\_count(

IN p\_department VARCHAR(100),

OUT p\_count INT

)

BEGIN

SELECT COUNT(\*) INTO p\_count

FROM employees

WHERE department = p\_department;

END //

DELIMITER ;

### 4.6 Performance Tuning and Optimization

#### 4.6.1 Index Optimization

-- Analyze table structure and create appropriate indexes

ANALYZE TABLE employees;

-- Create composite indexes for common query patterns

CREATE INDEX idx\_emp\_dept\_date ON employees(department, hire\_date);

-- Monitor index usage SELECT

table\_name, index\_name,

cardinality, pages

FROM information\_schema.statistics

WHERE table\_schema = 'target\_database';

#### 4.6.2 MySQL Configuration Tuning

mysqladmin -u root -p extended-status | grep -E

"(Innodb\_buffer\_pool|Qcache|Threads)"

# Tune InnoDB parameters

SET GLOBAL innodb\_buffer\_pool\_size = 8589934592; -- 8GB

SET GLOBAL innodb\_log\_buffer\_size = 67108864; -- 64MB

SET GLOBAL innodb\_flush\_method = O\_DIRECT;

### 4.7 Testing and Validation

#### 4.7.1 Data Integrity Verification

-- Row count validation

SELECT 'Oracle' as source, COUNT(\*) as row\_count FROM oracle\_table

UNION ALL

SELECT 'MySQL' as source, COUNT(\*) as row\_count FROM mysql\_table;

-- Checksum validation

SELECT

SUM(CRC32(CONCAT\_WS('|', col1, col2, col3))) as checksum

FROM mysql\_table;

-- Sample data comparison

SELECT \* FROM mysql\_table

WHERE id IN (

SELECT id FROM (

SELECT id FROM mysql\_table ORDER BY RAND() LIMIT 100

) sample

);

4.7.2 Performance Benchmarking

# MySQL performance testing using sysbench sysbench oltp\_read\_write \ --mysql-host=localhost \

--mysql-user=root \

--mysql-password=password \

--mysql-db=target\_database \

--tables=10 \ --table-size=100000 \ prepare

sysbench oltp\_read\_write \

--mysql-host=localhost \

--mysql-user=root \

--mysql-password=password \

--mysql-db=target\_database \

--tables=10 \

--table-size=100000 \

--threads=16 \

--time=300 \

Run

## Questions

**Question 1**: What are the primary challenges encountered when migrating from Oracle 19c to MySQL 8.0, and how can they be effectively addressed?

Answer: The primary challenges include data type incompatibilities, SQL syntax differences, stored procedure conversion complexities, and performance optimization requirements. These can be addressed through comprehensive premigration assessment, systematic use of migration tools like MySQL Workbench, manual conversion of complex objects, and thorough testing protocols. Specific attention should be paid to Oracle-specific features like ROWNUM, DECODE functions, and PL/SQL constructs that require MySQL equivalents.

**Question 2**: How does the performance of MySQL 8.0 compare to Oracle 19c after migration, and what optimization strategies ensure optimal performance?

Answer: MySQL 8.0 can achieve comparable or superior performance to Oracle 19c through proper configuration and optimization. Key strategies include optimizing InnoDB buffer pool size, implementing appropriate indexing strategies, utilizing MySQL 8.0's improved optimizer, and leveraging features like invisible indexes and resource groups. Performance benchmarking shows that properly tuned MySQL 8.0 systems can match Oracle 19c performance while providing better costeffectiveness and resource utilization.

**Question 3**: What automated tools and methodologies are most effective for largescale Oracle to MySQL migrations, and what are their limitations?

Answer: MySQL Workbench Migration Wizard provides the most comprehensive automated migration capabilities, supporting schema conversion, data transfer, and basic optimization suggestions. However, limitations include incomplete stored procedure conversion, manual intervention requirements for complex queries, and the need for custom scripting for large data volumes. Supplementary tools like custom Python ETL scripts, Oracle Data Pump exports, and MySQL utilities provide additional automation capabilities for specific migration phases.

**Question 4**: How can data integrity and consistency be guaranteed throughout the Oracle 19c to MySQL 8.0 migration process?

Answer: Data integrity is ensured through multiple validation layers including row count verification, checksum comparisons, sample data analysis, and referential integrity checks. Implementation of transactional migration processes, comprehensive backup strategies, and rollback procedures provides additional security. Automated testing scripts comparing source and target data, along with business logic validation, ensure complete data accuracy and consistency postmigration.

**Question 5**: What are the specific considerations for migrating Oracle 19c databases on Oracle Linux 8, and how does the platform influence migration strategy?

Answer: Oracle Linux 8 provides optimal compatibility for both Oracle 19c and MySQL 8.0, offering advantages including shared library compatibility, consistent performance characteristics, and simplified system administration. Platform-specific considerations include utilizing Oracle Linux's container capabilities for testing environments, leveraging system-level optimization features, and ensuring proper resource allocation for concurrent operation of both database systems during migration phases.

## Conclusions

The migration from Oracle 19c to MySQL 8.0 on Oracle Linux 8 represents a significant undertaking requiring careful planning, systematic execution, and comprehensive validation. This research demonstrates that successful migrations are achievable through adherence to established methodologies, utilization of appropriate tools, and implementation of rigorous testing protocols.

Key findings indicate that MySQL 8.0 provides substantial improvements over previous versions, making it a viable alternative to Oracle 19c for many enterprise applications. The enhanced performance characteristics, improved security features, and cost-effectiveness of MySQL 8.0 support business cases for migration initiatives.

The Oracle Linux 8 platform provides an optimal environment for migration activities, offering compatibility advantages and performance benefits for both source and target database systems. The platform's container capabilities and resource management features facilitate efficient migration testing and validation processes.

Critical success factors identified include comprehensive pre-migration assessment, systematic schema conversion processes, robust data validation procedures, and thorough performance optimization. Organizations undertaking such migrations should allocate sufficient resources for testing phases and maintain contingency plans for rollback scenarios.

Future research opportunities exist in areas including automated migration tool enhancement, machine learning-based optimization strategies, and cloud-native migration approaches. The continuous evolution of both Oracle and MySQL platforms necessitates ongoing evaluation of migration methodologies and best practices.

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