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JOCOTITLÁN HIGHER STUDIES TECHNOLOGY

Computer Systems Engineering

ACTIVITY

“Oracle 19C RMAN Backup Practice”

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A S I G N A T U R

Database administration

G R O U P

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GENERAL OBJECTIVE:

Implement an efficient backup and recovery strategy using Oracle RMAN (Recovery Manager) to ensure the availability, integrity, and rapid recovery of critical data, minimizing the impact on database performance and meeting RTO and RPO SLAs.

SPECIFIC OBJECTIVES WITH RMAN:

- Automate and optimize backups with RMAN
- Configure RMAN scripts to perform automated full, incremental, and differential backups.

EXTENDED THEORETICAL FRAMEWORK

Backup and recovery strategies are essential components of a robust database management system (DBMS). They minimize downtime and data loss, which are critical for business continuity. Oracle RMAN is deeply integrated with the Oracle Database, providing efficient backup and recovery with minimal impact on database performance.

RMAN supports several types of backups: full, incremental, cumulative, and image copies. Full backups capture the entire database state, while incremental backups reduce backup time and storage by saving only changed data blocks. This incremental approach is efficient in environments with frequent data changes.

The ARCHIVELOG mode is a fundamental configuration in Oracle databases that enables the database to archive filled redo log files before overwriting them. This feature is necessary for online backups, meaning backups can be taken without shutting down the database, which is critical for systems requiring high availability. Recovery techniques in RMAN include complete recovery, incomplete recovery (to a point in time or SCN), and recovery using backups with missing datafiles or control files. RMAN's catalog and control file maintain metadata about backups and their locations, simplifying the recovery process.

Automation through RMAN scripts allows DBAs to schedule regular backups, enforce retention policies, and perform routine maintenance without manual intervention. Retention policies help ensure compliance with organizational or regulatory requirements regarding data retention and disaster recovery readiness. Furthermore, RMAN integrates with Oracle Enterprise Manager, providing graphical interfaces and monitoring tools for backup and recovery activities. This integration enhances usability and facilitates proactive database management.

In summary, Oracle RMAN is a comprehensive tool that supports effective backup and recovery strategies, ensuring data protection, minimizing downtime, and enabling quick restoration of database services in case of failure.



DEVELOPMENT

Initial setup

```
Archivo  Editar  Ver  Buscar  Terminal  Ayuda
[oracle@localhost ~]$ sqlplus

SQL*Plus: Release 19.0.0.0.0 - Production on Fri May 16 08:56:35 2025
Version 19.3.0.0.0

Copyright (c) 1982, 2019, Oracle. All rights reserved.

Enter user-name: / as sysdba
Connected to an idle instance.

SQL> startup
ORACLE instance started.

Total System Global Area 3992977336 bytes
Fixed Size                  9142200 bytes
Variable Size               805306368 bytes
Database Buffers           3170893824 bytes
Redo Buffers                 7634944 bytes
Base de datos montada.
Base de datos abierta.
SQL>
```

-- Check the archivelog mode

SELECT log_mode FROM v\$database;

```
SQL> select log_mode from v$database;

LOG_MODE
-----
NOARCHIVELOG

SQL> █
```

-- Configure ARCHIVELOG (requires reboot)

SHUTDOWN IMMEDIATE

```
SQL> shutdown immediate;
Base de datos cerrada.
Base de datos desmontada.
Instancia ORACLE cerrada.
SQL>
```



STARTUP MOUNT

```
SQL> startup mount
Instancia ORACLE iniciada.

Total System Global Area 3992977336 bytes
Fixed Size                  9142200 bytes
Variable Size              805306368 bytes
Database Buffers          3170893824 bytes
Redo Buffers                7634944 bytes
Base de datos montada.
SQL>
```

ALTER DATABASE ARCHIVELOG;

```
SQL> ALTER DATABASE ARCHIVELOG;

Base de datos modificada.

SQL> █
```

-- We check

```
SQL> SELECT LOG_MODE FROM V$DATABASE;

LOG_MODE
-----
ARCHIVELOG

SQL>
```

ALTER DATABASE OPEN;

```
SQL> ALTER DATABASE OPEN;

Base de datos modificada.

SQL>
```

-- Configure recommended parameters

ALTER SYSTEM SET db_recovery_file_dest_size=20G SCOPE=BOTH;

```
SQL> ALTER SYSTEM SET db_recovery_file_dest_size=20G SCOPE=BOTH;

Sistema modificado.

SQL> █
```



```
ALTER SYSTEM SET db_recovery_file_dest='/u01/app/oracle/fast_recovery_area'  
SCOPE=BOTH;
```

For this instruction we must check if the directory exists, otherwise create it.

For this we must open an alternate window on our server and give the following command

```
[oracle@localhost ~]$ ls -l /u01/app/oracle  
total 4  
drwxrwxrwx. 7 oracle oinstall 73 abr 22 09:56 admin  
drwxrwxrwx. 5 oracle oinstall 47 abr 22 10:36 audit  
drwxrwxrwx. 5 oracle oinstall 47 mar 12 21:24 cfgtoollogs  
drwxrwxrwx. 2 oracle oinstall 6 mar 12 21:00 checkpoints  
drwxrwxrwx. 23 oracle oinstall 4096 mar 12 21:00 diag  
drwxrwxrwx. 7 oracle oinstall 95 abr 29 11:37 oradata  
drwxrwxrwx. 3 oracle oinstall 18 mar 12 20:00 product  
[oracle@localhost ~]$
```

As you can see, there is no directory named /u01/app/oracle/fast_recovery_area, it must be created

```
[oracle@localhost ~]$ mkdir -p /u01/app/oracle/fast_recovery_area/ORCL  
[oracle@localhost ~]$
```

We check

```
[oracle@localhost ~]$ ls -l /u01/app/oracle  
total 4  
drwxrwxrwx. 7 oracle oinstall 73 abr 22 09:56 admin  
drwxrwxrwx. 5 oracle oinstall 47 abr 22 10:36 audit  
drwxrwxrwx. 5 oracle oinstall 47 mar 12 21:24 cfgtoollogs  
drwxrwxrwx. 2 oracle oinstall 6 mar 12 21:00 checkpoints  
drwxrwxrwx. 23 oracle oinstall 4096 mar 12 21:00 diag  
drwxr-xr-x. 3 oracle oinstall 18 may 16 09:03 fast_recovery_area  
drwxrwxrwx. 7 oracle oinstall 95 abr 29 11:37 oradata  
drwxrwxrwx. 3 oracle oinstall 18 mar 12 20:00 product  
[oracle@localhost ~]$
```

Ok now we apply the command

```
SQL> ALTER SYSTEM SET db_recovery_file_dest='/u01/app/oracle/fast_recovery_area' SCOPE=BOTH;  
Sistema modificado.  
SQL>
```



2. Perform full and incremental backups with RMAN

Connect to RMAN

For this you must do it from the operating

system rman target /

```
[oracle@localhost ~]$ rman target /  
  
Recovery Manager: Release 19.0.0.0.0 - Production on Fri May 16 09:06:26 2025  
Version 19.3.0.0.0  
  
Copyright (c) 1982, 2019, Oracle and/or its affiliates. All rights reserved.  
connected to target database: ORCL (DBID=1723374574)  
  
RMAN>
```

Full Backup

RMAN> BACKUP DATABASE PLUS ARCHIVELOG;

```
Starting backup at 16-MAY-25  
current log archived  
using channel ORA_DISK_1  
channel ORA_DISK_1: starting archived log backup set  
channel ORA_DISK_1: specifying archived log(s) in backup set  
input archived log thread=1 sequence=27 RECID=2 STAMP=1201248130  
channel ORA_DISK_1: starting piece 1 at 16-MAY-25  
channel ORA_DISK_1: finished piece 1 at 16-MAY-25  
piece handle=/u01/app/oracle/fast_recovery_area/ORCL/backupset/2025_05_16/o1_mf_  
_annnn_TAG20250516T080210_n2gkc31h_.bkp tag=TAG20250516T080210 comment=NONE  
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01  
Finished backup at 16-MAY-25  
  
Starting Control File and SPFILE Autobackup at 16-MAY-25  
piece handle=/u01/app/oracle/fast_recovery_area/ORCL/autobackup/2025_05_16/o1_mf_  
_s_1201248132_n2gkc4hr_.bkp comment=NONE  
Finished Control File and SPFILE Autobackup at 16-MAY-25  
  
RMAN>  
RMAN> █
```

Incremental backup level 1

RMAN> BACKUP INCREMENTAL LEVEL 1 DATABASE PLUS ARCHIVELOG;



Differential incremental backup

RMAN> BACKUP INCREMENTAL LEVEL 1 CUMULATIVE DATABASE PLUS ARCHIVELOG;

```
Starting backup at 16-MAY-25
current log archived
using channel ORA_DISK_1
channel ORA_DISK_1: starting archived log backup set
channel ORA_DISK_1: specifying archived log(s) in backup set
input archived log thread=1 sequence=29 RECID=4 STAMP=1201248272
channel ORA_DISK_1: starting piece 1 at 16-MAY-25
channel ORA_DISK_1: finished piece 1 at 16-MAY-25
piece handle=/u01/app/oracle/fast_recovery_area/ORCL/backupset/2025_05_16/o1_mf_
annnn_TAG20250516T080432_n2gkhjj2_.bkp tag=TAG20250516T080432 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
Finished backup at 16-MAY-25

Starting Control File and SPFILE Autobackup at 16-MAY-25
piece handle=/u01/app/oracle/fast_recovery_area/ORCL/autobackup/2025_05_16/o1_mf_
s_1201248273_n2gkhky6_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 16-MAY-25

RMAN> 
```

Backup of controlfile and spfile

RMAN> BACKUP CURRENT CONTROLFILE;

```
RMAN> BACKUP CURRENT CONTROLFILE;

Starting backup at 16-MAY-25
using channel ORA_DISK_1
channel ORA_DISK_1: starting full datafile backup set
channel ORA_DISK_1: specifying datafile(s) in backup set
including current control file in backup set
channel ORA_DISK_1: starting piece 1 at 16-MAY-25
channel ORA_DISK_1: finished piece 1 at 16-MAY-25
piece handle=/u01/app/oracle/fast_recovery_area/ORCL/backupset/2025_05_16/o1_mf_
ncnnf_TAG20250516T080614_n2gklr0b_.bkp tag=TAG20250516T080614 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:02
Finished backup at 16-MAY-25

Starting Control File and SPFILE Autobackup at 16-MAY-25
piece handle=/u01/app/oracle/fast_recovery_area/ORCL/autobackup/2025_05_16/o1_mf_
s_1201248377_n2gklscs_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 16-MAY-25

RMAN> 
```




RMAN> BACKUP SPFILE;

```
RMAN> BACKUP SPFILE;

Starting backup at 16-MAY-25
using channel ORA_DISK_1
channel ORA_DISK_1: starting full datafile backup set
channel ORA_DISK_1: specifying datafile(s) in backup set
including current SPFILE in backup set
channel ORA_DISK_1: starting piece 1 at 16-MAY-25
channel ORA_DISK_1: finished piece 1 at 16-MAY-25
piece handle=/u01/app/oracle/fast_recovery_area/ORCL/backupset/2025_05_16/o1_mf_
nnsnf_TAG20250516T080638_n2gkmg90_.bkp tag=TAG20250516T080638 comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
Finished backup at 16-MAY-25

Starting Control File and SPFILE Autobackup at 16-MAY-25
piece handle=/u01/app/oracle/fast_recovery_area/ORCL/autobackup/2025_05_16/o1_mf_
s_l201248399_n2gkmhrd_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 16-MAY-25

RMAN>
```

3. Configure retention and automation policies

Configure retention policy (7 days)

RMAN> CONFIGURE RETENTION POLICY TO RECOVERY WINDOW OF 7 DAYS;

```
RMAN> CONFIGURE RETENTION POLICY TO RECOVERY WINDOW OF 7 DAYS;

new RMAN configuration parameters:
CONFIGURE RETENTION POLICY TO RECOVERY WINDOW OF 7 DAYS;
new RMAN configuration parameters are successfully stored

RMAN> █
```

Configure backup automation

RMAN> CONFIGURE CONTROLFILE AUTOBACKUP ON;

```
RMAN> CONFIGURE CONTROLFILE AUTOBACKUP ON;

new RMAN configuration parameters:
CONFIGURE CONTROLFILE AUTOBACKUP ON;
new RMAN configuration parameters are successfully stored

RMAN>
```




RMAN> CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO
'/backups/%F';

```
RMAN> CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '/backups/%F';

new RMAN configuration parameters:
CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '/backups/%F';
new RMAN configuration parameters are successfully stored

RMAN> █
```

List settings

RMAN> SHOW ALL;

```
RMAN> SHOW ALL;

RMAN configuration parameters for database with db_unique_name ORCL are:
CONFIGURE RETENTION POLICY TO RECOVERY WINDOW OF 7 DAYS;
CONFIGURE BACKUP OPTIMIZATION OFF; # default
CONFIGURE DEFAULT DEVICE TYPE TO DISK; # default
CONFIGURE CONTROLFILE AUTOBACKUP ON;
CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '/backups/%F';
CONFIGURE DEVICE TYPE DISK PARALLELISM 1 BACKUP TYPE TO BACKUPSET; # default
CONFIGURE DATAFILE BACKUP COPIES FOR DEVICE TYPE DISK TO 1; # default
CONFIGURE ARCHIVELOG BACKUP COPIES FOR DEVICE TYPE DISK TO 1; # default
CONFIGURE MAXSETSIZE TO UNLIMITED; # default
CONFIGURE ENCRYPTION FOR DATABASE OFF; # default
CONFIGURE ENCRYPTION ALGORITHM 'AES128'; # default
CONFIGURE COMPRESSION ALGORITHM 'BASIC' AS OF RELEASE 'DEFAULT' OPTIMIZE FOR LOAD TRUE ; # default
CONFIGURE RMAN OUTPUT TO KEEP FOR 7 DAYS; # default
CONFIGURE ARCHIVELOG DELETION POLICY TO NONE; # default
CONFIGURE SNAPSHOT CONTROLFILE NAME TO '/u01/app/oracle/product/19.3/dbhome_1/dbs/snapcf_orcl.f'; # default

RMAN>
```

4. Full Recovery Practice

Simulate loss of data files

RMAN> SHUTDOWN IMMEDIATE;

```
RMAN> SHUTDOWN IMMEDIATE;

database closed
database dismounted
Oracle instance shut down

RMAN>
```



RMAN> STARTUP MOUNT;

```
RMAN> STARTUP MOUNT;

connected to target database (not started)
Oracle instance started
database mounted

Total System Global Area      3992977336 bytes

Fixed Size                      9142200 bytes
Variable Size                  805306368 bytes
Database Buffers               3170893824 bytes
Redo Buffers                    7634944 bytes

RMAN> █
```

RMAN> RESTORE DATABASE;

```
RMAN> RESTORE DATABASE;

Starting restore at 16-MAY-25
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=170 device type=DISK

skipping datafile 5; already restored to file /u01/app/oracle/oradata/ORCL/pdbse
ed/system01.dbf
skipping datafile 6; already restored to file /u01/app/oracle/oradata/ORCL/pdbse
ed/sysaux01.dbf
skipping datafile 8; already restored to file /u01/app/oracle/oradata/ORCL/pdbse
ed/undotbs01.dbf
skipping datafile 9; already restored to file /u01/app/oracle/oradata/ORCL/orclp
db/system01.dbf
skipping datafile 10; already restored to file /u01/app/oracle/oradata/ORCL/orcl
pdb/sysaux01.dbf
skipping datafile 11; already restored to file /u01/app/oracle/oradata/ORCL/orcl
pdb/undotbs01.dbf
skipping datafile 12; already restored to file /u01/app/oracle/oradata/ORCL/orcl
pdb/undotbs01.dbf
```

RMAN> RECOVER DATABASE;

```
RMAN> RECOVER DATABASE;

Starting recover at 16-MAY-25
using channel ORA_DISK_1
channel ORA_DISK_1: starting incremental datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup set
destination for restore of datafile 00001: /u01/app/oracle/oradata/ORCL/system01
.dbf
destination for restore of datafile 00003: /u01/app/oracle/oradata/ORCL/sysaux01
.dbf
destination for restore of datafile 00004: /u01/app/oracle/oradata/ORCL/undotbs0
1.dbf
destination for restore of datafile 00007: /u01/app/oracle/oradata/ORCL/users01.
dbf
destination for restore of datafile 00013: /u02/oradata/brayanISC01/ts_datos01.d
bf
destination for restore of datafile 00014: /u03/oradata/brayanISC01/ts_indices01
.dbf
destination for restore of datafile 00015: /u04/oradata/brayanISC01/ts_usuarios.
dbf
destination for restore of datafile 00016: /u01/app/oracle/product/19.3/dbhome_1
```



5. Point-in-Time Recovery (PITR)

Determine recovery point

RMAN> LIST BACKUP SUMMARY;

```
RMAN> LIST BACKUP SUMMARY;

List of Backups
=====
Key          TY LV S Device Type Completion Time #Pieces #Copies Compressed Tag
-----
1           B A A DISK      16-MAY-25          1         1      NO    TAG20250516T090828
2           B A A DISK      16-MAY-25          1         1      NO    TAG20250516T091013
3           B 1 A DISK      16-MAY-25          1         1      NO    TAG20250516T091014
4           B A A DISK      16-MAY-25          1         1      NO    TAG20250516T091116
5           B 1 A DISK      16-MAY-25          1         1      NO    TAG20250516T091117
6           B F A DISK      16-MAY-25          1         1      NO    TAG20250516T091201
7           B F A DISK      16-MAY-25          1         1      NO    TAG20250516T091203
8           B F A DISK      16-MAY-25          1         1      NO    TAG20250516T091229
9           B F A DISK      16-MAY-25          1         1      NO    TAG20250516T091230

RMAN>
```

RMAN> LIST ARCHIVELOG ALL;

```
RMAN> LIST ARCHIVELOG ALL;

List of Archived Log Copies for database with db_unique_name ORCL
=====

Key          Thrd Seq      S Low Time
-----
1           1     26      A 16-MAY-25
      Name: /u01/app/oracle/fast_recovery_area/ORCL/archivelog/2025_05_16/o1_m
f_1_26_n2gk9r2c_.arc
2           1     27      A 16-MAY-25
      Name: /u01/app/oracle/fast_recovery_area/ORCL/archivelog/2025_05_16/o1_m
f_1_27_n2gkc2vb_.arc
3           1     28      A 16-MAY-25
      Name: /u01/app/oracle/fast_recovery_area/ORCL/archivelog/2025_05_16/o1_m
f_1_28_n2gkfv4p_.arc
4           1     29      A 16-MAY-25
      Name: /u01/app/oracle/fast_recovery_area/ORCL/archivelog/2025_05_16/o1 m
```

RMAN> LIST ARCHIVELOG ALL;

```
RMAN> LIST INCARNATION;

List of Database Incarnations
DB Key  Inc Key DB Name  DB ID          STATUS  Reset SCN  Reset Time
-----
1       1      ORCL    1723374574    PARENT      1          17-APR-19
2       2      ORCL    1723374574    CURRENT    1920977     12-MAR-25

RMAN>
```



QUESTIONS

1. What steps are required to enable ARCHIVELOG mode in an Oracle 19c database, and why is it important to activate it before performing backups with RMAN?

Answer:

To enable ARCHIVELOG mode, you must first shut down the database using SHUTDOWN IMMEDIATE, then start it in mount mode with STARTUP MOUNT. Next, execute ALTER DATABASE ARCHIVELOG, and finally open the database using ALTER DATABASE OPEN. Enabling ARCHIVELOG mode is essential for RMAN to include archived redo logs in backups, allowing point-in-time recovery and ensuring no committed transactions are lost.

2. What is the difference between a level 1 incremental backup and a cumulative level 1 backup in RMAN, and which commands are used for each?

Answer:

A level 1 incremental backup only includes blocks changed since the last level 0 or level 1 backup, whereas a cumulative level 1 backup includes all blocks changed since the last level 0 backup.

- **Command for level 1 incremental backup:**

BACKUP INCREMENTAL LEVEL 1 DATABASE PLUS ARCHIVELOG;

- **Command for cumulative backup:**

BACKUP INCREMENTAL LEVEL 1 CUMULATIVE DATABASE PLUS ARCHIVELOG;

3. What needs to be configured in Oracle to automate backups, and what format should be set for control file autobackups?

Answer:

To automate backups in Oracle RMAN, the following commands should be configured:

- CONFIGURE CONTROLFILE AUTOBACKUP ON;
- CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '/backups/%F'; This ensures that the control file and SPFILE are automatically backed up and saved with a unique name in the specified path.

4. How is a full recovery performed after a data file loss using RMAN?

Answer:

To perform a full recovery after losing data files:



- Shut down the database: SHUTDOWN IMMEDIATE;
- Mount the database: STARTUP MOUNT;
- Restore the database: RESTORE DATABASE;
- Recover the database: RECOVER DATABASE;
- Open the database: ALTER DATABASE OPEN; These steps restore and recover all data files to their most recent consistent state.

5. What RMAN commands are used to recover a lost control file, and what is the sequence of steps to follow after restoring it?

Answer:

To recover a lost control file:

- Start the instance without mounting: STARTUP NOMOUNT;
- Restore the control file: RESTORE CONTROLFILE FROM AUTOBACKUP;
- Mount the database: ALTER DATABASE MOUNT;
- Recover the database: RECOVER DATABASE;

Open the database with reset logs: ALTER DATABASE OPEN RESETLOGS;
This process fully recovers the control file and brings the database back online.

CONCLUSION

This practice helped consolidate key knowledge about backup and recovery in Oracle 19c using RMAN. It demonstrated the importance of configuring ARCHIVELOG mode, understanding different backup types, and simulating realistic failure and recovery scenarios. Moreover, the implementation of retention policies and scripting strategies emphasized the significance of automation and routine validation in database maintenance. These skills are fundamental for any database administrator to ensure data security, availability, and disaster preparedness in enterprise systems.

During the practice, several challenges arose that had to be addressed. One major issue was limited disk space in the virtual machine environment, which impacted the ability to perform large backups. To solve this, the virtual machine was cloned and allocated additional storage, allowing more flexible backup and recovery operations. Another problem involved some RMAN commands not being recognized due to incorrect environment setup or syntax errors. This was resolved by carefully reviewing the Oracle environment variables, ensuring proper Oracle user permissions, and consulting official Oracle documentation to correct command usage.

Additionally, simulating different failure scenarios—such as loss of control files or redo logs—required precise steps and understanding of RMAN's restore and recover



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processes. Through trial and error and guided practice, these scenarios were successfully executed, reinforcing practical skills.

The experience underscored the importance of preparation, documentation, and troubleshooting skills in database administration. It also highlighted that real-world backup and recovery requires not only theoretical knowledge but also hands-on practice to manage unexpected issues effectively. Overall, the learning gained from overcoming these obstacles has strengthened my ability to plan, execute, and automate Oracle database backups and recoveries, which are critical for maintaining enterprise data integrity and availability.