



Migrating Oracle 11gR2 to Oracle 12cR1

Upgrading and migrating Oracle 11gR2 RAC Databases running on legacy infrastructure to Oracle 12c Pluggable Databases running on the latest Dell infrastructure.

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Executive Summary

Upgrading legacy IT infrastructure is a major cause of concern for many organizations today. There is a requirement to efficiently assess new technologies in terms of performance, energy-efficiency, high-availability, etc, and then choose the right infrastructure for the upgrade process. However, this crucial operation invites a lot of risks and application downtime. At the same time, this upgrade process can have a significant impact on cost reduction and increased productivity.

The Dell enterprise portfolio is evolving as a benchmark in terms of performance, cost-effectiveness, and energy efficiency.

This white paper helps you to migrate and consolidate your legacy Oracle® database infrastructure to the latest Oracle database running on Dell infrastructure.

This white paper addresses all the challenges that can be faced by an organization seeking to migrate its legacy Oracle database. The Dell Solutions Engineering team has devised an optimum solution that helps to reduce database downtime efficiently while completing the migration and consolidation operation.



1 Introduction

Oracle Database 12c includes many exciting new features that can help a customer reduce IT costs by simplifying consolidation, provisioning, and upgrades. Oracle Database 12c introduces a new architecture featuring Oracle Multitenant that simplifies the process of consolidating databases onto the cloud. It delivers all the benefits of managing many databases as one, yet retains the data isolation and resource prioritization of separate database.

The latest Dell™ PowerEdge™ servers are equipped with greater CPU, memory, and network resources.

Combining Oracle 12c multitenant architecture with Dell hardware can deliver benefits far beyond simple server consolidation and management.

Dell storage solutions provide a highly efficient and flexible virtualized storage platform for enterprises and the cloud, which helps to store more data in a smaller footprint using storage features like storage tiering and snapshots.

As database sizes have grown and maintenance windows have continued to shorten, the ability to migrate large databases within a scheduled window using conventional methods is no longer practical. In this migration solution, the Dell storage snapshots are used to address the migration challenges. Dell storage snapshots have the following advantages:

- Space efficient snapshot backup.
- Significant reduction in backup time compared to traditional backup methods.
- Easy rollback of entire volumes in case of downgrade.
- Consistency group to maintain data integrity.
- Efficient in case of huge database migration.



2 Overview of Key Technology Components

The key technology components used in this solution are:

- Dell PowerEdge Server
- Dell Storage
- Oracle Database 12c



2.1 Overview of Dell PowerEdge Server

The latest Dell PowerEdge servers feature **the Intel® Xeon® E5-2600 series processors** based on the Sandy Bridge-EP architecture. Intel Xeon E5-2600 series processors provide up to 8 physical cores or 16 logical cores through hyper-threading, and support optimized turbo boost technology.

Dell PowerEdge servers include the **ExpressFlash PCIe SSDs** to deliver better internal storage performance by connecting the SSDs directly to the processor using the PCIe bus. These PCIe solid state drives have up to 3x performance of standard SAS SSDs and 1000x performance of 15K SAS hard drives.

Dell PowerEdge servers help improve the IT experience with the following features:

- Agent-free server management for ease of server management
- Auto-update for replacement parts to reduce maintenance time
- Power monitoring and control for efficient cooling
- Fabric flexibility for tailoring networks to applications
- SATA, SAS, SSD and PCI Express Flash drives for optimum data storage
- Best-in-class RAID for data protection
- Major I/O performance enhancements for better throughput
- Greater memory density and capacity along with Intel Xeon E5 processors for performance enhancement.

2.2 Overview of Dell Storage

Dell Fluid Data architecture integrates today's best-of-breed technologies, including industry-leading automated tiered storage, storage virtualization, thin provisioning, and space efficient snapshots.

Storage snapshots are point-in-time copies of source volume data.

These snapshots are space efficient and are only a set of pointers to the data in the base volume. A snapshot can be used as a backup and restore solution by mounting it to a host for both read and write access. A snapshot can be created from multiple volumes to maintain a consistent set of data across all volumes. Snapshots can be scheduled automatically or can be performed manually.

The **consistency group** feature takes snapshots of database applications where the data is spread across multiple volumes to maintain a consistency across all volumes.

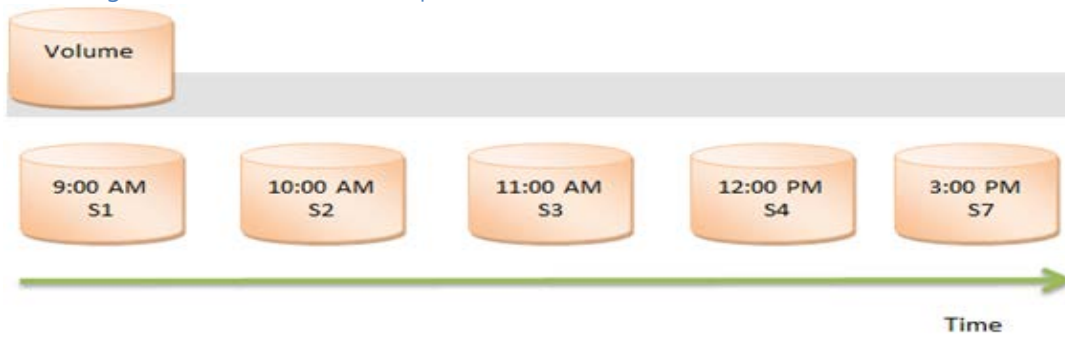
To ensure consistency, volume IO is halted for all volumes when the snapshots are created. Once snapshots are created, IO is resumed for all the volumes.

Term	Dell Compellent	Dell PowerVault	Dell EqualLogic
Storage Consistency Group	Consistency Group	Consistency Group	Volume Collection
Storage Snapshot	Data Instant Replay (DIR)	Snapshot Image Snapshot Virtual Disk	Snapshot



Figure 1

Snapshots of Source Volumes



2.3 Oracle Database 12c

Oracle Database 12c introduces an innovative new multitenant architecture that streamlines the deployment and consolidation of multiple databases quickly onto the database cloud which maximizes resource efficiency and flexibility. This allows you to manage many databases as one without application changes. This results in a fast, scalable, reliable, and secure database platform, making Oracle database 12c the ideal platform for cloud deployments.

Consolidation of multiple Oracle databases to Oracle 12c multitenant pluggable databases has the following benefits:

- Manage many databases as one.
- Fewer patches, upgrades and backups.
- Rapid provisioning and cloning of pluggable databases.

3 Upgrade and Migration Methodology

Migration of Oracle database infrastructure involves changes to server, storage, operating system and database software.

3.1 Database Upgrade

The direct upgrade to Oracle Database 12c can be done using either the Database Upgrade Assistant (DBUA) or the command-line upgrade scripts.

DBUA is a graphical user interface that guides you through the database upgrade process and allows you to specify options for your database upgrade. For more information on DBUA, see the [Oracle Database Upgrade Guide](#).

Command-line upgrade utility uses "catctl.pl" script. This method is the most commonly used by database administrators. For more information on the CLI upgrade utility, see the [Oracle Database Upgrade Guide](#).

3.2 Database Migration

Oracle Database migration involves migrating the data from source to the target. There are many possible migration techniques, the most commonly used Oracle tools are listed below:

- Transportable Tablespaces or Full Transportable Export/Import
- Oracle Data Pump Export/Import
- Original Export/Import

The above utilities have their own limitations in case of database size, storage capacity, downtime and complexity.

In this white paper, space efficient Dell Storage Snapshot technology is used to migrate the data from source to target with minimal effort and downtime.

3.3 Server Migration

Server migration is a process of replacing a legacy server with the latest. Oracle database migration to the latest Dell server is to augment the computing power, better performing CPU and memory resources. In this solution, server migration is performed by migrating an Oracle 11gR2 database on legacy server to the latest Dell PowerEdge server with Oracle 12c.

3.4 Storage Migration

Storage migration is a process of migrating data from legacy storage to the latest. The latest Dell fluid data architecture comprises of Dell Compellent, Dell EqualLogic and Dell PowerVault. Oracle Automatic

Storage Management can be used in database storage migration after migrating Oracle 11gR2 to Oracle 12c PDB. For Oracle database storage migration, see the Dell blog [Oracle Database Storage Migration](#).

3.5 Operating System Migration

Operating system migration is the process of moving a database from one operating system version to the latest version. Operating system migration from Red Hat Enterprise Linux 5.x to Red Hat Enterprise Linux 6.x is covered in this white paper.

Red Hat does not support in-place upgrades between any major versions of Red Hat Enterprise Linux. Hence migration on the same server is not possible.

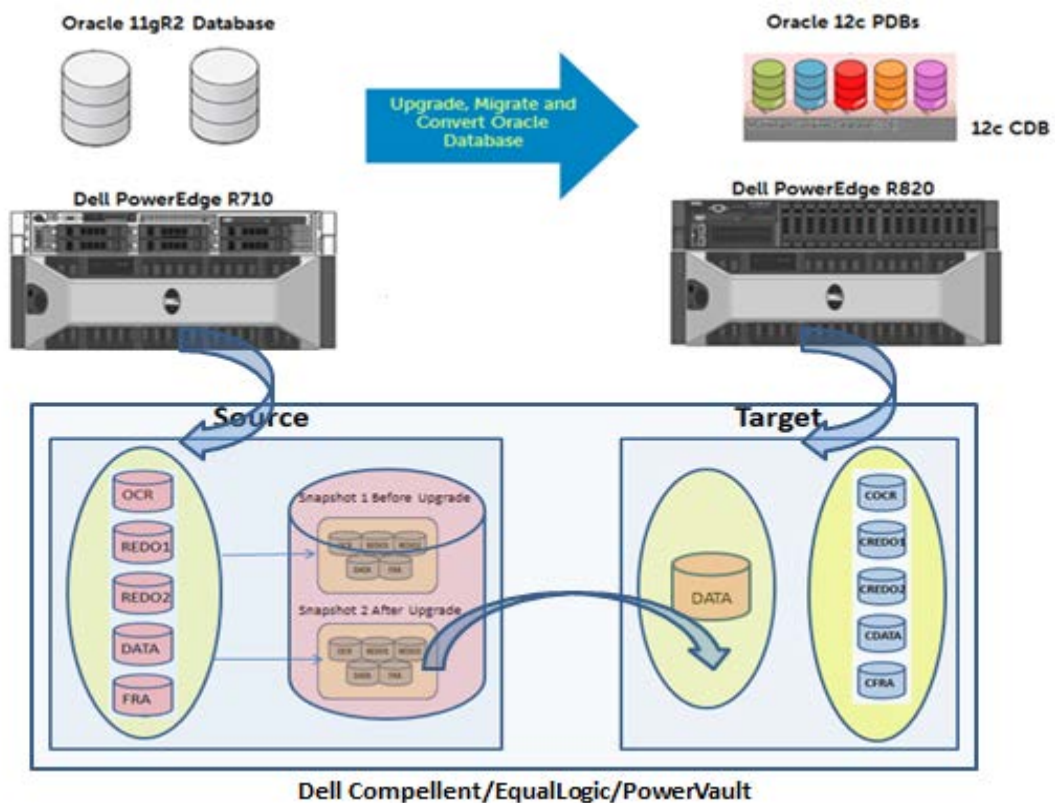
In this solution, operating system migration is achieved by installing a new operating system on the latest Dell Server and migrating the database using Dell Storage Snapshot.



4 Solution Architecture

Dell solutions are designed to replicate the real-world deployments. The figure illustrates the architectural diagram for upgradation and migrating a legacy Oracle 11gR2 database on Dell PowerEdge R710 to Oracle 12c pluggable database on the Dell PowerEdge R820 using storage snapshots.

Figure 2 Dell Solution Architecture for Migrating Oracle 11gR2 to Oracle 12c PDB



5 Test Methodology

A two-node Oracle 11gR2 Real Application Cluster (RAC) is referred to as the legacy production database environment. A 300GB database is used to perform the migration effort to Oracle database 12c multitenant architecture and the latest Dell infrastructure. The database is configured with five volumes for the legacy source as described in the following table.

Table 1 Mapped Database Storage Volumes and Corresponding ASM Disk Groups

Database	Volumes	File Type	Size(GB)	ASM Disk Group
Oracle 11gR2	OCR	Cluster Configuration File	5	OCR
	DATA	Oracle database data files and temp files	500	DATA
	REDO1	Redo log files and control files	5	REDO1
	REDO2	Multiplexed redo logs and control files	5	REDO2
	FRA	Flashback logs and Archived Logs	1000	FRA

This steps below describes the methodology used in our testing.

1. Prior to upgrading Oracle 11gR2 RAC database to Oracle 12c take a storage snapshot of all the 11gR2 database volumes so that the database can be restored back or downgraded to 11gR2 easily by remounting the snapshot volumes.
2. Upgrade Oracle 11gR2 RAC database to Oracle 12c Non-CDB database in the legacy environment.
3. Setup a new infrastructure with Red Hat Enterprise Linux 6.4 and create a Oracle 12c RAC CDB with the volumes described in the table below.

Table 2 Mapped Database Storage Volumes and Corresponding ASM Disk Groups

Database	Volumes	File Type	Size(GB)	ASM Disk Group
Oracle 12c CDB	CDBOCR	Cluster Configuration File of CDB	5	CDB_OCR
	CDBDATA	Oracle database data files and temp files of CDB	100	CDB_DATA
	CDBREDO1	Redo log files and control files of CDB	10	CDB_REDO1
	CDBREDO2	Multiplexed redo logs and control files of CDB	10	CDB_REDO2
	CDBFRA	Flashback logs and Archived Logs of CDB	2000	CDB_FRA

4. Take a snapshot of Oracle 12c Non-CDB volumes.
5. Create a manifest file and copy the manifest file to new server.
6. Mount the 12c Non-CDB DATA snapshot volume to the new server where Oracle 12c CDB is created.
7. Convert the Oracle 12c Non-CDB to PDB using the manifest file.



5.1 Hardware Environment

This section describes the details of the hardware environment used for the source Oracle 11gR2 and the target Oracle 12c RAC database.

Table 3 Hardware Configuration

Purpose	Details
Servers for hosting Oracle 11gR2	Two Dell PowerEdge R710 servers with Two Intel Xeon 4-core 2.40 GHz Processors 16 GB of RAM
Servers for hosting Oracle 12c	Two Dell PowerEdge R820 servers with Four Intel Sandy Bridge 8-core 2.20 GHz Processors 64 GB of RAM
Storage for hosting Oracle 11gR2	Dell Compellent SC40 Dell EqualLogic PS6010XV Dell PowerVault MD3620f
Storage for hosting Oracle 12c	Dell Compellent SC8000 Dell EqualLogic PS6110XV Dell PowerVault MD3660f
Storage Switch	Brocade 5100 for Compellent and PowerVault & Dell Force10 S4810 for EqualLogic
Network Switch	Dell Power Connect 6248 for Oracle RAC Public and Private Interconnect.

5.2 Software Environment

This section describes the details of the software environment used for source Oracle 11gR2 and target Oracle 12c RAC database.

Table 4 Software Configuration

Software	Version and Purpose
Red Hat Enterprise Linux	RHEL 5.5 for source and RHEL 6.4 for target
Oracle Database 11gR2 RAC	Enterprise Edition 11.2.0.2.0 for Oracle Grid Infrastructure and Database
Oracle Database 12c RAC	Enterprise Edition 12.1.0.1.0 for Oracle Grid Infrastructure and Database



6 Steps for Migration

The detailed steps for Oracle database upgradation and migration are as follows:

1. Take consistent snapshot of all Oracle Grid and database volumes.
2. Upgrade the Oracle Grid Infrastructure.
3. Upgrade the Oracle database software.
4. Upgrade the existing Oracle database 11gR2 to 12cR1 using the command-line upgrade.
5. Build a new infrastructure of Oracle 12c Container database.
6. Convert the upgraded Database to Oracle 12c PDB.

6.1 Oracle Database Volumes Snapshot Backup

The snapshot backups are storage based backups which can be used to create an image of the database volumes, and can be reused by mounting the snapshot volumes back onto the server. The snapshot of the database volumes can be taken when the Oracle database is shutdown or mounted otherwise in hot backup mode.

Before doing upgrade, take a consistent snapshot of all Oracle Grid and database volumes, so that the production database can be restored or downgraded to 11gR2 easily.

For detailed storage snapshot backup refer to Dell whitepaper [Oracle Database Backup and Recovery using Dell Storage Snapshot Technologies](#)

6.2 Upgrade Oracle Grid Infrastructure

Command-line upgrades are used in this solution. If the source database is 11gR2 version (11.2.0.2 or higher), it can be directly upgraded to Oracle 12c Release 1 (12.1). This is an out-of-place upgrade, which will create a new GI Home and leave the old Home untouched for us to rollback or downgrade easily. Check or validate nodes readiness for upgrade.

After successful rootupgrade.sh execution on all nodes, check Oracle Clusterware active version on the cluster and Oracle Clusterware version on each node.

For more details on how to upgrade Oracle 11gR2 Grid Infrastructure to Oracle 12cR1 refer to Dell wiki [How to upgrade Oracle 11gR2 Grid Infrastructure to Oracle 12cR1](#)



6.3 Upgrade Oracle Database Software

To upgrade an existing Oracle 11gR2 RAC database software to Oracle 12c, you have to download and then install the Oracle 12c Release 1 database software in a new Oracle Home and make sure there are no relinking errors. Also, install the latest available patch set, opatch, or CPU patches if available.

Copy the parameter files and password file from the Oracle Home of the database being upgraded to the new Oracle Home for Oracle Database 12c. Remove or comment out obsolete and deprecated initialization parameters.

For more details on how to upgrade Oracle 11gR2 Database Software to Oracle 12cR1 refer to Dell wiki [How to upgrade Oracle 11gR2 Database Software to Oracle 12cR1](#)

6.4 Upgrading Oracle Database to 12c

The database is manually upgraded by following the process outlined in **Oracle Doc ID 1503653.1**. The process of upgrading your Oracle database using command-line upgrade can be divided into three phases.

6.4.1 Pre-upgrade Phase

1. Take a full valid database RMAN backup before the upgrade.
2. Check the integrity of the source database prior to starting the upgrade using script dbupgdiag.sql.
3. Run the 12c pre-upgrade script preupgrd.sql on source database and then run any required pre-upgrade fixup scripts preupgrade_fixups.sql.
4. Run the pre-upgrade utility package utluppkg.sql to perform checks on a database.
5. Change the cluster database parameter to false and shutdown all instances of RAC.

6.4.2 Upgrade Phase

1. Startup only the primary instance of the RAC database using startup upgrade.
2. Run the Oracle command line upgrade utility catctl.pl from the new Oracle Home, which enables parallel processing for database upgrade.

6.4.3 Post-upgrade Phase

1. Run the post-upgrade actions script catuppst.sql and postupgrade_fixups.sql.
2. Run the utlrp.sql to recompile any invalid objects within the database.
3. Upgrade the database configuration in Oracle Clusterware and make sure the environment variables and oratab file point to Oracle 12cR1 directories.
4. Upgrade the Time Zone file version using DBMS_DST package after upgrading database to 12cR1 is complete. See **Oracle Doc ID 977512.1** for details.



6.5 Building a new Infrastructure of Oracle 12c Container Database.

Oracle database 12c Release 1 has common Container database and multiple application or user specific pluggable databases.

Before converting or plugging Oracle 12c Non-CDB to PDB you have to setup or create new Oracle database 12c Container database on the latest Dell infrastructure and the latest supported RHEL OS. Convert or plug-in Oracle 12c Non-CDB to PDB to newly created Oracle 12c Container database or already existing Oracle 12c database with CDB and PDBs.

The steps to build a new infrastructure of Oracle 12c Container database are as follows:

1. Identify the software, hardware, network and operating system requirements.
2. Install RHEL 6.4 on the identified latest Dell PowerEdge servers.
3. Prepare nodes for Oracle RAC installation
4. Prepare shared storage for Oracle RAC installation
5. Install and configure Oracle 12cR1 Grid Infrastructure
6. Install Oracle 12cR1 Database software
7. Create disk groups using ASMCA
8. Create Container database using DBCA

For more details on how to build a new infrastructure of Oracle 12c Container database refer to Dell wiki [How to deploy Oracle 12c Release 1 on RHEL6/Oracle Linux 6](#)

6.6 Converting Upgraded Database to Oracle 12c PDB

The Oracle database which contains the set of tablespaces and their datafiles that contain data dictionary tables which holds the metadata and the actual data that holds the application back end's quota-consuming data is called the pluggable database (PDB). The PDB can be easily provisioned or cloned to local or remote CDB using unplug and plug options.

Provisioning the newly upgraded Oracle 12c Non-CDB database to PDB is done by following the process defined in the My Oracle Support document [How to migrate an existing pre12c database\(nonCDB\) to 12c CDB database ? \(Doc ID 1564657.1\)](#). This solution uses Dell Storage snapshots to present datafiles and tempfiles, as host copy methods or Oracle utilities consume more time during migration.

To convert the newly upgraded Oracle 12c Non-CDB to PDB you have to do the following steps:

1. Take a consistent snapshot of all the database volumes after upgrade.
2. Generate a PDB manifest file for Oracle 12c Non-CDB.
3. Mount the DATA snapshot volume on the Oracle 12c Container Database.
4. Create a pluggable database using datafiles present in DATA snapshot volume.
5. Convert to pluggable database data dictionary.



6.6.1 Snapshots of Upgraded Database Volumes

After upgrading the Oracle database to 12c, it is called Oracle 12c Non-CDB database. The consistent snapshot of all the Non-CDB database volumes is created manually. For more details on how to take snapshot backup refer to Dell whitepaper [Oracle Database Backup and Recovery using Dell Storage Snapshot Technologies](#)

6.6.2 Generating a PDB Manifest File

Use the DBMS_PDB package to generate an XML metadata manifest file. The XML manifest file describes the database files of the Non-CDB database used during conversion.

Before converting Oracle 12c Non-CDB to PDB, you must generate a XML metadata manifest file. To generate a manifest file you have to shutdown all the database instances and mount the primary instance in exclusive mode. The detailed steps to generate a manifest file are as below:

1. Run the dbms_pdb package, as shown below to generate the manifest file.

```
SQL> exec
dbms_pdb.describe(pdb_descr_file=>' /opt/oracle/oradata/noncdb/noncdb.xml '
);
PL/SQL procedure successfully completed.
SQL> ! cat /opt/oracle/oradata/noncdb/noncdb.xml
```

2. Copy the generated manifest file to the new Dell server where the Oracle 12c CDB is created.

```
SQL> ! scp /opt/oracle/oradata/noncdb/noncdb.xml <NEW SERVER
IP>: /opt/oracle/oradata/noncdb/
```

6.6.3 Mounting Snapshot Volume on the Oracle 12c Container Database Server

1. Create a volume from the snapshot of the DATA volume and map the volume to the new server.
2. Mount the DATA snapshot volume on the new server.
3. Rescan the snapshot volume disk using rescan-scsi-bus.sh and add the scsi ids of the disks to the multipath.conf file and then run service multipathd reload .
4. Make changes in the udev rules and run start_udev to set the required ownership for the Oracle ASM disks.
5. Mount the DATA disk group using ASMCA or alter disk group [Diskgroup Name] mount.

6.6.4 Creating a Pluggable Database

Create a new pluggable database using the previously generated manifest file and the datafiles and tempfiles presented from the Dell storage snapshot. The **NOCOPY** clause is used as the datafiles are in the correct location and **TEMPFILE REUSE** clause is used as the file with the same name as the tempfile specified in the XML file exists in the target location. These options are used in the create pluggable



statement to plug-in Non-CDB to PDB. The detailed steps to create pluggable database from 12c Non-CDB datafiles are as below:

1. Create a PDB using Non-CDB datafiles and tempfiles.

```
SQL> CREATE PLUGGABLE DATABASE MIGDB USING
      '/opt/oracle/oradata/noncdb/noncdb.xml'
      NOCOPY
      TEMPFILE REUSE;
```

2. Open the created PDB in read write mode in all instances.

```
SQL> ALTER PLUGGABLE DATABASE MIGDB OPEN INSTANCES=ALL;
Warning: PDB altered with errors
```

3. Close the created PDB in all instances.

```
SQL> ALTER PLUGGABLE DATABASE MIGDB CLOSE INSTANCES=ALL;
Pluggable database altered
```

4. Open the created PDB in read write mode in all instances.

```
SQL> ALTER PLUGGABLE DATABASE MIGDB OPEN INSTANCES=ALL;
Warning: PDB altered with errors
```

6.6.5 Converting to Pluggable Database Data Dictionary

The process of converting to PDB is completed after removing the unnecessary data held in the pluggable database data dictionary from its original version as a non-container database. If you need to upgrade the container database at imminent time, this step is mandatory to run. PDB plugged in is a Non-CDB, which requires `noncdb_to_pdb.sql` to be run for complete conversion to PDB.

Connect to new pluggable database `migdb` and then run:

```
SQL> @$ORACLE_HOME/rdbms/admin/noncdb_to_pdb.sql
SQL> ALTER PLUGGABLE DATABASE MIGDB CLOSE INSTANCES=ALL;
Pluggable database altered
SQL> ALTER PLUGGABLE DATABASE MIGDB OPEN INSTANCES=ALL;
Pluggable database altered
```

To avoid the ASM diskgroup name conflict during consolidation of Oracle 11gR2 databases to Oracle 12c PDBs, you have to rename the DATA ASM diskgroup name before converting it to PDB.

For more details on how to rename ASM diskgroup in Oracle 12c RAC database refer to Dell wiki [How to rename ASM diskgroup in Oracle 12c RAC Database](#)



7 Conclusion

Migrating to the latest database infrastructure enables you to run business applications faster, simplify IT, improve business availability and performance. Migrating to Oracle database 12c and the latest Dell Infrastructure together provides reliability, reduced cost, easier management, fewer upgrades, backup and rapid provisioning of PDBs.

Using Dell storage snapshot for migration has the following advantages:

- Minimize the planned database downtime during migration.
- Efficient in case of multiple database consolidations to Oracle 12c PDB's.
- Migration time is independent of the database size.
- Quickly clone or provision PDBs for test and development
- Nondisruptive to existing Oracle database production infrastructure.

Additional Resources

Support.dell.com is focused on meeting your needs with proven services and support.

DellTechCenter.com is an IT Community where you can connect with Dell Customers and Dell employees for the purpose of sharing knowledge, best practices, and information about Dell products and installations.

Referenced or recommended Dell publications:

- Oracle Database Backup and Recovery Using Dell Storage Snapshot Technologies

http://en.community.dell.com/techcenter/enterprise-solutions/m/oracle_db_gallery/20336712.aspx

- Oracle Database Migration to Dell PowerEdge 12th Generation Servers and Dell Compellent Storage Systems

http://en.community.dell.com/techcenter/enterprise-solutions/m/oracle_db_gallery/20153849.aspx

Referenced or recommended Oracle publications:

- Oracle Database 12c Introduction

<http://www.oracle.com/us/products/database/overview/index.html>

- Oracle Multitenant Architecture white paper

<http://www.oracle.com/technetwork/database/multitenant-wp-12c-1949736.pdf>

- Oracle Whitepaper - Upgrading to Oracle Database 12c

<http://www.oracle.com/technetwork/database/upgrade/upgrading-oracle-database-wp-12c-1896123.pdf>

- Database Server Upgrade/Downgrade Compatibility Matrix (Doc ID 551141.1)
- Complete Checklist for Manual Upgrades to Oracle Database 12c Release 1 (12.1) (Doc ID 1503653.1)
- How to migrate an existing pre12c database(nonCDB) to 12c CDB database ? (Doc ID 1564657.1)
- Supported Backup, Restore and Recovery Operations using Third Party Snapshot Technologies (Doc ID 604683.1)
- Backup and Recovery Scenarios (Doc ID 94114.1)

