Upgrade and Migrate to Oracle Database 12c Release 2

Best practices for minimizing downtime

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- Database upgrades and data migration
- High Availability solutions
- Performance Tuning and health checks
- Security Audits
- Onsite and Online Training
- GoldenGate implementation projects
- And more ....
Agenda

• Discuss best practices which can be taken to reduce downtime and outages required for Oracle 12c database upgrades
• Evaluate the various upgrade methods available to both migrate as well as upgrade databases to Oracle 12c Release 2
• Performing minimal downtime database upgrades
Upgrade or Upgrade and Migration?

• Upgrade
  • Data Dictionary (not user data)
  • Upgrade independent of size

• Migration
  • Both Data Dictionary as well as user data
  • Upgrade only a subset of current data
  • Move upgraded data to new hardware or new platform
  • Change characterset as part of upgrade
  • Migration usually dependent on size of database or data being migrated
What factors influence upgrade duration

Database upgrade duration depends on:

- Number of installed components and database options - see DBA_REGISTRY –
- Number of objects in the database – ERP type applications have high amount of dictionary tables
- To less extent: CPU cores and IO throughput
- 40 to 90 minutes approximate upgrade duration
Can you minimize the upgrade downtime?

- Upgrade planning
- Upgrade preparation
- Choosing the appropriate upgrade/migration method
- Application stability post-upgrade is maybe more important than minimizing upgrade downtime!
- Avoid unplanned outages post-upgrade!
Is now the time to upgrade?

• Road map of product releases
  • 11.2 released in 2009
  • 12c Release 1 in June 2013
  • 12c Release 2 March 2017

• 11.2.0.4 waived extended support ends in Dec 2018 extended from 31st May 2017
• All versions < 11.2.0.4 are out of support!
• Maintenance costs for unsupported versions may be higher than upgrade costs!
What is stopping people from upgrading

• Scared optimizer changes/enhancements may affect key SQL queries
• No certification for applications on Oracle Database 12.x
• Upgrade requires too much effort or don’t have skills
• System is working fine – there is no need for an upgrade!
• *Cannot afford downtime* – we will address this concern (minimal downtime upgrade methods)
Why Upgrade ...?

- Oracle Multitenant
- Rapid Home Provisioning
- Oracle Automatic Data Optimization
- Performance Improvements
- Data Guard Far Sync
- Big Data SQL
- Application Continuity
- JSON Document Store
- Data Redaction
- Oracle In-Memory
- Pattern Matching
Why Upgrade ....?

• Online conversion of non-partitioned to partitioned table
• Flashback PDB
• Hot cloning of PDB
• Auto-list partitioning
• Read-only partitions
• In-memory on standby database
• Encrypt tablespaces online
• Database Sharding

How will any of the new features benefit the business or application end users??
Database Upgrade/Migration Planning

- **Step-by-Step Strategy**
  - Piecemeal to mitigate risks – learn as we go

- **Big-Bang Strategy**
  - All in one single downtime window
  - Sometimes necessary due to dependencies

- Least Critical First
- Most Critical First

*Upgrade downtime allowable will very often dictate upgrade method to be used*

Can your database application’s users afford to withstand a *limited* amount of time with only *read-only access* to the database being migrated?
Upgrade and Migration Methods

- Expdp/impdp
- Transportable Tablespaces
- Transportable Databases
- Transient Logical Standby
- RMAN Cross Platform Inc. Backups
- GoldenGate

- Oracle 10.2
- Oracle 11.1
- Oracle 11.2.0.2
- Oracle 11.2.0.3/4
- Oracle 12.1.0.1/2

- Oracle 10.2
- Oracle 11.1
- Oracle 11.2.0.2
- Oracle 11.2.0.3/4
- Oracle 12.1.0.1/2

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- Oracle 11.1
- Oracle 11.2.0.2
- Oracle 11.2.0.3/4
- Oracle 12.1.0.1/2
Oracle 12c upgrades are faster!

- Faster upgrades in 12c Direct upgrade supported versions
- Runs database upgrade scripts in parallel
- Reduced downtime for upgrades
- Note: DBUA – no hardware change (old and new homes need to be present)
- Prioritise upgrades for PDBs within a CDB
- Most critical PDB upgraded first and available first
- If DBUA failure, first attempt command line upgrade before restoring!
DBUA and Manual Upgrade

$ORACLE_HOME/perl/bin/perl catctl.pl -n 8 -l /home/orcl catupgrd.sql

Direct Upgrade with DBUA

11.2.0.3 and higher
Upgrade preparation

• Empty the recycle bin (PURGE DBA_RECYCLEBIN)
• Check for INVALID objects in application schemas as well as SYS and SYSTEM
• Recompile invalid objects before upgrade or migration
• Make a note of objects still INVALID even after recompile. Reconcile this after upgrade is performed
• Check for any duplicate objects in SYS and SYSTEM
• Check any INVALID components via DBA_REGISTRY
Upgrade preparation

- Remove components not in use — example APEX in CDB prevents unplug and plug of PDB between 12.1.0.2 and 12c Release 2 due to difference in versions

```sql
SQL> create pluggable database pdb1 using '/tmp/pdb1.xml'
file_name_convert=('/u03/app/oradata/cdb121/','/u03/app/oradata/cdb122/');

create pluggable database pdb1 using '/tmp/pdb1.xml'
  *
ERROR at line 1:
ORA-65346: The PDB version is lower and components (APEX) are missing in CDB.
```

*In this example APEX was not installed in 12.2 CDB*
Upgrade preparation

• Obtain and preserve performance statistics
• Adjust AWR settings to increase retention settings and snapshot frequency via DBMS_WORKLOAD_REPOSITORY
• Take steps to ensure execution plan stability
• Enable Flashback in the database just before upgrade if flashback logging is not currently enabled
• Have a downgrade plan as well!
Upgrade preparation

• SQL Performance Analyzer – capture SQL’s into SQL Tuning Set (STS)
  • Export, Import and then evaluate using SPA

• Consider SQL Tuning Advisor for any regressed SQL

• SQL Plan Baselines
  • DBMS_SPM. CREATE_STGTAB_BASELINE
  • DBMS_SPM. PACK_STGTAB_BASELINE
  • DBMS_SPM. UNPACK_STGTAB_BASELINE

• Real Application Testing
  • Capture, Process and Replay workload

• AWR difference reports
  • Current environment and upgraded test environment
Only upgrade what's required!

• Remove obsolete components
  • EM Control Repository (replaced by Database Express)
  • Ultrasearch
  • Oracle Multimedia
  • Oracle Expression Filter ....etc
Prepare and patch target ORACLE_HOME:

- Install 12c software – install newest patch set or base release
- Apply latest bundle patch or PSU
- Apply any published interim patches for known issues
- BEFORE!
  - Upgrade or Migration
Pre-Upgrade Checks

• Download the most recent version of preupgrade.jar
  • MOS Note: 884522.1

```
[oracle@linux01 bin]$ $ORACLE_HOME/jdk/bin/java -jar 
/u02/app/oracle/product/12.2.0/dbhome_1/rdbms/admin/preupgrade.jar dir /tmp -c pdb1
```

• Preupgrade generated files:
  • /tmp/preupgrade.log
  • /tmp/preupgrade_fixups.sql
  • /tmp/postupgrade_fixups.sql

Do this well in advance of actual upgrade!
Monitor the upgrade process

- Don’t just depend on progress bar in DBUA
  - tail –f alert.log
  - tail -f catupgrd*.log

- 12.2 upgrade generates more achieve logs as compared to 12.1
- NOARCHIVELOG mode for upgrade?
- Upgrade hung?
  - Check FRA (Fast Recovery Area) disk space
  - Check value for db_recovery_file_dest_size
Post-Upgrade checks

• Adjust time zone post upgrade

<table>
<thead>
<tr>
<th>Oracle Database Release</th>
<th>Default TZ Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2.0.3 – 11.1.0.7</td>
<td>DST V4</td>
</tr>
<tr>
<td>11.2.0.1</td>
<td>DST V11</td>
</tr>
<tr>
<td>11.2.0.2 - 11.2.0.4</td>
<td>DST V14</td>
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<tr>
<td>12.1.0.1, 12.1.0.2</td>
<td>DST V18</td>
</tr>
<tr>
<td>12.2.0.1</td>
<td>DST V26</td>
</tr>
</tbody>
</table>

SQL> shutdown immediate;
Pluggable Database closed.

SQL> alter pluggable database open upgrade;
Pluggable database altered.

SQL> exec dbms_dst.begin_upgrade (26);
PL/SQL procedure successfully completed.
Post-Upgrade checks

• Minimum COMPATIBLE parameter for 12c is 11.0.0
• DBUA or manual upgrade will not change COMPATIBLE parameter
• Leave COMPATIBLE at original value for at least a week before changing to a higher value
• Cannot downgrade once COMPATIBLE is set to a new higher value!
• Database restart is required to change the COMPATIBLE parameter

```sql
SQL> alter system set compatible = '12.2.0' scope=spfile;
```
Upgrades using Data Pump

- Have to use exp/imp for Oracle database 10.1 and lower
- Ease of use
- Lots of good new Data Pump features in 12c
- But still longest downtime window for upgrade
- Great to also perform a reorganization and defragmentation of the database as part of the upgrade process
- But not a good option for minimal downtime upgrades especially for VLDBs
- Downtime for not only importing data but also creating indexes
Transportable Tablespaces

- TTS – available since Oracle 8i
- XTTS – available since 10g
- Copying data files faster than copying rows of data
- Tablespaces needed to be self-contained as well as read-only
- Cross platform support for moving data between Little Endian and Big Endian platforms
  - RMAN CONVERT
  - DBMS_FILE_TRANSFER – does not require staging area and slower
- Conversion can be done on source or target system
- Need space for staging - could be a show stopper for VLDBs
- Cannot transport SYSTEM/SYSAUX – metadata export/import can take a very long time for applications with thousands of objects (Oracle Apps for eg.)
Transportable Database

• 11.2.0.3 and higher source
• Combines Data Pump ease of use with TTS speed of migration
• Migrate data between platforms on same Endian platform (not anymore)
• Migrate data between platforms on different Endian platform – supported in 12c with RMAN (or DBMS_FILE_TRANSFER) endian conversion
• Migrate both user data as well as data dictionary
• Application/User Tablespaces as well as Administrative Tablespaces
• Requires same data file conversion using RMAN – either on source or target
• Upgrade Non-CDB/Non-CDB, PDB/PDB, PDB/Non-CDB
Transportable Database

Upgrading/Migrating from an 11.2.0.4 non-CDB into a 12c pluggable database

• Create a new PDB in the destination 12c CDB using the create pluggable database command
• Set the user and application table spaces in the source database to be READ ONLY
• Export from the source database using expdp with the FULL=Y, VERSION=12.0 and TRANSPORTABLE=ALWAYS
• Copy the dump file and data files for table spaces containing user/application data to the destination
• Create a directory object in the destination PDB pointing to the folder containing dump file
• Using an account that has the DATAPUMP_IMP_FULL_DATABASE privilege, import into the target database using impdp with the FULL=Y and TRANSPORT_DATAFILES parameters
• Restore the user table spaces in source database to read/write mode
RMAN Cross Platform Incremental Backups

- Both Transportable Tablespaces/Databases have a large downtime component when tablespaces are in read-only mode
- Simplify the platform migration and minimize read-only down time on the source database using incremental based approach
- Reduce downtime by 8 times versus traditional migration approaches
- Supports cross platform – conversion either on source or on target
- Initial copy of the datafiles occurs while the source database remains online.
RMAN Cross Platform Incremental Backups

• Transfer source datafiles to the destination (source database remains online)
• Convert datafiles to new endian format if required
• Create an incremental backup of the source tablespaces
• Transfer the incremental backup to the destination
• Convert the incremental backup to new endian format if required
• Apply the incremental backup to the destination database
RMAN Cross Platform Incremental Backups

- Repeat the incremental backup steps as needed
- Place the source database into read only mode – outage starts only now
- Take one last incremental backup, copy, apply and recover on target
- Export metadata from the source
- Import metadata on the destination
- Make tablespaces on destination read/write
Rolling upgrade using Transient Logical Standby

• Start with the 11.2.0.4 Data Guard physical standby database and convert that to a transient logical standby database. Users are still connected to primary database

• Upgrade the transient logical standby database to 12.1.0.1

• The transient logical standby process uses SQL Apply to take redo generated by a database running a lower Oracle version (11.2.0.4), and apply the redo to a standby database running on a higher Oracle version (12.1.0.1)

• Perform a switchover so that the original primary database now becomes a physical standby database

• Use Redo Apply to synchronize (and upgrade) the original primary database with the new upgraded primary database

• Perform another switchover to revert the databases to their former roles
Rolling upgrade using Transient Logical Standby

- Database Rolling Upgrade Shell Script (Doc ID 949322.1) – download script physru
  
  $physru <sysdba user> <primary TNS alias> <physical standby TNS alias>
  <primary db unique name> <physical standby db unique name> <target version>

- Manual steps required by the DBA
  - Install Oracle 12c software on both primary and standby sites
  - Upgrade the standby database using DBUA or manual upgrade.
  - Start the upgraded standby database in the new Oracle 12c home
  - Start the original primary database in the new Oracle 12c home
Rolling upgrade using Transient Logical Standby

First execution

- Create control file backups for both the primary and the target physical standby database

- Creates Guaranteed Restore Points (GRP) on both the primary database and the physical standby database that can be used to flashback to beginning of the process or any other intermediate steps along the way

- Converts a physical standby into a transient logical standby database.
Rolling upgrade using Transient Logical Standby

Second Execution

• Use SQL apply to synchronize the transient logical standby database and make it current with the primary

• STARTUP UPGRADE – apply manual upgrade procedure to 12c R1/R2

• Performs a switchover to the upgraded 12c transient logical standby and the standby database becomes the primary

• Performs a flashback on the original primary database to the initial Guaranteed Restore Point and converts the original primary into a physical standby
Rolling upgrade using Transient Logical Standby

Third execution

- Starts Redo Apply on the new physical standby database (the original primary database) to apply all redo that has been generated during the rolling upgrade process, including any SQL statements that have been executed on the transient logical standby as part of the upgrade.

- When synchronized, the script offers the option of performing a final switchover to return the databases to their original roles of primary and standby, but now on the new 12c database software version.

- Removes all Guaranteed Restore Points.
Minimal downtime upgrades with Oracle GoldenGate

• Minimal (not zero!)
• Downtime will depend on fast client/application can be re-pointed to upgraded database
• Heterogenous – supports wide variety of RDBMS’s and platforms
• License costs ..? – adds to upgrade project cost
• But possible to procure term licenses just for upgrade
• Data can be filtered, transformed, and processed along with upgrade
• Do you have the additional OGG skills?
• OGG 12.2 does not support Oracle Database 12c Release 2 as yet!
GoldenGate Cloud Services
One of the best solutions to move (and upgrade) on premise data to the Cloud
Minimal downtime upgrades with Oracle GoldenGate

- Install OGG on both source and target upgrade site
- Install Oracle 12c Release 2 binaries and patches
- Create and start extract on source
- Create replicat on target – do not start!
- Full database export on source 11g
- Full database import on target 12c
- Changes pre-export/during export/post-upgrade being captured
- Outage starts now
- Start replicat on target – replicat filters transactions based on SCN
- Point users/application to upgraded 12c database
- Outage completed!
THANKS!

Enjoy the OTN Yathra!

Feedback/Questions to:
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