Best Practice Oracle Database 12c Upgrade

Please do not power off or unplug your machine. Installing update 1 of 5.
About me

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Who we are
dbi services

Experts At Your Service
> 45 specialists in IT infrastructure
> Certified, experienced, passionate

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> 100% self-financed Swiss company
> Over CHF 6 mio. turnover

Leading In Infrastructure Services
> More than 120 customers in CH, D, & F
> Over 40 SLAs dbi FlexService contracted
Best Practice Oracle Database 12c Upgrade

1. Where are we now?
2. Which options do I have?
3. Which problems may I encounter?
   - Related to the upgrade itself
   - Related to the new features
4. Maintain Oracle database 12c
5. Core Message
Best Practice Oracle Database 12c Upgrade
Where are we now?

- Oracle database roadmap
- Database patchset schedule
- Oracle Standard Edition (SE2)
- Client/Server interoperability
Where are we now?
Oracle Database roadmap (Doc ID 1360790.1)
Where are we now?
Database patchset schedule – 1

Release Schedule of Current Database Releases (Doc ID 742060.1)

Oracle 11.2.0.3
> Patchset G.A Date : 23-09-2011
> End-of-premier support: 27-08-2015

Oracle 11.2.0.4
> Patchset G.A Date : 27-08-2013
> End-of-premier support: 31-01-2015
> Free-waived support end: 31-01-2016 extended until 31-05-2017
> Oracle Database 11gR2 (11.2) Lifetime Support Changes (Doc ID 2068368.1)
Where are we now?
Database patchset schedule – 2

Oracle 12.1.0.1
> G.A Date : 25-05-2013
> End-of-premier support: 31-08-2016 (originally planned for 01-09-2015)

Oracle 12.1.0.2
> G.A Date : 22-07-2014
> End-of-premier support: 31-07-2018

Oracle 12.2.0.1
> Planned 1H CY2016
> Beta program 2 ongoing
Where are we now?
Oracle Standard Edition – 1

Lifetime Support Policy: Oracle Technology Products

**Oracle Database Releases**

<table>
<thead>
<tr>
<th>Release</th>
<th>GA Date</th>
<th>Premier Support Ends</th>
<th>Extended Support Ends</th>
<th>Sustaining Support Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.7</td>
<td>Sep 2000</td>
<td>Dec 2004</td>
<td>Dec 2006</td>
<td>Indefinite</td>
</tr>
<tr>
<td>10.1</td>
<td>Jan 2004</td>
<td>Jan 2009</td>
<td>Jan 2012</td>
<td>Indefinite</td>
</tr>
<tr>
<td>10.2</td>
<td>Jul 2005</td>
<td>Jul 2010</td>
<td>Jul 2013</td>
<td>Indefinite</td>
</tr>
<tr>
<td>11.2</td>
<td>Sep 2009</td>
<td>Jan 2015</td>
<td>Dec 2020</td>
<td>Indefinite</td>
</tr>
<tr>
<td>Standard Edition One (SE1) 12.1</td>
<td>Jun 2013</td>
<td>Aug 2016</td>
<td>Not Available</td>
<td>Indefinite</td>
</tr>
</tbody>
</table>
Where are we now?
Oracle Standard Edition – 2

**New game, new rules**: Releases beyond 12.1.0.1 will only be available to Standard Edition 2 (SE2) and Enterprise Edition users

- Named user plus (NUP) licensing
  - The **minimum** that was 5 NUP, it’s now **10 NUP** and this per server
- Sockets
  - The **maximum** was 4 sockets for a cluster (RAC), it’s now **2**

Which database edition do you want to install?

- **Enterprise Edition (6.4GB)**
  - Oracle Database 12c Enterprise Edition is a self-managing database that has the scalability, performance, high availability, and security features required to run the most demanding, mission-critical applications.

- **Standard Edition Two (6.1GB)**
  - Oracle Database 12c Standard Edition Two is a full-featured data management solution ideally suited to the needs of medium-sized businesses. It includes Oracle Real Application Clusters for enterprise-class availability and comes complete with its own Oracle Clusterware and storage management capabilities.

Where are we now?
Client/Server interoperability – 1

Client / Server Interoperability Support Matrix for Different Oracle Versions (Doc ID 207303.1)

The client version really matters!

<table>
<thead>
<tr>
<th>Client Version</th>
<th>12.1.0</th>
<th>11.2.0</th>
<th>11.1.0</th>
<th>10.2.0</th>
<th>10.1.0</th>
<th>9.2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.1.0</td>
<td>Yes</td>
<td>Yes</td>
<td>Was</td>
<td>MDS #7</td>
<td>No #3</td>
<td>No #3</td>
</tr>
<tr>
<td>11.2.0</td>
<td>Yes</td>
<td>Yes</td>
<td>Was</td>
<td>MDS #7</td>
<td>No</td>
<td>Was #5</td>
</tr>
<tr>
<td>11.1.0</td>
<td>Was</td>
<td>Was</td>
<td>Was</td>
<td>Was #7</td>
<td>Was #6</td>
<td>Was #5</td>
</tr>
<tr>
<td>10.2.0</td>
<td>MDS #7</td>
<td>MDS #7</td>
<td>Was #7</td>
<td>MDS</td>
<td>Was</td>
<td>Was #5</td>
</tr>
<tr>
<td>10.1.0 (#4)</td>
<td>No</td>
<td>Was #6</td>
<td>Was #6</td>
<td>Was</td>
<td>Was</td>
<td>Was</td>
</tr>
<tr>
<td>9.2.0</td>
<td>No #8</td>
<td>Was #5</td>
<td>Was #5</td>
<td>Was #5</td>
<td>Was</td>
<td>Was</td>
</tr>
</tbody>
</table>

Use case: Oracle 10.2 client // Oracle 12cR1 database

> SQL*Net encryption can’t be enabled!
## Where are we now?

### Client/Server interoperability – 2

How to check the Oracle client’s version?

```sql
SQL> SELECT s.username, c.client_version, c.client_driver, s.module
FROM v$session s, v$session_connect_info c
WHERE s.sid = c.sid AND UPPER(s.module) like '%EM%';
```

<table>
<thead>
<tr>
<th>USERNAME</th>
<th>CLIENT_VERSION</th>
<th>CLIENT_DRIVER</th>
<th>MODULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYS</td>
<td>11.1.0.7.0</td>
<td>jdbcthin</td>
<td>emagent_SQL_oracle_database</td>
</tr>
<tr>
<td>SYS</td>
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<td>jdbcthin</td>
<td>emagent_SQL_oracle_database</td>
</tr>
<tr>
<td>SYS</td>
<td>11.1.0.7.0</td>
<td>jdbcthin</td>
<td>EM Realtime Connection</td>
</tr>
<tr>
<td>SYS</td>
<td>11.2.0.3.0</td>
<td>jdbcthin</td>
<td>EM Realtime Connection</td>
</tr>
<tr>
<td>SYS</td>
<td>11.2.0.3.0</td>
<td>jdbcthin</td>
<td>EM Realtime Connection</td>
</tr>
<tr>
<td>SYS</td>
<td>11.2.0.3.0</td>
<td>jdbcthin</td>
<td>EM Realtime Connection</td>
</tr>
</tbody>
</table>

**Starting With Oracle JDBC Drivers** (Doc ID 401934.1)
Best Practice Oracle Database 12c Upgrade

Which options do I have?

- Migration paths
- Direct upgrade
- DBUA vs Manual upgrade
- Multitenancy
Which options do I have?
Migration paths – 1

Oracle <= 10.1

- Bigger downtime
  - exp/imp
  - expdp/impdp

- Medium downtime
  - Transportable Tablespaces

- Near zero downtime
  - Replication
Which options do I have?
Migration paths – 2

Oracle => 10.2

Bigger downtime
- expdp/impdp
- CTAS
- SQL Loader
- Transportable Database

Medium downtime
- Transportable Tablespaces
- Full Transportable Tablespaces

Near zero downtime
- Replication
Which options do I have?

Direct Upgrade – 1

Supported when source database is running on
- Oracle Database 10.2.0.5
- Oracle 11.1.0.7
- Oracle 11.2.0.2 or later

Other cases cannot upgrade directly to 12c
- Use a migrate option (exp/imp for example)
- Upgrade to intermediate release before upgrade to 12c

Upgrade process should be carefully prepared and tested 😊
Which options do I have?
Direct Upgrade – 2

- Oracle compatible release
  - Bigger downtime
    - DBUA
    - Manual
  - Medium downtime
    - Transportable Tablespaces
    - Full Transportable Tablespaces
Which options do I have?

Manual vs. DBUA

**Manual**
- Full control over all steps
- Can be restarted in case of failure to specific step
- Requires many scripts to be started
- All post-upgrade tasks have to be done manually

**DBUA**
- Run automatic pre-upgrade checks
- Allow automatic fix
- Manage post-upgrade tasks
- Cannot be restarted in case of failure
Which options do I have?
Multitenancy – Upgrade and plugin as a PDB

Direct upgrade to PDB is not supported
> Convert 12c non-CDB to PDB is supported

Upgrade from 11g to PDB requires intermediate steps
> Requires a container database on the same server
> Upgrade database to 12c
> Convert the database as PDB
  [@?/rdbms/admin/noncdb_to_pdb.sql]
> Plug the database into the existing container

Other available path to PDB
> Import using expdp/impdp
> Transportable tablespaces
Best Practice Oracle Database 12c Upgrade
Which problems may I encounter?

- UPGRADE Assault course (some bugs & hints)
- Evolutions in the Optimizer 12cR1
- Adaptive query optimization
- Codename “O.F.E”
Which problems may I encounter?
Assault course (some bugs & hints) – 1

Pre-Upgrade

> Bug 17325413 - DROPPED COLUMN WRITTEN TO DISK BLOCK
> https://blogs.oracle.com/UPGRADE/entry/ouch_this_really_hurts_bug
> Apply most recent PSU

> Download and Run Oracle’s latest Database Pre-Upgrade Utility (Doc ID 884522.1)

> Save DB-Links password (SYS.LINK$, in case the database has to be downgraded again), Roles protected through passwords
> DB Links passwords are encrypted during 12c upgrade

> Oracle Database Upgrade Path Reference List (Doc ID 730365.1)
> Complete Checklist for Manual Upgrades to Oracle Database 12c Release 1 (12.1) (Doc ID 1503653.1)
Which problems may I encounter?
Assault course (some bugs & hints) – 2

Post-Upgrade

- [https://blogs.oracle.com/UPGRADE/entry/dbca_12c_and_datapatch_pl](https://blogs.oracle.com/UPGRADE/entry/dbca_12c_and_datapatch_pl)
- DBUA does not execute datapatch.pl as part of the post-upgrade actions
- DBCA does not execute datapatch.pl as part of the database creation process
- Workaround: run datapatch manually (fixed as of PSU January 2016 - 160119)

```bash
# $ORACLE_HOME/Opatch/datapatch -verbose
```

- Bug 18082840 - ORA-600 [KZPCPW:INVALID VERIFIER TYPE] ON PASSWORD CHANGE
- Happens for users who cannot freely reuse the passwords
- Related to the undocumented password change method IDENTIFIED BY VALUES
- Workaround: (no permanent fix yet planned, still under testing)

```sql
SELECT COUNT(*) FROM sys.user_history$;
DELETE FROM user_history$;
```
Which problems may I encounter?
Evolutions in Optimizer 12cR1 – 1

Adaptive query optimization

Before execution
- New Histograms
- Online Gathering
- Private Statistics

First execution
- Dynamic Statistics
- Adaptive Plans

Next execution
- Auto Reoptimization

For future executions
- SQL Plan Directives
Which problems may I encounter?
Adaptive query optimization – 1

Adaptive plans
> Two adaptive methods
  > Join method
  > Parallel Distribution
> Happens only for the first, default execution
> V$SQL.IS_RESOLVED_ADAPTIVE_PLAN
  > Values are Y|N or NULL (Y indicates the final plan has been chosen)

EXPLAIN PLAN shows only the first execution plan

Use dbms_xplan.display(format=>'LAST ADAPTIVE'));

Note
-----
- this is an adaptive plan (rows marked '-' are inactive)
Which problems may I encounter?
Adaptive query optimization – 2

Adaptive plans can be completely or partially disabled

> At session, system level

```sql
_OPTIMIZER_ADAPTIVE_PLANS = FALSE
```

> Hints

```sql
/*+ NO_ADAPTIVE_PLAN */
/*+ ADAPTIVE_PLAN */
```

> For specific features

```sql
_OPTIMIZER_NLJ_HJ_ADAPTIVE_JOIN = FALSE
_PX_ADAPTIVE_DIST_METHOD = OFF
```
Which problems may I encounter?
Adaptive query optimization – 3

Adaptive statistics – **Automatic Dynamic Statistics (ADS)**
> formerly called Dynamic Sampling

Adaptive query optimization controls only ADS
> ADS happens when

```
OPTIMIZER_ADAPTIVE_FEATURES = TRUE
OPTIMIZER_DYNAMIC_SAMPLING = 2 (default or higher)
```

> ADS **does not happen** when (Oracle 11g behavior, dynamic sampling)

```
OPTIMIZER_ADAPTIVE_FEATURES = FALSE
OPTIMIZER_DYNAMIC_SAMPLING = 2 (except 11)
```

> Level 11 means ADS is enabled forever despite of
  OPTIMIZER_ADAPTIVE_FEATURES setting
Which problems may I encounter?
Adaptive query optimization – 4

Ways to disable Adaptive Dynamic Statistics

> At session, system level

OPTIMIZER_DYNAMIC_SAMPLING = 0

> Hint for all tables

```sql
/*+ DYNAMIC_SAMPLING( 0 ) */
```

> Hint for specific tables

```sql
/*+ DYNAMIC_SAMPLING( <tab/alias name> 0 ) */
```

Next step:

> Is the issue related to statistics feedback, SQL Plan Directives or the Result Cache?
Which problems may I encounter?
Adaptive query optimization – 5

Adaptive statistics - **Automatic reoptimization**
> formerly called Cardinality (statistics) feedback
> The execution plan changes for subsequent execution
  V$SQL_SHARED_CURSOR.USE_FEEDBACK_STATS (values Y|N)

Ways to disable Automatic reoptimization
> At session, system level
  ```
  _OPTIMIZER_USE_FEEDBACK = FALSE
  _OPTIMIZER_GATHER_FEEDBACK = FALSE
  ```
> Hint
  ```
  /*+ OPT_PARAM( '_OPTIMIZER_USE_FEEDBACK' 'FALSE' ) */
  ```

Bug 20311655 : SQL PLAN DIRECTIVE INVALIDATED BY STATISTICS FEEDBACK
Which problems may I encounter?

Adaptive query optimization – 6

Adaptive statistics – SQL Plan Directives

- `V$SQL.IS_REOPTIMIZABLE` (values Y|N|R)

Why?

- Because of cardinality misestimates

Where?

- Single table cardinality misestimates
- JOIN cardinality misestimates
- Query block cardinality misestimate
- GROUP BY cardinality misestimate
- HAVING cardinality misestimate

Consequence

- More static statistic gathering (ie: extended statistics)
  - `dbms_stats.gather_database_stats_job_pro`
- More dynamic statistics (ADS)
Which problems may I encounter?
Adaptive query optimization – 7

Matching the directives used and the SQL_ID using them

Note
-----
- dynamic statistics used: dynamic sampling (level=2)
- 1 Sql Plan Directive used for this statement

UNDOCUMENTED: dbms_xplan.display(format=>'+metrics'))

Sql Plan Directive information:
-------------------------------
Used directive ids:
  3140844622355566871

Disable specific directives
Which problems may I encounter?
Adaptive query optimization – 8

Long parsing time due to a lot of SQL Plan Directives
> It takes time to check all of them on the dictionary
> High dynamic sampling activity
> Result cache invalidation (SQL with literals)

Disable completely the SQL Plan Directives

```sql
# disable use of directives
 OPTIMIZER_DSDIR_USAGE_CONTROL = 0

# disable creation of directives
 SQL_PLAN_DIRECTIVE_MGMT_CONTROL = 0
```

Bug 20465582: SQL PLAN DIRECTIVES CAUSING SLOWDOWN OF DICTIONARY QUERIES (Fixed in 12.2)
Which problems may I encounter?
Adaptive query optimization – 9

High "Latch Free" Waits with Contention on 'Result Cache: RC Latch' when RESULT_CACHE_MODE = MANUAL on Oracle 12c (Doc ID 2002089.1)

SQL Plan Directives meaning there is not enough statistics
> Object used by lots of OLTP queries
> Adaptive Dynamic Statistics started too often to get better cardinalities

Side effect: put pressure on result cache latch
> Result cache may be filled by output invalidated before re-use

_OPTIMIZER_ADS_USE_RESULT_CACHE = FALSE

> Vortrag DOAG Datenbank 2015
> https://goo.gl/8NpKXX

DOAG#DB16 – Düsseldorf
Which problems may I encounter?
Codename “O.F.E”

OPTIMIZER_FEATURES_ENABLE

> Which features do we want to use?
> Those who works of course 😊

Keep O.F.E = 12.1.0.2 and disable only what does not work for you

> Every version comes with fixes (and features)
> Try to find out which feature is responsible for your problem

How to Approach Issues that Appear Related to Adaptive Features Such as Adaptive Query Optimization (Doc ID 2068807.1)

Adaptive Query Optimization (Doc ID 2031605.1)

http://blog.dbi-services.com/ofe-optimizer-features-enable/
http://blog.dbi-services.com/the-taboo-of-underscore-parameters
Best Practice Oracle Database 12c Upgrade
Maintain Oracle database 12c

- Patching Oracle 12c
- MAX_STRING_SIZE
Maintain Oracle database 12c
Patching

Regular database patching “Combo OJVM+DB P.S.U”

```
# datapatch -verbose
...
Current state of SQL patches:
Patch 21555660 (Database PSU 12.1.0.2.5, Oracle JavaVM Component (Oct2015)):
...
Error: prereq checks failed!
patch 21555660: rollback script /u00/app/oracle/product/12.1.0.2_160119/sqlpatch/21555660_rollback.sql does not exist
Prereq check failed, exiting without installing any patches.
...```

New behavior (S.R closed), commodity

> “in-place” PSU application
> Rollback OJVM PSU before the Oracle Home “switch”
Oracle 12cR1 NF - **MAX_STRING_SIZE** = EXTENDED

- Fixed bugs
  - Bug 20539050 - ORA-30556 ON USING /RDBMS/ADMIN/UTL32K
  - Bug 21656315 - RECOVER TABLE COMMAND FAILS WITH ORA-14693 IF MAX_STRING_SIZE = EXTENDED
  - Bug 18264857 ORA-24920 "column size too large for client" from 12.1 JDBC client from DB with max_string_size=extended

Effect of MAX_STRING_SIZE on Data Guard (Doc ID 2010497.1)

Our recommendation is to create a dedicated 12cR1 database for application using this feature.

- Things will for sure change with the upcoming 12cR2 release
Best Practice Oracle Database 12c Upgrade
Core Message
TEST, TEST, TEST and Re-TEST!

- Oracle 12.1.0.2 + Combo OJVM+DB P.S.U 160119
- Left-outer join fails ...

Thu Feb 18 13:45:25 2016
Exception [type: SIGSEGV, Address not mapped to object] [ADDR:0x0] [PC:0xCBB3A8B, evaopn3()+107] [flags: 0x0, count1]
Errors in file /u00/app/oracle/diag/rdbms/p1bnkg_site1/PBACT212/trace/P1BNKG_ora_29623.trc (incident=17859):
ORA-07445: exception encountered: core dump [evaopn3()+107] [SIGSEGV] [ADDR:0x0] [PC:0xCBB3A8B] [Address not mapped to object] []

- S.R answer 01-02-2016 : disable adaptive features
- S.R answer 25-02-2016 : rollback MAX_STRING_SIZE = EXTENDED
- 30-03-2016 Patch 20228791 available
  - on top of Combo OJVM+DB P.S.U 160119
Core Message

Last one but not least

Read the posts from Mike Dietrich
(*Master Product Manager* - Database Upgrade & Migrations - Oracle)

> [Read the posts from Mike Dietrich](https://webcache.googleusercontent.com/search?q=cache:rxwunNgkEvUJ:https://blogs.oracle.com/UPGRADE/entry/my_current_parameter_recommendations_oracle+%&cd=1&hl=en&ct=clnk&gl=ch)

Oracle 12c optimizer “adaptive everywhere”

> Less predictable
> SQL plan management shall be checked regularly
> Oracle 12c upgrade recommendation:
> *start from Zero and delete the SQL profiles*

Introduce smoothly single-tenant database instances

> Traditional database architecture deprecated (in future releases)
Any questions? Please do ask.