What's New in Oracle Data Pump?

Oracle Database 12c Release 2

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ORACLE

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What's New in Data Pump?

Parallel Export/Import of Metadata

Substitution Variables & Wildcards

REMAP_DIRECTORY

Long Identifier support

TRUST_EXISTING_TABLE_PARTITIONS

Validation & Verification options

Other 12.2 Features

Recap of 12.1 Features

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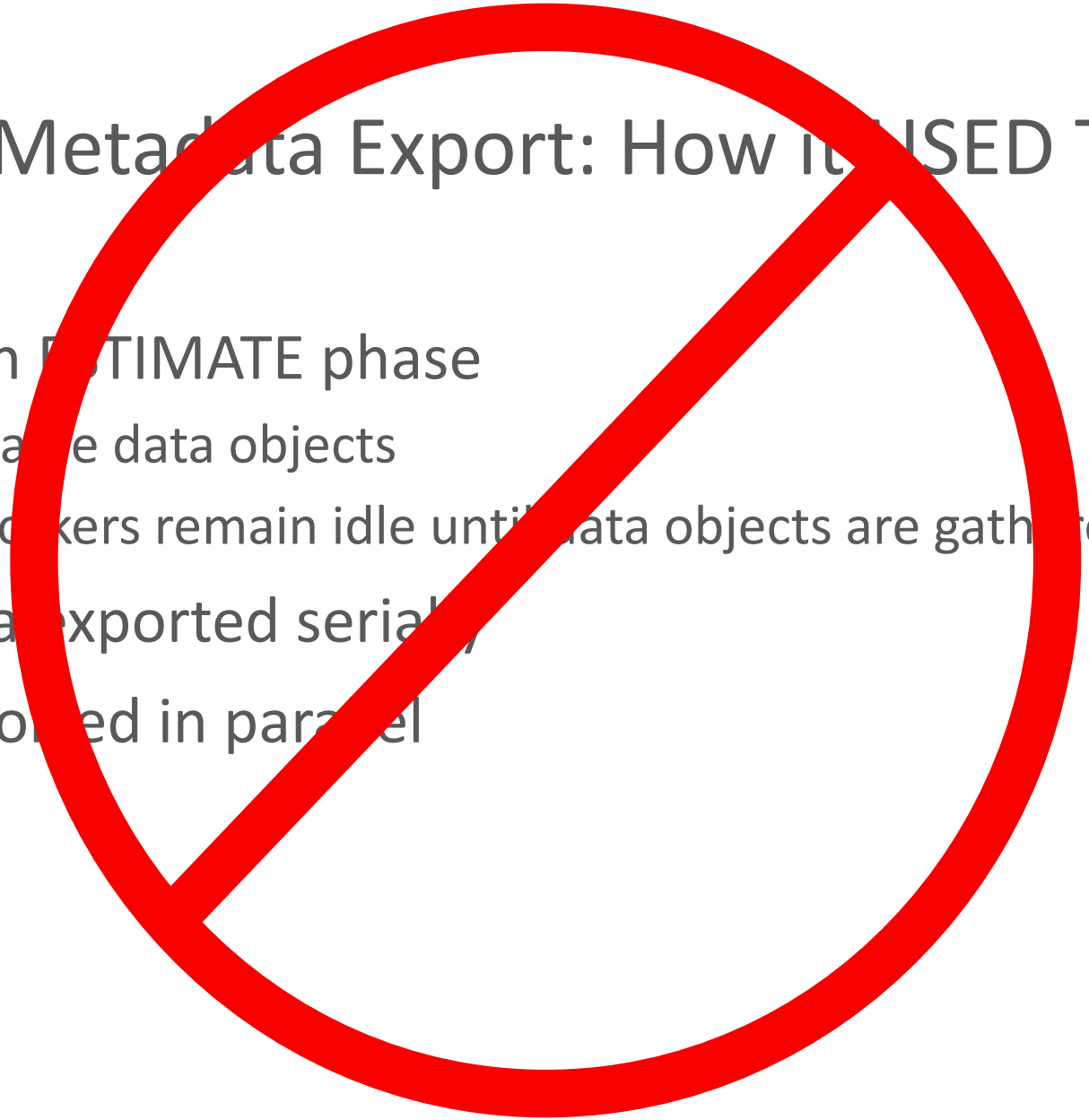
Parallel Metadata Export: How it USED TO Work

Pre-12.2

- Start with ESTIMATE phase
  - Gather table data objects
  - Other workers remain idle until data objects are gathered
- Metadata exported serially
- Data exported in parallel



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Parallel Metadata Export: How it Works Now

New Feature in 12.2

- Start with Analysis step
  - Metadata objects passed immediately to workers as they are found
  - E.g. Worker 1 finds a set of TABLE definitions, they are handed off to worker 2
- ESTIMATE phase still happens, but metadata no longer held up by estimate
- Notes:
  - Works for dumpfile jobs, and for network jobs if destination database is 12.2
  - Transportable jobs are not (yet) parallel for metadata
  - ESTIMATE phase now uses STATISTICS only
  - Restart works as always

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Parallel Metadata Export: Logfile

- 12.1.0.2

```
18-SEP-16 10:53:16.733: Starting "SYSTEM"."MD_EXP_16_12102":  system/******** parfile=md_exp_16_12102.par
18-SEP-16 10:53:17.600: Startup took 2 seconds
18-SEP-16 10:53:17.623: Estimate in progress using BLOCKS method...


18-SEP-16 10:54:37.945: Processing object type DATABASE_EXPORT/NORMAL_OPTIONS/VIEWS_AS_TABLES/TABLE_DATA
18-SEP-16 10:55:30.500:      Estimated 10 TABLE_DATA objects in 0 seconds
18-SEP-16 10:55:30.502: Processing object type DATABASE_EXPORT/SCHEMA/TABLE/TABLE_DATA
18-SEP-16 10:55:56.008:      Estimated 36026 TABLE_DATA objects in 79 seconds
18-SEP-16 10:55:56.380: Startup took 162 seconds
18-SEP-16 10:55:56.556: Startup took 162 seconds
18-SEP-16 10:55:56.757: Startup took 162 seconds
18-SEP-16 10:55:56.949: Startup took 162 seconds


18-SEP-16 10:56:01.566: Total estimation using BLOCKS method: 74.77 GB
18-SEP-16 10:56:02.015: Processing object type DATABASE_EXPORT/PRE_SYSTEM_IMPCALLOUT/MARKER
18-SEP-16 10:56:02.022:      Completed 1 MARKER objects in 1 seconds
18-SEP-16 10:56:02.023: Processing object type DATABASE_EXPORT/PRE_INSTANCE_IMPCALLOUT/MARKER
18-SEP-16 10:56:03.534:      Completed 1 MARKER objects in 0 seconds
18-SEP-16 10:56:03.535: Processing object type DATABASE_EXPORT/TABLESPACE
```

- 12.2.0.1

```
18-SEP-16 15:24:32.166: Starting "SYSTEM"."MD_EXP_16_12201":  system/******** parfile=md_exp_16_12201.par
18-SEP-16 15:24:32.742: W-1 Startup took 2 seconds
18-SEP-16 15:24:35.601: W-3 Startup took 3 seconds
18-SEP-16 15:24:36.148: W-2 Startup took 3 seconds
18-SEP-16 15:24:36.205: W-4 Startup took 4 seconds
18-SEP-16 15:24:36.393: W-5 Startup took 4 seconds
18-SEP-16 15:24:36.490: W-6 Startup took 4 seconds
18-SEP-16 15:24:36.491: W-7 Startup took 4 seconds
18-SEP-16 15:24:36.650: W-8 Startup took 4 seconds
18-SEP-16 15:24:36.714: W-9 Startup took 4 seconds
18-SEP-16 15:24:36.715: W-10 Startup took 4 seconds
18-SEP-16 15:24:36.716: W-11 Startup took 4 seconds
18-SEP-16 15:24:37.153: W-12 Startup took 4 seconds
18-SEP-16 15:24:37.187: W-13 Startup took 4 seconds
18-SEP-16 15:24:37.220: W-14 Startup took 4 seconds
18-SEP-16 15:24:37.253: W-15 Startup took 4 seconds
18-SEP-16 15:24:37.286: W-16 Startup took 4 seconds
18-SEP-16 15:24:37.323: W-3 Processing object type DATABASE_EXPORT/PRE_SYSTEM_IMPCALLOUT/MARKER
18-SEP-16 15:24:37.324: W-3      Completed 1 MARKER objects in 0 seconds
18-SEP-16 15:24:37.358: W-2 Processing object type DATABASE_EXPORT/PRE_INSTANCE_IMPCALLOUT/MARKER
18-SEP-16 15:24:37.359: W-2      Completed 1 MARKER objects in 0 seconds
18-SEP-16 15:24:37.436: W-7 Processing object type DATABASE_EXPORT/PROFILE
18-SEP-16 15:24:37.509: W-8 Processing object type DATABASE_EXPORT/SYS_USER/USER
18-SEP-16 15:24:37.580: W-4 Processing object type DATABASE_EXPORT/ROLE
18-SEP-16 15:24:37.584: W-7      Completed 3 PROFILE objects in 1 seconds
18-SEP-16 15:24:37.585: W-8      Completed 1 USER objects in 0 seconds
18-SEP-16 15:24:37.664: W-4      Completed 64 ROLE objects in 0 seconds
```

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Parallel Metadata Import

- Pre-12.2:
  - One worker per partition/subpartition
  - PQ used if partitions are large enough
  - Package bodies loaded in parallel
- With patch for bug 22273229
  - Indexes built in parallel
  - Constraints created in parallel
  - Available as backport to 12.1.0.2, 11.2.0.4

- Starting with 12.2
  - Added parallel import of most other metadata objects
  - Some exceptions
    - Types (due to inheritance)
    - Schemas
    - Procedural actions

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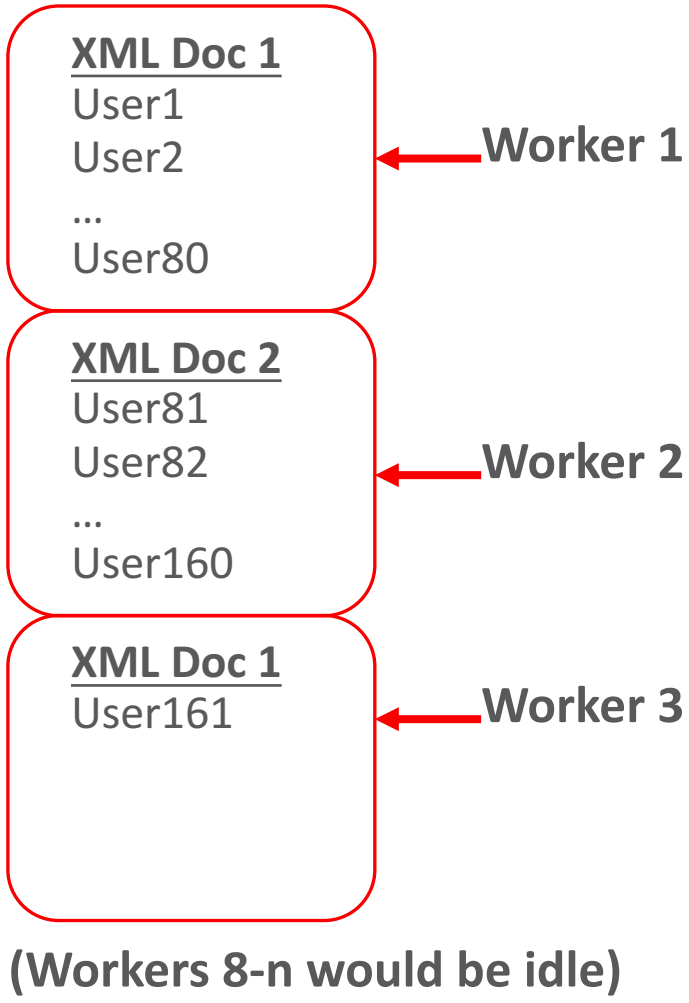
Parallel Metadata Import: Internals

- Metadata is exported in XML documents
  - Each XML document in dumpfile contains *n* objects of a given type
- XML documents are allocated to workers 1 document at a time
- Example: 161 users to import
  - Users are exported with up to 80 users per XML document
  - What happens with `PARALLEL=8`?
- Notes:
  - Works for conventional (dumpfile) jobs
  - Not (yet) for transportable jobs or network mode
  - Restart works same as always
  - Status command will show multiple workers on metadata



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Parallel Metadata Import: Logfile

- Comparison with `PARALLEL=8` for 27586 object grants and `METRICS=Y`
  - 12.1.0.2

```
15-SEP-16 13:56:16.317: Processing object type DATABASE_EXPORT/SCHEMA/SEQUENCE/GRANT/OWNER_GRANT/OBJECT_GRANT
15-SEP-16 13:57:06.374:      Completed 27586 OBJECT_GRANT objects in 50 seconds
```

  - 12.2.0.1

```
15-SEP-16 11:59:35.190: W-7 Processing object type DATABASE_EXPORT/SCHEMA/SEQUENCE/GRANT/OWNER_GRANT/OBJECT_GRANT
15-SEP-16 11:59:49.304: W-4       Completed 27586 OBJECT_GRANT objects in 10 seconds
15-SEP-16 11:59:49.304: W-4       Completed by worker 1 3426 OBJECT_GRANT objects in 10 seconds
15-SEP-16 11:59:49.304: W-4       Completed by worker 2 3440 OBJECT_GRANT objects in 10 seconds
15-SEP-16 11:59:49.304: W-4       Completed by worker 3 3440 OBJECT_GRANT objects in 10 seconds
15-SEP-16 11:59:49.304: W-4       Completed by worker 4 3440 OBJECT_GRANT objects in 9 seconds
15-SEP-16 11:59:49.304: W-4       Completed by worker 5 3440 OBJECT_GRANT objects in 10 seconds
15-SEP-16 11:59:49.304: W-4       Completed by worker 6 3520 OBJECT_GRANT objects in 10 seconds
15-SEP-16 11:59:49.304: W-4       Completed by worker 7 3440 OBJECT_GRANT objects in 10 seconds
15-SEP-16 11:59:49.304: W-4       Completed by worker 8 3440 OBJECT_GRANT objects in 10 seconds
```

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Performance: Parallel Metadata Import

- Examples from E-Business Suite test database

Object Type	Count	11.2.0.4 PARALLEL=32	12.1.0.2 PARALLEL=8	12.1.0.2 PARALLEL=32 With Patch	12.1.0.2 PARALLEL=8	12.2.0.1 PARALLEL=32	Comments
OBJECT_GRANT (owner)	27586	49	50	51	10	22	Hard connect for each grant
SYNONYM	43254	105	109	111	25	44	
TYPE	4364	108	114	119	111	110	Handled by single worker
PROCACT_SCHEMA	606	198	216	214	152	175	Handled by single worker
TABLE	33164	923	1160	1298	368	248	
OBJECT_GRANT (table)	358649	541	543	578	142	157	Hard connect for each grant
INDEX	53190	6721	5770	360	418	272	
PACKAGE	53217	424	476	474	114	54	
VIEW	34690	538	583	593	151	184	
PACKAGE_BODY	52092	1363	1974	1186	1981	959	Always parallel since 11.2

*import time in seconds

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Substitution Variables for Dumpfile Name

- Substitution variables for dumpfile name:
  - Pre-12.2: %U generates a fixed-width 2-digit number
    - e.g. `dumpfile=exp%U.dmp`
  - New option for 12.2 expdp or impdp:
    - %l or %L: Incrementing number from 01 up to 2147483646
  - New options in 12.2 expdp only:
    - %d or %D: Day of Month in DD format
    - %m or %M: Number of Month in MM format
    - %y or %Y: Year in YYYY format
    - %t or %T: Full date in YYYYMMDD format

```
$ expdp system/oracle directory=mydir       \
  filesize=50K dumpfile=exp%T_%L.dmp full=y
...
...
...
. . exported "WMSYS"."WM$METADATA_MAP"
0 KB       0 rows
Master table "SYSTEM"."SYS_EXPORT_FULL_01" successfully
loaded/unloaded
******************************************************
**********************
Dump file set for SYSTEM.SYS_EXPORT_FULL_01 is:
/home/oracle/exp20160917_01.dmp
/home/oracle/exp20160917_02.dmp
/home/oracle/exp20160917_03.dmp
...
...
/home/oracle/exp20160917_67.dmp
/home/oracle/exp20160917_68.dmp
/home/oracle/exp20160917_69.dmp
/home/oracle/exp20160917_70.dmp
/home/oracle/exp20160917_71.dmp
/home/oracle/exp20160917_72.dmp
Job "SYSTEM"."SYS_EXPORT_FULL_01" successfully
completed at Sat Sep 17 23:47:31 2016 elapsed 0
00:03:00
```

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Wildcards for TRANSPORT_DATAFILES

- Use a wilcard in 12.2 instead of listing every file
- Pre-12.2:

```
TRANSPORT_DATAFILES=users01.dbf
TRANSPORT_DATAFILES=users02.dbf
…
TRANSPORT_DATAFILES=data1.dbf
TRANSPORT_DATAFILES=data2.dbf
…
```

- New Feature: wildcards
  - * (asterisk) matches multiple characters
  - ? (question mark) matches a single character

```
TRANSPORT_DATAFILES=users*.dbf
TRANSPORT_DATAFILES=data?.dbf
…
```

```
$ impdp system/oracle@pdb2 network_link=sourcedb \
version=12 full=y transportable=always metrics=y \
exclude=statistics \
directory=mydir \
logfile=pdb2.log \
transport_datafiles='/u02/oradata/CDB2/pdb2/user*.dbf'
```

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REMAP_DIRECTORY

- Applies to DDL where directory specs are used
  - E.g. CREATE TABLESPACE
- Change directory spec without changing filenames
- Useful when moving between OS platforms
  - Example: importing dumpfile created on OpenVMS into database on Linux

```
REMAP_DIRECTORY="'DB1$:[HRDATA.PAYROLL]':'/db1/hrdata/payroll/'"
```

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Long Identifier Support

- Long (128-byte) identifiers are supported in 12.2 by
  - Data Pump expdp/impdp
  - SQL*Loader
  - ORACLE_LOADER access driver
  - ORACLE_DATAPUMP access driver
  - External Tables
- Importing database must support 128-byte identifiers
  - Be careful when exporting with VERSION=12.1 or earlier

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TRUST_EXISTING_TABLE_PARTITIONS

- Pre-12.2
  - Importing into existing table was done serially
  - Data Pump couldn't be sure that partitioning in DB matched partitioning in dumpfile
- New 12.2 Parameter:
  `DATA_OPTIONS=TRUST_EXISTING_TABLE_PARTITIONS`
  - Big performance boost
  - If partitions don't match…error:

```
ORA-31693: Table data object "SH"."SALES_BIG_PT":"SALES_2000" failed to load/unload and is being skipped due to error:
ORA-29913: error in executing ODCIEXTTABLEFETCH callout
ORA-14401: inserted partition key is outside specified partition
```

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Data Validation & Verification

Extra Validation for Things That Should Never Happen

- DATA_OPTIONS=VALIDATE_TABLE_DATA
  - Import only
  - Validates date and number formats of table data
  - Default is no validation

```
ORA-02374: conversion error loading table "DPV"."TEST18"
ORA-12899: value too large for column C1 (actual: 500,
maximum: 498)
ORA-02372: data for row: C8 : '
```

- DATA_OPTIONS=VERIFY_STREAM_FORMAT
  - Export only
  - Default is no verification

```
Starting "SCOTT"."SYS_EXPORT_TABLE_01":  scott/******** tables=t
directory=dmpdir dumpfile=t.dmp reuse_dumpfiles=true
Processing object type TABLE_EXPORT/TABLE/TABLE_DATA
Processing object type TABLE_EXPORT/TABLE/STATISTICS/TABLE_STATISTICS
Processing object type TABLE_EXPORT/TABLE/STATISTICS/MARKER
Processing object type TABLE_EXPORT/TABLE/TABLE
. . exported "SCOTT"."T"                                  5.570
KB       1 rows
ORA-31694: master table "SCOTT"."SYS_EXPORT_TABLE_01" failed to
load/unload
ORA-02354: error in exporting/importing data
ORA-26009: stream verification error: [1], [0], [0], [0]
```

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Other 12.2 Features (1)

- Use direct path load in network mode!
  - Specify `ACCESS_METHOD=DIRECT_PATH` with `NETWORK_LINK=<dblink>`
  - Allows network import of `LONG` and `LONG RAW`
- Data Pump available in Instant Client
  - Tools package for Instant Client
  - Includes SQL*Loader, expdp, impdp, exp, imp
- Views that describe available transforms
  - `DBMS_METADATA_TRANSFORMS`
  - `DBMS_METADATA_TRANSFORM_PARAMS`
  - `DBMS_METADATA_PARSE_ITEMS`

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Other 12.2 Features (2)

- New interactive commands
  - `TRACE` parameter can be set for a running job
    - No need to stop/restart job for tracing to take effect
  - `STOP_WORKER` command
    - Kill an individual worker you believe to be hung or stuck
  - Both will be documented in MOS notes
- Enhanced log files
  - When METRICS=Y
    - Show worker ID for each item processed
    - Show access method for each table
  - Include contents of parfile in logfile

```
18-SEP-16 15:24:30.950: ;;;
**************************************************
18-SEP-16 15:24:30.951: ;;; Parfile values:
18-SEP-16 15:24:30.953: ;;;  parfile:  job_name=md_exp_16_12201
18-SEP-16 15:24:30.955: ;;;  parfile:  reuse_dumpfiles=Y
18-SEP-16 15:24:30.957: ;;;  parfile:  logtime=all
18-SEP-16 15:24:30.958: ;;;  parfile:  metrics=Y
18-SEP-16 15:24:30.960: ;;;  parfile:  parallel=16
18-SEP-16 15:24:30.962: ;;;  parfile:  full=Y
18-SEP-16 15:24:30.963: ;;;  parfile:  logfile=md_exp_16_12201.log
18-SEP-16 15:24:30.965: ;;;  parfile:  dumpfile=md16_12201_%U.dmp
18-SEP-16 15:24:30.966: ;;;  parfile:  directory=EBSIMP
18-SEP-16 15:24:30.968: ;;;
**************************************************
```

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Recap of 12.1 Features

- VIEWS_AS_TABLES parameter
  - Lets you export the contents of a view as a table
- TRANSFORM parameter options
  - TRANSFORM=DISABLE_ARCHIVE_LOGGING:Y
    - Will disable archive logging during import for tables and/or indexes
  - TRANSFORM=LOB_STORAGE:SECUREFILE
  - TRANSFORM=STORAGE:N
  - TRANSFORM=TABLE_COMPRESSION:<compression_clause>
- LOGTIME=[NONE | STATUS | LOGFILE | ALL] parameter
  - Will write timestamps on status and/or logfile messages

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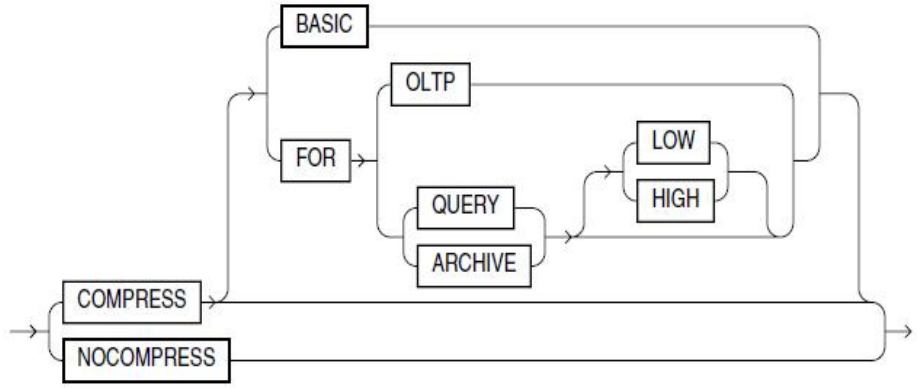
Data Pump News in Oracle 12c

- `TRANSFORM` option to enable Advanced/HCC Compression
  - Example:
    - `TRANSFORM=TABLE_COMPRESSION:"compress for query high"`
  - But: Granularity only on the entire import
    - Workarounds:
      - Precreate objects
        - Downside: Will slow down import!!!
          or:
      - Precreate the tablespace with COMPRESS option
        - `create tablespace ARCHIGH datafile 'archigh.ora' size 100G default compress for archive high;`
      - Then run Data Pump with `TRANSFORM=TABLE_COMPRESSION:N`
        - This will drop all embedded compression attributes associated with the tables
        - Now tablespace compression option will be used for all newly created tables



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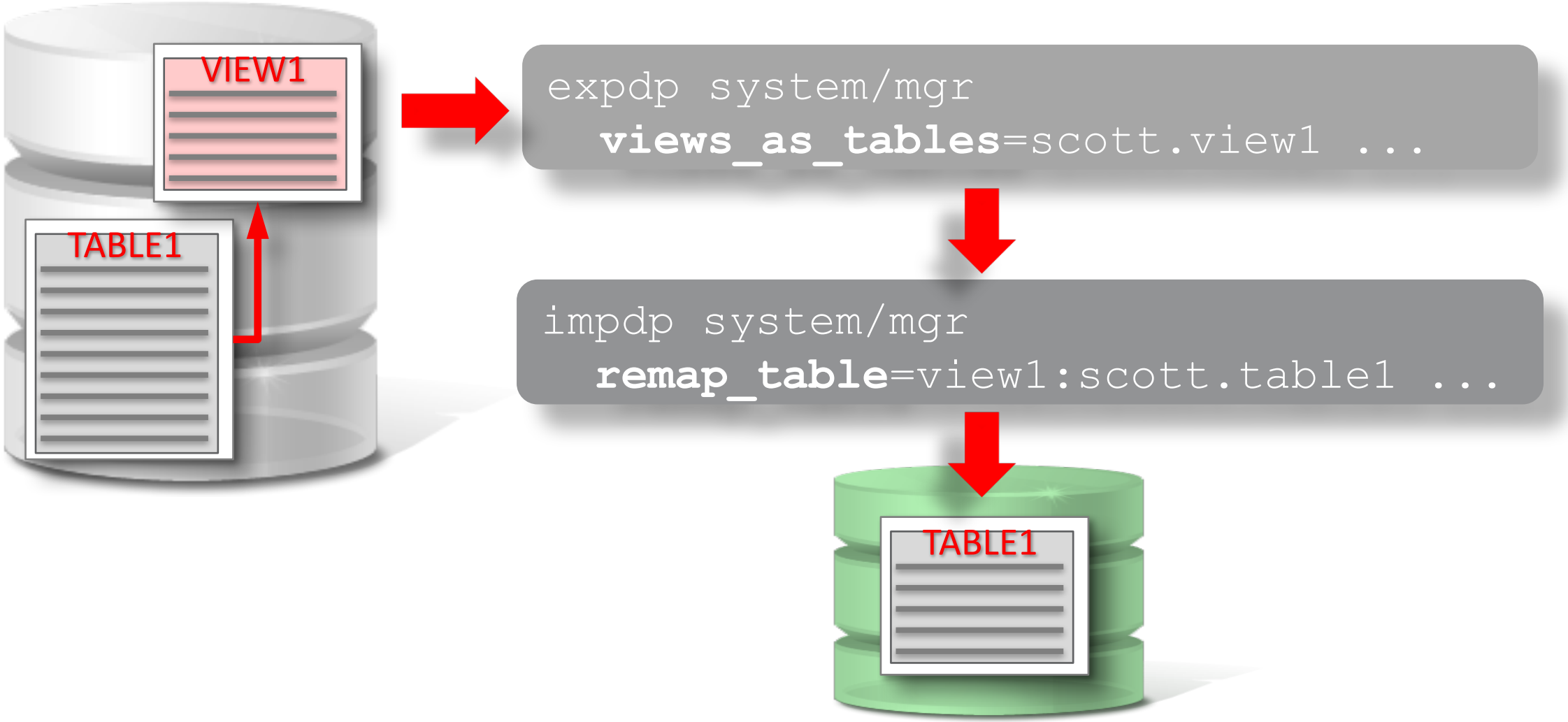
Exporting Views as Tables



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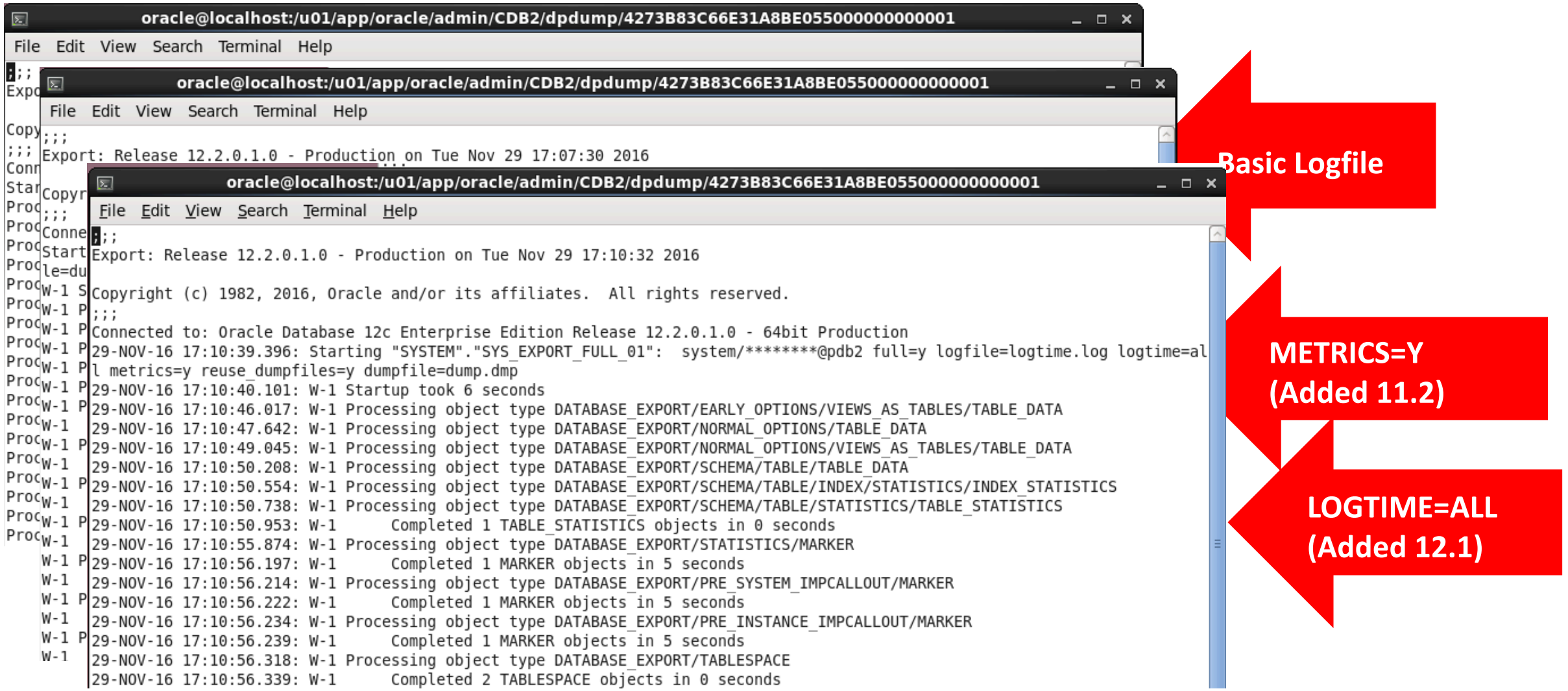
Improved Log Files: METRICS=Y and LOGTIME=ALL



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Enhanced Compression Algorithm

- COMPRESSION_ALGORITHM
  - Defines the compression algorithm when compressing dump files
    - BASIC The same algorithm used in previous versions. Good compression, without severely impacting on performance
    - LOW : For use when reduced CPU utilization is a priority over compression ratio
    - MEDIUM: Recommended option. Similar characteristics to BASIC, but uses a different algorithm
    - HIGH: Maximum available compression, but more CPU intensive
  - Performance:
    - Compression ratio
    - CPU usage

```
$ expdp scott/tiger tables=emp directory=mydir
dumpfile=emp.dmp logfile=expdp_emp.log
compression=all compression_algorithm=medium
```

  - Requires Advanced Compression Option license

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Enhanced Compression Algorithm

- Customer evaluation
  - BASIC
    at 3.5 TB/hour

Disk-Group-I/O

Name	Disks	AvgBusy	Read|Write-KB/s	TotalMB/s	xfers/s	BlockSizeKB
slot02	6	9.3%	123120.4|0.0	120.2	241.1	510.7
slot03	6	6.7%	103354.8|0.0	100.9	202.2	511.1
slot05	6	9.0%	130420.9|7.0	127.4	262.0	497.8
slot06	6	10.5%	158841.9|175.3	155.3	329.3	
slot08	6	8.4%	130835.3|0.0	127.8	256.0	511.0
slot09	6	10.1%	136525.9|0.0	133.3	267.0	511.3
slot10	6	6.6%	140383.4|0.0	137.1	275.0	510.6
slot11	6	6.8%	112600.0|2.0	110.0	220.7	510.3
Groups= 8 TOTALS	48	1.4%	1036082.5|184.3	1012.0	2053.3	

  - MEDIUM
    at 7.0 TB/hour

Disk-Group-I/O

Name	Disks	AvgBusy	Read|Write-KB/s	TotalMB/s	xfers/s	BlockSizeKB
slot02	6	14.5%	255770.4|0.0	249.8	500.9	510.7
slot03	6	16.0%	273037.4|11.5	266.6	535.1	510.3
slot05	6	15.4%	264851.1|17.5	258.7	519.0	510.3
slot06	6	13.2%	222160.7|425.5	217.4	502.4	443.1
slot08	6	15.0%	267156.6|1.5	260.9	523.3	510.5
slot09	6	14.8%	263140.4|6.5	257.0	515.3	510.6
slot10	6	14.6%	259603.7|2.5	253.5	508.5	510.5
slot11	6	14.9%	258113.0|5.4	252.1	505.8	510.4
Groups= 8 TOTALS	48	2.5%	2063833.5|470.4	2015.9	4110.285	

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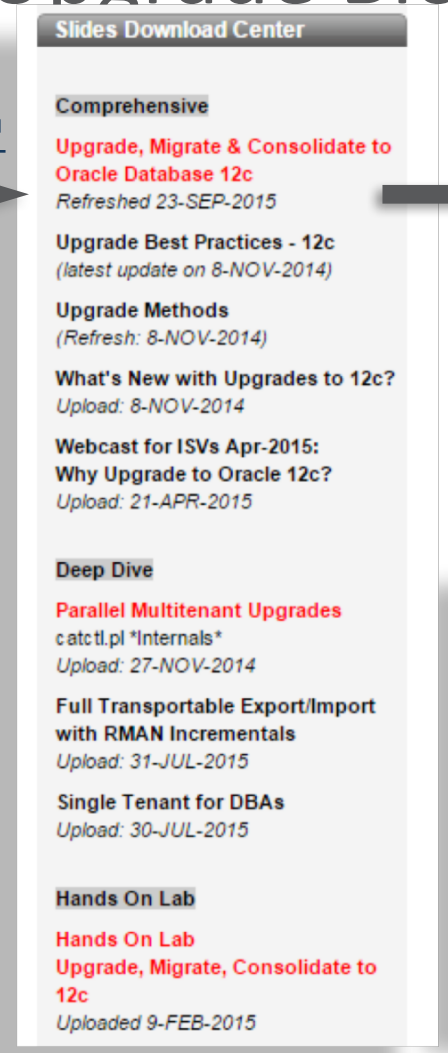

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