ORACLE DATABASE 12c

Different Ways to Upgrade and Migrate to Oracle Database 12*c*

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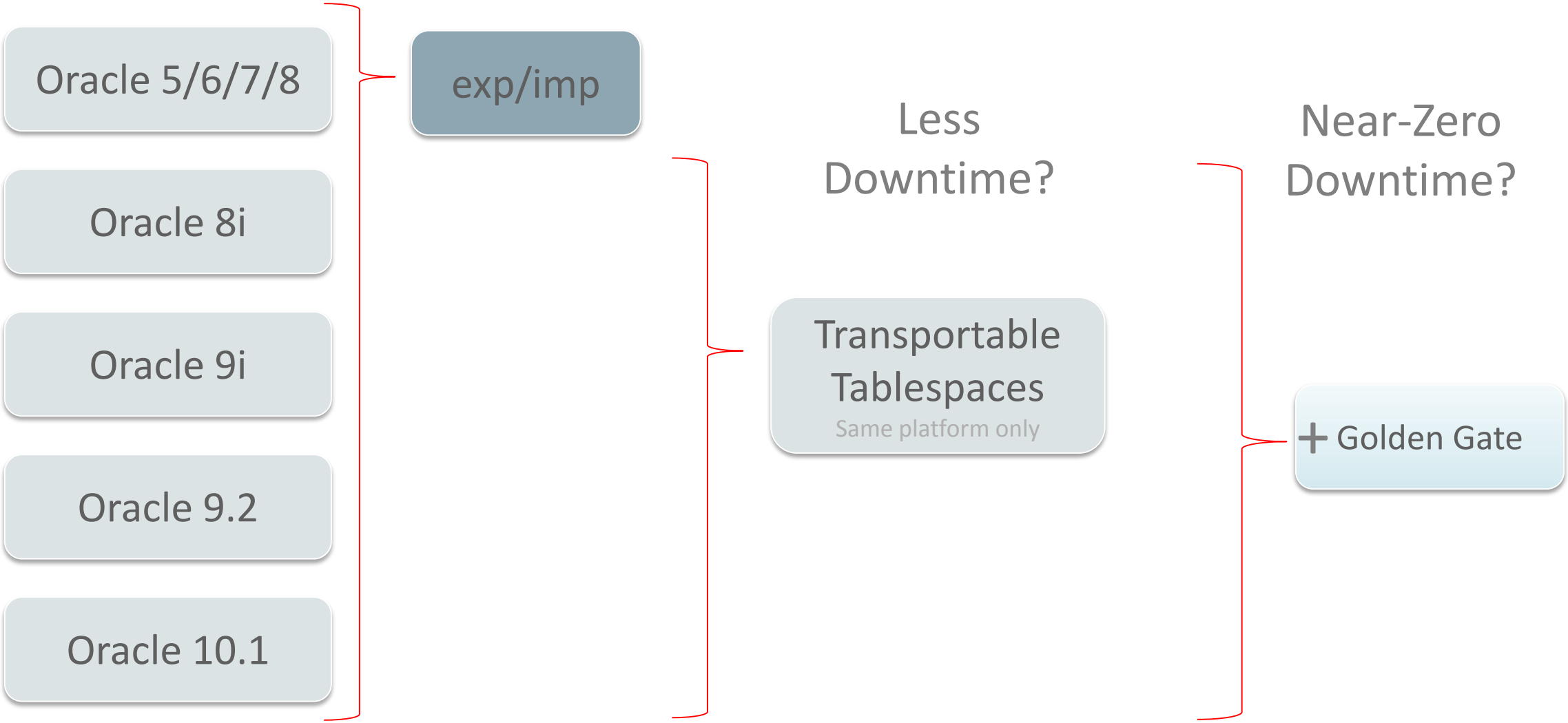
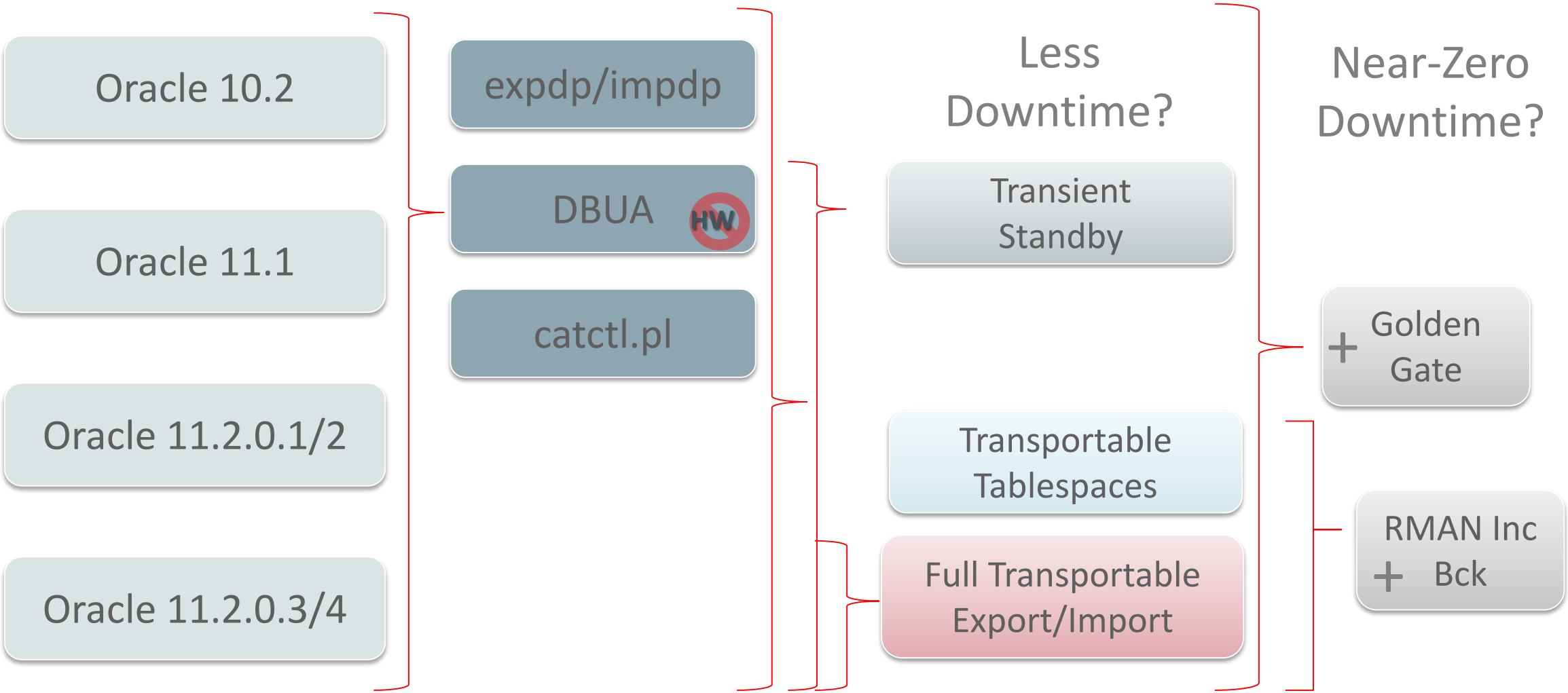
Updated: 08-DEC-2014

ORACLE

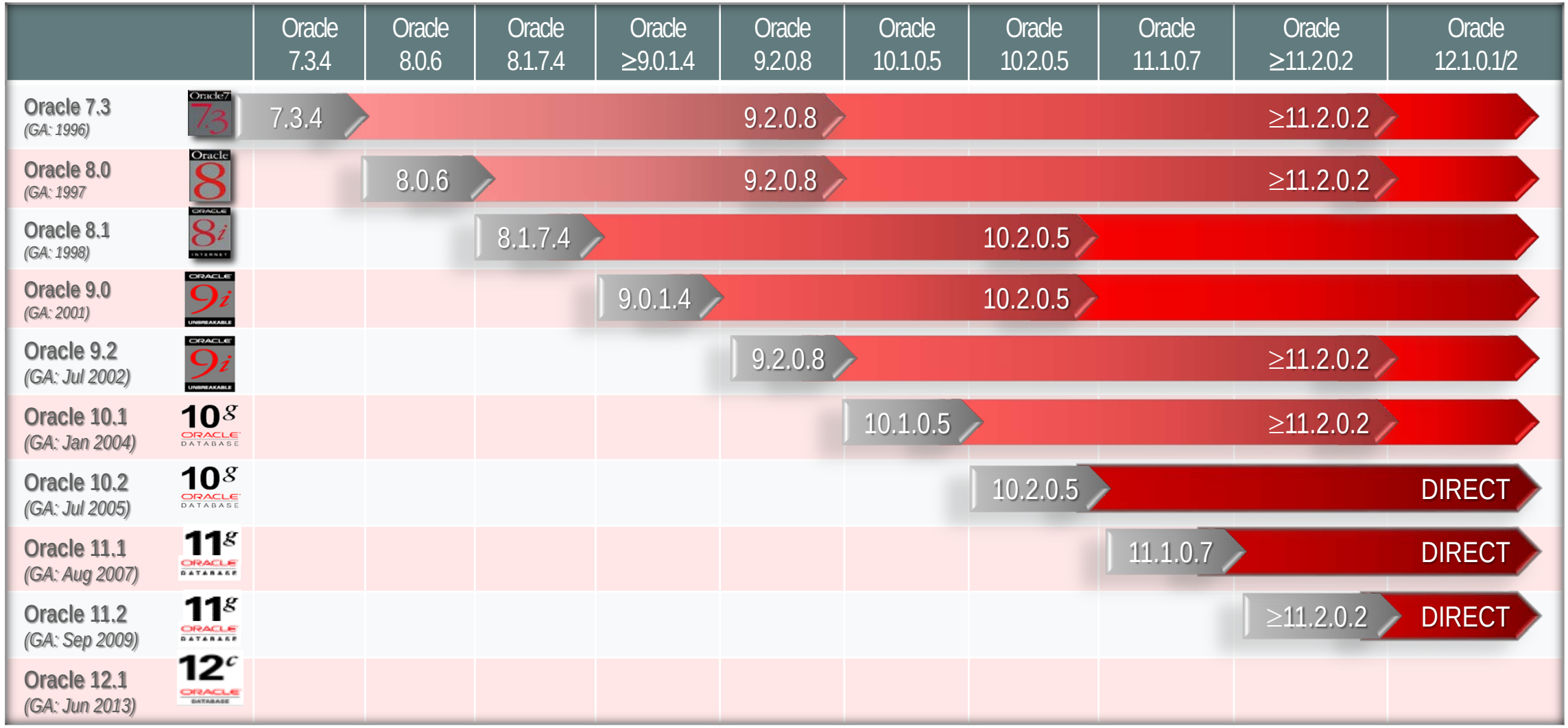
Upgrade/Migrate Older Oracle Releases



Upgrade Options to Oracle Database 12c



Upgrade to Oracle Database 12c



Please note: This graph will apply to database upgrades only!

Upgrade SQL Automation

New Pre-Upgrade Script

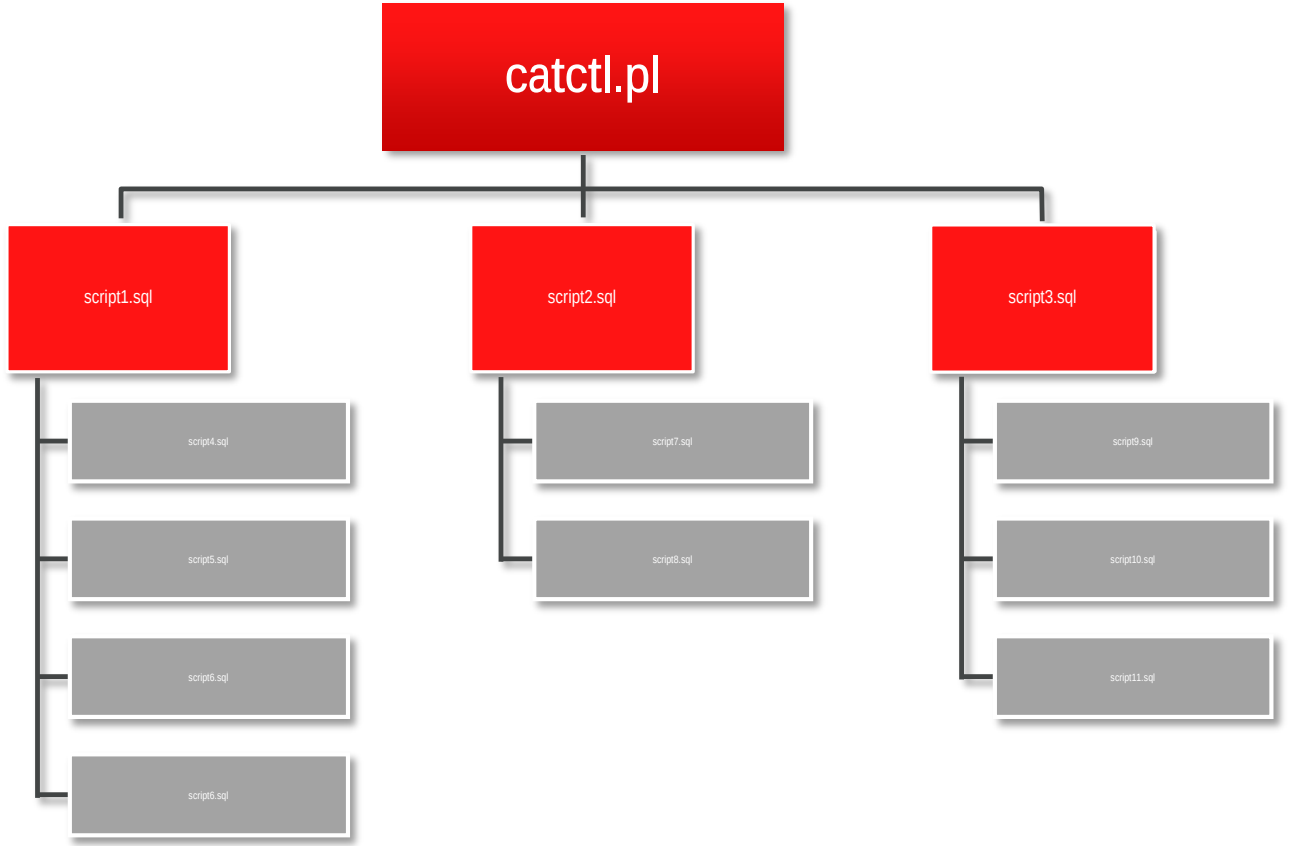
- `preupgrd.sql`
- Executes pre-upgrade checks
- Runs in source environment
- Generates fixup scripts
  - `preupgrade_fixups.sql`
  - `postupgrade_fixups.sql`
- MOS Note:884522.1

```
**************************************************************************
Fixup:       PURGE_RECYCLEBIN
Description: Check that recycle bin is empty
**************************************************************************
Fixup Succeeded
**************************************************************************


**************************************************************************
                        [Pre-Upgrade Recommendations]
**************************************************************************

                         ****************************************
                         ******** Dictionary Statistics *********
                         ****************************************

Please gather dictionary statistics 24 hours prior to
upgrading the database.
To gather dictionary statistics execute the following command
while connected as SYSDBA:
    EXECUTE dbms_stats.gather_dictionary_stats;
```

Faster Upgrade – Less Downtime

New Parallel Upgrade

- `catctl.pl`
- Runs database upgrade in parallel
- Up to 40% faster upgrade
- Used and proven by selected Oracle Database 11*g* global customers
  - Telco billing
  - >100 SAP systems
  - Large DWH



"The new parallel upgrade script promises to drastically reduce downtime due to planned maintenance. We saw a 37% improvement over the previous upgrade process in our environment."

– Harald Stefan, Leiter Datenbanken
Payback GmbH

Faster Upgrade – Less Downtime

New Parallel Upgrade

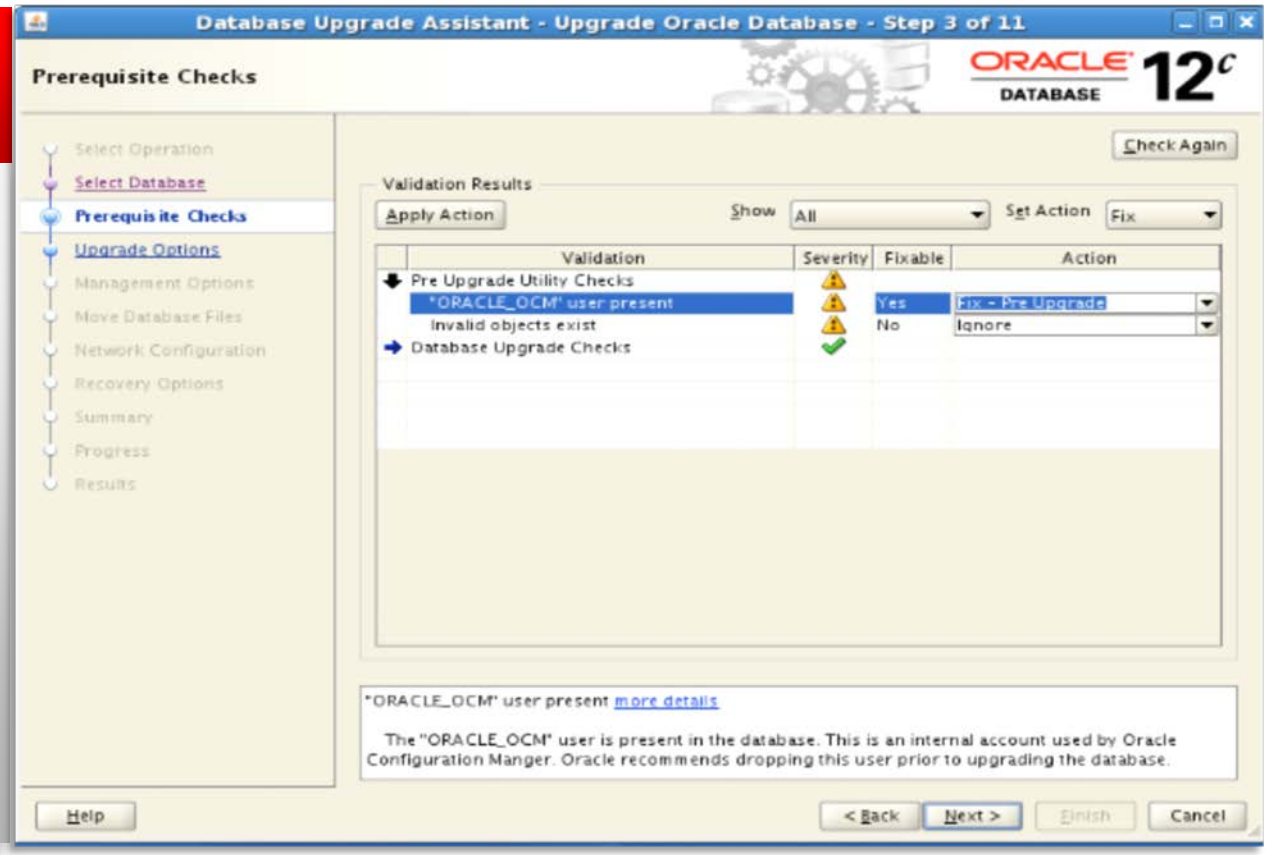
```
$> $ORACLE_HOME/perl/bin/perl catctl.pl -n 8 catupgrd.sql
```

```
Parallel Phase #:34 Files: 14     Time: 113s
Restart  Phase #:35 Files: 1      Time: 0s
Parallel Phase #:36 Files: 11     Time: 19s
Restart  Phase #:37 Files: 1      Time: 0s
Serial   Phase #:38 Files: 1      Time: 8s
Restart  Phase #:39 Files: 1      Time: 0s
Serial   Phase #:40 Files: 1      Time: 10s
Serial   Phase #:41 Files: 1      Time: 3s
Restart  Phase #:42 Files: 1      Time: 0s
Parallel Phase #:43 Files: 2      Time: 411s
Restart  Phase #:44 Files: 1      Time: 1s
Serial   Phase #:45 Files: 2      Time: 510s
Restart  Phase #:46 Files: 1      Time: 1s
Parallel Phase #:47 Files: 2      Time: 35s
Restart  Phase #:48 Files: 1      Time: 0s
Serial   Phase #:49 Files: 1      Time: 3s
Serial   Phase #:50 Files: 1      Time: 313s
Grand Total Time: 2468s
```

Simplified Upgrade

Database Upgrade Assistant

- Pre-Upgrade Automation
- Parallel Upgrade
- RMAN Integration
- Guaranteed Restore Points
- Activity and Alert Log

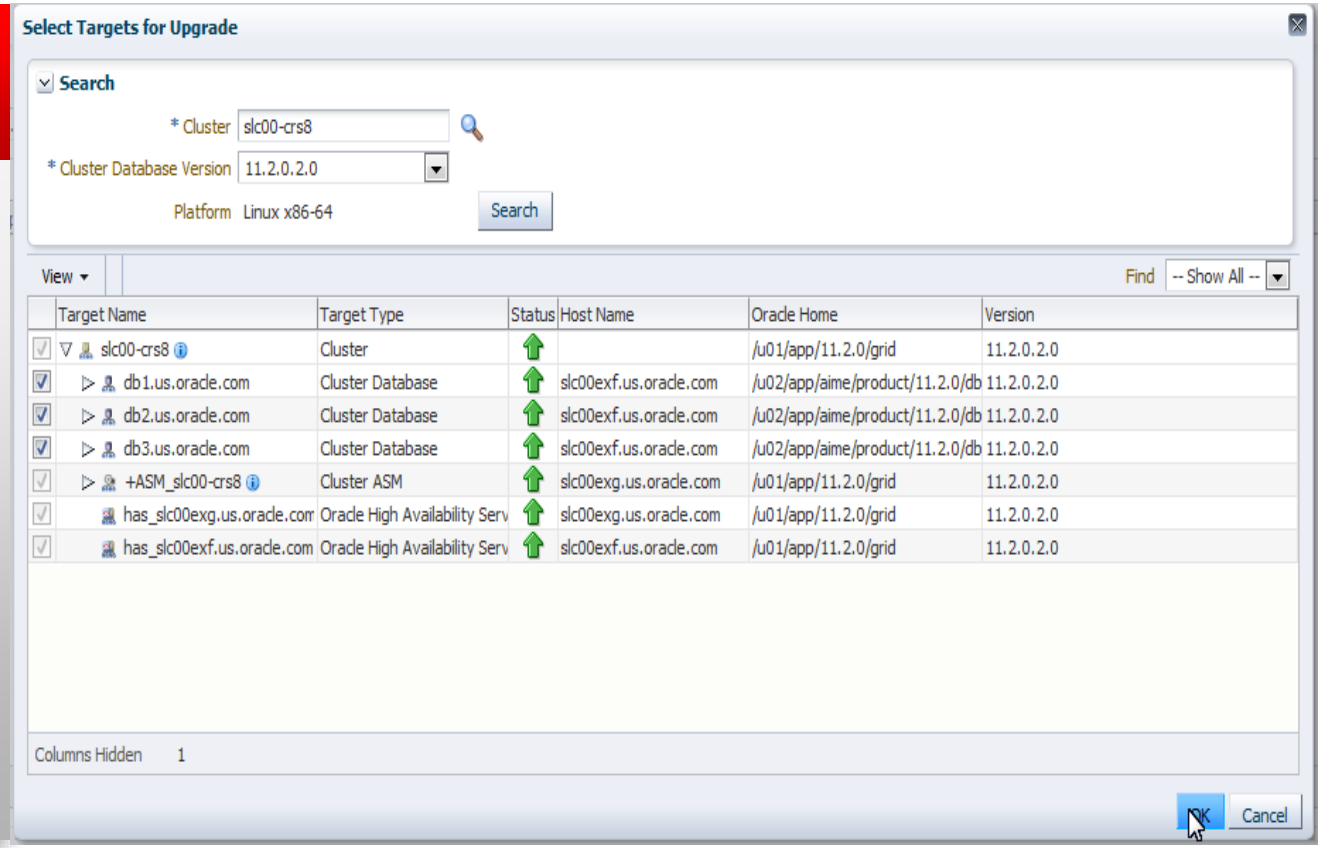


Enterprise Manager Mass and RAC Upgrades

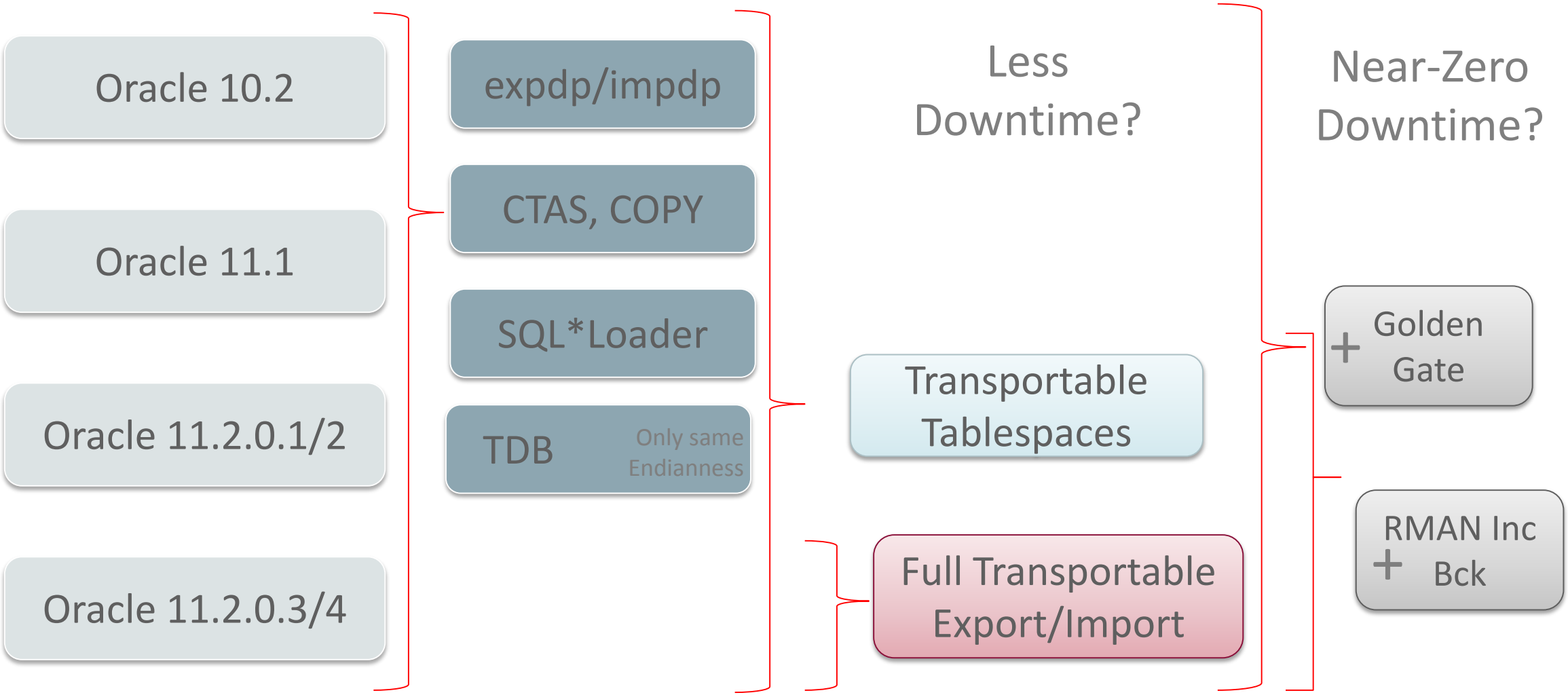
EM Cloud Control

- Mass Upgrades
- Grid Infrastructure Upgrades
- RAC Database Upgrades
- Standby Database Upgrades

✧ Note: Requires Lifecycle Management Pack



Migration Options to Oracle Database 12c

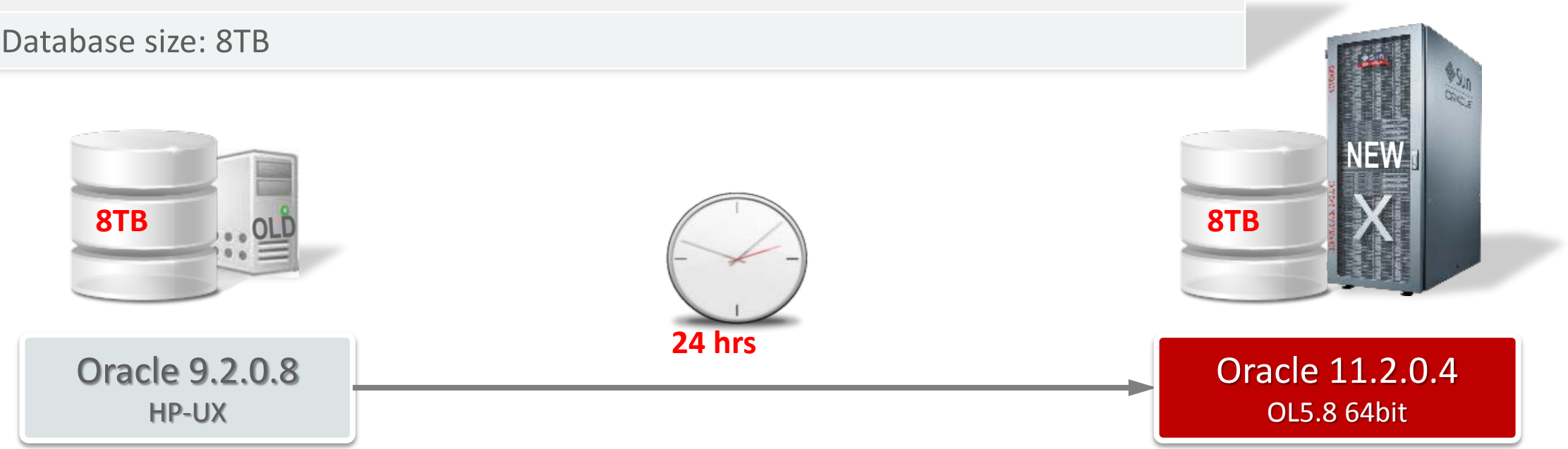


Data Pump Migration

Cross Endianness Migration

- Example: Migration of a single instance database to Exadata

Example Facts & Description
1. Hardware migration to an Exadata Database Machine
2. Cross Endianness database migration from Oracle 9.2.0.8 to Oracle 11.2.0.4
3. Maximum tolerated downtime: 24 hours
4. Database size: 8TB



Cross Endianness Migration

- Basic options with Oracle 9*i*:
  - `exp` and `imp`

    - Import of all versions ≥ Oracle V5 possible
      - `exp` is *not supported* for general use since Oracle 11*g*
        - But the utility is still there and can be used
      - `imp` is still supported

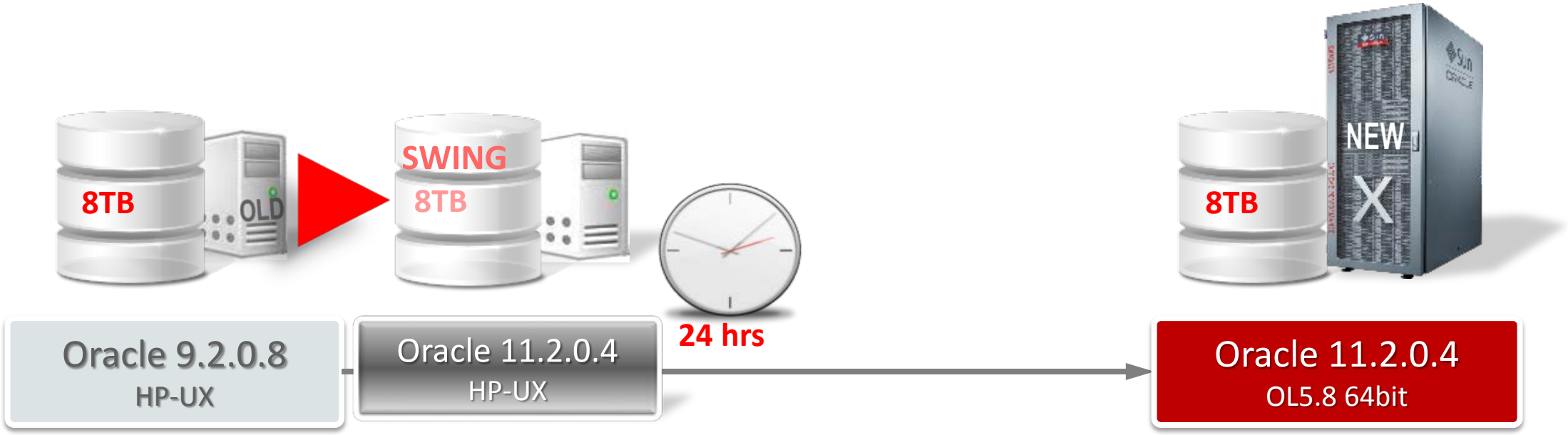
24 hrs

Oracle 9.2.0.8
HP-UX

Oracle 11.2.0.4
OL5.8 64bit

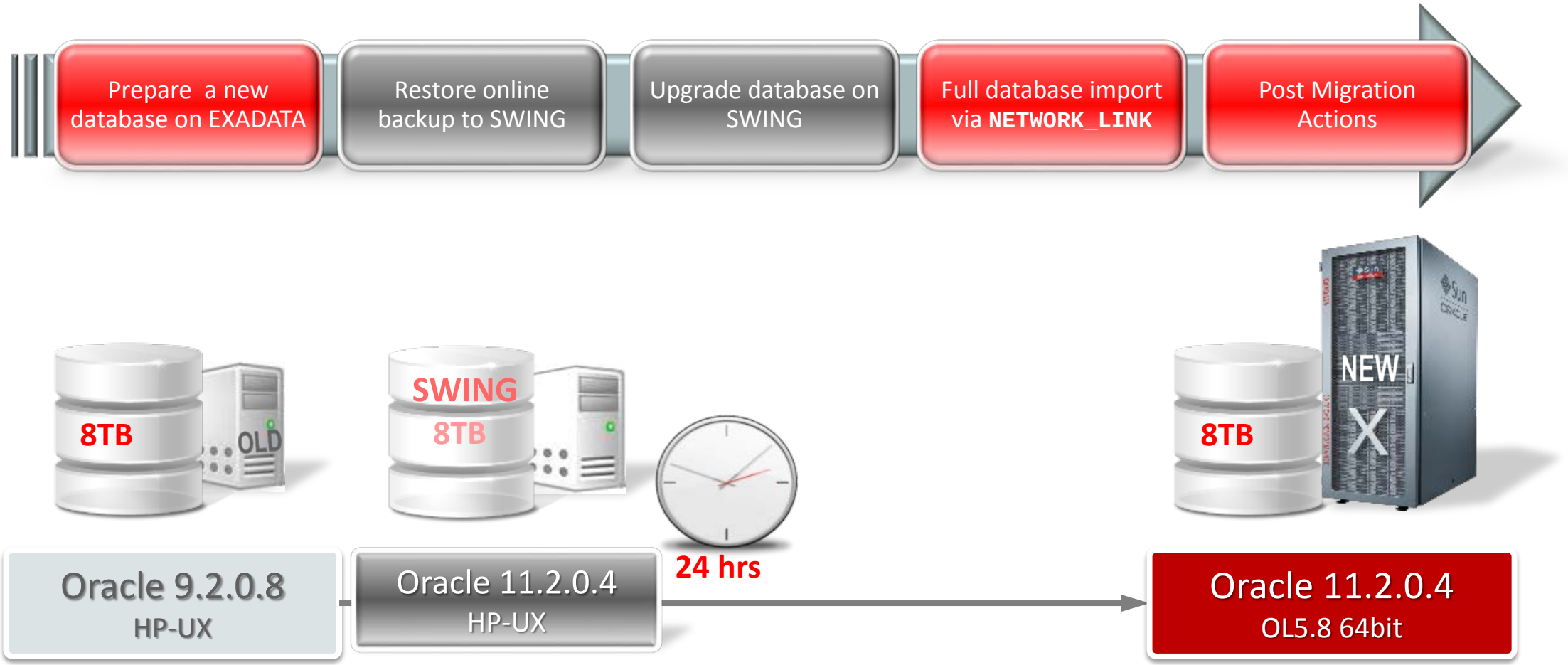
Cross Endianness Migration

- Better options since Oracle 10g:
  - Data Pump `expdp` and `impdp`
    - Usually the first option to try
  - Cross platform Transportable Tablespaces (xTTS)
    - More complicated, more manual steps than pure Data Pump



Case 3: Cross Endianness Migration

- Migration of a single instance database to Exadata



Data Pump Best Practices

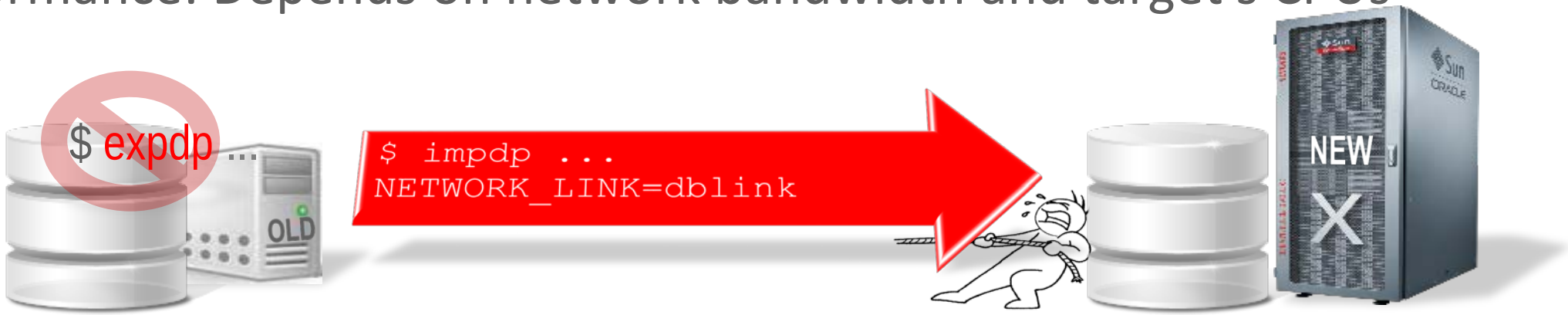
- For *full exports:*
  - Role EXP_FULL_DATABASE is required
- For export *consistency* use:
  - FLASHBACK_TIME=SYSTIMESTAMP
    alternative:
  - CONSISTENT=Y [since Oracle 11.2 – Legacy Interface]
    - This will increase UNDO requirements for the duration of the export
- Always set parameters:
  - EXCLUDE=STATISTICS
  - METRICS=YES

Data Pump Best Practices

- Speed up Data Pump:
  - PARALLEL=*n*
    - Typically *n* = 2x *<number of CPU cores>*
  - EXCLUDE=INDEXES on import
    1. Initial `impdp` with `EXCLUDE=INDEXES`
    2. Second `impdp` with `INCLUDE=INDEXES SQLFILE=indexes.sql`
    3. Split `indexes.sql` into multiple SQL files and run in multiple sessions
  - Set `COMMIT_WAIT=NOWAIT` and `COMMIT_LOGGING=BATCH` during full imports

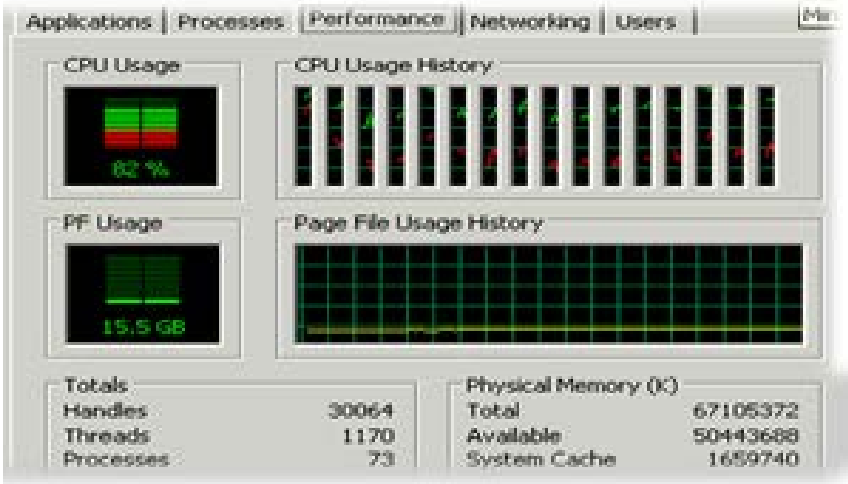
Data Pump Best Practices

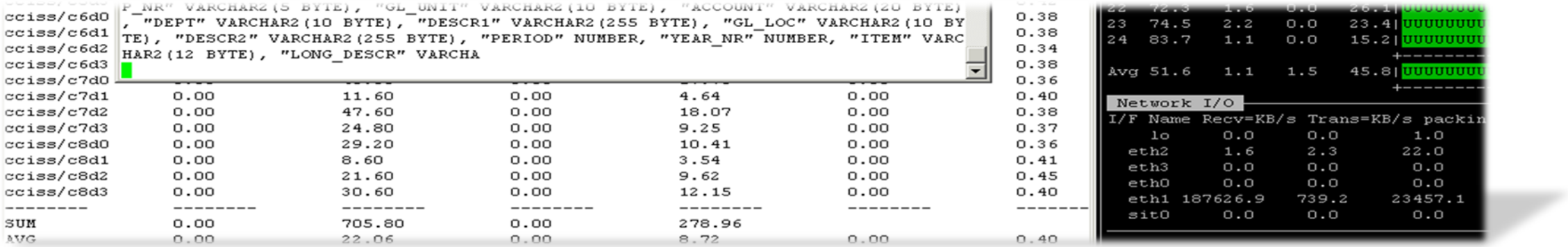
- Direct import via database link
  - Parameter: `NETWORK_LINK`
    - Run only `impdp` on the target system - no `expdp` necessary
    - No dump file written, no disk I/O, no file transfer needed
- Restrictions of database links apply:
  - Does not work with `LONG/LONG RAW` and certain object types
- Performance: Depends on network bandwidth and target's CPUs



Data Pump Best Practices

- *Real World Case:*
  Kaiser Permanente, Medicare (USA)
  - impdp on NETWORK_LINK with 8 vs 16 CPU cores
    - 10GBit connection leveraged up to 8 Gbit
    - 1 TB table copied in ~15 min ⇨ 4 TB/hour
  - Network bandwidth and CPU bound

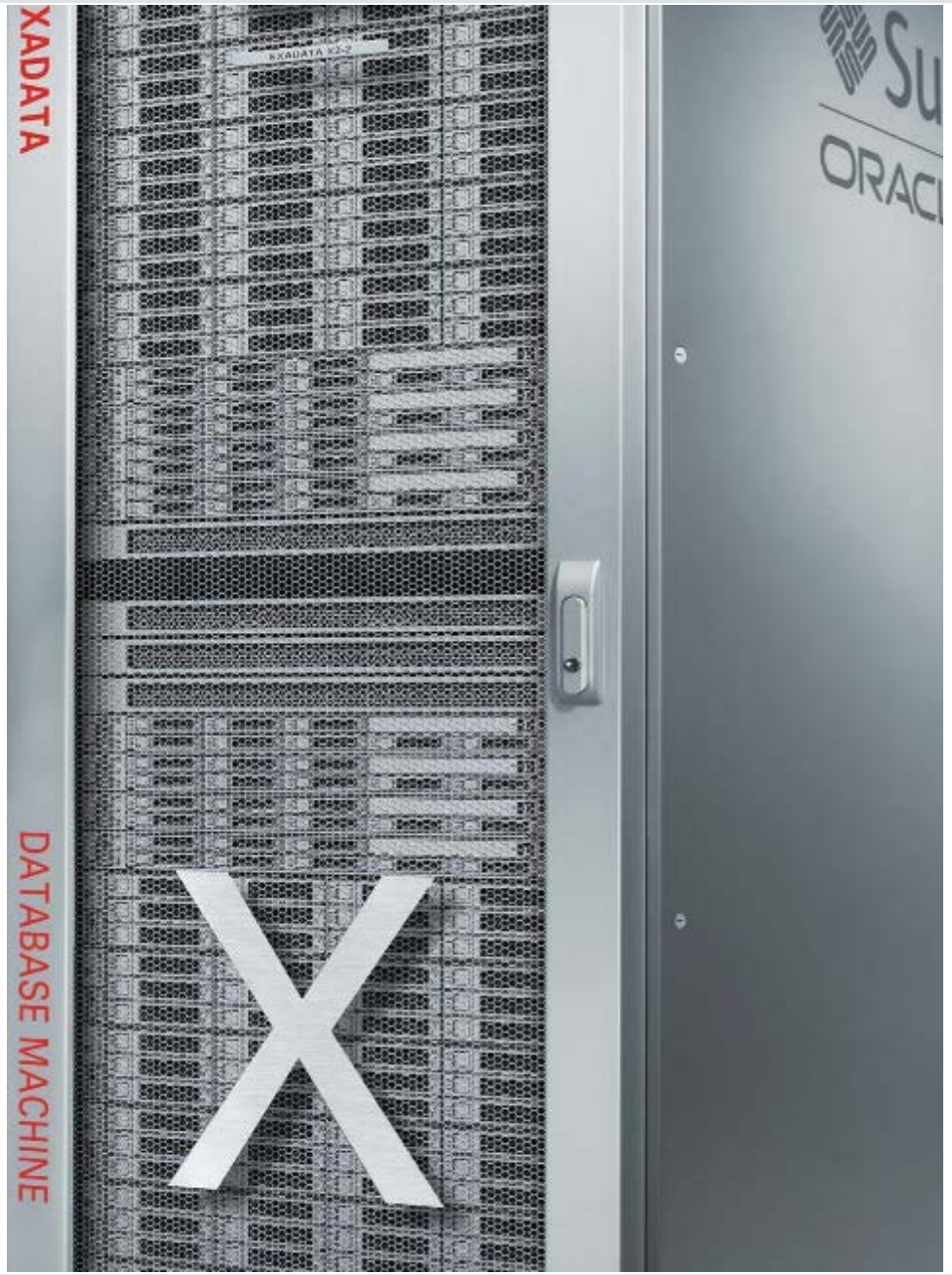




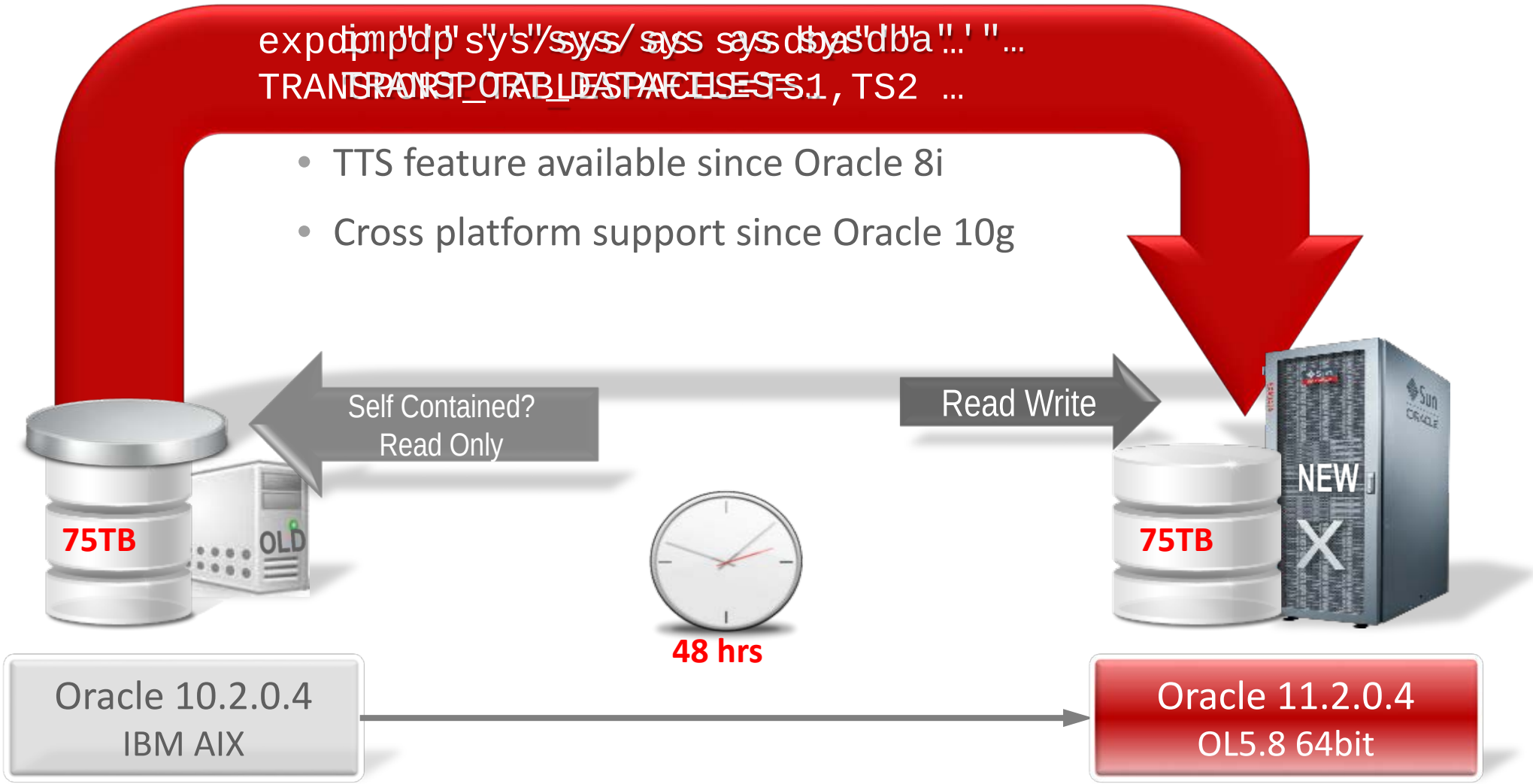
Data Pump News in Oracle 12c

- Full transportable export/import for an entire database
- Support for multitenant container databases and pluggable databases
- New …
  - 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

Transportable Tablespaces

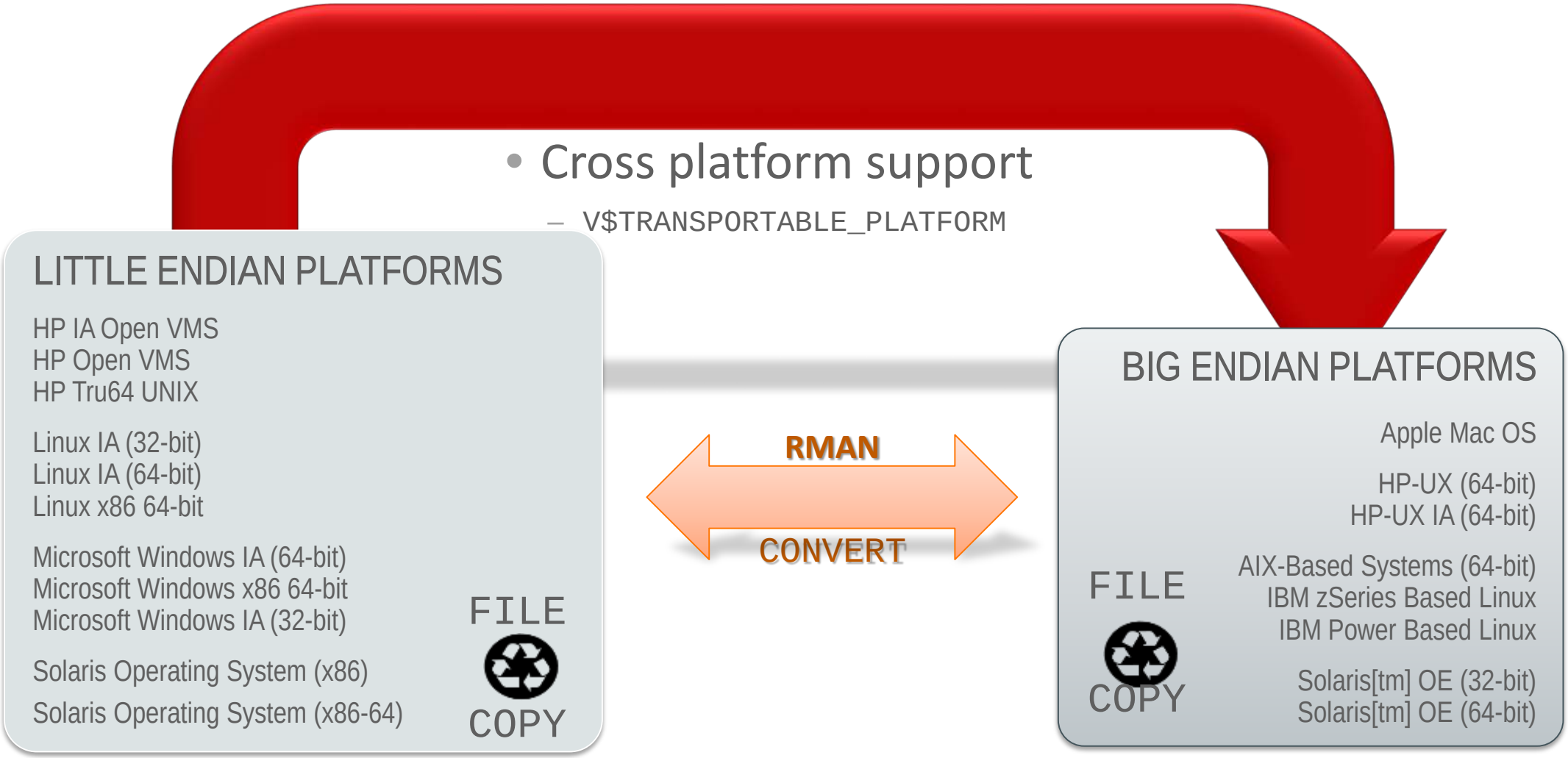


Concept Transportable Tablespaces

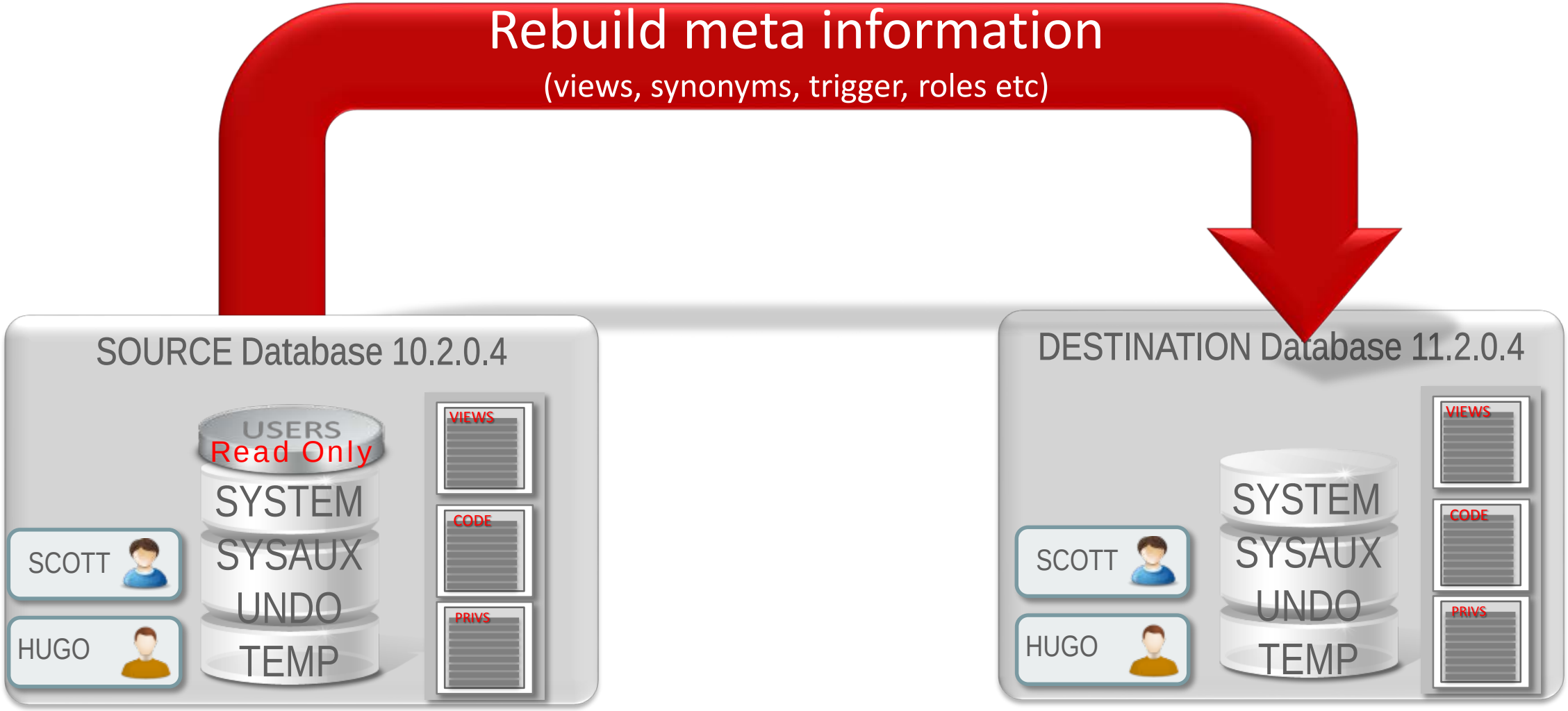


Concept Transportable Tablespaces xTTS

- Cross platform support
  - V$TRANSPORTABLE_PLATFORM



Upgrade/Migration: Transportable Tablespaces



Possible options

- Moving meta information - 3 possible options
  - The “brute force” approach
    - Data Pump

```
expdp/impdp CONTENT=METADATA_ONLY
```

  - The “smart” approach
    - DBMS_METADATA

```
SELECT DBMS_METADATA.GET_DDL('SYNONYM',
SYNONYM_NAME, OWNER) FROM all_synonyms
where owner='PUBLIC' and table_owner
not in ('SYS');
```

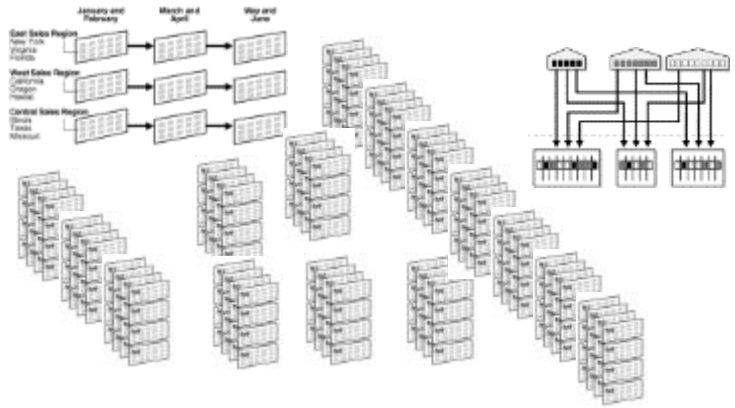
  - A “same OS” approach
    - RMAN duplicate
    - Does not work for platform changes

```
RMAN> duplicate target database to
'NEW' skip tablespace DATA1, DATA2
```

Transportable Tablespaces

- TTS might not be a good solution when …
  - Too many objects to rebuild
    - Views, synonyms, sequences …
    - Simple is better for fast TTS!!!

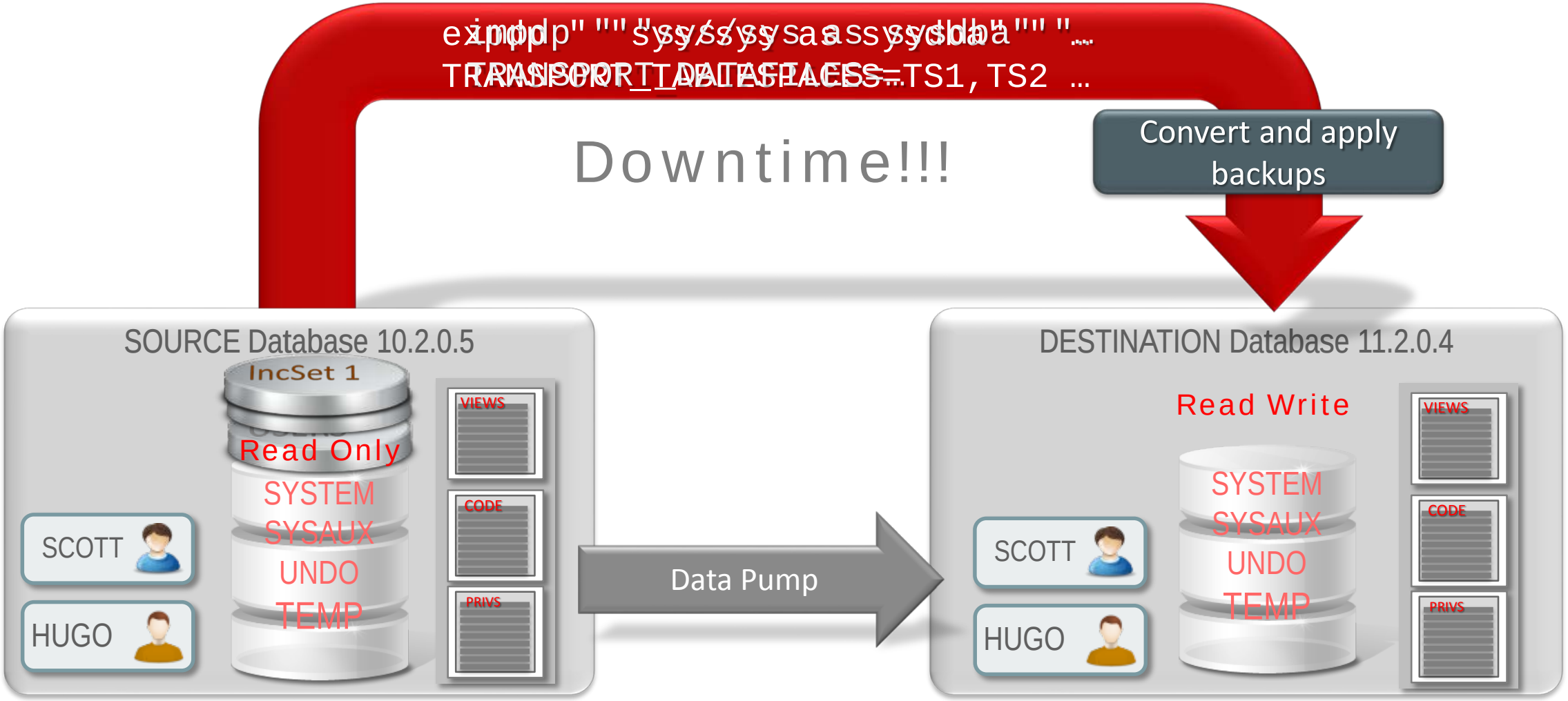
  - Too many objects in tablespaces slow down meta expdp/impdp
    - (Sub)partitions, partitioned indexes …



Speed Up Transportable Tablespaces

- Usually the biggest pain points with TTS
  - Downtime due to:
    - Duration to copy very large amounts of data
    - Duration to convert many tablespaces cross Endianness
- New technique: Avoid the copy & convert phase
  - RMAN can convert incremental backups cross platform
    - Available since Oracle 11.2.0.3 for Exadata only
    - Available for Linux x86-64 with Oracle 11.2.0.4
    - Available on all platforms starting with Oracle 12*c*
    - See MOS Note:1389592.1 for description and Linux perl scripts

Transportable Tablespaces with Incremental Backups



Full Transportable Export/Import

NEW

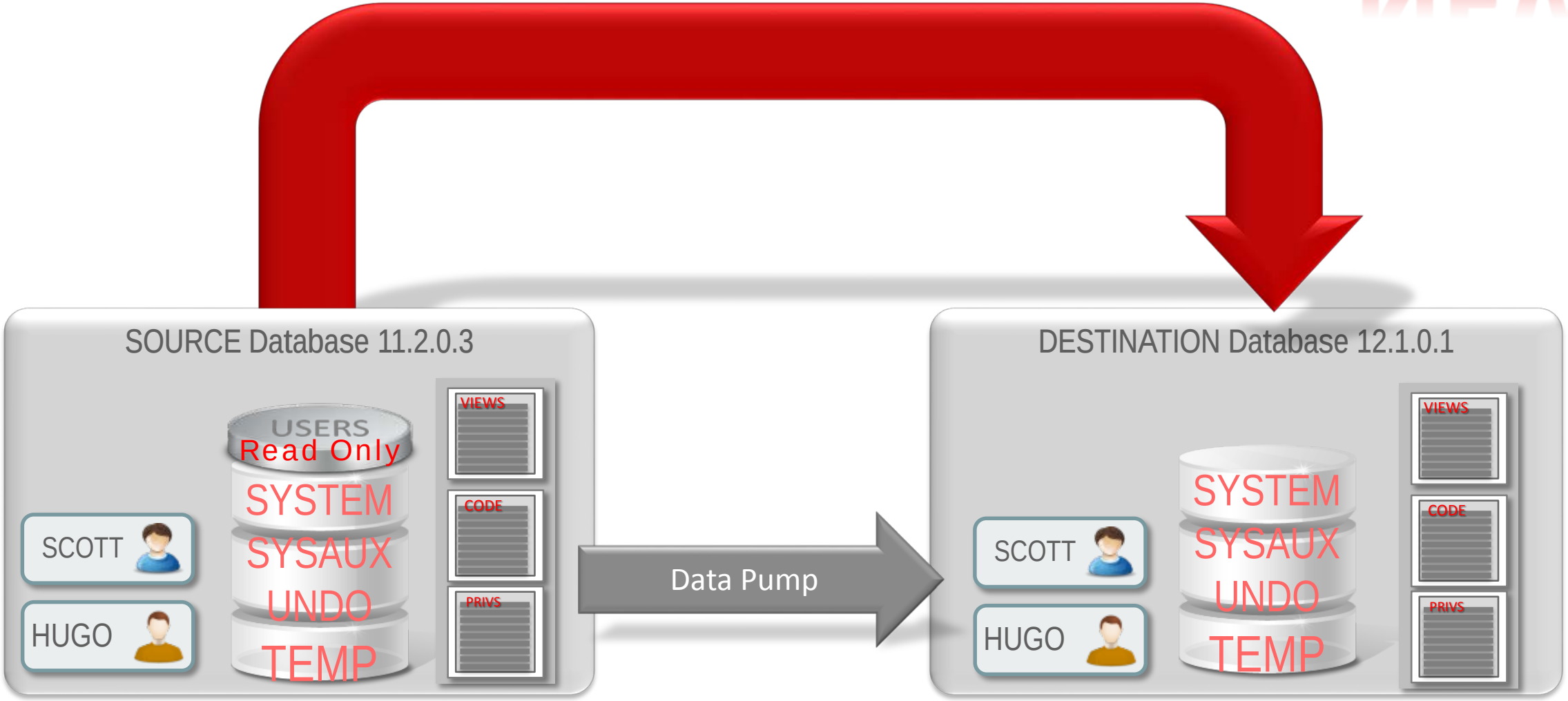
- Combining:
  - Transportable Tablespaces with
  - Data Pump taking care of all meta information with optional
  - RMAN incremental backups to decrease downtime
- One Command Migration

```
impdp … VERSION=12 FULL=Y TRANSPORTABLE=ALWAYS …
```

- This works:
  - Cross platform (with RMAN CONVERT)
  - With or without Oracle Multitenant
  - Source can be Oracle 11.2.0.3/4 or newer
  - Target must be at least Oracle 12.1.0.1

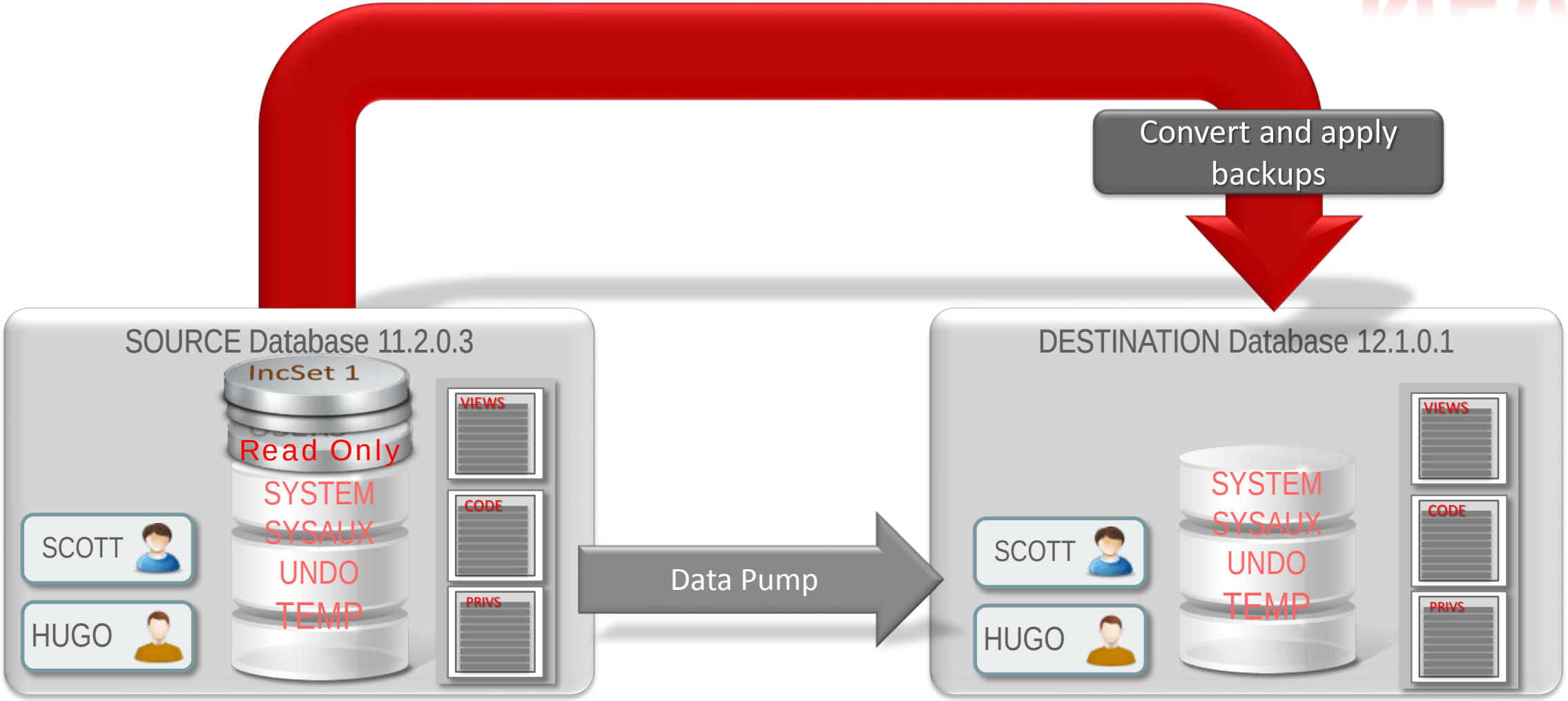
Full Transportable Export/Import with Copies

NEW



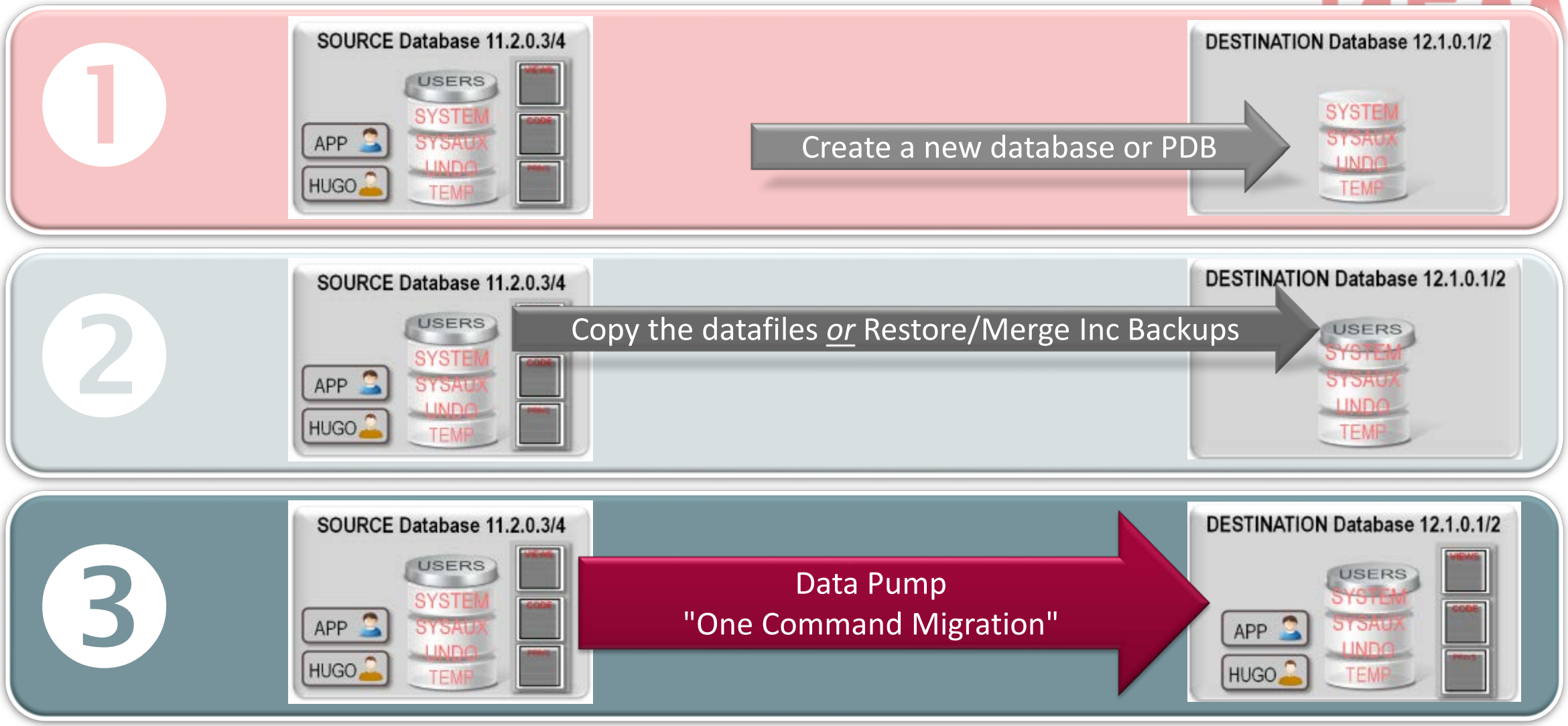
Full Transportable Export/Import with Backups

NEW



Full Transportable Export/Import in 3 Steps

NEW



ORACLE

Zero Downtime?

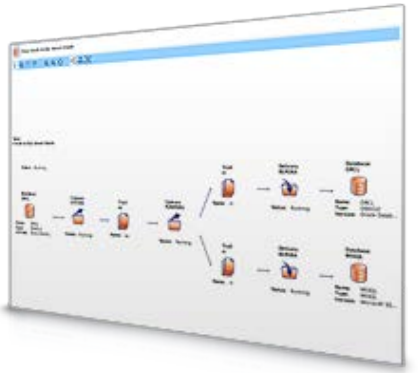
Introduction

- True ZERO Downtime is very hard to achieve
  - Only Oracle TimesTen In-Memory Database can do that

- Replication technologies are easier to handle and setup
  - A limited downtime will occur to switch clients/application
    - Active/active scenarios are possible depending on the application and usage scenario
- 

- Technologies:
  - Oracle Golden Gate
    - NOTE: Oracle Streams is deprecated as of Oracle Database 12*c*

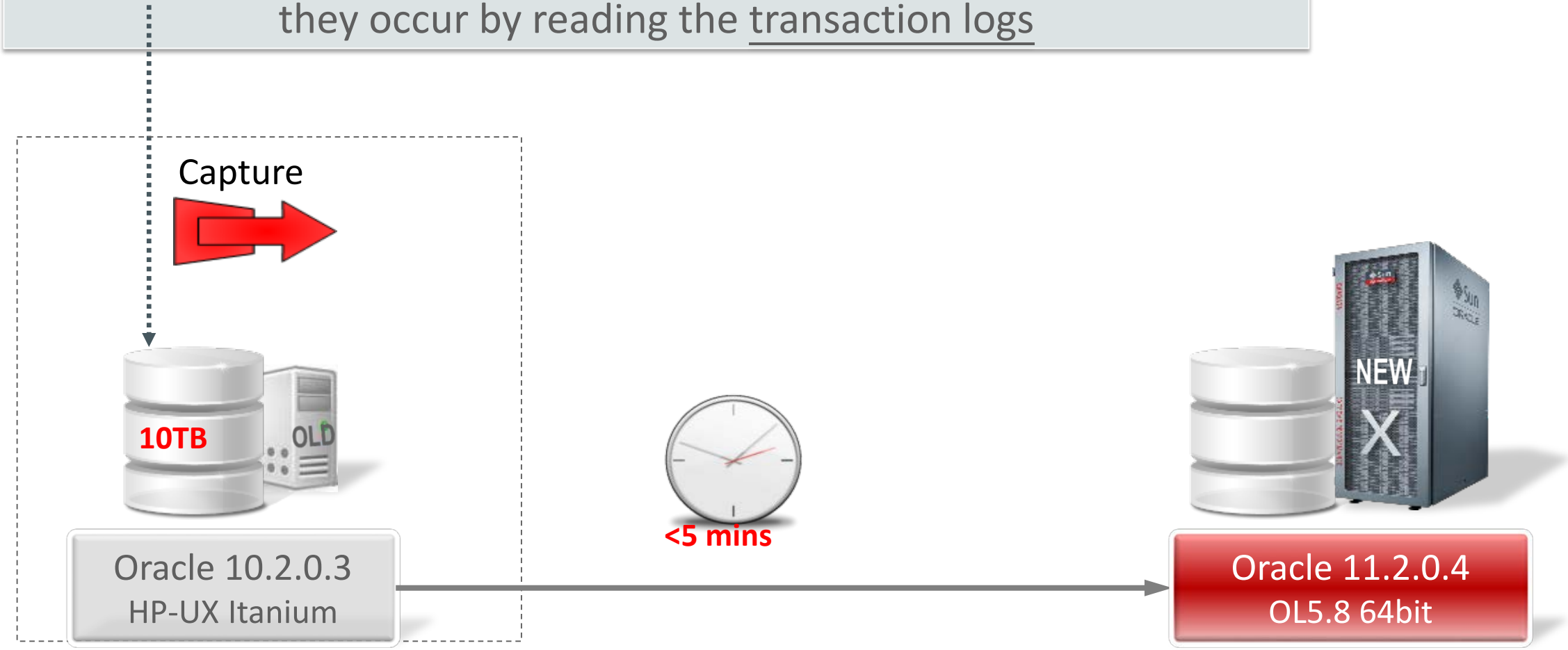
Oracle Golden Gate



- Paid option of the database
  - Migratable license for 1 year which includes Active Data Guard
- Works with many Oracle database versions
  - Golden Gate 12.1 supports Oracle ≥ 11.1.0.6
    - Golden Gate 11.2 supports Oracle ≥ 10.2.0.4
      - *For earlier database versions (8i (DML only), 9i-11.1) use Golden Gate 10.4*
- Oracle GoldenGate Installation and Setup Guide
- Also works with non-Oracle databases (DB2, Teradata …)
- GoldenGate OTN page:
  http://www.oracle.com/technetwork/middleware/goldengate/overview/index.html

Start Capture Mechanism → Build Up Database Copy with Data Pump or TTS → Start Apply Mechanism

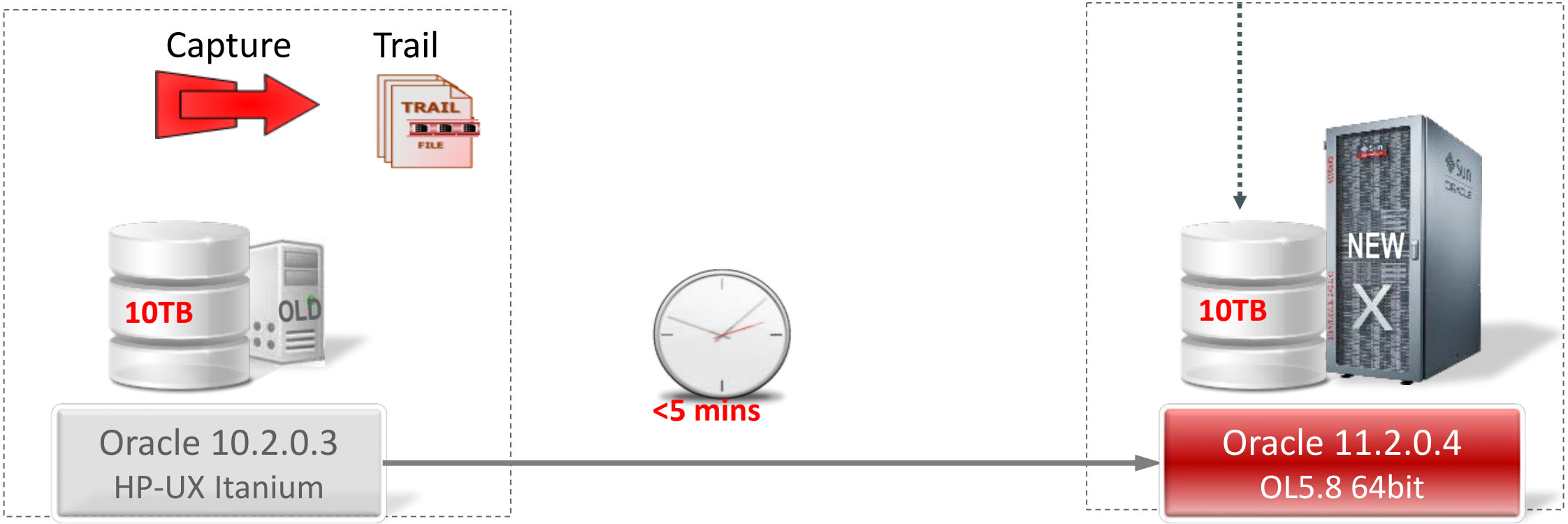
Capture: committed transactions are captured (and can be filtered) as they occur by reading the transaction logs



Trail: stages and queues data for routing

Start Capture Mechanism → Build Up Database Copy with Data Pump or TTS → Start Apply Mechanism

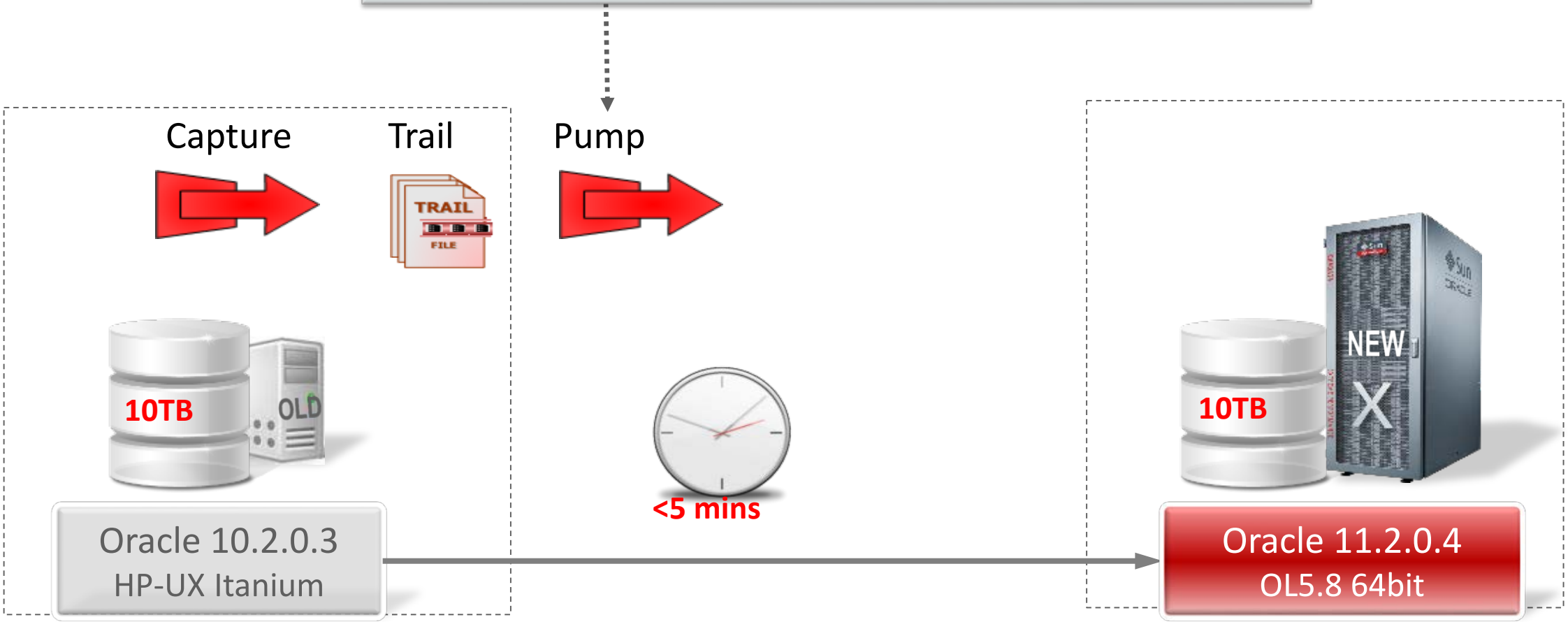
Build up the target database using:
- Transportable Tablespaces x-Platform
- Export/Import with Data Pump

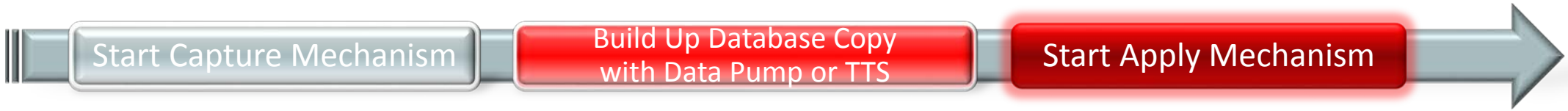


 | Different Ways to Upgrade and Migrate to Oracle Database 12c

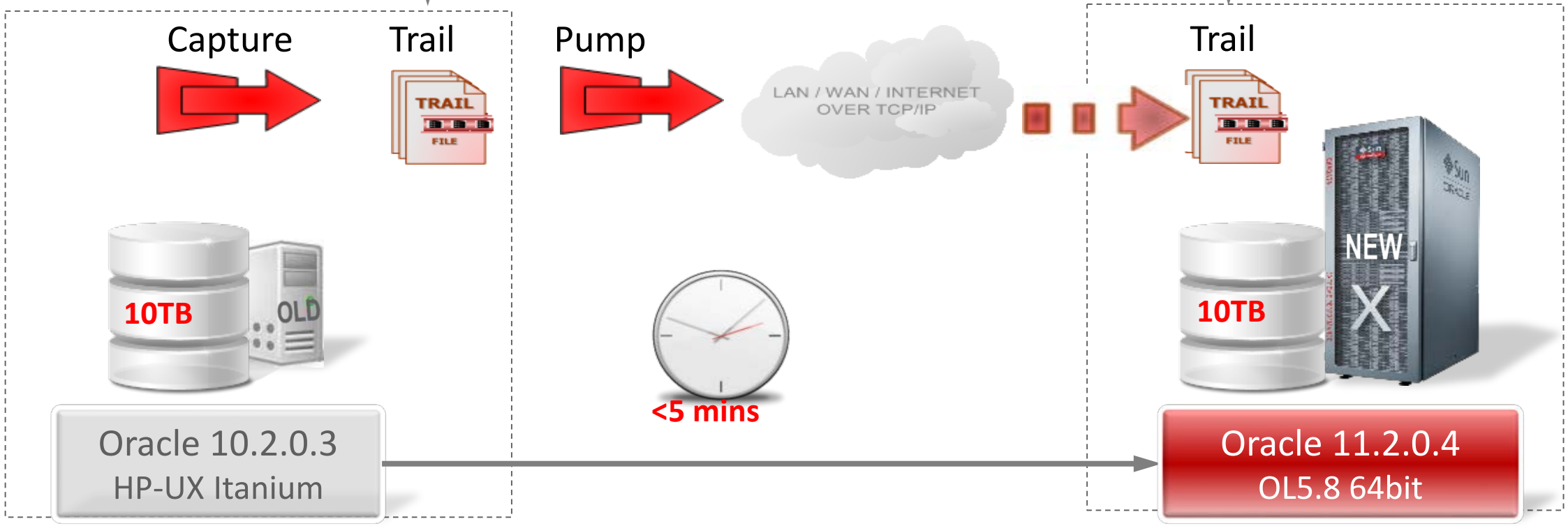
Start Capture Mechanism → Build Up Database Copy with Data Pump or TTS → Start Apply Mechanism

Pump: distributes data for routing to target(s)



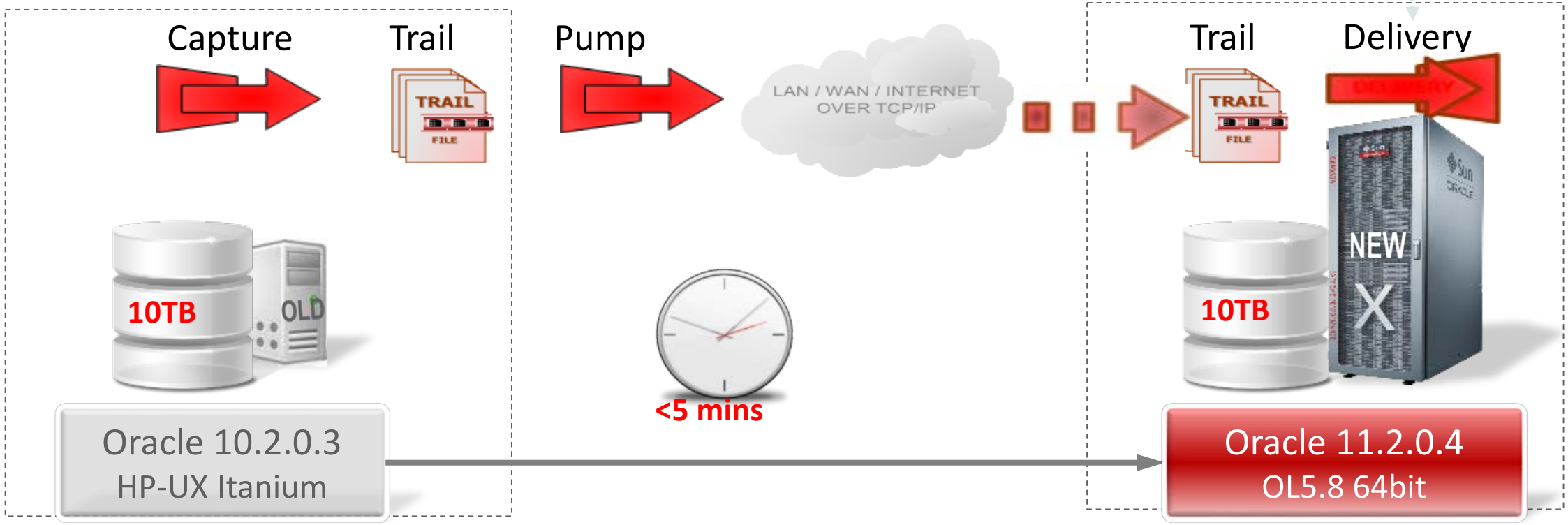


Route: data is compressed, encrypted for routing to target(s)

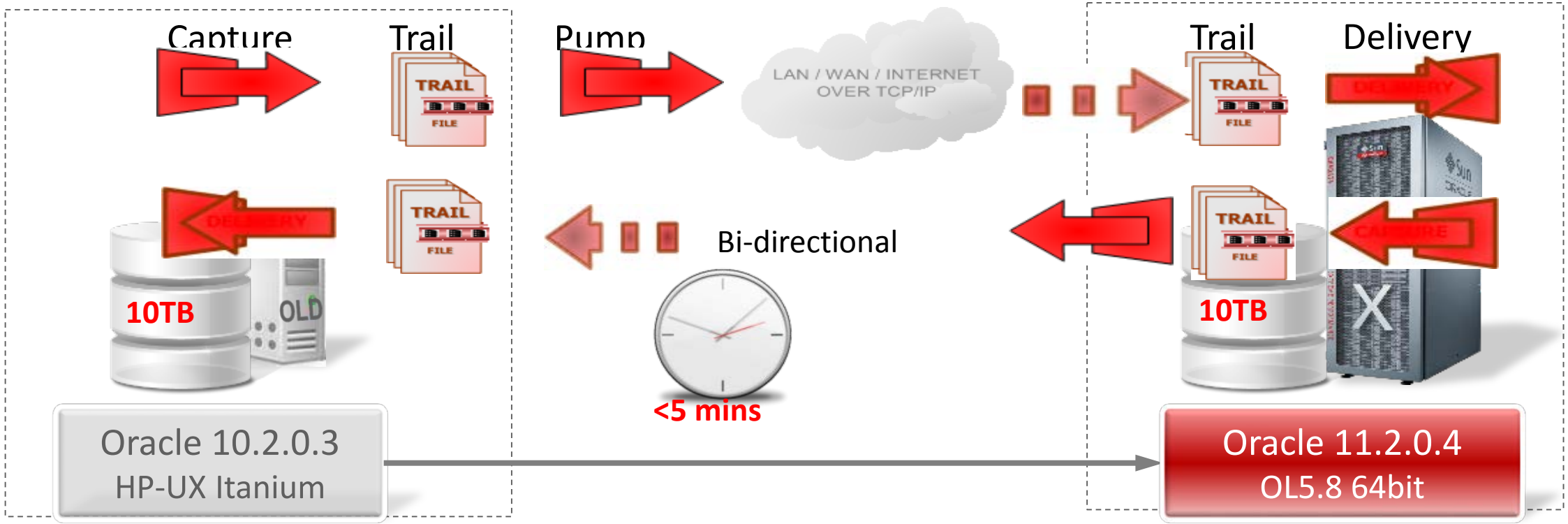


Start Capture Mechanism → Build Up Database Copy with Data Pump or TTS → Start Apply Mechanism

Delivery: applies data with transaction integrity, transforming the data as required

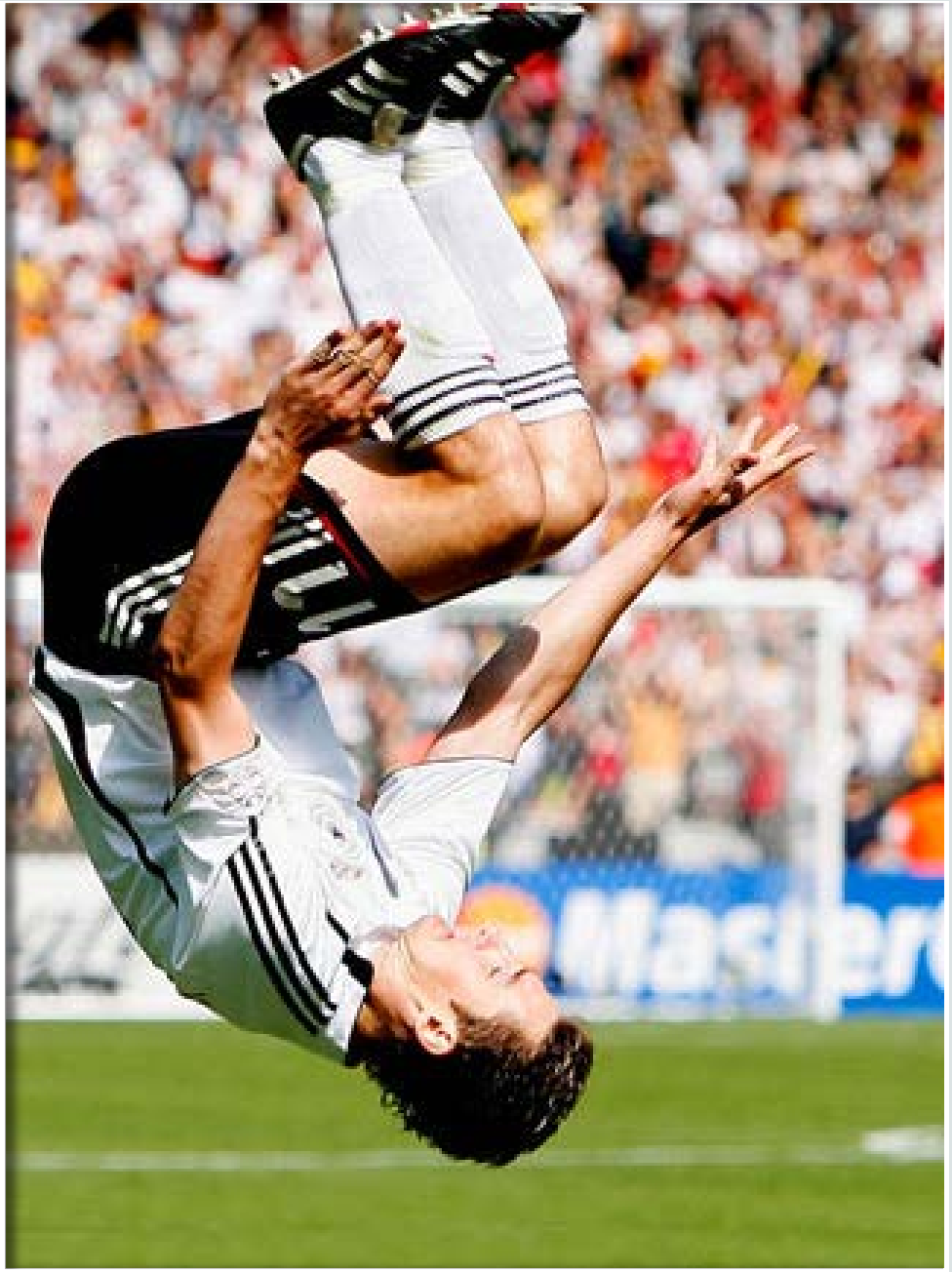


GoldenGate works bidirectionally - from higher to lower release as well!



Case 6:

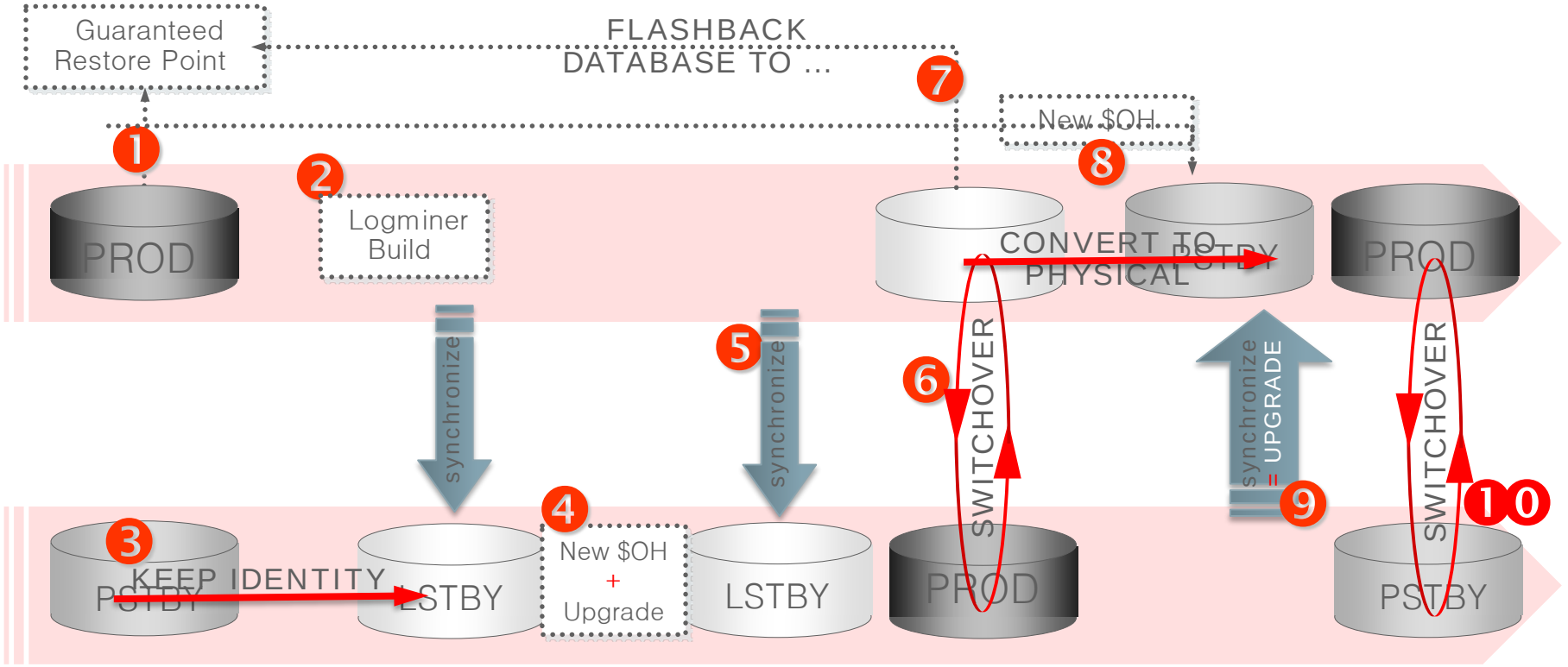
Real Rolling Upgrade



Basic Facts and Information

	Physical Standby	Logical Standby	Transient Standby
Standby Type	Block identical copy of PROD	Logical copy of PROD	Physical, converted temporarily into Logical – and return
Apply Technique	Redo Apply	SQL Apply	Redo and SQL Apply
Build Up	RMAN DUPLICATE	Convert from Physical	RMAN Duplicate, then Convert
Switchover	< 1 min	Seconds	Seconds + < 1 min

Transient Logical Standby - Workflow



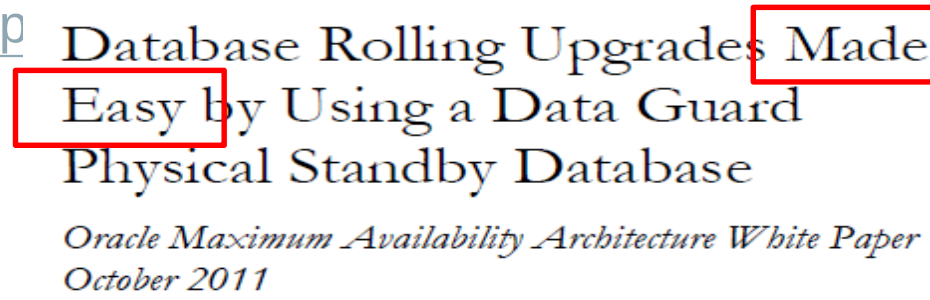
Transient Logical Standby – White Paper

- Transient Upgrade Concept:
  http://www.oracle.com/technetwork/database/features/availability/maa-wp-[illegible]lingu-1-131927.pdf

Database Rolling Upgrade Using Transient Logical Standby:
Oracle Data Guard 11g

Oracle Maximum Availability Architecture White Paper
September 2008

- Shell scripts in Note:949322.1 for automation:
  http://www.oracle.com/technetwork/database/features/availability/maa-wp-[illegible]2.pdf



Database Rolling Upgrades Made Easy by Using a Data Guard Physical Standby Database

Oracle Maximum Availability Architecture White Paper
October 2011

DBMS_ROLLING

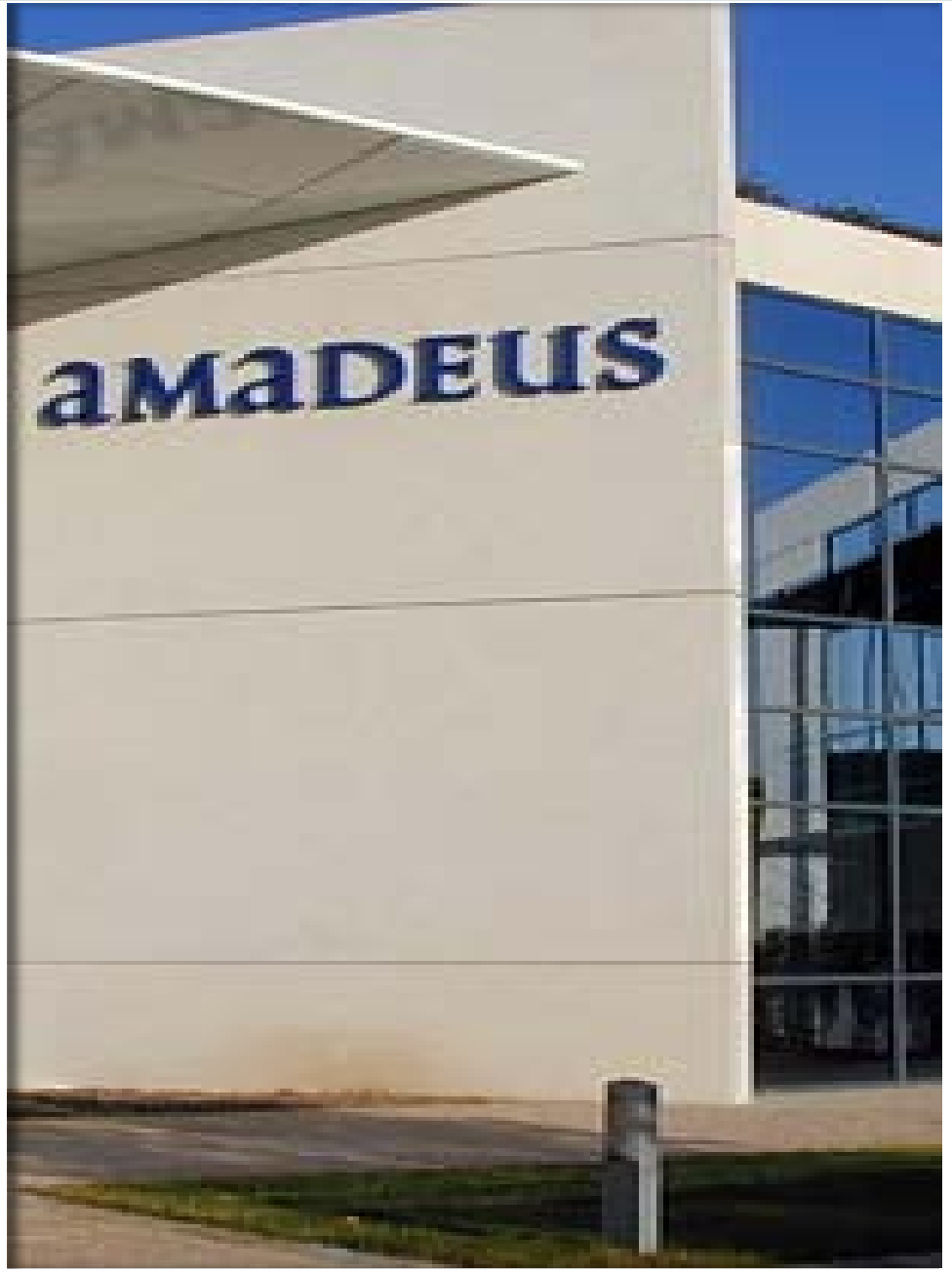
NEW

- Data Guard Simple Rolling Upgrade
  - Semi-automation of Transient Logical Standby Rolling Upgrade
  - Works with Data Guard Broker
  - Procedure DBMS_ROLLING
    - INIT_PLAN
    - DESTROY_PLAN
    - BUILD_PLAN
    - SET_PARAMETER
    - START_PLAN
    - SWITCHOVER
    - FINISH_PLAN
    - ROLLBACK_PLAN
  - Usable for maintenance tasks beginning with Oracle 12.1.0.1
  - Usable for upgrades beginning with the first patch set of Oracle 12*c* (12.1.0.2)
    - *DBMS_ROLLING usage requires a license for Active Data Guard*

Migration with GoldenGate

amadeus

Your technology partner



Real World Checkpoint

amadeus
Your technology partner

- Customer
- Project
- Constraints
- Preparation
- Migration
- Success?
- Remarks

- Amadeus is a leading transaction processor for the global travel and tourism industry

DISTRIBUTION BUSINESS

711 airlines
110,000+ hotel properties
30 car rental companies
50+ cruise and ferry lines
207 tour operators
24 insurance companies
95 railways

IT SOLUTIONS

Inventory
Departure Control
e-Commerce

Airlines
Airports
Hotels
Rail

20,000+ tx/sec (peak)
< 0.3 sec response time
10 Petabytes of storage
3+ million net bookings/day
> 1 billion tx/day

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Real World Checkpoint

amadeus
Your technology partner

Customer
Project
Constraints
Preparation
Migration
Success?
Remarks

- Migrate Oracle 10g production databases to Oracle 11g on new HW and/or OS platform

Source		Target
Oracle 10.2.0.3 RAC HPUX v2	→	Oracle 11.2.0.2/3 RAC HPUX v3
	→	Oracle 11.2.0.2/3 RAC RHE Linux
Oracle 10.2.0.3 Single Instance HPUX v2	→	Oracle 11.2.0.2/3 RAC One RHE Linux

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Real World Checkpoint

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- Preparation
- Migration
- Success?
- Remarks

- Fixed quarterly outage windows
- Maximum of 5 minutes database downtime
- No service impact outside the outage window
- Endian change: HP-UX ⇨ to Linux (big ⇨ little endian)
- Possibility of fallback during and after the outage
- High volume of DB changes (redo of up to 20MB/sec)
- Large database sizes (up to 14TB)
- Possibility for physical re-organization
  - Fresh data dictionary
  - Tablespace and partitioning redesign

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Real World Checkpoint

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Your technology partner

- Customer
- Project
- Constraints
- **Preparation**
- Migration
- Success?
- Remarks

- In-depth proof of concept (supported by Oracle)
  - Focusing on functional aspects
  - Focusing on data volume
- Standardized migration process model with timeline
- Home-made scripts and procedures to support setup, monitoring, tuning and switch over
- Training of in-house specialist supporting the DBAs

Real World Checkpoint

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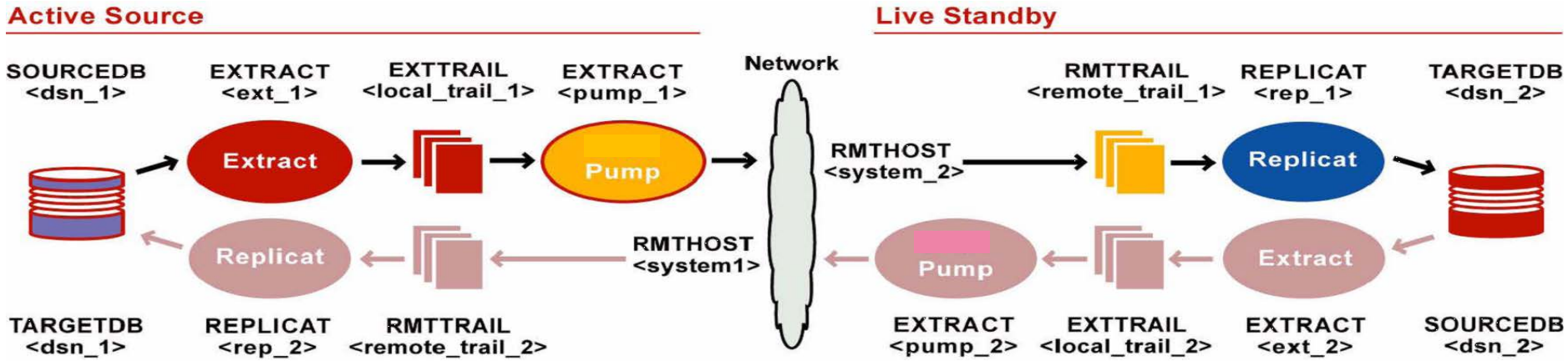
Customer
Project
Constraints
Preparation
Migration
Success?
Remarks

- Instantiation of new 11g database: expdp from Physical Standby
- Installation, configuration, tuning of GG replication



- Comparison of source/target DB content (Veridata)
- Rehearsals of switch over and fallback
- Switch over: Stop replication / Start reverse-replication

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Real World Checkpoint

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Customer
Project
Constraints
Preparation
Migration
Success?
Remarks

- 15 databases successfully migrated, so far (*Oct 2012*)

Source	Target	Migrated
Oracle 10.2.0.3 RAC HPUX v2	Oracle 11.2.0.2/3 RAC HPUX v3	6 ✓
	Oracle 11.2.0.2/3 RAC RHE Linux	3 ✓
Oracle 10.2.0.3 Single Instance HPUX v2	Oracle 11.2.0.2/3 RAC One RHE Linux	6 ✓

- Switchover duration: 2-6 minutes
- No fallback performed

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Real World Checkpoint

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Customer
Project
Constraints
Preparation
Migration
Success?
Remarks

- The concept proved to handle a smooth and secure migration across different DB versions and HW/OS platforms

- To be considered …
  - Instantiation of target database (incl. Plan Stability)
  - Customized GG setup per database
  - Handling of unsupported data types (e.g. ANYDATA)
  - Impact of supplemental logging on source DB
  - Effort of tuning GG for DBs with high DML rate (e.g. parallel replicate processes)

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Real World Checkpoint

Customer
Project
Constraints
Preparation
Migration
Success?
Remarks

- Payback GmbH
  - Belongs to Loyalty Partner GmbH which belongs to American Express
  - HQ in Munich, Germany
  - Develops and operates professional customer loyalty programs based on customized IT solutions
    - Provider for Payback
    - Active in Germany, Poland, India, Italy and Mexico

Real World Checkpoint

PAYBACK

Customer

Project

Constraints

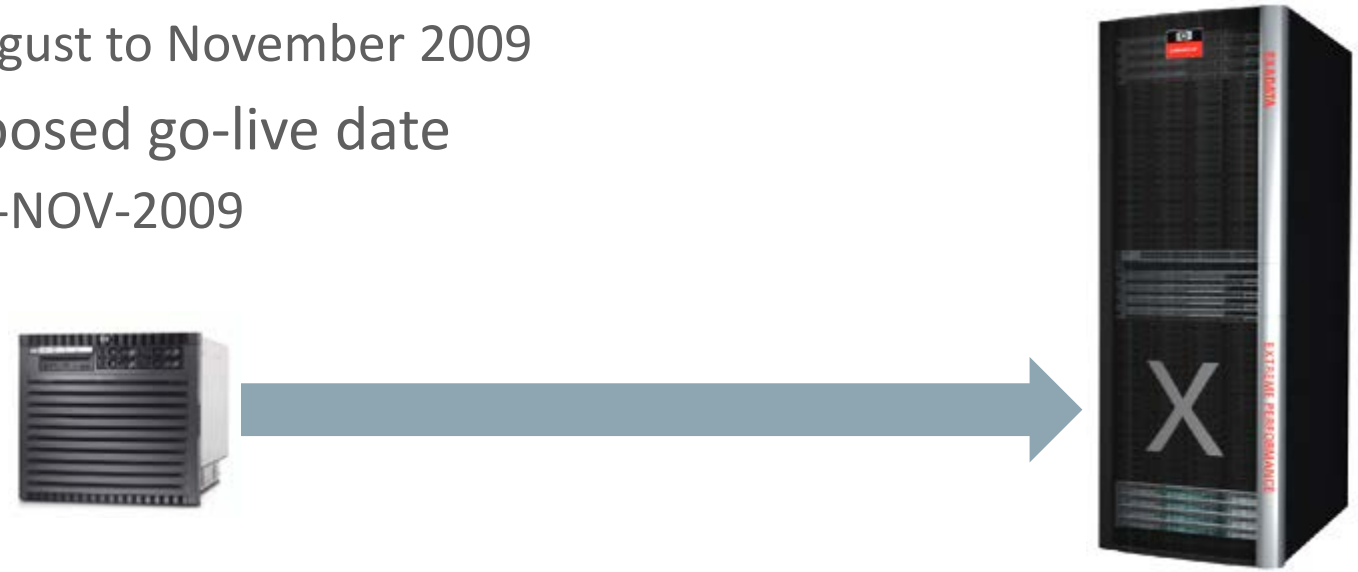
Preparation

Migration

Success?

Remarks

- Migrate 7TB / 1.5TB from HP-UX to Exadata V1
  - Cross platform, cross Endianness, cross version
    - Oracle 9.2.0.7 on HP-UX ⇨ Oracle 11.1.0.7 on OL
  - 4 months planning and migration phase
    - August to November 2009
  - Proposed go-live date
    - 15-NOV-2009



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Real World Checkpoint

Customer
Project
Constraints
Preparation
Migration
Success?
Remarks

- Move everything in less than 24 hrs
- Network bottleneck
  - Remedy:
    Install extra InfiniBand hardware into HP box
    ⇨ ~ 3GB/sec throughput!

Real World Checkpoint

PAYBACK

Customer

Project

Constraints

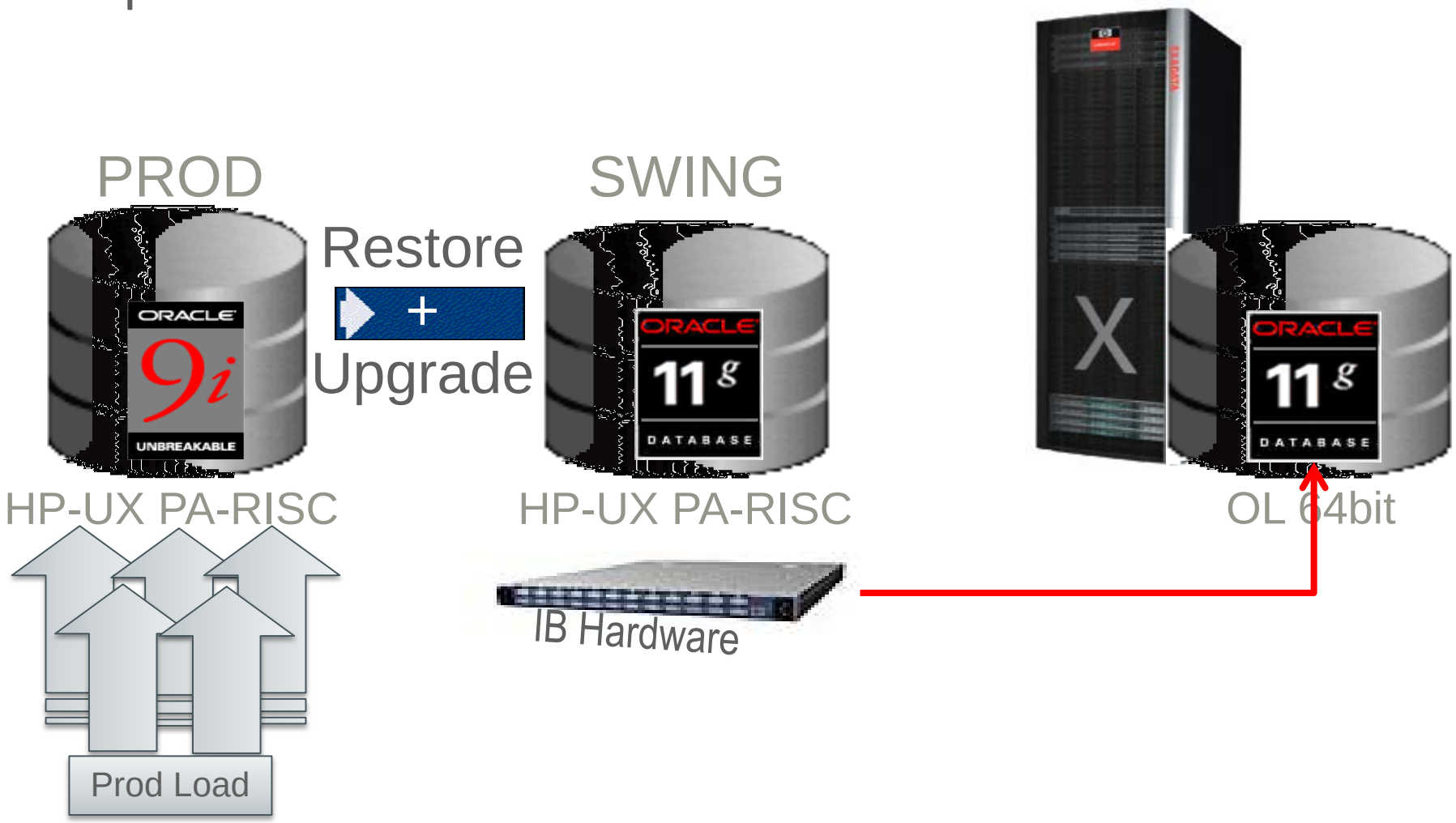
Preparation

Migration

Success?

Remarks

- Setup:



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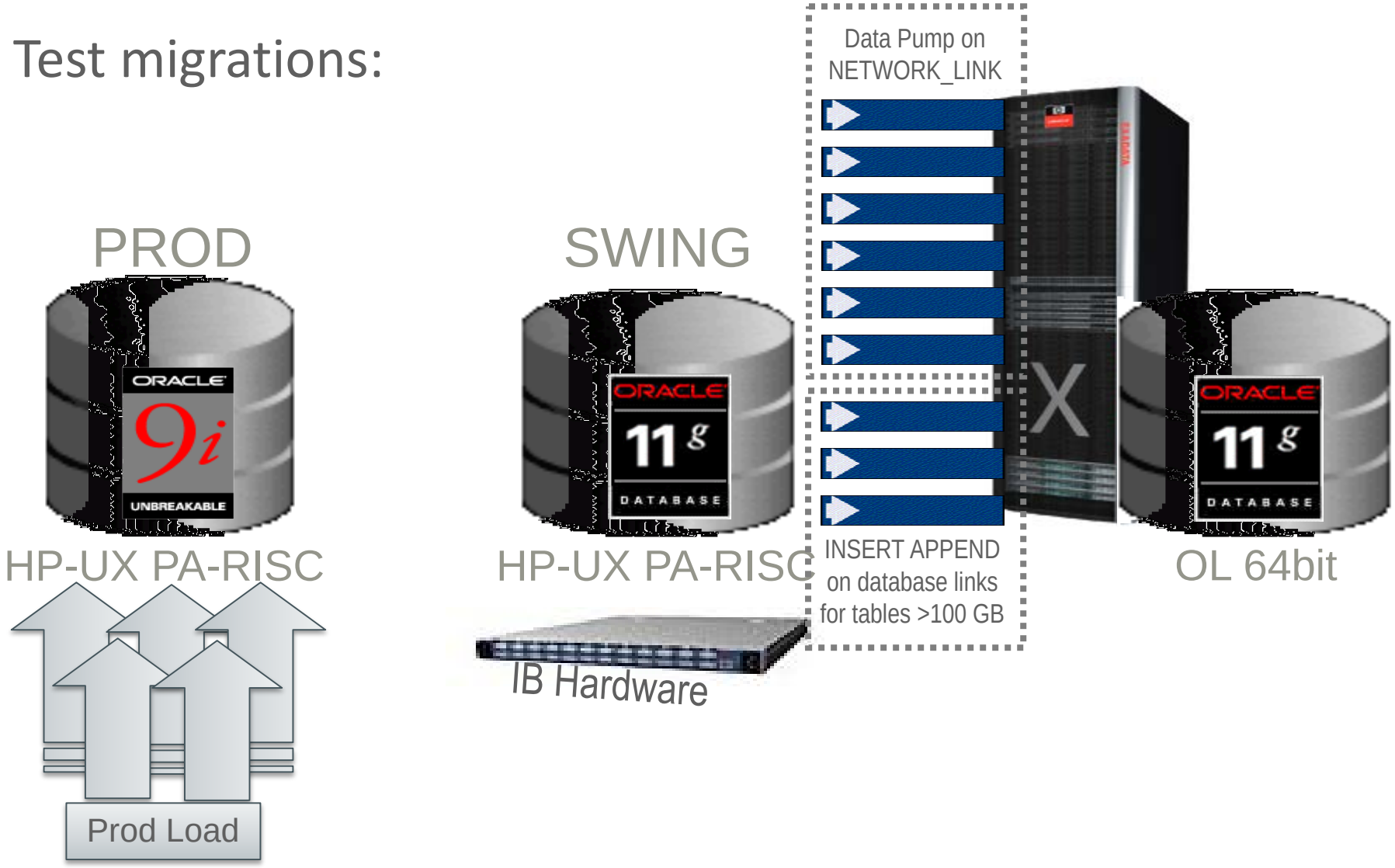
 | Different Ways to Upgrade and Migrate to Oracle Database 12c

Real World Checkpoint

PAYBACK

- Customer
- Project
- Constraints
- Preparation
- Migration
- Success?
- Remarks

- Test migrations:



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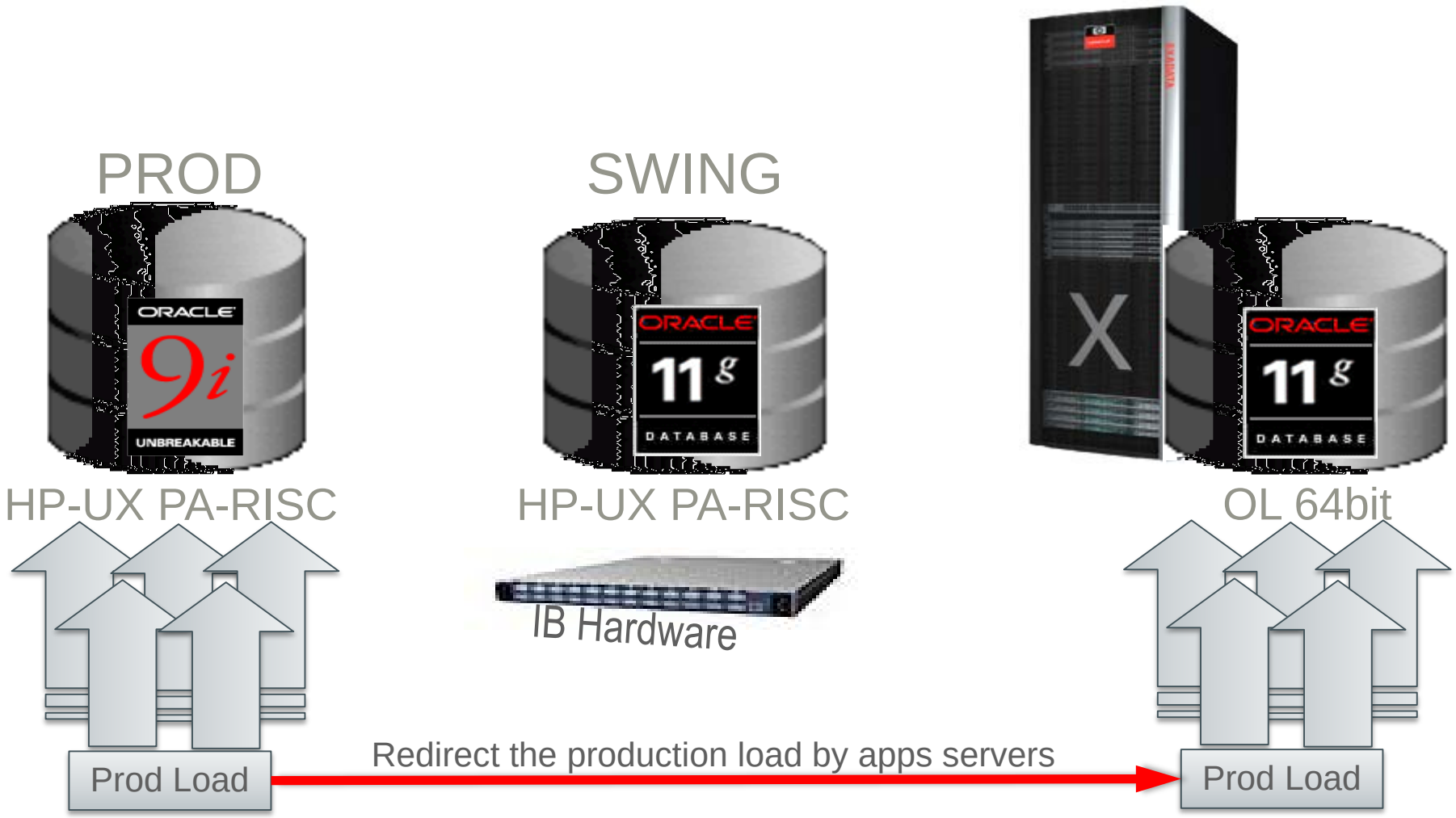
Real World Checkpoint

PAYBACK

- Customer
- Project
- Constraints
- Preparation
- Migration
- Success?
- Remarks

- Parallel live loads: Performance tests



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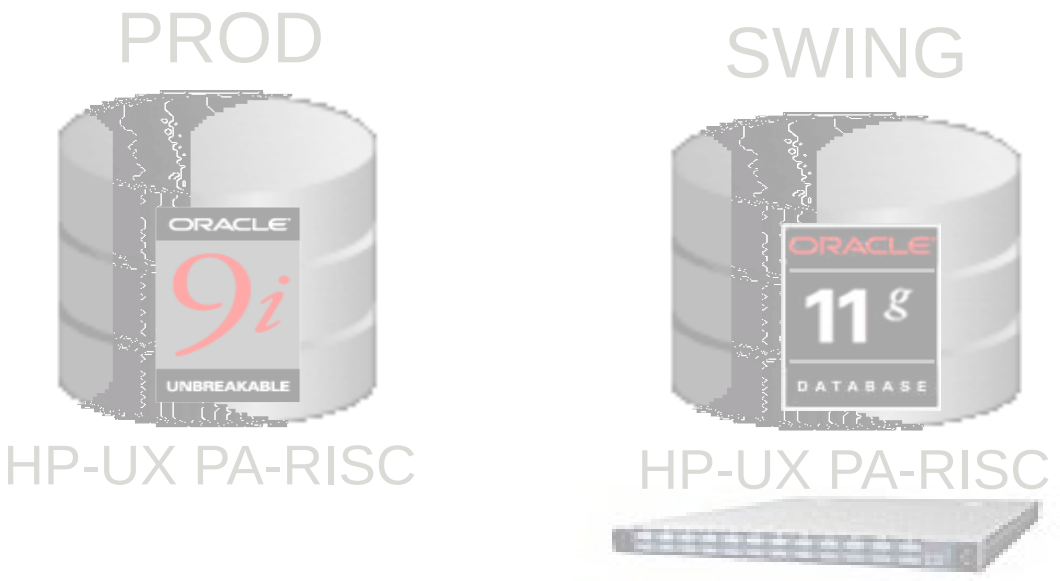
Real World Checkpoint

PAYBACK

- Customer
- Project
- Constraints
- Preparation
- **Migration**
- Success?
- Remarks

- Final test became LIVE migration



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Real World Checkpoint

Customer
Project
Constraints
Preparation
Migration
Success?
Remarks

- Live? And alive?
  - Yes! Go-live in early November 2009
    - Two weeks earlier than proposed
  - Total upgrade and migration time: ~20 hours
    - ~ 8 hours: Restore and recovery
    - ~ 1 hour: Database upgrade to Oracle 11.1.0.7
    - ~10 hours: Data migration to Exadata V1
    - ~ 1 hour: Smoke testing and final verification
  - Dramatic performance improvements
    - Job runtimes decreased by 80%
    - User complaints about too fast performance … really!!

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Real World Checkpoint

PAYBACK

Customer

Project

Constraints

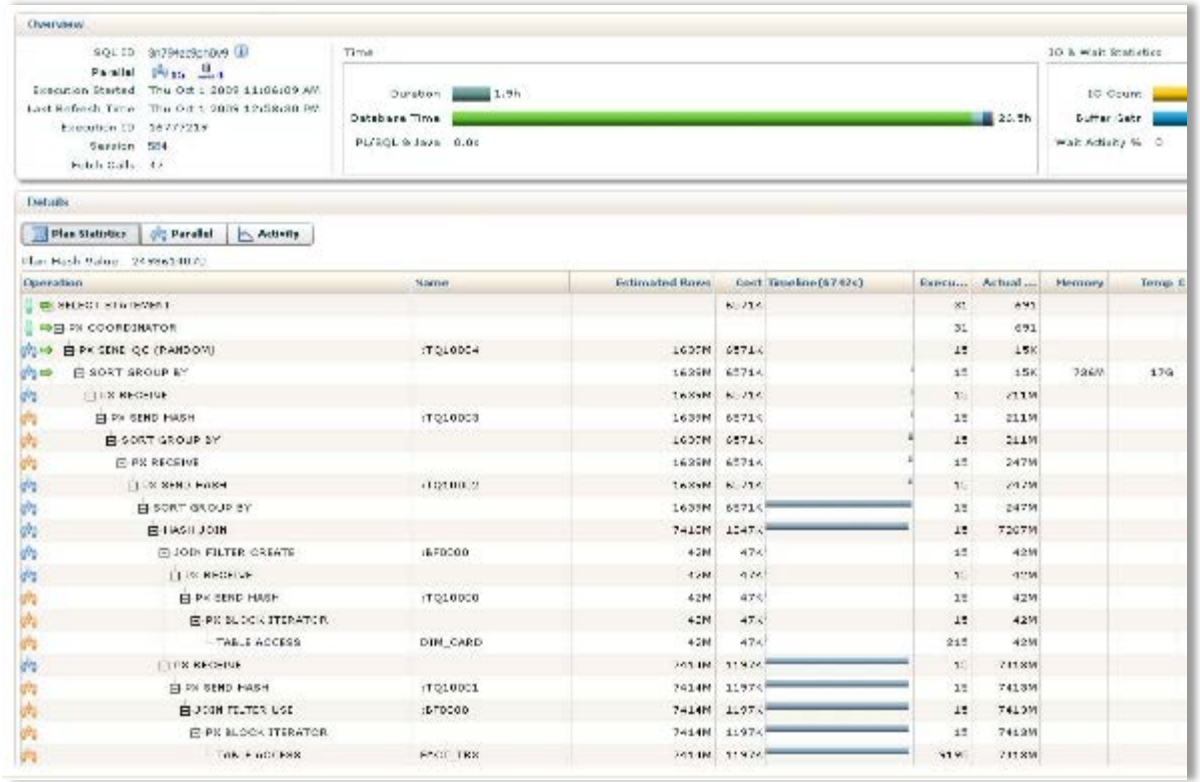
Preparation

Migration

Success?

Remarks

- Not a single piece of SQL had to be changed!!!
  - Most critical job: runtime from 30 hrs to < 2hrs



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Real World Checkpoint

- Customer
- Project
- Constraints
- Preparation
- Upgrade
- Success?
- Remarks

- Same customer again … Payback GmbH

Real World Checkpoint

Customer

Project

Constraints

Preparation

Upgrade

Success?

Remarks

- Migrate 14TB from Exadata V1 to Exadata X2-2
  - 2 months planning and migration phase
    - June to July 2012
  - Proposed go-live date
    - 22-JUL-2012
  - MOS Note: 1055938.1
    Migrating from HP Oracle Database Machine to
    Sun Oracle Database Machine 11.2 using Data Guard

Real World Checkpoint

- Customer
- Project
- Constraints
- Preparation
- Upgrade
- Success?
- Remarks

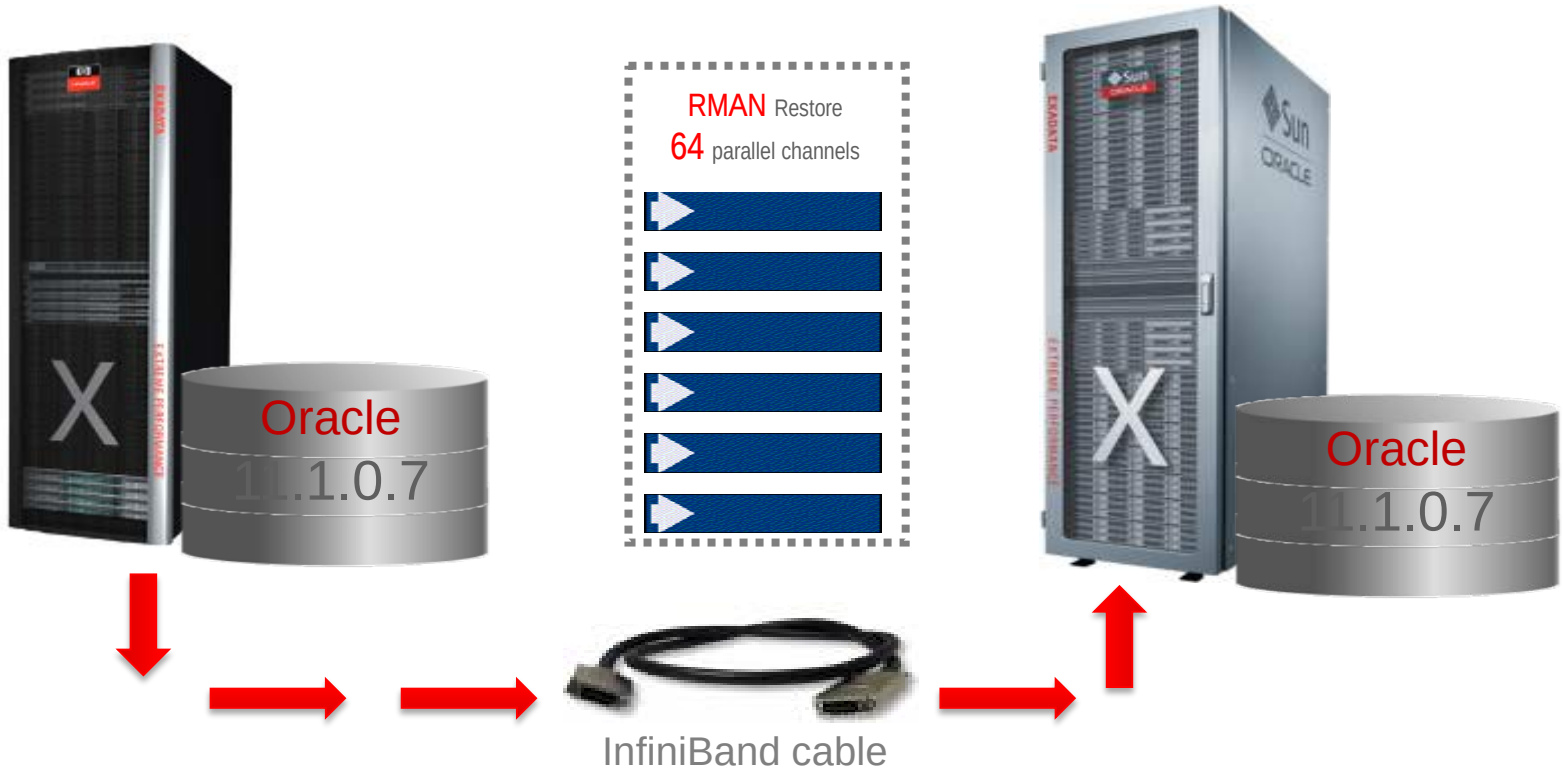
- Database has grown from 7TB to 14TB
- Downtime: less than 8 hrs
- Network "bottleneck"
  - Remedy: Extra IB cabled connection from V1 to X2-2

Real World Checkpoint

PAYBACK

Customer
Project
Constraints
Preparation
Upgrade
Success?
Remarks

- Restoring 14TB with RMAN
  - DUPLICATE FOR STANDBY FROM ACTIVE DATABASE
- Removed unused components from the source database



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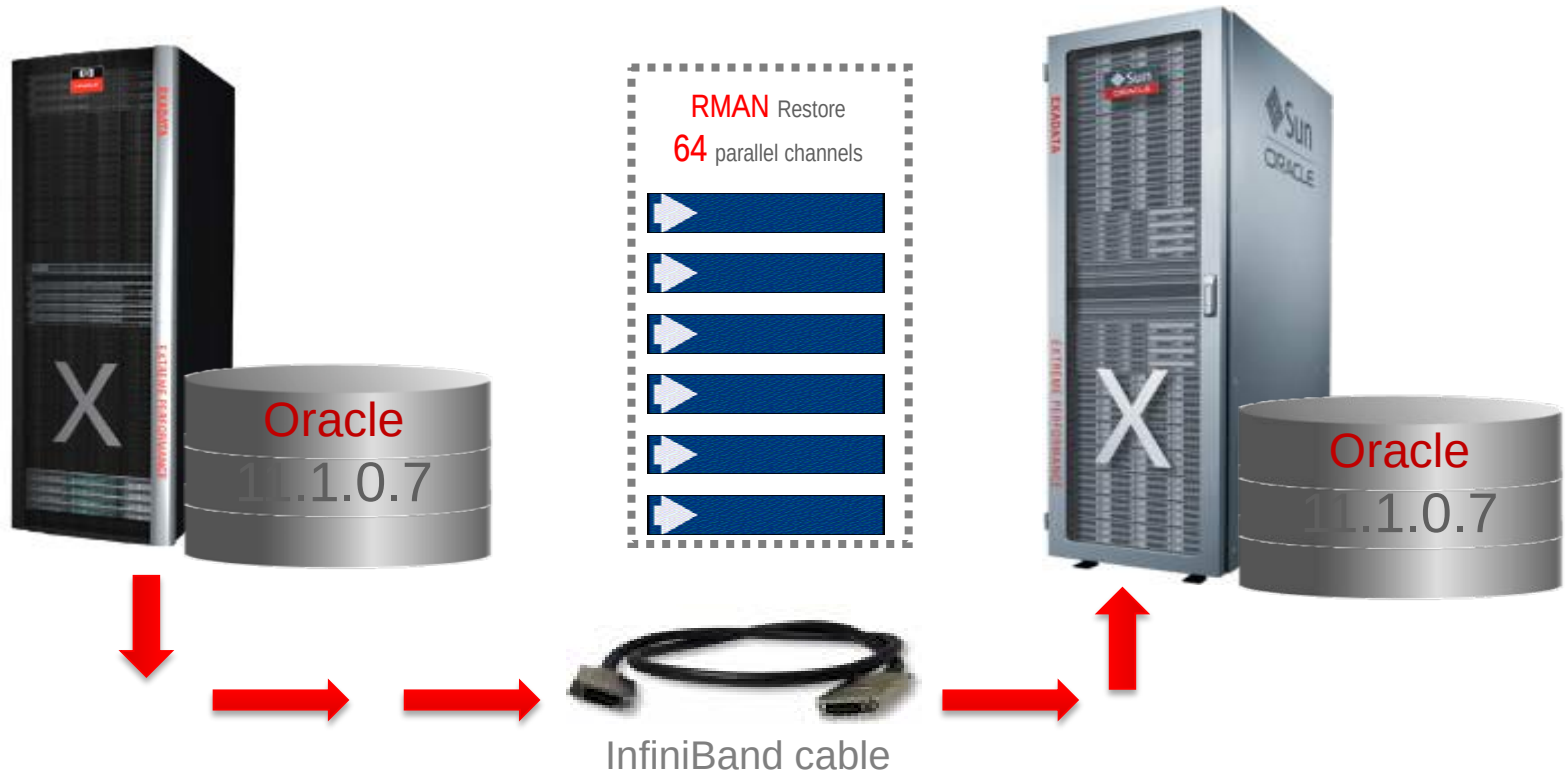
Real World Checkpoint

PAYBACK

Customer
Project
Constraints
Preparation
Upgrade
Success?
Remarks

- Live upgrade/migration
  - RMAN Restore and Recovery: <3 hours
    - 64 parallel RMAN channels allocated: >4TB/hour



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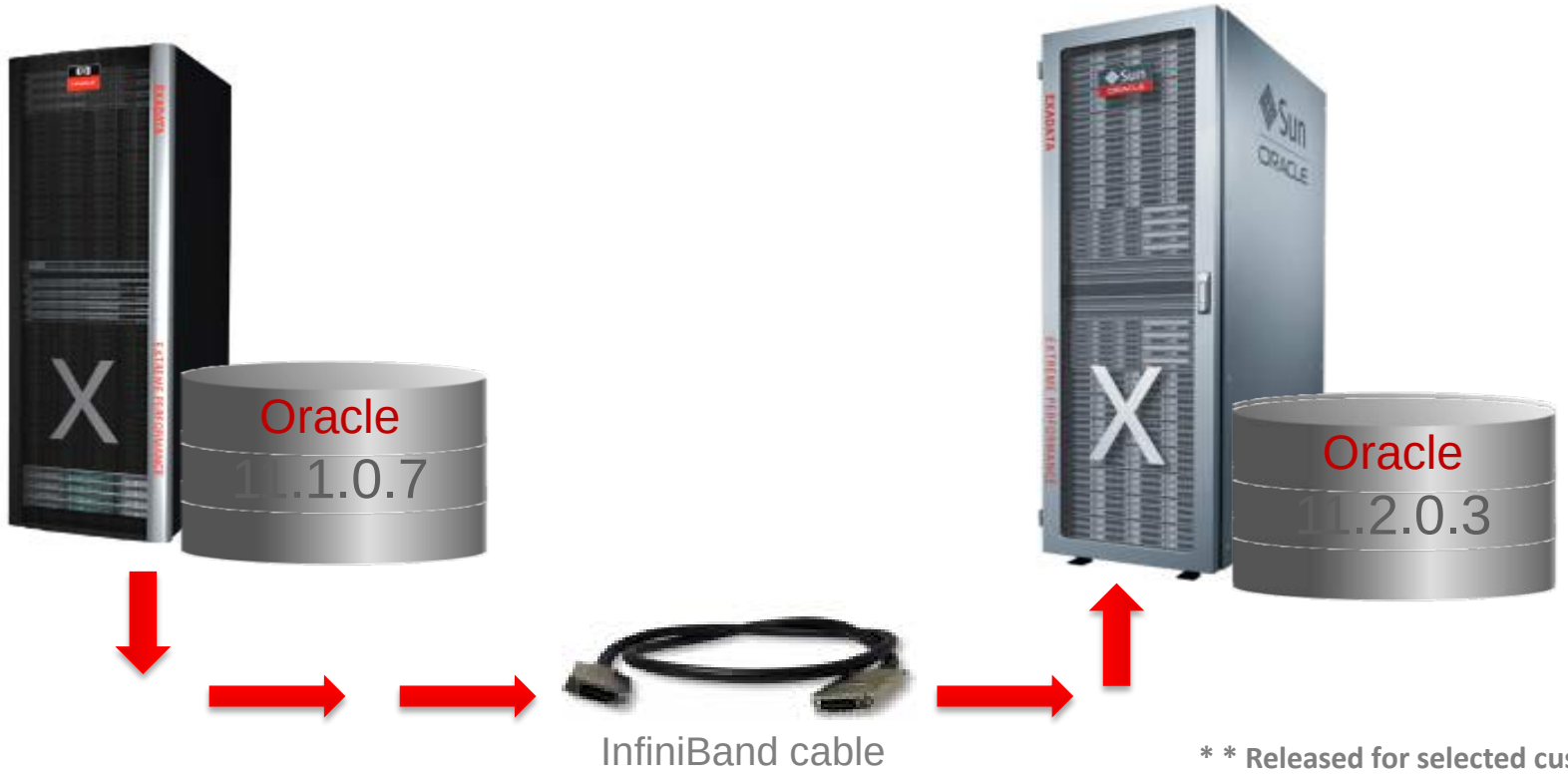
Real World Checkpoint

PAYBACK

Customer
Project
Constraints
Preparation
Upgrade
Success?
Remarks

- Database upgrade 11.1.0.7 ⇨ 11.2.0.3
  - Using the **new PARALLEL UPGRADE*** scripts
    - Total database upgrade time including recompilation and time zone change: 20 mins



* * Released for selected customers olly

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Real World Checkpoint

Customer
Project
Constraints
Preparation
Upgrade
Success?
Remarks

- Live? And alive?
  - Yes! Go-live on 3-JUL-2012
    - Almost three weeks earlier than proposed
  - Total migration and upgrade time: ~4 hours
    - < 3 hours: Restore for Standby and recovery
    - < 20 mins: Database upgrade to Oracle 11.2.0.3
    - ~ 40 mins: Extra tasks (crsctl etc.)
  - Significant performance improvements
    - Job runtimes decreased again by 30-60%

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 |

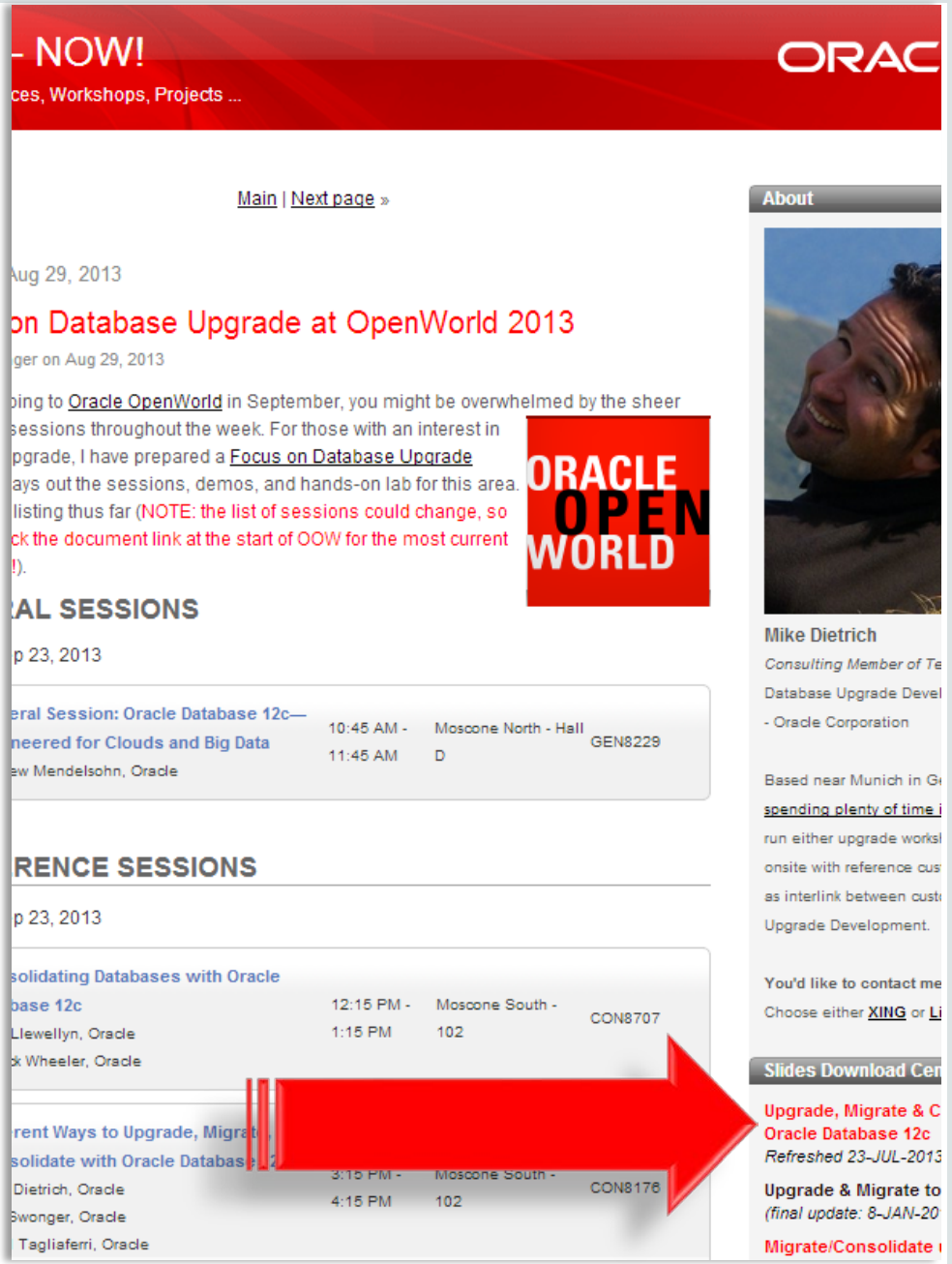
Real World Checkpoint

- Customer
- Project
- Constraints
- Preparation
- Upgrade
- Success?
- Remarks

- A few plans did change – but we were prepared ☺
  - Had captured all plans from AWR into an SQL Tuning Set
  - Remedied failing plans with SQL Plan Management

Resources

- Download slides from:
  - –http://blogs.oracle.com/UPGRADE



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