



DB

Database Services

CERN IT
Department

Going deeper into Real Application Testing

Learn how to make smoother migrations to 11g

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CERN IT-DB

- CERN
- Why Real Application Testing?
- Real Application Testing with EM
- A closer look at Real Application Testing
- Upgrade with Real Application Testing
 - measure the difference,
 - ... and performance issue,
- Methodology
- Recommendations and conclusions

- The largest particle physics lab in the world

Annual budget

982 mln CHF
687 mln GBP

+ External funding
for experiments



People:

- 2400 staff
- 900 students
(post-doc and undergraduate)
- 9000 users
- 2000 contractors

 AUSTRIA (1959)	 DENMARK (1953)	 GREECE (1953)	 NORWAY (1953)	 SPAIN (1/1961-12/1968-1/1983)
 BELGIUM (1953)	 FINLAND (1991)	 HUNGARY (1992)	 POLAND (1991)	 SWEDEN (1953)
 BULGARIA (1999)	 FRANCE (1953)	 ITALY (1953)	 PORTUGAL (1986)	 SWITZERLAND (1953)
 CZECH FR (1993)	 GERMANY (1953)	 NETHERLANDS (1953)	 SLOVAK FR (1993)	 UNITED KINGDOM (1953)

Eight Observer States

European Commission, USA, Russian Federation, India, Israel, Japan, Turkey, UNESCO

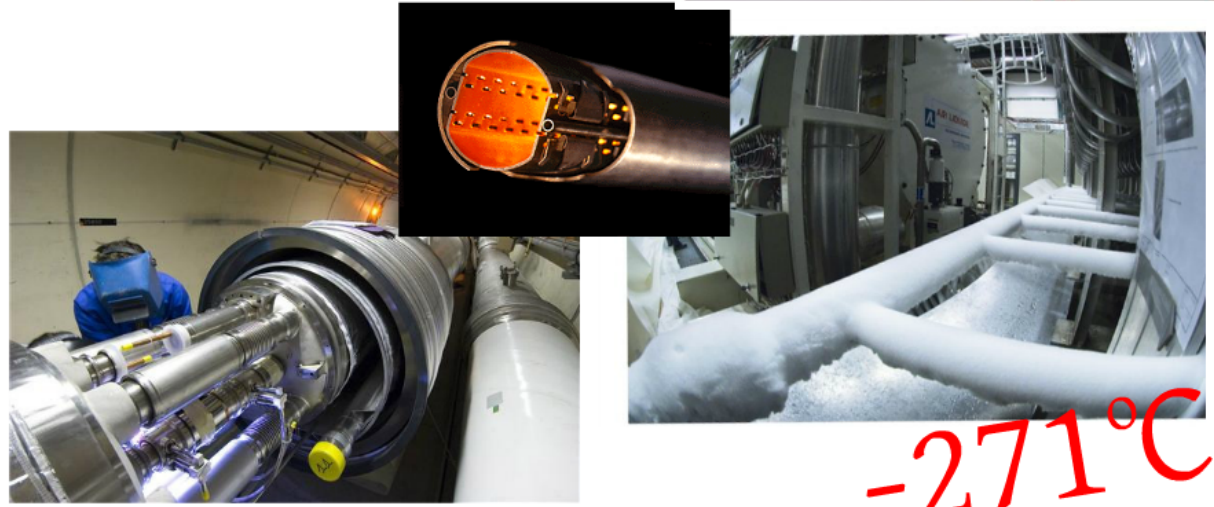
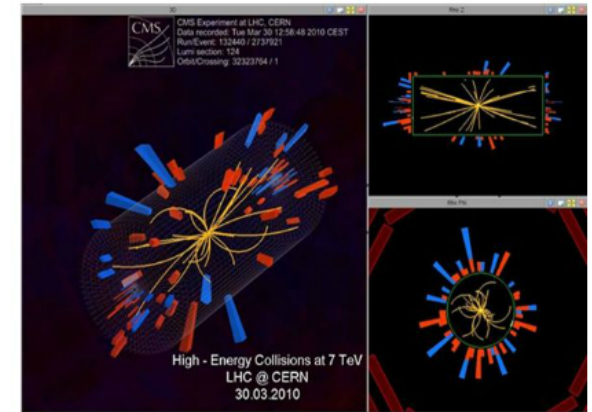
The largest particle accelerator & detectors

- 17 miles (27km) long tunnel
- thousands of superconducting magnets
- ultra vacuum 10x emptier than on Moon
- coldest place in the Universe
- 600 million collisions per second detected by hundreds of million sensors

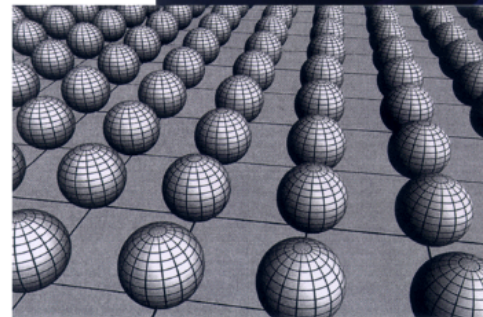
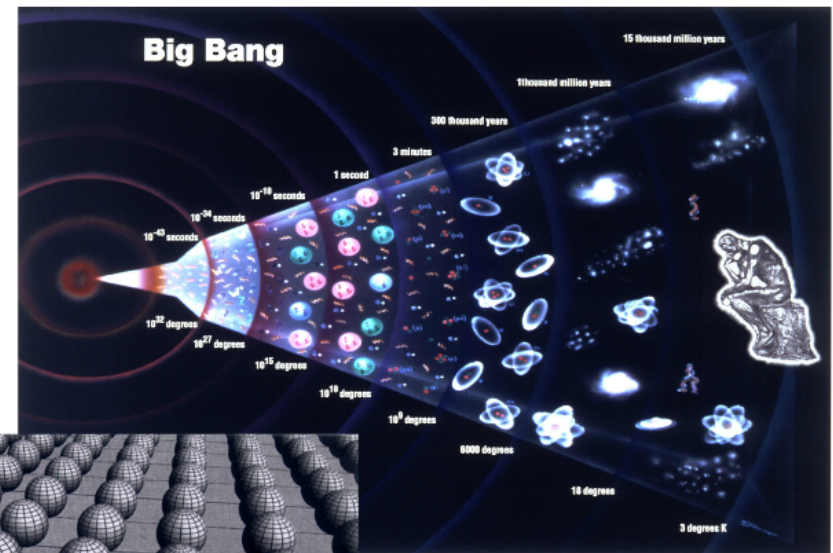
Total cost:

4.6

BCHF



- What is mass?
- What is 96% of the Universe made of?
- Where did the antimatter go to?
- What was the universe like just after the « Big Bang »?
- Are there extra dimensions of space?

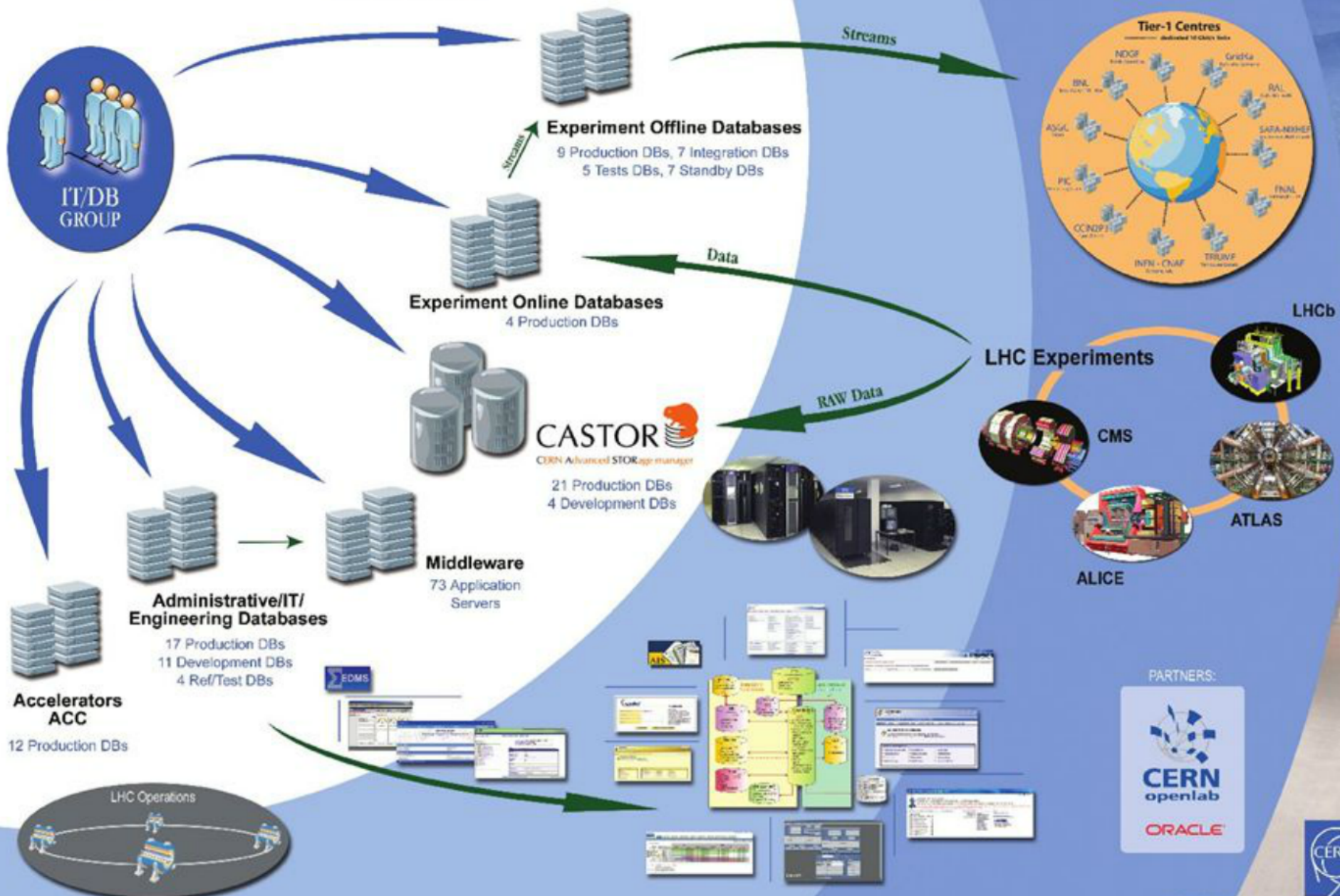


Worldwide LHC Computing Grid

- 25 Petabytes (25 millions Gigabytes) of data stored and analysed every year
- > 79,000 physical CPUs
- > 282,000 logical CPUs
- 140 computer centres around the world – more than 8000 physicists



<http://cern.ch/it-dep/db/>



PARTNERS:

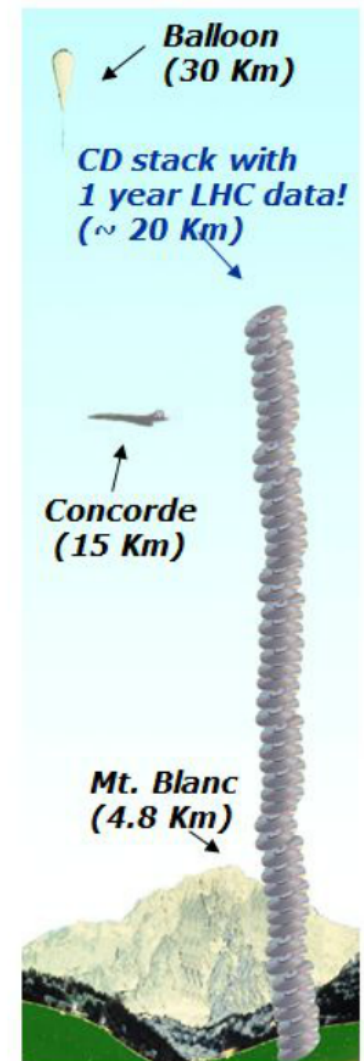


CERN databases services

- ~130 databases, most of them database clusters (Oracle RAC, 2 – 6 nodes)
- Currently over 3000 disk spindles providing more than ~3PB raw disk space (NAS and SAN)
- MySQL service starting

Some notable databases at CERN

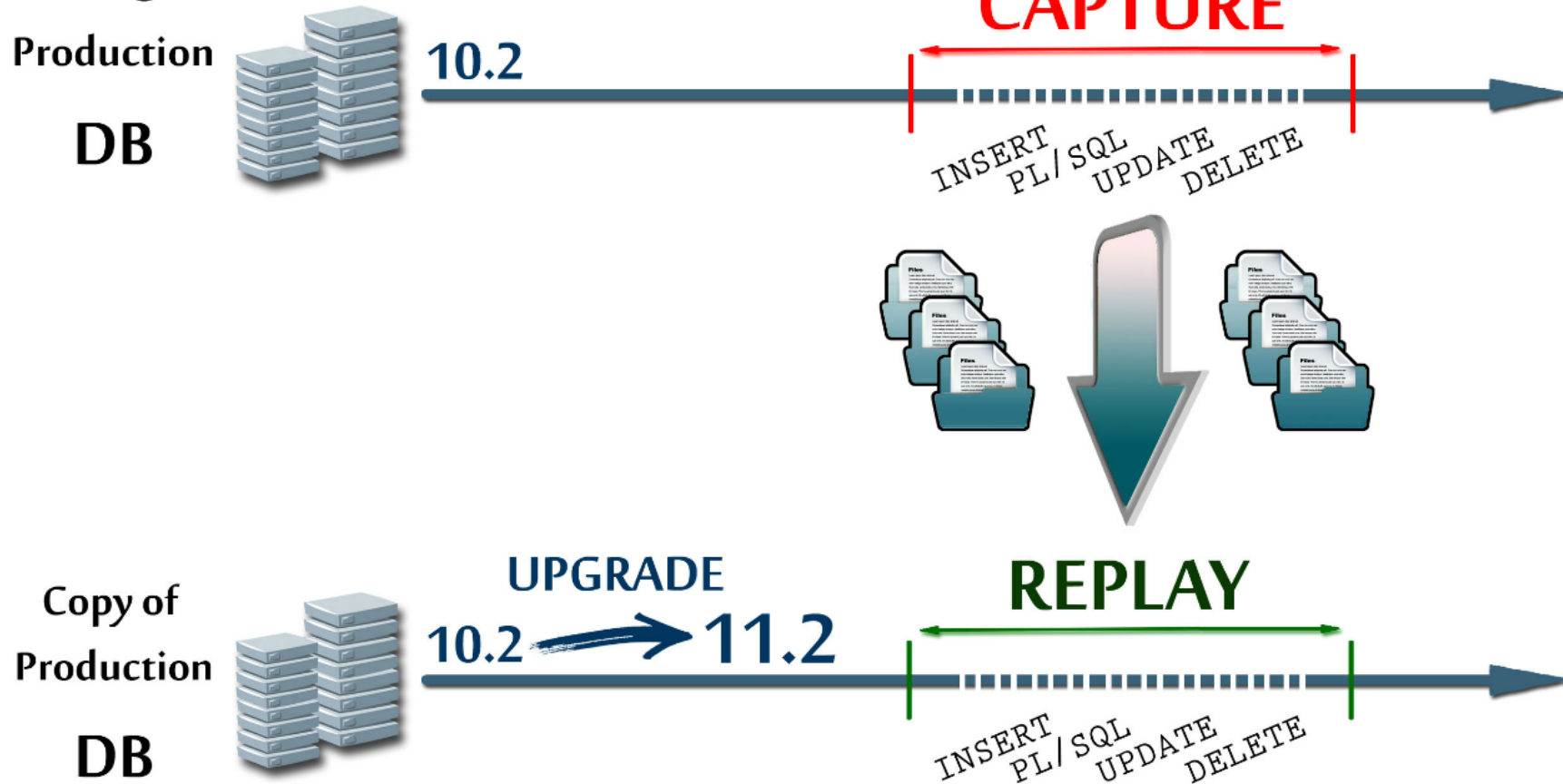
- Experiments' databases – 14 production databases
 - Currently between 1 and 12 TB in size
 - Expected growth between 1 and 10 TB / year
- LHC accelerator logging database (ACCLOG) – ~94 TB, $>3.5 * 10^{12}$ rows, expected growth up to 70TB / year
- ... Several more DBs in the 1-2 TB range



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- "DBAs and developers test, not the users!"
- All developers and DBAs have been dreaming trying for years: replaying the real workload
- Capture in 9.2+, replay in 11.1+
 - we started with capture 10.2
 - Real Application Testing is licensable option for Oracle Database EE: Database Replay + SQL Performance Analyzer (SPA) + SQL Tuning Sets (STS)

- No agent!



Enabled by default, if needed relink:

`make -f ins_rdbms.mk rat_on ioracle or chopt enable rat`

- major upgrades
- minor upgrades (CPU/PSU, one-off patches)
- platform change (hardware / OS change)
- database parameters change (sga_max_size, compatible, etc.)
- application schema change (new/removed index, etc.)
- execution plan changes (outline/SQL Plan Management...)
- consolidation / adding workload
- compression / partitioning
- and also for validating backup...

NOT ONLY
FOR
UPGRADES!

- Fully accessible, either
 - from Enterprise Manager
 - or from command line (PL/SQL packages)
- WRC binary required for the replay
 - In the RDBMS 11g software
 - Also available from Instant Client

*Instant Client Package - WRC: Workload Replay Client used to replay workload for RAT's DB Replay Feature

- ☒ [instantclient-tools-linux-x86-64-11.2.0.2.0.zip](#) (156,431 bytes) (cksum - 1027842478)
- ☒ [oracle-instantclient11.2-tools-11.2.0.2.0.x86_64.rpm](#) (134,661 bytes) (cksum - 534617225)

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- Where to start?

ORACLE Enterprise Manager Cloud Control 12c

Setup Help MPIORKOW Log Out

Enterprise Targets Favorites History Search Target Name

Summary
Monitoring
Job
Reports
Configuration
Compliance
Provisioning and Patching
Quality Management
My Oracle Support
Infrastructure Cloud
Database Cloud
Chargeback
Consolidation Planner
Open

Application Replay
Database Replay
SQL Performance Analyzer
Data Discovery and Modeling
Data Subset Definitions
Data Masking Definitions
Data Masking Formats

Page Refreshed Nov 25, 2011 11:11:18 AM CET

Oracle Load Map
Total Active Sessions 3.3
View Level: Database Instance

3.095 0.135
0.072
0.031

Job Activities

Status	Submitted To Any Target
Problem Executions (last ...)	0
Action Required Executio...	0
Suspended Executions (la...	0
Scheduled Executions (las...	0
Running Executions (last ...)	0

Status

4 Members ↑ 4 Up

Most Affected Members (Last 24 Hours)

Name	Type	Status	Availability (%)
rat11.cern.ch		↑	100
		↑	100
		↑	100
		↑	100

- Possible actions
 - Prepare Test Database

ORACLE Enterprise Manager Cloud Control 12c

Setup Help MPIORKOW Log Out

Enterprise Targets Favorites History Search Target Name

rat11.cern.ch Logged in as SYS dbvrtg020

Cluster Database Performance Availability Schema Administration

Database Replay

Database Replay allows workloads to be captured from production systems and re-executed with high fidelity on test copies of production databases. This enables detailed analysis of how the proposed changes may affect production systems; for instance, patching or upgrading database software.

Page Refreshed Nov 25, 2011 2:21:28 PM CET Refresh

Task List

Expand All Collapse All

Task Name	Description	Go to Task
> Capture Production Workload	Initiate or schedule a workload capture, export AWR data after capture, and copy captured files to the workload staging area.	
∨ Prepare Test Database	Set up a test database from production, upgrade or otherwise modify the test database, and isolate the test database prior to replay.	
Set Up Test Database	Clone the production database to a test environment. The test database should be restored to match the capture database at the start of capture. You may make any changes to the test environment as needed.	
Isolate Test Database	Isolate the test system from production environment prior to the workload replay. This task must be performed on the test database target.	
> Prepare for Replay	Prepare the workload capture files for replay (preprocess), copy the preprocessed workload files to the workload staging area, deploy the Replay Clients, and copy the preprocessed workload files to the Replay Client hosts.	
> Replay Workload on Test Database	Set up the workload replay on the test database, copy the replay results to the workload staging area, and analyze the results.	

Active Capture and Replay

Select	Name	Type	Directory Object	Start Time
	No items found			

DB

Capturing Workload

ORACLE Enterprise Manager Cloud Control 12c Setup ▾ Help ▾ MPIORKOW | Log Out »

Enterprise ▾ Targets ▾ Favorites ▾ History ▾ Search Target Name ▾

rat11.cern.ch Logged in as SYS | dbvrtg020

Cluster Database ▾ Performance ▾ Availability ▾ Schema ▾ Administration ▾

Logged in As SYS




Database Replay

Database Replay allows workloads to be captured from production systems and re-executed with high fidelity on test copies of production databases. This enables detailed analysis of how the proposed changes may affect production systems; for instance, patching or upgrading database software.

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Task List

Expand All | Collapse All

Task Name	Description	Go to Task
▼ Capture Production Workload	Initiate or schedule a workload capture, export AWR data after capture, and copy captured files to the workload staging area.	
Capture Workload	Capture a workload from the production environment. This can be scheduled to accommodate a database restart if desired.	
Export AWR Data	Export AWR data to provide a better performance comparison between captured and replayed workloads.	
Copy to Workload Staging Area	Copy captured files away from production to the workload staging area for later preprocessing. For a cluster database, captured files from different database instances can be consolidated in the workload staging area.	
▶ Prepare Test Database	Set up a test database from production, upgrade or otherwise modify the test database, and isolate the test database prior to replay.	
▶ Prepare for Replay	Prepare the workload capture files for replay (preprocess), copy the preprocessed workload files to the workload staging area, deploy the Replay Clients, and copy the preprocessed workload files to the Replay Client hosts.	
▶ Replay Workload on Test Database	Set up the workload replay on the test database, copy the replay results to the workload staging area, and analyze the results.	

▼ Active Capture and Replay

Select	Name	Type	Directory Object	Start Time
<input type="checkbox"/>	No items found			

▶ Workload Capture History

- Checking prerequisites

ORACLE Enterprise Manager Cloud Control 12c Help ▾

Plan Environment Options Parameters Schedule Review

Capture Workload: Plan Environment

Database rat11.cern.ch
Logged In As sys

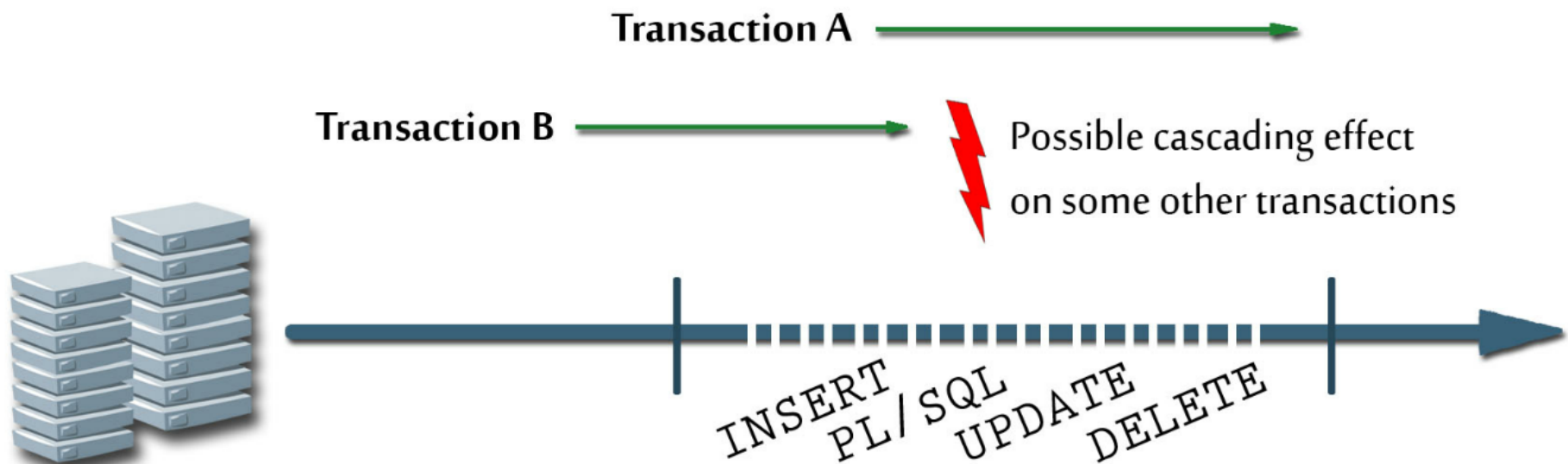
[Cancel](#) Step 1 of 5 [Next](#)

The following prerequisites should be met to avoid potential problems before proceeding to capture the workload.

Prerequisite	Acknowledge
Make sure there is enough disk space to hold the captured workload. Consider doing a short duration workload capture and using it for estimating the disk space requirement of a full workload capture.	<input checked="" type="checkbox"/>
Make sure you can restore the replay database to match the capture database at the start of the workload capture. A successful workload replay depends on application transactions accessing application data identical to that on a capture system. Common ways to restore application data state include point-in-time recovery, flashback, and import/export.	<input checked="" type="checkbox"/>

[Cancel](#) Step 1 of 5 [Next](#)

- Recommendation is to stop the database instances, then start the instance(s) in restricted mode and then enable capture.
Not possible in most cases
- It means that it can incur errors for dependent transactions
- Not an issue if errors are negligible percentage of the workload



- Options
 - Workload filters

Workload Filters

Workload filters can customize the workload to be captured. By default, most external client requests made to the database are captured. Refer to the Oracle Real Application Testing User's Guide for more information.

Filter Mode: **Exclusion** ▼

Excluded Sessions
All sessions will be captured except for those listed below.

Filter Name	Type	Session Attribute	Value	Remove
Oracle Management Service (DEFAULT)	Excluded	Program ▼	OMS	
Oracle Management Agent (DEFAULT)	Excluded	Module ▼	emagent%	

[Add Another Row](#)

TIP You may use % for wildcard in a filter value.

- Database restart

ORACLE Enterprise Manager Cloud Control 12c Help ▼

Plan Environment **Options** Parameters Schedule Review

Capture Workload: Options
Database: rat11.cern.ch
Logged in As: sys [Cancel](#) [Back](#) Step 2 of 5 [Next](#)

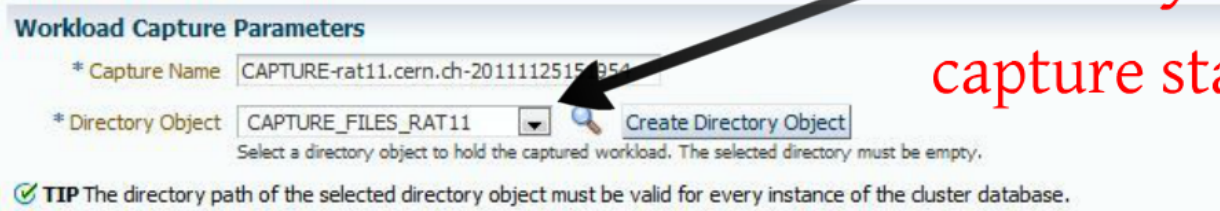
Database Restart Options
A database restart prior to a workload capture is recommended to ensure a complete and accurate capture. Not restarting could capture in-flight transactions, which may adversely affect the replay of subsequent captured transactions.

Do not restart the database prior to the capture.

Restart the database prior to the capture.

- Capture

- Capture parameters



Workload Capture Parameters

* Capture Name: CAPTURE-rat11.cern.ch-2011112515:954


* Directory Object: CAPTURE_FILES_RAT11

Select a directory object to hold the captured workload. The selected directory must be empty.

TIP The directory path of the selected directory object must be valid for every instance of the cluster database.

Directory must be empty before capture start

- Shutdown/Startup parameters



Database Shutdown Parameters

Immediate
Rollback active transactions and disconnect all connected users.

Transactional
Disconnect all connected users after transactions have completed.

Abort
Instantaneous shutdown by aborting the database instance.

Force the database to shut down
Use this option to shut down the database if any cluster managed database services are up.

Database Startup Parameters

Startup using current spfile.

Specify parameter file (pfile) on database host.

Specify the fully qualified name for the pfile.

The way the DB is stopped before capture start

The way the DB is opened before capture start



Capturing Workload

- Scheduling capture
 - Job parameters
 - Job schedule

Job Parameters

* Job Name: CAPTURE-RAT11.CERN.CH-20111125155050

Description: RAT Test Capture

Job Schedule

Choose a start time and a capture duration so that the workload you are interested in replaying at a later time can be captured.

Start

Immediately
 Later

Date: Nov 25, 2011
(example: Nov 25, 2011)

Time: 3:50:00 AM PM

Capture Duration

Not Specified
Capture must be stopped manually if duration is not specified

Duration

Hours: 2 Minutes: 0

Capture will run until stopped by hand

- Job credentials

Job Credentials

Host Credentials

Credential: Preferred Named New

Credential Name: ORACLE@DBVRTG017

Attribute	Value
UserName	orade
Password	*****

[More Details](#)

- Reviewing settings

ORACLE Enterprise Manager Cloud Control 12c Help ▾

Plan Environment Options Parameters Schedule **Review**

Capture Workload: Review

Database: rat11.cern.ch [Cancel](#) [Back](#) Step 5 of 5 [Submit](#)

Logged In As: sys

Review the following settings for capturing the workload.

Job Name: CAPTURE-RAT11.CERN.CH-20111125161018
Capture Name: CAPTURE-rat11.cern.ch-20111125161018
Directory Object: CAP_FILES_RAT11
Directory Path: /ORA/dbs03/RPM112_TEST/CAP_FILES_RAT11
Start Time: Immediately
Capture Duration: 0 Hours 15 Minutes
Restart Database: No

Workload Filters: Excluded Sessions

Filter Name	Type	Session Attribute	Value
Oracle Management Service (DEFAULT)	Excluded	Program	OMS
Oracle Management Agent (DEFAULT)	Excluded	Module	emagent%

[Cancel](#) [Back](#) Step 5 of 5 [Submit](#)

- Reviewing results

The OK button will return to the Database Replay home page.

Status Completed

▼ Summary

Name	CAPTURE-rat11.cern.ch-20111125172441	Captured Data Size (MB)	0.11
Directory Object	CAP_FILES_RAT11 ⓘ	Duration (hh:mm:ss)	00:14:55
Database Name	RAT11	Start Time	Nov 25, 2011 5:25:57 PM CET
Capture Database Version	11.2.0.3.0	End Time	Nov 25, 2011 5:40:52 PM CET
Cluster Database	Yes	Start SCN	3149695
DBID	3483098203	End SCN	3160947
Capture Error Code	None	AWR Data Exported	No
Capture Error Message	None	SQL Tuning Set Name	n/a

Export AWR Data OK

AWR can be gathered later

Workload Profile Workload Filters

Average Active Sessions

View Workload Capture Report

Comparison

	Total	Capture	Percentage of Total
Database Time (hh:mm:ss)	00:01:11	00:00:24	33.80
Average Active Sessions	0.08	0.03	33.80
User Calls	13,974	634	4.54
Transactions	575	0	n/a
Session Logins	332	7	2.11
Application Errors	n/a	108	n/a

- Capture report

Database Capture Report For RAT11

DB Name	DB Id	Release	RAC	Capture Name	Status
RAT11	3483098203	11.2.0.3.0	YES	CAPTURE-rat11.cern.ch-20111125172441	COMPLETED

Information	Capture
Start time:	25-Nov-11 16:25:57 (SCN = 3149695)
End time:	25-Nov-11 16:40:52 (SCN = 3160947)
Duration:	14 minutes 55 seconds
Capture size:	113.01 KB
Directory object:	CAP_FILES_RAT11
Directory path:	/ORA/dbs03/RPM112_TEST/CAP_FILES_RAT11
Directory shared in RAC:	TRUE
Filters used:	2 EXCLUSION filters

Captured Workload Statistics

- 'Value' represents the corresponding statistic aggregated across the entire captured
- '% Total' is the percentage of 'Value' over the corresponding system-wide aggregate

Statistic Name	Value	% Total
DB time (secs)	23.61	33.35
Average Active Sessions	0.03	
User calls captured	634	4.54
User calls captured with Errors	108	
Session logins	7	2.11
Transactions	0	0.00

DB Capture Report

- [Capture Statistics](#)
- [Workload Captured](#)
- [Workload Not Captured - Contains Unreplayable Calls](#)
- [Workload Not Captured - User Filtered](#)
- [Workload Not Captured - DB Scheduler Jobs and Background Activity](#)
- [SQL Text](#)
- [Workload Filters](#)

- Java application to produce report (see references)

PL/SQL

Maximum Workload Impact: 100 % of DB Time

Rationale

If the replay is much slower than expected, try to run in unsynchronized mode.

Action

A significant part of your workload comes from PL/SQL.

If the PL/SQL blocks or functions have 'complicated' logic or multiple commits in them, they are hard to synchronize and their behavior might change during replay. You might see a different workload profile during replay if this is the case.

SCHEDULED JOBS

Maximum Workload Impact: 40 % of DB Time

Rationale

During the capture period, a significant amount of the workload was created by scheduled jobs. If some of these jobs were scheduled before the capture period, they have not been captured and will not be replayed.

Action

In order for their work to be done during replay, the same jobs should be scheduled to run during the replay period.

SYSDATE and other time-dependent functions

Maximum Workload Impact: 9 % of DB Time

Rationale

A significant part of your SQL workload is referencing SYSDATE.

Action

The system clock needs to be restored to its capture value before replay.

Non captured workload

Maximum Workload Impact: 5 % of DB Time

Rationale

A significant amount of the workload running during the capture period was not captured, most likely because of capture filters.

Action

This part of the workload will not be replayed and will not appear in the AWR reports.

Also available in Oracle Enterprise Manager
Database Control 11.2.0.2 and above

- Selecting workload

Database Replay > Copy to Workload Staging Area: Select Captured Workload
Copy to Workload Staging Area: Select Captured Workload

Select a captured workload to copy to the workload staging area. The workload staging area is a location separate from any managed databases where this capture will be maintained.

Workload Capture
 Select a captured workload to copy.

Target Type Cluster Database
 Target Name rat11.cern.ch
 * Capture CAPTURE-rat11.cern.ch-20111125172441 (25-Nov-2011 17:25:57 o'clock CET) ▼

▼ **Capture Summary**

Name	CAPTURE-rat11.cern.ch-20111125172441	Captured Data Size (MB)	0.11
Status	Completed	Duration (hh:mm:ss)	00:14:55
Directory Object	CAP_FILES_RAT11 ?	Start Time	25-Nov-2011 17:25:57 o'clock CET
Database Name	RAT11	End Time	25-Nov-2011 17:40:52 o'clock CET
Capture Database Version	11.2.0.3.0	Start SCN	3149695
Cluster Database	Yes	End SCN	3160947
DSID	9483098203	AWR Data Exported	Yes
Capture Error Code	0	Preprocessed Database Version	n/a
Capture Error Message	None		

- Copying workload

Copy to Workload Staging Area

Copy the workload directory for the capture to a new location to move it from the file system of the captured database. This workload staging area will be available for subsequent capture and replay tasks.

Current Location of the Workload Directory

Host dbvrtg020
 Directory /ORA/db03/RPM112_TEST/CAP_FILES_RAT11

Credential Preferred Named New

Credential Name NC_DBVRTG02_2011-11-25-161127 ▼

Attribute	Value
UserName	oracle
Password	*****
More Details	

Workload Staging Area Directory Location

* Host dbvrtg017

* Directory /ORA/db03/RPM112_TEST/COPY_CAP_FILES_RAT11

Credential Preferred Named New

Credential Name ORACLE@DBVRTG053 ▼

Attribute	Value
UserName	oracle
Password	*****
Privilege Type	SUDO
Run As	oracle
More Details	

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- One file created per server process (each session for dedicated server process),
- Sequential, buffered writing per session

```
access("/.../wcr_7jya5h0000009.rec", F_OK) = -1 ENOENT (No such file or directory)
```

```
open("/.../wcr_7jya5h0000009.rec", O_RDWR|O_CREAT|O_TRUNC, 0666) = 10
```

```
$ ls -lrt /proc/7576/fd/  
lrwx----- 1 oracle ci 64 Sep 20 22:06 9 ->  
[...]/wcr_7jwjrh0000002.rec
```

```
$ strace -tt -T -p 7937 2>&1 | grep "write(9"  
22:24:30.745968 write(9, "..."...., 4096) = 4096 <0.000028>  
22:24:30.746050 write(9, "..."...., 45056) = 45056 <0.000044>  
22:24:30.746149 write(9, "..."...., 684) = 684 <0.000016>  
  
22:24:31.111495 write(9, "..."...., 4096) = 4096 <0.000026>  
22:24:31.111584 write(9, "..."...., 45056) = 45056 <0.000038>  
22:24:31.111675 write(9, "..."...., 713) = 713 <0.000017>  
  
22:24:31.474120 write(9, "..."...., 4096) = 4096 <0.000027>  
22:24:31.474193 write(9, "..."...., 45056) = 45056 <0.000040>  
22:24:31.474282 write(9, "..."...., 712) = 712 <0.000019>
```

- Measured to be less than 4-5% in all our deployments (sometimes less than 1%)
- Space and impact depends on the number of database calls with length of binds (usage of LOBs, etc.)
- Space requirements (from 340MB/hour to 2815MB/hour on some of our workloads)
 - Starting point 2 x Bytes received via SQL*Net from client

- Capture is same as for single instance
 - `DBMS_WORKLOAD_CAPTURE.START_CAPTURE` **only once**
 - `alert_AISDBP1.log:DBMS_WORKLOAD_CAPTURE.START_CAPTURE(): Starting database capture at 09/26/2011 16:48:59`
 - `alert_AISDBP2.log:DBMS_WORKLOAD_CAPTURE.START_CAPTURE(): Starting database capture at 09/26/2011 16:48:59`
 - `alert_AISDBP3.log:DBMS_WORKLOAD_CAPTURE.START_CAPTURE(): Starting database capture at 09/26/2011 16:48:59`
 - `alert_AISDBP4.log:DBMS_WORKLOAD_CAPTURE.START_CAPTURE(): Starting database capture at 09/26/2011 16:48:59`
- Replay requires that all files are accessible
- Services should be used for connection mapping
 - Actually not RAC specific

```
DBMS_WORKLOAD_REPLAY.REMAP_CONNECTION  
(connection_id => XX, replay_connection =>  
'(DESCRIPTION=...')
```


- Enough WRC clients (c.f. wrc mode=calibrate)
- Job/scheduler sessions are not captured
 - Jobs will be played as “normally” (would they be captured, they would run twice!)
- Both commit and timing dependencies are preserved
 - Including the number of rows fetched, think time (includes network latency)
- Enqueue locking is preserved
 - In synchronised mode, becomes intended locking

- DB Replay Report

Replay Statistics

Statistic	Replay	Capture
DB Time	208459.275 seconds	8507.975 seconds
Average Active Sessions	47.17	2.41
User calls	1211358	1211388
Network Time	2302270.095 seconds	
Think Time	1257596.755 seconds	

Replay Divergence Summary

Divergence Type	Count	% Total
Session Failures During Replay	0	0.00
Errors No Longer Seen During Replay	560	0.05
New Errors Seen During Replay	16887	1.39
Errors Mutated During Replay	5993	0.49
DMLs with Different Number of Rows Modified	382	0.03
SELECTs with Different Number of Rows Fetched	10076	0.83

By Divergence magnitude

(-) Hide

Max divergence magnitude	Divergence distribution (%)	Count
less rows than expected were affected	4.71	18
more rows than expected were affected	.26	1
no rows affected	95.02	363

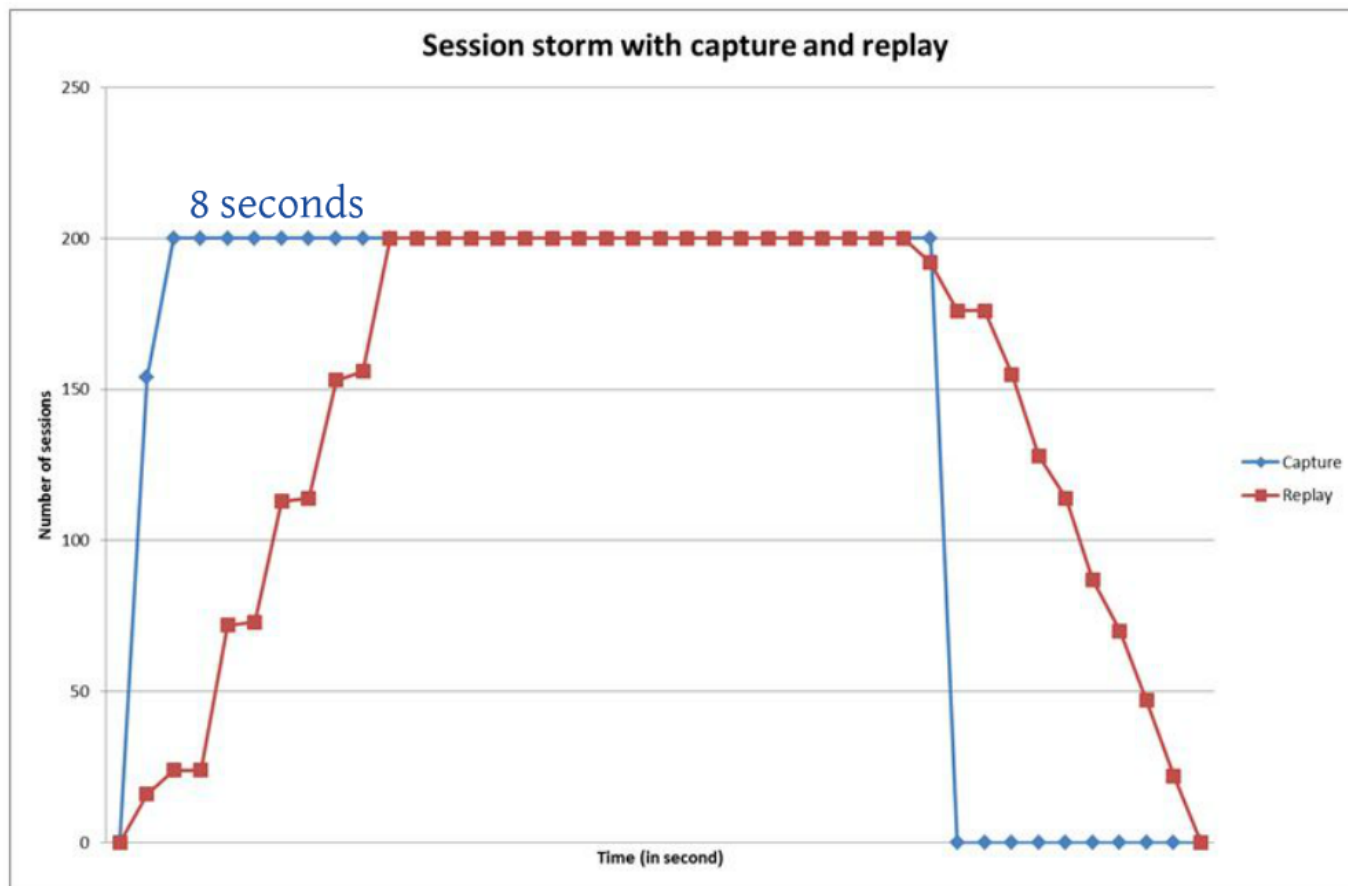
SELECT Data Divergence

By Application

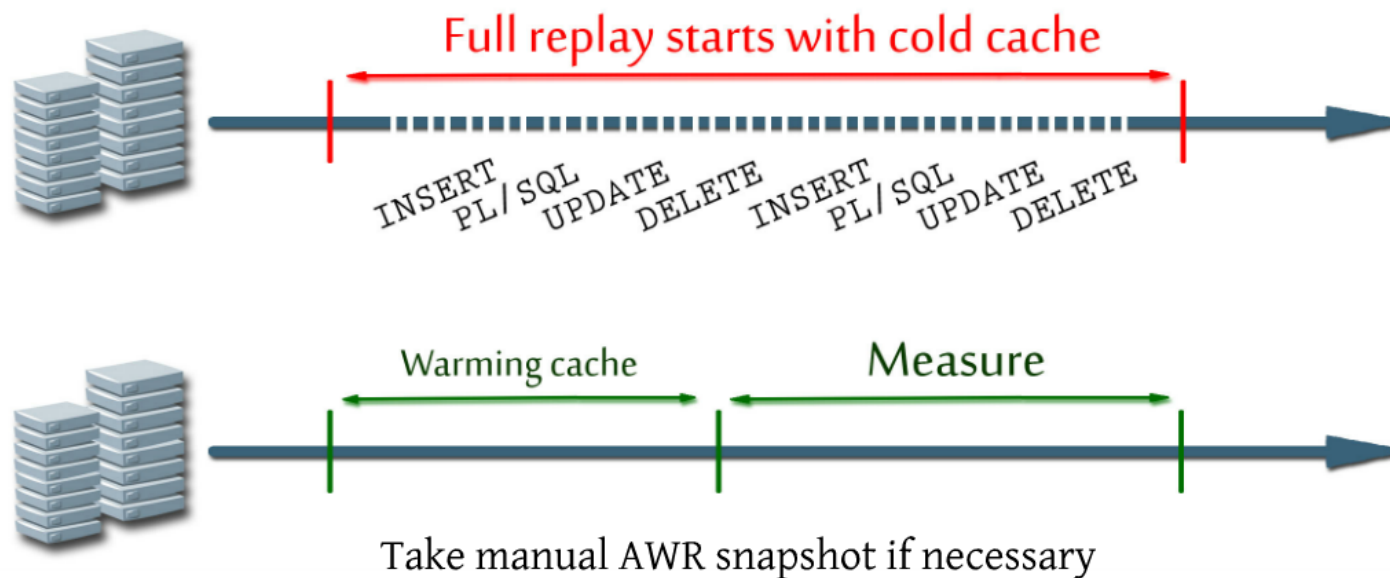
(-) Hide

Service Name	Module Name	Action Name	Avg Rows Affected	Avg Absolute Rows Affected	Number of Distinct Sessions	Count	First Occurrence	Last Occurrence
AISDBP.WORLD	JDBC Thin Client	UNNAMED	-.3	1.6	36	2621	2011-10-02T01:12:12.360973+02:00	2011-10-02T02:21:58.
AISDBP.WORLD	Realtime Connection	RAC_WAIT	-8.3	8.3	1	1524	2011-10-02T01:13:21.151991+02:00	2011-10-02T02:21:58.

- Not exactly replayed as in capture (but not far), replay connections are ramped



- Warming DB caches can make differences
 - Has globally less impact for long capture/replay
 - Can take the AWR reports after a first period of replay
 - And compare between this snapshot and the "end capture" snapshot
 - Also an interesting feature to assess warm-up effect

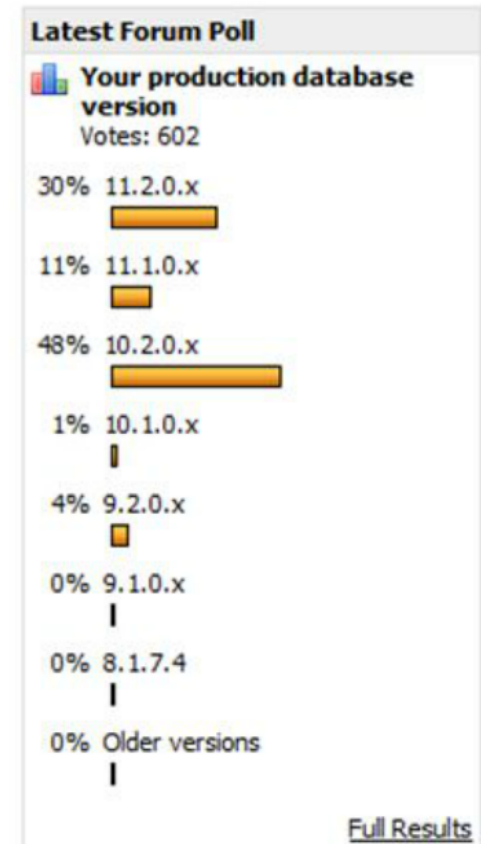


Some limitations, to be understood to obtain the best results

- Direct path load of data from external files using utilities such as SQL*Loader
- Non-PL/SQL based Advanced Queuing (AQ)
- Flashback queries
- Oracle Call Interface (OCI) based object navigations
- Non SQL-based object access
- Distributed transactions (any distributed transactions that are captured will be replayed as local transactions)

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- Even more than for other operations, upgrade teams are usually making best guesses and fixing if needed.
- Downgrading may or may not be possible...
 - has **compatible** been incremented?
- Should we keep **optimizer_feature_enable** to 10.2.0.5? Memory parameters change, platform change, etc.
- Executions plan can change, ORA-600, ORA-7445, etc.



- AWR based (DB time, topN statements, etc.)
 - `exec dbms_workload_capture.export_awr (capture_id => XX);`
 - `DBMS_WORKLOAD_REPOSITORY.AWR_DIFF_REPORT_HTML`
 - `select dbms_workload_capture.import_awr(capture_id => XX, staging_schema => 'XX') from dual;`

Snapshot Set	DB Name	DB Id	Instance	Inst num	Release	Cluster	Host	Std Block Size
First (1st)	ALICESTG	1368869684	ALICESTG1	1	10.2.0.5.0	YES	dbsrvc203	8192
Second (2nd)	ALICESTG	3208278054	ALICESTG1	1	11.2.0.2.0	NO	dbsrvg418.cern.ch	8192

Snapshot Set	Begin Snap Id	Begin Snap Time	End Snap Id	End Snap Time	Avg Active Users	Elapsed Time (min)	DB time (min)
1st	16945	22-Sep-11 16:00:54 (Thu)	16946	22-Sep-11 16:37:00 (Thu)	2.0	36.1	72.4
2nd	16946	24-Sep-11 19:33:18 (Sat)	16948	24-Sep-11 21:29:01 (Sat)	1.3	115.7	146.3
%Diff					-37.0	220.6	102.2

- Active Session History
- Graph (Enterprise Manager)
- All via reports or SQL interface

- Compare Period Report

```

dbms_workload_replay.COMPARE_PERIOD_REPORT(
  replay_id1=>1, replay_id2=>null, format=>dbms_workload_replay.type_html, result=>vblob);

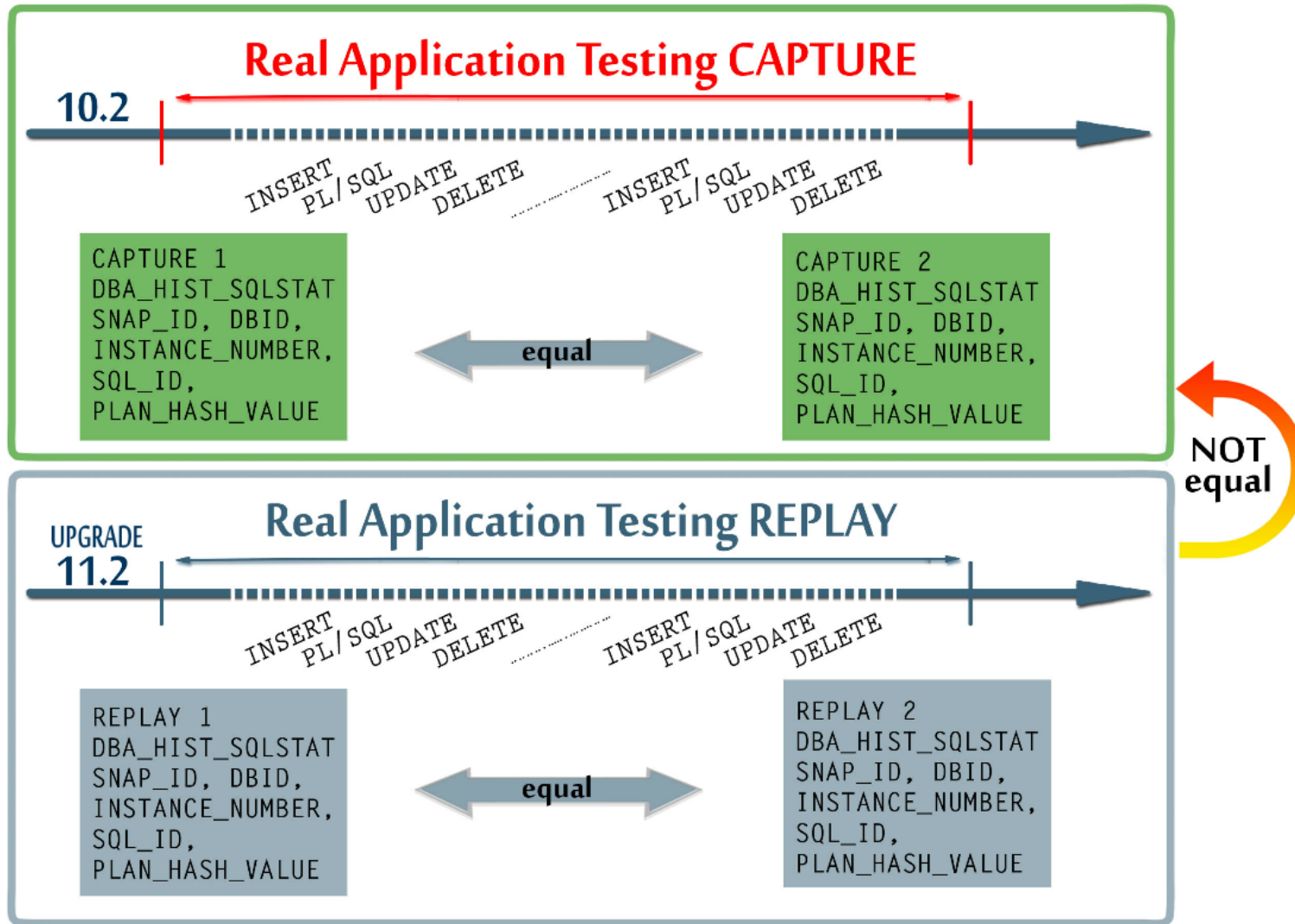
```

(-) Changes to Important Parameters

	Capture	Replay
processes	1500	1300
sessions	1655	1976
open_cursors	1024	800
compatible	10.2.0.1.0	10.2.0.5
cluster_database	TRUE	FALSE

(-) Changes to Optimizer-Relevant Parameters

		min	average	max
pga_aggregate_target	Capture	1 G	2.5 G	3 G
	Replay	450 M	450 M	450 M
optimizer_capture_sql_plan_baselines	Capture	NULL		
	Replay	FALSE		
optimizer_use_invisible_indexes	Capture	NULL		
	Replay	FALSE		
optimizer_use_pending_statistics	Capture	NULL		
	Replay	FALSE		
optimizer_use_sql_plan_baselines	Capture	NULL		
	Replay	TRUE		
optimizer_features_enable	Capture	10.2.0.5		
	Replay	11.2.0.2		
query_rewrite_enabled	Capture	TRUE		
	Replay	true		
query_rewrite_integrity	Capture	enforced		
	Replay	trusted		
result_cache_mode	Capture	NULL		
	Replay	MANUAL		
workarea_size_policy	Capture	AUTO		
	Replay	auto		



```

select * from
(select distinct c1.sql_id, c1.PLAN_HASH_VALUE, c1.parsing_schema_name from
DBA_HIST_SQLSTAT c1, DBA_HIST_SQLSTAT c2
where c1.dbid=c2.dbid and c1.dbid=1523625663
and c1.snap_id=86777 and c2.snap_id=86779
and c1.sql_id=c2.sql_id and c1.parsing_schema_name=c2.parsing_schema_name) c,
(select distinct r1.sql_id, r1.PLAN_HASH_VALUE, r1.parsing_schema_name from
DBA_HIST_SQLSTAT r1, DBA_HIST_SQLSTAT r2
where r1.dbid=r2.dbid and r1.dbid=2416127519
and r1.snap_id=86902 and r2.snap_id=86904
and r1.sql_id=r2.sql_id and r1.parsing_schema_name=r2.parsing_schema_name) r
where c.parsing_schema_name=r.parsing_schema_name and c.sql_id=r.sql_id and
c.PLAN_HASH_VALUE <> r.PLAN_HASH_VALUE;

```

SQL_ID	PARSING_SCHEMA_NAME	PLAN_HASH_VALUE	PLAN_HASH_VALUE
az33m61ym46y4	TOOLS_BAMBOO	65779599	1787062016
12qas01c7u7b2	APPT	567743951	4264701941
2y8gak7yksxcv	EGEE3	2855226907	371117825
dp4u6xqb5qssw	NAVIGATOR	3515771902	1824466124
1zv8vch4az8w6	NAVIGATOR	3515771902	1824466124
81dp53j6d2f0h	IM	2626905313	1266761433
g1tvm117sp2pw	CERN_DBA	2325995021	2571336381

Top SQL Comparison by Elapsed Time

- Ordered by absolute value of 'Diff' column of 'Elapsed Time % of DB time' descending
- '#Plans' column indicates the number of distinct execution plans for the statement in 1st and 2nd periods and in Both periods combined
- '1st Total' and '2nd Total' show respective running totals for '1st' and '2nd' columns of 'Elapsed Time % of DB time'
- DB time First: 1,336.19 seconds, Second: 102,678.37 seconds
- Captured SQL Elapsed Time First: 777.66 seconds, Second: 2,687.68 seconds
- Captured SQL Elapsed Time as a % of DB time First: 58.2%, Second: 2.62%
- Captured PL/SQL Elapsed Time as a % of DB time First: 47.31%, Second: .56%
- Common SQL Elapsed Time as a % of DB time First: 4.79%, Second: .36%

SQL Id	Elapsed Time % of DB time					Elapsed Time (ms) per Exec		#Exec/sec (DB time)		CPU Time (ms) per Exec		I/O Time (ms) per Exec		Physical Reads per Exec		#Rows Processed per Exec		#Executions		#Plans	SQL Text
	1st	1st Total	2nd	2nd Total	Diff	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st/2nd/Both	
94vzsmtv6uwq1	22.81	22.81			-22.81	304,757		0.00		304,820		78		9.00		1.00		1			DECLARE job BINARY_...
5up45xw1tb59g	21.89	44.69			-21.89	292,444		0.00		287		493		44.00		0.00		1			BEGIN DBMS_WORKLOAD_C
21xri10nz3psp	11.53	56.22			-11.53	154,008		0.00		156,845		78		9.00		136,948.00		1		1// 1	INSERT /*+ BYPASS_RECURSIVE_
cbwrgvq0dau4j	10.12	66.34			-10.12	135,281		0.00		138,038		0		0.00		3,097.00		1		1// 1	INSERT /*+ BYPASS_RECURSIVE_
ftj6kv3h81tj7	9.01	75.36			-9.01	120,447		0.00		10		0		0.00		2.00		1		1// 1	SELECT * FROM INFORJMTFEEDBACK..
2nq0v7pfu8um7	3.42	78.78			-3.42	0		274.33		0		0		0.00		1.00		366,560		1// 1	SELECT SUM(NVL(D.V 1)*SU...
dp4u6xqb5qsswv	2.76	81.54	0.12	0.12	-2.65	15	56	1.85	0.02	15	51	0	2	0.00	0.45	0.87	0.87	2,471	2,118	1/ 1/ 2	select login_as from irr
0az7czjdw8z7l	1.50	83.04			-1.50	4,007		0.00		2,691		152		0.00		0.00		5			declare lbRec dbms_rc
dx1yvsc93ityg	1.43	84.48			-1.43	0		59.98		0		0		0.00		1.00		80,150		1// 1	SELECT NVL(SUM(D.V

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- Once you have a base capture/replay which is reproducing well enough the workload

1. Replay and gather comparative information between capture and replay

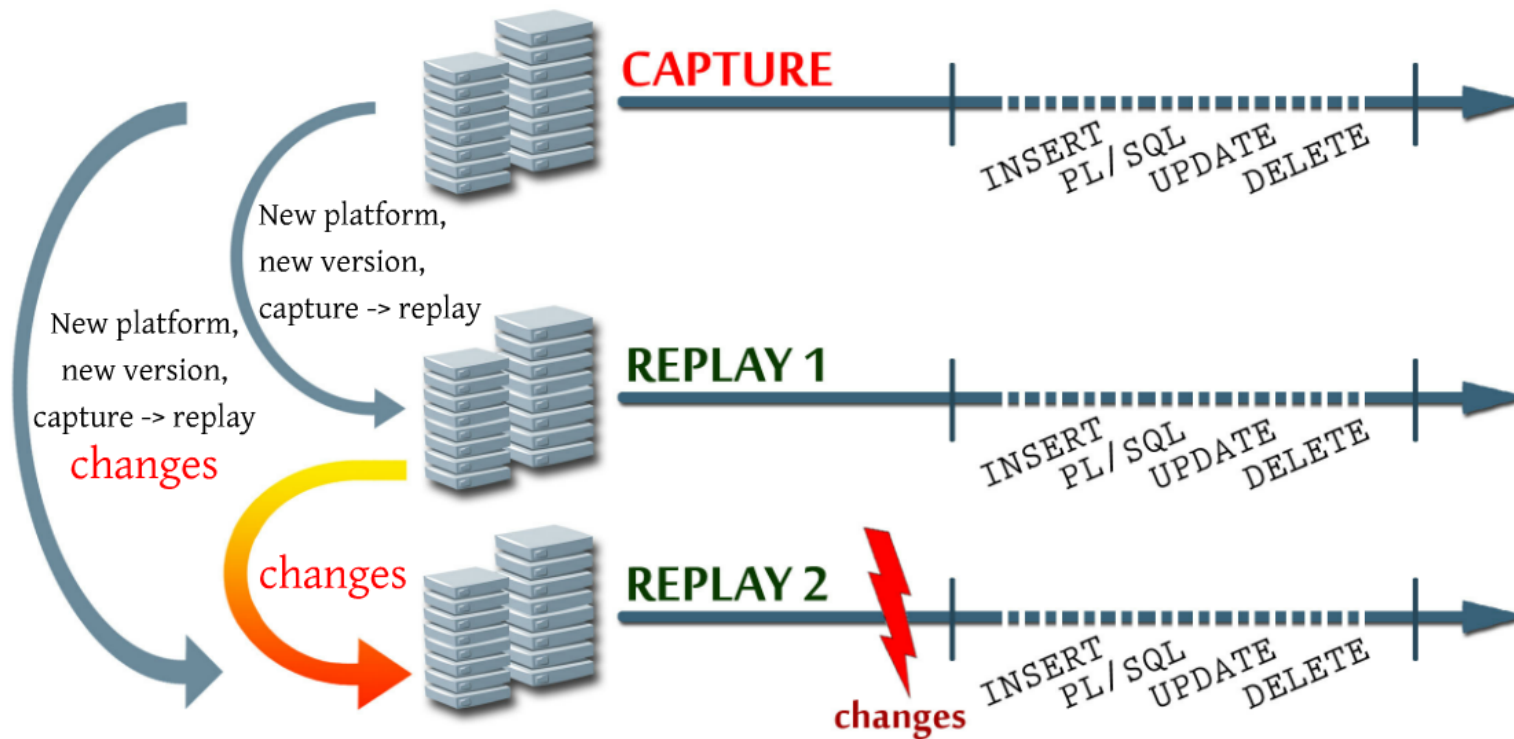
4. Modify configuration (path, SQL execution plan, etc.)

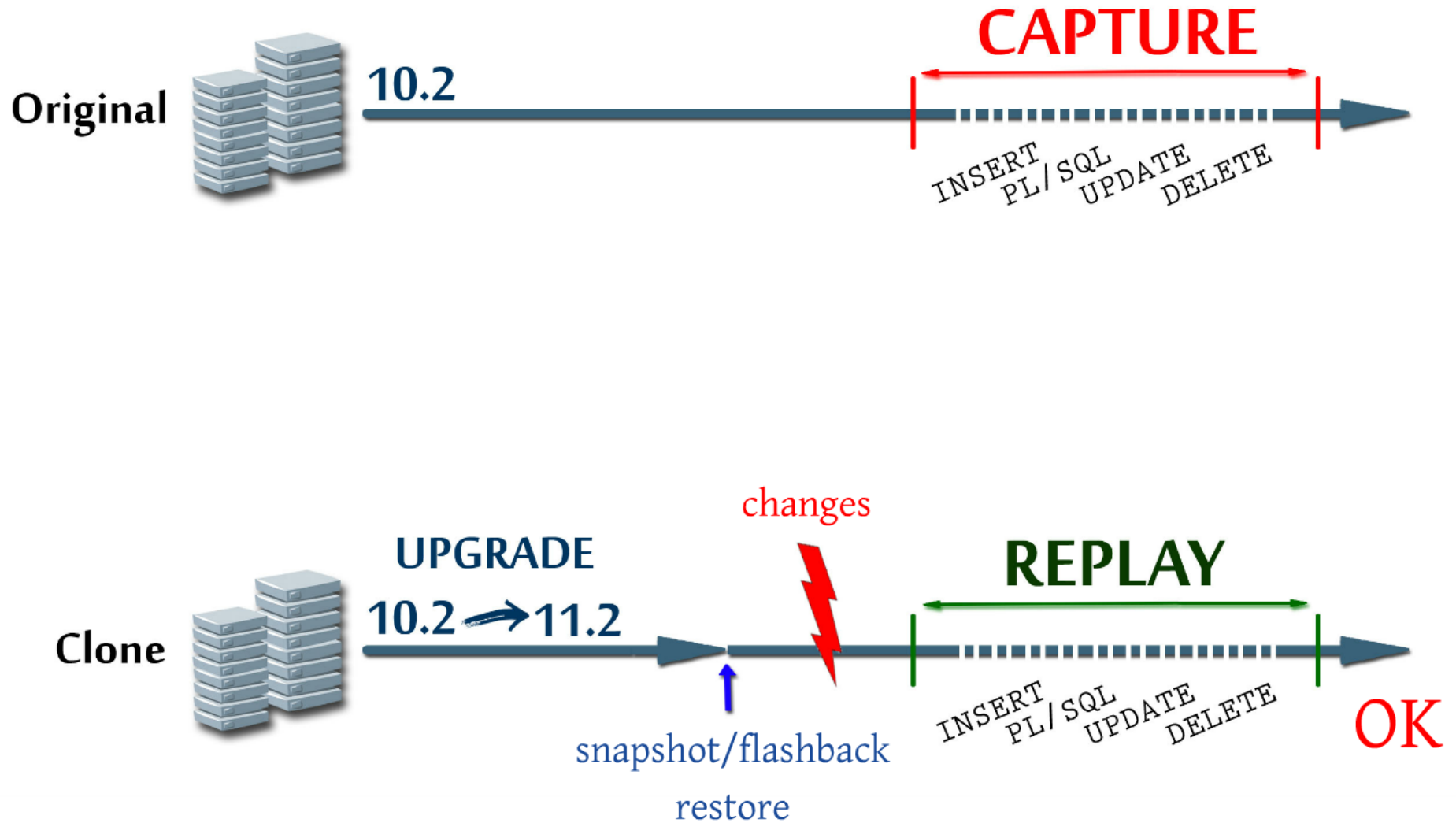


2. Identify inadequate performance or results

3. Understand root cause for the inadequate performance or results

- Advise to compare between replays when doing multiple changes and replay versus the capture (same version, measure only the differences not the capture/replay differences)

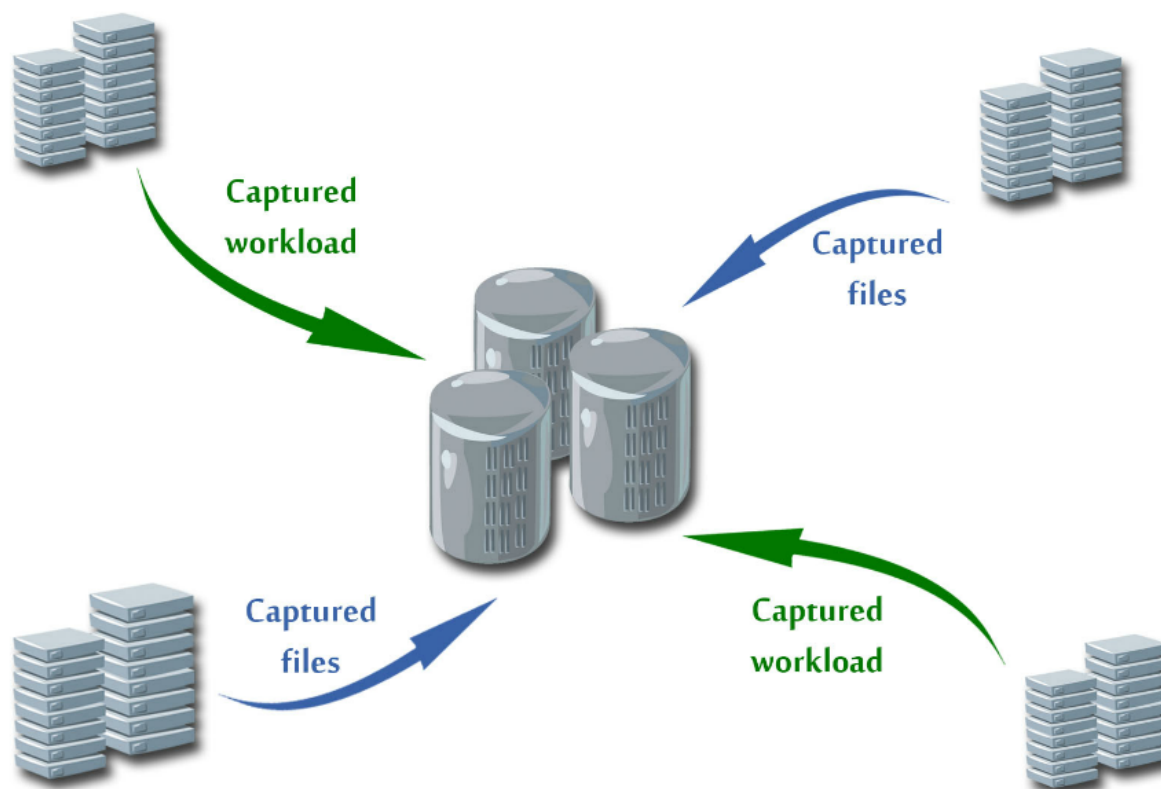




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- Start small for capture (space/IOPS)
- Understand the job model
- Understand date/time model
- Consider length for capture and replay?
 - Ensure adequate warm-up...
- Do not capture everything (backup, EM, etc.)
 - More errors in replay, more difficult to identify fixes to be made

- Following Oracle idea with Staging Area we can create central capture workload repository,
- Gather captured workload from your Production databases



- Not only for upgrades!
- The feature developers and DBA's have been dreaming about to avoid upgrade crisis
 - The end of synthetic workloads
- Good integration inside Enterprise Manager makes it easy to use (full PL/SQL API also available)
- In most cases, a turn-key solution
 - Some workload considerations: enough bandwidth/IOPS for caputre files, OS date/time, relevant SQLs not excluded (use Workload Analyzer)
- Enables DBA/developers to identify issues in many cases

DB

Questions

CERNIT
Department

?

- Oracle Real Application Testing
<http://www.oracle.com/us/products/database/options/real-application-testing/index.html>
- My Oracle Support note Real Application Testing Now Available for Earlier Releases [ID 560977.1]
- VLDB and ACM papers on database replay
<http://www.vldb.org/pvldb/2/vldb09-588.pdf> and
<http://dl.acm.org/citation.cfm?id=1376732>
- Simora <http://www.scaleabilities.co.uk/index.php/Simora/Introduction.html>
- Replay analyser
<http://www.oracle.com/technetwork/database/focus-areas/manageability/db-replay-analyzer-172990.html>