

# Oracle Database 11g Replay: The In-built Recorder for Real Application Testing

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# Agenda

- Overview of Database Replay
- Need for Database Replay
- Database Replay Phases
- Capture Workload
- Pre-processing the Capture Workload
- Replay the Workload
- Analysis and Reporting
- Q & A

# Overview of Database Replay

- Simulation of production database workload on test environment
- System Administrators and DBAs can test the impact of system changes including
  - Database Upgrade & Patches
  - Operating System Upgrades and Migrations
  - Database configuration changes
  - Hardware changes
- In this presentation, we shall test the impact of the system due to patch application

## Need for Database Replay

- Database replay makes real world testing possible
- Extensive testing and validation is expensive
- Eliminates the need of workload simulation scripts
- Replaying actual production workload for testing
- System Administrators and DBAs can independently perform the tests
- System availability and performance not impacted

# Database Replay Phases

- Workload capture in production
  - Captures all external database requests
  - Writes data to binary file
- Workload processing
  - Move binary file to test system
  - Capture files are converted to replay files
  - Creates necessary metadata to replay needed for replaying workload
  - Resource intensive process
- Workload Replay
  - Process the replay files
  - Submits the production load to the test database with exact timing and concurrency
  - Multiple replay clients
- Analysis and Reporting
  - Errors
  - Data divergence
  - Performance divergence

# Capture Workload

- Capture Workload in production
- Create directory to hold to capture logs
- Start capture process

```
SQL> BEGIN
2  DBMS_WORKLOAD_CAPTURE.start_capture( name => 'PROD_CAPTURE',
3                                         dir  => 'DB_REPLAY_CAPTURE_DIR' );
4  END;
5  /

PL/SQL procedure successfully completed.
```

ORACLE Enterprise Manager 11g Database Control

Database Instance: infprod > Setup Preferences Help Logout Database

Database Replay Logged in As SYS

The Database Replay feature allows database workload to be captured on one system and replayed later on a different system. Replaying a captured workload can be useful to compare two different systems. Page Refreshed Feb 25, 2008 11:50:07 PM CST Refresh

Task	Task Name	Description	Go to Task
1	Capture Workload	Choose this option to capture workload on this database.	
2	Preprocess Captured Workload	Preprocessing will prepare a captured workload for replay. This must be done once for every captured workload.	
3	Replay Workload	Choose this option to replay a preprocessed workload on this database.	

[View Workload Capture History](#)

**Active Capture and Replay**

Select	Name	Type	Directory Object	Start Time
<input checked="" type="checkbox"/>	PROD_CAPTURE	Capture	DB_REPLAY_CAPTURE_DIR	Feb 25, 2008 11:34:00 PM CST

**Overview**

The following are the typical steps to perform Database Replay:

1. Capture the workload on a database. (Task 1)
2. Optionally export the AWR data. (Task 1)
3. Restore the replay database on a test system to match the capture database at the start of the workload capture.
4. Make changes (such as perform an upgrade) to the test system as needed.
5. Copy the workload to the test system.
6. Preprocess the captured workload. (Task 2)
7. Configure the test system for the replay.
8. Replay the workload on the restored database. (Task 3)

Database | Setup | Preferences | Help | Logout

# Capture Workload

- Stop capture process

ORACLE Enterprise Manager 11g Database Control

Database Instance: infprod > Database Replay

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View Workload Capture History

**Active Capture and Replay**

View Stop

Select	Name	Type	Directory Object	Start Time
<input checked="" type="checkbox"/>	PROD_CAPTURE	Capture	DB_REPLAY_CAPTURE_DIR	Feb 25, 2008 11:34:00 PM CST

Database | Setup | Preferences

ORACLE Enterprise Manager 11g Database Control

Database Instance: infprod > Database Replay > Confirmation

Job 'EXPORT-AWR-20080226002151' to export the AWR data has been submitted to the database scheduler.

[View Job](#)

**View Workload Capture: PROD\_CAPTURE**

Status: **Completed**

**Summary**

Name	PROD_CAPTURE	Captured Data Size (MB)	2.04
Directory Object	DB_REPLAY_CAPTURE_DIR	Duration (hh:mm:ss)	00:39:15
Database Name	INFPROD	Start Time	Feb 25, 2008 11:34:00 PM CST
Capture Database Version	11.1.0.6.0	End Time	Feb 26, 2008 12:13:15 AM CST
DBID	530026227	Start SCN	1016530
Capture Error Code	None	End SCN	1355413
Capture Error Message	None		

Workload Profile | Workload Filters

ORACLE Enterprise Manager 11g Database Control

Database Instance: infprod > Processing: Stop Capture

Processing.

This operation will continue even if this browser window is closed.

Database | Setup | Preferences | Help | Logout

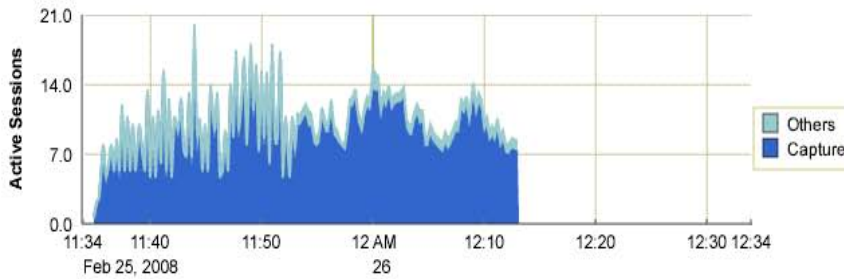
OK

# Capture Workload

- Workload capture report

[View Workload Capture Report](#)

**Average Active Sessions**



**Comparison**

	Total	Capture	Percentage of Total
Database Time (hh:mm:ss)	06:43:23	01:42:19	25.36
Average Active Sessions	10.28	2.61	25.36
User Calls	9,550	9,023	94.48
Transactions	2,635	428	16.24
Connects	83	23	27.71
Application Errors	N/A	429	N/A



## Workload Processing

- Transfer capture files from production server to test server i.e. infPROD to infTEST in this example
- Move capture files to location where it's processed
- "Preprocess Captured Workload" converts capture files into replay files
- This process creates metadata for replay
- It's a resource intensive process, ideally not to be done in the production server
- For RAC, capture files from all instances are moved to one instance

# Workload Processing

## Database Replay

The Database Replay feature allows database workload to be captured on one system and replayed later on a different system. Replaying a captured workload can be useful to compare two different systems.

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[View Workload Capture History](#)

ORACLE Enterprise Manager 11g Database Control

Database Instance: infTEST > Database Replay > Setup Preferences Help Logout Database

Preprocess Captured Workload Logged in As SYS

**Directory**  
Select a directory object that contains a captured workload.

\* Directory Object:

**▼ Capture Summary**

Name	PROD_CAPTURE	Captured Data Size (MB)	2.04
Status	Completed	Duration (hh:mm:ss)	00:39:15
Directory Object	DB_REPLAY_CAPTURE	Start Time	Feb 25, 2008 11:34:00 PM CST
Database Name	INFPROD	End Time	Feb 26, 2008 12:13:15 AM CST
Capture Database Version	11.1.0.6.0	Start SCN	1016530
DBID	530026227	End SCN	1355413
Capture Error Code	0	Preprocessed Database Version	11.1.0.6.0
Capture Error Message	None		

```
SQL> BEGIN
2  DBMS_WORKLOAD_REPLAY.process_capture('DB_REPLAY_CAPTURE');
3  END;
4  /
```

PL/SQL procedure successfully completed.

## Workload Replay

- Processed workload can be replayed in any database having same or higher version
- Reset system time in test server to start of production capture process
- Replay driver are clients program that consumes processed workload and sends request to replay system
- Perform the OS/database change on the test system. In this example, application of a patch
- Replay of captured workload

# Workload Replay

## Database Replay

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[View Workload Capture History](#)

ORACLE Enterprise Manager 11g Database Control

Setup Preferences Help Logout Database

Choose Initial Options Customize Options Prepare Replay Clients Wait for Client Connections Review

**Replay Workload: Choose Initial Options**

Database: **infTEST** (Cancel) Step 1 of 5 (Next)  
 Capture Name: **PROD\_CAPTURE**  
 Logged In As: **SYS**

Replay Name:

**Initial Options**  
 Choose the initial replay options.

Use the default replay options  
 Use replay options from a previous replay

Replay Name:

ORACLE Enterprise Manager 11g Database Control

Setup Preferences Help Logout Database

Choose Initial Options **Customize Options** Prepare Replay Clients Wait for Client Connections Review

**Replay Workload: Customize Options**

Database: **infTEST** (Cancel) (Back) Step 2 of 5 (Next)  
 Capture Name: **PROD\_CAPTURE**  
 Logged In As: **SYS**

Connection Mappings  **Replay Parameters**

Replay Clients must establish connections to the replay database. Specify connection details to the replay database using either a single connect descriptor or net service name. Optionally, you can map every captured connect descriptor to a separate connect descriptor or net service name for the replay database.

**TIP** Connections must point to the replay database for a successful replay.

Use a single connect descriptor for all client connections. (Test Connection)

`{DESCRIPTION=(ADDRESS_LIST=(ADDRESS=(PROTOCOL=TCP)(HOST=#$T7SCL.FAC.local)(PORT=1521)))  
(CONNECT_DATA=(SID=infTEST))}`

Use a single TNS net service name for all client connections.

**TIP** All Replay Clients must be able to resolve the net service name (for example through a local tnsnames.ora file).

Use a separate connect descriptor or net service name for each client connect descriptor captured in the workload.

Connection Mappings  **Replay Parameters**

(Cancel) (Back) Step 2 of 5 (Next)

# Workload Replay

- Replay client

ORACLE Enterprise Manager 11g Database Control

Setup Preferences Help Logout Database

Choose Initial Options Customize Options **Prepare Replay Clients** Wait for Client Connections Review

**Replay Workload: Prepare Replay Clients**

Database **infTEST**   Step 3 of 5

Capture Name **PROD\_CAPTURE**

Logged In As **SYS**

The Replay Client is a multithreaded program (an executable named wrc) where each thread submits a captured session's workload. This program is made available as part of the standard Oracle Client as well as the Oracle Instant Client. Refer to system documentation on how to set up and start the Replay Clients.

When you are ready to start the Replay Clients, continue to the next step and then start the Replay Clients.

Step 3 of 5

ORACLE Enterprise Manager 11g Database Control

Setup Preferences Help Logout Database

Choose Initial Options Customize Options Prepare Replay Clients **Wait for Client Connections** Review

**Replay Workload: Wait for Client Connections**


Database **infTEST**   Step 4 of 5

Capture Name **PROD\_CAPTURE**

Logged In As **SYS**

**The database is waiting for connections from the Replay Clients. Start the Replay Clients now.**

When all the Replay Clients have connected, proceed to the next step to continue the replay setup.



The database is waiting for connections from Replay Clients.

⚠ This operation may take some time to complete. If you close this browser window or navigate to a different page, your place in the replay process will not be saved.

**Client Connections**

SID	Host	OS Process ID	OS User Name	Program
No items found				

Step 4 of 5

Database | Setup | Preferences | Help | Logout

# Workload Replay

- “Wait for client requests” screen checks for replay client processes
- Start the replay client processes

```
C:\Documents and Settings\amandal>wrc system/infctest mode=replay replaydir=c:\ca
pture

Workload Replay Client: Release 11.1.0.6.0 - Production on Tue Feb 26 02:23:09 2
008

Copyright (c) 1982, 2007, Oracle. All rights reserved.

Wait for the replay to start (02:23:09)
Replay started (02:26:50)
```

The screenshot shows the Oracle Enterprise Manager 11g Database Control interface. The breadcrumb trail indicates the current step is 'Wait for Client Connections' within the 'Replay Workload' process. The interface displays the following information:

- Database: **infTEST**
- Capture Name: **PROD\_CAPTURE**
- Logged In As: **SYS**

The main message states: "The database is waiting for connections from the Replay Clients. Start the Replay Clients now." Below this, a status indicator shows a checkmark and a clock icon, with the text: "At least one Replay Client is connected. You may start more connections or continue to the next step." A warning note indicates that the operation may take time and that the current state will not be saved if the browser window is closed.

A table titled "Client Connections" shows the following data:

SID	Host	OS Process ID	OS User Name	Program
136	FAC185T75C1	5948:1576	FAC/amandal	wrc.exe

# Workload Replay

ORACLE Enterprise Manager 11g Database Control Setup Preferences Help Logout Database

Choose Initial Options   Customize Options   Prepare Replay Clients   Wait for Client Connections   **Review**

**Replay Workload: Review**  
Logged In As **SYS** Cancel Back Step 5 of 5 Submit

**Information**  
Time for resetting the clock: Feb 25, 2008 11:34:00 PM CST.  
It is recommended that the system time on the database host platform be changed to a value that is close to the capture start time. This must be done just before replay is started. Not doing so might present an invalid data set to the replayed time-sensitive workload, thus causing data divergence. Examples include statements that use the SYSDATE and SYSTIMESTAMP functions. Resetting the time will also minimize job scheduling inconsistencies between replay and capture.

Workload PROD\_CAPTURE will be replayed on database 'infTEST'.

Database	infTEST
Capture Name	PROD_CAPTURE
Replay Name	REPLAY-infTEST-20080226021803
Directory Object	DB_REPLAY_CAPTURE
Connected Replay Clients	1

Cancel Back Step 5 of 5 Submit

Database | Setup | Preferences | Help | Logout

ORACLE Enterprise Manager 11g Database Control Setup Preferences Help Logout Database

Database Instance: infTEST > Database Replay > Logged In As SYS

**Confirmation**  
The workload replay has started.

View Data Real Time: 60 Second Refresh

**View Workload Replay: REPLAY-infTEST-20080226021803** Page Refreshed Feb 26, 2008 2:26:56 AM CST Refresh OK

Status **In Progress** (Stop Replay)

**Summary**

Replay Name	REPLAY-infTEST-20080226021803	Capture Name	PROD_CAPTURE
Directory Object	DB_REPLAY_CAPTURE ⓘ	Duration (hh:mm:ss)	00:00:06 ⓘ
Database Name	infTEST	Prepare Time	Feb 26, 2008 2:20:59 AM CST
DBID	106506683	Start Time	Feb 26, 2008 2:26:45 AM CST
Replay Error Code	N/A	End Time	N/A
Replay Error Message	None		

# Workload Replay

- Comparison between capture and replay

ORACLE Enterprise Manager 11g Database Control

Database Instance: infTEST > Database Replay > View Workload Replay: REPLAY-infTEST-20080226021803

Status: **In Progress** (Stop Replay)

**Summary**

Replay Name	REPLAY-infTEST-20080226021803	Capture Name	PROD_CAPTURE
Directory Object	DB_REPLAY_CAPTURE	Duration (hh:mm:ss)	00:06:22
Database Name	infTEST	Prepare Time	Feb 26, 2008 2:20:59 AM CST
DBID	106506683	Start Time	Feb 26, 2008 2:26:45 AM CST
Replay Error Code	N/A	End Time	N/A
Replay Error Message	None		

Workload Profile | Connection Mappings | Replay Parameters | Report

Network Time (hh:mm:ss) 00:00:39  
Think Time (hh:mm:ss) 00:39:26

**Elapsed Time Comparison**

Category	Elapsed Time (Minutes)
Capture	~6
Replay	~4

ORACLE Enterprise Manager 11g Database Control

Database Instance: infTEST > Database Replay > View Workload Replay: REPLAY-infTEST-20080226021803

Status: **Completed**

**Summary**

Replay Name	REPLAY-infTEST-20080226021803	Capture Name	PROD_CAPTURE
Directory Object	DB_REPLAY_CAPTURE	Duration (hh:mm:ss)	00:39:28
Database Name	infTEST	Prepare Time	Feb 26, 2008 2:20:59 AM CST
DBID	106506683	Start Time	Feb 26, 2008 2:26:45 AM CST
Replay Error Code	N/A	End Time	Feb 26, 2008 3:06:13 AM CST
Replay Error Message	None		

Workload Profile | Connection Mappings | Replay Parameters | Report

Network Time (hh:mm:ss) 00:13:29 Clients 1  
Think Time (hh:mm:ss) 06:44:47 Clients Finished 1

**Elapsed Time Comparison**

Category	Elapsed Time (Minutes)
Capture	~39
Replay	~36

Legend:   
■ Replay Elapsed   
■ Capture Elapsed   
■ Not Yet Replayed

**Assessing the Replay**

The Elapsed Time Comparison chart shows how much time the replayed workload has taken to accomplish the same amount of work as captured.

When the Replay bar is shorter than the Capture bar then the replay environment is processing the workload faster than the capture environment.

The divergence table gives information about both the data and error discrepancies between the replay and capture environments, which can be used as a measure of the replay quality.



## Analysis and Reporting

- Comparison reports indicates if any change ( Application of patches, in our example ) has affected performance of the system
- Types of divergences reported are
  - Data Divergence based on number of rows returned by each call
  - Error Divergence based on error differences reported during capture, replay process
  - Performance Divergence based on the high level performance information of Capture and Replay report. Additional performance analysis and diagnostics reports like ADDM, AWR & ASH

# Analysis and Reporting

## DB Replay Report for REPLAY-infTEST-20080226021803

DB Name	DB Id	Release	RAC	Replay Name	Replay Status
INFTEST	106506683	11.1.0.6.0	NO	REPLAY-infTEST-20080226021803	COMPLETED

### Replay Information

Information	Replay	Capture
Name	REPLAY-infTEST-20080226021803	PROD_CAPTURE
Status	COMPLETED	COMPLETED
Database Name	INFTEST	INFPROD
Database Version	11.1.0.6.0	11.1.0.6.0
Start Time	26-FEB-08 02:26:45	25-FEB-08 23:34:00
End Time	26-FEB-08 03:06:13	26-FEB-08 00:13:15
Duration	39 minutes 28 seconds	39 minutes 15 seconds
Directory Object	DB_REPLAY_CAPTURE	DB_REPLAY_CAPTURE
Directory Path	ci:\capture	ci:\capture

### Replay Options

Option Name	Value
Synchronization	TRUE
Connect Time	100%
Think Time	100%
Think Time Auto Correct	TRUE
Number of WRC Clients	1 (1 Completed, 0 Running )

### Replay Statistics

Statistic	Replay	Capture
DB Time	85.718 seconds	6138.611 seconds
Average Active Sessions	.04	2.61
User calls	9023	9023
Network Time	809.451 seconds	
Think Time	24286.554 seconds	

### Divergence

	Number of Calls	Percentage of Total Calls
<b>Error Divergence:</b>		
Session Failures Seen During Replay	0	0.00
Errors No Longer Seen During Replay	351	3.89
Errors Mutated During Replay	0	0.00
New Errors Seen During Replay	0	0.00
<b>Data Divergence:</b>		
DMLs with Different Number of Rows Modified	1	0.01
SELECTs with Different Number of Rows Fetched	228	2.53

### ▼ Detailed Comparison

	Capture	Replay	Percentage of Capture
Duration (hh:mm:ss)	00:39:15	00:39:28	100.55
Database Time (hh:mm:ss)	01:42:19	00:01:26	1.40
Average Active Sessions	2.61	0.04	1.39
User Calls	9,023	9,023	100.00

# Thank You !