Zero Downtime: Hiding Planned Maintenance and Unplanned Outages from Applications

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Safe Harbor Statement

Program Agenda

1 Problems to Solve

2 Fast Application Notification

3 Continuous Connections

4 Hiding Planned Maintenance

5 Hiding Unplanned Outages

6 Success Stories

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1 What problems confront applications at database outages?

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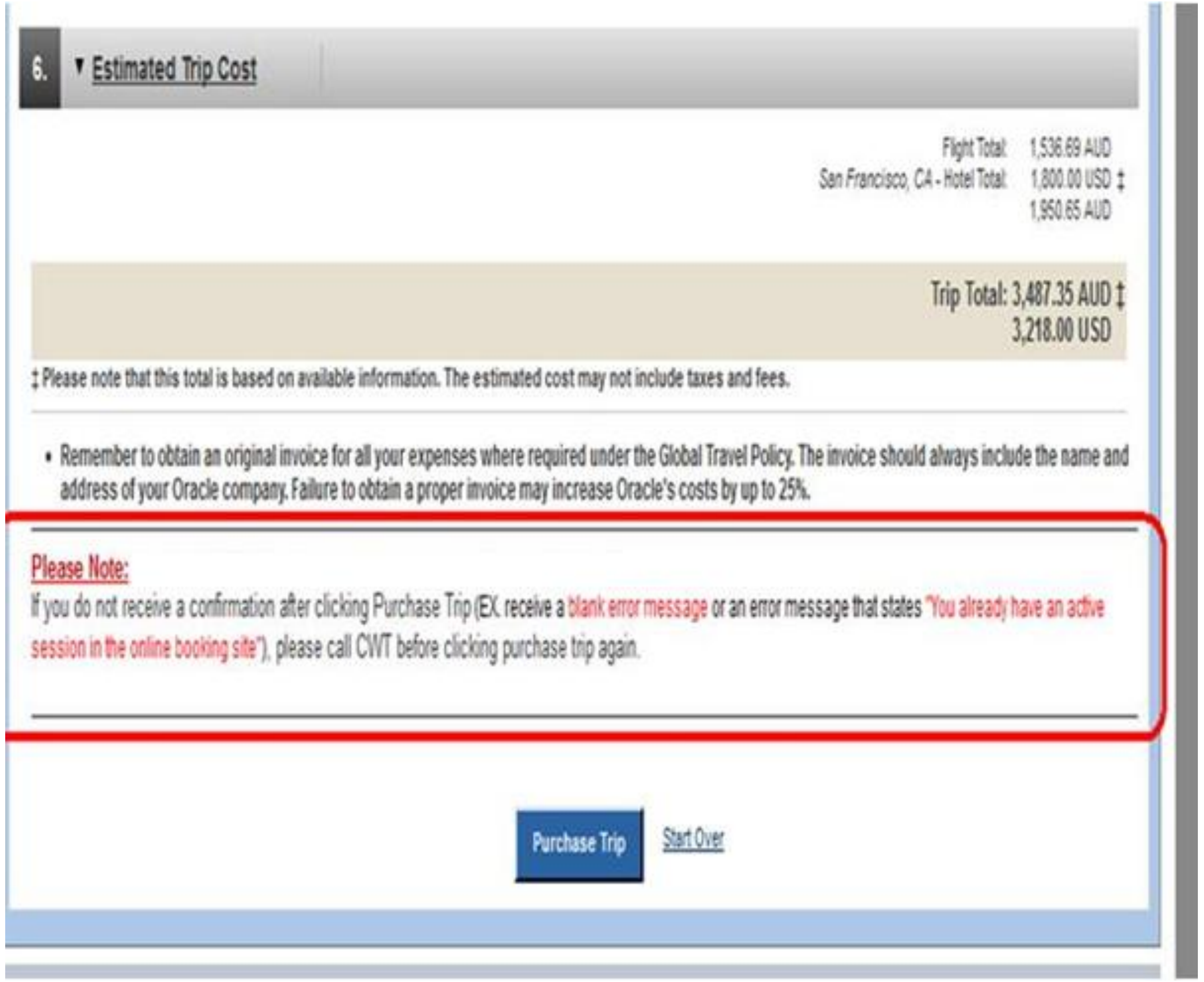
In-Flight Work

Sorry. Internal Server Error - 500 Error
We are currently experiencing an issue with our servers on coolcar.com. Please come back later.

Pre-12c Situation

Database outages cause in-flight work to be lost, leaving users and applications in-doubt

- Restart applications and mid-tiers
- User frustration
- Cancelled work
- Duplicate submissions
- Errors even when planned
- Developer pains



6. ▾ Estimated Trip Cost

Flight Total:	1,536.69 AUD
San Francisco, CA - Hotel Total:	1,800.00 USD ‡
	1,950.65 AUD

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- Remember to obtain an original invoice for all your expenses where required under the Global Travel Policy. The invoice should always include the name and address of your Oracle company. Failure to obtain a proper invoice may increase Oracle's costs by up to 25%.

Please Note:
If you do not receive a confirmation after clicking Purchase Trip (EX. receive a blank error message or an error message that states "You already have an active session in the online booking site"), please call CWT before clicking purchase trip again.

How do we reach all applications?

- Move work to different instance/database with no errors reported to applications at planned maintenance
- Hide unplanned database outages from the applications
- Take adoption out of the developers hands to configuration/operation only
- Work with current drivers and older database, whenever possible

2 Outage Detection

The dead thing cannot tell you that it's dead

Applications Waste Time

- Hanging on TCP/IP timeouts
- Connecting when services are down
- Not connecting when services resume
- Receiving errors during planned maintenance
- Processing partial results when server is down
- Attempting work at slow, hung, or dead nodes

Performance issues not reported in your favorite tools.

Fast Application Notification

Proven since 10g

- **Down** – received in low ms to invoke failover
- **Planned Down** – drains sessions for planned maintenance with no user interruption whatsoever
- **Up** – Re-allocates sessions when services resume
- **Load %** - Advice to balance sessions for RAC locally and GDS globally
- **Affinity** - Advice when to keep conversation locality

12c: Auto-Configuration + Global Data Services

12c FAN: Standardized, Auto-Configured

Client	10g	11g	12c
JDBC Implicit Connection Cache	ONS	ONS	desupport
JDBC Universal Connection Pool		ONS	**ONS**
OCI/OCCI driver	AQ	AQ	**ONS**
ODP.NET Unmanaged Provider (OCI)	AQ	AQ	**ONS**
ODP.NET Managed Provider (C#)		ONS	**ONS**
OCI Session Pool	AQ	AQ	**ONS**
WebLogic Active GridLink		ONS	**ONS**
Tuxedo		ONS	**ONS**
Listener	ONS	ONS	**ONS**

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12c JDBC FAN Auto-Configures

- **12c JDBC clients and 12c Oracle database**
  - Check ons.jar is included in the class path
  - To enable FAN set the pool property
    - **fastConnectionFailoverEnabled=true**

- **Before 12c - JDBC clients or database**
  - also set the pool property for remote ons
    - **ONSConfiguration=nodes=mysun05:6200,mysun06:6200, mysun07:6200,mysun08:6200**

12c OCI FAN Auto-Configures

- **12c OCI clients and 12c Oracle database**

  Use srvctl to configure the service for AQ HA Notification:

  srvctl modify service -db EM -service GOLD **-notification TRUE**

  For the client, enable in oraaccess.xml

```
<oraaccess>
  <default_parameters>
    <events>true</events>
  </default_parameters>
</oraaccess>
```

- **Before 12c OCI clients or database**
  - Enable OCI_EVENTS at environment creation OCIEnvCreate(..)
  - Link the app with the client thread o/s library.

12c ODP.Net FAN Auto-Configures

- **12c ODP.Net clients and 12c Oracle database**

  Use srvctl to configure the service for AQ HA Notification:

  srvctl modify service -db EM -service GOLD **-notification TRUE**

  To enable FAN, in the connection string -

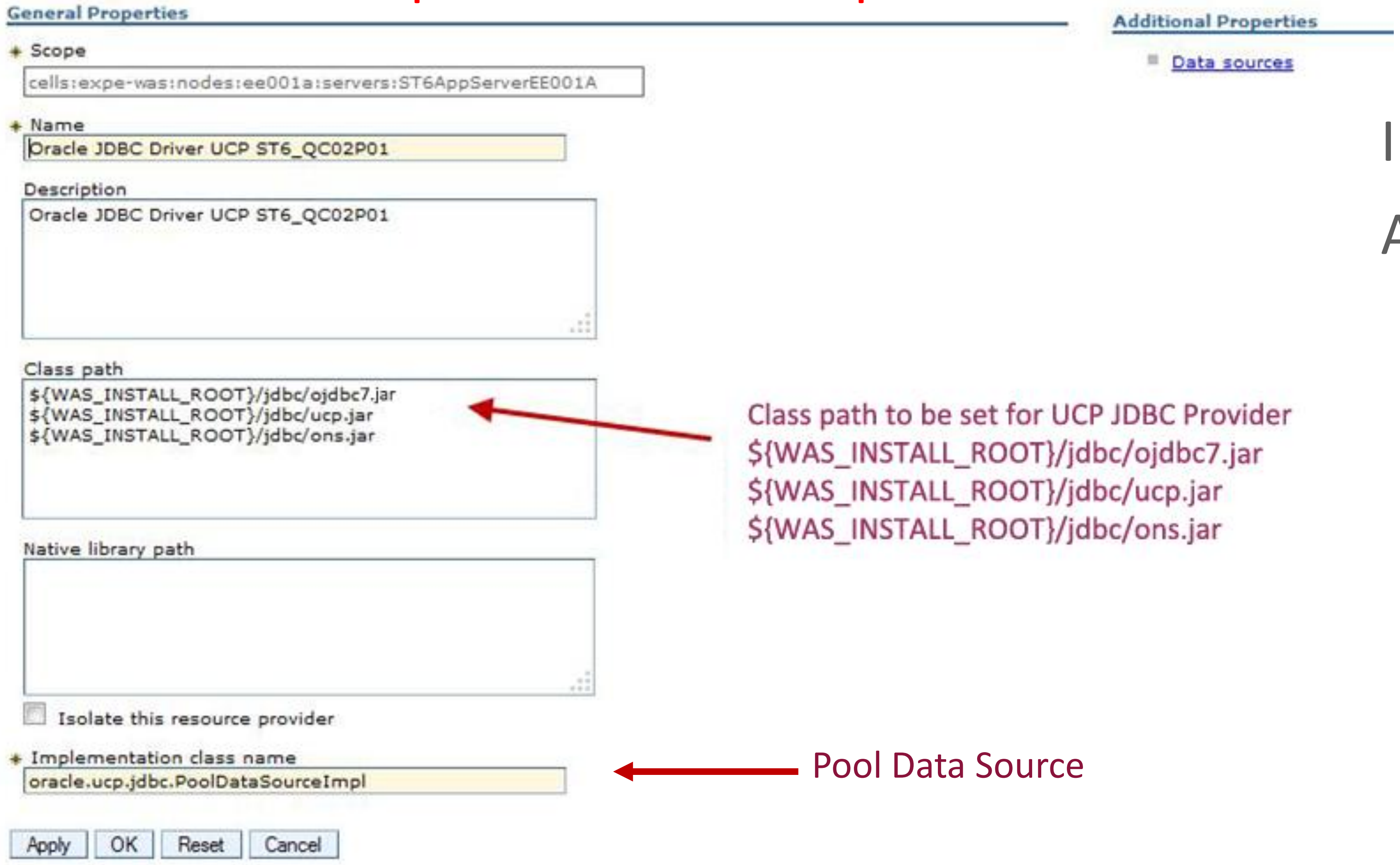
  – **"user id=oracle; password=oracle; data source=HA; pooling=true; HA events=true;"**

  To enable Runtime Load Balancing, also in the connection string -

  – **"user id=oracle; password=oracle; data source=HA; pooling=true; HA events=true; load balancing=true;"**

FAN with other Java Application Servers

Use UCP – a simple DataSource replacement



General Properties

Scope
cells:expe-was:nodes:ee001a:servers:ST6AppServerEE001A

Name
Oracle JDBC Driver UCP ST6_QC02P01

Description
Oracle JDBC Driver UCP ST6_QC02P01

Class path
```
${WAS_INSTALL_ROOT}/jdbc/ojdbc7.jar
${WAS_INSTALL_ROOT}/jdbc/ucp.jar
${WAS_INSTALL_ROOT}/jdbc/ons.jar
```

Native library path

☐ Isolate this resource provider

Implementation class name
oracle.ucp.jdbc.PoolDataSourceImpl

Class path to be set for UCP JDBC Provider
${WAS_INSTALL_ROOT}/jdbc/ojdbc7.jar
${WAS_INSTALL_ROOT}/jdbc/ucp.jar
${WAS_INSTALL_ROOT}/jdbc/ons.jar

Pool Data Source

IBM WebSphere

Apache Tomcat

Monitor FAN

- **Create a FAN callout in ..$GRID_HOME/racg/userco**
- **Download ONS subscriber (ONCCTL) from OTN RAC page**

```
oncctl
..
VERSION=1.0 event_type=SERVICEMEMBER service=orcl_swing_pdb2 instance=orcl1 database=orcl
db_domain= host=sun01 status=down reason=USER timestamp=2014-07-30 12:02:51 timezone=-07:00
VERSION=1.0 event_type=SERVICEMEMBER service=orcl_swing_pdb10 instance=orcl1 database=orcl
db_domain= host=sun01 status=down reason=USER timestamp=2014-07-30 12:02:52 timezone=-07:00
VERSION=1.0 event_type=SERVICE service=orcl_swing_pdb10 database=orcl db_domain= host=sun01
status=down reason=USER
```

Continuous Connections

Applications should see no errors while services relocate.

Connections Appear Continuous

while a service is temporarily unavailable

Safe for logon storms

Retry while service is unavailable

New

```
alias =(DESCRIPTION =
   (CONNECT_TIMEOUT=90)  (RETRY_COUNT=30)(RETRY_DELAY=3)
        (TRANSPORT_CONNECT_TIMEOUT=3)
    (ADDRESS_LIST =
        (LOAD_BALANCE=on)
        ( ADDRESS = (PROTOCOL = TCP)(HOST=primary-scan)(PORT=1521)))
    (ADDRESS_LIST =
        (LOAD_BALANCE=on)
        ( ADDRESS = (PROTOCOL = TCP)(HOST=secondary-scan)(PORT=1521)))
    (CONNECT_DATA=(SERVICE_NAME = gold-cloud)))
```

OCI Only

Expand scan

Transparent Planned Maintenance

Applications should see no errors during maintenance.

Transparent Planned Maintenance

- Drains work away from instances targeted for maintenance initiated by FAN
  - Supports well behaved applications using Oracle pools
    - WebLogic Active GridLink, UCP, ODP.NET unmanaged and managed, OCI Session Pool, PHP
    - 3rd party application servers using UCP DataSource: IBM Websphere, Apache Tomcat,..
- Failover at transactional disconnect
    - applications adapted for TAF SELECT with OCI or ODP.Net unmanaged provider
    - applications with own/custom failover

DBA steps - Drain Work at Safe Places

Repeat for each service allowing time to drain

- **Stop service (no –force)**

```
SRVCTL stop service –db .. -instance .. [–service] .. (omitting –service stops all)
```

- or **Relocate service (no –force)**

```
SRVCTL relocate service –db .. -service .. –oldinst .. –newinst
SRVCTL relocate service –db .. -service .. –currentnode.. –targetnode
```

- **Wait to allow sessions and XA branches to drain**. (see notes)
- **For remaining sessions, stop transactional per service**

```
exec dbms_service.disconnect_session('[service]', DBMS_SERVICE.POST_TRANSACTION);
```

- **Now stop the instance immediate;**
- **Disable to prevent restarts during maintenance**

```
SRVCTL disable instance –db .. -instance
```

How it works

Applications using …	Oracle pools or drivers – WebLogic Active GridLink, UCP, ODP.NET managed/unmanaged, OCI, Tuxedo 3rd party App Servers using UCP: IBM WebSphere, Apache Tomcat, RedHat JBoss
DBA Step	**srvctl [relocate|stop] service (no –force)**
Sessions Drain	Immediately New work is redirected by listeners Idle sessions are released Active sessions are released when returned to pools

FAN Planned

Pools drain sessions as work completes

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Planned Maintenance at NEC

WebLogic Active GridLink and Real Application Clusters

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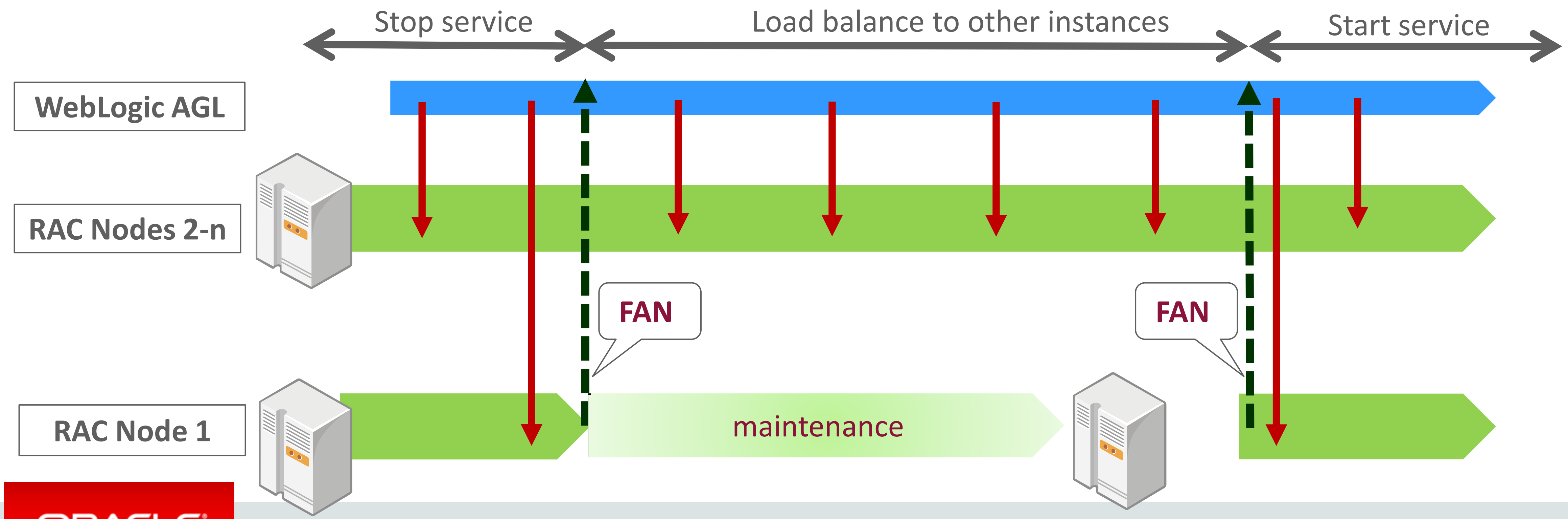
1. srvctl stop services at one instance & drain **(e.g. 5-7s)**
2. Instance shutdown
3. Apply patch or change parameter or other maintenance
4. Restart instance & service

No errors, application continues



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Planned Maintenance at NEC

WebLogic Active GridLink and Data Guard

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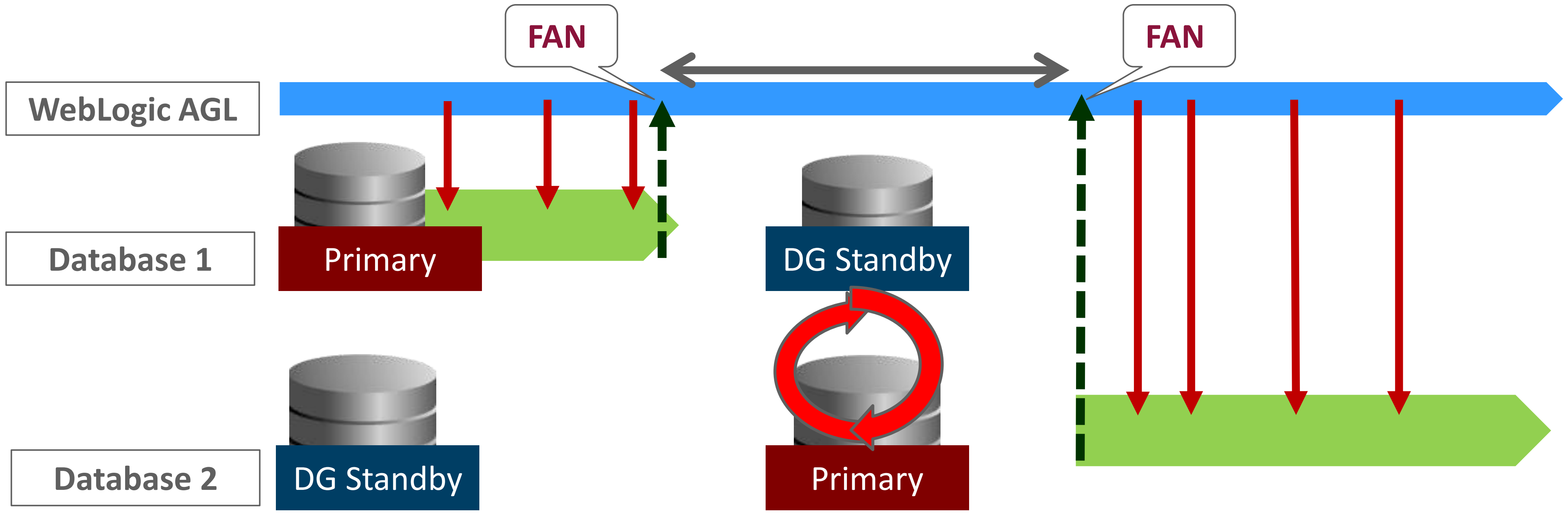
1. srvctl stop services on primary site & drain **(e.g. <u>25s – 30s</u>)**
2. Data Guard switchover
3. New primary database open, start service, rebalance

No errors, application continues



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High Availability by Patch Type

	One- Off	PSU/CPU	Bundle Patch	Patch Set
RAC Rolling	96%	All	Most	No
Standby First	98%	All	All	No
Out of Place	All	All	Exadata bundles	No
Online - Hot	82%*	No	No	No

** Available from 11.2.0.2 onward*

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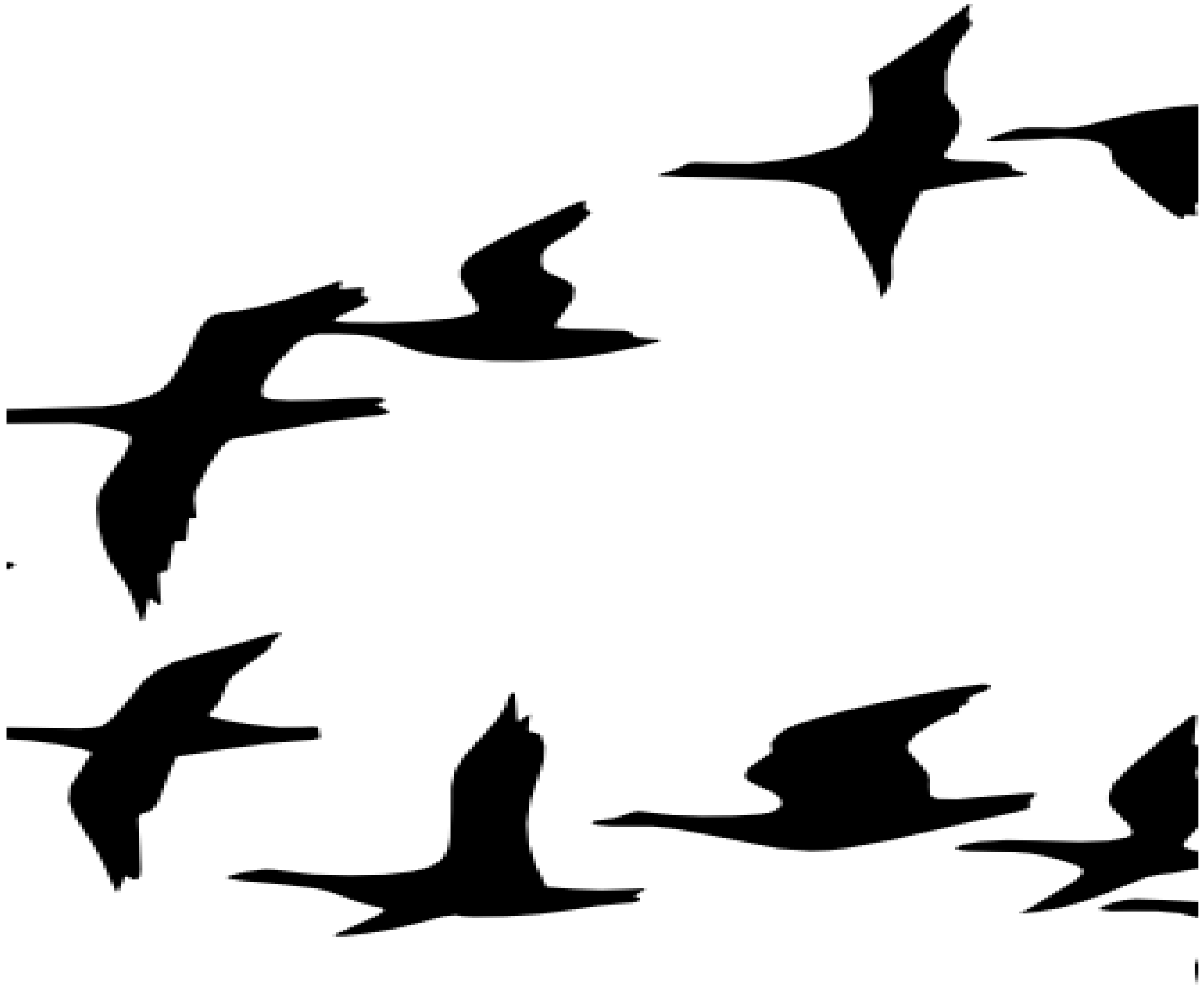
Enterprise Applications

Application	DBA operation at planned maintenance	Configuration Setting
Siebel	disconnect sessions transactional	NET
PeopleSoft	disconnect sessions transactional	NET and TAF SELECT
JD Edwards	disconnect sessions transactional	NET
Informatica	disconnect sessions transactional	NET



Planned Draining Demonstration

New Concepts

Application Failover with Oracle 12c

Database Request – UCP example

```
PoolDataSource pds = GetPoolDataSource();
Connection conn = pooldatasource.getConnection();
PreparedStatement pstmt = …
    …
     SQL, PL/SQL, local calls, RPC
      …
conn.commit();
conn.close();
```

Request Begins

Request Body often ends with **COMMIT**

Request Ends

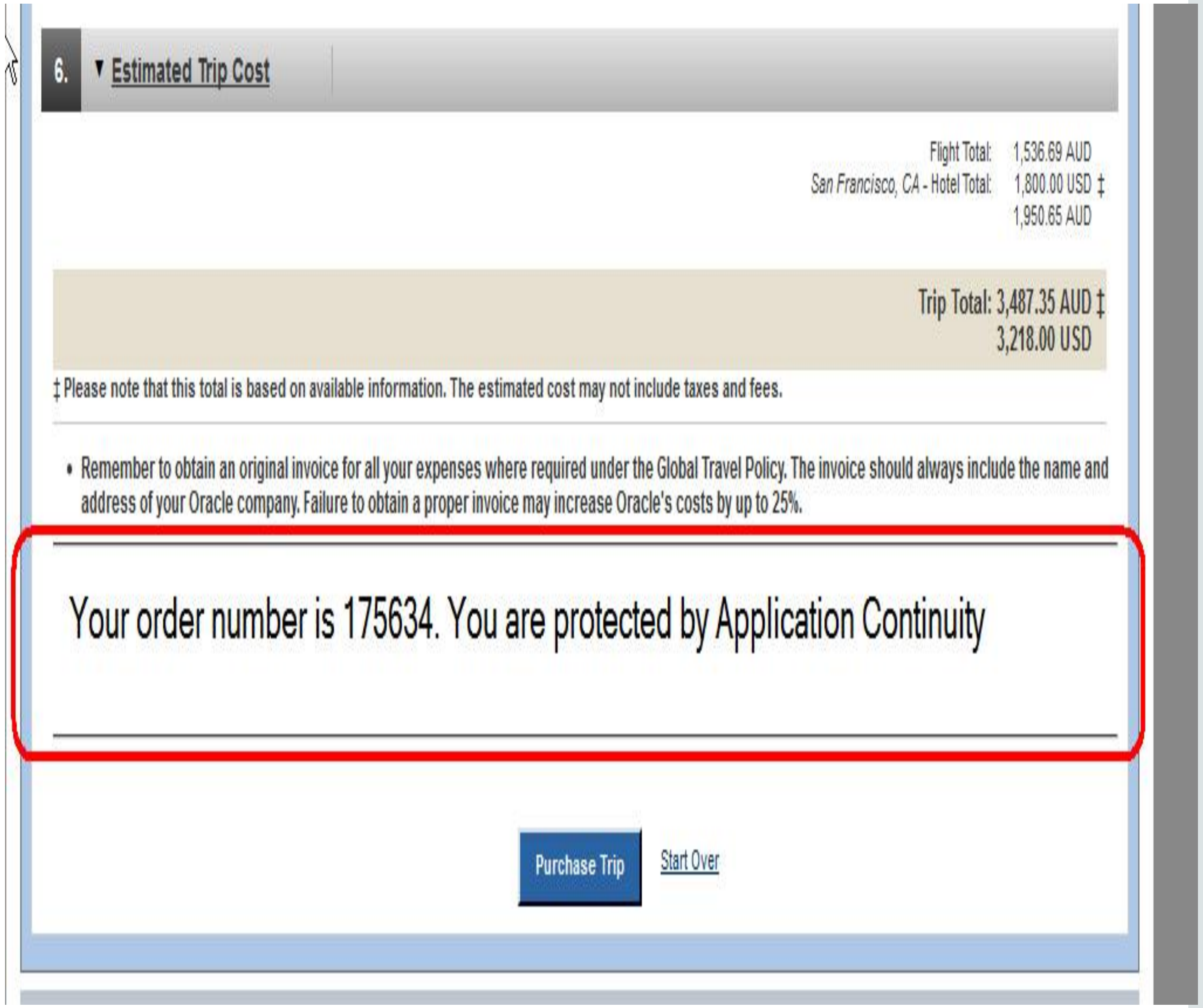
Application Continuity

Unplanned outages should be hidden from applications

Application Continuity

In-flight work continues

- Replays in-flight work on recoverable errors
- Masks most hardware, software, network, storage errors and outages
- Supports JDBC-Thin, UCP, WebLogic Server, 3rd Party Java app servers
- RAC, RAC One, & Active Data Guard
- Improves end user experience



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- Remember to obtain an original invoice for all your expenses where required under the Global Travel Policy. The invoice should always include the name and address of your Oracle company. Failure to obtain a proper invoice may increase Oracle's costs by up to 25%.

Your order number is 175634. You are protected by Application Continuity

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Application Continuity Demonstration

Phases in Application Continuity

1 – Normal Operation

- Client marks database requests
- Server decides which calls can & cannot be replayed
- Directed, client holds original calls, their inputs, and validation data

2 – Outage Phase 1: Reconnect

- Checks replay is enabled
- Verifies timeliness
- Creates a new connection
- Checks target database is valid
- Uses Transaction Guard to force last outcome

3 – Outage Phase 2: Replay

- Replays captured calls
- Ensures results returned to application match original
- On success, returns control to the application

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Exclusions

When replay is not enabled

Application Level

- Default database or default PDB service
- Deprecated, non-standard JDBC classes
- XA in 12.1

Request Level

- Admin actions
  - Alter system
  - Alter database
  - Alter session (subset)
- Active Data Guard with read/write DB links

Target Database

- Databases able to diverge
  - Logical Standby
  - Golden Gate
  - PDB Clone

Steps to use Application Continuity

Check	What to do
Request Boundaries	UCP, WebLogic, and standard 3rd Party App servers – return connections to pool
JDBC Deprecated Classes	Replace non-standard classes (MOS 1364193.1)
Side Effects	Use disable API if a request has a call that should not be replayed
Callbacks	Register a callback for applications that change state outside requests For WebLogic and UCP labels – do nothing
Mutable Functions	Grant keeping mutable values, e.g. sequence.nextval

Grant Mutables

Keep original function results at replay

For owned sequences:

ALTER SEQUENCE.. [sequence object] [KEEP|NOKEEP];

CREATE SEQUENCE.. [sequence object] [KEEP|NOKEEP];

Grant and Revoke for other users:

GRANT [KEEP DATE TIME | KEEP SYSGUID].. [to USER]

REVOKE [KEEP DATE TIME | KEEP SYSGUID][from USER]

GRANT KEEP SEQUENCE on [sequence object] [to USER] ;

REVOKE KEEP SEQUENCE on [sequence object] [from USER]

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Configuration at Database

Set Service Attributes

FAILOVER_TYPE = TRANSACTION for Application Continuity

Review the service attributes:

- COMMIT_OUTCOME = TRUE for Transaction Guard
- REPLAY_INITIATION_TIMEOUT = 300 after which replay is canceled
- FAILOVER_RETRIES = 30 for the number of connection retries per replay
- FAILOVER_DELAY = 3 for delay in seconds between connection retries

Configuration at Client

Use JDBC Replay Data Source

At WebLogic Console or UCP, Weblogic, or your own property file -

```
Select new 12.1 datasource

replay datasource=oracle.jdbc.replay.OracleDataSourceImpl
```

Application Continuity Performance

WebLogic Server Active GridLink and Real Application Clusters

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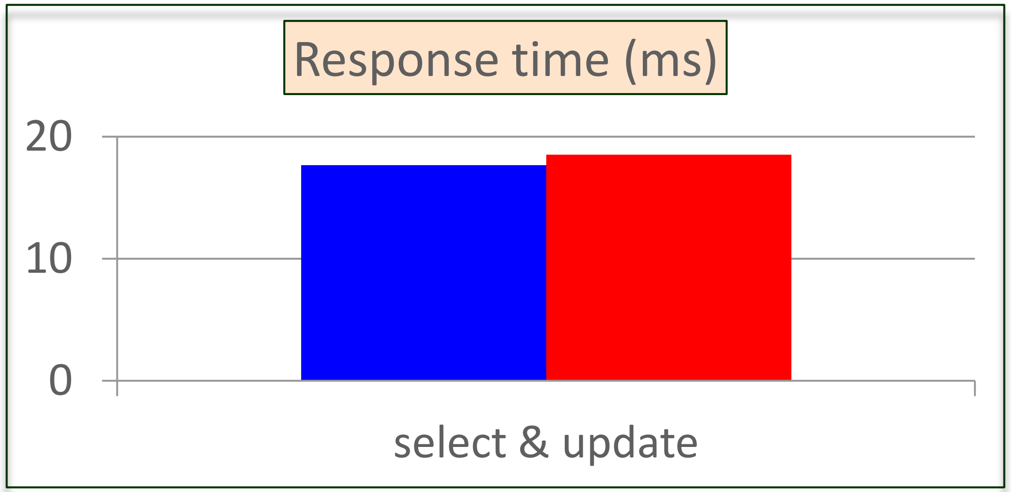

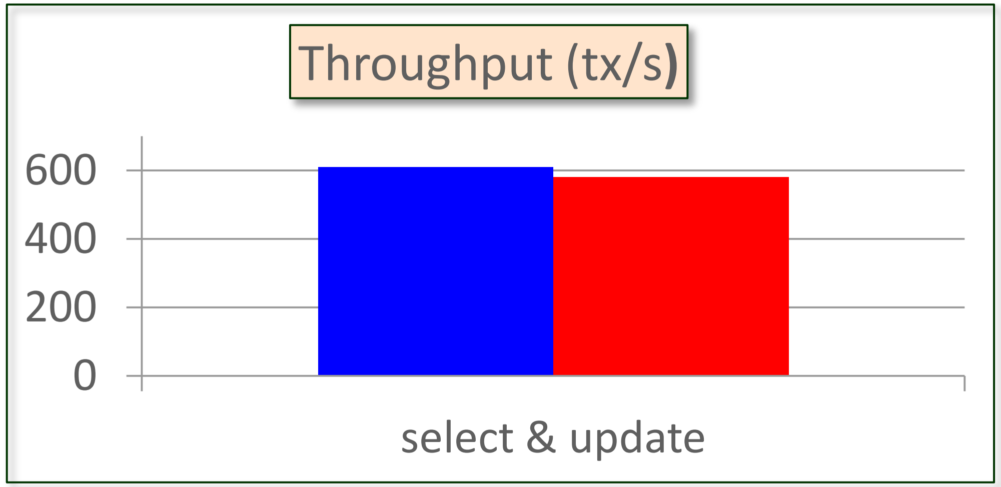

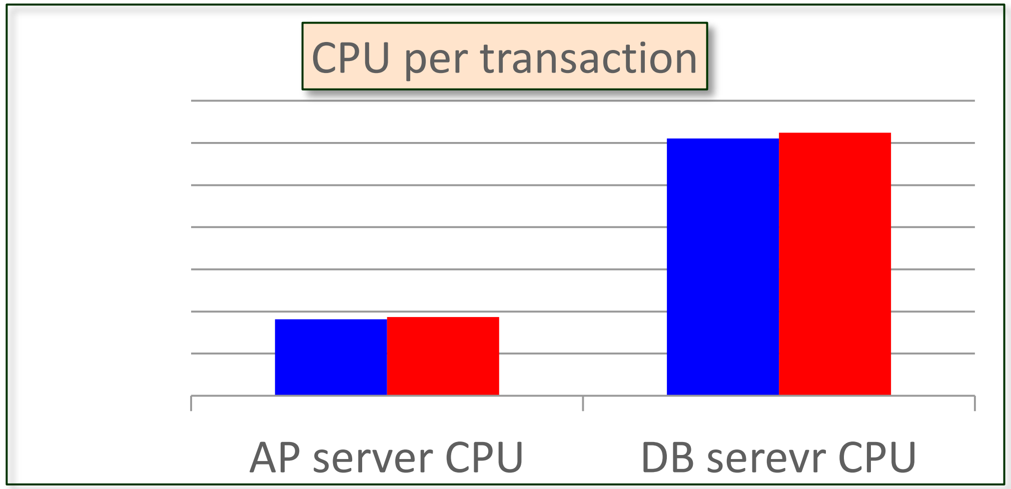

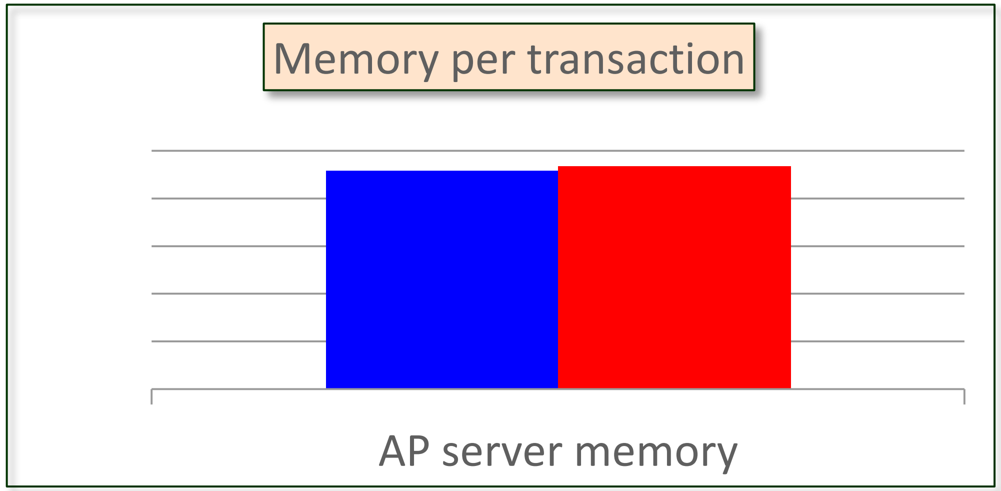

🟦 AC OFF
🟥 AC ON

MedRec Application

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Killing Sessions - Extended

DBA Command	Replays
srvctl stop service -db orcl -instance orcl2 -force	**YES**
srvctl stop service -db orcl -node rws3 -force	**YES**
srvctl stop service -db orcl -instance orcl2 **–noreplay** -force	
srvctl stop service -db orcl -node rws3 **–noreplay** -force	
alter system kill session … immediate	**YES**
alter system kill session … **noreplay**	
dbms_service.disconnect_session([service], dbms_service. **noreplay**)	

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AC Statistics

Supported for Oracle JDBC replay driver

Statistics are client-side, cumulative per-connection or total for all pooled connections using oracle.jdbc.replay.ReplayableConnection

ReplayableConnection.getReplayStatistics (FOR_CURRENT_CONNECTION) returns statistics for current connection

ReplayableConnection.getReplayStatistics (FOR_ALL_CONNECTIONS) returns statistics for all connections in the pool

ReplayableConnection. clearReplayStatistics(StatisticsReportType) clears replay statistics – per connection or all connections

Runtime

TotalRequests = 1

TotalCompletedRequests = 1

TotalCalls = 19

TotalProtectedCalls = 19

Replay

TotalCallsAffectedByOutages = 3

TotalCallsTriggeringReplay = 3

TotalCallsAffectedByOutagesDuringReplay = 0

SuccessfulReplayCount = 1

FailedReplayCount = 0

ReplayDisablingCount = 0

TotalReplayAttempts = 3

Transaction Guard

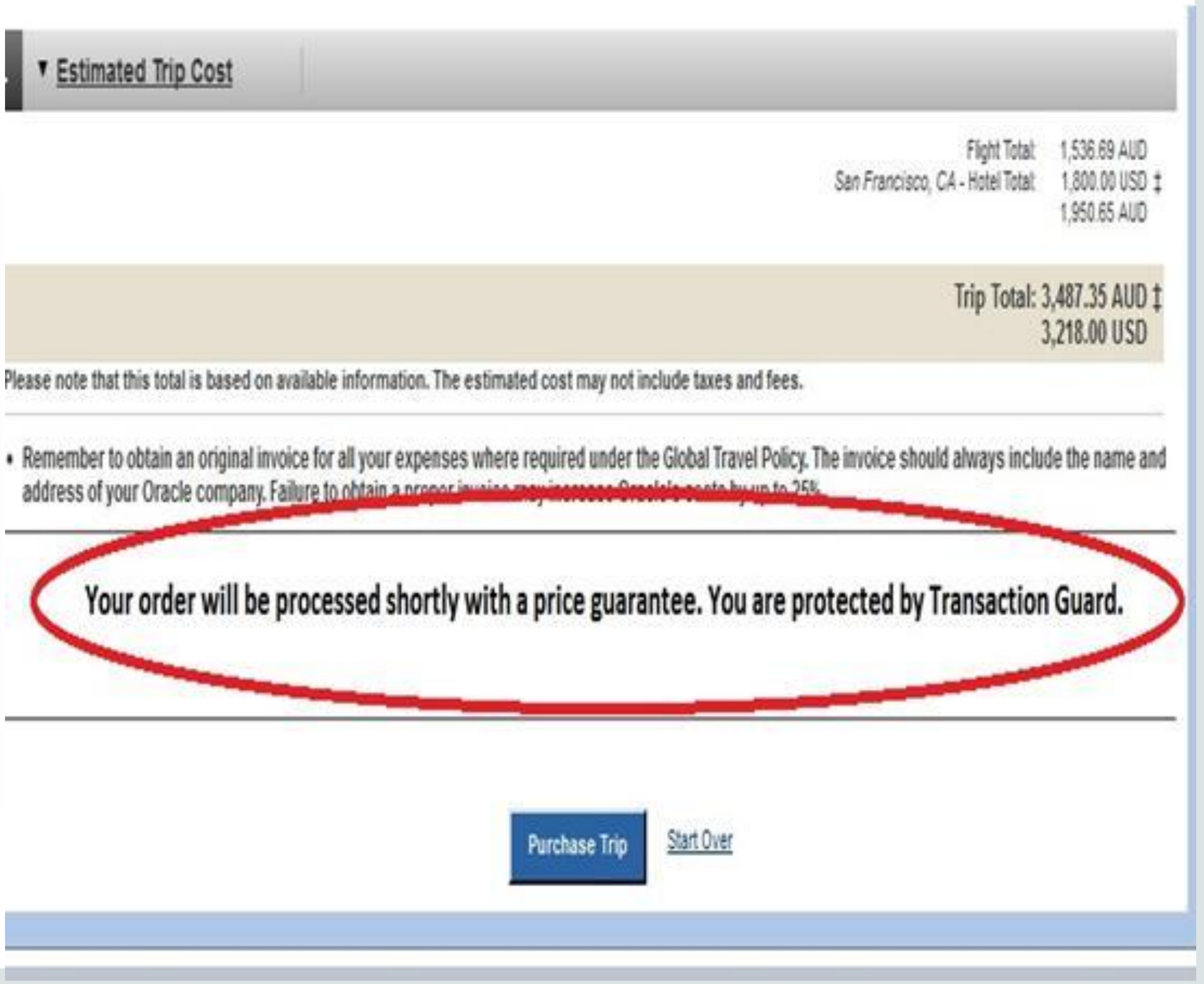
Unplanned outages should be hidden from applications

Transaction Guard

First RDBMS to preserve **COMMIT** Outcome

Reliable transaction outcome after outages

- Allows applications to deal with failures correctly
- Without Transaction Guard, retrying can cause logical corruption
- Application Continuity uses Transaction Guard
- API available with JDBC-thin, OCI/OCCI, ODP.NET



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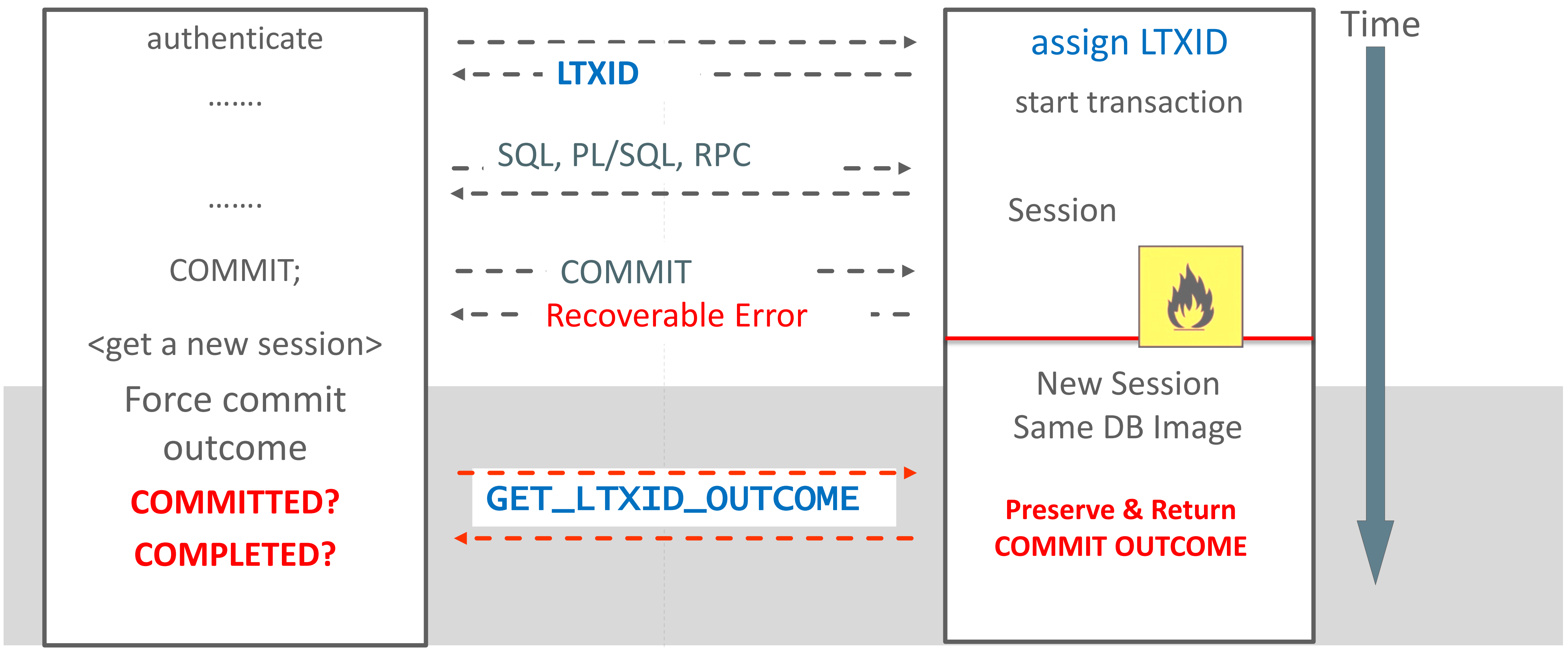
Your order will be processed shortly with a price guarantee. You are protected by Transaction Guard.

How Transaction Guard Works



Transaction Coverage

Inclusions 12.1

Local

Commit on Success (auto-commit)

Distributed and Remote

DDL, DCL, parallel DDL

PL/SQL with embedded COMMIT

PL/SQL with COMMIT as last call

Read-only (allowed for)

Exclusions 12.1

XA

Active Data Guard with R/W links to commit at primary

Database Target - Coverage

Inclusions 12.1

- Single Instance Oracle RDBMS
- RAC One Node
- Real Application Clusters
- Data Guard
- Active Data Guard
- Multitenant including unplug/plug

Exclusions Database Failed Over To -

- Logical Standby
- Golden Gate
- PDB Clones

Forcing Commit Outcome

GET_COMMIT_OUTCOME forces the commit outcome, returning -

- COMMITTED
  - TRUE the user call executed at least one commit
  - FALSE the user call is uncommitted and stays that way

- USER_CALL_COMPLETED
  - TRUE the user call ran to completion.
  - FALSE the user call is not known to have finished

    e.g. use if expecting return data – commit on success, commit embedded in PL/SQL

Use Case - Unambiguous Outcome

Database session outage

FAN aborts dead session FAST

Application receives an error

If "*recoverable error*" *then*

Add this part in the error handling routine

```
Get last LTXID from dead session
Obtain a new database session
// Force commit outcome
    execute DBMS_APP_CONT.GET_LTXID_OUTCOME with last LTXID
    If committed then {
        process committed ;   // e.g. let user know it committed
        if user_call_completed then application may continue
        else  application may not be able to continue}
  Else process uncommitted    // e.g. let user know its safe to resubmit
```

Server-side settings for Transaction Guard

- **On Service**
  - COMMIT_OUTCOME
    - Values – TRUE and FALSE
    - Default – FALSE
    - Applies to new sessions

- **GRANT EXECUTE** ON DBMS_APP_CONT TO <user>;

Transaction Guard – Key Takeaway

First RDBMS to preserve commit outcome

- Users should not see misleading errors when a transaction really did commit.
- Driver receives an LTXID at authentication and on every commit.
- Once the commit outcome is returned, **the result never changes**.
- Safe for applications and mid-tiers to return success or resubmit themselves.

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Success Stories
Out of the Box

Unplanned Failover with Application Continuity

WebLogic Active GridLink and Real Application Clusters

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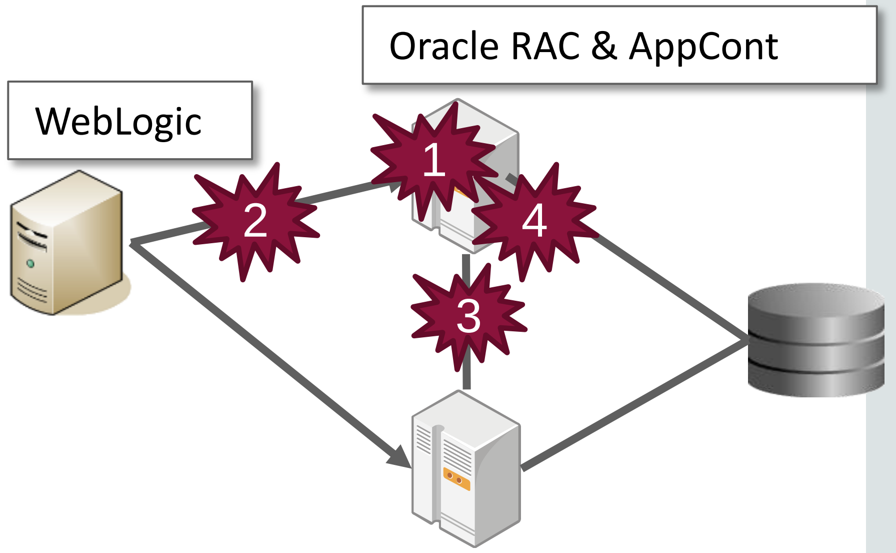
	BEFORE	AFTER
1	**DB 11gR2+WLS Generic DS** Error AP wait time:1s	**DB12c+ GridLink+AppCont** No errors, App Continues AP wait time:1s
2	**DB 11gR2+WLS Generic DS** TIMEOUT 900s (TCP keep-alive)	**DB12c+ GridLink+AppCont** No errors, App Continues AP wait time:1s
3	**DB 11gR2+WLS Generic DS** Error AP wait time: 30s	**DB12c+ GridLink+AppCont** No errors, App Continues AP wait time:30s
4	**DB 11gR2+WLS Generic DS** Hang AP wait time: minutes	**DB12c+ GridLink+AppCont** **+ NEC Monitor :** No errors, App Continues



1. Instance down
2. Public network down
3. Interconnect down
4. Background process hang

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Planned Failover with FAN

WebLogic Server Active GridLink, RAC and Data Guard

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DBA Operation	Maintenance	Result	Time to Drain all Sessions
RAC rolling	PSU apply using opatch	No errors to application	5s
RAC rolling	Instance parameter change	No errors to application	7s
Data Guard switchover	Site maintenance	No errors to application	29s
Data Guard switchover	Site maintenance fallback	No errors to application	25s

Planned and Unplanned Failover

RAC One Node, IBM WebSphere, Universal Connection Pool

Swiss Re

Maintenance	Result	Time allowed
Planned with FAN + Net	No errors to application	4 hours
Unplanned with Application Continuity + Net	No errors to application	10 minutes

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Runtime, Planned, & Unplanned

ODP.NET Unmanaged Provider, RAC, and Data Guard

EPSILON

Change	Improvement
11204 Client to 11204 DB (pending ODAC 12102)	Latest client software
Return connections to ODP.Net pool between requests Connection lifetime longer than 24 hours Min and max connections equal	Reduction in connection usage by 40-50% compared to dedicated connection model
TNS names with retry_count and timeouts	No errors for incoming work No errors to apps during service failover and switchover Login storms eliminated
FAN planned to drain connections for planned maintenance	No errors to apps at planned maintenance with RAC and with Data Guard
FAN + TAF SELECT to failover. TAF callbacks for transactional to rollback	Errors at unplanned reduced to transactions only

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Runtime, Planned, & Unplanned

ODP.NET Unmanaged Provider, RAC, and Data Guard

EPSILON

Database Method	Client Method	Example	Result	Time to Drain Sessions
RAC rolling upgrade/change	Drain with FAN + TNS	PSU / CPU	No errors to application	5s
Data Guard Switchover	Drain with FAN + TNS	Standby first PSU/CPU	No errors to application	25s
RAC Failover	Failover with FAN + TNS + TAF SELECT	Node outage	Errors for transactions	5s
Data Guard Failover	Failover with FAN + TNS + TAF SELECT	Site outage	Errors for transactions	-

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Anonymous – Unplanned with AC

WebLogic Server Active GridLink and Real Application Clusters

Workloads	Replay	Reason
concurrent OLTP with DML	succeeds	DML replays concurrently
concurrent OLTP query and DML mix	succeeds	Queries replay at original SCN
concurrent OLTP with select for update and DML mix	most succeed	Rejections only when unable to restore original

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The combinatorial solution with Application Continuity, Real Application Clusters, Data Guard, WebLogic Server Active GridLink and NEC hardware and middleware enables us to provide incredibly high available system for our Mission Critical customers. This solution will become our primary solution for cloud and big data areas.

Yuki Moriyama

Senior Manager, NEC Corporation

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Safe Harbor Statement

Hardware and Software
Engineered to Work Together

ORACLE®