Zero Downtime: Hiding Planned Maintenance and Unplanned Outages from Applications

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Program Agenda

1. Problems to Solve 10
2. Fast Application Notification 15
3. Continuous Connections 15
4. Hiding Planned Maintenance 15
5. Hiding Unplanned Outages 30
6. Success Stories
1 What problems confront applications at database outages?
In-Flight Work

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

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

• **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

Proven since 10g

12c: Auto-Configuration + Global Data Services
### 12c FAN: Standardized, Auto-Configured

<table>
<thead>
<tr>
<th>Client</th>
<th>10g</th>
<th>11g</th>
<th>12c</th>
</tr>
</thead>
<tbody>
<tr>
<td>JDBC Implicit Connection Cache</td>
<td>ONS</td>
<td>ONS</td>
<td>desupport</td>
</tr>
<tr>
<td>JDBC Universal Connection Pool</td>
<td></td>
<td></td>
<td><strong>ONS</strong></td>
</tr>
<tr>
<td>OCI/OCCI driver</td>
<td>AQ</td>
<td>AQ</td>
<td><strong>ONS</strong></td>
</tr>
<tr>
<td>ODP.NET Unmanaged Provider (OCI)</td>
<td>AQ</td>
<td>AQ</td>
<td><strong>ONS</strong></td>
</tr>
<tr>
<td>ODP.NET Managed Provider (C#)</td>
<td></td>
<td></td>
<td><strong>ONS</strong></td>
</tr>
<tr>
<td>OCI Session Pool</td>
<td>AQ</td>
<td>AQ</td>
<td><strong>ONS</strong></td>
</tr>
<tr>
<td>WebLogic Active GridLink</td>
<td></td>
<td></td>
<td><strong>ONS</strong></td>
</tr>
<tr>
<td>Tuxedo</td>
<td></td>
<td></td>
<td><strong>ONS</strong></td>
</tr>
<tr>
<td>Listener</td>
<td>ONS</td>
<td>ONS</td>
<td><strong>ONS</strong></td>
</tr>
</tbody>
</table>
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`
    • `oracle.ons.nodes.001=node1a,node1b,node1c... (all RAC nodes)`
    • `oracle.ons.nodes.002=node2a,node2b,node2c... (all RAC/DG nodes) ...`
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.
FAN with other Java Application Servers

Use UCP – a simple DataSource replacement

<table>
<thead>
<tr>
<th>General Properties</th>
<th>Additional Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>Data sources</td>
</tr>
<tr>
<td>Name</td>
<td></td>
</tr>
<tr>
<td>Oracle JDBC Driver UCP ST6_QC02P01</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>Oracle JDBC Driver UCP ST6_QC02P01</td>
<td></td>
</tr>
<tr>
<td>Class path</td>
<td></td>
</tr>
<tr>
<td>${WAS_INSTALL_ROOT}/jdbc/ojdbc7.jar</td>
<td></td>
</tr>
<tr>
<td>${WAS_INSTALL_ROOT}/jdbc/ucp.jar</td>
<td></td>
</tr>
<tr>
<td>${WAS_INSTALL_ROOT}/jdbc/ons.jar</td>
<td></td>
</tr>
<tr>
<td>Native library path</td>
<td></td>
</tr>
<tr>
<td>Isolate this resource provider</td>
<td></td>
</tr>
<tr>
<td>Implementation class name</td>
<td>oracle.ucp.jdbc.PoolDataSourceImpl</td>
</tr>
</tbody>
</table>

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

See OTN.
Monitor FAN

- Create a FAN callout in ..$GRID_HOME/racg/userco

- Download FANwatcher from OTN RAC page

FANwatcher

.. 
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 for OCI while a service is temporarily unavailable

alias = (DESCRIPTION =
(CONNECT_TIMEOUT=90) (RETRY_COUNT=20)(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)))
Connections Appear Continuous **for Java**
while a service is temporarily unavailable

alias =(DESCRIPTION =
  (CONNECT_TIMEOUT=4) **(RETRY_COUNT=20)(RETRY_DELAY=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)))
Connections Appear Continuous for ODP.NET while a service is temporarily unavailable

Increase ODP.NET “connection timeout" connection attribute for failover to complete.

```
alias =(DESCRIPTION =
  (CONNECT_TIMEOUT=10)  (RETRY_COUNT=20)(RETRY_DELAY=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)))
```
Lessons Learned – New Connections

• **ALWAYS use services to connect to the database.**
  – Do not use the database service or PDB service – these are for administration only, not HA

• Use current client driver (12102) with current or older RDBMS

• Use one DESCRIPTION – more cause long delays connecting

• Set CONNECT_TIMEOUT=90 or higher to prevent logon storms (OCI and ODP)
  • Do not also set JDBC property oracle.net.ns.SQLnetDef.TCP_CONNTIMEOUT_STR as it overrides

• Set LOAD_BALANCE=on per address to expand SCANs

• **Do not use Easy*Connect – it has no HA capabilities.**
Patches before 12.2

For Java Net Connections only:

• RETRY_COUNT must apply when service is down (19154304)

• Set LOAD_BALANCE=on per address to expand the SCAN (18057904)

• Use shorter CONNECT_TIMEOUT until TRANSPORT_CONNECT_TIMEOUT (19000803)
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 instances using your preferred method including opatch**

- **For major maintenance operations, disable to prevent restarts**
  
  `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

## 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
Planned Maintenance at NEC

WebLogic Active GridLink and Real Application Clusters

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
Planned Maintenance at NEC

WebLogic Active GridLink and Data Guard

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

No errors, application continues
## High Availability by Patch Type

<table>
<thead>
<tr>
<th>Patch Type</th>
<th>One-Off</th>
<th>PSU/CPU</th>
<th>Bundle Patch</th>
<th>Patch Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAC Rolling</td>
<td>96%</td>
<td>All</td>
<td>Most</td>
<td>No</td>
</tr>
<tr>
<td>Standby First</td>
<td>98%</td>
<td>All</td>
<td>All</td>
<td>No</td>
</tr>
<tr>
<td>Out of Place</td>
<td>All</td>
<td>All</td>
<td>Exadata bundles</td>
<td>No</td>
</tr>
<tr>
<td>Online - Hot</td>
<td>82%*</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

*Available from 11.2.0.2 onward*
# Enterprise Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>DBA operation at planned maintenance</th>
<th>Configuration Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siebel</td>
<td>disconnect sessions transactional</td>
<td>NET</td>
</tr>
<tr>
<td>PeopleSoft</td>
<td></td>
<td>NET and TAF SELECT</td>
</tr>
<tr>
<td>JD Edwards</td>
<td></td>
<td>NET</td>
</tr>
<tr>
<td>Informatica</td>
<td></td>
<td>NET</td>
</tr>
</tbody>
</table>
Planned Draining Demonstration
Fast Application Notification

- **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

**Proven since 10g**

**12c: Auto-Configuration + Global Data Services**
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
Database Request – UCP example

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

When replay is not enabled

<table>
<thead>
<tr>
<th>Application Level</th>
<th>Request Level</th>
<th>Target Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Default database or default PDB service</td>
<td>• Admin actions</td>
<td>• Databases able to diverge</td>
</tr>
<tr>
<td>• Deprecated, non-standard JDBC classes</td>
<td>– Alter system</td>
<td>– Logical Standby</td>
</tr>
<tr>
<td>• XA in 12.1</td>
<td>– Alter database</td>
<td>– Golden Gate</td>
</tr>
<tr>
<td></td>
<td>– Alter session (subset)</td>
<td>– PDB Clone</td>
</tr>
<tr>
<td></td>
<td>• Best effort for streams; OCI only – no ADT’s or AQ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Active Data Guard with read/write DB links</td>
<td></td>
</tr>
</tbody>
</table>
## Steps to use Application Continuity

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

Let the database know that it has a request

• Oracle Pools – JDBC UCP and WebLogic
  • Return connections to pool

• 3rd Party Java Application Servers
  IBM WebSphere, Apache Tomcat, your own
  • Use UCP – a simple DataSource switch
  • Return connections to pool

• Custom - Standalone Java, 3rd Party
Disabling Replay

Use `disableReplay` API for requests that should not be replayed.

Make a conscious decision to replay side effects

- e.g. Autonomous Transactions
- `UTL_HTTP`
- `UTL_URL`
- `UTL_FILE`
- `UTL_FILE_TRANSFER`
- `UTL_SMTP`
- `UTL_TCP`
- `UTL_MAIL`
- `DBMS_JAVA` callouts
- `EXTPROC`
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]
```
Callbacks

For applications that set state outside database requests

• WebLogic and UCP Connection Labeling
  – Do nothing

• Custom
  – Register Connection Initialization Callback
  – Sets initial state for a session at BOTH runtime and replay
  – Available with WebLogic, UCP, JDBC-Thin driver
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, or your own property file –

Select new 12.1 datasource

replay datasource=oracle.jdbc.replay.OracleDataSourceImpl

Use JDBC statement cache rather than the WLS Statement Cache
### Killing Sessions - Extended

<table>
<thead>
<tr>
<th>DBA Command</th>
<th>Replays</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>srvctl stop service -db orcl -instance orcl2 -force</code></td>
<td>YES</td>
</tr>
<tr>
<td><code>srvctl stop service -db orcl -node rws3 -force</code></td>
<td>YES</td>
</tr>
<tr>
<td><code>srvctl stop service -db orcl -instance orcl2 -noreplay -force</code></td>
<td></td>
</tr>
<tr>
<td><code>srvctl stop service -db orcl -node rws3 -noreplay -force</code></td>
<td></td>
</tr>
<tr>
<td><code>alter system kill session ... immediate</code></td>
<td>YES</td>
</tr>
<tr>
<td><code>alter system kill session ... noreplay</code></td>
<td></td>
</tr>
<tr>
<td><code>dbms_service.disconnect_session([service], dbms_service. noreplay)</code></td>
<td></td>
</tr>
</tbody>
</table>
Application Continuity Performance
WebLogic Server Active GridLink and Real Application Clusters

- **Response time (ms)**
  - Select & Update

- **Throughput (tx/s)**
  - Select & Update

- **CPU per transaction**
  - AP server CPU
  - DB server CPU

- **Memory per transaction**
  - AP server memory

**Throughput**
- AC OFF: 600 tx/s
- AC ON: 600 tx/s

**Response time**
- AC OFF: 10 ms
- AC ON: 10 ms

**MedRec Application**
AC Assessment

How effective is Application Continuity for user application
Where Application Continuity is not in effect - what steps need to be taken
When Application Continuity cannot be used and why due to a global restriction

<table>
<thead>
<tr>
<th>No</th>
<th>Assessment functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Pretest (sanity check)</td>
</tr>
<tr>
<td>1</td>
<td>JDBC Concrete Classes</td>
</tr>
<tr>
<td>2</td>
<td>Request Boundaries and Protection Level</td>
</tr>
<tr>
<td>3</td>
<td>Decide to Disable</td>
</tr>
<tr>
<td>4</td>
<td>Callbacks</td>
</tr>
<tr>
<td>5</td>
<td>Mutable Functions</td>
</tr>
</tbody>
</table>

Available now
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
Case Study – Instance Outage

Application Continuity replays – application sees no errors

1. Instance outage *
2. Replay driver receives error/FAN and connects to another RAC instance
3. Application Continuity replays
4. Application continues and returns to client

* Similar for session exit without FAN.
Lessons Learned

• Return connections to the connection pool between requests.

• Set http_request_timeout to allow the replay to occur

• Set REPLAY_INITIATION_TIMEOUT, RETRY_COUNT, and RETRY_DELAY

• Consider mutable values. Think of these in terms of delayed execution.

• If the application sets values after creating a connection outside the application – repeat these settings in the callback.

• If the application is using XA datasource – check why. Most apps do not need it.

• If experimenting and using V$instance etc, put these in the callback.
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 and timeouts correctly
- Without Transaction Guard, retrying can cause logical corruption
- Application Continuity uses Transaction Guard
- API available with JDBC-thin, OCI/OCCI, ODP.NET
How Transaction Guard Works

Oracle 12c Drivers

authenticate

......

......

COMMIT;

<get a new session>

Force commit outcome

COMMITTED?

COMPLETED?

Oracle 12c Database(s)

assign LTXID

start transaction

Session

New Session

Same DB Image

Preserve & Return

COMMIT OUTCOME

Oracle 12c Drivers

Oracle 12c Database(s)

LTXID

SQL, PL/SQL, RPC

COMMIT

GET_LTXID_OUTCOME

Error or timeout
Transaction Coverage

**Inclusions**

- 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**

- XA in 12.1
- Active Data Guard with database links used 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
PDB Clones
Golden Gate and third party replication
Use Case - Unambiguous Outcome

Database session outage

FAN aborts dead session FAST
Application receives an error
Get last LTXID from dead session
Obtain a new database session

// Force commit outcome
execute DBMS_APP_CONT.GET_LTXID_OUTCOME using last LTXID

If committed then {
    process committed ;       // let user or app know it committed
    if user_call_completed then application may continue
    else application may not be able to continue}

Else process uncommitted   // let user know its safe to resubmit or resubmit automatically
Connection jdbcConnection = getConnection();
boolean isJobDone = false;
while(!isJobDone) {
    try {
        // apply the raise (DML + commit):
        giveRaiseToAllEmployees(jdbcConnection, 5);
        // no exception, the procedure completed:
        isJobDone = true;
    } catch (SQLRecoverableException recoverableException) {
        // Retry only if the error was recoverable.
        try {
            jdbcConnection.close(); // close old connection:
        } catch (Exception ex) {}
    } catch (Exception ex) {
        try {
            jdbcConnection.close(); // close old connection:
        } catch (Exception ex) {}
    } catch (Exception ex) {
    }
    Connection newJDBCConnection = getConnection(); // reconnect to allow retry
    // Use Transaction Guard to force last outcome: committed or uncommitted
    LogicalTransactionId ltxid = ((OracleConnection)jdbcConnection).getLogicalTransactionId();
    isJobDone = getTransactionOutcome(newJDBCConnection, ltxid);
    jdbcConnection = newJDBCConnection;
}
catch(Exception ex)
{
    OracleLogicalTransaction olt = con.OracleLogicalTransaction;
    olt.GetOutcome(); // obtains new connection

    if (!olt.Committed) // guaranteed uncommitted
    {
        // safe for application or user to resubmit here
    }
    else
    {
        // transaction committed
        // test for completion  – This part is not needed for top level commit, and when states are not needed
        if (olt.UserCallCompleted)
        {
            // return committed status
        }
        else
        {
            // return committed status - and warn that return states are unavailable
        }
    }
}
Integration with TAF Basic or TAF SELECT

- TAF forces commit outcome on behalf of OCI and ODP.NET apps
- Extend exception handling as follows

```csharp
    catch (Exception ex)
    {
        // TAF is enabled
        if (ex.Number >= 25401 && ex.Number <= 25425)
        {
            if (ex.Number == 25402) // resubmit only on this TAF error
            {
                // application may cleanup, then rollback and resubmit here if desired
            }
        }
        else
        {
            // Handle exception – do not attempt resubmit
        }
    }

    Else //TAF is not enabled ... (handle as before)
```
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.
Success Stories
Out of the Box
Unplanned Failover with Application Continuity

WebLogic Active GridLink and Real Application Clusters

BEFORE

1. DB 11gR2+WLS Generic DS
   Error
   AP wait time: 1s

2. DB 11gR2+WLS Generic DS
   TIMEOUT
   900s (TCP keep-alive)

3. DB 11gR2+WLS Generic DS
   Error
   AP wait time: 30s

4. DB 11gR2+WLS Generic DS
   Hang
   AP wait time: minutes

AFTER

1. DB12c+ GridLink+AppCont
   No errors, App Continues
   AP wait time: 1s

2. DB12c+ GridLink+AppCont
   No errors, App Continues
   AP wait time: 1s

3. DB12c+ GridLink+AppCont
   No errors, App Continues
   AP wait time: 30s

4. DB12c+ GridLink+AppCont
   + NEC Monitor:
   No errors, App Continues

Oracle RAC & AppCont

1. Instance down
2. Public network down
3. Interconnect down
4. Background process hang
## Planned Failover with FAN

**WebLogic Server Active GridLink, RAC and Data Guard**

<table>
<thead>
<tr>
<th>DBA Operation</th>
<th>Maintenance</th>
<th>Result</th>
<th>Time to Drain all Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAC rolling</td>
<td>PSU apply using opatch</td>
<td>No errors to application</td>
<td>5s</td>
</tr>
<tr>
<td>RAC rolling</td>
<td>Instance parameter change</td>
<td>No errors to application</td>
<td>7s</td>
</tr>
<tr>
<td>Data Guard switchover</td>
<td>Site maintenance</td>
<td>No errors to application</td>
<td>29s</td>
</tr>
<tr>
<td>Data Guard switchover</td>
<td>Site maintenance fallback</td>
<td>No errors to application</td>
<td>25s</td>
</tr>
</tbody>
</table>
# Planned and Unplanned Failover

RAC One Node, IBM WebSphere, Universal Connection Pool

<table>
<thead>
<tr>
<th>Maintenance</th>
<th>Result</th>
<th>Time allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planned with FAN + Net</td>
<td>No errors to application</td>
<td>4 hours</td>
</tr>
<tr>
<td>Unplanned with Application Continuity + Net</td>
<td>No errors to application</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Database Method</td>
<td>Client Method</td>
<td>Example</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>RAC rolling upgrade/change</td>
<td>Drain with FAN + TNS</td>
<td>PSU / CPU</td>
</tr>
<tr>
<td>Data Guard Switchover</td>
<td>Drain with FAN + TNS</td>
<td>Standby first PSI/CPU</td>
</tr>
<tr>
<td>RAC Failover</td>
<td>Failover with FAN + TNS + TAF SELECT</td>
<td>Node outage</td>
</tr>
<tr>
<td>Data Guard Failover</td>
<td>Failover with FAN + TNS + TAF SELECT</td>
<td>Site outage</td>
</tr>
</tbody>
</table>
For Developers: Application Continuity offloads the challenging work of transaction resubmission during failure events, allowing developers to focus on functionality.

Christo Kutrovsky – ATCG Principal Consultant, Oracle ACE

For Enterprise Architects: Application Continuity is a major step towards the holy grail of a continuously available, consistent, and highly performing database cluster

Marc Fielding – ATCG Principal Consultant, Oracle
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
Safe Harbor Statement

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In-Flight Work - Unplanned

Previous Situation

1. Database Request
2. DB Calls
3. Errors or Timeouts
4. Errors even when request commits

Earlier Database Versions

- Database outages can cause in-flight work to be lost, leaving users and applications in-doubt
- Often leads to:
  - rebooting mid-tiers
  - user frustration
  - lost opportunities
  - duplicate submissions
  - developer pains
Application Continuity

Hides unplanned outages from applications and users

Hides most recoverable errors and timeouts for JDBC applications

Appears to applications as a slightly delayed execution.

1. Database Request

2. DB Calls

3. Errors or Timeouts

4. Application Continuity

5. Response

12c ORACLE Database
Transaction Guard

1. Database Request
2. DB Calls
3. Errors or Timeouts
4. Force Commit Outcome
5. Committed (or not)

Transaction Guard returns, committed or uncommitted, no matter where and when the error.

Once forced, the result never changes.
Transaction Guard

Safe for applications and mid-tiers to return success or resubmit themselves.

Customers are replacing unsafe cancel with safe cancel and replay.
Hardware and Software
Engineered to Work Together