Oracle Database Backup-and-Recovery
Best Practices and New Features

Timothy Chien
Principal Product Manager
Database High Availability

Husnu Sensoy
VLDB Expert
Turkcell Communication Services
Agenda

• What Keeps You Awake at Night?
• Oracle Data Protection Planning & Solutions
• Oracle Backup & Recovery Solutions
  – Physical Data Protection
    • Recovery Manager
    • Oracle Secure Backup
  – Logical Data Protection
    • Flashback Technologies
  – Recovery Analysis
    • Data Recovery Advisor
  – Putting It All Together: Customer Example
• Turkcell Backup & Recovery Case Study
• Q&A
What Keeps You Awake at Night?

Data Protection Concerns...

- Meeting recovery SLAs?
- Reducing exposure to data loss?
- Meeting backup windows?
- Dealing with long-term backup storage?
- Management complexity?
- Budget?

...Where do I begin?
Assess Recovery Requirements
First Step in Data Protection Planning

- **Identify** and prioritize critical data
- **Design** recovery requirements around data criticality
  - Assess tolerance for data loss - *Recovery Point Objective (RPO)*
    - How frequently should backups be taken?
    - Point-in-time recovery required?
  - Assess tolerance for downtime - *Recovery Time Objective (RTO)*
    - Downtime: Problem identification + recovery planning + systems recovery
    - Tiered RTO per level of granularity, e.g. database, tablespace, table, row
  - Determine backup retention policy
    - Onsite, offsite, long-term
- **Assess** data protection requirements
  - Physical: Disasters, outages, failures, corruptions
  - Logical: Human errors, application errors
Oracle Maximum Availability Architecture
Robust & Integrated Data Protection

Production Site

Database

Storage

Active Data Guard
- Fully Active
- Failover Replica

Standby Site

Database

Storage

Data Recovery Advisor
- Intelligent, Guided
- Recovery Analysis

Flashback Technologies
- Correct Errors by Moving Back in Time

Recovery Manager (RMAN) & Oracle Secure Backup (OSB)
- Low Cost, High Performance Backup & Recovery
# Oracle Data Protection Solutions

<table>
<thead>
<tr>
<th>Backup &amp; Recovery</th>
<th>Recovery Time Objective (RTO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Data Protection</td>
<td></td>
</tr>
<tr>
<td>• Recovery Manager (RMAN)</td>
<td>Hours/Days</td>
</tr>
<tr>
<td>• Oracle Secure Backup (OSB)</td>
<td></td>
</tr>
<tr>
<td>Logical Data Protection</td>
<td></td>
</tr>
<tr>
<td>• Flashback Technologies</td>
<td>Minutes/Hours</td>
</tr>
<tr>
<td>Recovery Analysis</td>
<td></td>
</tr>
<tr>
<td>• Data Recovery Advisor</td>
<td>Minimizes time for problem identification &amp; recovery planning</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disaster Recovery</th>
<th>Recovery Time Objective (RTO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Data Protection</td>
<td></td>
</tr>
<tr>
<td>• Active Data Guard</td>
<td>Seconds/Minutes</td>
</tr>
</tbody>
</table>
Oracle Backup & Recovery Solutions
“Backup and Recovery on Steroids”

Physical Data Protection

File System Data
- UNIX
- Linux
- Windows
- NAS

Oracle Databases

Recovery Manager (RMAN)

Recovery Analysis
- Data Recovery Advisor

Logical Data Protection
- Flashback Technologies
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Backup & Recovery Foundation
Complete Oracle Solution from Disk to Tape

- Oracle backup and recovery for your entire IT environment
- Multiple media options available to meet the most stringent SLAs
  - Local disk, remote Cloud storage, physical and virtual tape
Oracle Recovery Manager (RMAN)

Oracle-integrated Backup & Recovery Engine

- Intrinsic knowledge of database file formats and recovery procedures
  - Block validation
  - Online block-level recovery
  - Tablespace/data file recovery
  - Online, multi-streamed backup
  - Unused block compression
  - Native encryption

- Integrated disk, tape & cloud backup leveraging the Fast Recovery Area and Oracle Secure Backup
Oracle Fast Recovery Area

Automatic Disk-to-Disk (D2D) Backup & Recovery

- Fast Recovery Area – Integrated D2D backup and recovery
  - Favorable disk economics – low-cost disks used for recovery area
  - Oracle makes it even better with ‘restore-free recovery’:
    - switch datafile 4 to copy;
    - recover datafile 4;

- Fast incremental backups
  - Backs up only changed blocks
  - Changed blocks are tracked using a very efficient algorithm, e.g. 20X faster

- Nightly incremental backup rolls forward recovery area backup
  - No need to do full backups
    - recover copy of database with tag ‘ORCL’;

Integrated backup-storage tiering
RMAN New Features
Oracle Database 11g Release 2

• Automatic Block Repair
  – Allows corrupt blocks on the primary database to be automatically repaired from physical standby database, as they are detected.
  – In-line and transparent. User sees brief wait from query on corrupt block while it is being repaired.
  – Can also be performed on-demand via `RECOVER` command.
  – Requires Active Data Guard (real-time query on physical standby database).
Backup compression: popular way to save on storage costs

Multiple RMAN backup compression levels
- Choose compression levels & backup throughput
  - [BASIC] | HIGH | MEDIUM | LOW
  - HIGH – reduces backup size by 40%+ depending on data type
  - LOW – least impact on backup throughput
  - MEDIUM – best balance between compression and throughput
  - HIGH | MEDIUM | LOW require Advanced Compression Option
RMAN New Features

Oracle Database 11g Release 2

• In previous releases, DUPLICATE required RMAN client connections to source and clone databases.
• With enhanced DUPLICATE, connection to source database not needed for environments where network connection is not available.
### Additional RMAN New Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backup Fast Recovery Area to disk location</td>
<td>• Protect Fast Recovery Area with on-disk backup of its RMAN backups, archived logs, and controlfiles.</td>
</tr>
</tbody>
</table>
| Extended tablespace point-in-time recovery (TSPITR) capabilities | • Recover a dropped tablespace.  
• Perform multiple tablespace point-in-time recoveries, without requiring recovery catalog |
| Resumable DUPLICATE | • DUPLICATE can resume processing from most points of failure, reducing overall time. |
| CONVERT DATABASE can skip unneeded datafiles | • Reduces overall conversion time by only processing the required UNDO-containing data files. |
| SET NEWNAME FOR TABLESPACE | • Simplifies renaming of datafiles for RESTORE, DUPLICATE, and TSPITR operations. |
RMAN Best Practices
RMAN Best Practices

- Fast Recovery Area (FRA) guidelines
  - Place FRA on separate storage & store backups, in addition to copy of control file, redo logs, and archived logs, to protect all needed recovery-related files from production outages.
  - When estimating FRA size, if you want to keep:
    - Control file backups and archived logs
      - Estimate archived logs generated between successive backups on the busiest days and multiply total size by 2 to account for activity spikes.
    - Archived logs and Flashback logs
      - Multiply the archived log size between backups by 4, assuming Flashback retention = time between archived log backups.
    - Incremental backups
      - Add in their estimated sizes
    - On-disk image copy backup
      - Add in size of the database minus the size of temp files
## RMAN Performance Factors

### Balancing Backup and Restore Requirements

<table>
<thead>
<tr>
<th>Consideration</th>
<th>Performance Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Incremental Backup Strategy</strong></td>
<td>• Incremental backup strategy improves backup performance, with trade-off in recovery performance</td>
</tr>
<tr>
<td></td>
<td>• Enable block change tracking for fast incremental backups</td>
</tr>
<tr>
<td></td>
<td>• Cumulative vs. differential incremental backups</td>
</tr>
<tr>
<td></td>
<td>• ‘Incremental forever’ requires an initial full then incrementals thereafter</td>
</tr>
<tr>
<td></td>
<td>- <strong>Fast recovery</strong>: Current image copy of database readily available</td>
</tr>
<tr>
<td><strong>Multiplexing</strong></td>
<td>• Backup ‘x’ files in parallel per channel, improving backup performance</td>
</tr>
<tr>
<td></td>
<td>• RMAN multiplexing level = min(FILESPERSET, MAXOPENFILES)</td>
</tr>
<tr>
<td></td>
<td>• Exception: Set MAXOPENFILES = 1 for SAME or ASM datafiles</td>
</tr>
<tr>
<td></td>
<td>• Set # of RMAN channels = # of tape drives, so that <em>media management multiplexing is not used for RMAN backups</em></td>
</tr>
<tr>
<td></td>
<td>- Setting # of RMAN channels &gt; # of tape drives will impact restore, due to interleaved backup pieces on single tape</td>
</tr>
<tr>
<td><strong>Hardware/Network/Storage</strong></td>
<td>• Assess host resources, production disk I/O, HBA/network, tape drive throughput</td>
</tr>
<tr>
<td></td>
<td>• Minimum performant component of these will be performance bottleneck</td>
</tr>
</tbody>
</table>
Data Warehouse B&R Best Practices

- Exploit partitioning and read-only tablespaces
  - Older partitions can be moved to read-only tablespaces
  - Backup read-only tablespaces once, then periodically, depending on tape retention policy
- Divide full backup workload across multiple days
- Leverage database & backup compression
- Save time with tablespace level backups
  - Backup index tablespaces less frequently than data tablespaces
  - Backup scarcely used tablespaces less frequently
  - Reduce restore time for most critical tablespaces, by grouping them together in separate backups
- Take incremental backup when NOLOGGING operations finish to ensure recoverability
Test, Test, Test Recovery...

<table>
<thead>
<tr>
<th>Recovery Scenario</th>
<th>Oracle Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media Failure</td>
<td>RMAN – restore all files to new storage location</td>
</tr>
<tr>
<td>Block Corruption</td>
<td>RMAN Validate, Block Media Recovery, Trial Recovery, LogMiner</td>
</tr>
<tr>
<td>User/Logical Error</td>
<td>Flashback Technologies, RMAN TSPITR, LogMiner</td>
</tr>
<tr>
<td>Disaster</td>
<td>Data Guard; RMAN -- restore all files to new host/storage</td>
</tr>
</tbody>
</table>

- Data Recovery Advisor – built-in database failure diagnosis, analysis, & repair tool
Additional Resources

- RMAN Step-by-Step Performance Tuning (NEW)
- Very Large Database Backup & Recovery Best Practices
- Best Practices using Recovery Manager with Oracle Data Guard and Oracle Streams
Oracle Secure Backup
Oracle Secure Backup (OSB)
Enterprise Tape Backup Management

Protects Entire IT Environment

- Oracle Database 11g Release 2 to Oracle9i
- 25 – 40% faster tape backup
- Heterogeneous file systems (UNIX/Linux/Windows) and NAS devices
- Built-in Oracle Integration
- Centralized management in distributed environments
- Over 75% less expensive than comparable products
Oracle Secure Backup Cloud Module

Offsite Database Backups in the Cloud

- Oracle Secure Backup Cloud module: Backup databases to Amazon Cloud
  - Complements local disk and/or tape backup
  - Eliminates IT management overhead of a disaster recovery site
  - Backed by Amazon S3 uptime SLAs

- $3,500 per RMAN channel
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ORACLE
Logical Data Protection

Fast ‘Rewind’ of Logical Errors

Physical Data Protection

- File System Data
  - UNIX
  - Linux
  - Windows
  - NAS

- Oracle Databases

- Recovery Manager (RMAN)

- Recovery Analysis
  - Data Recovery Advisor
  - Logical Data Protection
    - Flashback Technologies

Oracle Databases

Recovery Manager (RMAN)
Flashback Technologies
Error Detection & Correction

• Flashback revolutionizes error recovery
  – View ‘good’ data as of a past point-in-time
  – Simply rewind data changes
  – Time to correct error equals time to make error

\[ \text{Correction Time} = \text{Error Time} + f(DB\_SIZE) \]

• Low impact
• Excellent tool for configuring QA, Dev and Training databases
• Flashback is easy – simple commands, no complex procedure
Error Investigation with Flashback

- **Flashback Query**
  - Query all data at point in time
  ```sql
  select * from Salary AS OF '12:00 P.M.' where ...
  ```

- **Flashback Version Query**
  - See all versions of a row between times
  - See transactions that changed the row
  ```sql
  select * from Salary VERSIONS BETWEEN '12:00 PM' and '2:00 PM' where ...
  ```

- **Flashback Transaction Query**
  - See all changes made by a transaction
  ```sql
  select * from FLASHBACK_TRANSACTION_QUERY where xid = HEXTORAW('000200030000002D');
  ```

- All above are based on available UNDO
Error Correction with Flashback

- **Flashback Database** – restore database to any point in time
- **Flashback Table** – restore contents of tables to any point in time (undo-based)
- **Flashback Drop** – restore accidentally dropped tables (based on free space in tablespace)
- **Flashback Transaction** – back out transaction and all subsequent conflicting transactions (redo-based)
Flashback Database

Continuous Data Protection (CDP)

- **Fast** point-in-time recovery strategy
- Eliminate the need to restore a whole database backup
- Continuous data protection for database
  - Optimized, before-change block logging
  - Restores just *changed* blocks
  - Replay log to restore DB to desired time
- It’s **fast** - recover in minutes, not hours
- It’s **easy** - single command restore
  
  Flashback Database to ‘2:05 PM’

“Rewind” button for the Database
Flashback Technologies New Features
Oracle Database 11g Release 2

- Increased Availability
  - Enable Flashback Database while database is open
    - Test Flashback without having to take downtime

- Better Manageability
  - Monitor Flashback Database progress with `v$session_longops`
    - Progress percentage can be found with \((\text{SOFA}R / \text{TOTA}L\text{WORK})\)

- Minimize System Impact
  - Optimized Flashback logging for batch/insert intensive loads
    - Potentially reduce Flashback logging impact to ~2%

- Extended Dependency Tracking
  - Flashback Transaction supports foreign key dependency tracking
Best Practices – Undo-based Flashback
Flashback Query, Flashback Table

- Use Undo Advisor (available through Enterprise Manager) to get recommendations on available undo retention for various sizes.
- Use fixed size undo
  - Undo retention automatically tuned for best possible retention based on tablespace size and current system load.
- Be aware of DDL restrictions – not possible to query in the past if table structure is modified (e.g. drop/modify column, move table, etc.)
- Further details:
  http://download.oracle.com/docs/cd/B19306_01/appdev.102/b14251/adfns_flashback.htm#sthref1496
Best Practices – Flashback Database

- Tune FRA storage
  - Use ASM, configure enough disk spindles, etc.
- Use physical standby database to test Flashback logging
- Use `V$FLASHBACK_DATABASE_LOG` to size log space, after running workload > duration of Flashback retention period.
- Create Guaranteed Restore Point (GRP) without enabling Flashback logging
  - Saves disk space for workloads where same blocks are repeatedly updated
  - Drop GRP to immediately reclaim space

Further details:
Metalink Note 565535.1 Flashback Database Best Practices & Performance
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Recovery Analysis
Intelligent, Guided Recovery

Physical Data Protection

- File System Data
  - UNIX
  - Linux
  - Windows
  - NAS

- Oracle Databases

Recovery Manager (RMAN)

Recovery Analysis

Data Recovery Advisor

Logical Data Protection

Flashback Technologies
Data Recovery Advisor

The Motivation

- Oracle provides robust tools for data repair:
  - RMAN – physical media loss or corruptions
  - Flashback – logical errors
  - Data Guard – physical problems

- However, problem diagnosis and choosing the right solution can be error prone and time consuming
  - Errors more likely during emergencies
Data Recovery Advisor (DRA)

- Oracle Database tool that automatically diagnoses data failures, presents repair options, and executes repairs at the user's request
- Determines failures based on symptoms
  - E.g. an “open failed” because datafiles f045.dbf and f003.dbf are missing
  - Failure Information recorded in diagnostic Automatic Diagnostic Repository (ADR)
  - Flags problems before user discovers them, via automated health monitoring
- Intelligently determines recovery strategies
  - Aggregates failures for efficient recovery
  - Presents only feasible recovery options
  - Indicates any data loss for each option
- Can automatically perform selected recovery steps
- Accessed via RMAN or EM

Reduces downtime by eliminating confusion
Data Recovery Advisor Wizard

Oracle Advised Recovery
The Data Recovery Advisor has detected failures. Click on "Advise and Recover" to have Oracle analyze and produce recovery advice.

- Failures Detected: Critical: 0, High: 1, Low: 0
- Failure Description: One or more non-system datafiles are missing

User Directed Recovery
- Recovery Scope: Whole Database
- Operation Type:
  - Recover to the current time or a previous point-in-time: Datafiles will be restored from the latest usable backup as required.
  - Restore all datafiles: Specify Time, SCN or log sequence. The backup taken at or prior to that time will be used. No recovery will be performed in this operation.
  - Recover from previously restored datafiles

Overview
- Recover database failures as advised by Oracle
- Restore and/or recover the entire database or selected objects
- Restore files to a new location
- Recover tablespaces to a point-in-time based on a timestamp, system change number (SCN), or log sequence number
- Recover datafile data blocks that are marked as corrupted, or based on datafile block IDs or tablespace block addresses
- Flashback database or tables to a specific system change number (SCN) or timestamp

Decrypt Backups

Host Credentials
To perform recovery, supply operating system login credentials to access the target database.
Data Recovery Advisor – View Failures

ORACLE Enterprise Manager 10g

View and Manage Failures

Select dropdown values and optionally enter failure description and impact strings to filter the data that is displayed in your results set.

Select failures and ...

Select failures and ...

Data file 5: 'private3/oracle/dioradata/NewYork/example01.dbf' EXAMPLE might be unavailable

Tip: All CRITICAL failures must be selected before "Advise". All CRITICAL failures must be unselected before "Set Priority High" or "Set Priority Low".

Related Links

Checkers

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About Oracle Enterprise Manager
Data Recovery Advisor – Manual Repair

Manual Actions

The following user actions may provide a faster recovery path for certain simple failures. Click "Re-assess Failures" if user actions are performed. Otherwise, click "Continue with Advice" to use the recovery advice generated for the failures selected.

Manual Action Details

If file /private3/oracle/cq/oradata/NewYork/example01.dbf was unintentionally renamed or moved, restore it.
Data Recovery Advisor – Recovery Advice

The repair includes complete media recovery with no data loss.

RMAN Script

```
# restore and recover datafile
restore datafile 5;
recover datafile 5;
```

Home | Targets | Deployments | Alerts | Compliance | Jobs | Reports | Setup | Preferences | Help | Logout

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About Oracle Enterprise Manager
Data Recovery Advisor – Summary

The repair includes complete media recovery with no data loss.

If Open Database after Recovery

The database is currently not open. Open the database after a successful recovery operation.

## Failures That Will Be Resolved

<table>
<thead>
<tr>
<th>Failure Description</th>
<th>Impact</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>One or more non-system datfiles are missing</td>
<td>See impact for individual child failures</td>
<td>HIGH</td>
</tr>
<tr>
<td>Some objects in tablespace EXAMPLE might be unavailable</td>
<td></td>
<td>HIGH</td>
</tr>
</tbody>
</table>

**RMAN Script**

- restore and recover datfile
- restore datfile 5
- recover datfile 5
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Putting It All Together..
Customer Example

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<th>Requirement</th>
<th>Service Level Agreement</th>
<th>Oracle Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPO</td>
<td>Any point in time within recovery window</td>
<td>➢ Archived Log Mode</td>
</tr>
<tr>
<td>RTO</td>
<td></td>
<td>➢ RMAN, OSB, DRA</td>
</tr>
<tr>
<td>• Tier 3</td>
<td>• &lt;1 hour for tablespace/datafile recovery</td>
<td>➢ Flashback Table</td>
</tr>
<tr>
<td></td>
<td>• &lt;3 hours for full database recovery</td>
<td>➢ Flashback Database</td>
</tr>
<tr>
<td>• Tier 2</td>
<td>• &lt;30 min for row/table recovery (within last 3 hrs)</td>
<td>➢ Data Guard</td>
</tr>
<tr>
<td></td>
<td>• &lt;1 hour for database recovery from logical errors (within last 2 hrs)</td>
<td></td>
</tr>
<tr>
<td>• Tier 1</td>
<td>• &lt;15 min for any database outage</td>
<td>➢ Data Guard</td>
</tr>
<tr>
<td>Disaster Recovery</td>
<td>Failover to standby database at secondary site</td>
<td>➢ OSB</td>
</tr>
<tr>
<td></td>
<td>Backups sent offsite</td>
<td></td>
</tr>
<tr>
<td>Retention Policy</td>
<td>Onsite backups - 3 day recovery window</td>
<td>➢ Fast Recovery Area, OSB</td>
</tr>
<tr>
<td></td>
<td>Offsite backups - 1 year tape retention</td>
<td></td>
</tr>
<tr>
<td>Backup Redundancy</td>
<td>Two backup copies on tape</td>
<td>➢ OSB</td>
</tr>
</tbody>
</table>
Recovery SLAs
Customer Example

- Oracle Solution - RMAN + OSB + Data Guard + DRA
  - One-time image copy backup to Fast Recovery Area (FRA)
  - Daily differential incremental backup to FRA
  - Image copy rolled forward daily until “sysdate – 4”
  - FRA sized for one image copy backup + 4 incrementals + 4 days of archived logs
  - Daily backup of FRA to tape via OSB (retained for 1 month)
  - Daily vaulting of tape backups to offsite location (retained for 1 year)
  - Real-time, synchronized physical standby database in Maximum Performance mode for disaster recovery
  - Leverage DRA for real-time detection and analysis of failures
Recovery SLAs
Customer Example

• Oracle Solution – Flashback Technologies
  – Size UNDO tablespace for 3 hour retention period
  – Set Flashback Database target retention time to 2 hours
  – Provision Flashback log space in FRA, based on 2 hour workload
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Remember?
Data Protection Concerns…

• Meeting recovery SLAs?
• Reducing exposure to data loss?
• Meeting backup windows?
• Dealing with long-term backup storage?
• Management complexity?
• Budget?

Solution…
Oracle Backup & Recovery Solutions
Complete & Targeted Recovery

Recovery Analysis

Logical Data Protection

Physical Data Protection
Recovery Manager
Oracle Secure Backup

Flashback Technologies

Data Recovery Advisor
OTN Resources

- Recovery Manager:

- Oracle Secure Backup

- Flashback Technologies

- Oracle Cloud Computing Center

- Oracle Maximum Availability Architecture
  http://www.oracle.com/technology/deploy/availability/htdocs/maa.htm
**HA Sessions, Labs, & Demos by Oracle Development**

**Sunday, 11 October – Hilton Hotel Imperial Ballroom B**
3:45p Online Application Upgrade

**Monday, 12 October – Marriott Hotel Golden Gate B1**
11:30a Introducing Oracle GoldenGate Products

**Monday, 12 October – Moscone South**
1:00p Oracle’s HA Vision: What’s New in 11.2, Room 103
4:00p Database 11g: Performance Innovations, Room 103
2:30p Oracle Streams: What’s New in 11.2, Room 301
5:30p Comparing Data Protection Solutions, Room 102

**Tuesday, 13 October – Moscone South**
11:30a Oracle Streams: Replication Made Easy, Room 308
11:30a Backup & Recovery on the Database Machine, Room 307
11:30a Next-Generation Database Grid Overview, Room 103
1:00p Oracle Data Guard: What’s New in 11.2, Room 104
2:30p GoldenGate and Streams - The Future, Room 270
2:30p Backup & Recovery Best Practices, Room 104
2:30p Single-Instance RAC, Room 300
4:00p Enterprise Manager HA Best Practices, Room 303

**Tuesday, 13 October – Marriott Hotel Golden Gate B1**
11:30a GoldenGate Zero-Downtime Application Upgrades
1:00p GoldenGate Deep Dive: Architecture for Real-Time

**Wednesday, 14 October – Moscone South**
10:15a Announcing OSB 10.3, Room 300
11:45a Active Data Guard, Room 103
5:00p Exadata Storage & Database Machine, Room 104

**Thursday, 15 October – Moscone South**
9:00a Empowering Availability for Apps, Room 300
12:00p Exadata Technical Deep Dive, Room 307
1:30p Zero-Downtime DB Maintenance, Room 103

**Demos Moscone West DEMOGrounds**
Mon & Tue 10:30a - 6:30p; Wed 9:15a - 5:15p
- Maximum Availability Architecture (MAA), W-045
- Oracle Streams: Replication & Advanced Queuing, W-043
- Oracle Active Data Guard, W-048
- Oracle Secure Backup, W-044
- Oracle Recovery Manager & Flashback, W-046
- Oracle GoldenGate, 3709

**Hands-on Labs Marriott Hotel Golden Gate B2**
**Monday** 11:30a-2:00p Oracle Active Data Guard, Parts I & II
**Thursday** 9:00a-11:30a Oracle Active Data Guard, Parts I & II
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