Top Oracle Database 11g High Availability Best Practices

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The presentation and a list of references that it contains can be found at:

http://tinyurl.com/HA-OW2010
Oracle Maximum Availability Architecture
Integrated, Fully Active, High ROI

**Production Site**
- RAC
  - Scalability
  - Server HA
- Flashback
  - Human error correction
- ASM
  - Volume Management
- RMAN & Fast Recovery Area
  - On-disk backups

**Active Replica**
- Active Data Guard
  - Data Protection, DR
  - Query Offload
- GoldenGate
  - Active-active
  - Heterogeneous
- Oracle Secure Backup
  - Backup to tape / cloud

Edition-based Redefinition, Online Redefinition, Data Guard, GoldenGate
- Minimal downtime maintenance, upgrades, migrations
Oracle Maximum Availability Architecture - MAA

Oracle Maximum Availability Architecture (MAA) is Oracle's best practices blueprint based on proven Oracle high availability technologies and recommendations. The goal of MAA is to achieve the optimal high availability architecture at the lowest cost and complexity.

- MAA best practices span the Exadata Database Machine, Oracle Database, Oracle Fusion Middleware, Oracle Applications, Grid Control and Oracle Partners.
- MAA accommodates a range of business requirements to make these best practices as widely applicable as possible.
- MAA leverages lower-cost servers and storage.
- MAA evolves with new Oracle versions and features.
- MAA is hardware and CS independent.

This Maximum Availability Architecture Overview describes how MAA is used to maximize systems availability and meet the most aggressive Service Level Agreements (SLAs) for system availability, quality of service, and data protection.

For MAA Best Practices and other technical information see:

MAA Best Practices
Oracle Technology Network

1 http://www.oracle.com/goto/maa
Then along comes Oracle Database 11g Release 2

Changing MAA best practices for:

- Installation and Configuration
- Database Consolidation
- Disaster Recovery
- Planned Maintenance
Agenda

- GRID install and client configuration
- Database consolidation – HA/DR included
- Industrial strength Data Guard Redo Transport
- Integrated, automatic client failover to a DR system
- Easy button for database rolling upgrades
- Use your standby database to increase performance
- Flexible solutions for snapshots and clones
- User experience – Bank Of America
Grid Infrastructure

Simplified Installation of Standard GRID Software Components

• Integration of Oracle Clusterware and ASM
  – Clusterware and ASM in single install, single home
  – VOTE/OCR stored on ASM
  – OUI does not support raw devices on new installs

• What DBA’s need to know about Grid Infrastructure:
  – Required for non-RAC databases if using ASM or Oracle Restart
  – 11.2.0.2 download from My Oracle Support
    • Patch #10098816, full install
  – New concept: SCAN-VIP and SCAN listeners
    • SCAN = Single Client Access Name

2http://st-curriculum.oracle.com/obe/db/11g/r2/prod/install/gridinstss/gridinstss.htm
3MOS Note 1053147.1, 11gR2 Clusterware and Grid Home - What You Need to Know
Single Client Access Name (SCAN)
The New Database Cluster Alias

- Used by clients to connect to any database in the cluster
- Removes the requirement to change the client connection if cluster changes
- Load balances across the instances providing a service
- Provides failover between “moved instances”
SCAN: Easier Client Configuration

- **Without SCAN** (pre-11g Rel. 2) TNSNAMES has 1 entry per node
- With every cluster change, all client TNSNAMES need to be changed

```plaintext
PMRAC =
  (DESCRIPTION =
   (ADDRESS = (PROTOCOL = TCP) (HOST = node1) (PORT = 1521))
   ...
   (ADDRESS = (PROTOCOL = TCP) (HOST = nodeN) (PORT = 1521))
   (CONNECT_DATA =
   ... ))
```

- **With SCAN** only 1 entry per cluster is used, regardless of the # of nodes:

```plaintext
PMRAC =
  (DESCRIPTION =
   (ADDRESS = (PROTOCOL = TCP) (HOST = clusterSCANname) (PORT = 1521))
   (CONNECT_DATA =
   ... ))
```
Connection Load Balancing using SCAN

Clients

Request connection to service = sales

SCAN VIP Listeners

Local Listeners

Oracle RAC Database Cluster

MOS Note 887522.1: Grid Infrastructure Single Client Access Name (SCAN) Explained
Program

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RAC One Node
The “Always On” Single Instance Database

- Built-in High Availability
  - Automated node failover

- Live migration of instances across servers
  - Online replacement of servers
  - Online patching and upgrades of operating system and infrastructure software
  - Rolling database patching

- Efficient consolidation of servers & storage

- Enhanced virtualization for Oracle Database
  - Extends and improves database availability and flexibility when running in a virtual server
RAC One Demonstration
HA/DR Included

Primary Site
RAC One-Node Cluster

Data Guard

Standby Site
Oracle Database 11g Release 2 Installer - Installing database - Step 4 of 10

Grid Installation Options

- Configure Security Updates
- Download Software Updates
- Installation Option
- Grid Installation Options
- Install Type
- Typical Installation
- Prerequisite Checks
- Summary
- Install Product
- Finish

Select the type of database installation you want to perform.

- Single Instance database installation

Oracle RAC One Node database installation

Select nodes in addition to the node, node2 in the cluster where the instance should start on a RAC or Oracle RAC One.

Node Name

1. dscba01
2. dscba02

SSH Connectivity... Select All Deselect All
Welcome to the Database Configuration Assistant for Oracle Real Application Clusters.

The Database Configuration Assistant enables you to create, configure, or delete a cluster database and manage database templates. It also enables you to add and delete instances of a cluster database.

Select the database type that you would like to create or administer:

- **Oracle RAC One Node database**
RAC One Node database can be Admin-Managed or Policy-Managed. A Policy-Managed RAC One Node database selects fail-over candidate server from associated server pool. Admin-Managed RAC One Node need specific candidate servers configured for fail over.

Configuration Type:  
- Admin-Managed  
- Policy-Managed

An Oracle database is uniquely identified by a Global Database Name, typically of the form "name:domain".

Global Database Name: racone

A database is referenced by an Oracle instance on each cluster database node. Specify a prefix to be used to name the cluster database instances.

Database Service name is used by applications to connect to RAC One Node database.

Service Name: salesjdbc

Select the candidate nodes on which you want to create the RAC One Node database. The local node "dscbac01" will always be used, whether or not it is selected.

dscbac01  
dscbac02
bash-3.2$ srvctl relocate database -d racone -n dscbac02 -v -w 3
Configuration updated to two instances

Starting ORACLE instance (normal)
bash-3.2$ svctrl relocate database -d racone -n dscbac02 -v -w 3
Configuration updated to two instances
Instance racone_2 started
Services relocated
Waiting for 3 minutes for instance racone_1 to stop.....

ALTER SYSTEM SET local_listener='(DESCRIPTION=(ADDRESS_LIST=(ADDRESS=(PROTOCOL=TCP)(HOST=10.204.32.270))(ADDRESS=(PROTOCOL=TCP)(HOST=localhost)))(SERVICE=racno2))';
ALT! Tue Aug 10 17:32:45 2010
Shut down instance racone_2
Shutting down instance racone_1, further logins disabled

SwingBench 2.4.0.678 : "Order Entry (PLSQL)"

Overview Chart

Maximum TPM 1501
Average TPM 1379
Maximum TPS 49
Average TPS 23
Maximum 59
Average 27
Instance racone_1 stopped
Configuration updated to one instance -bash-3.2$
• Server Failure
Thu Aug 12 11:48:48 2010
ALTER SYSTEM SET service_names='sales.jdbc' SCOPE=MEMORY SID='racone_1';
Thu Aug 12 11:48:48 2010
ALTER SYSTEM SET local_listener='(DESCRIPTION=(ADDRESS_LIST=(ADDRESS=(PROTOCOL=TCP)
=10,204,32,227)(PORT=1521)))' SCOPE=MEMORY SID='racone_1';

Overview Chart

Maximum TPS
1126
Average TPS
899

Maximum TPS
33
Average TPS
15

Maximum TPS
11
Average TPS
21

Response Time (milliseconds)
- Site Failure
13:25:48.34 Thursday, August 12, 2010
Initiating Fast-Start Failover to database "rostby"...
Performing failover NOW, please wait...
Failover succeeded, new primary is "rostby"
13:26:12.35 Thursday, August 12, 2010
RAC One Node and Data Guard

• What DBA’s Need to Know
  – RAC One Node 11.2.0.2 adds support for Data Guard
  – Standby database needs standby redo logs for 2 primary threads (the primary node and RAC One failover node)
  – Data Guard Broker requires a static entry for both instances in the listener.ora for each node defined for the RAC One database.
  – When using Data Guard Fast-Start Failover, do not set `FastStartFailoverThreshold` to a value less than the time it takes for RAC One-Node to complete primary node failover

5Open World Session 317078 Extreme Consolidation with Oracle RAC One Node
6http://download.oracle.com/docs/cd/E11882_01/rac.112/e16795/onenode.htm#RACAD7894
7http://download.oracle.com/docs/cd/E11882_01/network.112/e10836/concepts.htm#NETAG175
Program

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Primary waits no longer than `NET_TIMEOUT` parameter of `LOG_ARCHIVE_DEST_n` to receive acknowledgement from standby database.
85% Reduction in the Impact on Response Time
Makes Zero Data Loss Protection Practical to Implement on LAN/MAN

New SYNC transport:
- Reduces performance impact by up to 85%
- Negligible impact on low-latency LAN
  - 1ms response time impact in return for zero data loss protection

Application Response Time in Milliseconds

<table>
<thead>
<tr>
<th>Transport</th>
<th>&lt;1ms</th>
<th>5ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>No SYNC</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>11.1 SYNC</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>11.2 SYNC</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

Round-trip Network Latency
What DBAs Need to Know
Data Guard 11g SYNC Redo Transport

• If deploying a Data Guard 11.2 standby database:
  – Always evaluate SYNC when network latency < 5ms RTT
  – May still be practical at higher latencies

• Beneficial for all applications
  – Even if no zero data loss requirement
  – Greatly simplifies recovery
    • No need to figure out what data lost
Data Guard ASYNC Transport – Maximum Performance
Direct Transmission from Log Buffer and New Streaming Protocol

User Transactions
Queries, Updates, DDL

Primary Database

SGA
Redo Buffer

LGWR
Online Redo Logs

NSA

Oracle Net

RFS

MRP

Standby Redo Logs

Active Standby Database

Queries, Reports Testing & Backups
Data Guard 11g ASYNC/ARCH Streaming Protocol

Network Latency Has Negligible Impact on Network Throughput

Maximum Performance

- ASYNC
  - Redo Transport Rate MB/sec
  - Network Latency: 0ms, 25ms, 50ms, 100ms
  - Maximum Performance

Gap Resolution

- ARCH
  - Redo Transport Rate MB/sec
  - Network Latency: 0ms, 25ms, 50ms, 100ms
  - Gap Resolution
What DBAs Need to Know

Data Guard 11g ASYNC Redo Transport

- If network latency has too great an impact on performance
  - Use ASYNC with Data Guard Maximum Performance
  - ARCH is deprecated from documentation
    - No longer a best practice for Maximum Performance
    - No performance benefit, less data protection
- With ASYNC, increase log buffer size if necessary
  - Keeps NSA process reading from memory - MOS Note 951152.1
  - Use X$LOGBUF_READHIST to determine buffer hit rate
    SQL> select BUFSIZE, RDMEMBLKS, RDDISKBLKS, HITRATE, BUFINF from X$LOGBUF_READHIST;
- Set TCP send/receive buffer size equal to MAX(10mb,3xBDP)
  - Bandwidth Delay Product = Bandwidth x Round-trip network latency

8MOS Note 951152.1, View X$LOGBUF_READHIST and In-Memory Log Buffer Hit Rate Histogram
What DBAs Need to Know
Data Guard 11g ARCH Transport

- ARCH is only used by gap resolution and cascaded standbys
- Do NOT increase default for `MAX_CONNECTIONS`
  - Parameter enables multiple ARCH processes to transmit a single
    archive log in parallel - previously helpful when transmitting gaps.
  - Data Guard 11.2 streaming protocol makes this generally obsolete
- One exception to the above rules
  - Certain network environments place restrictions on the amount of
    bandwidth that can be consumed by a single network session
  - Multiple ARCH processes will benefit Maximum Performance
  - `MAX_CONNECTIONS` may also benefit such environments
- Set TCP send/receive buffer size equal to MAX(10mb,3xBDP)
  - Bandwidth Delay Product = Bandwidth x Round-trip network latency
Oracle 11g Transport Compression
Oracle Advanced Compression Option

- Reduce RPO, reduce bandwidth utilization

![Graph showing Bandwidth Consumption with uncompressed and compressed data rates.]

What DBA’s need to know:
- Hidden parameter enables redo transport compression for Maximum Performance in Oracle 11g Release 1, MOS Note 729551.1
- Compression for all protection modes from Oracle Database 11.2 onward

9MOS Note 729551.1, Redo Transport Compression in a Data Guard Environment
F5 Wan Optimization Module (WOM)

- Off-host transport compression
- Zero primary and standby CPU impact
- Also compresses transmission of online RMAN backup from Active Database
  - Helps with initial instantiation of a Data Guard Standby
- Does not require Oracle Database 11g

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Automatic Failover – Data Guard 11g Release 2
Database Down, Application Tier is Still Viable

1. Data Guard automatic failover
   Role specific database services start automatically (11.2)

2. FAN breaks clients out of TCP timeout
   TAF/FCF automatically directs connections to new primary

11Open World Session 316927, Seamless Application Failover with Oracle Data Guard
Integrated, Automatic Client Failover
Role Specific Services in Oracle Database11g Release 2

• Use `SRVCTL` to configure Clusterware managed services
  
  ```
  svrctl add service -d <db_unique_name> -s <service_name> 
  [-l [PRIMARY][,PHYSICAL_STANDBY][,LOGICAL_STANDBY] 
   [,SNAPSHOT_STANDBY]] 
  [-y {AUTOMATIC | MANUAL}][-r <instance1,instance2...>]
  ```

• Data Guard Broker-managed failovers:
  
  – CRS starts/stops services appropriate for database role
  – All FAN compliant clients are automatically notified
  – Eliminates need for custom client notifications and database triggers

• What DBA’s need to know
  
  – Data Guard Broker is required for complete automation
  – Oracle Restart (11.2.0.1) is required for non-RAC configurations

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13 Open World Session 316927, Seamless Application Failover with Oracle Data Guard
14 http://download.oracle.com/docs/cd/E11882_01/server.112/e10702/sofo.htm#CHDBHJIB
15 http://download.oracle.com/docs/cd/E11882_01/server.112/e10595/restart.htm#ADMIN12708
Program

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Database Rolling Upgrade
For Physical Standby Databases – Transient Logical Standby

- Oracle supported script to automate rolling upgrade
- The script automates the:
  - Temporary conversion of a physical standby to use SQL apply
  - Switchover of production to the standby after standby is upgraded
    - Original primary becomes a physical standby database
  - Upgrade and resynchronization of the original primary
  - A second switchover (optional) that returns all databases to their original roles
- What DBA’s needs to know: MOS Note 949322.1

\(^{16}\)MOS Note 949322.1: Oracle11g Data Guard: Database Rolling Upgrade Shell Script
Program

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Data Guard

Standby Database: Failover Target

Real-time Reporting

Read-write Workload

Continuous redo shipping, validation & apply

Production Database

Fast Incremental Backups

Physical Standby Database
Active Data Guard

Standby Database: Offload Production + Failover Target

Read-write Workload

Continuous redo shipping, validation & apply

Production Database

Active Standby Database (physical standby open read-only)

Real-time Reporting

Fast Incremental Backups
Active Data Guard - Improve Performance
For all Workload

- Double read-write throughput
- Increase read-only throughput by 70%
- Eliminate contention between read-write and read-only workload
Active Data Guard – What DBA’s Need to know

- Standby implements same read-consistency model as primary
  - Standby is a true read-only database
  - Ability to redirect writes for read-mostly applications
- Support for Oracle Applications
  - PeopleSoft: PeopleTools v8.51 supports online components such as PSQUERY, TREE Viewer, XMLP Viewer, SES Feeds Reader, and QAS and read-mostly batch programs (AppEngines)
  - E-Business Suite: Patch for R12.1.3 for offload of Oracle Reports to active standby. Of 13 longest running, 9 ran on Active Data Guard. Of 137 Oracle Reports tested, 72 successfully executed.
  - Oracle Business Intelligence Enterprise Edition and Oracle Top Link
- Active Data Guard 11.2 includes automatic block repair

18 Open World Session 316924, Oracle Active Data Guard – What’s Really Under the Hood?
Program

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One-Time Clone Instantiation
Oracle Recovery Manager (RMAN)

- Create clone using RMAN active database duplication
  
  DUPLICATE TARGET DATABASE TO clonedb
  FROM ACTIVE DATABASE

- Clone is created over a network without creating or restoring a backup
  - Requires connection to source database and RMAN recovery catalog

- Flexible
  - Clone can be a subset of the tablespaces in the source database

20http://download.oracle.com/docs/cd/E11882_01/backup.112/e10642/rcmdupdb.htm#CHDJJBCF
Clone Instantiation and Repeatable Refresh

Data Guard Snapshot Standby

- Instantiate or use an existing Data Guard standby database
- Convert to a Snapshot Standby and open read-write for testing
  
  ```
  DGMGRL> convert database <name> to snapshot standby;
  ```
  
  - Standby continues to receive, but does not apply, primary redo
- When testing complete, convert back to a physical standby
  
  ```
  DGMGRL> convert database <name> to physical standby;
  ```
  
  - Implicit flashback to guaranteed restore point and resync
- Clone is a full replica of the source database
Space-efficient Snapshots and Clones
Data Guard and Sun ZFS Storage Appliance

• Create a Data Guard Standby on Sun ZFS Storage Appliance
  – Standby database is dedicated to clone operations
  – Simple to add to any existing Data Guard configuration

• Create snapshots and clones using the storage appliance
  – Create a snapshot of the standby database (open read-only)
  – Create ‘n’ clones from the snapshot (open read-write)

• Fast and space efficient
  – Snapshots/clones are instantaneously created
    • zero space is allocated initially
  – Blocks are allocated as changes are made to the base file system
    • copy-on-write
Data Guard and Sun ZFS Storage Appliance

Architecture

Primary Site

Primary Database
Production

Standby Site

Standby Database
Failover Target
Offload read-only
Offload backups

Standby Database
Snapshots & Clones
Test, QA, Development

Data Guard

23Open World Session 317513 Using Unified Storage to Optimize Business System Performance
MAA Best Practices at Bank of America

9/21/2010

Vinod Haval
Vice President
Global Database
Product Manager

Bank of America
Who Doesn’t know BofA

- Largest bank holding company in the USA and second largest by market capitalization.
- Serves Clients in more than 150 countries
- Relationship with 99% of the US Fortune 500 companies
- Relationship with 83% of the Fortune Global 500 companies
- World’s largest Wealth Manager and major player in the Investment Banking Industry.
- FDIC Member and component of both S&P 500 Index and Dow Jones Industrial Average.
About Me..

• Wonderful 13 years in IT Industry primarily as Oracle DBA
• Working for Bank of America as VP of Product Management
• Responsible for Database Product Management (Oracle)
• Frequent Speaker at various conferences (OOW, IOUG and so on)
• Represents BofA on various Oracle CABs
• Board of Director on IOUG Exadata SIG
• Member of IOUG Support Council
Oracle Footprint

• 1000’s of Oracle Databases

• Oracle Database Enterprise Edition, Enterprise Manager Grid Control, E-Business Suite, Oracle CRM, Hyperion, Fusion Middleware

• Oracle Database 11g Release 2
  – The bank’s core RDBMS version as of July 1
  – 11gR2 upgrade ramping now, 10% of databases upgraded
Oracle MAA Fully Deployed

- Oracle RAC
- ASM
- Data Guard
- GoldenGate
- Streams
- Flashback Database
- Recovery Manager
- Fast Recovery Area
- Grid Control
Seven Application Tiers

- **Tiers 0 and 1**
  - Full MAA configuration
- **Tiers 2 through 6**
  - Single instance MAA configurations (non-RAC)
- **Business continuity implemented for all tiers**
  - Data Guard is implemented on 99% of all production databases
  - GoldenGate is used for multi-master configurations
    - e.g. one critical in-house application with 3-way replication between continents
Oracle Database 11g Release 2 Plans

• RAC One Node
  – Consolidate multiple single-instance databases on a single cluster
  – Utility computing that reduces cost and enhances service level
  – Exadata Database Machine is proving to be the ideal platform
    • Four Database Machines already in-house

• Active Data Guard
  – Increase return on investment in DR systems

• GoldenGate
  – For Tier 0 and 1 applications suited to multi-master deployment

• Oracle Advanced Compression
  – Storage savings
Conclusion

• It would be difficult for the Bank of America to meet its availability and data protection requirements without the Oracle Maximum Availability Architecture.
Oracle Maximum Availability Architecture
Integrated, Fully Active, High ROI

**Production Site**

RAC One Node
- Server HA
- Consolidation

RAC
- Server HA
- Consolidation
- Scalability

Flashback
- Human error correction

ASM
- Volume Management

RMAN & Fast Recovery Area
- On-disk backups

**Active Replica**

Active Data Guard
- Data Protection, DR
- Query Offload

GoldenGate
- Active-active
- Heterogeneous

Oracle Secure Backup
- Backup to tape / cloud

Edition-based Redefinition, Online Redefinition, Data Guard, GoldenGate
- Minimal downtime maintenance, upgrades, migrations
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### Key HA Sessions, Labs, & Demos by Oracle Development

#### Monday, 20 Sep – Moscone South *
- **3:30p** Extreme Consolidation with RAC One Node, Rm 308
- **4:00p** Edition-Based Redefinition, Hotel Nikko, Monterey I / II
- **5:00p** Five Key HA Innovations, Rm 103
- **5:00p** GoldenGate Strategy & Roadmap, Moscone West, Rm 3020

#### Tuesday, 21 Sep – Moscone South *
- **11:00a** App Failover with Data Guard, Rm 300
- **12:30p** Oracle Data Centers & Oracle Secure Backup, Rm 300
- **2:00p** ASM Cluster File System, Rm 308
- **2:00p** Exadata: OLTP, Warehousing, Consolidation, Rm 103
- **3:30p** Deep Dive into OLTP Table Compression, Rm 104
- **3:30p** MAA for E-Business Suite R12.1, Moscone West, Rm 2020
- **5:00p** Instant DR by Deploying on Amazon Cloud, Rm 300

#### Wednesday, 22 Sep – Moscone South *
- **11:30a** RMAN Best Practices, Rm 103
- **11:30a** Database & Exadata Smart Flash Cache, Rm 307
- **11:30a** Configure Oracle Grid Infrastructure, Rm 308
- **1:00p** Top HA Best Practices, Rm 103
- **1:00p** Exadata Backup/Recovery Best Practices, Rm 103
- **4:45p** GoldenGate Architecture, Hotel Nikko, Peninsula

#### Thursday, 23 Sep – Moscone South *
- **10:30a** Active Data Guard Under the Hood, Rm 103
- **1:30p** Minimal Downtime Upgrades, Rm 306
- **3:00p** DR for Database Machine, Rm 103

### Demos Moscone West DEMOGrounds

**Mon & Tue 9:45a - 5:30p; Wed 9:00a - 4:00p**
- Maximum Availability Architecture (MAA)
- Oracle Active Data Guard
- Oracle Secure Backup
- Oracle Recovery Manager & Flashback
- Oracle GoldenGate
- Oracle Real Application Clusters
- Oracle Automatic Storage Management

### Hands-on Labs Marriott Marquis, Salon 10 / 11

**Monday, Sep 20, 12:30 pm - 1:30 pm** Oracle Active Data Guard
**Tuesday, Sep 21, 5:00 pm - 6:00 pm** Oracle Active Data Guard

* All session rooms are at Moscone South unless otherwise noted
* After Oracle OpenWorld, visit [http://www.oracle.com/goto/availability](http://www.oracle.com/goto/availability)
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