Oracle Database 11g: Unbreakable Meets Best Practices

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Agenda

• Oracle Database High Availability (HA)
• HA Enhancements in Oracle Database 11g
• Maximum Availability Architecture (MAA)
Traditional Database HA

- Customer builds solution by integrating disparate components
- Monolithic often idle hardware
- No good solutions for:
  - Human Errors
  - Online Data Changes
  - Software Upgrades
Oracle’s Innovative Approach Breaks Tradeoff Between Availability and Cost

Best Availability AND Lowest Cost

- Better than Mainframe Availability
- PC Economics
- Seamless and Simple to Use
Oracle: Great Fit for a Scale-Out Architecture

- Scale-Out architecture
  - Commodity hardware building blocks
  - Inherently highly scalable & redundant

- Scalability & Availability responsibility moves out of hardware/OS to scale-out savvy software
  - First Web & Application server tiers
    - Application servers
  - Then DB tier
    - Shared disk and shared nothing databases
  - Then storage tier
    - Scale-out savvy storage software
Oracle’s Integrated HA Solution Set

Unplanned Downtime
- System Failures
- Data Failures

Planned Downtime
- System Changes
- Data Changes

Real Application Clusters
- ASM
- Flashback
- RMAN & Oracle Secure Backup
- Data Guard
- Streams

Oracle MAA Best Practices
- Online Reconfiguration
- Rolling Upgrades
- Online Redefinition

Oracle® MAA Best Practices
Oracle HA: Customer Success Stories

• ADT Security Services - Using Data Guard SQL Apply Across a Wide Area Network
• Amadeus - Using Data Guard for Disaster Recovery & Rolling Database Upgrades
• Amazon.com - Automatic Failover using Data Guard Fast-Start Failover
• Banknorth Group, Inc. - Using the Snapshot Capabilities of Flashback Technologies
• CGI - Helps Major North American Oil & Gas Company Save $500K with RMAN
• ChevronTexaco - RMAN DUPLICATE – DBA Time Saver to the Rescue
• Chicago Stock Exchange - Expects 171% ROI in Five Years from Oracle Enterprise Grid Computing
• Colgate-Palmolive - Increased Performance with RMAN
• CSX - Online RMAN Backups Protect over 16TB of Data
• Dell - Dell Consolidates European Support System with Oracle Enterprise Grid on Dell
• Fannie Mae - Supporting 835 transactions per second & Zero Data Loss Protection in Oracle Database 10g
• First American Real Estate - Using Data Guard
• Hartford - Incrementally Updating Transportable Tablespaces using RMAN
• Kemira GrowHow Ltd, UK - Replacing Outsourced Disaster Recovery Services with Oracle Data Guard
• KLM - KLM Royal Dutch Airlines Eliminates Costly Downtime with Grid Solution
• NeuStar - Synchronous Zero Data Loss Protection with Production and Standby Databases Separated by 300 Miles
• Ohio Savings Bank - Oracle Database 10g - Maximum Availability Architecture & Zero Data Loss
• Oracle Global IT - Oracle E-Business Suite with Data Guard over a WAN
• Purdue Pharma L.P. - Surviving Media Disaster with RMAN
• ReserveAmerica - Capitalizing on Oracle 10g Flashback Technologies
• Starwood Hotels - RMAN in Oracle Database 10g Best Practices for Maximum Benefit
• Swedish Post - Extending the DR system using reporting capabilities of Data Guard SQL Apply
• TALX Corporation - Increased Performance with RMAN and Oracle Database 10g
• Trilegiant - Online RMAN Backups Protect over 8TB of Data
• VP Bank - Using Data Guard SQL Apply to deploy content outside the corporate firewall

Oracle Database HA in 11g

• Goals:
  ✓ **Minimize** downtime
  ✓ **Utilize** all resources
  ✓ **Scale** for growth

• Achieve these with an integrated, best-of-breed HA architecture
Best-of-Breed Server Protection

**At Lowest Cost**

- **Unplanned Downtime**
  - System Failures
  - Data Failures

- **Planned Downtime**
  - System Changes
  - Data Changes

**Real Application Clusters (RAC)**
Server Scale-Out with RAC

- RAC pools standard low cost servers
- Great Scalability & Availability
  - No Idle Resources
- Runs commercial applications
  - Oracle Applications, SAP, etc.
- Thousands of production customers

- Designed to Tolerate Server Failures

- Fine-tuned performance, scaling, failover, management
- Enhanced, seamless integration with XA

Oracle 11g Database
Best-of-Breed Storage Protection
At Lowest Cost

Unplanned Downtime
- System Failures
- Data Failures

Planned Downtime
- System Changes
- Data Changes

Automatic Storage Management (ASM)
- Storage Failures
- Human Errors
- Data Corruptions
- Site Failures
Data Mirroring with ASM

- ASM mirrors data across low cost modular storage arrays
  - Automatically remirrors when disk or array fails
- ASM Enhancements
  - Automatically repair corrupt blocks from mirror copy
  - Fast resync of mirror copy upon recovery from transient disk failures – uses only changed blocks
  - Rolling Upgrade for ASM instances

Designed to Tolerate Storage Array Failures
Best-of-Breed Human Error Protection
At Lowest Cost

Unplanned Downtime
- System Failures
  - Data Failures
  - Storage Failures
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Planned Downtime
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Flashback Technologies
Revolution in Recovery

• Flashback Revolutionizes Error Recovery
  • Operates on just changed data
  • Time to correct error equals time to make error
    • Minutes instead of hours

**Correction Time = Error Time + \( f(DB\_SIZE) \)**

• Flashback is Easy
  • Single command instead of complex procedure
  • Very low performance overhead – less than 2%
  • Great for testing also!
Error Investigation with Flashback

- **Flashback Query**
  - Query all data at point in time

  ```
  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

  ```
  select * from Salary VERSIONS BETWEEN '12:00 PM' and '2:00 PM' where ...
  ```

- **Flashback Transaction Query**
  - See all changes made by a transaction

  ```
  select * from FLASHBACK_TRANSACTION_QUERY where xid = '000200030000002D';
  ```
Error Correction with Flashback

- Correct errors at any level
- **Flashback Database** – restore database to time
- **Flashback Table** – restore contents of tables to time

- **Flashback Transaction** – back out transaction and all subsequent conflicting transactions

**Also Great for Testing**
Flashback Data Archive

- Long term retention - years
- Automatically stores all changes to selected tables in Flashback Data Archive
  - Archive cannot be modified
  - Old data purged per retention policy
- View table contents as of any time using Flashback Query
- Uses
  - Change tracking/long term history
  - ILM
  - Auditing
  - Compliance

```
Select * from orders
AS OF 'Midnight 31-Dec-2004'
```
Best-of-Breed Data Corruption Protection
At Lowest Cost

Unplanned Downtime
- System Failures
  - Data Failures
    - Storage Failures
      - Human Errors
      - Data Corruptions
      - Site Failures

Planned Downtime
- System Changes
  - Data Changes

Data Recovery Advisor, RMAN, Oracle Secure Backup
Automated Disk Backups

- Fully automatic disk-based backup and recovery
  - Set and Forget

- Nightly incremental backup rolls forward recovery area backup
  - Changed blocks are tracked in production DB

- Full scan is never needed
  - Dramatically faster (20x)
  - Blocks validated to prevent corruption of backup copy

- Low cost ATA disks can be used for recovery area

Integrated storage tiering within the database!
Data Recovery Advisor

The Motivation

- Oracle provides robust tools for data repair:
  - RMAN – physical media loss or corruptions
  - Flashback – logical errors
  - Data Guard – physical or logical problems
- However, problem diagnosis and choosing the right solution can be error prone and time consuming
  - Errors more likely during emergencies
Data Recovery Advisor

- 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 repository (ADR)
  - Flags problems before user discovers them, via automated health monitoring
- Intelligently determines recovery strategies
  - Consolidates failures for efficient recovery
  - Presents only feasible recovery options
  - Indicates any data loss for each option
- Can automatically perform selected recovery steps

Reduces downtime by eliminating confusion
RMAN Enhancements

- **Better performance**
  - Intra-file parallel backup and restore of single data files >= 1 GB (multi-section backup)
  - Faster backup compression (ZLIB, ~40% faster)

- **Better security**
  - Virtual Private Catalog - allows the catalog administrator to grant visibility of a subset of registered databases in the catalog to specific RMAN users

- **Lower space consumption**
  - Duplicate database or create standby database over the network, avoiding intermediate staging areas

- **Integration with Windows Volume Shadow Copy Services (VSS) API**
  - Allows database to participate in snapshots coordinated by VSS-compliant backup management tools and storage products
  - Database is automatically recovered upon snapshot restore via RMAN
Oracle Secure Backup
Integrated Tape Backup Management

- Protects entire environment
  - Oracle9i forward
  - Application files
- Free Express edition bundled with the Oracle Database
- Low cost licensed edition
- Independent release schedule
  - Available: 10.1
  - Upcoming: 10.2
  - Beta planned for mid-summer

**Dare to Compare - Lowest Cost**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Leading Vendor</th>
<th>Oracle Secure Backup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tape Drive</td>
<td>$3,000</td>
<td>$3,000</td>
</tr>
<tr>
<td>SAN Backup per drive</td>
<td>$2,000</td>
<td>Free</td>
</tr>
<tr>
<td>UNIX Client Host</td>
<td>$600</td>
<td>Free</td>
</tr>
<tr>
<td>UNIX Media Server</td>
<td>$13,000</td>
<td>Free</td>
</tr>
<tr>
<td>Linux Media Server</td>
<td>$5,500</td>
<td>Free</td>
</tr>
<tr>
<td>Oracle Agent</td>
<td>$7,500</td>
<td>Free</td>
</tr>
<tr>
<td>NAS Filer-NDMP</td>
<td>$6,500</td>
<td>Free</td>
</tr>
<tr>
<td>Advanced Features: Vaulting, Encryption etc.</td>
<td>$$$$$$$</td>
<td>Free</td>
</tr>
</tbody>
</table>

- Oracle Secure Backup price is just $3000 per tape drive
  - Backup to virtual tape device (disk) is **Free**
  - **Free** Express Edition protects one database server to one attached tape drive
Oracle Secure Backup 10.2 Enhancements

- **Increased Security for data and backup domain**
  - Backup encryption for file systems and Oracle9i forward
- **Advanced media management**
  - Vaulting
  - Tape duplication
  - ACSLS support
- **Improved Manageability**
  - Automated backup of OSB catalog
  - Policy-based migration from VTL to tape
- **Performance improvements**
  - Strengthened RMAN and OSB Integration

Advanced Functionality at NO Extra Cost!
Best-of-Breed Disaster Protection
At Lowest Cost

Unplanned Downtime
- System Failures
  - Storage Failures
  - Human Errors
  - Data Corruptions

Data Failures
- Data Corruptions

System Changes
- Site Failures

Planned Downtime
- System Changes
  - Data Changes

Data Guard
Disaster Recovery (DR) Realities

• Customers don’t benefit from DR investment
  1. Expensive – choose no DR, or under-configure DR
  2. Idle systems – no productive use
  3. Rarely used – so no confidence failover will work
  4. Loses data – leads to downstream problems
  5. Slow – prefer to fix problems instead of using DR
  6. Limited protection – site failures only

• Requirements for useful / ubiquitous DR
  1. Cost-effective – hardware and software
  2. Efficient systems utilization
  3. Easy DR testing
  4. Fast automatic failover over long distances, with zero data loss
  5. Covers all common failures – not just site failures
  6. Application transparency
  7. Bonus – reduce planned downtime

• Need all of the above!
Data Guard: Best Failure Protection at Lowest Cost

- Synchronous or asynchronous redo shipping
- Corruptions don’t propagate
- Low cost servers and storage
- Data Guard is free with EE
- Thousands of production customers
Zero Data Loss over Long Distance

Data Guard DR Sweet Spot
- Far enough to avoid regional disaster
- Close enough for zero data loss

Data Guard: Synchronous Redo Shipping
- Data Guard redo transport uses order of magnitude less network messaging than disk-based remote mirroring
  - Enables zero data loss at hundreds of miles
Data Guard Enhancements

- Better standby resource utilization
- Enhanced HA / DR functionality
- Improved performance

Data Guard becomes an integral part of IT operations
Physical Standby with Real-Time Query

- Read-only queries on physical standby concurrent with redo apply
  - Supports RAC on primary / standby
  - Queries see transactionally consistent results
  - Handles all data types, but not as flexible as logical standby
Snapshot Standby – Leverage Standby Database for Testing

- Convert Physical Standby to Snapshot Standby and open for writes by testing applications
  - `ALTER DATABASE CONVERT TO SNAPSHOT STANDBY;`
- Discard testing writes and catch-up to primary by applying logs
  - `ALTER DATABASE CONVERT TO PHYSICAL STANDBY;`
- Preserves zero data loss
  - But no real time query or fast failover
- No idle resources
- Similar to storage snapshots, but:
  - Provides DR at the same time
  - Uses single copy of storage
Enhanced Fast-Start Failover

- Supports Maximum Performance (ASYNC) Mode
  - Automatic failover for long distance standby
  - Data loss exposure limited using Broker property `FastStartFailoverLagLimit` (default = 30 secs)

- Immediate fast-start failover for user-configurable health conditions
  - `ENABLE FAST_START FAILOVER [CONDITION <value>];`
    - Condition examples:
      - Datafile Offline
      - Corrupted Controlfile
      - Corrupted Dictionary
      - Inaccessible Logfile
      - Stuck Archiver
      - Any explicit ORA-xyz error

- Apps can request fast-start failover using `DBMS_DG.INITIATE_FS_FAILOVER`
Performance Improvements

• Faster Failover
  • Failover in seconds with Fast-Start Failover

• Faster Redo Transport
  • Optimized async transport for Maximum Performance Mode
  • Redo Transport Compression for gap fetching: new `compression` attribute for `log_archive_dest_n`

• Faster Redo Apply
  • Parallel media recovery optimization

• Faster SQL Apply
  • Internal optimizations

• Fast incremental backup on physical standby database
  • Support for block change tracking
Streams: Another Popular HA Solution

- All sites active and updatable
- Automatic conflict detection & optional resolution
- Supports data transformations
- Flexible configurations – n-way, hub & spoke, …
- Database platform / release / schema structure can differ
- Provides HA for custom apps where update conflicts can be avoided or managed
Streams Enhancements

- Streams Synchronous Capture
  - Available in all Editions of Oracle Database 11g
  - Efficient internal mechanism to immediately capture change
- Source and Target data compare & converge
- Streams Performance Advisor
- Split/Merge of Streams for Hub & Spoke replication
  - Maintains high performance for all replicas
  - Automated, fast “catch-up” for unavailable replica
- Cross-database LCR tracking
  - Trace Streams messages from start to finish in single view
- Performance optimizations
Best Online System Changes

At Lowest Cost

Unplanned Downtime

System Failures

Data Failures

Planned Downtime

System Changes

Data Changes

Online Reconfiguration

Online Upgrades
Online Reconfiguration –
Scaling on Demand

- CPU
  - Add/remove CPUs on SMP online

- Cluster Nodes
  - Add/remove RAC nodes online
  - No data movement needed

- Memory
  - Grow and shrink shared memory and buffer cache online
  - Auto tuning of memory online

- Disk
  - Add/remove ASM disks online
  - Automatically rebalance
Rolling Patch Update using RAC

1. Initial RAC Configuration
   - Clients: A, B

2. Clients on A, Patch B
   - Clients: A, B

3. Clients on B, Patch A
   - Clients: A, B

4. Upgrade Complete
   - Clients: A, B

Oracle Patch Upgrades, including Critical Patch Updates (CPUs)
Operating System Upgrades
Hardware Upgrades
SQL Apply – Rolling Database Upgrades

1. Initial SQL Apply Config

2. Upgrade node B to X+1

3. Run in mixed mode to test

4. Switchover to B, upgrade A

Patch Set Upgrades

Major Release Upgrades

Cluster Software & Hardware Upgrades
Online Patching of One-off Patches

• Ability to patch running Oracle executable
  • No downtime
  • No need to do rolling upgrades using RAC / Data Guard
  • Many one-off patches can be patched online
  • Great for diagnostic patches
    • E.g. debugging changes to better understand a problem before applying fix
• Supports enabling, disabling, de-installing patches with no downtime
• Integrated with Opatch
  • E.g. determine if a patch can be applied online:
    • `opatch query -is_online`
• Initially available on Linux (32 & 64-bit) and Solaris (64-bit)
• Long term goal is online patching of Critical Patch Updates (CPUs)
Rolling Database Upgrades Using Transient Logical Standby

- Start rolling database upgrades with physical standbys
- Temporarily convert physical standby to logical to perform the upgrade
  - Data type restrictions limited to short upgrade window
- No need for separate logical standby for upgrade
- Also possible in 10.2 (more manual steps)

Leverage your physical standbys!
Best Online Data Changes
At Lowest Cost

Unplanned Downtime
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Online Redefinition

ORACLE
Online Redefinition

- All indexing operations can be done online
  - Create new index, move index, defragment index
- Tables can be Reorganized & Redefined online (**DBMS_REDEFINITION**)
  - Table contents are copied to a new table
    - Defragments and allows changing location, table type, partitioning
  - Contents can be transformed as they are copied
    - Can change columns, types, sizes - specified using SQL “Select”
- Updates and Queries can continue uninterrupted
Online Operations & Redefinition Improvements

- Fast ‘add column’ with default value
- Invisible indexes speed application migration and testing
- No recompilation of dependent objects when Online Redefinition does not logically affect objects
- Support Online Redefinition for tables with Materialized Views
- Enhanced Online DDL execution
  - DDL operations now wait if underlying resource is busy (configured through `DDL_LOCK_TIMEOUT` parameter)
  - Some DDL operations (add/modify constraint, add column, Index create/rebuild) only require shared lock
Oracle Maximum Availability Architecture
Maximum Availability Architecture (MAA)

*Integrated set of HA best practices*

- Technology alone is not enough
- MAA is also a blueprint for achieving HA
  - Brings together all that has been discussed
  - Operational best practices
  - Prevent, tolerate, and recover
- Tested, validated, and documented
  - Database, Storage, Cluster, Network
  - 35 person year effort

Maximum Availability = Unbreakable Architecture + Best Practices
Oracle Maximum Availability Architecture

Integrated suite of best-of-breed HA technologies
- Each is scale-out, fully active, data centric

Best Availability AND
Lowest Cost

Real Application Clusters & Clusterware
Fault Tolerant
Server Scale-Out

Online Upgrade
Upgrade Hardware and Software Online

Data Guard
Fully Active Failover Replica

Automatic Storage Management
Fault Tolerant Storage Scale-Out

Database

Flashback
Correct Errors by Moving Back in Time

Online Redefinition
Redefine Tables Online

Recovery Manager & Oracle Secure Backup
Low Cost High Performance Data Protection & Archival

Database

Storage
Oracle MAA Changes

Traditional HA/DR Paradigm

• Many businesses implement localized component level HA solutions

• DR is an afterthought, often implemented using mirroring technologies which do not offer adequate protection
  • Correlated failures, inter-component failures, software failures, upgrades, etc. remain significant vulnerabilities
  • Requires integration of disparate technologies

• **MAA: integration of HA and DR**
  • Data Guard standby database becomes an essential HA element of any systems architecture
    • Integrated with RAC for server HA
    • Provides highly effective fault isolation
    • Capable of failovers in seconds, with zero data loss
    • Standby database provides a productive computing resource
Resources

• **Maximum Availability Architecture white papers:**
  http://www.oracle.com/technology/deploy/availability/htdocs/maa.htm

• **Oracle HA Portal on OTN:**
  http://www.oracle.com/technology/deploy/availability/

• **Oracle HA Customer Success Stories on OTN:**