The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle’s products remain at the sole discretion of Oracle.
Agenda

• Oracle’s Data Repair Solution
• Novartis Case Study
• Pacific Gas & Electric Case Study
• Summary
• Q&A
Oracle’s Integrated HA Solutions

Unplanned Downtime
- System Failures
- Data Failures
- Data Repair

Planned Downtime
- System Changes
- Data Changes

Real Application Clusters
- ASM
- H.A.R.D
- Data Guard
- Streams

Flashback Technologies
- RMAN & Oracle Secure Backup

Online Reconfiguration
- Rolling Upgrades

Online Redefinition

Oracle MAA Best Practices
Flashback Time Navigation

- **Flashback Query**
  - Query all data at point in time
  
  ```sql
  Select * from Emp AS OF '2:00 P.M.' where ...
  ```

- **Flashback Versions Query**
  - See all versions of a row between two times
  - See transactions that changed the row
  
  ```sql
  Select * from Emp VERSIONS BETWEEN '2:00 PM' and '3:00 PM' where ...
  ```

- **Flashback Transaction Query**
  - See all changes made by a transaction
  
  ```sql
  Select * from FLASHBACK_TRANSACTION_QUERY where xid = '000200030000002D';
  ```
Flashback Error Correction

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database</td>
<td>- Recovery at all levels&lt;br&gt;  - Database Level&lt;br&gt;    - Flashback Database restores the whole database to a point-in-time&lt;br&gt;     - Uses Flashback Logs</td>
</tr>
<tr>
<td>Table</td>
<td>- Table Level&lt;br&gt;     - Flashback Table restores rows in a set of tables to a point-in-time&lt;br&gt;     - Uses UNDO in database&lt;br&gt;     - Flashback Drop restores a dropped table or an index&lt;br&gt;     - Recycle bin for DROPs</td>
</tr>
<tr>
<td>Row</td>
<td>- Row Level&lt;br&gt;     - Flashback Query restores rows to time</td>
</tr>
</tbody>
</table>

Database<br>Customer<br>Order
Recovery Manager (RMAN)
Oracle’s Backup & Recovery Utility

- Integral feature of the database that sends data to disk and tape
- Smart
  - Sophisticated backup and recovery strategies
- Fast
  - Optimized backup to disk for fastest recovery
  - Block level incremental backup
- Reliable
  - Block contents are validated during backup
- Easy
  - Simple management with Enterprise Manager
- Supports over 20 Media Managers
  - Veritas, Legato, Tivoli, HP, Oracle Secure Backup, etc.
Oracle Secure Backup
Tape Backup Management

- Protects your entire environment
- Oracle integrated advantage
- Fastest database tape backup
- Maximum backup security
- Low cost!
Novartis

Backup & Recovery Case Study

Jonathan Intner

Novartis
Agenda

- Who am I?
- Why am I here?
- RMAN Project:
  - Basic Project Goals
  - Backup architecture prior to RMAN
  - Required expertise for a successful RMAN Project
  - RMAN architecture
  - Issues encountered implementing the Symantec NetBackup (NBU) API
Basic Project Goals

- Improve availability.
- Improve recoverability.
- Ensure the integrity of Oracle backups.
- Tighter integration of the Oracle backups with the existing backup infrastructure.

Cost savings

- Allow the DBAs to have
  - The ability to backup a database as an entity.
  - More control of the verification of the success of the backups
Environment

- Primary DBA for hundreds of databases across tens of servers, serving almost every application imaginable.
- The disk farm supporting these applications are in the teens of terabytes.
- Server OSes include:
  - Solaris
  - HP-UX
  - AIX
  - Wintel excluded from consideration (for now)
- Versions of Oracle:
  - ~75% 9iR2 (9.2.0.4.0, 9.2.0.5.0, 9.2.0.6.0, 9.2.0.7.0, 9.2.0.8.0)
  - ~12% 10gR1 or R2
  - ~12.5% 8.1.7.4
Backup architecture prior to RMAN

- Server-based Weekly Cold Backups
- Archive logs (typically) kept for 1 month
- A critical question for our customers became:
  - Are planned outages still outages?
Required Expertise for a Successful RMAN Project

- Project Manager
  - Document, document, document
  - Finance
    - Capital
    - Expense
- DBA
- Media Manager
- System Administrator
- Storage Administrator
Architecture Alternatives

Alternatives:

- Have RMAN copy the files from database-to-disk and then have NetBackup (NBU) copy the files from disk-to-tape.
  - Rejected ‘cause managing the backups in NBU would be too complicated.
- Use the NBU API to have RMAN copy files from database-to-tape.
- Now considering using Oracle Secure Backup and a Virtual Tape Library (VTL) which would use Oracle Secure Backup as the Media Manager.
Have RMAN copy the files from database-to-disk and then have NetBackup copy the files from disk-to-tape.
Use the NetBackup API to have RMAN copy files from database-to-tape.

RMAN started on client DB.
NBU API copies database onto ATA disk pool connected to an existing media server.

NBU Vaulting process copies data from ATA disk to tape.
Hardware currently in use

- Large disk pool of SAN-attached SATA disk.
- Dedicated NBU Media Server for RMAN.
- Considering a backup network to minimize the impact on the main network.
- Real Application Cluster supporting the RMAN Catalog
Conclusion

- Challenges
- Critical Success Factors:
  - Professional Project Management
  - Committed and dedicated project participants
  - Sufficient resources to successfully complete the project
Project Management for DBAs

- Document, document, document
- Finance
  - Capital
  - Expense
Pacific Gas and Electric
Backup & Recovery Case Study

Eugene Psoter
Pacific Gas and Electric Company
PG&E Agenda

• Introduction
• Background on the Company and Application
• Drivers for Change and the Solution
• Designing for Failures
• High Level Principles and Trade-offs
• Failure Analysis and Recovery by Design
PG&E Company Info

- Service Area- 70,000 sq. mi. in northern and central California
- Service Area Population – 15 million people (about 5% of US pop)
- Electric Distribution customer accounts – 5.0 million
- Natural Gas Distribution Customer Accounts – 4.2 million
- Revenue $11.7 Billion
- Assets: $34 Billion
- System: 146,744 circuit miles of electric transmission and distribution lines, 46,832 miles of natural gas transmission and distribution pipelines, 6420 MW of generation
- Electricity delivered in 2005: 81,626 GWh
- Natural Gas Throughput in 2005: 844,068 Million Cubic Feet MMcf
- Employees 19,800
- Shareholders: approx 200,000
The Application
Customer Care & Billing

Application
- CC&B 1.5 from SPL Worldgroup
- 2300 concurrent online users, 300,000+ bills per day, Internet presence
- Supports operational systems for field force dispatch, outage management, etc.
- Nearly 7x24x7 uptime requirement (20 minute read-only nightly window in place, scheduled weekend outages usually acceptable, weather dependent)

Technology
- Database: 14 TB of data using DB2 on a zSeries mainframe
- App servers: 3 Tuxedo (online), 4 batch
- Web Servers: 9 servers with 24 instances of WebLogic
- Daily – 1 Billion select/fetch, 100 Million insert/update/delete

Backup and Recovery
- SAN SNAPShot, backed up to tape daily, PPAC to DR center
- DB2 online image copies daily to tape -- all data and catalog.
Business Drivers for Change

- Increasing loads due to data growth + internet growth
- Long (7yr) data retention requirements from various regulatory and legislative rules
- SmartMeter initiative will significantly increase database size (45+ TB)
- Costs associated with supporting growth on the mainframe platform (Unit of Measure is Millions$ for mainframe, 100Ks$ Mid-Tier)

Key Project Drivers

- Support the business requirements
- Simplify operations
- Reduce costs
  - Note potential conflict with above 2 items
Solution

- Move to Oracle database running on Mid-Tier Unix servers

- Utilize Oracle RAC to provide incrementally scalable growth and high availability to the system

- Utilize Oracle technologies to the max (ASM, RMAN, Flashback, etc) to simplify the software stack

- Move away from a reliance on tapes as a first tier recovery mechanism
Database Server Design
Project Timelines

Jan 05 Mar 05 Jun 05 Sep 05 Dec 05 Jan 06 Mar 06 Jun 06 Sept 06 Dec 06 Jan 07 Mar 07 Apr 07

- Project Inception
  - Business Case
  - Requirements
  - Initial Design
  - Cost Estimate

- Small Scale RAC Cluster POC
  - Acquire
  - Install
  - Large Scale POC

- Full Scale Hardware
  - Specify Requirements
  - Acquire & Install DR/Test System
  - Configure DR/Test System
  - Acquire & Install PROD System

- Data Conv

- Decision to move forward

- Production

- Full Scale Data Conversion
  - 14TB

- Testing
  - Backup & Recovery/Data Guard
    - Sept – Nov ‘06
  - Application & Interface
    - Oct – Dec ‘06
  - ORT - Jan ’07 (Cycle 1), Feb ’07 (Cycle 2), Mar ’07 (Cycle 3)
“Anything That Can Possibly Go Wrong, Does “

epigraph of John Sack's
The Butcher: The Ascent of Yerupaja (1952)

BUT ->

“Failure is not an option“

Gene Kranz
Flight Director NASA
During the Apollo XIII Crisis
Designing for Failures

- What can fail (and how often)

- Business tolerance for outages
  - (PG&E) Planned weekend outages can be accommodated, weather permitting

- Business continuity requirements for disasters
  - (PG&E) 48 Hours to recover with < 24 hours data loss

- Strategies to accommodate failures while meeting requirements
Design Tradeoffs

• Meet the business requirements
  – Does the current requirement seem reasonable for a new system?
  – Can you do better without increasing costs / risks?
  – Do the new requirements change the design that you are currently using?

The fundamental question is:
How much do you overbuild?
Design Tradeoffs

- **Simplify Operations**
  - Operating a complex system introduces risks that something will go wrong
  - The operational costs for the system will, over time, exceed the construction costs
  - Your design can help compensate for this by:
    - Reduce the number of software & hardware technologies in the design
    - Automate processes as much as you can
    - Use redundancy for transparent failure recoveries

- **Reduce costs**
  - Reduce the number of software and hardware technologies
  - Use lower end hardware where possible
  - Simplify operations
Things to Consider…

- RAC vs single instance vs High Availability OS Cluster
- Storage arrays – Enterprise vs Mid-Tier
- RMAN vs other software
- Disk backups vs tape
- Flashback options vs restores
- SAN ‘SnapShot’ capabilities vs storage costs
- Spinning DR vs Restore from backup
- Network bandwidth between centers
Backup And Recovery Principles

• Failures will happen, so plan accordingly

• Prefer hardware redundancy where it is cost effective

• If a device is expected to fail occasionally (as opposed to rarely), assume you will have a concurrent double failure on that device (e.g. lose 2 disks on a raid array)

• Use the “defense in depth” approach where multiple layers of protection are built in to the design.

• Prefer to use database recovery tools (simplify software stack) over other options
Failure Analysis -
what can fail and how to recover

- Single and Multiple hardware failures
- Physical database corruption
- Logical database corruption
- Disaster
Recovery by Design

Transparent recovery for routine failures

– Use RAID to protect:
  • Single Disk Drive, Multiple Disk Drives, Disk Array Drawer

– Use redundant hardware to protect:
  • Disk Array Controller, SAN Switch, SAN Network, HBA, RAC Node

Intervention recovery for rare failures:

– Use Recovery and DR to protect:
  • Multiple RAC node failures, Storage Subsystem failure, Physical and Logical database corruption, Data Center failure
Recovery Settings

• Daily backup to disk (Flash Recovery Area) on primary and standby database
  – Level 0 incremental first day, level 1 incremental on days thereafter
  – Incrementally Updated Backups (roll forward every 3 days)
  – Block Change Tracking enabled on primary database

• One month backup cycle (full level 0 each month)
• Keep previous month copy (2 full on-disk copies)
Recovery Settings

- Archive logs
  - On primary database -- multiplexed 3 ways (FRA, 1 local, 1 physical standby).
  - On physical standby database -- multiplexed 2 way (FRA, 1 local).
- Archive log switches tuned to 2-15 minute intervals
- Data Guard LGWR ASYNC mode
- Weekly full backup from physical standby database FRA to tape
Recovery Options

• Physical Database Corruption
  – RMAN datafile or tablespace restore and recovery
  – RMAN block media recovery

• Logical Database Corruption
  – Flashback Table
  – Flashback Query
  – Flashback Database
  – RMAN TSPITR or DBPITR
Recovery Options

• Disaster Recovery
  – If production storage affected, switch to Flash Recovery Area image copies
  – Data Guard Failover
  – Switch Back
PG&E Summary

- Failure will happen, so spend the effort to design for it
- Take a holistic view of the database system and realize your tradeoffs and leverage points
- Make the system as simple as possible, but no simpler

- Reference Documents
  - Backup and Recovery Basics – 10g Release 2
  - Backup and Recovery Advanced User's Guide – 10g Release 2
  - Using Recovery Manager with Oracle Data Guard in Oracle Database 10g
Summary

• Oracle’s Data Repair Solution
  • Flashback Technologies
  • Recovery Manager
  • Oracle Secure Backup

• Effective Backup and Recovery Implementation
  • Identify pain points
  • Design for the long-term
  • Identify resources early
  • Phased approach
  • Test, test, test
Questions and Answers