



Starwood Hotels: RMAN in Oracle Database 10g Best Practices for Maximum Benefit



"Our Oracle Database 10g RMAN incremental backups are about 10x faster than the same incremental backups using Oracle RMAN 9i reducing our backup window from 19 hours down to 2 hours!"

---Arup Nanda

Manager of Database Systems, Starwood Hotels

Corporate Profile: Starwood Hotels

- One of the world's largest hotel and leisure companies.
- Operates under several popular brand names; Westin Hotels & Resorts, Sheraton and St. Regis to just name a few
- Portfolio includes affiliations to over 700 properties with approximately 229,000 rooms in 82 countries
- Employees over 110,000 people
- <http://www.starwoodhotels.com/>

Starwood Hotel: Data Protection Challenges and Objectives

- Reduce 19+ hour backup time for an 8TB database, while maintaining 24x7 availability
- Reduce IT expenditures on backup infrastructure through hardware or software cost savings
- Meet Recovery Time Objective (RTO) of 2 hours and increase overall availability of the database.

Starwood Hotels Oracle Environment

- Oracle Database 9.2.0.5 upgraded to Oracle 10.1.0.1
- 8TB data warehouse database
- Enterprise class machine with 24 CPUs and 48GB of RAM.
- 8 drive tape library system

OVERVIEW

Starwood Hotels utilizes Oracle OLTP and data warehouse databases as the backbone of their online reservations, bookings, guest communications and marketing campaigns. To protect these mission-critical Oracle Databases, Starwood has relied on Recovery Manager (RMAN) for over 5 years beginning with Oracle 8i.

As with many enterprise organizations, Starwood Hotels was experiencing tremendous data growth, while business requirements were demanding shorter recovery time objectives. Their existing backup and recovery infrastructure would soon experience growing pains especially for their 8TB data-warehousing database without additional hardware, software or a redesign.

Starwood Hotels re-architected their backup and recovery infrastructure to meet their recovery time objectives by utilizing RMAN in Oracle Database 10g and disk-based backups.

INTRODUCTION

Starwood Hotels & Resorts Worldwide, Inc. is one of the leading hotel and leisure companies in the world with more than 700 properties in more than 80 countries and 110,000 employees at its owned and managed properties. With internationally renowned brands, Starwood is a fully integrated owner, operator and franchisor of hotels and resorts including: St. Regis, The Luxury Collection, Sheraton, Westin, Four Points by Sheraton, W brands, as well as Starwood Vacation Ownership, Inc., one of the premier developers and operators of high quality vacation interval ownership resorts.

ORIGINAL BACKUP ARCHITECTURE

The enterprise IT staff at Starwood Hotels had successfully implemented a centralized backup management strategy with RMAN using Oracle9i and a 3rd party media management software for tape backups. However, the backup and recovery infrastructure did not easily and affordably scale to meet their projected data growth rates and recovery time objectives.

Their 8TB data-warehousing database represented the biggest backup and recovery challenge since it was expected to double in size to 16TB within the next 12 to 18 months. The following describes Starwood Hotel's backup schedule and challenges for this growing database.

Recovery Time Objectives (RTO)

2 hours, in case of standard failures, and a 24 hour RTO for a complete site failure (disaster).

Oracle9i Database Backup Schedule

RMAN Configuration

- FILESPERSET=10
- Parallelism of 8 achieved by using different disk format strings for each channel. Each channel writes into a different filesystem, which enables parallel data movement to the tape by the tape management software. Using a single named channel with parallelism of 8 would not have achieved that.

Full (level 0) backup weekly (every Sunday)

Incremental (level 1) daily

Approximate Backup Time = 19 hours for full or incrementals*

Primary Challenges Encountered:

1. 19 hour backup time with Oracle9i RMAN exceeded backup windows
2. Higher CPU was utilized with incremental backups than with full backups*
3. Database size was projected to double (from 8TB to potentially 16 TB)
 - a. Daily backups would no longer be feasible, assuming a 38 hour backup time (19 hours x 2)
4. Recovery from tape did not meet the 2 hour recovery time objective

* With Oracle9i, incremental backups generally saved on media consumption but not much on time since a full database scan is required to discover change blocks to be included in the backup.

WEIGHING THE OPTIONS

To best address their backup and recovery challenges, the experienced DBA staff at Starwood Hotels weighed their options to meet their technical needs and budget.

Option	Advantage	Why option was eliminated
Reduce Backup Frequency (Every other day instead of daily)	Backup times would not overlap	Could not meet RTO of 2 hours
Optimized backups (only backup read-only tablespaces once)	Reduces amount of data to backup	Few or no read-only tablespaces in this specific database; would have little or no impact
Add more tape drives	Reduce backup completion time	Tape libraries were already at maximum drive capacity

To resolve their current and projected data protection challenges, they had to adopt a new approach entirely. Another option was put on the table – What about disk based backup? Disk storage technology had become extremely reliable and price competitive with tape.

Starwood Hotels decided to implement a disk-based backup and recovery architecture for their Oracle9i as an interim step to an upgrade to Oracle Database 10g.

RMAN IN ORACLE DATABASE 10g KEY ENHANCEMENTS

Arup Nanda, Starwood Hotels' Manager of Database Systems, participated in the Oracle Database 10g beta and well understood the benefits Starwood Hotels would achieve by upgrading to Oracle Database 10g. He had identified three key RMAN features that would help them successfully meet their backup and recovery goals.

1. Block Change Tracking – Provides the ability for fast incremental backups

- a. The new block change tracking feature is a bitmap file which tracks the physical block location of changes to the database
 - b. RMAN uses the change tracking file to identify changed blocks since the last backup, therefore eliminating the need for full database scans during an incremental backup
 - c. CPU utilization is reduced since the full database scans are no longer necessary
2. Flash Recovery Area – Increased manageability of online backups and recovery related files
 - a. Unified storage location for all recovery related files
 - b. By setting the RMAN Retention Policy, RMAN would be able to automatically manage the space requirements of the Flash Recovery Area by deleting obsolete RMAN backups and archive logs no longer needed for the specified recovery time
 3. Incrementally Updated Backups – Eliminated the need for full backups
 - a. Increased recovery time since a more recent full backup can be kept online
 - b. Incremental backups are merged into the online full image backup thereby creating a new full backup current to the point of the merged incremental
 - c. After the initial full (level 0) backup, only incrementals are needed

RE-ARCHITECTURE IS A SUCCESS!

Starwood Hotels had decided to re-architect their backup and recovery infrastructure to disk-based backups. Their initial disk-based backup strategy was first implemented with Oracle9i to meet their recovery objectives and better-position them to take advantage of disk backup and storage enhancements inclusive of Oracle Database 10g.

When Starwood Hotels upgraded to Oracle Database 10g, they adopted the Oracle recommended backup strategy, which was well suited for their environment. With a 2-hour RTO, they chose to increase the incremental backup schedule to two per day and maintain two full backups. An overview of their plan follows:

Recovery Plan

From disk if recovery point is within 24 hours

From tape if recovery point exceeds 24 hours

Disk Backup Schedule

Daily Incremental Backups to the Flash Recovery Area

Two incrementals daily; scheduled once every 12 hours

Daily merge of the previous day's incremental backup into a corresponding online full backup

Two full backups are maintained and updated daily

Backups available within the Flash Recovery Area

Maintain redundancy of 2 full backups

- Two full image backups current to point-in-time of the previous day's corresponding incremental backup (Incrementally Updated Backups)
- Each daily incremental backup is merged into an assigned full backup making the two full online backups current to a point 12 hours apart (incrementals scheduled every 12 hours)

Two incremental backups (Current day's two incrementals)

Archive logs

Archive to Tape

Flash Recovery Area archived to tape

Archive logs backed up to tape immediately

The table below demonstrates how Starwood addressed their backup and recovery challenges with a disk based infrastructure and upgrade to Oracle Database 10g. The advantages achieved relating to specific features of the Oracle Database 10g have been notated.

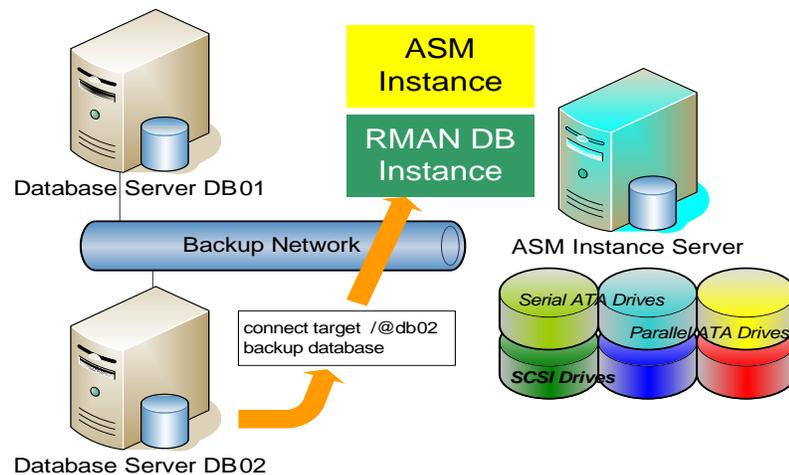
The results	How the challenges were met	
Daily incremental backups now complete in 2 hours (10x faster)	Fast incremental backup were achieved by enabling block change tracking	Oracle Database 10g
Eliminated weekly full backup, replacing it with an incremental backup	Incrementally Updated Backups eliminate the need for full backups after the initial full	Oracle Database 10g
Increased ROI of Oracle investment	Low-cost disks could be more effectively implemented with the Flash Recovery Area and ASM	Oracle Database 10g
Meet 2 hour RTO	Disk-based backup presented several recovery and availability advantages over tape: <ul style="list-style-type: none"> ▪ Restore and recovery are faster from disk than tape ▪ RMAN block media recovery is more efficient from the random access of disk as opposed to the sequential read format of tape which could be slow 	

STORAGE ENHANCEMENTS IN ORACLE DATABASE 10g

With Automatic Storage Management (ASM) in Oracle Database 10g, Starwood Hotels was able to utilize cheaper SATA disks thereby eliminating the expensive SAN frame and volume manager they had been utilizing with their disk-backups with RMAN in Oracle9i. The inexpensive disks are grouped together with ASM disk group achieving high performance by striping across many disks and reliability with ASM mirroring. Using ASM with SATA disks, Starwood achieved the scale of performance and reliability with a low cost implementation, normally achieved only with expensive disks.

Oracle Documentation

- [Oracle Database 10g Backup and Recovery Basics](#)
- [Tuning Oracle Recovery Manager](#)
- [RMAN Performance Testing at Sun Customer Performance Center: 1 TB/hr Backup & Restore](#)
- [HP & RMAN Performance Benchmarking: 3 TB/hr Backup, 1 TB/hr Restore](#)



Starwood has defined their Flash Recovery Area as an ASM disk group.

CONCLUSION

Starwood Hotels met their backup and recovery challenges by re-architecting their backup infrastructure utilizing a disk-based backup strategy and capitalizing on the technological enhancements in Oracle Database 10g. The benefits included:

- Backup times were reduced from 19 hours to 2 hours
 - Fast incremental backups achieved by enabling block change tracking
 - Full backups are no longer needed, thanks to incrementally Updated Backups
- Improved Recovery Times
 - Incrementally Updated Backups are current with the latest incremental, eliminating the need to apply incrementals on recovery
 - Block Media Recovery performs much faster from disk than from tape
- Better resource utilization – lower CPU usage
 - Full database scans are no longer required for incremental backups with Block Change Tracking enabled
- Saved costs utilizing inexpensive SATA disks with Oracle ASM instead of SAN frames and a volume manager



Starwood Hotels: Case Study

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