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WestJet
Oracle Exadata Technical Case Study

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*"*WestJet consolidated 16 databases while delivering exceptional and consistent performance to our online ticketing, customer rewards and loyalty programs. Performance is at least 19 times faster. "
-Kris Trzesicki, Database Architect, WestJet

Overview

WestJet Airlines Ltd.[1] was founded in 1996 and is a Canadian low-cost carrier that provides scheduled and charter air service to 87 destinations in Canada, the United States, Mexico, Central America and the Caribbean. WestJet is Canada's second largest airline. WestJet's corporate culture has been built around caring for you, our guests, by providing a great guest experience. After claiming top spot in Waterstones' study of Canada's 10 Most Admired Corporate Cultures for four years, WestJet was inducted into its Hall of Fame in 2010. In 2011 WestJet was designated as a J.D. Power Customer Service Champion (one of two companies in Canada and the only airline to make the list), ranked 3rd in Aon Hewitt's best employers in Canada and was chosen as the Canadian airline with the best flight attendants by flightnetwork.com. WestJet was also chosen as Canada's preferred airline.

WestJet's initial move to the Oracle Exadata Database Machine was prompted by a desire to deliver an enhanced online user experience and to take back control of its outsourced online ticketing. WestJet has successfully deployed its online ticketing and customer loyalty programs on Oracle Exadata Database Machine using the Oracle Maximum Availability Architecture (MAA). Exadata MAA enables WestJet to achieve the highest levels of performance, data availability and data protection. WestJet further consolidated a total of 16 databases on to Exadata at the time of this writing. This case study describes the technical details behind WestJet's deployment on Exadata Database Machine. WestJet is hopeful this information will benefit other Exadata users as they deploy demanding online transaction processing (OLTP), reporting and batch processing systems on Oracle's Exadata Database Machine.

[1] http://www.westjet.com/guest/en/about/shtml

Intended Audience

This paper reviews WestJet's use of Oracle Exadata Database Machineand provides configuration details and benefits specific to the deployment being discussed. Readers are assumed to have experience with Oracle Database 11g technologies, familiarity with the Oracle Maximum Availability Architecture (MAA), and a general technical understanding of Oracle Exadata Database Machine. When referenced in this paper, in-depth background on these topics will be deferred, as they are covered in other documentation and technical white papers available on the Oracle Technology Network[2]. Where applicable, links to additional technical information are provided in footnotes that accompany each section. Appendix A also provides a list of the Oracle acronyms used in this paper.

Introduction

WestJet is the second largest airline in Canada and, by 2016, envisions itself as being one of the five most successful international airlines providing guests with a friendly and caring experience. WestJet's Strategic Plan is built on four pillars for long-term success:

- People and Culture
- Guest Experience
- Revenue and Growth
- Costs[3]

In 2012, to help achieve the goals of delivering an amazing Guest Experience and lowering Costs, WestJet began an effort to take back control of its outsourced online booking system and improve the performance of its customer loyalty program (mileage awards), customer notification (gate and schedule changes) along with other applications and functions.

WestJet's Business Objectives

WestJet began the journey with two primary business goals:

- Grow Guest Self Service to 60% by 2016
- Implement a database platform that will provide WestJet's customers an exceptional Guest Experience.

[2] http://www.oracle.com/technetwork/database/exadata/index.html

[3] http://www.westjet.com/pdf/investorMedia/factSheet.pdf

Growing Guest Self Service to 60% is directly tied to one of WestJet's strategic plan pillars – Costs. Growing self service also affects a significant number of customers since WestJet has 1.2 million active users as part of its WestJet Rewards program, not including non-rewards customers. In addition to ticketing WestJet wanted to expand its capabilities to include multi-channel shopping and reservations features. These services now include one stop shopping services such as hotel and rental car reservations, air port parking and special services like pet check-in.

In order to achieve its goal of 60% guest self service WestJet believed that it must deploy a database platform that will provide WestJet's customers an exceptional Guest Experience. WestJet also believes that providing consistency of performance, regardless of workload, and improving service availability, especially during upgrades, are essential elements to achieve its goal. As part of its database platform requirements, WestJet considered platform supportability and the ability to consolidate databases to further reduce costs.

WestJet and Oracle

WestJet had already been using Siebel Customer Resource Management (CRM) and Oracle Database 11g R1. Some applications were previously hosted internally and some were outsourced to a third party.

WestJet conducted a thorough evaluation of potential technology providers for its next generation architecture and selected the Oracle Exadata Database Machine. The Oracle Exadata Database Machine includes Oracle Real Application Cluster (Oracle RAC) and Oracle Data Guard. Oracle RAC provides high availability and scalable performance and Data Guard provided a reliable disaster recovery solution. Oracle Clusterware, Oracle Automatic Storage Management (ASM), and Oracle Flashback technologies add to the HA architecture. With Exadata, also found that it would dramatically reduce time to market, since the Engineered System is pre-configured and pre-tested.

WestJet selected an Exadata X2-2 Quarter Rack configuration for its production environment. WestJet also selected an Exadata X2-2 Quarter Rack for its staging environment and another Exadata X2-2 Quarter Rack for its disaster recovery system at a remote site.

WestJet: Migration

WestJet's previous environment included a pair of HP Unix servers and x64 servers in each of its two data centers. The Oracle Database was 11gR1. Storage was provided by a dedicated HP EVA Storage on a SAN.

Siebel: During this migration the database was upgraded from 11.1.0.7 to 11.2.0.3. The databases were 200 GB in size.

Aircraft Maintenance: During this migration the database was upgraded from 11.2.0.2 to 11.2.0.3. The databases were 70 GB in size.

Identity/Profile Services: During this migration the database was upgraded from 11.1.0.7 to 11.2.0.3. The databases were 30 GB in size.

The high level migration steps for each migrated database were:

- Build full database configuration on Exadata and run it in parallel with a number of refresh/test cycles.
- On cutover day WestJet planned an outage, performed a DataPump export and imported the data to the new version of database on Exadata. The process was automated with an Oracle Enterprise Manager Cloud Control job.

See *Oracle MAA Best Practices: Migration to Exadata Database Machine* for more information on different options for migrating to Exadata.[4]

WestJet: Greenfield

Three new applications were also implemented on Exadata:

Internet Booking Engine: The databases were initially 5 GB in size in 2012 (it has since grown to 660 GB in November 2013 with expected growth to 1.1 TB by March 2014).

Enterprise Notifications: The databases were initially 1GB and are approaching 40GB in October 2013.

WestJet.com Profile: The database was 1GB and it is about that size in October 2013.

[4] http://www.oracle.com/technetwork/database/features/availability/xmigration-11-133466.pdf

Exadata MAA Architecture

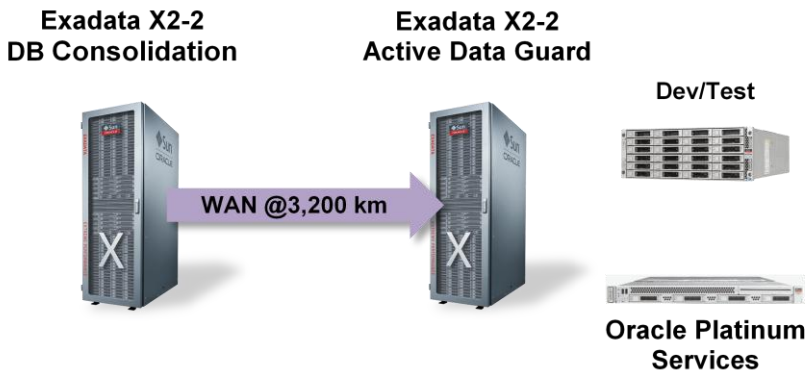

FIGURE 1: WESTJET OVERVIEW

WestJet uses x64 servers for its development/test environment before moving data to a staging environment on Exadata and, ultimately, to an Exadata production environment. The primary database are configured as a 2-node Oracle RAC[5] databases running on an Exadata X2-2 Half Rack system that is divided logically into two quarter racks (2 compute nodes and 3 cells for production and 2 compute nodes and 4 storage cells for staging). Local High Availability is provided by Oracle RAC and redundant components internal to Exadata. WestJet's Internet Booking Engine database was 660 GB at the time this paper was written October 2013, and is projected to grow to 1.1 TB in March 2014.

The primary databases are also configured with:

- Flashback Database[6] using a flashback retention period of 24 hours.
- There are three ASM[7] diskgroups, YCP_DAT (data), YCP_RECO (Fast Recovery Area) and DBFS configured using ASM normal redundancy. ASM normal redundancy is an MAA best practice when a Data Guard standby database is available to protect against multiple failures. The disk groups are sized at 6TB and 3TB respectively.
- WestJet follows MAA Best Practice for optimal corruption prevention, detection and repair.[8] WestJet has configured:

[5] www.oracle.com/goto/rac

[6] www.oracle.com/goto/flashback

[7] www.oracle.com/technetwork/database/index-100339.html

[8] www.oracle.com/technetwork/database/focus-areas/availability/maa-datacorruption-bestpractices-396464.pdf

- `DB_BLOCK_CHECKSUM` – to validate physical consistency
- `DB_BLOCK_CHECKING` – to validate logical consistency
- `DB_LOST_WRITE_PROTECT` – to detect silent corruption and prevent propagation to standby database.
- A combination of Active Data Guard and Data Guard, depending on the database. For applications where WestJet uses the disaster recovery site for read access or to run reports, it runs Active Data Guard. Active Data Guard is configured with automatic block repair. If a block corruption is detected at the primary database, Oracle will automatically repair the corruption using a valid copy obtained from the Active Data Guard standby database. The repair is transparent to the application and the user. Notification that a block was repaired is provided in the database alert log.

WestJet's workload is a mix of online transactions and batch processing. Data is loaded 24x7 from data files, enterprise service bus, and web services. Database workloads are characterized by a high volume of small inserts as well as reports, batch jobs, and analytics.

Secondary Database – Data Guard Physical Standby

A similarly configured Active Data Guard physical standby database runs on a separate Exadata Quarter Rack located in Data Center 2, 3,200 kilometers (5,100 miles) from the primary site.

Data Guard is configured in Maximum Performance mode with asynchronous redo for fast switch over in the event of a failure at the primary site. This architecture protects from lost writes and data corruption and was selected for its simplicity and performance. This prevents a standby or network outage from impacting the availability of the primary database when the primary is otherwise healthy. Standby redo log files at the standby database have been placed on the highest performance ASM disk group (DATA), to further minimize the impact of synchronous transmission on primary database performance.

Data Guard Automatic Block repair is used to automatically repair on-disk corruptions detected by Oracle, transparent to the user and application.

Data Guard Broker[9] provides a simple command-line interface to enable the Data Guard management of all primary/standby databases from any system that is part of a Broker configuration. Manual role transitions are executed via Broker command (switchover for planned transitions, failover for unplanned). The Broker also enables the complete set of Data Guard monitoring and administration capabilities available with Oracle Enterprise Manager.

[9] http://docs.oracle.com/cd/E11882_01/server.112/e17023/toc.htm

See the Oracle Technology Network for more information on Oracle Active Data Guard.[10] See *Disaster Recovery Best Practices for Exadata Database Machine* for more information on the specific use of Data Guard with Exadata.[11]

Network

Primary and standby systems are connected with a 400 Mb/sec link. Round-trip network latency between primary and standby sites (RTT) is 46 milliseconds.

From Data Guard 11g onward, it is no longer necessary to increase SDU size beyond the default when using Data Guard ASYNC redo transport or for when Data Guard automatically resolves archive log gaps using the ARCH process.

WestJet has also followed MAA best practice for setting TCP send/receive buffer size according to the MAA best practice of 3xBDP (Bandwidth Delay Product). BDP = (network bandwidth) x (round trip network latency). This calculation yields a value of 2,300,000 bytes. However, as of Data Guard 11g the MAA Best Practice for TCP send/receive buffer size has been amended to be either 3xBDP or 10MBytes, whichever is larger.[12] The minimum of 10MBytes is a function of the design for the new streaming network protocol used by Data Guard 11g ASYNC (Data Guard Maximum Performance) and ARCH (automatic gap resolution). WestJet will set TCP send/receive buffer size at the 10MByte minimum to insure optimal network utilization and redo-transport throughput when resolving archive log gaps.

Monitoring and Management:

WestJet uses a combination of capabilities to monitor and manage its Exadatas. Its internal enterprise team monitors availability and basic health 24x7 with Solarwinds Orion monitoring tool WestJet's database team currently uses Oracle Enterprise Manager Cloud Control 12c and the available plugins for monitoring and alerting of the databases and Exadata machines[13]. Daily health checks are based on Enterprise Manager Cloud Control 12c monitoring and data center teams perform visual hardware inspections twice a day. WestJet also uses Oracle Platinum Support and Automatic Service Requests to monitor the Exadata hardware. Any critical alerts are sent to on call personnel immediately.

Exachk – automated health-check for Exadata is also run regularly on all of WestJet's Exadata systems.[14]

Automatic Service Request (ASR)[15] is being utilized at WestJet.

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[10] www.oracle.com/goto/dataguard

[11] www.oracle.com/technetwork/database/features/availability/maa-wp-dr-dbm-130065.pdf

[12] http://docs.oracle.com/cd/E11882_01/server.112/e10803/config_dg.htm#CEGEADFC

[13] https://support.oracle.com/CSP/main/article?cmd=show&type=NOT&id=1110675.1

[14] https://support.oracle.com/CSP/main/article?cmd=show&type=NOT&id=1070954.1

Data Guard Role Transitions (switchover/failover)

Failover/switchover processes are controlled by the IT Operations Center. WestJet desires to manually control the switchover/failover and to be able to make decisions regarding failovers. There are dependencies in the application workflow that WestJet has to account for when failing over) due to external dependencies above the Application and Database tiers. This also controls the Data Guard Broker[16] and the application activation processes. All role transitions include network, proxy, application and database tiers.

Complete site failover (for unplanned outages) has been timed at approximately 8 minutes, including the time needed to seek management approval to failover.

- Database failover consumes 5 minutes.
- Application tier failover takes an additional 3 minutes.

Flashback Database is implemented to allow fast reinstantiation of a failed primary database as a standby database for the new primary (no restore required). The time required for complete re-instantiation is a function of the time required for two activities

- Time spent flashing back the original primary database to insure it is in the past of the SCN where the standby became the new primary.
- Time spent resynchronizing the new standby with all transactions that have occurred at the new primary database. This time will vary based upon how long it takes to repair the fault that triggered the failover in the first place.

WestJet has only had to perform a failover in test. The test allowed a days worth of processing at the new primary after failover before the original primary was brought back online. The process of complete reinstatement and resynchronization of the old primary as a standby database for the new primary was completed in less than 10 minutes.

Complete site switchover (in support of planned maintenance) has been timed at between 2 and 12 minutes, depending on the usage of the databases and their ability to shutdown cleanly. Switchover takes slightly longer to allow for the orderly transition of application clients from the original primary to the new primary, something that is not required for failover when there is a sudden outage of the original primary database.

WestJet conducts annual failover tests. Switchover operations are conducted more frequently to minimize downtime during planned maintenance. Hardware maintenance and many types of software maintenance are performed first on the standby system. The only downtime for such maintenance is

[15] www.oracle.com/asr

[16] http://www.oracle.com/pls/db112/to_toc?pathname=server.112/e17023/toc.htm

the time required for the switchover operation to complete – between 2 and 12 minutes from above, regardless of the time spent on the maintenance activity.

Backup Strategy

WestJet currently performs full backups, including archive logs,on a nightly basis. With data growth WestJet plans to switch to weekly backups with daily incremental backups along with daily backups of archive logs.

Backups are performed at the primary site and replicated by Data Domain to the disaster recovery site. WestJet is investigating the option of offloading the primary database machine and performing backups only at the standby (primary and standby databases are exact physical replica's, backups are interchangeable).

For optimal performance and data protection RMAN[17] is used to perform on-disk backups to the Fast Recovery Area on Exadata storage. Backups are then run off to EMC Data Domain to conserve disk space. RMAN scripts also provide automated management of archive log files.

Under normal circumstances, WestJet will use Data Guard's automatic gap resolution to resynchronize the standby database following network or standby server outages. In the event of an extended outage, WestJet will use an RMAN incremental backup in place of Data Guard's automated solution to more quickly resynchronize a standby database if it has fallen far behind the primary. The RMAN incremental process for catching up a standby database is:[18]:

- Determines the last SCN applied at the standby.
- Perform a fast incremental backup of the primary from that SCN. Note that RMAN Block Change Tracking is used for fast incremental backups.
- The incremental is used to restore the standby database to a point in time close to the current time on the primary.
- Data Guard then automatically performs the final resynchronization using redo from transactions that had committed since the incremental backup was taken.

Planned Maintenance

Oracle Platinum Support

WestJet's general approach to Exadata patching is to implement Exadata Bundle Patches on a half yearly basis and to assess the remainder of their software stack on a similar cycle unless there is a

[17] www.oracle.com/goto/rman

[18] http://docs.oracle.com/cd/E11882_01/server.112/e25608/rman.htm#CIHIAADC

recommendation that requires a faster implementation due to the risk profile. WestJet implements bundle patches via Oracle's Platinum support where WestJet schedules time with Oracle engineers to patch and upgrade the Exadatas. WestJet patches all components starting with the storage cells, then GI infrastructure, Oracle home and the databases. By implementing a single bundle patch with Exadata (as opposed to independent patches for each layer of the stack if it had deployed a component based architecture) and deploying Platinum Services, WestJet has dramatically reduced its maintenance costs and realized 70% savings in patching and testing. Further, WestJet has implemented several rolling patches without affecting Exadata availability.

Functional and performance tests are run with Bundle Patches over a course of five to seven days in isolation from production on an Exadata test environment. Successful testing preceded the implementation of Exadata Bundle Patch 11 and Bundle Patch 20 over the past year with no negative impact to production.

Once testing is complete using the Exadata test system, WestJet uses Standby-First patching when possible as the preferred method for introducing patches and other planned maintenance into the production environment. Standby-First patching uses Data Guard switchover to reduce downtime and risk when installing patches and performing other planned maintenance in the production environment.

The general approach to WestJet's use of Standby-First Patching is:

- First install a patch at the physical standby while production continues to run unchanged on the primary system.
- After the patch is deployed Data Guard will automatically resynchronize the patched physical standby database with the primary.
- When satisfied that there has been sufficient validation of the patch at the standby database, a Data Guard switchover is executed to transition production to the standby.
- The only database downtime typically required by the Standby-First patching process is the time required to execute a switchover. If a patch also requires SQL scripts or commands, then the downtime period will be slightly longer while these are run as part of a post-installation process on the new primary (after the switchover has been executed but before the database is open for new connections).

See My Oracle Support Note 1265700.1 for more information and best practices on Standby-First patching[19].

[19] https://support.oracle.com/CSP/main/article?cmd=show&type=NOT&id=1265700.1

In addition to consultation with Oracle's Exadata Solutions Support Center staff (ESSC), WestJet utilizes the following key Oracle Support notes when planning maintenance activities:

- Note 888828.1: Latest updates and patching recommendations for Exadata Database Machine.[20]
- Note 1262380.1: Best practices for testing/implementing recommended patches.[21]
- Note 1070951.1: MAA Health Check - exachk[22]
- Note 1110675.1: Exadata Database Machine monitoring and the Automated Service Request (ASR).[23]

WestJet: Consolidation and Performance

Three X2-2 Exadata Quarter racks replaced a pair of HP Unix servers and 23 x64 servers along with HP EVA storage. As discussed, one Quarter rack Exadata X2-2 is used for staging, one for production and one for disaster recovery. Some of the key differences WestJet has experienced between its legacy systems and Exadata are illustrated in Table 1.

Table 1: Comparison of Siebel Operating Environments

HP-UX & x64 on EVA Storage	**Exadata**
Expert application and database tuning	No tuning required post migration – 1 index added
Customized database statistics	Default Oracle Maintenance statistics
Frequent I/O performance issues	No I/O performance issues
Long running back up	Faster Backup
Overlap in heavy batch processing	Batch jobs fit in the allocated windows

In order to provide an exceptional Guest Experience, one of WestJet's goals was consistency of performance regardless of workloads. A sample of the dramatic performance improvements using Exadata is provided in Table 2. Exadata far exceeded WestJet's initial performance goals. Performance is at least 2.5 times better for data extraction and at least 19 times better for query performance. Backups now fit within a short back up window and do not interfere with other jobs that are running. Exadata exceeded WestJet's goals so much so that in addition to the Siebel databases, WestJet has been

[20] https://support.oracle.com/CSP/main/article?cmd=show&type=NOT&id=888828.1
[21] https://support.oracle.com/CSP/main/article?cmd=show&type=NOT&id=1262380.1
[22] https://support.oracle.com/CSP/main/article?cmd=show&type=NOT&id=1070951.1
[23] https://support.oracle.com/CSP/main/article?cmd=show&type=NOT&id=1110675.1

able to consolidate a total of 16 databases on its X2-2 quarter rack production Exadata. WestJet has observed that the same database on Exadata needs smaller SGA and buffers due to better I/O response on Exadata. WestJet estimates that it can consolidate an additional 2 databases on its Exadata Quarter rack.

Table 2: Performance Improvements with Exadata

Process	Average Before Exadata	Average After Exadata	Improvement
Backup	5 hours	0.5 hours	10 x
Revenue Accounting – Corrections	13 min 33 sec	5 sec	162 x
Customer Profiles	33 min	13 min	2.53 x
Revenue Accounting – Daily TX	174 min	9 min	19.3 x

Reduced Data Center Admin Needs

Exadata has reduced system sprawl within the data centers. Being pre-configured and pre-tested Exadata reduced deployment time and Platinum Service has dramatically reduced WestJet's deployment maintenance costs.

With the growth it has experienced WestJet has not had to build out additional infrastructure as a result of deploying Exadata, thus providing a highly efficient environment. Data Center costs have been reduced with smaller footprint and lower power.

While WestJet has deployed three Exadata quarter racks thus far, no additional staff was added. The database group has taken on the support functions for Exadata, including hardware support and patching via Platinum Services. The reduction in support and administration has allowed the existing systems administrators to focus on other areas of the business.

Hybrid Columnar Compression

While the current dataset is comparatively small, WestJet is experiencing rapid growth. As such, it began investigating the use of Hybrid Columnar Compression based on the age of the data. WestJet considered three scenarios: No compression; Compress for Query and Compress for archive. By applying HCC to data based on age, WestJet was able to save 87 GB. The data is summarized in Table 3.

Based on its testing, WestJet would recommend:

- Partitioned tables will guarantee performance
- Use DBMS_REDEFINITION for partitioning

In addition to saving storage costs with HCC, WestJet expects to recreased network requirements for replication.

Table 3: Summary of Compression Achieved

Data	Compression Hierarchy	Compression	Before Compression	After Compression
Partition 1	No Compression	-	88 GB	-
Partition 2	Compress for query	Up to 50x	34 GB	0.68 GB
Partition 3	Compress for archive	Up to 170 x	54 GB	0.32 GB

Post-Production Experience

WestJet has concluded the following from its Exadata experience:

- WestJet has thus far consolidated 16 databases on Exadata. Exadata has proven to be fully resilient and Exadata performance has been consistent across all workloads, delivering consistency in the user experience.

WestJet has found Exadata to be completely resilient. Since going live in 2012, WestJet has not had an unplanned outage. The only outages WestJet has experienced thus far have been for planned maintenance. For example, WestJet initiated a planned outage when installing JMV Multimedia and Spatial Locator that required an outage on the individual database for installation. WestJet also performed network changes that required a brief outage.

Conclusion and Lessons Learned

As a general recommendation, WestJet encourages Exadata users to keep their installations as straightforward as possible and to follow Oracle MAA Best Practices[24]. Doing so enabled WestJet to benefit not only from its own experience with Exadata, but also from the collective experience of the extensive Exadata installed base.

[24] www.oracle.com/goto/maa

WestJet has realized significant benefit from Exadata's ability to accelerate implementation, deliver high performance, achieve high availability and simplify support. By leveraging Oracle MAA Best Practices Exadata has proved to be both a reliable and performant solution.

By taking control of the customer experience WestJet is closer to its customers and is able to deliver its online services at lower cost and higher availability than before. WestJet now delivers ticketing, rewards program, loyalty customer portal, email marketing campaigns, guest self-service and loyalty analytics for its 1.2 million active users of the WestJet Rewards program and non-Rewards customers.

Lessons Learned

WestJet has completed several rolling patch upgrades without affecting Exadata availability.

WestJet recommends having a secure IP zone ready for Exadata before deploying Exadata. WestJet also recommends considering your future growth plans to reserve sufficient IP space.

Future Plans

WestJet has the following plans for its Exadata installation:

- Upgrade to Siebel 8.2.2.3 – 3rd Qtr. 2013
- Implement Siebel HCC (1-2 Million/Week) – 4th Qtr. 2013
- Additional Siebel Functionality
  - Travel Agent Commission – 2013
  - Call Center CTI integration and Case Management - 2014
- Other Tier 1 database consolidations … - 2013/2014
- Memory Optimization – September 2013
- Revenue Management - 2013
- BI Analytics Initiative – 2014
- Purchasing two additional Exadata Quarter Racks– 1st Qtr. 2014
- Active Data Guard / Golden Gate - 2014

Appendix A

- RAC = Real Application Clusters
- ASM = Automatic Storage Management
- BDP = Bandwidth Delay Product
- MAA = Maximum Availability Architecture
- SCAN = Single Client Access Name
- SLA = Service Level Agreement
- DBFS = Database File System
- HCC = Hybrid Columnar Compression
- ACO = Advanced Compression Option
- FAN = Fast Application Notification
- RMAN = Oracle Recovery Manager
- HA = High Availability
- DR = Disaster Recovery
- RPO = Recovery Point Objective
- RTO = Recovery Time Objective
- FRA = Fast Recovery Area
- CRS = Cluster Ready Services
- ASR = Automated Service Request

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Hardware and Software, Engineered to Work Together