



CSX: Online RMAN Backups Protect over 16TB of Data



"We saved about \$500,000 in licensing and maintenance fees by implementing RMAN instead of continuing with a 3rd party software, not to mention backup failures were reduced by over 90%. It is a big win!"

---Charles Pack

Data Management IT Architect, CSX Technology

Corporate Profile: CSX

- Owns the largest rail network in the eastern United States
- Provides rail freight transportation over a network of 23,000 miles in 23 states
- Over 20 years in business with over 40,000 employees
- \$8.5 Billion in average annual operating revenue over that past 5 years
- <http://www.csx.com/>

CSX Technology: Data Protection Challenges and Objectives

- Backup Very Large Data Warehouse database within 8 hour backup window, while maintaining 24x7 availability
- Reduce licensing and maintenance costs of using a 3rd party backup software for the Oracle database
- Meet Mean Time To Recover (MTTR) service level agreements of 12 to 48 hours (depending on criticality of database), for Disaster Recovery

CSX Technology Oracle Environment

- Oracle Databases 8.1.7.4 and 9.2.0.4
- Over 300 databases, 16 TB within total environment (Production accounts for 100+ databases, 8 TB)
- Media Management Layer (MML): Veritas Netbackup 4.5 FP 6
- Applications: Oracle Financials, Peoplesoft, and custom applications

OVERVIEW

CSX relies on the Oracle database for the infrastructure for mission critical OLTP and data warehouse applications. Oracle options and features supported by the CSX DBA team include Oracle9i Real Applications Cluster (RAC), Advanced queuing (AQ) and Messaging Gateway, Heterogeneous Services, Transparent Gateway, Replication, Workflow, Partitioning, and Spatial. From Oracle Financials to custom applications tracking the location of trains, CSX depends on Recovery Manager (RMAN) for online data protection of the Oracle database. Reliable, online RMAN backups to tape are an integral component of disaster recovery planning for the Oracle database.

INTRODUCTION

CSX Corporation is the parent company of a number of subsidiaries that provide freight transportation services across America and around the world. Formed in 1980, CSX Transportation operates the largest rail network in the eastern United States. CSX Intermodal provides transportation services across the United States and into key markets in Canada and Mexico. CSX Corporation subsidiaries also perform maritime operations, including an international terminal services company.

Together with a focused management team, the 40,000 dedicated, talented and hard working people of CSX Corporation and its subsidiaries constantly pull together to consistently and reliably meet customers' needs.

DATA PROTECTION STRATEGY

The Oracle database department at CSX Technology manages over 100 production databases, 300 instances and 16+ terabytes of data. With 24 x 7 availability requirements for the majority of Oracle databases, CSX uses RMAN online backups for the production databases.

The data protection strategy at CSX is structured by various tiers, which provide the appropriate level of protection based on the data criticality. Each data tier corresponds to a specific recovery time objective, thereby determining the backup strategy and restore priority in the event of a disaster.



System & Hardware

- **OLTP Databases:** AIX 5L on IBM RS 6000s; Solaris 8 on Sun Fires
- **Data Warehousing Databases:** AIX 5L on RS 6000s
- **Storage:** Production - HDS 9960 and 9980 DASD, Dev/Test – EMC Clarion DASD
- **Tape Storage:** StorageTek 9310 silo with 18 9730C fiber-connected tape drives

Backup & Recovery Solution

- Oracle Recovery Manager (RMAN)
- 5000 concurrent users on production systems
- Nightly full online backups of production databases to tape
- Archive Logs backups to tape twice per day approximately 600 Gb
- Recovery time objective of 48 hrs, for restoring all Tier 1 and 2 databases
- Average Oracle9i RMAN recovery speed 100 Gb / hour achieved
- 14 day tape retention policy at datacenter
- Production backup tape copies vaulted offsite
- Full disaster recovery testing conducted once per year

With an experienced team of nine DBAs, CSX has standardized backup and recovery of Oracle8i and Oracle9i databases with RMAN. RMAN provides the following recovery capabilities:

- Tested and proven reliability to meet Recovery Time Objectives (RTO) of 12 to 48 hours depending on criticality of database. For example, Tier 1 production databases in “unplanned” disasters can be restored and recovered from bare metal status to fully operational status for over 4 TB in 12 hours. For “planned” disasters, critical production databases are returned to service in less than 4 hours for critical data.
- Automated point-in-time recovery process, applying all appropriate archive logs
- Corruption detection during the backup and restore process, helping insure successful recoveries
- Seamless integration with RMAN and Veritas NetBackup for a centralized tape management strategy, with DBA maintaining responsibility and control of database data protection
- Online RMAN backups completed within required backup window while meeting CSX’s 24 x 7 availability requirements

INCREDIBLE COST SAVINGS WITH RMAN

About 4 years ago, CSX first implemented RMAN for their Oracle 8.0 databases along with a re-architecting of their server infrastructure. Their RMAN implementation and infrastructure changes simplified backup procedures saving DBA labor costs.

Before RMAN implementation, they had one full-time DBA designated for database data protection and another DBA at approximately 25% time utilization. Their current RMAN implementation only demands about 25% of one full-time DBA’s time for their entire 16TB database environment; that’s a labor savings equal to one full-time DBA.

As part of their server infrastructure re-architecture, CSX would have incurred one-time licensing fees of up to \$500,000 (List price) for their existing 3rd party backup software, in addition, to the \$50,000 + annual maintenance fees. By implementing RMAN, they avoided these costs entirely!

The CSX management team was successful in lowering costs and increasing productivity by implementing RMAN. In addition to the cost savings, the reliability of backups improved dramatically with backup failures being reduced by over 90%.

RMAN Configuration

- **FILESERSET=1024**
- **MAXOPENFILES=1** for some databases
- **Tape block size=500KB**
- **Large_pool_size = 25m** for most OLTP databases; up to 200m for large databases that use parallel query

STANDARDIZING PROCEDURES WITH RMAN

The CSX database administrators achieve maximum productivity by standardizing backup and recovery procedures across the enterprise.

To achieve consistency and additional automation across databases, a CSX DBA wrote UNIX shell scripts and RMAN command files. The scripts are located in a directory that is NFS mounted on each database server.

Backup jobs are scheduled through a 3rd party cross-platform scheduling tool, and each job executes the parameter-driven “rman_backup” shell script. When a database is backed up for the first time, the “rman_backup” shell script creates a standard RMAN command file for the database, which the DBA can then tune as needed for the specific database.

To recover a database, the DBA runs the “rman_recovery” script, which generates RMAN recovery command files that can then be modified based on the recovery requirements.

While these scripts were first implemented by CSX using RMAN with Oracle 8.0, the core functionality has remained effective through their upgrade to Oracle9i. To take advantage of enhancements offered in current releases, they modify their core scripts created in Oracle8. This design consistency has saved considerable time with upgrading from 8.0 to 8.17 and now Oracle9i.

ANNUAL RMAN RECOVERY TESTING FOR DR

Headquartered in Jacksonville, Florida, CSX’s disaster recovery plan takes into account the possibility of hurricanes. During Florida’s six month hurricane season, CSX management keeps a watchful eye on the weather pattern ready to “declare impending disaster” if necessary, and moving operations to their remote facility.

Upon declaration, a well-orchestrated chain of events is implemented transporting personnel and backup tapes, in addition to triggering the network transport of archive logs to the remote facility. Once at the secondary site, the databases are restored on a pre-determined order based on tier level. Tier 1 and 2 systems are operational within 48 hours.

An important component of CSX’s data protection strategy is an annual disaster recovery exercise at the remote DR location. The well-documented disaster recovery procedure is thoroughly tested in a 48-hour build of systems from start to finish.

In the disaster exercise, tapes of the most recent RMAN backups and archive logs are shipped to the remote facility. While the DBA staff and backup tapes are in transit, network bandwidth to the DR location is increased, and archive logs generated at the primary data center are continuously shipped over the network to a “catcher system” at the remote facility, using Oracle’s multiple archive log destination feature. Upon arrival at the DR site, the databases must be restored and recovered from tape, and archive logs applied from the catcher system.

Each year at the DR exercise, RMAN backups are tested and proven to successfully meet the CSX service level agreements for the Oracle database.

“RMAN is reliable, predictable and keeps the tape drives spinning consistently at about 100GB/hour throughput per drive. I’ve never found RMAN to be a bottleneck in the process; it just works!”

*---Rich McClain
Senior DBA, CSX
Technology*

CONCLUSION

For over 4 years, CSX has relied on Oracle Recovery Manager (RMAN) for data protection of Oracle 8.0, Oracle8i and Oracle9i databases. RMAN's intimate knowledge of the database provides CSX

- Reliability and ease of use for backup and recovery
- Online RMAN backups
- Corruption checking during backup and restore
- Restore speeds averaging 100 Gb/ hour from tape
- Seamless integration with Veritas NetBackup
- Excellent value proposition; no additional cost with the Oracle database

Oracle Documentation

- [Oracle9i Recovery Manager User's Guide](#)
- [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](#)



CSX: Case Study

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