Protecting Oracle databases with HPE StoreOnce Catalyst and RMAN

Oracle database backup using the HPE StoreOnce Catalyst Plug-in for Oracle RMAN
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Introduction

In today's business environment, Oracle® database administrators rely on the most efficient, high-performing, and reliable backup systems. Database administrators (DBAs) need to protect increasing levels of data while keeping costs under control. HPE StoreOnce Systems provide a disk-based data protection platform while addressing data growth by applying HPE StoreOnce deduplication software for efficient, longer-term backup data retention.

HPE StoreOnce Systems provide a unique combination of features, including industry-leading performance, high availability, and high capacity.

HPE StoreOnce Catalyst software was developed to dramatically improve the performance, function, and integration of backup utilities such as RMAN. The HPE StoreOnce Catalyst Plug-in for Oracle RMAN (RMAN Plug-in) enables deduplication on the Oracle server or dedicated HPE StoreOnce System. HPE StoreOnce Catalyst allows better utilization of advanced, disk-based storage solutions while increasing efficiency and performance.

Many Oracle databases today are protected by backup to HPE StoreOnce Systems. The HPE StoreOnce Catalyst Plug-in for Oracle RMAN extends the data protection capabilities of HPE StoreOnce Systems in Oracle environments. The RMAN Plug-in is for Oracle DBAs responsible for protecting Oracle databases. Using the familiar RMAN interface, the plug-in enables backup to a Catalyst Store on an HPE StoreOnce System without a data protection application.

This document describes the benefits of using the HPE StoreOnce Catalyst Plug-in for Oracle RMAN in conjunction with Oracle RMAN to back up Oracle databases, without using a data protection application. This document also recommends backup and recovery implementation strategies.

The following are key advantages of using the HPE StoreOnce Catalyst Plug-in for Oracle RMAN to backup Oracle databases to HPE StoreOnce Catalyst stores:

- **Increased deduplication**: The RMAN Plug-in is programmed with intelligent RMAN data stream analysis to produce higher deduplication ratios and storage savings. RMAN multiplexed backup sets and media manager multiplexing have minimal effect on HPE StoreOnce Catalyst deduplication ratios.

- **Increased backup speed**: Using multiple RMAN backup channels to a Catalyst store improves throughput performance with little to no impact on data deduplication ratios.

- **Increased availability of server resources**: A weekly full and daily incremental backup schedule uses less server and HPE StoreOnce compute and bandwidth resources during back up than a daily full backup schedule.

- **DBA controlled backups with source side deduplication**: Oracle RMAN database backups to a Catalyst store can be controlled by the DBA. No data protection software is required, and when configured for source side data deduplication, less network and storage bandwidth is required.

- **Supports RMAN Duplexing backup sets**: RMAN backups can be configured to create up to four copies of backup files (original backup plus three copies) for redundancy and protection. The RMAN Plug-in works at the Media Management Layer to provide up to four catalyst targets to RMAN.

- **Catalyst Managed Copy**: The RMAN Plug-in also provides HPE StoreOnce Catalyst Managed copies of backups where secondary backup copies are delegated to HPE StoreOnce Systems (appliance-to-appliance copy) thus freeing up CPU cycles of the Oracle server for online database processing.

- **Catalyst Copy Utility**: With HPE StoreOnce Catalyst Plug-in version 3.1 and later, RMAN backups can be decoupled from the additional Disaster Recovery (DR) copies. This allows a DBA to create copies of Oracle backups to alternate HPE StoreOnce Systems separate from the original RMAN backup job at a later time. This reduces the time the database is in backup mode and avoids the issue where RMAN considers a failure of a single copy to be a failure of the backup and all copies.

- **Better scalability**: HPE StoreOnce Catalyst targets support millions of backup objects providing better scalability than StoreOnce NFS targets.

HPE StoreOnce Systems are a disk-based backup system that deliver leading price-performance and deduplication of Oracle database backup data. HPE StoreOnce Systems can consolidate the storage of multiple database backups onto a single, rack-mountable system while improving reliability compared to backup to tape by reducing potential errors caused by media handling. For business environments with remote offices or a disaster recovery site, the RMAN Plug-in can be used to store database backup copies to local and DR site HPE StoreOnce Systems.

HPE StoreOnce Systems are ideal for mission-critical application backup data for small to large data centers running key business applications, such as Oracle. Proper configuration of Oracle database backups with RMAN and the RMAN Plug-in to an HPE StoreOnce Catalyst store provides the shortest backup times and most efficient use of capacity.
**Technology overview**

**HPE StoreOnce Systems—key features and benefits**

**HPE StoreOnce deduplication, store more data on disk**

HPE StoreOnce deduplication reduces the disk space required to store backup data sets without impacting backup performance. Retaining more backup data on disk longer enables greater data accessibility for rapid restore of lost or corrupt files and reduces downtime.

Deduplication ratios are strongly influenced by two factors: data change rate and backup data retention periods. Low data change rates and data retained for longer periods of time yield higher deduplication ratios.

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**Note**

HPE StoreOnce Systems do not deduplicate across Catalyst stores. Each Catalyst store is an independent deduplication domain. For increased deduplication ratios, use unique Catalyst stores for different data types.

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**Deduplication-enabled replication**

HPE StoreOnce deduplication is the technology enabler for HPE StoreOnce Deduplication-enabled replication, which allows fully automated replication over low-bandwidth links to a disaster recovery (DR) site, giving Remote Office/Branch Office (ROBO) and small data centers a cost-effective DR solution for the first time. The RMAN Plug-in supports deduplication-enabled replication with the Catalyst Managed Copy feature (CMC) and Catalyst Copy Utility.

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**Note**

HPE StoreOnce Catalyst Managed Copy was introduced in version 2.0 of the RMAN Plug-in. For previous versions of the plug-in, RMAN duplexed backup sets are supported.

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**Rapid restore of data for dependable, worry-free data protection**

HPE StoreOnce Systems offer immediate access to backups for rapid restores. HPE StoreOnce deduplication allows more data to be stored closer to the data center for longer periods of time, which offers immediate access for rapid restores.

**Automate, simplify, and improve the backup process**

HPE StoreOnce Systems automate the backup processes allowing reduced time spent managing data protection. Implementing hands-free, unattended daily backup is especially valuable for environments with limited IT resources, such as remote or branch offices.

HPE StoreOnce Systems can back up multiple servers via a standard Ethernet or Fibre Channel network simultaneously to a disk-based solution instead of sequentially to a tape drive or autoloader, providing substantially reduced backup windows.

HPE StoreOnce Systems can be intuitively managed and configured by using the built-in Web browser’s administrative interface. HPE StoreOnce Systems are self-managing backup appliances that require little, if any, routine maintenance. Unlike other disk-based storage devices, HPE StoreOnce Systems do not require virus protection or LUN provisioning.

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**HPE StoreOnce Catalyst Plug-in for Oracle RMAN—key features and benefits**

**Direct backup to a StoreOnce Catalyst store, data protection software not required**

The RMAN Plug-in integrated with Oracle RMAN enables backup management and direct backup and restore of Oracle databases to Catalyst stores without a backup application. This includes full, incremental, and multi-channel backup. The RMAN Plug-in does not integrate with a backup application but can coexist in an environment with a backup application. This enables the database to be part of an organization-wide backup and recovery policy while giving flexibility to the DBA to run backups and recoveries according to specific needs.

**Improved deduplication ratios, store more data**

The RMAN Plug-in improves the deduplication ratio for Oracle RMAN backups onto Catalyst stores compared to backups that do not use the plug-in. Backup data requires less storage so more backups can be stored on the HPE StoreOnce System.

**Backup Oracle databases in less time**

The RMAN Plug-in generates faster backups than backup to NAS or virtual tape targets.
Scalability
The RMAN Plug-in targets support millions of backup objects providing better scalability than HPE StoreOnce NFS targets.

Use less network bandwidth
The RMAN Plug-in optimizes network utilization when using source side deduplication (low-bandwidth mode).

Supports both Ethernet and Fibre Channel transports
HPE StoreOnce Catalyst over Fibre Channel functions the same way as standard HPE StoreOnce Catalyst (over Ethernet), Oracle RMAN will not perceive a difference. (Note that optimized copies continue to run over an Ethernet interface: the primary copy may use HPE StoreOnce Catalyst over Fibre Channel (CoFC), but the replication of data between HPE StoreOnce Systems is only supported over Ethernet.)

Multiple copies of Oracle database backups, better protection from failure
The RMAN Plug-in provides database administrators with two options to create multiple copies of backup sets using RMAN duplexing, and an additional option to create copies decoupled from RMAN.

- Host managed copies: The RMAN Plug-in supports the RMAN copy feature (duplexed backups). This provides a method to send a copy of the same database backup to more than one target for increased protection from failure.

- Catalyst managed copies: The HPE StoreOnce Catalyst Managed Copy feature expands on the RMAN duplexed backups where secondary backup copies are delegated to HPE StoreOnce Systems (appliance-to-appliance copy), which frees up the Oracle server CPU cycles for database processing. In this way, the RMAN catalog maintains authority and control of the dataset copies while the actual replication work is offloaded to the HPE StoreOnce Systems.

- Catalyst Copy utility: With the RMAN plug-in version 3.1 or later, the Catalyst Copy utility can be used to separate the creation of Disaster Recovery copies from the original RMAN backup job. With RMAN duplexed backup jobs, RMAN views a failure on any copy to be a failure of the entire backup job and deletes successful copies. The Catalyst Copy utility can be used to create copies of the original RMAN backup job to other HPE StoreOnce Systems at a later time while providing seamless restore and recovery from any of the backup copies.

Simple installation and configuration
The RMAN Plug-in is installed on the Oracle database server using the plug-in installation tool. Configuration is a simple modification to the plug-in configuration file.

Oracle database backups to Catalyst stores are invoked using standard RMAN backup commands
Oracle database backups to Catalyst stores using the RMAN Plug-in are invoked with standard RMAN backup commands by using channel device type SBT_TAPE and referencing the RMAN Plug-in SBT library through the PARMS parameter of the ALLOCATE CHANNEL command.

<table>
<thead>
<tr>
<th>Table 1. HPE StoreOnce Catalyst Plug-in for Oracle RMAN or a data protection application with an Oracle agent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HPE StoreOnce Catalyst Plug-in or for Oracle RMAN</strong></td>
</tr>
<tr>
<td>Used by Database Administrator (DBA)</td>
</tr>
<tr>
<td>Managed through the RMAN interface as an extension of database operations</td>
</tr>
<tr>
<td>Solely to protect Oracle databases, typically by DBAs</td>
</tr>
<tr>
<td>Catalyst Managed Copy feature provides RMAN the ability to control catalyst copies between appliances providing DR replication</td>
</tr>
<tr>
<td>Requires a Catalyst license on target appliance</td>
</tr>
<tr>
<td>Back up to a Catalyst store</td>
</tr>
</tbody>
</table>

Using the HPE StoreOnce Catalyst Plug-in for Oracle RMAN
An important part of Oracle database administration is maintaining a consistent set of backup data. Whether data is lost due to user error, system failure, or site catastrophe, there is a need for data recovery. An HPE StoreOnce System, integrated with the RMAN Plug-in and a well-planned data protection strategy, includes regular Oracle database backups to maintain a consistent set of data for recovery purposes.

Note: Oracle Image Copy backups are not supported by the RMAN Plug-in.

Oracle duplexed backup sets
The RMAN Plug-in can be easily configured with RMAN duplexed backup sets to send up to four identical copies (initial backup plus three backup copies) of each database backup piece to different Catalyst stores. Backup copies can even be sent to different HPE StoreOnce Systems as shown in figure 1. Generating multiple backup copies simultaneously will likely require additional server resources.
In version 3.1 of the RMAN Plug-in, Host managed (application managed) copy and Catalyst managed copy are joined by Catalyst Copy utility to provide 3 methods to protect databases through duplication.

- Host managed (application managed) copy – Backup copies are triggered and run from the Oracle host. In this method, the Oracle server streams backups to multiple HPE StoreOnce Systems in parallel. This creates a heavier resource load on the client as Oracle has to perform multiple writes for every read operation. Both copies must complete successfully for RMAN to end the job successfully.

- Catalyst Managed Copy – The Oracle server effectively sends one backup to a primary HPE StoreOnce System. The RMAN Plug-in and HPE StoreOnce device handles the physical duplication of copies while keeping the RMAN catalog current. The copies are done on a per backup file basis: as a backup file is written to the primary store it is replicated to the secondary store—RMAN waits for all copies to be completed successfully before ending the job.

- Catalyst Copy utility – Disaster recovery copies are separate from the primary backup. RMAN sends a backup to the primary HPE StoreOnce System and at a later time the DBA initiates an HPE StoreOnce Catalyst optimized copy to a secondary HPE StoreOnce System using the Catalyst Copy utility. This reduces the duration and resource load of the primary backup and eliminates the issue of failed copies causing the primary copy to fail that is inherent with RMAN duplexed backups.

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**Figure 1a.** HPE StoreOnce Catalyst Plug-in for Oracle RMAN
Figure 1b. HPE StoreOnce Catalyst Plug-in Catalyst Copy Utility
Oracle backup infrastructure components

Table 2. Backup components required to successfully recover an Oracle database from most types of failure

<table>
<thead>
<tr>
<th>Component</th>
<th>Why component is needed for database recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>The last backup of the control file</td>
<td>The Oracle database control file records the physical structure of the database and must be available for writing by the Oracle database server whenever the database is open.</td>
</tr>
<tr>
<td>The last backup of all datafiles</td>
<td>Oracle database datafiles are physical files used to store data on disk. They are associated with Oracle &quot;tablespaces&quot; which are logical containers for database tables and indexes.</td>
</tr>
<tr>
<td>All archived redo logs since the last database backup (if the database is running in ARCHIVELOG mode)</td>
<td>Archived redo logs are used to store filled groups of online redo log files. They are needed to recover the database to a specific point in time.</td>
</tr>
<tr>
<td>Copies of configuration files such as the server parameter file, tnsnames.ora, and listener.ora</td>
<td>Oracle configuration files contain configuration information for the database to use at startup time and information for the database network and connections.</td>
</tr>
<tr>
<td>RMAN recovery catalog</td>
<td>The RMAN recovery catalog holds RMAN repository data for one or more databases. The repository data is created during database backups and is used for database restore and recovery.</td>
</tr>
</tbody>
</table>

It is common practice to perform daily backups of the control file, datafiles, parameter file, tnsnames.ora, and listener.ora of an Oracle database and Recovery catalog database. Archived redo logs are backed up throughout each day as necessary. The tnsnames.ora, listener.ora, and PFILE (text parameter file) should be part of a standard file system backup.

**Note**
If the Oracle database parameter file is binary, it will be backed up with the control file autobackup. If the parameter file is text based, then it needs to be part of a file system backup.

**Capacity planning**
The required backup storage capacity for Oracle database backups depends on the following:

- Size of the Oracle database
- Size of the archived redo logs (if running in archive log mode)
- Backup retention policy (recovery points needed)
- Type of backups (full, incremental, differential)
- Frequency of backups
- Oracle database rate of change
- The deduplication ratio achieved by the HPE StoreOnce System

**Note**
For the purposes of this document, the Oracle database rate of change refers to the amount of data that would be contained in an incremental backup as a percentage of a full backup. A 100 GB full backup with a subsequent 5 GB incremental backup before the next full backup would be a five percent rate of change.

It may be desirable for a DBA to store up to a month's backups on the HPE StoreOnce System to enable quick restore. Data deduplication provides more backup space without increasing the physical capacity of the backup device; however, a dynamic Oracle database with changing data affects the backup data deduplication ratio.

In performing Oracle RMAN backup tests using the RMAN Plug-in, HPE used TPC-C benchmark standard data and RealDB data. (RealDB is an internal database population and data change tool which uses data loaded from internet webpages) Rows and columns in the database were updated between each backup until the desired rate of change was reached. Figure 2 shows the effect of the data change rate on the deduplication ratio.
Figure 2. How HPE StoreOnce Catalyst Plug-in for Oracle RMAN deduplication ratios trend over time for varying database rate of change between backups. (Tests were run on a 100 GB Oracle 12c database running on a 2 node Windows RAC to an RMAN Plug-in Version 3.1 using Realdb benchmark data.)

**Note**
The deduplication ratio of the first backup written to a HPE StoreOnce target is mainly due to compression, which varies according to data type.

**Archived redo logs**
- The backup of an Oracle database running in ARCHIVELOG mode may take place with the database open. Full database datafile backups deduplicate at a higher ratio when compared to archive log backups, since archived redo logs by nature tend to be more "unique" data.
- HPE StoreOnce System capacity required for archive log backups is typically half of the actual size of the data.

If an Oracle database is running in NOARCHIVELOG mode, the only valid database backup is made with the database mounted after a consistent shutdown. There are no archive logs to backup, so the overall data deduplication ratio will be higher.

**Weekly full and daily incremental backups**
Many backup environments use a weekly full and daily incremental backup schedule. Some characteristics of full and incremental backups are:
- Full backups include both the changed and unchanged data in a data set.
- Incremental backups include only changed data in a data set.
- Changed data does not deduplicate as well as unchanged data, therefore, incremental backups may not deduplicate as well as full backups.
- Incremental backups are usually much quicker than full backups and use fewer resources, which results in less impact to the backup server, disk storage device, and HPE StoreOnce System.
- End-to-end data compaction is greater for schedules that include incremental backups when compared with daily full backup schedules; the result is less storage space usage on the HPE StoreOnce System even though deduplication ratios are lower for incremental backups.
- Full backups enable faster and simpler recovery than incremental backups or a mix of full and incremental backups.
- Oracle’s Block Change Tracking (BCT) feature increases incremental backup performance. By logging changed data blocks to avoid re-scanning all data blocks for changed blocks with every incremental backup.

**Note**
Data compaction refers to the removal of redundant information from a backup set prior to storing on a backup device. Incremental backups, deduplication, and compression are all methods for removing redundant data from a backup set.
Figure 3a. Comparison of backup throughput and duration when running daily full backup and weekly full backup with daily incremental schedules—both run with two percent rate of change and retention period 28 days. (Tests were run on a HP-UX server backing up an Oracle database to a Catalyst store using the RMAN Plug-in version 2.0.)

Figure 3b. Backup duration when running a weekly full backup with daily incremental schedule running with and without Oracle Block Change Tracking enabled—run with four percent rate of change. (Tests were run on a 2 node Oracle RAC running on Linux® RHEL 7.2 with Oracle 12c database server backing up to a Catalyst store using the RMAN Plug-in version 3.1.)
Figure 4a. The effect on HPE StoreOnce Catalyst deduplication ratios and size on disk when running daily full backup and weekly full backup with daily incremental schedules—both run with two percent rate of change and retention period 28 days. (Tests were run on an HP-UX server backing up an Oracle database to a Catalyst store using the RMAN Plug-in version 2.0 using TPC-C benchmark standard data.)

Figure 4b. The effect on HPE StoreOnce Catalyst deduplication ratios when running a weekly full backup with daily incremental schedule with and without Oracle Block Change Tracking enabled—run with four percent rate of change. (Tests were run on a 2 node Oracle RAC running on Linux® RHEL 7.2 with Oracle 12c database server using RealDB data backing up to a Catalyst store using the RMAN Plug-in version 3.1.)

Note
Incremental backup schedules were run with Oracle Block Tracking disabled unless specifically stated.
Figure 3a shows that even though the daily full backup schedule shows a consistently higher throughput than a weekly full with daily incremental schedule, the overall backup duration for the weekly full with daily incremental backups is lower.

Figure 3b shows that the use of Oracle Block Change Tracking produced a significant decrease in backup duration on incremental backups.

Figure 4a shows that the deduplication ratio for both schedules follow an increasing pattern but level out once the previous backups begin to expire or “roll off.” Also, note that even though the dedupe ratio for the daily full backup schedule is considerably higher, the size on disk for the weekly full with daily differential is lower.

Figure 4b shows that enabling Oracle Block Change Tracking does not impact StoreOnce deduplication rates or StoreOnce storage resources.

Capacity planning usage models
An Oracle environment with a 14-day backup data retention requirement can have several HPE StoreOnce System usage models. Usage models change based on parameters such as the following:

- Backup schedule type
  - Daily full backups deduplicate well but use more server and HPE StoreOnce compute and bandwidth resources during a backup.
  - Weekly full with daily incremental backups do not deduplicate as well but use less compute and bandwidth resources. The end-to-end data compaction for weekly full with daily incremental backup schedules may be better than daily full backups.

- Database daily rate of change—lower change rates result in better deduplication ratios, as shown in figure 2, and require less HPE StoreOnce System storage.

Figure 5 compares five usage models for Oracle RMAN backups using the RMAN Plug-in with the following common characteristics:

- DB size: 1 TB
- Backup schedule: Daily
- Retention period: 14 days

For each usage model figure 5 shows the overall size of the Oracle DB backup data without deduplication (14 daily backups of 1 TB each) vs. the size of the data on the HPE StoreOnce appliance after deduplication.

![Figure 5. Data compaction comparison of different Oracle RMAN backup usage models](image-url)
RMAN parameters and effects on Oracle RMAN backup throughput and deduplication ratios

Oracle RMAN statements and parameters can be used to control backup data streams. HPE recommends reading Oracle documentation available at docs.oracle.com for a full explanation of all RMAN statements and parameters. This document will focus on the effects the ALLOCATE CHANNEL statement, and the MAXOPENFILES and FILESPERSET parameters have on backup data streams.

RMAN backups store data in a backup structure called a backup set. A backup set contains data from one or more datafiles, tablespaces, archive logs, control file, or parameter file (SPFILE).

Backup throughput, backup data interleaving, number of backup sets, and number of output files in a backup depend on RMAN statements and parameters such as:

- **ALLOCATE CHANNEL** – This statement allocates a channel to a media manager such as the RMAN Plug-in, or to a local backup device such as a HPE StoreOnce NAS share.

- **MAXOPENFILES** – This parameter specifies the maximum number of datafiles that can be open at a given time for a single allocated channel. MAXOPENFILES 8 is the default unless specified in the ALLOCATE CHANNEL statement.

- **FILESPERSET** – This parameter specifies the number of datafiles to be written into a backup set. FILESPERSET is set dynamically unless specified in the BACKUP statement. The default is determined by the number of datafiles divided by the number of allocated channels (not to exceed 64). The number of backup sets is equal to the number of datafiles divided by FILESPERSET.

**Note**

Typically deduplication ratios are a factor of the data type, daily rate of change, FILESPERSET, ALLOCATED CHANNELS, MAXOPENFILES, backup schedule type and backup retention period as observed and measured during testing. A benefit of using the RMAN Plug-in is that FILESPERSET, ALLOCATED CHANNELS, and MAXOPENFILES have very minimal effect on deduplication ratios. Deduplication ratios will vary according to the environment.

**Multiplexed backup sets**

RMAN can read multiple files from disk simultaneously and write their blocks into the same backup set. For example, if an RMAN channel was allocated with MAXOPENFILES 2 and backup parameter FILESPERSET 2 was used, RMAN would read two datafiles simultaneously, and combine the blocks from the datafiles into a single backup piece. This is a multiplexed backup set, and results in RMAN interleaving data from multiple datafiles into the same backup set. (HPE testing of multiplexed backup sets on an Oracle database using the RMAN Plug-in showed no performance benefits.)

**Media manager multiplexing**

RMAN multiplexed backup sets is different from media manager multiplexing. Multiple RMAN channels can be opened simultaneously to the same Catalyst store using the RMAN Plug-in. In this case, the media manager writes concurrent output from multiple RMAN channels to a single Catalyst store. This is called media manager multiplexing, and results in the HPE StoreOnce interleaving data from multiple RMAN channels onto the same Catalyst store.

**To increase backup throughput performance**

Use the RMAN ALLOCATE CHANNEL statement to open multiple RMAN channels concurrently, and set MAXOPENFILES and FILESPERSET to 1 to avoid multiplexed backup sets. RMAN multiplexed backup sets and media manager multiplexing have minimal impact on data deduplication when using the RMAN Plug-in.
Figure 6. RMAN multiplexed backup sets and media manager multiplexing

Note
Allocating more and more RMAN channels and opening more and more datafiles simultaneously might eventually exhaust Oracle server and HPE StoreOnce resources. The optimal number of allocated channels and open datafiles is dependent upon the environment.
Figure 7a. The effect on HPE StoreOnce Catalyst throughput when using different Oracle RMAN parameter settings. (Tests were run on an HP-UX server backing up an Oracle database to a Catalyst store using the RMAN Plug-in version 2.0.)

Figure 7b. The effect on HPE StoreOnce Catalyst throughput when using different Oracle RMAN parameter settings. (Tests were run on a 2 node Windows RAC cluster backing up an Oracle database to a Catalyst store using the RMAN Plug-in version 3.1.) Note: To test 16 streams, a 1TB database with 32 datafiles was used.
Figures 7a and b demonstrate that allocating more RMAN channels for backup results in increased backup throughput.

Figures 8a and b demonstrate that RMAN multiplexed backup sets and media manager multiplexing has minimal effect on Catalyst store deduplication ratios when using the RMAN Plug-in.

**Note**
RMAN encryption and compression—HPE StoreOnce does not deduplicate RMAN backup data when RMAN encrypted or compressed backups are enabled because these options will always generate unique backup data for every backup.
Disabling RMAN compression and encryption

RMAN compression is enabled by using the BACKUP command AS COMPRESSED BACKUPSET parameter. For better HPE StoreOnce deduplication ratios, HPE recommends not using the AS COMPRESSED BACKUPSET parameter when backing up Oracle databases to StoreOnce Catalyst stores.

RMAN encryption is disabled by default. For better StoreOnce deduplication ratios, HPE recommends not using RMAN encryption when backing up Oracle databases to StoreOnce Catalyst stores.

Go to docs.oracle.com for more information on RMAN compression and encryption.

If data encryption is required, Catalyst stores can be created with encryption enabled to encrypt the backup data on the HPE StoreOnce System.

Implementing the HPE StoreOnce Catalyst Plug-in for Oracle RMAN

The following is an example of the basic configuration settings in the RMAN Plug-in version 3 configuration file for UNIX®/Linux and Windows®.

# (C) Copyright 2015 Hewlett-Packard Development Company, L.P.

# BASIC CATALYST SETTINGS

# StoreOnce node address used for backup. Supply the address of the StoreOnce service set
# Required
# Accepts: IPv4, FQDN, COFC- & IPv6. IPv6 addresses should be quoted; e.g. “fdca:cd45:5ab0:995::7”
CATALYST_STORE_ADDRESS: 192.168.1.8

# Catalyst store name used for backup.
# Required
CATALYST_STORE_NAME: ora_catalyst_source

If the Catalyst over Fibre Channel option is used, the only change to the Plug-in configuration file needed is to enter the HPE StoreOnce System’s Fibre Channel Identifier or Identifier Alias (user-assignable) for the CATALYST_STORE_ADDRESS parameter. The Fibre Channel Identifier of the HPE StoreOnce System can be obtained from the HPE StoreOnce Web GUI as shown in figure 9.

Example using the FC Identifier below:

CATALYST_STORE_ADDRESS: COFC-USE518P97801

# Catalyst store name used for backup.
# Required
CATALYST_STORE_NAME: ora_catalyst_source
Figure 9. Screen shot of the Fibre Channel setting tab on the HPE StoreOnce Catalyst Configuration section showing the HPE StoreOnce Identifier and Identifier Alias.

If an issue occurs with the Fibre Channel connectivity between the host and the HPE StoreOnce System, backups/restores can easily be switched to use Catalyst over Ethernet (CoE) by editing the plug-in configuration file to use the IP address or host name of the HPE StoreOnce System.
Sample RMAN backup and recovery scripts

The following RMAN scripts are examples of how to use statements and parameters to backup an Oracle database on a UNIX server to a Catalyst store or restore an Oracle database from a Catalyst store using the RMAN Plug-in. (All examples reference version 3 of the plug-in library and configuration file. Previous versions of the plug-in used a different name for the library file and configuration file.)

**Note**

A vital part of an Oracle database backup and recovery plan is backing up the control file. The control file is needed to be able to open or mount the database for restore. Therefore, it is a good idea to enable the RMAN control file and server parameter file autobackup feature.

The following is an example of verifying and enabling CONTROLFILE AUTOBACKUP in RMAN.

```
RMAN> show CONTROLFILE AUTOBACKUP;

RMAN configuration parameters for database with db_unique_name oradb are:
CONFIGURE CONTROLFILE AUTOBACKUP OFF;

RMAN> CONFIGURE CONTROLFILE AUTOBACKUP ON;

new RMAN configuration parameters:
CONFIGURE CONTROLFILE AUTOBACKUP ON;
new RMAN configuration parameters are successfully stored
starting full resync of recovery catalog
full resync complete

RMAN configuration parameters for database with db_unique_name oradb are:
CONFIGURE RETENTION POLICY TO REDUNDANCY 1; # default
CONFIGURE BACKUP OPTIMIZATION OFF; # default
CONFIGURE DEFAULT DEVICE TYPE TO DISK; # default
CONFIGURE CONTROLFILE AUTOBACKUP ON;
CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '% F'; # default
```

The first script is an example of opening a single channel to send Oracle data files and archive logs to a Catalyst store on a Windows host:

```
RUN {
    ALLOCATE CHANNEL ch00 TYPE SBT_TAPE
    MAXOPENFILES 1
    PARMS 'SBT_LIBRARY=c:\PROGRA~1\Hewlett-Packard\StoreOnce\isvsupport\oracle\lib\isvsupport_rman.dll
            ENV=(CONFIG_FILE=plugin.conf)'  
    FORMAT 'df_%d_ch00_%U';

    BACKUP
    FILESPERSET 4
    DATABASE;

    sql 'alter system archive log current';

    BACKUP
    FILESPERSET 4
    ARCHIVELOG ALL DELETE INPUT;

    RELEASE CHANNEL ch00;
}
The second script is an example of restoring and recovering an Oracle database from a Catalyst store on a Windows host. In this example the control file does not need recovery, and the database is in “startup mount” mode ready for database restore and recovery:

```
RUN {
  ALLOCATE CHANNEL ch00 TYPE SBT_TAPE
    PARMS 'SBT_LIBRARY=c:\PROGRAM-FILES\Hewlett-Packard\StoreOnce\isvsupport\oracle\lib\libisvsupport_rman.dll
          ENV=(CONFIG_FILE=plugin.conf)'
  RESTORE DATABASE;
  RECOVER DATABASE;
  ALTER DATABASE OPEN;
  RELEASE CHANNEL ch00;
}
```

The third script is an example of opening multiple channels to send Oracle data files to a Catalyst store on a UNIX host.

```
RUN {
  ALLOCATE CHANNEL ch00 TYPE SBT_TAPE
    MAXOPENFILES 1
    PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
           ENV=(CONFIG_FILE=plugin.conf)
           FORMAT 'df_%d_ch00_%U';
    ALLOCATE
    CHANNEL ch01 TYPE SBT_TAPE
    MAXOPENFILES 1
    PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
           ENV=(CONFIG_FILE=plugin.conf)
           FORMAT 'df_%d_ch01_%U';
    ALLOCATE
    CHANNEL ch02 TYPE SBT_TAPE
    MAXOPENFILES 1
    PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
           ENV=(CONFIG_FILE=plugin.conf)
           FORMAT 'df_%d_ch02_%U';
    ALLOCATE
    CHANNEL ch03 TYPE SBT_TAPE
    MAXOPENFILES 1
    PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
           ENV=(CONFIG_FILE=plugin.conf)
           FORMAT 'df_%d_ch03_%U';

  BACKUP
    FILESPERSET 1
    FULL
    DATABASE;

  sql 'alter system archive log current';
  BACKUP
    FILESPERSET 8
    ARCHIVELOG ALL DELETE
    INPUT FORMAT 'al_%d_%U';
    RELEASE CHANNEL ch00;
    RELEASE CHANNEL ch01;
    RELEASE CHANNEL ch02;
    RELEASE CHANNEL ch03;
}
```
Oracle RAC considerations

- The RMAN Plug-in must be installed on all RAC nodes. The RMAN Plug-in should be installed locally on each node individually (e.g. Do not install on a shared disk or UNC path).
- All RAC nodes should use a plug-in configuration file with matching configuration settings. Alternatively, a single configuration file residing on a common shared location may be used.

Below is an example of opening multiple channels to send Oracle data files to a Catalyst store on a UNIX Oracle RAC node:

```sql
RUN {
  ALLOCATE CHANNEL ch00 TYPE SBT_TAPE MAXOPENFILES 1
  PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
  ENV=(CONFIG_FILE=plugin.conf)
  FORMAT 'df_%d_ch00_%U' connect 'system/pwd@oradb';

  ALLOCATE CHANNEL ch01 TYPE SBT_TAPE MAXOPENFILES 1
  PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
  ENV=(CONFIG_FILE=plugin.conf)
  FORMAT 'df_%d_ch01_%U' connect 'system/pwd@oradb';

  ALLOCATE CHANNEL ch02 TYPE SBT_TAPE MAXOPENFILES 1
  PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
  ENV=(CONFIG_FILE=plugin.conf)
  FORMAT 'df_%d_ch02_%U' connect 'system/pwd@oradb';

  ALLOCATE CHANNEL ch03 TYPE SBT_TAPE MAXOPENFILES 1
  PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
  ENV=(CONFIG_FILE=plugin.conf)
  FORMAT 'df_%d_ch03_%U' connect 'system/pwd@oradb';

  BACKUP FILESPERSET 1 FULL DATABASE;
  sql 'alter system archive log current';
  BACKUP FILESPERSET 8
  ARCHIVELOG ALL DELETE INPUT FORMAT 'al_%d_%U';
  RELEASE CHANNEL ch00;
  RELEASE CHANNEL ch01;
  RELEASE CHANNEL ch02;
  RELEASE CHANNEL ch03;
}
```
Oracle Multitenant databases
The RMAN Plug-in is compatible with Oracle's Multitenant database feature. The RMAN Plug-in performs and is referenced in the same manner as with normal databases.

Below is an example of a backup of a pluggable database using the RMAN Plug-in.

```sql
RUN {
    ALLOCATE CHANNEL ch00 TYPE SBT_TAPE MAXOPENFILES 1
    PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_cman.so
    ENV=(CONFIG_FILE=plugin.conf)'
    FORMAT 'df_%d_ch00_%U' connect 'system/pwd@ocadb';
    BACKUP FILESPERSET 1 FULL PLUGGABLE DATABASE RCPDB1
}
```

Note: Oracle recommends that the container database and all pluggable databases be recovered at the same time to avoid possible inconsistencies in metadata.

Oracle Enterprise Manager Cloud Control (OEM) and the HPE StoreOnce Catalyst Plug-in for RMAN.

- Figure 10 shows the Plug-in library referenced in the Media Management Settings section of the Backup Settings page. (This example is of a Windows RAC setup running Oracle 12c.)

---

**Figure 10.** Oracle Enterprise Manager Backup Settings page.
RMAN catalog maintenance with StoreOnce Catalyst stores

Using the RMAN Plug-in configuration files to separate datafile and archive log backups:

- A plug-in configuration file can only reference a single Catalyst store at a time for database backup and recovery, and RMAN catalog maintenance.

- Multiple plug-in configuration files may be created and used by RMAN to use multiple Catalyst stores.

- If a DBA wants to send archive log backups to a different Catalyst store than datafile backups, a separate RMAN channel should be allocated for archive log backups. The archive log backup channel should point to a plug-in configuration file that references a different Catalyst store than the channels allocated for datafile backups.

- Listing the backups in the RMAN catalog will show different media for the archive log backups than it shows for the datafile backups if different Catalyst stores were used.

The scenario where multiple Catalyst stores are used for backup and recovery presents RMAN catalog maintenance challenges:

- When maintaining the RMAN catalog to delete backups, the user allocates a channel for maintenance to communicate with the HPE StoreOnce System, but that channel can only reference a single Catalyst store.

- When a cross-check is run to synchronize the RMAN catalog with the backup files on the HPE StoreOnce System, only backups on the Catalyst store that is referenced by the allocated channel will be found. This can cause all other backups to be marked as expired when in fact they may still exist on a different Catalyst store.

Recommendations to make RMAN catalog maintenance simpler:

- Use the RMAN BACKUP command TAG parameter to tag the backup with the Catalyst store name. For example, if an RMAN channel is opened to the Catalyst store named "ora_catalyst_store":

  RMAN> BACKUP DATABASE INCLUDE CURRENT CONTROLFILE TAG 'ora_catalyst_store';

- The tag can be used to only take action in the RMAN catalog for backups that match the tag. For example, if an RMAN maintenance channel is opened to the Catalyst store named “ora_catalyst_store” and the backups were tagged with the Catalyst store name, then the tag could be used by the following RMAN commands:

  RMAN> LIST BACKUP TAG 'ora_catalyst_store';

  RMAN> CROSSCHECK BACKUP TAG 'ora_catalyst_store';

  RMAN> DELETE BACKUP TAG 'ora_catalyst_store';
DR with the HPE StoreOnce Catalyst Plug-in for Oracle RMAN

Most companies recognize the importance of a robust data protection strategy. Enterprise-level customers are likely to invest in an offsite DR facility. In addition, many companies, large and small, are protecting Oracle database applications in remote offices where untrained IT staff are expected to manage a daily backup process—generally involving the changing of physical tapes, which is a process prone to human error.

The RMAN Plug-in with RMAN duplexed backup sets offers the solution to both of these problems by allowing local Oracle backup data to be duplicated to up-to four HPE StoreOnce Catalyst stores (initial backup plus three backup copies) in a reliable, capacity-optimized manner. The Catalyst stores may exist on multiple HPE StoreOnce Systems so it is possible to have a database backup copy on a local HPE StoreOnce System and a remote HPE StoreOnce System at a DR site. This provides the following flexibility in Oracle data recovery, as illustrated in figure 11:

- Oracle databases can be recovered from the local site HPE StoreOnce System to the original Oracle server.
- If a total disaster of the Oracle database source site occurs, the DR site HPE StoreOnce System can be shipped to the Oracle server site or the backup data can be restored over the WAN to the Oracle server site for complete Oracle database recovery.
- Oracle databases can be recovered from the DR site HPE StoreOnce System to a DR site redundant Oracle server. The DR site redundant Oracle server is a secondary Oracle server specifically used for DR purposes in case of local site primary Oracle server failure.

**Recovery scenarios**

Figure 11. Disaster recovery scenarios that might occur and the recovery path available when using RMAN duplexing with the RMAN Plug-in to create multiple copies of database backups to local and DR site HPE StoreOnce Catalyst stores.
To duplicate data to a remote target site, the RMAN Plug-in version 3 paired with RMAN duplexed backups supports both Host managed copy and Catalyst Managed Copy as in the following demonstration. (Version 1 of the plug-in only supports Host managed copy.)

**Using RMAN duplexed backups with HPE StoreOnce Catalyst Plug-in for Oracle RMAN**

The RMAN Plug-in appears as a SBT tape device type to RMAN, therefore the Oracle database parameter `BACKUP_TAPE_IO_SLAVES` must be set to `TRUE` in order to enable duplexing of backups with the RMAN Plug-in. The following commands check the value of `BACKUP_TAPE_IO_SLAVES` and change it to `TRUE` if necessary:

```
SQL> show parameter BACKUP_TAPE_IO_SLAVES;

NAME TYPE VALUE
------------------------------------ ----------- ------------------------------
backup_tape_io_slaves boolean FALSE

SQL> alter system set BACKUP_TAPE_IO_SLAVES=TRUE scope=spfile;
System altered.

SQL> shutdown immediate;
Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> startup;
ORACLE instance started.
...
Database mounted.
Database opened.

SQL> show parameter BACKUP_TAPE_IO_SLAVES;

NAME TYPE VALUE
------------------------------------ ----------- ------------------------------
backup_tape_io_slaves boolean TRUE
```

By default, the RMAN Plug-in is set to use Host managed copies (which is standard Oracle RMAN duplexed backups). To use Host managed copies, under the **CATALYST COPY TARGETS** section of the RMAN Plug-in configuration file ensure that the **APPLICATION_MANAGED_COPIES** option is set to “enabled” and add configuration information for the Catalyst copy target(s). For example:

```
# (C) Copyright 2015 Hewlett-Packard Development Company, L.P.

########################################################################
# BASIC CATALYST SETTINGS
########################################################################

# StoreOnce node address used for backup. Supply the address of the StoreOnce service set
# Required
# Accepts: IPv4, FQDN, COFC- & IPv6. IPv6 addresses should be quoted; e.g. “fdca:cd45:5ab0:995::7”
```
CATALYST_STORE_ADDRESS: 192.168.1.8

# Catalyst store name used for backup.
# Required
CATALYST_STORE_NAME: ora_catalyst_source

# CATALYST COPY TARGETS

# Enabling this option the ISV will manage the copy
# Optional
# APPLICATION_MANAGED_COPIES:<ENABLE/DISABLE>
APPLICATION_MANAGED_COPIES:ENABLED

# StoreOnce node address of the 1st Catalyst copy target.
# Optional
# CATALYST_COPY1_STORE_ADDRESS:<StoreOnce Copy Node Address>
CATALYST_COPY1_STORE_ADDRESS:192.168.1.12

# Catalyst store name of the 1st copy target.
# Optional
# CATALYST_COPY1_STORE_NAME:<Catalyst Store Name>
CATALYST_COPY1_STORE_NAME: ora_catalyst_target

---
Note
When configuration changes are made to the RMAN Plug-in configuration file, RMAN channels must be reallocated to activate the new configuration.

The following example RMAN backup script creates two backup set copies of a database and archive logs:

```sql
RUN {
  ALLOCATE CHANNEL ch00 TYPE SBT_TAPE
    MAXOPENFILES 1
    PARMS 'SBT_LIBRARY=/oracle/hp/HP-Catalyst-RMAN-Plugin/bin/libisvsupport_rman.so
    ENV=(CONFIG_FILE=plugin.conf)
    FORMAT 'dbf_%d_ch00_%u_%c';
  BACKUP
    COPIES 2
    FILESPERSET 12
    FULL
    DATABASE
    TAG 'oradb_full';
  sql 'alter system archive log current';
  BACKUP
```
To use Catalyst Managed copies, no change is necessary to the RMAN backup scripts. In the RMAN Plug-in configuration file, under the **CATALYST COPY TARGETS** section, **APPLICATION_MANAGED_COPIES** option needs to be set to **DISABLED** which notifies the RMAN Plug-in to use the Catalyst Managed Copy feature. For example:

```plaintext
# (C) Copyright 2015 Hewlett-Packard Development Company, L.P.

########################################################################
# BASIC CATALYST SETTINGS
########################################################################

# StoreOnce node address used for backup. Supply the address of the StoreOnce service set
# Required
# Accepts: IPv4, FQDN, COFC- & IPv6. IPv6 addresses should be quoted; e.g. “fdca:cd45:5ab0:995::7”
CATALYST_STORE_ADDRESS: 192.168.1.8

# Catalyst store name used for backup.
# Required
CATALYST_STORE_NAME: ora_catalyst_source

########################################################################
# CATALYST COPY TARGETS
########################################################################

# Enabling this option the ISV will manage the copy
# Optional
# APPLICATION_MANAGED_COPIES:<ENABLE/DISABLE>
APPLICATION_MANAGED_COPIES:DISABLED

# StoreOnce node address of the 1st Catalyst copy target.
# Optional
# Accepts: IPv4, FQDN, IPv6. IPv6 addresses should be quoted; e.g. “fdca:cd45:5ab0:995::7”. COFC addresses are not supported when APPLICATION_MANAGED_COPIES is set to DISABLE
# CATALYST_COPY1_STORE_ADDRESS:<StoreOnce Copy Node Address>

# RELEASE CHANNEL ch00;
}
CATALYST_COPY1_STORE_ADDRESS:192.168.1.12

# Catalyst stoe name of the 1st copy target.
# Optional
# CATALYST_COPY1_STORE_NAME:<Catalyst Store Name>
CATALYST_COPY1_STORE_NAME: ora_catalyst_target

Note
The %c format specifier generates a backup copy number that is used internally by the RMAN Plug-in. The %u format specifier generates a unique name for the backup. These are mandatory parameters that need to be specified. The format for the autobackup of control files should be left as the default, %F.

Note
With the Catalyst Managed Copy feature, only the primary backup is supported with Catalyst over Fibre Channel. All StoreOnce Catalyst copies take place over Ethernet. When configuring a StoreOnce Catalyst copy destination, an Ethernet address should be provided instead of a Catalyst over Fibre Channel address.

Example listing on a UNIX/Linux host of RMAN backups showing two backup set copies with their corresponding HPE StoreOnce Catalyst server and Store name in the media field.

RMAN> LIST BACKUP TAG 'ORADB_FULL';

List of Backup Sets
------------------

BS Key    Type    LV    Size  
------- ---- --- ----------
 17287    Full    104.42G

List of Datafiles in backup set 17287

<table>
<thead>
<tr>
<th>File</th>
<th>Type</th>
<th>Ckp SCN</th>
<th>Ckp Time</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/system01.dbf</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/sysaux01.dbf</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/undotbs01.dbf</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/users01.dbf</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/RDB1.dbf</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/RDB2.dbf</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/RDB3.dbf</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/RDB4.dbf</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/RDB5.dbf</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/RDB6.dbf</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/RDB7.dbf</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Full</td>
<td>10-FEB-2016 15:54:54</td>
<td>/oradata_gpdb_00/ORADB/RDB8.dbf</td>
<td></td>
</tr>
</tbody>
</table>
Backup Set Copy #1 of backup set 17287
Device Type Elapsed Time Completion Time Compressed Tag
----------- ------------ -------------------- ---------- ---
SBT_TAPE 00:21:10 10-FEB-2016 16:16:04 NO ORADB_FULL

List of Backup Pieces for backup set 17287 Copy #1
BP Key  Pc# Status Media Piece Name
------- --- ----------- ----------------------- ----------
17294 1 AVAILABLE 192.168.1.8:ora_catalyst_source dbf_ORADB_ch00_bbqtj8ue_1

Backup Set Copy #2 of backup set 17287
Device Type Elapsed Time Completion Time Compressed Tag
----------- ------------ -------------------- ---------- ---
SBT_TAPE 00:21:10 10-FEB-2016 16:16:04 NO ORADB_FULL

List of Backup Pieces for backup set 17287 Copy #2
BP Key  Pc# Status Media Piece Name
------- --- ----------- ----------------------- ----------
17295 1 AVAILABLE 192.168.1.12:ora_catalyst_target dbf_ORADB_ch00_bbqtj8ue_2

BS Key Type LV Size
------- ---- -- ----------
17288 Full 10.00M

SPFILE Included: Modification time: 27-JAN-2016 18:47:45
SPFILE db_unique_name: ORADB
Control File Included: Ckp SCN: 54938297 Ckp time: 10-FEB-2016 16:16:10

Backup Set Copy #1 of backup set 17288
Device Type Elapsed Time Completion Time Compressed Tag
----------- ------------ -------------------- ---------- ---
SBT_TAPE 00:00:10 10-FEB-2016 16:16:20 NO ORADB_FULL

List of Backup Pieces for backup set 17288 Copy #1
BP Key  Pc# Status Media Piece Name
------- --- ----------- ----------------------- ----------
17296 1 AVAILABLE 192.168.1.8:ora_catalyst_source dbf_ORADB_ch00_bcqtja6a_1

Backup Set Copy #2 of backup set 17288
Device Type Elapsed Time Completion Time Compressed Tag
----------- ------------ -------------------- ---------- ---
SBT_TAPE 00:00:10 10-FEB-2016 16:16:20 NO ORADB_FULL

List of Backup Pieces for backup set 17288 Copy #2
BP Key  Pc# Status Media Piece Name
------- --- ----------- ----------------------- ----------
17297 1 AVAILABLE 192.168.1.12:ora_catalyst_target dbf_ORADB_ch00_bcqtja6a_2

BS Key Size
List of Archived Logs in backup set 17327

<table>
<thead>
<tr>
<th>Thrd</th>
<th>Seq</th>
<th>Low SCN</th>
<th>Low Time</th>
<th>Next SCN</th>
<th>Next Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140</td>
<td>54937030</td>
<td>10-FEB-2016 15:41:36</td>
<td>54938329</td>
<td>10-FEB-2016 16:16:28</td>
</tr>
<tr>
<td>1</td>
<td>141</td>
<td>54938329</td>
<td>10-FEB-2016 16:16:28</td>
<td>54938347</td>
<td>10-FEB-2016 16:16:30</td>
</tr>
</tbody>
</table>

Backup Set Copy #1 of backup set 17327

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Elapsed Time</th>
<th>Completion Time</th>
<th>Compressed Tag</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBT_TAPE</td>
<td>00:00:10</td>
<td>10-FEB-2016 16:16:42</td>
<td>NO</td>
</tr>
</tbody>
</table>

ORADB_FULL

List of Backup Pieces for backup set 17327 Copy #1

<table>
<thead>
<tr>
<th>BP Key</th>
<th>Pc#</th>
<th>Status</th>
<th>Media</th>
<th>Piece Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>17330</td>
<td>1</td>
<td>AVAILABLE</td>
<td>192.168.1.8:ora_catalyst_source</td>
<td>al.ORADB_bdqtja70_1</td>
</tr>
</tbody>
</table>

Backup Set Copy #2 of backup set 17327

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Elapsed Time</th>
<th>Completion Time</th>
<th>Compressed Tag</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBT_TAPE</td>
<td>00:00:10</td>
<td>10-FEB-2016 16:16:42</td>
<td>NO</td>
</tr>
</tbody>
</table>

ORADB_FULL

List of Backup Pieces for backup set 17327 Copy #2

<table>
<thead>
<tr>
<th>BP Key</th>
<th>Pc#</th>
<th>Status</th>
<th>Media</th>
<th>Piece Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>17331</td>
<td>1</td>
<td>AVAILABLE</td>
<td>192.168.1.12:ora_catalyst_target</td>
<td>al.ORADB_bdqtja70_2</td>
</tr>
</tbody>
</table>

---

**Note**

In a restore situation, if the primary catalyst store is unavailable during a restore, the RMAN Plug-in configuration file must be altered such that the secondary catalyst store is configured as the primary catalyst store. (This applies to both Catalyst Managed Copy and Host managed copy.)

**Catalyst Copy Redirect feature**

The Copy Redirect feature allows for routing the backups and copies onto separate networks for performance or security reasons. For instance, if the primary backup traffic is on a FC SAN, the copy can use an Ethernet LAN.

In the example below, a catalyst copy target is setup with copy data traffic set to use a backup network (10.0.0.x) while the copy management traffic is sent over the primary LAN (10.10.4.x)

```
# Catalyst store name of the 1st copy target.
CATALYST_COPY1_STORE_ADDRESS:10.0.0.40
CATALYST_COPY1_STORE_NAME:rac_rc100gb_copy

# Alternative addresses for Catalyst copy targets.
# Optional
# This parameter defines separation of catalyst command path and catalyst copy paths.
# If configured, the destination server receives data on alternative address during
# the catalyst copy operation.
# <Catalyst Command Traffic Address> : Copy target defined in parameters CATALYST_COPYn_STORE_ADDRESS
# <Catalyst Copy Address> : Alternative address for the copy target, through which data is copied to destination.
```
# To define split addresses for multiple copy targets, add multiple entries.
# CATALYST_COPY_REDIRECT_ADDRESS:<Catalyst Command Traffic Address>:<Catalyst Copy Address>
CATALYST_COPY_REDIRECT_ADDRESS: 10.10.4.85:10.0.0.40

**Using Catalyst Copy utility to create backup copies to alternate HPE StoreOnce Systems.**

As stated, the HPE StoreOnce Catalyst Copy utility, has the ability to create offline copies of backups apart from the initial RMAN backup. RMAN is not aware of the copies created by the utility. The DBA will need to manage the copies using the Catalyst Copy utility features

**Note:** The HPE StoreOnce Catalyst Copy utility and Copy Redirect features are only available in versions 3.1 and later of the plug-in.

Example of Catalyst Copy command showing a copy of Catalyst items from a primary Catalyst target to a secondary target.

```
$ ./StoreOnceCatalystCopy  --copy --origin 10.0.0.23 --origin-store rac_rc100gb_store --destination 10.0.0.40 --destination-store rac_100gb_copy --filtercreateddate-range [26/04/2017-00:00:00]:[26/04/2017-18:00:00]
```

<table>
<thead>
<tr>
<th>Current Time</th>
<th>Wed Apr 26 15:32:20 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of items detected in origin</td>
<td>38</td>
</tr>
<tr>
<td>Number of Catalyst items processed</td>
<td>5</td>
</tr>
<tr>
<td>Remaining number of Catalyst items to process</td>
<td>33</td>
</tr>
<tr>
<td>Number of Catalyst items queued</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current Time</th>
<th>Wed Apr 26 15:32:22 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of items detected in origin</td>
<td>38</td>
</tr>
<tr>
<td>Number of Catalyst items processed</td>
<td>38</td>
</tr>
<tr>
<td>Remaining number of Catalyst items to process</td>
<td>0</td>
</tr>
<tr>
<td>Number of Catalyst items queued</td>
<td>38</td>
</tr>
</tbody>
</table>

Operation Complete:
- Total number of Catalyst items queued : 38
- Total number of Catalyst items that failed to queue : 0

Example using the HPE StoreOnce Catalyst Copy utility to remove backup copies from the secondary target when the primary backup has been expired by RMAN (in this example the items to be copied are filtered by the creation date of the items).

```
$ ./StoreOnceCatalystCopy  --expire-items --origin 10.0.0.23 --origin-store rac_rc100gb_store --destination 10.0.0.40 --destination-store rac_100gb_copy --filtercreateddate-range [26/04/2017-00:00:00]:[26/04/2017-18:00:00]
```

```
--------------
CatalystItemName
--------------

dbf_rc100gb_ch06_i8s2llq1_1_1.meta
dbf_rc100gb_ch01_13s2llq1_1_1.meta
dbf_rc100gb_ch06_i8s2llq1_1_1.data
dbf_rc100gb_ch03_i8s2llq1_1_1.meta
dbf_rc100gb_ch01_13s2llq1_1_1.data
dbf_rc100gb_ch03_i8s2llq1_1_1.data
dbf_rc100gb_ch05_i7s2llq1_1_1.meta
dbf_rc100gb_ch00_i2s2llq1_1_1.meta
dbf_rc100gb_ch05_i7s2llq1_1_1.data
dbf_rc100gb_ch07_i9s2llq1_1_1.data
dbf_rc100gb_ch00_i2s2llq1_1_1.data
dbf_rc100gb_ch02_i4s2llq1_1_1.meta
dbf_rc100gb_ch07_i9s2llq1_1_1.data
dbf_rc100gb_ch04_i6s2llq1_1_1.meta
dbf_rc100gb_ch02_i4s2llq1_1_1.data
dbf_rc100gb_ch04_i6s2llq1_1_1.data
dbf_rc100gb_ch00_i2s2llq1_1_1.meta
dbf_rc100gb_ch01_ibs2llsn_1_1.meta
dbf_rc100gb_ch06_ias2llva_1_1.meta
dbf_rc100gb_ch00_i2s2llva_1_1.meta
dbf_rc100gb_ch03_ids2llvb_1_1.meta
dbf_rc100gb_ch00_i2s2llva_1_1.data
```
Recommendations

- Oracle daily full backups vs. weekly full with daily incremental backups
  - Daily full backups deduplicate at a much higher rate than weekly full with daily incremental backups but require more server and HPE StoreOnce System storage resources.
  - Weekly full with daily incremental backups send considerably less data to the HPE StoreOnce System for deduplication processing.
  - Full backups are easier and faster for most restore operations.
  - If daily full backups and faster restore operations are not required, HPE recommends a backup schedule that includes incremental backups to reduce the resource load required for Oracle database backup.
  - Using Oracle Block Change Tracking has minimal to no impact on HPE StoreOnce deduplication, but does decrease the backup time on incremental backups. To increase daily incremental backup performance, enable Oracle Block Change Tracking.
  - Use the backup protocol that fits best into the backup strategy. Whether using Catalyst over Ethernet or Catalyst over Fibre Channel, the effect on backup throughput and HPE StoreOnce size on disk is minimal

- Backup retention periods that include regular backup expiration:
  - HPE StoreOnce deduplication ratios and size on disk for a backup target will continue to increase until backups to the target exceed their retention period and are expired. At this point, deduplication ratios and size on disk will likely level off.
  - For capacity planning, consider that size on disk will likely level off when backups begin to expire as long as the size of the database remains constant.

- Increase Oracle database backup throughput to the HPE StoreOnce System by using multiple RMAN channels concurrently. Note that more channels leads to increased host CPU resource load.

- Because RMAN dataset multiplexing or interleaving does not generally lead to increased throughput performance when using the RMAN Plug-in, HPE recommends setting MAXOPENFILES equal to 1.

- HPE StoreOnce does not deduplicate encrypted or compressed data, therefore, HPE recommends disabling RMAN encryption and compression.

- If network bandwidth is a concern (that is, a low-throughput WAN link), low-bandwidth mode (source-side deduplication) is recommended because it reduces the amount of data transferred to the HPE StoreOnce System.

- The RMAN Plug-in creates additional CPU load on the Oracle server when performing source-side deduplication. Whether adding this feature to an existing Oracle server or designing a new Oracle server, a specific sizing exercise should take place to ensure sufficient CPU resources are available to take advantage of the source-side deduplication feature of the RMAN Plug-in. For more details, consult a HPE pre-sales representative.

- HPE StoreOnce Catalyst compression and checksum
  - WAN—If performing HPE StoreOnce Catalyst Ethernet backups over WAN, it is recommended to enable Catalyst payload compression and checksums to ensure reliable and safe transport of backup data.
  - Fibre Channel/LAN—Because these transports are generally more secure and reliable, HPE StoreOnce Catalyst payload compression and
checksums may be set to DISABLED via the plug-in configuration file to reduce overhead on the host server and increase throughput.

Note: In RMAN Plug-in versions 3.1 and later, Catalyst payload compression and checksums are disabled by default. The plugin install menu will prompt user if backups will be performed over a Wide Area Network and enable these options in that case.

- Disaster recovery
  - Host managed copy—RMAN writes dataset backup and copies in parallel. This results in heavier resource load on the database server but may complete in a shorter time than Catalyst managed copies.
  - Catalyst Managed Copy—The HPE StoreOnce System handles the replicating of backup copies and performs the copies in a serial manner. This feature reduces the resource load on the database server and may increase the overall backup job time as compared with Host Managed Copy since RMAN waits for all copies to be completed before declaring the job finished.
  - If copies are done over a WAN, the data should be deduped prior to the copy. Catalyst Managed Copy is designed for this purpose. (Host Managed Copy running in low-bandwidth mode can also be used.)
  - Catalyst Copy utility—Backup copies are created apart from the initial RMAN backup. This feature reduces the risk of copy failures impacting the initial RMAN backup, and allows any number of copies to be created at any time after the initial backup. As with Catalyst Managed Copy, the copy processing load is handled by the HPE StoreOnce Systems thus reducing the load on the database server.

Conclusion
Oracle customers demand an efficient, reliable data growth management backup system environment while keeping costs under control, and some Oracle DBAs need full control of database backup and recovery. HPE provides a variety of reliable data protection storage solutions that address such requirements, such as HPE StoreOnce Systems and the HPE StoreOnce Catalyst Plug-in for Oracle RMAN. HPE StoreOnce Systems offer high performance and reliability while addressing data growth through HPE StoreOnce data deduplication technology. The RMAN Plug-in gives DBAs full control of database backup and recovery. HPE StoreOnce Systems integrate easily with Oracle RMAN to protect important mission-critical databases. Combining Oracle RMAN and HPE StoreOnce Systems with the RMAN Plug-in provides a comprehensive data protection solution for Oracle application data.
Useful links

HPE StoreOnce Backup manuals

Oracle manuals
docs.oracle.com

HPE StoreOnce Catalyst Solution Service
Technical data sheet

Learn more at
hpe.com/storage/StoreOnce
hpe.com/storage/StoreOnce/OracleRMAN