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Protecting Oracle Database Appliance – Tape Backup with Symantec NetBackup

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Introduction

The Oracle Database Appliance is an engineered system consisting of hardware, software, and storage that saves customers time and money by simplifying deployment, maintenance, and support of high availability database solutions. The Oracle Database Appliance provides double or triple mirrored redundancy using Automatic Storage Management software. The Database Appliance is comprised of two nodes, each having its own dedicated power, memory, CPU, RAID control, etc. to allow for maximum redundancy. It allows for single instance, Real Application Clusters (RAC) One Node or full Oracle RAC configurations. Additionally, the Database Appliance supports virtualization using Oracle Virtual Machine (OVM). With the high level of redundancy, the chances of a physical failure are remote but still possible (ex. natural disaster or fire). There is also the possibility of logical corruption such as inadvertently deleted records or errors in programming. Due to the possibility of a disaster and/or logical corruption, it is still necessary to backup up the database to provide an extra layer of data protection, along with offsite storage capabilities. Oracle StorageTek (STK) Tape Libraries and Oracle StorageTek Tape Drives offer cost effective solutions for meeting Recovery Point Objectives (RPO) and Recovery Time Objectives (RTO) for the Oracle Database Appliance. The information in this document details how to setup Symantec NetBackup to backup the Oracle Database Appliance using Oracle StorageTek tape products. The information in this document is intended to detail basic configuration of NetBackup (NBU) on the Oracle Database Appliance to allow for RMAN backups directly to tape. A restore example, private network example, and performance tuning example are also included to assist with providing additional knowledge on using NBU with the Oracle Database Appliance, and to assist with optimizing your backup environment.

Hardware and Software

Below is a summary of the hardware and software utilized for Oracle Database Appliance tape tests.

Note: The table below only lists the combinations of hardware/software that were tested. There are newer generations of hardware/software available. Based on the hardware used for testing it is not expected that performance will differ appreciably (especially in a two to four tape drive configuration) as resources on the hardware used for testing were not anywhere close to being consumed. Newer generations of hardware should perform at the same level or better. The most likely limiting factor to performance is the network connection which is limited at 10Gb unless port bonding is implemented followed by the Host Bus Adapter card which if 16Gb Fibre, can handle 32GB of data or if 12Gb SAS, can handle 24Gb of data.

TABLE 1.TEST ENVIRONMENT

HARDWARE/SOFTWARE	VERSION	PURPOSE
Oracle Database Appliance	X3-2, Appliance Manager 12.1.2.1.0	Database Appliance
Oracle Linux	5.10 (Oracle Database Appliance X3-2 & Backup Server)	OS on Database & Backup Server
Oracle Linux Kernel	Oracle Linux 5.10 Kernel = 2.6.39-400.214.3.el5uek (X3-2)	Kernel on Database Server
NetBackup	7.6	Backup Software
Oracle Server X4-2L used for testing, but recommend Oracle Server X5-2	Base Hardware	NetBackup Master/Media Server
Oracle StorageTek SL150	Latest Firmware	Tape Library for Backup
LTO6 Half Height Tape Drives (2)	Latest Firmware	Tape Drives for Backup
12Gb SAS PCIe HBA	Latest Firmware	Tape Connectivity to Media Server

NetBackup Master and Media Server

To manage the backup and recovery operations on the Oracle Database Appliance, a 1u single processor machine has plenty of resources as the Master/Media Server for NetBackup.

Oracle StorageTek Library and Tape Drives

Oracle StorageTek SL150 with two LTO-5 or LTO-6 tape drives. Also compatible are the Oracle StorageTek SL500 or SL24/48 with LTO tape drives (LTO6 not supported in SL24/48).

Operating System

The NetBackup Master/Media Server has Oracle Linux installed.

Backup Software

NetBackup Server software and associated licensing.

Connectivity

This section explains the different interfaces that will be utilized in this environment.

Ethernet

The NetBackup Master/Media Server requires a GbE or 10GbE connection to the Oracle Database Appliance depending on which interface will be used for backup.

Serial Attached SCSI (SAS)

A single SAS HBA card in the NetBackup Master/Media Server is used to attach each tape drive directly to the NBU Master/Media Server.

Diagram of Configuration

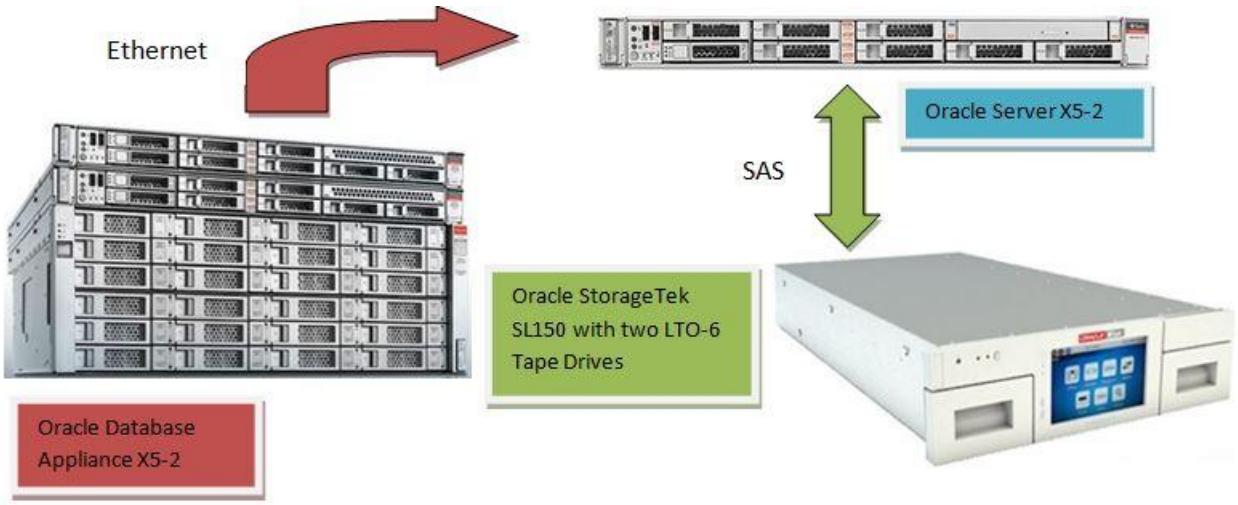

Figure 1: Physical components and connections for Oracle Database Appliance tape solution.

Date Synchronization

Ensure you are using Network Time Protocol (NTP) or have all the dates/times between all servers involved in this configuration in sync.

Oracle StorageTek Tape Configuration

The Oracle StorageTek (STK) SL150 is a modular library system with high capacity and high reliability which can be attached to a host via fiber channel or SAS. This configuration will utilize a SAS connection. The SL150 is a bridged library which means robot control commands are channeled through one of the tape drives (no separate connection for the robot). If this is a new library, follow the instructions in the SL150 documentation to setup the library. Following the initial setup of the SL150; connect the tape drives to the NBU Master/Media Server. To connect the SL150 to the Oracle Server X5-2 NBU Master/Media Server use a multi-pronged SAS cable, or individual SAS cables, to hook each tape drive to one or both of the SAS ports on the X5-2 SAS HBA card. See figures 2 & 3 below:

Physical Attachments

Figure 2: Rear of Oracle StorageTek SL150 tape library with two LTO SAS attached tape drives.

Figure 3: Rear of Oracle Server X5-2 with multi-pronged SAS cable connected to SAS HBA card.

Library Monitoring

After initial library configuration, the Oracle StorageTek Library Browser User Interface (BUI) can be used to monitor, re-configure and operate the SL150 library. SL150 BUI is pictured in figure 4:

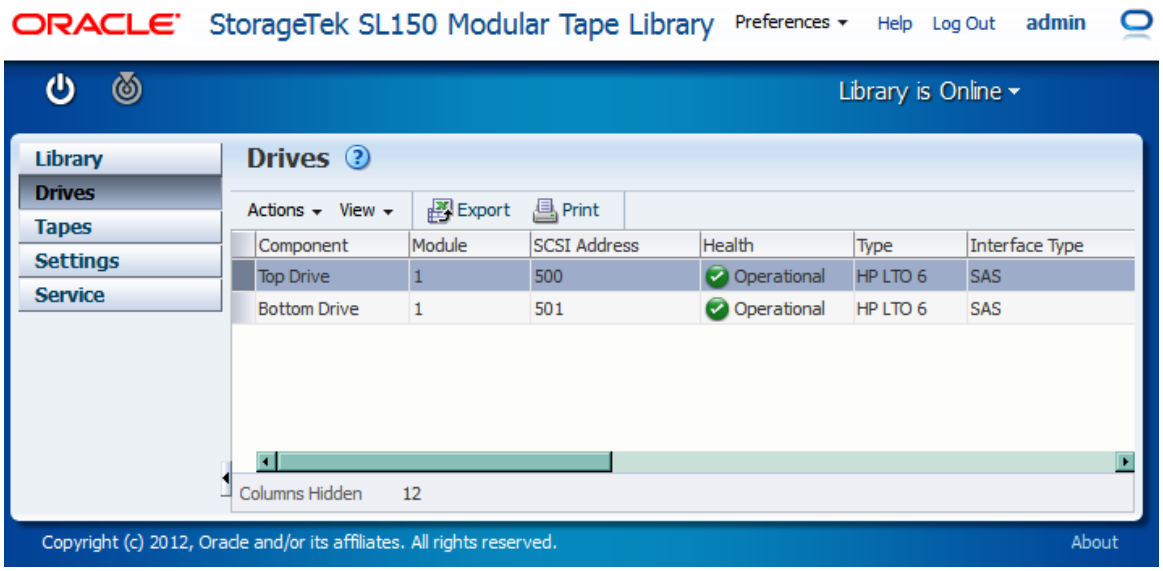

Figure 4: Oracle StorageTek SL150 Modular Tape Library BUI.

Library Drive OS Verification

Use the sg utility to verify you can see the Oracle StorageTek tape library and LTO-6 tape drives on the NetBackup Master/Media Server (sg_map requires sg3 utilities to be installed in Linux. See MOS note 1461798.1 for details on installing RPM's to the Oracle Database Appliance):

```
[root@xman2 ~]# sg_map -i -x
/dev/sg0  0 0 0 0  1  /dev/nst0  HP       Ultrium 6-SCSI    32DS
/dev/sg1  0 0 1 0  1  /dev/nst1  HP       Ultrium 6-SCSI    32DS
/dev/sg2  0 0 1 1  8  STK      SL150          0182
/dev/sg3  1 0 0 0  0  /dev/sda  HITACHI   H106030SDSUN300G  A2B0
/dev/sg4  1 0 1 0  0  /dev/sdb  HITACHI   H106030SDSUN300G  A2B0
/dev/sg5  1 0 2 0  0  /dev/sdc  HITACHI   H106030SDSUN300G  A2B0
/dev/sg6  1 0 3 0  0  /dev/sdd  HITACHI   H106030SDSUN300G  A2B0
/dev/sg7  1 0 4 0  0  /dev/sde  HITACHI   H106030SDSUN300G  A2B0
/dev/sg8  1 0 5 0  0  /dev/sdf  HITACHI   H106030SDSUN300G  A2B0
/dev/sg9  1 0 6 0  0  /dev/sdg  HITACHI   H106030SDSUN300G  A2B0
/dev/sg10  1 0 7 0  0  /dev/sdh  HITACHI   H106030SDSUN300G  A2B0
/dev/sg11  8 0 0 0  0  /dev/sdi  ORACLE    SSM               PMAP
```

From the above output the Oracle StorageTek tape library (STK SL150) and two HP LTO-6 (Ultrium 6) drives are present.

NBU Configuration

NetBackup configuration for tape backup with the Oracle Database Appliance is comprised of several tasks including OS setup, installation of the NetBackup software, linking the RMAN library, configuring storage devices, configuring policies, communication verification and modifying host properties.

Note: Not all screen shots are displayed in the following sections, only the key ones. Always refer to the NetBackup documentation for additional details (links in Appendix).

Modify /etc/hosts files

Modification of the /etc/hosts files on the NBU Master/Media server and database nodes depends on which network interface will be used for backup, and the DNS setup in the environment. If the primary network is used for backup, and all hosts are in DNS, no changes to /etc/hosts files are required. If DNS, or another naming service, is not available, then the NBU Master/Media server needs to be added to /etc/hosts on each database node and each database node needs to be added to /etc/hosts on the NBU Master/Media Server. The example and screen shots in this paper detail setup of a backup using the primary public Ethernet interface. If you plan to use one of the additional interfaces available on the Oracle Database Appliance for backups over a private network, please see the NBU Private Network Configuration section near the end of this document for details on that configuration.

Install NetBackup

For additional details on NetBackup installation, please refer to the NetBackup Installation heading in the Appendix:

1. Install NetBackup Server software on the Sun server designated as the NBU Master/Media Server (host **xman2** in this example). Specify hostname **xman2** as the name of the Master Server. When prompted as to whether or not you have Media Servers specify no (this is an all in one Master/Media Server). Generally, other than the hostname specification, all defaults will be chosen during the installation, but answer installation questions per your environment and refer to the Symantec documentation for further details.

   Example:
   Enter the name of the NetBackup server: xman2

   Is xman2 the master server? [y,n] (y)
   Do you have any media servers? [y,n] (n)

2. Install NetBackup Client software on each of the database servers. Prior to installation ensure xinetd is running on each of the database servers. Use the appropriate hostname based on the network to be used for transferring backup data (**hamms1 & hamms2 in this example**).

Modify bp.conf files

Modification of the NBU bp.conf files is only necessary if you plan to use a private network for your backups. See NBU Private Network Configuration section of this document for further details.

Link RMAN to NetBackup

Link the Oracle RMAN binary to NetBackup (Repeat on each database server):

1. Log in as root to the database server.
2. Switch user to oracle: **su – oracle**
3. Change to lib directory in Oracle Home: **cd $ORACLE_HOME/lib**
4. Execute NetBackup link script: **/usr/openv/netbackup/bin/oracle_link**
5. Verify link: l**s -l $ORACLE_HOME/lib/libobk.so**

Verify Communications

1. From the NBU Master/Media Server (xman2) launch the NetBackup GUI:
   /usr/openv/netbackup/bin/jnbSA&

2. Navigate to the Media Server list: NetBackup Management->Host Properties->Media Servers. You should see xman2 in the list. Select it and a green check box should appear indicating you are connected to the server (see figure 5):

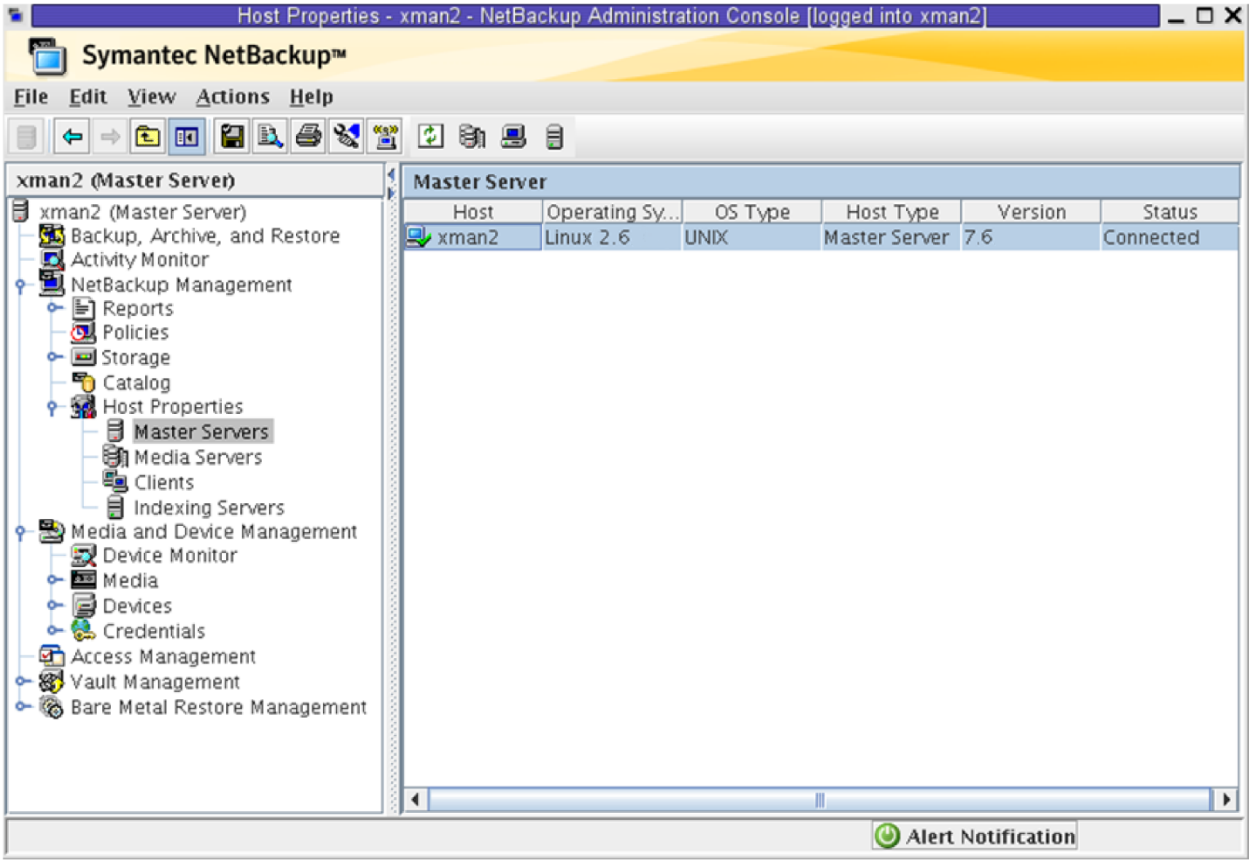

Figure 5: NetBackup Host Properties Media Server list.

Configuring Storage Devices

1. Use the Configuration Wizard and follow the prompts to configure your storage devices. For this configuration the robot and tape drives should be discovered on the Master/Media Server – xman2 (see figure 6):

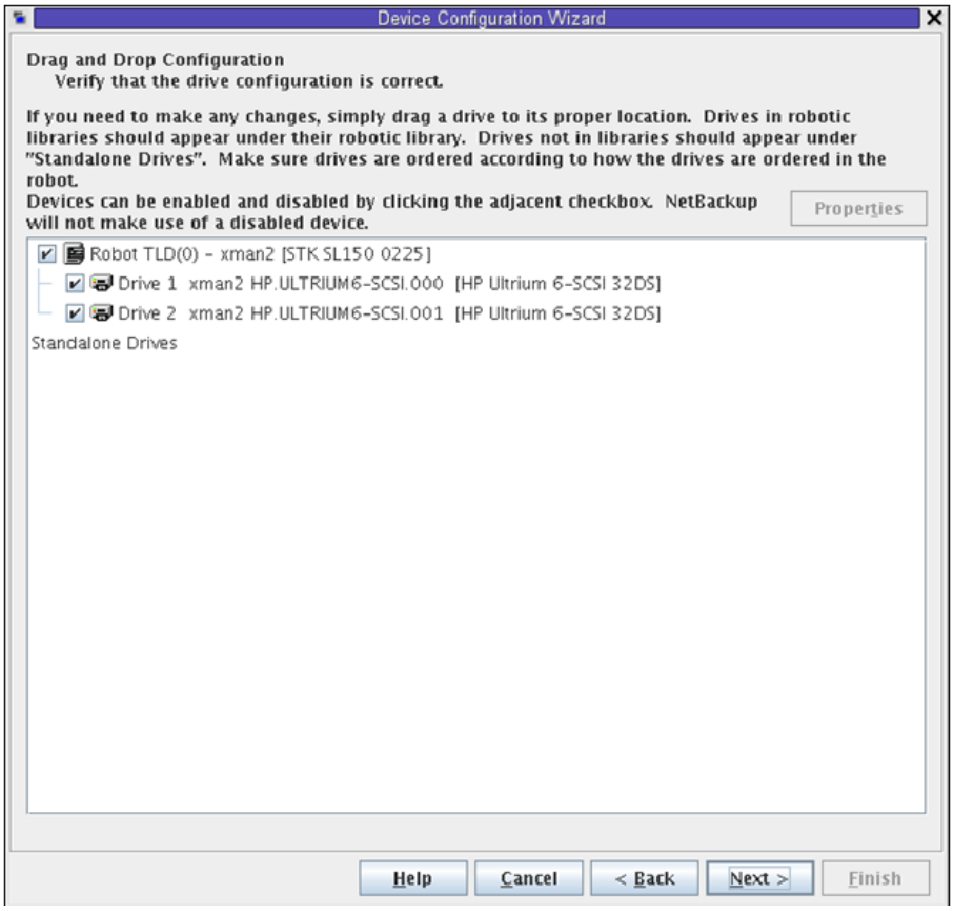

Figure 6: NetBackup Device Configuration Wizard.

2. Navigate to Media and Device Management-> Devices->Drives and then Media Management->Devices->Robots to verify your configuration.
3. Inventory the robot and setup tape pools per your organizational rules.

4. Navigate to NetBackup Management->Storage->Storage Units and verify that a Storage Unit was created during the device configuration (xman2-hcart2-robot-tld-0 in this example). See figure 7 below:

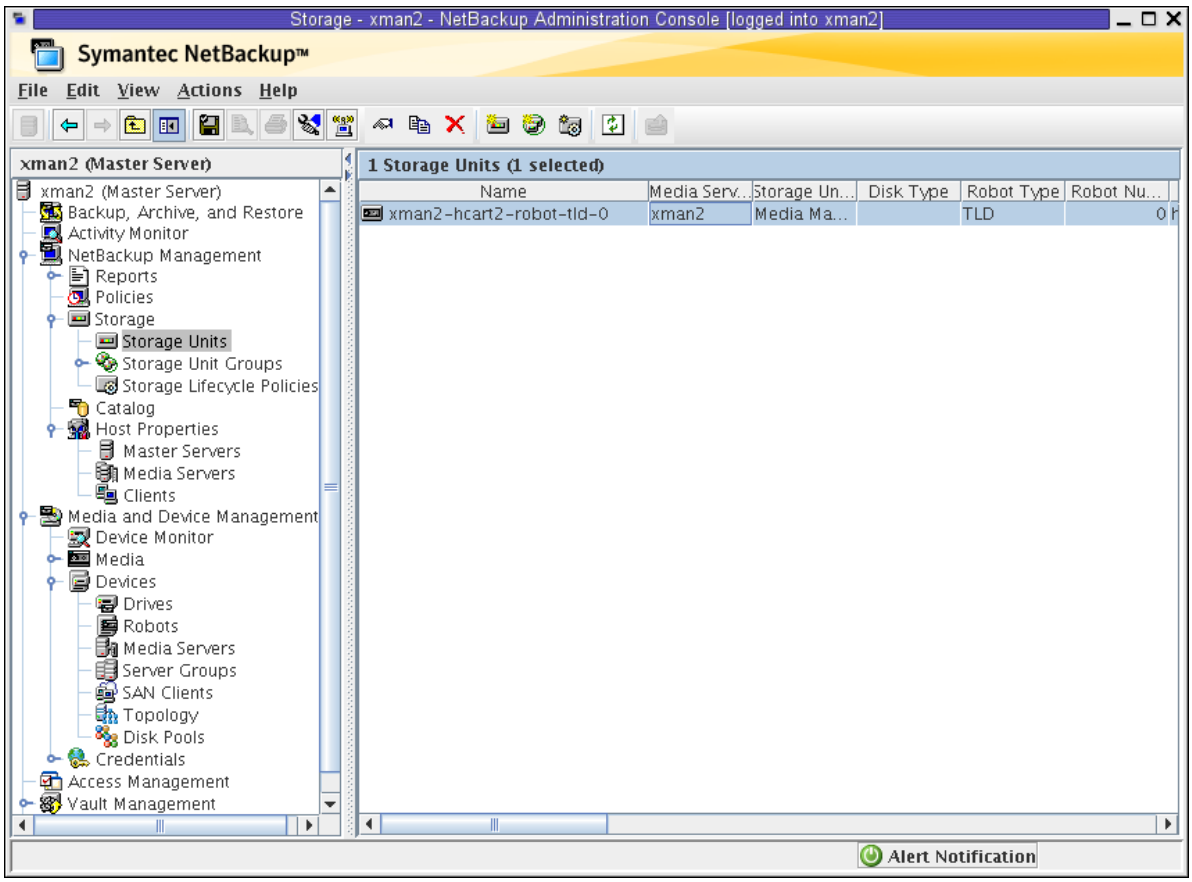

Figure 7: NetBackup Storage Units.

Create NetBackup Policies

For this configuration, two NetBackup policies are setup for RMAN operations. The first policy called Automatic-Oracle is setup to control scheduled execution of the RMAN script. A defined schedule is created in the policy (daily full for example), the client which will execute the script is selected, and the path to the RMAN script on the selected database node (you can setup multiple nodes for script execution in case one is down, but that is not covered in this document) is supplied as the backup selection. The only purpose of the 1st policy is to execute the RMAN script on the defined schedule. The 2nd policy which will be called OracleAppPolicy contains a Default Application Schedule and the names of each node in the RAC cluster. This policy is required to allow access to the NBU server from the Oracle RAC nodes as well as defining which storage resources are available to the Oracle RAC nodes. Since the RMAN script is executed on one of the RAC nodes, it is considered a user-defined backup and NetBackup needs a method to authorize the database nodes to access the NBU server resources for backup jobs. Authorization is accomplished via this policy. In the OracleAppPolicy policy you specify a storage unit, define the backup window and specify the clients (the database nodes). No backup selection is specified as that is controlled by the RMAN script. You could potentially have both schedules in the same policy, but they are setup separately here for a better illustration. Please consult the NetBackup for Oracle Administrator's Guide linked in the Appendix for further details.

Automatic-Oracle Policy

1. Navigate to NetBackup Management->Policies, right click with the mouse cursor in the All Policies list and select New Policy. Name the policy Automatic-Oracle and click OK to advance to the Attributes section of the policy(see figure 8):

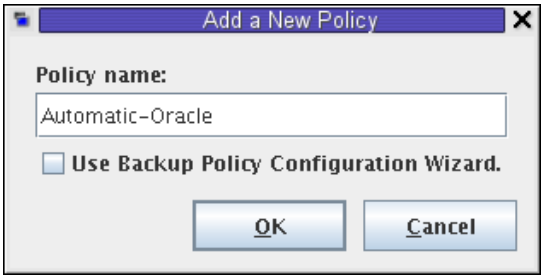

Figure 8: NetBackup Policy name screen for Add a New Policy

2. Set policy type to **Oracle.**
3. Set Policy Storage to Storage Unit to **xman2-hcart2-robot-tld-0**.
4. Set Policy Volume Pool to the pool you are using.
   See figure 9 below:

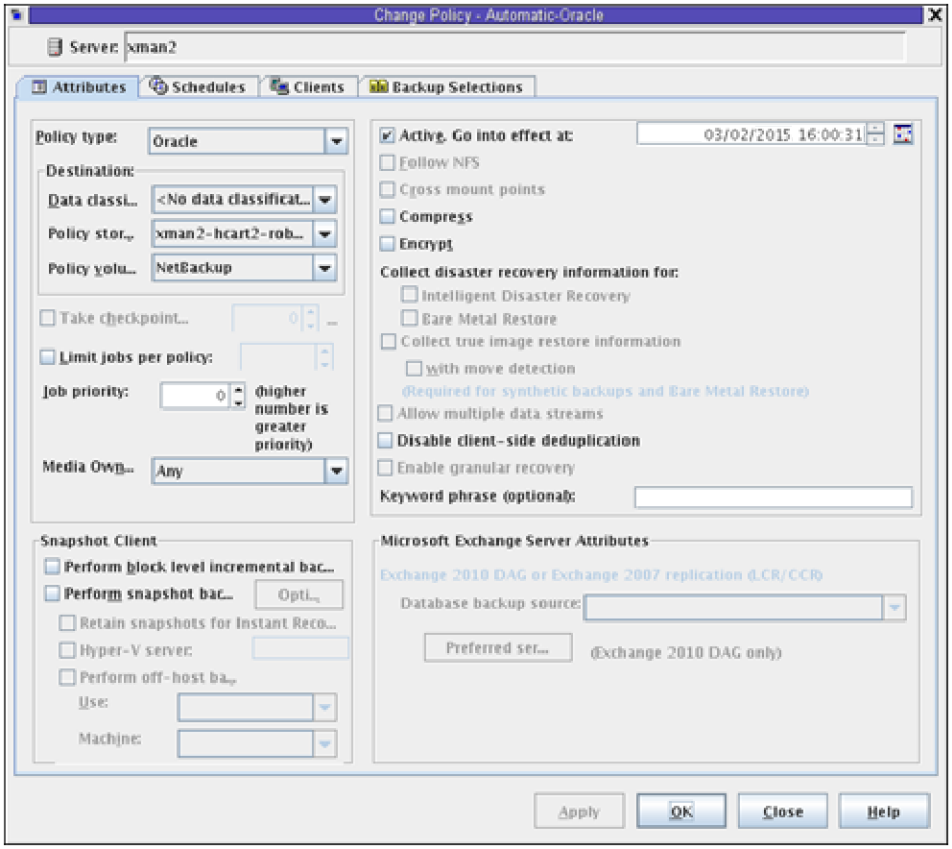

Figure 9: NetBackup Attributes screen for Add a New Policy.

Create schedules for your backups. In this example we are creating a full backup with the **Automatic Full Backup** Type (see figure 10):

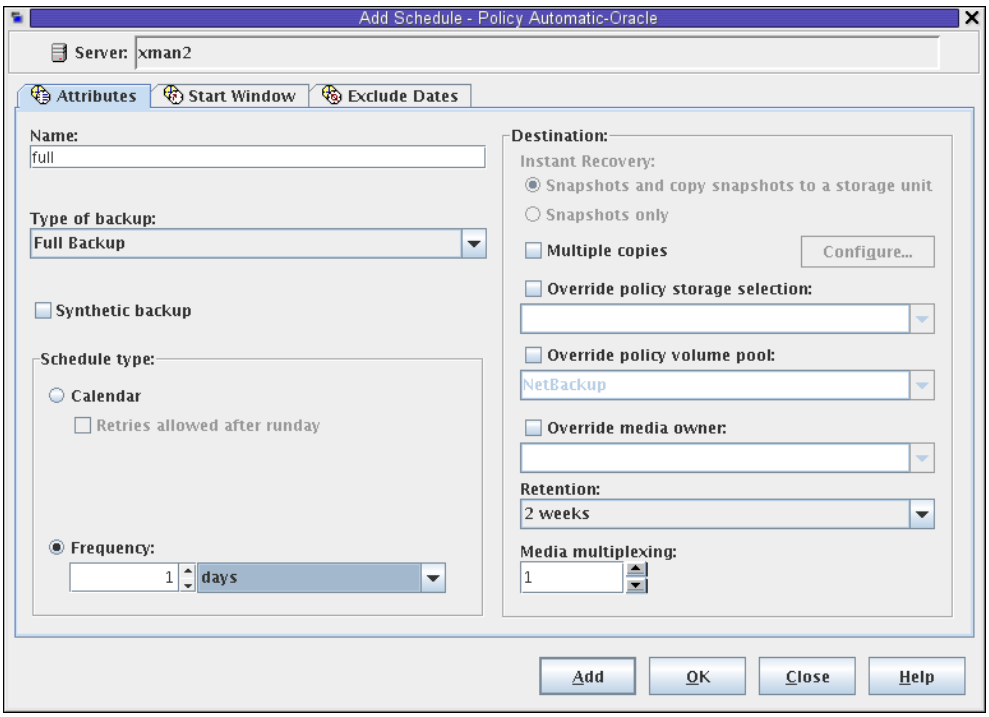

Figure 10: NetBackup Add Schedule Attributes screen for Add a New Policy.

Define your **Start Window** to the time frame that you want your backups to run (see figure 11):

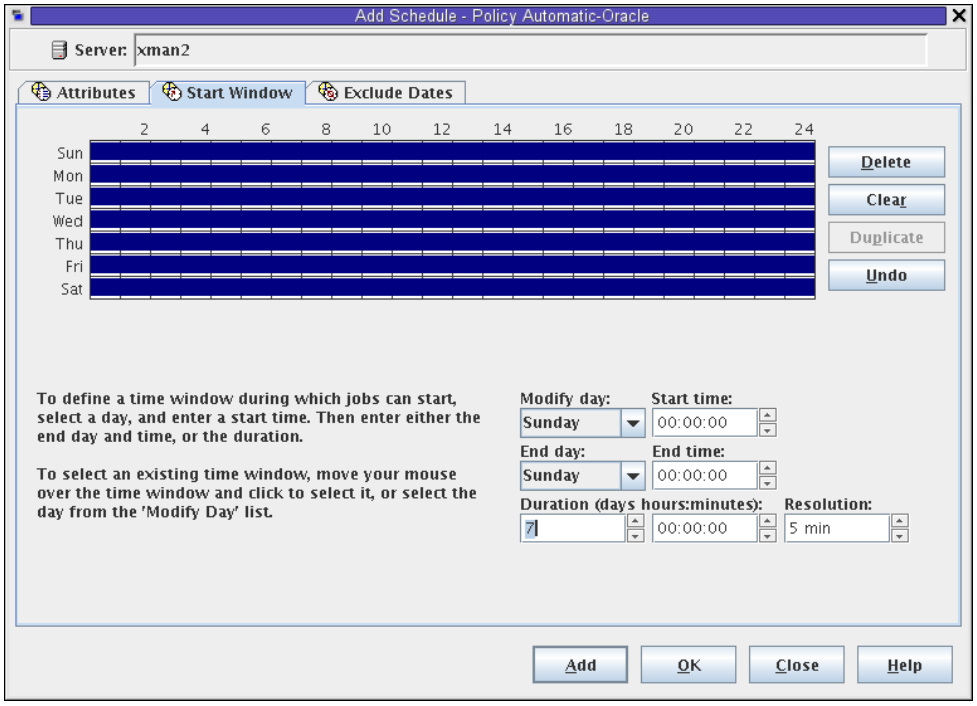

Figure 11: NetBackup Add Schedule Start Window screen for Add a New Policy.

Define your clients. The client in this example is the host which will execute the RMAN script. In this example **hamms1** is used to execute the RMAN script. If you wish to have redundancy you can setup this entry using the Single Client Access Name (SCAN), and specify the SCAN address here. Note that other setup is also required in hosts files, bp.conf files, and specific Oracle Database files to allow the SCAN address to work. Setting up SCAN is beyond the scope of this document; please refer to your Oracle documentation (see figure 12):

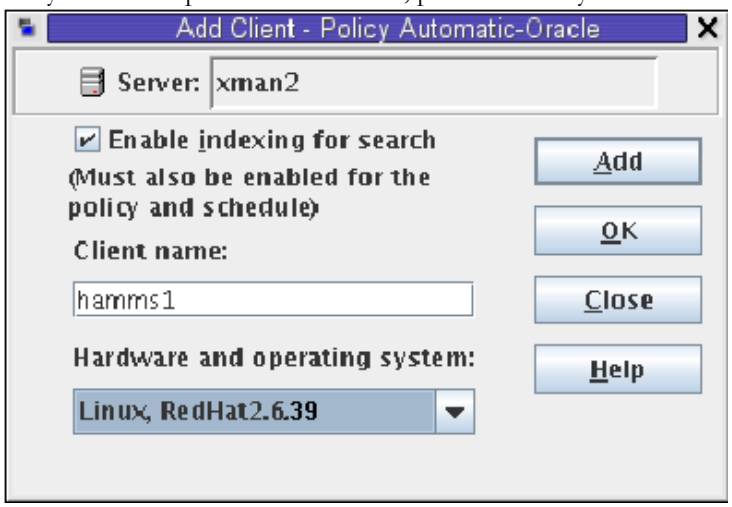

Figure 12: NetBackup Add Client screen for Add a New Policy.

Note: **hamms1** is the only client being added to the Clients tab in this example.

Define the backup selection to include the path to the RMAN script (script creation covered in a later section of this document) on **hamms1** (see figure 13):

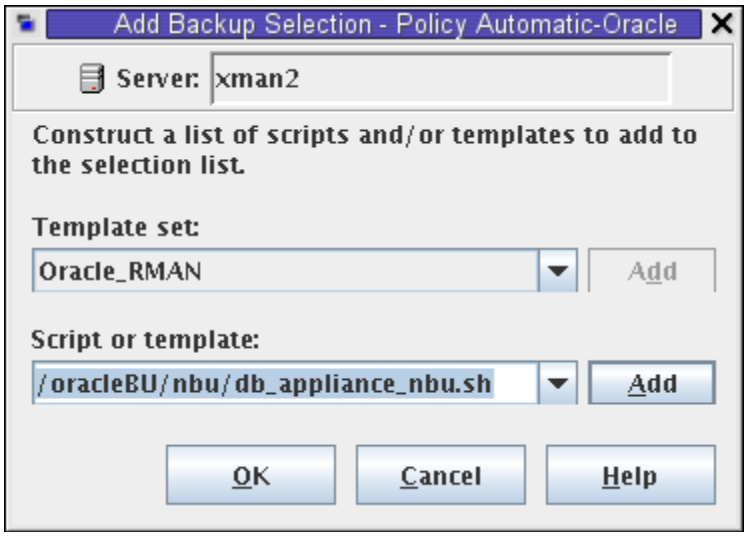

Figure 13: NetBackup Add Backup Selection screen for Add a New Policy.

Note: This is the path to the script on the database server(s) not the NBU Master/Media server.

OracleAppPolicy

1. Navigate to NetBackup Management->Policies, right click with the mouse cursor in the All Policies list and select New Policy. Name the policy OracleAppPolicy and click OK to advance to the Attributes section of the policy (see figure 14):

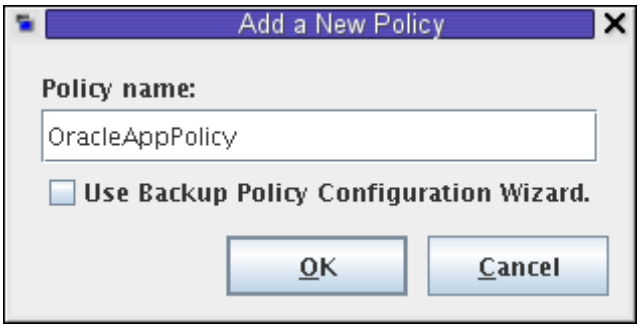

Figure 14: NetBackup Policy name screen for Add a New Policy.

2. Set policy type to **Oracle.**
3. Set Policy Storage to Storage Unit Group **xman2-hcart2-robot-tld-0.**
4. Set Policy Volume Pool to the pool you are using.
   See figure 15:

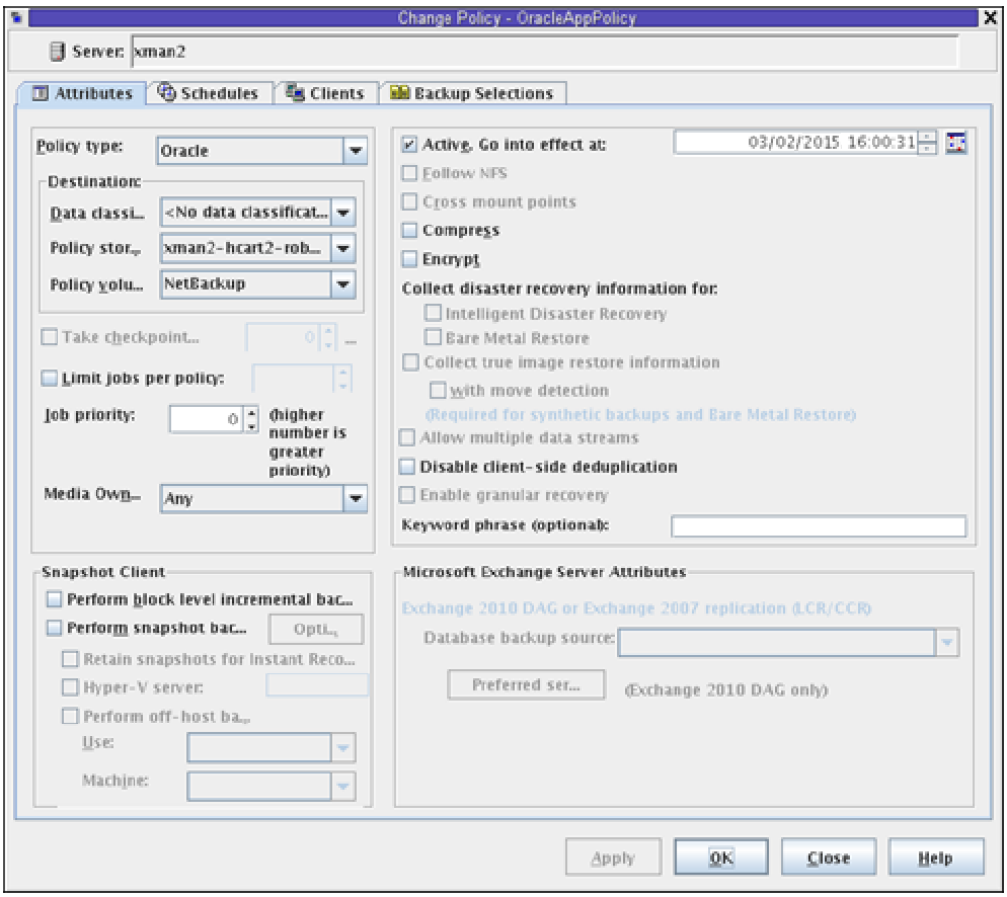

Figure 15: NetBackup Attributes screen for Add a New Policy.

Create an application backup schedule for your backups. You must use Type **Application Backup** for RMAN to work successfully (see figure 16):

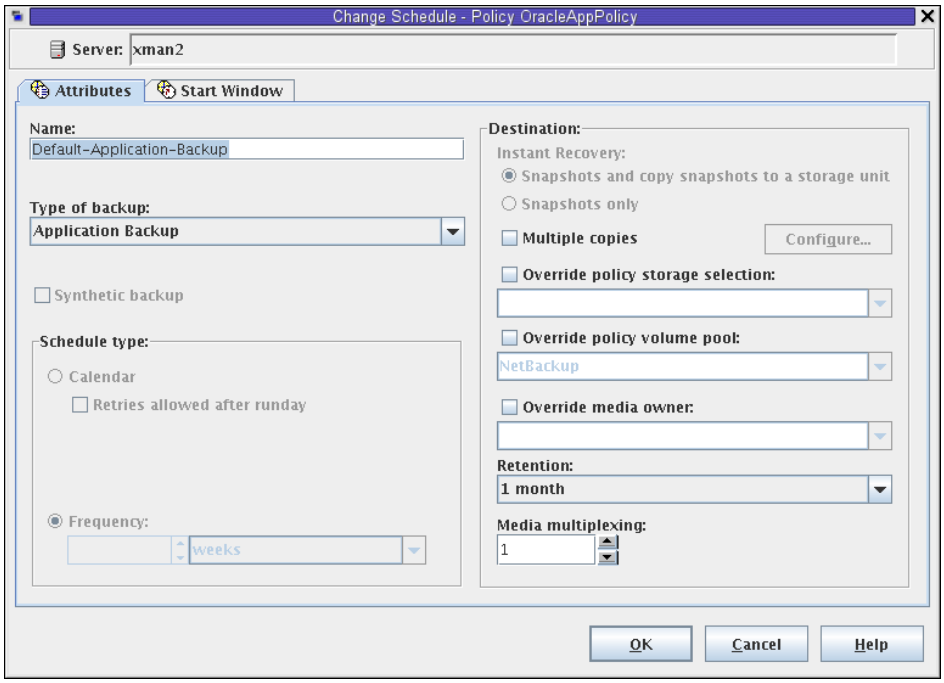

Figure 16: NetBackup Add Schedule Attributes screen for Add a New Policy.

Define your start window to be open for 24 hours. The primary schedule is controlled by the first policy you created (Automatic-Oracle). This policy needs have its start window open for 24 hours to ensure it covers the same time frame as the other policy (see figure 17):

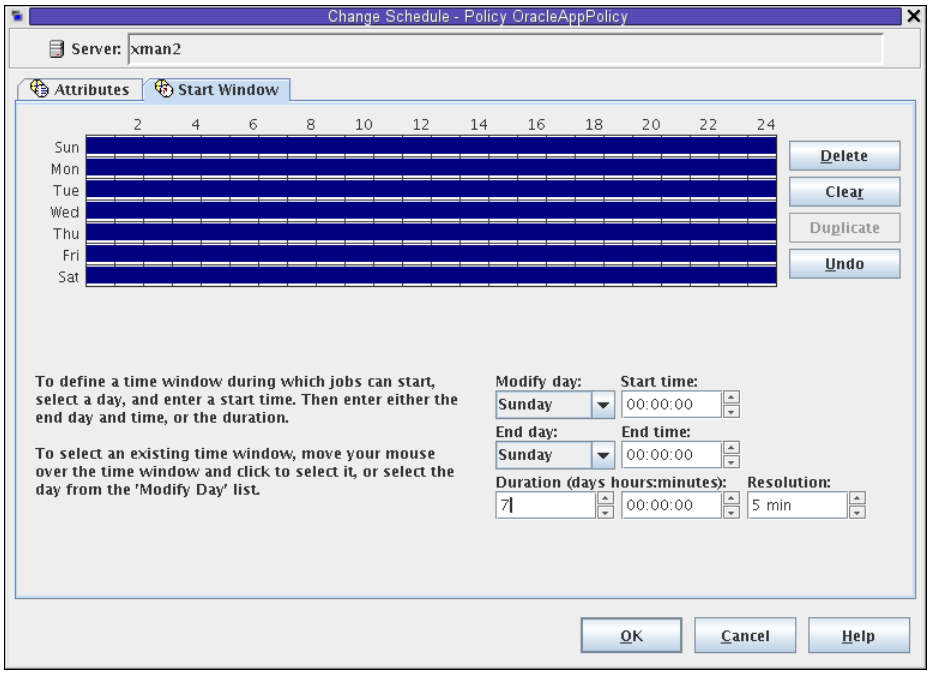

Figure 17: NetBackup Add Schedule Start Window screen for Add a New Policy.

Define your clients. Each database server needs to be defined as a client in this section (see figures 18, 19, & 20):

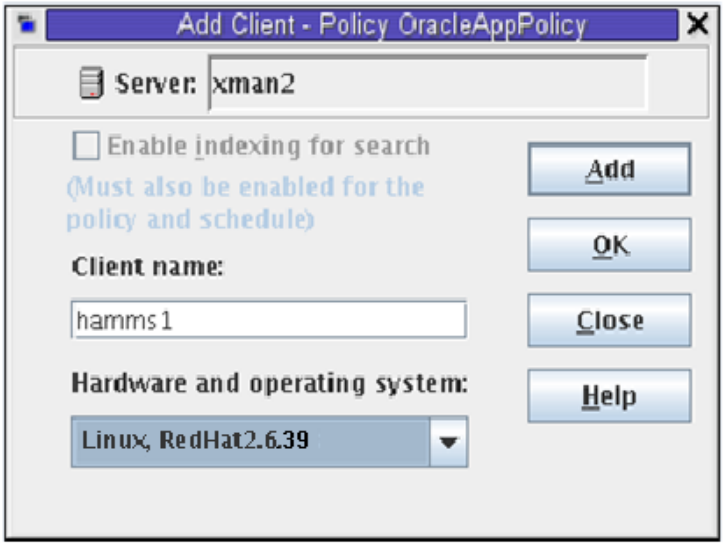

Figure 18: NetBackup Add Client Policy name screen for Add a New Policy.

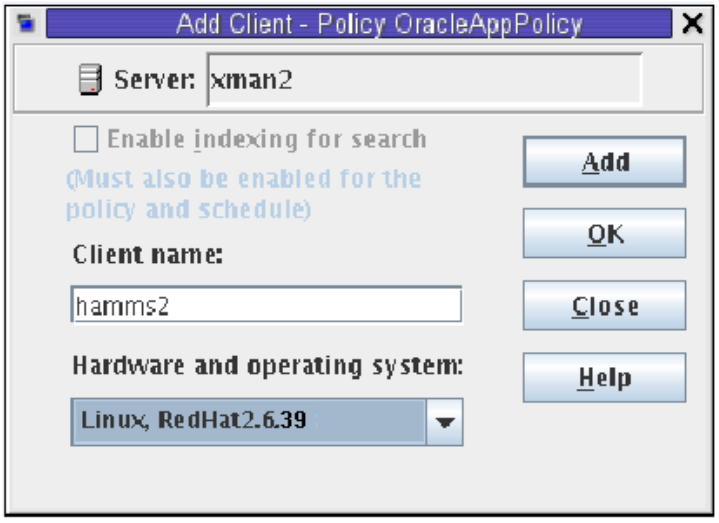

Figure 19: NetBackup Add Client Policy name screen for Add a New Policy.

After adding each client, the Clients tab in the policy should look as follows (see figure 20):

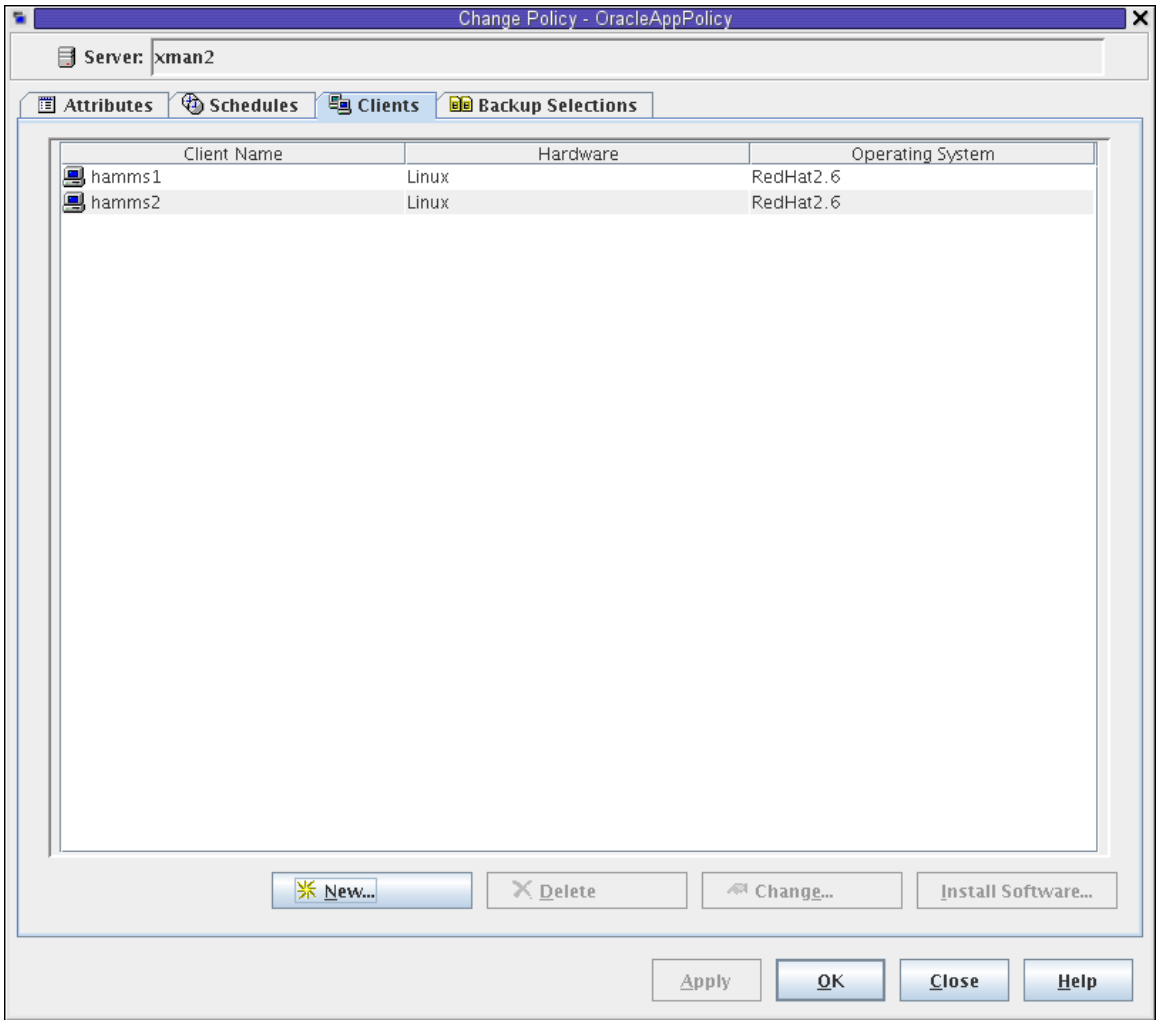

Figure 20: NetBackup Clients screen for Add a New Policy.

The Backup Selections section is left blank, as RMAN controls what is being backed up based on the settings in the RMAN script.

Verify NetBackup Clients

Navigate to NetBackup Management->Host Properties->Clients and you should see hamms1 and hamms2 listed. Select each one and a green check box should appear indicating that you are connected to each client (see figure 21).

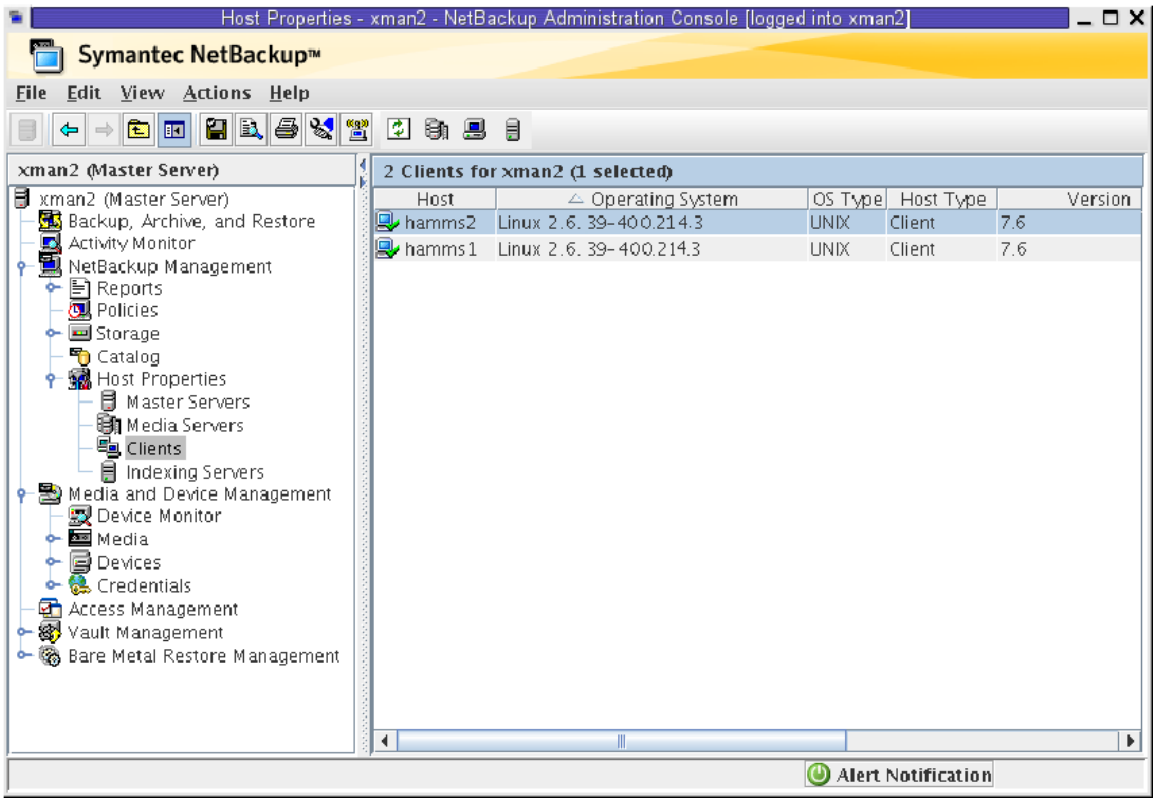

Figure 21: NetBackup Host Properties Clients screen.

NetBackup Host Property Configuration

Navigate to NetBackup Management->Host-Properties->Master Servers and change the "Maximum jobs per client" to be greater than or equal to the maximum number of active RMAN channels to be used – two in this configuration (see figure 22).

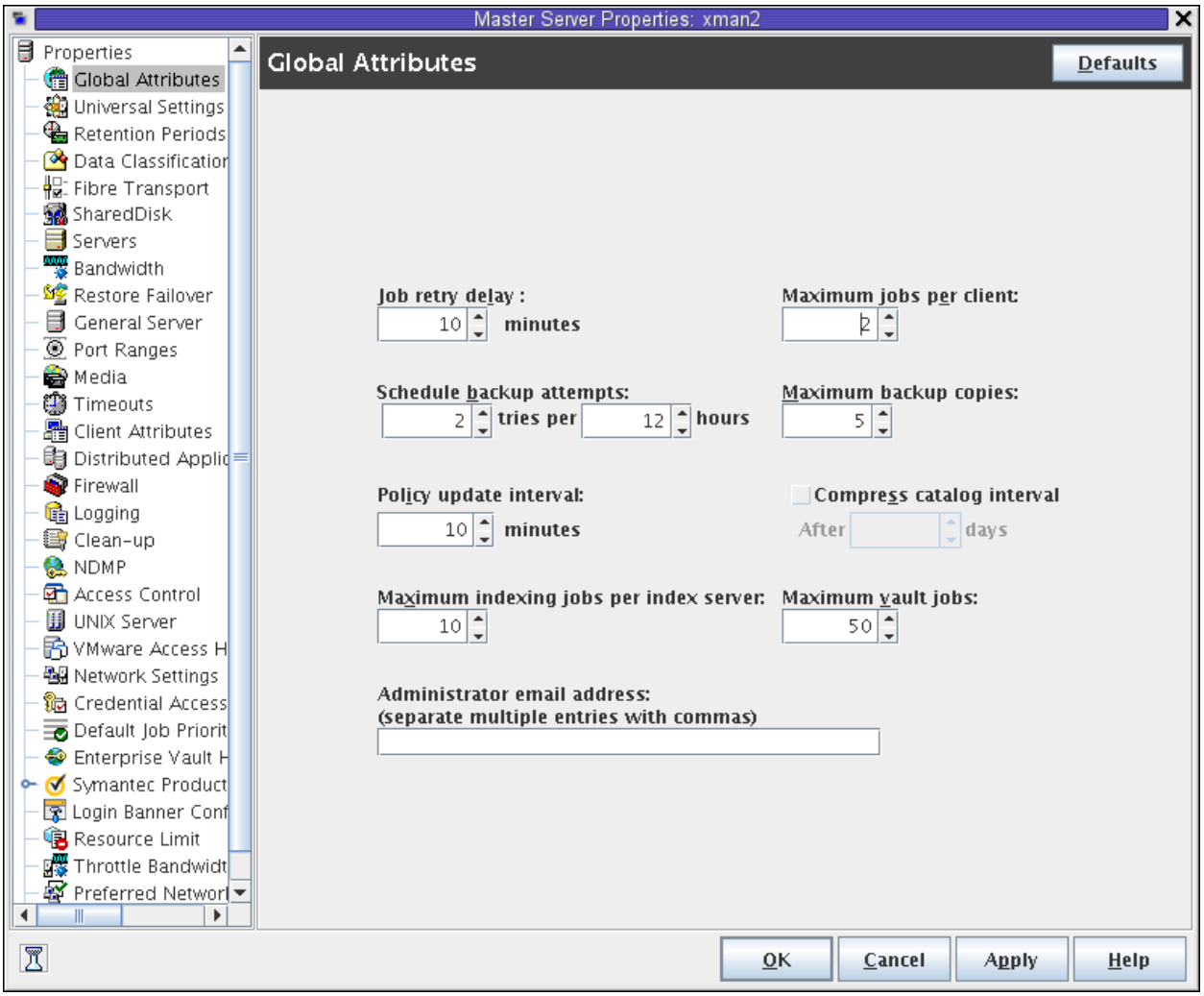

Figure 22: NetBackup Master Server Properties screen.

RMAN Script

In the previous section a policy was setup to execute the RMAN script. The RMAN script must now be created. Additionally, the tnsnames setup for the Oracle Database must be modified to allow for proper script execution.

Copy RMAN Template

Copy the hot database backup template script from the NetBackup RMAN examples on the NBU client to the location you specified in the NBU Automatic-Oracle policy under Backup Selections. This operation should be done logged in as the root user. Do this operation on one client, modify the script to match your environment, and then copy the script to each of the other database hosts, if needed (i.e. using SCAN address).

Example: host hamms1 will be used to create the script and it will be copied to location /oracleBU/nbu.

1. mkdir -p /oracleBU/nbu
2. cp /usr/openv/netbackup/ext/db_ext/oracle/samples/rman/hot_database_backup.sh /oracleBU/nbu/db_appliance_nbu.sh
3. Ensure the RMAN script is executable for owner and group:
   chmod 770 db_appliance_nbu.sh

Modifications of RMAN Script

Change the ORACLE_HOME entry to match your specific ORACLE_HOME path:

Example: **ORACLE_HOME=/u01/app/oracle/product/12.1.0.2/dbhome_1**

Change the ORACLE_SID to match your SID:

Example: **ORACLE_SID=isr1**

Change environment variables to match your Oracle installation:

ORACLE_BASE=/u01/app/oracle
LD_LIBRARY_PATH=$ORACLE_HOME/lib
export ORACLE_BASE LD_LIBRARY_PATH

Change the ORACLE_USER to the user executing RMAN:

Example: **ORACLE_USER=oracle**

Change the TARGET_CONNECT_STR to match the authentication for your environment:

Example: **TARGET_CONNECT_STR=sys/welcome1**

Beginning in the section CMD_STR= Modify the allocation of channels for the backup section of the script. The number of channels allocated needs to match the number of tape drives on the NetBackup Master/Media Server (2 in this example). Also note that a round robin allocation from each database host is being setup (e.g. first channel to hamms1, second channel to hamms2,). For any blank spaces between allocate channel entries there must be a pound comment sign, otherwise problems will occur. Also note that the policy name specified for NB_ORA_POLICY must match the policy name created in NetBackup.

```
$RMAN target $TARGET_CONNECT_STR nocatalog msglog $RMAN_LOG_FILE append << EOF
RUN {
ALLOCATE CHANNEL ch00 TYPE 'SBT_TAPE'
PARMS='ENV=(NB_ORA_CLIENT=hamms1,NB_ORA_SERV=xman2,NB_ORA_POLICY=OracleAppPoli
cy)' CONNECT='sys/welcome1@isr1';
ALLOCATE CHANNEL ch01 TYPE 'SBT_TAPE'
PARMS='ENV=(NB_ORA_CLIENT=hamms2,NB_ORA_SERV=xman2,NB_ORA_POLICY=OracleAppPoli
cy)' CONNECT='sys/welcome1@isr2';
```

The default section of the CMD_STR section is split into three parts. In the first section channels are allocated, the database is backed up, and the channels are released. In the second section channels are allocated, the archive logs are backed up, and the channels are released. In the third section channels are allocated, the control file is backed up, and channels are released. To simplify the script remove each section, allocate channels only once (per above) and run command:

```
BACKUP AS BACKUPSET INCREMENTAL LEVEL 0 DATABASE INCLUDE CURRENT
CONTROLFILE PLUS ARCHIVELOG;
```

Finally release the allocated channels:

```
RELEASE CHANNEL ch00;
RELEASE CHANNEL ch01;
}
EOF
```

Required tnsnames.ora Changes

In order to evenly spread the backup load across each of the database servers, the database server executing the RMAN script (hamms1 in this example) must be able to open RMAN channels on the other database server. This requires modifications to the tnsnames.ora file on each database server.

1) Modify the /u01/app/oracle/product/12.1.0/dbhome_1/network/admin/tnsnames.ora file with a text editor

Original file:

```
[root@hamms1 admin]# cat tnsnames.ora
# tnsnames.ora Network Configuration File:
/u01/app/oracle/product/12.1.0/dbhome_1/network/admin/tnsnames.ora
# Generated by Oracle configuration tools.


HAMMS =
(DESCRIPTION =
(ADDRESS = (PROTOCOL = TCP)(HOST = hamms-scan)(PORT = 1521))
(CONNECT_DATA =
(SERVER = DEDICATED)
(SERVICE_NAME = isr)
)
)
```

2) Modify the file on each node to look as follows:

```
# tnsnames.ora Network Configuration File:
      /u01/app/oracle/product/12.1.0/dbhome_1/network/admin/tnsnames.ora
# Generated by Oracle configuration tools.

HAMMS =
  (DESCRIPTION =
   (ADDRESS = (PROTOCOL = TCP)(HOST = hamms-scan)(PORT = 1521))
   (CONNECT_DATA =
   (SERVER = DEDICATED)
   (SERVICE_NAME = isr)
  )
 )
hamms1 =
  (DESCRIPTION =
    (ADDRESS = (PROTOCOL = TCP)(HOST = hamms1)(PORT = 1521))
    (CONNECT_DATA =
    (SERVER = DEDICATED)
    (SERVICE_NAME = isr)
    (SID = isr1)
  )
 )
hamms2 =
  (DESCRIPTION =
  (ADDRESS = (PROTOCOL = TCP)(HOST = hamms2)(PORT = 1521))
  (CONNECT_DATA =
  (SERVER = DEDICATED)
  (SERVICE_NAME = isr)
  (SID = isr2)
   )
  )
```

3) After modifying tnsnames.ora verify ownership/permissions on the file to ensure they are correct:
   i) Owner should be oracle
   ii) Group should be oinstall
   iii) Permissions should be rw-r----- or 640 octal

NetBackup Alternate Restore Configuration

When you run parallel backups across database nodes, permissions on restores become an issue, because as far as NetBackup is concerned different nodes own different pieces of the backup. In the RMAN script above, two channels were allocated but to separate nodes (hamms1 and hamms2). If you try to restore the database backup from a single node you will encounter errors accessing any pieces owned by the other node. Additionally, if you try to allocate channels to both nodes during restores without conducting the required setup in NetBackup, it will also fail. To allow this configuration to work properly, you must enable alternate restores in NetBackup for the database nodes.

On the NetBackup Master/Media server execute the following steps:

1) cd /usr/openv/netbackup/db
2) mkdir altnames
3) cd altnames

4) echo hamms1 >> hamms1
5) echo hamms2 >> hamms1
6) cp hamms1 hamms2

The end result is that you have two files – one named hamms1 and one named hamms2, both containing the contents:

hamms1
hamms2

There are several different scenarios for alternate restores in NetBackup and all require the altnames directory to be setup. In the restore example illustrated later in this document we are allocating the channels to the same hosts that were used during backup, but this scenario assumes both nodes are present and available for use during the restore. You can also link the node names in the NetBackup catalog so either node can restore the other node's pieces, but you must be careful that regular filesystem backups do not get mixed in with the database backups. Please refer to the following collateral for complete information about alternate restores in an Oracle RAC configuration with NetBackup:

Pages 201-207 in:

Symantec NetBackup 7.6 for Oracle Administrator's Guide

Technote:

Steps needed to restore an Oracle Real Application Cluster (RAC) database that has been backed up via multiple node names

Execute Backup Test

NetBackup setup is now complete. Cycle the daemons on the NetBackup Master/Media server to ensure all configurations changes are refreshed. Execute a backup by manually executing the Automatic backup schedule (**Automatic-Oracle**) from the NBU GUI and monitor the jobs.

Restoring the Database

In the event of a logical database corruption, or a complete disaster, restoration of the database from tape can be executed. While it is possible to configure and execute a restore from the NetBackup GUI (Refer to NBU documentation), in most instances the Database Administrator (DBA) will be conducting the restoration, and will be executing the restore job from the machine where the database resides. The DBA will use RMAN to request the needed backup pieces from the NBU Media Management Layer. The RMAN backup pieces are cataloged in the controlfile, or RMAN Catalog if using Recovery Manager with catalog, and NBU also knows about the pieces in its own catalog. If a complete disaster has occurred and the Oracle Database Appliance has been re-imaged, you will also require the DBID of your database to perform the restore.

Restore Demonstration

There are many different restore scenarios available with RMAN, depending on the type of problem encountered in the database (consult RMAN documentation for complete information). For this example, assume that one or more controlfiles are damaged and so are some of the datafiles that underlay the database. Also assume all archive logs are intact in the Fast Recovery Area (FRA). The basic steps in the RMAN restore process are to restore the controlfile, restore the database, and then recover the database. After the controlfile is restored, the database will know which backup pieces are needed based on data contained in the restored controlfile. If the archive logs are still available in the FRA you can use them to recover up to present or to a specific point in time (they are available

in this example). If the archive logs have to be recovered you can only recover up until the point in time of the last archive log. This is known as an incomplete recovery.

Example of steps to restore and recover database:

From hamms1 execute the following

[oracle@hamms1 ~]$ rman target /

Recovery Manager: Release 12.1.0.2.0- Production on Mon Mar 02 15:30:24 2015

connected to target database: HAMMS (DBID=1458682921)

RMAN> shutdown immediate;

using target database control file instead of recovery catalog
database closed
database dismounted
Oracle instance shut down

**** Also login to hamms2 with SQL Plus and execute a shutdown immediate****

RMAN> startup nomount;

connected to target database (not started)
Oracle instance started

Total System Global Area 25654751232 bytes

Fixed Size 2238472 bytes
Variable Size 2818574328 bytes
Database Buffers 22749904896 bytes
Redo Buffers 84033536 bytes

RMAN> run
2> {
3> ALLOCATE CHANNEL ch00 TYPE 'SBT_TAPE' PARMS
'ENV=(NB_ORA_CLIENT=hamms1,NB_ORA_SERV=xman2)' ;
4> restore controlfile from autobackup;
5> }

allocated channel: ch00
channel ch00: SID=688 instance=isr1 device type=SBT_TAPE
channel ch00: Veritas NetBackup for Oracle - Release 7.6 (2013111313)

Starting restore at 02-MAR-2015

channel ch00: looking for AUTOBACKUP on day: 20150302
channel ch00: AUTOBACKUP found: c-2670003667-20150302-00
channel ch00: restoring control file from AUTOBACKUP c- 2670003667-20150302-00

```
channel ch00: control file restore from AUTOBACKUP complete
output file name=+DATA/hamms/control01.ctl
Finished restore at 02-MAR-15
released channel: ch00

RMAN> alter database mount;

database mounted
```

****Also login to hamms2 and run startup mount; so you can open a channel on hamms2 for a parallel restore****

```
RMAN> run
2> {
3> SET AUTOLOCATE ON;
4> ALLOCATE CHANNEL ch00 TYPE 'SBT_TAPE' PARMS
'ENV=(NB_ORA_CLIENT=hamms1,NB_ORA_SERV=xman2)' CONNECT='sys/welcome1@isr1';
5> ALLOCATE CHANNEL ch01 TYPE 'SBT_TAPE' PARMS
'ENV=(NB_ORA_CLIENT=hamms2,NB_ORA_SERV=xman2)' CONNECT='sys/welcome1@isr2';
6> restore database;
7> }

executing command: SET autolocate

allocated channel: ch00
channel ch00: SID=461 instance=isr1 device type=SBT_TAPE
channel ch00: Veritas NetBackup for Oracle - Release 7.6 (2013111313)

allocated channel: ch01
channel ch01: SID=916 instance=isr2 device type=SBT_TAPE
channel ch01: Veritas NetBackup for Oracle - Release 7.6 (2013111313)

Starting restore at 02-MAR-2015
Starting implicit crosscheck backup at 02-MAR-2015
Crosschecked 5 objects
Finished implicit crosscheck backup at 02-MAR-2015

Starting implicit crosscheck copy at 02-MAR-2015
Finished implicit crosscheck copy at 02-MAR-2015

searching for all files in the recovery area
cataloging files...
cataloging done

List of Cataloged Files
=======================
File Name: +reco/ HAMMS/ARCHIVELOG/2015_03_02/thread_2_seq_3.394.775292957

channel ch00: starting datafile backup set restore
channel ch00: specifying datafile(s) to restore from backup set
channel ch00: restoring datafile 00001 to +DATA/hamms/datafile/system.257.774705241
channel ch00: restoring datafile 00004 to +DATA/hamms/datafile/undotbs2.261.774705283
```

```
channel ch00: restoring datafile 00005 to +DATA/hamms/datafile/users.262.774705285
channel ch00: reading from backup piece 4bn3c1le_1_1
channel ch01: starting datafile backup set restore
channel ch01: specifying datafile(s) to restore from backup set
channel ch01: restoring datafile 00002 to +DATA/hamms/datafile/sysaux.258.774705249
channel ch01: restoring datafile 00003 to +DATA/hamms/datafile/undotbs1.259.774705253
channel ch01: reading from backup piece 4cn3c1rh_1_1
channel ch01: piece handle=4cn3c1rh_1_1 tag=TAG20150302T105513
channel ch01: restored backup piece 1
channel ch01: restore complete, elapsed time: 00:02:05
channel ch00: piece handle=4bn3c1le_1_1 tag=TAG20150302T105513
channel ch00: restored backup piece 1
channel ch00: restore complete, elapsed time: 00:04:16
Finished restore at 02-MAR-2015
released channel: ch00
released channel: ch01


RMAN> run
2> {
3> SET AUTOLOCATE ON;
4> ALLOCATE CHANNEL ch00 TYPE 'SBT_TAPE' PARMS
'ENV=(NB_ORA_CLIENT=hamms1,NB_ORA_SERV=xman2)' CONNECT='sys/welcome1@isr1';
5> ALLOCATE CHANNEL ch01 TYPE 'SBT_TAPE' PARMS
'ENV=(NB_ORA_CLIENT=hamms2,NB_ORA_SERV=xman2)' CONNECT='sys/welcome1@isr2';
6> recover database;
7> }

executing command: SET autolocate

allocated channel: ch00
channel ch00: SID=461 instance=hamms1 device type=SBT_TAPE
channel ch00: Veritas NetBackup for Oracle - Release 7.6 (2013111313)

allocated channel: ch01
channel ch01: SID=916 instance=hamms2 device type=SBT_TAPE
channel ch01: Veritas NetBackup for Oracle - Release 7.6 (2013111313)

Starting recover at 02-MAR-2015

starting media recovery

archived log for thread 1 with sequence 2 is already on disk as file
+RECO/hamms/archivelog/2015_03_02/thread_1_seq_2.392.775292653
archived log for thread 1 with sequence 3 is already on disk as file
+REDO/hamms/onlinelog/group_1.256.774705197
archived log for thread 2 with sequence 2 is already on disk as file
+RECO/hamms/archivelog/2015_03_02/thread_2_seq_2.393.775292849
archived log for thread 2 with sequence 3 is already on disk as file
+RECO/hamms/archivelog/2015_03_02/thread_2_seq_3.394.775292957
archived log file name=+RECO/ hamms/archivelog/2015_03_02/thread_1_seq_2.392.775292653 thread=1
sequence=2
archived log file name=+RECO/hamms/archivelog/2015_03_02/thread_2_seq_2.393.775292849 thread=2
```

sequence=2
archived log file name=+REDO/hamms/onlinelog/group_1.256.774705197 thread=1 sequence=3
archived log file name=+RECO/hamms/archivelog/2015_03_02/thread_2_seq_3.394.775292957 thread=2 sequence=3
Finished recover at 02-MAR-2015
released channel: ch00
released channel: ch01

RMAN> alter database open resetlogs;

database opened

RMAN>

****Also login to hamms2 and run alter database open; to bring the 2nd instance back online****

NBU Private Network Configuration

The NBU configuration in this paper utilized the public network interface for the database backup traffic. It is a perfectly valid configuration as you may have idle time overnight to execute a database backup. However, depending on your organization's backup requirements, it may also be necessary to offload backup traffic to one of the other interfaces on the Oracle Database Appliance (Ex. alleviate traffic on the public network, faster backup time required, etc.). The following example details how to setup NetBackup to use a 10GbE bonded interface for database backups.

OS Setup

First you must configure the 10GbE interfaces on the Master/Media server, and each of the database nodes. For this example, assume you have configured the following host names and IP addresses for the Master/Media Server and the database nodes:

xman2-xbond0 – 192.168.10.100
hamms1-xbond0 – 192.168.10.101
hamms2-xbond0 – 192.168.10.102

If the hostnames are not in the DNS map, or other naming service map, they must be in the local hosts file on each of the servers in the configuration (xman2, hamms1, and hamms2).

NetBackup Setup

To configure the 10GbE interface for NetBackup you would follow the same procedures used in the NBU Configuration section of this document, installing the Master/Media server with the public hostname xman2, and installing each client with the public names of hamms1 and hamms2. Once the software is installed the changes below are required in the NBU setup to direct the traffic across the 10GbE interface. Alternatively, if this NetBackup Master/Media server is dedicated to the Oracle Database Appliance you can install it using the names of the private interfaces on the hosts (xman2-xbond0 for the Master/Media and hammsx-xbond0 for the clients) and the setup would be identical to the public interface setup described in this paper. If the NetBackup Master Server is required to backup other clients that have no access to the private network, you need to use this procedure.

NetBackup bp.conf modification

The NetBackup bp.conf files must be edited to allow for traffic on the 10GbE interface.

There are no changes required to the xman2 bp.conf file.

hamms1 original bp.conf file:

SERVER = xman2
CLIENT_NAME = hamms1
CONNECT_OPTIONS = localhost 1 0 2

hamms1 modified bp.conf file:

SERVER = xman2-xbond0
SERVER = xman2
CLIENT_NAME = hamms1-xbond0
CONNECT_OPTIONS = localhost 1 0 2

hamms2 original bp.conf file:

SERVER = xman2
CLIENT_NAME = hamms2
CONNECT_OPTIONS = localhost 1 0 2

hamms2 modified bp.conf file:

SERVER = xman2-xbond0
SERVER = xman2
CLIENT_NAME = hamms2-xbond0
CONNECT_OPTIONS = localhost 1 0 2

NBU Policy Setup

For the Automatic-Oracle policy the client name on the Clients tab of the policy needs to be hamms1-xbond0 instead of hamms1.

For the OracleAppPolicy the client names on the Clients tab of the policy need to be:

hamms1-xbond0
hamms2-xbond0

instead of

hamms1
hamms2

NetBackup Alternate Restore Configuration

NetBackup alternate restore configuration must also be modified for the private network hostnames:

1) cd /usr/openv/netbackup/db/altnames
2) echo hamms1-xbond0 >> hamms1-xbond0
3) echo hamms2-xbond0 >> hamms1-xbond0
4) cp hamms1-xbond0 hamms2-xbond0

RMAN Script Changes

Any RMAN scripts being used on the clients must have their channel allocation strings modified to use the private hostnames:

ALLOCATE CHANNEL ch00 TYPE 'SBT_TAPE' PARMS='ENV=(NB_ORA_CLIENT=hamms1-xbond0,NB_ORA_SERV=xman2-xbond0,NB_ORA_POLICY=OracleAppPolicy)' CONNECT='sys/welcome1@isr1';
ALLOCATE CHANNEL ch01 TYPE 'SBT_TAPE' PARMS='ENV=(NB_ORA_CLIENT=hamms2-xbond0,NB_ORA_SERV=xman2-xbond0,NB_ORA_POLICY=OracleAppPolicy)' CONNECT='sys/welcome1@isr2';

Execution

After making the changes to the bp.conf, policy setup, alternate restore configuration, and RMAN scripts, the backup execution would be the same as detailed above in the paper for the public network interface setup.

Additional information

For additional information on NetBackup private interface setup please refer to technotes under the NetBackup Network Configuration section of the Appendix.

Performance Tuning

The NetBackup default settings for transferring data to tape are set generically and must be tuned to match your environment, in order to achieve maximum transfer rates. There are two key setting in NBU used to tune tape performance – SIZE_DATA_BUFFERS and NUMBER_DATA_BUFFERS. The SIZE_DATA_BUFFERS setting controls the block size of data chunks written to tape and the NUMBER_DATA_BUFFERS setting controls the number of buffers that can be used when writing to tape.

Before any tuning can be executed, you must first identify if you have a bottleneck and where the bottleneck is in the transfer path. This activity requires NBU logging to be enabled. Perform the following operations:

Capture Data

- Enable the NetBackup bptm log on the NetBackup Master/Media server (mkdir /usr/openv/netbackup/logs/bptm and cycle daemons).
- Execute a backup of the Oracle Database Appliance to capture data in the bptm log.
- Once the job completes run the following command to capture the job transfer rate:
  - more /usr/openv/netbackup/logs/bptm/log.DATE | grep –i kbytes/sec (Note: Using bptm provides transfer rate minus time required to mount and position)
  - Example of a 2 channel job over 10GbE:
    Stream 1
    14:35:36.873 [5203] <4> write_backup: successfully wrote backup id hamms1-xbond0 _1332444634, copy 1, fragment 1, 520759328 Kbytes at 134037.478 Kbytes/sec
    Stream 2
    14:32:09.754 [5218] <4> write_backup: successfully wrote backup id hamms2-xbond0 _1332444635, copy 1, fragment 1, 490357280 Kbytes at 133351.920 Kbytes/sec
- Analyze the BPTM log to identify if/when you are waiting for "full buffers"
  - more /usr/openv/netbackup/logs/bptm/log.DATE | grep –i "waited for full"
  - Example:
    Stream 1 (520759328 Kbytes)
    03/02/2015 14:35:24 - Info bptm (pid=5203) waited for full buffer 133685 times, delayed 136084 times
    Stream 2 (490357280 Kbytes)

03/02/2015 14:31:57 - Info bptm (pid=5218) waited for full buffer 118447 times, delayed 120079 times

Note: This data can also be retrieved from the NBU GUI in the Activity Monitor Job Details window.

Interpret Data

If there is excessive waits for full buffers, as in the example above, this indicates that the NBU bptm process is not receiving data fast enough. The NUMBER_DATA_BUFFERS and SIZE_DATA_BUFFERS files should be modified to reduce the waits. These files are text files stored in the /usr/openv/netbackup/db/config directory on the Master/Media Server. Note that they do not exist by default and should be created. Each file contains a single numeric value for the setting. The NUMBER_DATA_BUFFERS is an integer value and the SIZE_DATA_BUFFERS is also an integer value, but must be specified in increments of 1024 (ex. 32K = 32768).

If the bptm log shows waiting for empty buffers, then data is arriving faster than it can be written to tape. In this scenario tune the NUMBER_DATA_BUFFERS to see if the waits can be reduced.

Optimize

Modify the NUMBER_DATA_BUFFERS, SIZE_DATA_BUFFERS and execute additional backup jobs to measure performance. Check bptm for full buffers and repeat procedure until no further speed improvements are achieved. When you are finished tuning remember to disable NetBackup logging to avoid filling up the disk location where NBU resides.

Output after tuning to a 1MB block size (1048576 in SIZE_DATA_BUFFERS) and 256 buffers (256 in NUMBER_DATA_BUFFERS):

Stream 1
16:17:34.206 [10949] <4> write_backup: successfully wrote backup id hamms1-xbond0_1332451734, copy 1, fragment 1, 520759328 Kbytes at 179497.350 Kbytes/sec

03/02/2015 16:17:20 - Info bptm (pid=10949) waited for full buffer 20 times, delayed 93 times
Stream 2
15:58:29.941 [10973] <4> write_backup: successfully wrote backup id hamms2-xbond0_1332451737, copy 1, fragment 1, 490357280 Kbytes at 279384.526 Kbytes/sec

03/02/2015 15:58:17 - Info bptm (pid=10973) waited for full buffer 8 times, delayed 20 times

You can see the transfer rate is improved and the waits/delays have been reduced greatly. Rates will also vary depending on the data. For the above jobs, stream1 included the SYSTEM and SYSAUX tables which have mostly unique data and therefore a lower compression rate. Stream 2 contained the core data which achieved a much higher compression rate and therefore the speed was faster (179MBs for stream 1 vs. 279MBs for stream2).

Please see the NetBackup tuning guide referenced in the Appendix for more details.

Hardware Compression

By default most tape drives have compression enabled, and it is recommended to compress at the tape drive level. You can experiment with compression using RMAN, but if you opt to enable compression at a different layer of the backup architecture you must disable tape drive compression to avoid doubling compression, which can result in larger backups and slower transfer rates.

Recommended tuning by tape drive

The table below shows the transfer rates achieved in the test environments following tuning.

TABLE2. PERFORMANCE STATISTICS ORACLE DATABASE APPLIANCE X3-2

DRIVE TYPE	NUMBER_DATA_BUFFERS	SIZE_DATA_BUFFERS	INTERFACE	AVERAGE BACKUP TRANSFER RATE PER TAPE DRIVE WITH HARDWARE COMPRESSION	AVERAGE RESTORE TRANSFER RATE PER TAPE DRIVE WITH HARDWARE COMPRESSION
LTO-6	256	1MB (1048576)	10GbE	380 MBs	290MBs
LTO-5	256	1MB (1048576)	10GbE	225 MBs	220 MBs
LTO 5	256	1MB (1048576)	GbE	57MBs	64MBs

Note: Modifying the NUMBER_DATA_BUFFERS in our environment had a negligible effect on transfer rates. The primary differentiator for transfer speeds was the SIZE_DATA_BUFFERS. Experiment in your environment to determine what settings work best for your configuration. Also note that transfer rate will vary depending on the compression ratio achieved.

Note2: The limiting factor on a GbE interface backups is the Ethernet interface on the Master/Media server, not the tape drives. Each node can send up to 120Mbs per second through a GbE interface (bond is active-passive), but the Master/Media can only consume 120MBs total as that is the capacity of the interface. If active-active bonding is configured, and/or more NICs or multiple Medias Servers are used, higher rates could be achieved, as the tape drives were not saturated.

Conclusion

In conclusion, Oracle StorageTek tape products offer cost effective data protection for the Oracle Database Appliance and, when coupled with Symantec NetBackup, provide a complete solution for data protection.

Additional Resources (Appendix)

- NetBackup 7.6 Documentation
- NetBackup for Oracle Administration Guide
- NetBackup Installation
- NetBackup Network Configuration:
- How network interfaces are selected in NetBackup 6.x/7.x when there are multiple NICs on a NetBackup host
- NetBackup Tuning
- Database Appliance Collateral
- RMAN Documentation

Protecting Oracle Database Appliance -Tape Backup with Symantec NetBackup 7.6
March 2015
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