Tagging, Encoding, and Encrypting with RMAN

The Engineering of the Intelligent Backup

Anthony D. NORIEGA, MBA, MSCS, OCP
Speaker Qualifications

- Independent Consultant, ADNR & D
- Speaker at NYOUG meetings, IOUG, Quest, SEOUC, ECO and Oracle Open World Conferences
- 25 years of IT experience
- 21 years of Oracle experience, 17 as a DBA (v6 thru 11g)
- Custom RMAN backup engineering for industry-specific storage architecture and development.
- Backup experience with RMAN and other products in finance, banking, trading, media, marketing, printing, and healthcare industries.
- High availability experience using RAC, AQ, AR, Data Guard, and OFS.
- MBA MIS, Montclair State University, 2006
- MS Computer Science, NJIT, 1993
- PhD CIS candidate, NJIT, 1997
About the Speaker

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Anthony Noriega
Objectives

- Entice the customization of RMAN backups to attain regulatory compliance.
- Provide a versatile framework for a robust, flexible, and reliable backup business model.
- Emphasize the need for custom tagging and encoding in the perspective of optimal backup granularity for reliable complementary backup operations, such as restore and cloning.
- Apply encryption for data protection.
- Present a dynamic backup model to fully secure backup operations.
Business Framework
Typical Backup Issues

- Minimum backup security
- Restore point usually not guaranteed
- Concerns on required integrity and unity
- Backup timeframe lags due to backup simplicity
- Missing exact timestamps on backup sets and pieces
- Unmatched general regulatory compliance
- Lack of encryption for regulatory compliance
- Required password security
- Unreliable operating procedures
- Insufficient integration with other Oracle technologies
- Missing compression capabilities
- Justification for a new improved policy and standard
Backup Models Paradigm Trends

- Backup Integrity, Cohesion, Coupling
- Regulatory Compliance: Data Privacy (Required Tiered Credentials)
- Storage Development Integration (Compression, Cluster File System, etc.)
- Regulatory Compliance: Data Security (Encryption)
- Agility and Automation

Business Framework
Backup Modernization Goals

- **Agility**: Faster backups, better and more reliable results.
- **QoS**: Improved operations performance and reliability.
- **Tiered Credentials**: Privileged DBAs.
- **Storage Infrastructure Integration**: Custom backups using proprietary or vendor technology with user friendly interface.
- **Cloud Integration**: Ability to access virtual, physical, and cluster file system layers with volume management capabilities.
- **Big Data Perspective**: Big Data Support.
Technical Framework
Tagging Strategies

- Oracle default tagging is smart.
- Custom tagging can support corporate backup management and data warehousing integration when managing backup data across platforms.
- Tags are specific to territories, timeframes, business units, goal seeking records and various others.
- Tags can be customized dynamically.
Tagging Strategies

Oracle@localhost:

<table>
<thead>
<tr>
<th>BS Key</th>
<th>Type LV Size</th>
<th>Device Type</th>
<th>Elapsed Time</th>
<th>Completion Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>12576</td>
<td>Incr 0 24.52M DISK</td>
<td></td>
<td>00:01:29</td>
<td>21-MAR-13</td>
</tr>
<tr>
<td>BP Key: 12586</td>
<td>Status: AVAILABLE Compressed: YES Tag: ORCLNLFULL</td>
<td>Piece Name: /home/oracle/app/oracle/flash_recovery_area/orcl/backupset/20130321 ORCL.dbf L0 1458106461554ho52u5k1_l1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>List of Datafiles in backup set 12576</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>File LV Type Ckp SCN Ckp Time Name</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 0 Incr 9921426 21-MAR-13 /home/oracle/app/oracle/oradata/orcl/undotbs01.dbf</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RMAN> list backupset of controlfile;

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

<table>
<thead>
<tr>
<th>BS Key</th>
<th>Type LV Size</th>
<th>Device Type</th>
<th>Elapsed Time</th>
<th>Completion Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>13689</td>
<td>Full 9.39M DISK</td>
<td></td>
<td>00:00:01</td>
<td>21-MAR-13</td>
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<tr>
<td>BP Key: 13700</td>
<td>Status: AVAILABLE Compressed: NO Tag: TAG20130321T113425</td>
<td>Piece Name: /home/oracle/app/oracle/flash_recovery_area/ORCL/autobackup/2013_03_21/o1_mfs_810646465_8npnokv4_.b kp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control File Included: Ckp SCN: 9922921 Ckp time: 21-MAR-13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RMAN>
Tagging Strategies

RMAN> list backupset of database tag 'ORCLLNXFULL';

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

<table>
<thead>
<tr>
<th>BS Key</th>
<th>Type</th>
<th>LV Size</th>
<th>Device Type</th>
<th>Elapsed Time</th>
<th>Completion Time</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Incr</td>
<td>184.75M</td>
<td>DISK</td>
<td>00:12:51</td>
<td>21-MAR-13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BP Key: 12577</td>
<td>Status: AVAILABLE</td>
<td>Compressed: YES</td>
<td>Tag: ORCLLNXFULL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piece Name: /home/oracle/app/oracle/flash_recovery_area/orcl/backupsset/20130321_ORCL_dbf_L0_1428106451334eo52tkd_1_1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List of Datafiles in backup set 12567</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>File LV Type Ckp SCN Ckp Time Name</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Incr</td>
<td>9920590</td>
<td>21-MAR-13</td>
<td>/home/oracle/app/oracle/oradata/orcl/system01.dbf</td>
<td></td>
</tr>
<tr>
<td>BS Key</td>
<td>Type</td>
<td>LV Size</td>
<td>Device Type</td>
<td>Elapsed Time</td>
<td>Completion Time</td>
</tr>
<tr>
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<td>--------------</td>
<td>-----------------</td>
</tr>
<tr>
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<td>381.68M</td>
<td>DISK</td>
<td>00:16:51</td>
<td>21-MAR-13</td>
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<td></td>
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<td></td>
</tr>
<tr>
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<td>Status: AVAILABLE</td>
<td>Compressed: YES</td>
<td>Tag: ORCLLNXFULL</td>
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<td></td>
</tr>
<tr>
<td>Piece Name: /home/oracle/app/oracle/flash_recovery_area/orcl/backupsset/20130321_ORCL_dbf_L0_1408106451324co52tkc_1_1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>List of Datafiles in backup set 12568</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
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<td>9920583</td>
<td>21-MAR-13</td>
<td>/home/oracle/app/oracle/oradata/orcl/sysaux01.dbf</td>
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<td>BS Key</td>
<td>Type</td>
<td>LV Size</td>
<td>Device Type</td>
<td>Elapsed Time</td>
<td>Completion Time</td>
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<td>12569</td>
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<td>00:16:52</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Encoding Strategies

• Backup pieces can be encoded to facilitate schema data physical location within location.
• Custom encoding improves automation with improved backup granularity control.
• Tags can be encoded with a scientific and business perspective for historic research.
FUNCTION sf_simple_encoding (string1 IN VARCHAR2, string2 IN VARCHAR2, string3 IN VARCHAR2) RETURN VARCHAR2 IS
v_custom_tag VARCHAR2(4000);
BEGIN
    SELECT RTRIM(string1)||RTRIM(string2)||RTRIM(string3) AS custom_encode
    INTO v_custom_tag
    FROM dual;

RETURN v_custom_tag;
END sf_simple_encoding;

SQL> begin
    2   dbms_output.put_line('DNA tag is : ||sf_simple_encoding(string1 => 'YDR511W', string2 => 'ATG', string3 => 'TCT'));
    3 end;
    4 /
DNA tag is : YDR511WATGTCT
PL/SQL procedure successfully completed.

SQL> begin
    2   dbms_output.put_line('CERN Test Tag is: ||sf_simple_encoding(string1 => 'CERN', string2 => 'LB716', string3 => 'TST101'));
    3* end;
SQL> /
CERN Test Tag is: CERNLB716TST101
PL/SQL procedure successfully completed.
Encryption Strategies

- Backup encryption is automated and encryption wallet is open transparently for backup operations.
- Supported encryption algorithms are transparent to backup operations.
- Encryption management is a main DBA duty, and the encryption wallet should be secured in accordance with corporate policies and regulatory compliance practices.
Encryption Strategies

Wallet Creation

mkstore -wrl -create

orapki wallet create -wallet .

orapki wallet create -wallet . auto_login_local

mkstore -wrl -createCredential {CredentialString} {dBUserName} [dbusrPw]

mkstore -wrl -createCredential orcl_keyholder1 adndba "syspwd"
Encryption Strategies

Wallet Location

```
[oracle@localhost admin]$ pwd
/home/oracle/app/oracle/product/11.2.0/dbhome_2/network/admin
[oracle@localhost admin]$ ls -lt
total 32
drwxr-xr-x  3 oracle oracle 4096 May 23 16:19 samples
-rw-------  1 oracle oracle  4298 Feb 19 09:32 cwallet.sso
-rw-------  1 oracle oracle  4221 Feb 19 09:32 ewallet.pl2
-rw-rw-r--  1 oracle oracle   799 Feb 19 09:30 sqlnet.ora
-rw-rw-r--  1 oracle oracle   962 Jan 15 08:32 listener.ora
-rw-rw-r--  1 oracle oracle   619 Jan 15 08:20 tnsnames.ora
[oracle@localhost admin]$ 
```
Encryption Strategies

sqlnet.ora settings (Windows)

```
# sqlnet.ora Network Configuration File:

SQLNET.AUTHENTICATION_SERVICES = (NONE)
SSL_CLIENT_VERSION = 0
SSL_VERSION = 1.0
NAMES.DIRECTORY_PATH = (TNSNAMES)
SSL_CLIENTAUTHENTICATION = FALSE
SQLNET.INBOUND_CONNECT_TIMEOUT = 0
ADR_BASE = C:\app\oracle\product\11.2.0\dbhome_4\log
#SQLNET.WALLET OVERRIDE = FALSE

WALLET_LOCATION =
(SOURCE =
 (METHOD = FILE
  (METHOD_DATA =
   (DIRECTORY = c:\app\oracle\product\11.2.0\dbhome_4\network\admin)
  )
 )
)
```
Encryption Strategies

sqlnet.ora settings (Linux or Unix)

```sql
# sqlnet.ora Network Configuration File:

SQLNET.AUTHENTICATION_SERVICES = (NONE)
SSL_CLIENT_VERSION = 0
SQLNET.WALLET_OVERRIDE = FALSE
SSL_VERSION = 0
NAMES.DIRECTORY_PATH = (TNSNAMES)
SSL_CLIENT_AUTHENTICATION = FALSE
SQLNET ENCRYPTION_TYPES_SERVER = (AES128, AES256, 3DES168, AES192, 3DES112, RC4_128)
SQLNET.INBOUND_CONNECT_TIMEOUT = 0
ADR_BASE = /home/oracle/app/oracle/product/11.2.0/dbhome_2/log

WALLET_LOCATION =
  (SOURCE =
    (METHOD = FILE
      (METHOD_DATA =
        (DIRECTORY = /home/oracle/app/oracle/product/11.2.0/dbhome_2/network/admin)
      )
    )
  )
```

Technical Framework
Encryption Strategies

- Backup encryption is automated and encryption wallet is open transparently for backup operations.
- Supported encryption algorithms are transparent to backup operations.
- Encryption management is a main DBA duty, and the encryption wallet should be secured in accordance with corporate policies and regulatory compliance practices.

```sql
SQL> get /tmp/cl.sql
1  create table mdprofile (id number primary key using index,
2    last_name  varchar2(30) encrypt using 'AES128',
3    first_name varchar2(30) encrypt ,
4    status     varchar2(10),
5    profile    clob)
6  * tablespace users
SQL> /

Table created.

SQL>
```
Architectural Considerations

Technical Framework
Architectural Considerations

**Technical Framework**
RMAN Configuration Environment

> connected to recovery catalog database

RMAN> show all;

RMAN configuration parameters for database with db_unique_name ORCL are:
CONFIGURE RETENTION POLICY TO RECOVERY WINDOW OF 1 DAYS;
CONFIGURE BACKUP OPTIMIZATION ON;
CONFIGURE DEFAULT DEVICE TYPE TO DISK; # default
CONFIGURE CONTROLFILE AUTOBACKUP ON;
CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '%F'; # default
CONFIGURE DEVICE TYPE DISK PARALLELISM 4 BACKUP TYPE TO BACKUPSET;
CONFIGURE DATAFILE BACKUP COPIES FOR DEVICE TYPE DISK TO 1; # default
CONFIGURE ARCHIVELOG BACKUP COPIES FOR DEVICE TYPE DISK TO 1; # default
CONFIGURE CHANNEL 1 DEVICE TYPE DISK FORMAT '/home/oracle/app/oracle/flash_recovery_area/orcl/backups/%T_%d_orabkp_L0_%s%t%U';
CONFIGURE CHANNEL 2 DEVICE TYPE DISK FORMAT '/home/oracle/app/oracle/flash_recovery_area/orcl/backups/%T_%d_orabkp_L0_%s%t%U';
CONFIGURE CHANNEL 3 DEVICE TYPE DISK FORMAT '/home/oracle/app/oracle/flash_recovery_area/orcl/backups/%T_%d_orabkp_L0_%s%t%U';
CONFIGURE CHANNEL 4 DEVICE TYPE DISK FORMAT '/home/oracle/app/oracle/flash_recovery_area/orcl/backups/%T_%d_orabkp_L0_%s%t%U';
CONFIGURE MAXSETSIZE TO UNLIMITED; # default
CONFIGURE ENCRYPTION FOR DATABASE ON;
CONFIGURE ENCRYPTION ALGORITHM 'AES128'; # default
CONFIGURE COMPRESSION ALGORITHM 'HIGH' AS OF RELEASE 'DEFAULT' OPTIMIZE FOR LOAD TRUE;
CONFIGURE ARCHIVELOG DELETION POLICY TO NONE; # default
CONFIGURE SNAPSHOT CONTROLFILE NAME TO '/home/oracle/app/oracle/product/11.2.0/dbhome_2/dbs/snapcf_orcl.f'; # default

RMAN>
Security Framework

• Transparent Data Encryption (TDE)

• Supported Algorithms
  o AES128
  o AES256

• Wallet and Registry Integration

• Encryption Methods
  HSM, FILE, Registry, Certificates…

• Authentication Methods
  OS Methods (NTS), Kerberos, LDAP…
Planning the Backup Model
Planning the Backup Model
Planning the Backup Model

Technical Framework
Planning the Backup Model

Technical Framework
Planning the Backup Model

```sql
SQL> CREATE OR REPLACE AND COMPILE JAVA SOURCE NAMED "OSCommand" AS
import java.io.*;
public class OSCommand{
public static String Run(String Command){
try{
Runtime.getRuntime().exec(Command);
return("0");
}
catch (Exception e){
System.out.println("Error running command: " + Command + 
\"n" + e.getMessage());
return(e.getMessage());
}
}

Java created.
```

```sql
SQL> CREATE or REPLACE FUNCTION OSCommand_Run(Command IN STRING) RETURN VARCHAR2 IS
LANGUAGE JAVA
NAME 'OSCommand.Run(java.lang.String) return int';

Function created.
```
Planning the Backup Model

```
SQL> CREATE OR REPLACE AND COMPILE JAVA SOURCE NAMED "OSCommand" AS
import java.io.*;
public class OSCommand{
public static String Run(String Command){
try{
Runtime.getRuntime().exec(Command);
return("0");
}
catch (Exception e){
System.out.println("Error running command: " + Command + 
"\n" + e.getMessage());
return(e.getMessage());
}
}

CREATE OR REPLACE
PROCEDURE OSCommandExec(Command IN STRING) IS
LANGUAGE JAVA
NAME 'OSCommand.Run(java.lang.String)';
```
Planning the Backup Model

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.
Backup Components

- Invoking Shell with actual parameters (matching RMAN substitution variables).
- RMAN FlexScript with substitution arguments.
- Encoding functions or prepared customized code as actual substitution variable. Encoding functions can include:
  - Tag Generating functions
  - File system path
  - Backup pieces naming conventions functions
  - Various others
Sample RMAN Flex Script

```sql
set encryption &1;
run {
    allocate channel ch1 type disk;
    sql 'alter system archive log current';
    sql 'begin create_restore_point; end;';
    crosscheck archivelog all;
    release channel ch1;
    allocate channel ch1 type disk;
    allocate channel ch2 type disk;
    allocate channel ch3 type disk;
    allocate channel ch4 type disk;
    set limit channel ch1 kbytes 16577216;
    set limit channel ch2 kbytes 16577216;
    set limit channel ch3 kbytes 16577216;
    set limit channel ch4 kbytes 16577216;
    BACKUP AS &2 BACKUPSET
        INCREMENTAL LEVEL &3 &4
        FORMAT '/home/oracle/app/oracle/flash_recovery_area/orcl/backupset/%T_%d_dbbkp_L0_%s%t%U' tag = &7
    FILESPERSET &6
        (database);
    BACKUP AS &2 BACKUPSET
        INCREMENTAL LEVEL &3 &4
        FORMAT '/home/oracle/app/oracle/flash_recovery_area/orcl/backupset/%T_%d_ctlbkp_L0_%s%t%U' tag = &7
        (current controlfile);
    sql 'alter system archive log current';
    BACKUP AS &2 BACKUPSET
        INCREMENTAL LEVEL &3 &4
        FORMAT '/home/oracle/app/oracle/flash_recovery_area/orcl/backupset/%T_%d_arcbkp_L0_%s%t%U' tag = &7
        (archivelog all);
    backup spfile;
    sql 'alter database backup controlfile to trace';
    release channel ch1;
    release channel ch2;
    release channel ch3;
    release channel ch4;
}
resync catalog;
list backupset of database;
list backupset of controlfile;
list backupset of archivelog all;
list restore point all;
report schema;
validate check logical skip inaccessible database;
restore validate database;
restore validate archivelog all;
report obsolete;
delete noprompt obsolete;
exit;
```
Sample RMAN Flex Script

Recovery Manager: Release 11.2.0.3.0 - Production on Wed May 1 16:54:11 2013
Copyright (c) 1982, 2011, Oracle and/or its affiliates. All rights reserved.

connected to target database: ADNI_BMSX (DBID=2634802274)
connected to recovery catalog database

RMAN> # Will allow for encrypted rman backups without introducing any keys, once the wallet is opened...
RMAN> # should pass tag as a partial parameter for the tag name.
RMAN> 4> set encryption ON;
5> 6> run {
7> allocate <channel ch1 type disk;
8> sql 'alter system archive log current';
9> crosscheck archivelog all;
10> release channel ch1;
11> allocate channel ch1 type disk;
12> allocate channel ch2 type disk;
13> allocate channel ch3 type disk;
14> allocate channel ch4 type disk;
15> set limit channel ch1 kbytes 16577216;
16> set limit channel ch2 kbytes 16577216;
17> set limit channel ch3 kbytes 16577216;
18> set limit channel ch4 kbytes 16577216;
19> backup as backupset incremental level 1
20> format 'C:\app\oracle\flash_recovery_area\adni_bmsx\BACKUPSET\%T_%d_L1_bkp_Db_%s\%t\%u' tag = adni_bmsx_INL1_201305011653
21> filesystem 1 (database);
22> backup as backupset incremental level 1
23> format 'C:\app\oracle\flash_recovery_area\adni_bmsx\BACKUPSET\%T_%d_L1_bkpCtl_%s\%t\%u' tag = adni_bmsx_INL1_201305011653
24> (current controlfile);
25> sql 'alter system archive log current';
26> backup as backupset incremental level 1
27> format 'C:\app\oracle\flash_recovery_area\adni_bmsx\BACKUPSET\%T_%d_L1_bkp_Arc_%s\%t\%u' tag = adni_bmsx_INL1_201305011653
28> (archivelog all);
29> backup spfile;
30> sql 'alter database backup controlfile to trace';
31> release channel ch1;
32> release channel ch2;
33> release channel ch3;
34> release channel ch4;
35> }
36> resync catalog;
37> list backupset of database;
38> list backupset of controlfile;
39> list backupset of archivelog all;
40> list restore point all;
41> report schema;
42> validate check logical skip inaccessible database;
43> restore validate database;
44> restore validate archivelog all;
45> report obsolete;
46> delete noprompt obsolete;
47> exit;
48> executing command: SET encryption
Sample RMAN Flex Script

allocated channel: ch1
channel ch1: SID=26 device type=DISK

sql statement: alter system archive log current

starting full resync of recovery catalog
full resync complete
validation succeeded for archived log
archive log file name:C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADMINBMS\ARCHIVELOG\2013_05_01\01_MF_1_472_BR2CY3XS_.ARC RECID=468 STAMP=814273568
validation succeeded for archived log
archive log file name:C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADMINBMS\ARCHIVELOG\2013_05_01\01_MF_1_473_BR2CY3JN_.ARC RECID=469 STAMP=814273669
validation succeeded for archived log
archive log file name:C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADMINBMS\ARCHIVELOG\2013_05_01\01_MF_1_474_BR2CY3LY_.ARC RECID=470 STAMP=814292762
validation succeeded for archived log
archive log file name:C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADMINBMS\ARCHIVELOG\2013_05_01\01_MF_1_475_BR2CY3MF_.ARC RECID=471 STAMP=814293299
validation succeeded for archived log
archive log file name:C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADMINBMS\ARCHIVELOG\2013_05_01\01_MF_1_476_BR2CY30S_.ARC RECID=472 STAMP=814293301
validation succeeded for archived log
archive log file name:C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADMINBMS\ARCHIVELOG\2013_05_01\01_MF_1_477_BR2CY30S_.ARC RECID=473 STAMP=814294456
Crosschecked 6 objects

released channel: ch1
allocated channel: ch1
channel ch1: SID=26 device type=DISK

allocated channel: ch2
channel ch2: SID=524 device type=DISK

allocated channel: ch3
channel ch3: SID=33 device type=DISK

allocated channel: ch4
channel ch4: SID=525 device type=DISK

Starting backup at 01-MAY-2013 16:54:28
channel ch1: starting incremental level 1 datafile backup set
channel ch1: input datafile number=00000 name=C:\APP\ORACLE\ORADATA\ADMINBMS\$MGMT.DBF
channel ch1: starting piece 1 at 01-MAY-2013 16:54:30
channel ch2: starting incremental level 1 datafile backup set
channel ch2: input datafile number=00001 name=C:\APP\ORACLE\ORADATA\ADMINBMS\$SYSTEM01.DBF
channel ch2: starting piece 1 at 01-MAY-2013 16:54:30
channel ch3: starting incremental level 1 datafile backup set
channel ch3: input datafile number=00002 name=C:\APP\ORACLE\ORADATA\ADMINBMS\$UNDOTBS01.DBF
channel ch3: starting piece 1 at 01-MAY-2013 16:54:31
channel ch4: starting incremental level 1 datafile backup set
channel ch4: input datafile number=00003 name=C:\APP\ORACLE\ORADATA\ADMINBMS\$EXAMPLE01.DBF
channel ch4: starting piece 1 at 01-MAY-2013 16:54:33

backup set complete, elapsed time: 00:00:03
Sample RMAN Flex Script

allocated channel: ch1
channel ch1: SID=26 device type=DISK

sql statement: alter system archive log current

starting full resync of recovery catalog
full resync complete
validation succeeded for archived log
archived log file name:C:\APPL\ORACLE\FLASH\RECOVERY\ADMINI\ARCH\LOG\2013_05_01\01_MF_1_472_BR2CY3XS_.ARC RECID=468 STAMP=814273688
validation succeeded for archived log
archived log file name=C:\APPL\ORACLE\FLASH\RECOVERY\ADMINI\ARCH\LOG\2013_05_01\01_MF_1_473_BR2CV53N_.ARC RECID=469 STAMP=814273669
validation succeeded for archived log
archived log file name=C:\APPL\ORACLE\FLASH\RECOVERY\ADMINI\ARCH\LOG\2013_05_01\01_MF_1_474_BR2YR7Q2_.ARC RECID=470 STAMP=814292762
validation succeeded for archived log
archived log file name=C:\APPL\ORACLE\FLASH\RECOVERY\ADMINI\ARCH\LOG\2013_05_01\01_MF_1_475_BR2Z3MF4_.ARC RECID=471 STAMP=814293299
validation succeeded for archived log
archived log file name=C:\APPL\ORACLE\FLASH\RECOVERY\ADMINI\ARCH\LOG\2013_05_01\01_MF_1_476_BR2Z305S_.ARC RECID=472 STAMP=814293381
validation succeeded for archived log
archived log file name=C:\APPL\ORACLE\FLASH\RECOVERY\ADMINI\ARCH\LOG\2013_05_01\01_MF_1_477_BR307R17_.ARC RECID=473 STAMP=814294456

Crosschecked 6 objects

released channel: ch1
allocated channel: ch1
channel ch1: SID=26 device type=DISK

allocated channel: ch2
channel ch2: SID=24 device type=DISK

allocated channel: ch3
channel ch3: SID=33 device type=DISK

allocated channel: ch4
channel ch4: SID=525 device type=DISK

Starting backup at 01-MAY-2013 16:54:28
channel ch1: starting incremental level 1 datafile backup set
channel ch1: specifying datafile(s) in backup set
input datafile file name=C:\APPL\ORACLE\DBDATA\ADMINI\MGRM\DBF
channel ch1: starting piece 1 at 01-MAY-2013 16:54:30
channel ch2: starting incremental level 1 datafile backup set
channel ch2: specifying datafile(s) in backup set
input datafile file name=C:\APPL\ORACLE\DBDATA\ADMINI\SYSTEM01\DBF
channel ch2: starting piece 1 at 01-MAY-2013 16:54:30
channel ch3: starting incremental level 1 datafile backup set
channel ch3: specifying datafile(s) in backup set
input datafile file name=C:\APPL\ORACLE\DBDATA\ADMINI\UNDOTBS01\DBF
channel ch3: starting piece 1 at 01-MAY-2013 16:54:31
channel ch4: starting incremental level 1 datafile backup set
channel ch4: specifying datafile(s) in backup set
input datafile file name=C:\APPL\ORACLE\DBDATA\ADMINI\EXAMPLEB1\DBF
channel ch4: starting piece 1 at 01-MAY-2013 16:54:31
channel ch1: finished piece 1 at 01-MAY-2013 16:54:33
channel ch1: backup set complete. elapsed time: 08:08:03
Sample RMAN Flex Script

Starting full resync of recovery catalog
Full resync complete

List of Backup Sets

<table>
<thead>
<tr>
<th>BS Key</th>
<th>Type LV Size</th>
<th>Device Type Elapsed Time Completion Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>11771</td>
<td>Incr 0 22.66M DISK  08:04:16  01-MAY-2013 11:03:14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BP Key: 11784 Status: AVAILABLE Compressed: YES Tag: ADNIBMSX_FLL0_201305011057</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1330_ADNIBMSX_L0_BKP_DB_13388142731389008HKJH_1_1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>List of Datafiles in backup set 11771</td>
<td></td>
</tr>
<tr>
<td></td>
<td>File LV Ckp SCN  Ckp Time  Name</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Incr 28687384781 01-MAY-2013 18:59:08 C:\APP\ORACLE\ORADATA\ADNIBMSX\EXAMPLE01.DBF</td>
<td></td>
</tr>
<tr>
<td>11772</td>
<td>Incr 0 36.52M DISK  08:04:18  01-MAY-2013 11:03:15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BP Key: 11785 Status: AVAILABLE Compressed: YES Tag: ADNIBMSX_FLL0_201305011057</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1335_ADNIBMSX_L0_BKP_DB_13350714273137908HKJH_1_1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>List of Datafiles in backup set 11772</td>
<td></td>
</tr>
<tr>
<td></td>
<td>File LV Ckp SCN  Ckp Time  Name</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Incr 28687384749 01-MAY-2013 18:58:58 C:\APP\ORACLE\ORADATA\ADNIBMSX\MGMT.DBF</td>
<td></td>
</tr>
<tr>
<td>11773</td>
<td>Incr 0 1.07M DISK  08:01:33  01-MAY-2013 11:04:52</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BP Key: 11786 Status: AVAILABLE Compressed: YES Tag: ADNIBMSX_FLL0_201305011057</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1340_ADNIBMSX_L0_BKP_DB_134081427339008HKRN_1_1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>List of Datafiles in backup set 11773</td>
<td></td>
</tr>
<tr>
<td></td>
<td>File LV Ckp SCN  Ckp Time  Name</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Incr 28687384925 01-MAY-2013 11:03:25 C:\APP\ORACLE\ORADATA\ADNIBMSX\MGMT_AD43.DBF</td>
<td></td>
</tr>
<tr>
<td>11774</td>
<td>Incr 0 183.73M DISK  08:06:44  01-MAY-2013 11:05:41</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BP Key: 11787 Status: AVAILABLE Compressed: YES Tag: ADNIBMSX_FLL0_201305011057</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1336_ADNIBMSX_L0_BKP_DB_13368142731379008HKJH_1_1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>List of Datafiles in backup set 11774</td>
<td></td>
</tr>
<tr>
<td></td>
<td>File LV Ckp SCN  Ckp Time  Name</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Incr 28687384752 01-MAY-2013 18:58:58 C:\APP\ORACLE\ORADATA\ADNIBMSX\SYSTEM01.DBF</td>
<td></td>
</tr>
<tr>
<td>11775</td>
<td>Incr 0 1.02M DISK  08:00:46  01-MAY-2013 11:06:21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BP Key: 11788 Status: AVAILABLE Compressed: YES Tag: ADNIBMSX_FLL0_201305011057</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1341_ADNIBMSX_L0_BKP_DB_134181427353508HKV_1_1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>List of Datafiles in backup set 11775</td>
<td></td>
</tr>
<tr>
<td></td>
<td>File LV Ckp SCN  Ckp Time  Name</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Incr 28687385143 01-MAY-2013 11:05:43 C:\APP\ORACLE\ORADATA\ADNIBMSX\HZNENCRCR01.DBF</td>
<td></td>
</tr>
</tbody>
</table>
Using Restore Points

```sql
SQL> select * from rman.rc_restore_point;

<table>
<thead>
<tr>
<th>DBINC_KEY</th>
<th>RECID</th>
<th>STAMP</th>
<th>SITE_KEY</th>
<th>NAME</th>
<th>RESTORE_P</th>
<th>CREATION_</th>
<th>SCN</th>
<th>LON</th>
<th>PRE</th>
<th>GUA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RSP20130320111239</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-MAR-13</td>
<td>9865425</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21-MAR-13</td>
<td>9920107</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10 rows selected.
```
Using Restore Points

RMAN> list restore point all;

<table>
<thead>
<tr>
<th>SCN</th>
<th>RSP Time</th>
<th>Type</th>
<th>Time</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>9865425</td>
<td></td>
<td>GUARANTEED</td>
<td>20-MAR-13</td>
<td>RSP20130320111239</td>
</tr>
<tr>
<td>9871160</td>
<td></td>
<td>GUARANTEED</td>
<td>20-MAR-13</td>
<td>RSP20130320120058</td>
</tr>
<tr>
<td>9877000</td>
<td></td>
<td>GUARANTEED</td>
<td>20-MAR-13</td>
<td>RSP20130320130509</td>
</tr>
<tr>
<td>9880212</td>
<td></td>
<td>GUARANTEED</td>
<td>20-MAR-13</td>
<td>RSP20130320133715</td>
</tr>
<tr>
<td>9882365</td>
<td></td>
<td>GUARANTEED</td>
<td>20-MAR-13</td>
<td>RSP20130320134222</td>
</tr>
<tr>
<td>9883938</td>
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<td>GUARANTEED</td>
<td>20-MAR-13</td>
<td>RSP20130320134817</td>
</tr>
<tr>
<td>9885341</td>
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<td>GUARANTEED</td>
<td>20-MAR-13</td>
<td>RSP20130320135049</td>
</tr>
<tr>
<td>9913274</td>
<td></td>
<td>GUARANTEED</td>
<td>21-MAR-13</td>
<td>RSP20130321101430</td>
</tr>
<tr>
<td>9915410</td>
<td></td>
<td>GUARANTEED</td>
<td>21-MAR-13</td>
<td>RSP20130321101932</td>
</tr>
<tr>
<td>9920107</td>
<td></td>
<td>GUARANTEED</td>
<td>21-MAR-13</td>
<td>RSP20130321111204</td>
</tr>
</tbody>
</table>

RMAN>
Using Restore Points

CREATE OR REPLACE PROCEDURE create_restore_point IS
  v_scn VARCHAR2(20);
  v_ts VARCHAR2(30);
BEGIN
  SELECT to_char(current_scn),
         to_char(sysdate,'rrrrmmddhh24miss')
  INTO v_scn,
         v_ts
  FROM sys.v$database;
  EXECUTE IMMEDIATE 'create restore point '||'rsp_'||v_scn||'_'||v_ts||' guarantee flashbackup database';
EXCEPTION
  WHEN OTHERS THEN
    DBMS_OUTPUT.put_line(SQLERRM);
END create_restore_point;

RMAN> sql 'begin create_restore_point; end; '
sql statement: begin create_restore_point; end;
Sample Linux/Unix Shell

#!/bin/sh
#
export ORACLE_HOME=/home/oracle/app/oracle/product/11.2.0/dbhome_2
export ORACLE_HOME_LISTENER=$ORACLE_HOME
export PATH=$ORACLE_HOME/bin:$PATH

whoami
whoami
whoami

exit

#!/bin/bash
#
export ORACLE_HOME=/home/oracle/app/oracle/product/11.2.0/dbhome_2
export ORACLE_HOME_LISTENER=$ORACLE_HOME
export PATH=$ORACLE_HOME/bin:$PATH

whoami
whoami
whoami

exit
Sample Batch Command File

set NLS_DATE_FORMAT=DD-MON-RRRR HH24:MI:SS
set PATH=c:\app\oracle\product\11.2.0\dbhome_4\bin\n
set PATH=set PATH=echo %PATH%

c:\app\oracle\product\11.2.0\dbhome_1\bin\rman target SYS/%PWDs%@ADNSBX CATALOG RMAN/%PWD2%@ADNSBX @f:\adn\rman\cat\r_backup.rman USING 'on' 'COMPRESSED' '1' 'CUMULATIVE' 'adnsbx' 1 'adnsbx_CIL1_201305061456' LOG=f:\adn\rman\cat\log\adnsbx_r_backup.rman_L1_201305061456.log

exit

LOG=f:\adn\rman\cat\log\adnsbx_r_backup.rman_L1_201305092153.log
exit
PL/SQL Implementation (UTL_RMAN)

• PKG_UTL_RMAN can provide a custom RMAN backup ran from PL/SQL in integration with substitution variables in an RMAN script including encryption and providing customized tags.

• Functions can be created to:
  o Create custom tags
  o Dynamically name backup pieces
  o Dynamically control path
PL/SQL Implementation

-- Generates the RMAN Backup command line
FUNCTION genRmanLine RETURN VARCHAR2 IS
    v_rmanline_fun VARCHAR2(4000);
BEGIN
    SELECT v_Bin_Dir,
        ' rman target'
    FROM dual;
    v_Filename 'i' 
    ip_rmantuser
    '/' 
    ip_rmantuserpwd 
    DECODE(ip_target, NULL, NULL, '@' || ip_target)
    ',
    DECODE(ip_rcvcat, NULL, 'NOCATALOG', 'CATALOG')
    ,
    DECODE(ip_rcvcat, NULL, NULL, ip_rmanuser)
    DECODE(ip_rcvcat, NULL, NULL, '/' )
    DECODE(ip_rcvcat, NULL, NULL, ip_rmanuserpwd )
    DECODE(ip_rcvcat, NULL, NULL, '@' || ip_rcvcat)
    ,
    '@'
    v_Path_Dir 
    NVL(ip_Fname, 'r_backup.rman')
    ,
    ' USING ' 
    CHAR(39)
    ip_Encr_Flag 
    CHAR(39)
    ',
    DECODE( UPPER(ip_Comp_Flag), 'C', CHR(39) || 'COMPRESSED' || CHR(39), CHR(39))
    TO_CHAR(ip_lvl, '9')
    ,
;
BEGIN
    SELECT user
    INTO v_user
    FROM sys.dual;

    v_Path_Dir := getPathDir (ipDir => ip_rman_script_dir);

    v_Bin_Dir := NVL( getPathDir (ipDir => ip_Oracle_bin_dir), getOracleBinDir() );

    v_logPath_Dir := getPathDir (ipDir => ip_log_dir);

    prcGetTimestamps(ip_Ts1 => v_ts, ip_Ts2 => v_ts2);

    v_rmanline := genRmanLine() || crlf;

    DBMS_OUTPUT.put_line(v_rmanline);

    v_Fname := SUBSTR(NVL(ip_Fname,'r_backup.rman'),1,14)||v_ts||'.bat';

    v_dFname := SUBSTR(NVL('del_'||ip_Fname,'r_backup.rman'),1,14)||v_ts||'.bat';
    -- writes rman command line
    sub_write_cmd_line();

    dbms_output.put_line(v_rmanline);

    v_rmanbkp_name := NVL(ip_target,NVL(ip_rcvcat,'ORCL'))||'_RMANBKP'||v_ts2;

    v_batch_file := getPathDir (ipDir => ip_rman_batch_dir)||v_Fname;

    sub_create_bkp (ip_jname => v_rmanbkp_name, ip_jtype => 'EXECUTABLE', ip_jaction => v_batch_file);
END;
PROCEDURE SP_CALLRMANLINE IS
begin
  SP_RMANLINE(
    ip_rmantuser => 'SYS',
    ip_rmantuserpwd => '%WINPWD_T%',
    ip_rmanuser => 'RMAN',
    ip_rmanuserpwd => '%WINPWD_C% ',
    ip_target => 'ADNIBMSX',
    ip_rcvcat => 'ADNIBMSX',
    ip_rman_script_dir => 'RMAN_SCRIPT_DIR',
    ip_rman_batch_dir => 'RMAN_BATCH_DIR',
    ip_Fname => 'r_backup.rman',
    ip_log_dir => 'RMAN_LOG_DIR',
    ip_lvl => 1,
    ip_Cum_Opt => 'C',
    ip_Oracle_bin_dir => 'ORACLE_BIN_DIR',
    ip_Comp_Flag => 'C',
    ip_Encr_Flag => 'ON',
    ip_Filesp => 1
  );
  exception
  when others then
    dbms_output.put_line(sqlerrm);
end;
-- Returns the actual directory path...
FUNCTION getPathDir (ipDir IN VARCHAR2) RETURN VARCHAR2 IS
    lvPathDir VARCHAR2(4000);
BEGIN
    SELECT directory_path
    INTO lvPathDir
    FROM sys.dba_directories
    WHERE directory_name = ipDir;
    RETURN lvPathDir;
EXCEPTION
    WHEN NO_DATA_FOUND THEN
        DBMS_OUTPUT.put_line('Invalid File system path or directory name.');
        RETURN NULL;
    WHEN OTHERS THEN
        RAISE;
        DBMS_OUTPUT.put_line(SQLERRM);
END getPathDir;

FUNCTION getOracleBinDir RETURN VARCHAR2 IS

    lvOraHomeDir VARCHAR2(4000);
    lvOraBinDir VARCHAR2(4000);
BEGIN
    sys.dbms_system.get_env('ORACLE_HOME', lvOraHomeDir);
    lvOraBinDir := lvOraHomeDir||'\bin';
Scheduler Job Usage in PL/SQL Implementation

```sql
lv_bkp_time TIMESTAMP;

BEGIN

SELECT current_timestamp + INTERVAL '0 0:00:30.000' DAY TO SECOND(3) AS vs
  INTO lv_start_time
  FROM dual;

SELECT current_timestamp + TO_DSINTERVAL('0 0:01:00.000') AS tsb kp
  INTO lv_bkp_time
  FROM dual;

sys.dbms_scheduler.create_job(
  job_name => ip_jname,
  job_type => ip_jtype,
  job_action => ip_jaction,
  start_date => lv_start_time,
  job_class => 'DEFAULT_JOB_CLASS',
  comments => 'Generates and executes an Oracle backup job',
  auto_drop => TRUE,
  enabled => FALSE
);

sys.dbms_scheduler.set_attribute( name => ip_jname, attribute => 'job_priority', value => 1 );

sys.dbms_scheduler.set_attribute( name => ip_jname,
  attribute => 'logging_level',
  value => DBMS_SCHEDULER.LOGGING_FULL
);

sys.dbms_scheduler.enable( ip_jname );

sys.dbms_lock.sleep(60);
```
Analytic Framework
Backup Model Benefits

• Improved Control on Capacity Planning
• Dynamic capability for optimal performance tuning.
• Enhanced Data Privacy
• Superior Data Security via Oracle TDE.
Backup Model Benefits

- Dynamic Implementation
- Backup type usage flexibility via one unique RMAN script
- Easy deployment
- Transparent user-friendly backup operations and control
- Secret backup instantiation each time
- Autodrop (scheduler job) capable.
Future Expectations

• Sorting data files by size for parallel performance automation.
• Improved RMAN backup acceleration based on optimal block change tracking.
• Improved encryption methods with TDE.
• Improved supplied encoding capabilities.
• Custom tagging automation.
• Tagging and encoding as directives for performance tuning options.
Demonstration
Concluding Remarks

• Backup encryption is mission critical to attain regulatory compliance.
• Encoding is key to the engineering of the smart backup.
• Tagging has a taxonomic, smart, and business intelligence purpose in backup management and storage development.
• Tagging, encoding and encrypting with RMAN are used by the best and privileged DBAs.
Questions and Answers

RMAN

TAGGING

ENCODING

ENCRYPTING

TDE
Thank you!

• Please visit my blog at:
  http://noriegaaoracleexpert.blogspot.com
  www.adnresearch.com

• orclConsultant@gmail.com