Tagging, Encoding, and Encrypting with RMAN

The Engineering of the Intelligent Backup

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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

- BS Systems Engineering, Universidad del Norte, 1987.

About the Speaker

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)

REGULATORY COMPLIANCE: DATA SECURITY (ENCRYPTION)

STORAGE DEVELOPMENT INTEGRATION (COMPRESSION, CLUSTER FILE SYSTEM, ETC.)

AGILITY AND AUTOMATION
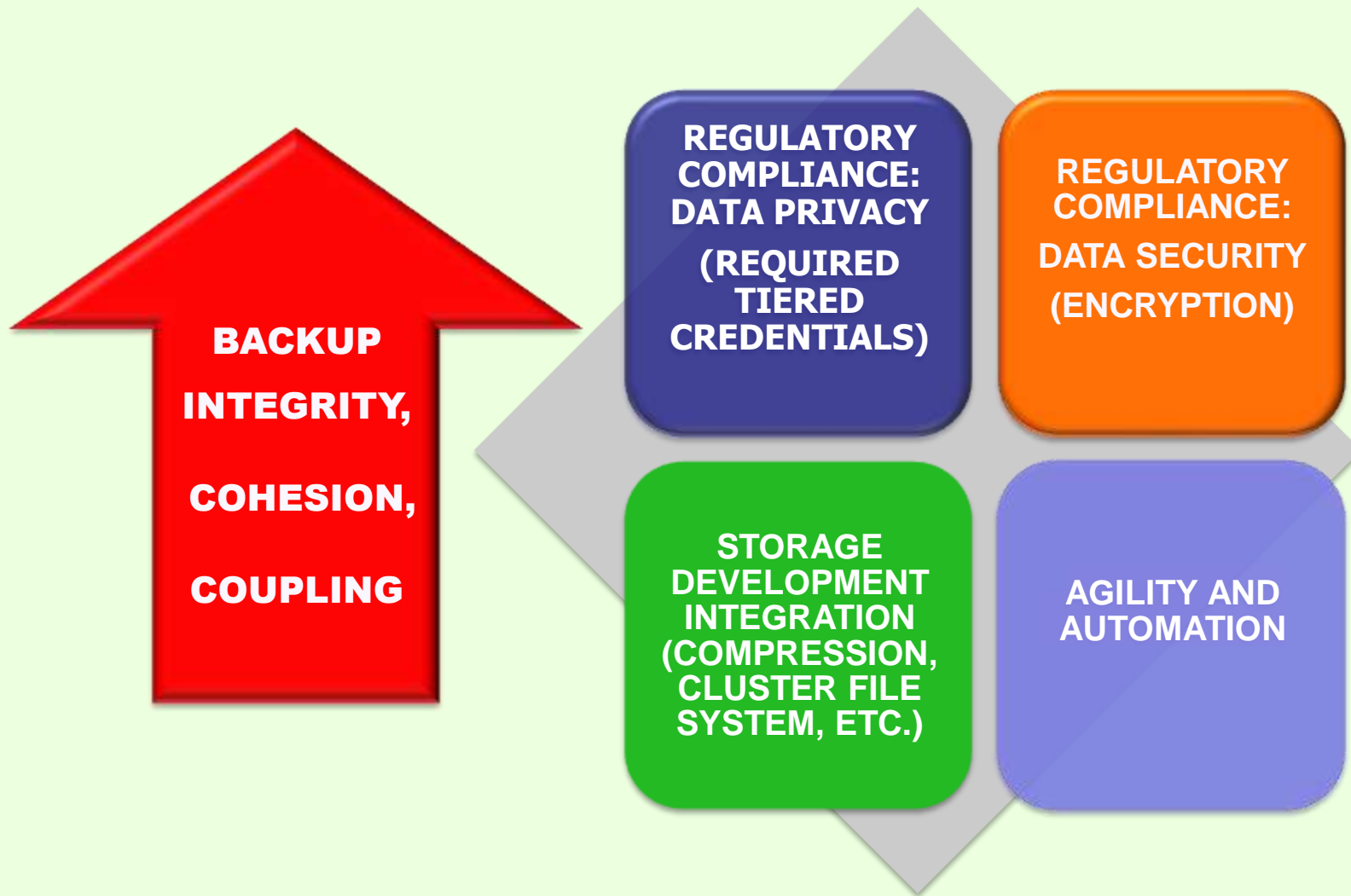
Backup Modernization Goals

- **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


```
BS Key   Type LV Size         Device Type Elapsed Time Completion Time
-------  ---- -- ----------   ----------- ------------ ---------------
12576    Incr 0  24.52M       DISK          00:01:29     21-MAR-13
         BP Key: 12586   Status: AVAILABLE  Compressed: YES  Tag: ORCLLNXFULL
         Piece Name: /home/oracle/app/oracle/flash_recovery_area/orcl/backupset/20130321_ORCL_dbf_L0_1458106461554ho52ukb_1_1
  List of Datafiles in backup set 12576
  File LV Type Ckp SCN    Ckp Time  Name
  ---- -- ---- ---------- --------- ----
   3   0  Incr 9921426    21-MAR-13 /home/oracle/app/oracle/oradata/orcl/undotbs01.dbf

RMAN> list backupset of controlfile;


List of Backup Sets
===================


BS Key   Type LV Size         Device Type Elapsed Time Completion Time
-------  ---- -- ----------   ----------- ------------ ---------------
13689    Full    9.39M        DISK          00:00:01     21-MAR-13
         BP Key: 13700   Status: AVAILABLE  Compressed: NO  Tag: TAG20130321T113425
         Piece Name: /home/oracle/app/oracle/flash_recovery_area/ORCL/autobackup/2013_03_21/o1_mf_s_810646465_8npnokv4_.bkp
  Control File Included: Ckp SCN: 9922921      Ckp time: 21-MAR-13

RMAN>
```

Technical Framework

Tagging Strategies

```
RMAN> list backupset of database tag 'ORCLLNXFULL';


List of Backup Sets
===================


BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ ---------------
12567   Incr 0  184.75M    DISK         00:12:51     21-MAR-13
        BP Key: 12577   Status: AVAILABLE  Compressed: YES  Tag: ORCLLNXFULL
        Piece Name: /home/oracle/app/oracle/flash_recovery_area/orcl/backupset/20130321_ORCL_dbf_L0_1428106451334eo52tkd_1_1
  List of Datafiles in backup set 12567
  File LV Type Ckp SCN    Ckp Time  Name
  ---- -- ---- ---------- --------- ----
  1    0  Incr 9920590    21-MAR-13 /home/oracle/app/oracle/oradata/orcl/system01.dbf

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ ---------------
12568   Incr 0  381.68M    DISK         00:16:51     21-MAR-13
        BP Key: 12578   Status: AVAILABLE  Compressed: YES  Tag: ORCLLNXFULL
        Piece Name: /home/oracle/app/oracle/flash_recovery_area/orcl/backupset/20130321_ORCL_dbf_L0_1408106451324co52tkc_1_1
  List of Datafiles in backup set 12568
  File LV Type Ckp SCN    Ckp Time  Name
  ---- -- ---- ---------- --------- ----
  2    0  Incr 9920583    21-MAR-13 /home/oracle/app/oracle/oradata/orcl/sysaux01.dbf

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ ---------------
12569   Incr 0  117.23M    DISK         00:16:52     21-MAR-13
```

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.

Encoding Strategies

```
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;

EXCEPTION WHEN OTHERS
THEN
raise_application_error(-20119,'Invalid values used.');
DBMS_OUTPUT.put_line(SQLERRM);
RETURN NULL;
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.
```

```
  1  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.
```

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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.p12
-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_CLIENT_AUTHENTICATION = 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)

```
oracle@localhost:~/app/oracle/product/11.2.0/dbhome_2/network/admin
File   Edit   View   Terminal   Tabs   Help
# 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)
    )
  )

~
```

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Encryption Strategies

- Backup encryption is automated and

```
SQL> get /tmp/c1.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>
```

policies and regulatory compliance
practices.

Architectural Considerations

Architectural Considerations

Server Process 1 ⟷ PGA

Server Process 2 ⟷ PGA

Background Processes ⟷ PGA

SYSTEM GLOBAL AREA (SGA)

Database Buffer Cache

| Default | 2k | 4k | 16k | recycle | keep |

Java Pool

Redo Buffer

Shared Pool

Streams Pool

Large Pool

Server Process 3 ⟷ PGA

Oracle Process ⟷ PGA
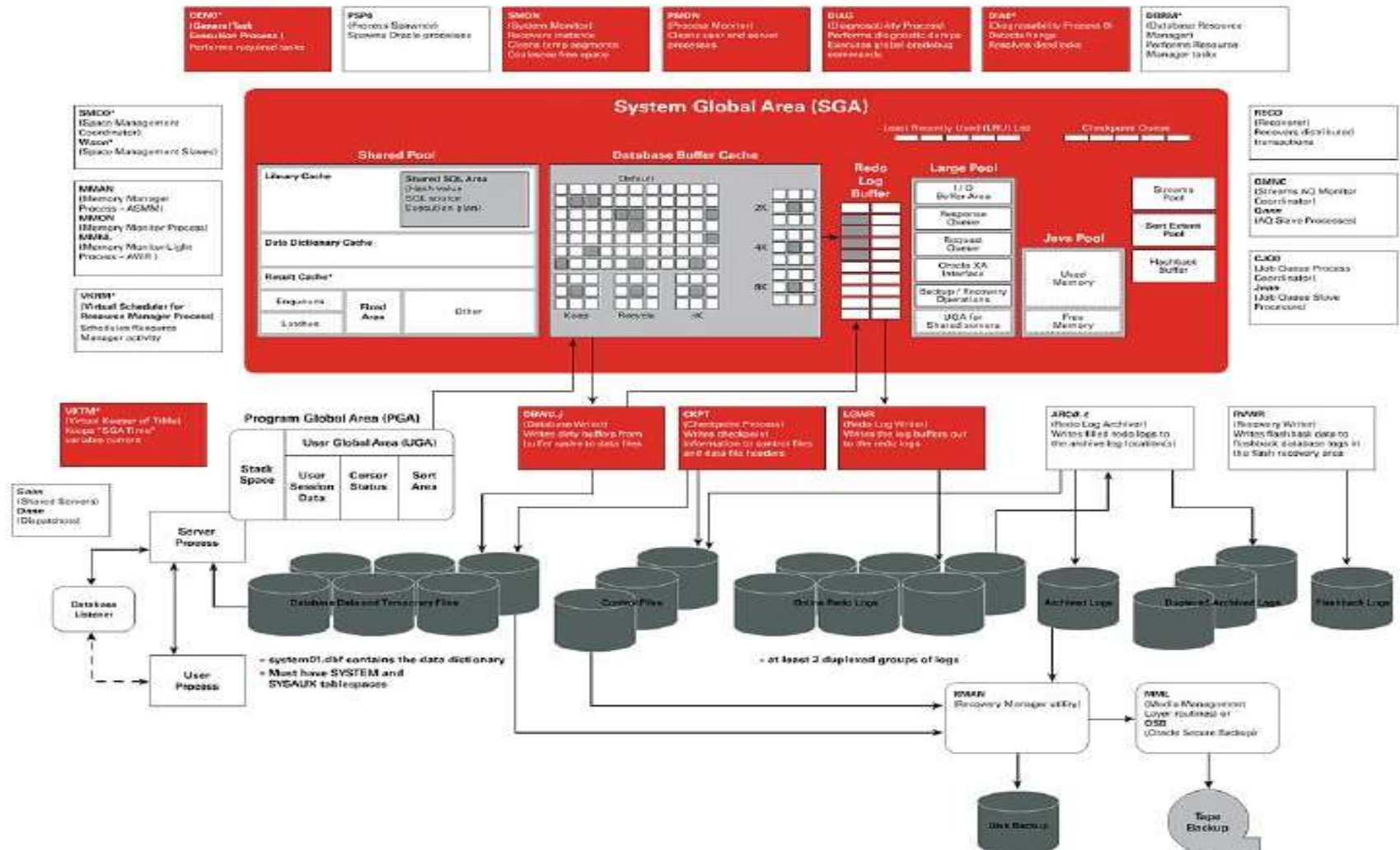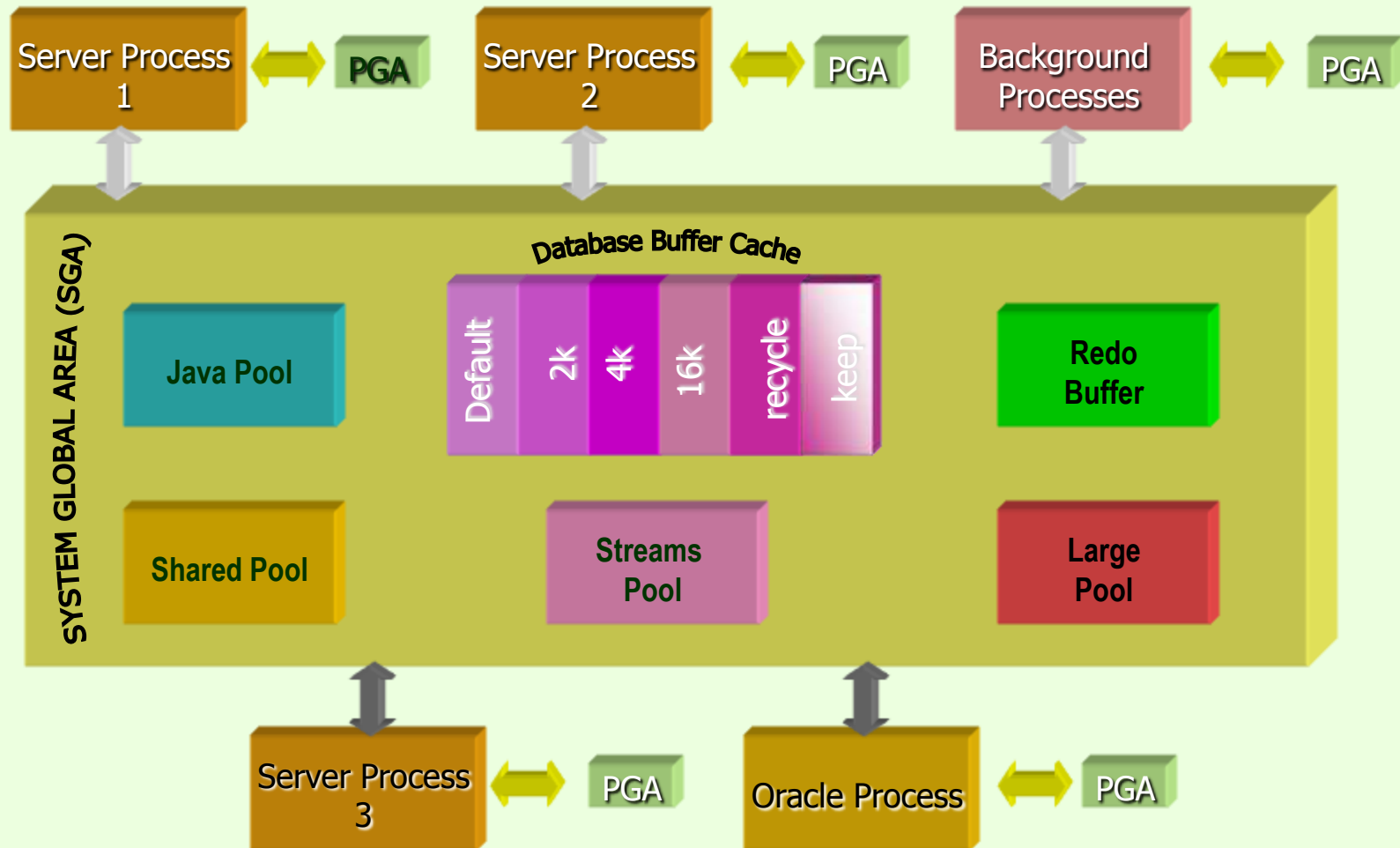
RMAN Configuration Environment

File   Edit   View   Terminal   Tabs   Help

```
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/backupset/%T_%d_orabkp_L0_%s%t%U';
CONFIGURE CHANNEL 2 DEVICE TYPE DISK FORMAT   '/home/oracle/app/oracle/flash_recovery_area/orcl/backupset/%T_%d_orabkp_L0_%s%t%U';
CONFIGURE CHANNEL 3 DEVICE TYPE DISK FORMAT   '/home/oracle/app/oracle/flash_recovery_area/orcl/backupset/%T_%d_orabkp_L0_%s%t%U';
CONFIGURE CHANNEL 4 DEVICE TYPE DISK FORMAT   '/home/oracle/app/oracle/flash_recovery_area/orcl/backupset/%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>
```

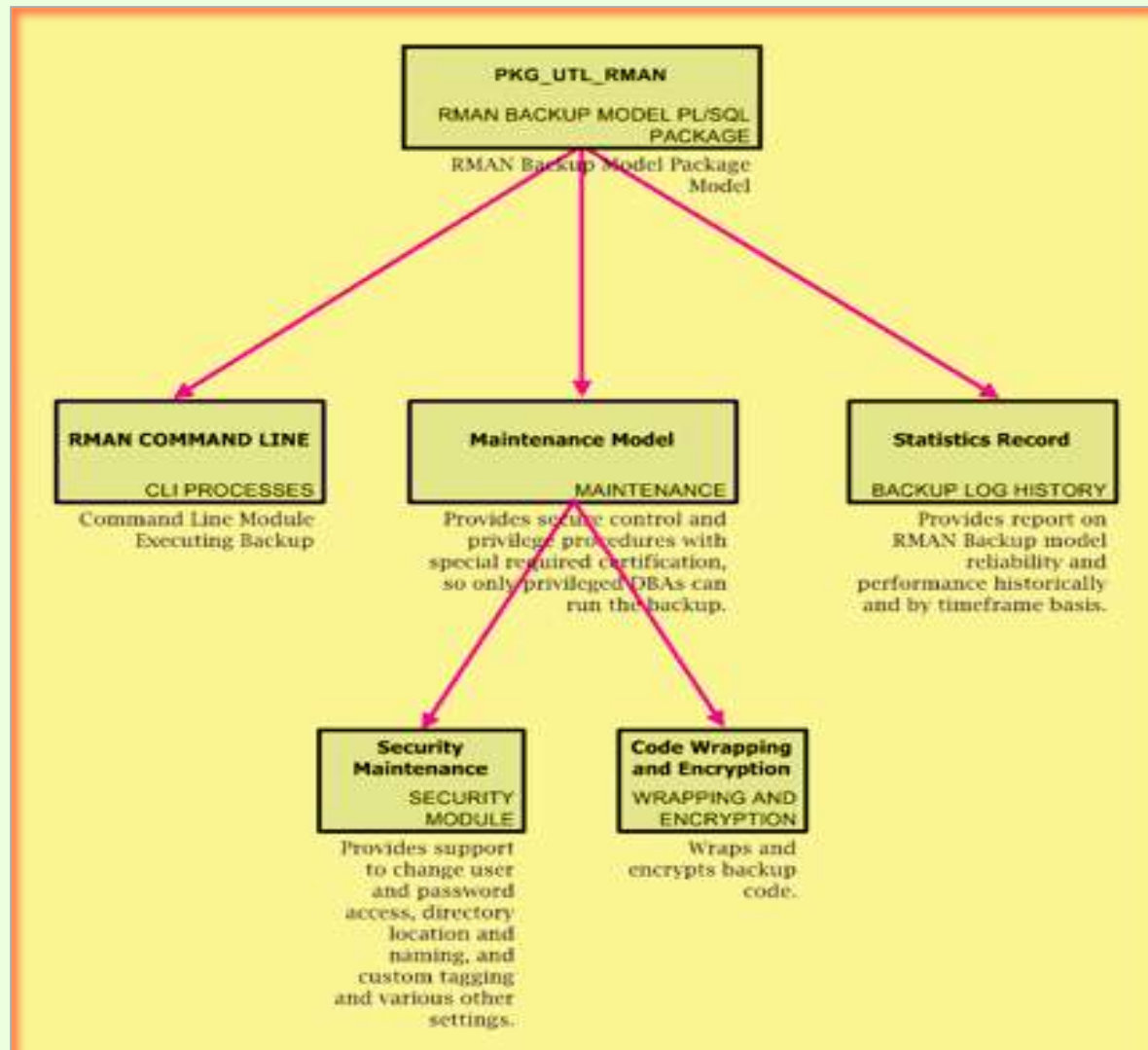# Security Framework

- **Transparent Data Encryption (TDE)**
- **Supported Algorithms**
  - AES128
  - AES256
- **Wallet and Registry Integration**
- **Encryption Methods**

  HSM, FILE, Registry, Certificates…

- **Authentication Methods**

  OS Methods (NTS), Kerberos, LDAP…

Planning the Backup Model
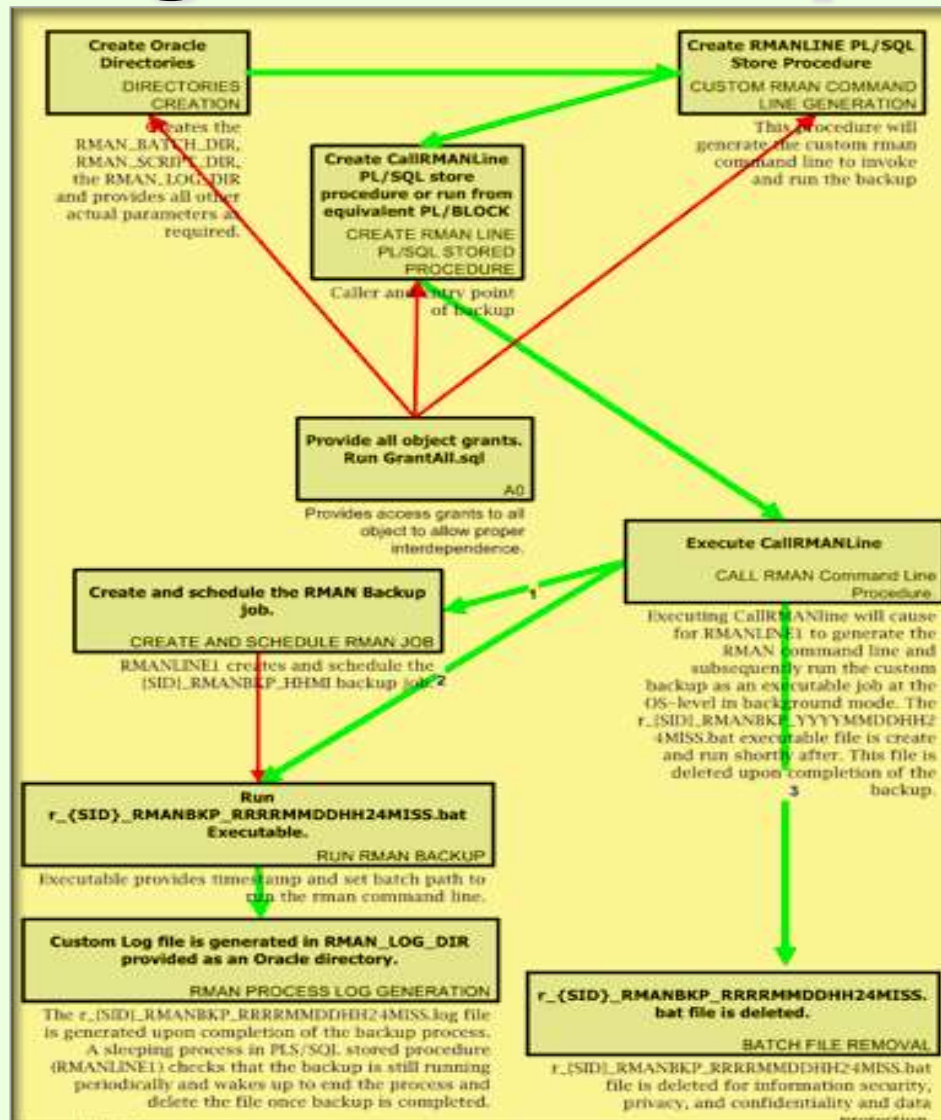
Planning the Backup Model

Planning the Backup Model

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Planning the Backup Model
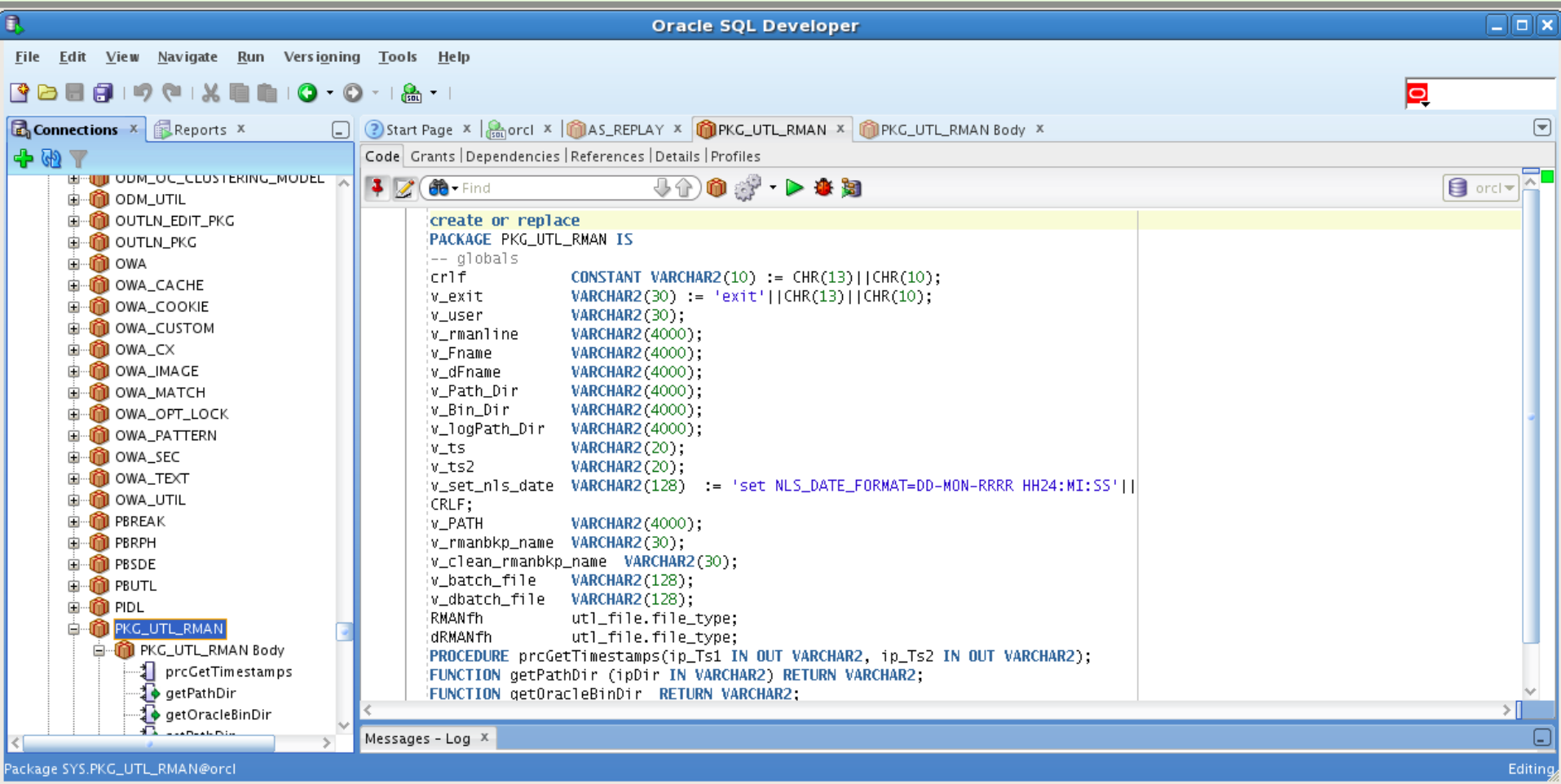
```
SQL> CREATE OR REPLACE AND COMPILE JAVA SOURCE NAMED "OSCommand" AS
import java.io.*;
public class OSCommand{
public static String Run(String Command){
try{
Runtime.getRuntime().exec(Command);
return("0");
}
catch (Exception e){
System.out.println("Error running command: " + Command +
"\n" + e.getMessage());
return(e.getMessage());
}
}
}   2    3     4     5     6     7     8     9    10    11    12    13    14    15
 16  /

Java created.
```

```
SQL> CREATE or REPLACE FUNCTION OSCommand_Run(Command IN STRING)
RETURN VARCHAR2 IS
LANGUAGE JAVA
NAME 'OSCommand.Run(java.lang.String) return int';   2    3    4
  5  /

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());
}
}
}    2    3    4    5    6    7    8    9    10   11   12   13   14   15
 16  /

Java created.
```

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

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Planning the Backup Model

```
SQL> BEGIN
dbms_java.grant_permission( 'SYS','SYS:java.io.FilePermission','<<ALL FILES>>','execute');
END;  2    3
  4  /

PL/SQL procedure successfully completed.

SQL> BEGIN
   dbms_java.grant_permission( 'SYS','SYS:java.lang.RuntimePermission', 'writeFileDescriptor', '*' );
END;  2    3
  4  /

PL/SQL procedure successfully completed.

SQL> BEGIN
dbms_java.grant_permission( 'SYS','SYS:java.lang.RuntimePermission', 'readFileDescriptor', '*' );
END;  2    3
  4  /

PL/SQL procedure successfully completed.

SQL> COMMIT WORK;
```

```
SQL> begin
  2     dbms_java.grant_permission('SYS','SYS:java.io.FilePermission','<<ALL FILES>>','execute');
  3     dbms_java.grant_permission('SYS','SYS:java.lang.RuntimePermission','readFileDescriptor','*');
  4     dbms_java.grant_permission('SYS','SYS:java.lang.RuntimePermission','writeFileDescriptor','*');
  5     commit work;
  6  end;
  7  /

PL/SQL procedure successfully completed.
```

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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:

  - o Tag Generating functions

  - o File system path

  - o Backup pieces naming conventions functions

  - o Various others

Sample RMAN Flex Script

```
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;
```

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Sample RMAN Flex Script

```
Recovery Manager: Release 11.2.0.3.0 - Production on Wed May 1 16:54:11 2013

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

RMAN> # Will allow for encrpted rman backups without introducing any keys, once the wallet is opned...
2> # should pass tag as a partial parameter for the tag name.
3>
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
20>             INCREMENTAL LEVEL 1
21>             FORMAT 'C:\app\oracle\flash_recovery_area\adnibmsx\BACKUPSET\%T_%s_%d_L1_bkp_Db_%s%t%U'  tag = adnibmsx_INL1_201305011653
22>          FILESPERSET 1
23>            (database);
24>          BACKUP AS   BACKUPSET
25>             INCREMENTAL LEVEL 1
26>             FORMAT 'C:\app\oracle\flash_recovery_area\adnibmsx\BACKUPSET\%T_%s_%d_L1_bkp_Ctl_%s%t%U' tag = adnibmsx_INL1_201305011653
27>            (current controlfile);
28>            sql 'alter system archive log current';
29>           BACKUP AS   BACKUPSET
30>             INCREMENTAL LEVEL 1
31>             FORMAT 'C:\app\oracle\flash_recovery_area\adnibmsx\BACKUPSET\%T_%s_%d_L1_bkp_Arc_%s%t%U' tag = adnibmsx_INL1_201305011653
32>             (archivelog all);
33>          backup spfile;
34>          sql 'alter database backup controlfile to trace';
35>          release channel cH1;
36>          release channel cH2;
37>          release channel cH3;
38>          release channel cH4;
39>       }
40>          resync catalog;
41>          list backupset of database;
42>          list backupset of controlfile;
43>          list backupset of archivelog all;
44>          list restore point all;
45>          report schema;
46>          validate check logical skip inaccessible database;
47>          restore validate database;
48>          restore validate archivelog all;
49>          report obsolete;
50>          delete noprompt obsolete;
51>          exit;
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
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_472_8R2CY3XS_.ARC RECID=468 STAMP=814273668
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_473_8R2CY5JN_.ARC RECID=469 STAMP=814273669
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_474_8R2YLR7Q_.ARC RECID=470 STAMP=814292762
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_475_8R2Z3MF4_.ARC RECID=471 STAMP=814293299
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_476_8R2Z3005_.ARC RECID=472 STAMP=814293301
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_477_8R307R17_.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: specifying datafile(s) in backup set
input datafile file number=00009 name=C:\APP\ORACLE\ORADATA\ADNIBMSX\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: specifying datafile(s) in backup set
input datafile file number=00001 name=C:\APP\ORACLE\ORADATA\ADNIBMSX\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 number=00003 name=C:\APP\ORACLE\ORADATA\ADNIBMSX\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 number=00005 name=C:\APP\ORACLE\ORADATA\ADNIBMSX\EXAMPLE01.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
piece handle=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1383_ADNIBMSX_L1_BKP_DB_1383814294470B708I9E6_1_1 tag=ADNIBMSX_INL1_201305011653 comment=NONE
channel cH1: 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:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_472_8R2CY3XS_.ARC RECID=468 STAMP=814273668
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_473_8R2CY5JN_.ARC RECID=469 STAMP=814273669
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_474_8R2YLR7Q_.ARC RECID=470 STAMP=814292762
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_475_8R2Z3MF4_.ARC RECID=471 STAMP=814293299
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_476_8R2Z3005_.ARC RECID=472 STAMP=814293301
validation succeeded for archived log
archived log file name=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\ARCHIVELOG\2013_05_01\O1_MF_1_477_8R307R17_.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: specifying datafile(s) in backup set
input datafile file number=00009 name=C:\APP\ORACLE\ORADATA\ADNIBMSX\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: specifying datafile(s) in backup set
input datafile file number=00001 name=C:\APP\ORACLE\ORADATA\ADNIBMSX\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 number=00003 name=C:\APP\ORACLE\ORADATA\ADNIBMSX\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 number=00005 name=C:\APP\ORACLE\ORADATA\ADNIBMSX\EXAMPLE01.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
piece handle=C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1383_ADNIBMSX_L1_BKP_DB_1383814294470B708I9E6_1_1 tag=ADNIBMSX_INL1_201305011653 comment=NONE
channel cH1: backup set complete, elapsed time: 00:00:03
```

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Sample RMAN Flex Script

```
starting full resync of recovery catalog
full resync complete


List of Backup Sets
===================


BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ ----------------
11771   Incr 0  22.66M     DISK        00:04:16     01-MAY-2013 11:03:14
        BP Key: 11784   Status: AVAILABLE  Compressed: YES  Tag: ADNIBMSX_FLL0_201305011057
        Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1338_ADNIBMSX_L0_BKP_DB_13388142731389Q08HKJI_1_1
  List of Datafiles in backup set 11771
  File LV Type Ckp SCN    Ckp Time             Name
  ---- -- ---- ---------- -------------------- ----
  5    0  Incr 28687384761 01-MAY-2013 10:59:08 C:\APP\ORACLE\ORADATA\ADNIBMSX\EXAMPLE01.DBF

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ ----------------
11772   Incr 0  36.52M     DISK        00:04:18     01-MAY-2013 11:03:15
        BP Key: 11785   Status: AVAILABLE  Compressed: YES  Tag: ADNIBMSX_FLL0_201305011057
        Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1335_ADNIBMSX_L0_BKP_DB_13358142731379N08HKJH_1_1
  List of Datafiles in backup set 11772
  File LV Type Ckp SCN    Ckp Time             Name
  ---- -- ---- ---------- -------------------- ----
  9    0  Incr 28687384749 01-MAY-2013 10:58:58 C:\APP\ORACLE\ORADATA\ADNIBMSX\MGMT.DBF

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ ----------------
11773   Incr 0  1.07M      DISK        00:01:33     01-MAY-2013 11:04:52
        BP Key: 11786   Status: AVAILABLE  Compressed: YES  Tag: ADNIBMSX_FLL0_201305011057
        Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1340_ADNIBMSX_L0_BKP_DB_13408142733999S08HKRN_1_1
  List of Datafiles in backup set 11773
  File LV Type Ckp SCN    Ckp Time             Name
  ---- -- ---- ---------- -------------------- ----
  10   0  Incr 28687384925 01-MAY-2013 11:03:25 C:\APP\ORACLE\ORADATA\ADNIBMSX\MGMT_AD4J.DBF

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ ----------------
11774   Incr 0  183.73M    DISK        00:06:44     01-MAY-2013 11:05:41
        BP Key: 11787   Status: AVAILABLE  Compressed: YES  Tag: ADNIBMSX_FLL0_201305011057
        Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1336_ADNIBMSX_L0_BKP_DB_13368142731379008HKJH_1_1
  List of Datafiles in backup set 11774
  File LV Type Ckp SCN    Ckp Time             Name
  ---- -- ---- ---------- -------------------- ----
  1    0  Incr 28687384752 01-MAY-2013 10:58:58 C:\APP\ORACLE\ORADATA\ADNIBMSX\SYSTEM01.DBF

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ ----------------
11775   Incr 0  1.02M      DISK        00:00:46     01-MAY-2013 11:06:21
        BP Key: 11788   Status: AVAILABLE  Compressed: YES  Tag: ADNIBMSX_FLL0_201305011057
        Piece Name: C:\APP\ORACLE\FLASH_RECOVERY_AREA\ADNIBMSX\BACKUPSET\20130501_1341_ADNIBMSX_L0_BKP_DB_13418142735359T08HKVV_1_1
  List of Datafiles in backup set 11775
  File LV Type Ckp SCN    Ckp Time             Name
  ---- -- ---- ---------- -------------------- ----
  7    0  Incr 28687385143 01-MAY-2013 11:05:43 C:\APP\ORACLE\ORADATA\ADNIBMSX\HZNENCR01.DBF
```

Using Restore Points

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

 DBINC_KEY         RECID        STAMP    SITE_KEY NAME
     RESTORE_P CREATION_  SCN LON PRE GUA
---------- ---------- -------- --------- --------- ----------------------------
--------------- -------- -------- --------- --------- --- --- ---
         2                                3 RSP20130320111239
     20-MAR-13    9865425 NO    YES YES

...   ...   ...   ....  ......  ...   ...   ...   ....  .....  ....  ...
         2                                3 RSP20130321111204
     21-MAR-13    9920107 NO    YES YES

10 rows selected.
```

Using Restore Points

```
RMAN> list restore point all;

SCN                 RSP Time    Type        Time      Name
----------------    ----------  ----------  --------- ----
9865425                         GUARANTEED  20-MAR-13 RSP20130320111239
9871160                         GUARANTEED  20-MAR-13 RSP20130320120058
9877000                         GUARANTEED  20-MAR-13 RSP20130320130509
9880212                         GUARANTEED  20-MAR-13 RSP20130320133715
9882365                         GUARANTEED  20-MAR-13 RSP20130320134222
9883938                         GUARANTEED  20-MAR-13 RSP20130320134817
9885341                         GUARANTEED  20-MAR-13 RSP20130320135049
9913274                         GUARANTEED  21-MAR-13 RSP20130321101430
9915410                         GUARANTEED  21-MAR-13 RSP20130321101932
9920107                         GUARANTEED  21-MAR-13 RSP20130321111204

RMAN>
```

oracle@localhost:~

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 'll'rsp_'llv_scnll'_'llv_tsll' 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
echo $PATH
$ORACLE_HOME/bin/rman target sys/${PWDs}@adnsbx catalog rman/${PWDr}@adnsbx @$RMAN_SCRIPT_DIR/r_backup.rman  USING  'on' 'compressed'  1 'cumulative'  'adnsbx'
1 'adnsbx_CIL1_201305092153'  LOG=$RMAN_LOG_DIR/adnsbx_r_backup.rman_L1_201305092153.log
exit
```

```
#!/bin/sh
#
#
```

```
#!/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
echo $PATH
$ORACLE_HOME/bin/rman target sys/${PWDs}@adnsbx catalog rman/${PWDr}@adnsbx @$RMAN_SCRIPT_DIR/r_backup.rman  USING  'on' 'compressed'  1 'cumulative'  'adnsbx'
1 'adnsbx_CIL1_201305092153'  LOG=$RMAN_LOG_DIR/adnsbx_r_backup.rman_L1_201305092153.log
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\

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:
  - Create custom tags
  - Dynamically name backup pieces
  - 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'
         ||' '
         ||ip_rmantuser
         ||'/'
         ||ip_rmantuserpwd
         ||DECODE(ip_target, NULL, NULL, '@'||ip_target)
         ||' '
         ||DECODE(ip_rcvcat, NULL, 'NOCATALOG', 'CATALOG')
         ||' '
         ||DECODE(ip_rcvcat, NULL, NULL, ip_rmancuser)
         ||DECODE(ip_rcvcat, NULL, NULL, '/')
         ||DECODE(ip_rcvcat, NULL, NULL, ip_rmancuserpwd )
         ||DECODE(ip_rcvcat, NULL, NULL, '@'||ip_rcvcat)
         ||' '
         ||'@'
         ||v_Path_Dir
         ||NVL(ip_Fname, 'r_backup.rman')
         ||' '
         ||' USING '
         ||' '
         ||CHR(39)
         ||ip_Encr_Flag
         ||CHR(39)
         ||' '
         ||DECODE( UPPER(ip_Comp_Flag) , 'C' ,  CHR(39)||'COMPRESSED'||CHR(39),  CHR(39)||' '||CHR(39) )
         ||' '
         ||TO_CHAR(ip_lvl,'9')
         ||' '
```

PL/SQL Implementation

```
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) ;
```

PL/SQL Implementation

```
PROCEDURE SP_CALLRMANLINE IS
begin
SP_RMANLINE(
                ip_rmantuser => 'SYS',
                ip_rmantuserpwd => '%WINPWD_T%',
                ip_rmancuser => 'RMAN',
                ip_rmancuserpwd => '%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_Filesps => 1
            );
exception
when others then
dbms_output.put_line(sqlerrm);
end;
```

PL/SQL Implementation

```
-- 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\';
```

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Scheduler Job Usage in PL/SQL Implementation

```
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 tsbkp
    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);
```

Scheduler Job Usage in PL/SQL Implementation

Technical Framework

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.

RMAN

TAGGING

ENCODING
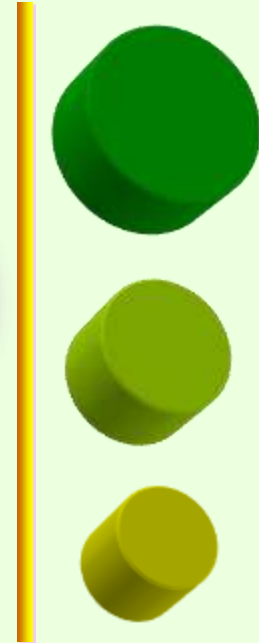
ENCRYPTING

TDE

Thank you!

- **Please visit my blog at:**

  http://noriegaaoracleexpert.blogspot.com

  www.adnresearch.com

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