RMAN recipes for disaster

SIOUG/HrOUG 2016

Tuomas Pystynen, Miracle Finland

Who am I

- Database consultant

  Miracle Finland 2008 (founder)

  Deepbase Consulting 1998

- Oracle Corporation

  RMAN Development

  Oracle7 testing

- Oracle Finland
- Oaktable member

Have a disaster recovery plan

- Gather business requirements

  Recovery Time Objective RTO

  Recovery Point Objective RPO (data loss)

- Identify potential risks

  Human error, software bug, hardware failure, natural disaster

- Plan preventive and corrective measures

  monitoring, backups, standby databases,

Be prepared

- Plan backup and recovery strategy carefully
- Schedule and monitor regular backups
- Test, document and practise recovery procedures

Backup considerations

- Backup media

  Disk, SAN or NAS (dNFS works well)

  Tape, 3rd party MML with RMAN support (SBT)

- Backup and restore speed is important

  must apply all redo generated during backup

- Incremental backups

  faster and smaller than full backups

- NOLOGGING operations can not be recovered using redo logs

Backup script example

```
rman target=/ << EOF > $BACKUP_DIR/backup_database_$ORACLE_SID.log

set echo on;

# set defaults
configure controlfile autobackup on;
configure controlfile autobackup format for device type disk to '$BACKUP_DIR/cf_%F';
configure snapshot controlfile name to '+DATA/$DB_NAME/controlfile/snapcf';
configure device type disk backup type to compressed backupset;
configure compression algorithm 'LOW'; # requires ACO license!
configure device type disk parallelism 8; # requires Enterprise Edition
show all;

# delete old archive logs and backups
delete noprompt backup completed before 'sysdate-7';
delete noprompt archivelog all completed before 'sysdate-7';

# backup database
backup filesperset 1 section size 32G format '$BACKUP_DIR/db_%d_%N_%T_%s_%p' database;

# backup all archivelogs
backup format '$BACKUP_DIR/al_%d_%h_%e_%T_%s' archivelog all not backed up;

exit

EOF
```

Monitor backups

```
rem RMAN records only successfully completed backups in the controlfile

rem check how old is the last backup of datafile 1
SQL> select (sysdate - max(completion_time)) days_old from v$backup_datafile where file#
= 1;

DAYS_OLD
----------
.015474537

rem check how old is the last archivelog backup
SQL> select (sysdate - max(next_time)) days_old from v$backup_redolog;

DAYS_OLD
----------
.007175926
```

Backup maintenance

- Delete old backups and archive logs

  using delete completed before command

  using delete obsolete and retention policy

  using retention/deletion policy and FRA

- Ensure control_file_record_keep_time is longer than retention time
- Test and monitor to ensure that deletion works as expected

  monitor free disk space or tape capacity

Recovery catalog

- Recovery catalog makes certain recovery operations easier

  especially when controlfile is damaged or lost

- Recovery catalog is useful

  when backups are retained for a long time

  tablespaces are created and dropped frequently

  in Data Guard standby database configurations (11g)

- When not using Recovery catalog

  backup controlfile frequently

Test and practise recovery

- Duplicate database is a good test for backups

  checks that backups exist and can be restored

- Document recovery procedures

  at least basic recovery cases

  real-life situations are usually more complex

- Practise recovery regularly

  real cases happen too seldom

Prerequisites for recovery

- A database server

  with Oracle installed
- Disk space for restore
- Backups of datafiles and archivelogs
- Information for creating or restoring

  parameter file

  controlfile

When a problem occurs

- Diagnose the problem first

  is the database still running?

  are some files damaged or corrupt?

  is some data missing or logically corrupt?

  check alert logs and trace files

Data Recovery Advisor

```
# RMAN Data Recovery Advisor

Lists failures recorded by the Data Recovery Advisor. The database to which RMAN is
connected must be a single-instance database and must not be a physical standby database.
The Data Recovery Advisor can detect and repair a wide variety of physical problems that
cause data loss and corruption. Physical corruptions are typically caused by faulty I/O
subsystems or human error. The Data Recovery Advisor may not detect or handle some types
of logical corruptions. Corruptions of this type require help from Oracle Support
Services.

RMAN> list failure detail;

Failure ID Priority Status    Time Detected       Summary
---------- -------- --------- ------------------- -------
146682     HIGH     OPEN      2012.11.19 20:00:18 One or more non-system datafiles are
missing
  Impact: See impact for individual child failures
  List of child failures for parent failure ID 146682
  Failure ID Priority Status    Time Detected       Summary
  ---------- -------- --------- ------------------- -------
  146685     HIGH     OPEN      2012.11.19 20:00:18 Datafile 4: '/u01/oradata/TEST11/
users01.dbf' is missing
    Impact: Some objects in tablespace USERS might be unavailable
```

Data Recovery Advisor

```
RMAN> advise failure 146682;

...
Optional Manual Actions
=======================
If file /u01/oradata/TEST11/users01.dbf was unintentionally renamed or moved, restore it

Automated Repair Options
========================
Option Repair Description
------ ------------------
1      Restore and recover datafile 4
  Strategy: The repair includes complete media recovery with no data loss
  Repair script: /u01/app/diag/rdbms/test11/TEST11/hm/reco_3549534623.hm

   # restore and recover datafile
   sql 'alter database datafile 4 offline';
   restore datafile 4;
   recover datafile 4;
   sql 'alter database datafile 4 online';
```

Diagnose problem 1

```
# check instance and database status
SQL> select host_name, status, startup_time from gv$instance;

HOST_NAME            STATUS       STARTUP_TIME
-------------------- ------------ --------------------
ip-10-54-38-226      OPEN         2012.11.19 19:37:51

# check controlfiles
SQL> select name, status from v$controlfile;

NAME                                               STATUS
-------------------------------------------------- -------
/u01/oradata/TEST11/control01.ctl
/u01/flash_recovery_area/TEST11/control02.ctl

# check online redo logfiles
SQL> select member, status from v$logfile order by group#;

MEMBER                                             STATUS
-------------------------------------------------- -------
/u01/oradata/TEST11/redo01.log
/u01/oradata/TEST11/redo02.log
/u01/oradata/TEST11/redo03.log
```

Diagnose problem 2

```
# check datafile status
SQL> select file#, name, status, error from v$datafile_header;

     FILE# NAME                                               STATUS  ERROR
---------- ------------------------------------------------- ------- ------------------
         1 /u01/oradata/TEST11/system01.dbf                  ONLINE
         2 /u01/oradata/TEST11/sysaux01.dbf                  ONLINE
         4                                                   ONLINE  CANNOT OPEN FILE
         5 /u01/oradata/TEST11/example01.dbf                 ONLINE
         6 /data1/oradata/TEST11/tbs_physical.dbf            ONLINE
         7 /data1/oradata/TEST11/tbs_logical.dbf             ONLINE
         8 /data1/oradata/TEST11/tbs_lost.dbf                ONLINE
         9 /u01/oradata/TEST11/opera_dw_data.dbf             ONLINE
        10 /u01/oradata/TEST11/hwsbw_data.dbf                ONLINE
        11 /u01/oradata/TEST11/undotbs.dbf                   ONLINE

10 rows selected.

# check corrupt blocks
SQL> select * from v$database_block_corruption;

     FILE#     BLOCK#     BLOCKS CORRUPTION_CHANGE# CORRUPTIO
---------- ---------- ---------- ------------------ ---------
         7          7          5            1585446 NOLOGGING
```

Controlfile corruption example

```
# A RAC database crashed with this error in the alert log

********************* ATTENTION: *********************
 The controlfile header block returned by the OS
 has a sequence number that is too old.
 The controlfile might be corrupted.
 PLEASE DO NOT ATTEMPT TO START UP THE INSTANCE
 without following the steps below.
 RE-STARTING THE INSTANCE CAN CAUSE SERIOUS DAMAGE
 TO THE DATABASE, if the controlfile is truly corrupted.
 In order to re-start the instance safely,
 please do the following:
 (1) Save all copies of the controlfile for later
     analysis and contact your OS vendor and Oracle support.
 (2) Mount the instance and issue:
     ALTER DATABASE BACKUP CONTROLFILE TO TRACE;
 (3) Unmount the instance.
 (4) Use the script in the trace file to
     RE-CREATE THE CONTROLFILE and open the database.
******************************************************
CKPT (ospid: 27787362): terminating the instance

# The solution was to restore the controlfile from the latest autobackup,
# recover database and open database.
```

Choose recovery procedure

- Typical recovery procedures

  block recovery

  datafile or tablespace recovery

  complete database recovery

  database point-in-time recovery

  tablespace point-in-time recovery

  restore a duplicate database (to point-in-time)

  flashback database

Check available backups

- Check that necessary backups are available

  avoid wasting time
- Complete recovery needs

  all archived logs since the backup and

  all online redo logs
- Point-in-time recovery needs

  datafile backups taken before the point-in-time

  all archived logs until the point-in-time

List available backups

```
RMAN> list backup of database completed after 'sysdate - 1';

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ -------------------
113     Full    2.16M      DISK        00:00:01     2012.11.22 20:43:22
        BP Key: 113   Status: AVAILABLE  Compressed: YES  Tag: TAG20121122T204059
        Piece Name: /data2/backup/df_TEST11_USERS_4_20121122_151
  List of Datafiles in backup set 113
  File LV Type Ckp SCN    Ckp Time             Name
  ---- -- ---- ---------- -------------------- ----
  4       Full 5663918    2012.11.22 20:43:21 /u01/oradata/TEST11/users01.dbf

RMAN> list backup of archivelog from time 'sysdate - 1';
BS Key  Size       Device Type Elapsed Time Completion Time
------- ---------- ----------- ------------ -------------------
122     20.74M     DISK        00:00:09     2012.11.22 20:44:07
        BP Key: 122   Status: AVAILABLE  Compressed: YES  Tag: TAG20121122T204358
        Piece Name: /data2/backup/al_TEST11_1142_20121122_160

  List of Archived Logs in backup set 122
  Thrd Seq     Low SCN    Low Time             Next SCN   Next Time
  ---- ------- ---------- -------------------- ---------- ---------
  1    1140    5405099    2012.11.22 20:20:31 5524487    2012.11.22 20:28:45
  1    1141    5524487    2012.11.22 20:28:45 5642897    2012.11.22 20:38:01
  1    1142    5642897    2012.11.22 20:38:01 5670387    2012.11.22 20:43:56
```

Latest backups

```
# select latest full backup of each datafile
SQL> select bdf.file#, bdf.checkpoint_change#, bdf.checkpoint_time, bdf.completion_time,
absolute_fuzzy_change#
  2  from v$backup_datafile bdf
  3  where bdf.checkpoint_change# =
  4    (select max(bdf2.checkpoint_change#)
  5     from v$backup_datafile bdf2
  6     where bdf2.file# = bdf.file# and bdf2.creation_change# = bdf.creation_change#
  7     and   bdf2.incremental_change# <= bdf2.creation_change#)
  8  and   bdf.creation_change# =
  9    (select max(df.creation_change#)
 10     from v$datafile df
 11     where df.file# = bdf.file#) order by bdf.file#;

FILE# CHECKPOINT_SCN CHECKPOINT_TIME     COMPLETION_TIME          FUZZY_SCN
----- -------------- ------------------- ------------------- -------------
    1        5646195 2012.11.22 20:41:00 2012.11.22 20:42:24             0
    2        5656102 2012.11.22 20:42:25 2012.11.22 20:43:11             0
    4        5663918 2012.11.22 20:43:21 2012.11.22 20:43:22             0
    5        5665862 2012.11.22 20:43:31 2012.11.22 20:43:41             0
    6        5669238 2012.11.22 20:43:51 2012.11.22 20:43:51             0
    7        5669509 2012.11.22 20:43:52 2012.11.22 20:43:52             0
    8        5669780 2012.11.22 20:43:54 2012.11.22 20:43:54             0
    9        5668232 2012.11.22 20:43:47 2012.11.22 20:43:48             0
   10        5668970 2012.11.22 20:43:50 2012.11.22 20:43:50             0
   11        5664537 2012.11.22 20:43:24 2012.11.22 20:43:27       5664542
```

Save existing files

- Save existing files before doing restore
  especially online redo logs and controlfile
  do not overwrite files without backups

Restore parameter file

- If parameter file is lost or must create a new database instance

  restore spfile from backups

  or create parameter file manually

Spfile file restore

```
# restore spfile from autobackup
RMAN> startup force nomount;  # startup without spfile

starting Oracle instance without parameter file for retrieval of spfile

RMAN> set dbid 1234567890;
RMAN> set controlfile autobackup format for device type disk to '/opt/backup/%F';
RMAN> restore spfile from autobackup;

RMAN> startup force nomount   # restart with restored spfile

# check restored spfile parameters

SQL> select name, value from v$spparameter where isspecified = 'TRUE' order by name;

NAME                           VALUE
------------------------------ --------------------------------------------------
...
control_files                  /u01/oradata/TEST11/control01.ctl
control_files                  /u01/flash_recovery_area/TEST11/control02.ctl
db_block_size                  8192
db_create_file_dest            /u01/oradata
db_domain
db_name                        TEST11
db_recovery_file_dest          /u01/flash_recovery_area
...
```

Restore controlfile

- If all controlfiles are lost or damaged

  restore controlfile from a backup or

  recreate controlfile

- When trying complete recovery

  restore controlfile from latest backup

- When trying point-in-time recovery

  restore controlfile from a backup taken near the point-in-time

Controlfile restore

```
SQL> startup force nomount
SQL> show parameter control_files

NAME                                 TYPE        VALUE
------------------------------------ ----------- ------------------------------
control_files                        string      /u01/oradata/TEST11/control01.ctl,
                                                 /u01/flash_recovery_area/TEST11/con
                                                 trol02.ctl
```

```
# restore controlfile
# if controlfile backup is in the latest autobackup

RMAN> set dbid 123456789;
RMAN> set controlfile autobackup format for device type disk to '/opt/backup/%F';
RMAN> restore controlfile from autobackup;

# if controlfile backup is in a known file

RMAN> restore controlfile from '/opt/backup/controlfile_backup.dbf';
```

Controlfile restore from tape

```
# restore controlfile from autobackup on tape

alter system set control_files='/oradata/database/TEST/control01.ctl' scope=spfile;

startup force nomount

set dbid=1234567890;
set controlfile autobackup format for device type sbt to 'CONTROLFILE.PROD.%F';
run {
allocate channel c0 type sbt PARMS="SBT_LIBRARY=/usr/local/avamar/lib/libobk_avamar64.so"
format '%d_%U';
send channel 'c0' '"--prefix=11g/HOT/" "--flagfile=/home/oracle/my-avtar-flags.txt" "--
bindir=/usr/local/avamar/bin" "--logfile=/tmp/restore.log"';
restore controlfile from autobackup MAXSEQ=00;
release channel c0;
}
```

Recreate controlfile

```
# generate create controlfile statement to a file before hand

SQL> alter database backup controlfile to trace as '/tmp/recreate_cf.sql' noresetlogs;

CREATE CONTROLFILE REUSE DATABASE "TEST11" NORESETLOGS  ARCHIVELOG
    MAXLOGFILES 16
    MAXLOGMEMBERS 3
    MAXDATAFILES 100
    MAXINSTANCES 8
    MAXLOGHISTORY 697
LOGFILE
  GROUP 1 '/u01/oradata/TEST11/redo01.log'  SIZE 50M BLOCKSIZE 512,
  GROUP 2 '/u01/oradata/TEST11/redo02.log'  SIZE 50M BLOCKSIZE 512,
  GROUP 3 '/u01/oradata/TEST11/redo03.log'  SIZE 50M BLOCKSIZE 512
DATAFILE
  '/u01/oradata/TEST11/system01.dbf',
  '/u01/oradata/TEST11/sysaux01.dbf',
  '/u01/oradata/TEST11/users01.dbf',
  '/u01/oradata/TEST11/example01.dbf',
  '/data1/oradata/TEST11/tbs_physical.dbf',
  '/data1/oradata/TEST11/tbs_logical.dbf',
  '/data1/oradata/TEST11/tbs_lost.dbf',
  '/u01/oradata/TEST11/opera_dw_data.dbf',
  '/u01/oradata/TEST11/hwsbw_data.dbf',
  '/u01/oradata/TEST11/undotbs.dbf'
CHARACTER SET WE8MSWIN1252;
```

Check and fix controlfile

- Check the restored controlfile

  mount the database first

- Check datafile names

  use set newname to restore to another location

- Check backups

  catalog missing backups needed for recovery

- Check archive logs

  catalog missing archive logs needed for recovery

Check controlfile

```
rem check that logfile and datafile entries point to correct location
SQL> select group#, member from v$logfile order by group#;
    GROUP# MEMBER
---------- ------------------------------------------------------
         1 /u01/oradata/TEST11/redo01.log
         2 /u01/oradata/TEST11/redo02.log
         3 /u01/oradata/TEST11/redo03.log
```

```
SQL> select file#, name, status from v$datafile;
     FILE# NAME                                                 STATUS
---------- ---------------------------------------------------- -------
         1 /u01/oradata/TEST11/system01.dbf                     SYSTEM
         2 /u01/oradata/TEST11/sysaux01.dbf                     ONLINE
         3 /u01/oradata/TEST11/tbs_physical.dbf                 ONLINE
         4 /u01/oradata/TEST11/users01.dbf                      ONLINE
         5 /u01/oradata/TEST11/example01.dbf                    ONLINE
         6 /u01/oradata/TEST11/tbs_logical.dbf                  ONLINE
         7 /u01/oradata/TEST11/tbs_offline.dbf                  OFFLINE
         8 /u01/oradata/TEST11/tbs_onoff.dbf                    OFFLINE
         9 /u01/oradata/TEST11/tbs_readonly.dbf                 ONLINE
        10 /u01/oradata/TEST11/tbs_skip.dbf                     ONLINE
        11 /u01/oradata/TEST11/undotbs.dbf                      ONLINE
        12 /u01/oradata/TEST11/datafile/o1_mf_tbs_omf_8cdv8n5h_.dbf ONLINE
        13 /u01/oradata/TEST11/tbs_old.dbf                      ONLINE
        14 /u01/oradata/TEST11/tbs_incremental.dbf              ONLINE
```

Check controlfile

```
RMAN> list backup of database completed after 'sysdate - 1';

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ -------------------
140     Full    1.27G      DISK        00:01:01     2012.11.28 22:01:01
        BP Key: 140   Status: AVAILABLE  Compressed: NO  Tag: TAG20121128T215959
        Piece Name: /data2/backup/db_backup_1
  File LV Type Ckp SCN    Ckp Time             Name
  ---- -- ---- ---------- -------------------- ----
  1       Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/system01.dbf
  2       Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/sysaux01.dbf
  3       Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/tbs_physical.dbf
  4       Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/users01.dbf
  5       Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/example01.dbf
  6       Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/tbs_logical.dbf
  7       Full 6136052    2012.11.28 21:59:51 /u01/oradata/TEST11/tbs_offline.dbf
  8       Full 6136067    2012.11.28 21:59:51 /u01/oradata/TEST11/tbs_onoff.dbf
  9       Full 6136078    2012.11.28 21:59:51 /u01/oradata/TEST11/tbs_readonly.dbf
  10      Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/tbs_skip.dbf
  11      Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/undotbs.dbf
  12      Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/datafile/o1_mf_tbs_omf.
  13      Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/tbs_old.dbf
  14      Full 6136114    2012.11.28 22:00:00 /u01/oradata/TEST11/tbs_incremental.dbf

RMAN> list backup of archivelog from time 'sysdate - 1';
specification does not match any backup in the repository
```

Catalog missing backups

```
RMAN> catalog backuppiece '/data2/backup/al_backup_2';

cataloged backup piece
backup piece handle=/data2/backup/al_backup_2 RECID=143 STAMP=800577231

RMAN> list backup of archivelog from time 'sysdate - 1';

BS Key  Size       Device Type Elapsed Time Completion Time
------- ---------- ----------- ------------ -------------------
143     17.67M     DISK        00:00:00     2012.11.28 22:05:52
        BP Key: 143   Status: AVAILABLE  Compressed: NO  Tag: TAG20121128T220551
        Piece Name: /data2/backup/al_backup_2
  Thrd Seq     Low SCN    Low Time             Next SCN   Next Time
  ---- ------- ---------- -------------------- ---------- ---------
  1    1237    6134781    2012.11.28 21:57:42 6136120    2012.11.28 22:00:01
  1    1238    6136120    2012.11.28 22:00:01 6136247    2012.11.28 22:01:00
  1    1239    6136247    2012.11.28 22:01:00 6136346    2012.11.28 22:02:01
  1    1240    6136346    2012.11.28 22:02:01 6136412    2012.11.28 22:03:01
  1    1241    6136412    2012.11.28 22:03:01 6136489    2012.11.28 22:04:01
  1    1242    6136489    2012.11.28 22:04:01 6136602    2012.11.28 22:05:00
  1    1243    6136602    2012.11.28 22:05:00 6136724    2012.11.28 22:05:50
```

Restore datafiles

- RMAN decides which backups to use

  usually the latest backup of each datafile

  point-in-time recovery uses backups taken before

  can use tags, device type to influence selection

- RMAN can use only backups listed in control file or recovery catalog
- By default datafiles are restored to location recorded in the controlfile

  can use set newname to override location

  OMF datafiles may get a new name

Restore datafile

```
SQL> select bdf.file#, bdf.checkpoint_change#, bdf.checkpoint_time, bdf.completion_time,
absolute_fuzzy_change# from v$backup_datafile bdf where file# = 4;

FILE# CHECKPOINT_SCN CHECKPOINT_TIME     COMPLETION_TIME         FUZZY_SCN
----- -------------- ------------------- ------------------- -------------
    4        5399256 2012.11.22 20:19:59 2012.11.22 20:19:59             0
    4        5663918 2012.11.22 20:43:21 2012.11.22 20:43:22             0
```

```
# try to restore to point-in-time before the first backup, fails
RMAN> restore tablespace users until time '2012.11.22 20:00:00';

RMAN-06023: no backup or copy of datafile 4 found to restore

# restore to point-in-time between the backups, uses first backup
RMAN> restore tablespace users until time '2012.11.22 20:30:00';

channel ORA_DISK_1: restoring datafile 00004 to /u01/oradata/TEST11/users01.dbf
channel ORA_DISK_1: reading from backup piece /data2/backup/df_TEST11_USERS_4_20121122_13

# restore to current time, uses last backup
RMAN> restore tablespace users;

channel ORA_DISK_1: restoring datafile 00004 to /u01/oradata/TEST11/users01.dbf
channel ORA_DISK_1: reading from backup piece /data2/backup/df_TEST11_USERS_4_20121122_15
```

Restore datafile

```
# restore datafile from a specified backup set
RMAN> restore tablespace users from tag 'TAG20121122T201738';

channel ORA_DISK_1: restoring datafile 00004 to /u01/oradata/TEST11/users01.dbf
channel ORA_DISK_1: reading from backup piece /data2/backup/df_TEST11_USERS_4_20121122_13

# try to restore datafile from a tape backup, does not exist
RMAN> restore tablespace users device type sbt_tape;

channel ORA_SBT_TAPE_1: WARNING: Oracle Test Disk API

RMAN-06100: no channel to restore a backup or copy of datafile 4


# restore datafile to a new location
RMAN> run {
  set newname for datafile 4 to '/u01/oradata/TEST11/users01_new.dbf';
  restore tablespace users;
  switch datafile 4;
}

channel ORA_DISK_1: restoring datafile 00004 to /u01/oradata/TEST11/users01_new.dbf
channel ORA_DISK_1: reading from backup piece /data2/backup/df_TEST11_USERS_4_20121122_15
datafile 4 switched to datafile copy
```

Restore database

```
RMAN> restore database skip tablespace tbs_skip;

Starting restore at ...
allocated channel: ORA_DISK_1
creating datafile file number=13 name=/u01/oradata/TEST11/tbs_new.dbf
channel ORA_DISK_1: starting datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup set
channel ORA_DISK_1: restoring datafile 00007 to /u01/oradata/TEST11/tbs_offline.dbf
channel ORA_DISK_1: restoring datafile 00008 to /u01/oradata/TEST11/tbs_onoff.dbf
channel ORA_DISK_1: restoring datafile 00009 to /u01/oradata/TEST11/tbs_readonly.dbf
channel ORA_DISK_1: reading from backup piece /data2/backup/db_backup_1
channel ORA_DISK_1: piece handle=/data2/backup/db_backup_1 tag=TAG20121130T230829
channel ORA_DISK_1: restore complete, elapsed time: 00:00:25
channel ORA_DISK_1: starting datafile backup set restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup set
channel ORA_DISK_1: restoring datafile 00001 to /u01/oradata/TEST11/system01.dbf
channel ORA_DISK_1: restoring datafile 00002 to /u01/oradata/TEST11/sysaux01.dbf
channel ORA_DISK_1: restoring datafile 00003 to /u01/oradata/TEST11/tbs_physical.dbf
channel ORA_DISK_1: restoring datafile 00004 to /u01/oradata/TEST11/users01.dbf
channel ORA_DISK_1: restoring datafile 00005 to /u01/oradata/TEST11/example01.dbf
channel ORA_DISK_1: restoring datafile 00006 to /u01/oradata/TEST11/tbs_logical.dbf
channel ORA_DISK_1: restoring datafile 00011 to /u01/oradata/TEST11/undotbs.dbf
channel ORA_DISK_1: reading from backup piece /data2/backup/db_backup_2
channel ORA_DISK_1: piece handle=/data2/backup/db_backup_2 tag=TAG20121130T231258
channel ORA_DISK_1: restore complete, elapsed time: 00:01:15
```

Restore monitoring

- Restore usually takes longer than backup

  many hours when restoring a large database

  time depends on many factors

- Can monitor the progress of restore

  using v$session_longops or v$rman_status

RMAN monitoring

```
RMAN> backup tablespace users;
2>
Starting backup at 16-APR-12
using target database control file instead of recovery catalog
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=38 device type=DISK
channel ORA_DISK_1: starting compressed full datafile backup set
channel ORA_DISK_1: specifying datafile(s) in backup set
input datafile file number=00004 name=/u01/oradata/TEST11/users01.dbf
channel ORA_DISK_1: starting piece 1 at 16-APR-12

SQL> select sid, module, action, client_info from v$session where program like 'rman%';

 SID MODULE                                   ACTION                CLIENT_INFO
---- ---------------------------------------- --------------------- ------------------------
  38 backup full datafile                     0000018 STARTED16     rman channel=ORA_DISK_1
  41 rman@ip-10-226-234-111 (TNS V1-V3)       0000003 FINISHED66
  55 rman@ip-10-226-234-111 (TNS V1-V3)

SQL> select sid, message, time_remaining from v$session_longops where sofar < totalwork;

 SID MESSAGE                                                                   TIME_REMAINING
---- ------------------------------------------------------------------------ --------------
  41 RMAN: aggregate input: backup 33: 382078 out of 870080 Blocks done                  469
  38 RMAN: full datafile backup: Set Count 93: 419070 out of 870080 Blocks done          434
```

RMAN wait events

```
SQL> select event, 10*time_waited total_time, total_waits, 10*time_waited/total_waits
avg_wait, 10*max_wait max_wait
  2  from v$session_event
  3  where sid = &1
  4  union
  5  select stat_name, value/1000, null, null, null
  6  from v$sess_time_model
  7  where sid = &1
  8  and value > 0
  9  order by 2 desc;

EVENT                          TOTAL_TIME TOTAL_WAITS      AVG_WAIT      MAX_WAIT
------------------------------ ---------- ----------- ------------- -------------
background elapsed time            43,121
RMAN backup & recovery I/O         15,690        1485          10.6          70.0
SQL*Net message from client        11,170          58         192.6         9,340.0
RMAN cpu time (backup/restore)      1,320
background cpu time                 1,320
control file sequential read          140         113           1.2          20.0
Disk file operations I/O               90          20           4.5          60.0
```

RMAN recover

- Recovers restored datafiles using

  incremental backups

  offline ranges

  archived logs/online redo logs

- Applying incremental backups can also recover NOLOGGING operations

  no need to restore incremental backups

- Archived logs are restored as needed

  can specify an alternate location for restore

Recovery

- Database must be mounted to perform database recovery

  or open when recovering datafiles or tablespaces

  database recovery will not recover offline files

- Recovery starts from the checkpoint SCN of each datafile

  checkpoint SCN is advanced during recovery

- RMAN determines which archivelogs and incremental backups are needed

RMAN recovery example

```
RMAN> recover database skip tablespace tbs_skip;

allocated channel: ORA_DISK_1
datafile 9 not processed because file is read-only
applied offline range to datafile 00008
offline range RECID=16 STAMP=800576557
channel ORA_DISK_1: starting incremental datafile backup set restore
destination for restore of datafile 00014: /u01/oradata/TEST11/tbs_incremental.dbf
channel ORA_DISK_1: restore complete, elapsed time: 00:00:01
Executing: alter database datafile 10 offline
starting media recovery
archived log for thread 1 with sequence 1243 is already on disk as file /u01/flash_re...
channel ORA_DISK_1: starting archived log restore to default destination
channel ORA_DISK_1: restoring archived log
archived log thread=1 sequence=1242
channel ORA_DISK_1: restore complete, elapsed time: 00:00:01
archived log file name=/u01/flash_recovery_area/TEST11/archivelog/2012_11_28/
o1_mf_1_1242_8cdwzscv_.arc thread=1 sequence=1242
channel default: deleting archived log(s)
archived log file name=/u01/flash_recovery_area/TEST11/archivelog/2012_11_28/
o1_mf_1_1242_8cdwzscv_.arc RECID=656 STAMP=800576921
archived log file name=/u01/flash_recovery_area/TEST11/archivelog/2012_11_28/
o1_mf_1_1243_8cdwzs6x_.arc thread=1 sequence=1243
media recovery complete, elapsed time: 00:00:05
Finished recover at ...
```

Open database

- Alter database open

  can be used when all redo has been applied

- Alter database open NORESETLOGS

  used when using a backup controlfile and all redo has been applied. No longer needed/supported?

- Alter database open RESETLOGS

  is needed after point-in-time recovery

  database must be in a consistent state

  will clear online redo logs!

Check database after recovery

- Check your data

  especially NOLOGGING objects

- Check that tablespaces are online

  offline tablespaces are not recovered

- Export and/or backup database

  Full database export is a good validation of data

  RMAN backup checks all blocks it reads