用户管理的备份和恢复是指使用OS命令（UNIX：cp，Windows：cpoy）备份和恢复数据库物理文件（数据文件，控制文件）的过程。当数据库处于ARCHIVELOG模式时，重做历史信息会被存放到归档日志中。因为归档日志是介质恢复所必须的文件，所以在ARCHIVELOG模式下还应该考虑备份归档日志。

1 完全数据库恢复

通常情况下，由于介质故障使一个或多个数据文件不可访问时，可以执行数据库完全恢复。在完全恢复期间，使用所有可用的重做将数据库恢复到当前的SCN。

数据字典视图V$RECOVER_FILE指出哪些文件需要恢复。根据不同的情况，可以恢复整个数据库，也可以恢复单个表空间或数据文件。完全恢复后，打开数据库时不需要使用RESETLOGS，所以可以选择一次恢复一些数据文件，然后恢复其余的数据文件。

1.1 数据库关闭时的恢复

当数据库未打开，执行完全恢复时，可以在一个操作中恢复所有损坏的数据文件，或者分别在单个操作对每一个损坏的数据文件进行单独恢复。

该恢复过程假设：

- 当前控制文件可用；
- 所有的数据文件都已备份；
- 所有需要的归档重做日志可用；

1.1.1 执行一致性完全数据库备份

列出需备份的数据文件和控制文件信息：

```
SQL> SELECT NAME FROM v$datafile;

NAME
----------------------------------------------
/u01/app/oracle/oradata/orcl/system01.dbf
/u01/app/oracle/oradata/orcl/sysaux01.dbf
/u01/app/oracle/oradata/orcl/undotbs01.dbf
/u01/app/oracle/oradata/orcl/test01.dbf
/u01/app/oracle/oradata/orcl/users01.dbf

SQL> SELECT NAME FROM v$controlfile;

NAME
```

/u01/app/oracle/oradata/orcl/control01.ctl
/u01/app/oracle/fast_recovery_area/orcl/control02.ctl
关闭数据库，使其处于一致性状态：
SQL> shutdown immediate
Database closed.
Database dismounted.
ORACLE instance shut down.
使用操作系统命令，将上述数据文件和控制文件备份到/home/oracle/backup目录下：
[oracle@strong ~]$ mkdir backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/system01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/sysaux01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/undotbs01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/test01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/users01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/control01.ctl /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/fast_recovery_area/orcl/control02.ctl
/home/oracle/backup

> 上述命令生成脚本为：
> SELECT 'cp '|| NAME ||' /home/oracle/backup' cp_name FROM v$datafile
> UNION ALL
> SELECT 'cp '|| NAME ||' /home/oracle/backup' FROM v$controlfile;

备份完成，启动数据库：
SQL> startup
ORACLE instance started.

Total System Global Area 788529152 bytes
Fixed Size   8625656 bytes
Variable Size   566231560 bytes
Database Buffers   209715200 bytes
Redo Buffers   3956736 bytes
Database mounted.
Database opened.

1.1.2 数据库恢复

删除users01.dbf模拟故障：
[oracle@strong ~]$ cd /u01/app/oracle/oradata/orcl/
[oracle@strong orcl]$ ll
total 2743076

```
-rw-r-----. 1 oracle oinstall  10600448 Jul 27 11:30 control01.ctl
-rw-r-----. 1 oracle oinstall 209715712 Jul 27 11:29 redo01.log
-rw-r-----. 1 oracle oinstall 209715712 Jul 27 11:30 redo02.log
-rw-r-----. 1 oracle oinstall 209715712 Jul 27 11:29 redo03.log
-rw-r-----. 1 oracle oinstall 859840512 Jul 27 11:29 sysaux01.dbf
-rw-r-----. 1 oracle oinstall 943726592 Jul 27 11:27 system01.dbf
-rw-r-----. 1 oracle oinstall  33562624 Jul 27 00:18 temp01.dbf
-rw-r-----. 1 oracle oinstall 104865792 Jul 27 11:27 test01.dbf
-rw-r-----. 1 oracle oinstall 214966272 Jul 27 11:27 undotbs01.dbf
-rw-r-----. 1 oracle oinstall  41951232 Jul 27 11:27 users01.dbf
[oracle@strong orcl]$ rm users01.dbf
```

执行日志切换，则系统宕机：

```
SQL>alter system archive log current;
alter system archive log current
*
ERROR at line 1:
ORA-03113: end-of-file on communication channel
Process ID: 8101
Session ID: 1 Serial number: 53328
```

启动数据库至Mount状态，查看V$RECOVER_FILE信息，可看出文件丢失：

```
SQL> startup mount
ORACLE instance started.

Total System Global Area  788529152 bytes
Fixed Size                  8625656 bytes
Variable Size             566231560 bytes
Database Buffers          209715200 bytes
Redo Buffers                3956736 bytes
Database mounted.
SQL> select file#,online_status,error from v$recover_file;

    FILE# ONLINE_ ERROR
---------- ------- ----------------------------
         7 ONLINE  FILE NOT FOUND
```

还原数据文件，将备份的数据文件拷贝至原位置：

```
[oracle@strong ~]$ cp /home/oracle/backup/users01.dbf /u01/app/oracle/oradata/orcl/
```

> 如果数据库是打开的，则先关闭数据库，如果原位置永久性损坏，则需拷贝到一个新位置，此时需要使用ALTER DATABASE RENAME FILE命令进行文件的重命名或重定位。

执行数据文件恢复：

SQL> recover automatic datafile 7;
Media recovery complete.
恢复完成打开数据库：
SQL> alter database open;

Database altered.

1.1.3 备份离线的表空间和数据文件

查看USERS表空间对应的数据文件：
SQL> SELECT file_NAME,tablespace_name,online_status FROM Dba_Data_Files t WHERE t.tablespace_name='USERS';

FILE_NAME TABLESPACE_NAME ONLINE_
---------- ---------- -------
/u01/app/oracle/oradata/orcl/users01.dbf USERS ONLINE
将USERS表空间离线：
SQL> alter tablespace users offline;

Tablespace altered.
数据文件备份：
[oracle@strong ~]$ mkdir ts_back
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/users01.dbf /home/oracle/ts_back/
将USERS表空间在线：
SQL> alter tablespace users online;

Tablespace altered.
归档未归档日志，确保恢复表空间备份所需的重做已归档：
SQL> alter system archive log current;

System altered.

1.1.4 备份在线的表空间和数据文件

查看USERS表空间对应的数据文件：
SQL> SELECT file_NAME,tablespace_name,online_status FROM Dba_Data_Files t WHERE t.tablespace_name='USERS';

FILE_NAME TABLESPACE_NAME ONLINE_
---------- ---------- -------
/u01/app/oracle/oradata/orcl/users01.dbf USERS ONLINE

启用备份模式：
SQL> alter tablespace users begin backup;

Tablespace altered.
数据文件备份：
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/users01.dbf
/home/oracle/ts_back/users01_20180727.dbf
移除备份模式：
SQL> alter tablespace users end backup;

Tablespace altered.
归档未归档日志，确保恢复表空间备份所需的重做已归档：
SQL> alter system archive log current;

System altered.

> 可以并行或串行的方式进行备份，并行即一次性将要备份的表空间和数据文件启用备份模式，串行即一次备份一个表空间或数据文件的方式。

1.1.5 介质故障或SHUTDOWN ABORT后中止备份

以下情况会导致表空间备份失败并不完整：

- 备份结束，没有运行ALTER TABLESPACE ... END BACKUP语句；
- 实例故障或SHUTDOWN ABORT中止备份；

启用备份模式：
SQL> alter tablespace users begin backup;

Tablespace altered.
SHUTDOWN ABORT关机：
SQL> shutdown abort;
ORACLE instance shut down.
启动数据库，出现错误：
SQL> startup
ORACLE instance started.

Total System Global Area 788529152 bytes
Fixed Size   8625656 bytes
Variable Size   566231560 bytes
Database Buffers   209715200 bytes
Redo Buffers   3956736 bytes

Database mounted.
ORA-10873: file 7 needs to be either taken out of backup mode or media recovered
ORA-01110: data file 7: '/u01/app/oracle/oradata/orcl/users01.dbf'
查看数据字典视图V$BACKUP，可看到正在备份中的数据文件：
SQL> SELECT * FROM v$backup WHERE status='ACTIVE';

```
    FILE# STATUS            CHANGE# TIME           CON_ID
--------- ----------------- ---------- --------- ----------
        7 ACTIVE            1932309 27-JUL-18           0
```

移除备份模式并打开数据库：
SQL> alter database end backup;

Database altered.

SQL> SELECT * FROM v$backup WHERE status='ACTIVE';

no rows selected

SQL> alter database open;

Database altered.

> 或者使用RECOVER DATABASE方式进行恢复。

1.1.6 备份控制文件

备份控制文件至二进制文件：
SQL> alter database backup controlfile to '/home/oracle/ctl.bak';

Database altered.
备份控制文件至Trace文件：
SQL> alter database backup controlfile to trace;

Database altered.

> 更详细内容参照体系结构篇中管理控制文件内容。

1.1.7 备份归档重做日志文件

查询数据库产生的归档日志文件：
SQL> SELECT NAME,thread# FROM v$archived_log;

```
NAME                                                                             THREAD#
---------------------------------------------------------------------------------------------------------------- ----------
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_27/o1_mf_1_11_foo2vpj2_.arc
1
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_27/o1_mf_1_12_foo4dcf3_.arc
1
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_27/o1_mf_1_13_foo4dfco_.arc
1
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_27/o1_mf_1_14_foo5gjbd_.arc
1
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_27/o1_mf_1_15_foo73n6r_.arc
1
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_27/o1_mf_1_16_foognn9j_.arc
1
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_27/o1_mf_1_17_fooht967_.arc
1

7 rows selected.
```

备份归档日志至指定目录：

```
[oracle@strong ~]$ cp -R /u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/* /home/oracle/archivelog/
```

1.2 数据库打开时的恢复

当数据库处于打开状态时，可以执行非系统数据文件的完全恢复。

该恢复过程假设：

- 当前控制文件可用；
- 所有的数据文件都已备份；
- 所有需要的归档重做日志可用；

删除USERS表空间对应的数据文件users01.dbf：

```
[oracle@strong orcl]$ rm users01.dbf
```

新开启一个会话，执行查询出错，此时数据库仍处于打开状态：

```
[oracle@strong ~]$ sqlplus /nolog

SQL*Plus: Release 12.2.0.1.0 Production on Fri Jul 27 15:23:16 2018
```

```
SQL> conn / as sysdba
Connected.
SQL> select count(1) from t_hwm;
select count(1) from t_hwm
                     *
ERROR at line 1:
ORA-01116: error in opening database file 7
ORA-01110: data file 7: '/u01/app/oracle/oradata/orcl/users01.dbf'
ORA-27041: unable to open file
Linux-x86_64 Error: 2: No such file or directory
Additional information: 3
```

将数据文件users01.dbf'对应的表空间离线：

```
SQL> alter tablespace users offline;

Tablespace altered.
```

还原备份的数据文件：

```
[oracle@strong ~]$ cp /home/oracle/backup/users01.dbf /u01/app/oracle/oradata/orcl/
```

对数据文件进行介质恢复：

```
SQL> recover automatic tablespace users;
Media recovery complete.
```

将表空间置为在线状态，从而完成恢复：

```
SQL> alter tablespace users online;

Tablespace altered.
```

2 不完全数据库恢复

不完全恢复也称为数据库时间点的恢复，即DBPITR。通常，在以下几种情况下执行DBPITR恢复：

- 恢复数据库至用户或管理员错误之前的SCN；
- 数据库包含损坏的数据块；
- 由于归档重做日志不可用导致完全数据库恢复失败；
- 利用生产库的备份创建测试数据库；

2.1 基于取消的不完全恢复

基于取消的恢复中，通过提示归档重做日之文件的建议的文件名来进行恢复，当执行CANCEL而不是文件名或者将所有的重做应用到数据文件时，恢复停止。这种恢复常发生在恢复所需的归档日志丢失或重做日志不可用的情况下。

该恢复假设：

- 当前控制文件可用；
- 所有数据文件已备份；

2.1.1 联机备份进行数据库全备

进入备份模式：
SQL> alter database begin backup;

Database altered.
数据库全备：
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/system01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/sysaux01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/undotbs01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/test01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/users01.dbf /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/oradata/orcl/control01.ctl /home/oracle/backup
[oracle@strong ~]$ cp /u01/app/oracle/fast_recovery_area/orcl/control02.ctl
/home/oracle/backup
退出备份模式：
SQL> alter database end backup;

Database altered.

2.1.2 进行基于取消的不完全恢复

创建测试数据表：
SQL> create table stu.t_cancel(id number,cdate date default sysdate);

Table created.
查看日志信息，当前日志序列号为1：
SQL> archive log list
Database log mode Archive Mode
Automatic archival Enabled
Archive destination USE_DB_RECOVERY_FILE_DEST
Oldest online log sequence 1
Next log sequence to archive 1
Current log sequence 1
查看归档日志文件：
[oracle@strong 2018_07_28]$ ll

total 0
插入数据，并将1号日志切换，归档日志为o1_mf_1_1_foqq24cj_.arc：
SQL> alter user stu quota unlimited on users;

User altered.

SQL> insert into stu.t_cancel(id) values(1);

1 row created.

SQL> commit;

Commit complete.

SQL> alter system switch logfile;

System altered.
再次查看日志序列号，当前日志为2，并插入数据切换日志，归档日志为o1_mf_1_2_foqq4hm6_.arc：
SQL> archive log list
Database log mode Archive Mode
Automatic archival Enabled
Archive destination USE_DB_RECOVERY_FILE_DEST
Oldest online log sequence 1
Next log sequence to archive 2
Current log sequence 2
SQL> insert into stu.t_cancel(id) values(2);

1 row created.

SQL> commit;

Commit complete.

SQL> alter system switch logfile;

System altered.
再次插入数据并切换日志，归档日志为o1_mf_1_3_foqq68fk_.arc：
SQL> insert into stu.t_cancel(id) values(3);

1 row created.

SQL> commit;

Commit complete.

SQL> alter system switch logfile;

System altered.

删除数据文件模拟故障：

[oracle@strong orcl]$ rm system01.dbf users01.dbf

数据库宕机后，启动至Mount状态：

[oracle@strong ~]$ sqlplus /nolog

SQL*Plus: Release 12.2.0.1.0 Production on Sat Jul 28 11:04:31 2018

Copyright (c) 1982, 2016, Oracle. All rights reserved.

SQL> conn / as sysdba
Connected to an idle instance.
SQL> startup mount
ORACLE instance started.

Total System Global Area 843055104 bytes
Fixed Size   8626288 bytes
Variable Size   587206544 bytes
Database Buffers   243269632 bytes
Redo Buffers   3952640 bytes
Database mounted.

查看V$RECOVER_FILE信息：

SQL> select file#,online_status,error from v$recover_file;

    FILE# ONLINE_ ERROR
---------- ------- ------------------------------
         1 ONLINE FILE NOT FOUND
         7 ONLINE FILE NOT FOUND

还原数据库，将备份拷贝至原位置（必须复制全备的所有数据文件）：

[oracle@strong ~]$ cp /home/oracle/backup/*.dbf /u01/app/oracle/oradata/orcl/

> 可以先尝试进行一次完全恢复，命令为recover database。

移除一个归档日志：

[oracle@strong 2018_07_28]$ mv o1_mf_1_2_foqq4hm6_.arc o1_mf_1_2_foqq4hm6_.arc.del

基于取消恢复数据库，可通过v$recovery_log查看恢复所需的归档日志：

```
SQL> recover database until cancel;
ORA-00279: change 1545331 generated at 07/28/2018 10:52:58 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_1_foqq24cj_.arc
ORA-00280: change 1545331 for thread 1 is in sequence #1


Specify log: {<RET>=suggested | filename | AUTO | CANCEL}
auto
```

> 执行恢复，auto之后会自动应用归档日志，当恢复到不存在的归档日志时，会自动退出。

```
ORA-00279: change 1547093 generated at 07/28/2018 11:00:20 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_2_foqq4hm6_.arc
ORA-00280: change 1547093 for thread 1 is in sequence #2
ORA-00278: log file
'/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_1_foqq24cj_.arc'
no longer needed for this recovery


ORA-00308: cannot open archived log
'/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_2_foqq4hm6_.arc'
ORA-27037: unable to obtain file status
Linux-x86_64 Error: 2: No such file or directory
Additional information: 7
```

以RESETLOGS方式打开数据库：

```
SQL> alter database open resetlogs;

Database altered.
```

> 可以从告警日志看到信息RESETLOGS after incomplete recovery UNTIL CHANGE 1547093 time 07/28/2018 11:00:20。

查看数据，检查恢复结果：

```
SQL> select *from stu.t_cancel;

        ID CDATE
---------- -------------------
         1 2018-07-28 11:00:07
```

注：第二条记录出现在归档o1_mf_1_2_foqq4hm6_.arc中，因其删除，故其之后的归档都不可恢复。

2.1.3 不完全恢复后进行备份

SQL> alter database begin backup;

Database altered.

[oracle@strong backup]$ rm *
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/system01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/sysaux01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/undotbs01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/test01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/users01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/control01.ctl /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/fast_recovery_area/orcl/control02.ctl
/home/oracle/backup

> 该cp命令可以在SQL命令行执行，即host cp ....方式执行。

SQL> alter database end backup;

Database altered.

SQL> alter system switch logfile;

System altered.

SQL> alter system archive log current;

System altered.

2.2 基于时间或更改的不完全恢复

基于时间或更改的不完全恢复是通过指定一个时间点或SCN进行的恢复。

该恢复过程假设：

- 当前控制文件可用；
- 所有数据文件已备份；

2.2.1 测试数据准备

```
SQL> insert into stu.t_cancel (id) values(2);

1 row created.

SQL> commit;

Commit complete.

SQL> select *from stu.t_cancel;

        ID CDATE
---------- -------------------
         1 2018-07-28 11:00:07
         2 2018-07-28 13:22:52

SQL> select sysdate from dual;

SYSDATE
-------------------
2018-07-28 13:23:09
SQL> insert into stu.t_cancel(id) values(3);

1 row created.

SQL> insert into stu.t_cancel(id) values(4);

1 row created.

SQL> commit;

Commit complete.
SQL> truncate table stu.t_cancel;

Table truncated.
```

2.2.2 执行基于时间或SCN的不完全恢复

关闭数据库：

```
SQL> shutdown immediate
Database closed.
```

Database dismounted.
ORACLE instance shut down.
数据文件还原：
[oracle@strong ~]$ cp /home/oracle/backup/*.dbf /u01/app/oracle/oradata/orcl/
启动数据库至Mount状态：
SQL> startup mount
ORACLE instance started.

Total System Global Area 843055104 bytes
Fixed Size   8626288 bytes
Variable Size   587206544 bytes
Database Buffers   243269632 bytes
Redo Buffers   3952640 bytes
Database mounted.
查看V$RECOVER_FILE信息，通过该视图查看备份文件的时间点，确定备份时间在恢复时间点之前：
SQL> SELECT file#,online_status,error,change#,time FROM v$recover_file;

    FILE# ONLINE_ ERROR   CHANGE# TIME
---------- ------- ------------------------------ ---------- ------------------
         1 ONLINE   1548234 2018-07-28 11:22:16
         3 ONLINE   1548234 2018-07-28 11:22:16
         4 ONLINE   1548234 2018-07-28 11:22:16
         5 ONLINE   1548234 2018-07-28 11:22:16
         7 ONLINE   1548234 2018-07-28 11:22:16
执行基于时间点的不完全恢复：
SQL> recover database until time '2018-07-28 13:23:09';
Media recovery complete.
SQL> alter database open resetlogs;

Database altered.
或者基于SCN的恢复：
SQL> recover database until change 1554578;
ORA-00279: change 1548234 generated at 07/28/2018 11:22:16 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_1_foqrm0qf_.arc
ORA-00280: change 1548234 for thread 1 is in sequence #1

Specify log: {<RET>=suggested | filename | AUTO | CANCEL}
auto
ORA-00279: change 1548553 generated at 07/28/2018 11:26:24 needed for thread 1

ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_2_foqrmd3c_.arc
ORA-00280: change 1548553 for thread 1 is in sequence #2

ORA-00279: change 1548559 generated at 07/28/2018 11:26:36 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_3_for0dyto_.arc
ORA-00280: change 1548559 for thread 1 is in sequence #3

Log applied.
Media recovery complete.
SQL> alter database open resetlogs;

Database altered.

> SCN和一个时间点对应，比如时间点2018-07-28 13:23:09等价于SCN 1554578，两者的转换关系可用函数timestamp_to_scn和scn_to_timestamp实现。

查看数据，恢复时间点之后的数据丢失，只保留该时间点之前的数据：
SQL> select * from stu.t_cancel;

```
        ID CDATE
---------- -------------------
         1 2018-07-28 11:00:07
         2 2018-07-28 13:22:52
```

2.2.3 不完全恢复后进行备份

SQL> alter database begin backup;

Database altered.

[oracle@strong backup]$ rm *
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/system01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/sysaux01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/undotbs01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/test01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/users01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/control01.ctl /home/oracle/backup

[oracle@strong backup]$ cp /u01/app/oracle/fast_recovery_area/orcl/control02.ctl /home/oracle/backup

SQL> alter database end backup;

Database altered.

SQL> alter system switch logfile;

System altered.

SQL> alter system archive log current;

System altered.

3 非归档模式下数据库的恢复

当数据库处于非归档模式时，如果出现介质故障，那么进行恢复的唯一选项通常是恢复一致的完全数据库备份。恢复步骤如下：

- 关闭数据库；
- 还原数据库文件（操作系统命令，cp）；
- 还原控制文件（修改初始化参数文件CONTROL_FILES）；
- 启动数据库至Mount状态；
- 恢复数据库（基于取消的不完全恢复）；
- 打开数据库（RESETLOGS方式）；

4 高级恢复场景

4.1 所有当前控制文件都丢失后的恢复

当控制文件不可访问时，可以启动实例，但不能装载和打开数据库，还原备份的控制文件后，必须以RESETLOGS方式打开数据库。对控制文件的还原依赖于在线重做日志是否可用，具体如下：

Status of Online Logs	Status of Data Files	Restore Procedure
Available	Current	If the online logs contain redo necessary for recovery, then restore a backup control file and apply the logs during recovery. You must specify the file name of the online logs containing the changes to open the database. After recovery, open the database with the RESETLOGS option. **Note:** If you re-create a control file, then it is not necessary to use the OPEN RESETLOGS option after recovery when the online redo logs are accessible.
Unavailable	Current	If the online logs contain redo necessary for recovery, then re-create the control file. Because the online redo logs are inaccessible, open RESETLOGS.
Available	Backup	Restore a backup control file, perform complete recovery, and then open the database with the RESETLOGS option.
Unavailable	Backup	Restore a backup control file, perform incomplete recovery, and then open RESETLOGS.

4.1.1 使用备份控制文件进行恢复

测试数据准备：

```
SQL> insert into stu.t_cancel(id) values(3);

1 row created.

SQL> commit;

Commit complete.

SQL> select *from stu.t_cancel;

        ID CDATE
---------- -------------------
         1 2018-07-28 11:00:07
         2 2018-07-28 13:22:52
         3 2018-07-28 14:55:10
```

关闭数据库：

```
SQL> shutdown abort;
ORACLE instance shut down.
```

还原控制文件：

```
[oracle@strong backup]$ cp control01.ctl  /u01/app/oracle/oradata/orcl/
[oracle@strong backup]$ cp control02.ctl /u01/app/oracle/fast_recovery_area/orcl/
```

启动数据库至Mount状态：

```
SQL> startup mount;
ORACLE instance started.
```

Total System Global Area 843055104 bytes
Fixed Size   8626288 bytes
Variable Size   587206544 bytes
Database Buffers   243269632 bytes
Redo Buffers   3952640 bytes
Database mounted.
恢复数据库：
SQL> recover database using backup controlfile;
ORA-00279: change 1555605 generated at 07/28/2018 13:56:19 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_3_%u_.arc
ORA-00280: change 1555605 for thread 1 is in sequence #3

Specify log: {<RET>=suggested | filename | AUTO | CANCEL}
/u01/app/oracle/oradata/orcl/redo03.log
Log applied.
Media recovery complete.

> 当提示应用归档日志时，收到错误信息提示所需的归档日志丢失，那么可能所需的重做记录位于在线重做日志文件中，这种情况发生在实例故障时重做日志还没有进行归档。

SQL> alter database open;
alter database open
*
ERROR at line 1:
ORA-01589: must use RESETLOGS or NORESETLOGS option for database open

SQL> alter database open resetlogs;

Database altered.
查看恢复后的数据：
SQL> select *from stu.t_cancel;

        ID CDATE
---------- -------------------
         1 2018-07-28 11:00:07
         2 2018-07-28 13:22:52
         3 2018-07-28 14:55:10
恢复后对数据库进行备份：

SQL> alter database begin backup;

Database altered.

[oracle@strong backup]$ rm *
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/system01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/sysaux01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/undotbs01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/test01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/users01.dbf /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/oradata/orcl/control01.ctl /home/oracle/backup
[oracle@strong backup]$ cp /u01/app/oracle/fast_recovery_area/orcl/control02.ctl /home/oracle/backup

SQL> alter database end backup;

Database altered.

SQL> alter system switch logfile;

System altered.

SQL> alter system archive log current;

System altered.

4.1.2 使用备份控制文件进行恢复（新增数据文件）

场景：

- 备份数据库；
- 创建新的表空间；
- 通过CREATE TABLESPACE操作恢复备份控制文件，并进行介质恢复；

创建新的表空间ALEN：
SQL> create tablespace alen datafile '/u01/app/oracle/oradata/orcl/alen01.dbf' size 50M,'/u01/app/oracle/oradata/orcl/alen02.dbf' size 50M ;

Tablespace created.
关闭数据库：
SQL> shutdown abort;
ORACLE instance shut down.

还原控制文件：

```
[oracle@strong backup]$ cp control01.ctl  /u01/app/oracle/oradata/orcl/
[oracle@strong backup]$ cp control02.ctl /u01/app/oracle/fast_recovery_area/orcl/
```

启动数据库至Mount状态：

```
SQL> startup mount;
ORACLE instance started.

Total System Global Area  843055104 bytes
Fixed Size                  8626288 bytes
Variable Size             587206544 bytes
Database Buffers          243269632 bytes
Redo Buffers                3952640 bytes
Database mounted.
```

恢复数据库：

```
SQL> recover database using backup controlfile;
ORA-00279: change 1561256 generated at 07/28/2018 15:09:09 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_1_for6vy72_.arc
ORA-00280: change 1561256 for thread 1 is in sequence #1


Specify log: {<RET>=suggested | filename | AUTO | CANCEL}
/u01/app/oracle/oradata/orcl/redo01.log
ORA-00279: change 1561365 generated at 07/28/2018 15:30:06 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_2_for6w6nx_.arc
ORA-00280: change 1561365 for thread 1 is in sequence #2
ORA-00278: log file '/u01/app/oracle/oradata/orcl/redo01.log' no longer needed for this
recovery


Specify log: {<RET>=suggested | filename | AUTO | CANCEL}
/u01/app/oracle/oradata/orcl/redo02.log
ORA-00279: change 1561371 generated at 07/28/2018 15:30:14 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_3_%u_.arc
ORA-00280: change 1561371 for thread 1 is in sequence #3
ORA-00278: log file '/u01/app/oracle/oradata/orcl/redo02.log' no longer needed for this
recovery
```

Specify log: {<RET>=suggested | filename | AUTO | CANCEL}
/u01/app/oracle/oradata/orcl/redo03.log
ORA-00283: recovery session canceled due to errors
ORA-01244: unnamed datafile(s) added to control file by media recovery
ORA-01110: data file 8: '/u01/app/oracle/oradata/orcl/alen02.dbf'
ORA-01110: data file 2: '/u01/app/oracle/oradata/orcl/alen01.dbf'

ORA-01112: media recovery not started

> 出现以上错误，ORA-01244: unnamed datafile(s) added to control file by media recovery。
> 查看V$DATAFILE信息，可看到新建的表空间对应的数据文件出现未命名。

SQL> select file#, name FROM v$datafile;

FILE# NAME
---------- --
1 /u01/app/oracle/oradata/orcl/system01.dbf
2 /u01/app/oracle/product/12.2.0/dbhome_1/dbs/UNNAMED00002
3 /u01/app/oracle/oradata/orcl/sysaux01.dbf
4 /u01/app/oracle/oradata/orcl/undotbs01.dbf
5 /u01/app/oracle/oradata/orcl/test01.dbf
7 /u01/app/oracle/oradata/orcl/users01.dbf
8 /u01/app/oracle/product/12.2.0/dbhome_1/dbs/UNNAMED00008
7 rows selected.

> 可通过告警日志看到原文件和未命名文件的对应关系：
> Media Recovery Log /u01/app/oracle/oradata/orcl/redo03.log
> File #2 added to control file as 'UNNAMED00002'. Originally created as:
> '/u01/app/oracle/oradata/orcl/alen01.dbf'
> File #8 added to control file as 'UNNAMED00008'. Originally created as:
> '/u01/app/oracle/oradata/orcl/alen02.dbf'
> Errors with log /u01/app/oracle/oradata/orcl/redo03.log
> Recovery interrupted!

对数据文件进行重定位和重命名：
SQL> alter database rename file
'/u01/app/oracle/product/12.2.0/dbhome_1/dbs/UNNAMED00002' to
'/u01/app/oracle/oradata/orcl/alen01.dbf';

Database altered.

SQL> alter database rename file
'/u01/app/oracle/product/12.2.0/dbhome_1/dbs/UNNAMED00008' to

'/u01/app/oracle/oradata/orcl/alen02.dbf';

Database altered.
再次进行恢复，并以RESETLOGS方式打开数据库：
SQL> recover database using backup controlfile;
ORA-00279: change 1562241 generated at 07/28/2018 15:35:20 needed for thread 1
ORA-00289: suggestion :
/u01/app/oracle/fast_recovery_area/orcl/ORCL/archivelog/2018_07_28/o1_mf_1_3_%u_.arc
ORA-00280: change 1562241 for thread 1 is in sequence #3

Specify log: {<RET>=suggested | filename | AUTO | CANCEL}
/u01/app/oracle/oradata/orcl/redo03.log
Log applied.
Media recovery complete.
SQL> alter database open resetlogs;

Database altered.
恢复完成，对数据库进行备份：略...

4.2 重建控制文件

参照：管理控制文件。

4.3 备份不可用时重建数据文件

如果数据文件损坏，并且没有备份时，仍然可以对其进行恢复，但需要满足：

- 数据文件创建之后所有的归档日志文件可用；
- 控制文件包含损坏的数据文件的名称（也就说说，数据文件名称记录在控制文件中）；

1）删除数据文件以及备份文件

[oracle@strong ~]$ rm /u01/app/oracle/oradata/orcl/test01.dbf
[oracle@strong ~]$ rm /home/oracle/backup/test01.dbf

2）重启数据库

SQL> shutdown abort
ORACLE instance shut down.
SQL> startup

```
ORACLE instance started.

Total System Global Area  788529152 bytes
Fixed Size                  8625656 bytes
Variable Size             612368904 bytes
Database Buffers          163577856 bytes
Redo Buffers                3956736 bytes
Database mounted.
ORA-01157: cannot identify/lock data file 5 - see DBWR trace file
ORA-01110: data file 5: '/u01/app/oracle/oradata/orcl/test01.dbf'
```

3）还原数据文件

```
SQL> alter database create datafile '/u01/app/oracle/oradata/orcl/test01.dbf';

Database altered.

SQL> recover datafile '/u01/app/oracle/oradata/orcl/test01.dbf';
Media recovery complete.
```

4）打开数据库并验证

```
SQL> alter database open;

Database altered.

SQL> select count(1) from t_test;

  COUNT(1)
----------
     72666
```

5）备份数据库

略

4.4 在线重做日志文件丢失后的恢复

如果数据库介质故障导致在线重做日志不可用，则对其的恢复依赖于以下条件：

- 在线重做日志的配置，是镜像或非镜像；

- 介质故障的类型，是暂时故障或是永久故障；
- 介质故障影响的在线重做日志文件的类型，是current、active、unarchived或inactive。

下面的表格展示了V$LOG中status信息，在在线重做日志的恢复中，这些信息非常重要：

Status	Description
UNUSED	The online redo log has never been written to.
CURRENT	The online redo log is active, that is, needed for instance recovery, and it is the log to which the database is currently writing. The redo log can be open or closed.
ACTIVE	The online redo log is active, that is, needed for instance recovery, but is not the log to which the database is currently writing. It may be in use for block recovery, and may or may not be archived.
CLEARING	The log is being re-created as an empty log after an ALTER DATABASE CLEAR LOGFILE statement. After the log is cleared, then the status changes to UNUSED.
CLEARING_CURRENT	The current log is being cleared of a closed thread. The log can stay in this status if there is some failure in the switch such as an I/O error writing the new log header.
INACTIVE	The log is no longer needed for instance recovery. It may be in use for media recovery, and may or may not be archived.

4.4.1 丢失多路复用日志组的成员的恢复

创建一个新的多路复用的日志组
SQL> alter database add logfile group 4
('/u01/app/oracle/oradata/orcl/redo401.log','/home/oracle/log/redo402.log') size 50M;

Database altered.

切换日志，使日志组4使用
SQL> alter system switch logfile;

System altered.

删除日志组4的一个成员
[oracle@strong log]$ rm redo402.log

> 删除后数据库仍能提供服务，但告警日志会出现下面的信息：
> 2018-08-04T13:20:02.940351+08:00
> Errors in file /u01/app/oracle/diag/rdbms/orcl/orcl/trace/orcl_m000_3753.trc:
> ORA-00313: open failed for members of log group 4 of thread 1
> ORA-00312: online log 4 thread 1: '/home/oracle/log/redo402.log'
> ORA-27037: unable to obtain file status
> Linux-x86_64 Error: 2: No such file or directory
> Additional information: 7

删除日志组成员并新增成员

SQL> alter database drop logfile member '/home/oracle/log/redo402.log';

Database altered.

SQL> alter database add logfile member '/home/oracle/log/redo402.log' to group 4;

Database altered.

4.4.2 在线重做日志组所有成员都丢失后的恢复

如果由于介质故障导致在线重做日志组所有成员都损坏了，那么根据在线重做日志组的类型以及数据库的归档模式，可以出现不同的场景。

如果损坏的在线重做日志组的状态是current和active，那么需要crash recovery，其他状态则不需要，下面展示了不同的恢复场景：

If the Group Is...	Then...	And You Can...
Inactive	It is not needed for crash recovery	Clear the archived or unarchived group.
Active	It is needed for crash recovery	Attempt to issue a checkpoint and clear the log; if impossible, then you must either use Flashback Database or restore a backup and perform incomplete recovery up to the most recent available redo log.
Current	It is the redo log that the database is currently writing to	Attempt to clear the log; if impossible, then you must either use Flashback Database or restore a backup and perform incomplete recovery up to the most recent available redo log.

4.4.2.1 丢失Inactive在线重做日志组

SQL> shutdown abort
ORACLE instance shut down.
SQL> startup mount
ORACLE instance started.

Total System Global Area 788529152 bytes
Fixed Size   8625656 bytes
Variable Size   658506248 bytes
Database Buffers   117440512 bytes
Redo Buffers   3956736 bytes
Database mounted.
SQL> SELECT group#,members,archived,status FROM v$log;

    GROUP#   MEMBERS ARC STATUS
---------- ---------- --- ----------------
         1   1 YES INACTIVE

```
4          2 YES INACTIVE
3          1 NO  CURRENT
2          1 YES INACTIVE

SQL> host rm /u01/app/oracle/oradata/orcl/redo01.log

SQL> host ls /u01/app/oracle/oradata/orcl/redo01.log
ls: cannot access /u01/app/oracle/oradata/orcl/redo01.log: No such file or directory

SQL> alter database clear logfile group 1;

Database altered.

SQL> host ls /u01/app/oracle/oradata/orcl/redo01.log
/u01/app/oracle/oradata/orcl/redo01.log
```

> 如果inactive的日志组没有被归档，则使用命令alter database clear unarchived logfile group 1;

4.4.2.2 丢失Active在线重做日志组

如果数据库处于打开状态，则可以按照下面的进行操作：

```
SQL> alter system checkpoint;

System altered.
SQL> alter database clear logfile group 1;

Database altered.
```

如果数据库处于关闭状态，需要进行不完全恢复，参照前面的不完全恢复。

4.4.2.3 丢失多个重做日志组

如果丢失了多个在线重做日志组，那么使用恢复方法恢复最难恢复的日志，从难道到易的顺序如下：

- current在线重做日志；
- active在线重做日志；
- unarchived在线重做日志；
- inactive在线重做日志。