

```

WAIT #1: nam='direct path read' ela= 4 p1=6 p2=1 p3=1
WAIT #1: nam='direct path read' ela= 5 p1=7 p2=1 p3=1
WAIT #1: nam='direct path read' ela= 4 p1=8 p2=1 p3=1
WAIT #1: nam='direct path read' ela= 7 p1=9 p2=1 p3=1
WAIT #1: nam='direct path read' ela= 4 p1=10 p2=1 p3=1
WAIT #1: nam='direct path read' ela= 4 p1=201 p2=1 p3=1

```

然后抛出了异常，提示 UNDO 文件需要恢复。

我们可以转储一下控制文件，看看控制文件中记录了什么信息，以及为何 UNDO 文件需要恢复：

```

SQL> alter session set events 'immediate trace name file_hdrs level 12';
Session altered.

```

控制文件中记录的信息包含了对于恢复至关重要的 RBA 信息，RBA 由三部分组成，分别为日志序号，日志块号，偏移量信息，数据文件的恢复需要从这个 RBA 开始。

以下日志中显示，对于 SYSTEM 表空间其 RBA 为 0x13e.2.10:

```

FILE HEADER:
    Software vsn=153092096=0x9200000, Compatibility Vsn=134217728=0x8000000
    Db ID=615401347=0x24ae4783, Db Name='SXHXDTS'
    Activation ID=0=0x0
    Control Seq=2624=0xa40, File size=52480=0xcd00
    File Number=1, Blksiz=8192, File Type=3 DATA
Tablespace #0 - SYSTEM  rel_fn:1
Creation  at   scn: 0x0000.0000000b 05/12/2002 16:17:58
Backup taken at scn: 0x0000.00000000 01/01/1988 00:00:00 thread:0
  reset logs count:0x2cebbf43 scn: 0x0000.0002e872 recovered at 12/31/2011 17:47:30
  status:0x4 root dba:0x004001a1 chkpt cnt: 942 ctl cnt:941
begin-hot-backup file size: 0
Checkpointed at scn:  0x0000.0156eaa8 12/31/2011 17:47:31
thread:1 rba:(0x13e.2.10)
enabled threads: 01000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000

```

而对于 UNDO 表空间，其 RBA 信息为 0x13d.2.10。这个 RBA 及其对应的检查点小于 SYSTEM 表空间的相应信息：

```

FILE HEADER:
    Software vsn=153092096=0x9200000, Compatibility Vsn=134217728=0x8000000
    Db ID=615401347=0x24ae4783, Db Name='SXXHDTs'
    Activation ID=0=0x0
    Control Seq=2618=0xa3a, File size=25600=0x6400
    File Number=2, Blksiz=8192, File Type=3 DATA
Tablespace #1 - UNDOTBS1 rel_fn:2
Creation at scn: 0x0000.0002dd31 05/12/2002 20:22:54
Backup taken at scn: 0x0000.00000000 01/01/1988 00:00:00 thread:0
reset logs count:0x2cebbf43 scn: 0x0000.0002e872 recovered at 12/31/2011 08:28:19
status:0x4 root dba:0x00000000 chkpt cnt: 927 ctl cnt:926
begin-hot-backup file size: 0
Checkpointed at scn: 0x0000.0155b0f1 12/31/2011 08:28:19
thread:1 rba:(0x13d.2.10)

```

而数据库的检查点信息如下，显然检查点信息和 UNDO 最后的检查点相符合，SYSTEM 等文件的检查点已经超前。

以下是 REDO THREAD 记录，其中明确说明当前数据库有 3 组日志文件，第一个是 1，第三个是 3，当前使用日志组 1，最后的序列号是 13d:

```

*****
REDO THREAD RECORDS
*****
(blkno = 0x4, size = 104, max = 1, in-use = 1, last-rcid= 0)
THREAD #1 - status:0xf thread links forward:0 back:0
#logs:3 first:1 last:3 current:1 last used seq#:0x13d
enabled at scn: 0x0000.0002e872 06/12/2011 18:30:27
disabled at scn: 0x0000.00000000 01/01/1988 00:00:00
opened at 12/31/2011 08:28:19 by instance sxxhdts
Checkpointed at scn: 0x0000.0155b0f1 12/31/2011 08:28:19
thread:1 rba:(0x13d.2.10)
enabled threads: 01000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
log history: 316

```

日志记录的最后检查点 SCN 是 0155b0f1,其 RBA 为 13d.2.10 . 注意, 这个数据库最后完成的检查点位于 2011 年 12 月 31 日, 这也是一个没有撑过新年的数据库之一。

前面提到 SYSTEM 表空间的检查点 SCN 为 0156eaa8,RBA 为 13e.2.10,对比列表如下:

	Checkpoint SCN	RBA
SYSTEM	0156eaa8	0x13e.2.10
UNDO	0155b0f1	0x13d.2.10
Diff	80311	

由于 UNDO 文件的 RBA 及检查点信息滞后, 所以优先提示从 UNDO 表空间进行恢复, 恢复的起点就是 0x13d.2.10:

```
SQL> alter session set events '10046 trace name context forever,level 12';
```

```
Session altered.
```

```
SQL> recover datafile 2;
```

```
Media recovery complete.
```

以下是告警日志中恢复 UNDO 文件的提示:

```
Tue Jan 10 13:35:35 2012
```

```
ALTER DATABASE RECOVER datafile 2
```

```
Media Recovery Start
```

```
WARNING! Recovering data file 2 from a fuzzy backup. It might be an online
backup taken without entering the begin backup command.
```

```
Tue Jan 10 13:35:35 2012
```

```
Recovery of Online Redo Log: Thread 1 Group 1 Seq 317 Reading mem 0
```

```
Mem# 0 errs 0: D:\ORACLE\ORADATA\SXXHDTs\REDO01.LOG
```

```
Media Recovery Complete
```

```
Completed: ALTER DATABASE RECOVER datafile 2
```

恢复完成之后, 检查控制文件及数据文件信息, 可以确认恢复是被正确执行了的。控制文件中的检查点信息如下:

```
*****
```

```
CHECKPOINT PROGRESS RECORDS
```

```
*****
```

```
(blkno = 0x4, size = 104, max = 1, in-use = 1, last-rcid= 0)
```

```

THREAD #1 - status:0x1 flags:0x0 dirty:0
low cache rba:(0xffffffff.ffffffff.ffff) on disk rba:(0x13d.ac56.0)
on disk scn: 0x0000.01569c86 12/31/2011 17:45:38
resetlogs scn: 0x0000.0002e872 06/12/2011 18:30:27
heartbeat: 772188978 mount id: 633905756
MTTR statistics status: 3
Init time: Avg: 9938392, Times measured: 3
File open time: Avg: 12349, Times measured: 39
Log block read time: Avg: 24, Times measured: 32770
Data block handling time: Avg: 2067, Times measured: 301

```

其中 On Disk RBA 是恢复的终点, 也即 0x13d.ac56.0, UNDO 文件恢复之后, 其文件信息如下, 注意其 RBA 信息同样推进到 0x13d.ac56.0, 也就是说所有的 REDO 都被应用, 这是基于所有 REDO 的完全恢复:

```

WAIT #1: nam='db file sequential read' ela= 166 p1=2 p2=1 p3=1
FILE HEADER:
    Software vsn=153092096=0x9200000, Compatibility Vsn=134217728=0x8000000
    Db ID=615401347=0x24ae4783, Db Name='SXXHDTS'
    Activation ID=0=0x0
    Control Seq=2625=0xa41, File size=25600=0x6400
    File Number=2, Blksiz=8192, File Type=3 DATA
Tablespace #1 - UNDOTBS1 rel_fn:2
Creation at scn: 0x0000.0002dd31 05/12/2002 20:22:54
Backup taken at scn: 0x0000.00000000 01/01/1988 00:00:00 thread:0
reset logs count:0x2cebbf43 scn: 0x0000.0002e872 recovered at 01/10/2012 13:35:35
status:0x0 root dba:0x00000000 chkpt cnt: 930 ctl cnt:929
begin-hot-backup file size: 0
Checkpointed at scn: 0x0000.01569c86 12/31/2011 17:45:38
thread:1 rba:(0x13d.ac56.0)

```

ORA-600 2758 错误解析

分析以上的恢复过程, 根据 RBA 的推进, 说明恢复过程是成功的, 实现了所有 REDO 的应用, 属于完全恢复。

但是当我们依次恢复了所有表空间之后，尝试 Open 数据库时，出现了如下错误：

```
SQL> alter database open;
alter database open
*
ERROR at line 1:
ORA-00600: internal error code, arguments: [2758], [1], [4294967295], [204800],
[10], [], [], []
```

这个错误在 MOS 上没有相关说明，需要我们进一步的深入去分析其根本原因，通过猜测、进而深入，是学习和研究 Oracle 数据库技术的重要手段。

此时转储控制文件，查看检查点信息和数据文件信息，可以发现检查点和 On Disk RBA 信息还是正确的：

```
*****
CHECKPOINT PROGRESS RECORDS
*****
(blkno = 0x4, size = 104, max = 1, in-use = 1, last-rcid= 0)
THREAD #1 - status:0x2 flags:0x0 dirty:72
low cache rba:(0x13d.9d72.0) on disk rba:(0x13d.ac56.0)
on disk scn: 0x0000.01569c86 12/31/2011 17:45:38
resetlogs scn: 0x0000.0002e872 06/12/2011 18:30:27
heartbeat: 772199262 mount id: 633916567
MTTR statistics status: 3
Init time: Avg: 9938392, Times measured: 3
File open time: Avg: 9695, Times measured: 39
Log block read time: Avg: 24, Times measured: 32770
Data block handling time: Avg: 2067, Times measured: 301
```

但是 REDO 记录的检查点信息出现了问题，注意检查点时间推进到 2012-01-10 13:41:37,但是 RBA 信息的块号显示为 ffffffff，这是最大值填充，显然是一个错误的信息：

```
*****
REDO THREAD RECORDS
*****
(blkno = 0x4, size = 104, max = 1, in-use = 1, last-rcid= 0)
THREAD #1 - status:0xf thread links forward:0 back:0
```

```

#logs:3 first:1 last:3 current:1 last used seq#:0x13d
enabled at scn: 0x0000.0002e872 06/12/2011 18:30:27
disabled at scn: 0x0000.00000000 01/01/1988 00:00:00
opened at 01/10/2012 13:41:37 by instance ora9i
Checkpointed at scn: 0x0000.0156eaa9 01/10/2012 13:41:37
thread:1 rba:(0x13d.ffffffff.10)
enabled threads: 01000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
log history: 316

```

继续检查数据文件信息，以下为 SYSTEM 表空间内容，发现数据文件头信息的 RBA 也已经变更，同样块号被标记为 ffffffff，注意这里的检查点信息 0156eaa9，其十进制表示为 22473385：

```

DATA FILE #1:
  (name #8) D:\ORACLE\ORADATA\SXXHDTS\SYSTEM01.DBF
creation size=0 block size=8192 status=0xe head=8 tail=8 dup=1
tablespace 0, index=6 krfil=1 prev_file=0
unrecoverable scn: 0x0000.00000000 01/01/1988 00:00:00
Checkpoint cnt:943 scn: 0x0000.0156eaa9 01/10/2012 13:41:37
Stop scn: 0xffff.ffffffff 12/31/2011 17:45:38
Creation Checkpointed at scn: 0x0000.0000000b 05/12/2002 16:17:58
thread:0 rba:(0x0.0.0)
enabled threads: 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
Offline scn: 0x0000.0002e871 prev_range: 0
Online Checkpointed at scn: 0x0000.0002e872 06/12/2011 18:30:27
thread:1 rba:(0x1.2.0)
enabled threads: 01000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
Hot Backup end marker scn: 0x0000.00000000
aux_file is NOT DEFINED
FILE HEADER:
  Software vsn=153092096=0x9200000, Compatibility Vsn=134217728=0x8000000
  Db ID=615401347=0x24ae4783, Db Name='SXXHDTS'
  Activation ID=0=0x0

```

```

Control Seq=2638=0xa4e, File size=52480=0xcd00
File Number=1, Blksiz=8192, File Type=3 DATA
Tablespace #0 - SYSTEM rel_fn:1
Creation at scn: 0x0000.0000000b 05/12/2002 16:17:58
Backup taken at scn: 0x0000.00000000 01/01/1988 00:00:00 thread:0
reset logs count:0x2cebbf43 scn: 0x0000.0002e872 recovered at 12/31/2011 17:47:30
status:0x4 root dba:0x004001a1 chkpt cnt: 943 ctl cnt:941
begin-hot-backup file size: 0
Checkpointed at scn: 0x0000.0156eaa9 01/10/2012 13:41:37
thread:1 rba:(0x13d.ffffffff.10)

```

经过检查发现所有文件的 RBA 信息都指向了 0x13d.ffffffff.10, 这里的 ffffffff 代表的是 4294967295, 即 4G , 13d 代表的是 317 日志序列。

对于 ORA-600 错误, 其中的参数 [1] 代表的是日志组 1, 第二个参数 4294967295 代表的就是 RBA 的块号, 参数 4 代表的是偏移量:

```

SQL> alter database open;
alter database open
*
ERROR at line 1:
ORA-00600: internal error code, arguments: [2758], [1], [4294967295], [204800],
[10], [], [], []

```

那么 Redo 日志组 1 最终写到了什么位置呢?

通过如下命令转储日志文件, 将 AC55 之后的 REDO 信息转储出来:

```

SQL> alter system dump logfile 'D:\ORACLE\ORADATA\SXXHDTS\REDO01.LOG' rba min 317 . 44117 ;
System altered.

```

可以看到 Redo 最后的记录写到日志序列 317 的 ac55 位置, 也就是说下一个 RBA 就正是 On-Disk-Rba 记录的 ac56 :

```

DUMP OF REDO FROM FILE 'D:\ORACLE\ORADATA\SXXHDTS\REDO01.LOG'
Opcodes *.*
DBA's: (file # 0, block # 0) thru (file # 65534, block # 4194303)
RBA's: 0x00013d.0000ac55.0000 thru 0xffffffff.ffffffff.ffff
SCN's scn: 0x0000.00000000 thru scn: 0xffff.ffffffff

```

Times: creation thru eternity

FILE HEADER:

Software vsn=153092096=0x9200000, Compatibility Vsn=153092096=0x9200000

Db ID=615401347=0x24ae4783, Db Name='SXXHDTS'

Activation ID=615377539=0x24adea83

Control Seq=2618=0xa3a, File size=204800=0x32000

File Number=1, Blksiz=512, File Type=2 LOG

descrip:"Thread 0001, Seq# 0000000317, SCN 0x00000155b0f0-0xffffffffffff"

thread: 1 nab: 0xffffffff seq: 0x0000013d hws: 0x2 eot: 1 dis: 0

reset logs count: 0x2cebbf43 scn: 0x0000.0002e872

Low scn: 0x0000.0155b0f0 12/31/2011 08:28:19

Next scn: 0xffff.ffffffff 01/01/1988 00:00:00

Enabled scn: 0x0000.0002e872 06/12/2011 18:30:27

Thread closed scn: 0x0000.0155b0f0 12/31/2011 08:28:19

Log format vsn: 0x8000000 Disk cksum: 0x13d8 Calc cksum: 0x13d8

Terminal Recovery Stamp scn: 0x0000.00000000 01/01/1988 00:00:00

Most recent redo scn: 0x0000.00000000

Largest LWN: 0 blocks

End-of-redo stream : No

Unprotected mode

Miscellaneous flags: 0x0

CHANGE #1 MEDIA RECOVERY MARKER SCN:0x0000.00000000 SEQ: 0 OP:17.3

Crash Recovery at scn: 0x0000.0155b0ef

REDO RECORD - Thread:1 **RBA: 0x00013d.0000ac55.0090** LEN: 0x0054 VLD: 0x01

SCN: 0x0000.01569c85 SUBSCN: 1 12/31/2011 17:45:38

CHANGE #1 TYP:0 CLS:17 AFN:2 DBA:0x00800009 SCN:0x0000.01569c84 SEQ: 1 OP:5.4

ktucm redo: slt: 0x0006 sqn: 0x00004336 srt: 0 sta: 9 flg: 0x2

ktucf redo: uba: 0x00800370.01ef.34 ext: 2 spc: 4390 fbi: 0

END OF REDO DUMP

----- Redo read statistics for thread 1 -----

Read rate (ASYNC): 22058Kb in 0.92s => 22.83 Mb/sec

Longest record: 1Kb, moves: 4/91535 (0%)


```
Change moves: 31544/212533 (14%), moved: 2Mb
```

以上这些输出和控制文件中记录的信息想符合，问题在于最后打开数据库时，检查点 RBA 被异常增进到 ffffffff,这就导致了异常，如果我们将检查点的信息回退到 ac56 位置，则错误应当可以被消除。

Oracle 控制文件中记录的 On Disk RBA 指向 REDO 中最后一个 RBA 的下一个地址，此时重做日志中最后一个 RBA 是 0x00013d.0000ac55.0090 ,因此下一个地址可以将 RBA 指向 ac56.读者可以通过正常数据库的记录分析一下 RBA 和文件头的信息相关性。

通过 BBED 解决 ORA-600 错误

使用 BBED 可以修改控制文件中的检查点信息：

```
E:\>bbed parfile=par.txt
```

```
口令:blockedit
```

```
BBED: Release 2.0.0.0.0 - Limited Production on 星期二 1月 10 16:00:34 2012
```

```
Copyright (c) 1982, 2002, Oracle Corporation. All rights reserved.
```

```
***** !!! For Oracle Internal Use only !!! *****
```

找到第七个数据块：

```
BBED> set file 11 block 7
```

```
FILE#          11
```

```
BLOCK#         7
```

```
BBED> dump
```

```
File: D:\Oracle\ORADATA\SXXHDTS\CONTROL03.CTL (11)
```

```
Block: 7          Offsets: 0 to 511          Dba:0x02c00007
```

```
-----
15020000 07000000 4e0a0000 ffff0104 e6320000 0f000000 a9ea5601 00000000
11ee062e 01000000 3d010000 ffffffff 10001804 02000000 00000000 00000000
03000100 03000100 3d010000 72e80200 00000000 43bfef2c 00000000 00000000
00000000 3c010000 6f726139 69007300 00000000 00000000 11ee062e 00000000
```

找到全 f 的 RBA 标志位:

```
BBED> find /x ffffffff
```

```
File: D:\Oracle\ORADATA\SXXHDTS\CONTROL03.CTL (11)
```

```
Block: 7                Offsets: 44 to 555                Dbal: 0x02c00007
```

```
-----  
ffffff 10001804 02000000 00000000 00000000 03000100 03000100 3d010000  
72e80200 00000000 43bfef2c 00000000 00000000 00000000 3c010000 6f726139  
69007300 00000000 00000000 11ee062e 00000000 00000000 00000000 00000000  
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000  
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

将该参数值修改为 ac56, 由于换位存储, 实际修改为 56ac :

```
BBED> modify /x 56ac0000
```

```
Warning: contents of previous BIFILE will be lost. Proceed? (Y/N) Y
```

```
File: D:\Oracle\ORADATA\SXXHDTS\CONTROL03.CTL (11)
```

```
Block: 7                Offsets: 44 to 555                Dbal: 0x02c00007
```

```
-----  
56ac0000 10001804 02000000 00000000 00000000 03000100 03000100 3d010000  
72e80200 00000000 43bfef2c 00000000 00000000 00000000 3c010000 6f726139  
69007300 00000000 00000000 11ee062e 00000000 00000000 00000000 00000000  
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000  
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
```

修改后的数据块会标记为损坏, 需要重新计算校验位并应用:

```
BBED> verify
```

```
DBVERIFY - 验证正在启动
```

```
FILE =D:\Oracle\ORADATA\SXXHDTS\CONTROL03.CTL
```

```
BLOCK = 7
```

```
块 7 已损坏
```

```
***
```

```
Corrupt block relative dba: 0x00000007 (file 0, block 7)
```

```
Bad check value found during verification
```

```
Data in bad block -
```

```
type: 21 format: 2 rdba: 0x00000007
last change scn: 0xffff.00000a4e seq: 0x1 flg: 0x04
consistency value in tail: 0x0a4e1501
check value in block header: 0x32e6, computed block checksum: 0xac56
spare1: 0x0, spare2: 0x0, spare3: 0x0
***
```

DBVERIFY - 验证完成

检查的总块数: 1

已处理的总块数 (数据): 0

无法处理的总块数 (数据): 0

已处理的总块数 (索引): 0

无法处理的总块数 (索引): 0

空的总块数: 0

标记为损坏的总块数: 1

汇入的块总数: 0

BBED> sum apply

Check value for File 11, Block 7:

current = 0x9eb0, required = 0x9eb0

然后来尝试启动数据库, 注意此时数据库可以顺利被打开, 不再需要执行任何恢复或者日志重置:

```
SQL> startup nomount pfile=initora9i.ora
```

```
ORACLE instance started.
```

```
Total System Global Area 126950956 bytes
Fixed Size                  454188 bytes
Variable Size               92274688 bytes
Database Buffers           33554432 bytes
Redo Buffers                 667648 bytes
```

```
SQL> alter database mount;
```

```
Database altered.
```

```
SQL> alter database open;
```

Database altered.

最后再来查询一下文件头信息内容:

```
SQL> alter session set events 'immediate trace name file_hdrs level 12';
```

Session altered.

可以看到现在文件头上的检查点信息全部恢复了正常:

FILE HEADER:

Software vsn=153092096=0x9200000, Compatibility Vsn=134217728=0x8000000

Db ID=615401347=0x24ae4783, Db Name='SXXHDTS'

Activation ID=0=0x0

Control Seq=2647=0xa57, File size=52480=0xcd00

File Number=1, Blksiz=8192, File Type=3 DATA

Tablespace #0 - SYSTEM rel_fn:1

Creation at scn: 0x0000.0000000b 05/12/2002 16:17:58

Backup taken at scn: 0x0000.00000000 01/01/1988 00:00:00 thread:0

reset logs count:0x2cebbf43 scn: 0x0000.0002e872 recovered at 01/10/2012 16:01:22

status:0x4 root dba:0x004001a1 chkpt cnt: 947 ctl cnt:946

begin-hot-backup file size: 0

Checkpointed at scn: 0x0000.015738cc 01/10/2012 16:01:22

thread:1 rba:(0x13e.2.10)

告警日志信息解析

在告警日志文件中,记录了数据库打开的过程:

Tue Jan 10 16:01:22 2012

alter database open

Tue Jan 10 16:01:22 2012

Beginning crash recovery of 1 threads

Tue Jan 10 16:01:22 2012

Started redo scan

Tue Jan 10 16:01:22 2012

Completed redo scan

```
0 redo blocks read, 0 data blocks need recovery
```

注意此处明确提示,数据库恢复从日志序列 317 开始,日志块 44118(16 进制就是 ac56),SCN 为 22473385,也正是控制文件中记录的 0x156EAA9。

所以我们说,告警日志中记录的每一条记录都有其重要含义,如果能够深入分析,研究清楚其中的内容,那么我们的 Oracle 学习和深入就可以变得相当容易。

```
Tue Jan 10 16:01:22 2012
Started recovery at
  Thread 1: logseq 317, block 44118, scn 0.22473385
Tue Jan 10 16:01:22 2012
Recovery of Online Redo Log: Thread 1 Group 1 Seq 317 Reading mem 0
  Mem# 0 errs 0: D:\ORACLE\ORADATA\SXXHDTs\REDO01.LOG
Tue Jan 10 16:01:22 2012
Completed redo application
```

接下来日志记录了恢复终点,注意由于 44118 是 ac56,最后一个 RBA 块,所以恢复就此停止,而 SCN 序列号被推进了 1 位,不知道诸位读者是否会拍案叫绝,Oracle 数据库就是如此精密,如此句句言之有物:

```
Tue Jan 10 16:01:22 2012
Ended recovery at
  Thread 1: logseq 317, block 44118, scn 0.22493386
  0 data blocks read, 0 data blocks written, 0 redo blocks read
Crash recovery completed successfully
Tue Jan 10 16:01:22 2012
Thread 1 advanced to log sequence 318
Thread 1 opened at log sequence 318
  Current log# 2 seq# 318 mem# 0: D:\ORACLE\ORADATA\SXXHDTs\REDO02.LOG
Successful open of redo thread 1
Tue Jan 10 16:01:22 2012
SMON: enabling cache recovery
Tue Jan 10 16:01:23 2012
Successfully onlined Undo Tablespace 1.
Tue Jan 10 16:01:23 2012
SMON: enabling tx recovery
Tue Jan 10 16:01:23 2012
```

```

Database Characterset is ZHS16GBK
Updating 9.2.0.1.0 NLS parameters in sys.props$
-- adding 9.2.0.8.0 NLS parameters.
replication_dependency_tracking turned off (no async multimaster replication found)
Completed: alter database open
Tue Jan 10 16:02:27 2012
Restarting dead background process QMN0
QMN0 started with pid=9, OS id=4072

```

对于这种情况，主要的问题在于控制文件的信息存在缺失，使得恢复的终点判断有误，写入了错误的 RBA 信息。

重建控制文件恢复

如果通过重建控制文件，清除控制文件中记录的检查点信息，其余内容从数据文件头上提取，则可以将恢复推进到日志文件尾部，完成完全恢复。

以下是重建控制文件的过程：

```

Tue Jan 10 16:36:36 2012
Starting ORACLE instance (normal)
Tue Jan 10 16:36:37 2012
CREATE CONTROLFILE REUSE DATABASE "SXXHDTS" NORESETLOGS NOARCHIVELOG
-- SET STANDBY TO MAXIMIZE PERFORMANCE
MAXLOGFILES 50
MAXLOGMEMBERS 5
MAXDATAFILES 100
MAXINSTANCES 1
MAXLOGHISTORY 226
LOGFILE
GROUP 1 'D:\ORACLE\ORADATA\SXXHDTS\REDO01.LOG' SIZE 100M,
GROUP 2 'D:\ORACLE\ORADATA\SXXHDTS\REDO02.LOG' SIZE 100M,
GROUP 3 'D:\ORACLE\ORADATA\SXXHDTS\REDO03.LOG' SIZE 100M
-- STANDBY LOGFILE
DATAFILE

```

```
'D:\ORACLE\ORADATA\SXXHDTS\SYSTEM01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\UNDOTBS01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\CWMLITE01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\DRSYS01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\EXAMPLE01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\INDX01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\ODM01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\TOOLS01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\USERS01.DBF',
'D:\ORACLE\ORADATA\SXXHDTS\XDB01.DBF'
```

CHARACTER SET ZHS16GBK

Tue Jan 10 16:36:37 2012

Successful mount of redo thread 1, with mount id 634003285

Tue Jan 10 16:36:37 2012

Completed: CREATE CONTROLFILE REUSE DATABASE "SXXHDTS" NORESE

重建后控制文件主要内容如下:

*** 2012-01-10 16:36:51.549

*** SESSION ID:(9.1) 2012-01-10 16:36:51.539

DUMP OF CONTROL FILES, Seq # 2627 = 0xa43

FILE HEADER:

Software vsn=153092096=0x9200000, Compatibility Vsn=134217728=0x8000000

Db ID=615401347=0x24ae4783, Db Name='SXXHDTS'

Activation ID=0=0x0

Control Seq=2627=0xa43, File size=278=0x116

File Number=0, Blksiz=8192, File Type=1 CONTROL

以下数据库条目中的检查点信息来自于日志文件, 其检查点 SCN 为 0155b0f0, 以下内容都是重新构建出来的:

```
*****
DATABASE ENTRY
*****
(blkno = 0x1, size = 192, max = 1, in-use = 1, last-rcid= 0)
```

```

DF Version: creation=0x9200000 compatible=0x8000000, Date 01/10/2012 16:36:37
DB Name "SXXHDTS"
Database flags = 0x00400102
Controlfile Creation Timestamp 01/10/2012 16:36:37
Incmlpt recovery scn: 0x0000.00000000
Resetlogs scn: 0x0000.0002e872 Resetlogs Timestamp 06/12/2011 18:30:27
Prior resetlogs scn: 0x0000.00000001 Prior resetlogs Timestamp 05/12/2002 16:16:56
Redo Version: creation=0x9200000 compatable=0x9200000
#Data files = 10, #Online files = 10
Database checkpoint: Thread=1 scn: 0x0000.0155b0f0
Threads: #Enabled=1, #Open=1, Head=1, Tail=1
enabled threads: 01000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
Max log members = 5, Max data members = 1
Arch list: Head=0, Tail=0, Force scn: 0x0000.00000000scn: 0x0000.00000000
Controlfile Checkpointed at scn: 0x0000.00000000
thread:0 rba:(0x0.0.0)
enabled threads: 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000

```

重建控制文件之后，检查点记录部分被清空，这部分信息无从获得，恢复将依据控制文件进行推进，以下是检查点进程的信息记录：

```

*****
CHECKPOINT PROGRESS RECORDS
*****
(blkno = 0x4, size = 104, max = 1, in-use = 1, last-rcid= 0)
THREAD #1 - status:0x0 flags:0x0 dirty:0
low cache rba:(0x0.0.0) on disk rba:(0x0.0.0)
on disk scn: 0x0000.00000000 01/01/1988 00:00:00
resetlogs scn: 0x0000.00000000 01/01/1988 00:00:00
heartbeat: 772257562 mount id: 634003285
MTTR statistics status: 1
Init time: Avg: 0, Times measured: 0
File open time: Avg: 100000, Times measured: 1

```



```
Log block read time: Avg: 20, Times measured: 1
Data block handling time: Avg: 558, Times measured: 1
```

以下是日志检查点信息，注意这里的检查点信息能够正确获得，其信息来自 REDO 日志文件，检查点为 0155b0f0,这个内容对应到了 REDO 日志头块的 SCN,RBA 的块号显示为 2,也就是头块之后的第一个日志块:

```
*****
REDO THREAD RECORDS
*****

(blkno = 0x4, size = 104, max = 1, in-use = 1, last-rcid= 0)
THREAD #1 - status:0x7 thread links forward:0 back:0
#logs:3 first:1 last:3 current:1 last used seq#:0x13d
enabled at scn: 0x0000.0002e872 06/12/2011 18:30:27
disabled at scn: 0x0000.00000000 01/01/1988 00:00:00
opened at 01/01/1988 00:00:00 by instance
Checkpointed at scn: 0x0000.0155b0f0 12/31/2011 08:28:19
thread:1 rba:(0x13d.2.0)
enabled threads: 01000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
log history: 0
```

接下来检查数据文件信息，来自文件头的信息尚未有变化，其信息由文件头提出，所以固有不变:

```
DATA FILE #1:
(name #13) D:\ORACLE\ORADATA\SXXHDTs\SYSTEM01.DBF
creation size=0 block size=8192 status=0x12 head=13 tail=13 dup=1
tablespace 0, index=1 krfil=1 prev_file=0
unrecoverable scn: 0x0000.00000000 01/01/1988 00:00:00
Checkpoint cnt:942 scn: 0x0000.0156eaa8 12/31/2011 17:47:31
Stop scn: 0xffff.ffffffff 01/10/2012 16:36:37
Creation Checkpointed at scn: 0x0000.0000000b 05/12/2002 16:17:58
thread:0 rba:(0x0.0.0)
enabled threads: 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
Offline scn: 0x0000.00000000 prev_range: 0
Online Checkpointed at scn: 0x0000.00000000
```

```

thread:0 rba:(0x0.0.0)
enabled threads: 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
Hot Backup end marker scn: 0x0000.00000000
aux_file is NOT DEFINED
FILE HEADER:
    Software vsn=153092096=0x9200000, Compatibility Vsn=134217728=0x8000000
    Db ID=615401347=0x24ae4783, Db Name='SXXHDTS'
    Activation ID=0=0x0
    Control Seq=2624=0xa40, File size=52480=0xcd00
    File Number=1, Blksiz=8192, File Type=3 DATA
Tablespace #0 - SYSTEM rel_fn:1
Creation at scn: 0x0000.0000000b 05/12/2002 16:17:58
Backup taken at scn: 0x0000.00000000 01/01/1988 00:00:00 thread:0
reset logs count:0x2cebbf43 scn: 0x0000.0002e872 recovered at 12/31/2011 17:47:30
status:0x4 root dba:0x004001a1 chkpt cnt: 942 ctl cnt:941
begin-hot-backup file size: 0
Checkpointed at scn: 0x0000.0156eaa8 12/31/2011 17:47:31
thread:1 rba:(0x13e.2.10)

```

以下为 UNDO 表空间的文件头信息，其内容与之前一致：

```

DATA FILE #2:
    (name #12) D:\ORACLE\ORADATA\SXXHDTS\UNDOTBS01.DBF
creation size=0 block size=8192 status=0x12 head=12 tail=12 dup=1
tablespace 1, index=2 krfil=2 prev_file=0
unrecoverable scn: 0x0000.00000000 01/01/1988 00:00:00
Checkpoint cnt:927 scn: 0x0000.0155b0f1 12/31/2011 08:28:19
Stop scn: 0xffff.ffffffff 01/10/2012 16:36:37
Creation Checkpointed at scn: 0x0000.0002dd31 05/12/2002 20:22:54
thread:0 rba:(0x0.0.0)
enabled threads: 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
Offline scn: 0x0000.00000000 prev_range: 0
Online Checkpointed at scn: 0x0000.00000000

```

```

thread:0 rba:(0x0.0.0)
enabled threads: 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000
Hot Backup end marker scn: 0x0000.00000000
aux_file is NOT DEFINED
FILE HEADER:
    Software vsn=153092096=0x9200000, Compatibility Vsn=134217728=0x8000000
    Db ID=615401347=0x24ae4783, Db Name='SXXHDTs'
    Activation ID=0=0x0
    Control Seq=2618=0xa3a, File size=25600=0x6400
    File Number=2, Blksiz=8192, File Type=3 DATA
Tablespace #1 - UNDOTBS1 rel_fn:2
Creation at scn: 0x0000.0002dd31 05/12/2002 20:22:54
Backup taken at scn: 0x0000.00000000 01/01/1988 00:00:00 thread:0
reset logs count:0x2cebbf43 scn: 0x0000.0002e872 recovered at 12/31/2011 08:28:19
status:0x4 root dba:0x00000000 chkpt cnt: 927 ctl cnt:926
begin-hot-backup file size: 0
Checkpointed at scn: 0x0000.0155b0f1 12/31/2011 08:28:19
thread:1 rba:(0x13d.2.10)

```

此时尝试直接 Open，遇到 ORA-01110 错误，提示 SYSTEM 表空间需要恢复，实际上整个数据库都需要向前推演恢复：

```

SQL> alter database open;
alter database open
*
ERROR at line 1:
ORA-01113: file 1 needs media recovery
ORA-01110: data file 1: 'D:\ORACLE\ORADATA\SXXHDTs\SYSTEM01.DBF'

```

执行恢复后数据库可以直接 Open 打开：

```

SQL> recover database;
Media recovery complete.
SQL> alter session set events 'immediate trace name CONTROLF level 12';
Session altered.

```

```
SQL> alter session set events 'immediate trace name file_hdrs level 12';
```

```
Session altered.
```

```
SQL> alter database open;
```

```
Database altered.
```

这样就完成了恢复，告警日志中记录了如下过程：

```
Tue Jan 10 16:41:59 2012
```

```
Started redo scan
```

```
Tue Jan 10 16:41:59 2012
```

```
Completed redo scan
```

```
44116 redo blocks read, 0 data blocks need recovery
```

这里的恢复由 317 日志开始，SCN 为 22393072

```
Tue Jan 10 16:41:59 2012
```

```
Started recovery at
```

```
Thread 1: logseq 317, block 2, scn 0.22393072
```

```
Tue Jan 10 16:41:59 2012
```

```
Recovery of Online Redo Log: Thread 1 Group 1 Seq 317 Reading mem 0
```

```
Mem# 0 errs 0: D:\ORACLE\ORADATA\SXXHDTS\REDO01.LOG
```

```
Tue Jan 10 16:41:59 2012
```

```
Completed redo application
```

恢复的终点是块 44118，SCN 22473382

```
Tue Jan 10 16:41:59 2012
```

```
Ended recovery at
```

```
Thread 1: logseq 317, block 44118, scn 0.22473382
```

```
0 data blocks read, 0 data blocks written, 44116 redo blocks read
```

```
Crash recovery completed successfully
```

```
Tue Jan 10 16:41:59 2012
```

```
Thread 1 advanced to log sequence 318
```

```
Thread 1 opened at log sequence 318
```

```
Current log# 2 seq# 318 mem# 0: D:\ORACLE\ORADATA\SXXHDTS\REDO02.LOG
```

```
Successful open of redo thread 1
```

```
Tue Jan 10 16:41:59 2012
```

```

SMON: enabling cache recovery
Tue Jan 10 16:41:59 2012
Successfully onlined Undo Tablespace 1.
Dictionary check beginning
Tablespace 'TEMP' #2 found in data dictionary,
but not in the controlfile. Adding to controlfile.
Dictionary check complete
Tue Jan 10 16:41:59 2012
SMON: enabling tx recovery
Tue Jan 10 16:41:59 2012
Database Characterset is ZHS16GBK
Updating 9.2.0.1.0 NLS parameters in sys.props$
-- adding 9.2.0.8.0 NLS parameters.
replication_dependency_tracking turned off (no async multimaster replication found)
Completed: alter database open

```

技术提示

关于 Low Cache RBA 和 On Disk RBA，以下是一点补充说明，从动态视图 X\$KCCP 可以获得检查点信息及 RBA 进程进度信息：

```

SQL> |
  1 SELECT cpdrt,
  2 cplrba_seq || '.' || cplrba_bno || '.' || cplrba_bof "low_cache_rba",
  3 cpodr_seq || '.' || cpodr_bno || '.' || cpodr_bof "on_disk_rba"
  4* FROM x$kcpcp where cplrba_seq >0
SQL> /

```

CPDRT	low_cache_	on_disk_rb
205	208.2625.0	208.4721.0

转储控制文件，其中的检查点记录如下：

```

*****
CHECKPOINT PROGRESS RECORDS

```

```

*****
(size = 8180, compat size = 8180, section max = 11, section in-use = 0,
last-recid= 0, old-recno = 0, last-recno = 0)
(extent = 1, blkno = 2, numrecs = 11)
THREAD #1 - status:0x2 flags:0x0 dirty:205
low cache rba:(0xd0.a41.0) on disk rba:(0xd0.1271.0)
on disk scn: 0x0000.00417af3 01/16/2012 17:47:58
resetlogs scn: 0x0000.00080634 12/06/2011 14:58:40
heartbeat: 772248185 mount id: 1299842038

```

以上两者信息一致:

```

SQL> select to_number('d0','xxx') seq,
2 to_number('a41','xxx') lowblock,to_number('1271','xxx') highblock
3 from dual;

```

SEQ	LOWBLOCK	HIGHBLOCK
208	2625	4721

从小恙到灾难

重建控制文件失误导致的故障

在 2012 新年后的第一个工作日，我们又接收到一则客户服务请求，又一次数据灾难发生。这是又一次我们称为从感冒治疗成癌症的过程。原本并不复杂的一次数据库故障，在经过错误的处理之后，数据库的小病变成了重恙。

灾难描述

这次灾难是这样发生的：

1. 客户数据库因为断电而崩溃
2. 服务器重启后控制文件出现不一致错误
3. 服务商通过重建控制文件，试图恢复控制文件的一致性
4. 通过重置日志进行数据库强制打开
5. 打开数据库后实例崩溃
6. 数据库无法正常打开，并且发现重建控制文件时遗失了大量文件
7. 灾难形成

重建控制文件失误，这是最基本技能的缺失。

案例警示

这个案例对我们的警示是：

1. 技术人员的基本功必须扎实可靠

如果技术人员没有扎实的基本功，则可能在简单的问题上犯下错误，这些简单的错误有可能积累最终致命。

在这个案例中，如果技术人员能够正确的创建控制文件，不遗漏数据文件，则灾难就不至于形成。

2. 技术专家的推理判断必须能够还原事实真相

对于技术专家，必须能够准确判断故障的成因，逐步推理，解释清除，并且要能够从现场搜集证据，支持自己的判断。

专家的作用在于清晰的解构案情的来龙去脉，从而做出正确判断，避免走不必要的弯路。唯有正确的判断，才能有正确的处理。

3. 在完成技术分析之前不要草率进行恢复尝试

在面对灾难时，不要急于进行恢复尝试，首先应该在不改变、不破坏环境的情况下，进行充分的技术分析，根据分析结果确定恢复方案，避免草率的尝试。

当然，在进行实际操作之前，必须做好备份工作。

再一次提示大家，无知者不能够无畏。

技术回放

这个数据库崩溃于 2011 年 12 月 30 日，同样是一个倒在 2012 前的数据库。让我们看一看灾难的形成过程。

以下是用户重建控制文件的过程，注意这个创建脚本是用户手工编写的，其中仅仅指定了一个数据文件，即 SYSTEM 表空间：

```
Sat Jan 28 19:38:04 2012
CREATE CONTROLFILE REUSE DATABASE "ORCL" RESETLOGS NOARCHIVELOG
LOGFILE
  GROUP 1 'c:\z1\REDO01.LOG' SIZE 100M,
  GROUP 2 'c:\z1\REDO02.LOG' SIZE 100M,
  GROUP 3 'c:\z1\REDO03.LOG' SIZE 100M
DATAFILE
  'H:\2011\oradata\orcl\SYSTEM01.DBF'
CHARACTER SET ZHS16GBK

Sat Jan 28 19:38:04 2012
Successful mount of redo thread 1, with mount id 1301551900.
```