Dbvisit
THE SMART ALTERNATIVE

# Evolution of Oracle Database Redo Logs Through Versions

UGF2264

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# Agenda

- What is redo, after all?
- Basic structure of redo
- Change record in detail
- Across versions: changes to data change records
- Across versions: new change record types
- Q&A

# Vit Spinka

- Working with Oracle Database since 8*i*
- Oracle Certified Master
- Principal developer of Dbvisit Replicate
- … which gets its data by parsing Oracle redo logs


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- This presentation for download at http://vitspinka.cz/download.html

# Dbvisit


- HQ in New Zealand, US subsidiary, partners throughout the world
- Used in 80+ Countries
- Database Replication is our playground
- Worldwide leader in DR solutions for Oracle Standard Edition
- Product Engineers with “real world” DBA Experience
- Regular presenters at Oracle events such as OOW, Collaborate and NZOUG
- Passionate about Oracle Technology




# Trusted in 80+ countries. . .


. . . By 800+ companies.

# What is redo, after all

- Basic goal: recover database
- Online redo: instance/crash recovery
- Archive redo: media recovery
- Every change is written to redo before data files
- Allows to replay changes

# What is redo, after all

- Optimized for recovery and for performance
- Binary format
- Even when dumped to text, still pretty cryptic
- Saves space by using object ids; wastes space by aligning to blocks
- Block size “fixed” (actually: default 512 bytes, HP-UX 1024 bytes, 11.2+ and Advanced Disk Format: 4096 bytes)

# Redo dump

- MOS Note 103181.6
- ALTER SYSTEM DUMP LOGFILE 'filename';

- The resulting trace file is huge and contains most (but not all!) interesting information from the redo in a text format
- We will see these dumps further in this session

- Database can dump redo from a different database, as long as the endian (big/little) match and version is the same or higher than the source db*

# Basic structure of redo

- Header

```
FILE HEADER:
     Compatibility Vsn = 202375168=0xc100000
     Db ID=1365223133=0x515fa6dd, Db Name='ORCL'
     Activation ID=1365239005=0x515fe4dd
     Control Seq=3327=0xcff, File size=102400=0x19000
     File Number=2, Blksiz=512, File Type=2 LOG
descrip:"Thread 0001, Seq# 0000000104, SCN 0x0000002d22aa-0xffffffffffff"
thread: 1 nab: 0xffffffff seq: 0x00000068 hws: 0x1 eot: 1 dis: 0
resetlogs count: 0x31ea5b5f scn: 0x0000.001a3f12 (1720082)
prev resetlogs count: 0x30a7312f scn: 0x0000.00000001 (1)
Low  scn: 0x0000.002d22aa (2957994) 07/08/2014 15:58:30
Next scn: 0xffff.ffffffff 01/01/1988 00:00:00
```

```
FILE HEADER:
   Compatibility Vsn = 202375168=0xc100000
   Db ID=1365223133=0x515fa6dd, Db Name='ORCL'
   Activation ID=1365239005=0x515fe4dd
   Control Seq=3327=0xcff, File size=102400=0x19000
   File Number=2, Blksiz=512, File Type=2 LOG
descrip:"Thread 0001, Seq# 0000000104, SCN 0x0000002d22aa-0xffffffffffff"
thread: 1 nab: 0xffffffff seq: 0x00000068 hws: 0x1 eot: 1 dis: 0
resetlogs count: 0x31ea5b5f scn: 0x0000.001a3f12 (1720082)
prev resetlogs count: 0x30a7312f scn: 0x0000.00000001 (1)
Low  scn: 0x0000.002d22aa (2957994) 07/08/2014 15:58:30
Next scn: 0xffff.ffffffff 01/01/1988 00:00:00
```

# Basic structure of redo

- Blocks
- Only a physical structure
- They are used in the RBA – redo block address

# Basic structure of redo

- Redo record
- Spans one or more redo blocks
- One redo block can have multiple redo records (if created by the same server process)
- Each redo record has an RBA, pointing to start of the redo record
- Header – SCN, time, size; trace will lie and show these even if they are not in the header
- Change records – actual data

```
REDO RECORD - Thread:1 RBA: 0x000068.00000015.0010 LEN: 0x007c VLD: 0x05 CON_UID: 3345156736
SCN: 0x0000.002d22c3 SUBSCN:  1 07/08/2014 15:58:58
(LWN RBA: 0x000068.00000015.0010 LEN: 0002 NST: 0001 SCN: 0x0000.002d22c0)
```

```
REDO RECORD - Thread:1 RBA: 0x000068.00000015.0010 LEN: 0x007c VLD: 0x05
CON_UID: 3345156736
SCN: 0x0000.002d22c3 SUBSCN:  1 07/08/2014 15:58:58
(LWN RBA: 0x000068.00000015.0010 LEN: 0002 NST: 0001 SCN: 0x0000.002d22c0)
```

# Basic structure of redo

- Change record
- Describes actual change
- Data changes: change to undo, change to data (tables, indexes)
- Transactions: changes to undo (allocate undo entry), commit/rollback
- Maintenance: space allocation, ASSM bitmaps…
- All is referenced by ids valid on the source: object id, data object id, datafile Absolute File Number, DBA, undo segment id…

# Basic structure of redo

- Since 9*i*, redo is used by LogMiner and Streams
- More information needed:
- How do you assemble row pieces together
- How do you identify row if you cannot use rowid
- Answer: supplemental logging
- Adds row assembly information
- Adds primary key information (or whatever you specify)
- Oracle also added actual DDL text to redo
- Sadly, none of this is visible in the text dump

# Change record in detail

- Type of change is in OP, consisting of “Layer” and “Opcode”
- Interesting layers:
- 5: Undo (5.2 allocate undo header, 5.1 undo change, 5.4 commit)
- 11: Table data (insert, update, delete, lock, …)
- 10: Index data
- And some more (19.1 direct load, 24.1 DDL)

- One change record (usually) modifies one database block

# Change record in detail

- Example: one insert, then commit
- Start transaction:

```
CHANGE #2 CON_ID:1 TYP:0 CLS:19 AFN:4 DBA:0x01000090 OBJ:4294967295 SCN:0x0000.002d228d SEQ:1 OP:5.2 ENC:0
RBL:0
ktudh redo: slt: 0x0013 sqn: 0x000008d3 flg: 0x0052 siz: 112 fbi: 0
            uba: 0x01003327.0187.04    pxid:  0x0000.000.00000000        pdbid:3345156736
```

- (strictly speaking: this is undo block allocation and can happen multiple times in a transaction)
- SCN in change header is not interesting – SCN of change is in redo header

```
CHANGE #2 CON_ID:1 TYP:0 CLS:19 AFN:4 DBA:0x01000090 OBJ:4294967295
SCN:0x0000.002d228d SEQ:1 OP:5.2 ENC:0 RBL:0
ktudh redo: slt: 0x0013 sqn: 0x000008d3 flg: 0x0052 siz: 112 fbi: 0
            uba: 0x01003327.0187.04    pxid:  0x0000.000.00000000
pdbid:3345156736
```

# Change record in detail

- Example: insert into hr.jobs values (‘TE_TEST’, ‘Test job’, 1, 100)
- Redo

```
CHANGE #1 CON_ID:3 TYP:0 CLS:1 AFN:13 DBA:0x034000bb OBJ:95424 SCN:0x0000.00285536 SEQ:2 OP:11.2 ENC:0 RBL:0
KTB Redo
op: 0x01  ver: 0x01
compat bit: 4 (post-11) padding: 1
op: F  xid:  0x0002.013.000008d3    uba: 0x01003327.0187.04
KDO Op code: IRP row dependencies Disabled
  xtype: XA flags: 0x00000000  bdba: 0x034000bb  hdba: 0x034000ba
itli: 1  ispac: 0  maxfr: 4858
tabn: 0 slot: 0(0x0) size/delt: 26
fb: --H-FL-- lb: 0x1  cc: 4
null: ----
col  0: [ 7]  54 45 5f 54 45 53 54
col  1: [ 8]  54 65 73 74 20 6a 6f 62
col  2: [ 2]  c1 02
col  3: [ 2]  c2 02
```

```
CHANGE #1 CON_ID:3 TYP:0 CLS:1 AFN:13 DBA:0x034000bb OBJ:95424
SCN:0x0000.00285536 SEQ:2 OP:11.2 ENC:0 RBL:0
KTB Redo
op: 0x01  ver: 0x01
compat bit: 4 (post-11) padding: 1
op: F  xid:  0x0002.013.000008d3    uba: 0x01003327.0187.04
KDO Op code: IRP row dependencies Disabled
  xtype: XA flags: 0x00000000  bdba: 0x034000bb  hdba: 0x034000ba
itli: 1  ispac: 0  maxfr: 4858
tabn: 0 slot: 0(0x0) size/delt: 26
fb: --H-FL-- lb: 0x1  cc: 4
null: ----
col  0: [ 7]  54 45 5f 54 45 53 54
col  1: [ 8]  54 65 73 74 20 6a 6f 62
col  2: [ 2]  c1 02
col  3: [ 2]  c2 02
```

# Change record in detail

```
CHANGE #5 CON_ID:1 TYP:0 CLS:20 AFN:4 DBA:0x01003327 OBJ:4294967295 SCN:0x0000.002d228c SEQ:1 OP:5.1 ENC:0
RBL:0
ktudb redo: siz: 112 spc: 7776 flg: 0x0012 seq: 0x0187 rec: 0x04
            xid:  0x0002.013.000008d3
ktubl redo: slt: 19 rci: 0 opc: 11.1 [objn: 95424 objd: 95424 tsn: 3]
Undo type:  Regular undo        Begin trans    Last buffer split:  No
Temp Object:  No
Tablespace Undo:  No
             0x00000000  prev ctl uba: 0x01003327.0187.03
prev ctl max cmt scn:  0x0000.002d1e27  prev tx cmt scn:  0x0000.002d1e39
txn start scn:  0x0000.002d22c3  logon user: 114  prev brb: 16790299  prev bcl: 0 BuExt idx: 0 flg2: 0
KDO undo record:
KTB Redo
op: 0x03  ver: 0x01
compat bit: 4 (post-11) padding: 1
op: Z
KDO Op code: DRP row dependencies Disabled
  xtype: XA flags: 0x00000000  bdba: 0x034000bb  hdba: 0x034000ba
itli: 1  ispac: 0  maxfr: 4858
tabn: 0 slot: 0(0x0)
```

```
CHANGE #5 CON_ID:1 TYP:0 CLS:20 AFN:4 DBA:0x01003327 OBJ:4294967295 SCN:0x0000.002d228c
SEQ:1 OP:5.1 ENC:0 RBL:0
ktudb redo: siz: 112 spc: 7776 flg: 0x0012 seq: 0x0187 rec: 0x04
            xid:  0x0002.013.000008d3
ktubl redo: slt: 19 rci: 0 opc: 11.1 [objn: 95424 objd: 95424 tsn: 3]
Undo type:  Regular undo        Begin trans    Last buffer split:  No
Temp Object:  No
Tablespace Undo:  No
             0x00000000  prev ctl uba: 0x01003327.0187.03
prev ctl max cmt scn:  0x0000.002d1e27  prev tx cmt scn:  0x0000.002d1e39
txn start scn:  0x0000.002d22c3  logon user: 114  prev brb: 16790299  prev bcl: 0 BuExt
idx: 0 flg2: 0
KDO undo record:
KTB Redo
op: 0x03  ver: 0x01
compat bit: 4 (post-11) padding: 1
op: Z
KDO Op code: DRP row dependencies Disabled
  xtype: XA flags: 0x00000000  bdba: 0x034000bb  hdba: 0x034000ba
itli: 1  ispac: 0  maxfr: 4858
tabn: 0 slot: 0(0x0)
```

# Across versions: changes in time

- How the redo record header evolved:
- 9*i*

```
REDO RECORD - Thread:1 RBA: 0x0006e8.00000007.0018 LEN: 0x00e8 VLD: 0x01
SCN: 0x0000.006b5967 SUBSCN:  1 07/13/2014 14:44:35
```

- 11*g*

```
REDO RECORD - Thread:1 RBA: 0x00000c.00000005.0050 LEN: 0x00a4 VLD: 0x01
SCN: 0x0000.000cc465 SUBSCN:  1 07/13/2014 14:38:52
(LWN RBA: 0x00000c.00000005.0050 LEN: 0003 NST: 0001 SCN: 0x0000.000cc465)
```

- 12*c* (non-CDB)

```
REDO RECORD - Thread:1 RBA: 0x0008e6.00000002.0010 LEN: 0x006c VLD: 0x05 CON_UID: 0
SCN: 0x0000.00f51e47 SUBSCN:  1 07/13/2014 19:17:13
(LWN RBA: 0x0008e6.00000002.0010 LEN: 0003 NST: 0001 SCN: 0x0000.00f51e47)
```

- 12*c* (multitenant)

```
REDO RECORD - Thread:1 RBA: 0x000068.00000017.0010 LEN: 0x006c VLD: 0x05 CON_UID: 3918633952
SCN: 0x0000.002d22ca SUBSCN:  1 07/08/2014 15:59:07
(LWN RBA: 0x000068.00000017.0010 LEN: 0003 NST: 0001 SCN: 0x0000.002d22c7)
```

```
REDO RECORD - Thread:1 RBA: 0x0006e8.00000007.0018 LEN: 0x00e8 VLD: 0x01
SCN: 0x0000.006b5967 SUBSCN:  1 07/13/2014 14:44:35

REDO RECORD - Thread:1 RBA: 0x00000c.00000005.0050 LEN: 0x00a4 VLD: 0x01
SCN: 0x0000.000cc465 SUBSCN:  1 07/13/2014 14:38:52
(LWN RBA: 0x00000c.00000005.0050 LEN: 0003 NST: 0001 SCN: 0x0000.000cc465)

REDO RECORD - Thread:1 RBA: 0x0008e6.00000002.0010 LEN: 0x006c VLD: 0x05
CON_UID: 0
SCN: 0x0000.00f51e47 SUBSCN:  1 07/13/2014 19:17:13
(LWN RBA: 0x0008e6.00000002.0010 LEN: 0003 NST: 0001 SCN: 0x0000.00f51e47)

REDO RECORD - Thread:1 RBA: 0x000068.00000017.0010 LEN: 0x006c VLD: 0x05
CON_UID: 3918633952
SCN: 0x0000.002d22ca SUBSCN:  1 07/08/2014 15:59:07
(LWN RBA: 0x000068.00000017.0010 LEN: 0003 NST: 0001 SCN: 0x0000.002d22c7)
```

9*i*

11*g*

12*c*

12*c pdb*

# Across versions: ordering

- Thanks to optimizations, redo is less and less sequential
- Changes in one redo record can be in different order (some 11g, much 12c)

```
CHANGE #1 CON_ID:3 TYP:0 CLS:1 AFN:13 DBA:0x034000bb OBJ:95424 SCN:0x0000.00285536 SEQ:2 OP:11.2 ENC:0 RBL:0
CHANGE #2 CON_ID:1 TYP:0 CLS:19 AFN:4 DBA:0x01000090 OBJ:4294967295 SCN:0x0000.002d228d SEQ:1 OP:5.2 ENC:0 RBL:0
CHANGE #3 CON_ID:3 TYP:0 CLS:1 AFN:13 DBA:0x034000c3 OBJ:95425 SCN:0x0000.002d22c3 SEQ:1 OP:10.2 ENC:0 RBL:0
CHANGE #4 CON_ID:1 TYP:0 CLS:19 AFN:4 DBA:0x01000090 OBJ:4294967295 SCN:0x0000.002d22c4 SEQ:1 OP:5.4 ENC:0 RBL:0
CHANGE #5 CON_ID:1 TYP:0 CLS:20 AFN:4 DBA:0x01003327 OBJ:4294967295 SCN:0x0000.002d228c SEQ:1 OP:5.1 ENC:0 RBL:0
CHANGE #6 CON_ID:1 TYP:0 CLS:20 AFN:4 DBA:0x01003327 OBJ:4294967295 SCN:0x0000.002d22c4 SEQ:1 OP:5.1 ENC:0 RBL:0
```

- And redo records are in different order, too (private strands?) – LWN (some 10g, much more 11g)

```
REDO RECORD - Thread:1 RBA: 0x000068.00000060.0010 LEN: 0x0078 VLD: 0x06 CON_UID: 1
SCN: 0x0000.002d236c SUBSCN:  1 07/08/2014 15:59:26

REDO RECORD - Thread:1 RBA: 0x000068.0000005f.0010 LEN: 0x0078 VLD: 0x06 CON_UID: 1
SCN: 0x0000.002d236c SUBSCN:  2 07/08/2014 15:59:26
(LWN RBA: 0x000068.00000060.0010 LEN: 0002 NST: 0002 SCN: 0x0000.002d236c)
```

```
CHANGE #1 CON_ID:3 TYP:0 CLS:1 AFN:13 DBA:0x034000bb OBJ:95424 SCN:0x0000.00285536
SEQ:2 OP:11.2 ENC:0 RBL:0
CHANGE #2 CON_ID:1 TYP:0 CLS:19 AFN:4 DBA:0x01000090 OBJ:4294967295
SCN:0x0000.002d228d SEQ:1 OP:5.2 ENC:0 RBL:0
CHANGE #3 CON_ID:3 TYP:0 CLS:1 AFN:13 DBA:0x034000c3 OBJ:95425 SCN:0x0000.002d22c3
SEQ:1 OP:10.2 ENC:0 RBL:0
CHANGE #4 CON_ID:1 TYP:0 CLS:19 AFN:4 DBA:0x01000090 OBJ:4294967295
SCN:0x0000.002d22c4 SEQ:1 OP:5.4 ENC:0 RBL:0
CHANGE #5 CON_ID:1 TYP:0 CLS:20 AFN:4 DBA:0x01003327 OBJ:4294967295
SCN:0x0000.002d228c SEQ:1 OP:5.1 ENC:0 RBL:0
CHANGE #6 CON_ID:1 TYP:0 CLS:20 AFN:4 DBA:0x01003327 OBJ:4294967295
SCN:0x0000.002d22c4 SEQ:1 OP:5.1 ENC:0 RBL:0


REDO RECORD - Thread:1 RBA: 0x000068.00000060.0010 LEN: 0x0078 VLD: 0x06 CON_UID: 1
SCN: 0x0000.002d236c SUBSCN:  1 07/08/2014 15:59:26

REDO RECORD - Thread:1 RBA: 0x000068.0000005f.0010 LEN: 0x0078 VLD: 0x06 CON_UID: 1
SCN: 0x0000.002d236c SUBSCN:  2 07/08/2014 15:59:26
(LWN RBA: 0x000068.00000060.0010 LEN: 0002 NST: 0002 SCN: 0x0000.002d236c)
```

# Across versions: changes in time

- How the change record header evolved:
- 9i `CHANGE #3 TYP:0 CLS: 1 AFN:4 DBA:0x0100001a SCN:0x0000.006b5965 SEQ:  2 OP:11.2`
- 10g `CHANGE #3 TYP:0 CLS: 1 AFN:5 DBA:0x01400046 OBJ:51677 SCN:0x0000.000fff16 SEQ:  1 OP:11.2`
- 11.1 `CHANGE #3 TYP:0 CLS: 1 AFN:4 DBA:0x01005fa7 OBJ:157491 SCN:0x0000.01380043 SEQ:  2 OP:11.2 ENC:0`
- 11.2 `CHANGE #3 TYP:0 CLS:1 AFN:5 DBA:0x014000bf OBJ:73299 SCN:0x0000.000cc464 SEQ:1 OP:11.2 ENC:0 RBL:0`
- 12c (non-CDB)

```
CHANGE #3 CON_ID:0 TYP:0 CLS:1 AFN:2 DBA:0x028000bf OBJ:91537 SCN:0x0000.00f51e47 SEQ:1 OP:11.2 ENC:0 RBL:0
```

- 12c (multitenant)

```
CHANGE #3 CON_ID:1 TYP:2 CLS:1 AFN:3 DBA:0x00c17afb OBJ:91833 SCN:0x0000.002d1f4c SEQ:1 OP:11.2 ENC:0 RBL:0
```

- 9i

```
CHANGE #3 TYP:0 CLS: 1 AFN:4 DBA:0x0100001a SCN:0x0000.006b5965 SEQ:  2 OP:11.2
```

- 10g

```
CHANGE #3 TYP:0 CLS: 1 AFN:5 DBA:0x01400046 OBJ:51677 SCN:0x0000.000fff16 SEQ:  1
OP:11.2
```

- 11.1

```
CHANGE #3 TYP:0 CLS: 1 AFN:4 DBA:0x01005fa7 OBJ:157491 SCN:0x0000.01380043 SEQ:
2 OP:11.2 ENC:0
```

- 11.2

```
CHANGE #3 TYP:0 CLS:1 AFN:5 DBA:0x014000bf OBJ:73299 SCN:0x0000.000cc464 SEQ:1
OP:11.2 ENC:0 RBL:0
```

- 12c (non-CDB)

```
CHANGE #3 CON_ID:0 TYP:0 CLS:1 AFN:2 DBA:0x028000bf OBJ:91537 SCN:0x0000.00f51e47
SEQ:1 OP:11.2 ENC:0 RBL:0
```

- 12c (multitenant)

```
CHANGE #3 CON_ID:1 TYP:2 CLS:1 AFN:3 DBA:0x00c17afb OBJ:91833 SCN:0x0000.002d1f4c
SEQ:1 OP:11.2 ENC:0 RBL:0
```

# Across versions: changes in time

- How the change records evolved – 9i undo

```
CHANGE #2 TYP:0 CLS:24 AFN:2 DBA:0x008020c4 SCN:0x0000.006b5953 SEQ:  1 OP:5.1
ktudb redo: siz: 100 spc: 680 flg: 0x0012 seq: 0x04a1 rec: 0x3e
            xid:  0x0004.020.000015bd
ktubl redo: slt: 32 rci: 0 opc: 11.1 objn: 7655 objd: 7655 tsn: 5
Undo type:  Regular undo        Begin trans    Last buffer split:  No
Temp Object:  No
Tablespace Undo:  No
             0x00000000  prev ctl uba: 0x008020c4.04a1.3d
prev ctl max cmt scn:  0x0000.006b013c  prev tx cmt scn:  0x0000.006b0144
KDO undo record:
KTB Redo
op: 0x03  ver: 0x01
op: Z
KDO Op code: DRP row dependencies Disabled
  xtype: XA  bdba: 0x0100001a  hdba: 0x01000019
itli: 1  ispac: 0  maxfr: 4863
tabn: 0 slot: 0(0x0)
```

# Across versions: changes in time

- How the change records evolved – 12c multitenant, same undo operation

```
CHANGE #2 CON_ID:1 TYP:0 CLS:18 AFN:4 DBA:0x010008eb OBJ:4294967295 SCN:0x0000.002d227a SEQ:1 OP:5.1 ENC:0 RBL:0
ktudb redo: siz: 112 spc: 4090 flg: 0x0012 seq: 0x022a rec: 0x23
            xid:  0x0001.010.0000075b
ktubl redo: slt: 16 rci: 0 opc: 11.1 [objn: 91833 objd: 91833 tsn: 1]
Undo type:  Regular undo        Begin trans    Last buffer split:  No
Temp Object:  No
Tablespace Undo:  No
             0x00000000  prev ctl uba: 0x010008eb.022a.22
prev ctl max cmt scn:  0x0000.002d1df7  prev tx cmt scn:  0x0000.002d1e0b
txn start scn:  0xffff.ffffffff  logon user: 0  prev brb: 16779495  prev bcl: 0 BuExt idx: 0 flg2: 0
KDO undo record:
KTB Redo
op: 0x03  ver: 0x01
compat bit: 4 (post-11) padding: 1
op: Z
KDO Op code: DRP row dependencies Disabled
  xtype: XA flags: 0x00000000  bdba: 0x00c17afb  hdba: 0x00c01e12
itli: 2  ispac: 0  maxfr: 4858
tabn: 0 slot: 1(0x1)
```

```
CHANGE #2 TYP:0 CLS:24 AFN:2 DBA:0x008020c4 SCN:0x0000.006b5953 SEQ:  1 OP:5.1
ktudb redo: siz: 100 spc: 680 flg: 0x0012 seq: 0x04a1 rec: 0x3e
            xid:  0x0004.020.000015bd
ktubl redo: slt: 32 rci: 0 opc: 11.1 objn: 7655 objd: 7655 tsn: 5
Undo type:  Regular undo        Begin trans    Last buffer split:  No
Temp Object:  No
Tablespace Undo:  No
             0x00000000  prev ctl uba: 0x008020c4.04a1.3d
prev ctl max cmt scn:  0x0000.006b013c  prev tx cmt scn:  0x0000.006b0144
KDO undo record:
KTB Redo
op: 0x03  ver: 0x01
op: Z
KDO Op code: DRP row dependencies Disabled
  xtype: XA  bdba: 0x0100001a  hdba: 0x01000019
itli: 1  ispac: 0  maxfr: 4863
tabn: 0 slot: 0(0x0)
```

9i

```
CHANGE #2 CON_ID:1 TYP:0 CLS:18 AFN:4 DBA:0x010008eb OBJ:4294967295 SCN:0x0000.002d227a
SEQ:1 OP:5.1 ENC:0 RBL:0
ktudb redo: siz: 112 spc: 4090 flg: 0x0012 seq: 0x022a rec: 0x23
            xid:  0x0001.010.0000075b
ktubl redo: slt: 16 rci: 0 opc: 11.1 [objn: 91833 objd: 91833 tsn: 1]
Undo type:  Regular undo        Begin trans    Last buffer split:  No
Temp Object:  No
Tablespace Undo:  No
             0x00000000  prev ctl uba: 0x010008eb.022a.22
prev ctl max cmt scn:  0x0000.002d1df7  prev tx cmt scn:  0x0000.002d1e0b
txn start scn:  0xffff.ffffffff  logon user: 0  prev brb: 16779495  prev bcl: 0 BuExt idx:
0 flg2: 0
KDO undo record:
KTB Redo
op: 0x03  ver: 0x01
compat bit: 4 (post-11) padding: 1
op: Z
KDO Op code: DRP row dependencies Disabled
  xtype: XA flags: 0x00000000  bdba: 0x00c17afb  hdba: 0x00c01e12
itli: 2  ispac: 0  maxfr: 4858
tabn: 0 slot: 1(0x1)
```

12c

# Across versions: since 9*i*

- DDL in redo
- Useless for recovery, useful for LogMiner, Streams etc.
- No detail in dump

```
REDO RECORD - Thread:1 RBA: 0x00099a.0000002d.00e8 LEN: 0x0228 VLD: 0x01
SCN: 0x0000.00fefec0 SUBSCN:  1 07/19/2014 14:16:25
CHANGE #1 MEDIA RECOVERY MARKER SCN:0x0000.00000000 SEQ:0 OP:24.1 ENC:0
```

- Even recursive DDL is there
- Later versions added other, non-interesting 24.1s

- But it *is* there

```
REDO RECORD - Thread:1 RBA: 0x00099a.0000002d.00e8 LEN: 0x0228 VLD: 0x01
SCN: 0x0000.00fefec0 SUBSCN:  1 07/19/2014 14:16:25
CHANGE #1 MEDIA RECOVERY MARKER SCN:0x0000.00000000 SEQ:0 OP:24.1 ENC:0
#XID: 0x0005.003.00002236
#part 1 of 1
#logon schema = SYS
#user schema = SYS
#object_id = 117610
#SQL text = CREATE TABLE hr.non_comptab
AS
SELECT * FROM all_objects
WHERE SUBSTR(object_name,1,1) BETWEEN 'A' AND 'WZZZZZ' and rownum<=1000
#object_owner = HR
#object_name = NON_COMPTAB
#base_object_id = 117610
```

# Compression

- First, a normal heap table CTAS, processed as direct insert:

```
CHANGE #2 CON_ID:0 TYP:1 CLS:1 AFN:6 DBA:0x01845d4b OBJ:117610 SCN:0x0000.00fefecc SEQ:1 OP:19.1 ENC:0 RBL:0
Direct Loader block redo entry
seg/obj: 0x1cb6a  csc: 0x00.fefec7  itc: 3  flg: E  typ: 1 - DATA
 data_block_dump,data header at 0x7ff9a25aa090
===============
flag=--------
0xe:pti[0]   nrow=76      offs=0
0x12:pri[0]  offs=0x1f29
…
0xa8:pri[75] offs=0x404
block_row_dump:
tab 0, row 0, @0x1f29
tl: 87 fb: --H-FL-- lb: 0x0  cc: 18
col  0: [ 3]  53 59 53
col  1: [ 6]  49 5f 43 4f 4c 32
…
col 17: [ 1]  59
```

```
CHANGE #2 CON_ID:0 TYP:1 CLS:1 AFN:6 DBA:0x01845d4b OBJ:117610 SCN:0x0000.00fefecc
SEQ:1 OP:19.1 ENC:0 RBL:0
Direct Loader block redo entry
seg/obj: 0x1cb6a  csc: 0x00.fefec7  itc: 3  flg: E  typ: 1 - DATA
 data_block_dump,data header at 0x7ff9a25aa090
===============
flag=--------
0xe:pti[0]   nrow=76  offs=0
0x12:pri[0]  offs=0x1f29
…
0xa8:pri[75] offs=0x404
block_row_dump:
tab 0, row 0, @0x1f29
tl: 87 fb: --H-FL-- lb: 0x0  cc: 18
col  0: [ 3]  53 59 53
col  1: [ 6]  49 5f 43 4f 4c 32
…
col 17: [ 1]  59
```

# Compression

- OLTP compression:

```
CHANGE #2 CON_ID:0 TYP:1 CLS:1 AFN:6 DBA:0x01845d63 OBJ:117611 SCN:0x0000.00fefef2 SEQ:1 OP:19.1 ENC:0
RBL:0
Direct Loader block redo entry
seg/obj: 0x1cb6b  csc: 0x00.fefef2  itc: 3  flg: E  typ: 1 - DATA
bdba: 0x610f0000
data_block_dump,data header at 0x7ff9a25aa090
===============
76543210
flag=-0------
ntab=2
nrow=356
      r0_9ir2=0x0
      mec_kdbh9ir2=0x20
                    76543210
      shcf_kdbh9ir2=----------
                 76543210
(see following slides)
```

```
CHANGE #2 CON_ID:0 TYP:1 CLS:1 AFN:6 DBA:0x01845d63 OBJ:117611 SCN:0x0000.00fefef2
SEQ:1 OP:19.1 ENC:0 RBL:0
Direct Loader block redo entry
seg/obj: 0x1cb6b  csc: 0x00.fefef2  itc: 3  flg: E  typ: 1 - DATA
bdba: 0x610f0000
data_block_dump,data header at 0x7ff9a25aa090
===============
     76543210
flag=-0------
ntab=2
nrow=356
    r0_9ir2=0x0
    mec_kdbh9ir2=0x20
                 76543210
    shcf_kdbh9ir2=----------
              76543210
    flag_9ir2=--R---OC    Archive compression: N
        fcls_9ir2[0]={ }
        perm_9ir2[18]={ 7 15 0 16 17 13 11 14 12 1 4 5 2 10 3 8 9 6 }
```

```
0x28:pti[0]    nrow=70   offs=0
0x2c:pti[1]    nrow=286  offs=70
0x30:pri[0]    offs=0x1d6d
…
block_row_dump:
tab 0, row 0, @0x1d6d
tl: 8 fb: --H-FL-- lb: 0x0  cc: 15
col  0: *NULL*
…
col 14: [ 7]  78 71 05 18 0c 34 1d
bindmp: 00 23 0f 0c 28 3b 29 28
…
tab 0, row 39, @0x1e23
tl: 10 fb: --H-FL-- lb: 0x0  cc: 1
col  0: [ 7]  78 71 05 18 0c 34 1e
bindmp: 00 0a cf 78 71 05 18 0c 34 1e
…
tab 1, row 0, @0x1ce1
tl: 17 fb: --H-FL-- lb: 0x0  cc: 18
col  0: *NULL*
…
col 17: [ 2]  c1 32
bindmp: 2c 00 04 01 ce 49 5f 43 4f 4c 32 ca c1 32 ca c1 32
```

# Compression

- HCC compression*:

```
CHANGE #2 CON_ID:0 TYP:1 CLS:1 AFN:6 DBA:0x01802743 OBJ:117643 SCN:0x0000.00ff5bff SEQ:1 OP:19.1 ENC:0
RBL:0
Direct Loader block redo entry
seg/obj: 0x1cb8b  csc: 0x00.ff5bf7  itc: 3  flg: E  typ: 1 - DATA
bdba: 0x00000000
data_block_dump,data header at 0x7f90bbd59090
===============
     76543210
flag=-0------
ntab=1
nrow=1
      r0_9ir2=0x0
      mec_kdbh9ir2=0x0
                    76543210
      shcf_kdbh9ir2=----------
                 76543210
(see following slides)
```

```
CHANGE #2 CON_ID:0 TYP:1 CLS:1 AFN:6 DBA:0x01802743 OBJ:117643 SCN:0x0000.00ff5bff
SEQ:1 OP:19.1 ENC:0 RBL:0
Direct Loader block redo entry
seg/obj: 0x1cb8b  csc: 0x00.ff5bf7  itc: 3  flg: E  typ: 1 - DATA
bdba: 0x00000000
data_block_dump,data header at 0x7f90bbd59090
===============
     76543210
flag=-0------
ntab=1
nrow=1
    r0_9ir2=0x0
    mec_kdbh9ir2=0x0
                  76543210
    shcf_kdbh9ir2=----------
              76543210
    flag_9ir2=--R-----    Archive compression: Y
        fcls_9ir2[0]={ }
0x16:pti[0]  nrow=1   offs=0
0x1a:pri[0]  offs=0x16e6
```

```
0x16:pti[0]  nrow=1   offs=0
0x1a:pri[0]  offs=0x16e6
block_row_dump:
tab 0, row 0, @0x16e6
tl: 2202 fb: --H-FL-- lb: 0x0  cc: 1
col  0: [2196]
Compression level: 04 (Archive High)
CU header:
CU total length: 2184
CU flags: NC-U-CRD-OP
ncols: 18
nrows: 11900
CU decomp length: 602   len/value length: 999600
row pieces per row: 1
num deleted rows: 0
START_CU:
 00 00 08 94 24 00 00 00 4b 44 5a 30 84 61 09 95 00 00 08 88 eb 06 00 12 2e ...
END_CU
bindmp: 2c 00 01 fe 94 08 00 00 08 94 24 00 00 00 4b 44 5a 30 84 61 09 95 00 ...
end_of_block_dump
```

# Across versions: LOBs

- Basic LOB example
- Data in row (LOB locator and/or inline LOBs)

```
CHANGE #2 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x01823dee OBJ:117598 SCN:0x0000.00fef392 SEQ:3 OP:11.2 ENC:0 RBL:0
KTB Redo
op: 0x02  ver: 0x01
compat bit: 4 (post-11) padding: 1
op: C  uba: 0x01000a3f.09b1.04
KDO Op code: IRP row dependencies Disabled
itli: 1  ispac: 0  maxfr: 4858
tabn: 0 slot: 1(0x1) size/delt: 51
fb: --H-FL-- lb: 0x1  cc: 3
null: ---
col  0: [ 2]  c1 03
col  1: [ 7]  41 41 41 41 41 41 41
col  2: [36]
 00 54 00 01 02 0c 80 00 00 02 00 00 00 01 00 00 00 44 82 e0 00 10 09 00 00
 00 00 00 00 00 00 00 00 00 00 00
```

```
CHANGE #2 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x01823dee OBJ:117598 SCN:0x0000.00fef392
SEQ:3 OP:11.2 ENC:0 RBL:0
KTB Redo
op: 0x02  ver: 0x01
compat bit: 4 (post-11) padding: 1
op: C  uba: 0x01000a3f.09b1.04
KDO Op code: IRP row dependencies Disabled
itli: 1  ispac: 0  maxfr: 4858
tabn: 0 slot: 1(0x1) size/delt: 51
fb: --H-FL-- lb: 0x1  cc: 3
null: ---
col  0: [ 2]  c1 03
col  1: [ 7]  41 41 41 41 41 41 41
col  2: [36]
 00 54 00 01 02 0c 80 00 00 02 00 00 00 01 00 00 00 44 82 e0 00 14 05 00 00
 00 00 00 1f 40 00 00 00 00 00 02 01 82 3d f6
Or inline:
col  2: [42]
 00 54 00 01 02 0c 80 00 00 02 00 00 00 01 00 00 00 44 82 df 00 16 09 00 00
 00 00 00 00 06 00 00 00 00 00 01 00 58 00 58 00 58
```

# Across versions: LOBs

- Basic LOB example
- Undocumented auxiliary info

```
CHANGE #1 MEDIA RECOVERY MARKER SCN:0x0000.00000000 SEQ:0 OP:11.17 ENC:0
#LOB:pre-11g basicfile LOB
#KDO Op code: LLB row dependencies Disabled
#LOGMINER DATA:
# LOB RCI MARKER:
# xid: 0x0003.00b.00002468
# (OBJN, OBJV, FLAGS, FLAGS2)=(117598, 1, -1, -1)
# LOB SEGCOL NUMBERS:
#  col  0:  segcol#: 3
# Non-lob Column Info:
#SUPLOG@col  1: [ 2]  c1 03
#SUPLOG@col  2: [ 7]  41 41 41 41 41 41 41
```

```
CHANGE #1 MEDIA RECOVERY MARKER SCN:0x0000.00000000 SEQ:0 OP:11.17 ENC:0
#LOB:pre-11g basicfile LOB
#KDO Op code: LLB row dependencies Disabled
#LOGMINER DATA:
# LOB RCI MARKER:
# xid: 0x0003.00b.00002468
# (OBJN, OBJV, FLAGS, FLAGS2)=(117598, 1, -1, -1)
# LOB SEGCOL NUMBERS:
#  col  0:  segcol#: 3
# Non-lob Column Info:
#SUPLOG@col  1: [ 2]  c1 03
#SUPLOG@col  2: [ 7]  41 41 41 41 41 41 41
```

# Across versions: LOBs

- Basic LOB example
- Undocumented auxiliary info

```
CHANGE #1 MEDIA RECOVERY MARKER SCN:0x0000.00000000 SEQ:0 OP:11.17 ENC:0
#LOB:11g LOB, op = 102
#KDO Op code: LLB row dependencies Disabled
# op: 102
# xid: 0x0003.00b.00002468
# lid: 000000010000004482e0
# column: 3
# lobsize?: 4000
# psize?: 8132
# offset?: 1
# objn: 117598
# objv: 1
```

```
CHANGE #1 MEDIA RECOVERY MARKER SCN:0x0000.00000000 SEQ:0 OP:11.17 ENC:0
#LOB:11g LOB, op = 102
#KDO Op code: LLB row dependencies Disabled
# op: 102
# xid: 0x0003.00b.00002468
# lid: 00000010000004482e0
# column: 3
# lobsize?: 4000
# psize?: 8132
# offset?: 1
# objn: 117598
# objv: 1
```

# Across versions: LOBs

- Basic LOB example
- Actual data

```
CHANGE #1 CON_ID: 0 TYP:1 CLS:1 AFN:6 DBA:0x01823df6 OBJ:117599 SCN:0x0000.00fef394 SEQ:1 OP:19.1 ENC:0
RBL:0
Direct Loader block redo entry
Long field block dump:
Object Id   117599
LobId: 00000010000004482E0 PageNo        0
Version: 0x0000.00000001  pdba: 25312752
00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a
...
00 20 00 20 00 20 00 20 00 20 00 20 00 20 00 20 00 20 00 20 00 20 00 20
```

- (note padding by space (0x20), that's not in the table data)

# Across versions: LOBs

- SecureFiles LOB example (11*g*)
- Very similar data in row, similar 11.7 (but different)
- A lot of chunk management
- Different operation for actual data

```
CHANGE #1 CON_ID: 0 TYP:10 CLS:1 AFN:6 DBA:0x01845b8b OBJ:117602 SCN:0x0000.00fef421 SEQ:1 OP:26.6 ENC:0 RBL:0
KDLI common [12]
type  0x20 [data]
  psiz  8060
  dba   0x01845b8b
KDLI fpload [11.32]
  scn   0x0000.00fef421
  xid   0x000c.01b.000012a1
  objd  117602
KDLI load data [4.56]
bdba    [0x01845b8b]
...
```

```
CHANGE #1 CON_ID: 0 TYP:10 CLS:1 AFN:6 DBA:0x01845b8b OBJ:117602 SCN:0x0000.00fef421
SEQ:1 OP:26.6 ENC:0 RBL:0
KDLI common [12]
type  0x20 [data]
  psiz  8060
  dba   0x01845b8b
KDLI fpload [11.32]
  scn   0x0000.00fef421
  xid   0x000c.01b.000012a1
  objd  117602
KDLI load data [4.56]
bdba    [0x01845b8b]
KDLI data load [0x0.8000]
00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a
...
00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a 00 2a
KDLI suplog [9.24]
  xid   0x0012.01b.000012a1
  objn  117601
  col#  3
```

# New in 12*c*: extended datatype

- It's really just LOB
- Inline or out-of-line, as length requests
- New OCI calls (OCIBindByName2, OCIBindByPos2)
- And you can index them (if length is small enough to fit into an index block)
- But internally, it's just a LOB

# New in 12*c*: column data

```
CHANGE #2 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eadd OBJ:119473 SCN:0x0000.01080d76 SEQ:1 OP:11.2 ENC:0 RBL:0
KTB Redo
op: C  uba: 0x010033a5.09d0.10
KDO Op code: IRP row dependencies Disabled
itli: 1  ispac: 0  maxfr: 4858
tabn: 0 slot: 2(0x2) size/delt: 219
fb: --H-FL-- lb: 0x1  cc: 6
null: ------
col  0: [ 2]  c1 04
col  1: [56]
 00 54 00 01 01 0c 00 80 00 01 00 00 00 01 00 00 00 49 1f 25 00 24 48 90 00
 1e 00 00 1a 01 00 6e 00 6d 00 6d 00 6d 00 6d 00 6d 00 6d 00 6d 00 6d 00 6d
 00 6d 00 6d 00 6d
col  2: [44]
 00 54 00 01 01 0c 00 80 00 01 00 00 00 01 00 00 00 49 1f 7e 00 18 40 90 00
 12 21 00 7f fe 01 01 01 01 89 ed ee 02 01 01 89 ee b7 03
col  3: [44]
 00 54 00 01 01 0c 00 80 00 01 00 00 00 01 00 00 00 49 1f 7f 00 18 40 90 00
 12 21 00 7f ff 01 01 01 01 89 ed f6 02 01 01 89 ef 37 03
```

```
CHANGE #2 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eadd OBJ:119473 SCN:0x0000.01080d76
SEQ:1 OP:11.2 ENC:0 RBL:0
KTB Redo
op: C  uba: 0x010033a5.09d0.10
KDO Op code: IRP row dependencies Disabled
itli: 1  ispac: 0  maxfr: 4858
tabn: 0 slot: 2(0x2) size/delt: 219
fb: --H-FL-- lb: 0x1  cc: 6
null: ------
col  0: [ 2]  c1 04
col  1: [56]
 00 54 00 01 01 0c 00 80 00 01 00 00 00 01 00 00 00 49 1f 25 00 24 48 90 00
 1e 00 00 1a 01 00 6e 00 6d 00 6d 00 6d 00 6d 00 6d 00 6d 00 6d 00 6d 00 6d
 00 6d 00 6d 00 6d
col  2: [44]
 00 54 00 01 01 0c 00 80 00 01 00 00 00 01 00 00 00 49 1f 7e 00 18 40 90 00
 12 21 00 7f fe 01 01 01 01 89 ed ee 02 01 01 89 ee b7 03
col  3: [44]
 00 54 00 01 01 0c 00 80 00 01 00 00 00 01 00 00 00 49 1f 7f 00 18 40 90 00
 12 21 00 7f ff 01 01 01 01 89 ed f6 02 01 01 89 ef 37 03
```

# New in 12*c*: index on extended

- Really nothing special

```
CHANGE #3 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eae7 OBJ:119484 SCN:0x0000.01080d78 SEQ:1 OP:10.8 ENC:0
RBL:0
index redo (kdxlne): (count=12) init header of newly allocated leaf block
….
CHANGE #2 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eae3 OBJ:119484 SCN:0x0000.01080d92 SEQ:1 OP:10.15 ENC:0
RBL:0
index redo (kdxbin) :  insert branch block row, count=3
KTB Redo
…
CHANGE #2 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eae6 OBJ:119484 SCN:0x0000.01080d91 SEQ:2 OP:10.8 ENC:0
RBL:0
index redo (kdxlne): (count=12) init leaf block being split
…
CHANGE #3 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eae7 OBJ:119484 SCN:0x0000.01080d92 SEQ:1 OP:10.5 ENC:0
RBL:0
index redo (kdxlre):  restore leaf row
```

```
CHANGE #3 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eae7 OBJ:119484 SCN:0x0000.01080d78
SEQ:1 OP:10.8 ENC:0 RBL:0
index redo (kdxlne): (count=12) init header of newly allocated leaf block
….
CHANGE #2 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eae3 OBJ:119484 SCN:0x0000.01080d92
SEQ:1 OP:10.15 ENC:0 RBL:0
index redo (kdxbin) :  insert branch block row, count=3
KTB Redo
…
CHANGE #2 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eae6 OBJ:119484 SCN:0x0000.01080d91
SEQ:2 OP:10.8 ENC:0 RBL:0
index redo (kdxlne): (count=12) init leaf block being split
…
CHANGE #3 CON_ID: 0 TYP:0 CLS:1 AFN:6 DBA:0x0189eae7 OBJ:119484 SCN:0x0000.01080d92
SEQ:1 OP:10.5 ENC:0 RBL:0
index redo (kdxlre):  restore leaf row
```

# Across versions: new features

- Oracle added locally managed tablespaces and ASSM:
- Instead of DML on SYS tables (uet$, fet$), we have layer 13 operations:

```
CHANGE #1 CON_ID:3 TYP:0 CLS:8 AFN:12 DBA:0x01014e10 OBJ:91563 SCN:0x0000.002d1daf SEQ:1 OP:13.22 ENC:0 RBL:0
Redo on Level1 Bitmap Block
Redo for state change
Len: 1 Offset: 12 newstate: 1
```

- Can be ignored if you are interested only in actual data

CHANGE #1 CON_ID:3 TYP:0 CLS:8 AFN:12 DBA:0x01014e10 OBJ:91563 SCN:0x0000.002d1daf SEQ:1 OP:13.22 ENC:0 RBL:0

Redo on Level1 Bitmap Block

Redo for state change

Len: 1 Offset: 12 newstate: 1

# Across versions: new features

- And sometimes you can only guess
- (MOS: something with DBFS / SecureFile Lobs?)

```
CHANGE #1 CON_ID:1 TYP:0 CLS:10 AFN:3 DBA:0x00c17e87 OBJ:99142 SCN:0x0000.002d0ca6
SEQ:1 OP:13.53 ENC:0 RBL:0
KTSL - PUA redo record:
1: Sync of 1 chunks
Chunk dba: c16f9d : Chunk length : 3 : Allocator xid: 0x0004.015.000008a5 : Allocation
scn: 0.2958179 : Mark flag: 2
```

```
CHANGE #1 CON_ID:1 TYP:0 CLS:10 AFN:3 DBA:0x00c17e87 OBJ:99142 SCN:0x0000.002d0ca6
SEQ:1 OP:13.53 ENC:0 RBL:0
KTSL - PUA redo record:
1: Sync of 1 chunks
Chunk dba: c16f9d : Chunk length : 3 : Allocator xid: 0x0004.015.000008a5 :
Allocation scn: 0.2958179 : Mark flag: 2
```

Dbvisit
THE SMART ALTERNATIVE

# QA


Twitter: @dbvisit
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# Example script used in this session

```
delete hr.jobs where job_id='TE_TEST';
alter system switch logfile;

insert into hr.jobs values ('TE_TEST', 'Test job', 1, 100);
commit;

column member new_value fname
select member from v$logfile join v$log using (group#) where
v$log.status='CURRENT' and rownum =1;
alter system dump logfile '&fname';
oradebug setmypid
oradebug tracefile_name
```