Understanding Oracle Locking Internals

Arup Nanda

Longtime Oracle DBA

@ArupNanda

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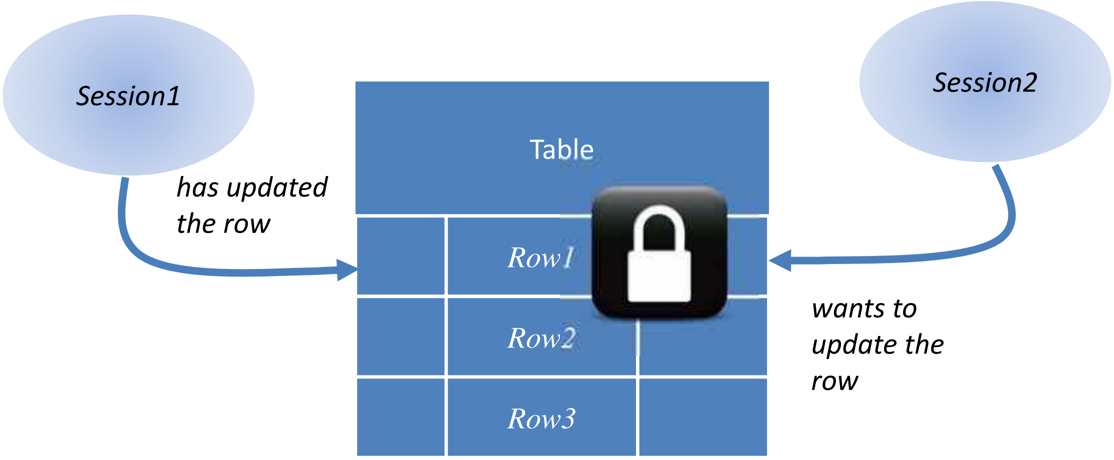
Locking



Session1

has updated the row

Table

Row1

Row2

Row3

Session2

wants to update the row

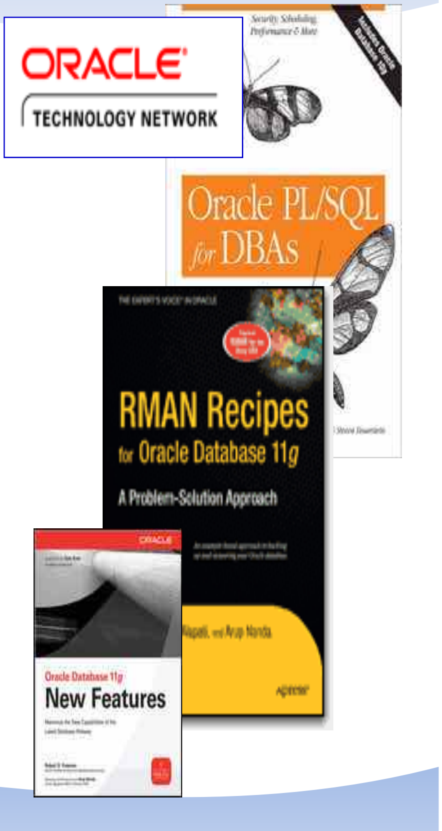
Is there a *central lock store* in Oracle?

Agenda

- What this is about?
  - How Oracle Locking Works
  - Understanding locking behavior
  - Tuning locking operations
- Tools
  - SQL*Plus

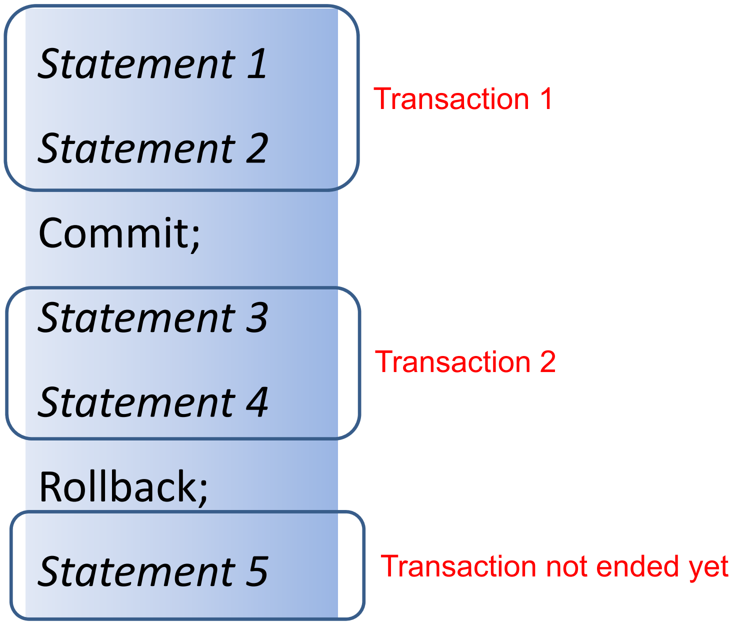
About Me

- Oracle DBA for 20 years and counting
- Speak at conferences, write articles, 4 books, provide trainings, security audits
- Blog: arup.blogspot.com
- Tweeter: @arupnanda
- Facebook.com/ArupKNanda



Transaction

- A transaction is a block which is ended by a commit or a rollback



Statement 1

Statement 2

Commit;

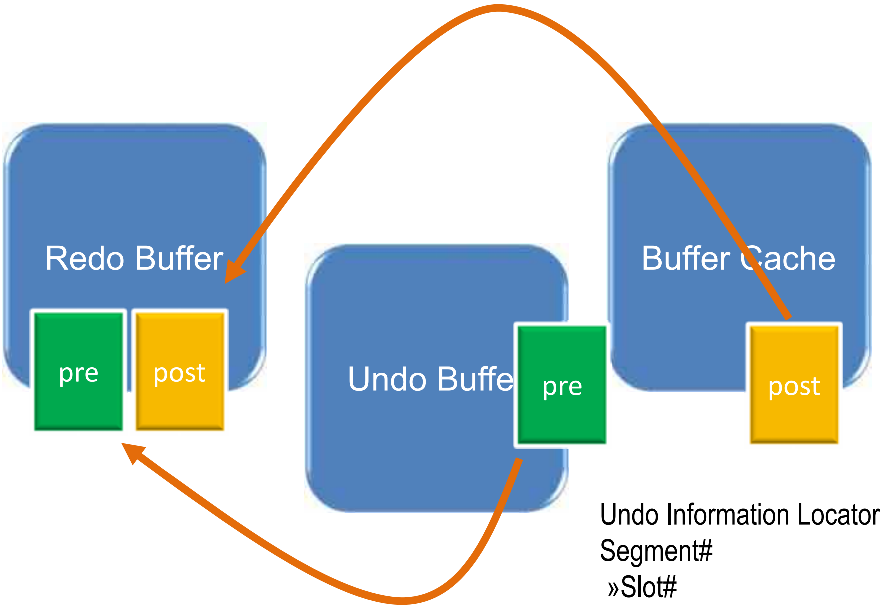
Statement 3

Statement 4

Rollback;

Statement 5

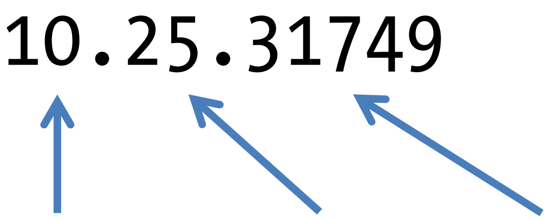
Transaction Data



Undo Information Locator
Segment#
»Slot#
»Sequence#

Transaction ID

- Checking for Transaction ID in own session
  - dbms_transaction.local_transaction_id

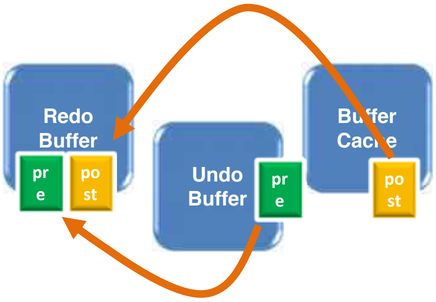


10.25.31749

Undo Segment#

Slot# in that segment

Sequence# in that slot

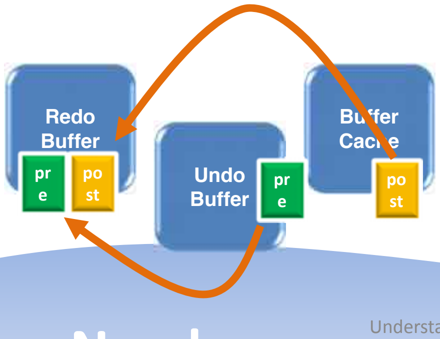


local.sql

Transaction Table

- A memory structure
- In SGA
- Exposed as X$KTCXB
- Visible as V$TRANSACTION

Transaction ID	Other Relevant Information
10.25.31749	Active/Inactive, Undo Blocks, etc.
10.25.10234	
10.25.32345	

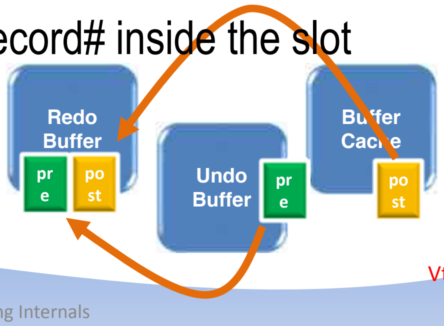


Checking for Txns

- All the transactions in the instance

```
select addr, xidusn, xidslot, xidsqn
from v$transaction;
```

  - ADDR: the address of the transaction – a raw value
  - XIDUSN: the undo segment number
  - XIDSLOT: the slot#
  - XIDSQN: the sequence# or record# inside the slot



Vtrans.sql

Txn and Session

- To Know Active Txns of a Session, join with V$SESSION

```
select sid
from v$session s,
v$transaction t
where t.ses_addr =
s.saddr
```

Txn1.sql

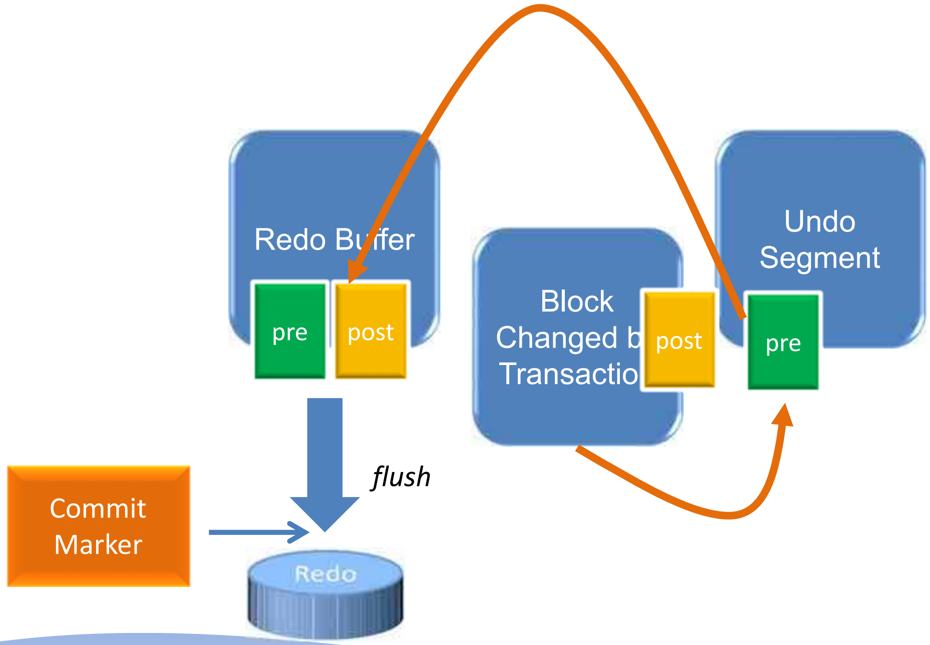
OR

V$TRANSACTION	V$SESSION
ADDR	TADDR
SES_ADDR	SADDR

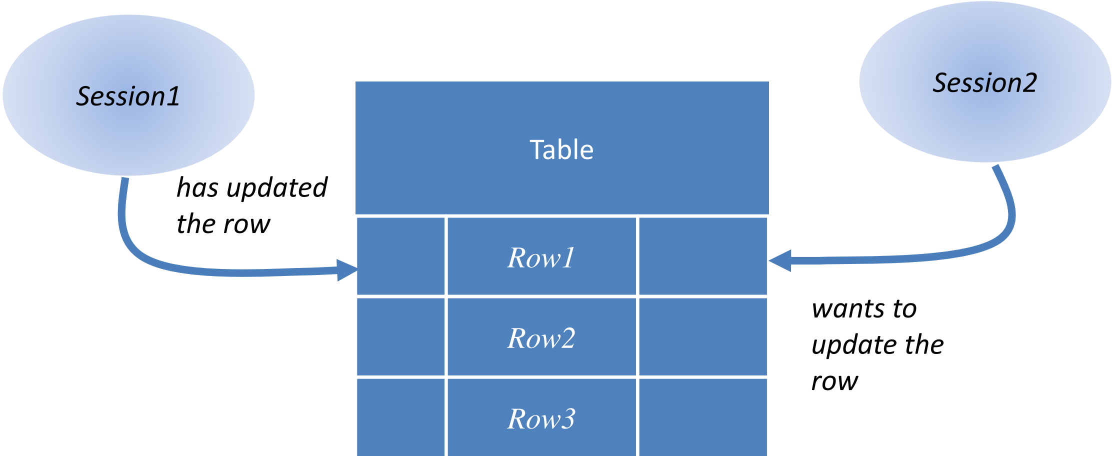
```
select sid
from v$session s,
v$transaction t
where t.addr = s.taddr
```

Txn2.sql

Commit



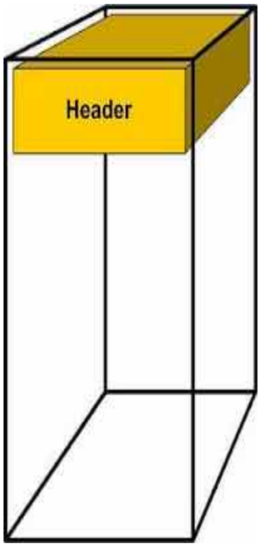
Locking



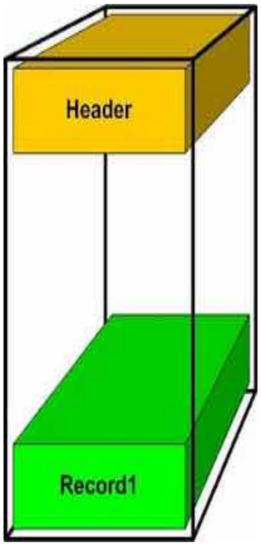
Lock Location

- There is no central locking facility
- Oracle puts the lock for a row in the block itself
- In slots called ITL Entry

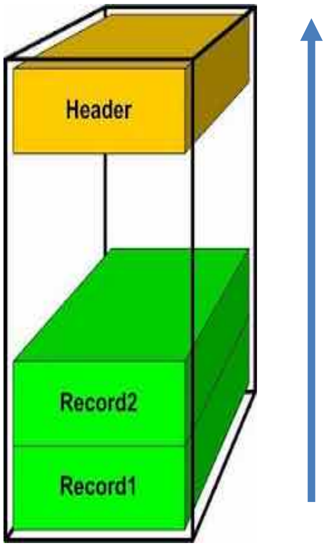
Empty Block



Records Getting Inserted



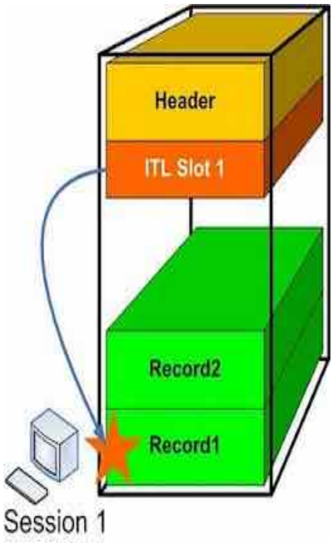
2nd Record



Records get inserted from tail end

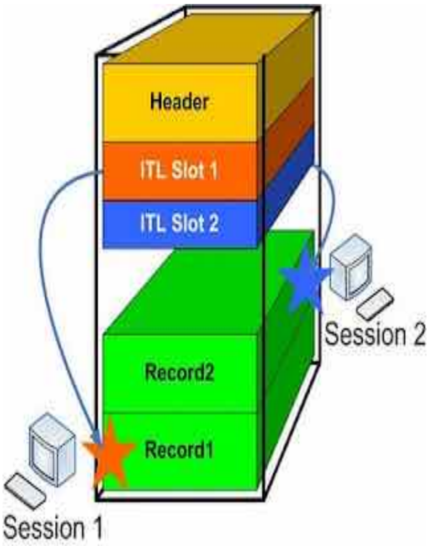
Locking

- Session 1 locks row 1
- It puts that information in the header of that block
- The transaction is “interested” in that row, hence “Interested Transaction”



Locking #2

- Session 2 locks row 2
- It also puts an interested transaction entry
- Now there is a “list” of interested transactions known as ITL



ITLs Continued

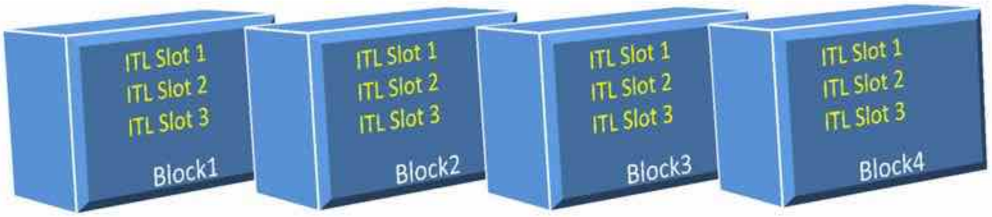
- Each ITL slot takes 24 bytes
- The total number of ITL slots can grow, as long as there is room in the block
- Can't exceed 50% of the block
- Max ITL is 255

Checking ITL

- Getting a block dump

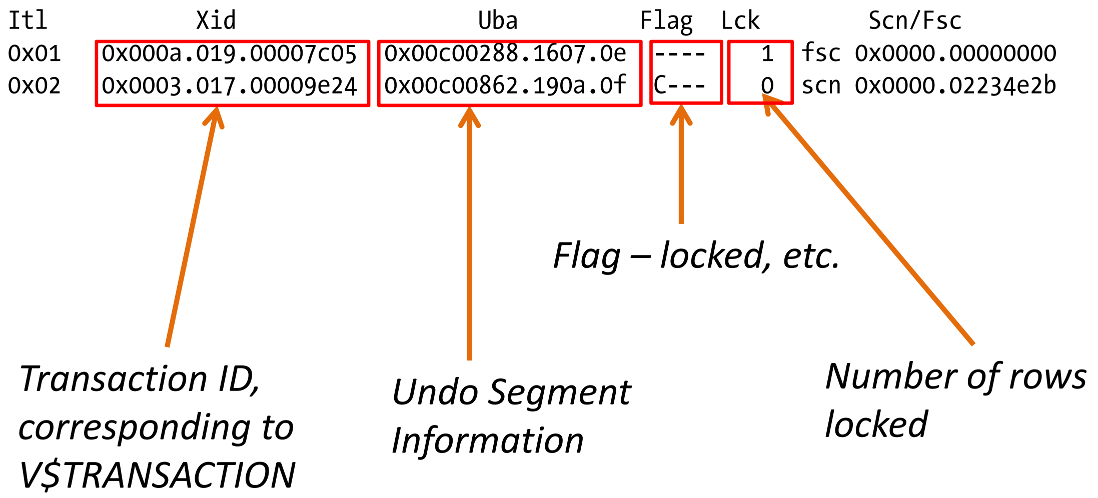
```
alter system dump datafile <DF#> block min
  <block#> block max <block#>;
```

- Creates a tracefile with the dump of the block



Dump.sql

ITL Record



```
Itl           Xid                  Uba         Flag  Lck        Scn/Fsc
0x01   0x000a.019.00007c05  0x00c00288.1607.0e  ----    1  fsc 0x0000.00000000
0x02   0x0003.017.00009e24  0x00c00862.190a.0f  C---    0  scn 0x0000.02234e2b
```

Flag – locked, etc.

Transaction ID, corresponding to V$TRANSACTION

Undo Segment Information

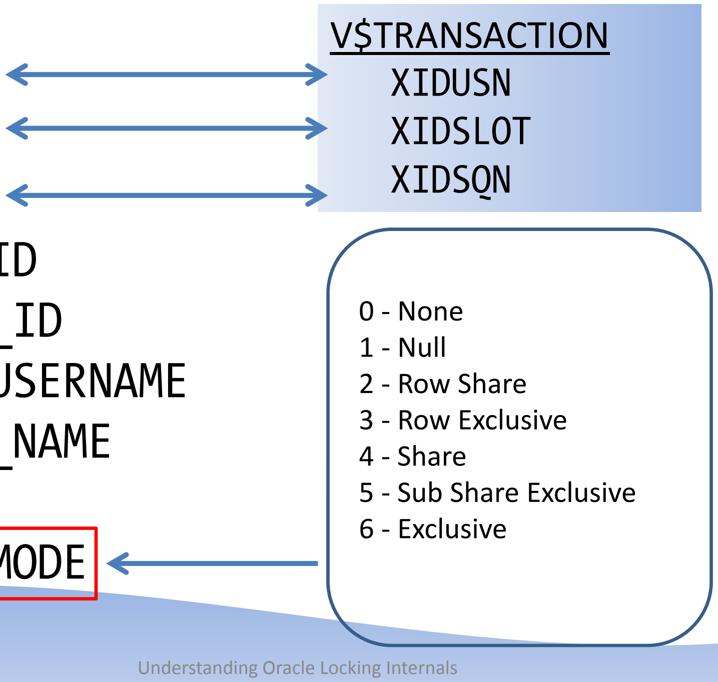
Number of rows locked

Commit and ITL

- ITL is not updated when commit happens
  - Commits are superfast
- When a new transaction encounters a lock in ITL
  - it must check the transaction table
  - If ACTIVE, then it's actually locked
- ITLs are cleared during cleanout

V$LOCKED_OBJECT

- Shows you the object locked
- XIDUSN
- XIDSLOT
- XIDSQN
- OBJECT_ID
- SESSION_ID
- ORACLE_USERNAME
- OS_USER_NAME
- PROCESS
- LOCKED_MODE



V$TRANSACTION
XIDUSN
XIDSLOT
XIDSQN

0 - None
1 - Null
2 - Row Share
3 - Row Exclusive
4 - Share
5 - Sub Share Exclusive
6 - Exclusive

```
select
    owner               object_owner,
    object_name         object_name,
    session_id          oracle_sid,
    oracle_username     db_user,
    decode(locked_mode,
        0, 'None',
        1, 'Null',
        2, 'Row Share',
        3, 'Row Exclusive',
        4, 'Share',
        5, 'Sub Share Exclusive',
        6, 'Exclusive',
        locked_mode) locked_mode
    from v$locked_object lo, dba_objects do
    where (xidusn||'.'||xidslot||'.'||xidsqn) = ('&transid')
    and do.object_id = lo.object_id
/
```

Lobj.sql

Blocking Session

- To find out the session that holds the lock this session is asking for

```
select
   blocking_session,
   blocking_instance,
   seconds_in_wait
from v$session
where sid = <sid>;
```

The SID of the session holding the lock

The Instance of the other session holding the lock

How long it has been waiting

Locked Row

- Checking for the row information

```
select row_wait_obj#,
       row_wait_file#,
       row_wait_block#,
       row_wait_row#
from v$session
where sid = <SID>;
```

To get the object information:

```
select owner, object_type, object_name,
       data_object_id
from dba_objects
Where object_id = 241876;

OWNER OBJECT_TYPE OBJECT_NAME DATA_OBJECT_ID
----- ----------- ----------- --------------
ARUP  TABLE       T1                  241877
```

```
ROW_WAIT_OBJ# ROW_WAIT_FILE# ROW_WAIT_BLOCK# ROW_WAIT_ROW#
------------- -------------- --------------- -------------
       241876           1024         2307623             0
```

Row from RowID

```
select * from arup.t1
where rowid = dbms_rowid.rowid_create (
                rowid_type      => 1,
                object_number   => 241877,
                relative_fno    => 1024,
                block_number    => 2307623,
                row_number      => 0
        );
```

Note:
DATA_OBJECT_ID;
not OBJECT_ID

```
COL1 C
---- -
   1 X
```

← *This is the row on which the lock is being requested*

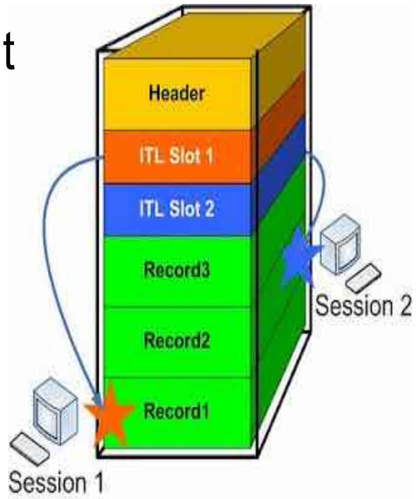
A Useful Script

```
select
        object_type,
        owner||'.'||object_name||':'||nvl(subobject_name,'-')
obj_name,
        dbms_rowid.rowid_create (
                1,
                o.data_object_id,
                row_wait_file#,
                row_wait_block#,
                row_wait_row#
        ) row_id
from v$session s, dba_objects o
where sid = &sid
and o.object_id = s.row_wait_obj#
/
```

Lock1.sql
Rowinfo1.sql

ITL Shortage

- ITL can't grow when the block is full
- The session will wait with an event `enq: TX - allocate ITL entry`
- To avoid it
  - Have plenty of room in the block
    - Increased PCTFREE, etc.
    - MINIMIZE_RECORDS_PER_BLOCK
  - Have a larger INITRANS



Finding ITL Shortage

- Query

```
select statistic_name, value
from v$segment_statistics
where object_name = '<Object Name>';
```

- Output

```
STATISTIC_NAME          VALUE
--------------------- -----
logical reads            7216
ITL waits                   2
…
```

STATISTIC_NAME

`ITL waits`
`row lock waits`

Historical

- AWR Repository

```
select snap_id, itl_waits_total, itl_waits_delta
from dba_hist_seg_stat
where obj# = <ObjID>
order by snap_id;
```

- Stats of Interest
  - ITL_WAITS_TOTAL
  - ITL_WAITS_DELTA
  - ROW_LOCK_WAITS_TOTAL
  - ROW_LOCK_WAITS_DELTA

Summary

- There is no central locking in Oracle
- A txn marks the rows locked in the block itself
- This is called Interested Transaction List (ITL)
- If no ITL slot is available, one is created is there is space; otherwise txn waits with ITL waits
- ITL entry shows undo information
- ITL is not updated as a part of commit
- Blog: http://arup.blogspot.com/2011/01/how-oracle-locking-works.html

Thank You!

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