RAC performance tuning

By

Riyaj Shamsudeen

These are receive metrics

RAC CR Wait Events

GC cr block 2-way/3-way

GC cr block busy

GC cr block congested/
GC cr grants congested.

GC cr multiblock request

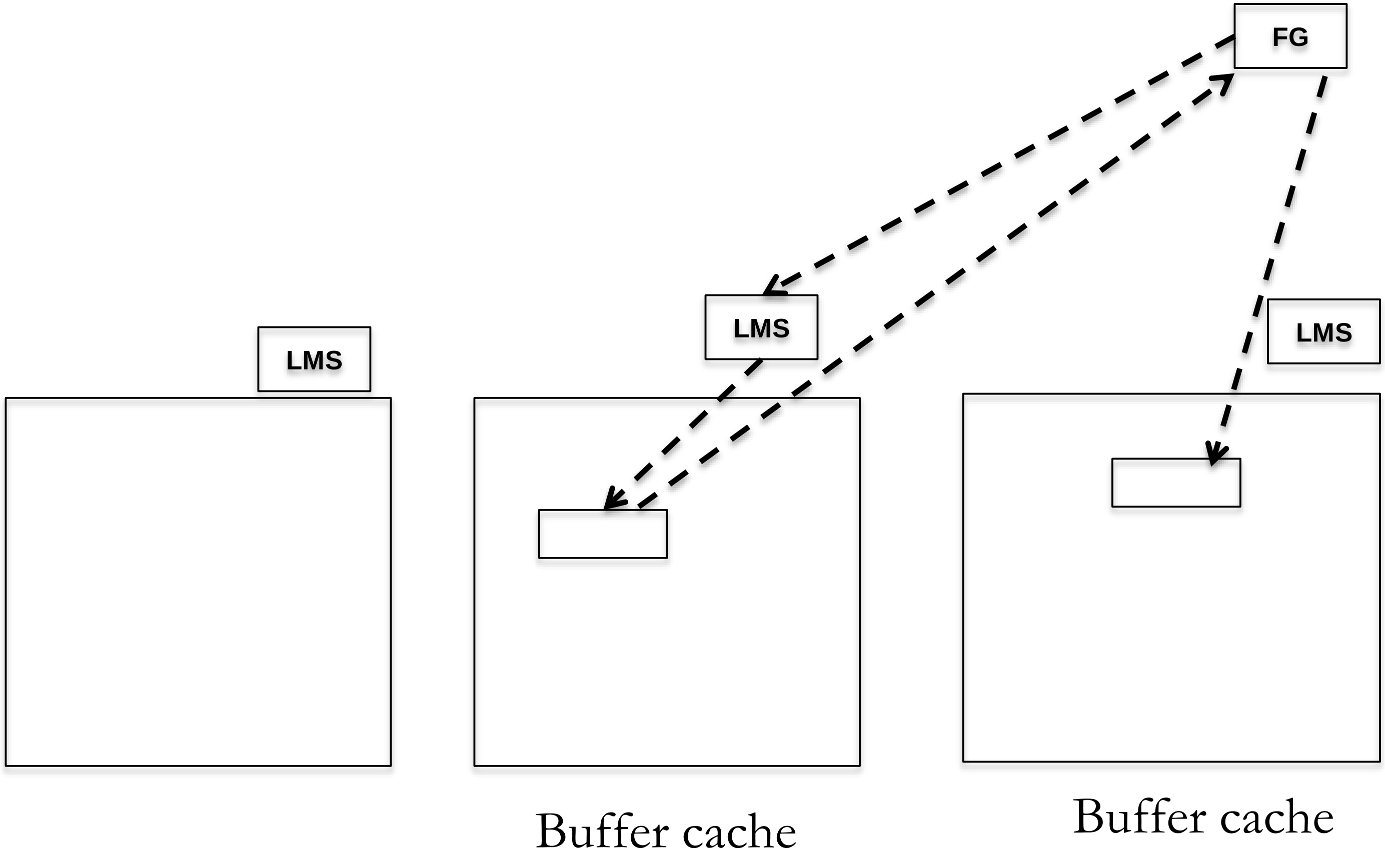
GC cr grants 2-way

CR Wait events

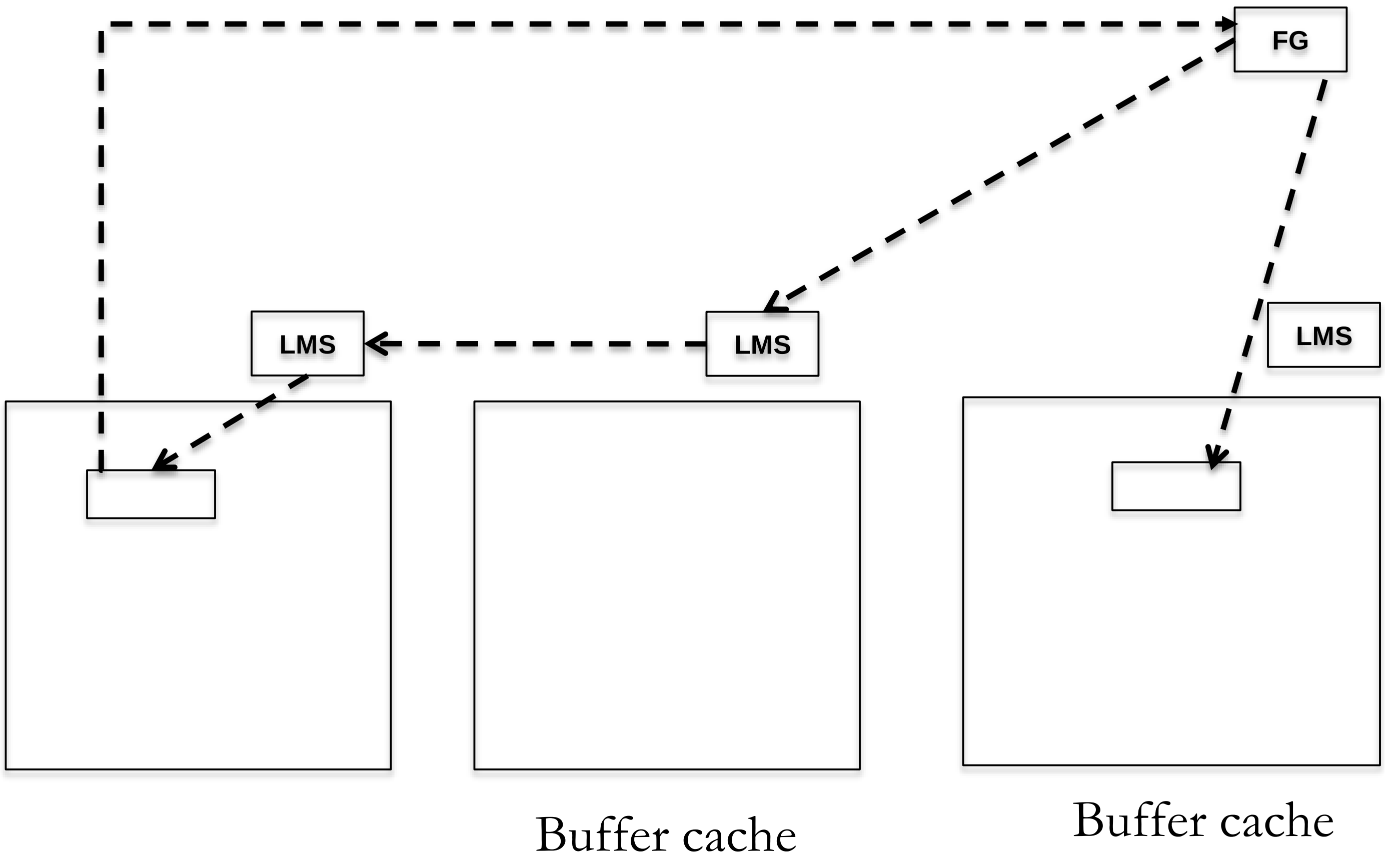
- Following are the top wait events associated with CR mode transfers:

gc cr block 2-way	Transfers without congestion or concurrency.
gc cr block 3-way	
gc cr multi block request	Multi block read
gc cr block busy	Concurrency related
gc buffer busy (acquire/release)	
gc cr grant 2-way	Grants
gc cr grant congested	Congestion related
gc cr block congested	

2-way



3-way



Event: GC CR block 2/3-way

- ‘gc cr block 2-way’ : block owner and master is the same instance.

- 3-way: The owner and master instance are different.

- **No additional overhead** incurred.

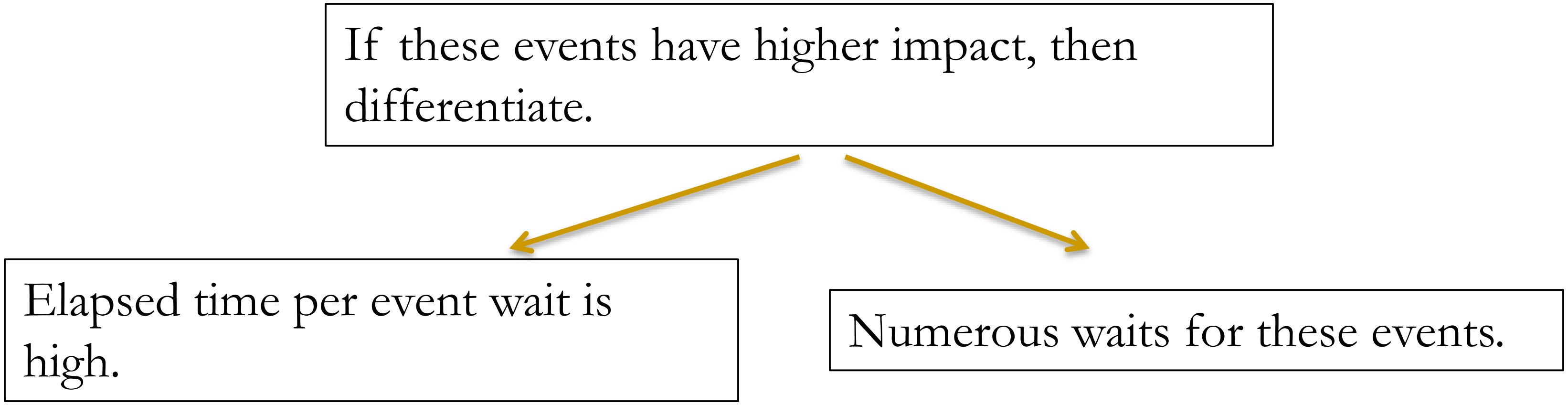
```
nam='gc cr block 2-way' ela= 627 p1=7 p2=6852 p3=1 obj#=76483 tim=37221074057
```

Dba_objects.dba_object_id or data_object_id

Demo: demo_cr_2way2.sql demo_cr_2way2.sql

Analysis

- gc cr block 2-way/3-way are baseline wait events.



If these events have higher impact, then differentiate.

Elapsed time per event wait is high.

Numerous waits for these events.

- Concurrency or congestion issues are not included in to these events.

Diagnostics – Longer individual events (1)

- Review the histogram for this event using event_histogram.sql script.

41% of waits took between 2-4ms in this example below.

```
   INST_ID EVENT                WAIT_TIME_MILLI WAIT_COUNT        PER
---------- -------------------- --------------- ---------- ----------
         1 gc cr block 2-way                  1    3720856       1.11
         1 gc cr block 2-way                  2  148016413      44.25
         1 gc cr block 2-way                  4  140006974      41.86
         1 gc cr block 2-way                  8   40140870         12
         1 gc cr block 2-way                 16    2491886        .74
         1 gc cr block 2-way                 32      43253        .01
...
         1 gc cr block 2-way               8192          9          0
         1 gc cr block 2-way              16384         24          0
```

Demo: event_histogram.sql

Possible reasons

- High CPU usage in the nodes.
- Network performance or Network configuration issue.
- Platform issues as SMP scaling or NUMA related.

- Good **baseline indicators** for cache fusion performance.

Diagnostics – Excessive waits (2)

- Use ASH or AWR to understand which object is inducing numerous waits for this wait event.

```
@ash_gcwait_to_obj.sql
Enter value for event_name: gc cr block 2-way
   INST_ID OWNER                OBJECT_NAME                      OBJECT_TYPE                 CNT
---------- -------------------- -------------------------------- -------------------- ----------
 ...
         1 APPLSYS              FND_CONCURRENT_PROCESSES         TABLE                       118
         1 INV                  MTL_SERIAL_NUMBERS               TABLE                       144
         1 INV                  MTL_TRANSACTIONS_INTERFACE_N1    INDEX                       176
         1 APPLSYS              FND_CONCURRENT_REQUESTS          TABLE                       184
         1 INV                  MTL_MATERIAL_TRANSACTIONS        TABLE                       211
         1 INV                  MTL_TRANSACTIONS_INTERFACE       TABLE                       216
         1                                                       Undo Header/Undo block?   18483
```

For undo header blocks/undo blocks, current_obj# is set to 0 and for undo blocks, curent_obj# is set to -1.

Demo: ash_gcwait_to_obj.sql

Recommendations

- Consider application affinity.
- Increase SGA size.

RAC CR Wait Events

GC cr block 2-way/3-way

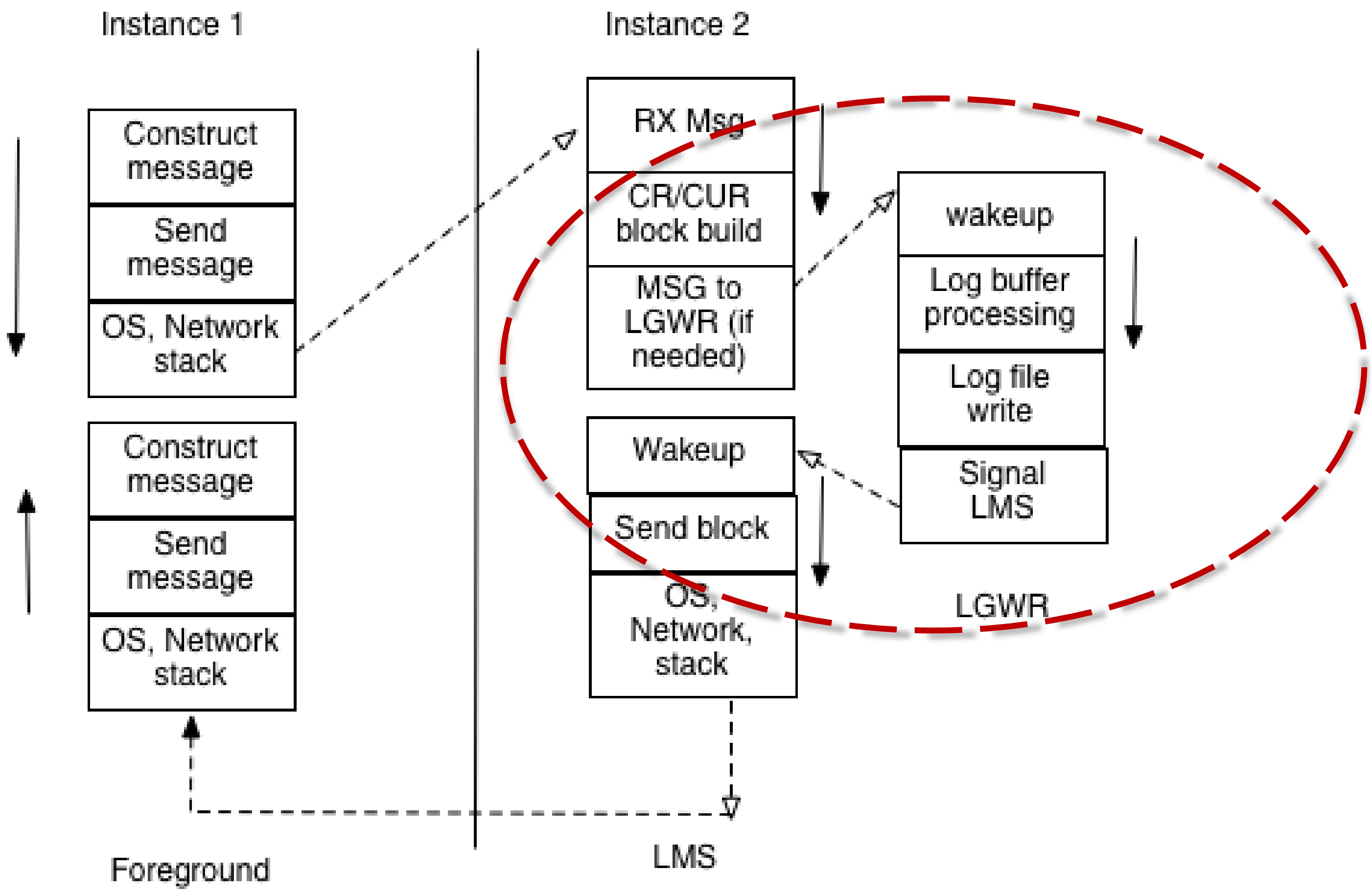
GC cr block busy

GC cr block congested/
GC cr grants congested.

GC cr multiblock request

GC cr grants 2-way

gc cr block busy (one possibility)



Event: GC CR block busy

- Implies that building of the block had to wait for an event, such as '**log flush sync**'.

- For example, if the block is undergoing changes, then LMS process need to create a consistent version of the block applying undo records.

- But, **LMS process must wait for LGWR to do a log flush sync** event before sending the block. Log flush sync event is similar to log file sync event during commit processing.

RAC CR Wait Events

GC cr block 2-way/3-way

GC cr block busy

GC cr block congested/
GC cr grants congested.

GC cr multiblock request

GC cr grants 2-way

Event: gc cr block congested/gc cr grants congested

- These wait events indicate that there were **CPU resource starvation or higher global cache workload** issues.

- For example, sudden spikes in global cache workload, CPU/memory starvation etc.

- Reducing CPU usage by tuning costly SQL statement.

- As with any wait events, how much is the impact?

Event: gc cr multi block request

- Full table scan.

- In 11gR2, just one request is sent to read a range of blocks.

```
nam='gc cr multi block request' ela= 19329 file#=8 block#=3557 class#=1 obj#=77779
nam='db file scattered read' ela= 2483 file#=8 block#=3550 blocks=8 obj#=77779
```

Recommendations

- Reducing full table scan will reduce the time spent on this event. But, do you need to ?

- Reduce Dynamic Sampling in RAC.

- Direct path reads and Adaptive direct path read features reads the block directly in to the PGA of the process, even for non-parallel processes.
- So, direct path reads do not suffer from GC wait events.

```
nam='direct path read' ela= 5024 file number=8 first dba=3648 block cnt=32 obj#=77779
nam='direct path read' ela= 479 file number=8 first dba=3712 block cnt=32 obj#=77779
```

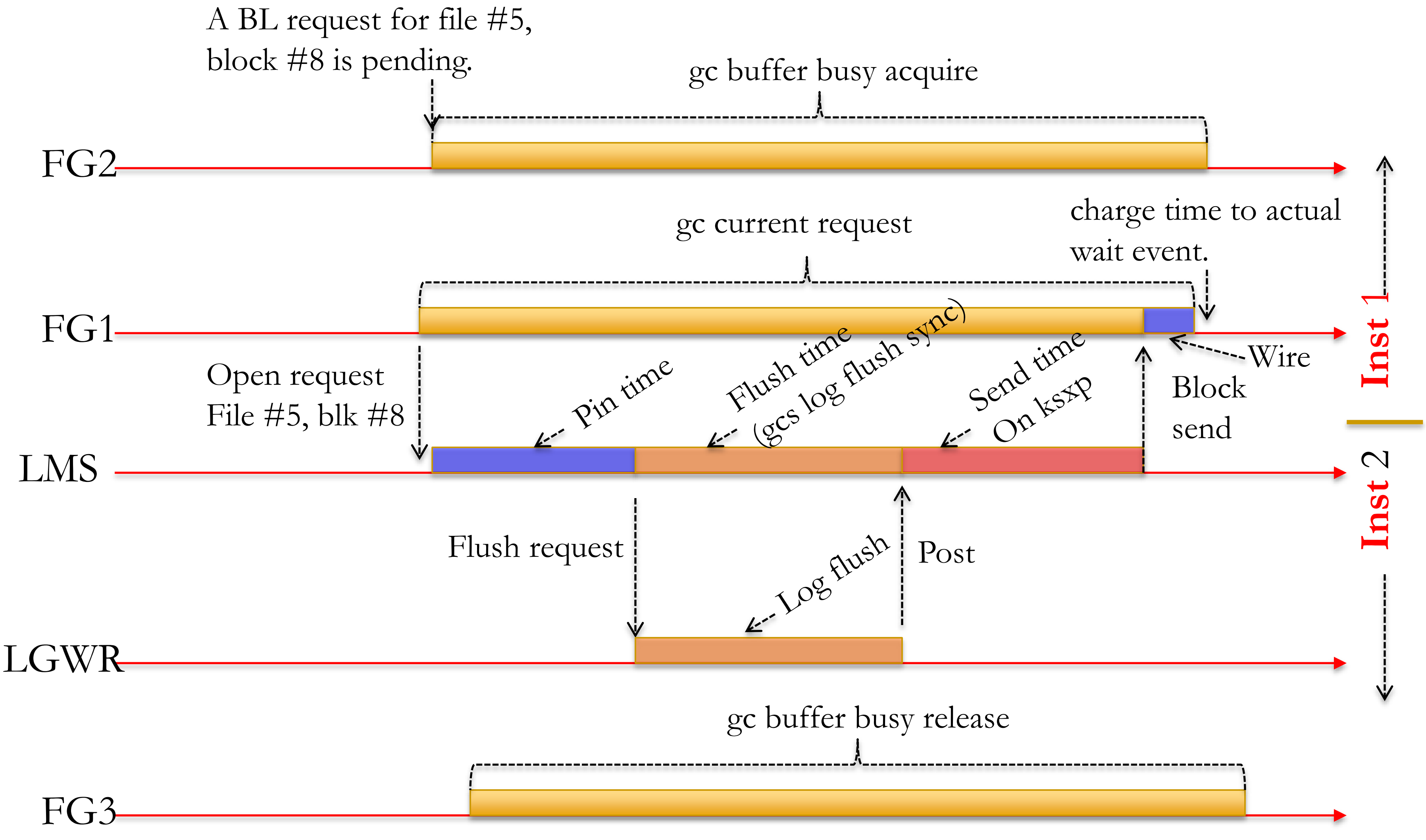
Demo:demo_gc_cr_mbr2.sql

CURRENT Wait events

- Following are the top wait events associated with CURRENT mode transfers:

gc current block 2-way	Transfers without congestion or concurrency.
gc current block 3-way	
gc current multi block request	
gc current block busy	Concurrency related
gc buffer busy	
gc current grant 2-way	Grants
gc current grant congested	Congestion related
gc current block congested	

gc buffer busy



Event: GC Buffer busy waits

- GC Buffer Busy waits are **usually symptoms**.
- GC buffer busy waits indicates that buffer is busy waiting for some sort of Global event.
    - Another session is working on that buffer and that session is waiting for a global cache event.
        - We need to understand why that session 2 is waiting for global cache event.
- 11g differentiates this event in to two events: 'gc buffer busy **acquire**' and 'gc buffer busy **release**'

Example

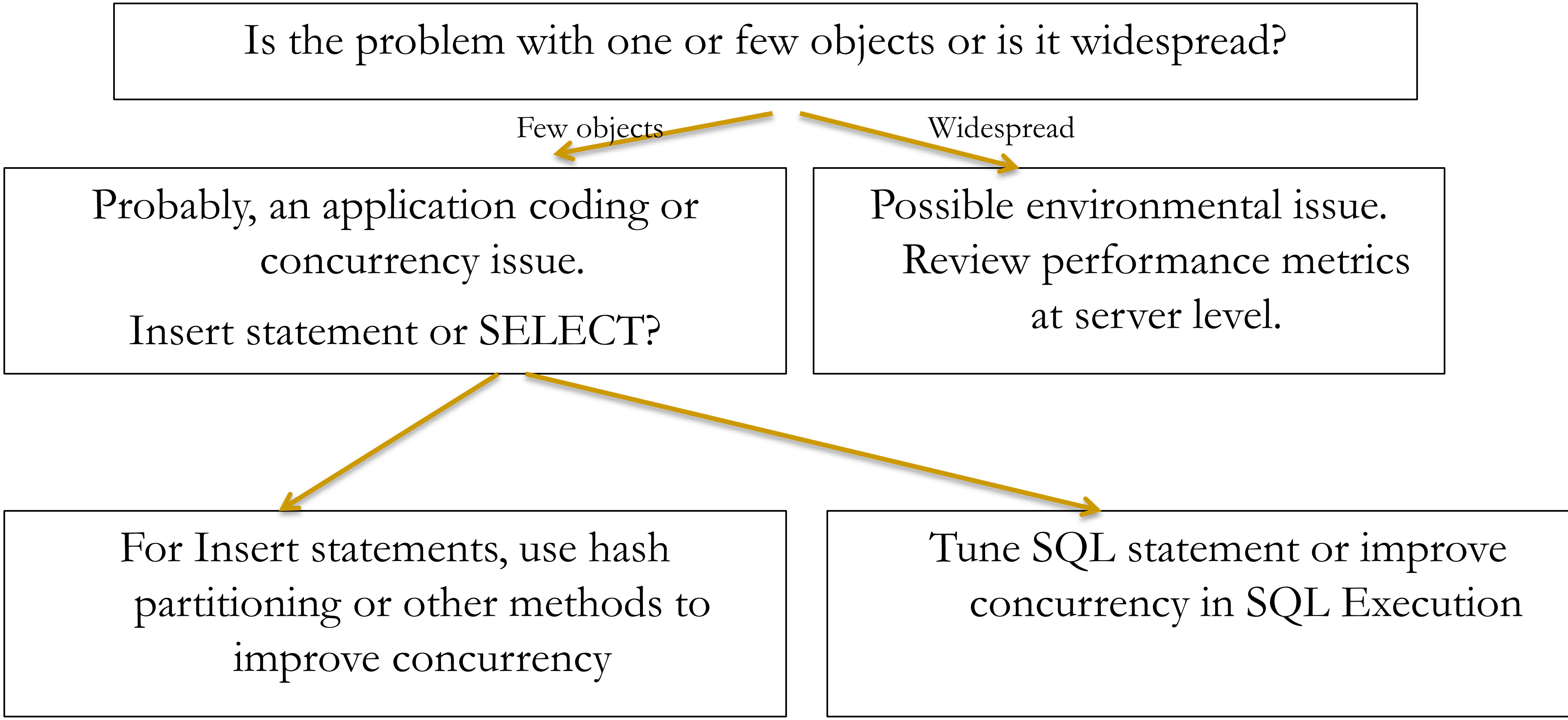
- Here is one example, where one session stuck waiting for a block.

```
WAIT #65: nam='gc current request' ela= 1220754 file#=1017 block#=1198237 id#=33554433 obj#=1598669
WAIT #65: nam='gc current request' ela= 1220767 file#=1017 block#=1198237 id#=33554433 obj#=1598669
WAIT #65: nam='gc current request' ela= 1221410 file#=1017 block#=1198237 id#=33554433 obj#=1598669
WAIT #65: nam='gc current request' ela= 1220810 file#=1017 block#=1198237 id#=33554433 obj#=1598669
WAIT #65: nam='gc current request' ela= 1220756 file#=1017 block#=1198237 id#=33554433 obj#=1598669
WAIT #65: nam='gc current request' ela= 1220763 file#=1017 block#=1198237 id#=33554433 obj#=1598669
WAIT #65: nam='gc current request' ela= 1220892 file#=1017 block#=1198237 id#=33554433 obj#=1598669
```

- Gv$session shows that **<u>other</u>** sessions are waiting for ‘gc buffer busy’ waits.

```
        P1         P2         P3   COUNT(*)
---------- ---------- ---------- ----------
...
      1017    1198215      65537         35
       995     707545      65537         37
       382     123951      65537         60
        96     373926      66336         65
      1017    1198237      65537        235
```

Diagnostics



Is the problem with one or few objects or is it widespread?

Few objects

Widespread

Probably, an application coding or concurrency issue.

Insert statement or SELECT?

Possible environmental issue. Review performance metrics at server level.

For Insert statements, use hash partitioning or other methods to improve concurrency

Tune SQL statement or improve concurrency in SQL Execution

Example (AWR)

- Many ‘gc buffer busy’ waits will result in high receive time for both CR and CUR traffic.

```
Global Cache and Enqueue Services - Workload Characteristics
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
                     Avg global enqueue get time (ms):      7.4
          Avg global cache cr block receive time (ms):    222.0
     Avg global cache current block receive time (ms):     27.5

            Avg global cache cr block build time (ms):      0.0
             Avg global cache cr block send time (ms):      0.1
      Global cache log flushes for cr blocks served %:      2.7
            Avg global cache cr block flush time (ms):  15879.9
```

Example– log file sync (AWR)

- High gc buffer busy waits are due to ‘log file sync’ waits as below.

```
Top 5 Timed Foreground Events
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
                                                           Avg
                                                          wait   % DB
Event                                 Waits     Time(s)   (ms)   time Wait Class
------------------------------ ------------ ----------- ------ ------ ----------
log file sync                         2,054      23,720  11548   45.8 Commit
gc buffer busy acquire               19,505      10,382    532   20.0 Cluster
gc cr block busy                      5,407       4,655    861    9.0 Cluster
enq: SQ - contention                    140       3,432  24514    6.6 Configurat
db file sequential read              38,062       1,305     34    2.5 User I/O
```

Example – Back ground waits (AWR)

- LMS process also will wait for ‘gcs log flush sync’.

```
                                                            Avg
                                        %Time Total Wait    wait    Waits   % bg
Event                             Waits -outs   Time (s)    (ms)     /txn   time
-------------------------- ------------ ----- ---------- ------- -------- ------
gcs log flush sync               80,695    51      1,862      23     34.7   32.9
log file parallel write          44,129     0        880      20     19.0   15.6
Log archive I/O                   1,607     0        876     545      0.7   15.5
gc cr block busy                    729    71        752    1031      0.3   13.3
db file parallel write           25,752     0        434      17     11.1    7.7
enq: CF - contention                166    64        307    1850      0.1    5.4
```

Example 2 – busy waits (AWR)

- These waits are tagged to busy events as these waits for ‘gcs log flush sync event’.

```
  CR Avg Time (ms)               Current Avg Time (ms)

            -------------------------------- --------------------------------

Inst Block

  No Class           All     Immed     Busy  Congst       All    Immed     Busy  Congst

---- -------- -------- ------- ------- ------- -------- ------- ------- -------

   2 data blo     50.5      1.2  9532.1    23.6     11.0      0.9  3550.4     5.0

   3 data blo    300.8      2.3  2151.1     6.4     81.9      1.3  6474.9    27.7

   3 others      746.7      1.0  1729.1     N/A     50.2      0.8   175.5    29.0

   3 undo blo      0.9      0.8    16.0     N/A      N/A      N/A     N/A     N/A

   3 undo hea   1986.1      0.8   1.3E+04     N/A      1.1      0.7     5.3     N/

   2 undo hea    701.5      0.8   1.4E+04     N/A   3974.6      0.9   5.2E+04

   2 others        0.8      0.8     N/A     N/A      1.0      0.9     1.3     N/A

   2 undo blo      3.0      0.9    10.7     N/A      N/A      N/A     N/A     N/A

                    -------------------------------------------------------------
```

Gc buffer busy – Objects related

- ASH or trace files can be used to identify the blocks suffering from excessive 'gc buffer busy' waits.
- Only use this method if there is no other issue affecting background processes.
- To understand gc buffer busy waits:
  - Identify the object and object type
  - Identify the block type
- Ash_gcwait_to_obj.sql can be used to identify the object name and type.

Demo: generate_insert_setup.sql ash_gcwait_to_obj.sql, ash_gcwait_to_obj_timed.sql
Generate_insert.ksh 1 10 and 11, 20

Gc buffer busy – Identify object

```
@ash_gcwait_to_obj.sql

 INST_ID EVENT                     OWNER   OBJECT_NAME            OBJECT_TYPE     CNT
---------- ----------------------- ------- ---------------------  --------------  -----
         1 gc buffer busy acquire  RS      T_GEN_INS_01_N1        INDEX               3
         2 gc buffer busy acquire  RS      T_GEN_INS_01_N1        INDEX              10
         2 gc buffer busy release  RS      T_GEN_INS_01           TABLE               4
```

Demo: ash_gcwait_to_obj.sql, ash_gcwait_to_obj_timed.sql

Gc buffer busy – Identify block

```
@ash_gcwait_to_block.sql
 INST_ID EVENT                          CURRENT_FILE# CURRENT_BLOCK#        CNT
---------- ------------------------------ ------------- -------------- ----------
         2 gc buffer busy acquire                     4         103582          4
         2 gc buffer busy acquire                     4         103607          3
         2 gc buffer busy acquire                     4         103603          3
         1 gc buffer busy acquire                     4         103582          2
         2 gc buffer busy release                     4         103615          2
         1 gc buffer busy acquire                     4         103583          1
         2 gc buffer busy release                     4         103586          1
         2 gc buffer busy release                     4         103613          1
```

In this example, many different blocks are involved in 'gc buffer busy' waits. A symptom of heavy insert load.

Demo: ash_gcwait_to_block.sql

Object type	Block type	Possible issue(s)
Table	Segment header	Freelists, freelist groups, deletes from one node,ASSM bugs etc
	Segment blocks	Heavy insert workload, heavy update to few blocks, SQL performance issues scanning few objects aggressively.
Index	Leaf block	Numerous inserts on indexed columns, sequence generated keys
	Root block/branch block	Insert + numerous index scans, concurrent inserts and deletes etc
Undo	Undo header block	Numerous short transactions
	Undo block	Long pending transaction and CR block generation
Dictionary	SEQ$ (object)	Sequences with nocache or order set and excessive access to sequence.

Measuring performance correctly

- It is essential to **review metrics from all nodes**. Common mistake I see is that DBAs review the metrics from just one node.
- Performance problem from **one node usually affects other** nodes. Funnily, unhealthy node itself might not see the slowness.
- Most Global cache wait events are **symptoms**, not necessarily problems.
- For example, Log file write slowness in one node can induce massive 'gc buffer busy' waits in other nodes.

Reviewing all nodes

- It is easy to create AWR reports from all nodes using my script: Refer awrrpt_all_gen.sql.

  [Don’t forget that access to AWR report needs license]

- Or use my script gc_traffic_processing.sql to review Global cache performance.

```
Default collection period is 60 seconds.... Please wait for at least 60 seconds...
---------|-----------|---------|-----------|----------|------------|------------|------------|----------|
Inst     | CR blk Tx | CR bld  | CR fls tm | CR snd tm| CUR blk TX | CUR pin tm | CUR fls tm |CUR blk TX|
---------|-----------|---------|-----------|----------|------------|------------|------------|----------|
2        |      67061|      .08|        .88|       .23|       34909|        1.62|          .2|       .23|
3        |      38207|      .17|       2.19|       .26|       28303|         .61|         .08|       .26|
4        |      72820|      .06|       1.76|        .2|       40578|        1.76|         .24|       .19|
5        |      84355|      .09|       2.42|       .23|       30717|        2.69|         .44|       .25|
--------------------------------------------------------------------------------------------------------
```

Demo: swing, awrrpt_all_gen.sql awrrpt_all_range_gen.sql gc_traffic_processing.sql awrgrpt.sql

Caution

- Don’t use gv$views directly to find **averages as that can be misleading.** Use AWR reports or custom scripts.
- gv$views are aggregated data and persistent from the instance restart.
- For example this query output can be misleading

(As the output of this query is aggregated over the life of the instances):

```
select b1.inst_id, b2.value "RECEIVED",
b1.value "RECEIVE TIME",
((b1.value / b2.value) * 10) "AVG RECEIVE TIME (ms)"
from gv$sysstat b1, gv$sysstat b2
where b1.name = ‘gc cr block receive time' and
b2.name = 'gc cr blocks received' and b1.inst_id = b2.inst_id
```

gc_traffic_print.sql

- You can use my script to print global cache performance data for the past minute.

```
---------|--------------|---------|----------------|----------|---------------|---------------|-------------|
Inst     | CR blocks Rx | CR time |  CUR blocks Rx | CUR time |  CR blocks Tx | CUR blocks Tx |Tot blocks   |
---------|--------------|---------|----------------|----------|---------------|---------------|-------------|
1        |         40999|    13.82|            7827|      4.82|          25070|          17855|        91751|
2        |         12471|     5.85|            8389|      5.28|          31269|           9772|        61901|
3        |         28795|     4.11|           18065|      3.97|          28946|           4248|        80054|
4        |         33105|     4.54|           12136|      4.68|          29517|          13645|        88403|
---------|--------------|---------|----------------|----------|---------------|---------------|-------------|
```

- During the same time frame, output of the script from prior slide:

```
 INST_ID   RECEIVED RECEIVE TIME AVG RECEIVE TIME (ms)
---------- ---------- ------------ ---------------------
         4  165602481    104243160             6.2947825
         2  123971820     82993393            6.69453695
         3  215681074    103170166             4.7834594
         1  134814176     66663093             4.9448133
```

Very misleading!

Demo: gc_traffic_print.sql

GC Send time

- Global cache send time is important metrics.

- Global cache **Send time in one node can affect Receive time** in all other nodes.

- For that matter, GC receive performance of unhealthy node will not be worse, but other nodes will suffer from GC receive performance

- For example, if node 2 is suffering from GC send latencies, other nodes will suffer from GC receive latencies, but node 2 might not suffer from GC receive latencies.

AWR –Send metrics

These are Send metrics

- Send metrics are broken down to various metrics. This section shows efficiency of LMS processes:

```
        Avg global cache cr block build time (ms):       0.1
         Avg global cache cr block send time (ms):       0.3
  Global cache log flushes for cr blocks served %:      18.7
        Avg global cache cr block flush time (ms):       4.9
```

- LMS processing delay ~=

Time to build block +

Time to wait for Log flush sync +

Time to send the block over the network.

AWR: GC Efficiency section

- Global cache efficiency section shows the local vs remote buffer cache access.

```
Global Cache Efficiency Percentages (Target local+remote 100%)
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Buffer access -  local cache %:   93.65
Buffer access - remote cache %:    0.35
Buffer access -         disk %:    6.00
```

Access to remote cache
Should be less than 10%

Disk access should be less than 10% for OLTP.

GC CR latency

- GC CR latency ~=

  Time spent in sending message to LMS +

  LMS processing (building blocks etc) +

  LGWR latency (if any) +

  LMS send time +

  Wire latency

Processing in the remote nodes

Averages can be misleading. Always review both total time and average to understand the issue.

Example – high undo – high GC timings

- Three instances are suffering from CR latency, except instance 2.

Wait time	Node 1	Node 2	Node 3	Node 4
Avg. CR block receive time	18.2	6.7	20.0	17.3
Avg CUR block receive time	14.6	5.0	11.6	17.3

- In RAC, node suffering from chronic issues causes GC performance issues in other nodes. With that logic in mind, node 2 should be suffering from chronic issues.

Example – high undo – latency breakdown

- Sum of flush time is higher, but it is comparable across the cluster.

But, notice the build time in node 2.

Statistics	Node 1	Node 2	Node 3	Node 4	Total
gc cr block build time	11,392	148,666	5,267	6,632	171,957
Gc cr block flush time	56,634	75,751	34,406	53,031	219,822
Gc cr block send time	9,153	7,779	4,018	7,905	28,855

Example – high undo – CR fabrication

- For CR blocks, time is spent in building blocks, which indicates consistent block generation.

Very high value compared to other nodes.

Statistics	Node 1	Node 2	Node 3	Node 4
data blocks consistent Reads – undo records applied	2,493,242	86,988,512	3,090,308	7,208,575
db block changes	6,276,149	43,898,418	20,698,189	14,259,340

GC CUR latency

- GC CUR latency ~=

  Time spent in sending message to LMS +

  LMS processing (pin blocks etc, defer) +

  LGWR latency (if any) +

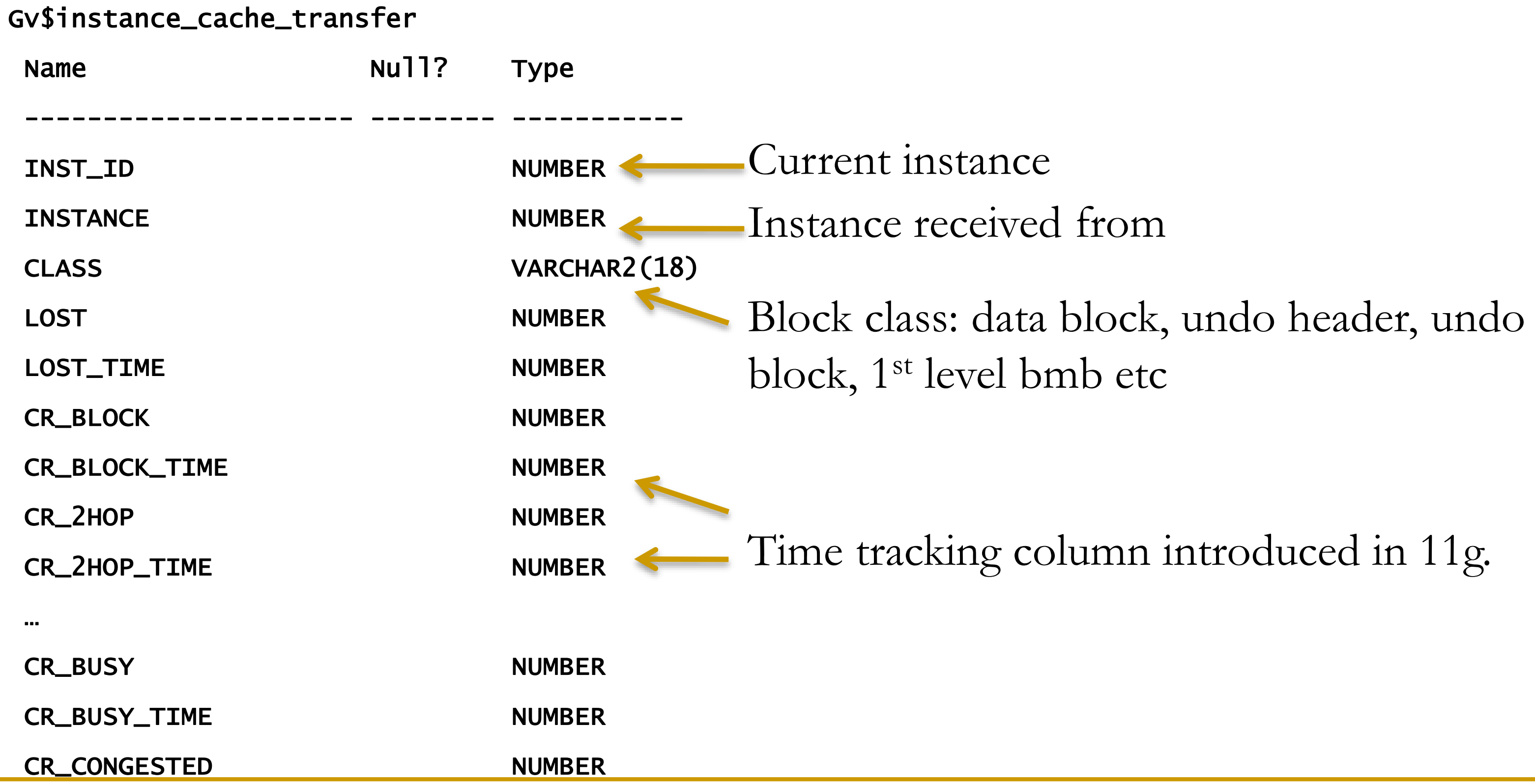
  LMS send time +

  Wire latency

Statistics : gc current block flush time
gc current block pin time
gc current block send time

Gv$instance_cache_transfer

- This is an ultra important view to see the traffic of packets received.
- 11g introduces many columns adding the time component to this view.



```
Gv$instance_cache_transfer
 Name                    Null?    Type
 ----------------------- -------- ------------
 INST_ID                          NUMBER
 INSTANCE                         NUMBER
 CLASS                            VARCHAR2(18)
 LOST                             NUMBER
 LOST_TIME                        NUMBER
 CR_BLOCK                         NUMBER
 CR_BLOCK_TIME                    NUMBER
 CR_2HOP                          NUMBER
 CR_2HOP_TIME                     NUMBER
 …
 CR_BUSY                          NUMBER
 CR_BUSY_TIME                     NUMBER
 CR_CONGESTED                     NUMBER
```

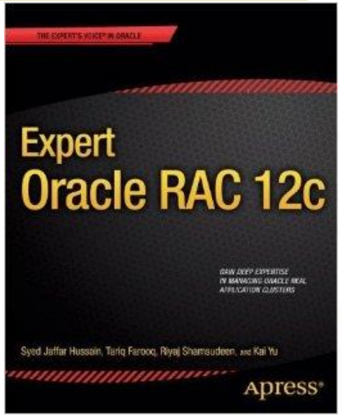
Current instance

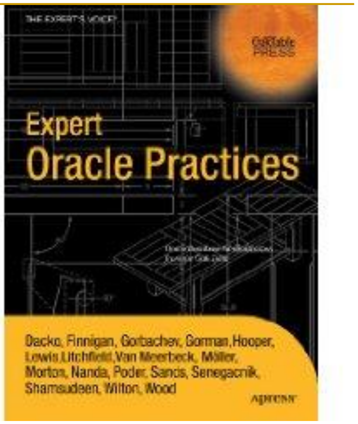
Instance received from

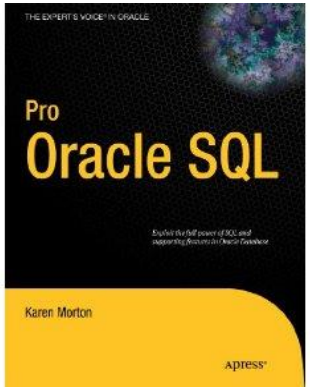
Block class: data block, undo header, undo block, 1st level bmb etc

Time tracking column introduced in 11g.

THANK YOU


THE EXPERT'S VOICE® IN ORACLE
Expert
Oracle RAC 12c
Syed Jaffar Hussain, Tariq Farooq, Riyaj Shamsudeen, and Kai Yu
Apress®

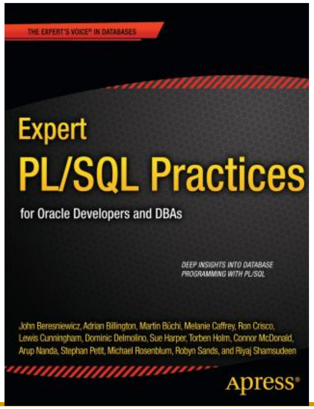

THE EXPERT'S VOICE®
OakTable PRESS
Expert
Oracle Practices
Dacko, Finnigan, Gorbachev, Gorman, Hooper, Lewis, Litchfield, Van Meerbeck, Möller, Morton, Nanda, Poder, Sands, Senegacnik, Shamsudeen, Wilton, Wood
Apress®



- ***Email: rshamsud@orainternals.com***
- ***Blog : orainternals.wordpress.com***
- ***Web: www.orainternals.com***

ORACLE® ACE Director

OakTable.net


THE EXPERT'S VOICE® IN DATABASES
Expert
PL/SQL Practices
for Oracle Developers and DBAs
DEEP INSIGHTS INTO DATABASE PROGRAMMING WITH PL/SQL
John Beresniewicz, Adrian Billington, Martin Büchi, Melanie Caffrey, Ron Crisco, Lewis Cunningham, Dominic Delmolino, Sue Harper, Torben Holm, Connor McDonald, Arup Nanda, Stephan Petit, Michael Rosenblum, Robyn Sands, and Riyaj Shamsudeen
Apress®