RAC: Administering Parallel Execution

By
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Who am I?

- 19 years using Oracle products/DBA
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- Specializes in RAC, performance tuning, Internals and E-business suite
- Chief DBA with OraInternals
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Parallel Execution

- Parallel query uses PX slave processes to perform work.

- A slave set perform specific task at a point in execution plan. After the completion of a task, slave set can be reassigned to perform a different task.

- Proper configuration of private interconnect and optimal execution plan is an essential step in scaling the PX operation.

- Placement of PX slaves can be controlled by Services or parallel_instance_group configuration.
Example

```sql
create index mut_t1 on mut (transaction_id)
parallel (degree 8) nologging;
```

<table>
<thead>
<tr>
<th>Id</th>
<th>Operation</th>
<th>Name</th>
<th>Rows</th>
<th>Bytes</th>
<th>Cost (%CPU)</th>
<th>Time</th>
<th>TQ</th>
<th>IN-OUT</th>
<th>PQ Distrib</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>CREATE INDEX STATEMENT</td>
<td></td>
<td></td>
<td></td>
<td>117K (100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>PX COORDINATOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>PX SEND QC (ORDER) :TQ10001</td>
<td>13M</td>
<td>166M</td>
<td></td>
<td>Q1,01</td>
<td>P-&gt;S QC (ORDER)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>INDEX BUILD NON UNIQUE MUT_T1</td>
<td></td>
<td></td>
<td></td>
<td>Q1,01</td>
<td>PCWP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>SORT CREATE INDEX</td>
<td></td>
<td></td>
<td></td>
<td>Q1,01</td>
<td>PCWP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>PX RECEIVE</td>
<td></td>
<td></td>
<td></td>
<td>116K (1)</td>
<td>00:05:50</td>
<td>Q1,01</td>
<td>PCWP</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>PX SEND RANGE :TQ10000</td>
<td>13M</td>
<td>166M</td>
<td>116K (1)</td>
<td>00:05:50</td>
<td>Q1,00</td>
<td>P-&gt;P RANGE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>PX BLOCK ITERATOR</td>
<td></td>
<td></td>
<td></td>
<td>116K (1)</td>
<td>00:05:50</td>
<td>Q1,00</td>
<td>PCWP</td>
<td></td>
</tr>
<tr>
<td>* 8</td>
<td>TABLE ACCESS FULL: MUT</td>
<td>13M</td>
<td>166M</td>
<td>116K (1)</td>
<td>00:05:50</td>
<td>Q1,00</td>
<td>PCWP</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

One set of server processes reading the data

Another set of server processes, sorting and creating index segments.

P -> P transfer between these two slave sets.
**PX: intra vs inter-instance**

- *Intra*-instance PX operation: All slaves are allocated in the current instance.

- *Inter*-instance PX operation: Slaves are allocated from more than one instance.

In intra-instance PX operation, Slaves communicate with each other, passing buffers between them and does not use interconnect.

In inter-instance PX operation, slaves use interconnect to exchange buffers and messages, among the slave sets or Co-ordinator processes.
Distribution method of rows between producers and consumers are key to avoid flooding interconnect.
Controlling placement

- Allocation of PX slaves can be controlled using few techniques:
  1) Services
  2) Instance groups/parallel_instance_group
  3) Combination of Services and parallel_instance_group

- Instance_groups based setup is widely used in the database versions 10g and below. By default, all instances can participate in a PX operation.

- From 10g onwards, you should control placement of slaves using Services.

- Placement control using services is much more elegant and dynamic. Failover of services automatically handles PX placement.
Placement: Two instances

- Sessions starting PX operations in inst1 can allocate slaves in both inst1 and inst2

```python
inst1.instance_groups='inst1','inst12'
inst2.instance_groups='inst2','inst12'
inst3.instance_groups='inst3'
inst1.parallel_instance_group='inst12'
```
Placement: Services: two instances

- Service FIN is located in two instances.
- Slaves allocated from inst1 and inst2.

```
srvctl add service -d solrac -s FIN -r inst1,ins2 -a inst3
```

demo:pq_query_nopart.sql with po service
Placement: Combination: PIG

- Service alone also can be used to control the placement.

- Slaves will be allocated from two instances: inst1 and inst2.

```sql
srvctl add service -d solrac -s FIN -r inst1,ins2,inst3
srvctl add service -d solrac -s FIN2 -r inst1,ins2
Alter session set parallel_instance_group='FIN2';
```

![Diagram showing placement configuration]
Recommendations

- Both instance_groups/parallel_instance_groups and Services method can be concurrently used in a database.

- That might complicate debugging, **Use services from 11g onwards**. Use instance_groups for 10g and below.

- For more granular control, use parallel_instance_groups and point to a more appropriate service, **as an exception**.
Measuring PQ traffic

- Until 11g, measuring PQ traffic is not easy.

- In 10g, if AWR does not report PQ interconnect traffic, but if the device statistics are reporting high interconnect traffic, then it is possible that application might be generating high PQ load.

- IPQ statistics are visible in x$ksxpc$elc$ient at a client level from 11g onwards.

- AWR snaps stores these statistics in dba_hist_ic_client_stats and prints PQ traffic in AWR section in a more readable format.
**AWR report**

- **AWR report in 11g prints the stats as a per second rate**

Interconnect Throughput by Client  DB/Inst: SOLRAC/solrac1  Snaps: 1012-1013

--> Throughput of interconnect usage by major consumers

--> All throughput numbers are megabytes per second

<table>
<thead>
<tr>
<th>Used By</th>
<th>Send</th>
<th>Receive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Cache</td>
<td>.02</td>
<td>.04</td>
</tr>
<tr>
<td>Parallel Query</td>
<td>.36</td>
<td>.15</td>
</tr>
<tr>
<td>DB Locks</td>
<td>.01</td>
<td>.01</td>
</tr>
<tr>
<td>DB Streams</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Other</td>
<td>.00</td>
<td>.00</td>
</tr>
</tbody>
</table>
PQ and cache fusion

- Parallel query slave processes read the block directly into their PGA using direct reads (except 11gR2 new feature – in memory parallelism).

- With direct reads to PGA, there is no need for global cache grants.

- For intra-instance parallel operation, the performance difference between a single instance and RAC is minimal.

- Still, objects need to be checkpointed at the start of a PQ operation from all nodes in case of RAC.
Parallel_execution_message_size

- Size of buffer transferred between the slaves is determined by the parameter parallel_execution_message_size (PEMS).
- Default value is too small increasing chatty traffic.
- The default value is 2k or 4K depending upon the version.
- Increase the value of this parameter to at least 16K. Downside is that increase in shared pool size (PX Msg Buffers).
- Realizing the performance implications of this parameter, default value increased to 16K in 11gR2 (Compatible must be set to 11.2.0.2 and OS specific).
- Jumbo frames + PEMS, both set above 16K are good starting points for the inter-instance PQ intensive environments.
New features (11.2)

- Auto DOP: Optimizer chooses optimal parallelism even if you don’t specify parallel hint or parallel degree at object level.

- Parallel Statement Queueing: Query will be queued until there is sufficient amount of PQ servers available.

- PQ queueing feature is useful in PQ intensive data warehousing environments.

- In memory parallelism: PQ can read blocks into buffer cache.

Demo: pq_queueing.sql if time permits
In-memory parallelism (11gR2)

- Due to the size of mammoth servers, now it is not uncommon to see SGA with a size of 100GB.

- 11gR2 introduced in-memory parallelism. Essentially, PQ servers can read buffers into SGA.
Parallel_force_local (11.2)

- This parameter controls whether the parallelism to be forced to single instance.

- Default is FALSE and there is no reason to change it. Parallel Statement Queueing feature (11.2) interacts badly if this parameter is true.

- Use services if you want to keep Parallel executions to a single node, rather than adjusting this parameter.
Parallel DML

- Parallel DML (changes) also works in the same way of Parallel query.

- Parallel slaves can be allocated in an instance or multiple instances depending upon the configuration.

- In DML operation there are two distinct group of parallel operations:
  - Parallelism for scan only.
  - Parallelism for both scan and changes.
Parallel DML – scan only-execution plan

In the execution plan below, UPDATE step is above Coordinator. Only Scanning is done in parallel, changes are done in serial.

<table>
<thead>
<tr>
<th>Id</th>
<th>Operation</th>
<th>Name</th>
<th>Rows</th>
<th>Bytes</th>
<th>Cost (%CPU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>UPDATE STATEMENT</td>
<td></td>
<td>1</td>
<td>1028</td>
<td>2600 (1)</td>
</tr>
<tr>
<td>1</td>
<td>UPDATE</td>
<td>HUGETABLE_HASH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>PX COORDINATOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>PX SEND QC (RANDOM)</td>
<td>:TQ10003</td>
<td>1</td>
<td>1028</td>
<td>2600 (1)</td>
</tr>
<tr>
<td>4</td>
<td>NESTED LOOPS</td>
<td></td>
<td>1</td>
<td>1028</td>
<td>2600 (1)</td>
</tr>
<tr>
<td>5</td>
<td>BUFFER SORT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>PX RECEIVE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>PX SEND BROADCAST</td>
<td>:TQ10002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>VIEW</td>
<td>VW_NSO_1</td>
<td>32186</td>
<td>408K</td>
<td>2445 (1)</td>
</tr>
<tr>
<td>9</td>
<td>HASH UNIQUE</td>
<td></td>
<td>1</td>
<td>817K</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>PX RECEIVE</td>
<td></td>
<td>1</td>
<td>817K</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>PX SEND HASH</td>
<td>:TQ10001</td>
<td>1</td>
<td>817K</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>HASH UNIQUE</td>
<td></td>
<td>1</td>
<td>817K</td>
<td></td>
</tr>
<tr>
<td>* 13</td>
<td>HASH JOIN</td>
<td></td>
<td>32186</td>
<td>817K</td>
<td>2445 (1)</td>
</tr>
<tr>
<td>14</td>
<td>PX BLOCK ITERATOR</td>
<td></td>
<td>32186</td>
<td>408K</td>
<td>1222 (0)</td>
</tr>
<tr>
<td>15</td>
<td>TABLE ACCESS FULL</td>
<td>HUGETABLE_HASH</td>
<td>32186</td>
<td>408K</td>
<td>1222 (0)</td>
</tr>
</tbody>
</table>
Should you use inter or intra-parallel operations?

- This is a thorny question in production environment.

- There is no correct answer to this question, it depends upon two factors:
  1. Node resources such as CPU, I/O bandwidth, IC bandwidth
  2. Size of the segment, whether it is partitioned or not etc.

- If the index creation can be completed with just one node, meaning the nodes are beefed up nodes, then you should use one node.

- If the nodes are not big enough, then it is okay to use all nodes, just realize that interconnect latency might affect performance.
Thank you for attending!

If you like this presentation, you will love my upcoming intensive Advanced RAC Troubleshooting class. Watch for updates in:

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URL: www.orainternals.com
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Las Vegas, Nevada

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