

# Использование некоторых новых возможностей SQL(CBO) в 12с

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# LATERAL

part of the ANSI standard, is an extension of the inline view syntax that provides left-correlation scoping within the inline view.

```
select t1.*, v2.*
from t1
  left join (
    select  t1_id
           , avg(val) val_avg
           , sum(val) val_sum
    from t2
    group by t1_id
  ) v2 on t1.flag='Y' and t1.id = v2.t1_id
```

```
SELECT A3.ID          ID
       ,A3.FLAG       FLAG
       ,A2.T1_ID_0    T1_ID
       ,A2.VAL_AVG_1  VAL_AVG
       ,A2.VAL_SUM_2  VAL_SUM
FROM   T1 A3
       ,LATERAL((SELECT A4.T1_ID    T1_ID_0
                     ,A4.VAL_AVG   VAL_AVG_1
                     ,A4.VAL_SUM   VAL_SUM_2
                   FROM   (SELECT A5.T1_ID T1_ID
                             ,AVG(A5.VAL) VAL_AVG
                             ,SUM(A5.VAL) VAL_SUM
                           FROM   T2 A5
                           GROUP  BY A5.T1_ID) A4
                   WHERE  A3.FLAG = 'Y'
                   AND    A3.ID = A4.T1_ID)
  ) (+) A2
```

## C Lateral:

```
select t1.*, v2.*
from t1
  ,lateral(
    select t1_id
           , avg(val) val_avg
           , sum(val) val_sum
    from t2
   where t1.flag='Y' and t1.id = t2.t1_id
   group by t1_id
  ) (+) v2;
```

## Тестовые таблицы:

```
create table t1(id, flag) as
  select level, 'N' from dual connect by level<=100
 union all
  select 101,'Y' from dual
 union all
  select 102,'Y' from dual;

create table t2(t1_id, val, padding) as
  select 1+mod(level,102), level, rpad(level,30,'x') from dual connect by level<=10000;

create index t2_ix on t2(t1_id);
```

## Исходный вариант:

Id	Operation	Name	Starts	A-Rows	A-Time	Buffers	OMem	lMem	Used-Mem
0	SELECT STATEMENT		1	102	00:00:00.02	259			
1	HASH GROUP BY		1	102	00:00:00.02	259	828K	828K	1344K (0)
2	NESTED LOOPS OUTER		1	296	00:00:00.01	259			
3	TABLE ACCESS FULL	T1	1	102	00:00:00.01	2			
4	TABLE ACCESS BY INDEX ROWID	T2	102	196	00:00:00.01	257			
* 5	INDEX RANGE SCAN	T2_IX	102	196	00:00:00.01	137			

Predicate Information (identified by operation id):

```
5 - access("T1"."ID"="T1_ID")
    filter("T1"."FLAG"=CASE WHEN ("T1_ID" IS NOT NULL) THEN 'Y' ELSE 'Y' END )
```

## C Lateral:

Id	Operation	Name	Starts	A-Rows	A-Time	Buffers	OMem	lMem	Used-Mem
0	SELECT STATEMENT		1	102	00:00:00.01	133			
1	NESTED LOOPS OUTER		1	102	00:00:00.01	133			
2	TABLE ACCESS FULL	T1	1	102	00:00:00.01	9			
3	VIEW		102	2	00:00:00.01	124			
4	SORT GROUP BY		102	2	00:00:00.01	124	2048	2048	
* 5	FILTER		102	196	00:00:00.01	124			
6	TABLE ACCESS BY INDEX ROWID	T2	2	196	00:00:00.01	124			
* 7	INDEX RANGE SCAN	T2_IX	2	196	00:00:00.01	4			

Predicate Information (identified by operation id):

```
5 - filter("T1"."FLAG"='Y')
7 - access("T1"."ID"="T2"."T1_ID")
```

## До 12с:

```
1 with t_unique( a ) as (
2     select min(t1.a)
3     from xt_unique t1
4     union all
5     select (select min(t1.a) from xt_unique t1 where t1.a>t.a)
6     from t_unique t
7     where a is not null
8 )
9 select/*+ use_nl(rids tt) */ *
10 from t_unique v
11     ,table(
12         cast(
13             multiset(
14                 select * from (
15                     select/*+ index_desc(tt1) */ tt1.rowid rid
16                     from xt_unique tt1
17                     where tt1.a=v.a
18                     order by tt1.a desc, tt1.b desc
19                 )
20                 where rownum<=5
21             )
22             as sys.odcivarchar2list
23         )
24     ) rids
25     ,xt_unique tt
26 where tt.rowid=rids.column_value
27* order by tt.a,tt.b desc
SQL> /
                where tt1.a=v.a
                    *
```

ERROR at line 17:

ORA-00904: "v"."a": invalid identifier

В 12.1.0.1 – 12.1.0.2 работает без ошибок!

## C Lateral:

```
1 with t_unique( a ) as (
2     select min(t1.a)
3     from xt_unique t1
4     union all
5     select (select min(t1.a) from xt_unique t1 where t1.a>t.a)
6     from t_unique t
7     where a is not null
8 )
9 select tt.*
10 from t_unique v
11     ,lateral(
12         select * from (
13             select tt1.*
14             from xt_unique tt1
15             where tt1.a=v.a
16             order by tt1.a desc, tt1.b desc
17         )
18         where rownum<=5
19* ) tt
SQL> /
        from xt_unique t1
        *
```

ERROR at line 3:

ORA-00600: internal error code, arguments: [qctcte1], [0], [], [], [], [], [], [], [], []

## Workaround:

```
with t_unique( a ) as (
    select min(t1.a)
    from xt_unique t1
    union all
    select (select min(t1.a) from xt_unique t1 where t1.a>t.a)
    from t_unique t
    where a is not null
)
,v_unique as (
    select a from t_unique where a is not null
    union all select null from dual where 1=0 -- <== fix
)
select tt.*
from v_unique v
, lateral(
    select *
    from (
        select tt1.*
        from xt_unique tt1
        where tt1.a=v.a
        order by tt1.a desc, tt1.b desc
    )
    where rownum<=5
) tt;
```

Fetch first 5 rows only:

```
with t_unique( a ) as (
    select min(t1.a)
    from xt_unique t1
    union all
    select (select min(t1.a) from xt_unique t1 where t1.a>t.a)
    from t_unique t
    where a is not null
)
,v_unique as (
    select a from t_unique where a is not null
    union all select null from dual where 1=0 -- <== fix
)
select /*+ use_nl(v r) */ *
from v_unique v
    ,lateral(
        select /*+ index_desc(tt (a,b)) */ tt.*
        from xt_unique tt
        where tt.a=v.a
        order by tt.a desc, tt.b desc
        fetch first 5 rows only
    ) r
order by r.a,r.b desc;
```



Plan hash value: 1026194560

Id	Operation	Name	Starts	A-Rows	A-Time	Buffers	Used-Mem
0	SELECT STATEMENT		1	150	00:00:00.77	11761	
1	SORT ORDER BY		1	150	00:00:00.77	11761	26624 (0)
2	NESTED LOOPS		1	150	00:00:00.77	11761	
3	VIEW		1	30	00:00:00.01	35	
4	UNION-ALL		1	30	00:00:00.01	35	
* 5	VIEW		1	30	00:00:00.01	35	
6	UNION ALL (RECURSIVE WITH) BREADTH FIRST		1	31	00:00:00.01	35	
7	SORT AGGREGATE		1	1	00:00:00.01	2	
8	INDEX FULL SCAN (MIN/MAX)	IX_UNIQUE_AB	1	1	00:00:00.01	2	
9	SORT AGGREGATE		30	30	00:00:00.01	33	
10	FIRST ROW		30	29	00:00:00.01	33	
* 11	INDEX RANGE SCAN (MIN/MAX)	IX_UNIQUE_AB	30	29	00:00:00.01	33	
12	RECURSIVE WITH PUMP		31	30	00:00:00.01	0	
* 13	FILTER		1	0	00:00:00.01	0	
14	FAST DUAL		0	0	00:00:00.01	0	
15	VIEW	VW_LAT_5E5D704D	30	150	00:00:00.77	11726	
* 16	VIEW		30	150	00:00:00.77	11726	
* 17	WINDOW BUFFER PUSHED RANK		30	150	00:00:00.76	11726	2048 (0)
18	TABLE ACCESS BY INDEX ROWID	XT_UNIQUE	30	91058	00:00:00.57	11726	
* 19	INDEX RANGE SCAN DESCENDING	IX_UNIQUE_AB	30	91058	00:00:00.18	272	

Predicate Information (identified by operation id):

```
5 - filter("A" IS NOT NULL)
11 - access("T1"."A">:B1)
13 - filter(NULL IS NOT NULL)
16 - filter("from$_subquery$_009"."rowlimit_$$_rownumber"<=5)
17 - filter(ROW_NUMBER() OVER ( ORDER BY INTERNAL_FUNCTION("TT"."A") DESC ,INTERNAL_FUNCTION("TT"."B") DESC )<=5)
19 - access("TT"."A"="V"."A")
```

```

SQL> explain plan for
 2      select /*+ index_desc(tt (a,b)) */ tt.*
 3      from xt_unique tt
 4      where tt.a=:a
 5      order by tt.a desc, tt.b desc
 6      fetch first 5 rows only;

```

Explained.

Plan hash value: 1631952215

```

-----
| Id | Operation                               | Name           | Rows  | Bytes | Cost (%CPU)| Time     |
-----+-----+-----+-----+-----+-----+-----+
|  0 | SELECT STATEMENT                         |                |       |       |    15 (100)|          |
|*  1 | VIEW                                     |                |       |       |    15 (0)| 00:00:01 |
|*  2 | WINDOW NOSORT STOPKEY                   |                |       |       |    15 (0)| 00:00:01 |
|  3 | TABLE ACCESS BY INDEX ROWID            | XT_UNIQUE      |    97 |  3201 |    15 (0)| 00:00:01 |
|*  4 | INDEX RANGE SCAN DESCENDING             | IX_UNIQUE_AB   |    97 |       |     2 (0)| 00:00:01 |
-----

```

Predicate Information (identified by operation id):

- ```

-----
 1 - filter("from$_subquery$_002"."rowlimit_$$_rownumber"<=5)
 2 - filter(ROW_NUMBER() OVER ( ORDER BY INTERNAL_FUNCTION("TT"."A") DESC
    ,INTERNAL_FUNCTION("TT"."B") DESC )<=5)
 4 - access("TT"."A"=:A)

```

## ИНДЕКСНЫЙ ДОСТУП В ПАРАЛЛЕЛИ ПО НЕСЕКЦИОНИРОВАННОЙ ТАБЛИЦЕ

```
SQL> select /*+ parallel(8) leading(li o) use_nl(o) */ sum(li.price)
  2   from z_line_items li
  3        , z_orders o
  4   where li.item_id = 42
  5         and o.id = li.order_id
  6         and o.order_type != 0;
```

До 12с:

Parallel Execution Details (DOP=8 , Servers Allocated=8)

| Name           | Type  | Server# | Elapsed<br>Time (s) | Cpu<br>Time (s) | IO<br>Waits (s) | Other<br>Waits (s) | Buffer<br>Gets | Read<br>Reqs | Read<br>Bytes |
|----------------|-------|---------|---------------------|-----------------|-----------------|--------------------|----------------|--------------|---------------|
| PX Coordinator | QC    |         | 0.03                | 0.02            |                 | 0.01               | 5              |              | .             |
| p000           | Set 1 | 1       | 0.60                | 0.39            | 0.21            |                    | 25455          | 256          | 4MB           |
| p001           | Set 1 | 2       | 0.53                | 0.32            | 0.21            |                    | 25440          | 77           | 3MB           |
| p002           | Set 1 | 3       | 0.54                | 0.32            | 0.22            |                    | 25608          | 40           | 3MB           |
| p003           | Set 1 | 4       | 0.52                | 0.34            | 0.18            |                    | 25311          | 80           | 3MB           |
| p004           | Set 1 | 5       | 0.54                | 0.34            | 0.20            |                    | 27166          | 66           | 3MB           |
| p005           | Set 1 | 6       | 0.51                | 0.29            | 0.18            | 0.05               | 21683          | 38           | 2MB           |
| p006           | Set 1 | 7       | 0.54                | 0.37            | 0.17            |                    | 29513          | 65           | 3MB           |
| p007           | Set 1 | 8       | 0.45                | 0.24            | 0.14            | 0.07               | 20290          | 27           | 2MB           |

  

| Id | Operation                   | Name         | Rows<br>(Estim) | Cost | Time<br>Active (s) | Start<br>Active | Execs | Rows<br>(Actual) |
|----|-----------------------------|--------------|-----------------|------|--------------------|-----------------|-------|------------------|
| 0  | SELECT STATEMENT            |              |                 |      | 1                  | +0              | 1     | 1                |
| 1  | SORT AGGREGATE              |              | 1               |      | 1                  | +0              | 1     | 1                |
| 2  | PX COORDINATOR              |              |                 |      | 1                  | +0              | 9     | 8                |
| 3  | PX SEND QC (RANDOM)         | :TQ10000     | 1               |      | 1                  | +0              | 8     | 8                |
| 4  | SORT AGGREGATE              |              | 1               |      | 1                  | +0              | 8     | 8                |
| 5  | NESTED LOOPS                |              |                 |      | 1                  | +0              | 8     | 90281            |
| 6  | NESTED LOOPS                |              | 7628            | 1845 | 1                  | +0              | 8     | 99035            |
| 7  | PX BLOCK ITERATOR           |              |                 |      | 1                  | +0              | 8     | 99035            |
| 8  | TABLE ACCESS FULL           | Z_LINE_ITEMS | 98425           | 442  | 1                  | +0              | 103   | 99035            |
| 9  | INDEX UNIQUE SCAN           | ID_Z_ORDERS  | 1               |      | 1                  | +0              | 99747 | 99035            |
| 10 | TABLE ACCESS BY INDEX ROWID | Z_ORDERS     | 1               |      | 1                  | +0              | 101K  | 90281            |

# 12c:

## Parallel Execution Details (DOP=8 , Servers Allocated=16)

| Name           | Type  | Server# | Elapsed Time (s) | Cpu Time (s) | IO Waits (s) | Concurrency Waits (s) | Other Waits (s) | Buffer Gets | Read Reqs | Read Bytes | Wait Events (sample #) |
|----------------|-------|---------|------------------|--------------|--------------|-----------------------|-----------------|-------------|-----------|------------|------------------------|
| PX Coordinator | QC    |         | 0.03             | 0.01         |              |                       | 0.02            |             |           | .          |                        |
| p000           | Set 1 | 1       | 0.46             | 0.10         | 0.05         | 0.03                  | 0.28            | 25006       | 639       | 5MB        |                        |
| p001           | Set 1 | 2       | 0.50             | 0.10         | 0.03         | 0.04                  | 0.33            | 25303       | 773       | 6MB        |                        |
| p002           | Set 1 | 3       | 0.39             | 0.10         | 0.06         | 0.01                  | 0.22            | 26363       | 685       | 5MB        |                        |
| p003           | Set 1 | 4       | 0.40             | 0.09         | 0.03         | 0.02                  | 0.26            | 23784       | 715       | 6MB        |                        |
| p004           | Set 1 | 5       | 0.41             | 0.10         | 0.04         | 0.02                  | 0.25            | 25938       | 685       | 5MB        |                        |
| p005           | Set 1 | 6       | 0.42             | 0.09         | 0.08         | 0.01                  | 0.25            | 22605       | 627       | 5MB        |                        |
| p006           | Set 1 | 7       | 0.52             | 0.10         | 0.08         | 0.02                  | 0.32            | 26100       | 702       | 5MB        |                        |
| p007           | Set 1 | 8       | 0.30             | 0.10         | 0.08         | 0.03                  | 0.09            | 25300       | 807       | 6MB        |                        |
| p008           | Set 2 | 1       | 0.00             | 0.00         |              |                       |                 |             |           | .          |                        |
| p009           | Set 2 | 2       | 0.00             | 0.00         |              |                       |                 |             |           | .          |                        |
| p00a           | Set 2 | 3       | 0.00             | 0.00         |              |                       |                 |             |           | .          |                        |
| p00b           | Set 2 | 4       | 0.00             | 0.00         |              |                       |                 |             |           | .          |                        |
| p00c           | Set 2 | 5       | 0.14             | 0.04         | 0.01         |                       | 0.09            | 197         | 196       | 2MB        |                        |
| p00d           | Set 2 | 6       | 0.00             | 0.00         |              |                       |                 |             |           | .          |                        |
| p00e           | Set 2 | 7       | 0.00             | 0.00         |              |                       |                 |             |           | .          |                        |
| p00f           | Set 2 | 8       | 0.00             | 0.00         |              |                       |                 |             |           | .          |                        |

## SQL Plan Monitoring Details (Plan Hash Value=1021166818)

| Id | Operation                           | Name                 | Rows (Estim) | Cost | Time Active (s) | Start Active | Execs | Rows (Actual) |
|----|-------------------------------------|----------------------|--------------|------|-----------------|--------------|-------|---------------|
| 0  | SELECT STATEMENT                    |                      |              |      | 1               | +0           | 1     | 1             |
| 1  | SORT AGGREGATE                      |                      | 1            |      | 1               | +0           | 1     | 1             |
| 2  | PX COORDINATOR                      |                      |              |      | 1               | +0           | 17    | 8             |
| 3  | PX SEND QC (RANDOM)                 | :TQ10001             | 1            |      | 1               | +0           | 8     | 8             |
| 4  | SORT AGGREGATE                      |                      | 1            |      | 1               | +0           | 8     | 8             |
| 5  | NESTED LOOPS                        |                      | 10           | 14   | 1               | +0           | 8     | 90281         |
| 6  | NESTED LOOPS                        |                      | 10           | 14   | 1               | +0           | 8     | 99035         |
| 7  | TABLE ACCESS BY INDEX ROWID BATCHED | Z_LINE_ITEMS         | 10           | 13   | 1               | +0           | 8     | 99035         |
| 8  | PX RECEIVE                          |                      | 10           | 3    | 1               | +0           | 8     | 99035         |
| 9  | PX SEND HASH (BLOCK ADDRESS)        | :TQ10000             | 10           | 3    | 1               | +0           | 8     | 99035         |
| 10 | PX SELECTOR                         |                      |              |      | 1               | +0           | 8     | 99035         |
| 11 | INDEX RANGE SCAN                    | ITEM_ID_Z_LINE_ITEMS | 10           | 3    | 1               | +0           | 8     | 99035         |
| 12 | INDEX UNIQUE SCAN                   | ID_Z_ORDERS          | 1            |      | 1               | +0           | 102K  | 99035         |
| 13 | TABLE ACCESS BY INDEX ROWID         | Z_ORDERS             | 1            |      | 1               | +0           | 103K  | 90281         |

## Workaround для 11.2:

```
select /*+ parallel(v 8) leading(v li o) use_nl(li) use_nl(o) */ sum(li.price)
  from (select rowid as rid
        from z_line_items
        where item_id = 42
        union all select rowid from dual where 1=0 -- <==
        ) v
   , z_line_items li
   , z_orders o
where v.rid = li.rowid
      and o.id = li.order_id
      and o.order_type != 0;
```

| Id   | Operation                   | Name                 | E-Rows | E-Bytes | Cost (%CPU) | E-Time   | TQ    | IN-OUT | PQ Distrib |
|------|-----------------------------|----------------------|--------|---------|-------------|----------|-------|--------|------------|
| 0    | SELECT STATEMENT            |                      |        |         | 15407 (100) |          |       |        |            |
| 1    | SORT AGGREGATE              |                      | 1      | 34      |             |          |       |        |            |
| 2    | PX COORDINATOR              |                      |        |         |             |          |       |        |            |
| 3    | PX SEND QC (RANDOM)         | :TQ10001             | 1      | 34      |             |          | Q1,01 | P->S   | QC (RAND)  |
| 4    | SORT AGGREGATE              |                      | 1      | 34      |             |          | Q1,01 | PCWP   |            |
| 5    | NESTED LOOPS                |                      |        |         |             |          | Q1,01 | PCWP   |            |
| 6    | NESTED LOOPS                |                      | 4921   | 163K    | 15407 (3)   | 00:00:06 | Q1,01 | PCWP   |            |
| 7    | NESTED LOOPS                |                      | 98426  | 2499K   | 14005 (3)   | 00:00:05 | Q1,01 | PCWP   |            |
| 8    | VIEW                        |                      | 98426  | 1153K   | 28 (22)     | 00:00:01 | Q1,01 | PCWP   |            |
| 9    | UNION-ALL                   |                      |        |         |             |          | Q1,01 | PCWP   |            |
| 10   | BUFFER SORT                 |                      |        |         |             |          | Q1,01 | PCWC   |            |
| 11   | PX RECEIVE                  |                      |        |         |             |          | Q1,01 | PCWP   |            |
| 12   | PX SEND ROUND-ROBIN         | :TQ10000             |        |         |             |          |       | S->P   | RND-ROBIN  |
| * 13 | INDEX RANGE SCAN            | ITEM_ID_Z_LINE_ITEMS | 98425  | 1345K   | 28 (22)     | 00:00:01 |       |        |            |
| * 14 | FILTER                      |                      |        |         |             |          | Q1,01 | PCWC   |            |
| 15   | PX BLOCK ITERATOR           |                      | 1      | 2       | 2 (0)       | 00:00:01 | Q1,01 | PCWC   |            |
| * 16 | TABLE ACCESS FULL           | DUAL                 | 1      | 2       | 2 (0)       | 00:00:01 | Q1,01 | PCWP   |            |
| 17   | TABLE ACCESS BY USER ROWID  | Z_LINE_ITEMS         | 1      | 14      | 1 (0)       | 00:00:01 | Q1,01 | PCWP   |            |
| * 18 | INDEX UNIQUE SCAN           | ID_Z_ORDERS          | 1      |         | 1 (0)       | 00:00:01 | Q1,01 | PCWP   |            |
| * 19 | TABLE ACCESS BY INDEX ROWID | Z_ORDERS             | 1      | 8       | 1 (0)       | 00:00:01 | Q1,01 | PCWP   |            |

Predicate Information (identified by operation id):

```
13 - access("ITEM_ID"=42)
14 - filter(NULL IS NOT NULL)
16 - access(:Z>=:Z AND :Z<=:Z)
18 - access("O"."ID"="LI"."ORDER_ID")
19 - filter("O"."ORDER_TYPE"<>0)
```

Parallel Execution Details (DOP=8 , Servers Allocated=8)

| Name           | Type  | Server# | Elapsed Time(s) | Cpu Time(s) | IO Waits(s) | Concurrency Waits(s) | Other Waits(s) | Buffer Gets | Read Reqs | Read Bytes |
|----------------|-------|---------|-----------------|-------------|-------------|----------------------|----------------|-------------|-----------|------------|
| PX Coordinator | QC    |         | 1.70            | 0.11        | 0.01        | 1.58                 |                | 200         | 1         | 8192       |
| p000           | Set 1 | 1       | 0.36            | 0.35        |             |                      | 0.01           | 27318       |           | .          |
| p001           | Set 1 | 2       | 0.41            | 0.40        |             |                      | 0.01           | 27320       |           | .          |
| p002           | Set 1 | 3       | 0.38            | 0.38        |             |                      |                | 27320       |           | .          |
| p003           | Set 1 | 4       | 0.35            | 0.35        |             |                      | 0.00           | 27320       |           | .          |
| p004           | Set 1 | 5       | 0.36            | 0.35        |             |                      | 0.01           | 27320       |           | .          |
| p005           | Set 1 | 6       | 0.41            | 0.41        |             |                      |                | 27320       |           | .          |
| p006           | Set 1 | 7       | 0.38            | 0.38        |             |                      |                | 27316       |           | .          |
| p007           | Set 1 | 8       | 0.35            | 0.34        |             |                      | 0.01           | 27316       |           | .          |

SQL Plan Monitoring Details (Plan Hash Value=2823899475)

| Id | Operation                   | Name                  | Rows (Estim) | Cost  | Time Active(s) | Start Active | Execs | Rows (Actual) |
|----|-----------------------------|-----------------------|--------------|-------|----------------|--------------|-------|---------------|
| 0  | SELECT STATEMENT            |                       |              |       | 1              | +4           | 1     | 1             |
| 1  | SORT AGGREGATE              |                       | 1            |       | 1              | +4           | 1     | 1             |
| 2  | PX COORDINATOR              |                       |              |       | 4              | +1           | 9     | 8             |
| 3  | PX SEND QC (RANDOM)         | :TQ10001              | 1            |       | 1              | +4           | 8     | 8             |
| 4  | SORT AGGREGATE              |                       | 1            |       | 1              | +4           | 8     | 8             |
| 5  | NESTED LOOPS                |                       |              |       | 1              | +4           | 8     | 90281         |
| 6  | NESTED LOOPS                |                       | 4921         | 15407 | 1              | +4           | 8     | 99035         |
| 7  | NESTED LOOPS                |                       | 98426        | 14005 | 1              | +4           | 8     | 99035         |
| 8  | VIEW                        |                       | 98426        | 28    | 1              | +4           | 8     | 99035         |
| 9  | UNION-ALL                   |                       |              |       | 1              | +4           | 8     | 99035         |
| 10 | BUFFER SORT                 |                       |              |       | 1              | +4           | 8     | 99035         |
| 11 | PX RECEIVE                  |                       |              |       | 1              | +4           | 8     | 99035         |
| 12 | PX SEND ROUND-ROBIN         | :TQ10000              |              |       | 1              | +4           | 1     | 99035         |
| 13 | INDEX RANGE SCAN            | ITEM_ID__Z_LINE_ITEMS | 98425        | 28    | 1              | +4           | 1     | 99035         |
| 14 | FILTER                      |                       |              |       |                |              | 8     |               |
| 15 | PX BLOCK ITERATOR           |                       | 1            | 2     |                |              |       |               |
| 16 | TABLE ACCESS FULL           | DUAL                  | 1            | 2     |                |              |       |               |
| 17 | TABLE ACCESS BY USER ROWID  | Z_LINE_ITEMS          | 1            | 1     | 2              | +4           | 99035 | 99035         |
| 18 | INDEX UNIQUE SCAN           | ID__Z_ORDERS          | 1            | 1     | 2              | +4           | 99035 | 99035         |
| 19 | TABLE ACCESS BY INDEX ROWID | Z_ORDERS              | 1            | 1     | 2              | +4           | 99035 | 90281         |

## Улучшения в параллельном выполнении запросов

| <a href="#"><u>PX_SELECTOR</u></a>              | выполнение работы QUERY COORDINATOR'а одним из SLAVE процессов (см. также <a href="#"><u>PX_SEND_1_SLAVE</u></a> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |           |      |        |       |        |        |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|------|--------|-------|--------|--------|------------|--------|------------|------------------|--|-------|-----|--|--|--|--|--|----------------|--|--|--|--|--|--|--|--|---------------------|----------|-------|-----|--|--|-------|------|-----------|-------------|--|-------|-----|--|--|-------|------|--|------------|--|-------|-----|--|--|-------|------|--|---------------|----------|-------|-----|--|--|-------|------|-------|-------------------|--|-------|-----|---|---|-------|------|--|-------------------|----------|-------|-----|---|---|-------|------|--|
| <a href="#"><u>PQ_REPLICATE</u></a>             | замена BROADCAST distribution - выполнение одного и того же сканирования сканирования всеми SLAVE-процессами                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |           |      |        |       |        |        |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| <a href="#"><u>HYBRID_HASH_DISTRIBUTION</u></a> | выбор HASH, BROADCAST или <a href="#"><u>SKEW</u></a> parallel distribution после проверки размера data set'а <a href="#"><u>STATISTICS_COLLECTOR</u></a> 'ом (см. также <a href="#"><u>12c Hybrid Hash Distribution with Skew Detection / Handling</u></a> и HINTS: <a href="#"><u>PQ_SKEW/NO_PQ_SKEW</u></a> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |           |      |        |       |        |        |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| PQ_DISTRIBUTE_WINDOW                            | <p>Для вычисления оконных теперь помимо PX SEND HASH используется и PX SEND RANGE (а судя по аутлайну еще и LIST, т.к. по list-partitioned таблице второй параметр равен 3, вместо обычного 2 для остальных случаев с PX SEND RANGE)</p> <hr/> <table border="1"> <thead> <tr> <th>Operation</th> <th>Name</th> <th>Rows</th> <th>Cost</th> <th>Pstart</th> <th>Pstop</th> <th>TQ</th> <th>IN-OUT</th> <th>PQ Distrib</th> </tr> </thead> <tbody> <tr> <td>SELECT STATEMENT</td> <td></td> <td>74384</td> <td>102</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>PX COORDINATOR</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>PX SEND QC (RANDOM)</td> <td>:TQ10001</td> <td>74384</td> <td>102</td> <td></td> <td></td> <td>Q1,01</td> <td>P-&gt;S</td> <td>QC (RAND)</td> </tr> <tr> <td>WINDOW SORT</td> <td></td> <td>74384</td> <td>102</td> <td></td> <td></td> <td>Q1,01</td> <td>PCWP</td> <td></td> </tr> <tr> <td>PX RECEIVE</td> <td></td> <td>74384</td> <td>100</td> <td></td> <td></td> <td>Q1,01</td> <td>PCWP</td> <td></td> </tr> <tr> <td>PX SEND RANGE</td> <td>:TQ10000</td> <td>74384</td> <td>100</td> <td></td> <td></td> <td>Q1,00</td> <td>P-&gt;P</td> <td>RANGE</td> </tr> <tr> <td>PX BLOCK ITERATOR</td> <td></td> <td>74384</td> <td>100</td> <td>1</td> <td>3</td> <td>Q1,00</td> <td>PCWC</td> <td></td> </tr> <tr> <td>TABLE ACCESS FULL</td> <td>TESTPART</td> <td>74384</td> <td>100</td> <td>1</td> <td>3</td> <td>Q1,00</td> <td>PCWP</td> <td></td> </tr> </tbody> </table> <hr/> <p>Outline Data</p> <pre> / **   BEGIN_OUTLINE_DATA   PQ_DISTRIBUTE_WINDOW(@"SEL\$1" 3)   FULL(@"SEL\$1" "TESTPART"@"SEL\$1")   OUTLINE_LEAF(@"SEL\$1")   ALL_ROWS   DB_VERSION('12.1.0.2')   OPTIMIZER_FEATURES_ENABLE('12.1.0.2')   IGNORE_OPTIM_EMBEDDED_HINTS   END_OUTLINE_DATA */ </pre> | Operation | Name | Rows   | Cost  | Pstart | Pstop  | TQ         | IN-OUT | PQ Distrib | SELECT STATEMENT |  | 74384 | 102 |  |  |  |  |  | PX COORDINATOR |  |  |  |  |  |  |  |  | PX SEND QC (RANDOM) | :TQ10001 | 74384 | 102 |  |  | Q1,01 | P->S | QC (RAND) | WINDOW SORT |  | 74384 | 102 |  |  | Q1,01 | PCWP |  | PX RECEIVE |  | 74384 | 100 |  |  | Q1,01 | PCWP |  | PX SEND RANGE | :TQ10000 | 74384 | 100 |  |  | Q1,00 | P->P | RANGE | PX BLOCK ITERATOR |  | 74384 | 100 | 1 | 3 | Q1,00 | PCWC |  | TABLE ACCESS FULL | TESTPART | 74384 | 100 | 1 | 3 | Q1,00 | PCWP |  |
| Operation                                       | Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Rows      | Cost | Pstart | Pstop | TQ     | IN-OUT | PQ Distrib |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| SELECT STATEMENT                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 74384     | 102  |        |       |        |        |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| PX COORDINATOR                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |           |      |        |       |        |        |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| PX SEND QC (RANDOM)                             | :TQ10001                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 74384     | 102  |        |       | Q1,01  | P->S   | QC (RAND)  |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| WINDOW SORT                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 74384     | 102  |        |       | Q1,01  | PCWP   |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| PX RECEIVE                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 74384     | 100  |        |       | Q1,01  | PCWP   |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| PX SEND RANGE                                   | :TQ10000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 74384     | 100  |        |       | Q1,00  | P->P   | RANGE      |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| PX BLOCK ITERATOR                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 74384     | 100  | 1      | 3     | Q1,00  | PCWC   |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |
| TABLE ACCESS FULL                               | TESTPART                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 74384     | 100  | 1      | 3     | Q1,00  | PCWP   |            |        |            |                  |  |       |     |  |  |  |  |  |                |  |  |  |  |  |  |  |  |                     |          |       |     |  |  |       |      |           |             |  |       |     |  |  |       |      |  |            |  |       |     |  |  |       |      |  |               |          |       |     |  |  |       |      |       |                   |  |       |     |   |   |       |      |  |                   |          |       |     |   |   |       |      |  |

## EXPRESSION EVALUATION

Выполнение скалярных подзапросов (коррелированных) SLAVE-процессами

### PQ FILTER

```
select
  owner,object_name
  , rank()over(partition by object_type order by object_id) drnk
from xt_test l
where exists(select/*+ no_unnest */ 0 from dual where dummy=object_name);
```

| Id  | Operation           | Name     | TQ    | IN-OUT | PQ Distrib |
|-----|---------------------|----------|-------|--------|------------|
| 0   | SELECT STATEMENT    |          |       |        |            |
| 1   | WINDOW SORT         |          |       |        |            |
| * 2 | FILTER              |          |       |        |            |
| 3   | PX COORDINATOR      |          |       |        |            |
| 4   | PX SEND QC (RANDOM) | :TQ10000 | Q1,00 | F->S   | QC (RAND)  |
| 5   | PX BLOCK ITERATOR   |          | Q1,00 | PCWC   |            |
| 6   | TABLE ACCESS FULL   | XT_TEST  | Q1,00 | PCWP   |            |
| * 7 | TABLE ACCESS FULL   | DUAL     |       |        |            |

Predicate Information (identified by operation id):

```
2 - filter( EXISTS (SELECT 0 FROM "SYS"."DUAL" "DUAL" WHERE "DUMMY"=:B1))
7 - filter("DUMMY"=:B1)
```

| Id  | Operation           | Name     | TQ    | IN-OUT | PQ Distrib |
|-----|---------------------|----------|-------|--------|------------|
| 0   | SELECT STATEMENT    |          |       |        |            |
| 1   | PX COORDINATOR      |          |       |        |            |
| 2   | PX SEND QC (RANDOM) | :TQ10001 | Q1,01 | F->S   | QC (RAND)  |
| 3   | WINDOW SORT         |          | Q1,01 | PCWP   |            |
| 4   | PX RECEIVE          |          | Q1,01 | PCWP   |            |
| 5   | PX SEND HASH        | :TQ10000 | Q1,00 | F->P   | HASH       |
| * 6 | FILTER              |          | Q1,00 | PCWC   |            |
| 7   | PX BLOCK ITERATOR   |          | Q1,00 | PCWC   |            |
| 8   | TABLE ACCESS FULL   | XT_TEST  | Q1,00 | PCWP   |            |
| * 9 | TABLE ACCESS FULL   | DUAL     |       |        |            |

Predicate Information (identified by operation id):

```
6 - filter( EXISTS (SELECT 0 FROM "SYS"."DUAL" "DUAL" WHERE "DUMMY"=:B1))
9 - filter("DUMMY"=:B1)
```



## Новые SQL PLAN OPERATIONS

### [DBA HIST PLAN OPERATION NAME](#)

| OPERATION_NAME                 | Описание                                                                                                                | Ссылки                 |
|--------------------------------|-------------------------------------------------------------------------------------------------------------------------|------------------------|
| JSONTABLE EVALUATION           | Выполнение функции <a href="#">JSON_TABLE</a>                                                                           | <a href="#">1</a>      |
| XMLTABLE EVALUATION            | Новое название для COLLECTION ITERATOR PICKLER FETCH по XQSEQUENCEFROMXMLTYPE<br>Операция XPATH EVALUATION осталась.    | <a href="#">2, 3</a>   |
| EXPRESSION EVALUATION          | Выполнение скалярных подзапросов (коррелированных) SLAVE-процессами                                                     | <a href="#">4</a>      |
| MATCH RECOGNIZE                | PATTERN MATCHING                                                                                                        | <a href="#">5</a>      |
| STATISTICS COLLECTOR           | Optimizer statistics collector                                                                                          | <a href="#">6</a>      |
| OPTIMIZER STATISTICS GATHERING | Сбор статистики при CREATE TABLE AS SELECT и INSERT-SELECT (GATHER_OPTIMIZER_STATISTICS/NO_GATHER_OPTIMIZER_STATISTICS) | <a href="#">7</a>      |
| CUBE JOIN                      | Joining Cubes to Tables and Views                                                                                       | <a href="#">8, 9</a>   |
| PX SELECTOR                    | выполнение работы QUERY COORDINATOR'а одним из SLAVE процессов                                                          | <a href="#">10, 11</a> |
| PX TASK                        | Параллельное обращение к fixed tables (x\$) в RAC на разных нодах                                                       |                        |
| VECTOR,<br>KEY VECTOR          | Inmemory aggregation                                                                                                    | <a href="#">12, 13</a> |

| OPERATION_NAME                | Описание | Ссылки |
|-------------------------------|----------|--------|
| RECURSIVE ITERATION           | ?        |        |
| WINDOW CONSOLIDATOR           | ?        |        |
| <i>DETECT END</i>             |          |        |
| <i>DM EXP MAX AGGR</i>        |          |        |
| <i>DM EXP MAX PAR</i>         |          |        |
| <i>FAULT-TOLERANCE BUFFER</i> |          |        |

## СПИСОК ССЫЛОК

| Автор             | Название                                                                   | Ссылка                                                                                                                                                                                                                  |
|-------------------|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (DOC)             | PX SELECTOR Concurrent Execution of Union All                              | <a href="http://docs.oracle.com/database/121/VLDBG/GUID-1F4C90F9-3EF5-423A-B55B-2593FB3F1433.htm">http://docs.oracle.com/database/121/VLDBG/GUID-1F4C90F9-3EF5-423A-B55B-2593FB3F1433.htm</a>                           |
| (DOC)             | Adaptive Plans: Parallel Distribution Methods                              | <a href="http://docs.oracle.com/database/121/TGSQL/tgsql_optcncpt.htm#TGSQL95022">http://docs.oracle.com/database/121/TGSQL/tgsql_optcncpt.htm#TGSQL95022</a>                                                           |
| Randolf Geist     | Parallel Execution Skew – 12c Hybrid Hash Distribution With Skew Detection | <a href="http://allthingsoracle.com/parallel-execution-skew-12c-hybrid-hash-distribution-with-skew-detection/">http://allthingsoracle.com/parallel-execution-skew-12c-hybrid-hash-distribution-with-skew-detection/</a> |
| Randolf Geist     | 12c Hybrid Hash Distribution with Skew Detection / Handling                | <a href="http://oracle-randolf.blogspot.de/2014/05/12c-hybrid-hash-distribution-with-skew.html">http://oracle-randolf.blogspot.de/2014/05/12c-hybrid-hash-distribution-with-skew.html</a>                               |
| (DOC)             | PQ FILTER                                                                  | <a href="https://docs.oracle.com/database/121/SQLRF/sql_elements006.htm#BABICDJE">https://docs.oracle.com/database/121/SQLRF/sql_elements006.htm#BABICDJE</a>                                                           |
| (DOC)             | JSON_TABLE                                                                 | <a href="http://docs.oracle.com/database/121/SQLRF/functions091.htm#CJAGJFEI">http://docs.oracle.com/database/121/SQLRF/functions091.htm#CJAGJFEI</a>                                                                   |
| 1. (DOC)          | JSON in Oracle Database                                                    | <a href="http://docs.oracle.com/database/121/ADXDB/json.htm#ADXDB6246">http://docs.oracle.com/database/121/ADXDB/json.htm#ADXDB6246</a>                                                                                 |
| 2. (DOC)          | XML_TABLE                                                                  | <a href="http://docs.oracle.com/database/121/SQLRF/functions268.htm#SQLRF06232">http://docs.oracle.com/database/121/SQLRF/functions268.htm#SQLRF06232</a>                                                               |
| 3. (DOC)          | Performing SQL Operations on XMLType Fragments Using XMLTABLE              | <a href="http://docs.oracle.com/database/121/ADXDB/xd03usg.htm#ADXDB4130">http://docs.oracle.com/database/121/ADXDB/xd03usg.htm#ADXDB4130</a>                                                                           |
| 4. Jonathan Lewis | EXPRESSION EVALUATION                                                      | <a href="https://jonathanlewis.wordpress.com/2015/05/12/parallel-query/">https://jonathanlewis.wordpress.com/2015/05/12/parallel-query/</a>                                                                             |
| 5.(DOC)           | SQL for Pattern Matching                                                   | <a href="http://docs.oracle.com/database/121/DWHSG/pattern.htm">http://docs.oracle.com/database/121/DWHSG/pattern.htm</a>                                                                                               |
| 6.(DOC)           | Optimizer statistics collector                                             | <a href="http://docs.oracle.com/database/121/TGSQL/tgsql_optcncpt.htm#TGSQL224">http://docs.oracle.com/database/121/TGSQL/tgsql_optcncpt.htm#TGSQL224</a>                                                               |
| 7.(DOC)           | GATHER_OPTIMIZER_STATISTICS                                                | <a href="https://docs.oracle.com/database/121/SQLRF/sql_elements006.htm#BABDBACG">https://docs.oracle.com/database/121/SQLRF/sql_elements006.htm#BABDBACG</a>                                                           |
| 8.(DOC)           | USE_CUBE                                                                   | <a href="https://docs.oracle.com/database/121/SQLRF/sql_elements006.htm#CHDCDDAC">https://docs.oracle.com/database/121/SQLRF/sql_elements006.htm#CHDCDDAC</a>                                                           |
| 9.(DOC)           | Joining Cubes to Tables and Views                                          | <a href="http://docs.oracle.com/database/121/OLAUG/query.htm#BGBCABGE">http://docs.oracle.com/database/121/OLAUG/query.htm#BGBCABGE</a>                                                                                 |
| 10.(DOC)          | Concurrent Execution of Union All                                          | <a href="http://docs.oracle.com/database/121/VLDBG/GUID-1F4C90F9-3EF5-423A-B55B-2593FB3F1433.htm">http://docs.oracle.com/database/121/VLDBG/GUID-1F4C90F9-3EF5-423A-B55B-2593FB3F1433.htm</a>                           |
| 11. Randolf Geist | 12c Parallel Execution New Features: 1 SLAVE distribution                  | <a href="http://oracle-randolf.blogspot.ru/2015/06/12c-parallel-execution-new-features-1.html">http://oracle-randolf.blogspot.ru/2015/06/12c-parallel-execution-new-features-1.html</a>                                 |
| 12. (DOC)         | Inmemory aggregation                                                       | <a href="https://docs.oracle.com/database/121/TGSQL/tgsql_transform.htm#TGSQL95255">https://docs.oracle.com/database/121/TGSQL/tgsql_transform.htm#TGSQL95255</a>                                                       |
| 13. (DOC)         | v\$key_vector                                                              | <a href="https://docs.oracle.com/database/121/REFRN/GUID-B41CC125-C824-417A-8901-32B4C59161B4.htm#REFRN30738">https://docs.oracle.com/database/121/REFRN/GUID-B41CC125-C824-417A-8901-32B4C59161B4.htm#REFRN30738</a>   |