Performance tuning an Oracle Spatial process: experience at a customer site

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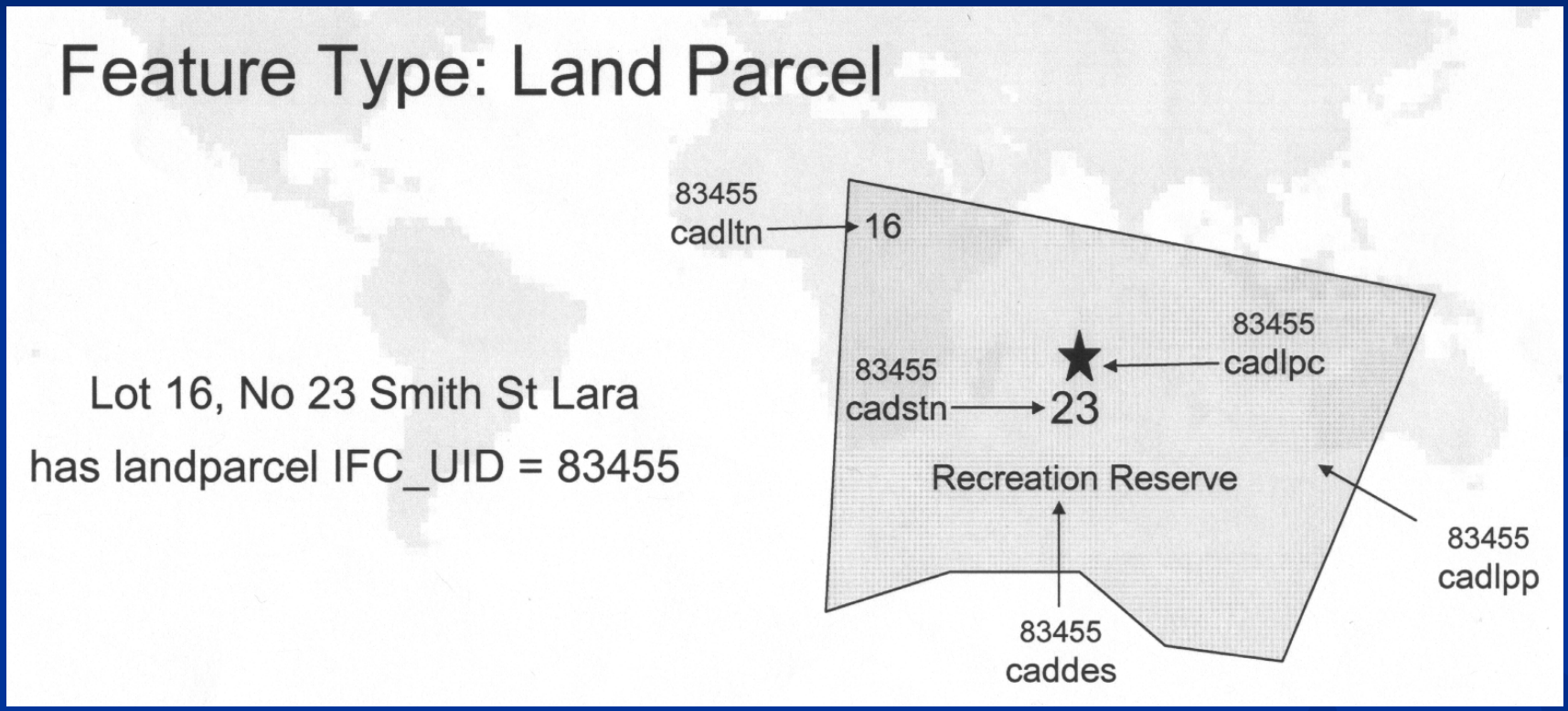
Business Need

- Old Dual CPU Solaris hardware
- "Wireframe" (350,000 lines) land parcel fabric
- Radius Topology structured 157,374 faces from "wireframe"
  - Thus there are 157,374 potential land parcels (topological faces)
- Requirements
  - Generate actual land parcel polygons from faces by intersection with parcel "point" (centroid) layer (156,543) and parcel data table
  - Do it "as fast as" possible on this old hardware

Visually



- It is possible to have multiple points inside a parcel but only one has the actual parcel details associated with it.

Methodology

- Use multiple sqlplus sessions
  - How?
- Avoid session conflicts
  - How?
- Achieve fast processing and insertion
  - How?

Approach

- Multiple sqlplus sessions

```
SET Commit_Interval=2000
SET Process_Max=3
SET parcel_table=SP_PARCEL
ECHO Create SP_PARCEL records from Faces with centroid
    processing via a number of parallel sessions
FOR /L %%i IN (1,1,%Process_Max%) DO @start "Face
    %%i %uname%.%parcel_table%" /D"%CD%" /i /min
    /realtime sqlplus -s %uname%/%upass%@%dbcon%
    @create_sp_parcel.sql %mfld_name% %%i
    %Process_Max% %Commit_Interval% %parcel_table%
    %uname%
```

- Easy!

Avoid Conflict?

- Simple stratification algorithm:

```
v_sql :=            'SELECT ID, GEOM_VERSION ‘;
v_sql := v_sql ||  '  FROM LSL_FACE$'||v_mfld_id;
v_sql := v_sql ||  ' WHERE ID NOT IN (SELECT
UNIVERSE_FACE_ID FROM USER_LSL_MANIFOLD_METADATA
WHERE manifold_id = '||v_mfld_id||')';
OPEN faceCursor
FOR v_sql;
LOOP
  FETCH faceCursor INTO v_id, v_geom_vn;
  EXIT WHEN faceCursor%NOTFOUND;
  -- Is this row for me?
  IF ( MOD( faceCursor%ROWCOUNT - 1,
         &&max_processes. ) + 1 = &&process_id. )
  THEN
```

Row Stratification - Visually

my_tables.sql | GISDB_MCW_TEST | SP_PARCEL

Columns | Data | Indexes | Constraints | Grants | Statistics | Column Statistics | Triggers | Dependencies | Deta

Sort... Filter:

	GID	TAG X	TAG Y	GEOMETRY	PRCL TYPE	LSTATUS
1	588666	460699.8475...	6463307.711090...	oracle.sql.STRU...	P	R
2	588667	460707.3491...	6463256.281887...	oracle.sql.STRU...	P	R
3	36871	439167.6059...	6475554.035103...	oracle.sql.STRU...	P	R
4	36872	458948.9774...	6465701.710220...	oracle.sql.STRU...	P	R
5	36873	433965.2711...	6449963.762625...	oracle.sql.STRU...	P	R
6	36856	447974.4669...	6470158.296694...	oracle.sql.STRU...	P	R
7	36857	446759.1895...	6468571.423166...	oracle.sql.STRU...	P	R
8	36905	447999.8575...	6470260.028922...	oracle.sql.STRU...	P	R
9	36897	454284.8342...	6471014.9667904	oracle.sql.STRU...	P	R
10	36898	447997.6712...	6470090.4835929	oracle.sql.STRU...	P	R
11	36899	447798.1696...	6470330.258925...	oracle.sql.STRU...	P	R
12	36900	449771.1806...	6470996.581411...	oracle.sql.STRU...	P	R
13	36901	451708.0861...	6440498.645756...	oracle.sql.STRU...	P	R
14	36902	446959.6953...	6468446.057426...	oracle.sql.STRU...	P	R
15	36904	449531.0015...	6471924.5229294	oracle.sql.STRU...	P	R
16	36895	460806.4356...	6462439.611480...	oracle.sql.STRU...	P	R
17	36896	468828.9964...	6472833.942067...	oracle.sql.STRU...	P	R
18	36886	449492.1578...	6471784.437184...	oracle.sql.STRU...	P	R
19	36887	448013.7556...	6470189.706746...	oracle.sql.STRU...	P	R
20	36888	451997.8139...	6439931.535267...	oracle.sql.STRU...	P	R

ProcessMax (3)

Process 1

Process 2

Process 2

Fast Processing

- Bottlenecks – Identify them!
- Hints – Use Them!
  - How?
  - Explain Plan
    - Huh?
      - Learn it!
- Batch or Array Inserts
  - The only way!

(Timing) Bottlenecks

- Find them by recording timing:
  - Eg Create Sdo_Geometry from RT topological face:

```
v_GetFaceStartTime := dbms_utility.get_time;
v_geom             := lsl_topo_util.face_get_geometry
                       (v_mfld_id, v_id, v_geom_vn);
v_GetFaceTotalTime := v_GetFaceTotalTime +
                        ( dbms_utility.get_time -
                          v_GetFaceStartTime );
```

(Timing) Bottlenecks 2

```
v_SdoInsideStartTime := dbms_utility.get_time;
SELECT /*+ ORDERED FIRST_ROWS(2) */
       pt.gid,
       pt.geometry.sdo_point.x,
       pt.geometry.sdo_point.y
  INTO v_spi, v_Tag_X, v_Tag_Y
  FROM sp_parcel_pt  pt,
       sp_parcels_bw pl
 WHERE SDO_INSIDE (pt.geometry, v_geom)
                   = 'TRUE'
   AND pl.gid = pt.gid;
v_SdoInsideTotalTime := v_SdoInsideTotalTime +
                        ( dbms_utility.get_time -
                          v_SdoInsideStartTime );
```

Actual point holding correct information is one whose GID is the same as in the sp_parcel_bw table

Hints and Spatial

- Hints can be used for Oracle Spatial too!
  - What Oracle says is "Best-Practice" is to use the ORDERED hint when the query window (geometry-2) in an operator (SDO_INSIDE) comes from a table then use the ordered hint, putting the table geometry-2 comes from first in the from clause.

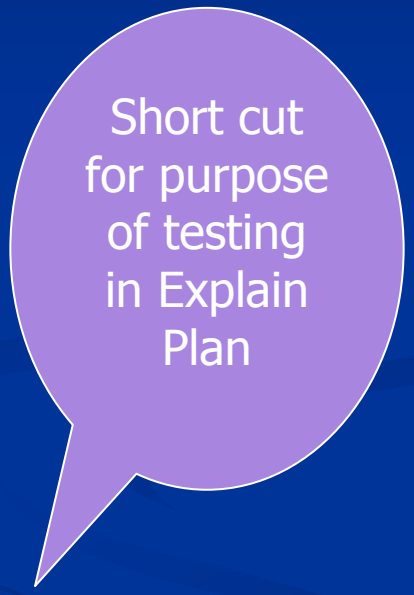
```
-- Now, is this a face that is really representing a parcel?
-- If it is, then:
-- 1. It should have a point in it
-- 2. And it should be THE point that represents the master centroid
BEGIN  -- Use a pl/sql block to capture no row, too many row EXCEPTIONS.
     v_SdoInsideStartTime := dbms_utility.get_time;
     SELECT /*+ ORDERED */
            pt.gid, pt.geometry.sdo_point.x, pt.geometry.sdo_point.y
       INTO v_spi, v_Tag_X, v_Tag_Y
       FROM sp_parcel_pt  pt,
            sp_parcels_bw pl
     WHERE SDO_INSIDE (pt.geometry, v_geom) = 'TRUE'
       AND pl.gid = pt.gid;
```

- But it doesn't appear fast enough: Why?

Explaining the query

```
SQL> explain plan
  2  set statement_id = 'FACE QUERY'
  3  for
  4  SELECT /*+ ORDERED */
  5         pt.gid,
  6         pt.geometry.sdo_point.x,
  7         pt.geometry.sdo_point.y
  8    FROM sp_parcel_pt  pt,
  9         sp_parcels_bw pl
 10   WHERE SDO_INSIDE (pt.geometry,
 11         lsl_topo_util.face_get_geometry (2, 45, 2))
 12         = 'TRUE'
 13     AND pl.gid = pt.gid;

Explained.
```



Interpret the results

```
SQL> select * from table(dbms_xplan.display('PLAN_TABLE','FACE QUERY','TYPICAL'));
PLAN_TABLE_OUTPUT
-------------------------------------------------------------------------------------------------
Plan hash value: 714054537
-------------------------------------------------------------------------------------------------
| Id | Operation                     | Name              | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------------
|  0 | SELECT STATEMENT              |                   |  1566 |   186K|     87   (5)| 00:00:02 |
|* 1 |  HASH JOIN                    |                   |  1566 |   186K|     87   (5)| 00:00:02 |
|  2 |   TABLE ACCESS BY INDEX ROWID| SP_PARCEL_PT      |  1566 |   177K|      3   (0)| 00:00:01 |
|* 3 |    DOMAIN INDEX               | SP_PARCEL_PT_$X   |       |       |             |          |
|  4 |   INDEX FAST FULL SCAN        | SP_PARCELS_BW_GID |   155K|   909K|     80   (0)| 00:00:01 |
-------------------------------------------------------------------------------------------------
```

Good?

Err… No

Definitely Not!

Change the query - FIRST_ROWS(n)

- Query should return 1 row if correct. If 2 rows then wrong answer.
- So, let's try the FIRST_ROWS(m) (or FIRST_ROWS_n) hint
  - What's that?
  - From the documentation:

"FIRST_ROWS(n)

This hint instructs Oracle to optimize an individual SQL statement with a goal of best response time to return the first n number of rows, where n equals any positive integer. The hint uses a cost-based approach for the SQL statement, regardless of the presence of statistic."

FIRST_ROWS(2) in action

- Our business rule says that while a parcel may have multiple points inside it, only ONE point (pl.gid = pt.gid) holds the right information.
  - That is our query should return 1 row if correct any more rows then we have the wrong answer.
  - So, let's optimise for a few rows via the FIRST_ROWS(n) hint:

```
-- Now, is this a face that is really representing a parcel?
-- If it is, then:
-- 1. It should have a point in it
-- 2. And it should be THE point that represents the master centroid
BEGIN  -- Use a pl/sql block to capture no row, too many row EXCEPTIONS.
  v_SdoInsideStartTime := dbms_utility.get_time;
  SELECT /*+ ORDERED FIRST_ROWS(2) */
         pt.gid, pt.geometry.sdo_point.x, pt.geometry.sdo_point.y
    INTO v_spi, v_Tag_X, v_Tag_Y
    FROM sp_parcel_pt  pt,
         sp_parcels_bw pl
  WHERE SDO_INSIDE (pt.geometry, v_geom) = 'TRUE'
    AND pl.gid = pt.gid;
  …
```

Explain Plan (First_Rows(2))

```
SQL> select * from table(dbms_xplan.display('PLAN_TABLE','FACE QUERY','TYPICAL'));
PLAN_TABLE_OUTPUT
-------------------------------------------------------------------------------------------------
Plan hash value: 4094247311
-------------------------------------------------------------------------------------------------
|Id  | Operation                    | Name              | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------------
|  0 | SELECT STATEMENT             |                   |     2 |   244 |     4   (0)| 00:00:01 |
|  1 |  NESTED LOOPS                |                   |     2 |   244 |     4   (0)| 00:00:01 |
|  2 |   TABLE ACCESS BY INDEX ROWID| SP_PARCEL_PT      |     2 |   232 |     2   (0)| 00:00:01 |
|* 3 |    DOMAIN INDEX              | SP_PARCEL_PT_$X   |       |       |            |          |
|* 4 |   INDEX RANGE SCAN           | SP_PARCELS_BW_GID |     1 |     6 |     1   (0)| 00:00:01 |
-------------------------------------------------------------------------------------------------
```

Yes… much better

Now that's more like it!

Array or Batch inserts

- Single INSERT statements are costly
- PL/SQL makes "ARRAY" inserts easy via:
  - FORALL statement
- Approach
  - Cache results of parcel building in array
  - Execute single FORALL statement for the cached set at a set interval

Declare Array

```
TYPE parcel_t IS TABLE
   OF sp_parcel%ROWTYPE
   INDEX BY PLS_INTEGER;
v_parcels          parcel_t;
v_parcel           s_parcel%ROWTYPE;

(Note: sp_parcel has an
  Sdo_Geometry column - fully
  supported in PL/SQL)
```

Fill the array with results of search

```
-- Fill our record with data
SELECT munseq_gid.NEXTVAL
   INTO v_parcel.gid
  FROM DUAL;
v_parcel.tag_x        := v_tag_x; -- From SELECT
v_parcel.tag_y        := v_tag_y;
v_parcel.spi          := v_spi;
v_parcel.geometry     := v_geom;
-- Assign record to array
v_counter             := v_counter + 1;
v_parcels(v_counter) := v_parcel;
```

Keep count of rows in cache

Batch insert

- When cache (varray of record) has reached parameter-driven limit – batch insert the data in the cache into the target table (sp_parcel):

```
IF ( MOD(v_counter,v_iterations) = 0 ) THEN
   v_BatchStartTime := dbms_utility.get_time;
   FORALL i IN 1..v_counter
     SAVE EXCEPTIONS
     INSERT INTO &&sp_parcel_table_name.
          VALUES v_parcels(i);
   COMMIT;
   v_BatchTotalTime := v_BatchTotalTime +
                       ( dbms_utility.get_time -
                         v_BatchStartTime );
   v_parcel_count   := v_parcel_count + v_counter;
   v_counter := 0;
END IF;
```

Pinning Tables and RTree Indexes

- As a final performance improvement:
  - The sp_parcel_pt table and its RTree index, and
  - The sp_parcel_bw table, plus;
  - The Radius Topology topology tables,
- … were all "pinned" into memory.
- Examples::

```
ALTER TABLE sp_parcel_pt STORAGE(BUFFER_POOL KEEP);
DECLARE
  v_nl_table_name varchar2(30);
BEGIN
  SELECT sdo_nl_index_table
    INTO v_nl_table_name
    FROM user_sdo_index_metadata
   WHERE sdo_index_name = 'SP_PARCEL_PT_$X';
  EXECUTE IMMEDIATE 'ALTER TABLE '||v_nl_table_name||'
   STORAGE(BUFFER_POOL KEEP)';
END;
/
```

Result

```
Report (sample)
_____________Faces Processed: 7869
__________Parcels from Faces: 7586
______Faces with no centroids: 249
Faces with multiple centroids: 34
__Total Execution Time (secs): 448
____Face_Get_Geom Time (secs): 229.3
_Sdo_Inside Query Time (secs): 142.3
_____Batch_Insert Time (secs): 3.84
_Processing speed (Faces/sec): 17.6
__________Face_Get_Geom (Avg): .0291
____________Sdo_Inside (Avg): .0181
__________Batch_Insert (Avg): .00768
```

Thanks

- My thanks go to:
  - Barwon Water (for the problem)
  - Open Spatial Pty Ltd (for the chance to work at their site)
  - Daniel Abugov (for QA'ing the talk so well)
  - Steven Feuerstein – PL/SQL Guru (for his books that helped me out with some tricky array processing of records).