



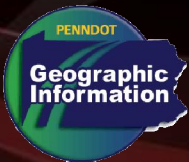
Using Oracle Spatial To Address Today's Transportation Issues

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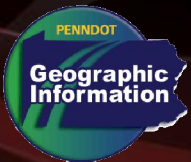
Disclaimer

Even if you are using an Oracle database, please just use this discussion to get an idea of what can be done. A lot of this may not even fit your work model. Besides that, a small percentage of people doing this report headaches and minor nausea. Prolonged exposure to coding/querying may irritate stomachs and produce ulceration. However, the majority of people see a benefit and continue to investigate what they can get out of the Oracle database investment.



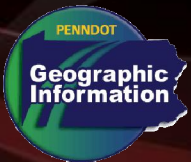
Why use Oracle Spatial?

- All DBMS are good at querying attribute data and producing query results
- Example: Find all crashes occurring last year on route 322 from segment 120 to 240



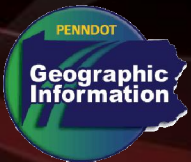
Why use Oracle Spatial?

- But what if the question you're asking includes a spatial component?
- Example: Find crashes occurring last year in a 1-mile buffer around road 12 from segment 120 to 240



Why use Oracle Spatial?

- Typically, you would have to use a GIS to access the data and locate the desired set of records
- Oracle Spatial allows you to do this with straight SQL!!!

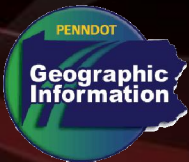


Querying Information Based on Geographic Location

- Against an area geometry:
 - Congressional District
 - School District
 - Municipality

```
SELECT body_name
  FROM body_table
 WHERE SDO_ANYINTERACT( geometry,
                        LATLONG( y, x ) ) = 'TRUE';
```

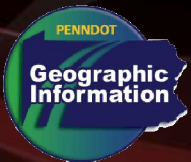
-- NOTE: LATLONG(Y,X) is a PennDOT function returning
-- an Oracle SDO_GEOMETRY object.



Querying Information Based on Geographic Location 2

- Against a state route:
 - Uses PennDOT LRS functions behind the scenes

```
FUNCTION get_seg_offset_from_latlong  
(  
  latitude    NUMBER,  
  longitude   NUMBER,  
  st_rt_no    VARCHAR2,  
  side_ind    VARCHAR2      DEFAULT      '1',  
  cty_code    VARCHAR2      DEFAULT      NULL  
) RETURN VARCHAR2;
```



Querying Information Based on Geographic Location 2 (Cont'd)

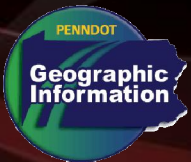
● Query:

```
SELECT PENNDOTLRS.GET_SEG_OFFSET_FROM_LATLONG(  
    40.025, -75.6067, '0030', '1') FROM DUAL;
```

● Answer:

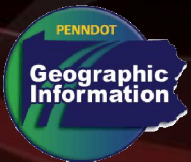
15,0030,0452,732,155

Return Value: The county code, route number, segment number, offset, and snapping error delimited by commas



Objectives

- Define the Oracle spatial data model
- Describe the SDO_GEOMETRY type
- Describe the steps to load spatial data
- Review PennDOT case studies
- Questions



What can be stored in Spatial?

- Point locations:

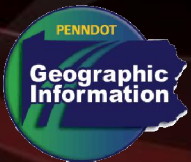
- Airports
- Street Intersections
- Crash Locations

- Line Strings:

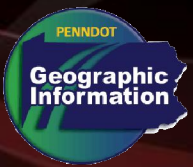
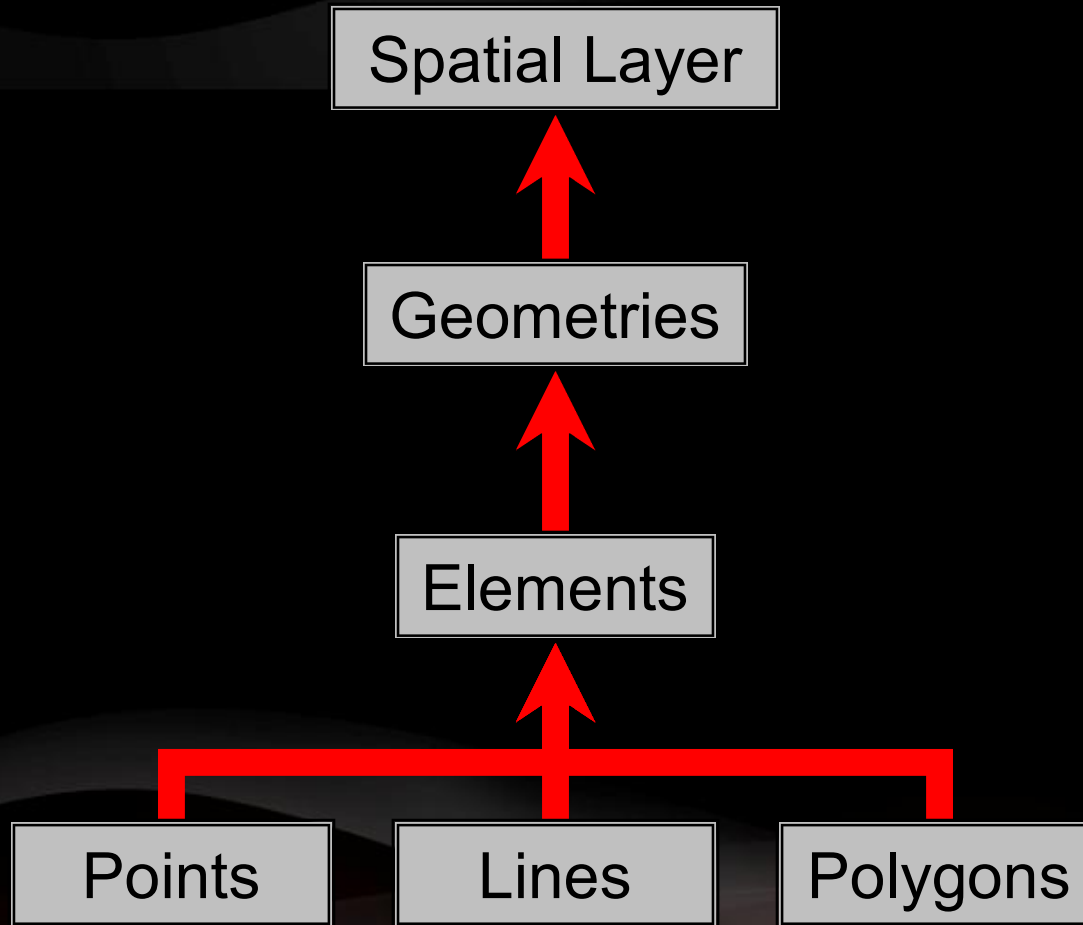
- Streets
- Railroads
- Rivers

- Polygons

- Municipality Boundaries
- Lakes
- Legislative Boundaries



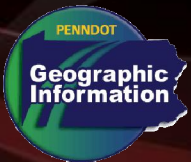
How Does Oracle Store the Data?



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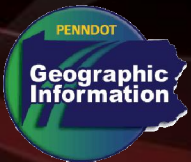
- SDO_GEOMETRY Data Type:

Property	Data Type
SDO_GTYPE	NUMBER
SDO_SRID	NUMBER
SDO_POINT	SDO_POINT_TYPE
SDO_ELEM_INFO	SDO_ELEM_INFO_ARRAY
SDO_ORDINATES	SDO_ORDINATE_ARRAY



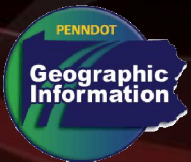
SDO_GEOMETRY: Point Example

```
SDO_GEOMETRY(  
    2001,  
    8265,  
    SDO_POINT_TYPE(-76.2681,  
                    40.0376,  
                    NULL),  
  
    NULL,  
    NULL  
)
```



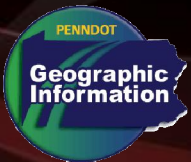
SDO_GEOMETRY: Line Example

```
MDSYS.SDO_GEOMETRY(  
  2002,  
  141122,  
  NULL,  
  SDO_ELEM_INFO_ARRAY(1,2,1),  
  SDO_ORDINATE_ARRAY(  
    -198126.63,-61790.33,  
    -197921.63,-61718.07,  
    -197876.59,-61680.0,  
    ...)  
)
```



How is spatial data loaded?

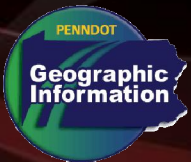
- Step #1: Create the table with the SDO_GEOMETRY column
- Step #2: Populate the metadata for the layer
- Step #3: Populate the data for the layer
- Step #4: Create the spatial index



How is spatial data loaded?

- Step #1: Create the table with the SDO_GEOMETRY column

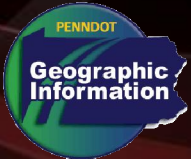
```
SQL> CREATE TABLE airports (  
2     airportid      NUMBER(10,0),  
3     facilityname   VARCHAR2(50),  
4     elevation      NUMBER(10,0),  
5     geometry       SDO_GEOMETRY);
```



How is spatial data loaded?

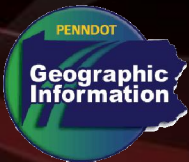
- Step #2: Populate the metadata for the layer

```
SQL> INSERT INTO user_sdo_geom_metadata
2     (table_name, column_name, diminfo, srid)
3     VALUES(
4         'AIRPORTS',
5         'GEOMETRY',
6         SDO_DIM_ARRAY(
7             SDO_DIM_ELEMENT('X', -180, 180, 0.5),
8             SDO_DIM_ELEMENT('Y', -90, 90, 0.5)),
9         8265);
```



How is spatial data loaded?

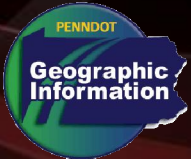
- Step #3: Populate the data for the layer
 - SQL*Loader
 - Oracle Import utility
 - INSERT statement
 - 3rd Party Utilities



How is spatial data loaded?

- Step #3: Populate the data for the layer

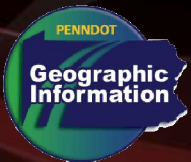
```
SQL> INSERT INTO airports
2     (airportid, facilityname, elevation, geometry)
3     VALUES (
4         1, 'CAPITAL CITY AIRPORT', 347,
5         SDO_GEOMETRY (
6             2001, 8265, NULL,
7             SDO_ELEM_INFO_ARRAY(1,1,1),
8             SDO_ORDINATE_ARRAY(-76.8508, 40.2168))
9     );
```



How is spatial data loaded?

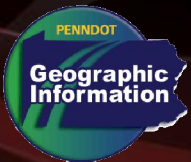
- Step #4: Create the spatial index

```
SQL> CREATE INDEX airports_sidx  
2     ON airports (geometry)  
3     INDEXTYPE IS mdsys.spatial_index  
4     PARAMETERS('SDO_INDX_DIMS=2  
5     LAYER_GTYPE="POINT");
```



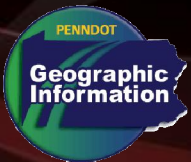
PennDOT Case Studies

- Case Study #1: Updating Event Tables
- Case Study #2: Crash Clustering
- Case Study #3: Analyzing Snow Truck Data
- Case Study #4: Detailing Highway Projects by Legislative Districts
- Case Study #5: Crashes in a Buffer Area



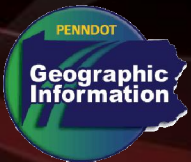
Case Study #1: Updating Event Tables

- Your event geometry can be calculated by Oracles spatial LRS functions.
- To do so will take a little preliminary work by your database team.
- Once set up, you can batch update your tables, or create line work on the fly for mapping.

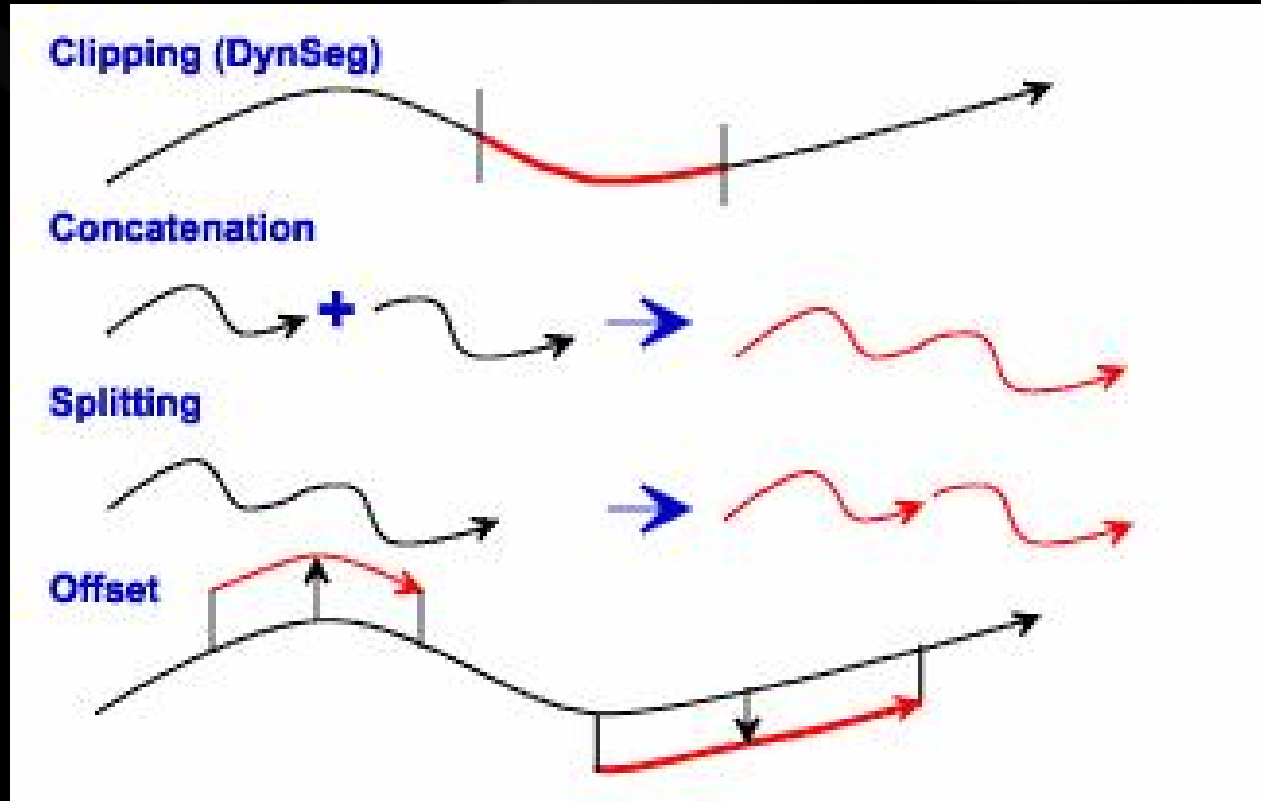


Requirements for LRS

- Table containing the data/geometry for the linear referencing system.
- Methods to reference the LRS segments.
- Method to return a point event on the LRS.
- Method to return a line event
 - Method to clip segments from the LRS.
 - Method to aggregate/append segments.



Main LRS Operations



The Main LRS Functions

- Retrieve a point event from the LRS:

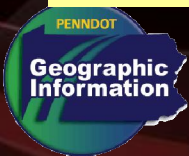
```
SELECT SDO_LRS.LOCATE_PT( lrs_geometry, measure )  
FROM dual;
```

- Clip a line event from the LRS:

```
SELECT SDO_LRS.DYNAMIC_SEGMENT(  
    lrs_geometry,  
    begin_measure,  
    end_measure ) FROM dual;
```

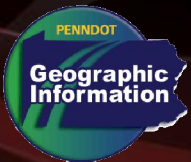
- Concatenate line segments:

```
SELECT SDO_UTIL.APPEND( geometry_1, geometry_2)  
FROM dual;           -- or --  
SELECT SDO_GEOM.SDO_UNION( geometry_1, geometry_2, 1)  
FROM dual;
```



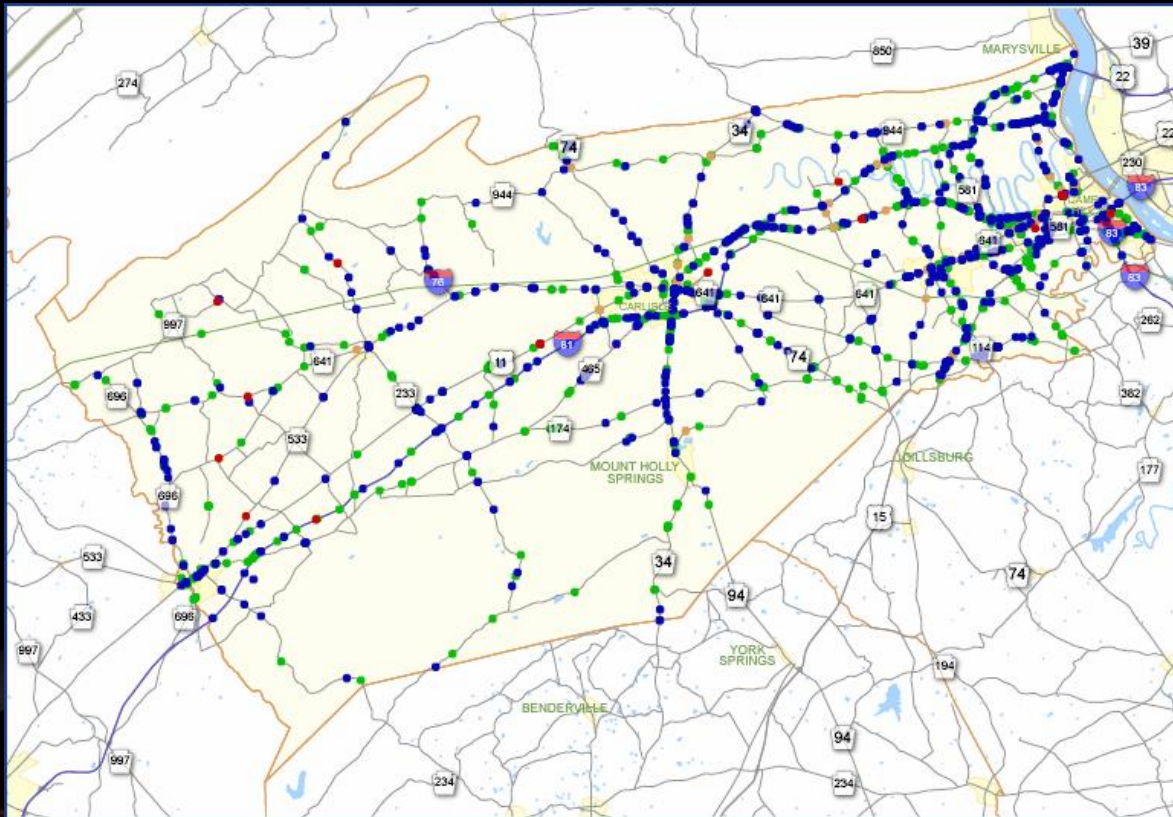
Case Study #2: Crash Data Analysis

- Working through SQL gives you the ability to fine tune your data search.
- For crash analysis we've actually put together a query that's taken the place of an outdated COBOL procedure. It uses sorting, temporary variables, logic branching and aggregating.



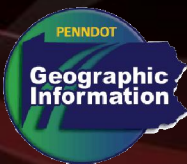
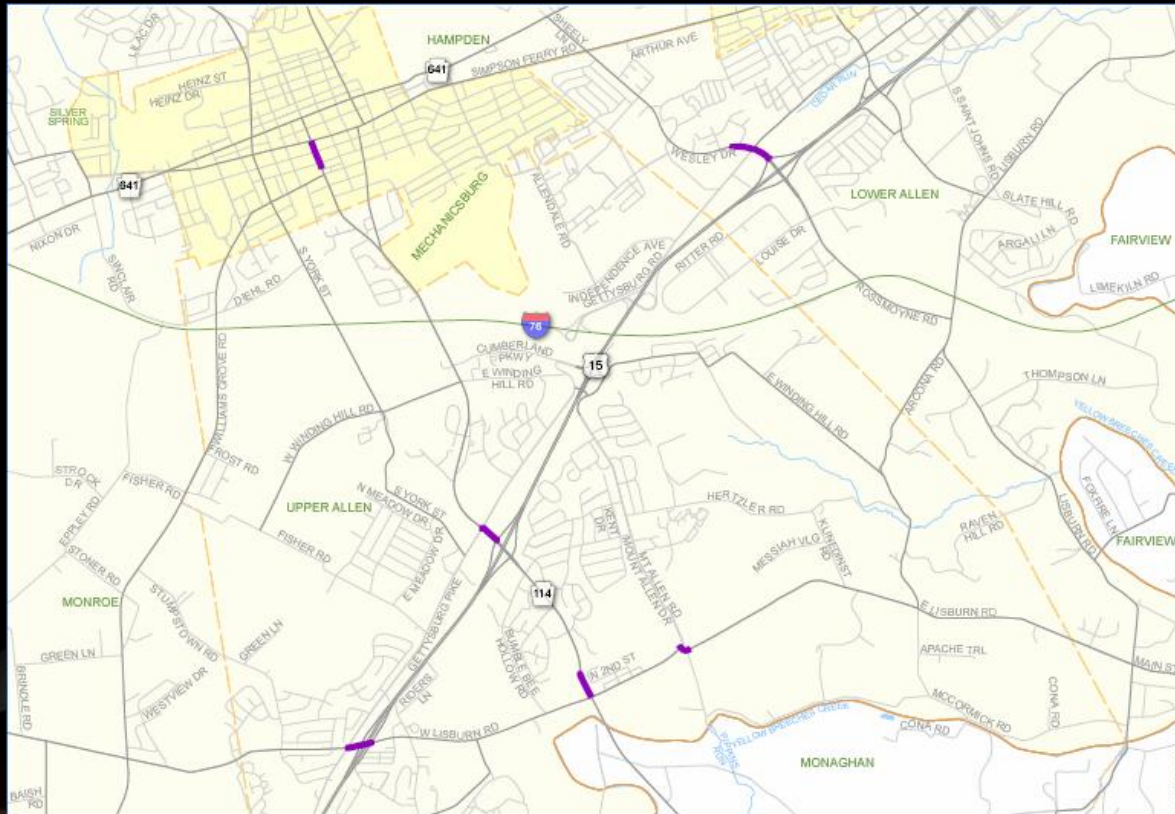
Case Study #2: Crash Clustering

- Find all wet road crashes and clusters in Cumberland County between 01/01/2001 and 12/31/2005



Case Study #2: Crash Clustering (Cont'd)

- Find all clusters from selected crash data. Minimum 8 crashes per 1000 feet. Takes 4-5 minutes.



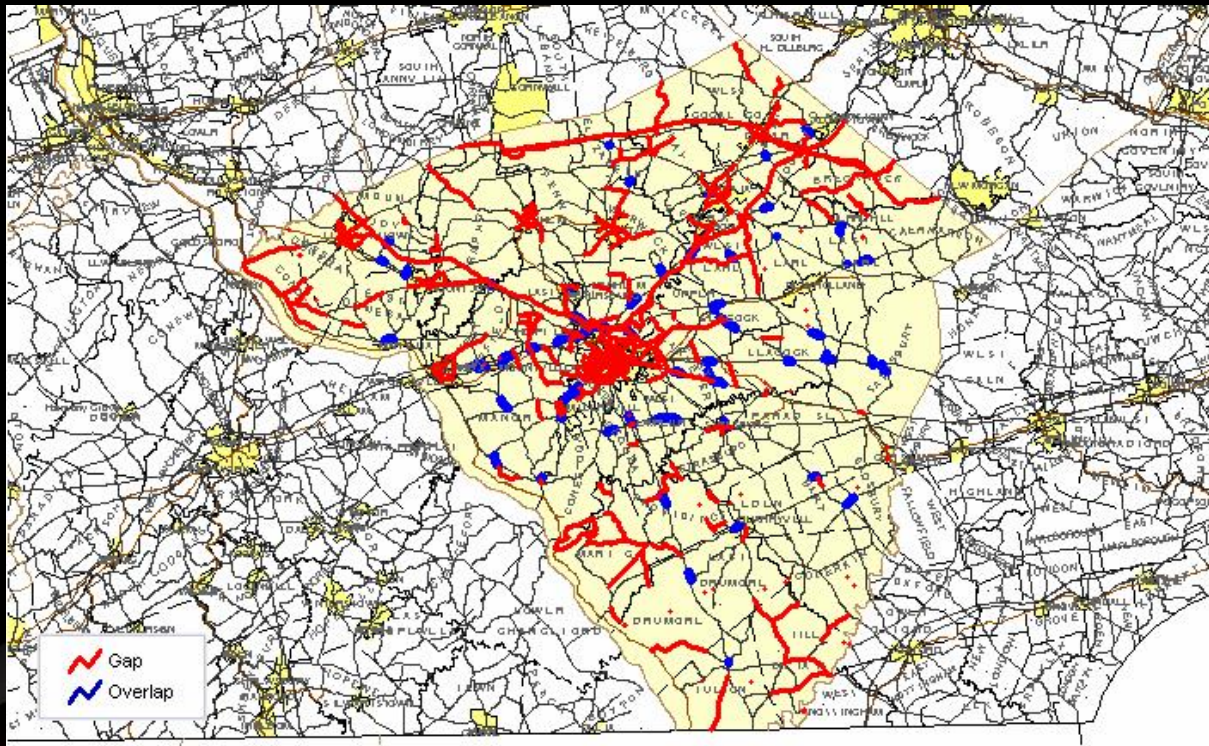
Case Study #2: Crash Clustering (Cont'd)

- Examine a cluster.



Case Study #3: Analyzing Snow Truck Data

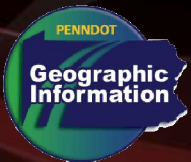
- Where in Lancaster County do the snow truck routes overlap and where are there gaps in coverage?



Case Study #3: Analyzing Snow Truck Data

- Find the overlaps in the truck coverage

```
SQL> SELECT a.truck_no truck_1,  
2         b.truck_no truck_2,  
3         SDO_GEOM.SDO_INTERSECTION(a.geometry,  
4                                     b.geometry,  
5                                     0.000005)  
6     FROM snow_route a,  
7         snow_route b  
8     WHERE SDO_ANYINTERACT(a.geometry, b.geometry)='TRUE'  
9         AND a.truck_no < b.truck_no);
```



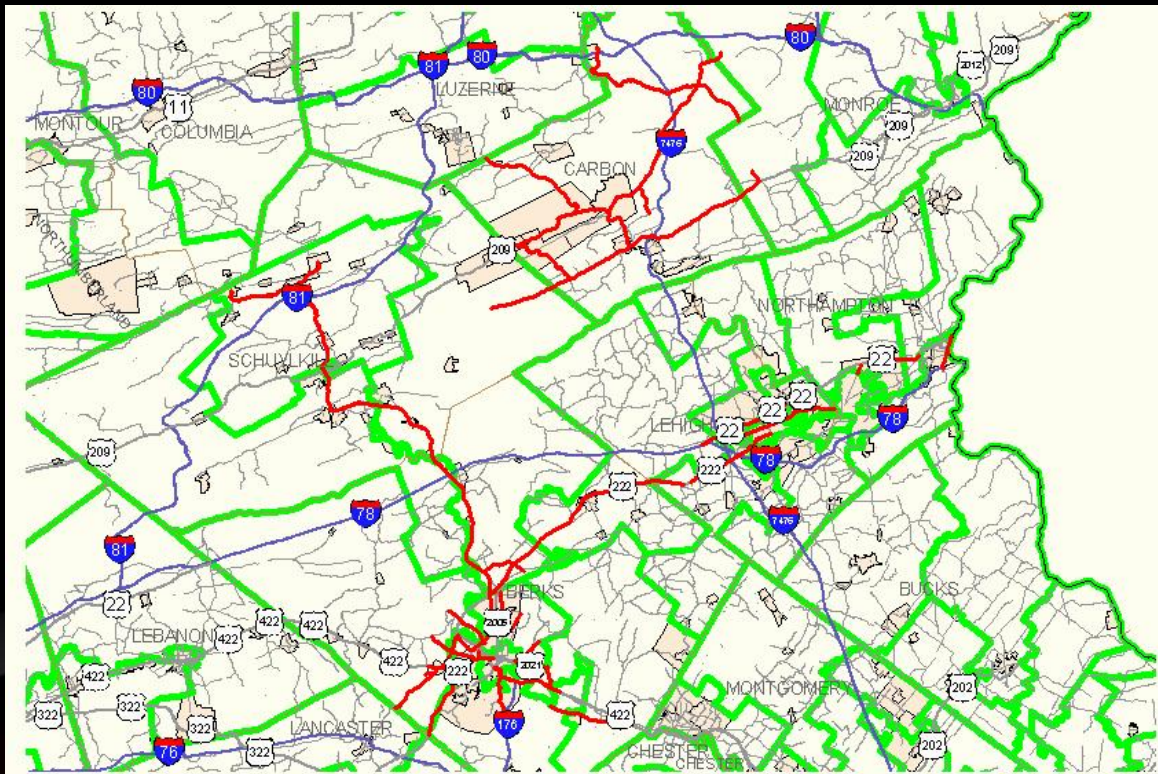
Case Study #3: Analyzing Snow Truck Data

- Find the gaps in the truck coverage

```
SQL> SELECT a.cty_code, a.st_rt_no,  
2         SDO_GEOM.SDO_DIFFERENCE(a.geometry,  
3                                 b.geometry,  
4                                 0.000005)  
5     FROM rmsseg a LEFT OUTER JOIN (  
6         SELECT cty_code, st_rt_no,  
7             SDO_AGGR_UNION(  
8                 SDOAGGRTYPE(c.geometry,0.000005))  
9                 geometry  
10            FROM snow_route c  
11            GROUPBY cty_code, st_rt_no) b  
12     ON (a.cty_code=b.cty_code AND  
13         a.st_rt_no=b.st_rt_no)  
14     WHERE SDO_GEOM.SDO_DIFFERENCE(a.geometry,  
15                                     b.geometry,  
16                                     0.000005) IS NOT NULL;
```


Case Study #4: Detailing Highway Projects by Legislative Districts

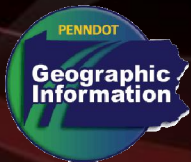
- Which legislative districts are affected by a highway project, and what is the mileage for each district?



Case Study #4: Detailing Highway Projects by Legislative Districts

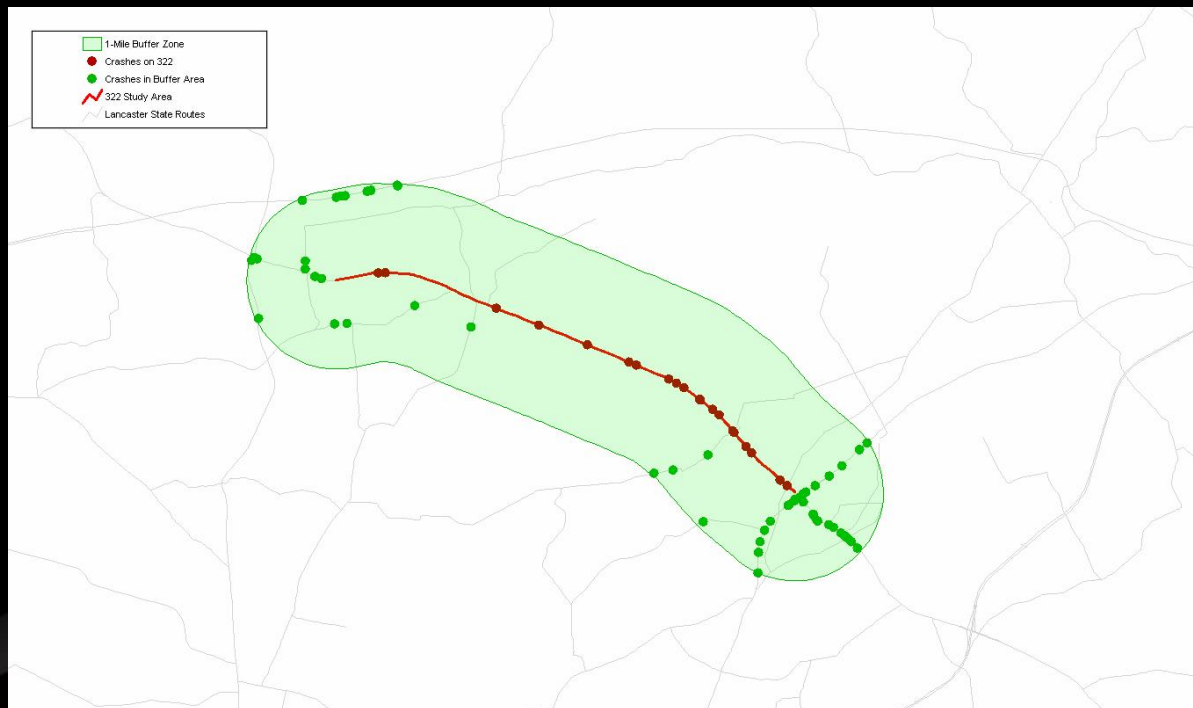
```
SQL> SELECT /*+ ORDERED */
2     h.leg_district_no,
3     SUM (sdo_geom.sdo_length (
4         sdo_geom.sdo_intersection (m.geometry,
5                                     h.geometry,
6                                     0.000005),
7         0.000005,
8         'UNIT=MILE')) AS miles,
9     FROM mpms_projects m,
10     house_districts h
11 WHERE m.proj_id = 62823
12     AND sdo_anyinteract (h.geometry, m.geometry) = 'TRUE'
13 GROUP BY h.leg_district_no;
```

District	Miles
17	117.93
11	91.55
6	90.22
122	87.89
15	51.22
124	51.01
128	31.61
126	31.12
123	29.38
129	21.90
125	20.44
187	18.51
134	12.86
...	...



Case Study #5: Crashes in a Buffer Area

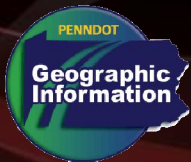
- Find all crashes occurring last year in a 1-mile buffer around route 322 from segment 120 to 240



Case Study #5: Crashes in a Buffer Area

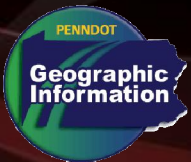
```
SQL>SELECT c.crn, c.vehicle_count
2 FROM crash_data c,
3      rmsseg r
4 WHERE r.cty_code = '36'
5      AND r.st_rt_no = '0322'
6      AND r.seg_no BETWEEN '0120' AND '0240'
7      AND c.crash_year = 2006
8      AND SDO_WITHIN_DISTANCE(
9          c.geometry,
10         r.geometry,
11         'distance=1 unit=mile') = 'TRUE';
```

CRN	VEHICLE_COUNT
2005126511	1
2005158435	2
2005130333	1
2005411484	2
2005413138	2
2005415182	1
2005149802	1
2005088618	1
2005088618	1
2005406780	1
2005193989	1
2005150547	1
...	...



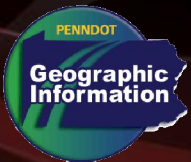
Additional Resources

- Oracle Technology Network
<http://otn.oracle.com/products/spatial/index.html>
- Discussion forum (Select Discussion Forum after clicking the link given above)
- MetaLink:
 - <http://metalink.oracle.com>
 - Registration required
 - Patch and TAR Information
- Oracle Spatial Special Interest Group
 - SIGs established around the world



Support from Oracle

- Oracle University
 - Offers fundamental and advanced training courses
 - <http://education.oracle.com>
 - Search for “Spatial”
- Oracle Contact
 - David Lapp (david.lapp@oracle.com)
Spatial Solution Specialist



Questions?

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