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Phoenix, Arizona USA

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Siva Ravada

Director of Development

LJ Qian

Senior Development Manager

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Developing Location-Enabled Applications:

Oracle Spatial Geocoding and Routing Engines

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Geocoding

- The geocoding process
- Geocoding data model
- Geocoding functions
- The SDO_GEO_ADDR structure
- Examples
- Structured Address Geocoding
- Reverse geocoding

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What is Geocoding?

- Geocoding takes a textual address as input and returns a longitude/latitude coordinate associated with the address
- Geocoding can have various levels of precision
  - House number
  - Street
  - Postal code
  - Town
- Geocoding is used in many application areas
  - Business Finders
  - Routing and directions
  - Mapping

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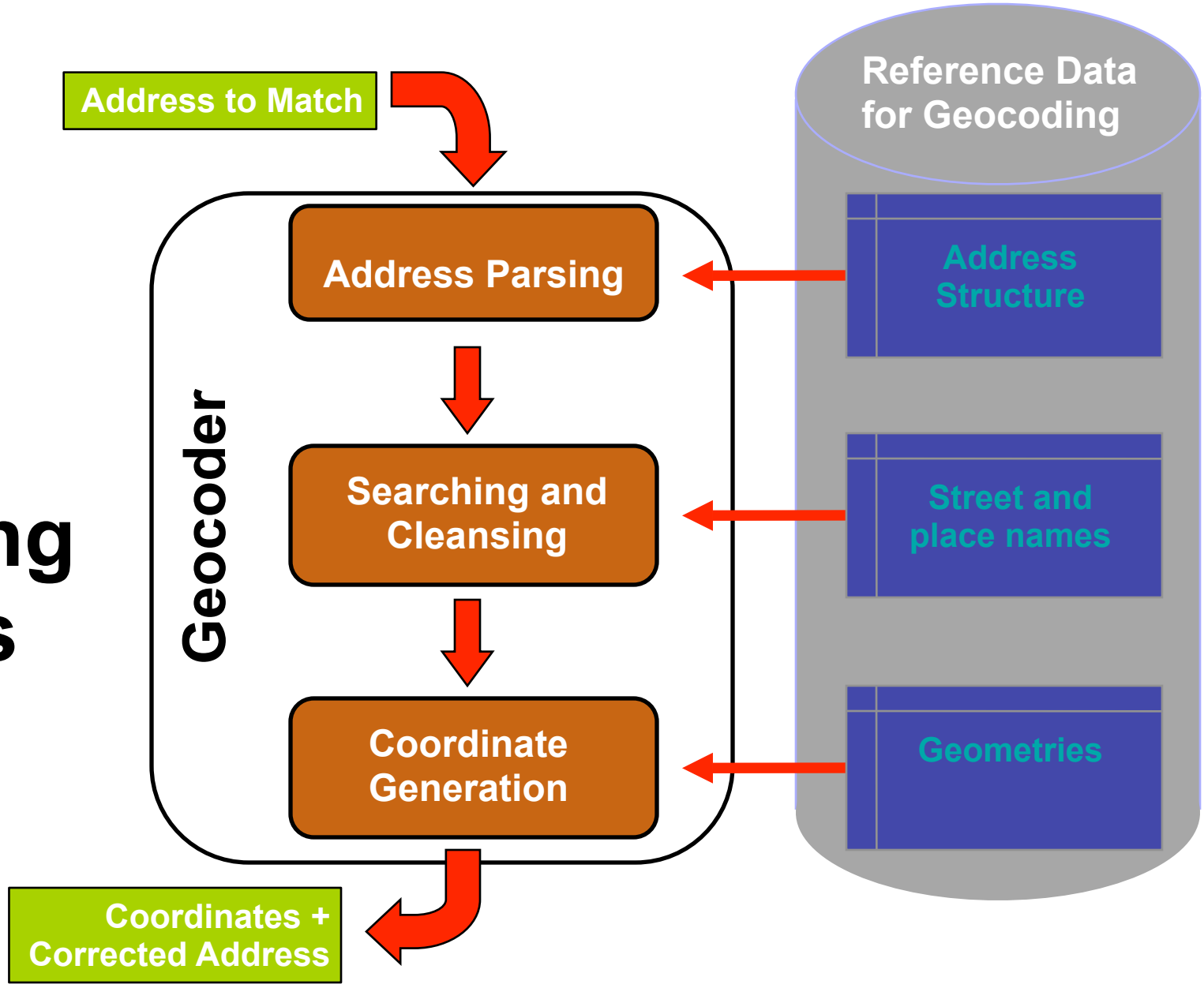
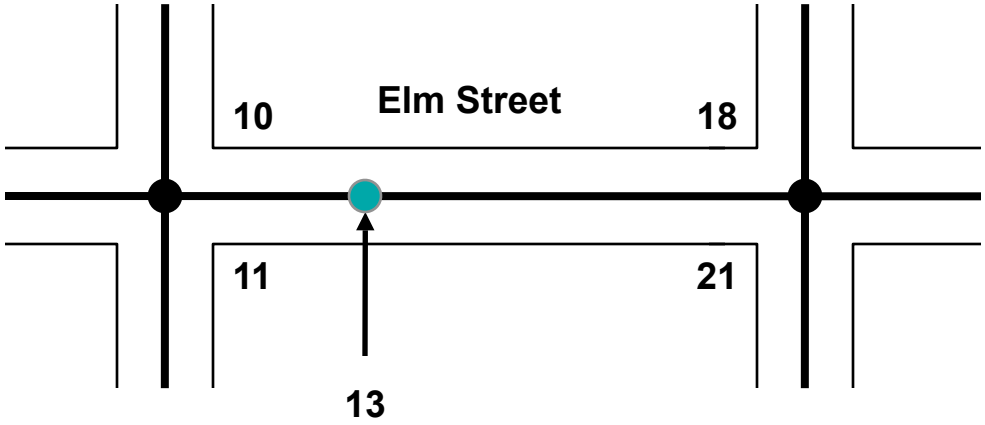
The Geocoding Process



Computing House Location

- Range Based Geocoding
  - Streets have ranges of addresses
  - Location for a given address is interpolated based on the start and end values of the range



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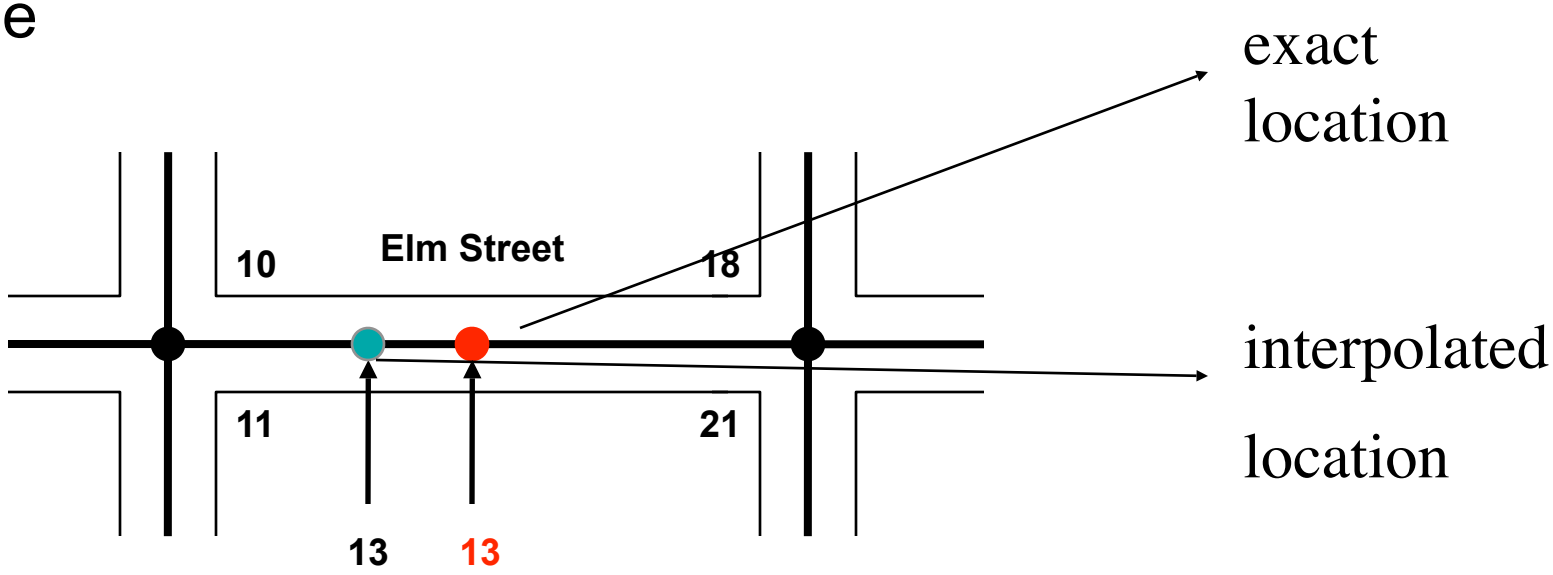
Computing House Location

- Point Address Based Geocoding
  - Streets have ranges of addresses
  - Each address may also have the exact long/lat stored
  - Location for a given address is found with an exact match or interpolated based on the start and end values of the range



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Oracle Spatial Geocoding

- Two APIs are provided
  - SQL: using PL/SQL functions
  - XML: sending XML requests to a web service
- Users must purchase data from Oracle Partners to use the Spatial geocoding functions
  - Data available from NAVTEQ
  - Other providers: format the data to meet the data model of the Geocoder
- Sample data is provided at Oracle partner sites. Links are provided from Spatial OTN web site:

  http://www.oracle.com/technology/products/spatial/htdocs/spatial_partners_data.html

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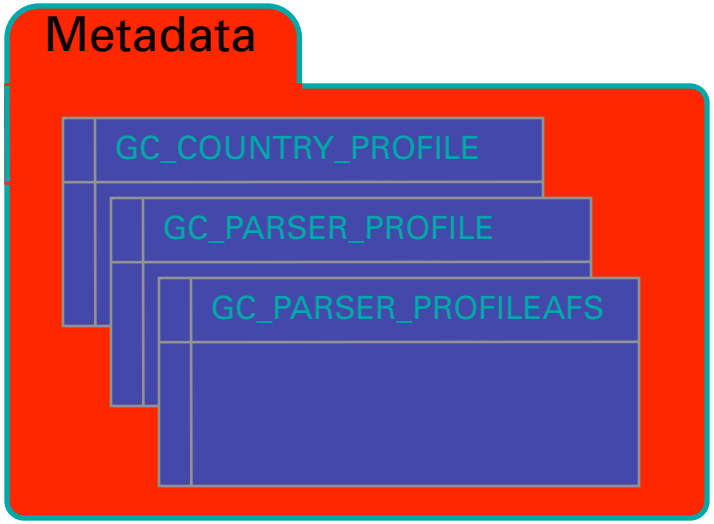
Geocoding Tables

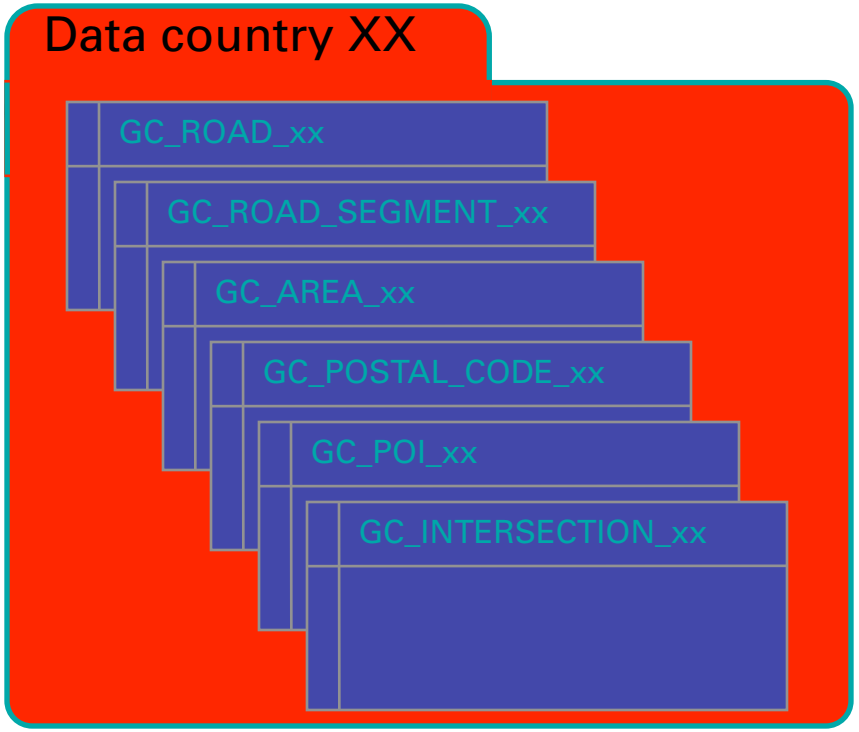
Metadata tables

- Describe the organization of the geocoding data
- Define address structure and parsing rules



Data tables

- Can have multiple sets of data
- One per country, or multiple countries per set
- Typically one set per country, with a country suffix



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Geocoding Metadata

- GC_COUNTRY_PROFILE
  - Describes the organizational structure of a country
  - Administrative levels, Languages
  - Suffix of data tables for the country
- GC_PARSER_PROFILEAFS
  - Describes the address structure in each country
  - XML notation
- GC_PARSER_PROFILES
  - Defines keywords and common abbreviations
  - Can also store common spelling mistakes

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Country Profile

- GC_COUNTRY_PROFILE table stores country profile information
  - Administrative area hierarchy definition
    - Number of admin levels
    - Optional admin levels
  - National languages for the country
  - Table-name suffix used by the data tables

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Address Format Structure

- GC_PARSER_PROFILEAFS table stores the XML definition of postal-address formats
  - An XML string describes each address format for a specific country

```
<address_line>
  <street_address>
    <house_number> …</house_number>
    <street_name>
        <prefix /> <base_name /> <suffix /> <street_type />
        <special_format> …</special_format>
    </street_name>
  </street_address>
</address_line>
```

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Parser Profiles

- GC_PARSER_PROFILES
  - Defines keywords and common abbreviations
  - Can also store common spelling mistakes
  - SDO_KEYWORDARRAY('US', 'USA', 'UNITED STATES', 'UNITED STATES OF AMERICA', 'U.S.A.', 'U.S.')
    - OUTPUT_KEYWORD: US
  - SDO_KEYWORDARRAY('AV', 'AVENUE', 'AVE', 'AVEN', 'AVENU', 'AVN', 'AVNUE', 'AV.','AVE.')
    - OUTPUT_KEYWORD: AV
  - SDO_KEYWORDARRAY('40TH', 'FORTIETH')
    - OUTPUT_KEYWORD: 40TH

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Geocoding Data

- GC_ROAD_xx
  - Street names and house numbers. Used for name searches
- GC_ROAD_SEGMENT_xx
  - Street segments with geometries and house numbers. Used for computing coordinates
- GC_AREA_xx
  - Administrative areas
- GC_POSTAL_CODE_xx
  - Postal codes
- GC_POI_xx
  - Points of interest
- GC_INTERSECTION_xx
  - US only: intersection based-searches.

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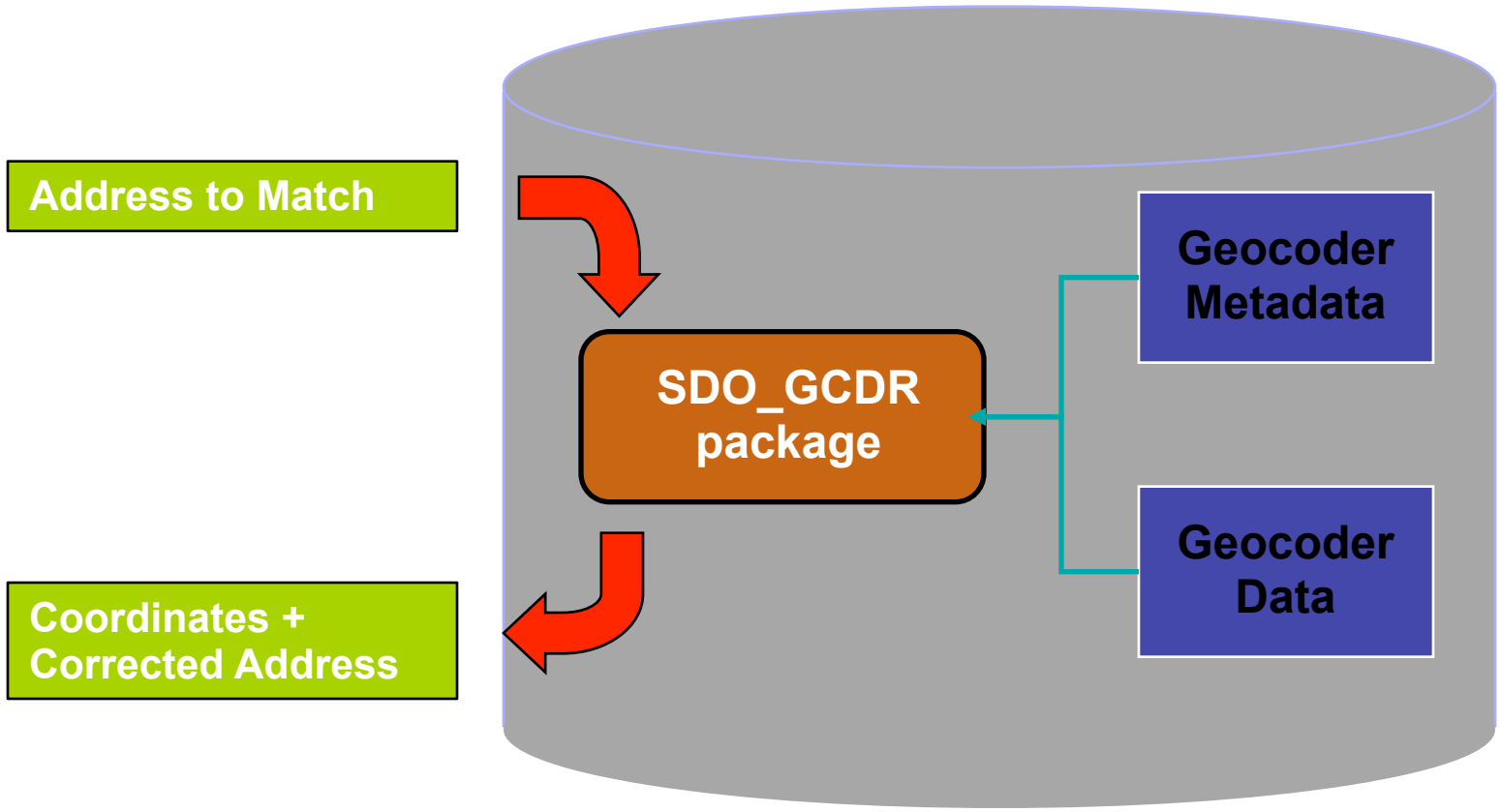
Geocoder Functions and Data



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Geocoding functions

The geocoding functions provided are:

- SDO_GCDR.GEOCODE
  - Returns an SDO_GEO_ADDR object with address and geocoding process information
- SDO_GCDR.GEOCODE_ALL
  - Returns an array of SDO_GEO_ADDR objects with address and geocoding process information
- SDO_GCDR.GEOCODE_AS_GEOMETRY
  - Returns an SDO_GEOMETRY object with the location of the geocoded address

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Street Name Structure

- Street Name has 4 basic parts
  - North Access Road East
- Base Name
  - Access
- Type
  - Road (Rd), Street (St), Avenue (Av), etc.
- Prefix
  - North (N), South (S), East (E), West (W)
- Suffix
  - North (N), South (S), East (E), West (W)

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Match mode

Match mode is how close the specified address matches the stored address

- EXACT – All attributes in address match storage
- RELAX_STREET_TYPE – Allows match if street type (Street, Road, Blvd, Ave) doesn't match
- RELAX_POI_NAME – Allows match if point-of-interest name doesn't match (Central Park = Central Pk)
- RELAX_HOUSE_NUMBER – House number and street type can be different

Match mode

- RELAX_BASE_NAME - The base name of the street, the house number, and the street type can be different from the data used for geocoding. For example, *Crosse Street* can match with *Cross Road*
- RELAX_POSTAL_CODE, DEFAULT - The postal code, base street name, house number, and street type can be different from the stored data
- RELAX_BUILTUP_AREA, RELAX_ALL – Semantics of RELAX_POSTAL_CODE, but also relaxes city or town name as long as match is in the same county

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Resulting address: SDO_GEO_ADDR

- Structure returned by functions GEOCODE() and GEOCODE_ALL()
- Contains the latitude and longitude of the address, but also:
  - Corrected and completed address details
  - Indications on the precision of the match

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Geocoding Result

LONGITUDE	Geocoded longitude
LATITUDE	Geocoded latitude
MATCHCODE	Numeric match information
ERRORMESSAGE	How address elements matched
MATCHVECTOR	How address elements matched

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Full Address Details

STREET_NAME	The full name of the street
SETTLEMENT	The city or town
REGION	The state or province
POSTALCODE	Normal postal code
POSTALADDONCODE	Postal code extension
FULLPOSTALCODE	Full postal code
HOUSENUMBER	House number: *123* in 123 Main St
BASENAME	Street base name: *Main* in 123 Main Street
STREETTYPE	St for Street, Ave for Avenue, Rd for Road, etc
STREETPREFIX	Prefix: S in 123 S Main Street
STREETSUFFIX	Suffix: NW in 123 Main Street NW
SIDE	Side of street
PERCENT	Percentage value representing how far along the street you are when going from lower to higher street addresses
EDGEID	Optional edge information if topological

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Matchcode: how did we match the input

1	Exact match: the city name, postal code, street name, street type (and suffix or prefix or both, if applicable), and house number match
2	The city name, postal code, street name, and house number match, but the street type, suffix, or prefix does not match
3	The city name, postal code, and street base name match, but the house number does not match
4	The city name and postal code match, but the street name does not match
10	The city name matches, but the postal code does not match
11	The postal code matches the data used for geocoding, but the city name does not match

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Errormessage: How precise is the match

- String of 17 characters.
- Each character corresponds to one address element.
- Each character indicates whether we matched on this address element.
- '?' indicates no match on that element
- Some positions not used

Errormessage

Position	Meaning	Value When Matched
5	House or building number	#
6	Street prefix	E
7	Street base name	N
8	Street suffix	U
9	Street type	T
10	Secondary unit	S
11	Built-up area or city	B
14	Region	1
15	Country	C
16	Postal code	P
17	Postal add-on code	A

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Matchvector

- Also a string of 17 characters.
- Each position corresponds to one address element – just like ERRORMESSAGE
- Each position can have 4 values

Value	Meaning	
0	MATCHED	Address element specified and matched
1	ABSENT	Element not specified and not replaced
2	CORRECTED	Element specified but not matched, and was replaced with the correct value
3	IGNORED	Element specified, not matched and not replaced
4	SUPPLIED	Element missing, filled from the database.

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D E M O N S T R A T I O N

Demonstration Title Here

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Example: Street Level Match

```
SELECT SDO_GCDR.GEOCODE('SPATIAL',
  SDO_KEYWORDARRAY('Clay Street', 'San Francisco, CA'),
  'US', 'DEFAULT') GEO_ADDR
FROM DUAL;
```

```
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(NULL), NULL, 'CLAY ST', NULL, NULL,
'SAN FRANCISCO', NULL, 'CA', 'US', '94109', NULL, '94109', NULL,
'1698', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600689, '????
#ENUT?B281CP?', 1, 'DEFAULT', -122.42093, 37.79236, '????4101010??
004?'))
```

MATCHCODE 1 = exact match with provided input

Match on the center house number of Clay St

Postal code filled in, street address corrected

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Example: House Level Match

```
SELECT SDO_GCDR.GEOCODE('SPATIAL',
  SDO_KEYWORDARRAY('1350 Clay', 'San Francisco, CA'),
  'US', 'DEFAULT') GEO_ADDR
FROM DUAL;
```

```
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(NULL), NULL, 'CLAY ST', NULL, NULL,
'SAN FRANCISCO', NULL, 'CA', 'US', '94109', NULL, '94109', NULL,
'1350', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', .49, 23600696,
'????#ENU??B281CP?', 2, 'DEFAULT', -122.41522, 37.7930729, '????
0101410??004?')
```

MATCHCODE 2 = street type not matched

Match on the exact house number of Clay St

Postal code filled in, street address completed

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Example: Address Correction

```
SELECT SDO_GCDR.GEOCODE('SPATIAL',
  SDO_KEYWORDARRAY('1350 Clay Avenue', 'San Francisco, 94119 CA'),
  'US', 'DEFAULT') GEO_ADDR
FROM DUAL;
```

```
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(NULL), NULL, 'CLAY ST', NULL,
NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94109', NULL, '94109',
NULL, '1350', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', .49,
23600696, '????#ENU??B281C??', 10, 'DEFAULT', -122.41522,
37.7930729, '????0101210??002?')
```

MATCHCODE 10 = postal code not matched

Match on the exact house number of Clay St

Postal code and street name corrected

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Example: Address Spelling Correction

```
SELECT SDO_GCDR.GEOCODE('SPATIAL',
  SDO_KEYWORDARRAY('100 VAN NOUSS', 'San Francisco, CA'),
  'US', 'DEFAULT') GEO_ADDR
FROM DUAL;
```

```
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(NULL), NULL, 'VAN NESS AVE', NULL,
NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94102', NULL, '94102',
NULL, '100', 'VAN NESS', 'AVE', 'F', 'F', NULL, NULL, 'R', .01,
23619765, '????#E?UT?B281CP?', 4, 'DEFAULT', -122.41942,
37.7763488,
          '????012141O??004?')
```

MATCHCODE 4 = street address not matched

Fuzzy match on street name

Postal code inserted and street name corrected

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Multiple matches
The *geocode_all()* function

```
SELECT SDO_GCDR.GEOCODE_ALL('SPATIAL',
  SDO_KEYWORDARRAY('Clay Street', 'San Francisco, CA'),
  'US', 'DEFAULT') GEO_ADDR
FROM DUAL;
```

```
SDO_ADDR_ARRAY (
 SDO_GEO_ADDR(1, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', NULL, NULL,
  'SAN FRANCISCO', NULL, 'CA', 'US', '94109', NULL, '94109', NULL, '1698',
  'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600700, '????#ENUT?B281CP?',
  1, 'DEFAULT', -122.42093, 37.79236, '????4101010??004?'),
 SDO_GEO_ADDR(1, SDO_KEYWORDARRAY(), NULL, 'CLAY ST', NULL, NULL,
  'SAN FRANCISCO', NULL, 'CA', 'US', '94108', NULL, '94108', NULL, '978',
  'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', 0, 23600689, '????#ENUT?B281CP?',
  1, 'DEFAULT', -122.40904, 37.79385, '????4101010??004?'),
...
)
```

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Simple interface: the *geocode_as_geometry()*

```
SELECT SDO_GCDR.GEOCODE_AS_GEOMETRY('SPATIAL',
  SDO_KEYWORDARRAY('1350 Clay', 'San Francisco, CA'), 'US')
FROM DUAL;
```

```
SDO_GEOMETRY(2001, 8307, SDO_POINT_TYPE(-122.41522, 37.7930729,
NULL), NULL, NULL)
```

No match_mode parameter: always DEFAULT mode
No matchcode returned

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Using Structured Input

Pass individual address fields in a structured way

- SDO_GCDR.GEOCODE_ADDR
  - Like GEOCODE, but takes an SDO_GEO_ADDR object as input
- SDO_GCDR.GEOCODE_ADDR_ALL
  - Like GEOCODE_ALL, but takes an SDO_GEO_ADDR object as input

- Useful when input data is already structured
  - Avoids unnecessary address parsing and parsing errors

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Structured Geocoding functions

```
SDO_GEO_ADDR = SDO_GCDR.GEOCODE_ADDR (
    <USER_NAME>, <SDO_GEO_ADDR>)
```

```
SDO_GEO_ADDR_ARRAY = SDO_GCDR.GEOCODE_ADDR_ALL (
    <USER_NAME>, <SDO_GEO_ADDR>)
```

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Structured Geocoding Example

```
SELECT SDO_GCDR.GEOCODE_ADDR('SPATIAL',
  SDO_GEO_ADDR (
    'US',                  -- COUNTRY
    'DEFAULT',             -- MATCHMODE
    '1200 Clay Street',    -- STREET
    'San Francisco',       -- SETTLEMENT
    NULL,                  -- MUNICIPALITY
    'CA',                  -- REGION
    '94108'                -- POSTALCODE
  )
)
FROM DUAL;
```

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Point Address Geocoding

- Point Addressing data has an exact long/lat for each address
  - This is different from the range based addressing where each road segment has an address range
- Support for this feature requires a new data table in addition to the current set of Geocoder tables
- New table: GC_ADDRESS_POINT_NVT
- No interface change required, if this table exists we use it to refine the result using the exact long/lat provided in the table

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Point Address Geocoding Data

- Customers can buy this new data set from NAVTEQ
- NAVTEQ Point Addressing data product
- This is in addition to the NAVTEQ Geocoding data in Oracle Data Format (ODF)

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Example: Point Address

```
SELECT SDO_GCDR.GEOCODE('SPATIAL',
  SDO_KEYWORDARRAY('1000 Howard st', 'San Francisco, CA'),
  'US', 'DEFAULT') GEO_ADDR
FROM DUAL;
```

```
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(), NULL, 'HOWARD ST', NULL, NULL,
'SAN FRANCISCO', 'SAN FRANCISCO', 'CA', 'US', '94103', NULL,
'94103', NULL, '1000', 'HOWARD', 'ST', 'F', 'F', NULL, NULL, 'L', .
48, 199088340, '??X?#ENUT?B281CP?', 1, 'DEFAULT', -122.40742,
37.77953, '??010101010??004?')
```

MATCHCODE 1 = exact match

Match on the exact house number of Clay St

Postal code filled in, street address completed

Point address match found

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Reverse Geocoding

- This is the opposite of geocoding
- Given a point location, determine the street address
  - Find the nearest road segment
  - Project the point location on the road segment
  - Compute house number by interpolation
  - Fill in address details: street name, postal code, city name, etc.

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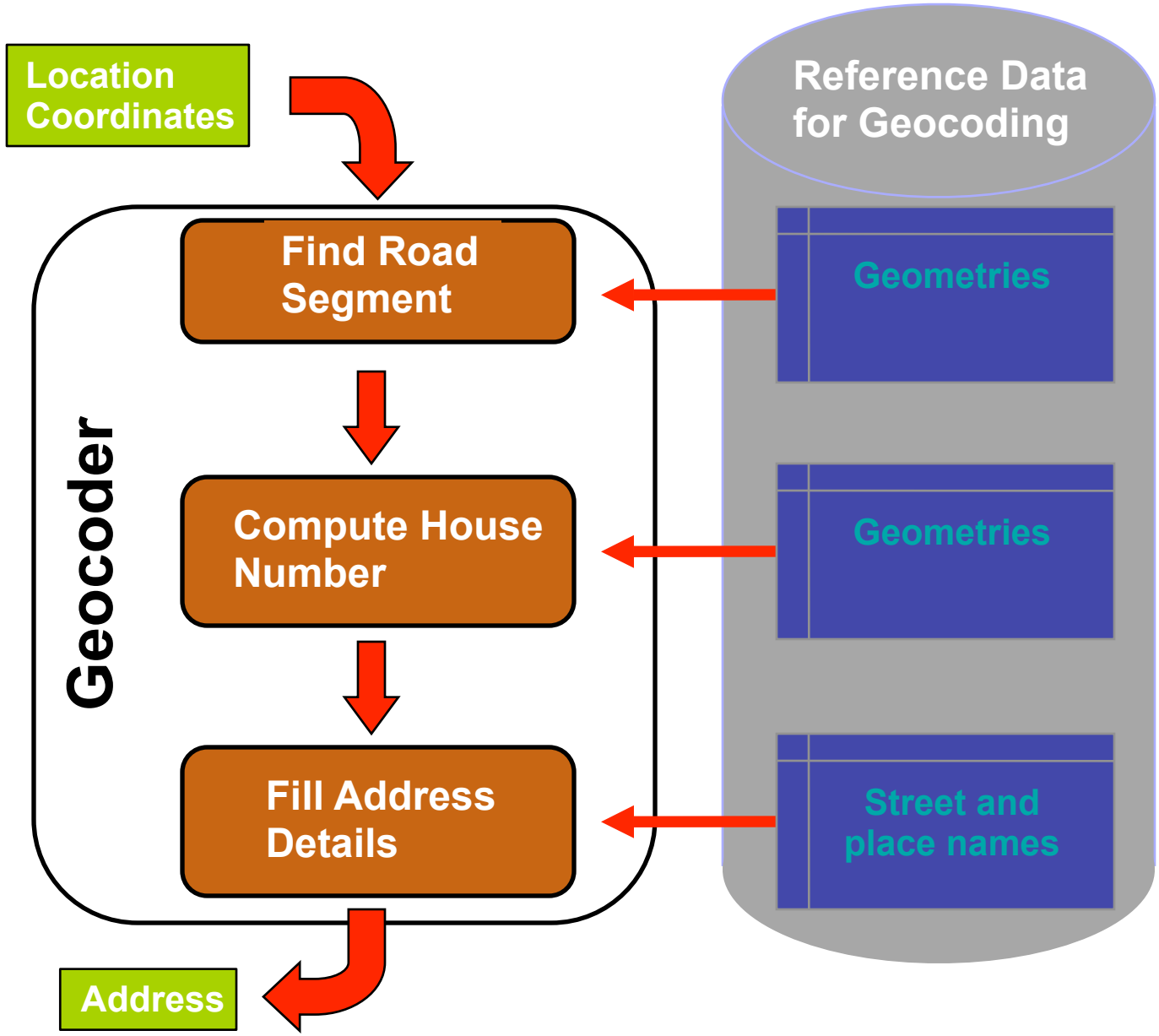
Reverse Geocoding Process



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Reverse Geocoding Example

```
SELECT SDO_GCDR.REVERSE_GEOCODE ('SPATIAL',
  SDO_GEOMETRY(2001, 8307,
    SDO_POINT_TYPE(-122.41522, 37.7930729, NULL), NULL, NULL),
   'US')
FROM DUAL;
```

```
SDO_GEO_ADDR(0, SDO_KEYWORDARRAY(NULL), NULL, 'CLAY ST', NULL,
NULL, 'SAN FRANCISCO', NULL, 'CA', 'US', '94109', NULL, '94109',
NULL, '1350', 'CLAY', 'ST', 'F', 'F', NULL, NULL, 'L', .48798407,
23600696, '', 1, 'DEFAULT', -122.41521956, 37.7930724356)
```

- Note that the coordinates returned are on the road segment
- Can be different from the input coordinates

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What if you do not like objects?

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- Use a sub-query to extract results from SDO_GEO_ADDR

```
SELECT G.GC.STREETNAME, G.GC.HOUSENUMBER, G.GC.POSTALCODE,
       G.GC.SETTLEMENT
FROM (
SELECT SDO_GCDR.GEOCODE ('SCOTT',
  SDO_GEOMETRY(2001, 8307,
    SDO_POINT_TYPE(-122.41522, 37.7930729, NULL), NULL, NULL),
   'US') GC
FROM DUAL) G;
```

```
GC.STREETNAME          GC.H GC.PO GC.SETTLEMENT
---------------------- ---- ----- ------------------
CLAY ST                1350 94109 SAN FRANCISCO
```

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What if you do not like objects?

- Can also use the WITH clause

```
WITH GC_RESULT AS (
SELECT SDO_GCDR.REVERSE_GEOCODE ('SPATIAL',
  SDO_GEOMETRY(2001, 8307,
    SDO_POINT_TYPE(-122.41522, 37.7930729, NULL), NULL, NULL),
   'US') GC
FROM DUAL )
SELECT G.GC.STREETNAME, G.GC.HOUSENUMBER, G.GC.POSTALCODE,
       G.GC.SETTLEMENT
FROM GC_RESULT G;
```

```
GC.STREETNAME          GC.H GC.PO GC.SETTLEMENT
---------------------- ---- ----- --------------------
CLAY ST                1350 94109 SAN FRANCISCO
```

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What if you do not like objects?

- Use the TABLE() notation with a GEOCODE_ALL call

```
SELECT STREETNAME, HOUSENUMBER, SETTLEMENT, LONGITUDE, LATITUDE
FROM TABLE (SDO_GCDR.GEOCODE_ALL('SPATIAL',
  SDO_KEYWORDARRAY('1350 Clay', 'San Francisco, CA'),
  'US', 'DEFAULT')
);
```

```
STREETNAME           HOUS SETTLEMENT              LONGITUDE
LATITUDE
-------------------- ---- -------------------- ----------
----------
CLAY ST              1350 SAN FRANCISCO        -122.41522
37.7930729
CLAYTON ST           1350 SAN FRANCISCO        -122.44639
37.7593208
```

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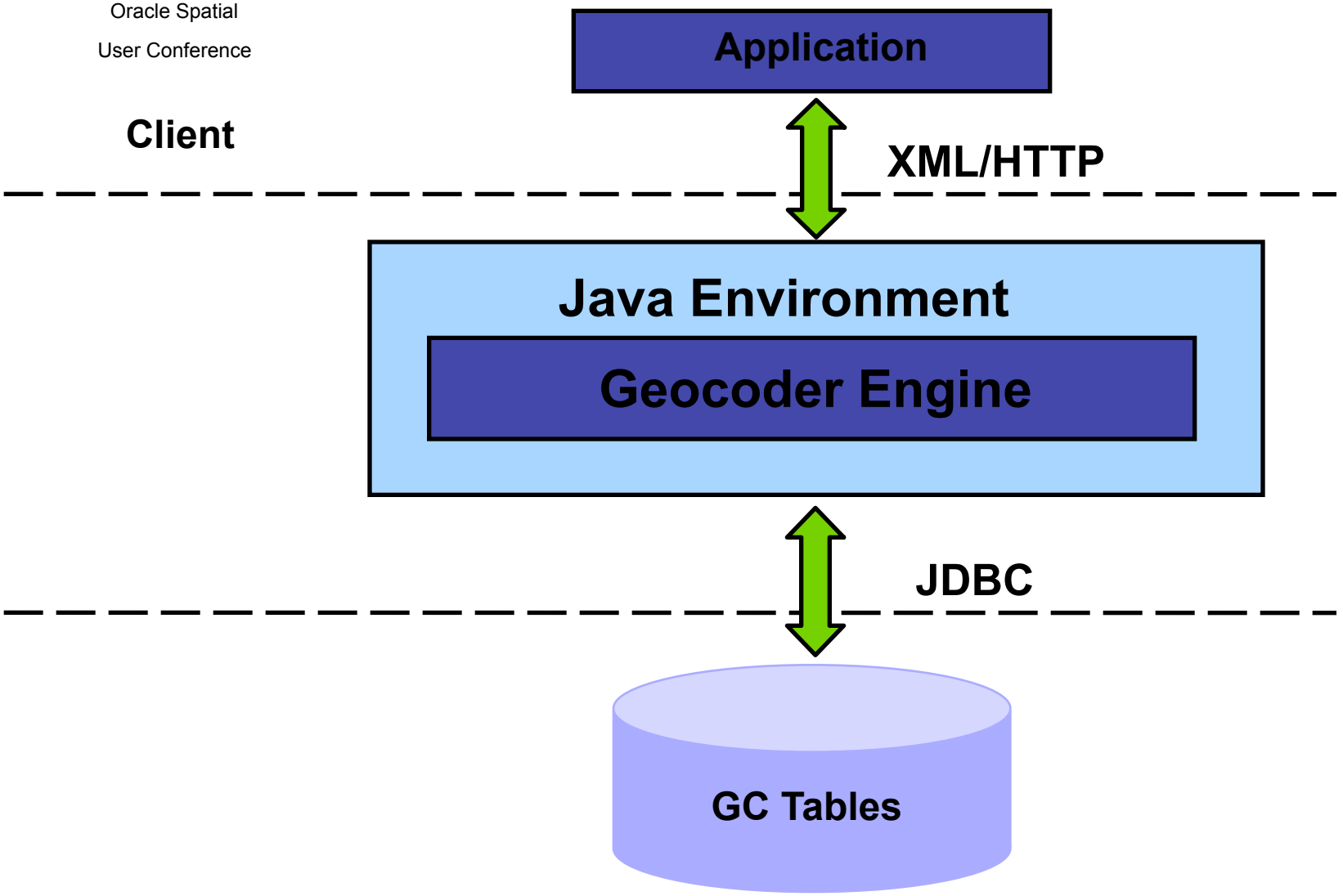
Geocoding Web Service



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Installing and configuring the geocoding web service

- Deploy GEOCODER.EAR using the application server console
  - File is in $ORACLE_HOME/md/jlib
  - The geocoder startup fails because the default configuration points to an inaccessible database
- Update geocoder configuration
  - Using geocoder console: http://<server>/geocoder/admin.jsp
  - Or manually update file $J2EE_HOME/applications/geocoder/web/WEB-INF/config/geocodercfg.xml
  - Set proper database connection to database user that owns the geocoding tables

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Using the Geocoding Web Service

Request:

```
<?xml version="1.0" standalone="yes"?>
<geocode_request>
  <address_list>
    <input_location id="1">
      <input_address match_mode="default">
        <unformatted country="FR" >
          <address_line value="13 rue Royale" />
          <address_line value="Paris" />
        </unformatted >
      </input_address>
    </input_location>
  </address_list>
</geocode_request>
```

Response:

```
<geocode_response>
  <geocode id="1" match_count="1">
    <match sequence="0" longitude="2.322855" latitude="48.867909999999995"
     match_code="1" error_message="????#ENUT?B281CP?" match_vector="????0101010??404?">
     <output_address name="" house_number="13" street="RUE ROYALE" builtup_area="PARIS"
      order1_area="ÎLE-DE-FRANCE" order8_area="" country="FR" postal_code="75008"
      postal_addon_code="" side="L" percent="0.75" edge_id="228533511"/>
    </match>
  </geocode>
</geocode_response>
```

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Using a Structured Input Address

Request:

```
<?xml version="1.0" standalone="yes"?>
<geocode_request>
  <address_list>
    <input_location id="1">
      <input_address match_mode="default">
        <gen_form country="FR"
          street="13 rue Royale"
          city="Paris"
          postal_code="75008"
        />
      </input_address>
    </input_location>
  </address_list>
</geocode_request>
```

Response:

```
<geocode_response>
  <geocode id="1" match_count="1">
    <match sequence="0" longitude="2.322855" latitude="48.867909999999995"
     match_code="1" error_message="????#ENUT?B281CP?" match_vector="????0101010??404?">
     <output_address name="" house_number="13" street="RUE ROYALE" builtup_area="PARIS"
      order1_area="ÎLE-DE-FRANCE" order8_area="" country="FR" postal_code="75008"
      postal_addon_code="" side="L" percent="0.75" edge_id="228533511"/>
    </match>
  </geocode>
</geocode_response>
```

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Reverse Geocoding

Request:

```
<?xml version="1.0" standalone="yes"?>
<geocode_request vendor="elocation">
  <address_list>
    <input_location id="1"
      country="FR"
      longitude="2.322855"
      latitude="48.867909999999995">
    </input_location>
  </address_list>
</geocode_request>
```

Response:

```
<geocode_response>
  <geocode id="1" match_count="1">
    <match sequence="0" longitude="2.3228550000005823" latitude="48.867909999999576"
     match_code="1" error_message="" match_vector="????4141414??404?">
     <output_address name="" house_number="13" street="RUE ROYALE" builtup_area="PARIS"
      order1_area="ÎLE-DE-FRANCE" order8_area="" country="FR" postal_code="75008"
      postal_addon_code="" side="L" percent="0.7499999999984763" edge_id="228533511"/>
    </match>
  </geocode>
</geocode_response>
```

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Reverse geocoding with projected point

Request:

```
<?xml version="1.0" standalone="yes"?>
<geocode_request vendor="elocation">
  <address_list>
    <input_location id="1"
      country="FR"
       x="598997.994"
       y="2429954.32"
       srid="41014">
    </input_location>
  </address_list>
</geocode_request>
```

Response:

```
<geocode_response>
  <geocode id="1" match_count="1">
    <match sequence="0" longitude="2.32315" latitude="48.86832"
     match_code="1" error_message="" match_vector="????4141414??404?">
     <output_address name="" house_number="17" street="RUE ROYALE" builtup_area="PARIS"
      order1_area="ÎLE-DE-FRANCE" order8_area="" country="FR" postal_code="75008"
      postal_addon_code="" side="L" percent="1.0" edge_id="228533511"/>
    </match>
  </geocode>
</geocode_response>
```

Clay St, San Francisco

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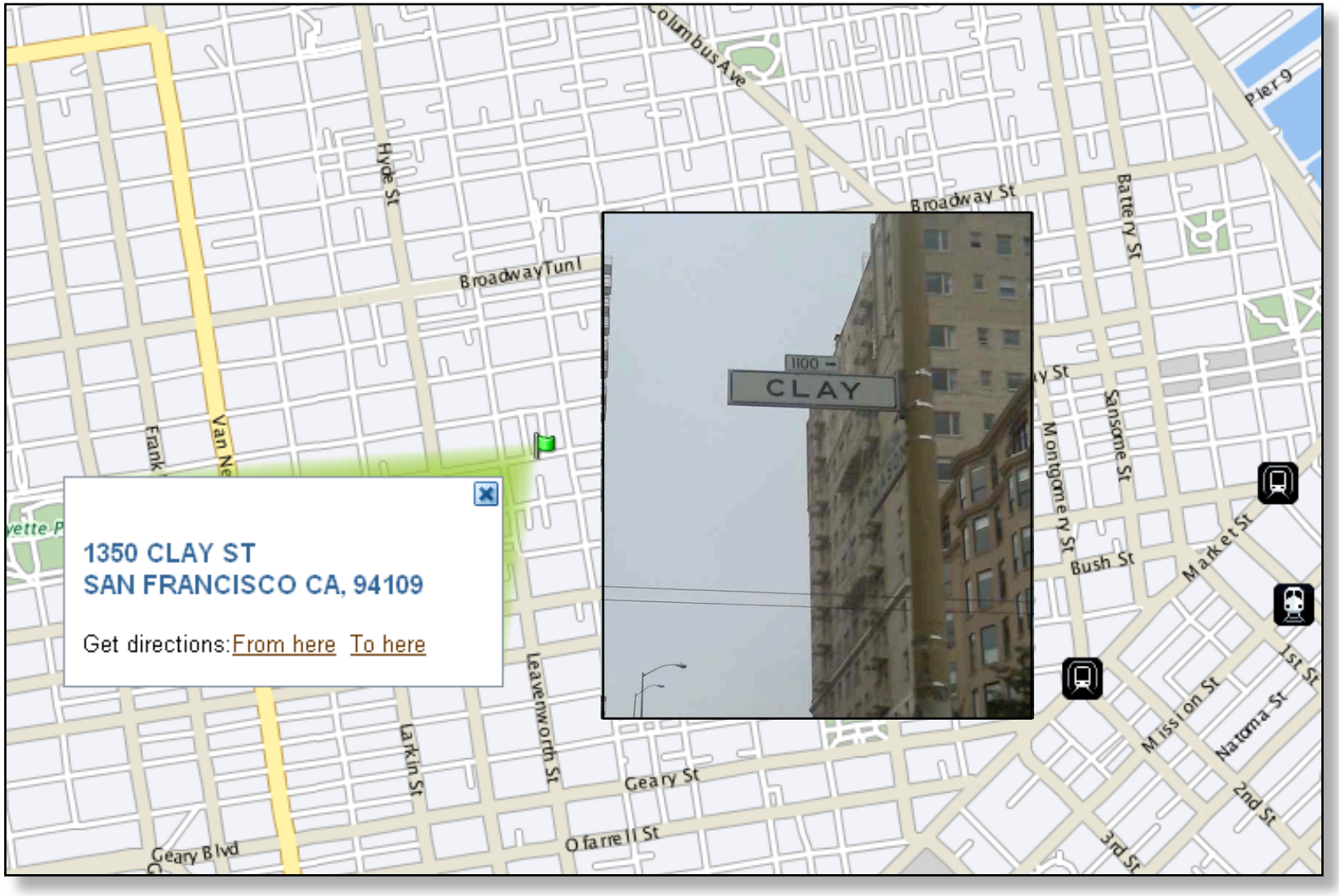

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Routing Engine

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Routing Server

- Architecture
- Routing tables
- Partitioning the network
- Installation and configuration
- How to formulate route requests
- Structure of the route responses

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The Oracle Spatial Routing Engine

- The Oracle Spatial Routing Engine is an XML-based Web service.
- Provides driving directions between two locations
  - Directions, estimated distance and drive time, geometry, …
- Requires a suitable road network as well as geocoding data
- Users must purchase data from Oracle Partners to use the Spatial routing and geocoding functions
  - Data available from NAVTEQ
  - Other providers: format the data to meet the data model of the router
- Sample data is provided at Oracle partner sites. Links are provided from Spatial OTN web site:

  http://www.oracle.com/technology/products/spatial/htdocs/spatial_partners_data.html

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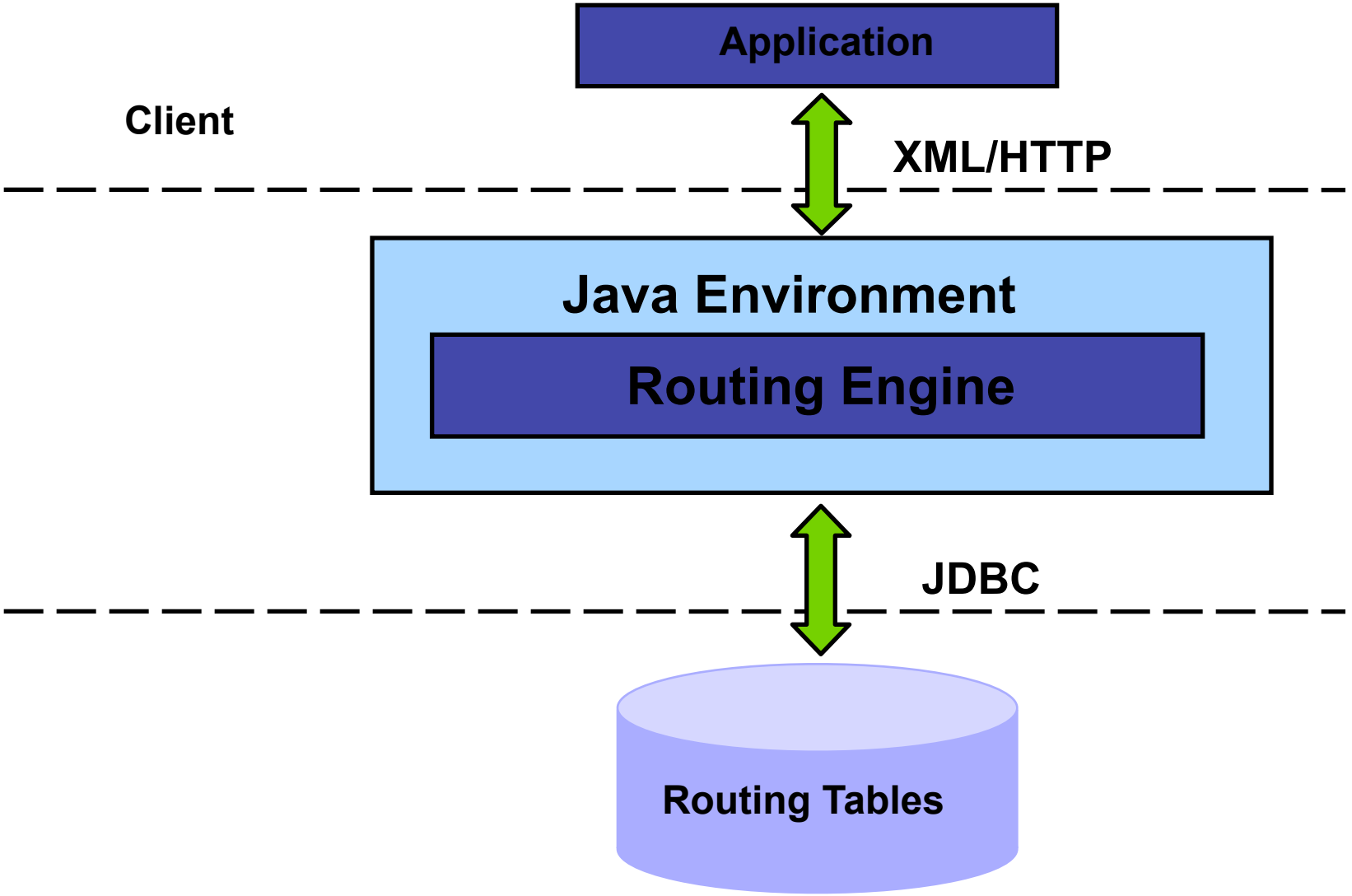
Routing Web Service Architecture



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Routing Tables

- EDGE table
  - Describes all road segments in the network
  - Each segment has a unique identifier
- NODE table
  - Describes all road intersections
- SIGN_POST table
  - Optional
  - Relates edges at intersections
  - Used for signposts at highway exits
- PARTITION table
  - One row per network partition

Installation and configuration

- Deploy ROUTESERVER.EAR using the application server console
  - The router startup fails because the default configuration points to an inaccessible database
- Update router configuration
  - Manually update file $J2EE_HOME/applications/routeserver/web/WEB-INF/web.xml
  - Set connection to user for routing tables
  - Choose type of geocoder to use and configure it
    - Database or web service
  - Set default language, default driving side, etc.
- Restart OC4J container!

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Router Configuration

- **Type of geocoder to use**
  - geocoder_type (“thinclient”,“httpclient” or “none”)
  - geocoder_match_mode
- **Database connection for geocoding tables (“thinclient” geocoder)**
  - geocoder_schema_host
  - geocoder_schema_port
  - geocoder_schema_sid
  - geocoder_schema_username
  - geocoder_schema_password
- **URL to geocoding service (“httpclient” geocoder)**
  - geocoder_http_url
  - geocoder_http_proxy_host

Router Configuration

- **General parameters**
  - local_road_threshold
  - highway_cost_multiplier
  - max_speed_limit
  - driving_side
  - language
  - distance_function_type

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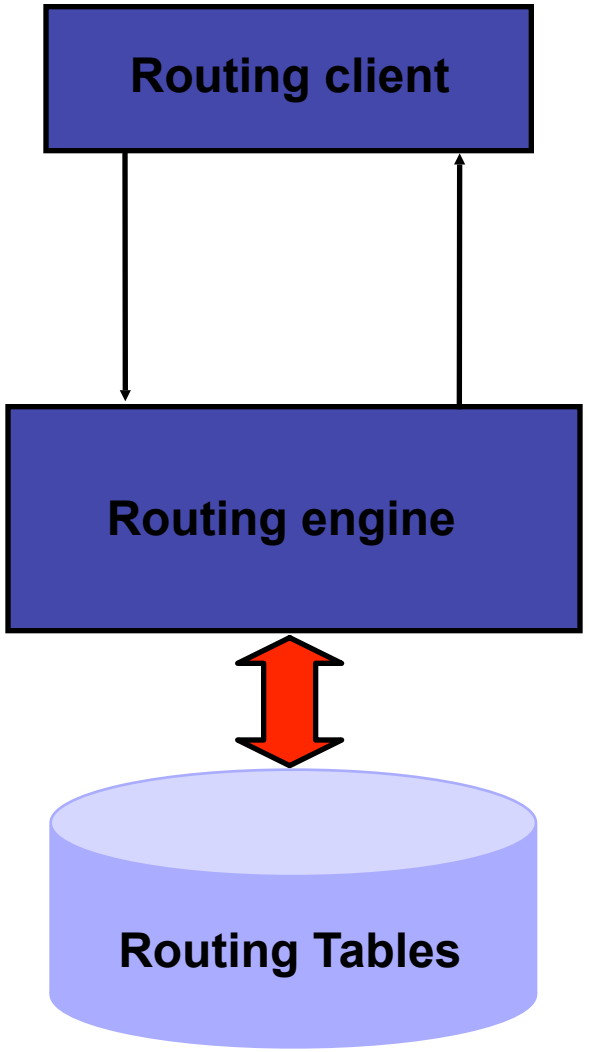
Routing Query

- A route request consists of:
  - Preferences
  - Start location
  - End location
- A batch route request consists of:
  - Preferences
  - Start location
  - End locations



- A route response consists of:
  - Route information
  - Optional Geometry
  - Segment information (for each segment of the route)
- A batch route response consists of:
  - Route information (for each route)

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XML Input for a Route Request

- Start location is an unformatted address
- End location is a formatted US address

```
<?xml version="1.0" standalone="yes"?>
<route_request id="1" route_preference="shortest"
  return_driving_directions="true"
  distance_unit="mile" time_unit="minute"
  return_route_geometry="true">
  <start_location>
    <input_location id="1" >
      <input_address>
        <unformatted country="US" >
          <address_line value="747 Howard Street" />
          <address_line value="San Francisco, CA" />
        </unformatted >
      </input_address>
    </input_location>
  </start_location>
  <end_location>
    <input_location id="2" >
      <input_address>
        <us_form2 street="1300 Columbus"
          city="San Francisco" state="CA"/>
      </input_address>
    </input_location>
  </end_location>
</route_request>
```

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A Route Request

An XML request for a single route includes:

- A numeric route ID
- One start and one end location
- Optionally, one or more attributes:
  - Route preference: fastest or shortest
  - Road preference: highway or local
  - Whether to return the geometry of the route
  - Time and distance units
  - Language for driving directions

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Route Request Attributes

Attribute	Possible Values
route_preference	FASTEST SHORTEST
road_preference	HIGHWAY LOCAL
return_driving_directions	TRUE or FALSE
driving_directions_detail	LOW MEDIUM HIGH
return_hierarchical_driving_directions	TRUE or FALSE
return_route_geometry	TRUE or FALSE
return_segment_geometry	TRUE or FALSE
return_detailed_geometry	TRUE or FALSE
return_route_edge_ids	TRUE or FALSE
return_segment_edge_ids	TRUE or FALSE
language	ENGLISH FRENCH GERMAN ITALIAN SPANISH
distance_unit	KM MILE METER
time_unit	HOUR MINUTE SECOND

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XML Response to a Route Request

```
<?xml version="1.0" ?>
<route_response>
  <route
    id="8"
    step_count="14"
    distance="30.28667355371901"
    distance_unit="mile"
    time="35.02037760416667"
    time_unit="minute">
    <segment
      sequence="1"
      instruction="Start out on WINTER ST (Going South)"
      distance="1.2041612436793172"/>
    <segment
      sequence="2"
      instruction="Stay STRAIGHT to go onto TOTTEN POND RD (Going East)"
      distance="0.08879983757738225"/>
    . . . . .
    <segment
      sequence="14"
      instruction="Turn LEFT onto WYMAN ST (Going North)"
      distance="0.24681569656886923"/>
  </route>
</route_response>
```

Origin and destination

- The previous route request used addresses for the start and end locations.
- Can also specify a pre-geocoded location
  - Link id, side, relative position (0.0 to 1.0)
- Can also specify spatial coordinates
  - This is useful for Telematics and other applications.
- From a location specified by coordinates, what is the route to a particular address?
- Given a current location, what is the route to a location specified by coordinates?

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Using Geographical Locations

```
<?xml version="1.0" standalone="yes"?>
<route_request id="1" route_preference="fastest"
  return_driving_directions="true"
  distance_unit="mile" time_unit="minute">
  <start_location>
    <input_location id="1"
      longitude="-122.4014128" latitude="37.7841193" />
  </start_location>
  <end_location>
    <input_location id="2" >
      <input_address>
        <unformatted country="US" >
          <address_line value="1300 Columbus" />
          <address_line value="San Francisco, CA" />
        </unformatted >
      </input_address>
    </input_location>
  </end_location>
</route_request>
```

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A Batch Route Request: *Multiple destinations*

An XML request for a batch route includes:

- A numeric route ID
- One start and one or more end locations
- Optionally, one or more of the following attributes:
  - route_preference: Fastest (default) or shortest
  - road_preference: Highway (default) or local
  - distance_unit: Kilometer, mile (default), meter
  - time_unit: Hour, minute (default), second
  - sort_by_distance: Sorts the returned information in ascending order by distance (FALSE by default)
  - cutoff_distance: Returns information only if the distance is less than or equal to a specified distance (no limit by default)

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XML Input for a Batch Route Request

```
<?xml version="1.0" standalone="yes"?>
<batch_route_request
  id="8"
  route_preference="fastest"
  road_preference="highway"
  return_driving_directions="false"
  sort_by_distance = "true"
  cutoff_distance="35"
  distance_unit="mile"
  time_unit="minute">
  <start_location>
    <input_location id="1">
      <input_address>
        <us_form1
          street="1000 Winter St"
          lastline="Waltham, MA" />
      </input_address>
    </input_location>
  </start_location>
  <end_location>
    <input_location id="10">
      <input_address>
        <us_form1
          street="1 Oracle Dr"
          lastline="Nashua, NH" />
      </input_address>
    </input_location>
  </end_location>
  . . . .
  <end_location>
    <input_location id="11">
      <input_address>
        <us_form1
          street="22 Monument Sq"
          lastline="Concord, MA" />
      </input_address>
    </input_location>
  </end_location>
</batch_route_request>
```

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XML from a Batch Route Request

```
<?xml version="1.0" standalone="yes" ?>
<batch_route_response id="8">
  <route id="11"
    step_count="0"
    distance="9.132561517429938"
    distance_unit="mile"
    time="12.4705078125"
    time_unit="minute" />
  <route id="12"
    step_count="0"
    distance="17.74747391140558"
    distance_unit="mile"
    time="20.413236490885417"
    time_unit="minute" />
  <route id="10"
    step_count="0"
    distance="30.28667355371901"
    distance_unit="mile"
    time="35.02037760416667"
    time_unit="minute" />
</batch_route_response>
```

- One <route> element per destination
- Includes distance and time
- Destinations ordered by distance

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Routing Engine

- Routing Application is now built on top of NDM LOD engine
- Routing Engine uses all the extensibility of the underlying NDM engine
- Truck routing is an example of customizing the routing engine specific to an application based on user data

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Truck Routing

- <?xml version="1.0" standalone="yes"?> <route_request id="8" route_preference="shortest" road_preference="highway" vehicle_type="truck" return_driving_directions="true" distance_unit="mile" time_unit="hour" return_route_geometry="false" >
- Route Request vehicle_type
  - (auto|truck) optional, defaults to auto
- Route Request truck_type
  - truck_type: (delivery|public|trailer) optional, no default

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Truck Routing

- truck_height: (positive float) optional, no default
- truck_length: (positive float) optional, no default
- truck_per_axle_weight: (positive float) optional, no default
- truck_weight: (positive float) optional, no default
- truck_width: (positive float) optional, no default
- length_unit: (metric|us) optional, default US
- weight_unit: (metric|us) optional, default US
- Truck height, length and width are specified in length_unit units
- Truck per axle weight and weight and specified in weight_unit units

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Truck Routing Data

- Table definition for trucking data table
- This table contains data from the NVT_TRANSPORT table from NAVTEQ
  - NAVTEQ Transport Product
- Trucking User Data table

```
ROUTER_TRUCK_DATA (
 edge_id NUMBER,
 maintype NUMBER(2),
 subtype NUMBER(2),
 value NUMBER(2));
```

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DEMONSTRATION

Demonstration Title Here

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Javascript APIs for Geocoder and Routing Engine

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Using the new eLocation GeoCoding & Routing APIs

- A new JavaScript class: **OracleELocation**
- Two methods:
  - for geocoding: **geocode**(address, callBack, errHandler)
  - for routing/directions: **getDirections**(…)

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How to import the new API scripts

In your HTML page, import the API scripts from elocation.oracle.com:

```
<script src="http://elocation.oracle.com/elocation/jslib/oracleelocation.js"
        type="text/javascript">
</script>
```

You must also import the MapViewer JS API :

```
<script src="http://elocation.oracle.com/mapviewer/fsmc/jslib/oraclemaps.js" type="text/javascript">
</script>
```

You are now ready to make use of the new OracleELocation class.

The online API documentation can be found here:

http://elocation.oracle.com/elocation/ajax/apidoc/symbols/OracleELocation.html

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Construct a new OracleELocation instance

After importing the class scripts, you will create a new OracleELocation instance.

```
<script type="text/javascript">
  var eloc;
   …


    function init()
     {
          eloc = new OracleELocation("http://elocation.oracle.com/elocation") ;
      }
```

The constructor of OracleELocation takes as a parameter the URL to the eLocation server.

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How to geocode an address

To geocode a street address (US and Western EU countries only at the moment), simply invoke the geocode() method on the OracleELocation object just created.

var myAddress = “500 Oracle Pkwy, Redwood Shores, CA, 94065”;

eloc.**geocode**(myAddress, **printResult**);

The “**geocode**” function internally invokes an AJAX call to the Oracle eLocation service for the actual work.

Callback function:

Note the function named “**printResult**”. It is a user-supplied callback function that will be invoked automatically when the geocoding result is returned from the eLocation server. It is inside this callback function that you will interpret the geocoding result and do something with it, such as printing the longitude/latitude of the geocoded address, or display it on a map.

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How to interpret the geocoding result

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In your callback function, the geocoding result is passed in as the only argument.

```
function  printResult(gcResult)
{
    //interpret and process the geocoding result
    …
}
```

A few things worth noting about the **gcResult** parameter:

- It is an array of (geocoded/validated) addresses
- If the input address has multiple matches, gcResult will have multiple address objects
- Each address object contains the following attributes:
  - x : The x (longitude) coordinate of the result location.
  - y : The y (latitude) coordinate of the result location.
  - houseNumber : Address street house number
  - street : Street
  - settlement : City
  - municipality: Municipality
  - region : Region(state, province, etc.)
  - postalCode: Postal code
  - country: Country
  - matchVector: Match vector that tells how each address field is matched. Please refer to Oracle Spatial Developer's guide for more information.
  - accuracy: Result accuracy
  - matchCode: Match code

The following is a complete geocoding example.

```
<html>
 <head>
  <title>Oracle eLocation API Example: Simple Geocoding</title>
  <script src="http://elocation.oracle.com/elocation/jslib/oracleelocation.js"  type="text/javascript"></script>
  <script src="http://elocation.oracle.com/mapviewer/fsmc/jslib/oraclemaps.js"  type="text/javascript"></script>
  <script type="text/javascript">
                                var eloc;

                                function init() {
                                        eloc = new OracleELocation("http://elocation.oracle.com/elocation") ;
                                }
                                function submitAddress() {                              {
                                        var addr = document.getElementById("address").value
                                        eloc.geocode(addr, printResult);
                                }
                                function printResult(gcResult) {
                                        if(gcResult.length==0)  //no match
                                                alert("No matching address found!") ;
                                        else if(gcResult.length==1) //1 exact match
                                        {

                printJustOne(gcResult[0]);
                                        }
                                        else
                                        {
                                                alert("Multiple matches found. Printing 1st matched address
only.");
                                                printJustOne(gcResult[0]);
                                        }
                                }
                                function printJustOne(addrObject){
                                        if(addrObject.accuracy<1)
                                                alert("No matching address found!");
                                        else
                                                alert("gc result: long="+ addrObject.x+", lat="+addrObject.y);
                                }
  </script>
 </head>
 <body onload="init()">
                                <input type="text" name="address" id="address" size=60 value="500 Oracle pkwy, Redwood
Shores, CA 94065">
                                <input type=button onclick="submitAddress()" value="Geocode this..."/>
 </body>
</html>
```

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How to get driving directions

The new eLocation class also provides a convenient method for getting driving directions between two or more addresses.

```
var addrs = new Array() ;
addrs[0] = “500 Oracle Pkwy, Redwood City, CA, 94065”;
addrs[1] = “170 West Tasman Dr., San Jose, CA 95134”;
addrs[2] = “345 Park Avenue, San Jose, CA 95110”;
```

```
eloc.getDirections(addrs, printResult, routeErrHandler,
        {routePref:"shortest", roadPref:"highway", distUnit:"km"},
        {mapview:mapview, zoomToFit:true, resultPanel:document.getElementById("directions")});
```

As you can see, getDirections() is a very powerful method. It can take two or more addresses (stops), and produce a route for each consecutive pair of addresses, complete with turn-by-turn directions. You can also specify the routing preferences. Finally you can display the route result both graphically on an Oracle Maps map, and in a tabular form for the turn-by-turn directions.

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How to get driving directions – ctd.

The getDirections() method takes the following parameters:

- dests - an array of destination addresses (except the 1st one which is the starting address)
- callBack – a user-supplied callback function for custom route result processing
- errHandler – a user-supplied error handling function; invoked automatically if the routes cannot be computed (such as when one of the input addresses is invalid.)
- routeOptions – an object that specifies various routing preferences
- mapOptions – an object that specifies where and how the routes can be displayed on a map

Note that when displaying routes on a map, the map display area must reside on the same Web page where the routing code is invoked.

Note also if you use a custom callback function to display or process the route result, then the mapOptions object should be set to null.

For more details on the attributes of the routeOptions and mapOptions objects, please refer to the online API doc here:

http://elocation.oracle.com/elocation/ajax/apidoc/symbols/OracleELocation.html

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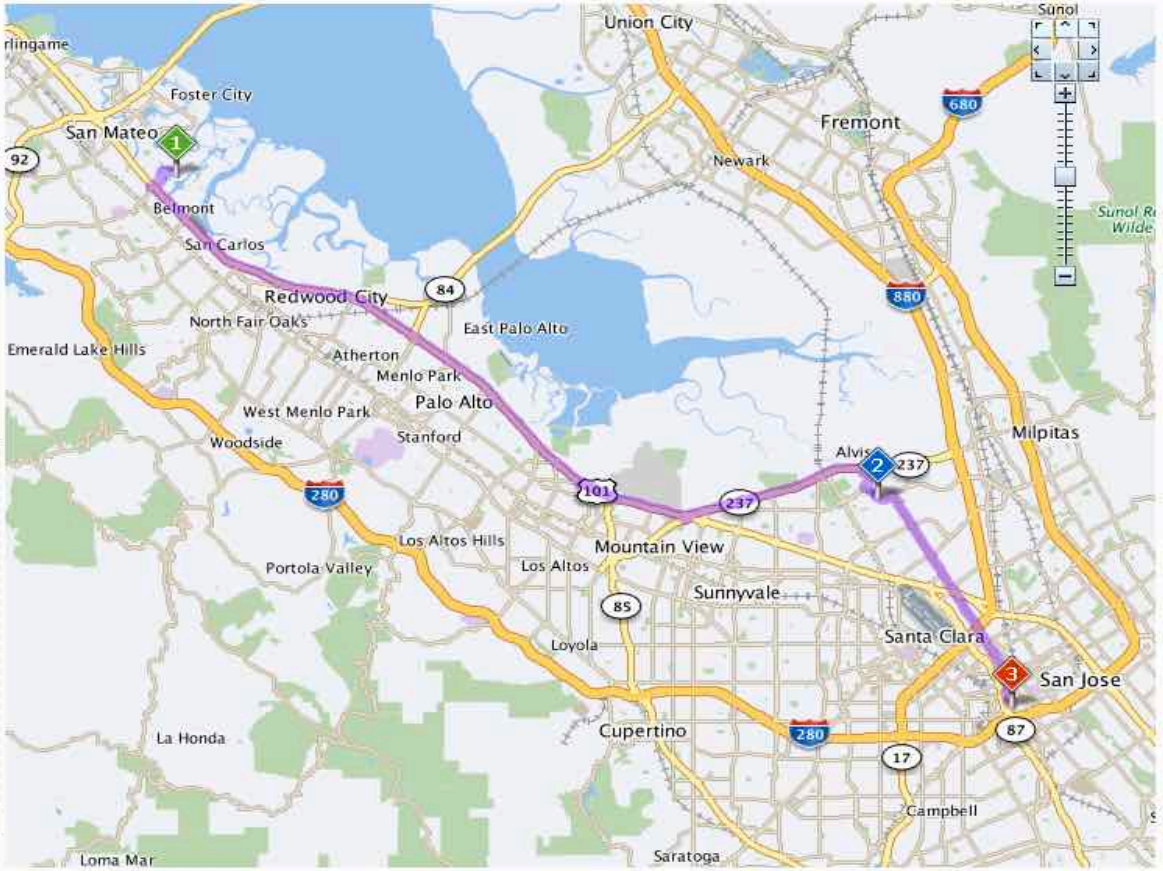
How to get driving directions - a screenshot

eLocation AJAX Routing API demo

Stop 1 : 500 Oracle Pkwy, Redwood City, C
Stop 2 : 170 West Tasman Dr., San Jose, C
Stop 3 : Park Avenue, San Jose, CA 95110
Get Directions...

Estimated time: 36 min
Distance: 47.7 km

Direction	Distance	Time
Start from 500 ORACLE PKY, REDWOOD CITY, CA 94065		
Start out on ORACLE PKY (Going West)	912 m	1 min
Turn RIGHT onto MARINE PKY/MARINE WORLD PKY (Going West)	135 m	6 sec
Stay STRAIGHT to go onto RALSTON AVE (Going Southwest)	308 m	21 sec
Take US-101 RAMP toward SAN JOSE	653 m	41 sec
Stay STRAIGHT to go onto RAMP (Going Southeast)	469 m	29 sec
Stay STRAIGHT to go onto US-101 S (Going Southeast)	24.8 km	13 min
Take CA-237 RAMP toward ALVISO	406 m	37 sec
Stay STRAIGHT to go onto CA-237 E (Going East)	489 m	19 sec



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