Harnessing Location with Node.js and Oracle Database

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Safe Harbor

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Why This Matters

Everything happens somewhere.

Enterprise and consumer apps are now expected to be “location-enabled”. With the maturity of geospatial features in common dev and data management platforms and libraries, it’s easy to harness location in your applications.

Agenda

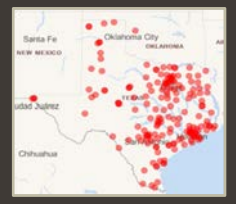
- Node.js and Oracle Spatial; concepts and drivers
- Demo 1
    - Build a REST API - Data fusion and proximity analysis
- Demo 2
    - Build a Web app – Location tracking and geofencing

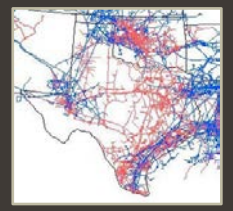
Node.js

- Open-source JavaScript run-time
- Designed for asynchronous, event driven applications
- Built to handle streaming content
- Easily create REST APIs
- Ecosystem of modules

Oracle Database - Spatial and Graph

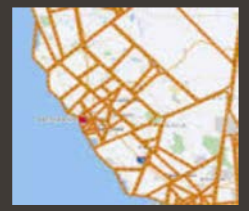
Deployable Components	Mapping	Geocoding	Routing	Web Services (OGC)	Studio

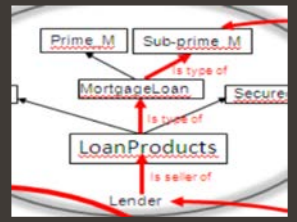

Points


Lines

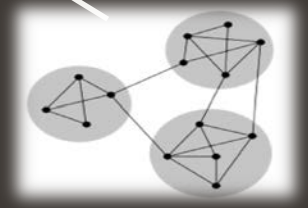

Polygons


Location Tracking (Geofencing)


Networks



RDF Graphs


Property Graphs

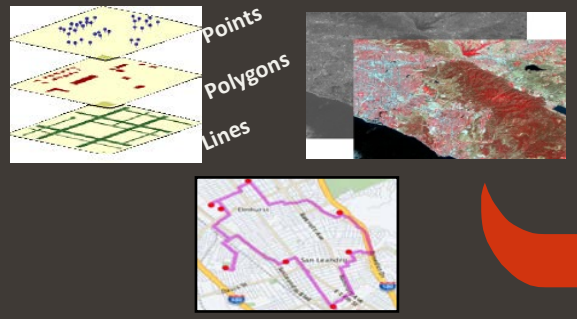

Raster


3D / LiDAR

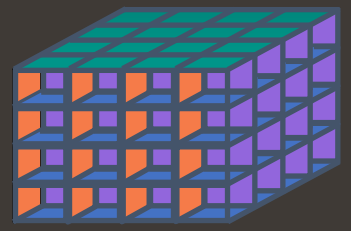

Topologies

Oracle Spatial and Graph

Native Geospatial Data Types



Native Spatial Indexing

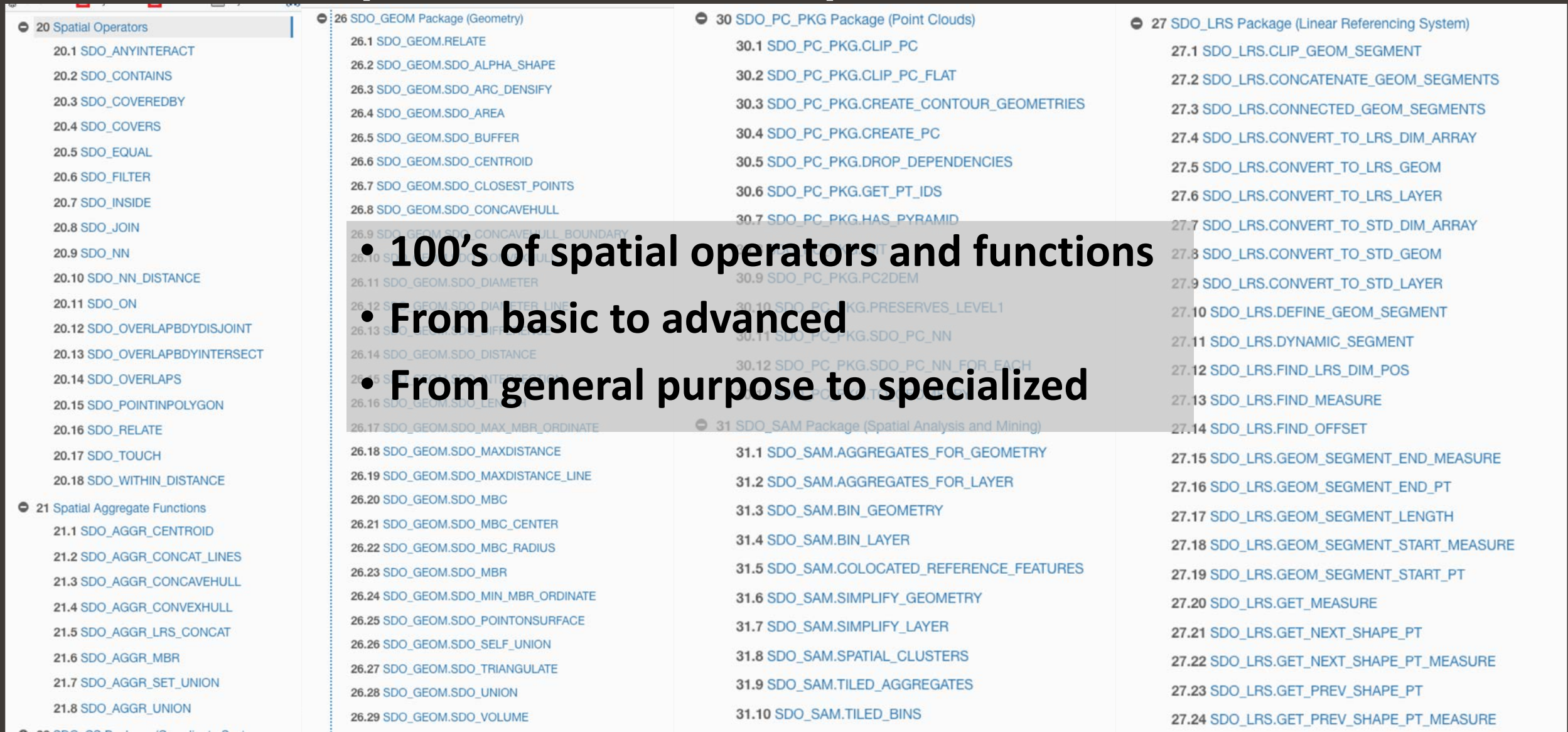


Fast Access to Spatial Data

Spatial Analysis Through SQL

```
SELECT a.customer_name, a.phone_number
FROM policy_holders a
WHERE sdo_within_distance( a.geom, hurricane_path_geom,
          'distance = 10 unit = mile') = 'TRUE';
```

Oracle Spatial and Graph



- **100's of spatial operators and functions**
- **From basic to advanced**
- **From general purpose to specialized**

Spatial data type

```
SQL> desc countries
Name      Null? Type
--------- ----- ------------------
ID              NUMBER
ISO_A3          VARCHAR2(3)
NAME            VARCHAR2(26)
GEOMETRY        MDSYS.SDO_GEOMETRY
SQL>
```

```
SQL> SELECT geometry
  2  FROM countries
  3* WHERE name='Aruba';

GEOMETRY
----------------------------------------
SDO_GEOMETRY(2003, 8307, NULL,
SDO_ELEM_INFO_ARRAY(1, 1003, 1),
SDO_ORDINATE_ARRAY(-69.8760919, 12.42720123, -
69.879425, 12.45340118, -69.9150301,
12.49686106, -69.9238926, 12.51903025, -
69.935649, 12.5316393, -69.9961879,
12.57737295, ...
```

Spatial query

```
SQL> SELECT a.name
  2  FROM populated_places a, countries b
  3  WHERE sdo_inside(a.geometry, b.geometry) = 'TRUE'
  4* and b.name='Belize';

NAME
--------------------------------------------------
El Cayo
Punta
Gorda
Belmopan
Orange
...
```

Spatial query

```
SQL>  SELECT name
  2   FROM countries
  3   WHERE sdo_contains(
  4             geometry,
  5             SDO_GEOMETRY(2001,8307,
  6                          SDO_POINT_TYPE(-99.3, 23.1, NULL), NULL, NULL))
  7             = 'TRUE';

NAME
--------------------------
Mexico
```


Spatial cast to/from GeoJSON

```
SQL> SELECT sdo_util.to_geojson(geometry)
  2  FROM countries
  3* WHERE name='Aruba';

SDO_UTIL.TO_GEOJSON(GEOMETRY)
------------------------------
{ "type": "Polygon", "coordinates": [ [ [-69.8760918785688,
12.4272012328116], [-69.8794250088263, 12.4534011841892],
[-69.9150300699863, 12.4968610642473], [-69.923892578319,
12.5190302533902], [-69.9356489664463, 12.5316393031227],
[-69.9961879071357, 12.5773729453627], [-70.006368164159,
12.5853827920903], [-70.0480452075418,
12.6319949343567],... ] }
```

Spatial cast to/from GeoJSON

```
SQL>  SELECT name
  2   FROM countries
  3   WHERE sdo_contains(
  4         geometry,
  4         sdo_util.from_geojson(
  5          '{"type": "Point", "coordinates": [-99.3, 23.1] }'))
  6          = 'TRUE';

NAME
--------------------------
Mexico
```

Supply fire perimeter as GeoJSON→ find nearby sites

```
SQL> SELECT facility_name,
  2         round(SDO_NN_DISTANCE(1),1) distance,
  3         sdo_util.to_geojson(geometry) as geometry_gj
  4  FROM  demo_data.epa_tri_facilities
  5  WHERE sdo_nn(geometry,sdo_util.from_geojson(
  6     '{"type": "Polygon", "coordinates":[[[-110.497, 37.658],[-110.493, 37.658],'||
  7             '[-110.493, 37.660],[-110.497, 37.660],[-110.497, 37.658]]]}'),
  8             'sdo_num_res=10 distance=500 unit=KM', 1) ='TRUE'
  9  ORDER BY distance;

FACILITY_NAME                          DISTANCE  GEOMETRY_GJ
-------------------------------------------------------------------------------
SALT RIVER GENERATING STATION          115.2   { "type": "Point", ... }
LISBON VALLEY MINING CO                125.1   { "type": "Point", ...}
PACIFICORP HUNTER                      174.5   { "type": "Point... }
US GYPSUM CO                           183.7.  { "type": "Point",...}
...
```

node-oracledb

- Node.js add-on for robust access to Oracle db
- Open source, maintained by Oracle
- Oracle Node.js Developer Center
  https://www.oracle.com/database/technologies/appdev/nodejs.html
- Doc, examples
  https://oracle.github.io/node-oracledb/
- Source
  https://github.com/oracle/node-oracledb

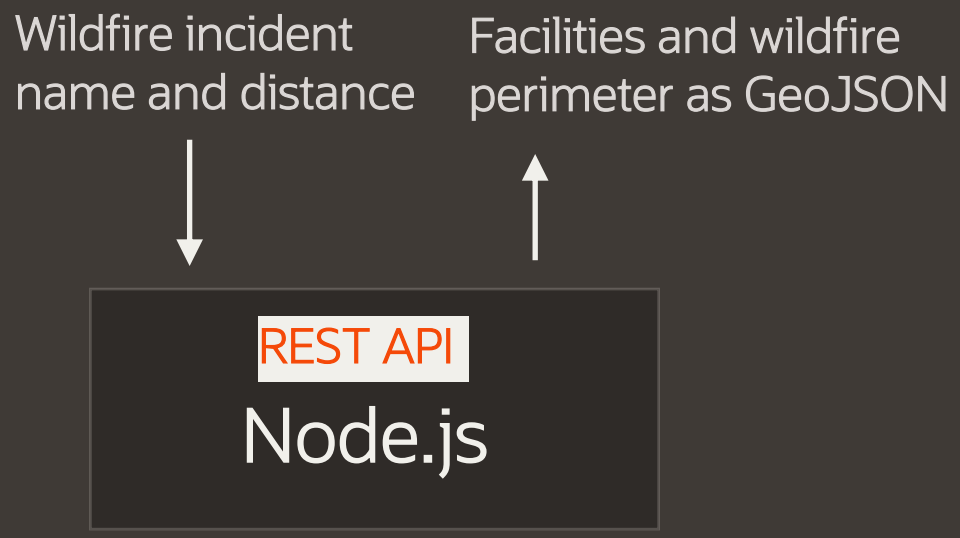
- → Async/Await, Promises, Callbacks and Streams
- → SQL and PL/SQL execution
- → Oracle Database High Availability features
- → Oracle Net features including encryption
- → Array Fetches and Bulk loading features
- → Oracle Named Types and Collection support
- → Large Objects: CLOBs and BLOBs as Streams or Strings and Buffers
- → Oracle Database 12c JSON datatype
- → Simple Oracle Document Access (SODA)
- → Continuous Query Notification (CQN)
- → Advanced Queuing (AQ)
- → REF CURSORs and Implicit Results
- → Data binding using JavaScript objects or arrays
- → Inbuilt Connection Pool with Queuing, Aliasing, Tagging, Draining, Heterogeneous and Homogeneous connections, Proxy connections and Liveness checking
- → Database Resident Connection Pooling (DRCP)
- → Privileged connections
- → External authentication
- → Password changing
- → Statement Saching and Client Result Caching
- → End-to-end tracing, mid-tier authentication, and auditing

Why Node.js with Spatial?

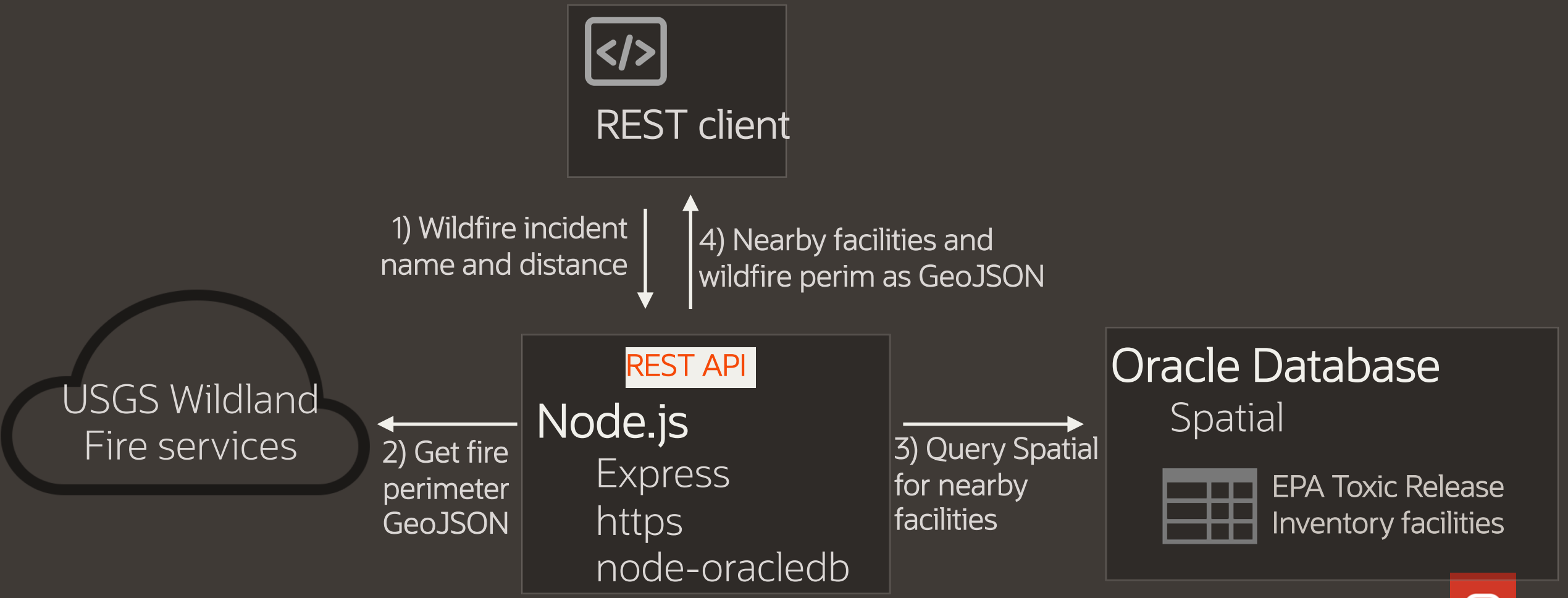
- ✓ Fusion of internal/external location-based data/services
- ✓ Subscribe to location-based events and streams
- ✓ JavaScript and GeoJSON pervasive in web mapping apps
- ✓ Robust Node.js module ecosystem
  - node-oracledb driver maintained by Oracle
  - Express for REST API
  - Socket.IO for event handling
- ✓ Cloud-ready
  - Node.js on Oracle Container Engine for Kubernetes or OCI Compute
  - Spatial on ExaCS, ExaCC, ADW, ATP, DBCS High/Extreme Performance

Demo 1:
REST API - Data fusion and proximity analysis

- Wildfire info from external geospatial web service
- Facility info and spatial analysis from Oracle Spatial



Demo 1:
REST API - Data fusion and proximity analysis



Demo 1

Demo 1: Code walkthrough

```
//adapted from https://github.com/oracle/node-oracledb/tree/master/examples

... require modules express, https, oracledb ...
... proxy and oracledb settings ...

const app = express();

const server = app.listen(3000, () => {
  var host = server.address().address
  var port = server.address().port
  console.log('app listening at http://%s:%s', host, port)
})

app.get('/incidentname/:incidentname/distance/:distance', (req, res) => {
  getFirePerim(req, res)
})
```

Demo 1: Code walkthrough cont.

```
const options = ... USGS service host, port, method...
const path = ... USGS service fixed path elements...

const getFirePerim = (req, res) => {
  console.log('getting fire perimeter from USGS service...')
  options.path = path + '%27' + req.params.incidentname + '%27'
  https.request(options, (res2) => {
    let body = ''
    res2.on('data', (chunk) => {
      body += chunk
      console.log(' get chunk...')
    })
    res2.on('end', () => {
      if (JSON.parse(body).features.length > 0) {
        const gj = JSON.stringify(JSON.parse(body).features[0].geometry)
        runQuery(gj, req, res)
      } else { res.send('cannot get fire perimeter') }
    })
  }).end()
}
```

Demo 1: Code walkthrough cont.

```
async function runQuery(gj, req, res){
const gjArray = []
try {
    // Dedicated connection for demo. For a production app use a connection pool.
    const connection = await oracledb.getConnection(dbConfig)
    const nnParams = 'sdo_num_res=100 distance=' + req.params.distance + ' unit=KM';
     const result = await connection.execute(
      `select facility_name, industry_sector, round(SDO_NN_DISTANCE(1),1) distance,
       sdo_util.to_geojson(geometry) as geometry
      from epa_tri_facilities
      where sdo_nn(geometry,sdo_util.from_geojson(:1),
                   '${nnParams} unit=KM', 1) ='TRUE'
      order by distance`, { 1: { val: gj, type: oracledb.CLOB } })

    result.rows.forEach(function (item) {
      const tmp = { type: 'Feature' }
      tmp.properties = { facility_name: item.FACILITY_NAME, distance: item.DISTANCE }
      tmp.geometry = JSON.parse(item.GEOMETRY)
      gjArray.push(tmp)
    })
```

Demo 1: Code walkthrough cont.

```
const perim = { type: 'Feature' }
perim.properties = { incidentname: req.params.incidentname }
perim.geometry = JSON.parse(gj)
gjArray.push(perim)

const geojson = { type: 'FeatureCollection', features: gjArray }
res.setHeader('Content-Type', 'application/json')
res.send(
  JSON.stringify(geojson))
console.log('... done')
```

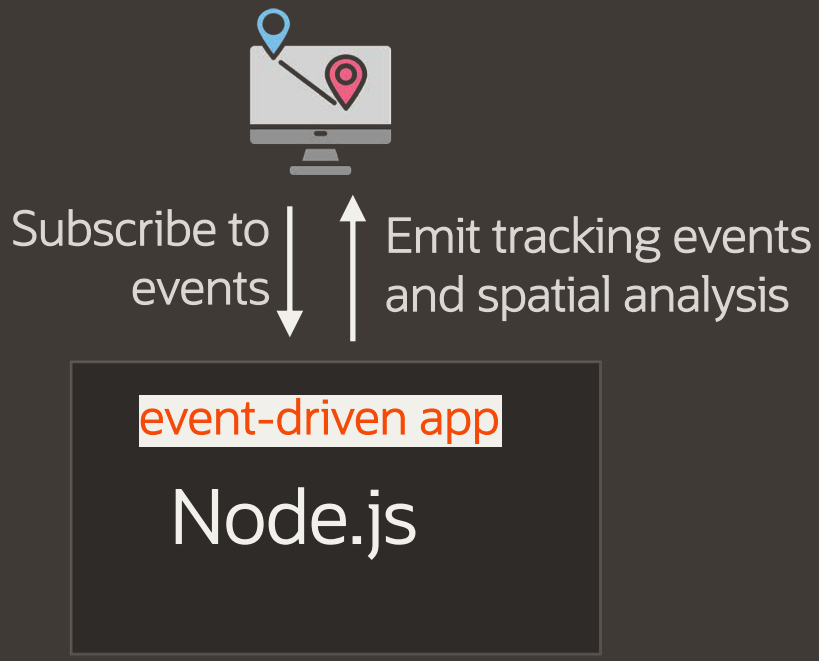
Demo 2:
Web app – Location tracking and geofencing

Context…

- Geofences are predefined regions that represent areas of interest, such as the regions surrounding secure facilities
- Location tracking detects objects entering/existing a geofence and sends messages
- Oracle Spatial Location Tracking Server
  - In-database feature of Oracle Spatial and Graph
  - Uses Oracle Database Advanced Queuing (AQ) for event messages
  - Designed for large volume of complex geofences and many moving objects
  - For simplicity, in this demo we track only 1 object

Demo 2:
Web app – Location tracking and geofencing

- An object continually moves to random locations
- Location and geofencing messages from Oracle Spatial Location Tracking Server
- Spatial analysis results from Oracle Spatial queries



Demo 2:
Web app – Location tracking and geofencing

3) Emit tracking event and spatial analysis results

event-driven app

Node.js

Express

Socket.io

node-oracledb

1) subscribe to tracking message queue

2) dequeue messages and run spatial queries

Oracle Database

Spatial, AQ

Object moving into region enqueues a message

Demo 2

Demo 2: Server code walkthrough

```
// adapted from examples at
// https://github.com/oracle/node-oracledb/tree/master/examples

... require modules express, http, socket.io, oracledb ...
... proxy and oracledb settings ...

async function startExpress () {
  app.get('/', function (req, res) {
    res.sendFile(__dirname + '/socket-trkr-map.html')
  })
  app.post('/countries.json', function (req, res) {
    res.sendFile(__dirname + '/countries.json')
  })
  http.listen(port, function () {
    console.log('Listening on http://localhost:' + port)
  })
}
```


Demo 2: Server code walkthrough cont.

```
const query =
`WITH x as (
 SELECT sdo_geometry(2001,8307, sdo_point_type(:1, :2, null),null,null) as g
 FROM dual )
   SELECT a.name, a.iso_a3 as iso_code,
         round(sdo_geom.sdo_distance(
                    x.g,
                    sdo_util.polygontoline(a.geometry),
                    0.05, 'unit=KM'),0) as dist_from_border_km,
          b.nameascii||', '||b.adm0name as nearest_populated_place,
          round(sdo_nn_distance(1)/1000,2) as distance_from_nearest_place
   FROM countries_oceans a, ne_10m_populated_places_simple b , x
   WHERE id=:3
   AND sdo_nn(b.geometry, x.g, 'sdo_num_res=1',1)='TRUE'`;
```

Demo 2: Server code walkthrough cont.

```
async function startOracle() {
 let connection;
 try {
  let result;
  // Dedicated connection for demo. For a production app use a connection pool.
  connection = await oracledb.getConnection(dbConfig);
  const queue = await connection.getQueue(queueName,
                                          {payloadType: "MDSYS.NOTIFICATION_MSG"});
  const msg = await queue.deqOne(); // wait for a message
  await connection.commit();
  if (msg) {
    result = await connection.execute(
                query,[msg.payload.X, msg.payload.Y, msg.payload.REGION_ID] );
    io.emit('message', [msg.payload, result.rows]);
    }
  setTimeout(function(){startOracle();}, 3000);
 }
```

Demo 2: Client code walkthrough

```
... include jquery, oraclemapsv2, socket.io js...
... create map and message divs...

$(function () {
   var map = new OM.Map(document.getElementById('map'));
   var markerLayer = new OM.layer.MarkerLayer("markerlayer1");
   var insertMapMarker = function(id, cx, cy, srid, text) {
                          var myobj = {id: id, markerText: text,
                                  position: {'x': cx, 'y': cy,'srid': srid}};
                          var mm = new OM.MapMarker(myobj);
                          markerLayer.addMapMarker(mm);
                         };
   var countriesLayer = new OM.layer.VectorLayer('countries',
                         {def:{type:OM.layer.VectorLayer.TYPE_DATAPACK,
                          url:"http://localhost:3000/countries.json"}} );
   countriesLayer.setRenderingStyle(new OM.style.Color(
      {strokeThickness:1,stroke:"#f7fcb9",fill:"#b2bec6",fillOpacity:0.25}));
```

Demo 2: Client code walkthrough cont.

```
map.addLayer(countriesLayer);
map.addLayer(markerLayer);
map.addLayer(new OM.layer.ElocationTileLayer("tilelayer"));
map.setMapCenter( new OM.geometry.Point(-30, 40, 4326) );
map.setMapZoomLevel(1) ;
map.init() ;

var socket = io();
socket.on('message', function(msg){
  $('#messages').empty();
  $('#messages').append($('<li>').text('Object '+msg[0].OBJECT_ID));
  $('#messages').append($('<li>').text(msg[0].TIME));
  $('#messages').append($('<li>').text(msg[0].X+'°, '+msg[0].Y+'°'));
  $('#messages').append($('<li>').text('--------------------'));
  $('#messages').append($('<li>').text(msg[1][0].NAME));
  $('#messages').append($('<li>').text(msg[1][0].DIST_FROM_BORDER_KM...
  $('#messages').append($('<li>').text(msg[1][0].DISTANCE_FROM_NEAREST_PLACE...
  markerLayer.removeAllFeatures();
  insertMapMarker(0, msg[0].X, msg[0].Y, 4326, msg[0].OBJECT_ID);
  });
});
```

Takewaways

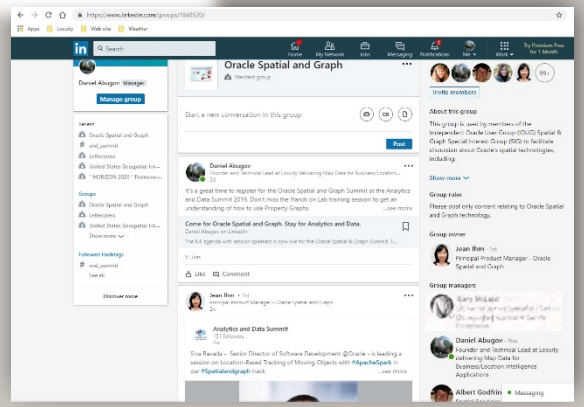
- It's easy to use the Spatial features of Oracle Database with Node.js apps
- Data fusion and REST API development are low hanging fruit
- node-oracledb driver greatly simplifies the process

The Spatial & Graph SIG User Community

Now part of BIWA User Group

We are a vibrant community of customers and partners that connects and exchanges knowledge online, and at conferences and events.

Oracle Spatial & Graph SIG



Meet us at OpenWorld! Monday-Wednesday
Moscone West, Level 3, User Group area
at the *BIWA/Analytics Community* table

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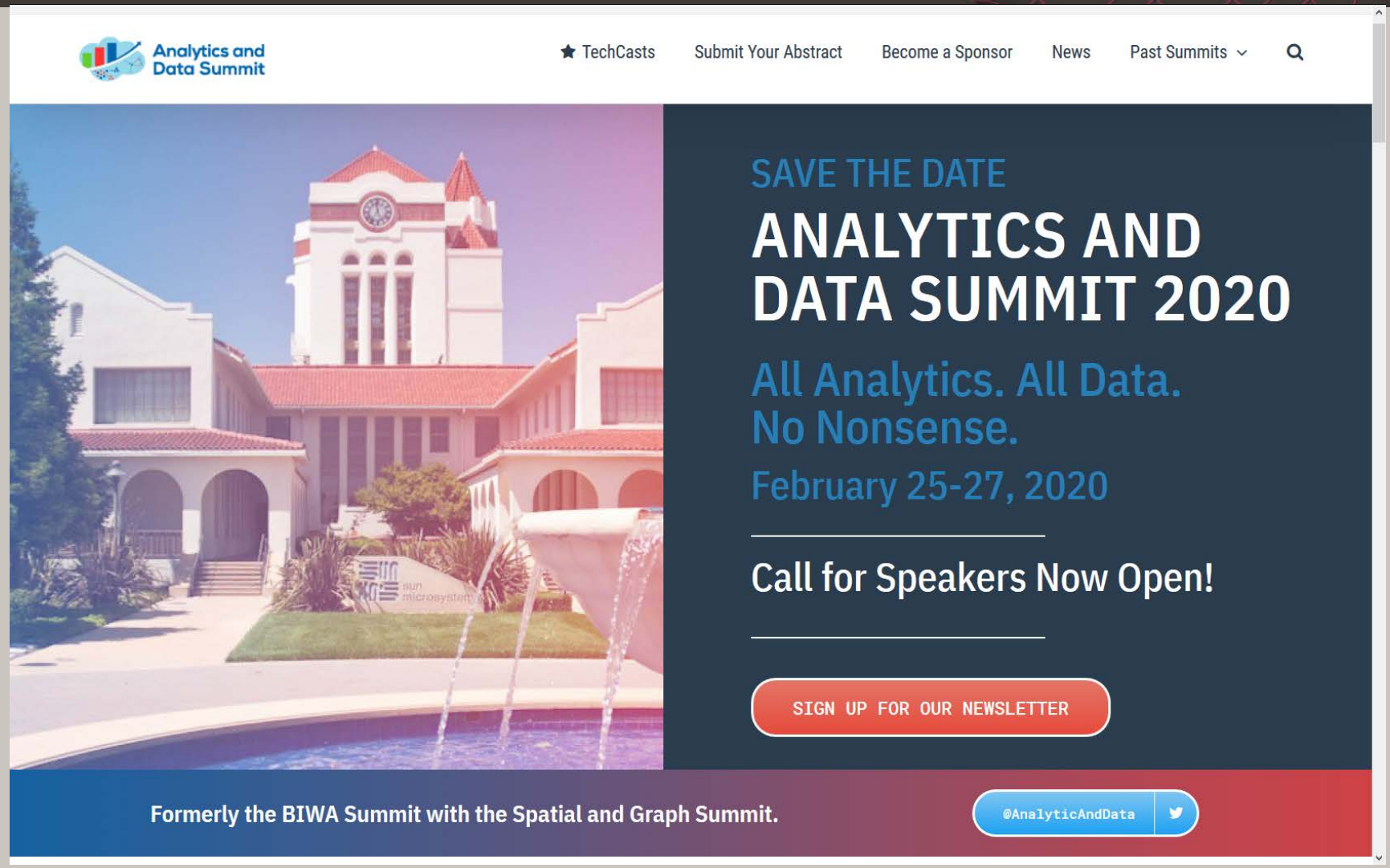

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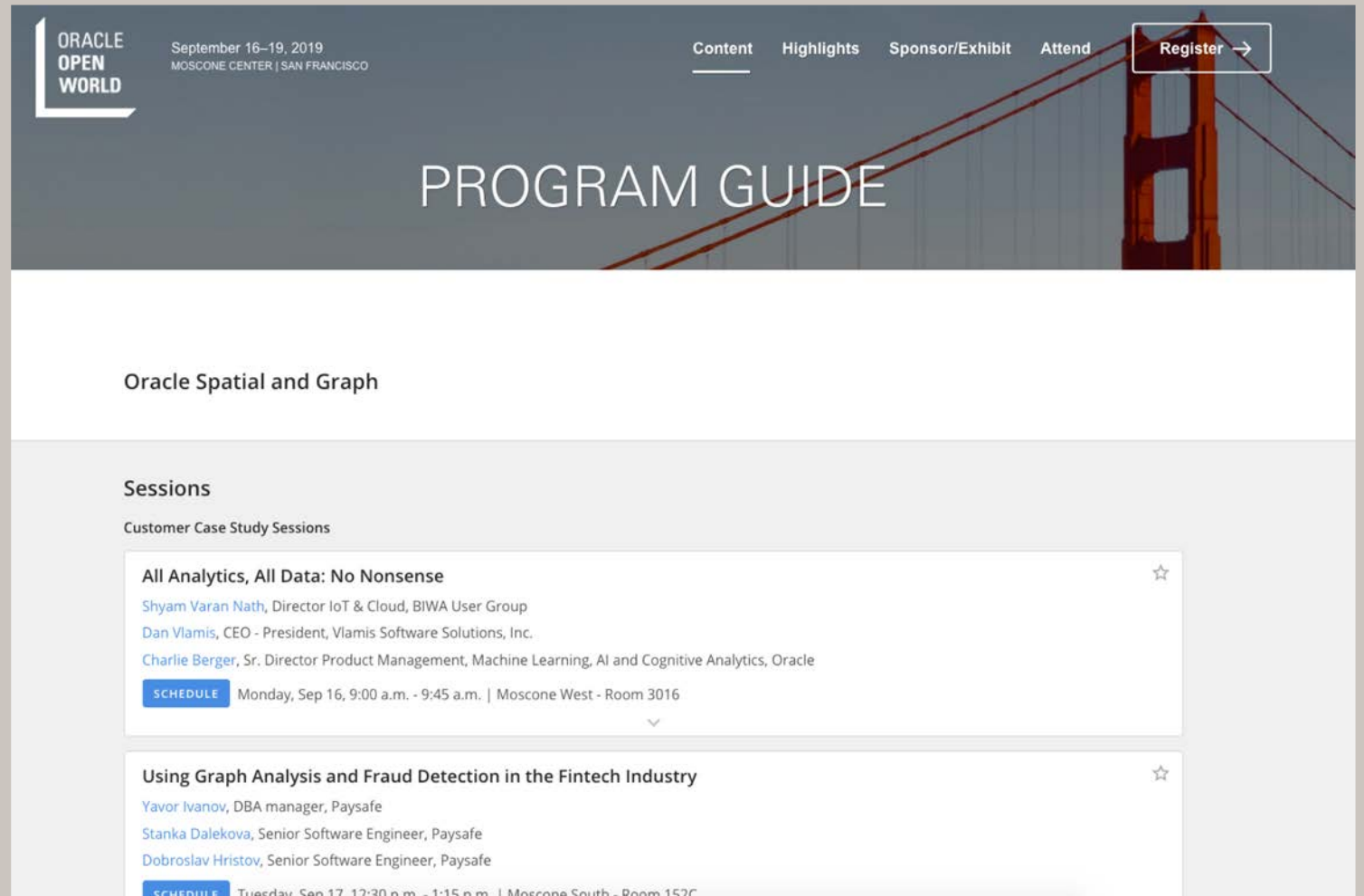
Spatial at OOW and Code One 2019

Sessions, workshops, demos…
bit.ly/SpatialGraphOOW19



Resources - Get Started

- Oracle Spatial and Graph product pages
  oracle.com/technetwork/database/options/spatialandgraph
- YouTube channel youtube.com/c/OracleSpatialandGraph
- Blog – examples, tips & tricks
  blogs.oracle.com/oraclespatial | blogs.oracle.com/bigdataspatialgraph
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- Oracle Spatial and Graph Group

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