May 2012
Oracle Spatial User Conference
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Burlington Hydro

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Intelligent Networks
AGSI
Deploying a Smart Grid Network at Burlington Hydro
OVERVIEW

- Centrally managed, authoritative database for all electric network and asset data in Oracle SDO geometry format
- Incorporates 7 corporate systems and 8 departmental systems that were previously silo databases; enable enterprise access and workflow
- Supports Business Functions, Departments, Constituents

CHALLENGES / OPPORTUNITIES

- Need for extreme high performance on spatial queries including Live Operations and Mobile, scalability for Smart Grid Data, and security for mission critical data
- Need to integrate multiple disparate data sets
- Source data over 30% of facility data incorrect; no nodal network connectivity existed
- 5.8 Billion AMI records relating to Geospatial Meters

SOLUTIONS

- Oracle Standard Edition One
  - Locator
- Oracle Fusion Middleware
  - MapViewer, WebLogic future (currently OC4j)

RESULTS

- Reduced asset management reports from months to minutes with significantly enhanced accuracy
- Consolidation of raster, vector, network data in a 7 GB sized central repository with live links to TB sized Smart grid databases
- Enterprise wide adoption of geospatial technology
- Created a common single system of record for the network and all business related asset information
- Citywide network connectivity model of electrical distribution system, sites and customers
- Enhanced data accuracy and timeliness for real-time business decision making purposes and capital planning

Burlington Hydro

GO360Networks Enterprise Solution
Program Agenda

- Burlington Hydro Utility Overview
- BHI`s Smart Grid Initiatives
- How GO360 Open Architecture Oracle Spatial Foundation Addresses BHI Needs
- BHI`s Smart Grid Challenges
- Enterprise GeoSolution Examples at BHI
- Network design, Asset Management, Mobile etc.
- GO360 Smart Grid Solution Examples at BHI and Neighbouring Utilities
Burlington Hydro Background

Customers Served
• Over 60,000 Residential Customers
• Over 5,500 Commercial and Industrial Customers

Assets
• 32 Substations
• 1,600 kilometres of Low Voltage Distribution Lines
• 93 Full Time Employees
Burlington Hydro Background
Burlington Hydro Background

• GridSmartCity™ Initiatives
  – Smart Automated Distribution Switching (Self Healing, High Reliability)
  – 65,000 Smart Meters deployed with Time-of-Use Billing
  – Distributed Renewable Generation is spreading
  – Electric Vehicle Charging Stations
  – Factory Ride-Through Systems
  – Battery-Based Electricity Storage as a deployable grid resource
BHI Smart Grid
Enterprise Approach “Why Go360”

Smart Grid has Focused Open Architecture as a Main Requirement for Utility I.T.

Multitude of Smart Devices and Integrated Systems
• AMI, SCADA, Smart Switches, Power Line Monitors etc.
• MDMR, CIS, ERP, Engineering Analysis etc
  • Proprietary GIS Systems Integration Very Costly and Inflexible
  • All BHI Data stored Directly in Oracle / Oracle Spatial

• Integration Effort Fast and Utilize Existing I.T. Resources
BHI Smart Grid
Enterprise Approach “Why GO360”

Real-Time Bi-Directional Communications
• Advance Distribution Management Systems, Outage Management, Mobile etc.

“Big Data”
• Medium Size Utilities Generating Billions of Transactions / Records per Year
• Store, Access and Scale Quickly and Cost Effectively
Go360Networks: Applications Through Integration Facilitating Complete Lifecycle Asset Management

Go360 Provides Enterprise Utility Specific Solutions

Oracle Spatial Database

- SOA Architecture.
- Live Data Updates and Bi-Directional Communications
Go360Networks: Applications Through Integration Facilitating Complete Lifecycle Asset Management

GO360 Provides Enterprise Utility Specific Solutions

Oracle Spatial Database

• Enterprise Access for utility Specific Applications
  – Network Design and Connectivity Model Management
  – Asset Management
  – Mobile with Real-Time Bi-Directional Information Updates
    • Tablets, iPhone, Android, Blackberry etc.
  – Outage Management (OMS)
  – Distribution Management Solution (DMS)
  – Smart Grid Analytics
  – Executive Dashboards
Go360Networks: Applications Through Integration Facilitating Complete Lifecycle Asset Management
Integrated and Accessible Solutions For Your Business Users From a Single Common Database
Burlington Hydro
I.T. Systems History

• Legacy CableCad Environment
  – Internally Maintained Land Base
    • Parcels, Address Points, Cad Layers and Text

• Daffron ERP: Billing, Work Orders, Transformers Assets, Time Reporting etc.

• Dromey DESS: Engineering Analysis

• Asset Condition Assessment DB: Nameplate, Condition and Photo Data

• SCADA

• GridSmartCity™ Infrastructure (Phase 2): e.g. Smart Switching, AMI, EV Fleet Implementations, EV Charging Stations, Renewable Energy etc.
BHI Consultant Recommendations Prior to Implementing GO360

- Move from Stand Alone to Enterprise Integration
- Functionally Rich Design Solution
  - Productivity Enhancements e.g. AutoCAD Integration
  - Streamline Business Data Ownership, Use and Entry Processes
- Mobile Workforce
- CableCad Data Conversion
- System & Data Integration introducing Enhanced Geospatial Functions
- Support Smart Meter / Smart Grid Initiatives
- Focus on Real-Time (Leverage Investment AMI Network)
- Vision of Enterprise Access and Use for Data and Technology
“Two of the main factors affecting GIS today are the move towards using Internet technology to be able to serve GIS data to a much broader user base and efforts by the Open Geospatial Consortium (OGC) to promote interoperability. BHI needs to implement a new GIS that will fit its technology vision and provide the benefits of today’s GIS to BHI operations.”

BHI Independent Consultant
Initial BHI Targeted Implementation

• Main Conduit for Information Corporate Wide
  – Engineering
  – Operations / Control Room
  – Customer Service
  – Mobile
  – Finance
  – HR

• Productivity Enhancement
  – Access to High Quality Information in Real-Time
  – Improve Work Capabilities i.e. Combine separate tasks into a seamless workflow
  – Streamline Data Update into a Single Process through Automation

• Timing Was Good – Tied in Regulatory Asset Inspection and Data Collection Initiatives
Go360Networks
Current Implementation at BHI

Executive Dashboards  Mobile Asset Inspection  Mobile Cable Locator  Enterprise Viewer  LiveOps

Survalent SCADA  spatialNET Power  Daffron CIS & ERP  DESS Analysis  AMI & Intelli-team
SpatialNET Power – Robust Design And Network Management

Includes Robust Job Management, Versioning & Conflict Resolution Capabilities
BHI Project Implementation

• spatialNET Power
  – Distribution Design and Network Topology
    • AutoCAD Partner Solution – ACAD Interface for Editing and Design
    • Direct Read / Write to Oracle Spatial
    • spatialNET Engine for:
      – Job Management / Versioning etc.
      – Automated Connectivity on the Fly
      – Engineering Standards and Bill of Materials
      – Map Production
      – Spatial and Attribute Queries
      – On-Board Table and Attribute Configuration
      – Integration 3rd Party Systems e.g. Dromey DESS, DWG, Multi-Speak etc.
Network Design with Engineering Standards
Job Estimating, “What Ifs” and Asset Tracking
(2204 Compliancy)
BHI spatialNET Power
7cm Ortho Imagery Example
BHI spatialNET Power Examples
Network Connectivity Trace and Equipment Report
Enterprise Go360Networks Web
Current BHI Solution Implementation

- Direct “Live” Read / Write to SPATIALnet Power
- Attribute and SPATIAL Asset Queries and Reporting
  - Canned and Ad Hoc SQL Queries
  - Multiple Spatial Queries (by Fence, Grid, Buffer, Network trace)
- Customer Account Information Maintenance
  - Integration CIS and ERP (equipment nameplate and financials)
- Available to Internal and Contract Staff including Mobile Solutions
- Operations
  - Outage Management with SCADA, Self Healing Switch and AMI Integration
  - Outage Statistic Reporting CAIDI, SAIDI, SAIFI – Pinpointing Cause of Problem Spatially for Accurate Reports
- Executive Dashboards
  - HR, Engineering, Financials, CIS, Call Centre, Scorecard
GO360Networks Live Applications
Integration and Deployment at BHI Examples
Go360net: Live Access Via The Web
Supporting Asset Management And Operations
Associated Asset Report e.g. Age and Proximity to Other Planned Work
Mobile Solutions: Field Asset Inspection Example
Analysis and Work & Accomplishment Reporting

Automated E-Mail Notification

Accomplishments and Asset Condition

Task Report

Completed
Not completed
Cleaning
Repair
New GO360 Mobile Form Factors
Android, BlackBerry, iOS, Windows

- Devices
  - Blackberry
  - iPhone
  - Android phones
  - Tablets (iPad, Playbook, Toughbook, etc.)
  - Wall Maps

- Includes all functionality
  - Query
  - GPS
  - Edit
  - Thematic’s
  - Live Ops
Performance Monitoring Dashboards

BHI Example
Financials and Drill Downs
GO360Networks 2012 Initiatives

- Automating Network Pinning and Work Protection Tagging
  - Includes SCADA Integration
- Enhancing GO360 Asset Inspection to include Pole Testing & New Transformer Details
- Automating Outage Statistics CAIDI, SAIDI and SAIFI Reporting
- Complete OMS (LiveOps)
  - Smart Grid Enabled i.e. AMI, Self Healing Switches, other Smart Sensors
  - Integrates with Completed Pinning and Tagging
  - Manage Outages and Restoration including Crew Management
  - Re-configure Network via Engineering Switch Order Management
- Full Mobile Field Force Automation
  - Live Bi-Directional Communications with Operations including Automated Dispatch and Job Closing
- Asset Analytics
GO360LiveOps: Automating Network Pinning and Work Protection Tagging

Geographic View

Allows for:

- Manual Operator Placement
- Substation SCADA (One Second Reads)
- Intelligent Self-Healing Switches (One Second Reads)
## GO360LiveOps Reports

### Report Active Pins by Type

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<thead>
<tr>
<th>PK_ID</th>
<th>REQUESTOR</th>
<th>USERID</th>
<th>TYPE</th>
<th>OWNER_ID</th>
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Results: 18
AMI Integration Example – Transformer Monitoring and Analysis
Real-Time Smart Grid for Operations and Asset Analytics e.g. Overload Analysis Example
Detailed Geographic View. Transformer Overloading
Smart Grid for Operations and Asset Analytics

Loading Profile at Transformer
Color Coded by % Overload In 15 min. Intervals

>110%
Smart Grid for Operations and Asset Analytics
Transformer Daily Summary Report (July 5, 2010)

<table>
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<th>Transformer Number: OT3979</th>
<th>Report Period: 05/07/2010 to 05/07/2010 in 15 min. Intervals</th>
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<td>Transformer Rating: 50.0 KVA</td>
<td>Peak Demand: 79.68 KWh</td>
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<td>Peak Demand: 88.53 KVA</td>
<td>Overload: 64% of the time</td>
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<tr>
<td>Peak Interval Reading (kW/15min) * 4 / 0.9 (kVA)</td>
<td>Overload: 64% of the time</td>
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<tr>
<td>% of time for which transformers overloaded</td>
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<tr>
<td>Load Factor Rating: 0.64</td>
<td>Ratio of Avg. Demand to Max. Demand</td>
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<tr>
<td>Use Factor Rating: 1.77</td>
<td>Ratio of Peak Demand (kVA) to Installed Capacity</td>
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<tr>
<td>Outage Count: 1</td>
<td>Derived from AMRDEF daily outage summary values</td>
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<tr>
<td>Outage Duration: 15.0 Minutes</td>
<td>Loss of Life: 1.11%</td>
</tr>
<tr>
<td>Loss of Life: 1.11%</td>
<td>As Defined by Appropriate IEEE Standard</td>
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<tr>
<td>Coincidence Factor: 1.0</td>
<td>Max. simultaneous demand (in kVA) divided by sum of maximum</td>
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<tr>
<td>Throughput: 1227.27 Kwh</td>
<td>demands of each device (in kVA)</td>
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Smart Grid for Operations and Asset Analytics
Transformer Weekly Summary Report (July 5 to July 9, 2010)

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<td>Transformer Rating: 50.0 KVA</td>
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<td>Peak Demand: 82.74 KWh</td>
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<tr>
<td>Overload: 74%</td>
<td>% of time for which transformer overloaded</td>
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<td>Load Factor Rating: 0.65</td>
<td>Ratio of Avg. Demand to Max. Demand</td>
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<td>Use Factor Rating: 1.84</td>
<td>Ratio of Peak Demand (kVA) to Installed Capacity</td>
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<td>Outage Count: 2</td>
<td>Derived from AMRDEF daily outage summary values</td>
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<td>Outage Duration: 30.0 Minutes</td>
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<td>Loss of Life: 6.7%</td>
<td>As Defided by Appropriate IEEE Standard</td>
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<tr>
<td>Coincidence Factor: 1.0</td>
<td>Max. simultaneous demand (in kVA) divided by sum of maximum demands of each device (in kVA)</td>
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<tr>
<td>Throughput: 6481.07 KWh</td>
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</table>

- **Overload:** 74% of the time
- **Loss of Life:** 6.7%
Smart Grid for Real-Time Operations and Asset Analytics

Time Based Playback Example

- July 5th [Midnight]
- July 5th [7 AM]
- July 5th [5 PM]
- Temporary Outage Events
- July 6th [Midnight]
AMI Asset Analytics

Detailed Geographic View of Transformer Overloading

Loading Profile at Transformer Colour Coded by % Overload

Summary Statistics e.g. Daily, Weekly, Monthly, Summer Peak etc.
Enterprise Go360Networks on Oracle

Realizing our Vision

- **One Centrally Maintained Asset Database to Serve Enterprise**
  - Operations, Mobile Crews, Asset Management, Engineering, System Planning, Asset Inspection, Cable Locates, Executive

- **Ease of System Integration**
  - Within a very short period of time able to integrate CIS, ERP, SCADA, Smart Switches, AMI

- **Live Solutions Enabling Efficient Operations Leveraging Smart Grid**
  - Automate Operations, Enhanced Reliability, Enhance Asset and Energy Analytics

- **Available to any Internal and Contract Staff including Mobile Solutions in A Secure Manner**

- **Operations**
  - Outage Management with SCADA, Self Healing Switch and AMI Integration
  - Outage Statistic Reporting CAIDI, SAIDI, SAIFI – Pinpointing Cause of Problem Spatially for Accurate Reports

- **Executive Dashboards**
  - HR, Engineering, Financials, CIS, Call Centre, Scorecard