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**S P A T I A L**

May 2012  
Oracle Spatial User Conference



# Oracle Spatial User Conference

May 23, 2012  
Ronald Reagan Building and International Trade Center  
Washington, DC USA



# **Dan Guatto, P. Eng.**

COO & Vice President of Engineering  
and Operations  
Burlington Hydro

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Executive Vice President  
Intelligent Networks  
AGSI



# **Deploying a Smart Grid Network at Burlington Hydro**



# Burlington Hydro GO360Networks Enterprise Solution



## 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)

5



## 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



## 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

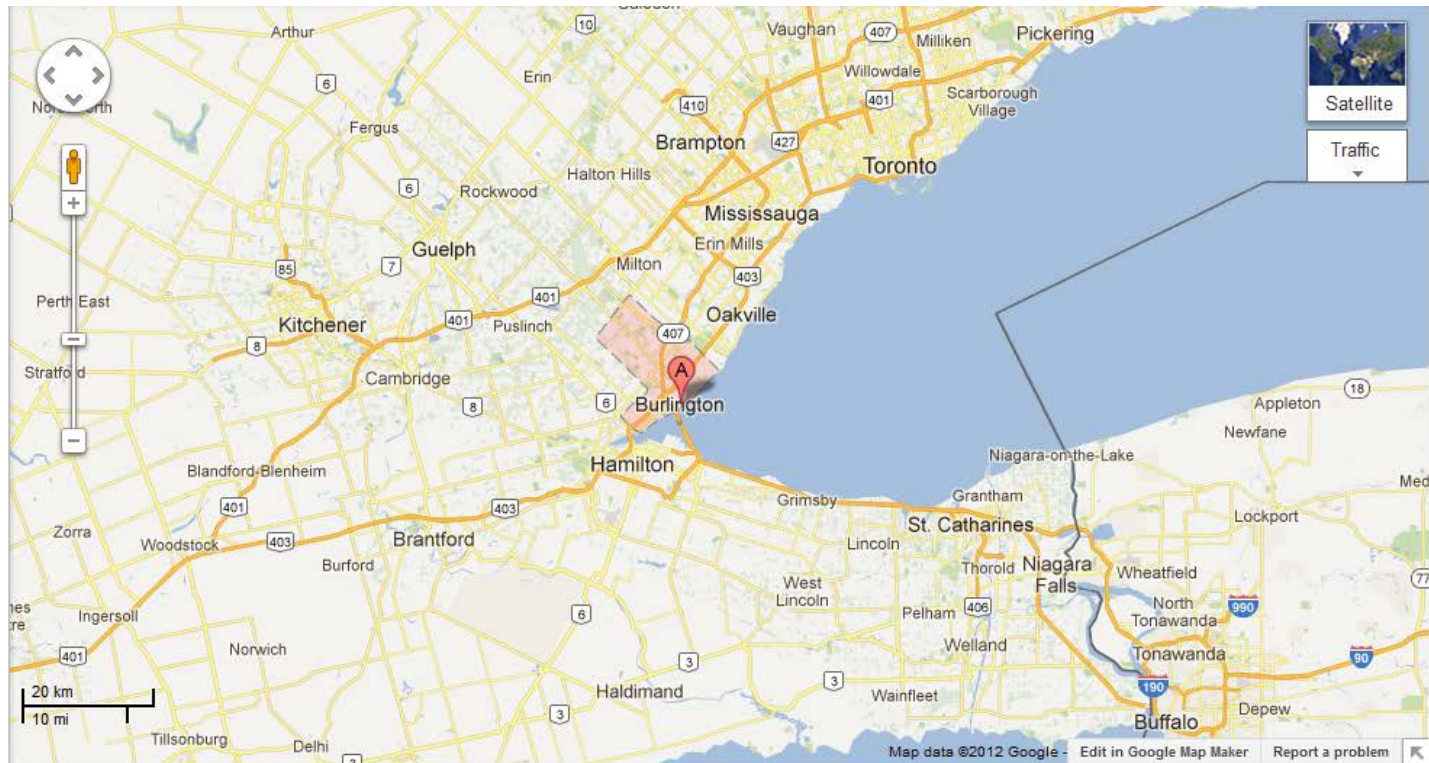
## Customers Served

- 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**

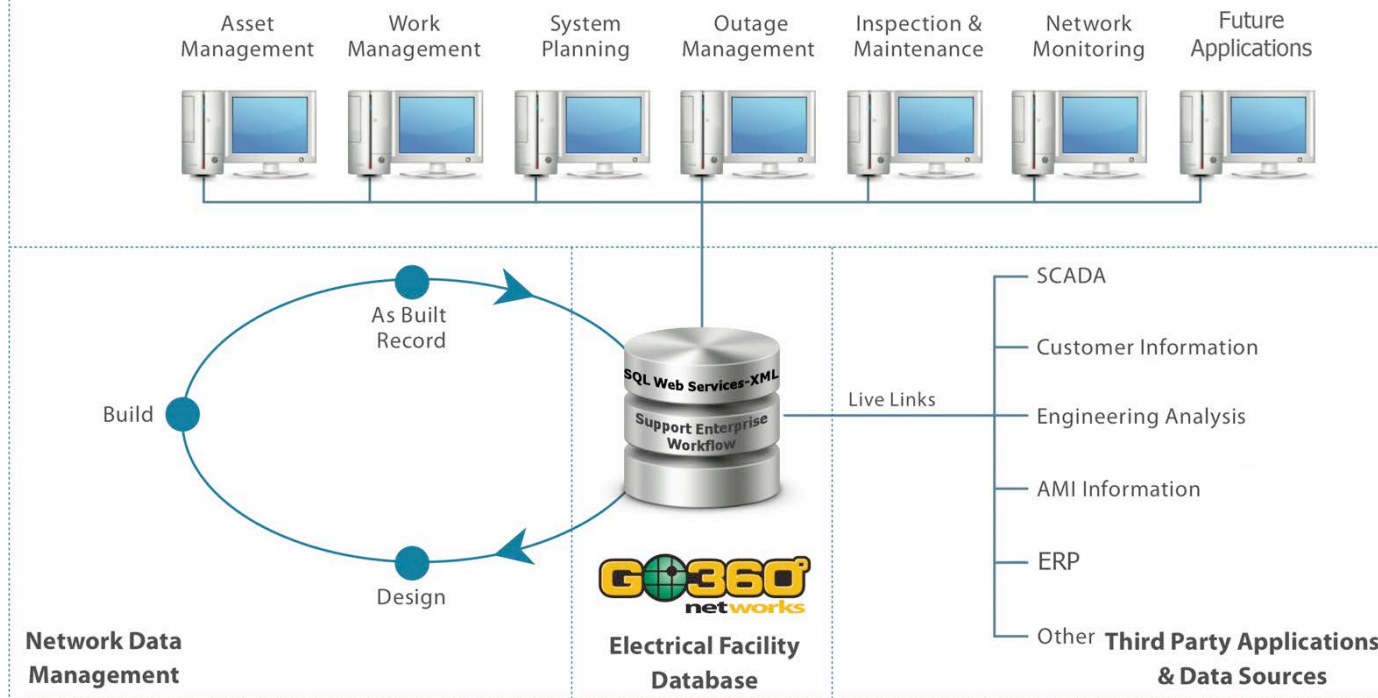
## **GO360 Provides Enterprise Utility Specific Solutions**

### **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

## GO360Networks Enterprise Integration



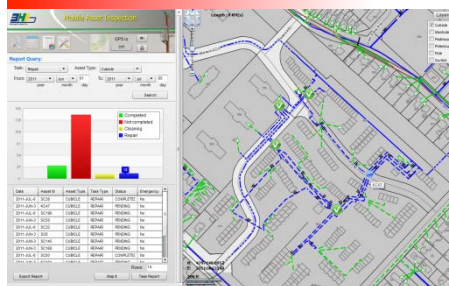


# Integrated and Accessible Solutions For Your Business Users From a Single Common Database

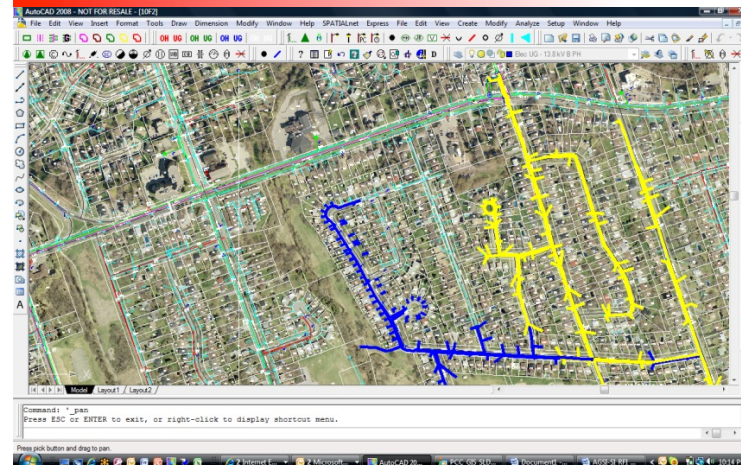
## Executive Dashboards



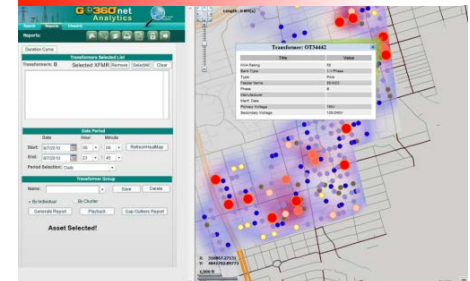
## Asset Management



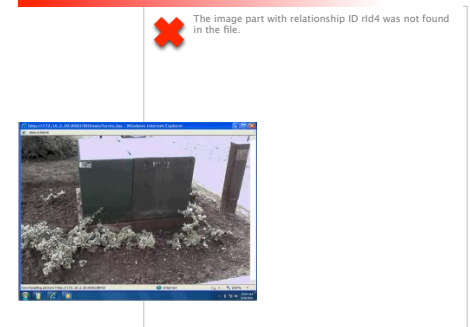
## Network Design / Connectivity Model



## Smart Grid Analytics



## Mobile





# 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**



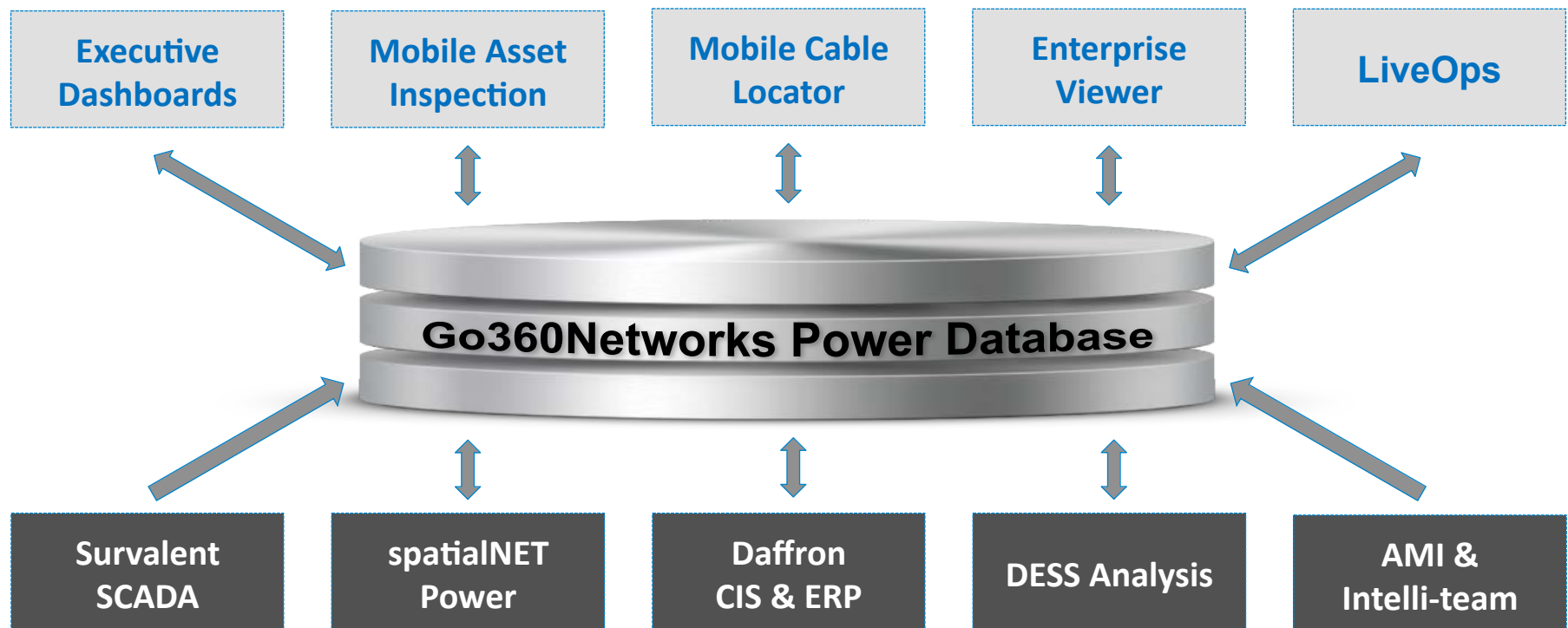
# Initial BHI Targeted Implementation

- **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

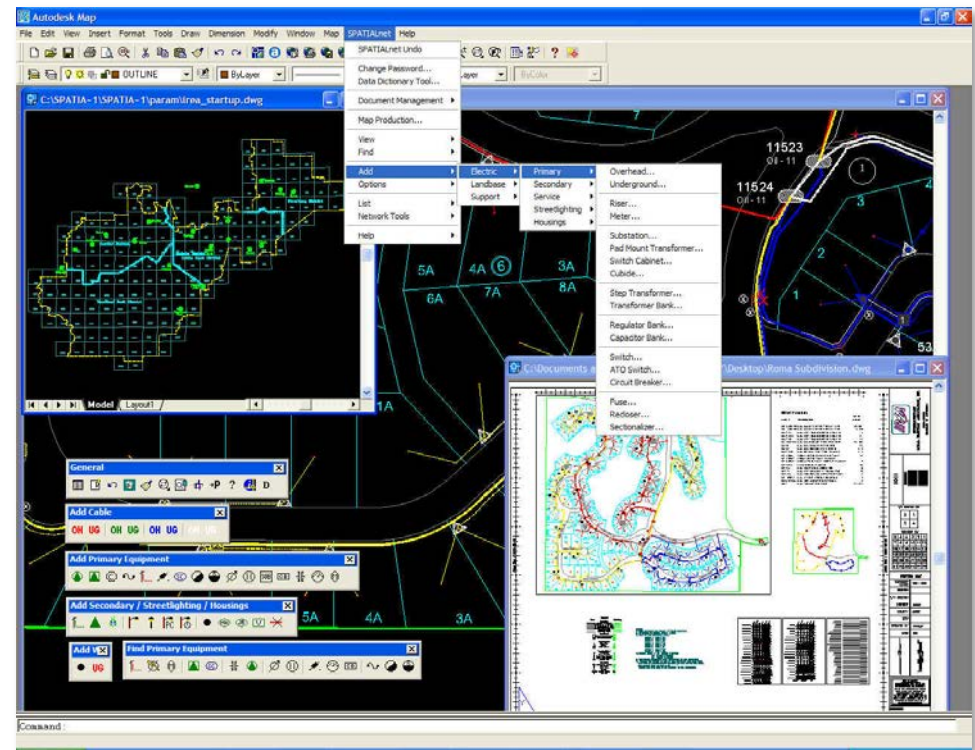
## Current Implementation at BHI





# 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)

The screenshot shows the AutoCAD 2008 interface with a network design project. Two dialog boxes are open over the drawing area.

**Pole Creation Dialog:**

- Operational Mode: Selection
- Autoselect newly created entity: ☐
- Date Installed: 23/Feb/2009
- Work Order Number: Horizon
- Equipment ID:
- Type: UTILITY\_POLE
- CU Package: NO\_PACKAGE
- Height: 45
- Class: 4
- Material: Wood
- Pole Date: 02/23/09
- Pole Use: Primary
- CC Status:
- Joint Use:
- Location:
- Framing Std No:
- Mfr:
- Treatment:

**CU Packages Dialog:**

CU Package	Description
04-033M	15KV VERT 2CKT 16-60DEG 50 POLE
04-035M	15KV 2CKT 61-90DEG 50 POLE
04-037M	15KV 2CKT VERT DEADEND 50 POLE
04-051M	44TANG15VERT 1CKT 0-4DEG 55 POLE
04-053M	44TANG15VERT1CKT 5-15DEG 55 POLE
04-055M	44TANG15VERT2CKT 0-4DEG 55 POLE
04-057M	
04-059M	
04-061M	
04-063M	
04-065M	
04-067M	
04-069M	
04-071M	
04-073M	
04-075M	
04-077M	
04-079M	
04-081M	

**Material List Table:**

DESCRIPTION	STOCK #	QUANTITY	VALUE	STORES	TOTAL
<b>MATERIAL LIST</b>					
ANCHOR 12"SINGLE HELIX3/4"	ANCH100	1	\$25.62	\$5.12	\$30.74
BOLT MACH 3/4"x10"	BOLT502	1	\$1.41	\$0.28	\$1.69
BRACKET POLETOP INSUL VE	BRAC101	1	\$10.91	\$2.18	\$13.09
CLAMP AERIAL	CLAM520	1	\$8.26	\$1.65	\$9.91
CONNECTOR TAP 266.8-4/0&3/	CONN401	2	\$6.11	\$2.44	\$14.66
CROSSARM HOLLOW STEEL 5	CROS106	1	\$62.10	\$12.42	\$74.52
INSUL VERT POST 15KV	INSU900	1	\$43.31	\$8.66	\$51.97
<b>TOTAL MATERIAL</b>					<b>\$196.60</b>
<b>LABOUR</b>					
	#OF MEN	HOURS	TOTAL	\$/HRS	TOTAL
	2	2.5	5	40	\$200.00
<b>TOTAL LABOR</b>					<b>\$200.00</b>
<b>TOTAL GRAND</b>					<b>\$369.60</b>



# BHI spatialNET Power 7cm Ortho Imagery Example



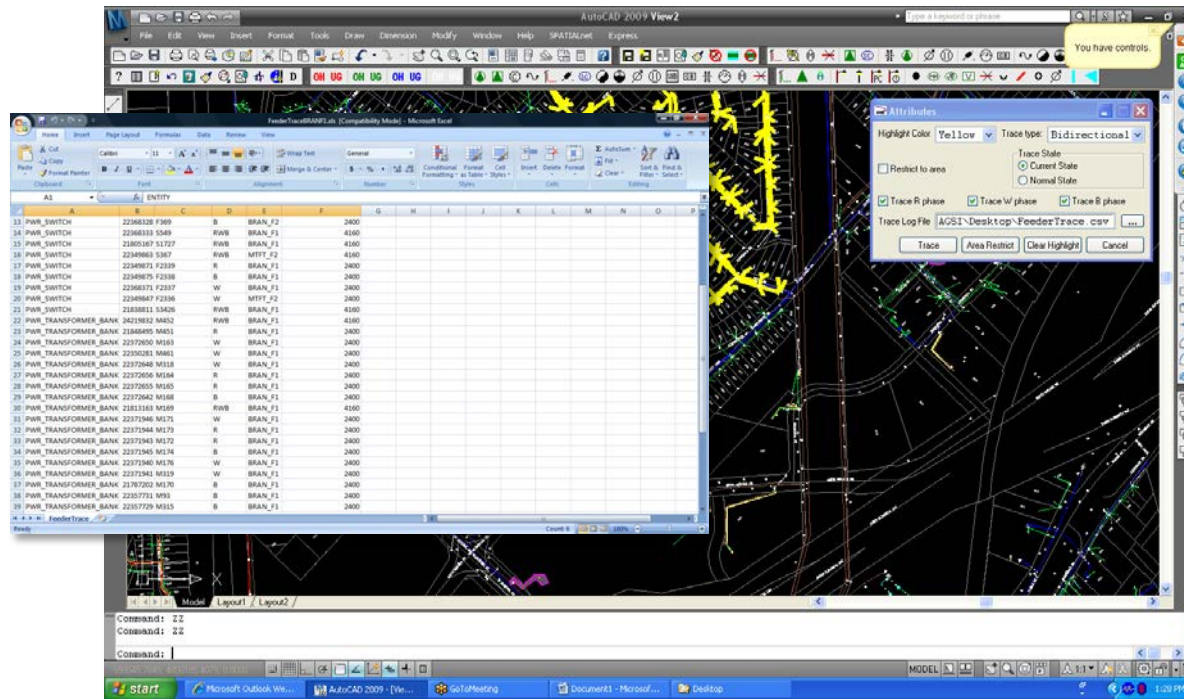
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# BHI spatialNET Power Examples

## Network Connectivity Trace and Equipment Report





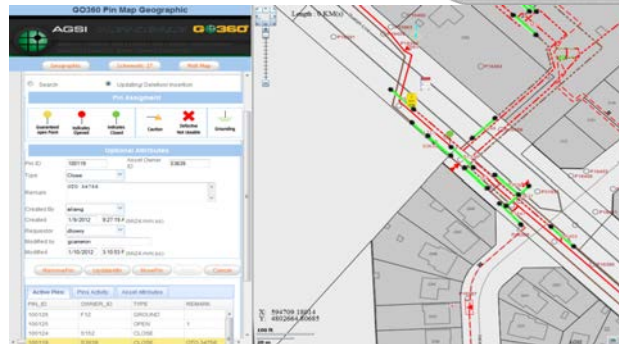
# Enterprise Go360Networks Web

## 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



# GO360 Networks Live Applications Integration and Deployment at BHI Examples





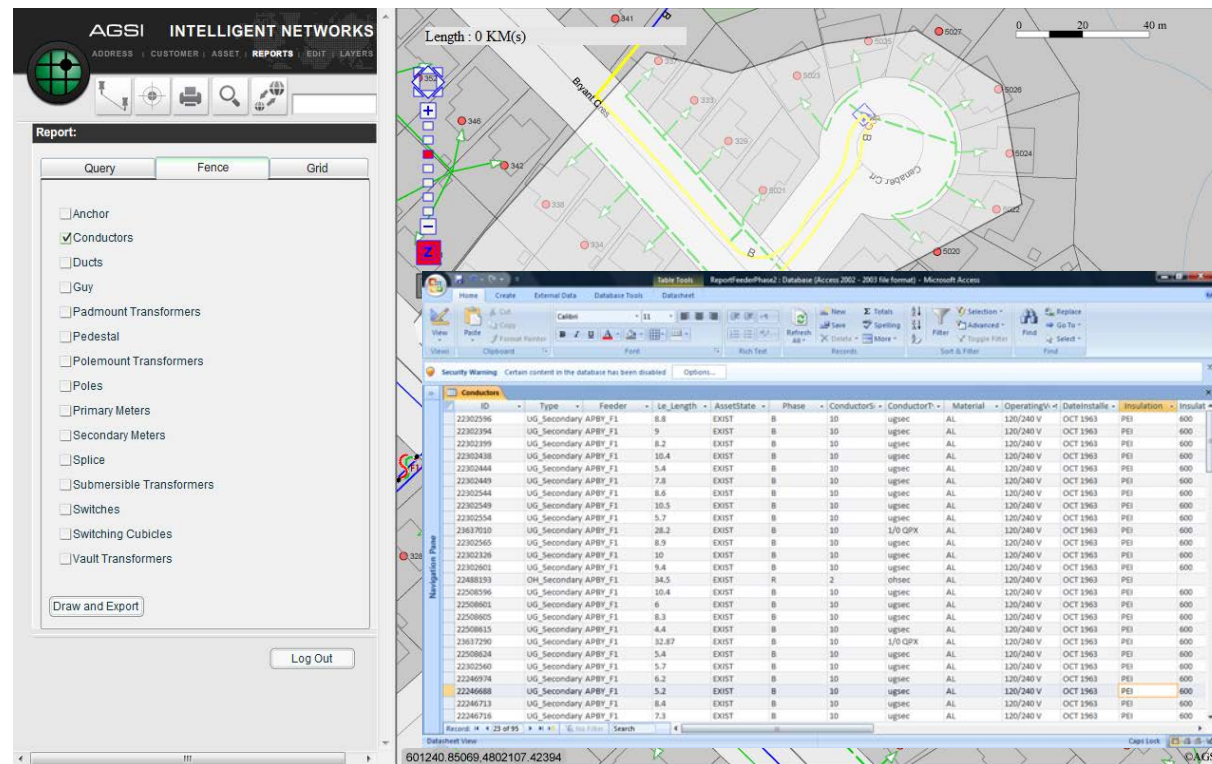
# Go360net: Live Access Via The Web Supporting Asset Management And Operations

The screenshot displays the AGSI Intelligent Networks web application interface, which is divided into several sections:

- Asset Attributes - Key ID 22295727:** A list of attributes for a specific asset, including:
  - SType: PWR\_POLE
  - Job\_ID: AV/NEON
  - Asset\_State: EXIST
  - Journal: 0
  - JMO\_Status: 0
  - Published: Y
  - Date\_Published: 1/28/2010 10:01:10 PM
  - Type: B-H Pole
  - Height: 0
  - Pole\_Date: 1/1/1800 12:00:00 AM
  - Pole\_Use: P8200
  - Class: -
  - Material: -
  - Local #: P8200
  - Instruction Order Num: -
  - Work Order Number: -
  - Address: -
  - Street\_Location: BACKLOT
  - Treatment: -
  - Treatment\_Length: -
  - Number\_Of\_Gaps: 0
  - Number\_Of\_Anchors: 0
  - Attached\_Equipment: -
  - Equipment\_ID\_Number: -
  - Joint\_Use: 3228
  - Joint\_Use\_Attachment: -
  - Control\_Wire\_BH\_Sec: -
  - Permit\_Number: -
  - Map\_Grid: -
- Layers:** A list of layers available for the map, including:
  - Civil
  - Conductors
  - Fault Indicator
  - Grids
  - JobFootPrint
  - Junction Box
  - Meters
  - OH Transformers
  - Poles
  - Proposed
  - Riser
  - Splice
  - Substations
  - Switches
  - Switching Cubicle
  - Tail Terminator
  - Transformers
- Map:** A map showing the location of the asset, with various colored lines and markers representing different types of infrastructure. A scale bar indicates a length of 0 KM(s).
- Photo Viewer:** A window showing a photo of the asset, labeled "IMG\_7550.jpg", with a date of "January 27-A" and a location of "Pole". The photo shows a utility worker on a pole in a snowy environment.

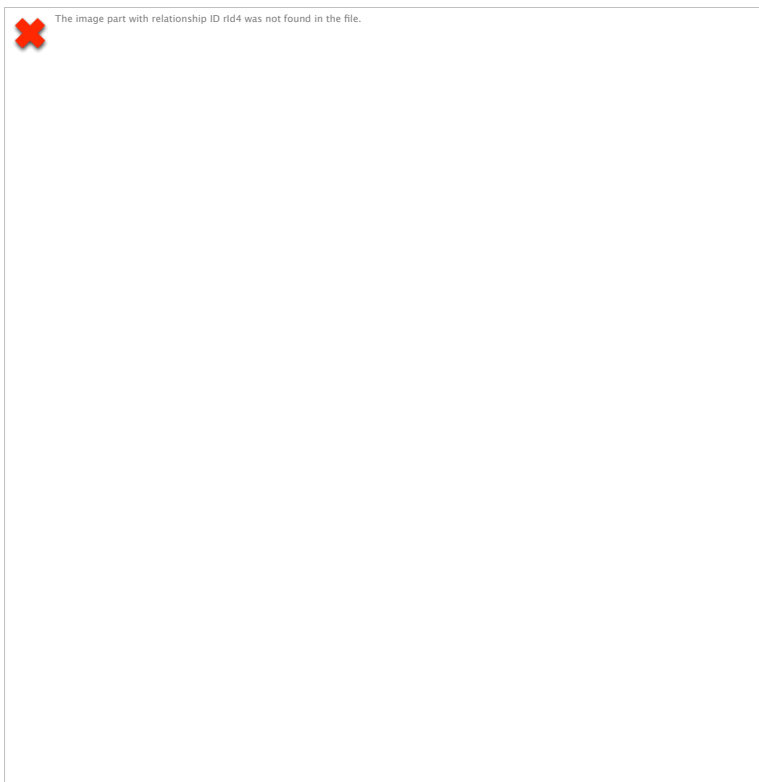


# Associated Asset Report e.g. Age and Proximity to Other Planned Work



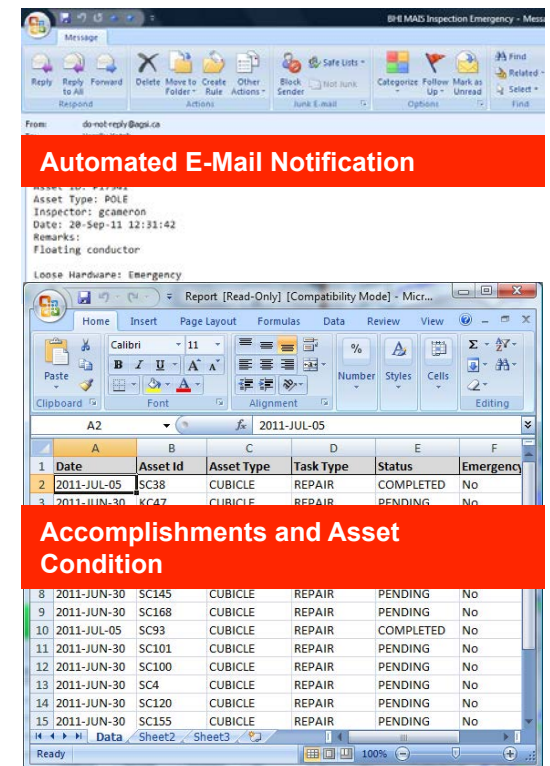
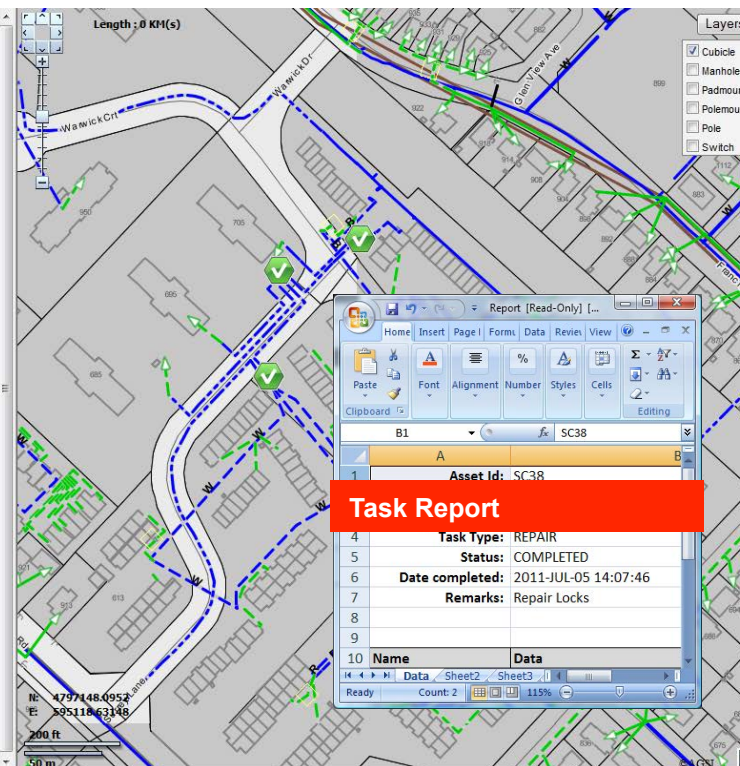
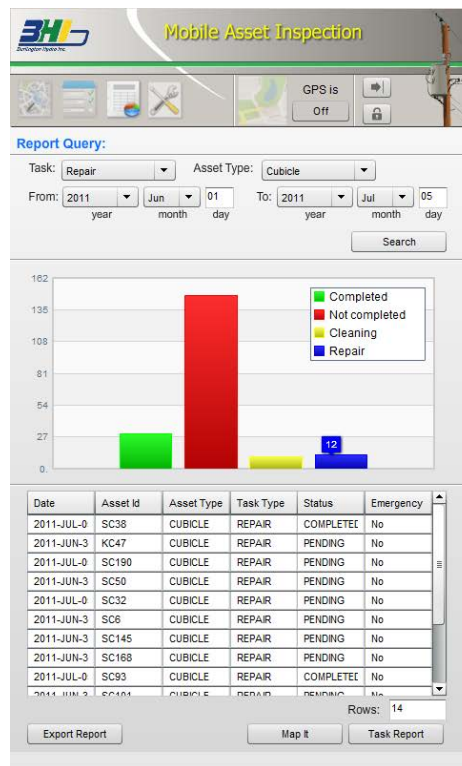


## Mobile Solutions: Field Asset Inspection Example





# Analysis and Work & Accomplishment Reporting





# 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



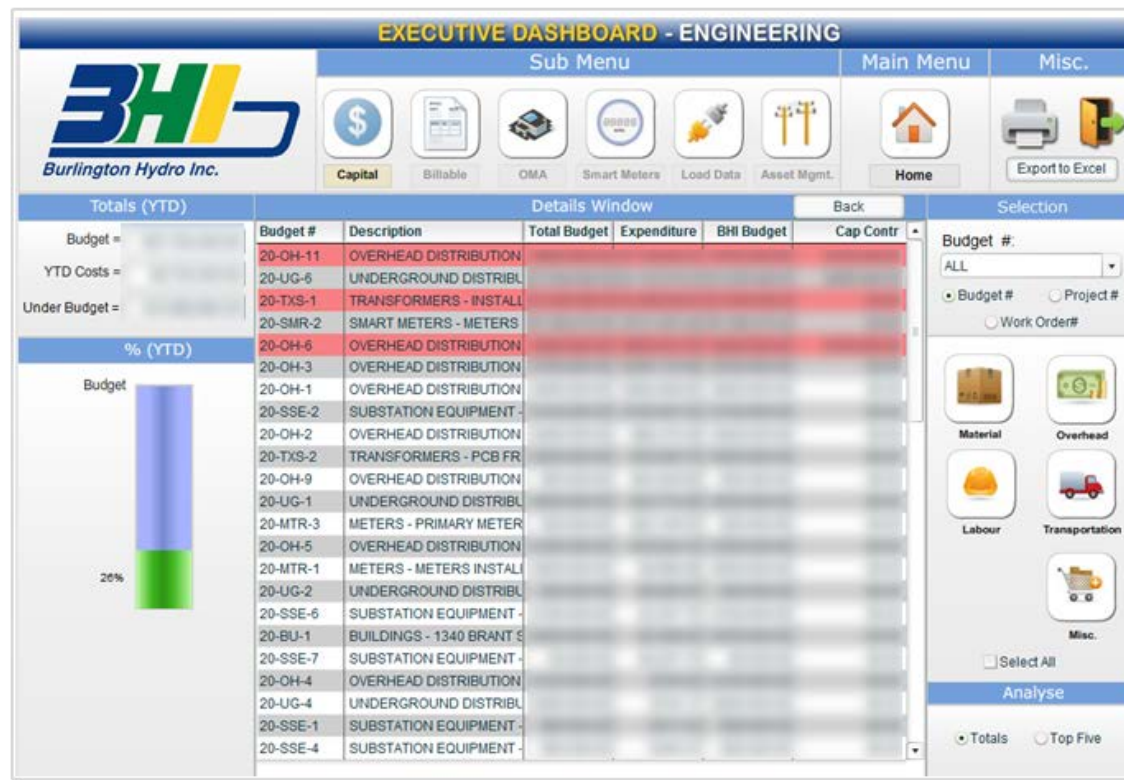


# Performance Monitoring Dashboards

## 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

The screenshot displays the GO360LiveOps Geographic View interface. On the left, there is a sidebar with navigation tabs: Geographic, Schematic 13, and Schematic 27. Below these are icons for Wall Map, Pin Map, and other functions. A search bar is present, and a 'Pin Operations' section includes buttons for 'RemovePin', 'UpdateAttri', 'MovePin', 'Post', and 'Cancel'. The main map area shows a network of lines (likely power lines) with various pins placed along them. A detailed attribute panel is open for a specific pin, showing the following information:

Pin ID:	100492
Asset Owner ID:	S413
Type:	CLOSED
Remark:	OTO 3467 - Load Shifting
Created By:	gcameron
Created:	2012-05-07
Requestor:	Pgerman
Modified by:	gcameron
Modified:	2012-05-07

### Allows for:

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

# GO360LiveOps

## Schematic View

The screenshot displays the GO360LiveOps Schematic View interface. The top navigation bar includes tabs for Geographic, Schematic 13, and Schematic 27, with a 'Wall Map' button below. The main map area shows a schematic diagram with red and blue lines representing assets, and several buildings labeled 'TYNDAGA MS', 'ORCHARD MS', and 'BRANT MS'. A detailed attribute window is open over a specific pin, displaying the following information:

Pin ID:	100388
Asset Owner ID:	S2729
Type:	GUARANTEED OPEN
Remark:	
Created by:	nkoopman
Created:	2012-04-25
Requestor:	
Modified by:	nkoopman
Modified:	2012-04-25

The left sidebar contains search and operation tools. The 'Pin/Tag Layer' is set to 'PIN\_SCHEM13'. Below this are buttons for 'Address Search', 'Feature Search', and 'Pin Operations'. The 'Pin Assignment' section includes icons for 'Guaranteed open Point', 'Indicates Opened', 'Indicates Closed', 'Caution', 'Defective Not Useable', and 'Grounding'. The 'Optional Attributes' section includes input fields for Pin ID, Owner ID, Type, Remark, Created, Created on (hh24mm:ss), Requestor, and Modified On (hh24mm:ss). At the bottom of the sidebar are buttons for 'RemovePin', 'UpdateAttri', 'MovePin', 'Post', and 'Cancel'.





# GO360LiveOps Reports

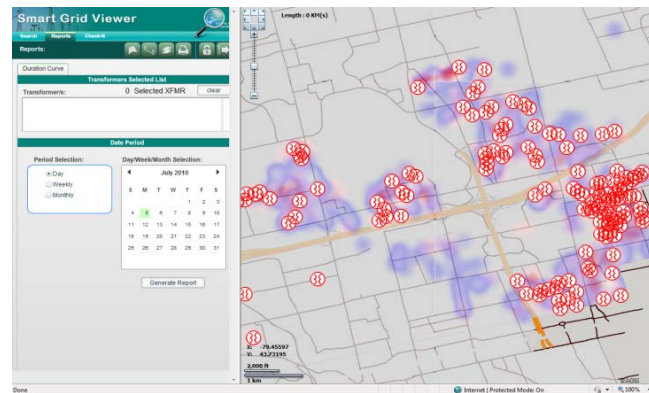
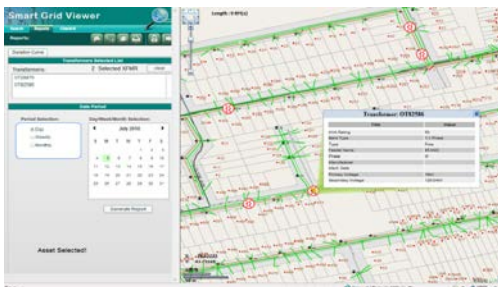
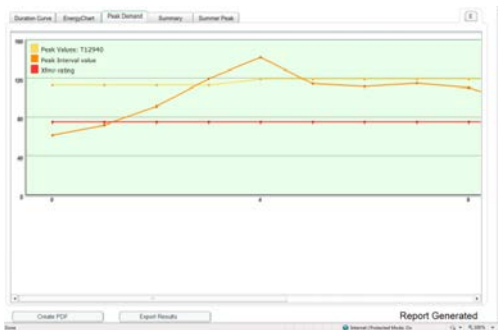
Report Active Pins by Type					
PIN_ID	REQUESTOR	USERID	TYPE	OWNER_ID	CREATE_DATE
100295	Pgerman	aliang	OPEN	FP339	07/03/2012 1:54:03 PM
100303	Pgerman	gcameron	OPEN	FM111	14/03/2012 8:29:53 PM
100306		gcameron	OPEN	L235	16/03/2012 9:04:38 PM
100307		gcameron	OPEN	F817	17/03/2012 8:49:11 AM
100308		gcameron	OPEN	S276	20/03/2012 2:17:32 PM
100309	Pgerman	psmith	OPEN	S2979	23/03/2012 5:20:18 PM
100324	Nkoopman	gcameron	OPEN	S3635	09/04/2012 9:01:16 AM
100341		gcameron	OPEN		16/04/2012 1:35:39 PM
100343		nkoopman	OPEN		16/04/2012 3:19:53 PM
100361		nkoopman	OPEN		17/04/2012 10:28:23 AM
100363	Nkoopman	psmith	OPEN	S109	17/04/2012 1:12:34 PM
100381		nkoopman	OPEN		18/04/2012 4:45:01 PM
100382		nkoopman	OPEN		19/04/2012 9:56:33 AM
100392		nkoopman	OPEN	S2730	08/05/2012 4:01:01 AM
100420		nkoopman	OPEN	N203	30/04/2012 10:01:42 AM
100431		nkoopman	OPEN		01/05/2012 12:21:43 PM
100469		HXIA	OPEN		04/05/2012 2:46:16 PM
100480		nkoopman	OPEN		04/05/2012 5:38:36 PM

Results: 18

ExportReports



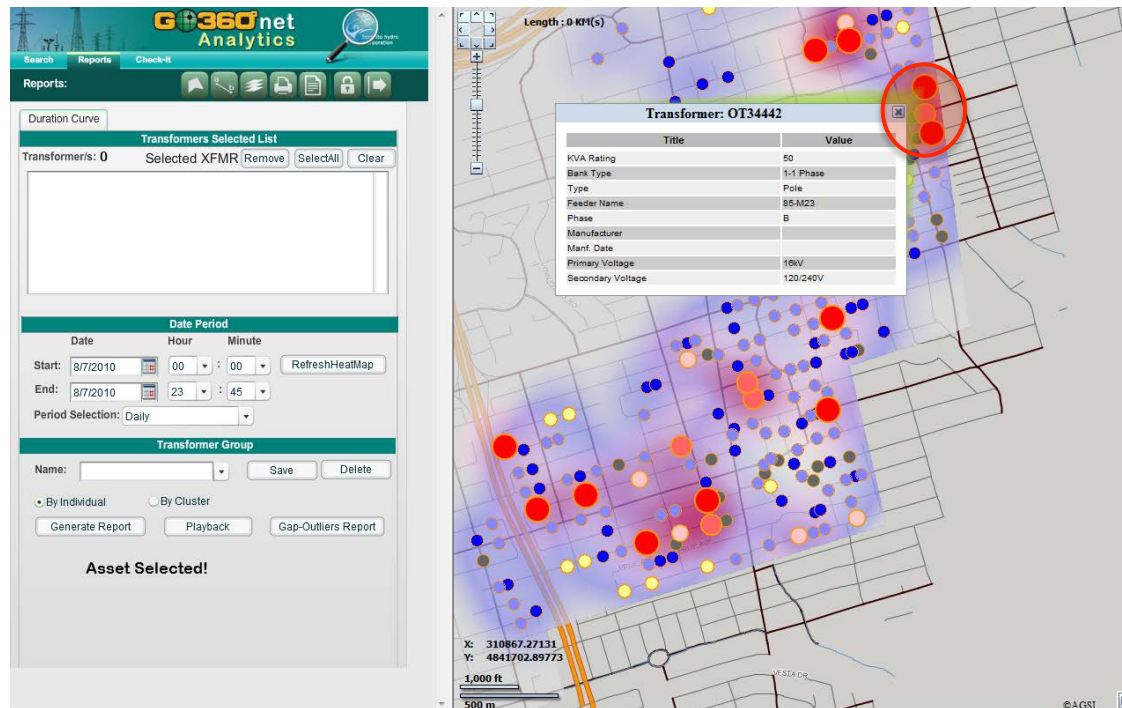
# AMI Integration Example – Transformer Monitoring and Analysis





# Real-Time Smart Grid for Operations and Asset Analytics e.g. Overload Analysis Example

## Detailed Geographic View. Transformer Overloading

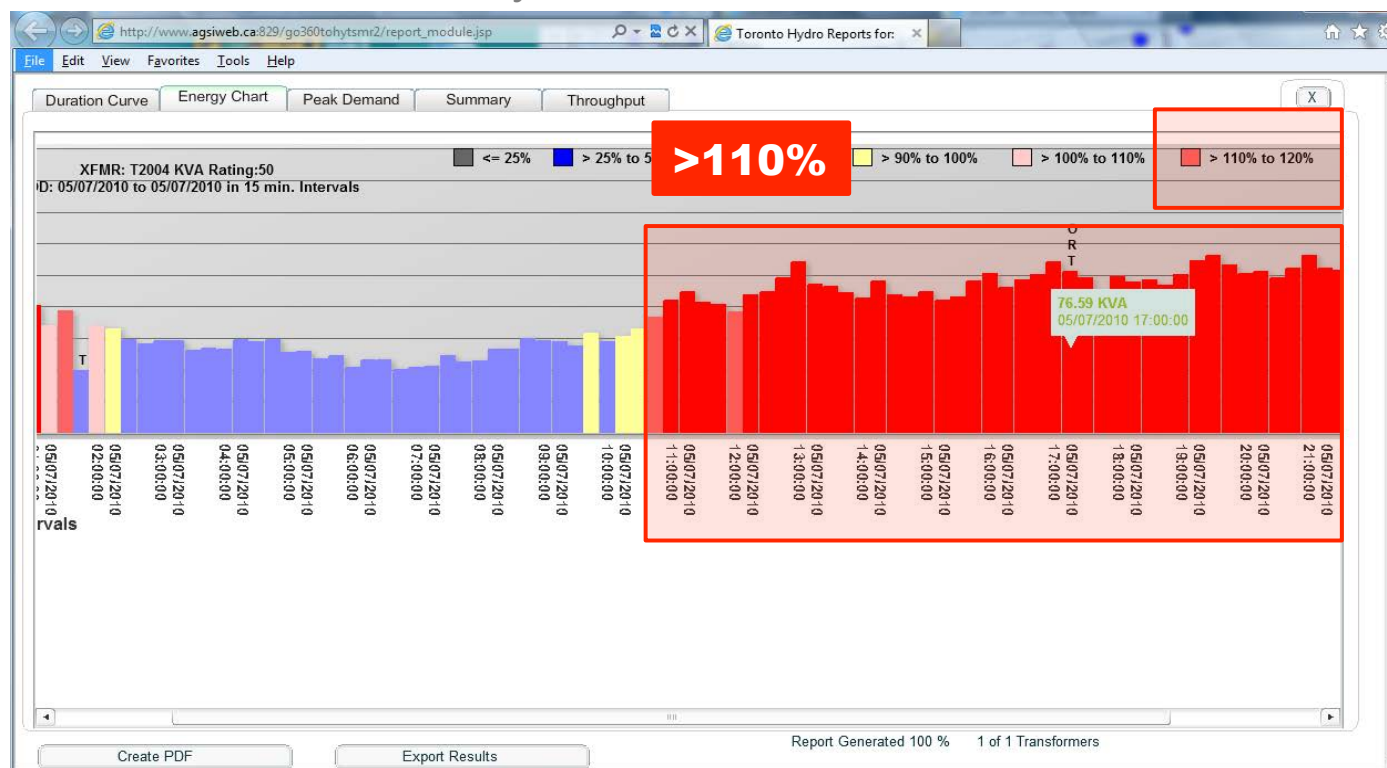




# Smart Grid for Operations and Asset Analytics

Loading Profile at Transformer

Color Coded by % Overload In 15 min. Intervals



# Smart Grid for Operations and Asset Analytics

## Transformer Daily Summary Report (July 5, 2010)

Transformer Number: OT3979		Report Period: 05/07/2010 to 05/07/2010 in 15 min. Intervals	
		Formula	
Transformer Rating:	50.0 KVA		
Peak Demand:	88.53 KVA	Peak Interval Reading (kW/15min) * 4 / 0.9 (kVA)	
Peak Demand:	79.68 KWh	<b>Overload: 64% of the time</b> (was reset)	
Overload:	64 %	% of time for which transformer is overloaded	
Load Factor Rating:	0.64	Ratio of Avg. Demand to Max. Demand	
Use Factor Rating:	1.77	Ratio of Peak Demand (kVA) to Installed Capacity	
Outage Count:	1	Derived from AMRDEF daily outage summary values	
Outage Duration:	15.0 Minutes	<b>Loss of Life: 1.11%</b>	
Loss of Life:	1.11 %	As Defined by Appropriate IEEE Standard	
Coincidence Factor:	1.0	Max. simultaneous demand (in kVA) divided by sum of maximum demands of each device (in kVA)	
Throughput:	1227.27 KWh		

# Smart Grid for Operations and Asset Analytics

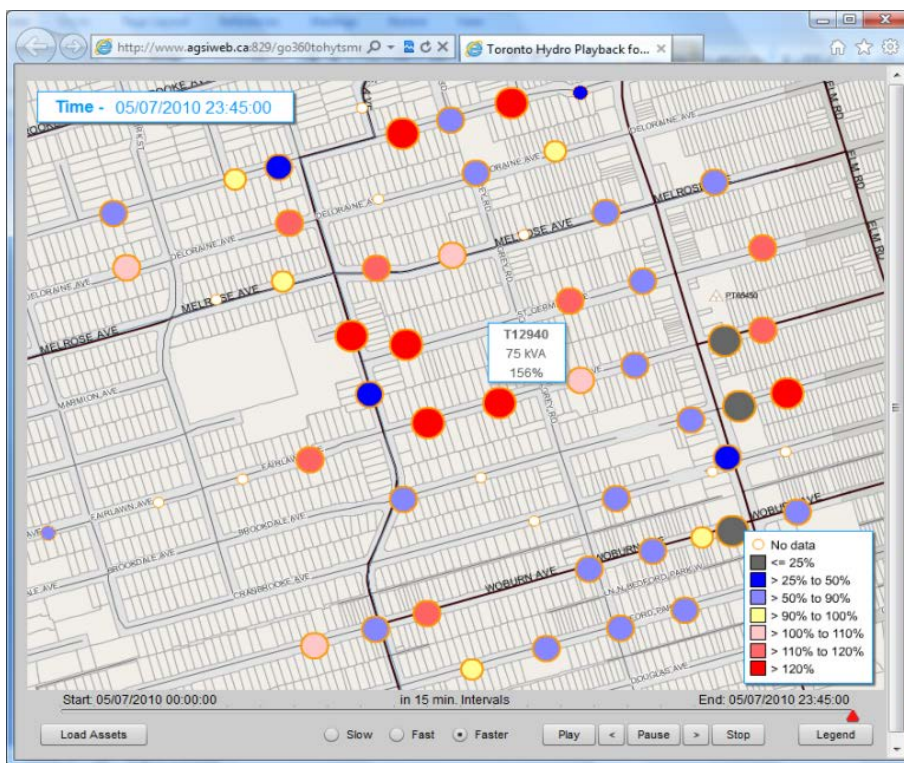
Transformer Weekly Summary Report (July 5 to July 9, 2010)

Transformer Number: OT3979		Report Period: 05/07/2010 to 09/07/2010 in 2 hour Intervals	
		Formula	
Transformer Rating:	50.0 KVA		
Peak Demand:	91.93 KVA	Peak Interval Reading (kW/15min) * 4 / 0.9 (kVA)	
Peak Demand:	82.74 KWh	<b>Overload: 74% of the time</b> (was reset)	
Overload:	74 %	% of time for which transformer is overloaded	
Load Factor Rating:	0.65	Ratio of Avg. Demand to Max. Demand	
Use Factor Rating:	1.84	Ratio of Peak Demand (kVA) to Installed Capacity	
Outage Count:	2	Derived from AMRDEF daily outage summary values	
Outage Duration:	30.0 Minutes	<b>Loss of Life: 6.7%</b>	
Loss of Life:	6.7 %	As Defined by Appropriate IEEE Standard	
Coincidence Factor:	1.0	Max. simultaneous demand (in kVA) divided by sum of maximum demands of each device (in kVA)	
Throughput:	6481.07 KWh		



# Smart Grid for Real-Time Operations and Asset Analytics

Time Based Playback Example



July 5<sup>th</sup> [Midnight]

July 5<sup>th</sup> [7 AM]

July 5<sup>th</sup> [5 PM]

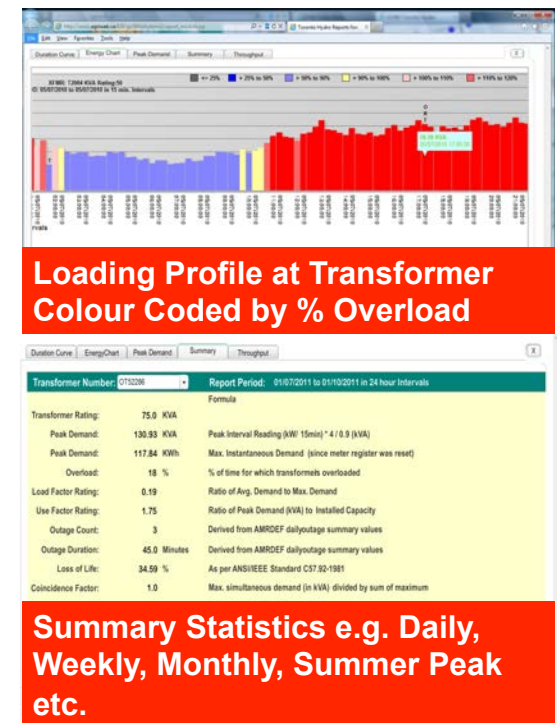
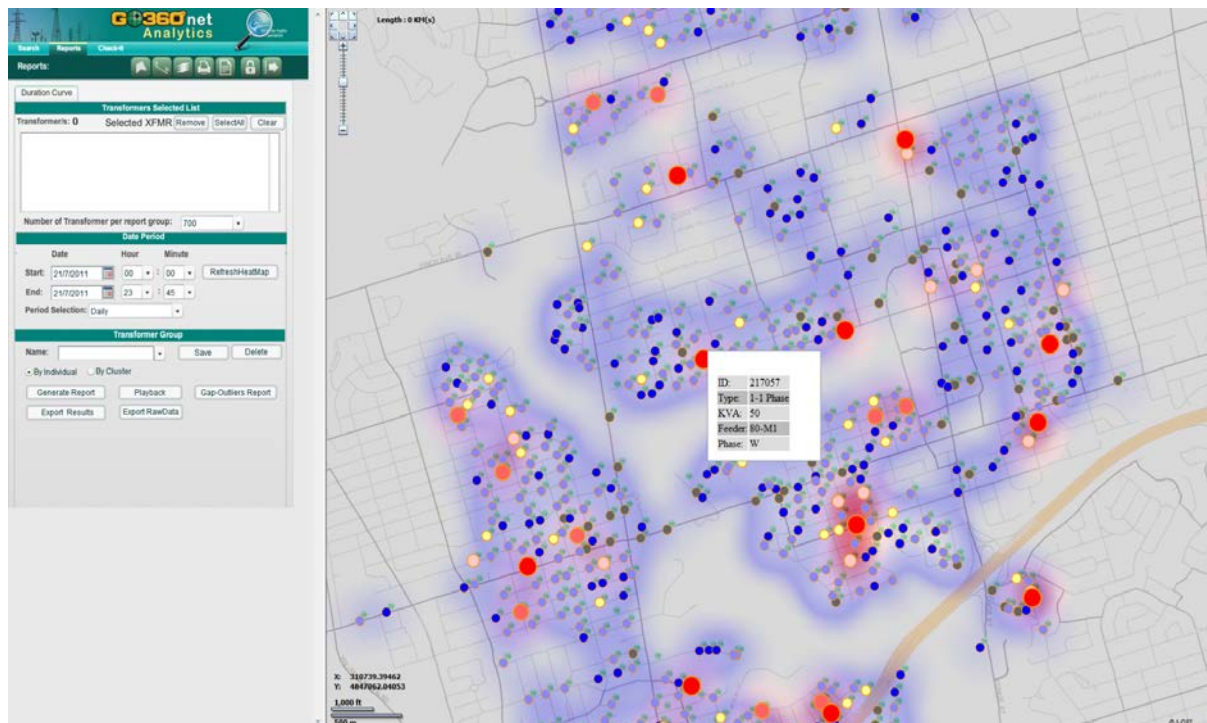
*Temporary Outage Events*

July 6<sup>th</sup> [Midnight]



# AMI Asset Analytics

## Detailed Geographic View of Transformer Overloading







# 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