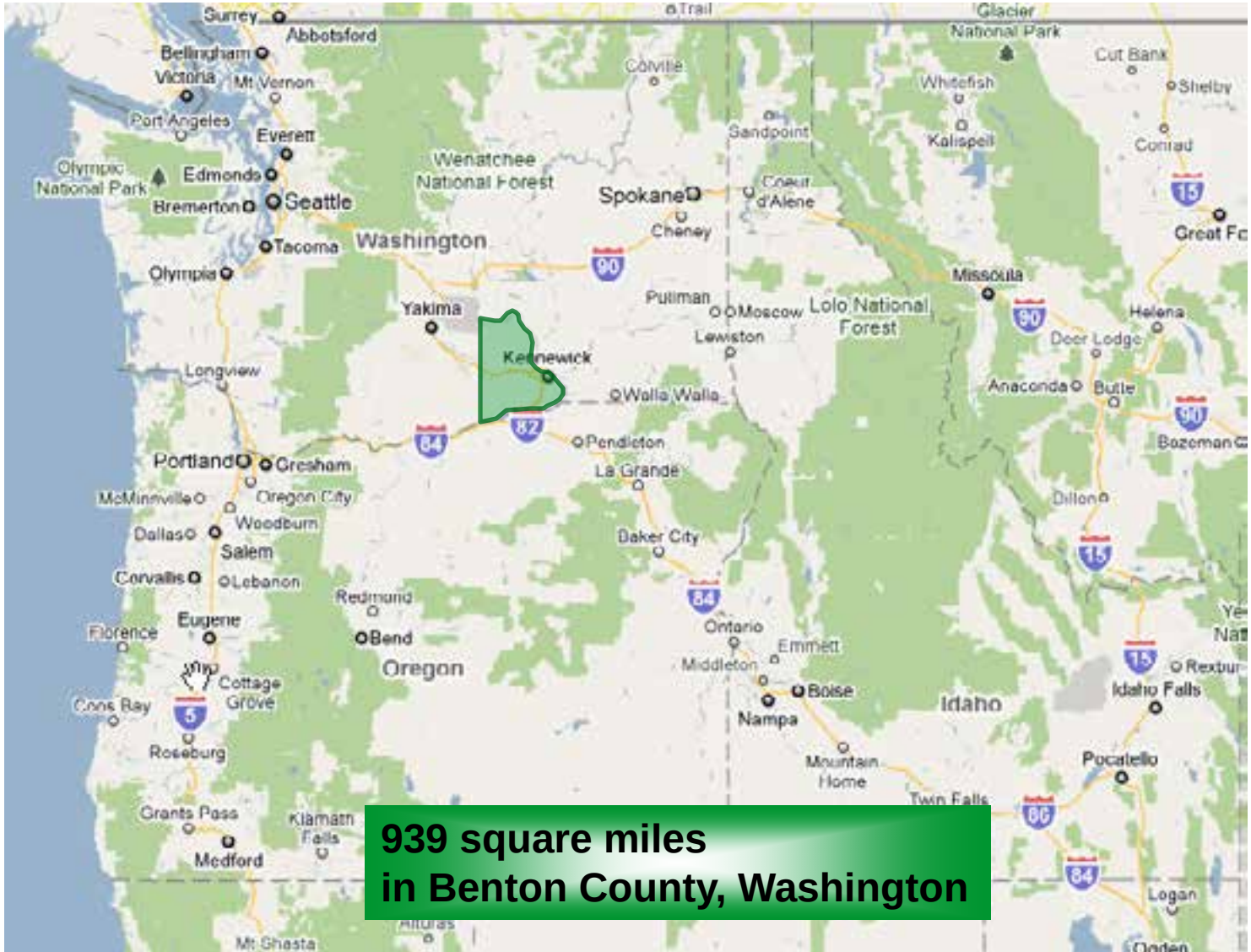
GIS and ADMS for Smart Grid Data Analytics

Jared Waddell
GIS Specialist
Benton PUD

John Dirkman, P.E.
Smart Grid Product Manager
Schneider Electric

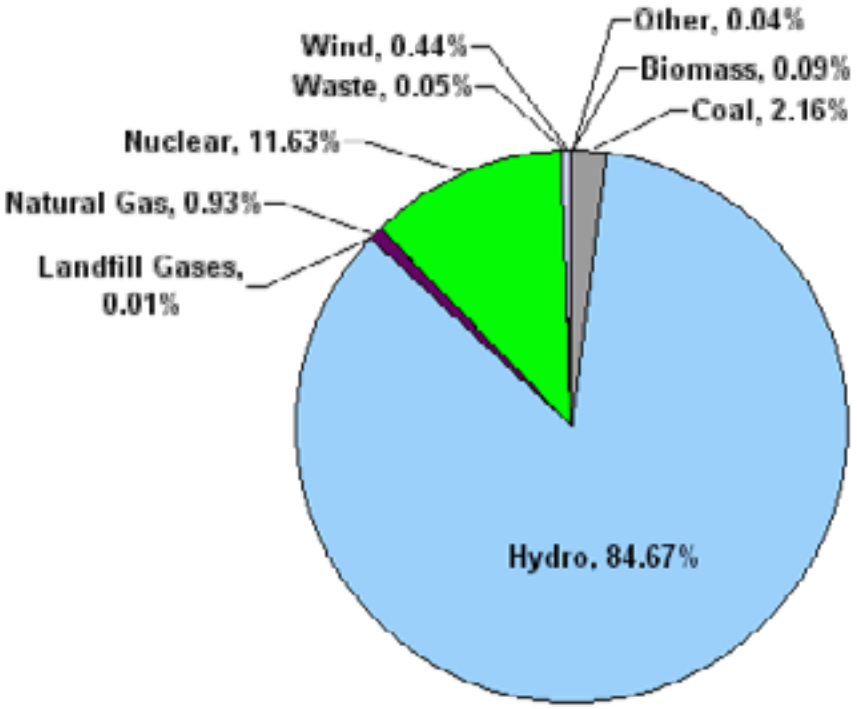
Esri User Conference
17 July 2014

Benton PUD Location



Benton PUD Overview

- Number of Customers: 48,455
- Residential Electric Rate: $0.0605 / kWh
- 115 kV transmission lines: 91 miles
- Distribution lines: 1,596 miles
- Substations: 37
- Substation Capacity: 653 MVA
- System Peak (2009): 401 MW
- Transformers: 17,745
- Meters: 47,487
- Employees: 148
- Fuel Mix:



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the global specialist
in energy management

A global company

$34 billion revenue in 2013

43% of sales in new economies

160,000+ people in 100+ countries

committed to innovation

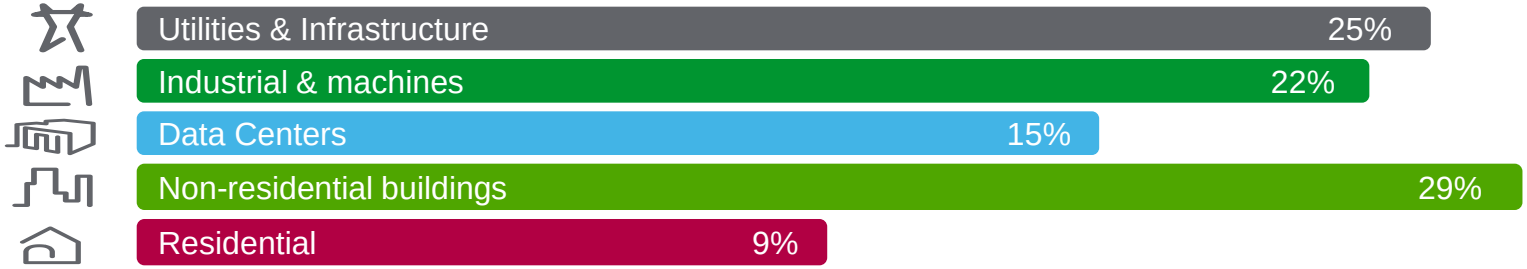
4-5% of sales devoted to R&D

~$1.5 billion devoted to R&D

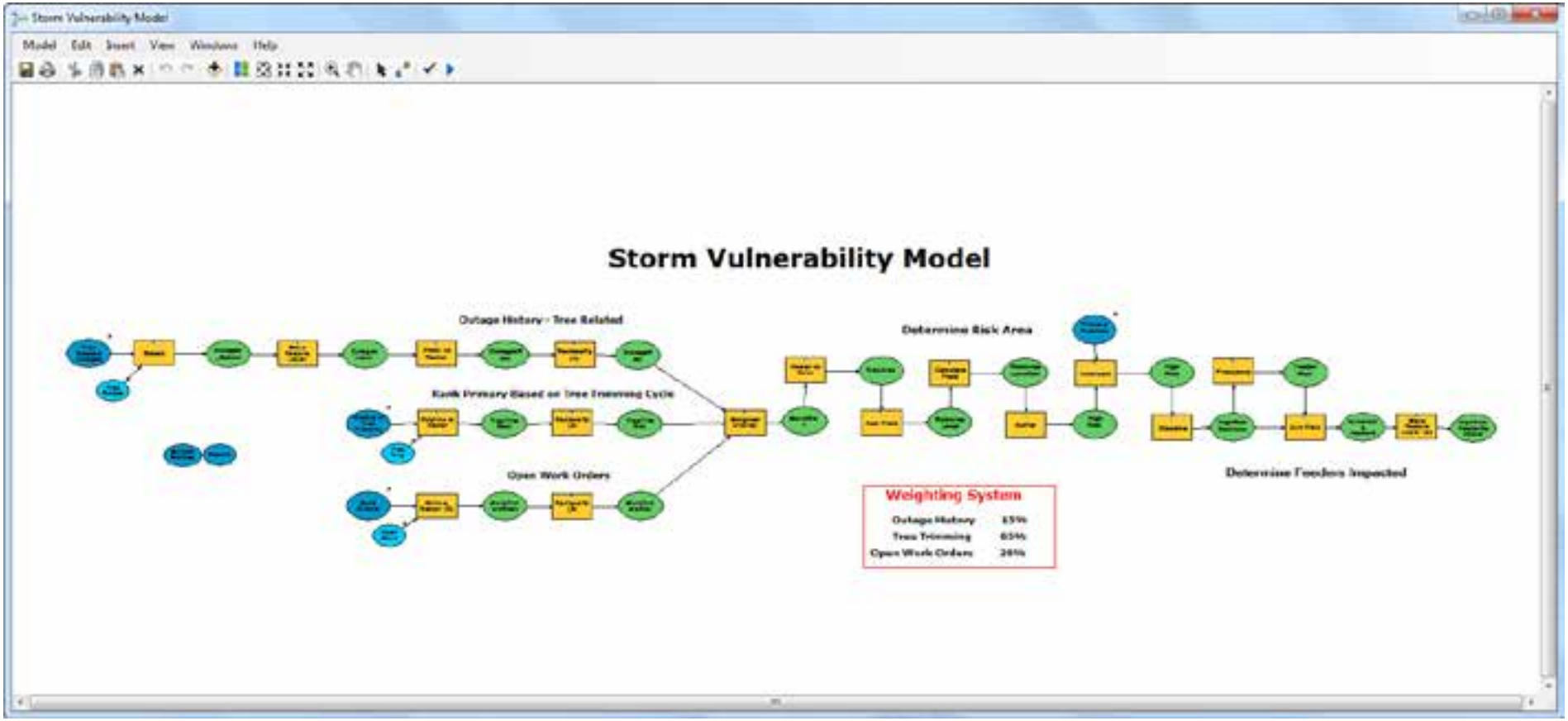
Some of the world class brands that we have built or acquired in our 175 year history

SQUARE D by Schneider Electric
TELVENT
dtn
AREVA
invensys
APC by Schneider Electric
xantrex Smart choice for power
SummitEnergy
PELCO by Schneider Electric
PowerLogic
NU-LEC INDUSTRIES
Modicon

Delivering Solutions for End Users



ArcGIS for Analytics



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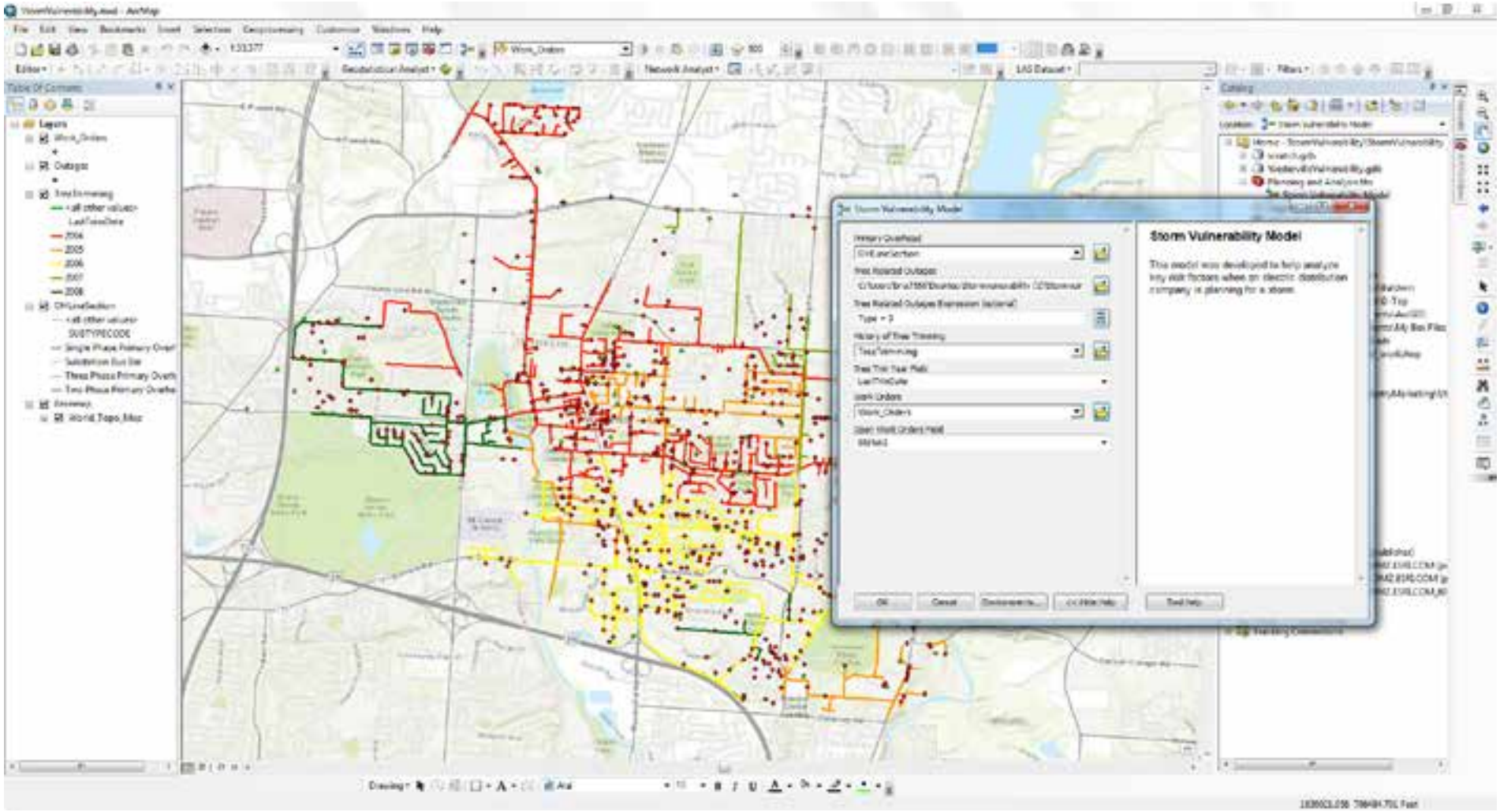
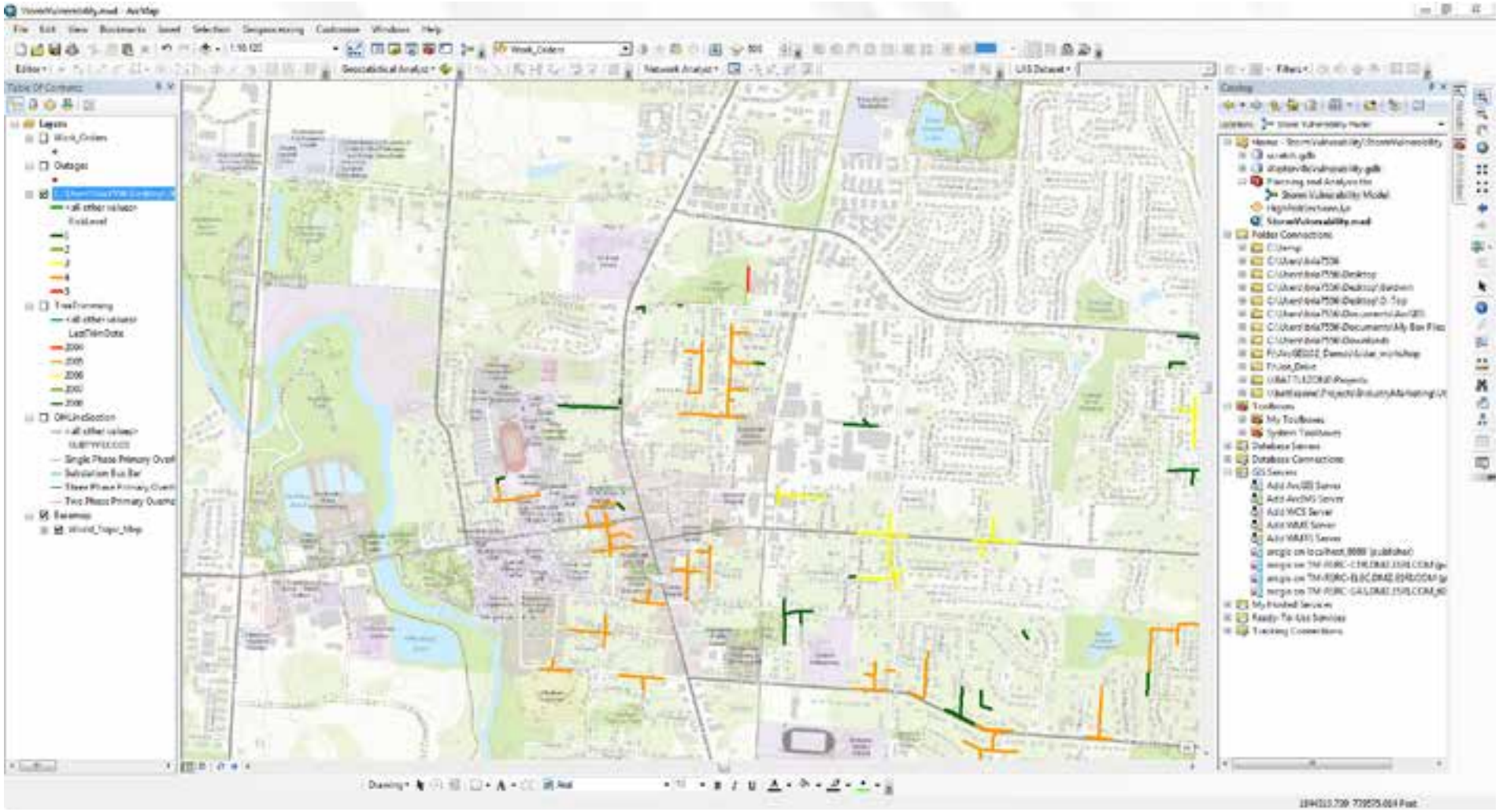
ArcGIS for Analytics



ArcGIS for Analytics



Custom Gas Autoupdaters

- SetInspectionStatus Autoupdater
  - Assigns a value to the InspectionStatus field for valves, exposed pipe, and regulators
  - InspectionStatus value is determined based on the value of the related inspection object's InspectionDueDate and the current system date

Code	Description	Symbology
99	Due In More Than 90 Days	green
90	Due Within 90 Days	yellow
30	Due Within 30 Days	orange
0	Out of Compliance	red

Custom Gas Autoupdaters

- CreateInspection Autoupdater
  - When an inspection is completed (the InspectionCompletionDate field populated by the user):

1. create a new inspection record in the inspection table
2. copy the Related*Feature*OID field
3. populate the InspectionDueDate field with a value of the InspectionCompletionDate field plus a duration read from a configurable table

Custom Gas Autoupdaters

- SetPassFail Autoupdater
  - When a user updates the RESULTS field for a Reading object, this AU writes a pass/fail value to the PassFail attribute
  - The pass/fail value shall depend on a comparison of values in a configurable table

Object	Comp	PassValue
RectifierReadings	GT	1.45
TestPointReadings	LT	0.34

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Routing for Inspections

Total Distance: 1.1 mi
Total Time: 2 min

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How do Weather Services Help Prepare a Utility's Response?

- Must address all types of weather causing outages
  - Lightning
  - Wind
  - High heat/humidity
  - Ice and heavy snow
  - Hurricanes and tornados
  - Heavy rain/flooding
- Visibility is key to preparedness
  - What will happen?
  - Precisely when?
  - Where will service territory be impacted?
- Key decisions
  - Crew on-call, holdover, and dispatch
  - Pre-positioning and mid-storm positioning
  - Mutual assistance calls – in both directions
  - Materials requirements

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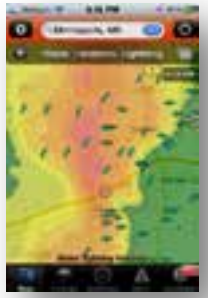
Keys to Weather Preparedness

- Before event:
  - High quality forecasts
  - Expert meterological consultation
  - Alerting
- During/just before event:
  - Real time lightning
  - Nowcasting tools
  - Current situational awareness
  - GPS all-clear alerting
- After event:
  - Post-storm inspection tools



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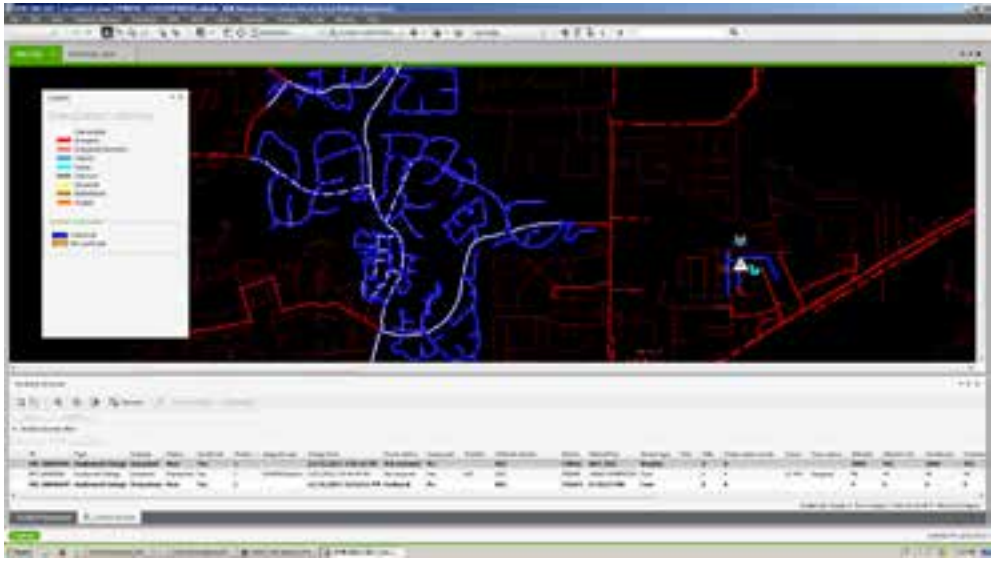
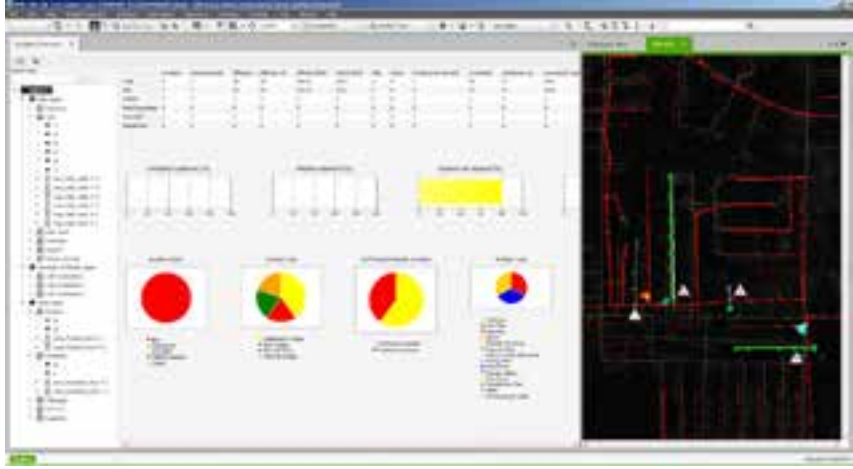
During Storm - Improved Response

- Track and Manage Real Time Weather Information
  - Storm events: lightning, wind, heavy snow, ice
  - Crew safety and restoration
- Initiation of Restoration Activities
  - Track and predict outages via analytics
  - All-clear alerting
- Improved Situational Awareness
  - Internal Common Operating Picture (COP), including mobility
  - Call management functionality for customer trouble calls



After Storm



- Reduced Restoration Time
  - Predictive Outage Optimization
  - Crew management and optimization
- Timely updates for public
  - Accurate estimated time of restoration (ETR)
  - Public outage web maps
- Damage Assessment
  - Spatial relationship of weather events to network assets
  - Lightning strikes
  - Outage cause analysis
- Feed back into future preparations
  - Better crew positioning and equipment availability
  - Lightning arresters, switch placement, network reinforcement

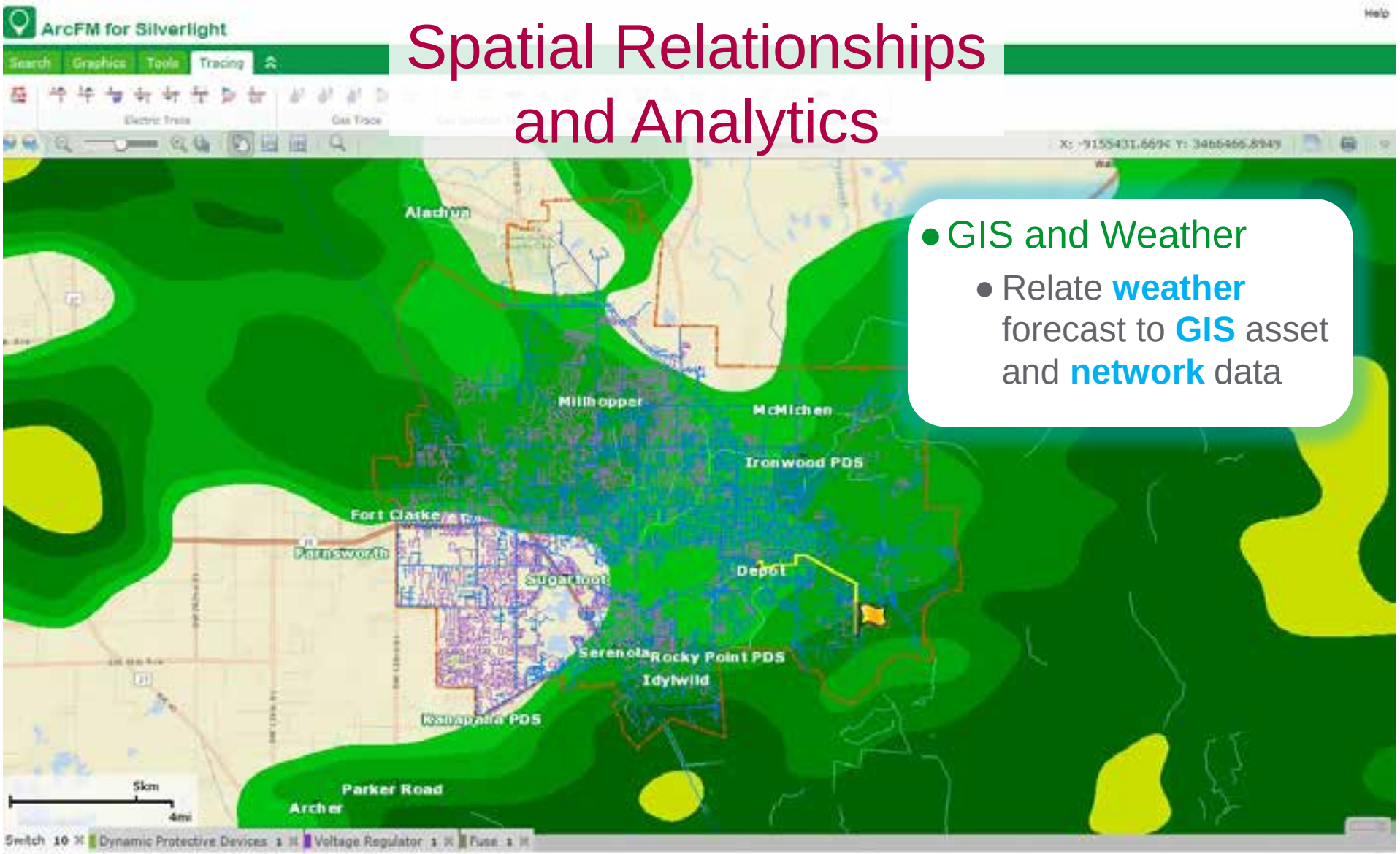
$$\mathrm{SAIDI} = \frac{\sum U_i N_i}{\sum N_i}$$

$$SAIFI = \frac{\sum N_i}{N_T}$$

$$\mathrm{CAIDI} = \frac{\sum U_i N_i}{\sum \lambda_i N_i}$$

$$CAIFI = \frac{\sum N_i}{CN}$$

Spatial Relationships and Analytics

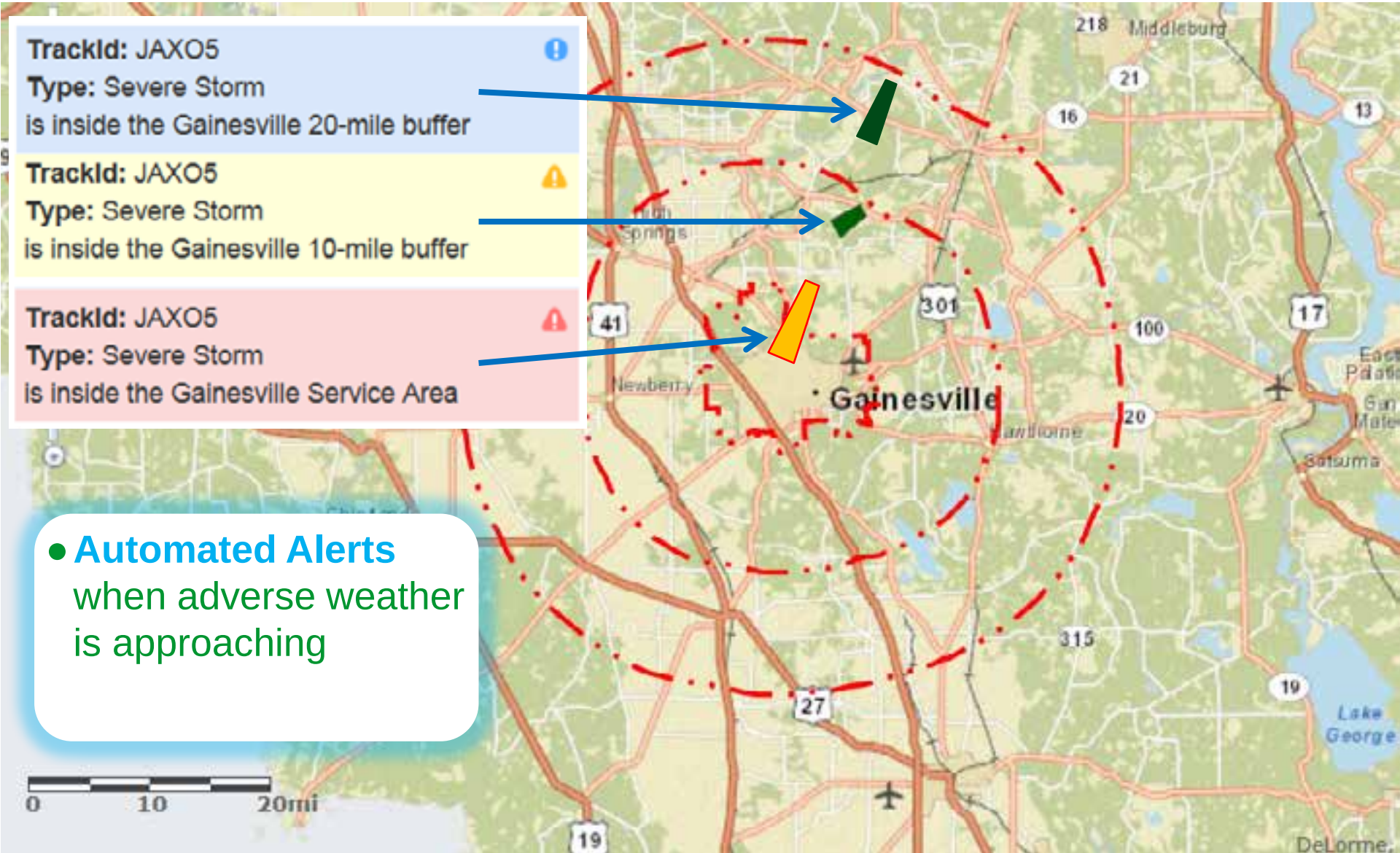


- GIS and Weather
  - Relate **weather** forecast to **GIS** asset and **network** data

Switch 10 | Dynamic Protective Devices 1 | Voltage Regulator 1 | Fuse 1

	Facility ID	Subtype	Phase Designation	Normal Position A	Normal Position B	Normal Position C	FEEDERID	FEEDERID2	Operating Voltage	Installation Date	Device ID
37388-NONE984	37388-NONE984	Double Deadend	A	Closed	Not Applicable	Not Applicable	203		12.5 kV Grounded Y		
17211-DXL460	17211-DXL460	Blade	ABC	Closed	Closed	Closed	203		12.5 kV Grounded Y	5/7/1997	DXL460
55084-NONE1389	55084-NONE1389	Double Deadend	ABC	Closed	Closed	Closed	203		12.5 kV Grounded Y		
50646-DXL475	50646-DXL475	Blade	ABC	Closed	Closed	Closed	203		12.5 kV Grounded Y	10/14/1997	DXL475
16722-DXL517	16722-DXL517	Blade	ABC	Closed	Closed	Closed	203		12.5 kV Grounded Y	5/6/1997	DXL517
23536-DX676	23536-DX676	Blade	ABC	Closed	Closed	Closed	203		12.5 kV Grounded Y		DX676

Event Alerts

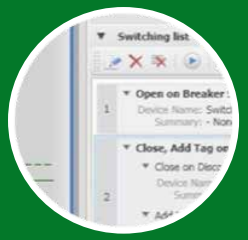


- **Automated Alerts** when adverse weather is approaching

The Advanced DMS

DMS

Network automation, FLISR, VVO, Energy Losses, Relay Protection

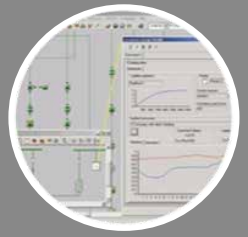


SCADA

Alarming, Tagging, Trending, Switching Validation

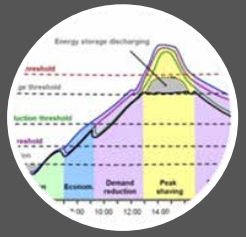
OMS

Incident, Fault, Customer Call, Switching, and Crew Mgmt and Reporting



EMS

State Estimation, AGC, Economic Dispatch, Unit Commitment



DSM

Load Forecast, Distributed Energy Mgmt, Demand Response

Common Platform, Database, Infrastructure, Security, History, and User Interface

Common User Experience, Integrated Components

Data, Performance, Calculation

Security, Scalability, Integration, Availability

Applications

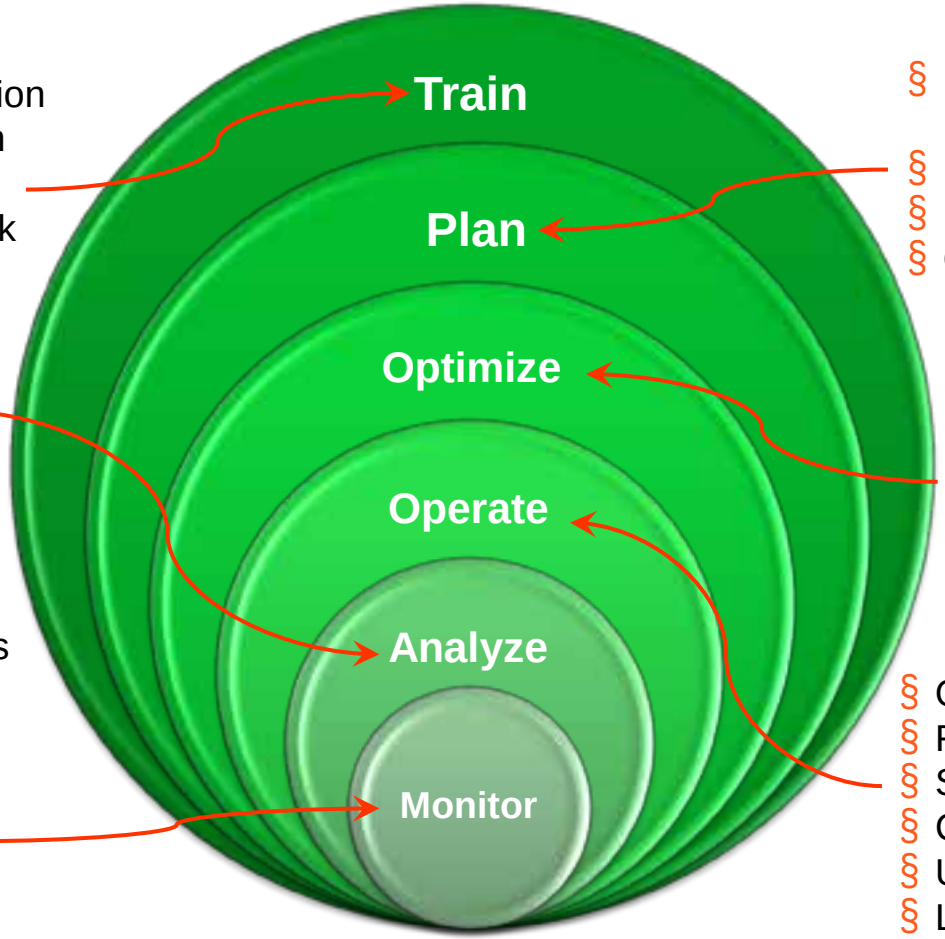
DMS | SCADA | OMS | EMS | DSM

Network Model Management

Realtime Infrastructure

ADMS Functionality

ADMS Benefits
- **Safety**
- **Reliability**
- **Efficiency**
- **Standardized Training**
- **Unified Interface**
- **Advanced Analytics**



- Real-time Simulation
- Off-line Simulation
- What-if Analysis
- Historical Playback

- Medium and Long-term Load Forecasting
- Network Automation
- Network Reinforcement
- Optimal Device Placement

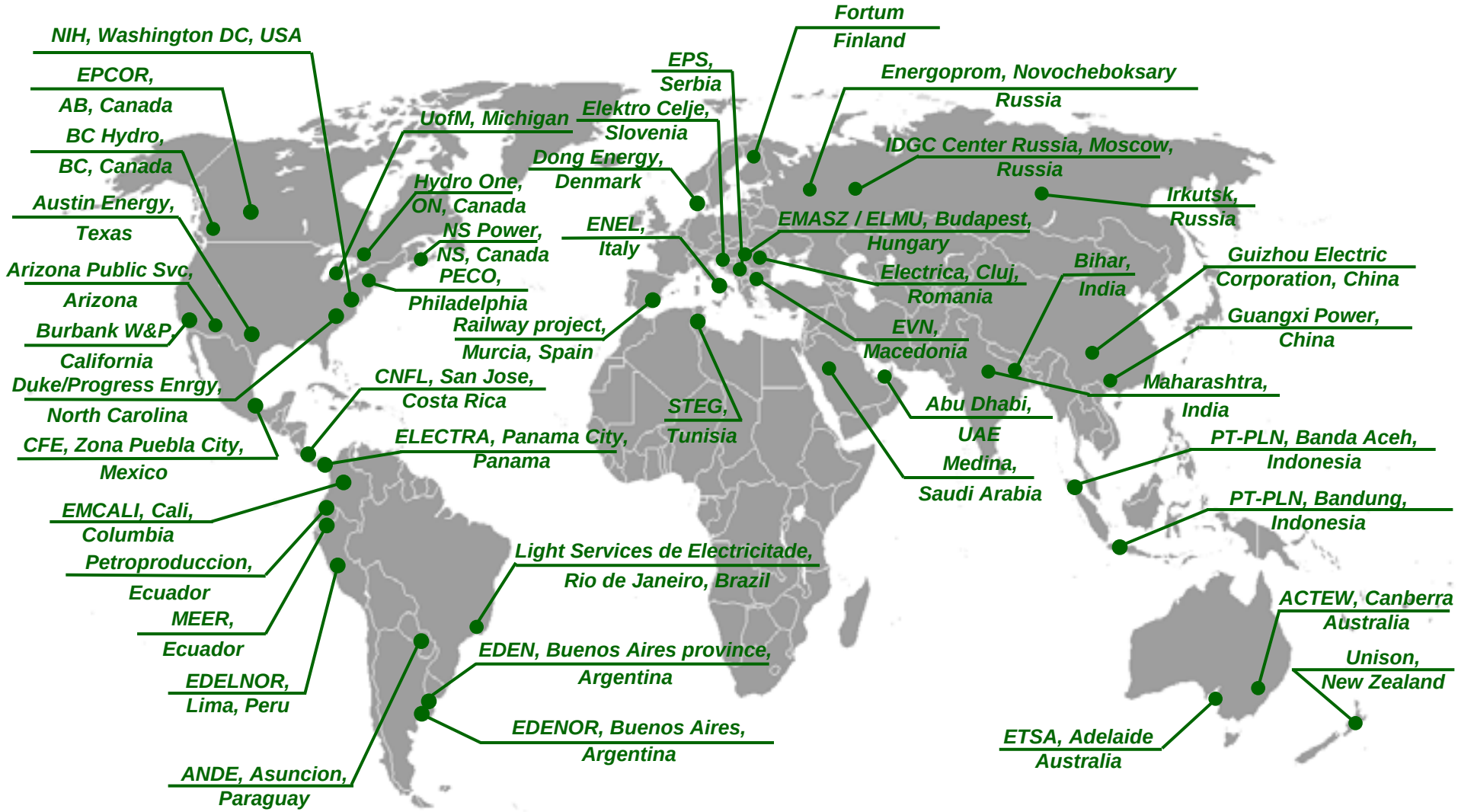
- Load Flow
- State Estimation
- Energy Losses
- Fault Calculation
- Reliability Analysis
- Relay Protection
- Device Capability
- Contingency Analysis

- Volt/VAR Optimization
- Network Reconfiguration
- Near and Short-term Load Forecasting
- Demand Response
- Distributed Energy Mgmt.

- Telemetry
- Alarming
- Tagging
- Trending
- Reporting

- Outage Management
- Fault Management
- Switch Management
- Crew Management
- Under-load Switching
- Large Area Restoration
- Load Shedding

ADMS Projects Worldwide



Over 180 control centers and 88M meters

Only ADMS to be awarded Gartner's highest rating in 2012, 2013, 2014

Main Benefits of ADMS Analytics

Results of ADMS Operational Analytics can be used by the utility for:

- predictive Demand Response via network reconfiguration/switching, voltage reduction, volt/VAR optimization, and load shedding
- proactive maintenance from short circuit analysis and over-voltage, over-load, and over-temperature conditions
- predictive network reinforcement and optimal device placement
- other network analysis and prediction functions

Source: Enterprise CIO Forum

Playback and Snapshot Functions

Playback

- Via playback of prerecorded events, operators can observe past operating conditions through time and quickly and easily determine times and locations of network irregularities

Snapshot

- Snapshot functionality stores network topology and measured and calculated values during specific points in time
- Running a set of power applications on various data snapshots enables root cause analysis and comparison of problems occurring at different points in time

Historical Trending

- Historical trending analyzes historical measured and calculated values and manages comparison of trends
- Provides analysis capabilities for
  - Undervoltage
  - Overvoltage
  - Overload
  - Over generation
- Results of analysis are often the main driver for network reconfiguration and reinforcement, leading to lower grid maintenance costs

Violation Monitoring

- Violation Monitoring provides analysis of all under- and overvoltage, overload, and over generation periods corresponding with peaks in grid power
- Analysis serves as the main driver for network reconfiguration and reinforcement and for subsequent lower grid maintenance costs

Historical Analytical Subsystem (HAS)

- HAS captures snapshots of the ADMS model and stores measured and calculated values for all nodes in the grid in the topology hierarchy structure, providing a base for advanced trend analysis and reporting
- The HAS service is a separate ADMS instance that uses extract, transform, and load (ETL) functionality to
  - load snapshots from DMS history (extract)
  - analyze snapshots by running a user-configurable set of ADMS power applications
  - write the resulting data in a report-friendly schema (transform)
  - store in HAS database (load)
- HAS is delivered with set of predefined reports
- Additional reports can easily be created combining data from both the HAS database and other ADMS databases, like DMS and OMS history

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Historical Analytical Subsystem (HAS)

- HAS provides value to utilities by providing a focused view of grid changes over time
- The analyses that can be executed can identify conditions such as
  - needed network reconfiguration
  - regional peaks in loading that can be smoothed
  - high frequency of over-temperature conditions that can lead to proactive maintenance
- Recorded results of short circuit analysis can identify sets of equipment that need to be replaced
- Recorded results of contingency analysis can identify the need for network reinforcement

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ADMS Data Stored in HAS

- Switching Sequences are stored for later retrieval and execution
- Save Cases - snapshots of the network model state (switchgear statuses, measurement values, etc)
- Temporary element changes - historical information about setting/removing temporary elements
- Tag changes - historical information about setting and removing tags
- Network outage impacts - records about affected consumers per outage, number of outages per day, etc.
- VVO results - data generated from Volt/VAR Optimization (VVO) function by transformer areas, substations, and feeders
- Load model - changes to parameters of load models for characteristic consumer types are stored periodically together with changes of corrective load factors for consumer groups

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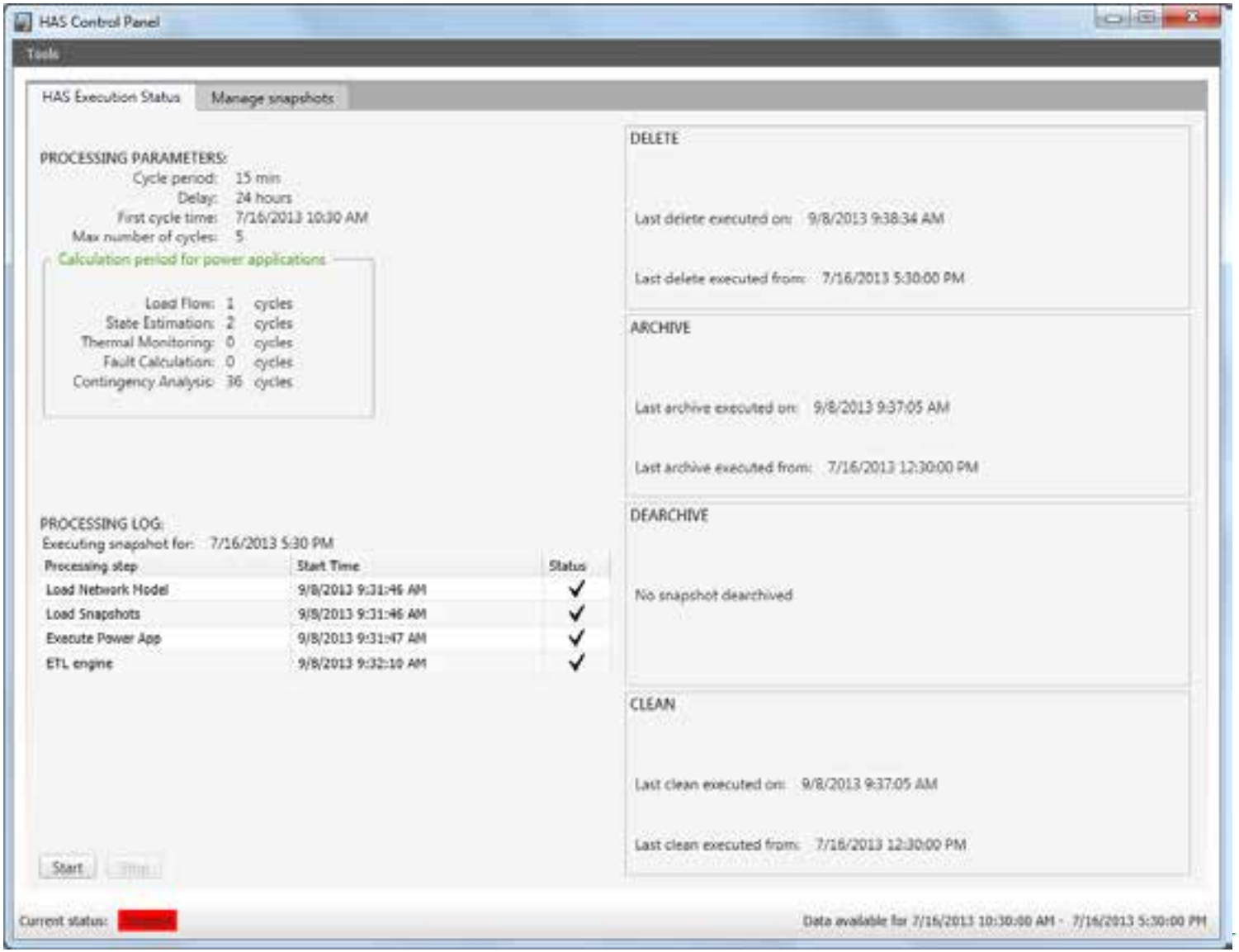
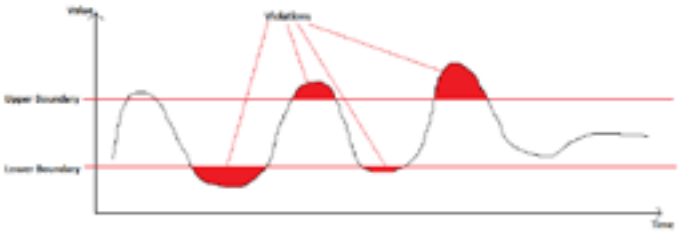
HAS Control Panel



Summary and Questions

- GIS and ADMS provide sophisticated tools for data analytics
- Customizations can provide better data for analytics
- Understand your source data
- Analytics provide valuable, tangible benefits
- For more information on ADMS: http://www.schneider-electric-dms.com/ or contact me at john.dirkman@schneider-electric.com
- Questions?



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