Operational Insights for Low Voltage Secondary Network (LVSN)

Webinar

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Presenter introduction

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Jean-Sebastien is an experienced manager with more than 10 years’ experience in the power system industry. He leads successful engineering projects and R&D activities for CYME International T&D, part of Eaton Corp…

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Market Drivers

- Utilities retrieve large amounts of data (EMS, AMI, Network Protectors, MDM)
- Few solutions are on the market that can monitor large low voltage secondary meshed networks
- GIS extraction and/or CYME models of the LVSN are now available for large IOUs and public power utilities
- Utilities are now looking to optimize and monitor LVSN
- New technologies are currently available to study large LVSN systems e.g. Distribution State Estimator (DSE) and NP Server
Problem Statement

- LVSN are subject to voltage violations in the event of a significant state change
- Many utilities experience major problems with LVSN (e.g. manhole fires and explosion, cascaded cable failures)
- LVSN are complex systems due to highly meshed configurations
- LVSN have only few measurements resulting in uncertainty of the grid state and lack of grid awareness
- No commercial solutions are available that can monitor and optimize efficiently LVSN
Solution Overview

- Distribution network model extract from GIS system
- Telemetry data from SCADA/Historian, AMI-MDM, Network Protectors, or enterprise data management system
- Real-Time Distribution State Estimation and N-p Contingency to identify overloads and voltage violations
- Alarms and notifications for network abnormal conditions
- Network detailed/simplified visualization and monitoring
- General connectivity to IT systems for potential advanced asset management and predictive risk assessment
Value proposition

• Detects overloaded equipment that can lead to failure or premature aging. Prioritizes maintenance planning (e.g. transformer overloaded 75% of the time).

• Detects under/over voltages that can cause utility and end-user equipment damage.

• Provides guidance to make decisions and control field devices based upon real-time information (e.g. switching).

• Achieves and validates operational efficiencies and power quality targets (e.g. conservation voltage reduction).

• Detects unknown system conditions (e.g. shunt capacitor fuse blown or parallel cable failure).

• Improves grid awareness and reliability.

• Determines the level of grid resiliency.
Use Case 1: Operational Support

**Step 1** – Operator observes an abnormal condition through SCADA that requires immediate action.

**Step 2** – Network Engineer opens CYME software and performs an event historical playback.

**Step 3** – The network is in the real-time state and the Network Engineer acknowledges the abnormal condition.

**Step 4** – The network engineer is in offline mode and performs mitigation scenarios.

**Step 5** – Operator evaluates mitigation plan and executes if feasible.

**Step 6** – Operator observes that the system is returned to normal state.

E.g. N-2 Contingency

E.g. Load Shedding - 1 Spot Network
Use Case 2: Network Planning using RT data

**Step 1** – Network Engineer observes data trending and alarms in Visual T&D

**Step 2** – Network Engineer opens CYME software and performs an event historical playback

**Step 3** – The network is set at a historical date where an alarm was generated. He observes that the static network is not representative of the network in operation

**Step 4** – The network engineer discovers that an asset is out of operation (e.g. cable failure) and requests field maintenance

**Step 5** – Field maintenance crew installs or repair assets

**Step 6** – The network engineer updates database with field new asset

**Step 7** – Network Engineer observes the alarms has been removed
Eaton’s Solution
Eaton’s solution architecture

Diagram of Eaton’s solution architecture with various components such as CYME Software Applications, Power System Analysis, Operational Support, and Data Analytics.
Eaton Technologies

• Technology 1 – CYME Power System Analysis
  • Secondary Network Analysis, Distri. State Estimator and Event Historical Playback
  • CYME Server for scalable real-time simulation

• Technology 2 – Visual T&D & Communication Server
  • Data Historian, Real-Time Visualisation, Data trending and exploring
  • Real-Time Exchange Platform for distribution automation

• Technology 3 – VaultGard and NPServe
  • DNP3 communication with SCADA/Historian enterprise system
  • Network Protectors real time status and data

• Technology 4 – IED Manager Suite (IMS)
  • Track IED inventory, secure remote access, manage firmware and settings updates
VT&D – Substation & Network

SCADA vs. Estimated

Substation

Network
VT&D – Dashboard
CYME – Event Historical Playback
Technology 1
CYME Power System Analysis
Model the Secondary Grid Network to include complete vaults with their transformers, protective devices, network protectors, secondary lines and cables.

- Specialized unbalanced Newton-Raphson load flow and robust short-circuit for heavily meshed network
- Network Protectors
  - Complete relay settings (available soon)
  - Polar plot to visualize simulation results and trip/close regions (available soon)
- Identify overloaded conductors and devices
- Identify abnormal conditions
- Simulate contingency scenarios with the automatic operation of network protectors
- Model spot networks
CYME – Distribution State Estimator (DSE)

Real-Time Power Flow

• The DSE analysis is typically used for Real-Time power flow integrating SCADA/GIS data.
• Estimates load values based on feeder demands across the network and transformer connected capacity, consumption/billing data or existing calculated load data.
• Identifies real-time abnormal conditions such as overloads, low/high voltages situations
• Helps operators to visualise and monitor distribution systems and assist the operators to plan system operations
• Serves as the initial analysis prior to run multiple scenarios such as Contingency N-p and Network Reconfiguration
IEEE 342 LV Networked System Example

- Substation and Feeders
  - 1 Substation – 2 XFO DOdo
  - 8 Distribution Feeders

- Low Voltage Secondary Network
  - 1 Grid Network
  - 68 Network Protectors (NP)
  - 8 Spot Network

- Meters
  - 8 Breaker Meters – Amp/PF
  - 68 NP Meters - kW/kvar

- Pseudo-Measurements
  - 208 Spot Loads (50% Error)
Technology 2
Visual T&D & Communication Server
Visual T&D

- Real-time data display
- Single-line diagrams
- Data point tagging for information and control inhibition
- Alarm and event processing
- Email and pager notifications
- Complete historical data logging for all transitions and historical data views
- Report generation
- Client-server architecture
- Scalable licensing model
- Supports a large variety of devices and data sources
- Enhanced data logging using various deadband options
- Commercial Database support
Data communications solutions

- Enterprise Gateway and Communication Server front-end processors
- Protocol translation (DNP3, IEC 60870-5-101/103/104, IEC 61850, ICCP)
- Data concentration
- System-wide device automation and integration
- Automatic event file retrieval and file pushing
- Remote control and pass-through
- Data distribution
- Substation-hardened computing
- Substation I/O monitoring and control
- NERC CIP-compliant security
Technology 3
VaultGard and NPServe
VaultGard and NPServe

VaultGard

• Connect up to 32 MPCV relays on one VaultGard for application flexibility.
• VaultGard can communicate with third-party devices: DNP 3.0 up and downlink, over Ethernet; and DNP 3.0 via RS-485 connection.

NP Serve

• Extracts and concentrates data from sensors and IEDs
• High speed extraction and concentration
• Controls third-party devices
• Multiple I/O channels available for collection of sensors
• Seamlessly integrates with the VaultGard communication system
• Exports to SCADA, control centers, and any other management applications
IED Manager Suite (IMS) for network management
Managing IEDs is all about:

- Providing secure remote access
- Retrieving sequence of events and oscillography
- Managing device configuration
- Tracking IED inventory
- Managing passwords
- Managing firmware versions
- Monitoring status and health

IED Manager Suite

- Centralized focus for complete network device management
  - Relays
  - VaultGard
  - NPServe
- Traceable change management
  - Who, What, When
- Comprehensive reporting
Summary
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Q&A / Discussion