Multi-Application Smart Grid Networks

USE CASE

Cisco-Itron Network Solutions:
Multiplying Platform Value with New DA Strategies

- Common, Open Standards to Simplify Interoperability
- Scalable and Manageable Network Infrastructure
- Optimized DA Processes
- Greater Return on Investment from AMI Platform

Challenge

Transmission and distribution operations run multiple applications—and use data from a wide variety of sources—to efficiently and reliably provide power. Traditionally, distribution operations have deployed multiple networks that narrowly focus on measuring and collecting data from devices solely employed for that purpose. However, this approach is unsustainable given smart grid goals. Smarter devices provide an opportunity to increase control and improve efficiency and service quality, but will also increase the amount, type and complexity of data, as well as number of applications demanding new networks. Volt/VAr optimization (VVO) and conservation voltage reduction (CVR) are typical DA examples of the significant benefits that can be achieved by employing a multi-application field-area network (FAN) for improved operational efficiency and cost-saving DA strategy deployment.

Utilities can increase the return on their AMI investments with applications that improve efficiency, increase reliability and customer satisfaction, lower costs and provide new services

Opportunity

From generation to transmission and distribution, there are voltage losses throughout the electrical grid that impact the utility's power quality of service to its customers. The quality of delivered energy deteriorates due to the inefficient transmission of power caused by capacitive or inductive loads (measured in VAr levels). Furthermore, higher VAr levels create power quality problems for industrial businesses as well as utility operations.

According to a major IOU, "Although temporary deviations from specified ranges are generally allowed, frequent and persistent violations can result in perceptible negative impacts to customers. A high steady-state voltage can reduce the life of customer equipment such as light bulbs and electronic devices, while at the same time increase customer demand and system losses. A low steady-state voltage can lead to low illumination levels, slow heating of heating devices, motor starting problems, and overheating in motors".[1]

Another utility challenge is that VAr delivery is costly. To manage Volt/VAr levels, utilities typically purchase costly infrastructure equipment such as load tap changers (LTCs), voltage regulators, and capacitor banks (fixed and switched).

For more information, visit www.openthegrid.com.

Solution

A utility can increase the return on its AMI investment if it can efficiently support applications that improve efficiency, increase reliability and customer satisfaction, lower costs or provide new services. VVO is one DA application that optimizes power quality to improve operational efficiency and service quality by reducing excess voltage.

The Itron and Cisco solution enables cost-effective DA strategies by seamlessly connecting intelligent electronic devices (IEDs) and sensors through standards-based communication gateways to support third-party, low-cost, feeder-sensing devices.

This architecture simplifies integration, enables scalable management of devices and applications, provides industry-proven security and extends grid intelligence to additional applications.

VVO can use end-of-line (EOL) smart meter data for voltage monitoring, combined with other field data collected over a multi-application network, to better manage power quality. In addition, Pike Research validates the benefits of VVO in an AMI environment, stating "Higher accuracy of the application can be realized by by measuring more extensively at points along the power line and deploying applications capable of reacting promptly to voltage control [to meet specific operational objectives]. VVO can be manipulated to save power in narrower bands and conserve power during periods of high demand or under circumstances where infrastructure constraints require demand reduction. Better control and faster responsiveness to fluctuations can allow voltages to be set at lower values while still meeting regulatory requirements".[2]

CVR is related to VVO and is another example of how to increase the ROI of a multi-application FAN. Typically, utilities have executed CVR at the substation to manage the substation voltage. However, utilities can use communication-enabled downstream capacitors/voltage regulators and EOL voltage references to reduce the EOL voltage to the lowest allowable voltage limit per ANSI C.84.1. A VVO application can optimize circuit switch capacitor banks controls, a utility can optimize power factor efficiency while providing the lowest amount of losses on the distribution circuit. Often, utilities will recognize almost 10 percent reduction in line losses. Success of this strategy is dependent on smart meter data combined with distribution system data that can only be economically collected over a multi-application network.

Ease of integration, manageability and security are critical to the multi-application capabilities of the FAN. The Itron and Cisco communication network enables cost-effective DA strategies by seamlessly connecting intelligent electronic devices (IEDs) and sensors through communication gateways.

Since the network supports both IPv4 and IPv6 field protocols, this architecture simplifies integration, enables scalable management of devices and applications, and provides industry-proven security. Once in place, this network extends your grid intelligence to support additional applications such as condition-based maintenance (CBM), which provides utilities with new data from IEDs to improve asset management. This also provides access for multiple users to gain grid situational awareness and improve operational performance with a single communication architecture.

Benefits

In a recent PUC filing, a major US utility[3] recognized VVO as a solution that could have an ongoing benefit:

Direct Expense Reductions

- Reduction in voltage monitoring projects; 80% reduction in power quality operation/ engineering projects resulted in $200K expense reduction per year
- Reduced maintenance costs associated with distribution capacitor asset inspections provides $148K expense reduction per year
- Reduced maintenance costs associated with breaker inspections (requires regulatory relief from inspection process mandated by Ohio PUC) provides $79K expense reduction per year

Avoided Costs – Capital

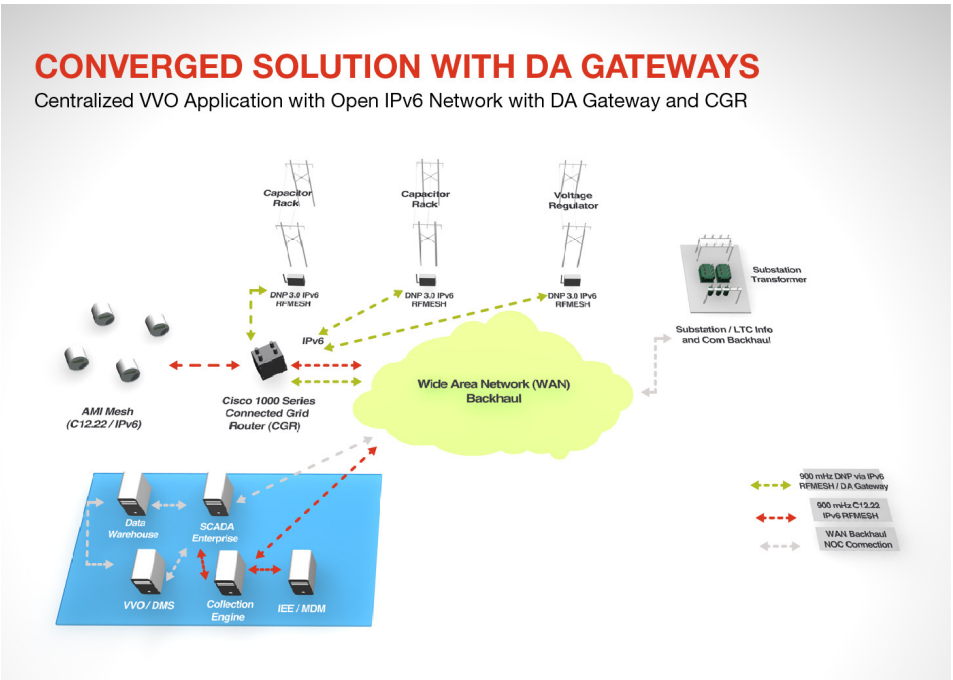
- Operational efficiency from grid awareness and CBM results in reduction in CAP-EX for asset management; 2% reduction in $35M budget produces $700K per year avoided costs
- Expected reliability improvements will reduce SAIFI 32% from 1.60 to 1.10 through new relay equipment by .20 – 144,588 customer interruptions; Sectionalization will reduce SAIFI by .25 – 180,735 customer interruptions; and feeder automation will reduce SAIFI by .05 – 36,147 customer interruptions

Avoided Costs – Generation

- System Voltage Control Demand Reduction Initiative for energy, capacity and CO_2 results in capacity/load reduction of 1% over 8760 hours per year
- Power Shortage Voltage Regulation Demand Reduction provides a 5% capacity/load reduction at Peak 2% of annual time
- VAr Management Reduction in Capacity/ Demand eliminates VAr/Circuit overbuild and improved maintenance, and asset deferral of generation capital spend
- Reduction in distribution line losses within energy, capacity, and CO_2 reductions results in 1% fewer distribution line losses and 10% less capital investment in generation

Why Itron & Cisco?

- Support Multiple Applications
  - Leveraging the OpenWay architecture supports multiple applications. AMI, demand response and distribution automation applications extend the functionality of the OpenWay system
- Employ Standards-Based Technology
  - Legacy and future protocols such as DNP 3.0 (IEEE 1815) and IEC 61850 are supported via Itron's RF mesh and WAN communications
  - Partnering with several DA vendors supports the open-standards integration of hardware to network communication architecture and redundancy of primary and secondary networks
- Ensure Device Interoperability
  - Itron's smart grid network is flexible in supporting multi-protocol devices and standards-based interoperability
- Deliver Distribution Automation Applications
  - Effectively deliver data from DA devices to an enterprise application such as an integrated Volt/VAr scheme. This scenario delivers data from voltage regulators (or LTCs) and switched capacitor banks to manage power factor optimization and voltage loss management



Conclusion

As mentioned earlier, utilities can minimize losses to a certain extent using voltage regulators. However, by leveraging advanced DA applications and technologies—such as the VVO example above—economic savings from cost avoidance in operational efficiency are easily realized. Specifically, generation costs are reduced, including reductions in green house gas (GHG) emissions.

EPRI has conservatively estimated that a 1% reduction energy losses from smart grid-enabled distribution automation translates into at least 0.03 gigatons of CO_2 GHG emission reductions.

The optimized solution benefit also provides less line losses and more efficient power delivery, which can improve system efficiency and power quality. Lastly, another benefit of communication-enabled controls is the ability to execute conditioned-based maintenance through control monitored conditions and identify capacitor assets that may require service or replacement based on out-of-tolerance readings or problems.

While utilities assess their investment in improving reliability and operational efficiency, the ability to manage diverse applications across a multi-service network can deliver value as identified in several distribution automation use cases that support DA objectives, including using VVO to optimize loads and manage system capacity.

As utilities evaluate their communication options to incorporate DA devices for data integration in support of grid-optimization software solutions, the value of these applications are dependent on timely, accurate and secure data. An open, standards-based IP network will provide utilities with quality information to cost-effectively achieve their overall key objectives within a multi-service communication architecture that delivers both AMI and DA applications on the same communications platform.

[1]Yuan, G., Yohn, T., Deaver, B., et al. *The Functionalities and Benefits of a Two-Way Centralized Volt/VAr Control and Dynamic Voltage Optimization*, 1.

[2]*Distribution Automation Distribution Switchgear, Volt/VAr Systems, Fault Detection/Isolation, and Feeder Protection/Control: Market Analysis and Forecasts.* Published 4Q 2010.

[3]Ohio, D. E. (2011, June 30). *Duke Smart Grid Testimony to Adjust Rider Before Ohio PUC Case No. 10-2326-GE-RDR.* Duke Energy Ohio.