Design and Implementation of a Communication Network to Support Real-time Distribution Feeder Automation, SCADA Integration and Backhaul of Substation and Metering Data

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Topics

- Wake Electric Background
- Unique Technology
- Project Requirements
- Implementation
- Results
- Questions & Answers
Background

Serves 37,000 consumers in 7 counties

Utility’s Mission
- Member owned utility
- Increase operational efficiencies
- Improve service quality

This Project
- Deploy comm system for SG App’s
- Implement high-speed FLISR / ATS
- Critical load served from 3 sources

Challenges
- Design comm system just one time
- Comm must support real-time FLISR
Unique Technology
Contributors to Project’s Success

- Use of a Communication Simulator to model performance of communication technologies for Smart Grid applications.

- Real-time Fault Location, Isolation and Service Restoration (FLISR) that uses differential protection through the communications network.

- Treat entire distribution network as a distributed, high-speed Automatic Transfer Scheme (ATS).
Design Considerations
FLISR / ATS Requirements

- All Fault Location, Isolation and Service Restoration (FLISR) sequences to be completed within 0.5 seconds.
- Source transfer sequences within 0.25 seconds.
- Support interconnected feeder system with three sources.
- Interoperable with existing reclosers.
- Retain existing controls for field staff.
- Integrate with existing SCADA system.
- Integrate with existing OMS system.
Communication System
Overview

Requirements
- Enough bandwidth for FLISR System
- Scalable design

Additional Benefits
- Replace less reliable, shared public network
- Substation backhaul
- Sensus Metering backhaul
- Integration of FLISR with SCADA

FLISR System Characteristics
- Peer-to-Peer communication required
- High-speed operation to support critical load
- Interoperable with existing switchgear

Actions
- Performed independent communication study
- WiMAX selected
Design Considerations
Communications Platform

RF Considerations
- Availability of tower for mounting base stations
- Base station height
- Pole-top radio height

Data Management Considerations
- Low latency and reliability
- Robust traffic management techniques
- Ruggedized and dedicated network resources
- IP network interoperability
- Flexible architecture
- High security
Design Considerations
Communications Study Evaluation

RF Considerations
- Sensus FlexNet
- WiMAX
- Cellular (4G/LTE)
- Wi-Fi Mesh

Smart Grid Programs Evaluated
- Advanced Metering Infrastructure (AMI)
- Substation SCADA
- Distribution SCADA
- Fault Circuit Indicators (FCI)
- Conservation Voltage Reduction (CVR)
- Fault Location, Isolation and Service Restoration (FLISR)
Communications Study Results
Eye-opening Insights and Peace of Mind

- Wake Electric learned that its existing AMI network was capable of also supporting fault current indicator monitoring (FCI).
- Based on the study, the utility chose to use the AMI network for portions of its DA initiatives, avoiding previously anticipated CAPEX.
- WiMAX was chosen for FLISR pilot and backhaul communications.
- The study also pinpointed the best location to perform the pilot.
- The study boosted the utility’s confidence in the current communication infrastructure’s ability to make greater use of bandwidth and extend the value of the utility’s metering investment.
Why was WiMAX Chosen for FLISR / ATS?

- Supports IEC 61850 “GOOSE” messages used by FLISR system.
- Cost Effective: No data service fees applies.
- VLAN feature for traffic management.
- Interoperable with existing infrastructure and systems.
- Wide Coverage.
- Supports NLoS (Near Line of Sight).
- High Security.
- Supports AES (Advanced Encryption Standard).
- 3DES (Triple Data Encryption Standard).
- Carrier based system with quality of service.
RF Network Design
Technical Drawing
WiMAX Quality Of Service Settings

Two Service Flows Established

1. Real-time FLISR system
   - GOOSE service flows classified by VLAN
   - VLAN traffic given higher priority

2. SCADA, FLISR HMI and Sensus systems
Substation Backhaul

SS - Subscriber Unit
BS - Base Station
PoE - Power over Ethernet

PoE
Cisco 3925 Router
ASA 5510 SCADA Firewall
Cisco Switch
SCADA Server

Office
Tower
Substation

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SCADA Integration

Field devices provide IEC 61850 operational data to Concentrator/HMI
- Recloser status
- Local/Remote
- HLT ON/OFF
- Ground Trip ON/OFF
- Reclosing ON/OFF
- Lockout
- Measurements
- Trip Values

Data Concentrator converts IEC 61850 to DNP3 for SCADA

Commands from SCADA
- Open/Close
- Modes of operation (Auto, Restore, Sectional Control, Simulation)
- HLT ON/OFF, Ground Trip ON/OFF; Reclosing ON/OFF
Security Considerations
Blueprint

Physical
- Secure tower location with base stations at 412 feet above ground.
- Utility locks on all field devices with NEMA cabinets.
- Secure server room at the utility.

IT Security
- Firewall isolated servers within the cooperative building.
- Inherent WiMAX security – AES and 3DES.
- GOOSE traffic isolated by VLAN.
- Priorities established through service flows.
- To avoid communication race conditions, FLISR uses sequential logic (i.e., AND gate programming).
Control One Line Screen on HMI
Fault on line section between reclosers P1 and P2
Control One Line Screen on HMI
Fault on line section between reclosers P1 and P2
Control One Line Screen on HMI
Fault on line section between reclosers P1 and P2
Control One Line Screen on HMI
Fault on line section between reclosers P1 and P2
Control One Line Screen on HMI
Fault on line section between reclosers P1 and P2
Control One Line Screen on HMI
Fault on line section between reclosers P4 and P5
Control One Line Screen on HMI
Fault on line section between reclosers P4 and P5
Control One Line Screen on HMI
Fault on line section between reclosers P4 and P5
Control One Line Screen on HMI
Fault on line section between reclosers P4 and P5
Control One Line Screen on HMI
Fault on line section between reclosers P4 and P5
Control One Line Screen on HMI
Loss of Source at Heritage 5 and Walkers 3 Substations
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Loss of Source at Heritage 5 and Walkers 3 Substations
New Technology  
Advantages of using a Communication Simulator

- Using the number of comm nodes, their GPS coordinates and the type of SG app’s to be implemented, the Communication Simulator models & compares each comm technology for coverage, performance & cost.
- Determines which communications technologies will perform best according to the utility’s smart grid roadmap.
- Calculates how much additional bandwidth is available for future smart grid applications.
- Suggests the best placement for base station and subscriber antennas.
- Estimates the CAPEX and OPEX for each technology.
- Reduces false starts.
- Provides roadmap for success.
New Technology
Advantages of Differential Protection across Distribution Network

- Fast, selective and easy to implement.
- Reduces number of setting groups required for protection coordination.
- Simplifies planning; reduces cost of engineering & coordination studies.
- Reduces number of switching operations to isolate faulted section.
- Does not interrupt power to customers upstream of fault.
- Provides ability to segment short lines.
New Technology
Advantages of a High-speed, Network-wide, Multi-source ATS

- While most ATS are centralized, a decentralized architecture can make use of multiple power sources across a wide geographical area.
- Technology exists today to use up to 8 sources with source priority.
- Source transfer times of 75 to 250 milliseconds can be achieved.
- Employ low-cost, industry-standard reclosers, switches or CBs.
- Prevent loss of power to critical loads caused by HV line sags & faults.
- Eliminate the cost of constructing lines, pad-mount ATS and/or substation to feed a critical load from another transmission source.
Conclusion

- Using modern technologies, all project requirements were met.
- WiMAX is proven to be a viable communication platform that is cost effective and field deployable.
- FLISR system proves to be an asset in minimizing outages and improving operations.
- Interoperability with SCADA and OMS was achieved.
- Interoperability with existing primary switchgear was achieved.
- A secure communication network was established.
Questions

Thank You!

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