Case Study: Distribution Automation

Utility Profile

The utility provides service to more than one million customers via 750+ distribution feeders, mainly made up of overhead lines. These feeders are subject to the usual storm-related problems involving damage caused by thunderstorms, lightning, tree contact, ice storms and hurricanes. Compared to other electric utilities in the region, the utility provides the fastest restoration, on average, although in the past customers experienced more frequent sustained interruptions.

Project Overview

Analysis of customer outages determined that 78% of interruptions were caused by faults on main three-phase lines. Main line faults would cause, on average, 2000 customers to lose power. To reduce these outages, the utility instituted reliability programs that include trimming trees, installing lightning arresters, installing covered wire and replacing obsolete armless insulators. These programs reduced outages, but were not sufficient to reach the desired level of service continuity.

To further improve reliability, the utility installed an advanced distribution automation system hat isolates faults and restores non-damaged portions of the main line circuit based on real-time parameters of voltage, current, breaker status and supervisory-controlled switch positions. Over the first 4 years of the project, 240,000 customers avoided a sustained interruption of service.

Key Approaches

Our experts applied an iterative approach to control risk and deliver incremental benefits thus proving the benefits of the approach.

Stage 1: Smart Switch - development of a remote terminal unit (RTU) that detects a permanent load-side fault and open a motor-operated switch prior to the substation breaker locking out. This fault detection scheme detects three levels of overcurrent: no loss of voltage, successful breaker trip reclose and breaker lockout.

The Smart Switch requires no communications network or relay co-ordination study to implement. Integration to the 400 existing and 350 new switches enabled the utility to reduce by 25% the number of customers affected by main line faults, amounting to 240,000 customers avoiding a sustained outage in the first 18.

Stage 2: PC SCADA/Communication – Provided operators remote indication and control of switches. The system provided, on a three-phase basis, voltage, current, power factor, load profiles and other real-time values for optimizing the distribution system. The spread spectrum radio network deployed uses unlicensed frequency hopping spread spectrum technology and established a 90% communications coverage in just under nine months.

Stage 3: AutoRestoration Algorithm - An advanced algorithm for the automatic restoration of power to the non-faulted feeder zones services the front end processor for communications with the RTUs.

Examples of Benefits

Tangible benefits were realized as part of this project:

- Smart Switches report loss of voltage and fault location.
- Substation breaker status and loading from the affected circuit as well as information from the adjacent tie circuit is provided immediately
- Based on real-time voltage, load, breaker status, switch positions and safety interlocks, the algorithm calculates and reports corrective measures to restore service.

The autorestoration algorithm restored multiple feeders and switches simultaneously in an open loop arrangement. In addition, operators set the level of automation for each circuit loop.

Results

The utility received a patent for the advanced restoration algorithm. While many utilities are using supervisory switching to isolate faults, most use operator remote control to restore service. This procedure is time consuming and inefficient, particularly during storm conditions when multiple faulted circuits occur.