Research Paper

1. Optimization problem

* Self-healing network reconfiguration algorithm
* Initial input is status information of lines. Faulty area must be isolated. The unhealthy bus blocks must be switched off
* Microgrid formation: iteratively determine healthy bus blocks. Then determine boundaries of microgrids.
* Nodal power P/Q balance constraints:
* Line P/Q limits
* Generator P/Q limits
* Node voltage and line power flow limits
* Non/switchable line energization
* Non/black start generator
* Bus block switching
* PV, EV, Diesel Generator ramp rate
* Maximize percentage of green energy generation from RES (PVs).
* meeting forecasted load demand while minimizing transmission losses
* Operational planning determined the optimal switching pattern for demand response management, network reconfiguration, dynamic constraints, fault level management and Volt-Var control.
* Load management was based on geographic information, load forecast, weather forecast, unit availability and energy storage capacity.

1. Three Level Communication System

* A three level communication network was designed in NS-3 to simulate the coordination required between the central energy management system, distribution automation system and load centers.

The Wide Area Network provided remote access of distribution management system to the microgrids via Wimax links. The high capacity links enabled pervasive control of distribution system for maintaining power quality, electrical stability and service continuity. The autonomous central controller performed supervisory tasks for distribution system automation. It enabled recovery from disturbances through a self-healing manner to mitigate power outages. Besides outage management, it also implemented distributed generation, demand response, Volt-Var regulation, feeder load management, fault detection and network reconfiguration.

The Field Area Network used PLCC smart meters located at load centers, capacitor banks and substations for wide area management. Distributed generators were controlled via set point commands for PLCs integrated with SCADA modems. To ensure effective power flow, status signals were relayed periodically from all protection relays, distributed generators, energy storage systems and load centers. The transmission line channels also conveyed switching commands for capacitor banks, load controllers, circuit breakers and generators.

The Home Area Network connected load controllers and sensors via Ethernet based automated metering infrastructure. This enabled monitoring of a large number of devices. The pervasive communication system enabled continuous scanning of operational data for greater control and flexibility. Intelligent electronic devices for meters, transducers and field components continuously collected information for remote station supervisory functions. The IEDs are complemented with data concentrators for integration; and remote terminal units for communication channel interfacing. The network interface module implemented distributed network protocol for physical interface conversion. The extensive monitoring was achieved with enhanced computational power and flawless coordination.

1. Power System Simulation