High performance, unbalanced, real-time power flow

Distribution networks are the most complex segment of the electrical supply system but are also the most lightly monitored. Even with the addition of the real-time Supervisory Control and Data Acquisition (SCADA) data, only a very small proportion of network flows are actually monitored. To more effectively operate a distribution network it is essential that power flows be known with a high degree of accuracy, particularly when projecting forward in time to determine expected flows. This improved information allows the operator to utilize the network to its full rated capacity and undertake switching of abnormal configurations with confidence.

e-terra Distribution Network Analysis is part of the e-terra suite of applications for real-time network management. It provides a full, unbalanced, real-time power flow for the entire network. Study copies of the current real-time network can be instantly created and modified to analyze planned or alternate conditions.

The Network Analysis functions are further enhanced by the addition of the Network Optimizer module which provides network reconfiguration and load management functions.

An integrated suite of tools

Network Analysis expands the capabilities of ALSTOM GRID’s e-terra suite of real-time network management system by integrating the distribution power flow functions into the existing network model and user interface.

The power flow works with a fully unbalanced model and is capable of solving for both radial and meshed networks, allowing all types of network conditions to be analyzed.

Voltage violations and overload conditions are displayed directly on the geographic network view.

The location of faults is automatically determined by analysis of fault currents and/or fault detector data, where available.

Operators can view the power flow values for any point on the network. Power flow analysis can be set to run at regular intervals, on topology changes or on demand.

A full range of tabular displays are used to show the detailed results of the analysis.

The network analysis tools can be used in both real-time and study mode to allow the dispatcher to more effectively plan and monitor proposed changes to the network switching.

Network Analysis is based on a robust, sophisticated and high-performance distribution power flow that allows dispatchers and planning engineers to study both the current (real-time) and future states of the network. The power flow utilizes the current network conditions including dynamic information from the SCADA system and Network Switching operations.

“Increased system awareness for operators and engineers”
Network Analysis provides the following functionality:

- **Distribution Power Flow (DPF)** This function finds the complex voltages at all nodes and the power flows through all feeder segments in the distribution system. Included within the Distribution Power flow is Bus Load Allocation (BLA) which provides estimates for the loads (kW and kVar) at the distribution feeder nodes and Limit Monitor (LIM) which checks the DPF solution for line flows and voltages outside of acceptable operating limits.

- **Power Quality Analysis (PQA)** The Power Quality Analysis function is responsible for estimating the quality of service. The function calculates voltage quality based on accumulated Power Quality Indices (PQI). The PQI represents the deviation of load voltage from quality limits. Quality values are calculated on-line and then stored for daily and monthly reports. The function allows distribution engineers to monitor the power quality in terms of the degree of normal and imbalance voltage limit violation.

- **Fault Location** This function uses information from protection relays and fault detectors to determine the likely location of a fault on a feeder. The results are presented to the operator as colored halos indicating the relative likelihood of the fault on each section of the feeder.

- **Loss Analysis (LA)** The DPF calculates the state (KW, kVar, Amps, kV, phase angle) from the distribution buses in primary substations to the equivalent load nodes. Loss Analysis uses the DPF results to calculate instantaneous technical power losses in the actual distribution system. The losses are available per phase for every device involved in DPF. Total losses are calculated for the substations and feeders within the selected area of analysis.

- **Protection Validation (PRV)** This function calculates the maximum and minimum short circuit current for a phase-to-phase or phase-to-ground fault at any point in the network. The calculated fault currents are then used to verify that each segment of the feeder is adequately protected.

- **Load Model and Forecast** Loads are modeled in the Distribution Network Operations model (DNOM) separate from the transformers. Each load is assigned to a load category. The load category provides the required data for accurately estimating the values in the Bus Load Allocation function. Load Forecast is used to estimate the loads on both individual nodes and feeders to support network analysis for future time-frames or in study-mode.

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**Advantage**

- Alstom Grid Energy Management and SCADA Systems are used by electricity utilities throughout the world. Alstom Grid employs industry experts to meet customer requirements.

- **e-terra** distribution Network Analysis has been specifically designed to meet the needs of all sizes of distribution utilities.
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