GE
Digital Energy

XA/21™ EMS

Energy Management Systems

Energy Management Systems to meet the challenges of today's smart grid environment

Electric utilities are faced with many challenges imposed by today's Smart Grid. High penetration of bulk renewables, demand response options, aging assets and an aging workforce, coupled with increased operating and maintenance costs, security, increased integration with external systems and increased data processing requirements contribute to the needs of today's advanced Energy Management System (EMS).

The XA/21 EMS meets these demands with a secure core system built on an open-standard, distributed architecture and augmented by powerful application suites for generation, transmission and distribution power grids.

Key Benefits

- Monitors and controls generation, transmission and distribution assests in real-time
- Provides real-time situational awareness coupled with advanced visualization capabilities for faster user recognition of the overall system status
- Analyzes near-term operating grid contingencies and provides alternative solutions to reduce potential outages
- Economically provides increased grid capacity while maintaining overall grid reliability and regulatory requirements
- Reduces overall system support costs through intuitive data and display maintenance support tools
- Meets today's secure system needs with flexible environments including fully redundant primary and backup production, quality assurance, training and development systems

Situational Awareness

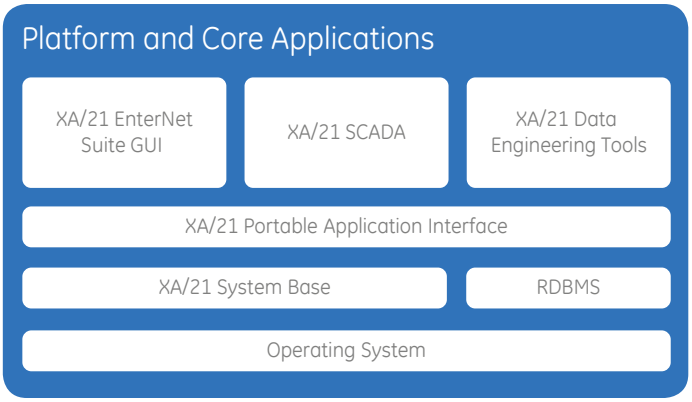
- Robust generation and transmission grid power system applications supporting real-time, study and training environments provide current and future operator situational awareness
- Built-in advanced visualization capabilities driven by a secure, platform independent Graphical User Interface
- World coordinate displays supporting transmission grid overviews provide support for graphical backgrounds, weather data, crew locations, flexible gradients and dynamic approaching limit symbols for flows and other real-time data
- Operator configurable dashboards provide support for displays, charts and graphs, summaries and graphical contingencies
- Advanced alarm and event summaries with operator customizable sorting and filtering

Advanced Functionality

- Enhanced grid reliability
- Increased grid capacity
- Advanced contingency awareness
- Decreased system support costs
- Secure system that meets worldwide regulatory requirements

imagination at work

XA/21 EMS Overview



The XA/21 EMS is designed to flexibly meet each utility's needs based on their asset fleet. The base system provides the XA/21 system platform infrastructure and three core application suites: EnterNet Suite (ES) (platform independent GUI), SCADA (DAC, Alarm Events, RT-Calcs, HIS, etc.) and Data Engineering Tools.

Optional applications can be added depending on each utility's needs. Generation applications provide a solution for generation and enterprise renewable management companies and industrials with onsite generation. Typical transmission grid operators may only need the advanced transmission applications. A vertically-integrated electrical utility can choose the entire suite of applications, including Transmission, Generation, Hydro and Distribution applications.

The distributed and extensible architecture of XA/21 scales from a single server to a fully redundant system with many servers supporting hundreds of operator consoles.

XA/21 systems are typically deployed in a multi-system environment, with separate systems for the Primary and Emergency Backup Control Centers and the Program Development, Quality Assurance and Operator Training Systems.

The secure architecture of XA/21 conforms to industry-standard security practices and is implemented with a layered strategy to ensure cyber security at the network, system and application levels.

Architecture

XA/21 is a network-based, distributed processing environment consisting of interconnected processing nodes which can be tailored to specific functions. XA/21 is a highly eXtensible Architecture based on industry-standards and designed to meet the needs of the EMS market well into the 21st century.

The XA/21 system is a highly available security-hardened solution that has the inherent capability to expand as user requirements dictate, both in terms of applications and architecture. XA/21 can be scaled from a single processing node to a fully redundant configuration with multiple servers supporting hundreds of users.

A redundant Local Area Network (LAN) serves as the data highway connecting the various elements in the XA/21 system. The XA/21 system uses a broadcast interface for the exchange and propagation of dynamically changing data required at multiple nodes in the network.

Each node with critical functionality in the XA/21 system connects to both the primary and backup LANs. Either LAN can be designated as prime with the other becoming the backup. The system continuously checks the integrity of both LANs.

The platform independent ES GUI consists of autonomous multi-headed high-performance graphics workstations connected to the LAN. The ES architecture supports a three-tiered (client, server, agent) configuration, allowing support for secure remote users with the server residing in the Demilitarized Zone (DMZ).

Multi-system Environment

XA/21 control systems are generally deployed in a multiple system environment to meet the security and redundancy needs of each utility. Most deployment environments include separate systems for the Primary and Emergency Backup Control Centers, as well as Development, Quality Assurance and Training. Three Backup Control System (BCS) options are natively supported within XA/21:

- Site Isolation BCS
- Standby or Snapshot BCS
- Integrated BCS

Optional Applications

Transmission Applications

- State Estimator
- Scheduling
- Contingency Analysis
- Optimal Power Flow
- Security-constrained Dispatch
- Remedial Action
- Preventative Action
- Network Status Processor
- Fault Level Analysis
- Voltage and Transient Stability
- Operator Training Simulator
- Enterprise Gateway

Generation Applications

- Automatic Generation Control
- Generation Dispatch
- Real-time Production Costs
- Reserve Monitoring
- Energy Scheduling and Accounting
- GDC Market Interface

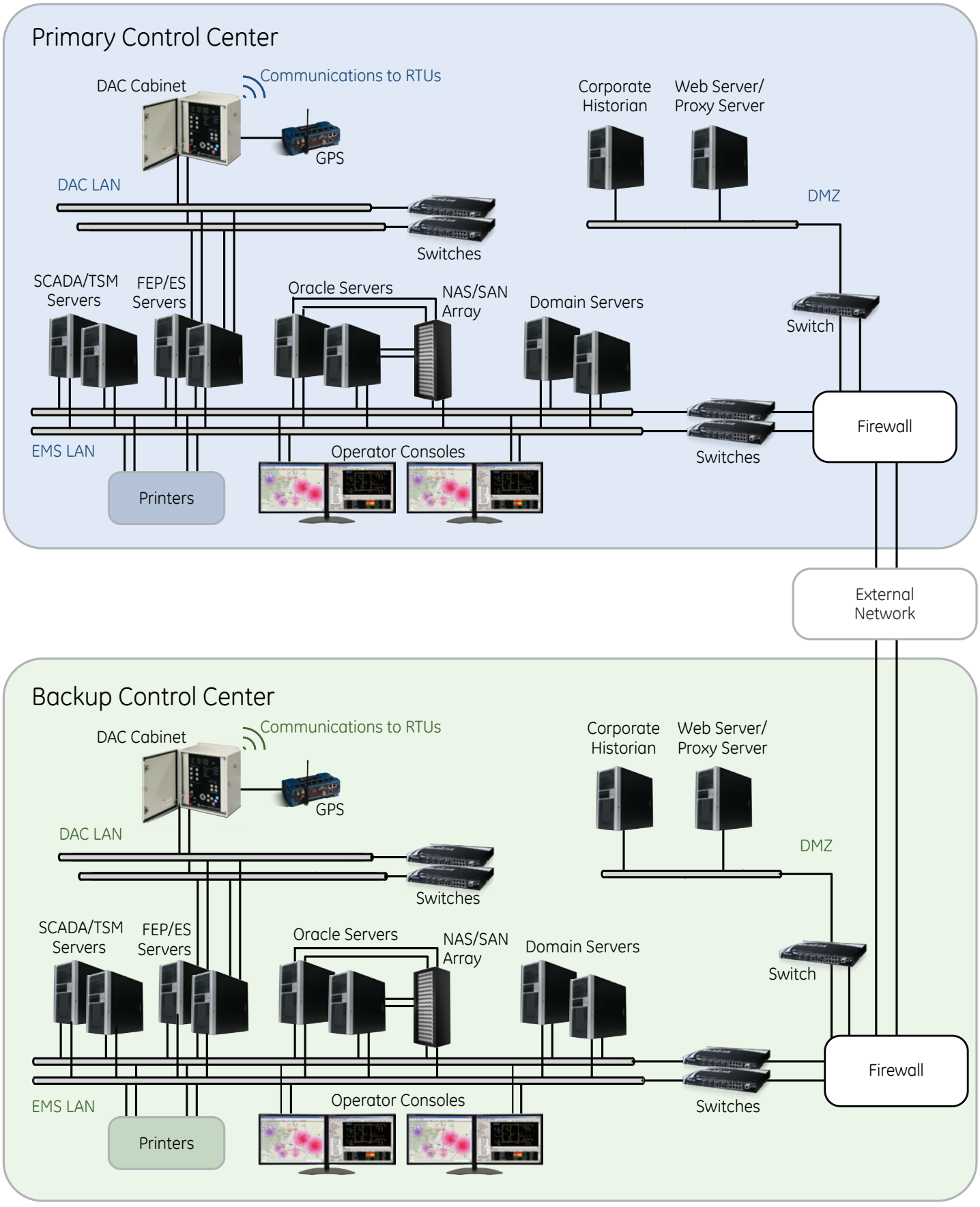
Hydro Applications

- Automatic Voltage Control
- Water Monitoring and Accounting
- Automatic Generation Control
- Power Scheduling
- Spillway Gate Control

Distribution Applications

- Connectivity Analysis
- Load Flow
- Fault Detection, Isolation and System Restoration
- Contingency Load Transfer
- Integrated Volt-Var Control

XA/21 System Architecture



Site Isolation Backup Control System

The Site Isolation (SISO) BCS provides an independent, isolated system that is loosely coupled with the primary system. Only one site is "active" (primary) at any given instance in time and the BCS must be manually prompted. Real-time updates are buffered and distributed in real-time. This BCS supports both Dual DAC and Isolated DAC scan options. The SISO BCS provides the highest overall system availability, with a moderate level of bandwidth required between the two systems.

Standby or Snapshot Backup Control System

The Standby or Snapshot BCS provides a separate system, with a critical data snapshot, periodically from the primary to the backup system for manual backup system initiation.

Integrated Backup Control System

The Integrated BCS extends the primary system across two geographic sites, allowing for four levels of server redundancy.

Secure Architecture

XA/21 systems are implemented with a defense-in-depth strategy to ensure the cyber security of the production environment, with processes at the business level and technical security measures at the network, host and application layers. The XA/21 system is designed to conform to industry-standard security practices, including those within the NIST SP 800-53 guidelines and NERC® CIP standard.

Security controls at the network level include:

- An architecture with a strictly defined perimeter.
- A DMZ network designed to eliminate direct communication between the critical trusted zone and the external networks.

Security controls at the host level include:

- A system built with only the software, accounts and services required for operational use.
- Malicious software prevention tools to detect, prevent, deter and mitigate the introduction, exposure and propagation of malware.
- Only the ports and services required for normal and emergency operations to communicate.
- File integrity monitoring to determine if unauthorized modifications have been made.
- Centralized user account management.
- Disaster recovery capabilities.

Security controls at the application level include:

- The use of secure coding standards to reduce the risk of software bugs and flaws creating security vulnerabilities.
- A system that has been independently tested for security vulnerabilities.
- Access controls designed to enforce authentication and accountability, as well as minimize the risk of unauthorized access.

Logging and auditing capabilities that allow for traceability of access and actions.

Visualization – EnterNet Suite GUI

The XA/21 system provides a rich, platform-independent user interface. Features of the ES GUI include basic SCADA visualization as well as many advanced situational awareness capabilities that enable operators to proactively monitor and control the power grid. The ES GUI is fully internationalized for single- and multi-byte languages and will run on Microsoft® and Linux® based consoles.

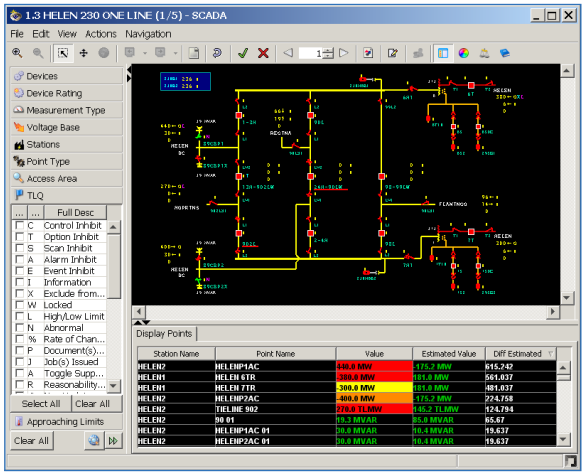
ES includes bookmarks displays, filtered and sorted summaries, charts and graphs, time series forms and dashboards. It allows the operator to link to URLs (e.g., maintenance records, photos, live camera for door alarm, outage management, geo-spatial maps, etc.). Displays can be referenced by external applications on the user console using a URL.

Displays

The ES GUI supports dynamic world-, page-, and list/grid-based displays. World-based displays are primarily used for large, geographic or schematic system maps. A single world coordinate display is composed of one or more layers of information that are automatically decluttered based on zoom level.

Page-based displays are designed to emulate the pages of a book. All pages are the same size and only one page can be viewed at a time. Page-based displays are primarily used for station one-line or schematics. The ES GUI allows the use of same display definition for multiple data sources (SCADA, Operator Training Simulator, advanced applications and historical playback) in real-time and study modes.

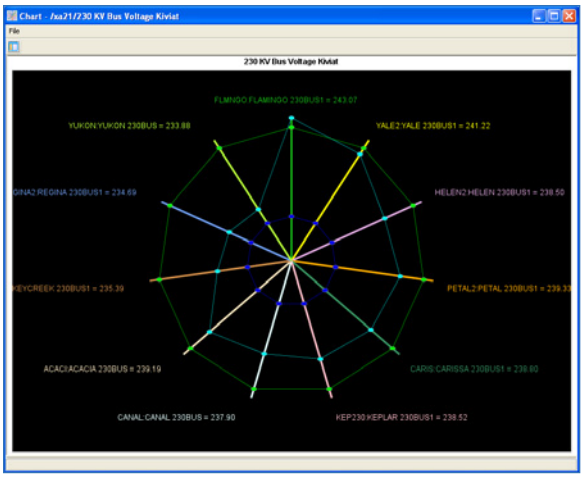
SCADA summaries are presented as a list- or grid-based display. Grid-based displays provide a highly flexible and feature-rich method for displaying tabular data, in which the total number of entries (rows) in the set varies with current system or filter conditions, and the tabular information is presented in columns that can be optionally viewed, sorted, re-sized and re-positioned by the user.



One-line Diagram

Charts and Graphs

Charts and graphs can be dynamically built using drag and drop into a wizard from a display. The ES GUI supports many chart and graph types including real-time and historical trends, kiviat, bar, line, compass, wind rose and power charts. Charts and graphs can be bookmarked and included in dashboards.

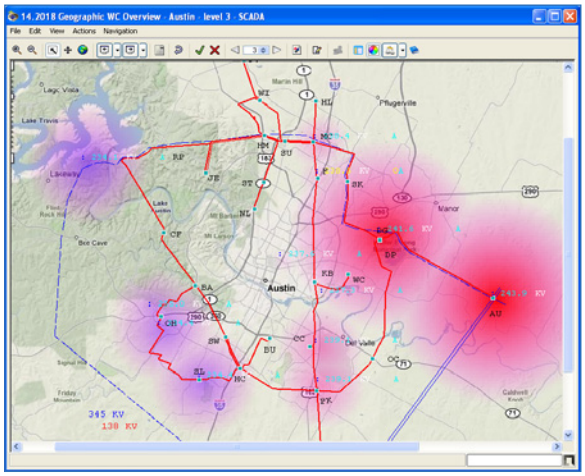


Kiviat Chart

Advanced Visualization

The ES GUI has many built-in advanced visualization capabilities, including:

- Graphical backgrounds
- Gradients based on display filter criteria
- Support for dynamic network coloring based on prevailing conditions
- Approaching limit symbols and summary colorization to show measurements approaching limit violations
- Geo-coordinate plotting of events on displays (e.g., lightning strikes, crew locations)
- Playback of data and events from data historians
- Bitmap weather overlays



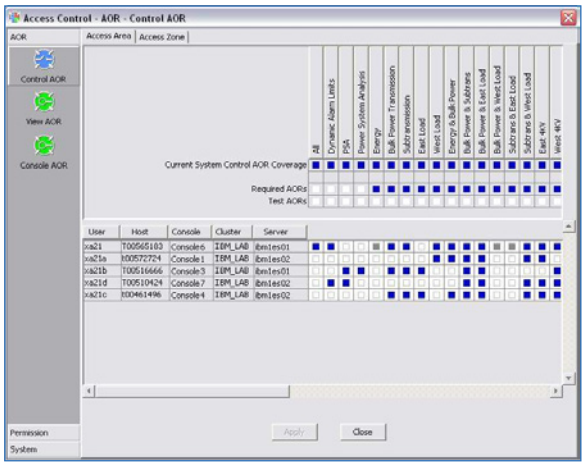
Geographical Overview with Voltage Gradients

Dashboards

A Dashboard is a convenient way of creating an overview display containing multiple display components that are joined together. A Dashboard provides the user with many different layout arrangements and can include displays, charts and graphs, and filtered and sorted summaries. Once built, each component of the Dashboard is fully functional and the completed dashboard can be bookmarked.

Access Control and Permissions

User interface features and functions are granted to a user based on each individual user's permissions, areas of responsibility (AORs) and other access control restrictions. Users are authenticated by a centralized domain server with support for multi-factor authentication.



Area of Responsibility Administration Display

SCADA Applications

Data Acquisition and Control

The Data Acquisition and Control (DAC) System is responsible for acquiring and processing data from and issuing controls to the following SCADA remote devices:

- Remote Terminal Units (RTUs)
- Time and Frequency Receivers
- Mapboards
- Digital Displays
- Strip Chart Recorders

Data acquisition tasks include remote device scanning, communication failure detection, message encoding and decoding, communication restoration, error checking and error rate monitoring. Data may be scanned at multiple different frequencies and may be demanded by either application programs or by operator request. The number of scan cycles, the frequency of each and the remote devices scanned is configurable by the programmer/engineer through the Database Editing System.

RTU Protocol Support

The XA/21 system supports a number of RTU protocols including DNP 3.0, IEC® 870-5-101, IEC 870-5-104 and Modbus®, as well as a large number of legacy protocols.

The DAC software maintains error statistics on, and the current status of, communications over the various channels via RTUs. This feature provides the operators and communications technicians with updated communications status information, including noisy channel conditions which result in normally un-noticed communications retries.

Sequence of Events (SOE) processing provides the operator with chronological reports and display(s) showing the change-of-state events for pre-defined RTU indication (status) points. SOE reports are maintained by the historical information system for the current and previous day's events.

Data Link Support

XA/21 Data Links provide the capability for communication with other control centers via a common protocol. XA/21 supports the following data link protocols:

- ELCOM™-90 (ELCOMB83 compatibility)
- ICCP for ISO® standard ISO/IEC 870-6

Association-based secure ICCP functionality is available.

OPC Data Access Server and Client Support

XA/21 extends the system architecture to loosely coupled PCs, by supporting Object Linking and Embedding for Process Control (OPC) Data Access (DA). The OPC Front-end Processor (FEP) communicates with OPC DA servers provided by one or more vendors for acquiring data on behalf of the XA/21 EMS.

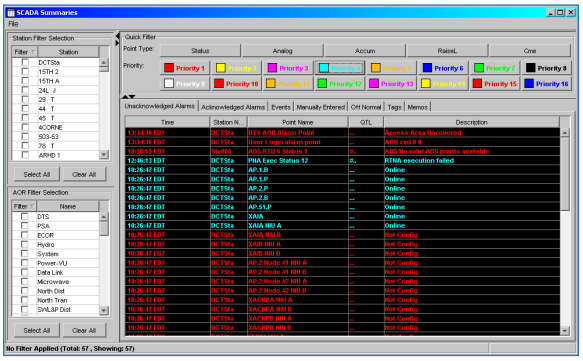
Phasor Measurement Unit Device

XA/21 has the capability to acquire synchrophasor measurements directly from Phasor Measurement Units (PMUs) and/or Primary Domain Controllers (PDCs) in IEEE® C37.118 format and store them into its real-time database for visualization and use by other applications such as the State Estimator.

Alarm and Events

The alarm and events reporting mechanism is designed to support up to 16 classes (1-16). For a given class, the handling and attributes (priority, color, audible) of each are database configurable.

Alarms and events are presented to the user in real-time within SCADA summaries. In addition, applications are available that allow the user to extract alarm and event data from the historical database.



Alarm/Event Summary

Load Shedding/Restoration

Automatic Load Shedding/Restoration (LS/R) provides a rapid method of opening and (optionally) closing groups of circuit breakers without the need to individually select and then operate each breaker separately. Groups are defined in the database and can be one of three types as follows.

Linear LS/R Group

Begins the shed at the breaker stated as the Start Point and proceeds to the end of the list or until the desired load is shed.

Circular LS/R Group

Begins at the Start Point and processes until the desired load is shed. Upon reaching the end the start point wraps back to the first breaker.

Rotational LS/R Group

Circular LS/R group that automatically restores the previously shed breaker(s).

Sequential Control (Automatic Supervisory)

Sequential Control provides the capability to schedule automatic execution of pre-defined control sequences. A sequence editor is provided to enable the easy creation and maintenance of sequences and to categorize them in a sequence library. The sequential control capability allows the user to perform operations such as:

- Switching sequence related to maintenance , isolation or feeder reconfiguration.
- De-energizing or energizing network elements such as parallel transformers.
- Group commands (ganged switching, device isolation, load shed).
- Conditional control of one or more devices at different stations as a result of detecting a specific system condition.

Transmission Switching Application

The Transmission Switching Applications (TSAs) are a suite of applications that can be deployed either individually or in combination.

TSA Real-time Switching Validation involves real-time validation of all requested switching device change of states. With this feature, every control request, manual state change request or programmatic non-control state change request associated with a switching device is validated against a set of configurable validation rules. If the request is invalid, it is rejected and not performed.

TSA Documents and Permits provides comprehensive management of the electronic documentation and field permits associated with switching (in PDF format).

TSA Switching Schedule Jobs provides comprehensive management of the electronic switching schedules associated with planned switching schedule jobs, fault switching schedules or unplanned switching schedules.

Given that each utility's types of switching schedules and operational procedures vary, TSAs are customizable through data configuration so they can be easily tailored to meet a given utility's needs.

Real-time Calculations

Real-time Calculations provides a standard and extensible calculation library which, in addition to arithmetic and logical operations, contains standard functions traditionally associated with a power system (e.g., MVA, PF). Points are associated to the calculations using the database administration facilities.

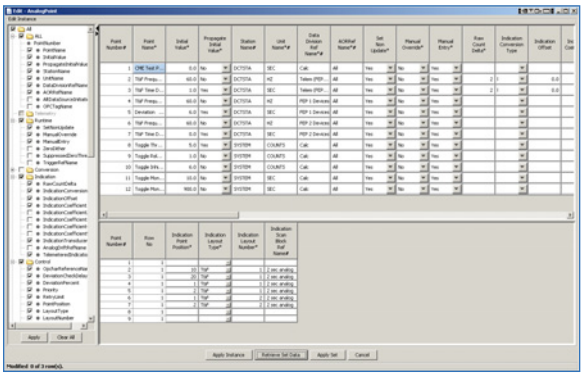
Historical Information Systems

XA/21 supports multiple Historical Information Systems including Oracle®'s RDBMS, Instep's eDNA, OSIsofts Inc.'s PI Historian and GE's Proficy data historian.

Data Engineering Tools

The XA/21 system provides a number of editors that allow users to manage and administer the database, displays and forms or reports, including the Database Suite, Commit User Interface, Display Editor, Display Update Manager, Pseudo Display Editor and Time Series Builder.

For the database and display editing functions, centralized editing controls changes to the on-line database by allowing editing at only one system (the Master), and automatically making the data available for commit by job at each of the other systems (the Slaves) to keep the data synchronized. All database edits and commits are performed on-line without any system failovers. The Commit User Interface and the Display Update Manager prepare and execute the files needed to perform this synchronization, and all configured systems have access to a centralized data storage repository of proven editing files.



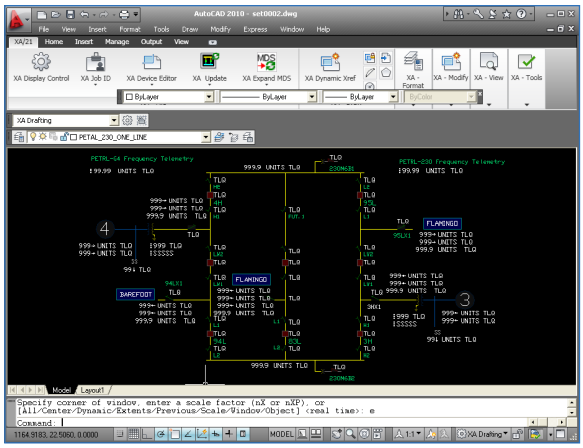
Database Editor

Database Editor Suite

The Database Editor Suite application is a combination of the Database Browser and the Database Editor functions. It allows for the display of XA/21 views, attributes and other structures that make up the XA/21 Logical Database, including allowing editing of these values.

Commit User Interface

The Commit User Interface provides the capability to choose one or more database modifications to apply to the on-line system. This design allows users to commit only the portions of data that are complete, while not interfering with the editing capabilities of other users. A user may select individual instances, jobs, multiple jobs or selections from several jobs for application to the operational database.



AutoCAD based Display Editor (One-line)

Display Editor

The XA/21 Display Editor is a set of interactive software tools that can be used to build and manage all elements of displays within an XA/21 system. The Display Editor is based on AutoCAD® with linkages back to the real-time database. In addition to the capabilities supplied by AutoCAD, the Display Build Facility provides the facilities to meet the requirements for displays in the XA/21 EMS environment. These facilities include:

- Definition of the static display information using AutoCAD's graphic drawing facilities for defining geographical or schematic diagrams.
- Incorporation of real-time or application data within a display.
- The ability to define graphical symbols to represent the current state of telemetered or calculated devices. These graphical symbols can be further organized into groups (called a device) and stored in libraries for future reference.
- The ability to define the characteristics (referred to as attributes) of a display such as display ID, pan/zoom characteristics, refresh rates, fonts, application interfaces, etc. These attributes vary depending on the type of display being constructed.

Display Update Manager

The Display Update Manager allows for the distribution of run-time displays to all systems. Once distributed, the displays are available to the operator on the next display call-up.

Pseudo Display Editor

The Pseudo Display Editor allows the engineer to build multiple displays based on a common template. An example of representative use is a wind farm. A typical wind farm is made up of many turbines/generators. Drawing and maintaining individual displays for each turbine would be very time consuming. As each turbine pseudo display is derived from a common template, any changes to the template are automatically reflected in the resultant turbine display.

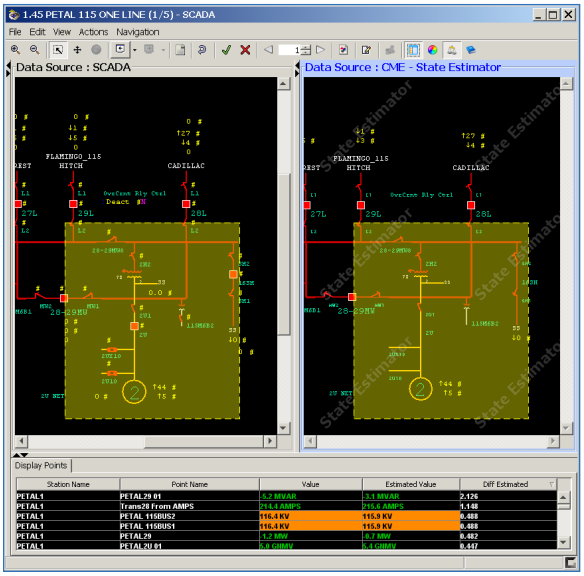
Time Series Form Builder

The Time Series Form Builder is a development tool used for creating applications for viewing XA/21 historical data from the Oracle relational database. The Time Series Form Builder is designed for the non-technical user, whereby simple point-and-click, drag-and-drop operations are used to create fully functional applications.

Transmission Applications

The XA/21 Transmission Security Management (TSM) subsystem delivers a powerful set of tools for efficiently operating and protecting the integrity of the power system. The TSM application module delivers rich information about the real-time system with the added capability of being able to examine near future states of the system.

With multi-user/multi-case support, the TSM subsystem provides a high performance environment for network analysis, contingency analysis, optional optimal power flow and optional fault level analysis functions. Using the TSM subsystem, control center personnel can identify and analyze potential operating problems and formulate various preventative strategies.



State Estimator Case Comparison

Base Applications

Real-time and Study State Estimator

The State Estimator (SE) engine estimates and analyzes the accuracy of the telemetry within the transmission network provides this functionality using robust algorithms. Estimated values are provided for all input measurement types as well as for bus phase angles and branch series and shunt impedances. SE has the ability to use PMU data such as time-aligned bus voltage and phase angles to improve results.

Study Power Flow

Study Power Flow uses robust algorithm techniques, including Newton and Fast-decoupled, for analyzing the transmission network within TSM. The Power Flow engines provide a base case off-line study solution that can be used for further study.

Network Status Processor

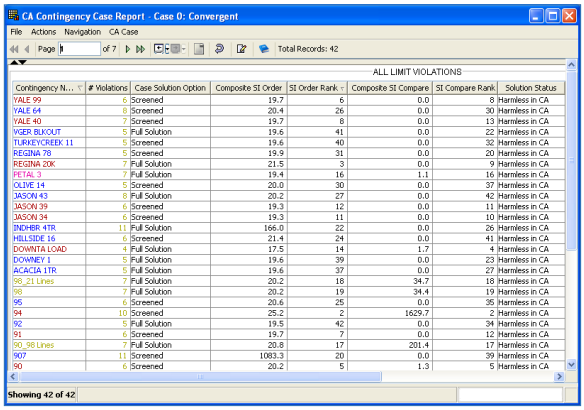
Network Status Processor (NSP) provides a precise determination of electrical connectivity at the individual bus section level. Rather than relying on user-defined calculations that must be maintained over time, NSP uses a detailed connectivity model in conjunction with generalized Boolean logic to accurately determine electrical connectivity and resulting energization status for each individual power system component.

Schedules

Schedules provide typical day and absolute schedules for use in determining the base network solution in Power Flow and in State Estimation where telemetry is not available or requires further scaling.

Real-time and Study Contingency Analysis/Contingency Selection

Contingency Analysis tools provide capabilities for studying the impacts of topological or MW generation changes to a base case solution. Each contingency case can be processed as part of a group of other contingency cases in a batch mode, providing the user with the ability to study impacts of many contingencies against known system conditions.



Contingency Analysis Case Report

Supplemental Applications

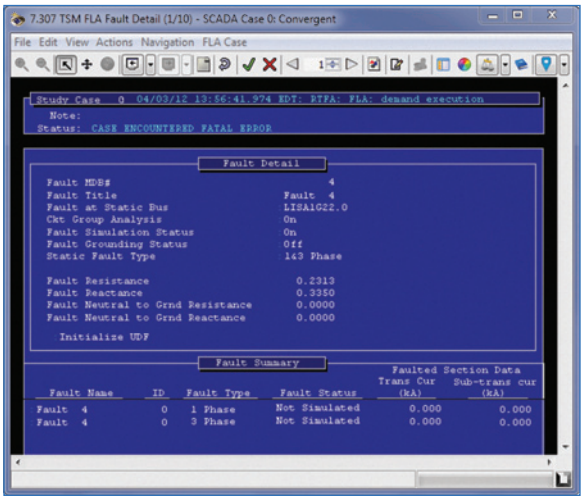
Real-time and Study Optimal Power Flow

To supplement the base transmission applications the following applications can be optionally included.

- **Security-constrained Dispatch Active Power Optimization**
  Optimization tools allow constraint limit violations to be relieved through several selectable objective function methodologies using active power controls. Users can choose to optimize all limits or only active power limits.
- **Voltage/VAR Scheduling Reactive Power Optimization**
  Constraint violations can be relieved through several selectable objective function methodologies using reactive power controls. Users can choose to optimize all limits or only reactive power limits.
- **Post-contingency Remedial Action Optimization**
  The Remedial Action (RA) module provides the capability to obtain independent optimized corrective rescheduling plans for each of a list of harmful contingency cases that is identified by Contingency Analysis. For each harmful case, a set of active and reactive power control moves is obtained that minimizes the values of the user-specified objectives while observing all operating limits designated for enforcement when implemented in the post-contingency time frame.
- **Pre-contingency Preventative Action Optimization**
  The Preventative Action (PA) module provides the capability to obtain optimized preventative scheduling plans for a list of contingency cases. PA minimizes the values of the user-specified objectives while observing all operating limits designated for enforcement in the base case and contingency cases. A set of active and reactive power control moves is obtained that results in the system remaining secure due to the occurrence of any one of the contingency cases when implemented in the pre-contingency time frame.

Real-time and Study Fault Level Analysis

Fault level analysis tools provide real-time and off-line study capability to simulate three-phase, phase-ground, phase-phase and phase-phase-ground fault currents. User-defined or pre-defined faults can be used within any active case.



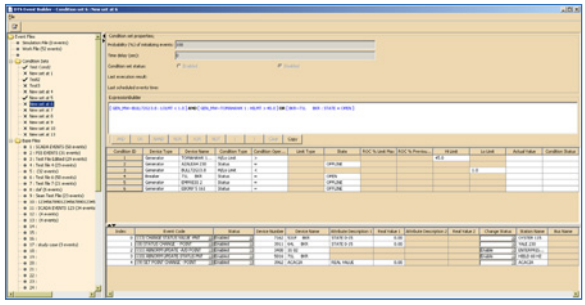
Fault Level Analysis Fault Detail Display

Voltage and Transient Stability

XA/21 supports an interface to third-party security assessment tools, including Voltage and Transient Stability.

Operator Training Simulator

Due to the ever-increasing growth and complexity of today's EMS, the need for training tools that supplement the traditional on the job training of system dispatchers is recognized as an important requirement in the control center environment. The Operator Training Simulator (OTS) provides simulated conditions through which operators can be trained to control the transmission grid on an XA/21 EMS, all based on the same engines and model as the base transmission applications. The OTS creates a realistic environment for the system operator to become familiarized with XA/21 system operation functions, test new operational approaches and learn to manage emergencies through simulated conditions.



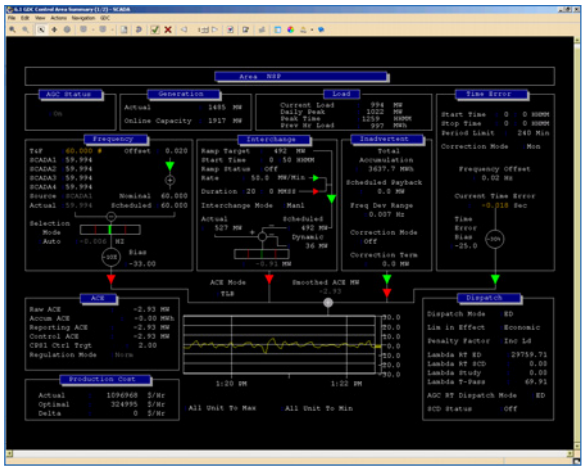
Operator Training Simulator - Conditional Event

Enterprise Gateway – IEC 61970 Common Information Model Exchange

The Enterprise Gateway (EG) allows the transmission model to be exchanged in Common Information Model (CIM) format. EG supports full and incremental model import and export into the XA/21. Imported models may be used as the base network model definition, as incremental changes to the external model or be imported into the study environment as an independent model.

Generation Applications

The XA/21 Generation Applications provide the functions required for dispatch and closed loop control of generation in an economical fashion while considering interchange schedules, generation limits and reserve requirements. In addition, the Generation Dispatch and Control (GDC) subsystem provides alarming as required in order to alert the operator to impending conditions.



Automatic Generation Control Summary

Automatic Generation Control

Automatic Generation Control (AGC) provides closed-loop control of generating units within a control area of an interconnected power system. AGC provides supplementary control of area generation to maintain area frequency and/or area net interchange within defined limits. The primary objective of AGC is to minimize the instantaneous and accumulated Area Control Error (ACE) subject to specified NERC control performance criteria. A secondary goal of AGC, in conjunction with the Generation Dispatch function, is to minimize the area production cost within the bounds of practical operating constraints.

Generation Dispatch

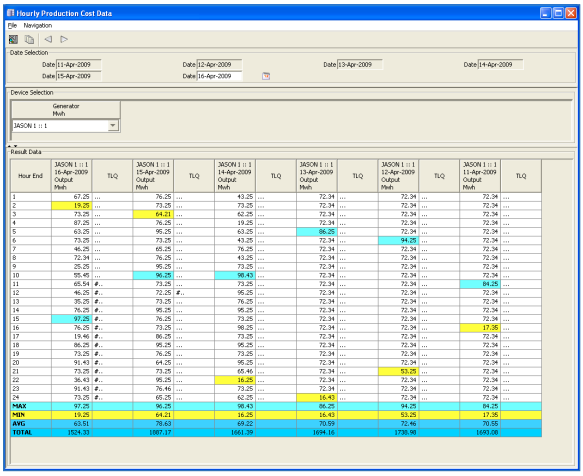
Generation Dispatch (GD) allocates the required amount of area generation among available on-line generating units in an economical fashion so as to minimize control area production cost with consideration of transmission losses and high/low generator limits.

The GD function supports conventional fossil fuel (i.e., coal, oil and natural gas) fired units and combustion turbines for which incremental heat rate (IHR) curves are available.

Real-time Production Costs

Real-time Production Cost (RTPC) processes real-time data for power system operating cost accounting. Historical Database Reports are prepared on a periodic basis, which summarize the fuel, operating and maintenance (OM) and startup/shutdown costs for each unit, plant and area in the power system.

RTPC also provides real-time production cost performance monitoring. The actual production cost is periodically compared with the optimal production cost (based on the Target Pass economic dispatch). An alarm is issued to the operator if the difference between actual and optimal production costs exceeds a pre-defined tolerance.



Production Cost

Reserve Monitoring

Reserve Monitoring provides current information on available active (MW) and reactive (MVAR) reserves in the system. The Reserve Monitor is a standard software feature of the GDC. However, definitions of the various Reserve parameters may vary with individual customer requirements.

Energy Scheduling and Accounting

Energy Scheduling and Accounting (ESA) provides the operator with the capability to schedule future operating plans (for load, generation and interchange) and review past accounting information through Java-based energy related forms and reports.

ESA comprises the following functions:

- AGC Performance Monitoring (APM)
- Production Costs and Fuel Accounting (PC)
- Interchange Scheduling (I/S)
- Inadvertent Interchange Accounting (IA)
- Load Forecasting with:
  - Similar Day Load Forecasting (SDF), or
  - Demand Forecasting (DF)
- Unit Commitment/Transaction Evaluation (UC/TE) or Comprehensive Operations Planning and Scheduling (COPS)

GDC Market Interface

XA/21 offers interfaces to many different regional market systems. A typical market system interface consists of the primary data being supplied via ICCP data links for Base points and Net Scheduled Interchange with XML files provided as supplementary or as a backup. XA/21 has the option of running in "Market mode" or independently as a backup for the Regional Marketing System. As each market interface is different, the XA/21 system can be customized to meet the needs of each utility.

Hydro Applications

For systems with reservoir-based, hydro-electric generators, XA/21 is available with several optional hydro applications.

Automatic Voltage Control with MVAR Balancing

Generator Automatic Voltage Control (AVC) and MVAR Balancing provide simultaneous operation of AGC with AVC to coordinate closed control of MW and MVAR generation within operational and capability limits.

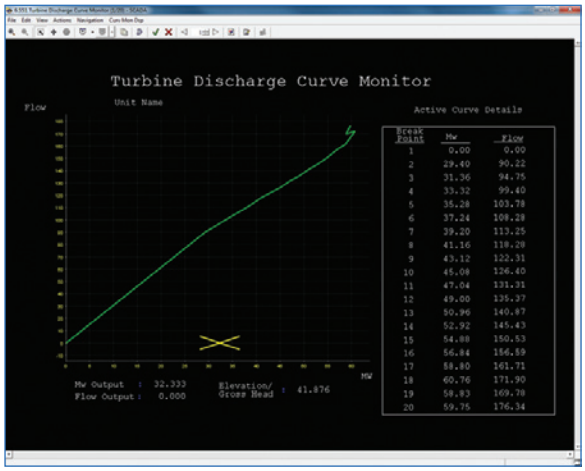
Water Monitoring and Accounting

Water Monitoring and Accounting provides the operator with a water release summary and detailed information for current/previous hour conditions for all reservoirs, plants, generators and gates (spillway, bypass, auxiliary releases) along with projected releases for the current hour.

Historical forms are available for summarizing water release on a daily, monthly and yearly basis.

Automatic Generation Control of Hydro Plants

AGC of hydro plants provides closed-loop MW control of hydro generators to meet the plants hourly base-point schedules or real-time plant set-points, while remaining within hourly plant operational water and generation limits.



Turbine Discharge Curve Monitor Display

Power Scheduling for Hydro Plants

The Power Scheduling functions support the processing of 24-hour (current/next days) plant base-point schedules and bus KV or MVAR schedules originating either locally or remotely (via data link).

Spillway Gate Control

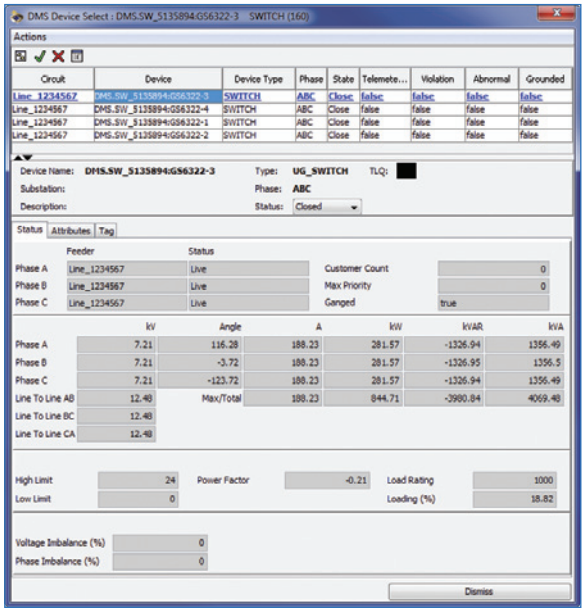
Spillway Gate Control provides open and closed loop control of spillway gates using either a total discharge or release level control objective.

Distribution Applications

XA/21 Distribution Management System (DMS) applications provide facilities for the effective management and operation of the distribution network from the distribution station and into the feeder network. DMS applications are based on models and graphics derived from a utility's GIS.

Distribution Connectivity Analysis

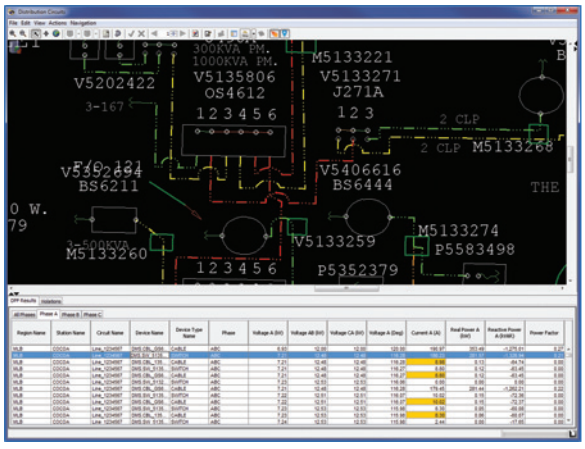
The Distribution Connectivity Analysis (DCA) application automatically monitors and analyzes the global connectivity network state based on static or wired connectivity and current open/closed status of switching devices. In addition, temporary changes to network topology applied by a user in the real-time operating environment are taken into account. The electrical status of each device in the network is always up-to-date.



Distribution Device Select Switch

Load Flow

Load Flow (LF) is an event-triggered application that uses network topology information, as well as the current estimated load demands, to calculate the three-phase voltage and current values for every device in the network. LF provides estimated values for those electrical quantities at network locations where SCADA measurements are not available.



Distribution Load Flow Results

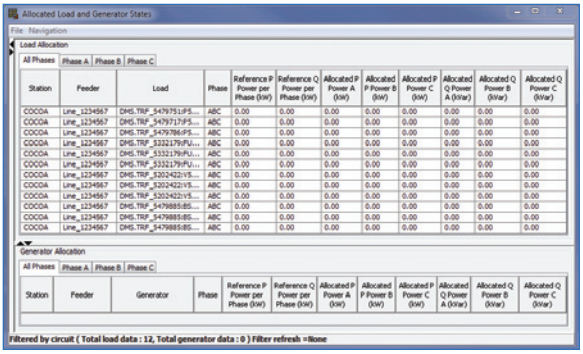
Fault Detection, Isolation and System Restoration

The objective of Fault Detection, Isolation and System Restoration (FDIR) is to improve customer service by minimizing the duration/extent of forced outages due to faults in the medium voltage radial network. Whenever a substation breaker or line recloser trips, and the associated auto-reclosing relay locks out, FDIR will:

- Automatically attempt to determine the location of the fault based on telemetered FRTU fault passage detection and breaker over-current relay trip data.
- Then attempt to identify switching actions to isolate the faulted section and restore power to un-faulted feeder sections up- and down-stream of the faulted section.
- Then display the recommended switching actions to the operator for approval and implementation.

Contingency Load Transfer

The interactive Contingency Load Transfer (CLT) study mode application provides switching recommendations for a network reconfiguration transferring load from one feeder to another to reduce overload on a particular device or re-energize outaged portions of the network.



Distribution Allocated Load and Generator States

Integrated Volt-Var Control

The Integrated Volt-Var Control (IVVC) determines desirable capacitor switching and transformer tap control actions resulting in better network operations. IVVC has two primary modes of operation: Voltage Control, concerned with temporarily reducing the total system load below defined levels at peak load periods; and VAR Control, concerned with maintaining the power factor at bulk supply points above minimum defined levels.

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