XA/21* SCADA
Energy Management System
XA/21* – A reliable, field-proven, secure and adaptable solution for optimizing the operation of generation and transmission assets.
The Business Case

Sweeping privatization, deregulation and re-regulation initiatives have radically altered the competitive landscape of the electric utility business. Deregulation in wholesale power markets has resulted in a tenfold increase in the number of interchange transactions. The combined effects of weather and forced outages have created congestion driving wholesale spot prices to all time highs. Competition is fierce. Security of the critical infrastructure and the IT systems used to manage it are paramount. The pressure for electrical utilities to reduce costs and maximize use of existing assets, while maintaining adequate security margins, has never been greater. In order to thrive in this environment, a reliable, adaptable, and secure information technology infrastructure is key essential.

Since its debut as the first open Energy Management System (EMS) offering in early 1990, the XA/21* system from GE Energy has continued to revolutionize the industry. With an established track record of field performance—over three and a half million hours of online operation—the XA/21 system is entrusted with the management of critical transmission & generation infrastructure in over 100 locations worldwide. GE Energy’s worldwide team of professionals and the XA/21 system’s modular software and open system architecture combine to enhance service performance and overall reliability, while facilitating continued compliance with ever-changing industry requirements.

Benefits

- Scalability from one to over 150 computing nodes
- Field proven reliability – over 100 installed systems, over 3.5m hours of online operation
- Flexibility to adapt to the ever-changing market and regulatory demands
- Low total cost of ownership
- A foundation of industry and de-facto standards including:
  - UNIX®
  - SQL
  - JAVA™
  - HTTP
  - IEC®
  - Windows®
  - TCP/IP
  - CORBA®
  - DNP 3
  - ODBC
  - ANSI® C
  - XML
  - IEC® 870-5 101
  - Fortran, C++
  - SSL
  - IEC® 870-6 TASE.2 (ICCP)
  - ELCOM 90
- Rich portfolio of world class advanced applications for transmission and generation
- User driven, internally funded and highly vital product evolution

The XA/21 system is all about improving your performance

Decision Support – Information Versus Raw Data

The XA/21 system presents a consistent real-time view of the entire electrical network to operators and management based on established end-user permissions. The capability to analyze alternate operating strategies based on current or postulated system conditions provides your operations team with valuable insight into possible courses of action. The XA/21 system is designed to ensure that timely, accurate information is available when you need it most.
Grid Security
As asset utilization levels continue to rise, the importance of secure grid operation becomes paramount. Explosive growth in the number of wholesale power trades continually stresses the transfer capability of the transmission grid. The XA/21 system supplies your operational staff with a powerful suite of information management tools that allows them to visualize, anticipate, and respond to ever changing system conditions. Whether through the smooth, reliable management of generated power in response to system disturbances, the vigilant monitoring of system conditions against operating limits, or the automated development of corrective and preventative strategies, the XA/21 system delivers.

Cyber Security
Equally important to the security of the grid itself is the security of the IT systems used to manage the grid. With an ever-changing spectrum of plausible threats ranging from disgruntled employees to cyber-terrorists, sound IT security has become an ongoing process that requires effective utilization of the latest technologies. In addition to more fundamental security mechanisms, such as firewalls and user ID/password protection, the XA/21 system also provides advanced security measures including centralized management of end users, user authentication, data/communication encryption, and file tampering detection.

Total Cost of Ownership
Tired of wrestling with your antiquated EMS? The XA/21 system is designed to reduce total operating and maintenance costs, including costs of ownership. The XA/21 system’s next generation Java™-based, full graphic user interface (EnterNet Suite*) eliminates client side installation and maintenance costs and substantially enhances overall operational efficiency. The EnterNet Suite interface support for embedded URLs provides tremendous impact on your Total Cost of Ownership by providing “out of the box” interface functionality with respect to other web-enabled systems. View documents and/or launch applications on other Enterprise systems, all without writing a single line of code. With the EnterNet Suite interface, the XA/21 system also provides the capability to cost effectively consolidate existing control centers—while continuing to support the geographically dispersed user community—resulting in significant savings.
Operating Costs

Fuel cost is far and away a generating company’s single largest operating expense. The XA/21 system helps to minimize fuel and fuel-related O&M costs while satisfying unit, plant, and system level operating constraints. It also helps reduce contractual and regulatory constraints, such as limited availability fuels and emission levels. The XA/21 system also can provide reduced transmission losses through the use of available reactive compensation and voltage controls. By providing an up-to-date, accurate picture of current system conditions relative to operational constraints, the XA/21 system can help to maximize the utilization of existing assets, allowing costly capital expenditures to be deferred.

Architectural Scalability and Flexibility

From single-computer development systems to geographically dispersed operational systems in excess of 150 nodes, you can rest assured that the XA/21 system will fit your operational needs today, tomorrow, and beyond. The XA/21 system provides for a myriad of options with respect to physical system configuration and user access including, but not limited to:

- Centralized, hierarchical or peer-to-peer control centers
- Geographically dispersed systems
- Dedicated standby emergency backup systems
- Remote user workstations and data acquisition nodes
- Corporate data warehouse

Conditional Online Database Editing

Add, modify or delete database entries online. Enter your data once. Choose from batch or interactive mode. With the industry's only true online integrated database editing facility, changes can be made to the database and committed to the online system without interruption of online operations. No reconfiguration or re-starting of the system required—just edit and commit your changes to the online system. All changes are automatically subjected to the full range of syntactic and semantic validation prior to being committed, thereby ensuring the integrity of the online data model is preserved. Once committed, you have the opportunity to evaluate your changes online and then accept or reject them. Rejection of previously committed changes results in only those changes being “rolled back” and the previous version of the online database being automatically restored.
Components of the XA/21 System

The XA/21 system is a high performance distributed control system that provides electric utilities worldwide with the capability to monitor, control, and optimize the operation of geographically dispersed assets in real time. Scalable from a single node—nonredundant system upward to geographically-dispersed systems containing literally hundreds of interconnected processing nodes—the XA/21 system is a common computing foundation that is fully configurable and can be tailored for specific system functions. The XA/21 system collects data from RTUs, IEDs and other operational systems to provide a single unified view of operational data across the utility’s operational enterprise. At the foundation of this architecture are the XA/21 System Base, Data Acquisition and Control, Data Link, Database, and EnterNet Suite Graphical User Interface modules. Together, they provide the basic framework for the day-to-day operation and maintenance of the generation and transmission grid.

Core Modules

The following XA/21 modules are present in each and every system and form the core platform upon which other optional advanced application modules can be deployed:

**System Base**

The XA/21 system’s System Base module is a high performance real-time service layer that isolates the various high level applications from differences between the native services appearing across the spectrum of different UNIX® operating systems and versions. System Base provides application startup, shut down, and migration services in addition to secure inter-process messaging, memory management, and priority-based scheduling services. System Base supports both point-to-point and broadcast-based communications, and is scalable to systems numbering in the hundreds of nodes.

**Data Acquisition and Control**

The XA/21 system’s Data Acquisition and Control (DAC) module acquires measurement data via remote terminal units or data links via a variety of industry standard protocols including DNP 3.0, IEC® 870-5 101, and others. In addition to serial communications, the XA/21 DAC also supports TCP/IP-based transport mechanisms enabling the host utility to benefit from:

- Significantly lower communications cost
- Higher reliability than dedicated leased circuits
- Higher communication speeds/reduced data latency

DAC also supports a wide variety of different options with respect to the configuration and switching of serial communication channel including:

- Single dedicated channel per RTU
- Dedicated primary and backup channels for each RTU
- Party lining (e.g. multiple RTUs on a single communication circuit)
- Loops (dual terminated party lines)
- Switching on the analog side of the modem
- Switching on the digital side of the modem
For those RTUs having redundant channel circuitry, DAC provides failover at the individual communication channel level, allowing data acquisition on remaining channels to continue unaffected. DAC also validates data for reasonability and communication failures by performing checks on process variable limits and by testing the quality and integrity of acquired data based on limits, normal/abnormal states, etc. Any abnormal conditions subsequently detected are alarmed. In addition, DAC also provides remote supervisory control capability via the following types of hardware interfaces:

- Raise/lower control
- Set point control
- Contact closure

**Data Link**

The XA/21 system’s Data Link module provides a mechanism for exchanging data and control requests with other control centers or other corporate IT systems in near real time. The Data Link module provides a family of industry standard protocols to these types of systems, including ICCP (TASE 2.0) and ELCOM 90. As a result of security initiatives by GE in this area, options for “Secure ICCP” are now available within the XA/21 system to authenticate both the sending and receiving parties using digital certificates and to encrypt the underlying data content being exchanged.

**Graphical User Interface**

A key differentiator of the XA/21 system is its state-of-the-art JAVA based, EnterNet Suite graphical user interface module. Unlike other limited function "web clients" that rely on browsers to make their data available, the EnterNet Suite interface is a high performance, full function Java client application capable of running on any platform that supports the Java Virtual Machine (JVM). As it does not rely on browsers, the EnterNet Suite interface is truly platform independent and does not suffer from browser related stability issues. The interface is available in three different configurations, each targeted at a specific niche of end-users:

- Full function dispatch client – dispatchers or administrators inside the control room
- Full function remote client – remotely located dispatchers or administrators
- View only remote client – remotely located executives, key customers, etc.

For the remote clients with control capability, VPN is utilized to provide both user authentication and data encryption. For remote view only clients, SSL is utilized to provide encryption of the operational data.
The EnterNet Suite interface provides a highly efficient, intuitive environment for the operator to view both the current and future operating states of the system and to effect the necessary control action that ensures safe and economic operation. Using high-speed pan and zoom in concert with direct linkages from alarm messages to equipment locations on displays, the operator can navigate large interconnected power system networks with ease. Among the many advanced features of the EnterNet Suite GUI are:

- Highly deterministic display response, irrespective of system activity levels
- High-speed pan and zoom with automatic display de-cluttering
- Single point of display definition and maintenance using AutoCAD®
- .dxf graphic import capability
- User selectable look and feel
  - Motif
  - Metal
  - Windows
- Support for embedded URL linkages, providing seamless integration with other systems and low Total Cost of Ownership
  - View/update documents resident on the XA/21 system or other IT platforms
  - Launch 3rd party applications locally or remotely
  - Embed graphics, video, web cams
  - Link to existing web pages
- Single set of online display definitions for all applications
- Support for projection mapboards

**Database**

The XA/21 database provides a secure central repository for all mission critical data. The XA/21 system's View Data Editor provides an object-oriented user interface for the administration of data in relational form, thereby eliminating the need for detailed knowledge of underlying database structures. The source database definition is then transformed from a series of relational tables into a performance-oriented collection of binary disc and memory resident structures known as the real-time database. Data from the real-time database is sampled and stored in either the Historical Information Storage and Retrieval Database (HISRDB) or the Continuous Recording Database (CRDB), depending on its respective frequency of collection.
The HISRDB is Oracle®-based and is utilized to provide a short-term operational history of events and less frequent periodic data samples. CRDB, on the other hand, is designed to capture high-speed data changes at scan rates. Finally, ODBC interfaces to each of these databases to provide open access to the real time and historical data samples via a variety of third party tools. Key features of the XA/21 database include the following:

- Single point of maintenance
- Enter data once and only once
- Relational source ("as built") and historical databases using ORACLE®
- Support for interactive and batch mode database maintenance
- Online, incremental database updates
- Full semantic and syntactic validation of entered data
- Performance-oriented real-time database ("as operated")

Optional Modules

The following optional XA/21 modules can be enabled, as needed, to form a fully integrated Energy Management System application suite:

**SCADA Applications**

**Load Shedding & Restoration**

The Load Shedding and Restoration (LS&R) module provides the engineer/operator with the capability to pre-define groups of loads for monitoring and subsequent consideration as part of various load relief strategies. In addition, LS&R provides for automatic restoration of shed load, based on the type of load relief scheme employed. Rotational, circular, and linear load relief schemes are supported. The number of loads to be shed at any point during a particular scheme is automatically computed, based on the MW requirement and the MW demands of the individual loads that make up the scheme. Depending on the type of scheme employed, restoration of a previously shed load may be accomplished automatically or manually at the operator’s request.

**Network Status Processor**

The Network Status Processor (NSP) module 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. NSP runs automatically on system startup and on an event driven basis thereafter, in response to operator entered or telemetered changes in switch statuses. Output of NSP may be used to drive the presentation of objects on displays, or as input into other applications/calculations.
Sequential Control

The Sequential Control (SQC) module provides the engineer/operator with a 4GL-based interface for defining control sequences. Using drag and drop techniques from online diagrams or tabular displays, in conjunction with a predefined “tool box” of functions, the user can define multi-step control sequences that involve the querying/setting of point value/state or quality attributes. The user can also define the issuance of alarms or events, and the issuance of control commands to controllable points. Once defined and validated, a control sequence can be invoked manually from a point select, periodically, or based on an event. Common uses for SQC generated sequences include automation of repetitive switching actions and implementation of corrective strategies.

Switch Order Management

Switch Order Management (SWOM) consists of three separate modules—Safety/Operational Validation, Online Documentation/Permitting and Job Management.

Safety/Operational Validation employs a detailed electrical connectivity analysis in order to validate requested switch status changes from operators as well as application programs such as ICCP, Sequential Control, Load Shedding/Restoration and real time calculations against defined safety and operational rules.

Online Documentation/Permitting provides comprehensive management of the electronic documentation associated with the switching process, including:

- Definition of document templates
- Population of defined templates
- Automatic determination of isolation and grounding points
- Association of documents with points or groups of points (e.g. group tagging)

Job Management provides a comprehensive framework for managing multi-step switching orders throughout their life cycles, including:

- Creation, pre-validation, final approval and execution of planned switching orders
- Emergency or ad hoc switching
- Archival of completed jobs, including all associated documents

Collectively, these modules provide the operator with a highly efficient framework for managing day-to-day maintenance of the transmission grid.
CRDB Playback

The XA/21 CRDB Playback module, also known as Power-VU* (PV), provides the operator with the capability to reconstruct and understand past event sequences by “playing back” historical data values and conditions from the continuous recording database through the use of control displays, study databases, and standard user interface (UI) displays. The control displays are used to select the data to be played back and to control speed and initiation of the playback process. Data corresponding to the time period of interest for the playback is extracted from the continuous recording database and loaded into a study database. The study database is then accessed from select client workstations using standard database access routines. Any standard UI display can be used to view the actual values that are being played back.

Power System Applications

Generation Dispatch and Control

XA/21 Generation Dispatch and Control (GDC) applications provide closed-loop control of generator MW outputs using the NERC CPS1 and CPS2 control criteria in order to achieve smooth, stable control of system frequency and power interchanges with neighboring utilities. These applications help to minimize fuel and variable O&M costs, while observing all unit and system operating constraints, including fuel contract limitations and emissions. The XA/21 GDC Suite is comprised of the following application modules:

- Automatic generation control
- Interchange scheduling
- Fuel and emissions monitoring
- Generation dispatch
- AGC performance monitoring
- Production costing
- Reserve monitoring

Transmission Security Management

The XA/21 Transmission Security Management (TSM) suite provides the operator with the capability to analyze and optimize the operation of the transmission grid under current and postulated system conditions. Whether directed at the current real-time network or a future planned network, XA/21 TSM Applications provide the operator with clear and concise information with respect to system vulnerabilities and opportunities.

At the foundation of the real-time TSM modules is the state estimator, a software application that utilizes available analog and status telemetry in conjunction with operator entered values and various types of schedule data. It estimates the current operational state of the network, alerting the operator to the presence of overloads and abnormal voltages in the process. The state estimator can often estimate quantities that are not metered, expanding the operator’s field of vision. The state estimator also improves
the overall reliability of the metering system and reduces maintenance costs by detecting sustained measurement errors, estimating replacement values, and alerting utility personnel as to the location of the suspect metering. In addition to detecting and correcting erroneous analog measurements, the XA/21 State Estimator also provides the capability to detect and correct erroneous status measurements and branch parameters.

The Contingency Selection and Analysis modules provide the capability to analyze the behavior of the system with regard to select hypothetical future operating states (contingency cases) and report the presence of overloads and/or abnormal voltages associated with each. Each contingency case consists of a one or more device state transitions (open or close) that are imposed in the base case solution to create the new hypothetical operating state. Such cases may be pre-defined and/or automatically generated based on current system conditions.

The objective of the Fault Analysis module is very similar to that of the Contingency Selection and Analysis modules, in that it also analyzes the impact of a series of hypothetical events on the power system, however, the events in this case are not device state transitions, but fault locations and associated fault types. The fault analysis module simulates the occurrence of 3-phase, phase-to-phase and/or single-phase faults at each specified location. It then determines if the electrically near breakers have sufficient interrupting capability to “break” the resulting fault current. Breakers with insufficient breaking capacity are identified for each fault case.

Security Constrained Dispatch (SCD) and Voltage VAR Scheduling (VVS) modules act to optimize the operation of the power system by recommending rescheduling of active and reactive power controls (generator MWs, phase shifter angles, interchange MWs and generator terminal voltages, transformer taps, shunt capacitor/reactors) in order to reduce fuel costs and transmission losses, respectively, while ensuring that the system is operated in a secure fashion. Alternatively, both the SCD and VVS can be used to recommend corrective or preventative action directed at mitigating the negative impact of contingency cases on real time operations. In addition to the default open loop mode of operation, both SCD and VVS modules are also available in closed loop capable versions, wherein recommended control actions are automatically implemented.
Study mode TSM modules provide the operator with the capability to analyze the security of the electrical network during projected future operating conditions, while considering the effects of scheduled maintenance. The Study Mode TSM Suite is comprised of the following modules:

- Parameter adaptation, network configurator, dispatcher power flow
- Contingency selection, contingency analysis
- Fault analysis
- Security constrained dispatch, voltage/VAR scheduling

**Voltage/Transient Stability**

Voltage and Transient Stability modules provide engineers and operators with an up to date assessment of the vulnerability of the system with respect to voltage collapse and/or transient phenomena.

Voltage stability analysis automatically determines voltage security limits, limiting contingencies, and problem areas. Features include:

- Comprehensive criteria definition (stability, voltage declines, reactive reserves, etc)
- Automatic contingency screening
- Steady-state and fast time-domain simulation
- Remedial measures to increase transfer capability
- Distributed computation engine

Transient stability analysis automatically determines transient security limits, critical contingencies, modes of oscillations, unstable groups of machines, and transient voltage violations. Features include:

- Comprehensive criteria definition (stability index, damping, transient voltage violations)
- Automatic contingency ranking
- Full time-domain simulation engine
- Multi-channel Prony analysis
- Automatic power transfer limit determination
- Automatic fault impedance calculation

**Unit Commitment/Transaction Evaluation**

Unit Commitment (UC) determines the minimum cost operating plan (generator commitment/loading levels and interchange schedules for each interval) over the short-term planning horizon while considering a broad range of unit and system operating constraints, including fuel contract limitations and emissions. At the operator’s discretion, the developed plan may be transferred to the Generation Dispatch and Control subsystem for automatic closed loop implementation.

Transaction Evaluation (TE) leverages the Unit Commitment case comparison capability to determine the economic and security impacts associated with incremental multi-hour, multi-block energy transactions.
Demand Forecasting

Demand Forecasting (DF) determines the best estimate of system load during the short-term planning horizon, based on forecasted weather conditions during this period. As the load forecast is used by unit commitment to derive the minimum cost operating plan, accuracy of the load forecast directly impacts the cost of operation. Key features of the XA/21 Demand Forecasting package include the following:

- Model identification based on piecewise linear regression
- Recognition and accommodation of non-typical days
- After-the-fact analysis of weather forecast and model error
- Real-time adaptive update of current day forecast, based on observed Error

Dispatcher Training Simulator

The Dispatcher Training Simulator (DTS) provides an accurate, realistic closed loop digital simulation of the electrical power system from the perspective of the trainee, allowing operators to be trained to respond to normal and emergency conditions, including black start. As all application software interfacing with the simulation is identical to that on the online system, the simulator is also valuable as a software test bed, allowing both database and software modifications to be validated fully, prior to installation on the online system. Key components of the DTS include the following:

- Instructor interface
- Detailed simulation models
  - Generator
  - Load
  - Frequency
  - Network
  - Relay
  - Interchange scheduling
  - External company AGC
- Simulation event processor
  - Absolute time events
  - Relative time events
  - Conditional events
Standard Interfaces

Corporate Information Storage and Retrieval
In order to meet the data needs of the larger corporate enterprise without jeopardizing the security or reliability of the online SCADA EMS system, an optional Oracle®-based Corporate Information Storage & Retrieval (IS&R) system can be configured to reside outside the control room firewall functioning as a long-term data warehouse. Select historical data is pushed from the HISRDB to the IS&R server, making it available to the corporate community.

PI™ Data Historian
For those users who have already made or are contemplating making an investment in OSIsoft Inc.’s PI™ data historian, an optional native interface to the XA/21 system is now available that effectively replaces the CRDB data store with the PI data historian. In addition to the PI data historian’s default standard of 1-bit (good/bad) quality coding, the XA/21 interface also provides for the optional storage of a full 64-bit quality word with each data value. A single point of data maintenance, if provided, wherein XA/21 resident point attributes define the points to be collected and the associated change dead bands. This data is then exported in a form suitable for subsequent batch load into the PI server as tag definitions. Playback of PI resident data using XA/21 displays is achieved by extracting the relevant data from the PI server and loading it into a study database. PI resident data is also accessible to other applications and users via ODBC or PI Process Book®.

e-Tag
The optional e-Tag interface provides for data exchange between the XA/21 Interchange Transaction Scheduling system and North America’s de facto standard for e-tag coordination, OATI’s webTrans™ module. The interface provides for a single point of entry and maintenance of interchange schedule data. NERC e-tags are defined and maintained within the webTrans™ module and automatically imported into the XA/21 system for subsequent use by the GDC and Energy Accounting modules.

Enterprise Gateway
The XA/21 Enterprise Gateway product provides a generalized framework for import/export of XML-encapsulated data. The product supports bidirectional transfer of the source database contents related to the definition of the electrical transmission grid and its associated generation sources—as described by the wires and resource packages of the IEC WG 13 CIM—thereby satisfying current requirements for RTO Model Exchange.
To find out how an XA/21 System can improve the information you use to make decisions, enhance operational security, and reduce costs, just visit our website at ge.com/energy

or contact us at:

GE Energy
1990 West NASA Blvd.
Melbourne, Florida 32904 USA
+ 1 321 435 5100
+ 1 888 779 6980 (toll free)