

OpenEnterprise™ Version 2.83

OpenEnterprise v2.83 is the latest release of Emerson Process Management's leading-edge Supervisory Control and Data Acquisition (SCADA) package. This Product Data Document provides an overview of the functionality and features of the product (including OpenEnterprise Server, Workstation, and WebToolkit).

Below is a brief summary of some of these changes, but please review this entire document and the release notes for full details.



New Capability of integrating DCS and SCADA

The primary purpose of the DeltaV™ RTU Connect solution is to:

- Provide real-time bi-directional pass through between Emerson's RTUs and DeltaV DCS System
- Generate real-time alarms as current alarms on the DeltaV Operator Station
- Record the historical RTU logged data to the PI historian
- Record system alarm and event data to the PEH historian

The DeltaV RTU Connect solution enables Emerson's RTUs and Flow Computers to seamlessly interface to a DeltaV network. The DeltaV RTU Connect provides wide area telemetry to the DeltaV system.

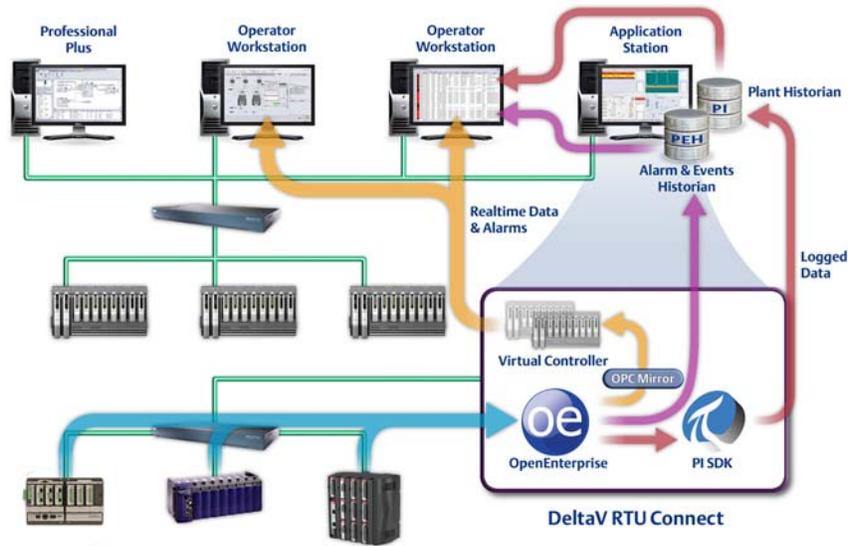
Operating and maintaining separate systems increases lifecycle costs. It was in recognition of this need that led to the development of the DeltaV RTU Connect solution. The DeltaV RTU Connect solution bridges the two systems and enables remote telemetry data to be monitored and controlled from a single system in the control room.

Client / Server Architecture

OpenEnterprise has been designed for medium- to large-sized SCADA systems, where significant improvements in network performance and reliability can be achieved by using a typical Client / Server architecture. This architecture has been optimized for use in situations where low bandwidth, poor quality and high latency networks exist - common in radio, cellular or WAN environments. The same improvements provide for industry leading performance over higher quality in-plant networks.

This design results in significant performance benefits, and typically results in less highly specified hardware at Operator Workstations. It provides the ability for data processing and collection to be performed separately from the process of providing data to the HMI, and to allow for external applications to use and process the data. It also reduces significantly the susceptibility of the system to virus attack or failures due to abuse, as the data collection function is normally performed by separate machine(s) than the operator workstations.





DeltaV RTU Connect Architecture

Any OpenEnterprise installation contains one or more OpenEnterprise Servers (that may optionally communicate with each other), and that may (also optionally) operate redundantly, allowing one server to take over from another following a hardware or software failure.

It also reduces significantly the susceptibility of the system to virus attack or failures due to abuse.

OpenEnterprise is ideally suited to distributed SCADA configurations, where multiple plants or facilities each require their own local control, monitoring and data storage, but where all plants need to be linked together so that Operators at any facility can monitor and control either local or remote equipment, independently of their current location. Each RTU or PLC will supply data to a local OpenEnterprise server (or redundant pair of servers), where historical and alarm data will be managed and archived. If workstations or other servers require this, it will be supplied to those locations on an 'as required' basis, without impacting on local communications to the RTUs and PLCs. This approach adds significantly to performance, especially in the case where RTUs are remotely located on radio or other low-bandwidth connections.

A typical OpenEnterprise installation will incorporate at least a single operator workstation, though server only installations are possible. The system can support hundreds of workstations, distributed across any TCP/IP network (including the Internet or radio / wireless networks). In general, only physical hardware and network resources will limit the size of any OpenEnterprise installation or its performance. The minimum required system for an OpenEnterprise installation is a single Intel based PC running Windows XP Pro. The recommended system runs Windows 2003 Server (Standard Edition), plus a number of Windows Vista or XP Operator Workstations.

For the latest details of the OEM hardware and software required to support OpenEnterprise, please refer to the release notes.

OpenEnterprise incorporates numerous features designed to meet the requirements of users in a wide range of SCADA and process industries. Many of these features are designed to significantly reduce the costs of system maintenance and configuration, and add to the flexibility and robustness of the system.

Real-time, Object-oriented Database

At the core of OpenEnterprise Server is a memory resident, event-driven database, which is the repository for all SCADA and configuration data. Internally, the database is entirely “Object-Oriented”. This is a software design technique in which data and code are combined together (‘encapsulated’) into individual components, known as “objects”. This highly-structured approach leads to a product that is easier to maintain, more robust and operates more efficiently than relational or traditional databases, especially in an event driven environment such as the typical SCADA system. Customers are seeing continuous up times (without any shutdown, scheduled or otherwise) of around 2 years on many systems. This translates into an overall system availability of around 99.98%, an industry-leading figure.

The transaction profile encountered on a SCADA system is often very different to that in a typical large relational database – the difference being that a SCADA system may have many thousands of small transactions per second, while a typical corporate database must support a smaller number of much larger transactions. This transaction model is best supported by the architecture adopted within OpenEnterprise.

The Object-Oriented methodology maps very well to the real world of SCADA and process control, where the equipment monitored and controlled by the SCADA system is comprised of discrete “objects” such as wells, valves, pumps, filter beds, boilers, meter-runs, etc.

Many SCADA systems can only provide support for discrete signals – the OpenEnterprise architecture also allows the database to model plant objects as discrete objects within the database, and to link these objects to displays. Alternatively, it is possible to link multiple database objects to single display objects, a technique used when the objects within the database are actually signals collected from traditional RTUs. It is not necessary for these objects to be contained within the same database or server – they can be distributed across a network of many servers.

In either case, the configuration of the HMI is greatly simplified, and more closely reflects the system being controlled. Once the visual representation of a plant component (for example a

compressor) has been created, it can be linked to individual physical plant items without considering the details of the I / O or tags associated with the object. This reduces significantly the engineering cost and complexity in developing applications. It is possible to add new tables and attributes to each deployed system to suit the application-specific requirements. For example, a table could be added holding an equipment maintenance database, cross-referenced to tag points, or to hold geographical data linked to a GIS system. All of this data is then accessible via the Operator Workstations, or any of the supported communications interfaces, without any custom modifications. Tables can be added to the system without interrupting systems operation. OpenEnterprise includes the ability to add or remove attributes to database objects, without any interruption to operations, increasing both flexibility and uptime.

The OpenEnterprise database is unusually flexible, in that end users are able to modify the schema shipped with the product - adding their own tables and objects to the database.

If required, additional functionality can be added to the server objects by developing object “methods” within the database using the optional “Control Language” (CL) development license available from Emerson, or by developing external applications using Visual Basic from Microsoft. (The OpenEnterprise workstation incorporates a Microsoft VBA license).

Standard Communications Technology

One of the most important features of OpenEnterprise is that it supports client / server architectures, with support for multiple clients and servers within any configuration. All the individual software components communicate via TCP / IP rather than using shared memory or proprietary transport mechanisms such as DCOM or CORBA. As a result, OpenEnterprise:

- Supports distributed client / server architectures using TCP / IP for communication between processes on the same physical machine or between processes on separate CPUs or machines (perhaps physically separated by thousands of miles). It is possible to support both OpenEnterprise Server and Workstation on a single machine or distribute the

processes across a number of separate machines. This provides a high degree of system scalability, fault tolerance and flexible network topologies.

- Is compatible with the most common network connections available today (including PPP, CDMA, GPRS, Wifi, and the Internet). OpenEnterprise components can communicate via any communications layer or device supporting the TCP / IP protocol and permitting socket-to-socket connections. Firewalls and VPNS are also supported.
- Supports OEM communications hardware available for a very wide range of physical communications media, including copper, satellite, radio, and fiber. There is generally an off-the-shelf TCP / IP solution available for almost any communications requirement encountered within the SCADA industry.

Flexible Fault-tolerant Solutions

OpenEnterprise supports system designs that offer a high degree of system availability. Some example configurations include:

Single Server

On a single physical box, the options for fault tolerance are obviously limited. However, Emerson recommends that OpenEnterprise Servers are always fitted with redundant disks (RAID Arrays), power supplies and fans, and powered from a suitable Uninterruptable Power Supply (UPS). In addition, even on a single server, OpenEnterprise incorporates critical process monitoring, and can automatically restart any server process, including third-party software packages, following a software failure. The database will be automatically restarted from a disk resident backup if a failure occurs while unattended, adding further to system robustness for cost sensitive applications. Support for automated shutdowns (preserving all historical data) following loss of power is included.

The database will be automatically restarted from a disk resident backup following failure.

Stratus

Industry Standard Stratus technology provides for complete fault tolerance at a reasonable cost. A Stratus server is effectively a standard PC with fully redundant hardware and no single point of failure. It is cost-effective (approximately twice the cost of an equivalent server), only requires a single set of licenses and is easier to manage than a Master / Standby configuration. For more information refer to <http://www.stratus.com/>

Master and Standby

In this arrangement, two physical servers are configured as OpenEnterprise servers. At any point in time, one of the two machines is "Master" and one is "Standby". The Master Server provides a continuous update of all data changes (on exception) to the Standby Server on a dedicated TCP / IP network segment.

In the event of failure of the Master Server, the Standby machine will automatically become the Master Server with its database up to date with the status of the process control network. A changeover to the Standby machine may be initiated by any of the following mechanisms:

- Soft switch (Manual intervention)
- Hardware switch (Manual intervention)
- Critical software process failure
- Detected hardware failure

The switch over between Master and Standby will normally be automatic, following a failure. However it can be manually initiated, either from a workstation display or (if required) a hardware T-Bar switch. Typically, this is only required on systems with serial network interfaces.

Distributed Systems

OpenEnterprise Server components can be distributed over a Local or Wide Area Network. In large SCADA applications, this allows components to be distributed on separate hardware platforms.

Typically, this is used where, either for reasons of economy or robustness, it is required to control multiple plants from either a single or multiple locations. For example:

- A large municipality may have multiple water treatment plants, each with its own server (so the plants may be operated separately). Under normal conditions, the plant is operated from a single control room, with the individual plants left unmanned, but connected via a WAN.
- A separate backup server may be configured identically to the server located on site, but be located remotely. In the case of a disaster scenario (e.g., fire) at the primary control center, the backup control center would take over from the primary control center.

DeltaV RTU Connect Technical Features

- Seamless bi-directional real-time communication between SCADA and DCS
- Includes an easy-to-use configuration tool that auto-generates the DeltaV FHX file
- Centralizes historical RTU data and alarms with timestamp
- Receives real-time data and alarms, and sends RTU commands
- Propagates RTU alarm configuration (limits and deadband) through to DeltaV
- Automatically backfills local RTU data in case of RTU communication loss

Data Access from OEM Applications

As previously mentioned, OpenEnterprise contains a high-speed, object-oriented database engine, optimized for the SCADA environment. In contrast, the MIS environment is still heavily reliant on the relational model for data access and manipulation.

In order to ensure complete integration with OpenEnterprise and existing MIS / IS and desktop applications, OpenEnterprise supports a wide range of traditional relational database access tools and interfaces.

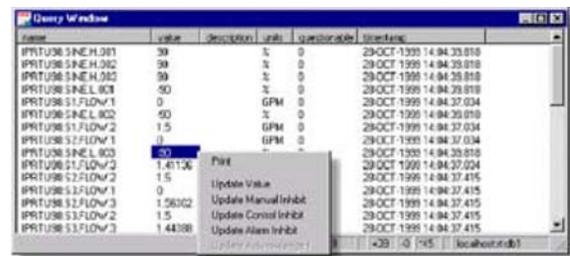
Structured Query Language

An ANSI (ISO 9075, 1989) compliant SQL Client is provided on all OpenEnterprise Servers and Workstations to permit command line SQL access to the OpenEnterprise Server database contents. This can also be used for running SQL scripts (simple text files containing SQL commands), or simple data import / export utilities, often used to provide compatibility with legacy systems. The SQL Client can also be used for configuration of the system, and modification of the database schema.

Standard SQL only supports snapshot queries – the data is returned to the client when the query is issued, and will only be changed if the client re-requests the data.

OpenEnterprise also includes an ActiveX component, the Database Object Viewer (DOV), which allows SQL queries to be displayed within other applications.

A unique feature of Database Object Server is that clients can request that the SQL query is active. After the data is initially returned to the client, a copy of the query is kept at the server, and any subsequent changes in the result set are immediately sent, by exception, to the initiating client. This functionality allows for the construction of tabular displays using SQL, where the output is the real-time results of an SQL Query. Using this technique, it is possible to build displays that show information that would previously have required custom programming – for example, a list of all the currently Control Inhibited (forced) signals on the entire system; a list of failed RTUs or a list of users connected to the server. It is also possible to configure ActiveSQL Query Windows to permit the user to modify the database (and RTU information, where appropriate) from a simple right-click menu.



In an extremely powerful extension to SQL, OpenEnterprise provides the ability to issue "Active Queries" against the OpenEnterprise server.

Open Database Connectivity

Almost all of the spreadsheets, database, reporting packages, and development environments within the PC environment provide easy-to-use graphical tools which utilize Microsoft's Open Database Connectivity (ODBC) to provide connectivity to a wide range of databases, including OpenEnterprise.

ODBC access to all real-time, historical and configuration data.

ODBC access to all data / configuration information on an OpenEnterprise installation is possibly the most powerful feature of the product, allowing real-time or historical data to be incorporated into almost any ODBC Compliant desktop application with a minimum of effort.

Dynamic Data Exchange

DDE is a legacy interface, used within OpenEnterprise to transfer live data, by exception, from the OpenEnterprise server to desktop applications, such as Microsoft Excel. Unlike ODBC, which is best at transferring large amounts of static or snapshot information, DDE is ideally suited to transferring relatively small amounts of dynamic information between server and client by exception – providing efficient use of available network bandwidth. (Note that “relatively small” can still mean thousands of live values into a single spreadsheet in real-time.)

It is often used when creating spreadsheet calculations, which are dynamically updated with real-time information gathered from the field. It is also an ideal choice when developing custom applications that require dynamic data (although in this role DDE is being replaced by OPC).

Note that the DDE implementation within OpenEnterprise requires no knowledge of the DDE tag format – it is a simple drag and drop operation to configure an Excel spreadsheet to show live data as it is collected from the RTU network. Also, communications across the network are achieved without the use of NETDDE, which further reduces the configuration effort and improves performance.

Object Linking and Embedding for Process Control (OPC)

OPC is not normally considered a relational database access tool (it was originally developed as a standard to provide HMI's with access to a wide range of proprietary RTUs and PLCs). OpenEnterprise provides the ability to access any real-time database attribute using OPC. This interface is used to provide data to the OpenEnterprise Workstation displays, and is highly optimized for transfer of large amounts of rapidly changing data from server to client. It can be used to develop custom applications in Visual Basic, C# or C++, which will then also have access to the entire contents of the database. There is also a wide range of OEM applications available that use OPC to collect data – all such applications are able to access the process and configuration data held within the OpenEnterprise server. Packages are available for plant and system modeling, historical data analysis and web server interfaces. Most of the other available SCADA HMI packages are also able to display data from OpenEnterprise servers using the OPC interface.

OpenEnterprise's ability to provide data to third-party OPC Clients is in addition to the ability to collect data from third-party OPC Servers. This ability makes OpenEnterprise the ideal product to select when looking for a solution to integrate a wide range of third-party hardware and software. OpenEnterprise includes a configuration tool, which allows tags to be imported from third-party OPC Servers in groups, greatly reducing the configuration effort.

OPC Historical Data Access

OpenEnterprise also supports the industry-standard OPC Historical Data Access Interface (OPC HDA). This is similar to the OPC standard for real-time data, except that it is intended to allow OEM applications access to the historical data held within the OpenEnterprise server. This interface is used primarily by the OpenEnterprise trending system, but is available for compatible external applications, which need access to the historical data (both raw and compressed) held within the server.

Client Application Programmers Interface

The OpenEnterprise Client Applications Programmer Interface (CAPI) provides a degree of functionality not currently provided by any of the non-proprietary standards described above.

It is similar to the ODBC interface, but allows the server to update the client, on a by-exception basis, with any changes in the database. This is extremely powerful, and allows for the implementation of efficient client server communications in circumstances where none of the interfaces described above provides a suitable solution. In general, it is a solution that should only be used by the experienced C++ programmer.

The interface that has been developed by Emerson is fully published and documented, and Software Development Kits (SDKs) are available to any other third-party integrator for any future system enhancements.

Virtual ControlWave

The Virtual ControlWave (VCW) introduces the power of the ControlWave™ product line to the OpenEnterprise Server, even for those users who don't currently have ControlWave hardware.

Available as an option for OpenEnterprise Servers, it provides very similar functionality to our standard range of ControlWave RTUs, but runs on industry standard PC hardware. Instead of traditional hardware I / O, the Virtual ControlWave can access any real-time data held within the OpenEnterprise database – data which can originate anywhere within the SCADA network. Like a traditional intelligent RTU or PLC, a program ('load') must be developed for it. This is done using ControlWave Designer – the same development tools used for the ControlWave line of RTUs.

The Virtual ControlWave can read and write both 'local' data, or can read/write 'field data' to any devices connected to the OpenEnterprise Server. The devices need not be Emerson hardware, and need not even be of the same type, or support the same communications protocols. This makes the Virtual ControlWave ideal for constructing distributed control applications with mixed hardware and protocols – while hiding the details from the applications programmer.

As the Virtual ControlWave has access to real field data, it can also be used for testing real application loads, before download to field RTUs, but using real field data – something that is not possible in the ControlWave Designer Simulator. Some typical applications for the Virtual ControlWave are:

- Distributed Control and Supervisory Control
- Flow or Storage Totalization
- Line Packs
- Leak Detection
- Calculations based on LIMS data
- Application Testing (before download to a real ControlWave)

Calculation Server Interface

OpenEnterprise also incorporates an easy-to-use interface intended for the less-experienced Visual Basic Programmer. It provides simple read / write access to database attributes and (indirectly) to values held in RTUs communicating with the server. It is intended for users not familiar with the programming techniques associated with OPC or ODBC who need to gain access to the server for relatively simple applications. No knowledge of RTU or PLC protocols or networking is needed to write code that can read or write values to these devices via the database.

Local Signal Maintenance Tool

The Local Signal Maintenance tool allows the user to add / delete / modify server based signals (whose values are NOT retrieved from the field). These are often used to store the results of server-based calculations generated using Virtual ControlWave or Calculation Server, or for manual entry of laboratory test data. The tool has been designed to replace the use of the SQL scripts and CSV files often used to configure local signals, and as such is designed to reduce the work in creating and managing large numbers of these signals.

OpenEnterprise Reporting Suite

OpenEnterprise includes a powerful set of reporting tools. These allow the user to design and implement reports that include data from the OpenEnterprise historical and real-time databases.

- It is also possible to configure the system for multiple servers to share the same security configuration, and to act as backup security servers, in a similar manner to Windows Domain Controllers. This improves system management in systems with multiple servers.
- Database builder (DBB) will automatically build the database, and configure data collection for your ControlWave and Network 3000 RTUs. This tool allows you to select one or more RTUs and add them to your SCADA system with a couple of mouse clicks. The system will then start collecting data, and making it available for display in mimics, trends, reports and all other OpenEnterprise components.
- Historian Configuration allows the system administrator to create and modify the OpenEnterprise Historical database, selecting the data to be logged and the time and rate at which it will be stored. This tool can also be used to assign objects and signals to the historian.
- Archive File Management allows the system administrator to monitor the generation of Historical archives, and to bring older data backups back on line. Easy to use, selection of a database tag, and a time period will allow restoration of all available data covering the selected period. The Archive File Manager also allows for the configuration of automated backups of historical data to offline backups, for example, a remote NAS server.
- System Monitor allows the user to view preselected tabular panels, showing diagnostics and configuration of local or remote databases. The system ships with a number of preconfigured views, but more can be added by the Administrator using XML text files to define them. A new feature in OpenEnterprise 2.81 is the ability to add time-saving user defined menus to the system monitor tool. These can be configured and used by the administrator to provide 'short cuts' to common database tasks that might otherwise require access to the operator interface or other configuration tools. An example might be a menu that allows the administrator to disable an RTU, or control-inhibit a signal from within the tool, rather than opening the NW3000 configuration tool or OpenBSI Dataview.

Includes complete online documentation of the standard database tables and attributes.

Database Explorer

The OpenEnterprise Database Explorer is an easy-to-use tool for interacting with the OpenEnterprise servers. It has the look and feel of Microsoft Explorer and provides the user with the capability from any OpenEnterprise Workstation or Server to:

- Connect to any OpenEnterprise database via LAN or WAN.
- Display database table definitions and structure ("schema") and the objects within those tables using drag, drop, point and click methods.
- Free format SQL data access.
- It is user extensible (via OEMenus) to add almost unlimited application specific functionality to the tabular views (Database Object Views) it uses to show data. For example, the end user can add the ability to modify any data directly from the database, or to add "notes" directly to the data, or edit the database contents.

Within the Database Explorer, full online documentation of the standard Database tables and attributes is provided. This permits the advanced user full access to the entire database schema documentation from within the product. This information is easily available by right-clicking on any table or attribute and selecting 'help' from the pop-up menu.

Use of the Database Explorer is security protected, as are all other OpenEnterprise configuration tools.

Display Generation and Maintenance

The user of any OpenEnterprise Workstation is able to create and edit display mimic files, assuming they have the required security privileges. The process of display creation is discussed in detail later in this document. There is no need to purchase additional packages or licenses to permit display editing. No compilation or 'release' process is required – all workstation displays and other components can be changed and viewed in real-time without interruption to normal operations.

OpenEnterprise Database Remote Device Interfaces (RDIs)

As a SCADA product OpenEnterprise includes a number of device drivers for access to the control hardware. Data acquisition for an OpenEnterprise SCADA solution is supported through PLCs / RTU protocol drivers that either reside in the OpenEnterprise Server or on a distributed IP Communications Controller. OpenEnterprise interfaces to various third-party industrial control products. The supported protocols presently include:

- Bristol BSAP (supports ControlWave and Network 3000 RTUs)
- Emerson ROC™ and ROC Plus (supports all devices using the ROC Standard and ROC Plus protocols, including FloBoss™ measurement products)
- All devices with OPC3.0 compliant interfacesoftware (e.g. , MODBUS, DNP3, FOUNDATION™ Fieldbus)
- Allen Bradley (all devices supported by RSLinx or Allen Bradley's OPC Server)
- Dynamic Logic
- Serck Proteus
- Exomatic

In addition, the ControlWave and NW3000 products can act as Data Concentrators, feeding data from a wide range of OEM devices into the OpenEnterprise server. These devices provide support for over forty different protocols, including:

- MODBUS (Slave and Master)
- Allen Bradley DH+ (Slave and Master, PLC2 and PLC5)
- Teledyne
- HART™
- AMI Master and Slave

(Please refer to the Network 3000 and ControlWave product documentation for information on additional supported protocols.)

The management and programming of Network 3000 and ControlWave devices is performed using the OpenBSI software suite, which is closely integrated into the product.

OpenBSI is a powerful suite of software programs that operate under Windows 2003 and XP. It is used to configure and Maintain the communications network for ControlWave and Network 3000 RTUs connected to OpenEnterprise. OpenBSI also includes a wide range of diagnostic tools and engineering utilities to program and download the RTUs, debug, schedule historical data collection and monitor network activity. All of these can be achieved with OpenEnterprise online and collecting data.

Once an RTU program load has been created, the OpenEnterprise server can be configured to collect the data from the RTU in only a few mouse clicks – there is a single point of configuration (the load file) for all information associated with the signal, including the alarm levels. Any subsequent changes in the ACCOL or Designer load will be reflected into the OpenEnterprise database, either automatically or manually.

The OpenBSI Communications Statistics Import tool imports communications statistics (numbers and types of errors; quantity of messages, etc.) from OpenBSI into the OpenEnterprise Database, where they can be logged historically. Active Polling is a feature which (optionally) boosts the rate of data collection for BSAP data which is currently displayed on operator mimics. Although it can be used to improve the apparent speed of the system, it should be used with care on large systems to avoid overloading the RTU network.

OpenEnterprise ROC RDI

The OpenEnterprise ROC Remote Device Interface (ROC RDI) is a communications driver which allows an OpenEnterprise Server to collect data from Emerson ROC and FloBoss field devices.

The ROC RDI has been developed to provide an easy-to-configure interface between OpenEnterprise and any field devices supporting the Standard ROC or ROC Plus communications protocol, with OpenEnterprise acting as the ROC Master device.

The driver is fully configurable, and supports a wide range of functionality, including:

- Read / Write of current values
- Collection of historical data
- Collection of alarms and events
- Time synchronization
- Write Individual parameter values
- Write Grouped parameter values
- Active polling*

Never again lose historical or alarm data due to a communications failure or server shutdown.

As well as supporting the writing of individual parameters, the driver supports the 'group write' of parameters values. This optimizes communications, and should always be used when writing a set of values which must be written concurrently (e.g., Gas composition data for AGA calculations).

Communications over TCP / IP and serial (direct, radio, or dialup) links is supported. The driver also provides optional support for 'fall back' communications links (for example, using a radio link, but falling back to a dialup if that fails). Each individual communications link can be given a 'cost' rating, in which case the least expensive available link will be used. In addition, modem pooling and remote terminal servers are supported.

Alarms collected from ROC devices are incorporated in the OpenEnterprise alarm system, and as such will be logged within the alarm and event history, and may be 'paged' to remote users using OpenEnterprise Messaging.

All historical data collected from ROC devices will be incorporated into the OpenEnterprise historical system, and may be 'backfilled' following interruptions to field communications.

OpenEnterprise Historical System

The OpenEnterprise Historian is used for long-term storage of data and events sourced from the real-time database. It is used to provide profiles of past manufacturing or process activity by capturing the data from the process and retaining it in an accessible format.

This data can be made available across the corporate network for use with common desktop spreadsheet, reporting, and database packages.

As well as the powerful trending tools provided with OpenEnterprise workstation, the OpenEnterprise Reporting package allows for historical data to be published in a wide range of text and graphical reports. Support for ODBC allows most third-party reporting and historical data analysis packages to work well with OpenEnterprise, either locally or across the network.

Historical charts, reports, and trends can also be published on secure web pages, either on an internal intranet or externally to your customers, using OpenEnterprise WebToolkit.

The Historian combines object and relational technologies, and is configured through a set of control tables that inform the Historian what data objects to log and how. This approach allows the historian to log any information held in the real-time database, rather than being limited to the more typical logging of signal values against time.

A user need only enter the signal name and time period for data they are interested in, and the system can locate and retrieve historical data, even if it has been archived.

*OpenEnterprise supports the concept of 'Active Polling', boosting the rate of data collection (and screen updates) for data only while it is visible on display mimics.

Data objects that are required for long term storage and analysis are allocated to historical “control groups”, which specify the frequency of storage (logging can also be configured to occur on exception); the source of the data objects and the “compression” types (if applicable). The group of data objects is then captured from the source and transparently passed to a raw historical data stream. The data objects within the historical data stream can then be fed into additional compressed data streams, to produce (for example) hourly averages or daily minima.

As well as incorporating real-time data from the OpenEnterprise Server, the historical system can be configured to save historical data collected from Emerson ROC, ControlWave, and Network 3000 RTUs. This allows the RTU to buffer historical data before transfer to the server, a common requirement where communications to the server are either poor or intermittent. Following a communication failure the server’s historical database will be “backfilled” with the missing data.

The data objects collected for each stream are saved to a unique historical log file, which users can access using the OpenEnterprise trending tools, or other tools using ODBC, SQL or OPC HDA.

The system manager defines the basic rules governing the way sampled data is stored to the raw historical data stream. The system can sample data by polling at a defined rate and save this data in a compressed data stream; or, if preferred, the system can be tasked to perform continuous data sampling and save to the raw historical stream only on an exception basis when values change. Within each compression stream, data objects can be time compressed (to reduce the stored data volume) using a comprehensive list of Boolean and / or analog compression routines.

Configuration and management of the Historian has been designed to be simple and secure. It is performed using the historical configuration tool, a “wizard” utility that allows authorized users to add / delete objects on-line from the Historian data stream and create new compression groups of data. Alternatively, the system may be configured using pre-configured SQL scripts. Although more suited to the “power user”, this approach provides additional flexibility.

Each user (or group of users) can have a pre-configured desktop environment, suited to their role, automatically loaded when they login to the system.

Historian Compression Types

Compression Type	Description
AND	Logical AND of all the status inputs over the compression period
OR	Logical OR of all the status inputs over the compression period
First	The oldest not NULL input value during the compression period
Last	The most recent not NULL input value during the compression period
Maximum	Maximum input value during the compression period
Minimum	Minimum input value during the compression period
Standard Deviation	Standard Deviation value of all samples during the compression period
Average	The time weighted average of input values over the compression period
Integral	Integral of all non-null values during the compression period
Total	Total of all non-null values during the compression period
ON Count	The number of times a Boolean switched ON during the compression period
ON Per Cent	Percentage of time a Boolean spent ON during the compression period
Duration	Period of time used to calculate other compression values

Also included are standard templates which define industry standard historical storage requirements, often regulatory in nature. These templates are defined in XML, and users can develop their own.

For long data storage, the Historical data streams can be configured to automatically archive data to disk for future on-line historical queries. These archive files can be moved to Network Attached Storage (NAS) devices as required. There is no limit (beyond available physical storage) as to the volume or age of data that may be stored for later retrieval. Users of the data need not be aware of the physical location of the data, or the file structures in which it is stored. All access is via industry standard tools and interfaces (typically SQL or ODBC).



You can display all historical data at Workstations using the OpenEnterprise Trending package.

Each user accesses the database and performs local analysis of process data via the desktop package that best matches their abilities and requirements. The OpenEnterprise WebToolkit and OpenEnterprise Terminal Services Workstation bring this data to the remote web browser in the form of trends, reports and tables. The OpenEnterprise Reporting Suite allows historical data to be distributed even further, using email and external web servers.

In order to simplify data access further for casual users who may be less experienced in the use of SQL, the system administrator can create SQL “Views” on the server, which provide filtered data more suitable for end users. For example, a view might be created called “Yesterday”, which would show only the hourly average, maximum, minimum for a set of signals, specified by name, for the previous day. This would effectively be a “canned” set of data, available across the network for all users.

The Historian is normally configured for automatic archiving of data to hard disk. System users may hold a number of archive files “on-line” for immediate access, with older archive files brought back on line with only a few clicks of the mouse. An automated catalog is created for the system, logging the names and contents of all archive files created since system installation, and where they are currently stored. A user need only enter the signal name and time period for data they are interested in, and the system can locate it, even if it has been archived.

OpenEnterprise Workstation

OpenEnterprise Workstation is a software package that provides operators, technicians and management with full access to all the real-time, historical, and diagnostic data gathered by the OpenEnterprise servers. The easy to use Human Machine Interface (HMI) integrates all aspects of SCADA management into a single package that is compatible with the 32-bit versions of Windows 2003, XP, and Vista.

Almost all of the OpenEnterprise Workstation functionality is supported for remote users within Internet Explorer, without developing new displays or changing the application.

The OpenEnterprise Workstation package includes a powerful set of tools in an object-oriented HMI development environment that enables an engineer to quickly create intuitive windows based graphical front ends for the control and management of industrial processes. No programming knowledge is required to use the product to create very powerful user interfaces.

Within the OpenEnterprise Workstation Environment there are a range of tools and utilities used to construct the final HMI used by the system operators. The two main tools are the OEDesktop and OEGraphics tools. These, combined with a number of other components, are used to construct the installed system’s HMI.

The user interface developed for use on Operator Workstations can also be viewed in Internet Explorer.



Easy to use Graphics engine allows for the rapid development of attractive mimics.

OEDesktop

The OEDesktop is a “shell” application that is used to manage the other windows and applications within the Workstation environment. It allows the user to control the position and location of Windows (including third party applications supporting the Microsoft Active Document standard).

Within the desktop, each window can be one of three types – either standard Multiple Document Interface (MDI) windows; Docked Windows (effectively fastened to one edge of the screen), or floating (windows which float above all the MDI and Docked windows on the screen).

Each window can either contain a Mimic Display, Data Object Viewer, Alarm Banner, Alarm Summary, Trend Window, OEM Active Document or ActiveX Control. Many windows can be open concurrently – only system resources and physical screen space limit the number. Once a configuration of multiple Windows has been configured, it can be saved and recalled later – in this way, individual users of the system configure their own operator environments, or save different environments for different operating scenarios.

The OpenEnterprise desktop also provides facilities for building custom menus – both “dockable” menu bars and “right-click” menus. In general, these menus can be attached to objects within any of the supported window types mentioned above. Most of the systems deployed use these menus to make the system simple and intuitive to use – no piece of information is ever more than a couple of mouse clicks away, and the operator only ever uses the keyboard when they have a value to type.

The addition of new field devices, I / O, display screens or historical groups can be performed on the live system with no interruption to data collection or operations.

An extremely powerful feature of the custom menu is the ability to transfer information from window to window, at the same time as implementing commands. For example, it is possible to implement an interface where the operator observes, in an Alarm Banner, that a “critical” alarm has occurred in an area of the plant. They would right click on the affected plant area, and select the “show alarm list” option. This brings up a list of the alarms in the affected area, and seeing an alarm; they can then select that and launch a trend of the signal, showing its value over the last few hours.

Similarly, an operator may call up an overview display from the alarm summary for the specific alarm, and from there take the actions required to make the plant safe while the problem is investigated. All of these links between applications are implemented using the custom menu tool (OEMenu) within the OpenEnterprise desktop.

When using multiple monitors on a single workstation, one OpenEnterprise desktop is normally used per monitor, using the window management tools to manage the windows on that monitor. For example, one monitor may be configured for various alarm management screens, another may include a map overview, and another process displays.

Display Builder (OEGraphics)

The OEGraphics display builder tool enables display (mimic) designers to configure object-oriented based high resolution, vector based process mimics for data sourced from an OpenEnterprise Real Time and Historical server network.

OEGraphics is used to:

- Graphically develop new mimics in a Microsoft “look-and-feel” environment, similar to PowerPoint
- Add / delete / save new mimics on-line
- Define mimic backgrounds (solid color, shading, or bitmaps)

- Import BMP, JPG, GIF; Microsoft Clipart, and AutoCad
- Create and save in a user-defined symbol library both static and dynamic graphical objects that can be displayed within a process mimic
- Define security access to objects, including displays
- Assign foreground, background, line, and shadow colors to all objects
- Assign and display any attribute of any process database point. All numeric data can optionally display a quality tag along with other tags to indicate whether it is in Alarm Inhibit / Enable, Manual Inhibit / Enable, and Control Inhibit / Enable. It is important to realize that almost any attribute of any object within the OpenEnterprise servers can be displayed within the workstation environment, including objects in tables created by the user.
- Display data as an animated objects, e.g., graphical bar-graph format, irregular fill vessel, or rotating pump impellers
- Position an object anywhere on a graphic background using standard windows select, drag, drop and re-sizing with the mouse
- Embed ActiveX components within displays – either supplied by Emerson or those from other vendors
- Ability to define links that, when selected, call up other displays in a pre-defined position and size, or replace the existing mimic in the current window. Links can also be used to enable ‘pop-ups’ (reduced size or inset mimics) which can be displayed while maintaining the current mimic on display. These are typically used for the implementation of features like auto / manual control panels.
- Print mimic
- Define layers within the display, used to determine which objects will be visible at which zoom levels. This provides significant flexibility in supporting “declutter”, resulting in the level of detail visible on the display when shown at low magnification.

In addition to these tools there are standard editing tools to facilitate mimic creation within the Display Builder, namely:

- Cut, paste, copy, duplicate, multi-level undo, redo, select all
- Snap to grid, toolbars, zoom factor, alignment, re-size, group / ungroup, back, front, flip, mirror

- Drawing utilities:
 - Object Rotation
 - Object Reshape
 - Zoom
 - Line
 - Style of Line
 - Square
 - Fill
 - Rectangle
 - Oval
 - Circle
 - Arc
 - Polygon
 - Freeform
 - Text

Display Object Re-use

In SCADA systems where there is often a high degree of replication of the same object types and mimics, OpenEnterprise utilizes object-oriented design methods to minimize the design and testing process. Subsequent changes to these objects can be made globally (across all displays), thus reducing maintenance effort further.

OEGraphics (like all other OpenEnterprise Workstation components) incorporates a powerful function called “aliasing”, whereby all or part of any tag name may be replaced at runtime, thus changing the links between the display and database. This facility allows a single object or display to be re-used many times, reducing development effort significantly.

OEGraphics is an ActiveX Container. This facility allows the “embedding” of ActiveX controls supplied by Emerson and others within displays. Emerson supplies various components are available from third-party suppliers. Every attempt has been made to ensure that OEGraphics is compatible with the widest range of these products – however, it is strongly recommended that tests are made of any such OEM components for compatibility with the OpenEnterprise system before commitments are made to their use within installed systems.

All OE graphic displays incorporate support for Microsoft VBA.

All OEGraphics displays incorporate support for Microsoft’s Visual Basic for Applications. This is an industry standard programming language (as provided in MS Word and Excel) which allows access to the data and functionality within the OpenEnterprise displays and which can also be useful in communicating with external OEM applications, or manipulating data within displays. You do not need to use it to build a powerful system – but having it available gives you extra flexibility.

Alarm / Event Management

A record of all alarms is maintained within the real-time database, and logged (optionally) to the historical database as well as (optionally) to a simple text file. All alarms and events are accessible via all the database access tools provided within OpenEnterprise. Assuming sufficient disc storage is available, the alarm and event history may be maintained indefinitely, and is accessible within seconds even when the events of interest may have occurred years ago. As an alternative, alarm storage can be configured to be cyclical, reducing the long-term storage required but resulting in the eventual loss of alarm / event history.

OpenEnterprise also includes a powerful Alarm and Event Viewer component, which is normally used to provide a standard “Alarm Line” at the bottom of the operators screen, and Alarm and Event Summaries. All notable system events are logged to the alarm and event system, even if they may not be considered as “alarms” (an example may be a user logging onto the system, or modifying a signal value).



Alarm client shows all current and unacknowledged alarms in real-time.

Categorization of Alarms

All OpenEnterprise alarms and events may be categorized in several ways:

- **Access Areas** – Common with all objects within the system, the system can be configured such that individual operators (or groups of operators) only have access to certain areas of the plant. Each signal (and any alarms generated from it) can be allocated to a specific access area, and will therefore only be visible to those users granted access to the area.
- **Plant areas** – Each signal and alarm can be associated with a plant area, normally used to represent a physical split of the plant equipment. It is possible to filter alarms based on this allocation.
- **Priorities** - Each alarm is assigned a priority. Typically this is used to indicate the severity of the alarm, but within the system it is also used to indicate how the alarm should be processed. For example: which printers it should appear on; which alarm summaries should show it; should it be auto-acknowledged or auto cleared; which colors it should be presented in; or which sound should be issued at the workstation when it occurs. Each priority of alarm can be configured separately to determine their behavior.

OpenEnterprise incorporates full support for the remote alarming facilities within the range of ControlWave, Network 3000, and ROC RTUs. This allows for alarms to be generated in the RTU, and (if necessary) buffered until they can be transmitted to the server. This ensures that no alarms will be lost or plant events missed during periods of time when the server may not be in operation or communications outages are experienced.

All Alarms may be “inhibited”, to prevent alarm checking as if there were no alarm defined for the tag.

Alternatively, alarms may be “suppressed”. In this case, the alarm is still generated and logged to the database, but is (optionally) not displayed on the operator console, thus reducing the “clutter” associated with nuisance alarms.

Alarms can be suppressed indefinitely, or for absolute or relative periods of time (perhaps allowing for maintenance to occur).

Analog alarms can have up to four alarm limits / conditions (e.g., High-High, High, Low, and Low-Low), digital alarm limits are either alarm when ON or alarm when OFF.

For internally derived alarms the following conditions are available, although not all are applicable to both digital and analog alarms:

- Greater than or equal (High and High-High)
- Greater than
- Less than
- Less than or equal (Low and Low-Low)
- Equal to
- Rate of change
- ON (changed true)
- OFF (changed false)
- Delayed ON
- Delayed OFF
- Toggle (changed)

From the alarm summary window, it is possible to export alarms to MS Excel with a single mouse click.

Both external and internal alarm conditions can be in one of four possible states (“Not In Alarm”; “In Alarm Not Acknowledged”; “In Alarm Acknowledged” and “Cleared Not Acknowledged”), with each state being represented by a different alarm color combination of foreground, background and blink attributes within the Alarm Summaries. OpenEnterprise can mimic the behaviour of most other competing SCADA systems, an important consideration when considering an upgrade, where staff is already familiar with a standardized way of representing alarm conditions.

Alarm Viewer

Alarms and event lists can be displayed at the Workstations in scrollable ‘Alarm Summaries’, using the Alarm Viewer component. The attributes of the alarm messages viewed within the displays can be selected from any of the attributes within the alarm or event list (over 30 are available), including the following:

- Alarm / Event priority
- Time and date of occurrence
- Alarm / Event description

- Name of Point (or object) in alarm
- Alarm Description
- Value causing alarm / event

Within the alarm summary window, it is possible to use selection criteria to filter the alarms / events to be viewed. Multiple selection criteria and wild cards can be used, and saved for later use:

- By Access Area
- By Plant Area (Site Name)
- By Priority
- By Operator responsibility
- By Alarm State
- By Point / Object Name (including wildcards)
- By Description
- By Date / Time

The Alarm Viewer also permits the user to view the alarms and events “historically”, together with any events that occurred on the system.

From the alarm summary window it is also possible to export selected alarms to MS Excel with a single mouse click – this can be useful in constructing reports or emails.

OpenEnterprise allows alarms to be individually (or per priority) configured as “Audible”. If so, they will be sounded with either the default Windows “beep” at the Workstations where it is displayed, or using a custom audio file configured for the alarm priority. In this manner, each alarm can be associated with a different sound at the workstation, with different sounds alerting operators to more serious problems. These can even include spoken announcements or warnings. The system also supports an external I / O driven “Klaxon” output, which may be used to drive a plant wide audio alert system, in addition to the local workstation alert.

Alarm Ribbons

The “Alarm Ribbon” component is provided to allow the Engineer to configure displays showing the quantity of outstanding alarms of various states (in / out of alarm; acknowledged / unacknowledged) per plant area (note that, unlike the Alarm Viewer, it only shows quantities of alarms per area, not the actual alarms).

The purpose of the Alarm Ribbon component is to give an immediate indication of alarm activity anywhere in the system either on a local or system basis, while viewing other displays – typically, it is used as an alternative to having a more traditional Alarm Viewer on display at all times.

Alarm Messaging

OpenEnterprise supports the transmission of alarms to remote pagers, Blackberry devices, cell phones and email accounts. This feature means it is no longer necessary to purchase third-party packages or hardware to be assured that operations staff will be aware of critical alarms when away from the control room environment. Simple filters can be constructed to handle specific alarm situations – for example, you may simply indicate that all “level” alarms are sent to a particular group of operators where all “fault” alarms are sent to the maintenance department.

...supports the transmission of alarms to remote pagers, Blackberry devices, cell phones, and email.

Alarm Escalation is also supported, so that if the individuals primarily responsible for a resolving a problem are unavailable or do not respond to their pages, responsibility can be escalated to alternative or expanded groups of individuals. The same alarm can be transmitted to different users in different preconfigured formats, to support the different physical devices (e.g., email, pagers, and PDAs) capable of receiving the messages.

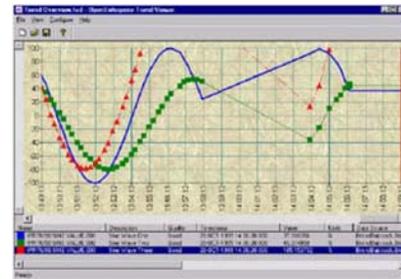
It is also possible to (optionally) allow remote users to acknowledge alarms from their mobile device, by entering a secure PIN number.

Trend Viewer

OpenEnterprise incorporates a flexible trending system, which is able to trend any real-time or historical data stored in the OpenEnterprise Server(s) within an installed system. No server configuration (beyond ensuring the value is logged) is required; all configuration is performed at the OpenEnterprise workstation using the OETrend window.

OpenEnterprise makes it very easy for operators to add their own trends to the system. It is possible to simply drag values from real-time mimic displays into a trend to create a historical

or real-time trend of the point. It is also possible to configure the system so that operators can right click on alarms or tables of data, and trend the selected point and associated variables. As an example, clicking on a low pressure alarm might trend the pressure, flow and set point for that location with a single action. These trends can then be saved for later re-use by the operator.



Trend Pens can be shown in different colors and styles to indicate the quality of stored data.

All windows may be re-configured, moved and re-sized within the workplace. Within a trend window, a user can customize the appearance of the trend. Users, subject to security, are able to configure the following at runtime:

- Assign style and color of pen plot
- Assign multiple signals to a trend base, with common or independent Y-Axis
- Enable/inhibit the display of signal attributes, i.e., tag name, units, current value, and Engineering units
- Change the color of a pen based on the quality of data, or any other historical or real-time parameter
- Move a cursor to determine value and time of intersection with the plot(s)
- Zoom both value and time axis, using “rubber banding”
- Assign points from a configured historical data stream for trending
- On-line add or delete signals to / from the trend window
- Define time period and compression type for historical data retrieval (including different historical periods for each pen – for comparing different time periods)
- Print the graphical trend
- Change the appearance of the grids and axis within the trend window
- Change the appearance of the trend background (either a solid color, graduated shading, or graphic file can be displayed)

A powerful feature of the trend system is the ability to export the visible data to a Microsoft Excel file (effectively providing a tabular trend) or to BMP or JPG files (typically for emailing or use in other documents).



WebView

WebView is a new component that allows for Operators to access Web Pages from within OpenEnterprise desktop, just as if they were another mimic. This allows for integration of data from both Emerson and third-party web based applications, without giving the operators access to a standard web browser. Possible uses are for access to WebToolkit, GIS Systems, Maintenance packages, or weather data. Aliases can be passed to the Webview as part of the URL, and the OpenEnterprise Security System is used to control operator access to the remote systems.

OpenEnterprise Notes System

OpenEnterprise incorporates a facility for attaching “notes” to objects within the database. Operators would typically use this to pass messages to other system users regarding specific items of equipment (for example, a note could be added to the system explaining why a specific signal was control inhibited). The notes are “attached” to plant objects as if they were virtual “sticky notes”.

In addition, it is possible for system users to send message notes directly to other users. This is similar to email (except that all such messages are logged within the server). Optionally, such messages can also be configured to generate alarms, drawing the operators’ attention to high priority notes.

Thin Client Access

OpenEnterprise supports several mechanisms for remote or ‘thin client’ access to the system. As well as providing remote access to the system, these packages also reduce installation and maintenance costs significantly as they are installed on central servers – there is no need to install or license any software on the operator workstations.

OpenEnterprise Terminal Services (OETS)

OETS uses Microsoft’s Terminal Services product to provide remote users access to the complete OpenEnterprise Desktop experience. All that is required on the client machine is a recent copy of Microsoft Internet Explorer. The OpenEnterprise Workstation package is installed on a Windows 2003 Server, and an OETS license installed. Depending on the performance of the Windows Server, around 20 concurrent remote users can use the system, but multiple servers can be deployed to increase this number. OETS is ideal for the customer who has already developed an operator HMI using the OpenEnterprise Workstation product. No re-engineering of displays, trends or other desktop components is required to provide a web-based user interface. It is a true operator workstation replacement, and as such should be deployed on a reliable network. It will work over slower networks such as radio or the Internet, but performance may suffer. In that environment you may wish to consider WebToolkit.

WebToolkit

WebToolkit is a true “thin client” interface designed to permit access to all the data held within the OpenEnterprise database from ANY device that supports HTML web browsing, including many PDAs and mobile phones.

WebToolkit uses Microsoft’s latest .NET technology together with AJAX, and is configured using standard Web page authoring tools from Microsoft (Visual Web Developer or Visual Studio). A basic user interface, giving access to all real-time, historical and alarm / event information can be configured in under an hour, and requires no HTML or web authoring experience.

WebToolkit can also be used by more experienced users to create more complex user interfaces, Corporate Intranets and Web Portals. It can also be used to create interfaces that integrate GIS services such as Google Maps.

It is designed with a simple, ergonomic interface that will be familiar with anyone who has used a web-based application. It has been designed to use minimal bandwidth, and work on the widest possible range of devices and physical connections (including wireless PDAs and Handheld PCs).

WebToolkit supports the following functionalities:

- Read / write signal access (including inhibit bits, where appropriate)
- Pre-configured lists of signals that may be viewed / edited (e.g., current well setpoints)
- Graphical Charting of historical data (interactive trends are available on those devices that support Java)
- Viewing of current alarms, and alarm acknowledgement
- Mimics
- Report Generation (including standard formatting for EPA reports)
- Report export to MS Excel on the client machine
- Audit trail access (for changes made via the web interface)
- User-based Security (both IIS and OE Security). Note that the entire interface can be configured as “read-only” for all users, for an additional level of security.

In Summary

OpenEnterprise has been designed to meet the needs of the user who is looking to make SCADA and process data available throughout the organization. It incorporates the experience Emerson has gained in a wide range of industries over several decades and generations of SCADA products. It is the ideal solution for the user who wants to make their SCADA solution a part of the business process, and incorporates many features to substantially reduce both the timescales and initial installation costs, as well as lifetime cost-of-ownership.

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