

Technical Information

TI 36J04A10-01E

Exaquantum
Plant Information
Management System Overview

Exaquantum

Exaquantum

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Introduction

Exaquantum/PIMS (Plant Information Management System) provides business benefits to users in the Hydrocarbons, Pulp & Paper, Power & Utilities, Chemicals and other industries.

This Document

This technical information (TI 36J04A10-01E) document provides an overview of Exaquantum by describing its standard features and system configurations. It is intended for people who are planning to purchase or recommend a new Information Management System.

Notes on This Document

The purpose of this document is not to warrant that Exaquantum is well suited to any particular purpose, but rather to describe the functional details of Exaquantum.

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Exaquantum Plant Information Management System

TI 36J04A10-01E 8th Edition

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1. System Overview

Exaquantum is a Plant Information Management System (PIMS) combined with a powerful user interface and web application.

The operations within process-based industries are generally controlled by a Process Control System (PCS). A PCS typically produces large amounts of data that must be converted into information to facilitate management decisions and optimize the operation of the plant. Exaquantum processes data from the various systems within a plant, including the PCS, to deliver high-value business information to all decision-makers throughout the organization.

This Technical Information document describes the functionality of Exaquantum. It is described in enough detail to provide engineers with a concept of the product, and provide adequate knowledge of Exaquantum so they know how users can make best use of the product.

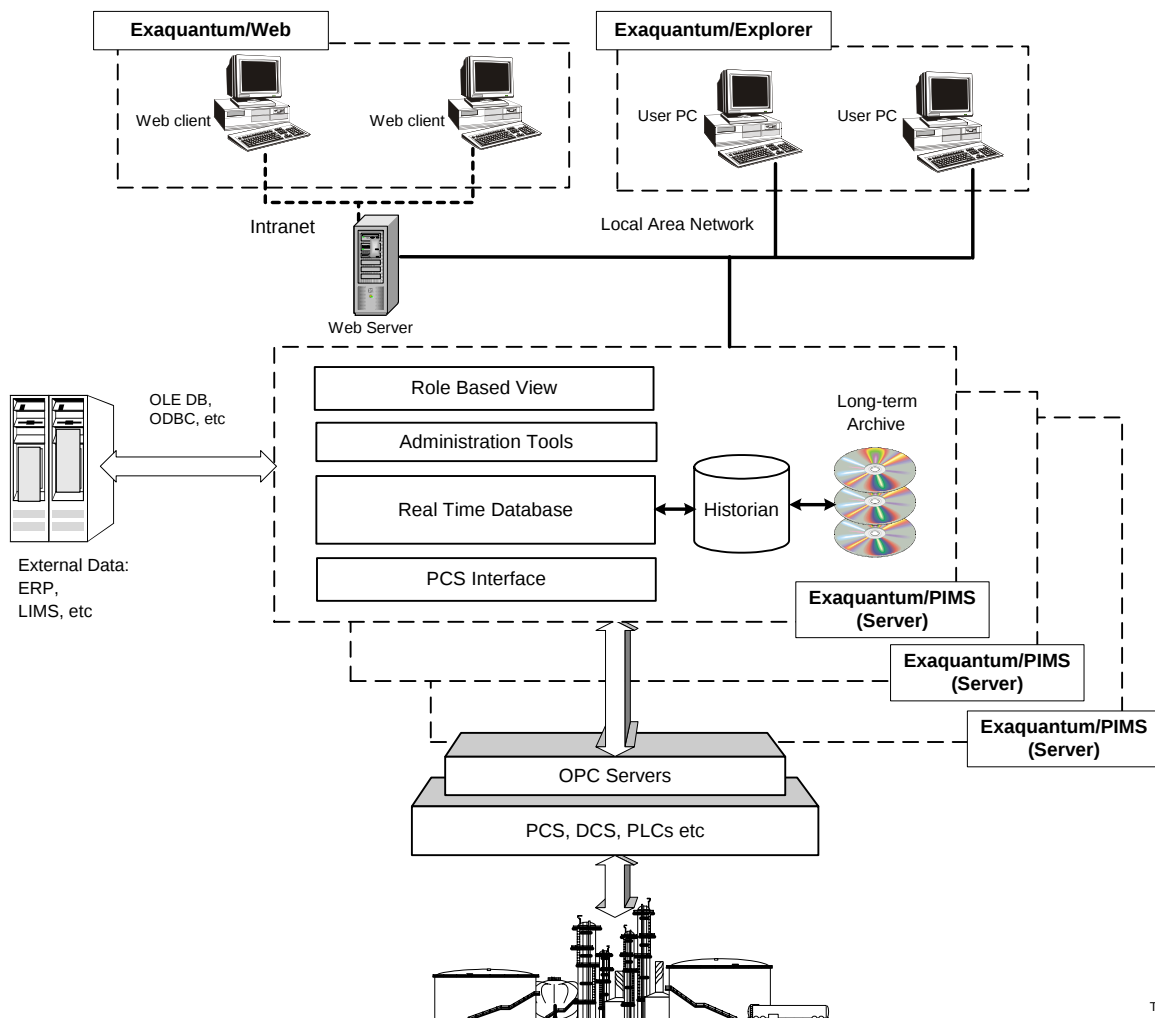


Figure: Exaquantum Overview

1.1 Benefits

Exaquantum is a powerful, easy-to-use solution that fulfils complex business information integration requirements.

Exaquantum provides visibility of key performance indicators (KPIs) using the ability to monitor and aggregate plant data, not just in process terms, but also in business terms. This all contributes to quicker decision-making, improved quality and increased profits. Scalability and low engineering requirements mean that the system is quickly up and running and delivering results rapidly.

Both raw and historical data are made available for analysis. The analytical quality of Exaquantum means that both operators and engineers can be informed of potential problems, allowing them to alter plant operations before product quality is substantially affected. This maintains product quality, whilst reducing waste and rework. Historical data provides proof of compliance with standards and regulatory requirements.

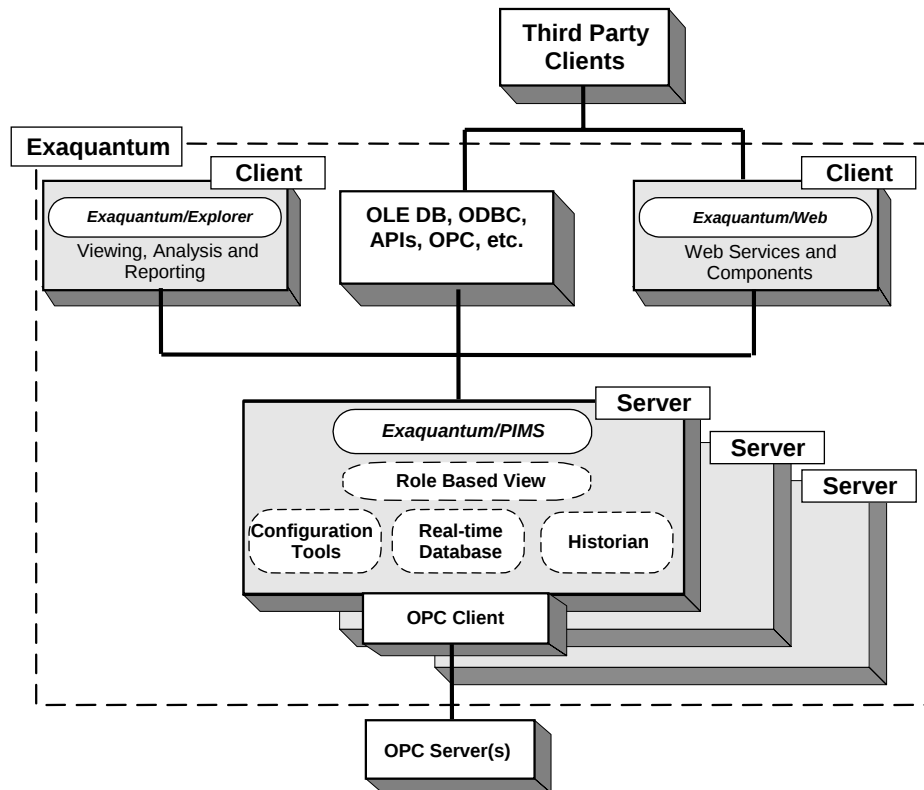
Exaquantum/Explorer provides a Windows-based user interface that presents clear, easy-to-use and configurable displays in the familiar Microsoft format. Users can view existing displays, or build their own plant displays, data representation or analysis displays in the form of Exaquantum/Explorer documents. Exaquantum/Explorer provides an editing and reporting environment that is usable by non-programmers, but also has the power and flexibility of a powerful scripting language for programmers.

Exaquantum/Web is an intranet browser-based user interface, providing all the benefits of thin client technology. A reduction in the Total Cost of Ownership (TCO) and the potential to expose Exaquantum information via XML are particularly beneficial to users. Features of Exaquantum/Web include pre-configured components, mimic configuration (through the Graphics Editor), and various component viewers.

Exaquantum maximizes the use of open standards such as ActiveX, XML, OLE DB and ODBC, allowing easy integration with other Microsoft-standard tools and systems, and OPC allowing connection to other systems.

1.2 System Components

The Exaquantum system components are shown in the following figure.



TIC1-3

Figure: Exaquantum System Components

The system forms a multi-tier architecture with OPC servers normally providing the raw process data. This data is first managed and accumulated within the Exaquantum/PIMS server. There may be multiple Exaquantum servers at this level. The data then becomes available to the Exaquantum/Explorer and/or the Exaquantum/Web applications. Exaquantum clients handle multiple Exaquantum servers transparently. Other third party clients can access the data, via the OLE DB/ODBC, APIs, and OPC interfaces. All client access is subject to the access security control provided by the Role Based Namespace. The main components of Exaquantum are described below.

Exaquantum/PIMS

The primary function of Exaquantum/PIMS is to store and manage data gathered from the PCS(s) and serve it to clients. It provides the following functionality:

- PCS Data Gathering using OPC for process data transfer, in terms of point data (DA) and Alarms and Events (A&E). Available PCSs and OPC servers are listed in Chapter 10.
- The Real-time Database provides high performance real-time storage for process and plant data. It provides flexible, user-defined calculations and aggregations (mean, maximum, minimum, standard deviation, summation, etc.) over multiple user-defined time periods.
- An optimized, long-term Historian provides efficient storage and fast retrieval of vast amounts of plant data, over very long time periods.
- A suite of easy-to-use configuration tools is provided to build, deploy and manage the

Exaquantum/PIMS environment.

- Industry standard open data interfaces
- OLE DB / ODBC interfaces
- Application Programming Interfaces (APIs)
- OPC interface.

Exaquantum/Explorer

Exaquantum/Explorer is a data visualization client that is run on user PCs. It is a powerful, flexible analysis and reporting environment through which business information may be presented in graphical displays, trends and reports. Exaquantum/Explorer handles multiple Exaquantum servers transparently.

The following controls and features (described in Chapter 5) are available in Exaquantum/Explorer:

- Graphics configuration and runtime support (Exaquantum/Explorer) with:
 - Components such as Trends, Data Entry Grid, Data Write Back, Alarms and Events viewing, Excel Viewer, and Web Browser.
- Explorer's advanced features such as:
 - Report Times
 - Scripting
 - Navigation
 - Data Parameterization.
- Excel Add-in and Excel Query Add-In.
- Graphics conversion from CENTUM CS 1000/CS 3000 to Exaquantum/Explorer.
- Role Based Name Space (RBNS) allows administrators to define access permissions to groups, based on user roles. Using these groups, fine control can be maintained over access to tags and function block information.

Exaquantum/Web

Users can deploy thin clients over the company's Intranet. Exaquantum/Web components can handle multiple Exaquantum servers transparently. The scope of supply of Exaquantum/Web is similar to that provided by Exaquantum/Explorer.

The following controls and features (described in Chapter 6) are available in Exaquantum/Web:

- Graphics Editor, incorporating process graphics
- Conversion of CENTUM CS 1000/CS 3000 graphics into Exaquantum/Web graphics and conversion of some Exaquantum/Explorer graphics into Exaquantum/Web graphics
- Pre-configured components for:
 - Trends
 - Alarms and Events viewing
- Excel Add-In over HTTP
- Web applications using ASP (Active Server Pages):
 - Function Block Viewer
 - Tag Viewer
 - Graphics built with the Graphics Editor.

-
- Role Based Name Space (RBNS) allows administrators to define access permissions to groups, based on user roles. Using these groups, fine control can be maintained over access to resources,

1.3 System Features

Exaquantum Features

Exaquantum is positioned as a fundamental application platform for a wide range of solutions. Features of the overall Exaquantum system include:

- **DCOM component based**

Exaquantum is a native Windows solution that is completely based on the COM/DCOM technology and applications. This allows the system to be easily integrated with other market-dominating software tools (such as Excel), and to continue to be so in the future.

- **Event-driven**

Data changes take place in an event-driven way throughout the system, ensuring fast, efficient processing, which allows wider scalability than in scan-based architecture. Clients also benefit because any changes on servers are notified immediately.

- **Wide range of the scalability coverage, from a single to multiple servers**

Multiple server support allows seamless and transparent access to more than one server by Exaquantum/Explorer and Exaquantum/Web clients. Users can therefore make use of various types of information from diverse sources in a single analysis or report.

- **Best fit in the contemporary network environment**

As Exaquantum is a native Microsoft Windows solution, it is normally deployed within the user's Windows network, and more general IT environment. In typical cases, Exaquantum can work as a gateway between the process control domain and office domain, keeping the two different networks separate.

- **International Support**

Exaquantum is NLS compliant. It is designed to run in any regional environment, and to support native languages. Exaquantum is available in either English or Japanese.

Exaquantum supports Daylight Saving Time where the setting is retrieved from the Windows Date/Time Properties.

Exaquantum/PIMS Features

Exaquantum/PIMS delivers comprehensive and varied features and functionality. These features (which are further described in subsequent chapters) are listed below.

- **Multiple-server**

Exaquantum/PIMS scales up seamlessly by allowing additional servers to be added providing extra capacity to cater for a large number of data points and users. By adding the RBNS feature, each user's ability to view data across different servers can be carefully controlled. The Exaquantum Cross-server Calculation feature allows values originating from different Exaquantum servers to be used in calculations.

- **Built-in aggregation and flexible scripted calculations**

The primary value of a PIMS system is its ability to derive valuable information from raw values; Exaquantum/PIMS has many means available to achieve this. For example, the built-in aggregation mechanism is unique in that most of the statistical information can be obtained by a simple click-to-select operation. Scripted calculations allow users to perform a wide variety of complex data manipulation calculations, even with user-supplied external functions. All these derived values are stored permanently, so users can change information at any level of derivation. The calculated and stored Quality code (another feature of Exaquantum/PIMS) enables users to judge the validity of information at a glance.

- **Counting tags based on raw values only**

An Exaquantum tag (data point) is usually accompanied by other information such as reference data (Description, Units and Engineering Ranges) and derived aggregation data. All these values are considered as properties of the subject tag; the license is charged against the tag only, not the sum of them all.

- **High availability by way of the History Catch-up and OPC Recovery**

Whenever Exaquantum/PIMS is started, history data that would otherwise have been lost can be restored from OPC servers, such as Yokogawa's OPC Server 'Exaopc', that support OPC HDA (Historical Data Access). Restored data includes raw tags, calculated tags and aggregations. Alarms and Events can also be restored if Exaquantum is connected with Exaopc.

Failures of the network resulting in the inability of Exaquantum to collect OPC process data can be later retrieved by using the Exaquantum OPC Recovery tool if the OPC server(s) support OPC HDA. Again, if Exaopc is used then Alarms & Events can also be recovered.

- **Simple and easy database creation**

A group of easy-to-use tools is provided to configure and administer Exaquantum. They have been created based on the renowned 'Builder' concept that has been developed uniquely by Yokogawa throughout the long CENTUM DCS lifetime.

- **Platform for event driven applications**

The Event Handling function prompts user-supplied application programs to run, on receipt of Alarms & Events messages, calculations and aggregations. This allows the application program to work in co-ordination with other parts of the system.

Exaquantum Client Features

Exaquantum/Explorer and Exaquantum/Web are easy-to-use component-based analysis and reporting tools. They have all the features and functionality required for monitoring the plant and effectively analyzing the data that is supplied to Exaquantum/PIMS.

- **Powerful data view customization in line with access security control**

Role Based Namespace is a mechanism by which users can be provided with their own views of the process data. This is particularly useful as the system gets bigger as finding information in a large list gets more time-consuming. By using Role Based Namespace, users can view a minimum set of frequently used information. From the administrator's point of view, Role Based Namespace is a powerful security control mechanism that limits access to process data accessible to users based on their roles.

- **Configure-to-use Exaquantum/Explorer concept**

Exaquantum/Explorer allows users to configure a wide variety of user interfaces: process graphics, reports or more complex screens. Exaquantum/Explorer is an ActiveX container that provides basic drawing elements (e.g. box, line, and text). It hosts complex ActiveX controls including Trend, Trend Comparison, Excel Viewer, and Alarms & Events viewers, thus allowing various types of functionally rich graphics and reports to be configured. The Excel Add-In is a stand-alone component that deploys Exaquantum information inside Excel spreadsheets. These software components provide useful user interfaces, needing little or no programming effort.

- **Thin Web Client Support based on Internet Explorer and IIS**

The Exaquantum/Web application is a thin client that provides a rich set of functionality to meet the complex PIMS data service requirements. There is minimal administration at client level. The protocol with which clients communicate with servers is fully HTTP based, allowing the application to meet contemporary network administration requirements. The Web server facilities for Exaquantum are provided by the Microsoft Internet Information Server (IIS),

Exaquantum Data Exposure Features

In order to satisfy the variety of data processing requirements, Exaquantum provides a number of ways to expose data. This generally means keeping up with the latest technology, and taking advantage of easier application development.

- **Industry standard OLE DB/ODBC interfaces**

Most RDB client programs depend greatly on these interfaces to get information from servers. Exaquantum provides OLE DB and ODBC access for these programs so that they can retrieve value-added Exaquantum information for further processing.

- **DCOM Application Programming Interfaces**

For complex data processing requirements (for example event-driven processing), application programs can take advantage of a number of APIs.

- **.NET Application Programming Interfaces**

These give the ability for programmatic management of Exaquantum configuration such as the creation, deletion, or modification of Tags.

- **Open Interface**

Provides the capability to import and/or export Exaquantum data through an interface

using OPC DA and HDA. This feature is also used by the Exaquantum cross-server calculation feature to enable Exaquantum calculation tags to perform calculations based on tag data originating from different Exaquantum servers.

The bulk data import facility through HDA gives application developers the means of importing bulk data efficiently into the Exaquantum History database.

- **Data import/export through text files**

A tool is available to write (import) and read (export) data values through pre-defined format text files. This is particularly useful for non-Windows or legacy systems.

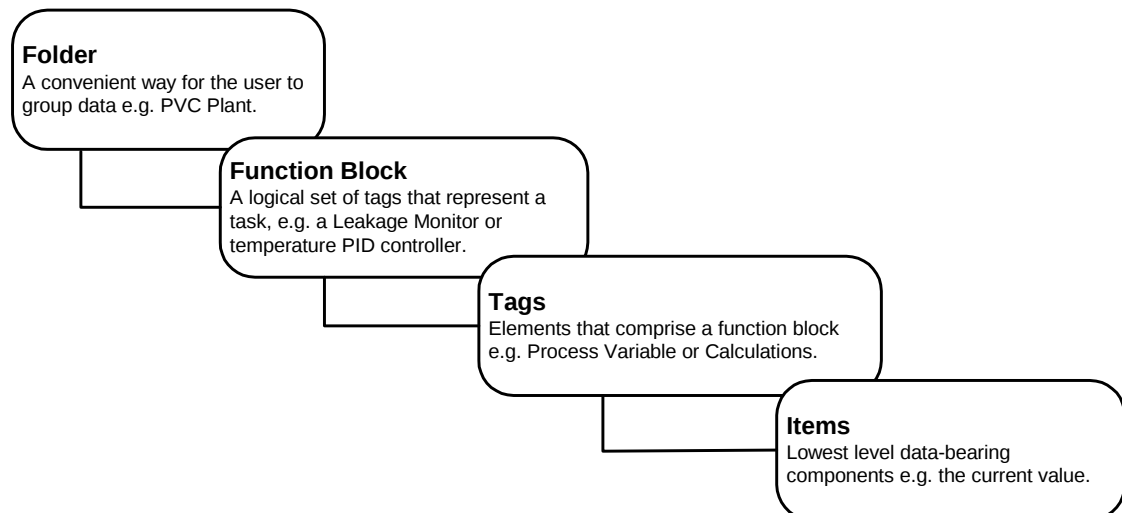
2. Real-time Database

The Exaquantum real-time database provides high performance real-time storage of plant-wide data. It also provides flexible, user-defined calculations and aggregations (mean, maximum, minimum, standard deviation, summation, etc.) over multiple user-defined time periods.

2.1 Organization and Structure

Data for the many items in a typical production environment is acquired from various sources by the Exaquantum real-time database. To ease the task of managing and using such a wealth of data, Exaquantum provides powerful ways to organize the data appropriate for the customer's own business needs. The primary components within the system are:

- Folders
- Function Blocks
- Tags
- Items



TIC 2-1

Figure: Relationship between Folders, Function Blocks, Tags and Items

Exaquantum tags are not the same as standard PCS tags but are instead equivalent to CENTUM DCS function block parameters with the addition of aggregation and reference data.

Exaquantum may also contain 'flat tags' that do not form part of a function block and are located directly under a folder.

Folders

Folders can be used to separate the plant up into logical functional units. The multi-level folder allows users to locate most items as required. The folder name will appear as part of the access string for all items in the folder. Folders can be created manually by users to group related data. A folder works in a similar way to a Function Block, in terms of grouping tags. However, in other respects it works differently. For example, creating a function block results in creating member tags too, whereas in the case of a folder, nothing else is created.

Function Blocks

An Exaquantum Function Block is a logical collection of tags meant to represent a task or information. The Function Block name will appear as part of the access string for all items in the function block. Each function block must be associated with a data structure called a Function Block Template, which consists of:

- A name ('Function Block Name')
- A number of associated tag(s), each of which has a logical name and a tag template (from which it was created) or is a shortcut that points to another tag. For more information about these templates, see Chapter 4.

Two typical uses of function blocks are described below, the first of which is the normal use for function blocks.

● Mirroring PCS Data Structures

Wherever a PCS has a functional data structure, such as PID controller, it consists of a number of process parameters. The PID controller, for example, may have PV (process variable), SV (setpoint value), MV (manipulated variable) and others like P, I, D, or MODE. The user may want to mirror a part or all of such a structure within Exaquantum and its Historian. In this case, the Function Block is used to group the process parameters to form a logical set.

● Represent a Logical Functioning Unit

It often happens that the same functioning structure appears repeatedly within a system. For example, wherever a pipe diverges into two, flow balance might be calculated. In this case, the 'functioning unit (structure)' can be defined as one in-flow process value, two out-flow process values, a formula to calculate balance, and a constant to store an alarm limit of deviation. Since this structure may appear many times across the system, it should be defined as a logical unit to represent the structure. This facilitates creating a new instance, changing an instance, or deleting an instance. The Exaquantum Function Block represents such a logical unit.

Another example of a function block is for differential summation. In order to calculate flow quantity in an accurate way, one commonly used practice is to generate accumulated summation by the PCS and then Exaquantum calculates the summation by subtracting the current summation from the last value. The best data structure to represent this function consists of the following set of elements:

- PCS accumulated summation value
- A temporary storage to store the last value
- A constant value to define the range of the accumulated summation, as the value wraps around the range
- A constant value to define deadband value
- A calculated summation value.

A function block can form a unit with these elements. Users can then easily create new differential summation points, modify parameters or change calculation formula all at once.

Tags

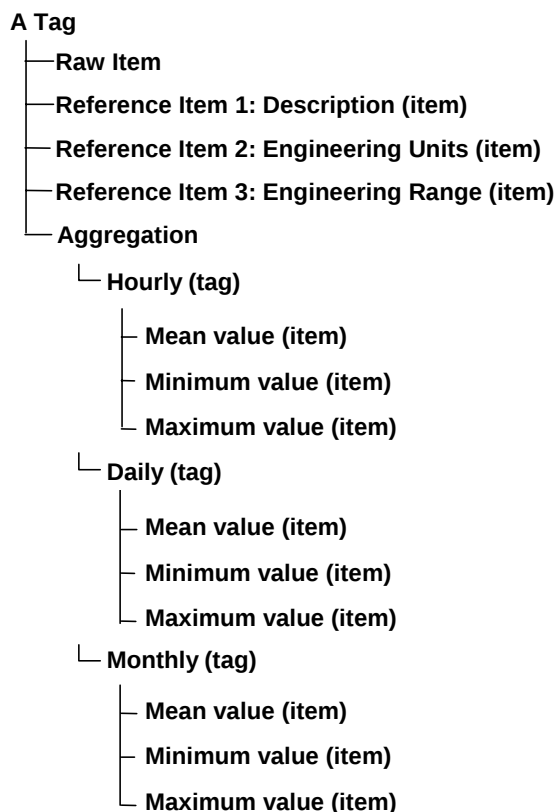
A tag is the basic unit of the Exaquantum data structure. There are three distinct types of tags in the system:

- Process tags where data is collected from or sent to an OPC server
- Calculation tags
- Manual entry tags for user entry or for 3rd party packages to store their data such as LIMS values.

A tag is configurable with settings categorized as:

- Type of tag: OPC, Calculated or Manual
- References (static information): Description, Engineering Units, Engineering Range
- Data type: integer, string, floating-point, etc.
- Nature of tag: continuous or discrete
- OPC settings: OPC update rate and percent deadband
- Historian notification rule: none, on-change or time (specific frequency)
- Calculation equation
- Which aggregations to perform.

A typical tag may consist of a number of items/tags, as shown below:



TIC 2-2

Figure: Example Tag Data Structure

Since a tag's elements are configurable, the complexity of the structure depends on the definition. Whenever a tag is discussed without a detailed definition, a 'standard configuration' is referred to. For example, Exaquantum performance is measured based

on a standard configuration of tags. The following configuration is considered as this standard:

A tag with ten (10) items:

- One raw item (such as .PV)
- Three reference items (Description, Engineering Units & Engineering Range)
- Six aggregation items (two aggregation periods (such as 1 hour and shift) x three calculations for each (such as Minimum, Maximum and Mean)).

The tag name will appear as part of the access string for all items in the tag (see 'Identifier', below under 'Items').

A function block tag can be a 'shortcut'. The intended use and characteristics of a shortcut are as follows:

- The primary purpose of shortcuts is to allow a cascaded calculation expression. For instance, if there is one input that needs a unit conversion (e.g. from flow to weight), it can be made into a function block. If there is another calculation to sum up several such weights, that can be another function block. In the latter case, do not reference inputs (weight tags) by the full path name, as they may move from the original place to another in the tag structure; this invalidates the expression. It is better to use a shortcut as a replicating dummy tag within the sum function block expression. The expression stays valid regardless of where tags are located. The assignment of real tags to shortcuts can be managed far more easily as a configuration task than by updating the expression.
- A shortcut is invalidated when the associated tag is deleted or moved. A tool is available to list such invalid shortcuts in the server.
- A shortcut can reference all types of tags (OPC, Calculated or Manual)
- A shortcut is not counted as a licensed tag.
-

Items

The item is the smallest data-bearing component in the system. All items have a:

- Identifier
- Value
- Timestamp
- Quality code.

The Identifier is different in nature from value, timestamp and quality. It has no memory allocated to it, as it is simply a name; the others have memory spaces allocated to store their representation.

● Identifier

The Identifier is a string by which the subject item is addressed. It always starts from the *Root* folder down to the subject of interest, each of elements being delimited by a dot (.).

These are typical identifiers:

- Raw item
Root.Folder.Tag.Value
- Reference item (Description in this example)
Root.Folder.Tag.Description
- Aggregation item (value)
Root.Folder.Tag.Aggregations.Hourly.Mean.Value

- **Value**

Value is the fundamental item of a tag. It is the data source from which the value originates that determines a tag's type:

- OPC tag: the value comes from the PCS via the OPC server
- Calculated tag: the value is generated by the Exaquantum Calculation Engine
- Manual tag: the value comes from an external unsolicited source such as human entry, ASCII file import, ODBC/OLE DB or other systems through the data access API.

OPC data is transferred to Exaquantum in an event-driven way based on the configurable update (scan) rate and percent deadband. The update rate is the minimum time between updates. The percent deadband is specified as percentage of the engineering range which the PCS data must go outside of before a data transfer to Exaquantum occurs.

All three types of tags can have aggregations. Unlike a tag's original raw values, which are event-driven in nature, aggregations are time-dependent, being available at the end of the aggregation period, for example each hour, day or shift.

- **Timestamp**

The timestamp is used for assigning the value to history and aggregations, allowing them to be sorted. It is therefore very important how a timestamp is assigned for values. The source of the timestamp for each tag type is as follows:

- OPC tag timestamps are supplied by the OPC server or by Exaquantum. Whenever time synchronization is implemented, it is recommended that OPC server time be used, as this is the time that is closer to the source. However, when there are more than one OPC servers that are not time-synchronized, Exaquantum time should be considered.
- Calculated tag timestamps are assigned by Exaquantum when the calculation takes place.
- Manual tag timestamps are assigned by the program that writes the value. For example, the Tag Editor (an Exaquantum configuration tool) assigns the system time at the point of update.

Exaquantum assigns to Aggregation items the timestamp of the aggregation period¹.

Time synchronization between Exaquantum and the OPC server(s) is important because the raw value timestamp is used in aggregation calculations that take place at Exaquantum time.

Time resolution is always 'seconds', although the OPC specification defines a 100 nanoseconds resolution interface. Time is rounded to seconds because most client programs are based on second precision, and therefore values with a finer time resolution may cause confusion. For example, if a user shows a list of raw values, and performs a summation with Excel, the summation will look incorrect because Excel rounds the times to 'second' resolution. In this case, the calculated summation would be correct if the times were not rounded to seconds. The preference, therefore, is to allow Excel (and other similar tools) not to round the results.

Whenever the time resolution is of particular concern, for example the time of event messages, Exaquantum does not round such time to seconds².

¹ Maximum and Minimum aggregations are time stamped at the point when the Maxima or Minima occur within an aggregation period.

² The second resolution is a client issue. The Exaquantum OPC client program rounds the time to seconds, VB programming interface can handle only second resolution. The RTDB and Historian, however, deal with time in a file time resolution (100 nanoseconds).

● Quality

The quality code contains 32 bits of information. The lower 16 bits represent the OPC status (Primary Quality); this status can be GOOD, UNCERTAIN, or BAD. The higher 16 bits represent a sub-status (Secondary Quality) that qualifies the OPC status.

How the status UNCERTAIN is interpreted, and hence used, is often vendor dependent. Exaquantum applies the following policy:

“Uncertain state is the best guess of value”; this means that values can be used with an understanding that it is not perfectly accurate.

Reflecting this policy, the interpretation of quality in an Exaquantum/Explorer trend is as follows:

- Uncertain points are shown in the graph as GOOD points
- Uncertain-Shutdown points are treated as BAD, resulting in no graph beyond this point.

There is an additional Primary Quality that is not OPC-related, but is associated with Offline Tags. This is ASSUMED.

● Assigning Quality

The logic of assigning quality depends on the type of items:

- OPC tags inherit the quality code provided by the OPC server (except BAD-OPC err, which is assigned by Exaquantum when the communication fails).
- Manual tags accept the source specification along with the value.
- Calculated tags – the default is determined as follows:
 - If any source item is BAD, then the result is defaulted BAD
 - If all of the source items have GOOD, then the result is defaulted GOOD
 - In all other cases the result is defaulted UNCERTAIN.

The calculated tag code can explicitly override the normally default quality code. If an error occurs while executing the expression, BAD is always assigned.

- Aggregation items

If all the input values within the period have GOOD quality, then the result is GOOD. If the period of BAD quality exceeds a system-wide defined period (%GOOD period), then the result is BAD. In other cases, the result is UNCERTAIN.

UNCERTAIN is a kind of GOOD in terms of calculating the %GOOD period. For example, if all the values over an aggregation period are Uncertain, the resulting aggregation has a quality code Uncertain, not Bad.

● Quality at Shutdown and Start-up

At shutdown and start-up, quality codes are allocated as follows:

- OPC tag. Uncertain-Shutdown is assigned. Soon after a subsequent start up, the value is recovered by OPC value.
- Calculated tag. Uncertain-Shutdown is assigned. Soon after a subsequent start up, the value is calculated and recovered.
- Manual tag. Preserved across the period when Exaquantum is shut down.
- Reference items. Preserved across the period when Exaquantum is shut down.
- Aggregation items. At a subsequent start up, the aggregation value is calculated based on the values saved at the time of shutdown, with a special quality code of Uncertain-Estimate. This potentially results in the correct value for the period interrupted by the shutdown and BAD value for the entirely missed periods.

- **Quality of Data Restored by History Catch-up**

History Catch-up is a function that restores raw, calculated and aggregation values which would otherwise be lost. The system allows an option to read OPC server's history information at start up, and restore values. Quality codes are allocated as follows:

- OPC tags:
 - When the OPC historical interface can receive the value before the shutdown point, that value will override the shut down point. If no value is available the shutdown point is unchanged.
 - If the catch-up fails in the middle of the catch-up operation, a shutdown mark Uncertain-Shutdown is inserted at that point.
- Calculated tags do not have any special points.
- Aggregation items behave in the same way as at start-up.

History Catch-up will only operate where the OPC Server(s) support OPC HDA.

- **Quality of History Information**

There are several cases where the quality of history information is affected, for example:

- When an archive (of historian) is created and put offline, the missing period will be marked BAD
- When a system database is restored with a backup made some time before (catastrophic recovery), all values from the end of database up to the time when the database is restored will be marked BAD.

- **Quality of Offline Tags**

There are situations when the input source(s) of OPC Tags may be unstable (e.g. during calibration), and the user needs to disconnect the input from Exaquantum to prevent the unstable data being stored and affecting calculations. This is achieved by setting the tags Offline.

- When a Tag is set Offline all OPC or Calculation result Items for that Tag will have their primary quality set to ASSUMED.
- The user may manually update a Tag value while it is Offline – in this case the secondary quality will always be set to REPLACED.
- The Offline status of Tags will be preserved across Exaquantum shutdown.

Flat Tag Structure

The 'flat tag' structure is used to locate tags directly under a folder. Unlike function block tags, a flat tag has no relation to other tags when one is created, modified or deleted. This structure is inherited from Exaquantum R1.0 and is preserved for the following potential usage though usage of flat tags is not limited to only these examples:

- To replicate non-structured PCS tags

Some types of PCSs, such as a PLC, may not have a structured functioning unit. In this case, flat tags may be used to replicate PCS tags in Exaquantum. Other Exaquantum logical units, like function blocks, may refer to such replicated tags by way of a 'shortcut'. The benefit of this approach is that PCS data can be configured to acquire data and to store historian data, even before the usage is designed and implemented in the form of function blocks.
- To allocate constants

If their usage is system-wide, it is logical to configure constant values in flat tags rather than in function blocks.

2.2 Calculations and Aggregations

Calculations

Exaquantum's Calculated tags can contain calculations ranging from simple, equation-based calculations (e.g. $\text{Result} = \text{SQR}(\text{TagA} + \text{TagC})$) to complex, scripted calculations using Microsoft VB scripting.

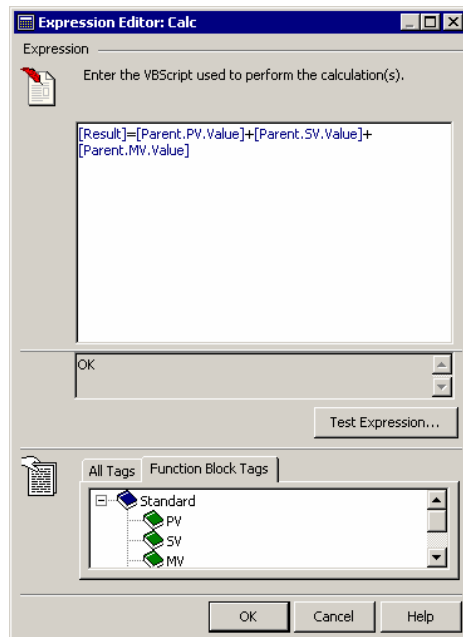


Figure: Example of a Scripted Calculation

The results of the calculations are no different from 'raw' process values; they may also be historized, aggregated, and used in other calculations. Exaquantum calculations are event-driven. When a new value arrives from a data source, the real-time database decides whether any derived items need to be updated as a result of this new value (on the basis of the dependency relationships Exaquantum maintains).

By adding the Cross-server Calculation feature, tags from other Exaquantum servers can be made available for use in calculations.

Exaquantum provides a number of useful features:

- Aggregation items can be used in calculation expressions. When they are used as inputs, users can perform data processing based on the latest aggregation results. When they are used as outputs, users can generate their own aggregation logics.
- Calculations are event-driven by nature, however timer functions allow time dependent processing, e.g. to monitor that a value does not change for 5 seconds.
- Besides a rich set of pre-configured functions, such as the quality helper functions, users can use their own function libraries inside the script.
- In order that a malfunctioning calculation does not to affect the entire system, the execution of a script is subject to time-out monitoring.
- Timer functions are available. They are particularly useful for monitoring the situation where there is no event update for a specified period of time.
- Expression allows for relative addressing within a function block calculated tag. Such a function block is location-independent and should be the most common.
- Calculated tags can generate internal events that trigger applications through Event Handling; this allows configuring applications to be closely linked to data processing.

Cross-Server Calculations

In an Exaquantum multi-server environment the data from all the connected Exaquantum servers can be made available for viewing by all the connected clients. However in a standard configuration the data can not be used in calculations. Adding the Cross-server Calculation feature (also known as 'Exaquantum OI' (Open Interface)) allows the data collected on one Exaquantum server to be used in calculations on another Exaquantum server.

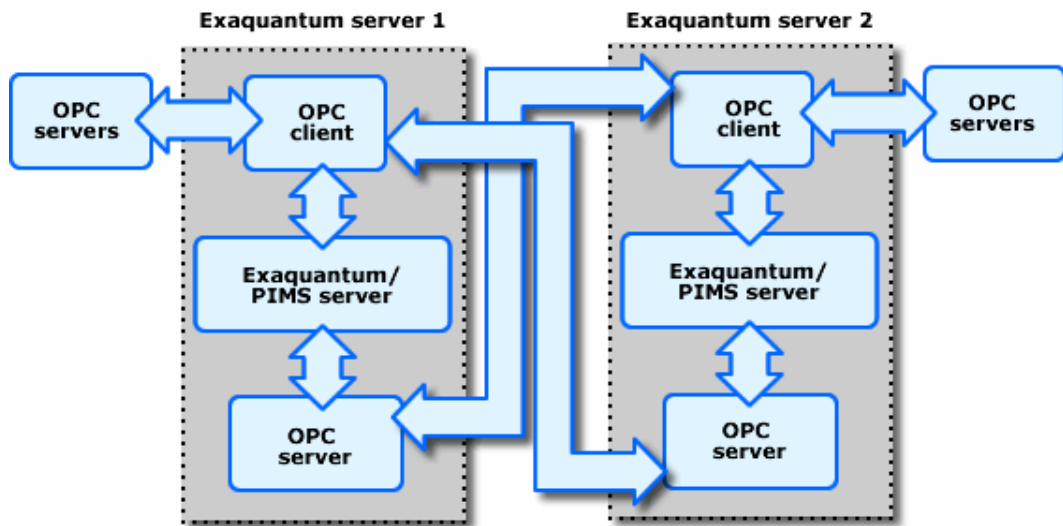


Figure: Conceptual representation of Cross-server Calculations

This facility is provided by adding an Exaopc server module to the Exaquantum installation. This allows one Exaquantum server to make its data available through an OPC interface. Thus one Exaquantum server can connect to the OPC server interface on another Exaquantum server as if they were connecting to an OPC.

In calculations, tag data collected using the Cross-server Calculation feature can be treated just like the tags from any other OPC server.

Aggregations

An Exaquantum aggregation is a special type of calculation that is carried out over a pre-defined period (aggregation period), according to a specified rule (aggregation method).

- **Aggregation Periods**

A tag can have aggregations defined for one or more Aggregation Periods such as an hourly aggregation and a daily aggregation.

Aggregation periods are defined by a time period and an offset. This allows definitions such as:

- 'Every day at 2 am'
- 'Every hour at 30 min after the hour'
- 'Every 15 min at 0, 15, 30 and 45 minutes after the hour'.

Some aggregations are calculated based on raw values, while others are calculated based on other aggregation results.

The features of the various aggregation periods are summarized in the table below.

Table: Aggregation Periods

Aggregation Period	Description	Time Period	Offset	Can be Derived from
Hour	Once every hour	Fixed (60 minutes)	0 to 59 (min)	Raw, Custom
Day	Once every day	Fixed (24 hours)	0 to 23 (hours)	Hour, Raw, Custom
Month	Once every month	Fixed (1 month)	1 to 28 days, or 'Last Day'	Day, Hour, Raw, Custom
'Custom' type	User-defined periods e.g. 8 hours as a Shift	Configurable time periods (maximum 24 hours)	'Time period' minus 1 minute	Raw (fixed)

● Daylight Saving Compliance

If the 'Automatically adjust clock for daylight saving changes' box is checked in the Windows Date/Time properties of the Windows Control Panel, Daily aggregations and Custom aggregations longer than one hour behave in the daylight saving compliant manner as:

- Calculations on daylight saving changes days are for 23 hours or 25 hours accordingly
- Aggregation calculation offset stays at the specified local time over daylight saving changes.

● Aggregation Methods

Two Aggregation types (Discrete and Continuous) are standard in Exaquantum.

The Discrete type provides the following aggregation methods:

- Count
- On Time
- On State (this is used to define any single state or value a user wants to count or time).

The Continuous type provides the following aggregation methods:

- Mean
- Minimum
- Maximum
- Standard Deviation
- Summation (including an Differential Summation option)
- Spot Value.

In order to calculate quality, an aggregation method called %GOOD is defaulted whenever particular aggregation methods are selected. These methods are On Time for Discrete, and Mean, Standard Deviation, or Summation for Continuous.

● User-supplied Aggregation Method

Users can either make use of pre-defined, system-supplied aggregation methods (above), or execute their own by using the 'Aggregation calculated tag'. A typical case is the calculation of an hourly aggregation based on two other hourly aggregations, to be averaged and multiplied by a constant.

To make use of the aggregation calculated tag, a calculated tag should be created based on a tag template to allow this aggregation. An expression must then be entered so that the aggregation(s) is supplied by the calculation.

2.3 Additional Real-time Database Features

2.3.1 Alarms and Events

Exaquantum obtains alarms and events from the PCS (where supported) via OPC Alarms and Events (A&E) servers. Alarms and events are historized, and are available for viewing through Exaquantum/Explorer, Exaquantum/Web or for access by Applications through the ODBC/OLE DB and COM/DCOM Interfaces. Filters can be defined, which are applied to the incoming data, in order to reduce the amount of data stored in Exaquantum. These filters are exclusive, that is they define what data is not required to be stored in Exaquantum.

2.3.2 Event Handling

Exaquantum includes the ability to activate application programs when:

- Any A&E messages are received from the PCS
- All aggregation calculations for an aggregation period are complete
- A calculated tag expression sends an event.

The event processing is implemented by the user as an external program to read the Microsoft Message Queue (MSMQ) for prompting messages, and process them accordingly. Exaquantum provides a configuration program that registers events to execute application programs, defines parameters to be passed to application programs, and selects which MSMQ the message is directed to.

Typical uses of the Event Handling function, and thus application programs, could include:

- Triggering reports at the end of an aggregation calculation
- Doing batch-oriented tracking or processing
- Providing the number of times a pump has been turned on and/or run hours.

Such Application programs work only on an Exaquantum server.

2.3.3 Data Write to Control System

Exaquantum has the ability to write values to the PCS through the OPC server.

When an OPC tag is configured to be 'write-able', writing to such a tag results in further write access of the value to the associated PCS. An Exaquantum/Explorer client, calculation expression, or application programs that write values using the Data Access API can also trigger write operations.

To ensure that a data write takes place properly, it is often necessary to configure the PCS and/or OPC server so that the PCS accepts data write requests. Exaquantum security controls (described next) are available to further restrict the ability to write to control systems.

All write operations are recorded in the Exaquantum system audit log with information such as user, time, items (or tags), and the value. The previous value(s) before the write operation is kept in the Historian to allow the Exaquantum audit log user interface to display the original and updated values.

2.3.4 Access Security Control

Access security control is one of the major concerns of PIMS administrators. In order to satisfy both administrators and users, Exaquantum provides a fine control mechanism, in addition to the basic user authentication, called 'Role Based Namespace' (RBNS) which is described in Chapter 4.

The main features of Exaquantum access security control are:

- The access to general resources that users are granted depends on the Windows Groups that they belong to. Such Groups, and hence controlled resources, are:

- QUserGroup – access to any Exaquantum resource
- QAdministratorGroup – all administration work (able to use Administration tools)
- QExplorerDesignGroup – Exaquantum/Explorer design
- QDataWriteGroup – data write access in general.

Each user can also have their own custom view of accessible information controlled by the Role Based Namespaces they are assigned.

- A user can be assigned read-only permission for the resources in the Role Based Namespace and none other. For instance, if a graphic created by user A contains a tag that does not appear in user B's Role Based Namespace, the graphic shows the tag as unavailable when user B runs the graphic.
- Role Based Namespace allows an access control list to be defined that indicates what resources the user can or cannot write to at a tag level if required.
- A user can belong to more than one Role Based Namespace.
- If a user has no Role Based Namespace defined, the intrinsic namespace is defaulted, thus all users must be assigned appropriate security groups.

Besides the access security control mechanism, Exaquantum provides a rich audit log allowing administrators to easily keep track of operations or changes made to the system.

The audit log includes the following operations:

- System Operations
- Write Operations
- Tag and Function Block generation
- Namespace changes
- Archiving
- System start up/shutdown (including the status of the History catch-up)
- Recalculation of Aggregations.

2.3.5 History Catch-up

History catch-up recovers missing process data within Exaquantum that occurred during an Exaquantum shutdown period. It does this by automatically reading OPC data from those OPC Servers supporting OPC HDA (Historical Data Access) and HAE (Historical Alarm and Event which is only available from Exaopc) interfaces when Exaquantum is re-started.

History catch-up provides the following features:

- Data in the historian covering the Exaquantum/PIMS server downtime period is populated as if the Server had remained online.
- All Item data is populated as:
 - Raw data
 - Aggregated data
 - Calculated data
- All Alarm and Event data is restored (only available with Exaopc).

- The catch-up behavior for Exaquantum is configurable as follows:
 - Catch-up may be turned on or off
 - If HDA access fails, the behavior may be configured to either fail Exaquantum start-up or skip the failure and carry on.
 - The start of HDA catch-up may be configured to the first aggregation period boundary of a selected aggregation before the start-up time.
- The Exaquantum Service Control Manager tool, which can be used to manually start up and shut down Exaquantum, shows the progress of the catch-up operation together with the estimated completion time. This allows the user to abort or cancel the catch-up if required. The option is useful if the estimated time to completion is too long.

2.3.6 OPC Data Recovery

OPC data recovery performs a similar function to history catch up (see previous section) with the main difference being that data recovery is used on demand on a running Exaquantum system.

The features of OPC data recover are:

- OPC data recovery can be used when the loss of data is other than as a result of the Exaquantum/PIMS server shutdown, such as network interruption or system failure.
- The Exaquantum/PIMS server is running.
- The time at which the recovery takes place can be determined to suit local operational conditions. In cases when system load is high or variable, it may be advantageous to choose specific times of low activity before recovery takes place.
- Multiple sources of data can be treated individually. This allows greater freedom to spread the load to suit local operating conditions.
- OPC data recovery will run as a background task alongside with the normal Exaquantum/PIMS activity. There is no unscheduled delay while the data is recovered.
- Alarms & Events are recovered if connected to Exaopc.

OPC data recovery is available in the form of an Exaquantum/PIMS system tool. It provides the following features:

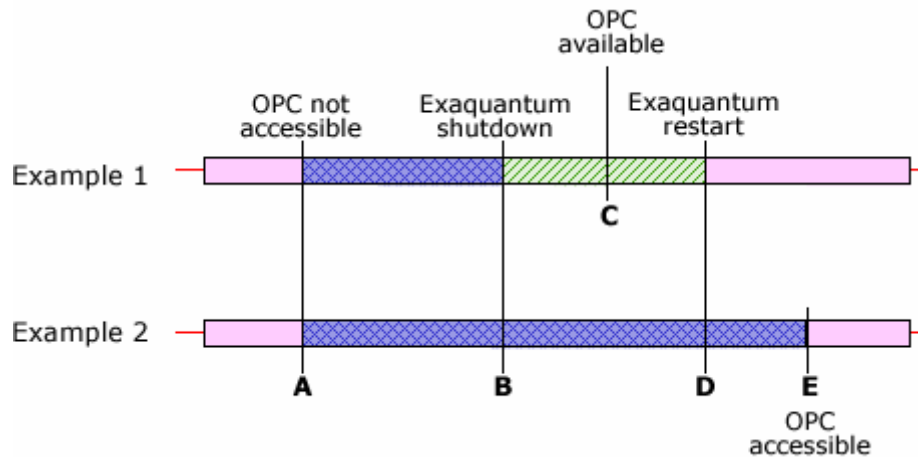
- One or more OPC data sources can be selected for recovery.
- The start and end time covering the period of OPC data loss can be configured.
- Each period of missing OPC data will be displayed and can be individually selected for recovery.
- During operation, the status of the recovery process is displayed.

There are some limitations:

- Aggregations and calculations are not (re)calculated.
- Alarm and Events are only recovered when connected to Exaopc.

Examples

The following two scenarios demonstrate where data recovery can be used to get data that will not normally be recovered by history catch-up.



Examples showing the difference between data availability using history catch-up and the OPC data recovery tool.

- **Example 1**

If history catch-up is enabled, the data between times B and D will be recovered automatically when the Exaquantum/PIMS server is restarted. Because the OPC server was unavailable when the Exaquantum/PIMS server was shut down, the data between A and B will not be recovered that way, however it can be recovered manually using the data recovery tool. If History catch up is not enabled then data for the whole period could be recovered using the data recovery tool.

- **Example 2**

Because the OPC server was not available when the Exaquantum/PIMS server shutdown at B, and restarted at D, none of the missing data will be recoverable by history catch-up. However, assuming it is available on the OPC server, data for the whole period can be recovered using the recovery tool.

3. Historian

The Exaquantum Historian is a powerful, efficient and fast data storage and retrieval component that:

- Stores real-time process data, aggregated data and reference data
- Stores PCS alarms and events and Exaquantum internal events
- Historizes all process data with an Identifier, Value, Timestamp and Quality
- Offers secure long-term archiving.

Clients can also make use of the Historian to retrieve information for a particular period, and then perform various types of analysis on it whose output is generally in the form of reports.

3.1 Historian Configuration

Historian Data Categories

The Exaquantum Historian stores a variety of data within an Relational Data Base (RDB) such as the following categories:

- **Raw Data**

These are OPC, Calculated and Manual tag values. They can be of any data type that Exaquantum recognizes such as integer, long integer, single-precision floating-point, double-precision floating-point or string.

- **Aggregated Data**

Similar to raw data except only the long integer and double-precision floating-point data types are used for numeric values.

- **Reference Data**

Description, Engineering Units and Engineering Ranges. They are a separate category because the rate at which data changes is significantly slower than in other categories.

- **Alarms and Events**

A structured set of data elements.

The Historian allocates different database tables for each of these data categories. These categories are often called Archive Groups as they are bound to archiving units.

Historian Configuration Parameter

The Historian allows some configuration tailored to how the user uses it.

- **Historian Storage Interval**

Users can choose from the following types of raw historian interval, on a per tag basis:

- None
- Time (set of selectable frequencies)
- On change.

The raw historian interval is not the same as the OPC update rate. Therefore if 'Time' has been selected, any changes (to the OPC update rate) that are a finer resolution than the raw historian interval are not stored in the Historian, even though the actual information shows changes.

Periodic time does not result in periodic historian storage. Information is stored only when the value has changed since the last Historian update.

Regardless of the type of raw historian interval selected, system-wide events such as start-up and shutdown cause values to be stored. In these cases, the information is allocated an appropriate secondary quality code.

3.2 Historian Data Processing

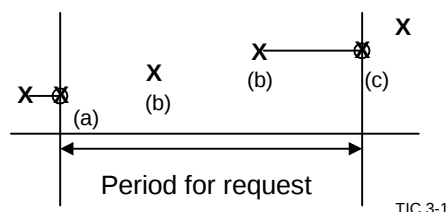
Interpolation

Because of the event-driven nature of Exaquantum, it is unlikely that values are actually stored in the Historian for the exact time that users want to look at. As a result of this, interpolation of data takes place. There are number of possible ways of interpolating data, including:

- Cast-forward: the previous value is extended in the future direction
- Cast-backward: the following value is extended in the past direction
- Linear: points are connected with straight lines
- Other more sophisticated ways, including Exponential.

In Exaquantum, interpolation is carried out either by clients, or by the data access layer that resides between the clients and server. It relies heavily on the way in which information is stored in the Historian. The Historian is tuned so that it can support Cast-forward only; there is therefore a certain limitation in other interpolation methods.

From the client viewpoint, the following figure illustrates interpolation in Exaquantum:



TIC 3-1

In this example, as a result of interpolating four points (point (a), multiple points (b), and point (c)) will be passed to client; points (a) and (c) having been added by the data access layer.

When clients (Exaquantum/Explorer) are using the Trend control, they can choose one of two ways to interpolate data, either Cast-forward or linear. In all other scenarios, only the Cast-forward method is supported.

If a request is made for future time (i.e. if the end time is in the future), the interpolation is made so that a BAD point is inserted at 'Now'. This results in disabling any line that may otherwise appear in the Exaquantum/Explorer trend in the future time period.

Historian Timestamp and Relevant Processing

The Historian assumes that a value's timestamp is UTC; this is true for every item. The

Historian stores values according to the UTC time series, and uses it as a key to identify stored values for read access. Two processes that are heavily dependent on the timestamp alignment issue are described below.

- **Late-arriving Historian Data**

The Historian makes use of RTDB technology (Microsoft SQL Server 2005), where the database schema is designed so the read operation is done most efficiently. In order that the search operation can take place less frequently, information for a certain period of time is combined in the form of a Binary Large Object (BLOB), and put into the database. This ensures high performance during read operations but low performance whenever there is a need to write to a past time.

In most cases, the system is tuned so that requests to write values to the past time period rarely happen. However, in those cases where requests (often referred to as late-arriving data) do happen; this results in a high CPU load for a period of time. Such cases include:

- LIMS data entry. Values are entered into Exaquantum some time after the sample timestamp
- A backward change in server time. A backward time change is likely to result in data loss whenever UTC duplicates. Therefore Exaquantum does not expect any large amount of time drift, especially backwards.

- **Versioning Data**

When a write request is made that coincides with an existing data point in terms of the timestamp, a new value is always 'appended' after the existing point; it does not overwrite the existing one. Ordinary users of the History information cannot get multiple points for a particular point in time. A special program, however, can retrieve all points. Such a program would be an audit trail log user interface that can show the previous and new values for the write operation.

3.3 Archiving

Archiving is the process used to move part of the current Historian information to a separate archive that is to be handled separately from the online Historian database.

For example, an archive can be backed up by an external medium or it can be removed from the disk to make more space for the online Historian database. The backed up archive can then be restored into the disk so that it is seamlessly available, together with the online database, to Exaquantum. With this mechanism, the Historian can allow a virtually unlimited amount of its information to be available to the user.

Archiving Groups

An archive can be made on an Archiving Group basis. The groups are:

Table: Archive Groups

Archive Group		Description
Type	Sub-type	
Raw Slow	-	Manual and Calculated tags whose Raw Historian Period is greater than the configured boundary setting. OPC data whose OPC Period is greater than the configured boundary setting.
Raw Fast	-	Manual and Calculated Tags whose Raw Historian Period is less than, or equal to, the configured boundary setting. OPC data whose OPC Period is less than, or equal to, the configured boundary setting.
Aggregation	Monthly	Calendar month aggregations
	Daily	Daily aggregations,
	Hourly	Hourly aggregations
	Custom	Customer defined aggregations with a period of less than one day
Reference	-	All reference items
Alarm & Events	-	Alarm and Event data
System Events	-	System event data
System Audit Trails	-	Changes to the tag structure

Raw (and possibly Alarms and Events) archives are likely to be used for analyzing production, while aggregation archives might be used to (re)produce reports.

Archiving Parameters

The user can control the size of an archive based on both the size of the media and the number of days to cover.

- Media size is meant to restrict the size of the archive to fit into the medium with which the archive will be backed up. This is a physical requirement that must be met before the following one is addressed.
- Number of days is meant to satisfy usability requirements. For example, where the user wants to make an archive on a time basis that is appropriate to his operational or management requirements (such as on a monthly or quarterly basis).

Auto-archiving and Auto-deletion Options

In order for administrators to be freed from daily administration tasks, archiving allows them to configure the auto-archiving or auto-deletion of Historian information. These options are configured on a 'per archive group' basis, and are not system wide.

These options rely on the 'Retention Period' of an archive group as follows:

- Auto-archiving. When the online information exceeds the Retention Period, an archive will be created in accordance with the above mentioned archiving parameters, i.e. media size or days.
- Auto-deletion. When the online information exceeds the Retention Period, any excess part of the Historian information is automatically deleted, on a day basis.

When the auto-archiving option is selected, there is also an option for a backup to be created automatically.

Once Exaquantum historical data has been archived, the historical data can be removed (made offline) automatically from the Exaquantum database after a configurable time period. For example, data may be archived every 30 days but still kept online for access by Exaquantum users for an additional 60 days before automatic removal.

3.4 Historian Management Tool

Exaquantum provides a tool to manage the Historian database. Typical cases that the tool will primarily address are when the disk is full and when time is accidentally changed to the future. These are described below.

- **When the disk gets full**

This situation should not occur if constant administration work is performed. However, if the disk does become full, the best way to resolve the problem is to delete the old historian information to make space for the Historian database until a permanent solution is implemented.

- **When time is accidentally changed to the future**

Normally Exaquantum is time-synchronized to a single OPC server. Whenever the OPC server time changes accidentally to the future (for instance one-year ahead), Exaquantum time will catch up eventually. One or more values with a future timestamp will be stored in the Historian. When the time is corrected, all of the now 'proper values' received from the OPC server are regarded as Late-arriving data which cause considerable problems to the Historian. In this case any wrong future values are simply removed from the Historian by this tool.

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4. Management and Administration Tools

Exaquantum is easy to install, configure and commission. This is achieved through a powerful combination of thoughtful design, a ready-to-run platform and a comprehensive set of tools. The ready-to-run platform contains most of the infrastructure and data support required for the rapid deployment of large-scale integrated information systems. The set of tools, used for both management and configuration purposes, are integrated into the Microsoft Windows Management Console (MMC).

Overview

The following Exaquantum tools are available:

- System Configuration
 - OPC Gateways
 - Production Calendar
 - History Catch-up Parameters
 - Server Management
 - Role Based Namespace Builder
 - License Management.
- Tag Configuration
 - Tag Template
 - Function Block Template
 - Tag Generation (four ways are available for generating function blocks/tags)
 - Tag Editor.
- Archiving
- Advanced
 - Event Generator
 - HIS Tag Generator.
- Help and Support.

Certain tools used by Exaquantum are for system administration. These are available from within the Windows Operating System (refer to Windows Help for more information):

- Windows Tools
- User Manager
- Backup and Restore
- Performance Monitor
- Event Viewer
- Microsoft SQL Server Enterprise Manager and other tools for database administration.

Some important concepts for configuring Exaquantum are described in the following sections.

Microsoft Management Console

The Microsoft Management Console (MMC) is used to access all Exaquantum Management and Administration tools ensuring that Exaquantum tools are handled in a manner consistent with the administration tools of many Microsoft products such as SQL Server.

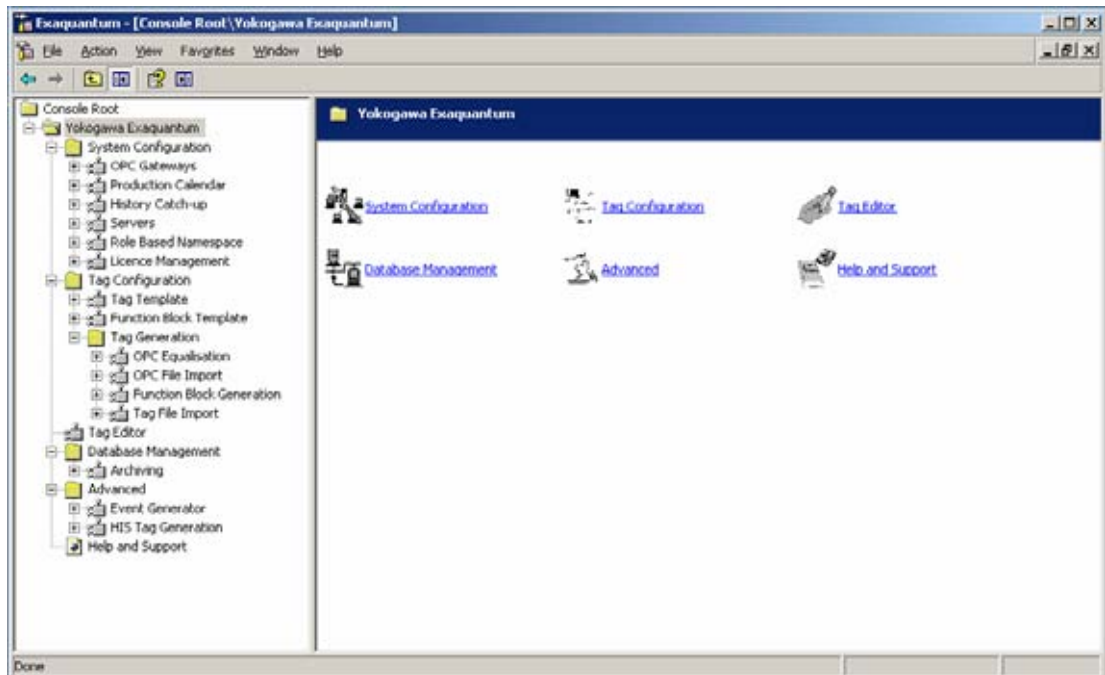


Figure: Microsoft Management Console with embedded Exaquantum Tools

The tools available within Exaquantum are displayed in the left part of the screen as a tree view. The administrator can expand each group to see the related sub-groups and/or the tools.

When a group is selected, the sub-groups and/or tools are displayed (as icons) in the right part of the screen. The user can access any tool either by selecting it from the tree view, or by clicking on the appropriate icon. At each level there is an option to return to the Main Menu (by clicking on the 'Main Menu' icon).

The Exaquantum Management Console can be opened either on the Exaquantum server or on any installed client machine, provided that the user is authorized to use this tool.

In the Exaquantum/Web environment, these tools may be accessed from a client IE through the Windows Terminal Server facility.

In a multi-server configuration, administration tools should be associated with one server at a time.

Not all of the functions available from the Management Console are accessible to installed client machines; some can only be used on the server.

4.1 System Administration Tools

4.1.1 Exaquantum Servers Configuration

The Server Management tool is used to define which Exaquantum servers make up the set of multiple servers used within Exaquantum. Before the Role Based Namespace can be configured, the Exaquantum servers must be defined.

4.1.2 OPC Gateway Configuration

OPC Gateways are OPC servers from which OPC values are retrieved by Exaquantum. To start configuring an OPC Gateway, certain information is required.

The most important piece of information that an administrator must define is the OPC server type. This is because Exaquantum can only connect to an OPC server type that appears in the pull down list. Any missing types must be defined using an Exaquantum tool which adds the missing type to the pull down list.

Whether or not Exaquantum reads Alarms and Events from an OPC gateway (assuming the OPC gateway supports OPC A&E) and whether these Alarms and Events are filtered is configurable. Other parameters, such as 'Use Exaquantum time', can be invoked only by restarting the Exaquantum server.

4.1.3 History Catch-up Parameters

The History Catch-up Parameters tool is used to define the behavior of History Catch-up as follows:

- Whether or not it should run at start up
- What should happen if the catch-up operation fails (e.g. abort the start up or cancel the catch-up to start normal processing)
- When exactly restoration of data should start (either preceding shutdown or at a boundary of a selected aggregation period).

4.1.4 Role Based Namespace Builder

The Role Based Namespace (RBNS) Builder is a mechanism by which Exaquantum administrators can configure Exaquantum users' view of Exaquantum information. It also provides a vital part of the access security control mechanism.

In order to configure the RBNS, the various user roles need to be identified first, e.g. Operators of Area 1, Site Manager, Plant Maintenance, etc.

Important aspects of the RBNS are described below.

- **What administrators can Configure in the Role Based Namespace**

A wide variety of operational and managerial information that Exaquantum provides can be screened to meet the individual's data utilization requirements. Such information includes:

- Folder structure
- Function blocks
- Tags.

- **Configuration**

All items within the RBNS are configured under the top root node. Folders can appear underneath in a multi-level hierarchy. Any other elements are located below a folder. Folders and elements can be configured as follows:

- A folder can simply be a pointer to an existing folder within an Exaquantum server. All the contents under the RBNS folder are then a replication of the pointed folder.

The administrator can specify either inclusive or exclusive name filters to limit the set of contents. The filter also allows the administrator to specify whether or not the aggregation information is exposed. For function blocks, the administrator can pick up a part of member tags.

- A function block or tag can be a pointer to an existing function block or tag within an Exaquantum server.

As such, there is no occurrence of the Exaquantum server name or identification within a path name of a function block or tag. Administrators can configure folder names so that they convey a server name or plant designation, but so that the software does not actually interpret the folder name.

- **Item Path Name**

In order to identify the RBNS by a path name, each path name always starts with an RBNS name followed by folder(s) then the object, e.g. MyView.Folder 1.Tag1.Value.

There are special path names that start with 'Root'. This allows for backward compatibility. In this case, the default RBNS called 'Root' is used. By default this is equivalent to the intrinsic (actual) namespace, and the administrator may change according to the access security requirements.

- **Data Write Security**

Folders, Function Blocks and Tags within an RBNS can be defined to be read or read/write.

- **Replication**

RBNS information, along with Exaquantum Servers information, will be replicated among relevant Exaquantum servers. This is useful as it allows a consistent RBNS to be used, even when the designated server is changed from one to another.

The designated server is where a client first goes to get the required information, such as the RBNS. When a designated server is not available (e.g. it is shut down), a client such as Exaquantum/Explorer can go to the stand-by designated Exaquantum server.

Replication can be performed with the RBNS Builder.

4.1.5 License Management

The License Management tool is used to administer the Exaquantum license code for an individual Exaquantum server. In an Exaquantum multi-server configuration, the license key for each server is periodically checked to ensure that it is valid and unique. A license breach on any of the Exaquantum servers is notified to users on all configured servers.

4.1.6 Production Calendar

The Production Calendar is used by administrators to define the:

- Aggregation period to be used (such as shifts)
- Parameters of each aggregation period
- Dependency of aggregations.

How the production calendar is configured affects all tags that need to have aggregations associated with them. Hence the production calendar must be defined before tags are configured.

It is possible to change production calendar definitions after configuring tags. However, as some changes (such as changing dependency) result in inconsistencies in the tag template, it is sometimes necessary to correct tag templates as well.

4.2 Tag Configuration Tools

The process of tag configuration is based on templates. It is a means of classifying tags and function blocks in terms of their structure and properties. Defining such settings in a separate data structure reduces the necessity to repeatedly set the same values for large numbers of tags.

The first stage in configuring tags and function blocks within Exaquantum, therefore, is to identify the same structure and properties across prospective tags and/or function blocks. Tag Templates and Function Block Templates can then represent this information, respectively. When tags or function blocks are subsequently produced, they can be associated with the proper templates.

4.2.1 Tag Template

The purpose of the Tag Template is to define a structure and set of properties upon which tags can be based when they are created (both function block tags and flat tags). Tag Templates must be configured before Function Block Templates.

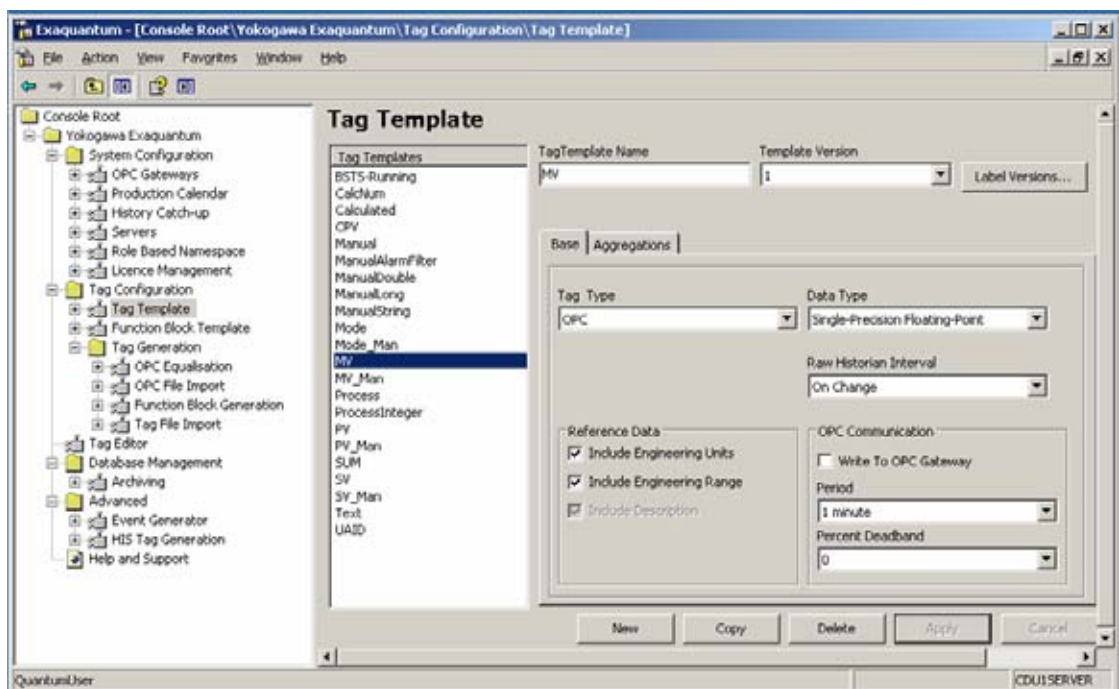


Figure: Tag Template Screen

Changes to the Tag Template are controlled by versions. This means that there could be a number of templates with the same name, but slightly different definitions. This is important because having versions allows changes to existing tags to be assessed when templates are to be updated. New tags are always created based on the latest version of the specified tag template.

4.2.2 Function Block Template

The Function Block Template is used to define which member tags a function block would contain when it is created. The Function Block Template also defines member tags' initial or default values. For example, a manual tag has an initial 'value' and a calculated tag has an 'Expression'.

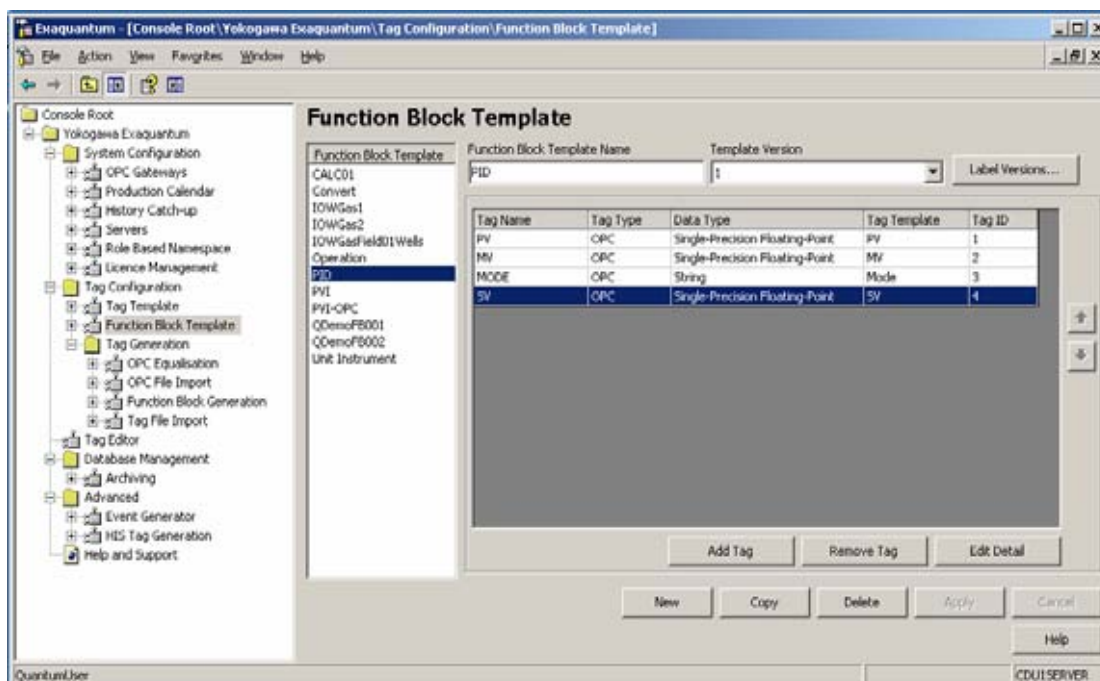


Figure: Function Block Template Screen

As with the tag template, the function block template is version-controlled. New function blocks are always created based on the latest version of the specified template.

4.2.3 Tag Generation

Tag Generation is a set of four tools that generate tags and/or function blocks. In each case the tool is a guided process with steps to be followed. The tools are:

- OPC Equalization – retrieve the PCS tag list through OPC server Browse interface
- OPC File Import – retrieve the PCS tag list from a file
- Function Block Generation – specify function blocks directly from a text file
- Tag File Import – specify tags and their definitions from a text file.

The tool used depends on the scenario, as follows:

- If the system has a pre-configured OPC server ready for Exaquantum access, the best choice is OPC Equalization. It assumes a tag naming convention established in the PCS tags, so that a potentially huge number of tags can be easily filtered by tag names using wildcard definitions. Currently this tool can only be used with Exaopc connected to CENTUM CS, CENTUM CS 1000 or CENTUM CS 3000 DCSs.
- If the system does not have a pre-configured OPC server ready for Exaquantum access, OPC File Import may be used. It is identical to OPC Equalization, except that the administrator must define all the information (essentially a list of tag names) that OPC Equalization normally creates automatically.
- The Function Block Generation tool allows administrators to create function blocks with whatever parameters that they want to specify. For instance, Exaquantum logical function block names can be allocated only with this tool.
- If the administrator wants to construct flat tags, then Tag File Import should be used.

All four invoke various interactive steps; all start by either selecting a 'job' to run, or creating a new one.

A 'Job' is used to identify the task that has created the tags/function blocks. This information is useful when templates are changed. A typical scenario is:

- Tags/Function blocks are created by one of the four methods described previously.
- When some changes are required (for example to add an aggregation period, to change the OPC update rate, or to add/remove/rename function block tags), a typical way is to find the job that created the subject tags/function blocks, and re-run it, after changing the template accordingly. Administrators can typically locate a job through the Tag Editor, as a particular tag/function block usually drives the required change; the Tag Editor shows the job when it is used to access such a tag/function block.
- When a job is rerun (or run), administrators are provided with an analysis report that shows the changes that are to take place. Administrators are then prompted to check the changes, and select an action: to continue, to change templates again, or even to cancel the operation.

4.2.4 Tag Editor

The Tag Editor is used to create, update and delete individual tags (both function block tags and flat tags). It allows:

- Creation of folders, function blocks, OPC tags, Calculated tags and Manual tags
- Editing of tags and function blocks by changing the associated templates (using the Template tools), and applying the templates through the Tag Editor
- Display of an analysis report whenever administrators attempt to make an update, deletion or creation of tags and function block
- Provision of information of a job that created the tag or function block
- OPC item ID to be specified and modified
- Setting the status of OPC tags and calculations to Offline.

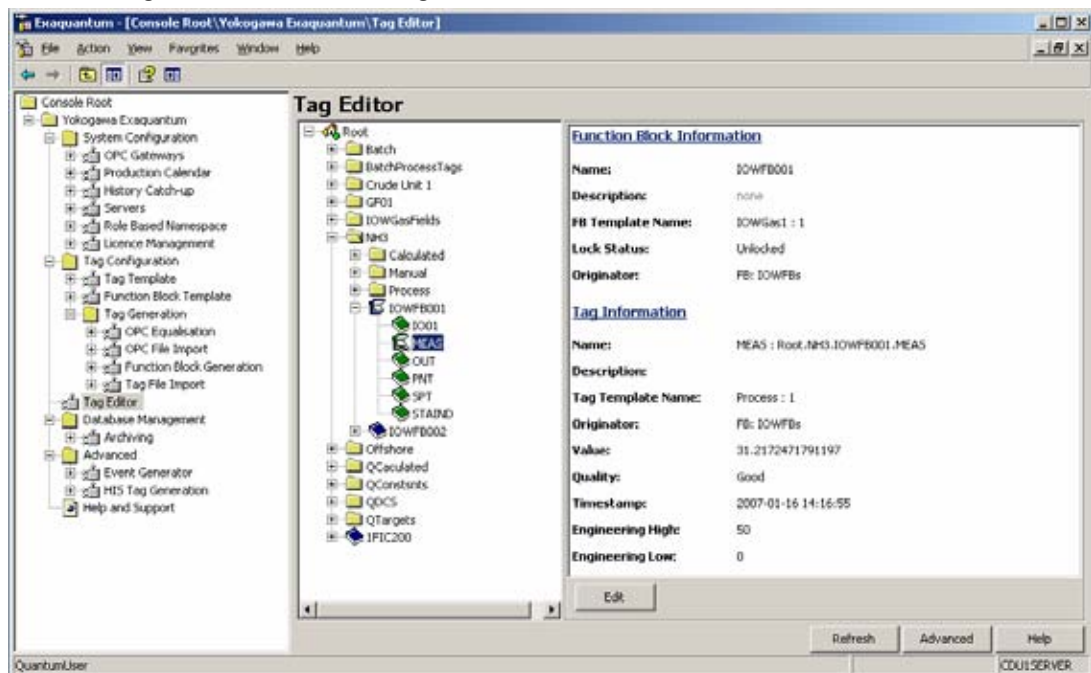


Figure: Tag Editor Screen

When Changes Take Effect

Changes can be made through various tools; the timing depends on the nature of the information to change.

● Tag/Function Block Oriented Information

Most of the changes made through the Function Block and Tag Templates take effect when the Tag Editor or Tag Generation tools are subsequently used to reconfigure function blocks and tags. However, when the Tag Editor changes certain values, the changes take effect immediately. These values are:

- Tag name or Function block name
- OPC gateway/item ID
- Reference data
- Value of Manual tags
- Expression of Calculated tags
- Offline or Online status.

There are some Tag Template values that cannot be changed once tags are created.

These values are:

- Tag type (OPC/Manual/Calculated)
- Data type
- Aggregation type (Continuous/Discrete).

- **System-wide Information**

How changes to some of system-wide information are implemented is detailed below.

Table: System-wide Information

Types of Information	Information to Change	Program or Timing
Production calendar	Offset	Next re-start
	Add/Remove	When tag templates are changed and tag generation is re-run
OPC gateway	Host name	Next re-start
System wide parameter	%GOOD threshold	Next re-start

Tags created after changing these values will work with the new value immediately.

4.3 Database Management and Advanced Tools

There are several other configuration and administration tools which are described in this Section.

4.3.1 Archiving

Archiving removes a requested amount of data from the Historian Data database into an Archive database and allows the archive to be managed independently.

- **Various Disk Space Administration Scenarios**

PIMS requires constant administration to ensure that there is sufficient data storage available to accommodate the ever-growing Historian information.

Scenarios and required tasks include:

- The most rapidly growing types of Historian data (or 'Archive Groups') are raw data and Alarms and Events data. Weekly, bi-weekly, or even monthly archiving and backing up are recommended for this data.
- Unless information is archived, even the largest available disk storage will eventually become full. It is therefore recommended that periodic monitoring of the disk storage be set up, so that emails can be sent when a particular threshold is reached, for instance. This monitoring is configured using the SQL Server mechanism; for further information see the Engineering Guide.
- If the entire disk storage is consumed without any prompt, then one of the Historian Management tools may be used to free disk space. The tool deletes the old raw data and Alarms and Events data until a pre-defined amount of free space is available. This tool is intended to recover what would otherwise be a catastrophic situation. This tool can be optionally configured to run periodically, so that free disk space is always assured.

- **What the Archive Tool Does**

The Archive tool provides administrators with following functions:

- Create and configure archives
- Allows for searching of archives
- Set up archiving parameters (days of archive, media size, etc.).

- **Archive States**

An Archive is essentially a small database that holds information of one Archive Group for a limited period of time. It can be in one of several different states:

- Candidate – The Archive is still a part of the online Historian information. In this state, the archive size (essentially days) can be tuned by a 'trial and error' approach. The information can also be backed up. The Delete operation can be used to permanently remove this information from the Historian without making a back up.
- Backed-up, Online – The Archive has been backed up to an external media, but the information is also still available for clients (i.e. it is Online). The 'Unrestore' operation can be used to remove the archive from the disk which will increase the amount of free disk space. The Backup operation is also available to make another backup.
- Backed-up, Online, requiring re-backup – The Archive has been restored from a backup. During the restore process, the Archiver added elements (indexes, columns) that were present in the QHistorianData database, but not in the archive database. These may have been added to QHistorianData during an upgrade of Exaquantum.
- Not Backed-up, Online – The Archive has been made, but not backed up to an external media. This state is abnormal and indicates that the action to back up the

archive has failed. The Backup operation must be repeated immediately.

- Offline – The Archive does not exist on disk and therefore is not available for clients. The Restore operation allows the archive to be brought back online, for clients to access.
- Removed – The Archive, that should be online, does not exist on the disk; the system has removed it. This situation may occur when the Exaquantum database has been restored from a previously made back up, so the archive was not included.

4.3.2 Event Handling

Exaquantum Event Handling provides the functionality to support event-driven applications built on top of the standard Exaquantum data processing. Typical applications include, but are not limited to:

- Automatically printing reports at the end of shifts
- Batch tracking
- Emailing or paging upon events.

The General concepts of Event Handling are described below.

- **Source Events**

Events that can trigger application programs are as follows:

- OPC Alarms and Events
- Exaquantum internal events, such as:
 - End of an aggregation period
 - User events defined within calculation tags.

The Event Handling server filters what would otherwise be a huge number of events, and sends only those events that applications are interested in, up to a maximum of 500 events.

- **Applications**

Applications may be programmed to wait for one or more Microsoft Message Queue (MSMQ) of interest through which the Event Handling server sends events.

They are background programs that run without having associated Windows screens. Sample application programs are available on request from a Yokogawa representative.

- **Configuration Interface Utility**

An Exaquantum tool accessed from the Management Console ('Event Generator' under the 'Advanced' tree folder) provides the following functionality:

- Displays a summary of registered applications
- Registers/unregisters application information
- Displays current Event Filter condition information
- Adds/deletes/modifies Event Filter condition
- Loads Event Filter condition
- Generates Manual Events.

4.3.3 HIS Tag Generation

The HIS Tag Generation tool allows tags to be generated from information gathered from CENTUM CS 1000 or CENTUM CS 3000 DCS trend groups.

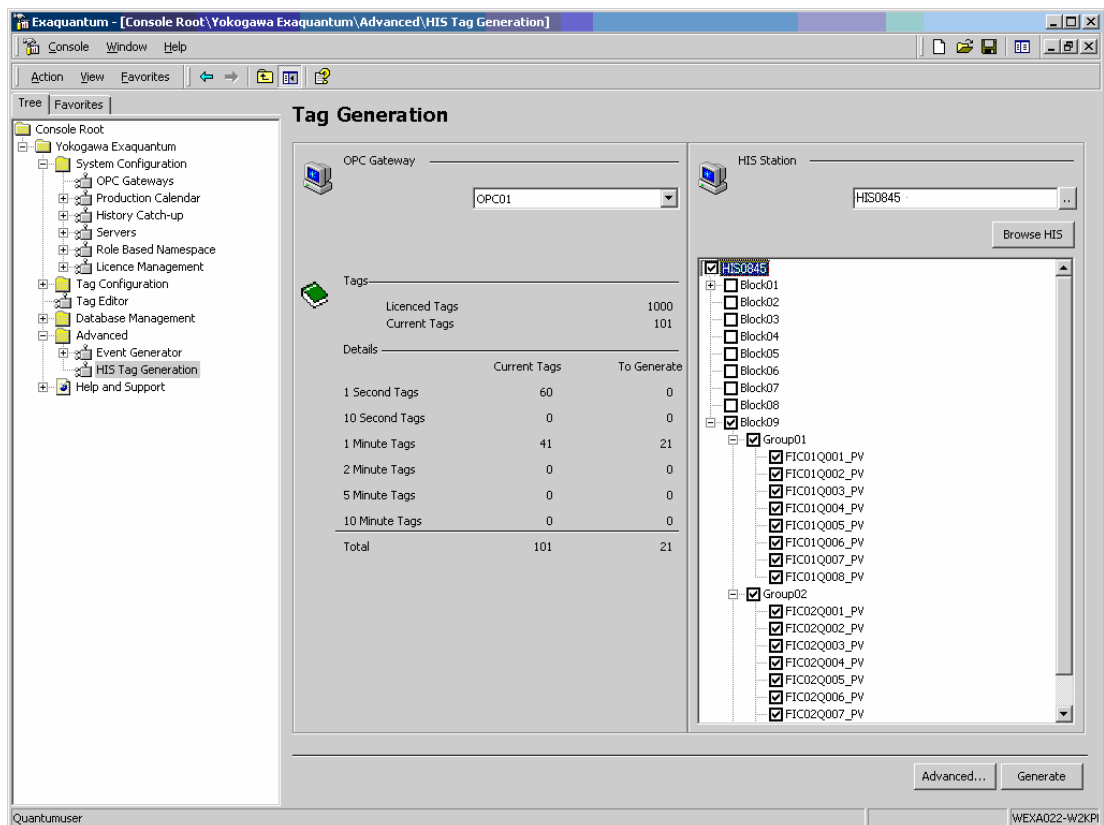
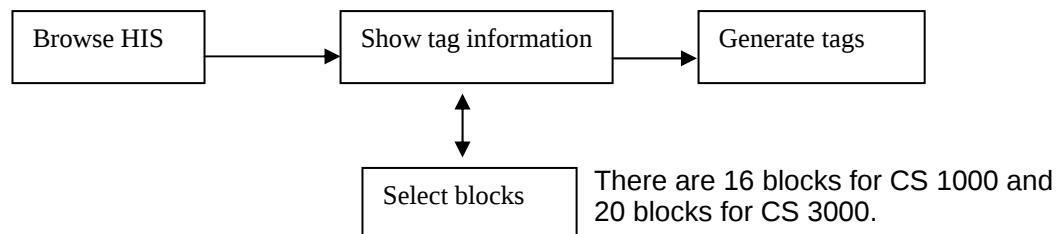


Figure: HIS Tag Generation Screen

The general operational flow is as follows:



This Tag Generation tool shows information and provides the following functionality:

- The current number of tags together with a licensed number of tags is displayed.
- The selecting of an OPC Gateway from a list.
- Browsing a HIS (Yokogawa's DCS Human Interface Station) computer displays a list of tags that can be generated together with their associated groups.
- When generating tags the HIS Tag Generation Tool will create tags with the following settings:
 - Tags will be generated under Root.<HIS name>.<Trend Block number>.<Trend group number> folder as flat tags.
 - The Exaquantum tag name will become <Tag Name>.<Tag Type>, e.g. 01FIC001.PV will be created instead of 01FIC001_PV.
 - Templates will be created and assigned based on the data type and update rate. Update rate will be converted as follows:

- 1SEC becomes a 1 second Exaquantum update rate
- 10SEC becomes a 10 second Exaquantum update rate
- 1MIN becomes a 1 minute Exaquantum update rate
- 2MIN becomes a 2 minutes Exaquantum update rate
- 5MIN becomes a 5 minutes Exaquantum update rate
- 10MIN becomes a 10 minutes Exaquantum update rate.

If the selected HIS is also an OPC Gateway then there is a maximum of 64 one second tags or 128 ten second tags that can be generated.

- The Exaquantum tags ranges are set to the Display ranges.
- Administrators may optionally select or de-select tags before generating tags so that the number of tags generated falls within the tag count limit.
- Administrators may import tags from a HIS that has already been imported from. In this case the Tag Generation Tool will only generate tags that are new.

4.4 Help and Support

The Exaquantum Management Console provides a file-based URL link to a support page written in HTML. The support page contains hypertext links to the on-line help files shipped with Exaquantum and to the Exaquantum support web-site on the worldwide web.

4.5 System Tools for Administration

The following administration tools are available to different categories of administrators.

4.5.1 Tools Intended for Administrators

- **Start-up and Shutdown**

Users can manually start up and shut down Exaquantum through a simple user interface program called Exaquantum Service Manager. This program provides a progress view and operational options while History Catch-up is in progress.

Exaquantum can be configured to start up automatically when the computer is started. There is also a command line tool that provides a way to automatically shut down the system upon receipt of a UPS message.

- **Database Backup and Restore**

The databases of the Historian and other configurations can be written to external media (as supported by SQL Server 2005) for later restoration. These tasks are carried out using the standard SQL Server backup and restore functions.

- **Windows Resource Backup and Restore**

In order to restore Exaquantum-specific resources in Windows system, it is suggested that a backup be taken. The user can decide which tools to use.

4.5.2 Tools Intended for Installation and Configuration Engineers

- **Installation**

The 'InstallShield' program is used to install and uninstall Exaquantum components.

- **User/Group Configuration**

The Exaquantum Users must be created before the Exaquantum system is ready for use. Guidance is given in the Installation Guide document.

- **Time Synchronization**

Exaquantum time should be synchronized with OPC server time. A special tool is provided to specify which OPC server Exaquantum time should be synchronized with, and how frequently the synchronization should take place. The target OPC server does not need any dedicated software to do this.

Exaquantum/Explorer is usually configured to time synchronize with an Exaquantum server or use the time provided by the network.

- **Database Sizing Tool**

This tool retrieves information that indicates how large a disk must be for it to be able to store the data planned for the Historian and other Exaquantum databases.

- **Database Creation Tool**

The SQL Server Exaquantum databases can be recreated with this tool.

- **Database Expansion Tool**

The Exaquantum Historian database can be expanded with this tool. This is normally used following an initial Installation, to expand the QHistorianData database to its working size.

- **Performance Monitor**

The standard Windows Performance Monitor tool is used for the purpose. This is especially useful when the project is at an early stage, when there could be a number of performance and stability oriented issues.

- **Diagnostics**

This tool provides two particular types of health indicator information:

- Version check tool, which verifies the integrity of the installation
- OPC diagnostics, which checks the health of the OPC communication.

- **Event Log**

The Exaquantum and SQL Server software execution process log files are made available to assist Yokogawa engineers during configuration and fault finding operations. They can be displayed using the Windows Event Viewer.

4.6 Support Tools

The following Support tools are available. In the Exaquantum multi-server environment, tools are associated with one single server at a time.

4.6.1 Configuration Reporting Tools

Cross-reference Tool

The Cross-reference tool allows administrators to produce reports of cross-referenced information that exist for a specified list of tags or templates in Exaquantum.

There are three types of Cross-reference checks that can be performed:

- References to specified tags in Exaquantum calculations or shortcuts
- All tags attached to a specified Tag Template
- All Function Blocks attached to a specified Function Block Template.

The Cross Reference tool has a flexible approach to reporting; the selection of tags or templates to search for allows selection of single tags or templates, wildcards, and folders (i.e. all tags within a folder), or a combination of all three.

Tag Configuration Viewer

The Tag Configuration Viewer assists configuration engineers in diagnosing problems and checking that the Exaquantum system is set up correctly.

The Tag Configuration Viewer provides:

- A viewer that displays Tag Configuration information
- A consistency checker that runs a check on the Exaquantum system and reports on various known configuration problems
- An export facility to store configuration information in CSV files.

4.6.2 Exaquantum Versioning Tool

The Exaquantum Versioning tool checks that the versions of all Exaquantum-related files

on the computer are correct. The files that are checked are those installed by Exaquantum, and common files that are installed as part of other software. The Versioning tool compares a list of all expected files, and their version numbers, with the actual files on a specific computer.

The Versioning tool also allows an administrator to create a log of 'file version information', based on what is currently installed on the computer. This can also be used to perform the version checks, rather than using the list supplied at installation. This is a useful option after installation, as it allows the administrator to check the 'as installed' software.

4.6.3 System Event Message Viewer

The System Event Message Viewer displays the audit log messages that are generated when significant events occur within Exaquantum. These event messages are stored within the Exaquantum database and may be viewed for a selected time range for individual or selected categories. In a multi-server Exaquantum configuration, a single server can be selected. One message is written for each event.

The contents of the list can be saved as a CSV file for use in other packages or applications.

There are six categories of event messages:

- System Operations
- Write Operations
- Archive Operations
- Tag Generation Operations
- Namespace Audit Trail
- Recalculation operations.

4.6.4 Status Monitoring Tool

The Status Monitoring Tool collects information about:

- Disk usage
- SQL Server database usage
- Exaquantum – OPC connection interruptions.

Either a windows message is sent to a specified computer, or a program or script may be executed, as defined by the system administrator, at a specified time every day.

A notification may be raised for the following conditions:

Disk usage

- Free Space less than, greater than, equal to or not equal to a set value.
- Used Space less than, greater than, equal to or not equal to a set value.

SQL Server database usage

- Free Space less than, greater than, equal to or not equal to a set value.
- Used Space less than, greater than, equal to or not equal to a set value.

Exaquantum OPC Connection

- Define the period to monitor how many times the OPC communication is interrupted between Exaquantum and each OPC server.

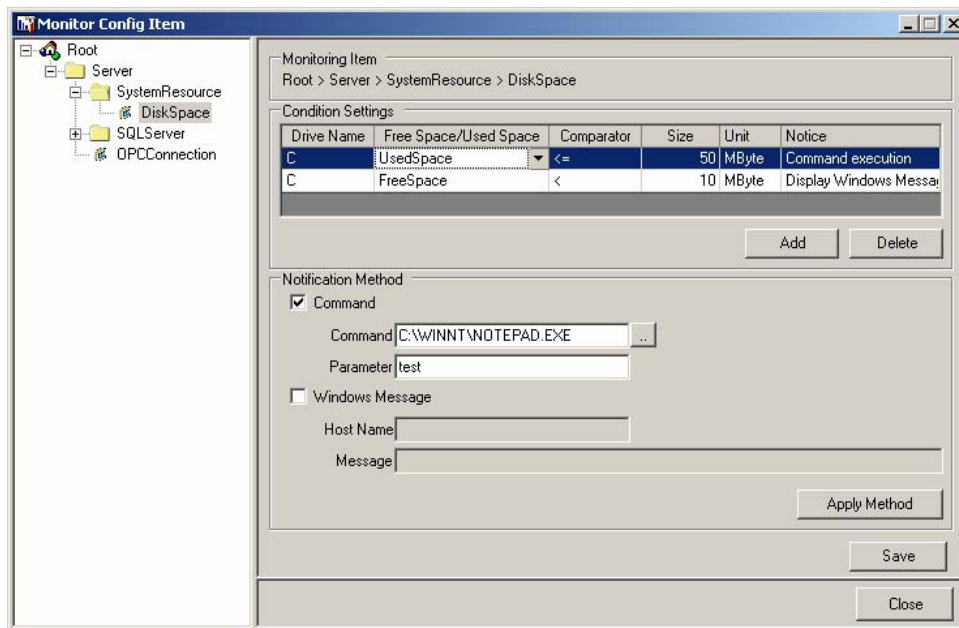


Figure: Status Monitoring Tool, Disk usage

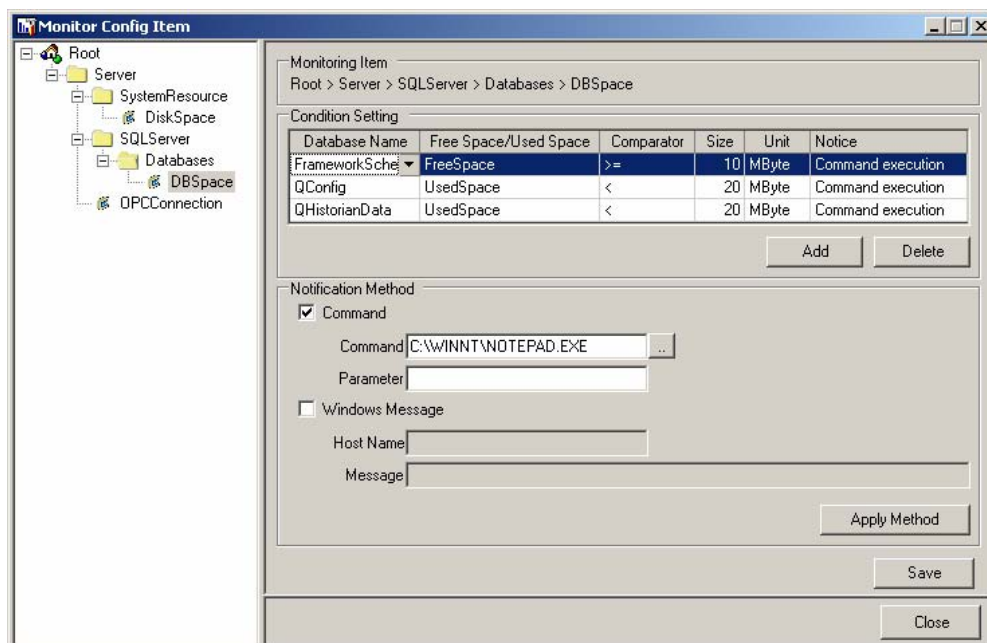


Figure: Status Monitoring Tool, Database usage

4.6.5 Exaquantum Startup Configuration Tool

The Exaquantum Startup Configuration Tool provides the ability to:

- Enable History Catch-up while Exaquantum is not running
- Configure Exaquantum to start upon starting of the operating system.

5. Exaquantum/Explorer

Exaquantum/Explorer has been designed using the standard Microsoft Multiple Document Interface (MDI) and ActiveX technology. This gives it a Microsoft look and feel so users who are familiar with Microsoft products will feel comfortable with most of its interactions and terminology.

The user interface screens (documents) can be created from a set of predefined graphics and controls (e.g. Trends, Alarm and Event Viewers, Excel Viewers, lines, text, buttons, drop-down lists, etc.) that present the plant information in a clear and easy-to-understand way.

5.1 General

Exaquantum/Explorer provides the infrastructure to build and link ActiveX controls into cohesive, industry applicable applications and reports. It can operate in either *Design Mode* or *Run Mode*. Design mode is used to create and modify user documents, using components that are available for document configuration. In Run mode, users can view and monitor the information contained in the documents that were created in Design mode. The number and type of actions that users can perform in Run mode depend on the attributes and functions added to the documents in Design mode.

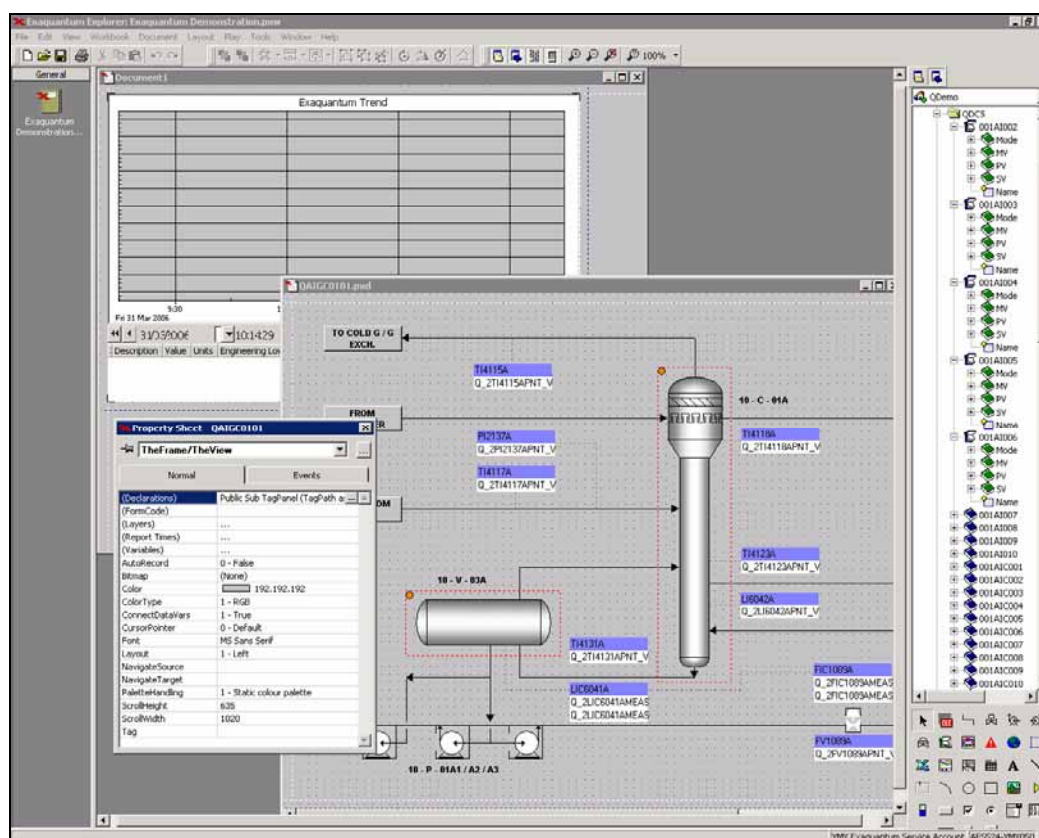


Figure: Exaquantum/Explorer – Design Mode

The Exaquantum/Explorer infrastructure includes these features:

- Native Objects such as lines, text, shapes
- Active X controls, such as Trends, Trend Comparisons, Alarm and Event Viewers
- Host Document for Controls
- Multiple Document Interface
- General Reporting Environment
- Tag Configuration
- Report Times
- Data Parameterization
- Scripting.

These features are described in Section 5.3.

The analysis and reporting features of Exaquantum/Explorer comprise a range of ActiveX controls. Each control specializes in a particular graphical representation of data from the Exaquantum Data Server. Furthermore, these ActiveX controls are hosted by the Exaquantum/Explorer infrastructure, which offers a number of features that can make the most of the ActiveX controls.

5.2 ActiveX Controls

The Exaquantum/Explorer functionality is implemented by ActiveX controls. Most of the important and useful ActiveX controls are supplied with Exaquantum/Explorer. This section describes some of commonly used ActiveX controls.

5.2.1 Trends

One of the greatest value of a PIMS system is in the long-term history, and the primary tool for examining history is the Trend control. There are a variety of scenarios in which a user will examine trends, for example, when the user wants to:

- Instantly view a tag trend, without having a pre-configured application
- Select 'personal' trends for rapid and frequent access to particular views of history
- Find pre-configured trends in a structured User Interface, using the interface structure to find particular groups of tags for particular times
- View live updating or static history trends.

● Trend Control

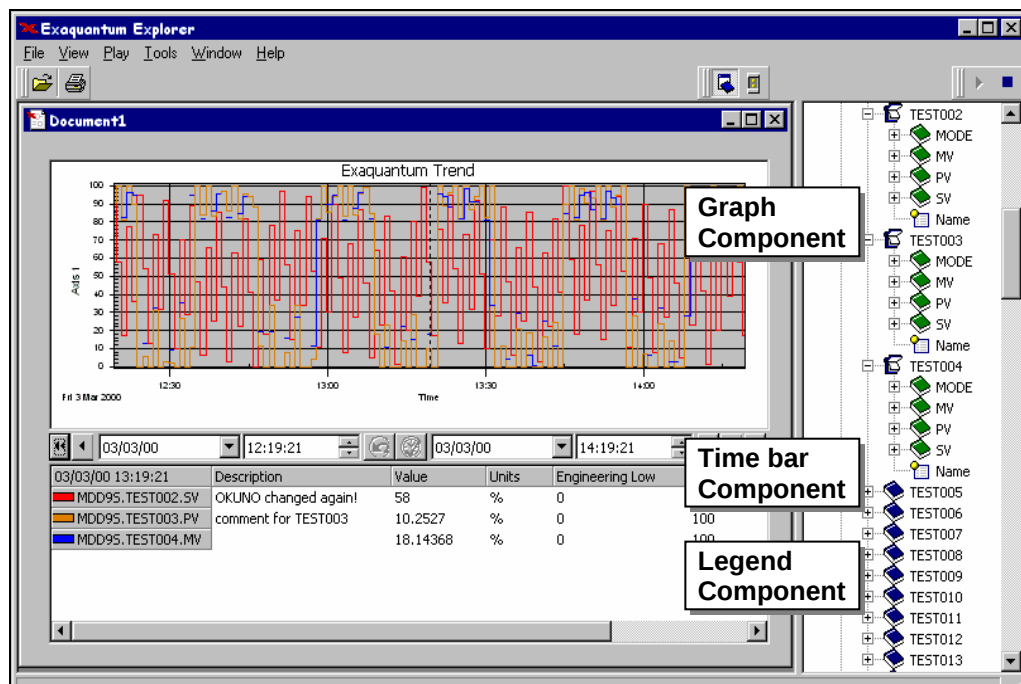


Figure: Trend Control Components

The Exaquantum Trend control supports all the above scenarios. The main features that support this range of uses are:

- Tags can be added to a Trend from the Exaquantum Data Selector by using 'drag and drop'. The Data Selector presents all the tags in the user's Role Based Namespace.
- Tags can be assigned to the Trend control while the control is running.
- The Trend control and Data Selector can easily be built into applications, configured with tags and saved as personal files. A Trend is then displayed by simply selecting a file.
- The Trend control can be built into many pages of a single application and configured with tags relevant to the page. The navigation facilities of the application can then lead the user to the page containing the trend of interest.

- The Trend control has a wide range of possible settings, including pen colors, line styles, live/historical, update rate. To ease the configuration process there are a range of typical templates for the most frequently used settings.

Once a user is viewing an instance of the Trend control configured with the tags of interest, he may want to fine-tune the plot range of the time and amplitude axis, to further investigate the tag history. Features to aid this are:

- Full control of the time-scale axis, start and end times, by direct setting
- Full control of the Y-axis, by direct setting. Up to six axes can be configured; they can appear either stacked or grouped (overlapped).
- Zoom facility. The user can use the mouse to select a rectangle on the Trend, and the rectangle will expand to cover the whole trend area, (the axis scaling changes automatically).
- Choice of point representation. Points on a trend can be connected by a line, or extended step wise, or be left unconnected.
- The Trend cursor can be positioned at any time. Details of tag values and the selected time will then appear in the legend area.

5.2.2 Trend Comparison Control

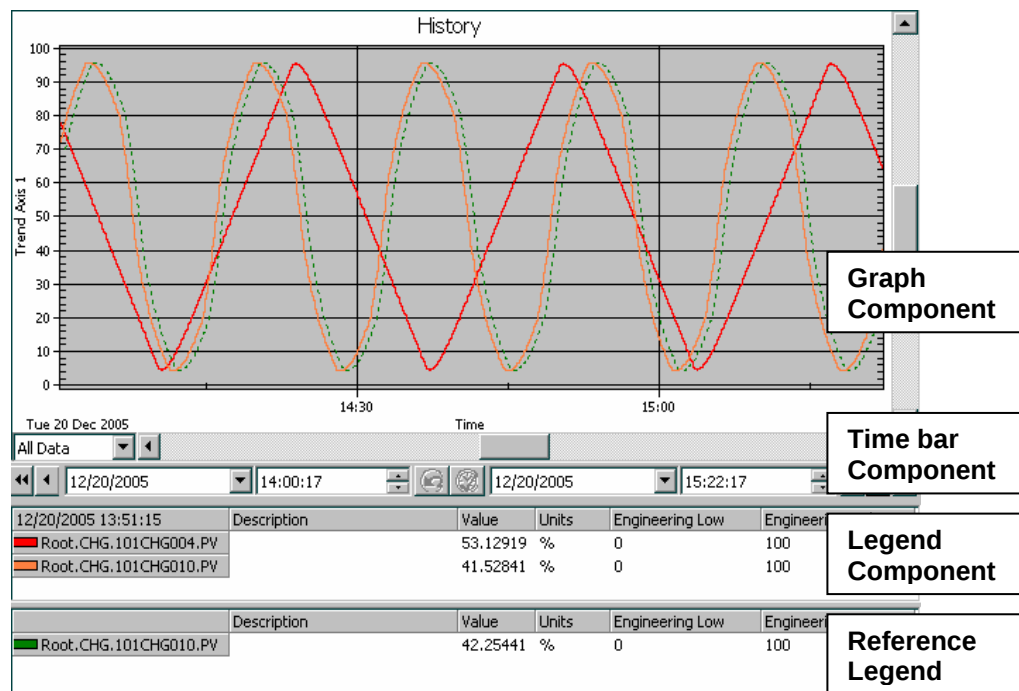


Figure: Trend Comparison Control Components

The Trend Comparison control provides all of the functionality of the Trend control but also allows a reference trend to be configured. This allows comparison between a live or historical trend with a known reference trend from a specific time in history. To aid this facility, groups of tags assigned to a trend may be saved to the database with a start and end time so that they may be reloaded at a later time to act as a reference.

5.2.3 Data Entry Grid

Now	Stored Value	Stored Quality	New Value	New Quality	Units	Engineering Low	Engineering High
02/03/2006 09:44:55							
Root Calc Tags: AEPV101_PV	95	Good		Good	%	0	100
Root Calc Tags: AEPV102_PV	93	Good		Good	%	0	100
Root Calc Tags: AEPV103_PV	4	Good		Good	%	0	100
Root Calc Tags: AEPV104_PV	77	Good		Good	%	0	100
Root Calc Tags: AEPV105_PV	71	Good		Good	%	0	100
Root Calc Tags: AEPV106_PV	7	Good		Good	%	0	100
Root Calc Tags: AEPV107_PV	1	Good		Good	%	0	100
Root Calc Tags: AEPV108_PV	33	Good		Good	%	0	100
Root Calc Tags: AEPV109_PV	20	Good		Good	%	0	100
Root Calc Tags: AEPV110_PV	41	Good		Good	%	0	100
Root station N-015-01-001.P01	68.4062296266012	Good		Good	0	0	0
Root station N-015-01-003.P03	75.3892643488259	Good		Good	0	0	0

Figure: Typical Data Entry Grid

The Data Entry Grid control allows the user to view information for a selection of tags where the information is displayed in a tabular form for a selected time.

Some information is best presented to the user in the form of a Data Grid, for example, several laboratory analysis results belonging to a single sample of a product.

In addition to being able to display information about tags, the Data Entry Grid allows data values and data qualities for tags to be changed and written back to the database by the user, for a selected time.

Tags can be easily configured to the Data Entry Grid with the aid of the Data Selector.

5.2.4 Alarm and Events

Alarms and Events are key types of information stored by Exaquantum (where supported by the data source).

Alarms are abnormal conditions that are defined for objects within the PCS. Each condition may include sub-conditions that enable the user to accurately identify the cause of the alarm. For example, the LevelAlarm condition may include sub-conditions such as HighAlarm, HighHighAlarm, LowAlarm, and LowLowAlarm.

Events are any changes to the PCS settings that may have an impact on site processes such as operator actions or system configuration changes.

Exaquantum/Explorer provides the ability to display current or historical alarm and event information through the Event Summary Control, and live updating data through the Event Update Control. In both of these controls, inclusive filters may be defined to display only those alarms and events that match specific conditions.

- **Event Summary Control**

OPC Server	Source	Message	Time	Event Categ	Severity	Condition	CENTUM Message ID	Station Nam	Station T
Crude Unit 1	FCS0103	FCS0103 Fail	03/11/2006	System Alarr	900		771	FCS0103	2006/11
Crude Unit 1	FCS0103	FCS0103 Recover	29/11/2006	System Alarr	900		772	FCS0103	2006/11
Crude Unit 1	FCS0103	FCS0103 LEFT Fail (SW STOP Code= 0000 0000 0000 0000)	29/11/2006	System Alarr	900		17	FCS0103	2006/11
Crude Unit 1	FCS0103	FCS0103 LEFT Manual Reset Start	29/11/2006	System Alarr	900		1	FCS0103	2006/11
Crude Unit 1	FCS0103	FCS0103 LEFT Control	29/11/2006	System Alarr	900		1105	FCS0103	2006/11
Crude Unit 1	FCS0103	FCS0103 Fail	29/11/2006	System Alarr	900		771	FCS0103	2006/11
Crude Unit 1	1FIC200	1FIC200 Crude Input Flow SV = 24.00 TNE/H old= 6.00 [T	03/01/2007	Operation re	200		5633	FCS0103	2007/01
Crude Unit 1	1FIC200	1FIC200 Crude Input Flow PV = 20.05 TNE/H HI	03/01/2007	Process Alar	500	HI	4353	FCS0103	2007/01
Crude Unit 1	1LIC300	1LIC300 Bottom Level PV = 80.21 % HI	03/01/2007	Process Alar	500	HI	4353	FCS0103	2007/01
Crude Unit 1	FCS0101	FCS0101 Recover	03/01/2007	System Alarr	900		772	FCS0101	2007/01
Crude Unit 1	FCS0101	FCS0101 RIGHT Fail (SW STOP Code= 0000 0000 0000 0000)	03/01/2007	System Alarr	900		17	FCS0101	2007/01

Figure: Typical Event Summary Control

By default, the Event Summary Control is displayed as a table of events in ascending chronological order. The table can be re-ordered by any column. Double-clicking on any event in the list will display a Detail window.

- **Event Update Control**

Crude Unit 1: 04/01/2007 17:07:33.000: FCS0103 Fail										Row 264 of 264
OPC Server	Source	Message	Time	Event Category	Severity	Condition	Message ID	Station Nam	Tag name	roup numb
Crude Unit 1	FCS0103	FCS0103 Fail	04/01/2007	System Alarm	900		771	FCS0103		
Crude Unit 1	1FIC200	1FIC200 Crude Input Flow SV	04/01/2007	Operation record	200		5633	FCS0103	1FIC200	
Crude Unit 1	FCS0103	FCS0103 LEFT Control	04/01/2007	System Alarm	900		1105	FCS0103		
Crude Unit 1	FCS0103	FCS0103 LEFT Manual Reset Start	04/01/2007	System Alarm	900		1	FCS0103		
Crude Unit 1	FCS0103	FCS0103 LEFT Fail (SW STOP Coc	04/01/2007	System Alarm	900		17	FCS0103		
Crude Unit 1	FCS0103	FCS0103 Recover	04/01/2007	System Alarm	900		772	FCS0103		

Figure: Typical Event Update Control

The Alarm and Event Update Control displays a list of the latest and events. The list is constantly updated as new alarms and events are received. In addition the control can be configured to display an alarm button that will flash when a new alarm or event is received. There are other configuration options that determine the style and size of the list, and how it is updated.

5.2.5 Web Browser



Figure: Example Web Browser Control

The Web Browser Control allows Web pages to be displayed in a host application, possibly with other ActiveX controls present.

5.2.6 Excel Viewer

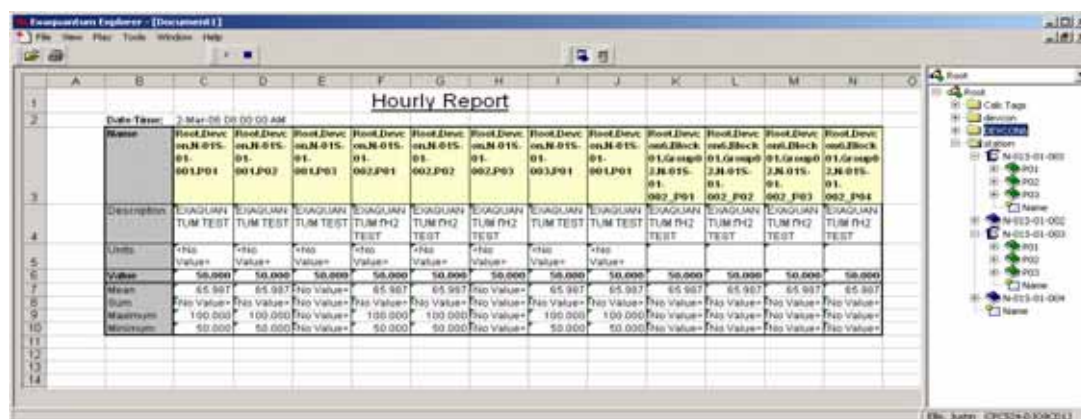


Figure: Typical Excel Viewer

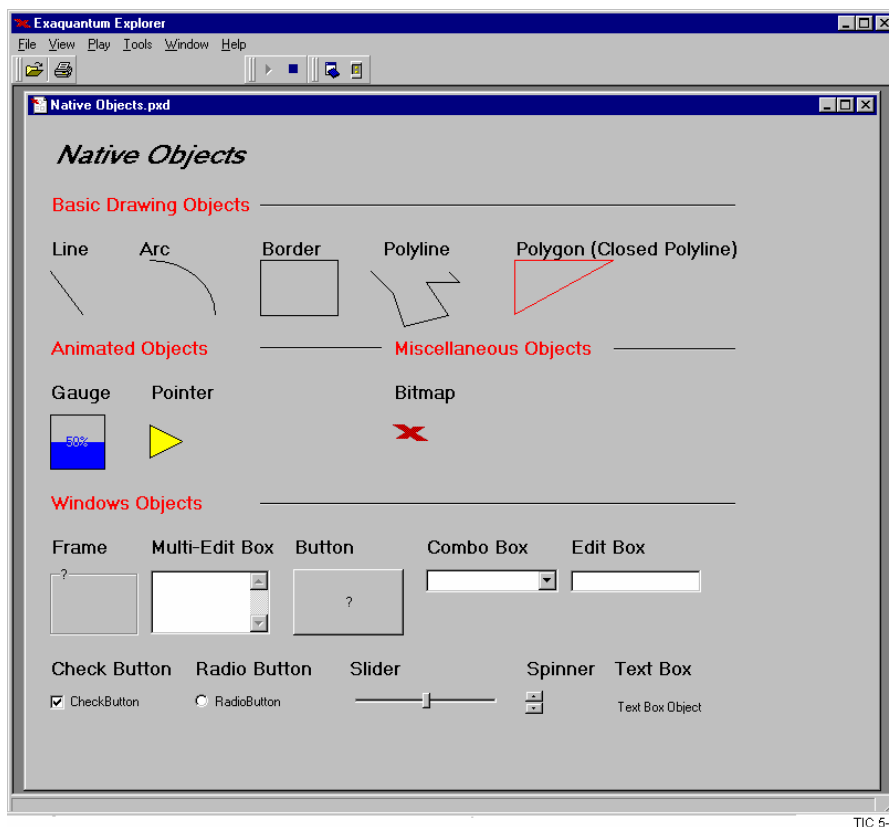
Excel is an invaluable tool for process data analysis and reporting. Excel has easy access to Exaquantum data, data in other Excel files, and any data available through an ODBC link. The user may have a reporting requirement that integrates data from one or more of these sources, and performs summary calculations.

The Excel Viewer allows an Excel file to be instantiated within an application, and hence viewed from the application.

5.3 Exaquantum/Explorer Infrastructure

5.3.1 Native Objects

Native Objects are similar to ActiveX controls, but are available only in the Exaquantum/Explorer environment. Examples of Native Objects are text box, edit box, and list box.



TIC 5-2

Figure: Example of a Document with Native Objects

Native Objects can be categorized as:

Drawing objects: e.g. line, circle, rectangle.

Animated objects: e.g. gauge, pointer.

Miscellaneous object: e.g. bitmap.

Window objects: e.g. list box, text box.

The most commonly used object is the text box. A text box can be configured to show a tag value by simply using "drag and drop" from the Data Selector.

5.3.2 Host Document for Controls

Controls are hosted by the Exaquantum/Explorer container. This container has the appearance of a document (in the following text, the word “Document” means a container configured with ActiveX controls).

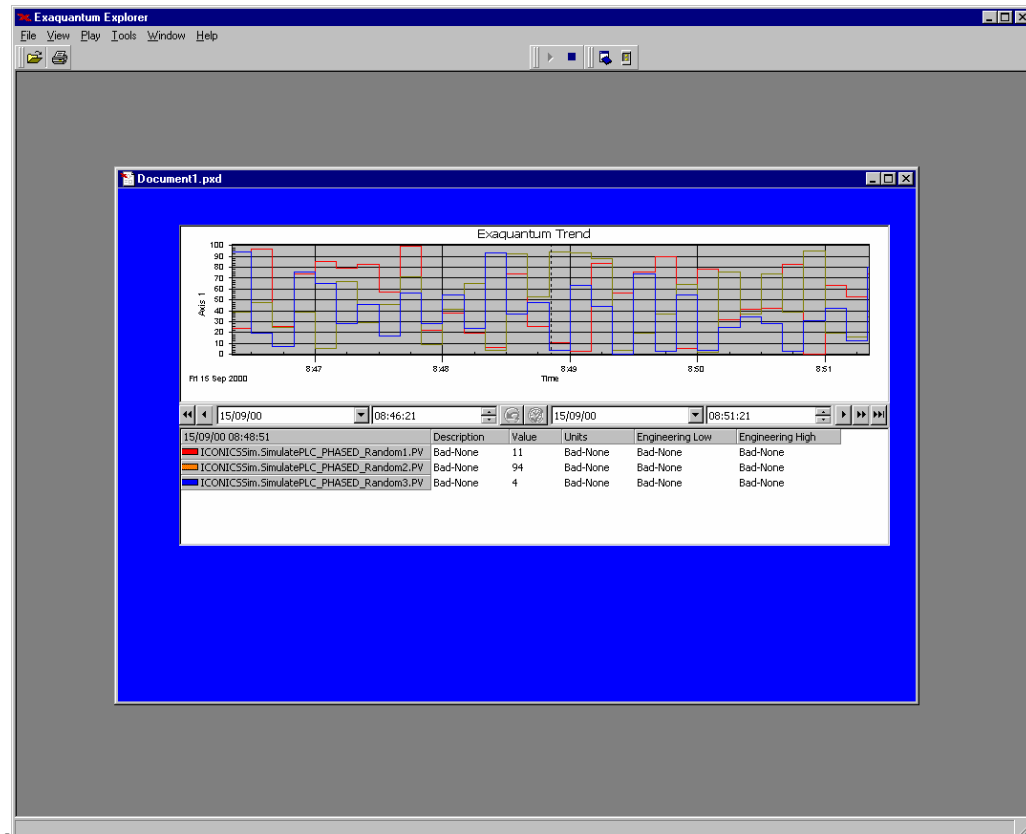


Figure: Example Document

With Exaquantum/Explorer in Design mode, a document can be populated with controls, which can be customized and also configured with tags. The document also supports a powerful scripting language (for more information, see Scripting).

The normal range of edit actions is supported. Drawing operations are supported with a configurable grid and snap-to-grid behavior.

Exaquantum/Explorer documents may also be saved in HTML format, and viewed in a business Intranet through Microsoft's Internet Explorer. Exaquantum/Explorer must be installed on the client computer to do this, and that client computer must be able to access the Exaquantum/Explorer documents.

5.3.3 Multiple Document Interface

Multiple documents can be active at the same time, and selected with the mouse. A document can be saved as a file, and this file can be activated by double-clicking it. Multiple documents can be activated simultaneously, with mouse selection or using the Window task bar to determine the foremost document.

However, the number of documents of interest will generally be sufficiently large that selection by mouse or taskbar is impractical. In this case, navigation between documents can be achieved with Button control navigation, allowing a hierarchical User Interface to be built. Navigation facilities can be added to documents, so that from one active document it is possible to 'navigate to' or 'select' another document. It is also possible to load the new document into a specified area on the current document.

Using navigation, a large set of documents can be linked together in a structured hierarchy that matches the site structure. For example, the initial document may have a navigation button to Utilities. Utilities may have navigation to Water. Water may navigate to Tank3. The Tank3 document may have pressure, level, and flow tags for Tank3.

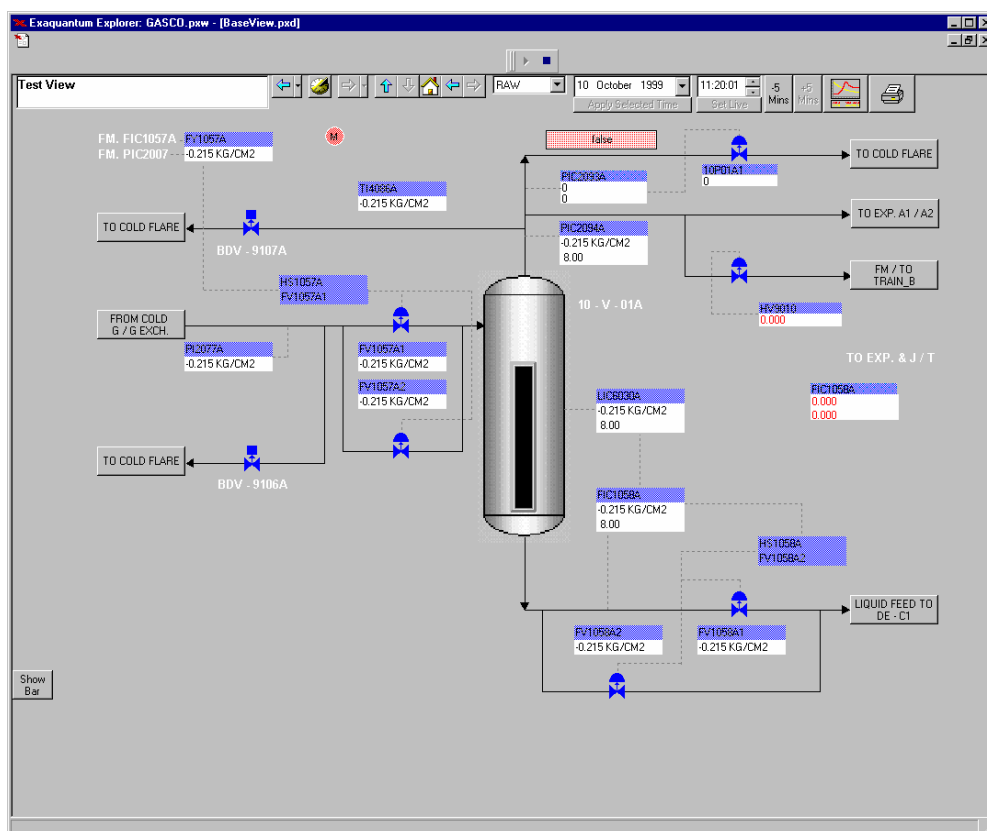


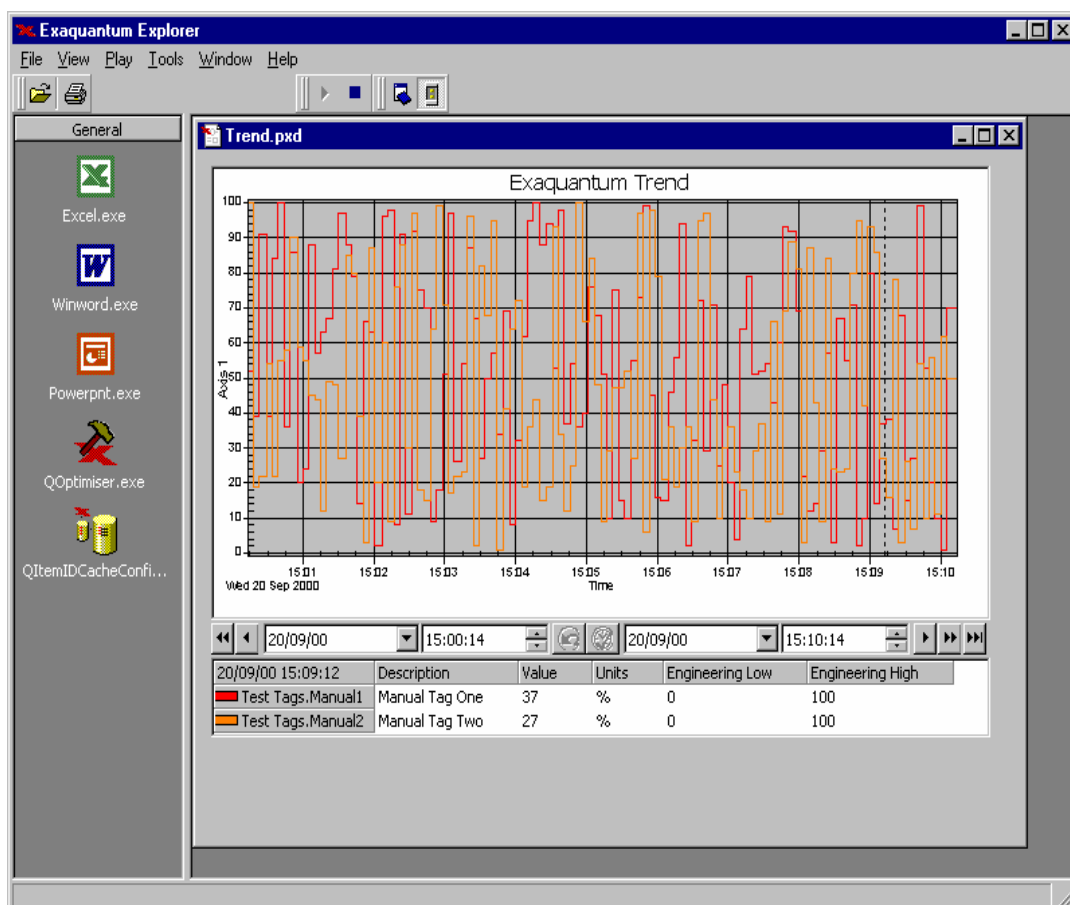
Figure: Example of Navigation Buttons on a Document

Exaquantum/Explorer also supports collecting documents into a single entity called a Workbook. The Workbook defines the Run mode environment: it sets the initial document, the Window style, and whether the Data Selector, Application Launcher and menus are available or disabled.

5.3.4 General Reporting Environment

Some users may use Exaquantum/Explorer as their single point-of-access for many applications. These applications may be general Office applications (such as Microsoft Word, and Excel) or they may be specific site applications (such as a Reconciliation package or Operations Logbook).

This is achieved through the Application Launcher, which can be used to open any external application. For example, from the Application Launcher it would be possible to launch Microsoft Word.



TIC 5-4

Figure: Example of Application Launcher

5.3.5 Tag Configuration

Tag configuration means the connection of Exaquantum tags to controls.

Exaquantum/Explorer supports 'drag and drop' to maximize the ease and speed of tag configuration therefore allowing tags to be 'dragged' from the Data Selector and 'dropped' directly onto the control.

The Data Selector shows the hierarchical structure that represents the user's view of Exaquantum process data (Role Based Namespace).

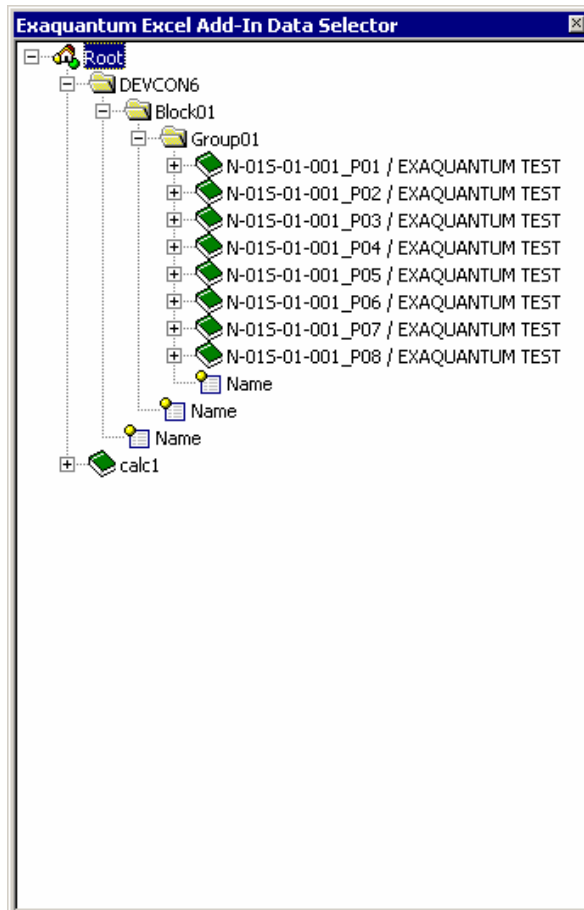


Figure: Example of the Exaquantum Data Selector used by the Exaquantum Excel add-in

The Data Selector can be used to search for and select specific data. If a tag has an associated description, then this will be displayed after the tag name with '/' as a separator. Data can be attached to the controls in a document by dragging the applicable item or tag from the Data Selector onto the control. This function binds the data to the Control. When the document is run, the data is displayed on the document.

5.3.6 Report Times

The data in a document will be associated with a time or period. For example, a single primary value will be for a single time, an aggregation value will be for a Calendar Period, and a trend will have a time period. Exaquantum/Explorer supports the association of all types of data with times and periods relevant to the Exaquantum server data.

Users will expect to select a time of interest (perhaps when a plant shutdown has occurred) and navigate through many documents with an unchanging time frame. Exaquantum/Explorer provides a comprehensive time selector for this. The Set Data Range/Update window allows the user to set any of three global time variables.

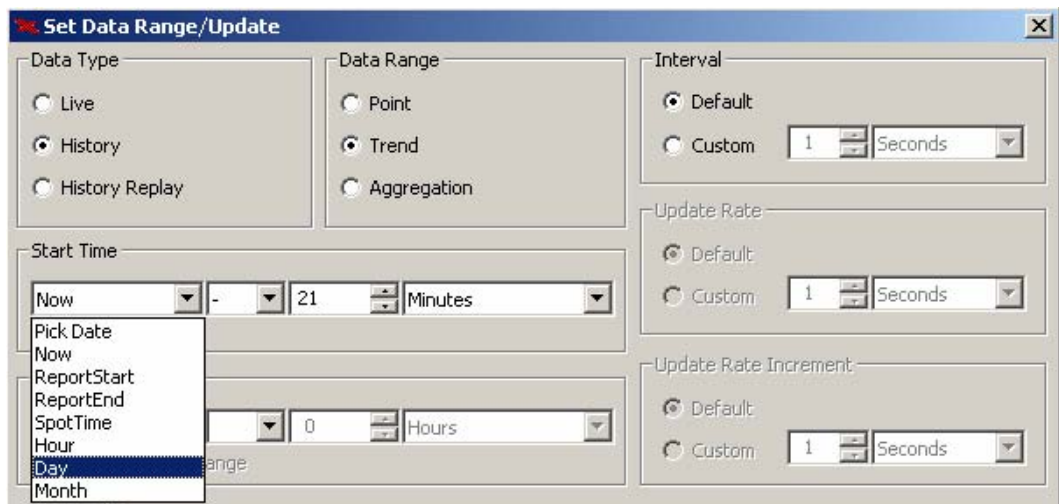


Figure: Set Data Range/Update Window

The three global time variables that Exaquantum/Explorer supports are SpotTime, ReportStart, and ReportEnd. Generally, Spot Time is used where data is for a single point in time, and ReportStart/ReportEnd are used where data is for a period. The values of these variables can be preserved through all documents. Tag data can be bound to any of these variables when the tags are selected for inclusion in a document.

Other types of time binding are also possible; data can be bound to:

- 'NOW' meaning the displayed data contains the latest value (live)
- A selected, unchanging, time
- A Calendar Period boundary.

5.3.7 Data Parameterization

The purpose of data parameterization is to introduce a level of indirect binding of control properties within documents to external data. A single document will be able to display different data, depending on the setting of parameterization variables.

When a tag is bound to a control, it is the whole tag path that is associated with the control, for instance "Root.Boiler1.10PI001.PV.Value". Data Parameterization allows some part of the path to be dynamically assigned when the document is running. This is particularly useful for switching the view of the data from primary value to an aggregation value.

For example, assume a text box is bound to the tag:

```
"Root.Boiler1.10PI001.PV." + <AggregationMEAN> + "Value:Value"
```

When the AggregationMEAN mean variable has the value NULL, then the text box will display the value of tag 10PI001.PV.

When the AggregationMEAN mean variable has the value "Aggregations.Day.Mean", then the text box will display the average Day value of tag 10PI001.PV.

The AggregationMEAN mean variable is a simple, locally held variable in the document, and can easily be changed with scripting.

5.3.8 Scripting

Scripting provides the ability to create programmatic interaction between components in a document, and between documents. It introduces programming flexibility into the whole of the Exaquantum/Explorer environment, and can be divided into three areas:

- Control to control interaction
- Tag data to control interaction
- Document to document interaction.

Control to Control Interaction

A control has events and properties. One control can interact with a second control by use of scripting configured in an event, whereby the script in the first control manipulates the property of the second control.

A simple example is:

- A button and a textbox are configured on a document
- The button eventclick event is configured with *text1.text="hello world"*
- Therefore, when the document is run and the button is clicked, the text box will display "hello world".

This type of scripting is applicable to Exaquantum/Explorer as an Application. It offers the possibility to create forms style user interfaces.

Scripting is achieved with the Script Editor or the Script Wizard which are described later in this document.

Tag Data to Control Interaction

A tag can be bound to a control by simply dropping the tag onto the control. This is a quick way to configure the display of a tag value. There may be further requirements on the display of a tag value, beyond the basic value.

For example, there may be a requirement to indicate the tag quality value by the color of the tag value. Good quality could be represented by a white Tag value and Bad quality by a red Tag value. This gives immediate feedback to the user of the 'worth' of the data being examined.

Another requirement may be to automatically format the number of decimal places displayed as a function of the magnitude of the Tag value. For example, if the Tag value is between 1 and 10, show 2 decimal places, if the tag value is between 10 and 100, show 1 decimal place.

These requirements can be achieved by binding the Tag to the control with scripting. This is a very powerful feature of Exaquantum/Explorer.

Document to Document interaction

Document interaction is controlled by the Manager object. A document can call on the methods/properties of the Manager.

It is possible to have two active documents, and for one document to interact with the other document.

Our previous example could be re-used in this context. A button on Document1 could have the 'eventclick' event configured as:

```
Dim Doc As Object
Set Doc = Manager.Documents.Item("Document2.pxd")
Doc.text1.text="Hello World"
Set Doc=Nothing
```

The result being that when the button on a document is clicked, "Hello World" appears in the text box on Document2.

This feature may be useful in a User Interface that is required to manage the whole document structure in some manner that is different to the standard Exaquantum/Explorer approach.

Script Editor

The Script Editor allows the editing of existing or the creation of new script files. It is also used to define functions and subroutines, which may be used in more than one script. This creates a library of shared routines for a particular document.

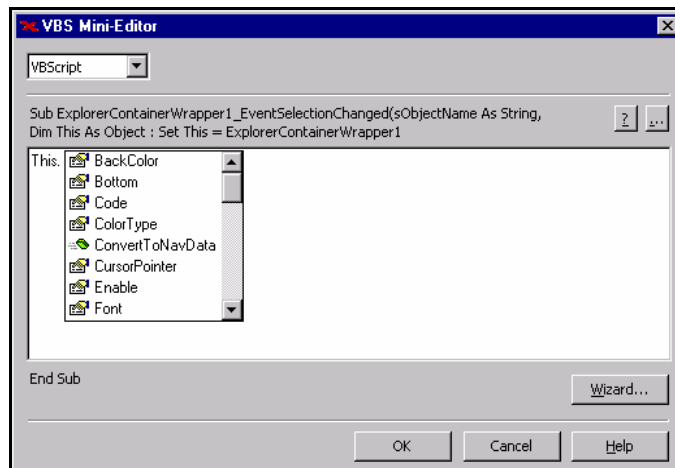


Figure: Script Editor Window

Script Wizard

The Script Wizard assists in identifying objects, properties and methods for inclusion in script. A list of the properties and methods for each currently configured Control can be obtained by using the drop-down lists at the top of the wizard. If a user needs to access a property or call a method, clicking on the Insert button will insert the required code into the edit window at the current location of the cursor.

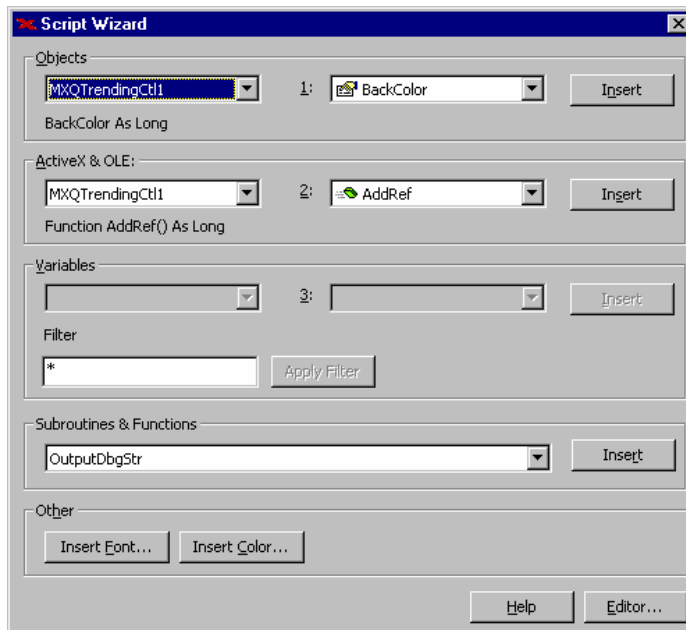


Figure: Script Wizard Window

The Exaquantum/Explorer scripting language is similar to Microsoft Visual Basic Scripting with the addition of a comprehensive help system and Script Wizard.

5.4 CS 1000/CS 3000 Graphics Conversion

This tool converts CS 1000 and CS 3000 DCS graphics into Exaquantum/Explorer format. Once converted, the graphics can be switched easily from showing raw to aggregation data or from current value to history value. Graphics may be converted from SVG format or by connecting to a HIS station to import a CS graphic directly.

CS 1000 and CS 3000 DCS graphics can also be imported in Exaquantum/Web format.

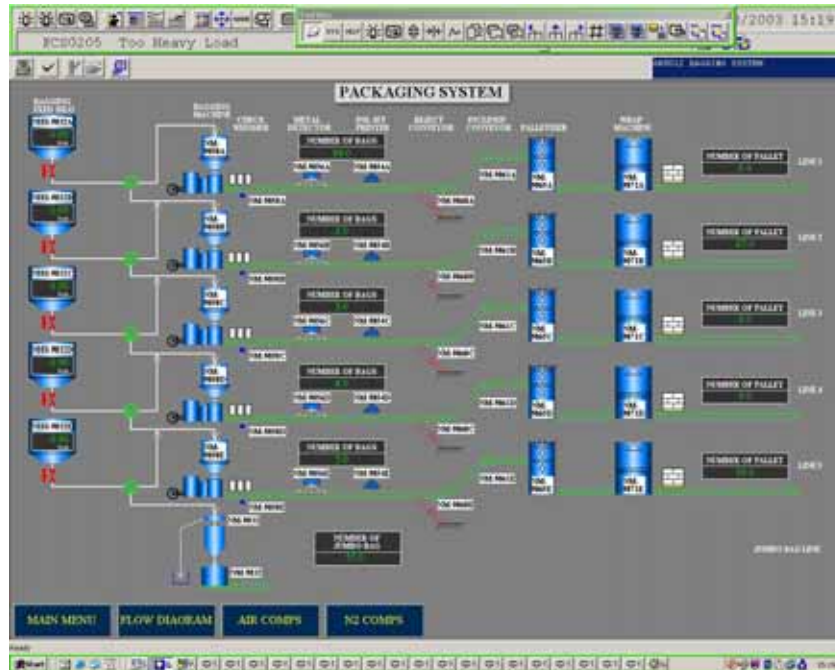


Figure: CENTUM CS 3000 Graphic

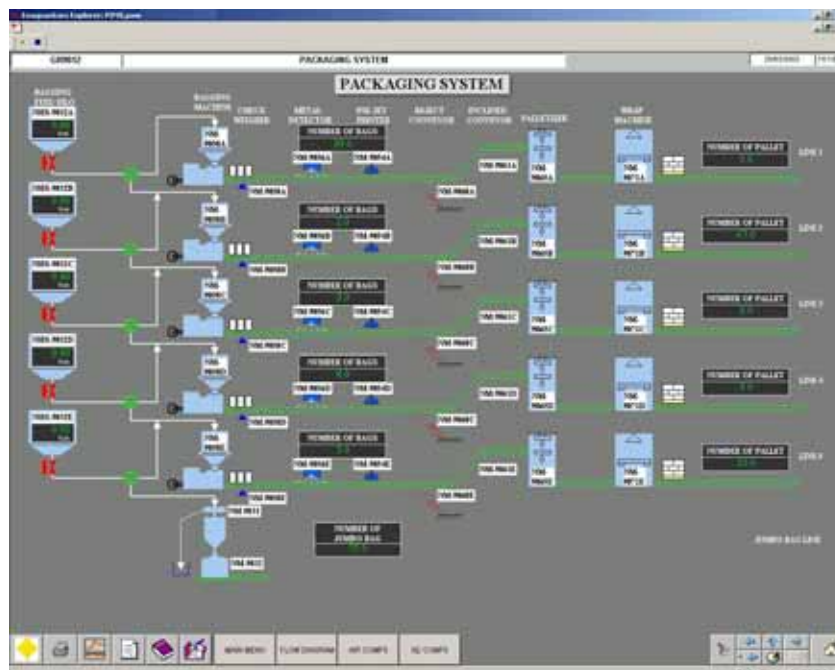
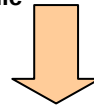


Figure: Exaquantum/Explorer Graphic

5.5 Excel Add-In

The Exaquantum Excel Add-In extends the standard Microsoft Excel capabilities to provide control and display of real-time and historical information. The Excel Add-In:

- Makes live and historical Exaquantum data available within Microsoft Excel
- Utilizes simple 'drag and drop' of Exaquantum data into spreadsheets
- Uses the standard Exaquantum Data Selector
- Integrates with the Exaquantum Production Calendar for setting report start and end times.

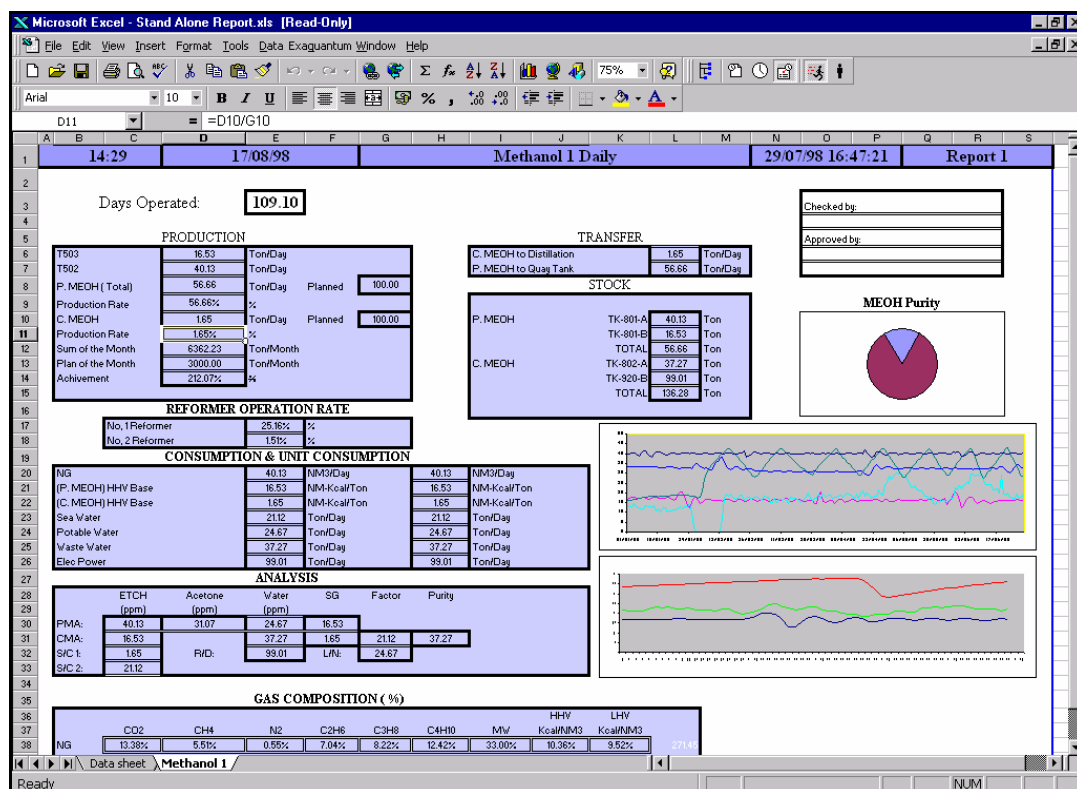


Figure: Example of an Excel Add-In Display

In order to use these features, in addition to the Exaquantum system a user requires Microsoft Excel to be installed.

During installation of the Exaquantum client, the Excel Add-in feature must be selected.

5.5.1 Aggregations

In addition to the standard facilities available in Exaquantum/Explorer, the Excel Add-in provides access to functions for calculating ad-hoc Aggregations. In this context, aggregations provide a way of summarizing raw data over a specific time period. The difference between standard aggregations and those available with Excel Add-ins is:

- Standard aggregations are calculated using the data available at the end of the configured period and automatically stored in the Historian database for later use.
- Aggregations in Excel are requested by a client and calculated on the fly as required. Values are calculated using the data currently available. The result is delivered to the client, for use in a spreadsheet.

Advantages

The main purpose of Excel aggregations is to create a reduced data set from the raw data for use in reports, where less detail may be required. In many situations, this method has several advantages over standard aggregations and spreadsheet calculations:

- Increased flexibility to adjust the time frame and parameters. Periods for aggregation can more easily be adjusted to match local business or operational needs.
- The ability to create historical aggregations. If requirements change, previously collected data can be used to create aggregations retrospectively.
- More efficient use of resources. Calculation is performed on the server and sent to the client, reducing the load on both the client PC and network. This can be significant for large numbers of aggregations over a long period.
- Reduced storage requirements because all the data does not automatically get stored. For example two-minute aggregations for a prolonged period will produce a significant amount of data. Producing the equivalent aggregation on demand, for only the period necessary, requires less storage.
- Less error due to late arriving data. Standard aggregations are calculated using the data available at the end of the period. Data that arrives later, such as LIMS, or erroneous values that were subsequently corrected, will not be included in stored aggregations.

It can be difficult to identify in advance exactly what aggregations to configure. Therefore, In order to cover every eventuality, a large number of aggregations were created and stored, which were rarely used. The ability to create aggregations as and when necessary means that, in many situations, the need to store a large number of regular aggregations can be reconsidered.

Functionality

To help produce meaningful reports the built in aggregation functions provided are:

- Minimum - the minimum value recorded during the calculation period.
- Maximum - the maximum value recorded during the calculation period.
- Mean - the running mean value calculated over the calculation period.
- Standard Deviation - the standard deviation over the calculation period.
- Summation:
 - Standard: the sum of the values over the calculation period.
 - Differential: the differential sum of the data between successive calculation periods.
- Spot Value - the value at the start of the calculation period.
- On Count - the number of times the value changed from 'off' to 'on' during the calculation period.
- On Time - the total amount of time the values was 'on' during the calculation period.

The additional functionality provided by of these types of aggregations is only available in the Exaquantum Excel Add-in feature. It is accessed using an enhanced version of the Set Data Range/Update window, which provides the extra controls necessary to configure the aggregations.

Figure: Set Data Range/Update dialog box from the Excel Add-in

Examples of use

The following scenarios demonstrate just two of the many situations where the flexibility of Excel aggregations can be used to great advantage.

- **Multi-state monitoring**

If a user needs to monitor a device that can be in one of several states, for example the operation of a pump. For maintenance purposes it is necessary to monitor the exact load provided by the pump over a given period. The pump could have 5 discrete operation levels, each associated with a load levels:

Off= 0

Standby = 5%

Low = 25%

Medium = 50%

High = 100%

By monitoring the duration that the pump is in each operating level and calculating the resulting overall time/load ratio, the point at which maintenance or inspection is required can be scheduled.

To achieve this with aggregations, a user would set an 'On time' aggregation to capture the duration that the pump was in each of the level states, and use the functionality within Excel to calculate the overall load over the given period.

- **Performance evaluation**

If the performance of a piece of equipment is under investigation aggregations can be configured covering tightly defined periods and very specific parameters in order to expose any anomalous behavior.

For example if a pump is under suspicion because the throughput is not as high as expected. In this case a combination of aggregations can be configured to extract all the relevant statistics related to the performance of the pump for just the period that it was operational.

During the investigation, the monitoring criteria can be easily adjusted, and the statistics recalculated, in order to concentrate on any anomalous performance, perhaps during the start up phase, or after a certain period of operation at full capacity.

5.6 Trend Analyze Window

The Trend Analyze screen will allow an operator to use a single screen for advanced analysis of tags along with their associated Alarms & Events.

It provides the operator with:

- A graphical display (trend) displaying tag information varying over time.
- The ability to compare trends from the same tag over different periods of time, by using two charts stacked one above the other.
- View trends from the tags that are in based in different groups.
- A list of the tags responsible for the ten most frequently occurring alarms and events, which can be used to produce trends.
- The facility to save and reload groups of trends for later use.
- A display, for the selected time period, Alarm and Event information for all tags contained in the Trend or for an operator selected tag in the Trend.

All user interaction is carried out through on-screen documents.

5.6.1 Trend View

The Trend View provides:

- Adding tags from the data selector.
- Saving and Loading of tags in trend groups.
- Setting of the time period covered by the display.

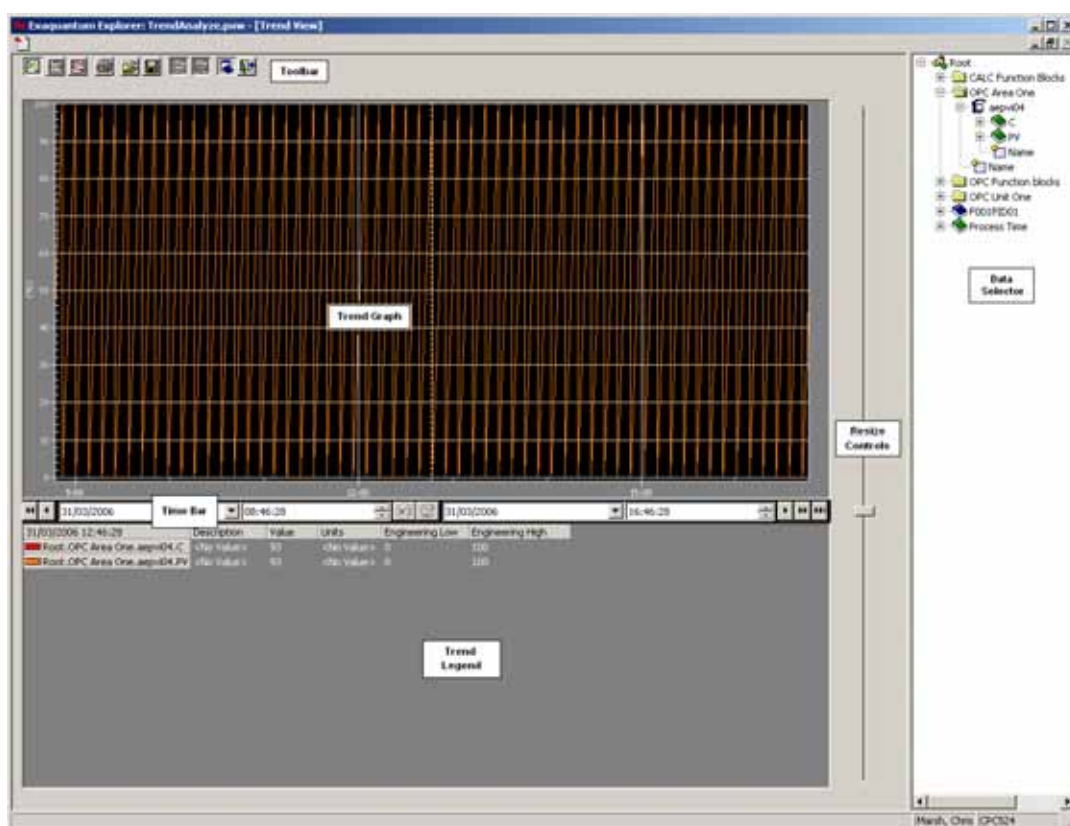


Figure: Trend View

5.6.2 Trends and Alarm and Events

This document allows a user to examine the behavior of trends, but in particular those related to the top ten alarm tags.

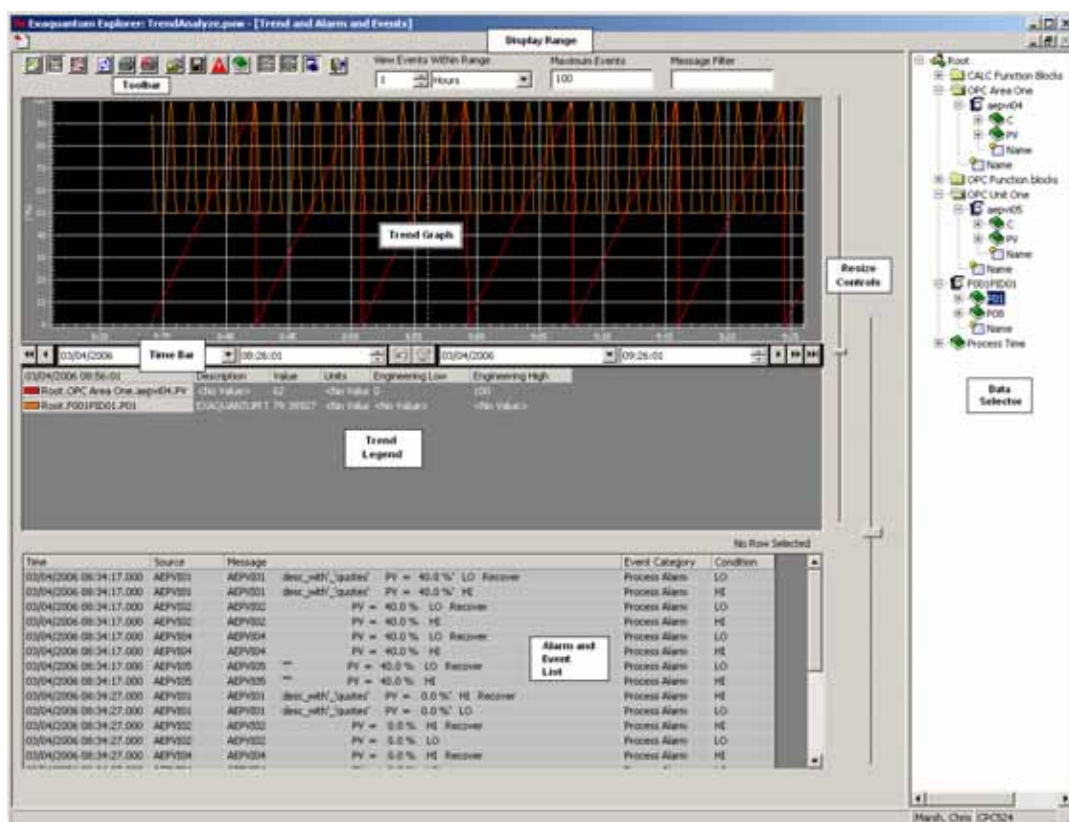


Figure: Trends and Alarm and Events

The top ten alarm tags are shown in the dialog below:

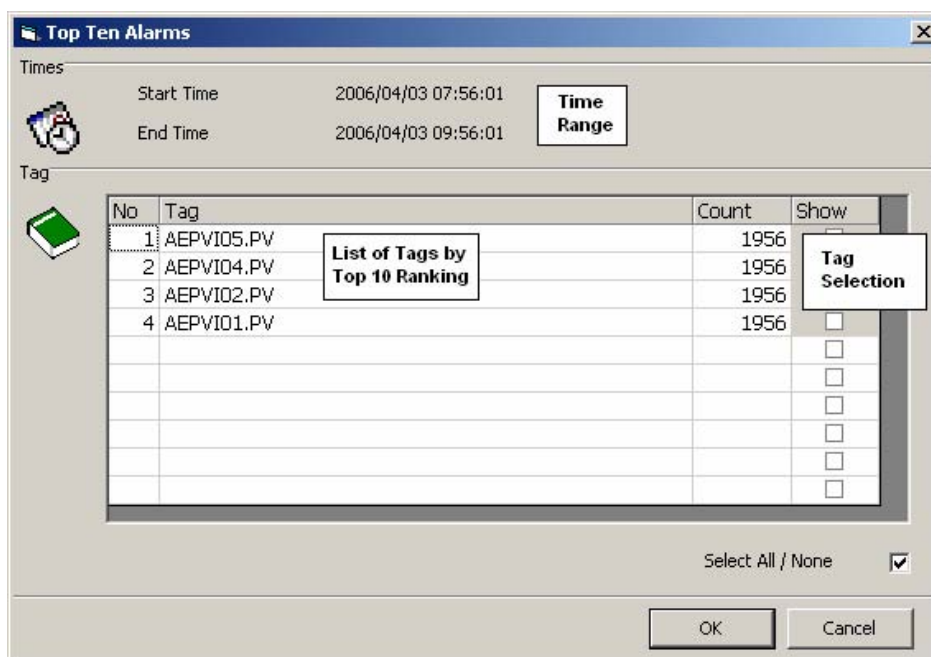


Figure: Top Ten Alarm Tags

5.6.3 Trend Comparison

This document allows a user to select sources of data and display them simultaneously as trends in two trend charts stacked one above the other.

The time period covered by the two trend charts can be changed independently to enable the trends to be compared over different periods.

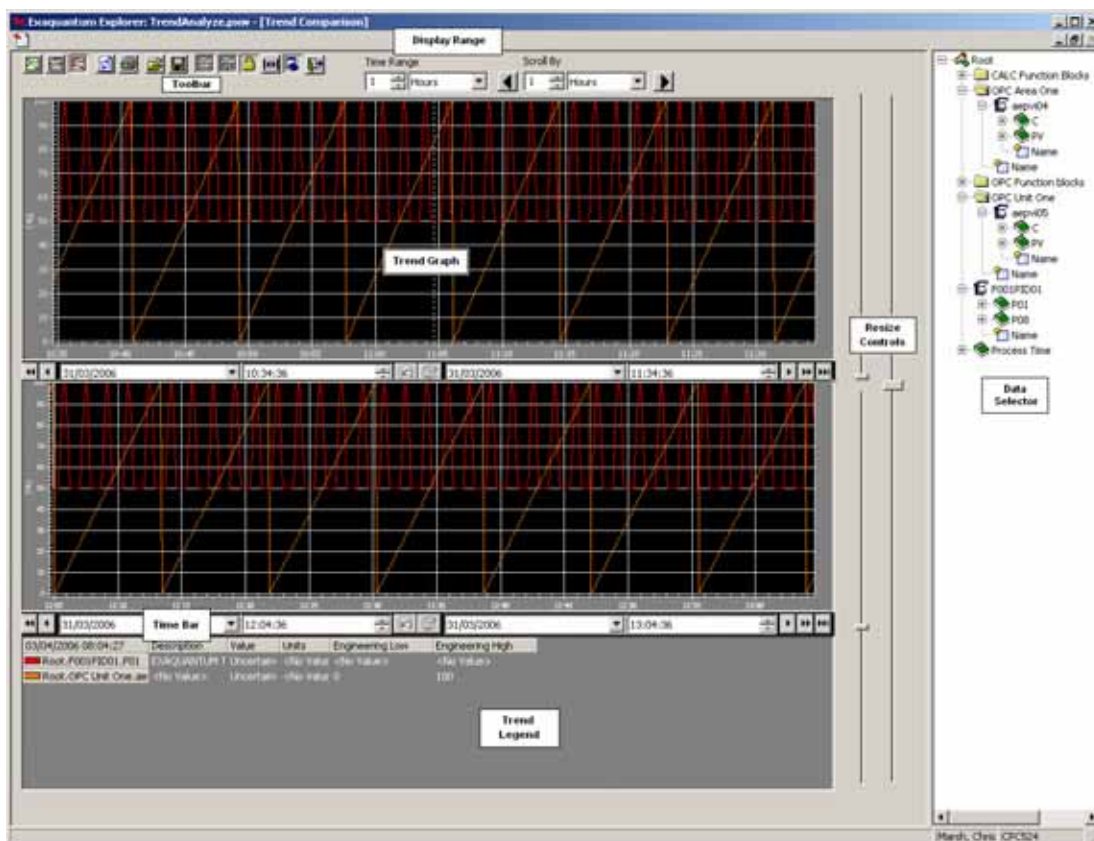


Figure: Trend Comparison

5.7 Trend Templates

With the goal of improving engineering efficiency, nine Exaquantum/Explorer trend templates are supplied that can be applied or adapted to meet different requirements.

5.7.1 Trend Templates Main Screen

When the Trend Templates Exaquantum/Explorer workbook is started, the following page is displayed to allow the user to select the appropriate template:

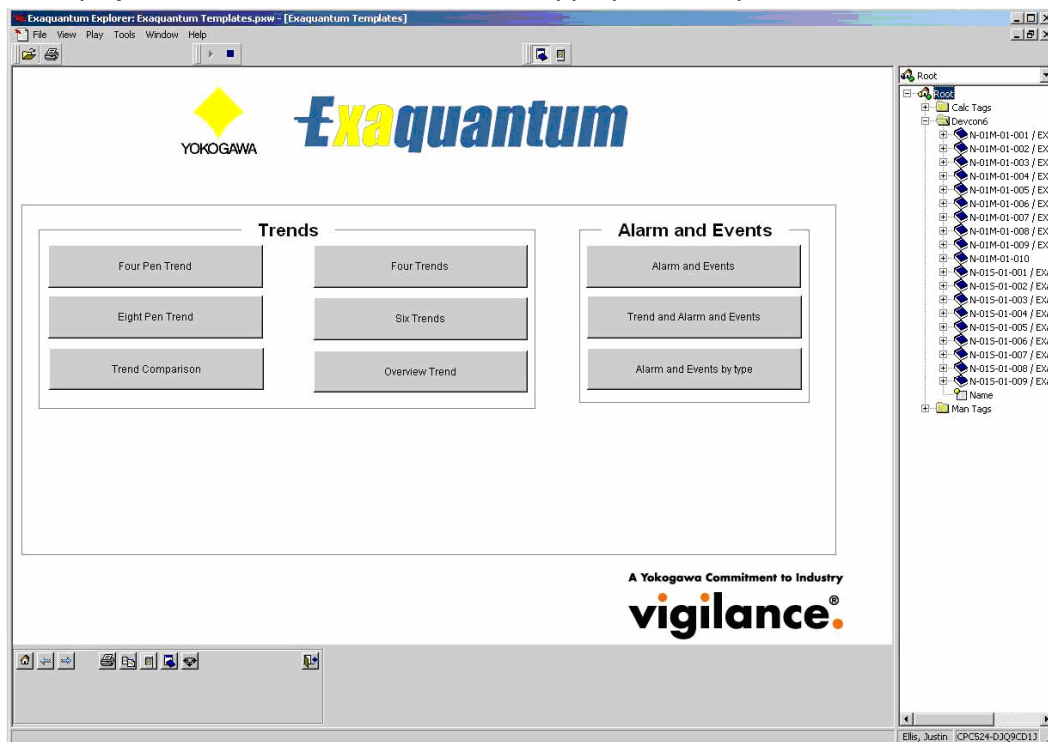


Figure: Trend Templates Main Screen

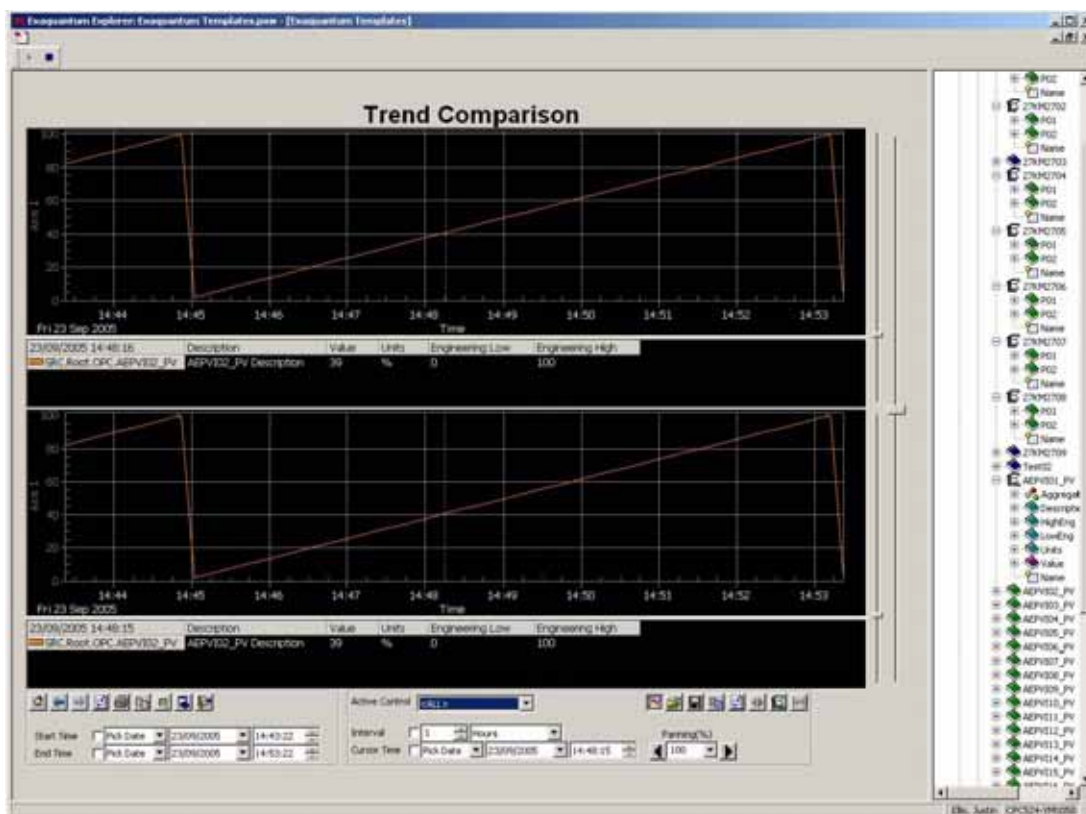


Figure: Trend Comparison Screen

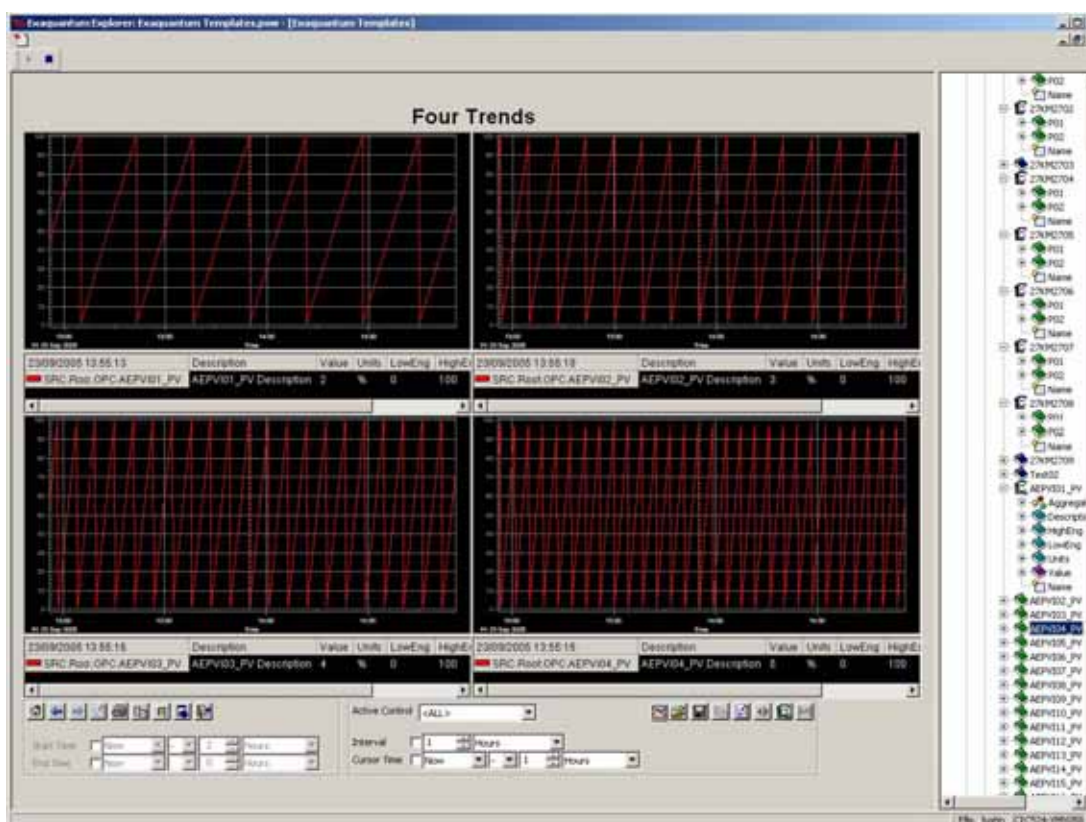


Figure: Four Trends Screen

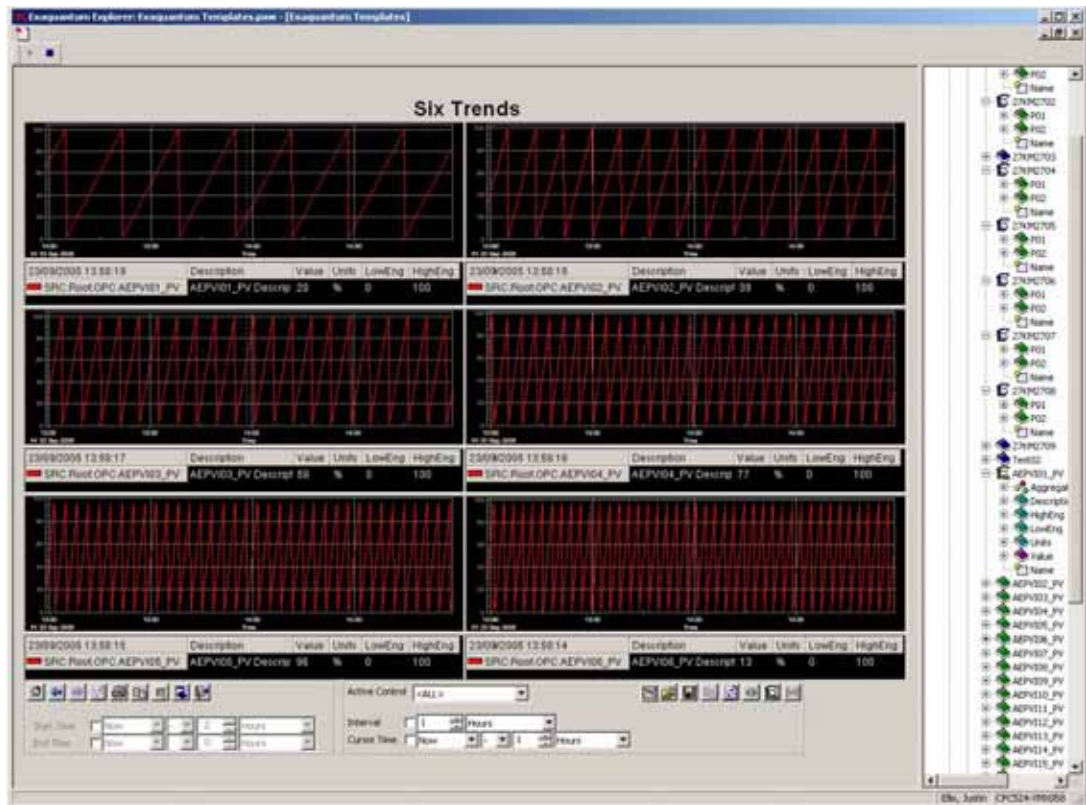


Figure: Six Trends Screen

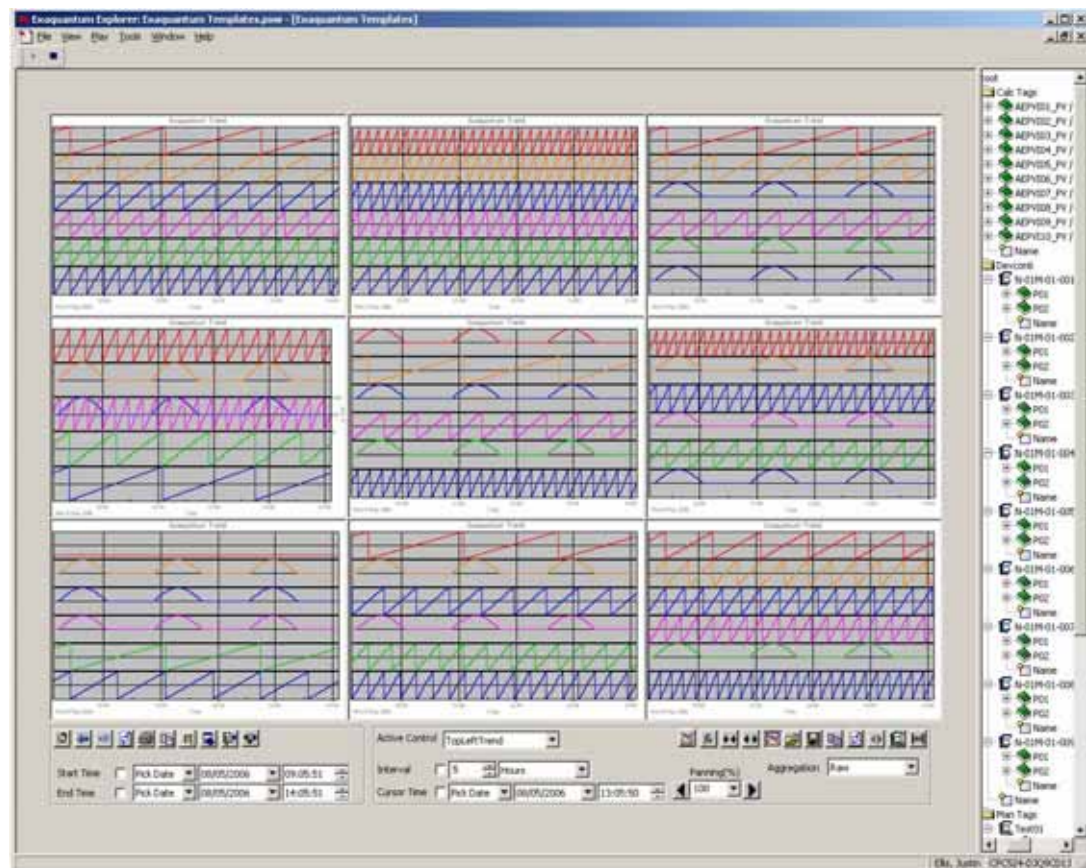


Figure: Nine Trends Overview Screen

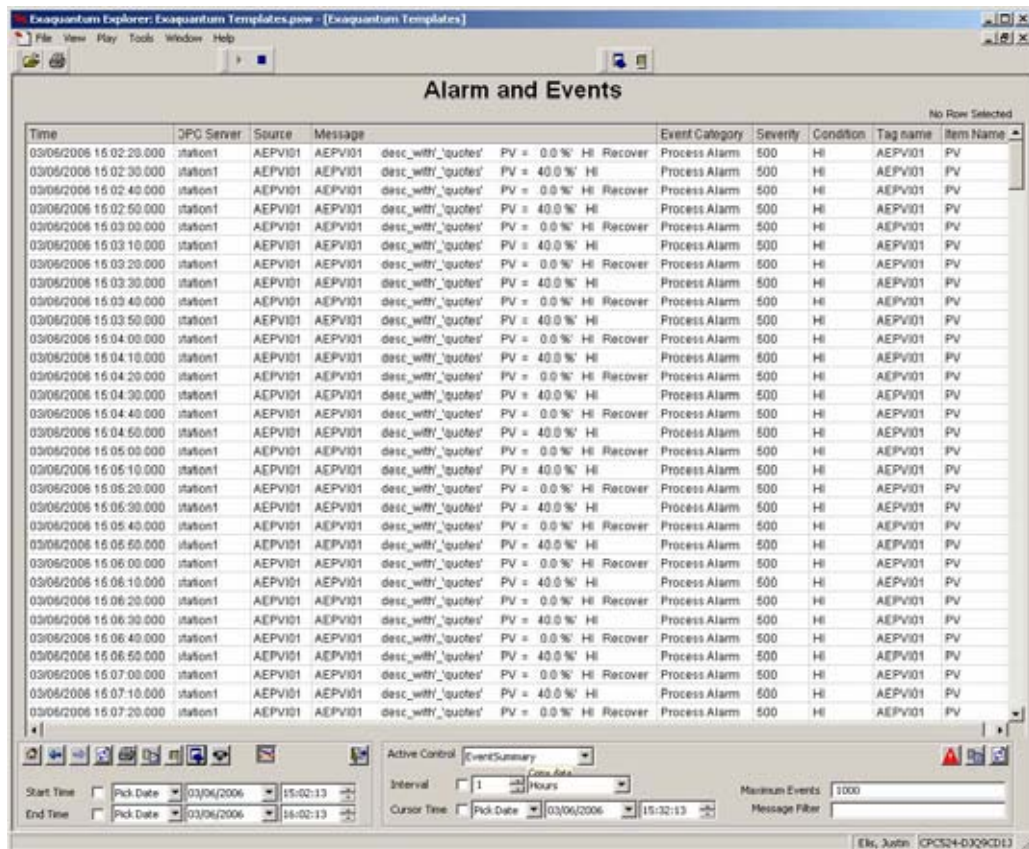


Figure: Alarms & Events Screen

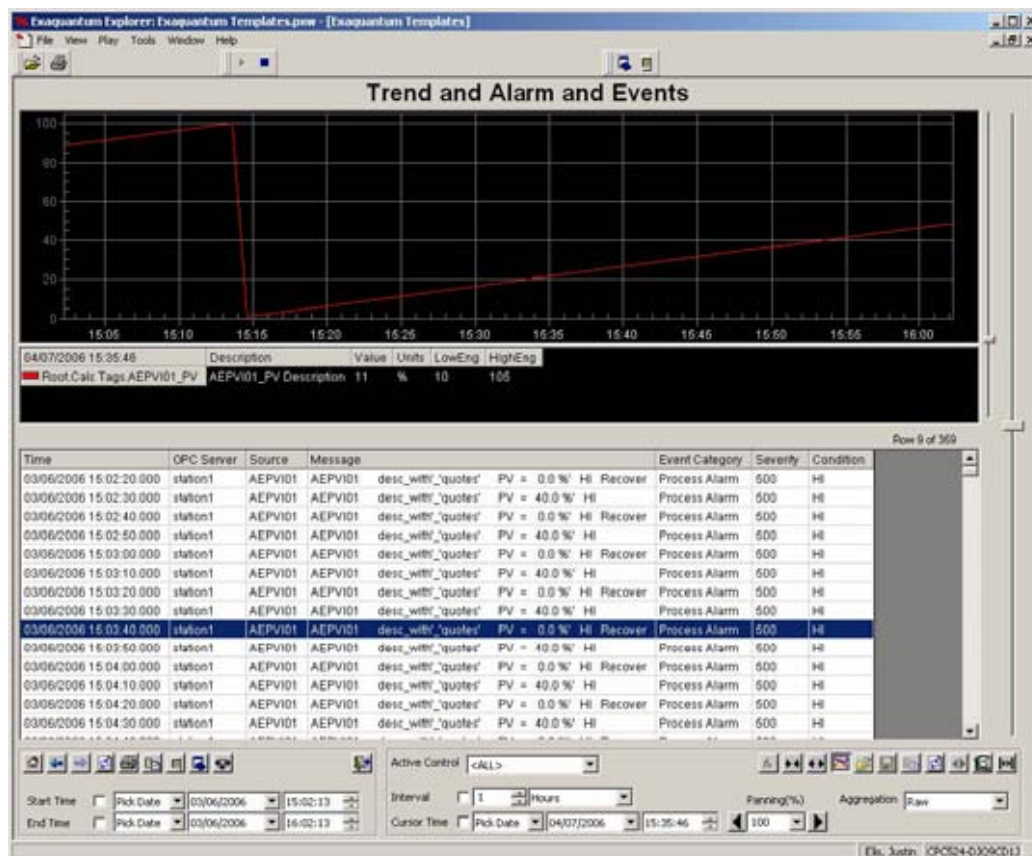


Figure: Combined Trend and Alarms & Events Screen

Exaquantum Explorer: Exaquantum Templates.pnw - [Exaquantum Templates]

File View Dev Tools Window Help

Alarm and Events by type

No Rows Selected

Time	2PC Server	Source	Event Category	Severity	Condition	Tag name	Item Name	Message
03/06/2006 15:02:20.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:02:30.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:02:40.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:02:50.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:03:00.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:03:10.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:03:20.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:03:30.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:03:40.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:03:50.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:04:00.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:04:10.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:04:20.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:04:30.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:04:40.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:04:50.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:05:00.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:05:10.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:05:20.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:05:30.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:05:40.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:05:50.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:06:00.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:06:10.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:06:20.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 0.0 % HI Recover
03/06/2006 15:06:30.000	station1	AEPV01	Process Alarm	500	HI	AEPV01	PV	AEPV01 desc_with_quotes PV = 40.0 % HI
03/06/2006 15:06:40.000	station1	ACTV01	Process Alarm	500	IR	ACTV01	PV	ACTV01 desc_with_quotes PV = 0.0 % IR Recover

☒ System Alarm
 ☒ Model/Status Change
 ☒ Operation Guidance Message
 ☒ Operation Record
☒ Process Alarm
 ☒ Sequence Message
 ☒ Engineering Maintenance
 ☒ Special Order Message

Active Control: EventSummary
 Start Time: Pick Date 03/06/2006 15:02:13
 End Time: Pick Date 03/06/2006 15:02:13
 Interval: 1 Hours
 Cursor Time: Pick Date 04/07/2006 15:34:01
 Maximum Events: 1000
 Message Filter:

Els, Justin OPC524-0029CD13

Figure: Alarms and Events by Type Screen

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6. Exaquantum/Web

Exaquantum/Web is designed for intranet deployment of the Exaquantum user interface. Exaquantum/Web provides a thin client alternative to Exaquantum/Explorer and delivers the benefits that customers expect when choosing web technology.

With Exaquantum/Web, Exaquantum information can be used even more effectively by being combined with data from a variety of sources within the user's working environment. Exaquantum/Web provides the best features of Exaquantum/Explorer, without the need for a full client installation prior to use.

6.1 Benefits of the Web

One of the main benefits is the reduction of the cost of ownership; this is achieved through:

- Minimum specification of PC hardware
- Centralized administration of software installation and management.

Contemporary software is making increasing use of Web technology because of the benefits to both developers and users. For the developers, constantly evolving technology enables them to make the most of their expertise. Also, because of the existence of and adherence to Web standards, the amount of compatible technology that is now available has greatly increased. The main benefit to the user is ease of use provided by a common interface standard.

Some of the specific benefits include:

- A standard framework that:
 - Allows the grouping of Exaquantum data into logical categories such as process mimics, alarm and event views or reports
 - Gives the user a customized view of the available resources.
- Web authoring tools that allow users to configure any combination of Web compliant components to work together. For example, a user may configure the Outlook e-mail environment next to the Exaquantum Alarms and Events viewer, so that all prompts can be seen through a single screen.

6.2 Architectural Overview

The illustration below outlines the make-up of the architecture:

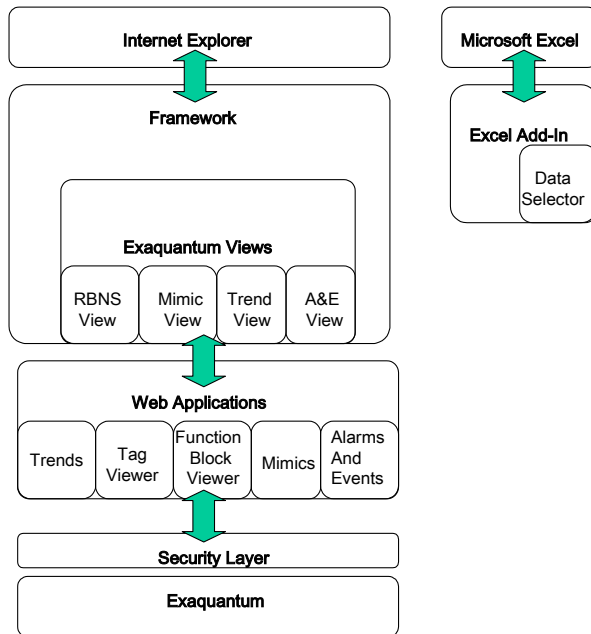


Figure: Web UI Overview

This architecture can be split into a number of key areas.

- **Framework**

The framework is a customizable and extensible web framework through which views of Exaquantum data are displayed. The views include the display of the Role Based Namespace, and selection of Mimics, Trends and Alarm and Event displays.

- **Web Applications**

Exaquantum Applications are also accessible through the framework. These applications are for viewing Tags (Tag Viewer), Function Blocks (Function Block Viewer), Mimics (Mimic Viewer), Trends, and Alarms and Events.

- **Excel Add-In**

The Exaquantum add-in for Microsoft Excel provides almost identical functionality to that of the thick client Excel Add-In. Spreadsheets that have been configured with the thick client version of the Excel Add-In are usable without any changes.

6.3 Scope of Supply

The most significant difference between Exaquantum/Web and Exaquantum/Explorer is that the runtime container is Microsoft Internet Explorer (IE). Exaquantum/Web comprises a number of components that are used to build the UI. These components are explained below.

Graphics Editor and Conversion Tools

Exaquantum/Web provides the following tools to address industry requirements:

- **Graphics Editor**

This is a stand-alone thick client that allows users to configure mimics for viewing on the Web. It creates graphics files in Scalable Vector Graphics (SVG) format. SVG is the W3C standard that is set to be the next generation graphics markup standard.

The Graphics Editor allows users to create graphics using basic graphical elements such as lines, circles, rectangles, or text. The properties (i.e. color, position, and value) of a graphic object can be dynamically changed, based on data values.

The Graphics Editor does not allow ActiveX controls such as the Trend and Alarm and Event Summary to be embedded in the graphics files. This is achieved using the web-authoring tool. Scripting of the graphical elements is limited to basic expressions.

- **Exaquantum/Explorer Graphics Conversion**

This tool converts Exaquantum/Explorer graphics into Exaquantum/Web format so that graphics are available in the Web environment. The conversion tool strips off Script. This can be replaced manually by expressions to animate graphical objects.

The conversion also removes ActiveX controls such as Trends and Alarm and Events. In the web environment these controls can be displayed alongside, for example, a plant mimic using a web-authoring tool such as Microsoft Front Page.

- **CS 1000/CS 3000 Graphics Conversion**

This tool converts CS 1000 and CS 3000 graphics into Exaquantum/Web format. Once converted, the graphics can be switched easily from showing raw to aggregation data or from current value to history value. Graphics may be converted from SVG format or by connecting to a HIS station to import a CS graphic directly.

Excel Add-In

The Exaquantum/Web Excel Add-in provides similar features to the Exaquantum/Explorer Excel Add-In. The following sections contain an explanation of the concept of reporting steps and a description of Excel Add-In features.

- **Reporting Steps**

It is useful to identify the steps associated with the reporting activity as follows:

- Template configuration – This is the step by which the user creates templates. Templates define shapes, types of values to be used, annotations (e.g. a title of report), etc. They are meant for a particular usage, e.g. a Daily report of utility consumption, but the report values are yet to come.
- Data source configuration – This is the step to run the templates and allocate the data sources from which the report values are to be retrieved. Allocation is typically done by dragging and dropping target tags onto a template. The outcome of this step may or may not be saved as runnable reports.

- Publishing – As the template and data source have been configured, report values should be now retrieved from the data source. The user may or may not tune retrieved values. Once the values are satisfactory, the user can publish the report. Publishing a report is essentially saving the worked out report in a read-only format.

Web Applications

A suite of applications provides views to Exaquantum data. The applications are accessible from the Exaquantum Home Page which acts as a portal to any web-based applications that are configured. For Exaquantum/Web these are:

- Role Based Namespace based Tag & Function Block Viewer
- Graphics
- Trends
- Alarm and Events.

Note: Exaquantum/Explorer contains some features that are not currently available through Exaquantum/Web. These include the Alarm and Event Update Control, Data Entry Grid and run time configuration of Trends.

- **Role Based Namespace Browser**

The Web version of the Role Based Namespace Browser is available to create a fully personalized and integrated user interface environment.

- **Tag Viewer**

This allows Tag details (i.e. Name, Description, Units and Engineering Limits) to be viewed. Value, Quality and Timestamp can be viewed for a spot time or a period in tabular form. For users with the appropriate permission, values can be written back to Exaquantum.

- **Function Block Viewer**

This allows the Value, Quality and Timestamp for a spot time for all of the tags within a Function Block to be viewed.

- **Graphics**

This view will show process graphics. It allows graphics to show data at a specified spot time and for raw or aggregated data.

Pre-configured Components

In order for users to easily configure the Web-based user interface, Exaquantum/Web provides a number of pre-configured components.

- **Trends**

The trend components are a vital part of Exaquantum/Explorer that provide a comprehensive view of Exaquantum data.

The Exaquantum/Web Trend component is a down-loadable ActiveX control that allows functionality as rich as that of the Exaquantum/Explorer Trend component. It communicates with the server by using HTTP so that the component fits in with Web network requirements.

The trend component allows users to select properties to fine-tune trend behavior.

- **Alarms and Events**

The viewing of Alarms and Events is provided by a version of the current Alarm and Event ActiveX control that has been adapted to the web environment. For example, the user

can select OPC server(s), type of Alarms and Events, time period and which columns to display.

6.4 Authoring Web Contents

Users will need to configure a number of pages to meet their own specific requirements. The major components to be configured, and how to configure them, are as follows:

- Mimics, through the Graphics Editor
- Pre-configured Trends, through the authoring tool
- Alarms and Events, through the authoring tool.

To enable users to configure Exaquantum/Web pages easily, Exaquantum provides configuration time features for Trend and Alarms & Events.

Microsoft Front Page is the recommended authoring tool. Exaquantum also provides a Front Page Add In that allows:

- Simple 'drag and drop' of Exaquantum data
- Publishing of mimics, trends and other views.

For more detailed information, refer to Volume 4 of the Exaquantum Engineering Guide.

6.5 Deployment Options

License

The Exaquantum license key code that the Exaquantum administrator will receive on purchasing Exaquantum will encode the purchased options.

When a license for multiple Exaquantum servers is purchased, the user will receive as many license codes as for the number of servers present. Each code is unique even if the conditions (i.e. number of tags, etc.) are the same.

If the Exaquantum/Web option is selected, all license codes will allow installation of the Exaquantum/Web option.

Installation

To enable Web access to one or more Exaquantum/PIMS servers there must be at least one Exaquantum/Web server in the system. The basic Web functionality is provided by the Microsoft IIS (Internet Information Server), which is supplied as a Windows installation option with all the supported operating systems (except where Microsoft 2000 professional or Microsoft XP is used as an Exaquantum server). Internet Information Server must be installed on the same platform as the Exaquantum/Web server.

- For small lightly loaded systems, the Exaquantum/Web server can be deployed on the same hardware as the Exaquantum/PIMS server.
- For larger systems the Exaquantum/Web server should be deployed on dedicated hardware.
- Exaquantum/Web is not available where Microsoft 2000 professional or Microsoft XP is used as an Exaquantum server.

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7. OLE DB Client

The Exaquantum OLE DB Client application allows the user to view a 'snapshot' of Exaquantum data using OLE DB/ODBC compliant reporting and analysis tools, such as Excel and Seagate Crystal Reports.

OLE DB allows generic access of information in various forms. Exaquantum makes full use of the technology by defining several access methods that primarily expose Trend information.

Exaquantum provides a simple wizard tool that allows users with no technical knowledge of OLE DB/ODBC to retrieve information.

7.1 OLE DB Client Tools

The OLE DB tools consist of:

- A Query Wizard for the production of QOLEDB queries
- An Item Selector for the selection of items.

Query Wizard

Users can construct query commands in an intuitive and comprehensive way, Exaquantum provides a wizard designed for Microsoft Excel. Using the Query Wizard, users are allowed to take advantage of OLE DB Client without knowing query parameters detail.

The Query Wizard prompts users for appropriate options. The first step is to select a query type, e.g., QTrendData, and a set of query specific selections will follow. In the case of QTrendData, these are:

- Select Times
- Select Options 'IncludeEdge' or 'IncludeBounding'
- Select Items
- Select Columns
- Finished.

Item Selector

The Item Selector is a standalone program accessible through the standard Window Programs menu. It provides the ability to select items to a list. Items can be dragged from the Data Selector to the selected list. The list of tags can then be copied to the clipboard as a comma-separated list. The list can then be pasted into the Crystal Reports entry box when prompted for the Items in a QData or QTrendData request.

7.2 Query Types

OLE DB Client has the following query types available:

- QData, retrieves tag data for a determined time (Tag Spot Data)
- QAEData, retrieves Exaquantum Alarm and Event data for a determined time
- QTrendData, retrieves tag data for a specific time and updates the data periodically.

The two of most commonly used commands (QData and QTrendData) are explained further.

QData: Tag Spot Data

This query will return information for specified items at a particular point in time.

The command consists of the following parameters:

Columns	One or more unique column names such as Path name, Aggregation period, Value, Secondary Quality and Timestamp, or the '*' character that is shorthand for requesting all columns.
SpotTime	A locale formatted date/time string, the minimum time resolution is 1 second. Pre-defined values, such as NOW, are available, as well as calculations like NOW – 10 minutes.
Attributes	IncludeEdge or IncludeBounding constants.
IncludeEdge	The point at the specified time is returned, or if a point does not exist then an interpolated value is returned from the last point in history.
IncludeBounding	The point at the specified time is returned or if the point does not exist then the previous point in history is returned.
Items	A list of fully qualified comma separated paths to the requested items. All paths start from 'Root'.

- **Example**

The command,

```
QData< "*", "24/05/00 11:36:00",
"IncludeEdge", "Root.Server1.F001PID01.PV.Value ">
```

will return a spot value populated into Excel spreadsheet as follows:

Name	Aggregation	Value	Quality	Secondary Quality	Timestamp
Root.Server1.F001PID01.PV.Value		12	Good	None	24/05/00 11:36:00

QA&EData: Alarm and Event Data

This query retrieves Exaquantum Alarm and Event data for a determined time.

- **Query Parameters**

The command consists of the following parameters:

Columns	One or more unique column names defined by the QAEData result set, or the '*' character. Multiple column names are comma separated. The '*' character is shorthand for requesting all columns.
StartTime	Inclusive start time of query for alarm and event data. A locale formatted date/time string; the minimum time resolution is 1 second.
EndTime	Inclusive end time of query for alarm and event data. A locale formatted date/time string; the minimum time resolution is 1 second.
MessageFilter	If a wildcard string is specified then alarms and/or events are only returned if the message matches the MessageFilter. The default is '*'.
MaximumEvents	Specifies the maximum number of alarm and/or events that can be returned; the default is to return all alarms and events.
OPCServers	A list of comma separated OPC server names for which alarm and event data is required. If no server is specified, data for all servers is returned.
Server	An Exaquantum server name from which to retrieve alarm and events. If no server is specified, the provider connects to the Primary server. Note that only one server may be specified.
Filter	A generic filter to be applied directly to the alarm and event database query. The default is no filter.

- **Example**

This example displays alarm and event data from Server 1 between the specified Start and End times that have a Severity of 500 and a Data value of more than 20. All columns will be displayed.

```
QAEData( "*", "24/05/00 11:26:00" , "24/05/00 11:36:00" , , , "Server 1", "", "(Severity = 500) AND (DataValue > 20)")
```

Server	Source	Timestamp	Message
Server 1	F002PID01	24/05/00 11:26:00	F002PID01 1234567890XXX1234567890 PV = 27.5 NM3/M HI Recover
Server 1	F002PID01	24/05/00 11:26:00	F002PID01 1234567890XXX1234567890 PV = 27.5 NM3/M LO
Server 1	F002PID01	24/05/00 11:26:01	F002PID01 1234567890XXX1234567890 PV = 47.7 NM3/M LO Recover
Server 1	F002PID01	24/05/00 11:26:02	F002PID01 1234567890XXX1234567890 PV = 30.7 NM3/M LO
Server 1	F002PID01	24/05/00 11:26:03	F002PID01 1234567890XXX1234567890 PV = 45.4 NM3/M LO Recover

Category	Severity	Condition	No of Attributes	CENTUM Message ID	Station Name	Tag Name	Recipe Group Number	Recipe Name
102	500	HI	10	4354	FCS0101	F002PID02	0	
102	500	LO	10	4353	FCS0101	F002PID02	0	
102	500	LO	10	4354	FCS0101	F002PID02	0	
102	500	LO	10	4353	FCS0101	F002PID02	0	
102	500	LO	10	4354	FCS0101	F002PID02	0	

Batch ID	Unit Recipe Number	Engineering Units	Data Value	Item Name
	0	NM3/M	27.5458030700684	PV
	0	NM3/M	27.5458030700684	PV
	0	NM3/M	47.6892623901367	PV
	0	NM3/M	30.7076587677002	PV
	0	NM3/M	45.412841796875	PV

QTrendData: Trend Data

This query will retrieve large amounts of trend data at a time. It allows multiple items and/or span of time within a single query.

- **Query Parameters**

The command consists of the following parameters:

- Columns** One or more unique column names such as Timestamp, Value and Secondary Quality, or the '*' character that is shorthand for requesting all columns.
- StartTime** Inclusive start time of query for trend data. A locale formatted date/time string; the minimum time resolution is 1 second.
- EndTime** Inclusive end time of query for trend data. A locale formatted date/time string; the minimum time resolution is 1 second.
- Interval** If Interval is specified as other than "00:00:00" then data is returned exactly once per Interval rather than for each data point in history.
- Attributes** IncludeEdge or IncludeBounding constants.
 - IncludeEdge** The point at the specified time is returned, or if a point does not exist then an interpolated value is returned from the last point in history.
 - IncludeBounding** The point at the specified time is returned or if the point does not exist then the previous point in history is returned.
- Items** A list of fully qualified comma separated paths to the requested items. All paths start from 'Root'.

- **Examples**

The first example query fetches the value and quality data of two Tags' values over a period of time with a re-sample interval of 1 hour. As a re-sample interval has been specified this dictates that the result set will have a shared Timestamp column for all items specified.

```
QTrendData< "*", "24/05/00 07:36:00" , "24/05/00 11:36:00" ,
"01:00:00" , "IncludeEdge",
"Root.Server1.F001PID01.SV.Value,Root.Server1.F001PID01.MV.Value
">
```

Represents the string <Root.Server1.F001PID01>

Timestamp	#.SV.Value:Value	#.SV.Quality:Value	#.SV.Secondary Quality:Value	#.MV.Value:Value	#.MV.Quality:Value	#.MV.Secondary Quality:Value
24/05/00 07:36:00	175	Good	None	100	Good	None
24/05/00 08:36:00	525	Good	None	100	Good	None
24/05/00 09:36:00	378	Good	None	100	Good	None
24/05/00 10:36:00	231	Good	None	100	Good	None
24/05/00 11:36:00	588	Good	None	100	Good	None

The second example query fetches the Timestamp and Value columns for two Tag value attributes. The re-sample interval is not specified so the raw values are returned and hence a separate Timestamp column exists for each requested item.

```
QTrendData< "Timestamp,Value", "24/05/00 11:26:00" , "24/05/00
11:36:00" , "00:00:00" , "IncludeEdge",
"Root.Server1.F001PID01.SV.Value,Root.Server1.F001PID01.MV.Value">
```

SV.Timestamp	Root.Server1.F001PID01.SV .Value:Value	MV.Timestamp	Root.Server1.F001PID 01.MV.Value:Value
24/05/00 11:26:00	364	24/05/00 11:26:00	100
24/05/00 11:26:20	287	24/05/00 11:36:00	100
24/05/00 11:27:20	210		
24/05/00 11:28:20	133		
24/05/00 11:29:20	553		
24/05/00 11:30:21	476		
24/05/00 11:31:21	399		
24/05/00 11:32:21	322		
24/05/00 11:33:21	245		
24/05/00 11:34:21	168		
24/05/00 11:35:21	588		
24/05/00 11:36:20	588		

7.3 OLE DB as a Programming Interface

Whenever an application program requires access to the Exaquantum data, the application program can use the OLE DB interface as an alternative to the DCOM based API.

The OLE DB interface is used in a similar way to SQL commands. Users familiar with SQL technology will understand the commands used in the OLE DB interface.

In summary, the significance of these two methods is as follows:

By using the OLE DB interface together with a commercially available application, e.g. FlexGrid, retrieving and populating information in a tabular form can be achieved with almost no programming effort. Writing back is also possible without writing any complex code. The application will not be limited to the tabular representation. There are, and will be, many OLE DB compliant toolkits in the market place, all of which are potential functional and representation programs of Exaquantum information through the Exaquantum OLE DB interface.

An application that requires asynchronous access to Exaquantum data should take advantage of the DCOM based API. With the OLE DB interface the application should access the data periodically by its own effort, while the DCOM API prompts the application for any changes of information.

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8. Exaquantum OPC Server

The Exaquantum OPC server (also known as the 'Exaquantum Open Interface' or 'Exaquantum OI') is an optional extra feature that can be installed and run on an Exaquantum server. It is designed to expose OPC DA and OPC HDA Exaquantum data to OPC clients. Subject to normal security access configuration, the data that is made available can be accessed by any suitable OPC clients. The overall effect is that the Exaquantum/PIMS server with the Exaquantum OPC server installed appears to clients just like a regular source of OPC data.

The Exaquantum OPC server has two purposes:

- Enable Exaquantum Cross-server Calculations. This allows an Exaquantum/PIMS server to make its data sources available to other Exaquantum/PIMS servers to use in Exaquantum calculation tags.
- Application packages can use their OPC clients to access Exaquantum live and historical process data.

The Exaquantum API Reference Manual provides further information for those who may like to develop other uses for the Exaquantum OPC server interface.

8.1 OPC Interface Compliance

● OPC HDA Server

The supported OPC HDA interfaces are:

- IOPCCommon Version 1.0 - custom interface only.
- IOPCHDA_Server Version 1.1 - custom interface only.
- IOPCHDA_Browser Version 1.1 - custom interface only.
- IOPCHDA_SyncRead Version 1.1 - custom interface only.
- IOPCHDA_SyncUpdate Version 1.1 – partial compliance only.

The following OPC HDA interfaces are not supported:

- IOPCHDA_SyncAnnotations
- IOPCHDA_AsyncRead
- IOPCHDA_AsyncUpdate
- IOPCHDA_AsyncAnnotations
- IOPCHDA_Playback

● OPC DA Server

The following custom interfaces are supported, partially compliant with OPC DA Version 2.05A.

- IOPCCommon Version 1.0
- IOPCServer
- IOPCItemMgt
- IOPCGroupStateMgt
- IOPCSyncIO
- IOPCAsyncIO2
- IOPCItemProperties (partial, LookupItemIDs is not implemented)
- IOPCBrowseServerAddressSpace (partial, BrowseAccessPaths is not implemented)

The following OPC DA interfaces are not supported:

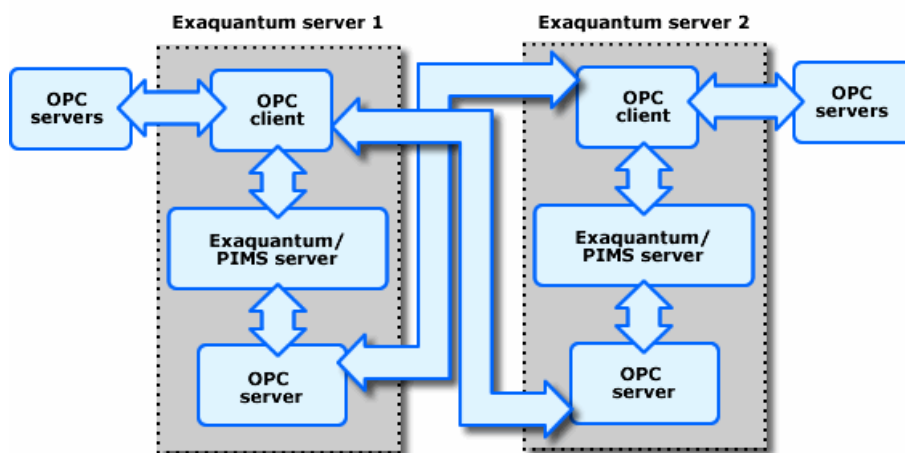
- IOPCServerPublicGroups
- IPersistFile
- IOPCPublicGroupStateMgt

8.2 OPC Server applications

8.2.1 Cross-Server Calculations

The Cross-server Calculation feature allows the Exaquantum/PIMS server to expose its data for use on another server, for example in calculations.

The figure below shows conceptually how two Exaquantum/PIMS servers work together when they are both also running Exaquantum OPC server in order to share their data sources.

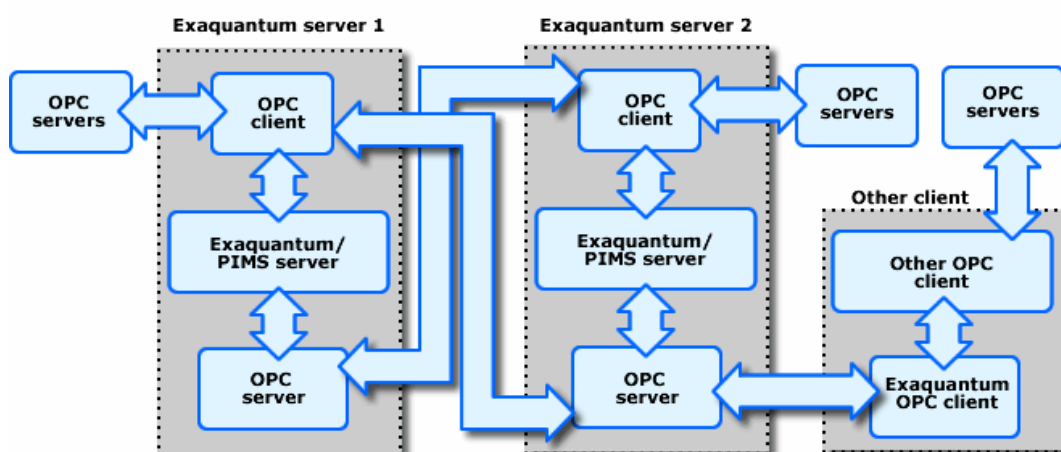


Exaquantum OPC server used to provide Cross-server calculations

8.2.2 Client access to the Exaquantum OPC server

The Exaquantum OPC client application can be installed on computers running other OPC client software in order to access the Exaquantum OPC server.

The conceptual diagram above has been supplemented to show how another client may access the OPC data available on an Exaquantum/PIMS server running the Exaquantum OPC server.



Exaquantum OPC servers and Exaquantum Clients used by other client

9. Exaquantum APIs

In addition to the OPC interfaces, Exaquantum also supports Application Program Interfaces (APIs). These provide Developers with programmatic access to Exaquantum. The APIs are presented in two forms, giving different functionality:

- COM interfaces
- .NET interfaces.

COM interfaces

These are standard COM automation interfaces, and are available to developers using Microsoft Visual Basic or Microsoft Visual C++. In particular, this allows the:

- Browsing the Exaquantum Namespace
- Reading of RTDB data (live and historical)
- Writing of RTDB data (live only)
- Reading Alarm and Event data.

.NET interfaces

The .NET Interfaces are available to any .NET language, such as Microsoft C# and Microsoft VB .NET. These provide:

- Configuration of Exaquantum the Management data
- Generation/deletion/modification of Exaquantum Tags
- Generation/deletion/modification of Exaquantum Folders.

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10. Deployment Options

The Exaquantum system can be configured in a wide range of ways to meet the differing needs of the customer's networking environments. The configuration options are detailed in this chapter.

10.1 Tested OPC Servers

Exaquantum supports the DA2.05a for the Data Access interface and the AE1.1 for the Alarms and Events interface. The following PCSs, via their associated OPC servers, have been tested and therefore supported by Yokogawa:

Table: Supported OPC Servers

PCS	OPC Server	Description	DA	A&E
Yokogawa CENTUM CS/CS 1000/CS 3000	Yokogawa Exaopc	CS cassette Exaopc version R1.01, R1.10, R1.20, R2.01, R2.10, R3.01, R3.01.50, 3.10, 3.11, 3.11.10, 3.20	Y	Y
Yokogawa CENTUM-XL	Yokogawa Exaopc	XL cassette Exaopc version R1.20, R2.01, R2.10, R3.01, R3.01.50, 3.10, 3.11, 3.11.10, 3.20	Y	Y
Yokogawa μ XL	Yokogawa Exaopc	μ XL cassette Exaopc version R1.20, R2.01, R2.10, R3.01, R3.01.50, 3.10, 3.11, 3.11.10, 3.20	Y	Y
Honeywell TDC 3000	Matrikon	Version 3.0.0	Y	N
Foxboro I/A series	Matrikon	Version 2.0.0	Y	N
Modbus	Matrikon	Version 3.1.0	Y	N

Note: The History Catch-up function requires Yokogawa Exaopc R2.01 or later.

10.2 Platform Availability

Exaquantum software components are available for following platform environments.

Table: Platform Availability

Component	Platform	Description
Exaquantum/PIMS	Windows 2000 Server Windows Server 2003 Standard Edition Windows 2000 Professional Windows XP Professional	Server (RTDB and Historian) and Configuration Tools Requires Microsoft SQL Server which is on the prerequisite CD supplied with Exaquantum
Exaquantum/Web Server	Windows 2000 Server Windows Server 2003 Standard Edition	Exaquantum/Web server on top of IIS (Internet Information Server)
Exaquantum/Explorer	Windows 2000 Professional Windows 2000 Server Windows XP Professional Windows Server 2003 Standard Edition	Client
Exaquantum/Web client	Windows 2000 Professional Windows 2000 Server Windows XP Professional Windows Server 2003 Standard Edition	Web client

Notes:

1. Windows NT is no longer supported for new installations; however old clients can still connect to the Exaquantum R2.20 server.
2. Exaquantum/PIMS on Windows 2000 Professional and Windows XP Professional is restricted to a maximum of 3,000 tags and 4 Exaquantum/Explorer users. Exaquantum/Web is not available due to the limitations of these operating systems.

Exaquantum is available in both English and Japanese. 'Language support' means that the following items are available in each language:

- One CD-ROM for the Exaquantum software
- Separate CD-ROMs for the pre-requisite software
- Default database settings in the language string
- Online manuals
- Online Help.

With Exaquantum/Explorer or Exaquantum/Web clients, Excel 2000, Excel XP and Excel 2003 are supported on every platform listed above.

10.3 Exaquantum Deployment and Network Configuration

The following Exaquantum components need to be considered when configuring the Exaquantum system for operating on the network:

- Exaquantum/PIMS server (comprising the Real-time Database (RTDB) and Historian)
- Configuration tools (comprising the UI tools set)
- Exaquantum/Explorer (including OLE DB based clients)
- Exaquantum/Web components (server side components)
- Web client
- Exaopc OPC server, the OPC interface for Exaquantum Cross-server Calculations and 3rd party OPC clients.

These components can be deployed in various combinations; the physical configuration differs depending on network requirements.

10.3.1 Co-existing with Other Software Packages

The only software approved by Yokogawa that can run in an Exaquantum/PIMS server is:

- Exaopc
- Microsoft Internet Information Server (IIS), used by the Exaquantum/Web server.

For other software (such as virus checkers) be contact your local Yokogawa representative for the latest information.

In particular project environments, performance, resource consumption or the number of potential concurrent users may need to be taken into consideration.

10.3.2 Configuration of Exaquantum/Explorer

Exaquantum provides a comprehensive guide for the installation of the server and client software to meet customer's network requirements. It is important, however, to have an understanding of the basic concepts of the Windows network and Exaquantum configuration cases. For a detailed description of network configuration, refer to Engineering Guide, Volume 2 (ref: IM 36J04A15-02E).

When an Exaquantum/Explorer client connects a server via the PPP protocol (which is the case where a modem or ISDN is the path between them), it is recommended that some investigation be done to assess the feasibility of the connectivity, in terms of performance and reliability.

When an Exaquantum/Explorer client needs to reside beyond the firewall, a special configuration of the firewall software is required. This is a consequence of employing DCOM communication protocol between the client and server. DCOM default setting uses a wide range of 'ports', whereas the firewall allows only a limited number of open ports. Additionally NAT (Network Address Translation) cannot support DCOM unless VPN or Microsoft Terminal Server is used

Examples of three configurations are illustrated below.

- **Typical Configuration (Single Server)**

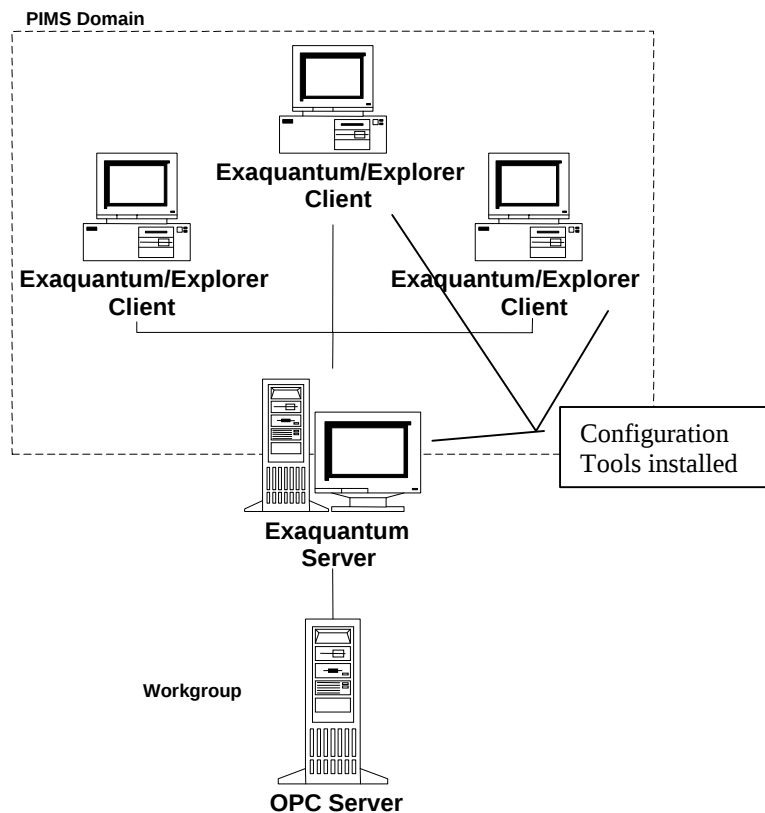


Figure: Typical Configuration

The Control system and PIMS domain (in some cases part of Office system) are physically separated by the Exaquantum server, which has two network cards and acts as a gateway.

The Exaquantum server and clients are part of the PIMS domain, so the administration work is reasonably easy.

The OPC server and other control system components are configured as a Workgroup, as administration work is less intensive in this category.

- **Exaquantum in an Existing Mid-scale to Large Network (Single Server)**

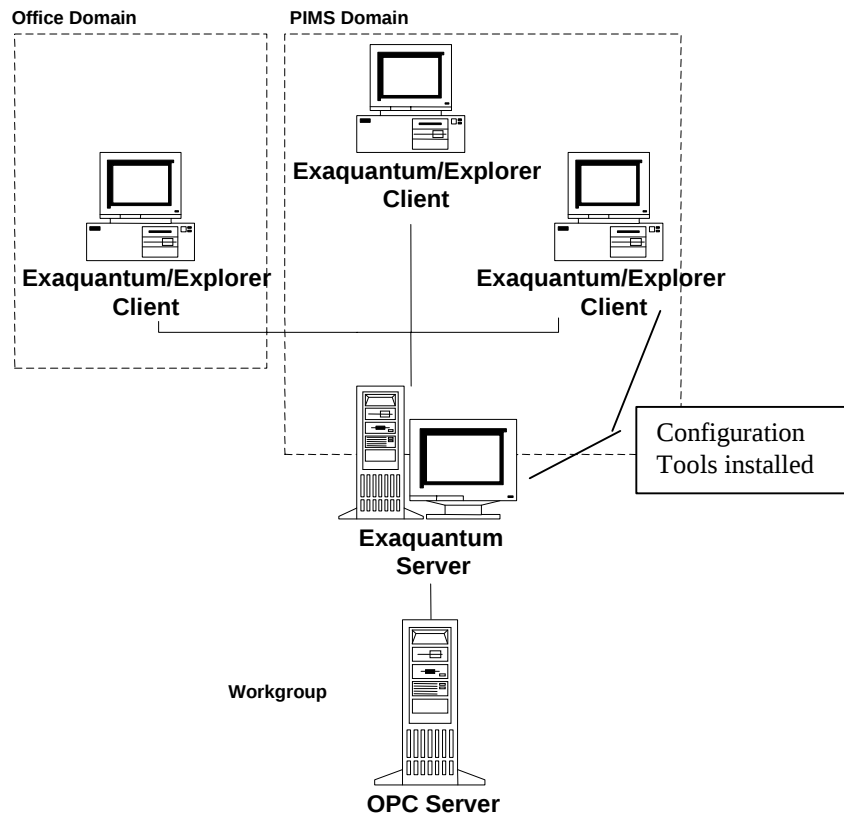


Figure: Mid-scale to Large Network

The PIMS system runs in a dedicated domain so administration work is kept separate from Office domain work.

Exaquantum/Explorer resides in both the Office domain and PIMS domain.

- **Newly Installed Small-scale System (Single Server)**

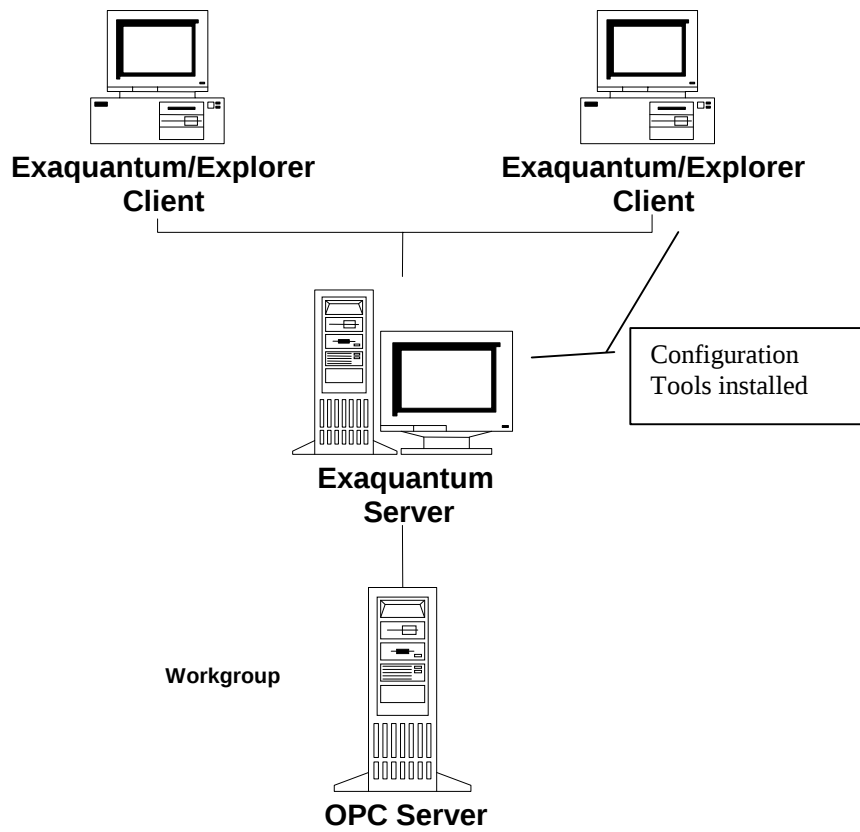


Figure: Newly Installed Small-scale System

In a small-scale system, the work of administrating the network is not so extensive. All the components are therefore put into the Workgroup configuration, rather than Domain.

The Domain configuration is useful when several PCs are involved, and network administration is not a negligible task. In small-scale systems, however, the cost-effective way is to put all the PCs into the Workgroup configuration. This is because the Domain configuration requires Domain Controller(s), which all cost more at the initial stage.

● Multiple Exaquantum Servers

Exaquantum/Explorer users can access multiple Exaquantum servers in a transparent way, i.e. the users see a single hierarchical structure of tags, which may comprise information obtained from multiple servers.

During installation, one server is designated as the primary server. This is then accessed first by Exaquantum/Explorer to obtain the tag structure information. The network should be configured so that each client may access all potential servers.

In the mid-scale to large system, there could be two possible situations as follows:

- Two Exaquantum servers in the same PIMS Domain
- One Exaquantum server in PIMS Domain 1 and another Exaquantum server in PIMS Domain 2.

These scenarios are shown below.

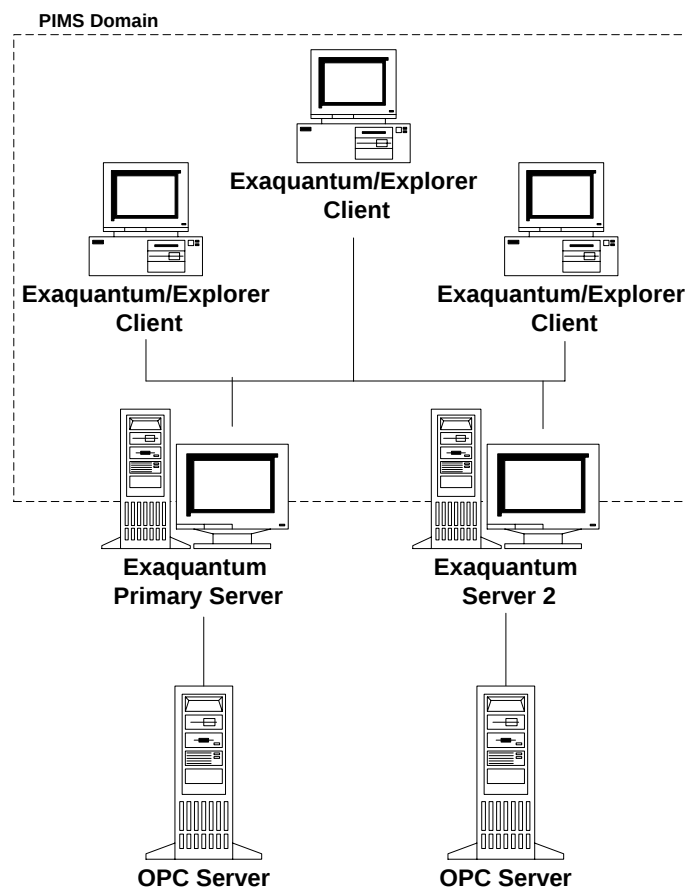


Figure: Multiple Servers / Single Domain Network

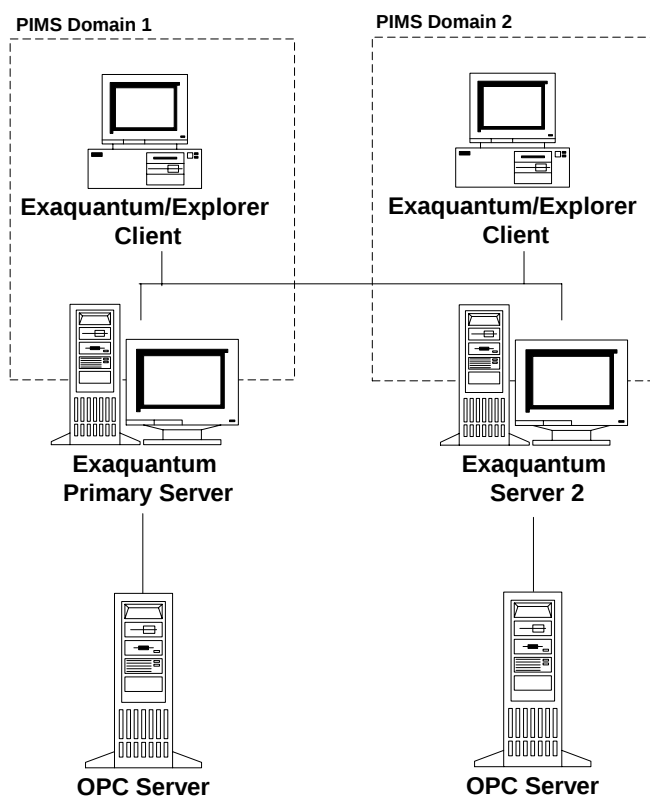


Figure: Multiple Servers / Multiple Domain Network

10.3.3 Configuration of Exaquantum/Web

Exaquantum information is available through a 'thin' client. Thin clients only require Internet Explorer Web browser software to be installed. Users who just want to make use of Exaquantum information typically work in this environment. A limited number of users who are authors of the Web contents also need to have the authoring tools ('thick' programs) installed on their PCs.

Some typical configurations are illustrated below.

- **Small Scale System**

In this case, there is only one Exaquantum server and it hosts the Web server as well. On this server, both Exaquantum/PIMS and Exaquantum/Web Server components are installed. The deployment of client software is made so that:

- Most clients have Microsoft Internet Explorer 6 installed and can access Exaquantum graphics and reports
- Configuration tools are also available through Windows Terminal Server for these clients
- A limited number of clients may have the authoring tools installed.

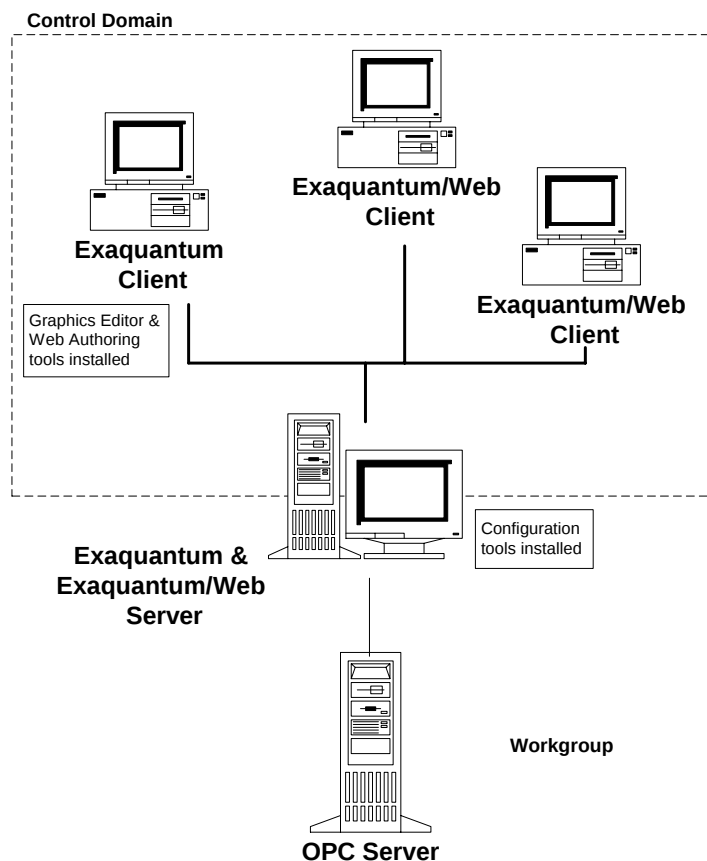


Figure: Small Scale System

- **Multiple Exaquantum servers system**

In this case, there are multiple Exaquantum servers, one of which hosts the Web server as well. The server that has the Exaquantum/Web Server components installed is the server that will be specified in the client URL path.

In the Web server, a primary designated server must be specified that is the server itself.

A back-up designated server will be one of other Exaquantum servers.
 The Exaquantum servers may be in the same domain or in different domains.
 The deployment of client software is the same as in the Small Scale system.

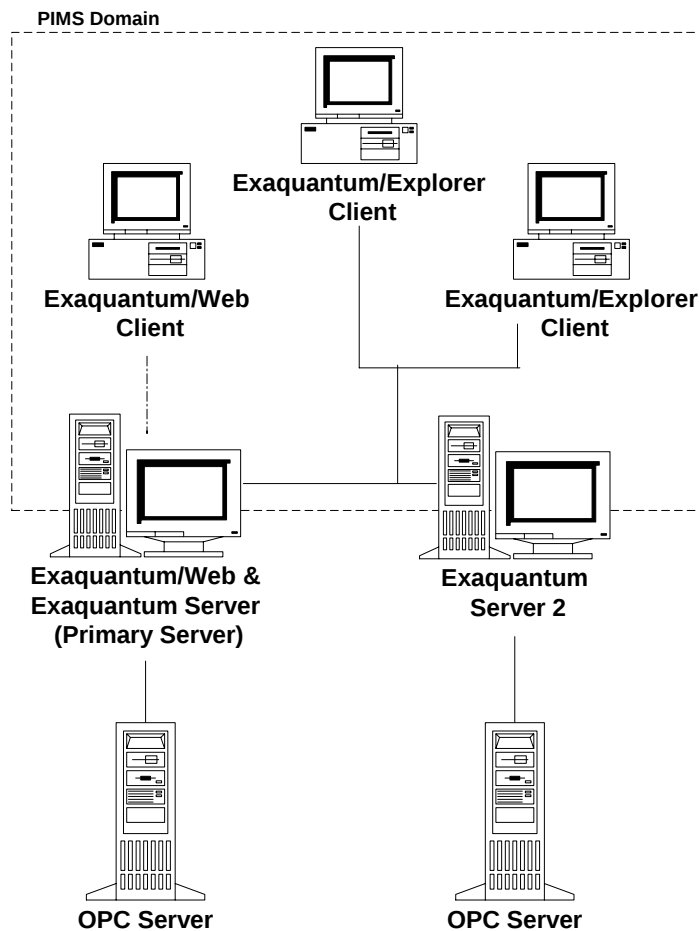


Figure: Multiple Exaquantum Servers System

● Large Web system

As the number of concurrent Web users grows, it is necessary to set up a dedicated Web server to provide Web users with the necessary access services, whilst Exaquantum/PIMS servers are left free from access by clients. This configuration is called the Large Web system.

If this is a newly installed system, one PC will have the Exaquantum/Web Server components installed and others will have the Exaquantum/PIMS components installed. For the Web server, one Exaquantum server must be specified as its primary designated server and another as the back-up designated server.

If this deployment is a transition from a multiple Exaquantum server system, first uninstall the Exaquantum/Web Server components from the Exaquantum server that runs the Web components, and then install a new Web server.

The Web server and Exaquantum servers may be in the same domain or in different domains. The deployment of client software is the same as in the Small scale system.

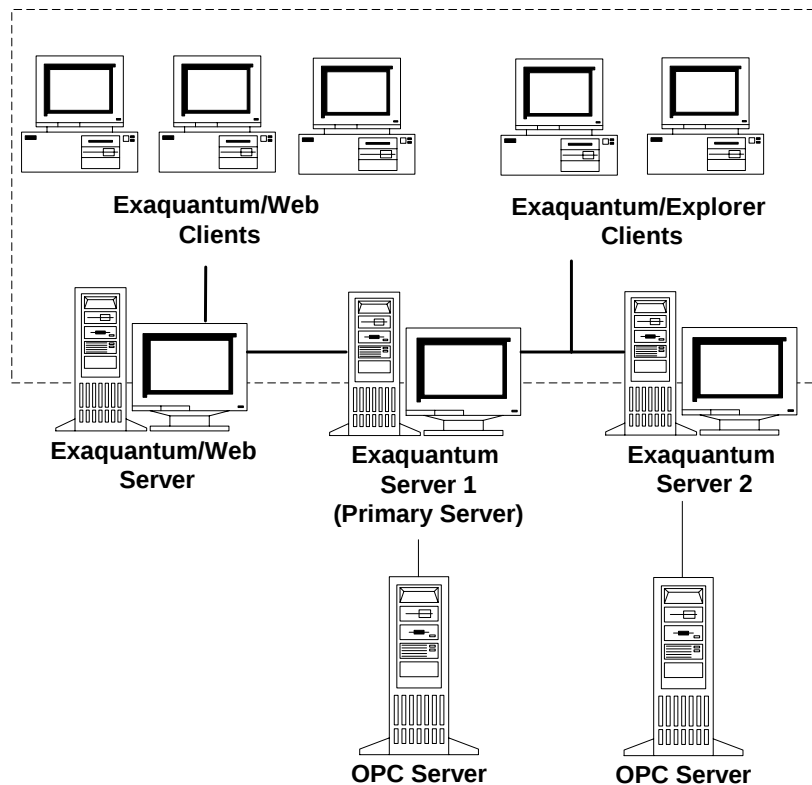


Figure: Large Web System

- **Redundant Web servers configuration**

In order to avoid a single point of failure, Microsoft offers Network Load Balancing (NLB) on its server products. This makes a group of web servers (usually called a 'server farm') appear on the network as a single network address (IP). As the client requests come in, a load balance algorithm is used to decide which server to allocate the traffic to. This service is normally used with a clustering service.

It is also possible to use a hardware balancing router. This is the usual way to achieve the hardware load balancing.

The finer detail of redundant configuration is beyond the scope of the Exaquantum product supply; contact a Yokogawa representative if this option is required.

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Exaquantum Glossary

TI 36J04A10-10E

This section contains a list of terms used in the Exaquantum document set. Each term is listed below in alphabetical order. Text shown in *Italic* form represents other terms defined in the Glossary.

A

- **ActiveX**
Microsoft 'Container' technology for embedding software items from one application into another.
- **ActiveX Control**
An ActiveX control is a standalone software component that performs a particular task in a predictable way. It can be used in many different applications, and the user will always know how to use it and how it is going to behave. ActiveX controls were formerly called *OLE* controls.
- **Add-in**
Supplemental programs that extend the capabilities of any program, e.g. Exaquantum/Explorer, by adding custom commands and specialized features. Where Exaquantum/Explorer is installed, the Exaquantum Excel Add-in is available that allows Excel to access Exaquantum data.
- **Administration Tools**
Also known as *Configuration Tools*.
- **A&E**
Alarms and Events. Used to call event messages generated by *OPC servers*.
- **Aggregation**
Calculation of summary values over a period of time. Built-in calculation for closing data.
- **Aggregation Period**
This is a period of time over which aggregations can be made, e.g. hour or month.

- **Application Launcher**

The Application Launcher is used to enhance the user interface. It can be used in a similar way to the Microsoft Outlook Task Bar, and can contain shortcuts to any application, in the same way as a User Desktop. This means that business or personal applications can be launched without having to minimize the user interface. As the Application Launcher is available in Run mode, it can be used as a navigation tool as well as a replacement for user desktop. In effect the Explorer user interface can be used as the user's default desktop (or as a Digital Dashboard), with live process data in the documents and access to all other business applications via the Application Launcher. This makes the Application Launcher a very powerful part of the user interface.

- **API**

Application Programming Interface that allows programmatic access by any application program to Exaquantum information.

- **Archiving (of historized data)**

The process of moving historized data into separate database than Historian database so that the portion can be managed independently; i.e. backing up onto an external medium, putting into offline state or back into online state.

B

- **BDC**

Backup Domain Controller. Windows network component to back up the *PDC* whenever the *PDC* fails.

- **BLOB**

Binary Large Object. A user-defined binary data structure which is set and interpreted by the application program; this is used by the Historian to store data efficiently.

C

- **Closing**

To finalize and store aggregations at the end of an aggregation period.

- **COM**

Component Object Model. A standardized way of linking software components, from possibly different vendors.

- **Configuration Tools**

The tools that configure and maintain Exaquantum.

- **Control System**

PC or computer based system that controls manufacture plant operations. They are real-time, required high reliability and availability. From Exaquantum viewpoint, they are primary data source, and additionally data sink when data write function is concerned.

D

- **Data Selector**

A tree-view of all available data in the Exaquantum system used for selecting data items by drag-and-drop in Explorer and Excel Add-In.

- **DCOM**

Distributed Component Object Model. Software components that reside on physically distributed computers.

- **DCS**

Distributed Control System. A *Process Control System (PCS)* that employs multiple computer units at different locations in the plant.

- **Design Mode**

Documents can be created in Design Mode using data received from the *PCS*, etc. Facilities such as layout editing and scripting are available in this mode.

- **DST**

Daylight Saving Time.

- **Document**

A document is a user-interface screen developed in Exaquantum/Explorer.

- **Domain Configuration**

A Windows Domain network configuration, which requires some Exaquantum configuration. Domain is used to simplify the management work of user accounts in mid-size to large network systems.

- **Dynamic**

Continuously changing or updated (i.e. 'live').

E

- **Embed/Nest**

Insert an object created in another application that supports *OLE* (such as Microsoft Word documents).

- **Embedding**

A form of copying in which the copied object resides in the destination file only, with no link to the source file, but can be edited using the same tools available in the source file. Changes made to an embedded object exist only within the destination file and do not change the source file from which the object was copied. Likewise, changes made to the source file are not reflected in the embedded object.

- **End User**

The customer for, or user of, the completed, configured Exaquantum system.

- **Equalization**

It is used to generate tags/function blocks data structure by way of OPC browse interface by which a candidate tag list is retrieved from the *OPC server*.

- **Exaopc**
Yokogawa's OPC server product.
- **Event**
An asynchronous generation of a message caused by the change of state of some resource or process.
- **Event Message**
A message generated typically by the *PCS*, to inform users of an abnormal condition or of a significant process occurrence.

F

- **Folder**
A folder is used to hold or contain *tags*, *function blocks*, or other folders. It provides a hierarchical naming service to locate *item data*.
- **Flat Tag**
A tag structure that has no relationship with other tags, and is located below a folder.
- **Function Block**
A function block is the generic term used to refer to the two-level structures used in *Exaquantum* to provide a meaningful function as a whole.

In some contexts, it may refer to a Yokogawa CS data structure that is meant to provide a control and monitoring function. This is also two-level structure.
- **Function Block Template**
A set of information to describe the structure and properties of function block. It consists of name, member tags and their definition and tags default values.

G

- **GUI**
Graphical User Interface; user interface software using graphical techniques. (Now commonly known as the *User Interface* (UI).)

H

- **Historian**
The Exaquantum component responsible for long term data storage.
- **History Stream**
The total history of a given history type which is available for *item data*; the stream is represented by RTDB column.
- **Historized Values**
Data that has been stored in the *Historian*.
- **HMI**
Human Machine Interface.
- **Hot Spot**
An area that can be activated by a mouse click.
- **Hyperlink**
A *hotspot* that allows the user to jump to another location. The location can include another file on the hard disk or company's network, an Internet address, or a location such as a bookmark or slide. The *hotspot* includes display text (which is often blue and underlined) that the user clicks to jump to the specified location.

I

- **IIS**
Microsoft's web Server product (Internet Information Server).
- **Instance**
Used to address a piece of information in contrast to class. It has a name linked to a physically existing object, and all of values that compose the object as a whole.
- **Intranet**
Internet technology used on a Local Area Network that provides similar services within an organization to those that are provided by the Internet outside the organization.
- **Item**
The lowest data level in the Exaquantum system. All items have a *value*, *timestamp* and *quality* code.
- **Item Data**
All data stored for an *item*.

J**K**

- **Key Performance Indicator (KPI)**
Calculated values related to the performance of the plant or equipment.

L

- **LIMS**
Laboratory Information Management System. An external system that manages all aspects of process laboratory work.

M

- **Multiple Document Interface (MDI) Functionality**
A Windows application that allows many documents to be open at the same time. Exaquantum/Explorer inherently provides an MDI.
- **Mimic**
A screen display that indicates the layout of a plant or process.
- **MMC**
Microsoft Management Console.
- **MV**
Manipulated Variable.

N

- **NLS**
Native Language Support.

O

- **Offline (of history data)**

History data that has been removed from Historian database, and hence not accessible by the programs.

- **OLE**

Object Linking and Embedding. See *ActiveX controls*.

- **OLE DB**

Microsoft-defined interface protocol and standard, which allows access to various types of source data in the form of structural two-dimensional array.

- **Online storage (of history data)**

History data that is part of Historian database and accessible by programs.

- **OPC**

OLE for Process Control; a defined set of interfaces, based on *OLE/COM* and *DCOM* technology.

- **OPC Server**

OPC servers implement OPC COM objects and their interfaces. An *OPC* client can configure the rate at which an OPC server should provide the data changes.

P

- **Palette**

A list of available colors, drawing and user-interactive controls etc for use in an Exaquantum/Explorer *document*.

- **PCS**

Process Control System. See *Control System*.

- **PDC**

Primary Domain Controller; a Windows network component that manages user account information in a centralized way.

- **PID**

Proportional Integral and Derivative Controller. Most often used control scheme within control system. It provides three types of feedback control capability as the name suggests.

- **PIMS**

Plant Information Management System. A computer system for managing information within a plant.

- **PLC**
Programmable Logic Controller. A *PCS* using programmable logic devices.
- **Production Calendar**
The business and operationally significant time periods which Exaquantum must be aware of in order to perform sensible calculation of *aggregation* values at the appropriate times.
- **Product Tools**
Also known as *Configuration Tools*.
- **Property**
A single *attribute* or parameter of an object.
- **Property (of an item)**
The aspects of an *item* that can be changed.
- **Property Sheet**
Displays the properties and events of the currently selected control or document. Allows the configuration of any parameters for a control.
- **PV**
Process Variable.
- **PVI**
Process Variable Input. A data and functional unit designed to monitor process status. Used in Control System.

Q

- **Quality Code**
A 32-bit chunk of information (see *VTQ*). The lower 16 bits represent *OPC* status (Primary Quality). The higher 16 bits represent a sub-status (Secondary Quality).

R

- **Raw History**
A history type used to address source of data within the RTDB.
- **Reference Data and Reference Items**
These are static and rarely change. They are the fixed attributes of a *tag*, e.g. the Description, Engineering Units or Engineering Range.
- **Report**
Any textual or graphical way of representing Exaquantum data.
- **Run Mode**
Documents created in *Design Mode* can be run and interacted with in Run Mode.

S

- **SCADA**
Supervisory Control and Data Acquisition (usually with *PLCs*).
- **Scripting Language**
A programming-type language that allows Exaquantum/PIMS and Exaquantum/Explorer's capability to be customized and expanded.
- **Server**
Computer holding master files and data for distribution to other computers.
- **Snap-to-grid**
Enables objects in an Exaquantum/Explorer *document* to be aligned with a grid when building the *document* (in Exaquantum/Explorer *Design Mode*).
- **SQL**
Structured Query Language; a universally used standard language developed by IBM for issuing queries/interacting with a database.
- **Support Tools**
A group of tools developed for advanced users of Exaquantum.
- **System Log**
A log file used to store all system activities.
- **SV**
Setpoint Value.

T

- **Tag**
A basic set of information within Exaquantum that is made up of *items*. There are three types of tags – OPC, Manual and Calculated.
- **Tag Generation**
This is a set of four programs that create and update large numbers of *tags* at one time. The program used to perform the task is determined by the type of source information.
- **Tag Template**
A set of information that describes structure and properties of *tags*.
- **Timestamp**
A property of an *item*, indicating the time of the value.
- **Trends**
Changes in values of measured parameters over a period of time, usually displayed in graph format.

U

- **Update Rate**
Rate at which data is updated (usually in seconds).
- **UTC**
Universal Time Co-ordinated. The same as Greenwich Mean Time (GMT).
- **User Interface**
Programs that allow user interactions such as showing data, updating data and triggering functions to be performed.

V

- **Value**
The part of the *VTQ* that represents the value of an *item*.
- **VTQ**
Value, Timestamp, Quality; a triplet that comprises an item.

W

- **Wizard**
A small program that assists the user in performing an operation, usually with pre-defined default values that can be changed if necessary.
- **Workbook**
Workbooks are used to specify the active document, and to control the start up and configuration options of documents in Run mode.
- **Workbook Viewer**
Shows the hierarchy of folders and files within the current workbook directory and in shared directories.
- **Workgroup Configuration**
A type of Windows network configuration where user account information and access security control is configured in each of composing PCs.
- **WYSIWYG**
What You See Is What You Get.

X

Y

Z

- **Zoom Feature**
Enables the user to select an area of interest and enlarge it.

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Revision Information

Title : Exaquantum Plant Information Management System Overview
Manual No. : TI 36J04A10-01E

Nov. 2000/2nd Edition/R1.01

All pages revised.

Oct. 2001/3rd Edition/R1.10

All pages revised.

May 2002/4th Edition/R2.01

All pages revised.

July 2003/5th Edition/R2.02

Updated with changes to software and environment.

August 2004/6th Edition/R2.10

Updated with changes to software and environment.

April 2006/7th Edition/R2.20

Updated with changes to software and environment.

February 2007/8th Edition/R2.30

Updated with changes to software and environment.

Written by Yokogawa Marex Limited

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Japan
