Technical Information

FAST/TOOLS
Technical Product Description

TI 50A01A20-01EN

YOKOGAWA

Yokogawa Electric Corporation
2-9-32, Nakacho, Musashino-shi, Tokyo, 180-8750 Japan

Blank Page

Introduction

About this document

This document is designed to provide a reader with an overview of the capabilities and functionality of the FAST/TOOLS software package. A technical reader will gain an introduction of how the package is structured to give the foundations for further reading. It gives the reader an appreciation of today's automation application requirements in various industries can be met with a high performance, functionally advanced package such as FAST/TOOLS. This FAST/TOOLS Technical Information (TI) document provides an extensive overview of the core software functions itself as well as of its user environment and architecture such as (web) clients, (web) servers, redundancy, access and security. It is also taps into some of the configuration, engineering and diagnostic tools commonly used when building applications. These tools are used to speed up the engineering process and to ensure the delivery of reliable systems. More application-oriented information can be found in the various application notes that are available. These notes give examples of actual FAST/TOOLS solutions in various industries and locations around the world. More detailed technical information can be found both in the Instruction Manuals (IM's) and in the on-line help functionality of FAST/TOOLS.

Trademark

Trademark

- FAST/TOOLS is a registered trademark or a trademark of Yokogawa Electric Corporation.
- All other company or product names appearing in this document are trademarks or registered trademarks of their respective holders.
- We do not use TM or ® mark to indicate those trademarks or registered trademarks in this manual.

FAST/TOOLS
Technical Product Description

TI 50A01A20-01EN 7th Edition

CONTENTS

Blank Page

1 Introduction

FAST/TOOLS is Yokogawa's web-based real-time information management and visualization software environment that brings together our process management infrastructure, automation expertise, and ecosystem support for greater efficiency and improved operational agility. It can be deployed from traditional SCADA applications up to Enterprise Automation Solutions.

Broad application range

This rich production and process supervisory software can be utilized to monitor main production facilities such as petrochemical complexes and power plants, as well as sub-processes such as utilities, reactors, tank farms, and loading and offloading facilities. FAST/TOOLS is successful in critical applications for production visualization, alarm management and measurement analysis due to its very stable design, support of redundant and nonstop systems, it's very high performance and on-line configuration possibilities. These properties contribute to high efficiency and high quality production processes.

Corporate-wide automation environment

FAST/TOOLS features an intuitive design that works with all Yokogawa solutions, allowing it to serve as a corporate-wide automation environment (enterprise control system). It offers enhanced data acquisition, system integration, and remote operations. Furthermore it accommodates the deployment of information to subscribers through a secure cloud service that is always up to date, thereby increasing overall efficiency and eliminating the need for the exchange of paper documents.

Single, easy-to-use user interface

Dashboards can deliver cross-referenced information on business performance factors along with e.g. data on energy efficiency, carbon emissions, and direct cost savings that can be used to determine the effectiveness of efforts to reduce energy consumption and waste, and monitor compliance with environmental standards.

A single, easy-to-use user interface allows in addition to regular process visualization (standard operator desktop) for the integration of the document management, video/CCTV, maintenance, and other software environments required for all communication and collaboration needs.

High performance and platform independent architecture

The design is based on platform independent architecture and supports multiple configuration options from single node solutions to multi-node client/server systems to easily tailor it to the end user needs. The software package is scalable from less than a hundred to more than a ten million I/O points, and supports many industry standards such as OPC, ODBC, HTML5, XML, to integrate with enterprise assets, such as RDBMS and OSI-PI environments.

2 System Overview

2.1 Monitoring & Control Solutions Platform

FAST/TOOLS provide solution possibilities in a wide range of monitoring & control execution applications where, for example one or more of the following requirements apply:

- Multiple Process Site environments
- High level (KPI) Management and Supervision
- Remote management and operations
- Alarm Management and Analysis
- Integration of (3rd party) PLC/RTU based control systems
- Wide Area (Media independent and Intermitted) communication
- Low bandwidth communication
- Migration and integration of (3rd party) (legacy) systems
- Integration with Application packages such as Batch Tracking, Leak Detection & Allocation.
- Disaster recovery and high availability architecture requirements
- Closed loop control performed by subsystems
- Relatively high content sequential (logic) control
- Open Commercial-Of-The-Shelf IT infrastructure and security requirements
- Where information needs are distributed according to the needs of the users
- Centralized data gathering with associated Alarm & Event management
- System wide real-time and historical trending and reporting
- Extensive mobility solutions for (smart phone and tablet use)
- Production forecasting and predictive asset management.
- Diagnostic, Tuning, Optimization and analysis of (raw) data

These characteristics are often seen in, Oil & Gas production and transport, infrastructure, utilities monitoring and control and high performance manufacturing applications. It also allows the flexibility of combining different types of systems to provide hybrid solutions, both on new and existing sites (green and brown field development).

2.2 Function Overview

The list below provides a first brief grasp of the functions that can be covered by FAST/TOOLS based system solutions. These subjects are presented in more detail in the subsequent paragraphs and sections of this TI document.

2.2.1 Web-based Environment

FAST/TOOLS offers a very rich environment for distributed HMI's with zero deployment functionality for centralized system management.

- Benefits include:
  - Client Applications can be start from any web-browser.
  - No need to manage licenses and software installations on the client side
  - Remote engineering capabilities
- For light users with tablets and smart phone only a HTML5 compliant web browser is required, which most widely adopted products are supporting today.
- Increased responsiveness, performance and interactivity of distributed HMI clients is achieved by exchanging small amounts of data with the server "behind the scenes".

2.2.2 Layers and Visibility Groups

- All dynamic and static information of all display objects are represented and traced in a structured and easy to navigate tree.
- Information can be logically grouped through the support of dynamic layers & visibility groups. Benefits include:
  - Process flow diagrams can be designed in one layer, detailed instrumentation in second and electrical schemes in a third layer, etc.
  - Different user groups (i.e. Engineers, Maintenance, Operators, Plant Managers) can be authorized to see and/or access specific layers as controlled by FAST/TOOLS.
  - Application & system details can be turned on and off triggered by security settings, process conditions and zoom levels
  - Advanced trending/display capabilities with fast and smooth panning, zooming (with clutter/de-cluttering based on zoom detail levels), layering, 3D, etc. functionality.

2.2.3 Secure

FAST/TOOLS leverages standard and proven web security techniques as administered by IT departments like:

- Network Centric Computing (for example Citrix XenApp).
- VPN Tunneling Token & Username/Password (level 2 security), Biometric fingerprint (Level 3 security).
- Built-in endpoint scans and policy controls which takes into account each user's role, device characteristics and network conditions to determine which applications and information they are authorized to access.

2.2.4 Service-driven

- Service driven system architecture with web based push technology and SOA (Services Oriented Architecture) principles. The software allows assignment to its web services interface and can connect to web services of 3rd party applications.

2.2.5 Alarm Management and Analysis

- Multi-page alarming functionality with sorting & filter options (Microsoft Outlook style) based on priority, time, etc. adjustable acknowledgment/reset options, rerouting of alarms, delaying, Repeating which can be optionally distributed externally to mobile devices as well. (Tablets, Smartphones, etc.)
- An enhanced Alarm System Performance Analysis environment, to define key performance measurements, to analyze the behavior of the alarm system and present this from different angles, compliant to the EEMUA 191 and ISA/ANSI 18.2 standards

2.2.6 Engineering Efficient

- On and off-line editing (adding/removing) of graphics, item (tag-) definitions, reports, I/O drivers with test & Simulation functions.
- Object oriented engineering; create templates and symbols once and use them as many times for current & future application configurations.
- Object oriented graphics with rich animation capabilities; no need to update symbols separately. A single change in a parent symbol will update (scheduled) all child symbols application wide.
- Direct animation on drawing elements and shapes which can be activated and changed in their properties
- Shapes and symbols can be intuitively manipulated in virtually any way. Examples of this are sheering, rejoining, add/subtract and reforming.
- Engineering sheets (toolbox, properties, actions, parameters, etc.) can be sized and ergonomically organized as appropriate and comfortable to the user.
- Report distribution to remote locations.
- Microsoft Excel Add-in for (Real-time!) external report publishing to HTML5 for web based reporting.

2.2.7 Communication

- Communication scheduling, based on time or availability of communication lines for geographical dispersed PLC/RTU-stations.
- Automatic data-archiving of historical data on all common used back-up media and data clean-up to guard sufficient availability of disks space.
- Unlimited I/O (the largest working systems have over a four million field I/O in a single system environment).
- Over more than 1000 different I/O drivers can run in parallel on one server.
- Open interfaces (OPC, ODBC, SQL, XML, HTML5) both Client & Server e.g. used for reporting/ MIS functionality /Web-enabling and customer RDBMS integration.
- Fine-tuning & Diagnostic tools to optimize performance.
- Media independent Communication support over e.g. Fiber Optic, Wireless radio, Satellite, GSM, GPRS, etc.
- Time synchronization from GPS towards subsystems including time distribution to other nodes using NTP.

2.2.8 GIS Integration

FAST/TOOLS Web based structure allows embedding dynamic GIS maps in its operator environment. GIS maps can be related to and synchronized with operator mimics in FAST/TOOLS and made (in)visible or transparent as a layer in the FAST/TOOLS operator environment. This enables the user to:

- View GIS maps in FAST/TOOLS
- Display process conditions on GIS maps
- Synchronize GIS data to FAST/TOOLS projects
- Avoid duplicate/incorrect data entry
- Multi-level graphical display of GIS & FAST/TOOLS data

This approach to GIS integration eliminates the need for manual updates of GIS information in a SCADA system. Updates can be fully maintained at the GIS and are linked into the Web based HMI of FAST/TOOLS. GIS Integration is a Tokuchu function.

2.2.9 RDBMS Engine

The traditional way in FAST/TOOLS for getting data sets into foreign database systems is to use its ODBC interface which connects directly to the FAST/TOOLS Data Set Services (DSS) layer. This is a powerful feature for connecting FAST/TOOLS data into the familiar office environment. In practice however this can introduce a performance hit when complex queries are performed; particularly joins that do not use database keys, since the internal database is primarily optimized for fast storage which has first priority securing field data under all circumstances.

2.2.10 Trending and Reporting

The FAST/TOOLS trend component provides outstanding trend visualization capabilities for all real-time and historical FAST/TOOLS data. The user interface is very intuitive and allows for fast open and closed trend configuration in a few minutes. FAST/TOOLS also provides an extensive library of ready-to-use trend templates. It only requires connecting an item to the pen and the trend is ready to run. Besides the trend templates it is possible to make customized trends or adjust the trends from the library. The three types of trends in FAST/TOOLS are:

- Real-time trends
- Historical trends
- X-Y Plots

2.2.11 Enterprise Automation

For large scale geographically dispersed projects, there may be a hierarchy of individual Process Automation Systems, which in turn are each responsible for a specific region, and are managed by a higher level system. For these applications FAST/TOOLS provides a flexible, scalable architecture for EAS, by supporting multi-level/multi-node configurations. It is possible to balance server functions over multiple machines, for example for data acquisition or for supporting many HMI clients. This architecture lends itself very well to Enterprise wide remote operations, - monitoring and - maintenance projects for dispersed production sites and supply chain infrastructures such as oil and gas fields, pipeline grids, water distribution, energy generation, etc. This delivers strong benefits in improved safety, reductions in operational costs and more efficient production management.

2.2.12 Application Integration

FAST/TOOLS allows integration of information from all kinds of data sources such as video streaming (CCTV, CAMs), URL (Internet/Intranet), databases, spreadsheets, documents, etc. These sources are available as standard components that can be applied with minimal configuration effort.

2.3 Scalable Architecture

The FAST/TOOLS architecture allows for true scalability accommodated through a flexible open system architecture and modular software approach that can be easily extended when application needs expand. Besides its scalability the architecture of FAST/TOOLS seamlessly integrates with other Software and Hardware solutions from YOKOGAWA such as its CENTUM-VP DCS, ProSafe-RS Safety Controller, STARDOM RTU, NetSol products, PRM Asset Management and ExaQuantum PIMS software. Also seamless integration with many other 3rd party software and hardware solutions is standard available.

2.3.1 Flexibility through open system Design

FAST/TOOLS is not limited to stand-alone systems, but allows distributed functionality and caters for environments where system availability is a prime issue by various redundant configuration concepts. Networking can be configured fully redundant e.g. redundant networks between servers and HMI's (Users) and between servers and PLC or RTU. In the following paragraphs examples of the typical supported architecture concepts are provided combinations of these can be freely made to build fit-for-purpose system architectures.

2.3.2 Standalone architecture

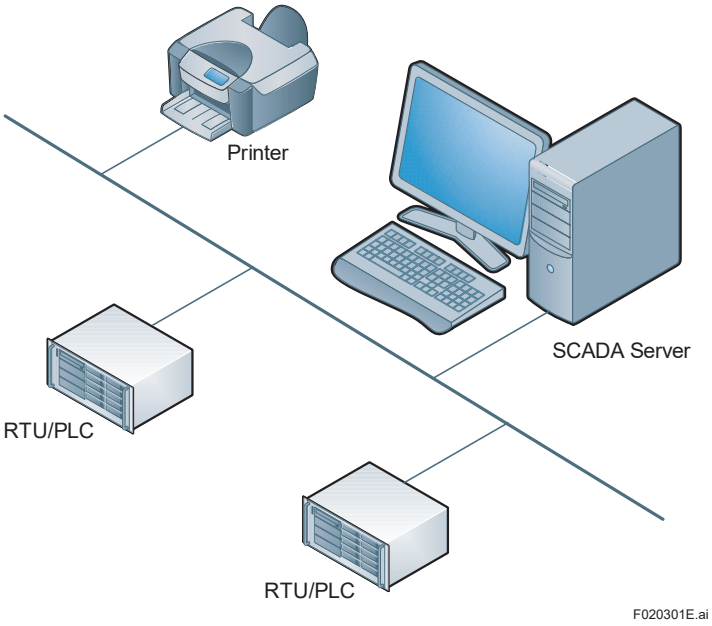


Figure 2.1 sample architecture: 'standalone' concept

In a stand-alone configuration (see figure 2.1), the roles of Web HMI Server/Client, Application Host Server and Front-end are actually combined in one physical computer system. In a distributed configuration the roles of Web HMI Server/Client, Application Host Server and Front-end are often mapped one to one on separate physical computer systems. However, it is also possible to combine these roles in one and the same physical computer system (for example a physical computer system that acts as Application Host Server and Web HMI Server/Client component). This type of configuration may be used for relatively small applications where it is acceptable to have only one combined Web HMI Server/Client station for data acquisition, operator supervision and engineering.

2.3.3 Distributed Web HMI Server/Client Architecture

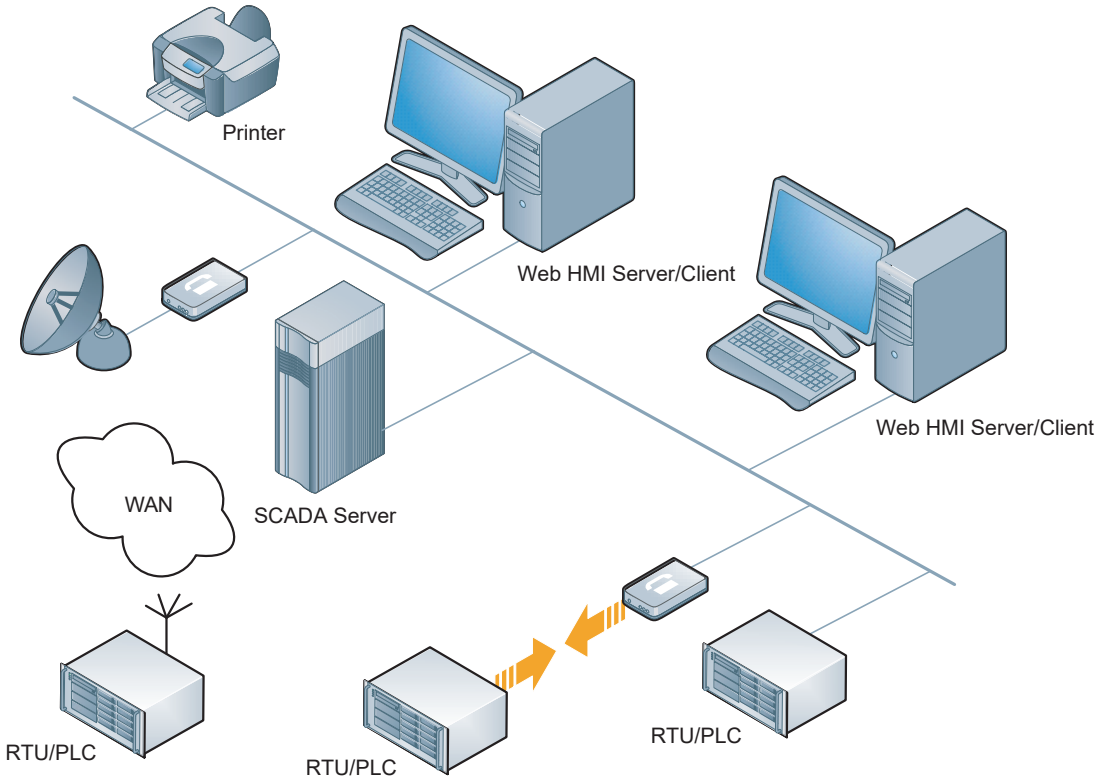


Figure 2.2 sample architecture: distributed Web HMI Server/Client concept

The 'Distributed Web HMI Server/Client' concept (see figure 2.2) allows for more scalability. It is based on running the data acquisition, applications and real-time database environment on a dedicated heavy duty Server while running the engineering and operations environment on one or more dedicated Web HMI Server/Client computers. This type of configuration may be used for fairly large applications with many RTU/PLC controllers randomly located at different geographical locations.

2.3.4 Remote Web HMI Client Architecture

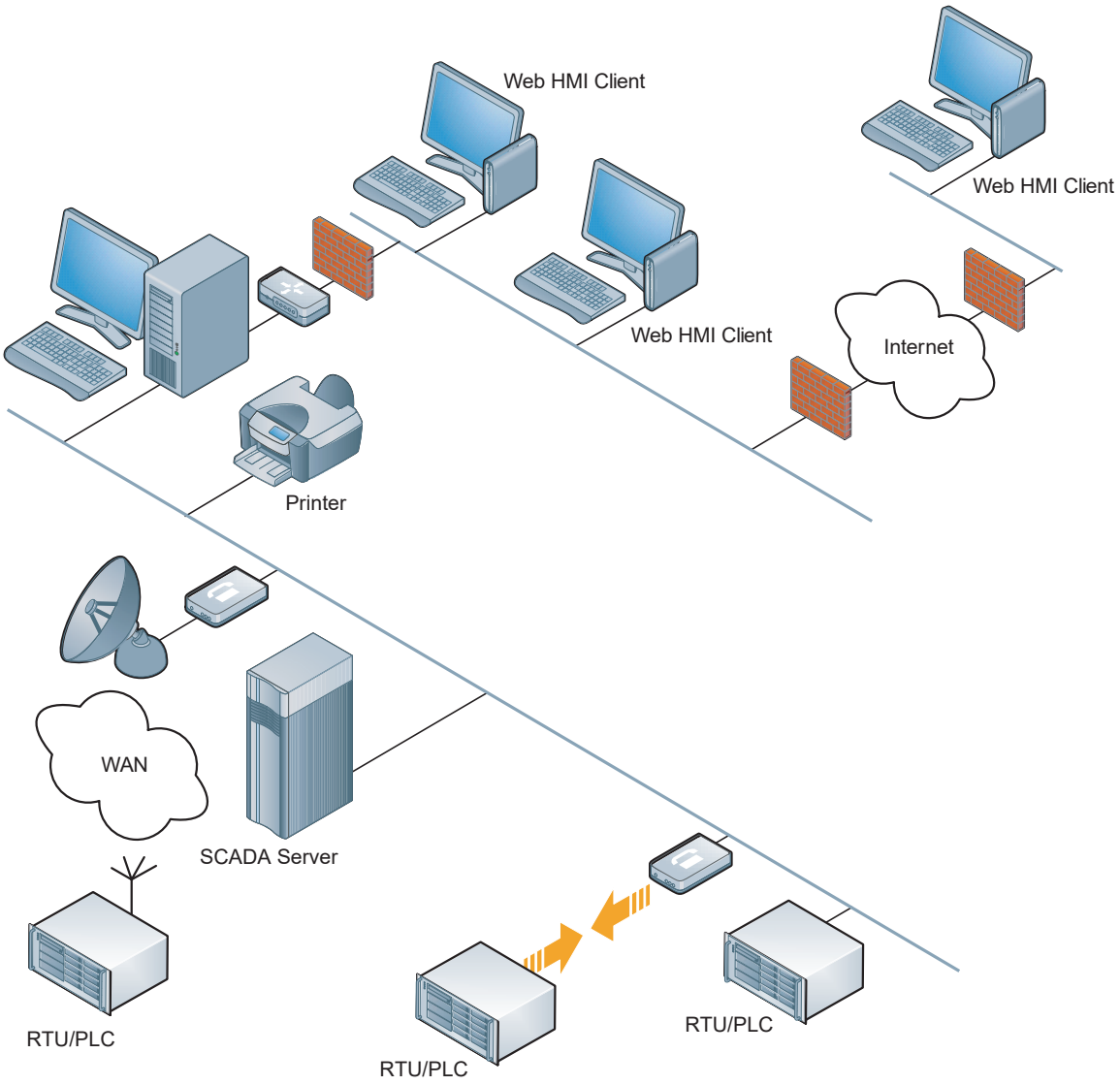


Figure 2.3 sample architecture: 'remote Web-HMI client' concept

The 'Remote Web HMI Client' concept (see figure 2.3) allows for enhanced HMI flexibility and negligible cost for maintaining remote clients across geographically dispersed locations. It is based on running a Web HMI Server on a dedicated computer serving its associated remote Web HMI Clients. These Web HMI Clients can be easily deployed on any computer device at any location over LAN, WAN and VPN networks. Local software installation and license registration is not required (zero deployment), while it is initiated through a standard supported Web browsers. This type of configuration may be used for applications when many 'light' and/or remote users need a real-time window into the visualization environment.

2.3.5 Host-to-Host Architecture

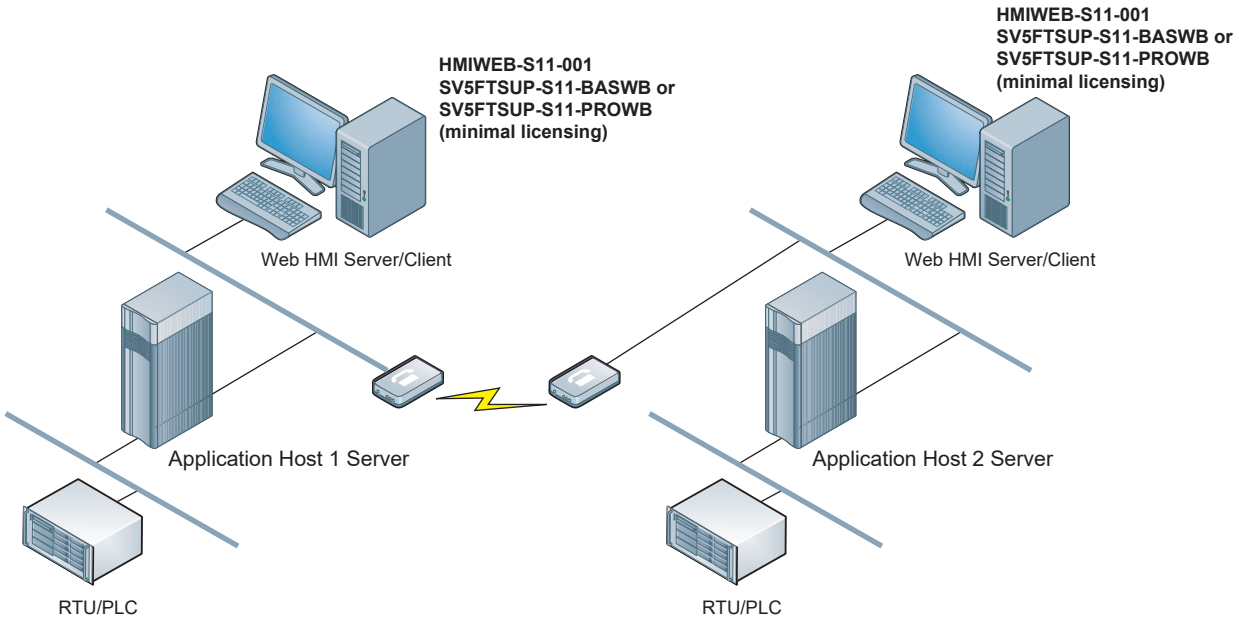


Figure 2.4 sample architecture: host to host coupling

The ‘Host to Host’ concept (see figure 2.4) allows for loosely coupling two or more autonomous FAST/TOOLS systems to exchange or synchronize ‘real-time’ data across independent system domains. This type of configuration may be used for applications where several systems at a central or across dispersed process locations need to be fully independent in terms of maintainability and operations, while at the same time exchange key data with other (high level master) FAST/TOOLS Servers.

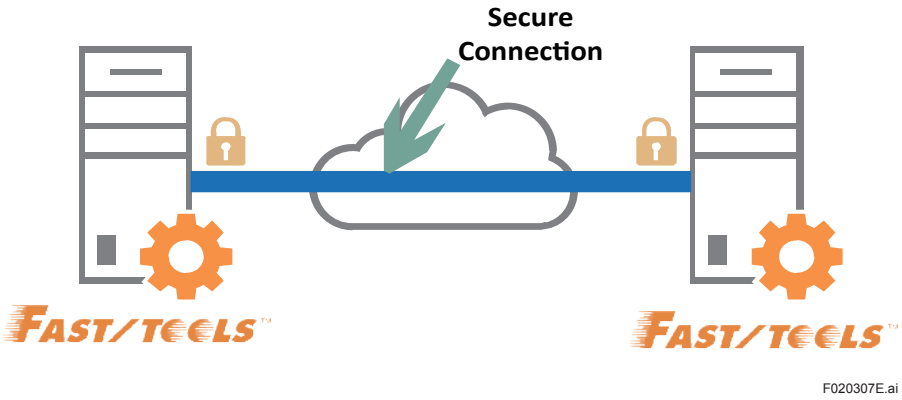
Secure Host to Host communication

To support high levels of data and system security within FAST/TOOLS is there the possibility to encrypted host to host communication as a second level of defense and security besides IT based services such as the native integration with Active Directory Services. Communication encryption between two FAST/TOOLS Systems can be set between two FAST/TOOLS nodes or between the RGS and one FAST/TOOLS node.

FAST/TOOLS Host to Host security is based on industry standards that are also used for secure communication on the Internet, such as SSL, DTLS, TLS and public/private keys.

This provides an enhanced level of safety encrypted communication between the different FAST/TOOLS systems.

Encrypted network communication (AES-256) is supported for: Host Server, Web HMI Server, Web HMI Client and Enterprise Servers connections.



F020307E.ai

Figure 2.5 Host to Host encryption between two nodes

2.3.6 Enterprise Architecture

For large scale geographically dispersed projects, there may be a hierarchy of individual Process Automation Systems, which in turn are each responsible for a specific region, and are managed by a higher level system. For these applications FAST/TOOLS provides a flexible, scalable architecture for Enterprise Automation Solutions, by supporting multi-level/multi-node configurations. It is possible to balance server functions over multiple machines, for example for data acquisition or for supporting many HMI clients. This architecture lends itself very well to Enterprise wide remote operations, - monitoring and - maintenance projects for dispersed production sites and supply chain infrastructures such as oil and gas fields, pipeline grids, water distribution, energy generation, etc.

In ISA-95, the functional levels of an Enterprise Control system are defined. Note that the levels presented in the sample architecture on the next page relate to a physical business model in which a company consists of a headquarters, regional offices and local offices. All these locations can contain systems which together form the Enterprise Architecture. This should not be confused with the automation levels defined in ISA-95, in which the logical information layers of a control system are defined. In the Enterprise Architecture, four major levels are identified (see sample architecture on the next page). Each level has its typical characteristics and usage.

Corporate level

At the corporate level, all KPI's and other process data of all the business units are collected and aggregated providing a holistic view of the performance of the enterprise and its operational groups down to process level in real-time.

Business unit level

The business unit level is typically responsible for all areas within the business unit. The business unit contains a FAST/TOOLS server node that exchanges KPI's and other process data with the Area level. At the business unit level, users are expected to have access to data that is supportive in optimizing production of individual as well as interrelated assets.

Area level

The area level supervises all processes within a graphical area to provide control over this area. It contains a FAST/TOOLS server node that is connected to all DCS and/or SCADA systems at the process level. A typical application at this level is to control the total amount of production within the area, and to supply production KPI's.

Process level

The process level contains local DCS/SCADA/PLC systems or other automation control/ monitoring equipment that directly interacts with the process. As an example a typical large gas production platform that is controlled by a DCS system and exchanging process information with the area level.

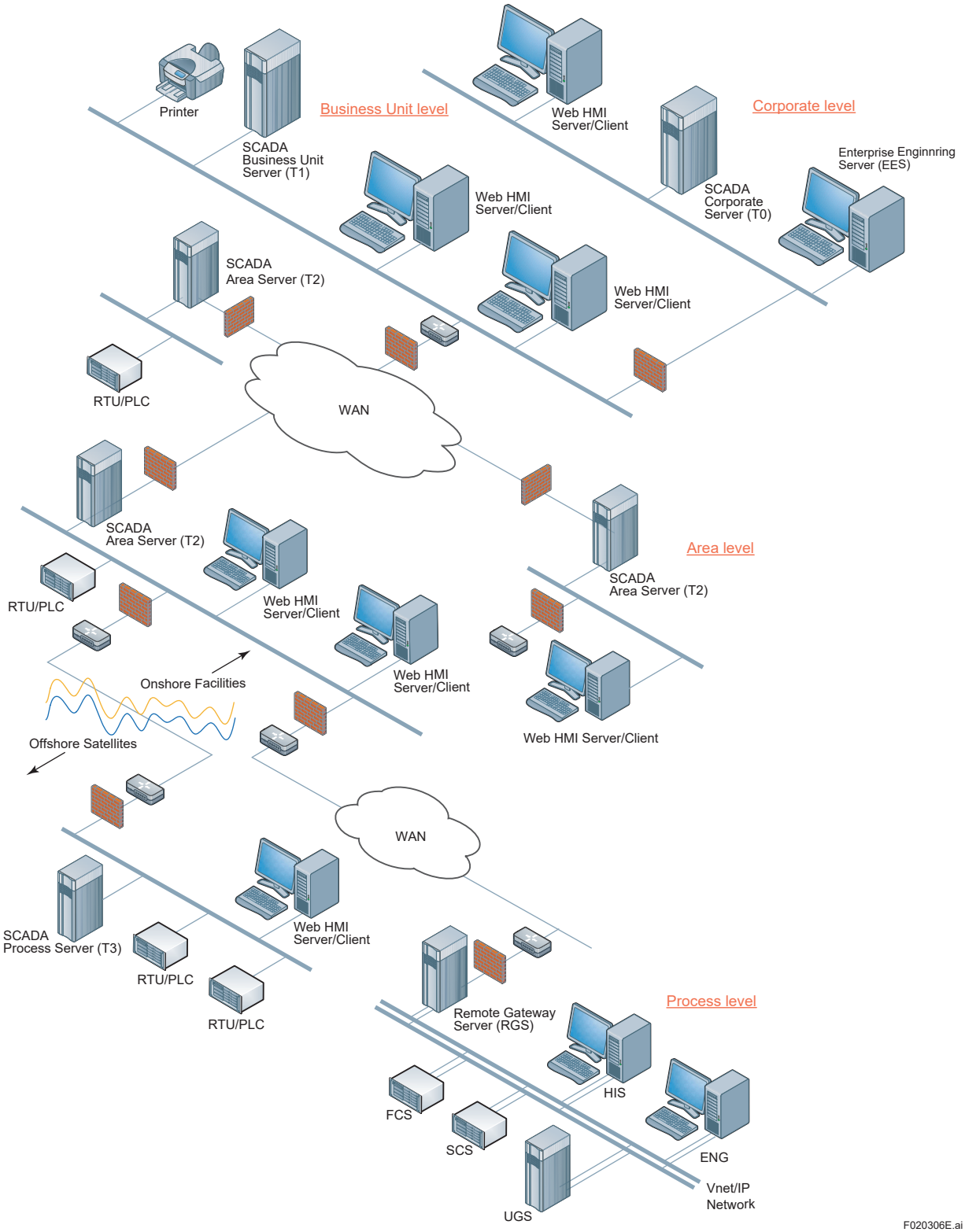


Figure 2.6 sample architecture: 'enterprise system' concept

The above sample of a typical Enterprise Architecture provides an impression of the flexibility to compose fit for purpose enterprise wide automation system integrated architecture. This functionality is offered without compromising on the autonomous operation of the individual server nodes that can directly serve information from all levels to a single visualization environment.

2.3.7 Media Independent Communication Capability

FAST/TOOLS supports many dedicated PLC/RTU driver protocols developed for data acquisition, to enhance communication performance and reliability. FAST/TOOLS can provide direct communication links to various brands of DCS/PLC/RTU on the same server. It also has many proven communication interfaces through Fibre Optics, serial lines, Wireless Radio, Satellite, GSM, GPRS, PSTN and Wifi. Furthermore FAST/TOOLS uses industry (embedded) standards such as OPC, XML, ODBC, and HTML5. to connect to 3rd party products.

2.3.8 Application Scalability

FAST/TOOLS systems have been realized in a range from 50 I/O points to more than a few million I/O points. Field inputs can be easily organized as unique items based on multi-level item/object tag names up to 128 levels, and 255 characters in total e.g. “Country.Region.Plant.Area. Section.Unit. …… Tag (item)”. Each item can be “blocked” to disable nuisance alarms when the related field equipment is on maintenance, or can be put “off-scan” to allow future equipment to be engineered into the system without actual scanning of the related field signals. Item value updates that are monitored/controlled on local as well as centralised server nodes can be updated on the HMI clients from both levels though an automatic communication path resolving mechanism. This provides a transparent cross enterprise visual ization environment.

2.4 Object Oriented and Efficient Engineering

Object Oriented is the programming paradigm in FAST/TOOLS using “objects”, (instances of classes or templates) which consists of methods together with their interactions, to design your application environment. This means that for instance a control symbol is made once (or taken from the template library) and used as many times through-out the system as required. This Allows for rapid deployment and modifications during both the engineering phase and system lifecycle phase.

2.4.1 Engineering Efficiency

Plant equipment (e.g. block valves, pumps) can be organized as objects with defined properties and characteristics. The defined objects can be easily propagated to the entire wide area application by assigning a unique tag number to each object. A ‘Quick-load’ configuration utility is available to build the application database from the plant database in e.g. MS Excel/Access. These unique engineering functions save engineering time and reduce errors, especially for larger systems and for future extensions.

2.4.2 Online modifications 24/7

Modifications or adding/deleting configuration data and objects can be also done online without the requirement to stop/reboot the system. This applies for almost anything in the system such as tags, objects, symbols, classes, templates, graphics, etc. Bulk modification can be done via the so-called “quick-load” utility. Exports out of live systems can also be done for comparison and analysis. While loading the configuration changes, FAST/TOOLS continuously check’s the “quick-loaded” data. Errors in configurations will be reported instantly, stopping the loading process or prompting the user to skip or correct the error(s).

2.5 Modular Software Design

The basic functions of FAST/TOOLS are delivered through its Web-based graphical User Interface for process visualization, data acquisition, interaction with field equipment, connectivity with application packages, real time event/alarm management, Trending, Reporting, Data Analysis, Playback and storing the real-time and historical information. The FAST/TOOLS package is furthermore accompanied with system installation and configuration tools, a data management system and real-time networking for communication between the modules. Optionally modules, with specific required functions, can be added as a plug-in to the networking layer.

The minimal configuration of a FAST/TOOLS system comprises the following modules:

- BUS/FAST (Secure and media independent real-time communication layer)
- ITEM/FAST (Module that manages the real-time database)
- DATABASE/FAST (Module that manages all item/history/alarm definitions)
- EQUIPMENT/FAST (Module that manages all I/O-driver actions to field equipment)

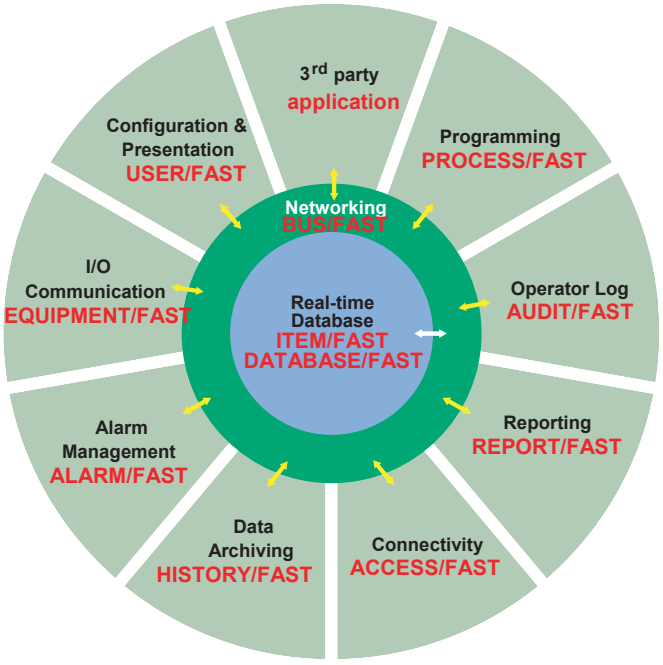


Figure 2.7 FAST/TOOLS Modular Structure

The following modules (see figure 2.7) are connected to the bus (BUS/FAST) in order to provide the full scope of functionality that FAST/TOOLS standard offers:

- ALARM/FAST (Module that handles all alarming functions)
- HISTORY/FAST (Module that takes care of saving item data, alarms, reports, audit data)
- AUDIT/FAST (Module that manages audit definitions and the data to be audited)
- PROCESS/FAST (Module that allows object oriented engineering of tasks)
- REPORT/FAST (Module that manages all report definitions and generations)
- ACCESS/FAST (Module that manages the ODBC/OPC interface)
- USER/FAST (Module that supplies the configuration & Graphical User Interface)

FAST/TOOLS comprises in a minimal configuration the modules as summarized above which connect to the communication data bus called BUS/FAST. The real-time database is one of the modules that connect to the internal bus. All FAST/TOOLS modules are event based and submit their events to the bus. The bus passes these events to modules that are subscribed to these events. This means that a running system normally has a very low CPU-load and can be based on low entry Commercial Of The Shelf equipment.

2.6 Availability

FAST/TOOLS support full communication and application redundancy in a fully “High Availability Computing” (HAC) environment, independent of applied communications media and system server hardware. There are several features available in FAST/TOOLS for building HAC system configurations combined with advanced guidance tools for some typical setups. The HAC features are divided into dedicated functional parts, each fulfilling a specific role.

Regarding Dual-redundant Platform for Computer, please see GS 50A01A10-01EN.

2.6.1 Failover/Fallback

The High Availability Computing (HAC) software module will take care of handling Dual, Triple, Quad redundant servers and redundant hard drive configurations (RAID), independent of applied communications media, geographical distance, different domains, and system server hardware. And with functionalities to manage which server is active and which server is standby and how and when to switchover to a specific standby server.

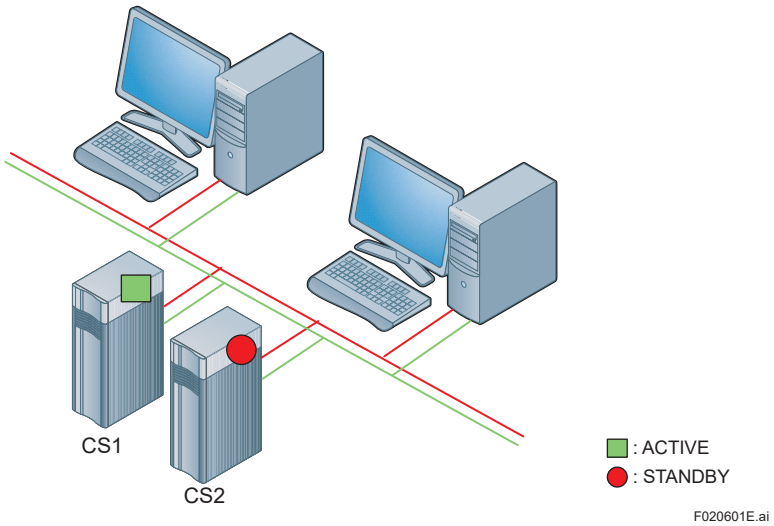


Figure 2.8 FAST/TOOLS High Availability Computing (HAC)

Initial Status

When a redundant server combination is initially started they will always start up as a HOT STANDBY server. The servers in a redundant configuration are of equal value, when the system starts initially and both servers are STANDBY the server that has been assigned as the PRIMARY server will become ACTIVE and the other (SECONDARY) server will remain in STANDBY mode.

Up and Running

Once a redundant server combination is up and running, one server will be running the application suite in its entirety, whilst the other server will be running a minimum set of FAST/TOOLS functions sufficient to monitor its own system and its associated redundant counterpart. The server that is running the full real-time FAST/TOOLS environment is said to be the ACTIVE server and all application functions will be handled by this machine. The other server that is running the minimum set is said to be the HOT STANDBY server and does not provide any application functions. Failover and fallback is transparent to the user and does not require dispatchers moving to the fallback location.

System Recovery Time

The system recovery time depends on the system configuration and the hardware used. The switch-over time (under 5 seconds) is not based on the time required to switch but the time it takes to detect a fault, the number of retries, and then the decision to switch to secure & protect the systems stability. Also Fault tolerant (non-stop) running systems are supported and available to eliminate a single point of failure.

Island Situation

The ‘active’ server does not shut itself down in a bad health situation, but will be shut down by the ‘hot standby’ server. The only exception to this is when the server is in an island state. This means that the server detects that it has no connection to the partner, no connection to any other network devices and so is isolated from the rest of the world. In this case it has no connection to the field and no-one to shut it down, so the server will shut itself down in this case after a predefined timeout.

High Availability Computing in practice;

1. Operational mode

During normal operation HAC will run in automatic mode. Only for maintenance reasons HAC will be put in manual mode.

2. Primary, Secondary and more HAC servers

A main Server (1) at the Primary location will be the Primary server as default and a second Server (2) at the Recovery location as fallback. The Seconday server will have second priority and Server (3) at for instance the back-up (BMS) location will be the tertiary server having third priority and so on with “X” locations.

3. Switchover conditions

In case of a critical failure the active server will switchover to one of the standby servers based on priority. Also the standby servers are continuously monitored for failures. In case of a failure on the standby server it is not possible to switch to this server and the failure will be alarmed to the operator.

In general various system nodes are monitored at Server level which comprises of multiple Operator Stations available locally over LAN, various network devices monitored for their availabilty, critical processes are being monitored for their failure or their queue filling up with messages or when the CPU load on a server is too high for a too long period of time indicating a potential problem. Hence a switchover will take place based on above mentioned monitoring & diagnostics conditions.

The mechanism is as explained below for managing e.g. Triple redundant servers manually.

In normal condition CS1 will be priority 1, CS2 will be priority 2 and CS3 will be priority 3 for active application server mode. Normally CS1 will be active, CS2 will be standby and CS3 will be standby mode.

When the server is in Manual mode, then its active / standby status will not change on its own whether other server is active or not. Its status can be changed to active or standby only manually. When two servers are active, the server that holds a higher priority will remain active and other one will reboot to become standby.

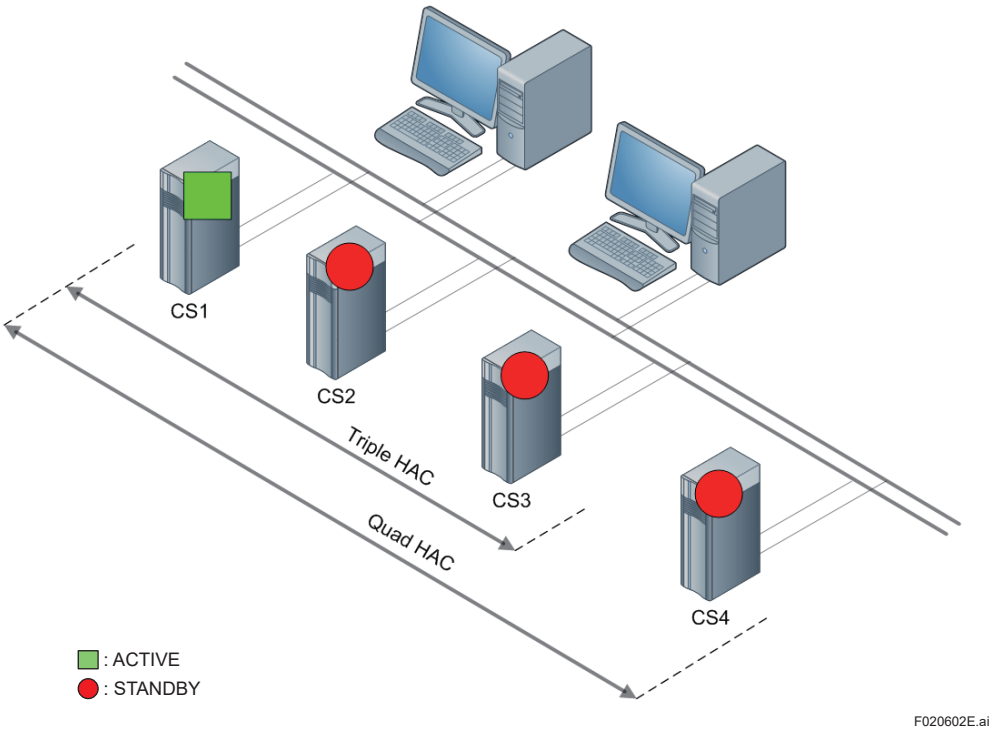


Figure 2.9 FAST/TOOLS Triple and Quad HAC support

When the server that hold a higher priority is in auto mode and standby, its status will change to active status automatically only when the the other active server fails or its status is changed from manually to standby.

In case CS2 to be made active, then the steps will be as follows

- Take CS1 into Manual mode
- Change the mode of CS1 to Standby
- CS2 will become active automatically
- Take CS1 to Auto mode

In case CS3 to be made active with above state (CS1 Standby, CS2 Active) then the steps will be as follows

- Take CS1 & CS2 into Manual mode
- Change the mode of CS2 to Standby
- CS3 will become active automatically
- Take CS1 & CS2 to Auto mode

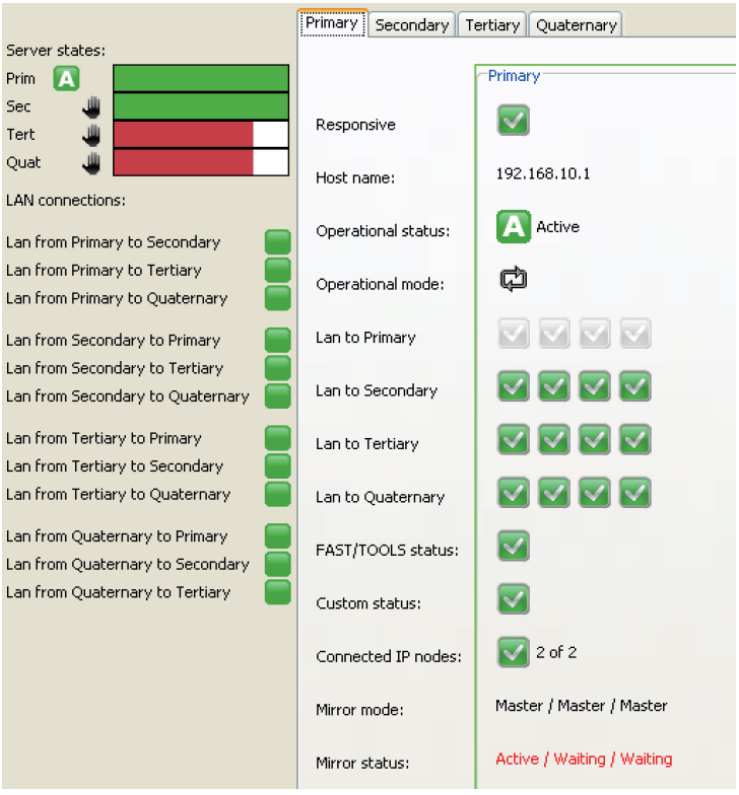
In case CS1 to be made active with above state (CS2 Standby, CS3 Active) then the steps will be as follows

- Take CS2 & CS3 into Manual mode
- Change the mode of CS3 to Standby
- CS1 will become active automatically
- Take CS2 & CS3 to Auto mode

The above mentioned philosophy will be similar when availability is supported across multiple physical or virtual servers.

4. Watch-dog

A “watch-dog” feature runs on each of the servers in a redundancy cluster. The Watchdog takes a number of critical inputs relating to the health of the ‘active’ system and of the ‘hot standby’ system. It decides whether the system is sufficiently healthy to carry on and take the least intrusive course of action to recover from any failure, or last whether the redundant server should be brought online. The Watchdog takes the following inputs as a basis for determining the health of the system:



F020603E.ai

Figure 2.10 FAST/TOOLS Watch-dog for HAC clusters

Current Application Host Server health:

- Current state of the network connection to the hot standby server(s)
- Availability of network devices
- Results of custom scripts

The watchdog can support the following configurations:

- Up to 4 network interfaces
- Up to 20 IP device checks
- Provision for periodic checks using custom scripts as input to the health check

5. Data Synchronization

Data is being synchronized continiously using integrity updates (initial full synchronization at start-up) and then by exception. To allow for a good startup of the standby server it is essential that this server is up to date with the most recent information from the active server. This means that critical databases, files and folders are to be synchronized from the activer server to the standby server. This is an automatic process between Active and Standby servers with necessary logs incase of any database synchronization problems.

2.7 Virtualization

Virtualization is a way to make more efficient use of today's high-performance CPUs, by allowing the software to you run multiple servers on the same hardware. One or more (virtual) servers share computing resources under the control of a hypervisor. More servers on a machine reduce the need for physical servers, which reduces hardware, space and power costs. Virtual servers can also be moved across physical systems to further align available resources with demand.

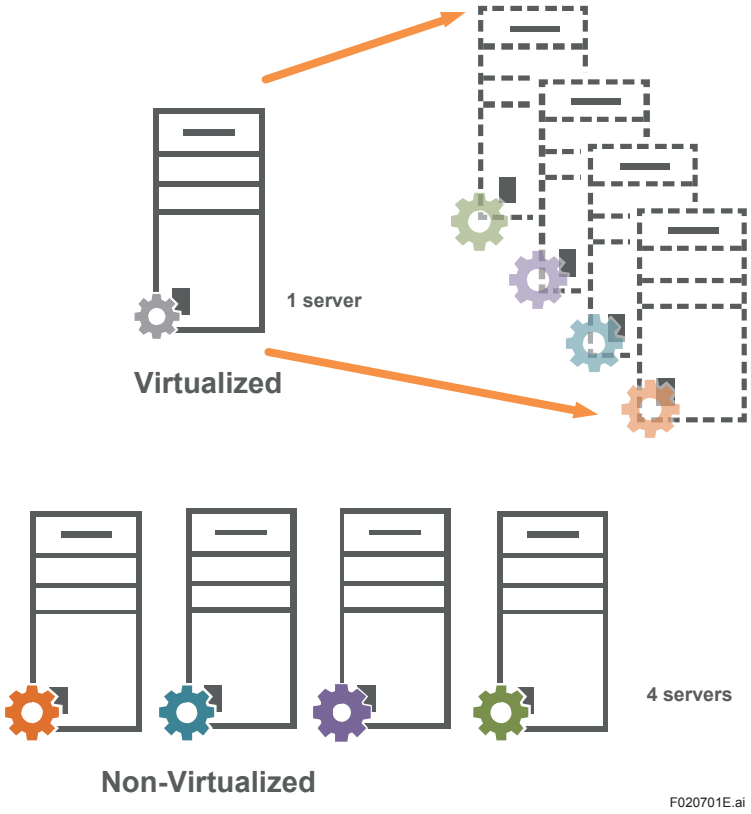


Figure 2.11 Virtualization of multiple servers on a single hardware platform environment.

Virtualization in the supervisory software environment is very viable and demand is increasing. FAST/TOOLS is providing solutions on integrated virtualized machines.

Virtualization in the general approach can be achieved by using market standard suppliers, such as VMware, which is recommended for FAST/TOOLS.

Virtualization gives many benefits, such as:

- Development purposes
- Enabling to run obsolete Operating Systems
- Efficient disaster recovery
- Performance differentiation
- Cost reduction in energy consumption

FAST/TOOLS uses a HMI Web Server architecture, where Engineering- and Operator Workstations access HMI Web Servers. This does not require high performance workstations and these environments are very suitable to be virtualized. Any virtualization environment can be used e.g. VM ware, Hyper-V, etc.

2.8 Cloud computing

Cloud computing is a service that relies on a highly virtualized physical infrastructure. In the cloud, applications generally run on virtual servers that are independent of the underlying hardware. (Indeed, a virtual server environment for your application can be one of the services a cloud computing provider offers.) But there's more to the cloud than virtualization, in that cloud computing is based on the concept of a "utility computing" service, where RAM, CPU cycles, storage and network bandwidth are commodities to be consumed on a "pay per use" basis, like water or electricity.

A cloud computing environment relies on many physical and virtual servers. It is configured in both hardware and software to provide high reliability and availability. Cloud based infrastructures are also very flexible and scalable, in the sense that an application can simply consume resources as needed.

2.9 Web Enabled

FAST/TOOLS has a truly Web-based HMI. All the workflow processes, business logic, and database links were designed after careful studies both technical and ergonomically. It's built to work autonomously with the most commonly used web browsers and can be extended with new applications.

F020901E.ai

Figure 2.12 FAST/TOOLS running in a standard Web-browser

Web-based applications can easily access legacy data on other platforms. Typically interactive, the application accepts input from the web user, processes the input, and displays the results.

2.9.1 Web-based HMI / Server

Applications and process information can be rapidly deployed to clients while the sources are easily maintained centrally on the host server(s). This so called "zero deployment" means that client applications can be start from any web-browser. By new update new version of the Web-HMI is available on the server. Benefits include faster application delivery and increased IT productivity based on broadly accepted secure IT technology.

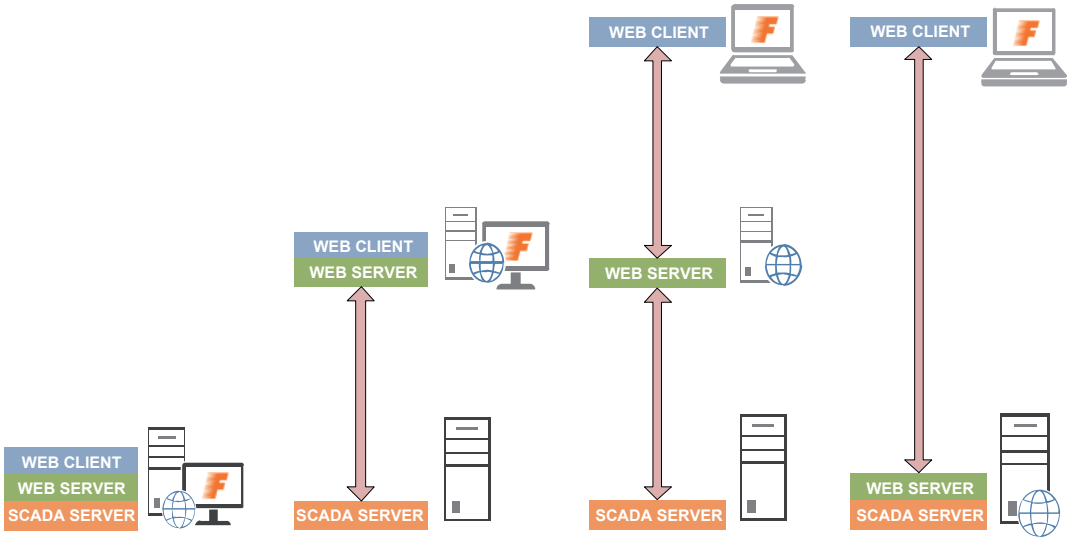
Other benefits of a web-based application are:

Information can be accessed anywhere an Internet connection is available. The information is 'real-time' (no waiting time for critical information). The information is more secure than it would be on a personal computer. Upgrades containing new functions and enhancements are free and automatically deployed there is no need to manually install software or license keys. Today Web-technologies are used more and more. Instead of specific client programs, Web browser environments become a user interface, a HMI, to an application.

F020902E.ai

Figure 2.13 Web-Based Visualization

The FAST/TOOLS Web HMI consists of a Web HMI Server and a Web HMI Client that can either run separate from the FAST/TOOLS Server or be installed altogether with the FAST/TOOLS Server environment on a standalone node. Installing the Web HMI Server on a separate node has the advantage that load can be shared between the FAST/TOOLS Server and Web HMI Server.



F020903E.ai

Figure 2.14 System Software Distribution

For Web HMI Operator Stations both Web HMI server and client are advised to be installed and maintained on the same machine as represented above.

FAST/TOOLS Web HMI client can run the follow modules:

- Operator Interface module
- Engineering module
- Edit module

2.9.2 Zero Deployment

In a configuration with Remote Web HMI Clients each Web HMI Client connect to the Web HMI server over the office LAN and get automatically loaded and updated with their specific HMI environment (called a zero deployment see figure 2.15) which is maintained at the Web HMI server.

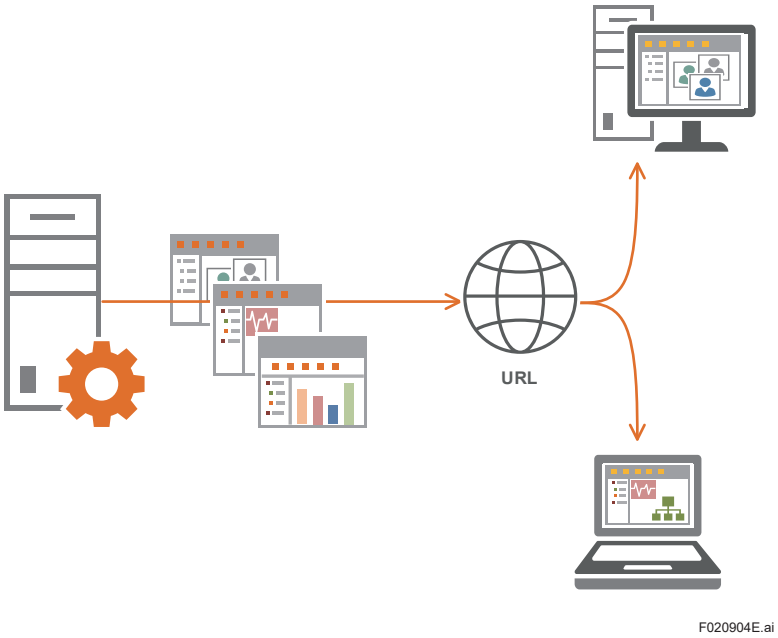


Figure 2.15 Zero Deployment Application Delivery

This allows for maximal scalability and flexibility with respect to remote operations and load sharing. Benefits are:

- Client Applications can be start from any web-browser
- No need to manage licenses on the client side
- Remote engineering capabilities

Benefits include faster application delivery and increased IT productivity through a broadly accepted technology which is positioned to leverage standard and proven web security techniques as administered by IT departments.

2.10 Mobile Devices

Besides the currently supported web-based clients for PC platforms, an HTML5 web environment is available that provides diagnostics, alarms, and process graphics over the cloud to tablets and smart phones. While the functions are slightly limited in comparison to full-blown web-based clients, rich functionality is provided for mobile devices, allowing anytime/anywhere access, with all appropriate authorization and security, through browsers (Google Chrome). This allows for quick data analysis and decision making.

2.10.1 On-demand and Real-time access

It provides On-demand and Real-time access to corporate data, with the appropriate authorization and security in place, to view trends, reports, diagnostics, KPIs, etc. via mobile devices/smart phones basically anywhere, everywhere.

It's helping users to see their data in rich graphics, allowing them to interact, perform quick data analysis and decision making at hand for any discipline in the workforce.

2.10.2 HTML5 and SVG deployment from the HMI

The mobile device environment is based on the HTML5 and SVG standard which supports for the latest multimedia environments. Graphics can be "saved-as" HTML5 for deployment to mobile devices.

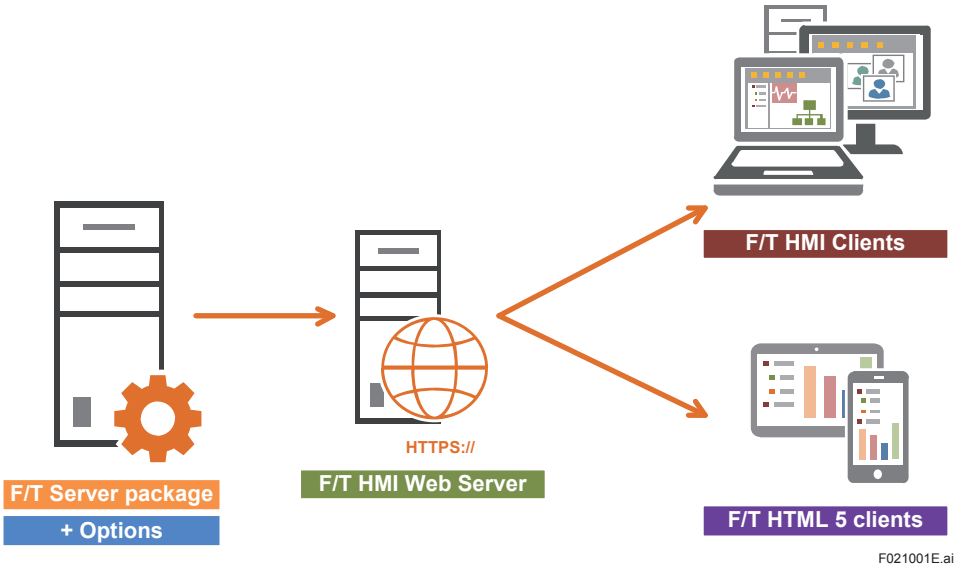


Figure 2.16 FAST/TOOLS support on Mobile (smart) devices

2.10.3 End-users capabilities

In terms of purposes we can think of mobile systems that enables remote modifications, maintenance and real-time management of process applications via secure web-based services, thereby increasing overall equipment efficiency (OEE) and return on assets (ROA).

2.10.4 Benefits for Mobile

- Improve operational awareness
- Accelerate troubleshooting on the spot
- Faster decision making
- Supports mobile collaboration networks across multiple disciplines

2.11 Alarm System Performance Analysis (ASPA)

Alarm Systems are an essential element of any SCADA Control and Management System. Although often seen as obvious they provide the vital support to operators for any particular application by attracting the attention to those situations that need corrective measures or procedures. With the introduction of more intelligence into process installations and integration of information from other systems into the SCADA environment (i.e. asset management, business and planning) there is an increasing variety and quantity of alarms. Without proper implementation of a good alarm philosophy operators will be flooded by alarms that exceed the recommended number of 10 per 10 minutes that can be managed within an acceptable time period. Yokogawa offers a very powerful Alarm Management System fully integrated into our FAST/TOOLS comprehensive Process Management System software. This system can accept sophisticated alarm philosophies to meet the requirements of any particular application taking into account the guidelines of the EEMUA 191 directives and the ISA 18.2 standard.

To measure the quality and effectiveness of the FAST/TOOLS Alarm Management System Yokogawa recommends ASPA (Alarm System Performance Analysis) which can be tailored to any specific application. ASPA supports the alarm system performance improvement processes to avoid operator overload and reduce the risk of critical alarms being overlooked, causing wrong or to late decisions putting safety as well as the continuity and quality of production at stake.

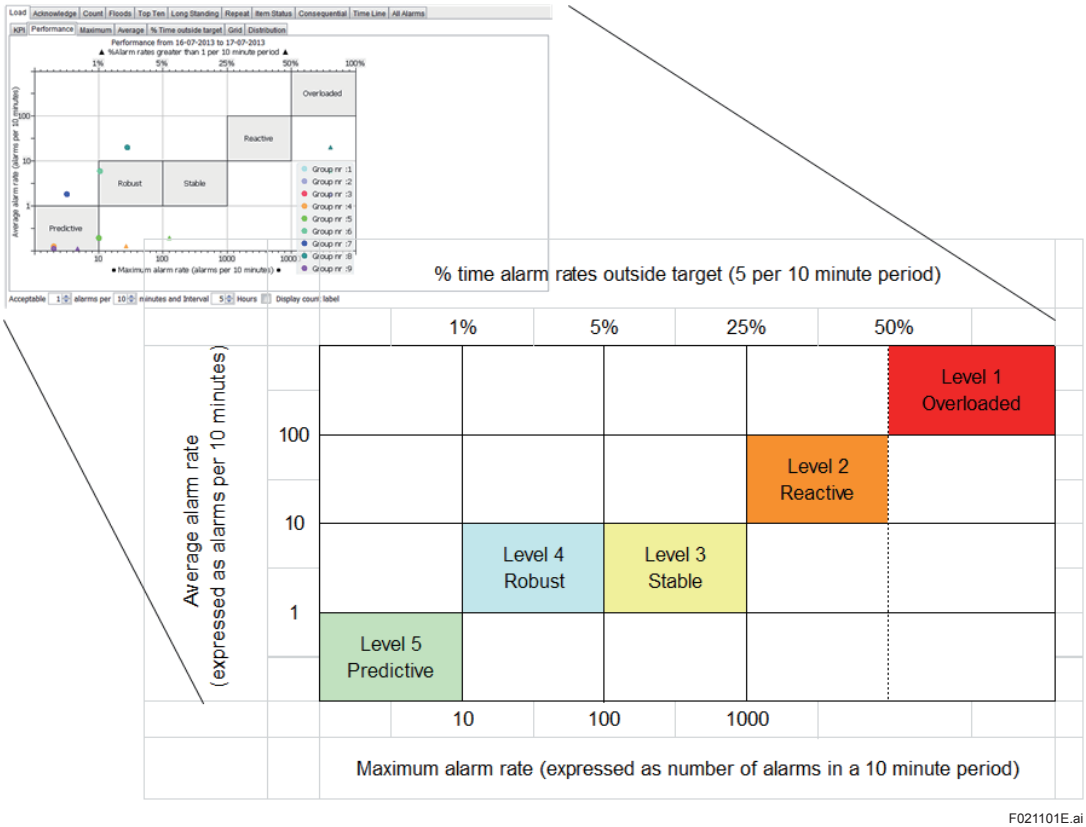
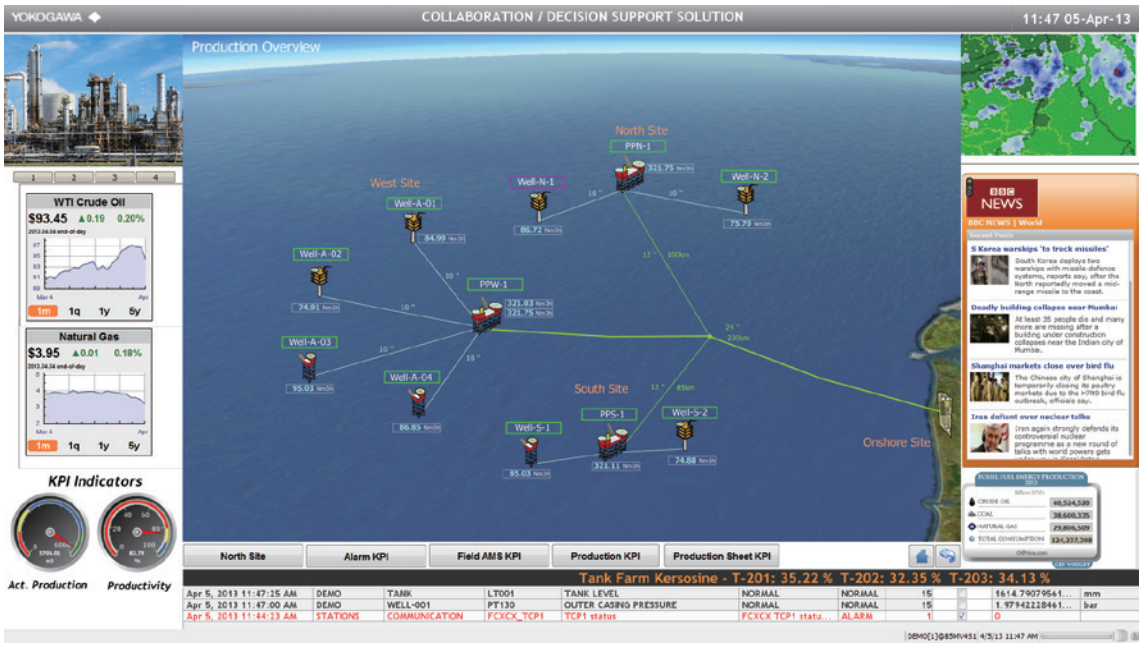


Figure 2.17 Alarm System Performance Results

ASPA metrics are the basis in the assessment of whether operators will find the alarm system easy to work with and does not exceed the ergonomically acceptable workload and quality. This is made visible by categorizing the state of the alarm system performance into five levels as defined by EEMUA 191. FAST/TOOLS ASPA identifies the worst case load during any ten minute time slice and categorizes this to alarm system performance levels in accordance with EEMUA 191 (see figure 2.17).

2.12 Collaboration / Decision Support Solution (CDSS)

The process industry (amongst others) is rapidly changing, driven by ever increasing pressures from legislation, competition from low cost countries, increases in energy costs and an aging workforce. From a process-automation point of view more agility and faster response is required by making decisions in real-time rather than through transactional processes and procedures. A significant benefit can be delivered through a tailored collaboration environment which can bring operational, maintenance and business information sources together in an integrated visualization and data collection context.



F021201E.ai

Figure 2.18 Integrated visualization and data collection context

This means that data from different sources needs to be interrelated and translated into information of the most elementary operational and business functions. From this top level overview it is possible to zoom in on the individual conditions to view their impact and relationship with the information and data they are derived from.

FAST/TOOLS Collaboration / Decision Support Solution (CDSS) delivers an environment that enables to better relate information in a visual context showing every impact on operational performance factors in a single view.

2.13 Platform Independency

FAST/TOOLS is an platform independent environment supporting various Windows platforms like Windows 10 and Window Server 2016, LINUX platforms like Red Hat and CentOS, and UNIX platforms like HP UNIX (on request).

Windows based systems and UNIX/LINUX systems can co-operate instantaneously. The best system-concept for any application is possible, e.g. a UNIX/LINUX servers for availability and stability in combination with Windows for the operator interface. Over the years FAST/TOOLS has supported many platforms and many systems are still running on other platforms. Ongoing attention is given to support the software on new operating systems as appropriate.

2.14 Performance

FAST/TOOLS is extensively tested on its software performance. Tests are conducted on low-entry Commercial-Of-The Shelf Systems to benchmark the performance. Systems are loaded and tested based on a system with over 16 million items in a database and over 150.000 items updates per second over a network. Test results show exceptional good performance with less than 5 % CPU load. Because FAST/TOOLS communication structure is event driven an update rate of these quantities of items is only applicable to very large system configurations.

With the fine-tuning tools FAST/TOOLS can be tuned to any specific application for optimized communications. For example, bandwidth restrictions in I/O-driver data transport can be optimized for improved throughput and reliability (which, in addition, reduces I/O-driver load on the system).

2.15 Security

To support organizations security policies, FAST/TOOLS and its applications are hardened to ensure protection against failures and help preventing unauthorized usage and access. Because of its transparent license policy, it is easy to take benefit of the cost savings from web based virtualization.

FAST/TOOLS Web based HMI server and client architecture provides easy remote access and security enhancements deploying reliably graphic and application services via secure web services technology. Apart from the standard operating system login account policies and/or hardware security solutions such as ID cards and biometric solutions such as Iris scan or fingerprints. FAST/TOOLS has its embedded security mechanisms.

2.15.1 Authorization levels

Users can be registered and assigned to privileges ranging from view-only up to full system configuration. During a FAST/TOOLS session in a single FAST/TOOLS environment, several users with different privileges can simultaneously have access to the application via username and password. For controlling functions the mechanism is to define a ‘process-areas’ for each area of responsibility users are assigned to. Items can be assigned to a process area (for a user or group of users) it should be allocated to for viewing and/or controlling. This privileging mechanism prevents operators from accidentally operating equipment beyond their responsibility. Key combinations can be blocked so that access to the Windows-environment is shielded off. Per user an initial start-up display can be defined and if the user is allowed to do configuration the possibilities can be limited. So, for example, for a certain type of user privileges can be set to change the low and high alarm while excluding him from changing the Low- Low and High-High limits. Additionally all these operator actions can be logged to network storage devices.

So basically all the privileges for a specific type of user are specified in user profiles which are defining as the:

Runtime Security:

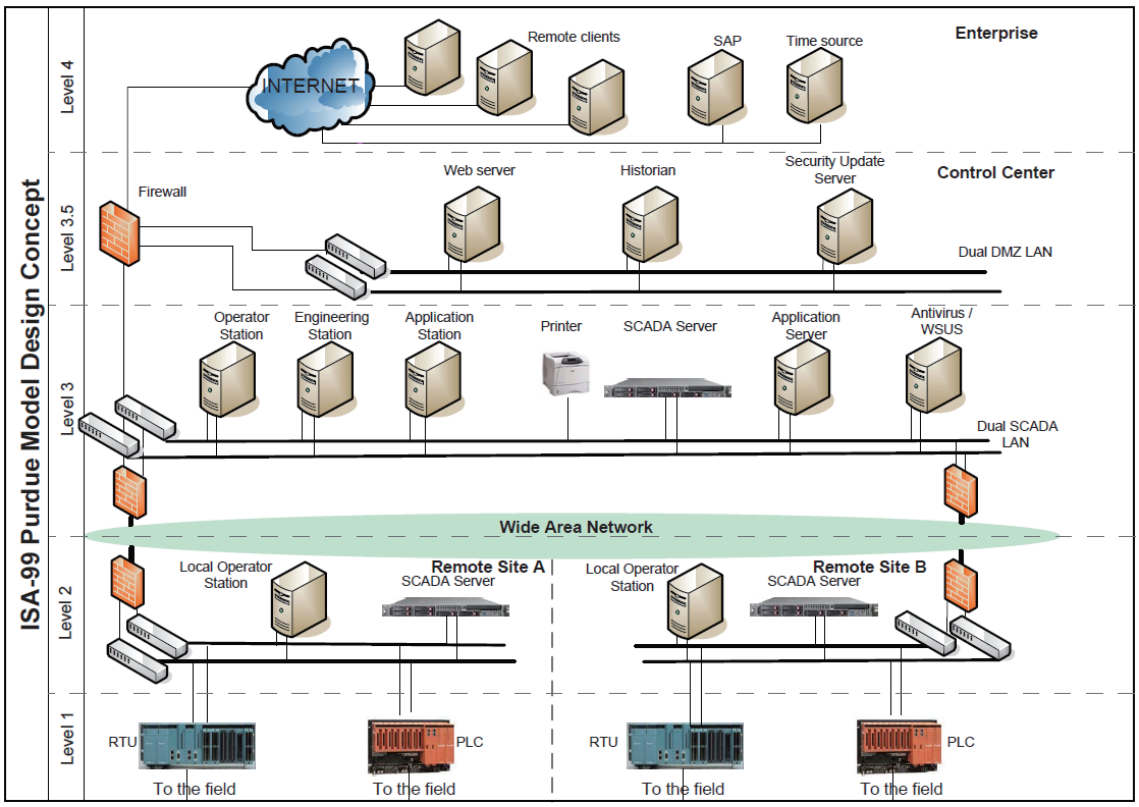
- login/password (application level)
- Process areas (items, displays, reports, etc. in access right groups)

Development/Engineering Security

- Authorization groups
- Which actions (delete, modify, etc.) are allowed on FAST/TOOLS definitions (displays, items, objects, classes, etc.)

2.15.2 Physical Segregation and Network Security

Besides the above mentioned security measures there are well developed Network Security Solutions, such as firewalls and Demilitarized Zones (DMZ).



F021501E.ai

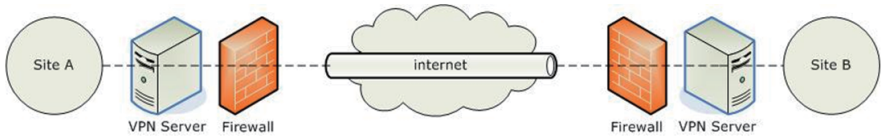
Figure 2.19 Network security levels according to ISA-99

When entering a different network level, securing the accessibility by placing a firewall on either site disables unwanted access. Yokogawa network security specialists advise to differentiate network Levels specified by ISA-99 (see figure 2.19)

2.15.3 Communication Infrastructure Security

FAST/TOOLS enable users to Monitor, Control and Engineer their application host systems in a wide geographical dispersed network configuration.

The FAST/TOOLS Web Server can be deployed at a great distance from the FAST/TOOLS Web HMI. Since the Web HMI's can run on any computer with a compatible Internet browser, transporting process data via the Internet requires well considered Cyber Security.



F021502E.ai

Figure 2.20 Virtual Private Network (VPN) connectivity

FAST/TOOLS mitigates the vulnerabilties by securing data transport using Secure Sockets Layer and if necessary equipped with a VPN connection (see figure 2.20).

2.15.4 Single sign-on

FAST/TOOLS supports synchronization with Windows user authentication processes and account settings in order:

- To avoid multiple logins for the same user, to Windows (or other supported platforms) and subsequent to FAST/TOOLS.
- To avoid complex user and user authorization maintenance.

SPNEGO Authentication

With single sign-on for HTTP requests, using the Simple and Protected NEGOtiation Mechanism (SPNEGO), web authentication is now supported which is a standard method for user authentication for web servers, including support for AD SSO from browser environments, Microsoft Excel, etc. It is a “pseudo mechanism” used by client-server software to negotiate the choice of security technology. SPNEGO is used when a client application wants to authenticate to a remote server, but neither end is sure what authentication protocols the other supports.

Users can securely negotiate and authenticate HTTP requests for secured resources in the FAST/TOOLS Host/Application Server by using the Simple and Protected GSS-API Negotiation Mechanism (SPNEGO) as the web authentication service for the FAST/TOOL Application Server. SPNEGO provides a mechanism for extending Kerberos to Web applications through the standard HTTP protocol. Kerberos is a network authentication protocol for client/server applications. Many types of clients connect to same web server, using different technologies that may not provide direct access to AD, especially browser based (e.g. HTML5, JAVA, Web Start).

FAST/TOOLS provides single sign-on for FAST/TOOLS Web Start and other client applications of the web server, specifically build for the HTML5 implementation.

(Fits current FAST/TOOLS single-sign-on implementation with Active Directory enabled systems)

2.15.5 Host to Host security

This functionality is described in paragraph 2.3.5 “Host-to-Host Architecture” of this TI document.

2.16 Broad application range

FAST/TOOLS is being applied as a fit for purpose solution for a broad range of applications in many industry segments. Some examples are:

- Pipeline Operations
- Upstream Oil and Gas Production
- Tank farms
- FPSO & Transportation Vessels
- Well Head & Manifold Platforms
- Tanker & Truck Loading & off-loading facilities.
- Infrastructure
- Power Transportation & Distribution Management
- Electrical Information and Control
- Wind and Solar panel farms
- Seawater Desalination
- Greenhouse (CO2) Gas Management
- Geo thermal heating/cooling facilities
- Dredger Control and Monitoring
- Mining & Minerals
- Water Distribution, Treatment, Storage and Supply

Bottom line is that virtually any Industrial Automation application can be addressed by FAST/TOOLS in combination with other Yokogawa fit for purpose solution portfolio's and products.

3. Visualization Environment

3.1 Human Machine Interface

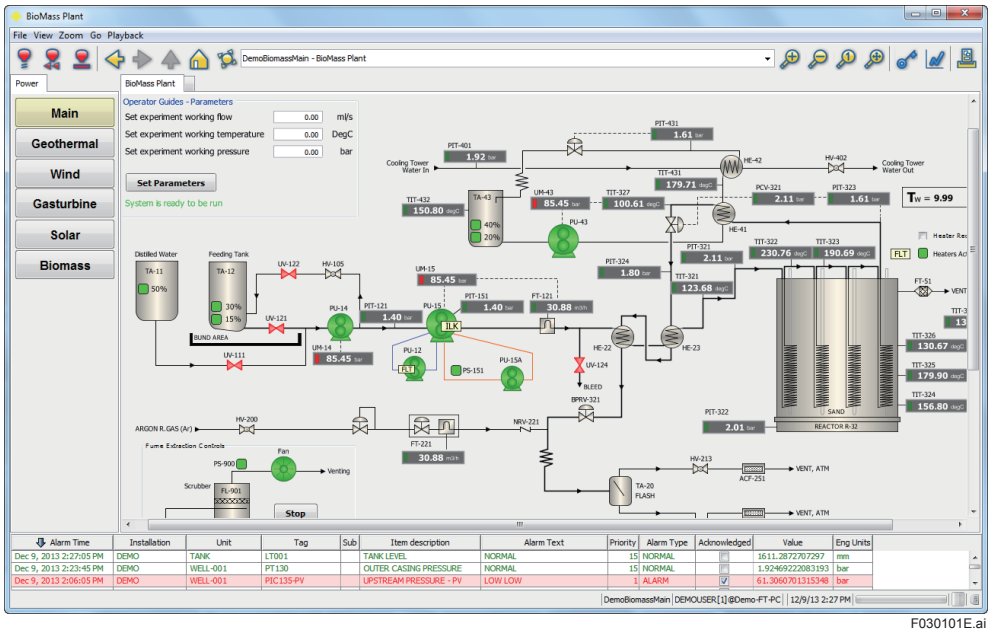
The Web based nature of the HMI environment of FAST/TOOLS allows operator to easily and intuitively navigate through the operator displays like a browser. The HMI is designed for remote deployment over wide area networks and delivers the benefits of incorporating todays best in class web technology and security mechanisms.

Some of the main benefits are:

- Minimum specification of Commercial-Of-The-Shelf hardware
- Centralized Server administration of software installation
- Load sharing through remotely deployed displays and distributed client/server architecture

3.1.1 Operator Interface

The benefits to the operator are ease of use provided by a common interface standard that allows the grouping of FAST/TOOLS data into logical categories such as process mimics, alarm and event views, historical and real-time trending, faceplates and reports (that can be step less zoomed and panned in 'real-time').



F030101E.ai

Figure 3.1 Web HMI Sample Operator Display

Furthermore process mimics can contain multiple dynamic layers and visibility groups which become active and visible depending on user privileges, process conditions, zoom level (clutter/declutter functionality).

Although the FAST/TOOLS HMI layout is freely configurable to meet specific application needs the basic elements and frames layout that can be enabled as part of the operator environment for supervision and control (see figure 3.2) are:

- Navigation panel
- Favorite's panel
- Zoom panel
- Multiple "tabs"
- Status information

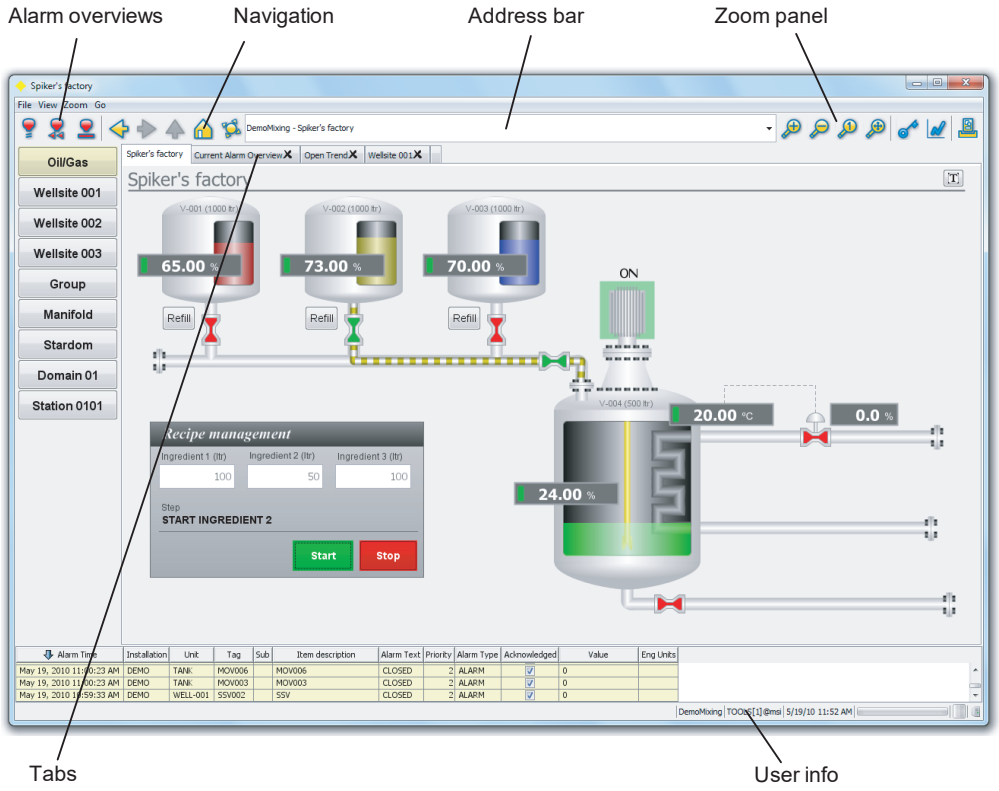
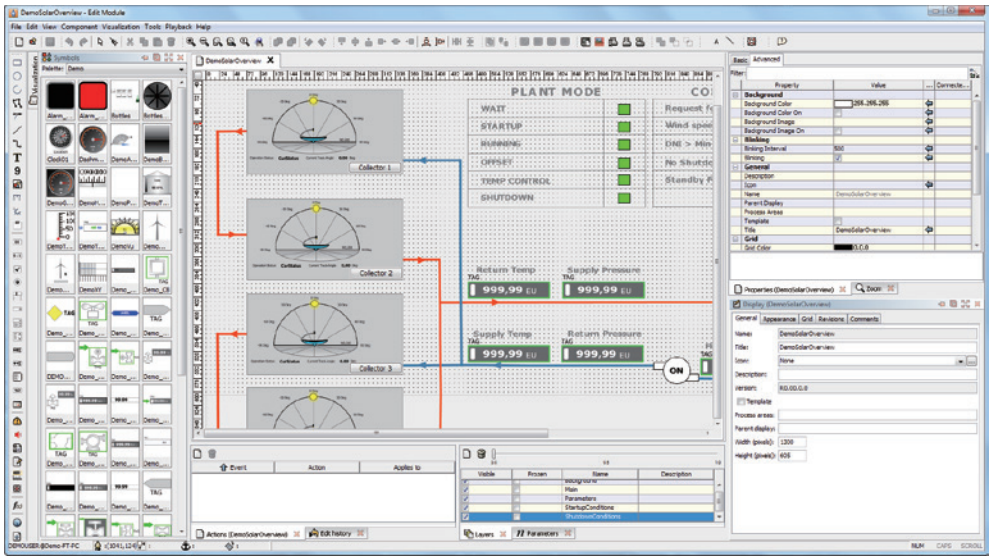


Figure 3.2 Web HMI basic elements

The FAST/TOOLS HMI menu and toolbar accommodates for advanced display navigation through browser history, menu's and direct display call-ups.

3.1.2 Visualization Editor

The FAST/TOOLS visualization editor is based on advanced scalable graphics shapes and symbols that can be intuitively manipulated in virtually any way. Examples of this are sheering, rejoining, add/subtract and reforming. Basically the editor combines the power of today's most sophisticated graphical applications in one easy manageable module. Furthermore it supports direct animation on process drawing elements and shapes which can be activated and changed transparently in their properties.



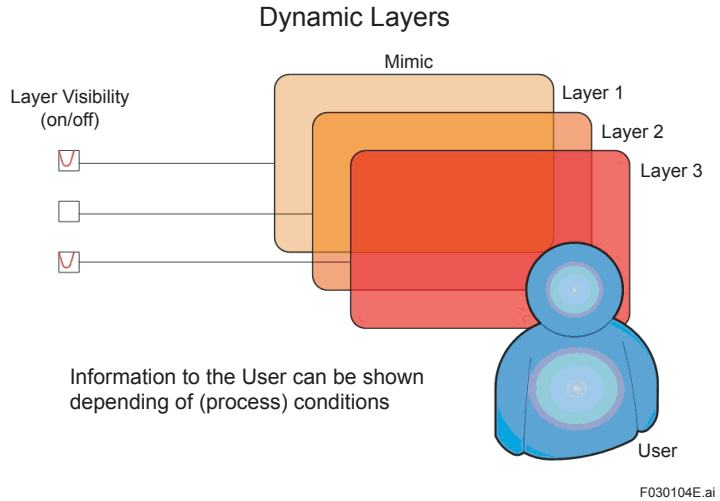
F030103E.ai

Figure 3.3 Web HMI basic elements

The visualization and engineering sheets (toolbox, properties, actions, parameters, etc.) can be sized and organized as appropriate. They are easy-to-manage and can be dragged and dropped, pinned or unpinned to appear on the pop-up side bar menus.

3.1.3 Dynamic Layers & Visibility Groups

This HMI technology allows process mimics to be built up with dynamic layers and backgrounds that can be independently made visible and/or transparent in the web-based operator environment (see figure 3.4). These layers can be triggered by process conditions, by zoom levels, by manual controls or by user login privileges and security settings. As a result, multi-level process supervision and KPI monitoring can be carried out within one operations environment.



F030104E.ai

Figure 3.4 Dynamic Layers and Visibility Groups

This technology better supports the logical separation and management of operational and maintenance information in a structured manner. It is possible, for example, to design the process flow diagrams in one layer, detailed instrumentation in a second layer, electrical power distribution schemes in a third layer and so on. It is also possible to authorize different users to see and/or access specific layers as controlled by the FAST/TOOLS software. This means that it is possible to visualize only that information that is relevant to a specific user, with resulting improvements in operational efficiency and the reduced risk of errors because there is no need to rebuild displays for each domain expert.

Other benefits include the fact that specific information for operations, maintenance, planning, scheduling, logistics and finance can be covered by distinct layers within one HMI environment.

Information content on one mimic can be made very rich without jeopardizing operator ergonomics because visualization groups can be defined for 'clutter/de-clutter' zooming and panning areas. This is a similar concept to the Google Earth style of zooming and panning, where details become visible depending on the display zoom level (see figure 3.5).

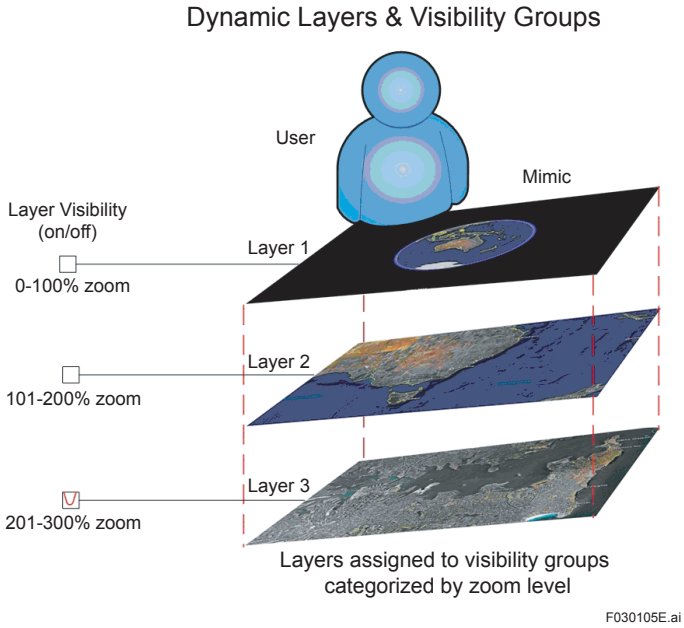


Figure 3.5 Google Earth Style Zooming and Panning

It is also possible to draw entire process areas in one large operator mimic, which can for instance be projected on a large video wall. The operator can zoom in on specific details by means of the continuously variable zoom factor, while simultaneously seeing an overview of the entire process in combination with detailed views of specific areas.

Furthermore this technique also allows to some extent for application-specific GIS Functionality embedded in FAST/TOOLS, with maps being imported and assigned to different layers in operator mimics.

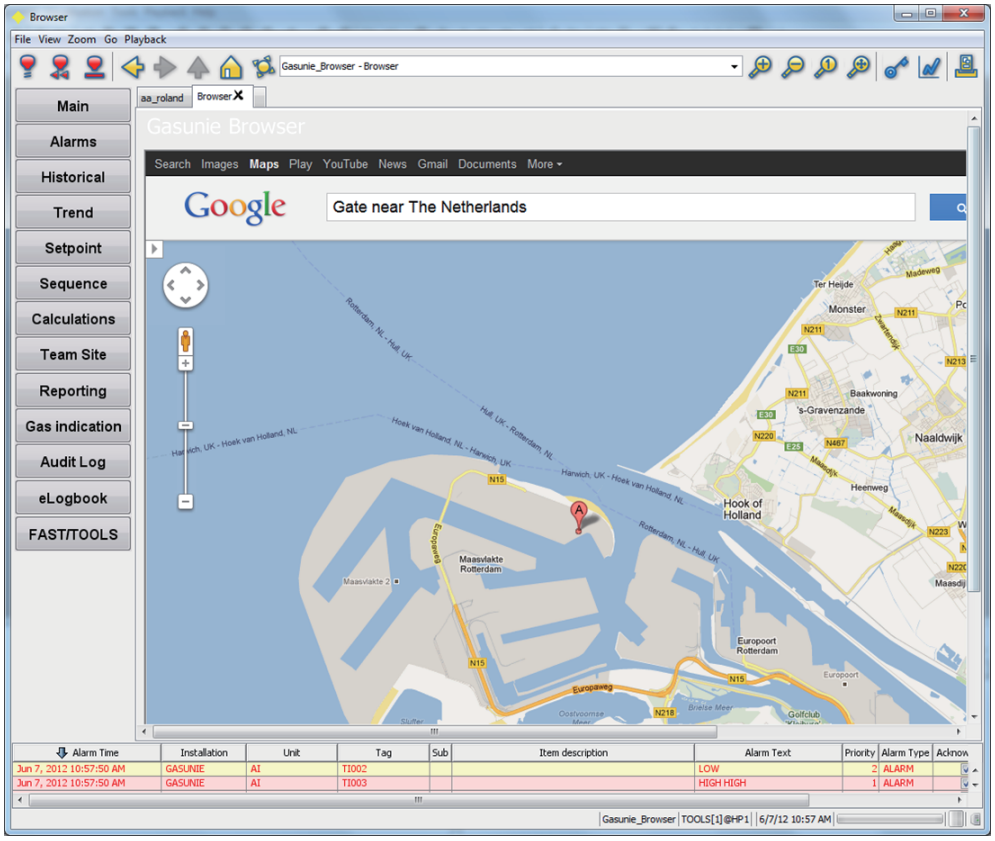
3.1.4 Integrated HMI components

With live process data and operation related information such as Web camera, forecast, etc. on large screen at the same time, better insight to supervisors is provided to make sound decisions on the actions to be taken by operator from a business management perspective.

The following FAST/TOOLS graphic components are available to support building an integrated environment.

Web Browser

- Handles a small subset of HTML5 specification (Use for HTML5 formatted text)
- Supported on all platforms (Embeds Web Browser)

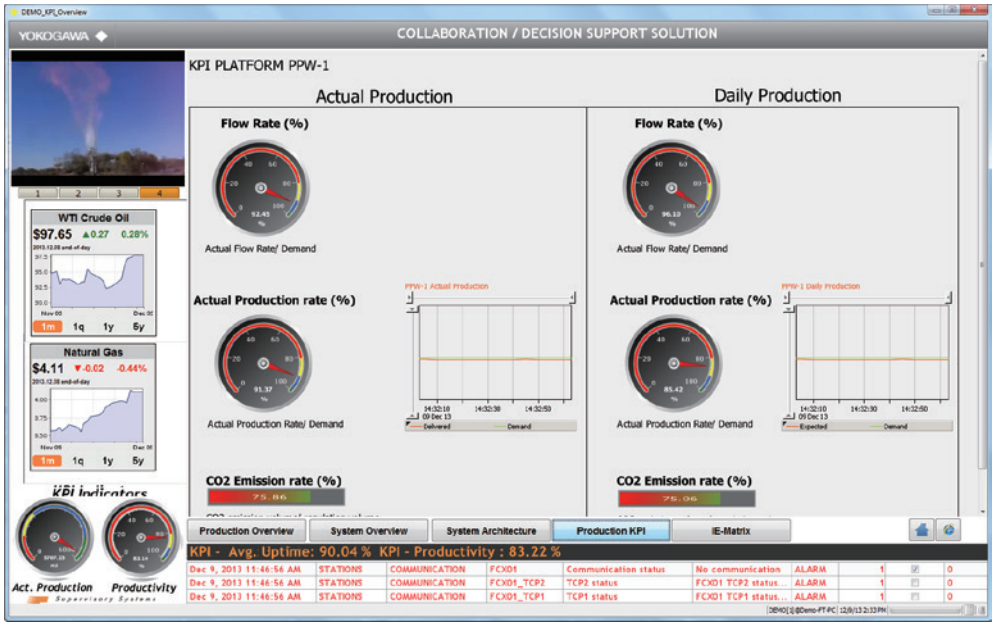


F030106E.ai

Figure 3.6 Embedded URL Component in FAST/TOOLS Operator Interface

Webcam/Video component

- Handles the most popular video file formats and sound mp3 files
- Supports motion jpeg video streams (cameras)
- All video files, sound files and streams are read from the Web-HMI Server
- Embeds Media Player (MP)



F030107E.ai

Figure 3.7 Embedded Webcam Component in FAST/TOOLS Operator Interface

3.2 Interoperability

FAST/TOOLS can easily connect and integrate (both on data and user interface level) with multiple applications simultaneously. The solution offered provides the flexibility to use anything from a simple data interface to the complete integration/embedding of applications.

With so called “info-Services” is an unified layer created that easily ties data sources to the HMI kernel. The Unified HMI can also tie-in directly with sources from e.g. logbook systems, document management systems, CCTV systems, weather information systems, contractual & financial systems, etc.

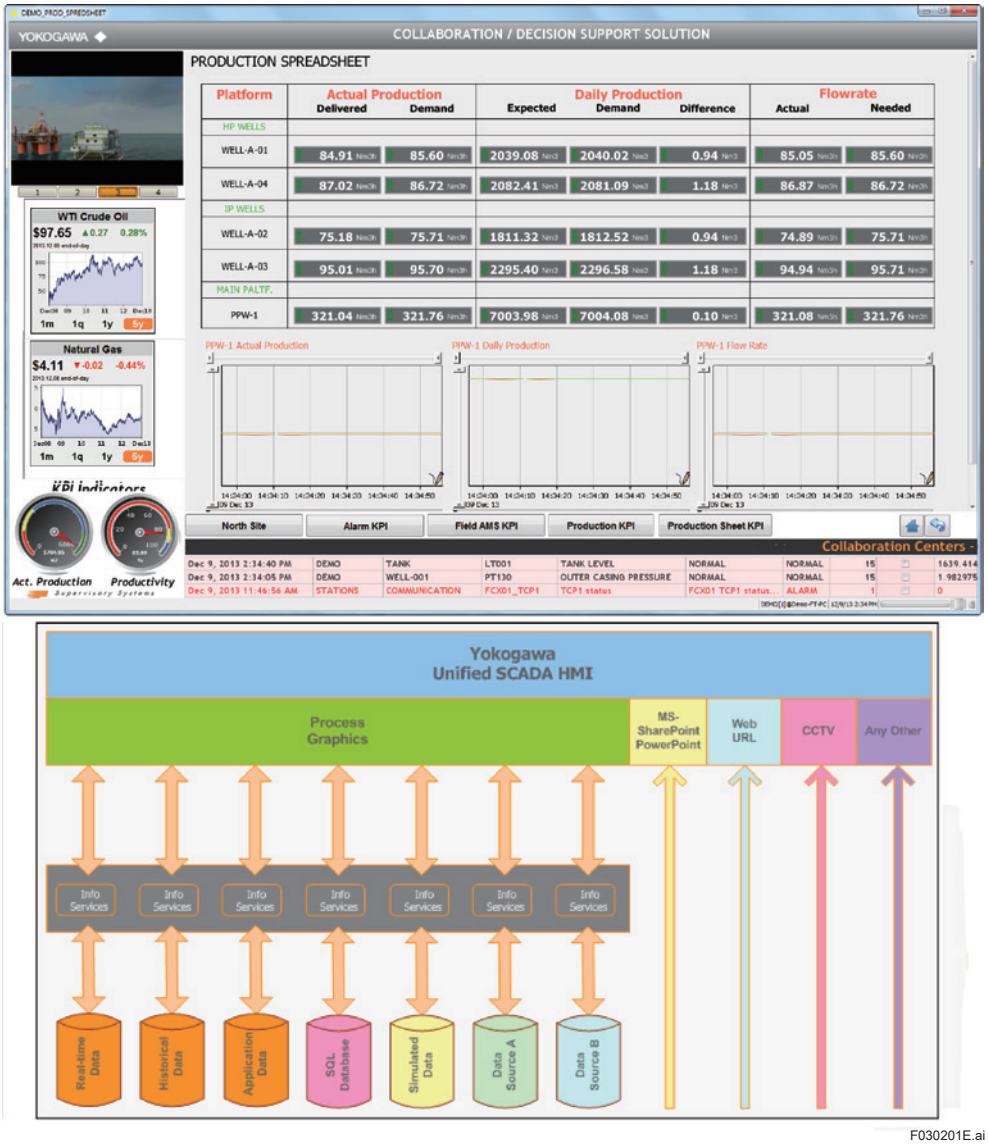


Figure 3.8 Example of dataflow – Info services

Any business applications that support open standards can be integrated with Yokogawa’s SCADA Suite. Depending on the IT architecture; we have experience with passive access (on the basis of API, OPC) or active via a Service Oriented Architecture (SOA) on the basis of XML. And as a third option Yokogawa can provide real-time RDBMS connectivity to related packages.

3.3 Configurability/adaptability of user interface

FAST/TOOLS can be modeled according to any (international) ergonomic guidelines due to its flexible nature. Free format of display layouts, graphic designs, layers, use of any true color pallet, no resolutions limitations, navigation panes and zoom & pan are native properties of our offered solution. The HMI is event driven and therefore capable of getting the attention of operators (triggers) on important events such as fire alarms, leaks, pressure surges, etc. Besides this a large library with (international standards) symbols and faceplates is available.

The entire Operator, Engineering and Maintenance environment can be altered/modified and/or extended with end-users own corporate design, style guides, faceplates, and object to have well designed and ergonomic user friendly designed HMI's.

Graphics build for e.g. control desk HMI's can also be used for video walls or mobile tablets due to the Web-based nature.

F030301E.ai

Figure 3.9 Adaptability of interface to any required user experience

Each HMI mimic is in a text-editable XML format file, enabling automatic display generation and modifications using standard text editing and macro tools resulting in increased productivity and reusability.

Yokogawa is strongly focusing on Human Centric Operations and Situational Awareness involving focus on Operator Effectiveness, Safety, Environment, Applications and Design. This is driving minimizing the risks of accidents; Eliminates unscheduled downtime and maximizes the business output and quality. These ideas result in Yokogawa's product and application solutions, control room design and ergonomics philosophies.

3.4 Mobile Clients (HTML5)

The number of Mobile Users is increasing heavily and has entered our every day (professional) life with increased interest from end-users in various industries.

In terms of purposes one can think of mobile systems that enables remote, maintenance, allows the deployment, and real-time management of operations applications via secure web-based services, thereby increasing overall equipment efficiency (OEE) and return on assets (ROA).

To enable mobility of the HMI on smart devices (Phones, Tablets, etc.) a HTML5 web HMI environment is available that provides diagnostics, alarms, and process graphics over the cloud to tablets and smart phones. While the functions are slightly limited in comparison to full-blown web-based clients, key mobile use functionality is provided for mobile devices, allowing anytime/ anywhere access, with all appropriate authorization and security, through browsers (Google Chrome). This allows for quick data analysis and decision making.

3.4.1 On-demand and Real-time access

It provides On-demand and Real-time access to corporate data, with the appropriate authorization and security in place, to view trends, reports, diagnostics, KPIs, etc. via mobile devices/smart phones basically anywhere, everywhere.

It's helping users to see their data in rich graphics, allowing them to interact, perform quick data analysis and decision making at hand for any discipline in the workforce.

F030401E.ai

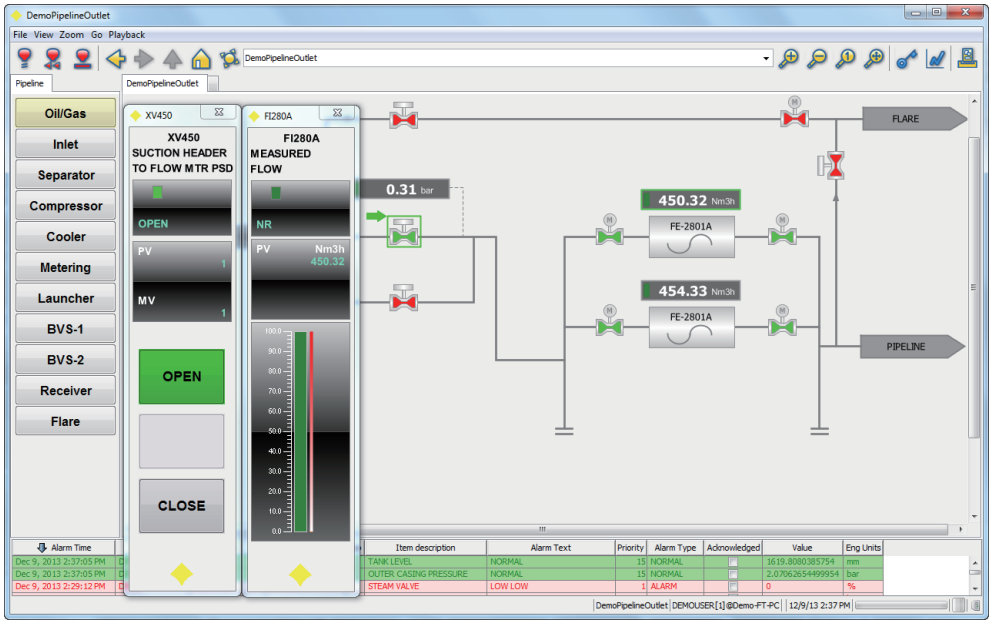
Figure 3.10 Mobile HTML5 user interface on tablet

3.4.2 Benefits for Mobile Solutions

- Improve operational awareness
- Accelerate troubleshooting on the spot
- Improve faster decision making
- Enhance and improve collaboration across

3.5 Operator Controls

Supervisory Control Systems must be able, as the term implies, to apply control to the process it monitors. These systems normally apply Control on two levels: on the SCADA data processing level and on the HMI level. On the HMI level, FAST/TOOLS has graphical operator controls that range from simple buttons, via sliders up to complete faceplates. See the examples in figure 3.11 below. Many animation features of FAST/TOOLS are available to extend the dynamic behavior. In case these predefined controls don't suit a specific application, new controls can be made. Because the graphic part of FAST/TOOLS is object oriented, a control symbol is made once and used as many times through-out the system as required.

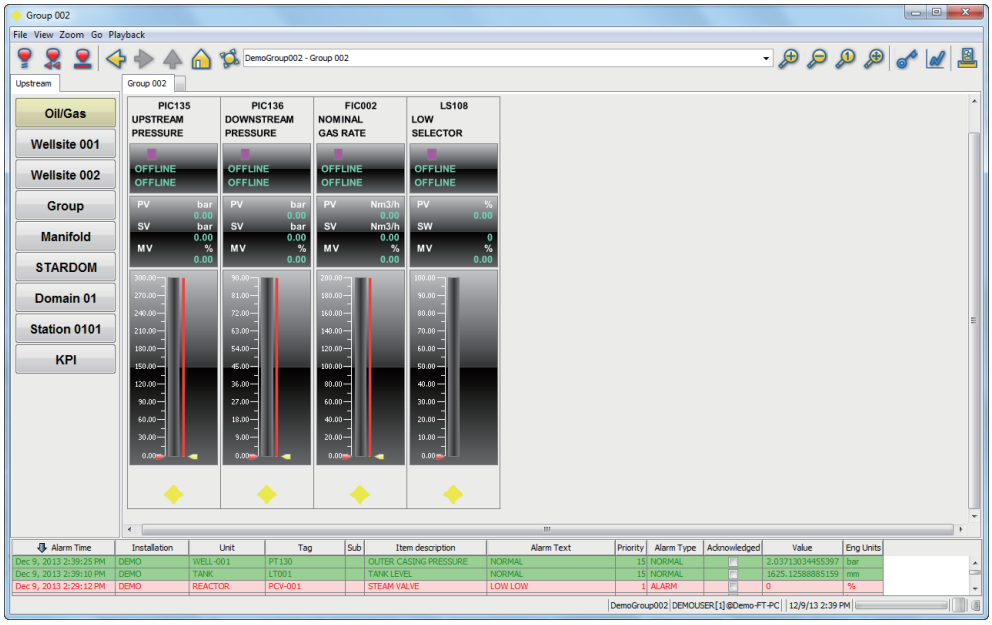


F030501E.ai

Figure 3.11 Operator Controls e.g. faceplates

Here are a few examples of how to define controls:

- Clicking on a symbol pops up a control display that shows e.g. valve status information and valve control buttons. The control pop-up may block other display actions. The pop-up is used for all symbols of the same type.
- A function key pops up an info display showing specific data of a tag or e.g. production data.
- It can be decided how operators change process values in the display: text entry, predefined values, via a slider or with up-down keys. In addition a 'bumpless' process value change can be made when switching over from manual to automatic mode or back.
- The alarm line can be provided with a 'jump-on-alarm'-function. Clicking on the active alarms makes the screen switch over directly to the display where the tag in alarm belongs. This fast access means avoiding time consuming searching for the right display.
- When working with more than one client station, you can block symbols on other displays if an operator has activated the one on his display. This prevents multiple operators from controlling the same device.
- Assign system functions to buttons on the screen. For example if a text editor must be available in the SCADA application a button which starts the application can be defined.
- Network status can be imported in displays. This allows the operator to warn system engineers about communication problems.



F030502E.ai

Figure 3.12 Operator Controls e.g. faceplates

Accessing the operating system from the displays can be blocked for operators, but allowed for the System Engineer.

3.5.1 Standard Faceplate libraries

FAST/TOOLS provides an extensive library of faceplates that have been optimized for use with Yokogawa process and safety controllers' product range (STARDOM, CENTUM, ProSafe-RS) but also adapts to 3rd party RTU/PLC controller products.

F030503E.ai

Figure 3.13 Standard faceplates

The faceplates all have the same modern style and inherited the basic layout and feel of the faceplates that operators are used to experience with Yokogawa process operations software. These faceplates enable to quickly build operator mimics with standards controls and symbols in reduced engineering time.

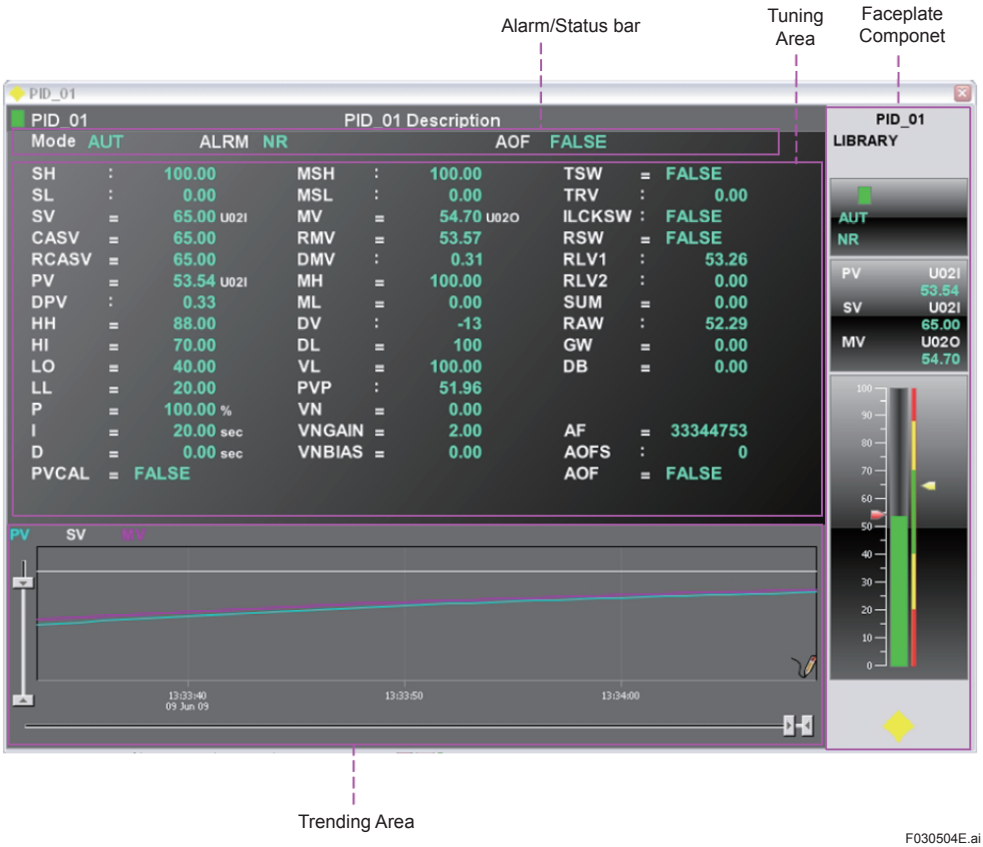


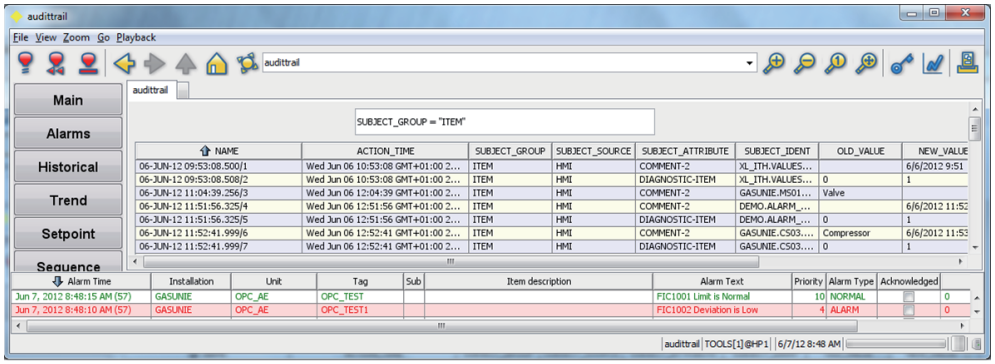
Figure 3.14 Standard faceplate tuning panel

Two libraries of faceplates are available. One library for faceplates with “full” tuning panel and trending area which provides a lot of detail information on control block parameters from Yokogawa controllers in addition to the essential process related information. There is also a library with so called “light” faceplate for more general use that visualizes only the process related controls and alarm information to an operator and also easily adapts to 3rd party RTU and PLC.

3.5.2 Operator Action Log (Audit Trail)

Some configuration changes or control actions can greatly influence the behavior of the system that is being controlled and monitored. It must be possible to retrieve this type of information afterwards via reports and playback function to be able to trace the cause of problems or to be able to improve operational procedures. AUDIT/FAST offers the possibility to define in a flexible way the events that must be stored, together with information like:

- Who? The operator name or the application program making the change.
- Where? From which location was the change invoked.
- When? The date and time that the change took place.
- What? The detail of what was changed, the old and new value if applicable.
- Why? An operator can add additional text for explanation.



F030505E.ai

Figure 3.15 Audit trail display

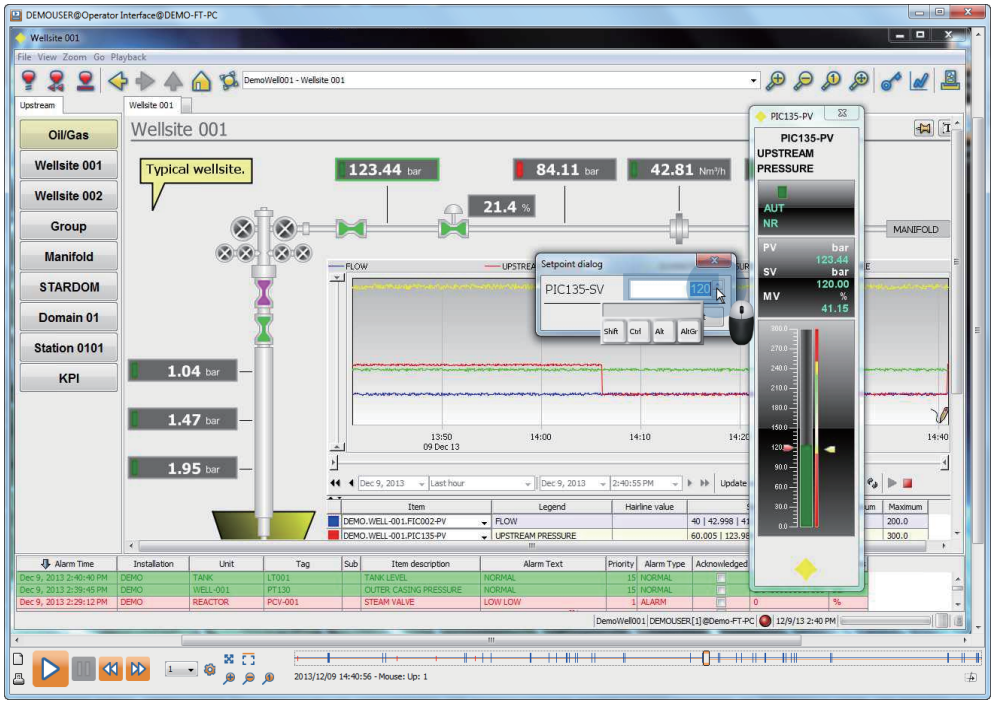
All logged operator actions can be viewed and browsed with the audit trail viewer (see figure 3.15). Examples of actions that may be logged:

- Change of set points
- Change of alarm limits
- Acknowledgement of alarms
- Opening/Closing valves
- Login/logout actions (successful and not successful)

All these events may be logged and retrieved locally, but may also be distributed to other nodes on the network for example the workstation of the system engineer.

3.5.3 Operations recording and playback

In addition to audit trail functionality FAST/TOOLS provides a comprehensive real-time operations video recording facility. It provides an intuitive playback function which is acting like the systems “flight recorder”. HMI Displays are recorded live and can provide real-time, synchronized live video feedback at any point in time combined with (historical) Alarm & Events, Process data, Trended data, etc. This includes the mouse tracks and relevant keyboard strokes. Recorded video data can be used for cause-and-effect analysis, operator training, and simulation to increase overall safety, security and regulatory compliance.



F030506E.ai

Figure 3.16 System in ’Play-Back’ mode

Major operational benefits of operations recording and play-back functionality are:

Training for operators

- Recordings of operational scenario’s or real live process disturbances can be used in operator training sessions.

Remote assistance by specialists

- A remote operator or specialist can issue a recording of his/her activities to show what actions have to be taken by a local operator to normalize a situation.

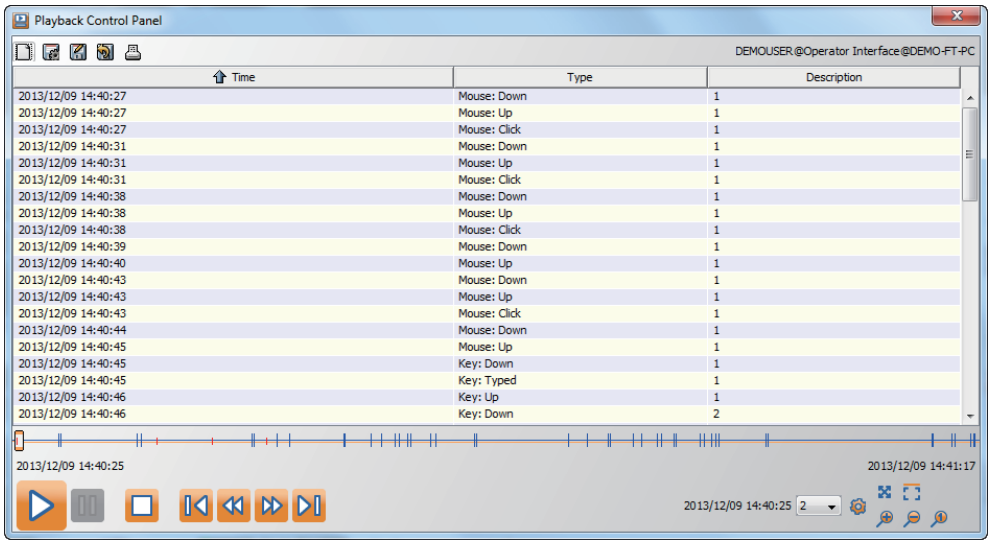
Ease of information provision to maintenance dept.

- The maintenance department can use recordings to analyze an actual situation to take appropriate actions to improve operational performance.

If a recording is active it will be indicated by a small red dot in the status line of the module frame:

For each user the following must be specified in the profile:

- If recording should be activated.
- If a user can view own recordings and/or from others as well.
- If a user is allowed to export a recording



F030507E.ai

Figure 3.17 Playback Controller

The playback controller (see figure 3.17) enables an authorized user to select earlier operational situations and re-play all operator actions and process conditions (alarms and events). It furthermore provides:

- information on each mouse stroke and keyboard entry made
- playback controls (play / stop, fast forward/backward)
- zoom and view functions
- Time scroll bar with event indicators

When desired all recordings can be exported to standard media player file format. It is also possible to start and stop recording based on an event rather than continuous recording to limit video storage space consumption.

3.6 Alarming and Events

One of the important aspects in operations management systems is alarming. This section describes the sophisticated way FAST/TOOLS processes alarms and events. ALARM/FAST is the module that handles alarming in FAST/TOOLS. This section describes first of all the way alarms are presented to the user and secondly some unique features of alarming which are typical for ALARM/FAST. Alarms must be distinguished from events. In FAST/TOOLS, events are alarms with limited alarm functionality. That is, they are not acknowledged or reset but are appearing in the historical overview and have the same configuration possibilities as alarms.

3.6.1 Presentation and Notification of Alarms

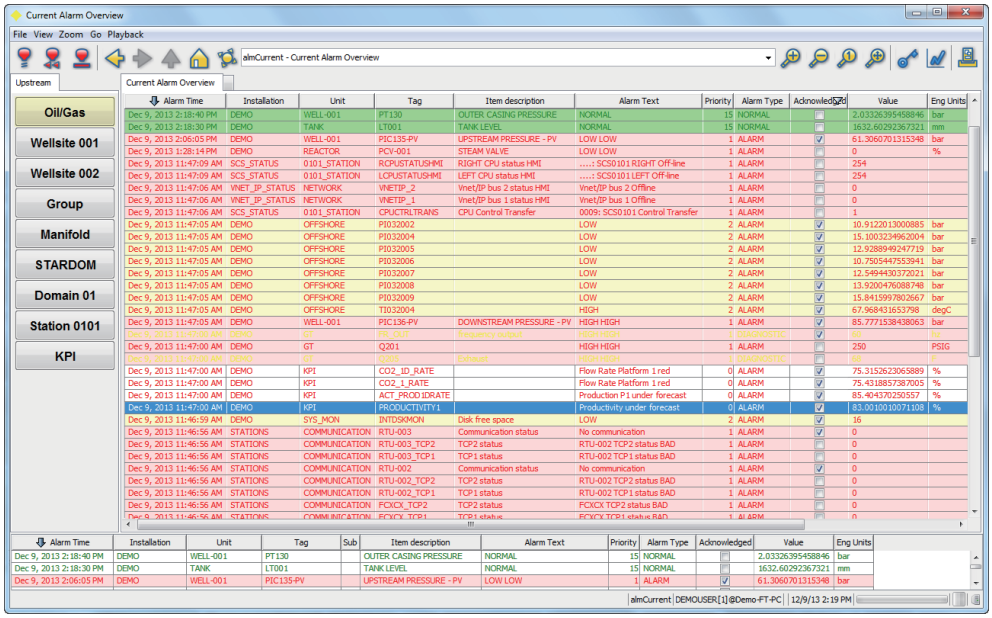
ALARM/FAST allows alarms to be presented on a number of different devices, like:

- Workstations
- Printers
- Smart phones and Tablets
- Acoustic devices (horns)

On workstations the alarm presentation will, in most cases, be a real-time alarm table in a frame with scroll bars containing significant information for the operator. Additionally, graphical objects to which the alarms apply, can be configured to change color, shape, position etc.

In ALARM/FAST the alarm information can be customized for each device. Generally speaking the alarm text line will contain information regarding:

- Alarm priority (0-15)
- Alarm status (Alarm, Event, Acknowledged, reset, normal, etc.)
- Date and time of the alarm (timestamp received from the PLC/RTU, with up to a millisecond accuracy when supported by PLC/RTU or generated by FAST/TOOLS if the PLC/RTU doesn't support time stamping at all)
- Item name, -value, -description and alarm description
- Alarm status text (Low, Low-Low, High, High-High, normal, under-range, over-range, offline, blocked, etc.) Alarms are presented in two ways:
  - Dynamically on display and/or printer (current alarms)
  - Historical (chronological in time) on display and/or printer Historical alarms can be archived on disk or external storage.



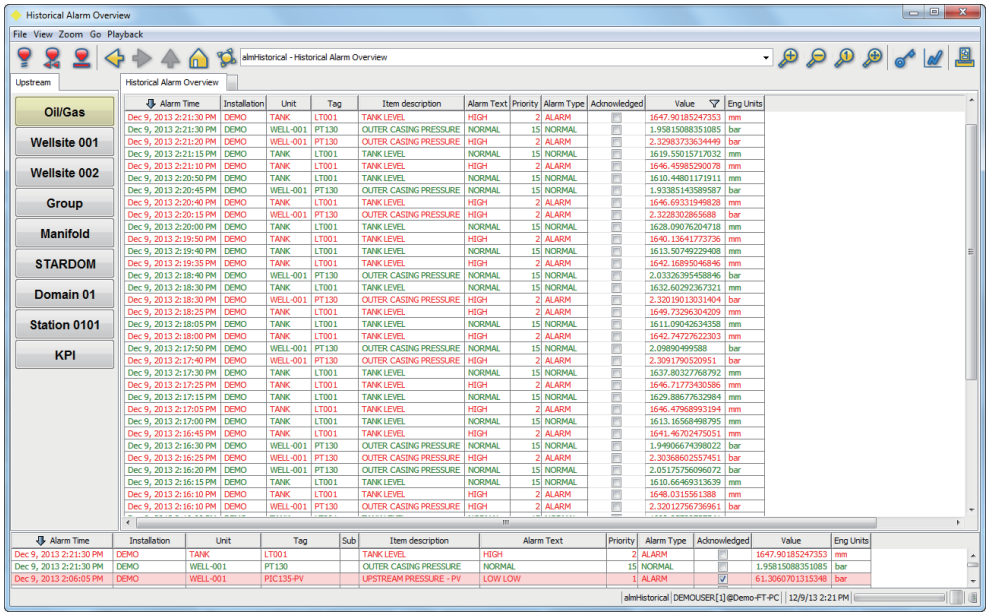
F030602E.ai

Figure 3.18 Current Alarm Overview Display

FAST/TOOLS has a current alarm overview with all alarms that are active or yet not acknowledged and a historical alarm overview with all alarm status changes over time. Current alarms can be presented in a scalable frame with scrollbar controls that for example can be defined as a separate current alarm display or a three line banner at the bottom or top (in the status bar) of the page. This overview is dynamic by nature; if an alarm no longer exists and is acknowledged (manually or automatically) then the alarm disappears from the screen. If there are no alarms active, this display or banner is empty. Every column of the alarm text line can be used to sort the alarm list so that current alarms can be sorted in:

- Priority base order
- Time base order
- Alarm status order
- Etc.

Every alarm status (Alarm, acknowledged alarm, repeated alarm, delayed alarm, normal, etc) can have its own distinct fore and background color or no background color. Furthermore definition of alarm line columns can be freely organized and represented.



F030603E.ai

Figure 3.19 Historical Alarm Overview Display

The historical alarm overview has the same functionality as described above for the current alarm overview. All status changes of alarms are represented in a fully scrollable historical alarm overview table with scroll bars and fast keys (page-up/down, etc.).

3.6.2 Alarm Management and Analysis

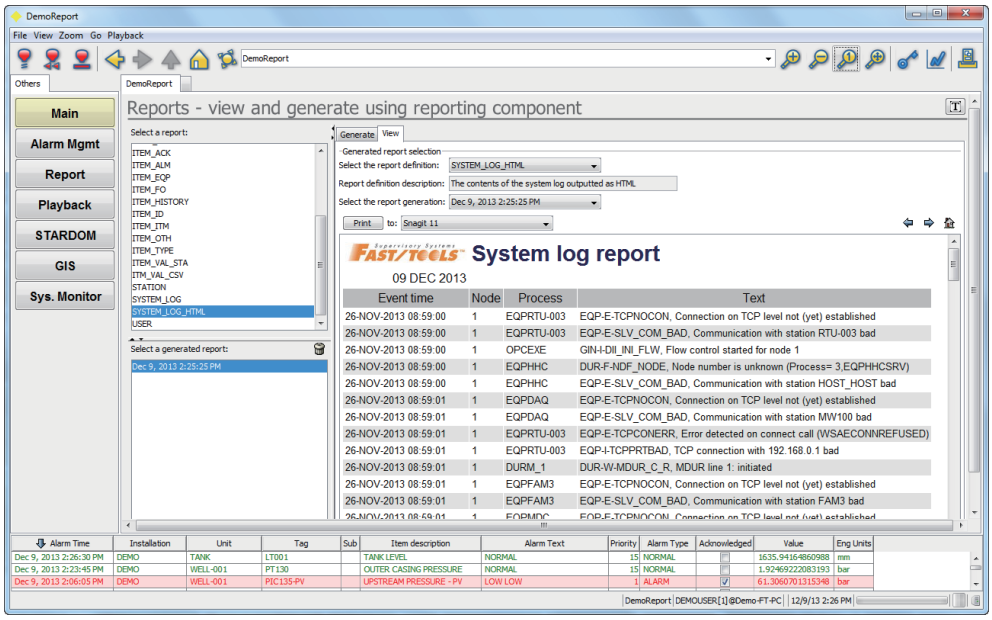
In addition to standard alarm views of current and historian alarms to inform operators and allows them to acknowledge them the alarm management and analysis capabilities of FAST/TOOLS stretches far beyond basic visualization. For this reason a detailed insight into the operational alarm management and analysis capabilities of FAST/TOOLS is provided in section 4 Operational Alarm Management & Analysis.

3.7 Reporting and Analysis

3.7.1 Reporting

REPORT/FAST is the module in FAST/TOOLS for generating reports of configuration, alarming, actual and historical data. REPORT/FAST enables to generate reports:

- Scheduled on time base (e.g. daily production or shift reports, or every first day of the month)
- On an event (item-change, e.g. to make a report of prior- and post shutdown events)
- On ad-hoc base
- By pushing a button and start a predefined report (e.g. a current alarm report)
- By on-line defining a new report and start generating it immediately (for example, to show all analog items with their physical high and low limit values)



F030701E.ai

Figure 3.20 Reporting component

Reports are shown on screen, printed on a report printer or saved to disk (and can be scheduled to be deleted after the lifetime has expired). Reports on disk are in readable ASCII-format. Any text editor to view, edit and print these reports can be used. REPORT/FAST uses database calls to generate reports, but has a lot more features than just that. For example:

- The report layout (margins, header, footer, paper size) can be defined on a per report base
- Reports can be assigned a priority. When more than one report is scheduled for generation at the same time, the order in which they are generated depends on their priority

Data to be retrieved for the report can be input for:

- Arithmetic operations (calculating averages for example).
- Functions for special purposes, e.g. production per shift or running hours of a pump.
- In a report conditions (based on calculations for example) which update the value of an item or its status can be defined.
- Reports can be routed to other destinations. For example a report on a daily basis to a remote office can be send to this destination via local telephone lines or rerouted when a printer went off-line due to e.g. ‘out of paper’.

3.7.2 Data Analysis

Standard functions for data-analysis and presentation are available in FAST/TOOLS. In addition you can use PROCESS/FAST, the object oriented programming language of FAST/TOOLS, to create specific calculations. The standard presentation of data includes a range of charts to display and analyze the data. In addition a range of built-in functions available in PROCESS/FAST can be used for data analysis or statistical process control. This statistical analysis is not restricted to the graphical environment alone; REPORT/FAST has a lot of statistical functions available that can be used in (periodical) reports, like Count, Sum, Avg, Max (of a range of values), Min, StdDev, Variance, etc. For example, an application requires a flow calculation program that calculates the position of individual valves based upon the throughput of a main valve. This main valve is controlled via the total of its flow relative to that of the individual valves. The positions of these valves are based on complex statistical formulas.

3.7.3 External Reporting

The traditional capabilities in FAST/TOOLS for getting data sets into foreign database systems is to use the ODBC interface which connects directly to the FAST/TOOLS Data Set Services (DSS) layer. This is a powerful feature for providing FAST/TOOLS data into the familiar office environment (Excel, Access). For customers that want to perform more complex queries that cross-section FAST/TOOLS data and want to integrate that data into their own RDBMS environments (Microsoft SQL Server, ORACLE and alike), an embedded RDBMS engine is available as well. This engine supports data aggregations and high performance real-time reporting (also in XML, HTML5 format) with off the shelf reporting packages and databases to easily adapt to any customer IT environment.

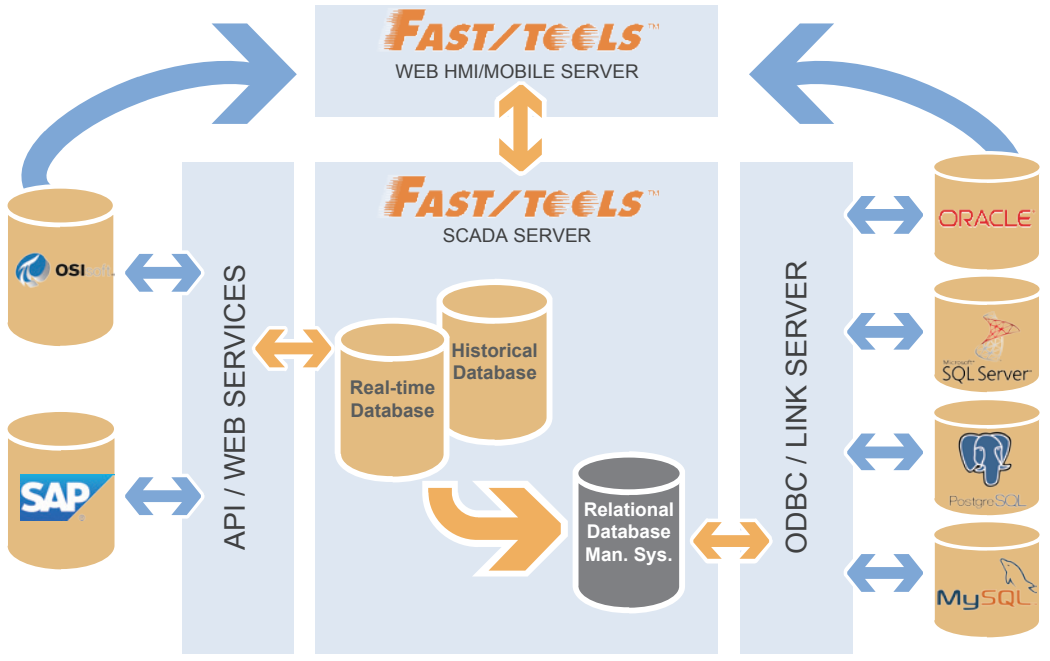
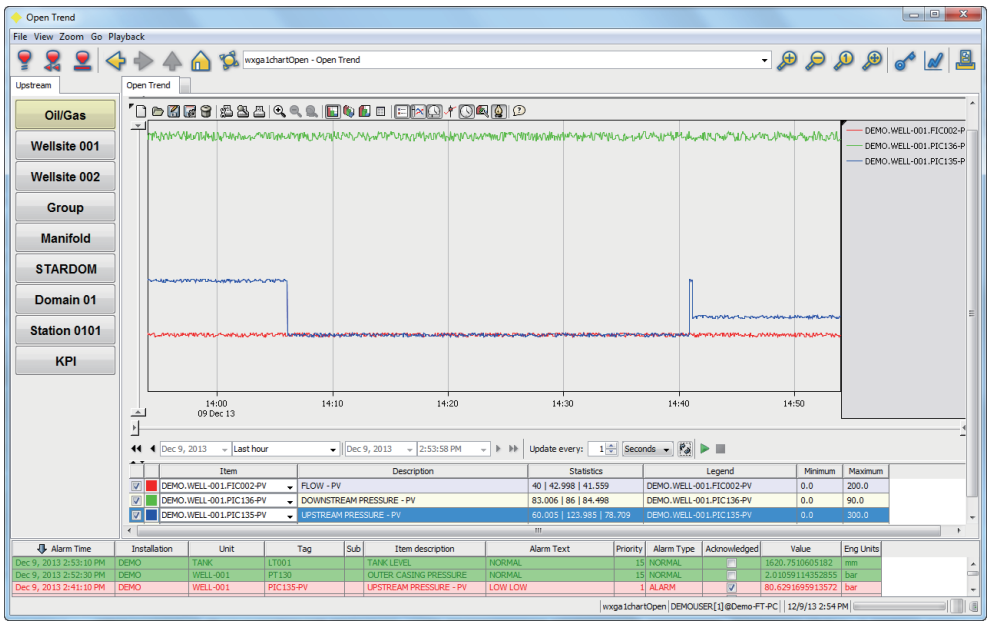


Figure 3.21 RDBMS engine

3.8 Trending

3.8.1 Trend Functions Overview

The FAST/TOOLS trend component provides outstanding trend visualization capabilities for all real-time and historical FAST/TOOLS data. The user interface is very intuitive and allows for fast open and closed trend configuration in a few minutes.



F030801E.ai

Figure 3.22 Open Trend

Some of the main features are:

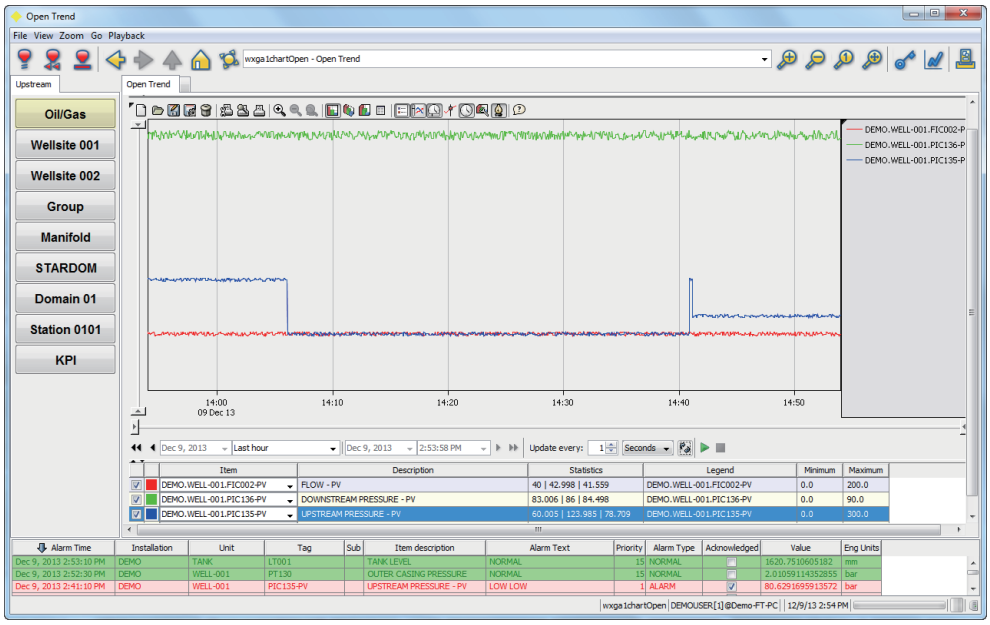
- Time based trending
- 2D & 3D Rendering
- X-Y Trend (show direct correlation between different process measurements in one overview)
- Representation of trend data in table format
- Full zoom capabilities and animation
- Historical & Real-Time trending
- Power full sliders for various axis like value and time
- Easy time-range selection
- Total of 50 pens in a single frame
- Automatic selection of history groups
- Supports relative and shift related time intervals
- Free to configure legend (location, description & transparency)
- Export trending data in bitmap and CSV data files
- Reversing of time and value axis
- Flip trending from horizontal to vertical position
- Complete flexibility of window decoration and layout
- Time offset on individual trend pens

- Right to left time-axis orientation
- Trend data health status indication (to inform the operator when trend data is not actualized by the field)
- Trending data statistics (min, max and average)

The FAST/TOOLS has an extensive library of ready-to-use trend templates. It only requires connecting an item to the pen and the trend is ready to run. Besides the trend templates it is possible to make customized trends or adjust the trends from the library. The three types of trends in FAST/TOOLS are:

- Real-time trends
- Historical trends
- X-Y Plots

X-Y plots are added to the rich pre-divined trending library to allow two dimensional views of important process characteristics X-Y Mode can be activated from the Trend Component Properties settings.



F030801E.ai

Figure 3.23 X-Y Trend

The most common parameters you can set for a trend in FAST/TOOLS:

- The pen appearance (continuous line, dashed line, points)
- Start-time and stop-time (can be changed on-the-fly)
- Min and Max scaling value of the process variable that is trended
- The process variable to connect to a pen
- Starting and stopping the trending process
- The number of samples to show on the display
- A hairline can be activated to read value and time at a sampled point
- The sampling rate with which the trend screen is updated
- Different time scales by varying start- and end-time (can be changed on-the-fly)

Up to 20 process variables can be plotted against another variable.

3.8.2 Trend Linked to Alarm/Event Views

One of the more advanced features of the FAST/TOOLS Trend component is a build in option to synchronize the representation of trend data with the historical alarm statuses based on time/ date.

This allows a user to click on an event in the trend display showing the hairline at that exact time including the related alarms in an overview in the same display (see figure 3.24). Also the other way around can be very useful by browsing through the alarm and event overviews and instantly have the trend lines related to these time frames visible. Clicking on an individual alarm-event will cause the hairline to snap to the time the alarm was generated in the associated trend. This provides powerful online (Sequence Of) Event analysis for Historical and Real-Time data.

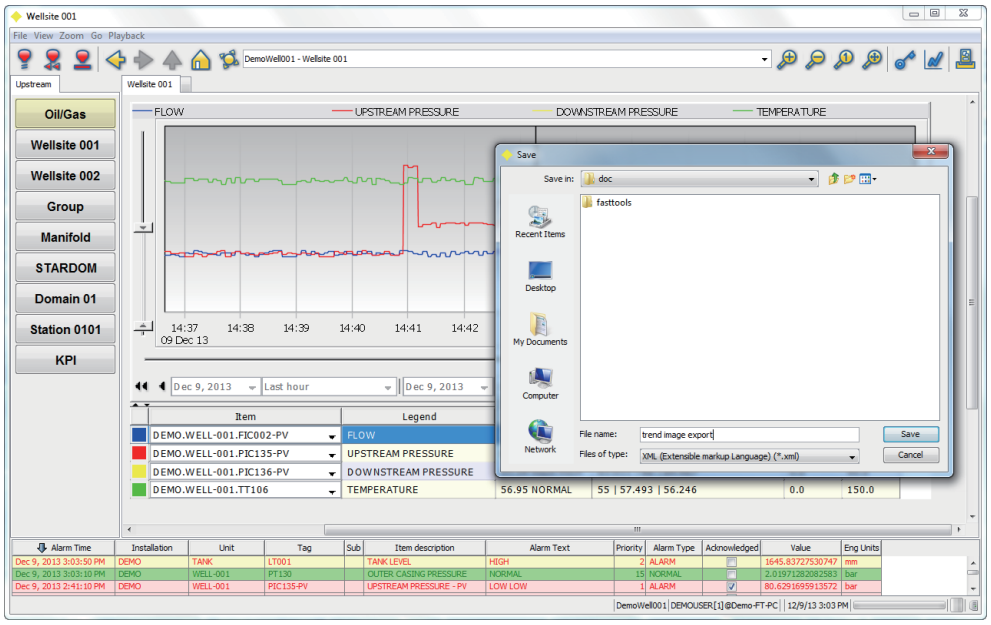
F030803E.ai

Figure 3.24 Trend linked to Alarm/Event view

When moving the trend hairline across the historical or real-time trend time-line the associated alarms and their status at that specific point in time are displayed. This also works the other way around that by direct alarm line selection the trend hairline jumps to the time-mark when the particular alarm was generated.

3.8.3 Trend Data / Image Export

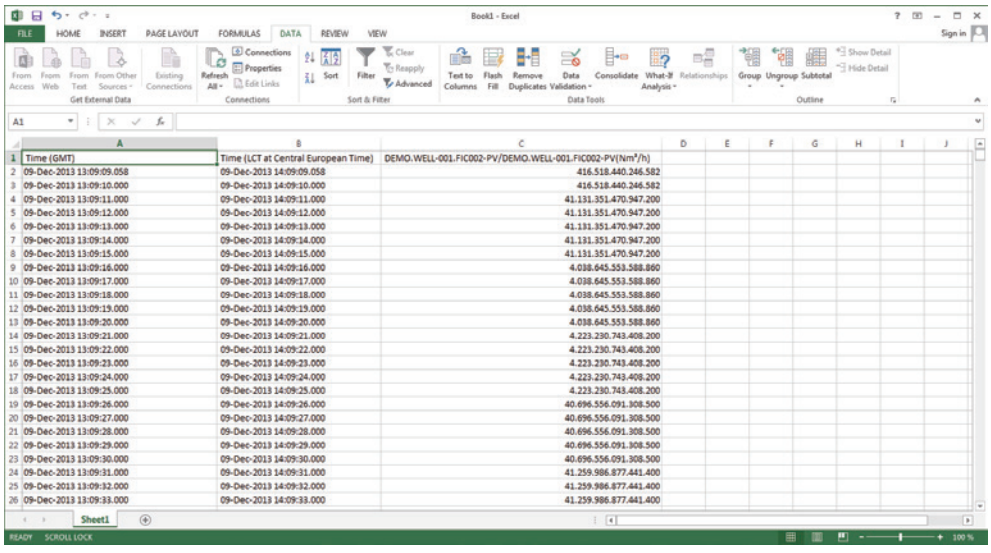
Via e.g. the trend overview users can simply export data directly to for instance Microsoft Excel or via CSV for use in other application packages. Similar a trend view can be exported to a .JPG image file.



F030804E.ai

Figure 3.25 Trend Data Export

This function copies trend data values and associated parameters like tag name, alarm limits, engineering units, data status, etc. directly to the clipboard.



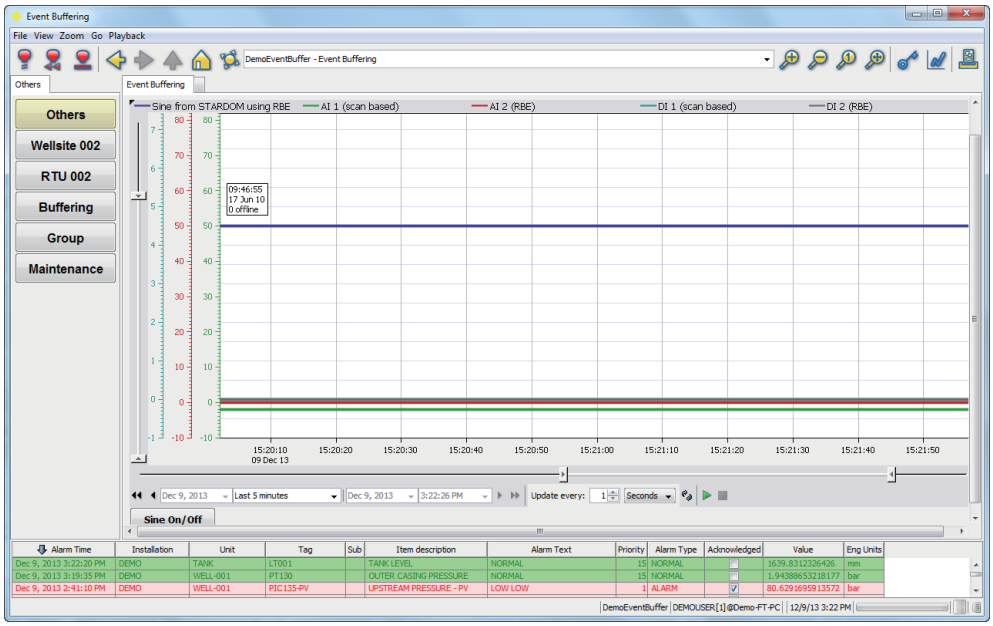
F030805E.ai

Figure 3.26 Trend values in Microsoft Excel

This allows for on demand issuing of any specific Trend data from the visualization environment to the office environment for external analysis.

3.8.4 Offline trend expressions

The trend component also has an option to show the ‘offline’ indication (status hints). The FAST/TOOLS trend component can render a trend in such a way that there is a visual indication whether the trended value is updated or not (offline) by the field.



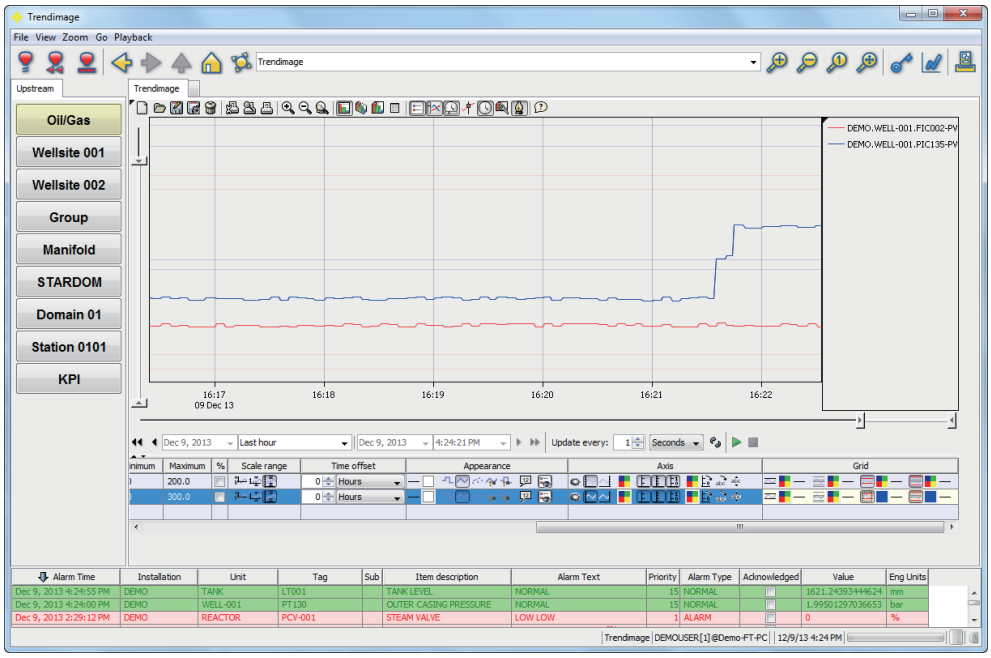
F030806E.ai

Figure 3.27 Trend offline expressions

The trend pen shows the periods over which the trended value was not actualized by the field and can provide this for each pen individually (see figure 3.27). The offline expression indication can also be disabled.

3.8.5 Alarm limit indications on trend pens

Trends often provide operators informative views on process values drifting for any reason to the boundaries of their desired operational window and eventually causing an (pre-) alarm.



F030807E.ai

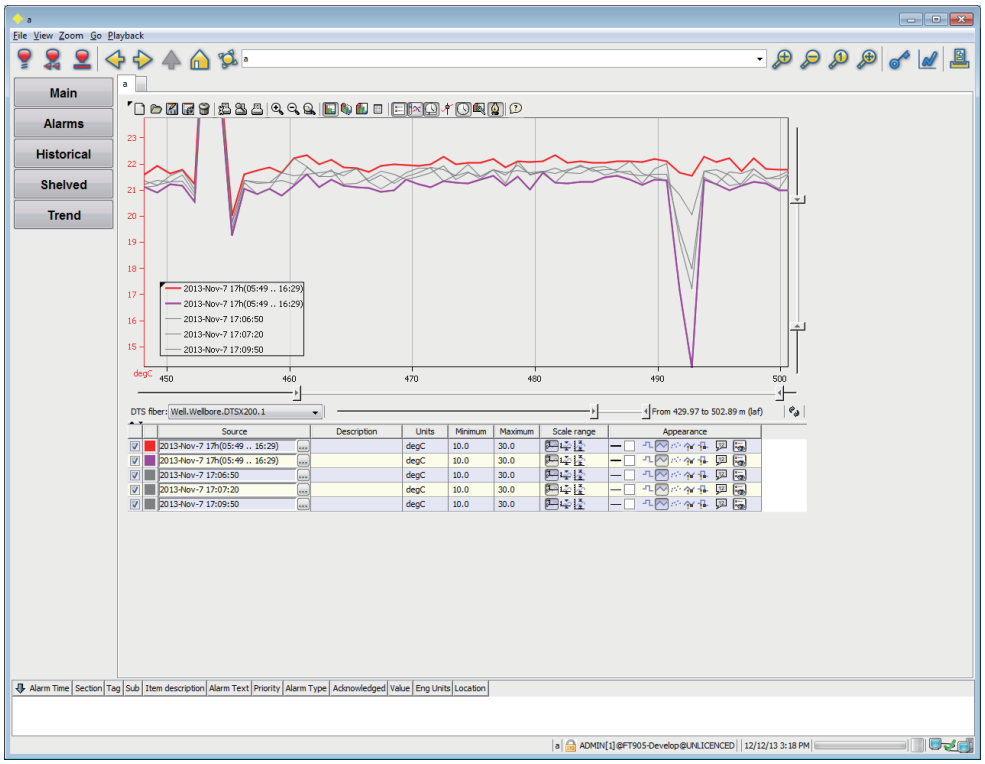
Figure 3.28 Alarm levels indications on trend pens

The trend component allows visualizing the alarm limits of a process value assigned to an individual trend pen. This is experienced to be much more informative to an operator than the value without any relation to an upper and lower border.

3.8.6 Distributed Temperature Sensing (DTS) Trending

FAST/TOOLS supports native connectivity with Yokogawa's Distributed Temperature Sensing (DTS) solution the DTSX200/DTSX3000 Fiber-Optic sensing device.
It is designed for Oil/Gas conventional and unconventional in-well (down-hole) applications as well as LNG and Refinery facilities, Pipeline and Tank leak detection, and other thermal monitoring applications.

FAST/TOOLS can read three dimensional data from DTSX: temperature for each point along the fiber (temperature, distance and time).



F030808E.ai

Figure 3.29 DTS Trending

3.9 Data Archiving

3.9.1 Local Data Storage

FAST/TOOLS supports storing data on disk with the lifetime you think is adequate and disk size capacity which can be calculated is determined by this. Data is kept on disk to be available for online trending or historical alarm displays with a storage life time that can range from hours, weeks or years. In addition there is the possibility to transfer relevant historical data to external storage (any media that can be mapped to a drive letter within the operating system such as CD/DVDwriters, USB-disks, RAID-disk arrays, NAS, SAN, etc.). The reasons why data is stored could be:

- Offline and On-line statistical analyses of data over longer time periods in order to find trends in production parameters or defects
- Offline and On-line processing of data for maintenance purposes
- Statutory or fiscal traceability reasons may force the user to keep relevant data available for several years in order to clarify responsibility

After a specified time, historical data will be moved to external storage, preventing the disk from becoming full. For example historical data will be moved to external storage when it is more than 5 years old. Data can be stored to external storage:

- Manually, on an ad-hoc basis
- Automatically, done by the scheduling mechanism of the external storage archiving process. (In most cases automatically external storage archiving is time based).

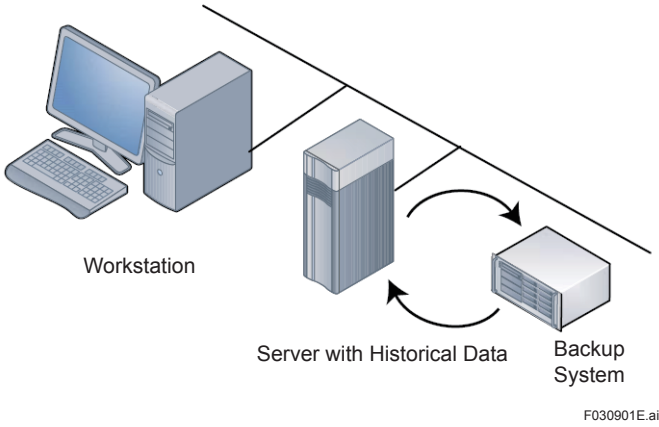


Figure 3.30 Local Data Storage

FAST/TOOLS keeps record of all the data that is externally stored. It shows a list of all media that have been used up till now. To restore data the name of the media after specifying the start and end-date of data to be restored will be shown. In addition the type of data to restore can be selected. This could be, for example, analog data only for trending in the past. Both actual and restored data can exist on the same system.

3.9.2 External Data Storage

Yokogawa has experience and the capabilities to connect, integrate and/or embed virtually any database (via e.g. ODBC/OPC/API). Real-time/Historical data can be shared/replicated to any environment. It's possible to use various ways simultaneously for instance complete data dumps, data by subscription and/or transferring changes only.

3.9.3 Networked Data Storage

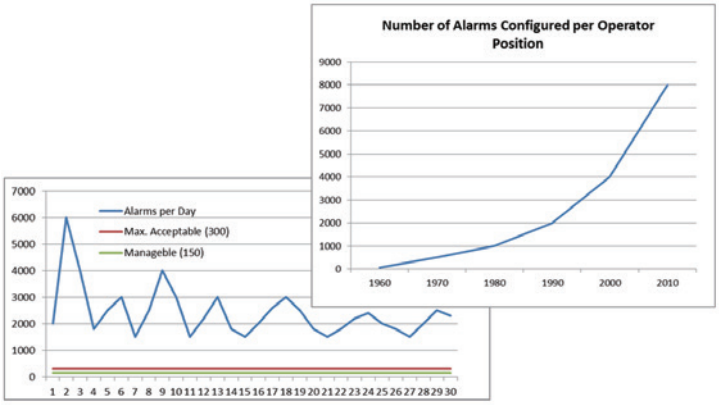
For security, storage capacity and accessibility reasons FAST/TOOLS data archiving is often integrated with (existing) Network Attached Storage (NAS) and Storage Attached Networks (SAN) IT facilities.

A Storage Area Network (SAN) is an architecture that serves as a link between servers (initiator) and storage devices (target) in such a way that it seems to the Servers OS that the storage is directly connected. Because the server and storage are physically separated can both be serviced independent.

Network-Attached Storage (NAS), is a storage facility, connected to the network, and uses the TCP/IP-protocol for data exchange. NAS-Servers are basically full-blown fileservers. With a NAS data is managed by the NAS-system itself.

4. Alarm Management and Analysis

Operational Alarm Management involves the proper design, implementation, operation and maintenance of alarm systems. The key objective is to safely operate industrial processes and effectively guard them against abnormal conditions during any state of operations.



F040001E.ai

Figure 4.1 Increasing numbers of configured alarms

The reason why alarm management has become of paramount importance to the process industry is the disproportional increase in the number of alarms configured per operator position over the past decades leading to unmanageable number of alarms being generated in particular during process state transitions. With “big data” at our doorstep this will increase proportionally fast.

These facts have a tremendously impact on the risk of missing a critical alarm leading to serious incidents (loss of human life, environmental pollution, damage to capital assets and loss of production).

The underlying causes of these numbers to grow out of proportion are mainly:

1. New process control systems technology allowing alarms to be easily added and changed

2. Human behavior [better safe than sorry] especially when information is easily unlocked

Guidelines and Standards like EEMUA 191 and ISA 18.2 prescribe what Alarm Management should incorporate and within what performance metrics alarm systems should operate to stay within manageable limits which demands for consistent Alarm Analysis. Regulatory bodies like OSHA and CSB (Chemical Safety Board) are now enforcing these guidelines and standards as “Recognized and Generally Accepted Good Engineering Practice (RAGAEP). Therefore failing compliancy of a regulated industry can lead to legal and financial sanctions. These sanctions can be massive in case of serious incidents caused by poor Alarm Management.

The ISA SP18.2 provides a frame work for what needs to be done to establish a proper alarm management lifecycle which comprises of the following main steps:

1. Develop, Adopt, and Maintain an Alarm Philosophy
2. Collect Alarm Data from your Systems Environment
3. Perform “Bad Actor” Alarm Resolution
4. Perform Alarm Rationalization

F040002E.ai

Figure 4.2 ISA SP18.2 frame work

Both EEMUA 191 and ISA 18.2 provide guidelines and performance targets to be met by process alarm systems to be effective and efficient.

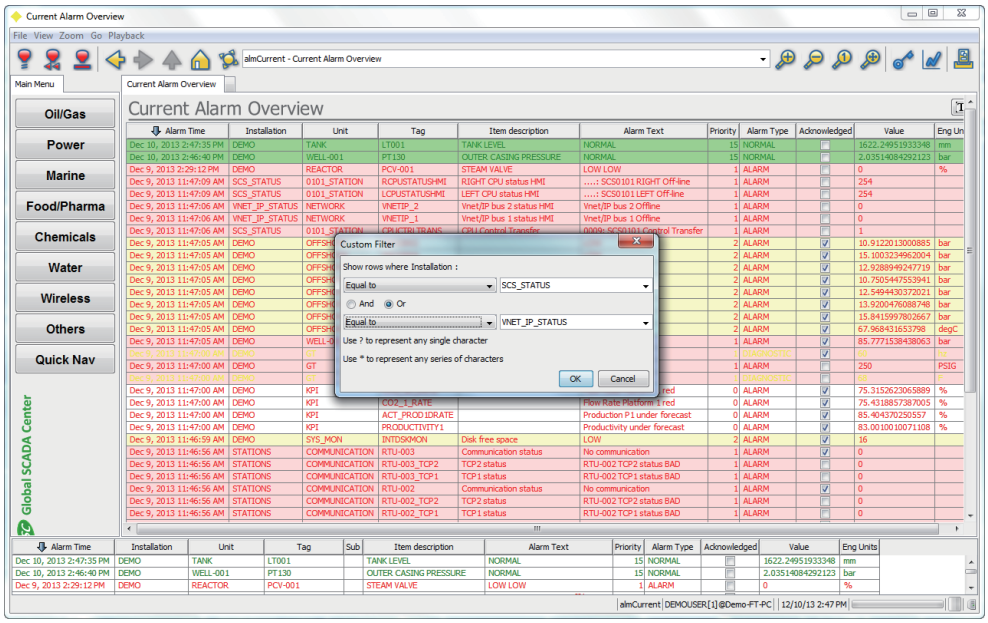
With the alarm management and analysis modules of the FAST/TOOLS operations management software Yokogawa delivers a total integrated alarm management solution (without the need for 3rd party software, interfaces and additional configuration work). Also for legacy systems that lack these alarm management capabilities FAST/TOOLS can be a solution to normalize the alarms to its sophisticated alarm system and analysis environment to comply with ISA 18.2 and EEMUA 191.

4.1 Operational Alarm Management

4.1.1 Filtering, delaying, suppression and rerouting

Filtering of Alarms

A lot of filtering types do allow to filter alarms on-line in current- and historical alarm displays. For example, alarms can be subscribed to up to 16 Areas-of-Interest (i.e. field devices or installations). Furthermore it is possible to define independently Alarm Selection Area to which users accounts can be individually assigned.



F040101E.ai

Figure 4.3 Operational Alarm Management

The alarm displays filter on this ‘Area-of-Interest’ In addition, special items (or group of items) can be left out from display. Filtering can be made user dependent. If user one logs in he gets ‘his’ alarms, if user two logs in he sees the alarms that ‘belong’ to him. The presentation of historical alarms can, but need not, be the same as for the current alarms.

Delayed alarms

Quite often, it is desired that, although the item is in alarm, alarming itself should be delayed because it is known, for example when starting up a system. If after a defined time the item is still in alarm, alarming should take place but if the alarm state changes back to normal during that period no alarm must be raised. Therefore an alarm delay time can be set by the system manager.

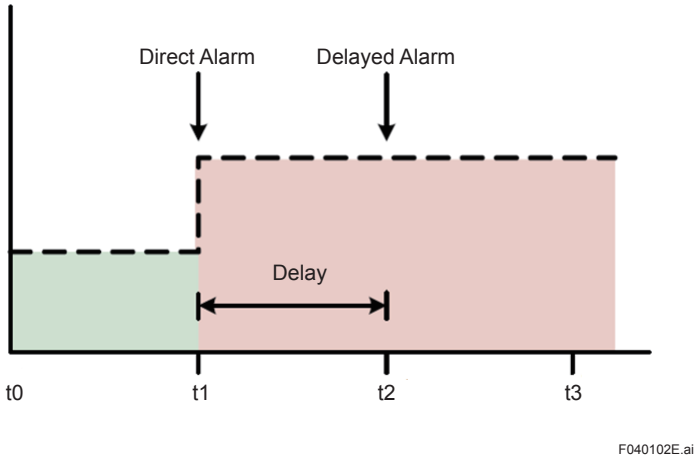


Figure 4.4 Delayed alarming

Repeated alarms

Sometimes it is desired to repeat an alarm if the alarm state continues to exist after the operator has acknowledged it. A so called repeat alarm can be defined for this situation. The repeat time can be configured by the system manager. The repeated alarm can be given a separate color.

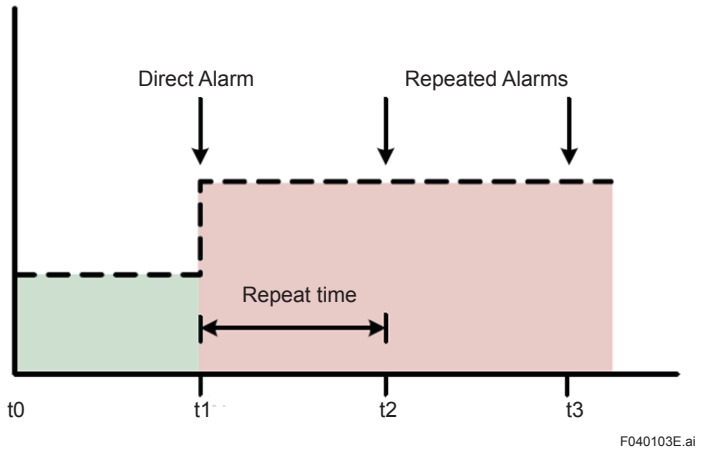


Figure 4.5 Repeated alarming

Operating System alarms

ALARM/FAST allows to direct system messages coming from your operating system to the alarm overview or printer. For example, a pre-alarm can be set on percentage of disk-usage. Crossing this limit will generate the pre-alarm in the alarm screens.

Jump on alarm

For fast access an operator need not find out on which screen the item is that is in alarm. When he sees an alarm popping up in the three line alarm banner or the current alarm overview, he can right-click on the alarm line in alarm. This will bring directly the screen up with the item it associated with, showing him the actual situation. This feature can be configured on a per item basis.

Rerouting of alarms

If alarms are not acknowledged within a certain time they can be rerouted to another destination.

Time scheduled routing of alarming

If at the end of the workday the operators leave the office, alarms can be scheduled in time to reroute to another destination.

Change of priority

Alarms that are not acknowledged within a certain time limit can be configured to change to a higher priority. This priority change can, for example, be coupled to rerouting or acoustic alarming.

Printing of alarms

Alarms can be directed to a printer. A printer allows alarms to be printed on a per alarm base. The format of the alarm line to be printed can be set independent from the format used in the current or historical alarm displays. Alarms can be printed with a header per page or as one long list.

Alarm reports

Reports can be made of current and historical alarms including filtering. In addition, reports can be defined that will print-out alarms that meet special criteria. For example, a report can be made that prints all alarms one minute before a trip up till two minutes after the trip. Hence, the trip itself can trigger the report, not knowing in advance which tag caused the trip.

Export of Alarm Overview Contents

The operator can export the contents of an alarm overview from the operator environment. Supported export formats are:

- Comma Separated Values format (CSV)
- XML format

The location and name of the exports can be entered by the operator. This specific export feature of an alarm overview component as many other properties can also individually be enabled/ disabled.

Audible alarming

A separate process takes care of audible alarming. Audible alarming can be done by:

- Playing sound files (e.g. wav-files). These files can be standard horn-signals or tailor made to represent for example spoken text or to distinguish alarms from other acoustic signals in the control room.
- Re-routing the audible alarm signal to the RTU/PLC, which on its turn activates a horn. A setup file is used to define which situations (items) subscribe to this audible alarming process. Individual items can subscribe but also a status item that represent a group of alarms. If one of the items in this group goes into alarm, regardless which one, the audible alarm will go off. More than one group can subscribe.

Alarm handling by Smart phones and Tablets

As elaborated under par. 3.4.1. Maintenance engineers can be notified of alarms by means of smart phones, tablets and PDA's. An escalation mechanism is used to determine which engineer is to be called if the previous one doesn't answer. Different telephone numbers can be inserted in this table, or an interface with a database to retrieve information like; who is responsible for the alarm, telephone numbers of the maintenance personal, maintenance follow up etc.

First alarm annunciation

In many situations, an alarm in a process results in a large number of derived alarms and it will not be clear from the alarm list what caused the fault (read: which alarm was first). ALARM/ FAST has two standard possibilities to filter the alarms for the operator, first-out and first-up. The first-out function enables alarms that come after the first alarm to be suppressed to prevent a 'snowball' effect. Only the first-out alarm is shown in the alarm display. In addition First-out groups can be organized in a hierarchical structure with parent and child relations - the behavior of the child first-out group being controlled by its parents. This feature can be used, for example, to prevent one device to make subsequent devices, which have their own First-out alarm group, go into alarm. The first-up function offers the possibility to separate the item that caused the first alarm in the group from all (subsequent) other alarms in the group. This function allows these presentation opportunities:

- The actual alarm that first caused the alarm collection group to go into alarm. Additionally this first-up item can be given a special color and priority, that makes it easy for the operator to distinguish the first-up alarm from all others.
- The first-up status-item. In the current alarm overview this item can be displayed until all alarms in the alarm collection have been acknowledged (and reset if this option is set). This status item can also be used to color a graphical object showing the status of an area, a unit, a zone or item of equipment.

Alarm collection can be assigned to an acknowledgement type.

4.2 Alarm Annunciation

4.2.1 Alarm Handling and Configuration

The way alarms need to be handled by the operator depends on a variety of factors, mostly determined by user specific alarm procedures. The following summary lists the features ALARM/ FAST supports:

- Alarm acknowledgement. Some alarms require acknowledgement, others don't (manual/ automatic).
- Sometimes, for example, at starting up a process, it is known that certain alarms will be raised which should then be suppressed (delayed).
- Repeating alarms. If alarms are not acknowledged within a time limit a repeat can be set on these alarms.
- Alarms can be grouped. One 'overall' item represents this group. Acknowledging this item acknowledges this group. Resetting this item resets the group.
- First up alarming for cases where the user is interested in the item that caused the first alarm within a group of alarms.
- First –out alarming for which the first alarm within a group suppresses successive alarms.
- For fast access to displays the operator can click on the alarm line. This makes the current display switch immediately to the display with the tag.
- Re-routing of alarms to another workstation if alarms are not acknowledged within a time limit.
- Re-routing of alarms after workday hours.
- Filtering is used if the operator is interested in alarms coming from a particular area of interests (process area).
- Dynamic priority: Priority changes when alarms last for a defined time or are not acknowledged within a defined time.

Acknowledging of alarms

The Current Alarm Overview allows the operator to manually acknowledge alarms.

He can acknowledge:

- Individual alarms by clicking on the particular alarm line
- A selected group of alarms in the current alarm overview at once (select and execute).

For this purpose there are two possibilities:

- Automatic (system) Acknowledgement. The alarm (or alarm group) is automatically acknowledged by FAST/TOOLS itself. This feature can be used to distinguish events or 'silent-alarms' from alarms.
- Process Acknowledgement. The value change of an item can be defined as the acknowledgement mechanism.

Acknowledge sequences

All field I/O-signals that are configured for alarming can have a status (High-High, High, Low etc). You decide the alarm annunciation for that status. For example a low-alarming can be shown on the alarm screen for which no acknowledging is required, while Low-Low requires acknowledging. The following table shows some of the possible statuses (for specialized purposes other statuses can be desired by users):

Status	Comment
Underranged	Signal < 4 mA (e.g. open connection)
Low	
Low-Low	
Normal	Can also be an alarm state!
High-High	
Blocked	Item Blocked by the system engineer
Overranged	Signal > 20 mA (e.g. short circuit)
Offline	No communication with PLC/RTU

ALARM/FAST uses ‘alarm-states’ for defining the alarm annunciation if the alarm status changes from one (alarm-) status to another:

Alarm State	Description
N	No Alarm
A1	Alarm state 1
A2	Alarm state 2
A3	Alarm state 3

The following figure shows the relation between states and the status of an alarm signal. In addition to these states an acknowledgement table is used that defines how acknowledgement takes places if a signal (to be more precise, its status) goes from one state to the next state.

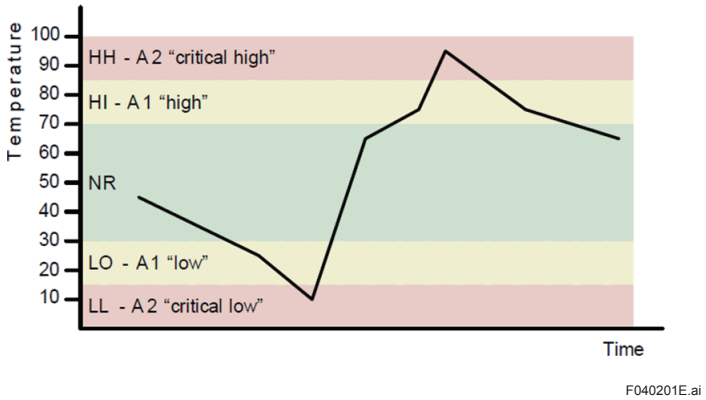


Figure 4.6 Alarm Status Level Settings

You define whether alarms are acknowledged manually or automatically. The following acknowledgment types are defined:

- Automatic. The alarm is automatically acknowledged by the FAST/TOOLS system
- Manual. The alarm has to be acknowledged by the operator

Current state	Next state		
	N	A1	A2
N ack	A	A	M
N nack	A	A	M
A1 ack	A	A	M
A1 nack	A	A	M
A2 ack	A	A	M
A2 nack	A	A	M

For example, if the current status of the signal is High and not acknowledged (A1nack) it will automatically be acknowledged if it goes to Normal (N). However, it must manually be acknowledged if the next state is A2. Now it is possible to give each alarm item its own acknowledgment matrix. The advantage of using this way of defining alarm acknowledging is its flexibility. For example items (or groups of items) that normally do not require acknowledgement and that go off-line or become under- or over-ranged now require attention of the operator and need acknowledgement.

Alarm collections

Items that are logically related to each other can be grouped into an Alarm-collection group representing a distinguishable unit, area or field device. This group has its own status-item representing that group (see figure 4.7). Acknowledging this status-item acknowledges the group. In addition, this item can be used to reset the group (freeing the unit, area or field device). If one of the items in the group goes into alarm the group goes into alarm, regardless of successive alarms in this group. Additional alarms after acknowledging the group make the group go into alarm again (flashing on the current alarm screen, for example).

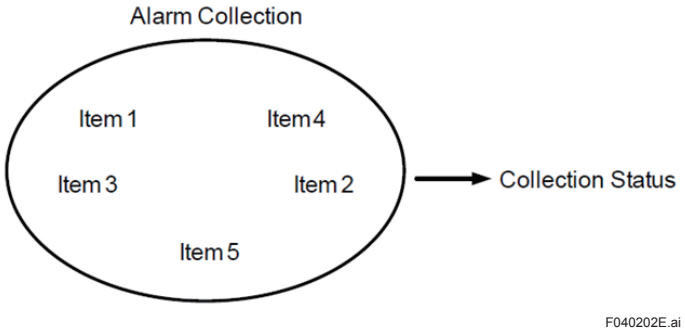


Figure 4.7 Alarm Collection Groups

The status-item shows the alarm status of the group and can be connected to a graphical object. For example, in a range of area-buttons on a top view page an area-button can be colored red if one of the items in this group goes into alarm, indicating to the operator there is something wrong in this area. Clicking on the button will bring up the area display. This status item itself can be displayed in the alarm overview to show the status of the group, area or field-device. Furthermore the value of this item is used as a counter for the number of items in the group that are currently in alarm.

4.2.2 Notification of Alarms by E-mail

FAST/TOOLS can simply send alarm notifications by e-mail. For this an alarm selection areas, notification destination and alarm notification users have to be specified in the engineering module.

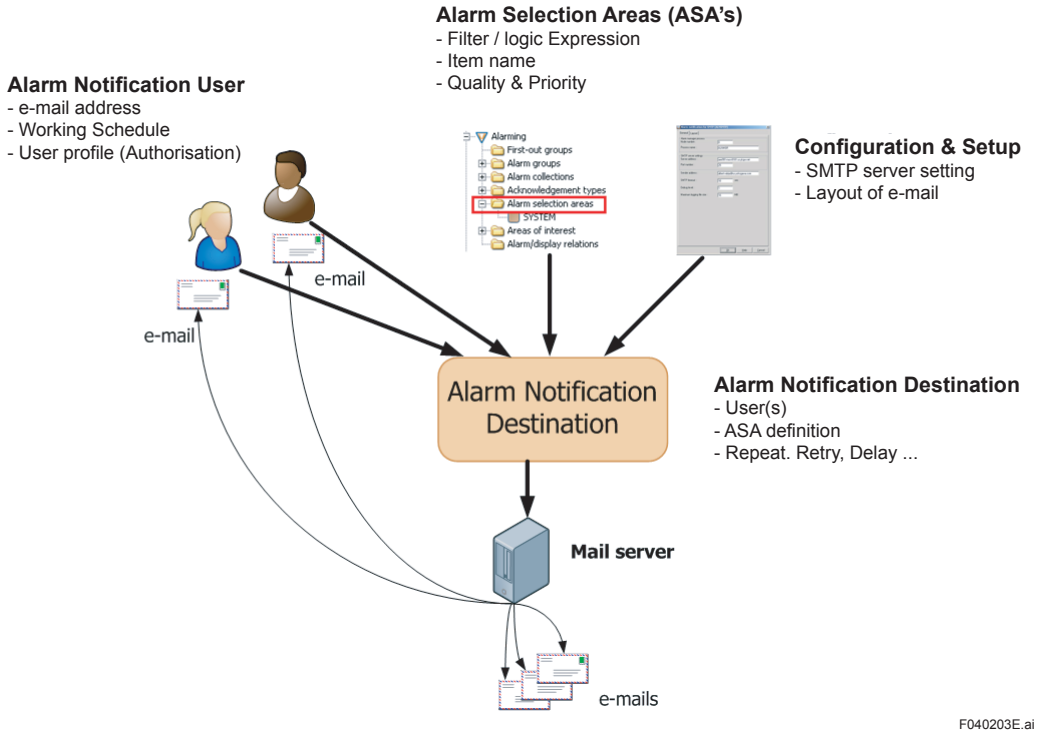
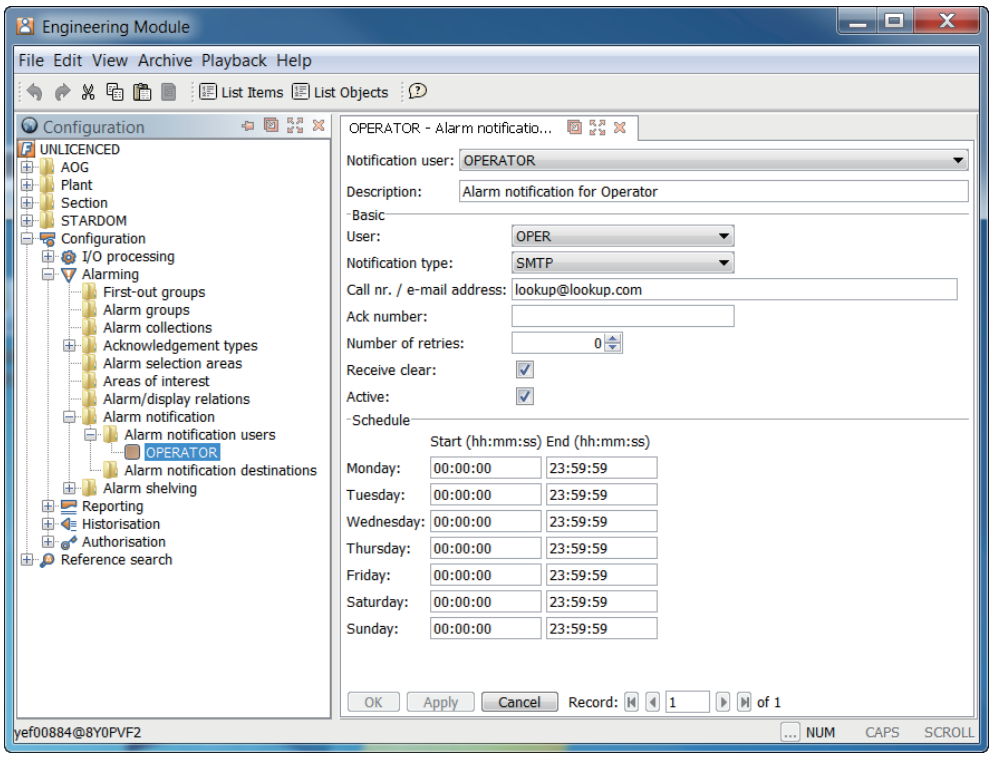


Figure 4.8 Alarm Notification by e-mail

With these basic definitions e-mail notifications can be customized to fit the exact needs for any application. This means that selected alarms (by means of alarm selection areas) can be assigned to an SMTP alarm destination on which individual users can subscribe (see figure 4.8).

After this setup the alarms that match the particular alarms selection areas (ASA) are sent via SMTP to the operators (users) that are subscribed to an ASA that matches these particular alarms. If the e-mail is not received it retries after a specified time interval to send the alarm again.

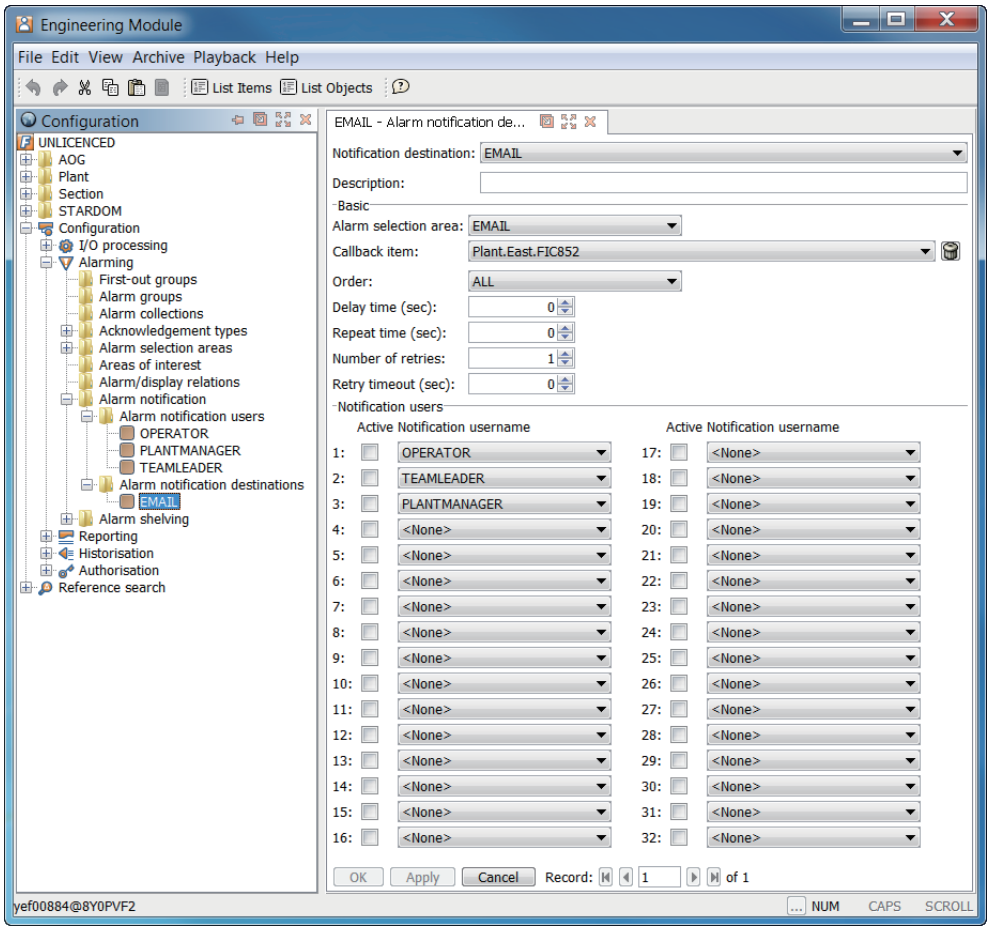


F040204E.ai

Figure 4.9 Alarm Notification users

Figure 4.9 shows the configuration form for the alarm notification users. The main settings are the e-mail addresses, working hours and authorization level of each user that is entitled to receive a defined selection of alarms by e-mail.

Figure 4.10 shows the configuration form for the alarm notification destinations. In these forms the alarm notification users can be subscribed to one or more defined ASA's.



F040205E.ai

Figure 4.10 Alarm notification destinations

In addition the following customization options must be defined:

- Order (authority sequence to receive the e-mail notifications)
- Delay time (alarm delay time)
- Repeat time (alarm repeat time until the item returns to normal)
- Number of retries
- Retry timeout

This flexibility allows customizing of the alarm philosophy to match each applications needs.

4.2.3 Alarm & Trend Overview ‘Linked’

FAST/TOOLS enables to dynamically link its trending view component with its alarm views component. This allows a user to click on an event in the trend view showing the hairline at that exact time including the related alarms on a view in the same display (see figure 4.11). Also the other way around can be very useful by browsing through the alarm and event overviews and instantly have a focused view on the trend lines related to this time window.

F040206E.ai

Figure 4.11 Alarm time sequence linked to trend view time window

Clicking on an individual alarm-event will cause the hairline to snap to the time the alarm was generated in the associated trend. This also supports online (Sequence Of) Event analysis for Historical data in a real-time trend view.

4.2.4 Sequence of Events Recording

Both current and historical alarm displays allow the display of Sequence Of Event data coming from specialized equipment that is able to record and time-stamp events. Data is shown in the right time-stamped order with a resolution down to millisecond if the equipment supports and supplies that resolution. Alarm lines can have color- and line formatting specific for this purpose. Events are different from alarms and should be shown separately.

4.2.5 Alarm Export

When the authorization settings allow it is possible to directly export all current, history and system alarm data from their respective views to an CSV or XML file which can be imported into Microsoft Excel and other office applications for further (statistical) analysis tailored to any customers requirements. For alarm analysis requirements conform to ISA 18.2 and EMUAA 191 FAST/TOOLS offers a the Alarm System Performance Analysis (ASPA) module which instantly delivers all metrics to provide a holistic picture on the effectiveness of the implemented alarm philosophy on any system environment. What ASPA offers in this respect is elaborated further in paragraph 4.3.4.

4.3 Alarm Analysis

With the introduction of more intelligent functions in process installations and the integration of asset management, business, and planning data from other systems into the process management environment, the variety and number of alarms has increased. Without the proper implementation of a good alarm philosophy, operators will be flooded with more alarms than they can handle, i.e. exceeding the recommended number of 10 alarms in a 10 minute period of time.

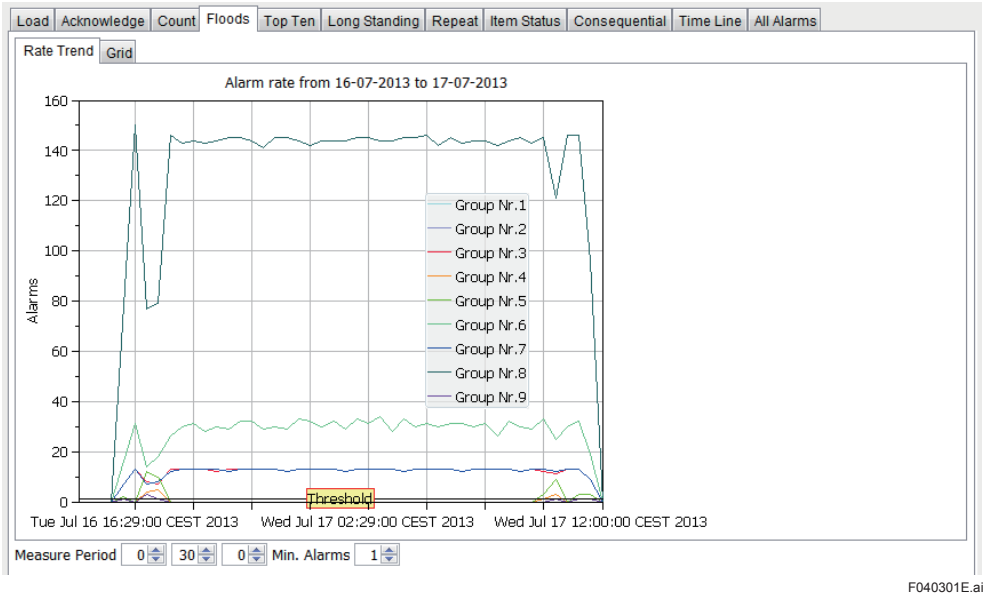


Figure 4.12 Alarm Analysis

FAST/TOOLS Alarm System Performance Analysis (ASPA) adds a significant new dimension to the alarm management capabilities of process management software. It eases the process of defining key performance measurements, analyzing alarm system behavior, and presenting this from different angles. This delivers a holistic and informative overview, providing guidance on operational improvements that can be made to create a sophisticated alarm management and analysis environment that is compliant with the EEMUA 191 and ISA/ANSI 18.2 standards, enhancing your process management system investment.

4.3.1 Alarm Analysis Functionality

FAST/TOOLS ASPA delivers critical statistical methods, views and tools providing performance analysis in relation to the “EEMUA 191 guidelines and ISA 18.2 standard” to ensure alarm system quality and effectiveness.

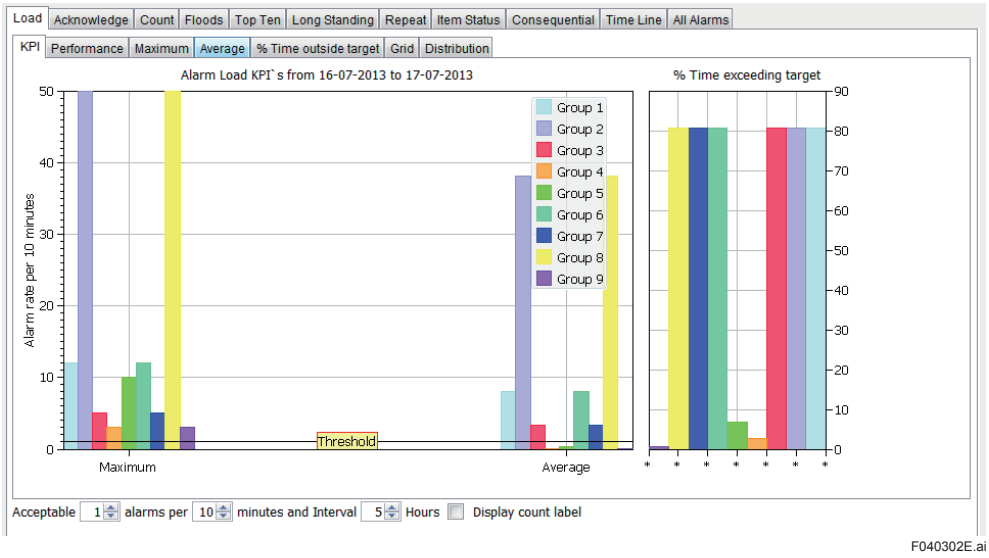


Figure 4.13 Alarm Analysis Functionality

Based on key performance measurements embedded in FAST/TOOLS ASPA, the behavior of the alarm system will be presented from different angles. This will deliver holistic and informative views providing guidance for improvement.

4.3.2 Deployment

FAST/TOOLS ASPA can be utilized for a number of objectives that contribute to improved effectiveness and performance of new and installed alarm systems.

Examples of FAST/TOOLS ASPA deployment objectives:

- To set and measure performance targets to enhance the quality of a (new) Alarm Management System
- To analyze the functioning of an existing alarm system
- As a management tool to follow the results from an ongoing improvement program such as Human Centric Operations
- To identify specific nuisance alarms and number of standing, delayed and suppressed alarms
- To demonstrate the performance of an alarm system to an independent auditor and regulatory bodies

4.3.3 Supported Alarm Analysis Metrics

FAST/TOOLS ASPA offers an extensive set of predefined metrics:

- Number of alarms over a defined period
- Most frequent alarms over a defined period
- Counts of standing alarms at defined times
- Counts of shelved alarms at defined times
- Identification of longest standing alarms over a defined period
- Proportion of alarms at each priority during a defined period
- Measurements of operator acceptance times
- Auto- and cross correlation of alarm records

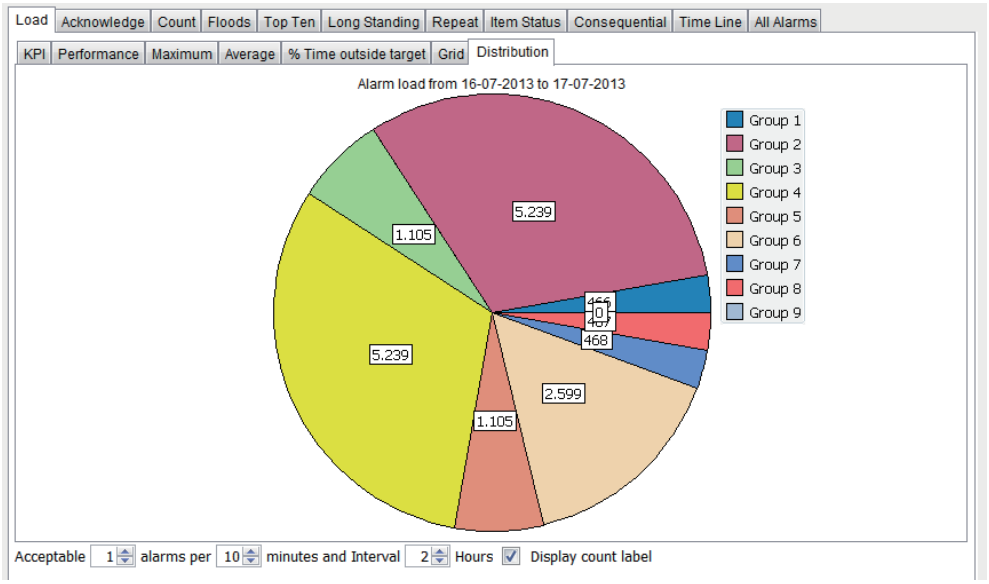
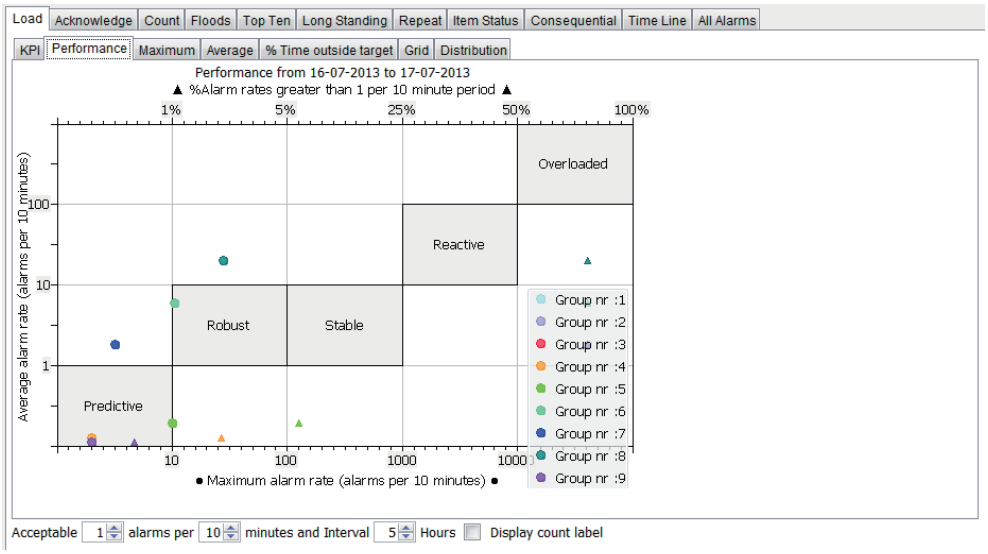


Figure 4.14 Alarm Analysis Metrics

4.3.4 EEMUA 191 & ISA 18.2 Metrics

- Operator Load KPI
- Operator Load Performance
- Alarm Rates and Floods
- Alarm Top 10 bad actors
- Long Standing Alarms
- Consequential – Alarm correlations
- Average Annunciated Alarm Rate per operator
- Annunciated Alarm Priority Distribution
- Peak Annunciated Alarm Rates per operator

These metrics are the basis in the assessment of whether operators will find the alarm system easy to work with and does not exceed the ergonomically acceptable workload and quality.



F040304E.ai

Figure 4.15 Alarm Analysis

This is made visible by categorizing the state of the alarm system performance into five levels as defined by EEMUA 191. FAST/TOOLS ASPA identifies the worst case load during any ten minute time slice and categorizes this to alarm system performance levels in accordance with EEMUA 191 (see figure 4.15).

4.3.5 Key Benefits

- Better insight into operator workload respecting ergonomic limitations
- Timely information about alarm system weaknesses
- Online monitoring of the improvement process
- Facilitating the benchmark categorization in accordance with EEMUA 191
- Monitoring operator responsiveness
- Provides all necessary views to identify potential (future) problems

5 Enterprise Automation Solution

An Enterprise Automation Solution (EAS) enables a company which has their operations spread across wide geographical areas in countries, regions or even on a world wide scale to deliver real-time and historical data from the pant/field level to the enterprise level. Through its unified visualization environment it provides and combines information from any geographically dispersed asset and enables real-time collaboration and interaction across roles and locations. At the enterprise level data can be interrelated, analyzed and transferred into meaningful information for asset monitoring and control of distributed automation systems.

The open nature of an EAS allows it to easily adapt to a Services Oriented Architecture (SOA) over which it can securely share information with various business applications conform the applicable IT policies for critical information.

This section describes the EAS capabilities of FAST/TOOLS for which applications it is most beneficiary and how it facilitates operations to reduce cost and optimize production.

5.1 Positioning

For large scale geographically dispersed projects, there may be a hierarchy of individual Process Automation Systems, which in turn are each responsible for a specific region, and are managed by a higher level system. For these applications FAST/TOOLS provides a flexible, scalable architecture for EAS, by supporting multi-level/multi-node configurations. It is possible to balance server functions over multiple machines, for example for data acquisition or for supporting many HMI clients. This architecture lends itself very well to Enterprise wide remote operations, - monitoring and - maintenance projects for dispersed production sites and supply chain infrastructures such as oil and gas fields, pipeline grids, water distribution, energy generation, etc. This delivers strong benefits in improved safety, reductions in operational costs and more efficient production management. In addition there is an increasing desire to translate increasing numbers of field data from production assets into meaningful information that can be used to optimize operational processes and procedures. This information can also provide better insight where cost reduction gains can be achieved. More specific the FAST/TOOLS enterprise automation solution architecture allows users:

- To work with a standardized and centralized unified visualization and analysis environment
- To effectively collaborate independent of physical location within the enterprise and function
- To make decisions based on real-time information and take proper action within a short time
- To obtain information with less exposure to safety risks

5.2 Enterprise Architecture

In today's world companies are integrating their operations to span all regions and countries they are active in. Therefore high-end users need to be able to access information from any physical location in the company not limited to country and other geographical boundaries. The FAST/TOOLS Enterprise Automation Solution architecture enables to swiftly deliver information across the enterprise network as well as through secured web access and smart mobile devices to the right user at the right time.

In ISA-95, the functional levels of an Enterprise Control system are defined. Note that the levels presented in the sample architecture on the next page relate to a physical business model in which a company consists of a headquarters, regional offices and local offices. All these locations can contain systems which together form the Enterprise Architecture. This should not be confused with the automation levels defined in ISA-95, in which the logical information layers of a control system are defined. In the Enterprise Architecture, four major levels are identified (see sample architecture on the next page). Each level has its typical characteristics and usage.

Corporate level

At the corporate level, all KPI's and other process data of all the business units are collected and aggregated providing a holistic view of the performance of the enterprise and its operational groups down to process level in real-time.

Business unit level

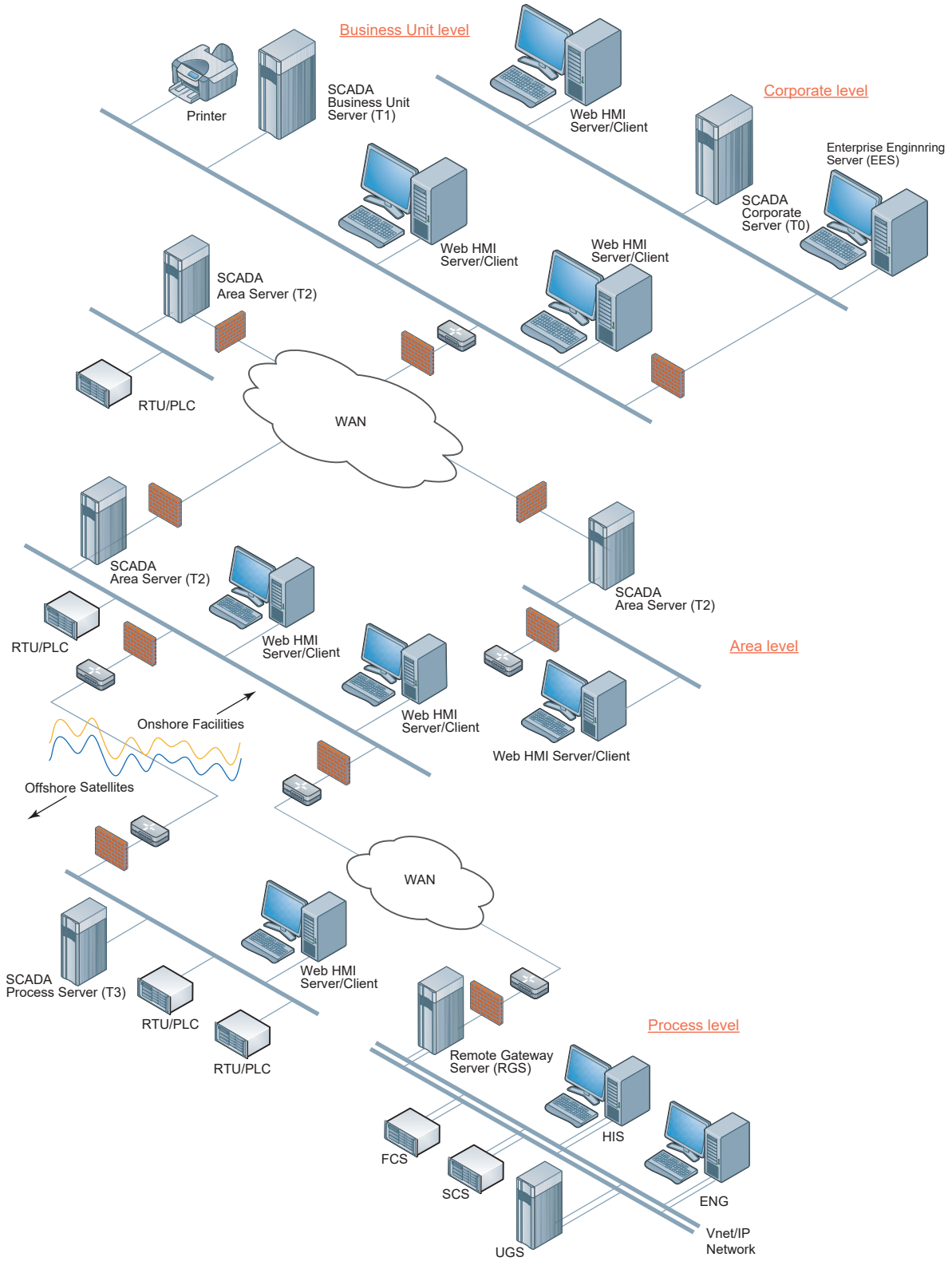
The business unit level is typically responsible for all areas within the business unit. The business unit contains a FAST/TOOLS server node that exchanges KPI's and other process data with the Area level. At the business unit level, users are expected to have access to data that is supportive in optimizing production of individual as well as interrelated assets.

Area level

The area level supervises all processes within a graphical area to provide control over this area. It contains a FAST/TOOLS server node that is connected to all DCS and/or SCADA systems at the process level. A typical application at this level is to control the total amount of production within the area, and to supply production KPI's.

Process level

The process level contains local DCS/SCADA/PLC systems or other automation control/ monitoring equipment that directly interacts with the process. As an example a typical large gas production platform that is controlled by a DCS system and exchanging process information with the area level.



F050201E.ai

Figure 5.1 sample architecture: 'enterprise system' concept

The above sample of a typical Enterprise Architecture provides an impression of the flexibility to compose fit for purpose enterprise wide automation system architecture. This functionality is offered without compromising on the autonomous operation of the individual server nodes that can directly serve information from all levels to a unified visualization environment.

5.3 Enterprise Efficiency

To ensure an effective and maintainable EAS the following functions are inherited in the FAST/TOOLS software and architecture for enterprise wide deployment:

Global data architecture

FAST/TOOLS EAS reduces engineering and maintenance cost as it eliminates duplication and replication efforts. Tags are created in a global name space and are put in a multi-level architecture that ensures their uniqueness at any level in the enterprise automation system.

Originated data sourcing

With FAST/TOOLS data collection and time stamping can be achieved as close to its source as possible ensuring trusted data accumulations across multiple network layers.

Flexible IT integration

The open top end RDBMS architecture of FAST/TOOLS and its adaptability to a Service-Oriented Architecture (SOA) ensures that data from the EAS environment can be easily shared with other business applications and/or systems at the corporate level.

Efficient communication

The event driven nature of the FAST/TOOLS architecture and optimized bandwidth utilization satisfy the high demand for data and information from field to enterprise level. In addition it supports for on demand delivery of data that only needs to be presented when a user is accessing a particular window with this specific information. This further reduces the demand for continuously distributing large amounts of data top down and up the architectural layers of the EAS.

5.4 Enterprise Operations

Enterprise operations delivers the process data to the users at each automation level (see figure below). This covers the process operator controlling the process at the Process level, up to the KPIs that are supplied to the financial systems of the enterprise at the corporate level.

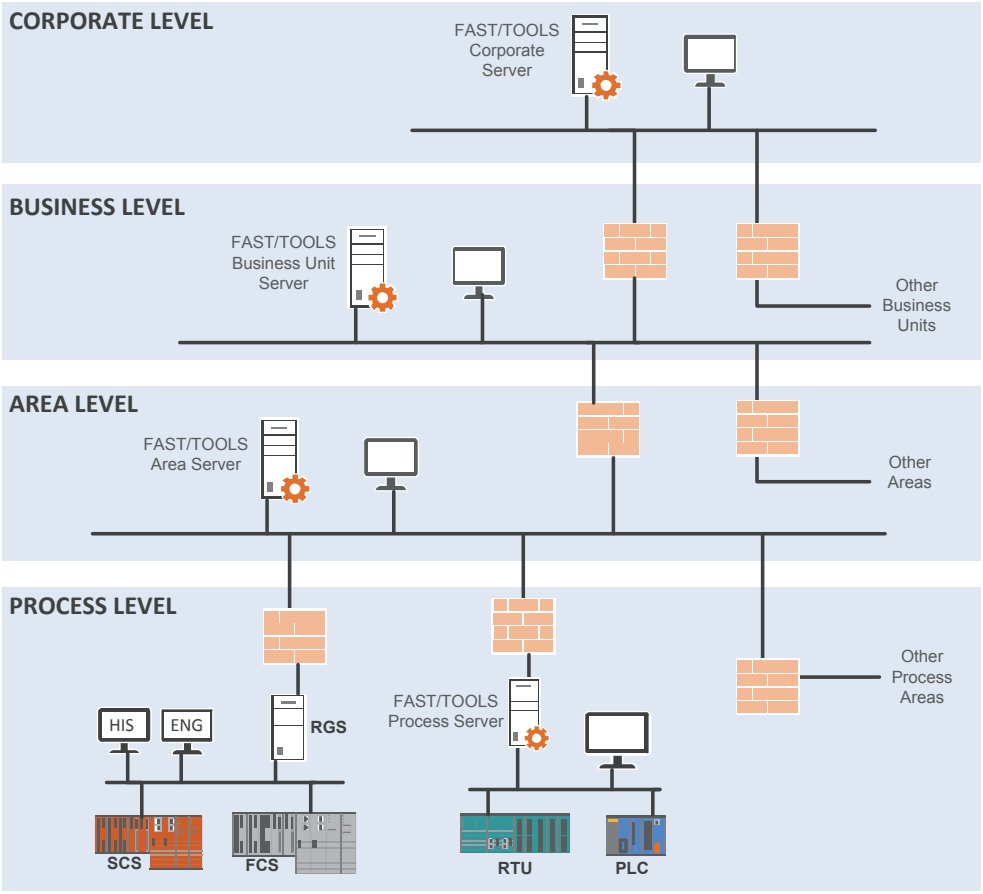
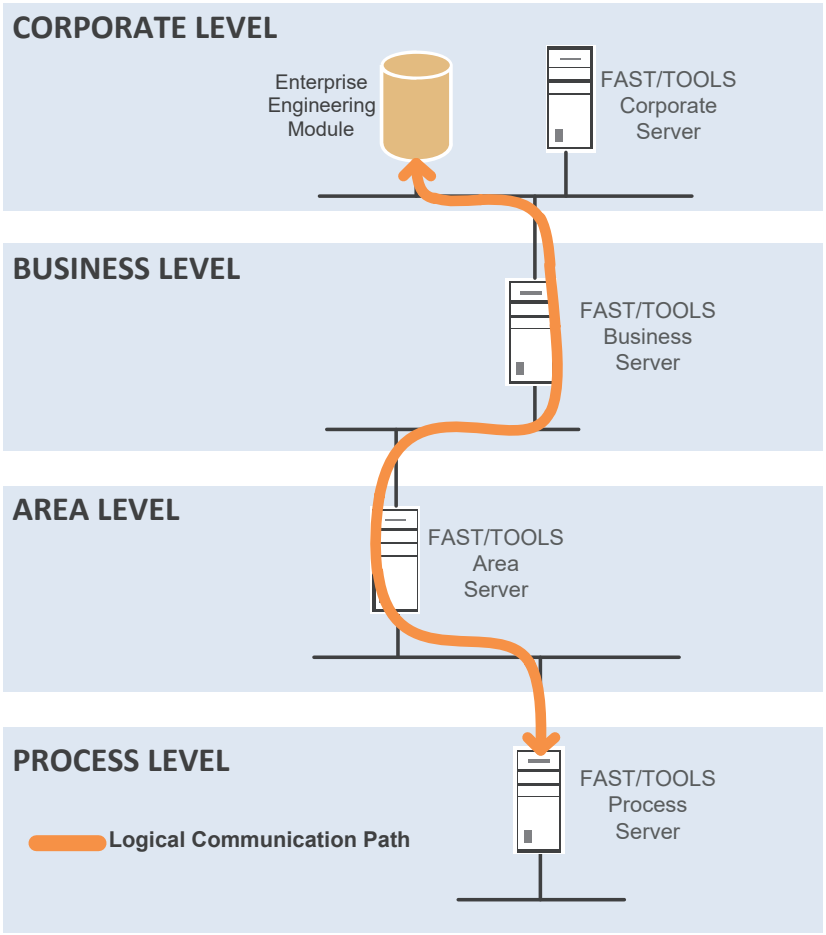


Figure 5.2 Functional levels

The FAST/TOOLS Enterprise Operation Module is responsible for gathering the data to be displayed to the user, and to process the user responses. For this it uses the name space server to establish the most optimal path to access data to be presented to the user. It tries to find alternative paths to the data if access to a certain server is temporarily interrupted. The rule based security model authorizes a user to perform certain operational tasks.

In the figure above, four networks are depicted: the Corporate network, the Business Unit network, the Area network and the Process network. These networks can be one physical network where the sections are separated by routers and firewalls, or these networks can be physically separated. In the latter case, a Business Unit server may have two network cards, one that connects the server to the Business Unit network, and one that connects the Business unit server to the Corporate network.

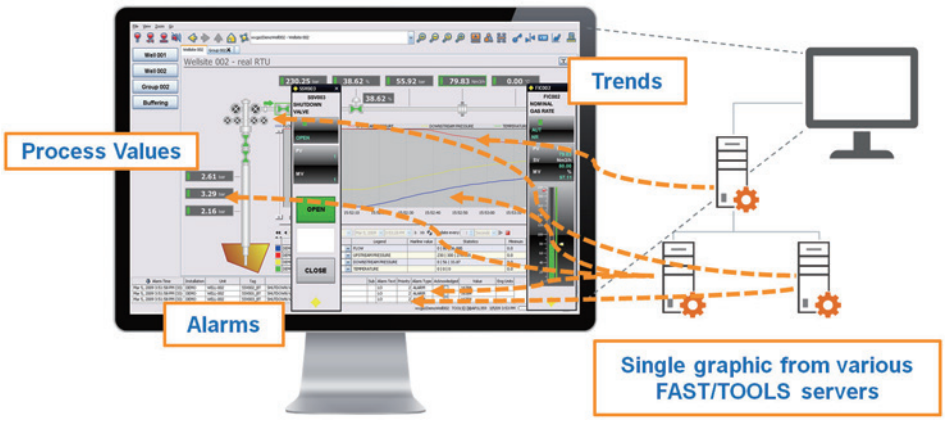
The logical automation network supports plug and play. When a server is added to the physical network at any level then the logical automation network will discover this and update its routing tables with the new server.



F050402E.ai

Figure 5.3 Information routing

In the figure above a logical connection between an Enterprise Operation Module located at the corporate level and one of the process server from which its visualization environment is gathering information from is shown. This allows the Enterprise Operations Module to connect to multiple FAST/TOOLS servers across several levels and to visualize the gathered information in one Mimic as illustrated here below.



F050403E.ai

Figure 5.4 Unified visualization environment

Enterprise Engineering

FAST/TOOLS provides support for multi-level, multi system architecture and maintaining consistency of engineering definitions between these systems.

These large geographical dispersed systems require a different approach from an engineering perspective with central engineering and managed deployment of configurations.

The FAST/TOOLS Enterprise Engineering Module is responsible for this system wide engineering where the Enterprise Engineering database contains all master enterprise definitions for all servers and deployment information (what runs where).

Engineering can be done online and offline simultaneously by local and remote engineers on an integrated enterprise engineering environment. This is easier to manage, and reduces complexity. A dedicated engineering workstation does not load other systems, does not require network access to servers during engineering and provides a method for standardizing engineering configurations across servers. This reduces project and engineering costs significantly.

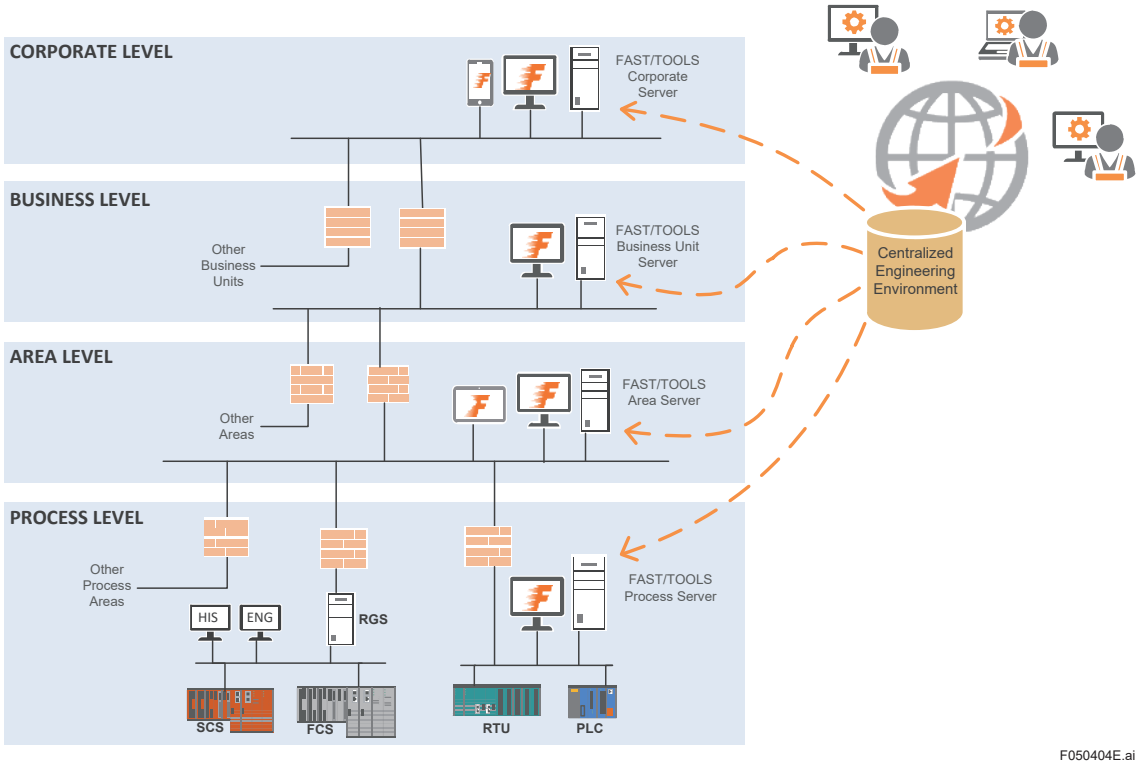


Figure 5.5 Enterprise Engineering environment

The Enterprise Engineering Station contains;

- Single engineering environment containing all common enterprise definitions and deployment data.
- Deploy and synchronize to multiple levels and areas from a single database.
- Local and remote access for multiple enterprise engineers on an integrated enterprise engineering environment

Enterprise Engineering is performed using the Enterprise Engineering Module that runs on the Enterprise Engineering Server(EES). EES is connected to Web-HMI client(s).

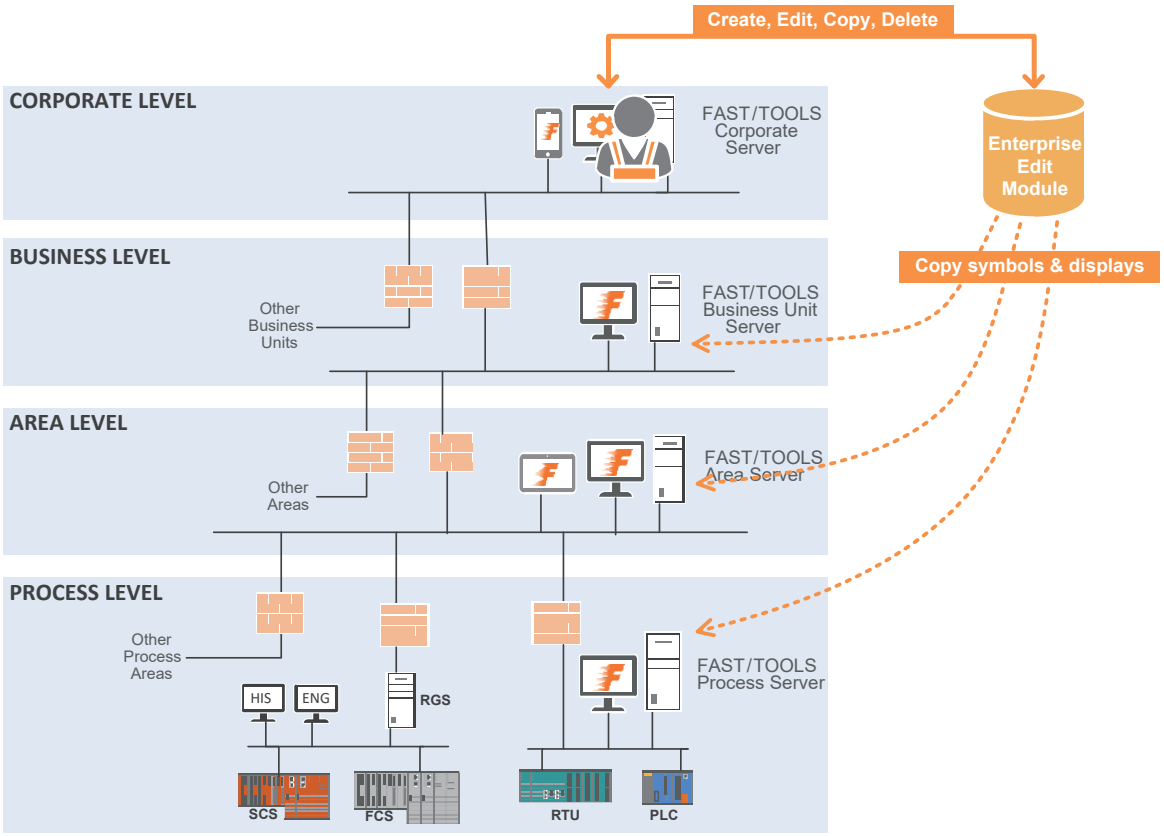


Figure 5.6 Enterprise Edit Module environment

The Enterprise Edit Module contains;

- Enterprise display management functions
- Edit enterprise displays local and remote
- Copy displays to other nodes
- Can be run from any enterprise node

Item calculation for Enterprise Server License

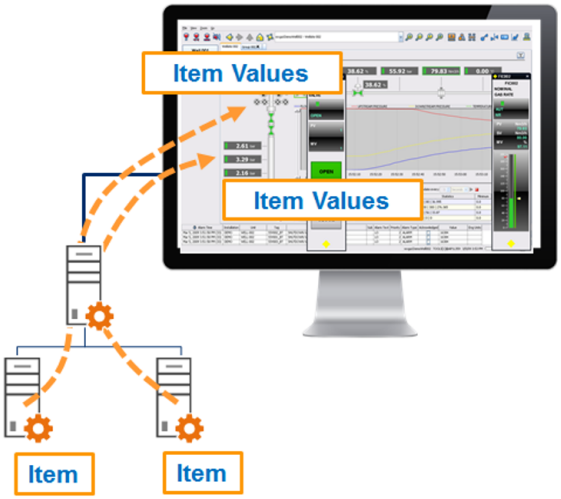
Enterprise Server (ES) (model RVSVRN, UNSVRN) is also required to have a proper license defining an available number of items which needs to be more than the number of items used on it. The following is the guideline to calculate the number of items needed on each ES.

The calculation of number of items is classified into the following four cases.

Case 1: The ES displays (*1) Items which are located on other ESs

If the ES only display items on other ESs as they are, without any modification or calculation to the items, then the ES needs no item on itself for those items. The ES needs no item license for them.

*1: The “display” includes both reading data from item and writing data to item, on a graphic.



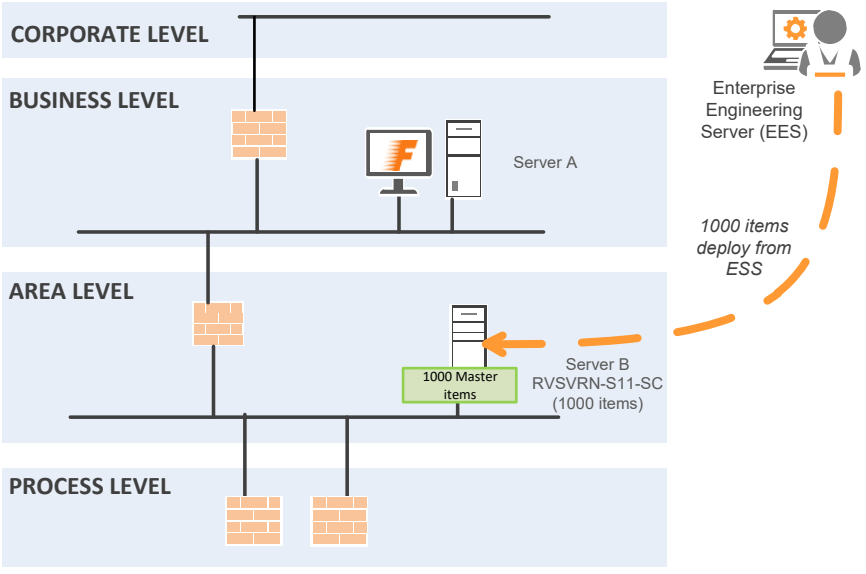
F050406E.ai

Figure 5.7 Display items on other ESs

Example:

- Displays connected with Server A only show data of items on Server B via Server A
- 1000 items are deployed from the EES to Server B

A required item license is only for Server B



F050407E.ai

Figure 5.8 Deploy items to Server B

Case 2: The ES uses (*2) items which are located on other ESs.

If the ES uses items on other ESs, then the ES needs to have the same number of items it uses on itself. The ES needs the item license for those items.

*2: The “use” means the following cases:

- Use the items in programs.

  User can create various programs by using programming languages (Java or FAST/TOOLS language) equipped on FAST/TOOLS, and the program can handle items for calculation, copy, reference and so on. If the ES uses items on other ESs, in the program in it, then it needs to have items for them on itself and is required to have the license for the items.

  *The program is called “Object”.

- Store the items as local Historical data

  If the ES stores items on other ESs, as Historical data on itself, then it needs to have items for them and is required to have license for the items.

In this case, same items are placed on multiple ESs which use the items and the values of items are synchronized constantly between the ESs. FAST/TOOLS have the concept of “Deployment group” to handle these items. These items – same items placed on multiple ESs – are in the same deployment group. The deployment group is constructed of items, Objects and ESs on which the items and Objects are deployed. The deployment groups are configured by user on engineering works.

Example:

- Server A and Server B construct the deployment group
- Displays shows items on the deployment group
- 1000 items are deployed from the EE server to ESs in the deployment group

Each server, Server A /Server B, requires the item license.

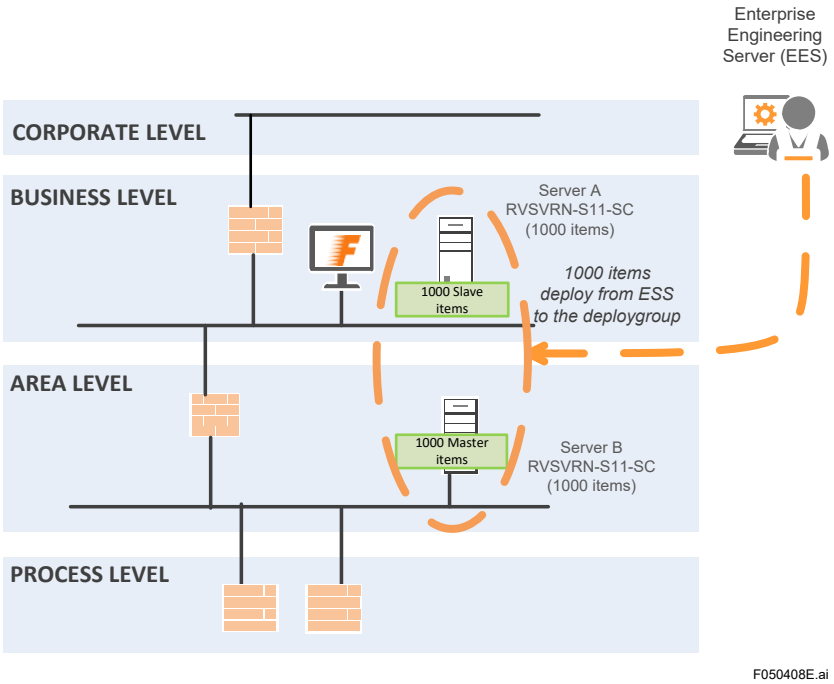


Figure 5.9 Deploy items to Server A and B

Case 3: The ES uses Objects which are located on other ESs and Objects have items created by the Objects.

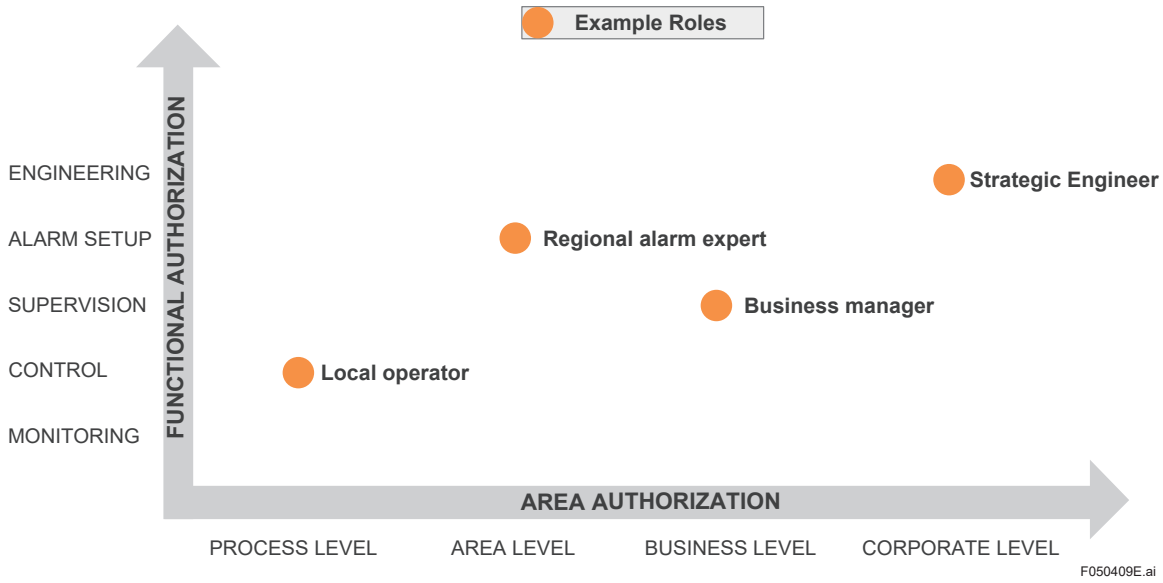
The ES can use Objects (programs) on other ESs. If the ES uses Objects with items which are created by the Objects on other ESs, then the ES needs to have the same number of items included in the Objects it uses on itself. Calculation of items is same as the case 2. The ES needs the item license for those items.

Case 4: The ES have local items.

If a ES have items defined on it, then it needs to have items for them and is required to have license for the items.

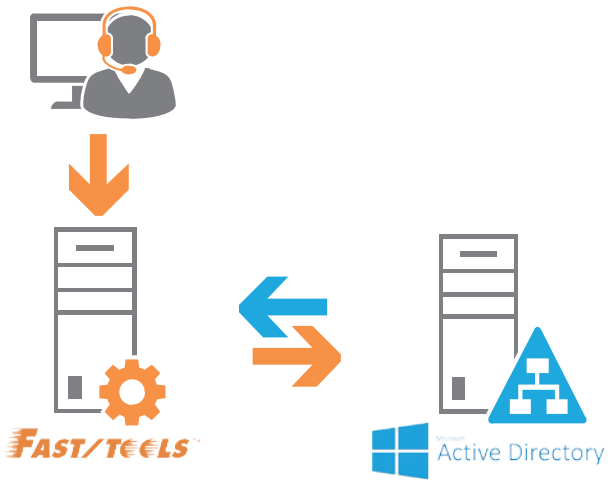
Role based authorization & authentication

In an Enterprise environment multiple roles are identified with different information requirements. These roles also require functional authorization versus area authorization to allow who has access to what, therefore requiring Role based Authorization & Authentication.



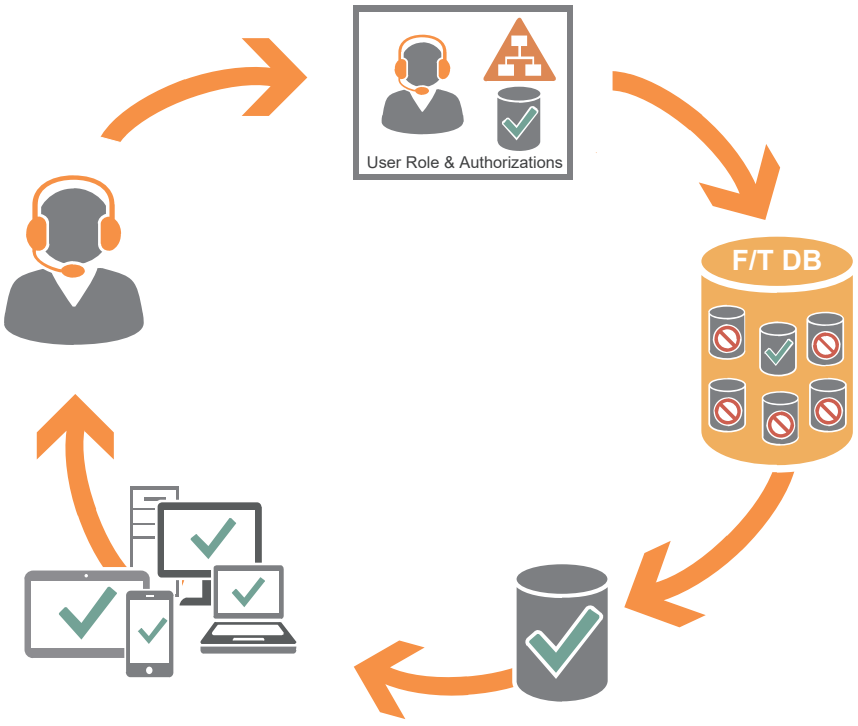
To enable these roles in a secure manner not only the security of the IT environment and operating system must be considered but also the SCADA based application security needs to work harmoniously.
Therefore FAST/TOOLS supports the integration with Active Directory.
Users can login with their Windows name and password, and Active Directory maintains all user profiles and permissions for all applications. A FAST/TOOLS user Group name for this user is stored in Active Directory and the user group name from Active Directory is mapped to the user group name in FAST/TOOLS. This is so-called “Single sign-on”.

Login functions of Operator Interface, Engineering Environment and Client applications are consolidated into one function. Also profiles of multiple FAST/TOOLS users assigned to an Active Directory user are merged. When Active Directory is enabled, user actions with a Windows user name are logged in Audit Trail.
For further security assurance measures all active users who login to FAST/TOOLS can be shown in Operator screens or used in applications while passwords are immediately encrypted when entertd.



F050410E.ai

This concept is further enhanced into role-based geo intelligence.
This means that Users can login with their Windows name and password, where the User Role determines which data and controls are accessible. The FAST/TOOLS database provides the allowed and usable data which can be presented to devices assigned to the user profile.



F050411E.ai

Secure and Robust networking and routing

Application communications between organization layers will use FAST/TOOLS networking and routing. A robust routing protocol function is employed to locate the requested tags. Only UDP ports required for FAST/TOOLS multi-node communications communications need to be made available in the firewalls between layers.

Existing FAST/TOOLS data set authorization and process area mechanisms will control access to enterprise configuration and local engineering capabilities.

SPNEGO Authentication

With single sign-on for HTTP requests, using the Simple and Protected NEGOtiation Mechanism (SPNEGO), web authentication is now supported which is a standard method for user authentication for web servers, including support for AD SSO from browser environments, MS Excel, etc. It is a “pseudo mechanism” used by client-server software to negotiate the choice of security technology. SPNEGO is used when a client application wants to authenticate to a remote server, but neither end is sure what authentication protocols the other supports.
Users can securely negotiate and authenticate HTTP requests for secured resources in the FAST/TOOLS Host/Application Server by using the Simple and Protected GSS-API Negotiation Mechanism (SPNEGO) as the web authentication service for the FAST/TOOL Application Server. SPNEGO provides a mechanism for extending Kerberos to Web applications through the standard HTTP protocol. Kerberos is a network authentication protocol for client/server applications. Many types of clients connect to same web server, using different technologies that may not provide direct access to AD, especially browser based (e.g. HTML5, JAVA, Web Start). FAST/TOOLS provides single sign-on for FAST/TOOLS Web Start and other client applications of the web server, specifically build for the HTML5 implementation.

(Fits current FAST/TOOLS single-sign-on implementation with Active Directory enabled systems)

5.5 Enterprise Data Integration

The FAST/TOOLS EAS distinguishes several major levels in accordance with ISA-95. All levels play an important role in data-storage, delivery, integration and presentation of information to different user groups from corporate down to operational level (see figure 5.10).

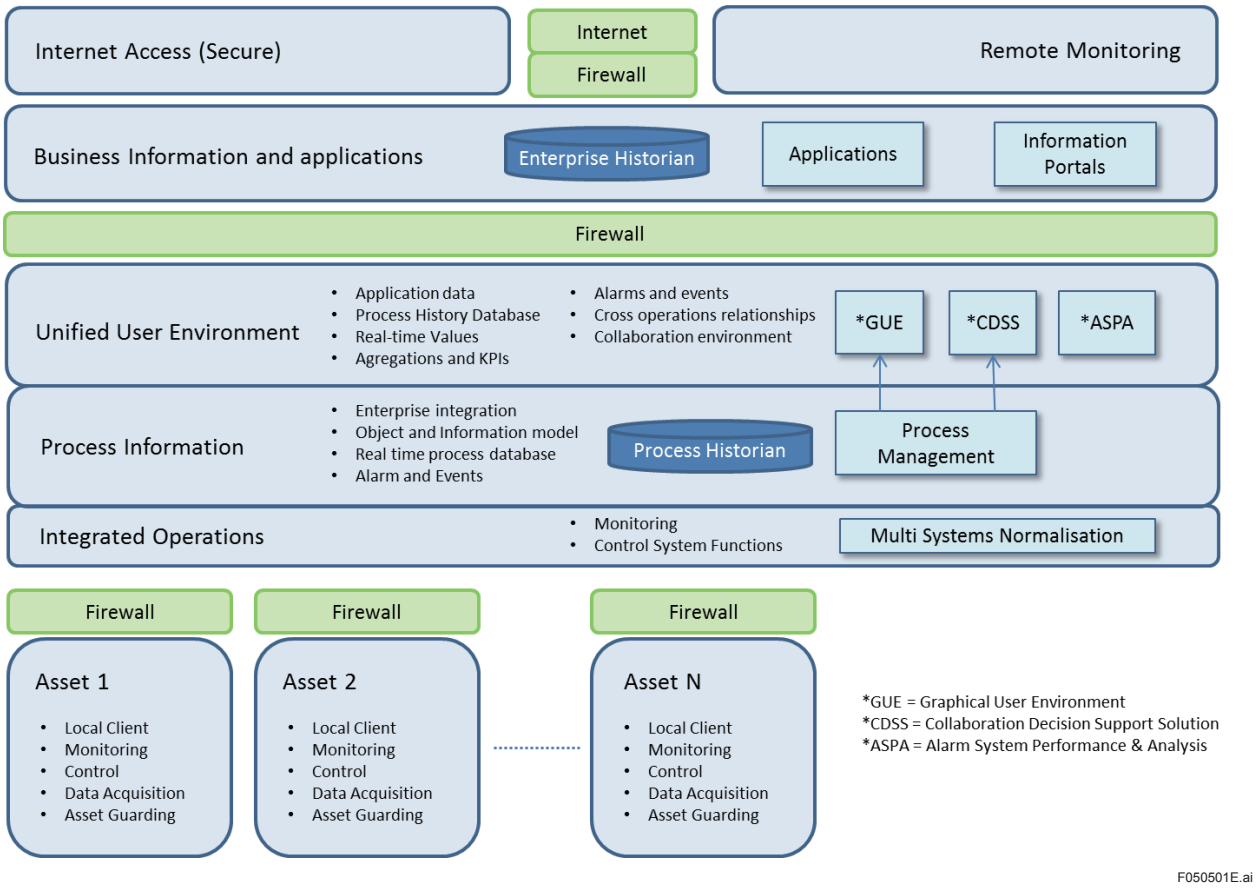


Figure 5.10 EAS Data Platform

The data is collected from any connected field/data source at the operational level and eventually stored for long term usage from the unified user environment which has access to the top end RDBMS engine that can do the intensive data calculations, reporting and analysis independently from the operations level that execute all internal data processing tasks and control and monitoring functions.

More information on the RDBMS engine and how it can provide linked servers functions to many common database environments (for instance Microsoft SQL Server, Oracle, etc.) is provided in section 6 ‘Application Integration’.

6 Application Integration

The process industry (amongst others) is rapidly changing, driven by ever increasing pressures from legislation, competition, increases in energy costs and an aging workforce. From a process-automation point of view to cope with these more agility and faster response is required by making decisions in real-time rather than through transactional processes and procedures.

A significant benefit can be delivered through a tailored collaboration environment which can bring operational and maintenance information sources together in an integrated visualization environment where information can be presented in a holistic context. This means that data from different sources needs to be interrelated and translated into information for operational functions. From this top level overview it is possible to zoom in on the individual conditions to view their impact and relationship with the information and data they are derived from.

With FAST/TOOLS it is possible to easily create an environment for the real-time capture of key operational and maintenance information from various sources, allowing improved visualization of information and showing with a single view its impact on performance. This facilitates better communication between users across roles both inside and outside an organization.

In addition to its open visualization environment FAST/TOOLS has a track record with integrating various advanced applications that serves its industries from an operations point of view such as:

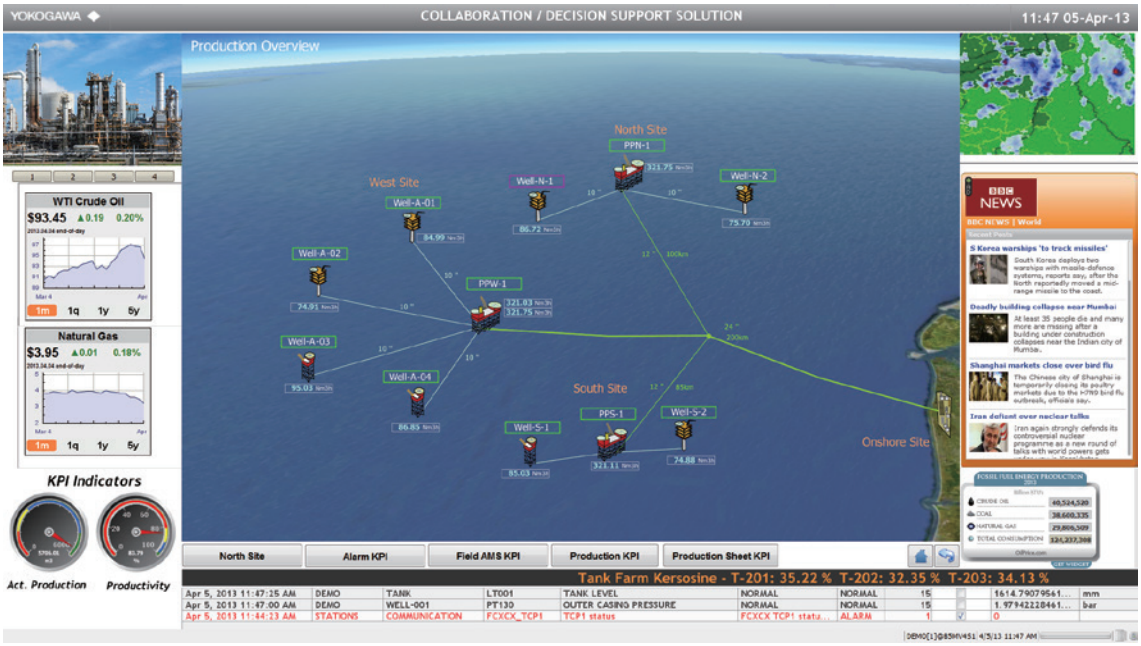
- **Asset Management**
- **Inventory Management**
- **Power Management**
- **Geographic Information**
- **Gas Flow Calculations**

This section describes the functionality of two essential components of the FAST/TOOLS software platform that enables application integration at visualization level as well as database level. Application integration can be desired at both levels or in particular cases only at visualization or database level. For integration at visualization level FAST/TOOLS offers it's Collaboration Decision Support Solution (CDSS) as elaborated in the first paragraph (see paragraph 6.1) of this section. Application integration at database level is made very easy through the build in top end RDBMS engine (see paragraph 6.2).

The distinction between these levels allows a better fit for purpose with respect to application integration preventing from unnecessary engineering and maintenance of interfaces.

6.1 Collaboration Decision Support Solution (CDSS)

This component of the FAST/TOOLS operations management system platform can be utilized to monitor main production facilities such as petrochemical complexes and power plants, as well as sub-processes such as utilities, reactors, tank farms, and loading and offloading facilities. Dashboards deliver cross-referenced information on operational performance factors along with data on energy efficiency, carbon emissions, and direct cost savings that can be used to determine the effectiveness of efforts to reduce energy consumption and waste, and monitor compliance with environmental standards. A single, easy-to-use user interface allows for the integration of the document management, video/CCTV, maintenance, and other software environments required for a users' communication and collaboration needs.



F060101E.ai

Figure 6.1 CDSS KPI Dashboards Sample

FAST/TOOLS CDSS expands the visualization of key operational information with powerful components founded on the most sophisticated operations management platform in the market and its 'state of the art' visualization environment, capturing 'real-time' operations, maintenance and business information in a single view.

6.1.1 Functionality

FAST/TOOLS CDSS informative views support data collection from a variety of sources which can be shared – globally - allowing continuous application improvement and management. Through its native Web-based and rigid infrastructure, FAST/TOOLS CDSS is capable of utilizing the best in class IT security techniques available. Software and tools have been developed taking the ISA 99 guidelines into account. FAST/TOOLS CDSS dashboards facilitate a holistic view over all key aspects of a users' operation and assets.

Another important aspect CDSS contributes to is the optimization of the efficiency of resources by facilitating the move to 'real-time' information sharing. The aim is to optimize human resources efficiently across local and remote production facilities and to centralize knowledge for more effective and consistent use.

6.1.2 Deployment

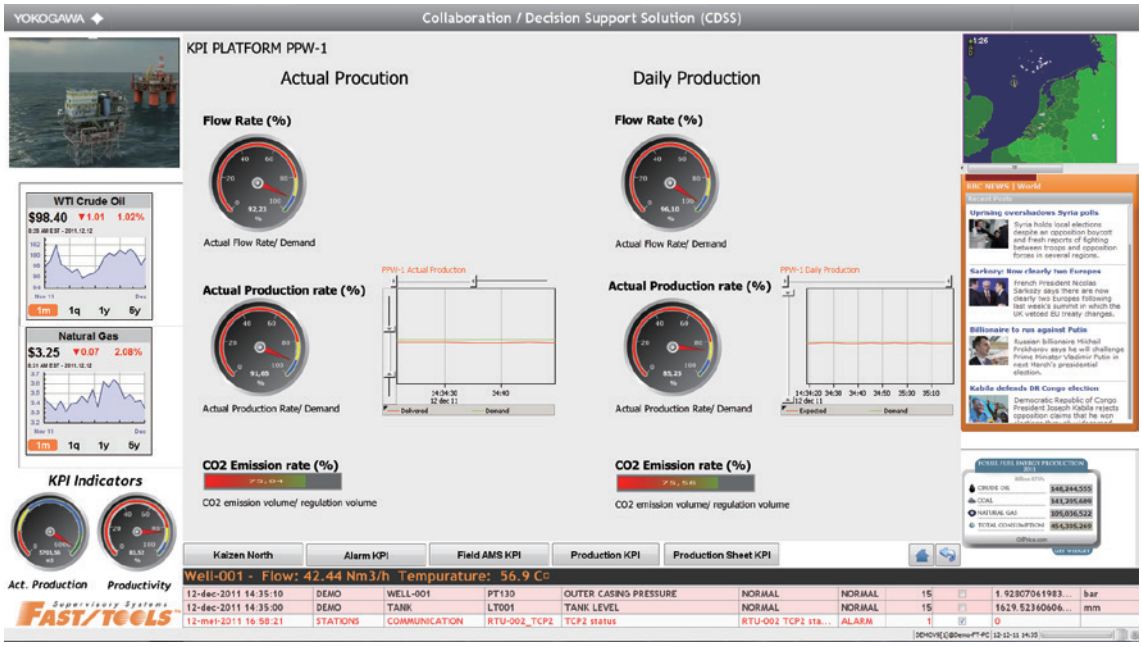
FAST/TOOLS CDSS can be utilized for a number of objectives that contribute to improved responsiveness and better informed decisions optimized to human factors.

But there is more FAST/TOOLS CDSS is not restricted to informative dashboards alone. It can provide details on the issues that have a direct negative impact on key performance indicators. For instance:

- Showing physical conditions of assets and their direct environment by means of integrated and easy to navigate video and web-cam controls
- Change in composition of the feedstock that may affect the process and may require optimization of process conditions
- Business information on commodity prices, supply and demand that may be useful to optimize production and maximize profitability in ‘real-time’
- Local weather station sources that can show and predict (animate) precipitation and temperatures from actual conditions to forecasts hours or days ahead

6.1.3 Powerful Components

To enable the functionality described above FAST/TOOLS CDSS allows integration of information from all kinds of data sources such as video streaming (CCTV, CAMs), URL (Internet/ Intranet), databases, etc. These sources are available as standard components that can be applied with minimal configuration effort. The following FAST/TOOLS graphic components are available to support building an integrated environment.



F060102E.ai

Figure 6.2 CDSS Components

URL Component (Web-Browser)

- Handles a small subset of HTML5 specification
- Supported on all FAST/TOOLS platforms
- Embeds Internet Explorer (IE) and its functionality

Webcam/Video component

- Handles the most popular video file formats and sound mp3 files
- Supports motion jpeg video streams (cameras)
- All video files, sound files and streams are read from the Web-HMI Server
- Embeds Media Player (MP)

6.1.4 Real-time data sourcing

To increase overall safety, security, and regulatory compliance FAST/TOOLS CDSS is founded on a flexible and platform independent environment that is capable of collecting data from Level 2 Integrated Control & Safety Systems (DCS & ESD), subsystems (RTU & PLC), reporting packages and data historians as well as Level 3 MES packages and convert relevant data from all those sources into meaningful information. The FAST/TOOLS CDSS platform is based on the latest web-technologies to bring these functions to end users whether they engage at a central decision support center or through a collaboration network of smart mobile devices (i.e. phone, tablet). FAST/TOOLS CDSS enables increased management efficiency through the continuous availability of process and maintenance information from all sources with a reduction in cycle time and the need for the exchange of paper documents. This allows applications to go beyond traditional HMI/SCADA related environments resulting in the continuous improvement.

6.1.5 Key Benefits of using CDSS

FAST/TOOLS CDSS can be utilized for a large number of objectives that contribute to improved effectiveness and performance of new and installed production management systems. The founding characteristics for these benefits are:

- Supports the delivery of essential information from all connected sources shared to specific enterprise groups by means of pre-defined trends & reports
- Supports the move from transactional processes to ‘real-time’ interaction and acts as an enterprise information monitoring system
- Optimize human resources efficiently across local and remote production facilities by centralizing knowledge for more effective and consistent use

6.2 RDBMS Engine

The traditional way in FAST/TOOLS for getting data sets into foreign database systems is to use its ODBC interface which connects directly to the FAST/TOOLS Data Set Services (DSS) layer. This is a powerful feature for connecting FAST/TOOLS data into the familiar office environment. In practice however this can introduce a performance hit when complex queries are performed; particularly joins that do not use database keys, since the internal database is primarily optimized for fast storage which has first priority securing field data under all circumstances.

6.2.1 Functionality

For users that want to perform more complex queries that cross-section FAST/TOOLS data and want to integrate that data into their own RDBMS environments (Microsoft SQL Server, ORACLE and alike), FAST/TOOLS has an embedded RDBMS engine. This function has two advantages over the traditional ODBC connection. Firstly data that needs to be exposed to the foreign database is first mapped to local database tables, hereby offloading FAST/TOOLS DSS from the queries that need to be executed on this data.

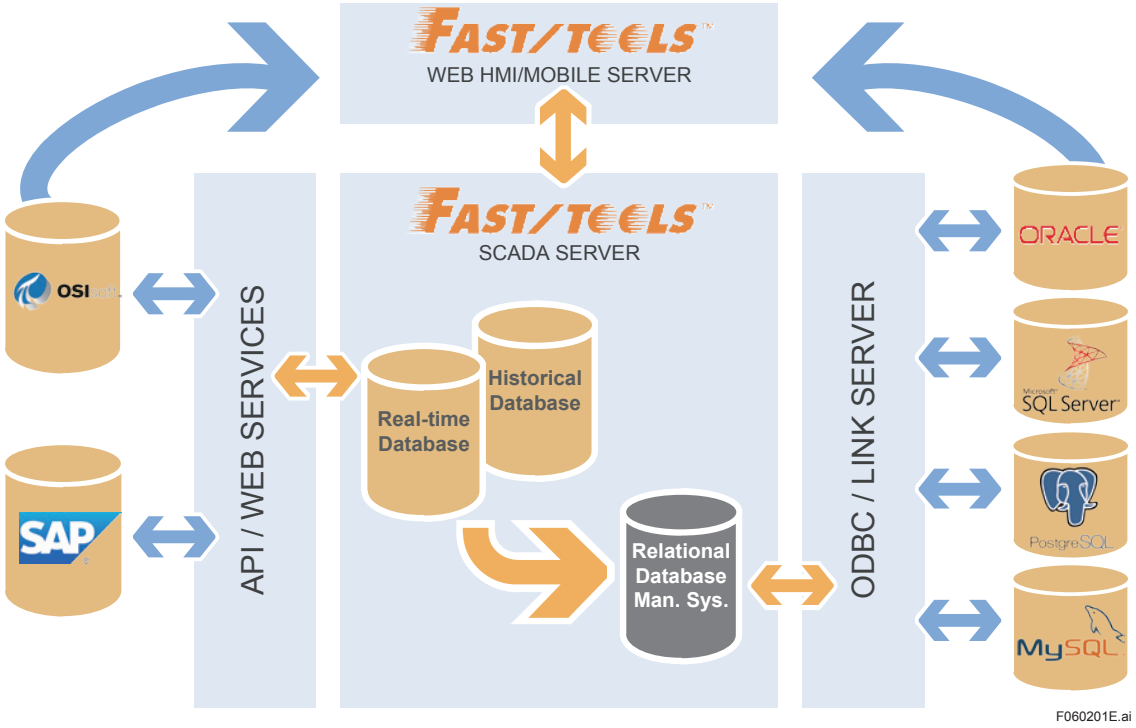


Figure 6.3 RDBMS Engine

Secondly the shape of these (pre-defined) tables can be defined (modified) at engineering time, ensuring that only relevant data is exposed to the customer's database and that it is organized in a way that best suits the application. The RDBMS engine contains a "distributor" module that runs on the same machine as the users' database and provides an ODBC interface to the mapped tables, allowing them to be used as "linked server" tables in the users' RDBMS system. This method improves data integration by allowing these tables to be queried and reported in the same way as native tables.

6.2.2 Data Read/Write

The RDBMS engine function supports reading of three types of data:

- Data set records
- Historical data
- Current item data

The mapping of these types of data to the target tables is performed using a dialog in the engineering module. Insertions, modifications and deletions to data set records will automatically result in changes to the corresponding mapped tables. For historical data the data will be polled from data set services at the specified intervals and used to populate the target tables. For item data, values will be aggregated, creating a new record containing the minimum, maximum, average and number of updates for the specified sampling period.

For writing data back from an external database to FAST/TOOLS, a special table will be provided that allows the application to update the value, quality and status of predefined items. The RDBMS engine triggers on updates to this table to perform the writing of the item within FAST/TOOLS. This may be necessary if useful data is calculated externally by the customer RDBMS, but would then be subsequently useful to be exposed within the FAST/TOOLS environment for alarming, trending, etc.

6.2.3 Set-up options

There are several setup options to fit any specific customer and performance requirements. In the figure 6.4 below each functional module operates independently and could be deployed on any combination between one and three physical (or virtual) machines.

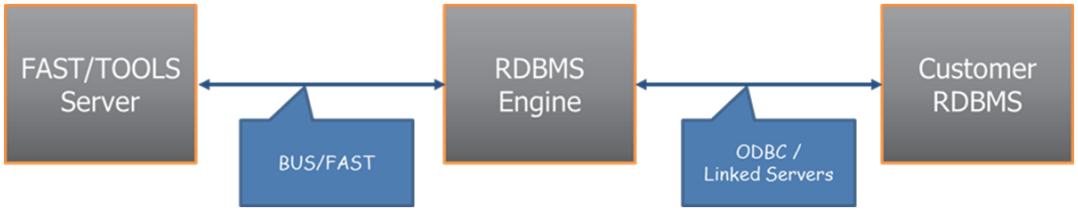


Figure 6.4 Set-up options functional modules

For example, all three modules may run on one machine, or each may have its own dedicated machine (server or PC). Another possibility is to run the RDBMS engine (Exposure Module) on the same physical system as the existing customer RDBMS system, which may be a good solution if the additional load of this functionality does not impact the RDBMS server in a way that would compromise its existing purpose. Importantly, the communication between each of these three modules should be transparent once configuration of the connections between them is completed.

A connection (see figure 6.4) between the FAST/TOOLS server (left-hand module) and its RDBMS engine (middle module) is established via FAST/TOOLS internal secure domain and media independent communications infrastructure BUS/FAST. The right-hand module represents the existing customer RDBMS system that the customer may wish to use in order to access the FAST/TOOLS data stored within the embedded RDBMS engine.

In case the FAST/TOOLS server and its RDBMS engine are not running on the same physical server and network connection is lost all data will be redirected to a preservation location on the local disk so that it may be send properly once the connection has been restored.

6.3 Power Management

Reducing power consumption and (remote) management of substations is becoming more and more demanding. FAST/TOOLS easily integrate with different power management application packages such as:

- Power System Monitoring & Simulation
- Advanced Monitoring
- Energy Accounting
- Real-time Simulation
- Event Playback
- Load Forecasting
- Intelligent Load Shedding
- Load preservation
- Load Restoration
- Load Shedding Validation
- Energy Management System
- Automatic Generation Control
- Economic Dispatch
- Interchange scheduling
- Reserve Management
- Intelligent Substation
- Substation Automation
- Switching Management
- Load Management

Its powerful and easy integration capabilities enables FAST/TOOLS to go beyond basic analysis of energy usage and cost to a proactive power management approach resulting in improved utilization, reliability and performance of the electrical systems.

6.4 Geographic Information Systems (GIS)

Yokogawa has experience and the capabilities to connect, integrate and/or embed GIS Systems in various ways. Yokogawa can get GIS maps out of their tools and populate them with dynamic objects for rendering in FAST/TOOLS. In this way FAST/TOOLS provide a single integrated environment to manage and map multiple assets, leveraging all the power of its object-oriented structure. This allows for quick and easy deployment of information to all users that in their turn have a rich overview of the operational assets and related infrastructure.

FAST/TOOLS Web based structure allows embedding dynamic Java based GIS maps in its operator environment. GIS maps can be related to and synchronized with operator mimics in FAST/TOOLS and made visible or transparent as a layer in the FAST/TOOLS operator environment. This enables the user to:

- View GIS maps in FAST/TOOLS
- Display process conditions on GIS maps
- Synchronize GIS data to FAST/TOOLS projects
- Avoid duplicate/incorrect data entry
- Multi-level graphical display of GIS & FAST/TOOLS data

This approach to GIS integration eliminates the need for manual updates of GIS information in a SCADA system. Updates can be fully maintained at the GIS and are linked into the Web based HMI of FAST/TOOLS.

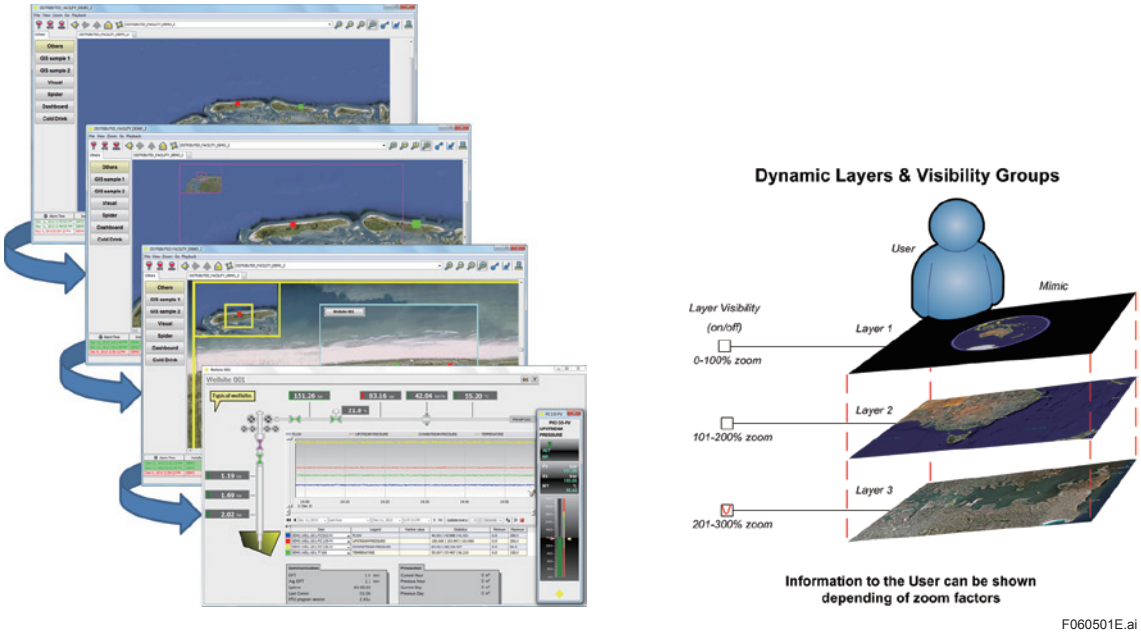


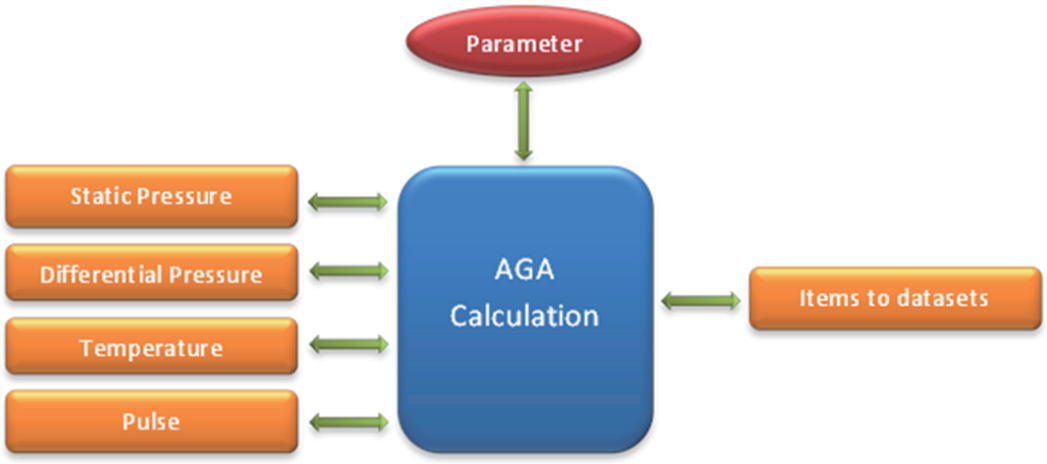
Figure 6.5 'Google Earth Style' Zooming & Panning

The 'Google Earth Style' Zooming & Panning functionality of FAST/TOOLS further characterizes this feature through:

- Fast and Smoothness (continuously variable and no need to open different windows to increases performance)
- Clutter / De-cluttering (meaning that details will become visible depending on the display zoom level)

6.5 Gas Flow Calculations (AGA)

Most modern Gas metering PLC and RTU feature intelligence for Gas Flow Calculation. The American Gas Association prescribes standard calculation models which ensure accurate Gas Flow Metering. For example the Stardom RTU is equipped with this intelligence. Since the brownfields can be equipped with legacy PLC/RTU models FAST/TOOLS supplies the calculation software within the SCADA System, giving the user the brownfield accuracy in Gas Flow Metering.



F060601E.ai

Figure 6.6 Gas flow calculations functional diagram

The integrated AGA Calculation engine is able to profile an amount of 1000 calculations show less than a second. An AGA calculation takes less than an average of 0.1 millisecond.

The set of FAST/TOOLS functions around the AGA Calculation engine can be divided into:

- Initialization function to allocate and initialize the parameter data for the calculation engine
- Input functions; each filling one or more of the input parameters
- Calculation function; which will do one calculation cycle over all given input parameters
- The resulting output parameters are made available for the output functions
- Output function; each retrieving one output parameter

Figure 6.6 provides a diagram of the functionality which is executed within FAST/TOOLS to perform the AGA Calculations. This processing is based on the input of a legacy PLC/RTU which cannot comply with the AGA Calculation standards.

The AGA calculation functions are a set of functions build around an AGA calculation engine. The AGA calculation engine contains the following flow calculation algorithms:

- AGA3 - Orifice metering of natural gas and other related hydrocarbon gases
- AGA7 - Measurement of gas by turbine meters
- AGA8 - Compressibility factors of natural gas and other related hydrocarbon gases
- AGA9 - Measurement of gas by multipath ultrasonic meters
- AGA10 - Speed of sound in natural gas and other related hydrocarbon gases
- AGA11 - Measurement of natural gas by Coriolis meter
- V-Cone
- Wafer-Cone

Further the following additional calculations are supported by the engine:

- Calculation of gross heating value, relative density and compressibility factor for natural gas mixtures from composition analysis by AGA5 or GPA2172 method
- Calculation of atmospheric pressure depending on latitude and altitude

6.6 Custom application development

Beyond its application integration capabilities as described above FAST/TOOLS has numerous ways to directly build own custom applications extensions on its software platform. This can be easily done by end users', system Integrators or Yokogawa application development groups. Users' can balance investments with particular applications build new or to expand the system with existing ones whatever functionally and commercially fits best.

The FAST/TOOLS operations management platform is a modular and layered solution that provides an open Service Oriented Architecture (SOA) that fits not only to Yokogawa's own data sources but also to 3rd party sources which can be anything from a database to a complete application data model. With so called "info-Services" a unified layer is created that easily ties data sources to the FAST/TOOLS visualization environment.

Besides the above FAST/TOOLS includes open interfaces based on its Data Set Services (DSS) layer, which appears to the application developer as an Application Programming Interface (API) for easy connection of third party software environments. An array of API's is provided under this layer to build extensions:

- VB-API
- .NET-API
- "C"-API
- JAVA-API
- Python-API
- WebServer-API
- ODBC-API

(There are programmer's language manuals, system integrators manuals and maintenance manuals for each function available).

Via the DSS layer all configuration data; tag definitions, alarm definitions, class definitions, etc. are accessible. Data Set Services encapsulate the databases allowing all configuration data to be accessed via a single interface. To add a DSS client to FAST/TOOLS the DSS API is available. Via a simple set of routines access to most of the FAST/TOOLS data tables is available. The DSS API has the following functions:

- Retrieving information about Data Set properties
- Synchronous I/O (read, write, update)
- Asynchronous I/O
- Notification when "something" changes
- Validating if data is correct

Each DSS client on top of the DSS layer can be a relatively thin client because the DSS layer takes care of the data access and integrity. To build "own" Web-based JAVA applications, FAST/TOOLS also has a Java based interface to the DSS layer.

For technical staff, both System Management (SCE-FT-SM) and Architecture & Internal Structure (SCEFT-AI) courses are available as possible training recommendations for Application Development.

7 Connectivity

7.1 Process Field I/O Communications

FAST/TOOLS offers many dedicated PLC/RTU driver protocols developed for data acquisition, to enhance communication performance and reliability. FAST/TOOLS can provide direct communication links to various brands of DCS/PLC/RTU systems & controllers on the same or multiple servers. It also has many proven communication interfaces through fiber optics, serial lines, wireless radio, satellite, GSM, GPRS and PSTN. The module of FAST/TOOLS that manages the communication with physical (distributed I/O devices) through RTU, PLC, DCS or ESD controllers is called EQUIPMENT/FAST. It uses device specific drivers, polls the equipment and updates the real-time database of FAST/TOOLS. In additions EQUIPMENT/FAST offers features that go beyond the traditional way of data collection. For example:

- On-line editing (adding/removing) of I/O devices
- Time or availability based communication scheduling for remote PLC/RTU-stations
- Up to more than 1000 different I/O devices can run in parallel on one host system.
- Media independent Communication support over e.g. Fiber Optic, Wireless radio, Satellite, GSM, GPRS and PSTN
- Time synchronization by connected GPS and NTP towards subsystems including time distribution to other nodes.
- Processing of time-tamping assigned by field equipment (providing the alarm overviews in the correct sequence reflecting the actual physical operational conditions).
- An EQUIPMENT/FAST I/O devices that can be configured to be time-master or time-slave for field equipment.
- Special driver for GPS based time synchronization.
- Modem scheduling is available for equipment at distant locations. This enables polling of for example 70 devices while only three modems are available.
- Event based data handling. Devices may initiate the data exchange in this case.
- History collection is supported. If a field device is able to build up history when it is unable to communicate with the host server caused by line disturbances, this history can be collected after reconnection and merged into the existing history files.
- Predictable (pre-settable) behavior on loss of communication. For example when Ethernet is the preferred line (fast communications) and disconnects a serial line temporarily takes over and switches back upon recovery of the preferred line.

7.1.1 Scan- or Event Based Data Acquisition

FAST/TOOLS also has extensive capabilities in scheduling the scanning of field devices. Either field devices will be scanned at regular intervals or communicate is event based. When field devices are scanned, the scan intervals may differ for each process variable, even when they are sourced from the same equipment. FAST/TOOLS processes events in the sequence they were generated.

7.1.2 Event Buffering

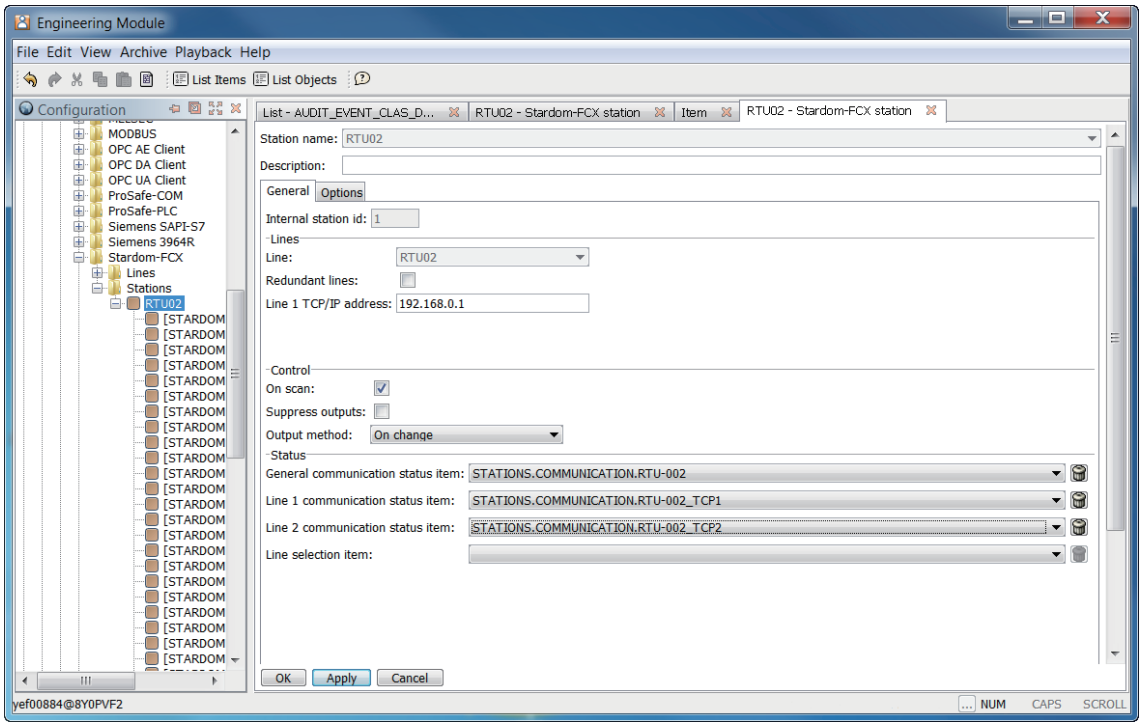
The amount collected data by a RTU would be huge if all data would be locally stored. To reduce the amount data, some RTU/PLC controllers like the Yokogawa STARDOM controller are capable to log only the data that has changed since the last time stamp. FAST/TOOLS periodically monitors for changed data on the STARDOM controller and acquires the data only in situations such as when there is a change in the data, an alarm occurs, or the refresh button is pressed by the operator. When FAST/TOOLS reads the logged data, it is time stamped and merged into its trend data buffer to ensure a seamless trend data graph, even if the network fails for a period of time and recovers.

7.1.3 Support of Cost Effective GPRS and Satellite Communication Services

Conventional telephone lines are billed per minute regardless of whether data is actually sent or not. When using GPRS mobile data service or Satellite communication (VSAT), the most common billing method used to transmit narrowband data, is based on the number of communication packets and is independent from connection time. To make the most advantages of GPRS or Satellite, Yokogawa's STARDOM FCN intelligent RTU and FAST/TOOLS have several functions that reduce the number of packets required to have a bi-directional communication. This dramatically lowers communication fees while no concessions are made in response time (e.g. for alarming). Reducing the number of data packets down with 80% in individual cases is achievable.

7.1.4 Adding an I/O Devices

When a FAST/TOOLS system is up and running, extensions can be made. New I/O devices, called stations, can be added on-line without stopping the FAST/TOOLS software. Once the station is defined, items can be created on-line and connected to I/O points.



F070101E.ai

Figure 7.1 Utilization of a new I/O driver

Some of the parameters available for I/O related items are:

- Address of the item (this may be a real address but can also be a logical name)
- Direction of the communication (from station, to station or both directions)
- Scanning method (scan based, event based)
- Conversion method (linear conversion, boolean, BCD, floating point, etc.)
- Input filtering (protect against too rapidly changing of analog and digital signals)

7.1.5 Plug-In Driver structure

An easy deployable “plug-in” driver structure, which goes beyond “traditional driver configuration”, is available for easy integration of new and existing infrastructures. This “plug-in” structure is both applicable for the Yokogawa product family as well as an extensive list of third-party controller hardware and software products.

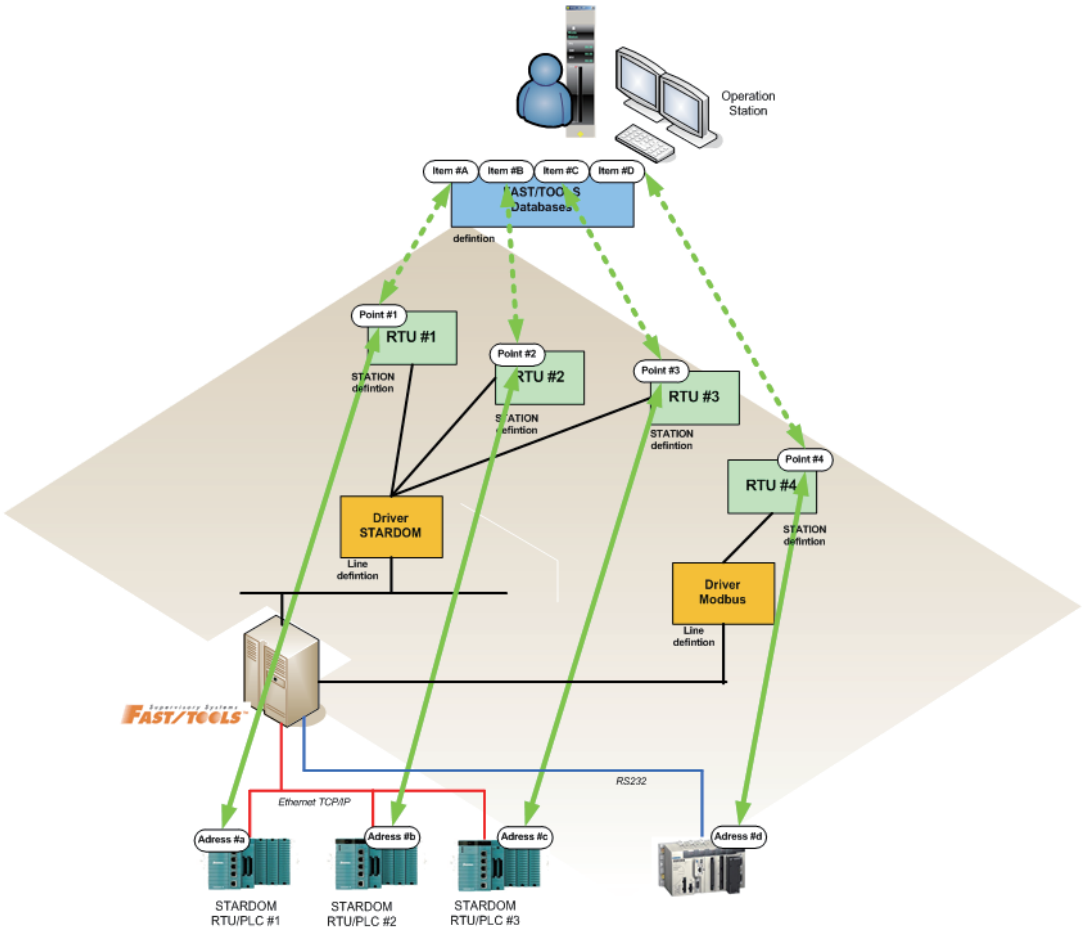
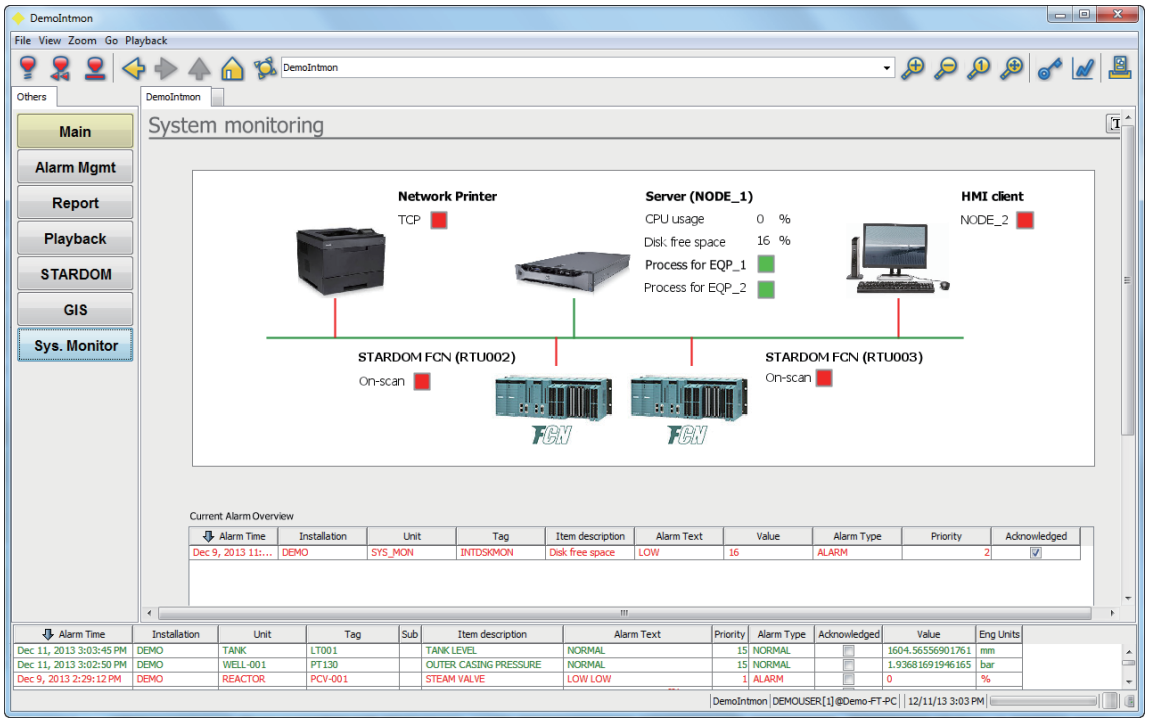


Figure 7.2 Plug-in driver concept

The interfacing environment is easily adaptable for dedicated protocols and tuning can be performed per device, channel and/or media. The Yokogawa product family includes CENTUM-VP, STARDOM Network Based Controllers/RTU, the ProSafe-RS Safety System, Exaquantum, the DAQMASTER Data Acquisition Units and the FA-M3 PLC.

Communication link monitoring

Each communication link, or its redundant back-up can be monitored by visualization its status in a graphic, or by including it in the FAST/TOOLS System Alarm Overview. This can provide an accurate overview of the entire system infrastructure “health” status.

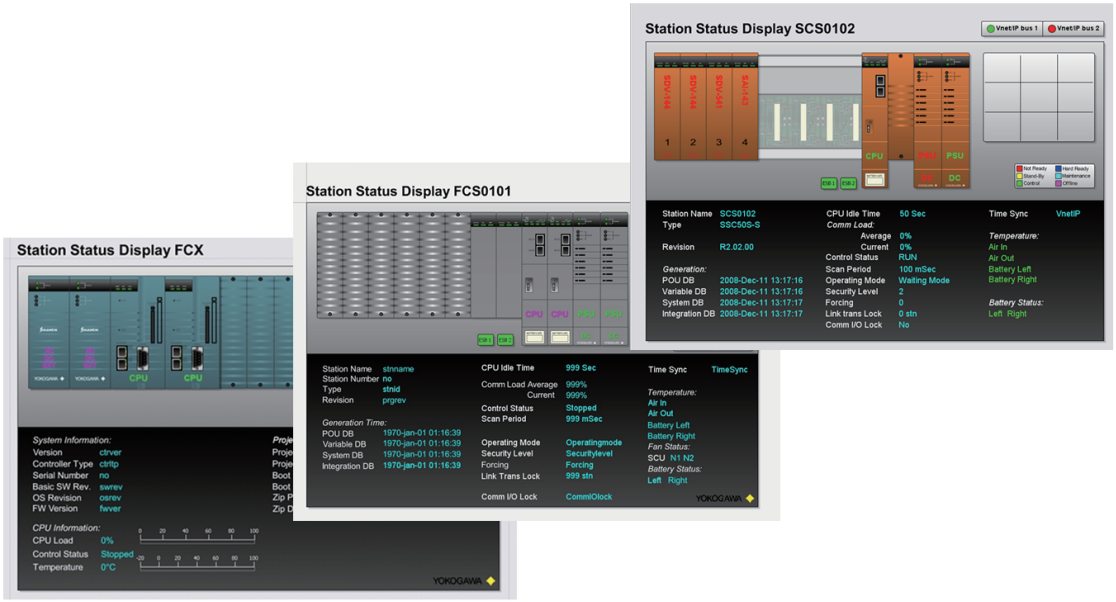


F070103E.ai

Figure 7.3 System “health” status display

Main Advantages:

- Software wiring of driver addresses by the introduction of ‘point’ labels. Points can now easily be connected/disconnected or reassigned to items. This enables easy loop checking and testing of displays and upgrade of PLC/RTU without the need to change the item configuration.
- Easy to add new drivers through the plug-in structure which seamlessly integrates with the engineering tools.
- Single configuration windows for all parameters of the driver.



F070104E.ai

Figure 7.4 Controller "health" status displays

Status Displays for Yokogawa equipment

Graphical status/diagnostic displays for the STARDOM, FA-M3 PLC and ProSafe-RS products lines (see figure 7.4) are standard available in FAST/TOOLS to provide detailed information on health, (CPU) load, hardware, communication paths, temperatures and memory capacity.

7.1.6 Supported Communication Protocols

FAST/TOOLS interfaces with most international brands of PLC, RTU and DCS natively or through open standards such as Modbus, OPC, DNP, IEC, & XML. Below a brief overview of the main integration characteristics and features of the FAST/TOOLS:

- Scan or event based data acquisition
- Very low bandwidth requirements
- Easily adaptable for dedicated protocols
- Tuning per device, channel and/or media
- Communication link monitoring

Please find below a selection of brands for which drivers have been developed:

- All Yokogawa branded controllers
- Schneider Electric
- Siemens
- Rockwell
- ABB
- Omron
- Hima
- Triconex
- Motorola
- GE Fanuc
- Emerson
- Emerson Fisher ROC
- Beckhoff
- Emerson Bristol Babcock
- Mitsubishi
- Allen-Bradley

The standard supported drivers that are available for a particular brand of controllers have been structured in equipment modules. For a detail overview please refer to the general specification of FAST/TOOLS document GS50A01A10-01EN.

7.2 OPC Data & Event Connectivity

7.2.1 OPC Unified Architecture

FAST/TOOLS provides an embedded OPC Unified Architecture (UA) environment certified by the OPC-Foundation. OPC UA is the next-generation standard that provides a cohesive, secure, and reliable cross-platform framework for access to real-time and historical data and events. The FAST/TOOLS OPC UA environment meets the requirements of the OPC certification program for interoperability and robust performance. The key characteristics are:

- OPC UA Redundancy
- Performance of over 100.000 updates per second
- Cross Platform communication
- Available for UNIX, Linux and Windows

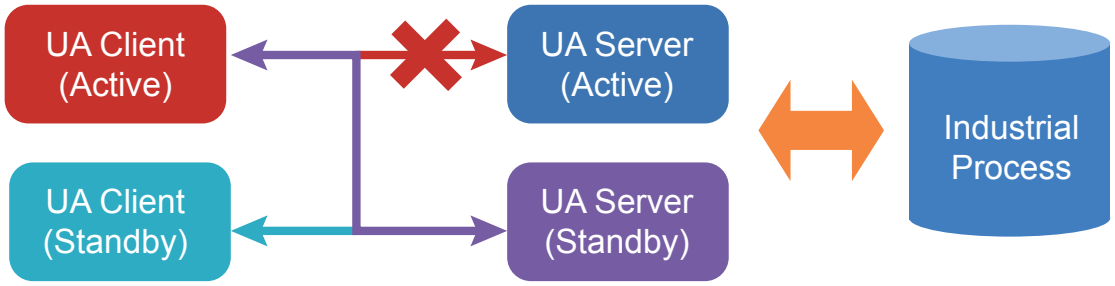


Figure 7.5 OPC UA supports redundant configurations

FAST/TOOLS was globally one of the first operations management software packages to embrace the OPC UA standard. In addition to the key characteristics as stated above, there are some distinct differences with respect to security and cross network domains deployment compared to classic OPC:

- Classic OPC has separate interfaces for Data Access (DA), Historical Data Access (HDA) and Alarm & Events (A&E). In contradiction OPC UA has one unified interface for all information; therefore all communication is coming from the same source via one channel.
- OPC UA enables other features such as: Cross Platform communication, Internet/Firewall friendly and secure communication.
- OPC UA provides a secure solution in the transport layer. This gives the convenience of enabling secure OPC data communication between different network Levels.
- OPC UA uses signatures to authorize and authenticate communication between client and server via encrypted communication.

As figure 7.6 shows the OPC UA Security Architecture, it is founded at both the application and communication layer.

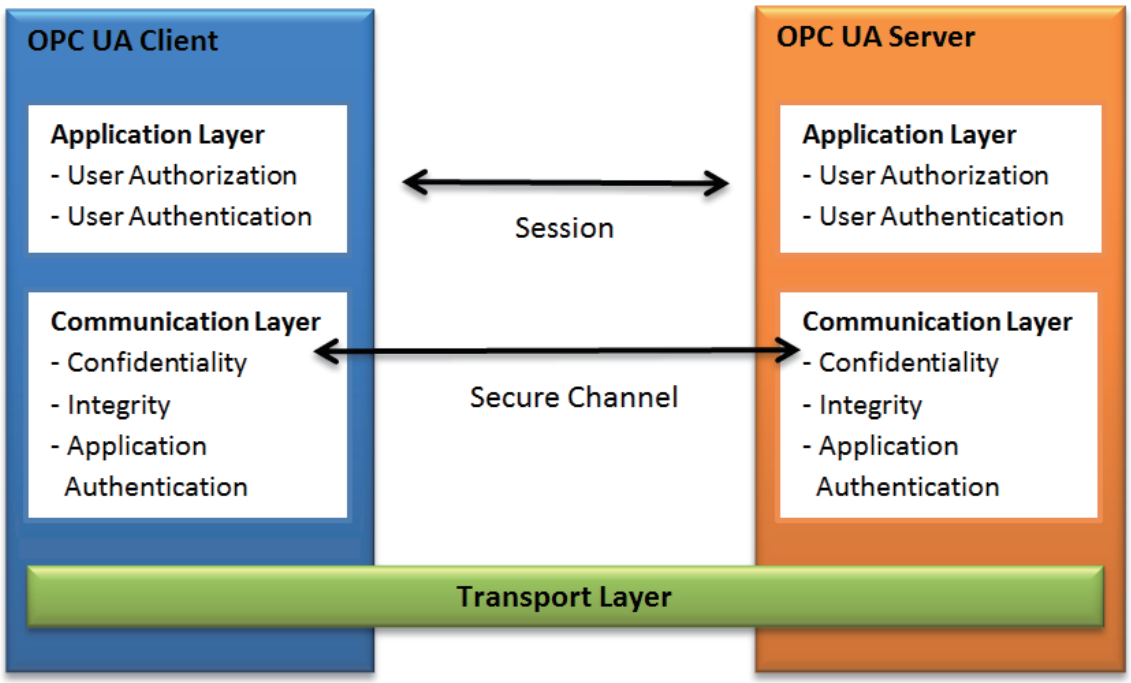


Figure 7.6 OPC UA Security Architecture

At the communication layer a secure channel is established between server and client by the application authentication process to ensure confidence and integrity. As soon as this secure channel is available the data/event exchange session can be initiated at the application layer by user authorization and authentication.

7.2.2 Classic OPC

For legacy installations and 3rd party software that does not support OPC UA (see par. 7.2.1) FAST/TOOLS continues to supports classic OPC-DA and OPC-A&E. Both server and client implementation are available.

In addition FAST/TOOLS continues to support Tunneled OPC for distributed communication (DCOM) links over the network infrastructure. OPC Tunneling provides a secure and robust interface in a distributed manner avoiding common known OPC issues across domains.

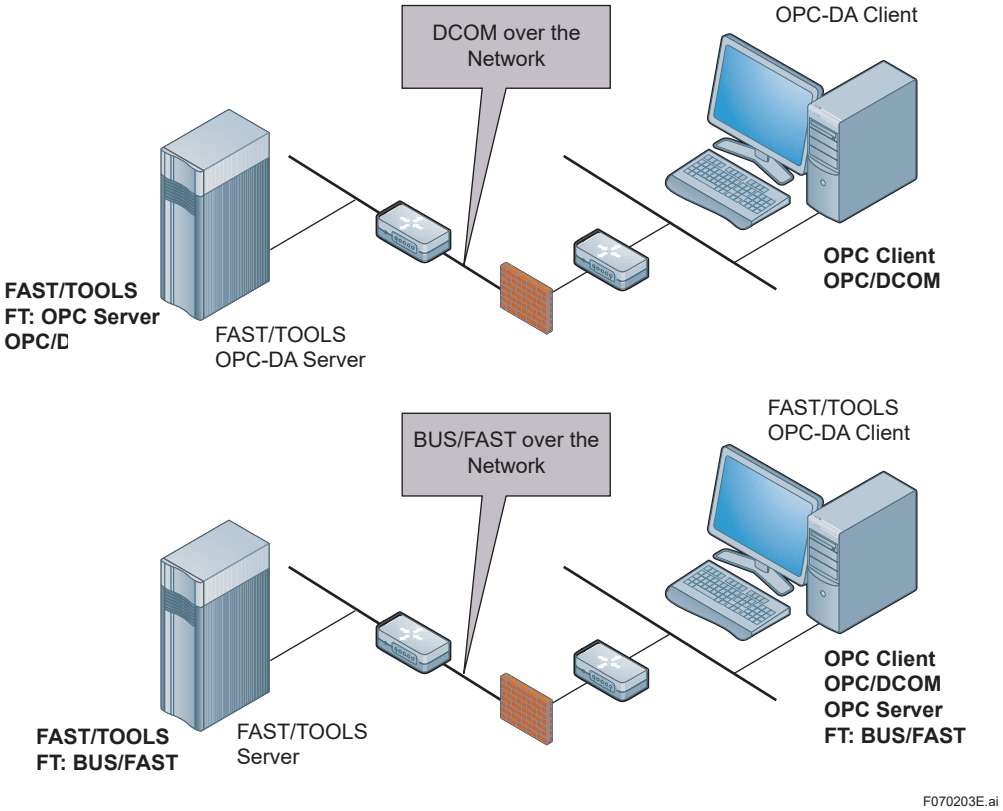


Figure 7.7 Tunneled OPC

OPC Tunneling is based on extending the secure and reliable BUS/FAST communication infrastructure of FAST/TOOLS up to the machine where the third party OPC server or client is installed.

7.2.3 OPC Unified Architecture (UA) certification

FAST/TOOLS provides an embedded OPC Unified Architecture (UA) environment certified by the OPC-Foundation and meeting the requirements of the OPC certification program for interoperability and robust performance. The OPC Unified Architecture is the next generation of the OPC standard featuring a cohesive, secure and reliable cross-platform framework for access to real-time and historical data and events. It retains all the functions of the 'classic' OPC including: data access alarm and conditions, history access, which effectively reduces the cost of system integration.

F070204E.ai

Figure 7.8 OPC Certified

FAST/TOOLS supports both Server (DA/A&C/HDA) and Client (DA) for OPC Unified Architecture (UA). The OPC UA Server enables a simple and effective solution for users requiring communication to upper layer management systems. OPC UA technology uses proven security concepts that offer protection against unauthorised access, against sabotage, the modification of process data and against careless operation. The OPC UA security concepts contain user and application authentication, the signing of messages and the encryption of the transmitted data itself.

The OPC UA feature allows users to leverage FAST/TOOLS extensive library of protocol drivers to connect new or existing equipment to a secure, reliable management network.

FAST/TOOLS also supports the 'classic' OPC Server and Client including tunneled OPC for distributed communication (DCOM) links over the network infrastructure. The OPC Tunneling provides a secure and robust interface in a distributed manner avoiding common known OPC issues across domains.

7.3 Vnet/IP Gateway Solutions

FAST/TOOLS is also the core of two prominent direct gateway solutions to connect the Yokogawa Vnet/IP network which sits at the heart of every CENTUM system to the open environment. At the low end the Unified Gateway Station (UGS) manages easy and seamless integration of packaged units at a plant site into the CENTUM system environment. This is a good solution for centralized applications with relative short distances between the production units and automation infrastructure. Complementary to centralized plant package unit integration with UGS modules FAST/TOOLS is utilized for the Remote Gateway Station (RGS) which is a complementary solution for remote operations across the open environment to multiple CENTUM systems Vnet/IP domains. With the RGS solution FAST/TOOLS delivers a unified remote visualization environment across multiple CENTUM, ProSafe-RS, 3rd party control and safety systems, PLC and RTU.

7.3.1 Unified Gateway Station (UGS)

The Unified Gateway Station (UGS) manages easy and seamless integration of packaged units at a plant site into the CENTUM system environment. It is based on the integration capabilities of the FAST/TOOLS platform and as such it is more tolerant in respect to inter systems communication. UGS is always delivered in conjunction with a CENTUM VP installation and as such it is part of the Yokogawa standard DCS product portfolio. More information can be found in the technical information document for CENTUM VP.

7.3.2 Remote Gateway Station (RGS)

FAST/TOOLS RGS delivers an integrated automation solution, which achieves a corporate-wide automation strategy across multiple domains and geographies. This is achieved providing access to Vnet/IP and while managing the low bandwidth and intermitted communication requirement at the top end from FAST/TOOLS.

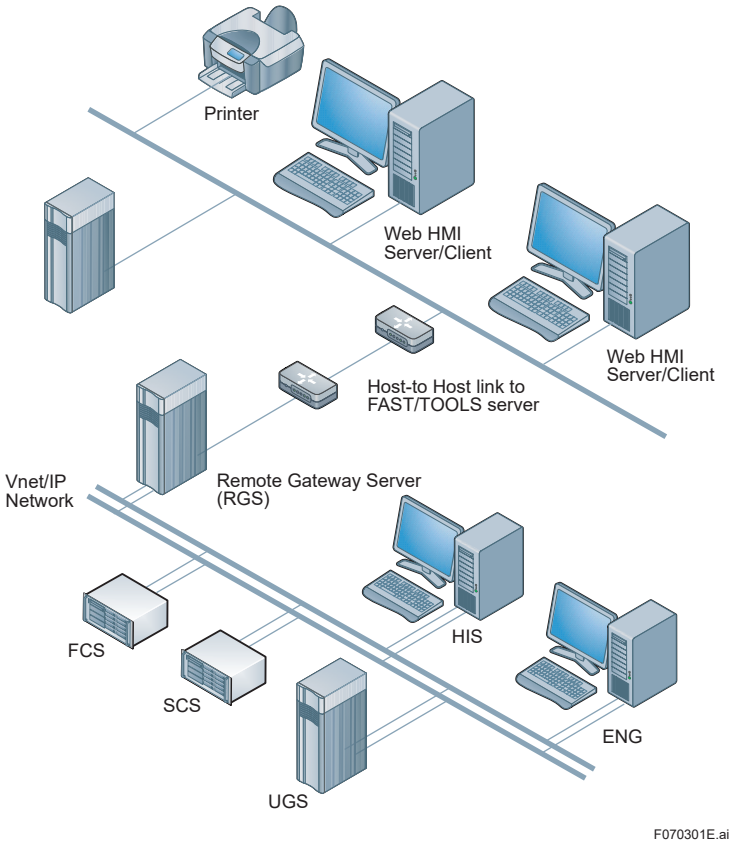


Figure 7.9 RGS sample architecture

The RGS can directly communicate over Vnet/IP to the connected FCS, SCS and UGS stations. The communication protocol Vnet/IP is managed by the Vnet/IP driver of EQUIPMENT/FAST. The RGS Server connects just as easy to Vnet/IP like any HIS or FCS.

The RGS can also directly read variable and function block data and assign these to the FAST/TOOLS database points (items). The alarm detection and generation can be done from FAST/TOOLS as well while the annunciation status is controlled by FAST/TOOLS.

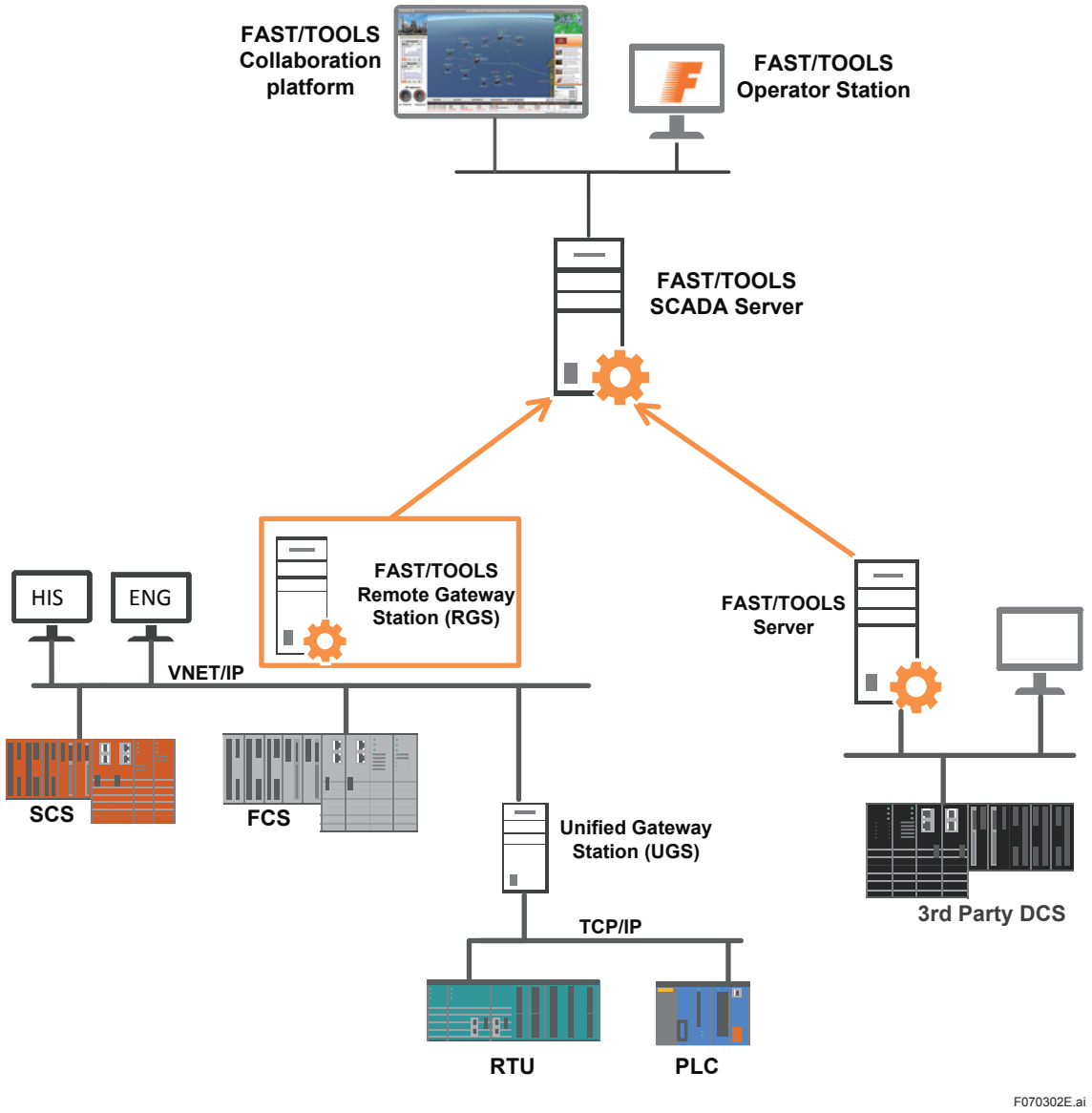


Figure 7.10 Native integration with CENTUM VP

High Availability and Redundancy

To increase the availability of the RGS it can be made fault tolerant with redundant communication networks. This functionality is based on FAST/TOOLS standard redundancy software, “High Availability Computing” (HAC).

Number of RGS systems in one System Environment

Each Vnet domain can connect to one (single or redundant) RGS. Because Host-to-Host communication is standard supported, up to 253 RGS nodes can be deployed within one integrated onshore/offshore FAST/TOOLS system. Other server nodes should be included in this number as well.

7.4 ODBC Interface

Relational Database Management System (RDBMS) integration with production automation control systems and their visualization and operations management software layer is nowadays a key requirement. The era of strict separation between Process Network infrastructure and Enterprise Network infrastructure is fading out rapidly. Companies desire more insight between application such as; Planning and Recourse Management (PRM), Customer Relation Management (CRM), and their production automation systems, in order to improve efficiency and quality control. The popularity of SQL and Oracle as well accepted solutions for IT departments, made them become a strong standard within the PRM and CRM systems.

The traditional way in FAST/TOOLS for feeding data sets into foreign database systems is to use its ODBC interface which connects directly to the FAST/TOOLS Data Set Services (DSS) layer. This is a powerful feature for bringing FAST/TOOLS data into the familiar office environment. The collected data can be used in reports, overviews, or stored in other databases. Via ODBC data can also be written back to FAST/TOOLS. The ODBC interface also enables the user to easily make reports in MS-Access or overviews in Microsoft Excel.

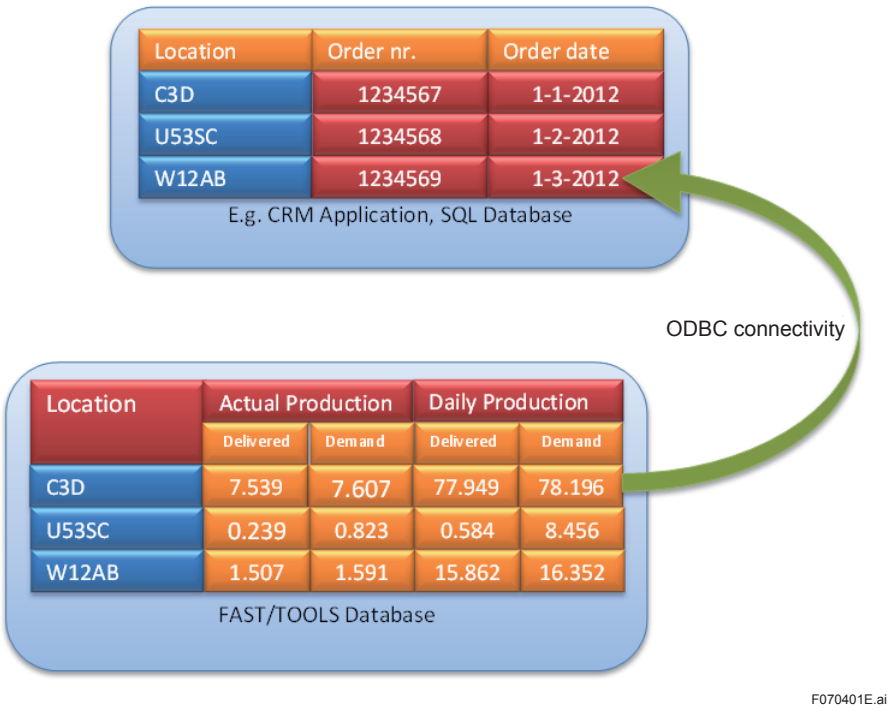


Figure 7.11 ODBC Connectivity

For users that want to perform more complex queries that cross-section FAST/TOOLS data and want to integrate that data into their own RDBMS environments (Microsoft SQL Server, ORACLE and alike), FAST/TOOLS has an embedded RDBMS engine. This functionality is described in paragraph 6.2 “RDBMS Engine” of this TI document.

7.5 Exaquantum Interface

FAST/TOOLS adapts to business applications that support ISA-95 open standard through Exaquantum and Yokogawa's business integration and plant information management software solution. This solution has been certified by SAP for interfacing production management data using SAP Net Weaver.

ISA-95 is an open standard based interface incorporating the B2MML XML schema that Yokogawa was instrumental in developing. In addition to bringing the considerable benefits of plant to business integration for SAP customers, the underlying advantages of using open-standards are:

- Increased interoperability and integration
- Reduced implementation and subsequent lower cost of ownership
- Vendor independent
- Flexible and agile
- Robustness and durability.

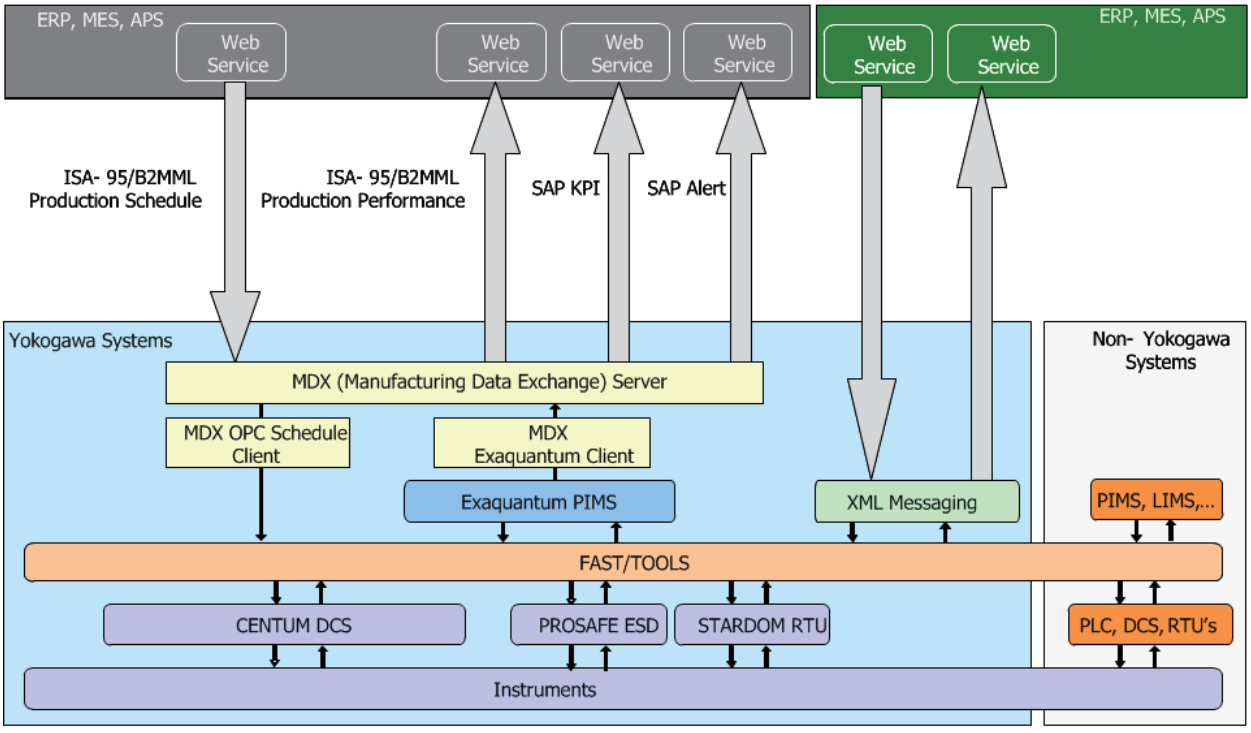


Figure 7.12 IT & Business Integration

Architecture

Yokogawa conforms to the ISA-95 standard which defines messaging interfaces between business and manufacturing operations functions as visualized in figure 7.12 above.

7.6 OSI-PI Interface

FAST/TOOLS has a native interface to OSI-PI, the software package from OSIsoft for plant information storage and reporting on which companies might already been standardized to with respect to data analysis and reporting. This real-time data collection interface (PI-FTLS Interface) offers many beneficial features and is a co-development between OSIsoft and Yokogawa. It enables the possibility to access data from the PI Home Node, via a TCP/IP connection, from the FAST/TOOLS Node, as show in figure 7.13.

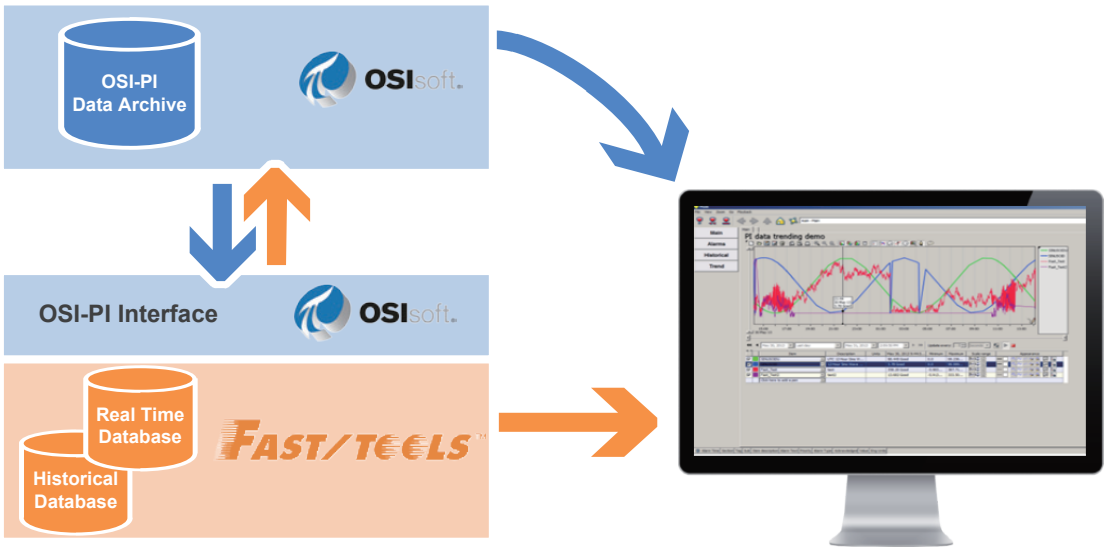


Figure 7.13 Diagram of Hardware Connection

This interface is developed to utilize OSIsoft PI features with the usability of FAST/TOOLS features. The PI-FTLS interface can convert FAST/TOOLS item status and/or item value in a similar PI tag name. Furthermore the PI output tag value and status can be converted to the FAST/TOOLS item value and/or status. By the use of random combinations of scan based, unsolicited and event based schemes the interface can collect data from FAST/TOOLS. Because the gathered data is vital to organizations, the interface uses security mechanisms to prevent data loss during event updates. The following data types are supported with the PI-FTLS Interface: Boolean, Integer, Real and String.

To ensure the required continuity of your application, FAST/TOOLS provides as elaborated in paragraph 2.6 a High Availability Computing solution (referred as HAC). The PI-FTLS Interface can be fully operate in conjunction with this FAST/TOOLS redundancy solution. In case the “Active” FAST/TOOLS node needs to switch over the “Standby” node automatically becomes the PI-FTLS Interface, primarily maintaining the PI functionality.

7.7 IEC 61850 Interface

The IEC 61850 standard is primarily meant for the design of electrical substation automation. The abstract data models defined in IEC 61850 can be mapped to a number of protocols. Current mappings in the standard are the MMS (Manufacturing Message Specification) and GOOSE. These protocols can run over TCP/IP networks or substation LANs using high speed switched Ethernet to guarantee the necessary response times within four milliseconds for protection relays.

To enable sophisticated integration of information from Intelligent Electronic Devices (IED) into FAST/TOOLS, full support is provided for the IEC 61850 MMS specification. The relationship between process control and power consumption is so strongly interwoven that, for optimal efficiency management, both should be integrated into one supervisory system.

From the profitability and regulatory compliance perspectives, power efficiency management and CO2 emissions reduction are of paramount importance in today's industrial processes and in the energy supply chain.

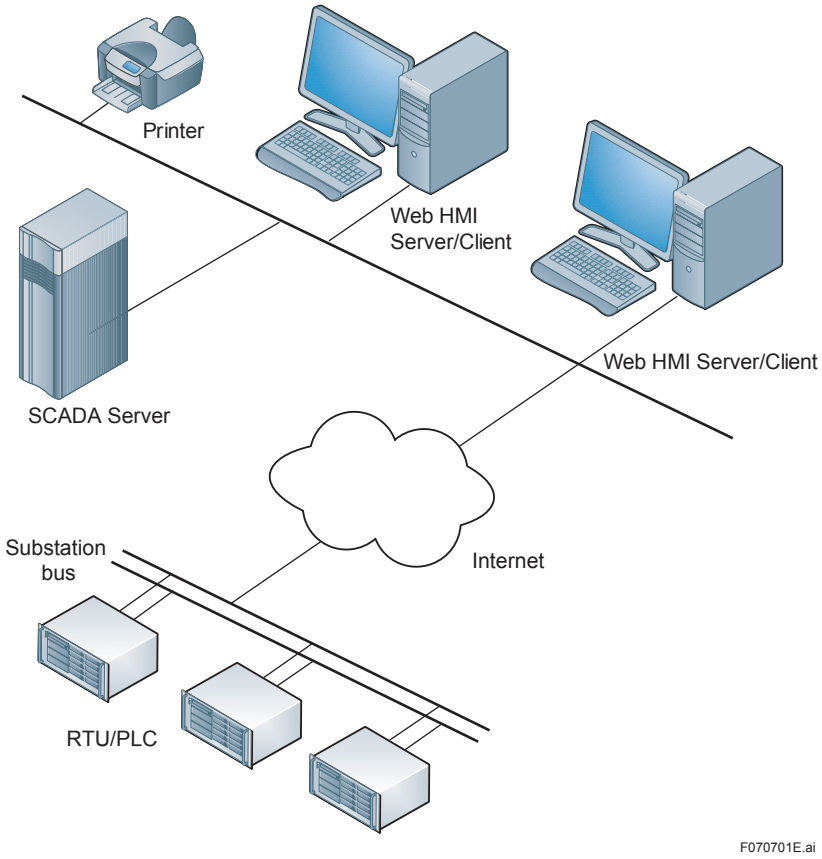


Figure 7.14 IED sample architecture

The objective of the IEC 61850 standard is to provide one safe, transparent and highly adoptable communication protocol for the Power Industry. This allows for straightforward communication to IED devices, which allow the users to retrieve GetDataValue (single object), GetDataSetValue (list of objects), SetDataValue, reporting (server driven), etc. IEC 61850 integration in FAST/TOOLS enables direct monitoring and controlling over de Substation Bus, as the depicted sample in figure 7.14.

8. Engineering

8.1 Engineering environment and functions overview

The engineering environment of FAST/TOOLS provides users with a familiar Windows look and feel experience. The application engineering has evolved to an intuitive interface layer that improves efficiency and easily adapts to new generations of users.

The FAST/TOOLS engineering environment is very rich in functionality enabling extensive engineering possibilities and freedom. Advanced functions and default settings can be concealed on user group/account basis to adapt to specific user level and requirements. An overview and relation of the major functional modules of the FAST/TOOLS engineering environment is provided in figure 8.1.

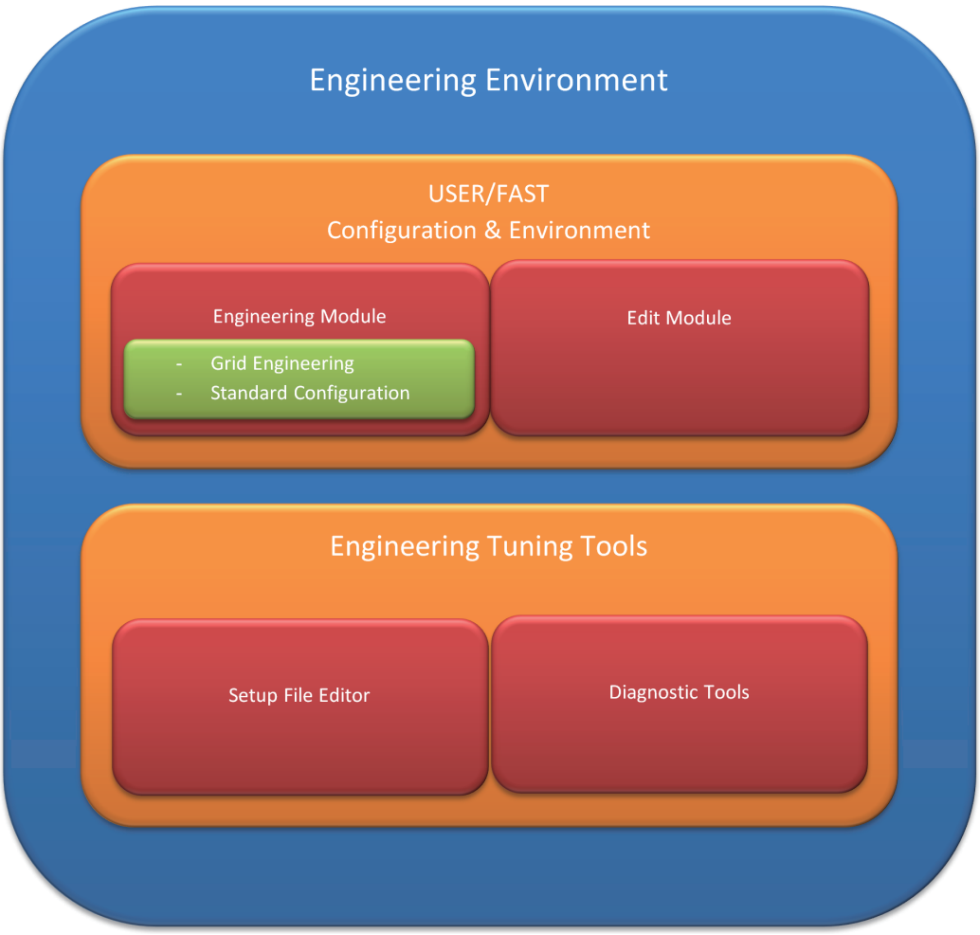
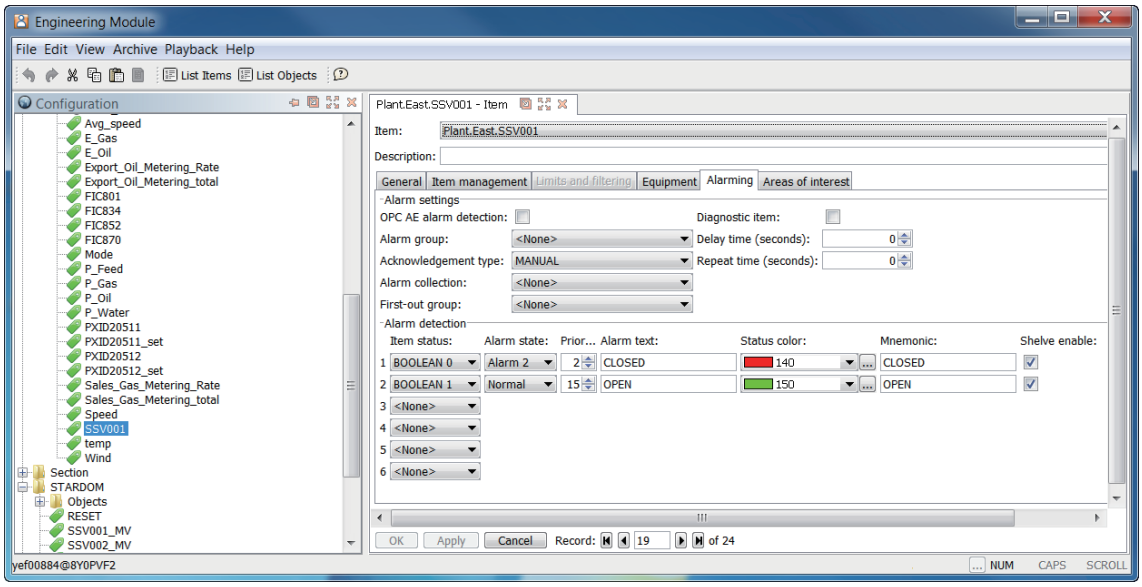


Figure 8.1 Engineering environment

A key benefit of the FAST/TOOLS engineering environment is the supports for on-line engineering and configuration of item definitions, alarm definitions, displays, etc. This prevents costly downtime of operational systems when application modifications and extensions have to be made.

The Windows look and feel of the engineering module enables efficient and intuitive engineering (see figure 8.2).



F080102E.ai

Figure 8.2 Engineering Module

The main configuration entities in the engineering module are:

- Equipment configurations
- Item definitions (e.g. Station, Unit, Item)
- Alarm configuration
- Classes & Object configuration
- Trigger groups settings
- Reporting setup
- Historian configuration
- Authorization profiles

The engineering experience is further enhanced by the extensive usability features that are integrated in the engineering environment which result in the following operational and technical benefits:

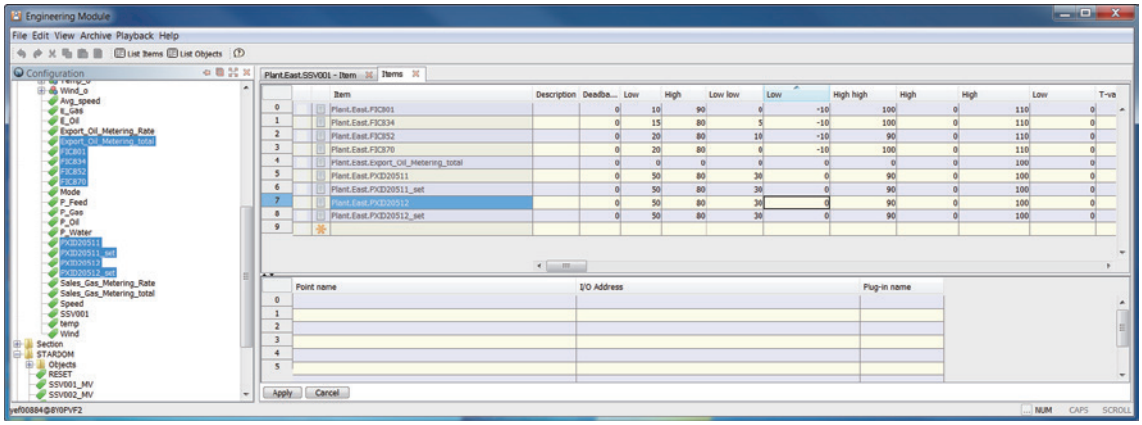
Operational benefits:

- Familiar drag and drop features
- Extensive Item filtering capabilities
- Simultaneously updating of multiple items. For example: activating the audit trailing function for a number of items at once.
- Straightforward visualization of multiple item values and item statuses.

Technical benefits:

- While running the engineering environment on a client, the user can always configure the server regardless of which operating system is installed.
- The engineering environment can run on the host server as well as on multiple clients simultaneously as a multi user environment.
- Reports can be generated on-line or archived to external media.

FAST/TOOLS furthermore support grid style application engineering to further improve efficiency and minimalize errors. Time can be gained when records can quickly copied and modified from one overview without the need to switch between various configuration windows.



F080103E.ai

Figure 8.3 Grid style application engineering

Grid style application engineering is shown in figure 8.3. Modification from this environment can be easily done by a user without the need for extensive instructions. In matter of a couple of clicks and renaming of the devices an accurate copy of the record is made in the database.

When configuration data is available from external sources that can be restructured in an open environment like Microsoft Office all data can be imported in one go with the available quick load utility of FAST/TOOLS. These unique engineering functions reduce engineering time and errors and provide increasing benefits for larger system configurations.

In addition to item based engineering FAST/TOOLS also support object based engineering enabling to create pre-defined object classes for functions like flow-, inventory-, performance-calculations and production equipment like pumps, motors and valves up to complete plant units HVAC, tanks, blenders, separators, turbines, etc. from which many instances can be generated. This results in the following operational and technical benefits:

Operational benefits:

- Significant reduction in configuration time, since the functionality is defined once as an object class and modifications are automatically propagated to all derived object instances.
- Configuration on a functional level which results in a more transparent way of engineering and relation to the physical production assets with less chances on errors and inconsistencies.

Technical benefits:

- Enables automatic creation and removal of items related to an object.
- Rule based alarm generation at object level as a result from calculations and item interrelations. These alarms automatically appear in alarm displays thereby notifying the operator on any specific process or asset state condition.

In the following paragraph more in depth information on the object based engineering functions of FAST/TOOLS is provided. The visualization editor functions to create mimics and information displays for the user interface are described in paragraph 8.3

8.2 Object based engineering

Plant equipment (e.g. valves, pumps, transmitters, etc.) can be organized as objects with predefined properties and characteristics.

The engineering environment allows users to modify standard available objects or create new objects, through the PROCESS/FAST entities in the engineering module. This functionality enables application engineering on a higher level using functional objects rather than configuring the system on item level. For instance adding a valve object to the application; where the user derives an object (child) from the valve class (parent), it automatically creates and configures the valve specific parameters as defined by the class; like name, location, alarm settings, colors, animations, etc. When removing a valve object instance the related items are also automatically removed.

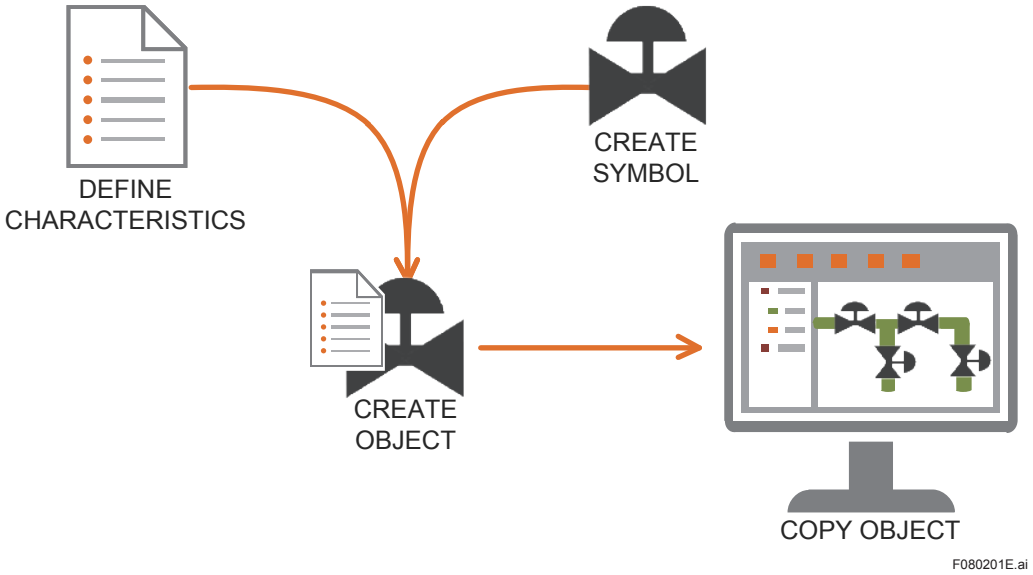


Figure 8.4 Object Based Engineering

The predefined object classes can be easily propagated to the entire application by assigning unique names to each object instance (see figure 8.4). Modifications made to an object class will be automatically propagated to all objects derived from this class.

PROCESS/FAST entities to build classes and objects support the following operators:

- Arithmetic operators
- Bitwise operators
- Boolean operators
- Relational operators
- String operators
- Transitional operators
- Functions like ABS(), SIN(), SQRT(), etc…
- User defined

The transitional operators are used to detect e.g. the first time a value crosses a limit and start appropriate actions like shutting down an inlet valve. Beyond the standard functions libraries and operators PROCESS/FAST provides a full java programming interface to develop advanced objects with high intelligence meeting any specific user requirement.

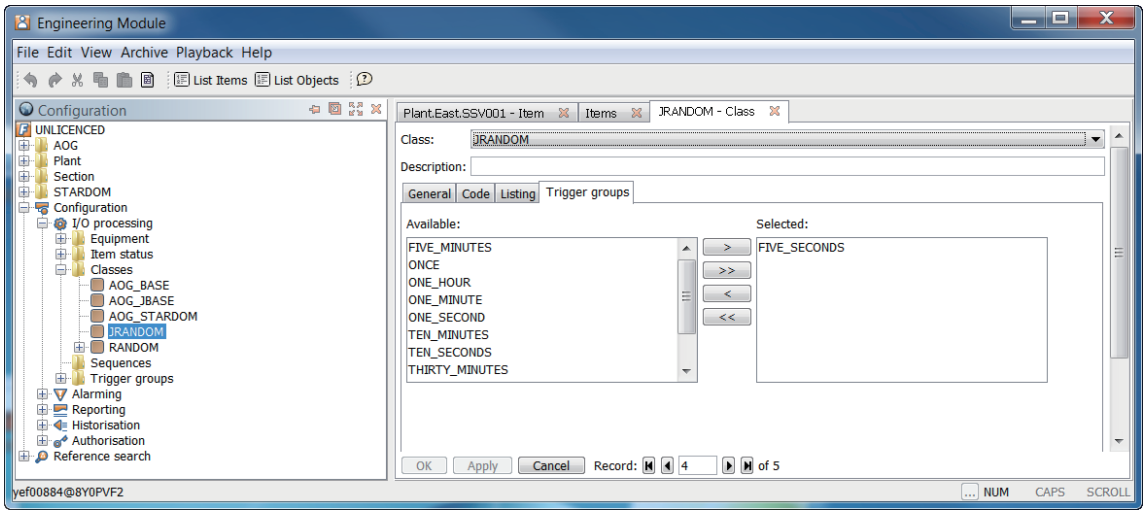
8.2.1 Object deployment

To balance the load of application objects or to execute objects as close as possible to its sources they can be distributed over multiple FAST/TOOLS nodes. When defining the object the user can specify on which node the object should be deployed. Objects can in this way also easily moved from one node to another.

8.2.2 Triggering Objects

Objects are activated by triggering them. Triggering is done:

- Continuously for real-time application execution
- Periodically on a time basis, for example to calculate an average value every ten minutes
- On event basis: for example on an item value change or status change or a time out
- Mix of the above, assigning a trigger group



F080202E.ai

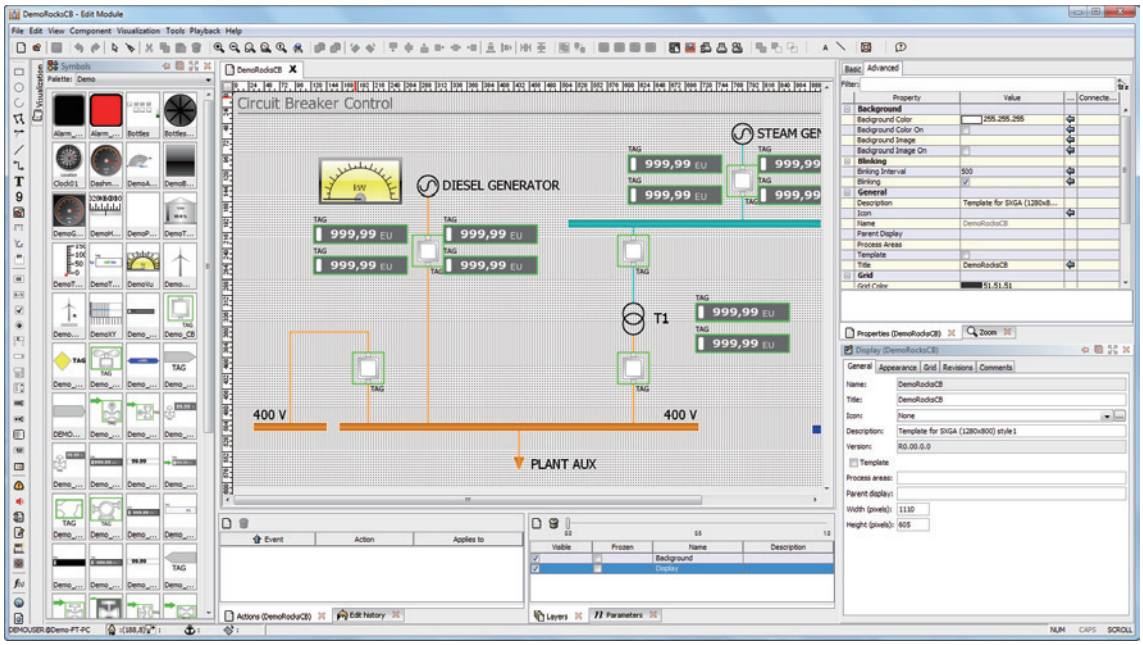
Figure 8.5 Object Triggering

Object triggering configuration functions also allows optimization of the application load to the user requirements (see figure 8.5). In this way optimal system performance under all conditions can be achieved.

8.3 Visualization Editor Functions

8.3.1 Advanced Display Editor (Edit Module)

The FAST/TOOLS visualization editor is based on advanced scalable graphics shapes and symbols that can be intuitively manipulated. Examples of this are; sheering, rejoining, add/ subtract and reforming. Basically the editor combines the power of today's most sophisticated graphical applications in one easy manageable environment. Furthermore it supports direct animation on process drawing elements and shapes which can be activated and changed transparently in their properties.



F080301E.ai

Figure 8.6 Visualization Editor Environment

The visualization and engineering sheets (canvas, toolbox, properties, actions, parameters, etc.) can be sized and organized as appropriate. They are easy-to-manage and can be dragged and dropped, pinned or unpinned to appear on the pop-up side bar menus. This allows users to establish an engineering desktop environment that meets their preferences and contributes to higher efficiency.

All dynamic and static information of all display objects are represented and traced in structured and easy to navigate tree. The user can exactly see all relations and building blocks of each HMI display. For example, by selecting on a static or dynamic element in the self-documentation tree the object it relates to is automatically selected and its properties are shown. This allows the FAST/TOOLS user to build very sophisticated intuitive and advanced mimic and information displays without losing oversight.

Below a sum up of features which can be utilized from the edit module and that contribute to increased operational performance and engineering efficiency:

- Dynamic layers and backgrounds that can be independently made visible or transparent through process conditions, manual controls or by user login privileges.
- Display actions can be blocked for the operator when a pop-up is shown. This feature prevents the operator from opening more than one pop-up window at the same time and thus obscuring the view on the process mimics and/or information displays.
- Dedicated pop-up for control actions. For example, a valve can be blocked on other workstations when it is activated by an operator. This ensures that only one operator at a time can control this valve.
- Actions can be triggered via Function-keys, Alt/Ctrl-combinations or right-mouse clicks. These actions do not need to be FAST/TOOLS related but can also start a non-FAST/TOOLS executable.
- Clutter and de-clutter zooming and panning functionality options for visibility groups (Google Earth zooming and panning style).
- Animations are embedded and can be activated and changed in the properties of drawing elements and shapes.
- ISA standardized symbols. The symbol library offers more than 3000 predesigned symbols for different industry applications.
- Predefined displays; alarm displays, trend displays, faceplates. These can be easily customized to meet the user requirements.
- Images of a production site or equipment can be inserted into the display.
- Chart types, the user can select from a wide range of chart such as: line graphs, X-Y-plots, 3D-line graphs. In order to create a suitable method of displaying process data in a statistical way.
- The user can create a display or symbol on one node and distribute it to other nodes at any connected (remote) location.
- XML-format storage of graphic displays. By means of scripting the content can be altered in order to create to make new displays. By use of tooling like; Find & Replace the user can make similar displays that show other ranges of items.
- Display coupling to a user account. At login it is determined which display hierarchy will be active.

8.3.2 Advanced Operating Graphics (AOG)

Advanced Operating Graphics (AOG) is a consulting service provided by Yokogawa to design PCS user interface based on human factors and knowledge engineering in order to improve users' situation awareness.

- Identify user, task and functional requirements for operation that require HMI support.
- Analyze the requirements in order to determine the needs and conditions to meet for the project.
- Provide guidance on designing and developing user interface including display layout, navigation, hierarchy, color pallet, data visualization, etc.
- Submit final report of achievements in the project.

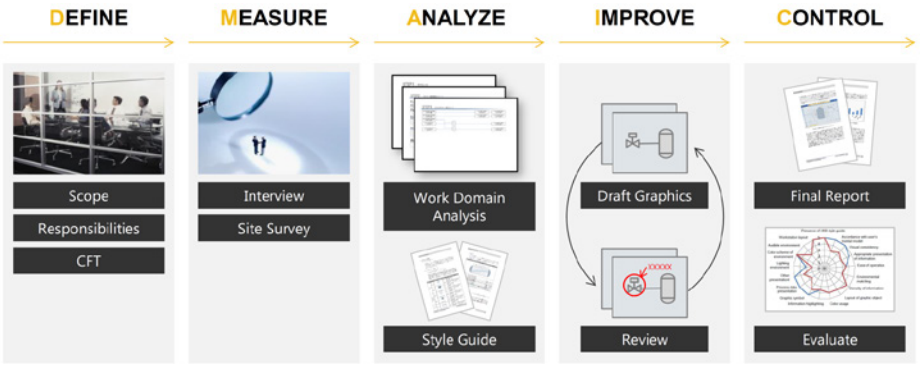


Figure 8.7 AOG Consulting Process

To support a more effective HMI strategy we have developed a symbol library adopting the ISA-101 philosophies. The ISA-101 standard helps users understand what those concepts mean and how to implement them. It is designed to develop and establish a consistent approach to effective HMI development and implementation for manufacturing and especially process industries. End users, automation suppliers and system integrators can use this standard to create more effective HMIs, which will lead to higher productivity and a safer operating environment. Therefore, the emphasis is on showing meaningful information rather than just numbers facilitating Advanced Operating Graphics (AOG).

The High Performance HMI is governed by the following principles:

Emphasis on information

Data in general are just numbers. A context is needed to give those numbers a meaning, whereas, information is something that is useful for the user.

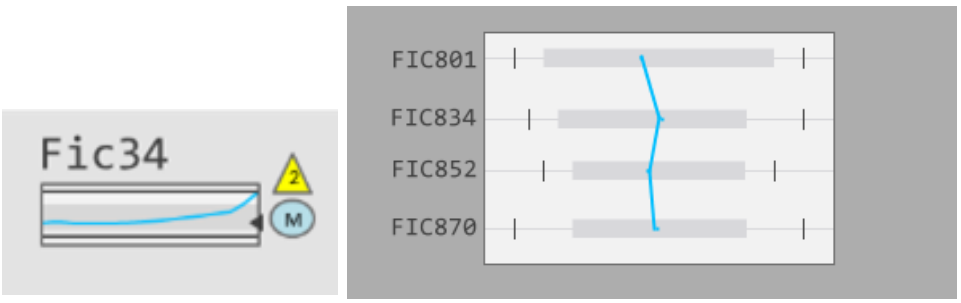


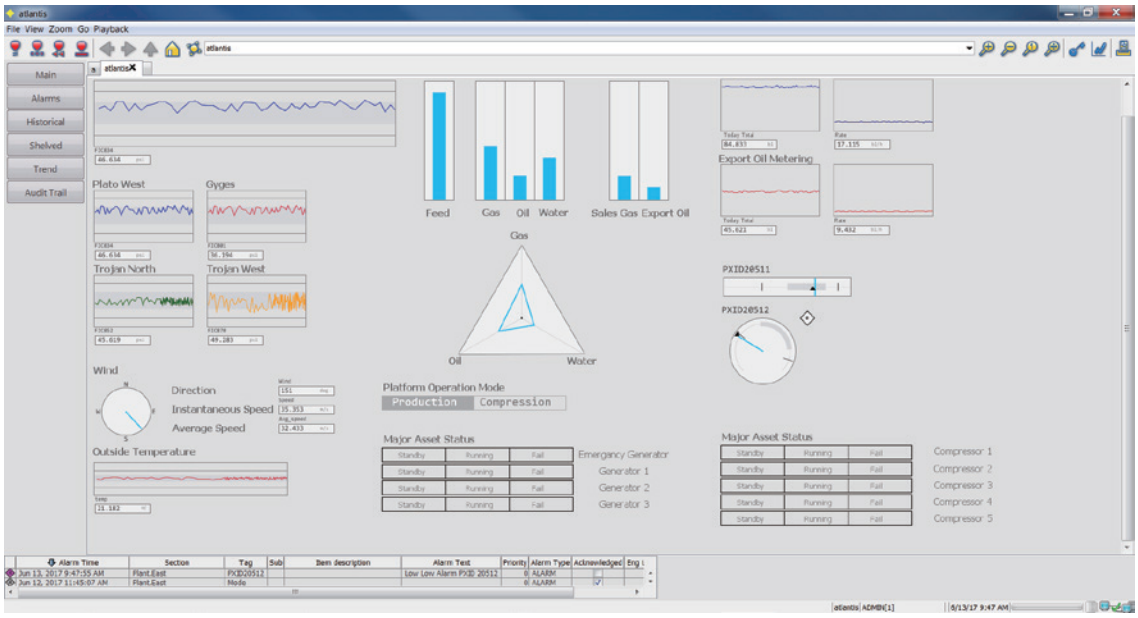
Figure 8.8 AOG compornent

When data are shown within a context, they become relevant for performing a particular task. Therefore, context and relevance are the keywords to convert data into information.

Seek the operator's attention only when required

Shows a colourful display is difficult for the Operator to see abnormal situations. By making use of limit colour and relevant information, the Operator can immediately find out what is imported.

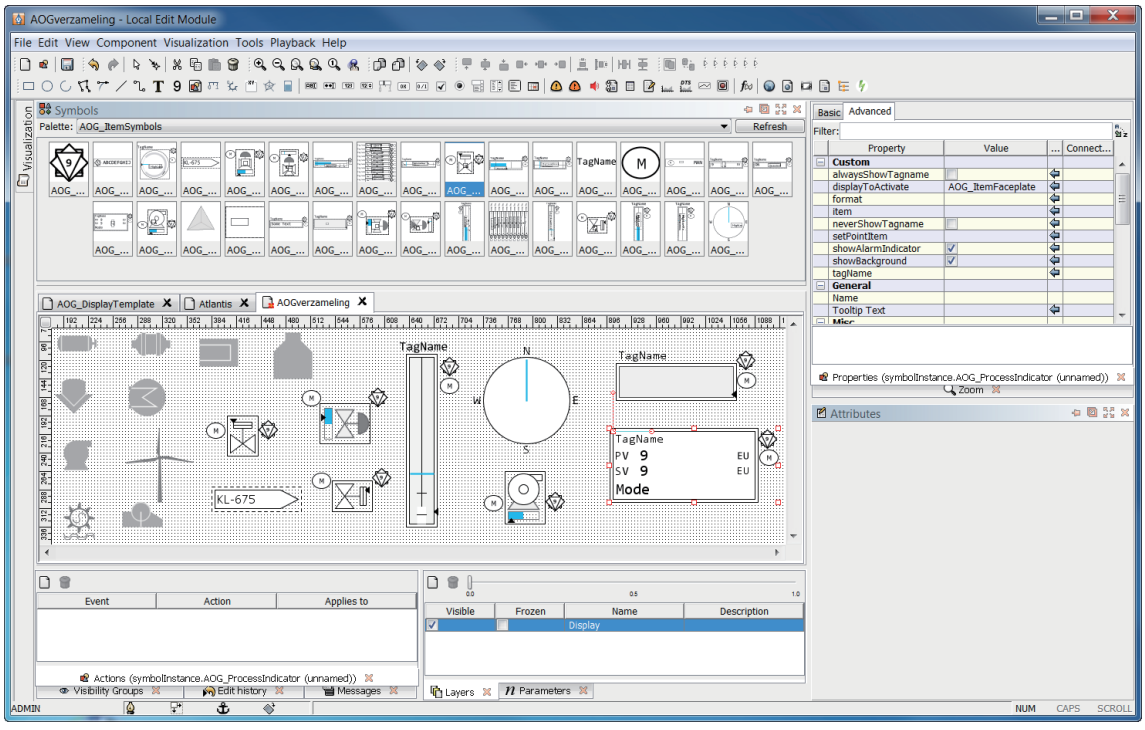
The AOG Symbol library and templates are standard available inside the FAST/TOOLS editor and ready to use in your displays, besides all the other symbols and templates we already have in the FAST/TOOLS editor.



F080303E.ai

Figure 8.9 High performance HMI

Note: AOG consulting service is available on request (TOKUCHU).

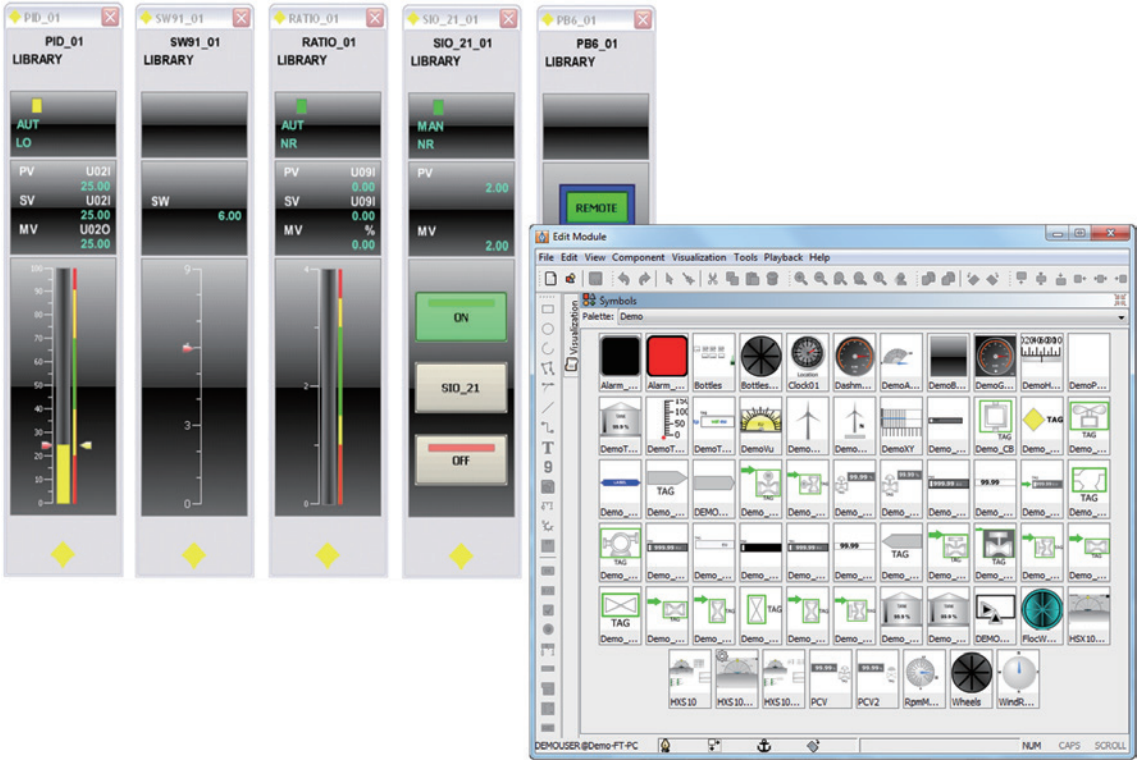


F080302E.ai

Figure 8.10 AOG library

8.3.3 Faceplate and Symbol Library

FAST/TOOLS provide a large number of symbols. Currently as standard more than 3000 industrial and manufacturing symbols are included. These libraries can be extended with any number of custom symbols.



F080302E.ai

Figure 8.11 Symbols and faceplates from library

A symbol consists of primitives like lines, squares and circles. Symbols can be designed once and used many times in displays. The user can create symbol animations by directly coupling display parameters to their visualization properties or make the symbol more universal and advanced by connecting an object class to it.

The standard symbol libraries in FAST/TOOLS are categorized as follows:

- Process Symbols
- Industry Symbols
- Standard & Guidelines Symbols
- General Symbols

Below an overview of the general content of each symbol library is provided:

List of Process Symbols:

- Airflow
- Blowers
- Chemicals
- Conveyors
- Heating Symbols
- Hydro

- Logic
- Ducts
- Air-conditioning
- Electrical
- Flexible tubing
- Controllers
- Material Handling
- Pipes
- Mixers
- Motors
- Process Cooling
- Process Heating
- Thermo
- Pumps
- Sensors
- Tanks
- Valves
- Wire & Cable

List of Industry Symbols:

- General Manufacturing Symbols
- Industrial
- Plant Facilities
- Power
- Water & Wastewater

List of Standard & Guidelines Symbols:

- ISA Symbols
- ISA Symbols 3D
- ASHRAE Control & Equipment
- ASHRAE Ducts
- ASHRAE Piping
- HVAC (heating, ventilation, and air conditioning)

List of General Symbols:

- Architectural
- Arrows
- Avionics
- Buildings
- Basic Shapes
- Computer Hardware
- Containers
- Nature
- Numbers
- Maps & Flags
- International Symbols
- Operator Interface
- Safety
- Scales
- Telecom Hardware
- Vehicles
- Safety
- Symbols Miscellaneous

8.4 Engineering Tools

8.4.1 Application Quick Loading Tool

A unique functionality of the FAST/TOOLS engineering environment is loading and exporting the entire application configuration though the “quick load engineering utility”

This enables the user to “quick load” applications and modifications online without stopping the system from its real-time duties. While loading the application FAST/TOOLS continuously checks the “quick load” data. An error in the configuration will be reported instantly, stopping the loading process or prompt the user for rejection or acceptance.

The advantages of preparing the applications configuration database this way are:

- Preparation of configuration data can be done off-line
- Data can be pre-checked on: Consistency, Format/Syntax and Completeness
- Re-use for other applications
- Easy and fast configuration of backup-systems

The following configuration data can be prepared off-line:

- Items
- Displays
- I/O-driver configurations
- Alarm collections
- History groups
- User-profiles
- Objects and classes

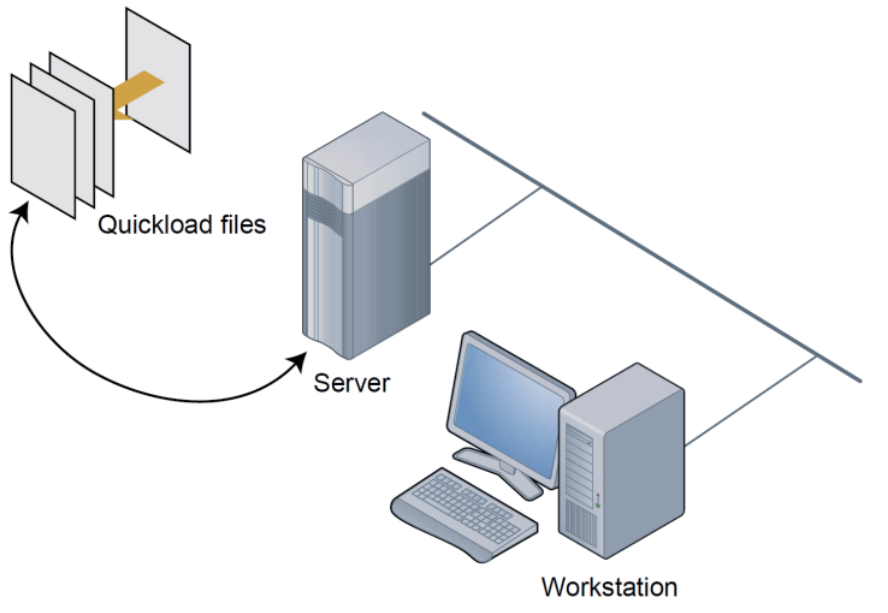
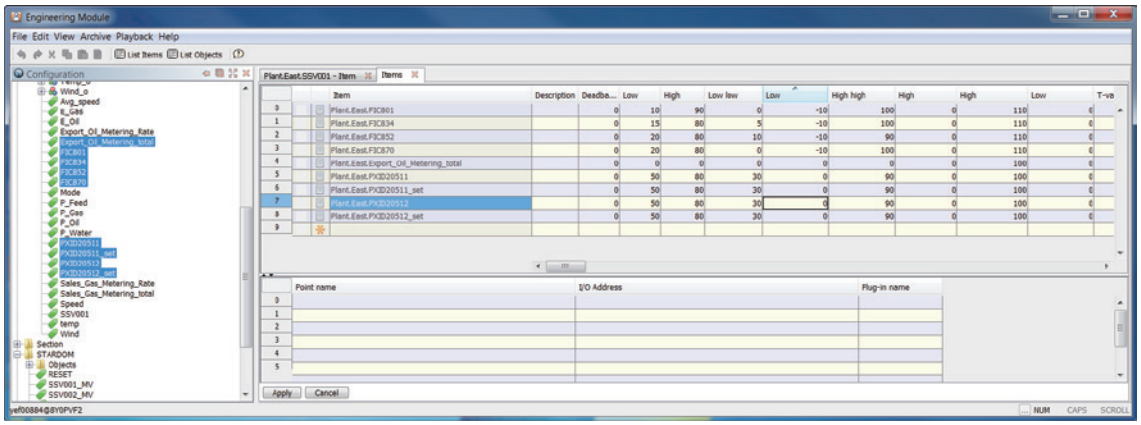


Figure 8.12 Quickload files

All configuration entities can be quick loaded. In addition graphics (e.g. templates) are stored as readable XML files and processed by scripts in order to generate unique graphics instances.

8.4.2 Grid Engineering

Complementary to the efficient methodology of the Quick Load tool, FAST/TOOLS provides grid style engineering. This enables the user to make rapid online multiplications and adjustments (see figure 8.13)



F080402E.ai

Figure 8.13 Grid Engineering

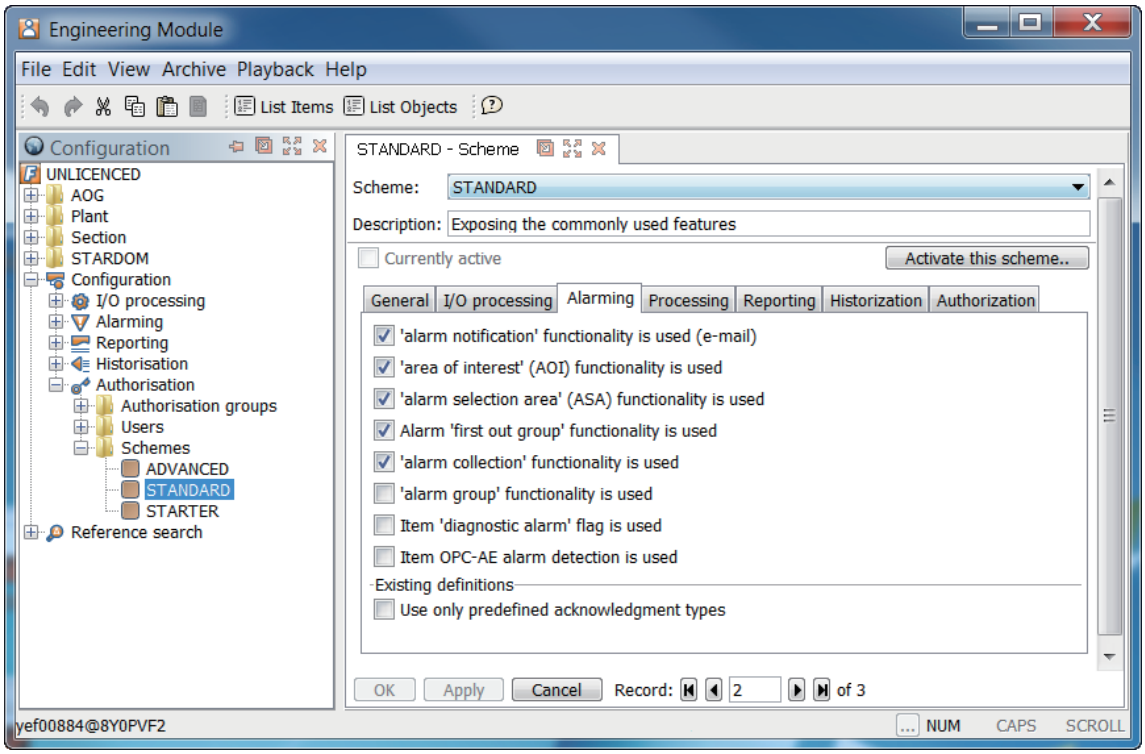
All item definitions can be adjusted and duplicated while using the Grid Engineering tool. This Make it a high efficient tool for engineering purposes and it allows keeping track of the process during modification. Some examples of item definitions that can be adjust are:

- Item description
- Alarm setting, such as: high-high, high, low, low-low, deadband, etc
- OPC A&E Detection
- Representation, such as: Integer, Boolean, Sting , Real
- Node Configuration
- Assigning Process Area

8.4.3 Standard Configuration Schemes

A FAST/TOOLS Scheme (see figure 8.14) determines if particular functionalities within the engineering module will be presented to a specific user group. This enables to concealing advanced functions and to increase the simplicity for basic use. Multiple schemes can be defined for the different user groups. These schemes can be applied for:

- I/O Processing
- Alarming
- Processing (configuration of classes and object)
- Reporting
- Historization
- Authorization
- General elements



F080403E.ai

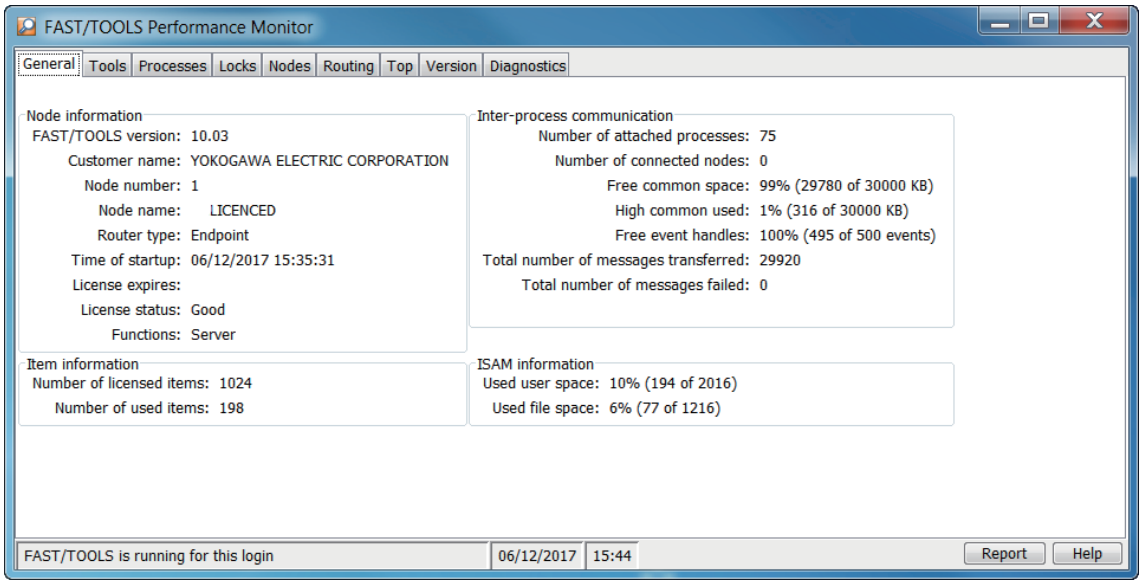
Figure 8.14 Engineering Scheme

Following the activation of a scheme the engineering environment for the user group it is assigned to will be limited in accordance with this scheme. This provides the user an engineering environment that adapts to its functional requirements without confusing him with additional options and settings.

8.4.4 Diagnostics Tools

FAST/TOOLS provide an extensive set of diagnostic tools allowing online monitoring of:

- Configuration settings
- Real-time values of items, communication statistics, process-load
- Time related issues
- Status values
- Module specific parameters



F080404E.ai

Figure 8.15 Performance Monitor

These diagnostic tools are used to locate suspicious faulty situations and to optimize the performance of the FAST/TOOLS system. Performance optimization can be done by:

- Balancing network traffic between e.g. a server and workstation in a redundant network
- Preventing queue overflows by defining larger queue sizes of FAST/TOOLS processes that are consuming more than others.
- Optimizing scan times of external process variables

In addition some diagnostic tools allow logging diagnostic data to a file on disk, which can be used for analyses later on. The diagnostic features are impressive and go as far as byte- and bit information. The following diagnostic tools are available within FAST/TOOLS:

Equipment manager diagnostic tool

For example, if there is a problem with a data connection with specific equipment, the equipment diagnostic tool which is part of EQUIPMENT/FAST, allows the user to see:

- What data is passing through the line
- Which items are involved
- Information about the gaps in the data stream
- Error response in data
- Timing issues
- The amount of poll-request per time interval
- Time synchronization
- Several communication failure counts (statistics)

Internal data traffic diagnostic tool

A lot of information can be gathered related to the internal data traffic in a FAST/TOOLS based system. Looking into the main data streams will provide the user information on how to tune the system. By examining the data traffic between processes a problem can easily be broken down into a single process. Some of the optimization possibilities are:

- Overview of total message traffic
- Overview of message traffic per process
- Show outstanding number of messages per process
- Overview of all time related actions (clock queue)
- Overview of traffic to other systems
- Logging of the data contents of messages transferred
- Block a message queue
- Influence the order of messages in a queue
- Selective flush messages from a queue
- Overview of maximum queue use since system start-up

Process variable related diagnostics

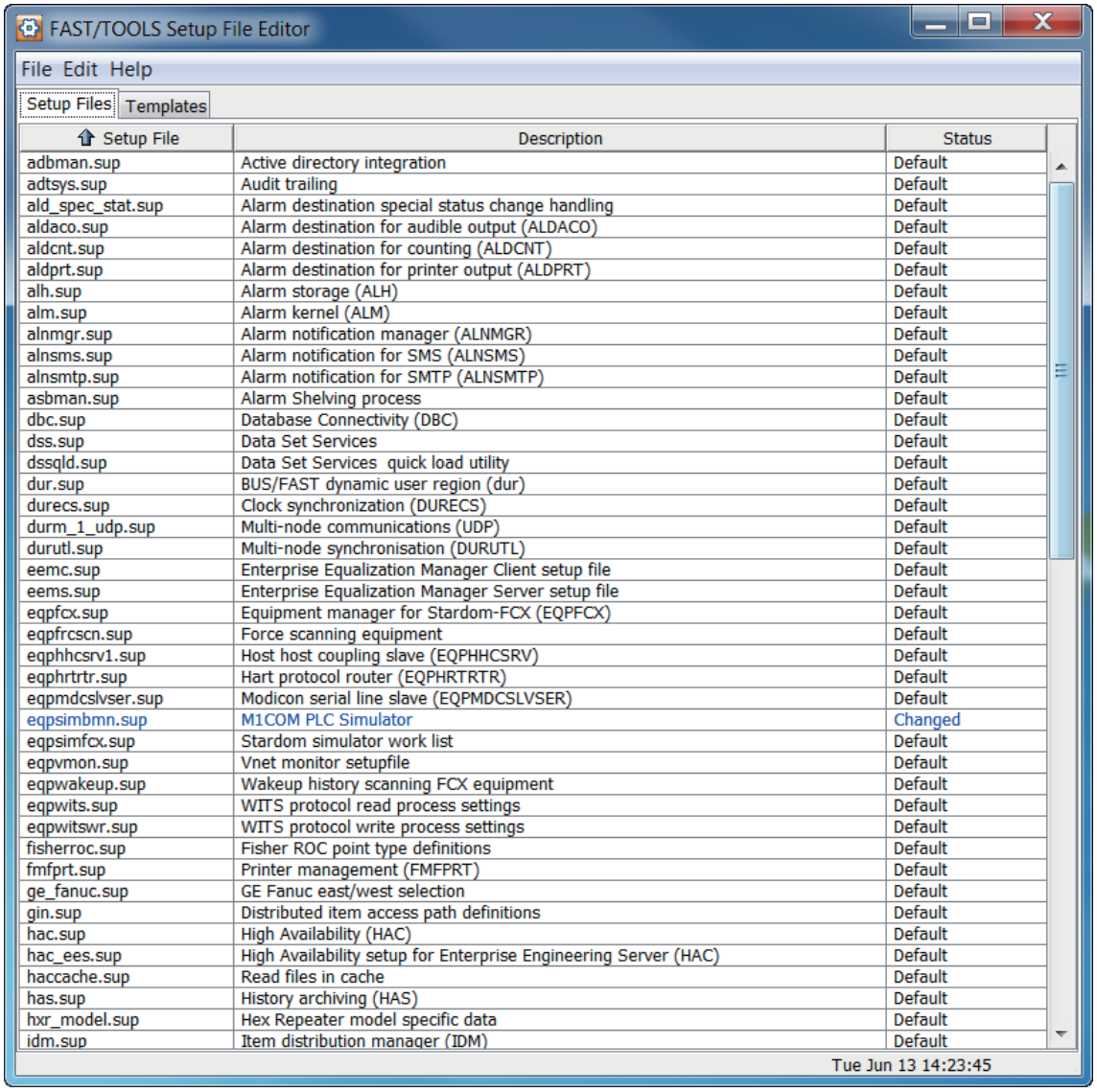
On process variable level the following information can be collected:

- Statistics about all actions related to process variables since system startup
- Overview of event streams between process variables and processes
- Detailed information about all history samples stored

8.4.5 Setup File Editor

The system administrator has the ability to change the default behavior of certain functions within the FAST/TOOLS environment. This behavior is parameterized via so called setup files. These parameters can be changed with the Setup File Editor.

The Setup File Editor provides an overview in one window of all available setup files and their current status: all default or non-default parameters, whether default settings are used or if they are changed.



Setup File	Description	Status
adbman.sup	Active directory integration	Default
adtsys.sup	Audit trailing	Default
ald_spec_stat.sup	Alarm destination special status change handling	Default
aldaco.sup	Alarm destination for audible output (ALDACO)	Default
aldcnt.sup	Alarm destination for counting (ALDCNT)	Default
aldprt.sup	Alarm destination for printer output (ALDPRT)	Default
alh.sup	Alarm storage (ALH)	Default
alm.sup	Alarm kernel (ALM)	Default
alnmgr.sup	Alarm notification manager (ALNMGR)	Default
alnsms.sup	Alarm notification for SMS (ALNSMS)	Default
alnsmtp.sup	Alarm notification for SMTP (ALNSMTP)	Default
asbman.sup	Alarm Shelving process	Default
dbc.sup	Database Connectivity (DBC)	Default
dss.sup	Data Set Services	Default
dssqld.sup	Data Set Services quick load utility	Default
dur.sup	BUS/FAST dynamic user region (dur)	Default
durecs.sup	Clock synchronization (DURECS)	Default
durm_1_udp.sup	Multi-node communications (UDP)	Default
durutl.sup	Multi-node synchronisation (DURUTL)	Default
eemc.sup	Enterprise Equalization Manager Client setup file	Default
eems.sup	Enterprise Equalization Manager Server setup file	Default
eqpfcx.sup	Equipment manager for Stardom-FCX (EQPFCX)	Default
eqpfrcscn.sup	Force scanning equipment	Default
eqphhcsrv1.sup	Host host coupling slave (EQPHHCSRV)	Default
eqphrtrtr.sup	Hart protocol router (EQPHRTRTR)	Default
eqpmdcslvser.sup	Modicon serial line slave (EQPMDCSLVSER)	Default
eqpsimbmn.sup	M1COM PLC Simulator	Changed
eqpsimfcx.sup	Stardom simulator work list	Default
eqpvmon.sup	Vnet monitor setupfile	Default
eqpwakeup.sup	Wakeup history scanning FCX equipment	Default
eqpwits.sup	WITS protocol read process settings	Default
eqpwitswr.sup	WITS protocol write process settings	Default
fisherroc.sup	Fisher ROC point type definitions	Default
fmfprt.sup	Printer management (FMFPRT)	Default
ge_fanuc.sup	GE Fanuc east/west selection	Default
gin.sup	Distributed item access path definitions	Default
hac.sup	High Availability (HAC)	Default
hac_ees.sup	High Availability setup for Enterprise Engineering Server (HAC)	Default
haccache.sup	Read files in cache	Default
has.sup	History archiving (HAS)	Default
hxr_model.sup	Hex Repeater model specific data	Default
idm.sup	Item distribution manager (IDM)	Default

F080405E.ai

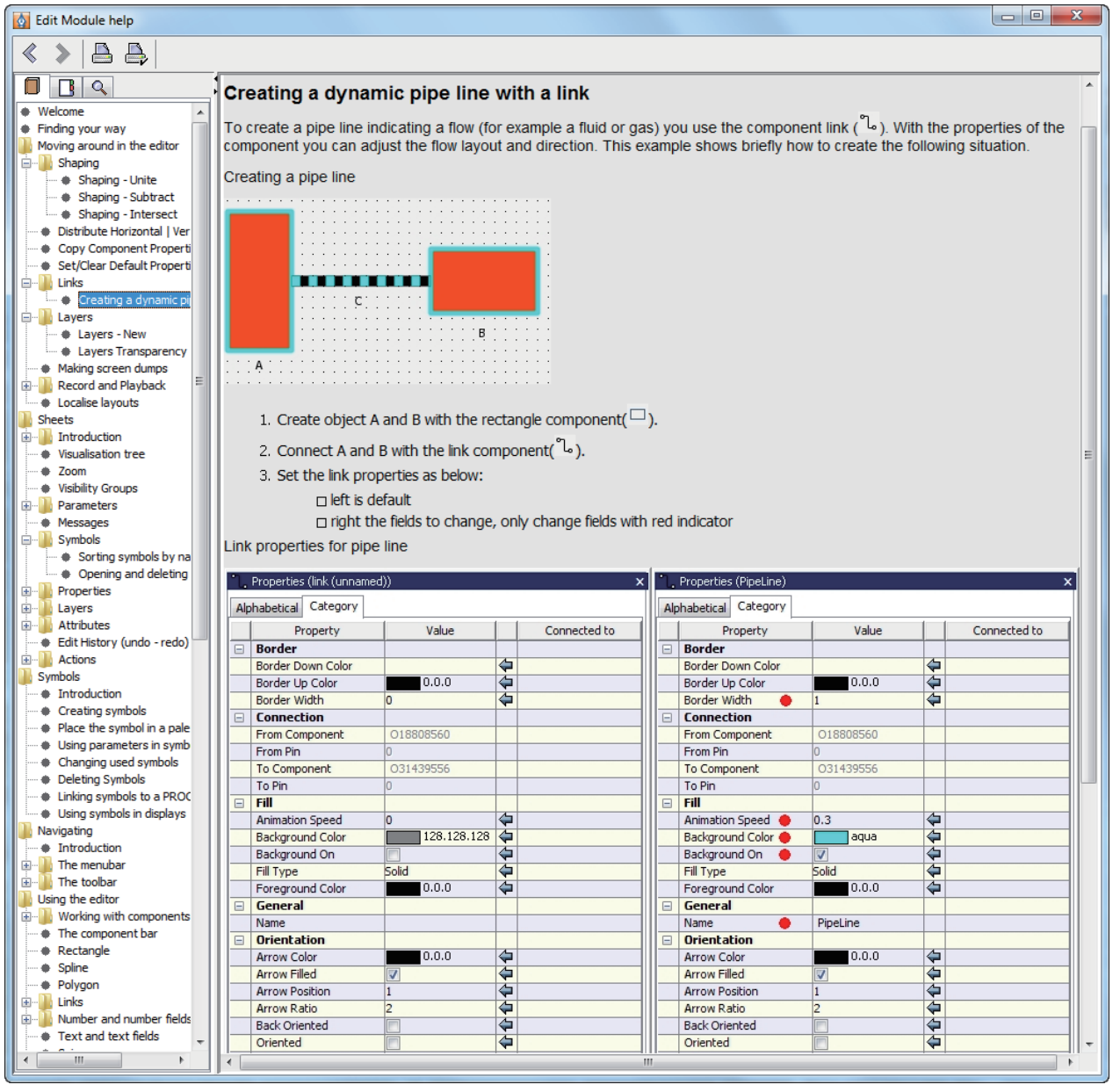
Figure 8.16 Setup file editor

After selecting a setup file it is possible to:

- Change the parameter settings via a pop-up window
- Change in one action all parameter settings back to their default value by clicking on the Default-button.

8.5 Online Help

FAST/TOOLS has a number of different levels of on-line help which assist in software use and application configuration. The first help level is the context sensitive help, which is available for all FAST/TOOLS dialogs. The second help level is accessible via the “help menu” and provides direct access to the “help contents” and “help guide”.



F080501E.ai

Figure 8.17 Online Help

The “help contents” operates like using standard Windows help functionality. This is presented in a books form. In the help index a part of a key word can be typed in to find the required information.

8.6 Migration of existing applications

Yokogawa is strongly supporting the migration of functionality, data and information across software generations. We support full communication and application redundancy and disaster recovery in a total “High Availability Computing” package, independent of applied communications media and system server hardware. Servers can be separated in different domains, different physical locations and be mirrored in order to guarantee data availability. Where we will go for is this “data loss is not applicable/acceptable”.

We provide mechanisms to transport functionality from development to test to acceptance to production in a managed way, including data and/or applications of the current system.

The system is upgraded in several phases which need to be discussed during FEED/Functional Design Phase. Data and applications like historical data, database content, reports, calculations, etc. need to be captured from the current environment and loaded into the new. During implementation phase at site the new system can operate in parallel to the existing system without being in control. Yokogawa has tremendous experience in Hot-cutovers where current manual inputs, operator notes, variables, etc. need to be transferred to the new system in a managed way. This needs a freeze and transfer strategy to enable a safe and reliable hand-over to the new system.

Figure 8.18 Portability of FAST/TOOLS applications

Capturing of data and applications can be done on various ways from approved Comma Separated File (.csv) extractions, evaluation what is valid, and quick loading into the new environment.

In a more intelligent way our software includes open interfaces based on the Data Set Services (DSS) layer, which appears to the application developer as an Application Programming Interface (API) for easy connection of third party software environments.

It allows for integration of application investments made in the past, preserving them for the future. End-users can balance investments of the system with particular applications build new or to expand the system with existing ones where this fits.

9 Services & Support

9.1 Documentation

There is a range of Yokogawa Instruction Manuals (IM) available for the FAST/TOOLS package. These manuals are written for two user groups:

- Operators and system managers
- System integrators and programmers

The IM's are clearly written with many illustrations and useful examples. The IM, in the English language, are delivered electronically with the FAST/TOOLS licenses. The System integrator and Maintenance manuals, and Programmers guides are part of the development kit and available in the English language.

9.2 Training

Yokogawa offers a series of standard FAST/TOOLS training courses. These are conducted in one of the excellent training facilities of Yokogawa around the world. Special training sessions can be organized at user location. Each course will give the student a thorough basis to the application of the course subject. The courses consist of a theoretical part and a series of hands-on sessions where the student will gain practical experience. The following courses are available:

Process Operations

Process Operators makes use of the application in order to monitor or control the process. These users do not necessarily have any knowledge of the underlying (FAST/TOOLS) system, except for the dialogue with the Human Machine Interface. Obviously, the process operator interface will strongly depend on the application demand. This lecture-based course combined with lab exercises provides the opportunity for hands-on experience with the fundamental TOOLS. This training is given on request and can be customized to a large extent.

System Management

The course is meant for System Managers who will configure and or maintain the FAST/TOOLS operational environment. This course can also be given to System Integrators and or Programmers. For these users the course is meant as an introduction to the course "FAST/TOOLS Architecture and Internal Structure". Subjects that are part of the course are:

- Configure alarm situations (e.g. limits, activation, alarm text, suppression, acknowledgement)
- Show process variables and display historical information
- Process control functions (classes)
- Define user reports
- Create mimics

9.3 Software Licensing

There are three different categories of software licensing, each supporting a different function. There is the Server Package, which include nearly all the FAST/TOOLS function modules. Depending on the numbers of tags a different license is required. The range starts with 250 tags up to an unlimited version (unlimited < 16 million) The number of supported tags can be increased in a later stage via extension licenses. This makes it possible to balance the investment of the SCADA system with the needs of a particular application and to expand the system only when necessary.

The third category is the Operator Station package. This includes the Web HMI Server and Client licenses. FAST/TOOLS requires to be purchased with support contract. The support contract covers technical support, telephone support and software upgrades. Support is therefore available while the system is being commissioned to assist the engineers with technical matters concerning the installation and configuration, as well as assisting the end users with any queries they may have. Our service and support center is able to provide 24/7 support.

FAST/TOOLS is designed so that it can be adapted to various languages and regions without engineering changes. The FAST/TOOLS software is standard available in English. Localization can be easily done by translating the language content files.

9.4 Consultancy

Yokogawa offers a complete set of professional services that can be tailored to specific needs. Our highly praised consultants provide services that offer a quick, cost-effective way to ensure success in developing and implementing FAST/TOOLS systems. Yokogawa has many years of experience assisting users from the process control industries, as well as in many other application areas. In addition, the company invests in the continuous education of our professional service staff. Yokogawa consultants can give you advice on the following subjects:

- Conceptual study
- Proof of concept study
- Feasibility study
- MAC (Main Automation Contractor) project approach
- Networking study
- Communication protocol interfacing
- Custom graphics
- Application prototypes
- Maintenance, tuning and upgrades
- Performance tuning
- Cyber security services
- Ergonomically control room design
- Definitions of process and role-based key performance indicators (KPIs)
- Portfolio wide consultancy

Yokogawa is dedicated to providing quality customized consulting services to our customers. Our consulting services are offered by a team of professionals who are highly experienced in conceptual, detail application and third parts software integration. The Yokogawa consulting staff includes senior developers and expert application builders with many years of experience.

Yokogawa consulting services are available in any form that fits your unique configuration and programming needs. Services range from simple, day rate advisory to complex, ongoing projects. Our staff can assist in any or all phases of the system integration process, from conceptual study to implementation and maintenance

10 Technical Review

System Architecture

- Client – Server Architecture with Rich and/or Thin clients Scalable system from single node to multi server systems
- Distributed SCADA system; mobile devices, workstations, servers and front-ends
- Enterprise Automation Solution (EAS) architectures
- Multi platforms (coexistence of different OS platforms is possible)

Supported platforms

- Microsoft Windows
- Linux Red Hat Enterprise and CentOS
- HP Unix

General

- Automatic time synchronization of all nodes.
- Time accuracy by GPS or Radio clock
- Max 256 nodes (nodes can be Servers, Workstations or Front-ends).
- Scalable from a few to over multiple millions of database points
- Object oriented application development environment within FAST/TOOLS
- Online engineering and application modifications without downtime.

Redundancy

- Primary/backup architecture fault tolerance architecture
- Redundant, Triple and Quad Fault-tolerant configurations

Networking

- Fault-tolerant network support (up to four network connections per server)
- TCP/IP based communications
- Ethernet
- Intranet / Internet
- Radio and Satellite
- 3G/4G, GSM, GPRS, CDMA
- VPN Tunneling
- Secure Host-to-host communication.

Connectivity

- OPC server and client (Both OPC UA and OPC Classic)
- ODBC server and client to access both process data as well as configuration data
- Data Set Service (DSS) appears to the application developer as an Application Programming Interface (API) for easy connection to 3rd party software and databases
- Native OSIsoft PI real-time connectivity (with store/forward data backfill integrity)

Data Collection

- Continuous communication link monitoring with automatic fail-over to max two alternative communication links tolerating multiple network faults.
- Up to a maximum of 1000 different connections can run on one node.
- Data acquisition on scan or event based
- OPC UA, and Classic
- RTU drivers for Modbus, WITS, DNP3 and HEX Repeater protocols
- IEC drivers for IEC 61850 and IEC 60870 protocols
- Native Yokogawa integration for CENTUM VP DCS, ProSafe-RS SCS controllers
- Native Yokogawa integration for STARDOM RTU, FA-M3 PLC and DAQMASTER
- Rockwell Automation drivers for CIP, DH+ & DF1 protocols (for PLC5, ControlLogix)
- Siemens drivers for 3964R & SAPI-S7 protocols (for S5 and S7 PLCs)
- Emerson drivers for BSAP & Fisher ROC protocols (for Bristol Babcock RTU)

Tags (data point items)

- The depth of sections can be zero up to 128, length of the entire path not longer then 256 total characters (ANSI). Section name length is max 31 characters (ANSI).
- Quality index
- Value clamping
- Sub-items
- Integrator
- Pulse counter
- Min/max indicator
- Rate of change
- Limit and deadband
- Blocks of items, unit & installation
- Data compression

Database

- Event driven structure
- Supports over 200,000 read/write actions per second per instance
- Load sharing to optimize performance
- Memory resident
- Can be distributed across multiple servers
- Alarm and Events database
- Real-time database
- Historical database
- 3rd party data exchange

Mimic Displays

- Object Oriented Display builder
- Extensive templates, symbol and objects library
- Faceplate library for control functions
- Unlimited number of displays and symbols
- Multi monitor support
- Screen resolution independent
- Rich animations on objects, display component and drawing elements (color, size, location, path move, rotation, value, flash, hide, visibility, transparency)
- Multiple layers and visibility groups
- Step less zooming and panning with decluttering support
- Dynamic gradient fills (diagonal, straight and circular directional, multi colors)
- Import of pictures and graphics (JPG, PNG, BMP and GIF format)
- Display and object instance aliasing for powerful global propagations of changes
- User-configurable tool tips
- User-configurable menus and display editing environment
- Easy tunable trend and alarm components
- Web URL view and Web cam
- Google Earth embeddable view
- Office embeddable views

Alarm and Event Management

- Alarm standardization in one environment with multiple customizable views
- Unlimited numbers of alarms – centralized or distributed
- Outstanding alarm overview and Sequence of Event (SOE) overview
- Extensive alarm filtering and shelving options
- ISA 18.2 and EEMUA191 compliant with ASPA module

- Highlighting most important alarms
- Dynamic alarm thresholds and suppression functions
- Export alarm overviews to XML, CSV readable by Microsoft Office® (Word, Excel) and HTML5
- Alarm database access through certified ODBC, OPC A&E and OPC UA A&C interfaces
- Audit trail tracking on changes of alarm settings (limits, priorities, groups, description, etc.)
- Define acknowledgement conditions for the alarms
- Define layout of alarm lines
- Delayed alarms
- Repeated alarms
- Alarm groups
- Alarm collections
- First out and first up alarm annunciation
- Alarm destination and escalation settings with filter options
- Send and reroute alarm to smart phones and tablets, e-mail, and printers services

Operator log/audit trail

- Track extensions and modifications made by authorized users
- Logging of explanations and clarification of changes made by users

Playback functionality

- Live screen recordings and playback of actions taken from any client
- Supported in both the engineering and operator environment
- Playback viewer with event indicators and controls for play, pause, back, forward, etc.
- Supported in both the engineering and operator environment

Trends

- Time based trending and X-Y plots
- Bar, line, points, scatter, & web
- Many pens simultaneously presented per trend window
- On/offline indication on trend line graph when field communication is lost
- Data backfill after recovery of communication with field controllers
- Alarm limits indications by means of thin alarm threshold lines in trend window.
- Zooming, panning and fast x-y-axis scaling
- Configurable sample periods
- Configurable trend background color and image
- Tunable trend appearance (visibility of legend, scaling, trend pen panel and settings)
- 3D trend views

- Hairline cursor
- Time/period based synchronization and linking with alarm views
- Scalable timeline and resolution
- Live and historical trending
- Real-time update of historical trends
- Export of trend data values to CSV and XML
- Export of trend views to JPEG and BMP
- Trend templates and save functions for fast appliance and retrieval by operations staff

Reporting and publishing

- Text-based and graphical reports
- Information can be sourced from real-time, historical, alarm and configuration databases
- Reports can include data from external sources through ODBC and XML
- Supports output to PDF, Excel and HTML5
- Scheduled and event-based report generation
- Report manager and report browsing
- Ad hoc generation of reports
- Printer management
- Manually select and publish reports based on date/time
- Adaptable to existing reporting environments

Historical Data Archiving

- On scan and event based
- Storing object information on time, item, event & direct based
- Averaging of history values and online data retention
- Configurable collection period groups
- Managing historical files and data compression settings
- Automatic archiving on external storage of all newly collected historical data
- Historical database store/forward data backfill integrity
- Historical data upload from 3rd party legacy systems
- SAN / NAS connectivity

Security

- In accordance with ISA 99 standard
- User name & password authentication
- Adaptable to IT level 2 and 3 security measures
- VPN and biometric COTS principles

- User group based
- Language selection
- Authorization level (0-999)
- Authorization groups
- Control access from process areas of responsibility down to database objects
- Initial display access
- Hierarchy field for forms access
- Control access to configuration functions
- Control access to historical information, audit trail info and user action recordings.
- Host-to-host Secure connection.
- Active Directory and SPNEGO authentication

Embedded Web views

- Embedded visualization of 3rd party software with Web enabled front end viewers
- Access to sources over URL, XML and HTML5
- Informative and easy to maintain

Virtualization

- System wide virtualization (servers as well as workstations)
- Applications and software deployable to (private) cloud environments
- VM Ware, Hyper-V, Citrix XenServer, Oracle VM, and Sun xVM compatible

Support tools

- FAST/TOOLS monitor
- On line protocol analyzer
- On line debug tools
- On line system diagnostics tools
- Setup file editor

Revision Information

Title: FAST/TOOLS Technical Product Description
Manual number : TI 50A01A20-01EN

May 2019/7th Edition
Revision with R10.04 Enhancements

July 2018/6th Edition
Revision to comply with the new accounting standard IFRS 15.

Dec. 2017/5th Edition
Revision with R10.03 Enhancements

Jan. 2014/4th Edition
Revision with R10.01 Enhancements

May 2011/3nd Edition
Revision with R9.04 Enhancements

June 2010/2nd Edition
Revision with R9.03 and the page modification by the layout change

Aug. 2009/1st Edition
Newly published

Written by Yokogawa Electric Corporation

Published by Yokogawa Electric Corporation
2-9-32 Nakacho, Musashino-shi, Tokyo 180-8750, JAPAN