SPPA-T3000
System Overview

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1.1 System Overview

1.1.1 Introduction

1.1.1.1 Introduction

Introduction

For years, control system vendors have continuously deployed new technologies to improve power generation capabilities. To address the increasing demand for real-time data, open- and standard-based components were integrated into proprietary control systems; for example:

- Field buses
- Open interfaces for data exchange between the enterprise level and production processes
- Open databases

to name just a few.

As a result of these integration efforts, DCS systems have grown into very complex structures, which are known to be difficult to maintain. Furthermore, the proliferation of multiple interfaces, parts, operating systems and the support tools have led to compromising availability and increasing obsolescence concerns.

Siemens has taken an innovative approach: the vision of free flow of real-time data, without the need to integrate any internal interfaces into proprietary software architectures.

Driven by this vision, and leveraging our strengths and experience in power generation, we have developed the first truly Component Based Control System in the world - SPPA-T3000.

All components are designed so that SPPA-T3000 easily performs all functions of the power plant process, including integration of third party interfaces and seamless interface to web-based applications.

SPPA-T3000 not only masters the requirements of traditional power plant control tasks, but also provides the real-time data platform needed for improving your power generation business processes. SPPA-T3000 achieves this without the disadvantages of classical control systems. It is designed using a component-based approach which results in a software solution instead of a collection of "forced to fit" pieces.

SPPA-T3000 provides a powerful application environment that enables you to tailor solutions to your specific enterprise needs. This includes the ability to coordinate and manage each and every aspect of your business processes in order to achieve operational excellence. SPPA-T3000 will provide you with substantial competitive advantages for engineering, startup and operation, as well as the administration and maintenance needed for your business.

1.1.1.2 Major Design Characteristics

Major Design Characteristics

The component-based concept

Embedded Component Services™ - ECS embeds all process-relevant data into every single component. This component-embedded approach allows all data to be intrinsically available for operation, engineering or diagnostics. A homogenous system architecture simplifies the system structure, offers a Single User Interface for all tasks and eliminates the need for the sub-systems and elaborate interfaces found in classic control systems.

SPPA-T3000 applies XML- and Java-technologies, allowing applications to be executed and delivered without operating system restrictions or hardware platform compatibility issues. This improves capabilities for tasks like I&C support and initiatives like plant optimization and process modification and tuning. All of these capabilities are also available remotely from any location. Traditional control systems contain hidden sub-systems with extensive
communication interfaces, all of which have to be engineered. Mapping data exchange and sub-system communication makes data consistency a challenge. Additional handling time, administration efforts and multiple software and hardware versions can result in multiple failure points and increased maintenance efforts. SPPA-T3000 eliminates these sub-systems. Its homogenous system architecture guarantees intrinsic data consistency and fewer components, resulting in a significant reduction in administration efforts and failure points.

Integration is the key to cutting costs. SPPA-T3000 addresses this issue by providing a platform built solely on open standards and off-the-shelf components for both hardware and software. Platform independence and openness guarantee easy integration with your business applications. This ensures the infrastructure that suits your business needs best. Information is provided from the lowest field device level straight to the control room, office or the corporate enterprise level. No interfaces are required, either through different gateways or via software adaptation. Moreover, SPPA-T3000 ensures consistent operation and engineering for basic automation and optimization by integrating the Process Optimization modules SPPA-P3000.

SPPA-T3000 offers one single user interface for engineering, configuration, commissioning, operation, diagnostics and service. Each object has all necessary information and interfaces embedded within. No proprietary software is necessary: a standard browser is the only thing required to view the status of the entire plant and to perform all automation activities. Windows-style drop-down menus, pop-up windows, multi-windowing, easy search functions, point information and many other features make the activities of operators and engineers intuitive and easy. Unrestricted concurrent workflow, even on a single object level, offers flexibility for any task.

SPPA-T3000 allows tailor-made solutions. This not only addresses your functional requirements, but also your personal preferences for different views and look-and-feel settings.

The simplicity of the system architecture allows for plug & play installation of software and hardware components. For example, additional operator stations can be easily connected without the need for any further software installation. The software component modularity reduces your maintenance and administration efforts.
1.1.1.3 Security

Security

Open solutions – but safe

New technologies providing more open communications and platforms are shifting more and more the pure reliability and availability requirement toward a focus on security and protecting power control assets, thus being exposed to both attacks from inside as well from outside.

Hardware protection, authorization, authentication and administration are the keys to managing the potential risks inherent in enabling services for remote access and operations, and for assuring business continuity in the event of any disturbance. SPPA-T3000 supports various protection measures and solutions to ensure secure and reliable plant operation.

In the context of protecting processes, information and assets, the following general security concepts addresses effectively:

- Strong firewall configuration for Thin Client communication (TCP 443)
- Encrypted communication (VPN) between office-Thin Client and Application Server
- Control room Thin Client protection by locking special keys, USB ports, CD/DVD drive, etc.
- Scalable access rights managed by user name, user groups and password
- Enabling OPC communication through secure firewall port using OPC tunneling SW
- Remote access for service via terminal server

This concept provides a reduced number of firewall ports for securing ports. Data security is increased and reliable protection of power plant controls provides secure remote access.
1.1.2 System Architecture

1.1.2.1 Introduction

System Architecture

Process control systems in power plants are also affected by new trends in the automation market. Changing requirements of customers and government rules are influencing the requirements of the power generation industry. These requirements can be met by either using new technologies or combining them with existing ones.

The classical hierarchical organization—with segregation into field level, process control level, unit control level and enterprise level—grows out of the functional organization of the business process of today. The future technology trend leads to another aspect: to divide the DCS into only two levels, the field level and the IT level. This simplification is accomplished through the introduction of internet technology into the enterprise, unit and process control levels on one side, and on the other side by the continually increasing intelligence of field devices. The IT level is characterized by the use of standard IT middleware, TCP/IP as communication medium, and the direct communication of all applications with each other. The field level only consists of intelligent sensors and actors. More and more information and functions will be located in the intelligent devices, e.g., basic equipment data, operative operation functions, short-term archive and service interfaces. SPPA-T3000 has already taken a lot of new trends into consideration in its architecture, such as the basic embedded Internet technology, the TCP/IP communication and the consequent component-based design. The benefits of these innovative architectures are:

- The use of standard IT technology offers new possibilities to develop I&C structures in conjunction with the information management of a company.
- The progress of DCS developments will be adapted to the speed of general IT developments.

1.1.2.2 Hardware Architecture

Hardware Architecture

SPPA-T3000 comprises:

User Interfaces: Thin Clients present all information regarding engineering, operation, and diagnostics. Thin Client enables any computer to access Web applications from any Web Browser over the Internet or a Corporate Intranet without having to install the application on every desktop system. The web-based origin of the Thin Clients used allow the use of various hardware like standard PCs, workstations, notebooks, and any other devices which can run a standard browser. In addition, existing IT infrastructure can be used as HMI.

Processing data and control algorithm are the main focus of the Power Services. But the Power Services provide additional services like archiving, configuring and engineering services, and alarming and diagnostics services. The hardware platform for all Power Services is the Application Server and Automation Servers that provide the highest availability.

The communication is provided via networks that link the different components together. The main communication is realized by a standard Ethernet network with TCP/IP. The communication to the Process Interfaces is established by PROFINET DP field bus. Other standards like MODBUS or Ethernet TCP/IP networks are available too. The field bus PROFINET DP is directly connected to the Runtime Container on the Automation Server.

The interface to the process provides signal conditioning and command output via I/O modules.

The fail safe system is integrated into the system and is based on Siemens Integrated Safety, using ET200M fail safe modules for I/O.
The architecture of SPPA-T3000 is characterized by:

- Providing an integrated system architecture from operate to automate.
- Using a single programming language (Java).
- Low system complexity.
- A modular software design.

### 1.1.2.3 Software Architecture

**Software Architecture**

In classical DCS it is common to use different tools, software or sub-systems that are optimized for a single, specific task, which are brought together by, more or less, complex middle-ware to synchronize the different tasks with each other. SPPA-T3000 uses the Embedded Component Services™ approach - called ECS. ECS means having all data for each process object located in a software object representation itself. All Views like Plant Display, Engineering, Alarms, etc. are supplied via the system services with current data.
The SPPA-T3000 software architecture consists of components which can be in principle distributed, due to the Java programming approach, freely on different hardware platforms. The typical SPPA-T3000 set-up is characterized by SPPA-T3000 User Interfaces, the Application and Technology Server, and the Automation Server. The Automation Logic is built by Automation Functions and Hardware Proxies (drivers for hardware components) engineered in the desired sequence and processing cycle and executed in case of real-time requirements in the SPPA-T3000 Automation Server which provides the real-time runtime environment to perform deterministic control tasks. Automation Logic can also be executed on the Application Server for non time critical operations such as performance calculation, operating hours monitoring etc. The Application Server provides the main system services of access controls, data distribution to the Thin Clients and the archiving. Also, it is the operating surrounding for OPC server and client components and provides the surrounding for permanent engineering data management. The Technology Server, if used together with SPPA-T3000, is the host of non DCS applications that are traditional not covered by I&C systems. In this case all necessary ECS components and services from the Application Server are used to empower the applications with the same look and feel. The Technology Server hosts the Technical Calculation Container which is the interface between the non DCS applications, such as Lifetime Calculations and the Plant Monitor, and other containers in SPPA-T3000. Any human interaction with the system is performed through Thin Clients as a Single User Interface.

Changes made in the automation and plant display set-up affect single central objects and be automatically inherited by all other components without having to duplicate the change in those other components.

Another important advantage is keeping the clients completely independent from all applications and control logic. Any re-definition of a strategy or even radical changes of automation logic will not influence the client software set-up. Thin Clients still accesses data via the Web-browser, receiving only the logic or calculation results provided by the single control objects. Thin Clients therefore could be standard PCs, without the need for locally stored system software.

A new dimension of flexibility is also provided by the modular software design, which allows for:

- Free adaptation of user requirements regarding control functions
- Customized system extension with respect to flexible selection of software packages and options
- Individual look & feel for plant displays, function diagrams and faceplates
- Integration of turbine controls and boiler protection according to SIL3

The main benefits of the SPPA-T3000 software architecture are:

- Total integration
  - Consistent views at any time
  - Only one data management location
  - Integrated I&C, plant display, alarm, diagnostic and engineering
  - No subsystems such as Engineering, Operation and Monitoring or Diagnostics System
  - No subsystem boundaries, but rather shared functionality
  - Integration of turbine control
  - Integration of fail-safe controls

- Platform independence
  - Protection of investment

- Openness
  - Easy integration of third-party products through applications hosting
  - Open XML interfaces inside and outside the system
  - Flexible integration of field devices
  - Flexible and easy updates and upgrades
  - Reduced administration efforts

In the automation world, the DCS has become a member of the enterprise software system. The SPPA-T3000 architecture is based on innovative Web technologies, and easily provides information in any format on a wide range of computing platforms, so that it can be integrated into your enterprise environment.
1.1.2.4 Interfaces

Interfaces

Coupling SIMATIC ancillary systems

In power plants, subsystems are often installed that perform a specific task autonomously, also known as black box systems. These include, for example, compressor units and soot extraction units and are mainly supplied by subcontractors complete with automation technology. If SIMATIC S7-300 or S7-400 systems are implemented as the automation technology, they can be coupled SPPA-T3000 via the networks. The connection to SIMATIC S7-300/400 is performed via PROFIBUS or via the Industrial Ethernet highway. Compared with the conventional technique of hard-wiring each signal separately, the advantages are as follows:

- Option of electrical isolation by using a fiber-optic bus system
- Reduced wiring costs
- Greater flexibility in the choice of signals, especially in the case of retrofitting
- Homogeneous integration of the ancillary system into the operator control and monitoring system of the overall plant.

Ancillary systems are always logically linked to an Automation Server that is located within SPPA-T3000. The data formats are converted in the Automation Server and data are exchanged between the components of the ancillary system and the SPPA-T3000 User Interface. The black box communication is based on S7 client/server.
communication with status, while the SPPA-T3000 serves as client, black box system as server. Generally, the communication lines are monitored.

To set-up of basic communication, the SPPA-T3000 Workbench is used. The engineering of data exchange is designed via communication Automation Function through SPPA-T3000 Embedded Component Services™. The engineering of communication blocks within the black box system is performed with the original engineering tools.

In the case of high demands on the availability of communications, single or redundant communication links through Industrial Ethernet are supported.

**Coupling third-party systems**

Process data from other automation and control systems can also be coupled via the Communication Module (CM104), different protocols are offered to perform the conversion of the standard formats into SPPA-T3000.

The Communication Module (CM104) enables external automation and control systems to be coupled to SPPA-T3000. The CM104 provides the MODBUS protocol interfaces and the IEC 60 870 telecontrol protocol for the coupling of external systems.

The CM104 converts data from third-party systems for SPPA-T3000 communication. For this purpose, the CM104 operates like an Automation Server on the Industrial Ethernet, runs a Runtime Container and transmits automation data to SPPA-T3000.

The following data can be exchanged with the third-party system via the interface:

- Binary values
- Analog values

**Connect/IEC: Connection via IEC 60870-5-101/104 (TCP/IP)**

IEC 60870-5-101 is an communication standard for telecontrol. The protocol is used as a general transmission protocol between SPPA-T3000 and electrical substations. Information is transmitted via serial connections (-101) or Ethernet (-104).

**Coupling TELEPERM ME: Connect/TME**

Connect/TME allows signal exchange with the TELEPERM ME process control system via direct CS275 communication.

The CS275 bus connects the individual components of the TELEPERM ME process control system. The SPPA-T3000 system provides an interface to the CS275 bus to facilitate signal exchange between TELEPERM ME and SPPA-T3000. The TELEPERM M/ME process control system contains blocks that permit cyclic or acyclic data transfer to other devices on the bus. The bus communication blocks BKS, BKE, AKS, AKE, MKS and MKE are used for transmitting data from one automation system to another or to SPPA-T3000 Automation Functions. Connect/TME provides the necessary protocol conversion in SPPA-T3000 and is installed on CM104.

This interface introduces cost efficient signal exchange between TELEPERM ME Automation Systems and SPPA-T3000.

### 1.1.2.5 Time Tagging

**Time Tagging**

**Principle**

Information for all Views is generated in the Automation Servers using the TTD mechanism (time tagged data). Information can be grouped into the following categories

- Information about signal changes
- Information about I&C faults (I&C alarms).

When a TTD is generated, the time of the change or fault is appended to the information. In the case of signals, time tagging always takes place on status change, i.e. in the case of

- Binary signals: on changing from 0 to 1 or vice-versa
- Analog signals: on overshooting an adjustable tolerance band (e.g. 0.5%).
A binary signal can, for example, be a value read in from a binary transmitter or a limit derived from a process value. Analog signals are measured values from the process or calculated variables. The value can be scanned for departure from the tolerance band whenever a signal is generated (e.g. module cycle of the FUMs). The tolerance band can be adjusted for each signal separately allowing adaptation to the process engineering requirements with respect to accuracy and temporal response. The TTDs obtained in this manner are further processed or displayed in the different Views for operation and in the Diagnostics View. They are conditioned for the operating personnel in the form of logs, displayed messages, trend diagrams or I&C overview displays. This data can also be archived in Application Server complete with the time tags.

**Source of Time Tags**
It is possible to configure which signals are to be time-tagged in addition to the I&C alarms that are specified as standard in all components. There are different possible sources for time tagging:

- **FUM modules**
  The time tag is assigned by the module software on signal acquisition or processing. Signals are time-tagged according to the FUM layout. The resolution of the time tag is 1 ms. The accuracy of binary, time-tagged signals is 6 ms system-wide when the FUM 210 BTI is implemented (i.e. also between two FUM modules that are assigned to different Automation Servers). Time-tagged fault events are generated by the monitoring functions on the module (e.g. channel faults).

- **SIM modules, failsafe SIM modules**
  The time tag for signals of the SIM modules is assigned on acquisition in the Automation Server. The cycle for acquisition or output of the signals in the Automation Server can be configured (typically 50/100/200 ms or base cycle, 2 x base cycle, 4 x base cycle, 8 x base cycle). The time accuracy is in accordance with the acquisition cycle configured. For special applications, it is also possible for binary signals to be acquired and time-tagged in the module when using AddFEM SOE.

- **Black box systems**
  The systems that are linked to the Automation Server, i.e. SIMATIC S7 black box systems, do not generate any events. These are generated from the Automation Server system software. The accuracy depends on the cycle time of the Black Box communications blocks.

**Principle of processing**
Always, the processing of signals follows the principle of input – processing – output.

This ensures a time chronological sequence in the Alarm Sequence Display. For example a hardware input signals receives the time tag when entering the DCS (by the Hardware Proxy), after logic processing before outputting to the process the second time tag is set. This command may be a “protection OFF”. Due to the cyclic processing it is ensured that the output signal “protection OFF” has an later time tag than the causing input signal.
The Alarm Sequence Display shows the chronological order of these signals.

**Time-of-day synchronization**

The Automation Server and the lower-level components require the current system time for the purpose of assigning the time tag. A time-of-day Server is the reference that ensures that all components have a synchronized time. It is connected to the Industrial Ethernet (Automation Highway) and ensures that the communication processors are synchronized. In SPPA-T3000 there is the NTP mechanism used with a request-response method. The client sends a time request packet to the time-of-day Server, that is answered by a time response packet.

The internal clock of the communication processors synchronize the associated Automation Server that, in turn, synchronize lower-level components such as modules. The AddFEM SOE is directly synchronized by a time synchronization signal from the time-of-day Server via fiber optic cable. There are three methods for synchronizing the time-of-day transmitter:

- GPS radio signal
- External clock (plant clock)
- Manual adjustment via a local operating panel and incrementing via the internal quartz clock.

The resolution of the time-of-day Server and all lower-level system times is 1 ms. This results in a time tag resolution of 1 ms.

The accuracy of the time adjustment inside the Automation Server and the Application Server is \( \leq 10 \text{ msec} \).
1.1.3 Function & Tasks

1.1.3.1 Introduction

Introduction
SPPA-T3000 is a modern Distributed Control System that provides the consummate functionality of a power plant control system. Flexibility and excellent system functionality, the architecture of Embedded Component Services™ ECS, off-the-shelf-components (COTS), standardized communication -- all guarantee that the demands made of a power plant control system are satisfied in full by SPPA-T3000:

- Simple and reliable process control
- Single-user interface for all functions like operation, engineering, diagnostics, maintenance, service, etc.
- Powerful, fast and uniform system-wide engineering
- Providing extensive library for all common controls and operation functions in power plants
- System openness at all levels
- Scalability in terms of system size and add-on functionality
- Direct and secure connection to the IT world.

SPPA-T3000 provides different system services to achieve power plant DCS functionality. All functions are provided in a modular and independent manner. Individual constellations are designed to have the best application solution. A single-user interface called Workbench provides the central interaction point that allows the operator and engineer to access all information, operate the plant, and perform required configuration and engineering tasks. Different views are offered by pure definition of user roles: sub-systems for engineering, automation and controls no longer exist. All views are displayed in windows, and several windows can be placed on the workbench:

The functions and views provided for different tasks like operation, engineering, service, etc., can be tailored individually, but all interactions are handled via the same single User Interface. The benefits are:

- All information at your fingertips
- No need to switch between different user stations or independent operating applications
- Easy navigation between different views
- Customizable according to user's requirements, including individual look & feel
- Use of your day-to-day applications concurrently with SPPA-T3000 on the same PC
The following chapter describes the functions of SPPA-T3000 in more detail:

- Controls
- Operation
- Engineering
- Diagnostics
- Communication

1.1.3.2 Controls

Description

Modern power plant management and efficient production management require automation methods to satisfy extreme demands. The basic functions - signal acquisition, processing and command output- are the bases for implementing higher-level unit control from start-up and shutdown programs, through to fully automatic operation of the processes in a power station.

The concept of the SPPA-T3000 control solution is fully software-based and independent from specific types of hardware. Availability and performance requirements define the type of hardware for SPPA-T3000. Scalability of the hardware and software components enables the construction of a flexible and adaptable structure to the requirements of the process and of the related conditions, with the following key features:

- Plug & Play
- Scalable HW/SW architecture
- Expandable HW/SW components during plant operation
- Online changeable
- Customizable functionality
- Integrated turbine fast-response controller and fail-safe controls according SIL3
- Homogenous structure for all types of power plant applications

Highlights:

- All functions for flexible control levels are available (from manual to 100% automatic mode)
- Object-based architecture on PC HW which means prepared for advanced tuning tools
- Easy maintenance due to central updates, without software at sub-systems

The scalability of SPPA-T3000, with scheduled project stages, minimizes the initial investment required by power stations.

The SPPA-T3000 services are distributed to the respective Power Servers. The number and type of the Servers required is largely dependent on the number of I/O signals.

The technological structure of the plant can be assigned to different Runtime Containers. Therefore, diverse requirements can be taken into consideration, such as:

- Stand-alone / autonomous system (e.g., water treatment)
- Central systems (e.g., unit control)
- Multi-train operation (Gas Turbine 1, Gas Turbine 2…) as well as multi-unit operation (unit 1, unit 2…)
- Higher/lower requirements of process speed (equipment protection/temperature measurement), etc.

Each Runtime Container, which represents the software run-time environment for the controls functions, can be operated autonomously, i.e. They are capable of independent Start and Stop and independent cycle times.
Control functions
With the available functions, an open-loop control for auxiliary equipment is as easily definable as a complex unit control. Plant-specific alarm philosophies, complex start-up and shutdown programs and process management tasks are solved according to uniform principles.
Essentially, the following basic components are employed:

- Hardware proxies manage the access to the process, perform signal acquisition and command outputs via respective input/output modules, and can therefore be considered as dedicated software drivers for corresponding hardware.
- Open-loop control tasks and closed-loop control tasks are defined by interconnecting automation functions
- Management Proxies monitor and control internal system processes
- Operation and diagnostic information are consistently presented to the Operator
- All signal changes and operation actions can be archived

Integrated failsafe functions
The highest requirements are demanded from the realization of failsafe controls which require official approvals like boiler protection and burner management systems (BMS). These are fulfilled by SPPA-T3000 by integration of SIMATIC SAFETY products. They are certified and fulfill requirements up to SIL 3 (Safety Integrity Level).

A hazardous situation is recognized by acquiring the plant status and corresponding logic. Thus, unacceptable operations can be avoided or countermeasures can be activated.

Continuous automatic checks ensure the efficiency of the protection system. The system reacts immediately and safety related when a system fault is recognized by the automatic fault detection. The failsafe controls run in a safe status or remain in a safe status.

The communication between Automation Server and failsafe I/O modules is performed via PROFIBUS DP using PROFIsafe profiles, which is an approved profile according to IEC/EN61508.

The failsafe system is integrated into the system and is based on Siemens Integrated Safety, using ET200M failsafe modules for I/O. The program is running in the Automation Server in a special password protected environment. The software blocks are TÜV approved. As an indication, that the program is failsafe, special colored software blocks are used.

The signals are time tagged in the Automation Server, with the cycle resolution. It is possible to combine fail safe and non-failsafe modules (ET200M) in the same Automation Server.

Signals are marshalled between the fail safe and the non fail safe environment in the function plans.

Operation and monitoring, engineering and DCS diagnostic functions behave in the same manner as all other ECS™ types in the system.
Automation functions

Automation Function Principle

The automation functions are divided into:

- Analogue arithmetic functions
- Binary arithmetic functions
- Signal monitoring and selection
- Closed-loop control functions
- Open-loop control functions
- Process functions and are specifically configured and optimized as solutions to the respective application case within the process-related processes (Lifecycle calculation, etc.).

For the complete set of Automation Functions, please refer to Library.

At any time, the function Compound Component allows SPPA-T3000 users to autonomously define automation functions and to offer them in the AF library to all users. No knowledge about a programming language is necessary since the new automation tasks are defined with the same graphical editor which is used for the plant engineering.
Hardware Proxy
The communication to real field devices or sub-layered systems is realized by Hardware Proxies.
Hardware Proxies are available for interfacing of:

- PROFIBUS DP devices

For the complete set of Hardware Proxies, please refer to Library.

Management Proxy
Management Proxies coordinate all software components and services of the SPPA-T3000 System.
Proxies are available for:

- SPPA-T3000 Services
- Operating System
- Server Modules
- Network communication
- Field device communication

For the complete set of Management Proxies, please refer to Library.

**Runtime Container**

The Runtime Container is responsible for the deterministic execution of Automation Functions, the Hardware Proxies and the connections between them. Based on the homogenous component architecture, the Runtime Container provides the same interfaces and features of an automation function module.
Plant extension

Power Servers, User Interfaces and the components of Network are extendable at any time and in running operation. Therefore it is no problem for SPPA-T3000 to install a complex system piecemeal over a long period of time without any concern about endangering the running operation.

1.1.3.3 Operation

Description

The SPPA-T3000 operator interface is a new cutting-edge solution for user-centric process control. With sophisticated alarm features and diagnostic information, it is much more than just a "window on the process". Real-time data, visualized through high-resolution process graphics like Plant Displays, Alarm Sequence Displays and other views such as Dynamic Function Diagrams or Diagnostics Views, simplify the review and analysis of live and historical process data. Searching for information is efficiently supported by the Point View feature providing comprehensive point information. User guidance and direct navigation (live links) put all information at your fingertips.
Single source of data - multiple views
Individual configurability of operator workplaces ensures both optimal configuration of the control room and of personalized workplaces:

- Flexibility in the number and configuration of monitors
- Access to all plant data from one workplace, restricted only by access rights
- Customizable menu bars, windows layout, and content
- User-specific start view, window configuration, favorites, filters, and the possibility to store user settings and screen configurations to be used as default settings after logging in
- Customizable views for all types of data, such as process values, diagnostics, archived values, and alarms
- User roles and authorization levels that can be freely defined by customers

The SPPA-T3000 Workbench user environment provides a homogenous user interface for configuration, operation, and diagnostics. Windowing techniques are used for viewing detail screens and for control and operation of control devices. Operators can view different plant aspects simultaneously, and zoom to a particular window when more detail is required. Everything is under control through:

- Fast recognition of specific plant conditions and malfunctions
- Fast and easy access to all required information, including diagnostics and hardware from all operator stations via live links
- User guidance via context-sensitive links and alarm indicators for easy navigation between different views
- Safe and secure operation
- Intuitive graphics configuration, easily modifiable to match changing plant configurations
- Sophisticated alarm management with user-specific configurable alarm displays
- Real-time and historical trending
- Freely configurable layout of reports
- Context-sensitive help functions make searching in user manuals obsolete. Press the help key at any time to navigate directly to the relevant help. Once in the help system, the standard facilities can be accessed, including search, hyperlinks, and the help navigation tree.
- Support of multiple languages, character sets, and cultural conventions

The main elements of Operation with SPPA-T3000 are:

**Plant Displays and Faceplates**
Plant displays and faceplates allow the operator to monitor and manipulate process control variables, as well as perform tasks such as operating devices, tuning loops, responding to alarms or changing set points.

**Alarms**
Alarms are used to inform the operator about deviations from the regular or planned operation in the power plant (process alarms) or about malfunctions in the I&C System (I&C alarms). Alarms can be displayed in the Alarm Sequence Display, in plant displays, or can be reported in logs.

**Alarms via E-mail**
To reduce service and maintenance efforts, SPPA-T3000 enables the application to generate e-mails based on alarms in the system. These e-mails contain the details of the alarms raised as well as diagnostic information and sender details. E-mail recipients (as pre-configured) are notified of the alarms and provided complete alarm details.

**Point View**
The point view allows the operator to display and modify the complete data set of a point, including live values and alarm states. The operator is able, through a single mouse click, to call up all information about a point from any station.

**Find Tags**
Find Tags allows the user to review point-related information. Points with common characteristics, status conditions or qualities can be generated in a list.
Dynamic Function Diagrams
Dynamic Function Diagrams contain live data indicating current signal values, such as equipment or release states. Navigation from a Faceplate to the corresponding Function Diagram is possible with a single mouse click.

Trend Displays
Trend displays are used to display archived or live values of process data in the form of a line chart.

Reports
The report system is used to extract any historical information that a user requires from the system archive. Reports can be triggered either manually or event-driven. Many different reports are available, e.g.:

- Status Reports
- Sequence Reports
- Trip Reports

Improved Balance Reports
The following Automation Function types are used for implementing improved balance reports:

- Checking analog values for steady-state conditions
- Balancing (integration), average, minimum and maximum of analog values over a period of time
- Moving average/minimum/maximum of analog values

Archive
All events and operator actions of the entire plant are efficiently stored in the Archive System. All data is stored in a central real-time database in chronological order, including a timestamp, a value and a quality status.

Multi Unit Operation
Within the concept Multi Unit Operation it is possible to monitor several units and combined systems from one control room with a minimum of personnel. Each unit is a self-contained unit, which stand-alone operation as well as interconnected operation must always be ensured. A superiority, fictitious unit can be defined but is not imperative. For reasons of independent operation it is recommended to establish a fictitious superiority unit.

View related Alarm Sequence Display (ASD)
An ASD window according to process related selections can be opened. The alarm signals are chosen by the system automatically, depending on operating view: Plant Display, Function Diagram, Faceplate for direct and quick access to relevant alarms.

Notebook Function
The notebook allows to create, read, add and remove notes connected to related I&C components or signals to improve the information exchange and communication way for the operator.
Interface to technological documentation
Interface to user created HTML based manuals like the technological documentation, which is out of scope of SPPA-T3000, allows for quick and easy access to process related information from any Automation Function or signal. An example for technological documentation is the Plant Manual.

Temporarily permission overriding
To log-over and to get more permissions without leaving the Workbench, users just override with temporarily permission results in fast operation of permission blocked functions without leaving the Workbench.

Import and link of tag specific information like wiring diagram or URL
All additional tag specific documents can be reached by Point View, Diagnostics View or Plant Display for fast access to additional documentation. These additional documents can comprise wiring diagram, hardware diagram etc. which are linked as external pdf files to an Automation Function. This ensures quick fault elimination by fast access to wiring diagram or documentation. This documents can be imported or linked (via URL) and automatically assigned to tags.

1.1.3.4 Engineering

Description
New dimensions of flexible and graphical interfaces for the engineering steps are provided by the modular software architecture of SPPA-T3000. This saves time due to:

- Integrated operation and control engineering with a single-user interface
- Single-user interface for all engineering tasks
- Guaranteed data consistency (no generating and loading of the user software)
- No mapping of sub-systems, code generation and down-loads
- Direct online changes, available immediately
- Choice of symbology, look & feel and user-specific desktops
- Simple drag & drop via different Views at a working place/work station (Multi-Window)
- Easy navigation between multiple Views
- Open standards - ready for the future
- Version control - change management
The Engineering Views form the basis for each SPPA-T3000 system. Its intuitive, user-friendly graphical interface allows for immediate and cost-effective conversions from conceptual design to detailed I&C implementation.

Further key features are:

- Horizontal Integration (product lifecycle)
- Integrated Engineering through close linkage between operation and automation
- Simultaneous work by several users independent of the location and with remote access

Central features of the engineering view are:

- Project View (Administration, Import/Export)
- Diagram Editor (Function Diagram, Plant Display, Search/Navigation)
- Online reconfiguration
- Spreadsheet engineering
- Change control

**Horizontal Integration**

SPPA-T3000 always provides the same user interface and functions, from the quotation phase through operation and maintenance of the system. Information is recorded only once and then consistently used in the subsequent project phases.
Integrated Engineering through close linkage between operation and automation

The process engineering is a priority for the plant designer and plant operator. The plant is technologically structured with the project view and is displayed in a similar way to that of Windows Explorer.

Within this hierarchy the plant identification system is freely definable. Any type of identifications (hierarchical, e.g., acc. IEC61346 or tag oriented systems) and mixture is possible. The hierarchy levels are not limited. Definitions are transferred from the lower levels to the individual objects. This technological structure generates the plant display hierarchy for rapid navigation between operating pictures.

Traditionally, coordination processes between HMI and the automation functions have essentially shaped the workflow. With SPPA-T3000, this is no longer mandatory. The focus is Integration, a function that only SPPA-T3000 makes consistently available. Starting with the P&I diagram, the HMI views of the technological functions are arranged in the plant displays. Next to the HMI view, the automation view is implicitly assigned to the function diagram. The time-consuming and sometimes incorrect assignment of individual signals between control configuration and process display is a thing of the past.

The process of “integrated engineering” can also be started from the function diagram. Different forms of operation views can be assigned to the technological object. The operation function can also be carried out from all views (plant display, function diagram, etc.).
The principle of "integrated engineering" not only makes the views of the technological functions available, but also generates the views for the components of the I&C system (Industrial Ethernet network, Power Server, Field bus and I/O-Modules).

**Simultaneous work by several users independent of the location**
Different users can process SPPA-T3000 projects simultaneously. These users can access the data simultaneously from different locations via the built-in web capability. A Transaction Mechanism ensures data consistency without obstructing the user.

**Project View**

**Lowest administration expenditure**:
Based on the Windows Style Guide, all views are presented to the user with a uniform look. A consistent concept for symbols, colors and operating mechanisms ensures a higher level of recognition. Therefore, the system is easy to learn and to use; the learning curve is reduced to a minimum.

The technique of multiple windows allows simultaneous work with different views at one work place. Styles, colors and functions can be set by project or can be user-specific. With that, customer-specific standards can be simply adapted to the system.

**User roles and access rights**
In a plant there are different tasks to be executed. These tasks can be assigned to different user profiles or roles. In general, they are assigned to the following roles: Operator, Senior shift engineer, Designer, Supervisor, I&C Service, Administrator, Management, etc. Functions can be assigned to each role, such as create/delete object, acknowledge alarm, simulate signal, etc. The availability of the different functions is controlled with licenses and access rights. The number and designation of the roles can be freely defined for the project to enable a more flexible and fully displayable depiction of customer-specific processes and workflows.

Each user can be assigned different roles, depending on the plant's technological or organizational structure. The user's authorization is secured throughout the system with a password.

**Import/Export**
The IO tool serves as an efficient tool for I&C engineering of sensors and actors. Data of measurements and drives coming from the process engineering (e.g. from R&I tool applications) have an elementary importance to the task description for the automation. The IO tool allows for flexible import of measurement and drive data and provides these data in an overview as measurement and drive lists in table format for further processing. These lists can be modified centrally which affects directly the Function Diagrams as well the hardware engineering.
From that, a new acquisition of the basic data is no longer necessary. The customer is, at this early phase, introduced to the system and can immediately influence the final configuration.

Prefabricated solutions are adopted from standard projects or realized plants. The plant ID codes can be changed easily and consistently by presetting the copying rules. These rules also apply when copying within a project (e.g., copying of homogenous parts of an I&C system).

The Hardware proxies (representative of the I/O module) and their functional assignment are automatically imported into Function Diagrams. The connections to respective automation objects are established automatically. The Ports of Hardware Proxies may be easily connected to as many Function Diagrams as required. The connection to the respective automation object is established automatically.

Data can be imported and exported to the system with XML-based interfaces. A preview function shows the effects of the intended data import, thereby enhancing quality assurance.

**VGB documentation**

VGB, a European technical association for power and heat generation, has developed guidelines for I&C documentation for power plants. SPPA-T3000 offers features to the user to meet the following VGB documentation guidelines VGB R170-C:

- **Documentation hierarchy:** The documentation is hierarchically structured to allow fast and efficient familiarization with complex and complicated functions. Starting with an overview, functions are described increasing in detail on each sublevel. Macros are used to create the hierarchical structure.

- **Individual Level Function Diagram:** Documenting control logic on Individual Level Diagrams is a VGB requirement. Individual level Function Diagrams can be generated from engineered Area Level Diagrams. The generated diagrams are printable and are navigable. This engineering process allows the engineer to create Area Level Function Diagrams for easier process understanding and readability, while maintaining VGB documentation conformance.
• Documentation Classification Code: Function Diagrams can be assigned a documentation classification code (DCC) that will appear in the title block of the printed drawings. The document identification code is according to IEC61355.

• Diagram Layout: The layout of incoming and outgoing signals in the generated individual level diagrams conforms with VGB guidelines.

Diagram Editor

Function diagram
The function diagram serves as a detailed description of the I&C solution through graphical interconnection of function blocks. To establish a technological reference and therefore increase the understanding of the functionality, essential parts of the I&C components can also be displayed.

Dynamic and non-dynamic elements can be placed via drag and drop from the libraries.

Apart from the previously described function of "integrated engineering", manual assignments of individual signals with dynamic elements are possible. It is possible to select between displaying IEC or other symbologies in the graphical representation.

The interconnection between the function blocks is carried out by clicking on the module ports. The ports to be connected do not need to be placed on the same function diagram.

The processing sequence of the individual function blocks is a result of the network of connections within a Runtime Container.

To increase the overview, function blocks and their interconnections can be grouped into Macros and, as a result, can form a technological hierarchy over several levels. These Macros can be stored in the library and subsequently used in other plant parts (standardization).

Plant display
The plant display primarily serves the purpose of monitoring the status of a plant or sub-function and controlling the process. This generally happens by enhancing the essential plant components (container, pumps, valves, pipe lines) with higher-level I&C functions (open-loop control, closed-loop control).

Dynamic and non-dynamic elements can be placed from the libraries into the plant display via drag and drop. For a professional display, graphic designs using standard functions (line, rectangle, circle, stretch, compress, color, shadow, pattern, etc.) are available.

In addition to the already described function, Integrated Engineering, it is possible to manually assign dynamic elements to individual signals.

Search/Navigation
Powerful search functions are available to help you sort out every work situation.

Each signal flow can be followed quickly and easily with the aid of the navigation function. The system will lead you
quickly from the source to your target and vice versa, independent of the respective view (plant display, function diagram, faceplate, etc.).

Time-consuming searches through piles of paper using outdated planning notes and page numbers are eliminated.

**Online reconfiguration**
The unique architecture of SPPA-T3000 consistently and immediately provides the Runtime Container with each modification of automation objects (e.g., new, modify, delete). Once initiated, the modification is activated in the Runtime Container and is made available for the process.

The respective status of the object is represented by different color codes on the diagrams.

Hence, the typical separate generation and loading of the respective user software in previous systems is eliminated. Besides the time advantage, no more inconsistencies exist between the engineering status and the process system. Elaborate efforts to determine differences are no longer necessary.

With the Activate/Deactivate function it is possible to test modified configuration in both redundant and non-redundant designs and, if necessary, to quickly switch back to the status prior to modification. The sometimes challenging handling of the redundancy, switching and separate loading of the processors is eliminated. This is major advantage for maintenance and service of the system.

**Spreadsheet Engineering**
A list interface is provided for processing large amounts of homogenous data. The data to be displayed can be freely defined from the selected object types. Simple selection, sorting and handling instructions are executed via this integrated interface. For complex operations using large amounts of data, the selected data scope can be exported and processed by conventional methods (e.g., MS Excel) and then re-imported to SPPA-T3000.
1.1.3.5 Diagnostics

Description
The diagnostic functions are enabled via the diagnostic view, which is the portal to efficient maintenance, service and asset management of the plant. All SPPA-T3000 components have the built-in capability of conducting self-diagnostics and of displaying clear messages for the entire system. No additional tools, equipment or applications are necessary. The following points lead to considerable savings in I&C maintenance:

• All information at your fingertips
• Easy navigation between multiple views
• Consistent look and feel throughout the system
• No proprietary equipment or additional diagnostic devices

All information at your fingertips
System monitoring and diagnostics are an integral part of SPPA-T3000. They are available instantly and without any additional configuration or equipment because of the embedded component concept. The system monitoring creates messages that provide the plant staff with clear information about the error status of a process control component. Process control components include sensors, transmitters, all DCS components (server, control processor, I/O card, etc.)

The goal is to provide the operator, service personnel and I&C system engineer with important system information that leads them directly to the cause of the failure as quickly as possible.

Easy navigation between multiple views
The system monitoring is based on the DCS self-diagnostic capabilities. All DCS-components that are necessary for plant operation provide diagnostic information. A unique Quality Code is applied to each system component.

The following two-step application model is used for the diagnostics within SPPA-T3000:

1. I&C messages alert the operator to the details about the malfunction. All incoming messages are displayed and archived. The operator is led to the standard message view on top of the workbench and informed about the effects of the error on the process. The configured reactions are automatically initiated.

2. From the ASD the operator can quickly navigate to the diagnostic view, which contains further details about the reason and location of the error, as an example the rack and slot of an affected module. The diagnostic view provides additional details of the error messages that have occurred.
Consistent look and feel throughout the system
All diagnostic information can be accessed from the operation view. The information displayed can be determined by user groups and assigned rights. This flexibility provides:

- Easy learning for all staff
- Efficient troubleshooting
- Fast error detection

Different views of diagnostic information are possible, depending on the special needs of plant personnel (operator, system engineer, technician, etc).

The diagnostic functions enable the user to check and analyze the current system state in detail.

No proprietary equipment or additional diagnostic devices
System monitoring is an integrated function that includes all hardware and software components. It is executed permanently in the background, parallel to the application functions. For this reason, an explicit configuration of this monitoring functionality by the user is not required.

These I&C messages are handled in the same manner as process messages.

The system supports the configuration of desired process reactions to process control errors (for example, approaching a safe state).

The two main views of the DCS diagnostics are:

- Fault Tracking
- Diagnostic View

Fault Tracking:

- Automatic detection and reporting of DCS faults for “fault tracking”
- Processing of the detected faults with compressed representation in a diagnostic tree
- User guidance to the origin (location) of the fault by hierarchy and / or by selection of an I&C alarm
- Information of service personal or the Siemens Remote Expert Center via email when occurring an alarm or via active operation
Diagnostic View:

Status information:

- Display of the detected components in graphical and textual representation with:
  - Detailed information
  - Display of the state of redundant components
  - Direct access (selection/diagnostic) to redundant components
  - Context-sensitive online help and online documentation of the selected components

- Comprehensive status information by using the hierarchical project structure and the detailed diagnostic view of each component

Graphical presentation of used devices:

- Channel-specific information (e.g., channel simulation, wire break, tag out, etc.)
- Quality code for each signal
- Hardware manufacturer and part numbers
- Releases of hard- and software
- Online documentation of components is available at your fingertips
- Usage of system resources is shown in a graphical manner
Status report:

- A list of components may be displayed. The criterion for the selection is, for example, the order number and the location of components with a special software release.
- An overview of system states is provided, e.g., simulated signals or tagged-out devices.
- Additionally, all functions provided by reports from the archive are available.

Getting active diagnostic data

To access the diagnostic view, simply right click the mouse on the following objects:

- The alarm line of the Alarm Sequence Display (ASD)
- The pictogram or faceplate
- The block representation inside the function diagram
- An element in the diagnostic tree
- The access to the diagnostic view is independent of the state of the selected object.

SPPA-T3000 self-diagnostic features and intuitive representation enable plant personnel to quickly determine where a system problem has occurred. As a result, fault detection and maintenance effort are reduced to a minimum. Based on the web-capability of SPPA-T3000, direct support from Siemens service personnel will be available upon request worldwide and 24 hours a day, 365 days a year!
1.1.3.6 Communication

Description
The emphasis of plant automation is shifting from simply controlling the plant process to streamlining it. By utilizing networks and databases, managers have easy access to historical or statistical data, allowing them to carry out detailed analyses, resulting in more informed decisions based upon commercial considerations for their fleet. Consequently, communication and the ability to provide all information, accurately, whenever and wherever it is needed, is the key to the power plant operation.

SPPA-T3000 provides the means of communication, and is based on proven worldwide standards.

Standard Ethernet networks are used to distribute system data and plant information between system components. The communication to the field level is realized by PROFIBUS DP. This offers reliable data transfer between and within all levels and components.

**Ethernet Network**
The Ethernet Network uses high performance area and cell network Fast Ethernet LAN technology for communication. All the advantages of a local area network are provided, such as:

- High-speed data transmission
- High availability using optical rings
- Shared printers
- Shared data from the server
- Shared software applications
- Stability under high use
- Full connectivity to all devices
- Ease of maintenance
Ethernet is the most popular physical layer LAN technology in use today. Its popularity is well-founded because of its ability to strike the right balance between speed, cost and ease of installation. These benefits, combined with wide acceptance in the computer marketplace and the ability to support virtually all popular network protocols, make Ethernet an ideal networking technology in SPPA-T3000.

**Integrated and Open Platform for Enterprise Resource Management**

The SPPA-T3000 connection architecture is comprised of a standard **OPC interface** for connecting the SPPA-T3000 platform to enterprise information systems. These systems typically include enterprise resource planning, mainframe transaction processing and database systems, dispatching management systems, plant information management systems and enterprise IT systems. Now, and in the future, SPPA-T3000 is open to new technologies, new tools and new partners; and not only in the world of automation, but also beyond it in the communication network of the IT world.

**Field Bus PROFIBUS DP**

Field communication connects devices in the field (e.g., actuators or sensors) to the Power Servers (e.g., S7-CPUs). For this purpose, SPPA-T3000 uses both PROFIBUS DP and PROFIBUS (IEC 61158/EN 50170) - the international standard for the field level is the global market leader in the area of field bus applications, and offers high performance process or field communication with short response times.

Thanks to the openness of PROFIBUS DP, components from various manufacturers that comply with the standard can be easily integrated. The IEC 61158/EN 50170 standard is your guarantee of future security for your investment. More than 300 manufacturers worldwide offer a wide range of PROFIBUS DP products for the field level. Siemens offers both field devices and network components.

PROFIBUS is a serial byte communication bus which runs the electrical signal separately from the power supply. The diagnostics of the PROFIBUS is quite extensive and covers the alarms related to the device, module or channel. Also, non-cyclic communication for alarms and Read-/Write functions are provided to allow reading status messages and optimizing parameters of the field device online.

PROFIBUS provides the advantages of real networking on the field side with the ability to share control functions in field devices and centrally in the control system, and remote calibration, commissioning and maintenance, and a real device inter-operability.
1.1.4 Components

1.1.4.1 Components

Introduction
SPPA-T3000 is entirely based on open standards and maximizes the application of off-the-shelf components (COTS). This ensures the maximum product lifecycle of your investment, and applies to both the hardware and software components of SPPA-T3000.

The following software standards are used in SPPA-T3000:

<table>
<thead>
<tr>
<th>JAVA</th>
<th>SPPA-T3000 programming language</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCP/IP,</td>
<td>for system-wide communication</td>
</tr>
<tr>
<td>Ethernet</td>
<td></td>
</tr>
<tr>
<td>XML</td>
<td>as the system-wide common data format for filing of the configuration data and import and export interfaces</td>
</tr>
<tr>
<td>HTML</td>
<td>start page on the Web to call up the User Interface</td>
</tr>
<tr>
<td>Windows</td>
<td>operating system for Application Server and Thin Clients</td>
</tr>
<tr>
<td>PROFIBUS DP</td>
<td>for flexible, supplier-independent I/O connection</td>
</tr>
</tbody>
</table>
SPPA-T3000 consists of the following components:

- User Interfaces
- Power Servers
- Networks
- Process Interfaces
1.1.4.2 User Interfaces

Description
The User Interfaces are provided by a Web browser that is installed on a Thin Client. This Web browser provides the operation and monitoring within the SPPA-T3000 Views.

Nearly any Web-capable device can be used as User Interface. The power plant can be accessed from the control room, or via any safe connection. Only authorized users can retrieve current plant status, operating data or control the process.

This approach allows easy workplace configurations for process control applications like centralized control rooms for several units or unmanned control rooms or remote diagnostics.

![User Interface Image]

The Web browser is a software application used to locate and display web pages. SPPA-T3000 is released for one of the most popular web browsers (Microsoft Internet Explorer).

To provide the features required for engineering and operation of the power plant process and automation tasks, specific extensions (JAVA applets) are applied. They are automatically loaded once after the first login into SPPA-T3000 or if updated applets are available on the server. With SPPA-T3000 no engineered data is stored locally on Thin Clients.

1.1.4.3 Power Servers

Description
SPPA-T3000 Power Servers provide all DCS functions and services needed for power plant control. Two hardware platforms are used to run the system services:

- Automation Server with all automation functions
- Application Servers to provide central services like archiving, configuration, alarming, etc.

Automation Server
The Automation Server is a hardware platform which provides high-performance, deterministic automation functions and the connection to the I/O level. The number of Automation Servers depends on the system configuration and can be scaled depending on the complexity of automation tasks. These automation tasks are performed by Automation Function (AF) components controlled by a Runtime (RT) Container. The RT Container provides the runtime environment, the Hardware Proxies (hardware drivers) and their interconnection.

To conform to the requirements for complex automation tasks and to minimize the risk of system downtimes, the Automation Servers use fault-tolerant configurations. They are based on the 1-out-of-2 principle, and are capable of a bumpless switch to the backup system in the event of a fault. These systems use a completely redundant design to maximize availability. This means that all major components of the Automation Server such as CPU, power supply and
hardware for coupling the two CPUs are present in pairs. Other components which are also made available in pairs in the interest of availability depends on the particular automation task.

A possible hardware platform is based on standard SIMATIC S7-CPU from the product spectrum of the world market leader in process automation: SIMATIC. To meet process requirements the S7 types S7-400 are available.

Failsafe Automation Servers (F/FH) are used for turbine or boiler protection with fail-safe controls. They detect not only errors in the process, but also their own internal errors, and will automatically set the plant to a safe state if an error is detected.

The fail-safe Automation Servers (F/FH) are based on SIMATIC S7-CPU's which combine standard automation and safety engineering in a single system. They are certified by TÜV (German Technical Inspectorate) and comply with safety requirements class SIL 1 to SIL 3 according to IEC 61508, requirements class AK 1 to AK 6 according to DIN V 19250/DIN V VDE 0801, and category 2 to 4 according to EN 954-1.

Another Automation Server hardware platform is provided by the CM104 (single/redundant) that provides the real-time processing environment for the SPPA-P3000 process optimization functions and the hardware platform for all SPPA-T3000 connect products (such as Connect/IEC, Connect/Modbus, Connect/TME, etc.) for connectivity to third-party systems. Based on standard PC components it provides most of the interfaces expected in a standard PC, and adds interfaces as well as changes the housing and expansion slot types to meet industrial needs. For applications requiring high availability, CM104 can be set up redundantly.

The SIMATIC FM458 is used to control the turbine functions integrated with SPPA-T3000. It provides high-speed closed-loop position control for combustion and steam turbines. The FM458 provides for extremely time-critical closed-loop controls.

Interfaces
Optional interfaces can be connected to the Automation Servers, e.g., for interconnection with MODBUS components based on the system architecture.

Application Server
The Application Server is available in two main characteristics,

- Application Server
- Technology Server

The Application Servers host common SPPA-T3000 applications, such as Web server, central Project Container and the archive. Applications can be accessed through the User Interfaces utilizing a standard Web browser. To provide the convenience of Windows-based application handling, the Application Server comes with a Microsoft Windows Server operating system.

The Application Server is available in a standard or a fault-tolerant design. Additionally, the Compact Application Server provides the functions of SPPA-T3000 Application Server together with a Thin Client in one hardware component.

The single Application Server (non-fault-tolerant) hardware design is based on high-performance servers for business-critical applications. Using a high-end product, including RAID functionality and hot-plug hard disks, ensures high availability.

The fault-tolerant hardware provides the highest level of availability. The fault-tolerant Application Server automatically manages its redundant components without interruption in data processing even if a component fails. For storage of archive data and system data backup a Swap Server can be configured to the Application Servers.
The Technology Server is an Application Server empowered by a runtime environment, for (diagnostic) applications, called the Technical Calculation Container (TCC). With a Technology Server it is possible to wrap existing applications and have them executed in the TCC. These applications appear as standard SPPA-T3000 Automation Function (AFI) functions, with the same engineering and overall usage.

The Technology Server is available with an identical hardware like the Application Server, but is mainly only used in single (non-fault-tolerant) variant. The Technology Server can operate in a SPPA-T3000 DSC system taking advantage of all standard SPPA-T3000 features and functions with the same overall look and feel.

The Technology Server can also operate as stand-alone installation without any part of SPPA-T3000 DCS system, e.g. in conjunction with other DSC Systems or data sources. Then, the Technology Server is equipped with all ECS components of a complete SPPA-T3000 system, except the automation functions of an Automation Server. Optionally, interfaces are offered by use of Automation Server CM104 as a gateway.
### 1.1.4.4 Networks

**Description**

Networks are used to distribute the system data and plant information within SPPA-T3000. SPPA-T3000 offers the following Networks:

- Ethernet network
- PROFIBUS DP

**Ethernet network**

The Ethernet network provides the basis for the communication between the installed system elements. From the Automation Servers, the data is transmitted via a high speed Ethernet network to the Application Server and then made available to any connected User Interfaces.

Network printers can be connected directly to the Ethernet network for printing any system information, including diagrams, engineering data or manuals. These printers can be accessed by any client or server in a SPPA-T3000 system (as is common in today’s office environment).

Additionally, SPPA-T3000 can be equipped with a gateway for communication in or out of the system. Secure access to the system is ensured by means of firewalls and up-to-date security measures.

As an option, Enterprise Resource Planning (ERP) systems can access control system information through a standard OPC interface to the Ethernet network. This results in the free flow of all information through the entire power generation business process.

Today’s networking technologies provide high speed data transmission based on standard protocols. The Ethernet network of SPPA-T3000 runs on Industrial Ethernet using the TCP/IP protocol for all process data exchange. The supported SIMATIC NET components with optical switch modules (OSM©) and fiber optic cables, or with electrical switch modules (ESM©) and industrial twisted pair, offer the following benefits:

- Practically unlimited communication capacity due to scalable switching technology
- A high degree of availability by fast redundancy switchover
- Network components for use in harsh industrial environments
- Network component monitoring with a highly efficient signaling concept
- Possibility to form sub-networks and network segments with full performance in each segment
- Local data traffic remains local due to Ethernet inherent address filtering by the switch
- Possibility to implement networks of up to 150 km in length
- Diagnosis of network components

To ensure continuous communication without any interruptions, rigorous redundancy strategies have been applied. The Industrial Ethernet bus system features mechanisms that prevent a communication system failure due to a single fault. By connecting the network, it remains functional even when one transmission route fails. If a network component fails, only the stations connected to that component are inaccessible. Redundant SPPA-T3000 components are connected to different switch modules within a ring configuration; this measure increases the availability even more.

PROFIBUS DP

PROFIBUS is an international standard and is applied to the field devices of many manufacturers supporting this standard (standardized to EN 50170 and IEC 61158).

PROFIBUS DP features:
- Standardized to EN 50170 and IEC 61158-3 Ed2.
- User-friendly, high data security, high availability
- Communication over two-wire cables and fiber-optic cables
- Bus access control: token passing with subordinate master-slave, equidistant DP bus cycle
- All protocol profiles can operate on a shared cable.
1.1.4.5 Process Interfaces

Description
A process interface is the hardware connection between the field and the process. All analog and binary process
variables from transmitters at the field level are acquired through a process interface. Commands performed by the
operator, or issued by the implemented automation functions, are also transmitted to the field level through the process
interface.

Distributed SIMATIC ET200M I/O systems are used for connecting field devices to SPPA-T3000, and are hooked up
using PROFIBUS-DP field bus. This results in high flexibility I/O design, either in central electronics rooms, remote
motor control centers (MCCs), or directly in the plant, with or without cabinets.

PROFIBUS-DP allows data exchange between the Automation Server and the distributed I/O - with low installation
requirements.

Standard I/O modules
SIMATIC signal modules (SM) are connected via the ET 200M I/O system.

ET200M provides the following features:
- Connection via PROFIBUS-DP
- Transmission rate up to 12 Mbit/s
- Optional redundancy
- Hot swapping of individual modules
- Modbus connectivity.

ET200M HART AI module
The SIM module 6ES7 331-7TF00-0AB0 with HART (Highway Addressable Remote Transducer) enables HART
devices to be connected. Engineers can directly access the field devices via a window using SIMATIC PDM (Process
Device Manager).

This is another module to help reduce commissioning and maintenance costs.

ET200M SOE DI module
The accuracy required for SOE can be achieved now with ET 200M in a specific configuration. This results in an
homogeneous I/O system consisting of less different components. An ET 200M with IM152-s High Feature with the
SIM digital input module 6ES7 321-7BH01-0AB0 can be set up to achieve an accuracy of 1ms per station and up to
4ms system wide.

Fail safe I/O modules
Fail safe I/O modules with integrated safety functions for use with the AS 417F/FH. This can be plugged into the
ET200M
Achievable safety classes in safety operation: SIL 2, SIL 3 to IEC 61508, AK 4, AK 6 to DIN V 19250, Category 3, 4 to EN 954-1

Use in standard mode with high diagnostics requirements

Also suitable for redundant operation

The special safety functions of the failsafe systems are coordinated with the failsafe I/O modules of the distributed ET 200M devices, which function to ensure plant safety should the CPU fail. The failsafe signal modules of these peripheral devices (digital inputs/outputs, analog input) are able to diagnose internal and external errors, have a redundant setup on account of safety demands, and meet requirements up to SIL 3 (IEC 61508) or AK 6 (VDE 0801). The input modules work in SIL 3/AK 6 with internal 2-out-of-2 channel evaluation. A safety response is triggered immediately if there are any differences. The digital output modules enable safe disconnection through a second disconnect path in the event of a faulty output.

Special I/O modules

The special I/O modules are based on AddFEM which offers the possibility of using partial functions of the automation in addition to the input and output functionality. These partial functions that are allocated to the AddFEM are designated as a Front-end Function.

High-speed recording of binary events is performed by the AddFEM SOE (Sequence Of Event), which performs event recording and time stamping with high accuracy. High-speed signal acquisition specially designed for turbine fast-response closed-loop controllers is performed by AddFEM Fast IO.

AddFEM PoCo provides the ”position controller” as a part of the turbine controls.

FUM I/O modules

FUM modules have been specially developed for power plant applications. Their functional scope has been optimized...
for the specific tasks in a power plant. Within the context of the higher I&C levels, the FUMs are equipped with pre-
processing units with medium to high processing performance.
The most important FUM tasks are:

- Signal acquisition, conditioning, processing, monitoring and signals and sensor power supply
- Individual open-loop and closed-loop controls
- Time tagging with 1 ms resolution for events (analog and binary)
- Monitoring functions with excellent fault differentiation for easy and precise diagnostics in the event of a fault.

The FUM modules are inserted into subracks that are mounted in electronics cabinets.

**FUM HART AI module**
This module is based on the existing FUM 230, 16 AI with added HART functionality. All transmitters that are certified for digital communication with the HART protocol can be connected through this module. Engineers can directly access the field devices via a window using SIMATIC PDM (Process Device Manager). The module helps reduce commissioning and maintenance costs.

**Connectivity of intelligent field devices**
SPPA-T3000 has been enhanced for connecting intelligent field devices, the single User Interface provides operation, engineering, DCS diagnostics for those devices in the same manner as for hardwired connected devices. Distributed configurations can be provided by PROFIBUS-DP that enable the operation of intelligent field devices directly connected to the Automation Servers.

Using the fieldbus technology has the following advantages:

- Reduces cables lengths, cable routes, modules, marshaling
- Reduces connection-oriented configuration data
- Reduces the occupied space.

Supported filed devices are:

- PROFIBUS DP slaves
- PROFIBUS PA slaves
- HART modules with complex functionality.

The integration of intelligent field devices reduces maintenance costs. It allows engineers to directly access the field devices via a window using SIMATIC PDM (Process Device Manager). Supported field devices are in detail:

- SIMOCODE DP 3FU50 for connecting motors using switches and contactors from 0.25 A to 820 A (motor contactor and control devices)
- SIMOCODE PRO 3FU70 for connecting motors using switches and contactors from 0.25 A to 820 A (motor contactor and control devices)
- SIPOS 5, DREHMO i-matic, AUMA-MATIC as adjustable speed and control actuators
- DP/PA Link for PROFIBUS-PA sensor and actuator technology
- SITRANS P DSI1
- DP AS-i link advanced for connecting binary actuators and sensors as well as load feeders for actuators less than 7.5 kW, pneumatic valves and magnetic valves.

**Generic Profibus Interface**
Any Profibus DP and PA device can be connected and engineered by means of GSD-files and configuration of the Generic Profibus Interface for cyclic data exchange.

**Black box interface via PROFIBUS**
The black box communication uses the S7 client/server communication. SPPA-T3000 works as client, the black box as server, whereas the server functionality is supported by the operating system. Single or redundant functionality is supported by the system.
In the event of redundant communication, the communication is alternating over both buses to the black box. If one of the busses is faulty, the communication runs over the other bus, whereas it will be tried to build up the redundant connection.

For the Engineering of communication blocks the black box engineering tools are available.

**Interface for flight recorder**

The flight data recorder is a device which is capable of making highly accurate data acquisition for digital and analog signals. Source is acquired e.g. from the governor controls or is directly hardwired from the field IO of a combustion turbine I&C. Data is time tagged on the flight data recorder.

SPPA-T3000 provides two Interfaces to connect flight recorders via PROFIBUS DP:

- PROFIBUS DP to Automation Server
- PROFIBUS DP to FM458.

**Interface for S7-300 Exciter**

SPPA-T3000 offers a direct Connection of S7-300 based exciters directly to Profibus as a cost efficient solution by homogenous integration for exciters with system conformity.

### 1.1.5 Solutions

#### 1.1.5.1 Introduction

**Introduction**

Today’s competitive business environment demands a new range of solution. A solution that not only meets the business needs of today, but also presents the logical path to meet the needs of tomorrow. SPPA-T3000 offers the necessary DCS platform to provide all necessary real-time data to supply optimization and management applications. A wide range of controls, processes, operations and business solutions are offered by Siemens as part of our integrated platform for your power plant.

Whether your enterprise objective is to generate new revenue streams, reduce operational costs, improve efficiency or flexibility, increase availability, or lower the plant emissions, or maybe all of the above … you can count on SPPA solution to deliver a secure, reliable, scalable platform that will handle your most demanding, mission-critical requirements.

#### 1.1.5.2 SPPA-R3000

**SPPA-R3000**

SPPA-R3000 is the solution for turbine I&C based on SPPA-T3000 functions. This homogenous DCS integration of turbine controls benefits to full integration for hardware and software into the main DCS. All operations, engineering, DCS diagnostics are performed according to the same handling as for the overall main DCS.

The following specific functions of the turbine I&C are part of SPPA-R3000:

- Steam turbine controller
- Wall temperature functions
- Turbine protection:
  - General turbine protection
  - Electronically over speed protection
  - Turbine trip release
- Turbine monitoring control:
  - Protection system
  - Turbine valve
The turbine protection and the fail-safe turbine trip system with over speed protection are integral parts of SPPA-R3000.

Turbine protection with SPPA-R3000 comprises of the following components:

- Fail-safe control of solenoid valves for trip valves for PG steam turbines for example or of a 2-out-of-3 trip modules for example for ABB steam turbine modernizations
- Integrated trip module system, certificated according to IEC 61508 SIL3
- Integrated over speed protection system, certificated according to IEC 61508 SIL3
- Electronically turbine protection
- Monitoring of turbine protection system

1.1.5.3 SPPA-P3000

Integrated Process Optimization SPPA-P3000

Optimizing processes in the power plant is one of the most demanding tasks of all. Especially if it is to be achieved without costly modifications on the mechanical engineering side, i.e. without major conversions to the steam generator and turbine.

This purely software-oriented approach followed by Siemens has been an ongoing success in the world’s power plants for just on a decade now and has made many operators happy people – especially when they think about their ROI (return on investment).

Besides being widely incorporated into new power plants, Siemens’ SPPA-P3000 process optimization is nowadays a popular choice for power plant upgrades. More and more operators are going beyond simply replacing their obsolete instrumentation and control systems and are taking the opportunity of a scheduled modernization to bring their power plants into line with the current market situation, which calls above all for greater flexibility and higher efficiency, better availability and lower emissions. This is precisely where the focus of the SPPA-P3000 Solutions lies. But see for yourself.

High flexibility

SPPA-P3000 Solutions enable optimum response to load demands. Our control concepts together with the extension of the operating range of the subordinate controls to lower minimum and higher maximum loads lay the foundations for flexible and at the same time stable operation.

Benefits:

- Increased revenue by provision of additional primary and secondary control capability
- Increased revenue or reduced financial losses thanks to consistent start-up capability, low cost start-up, reduced minimum or increased maximum load levels and fast response to changing load requirements.
High efficiency
SPPA-P3000 Solutions improve overall efficiency by various efficiency enhancement approaches which include reduction of valve throttling losses, optimization of combustion air, steam temperature or of cooling water.
Benefits:
Improved efficiency can be used to either
- Reduce fuel costs for the same level of power sales
- Increase revenue from additional power sales for the same level of fuel cost.

High availability
Implementation of model based feedforward control in SPPA-P3000 Solutions allows fuel overfiring to be reduced and the number of control actions to be kept to an absolute minimum. This simultaneously reduces operating life consumption effects on components. Thanks to the tried and tested load capability circuit, the plant avoids tripping on the loss of major components.
Benefits:
- Reduced frequency of failures thanks to low-stress operation
- Reduced frequency of trips as load capability circuit enables plant to ride loss of major components.

Low emissions
SPPA-P3000 Solutions achieve a reduction in emissions through stable plant operation and continuous operating point optimization for the separate burners. Any increase in efficiency yields a simultaneous reduction in CO2 emissions.
Benefits:
- Compliance with statutory emissions limits and avoidance of financial penalties for violations of these
- Revenue from sale of superfluous emissions credits
- Higher price can be realized for sale of ash.

1.1.5.4 SPPA-D3000 Diagnostic Suite

SPPA-D3000 Diagnostic Suite
The SPPA-D3000 Diagnostic Suite falls into four different products, namely SPPA-D3000 Plant Monitor, SPPA-D3000 Machinery Protection, SPPA-D3000 Machinery Analysis and SPPA-D3000 Operations Optimizer. Plant Monitor and Machinery Protection are integrated into T3000 using the power of the Embedded Component Services ™, whereas Machinery Analysis an Operations Optimizer are stand alone applications, being integrated with the next releases of SPPA-T3000.

SPPA-D3000 Plant Monitor
Plant Monitor is an analytic tool for a Model based monitoring of processes and machines with early failure detection. Prediction of all process parameters based on historical data (SPPA-T3000 archive or OPC-source) and evaluation if condition unknown or critical.
Plant Monitor is a software solution using advanced machine learning technology for machine condition monitoring. Plant Monitor can be trained to model the behavior of a machine or system based on historical data from multiple sensors or data sources during normal operation. After training it is able to monitor and detect deviations from normal operating behavior. Therefore, it can detect and localize faults at an early stage before a major failure occurs. Since Plant Monitor is adaptive, it can be used to monitor a variety of systems and components and sub components in a power plant. In Plant Monitor, for each monitored sensor an estimated value is calculated. If the residual, which is the difference between actual sensor measurement and estimate, deviates significantly from zero a fault or unknown behavior is detected and reported.
Plant Monitor supports the usage so called empirical, statistical models, which do not use any kind of pre-engineering like in other mathematical, thermo dynamical or physical models. The information about the asset modeled and monitored is only obtained from the historical data of the particular asset only. Due to this, the setup and engineering is very short in means of time and does not require any competences in the domain of modeling or diagnostics. With Plant Monitor a given asset can be modeled just by selecting the input values of interest from the historical data base. The just described input data are needed for the basic or primary training of Plant Monitor. Training data can be obtained from the T3k archive, from PI-System or other data sources with appropriate data interface. The setup and selection of data is performed in a fully graphical manor using the SPPA-T3000 workbench and engineering.

The integration into the SPPA-T3000 architecture gives Plant Monitor competitive advantages. Especially the integrated engineering approach of SPPA-T3000, the possibility of the customer to tailor the application by himself, the ease of use and the seamless integration into control systems are key.
SPPA-P3000 Plant Monitor is based on and fully integrated into ECS™. ECS™ is the core of SPPA-T3000, the software heart of the power plant.

So it comes with all benefits of the fourth generation DCS:
- Easy to use - also in engineering
- Multi unit capability
- Fast navigation between all views.

Differences to common monitoring systems are:
- Earliest possible detection of anomalies in monitored assets and processes, due to model based prediction
- Holistically analyzes all sensor values in correlation to each other
- Is applicable to all type of machines or processes, without detailed domain know-how
- Delivers real-time analytics for all operating regimens, even during transient operation
- Gives fleet wide and plant wide coverage
- Is the key enabler for condition based maintenance
- Plant Monitor technology recognizes changes in behavior even before normal alarm limits are reached
- Discovers even anomalies, which are subject to controls of DCS.

SPPA-D3000 Machine Protection VIB 3000
VIB 3000 a machinery protection system is a modular hardware and firmware platform to perform protective monitoring in the PG market for turbine sets and auxiliary machinery. This platform is an integral part of the PG I&C systems, as well as being able to operate stand – alone, i.e. without any I&C system. It is a mandatory requirement to equip any type of turbine set with a Vibration Protection Monitoring System. In Power plant applications there will be an I&C system, which (besides numerous other purposes) archives all measurement values and delivers a life display of the current plant. By this all vibration measurements have to be integrated in the I&C system.
With the SPPA D3000 platform SIEMENS offers a new modular platform for protective and diagnostic monitoring of turbo sets and auxiliary machinery.
Using the most modern electronic technology and manufacturing processes, SIEMENS new generation rack-based protection monitoring system – VIB 3000 - provides safe, reliable and high-quality solutions for protecting people, environments and machinery.
The VIB 3000-adds later on safety functions to the VIB - 3000 protection system and thus continues to meet our customer's demand for integrated, reliable safety and predictive monitoring solutions.

System Overview
Basic Functionality

The basic functionality of VIB 3000 is as follows:

- Powering of any kind of vibration sensors (accelerometers, velocity sensors, displacement sensors)
- Monitoring of sensor integrity inc. cabling
- Generating of characteristic values in real time
- Monitoring of these values in against absolute limits
- Voting logic to be used within the whole turbo set
- Deliver all measurement values and events to PG L I&C system via standard interfaces (Profibus DP)
- Hardwired interfacing to an AG F
- Hardwired interfacing of measurement values to I&C system components
- Generating of diagnostic measurement values (Narrow band, FFT, Orbit etc.)
- Standard interface to Condition Monitoring system (Ethernet)

VIB 3000 can be operated as an integrated component of the PG L I&C system. It will be connected to the AP via a redundant Profibus link. VIB 3000 engineering and will be performed via Profibus by using the SPPA-T3000 Workbench. The configuration task will be handled by PDM (Profibus device Manager).

Basic Design

The basic design shows the relationship between the various processing modules and the central modules. The processing modules offer up to 10 AC or DC channels per module. 10 Channels settable for nearly arbitrary machine protection measurement tasks. The input channels 8 & 9 provides hardware trigger for tachometer signals. Each channel provides power supply for all common transducer systems. The front panel BNC Connectors provides buffered raw transducer signal access. The Front panel Led’s indicate status of transducers, measurement channels, Communication and System internals. All VIB – P300 Modules offers a continues real time monitoring of transducer signals.
Measurement function are: Absolute case Vibration, Relative Shaft Vibration (Smax, MAX(Y,Y), Peak-Peak), Axial/Thrust position, Relative shaft expansion (single & dual probes), Combustion chamber Humming, Eccentricity, Tracking Narrow Band, No1-1X, Speed and rotational direction.
The Central Module VIB – M300 offers either single processing or redundant processing of all incoming measurement values from the monitoring modules. The module is also prepared for voting, vibration monitoring tasks and the Profibus communication to the I&C system.
The entire system offers three redundant layers. Layer 1: Sensors can be applied via jumpers also to additional the monitoring modules. Layer 2: The digital output of the monitoring modules can be applied to two central modules. Layer 3: The Profibus connection offers a redundant data communication line to the I&C system.

SPPA D3000 VIB 3000 takes over the Vibration based protection for turbine machinery and auxiliary equipment. Monitoring and tripping can be performed either in the VIB 3000 System or in the automation server of the I&C system. Buffered output signals can be transmitted to the Diagnostic Monitoring System SPPA D3000 VCAM 5000, which allows to perform turbine specific diagnostic activities.

Interfaces
The central module can be equipped additionally with 4-20 mA or relay output functionality. Also 8 binary inputs for Trip Multiply, Trip Override, Relay Reset and Channel Not-OK Reset are provided. As a summary maximum of three piggy back modules equipped with relays, 4-20 mA output or binary Inputs can be chosen selected by the user. 4 additional safety relays are already installed at the monitoring module.
Engineering

Setup & Configuration of VIB - 3000 will be performed with the Engineering Tool PDM (Profibus Device Manager). All other engineering activities like the engineering within the automation server, i.e. the preparation of limit comparison tasks, indication into the plant display, integration into protection schemes will be handled within the T 3000 workbench engineering tool.

SPPA-D3000 Machinery Analysis VCAM 5000

The consequential implementation of condition-orientated maintenance strategies requires fundamental knowledge of the machine’s condition. VIBROCAM 5000 provides this information for turbo machinery such as:

- Steam turbo-sets
- Gas turbines
- Pump-storage sets
- Compressors
- Turbo feed-water pumps.

Condition-orientated maintenance is the strategy for optimizing the availability of production machinery in order to increase profitability. With this knowledge technicians and engineers are in a position to increase the availability of machinery. Prerequisite to this are powerful diagnostics tools. Sensitive monitoring of the machinery's condition appropriate to the diagnosis guarantees that even slow-developing changes in the machinery's behavior can be recognized reliably. Early detection of slow-developing faults maximizes the reaction time for determining the most economic problem solution. Even the continued emergency operation of machinery which is already damaged or scheduled for overhauling is supported through the continuous critical observation of the development of damage.

Diagnosis of recognized faults Reliable knowledge of actual damage and its causes are prerequisites for an economic solution to the problem. Through the multitude of functions and diagrams available for damage recognition, VIBROCAM 500 provides basic yet innovative tools that support the implementation of condition-orientated turbo machinery maintenance strategies:

- Imbalance
- Misalignment
- Rubbing
- Power surge
- Crack propagation
• Looseness
• Blade breakage
• Foundation changes
and many more sources can be reliably detected.

**SPPA-D3000 Operations Optimizer**

One of the primary applications of SPPA-D3000 Operations Optimizer is the extremely fast analysis and display of correlations and interactions between thousands of operating parameters. Optimization targets are defined interactively at a mouse click through selection of pertinent value ranges. SPPA-D3000 Operations Optimizer provides directly a display of the relevant influencing quantities and the set points required to achieve optimization.

The effects of a particular parameter constellation on the whole plant or a specific sub process can be assessed quickly and easily with SPPA-D3000 Operations Optimizer. It performs this function by evaluating the real plant data from the I&C archive, i.e. without modeling.

Examples of typical optimization targets are

• to increase efficiency
• to minimize wear
• to minimize consumption

All the data necessary for an analysis of the response of each variable relative to thousands of other variables are basically already available. Only the large number of data, their distribution among various archives, and the correlations between them has hitherto prevented them from being used efficiently. Now for the first time, SPPA D-3000 Operations Optimizer makes it possible to process and use previously neglected knowledge from the various archives for the purposes of solving day-to-day tasks.

**Combination of millions of data sets from various archives**

• Rediscover known and unknown correlations
• Correlate countless numbers of parameters
• Support simulation of planned measures
• Optimize operating conditions
1.1.5.5 SPAA- S3000 Simulator

A simulator is an imitation of some real thing, state of affairs, or process. The SPPA-S3000 Simulator entails representing certain key characteristics or behaviors of a complex system, comprising of the DCS SPPA-T3000 and the power plant process.

An emulator duplicates the functions of one system with a different system, so that the second system behaves like the first system. This focus is on exact reproduction of external behavior and considering internal state.

The SPPA-S3000 Simulator exists of the original SPPA-T3000 HMI components, an emulation of the Automation Server and a 3rd party process model with an instructor station.

1.1.6 Design Examples

1.1.6.1 Introduction

Highest efficiency means that you are not only saving time during the whole usage period of your application; SPPA-T3000 allows for industrial use of current web-technology and offers a better overview and easier diagnostics. In the following pages you will find reports containing descriptions of applications and configurations for some of those plants that are already using SPPA-T3000.
### 1.1.6.2 Te To

**Description**

<table>
<thead>
<tr>
<th>Project</th>
<th>Te-To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
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</tr>
<tr>
<td>Customer</td>
<td>Hrvatska Elektroprivreda d.d. (HEP)</td>
</tr>
<tr>
<td>Capacity</td>
<td>District Heating Plant</td>
</tr>
<tr>
<td>Power Plant</td>
<td>Gas- and oil-fired Combined Heat and Power Station</td>
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<tr>
<td></td>
<td>3 Cogeneration units</td>
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<td></td>
<td>180 MW Total electrical power output</td>
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<tr>
<td></td>
<td>140 t/h Process steam up to</td>
</tr>
<tr>
<td>Project</td>
<td>DCS replacement for turbine and boiler of unit 3</td>
</tr>
<tr>
<td>Operative</td>
<td>from 11/2003</td>
</tr>
</tbody>
</table>

**Customer Benefit:**
- Customizable layouts of individual desktops and screens for each operator
- All functions for operation and engineering are available on all screens
- Flexible possibility to design individual pictures for special occasions like start-up

**Scope of supply:**

**Total I/O amount: 580**

<table>
<thead>
<tr>
<th>Signal Type</th>
<th>IO Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motors</td>
<td>44</td>
</tr>
<tr>
<td>AI</td>
<td>1000</td>
</tr>
<tr>
<td>DI</td>
<td>625</td>
</tr>
</tbody>
</table>

### 1.1.6.3 CCPP

**Description**

- **Project**: CCPP
- **Location**: Erlangen, Germany
- **Customer**: PG E (Siemens internal business)
- **Power Plant**: CCPP with steam turbine, combustion turbine and balance of plant with V94.3A (1 in 1). Siemens internal pilot to validate product deliveries and to benchmark standard and well-proven power plant design. FSS realized with discrete technology.
- **Project**: Standard DCS project
- **Capacity**: Combined Cycle Power Plant
  - Single shaft type V94.3A
  - 430 MW electrical output
  - Test against simulator
Project

CCPP

Operative

from 10/2004

Further plants

Korea, Bugkok 2, 550 MW
Germany, Herdecke, 400 MW
Italy, Livorno Feraris, 800 MW
Germany, Knapsack, 780 MW
Thailand, Songkhla, 780 MW
Azaibedshan, Sumgait, 500 MW
Thailand, Bang Pakong, 700 MW
South Korea, Bugok 2, 780 MW

Customer Benefit:

• Lower operation expenses due to reduced maintenance, spare parts and personnel
• Sizing of configuration becomes independent from standardized gas turbine models
• High degree of plant availability and operational reliability
• Operational flexibility allows short and easy startups and shut downs according to load demand

Scope of supply:

Total I/O amount: 4100
<table>
<thead>
<tr>
<th>Signal Type</th>
<th>IO Count</th>
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</thead>
<tbody>
<tr>
<td>Motors / actuators</td>
<td>135 / 65</td>
</tr>
<tr>
<td>Closed-loop control (step and continuous)</td>
<td>26 / 8</td>
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<tr>
<td>AI</td>
<td>285</td>
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<tr>
<td>TC</td>
<td>223</td>
</tr>
<tr>
<td>RTD</td>
<td>38</td>
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<tr>
<td>DI (Measurements / Hardware inputs)</td>
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<tr>
<td>DO</td>
<td>121</td>
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<tr>
<td>AO</td>
<td>7</td>
</tr>
<tr>
<td>Sub-loop control</td>
<td>26</td>
</tr>
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<td>Steps of sub-loop control</td>
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<tr>
<td>Pre-selection</td>
<td>133</td>
</tr>
<tr>
<td>Third-party interfaces (signals)</td>
<td>696</td>
</tr>
</tbody>
</table>
1.1.6.4 HKW1 Altbach

Description

Project  District heating unit 1
Location  Altbach/Deizisau, Germany

Customer Energieversorgung EnBW

Power Plant  District Heating Plant Altbach HKW1

Project  Replacement of TELEPERM ME by SPPA-T3000
- Exchange of 1300 transmitters, 220 control drives
- Remaining of the rest of the transmitters, open loop drives and the Switch Gear
- Remaining of the Field Cabling and the Cabling to Switch Gear
- Combination of central control room of unit 1 and 2 in control room of HKW2
- Installation of process optimization SPPA-P3000 for control improvements for a higher degree of automation
- Modernization of coal handling system by SPPA-T3000

Project  District heating unit 1

Capacity  Unit 4 (oil fired boiler and Gas turbine, 238 MWel, built in 1971)
- HKW1 (coal fired boiler, 431 MWel, District heating 280 MWth, built in 1985)
- HKW2 (coal fired boiler and Gas turbine, 397 MWel, District heating 280 MWth, built in 1997)
- Gas turbine B (60MW) and C (87MW)
Operative from 08/2006

Customer Benefit:
- Fast online changes under full load
- The DCS for process engineers
• Extreme ease of operation and maintenance
• Leanest system structure
• Lowest life-cycle costs
• Fully integrated turbine I&C

Scope of supply:
Total I/O amount: 30,000