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Examensarbete

Survey of SCADA SYSTEMS and visualization of a real life process

Thesis performed in the Division of Automatic Control

Jose Angel Gomez Gomez

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vid Linköpings tekniska högskola
av

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Översikt över SCADA-system och visualisering av verklig process

Survey of SCADA systems and visualization of a real life process

Författare
Author
Jose Angel Gomez Gomez

Sammanfattning
Abstract
Most of the industrial plants has a control center where is installed a SCADA (Supervisory Control And Data Acquisition) application. At the moment, it exists a great offer of acquisition, supervision and control of software and the evolution of this software follows a triple tendency: intercommunication between applications, standardization of the communications with the field devices and adoption of the communication surroundings. The report is divided in two parts. In the first the reader can learn the basic ideas of SCADA system and find the most important SCADA software available today. InTouch 7.1 and WinCC have been studied in more depth because they are the most successful software. In the second part is described the visualization of a real life process, it is the visualization of a toy car factory allocated in Linköping?s University and how interconnected the visualization process with the PLC (Programmable Logic Controller). In the report also are described the basic components needed to realize the visualization of any process involving PLCs.

Nyckelord
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INDEX

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In the report also are described the basic components needed to realize the visualization of any process involving PLCs.

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Thank you for all

I.INTRODUCTION

I.1 Background

In the Labotek, an undergraduate course laboratory at the department of electrical engineering, of Linköping's University, there is implemented a factory of toy cars made with LEGO.

This factory simulates the assembly line of cars and is constituted by a PLC (Programmable Logic Controller) that controls the process, a PC connected to the PLC, a control panel that is used to act on the factory and the own factory built entirely with LEGO.

With this project it is sought to study, which is the most appropriate software tool to carry out the visualization on a computer of this process and to develop a SCADA system that allows this visualization.

I.2 Overview of SCADA Systems

SCADA comes from the acronyms "Supervisory Control And Data Acquisition", that is data acquisition and supervision control. It is a software application specially designed to work on computers in the production control, providing communication with the devices (independent controllers, programmable robots, etc.) and controlling the process from the screen of the computer. In addition, it provides all the information that is generated in the process to diverse users, as much as the same level as to other supervisors within the company: quality control, supervision, maintenance, etc.

In this type of systems it usually exists a computer, which carries out tasks of supervision and management of alarms, as well as data processing and process control. The communication is made by means of special buses or LAN networks. All this is executed normally in real time, and is designed to give to the plant operator the possibility of supervising and controlling these processes. The necessary programs, and in this case the additional hardware that is needed, is generally denominated SCADA.

I.2.1 Functionality

A package SCADA must be ready to offer the following functionality:

- Possibility of creating alarm panels, which demand the presence of the operator to recognize a shutdown or situation of alarm, with registry of incidences.
- Generation of plant signal history that can be used for other programs.
- Execution of programs, that modify the control law, annul or even to modify the tasks associated to the robot, under certain conditions.
- Possibility of numerical programming, that allows arithmetic calculations of high resolution on the CPU of the computer.

With them, applications for computers can be developed, with capture of data, analysis of signals, presentations in screen, shipment of results to disc and printer, etc.

I.2.2 Requirements

A SCADA must fulfil several objectives so that its perfectly installation is taken advantage of:

- They must be systems of open architecture, able to grow or to adapt, according to the changing, the company necessities.
- They must communicate with total facility and transparently the user with the plant equipment and the rest of the company.

- They must be programs simple to install, without excessive exigencies of hardware, and easy to use, with user-friendly interfaces.

I.2.3 SCADA Modules

The modules or software blocks that allow the activities of acquisition, supervision and control are the following ones:

- **Configuration**: it allows the user to define the work surroundings of his SCADA being adapted to the particular application that is desired to develop.
- **Graphical interface of the operator**: it provides to the operator the functions of control and supervision of the plant. The process imagines, by means of synoptic graphs, is stored in the computer process and generated from the publisher, incorporated in the SCADA or concerned from another application during the configuration of the package.
- **Module of process**: it executes the pre-programmed actions of control from the present values of the read variables.
- **Management and data file**: it is in charge of the storage and ordered processing of the data, so that another application or device can have access to them.
- **Communications**: it is in charge of the transference of information between the plant and the hardware architecture that supports the SCADA, and between this one and the rest of computer elements of management.

I.3 Project Purpose

The project consists of two complementary parts:

I.3.1 Survey

The first part consists of making an investigation to discover the software tools developed by the main manufacturers of PLC´s available today.

This investigation consists of analysing the software developed by the main manufacturers of PLC´s (MITSUBISHI, SIEMENS, OMRON, etc), or of software (WONDERWARE, etc) visualize, indicating the characteristics of each program.

I.3.2 Implementation

The second part of the project consists of using the study made previously; select a tool, the one that is considered appropriate to make the visualization, and to apply it to a real application.

Develop a SCADA that allows supervising and to control the “Lego car factory” that is in the Labotek of Linköping’s University. For it the following points must be solved:

- **Used tool**: selection of the tool in which application SCADA will be developed. Study of this tool, possibilities that offer, limitations and operations.
- **Application developing**: create an application for the supervision, monitorization and control of the Lego car Factory.
- **Connectivity between the PLC and the computer**: to select the software adapted for the data transmission between the PLC and the computer.

I.4 Reader's Guide

This report is divided in two parts that correspond with the mains of this project.

In the chapter SURVEY, is explained how the study of the software has been carried out and some references to the corresponding appendices, in case of needing more information, are included.

In the chapter IMPLEMENTATION, the following aspects are included:

- Brief description of the application.
- Components selected for the realization of the application as well as the motivations that have taken to their selection.
- Description of the visualization environment.
- User's Manual for the use of the application.

II SURVEY

II.1 Description

In this study I have tried to discover all the existing tools today for the visualization of industrial processes. For this I have visited all the pages of manufacturers so much of hardware (PLC) as of software (SCADA systems) with the purpose of discovering the major part of possible software packages.

I have visited WEB pages of PLC manufacturers such as:

- Omron
- Allen
- GE Fanuc
- Mitsubishi
- Siemens
- Hitachi
- Etc.

And software as:

- USDATA
- Advantech
- Iconics
- National Instruments
- Rockwell Automation
- Wonderware
- Etc.

For more information about some package see the APPENDIX I. All the information collected in this appendix has been taken from the web pages of the developers.

The packages WinCC (appendix 2) and InTouch (appendix 3) have been emphasized because they were considered the most important ones.

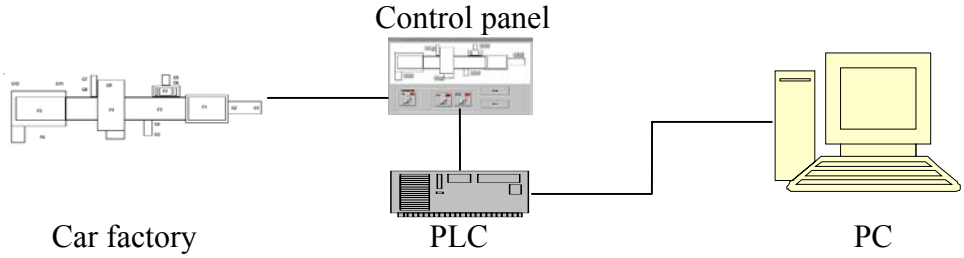
All the information collected in this section has been founded in the web using web pages like google, yahoo, etc.

III. IMPLEMENTATION

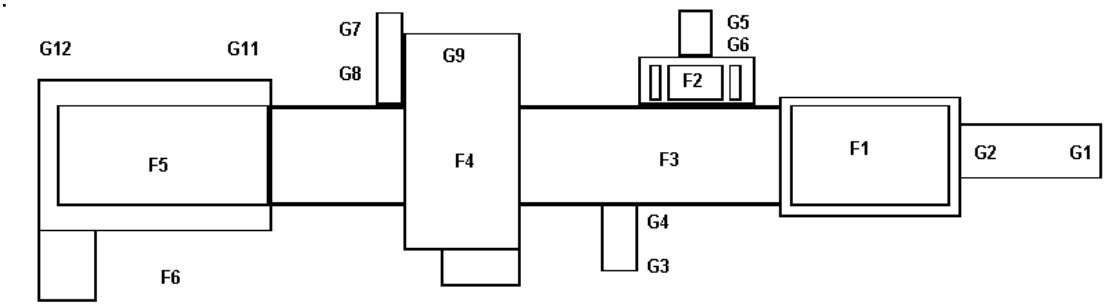
III.1 Description of Application

III.1.1 Hardware

The whole system consists of the factory of cars, the PLC with the control panel and a PC. All these components are connected as it is shown in the following figure.



The purpose of the SCADA application that shall be implemented is to show in which state is the factory of cars using the information picked up of the sensors that are in the factory. The disposition of these sensors can be seen in the following figure:



The meaning of each one can be seen it in the following table.

Tagname	Item	Logic value	Type	Comment
G1	X17	L	I/O Discrete	Ejector plates back
G2	X15	L	I/O Discrete	Ejector plates forward
G3	X13	L	I/O Discrete	Stop at bit-stop back
G4	X11	L	I/O Discrete	Stop at bit-stop forward
G5	X7	L	I/O Discrete	Ejector bits back
G6	X5	L	I/O Discrete	Ejector bits forward
G7	X3	L	I/O Discrete	Stop at press back
G8	X1	L	I/O Discrete	Stop at press forward
G9	X24	H	I/O Discrete	Press in top position
G11	X23	H	I/O Discrete	Turner receiver
G12	X22	H	I/O Discrete	Turner deliver
F1	X16	H	I/O Discrete	Stock plates empty
F2	X14	H	I/O Discrete	Stock bit empty
F3	X12	L	I/O Discrete	Chassis at bit-stop
F4	X10	L	I/O Discrete	Chassis at press
F5	X6	L	I/O Discrete	Chassis at turner
F6	X4	H	I/O Discrete	Signal from B

Each sensor is activated or not depending where the chassis or the corresponding object is.

The PLC that controls the toy car factory is a MITSUBISHI FX SERIES PROGRAMABLE CONTROLER, Model FX-16EX.

See also [6].

III.1.2 Software

In this thesis two of the main SCADA systems (InTouch and WinCC) have been studied in more detail than the others, in order to determine the advantages and disadvantages each one has.

III.1.2.1 Wonderware Intouch.

Wonderware InTouch is really easy to work with. You can build your application and most of the functions just “point and click”.

Is possible to learn to work with InTouch is a short period of time and there in not many major errors that you can do when build an application. It is easy for the maintenance people to understand how to work with it and alter pictures and connections.

It is easier to made Scripts for inexperienced programmer using InTouch than WinCC because of the usage of pointers in the Scripts that can make your application crash irregularly.

See also [1] and Appendix III.

III.1.2.2 Siemens WinCC

WinCC is well structured; the different functions of the SCADA are divided into several different programs (picture program, alarm, tag logging, reports, global scripts...). This is good because in a big project it will get easier to get an overview application.

WinCC is also very open. This is useful when you must do something out of the standard. Then you make C-Scripts that calls the different API´s (Application Program Interface) and make your own functions in a very standardized way.

The UADMIN (User Administration) is also a good example on the structure. You can make different permissions that can use on the objects. Then you make users groups and if you add a user it get a default permissions of the group but you can easily add/remove permissions on the individual user. In InTouch you must have some sort off authorizations value and give the user a certain value.

Some disadvantages of WinCC are:

- It takes time to learn.
- In a small project it will take time to configure.
- The WinCC application demands a very powerful computers and the server must be a dedicated server.

See also [2] and Appendix II.

III.1.3 Software Used

The execution and development surroundings are under Microsoft Windows NT Workstation 4.0.

The following software have been chosen for developing the application:

- The main software used is InTouch 7.1 (Wonderware), a tool for creating SCADA Systems. We have chosen InTouch for the next reasons:
  - Wonderware InTouch is really easy to work with and enough powerful for develop this application. You can build your application and most of the functions just “point and click”.
  - Is possible to learn to work with InTouch is a short period of time and there in not many major errors that you can do when build an application. It is easy for the maintenance people to understand how to work with it and alter pictures and connections.
  - It is easier to made Scripts for inexperienced programmer using InTouch than WinCC because of the usage of pointers in the Scripts that can make your application crash irregularly. See a brief comparison between WinCC and InTouch in appendix VI.
- For the connection and Data acquisition KEPServerEX (kepware) server have been used, because is a tool easy to configure and use. In addition KEPServerEX include drivers for use with a big quantity of PLC manufacturers like: Siemens, Mitsubishi A Series, Allen-Bradley, GE Fanuc, Omron, etc. See more information about KEPServerEX in the Appendix IV and [8].
- Also graphical packages are used for creation and adjustment of images like Microsoft Paint or Adobe Photoshop.

III.2 Description Visualization Environment

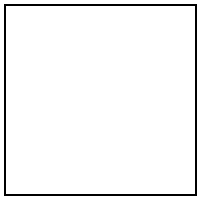
Since it has been said before to make the visualization InTouch 7.1 has been used.

The visualization process is compound by several windows and it can run in two modes: visualization mode and simulation mode. Following is described the application developed using InTouch 7.1.

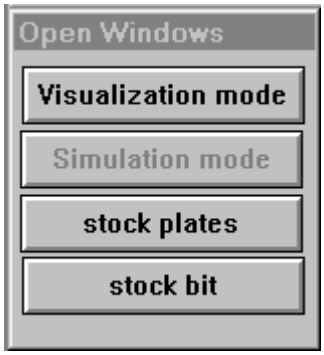
- The *"Open Windows"* is used to select the mode of operation: visualization mode or simulation mode. Also it is possible to open all those windows that are hidden in this moment for a determinate mode:

  - Visualization mode.
  - Simulation mode.
  - Press (visualization mode) / No plates (simulation mode).
  - Alarm (visualization mode) / No plates (simulation mode).

If we are working in *visualization mode* the options *NO plates* and *NO bits* are invisible, in the *simulation mode* the invisible windows are *Press* and *Alarm.*



visualization mode
simulation mode



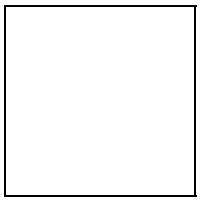
III.2.1 Visualization Mode

The visualization mode shows the state of each sensor in the factory and graphically represents it.

It is made up of the following windows:

- The window *"process"* is the most important because you can see throughout which the each element state of the car factory, representing graphically the sensors value that provides the I/O server.

In the following figure the window "process" is shown.



To achieve the visualization, the following representation has been used. In this example you can see how the G2 and G1 sensor information is represented in order to move the ejector plates (⇨ in the figure above).

→ Is visible if: Ejector plates forward

→ Is visible if: Ejector Plate's middle

→ Is visible if: Ejector plates back

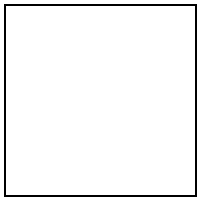
These are the conditions to show the ejector plates state depending on G1 and G2.

→ G1 == 1 AND G2 == 0;

→ G1 AND G2;

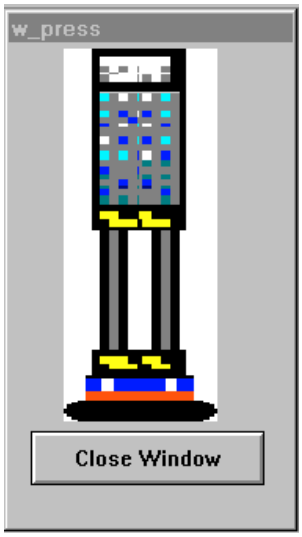
→ G1 == 0 AND G2 ==1;

• The window *"w_press"* is for showing the state of the press, and it can have two values:



Press on top position.

Press Down.

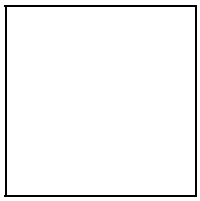


This window appears automatically when the chassis arrives to the press (F4 == 1), if it is hidden or clicking the option in the "open_windows".

• The window *"Alarm"* shows a history of the

alarms that have been taken place in the system, by different causes:

- The plates Stock is empty.
- The bit Stock is empty.



Also it is possible to see the alarms that have been recognized (clicking ack button) and those that the operator did not recognize.

III.2.2 Simulation Mode

The simulation mode is for simulating the operation of the factory, but now the state represented is totally independent of the PLC. The state is produced by using the “commands” window.

For achieving the simulation some variables and scripts have been defined in order to move all the components of the application.

For instance for simulating the movement of the plates ejector the following variables have been defined:

- plates: used for know where the plates ejector is.
- stockplates: current plates stock.
- platescha: plates is before the bit injector.
- Bit: the chassis is in the stop of the bit injector.

In function of these variables value we represent the ejector plates. Also a function called *move_plates_back and move_plates_forward* have been defined, the squeleton of these functions are shown here.

move_plates_forward *function*

```
IF plates == 0 THEN
    IF stockplates <= 0 THEN
      Show("NO_plates");
      start = 0;
      ELSE
        stockplates = stockplates - 1;
       plates = 1;
       platescha = 1;
       bit = 0;
  ENDIF;
```

```
ELSE
        IF plates == 1 THEN
          platescha = 2;
          plates = 2;
          bit =0;
ENDIF;
ENDIF;
```

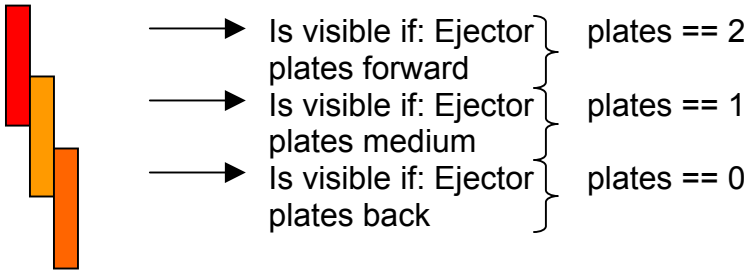
move_plates_dw *function*

```
IF plates == 2 THEN
    plates = 1;
    platescha = 0;
ELSE
    IF plates == 1 THEN
        plates =0;
        platescha = 0;
    ENDIF;
ENDIF;
```

Each time that the operator click on the button  on the plates in the "commands" window, the function *move_plates_forward* is called changing the value of *plates* variable if it is less than 2.

Also each time that the operator click on the button  on the plates in the "command" window the function *move_plates_back* is called changing the value of *plates* variable if it is more than 0.

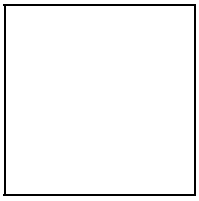
The graphical representation of *plates* is shown in the next figure.



The simulation mode is made of the following windows:

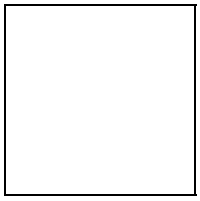
• The *"commands"* window is for simulating manually the operation of the factory. It represents the control panel that the PLC has, and is for controlling each of the motors in the factory.

This window works together with the window "process_rel" to realize the visualization of the simulation.



• In the window *"process_rel"* is represented the state of the factory in the simulation, the state now depend on the control panel described above not of the sensor values.

• The window *"No_plates"* shows the current stock of plates. When the stock is 0 then it shows an error message indicating that there are no plates in stock and that it is necessary to refill it in order to continue the production.



This window allows refilling the stock just clicking on the buttons and introducing the desired stock.

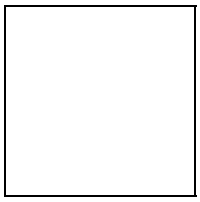
• The window *"w_press sim"* is for showing the state of the press in the simulation mode, and it could be two values:

- Press on top position.
- Press Down.

This window appears automatically when the chassis arrive to the press (chapress == 1), if it is hidden.

It is basically like "w_press" explained for the visualization mode.

• The window *"No_bit"* shows the current stock of bits. When the stock is 0 then it shows an error message indicating that there are no bits in stock and that is necessary to refill it in order to continue the production.



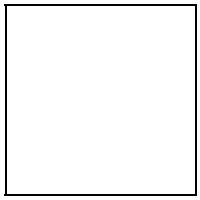
This window allows refilling the stock just clicking on the buttons and introducing the desired stock.

III.3 Link the application to Kepware´s Server.

Once the visualization environment is developed. The following step is to connect this environment with the PLC, to pick up the information of the different sensors.

How to carry out the connection of the visualization environment with the PLC using Kepware´s Server it is shown next step by step.

1. We have crated a single Access Name, which will be linked to the first device in the KEPServer project. To do this select Special/Access Names … in the WindowsMaker main menu in our application created with InTouch 7.1.



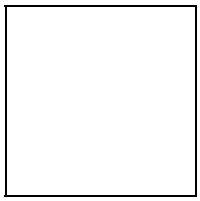
2. Click add to add a new Access Name

3. Enter a unique Access Name; we enter MLPLC to access to the tags on the server. The application name will always be “servermain”. The Topic Name will be always the alias that we created for the first device in our case “Channel1_device_1”.

4. As we use a DDE connection, this option must be selected and advised only active item so we have to select this option.

Note: if we were connecting to a remote Pc then we would introduce its name in Node Name.

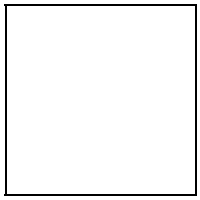
Then the configuration panel for our application looks like:



As we only use one Access Name we can finish the configuration clicking Close button to return to the project.

Now that we have created the link to the server we can add tags to the Tagname Dictionary to access to the information of the PLC.

1. Select Special/Tagname Dictionary … from the WindowsMaker main menu.



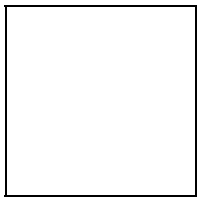
2. Select a Tagname for the tag, for example “G1”, that it said to us if the plate ejector is in the back position.

3. In the Tagname Dictionary, click on New to add a new tag. As all the values that we are going to read/write are Boolean we define all tagnames as an I/O Discrete, selecting this option clicking on the button Type.

4. Click on Access Name… to select where the data for the tag that we are defining will be coming from. We chose in all the cases “MLPLC” because is the unique Access Name that we have defined in our application, and because all the data will become from this point.

5. Click on Save to accept the new tag definition.

The figure shows the configuration window for the tagmane “G1”.



See the Appendix V where you can found all tags that we define for the application.

III.4 How to Run:

III.4.1 Software needed and required Files

To be able to execute the application it is indispensable to have the following software installed in the PC:

- Microsoft Windows
- Wonderware InTouch.
- KEPServerEX

The files required are:

- "**Vis_lego**": file that contains the visualization carried out in InTouch.
- "**lego_server.opf**": file that contains the configuration of the server OPC, necessary for the connection between the PLC and the application.

III.4.2 Running the application

In order to execute the application it is necessary to follow the next steps:

1. Execute the KEPServerEX program.
2. Open the file "lego_server.opf" clicking File/Open from the main menu.

Now that the OPC server is running is possible to execute the InTouch application correctly and interact with all the windows that have been explained before.

3. Open InTouch 7.1, installed in your computer.
4. The name of the application is "Vis_Lego". Then, when InTouch is opened select "Vis_lego" and click open button.
5. In a couple of seconds the application will be open.

To make the application run just you have to press on button "runtime", on the right side at the top of the window.

When the application is executed the first time only the window "process" and the window "Open_window" are shown, but is easy to change this windows selecting the window that you want to open just clicking on the "Open_window" option.

III.5 Conclusions

In this project several SCADA Systems have been studied and InTouch offers enough possibilities being a tool quite easy of using for what has been considered the most appropriate for the realization of this project.

As for the implementation part when we work with PLC´s the most difficult part of solving it is the one that refers to the interconnection PLC with the PC.

During the realization of this project, due to diverse technical problems, it was the part that more time has taken of solving.

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APPENDIX I. Main SCADA Systems

Note: The information collected in this appendix has been taken from the web pages of main software developers.

Factory Link 7

SUPPLIER: USDATA (http://www.usdata.com/)

FactoryLink is a collection of software tools used to build a variety of SCADA/HMI (Supervisory Control and Data Acquisition/Human-Machine Interface) applications in the manufacturing and process industries. It collects critical information from plant floor devices and then distributes the data in real-time to decision-makers whether they are on the plant floor, in the corporate office, or around the globe. FactoryLink provides advanced data processing functionality such as alarming, trending and data logging - allowing essential information to be provided to users and higher-level business systems as needed.

Some features of FactoryLink 7 include:

- Object-based configuration, external data import and standard technologies result in the lowest total cost of ownership.
- Many new tools are offered to create highly functional graphical user interfaces.
- Provides a large amount of pre-configured functionality that allows you to achieve a working application in record time.
- Supports OPC Client and Server for the collection and distribution of data, giving manufacturers the most open real-time automation system in the industry.
- Microsoft SQL Server 7.0 is shipped with FactoryLink to provide advanced data storage functionality out-of-the-box.

Paradym-31

SUPPLIER: Advantech (http://www.advantech.com/)

Advantech Paradym-31 is an IEC 1131-3 compliant MS-Windows based graphical programming environment which allows you to create, debug and manage real-time control programs like traditional Programmable Logic Controller (PLC) languages. It contains a highly integrated collection of programming tools for building PC-based control programs which run on Advantech ADAM-5510 control modules.

Combined with an Advantech ADAM-5510 controller, Advantech Paradym 31 software provides a complete automation control solution for open

PC-based users. Your customers can use Advantech's PC-based control solutions to build different systems based on customer needs.

WizFactory

SUPPLIER: eMation (http://www.emation.com/)

Complete solution for information and automatization, it combines the discreet and the continuous control with SCADA and Internet. Between its components is Wizcon for Windows and the Internet a powerful HMI/SCADA software package that delivers real-time and historical information from the plant floor to the boardroom and beyond. It has been designed to expertly handle all the responsibilities of SCADA with maximum flexibility and superb performance. It goes on to provide secure, multi-level access to any user through Java-enabled Web browsers.

Another component is WizPLC, it is an open, standards-based, soft logic solution for Windows NT. It is fully compliant with the IEC 61131-3 standards and languages. WizPLC can be operated standalone as a PC-based control system or in combination with Wizcon for a complete control and SCADA solution. WizPLC has been successfully deployed in a variety of industries. By offering integrated control development, execution and operator interface in one package, WizPLC cuts application development time and maintenance costs, increases performance and provides high data integrity, regardless of the hardware used.

Cimplicity Plant Edition

SUPPLIER: GE Fanuc (http://www.gefanuc.com/)

CIMPLICITY Plant Edition provides superior HMI and SCADA functionality and establishes a solid foundation for Collaborative Internet Manufacturing. True client/server architecture and open-system design offer fast, easy integration with the ability to grow from a single computer node to a plant-wide monitoring and control system providing real-time information from the factory floor to all levels of the enterprise.

CIMPLICITY HMI Plant Edition™ consolidates the collection of data from your facility's sensors and devices, then transforms the data into dynamic text, alarm and graphic displays. It gives users access to real-time information, helping them make better decisions and prevent problems before they occur for improved quality, productivity and profitability.

CIMPLICITY Plant Edition has more features and options than any other automation software. These features, called Power Tools, are organized within a Workbench that provides the easiest platform available to develop and maintain your applications.

Genesis32

SUPPLIER: Iconics (http://www.iconics.com/)

GENESIS32TM Enterprise Edition was designed from the ground up to take maximum advantage of Microsoft's DNA architecture, which includes; VBA, COM, DCOM and WEB enabling ActiveX technology. OPC is at the core of the ICONICS Award Winning family of 32 bit products and is the only product based exclusively on OPC.

GENESIS32 offers a totally non-proprietary set of open and scalable automation tools that provide the ultimate freedom of choice.

GENESIS32 is ideally suited for many applications requiring Visualization, Supervisory Control, Data Acquisition, Advanced Alarming, SPC/SQC, Report and Recipe Management and much more.

GENESIS32 seamlessly integrates with Batch, MES, MRP, MS Office and Information systems. Create enterprise and distributed applications using the latest OPC enabling technology. Interface to applications such as MS SQL, Oracle, Access, Excel and E-mail

Intellution Dynamics

SUPPLIER: Intellution (http://www.intellution.com/)

It is a family of software for automatization that constitutes one of the most powerful solutions available in the industry. Account with diverse components of software of high performance that provide solutions with automatization for HMI, SCADA, virtual processes of Batch, PLC´s and applications of Internet.

IFIX is a SCADA and MMI system that offers complete visualization of the process, storage and data management of process and control supervision. IBatch consists of an oriented solution to Batch processes very typical of the chemical, pharmaceutical industry, of drinks and foods. IWebServer is a solution that qualifies the remote visualization of the processes by means of Internet.

LabView

SUPPLIER: National Instruments (http://www.ni.com/)

With LabVIEW, you can rapidly create test, measurement, control, and automation applications using intuitive graphical development. Quickly create user interfaces to interactively control your system. Easily specify system functionality by assembling block diagrams. LabVIEW combines ease of use, performance, and powerful functionality to deliver better productivity for your immediate needs, while providing scalability for long-term requirements.

HMI/SCADA Paragon

SUPPLIER: Nematron (www.nematron.com/)

The innovative Paragon HMI & SCADA software package regulates control and management of process information. Unlike many PC-based SCADA system architectures, Paragon delivers high-performance and reliability in networked applications with a scaleable database design.

Paragon supports seamless cross-platform communication among operating systems from Windows NT to Windows 95 and OS/2 on the same network. Its open modular design and dynamic connectivity features simplify integration into enterprise-wide networks.

When coupled with Nematron's OpenControl PC-based control software, Paragon offers a deterministic, fast real-time control system that can operate the most complex batch, process, or hybrid control applications.

Its peer-to-peer and network architecture client/server design deliver data integrity and system reliability. Server modules generate and store all critical real-time and historical data, while high-speed client modules use the server data to present information to people and other systems. Built-in mechanisms allow data exchange with third-party applications through OPC, DDE, ActiveX, communications standards, and programming languages.

FactoryFloor Software

SUPPLIER: Opto 22 (http://www.opto22.com/)

Factory Floor is an integrated suite of industrial control software applications designed to help you solve control automation problems, build easy-to-use operator interfaces, and expand your manufacturing systems' connectivity.

OptoControl, the foundation of the FactoryFloor software suite, is an intuitive, graphical flowchart-based development environment that blends analog control, digital logic, and serial and network communications seamlessly in a single tag name database.

RSView32

SUPPLIER: Rockwell Automation (http://www.software.rockwell.com/)

Monitor and control automated machines and processes with RSView32 software, an integrated, scalable, component-based Human-Machine Interface (HMI) software package. Designed for Microsoft Windows 2000, NT, and Windows 95/98, RSView32 was the first HMI solution to embed Microsoft Visual Basic for Applications (VBA) into its core functionality and the first to embed the power of ActiveX technology into its graphic displays.

With VBA integrated as its built-in programming language, RSView32 can interact with Microsoft Office, BackOffice, other third-party software, and other Rockwell Software products. The RSView32 Add-On Architecture allows extending RSView32 with additional functionality and integrating that functionality directly into its core. RSView32 is both an OPC client and server, which provides added flexibility for peer-to-peer networking and the ability to implement a control system that easily and reliably interfaces control products from multiple vendors.

The RSView32 Active Display System -- compatible with Windows 2000 Terminal Services -- is a client/server solution, based on ActiveX and DCOM technologies that allows remote interaction with RSView32 graphic displays from other computers on a network. RSView32 Active Display System extends the reach of process control systems from the plant floor to the office and beyond. RSView32 WebServer provides access to graphic displays, tags, and alarms through any standard Internet browser.

APPENDIX II. WinCC HMI

Note: The information collected in this appendix has been taken from several web pages about SISMATIC WinCC.

See also [2].

SIMATIC WinCC is a performance-graded HMI and SCADA system for PCs incorporating Internet technology, open standard interfaces, powerful configuration tools and seamless integration with SIMATIC STEP 7 unified development environment. SIMATIC WinCC offers mature and reliable production management control, efficient configuration and is adaptable to simple and complex tasks based on Client / Server architecture.

One of the special features of WinCC is its total openness while still providing an optimised compatibility between the individual Siemens Industrial Software components, like the SIMATIC STEP 7 engineering suite and the SIMATIC WinAC PC-based Control system.

It is possible, for example, to centrally define process tags and messages once with STEP 7 and then make them available to WinCC and all other components. Engineering costs are significantly reduced.

SIMATIC WinCC can be readily used in combination with other standard and user specific applications, creating SCADA and HMI solutions, which meet precisely practical requirements. System houses can develop their own applications via the open interfaces by using WinCC as a specific basis for their system expansions. SIMATIC WinCC further builds the foundation for integrating plant floor information with the MES/ERP level.

WinCC fully supports distributed system architecture and is designed for a broad range of applications where connectivity into an existing automation environment, a large volume of communication interfaces, comprehensive process information and data handling are important.

Features and Benefits

- ***Graphics Designer***

A comprehensive library with pre-configured objects as well as supporting animations by wizards. Pre-defined objects also contain trend windows, bar graphs, input/output fields, alarm message windows or even ActiveX objects for more sophisticated graphics.

- ***Message System***

This system usage integrated wizards to easily configure alarm messages or event messages.

- ***Tag* Logging**

Ensure process data will be stored in WinCC either periodically or event based.

The Report System prints out shift reports with production data or configuration documentation. Reports are easily configured with dialog boxes and wizards, similar to the Graphics designer.

- ***Tag Browser***

The most powerful part of the Data Manager is the integrated STEP 7 Tag Browser, which allows direct access to the PLC tags, which already exist in a STEP 7 project. This significantly saves on engineering time, particularly in large configurations. Also, in WinCC runtime mode the use of SCADA tags in the associated STEP 7 program locations can be displayed to provide a quick direct process diagnostic in case of process failure.

- ***Interfaces***

Included are a variety of communication channels and open interfaces such as SIMATIC S7, SIMATIC S5, SIMATIC TI drivers, PROFIBUS DP, PROFIBUS FMS, Industrial Ethernet, TCP/IP, OPC-Server, OPC-Client, DDE-Server, and ActiveX. Optional interfaces are available to connect to Allen Bradley PLC's (DF1, DH, DH+, DH485, ControNet, DeviceNet, Ethernet), Modicon (Modus ASCII, RTU, Modbus+, Modbus Ethernet), GE (SNP, SNPX), Mitsubishi, Omron, Telemecanique and others.

OPC interfaces have become more and more common in the industries. WinCC includes an OPC Client and an OPC Server to interface to other applications. Being the OPC Server, WinCC can serve data to MES / ERP systems; being the OPC Client, WinCC receives data from MES / ERP system. However, this can only be used for Windows NT based MES / ERP systems, since OPC is based on COM / DCOM.

Additional options are available to specifically adapt WinCC to the application needed.

- ***PLC Redundancy***

Setup a redundant PLC configuration, using SIMATIC S7 300 or S7 400 PLC's, connected to WinCC. WinCC includes a wizard to setup this redundant PLC configuration (software redundancy). In case one PLC fails, WinCC automatically switches to the backup PLC.

- ***Server Redundancy***

This redundancy option allows you to install a primary WinCC PC next to a backup WinCC PC to secure process management and operation. Both PCs hold the same WinCC application and both collect the same PLC data. Typically the server Redundancy is combined with a Client / Server architecture, so that the operator never loses control over the production process. If the Primary WinCC PC fails, the backup WinCC PC takes over providing data to the WinCC Client. This guarantees constant data integrity. When the failed primary WinCC Server starts up again, the system automatically copies all the process values and messages for the down period – this means that two stations are available again that have the same data.

- ***Multi Client / Multi Server***

In WinCC the server redundancy option can be extended to accommodate large distributed applications across multiple PC's linked via TCP/IP. In this distributed architecture certain runtime modules (Alarm logging, Trending, Tag logging, pictures, etc.) can be assigned to a server or the application can be geographically split (maker, wrapper, packer, boxer, etc.). The WinCC clients on top of the servers can simultaneously access all data and pictures residing on the individual servers.

- ***Web Navigator***

In WinCC the Internet technology is fully implemented to connect remote PC's to a web server via Intranet or Internet. In this configuration the thin clients only run a standard browser (Internet Explorer, Netscape) next to a few ActiveX controls that need to be installed. On the thin client operators, service and maintenance personnel can read / write process information. The Web Navigator is a web server running on Microsoft Internet Information Server (IIS).

- ***Messenger***

This is an annotated e-mail system built into WinCC's runtime system. Directly out of the runtime system, operators are able to take screen shots, annotate them with voice and additional drawing and send them to other areas/people such as the service or maintenance engineer to notify about a critical process status.

- ***Guardian***

This is another ActiveX control to embed a Video Management System into WinCC's runtime system. A video camera captures production areas that cannot be accessed by operators or detects critical process situations, for example with changing equipment, by showing the necessary steps in a video.

- ***Open Development Kit***

The Open Development Kit (ODK) gives you access to the system API. This means that all open WinCC programming interfaces are available in the form of C function libraries. The facility is therefore provided for accessing the data and the functions of the WinCC system modules in a user program.

- ***MES / ERP Integration***

Today as well as in the future, automation architectures require SCADA systems to also interface tightly with MES / ERP systems. Information availability across all automation levels is critical to maintain a high level of productivity and to better manage the overall production. Depending on the specific integration requirements. WinCC provides several different ways to integrate with MES / ERP systems:

- ***Database Interface***

Typically MES / ERP systems use central databases to manage process information. Typical examples are: Oracle, Informix, Ingres, Microsoft SQL Server, etc.) The majority of all databases are ODBC (Open Data Base Connectivity) / SQL (Structured Query Language) compliant. These standard interfaces allow access to the database table and are used to run queries to analyze process information. WinCC also stores all process information (Runtime data) and the application itself (Configuration data) in an open database, providing these interfaces. Data exchange between WinCC and MES/ERP can be done bi-directionally, based on a Client Server structure.

- ***Browser interface***

Todays communication interfaces are heavily impacted by Internet technology. Application and data don't have to reside on a local hardware platform anymore. A Web Server provides data to a Web Client. WinCC includes an Internet ActiveX control that can be integrated into WinCC Runtime pictures to browse data on the Web (URL access) or on local and remote hard drives.

- ***TCP/IP Interface to UNIX and Windows NT***

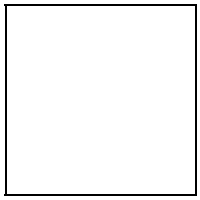
PM OPEN (process management) TCP/IP is another option available for WinCC. PM OPEN TCP/IP provides bi-directional exchange of data between WinCC and other Windows NT or UNIX platforms, using the TCP/IP protocol (UDP). This interface is primarily used to send process information that is either event driven or cyclic as well as sending and receiving alarm information. The PM OPEN TCP/IP configuration is done, using an integrated editor in the WinCC Explorer.

- ***SAP/R3 Interface***

SAP, the world's largest inter-enterprise software company, provides companies with business solutions that deliver a better return on information. SAP products and services integrate an organization from financials and human resources to manufacturing and sales and distribution. SAP offers a number of different modules. PM OPEN HOST/S is WinCC's interface software to SAP/R3 PM (plant maintenance module) and SAP/R3 Base module.

- ***HYBREX (Hybrid Expert System)***

With the HYBREX flow sheet simulator, we can provide you with a tool that captures, models, and analyses how your slab or strip changes while passing through the mill under different boundary conditions and how the mill itself behaves. You learn the impact of each parameter on cost and quality. Not only is this the basis for sound investment decisions, it is a prerequisite for the optimization of the your product range, product quality, equipment availability, and the mill itself.



- ***Web Control Center***

The Web Control Center of Siemens offers new possibilities for business wide (Intranet) and even worldwide (Internet) control of production and processes for customers und operators.

With WebCC, information once available in the control system only at the local level, including messages, reports, protocols, statistics, image and video data can now be used, exchanged and presented in multimedia form from any location.

What is more, all widely available databases can be accessed, and the transmission over fax or mobile phone can be established over an alarm server.

For controlling and monitoring of automation or control applications java enabled Web browsers, such as Netscape Communicator or Internet Explorer are used. Worldwide controlling with browser and mouse click, information exchange across systems, dynamic parameterization, and a full-graphic user interface -- WebCC gets you on the right track for the future.

WebCC is a platform independent application. Therefore WebCC will run on nearly any operating system e.g. Windows 95/98/NT, Mac, Unix, Solaris, Linux oder HP-UX. Thus all information retrieved by WebCC is available to authorized users on different hardware and software platforms.

WebCC comprises a core system that can be individually parameterised and configured. This web core is then accessed by flexible adaptation modules

for different data servers. Using modules, the system can be expanded and is so flexible that it can be readily adapted to any data server.

Using modules, the system can be expanded and is so flexible that it can be readily adapted to any control system. Images, which were created using WinCC or Data Views, can be converted to WebCC images. After image conversion and short revision the image can be used with WebCC.

- ***SIMATIC WinAC***

PC-Based Control translates into the SIMATIC® WinAC® (Windows Automation Center) Product Line. SIMATIC® WinAC® is an integrated solution for Control, HMI®, Networking and Data Processing, all running on the same platform. Based on functionality, WinAC® can be broken down into several components:

The Controlling part allows you to use your personal computer like a programmable logic controller (PLC) for running your process. WinAC® provides either a software PLC that runs as a real-time Windows task on your computer or a slot PLC (a PC board installed in your Computer) with full hardware PLC functionality.

WinAC® is configured, programmed and maintained with SIMATIC® STEP 7, the standard engineering environment for Siemens hardware PLC´s. A simple change over from a SIMATIC® S7-PLC to WinAC® or vice versa is possible at any time.

The Computing/Visualization functionality provides all the necessary open interfaces to view the process and to modify process data via standard applications (such as Microsoft® Excel, Visual Basic or any standard industrial HMI® packages for operator control and monitoring).

To further expand the integration capabilities for other technologies the SIMATIC® WinAC® ODK (Open Developer Kit) enables the integration of Motion, Vision and user-defined C/C++ code to support any kind of user developed extensions, special purpose libraries and add-ins.

APPENDIX III. Overview InTouch 7.1

Note: The information collected in this appendix has been taken from several web pages of InTouch 7.1.

See also [1]

Wonderware® InTouch® 7.1 for FactorySuite™ 2000 is the latest release of the world's leading, easiest to use, graphical human-machine interface (HMI) for industrial automation, process control and supervisory monitoring. InTouch 7.1 provides the visualization for a plant-centric, operator-centric manufacturing information system—where information is shared within and between plants—

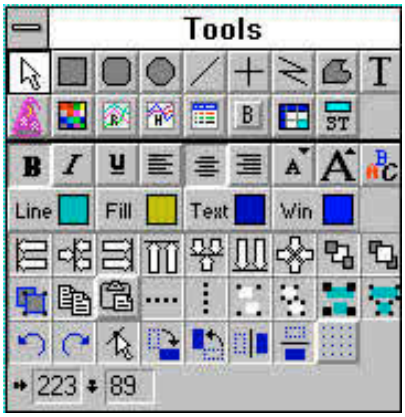
fully integrated with all types of information needed to empower the operator. It is the seventh generation of the industry's leading HMI from Wonderware, the company that pioneered the use of Windows® in industrial automation.

Wonderware® offers us by means of InTouch® the possibility of generating SCADA applications at the highest level, using the tools of object-oriented programming, for noncomputer science users.

Thousands of applications created with InTouch® are in total use and producing the best results at the moment. Their users inform into a very significant improvement in their quality and amount of production and in a reduction of project costs and maintenance. The QI Analyst modules, prescriptions or SQL, satisfy the information necessities and control of the industries.

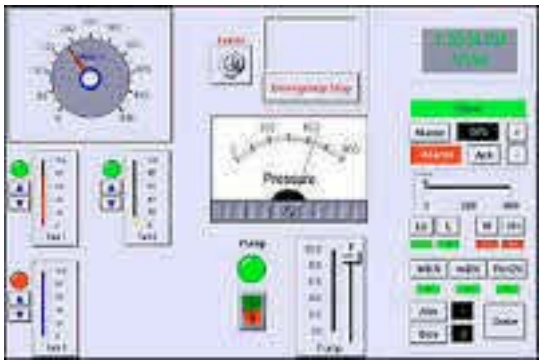
Object-oriented graphics

The applications easy to publish and to form, represent a smaller time of development. With InTouch® the user can move, change the size and animate to objects or groups to quickly and so simply and as static images. It has all type of design tools: simple drawings, alignment, work in multiple layers, spaced, rotation, investment, duplication, copy, elimination, etc. All these benefits are in an only and formable tool chest or in its menus.



Animation of objects

The properties of animation of the objects of InTouch® can be combined to offer complex changes of size, color, movement or position. It allows a limitless number of objects animated in each screen. It includes vertical and horizontal sliding bars; discreet bellboys or with associate actions; control of color on texts, fillings and lines according to discreet, analogical values or of alarms; control of width, height, vertical or horizontal position; fillings of objects by percentage; visibility; visualization of discreet, analogical data or texts with special properties; rotation; etc.



Active X

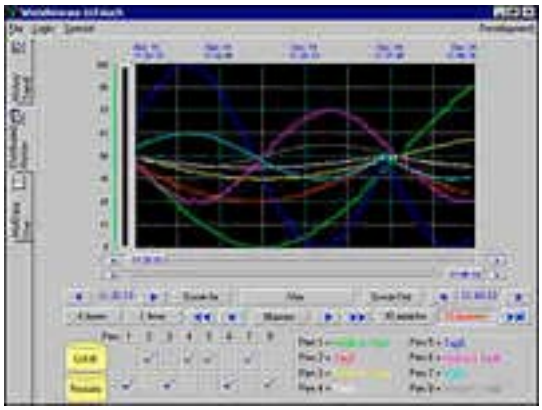
InTouch® is at the present time an ActiveX container. It allows to user to work in the same way directly with ActiveX controls that work with

Wizards. These ActiveX can come from Wonderware®, Microsoft® or any other supplier. Even you can process of a fast and simple way your applications ActiveX using VisualBasic.

OPC

SuiteLink® is a communication protocol processed by Wonderware of very high benefits for connection of applications FS2000 under TCP/IP, using the characteristics of security of Windows NT, which no need of configuration and high performance, specially for great volumes of data.

Historical graphics



The incorporation of historical is simple through the built-in objects. Each graph can present/display up to 16 pens with references to variables and independent historical files. Each one of the graphs arranges, in selection, run time of variables, visualization of the value in the position of the cursor, extension, displacement or trim. Limit as far as the number of graphs does not exist to visualize by screen or in all the application.

Alarms

InTouch® allows to form and to establish priorities of alarms quickly. Up to 999 different priorities, changes of color in agreement with the state of the alarm and up to 8 levels of hierarchy between groups of alarm with possibility of up to 16 sub-groups for each one of them. There is no limit in the number of alarms. They are possible to visualize all or an abstract of them of historical form or in real time and to be recorded in disc or to be printed in different customized formats. The new functions of distributed alarms include global or selective recognition, displacement by the list and visualization of alarms coming from different servers in an only panel.

Of course, the distributed management of alarms in network is also possible, allowing the same access and centralization from any node of the network.

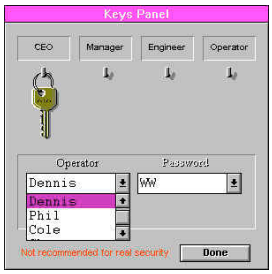
Programming

InTouch® has a simple and extensive programming language to the accomplishment of calculations in background, simulations, etc. Its programming is structured in groups and events. The conditional programs can be associated to results (true, false, while it is true or false) or buttons (when pressing, when maintaining or when loosen). The programs of screens are invoked when opening, closing or while the screen is visible. The programs by change of values activate to the change of values of tags, by actions of the operator (like the selection of objects), or like result of events or conditions of alarms.

The program editor shows all the functions available and has search utilities and replacement, conversion and up to 256 characters in expressions to conditional programs.

Its programming language supports to mathematical expressions and logics. The users can visualize decimal of simple precision numbers while they are calculate with double precision. New functions of manipulation of text chains, mathematics, input/output of files, resources of the system, hexadecimal and scientific representations of values have been added, etc.

Secutity



InTouch® offers up to 10,000 levels of access to which password can be assigned, assuring that the entrances to allowed areas and conditional operations of an application are not made correctly.

Update of optimised W/R

The use in InTouch® of techniques of exception in W/R of variables connected to second applications facilitates the data transfer of faster form.

Only the points of communication of visible objects or the used ones in alarms, historical or in user programs are continuously updated; because InTouch® maintains a registry of the used points, eliminating the use of complex tables.

In fact, Wonderware® created the FastDDE protocol to obtain updates of variables to high speeds.

Generation of Customized information and Documentation

The creation of reports in industrial applications is made automatically of simple form through events. InTouch® facilitates specific Wizards as the shipment of information by electronic mail and has powerful options to the documentation generation of an application.

Network applications

The Dynamic References allow to the user to modificate the properties of connection of their variables in run time, like directions of the PLC, cells of spreadsheets or other references DDE. Of this form can be visualized any cell of a spreadsheet using only one tag.

The Distributed Alarms support simultaneously multiples servers or suppliers of alarms, facilitating to the operator the possibility of monitoring the information of alarms of multiple locations. The new functions of distributed alarms allow to implement recognition, bars of displacement and other operations for the use in a network.

The Remote Development (NAD) has been included to facilitate the development of applications in network. It includes update of all the nodes of automatic form, per time, the operator or events of the application.

APPENDIX IV. Introduction to KEPServerEX

Note: Some of the information collected in this appendix has been taken from "KepserverEx Client connectivity guide".

See also [7]

KEPServerEX is a 32-bit windows application that provides a means of bringing data and information from a wide range of industrial devices and systems into client applications on your windows PC.

With the advent of 32 bit Operating Systems, and the use of Ethernet to provide communications between devices, there was a need for quicker and cleaner data transfer between software applications. This is where OPC saw its birth into the industry.

OPC (OLE for Process and Control) servers provide a standardized method of allowing multiple industrial applications to share data in a quick and robust manner. The OPC server provided in this package has been designed to meet the demanding requirements found in he industrial environment.

This OPC server has been designed as a two-part program. The primary component provides all of the OPC and DDE connectivity as well as the user interface functions. The second part is comprised of plug-in communications drivers. This two-part design allows you to add multiple communications options to your SCADA application while utilizing a single OPC server product thus reducing your learning curve as your project grows.

OPC technology reflects the move from closed proprietary solutions to open architectures that provide more cost-effective solutions based on established standards.

A Window based client application must be used to view data from the KEPServerEX application. In this section we will cover the basis of connecting InTouch 7.1 client to the KEPServerEX, although is possible to use this server for connecting a number of common OPC clients like: RSView32, WinCC, Genesis32, etc.

WONDERWARE's InTouch as a FastDDE or SuiteLink Client.

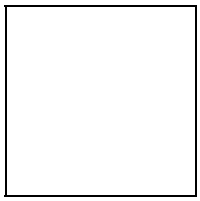
Connect to KEPServerEX with FastDDE or SuiteLink.

The Mitsubishi FX Device Driver was designed specifically for use with 32 bit OPC Server products and the Windows NT/95/98 operating systems running on Intel microprocessor based computers. It is intended for use with Mitsubishi FX series devices.

Wonderware provides several ways to connect to third party servers like KEPServerEX. FastDDE and SuiteLink allow Wonderware applications such InTouch to receive data from servers like KEPServerEx.

It is important to make certain that the server properly detected that you have Wonderware installed and it enabled FastDDE and SuiteLink support. You can do this by selecting Tools/Options… from the server main menu.

If wonderware was properly initialised on your Pc and the server detects it, you should see the FastDDE/SuiteLink tab in the Options dialog box. If the tab exists then click on it.



Designing a Project

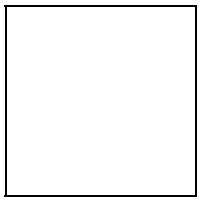
The server must be configured to determine the content of what the server will provide while it is operating. For a server project, we need to define channels, devices, optional tag groups, and tags.

Add a new channel.

The first step is to determine which communication driver(s) your application requires. A communication driver in the server is referred to as a channel.

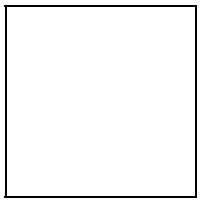
To add a new device to a channel you need to follow these steps:

1. To add a new channel to your project you can use either the Edit|New Channel, or the Toolbar Add Channel, or the context menu as it is shown here:

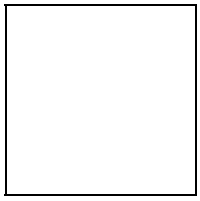


2. The channel wizard allows you name the channel and select a communications driver for example "Channel1". Simply click the next button to proceed to the next configuration wizard.
3. The next dialog allows you to select the communications driver that will be applied to this channel. In our case we select MITSHUBISHI FX driver, because we work with this kind of PLC´ s.

4. For the MITSHUBISHI FX driver this scream, display a channel summary page. Then click the "Finish" button.



With the new channel now added to the server, the server will appear as follows:



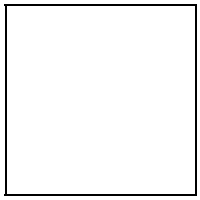
The red "x" denotes that the channel does not contain a valid configuration. The channel is not valid because a device has not been added to the channel. The next step is to add a new device to the channel.

Add a new device

In most cases a device refers to the identification of a physical node or station on a communications link. A device can also be viewed solely as a means of framing the definition of a connection to a specific point of interest in your application.

To add a new device to a channel you need to follow these steps:

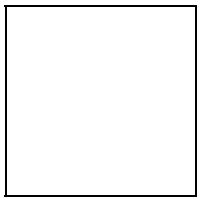
1. Select the channel to which you wish to add the device. Once the desired channel is selected you can use the Edit|Add Device, the Toolbar Add Device, or the context menu.



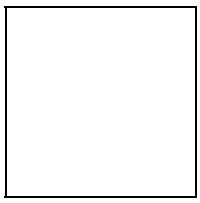
2. The device wizard allows you to name the device. For instance "Device1".
3. The next dialog allows you to select the model that best describes the device that you are defining, we have chosen FX device model from the drop list.
4. In this step of the communication you can enter the parameters you wish to use while communicating with the device, connect timeout refers to the time to wait for a successful initial connection (3s) and

request timeout refers to the time to wait for a request to be serviced (1000ms).

5. For the Mitsubishi FX driver the "Next" button will simply display a device summary page. As is shown in the following figure.



With a device now added to the channel, the server will appear as follows:



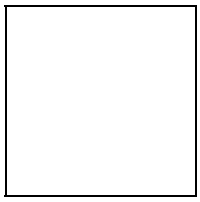
With a channel and device added to your project the server is ready to start providing data to OPC clients.

Now we have to define a set of tags to get data from a device to your client application using the server, and then use the name you assigned to each tag as the item of each OPC/DDE link between the client and the server.

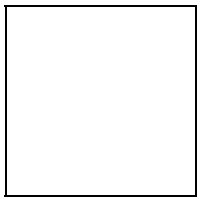
Add a new tag

To add a new tag to a device you need to follow these steps:

1. You must select a device name from your Channel/Device tree view within the server. Once the desired device is selected you can use the Edit|Add Tag, the Toolbar Add Tag, or the context menu.

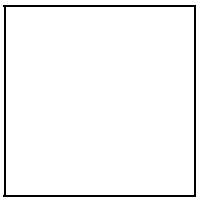


2. After clicking the new tag button you will be presented with the tag properties dialog. As shown below, the tag properties dialog allows you name the tag, specify a device specific address, select a data type, and set the access method of the tag. In the figure below you can see the definition of one tag used in the application.



As shown in the tag dialog above the tag name is "X0", the address is "X000", which correspond to the address of the PLC, the description which is optional is "Stop", which describes the purpose of this tag, the data type is "Word", client access is "Read Only" and DDE scan rate is "100" milliseconds which isn't used for OPC tags.

The steps previously shown, for add new tags, have been repeated for each variable in the next table for complete the application.



APPENDIX V. Tagname Dictionary

INPUT

Tagname	Item	Logic value	Type	Comment
G1	X17	L	I/O Discrete	Ejector plates back
G2	X15	L	I/O Discrete	Ejector plates forward
G3	X13	L	I/O Discrete	Stop at bit-stop back
G4	X11	L	I/O Discrete	Stop at bit-stop forward
G5	X7	L	I/O Discrete	Ejector bits back
G6	X5	L	I/O Discrete	Ejector bits forward
G7	X3	L	I/O Discrete	Stop at press back
G8	X1	L	I/O Discrete	Stop at press forward
G9	X24	H	I/O Discrete	Press in top position
G11	X23	H	I/O Discrete	Turner receiver
G12	X22	H	I/O Discrete	Turner deliver
F1	X16	H	I/O Discrete	Stock plates empty
F2	X14	H	I/O Discrete	Stock bit empty
F3	X12	L	I/O Discrete	Chassis at bit-stop
F4	X10	L	I/O Discrete	Chassis at press
F5	X6	L	I/O Discrete	Chassis at turner
F6	X4	H	I/O Discrete	Signal from B
START	X2	H	I/O Discrete	Start
STOP	X0	L	I/O Discrete	Stop
NÖDSTOP	X21	L	I/O Discrete	NODSTOP, emergency
TACHO	X20	H	I/O Discrete	TACHO

OUTPUT

Tagname	Output	Type	Description
E1F	Y0	I/O Discrete	Ejector Plates back
E1B	Y1	I/O Discrete	Ejector Plates forward
E2F	Y2	I/O Discrete	Stop at bit forward
E2B	Y3	I/O Discrete	Stop at bit back
E3F	Y4	I/O Discrete	Ejector bits forward
E3B	Y5	I/O Discrete	Ejector bits back
E4F	Y6	I/O Discrete	Stop at press forward
E4B	Y7	I/O Discrete	Stop at press back
E5F	Y10	I/O Discrete	Press down
E5B	Y11	I/O Discrete	Press up
E6F	Y12	I/O Discrete	Turn over B up
E6B	Y13	I/O Discrete	Turn over B down
LAMPA	Y14	I/O Discrete	Lamp on operator panel
E8	Y16	I/O Discrete	Transporter
E9	Y17	I/O Discrete	Signal to B