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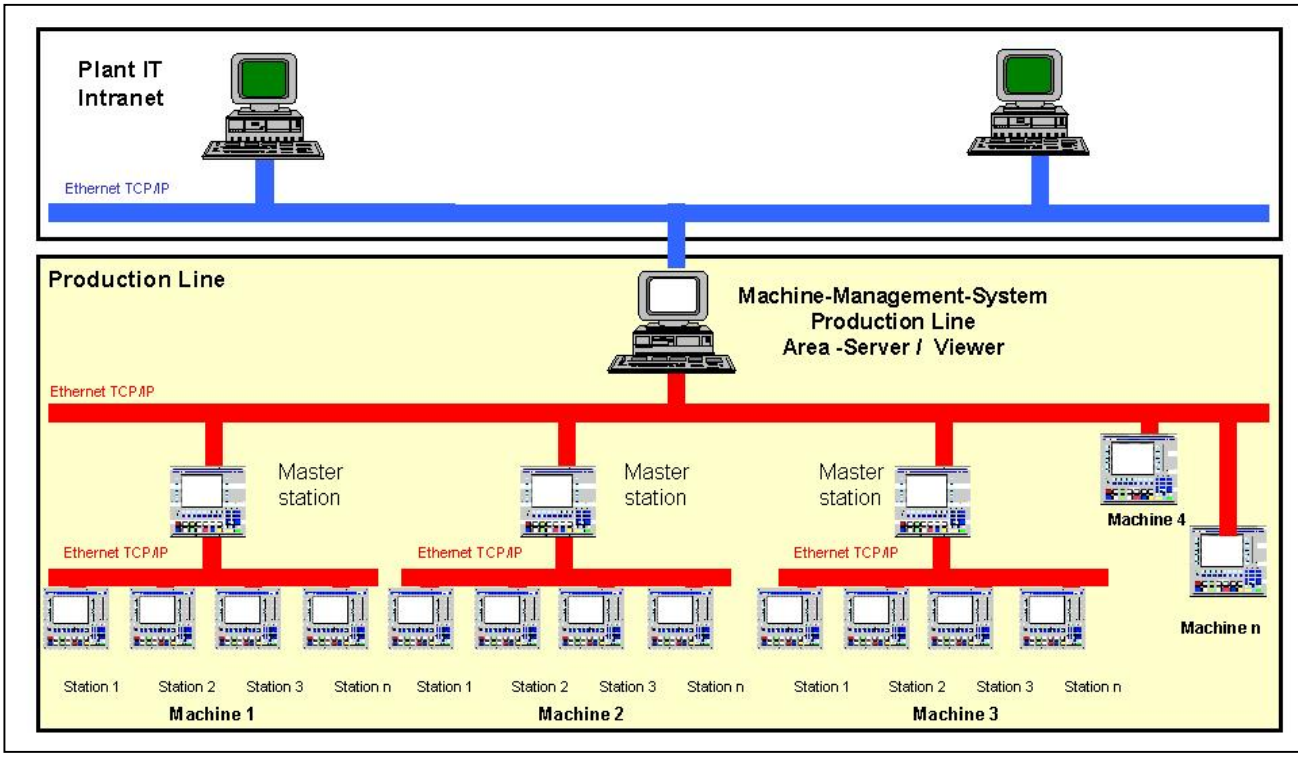

OPC-Server

Functional Description

Rexroth
Indramat

Title OPC-Server

Type of Documentation Functional Description

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Purpose of Documentation This documentation serves…

- to procure general knowledge
- to describe the features and installation
- as help to program and operation an OPC Client

Record of Revisions

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Contents

1 Introduction

1.1 Using this Document

This document is intended to provide the following information:

- Basic information about the OPC interfaces (Chapter 1)
- Special properties and installation of the Rexroth Indramat OPC server (Chapter 2)
- Information about programming and commissioning OPC clients

Knowledge required

A user who wants to develop an OPC client should have the following knowledge:

- General programming experience in Visual C++ and/or Visual Basic
- Knowledge of COM and/or DCOM programming
- Commissioning a remote client requires additional know-how to exist in the fields of
  - DCOM security settings, and
  - network configuration of the end user (machine user).

1.2 OPC Basics

Some of the information listed in this Chapter was taken from the publications and technical specifications of the OPC Foundation. Rexroth Indramat is a member of the OPC Foundation. Current information about the OPC Foundation can be found on the website *http://www.opcfoundation.org*.

Abbreviations

OPC™ stands for **O**LE for **P**rocess **C**ontrol. OLE (**O**bject **L**inking and **E**mbedding). It was first introduced by Microsoft for the communication between software components. Today, we are talking about COM (**C**omponent **O**bject **M**odel) or DCOM.

DCOM (**D**istributed **C**omponent **O**bject **M**odel) is a mechanism that is used for the communication between processes that run in different computers. DCOM is available in the Windows98™, WindowsNT™ and Windows2000™ (partly WindowsCE™ too) operating systems. It employs the TCP/IP protocol.

OPC objective

Providing a uniform communication interface for process data from any source (such as PLC or NC controllers) is the objective of OPC.

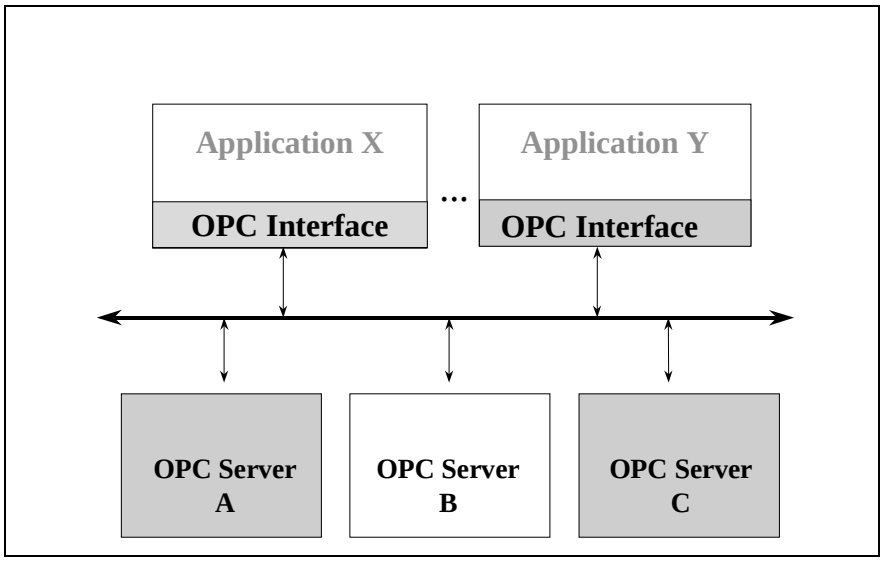

Fig. 1-1: Applications cooperate with OPC servers from different manufacturers

OPC specifications

In version 1 and 2 of the OPC specification the following datas are concentrate:

- Online Data Access, i.e., the efficient reading and writing of data between an application and a process control device flexibly and efficiently;
- Alarm and Event Handling, i.e., the mechanisms for OPC Clients to be notified of the occurrence of specified events and alarm conditions, and
- Historical Data Access, i.e., the reading, processing and editing of data of a historian engine.

Functionality such as security, batch and historical alarm and event data access belong to the features which are addressed in subsequent releases. The architecture of OPC leverages the advantages of the COM interface, which provides a convenient mechanism to extend the functionality of OPC.

The specifications include the following:

- A set of custom COM interfaces for use by client and server writers.
- References to a set of OLE Automation interfaces to support clients developed with higher level business applications such as Excel, Visual Basic, etc.

User utilize

Thereby the user (developer of OPC-Client applications) learns the following facilities:

- To realize the communication to the control only a minimum of control specific knowhow is necessary.
- When an application have to communicate with different controls the expenditure of adaptation is canceled

OPC Data Access Server

At a high level, an OPC Data Access Server is comprised of several objects:

- the server,
- the group, and
- the item.

OPC Server Objekt

The OPC server object maintains information about the server and serves as a container for OPC group objects. The OPC group object maintains information about itself and provides the mechanism for containing and logically organizing OPC items.

OPC Group

The OPC Groups provide a way for clients to organize data. For example, the group might represent items in a particular operator display or report. Data can be read and written. Exception based connections can also be created between the client and the items in the group and can be enabled and disabled as needed. An OPC client can configure the rate that an OPC server should provide the data changes to the OPC client.

There are two types of groups, public and local (or 'private'). Public is for sharing across multiple clients, local is local to a client. Refer to the section on public groups for the intent, purpose, and functionality and for further details. There are also specific optional interfaces for the public groups.

OPC Item

Within each Group the client can define one or more OPC Items. The OPC Items represent connections to data sources within the server. An OPC Item, from the custom interface perspective, is not accessible as an object by an OPC Client. Therefore, there is no external interface defined for an OPC Item. All access to OPC Items is via an OPC Group object that "contains" the OPC item, or simply where the OPC Item is defined.

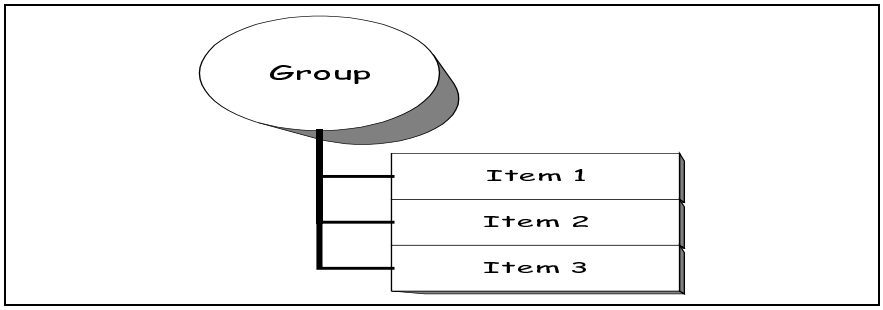

Fig. 1-2: Attribution of OPC Items to the OPC Group

Associated with each item is a Value, Quality and Time Stamp. The value is in the form of a VARIANT, and the Quality is similar to that specified by Fieldbus.

Note that the items are not the data sources - they are just connections to them. For example, the tags in a PLC controller exist regardless of whether an OPC client is currently accessing them. The OPC Item should be thought of as simply specifying the address of the data, not as the actual physical source of the data that the address references.

Custom and Automation Interface

OPC specifications always contain two sets of interfaces; Custom Interfaces and Automation interfaces. This is shown in.

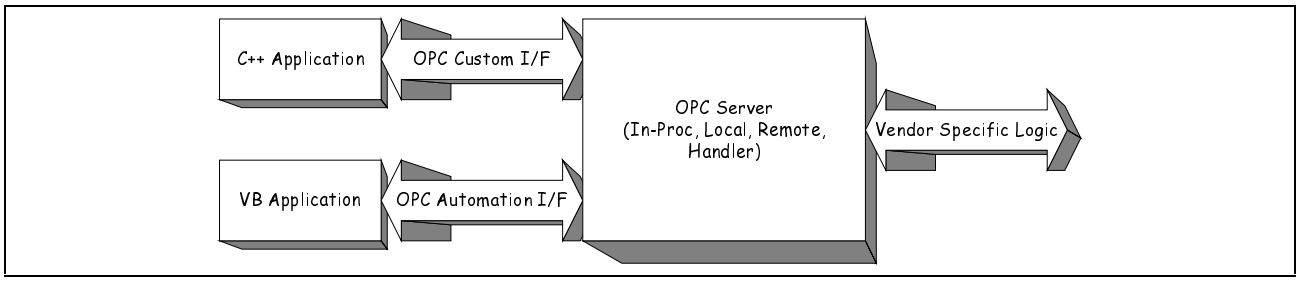

Fig. 1-3: Custom and Automation Interface

The OPC Specification specifies COM interfaces (what the interfaces are), not the implementation (not the how of the implementation) of those interfaces. It specifies the behavior that the interfaces are expected to provide to the client applications that use them.

Included are descriptions of architectures and interfaces that seemed most appropriate for those architectures. Like all COM implementations, the architecture of OPC is a client-server model where the OPC Server component provides an interface to the OPC objects and manages them.

There are several unique considerations in implementing an OPC Server. The main issue is the frequency of data transfer over non-sharable communications paths to physical devices or other data bases. Thus, we expect that OPC Servers will either be a local or remote EXE which includes code that is responsible for efficient data collection from a physical device or a data base.

An OPC client application communicates to an OPC server through the specified custom and automation interfaces. OPC servers must implement the custom interface, and optionally may implement the automation interface. In some cases the OPC Foundation provides a standard automation interface wrapper. This “wrapperDLL” can be used for any vendor-specific custom-server.

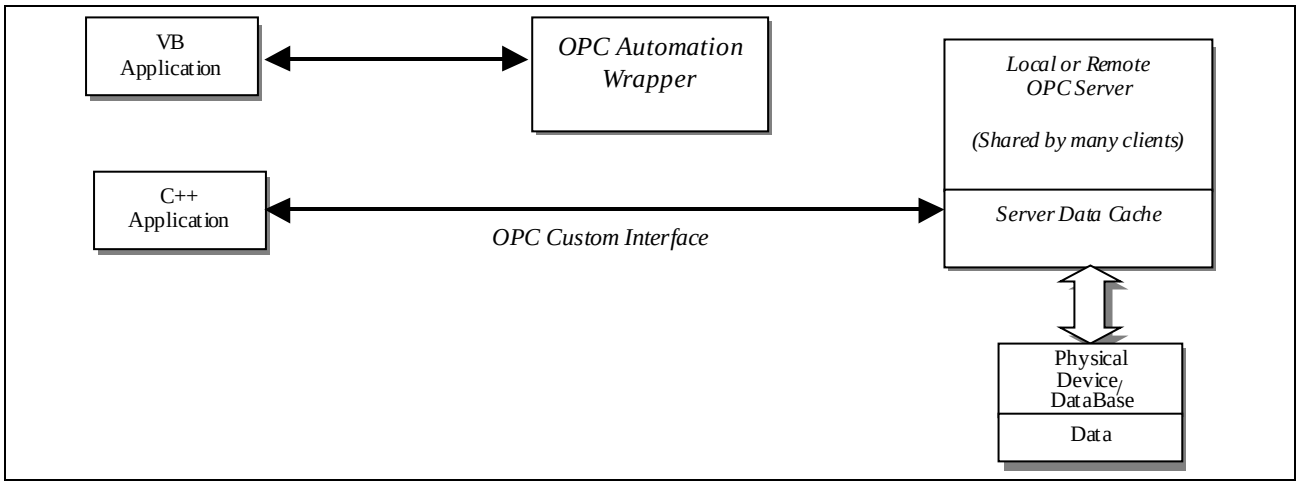

Fig. 1-4: Custom and Automation Interface

Local and remote servers

Distinction is made between

- **local servers** that only permit the access from local clients, and
- **remote servers** that can also be accessed via DCOM by clients of remote computers.

A local server can be implemented as a process-internal server (known as InProc or DLL server) or as a process-external server (known as Out-Proc, local or Exe server).

Out-Proc server

The OutProc server is an executable application. **OPCIndramat.exe** is started automatically via the COM mechanism when a client is linked with the Indramat OPC server. The OPC server is terminated automatically as soon as all interfaces of all clients are released. A remote server is always an OutProc server.

Multiple OPC clients may log on. Each client has an independent OPC server instance allocated.

The OutProc server consists of two parts: The functionality of the OPC server and the visual representation as a program.

InProc server

InProc servers have the advantage that no process limits are crossed for the data transfer between client and server. The disadvantage is that the server is a part of the client. Incorrect execution leads to a crash of the client, and vice versa.

The InProc server does not possess a screen output.

2 Properties of the Indramat OPC Server

2.1 General

Supported interfaces

The Rexroth Indramat OPC server supports

- Data Access Custom Interface standard version 2.03 (July 27, 1999), and,
- from Release 01V01 onwards, also Data Access Automation Interface standard version 2.02 (February 4, 1999).

This means that Visual C++ clients and Visual Basic (from Release 01V01 onwards) are able to read and write process data.

A detailed list of the supported optional interface objects is contained in Chapter 2.2 Data Access Custom Interface Standard.

Note: Please note that some items of version 1.0 of the Data Access Interface OPC specification are incompatible with version 2.0 of the specification.

The interfaces

- Alarms and Events, and
- Historical Data Access

are not supported at the moment.

Available server types

Rexroth Indramat provides all server types:

- Local InProc server
- Local OutProc server
- Remote server.

Special functions

The OPC standard functionality includes reading and writing of PLC variables. The Rexroth Indramat OPC server additionally offers

- access to CNC variables, CNC parameters and tool data,
- access to selected drive data, and
- commands for starting, stopping, and downloading NC programs.

Please refer to the publication of the Rexroth Indramat function interface [3] for a detailed description of all available commands.

Test and commissioning support

The Rexroth Indramat OPC server comes with a test client that enables communications with the controller to be checked at any time.

The data output of the OutProc server informs the user of the state of the OPC server.

2.2 Data Access Custom Interface Standard

The following tables specify the interfaces the Indramat OPC server supports. A detailed description can be found in the OPC specification [1]. The tables make reference to the corresponding Chapters if the utilization of the Indramat OPC server requires explanations.

If the "Option" column does not contain an entry, the interface is not an option and is supported by the Indramat OPC server.

Interfaces of the OPCServer object

Interface	Method	Option	Supported	Comment
IOPCServer	AddGroup		Yes	
	GetErrorString		Yes	See Chapter 2.3
	GetGroupByName		Yes	
	GetStatus		Yes	
	RemoveGroup		Yes	
	CreateGroupEnumerator		Yes	
IOPCServer PublicGroups		Yes	No	
IOPCBrowseServer AddressSpace		Yes	Partly	Only the "FLAT Space" property of this interface is supported
	QueryOrganization		Yes	
	ChangeBrowsePosition			Is not supported since only the FLAT property is supported.
	BrowseOPCItemIDs		Yes	
	GetItemID BrowseAccessPaths			Is not supported since no AccessPaths are supported. See IOPCItemMgt.
IOPCItemProperties				New in Version 2.0 of the OPC specification
	QueryAvailableProperties		Yes	
	GetItemProperties		Yes	
	LookupItemIDs		Yes	
IOPCCommon	SetLocaleID			New in Version 2.0 of the OPC specification
	GetLocaleID		Yes	
	QueryAvailableLocaleIDs		Yes	
	GetErrorString		Yes	see Chapter 2.3
	SetClientName		Yes	
IConnectionPoin Container				New in Version 2.0 of the OPC specification ConnectPointContainer for the IOPCShutdown interface. [1, Chapter 4.6.2]
	EnumConnectionPoints		Yes	
	FindConnectionPoint		Yes	
IPersistFile		Yes	No	

Fig. 2-1: Interfaces and methods of OPCServer

Interfaces of OPCGroup

Interface	Method	Option	Supported	Comment
IOPCGroupStateMgt	GetState		Yes	
	SetState		Yes	
	SetName		Yes	
	CloneGroup		Yes	
IOPCPublicGroup StateMgt		Yes	No	
IOPCASyncIO2 New in version 2.0 (of OPC specification)	Read			
	Write		Yes	
	Refresh2		Yes	
	Cancel2		Yes	
	SetEnable		Yes	
	GetEnable		Yes	
IOPCAsyncIO		Yes	No	Only in Version 1.0 of the OPC specification
IOPCItemMgt	AddItems		Yes	see Chapter 2.4
	ValidateItems		Yes	
	RemoveItems		Yes	
	SetActiveState		Yes	
	SetClientHandles		Yes	
	SetDatatypes		Yes	
	CreateEnumerator		Yes	
IConnectionPoint Container				New in version 2.0 of the OPC specification ConnectPointContainer for the IOPCDataCallback interface. [1, Chapter 4.6.1]
	EnumConnectionPoints		Yes	
	FindConnectionPoint		Yes	
IOPCSyncIO	Read		Yes	
	Write		Yes	
IDataObject		Yes	No	Only in Version 1.0 of the OPC specification
IEnumOPCItem attributes	Next		Yes	
	Skip		Yes	
	Reset		Yes	
	Clone		Yes	

Fig. 2-2: Interfaces and methods of OPCGroup

2.3 IOPCServer : GetErrorString

The GetErrorString method permits COM, OPC and Indramat error texts to be read. It converts an HRESULT value into an error text. The GetErrorString method is also contained in the IOPCCommon interface.

COM error

HRESULT values that are produced by COM are returned using FormatMessage, a WINAPI function. The language of the error texts is specified by the WindowsNT installation.

OPC error

The error texts of OPC HRESULT values are output in English only (see definition of constants in [1] Appendix A).

Errors of the Indramat function interface

Indramat error texts are returned with a standard error text.

For "custom error numbers", OPC HRESULT stipulates values with the ITF_FACILITY flag and code area 0x8000 – 0xFFFF.

Indramat function interface error numbers [3] are encoded in this area. GetErrorString can now be used for decoding this HRESULT value as an error text.

2.4 IOPCItemMgt : AddItems

This method is used for interconnecting function interface commands and OPC server. Below, the parameters are described an OPC client must transfer.

OPCITEMDEF structure

An "OPC Item" is defined using the OPCITEMDEF structure:

- szAccessPath is not supported
- szItemID required; function interface command, see below
- bActive required.
- hClient required
- dwBlobSize is not supported
- pBlob is not supported
- vtRequestedDataType required; the following VARTYPE are supported:

  VT_EMPTY
  VT_UI1
  VT_I2
  VT_I4
  VT_R4
  VT_R8
  VT_BSTR (base type "canonical datatype")

If VT_EMPTY is transferred as a value for vtRequestedDataType, the corresponding value for the PLC variable request (FI command **PVF**) is determined from the PLC and converted into a COM type (see table). VT_BSTR is returned if a corresponding type does not exist. Only *one-dimensional* arrays are supported. Structures cannot be converted because there is corresponding COM type here.

PLC type	COM type	Array
CHAR	VT_UI1	VT_ARRAY | VT_UI1
USINT	VT_UI1	VT_ARRAY | VT_UI1
Byte	VT_UI1	VT_ARRAY | VT_UI1
SINT	VT_I2	VT_ARRAY | VT_I2
INT	VT_I2	VT_ARRAY | VT_I2
WORD	VT_I2	VT_ARRAY | VT_I2
UINT	VT_I4	VT_ARRAY | VT_I4
DWORD	VT_I4	VT_ARRAY | VT_I4
DINT	VT_I4	VT_ARRAY | VT_I4
UDINT	VT_I4	VT_ARRAY | VT_I4
BOOL	VT_BOOL	VT_ARRAY | VT_BOOL
REAL	VT_R4	VT_ARRAY | VT_R4
Others	VT_BSTR	VT_ARRAY | VT_BSTR

Fig. 2-3: Conversion of the PLC data types in the OPC interface

The central parameter of the OPCITEMDEF structure is szItemID. Here, it corresponds to a function interface command, such as szItemID = "00_CC_PVF_int0", reading a PLC variable of the name of int0. The following peculiarities must be taken into account here:

1. The function interface distinguishes between a single read command (00_CR_..., 00_BR_..) and a cyclic read command (00_CC_.., 00__BC_..). This distinction is not made in the OPC server. This means that a read command can be opened by 00_CR_.., 00_BR.. or by 00_CC_..; 00_BC_.. (you should decide on one notation).
2. Since not every write command is also defined as a read command, a write command must be opened with 00_CW_.., 00_BW_.. .
3. A function interface command can supply several results (see, for example, 00_CC_APO_0_1_1 return value 1 = axis designation, value 2 = position value, and value 3 = device).

   In the default configuration, the result is interpreted and processed as a value. To avoid conversion errors, VT_BSTR should be employed as the standard item type.
4. The return value of a command with several results can be structured in a tabular form with lines and columns. This table is converted directly (1:1) if the client requests *vtRequestedDataType* = VT_ARRAY | VT_BSTR. A two-dimensional SAFEARRAY is generated with dimension = 1 as line and dimension = 2 as column.
5. Individual values of results can selectively be read with a command extension. To do this, you add the **{line, column}** specification after a function interface command.

   Example: `szItemID = "00_CC_APO_0 {1,2}"`

   See [3], Chapter ReadGroupItem] for the paramter value assignment of {line,column}.

2.5 Installation

Installation is performed by invoking the SETUP.EXE program on the install disk.

System requirements

Operating system: NT 4.0 SP5 or later. NT 4.0 SP3 is only sufficient if there is no access via DCOM.

Indramat User Interface Version 18V06 SP 1 or later.

Files and directories

The following files and directories are created during installation:

Directory	File name	Comment
	OPCIndramat.dll	InProc server
	OPCIndramat.exe	OutProc or remote server
LW:]\winnt\system32	OPCProxy.dll	Proxy/Stub DLL for marshaling the user-defined interfaces
LW:]\winnt\system32	OPCComn_ps.dll	Proxy/Stub DLL for marshaling the user-defined interfaces

Fig. 2-4: Installed files

Registrations

The Indramat OPC servers are self-registering COM servers. The registration is performed by the installation program. The Indramat OPC registration is performed after the OPC specification (see [1, 5] "Installation Issues"). After the installation, the System Registry contains the following entries:

Key	Value	Comment
HKEY_CLASSES_ROOT\OPC.Indramat		Version-independent ProgID
HKEY_CLASSES_ROOT\OPC.Indramat.1		Version-dependent ProgID
HKEY_CLASSES_ROOT\CLSID\ {37BBF4D0-DADF-11D2-84E4-0000C0EFA6D5}	CLSID_OPCIndramat = {37BBF4D0-DADF-11D2-84E4-0000C0EFA6D5}	CLSID of the OPC Indramat server
HKEY_CLASSES_ROOT\AppID\ {42E3B9C0-9E61-11D3-BF6C-00C04F5178B5}		
HKEY_CLASSES_ROOT\AppID\ OPCIndramat.exe		

Fig. 2-5: Entries in the System Registry

Using the CLSID, an OPC client can establish a connection to the server. Here, the OPC suggests a client connection via the component registration (see [4, Chapter 7] "**OPC Common Definitions and Interfaces**").

Manual registrations

Individual registrations can manually be created or deleted for service purposes.

InProc server

The InProc server (here OPCIndramat.dll) is registered using the **regsvr32.exe** utility. Regsvr32.exe is enclosed to each NT installation. It is in the [drive:]\winnt\system32 directory:

```
Regsvr32 opcindramat.dll
```

Deleting the COM server registration:

```
Regsvr32 /u opcindramat.dll
```

Out-Proc server

The OPCIndramat.exe server is registered by invoking the server with the following command line parameter:

`Opcindramat –regserver` or `opcindramat /regserver`

A corresponding error text is issued if the server cannot be registered.

Deleting the COM server registration:

`Opcindramat –unregserver` or `opcindramat /unregserver`

Proxy/Stub server

Two Proxy/Stub DLLs (OPCProxy.dll, OPCComn_ps.dll) are installed in the [drive:]\winnt\system32 directory and registered there for marshalling the user-defined interfaces.

These two DLLs should have at least the following functions.

- OPCProxy.dll Version 2,0,0,1
- OPCComn_ps.dll Version 1,0,0,2

Use the following procedure to read the version:

i. Use the Windows Explorer to select the DLL.
ii. Press the right-hand mouse button.
iii. Properties menu
iv. Dialog option field "Version"

Component categories

OPC [1, Chapter 5.1] suggests the registration of the OPC server under a component category. This registration is performed using the COM-CAT.DLL [drive:]\winnt\system32.

2.6 Communication Architecture

Communication with the controller takes place via the Indramat function interface (see Fig. 2-6: Indramat communication architecture). The OPC server logs on with the function interface. This may take several seconds. The connection to the function interface is closed when the server is terminated.

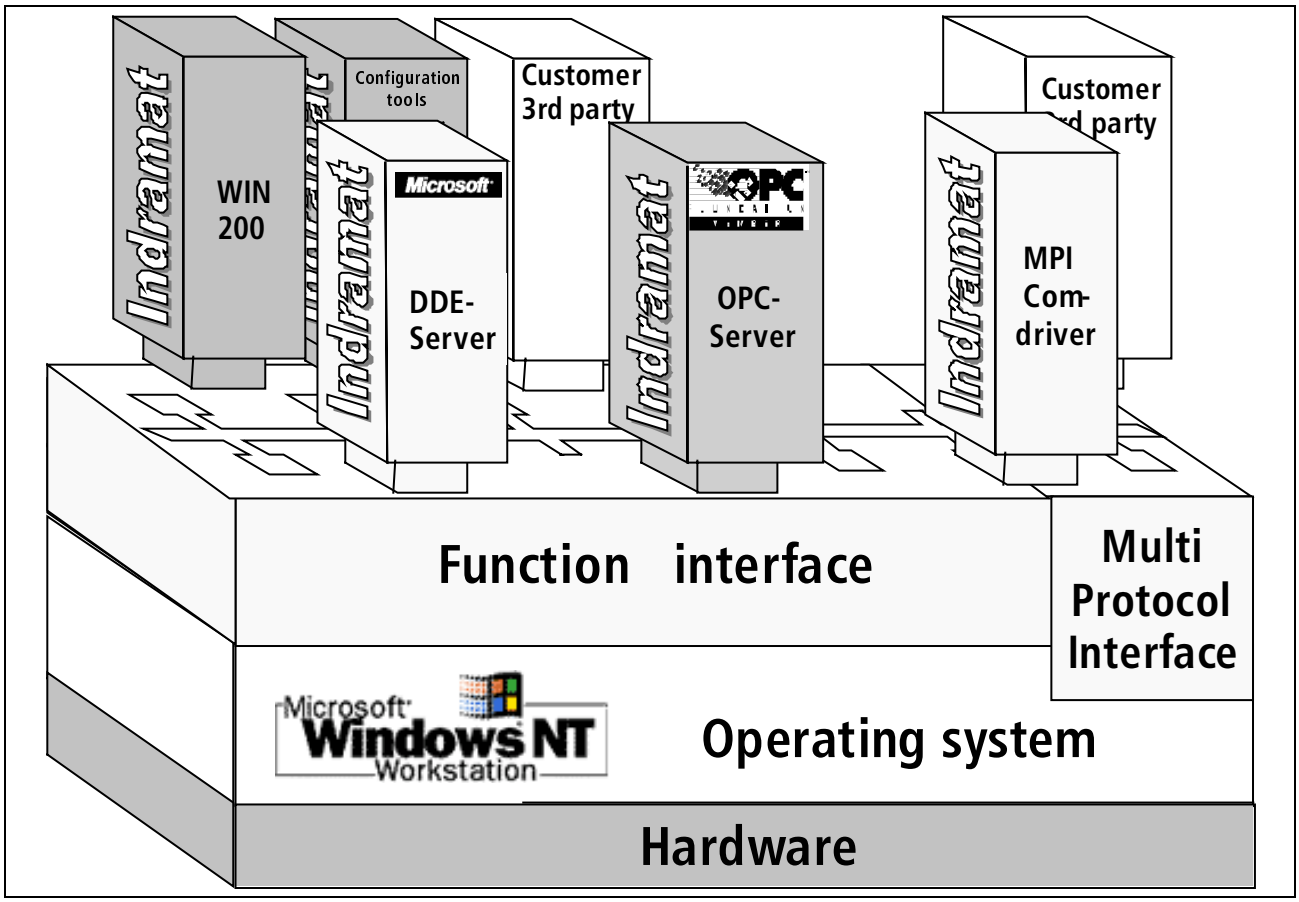

Fig. 2-6: Indramat communication architecture

Some function calls of the Indramat user interface (such as NC parameter download or PLC program download) require exclusive utilization of the communication link to the controller. While these functions are executed, the OPC server is set to OPC_STATUS_SUSPENDED status and group communication is interrupted. Once download has been terminated, the server is reset to its previous state and group communication is resumed.

The OPC server processes the following system messages for this purpose: [3; Chapter 3.5]:

- MSG_PCLUPDBEG
- MSG_PCLUPDEND
- MSG_PARUPDBEG
- MSG_PARUPDEND

2.7 The Indramat OPC Client Test

The Indramat OPC Client supports the functions according to he specification [1], and may be used for testing communications with the controller. The Indramat OPC Client is available with English user interface only.

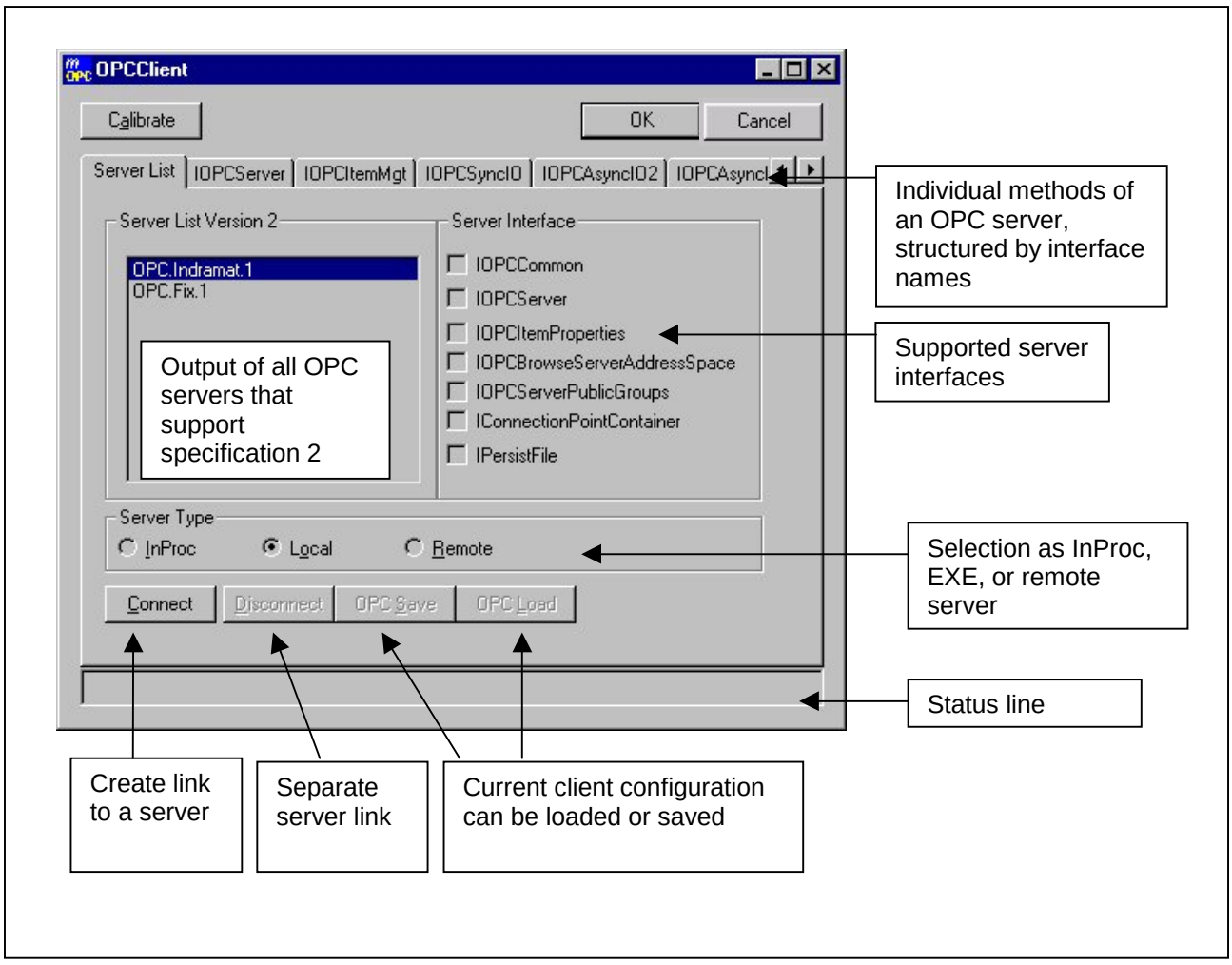

Fig. 2-7: Indramat OPC client

The Indramat OPC Client is structured such that the dialog pages that can be invoked via the register cards reflect the interface classes of an OPC server. The buttons of the main window have the following function:

OK Closes the dialog. If there is still a connection with an OPC server, this button is in an inactive state.

Abort Closes the dialog without taking notice of an existing connection. This button should only be used in an emergency.

Calibrate Invariable positioning of the window on the desktop.

Status line Output of information and error messages during program execution. HRESULT error messages can be read using the method IOPCServer :: GetErrorString (see OPCServer register card).

Dialog server list

Server list version 2 Once the Indramat OPC client has been started, all registered OPC servers are listed in the "Server list version 2" list box.

Server type From this list box, the user may select the server type:

- InProc DLL server
- Local Exe server
- Remote Access to an OPC server via DCOM

An input dialog is opened if a remote server is selected. This dialog can then be used for specifying remote computer name (TCP/IP number), domain name, user, and password.

Connect Once the server has been selected, Connect is used for establishing a link to the server.

Disconnect Shuts down an existing connection. You must ensure that all group lins are terminated beforehand (error message).

OPC Save This permits a client configuration to be saved. It saves group and item information.

OPC Load The data saved under OPC Save is read.

Server interface Following Connect, all interfaces are displayed that are supported by the selected OPC server.

IOPCServer Dialog

This dialog provides the functions for the OPC group management; the buttons correspond to the methods of the OPC interface class IOPCServer.

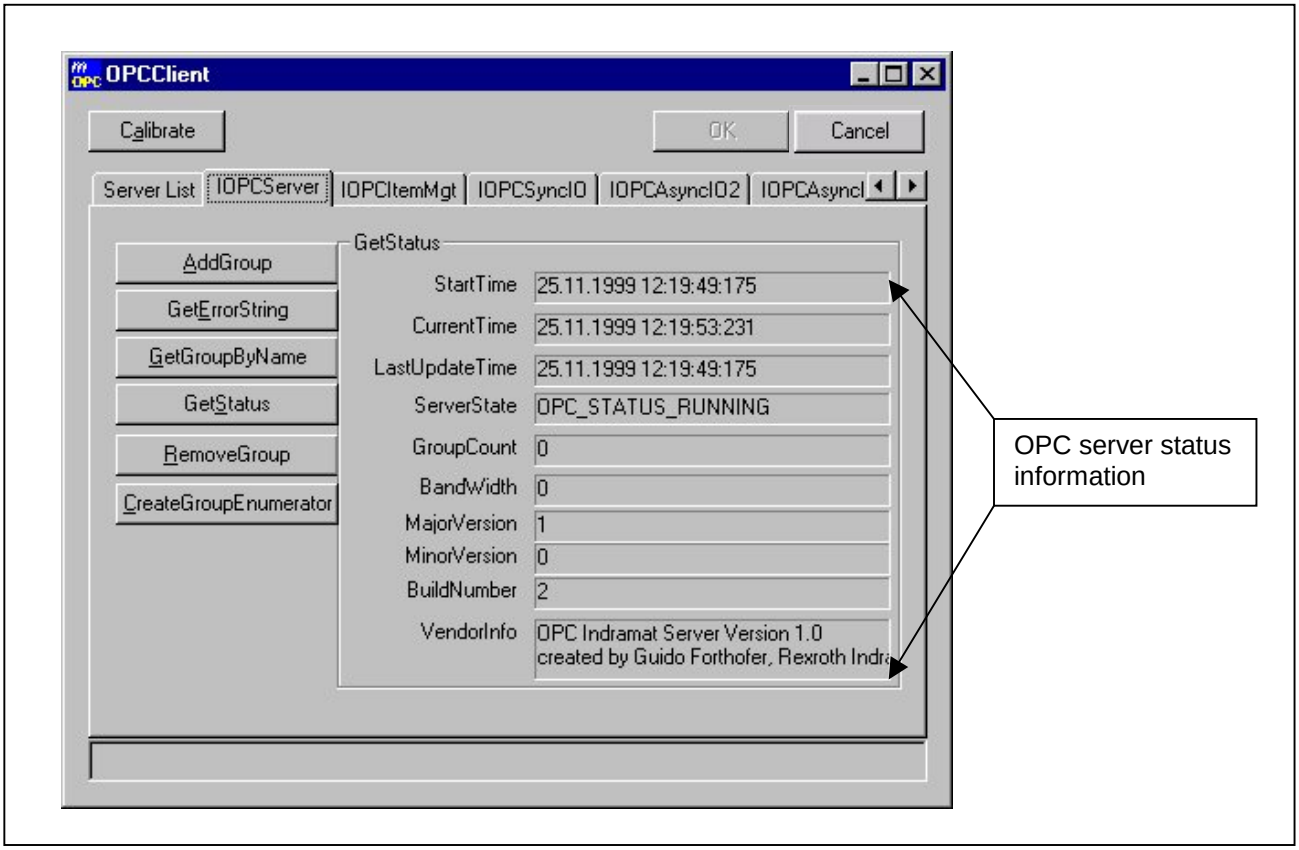

Fig. 2-8: Status display on the IOPCServer register card

AddGroup Creates a new group using the dialog shown in Fig. 2-9: Dialog Add Group. The updating rate is entered in msecs in the "Requested Update Rate" box. Press the AddGroup button to accept the data. Press the OK button to change back to the status overview.

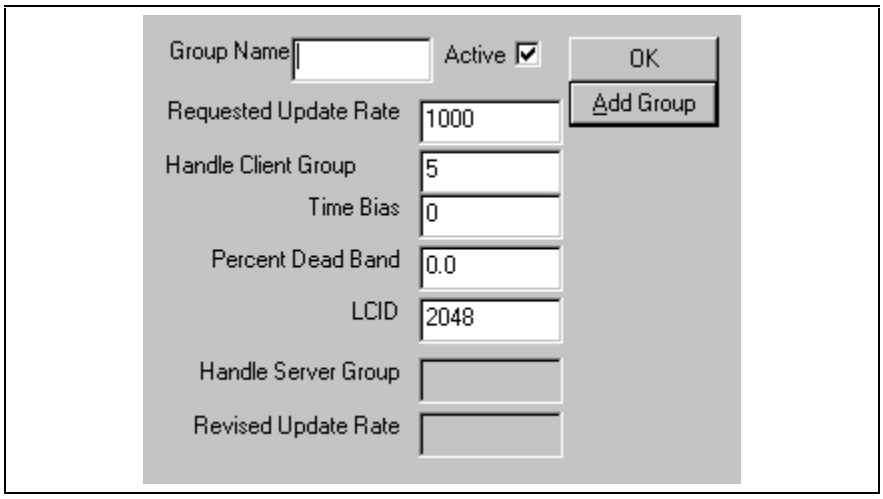

Fig. 2-9: Dialog Add Group

GetErrorString This method can be used for reading the error text of an HRESULT error code.

GetGroupByName Shows the supported interfaces for the specified group.

GetStatus Updates the values in the status display.

RemoveGroup Groups can be deleted via multiple selections. A green state shows that the group is deletable. A red state shows that items of the groups are still logged on.

CreateGroupEnumerator Creates a tabular overview of the properties of all groups.

Dialog IOPCItemMgt

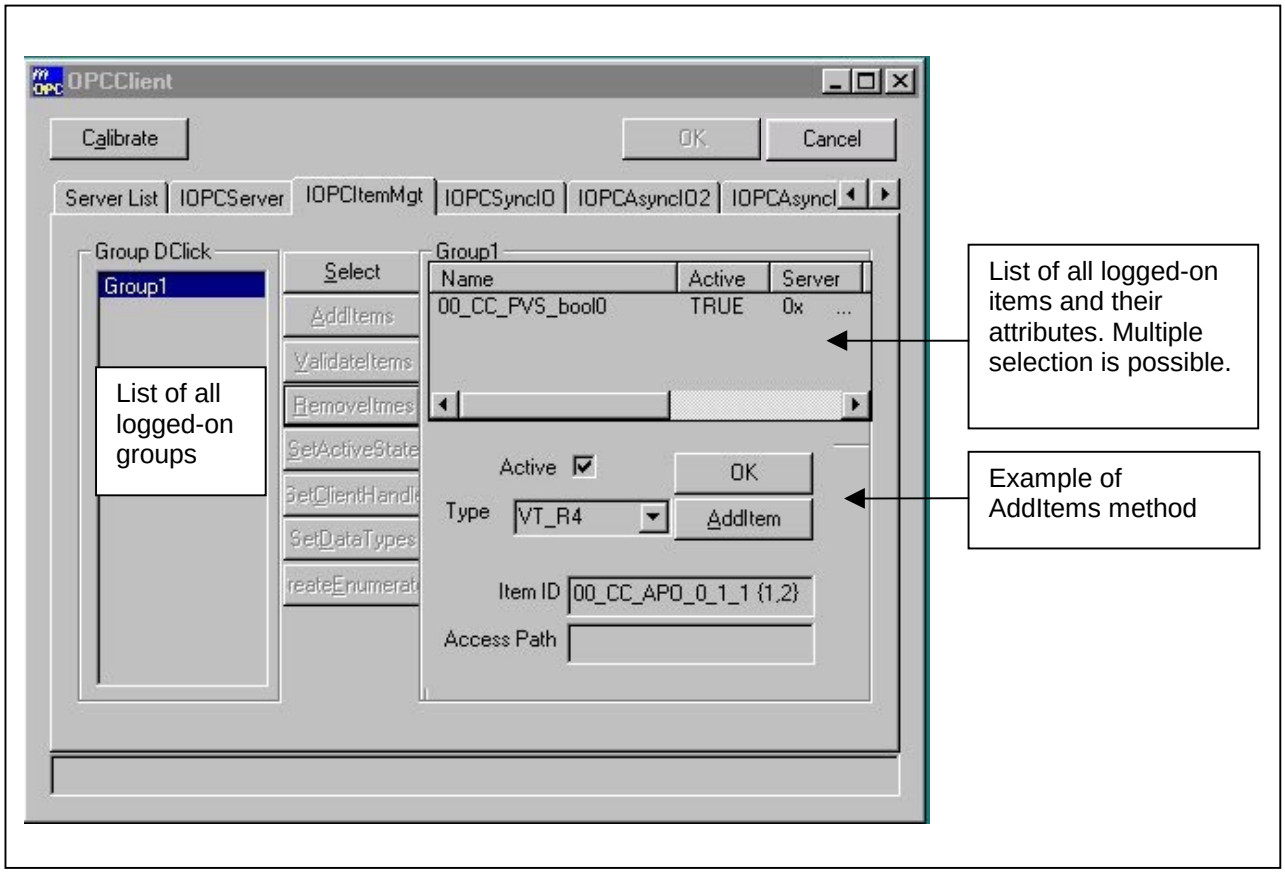

Fig. 2-10: Dialog for managing OPC items

Group DClick List of all groups that are logged on. To be able to execute the IOP-CItemMgt methods, you must first select a group (double click the mouse button or use Select button).

"Group names" list box Once a selection has been made, the items and their attributes are output in the list box (here: "Group1").

Select Selects a group from the list.

AddItems Adds new items to the selected group.

ValidateItems Is not supported.

RemoveItems Deletes the item selected from the item list.

SetActiveState Is not supported.

SetDataTypes Changes the data type of the item selected from the item list.

IOPCSyncIO dialog

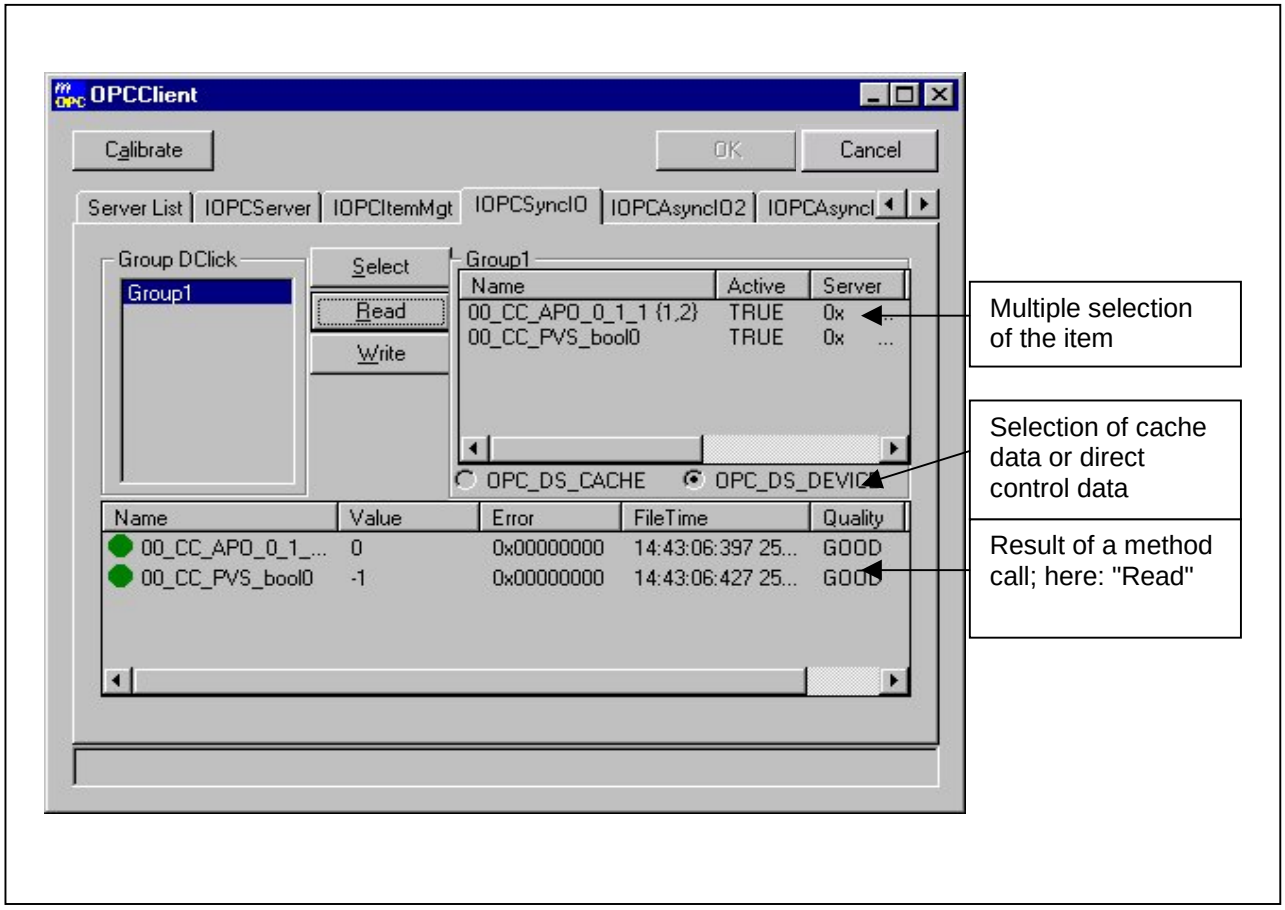

Fig. 2-11: IOPCSyncIO dialog

Select Selection of a group.

Read The read function is executed once the item has been selected. The result is displayed in the lower list box.

Write An input dialog is opened for each selected write value. After it has been entered, the data is transferred to the controller.

OPC_DS_CACHE Read data from the server cache

OPC_DS_DEVICE Read data directly from the controller

IOPCAsyncIO2 dialog

Due to the complexity of the asynchronous data request, the individual methods of the IOPCAsyncIO2 interface are distributed among several dialog pages.

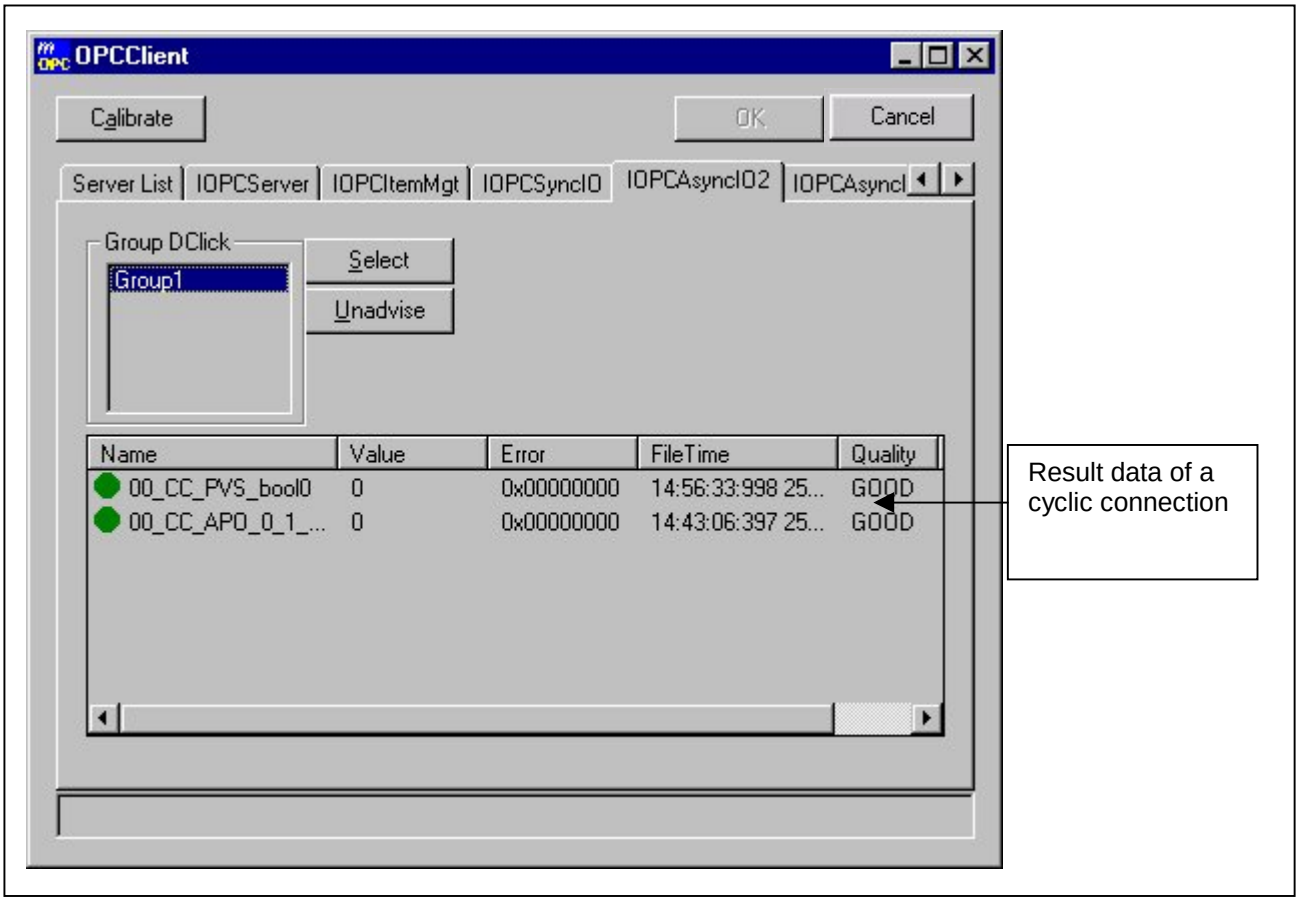

Fig. 2-12: IOPCAsyncIO2 dialog

Select Selection of a group. After the selection has been made, a link to the server is established via IOPCDataCallback or an existing link is visualized.

Unadvise An existing link via the IOPCDataCallback interface is cleared down.

IOPCAsyncIO2 Read Write dialog

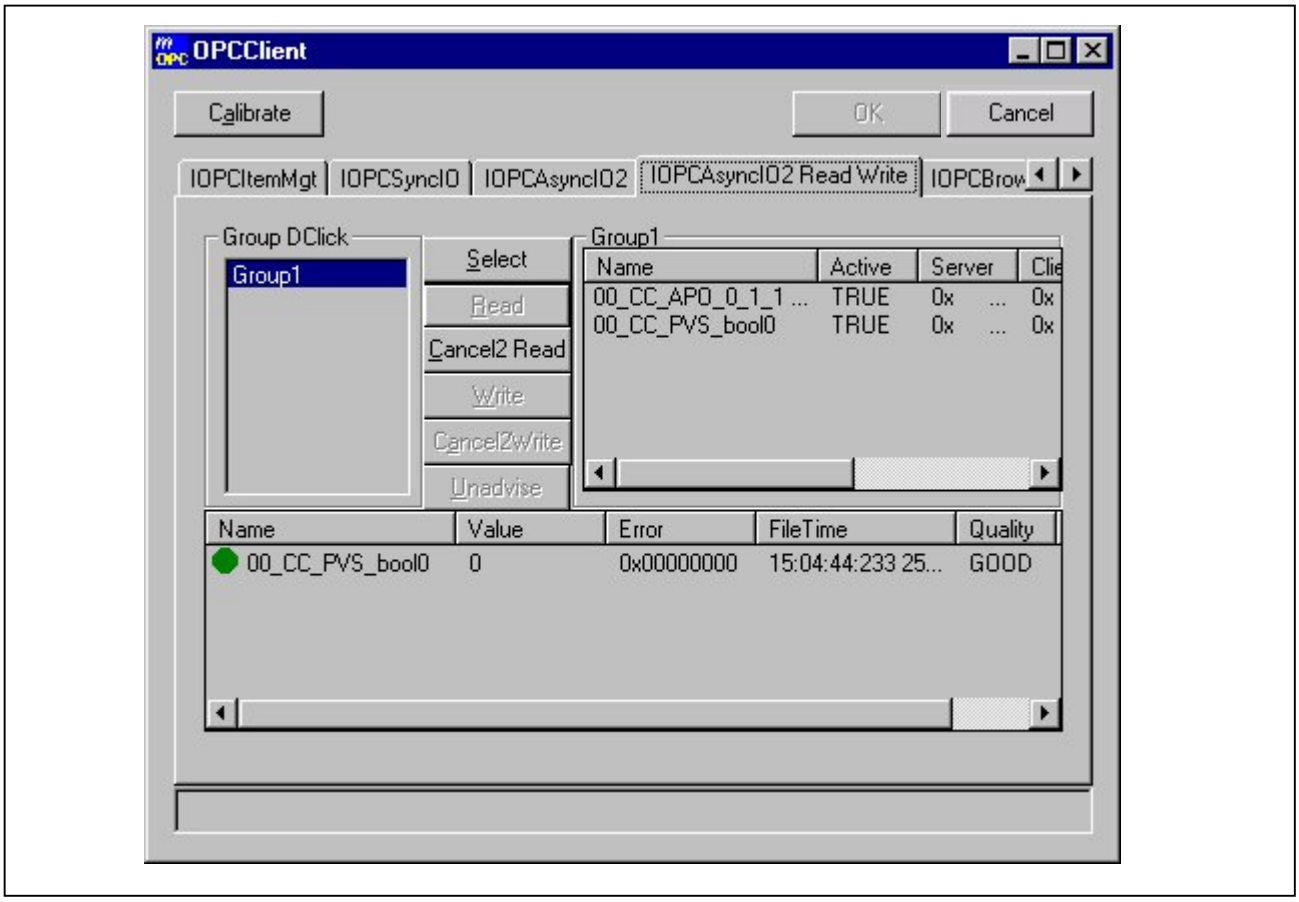

Fig. 2-13: IOPCAsyncIO2 Read Write dialog

Select Selection of a group.

Read After an item has been selected, the read function of the IOPCAsyncIO2 interface class is executed.

Cancel2 Read This aborts asynchronous reading.

Write After an item has been selected, the write function of the IOPCAsyncIO2 interface class is executed. This write function opens an input field for each write value.

Cancel2 Write This aborts asynchronous writing.

Unadvise An existing link via the IOPCDataCallback interface is terminated.

IOPCBrowseServerAddressSpace dialog

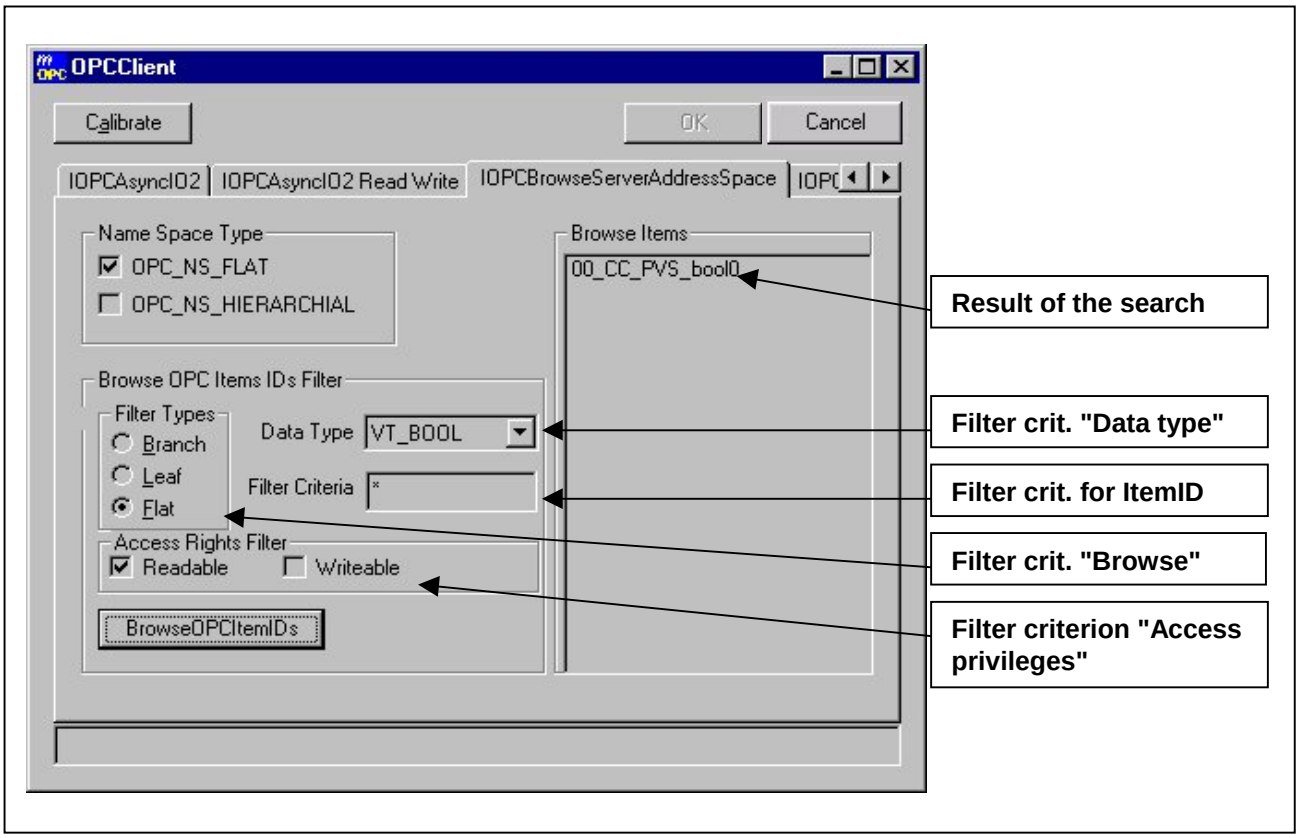

Fig. 2-14: IOPCBrowseServerAddressSpace dialog

This dialog is used for finding ItemIDs. The result consists of the conjunction of all criteria.

Filter criteria

Data Type: Search for a specific data type. Example VT_BOOL. Default value = VT_EMPTY

Filter Criteria: Text search; distinction between capital and small letters is not supported. Default value = "*" or "".

Access Rights Filter: Search for the corresponding access privileges. Default value = Readable

Filter Types: Selection of the browse methods. Default value = Flat

BrowseOPCItemIDs Starts a search request.

IOPCGroupStateMgt dialog

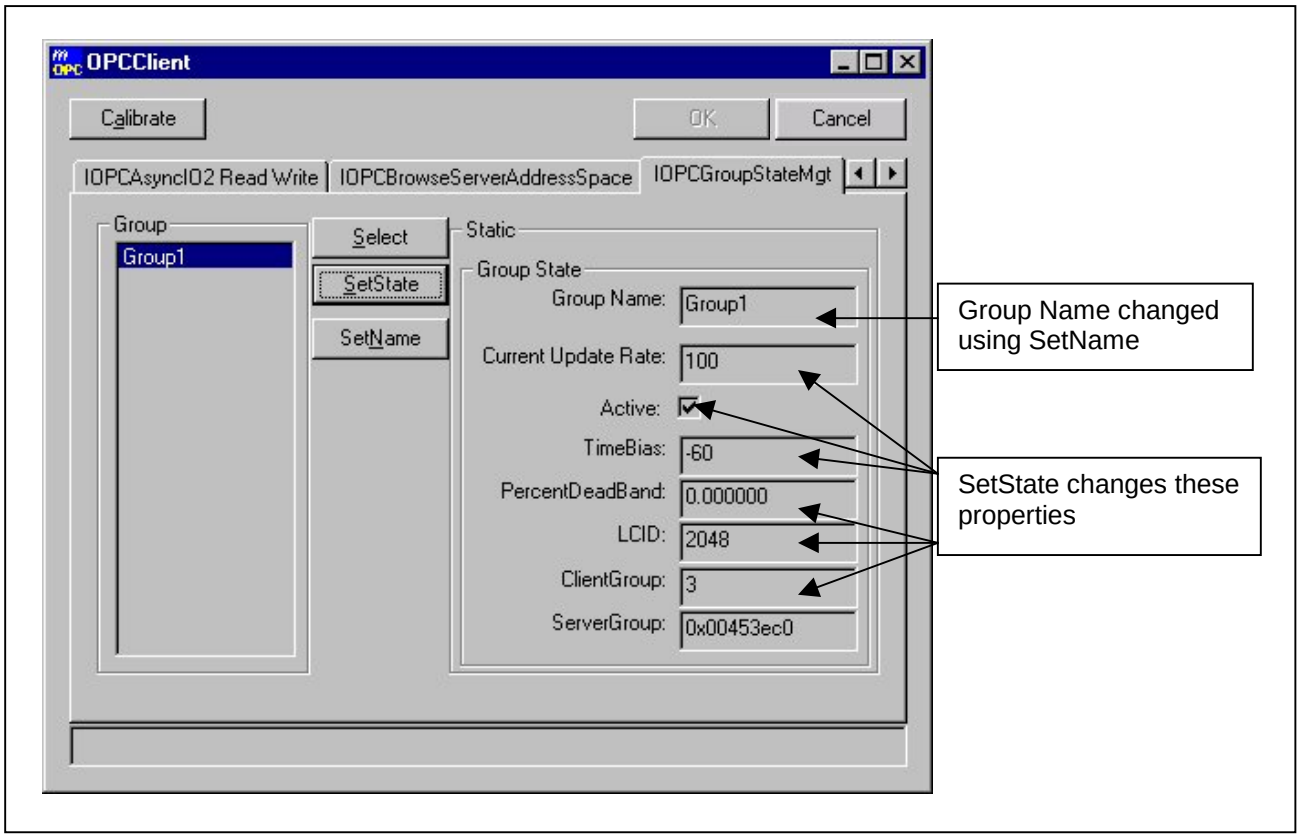

Fig. 2-15: IOPCGroupStateMgt dialog

The group properties can be changed here.

Select Selection of a group.

SetState This function permits the following properties to be modified:

- RequestedUpdateRate
- Active
- TimeBias
- PercentDeadband
- LCID
- ClientGroup

SetName Modification of the group name. It must be ensured that the same group name is not allocated repeatedly.

2.8 OPC Server Desktop

The program desktop is subdivided into three parts:

- The main window with menu, tool bar and status line
- The windows with all client links in a tree structure
- The information window

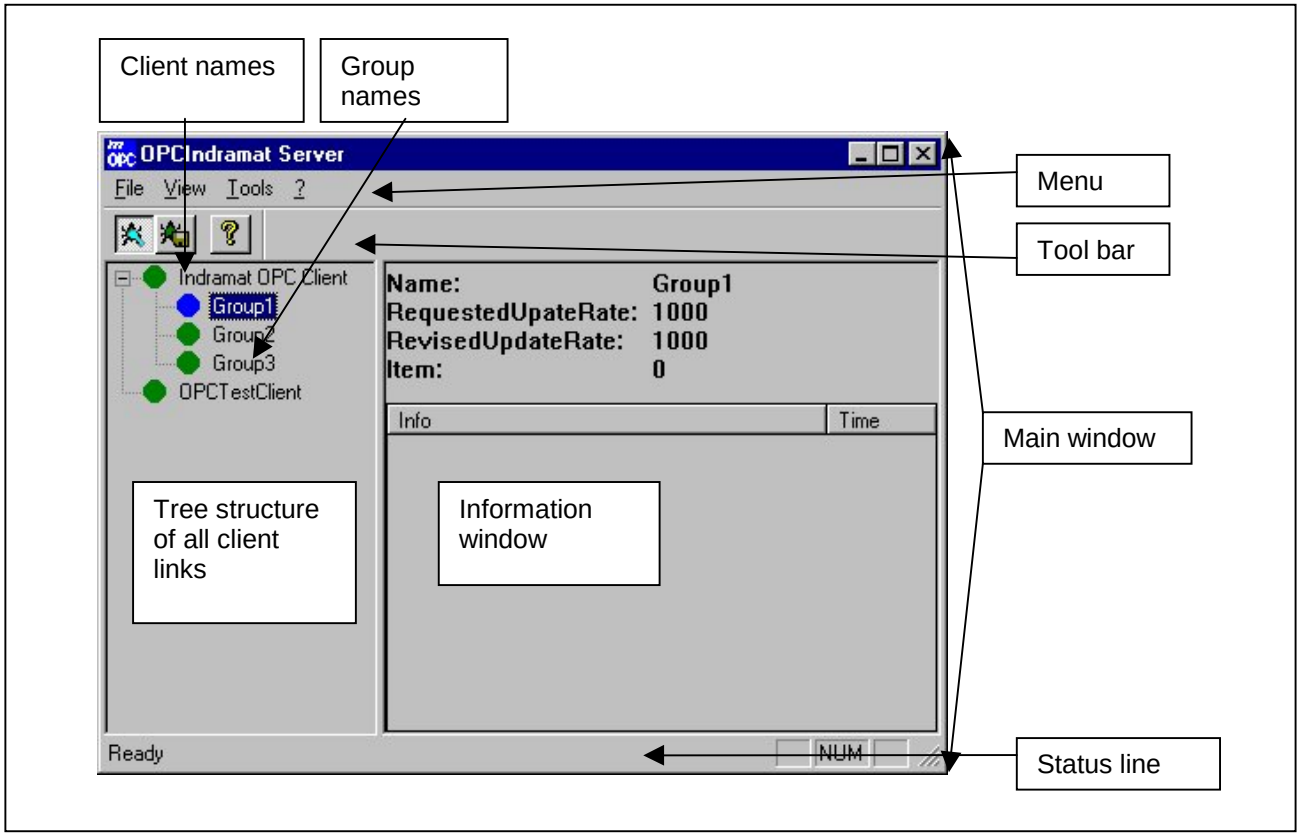

Fig. 2-16: OPC server desktop

Main window

File menu
- *Exit*: This menu item should only be invoked in an emergency (if, for example, the client crashes before it closes the connection).

View menu
- *Tool bar*: Displays and hides the tool bar.
- *Status bar*: Displays and hides the status line.

Tool menu
- *Trace Output*: Opens a list box in the lower part of the information window. Trace outputs are logged in this list box. To minimize the trace outputs, use the mouse for selecting a group or a client. The selection is marked by a blue bit map. Only up to 100 outputs are stored in the list box. The box is cleared once this number has been reached.
- *Trace File*: Here, basically the same is true as it was said under Trace Output. Merely the data is output into the "OPCInfo.txt" file.

? menu
- *About OPCIndramat*: Program and copyright information

Tool bar Here, it corresponds to the menu items *Tool menu* and *? menu*.

Status line Information output from the server

Window with the client connections

All client data items are output in a tree structure (a branch corresponds to an OPC client). The groups are shown as leaves beneath the branch. The figure above shows two clients that have logged on as "Indramat OPC Client" and "OPCTestClient". The first client possesses three groups with the group names "Group1", "Group2" and "Group3".

The bit maps are used as status display:

- *Green*, active state
- *Red*, inactive state
- *Blue*, selected branch, double click of the mouse
- *Yellow with exclamation mark*, suspended state (e.g. PLC download system message via function interface).

Information window

The information window is subdivided into two areas: The status information of the selected server or group, and a list box for the trace outputs. The list box is only visible if the *Trace Output* menu has been selected.

3 Development of an OPC Client

3.1 Error Handling

HRESULT error

OPC errors are transferred from the server to the client as "HRESULT values". A HRESULT value is of the following structure:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16
Sev		C	R	Facility											

Fig. 3-1: Structure of the HRESULT values

Sev: Severity Code (00 successful, 01 information, 10 warning, 11 error)

C Customer fault flag

R Reserved

Facility Facility code; there are some constants here (see [5])

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Code															

Fig. 3-2: Structure of the HRESULT values (continued)

Code Facility status code

The OPC server employs the constant FACILITY_ITF as the facility code to indicate errors.

The "code" is subdivided into several ranges:

0x0000 – 0x0200	Reserved Microsoft codes, OPC 1.0 error codes
0x0200 – 0x7FFF	Reserved OPC Foundation
0x8000 – 0xFFFF	OPC server error codes

Fig. 3-3: Structure of the facility codes

The Indramat OPC server employs the Indramat function interface as communication means. These errors are now converted into HRESULT values in the OPC server.

The Indramat function interface now has the problem of routing onwards the errors of employed components. This is done using an enhanced error system.

Since these error numbers depend on the employed components, an HRESULT error code is dynamically assigned in the Indramat OPC server. This error code is in the range 0xEEEE – 0xFFFF.

The error proper can be determined using this HRESULT value and the *GetErrorString* method.

3.2 DCOM Configuration

If you are thinking about a remote link between client and server, you must also take the security of a link into consideration since client and server are implemented in different computers.

There are two different security models for client-server connections. The reason of these two models is in the fact, that, for example, COM must also run in systems where there is no NT-specific security (such as Windows 95 or Windows 98).

COM security model

The security under COM is subdivided into different applications:

- *Activation control* defines who is allowed to start the execution of components.
- *Access control* is used for controlling the access to the objects of a component after this component has been started.
- *Authentication control* is used for verifying the privileges required for a network transfer and for protecting the data from unauthorized viewers.
- *Identity control* defines the security references that shall be used for controlling the components.

The security settings of a COM component are configured in two different ways:

- As declarative security settings
- As program-controlled security settings

Declarative security

Declarative security settings are configured in the registration, independently of the component's code (system administrator). These settings are made using a DCOM configuration program (dcomcnfg.exe). The user must possess system administrator privileges for this purpose. The following security settings can be configured: Activation, access, authentication, and identity change.

Note: Activation and identity security settings can ***not*** be defined in a program-controlled way. These settings must be defined before the corresponding component has been started.

This information can be allocated to two categories:

- *Standard security* concerns the security settings of all components that can be executed in the local computer.
- *Component-related security settings* are only valid for a specific component. The default security settings are overwritten.

The default security settings and the component-related security settings can both be overwritten by program-controlled security settings (see below).

Standard security

Start / execute and dcomcnfg.exe starts the DCOM – configuration program. Once the program has been started, the dialog window with the list of all configurable components is displayed (see Fig. 3-4: DCOM configurator: Component list).

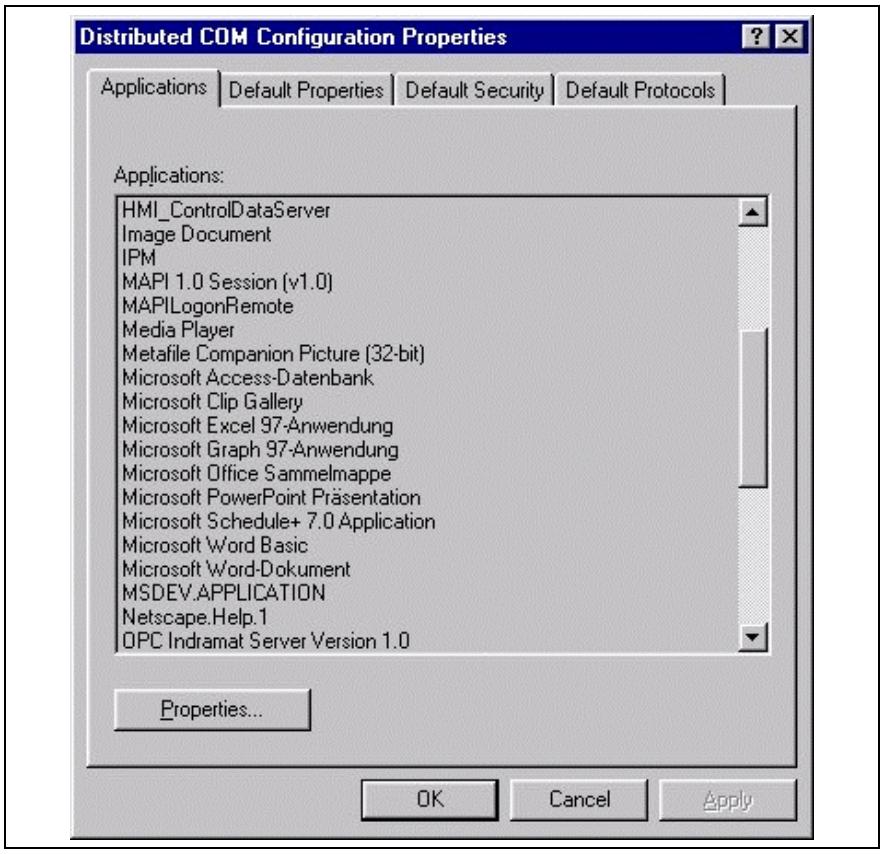

Fig. 3-4: DCOM configurator: Component list

Standard properties

Using the standard properties (see Fig. 3-5: DCOM configurator: Standard properties), the administrator can define the settings for authentication and identity change throughout the computer.

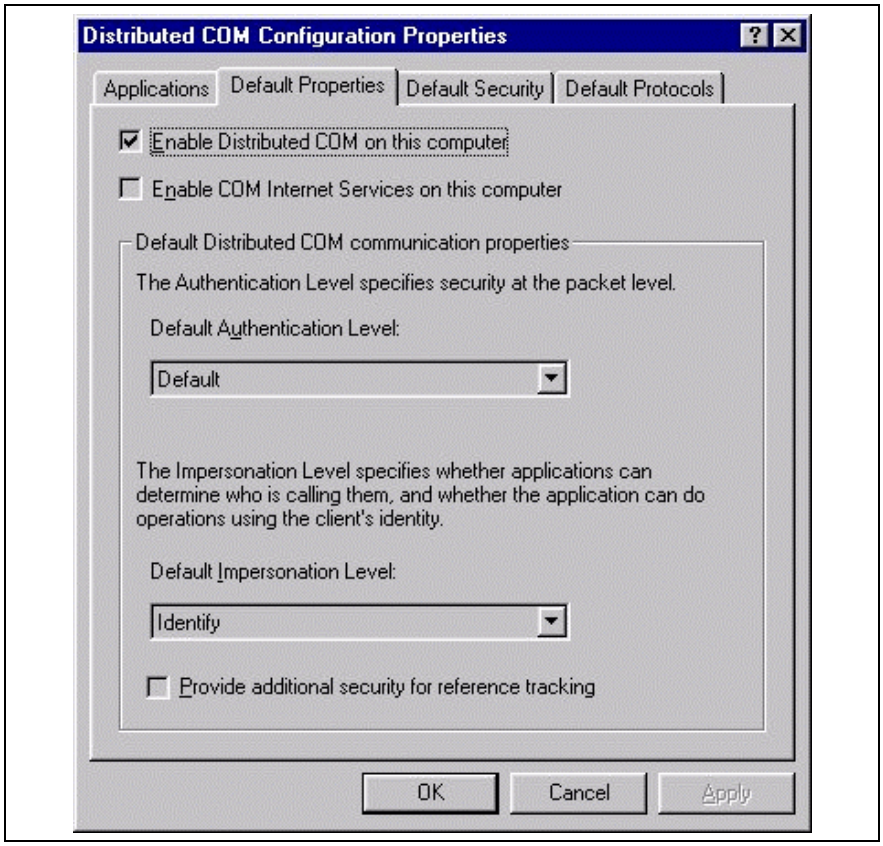

Fig. 3-5: DCOM configurator: Standard properties

Activating DCOM (Distributed COM) option in this computer

The *Activating DCOM (Distributed COM) in this computer* option is the main switch for the DCOM settings. All incoming and outgoing remote calls of the computer are rejected if this check box is not activated. This option is activated when the system is installed for the first time.

Authentication level

The *default authentication level* defines the basic authentication level of this system. Each component can overwrite this value.

Authentication level	Description
Default	Currently, this corresponds to the authentication on link level.
None	No authentication
Connecting	The client is authenticated once only when it establishes a link to the server for the first time.
Calling	The client is authenticated at the beginning of each remote invocation.
Packet	The system authenticates that all received data items come from the client from whom they are expected.
Packet integrity	All data items are authenticated, and it is ensured that the data has not been modified during the transfer between client and server.
Packet privacy	All parameters that are transferred in remote calls are authenticated, verified and encoded.

Fig. 3-6: DCOM configurator-default properties: Possible authentication levels

Identity change level

The *default identity change level* option defines the basic identity change level clients grant to their servers in this system. It is assumed that no component overwrites this value.

From the client's perspective, the identity level *Anonymous* is the safest setting because here the component is unable to obtain any information about the client.

The *Identify* level is selected as the default value.

Default identity change level	Description
Anonymous	The server is anonymous to the client. The server is not in a position to determine the client's identification data and is therefore unable to pass itself off as the client.
Identifying	The server is able to determine the client's identification data. For the purpose of ACL transfer, it can identify itself as the client, but it cannot access system objects as a client.
Representing	The server is able to simulate the client's security concept whilst it acts as a representative of the client.
Delegating	The server is able to simulate the client's security concept whilst it invokes other devices as a representative of the client.

Fig. 3-7: DCOM configurator-default properties: Identity change levels

Default security

The default security dialog is used for configuring the default access and default start privileges throughout the computer.

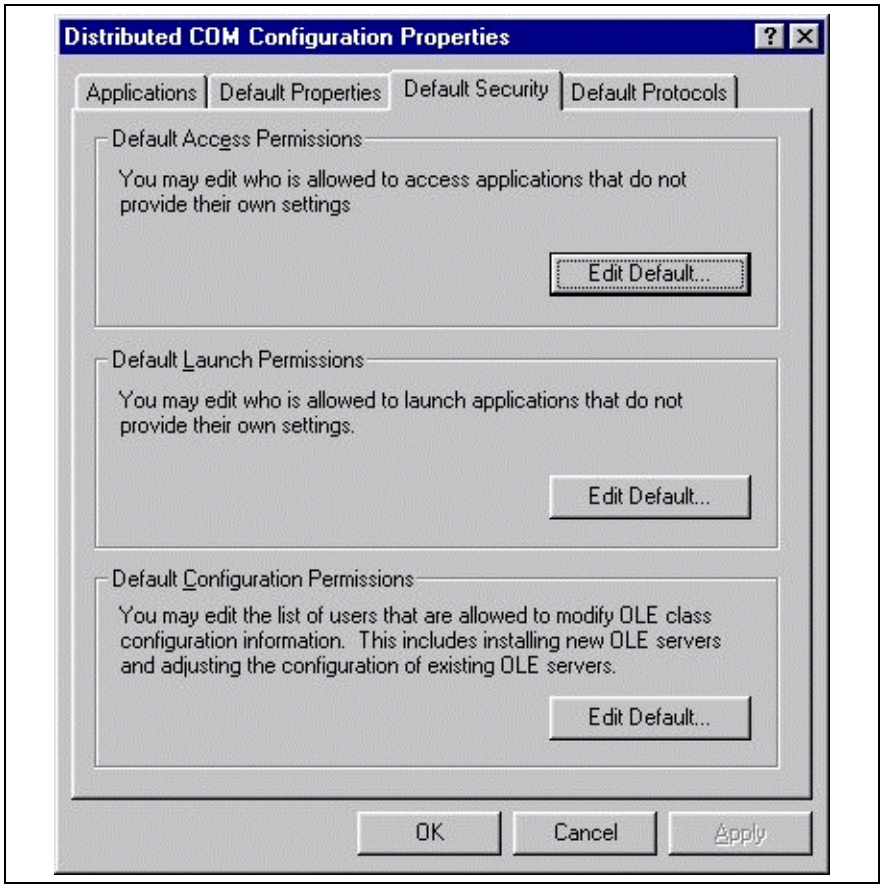

Fig. 3-8: DCOM configurator: Default security dialog

These settings are used by components that do not provide their own settings. Pressing the *Change default* button under *Default access privileges* displays a list of the users and user groups that may implicitly have a privilege granted or denied.

All entries can be found in the system registration under HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Ole. The following values are of interest here:

HKEY_LM\SOFTWARE\Microsoft\Ole	Description
DefaultLaunchPermission	Defines who is allowed to start components. Default may start administrator, system account and interactive user component.
DefaultAccessPermission	Defines who is allowed to access the component. The default value is empty.
LegacyAuthenticationLevel	Defines the default authentication level (default or connecting).
LegacyImpersonationLevel	Defines the default imitation level. The default value is identifying.

Fig. 3-9: Default security settings in the system registration

Note: Any modifications of the default settings will only take effect after the computer has been rebooted.

Component-related security settings

These component-related security settings overwrite the computer-wide default settings. All these entries are stored in the system registration under the *AppID* of the components.

HKEY_CLASS_ROOT\AppID\{AppID of the component}.

The following four values correspond exactly to the four areas of the COM security model (start, access, authentication, and identity control).

AppID values	Description
LaunchPermission	Defines who is allowed to start the component.
AccessPermission	Defines who is allowed to access the component.
AuthenticationLevel	Defines the authentication level of the component.
RunAs	Defines the user account that controls the execution of the component.

Fig. 3-10: Component-related security settings

The component-related security settings can be reached by selecting the component in the component list (invoked via the applications register card - see Fig. 3-4: DCOM configurator: Component list), and pressing the *Property* button. Clicking on the register card *Security* shows the dialog that is represented in Fig. 3-11: DCOM configurator: Component-related security settings.

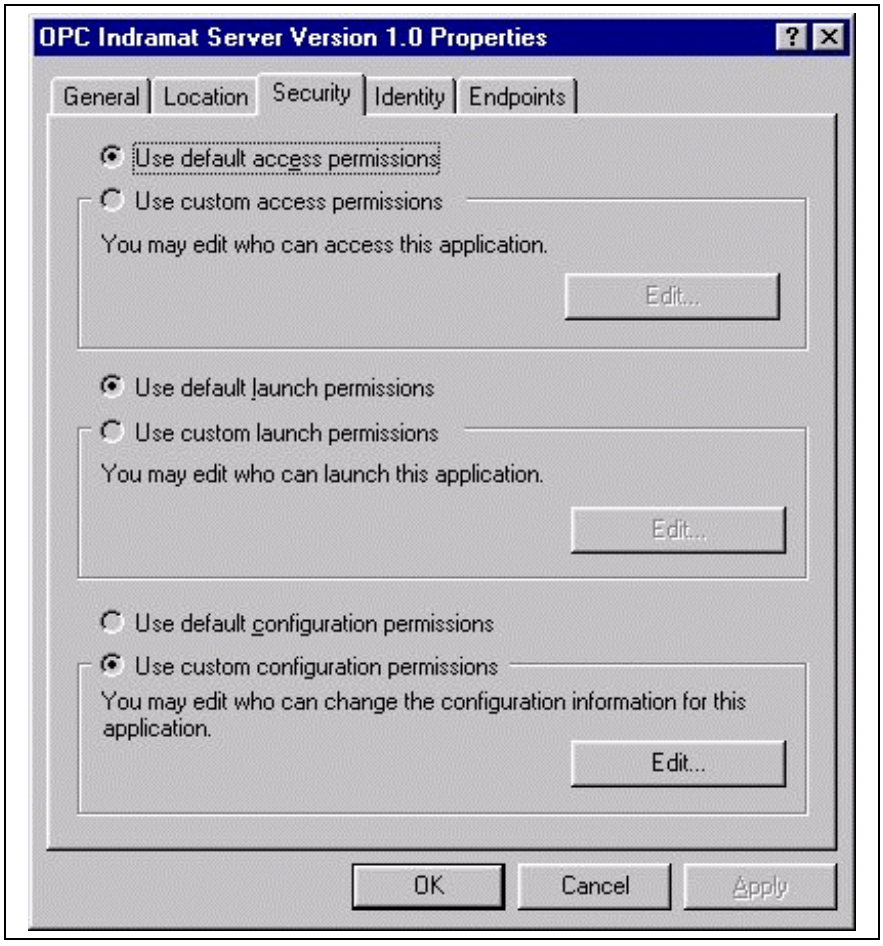

Fig. 3-11: DCOM configurator: Component-related security settings

These options concern the values *AccessPermission* and *LaunchPermission*. The default privileges accept the default values. Thus, only administrator, system account, or interactive user may have access after a first-time installation.

For **anonymous activation** and **anonymous access**, the following user values (*Any*) must be defined for start and access privilege and authentication level on the setting *None* (RPC_C_AUTH_LEVEL_NONE).

Identity

Identity defines under whose control the component shall be executed.

On the *Identity* register card, there are three options for the definition of the user account: *Interactive user; user who starts the application;* and *This user*. Any modifications that were performed concern the value *RunAs* of the AppID.

User who starts the application is used as default of the component's identity setting. This value is not entered as *RunAs* for the AppID. This setting means that the security references of the client process are used during the execution of the component. Components with this identity contain incomplete security references (for example, remote calls to other computers are not possible or common files in the network cannot be accessed).

When the identity *Interactive user* is selected, the component is executed under the control of the currently logged-on user. Three problems result with this setting:

- The component can only be executed when a user has logged on.
- It is not previously known who has logged on.
- The component "dies" if the user logs off during execution.

The option *This user* defines that the component shall be executed under the control of a special user account.

A user account COM employs for log-on purposes must have the special privilege *Log on as batch processing job* assigned. Otherwise, COM will not be able to successfully log on using this account.

This privilege **Log on as batch processing job** is assigned with the help of the user manager: User manager / guidelines / user privileges and activate displaying further user privileges.

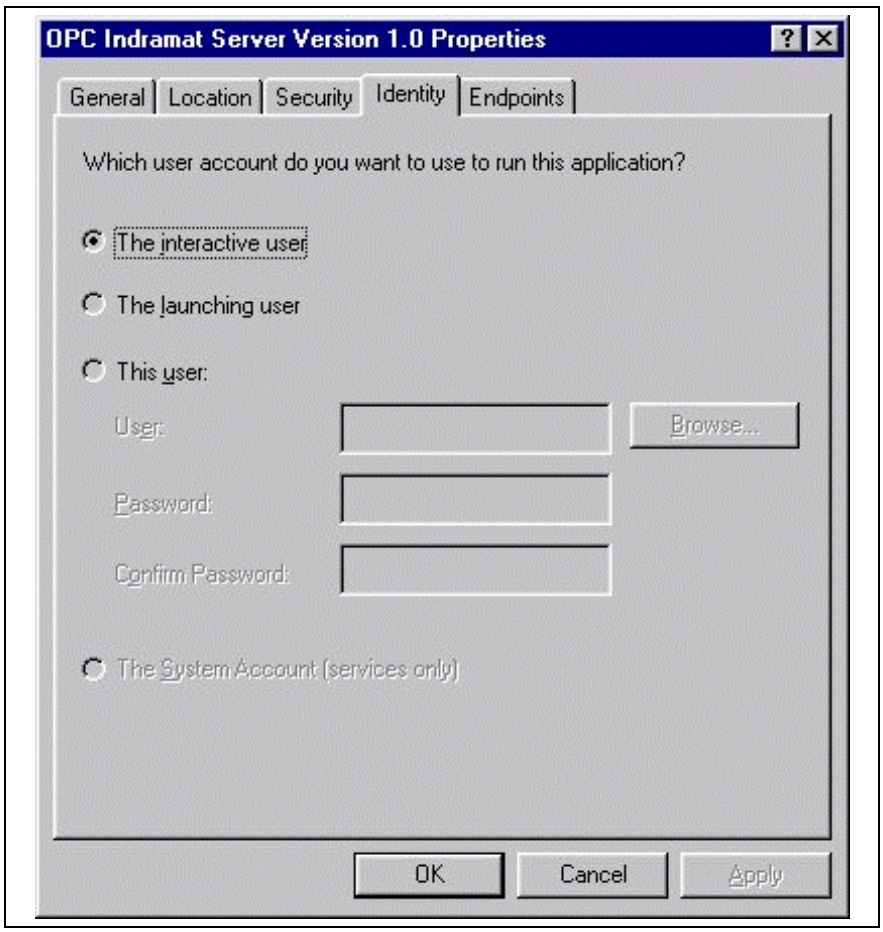

Fig. 3-12: DCOM configurator: Component-related identity settings

Program-controlled security

The developing engineer integrates *program-controlled security settings* into a component.

Configuring security settings in the registration offers certain advantages: It does not require any special precautions at the side of the component developer and it gives the administrator a higher flexibility in configuring the security settings.

For most components, a combined approach is the best choice.

CoInitializeSecurity function

CoInitializeSecurity defines the default security values of a given process. If a process does not invoke this function itself, COM automatically initiates the invocation of the function. Thus, COM determines the security setting from the registration.

The *dwAuthnLevel* and *dwImpLevel* parameters are the two most important transfer parameters of the above-mentioned function.

In the invocation of *CoInitializeSecurity*, the *Client* employs the *dwAuthnLevel* parameter to declare the default authentication level it wants to use for outgoing calls. The settings specified by the *component* in the invocation of *CoInitializeSecurity* with the *dwAuthnLevel* parameter define the lowest level on which client calls are accepted.

In each connection between a client and a component, COM determines the authentication setting of the parties and automatically defines the higher of the two settings as the authentication level. Consequently: *dwAuthnLevel* client >= *dwAuthnLevel* server. The following settings are valid for ConnectioPoints: *dwAuthnLevel* client == *dwAuthnLevel* server.

Anonymous access is permitted with the following settings: The first parameter of *CoInitializeSecurity* is initialized with ZERO and *dwAuthnLevel* is set to flag RPC_C_AUTHN_LEVEL_NONE.

In the invocation of *CoInitializeSecurity*, the client employs the *dwImpLevel* parameter to define the default identity change level the client wants to grant the components. This value is not used at the server side.

Program-controlled security in the Indramat OPC server

As described in the OPC interfaces, not only the function calls from the client to the server must be verified, but also the function calls from the server to the client. The server employs the *IConnectionPoint* and *IOPCAsyncIO2* interface classes for invoking functions of the client.

Due to this interrelation, the Indramat OPC server employs *CoInitializeSecurity* with the following parameters, and tolerates any OPC client invocation.

```
CoInitializeSecurity (NULL,                          //pVoid
        -1,                                          //cAuthSvc
        NULL,                                        //asAuthSvc
        NULL,                                        //pReserved1
        RPC_C_AUTHN_LEVEL_NONE,                      //dwAuthnLevel
        RPC_C_IMP_LEVEL_IMPERSONATE,                 //dwImpLevel
        NULL,                                        //pAuthInfo
        EOAC_NONE,                                   //dwCapabilities
        NULL);                                       //pvReserved2
```

Possible configuration

As it is obvious from the previous Chapters, a DCOM configuration is very complex since the declarative and program-controlled settings can influence the security and, consequently, the communication of client / server.

Furthermore, a diagnosis on the basis of the COM - HRESULT value is more difficult as a COM error message may have several causes. To facilitate an error diagnosis, you should therefore adhere to the following configuration steps.

Windows NT service packs (SP)

Windows NT 4.0 and SP 5 or later should be installed. Some settings are not possible with SP 3.

Network configuration

The client and server computers should be entered in a common domain. A common user with the same password must be entered in both computers. The user interface version and/or the OPC server shall be installed under this user.

The default transfer protocol must be replaced at the server side. The default value is UDP/IP. It should be changed to TCP/IP. Move it simply upwards in the displayed list (SP 5 or later). The reason of this replacement is a Microsoft error between DCOM and UDP/IP. The *DCOMCNFG.EXE* configuration program must be used here.

Declarative setting

These settings must be performed at the client side and at the server side. Once *DCOMCNFG.EXE* has been executed, select the OPC server "OPC Indramat Server Version 1.0" from the applications and change to the *Security* side. Preconfigured user and user "*Any*" must be inserted at *User-defined access privileges* and for *Use user-defined start privileges, Use user-defined configuration privileges*.

Program-controlled settings

The Indramat OPC server has a tolerant security setting with respect to a CPC client. This setting must then be taken into account at the *IOPCDataCallback* and/or *IOPCShutdown* ConnectionPoints. Failure to do so would make a sever / client interface connection via Advise impossible. The client should therefor use the above-mentioned settings for invoking *CoInitializeSecurity*.

Summary of DCOM settings

		Server	**Client**
General	Domain	Same domain	Same domain
	User manager	Enter the same user and password and log on	Enter the same user and password and log on
	User manager	Activate *host* account	Activate *host* account
Declarative only	dcomcnfg.exe	1 **Applications** select *OPC Indramat Server Version 1* 2 **General** set authentication level to *None*. 3 **Security** Use *user-defined start privileges*: Enter *Any* and logged-on user 4 **Security** Use *user-defined access privileges*: Enter *Any* user and logged-on user.	
Declarative and program-controlled		1 **Applications** select *OPC Indramat Server Version 1* 2 **Security** Use *user-defined start privileges*: Enter *Any* user and logged-on user. 3 **Security** Use *user-defined access privileges*: Enter *Any* user and logged-on user. 4 **Programming:** CoInitializeSecurity(NULL, -1, NULL, NULL, **RPC_C_AUTHN_LEVEL_NONE**, RPC_C_IMP_LEVEL_IMPERSONATE, NULL, EOAC_NONE, NULL)	**1 Programming:** For *IOPCDataCallbak* and *IOPCShutdown* CoInitializeSecurity(NULL, -1, NULL, NULL, **RPC_C_AUTHN_LEVEL_NONE**, RPC_C_IMP_LEVEL_IMPERSONATE, NULL, EOAC_NONE, NULL); **2 Programming:** improved log-on CoCreateInstanceEx and COSERVERINFO, COAUTHINFO, COAUTHIDENTITY structures

Fig. 3-13: Summary of the DCOM settings

3.3 OPC Foundation Test Program

The OPC Foundation provides a program tool that permits an existing OPC installation to be tested locally and/or remotely.

The following programs must be installed and/or applied for this test:

ActxPrxy.dll: [drive]:\winnt\system32. If this DLL does not exist, the *Aprxdist.exe* installation program must be invoked.

OPCEnum.exe: [drive]:\winnt\system32 must be installed and registered with opcenum /regserver.

Enumtest.exe: Check console test program for an existing OPC installation. The application is explained using an example.

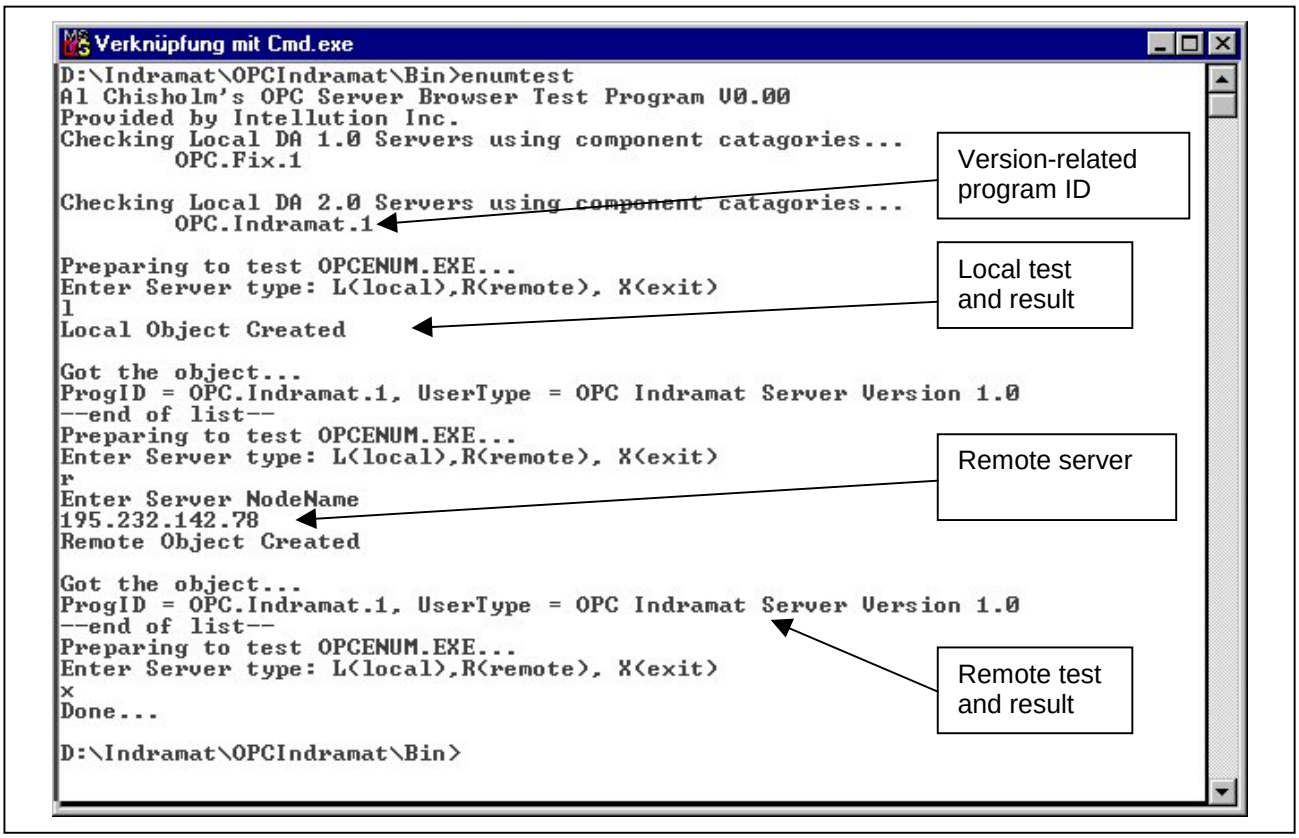

Fig. 3-14: Trace monitor main window

4 Applicable Documents

[1] Data Access Custom Interface Standard Version 2.03 (July 27, 1999); http://www.opcfoundation.org.

[2] Data Access Automation Interface Standard Version 2.02 (February 4, 1999); http://www.opcfoundation.org.

[3] System200 Function Interface 04VRS Application Description, Rexroth Indramat DOK-CONTRL-FUN*INT*V04-AW01-DE-P

[4] OPC Common Definitions and Interfaces; http://www.opcfoundation.org.

[5] Inside Distributed COM, Microsoft Press ISBN 3-86063-459-3

5 List of Figures

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