

# **Cimetrics BACnet OPC Server**

Installation and User Handbook

Version 2.50

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# 1 Preface

## 1.1 General information

Thank you for choosing the Cimetrics BACnet OPC Server. Using the BACnet OPC Server is the easiest way to interface between BACnet and OPC.

## 1.2 Do I need special knowledge?

You should be familiar with using OPC Server and clients to an OPC Server in a Microsoft Windows environment. In addition you should be well grounded in the basics of BACnet objects and services. You do not need any knowledge about programming.

## 1.3 Interesting literature

- ANSI/ASHRAE Standard 135-1995 BACnet – A Data Communication Protocol for Building Automation and Control Networks:

This book describes the ASHRAE-standard 135/1995 in detail. In addition to this book, many addendums are provided by the ASHRAE. These can be downloaded from the BACnet Homepage ([www.bacnet.org](http://www.bacnet.org)).

- OPC Data Access and Event/Alarm Specifications

These specifications describe Data Access and Event / Alarm handling with OPC. They can be downloaded from the OPC-Foundation Homepage ([www.opcfoundation.org](http://www.opcfoundation.org)).

## 1.4 Interesting Links in the World Wide Web

- [www.bacnet.org](http://www.bacnet.org)  
The official BACnet homepage.  
This site is the most important source for information about BACnet and new specifications.
- [www.big-eu.org](http://www.big-eu.org)  
Homepage of the European BACnet Interest Group including information about BACnet activities in europe.
- [www.opcfoundation.org](http://www.opcfoundation.org)  
Homepage of the OPC-Foundation. Several Downloads for specifications.
- [www.opceurope.org](http://www.opceurope.org)  
European homepage of OPC-Foundation

- [www.cimetrics.com](http://www.cimetrics.com)  
Homepage of Cimetrics, Inc. with information about BACnet products, protocol stacks and BACnet tools.
- [www.mbs-software.de](http://www.mbs-software.de)  
Homepage of MBS GmbH, exclusive distributor for Cimetrics products in Germany, Austria and Switzerland.

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- IBM-PC and IBM-AT are registered trademarks of the International Business Machines Corporation (IBM)
- LON and LONTalk are registered trademarks of Echelon, Inc.

### **1.6 Supported Specifications and Conformance Classes**

BACnet OPC Server Version 1.0 supports the OPC-Specifications for Data Access Version 1.0 and 2.0 and Event / Alarm handling Version 1.0, these are the current specifications for OPC. For BACnet the BACnet OPC Server Version 1.0 supports the functions for Conformance Class 4 plus the Functional Groups “COV Event Response” and “Event Response” (if supported by the BACnet-server).

### **1.7 Copyright**

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## 2 General information

### 2.1 The history of BACnet

- In 1987 the ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.) founded the Standard Project Committee SPC135P with the intention to define a communication protocol for building automation and energy-management.
- In the beginning of 1989 the ASHRAE journal reports about the general concept of this protocol
- After 3 reviews in 1991, 1994 and beginning of 1995 the ASHRAE published this protocol as ASHRAE standard 135-1995 (BACnet) in September 1995. Several suggestions from the industry were incorporated in the specification during the reviews.
- In December 1995 BACnet was accepted by the ANSI (American National Standards Institute) as the ASHRAE/ANSI Standard 135-1995
- In the beginning of 1997 BACnet became the European norm ENV 1805-1 for the management level and at the end of 1998 as ENV 13321 for the automation level of building automation systems.

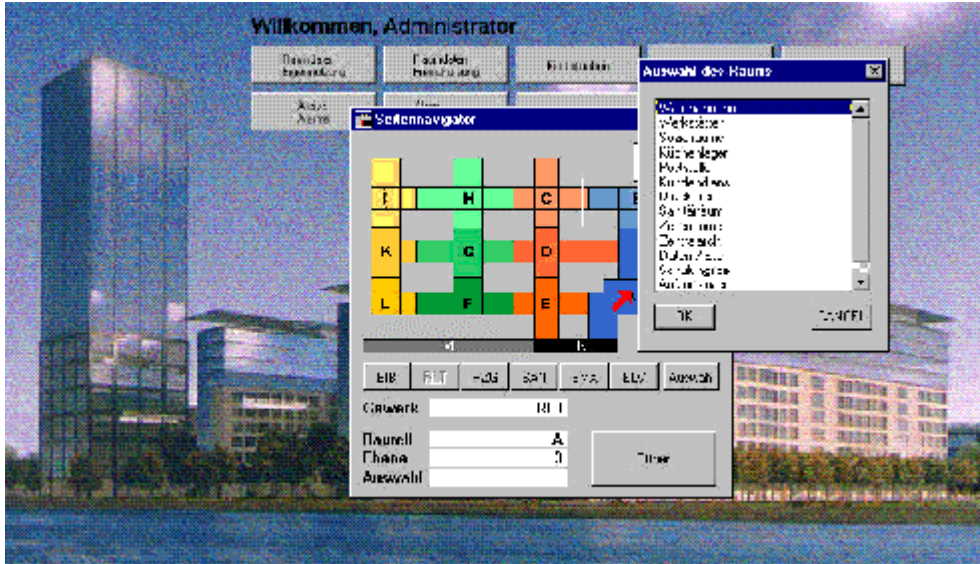
### 2.2 Application fields for BACnet

BACnet was designed and specified as an interoperable communication protocol for the management- and automation level of building automation applications. Due to the abstract data definitions, BACnet could also be used for other purposes like process-control. BACnet is mainly used to provide a vendor independant communication platform for energy management or to integrate different parts of plants to a common data protocol.

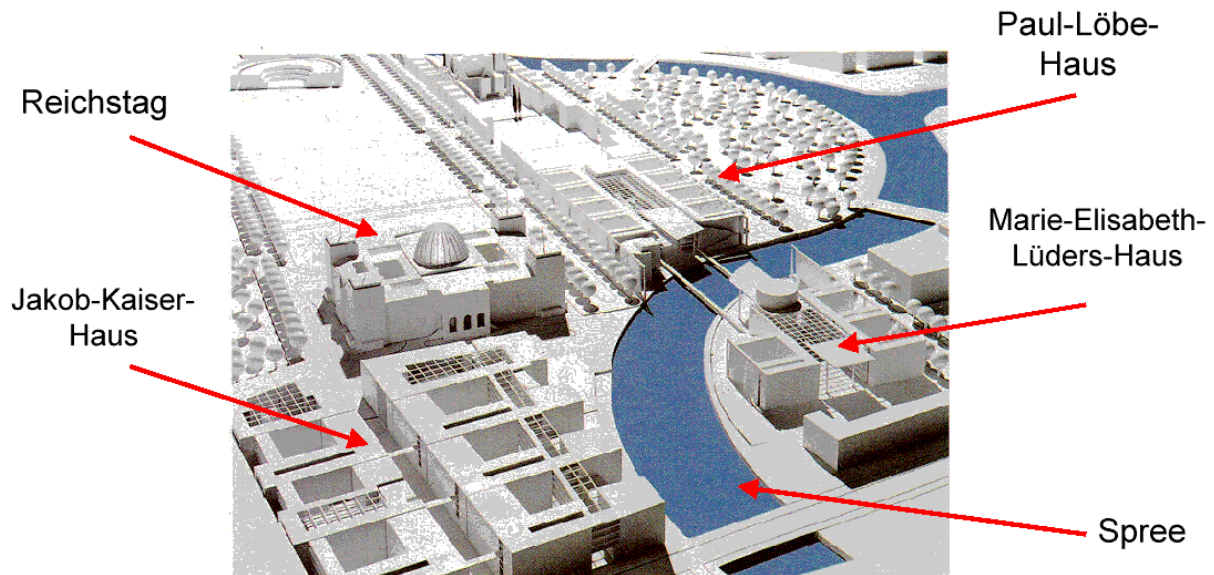
For this reason interoperability is one of the most important features that vendors should keep in mind when talking about BACnet.

### 2.3 Important BACnet projects in Europe

#### 2.3.1 Project Allianz insurance, Treptowers, Berlin



#### 2.3.2 Project technique compound for the buildings of parliament, Berlin



Further information about these projects are available from the European BACnet Interest Group e.V.

## 2.4 Client / Server Model

BACnet is designed as a client / server model. A server is a device that provides access to data objects. A client is a device that connects to one or more servers to read or write specific values of data objects. Furthermore BACnet provides notification services for automatic client update when changes of values occur.

## 2.5 Data objects in BACnet

Each BACnet-device (the term “device“can include also software virtual components running on PC-hardware) provides data as so-called “objects“. The device objects, at a minimum, describe each BACnet device itself. BACnet objects consist of so-called properties, which represent physical or virtual parameters.

### 2.5.1 The 18 standard BACnet objects

<b>Analog Input</b>	<b>Command</b>
<b>Analog Output</b>	<b>Device</b>
<b>Analog Value</b>	<b>Event Enrollment</b>
<b>Binary Input</b>	<b>Notification Class</b>
<b>Binary Output</b>	<b>File</b>
<b>Binary Value</b>	<b>Group</b>
<b>Multistate Input</b>	<b>Loop</b>
<b>Multistate Output</b>	<b>Program</b>
<b>Calendar</b>	<b>Schedule</b>

Specifications for further standard objects are in preparation, for example: Multi-state Value, Averaging object and Trending object. These specifications can be downloaded from the BACnet homepage.

The BACnet protocol is permanently extended with new features as well, for example for fire alarming systems.

The next pages show the properties of the device and analog-output objects.

**Note:** Also the properties of objects may be extended, please be sure to have the latest specifications from the ASHRAE.

## 2.5.2 Device Object Properties

PROPERTIES	CONFORMANCE CODE	ACCESS
Object_Identifier	R	R
Object_Name	R	R
Object_Type	R	R
System_Status	R	R
Vendor_Name	R	R
Vendor_Identifier	R	R
Model_Name	R	R
Firmware_Revision	R	R
Application_Software_Version	R	R
Location	O	R
Description	O	-
Protocol_Version	R	R
Protocol_Conformance_Code	R	R
Protocol_Services_Supported	R	R
Protocol_Object_Types_Supp.	R	R
Object_List	R	R
Max_APDU_Length_Accepted	R	R
Segmentation_Supported	R	R
VT_Classes_Supported	O	-
Active_VT_Sessions	O	-
Local_Time	O	-
Local_Date	O	-
UTC_Offset	O	-
Daylight_Savings_Status	O	-
APDU_Segment_Timeout	O	-
APDU_Timeout	R	R
Number_Of_APDU_Retries	R	R
List_Of_Session_Keys	O	-
Time_Synchronization_Recip.	O	-
Max_Master	O	-
Max_Info_Frames	O	-
Device_Adress_Binding	R	R



### 2.5.3 Analog Output Properties

PROPERTIES	CONFORMANCE CODE	ACCESS
Object_Identifier	R	R
Object_Name	R	R
Object_Type	R	R
Present_Value	R	R/W
Description	O	-
DeviceType	O	-
Status_Flags	R	R
Event_State	R	R
Reliability	O	-
Out_Of_Service	R	R
Units	R	R
Min_Pres_Value	O	R
Max_Pres_Value	O	R
Resolution	O	-
Priority_Array	R	-
Relinquish_Default	R	-
COV_Increment	O	-
Time_Delay	O	-
Notification_Class	O	R
High_Limit	O	R/W
Low_Limit	O	R/W
Deadband	O	R/W
Limit_Enable	O	R/W
Event_Enable	O	R/W
Acked_Transitions	O	-
Notify_Type	O	R/W

According to the access code the properties are readable or writable. A property that is writable is also intended to be readable.

The ASHRAE-Documents 135-1995 contains a complete description of all properties.

## 2.6 Access functions to BACnet objects

To access BACnet objects and their properties several access functions are defined in BACnet. This includes connecting to devices, reading or writing properties or subscription to COV (Change of Value) services.

## 2.7 BACnet Data Link Layer

For low-level data communication the BACnet standard defines various data link layers. The following table shows these layers according to their grouping in the ISO/OSI-layer-model:

<b>BACnet Application Layer</b>				
<b>BACnet Network Layer</b>				
<b>ISO 8802-2 Type 1</b>		MS/TP	<b>PTP</b>	LonTalk
<b>ISO 8802-3 "Ethernet"</b>	ARCNET	RS 485	<b>RS 232</b>	

The European norm specifies the following data link layers:

For the management level (ENV 1805-1):

- Ethernet (ISO 8802-3)
- TCP/IP
- PTP (Point To Point) for Dial-Up connections

For the automation level (ENV 13321):

- Ethernet (ISO 8802-3)
- TCP/IP
- PTP (Point To Point) for Dial-Up connections
- LON Talk

Additional layers defined in the BACnet standard like ARCnet or MS/TP are not yet supported in the European norm.

## 2.8 Interoperability with BACnet

As stated above, Interoperability is the most important feature in BACnet to operate systems from different vendors. To make sure that devices comply with these standards, BACnet defines several rules regarding implementation of objects and functions.

### 2.8.1 Conformance Code

3 different Conformance Codes define the implementation level for BACnet objects:

- R the property must be supported and has to be readable
- W the property must be supported and has to be readable and writable
- O this property is optional

### 2.8.2 Non-standard-Objects

Vendor specific objects require at least the following properties:

- Object\_Identifier
- Object\_Name (min. 1 char, printable characters)
- Object\_Type

### 2.8.3 Conformance Classes

BACnet-functions are subdivided into so-called “Conformance Classes“. Each of these classes (1-6) specifies a fixed number of functions, which have to be supported. The conformance classes are arranged in a hierarchy, which means that a device, which supports conformance class 3, has also to support all functions from class 1 and 2.

### 2.8.4 Client / Server behavior

BACnet uses the client/server model for data communication. The terms “initiate“ and “execute“ are used to denote that a device initiates a service as a client and that a device executes the service as server. These terms are mainly used in conjunction with BACnet-functions.

### 2.8.5 Functional Groups

In addition to conformance classes BACnet defines so-called functional groups to allow a classification of devices. The following table describes the examples “COV Event Initiation” and “COV Event Response”.

#### COV Event Initiation Functional Group (server-functionality)

Application Service	Init	Exec
SubscribeCOV		X
ConfirmedCOVNotification	X	

#### COV Event Response Functional Group (client functionality)

Application Service	Init	Exec
SubscribeCOV	X	
ConfirmedCOVNotification		X

“X” in the column “Init” means that the device supports the service as client.

“X” in the column “Exec” means that the device supports the service as a server.

Functional Groups can be defined in addition to conformance classes. Of course all minimum requirements of the functional groups and conformance classes have to be supported.

### 2.8.6 PICS (Protocol Implementation Conformance Statement)

PICS is a standard document that describes the supported functional groups, objects, and data link layers of BACnet devices. Vendors should provide a PICS document for each of their BACnet products and devices. To interface two different devices it is important to compare both PICS. For correct operation only functional groups, conformance classes, and data link layers, which are supported by both devices, can be used for the communication.

### **3 System requirements**

#### **3.1 Hardware**

The hardware platform can be IBM PC or compatible hardware. The minimum requirements for the PC are Pentium with 133 MHz processor and 32MB RAM. The installation needs about 20MB hard disk free. For a larger quantity of data objects we recommend the following configuration: PC with Pentium 400Mhz and 64 MB RAM or more depending on the quantity of data objects.

An Ethernet network interface card with Windows-driver is needed to connect to the BACnet network.

A CD-ROM drive may be required for the installation process.

A parallel (printer) port is necessary to install the software protection key.

#### **3.2 Operating system**

The operating system for the BACnet OPC Server can be Microsoft Windows NT Version 4.0 (We recommend installing the Service Pack 3 or higher), Windows 2000 or Windows XP.

### **4 Installing the BACnet OPC Server**

#### **4.1 Network adapter installation**

Before installing the BACnet OPC Server, an Ethernet network card should be installed in your system. Please refer to the documentation of your network interface card and the Windows help system for installing the drivers. Please read the Installation instructions carefully if you have Multiple Network Cards involved.

#### **4.2 Installing the software**

Log in as "Administrator". Insert the CD-ROM (if this is the method of installation). If the autostart option is set for the CD-ROM drive the Setup program will start automatically, if the option is not set, run the program "SETUP.EXE" from your CD-ROM drive. Follow the installation instructions.

## 5 Connecting to BACnet servers

The Device-Object of each BACnet device describes the supported features. Other BACnet devices in a BACnet network can read these properties and request information about the device.

Clients can locate servers within the network with the “Who-Is” service. Servers can inform clients about their network connection with the “I-Am” service.

These services are sent as a broadcast message to all devices in the network.

## 6 Referencing objects in a BACnet network

For networks with various devices, a unique referencing for devices is required. BACnet objects (and also device objects which are treated just like other BACnet objects) are referenced by object type and object instance, which results in a unique “BACnet Object-Identifier”.

Each instance number must be unique across all visible networks. Each device Object must have objects, which are unique to that particular Device Object.

For example server 1 supports an analog-output with the instance number 200, this means it should not support another analog-output with the same instance number. Nowhere on any visible network should there be another server with the instance number 1. All the servers have a unique instance number and each server has objects with unique instance numbers. Different servers can have objects with same instance numbers. For example server 1 and server 2 can have an analog-output with instance number 200.

## 7 Event-oriented notification COV

To reduce data traffic within the network, BACnet supports techniques for event-oriented notification. This means that servers notify their connected clients when changes of present value or status flags occur.

To use this mechanism servers provide so-called notification objects, which define conditions at which to notify the subscribed clients. When they subscribe, clients define the type of notification (confirmed or unconfirmed) and the lifetime of the notification period (a value of zero means: forever).

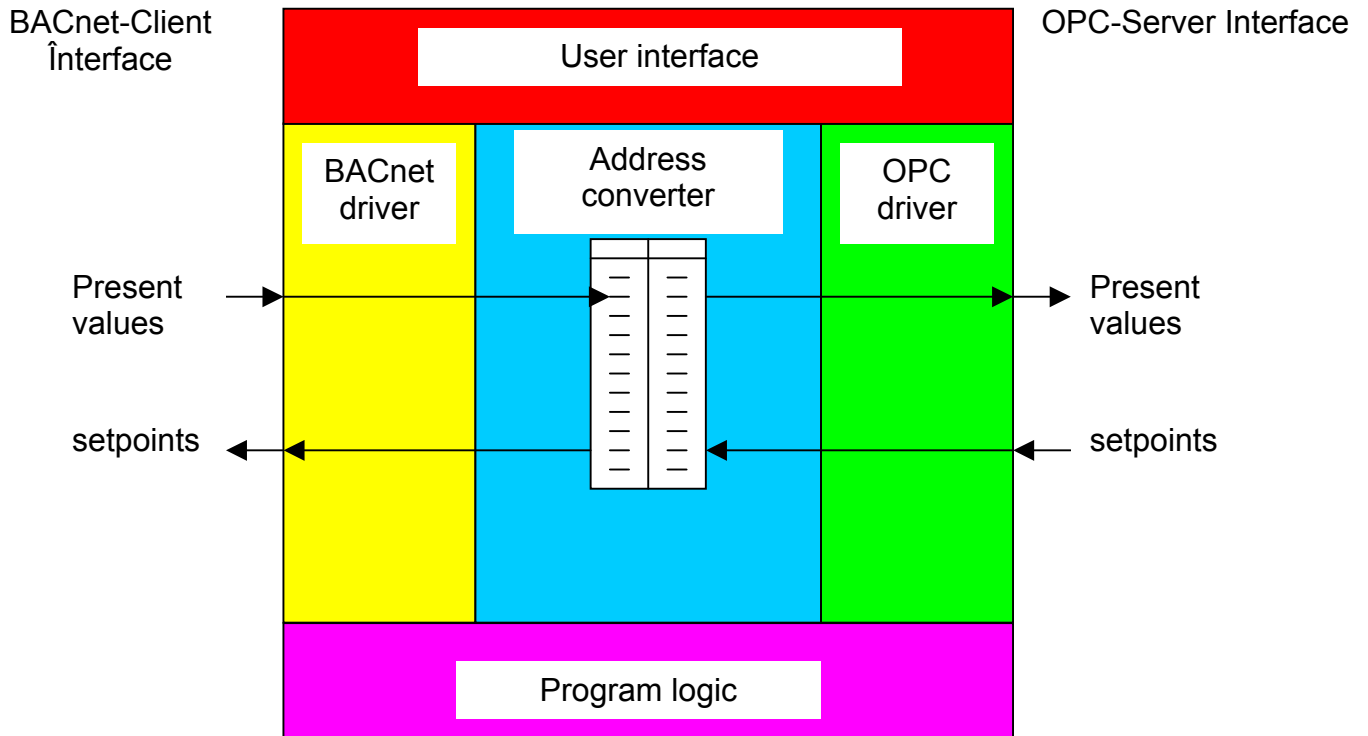
This technique is called COV (change of value) notification.

The following table shows which BACnet standard objects should support COV:

BACnet Object	Condition	Notified properties
Analog Input Analog Output Analog Value	<ul style="list-style-type: none"> <li>The present value has exceeded the threshold limit.</li> <li>The Status-flags have changed</li> </ul>	Present value, status-flags
Binary Input Binary Output Binary Value Multistate Input Multistate Output Multistate Value	<ul style="list-style-type: none"> <li>The present value has changed</li> <li>The Status-flags have changed</li> </ul>	Present value, status-flags
Loop	<ul style="list-style-type: none"> <li>The present value has exceeded the threshold limit.</li> <li>The Status-flags have changed</li> </ul>	Present value, status-flags, setpoint, controlled_variable_value

The BACnet OPC Server, when connected to BACnet devices that support these services supports COV services.

## 8 BACnet OPC Server Block diagram





## 9 Basics of the BACnet OPC Server

The BACnet OPC Server acts as BACnet Client and represents BACnet properties as OPC tags.

The list of tags can be stored as a Data definition file on hard disk (the file extension is .tdb).

You can easily add or remove single tags or devices from the data definition list. OPC Clients can subscribe on OPC tags and are notified about changes of BACnet properties.

OPC clients can write BACnet properties if write access is permitted. The BACnet OPC Server checks all incoming write commands and if not valid rejects the write request. In this case the corresponding OPC tag is marked as "bad".

OPC clients should always check the OPC quality flag. Data should only be transferred to the user interface when the flag is not "bad" or "uncertain". For further information on OPC quality, see the OPC articles, which can be downloaded from the OPC-foundation homepage.

## 10 Working with the BACnet OPC Server

The BACnet OPC Server uses a conversion table (also known as data definition table) for binding BACnet properties to OPC tags. Tables can be stored on hard disk as .tdb files. The most recent file is automatically loaded when starting the BACnet OPC Server again.

### 10.1 User-interface

The screenshot shows the BACnet OPC-Server application window. The title bar reads "BACnet OPC-Server". The menu bar includes "File", "Edit", "Setup", "View", and "Info". Below the menu bar is a toolbar with various icons. The main area is divided into two panes. The left pane shows a tree view of BACnet objects under the "Simple Remote I/O" device. The right pane displays a table of properties for the selected object.

datapoint-name	OPC datatype	value	access-ri
apdu-timeout	Unsigned Long	0	read / wr
application-software-ve...	Text-String	2.0	read-only
daylight-savings-status	Boolean	F	read-only
description	Text-String	test server	read-only
firmware-revision	Text-String	2.0	read-only
local-date	Date	05.10.1996	read-only
local-time	Text-String	12:34:56.78	read-only
location	Text-String	Test lab	read-only
max-apdu-length-acce...	Unsigned Long	1476	read / wr
model-name	Text-String	BACstac Example S...	read-only
number-of-apdu-retries	Unsigned Long	0	read / wr
object-identifier	Text-String	(device,1967)	read-only
object-list	Text-String	{(analog-input,1),(an...	read-only
object-name	Text-String	Simple Remote I/O ...	read-only
object-type	Long	8	read-only
protocol-conformance...	Unsigned Long	3	read-only
protocol-object-type-su...	Array of Boolean	T, T, T, T, T, T, F, F...	read-only
protocol-services-supp...	Array of Boolean	T, T, T, T, T, T, F, F...	read-only
protocol-version	Unsigned Long	1	read-only

At the bottom of the window, the status bar shows "Ready" on the left, "device(1967). -> 9 Objects -> 172 datapoints" in the center, and a green "Connected" indicator on the right.

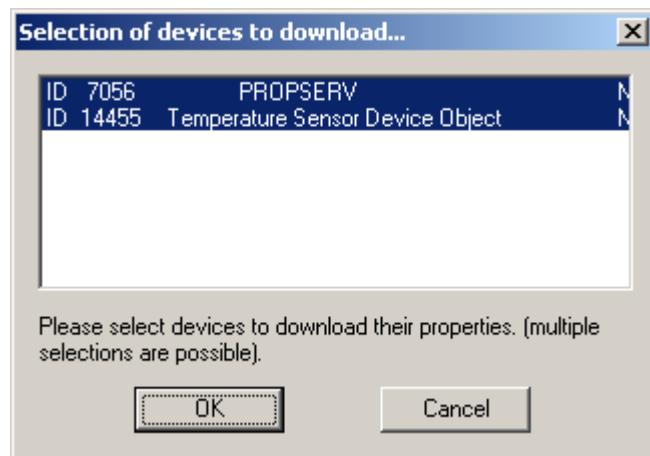
This table shows the main-screen of the application.

The tree on the left displays all connected BACnet servers with a list of the supported BACnet objects. On the right the properties of the currently selected BACnet object are shown.

## 10.2 Menu functions

### **Menu File:**

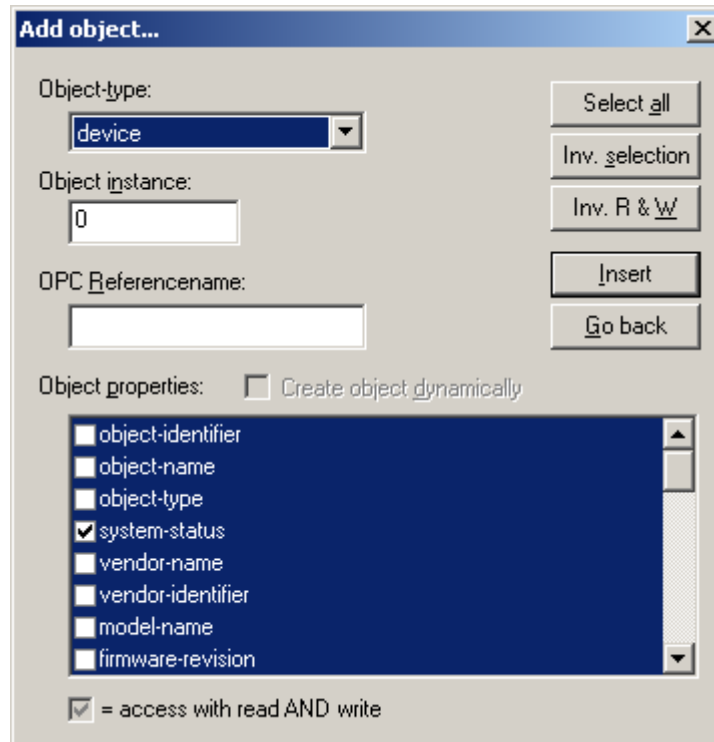
- **New**  
creates a new and empty data definition table
- **Open**  
loads an existing data definition table
- **Save**  
saves the current data definition table
- **Save As**  
saves the current data definition table with a new filename
- **Download from Network**  
Searches for BACnet devices (servers) on the BACnet network



- **Export text file**  
Exports a given configuration in .txt format
- **Import text file**  
Imports any saved configurations that exist in .txt format
- **Recent file list**  
4 most recent data definition files are shown here
- **Exit**  
Closes the application

**Menu Edit:**

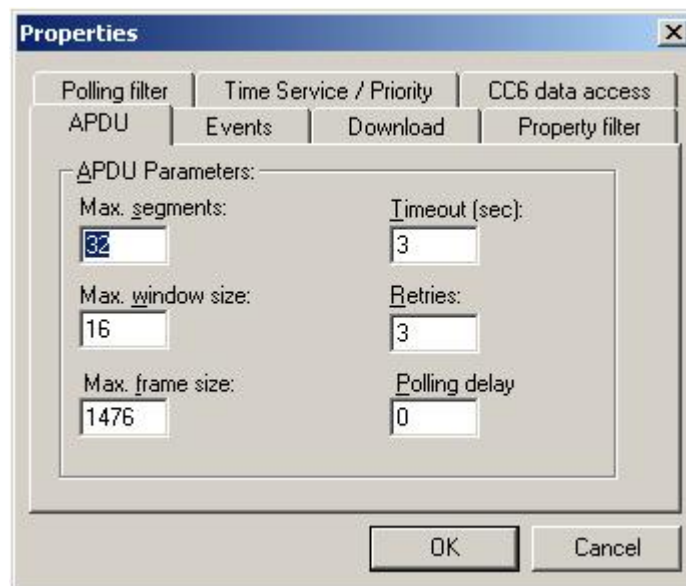
- **Delete object**  
deletes the currently selected BACnet object; after deleting, OPC clients can no longer access the object



- **Insert object**  
inserts a new BACnet object from the currently selected BACnet server. You may choose the properties, which should be transferred to OPC clients from the list.
- **Edit Object**  
The selected object and its properties can be edited using this feature. You can make properties be accessed with “Read & Write “ properties or vice versa.
- **Set value**  
Displays, and if write-access is permitted to this property, allows write of a new value
- **Time synchronization**

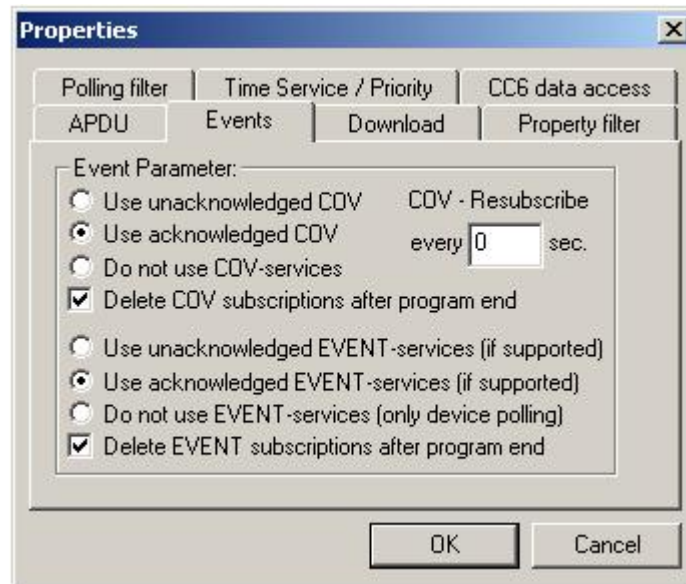
**Menu Setup:****• APDU**

In this dialog box the APDU parameters can be changed. Changes made to the parameters 'Timeout, Retries and Polling delay' can affect the performance. The Max\_segments that the OPC Server can handle is 32 for a segmented message. The Max\_Window size refers to the Maximum number of segments, which can be transmitted before an Acknowledgment is received. The Max\_Frame size is the maximum number of octets that a BACnet packet is allowed to have. (please do not alter these values unless and until you know what exactly you are doing)



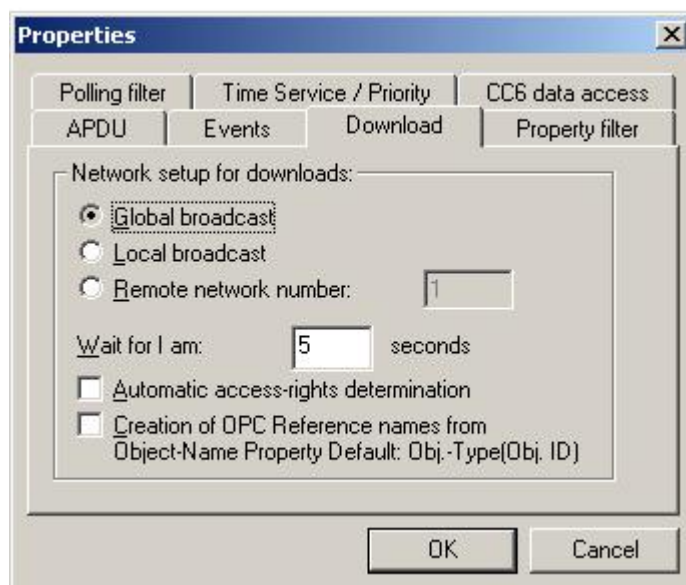
- **Events**

In this window, the event parameters can be changed.



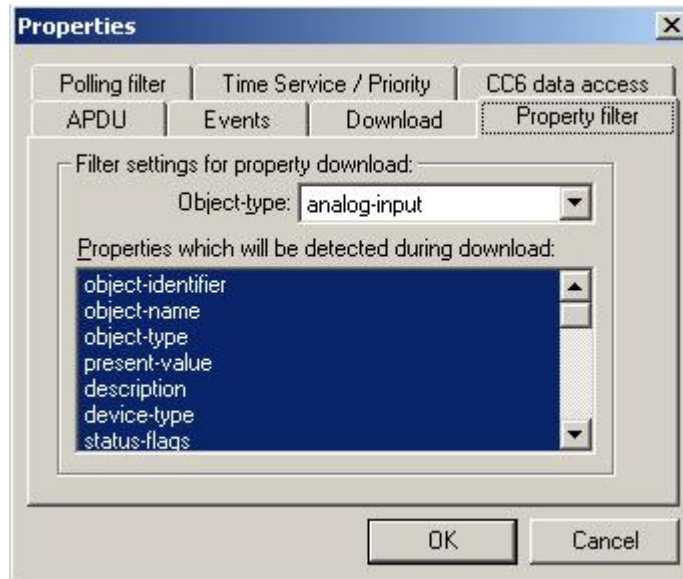
- **Download**

In this window, the user can choose to download BACnet servers from all the networks or a particular network. Checking the 'Global broadcast' will result in the OPC Server sending out Global broadcasts to discover devices in all the connected networks and the Local will result in Local broadcasts. If the user would like to download BACnet Devices from a particular network, he could do so by opting the 'Remote network number' by entering the desired network number



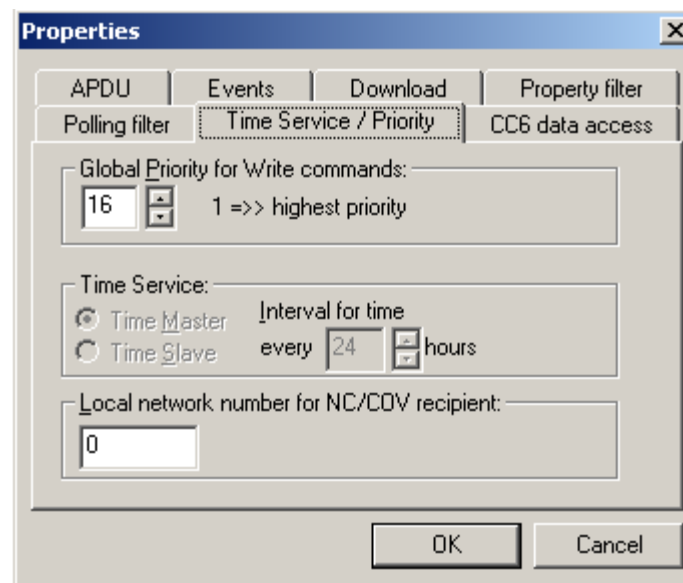
- **Property Filter**

In this window, the user can reduce traffic on the network and also improve the efficiency of the OPC Server by selecting to download only required properties for each Object type.



- **Time Service/Priority**

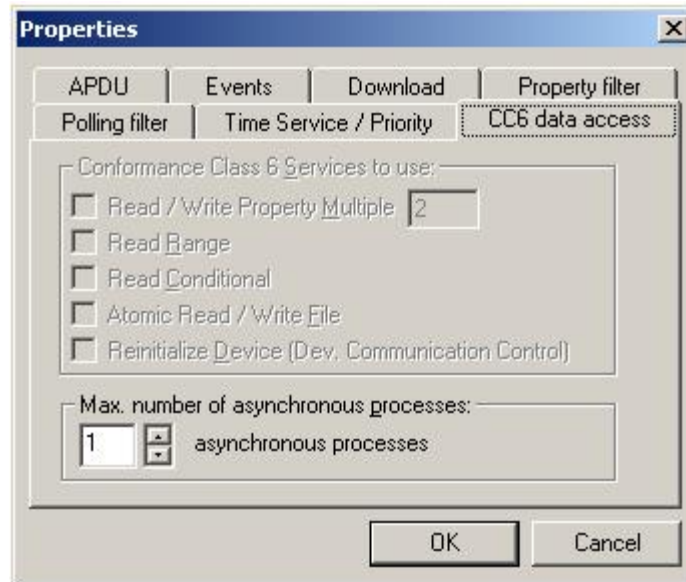
In this window, the user can change the Global priority for write commands. The default value is 16, which is the lowest priority.





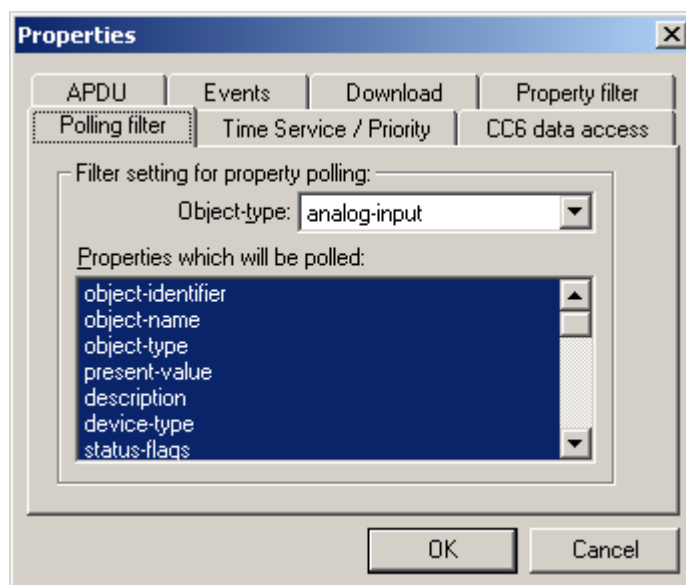
- **CC6 data access**

The default value of 1 prevents COV subscription, so if use of COV subscription is desired, increasing this number from the default is recommended.



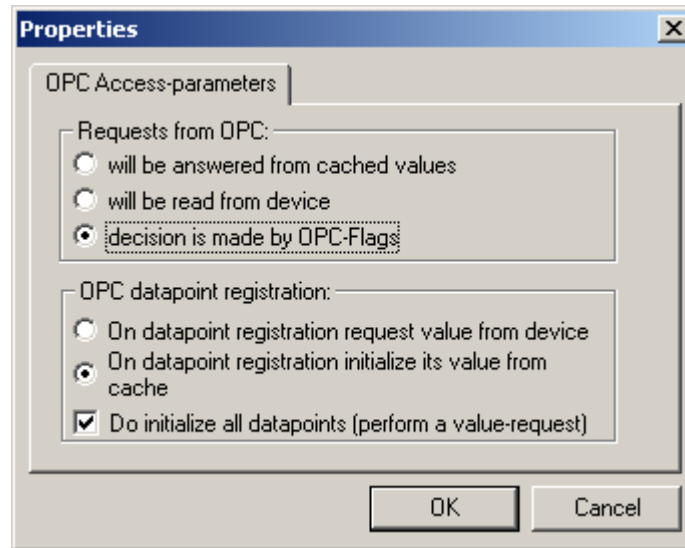
- **Polling Filter**

In this window, the user can select the properties of different objects that would require polling. The properties that have not been selected will not be polled and hence the OPC Server will not see their changed values. Optimum performance can be achieved by selecting only the required properties.



## OPC Props

In this window the user can access the OPC Parameters



### **Menu View:**

- **Parametric mode**  
Parametric mode allows configuration changes, such as Edit|Insert/Delete and File|Download operations. The OPC Server cannot be put into parametric mode while OPC Clients are connected. All OPC clients must be disconnected in order to go into parametric mode.
- **Monitoring**  
activates/deactivates the value-monitor
- **Status bar**  
activates/deactivates the status bar
- **Adjust window (left/right)**  
adjusts the main window vertical-separator

***Menu Info:***

- **About Cimetrics BACnet OPC Server**  
displays the copyright and program version information

## 11 Abbreviations and important terms

ASHRAE	<b>American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.</b>
ANSI	<b>American National Standards Institute</b>
BACnet	Abbreviation for <b>B</b> uilding <b>A</b> utomation and <b>C</b> ontrol <b>N</b> etworks ASHRAE standard 135-1995
COV	Abbreviation for <b>C</b> hange of <b>V</b> alue A BACnet service, which notifies clients about changes of present value or status-flags
Object	means BACnet object BACnet objects consist of various properties
OLE	Abbreviation for <b>O</b> bject <b>L</b> inking and <b>E</b> MBEDDING OLE describes mechanisms in Microsoft-Windows for Inter-process-communication.
OPC	Abbreviation for <b>O</b> LE for <b>P</b> rocess <b>C</b> ontrol Communication standard for Process control and management systems. These specifications were developed by the OPC-foundation.
PICS	<b>P</b> rotocol <b>I</b> mplementation <b>C</b> onformance <b>S</b> tatement Document that describes the supported functionality of each BACnet device
Property	what BACnet objects are comprised of Properties represent physical or virtual data or parameters