

SERVICIOS TELEMÁTICOS AVANZADOS

3.2- Modbus TCP

MODBUS is an application layer messaging protocol, positioned at level 7 of the OSI model, which provides client/server communication between devices connected on different types of buses or networks.

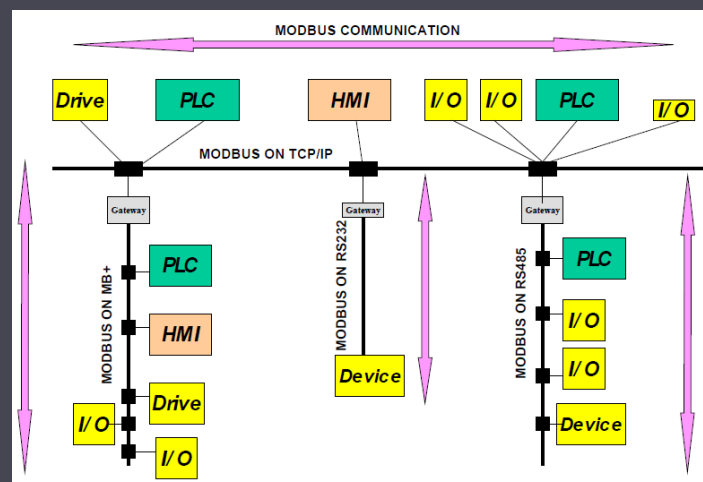
The industry's serial de facto standard since 1979, MODBUS continues to enable millions of automation devices to communicate.



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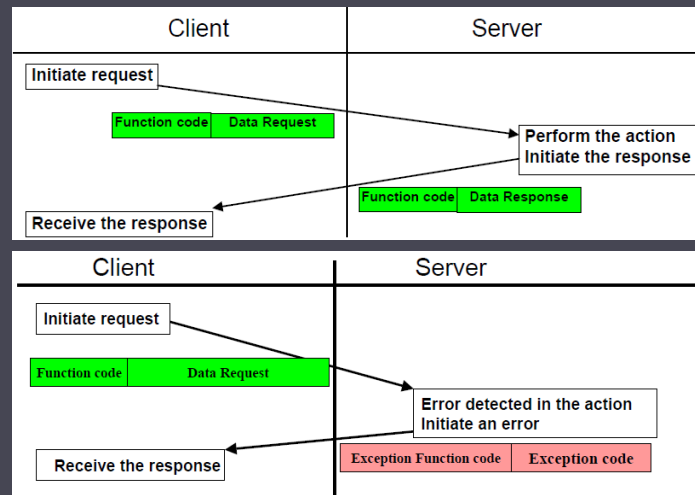
En Modbus TCP confluyen todas sus tecnologías



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No existe establecimiento de la conexión



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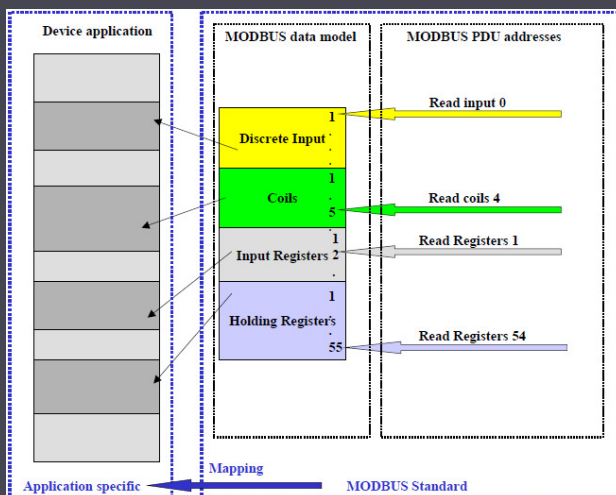
Los tipos de datos disponibles son los siguientes:

Primary tables	Object type	Type of	Comments
Discretes Input	Single bit	Read-Only	This type of data can be provided by an I/O system.
Coils	Single bit	Read-Write	This type of data can be alterable by an application program.
Input Registers	16-bit word	Read-Only	This type of data can be provided by an I/O system
Holding Registers	16-bit word	Read-Write	This type of data can be alterable by an application program.

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Mapas de memoria en dispositivos Modbus



Dirección 0 -> Registro 1

Dirección 5 -> Registro 5

...

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Funciones disponibles de intercambio de datos

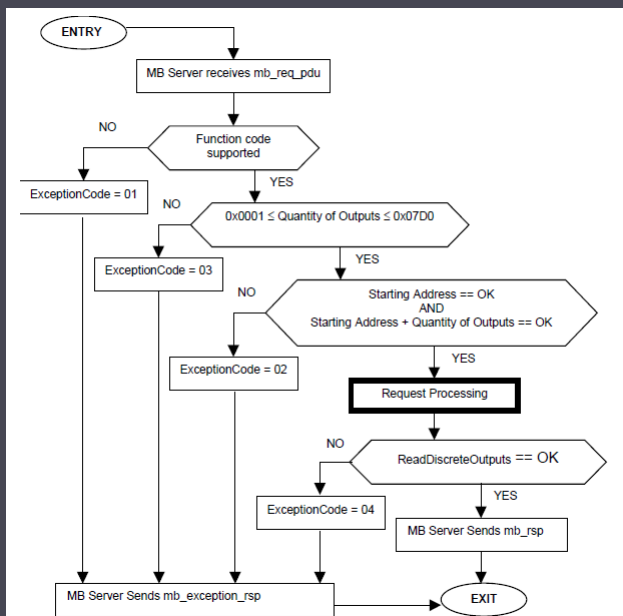
				Function Codes		
				code	Sub code	(hex)
Data Access	Bit access	Physical Discrete Inputs	Read Discrete Inputs	02		02
		Internal Bits Or Physical coils	Read Coils	01		01
			Write Single Coil	05		05
			Write Multiple Coils	15		0F
	16 bits access	Physical Input Registers	Read Input Register	04		04
			Read Holding Registers	03		03
		Internal Registers Or Physical Output Registers	Write Single Register	06		06
			Write Multiple Registers	16		10
			Read/Write Multiple Registers	23		17
			Mask Write Register	22		16
			Read FIFO queue	24		18

Es posible solicitar/modificar múltiples registros en un único request

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Proceso recepción solicitud



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Ejemplo solicitud de lectura de los Coils 20-38

Request		Response	
Field Name	(Hex)	Field Name	(Hex)
Function	01	Function	01
Starting Address Hi	00	Byte Count	03
Starting Address Lo	13	Outputs status 27-20	CD
Quantity of Outputs Hi	00	Outputs status 35-28	6B
Quantity of Outputs Lo	13	Outputs status 38-36	05

DATOS en formato big-Endian

	27-20	35-28	38-36
hex	CD	6B	05
bin	1100 1101	0110 1011	0000 0101

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Ejemplo solicitud de lectura de los Holding register 108-110

Request		Response	
Field Name	(Hex)	Field Name	(Hex)
Function	03	Function	03
Starting Address Hi	00	Byte Count	06
Starting Address Lo	6B	Register value Hi (108)	02
No. of Registers Hi	00	Register value Lo (108)	2B
No. of Registers Lo	03	Register value Hi (109)	00
		Register value Lo (109)	00
		Register value Hi (110)	00
		Register value Lo (110)	64

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Modbus header

	Description	Size	Example
MBAP Header	Transaction Identifier Hi	1	0x15
	Transaction Identifier Lo	1	0x01
	Protocol Identifier	2	0x0000
	Length	2	0x0006
	Unit Identifier	1	0xFF
MODBUS request	Function Code (*)	1	0x03
	Starting Address	2	0x0004
	Quantity of Registers	2	0x0001

Modbus

Transaction Identifier: Es un contador que permite enlazar los request con los response.

Unit Identifier: Es necesario para el direccionamiento de equipos esclavos.

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Respuesta a errores

Request

Function code	1 Byte	0x08
Sub-function	2 Bytes	
Data	N x 2 Bytes	

Response

Function code	1 Byte	0x08
Sub-function	2 Bytes	
Data	N x 2 Bytes	

OK

Error

Error code	1 Byte	0x88
Exception code	1 Byte	01 or 03 or 04

ERROR

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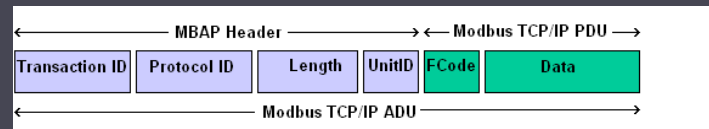
Exception codes

Exception Code	MODBUS name	Comments
01	Illegal Function Code	The function code is unknown by the server
02	Illegal Data Address	Dependant on the request
03	Illegal Data Value	Dependant on the request
04	Server Failure	The server failed during the execution
05	Acknowledge	The server accepted the service invocation but the service requires a relatively long time to execute. The server therefore returns only an acknowledgement of the service invocation receipt.
06	Server Busy	The server was unable to accept the MB Request PDU. The client application has the responsibility of deciding if and when to re-send the request.
0A	Gateway problem	Gateway paths not available.
0B	Gateway problem	The targeted device failed to respond. The gateway generates this exception

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Ejemplo telegrama Modbus



0001 0000 0006 11 03 006B 0003

0001: Transaction Identifier

0000: Protocol Identifier

0006: Message Length (6 bytes to follow)

11: The Unit Identifier (17 = 11 hex)

03: The Function Code (read Analog Output Holding Registers)

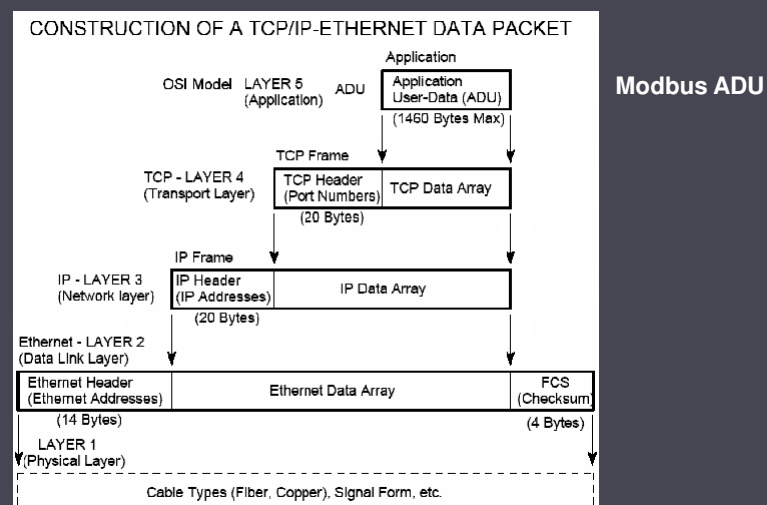
006B: The Data Address of the first register requested. (107 = 6B hex)

0003: The total number of registers requested. (read 3 registers 107 to 109)

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Ejemplo telegrama Modbus



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3.3- BACnet/IP

Building Automation and Controls NETwork

Developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), BACnet is an American national standard, a European standard, a national standard in more than 30 countries, and an ISO global standard.



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3.3- BACnet/IP

Las comunicaciones en BACnet utilizan diferentes medios físicos:

- Ethernet
- BACnet/IP
- Serie (RS232/RS485)
- ARCnet
- MS/TP
- LonTalk

BACnetApplicationLayer					Application
BACnet Network Layer (allows Routing)					Network
BACnet/IP	ISO 8802-2 Type 1	MS/TP	PTP	LonTalk	Data-Link
ISO 8802-3 „Ethernet“	ARCNET	RS 485	RS 232		Media-Access
					Physical

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3.3- BACnet/IP

La trama de BACnet tiene la siguiente estructura:

0x55	Preamble	2 octets
0xFF		
Frame Type		1 octet
Destination Address		1 octet
Source Address		1 octet
Length		2 octets, most significant octet first
Header CRC		1 octet
Data		(present if Length is non-zero) Length octets
Data CRC		(present if Length is non-zero) 2 octets
0xFF	pad	(optional) at most, 1 octet

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3.3- BACnet/IP

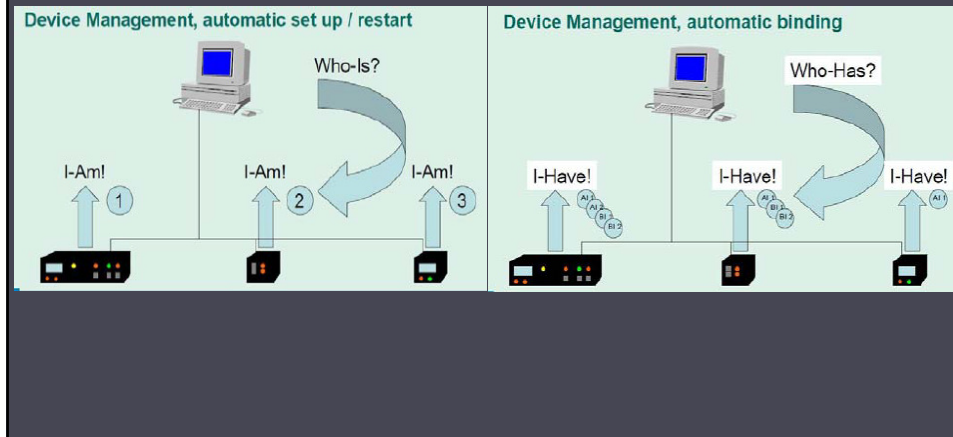
Áreas de interoperabilidad de los servicios

1. Data Sharing DS (Intercambio de datos)
2. Alarm and Event Management AE (Distribución de notificaciones y Ack. de alarmas)
3. Scheduling SCHED (Acciones que dependen de horarios y calendarios)
4. Trending T (Registro de variables y eventos)
5. Device and Network Management DM, NM, VT

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3.3- BACnet/IP

Ejemplos de servicios Device Management



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3.3- BACnet/IP

BACnet crea objetos con múltiples valores y propiedades

BACnet defines a collection of 23 standard object types

Binary Input	Multi-state Input	File
Binary Output	Multi-state Output	Program
Binary Value	Multi-state Value	Schedule
Analog Input	Loop	Trend Log
Analog Output	Calendar	Group
Analog Value	Notification Class	Event Enrollment
Averaging	Command	Device
LifeSafetyZone	LifeSafetyPoint	

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3.3- BACnet/IP

Las propiedades de los objetos son obligatorias (estandarización) u opcionales

Las propiedades pueden ser de lectura y/o escritura

Object_Name	ROOM_TEMP
Object_Type	ANALOG INPUT
Present_Value	20.3
Unit	62 = °C
High_Limit	30.0
Low_Limit	15.0

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	REAL,
description	[28]	CharacterString OPTIONAL,
device-type	[31]	CharacterString OPTIONAL,
status-fags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
update-interval	[118]	Unsigned OPTIONAL,
units	[117]	BACnetEngineeringUnits,
min-pres-value	[69]	REAL OPTIONAL,
max-pres-value	[65]	REAL OPTIONAL,
resolution	[106]	REAL OPTIONAL,
copy-increment	[22]	REAL OPTIONAL,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
high-limit	[45]	REAL OPTIONAL,

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Ejemplo objeto de actuador

Property Identifier	Property Datatype	Conformance Code	
Object_Identifier	BACnetObjectIdentifier	R	
Object_Name	CharacterString	R	
Object_Type	BACnetObjectType	R	
Present_Value	BACnetBinaryPV	W	
Description	CharacterString	O	
Device_Type	CharacterString	O	
Status_Flags	BACnetStatusFlags	R	
Event_State	BACnetEventState	R	
Reliability	BACnetReliability	O	
Out_Of_Service	BOOLEAN	R	
Polarity	BACnetPolarity	R	
Inactive_Text	CharacterString	O	
Active_Text	CharacterString	O	
Change_Of_State_Time	BACnetDateTime	O	
Change_Of_State_Count	Unsigned	O	
Time_Of_State_Count_Reset	BACnetDateTime	O	
Elapsed_Active_Time	Unsigned32	O	
Time_Of_Active_Time_Reset	BACnetDateTime	O	
Minimum_Off_Time	Unsigned32	O	
Minimum_On_Time	Unsigned32	O	
Priority_Array	BACnetPriorityArray	R	
Relinquish_Default	BACnetBinaryPV	R	
Time_Delay	Unsigned	O	
Notification_Class	Unsigned	O	
Feedback_Value	BACnetBinaryPV	O	
Event_Enable	BACnetEventTransitionBits	O	
Acked_Transitions	BACnetEventTransitionBits	O	
Notify_Type	BACnetNotifyType	O	
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O	
Profile_Name	CharacterString	O	

Conformance Codes:
R required, readable
W required, writable
O optional

Out_Of_Service
decouples the physical
output from the
Present_Value.

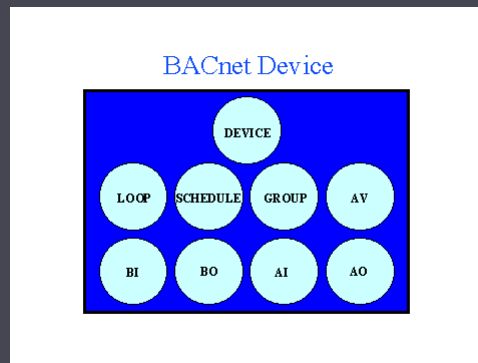
Properties required
because Present_Value
is *commandable*

Properties required for
intrinsic reporting

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3.3- BACnet/IP

Un dispositivo BACnet está compuesto por múltiples objetos



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3.3- BACnet/IP

El acceso a los objetos se realiza a través de los “Object Access Services”

Estos servicios son Unicast

AcknowledgeAlarm	AtomicWriteFile	WritePropertyMultiple
COV-Notification	AddListElement	PrivateTransfer
EventNotification	RemoveListElement	TextMessage
GetAlarmSummary	CreateObject	ReinitializeDevice
GetEnrollmentSummary	DeleteObject	VTOpen
SubscribeCOV	ReadProperty	VTCLose
SubscribeCOVProperty	ReadPropertyMultiple	VTData
LifeSafetyOperation	ReadRange	Authenticate
AtomicReadFile	WriteProperty	RequestKey
ReadPropertyConditional	DeviceCommunicationControl	

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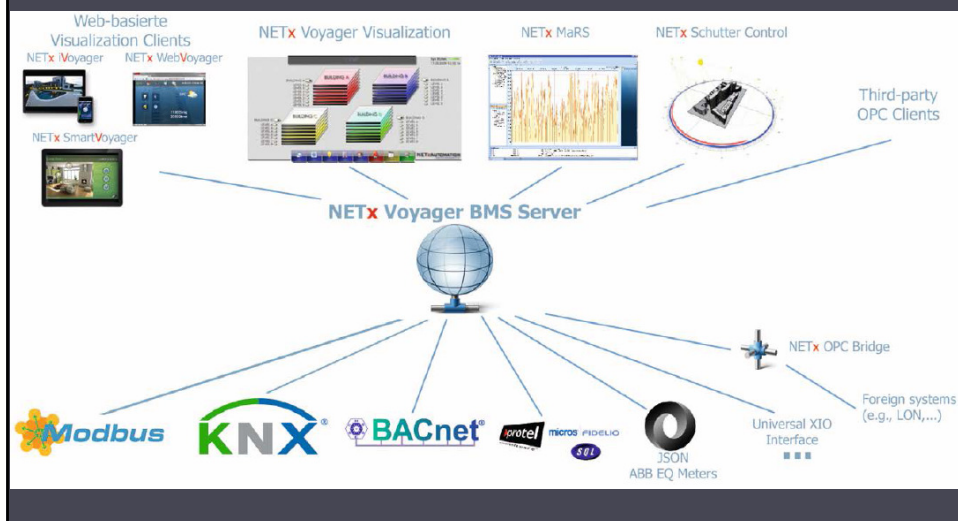
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Estos servicios comunes a varios dispositivos son Multicast

I-Am	TextMessage
I-Have	TimeSynchronization
COV-Notification	WhoHas
EventNotification	Whols
PrivateTransfer	UTC TimeSynchronization

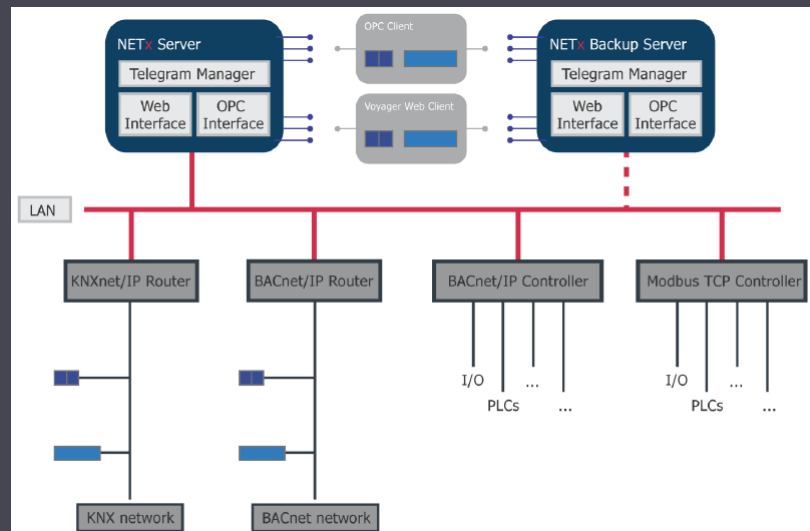
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4- EJEMPLO BMS MULTIPROTOCOLO



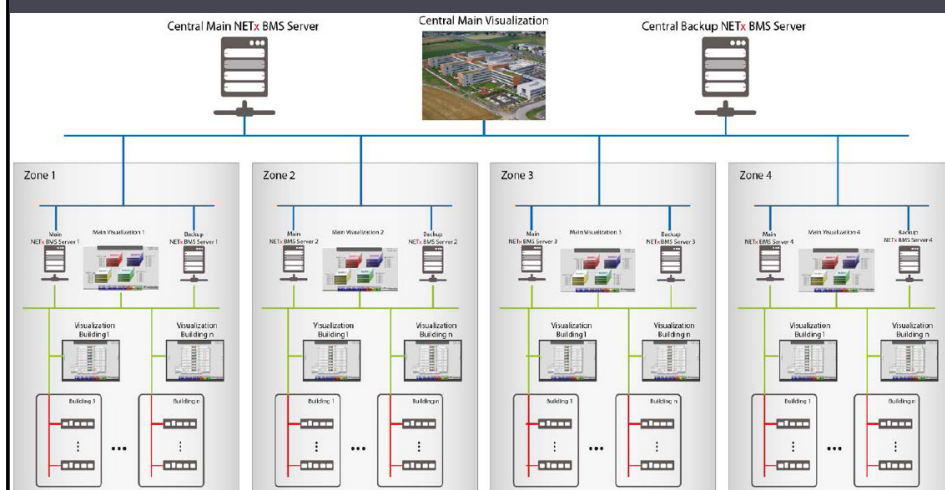
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4- EJEMPLO BMS MULTIPROTOCOLO



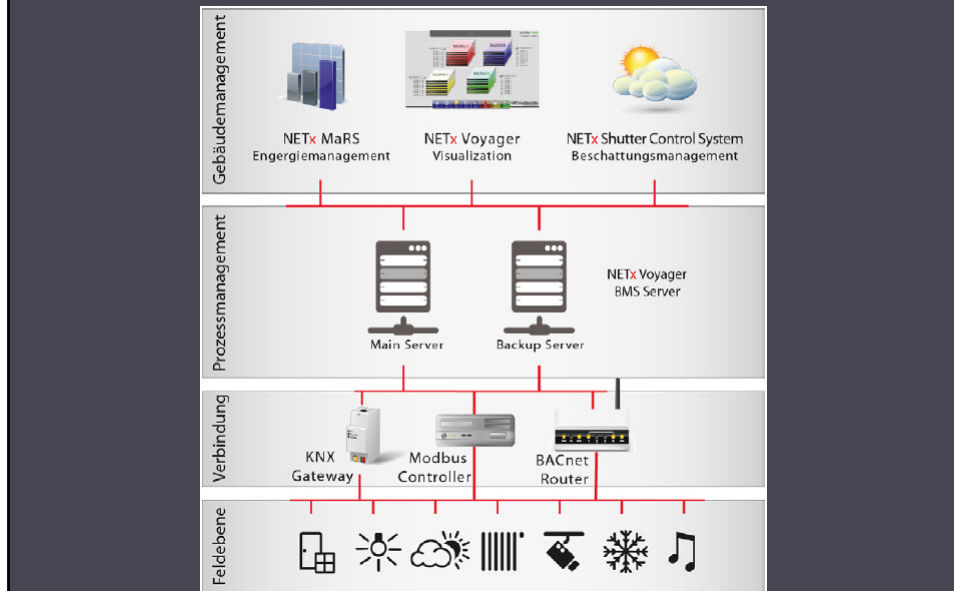
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4- EJEMPLO BMS MULTIPROTOCOLO



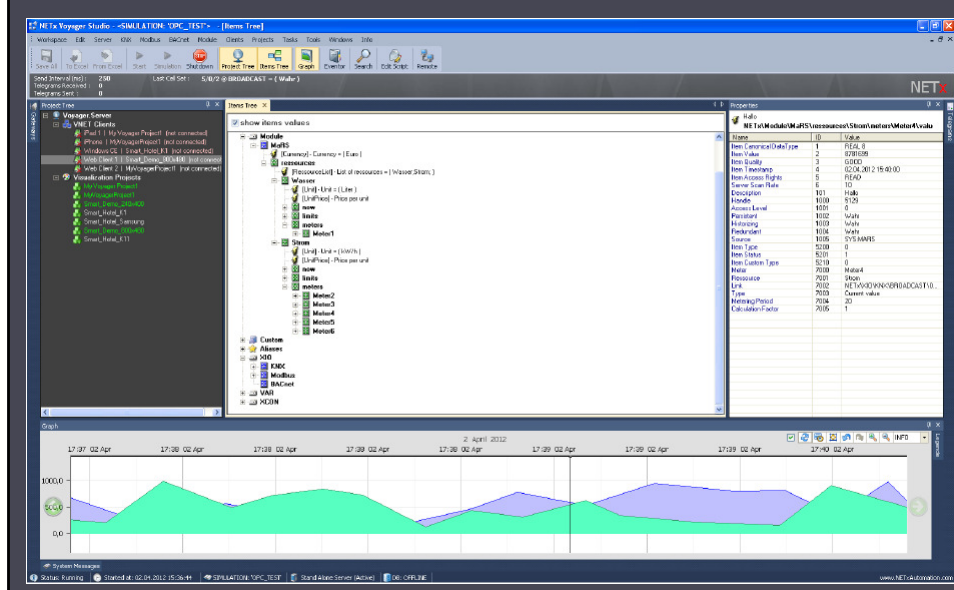
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4- EJEMPLO BMS MULTIPROTOCOLO



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4- EJEMPLO BMS MULTIPROCOLO



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4- EJEMPLO BMS MULTIPROTOCOLO

