Anybus BACnet to Modbus Gateway

HMS

Connecting Devices™

Important User Information

This document is intended to provide a good understanding of the functionality offered by the Anybus BACnet to Modbus Gateway. The document only describes the features that are specific to the Anybus BACnet to Modbus Gateway.

The reader of this document is expected to be familiar with high level software design, and communication systems in general.

Liability

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There are many applications of this product. Those responsible for the use of this device must ensure that all the necessary steps have been taken to verify that the applications meet all performance and safety requirements including any applicable laws, regulations, codes, and standards.

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The examples and illustrations in this document are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular implementation, HMS Industrial Networks AB cannot assume responsibility for actual use based on these examples and illustrations.

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Warning:	This is a class A product. in a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.
ESD Note:	This product contains ESD (Electrostatic Discharge) sensitive parts that may be damaged if ESD control procedures are not followed. Static control precautions are required when handling the product. Failure to observe this may cause damage to the product.

Table of Contents

P. About This Document

For more information, documentation etc., please visit the HMS website www.anybus.com.

P.1 Related Documents

Document	Author
Anybus BACnet to Modbus Gateway Installation Guide	SDa

P.2 Document History

Revision List

Revision	Date	Author(s)	Chapter(s)	Description
1.00	September 2014	SDa	-	First official release

P.3 Conventions & Terminology

The following conventions are used throughout this manual:

- Numbered lists provide sequential steps
- Bulleted lists provide information, not procedural steps

P.4 Support

For general contact information and support, please refer to the contact and support pages at www.hms-networks.com.

1. Introduction

The Anybus BACnet to Modbus Gateway is housed in a metal case that mounts on 35-mm DIN-rail. Power is from a 24 VAC/VDC (± 10%) source. The half-wave rectified power supply allows sharing of power with other half-wave devices.

The optically-isolated serial port allows for connection to either 2-wire or 3-wire RS-485 networks, using a removable 5-pin terminal block. Up to 30 RS-485 Modbus devices can share the serial bus at data rates 2.4 to 115.2 kbps.

The Ethernet port provides a shielded RJ-45 connector. Auto-negotiation and Auto-MDIX automatically matches connections to the attached equipment, thus allowing either CAT5 straight-through or crossover cable to be used for connecting to the BACnet/IP or Modbus TCP network at 10/100 Mbps.

A resident web server allows for commissioning, and troubleshooting via a standard web browser. A reset switch is provided for returning to the factory default IP address. LED indicators provide communication status on both the Ethernet and serial ports.

1.1 Hardware Overview

Power	DC	AC
Input voltage:	24 V	24 V
Input power:	6 W	10 VA
Input frequency:	N/A	47–63 Hz

(Intended for Class II circuits only)

Redundant Power Input
24 V AC/DC 10 VA half-wave regulated design allows power sharing with other half-wave devices.

Power LED
Indicates power is applied.

Reset IP Address
Press to reset gateway IP address to the default.

Ethernet Port
10/100 Mbps Ethernet port with auto-negotiation and Auto-MDIX. Protocols supported include HTTP, IP, UDP, TCP, Modbus TCP and BACnet/IP

Modbus LED:s
Monitoring of Modbus transmit and receive activity.

Modbus Port
Removable 3-wire isolated RS-485 connection with support for 2-wire non-isolated devices.

2. Configuration

Configuration of the Anybus BACnet to Modbus Gateway is via the built-in web pages, as depicted in the following illustrations.

2.1 Accessing the Configuration Pages

The configuration pages can be accessed via a standard web browser using Java 6 or later. The Anybus BACnet to Modbus Gateway is shipped with a default private IP address, which is 192.168.92.68. Enter this address in the browser to begin configuration.

There are 3 main areas that require configuration.

2.1.1 System

In all likelihood, the default IP address and subnet mask for the gateway will need to be changed, but it is always possible to reset the IP address to the default settings without losing any other configuration data. A name can be provided for the Anybus BACnet to Modbus Gateway. If there is an IP router on the attached Ethernet network, provide this IP address as the Gateway Address when configuring the System settings.

2.1.2 BACnet

The Anybus BACnet to Modbus Gateway must be assigned a unique device instance number independent of any other assignments. The UDP port is typically the default registered BACnet port 0xBAC0. Only under special circumstances does this need to be changed.

If the Anybus BACnet to Modbus Gateway is to be installed on a subnetted BACnet internetwork, it will be necessary for the gateway to register as a Foreign Device with a BACnet/IP Broadcast Management Device (BBMD), if none exists on the gateway's subnet. If this is the case, enter the IP address of a known BBMD, thereby invoking Foreign Device Registration with this BBMD. This is why the gateway address must be entered in the system settings. By registering as a foreign device, the Anybus BACnet to Modbus Gateway will be able to receive broadcast messages originating from other subnets. A BBMD registration time must be entered so that registration is continuously renewed on a periodic basis.

The final setting is the Virtual Network address. This is the unique BACnet network number assigned to the attached Modbus devices.

2.1.3 Modbus

The last section in the Configure Settings screen deals only with Modbus serial devices. The first decision concerns setting a baud rate between 2400 and 115200, although 19200 is the default. The next is to select Modbus RTU or Modbus ASCII. Modbus RTU is more common and is the default. Next is the Parity setting, which is recommended to be set to NONE, although EVEN is the default. If no parity is selected, an extra STOP bit is automatically added, so as to not change the frame length. Whatever the settings used, they MUST apply to ALL attached Modbus devices.

There are other settings that should not be touched unless there is good reason. Time settings are in milliseconds. Command Timeout is the time the master waits for a response from a slave. The Inter Scan Delay is the time between each polling cycle. The Offline Poll Period is the time the master will wait before trying to contact an offline slave. The Consecutive RD Delay is the amount of time the master waits when polling the same device with consecutive reads. If the slave device is capable of responding to a block read of consecutively numbered points, the Max Consecutive RD can be limited by this number.

Mapping Modbus Points to BACnet

Modbus data is considered as divided in four memory blocks - coils, discrete inputs, input registers and holding registers. Discrete inputs and coils are considered 1-bit points, while input registers and holding registers are 16-bit points. So, 1-bit points would be assigned either a BACnet BI or BO object type, while 16-bit points would be either an AI or AO. If the point was read-only, then it would be considered a BACnet input. All read/write points would be considered outputs. Using this convention, the following mapping rules apply when generating device profiles:

- Modbus Coils become BOs
- Modbus Discrete Inputs become BIs
- Modbus Input Registers become AIs
- Modbus Holding Registers become AOs

There is however, an exception to these rules. It is possible for a holding register to be packed as individual status bits or control points that require extraction. When generating the device profile, these are broken out as individual BOs or BIs, instead of as one AO. Object instance numbers are then assigned sequentially for each identified Modbus point.

3. Managing Modbus Devices

Once the Anybus BACnet to Modbus Gateway is properly configured, Modbus device profiles can be added for each connected Modbus device. The process for adding devices is similar for Modbus Serial or Modbus TCP devices.

3.1 Adding a Device

By clicking on the **Mapping Configuration** tab you will be presented with a Configured Devices box showing all Modbus devices that are currently being assessed by the Anybus BACnet to Modbus Gateway. Clicking on any of the devices listed will display a Device Information box showing the device profile of that particular device. The device profile lists all available Modbus points, with each entry having its own check-box. A checked box means that the associated point is being included in the gateway's scan list.

When viewing the Configured Devices box, a Modbus device can be added by clicking the **Add** button. From the drop-down Device Profile menu, select the appropriate device profile for the device to be added. The selected profile with pre-checked boxes will be added. You can add or delete the points of interest at any time before submitting the device to the scan list. Next, assign the Modbus slave address, in the range 1-246. If the device is a Modbus serial device, leave the Modbus IP Address at the default 0.0.0.0 setting. If the device is a Modbus TCP device, enter its IP address, as well as the slave address. If the Modbus TCP device is on a different subnet to that of the Anybus BACnet to Modbus Gateway, communication will be possible if IP routers are installed on the respective subnets.

A unique BACnet device instance number will need to be assigned to each connected Modbus device, and the Anybus BACnet to Modbus Gateway has a scheme to make assignments easier. Note that the Device Instance Auto box is checked, meaning that the gateway will attempt to automatically assign unique BACnet device instances to each Anybus BACnet to Modbus Gateway being installed. The following digit is determined by the Region Number, in the range 0-9.

The final digits are the Modbus slave address. If there is only one Anybus BACnet to Modbus Gateway on the BACnet internetwork, then there is no need to increment the Region Number from the default value of zero. If more than one Anybus BACnet to Modbus Gateway is being used in the same system, increment the Region Number for each added gateway, up to 9, to ensure that no duplicate BACnet device instances are generated.

For more than 10 Anybus BACnet to Modbus Gateways, it will be necessary to enter the BACnet device instance manually. Uncheck the Device Instance Auto box and enter a unique number in the range 0-4194302.

To complete the configuration, you can enter a name for the device you added on the top line. Once all entries are made, click **Submit** and then **Back** to return to the Configured Devices box. Once there, refresh the box and you will see your new device.

3.2 Modifying, Copying and Deleting Devices

From the Configured Devices box, you can modify settings in a device, and copy a device if multiple instances of the same device are to be used. It is also possible to delete a device.

3.3 Mapping Status

By clicking on **Mapping Status** you can determine the number of Modbus devices that are online, by observing the **Unit Status** box. To view a particular device, go to the Device Instance drop-down box and select the device. The Modbus address will automatically appear to the right of the device instance. Modbus TCP devices will appear as a combination of IP address and Modbus slave address. Using the Object Instance drop-down box you can scroll through all the objects that are being polled within that device. The first reference is the actual BACnet object instance, which is followed by the object instance type (AI, AO, BI or BO).

The last reference is the Modbus point. After selecting one of the objects, an object property can be selected through the **Object Property** drop-down. One property of interest would be the **Present Value** of the object. The present value of all objects can be read by clicking on the **Read** button, but not all objects can be written by supplying a value and clicking on the **Write** button. If the object property cannot be written, the Write button will be greyed out.

3.4 Upload Profile

Standard device profiles are supplied with the device, but new ones are continuously being developed. Newly developed profiles will be posted on the Anybus BACnet to Modbus Gateway support page, at http://www.anybus.com.

If a device profile is not available for your device, HMS supplies tools and instructions on how these can be created. Please see the Step-by-step guide for the Anybus Profile Builder and the support pages.

In addition, HMS will develop or modify an existing device profile based upon customer requests. Wherever the source of the new or modified device profile, it must first be loaded onto the customer's computer and then uploaded to the Anybus BACnet to Modbus Gateway, following the instructions under the **Upload Profile** tab.

4. Using Virtual BACnet Routing

In the BACnet protocol, physical BACnet devices are assigned unique device instances. In this way, any BACnet device on the same BACnet internetwork can be uniquely identified. Accommodations must be made for non-BACnet compliant devices such as Modbus devices, but the ability to uniquely identify each Modbus device within the BACnet internetwork can be retained thanks to virtual networking.

The Anybus BACnet to Modbus Gateway has one Modbus serial port that can accommodate up to 30 physical Modbus serial devices. Each of the attached devices must be configured for the same baud rate, the same parity, and the same serial protocol – RTU or ASCII. Each device must be assigned a unique slave ID, from 1 to 246. Additionally, the gateway will also support Modbus TCP slave devices connected via Ethernet. The Anybus BACnet to Modbus Gateway functions as a master to all these slave devices. Collectively, all the Modbus TCP and Modbus serial devices are assigned virtual BACnet network number during configuration.

Using the concept of virtual BACnet routing, each uniquely addressed Modbus slave device appears as an individual BACnet device, with a unique BACnet device instance assignment. Within this BACnet device is a collection of BACnet objects that relate to Modbus data points. Each Modbus device type requires a device profile, to allow the mapping of Modbus data points to BACnet object instances. HMS maintains a library of common device profiles, with the more popular profiles shipped with the product. Energy meter device profiles from Veris, Northern Design and Continental Control Systems are part of the library, and more are frequently added.

During commissioning, a Modbus device is "added" by selecting the appropriate device profile and assigning a unique BACnet device instance. Each device profile lists all the available Modbus data points for a particular Modbus device type, along with recommended BACnet object instance designations. A checkbox alongside a data point indicates that this point is to be polled by the Anybus BACnet to Modbus Gateway. By default, the most popular registers in each device profile are marked for polling, but the user can add or delete from this list via the web pages. Up to 30 edited device profiles can be added, each with a unique Modbus slave address and BACnet device instance. Each device profile can be the same, or different, depending upon the Modbus device type or the amount of points needing to be scanned. The only restriction is the 30 slot limit and the maximum total polled point count of 1000.

Shown below are three device profiles representing three Modbus devices that will be polled for data while appearing as BACnet devices. Each device has been assigned a unique BACnet device instance. The first two devices are identical and have the same device profile, while the third one is a totally different device. Note that the first two devices have different data points checked, demonstrating the flexibility in selecting only the points of interest that require polling. To poll multiple identical devices (e.g. energy meters) — edited device profiles can be copied to further speed up commissioning.

Device Name:	Veris A
Modbus Address:	40 (1 to 246)
Modbus IP Address:	0.0.0.0
Device Instance:	2450040

Modbus Registers (Max 1000):

- ☐ 400271 Avg Voltage L-N average of 3
- ☐ 400273 Avg Current average of 3
- ☑ 400275 Real Power phase A
- ☐ 400277 Real Power phase B
- ☐ 400279 Real Power phase C
- ☑ 400281 Power Factor phase A
- ☐ 400283 Power Factor phase B
- ☐ 400285 Power Factor phase C

Device Name:	Veris B
Modbus Address:	41 (1 to 246)
Modbus IP Address:	0.0.0.0
Device Instance:	2450041

Modbus Registers (Max 1000):

- ☐ 400271 Avg Voltage L-N average of 3
- ☐ 400273 Avg Current average of 3
- ☑ 400275 Real Power phase A
- ☑ 400277 Real Power phase B
- ☑ 400279 Real Power phase C
- ☑ 400281 Power Factor phase A
- ☑ 400283 Power Factor phase B
- ☑ 400285 Power Factor phase C

Device Name:	ND350
Modbus Address:	10 (1 to 246)
Modbus IP Address:	0.0.0.0
Device Instance:	2450010

Modbus Registers (Max 1000):

- ☐ 400513 eScale Energy Register
- ☑ 400515 kWh Energy Register
- ☑ 400517 kVAh Energy Register
- ☑ 400519 kvarh Inductive Energy Register
- ☑ 400521 kvarh Capacitive Energy Register
- ☑ 400523 Import kvarh Energy Register
- ☑ 400525 Export kWh Energy Register
- ☐ 400527 Export kvarh Energy Register

5. Applications

The following are examples of how the Anybus BACnet to Modbus Gateway can be used in various scenarios.

5.1 Application #1 - Two Virtual Networks

A common application is adding one or more Modbus serial networks to a BACnet system. Each Modbus serial network must be configured for the same Modbus serial protocol (RTU or ASCII), the same data rate (2400-115200 baud), and the same parity (ODD, EVEN or NONE).

Ensure that any wiring issues with 2-wire and 3-wire devices are addressed. In the system shown below, two virtual BACnet networks must be assigned - Network 1 and Network 2 - which are separate from the real BACnet network, numbered 3 in this example. If you are using the Device Instance Auto feature to automatically assign device instances, you must select a different Region Number for the two Anybus BACnet to Modbus Gateways, to ensure that no duplicate device instances are generated.
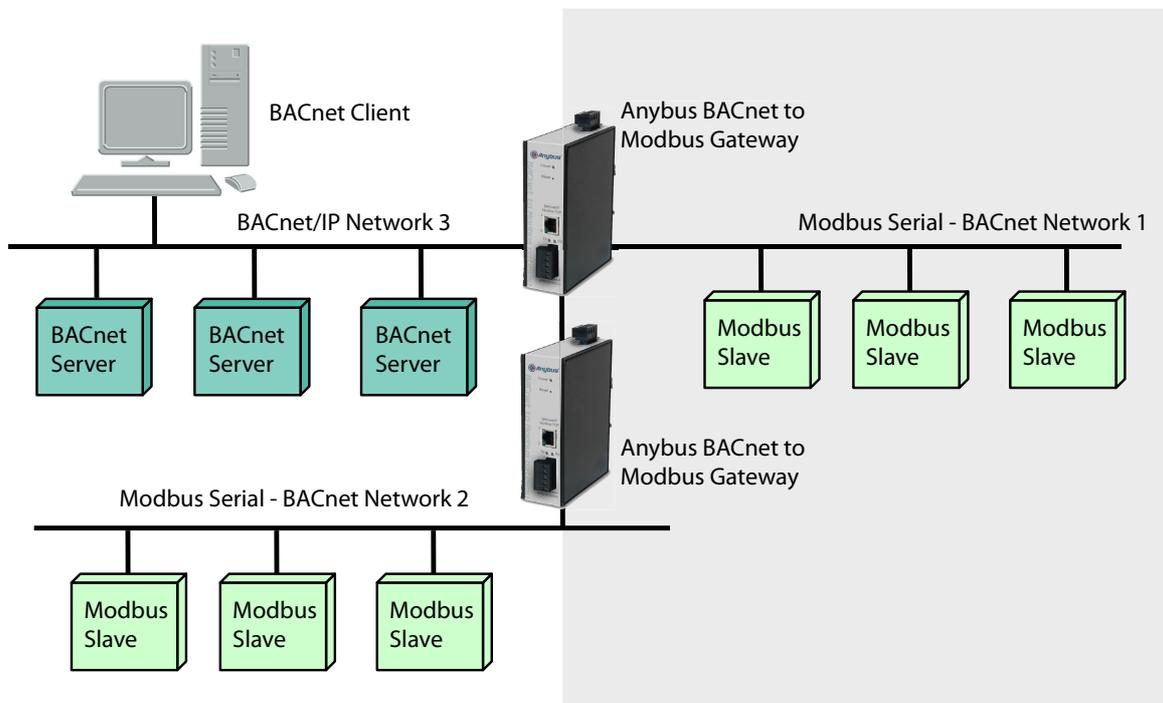
5.2 Application #2 - Mixing Modbus TCP and Serial

A single Anybus BACnet to Modbus Gateway can handle Modbus TCP devices and Modbus RTU devices simultaneously, as long as the 30 device/1000 polled point limit is maintained. In this application the Modbus TCP connection is known as a "one-armed gateway," because both Modbus TCP and BACnet/IP messages transfer through the same Ethernet port.

Configuration is similar to that of a Modbus serial device. However, this time the IP address of the Modbus TCP device must be entered, as well as a Modbus slave address. There is a potential conflict if using the Device Instance Auto feature and if a connected Modbus TCP device and a connected Modbus Serial device happen to use the same slave address. If a conflict is reported by the Anybus BACnet to Modbus Gateway, simply set the device instance manually - or select a different Region Number.

As only one Gateway is used in this application, only one virtual BACnet network number is assigned.
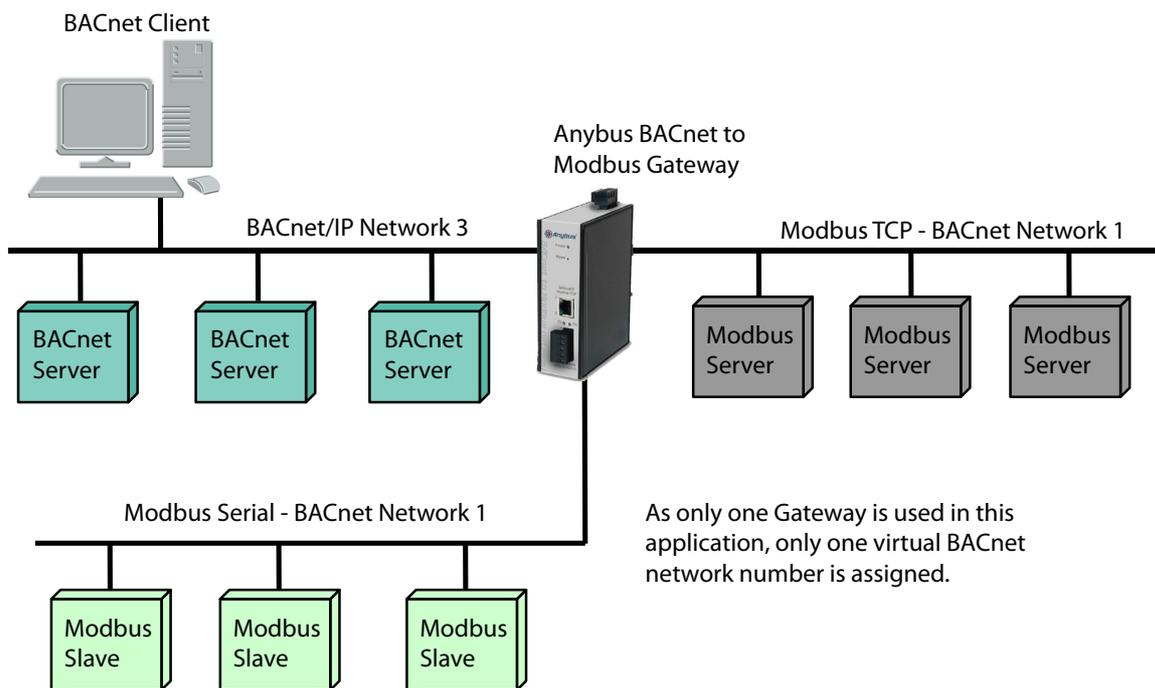
5.3 Application #3 - Modbus Serial to TCP Routing

The Anybus BACnet to Modbus Gateway will function inherently as a Modbus serial to Modbus TCP router. This mode requires no mapping configuration, since BACnet is not involved. Modbus TCP devices can function as clients, servers or as client/servers. When a Modbus TCP server device is configured, it must be assigned a slave address as well as an IP address. When a Modbus TCP client accesses a Modbus TCP server, communication occurs over Ethernet with no involvement from the Anybus BACnet to Modbus Gateway.

However, if a Modbus TCP client communicates with a Modbus serial device, the message is routed through the gateway, to its serial bus. For this application, no configuration is required other than the **System** and **Modbus** settings under the **Configure Settings** tab.
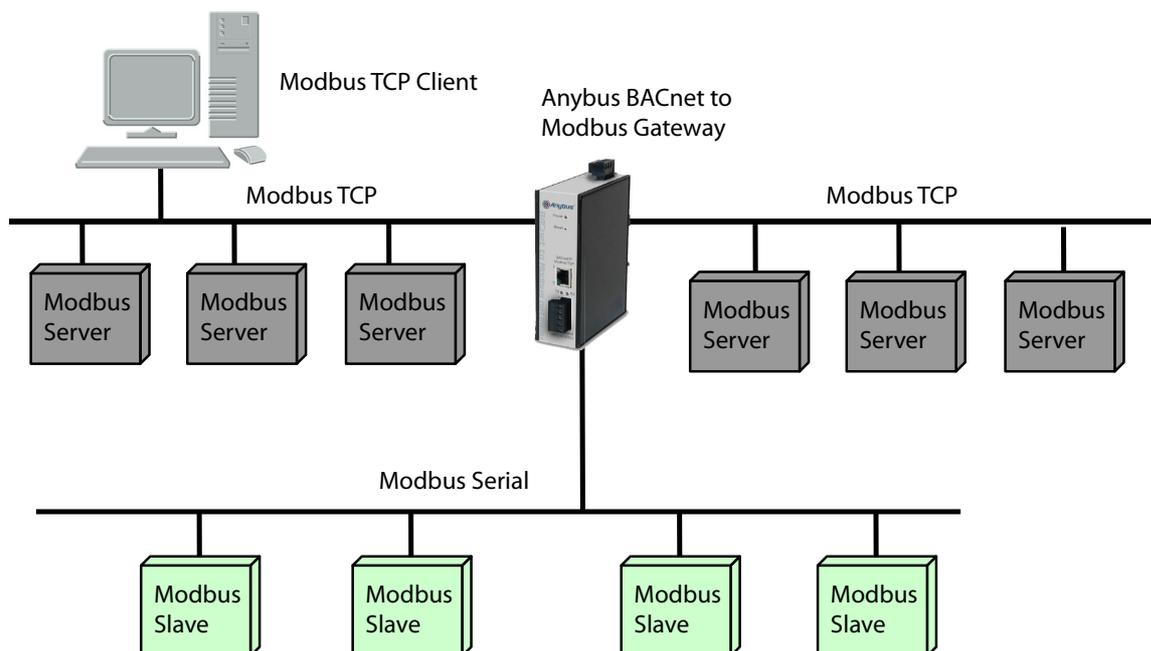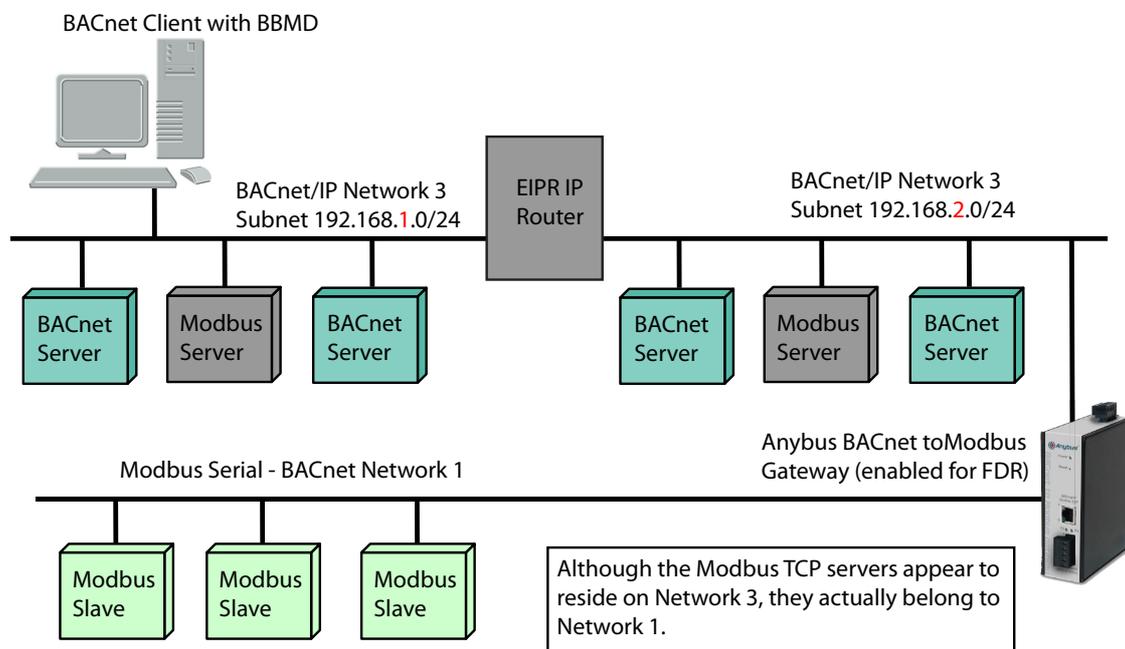
5.4 Application #4 - Sub-netted IP Network

When using IP networks, BACnet client devices, the Anybus BACnet to Modbus Gateway and Modbus TCP devices can all reside on different subnets, interconnected through IP routers. The gateway will still operate under these conditions.

Shown below are a BACnet client with BBMD capability and Modbus TCP servers on subnet 1, with the Anybus BACnet to Modbus Gateway and other Modbus TCP servers on subnet 2. Modbus serial devices are attached to the Anybus BACnet to Modbus Gateway's serial port. Between the two subnets is an IP router.

Enable foreign device registration in the Anybus BACnet to Modbus Gateway by setting its BBMD IP Address field to the IP address of the BACnet client. In the Anybus BACnet to Modbus Gateway System setup, set the Gateway Address to the IP address of the IP router. Modbus TCP and Modbus serial devices are entered as usual — allowing the BACnet client (or other BACnet clients) to discover all Modbus devices with no problems.

BACnet Client with BBMD

BACnet/IP Network 3
Subnet 192.168.1.0/24

EIPR IP
Router

BACnet/IP Network 3
Subnet 192.168.2.0/24

BACnet Server

Modbus Server

BACnet Server

BACnet Server

Modbus Server

BACnet Server

Anybus BACnet toModbus Gateway (enabled for FDR)

Modbus Serial - BACnet Network 1

Modbus Slave

Modbus Slave

Modbus Slave

Although the Modbus TCP servers appear to reside on Network 3, they actually belong to Network 1.

A. Technical Specifications

Power Requirements:	24 VAC ±10% 10 VA 47–63 Hz, or 24 VDC ±10% 6W	
Operating Temp:	0°C to +60°C	
Storage Temp:	-40°C to +85°C	
Relative Humidity:	10–95%, non-condensing	
Ingress Protection:	IP30	

Communication	**Ethernet**	**RS-485**
Compliance:	IEEE 802.3	Modbus V1.02
Protocols supported:	Modbus TCP	RTU Master
	BACnet/IP	ASCII Master
Data rate:	10 Mbps, 100 Mbps	2.4, 4.8 9.6, 19.2, 38.4, 57.6, 115.2 kbps
Physical layer:	10BASE-T, 100BASE-TX	RS-485, 3-wire isolated
Cable length (max)	100m	1200m (1000m if using 115.2 kbps)
Port connector:	Shielded RJ-45	5-pin removable terminal

LEDs:	**L (Link)**	**D (Duplex)**	**Tx**	**Rx**
	Green = 100 Mbps	Green = Full-duplex	Green= Activity	Green = Activity
	Yellow = 10 Mbps	Off = Half-duplex		
	Flash = activity	Flash = Collision		

Regulatory Compliance:	CE Mark; CFR 47
	Part 15 Class A
	RoHS
	UL 508; C22.2 No. 142-M1987