ADDENDA

ANSI/ASHRAE Addendum al to
ANSI/ASHRAE Standard 135-2012

Data Communication Protocol for Building Automation and Control Networks

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[This foreword and the "rationales" on the following pages are not part of this standard. They are merely informative and do not contain requirements necessary for conformance to the standard.]

FOREWORD

The purpose of this addendum is to present a proposed change for public review. These modifications are the result of change proposals made pursuant to the ASHRAE continuous maintenance procedures and of deliberations within Standing Standard Project Committee 135. The proposed changes are summarized below.

135-2012*al*-1 Specify Best Practices for Gateway Design, p. 2
135-2012*al*-2 Add new BIBBS and Devices Profiles, p. 6

In the following document, language to be added to existing clauses of ANSI/ASHRAE 135-2010 and Addenda is indicated through the use of *italics*, while deletions are indicated by ~~strikethrough~~. Where entirely new subclauses are proposed to be added, plain type is used throughout. Only this new and deleted text is open to comment at this time. All other material in this addendum is provided for context only and is not open for public review comment except as it relates to the proposed changes.

135-2012*al*-1 Specify Best Practices for Gateway Design

Rationale

The BACnet standard does not provide adequate direction for gateway manufacturers. This proposal specifies a set of best practices that are recommended for the design of successful gateways to/from the BACnet protocol.

[Insert into Clause 3, p. 7]

virtual BACnet device: a BACnet device that is modeled in software, usually in a gateway, and does not exist as a physical BACnet device.

virtual BACnet network: a network of virtual BACnet devices, usually modeled by a gateway where no physical BACnet network exists.

[Change **Clauses H.1 and H.2**, making H.2 part of H.1, p. 838]

H.1 BACnet Gateways

There are three basic approaches to BACnet gateways: mapping non-BACnet networks onto BACnet routers, modeling a single non-BACnet device as multiple BACnet devices and mapping multiple non-BACnet devices into a single device.

H1.1 Modeling non-BACnet Devices as BACnet Devices

~~H.1~~*H.1.1.1* Mapping Non-BACnet Networks onto BACnet Routers

In addition to providing the means to interconnect multiple BACnet networks, BACnet routers may also be used to provide a gateway function to non-BACnet networks. Non-BACnet networks are characterized by the use of message structures, procedures, and medium access control techniques other than those contained in this standard. The mapping from BACnet to non-BACnet networks is performed by extending the routing table concept to allow non-BACnet devices to be addressable using BACnet NPCI. Thus, each non-BACnet network is assigned a unique two-octet network number, and each device on the non-BACnet network is represented by a "MAC address" that may or may not correspond to the actual octets used to address the device using the medium access control in use on the foreign network. Since communication with devices on non-BACnet networks is, by definition, not standardized here, the specific procedures for interpreting, translating, or relaying messages received by such a router-gateway from either the BACnet or non-BACnet ports are *a local matter*~~outside the scope of this standard~~.

The non-BACnet network that is modeled in this manner by a BACnet gateway is referred to as a virtual BACnet network and the devices modeled on that network are referred to as virtual BACnet devices.

~~H.2~~*H.1.1.2* Multiple "Virtual" BACnet Devices in a Single Physical Device

A BACnet device is one that possesses a Device object and communicates using the procedures specified in this standard. In some instances, however, it may be desirable to model the activities of a physical building automation and control device through the use of more than one BACnet device. Each such device will be referred to as a ~~"~~virtual BACnet device.~~"~~ This can be accomplished by configuring the physical device to act as a router to one or more ~~"~~virtual *BACnet* networks.~~"~~ The idea is that each virtual BACnet device ~~would be~~ *is* associated with a unique DNET and DADR pair, i.e., a unique BACnet address. The physical device ~~would be expected to~~ performs exactly as if it were a router between *physical BACnet networks, so that from the physical side, there is no behavioral distinction between virtual and physical networks* ~~the network on which messages for the virtual BACnet devices are received and a real BACnet network with the same network number as assigned to the virtual BACnet devices~~.

The modeling of a single non-BACnet device as a network of multiple BACnet devices is sufficiently similar to mapping non-BACnet networks onto BACnet routers that the remainder of this annex presents only the other two gateway models.

H.1.1.3 Modeling non-BACnet Data as Objects in a Single BACnet Device

In many situations, the amount of data provided by a non-BACnet device is small, and there is no benefit in exposing the non-BACnet devices as individual BACnet devices. In these cases, the gateway provides access to data in the non-BACnet devices through objects within the gateway device. The methods used for interaction between the gateway and the non-BACnet devices, and the methods used for mapping data into BACnet objects is a local matter.

[Insert new **Clause H.2**, p. 838]

H.2 Requirements and Best Practices for BACnet Gateway Implementations

The design and implementation of BACnet gateways is a local matter. However, there are certain design choices that result in better interoperability between the BACnet devices, the BACnet gateway, and the non-BACnet devices.

Informative Note: This clause lists some of the design choices that have been shown to provide a positive user experience. In this clause, therefore, the word "should" is used to indicate a recommendation that conforms to those design choices.

H.2.1 General Best Practices

H.2.1.1 Caching Writes to Non-BACnet Devices

To achieve reasonable performance on the BACnet network, it is not always feasible for a gateway to wait for data to be written through to non-BACnet devices. As such, it is acceptable for gateways to return a Result(+) to a WriteProperty or WritePropertyMultiple request even though the values have not been written through to the non-BACnet device. It is also acceptable for the gateway to return the previously written value to a subsequent ReadProperty or ReadPropertyMultiple even if it has not been written through to the non-BACnet device. This may result in a slight difference in behavior between native BACnet data and data from non-BACnet devices.

H.2.1.2 Input, Output, and Value Objects

The choice of modeling non-BACnet inputs, outputs, and values as BACnet Input, Output, or Value objects is a local matter; however, the following guidance is provided.

For non-BACnet inputs:

- BACnet Input objects are recommended for non-BACnet inputs. When the Present_Value is made writable by taking the object out of service, values written to the Present_Value should not be assumed to be written through to the non-BACnet input.

For non-BACnet outputs:

- BACnet Output objects are recommended for use when the non-BACnet output is controlled only through BACnet and therefore the BACnet Present_Value can normally be assumed to be equal to the non-BACnet output value.

- Writable non-commandable BACnet Value objects are recommended for use when control of the non-BACnet output is shared between BACnet and non-BACnet entities. In this case, is it typical for the gateway to periodically read the non-BACnet output so that the BACnet Present_Value matches the non-BACnet output.

For non-BACnet values:

- Commandable BACnet Value objects are recommended when the non-BACnet value is controlled only through BACnet and therefore the BACnet Present_Value can normally be assumed to be equal to the non-BACnet value.

- Writable, non-commandable BACnet Value objects are recommended when control of the non-BACnet value is shared between BACnet and non-BACnet entities. In this case, is it typical for the gateway to periodically read the non-BACnet value so that the BACnet Present_Value matches the non-BACnet value.

- Non-writable, non-commandable BACnet Value objects are recommended for the case where the non-BACnet value is only being monitored and is not being controlled from BACnet. When the Present_Value is made writable by taking the object out of service, values written to the Present_Value should not be assumed to be written through to the non-BACnet value.

H.2.1.3 Priority_Array Handling

Gateways are required to implement Priority_Array properties correctly with all 16 entries as defined in clause 19.2.

H.2.1.4 Handling Requests That Take Too Long

Confirmed requests that cannot be fulfilled within the allowed APDU_Timeout shall result in an abort PDU being returned to the client. This condition may be caused by requests for too much data or for too many properties that are not cached in the gateway. One condition when this would occur is when a ReadPropertyMultiple request is received that would require the gateway to communicate with more non-BACnet devices that it can within the APDU_Timeout because the values are not cached in the gateway. Under such conditions, the gateway shall return the abort PDU with an abort reason of APPLICATION_EXCEEDED_REPLY_TIME, and the client is expected to retry the request with fewer properties.

H.2.1.5 Non-BACnet Devices That Sleep

When a gateway is providing access to a non-BACnet device that sleeps (i.e., the device is not always available to answer requests), the gateway shall cache all data and answer all BACnet requests using a data cache. Later, when the sleeping device wakes up, data updates are sent to the device, and reads are performed as required.

If non-BACnet devices are expected to wake up and report their status on a pre-determined schedule, when a device does not report its status, it shall be treated as if it is offline (see the following sections on how a gateway should treat offline devices).

H.2.2 Virtual Network Gateways

H.2.2.1 Offline Devices

When modeling devices as a virtual BACnet network of devices, communication timeout errors between the gateway and the non-BACnet device shall not result in the gateway returning an error, abort, or reject PDU in response to BACnet requests directed to the non-BACnet device. Instead, the gateway shall remain silent. This gives the best indication to the BACnet client that the device is offline.

When a gateway has determined that a non-BACnet device is offline, it shall also not send I-Am or I-Have requests on behalf of that device.

H.2.2.2 Spread Out I-Am, I-Have Requests

The gateway device is responsible for sending the I-Am and I-Have requests for the non-BACnet devices. When the number of non-BACnet devices increases, so too will the number of I-Am and I-Have requests that the gateway will be sending. In order to ease network traffic, the gateway should space out I-Am and I-Have requests.

H.2.2.3 Prepare for Numerous Outstanding Requests

Gateways to virtual BACnet networks should be prepared for a large number of simultaneous requests. Many client devices will restrict the number of outstanding requests to any particular device. Due to the gateway responding on behalf of a number of devices, such client niceties will not have the same benefit for the gateway device. As such, gateway devices should be prepared for significantly more traffic than a single normal BACnet device would receive.

H.2.3 Single Device Gateways

H.2.3.1 Organization of Data

When modeling non-BACnet data as objects within the gateway device, as the number of data points mapped into the gateway increases, the inter-data relationships become less apparent. In order to improve the organization of the mapped data points, gateways should use Structured View objects.

H.2.3.2 Offline Devices

Communication errors between the gateway and the non-BACnet device should be indicated via the Reliability property and Fault flag in the associated BACnet objects. The gateway should support initiation of event notifications to report such faults.

Properties that exist in objects in the gateway device shall return values when read and not errors, even when the non-BACnet device from which those values are normally read is offline. It is not acceptable for this style of gateway device to not respond to confirmed requests just because the non-BACnet device is offline.

[Change **Clause 5.1**, p. 19]

In most cases, a physical device will implement a single BACnet Device. It is possible, however, that a single physical device may implement a number of "virtual" BACnet Devices. This is described in Annex H.

Note that some application layer requirements are relaxed for BACnet gateways to non-BACnet protocols. See Annex H.

135-2012*al*-2 BIBBS and Devices Profile Changes

Rationale

There is currently no mechanism for specifying gateway, router, and BBMD functionality using BIBBs and device profiles.

The router configuration BIBBs are updated to ensure that configuration tools can perform all of the expected functions. The use of Initialize-Routing-Table is removed from these BIBBs due to known interoperability issues with the service and the pending addition of the Network Port object.

A new device profile is also added for those devices which do not match any existing device profiles. The intent is to provide a general profile that conveys no semantic requirements.

[Change **ANNEX A**, p. 776]

...

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:

_____
_____
_____

If this product is a communication gateway which presents a network of virtual BACnet devices, a separate PICS shall be provided that describes the functionality of the virtual BACnet devices. That PICS shall describe a superset of the functionality of all types of virtual BACnet devices that can be presented by the gateway.

...

[Change **Clause K.5.29**, p. 901]

K.5.29 BIBB - Network Management-Router Configuration-A (NM-RC-A)

The A device ~~may~~ *is capable of* query*ing*, ~~and~~ chang*ing, and verifying* the configuration of routers and half-routers.

The A device is capable of creating and deleting Network Port objects; reading all standard properties of the Network Port object type; and writing all standard properties of the Network Port object type except those defined as read-only by this standard.

BACnet Network Layer Message	Initiate	Execute
Who-Is-Router-To-Network	x	
I-Am-Router-To-Network		x
I-Could-Be-Router-To-Network		x
Establish-Connection-To-Network	*x*	
Disconnect-Connection-To-Network	*x*	
~~Initialize-Routing-Table~~	~~x~~	
~~Initialize-Routing-Table-Ack~~		~~x~~

BACnet Service	*Initiate*	*Execute*
ReadProperty	*x*	
WriteProperty	*x*	
CreateObject	*x*	
DeleteObject	*x*	

Devices claiming a Protocol_Revision less than 15 and conformance to this BIBB are not required to be able to create, delete or modify Network Port objects.

[Change **Clause K.5.30**, p. 873]

K.5.30 BIBB - Network Management-Router Configuration-B (NM-RC-B)

The B device responds to router management commands and shall meet the requirements for BACnet Routers as stated in Clause 6. *Devices claiming conformance to this BIBB shall meet the minimum requirements for a BACnet device as described by this standard and specifically by clause 22*.

BACnet Network Layer Message	Initiate	Execute
Who-Is-Router-To-Network	x	x
I-Am-Router-To-Network	x	x
~~Initialize-Routing-Table~~		~~x~~
~~Initialize-Routing-Table-Ack~~	~~x~~	
Reject-Message-To-Network	*x*	*x*
Router-Busy-To-Network	*x*	*x*
Router-Available-To-Network	*x*	*x*
Network-Number-Is	*x*	*x*
What-Is-Network-Number		*x*

BACnet Service	*Initiate*	*Execute*
Read-Property		*x*
Write-Property		*x*

Devices claiming a Protocol_Revision less than 11 and conformance to this BIBB are not required to support What-Is-Network-Number nor Network-Number-Is.

Devices claiming a Protocol_Revision less than 15 and conformance to this BIBB are not required to support WriteProperty nor the Network Port object type.

Devices shall meet the requirements in Clause 6 for the forwarding of Router-Busy-To-Network and the initiating of Router-Busy-To-Network message for other conditions remain optional.

[Add new **Clauses K.5.X1-K.5.X5**, p. 875]

K.5.X1 BIBB - Network Management - BBMD Configuration - B (NM-BBMDC-B)

The B device responds to BBMD management commands and shall meet the requirements for BBMDs as stated in Annex J.

- Supports 2-hop distribution (support for 1-hop is optional).
- Supports a minimum of five peer BBMDs.
- Supports a minimum of five simultaneous foreign device connections.
- At a minimum, supports foreign device registration lifetimes in the range 30 seconds – 9 hours.

Devices claiming conformance to this BIBB shall meet the minimum requirements for a BACnet device as described by this standard and specifically by clause 22.

BACnet Virtual Link Layer Message	Initiate	Execute
Write-Broadcast-Distribution-Table		x
Read-Broadcast-Distribution-Table		x
Read-Foreign-Device-Table		x
Delete-Foreign-Device-Table-Entry		x
Register-Foreign-Device		x
Forwarded-NPDU	x	x
Distribute-Broadcast-To-Network		x

Original-Unicast-NPDU	x	x
Original-Broadcast-NPDU	x	x

K.5.X2 BIBB - Network Management - BBMD Configuration - A (NM-BBMDC-A)

The A device is able to query and change the configuration of BBMDs.

BACnet Virtual Link Layer Message	Initiate	Execute
Write-Broadcast-Distribution-Table	x	
Read-Broadcast-Distribution-Table	x	
Read-Foreign-Device-Table	x	
Delete-Foreign-Device-Table-Entry	x	

K.5.X3 BIBB - Network Management - Foreign Device Registration - A (NM-FDR-A)

Devices claiming conformance to this BIBB shall be able to register as foreign device.

- Supports, at a minimum, foreign device registration lifetimes in the range 30 seconds – 9 hours.

BACnet Virtual Link Layer Message	Initiate	Execute
Register-Foreign-Device	x	
Distribute-Broadcast-To-Network	x	
Forwarded-NPDU		x
Original-Unicast-NPDU	x	x

K.5.X4 BIBB - Gateway-Virtual Network-B (GW-VN-B)

The B device provides access to data and functionality in non-BACnet devices. The B device models the devices as a collection of virtual BACnet devices and appears to the BACnet network as a router as described in Annex H. The B device shall, at a minimum, support NM-RC-B and DS-RP-B.

The gateway and each virtual BACnet device shall meet the minimum requirements for a BACnet device as described by this standard and specifically by clause 22.

K.5.X5 BIBB - Gateway-Embedded Objects-B (GW-EO-B)

The B device provides access to data and functionality in non-BACnet devices. The B device includes the data and functionality of the other devices through BACnet objects and services within the B device.

The B device shall support DS-RP-B.

The gateway shall meet the minimum requirements for a BACnet device as described by this standard and specifically by clause 22.

[Change **ANNEX L**, p. 876]

ANNEX L - DESCRIPTIONS AND PROFILES OF STANDARDIZED BACnet DEVICES (NORMATIVE)

(This annex is part of this Standard and is required of its use.)

This annex provides descriptions of ~~six~~ "standardized" types of BACnet devices. Any device that implements all the required BACnet capabilities for a particular device type and interoperability area may claim to be a device of that particular type. Devices may also provide additional capabilities and shall indicate these capabilities in their PICS.

BACnet device profiles are categorized into families:

- *Operator Interfaces. This family is composed of B-AWS, B-OWS, and B-OD.*
- *Controllers. This family is composed of B-BC, B-AAC, B-ASC, B-SA, and B-SS.*

- *Miscellaneous. This family is composed of B-RTR, B-GW, and B-BBMD.*

Devices may claim to be multiple device types. For example, a device may claim to be both a B-BC and the B-RTR. Devices that claim multiple device profiles shall only combine capabilities from different device families, with the exception that multiple profiles may be selected from the Miscellaneous family. For example, a device may claim the B-BC, B-RTR, and B-BBMD profiles, but a device may not claim both the B-BC and B-SS profiles.

The B-GENERAL device profile is not included in any of the profile families and is never claimed in conjunction with any other device profile, except those from the Miscellaneous family.

[Add new **Clauses L.X1-L.X4**, p. 880]

L.X1 BACnet Router (B-RTR)

A B-RTR is a BACnet network router. It connects two or more BACnet networks at the network layer. It enables specification of the following:

Data Sharing
- Ability to provide the values of any of its BACnet objects
- Ability to allow modification of some or all of its BACnet objects by another device

Alarm and Event Management
- No requirement

Scheduling
- No requirement

Trending
- No requirement

Device and Network Management
- Ability to respond to queries about its status
- Ability to respond to requests for information about any of its objects
- Ability to respond to communication control messages
- Ability to respond to network layer messages
- Ability to connect two or more data links

L.X2 BACnet Gateway (B-GW)

A B-GW is a BACnet gateway. It is intended for connecting one or more non-BACnet networks into a BACnet internetwork. There are two types of B-GW devices, those that represent non-BACnet devices as a network of virtual BACnet devices, and those that represent non-BACnet devices as BACnet objects. It enables specification of the following:

Data Sharing
- Ability to provide the values of any of its BACnet objects
- Ability to allow modification of some or all of its BACnet objects by another device

Alarm and Event Management
- No requirement

Scheduling
- No requirement

Trending
- No requirement

Device and Network Management
- Ability to respond to queries about its status
- Ability to respond to requests for information about any of its objects
- Ability to respond to communication control messages
- Ability to respond to network layer messages
- Ability to respond to queries about the status of a virtual BACnet device
- Ability to respond to requests for information about any of the objects of a virtual BACnet device

L.X3 BACnet Broadcast Management Device (B-BBMD)

A B-BBMD is a BACnet broadcast management device as defined in Annex J. It is intended for transporting broadcasts between different IP subnets. Devices which provide BBMD functionality along with some other BACnet functionality shall be capable of being reconfigured as a non-BBMD. It enables specification of the following:

Data Sharing
- Ability to provide the values of any of its BACnet objects
- Ability to allow modification of some or all of its BACnet objects by another device

Alarm and Event Management
- No requirement

Scheduling
- No requirement

Trending
- No requirement

Device and Network Management
- Ability to respond to queries about its status
- Ability to respond to requests for information about any of its objects
- Ability to respond to communication control messages
- Ability to respond to network layer messages
- Ability to manage BVLC functions

L.X4 BACnet General (B-GENERAL)

A B-GENERAL device is a BACnet device whose main function does not fall under any of the other device profiles. While the device may meet the functional requirements of one or more device profiles, the general description of the other profiles do not match the intended application of the device. It enables specification of the following:

Data Sharing
- Ability to provide the values of any of its BACnet objects

Alarm and Event Management
- No requirement

Scheduling
- No requirement

Trending
- No requirement

Device and Network Management
- Ability to respond to queries about its status
- Ability to respond to requests for information about any of its objects

[Change **Clause L.7**, p. 881]

L.7 Profiles of the Standard BACnet Devices

The following tables indicate which BIBBs shall be supported by each device type for each interoperability area.

Data Sharing

...	***B-RTR***	***B-BBMD***	***B-GW***	***B-GENERAL***	...
...	*DS-RP-B*	*DS-RP-B*	*DS-RP-B*	*DS-RP-B*	...
...					...
...	*DS-WP-B*	*DS-WP-B*	*DS-WP-B*		...
...					....
...					...
...					...

Alarm & Event Management

...	***B-RTR***	***B-BBMD***	***B-GW***	***B-GENERAL***	...
...					...
...					...
...					...
...					....
...					...
...					...
...					**...**
...					...

Scheduling

...	***B-RTR***	***B-BBMD***	***B-GW***	***B-GENERAL***	...

Trending

...	***B-RTR***	***B-BBMD***	***B-GW***	***B-GENERAL***	...

Device & Network Management

...	***B-RTR***	***B-BBMD***	***B-GW***	***B-GENERAL***	...
...	*DM-DDB-B*	*DM-DDB-B*	*DM-DDB-B*	*DM-DDB-B*[1]	...
...					...
...					...
...	*DM-DOB-B*	*DM-DOB-B*	*DM-DOB-B*	*DM-DOB-B*[1]	...
...					...
...					...
...					...
...					...
...					...
...					...
	NM-RC-B				
		NM-BBMDC-B			
			GW-EO-B[3]		
			GW-VN-B[3]		

[1] Not required if the device is a BACnet MS/TP Slave.
[2] Not required for devices claiming conformance to a Protocol_Revision less than 7.
[3] *One of these BIBBs shall be supported.*

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

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As an ongoing goal, ASHRAE will, through its Standards Committee and extensive Technical Committee structure, continue to generate up-to-date Standards and Guidelines where appropriate and adopt, recommend, and promote those new and revised Standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date Standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating Standards and Guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

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