SMART BUILDING EQUIPMENT

SBE-BNR-GW DUAL PORT BAC-net ROUTER

INSTRUCTION MANUAL

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Product Description:

The SBE-BNR-GW is a BACnet/IP to BACnet MS/TP router with built-in Modbus gateway. This compact device is din-rail mountable which makes it ideally suited for panel mounting. It can be powered by hard wired 12-24V AC or DC supply or via USB connection.

Features:

- One ethernet port
- Two RS-485 connections
- 12-24Vac/dc power with screw terminal connections
- Mini USB power connection
- Ethernet 110/100 Mbps half/full duplex with auto-negotiation and auto-DMIX
- Indicator LEDs monitor signal and power

Specifications:

Power Supply:	12-24V +/1 10% ac/dc (removable 2-wire terminal black)
	5Vdc, mini USB socket
Current Draw:	60mA (typical) / 120mA (max) @ 24Vdc
Power Consumption:	3W max
Operating Temperature:	14 to 176°F (-10 to 80°C)
Storage Temperature:	-40 to 194°F (-40 to 90°C)
Operating Humidity:	0 to 95% (non-condensing)
Protection:	Ip30
Dimensions:	4.76"H x 2.95"W x 1.14"D (121 x 75 x 29 mm)
Weight:	0.5 lb. (0.2 kg)
DIN Mount:	35 mm
Enclosure:	Metal
Ethernet:	IEEE 802.3 10/100 Mbps data rate
	Half/full duplex
	10BASE-T, 100BASE-TX physical layer
	RJ45 Ethernet Jack
	100m (max) CAT5 cable length
RS485:	ANSI/ASHRAE 135 (ISO 16484-5)
	Baud rates: 9600, 19200, 38400, 57600, 76800, 115200
	1500V isolated EIA-485 interface
	TVS and PTC for 15kv air/8kv contact ESD protection
	1/8 device load, 3937 ft. (max) cable length (2952 ft. on 115200bps)
	Removable 2-wire screw terminal blocks
	DIP switch for 120Ω bus terminator
	DIP switch for 519Ω bus biasing
Accessory:	Three 2-wire screw terminals, 3 ft. mini USB cable
Regulatory Compliance:	CE Mark; CFR 47, Part 15 Class B

Installation :

1. **Power Supply:**

    One of two power supply sources could be selected: AC/DC 12~24V on removable 2-wire terminal and DC 5V on mini USB socket.

2. **DIN rail install:**

    It is easy to lock on and remove from DIN rail by slightly pushing spring buckle inside DIN rail fastener.

3. **MS/TP wire:**

    Cable: An MS/TP EIA-485 network shall use shielded, twisted-pair cable with a characteristic impedance between 100 and 130 ohms. An additional conductor may also be used for common or signal reference where required by other BACnet devices on the same network requiring a common signal reference. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot). The shield shall be grounded at one end only to prevent group loops occurring.

    Connection: A MS/TP EIA-485 network shall use daisy-chained connections; the branch length should be as short as possible. T connections should be avoided.

    Max nodes: The maximum number of devices per segment shall be 32 (for full load), 64 (for 1/2 unit load), 128 (for 1/4 unit load), or 256 (for 1/8 unit load). Additional nodes may be connected by the use of repeaters.

    Termination: A termination resistance of 120 ohms shall be connected at each end of the network segment. No other termination resistors are allowed on the intermediate devices.

    Note: Termination resistors are built into the router with user selectable DIP switch.

    Bias: Each MS/TP segment can be installed with network bias resistors connected as shown in *Figure 1*. Each set of bias resistors shall consist of one pull up and one pull down resistor, each having a value of 510 ohms. If two sets of network bias resistors are provided, they shall be placed at two distinct nodes, preferably neat he ends of the segment so that proper bias levels can be maintained even if one of the bias notes loses power.
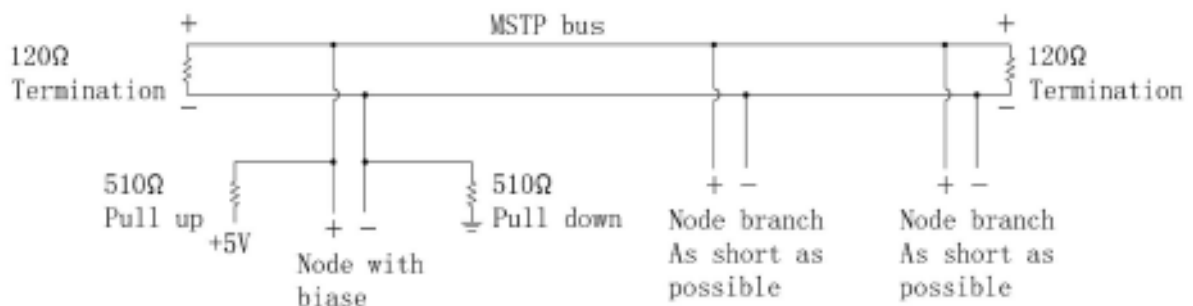

Figure 1: MS/TP Bus With Termination And Biasing

Commission:

1. **Offline Configuration & Import/Export:**

    User can configure the SBE-BNR-GW without device on hand and then export configuration to a file. When commissioning in the field, use only needs to import previously exported file and "Save & Reboot" to implement configuration.

2. **Default Setting & Reset:**

    By default, the IP of router is 192.168.100.1, DHCP server is enabled, WebUI username is "admin", and password is blank.

    To reset to default value, A paperclip is needed to press reset button in the small hole for more than 3 seconds and then release. The router will reboot and restore the default values.

3. **WebUI & System Settings:**

    To access WebUI, please set PC's IP to auto assignment (Or set a static IP to the same subnet as the router if DHCP is disabled).

    Connect CAT5 cable to router's RJ45 Ethernet jack. Open "http://192.68.100.1" (Use new IP of the router if it has been changed).
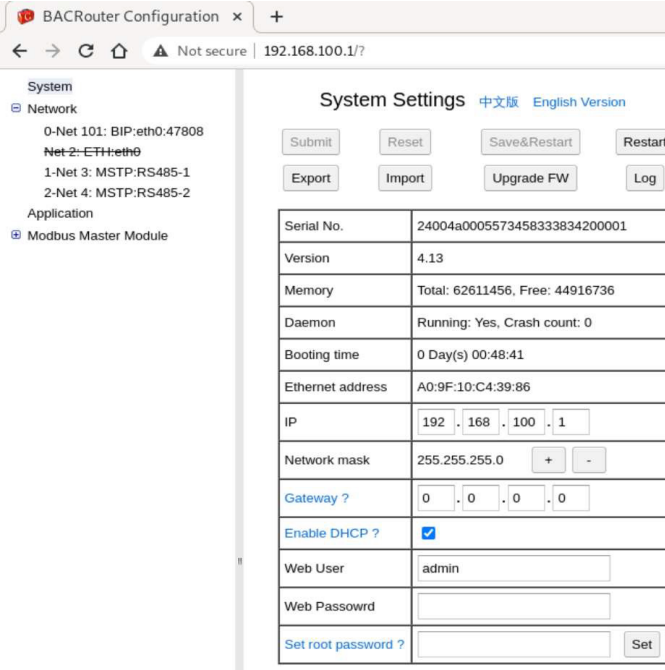
    If this fails, please pull out CAT5 cable from RJ45 jack, wait 10 seconds then plug in to retry.

    If successful, the browser will display a prompt for username and password. After inputting them, the "System Settings" web page will be displayed.

Username/Password: Username and password proterct the router from unauthorized access.

DHCP Server: The DHCP server assigns the IP to the PC joining network. The PC static IP does not need to be set manually and shouold be disabled as not to conflict with other DHCP servers.

Root Password: The Root Password can be used to access the router for maintenance. If the password has note been set, the set button will show **[Immediately Set]** otherwise only **[Set]**. For security reasons, please set a new password and record it before putting the router in use.

Figure 2: System Settings

4. **General Setting Procedure:**

Submit/Reset: There are **[Submit]** and **[Reset]** buttons on most setting pages. These buttons are enabled if any change is made. Clicking the **[Reset]** button will discard all changes. Clicking the **[Submit]** button will accept changes. Note: Accepted changes are stored in the browser and will be lost if browser if refreshed. When the **[Save&Restart]** button is clicked, changes will be saved and take effect.

Save/Restart: On the "System Settings" page, the **[Save&Restart]** button will be enabled if there are any changes submitted. Once it is clicked, the router will save all changes and restart. If no IP / Network Mask / Gateway / or Enable DHCP is changed, the router will perform a soft restart within 5 seconds, otherwise a hard restart should be performed to ensure changes take effect. This usually takes 30 seconds. If **[Restart Router]** button is clicked on the same page, the router will discard changes and make a soft start.

5. **Config Modify From BACnet:**

A few parameters can be modified through BACnet service. Those parameters will be discussed later in this manual. If configurations are modified through BACnet, the router will flash every 3 minutes while saving. If the router is powered off before changes are saved, all changes will be lost.

6. **LOG:**

On the "Systems Settings" page, clicking the **[Log]** button on the top will open the dialog box with log. This is helpful for trouble shooting. **(See Figure 3: Log Dialog)**
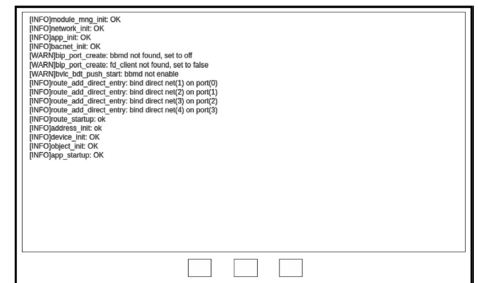

Figure 3: Log Dialog

7. **LEDs:**

Power LED: Red when power is on.

Status LED: Blue for 5 seconds when router powers up on hard restart, then turns off. After initialization is finished, it will flash every 3 seconds.

8. **Upgrade Firmware:**

On the "System Settings" page, clicking the **[Upgrade firmware]** button Upgrade firmware on top will open the dialog box to select firmware file to upgrade. Upgrading usually takes about one minute. Once it is finished, the web page will be automatically refreshed.
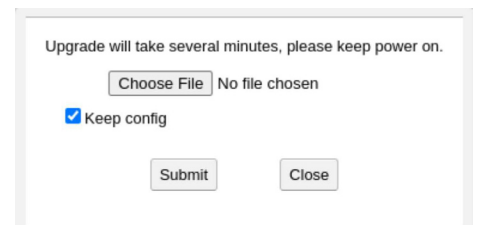

Figure 4: Upgrade Firmware

If "Keep config" checkbox is not selected before submitting, current configuration will be overwritten by default one. The filename format of firmware is backnet_router_X_Y.tar.gz, of which X is the version number and Y is the revision number. **(See Figure 4: Upgrade Firmware)**

Rescue Upgrade: WebUI is a complicated program built on Javascript. A failed upgrade can prevent the user from accessing WebUI. In these situations, upgrading to other versions is not possible. A rescue upgrade entry is located in: http://ipofBACRouter/app/upgrade. It is built with plain HTML and is always workable with any Web browser.
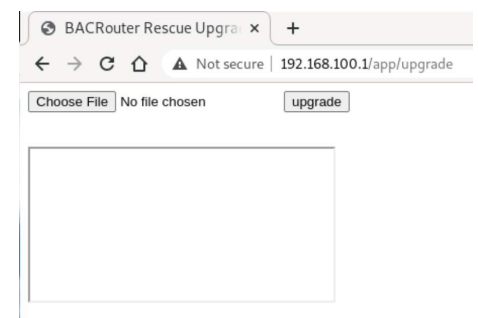

Figure 5: Rescue Upgrade

Network Settings:

As many as 10 ports can be created.

1. **VBUS Port:**

   VBUS port is a virtual data link port holding up to 254 virtual BACnet devices. Its maximum NPDU length is 1497 bytes. It is only used for gateway functionality. For router use, it should be deleted or disabled.

Figure 6: Network Settings

2. **Route Table:**

   Route table could be shown here.

   If route entries exceed limitation which is more than 1000, the excess entries will be omitted. If any network configuration is changed, this function will be disabled.

3. **Network Number:**

   In BACnet inter-network, each network has a unique network number ranging from 1 to 65534 (0 is for local network, 65535 is for global broadcast). If there is only one network, network number is meaningless.

   Auto Learning: BACnet addendum 135-2008g introduced network layer message types What-Is-Network-Number and Network-Number-Is. It allows the router dynamically learning network number on the fly from other routers. Setting network number as 0 will enable this feature.

   Network number can be changed by BACnet Initialize-Routing-Table service.

4. **Packet Capture:**

   The router supports packet capture on each enable port. Capture can be automatically or manually started.

   Automatically Start: On a enabled port's configuration page, if a "Packet capture buffer" size is selected, packet capture will automatically start when the router restart.

   Manually Start / Stop: On the enabled ports configuration page, clicking on the **[Packet Capture]** button will open a dialog box. User can change packet capture stat on the fly.

   Note: If any network configuration is changed, the **[Packet Capture]** button will be disabled.

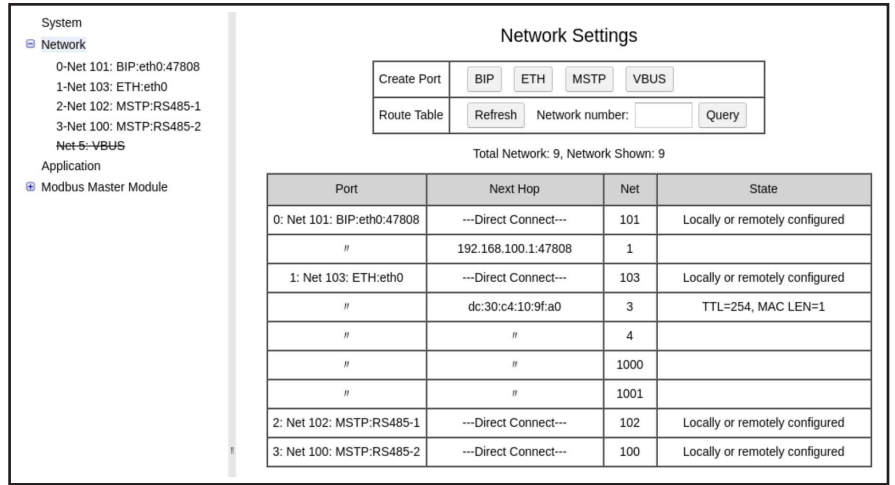   Packet capture state changed here will not be saved to flash.
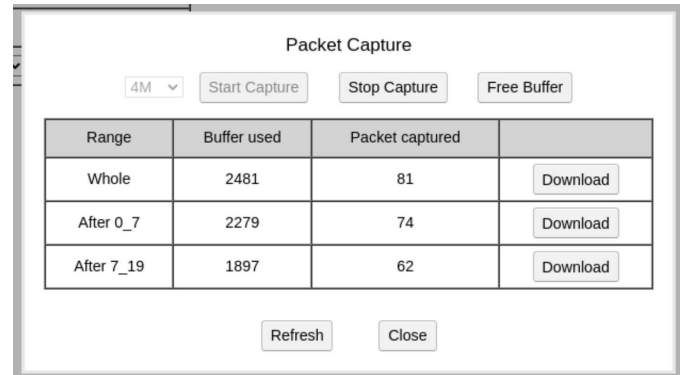

Figure 7: Packet Capture Dialog

5

Continuous Download: Because of limitation of capture buffer size, if buffer is fulled, preceding packets captured will be dropped. To overcome this problem, the router saves 4 latest download records, the continuous download can follow previous.

Each download has a packet serial range. The range will be used as part of the default saving filename. By refreshing the "Packet Capture" page after every download, there will be a download option with range.

Packets captured for a long time can be downloaded as multiple files. With Wireshark, multiple cap files can be combined to a single file.

Control From BACnet: If "Client mode" is disabled and "Packet capture mapping" is enabled in "Application Settings", the packet capture function will be mapped to writable multi_state_value BACnet objects.

Each route port that supports capture will has 2 multi_state_value_objects. One object is for buffer size with states of "64K", "128K", "256K", "512K", "1M", "2M", "4M", "8M", and "16M". Another object is for command with states of "Stop&-Clean", "Start", and "Stop".

Packet capture changed by BACnet service will not be saved to flash.

5. **General Runtime Info:**
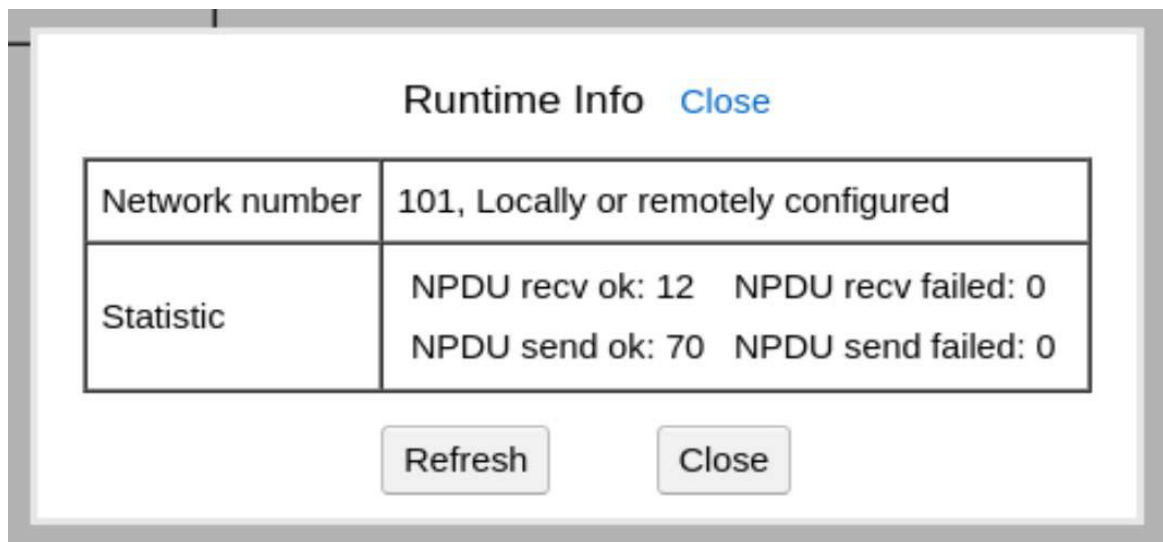
Figure 7: Packet Capture Dialog

On the enabled ports configuration page, clicking the **[Runtime Info]** button will open a dialog box for runtime info. Note: When a change on any page is submitted, the **[Runtime Info]** button will be disabled.

Network Number: Network layer message types Initializing_Routing_Table and Network_Number_Is may change network number from configured value. This field shows current network number and status. There are 3 possible status: "Locally or remotely configured, "Dynamically learned", "Not configured".

BIP Related:

The IP address of BIP port will automatically be picked up from "System Settings".

1. **Receive Global Broadcast:**

Some vendors (Most are Windows clients) improperly broadcast on 255.255.255.255 though BACnet standard require a subnet broadcast. The router will receive a global broadcast if this option is enabled. Note: If the mode is "Foreign device" or "BBMD" with NAT enabled, this option is unavailable.

2. **Accept Unmatched Destination IP:**

According to BACnet standard, BVLL type Original-Unicast-NPDU should be sent to broadcast destination. Some vendors do not obey these rules, so this option could be enabled to accept these messages with unmatched destination IP. Note: If the mode is "Foreign device" or "BBMD" with NAT enabled, this option is unavailable.

Figure 9: BIP Normal Mode

3. **BBMD Mode:**

In IP network, IP router usually will not relay broadcast packets between subnets. To resolve broadcast problem for BIP, there should be at least one BBMD (BACnet Broadcast Manage Device) in a subnet (BACnet addendum 135-2008o allow multiple BBMDs in a subnet, but it should be carefully configured to avoid broadcast storm. Usually only one BBMD in a subnet is still suggested). There are 2 main functions for BBMD: Relaying BACnet broadcast packet, Accepting register from foreign device.

Multiple BBMDs in subnet: If the router finds a BBMD not in local BDT (Broadcast Distribution Table), there may have multiple BBMDs in a subnet, if this feature is not enabled, the router will reject forwarded npdu from such BBMD and log error.

Interval To Push BDT: When a traditional BBMD scheme of only one BBMD in a subnet is implemented, BDTs in all BBMDs are identical. For convenient management of BDT, this option can be enabled on the current BBMD and other BBMDs need to be set to "Accept BDT push" so that a change made to the current BBMD's BDT will automatically propagate to other BBMDs. When the "Multiple BBVMDs in subnet" feature is enabled, this option will be unavailable.

BIP Settings

Submit   Reset   Delete   Runtime Info   Packet Capture

Enable	☑
Network number ?	101 1~65534, 0=Not configured
Hardware resource	eth0
Packet capture buffer(bytes) ?	4M
UDP Port	47808 47808~65535
Receive global broadcast ?	☐
Accept unmatched destination IP ?	☐
Mode	BBMD
multiple BBMDs in subnet ?	☐
Interval to push BDT(second) ?	0 30~65535, 0=Disable
NAT ?	0 . 0 . 0 . 0 : 47808 ☐ Enable
Cross-network broadcast support ?	☐
Accept BDT push from other	☑
Accept foreign device register	☑

Broadcast distribution table ?

IP	Distribution mask	UDP Port		
192.168.0.1	255.255.255.255	47808	Edit	×
192.168.1.1	255.255.255.255	47808	Edit	×

+

Figure 10: BIP BBMD Mode

NAT: When the router needs to communicate with wlan, the wlan IP router may work in NAT (Network Address Translation) mode which maps lan IP / port to wlan IP / port. This option should be enabled in such situations. The mapping wlan IP / port should be inputted in the fields. When BIP port works on NAT mode, it should not be used to communicate with other BIP devices in the same lan. Another BIP port can be created to communicate with other BIP devices. Note: For security reasons, run BIP over VPN internet.

Cross Network Broadcast: This option is only available when NAT is not selected. It can be enabled if the IP router for this subnet support relaying broadcast packet. Note: Most IP routers do not support this feature.

Accept BDT Push: If this option is enabled, writing to BDT from other BIP device will be allowed. Disabling it will avoid mis-writing.

Accept Foreign Device Register: If this option is enabled, registering from foreign devices will be accepted.

BDT: This field records all BBMDs. Each BBMD can be created or modified in the dialog as left. Note: This BIP port is BBMD as well and it will automatically append itself to BDT after submitting so the BIP port does not need inputting here. BDT may be over-written by BACnet BVLL request.

Foreign Device Table In Runtime Info: This field in runtime info shows foreign devices registered. Each device occupies one line, the format is: X:YZT, of which X is IP, Y is UDP port, Z is seconds to live, T is remaining seconds.

Figure 11: Runtime Info

4. Foreign Device Mode:

Foreign Device Mode is registered to BBMD to receive BIP broad-cast and local broadcast will be discarded.

Register Interval: This is the time interval on which registering repeats.

Register Time To Live: This tells BBMD how long to keep foreign device alive which is 3 time the Register Interval.

Figure 12: Foreign Device Mode

MS/TP Related:

1. Basic / Extend Mode:

The SBE-BNR-GW has some features extended over BACnet standard. There are 2 configuration modes:

Basic - Provides features defined in BACnet standard.

Extend - Provides all functions.

Figure 13: MSTP Settings Basic Mode

2. **Baudrate:**

BACnet defines 6 baudrates: 9600, 19200, 38400, 57600, 76800, 115200. The fixed mode is standard, auto and forced modes are extended features.

Figure 14: MSTP Settings Extend Mode

Auto: Auto is an extended feature. In Auto mode, when the router starts, it will sniffer the bus and keep switching baudrates until it finds a valid preamble of frame. Note: If the bus is idle, the router will keep waiting for data to detect baudrate. When the router detects continuous errors while running, it treats it as a wrong baudrate and will switch baudrates to find a valid preamble of frame. If the bus turns to idle during the process, it will revert to a previous valid baudrate.

Forced: Forced is an extended feature. Its purpose is to keep the bus baudrate at a preset value. The mechanism of Forced mode is similar to auto mode with two exceptions: A. If the router finds the bus is idle when it starts, it will use a preset baudrate. B. When the router gets token, it will switch to the preset baudrate. A router running on Forced mode will force device running on Auto mode to switch baudrate to preset value.

3. **AB Line Polarity:**

AB Line Polarity is an extended feature. If "Auto" is selected and the router finds a continuous error while running, it will swap polarity.

4. **Sniffer Mode:**

Sniffer Mode is an extended feature. When enabled, the router will listen on the bus. All NPDUs send to/receive from this port will be dropped. All options below will be unavailable in this mode.

5. Extended Frame:

Extended Frame was added since revision 16. There can be inter-operation problems between an extended frame enabled device and a legacy router. If there's a legacy router on the same bus, this feature should be disabled. However, disabling extended frame feature will still keep SBE-BNR-GW compatible with extended frame enabled devices.

6. Local MAC / Max Master:

Local MAC should be unique on the bus. Max master should be equal to setting of other devices on the same bus. To choose an unused local MAC and consistent max master, one could run the BACrouter on sniffer mode, then find proper values from "Recently active devices" and "Current max master" on the runtime info page. Max master of first MS/TP port can modified from BACnet.

7. Max Info Frames:

Defines how many NPDUs the router would send when it holds the token. A larger value means better throughout but worse latence (Less token pass rate). The default value for router is 10. Max info frames of first MS/TP port can be modified from BACnet.

By Occupy Time: By Occupy Time is an extended feature. The NPDUs passing router usually is between 10-50 bytes, but can be up to 501 or 1497 (Extended Frame). Larger NPDUs requires more time to send and receive. For NPDUs that need a reply from a targeted device, the router has to wait for a reply. Usually the targeted device needs more time to handle or generate larger NPDU and the router has to wait longer.

The time the router holding token can be varified impacts latency guaranty of the MSTP bus. To avoid this problem, the "By Occupy Time" feature limits the router's token holding time. The limitation is calculated by: byte_time*32*Max_info_frames.

8. Fast Device:

Fast Device is an extended feature. To be compatible with slow responding devices, the BACnet standard uses lax usage timeout and reply timeout. This can seriously impact the MS/TP network bandwidth, especially on high baudrate. In addition, there is also a fast group timeout. A table with MAC addresses allows for optimal network tuning by independently selecting fast devices to use fast group timeout.

When fast device is connected by a repeater, the delay including sending and receiving introduce by the repeater should be counted into timeout. BACnet standard allows 2 bits time delay on each repeater and a total of 10 bit time delay on total path.

Fast Timeout: Poll timeout; master reply timeout and slave reply timeout for fast group.

Select Fast Devices: This field selects which device is fast device.

Figure 15: Select Fast Devices on MS/TP Bus

9. Slave Proxy:

If this feature is enabled, the router acts as proxy of "Slave devices" on application view. "Slave devices" include MS/TP slave devices and master devices which do not support the BACnet Who-Is function. The router obtains Device_ID, Max_APDU, Vendor_ID, and Segmentation_Support from "Slave devices" by Read_Property or Read_Property_Multiple devices by sending I-Am service with source MAC address which "Slave device" has.

Figure 16: Slave Proxy Settings

Scan Interval: The range is from 120 seconds to 65535 seconds. This parameter defines how often the router scans "Slave Devices". There are two ways to scan "Slave Devices":

1. Auto Discovery

2. Manual Binding

Auto Discovery: If this feature is enabled, the router automatically scans all possible devices on the bus. Note: This feature will consume a large amount of bandwidth so it's suggested to increase the scan interval; enable Fast Device feature or limit devices to discover.

Devices To Discovery: This is an extended feature and only devices selected instead of all devices will be scanned in auto discovery.

Manual Binding: For "Slave Devices" that do not support Read_Property_Multiply service requests to the special device instance of 4194303, only manual binding works. The bindings of MAC address and device should be defined here. Enable/Disable of slave proxy/discovery, and manual binding may be overwritten by BACnet service.

10. Tx/Rx LEDs:

Each MSTP port has one Tx(Blue) and one Rx(red) LED. Tx LED flashes when anything is sent out, so if the router has joined token passing, it will keep flashing. Rx LED flashes only when NPDU for local or broadcasted is received. If the router is on sniffer mode, Rx will flash on any NPDU.

11. Runtime Info:

Figure 17: MS/TP Runtime Info

Token Pass Rate: It's average value for 30 seconds. The healthy value would be greater than 60.

Error Counts: There are error counts as preamble error; header error; data error; extended frame decode error; retry to pass token; failure to pass token; possible duplicated token; lost token; no answered BACnet request; no turnaround frame. If any values keep growing there may be a problem on the bus.

Current Max Master: This is a dynamically detected max master value. Note: If "unmatch to local setting" is shown, there may be an inconsistent max master setting on the bus.

Recently Active Other Devices: Provides statistics of every received frame source MAC for 30 seconds. Note: If any MAC is shown as a red color, it may be duplicated.

Baudrate And AB Line Polarity: This is an extended feature and is only available when baudrate mode is auto or forced: or polarity is auto. It shows current detected baudrate and polarity.

Slave Proxing: It is available when slave proxy feature is enables. Each line here shows a device proxied. The format is:

X:Y, L, S, I:N of which X is MAC, Y is device instance, L is max apdu length, S is segmentation support, I is vendor id, N is name of manufacturer.

12. Packet Capture Characteristics:

Frame Dividing: There are 2 rules to divide frames: A. Any data following valid frame is regarded as new frame. B. Idle time more than 33 bits is regarded as start of new frame.

Error Handle: There are several types of errors: signal noise, no stop bit, idle time between bytes too long (BACnet standard requires no more than 20 bits idle time between bytes), data verify error on header crc / data length / source MAC / data crc, incomplete frame. The data causing error and data following it will not be logged until there is a new frame.

Extended Frame: Extended frame types are defined in addendum 135-2012an. They use CRC32 to verify and COBS to encode. Extended frame of types BACnet Extended Data Expecting Reply and BACnet Extended Data Not Expecting Reply are used for BACnet NPDU transport. When the router captures extended frames, it just try to do CRC32 verification for data portion that keep encoded. Because Wireshark does not support decoding extended frames, following processor will be taken to output captured file:

If the frame type is BACnet Extended Data Expecting Reply or BACnet Extended Data Not Expecting Reply the router would try to decoding it using COBS rule, if decoding is ok, changes the frame type to BACnet Extended Data Expecting Reply or BACnet Extended Data Not Expecting Reply, generates crc16. New frame will be recognized by Wireshark as normal BACnet data frame to analyze. If decoding fails, the router just generates crc 16, so the new frame will be recognized as an unknown valid frame by Wireshark.

For other extended frame types, the router just generates crc16. The frame will be recognized as unknown valid frame by Wireshark.

Packet Capture

Range	Buffer used	Packet captured	Download		
Whole	842037	73855	Normal format	Interval format	Raw format
After 62972_64283	107251	9572	Normal format	Interval format	Raw format
After 64283_65644	92035	8211	Normal format	Interval format	Raw format
After 0_71670	24607	2185	Normal format	Interval format	Raw format
After 71670_73365	5590	490	Normal format	Interval format	Raw format

Refresh   Close

Figure 18: MS/TP Packet Capture

Interval Format: For analyzing timing and performance issues, the absolute time of packet may be insensitive but the idle time before packet may be more important. Interval format use idle time before packet as timestamp (with 5 us granularity). The downloaded filename starts with "i" (n for normal format).

To show idle time before packet, Wireshark's "Time Display Format" in the "View" top menu should be set to "Seconds Since Previous Captured Packet".
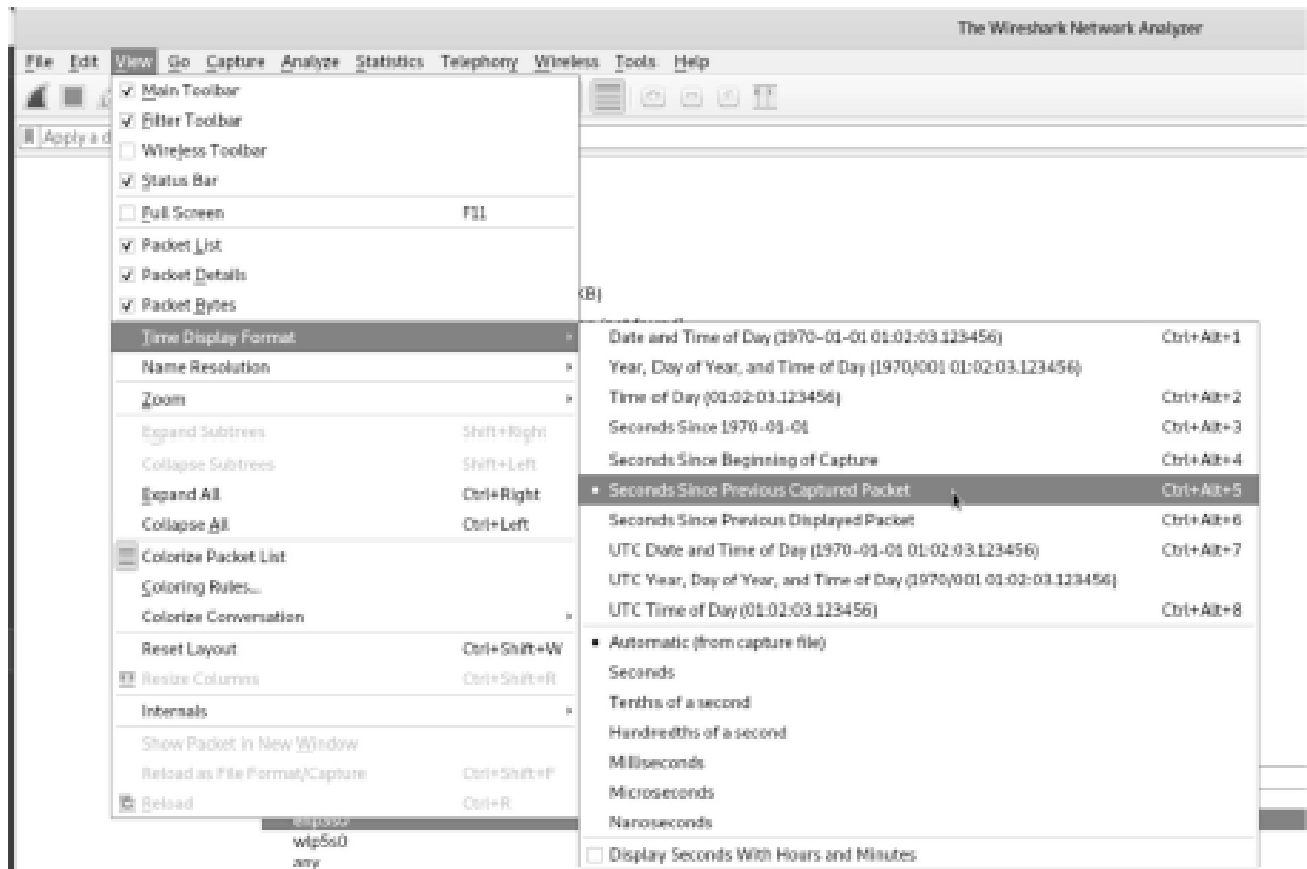
Figure 19: Set Wireshark Time Display Format For Interval Format Capture

Application Setting:

Selecting [Application] on the left tree menu will open application settings page.

Figure 20: Application Settings

1. **APDU Timeout/Retries:**

   These parameters are writable by BACnet service. If there are virtual BACnet devices in BACRouter, all BACnet devices share same value of APDU_Timeout and Number_of_APDU_retries.

2. **Client Mode:**

   The routing function need no application layer, so this feature could be enabled to get rid of below application layer settings, if compliance to BACnet device profile is unnecessary.

3. **Device Instance:**

   The value should be unique in whole BACnet inter-network within range from 0 to 4194302. It's writeable by BACnet service.

4. **Name Delimiter:**

   The BACnet object name in BACRouter may be composited of several fields, for example, the BACnet object name of a Modbus mapped point may be composited of master name, slave name, and point name, these fields are conjoined together by delimiter character defined here to form final object name.

5. **COV Notify Qos:**

   The SBE-BNR-GW supports COV subscriptions up to 2084, so it may send out lots of COV notifications if object values with COV subscriptions are changed, especially when mapped Modbus slave get online/offline. "COV notify" and "COV notify burst: limit COV notification sending rate to avoid network storm.

   Note: Notification will be delayed when the sending rate reaches the limitation.

Modbus Gateway:

1. **Mapping Mode:**

   Single Device Mode: If VBUS port is not enabled, BACRouter will work single device mapping mode, every Modbus slave device will be mapped into exclusive object instance space of 1000 in the only BACnet device defined in "Application Settings".

   Virtual Device Mode: If VBUS network port is enable, each slave device will be mapped to a virtual BACnet device on VBUS network. The MAC address will start from 1. The device instance of virtual BACnet devices could be modified by BACnet service.

2. **Online Test:**

   If master is enabled and configuration changing of master has been saved, then when configuring slave, online test will save a lot of time of debug.

   Point Test: When editing point's mapping, there are "Test raw value" row with [Read] button and [Write] button if point is writable. After clicking button, "Test result" will show result. The raw value here means no conversion.

Figure 21: Modbus Point Test

Read Group Test: On "read Group" dialog, [Test] will read group(s) and show result. If the slave is RTU/ASCII type, test result will include response time which may be useful to set appropriate "Reply timeout" in slave's "Modbus parameter".

Figure 22: Modbus Read Group Test

3. Runtime Info:

If master and slave are enabled and the configuration changing of them has been saved, [Runtime Info] button will show current state of slave and points.

Figure 23: Modbus Slave Runtime Info

4. Mapping Recommend:

BACnet input or value objects are recommended for Modbus points which are not controlled through BACnet.

BACnet output or value objects are recommended for Modbus writable points which are only controlled through BACnet.

For Modbus writable points which are controlled through BACnet and other mechanisms, there are three ways to integrate into BAnet:

> a. BACnet value objects. The Present_Value of the value objects will be writable to mapping BACnet writing to Modbus. Modbus read back point value will update Present_Value of the value objects.

> b. BACnet output objects. The Modbus read back point value will update Relinquish_Default of the output objects. Note: SBE-BNR-GW does not support SubscribeCOVProperty service, so there is not way to get COV notification on value change of Reliquish_Default.

> c. A BACnet output object and another BACnet input/value object for each Modbus point. The BACnet output object is used for command, the input/value object reflects Modbus read back value.

If a slave device represents multiple real devices, each real device has different Modbus data address, then multiple logic slave devices could be created, each logic slave device maps to real device.

5. **Batching Process Tips:**

   [Import CSV] and [Export CSV]could be used for creating large quantity of mappings, because it's more convenient to input/edit point's name/description in Excel.

   [Batch Conversion] could be used to modify conversion of all analog objects.

   [Batch Address] could be used to modify Modbus address for multiple points.

   [Import Point] could be used to import definition of all points from configuration file of slave.

   [Copy] could be used to copy configuration of current slave/master to new one.

   [Batch Import] could be used to import all slaves from configuration file master.

   [Batch Instance] could be used to modify object instance of all slave.

   [Batch Point] could be used to copy definition of all points from configuration file of slave into multiple slaves

Others:

1. **Circular Route:**

   BACnet does not allow circular route, that means there should be exactly one route path between any two nodes. Circular route usually causes broadcast storm and packet loss. One common causing is enabling both BIP and Ethernet for more than one device in same subnet, so there will be BIP and Ethernet paths between them. Errors and warnings in the log will be helpful to diagnose a misconfiguration.

2. **Network Number Conflict:**

   The network number for each network should be unique, else the packet will be lost. Errors and warnings in the log will help to diagnose a conflict.

3. **MS/TP Troubleshoot:**

   The most likely problem on a MS/TP is bus biasing. Without correctly biasing, when the line is idle between packets, the voltage between A lines will be close to 0, and it will become very noise sensitive. At least one bus biasing should be used (It is easy to implement this by turning the DIP switch of biasing on the router to ON position). Some devices will not receive the token with improper max master. The max master should be greater than or equal to max MAC of master device on the bus. The "Current max master" in runtime info may be checked for problem.

   Other reasons include termination; mismatched baudrate; wrong AB line polarity; MAC conflict. Special care should be taken on extended feature.

4. Wireshark:

Download Wireshark from: https://www.wireshark.org/download.html

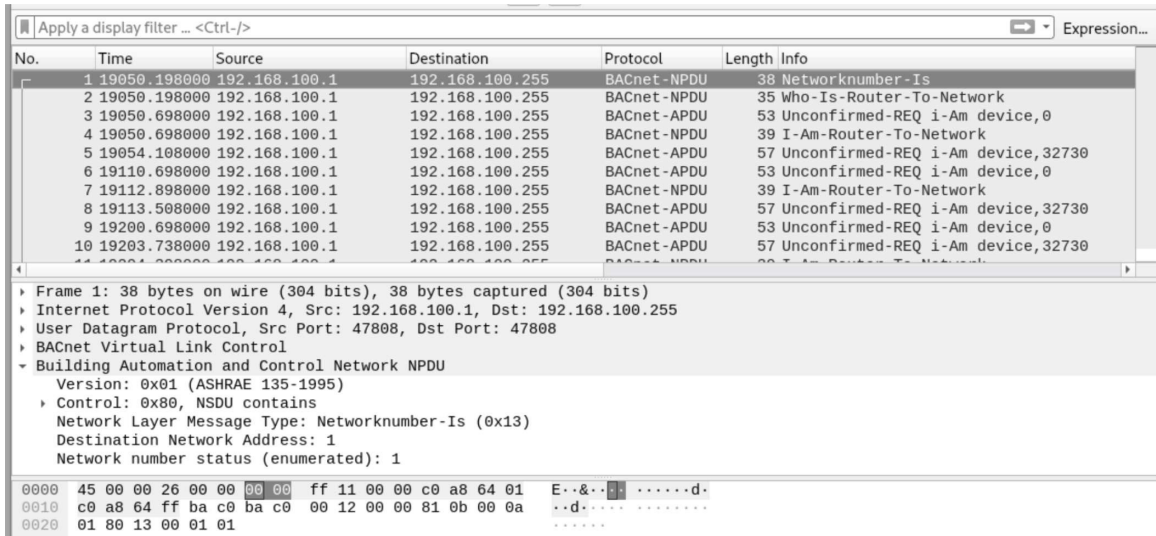After installation, captured file could be opened by Wireshark.

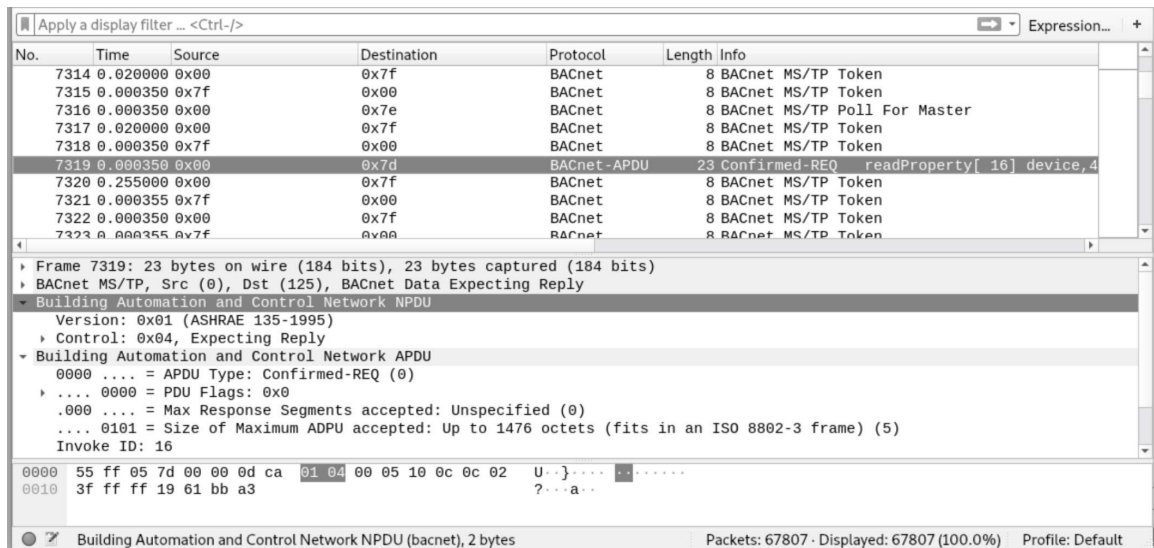*Figure 24: BIP Captured File Opened In Wireshark*

Figure 25: 115.2 Kbs MS/TP Captured File Opened In Wireshark As Interval Format

5. Packet Capture API:

Automatic traffic logging for later auditing is possible with the API.

HTTP Authentication method is Digest

Read config info: http://192.168.100.1/app/config

Read capture summary: http://192.168.100.1/app/capture_summary