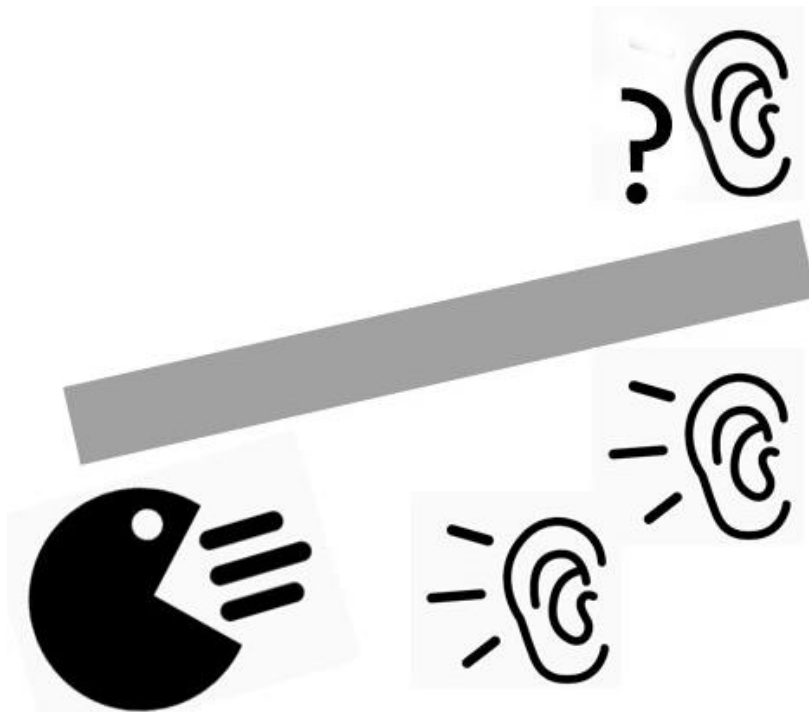


BACnet/IP and BBMDs

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TUTORIAL

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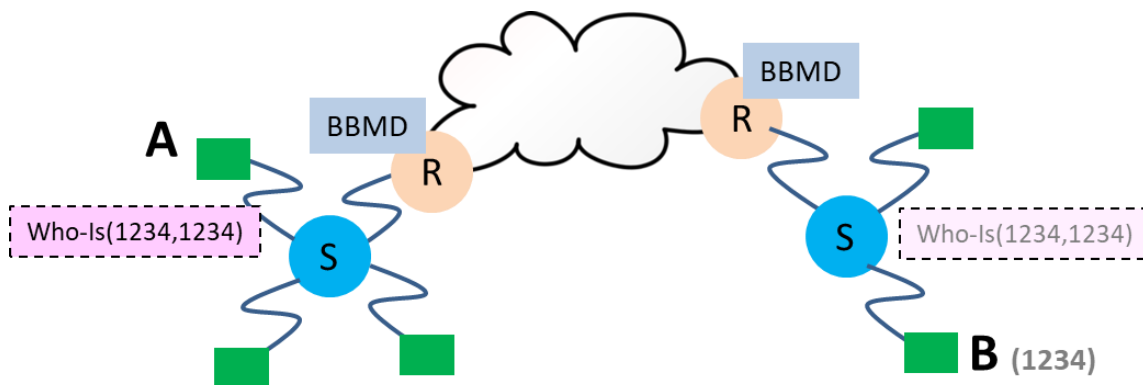
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Introduction

Most BACnet "MAC layers" have the ability to broadcast messages, that is to send a message that is received by all other nodes on that same medium. In the case of BACnet/IP (BIP) this leads to some special problems. Recall that in BIP addressing, BACnet treats the combination of the IP address and UDP port number as a single MAC address entity, 4 octets of IP address and 2 octets of UDP port number. So, from the BIP perspective, the MAC address is a single medium. In other words, the collection of nodes within the entire "IP infrastructure" that share the same UDP port number, are all considered to be on the same medium.

Normally when messages are "broadcast" on a particular medium, all of the nodes receive the broadcast. However, in BIP this is not the case. This is because BIP's "MAC address space" includes all of the IP subnets. In IP, routers specifically prevent the forwarding of broadcasts between subnets. Only so-called "subnet broadcasts" are allowed. If all of the BIP devices share the same IP subnet, then there is no issue since a subnet broadcast can reach all of the devices. But when BIP devices are present on more than one subnet, broadcasting is a problem because of the IP routing policy about broadcasts.

BIP solves this problem through the use of BACnet Broadcast Management Devices (BBMDs). When a BBMD is installed on a particular IP subnet, it listens continuously for BACnet/IP broadcasts. If one is heard, then the BBMD packages the packet content into a special kind of BIP message called a *forwarded NPDU* which is then unicast directly to each sister BBMD. What this means is that every BIP subnet must usually have a BBMD, and that each of those BBMDs must be configured with a list of the IP addresses of all of the other sister BBMDs. Each BBMD, when it receives a forwarded NPDU, will unpackage the packet content and rebroadcast it on the local IP subnet where the BBMD is configured. For regular BIP devices this process is invisible. The BIP devices just send subnet broadcasts, and the BBMDs handle the rest.



In this example device A sends a Who-Is packet as a subnet broadcast. The first BBMD hears this message and retransmits it across the IP infrastructure to the second BBMD which in turn unpacks it and retransmits it as a subnet broadcast which device B can then hear. If B sends an I-Am reply, then same process happens in reverse. So, as long as each IP subnet has a BBMD then everything is easy and invisible.

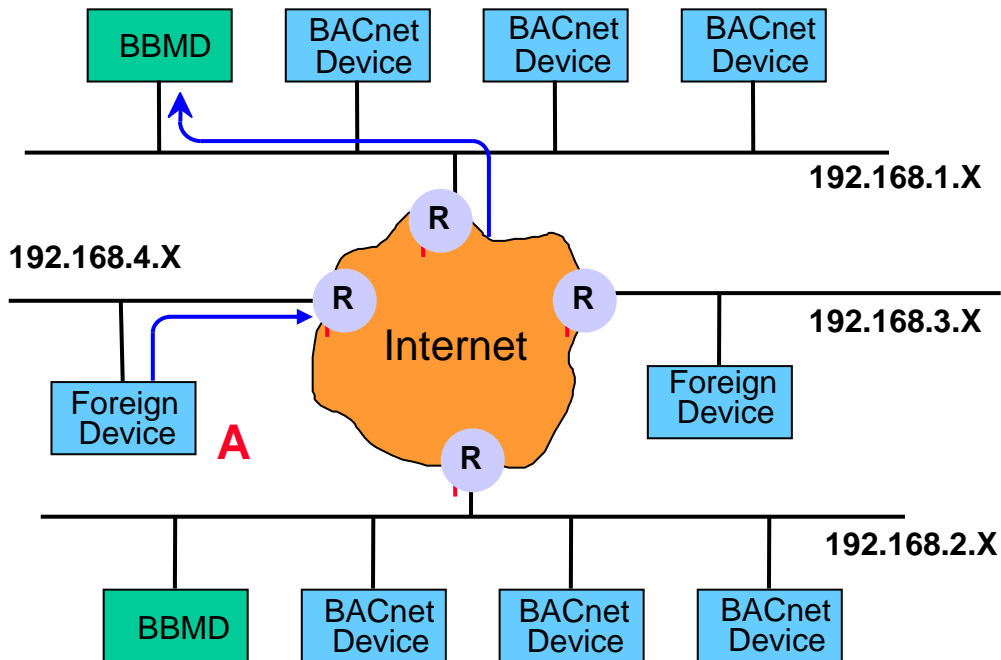
What Do We Mean by "Subnet Broadcast"?

In IP every device has an IP address that is 4 octets in length. This defines a "space" of 4,294,967,296 possible addresses. Usually, the IP address space is divided into regions (subnets). The *subnet mask* is a 32 bit set of ones and zeros where 1 defines the subnet and 0 defines the host or node portion. So, for example 11111111 11111111 11111111 00000000 is the common subnet 255.255.255.0. In our example device A might be 192.168.1.27. The subnet is 192.168.1.X and A is node 27. In IP, a subnet broadcast is the address whose subnet masked portion is the subnet and whose node portion is all 1s. In this example, 192.168.1.255 is the subnet broadcast address.

In the above example, let's say that B's IP is 192.168.2.35. Since A and B have different subnets, if A just sent a broadcast to 192.168.2.255 it would not be forwarded by the first router because it is not the same subnet as the router.

A Chicken in Every Pot and a BBMD on Every Subnet

Configuration is easier if there can be a BBMD on every subnet because only the BBMDs need to be configured and presumably there are not many of those. However, what happens in a situation when there is a BIP device on a given subnet, but no BBMD on that same subnet? How can that device communicate broadcasted messages to sister BIP devices? The answer is called *foreign device registration (FDR)*.



In this example, device A is on a subnet that has no BBMD of its own. So, on startup, device A sends a request to its BBMD (the identity of which must be configured in A) that says "I would like to register as a foreign device". The BBMD remembers the IP address of A and subsequently whenever that BBMD sees (or is forwarded) a broadcast packet it will also send a copy to device A. Similarly, when A wants to send a broadcast, instead of sending it as a subnet broadcast it is sent directly to the BBMD to be redistributed to all other BBMDs and foreign devices.

Issues with BBMDs

It would appear that BBMDs solve all of our BIP problems. What are the downsides?

- You need to have a BBMD on every subnet. Although BBMDs might seem to be dedicated stand-alone devices, this functionality is often built-in to BACnet routers or router/controllers so in practice there is usually a BBMD on BACnet subnets.
- As mentioned above, it isn't always feasible to have a BBMD on every subnet. In those circumstances you can use FDR and configure the foreign subnet device(s) to register with one of the BBMDs. This does cause a slight increase in traffic since every broadcast to and from a foreign device is actually sent three times. As long as there are not too many foreign devices this is usually not an issue. But it is bad practice to have a large number of FDRs.
- BBMDs do not all support FDR. Regrettably this feature was not required in BACnet for BBMDs prior to revision 18. Although quite common, there are some BBMDs that do not allow FDR. Even if supported, most BBMDs are limited in the number of simultaneous FDRs they can support, e.g. 5, 10 etc. If you need more FDRs than are supported in a given BBMD, you must either get another BBMD, or add a BBMD to the A subnet. Of course, if all of your BBMDs do not support FDR then you need to get one that does.

How Does This Affect Configuration?

One would expect that a BIP device must support configuration of these values:

- Which Ethernet adapter should be used for BIP (if there is more than one)
- The IP address of the adapter to use for BIP
- The subnet mask for that adapter

However, although not required by BACnet prior to revision 18, today every BIP device should support configuration of two modes of operation: subnet broadcast or FDR. In subnet broadcast mode only the above three parameters need to be configurable. In FDR mode, there are two additional parameters needed:

- The IP address of a BBMD to register with
- The "lifetime" of the subscription in seconds

Some implementations use a BBMD IP of 0.0.0.0 to mean "subnet broadcast mode" and anything else is FDR mode. Once registered with a BBMD for FDR, the registration only lasts for a certain lifetime. Some time prior to that lifetime the foreign device should re-register with the BBMD or else the subscription will lapse. This technique prevents monopolizing FDR connections by devices that are turned off or under maintenance.

Legal Stuff

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