Strategies for Using BACnet®/IP

By Christopher A. Hollinger

Thanks to the collaborative efforts of the controls industry at large, the ASHRAE BACnet® standards committee (Standing Standards Project Committee 135), along with the BACnet Manufacturers' Association and the BACnet Testing Laboratories continue to make major strides in advancing BACnet/IP as a primary building automation network. The technology is rapidly coming of age, and advances in the standards promise new benefits to users looking to reduce costs and increase the speed and efficiency of their building automation system networks.

BACnet/IP earned its name because it uses the Internet Protocol (IP) family, which is the core set of protocols for the Internet and virtually all corporate and institutional networks. According to the BACnet/IP Annex J in ANSI/ASHRAE Standard 135-2004, *BACnet®—A Data Communication Protocol for Building Automation and Control Networks,* BACnet networks may be formed from collections of devices that use the IP family of protocols for their communication. This means a wide array of BACnet/IP-enabled devices may be connected to the Ethernet IP network infrastructure common in every facility. Leveraging existing network infrastructure facilitates the convergence of building automation and IT systems, enables a degree of interoperability among systems, and leverages the cost of network infrastructure among a greater number of facility-wide systems. This offers the potential for significant cost savings and efficient use of assets.

BACnet/IP offers key advantages to users when considering the use of the protocol in their present and future network strategies. When building automation controllers are used on BACnet/IP, they offer distinct advantages, including universal control capabilities through sophisticated programming and resident input/output to bring direct control where it is needed. These building automation controllers are the most flexible and sophisticated components of a building automation system (BAS). (See sidebar, "Building Automation Controllers: 24/7 Multitaskers.")

BACnet/IP is commonly used to connect building automation controllers because of the potential efficiencies and cost savings provided. Therefore, the

question becomes: "what is the best choice of protocols when connecting building automation controllers to one another, to a workstation or to other higher-level devices?" The industry seems to be moving toward BACnet/IP as the answer to this question, and for good reasons.

Reasons to Consider BACnet/IP

At least three reasons exist as to why end users should strongly consider BACnet/IP for networking building automation controllers, as opposed to building automation controllers built on other network protocol options.

First is speed and performance. BACnet/IP leverages the fastest, highest performance Ethernet networks that are commonly used today. Using the Ethernet network makes the full range of high-speed data communication speeds available, from 10 megabytes (MB) to the very highest, 100 MB, and even gigabit networks. Although the higher speeds are not always necessary in BAS design, the IP network provides a wide range of performance options at reasonable prices.

This high speed and performance is beneficial for building automation controllers assigned the task of complex control for air handlers and sophisticated HVAC equipment, while simultaneously providing supervisory system-wide control functions such as trending, scheduling, alarming, and file transfers and database transfers. Because of the multiple tasks and critical communications requirements of building automation controllers, the high speed and bandwidth provides performance advantages.

Contributing to its higher efficiency and performance is the fact that the Ethernet network may also reduce latency by, for example, eliminating the need for a device to wait for a token-passing delay before being able to "talk" on the network. IP supports additional functionality, such as trace route and PING, to ensure connectivity via commands and responses from IP addresses.

Not only does IP support most of today's network data link technologies, but, when a new technology is introduced, IP support usually follows right behind it. The result is that extended capabilities and increasingly higher performance becomes available at decreasing cost. A prime example of this phenomenon is the rapid acceptance and adoption of wireless Ethernet networks.

A second reason to consider BACnet/IP is that it gives the user the option to operate the BAS by sharing the building's existing mainstream IT infrastructure. In BACnet/IP networks, devices use standard network interface cards, equipment and tools — plugs, jacks, IP routers, Ethernet switches, and so on. Category 5 cabling, which BACnet/IP typically uses for communication, is available in virtually every area of the building. Each of these translates into cost savings in terms of initial installation and ongoing maintenance and management of the BAS network.

A third very important reason for BACnet/IP acceptance is that IP technology is supported by the IT networking community as a whole, which offers advantages in terms of the availability of collective research and development resources. Users become the beneficiaries of the industry's substantial and ongoing investment in improving IP technology. Also, IP software is available for a range of platforms, so manufacturers have more choices when developing building automation controller technologies.

Some users looking into BACnet/IP choose to implement private networks. The user can choose to operate the BAS on its own, dedicated network or virtual LAN, if desired. Again, once the user opts to use BACnet/IP as opposed to another technology, all of the devices on the network are made available.

In addition, Internet access is possible. A device on BACnet/IP may use additional protocols to support a Web server and/or Web services so that users have the capability to access the building automation controller with the Web browser on their PC.

Users should also note that, while high network performance may be important for building automation controllers on the IP network, serial-based communications are typically preferred for terminal and floor-level, application-specific controllers. The benefit of Ethernet network performance is less important with lower capacity dedicated controllers. The additional cost of high performance processors and operating systems, and network infrastructure components needed to support Ethernet networks, oftentimes is not justified.

While BACnet/Ethernet solutions do provide some of the capabilities of BACnet/IP, they fall short of providing the IP infrastructure that the IT community prefers.

Addressing the Issues

It is advisable for users considering BACnet/IP for building automation controllers to understand some of the key issues that the BACnet standards committee is addressing and the progress the group is making toward solutions.

One of the issues inviting the most discussion is security. BACnet/IP presently needs a standardized, interoperable security mechanism, which means there is a risk for vulnerability. Fortunately, the working group of the BACnet standards committee responsible for network security is moving toward a possible solution. That solution will add the necessary security layer to BACnet that can be optionally deployed when needed. Meanwhile, BACnet/IP is not always suitable for use on unsecured networks, such as the Internet. Operating the building automation controllers on private networks or behind BACnet-aware firewalls is a sound strategy until BACnet/IP security issues can be fully resolved.

Another issue involves interoperability. At present, BACnet/IP devices may experience interoperability problems with commonly used network infrastructure components, such as IP routers, firewalls and dynamic host control protocol (DHCP) servers. For example, IP routers typically are configured by IT groups to block broadcasts. Since broadcasts often are used by BACnet/IP devices to discover other devices on networks, blocking broadcasts is detrimental to the protocol. Currently, the router issue is addressed with BACnet Broadcast Management Devices (BBMDs), configured to allow communications broadcast management across IP routers. This may solve the broadcast problem, but could cause other problems related to DHCP support because the BBMD relies on static IP addresses. These issues are being addressed by the BACnet standards committee, and they do not pertain to IP networks configured for a single IP subnet.

Efficient routing between BACnet/IP networks and serial networks can be a performance challenge, too. Network performance is limited by bandwidth when servers—such as supervisory controllers—are using serial protocols, and clients—such as workstations and Web clients—are using IP-based protocols. Often this is an architectural issue, but it is a very common condition in facilities that use low-speed networking technologies, such as EIA-485 networks, for supervisory control.

This condition can often be resolved through the use of a supervisory-class field panel that has an IP router with dual I/O ports built in; one port for IP, the other for master slave/token passing (MS/TP). This would allow less expensive, lower-level controllers on the network to communicate with each other (simple data exchanges) while the supervisory (building automation) controller could participate in the communication for such decision-making tasks as changing setpoints and collecting trend logs.

One last issue worth addressing is that BACnet/IP uses the user datagram protocol (UDP), a connectionless protocol. While UDP is well-supported, it does not have a network congestion control mechanism. Bear in mind that UDP may be somewhat unwelcome on corporate IT networks due to concerns about the possibility of network congestion and broadcasts required.

Changes Forthcoming

Mainstream networks constantly evolve. Some protocols, especially BACnet, were designed to evolve and be modified to continuously adapt to industry needs. But, even the most learned and experienced designers cannot be expected to predict the future with 100% accuracy. The BACnet committee has recognized this fact and has designed the BACnet protocol to facilitate relevant and effective modifications to meet future needs.

High-speed Ethernet has become commonplace, and BACnet/IP was designed to accommodate these speeds for building control systems data exchange. IPv6, essentially an updated version of IP with greater network addressing capabilities, is just now emerging and promises new benefits to users worldwide. IPv6 was developed primarily to solve a problem caused by a shortage of addresses in the current IPv4.

However, BACnet/IP does not currently support or accommodate IPv6 addresses. This is another issue the committee will address so that the BACnet/IP protocol will remain viable during the long term.

While the BACnet Standards Committee certainly has its hands full addressing many of these issues, it must be commended for the major strides it has already made in developing positive solutions. The committee has key advantages in its favor: it has the support of the entire industry behind it, and it has unity and commitment among all of its members toward a singular objective of providing problem-solving standards that will propel the acceptance and use of BACnet/IP protocol through the next decade and beyond.

Acknowledgments

A special contribution to this article was provided by Jim Butler, Associate Member ASHRAE. Butler is vice president and chief technology officer at Cimetrics, Boston.

Christopher A. Hollinger is systems integration product manager, Siemens Building Technologies.

Building Automation Controllers: 24/7 Multitaskers

Often referred to as "field panels," building automation or supervisory controllers are the programmable traffic centers and brains of any sophisticated building automation system (BAS). These devices are equipped to tackle the higher-level, supervisory BAS functions, such as scheduling, trend and event logging, file transfers, and alarm sensing and distribution.

A typical BAS operates using multilevel hierarchical control with a building automation controller acting as a sophisticated equipment and supervisory controller, and local controllers acting as terminal unit and basic equipment controller. As the local controllers control the equipment, the building automation controller monitors predicted disturbances to anticipate control actions. The building automation controller can then optimize building operations by using that historical information to predict performance.

Building automation controllers organize the signals that go to and come from equipment, such as sensors, actuators, drives and equipment controllers. Building automation controllers translate these signals into data that can be instantly viewable, programmable and actionable at the controller, through powerful control and reporting software (at a workstation or PC), or remotely through the Web. Building automation controllers contain modular components that provide increased flexibility and adaptability and lower overall lifecycle costs, especially for environments expecting change.