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# BACnet<sup>®</sup> to the Rescue

By Larry Bacher

**N**ot too many years ago, building owners, engineers and administrators were locked into a single vendor for their proprietary building automation systems (BAS). The owner was literally held hostage because if a system did not work as desired the only option was to replace the BAS vendor and equipment with another proprietary system—and potentially another problem.

Fast forward to today. With BACnet, along with advancements in technologies and other standards such as the Internet, building automation systems are at the heart of operation and sustainability within a facility. BACnet has been the nucleus for providing a platform that has taken the building controls industry into the 21<sup>st</sup> century.

So, using controls in a LEED Platinum facility should be a piece of cake, right? Wrong! Many of the same concerns we've dealt with in the past are still around. There is a mindset when it comes to building automation systems that BACnet has saved us. After all, pricing is more competitive, choices are greater, and the advent of a uniform protocol will cure all operational sins. However, it has been this "protocol panacea" mindset that has led many of us to rely on the "standard," rather than choosing the correct options when it comes to building automation. ASHRAE's BACnet protocol has given us the tool; we just need to use it wisely.

As a case in point, the Christensen Corporation developed a state-of-the-art

facility in downtown Boise, Idaho. The project was an 11-story, 195,000 ft<sup>2</sup> (18 120 m<sup>2</sup>) office building, and the goal was to achieve LEED Platinum certification. Facility design included an underfloor air-distribution system supplemented by a chilled water plant and geothermal for heating. Other sustainable building features include a graywater recycling system, rainwater recovery, lighting controls, and other concepts. Completed and certified in 2006, this was one of the first LEED-Core and Shell projects in the country and the 19<sup>th</sup> LEED Platinum building certified in the world (<http://tinyurl.com/bannerbank>).

The building automation system (BAS) design for this project was put to the BACnet test. Construction specifications included "all mechanical equipment shall include BACnet controllers/devices factory installed and tested." The underfloor zone equipment was specified without controls with the intent that the successful controls contractor would provide and install BACnet controllers during construction.

Also, the central plant, with the geothermal system, required additional controls not included with the equipment. The specification additionally stated that the BAS contractor will provide a BACnet network throughout the building for communication with all BACnet BAS devices.

As is the case in almost all construction projects, cost was a major factor in choosing the controls contractor. Since several of the contractors seemed comparable in capabilities, and all had BACnet products, price was the determining factor. One bid was 25% less than all of the others, so the low bid took the job.

As construction neared completion, issues occurred with the overall BACnet integration. This included little to no communication between the underfloor zones. Worse, minimal integration existed with the air handlers and the central plant (chilled water, geothermal). Because this was a core and shell construction project (no tenants at this point), integration between the major HVAC components was not a big deal. The building, with all of its sustainable technology, was certified as LEED-CS Platinum.

As tenants were signed and began moving in, problems began with the BAS integration. Since the tenant zones were not communicating with the air handlers, and the air handlers were having issues communicating with the central

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plant, occupant comfort was suffering. To compensate, much of the mechanical equipment was manually controlled or adjusted to meet the needs of the tenants. Instead of an “automation” approach to intelligently control the building, the system was largely a time clock.

Besides lack of occupant comfort, the building also was using more energy than anticipated. Equipment parameters were set to a worst-case scenario for meeting the perceived needs of the occupied tenant zones. Obviously, there were some big issues that needed to be addressed by the owner and the controls contractor.

Attempts were made to rectify the communication issue between the zones and mechanical equipment. After all, they were all talking BACnet, right? As is the case in many construction projects, especially one where technology is heavily promoted and implemented, lack of coordination and documentation can be a huge problem. Add to this several different control products, supplied by different vendors that further confused the issue, which led to finger pointing. The original controls contractor, who was also the integrator, felt that the final resolution to the problem was beyond his scope of work and declined to take further action to resolve the issue.

Left in a fairly sore predicament, the owner needed to make some tough decisions. Paying more money to the original controls contractor was one choice. Bringing another controls vendor into the situation was another. Because the owner chose BACnet for the overall building controls system, alternatives within Boise were available. Based on positive feedback from other property owners, Christensen decided to bring in a second contractor to evaluate and provide a solution to the integration problem. This contractor had bid on the original project, but had a higher quote.

With the new control contractor in place, the first step was to make a careful evaluation of the installed system. Once information was acquired from construction documents and the actual system, the new control contractor sat down with the owner to determine what the issues were and possible resolution to the problems. Additionally, the new contractor reviewed the original specifications, drawings and



Alpha Image Photography by Giuseppe Saitta, Courtesy of HDR Architecture

BACnet provides the building owner with many options for support of the control system.

sequence of operations to ensure that a proposed solution would not jeopardize or interfere with what was already in place for efficient operation of the building.

After careful evaluation, the contractor came up with a game plan to provide a means for bridging the differing BACnet systems into a cohesive network that would result in occupant comfort and reduce operating costs. Though there was some additional hardware needed, the bulk of the project required programming sequences for coordination of the mechanical infrastructure. Because BACnet was the common communication protocol between the building controllers from different manufacturers, the process for communication and integration was greatly enhanced. BACnet provided several advantages in reducing the complexity of this integration:

- The control vendor could easily identify existing control points when documentation was incomplete or non-existent; and
- Control and monitoring of the existing points were incorporated with minimal programming due to BACnet standards.

By January 2009, approximately four months after this new contract was signed,

the integration project was complete. The scope included integration of 2,400 BACnet points at the zone (tenant) level and more than 500 BACnet points at the equipment level. Information from the zones was now transmitted to the air handlers, and that information was sent to the central plant and geothermal system. Several enhancements further improved efficiency. These included:

- Optimal start/stop;
- Enhanced tenant scheduling;
- Trim and respond features that modify cooling/heating requirements from the zone level;
- Advanced trending for diagnostics; and
- New web-based graphics front-end.

After completion of the integration, the systems began to work better within the building. Tenants were provided with more comfortable conditions, which reduced complaints and increased productivity. Electricity use dropped 10%, and geothermal demand was reduced by 45%. Wear and tear on the mechanical system was lessened due to equipment only running when needed and not when perceived to be needed.

Today, the building owner is pleased with the results and choices made with BACnet. The facility is one of the most

energy efficient in Boise, and is significantly better than other buildings in its peer group. Tenant complaints have turned into tenant compliments. Since temperature problems are a big reason tenants look for new space, Christensen Corporation is pleased that their tenant occupancy and retention is one of the highest in the area.

In the future, because of BACnet, the owner has many options for support of the control system and operation of the facility. There are current plans to certify the building under LEED-Existing Buildings O&M. Commissioning required for this process will be greatly enhanced due to the open BACnet standard control system. Additionally, new methods and ideas in building operation can be implemented through BACnet such as smart grid technology and adaptive fault detection and diagnostics.

For lessons learned on this project, BACnet is a great standard that owners, engineers, architects, contractors and others can use in providing a quality building automation system. However, there still needs to be an understanding that a standard such as BACnet does not cure all problems when it comes to a reliable, functional control system. Here are some steps that should be addressed when designing, constructing and implementing a building automation system:

- Be sure to have a solid BACnet specification. Too often there are specifications from engineers that have been cut, clipped and pasted from the best of all manufacturers into one “master” specification. It looks good on paper, but no one manufacturer can meet all of the criteria. Using ASHRAE’s Guideline 13-2007, Specifying Direct Digital Control Systems, can help. There are also online tools, such as [ctrlspecbuilder.com](http://ctrlspecbuilder.com), which can assist.
- Spend time developing a comprehensive point list for both hardware points and software points (calculated values). Be sure to state whether these points are to be displayed graphically, trended, alarmed, etc.
- Sequence of operation is a key element. Not all details need to be stated, but having the intent of the operation within a mechanical system, as well as the overall function of the control system, is paramount. Too often control contractors are given a sequence that is very detailed at the zone level or air handler, but does not address the overall operation and desires of the design. When writing a sequence of operation, the engineer should be addressing these questions in addition to details on specific mechanical operation throughout the facility:
  - How does interaction at the zone level (most important part of a mechanical system) work all the way back to the central plant?
  - What is the overall goal in desired energy use?
  - What level of comfort is expected for the occupants?
- In selecting a controls contractor/integrator, use other important criteria besides pricing. This includes:
  - Contractor’s experience with the type of facility, i.e., hospitals, data centers, office buildings, schools, etc.
  - Size of the project compared to the control contractor’s capabilities. A 50-story high-rise building may

not be suitable for a controls contractor that only works on school projects.

- Time frame of the project. Does the control contractor have the manpower and resources to meet the project timeline?
- BACnet product offering. Different BACnet manufacturers provide various features that may, or may not, be desired by the owner.
- Control system experience. Make sure the contractor/integrator is versed in BACnet systems and has the required experience. Also, a contractor may know protocols and networks but that may not make them an expert on the proper control of mechanical systems.
- Mixing and matching different BACnet vendor offerings on a single network may not always be in the best interest of the project. It can lead to finger pointing and/or involve multiple parties for support. This is due to different programming tools possibly needed for future support or upgrades for the individual components.

Where BACnet came to the rescue for this project was the ability to provide an open platform allowing outside contractors and suppliers to support, with their specialized expertise, a solution that worked for the unique needs of this innovative facility. If locked into a proprietary system, as provided years ago, the project might have gone well. But the ability to arrive at a best solution, with the features required for this type of facility, would have been limited. BACnet opened the options and ideas for a successful project. ●

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