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## BACnet<sup>®</sup> Is Tie That Binds Tucson

By Nancy L. Robbers and Vern Baker, P.E., Member ASHRAE

**B**<sup>ACnet<sup>®</sup></sup> technology enabled the City of Tucson to realize a goal to have an open and competitive energy management and control system (EMCS). For years, the City of Tucson was locked into a proprietary control system with no options for competitive bidding except to operate multiple, separate systems. The city did not want to continue enduring operation and maintenance problems associated with that setup. As the aging control system approached the end of its useful life, the city began to explore replacement options, which included the possibility of a BACnet solution.

"We educated ourselves up front and decided BACnet was the best option for us in the long term," said Vern Baker, supervisor of the EMCS section. "The administration supported our recommendation to pursue a BACnet solution as a replacement." After an extensive, four-year replacement project, the City of Tucson realized its goal of obtaining multiple competitive bids for all new construction projects and now has a system that allows multiple users seamless access to all city facilities.



City of Tucson has a new open and

The city's original EMCS configuration consisted of two separate proprietary systems from Johnson Controls (JCI). The first, an older JC/85/40 located at the City's Convention Center, connected to DSC-8500 field panels through hardwired and dial-up connections. The 85/40 served the HVAC systems at the convention center, police and fire headquarters, and various libraries and neighborhood centers. The 85/40 also served the fire alarm system, primarily at the convention center and at selected locations. Then, the 85/40 system had reached its maximum capacity and the city brought a second system on-line, a JCI Metasys.

This system served HVAC controls via dial-up and leased lines. Combined, both systems served approximately 32 facilities with 5,600 points and 1,681,151 ft<sup>2</sup> (156 179 m<sup>2</sup>). As the original EMCS evolved, the City of Tucson invested in a wide area network (WAN) managed by the information technology (IT) department.



competitive EMCS.

The city hired a consulting group to evaluate the existing system and prepare a plan for a BACnet solution. The project team also included members of the city's facilities management (FM) division, the University of Arizona, and the city's procurement department and IT staff. The plan included three separate scopes of work built around a native BACnet specification.

Scope A involved integrating the existing Metasys system into the new, native BACnet system. The city's existing equipment was fairly new and still in good working order, and there was not adequate funding to completely replace this equipment. The project team installed BACnet/Metasys gateways to integrate the proprietary equipment into the new BACnet workstation.

Scope B entailed replacing all existing 85/40 equipment with new, native BACnet DDC equipment. The 85/40 equipment had reached its maximum capacity, so the team replaced a considerable portion of it. Due to budget restraints, a portion of the 85/40 equipment remained in place. By removing a substantial number of points from the system, the city freed up memory and improved operation of the 85/40 system. A future capital project will replace the remaining 85/40 equipment.

Scope C provided, installed and commissioned the BACnet workstation. The Scope C contractor coordinated with other contractors and the City of Tucson's IT staff to ensure an appropriate infrastructure was in place to communicate over the City



*City of Tucson operations, in dozens of building types and sizes, are spread across the metropolitan area, which encompasses more than 500 mi<sup>2</sup> (1300 km<sup>2</sup>) of wide open spaces.* 



BACnet solutions consolidate and monitor multiple city properties through a single controls system.

of Tucson's WAN. The contractor provided transparent access to building operators for all buildings on the EMCS.

Bids were set up to allow multiple awards to different contractors, and each was free to propose on all three scopes individually. However, if the contractor chose not to propose on all three scopes, he could submit a single proposal for Scope A only, or a single proposal for Scope B and C combined. The city's procurement department oversaw the request for proposal (RFP) process, which evaluated each proposal based on 10 criteria, including contractor qualifications, specification compliance, installation schedule and installation price, and future maintenance costs.

An evaluation committee—including members of FM, IT, procurement, engineering consultants and the University of Arizona—reviewed each proposal and rated them according to the criteria. The contractor with the highest scoring proposal for each scope of work won the contract. The city selected Climatec/Alerton as the winning bidder for all three scopes of work. It took approximately two years to complete the initial analysis, prepare the bidding documents and award the construction contract.

At the time of the city's upgrade and consolidation project, BACnet technology was fairly new. Many vendors and consulting engineers outside the project didn't believe interoperability was possible—especially with such a variety of multivendor equipment.

Scope A, integrating the Metasys-fitted building, posed a significant challenge. City project specifications dictated that the existing equipment be reused to save money. Though newer technology than the 85/40 hardware, Metasys was still proprietary and would require an N2 driver—not yet released to the market—to work in the upgraded system. When the N2 driver finally became available, the project team installed a Tridium JACE controller for network management, supervisory control logic and, for the first time, an entirely interoperable interface between BACnet and the city's WAN.

In the Scope B buildings deploying the 85/40 hardware, the renovation was fairly straightforward. The project team reused as much of the existing cable, wire and conduits as possible, replacing only incompatible temperature sensors, relays, and power supplies. The buildings then were connected to the city's Ethernet wide area network (WAN) using Alerton global controllers and BACtalk Integrators (BTIs).

EMCS. After completing the installation, the consuluting group provided a technical guideline specification for use by the city in all future construction projects. This technical guide-spec is based on the as-built condition of the new EMCS and requires native BACnet controls to ensure that all future control systems will integrate and interoperate effectively. The city currently has the option of selecting among three prequalified, local contractors for all new construction controls bids. Additional contractors request approval to bid on city projects with equally viable BACnet products, but the city remains satisfied with its current competitive balance and defers further expansion until it has more experience with the multiple vendor commissioning process.

The city is commissioning the new Patrick Hardesty Multi-Service Center. This facility houses the police, water and finance departments, as well as public meeting spaces. The Patrick Hardesty Multi-Service Center uses an Automated Logic system that maps into the existing Alerton BACtalk operator workstation. In all, the city added seven new or upgraded facilities to the EMCS system since construction of the new EMCS

system ended. The controls

for each project use the city's

guide-spec to competitively

bid subsequent installations.

The city handles mapping of

the new buildings to the front

end separately from the new

construction projects through

unit pricing provisions in the

The interoperability of its

new EMCS gives the city

centralized, single-seat moni-

maintenance agreement.

For Scope C, the project team established two desktop workstations and four laptop workstations, all running BACnet/Ethernet over the city's WAN. Facilities managers can connect to the WAN from any location to monitor and control the entire system. A full graphic display package with floor plans and system diagrams was installed in each computer. In addition, the new system provided a paging feature to assist FM staff in operating and maintaining HVAC systems. If conditions in the



Figure 1: Graphical displays enable staff to make quick and easy adjustments to the system.

HVAC systems go outside of preprogrammed parameters, the system pages EMCS operators and informs them of the alarm. Operators have mobile connectivity capability to access the WAN to remotely troubleshoot and correct the problem.

According to Baker, "The infrastructure of the city's EMCS allows our operators to provide a higher level of customer service. We often respond to HVAC operational issues before a building's occupants are even aware there's a problem. We also have more direct contact with our customers by going out in the field to investigate problems rather than being stuck at a central monitoring workstation. Because we're able to work in the field, we have been able to reduce our service contract costs by handling many of the issues ourselves rather than calling a contractor."

It took approximately two years from issuance of the EMCS construction contract to complete commissioning of the new

toring and control over all its buildings. BACnet-based laptop workstations mean facilities staff can connect to the city's WAN from any point to oversee and adjust operations as needed. Graphical displays allow the facilities staff at-a-glance views of the entire system as well as individual components and their performance. The ability to monitor and override functions from a single workstation provides easy maintenance and simplifies training since new operators can see equipment on the screen without having detailed knowledge of

each component. Graphical programming eliminates the need for city facilities staff to retain specialized programming skills for proprietary systems. "The new EMCS system aids the City of Tucson's energy

management efforts in numerous ways... in particular, our ability to examine trends, schedules and overall building operation from my desktop," said Vinnie Hunt, P.E., energy manager for the City of Tucson. "With the EMCS operators able to visit the field more often, we can better educate building occupants in proper thermostat operations, which reduces complaints and allows us to implement more aggressive, energy-saving schedules."

The city took approximately four years to consolidate and upgrade the EMCS, which involved 30 buildings, comprising approximately 3,900 points, and 1,100,000 ft<sup>2</sup> (102 190 m<sup>2</sup>). The total project cost—including design, construction and administration—was approximately \$1.4 million. Using the existing city WAN saved more than \$1 million in equipment for the communication infrastructure while providing a stable and efficient communication platform.

"This is not a demonstration project with unlimited funds and unlimited time," Baker said. "This is real world, with local government capital improvement funding and deadlines, especially since our system was aging. We had to compete with all the other requests for funding—such as police and fire—and prove we could deliver a completed project on time and on budget. In the beginning, it took a certain amount of faith to commit to, at that time, a leading edge technology such as BACnet. Local governments don't normally operate that way. It was the right decision for us. There is no faith required now. BACnet is no longer leading edge technology; it's here, it's real and it works. Our investment has paid off."



Figure 2: BACnet-based VCLPs with expansion modules monitor and control the ice rink chillers inside the Tucson Convention Center.

Nancy L. Robbers is a professional writer at Alerton, Redmond, Wash., and Vern Baker is superintendent of maintenance, management and planning for the City of Tucson Facility Management Division.

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