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*Houston's Lakewood Church is the largest in the U.S. A BACnet-based HVAC system keeps 16,000 worshippers cool in the sanctuary.*

# BACnet<sup>®</sup> for Megachurch

By Nancy L. Robbers

Houston's Lakewood Church is America's largest nondenominational church, with multiple services that attract tens of thousands of worshippers each week. The church building is the former Compaq Center, home to the Houston Rockets basketball team. An ambitious renovation in 2005 transformed the arena into a sanctuary, completely overhauling the interior to accommodate a pulpit, LED display screens and seating for 16,000 worshippers at a time.

Lakewood Church increased its congregation fivefold in the years just prior to the renovation. What began in a converted feed store 40 years earlier now required exponentially more space for evangelical, administrative and com-

munity services. Fifteen months after it began, the renovation was completed for \$95 million, \$75 million of which was construction costs. The entire job included 50,000 ft<sup>2</sup> (4645 m<sup>2</sup>) of new carpet, a power system that could light a 37-story

office high-rise, an additional 209,000 ft<sup>2</sup> (194 167 m<sup>2</sup>) to house classrooms and a broadcasting suite, and an upgrade to its HVAC system.

The primary need in renovating Lakewood Church's HVAC controls was to keep visitors and employees comfortable in the vast sanctuary, day care center, classrooms, administrative offices and other areas. On weeknights, a room may hold 300 people, but have only 40 guests for the same gathering the following week. The new system needed to offer flexible scheduling and programming to accommodate the church's many events.

Lakewood Church wanted to upgrade its existing 30-year-old air-handling units

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## About the Author

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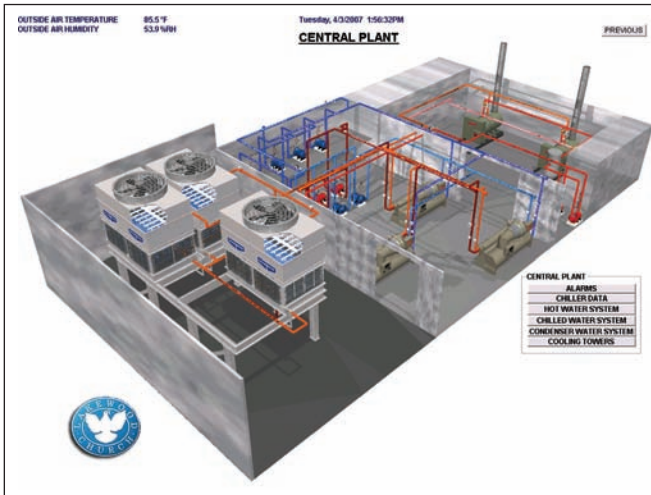


Figure 1: The BACnet-based GUI provides quick, comprehensive views of the the central plant for Lakewood Church.

(AHUs) instead of replacing them. They were built-up units, which meant they were much larger than prefabricated AHUs. They also were located in a tight space, which virtually eliminated the option of moving them. Most importantly, the AHUs ran on a single duct system that had constant speed fans with inlet vane controls. This meant the maintenance staff needed a way to moderate airflow and control energy costs.

Finally, the church's existing system used pneumatic controls, which resulted in significant time and labor spent checking and adjusting everything manually. The updated system needed to automate as many controls as possible so the staff could concentrate on more important tasks.

Lakewood Church installed a BACnet-based building automation system (BAS) that updated controls throughout the church building. In total, the Lakewood Church project included global controllers, field-level controllers, variable air volume (VAV) controllers, chillers, cooling towers, air-handling units and variable frequency drives (VFDs). Operator workstations run a native BACnet frontend that controls the entire facility.

To effectively cool the 606,500 ft<sup>2</sup> (5634 m<sup>2</sup>) in the completed building, Lakewood Church installed controls that updated the AHUs—four 100,000 cfm (47 195 L/s) units and four 60,000 cfm (28 317 L/s) units—with VFDs. The church built its own chiller plant for cooling creating an interface between the BACnet-based front-end software and the new chillers to give the facilities staff absolute control over airflow. Combined with using start-up delays on the AHUs—so that they don't all turn on at once—it means the church can use the required one million cfm (471 947 L/s) of air conditioning and still reduce its energy use.

Additionally, the installation of direct digital controls (DDC) automates monitoring and control tasks, enabling the staff to easily make changes to setpoints in any zone throughout the building. The facilities manager no longer needs to send a technician to check and adjust the status of any device.

Lakewood Church also installed a Web-based solution for the

## Project Scope

- 2 Operator Workstations
- 1 BACnet-Based Web Server
- 2 Control Modules
- 153 Field Controllers to Control Air-Handling Units, Fan-Coil Units and the Central Plant
  - 1 Controller in the Central Plant for Chillers, Towers, Pumping and Boilers
- 3 Water-cooled Chillers With Two Cooling Towers
- 4 Switchgear Panels
- 4 Field-level Gateways With Modbus
- 134 VAV Terminal Boxes
  - 4 100,000 cfm (47 195 L/s) and 4 60,000 cfm (28 317 L/s) Air-Handling Units
- 7 Variable Frequency Drives

building system, which uses standard Web browser technology to provide staff with access to their building system and data from anywhere they have access to the Internet.

The sanctuary features two 30 ft (9.14 m) rock waterfalls whose flow can be a gentle trickle or Niagara Falls. With the additional moisture in the environment, sensors communicating with the BACnet building system easily compensate for the excess humidity and provide efficient and cost effective cooling. The AHUs also use 100% outside air to maintain air quality in the 16,000-seat sanctuary.

The HVAC portion of the installation also included third-party integration. The church created interfaces with three chillers using a control module. This enabled staff to view equipment status instead of just the standard on/off mode, and to monitor and control four switchgear panels. The chillers use a building control unit (BCU), which is a BACnet-compatible global controller. With the BCU recognized as another BACnet device on its Ethernet LAN, Lakewood Church then used BACnet over IP to communicate with the chillers. The church also used one field-level gateway with Modbus<sup>®</sup> on each switchgear panel to directly communicate with them at MS/TP-level integration.

Lakewood Church now enjoys a system with greater functionality for its HVAC needs, including flexible scheduling for heating and cooling its myriad multi-use zones and, most importantly, the ability to track and maximize its energy use. With VFDs on the upgraded AHUs, Lakewood Church can better moderate its cooling functions to save energy and reduce costs. DDC enable the facilities staff to view the entire system from any workstation and then tweak any setting. With the BACnet-based solution, the facilities manager can remotely view and adjust the church's system, saving travel time and labor costs.

"We're multi-use, so we have classes and events going on in addition to regular office hours," said Greg Jenkins, facility manager for Lakewood Church. "With a BACnet system, we're able to easily schedule changes like that."●