

# 2009 BFRL Project Description

**Project Title:** Expansion Certification, and Demonstration of BACnet

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**BFRL Program:** Cybernetic Building Systems

**Objective:** To assist the building industry in improving the safety and operational efficiency of commercial buildings by enhancing the capability of communication protocol standards that enable the practical use of integrated HVAC, lighting, security, vertical transport, energy management, life safety, and emergency response systems.

## **Problem:**

*What is the problem?* For many years the building control industry has recognized the potential cost reductions and performance benefits of integrating products made by different manufacturers and from integrating historically stand-alone systems into a single building automation and control system. Significant progress has been made for HVAC applications through the development and widespread adoption of the BACnet communication protocol standard. However, significant barriers remain to the realization of fully integrated systems. These barriers include a lack of data models for applications such as lighting and vertical transport, network security mechanisms to protect critical systems, methods to protect the operational integrity of life safety systems when integrated into a larger system, integration of building automation data with business management systems, adapting to new technologies such as wireless sensors, and testing procedures to verify correct implementation of new protocol extensions. There is also a need to continue to harmonize evolving standards in the U.S. with international versions of the standard. Industry consensus on the importance of these issues is documented by the formation of topic specific working groups in the BACnet committee<sup>1</sup>, industry roadmaps<sup>2</sup>, and government policy documents<sup>3</sup>.

*Why is it hard to solve?* Buildings are complex systems of subsystems. Most commercial buildings are “one off” designs with unique operating needs. Interactions between subsystems

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<sup>1</sup> [www.BACnet.org/WG/index.html](http://www.BACnet.org/WG/index.html)

<sup>2</sup> U.S. Department of Energy, *High-Performance Commercial Buildings: A Technology Roadmap*, [http://www.eere.energy.gov/buildings/info/documents/pdfs/roadmap\\_lowres.pdf](http://www.eere.energy.gov/buildings/info/documents/pdfs/roadmap_lowres.pdf)

<sup>3</sup> Federal R&D Priorities for Energy Efficient Sustainable, and High Performance Buildings – Draft report from the NSTC Subcommittee on Buildings Technology Research and Development

can be complex and are often not well understood. Effective communication protocols must capture the information exchange requirements of many different applications while simultaneously being simple enough to be implementable at low cost and general enough to accommodate a wide range of system design constraints. In addition, they must enable efficiency improvements from system integration while accommodating the need for some systems (life safety and security) to meet strict requirements for security, integrity, and reliability.

***How is it solved today, and by whom?*** Portions of the problem have been solved. As a result of past NIST leadership, the BACnet standard has been created and adopted by over 30 countries and most HVAC control system manufacturers. Conformance testing tools and processes have been developed and industry run certification programs are in place. The unsolved portions are model development, security enhancements, characterization of the performance of emerging technologies, and new conformance test procedures that will expand the reach of BACnet to other building systems.

***Why NIST?*** This work is closely aligned with the BFRL mission to promote U.S. innovation and competitiveness by anticipating and meeting the measurement science, standards, and technology needs of the U.S. building industry. It builds on the BFRL core competence of Information, Communication, and Automaton Technologies for Intelligent Integrations of Building Design, Construction, and Operation. BFRL has an international reputation for excellence in this area as a result of over two decades of technical work and collaboration in related standards development. BFRL staff has leadership positions on the key U.S. and international committees involved.

#### **Approach:**

***What is the new technical idea?*** The new technical idea is to develop use cases for integrated building automation systems and use them to derive the underlying information exchanges needed to realize the goal of fully integrated building automation systems. Data models for representing this information will be developed along with protocol enhancements needed to exchange and process the information. The security features of BACnet will be strengthened in a way to enable a range of security options than can be selected and combined to respond to appropriate threats without requiring the overhead and expense of applying the highest level of security to all system components. For each new feature of the BACnet standard, test procedures will be developed for use in industry certification programs for BACnet products.

***Why can we succeed now?*** There is a clear industry demand from both building owners and building automation product manufactures, significant progress has already been made, the national and international standard committees who will use the results of the work are in place, and NIST has the technical expertise and laboratory facilities to conduct the work.

***What is the research plan?*** Efforts will focus on providing technical leadership in revising several BACnet addenda proposed in FY 2008, based on industry feedback from those proposals. Those addenda include enhancements that enable more sophisticated collection and logging of building performance data, extending the number of character sets supported to facilitate BACnet's use in more countries, new network security features, BACnet standard object types for selected lighting control products and applications, extending physical access

control systems capabilities, and revising the international versions of BACnet to include addenda already adopted in the United States.

Efforts will focus on revising an extensive proposal to enhance building automation network security. Results from prototype implementations and industry feedback will be available to clarify any implementation issues. The critical needs will be to develop robust test procedures for determining both compliance with the new security features and assessment of how well different options can withstand possible threats. Technical issues with adding capability to use ZIGbee wireless products will also be addressed.

Efforts will focus on expanding the integration of BACnet systems with business applications through BACnet web services, new BACnet additions for vertical transport, and implementing the results of the research for providing information to first responders that pertain to needed changes in building automation system communication. The work will be completed with the end result being emergence in the marketplace of BACnet products for a wide range of building automation applications beyond HVAC control.

### **Recent Results:**

**Impact:** BACnet has been implemented by every major HVAC control system manufacture in the world and has become the protocol of choice for integrated building automation systems.

**Impact:** BACnet interest groups have formed around the world to educate the building industry and promote the use of the technology.

**Impact:** A worldwide BACnet product testing and listing program has been established by BACnet International. Test laboratories are in operation in Germany and India.

**Outcome:** An ISO Maintenance Agency was established to keep the ISO version of BACnet and its companion testing standard synchronized with the ASHRAE/ANSI standard.

**Impact:** The U.S. maintains a world leadership position in developing future enhancements to the protocol standard.

**Outcome:** Addenda *a, c, d, e,* and *f* to ANSI/ASHRAE 135 2004 (BACnet) published. These addenda cover advanced features for life safety systems, web services, electric load control, and door control.

**Anticipated Impact:** There will be a significant expansion in the types of commercially available BACnet products and the use of the protocol in life safety, access control, and utility integration applications.

**Outcome:** Addenda *b, g, h, i,* and *j* to ANSI/ASHRAE 135 2004 (BACnet) for advanced event and trend logging, physical access control, lighting, and network security features published for public review and comment

**Output:** Alexander, Ejimofor, Holmberg, *BACnet at Georgia Tech*, ASHRAE Journal, Vol 49 No. 11, November 2007.

**Output:** Bushby, *BACnet Measures Up*, ASHRAE Journal, Vol. 49 No. 11, November 2007.

**Output:** Holmberg, *standards for Automated Demand Response Communications*, AICHE Conference, Proceedings of the American Institute of Chemical Engineers, New Orleans, LA 2008.

**Output:** Holmberg, Bushby, Butler, *BACnet for Utilities and Metering*, ASHRAE Journal, Vol 50 No. 4, April 2008.

**Output:** Song, Hong, Bushby, *A Performance Analysis of BACnet Local Area Networks*, HVAC&R Journal, Vol. 14 No. 2, March 2008.

**Standards and Codes:**

The results of this project will be revisions and extensions to ASHRAE Standards 135 and 135.1, and to their international equivalent standards EN ISO 16484-6 and EN ISO 16484-6.