White Paper

Open Systems: LonWorks® Technology and BACnet® Standard

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The Demand for Open Systems

Open systems are a growing part of every discussion on the latest and greatest control system offerings. End users and owners are embracing open systems to achieve vendor independence and interoperability. In response to end user and owner demands, specifying engineers and architects are calling for open systems in building specifications. The primary architectures specified are LONWORKS® and BACnet®. These two architectures aspire to the same goals of vendor independence and interoperability with very different implementation requirements. Table 1 below compares the two architectures and illustrates their differences, strengths and weaknesses.

	LONWORKS	BACnet
History	1988 – Released by the Echelon Corporation 1994 – LONMARK® Organization formed 1999 - ANSI/EIA standard	1987 – ASHRAE committee formed 1995 – BACnet Standard released 1995 – ASHRAE and ANSI standard
Goals	• Vendor Independence • Interoperability	• Vendor Independence • Interoperability
Architecture	• A "bottom up" solution focused on the controller • Open protocol • Flat architecture	• A "top down" solution focused on HMI integration • Open standard • Tiered architecture
Certification	• LONMARK Organization sets LONWORKS standards and certification requirements • Controller certification • LONMARK Functional Profiles • Standard data types (SNVT and SCPT)	• No certification process • Developing the BACnet Testing Laboratories (BTL) for testing and certification
Protocols	• LonTalk® • Embedded into every Neuron® Chip • Can be ported to any processor, from 8-bit microcontrollers to 32-bit microprocessors • Every LonWorks device uses LonTalk • Supports various media – 1 protocol	• Multiple protocols supported • Ethernet, ARCnet, MS/TP, PTP, LonTalk, IP (pending) • All industry standard protocols • Each with specific implementation and media requirements

	LONWORKS	BACnet
Controllers	• Neuron Chip processor • Neuron C programming language • I/O Channels • Transceiver • Hosted controller • Controllers have "out of the box" commonality	• Processor independent • Programming language independent • I/O channels • Final controller specification at manufacturer's discretion • Controllers have nothing in common "out of the box"
Distribution	• Direct from manufacturer as part of a complete solution • Many companies produce solution independent LONWORKS devices (lighting, sensors, drives, power metering, diagnostic, etc.) • Individual devices from an independent distributor who represents multiple vendors	• Direct from manufacturer as part of a solution • Very few companies produce solution independent BACnet devices (lighting controllers, diagnostic tools, gateways) • No independent distribution
OSI	• Data packet structure based on the 7-layer OSI reference model. • LonTalk uses 7-layer data communication packets • Using all 7 layers enables LonTalk to be used in control environments beyond building control	• Data packet structure based on the 7-layer OSI reference model • BACnet uses 4-layer data communication packets (collapsed architecture) • Using only 4 layers limits the number of control environments to which BACnet can be applied
Topology	• Flat architecture • No gateways • Change media, use same protocol • Every device is a peer on the network • Each device can communicate directly with the HMI using SNVT and SCPT data formats	• Tiered architecture • Gateway solution • Native BACnet solution • Change media, new protocol • Controllers are grouped behind supervisory devices • Typical implementation uses multiple protocols

Table 1. Comparison of LONWORKS and BACnet Architectures

Understanding the Differences

The differences between LONWORKS and BACnet affect manufacturing, product distribution, installation cost and system quality.

- *History*—Echelon developed the LONWORKS technology for profit; to achieve this goal, manufacturers, installers and end users must also profit. The BACnet standard was developed by a committee, which focused on consensus rather than profitability.

- *Goals*—To achieve the goal of vendor independence, users must have the ability to purchase product from multiple vendors and be able to easily install any chosen product into their existing network. To achieve the goal of interoperability, users must be able to create a control network that combines dissimilar systems (HVAC, security, access, lighting, elevator, fire, etc.) into one seamless network.

- *Architecture*—The flat LONWORKS architecture focuses on controller communication without the need for gateways. The tiered BACnet architecture originally focused on gateway integration, but now includes supervisory and field controllers.

- *Certification*—The LONMARK organization creates standards for the LONWORKS community, certifies controllers against those standards, and hosts a Web-board member discussion forum. BACnet users are organizing a certification organization; however, there are currently no certification standards or processes in place.

- *Protocols*—LonTalk can communicate across various media including unshielded twisted pair, fiber optics, radio frequency, Ethernet, infrared and power line carrier. LONWORKS routers are used to change media types within a single network. LonTalk is used at every level of a LONWORKS installation. BACnet uses multiple protocols at multiple speeds where each protocol has specific media requirements. A typical BACnet installation uses several protocols as shown in table 2.

Protocol	Reference	Speed
Ethernet	ISO 8802-3	10 Mbps
ARCNET	ATA/ANSI 878.1	156kbps
MS/TP (Master-Slave/Token Passing)	EIA-485 (RS-485)	9.6kbps, 19.2kbps, 38.4kbps, 76.8kbps
PTP (Point-To-Point)	EIA-232 (RS-232)	9.6kbps – 56kbps
LonTalk	Version 3.0 (ANSI/EIA 709.1-A1999)	32kbps – 1.25Mbps

Table 2. BACnet Protocols and Media Requirements

- *Controllers*—LONWORKS controllers require a transceiver and a central processor (typically the Neuron Chip). The transceiver communicates with the network and determines the communication media type. The Neuron Chip contains three 8-bit, in-line CPUs, on-board memory, and the LonTalk protocol. It is produced by two different companies (Toshiba and Cypress) at two different locations and more than 15 million have been sold. A LONWORKS-hosted controller contains a third-party processor behind the Neuron Chip to add greater processor speed and memory. For BACnet controllers, the manufacturer has total control over controller design, and must choose a processor and a protocol. There are no guidelines or "rules of thumb" to set expectations. Field controllers use a single protocol and are grouped under a supervisory controller that communicates to the HMI. The supervisory controllers use up to three protocols: one to communicate with the field controllers, one to communicate to the HMI and one for direct dial-in.

- *Distribution*—There are many LONWORKS products available from various manufacturers, including programmable controllers, application specific controllers, connectivity devices and software tools. These products can be purchased through third-party distributors. No other control architecture has as many products available for independent distribution. This creates a single source for products from various manufacturers. Independent distribution is only possible because of the interoperable nature of LONWORKS devices. There are no independent distributors of BACnet products, which are typically sold from the manufacturer as a complete solution. When a manufacturer designs a building controller, it is part of a

complete building control solution. The only exceptions to this are lighting controllers and gateways. The absence of a certification standard makes it extremely difficult for BACnet devices to have "out of the box" interoperability.

- *OSI*—The OSI (Open Systems Interconnect) 7-layer reference model is an international standard for conceptualizing network communication protocols and is widely used as the basis of many data communications standards. The 7-layer LonTalk protocol can be applied in a variety of control environments including HVAC, lighting, security, transportation, elevators, automated food service equipment, industrial control, connectivity, power monitoring, home automation, gateways and more. The BACnet 4-layer collapsed architecture is limited to HVAC and lighting controls and gateways. The number of applicable control environments is important when considering that the longevity of any standard or protocol is directly related to the size of its user base.

- *Topology*—The LONWORKS technology enables controllers from any building system to communicate on the same wire directly to the HMI. Control and equipment manufacturers have produced LONWORKS controllers for all aspects of building control. The BACnet standard offers a gateway integration solution to a single HMI. All major control and equipment manufacturers have a BACnet gateway product. Some control companies have developed a complete BACnet building solution that applies the standard from the controllers to the HMI. This solution, called Native BACnet, employs supervisory controllers, which creates a tiered architecture that is typically manufacturer specific.

Conclusion – Have the Goals Been Achieved?

The demand for open systems has led specifying engineers and architects to include the BACnet standard and LONWORKS technology in building control specifications as open system options. Since both are very different approaches to open systems and both seek to meet the goals of interoperability and vendor independence, the question is: "Have the goals been achieved?"

For the LONWORKS technology, the answer is "yes." The LONWORKS technology is a flat architecture, with hundreds of products available from various manufacturers. Many products are available from independent distributors, and the LONMARK association creates standards and certification.

For the BACnet standard, the answer is "no." The BACnet standard is a tiered architecture, with product available only as part of a solution and only directly from the manufacturer. No product testing or certification standards exist.