GOING OPEN – WIDE OPEN

LONWORKS® control technology has been experiencing an incredibly strong adoption rate in the commercial controls industry over the last few years. Despite the incorporation of the technology into a variety of products, until recently it has been difficult for a systems integrator to build a truly open, interoperable solution. There are several reasons for this. One reason is the nature of the typical commercial control problem. The majority of building automation projects in industrialized countries continues to be retrofit. This means that systems integrators need a way to integrate legacy control devices into a LONWORKS network without having to create a custom device.

Another reason is the structure of the market. While major manufacturers of building control systems continue to adopt LONWORKS technology at an accelerating pace, many are worried about the market changes that will be brought about by adoption of a standard network protocol and implementation of truly open architectures. Open architectures are viewed as a possible Pandora s Box to larger companies with substantial market shares; they prefer to maintain the status quo, which keeps their customers boxed in. They are not willing to accept the fact proven over and over in other industries such as information systems that open systems greatly expand markets, providing plenty of opportunity for many competitors to prosper by delivering new functions and added value to both old and new customers. Many of these manufacturers have found the use of the LONWORKS technology to be a cost-effective way to allow their proprietary devices to share information within their own closed system and wish to leave it at that.

There's a Crack in the Box!

It is unfortunate that not all control system manufacturers are ready to deliver truly open platforms. One of the more common system architectures deployed today, in both building and process control, is as shown in Figure 1. Here we see LONWORKS controllers connected on standalone channel segments. The emphasis is still on wiring sensors and actuators back to boxes rather than distributing the intelligence to the field devices. Software for network management and system monitoring is provided by a single vendor and is not based upon any open standard.
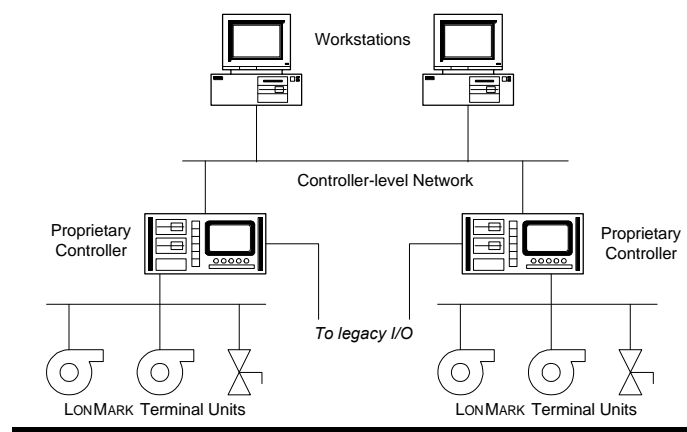

Figure 1. A typical system architecture today

This architecture only capitalizes on a small part of the power of LONWORKS. LONWORKS nodes in this architecture typically have limited decision-making responsibility and very limited interaction with nodes on other channel segments. This is a crack in the manufacturers proprietary box , but far from true openness. The system is still closed at the next level of the hierarchy, the supervisor controllers. These devices implement most of the control relationships between I/O devices, terminal units, and and other supervisor controllers. These large control panels or black boxes also act as a gateway for the information from the standard LONWORKS protocol into some other transport mechanism. The system controllers are often used to provide custom drivers for connectivity to another proprietary bus or to incorporate legacy equipment into the system. This is a one off, custom approach to solving the problem, and far from true openness. Each manufacturer has proprietary network tools for configuration and management. Further, each typically has proprietary HMI tools making it necessary for the integrator to spend time learning how to use a variety of interfaces without standards

The architecture shown in figure 1 is not the optimal control solution for a number of reasons. The most important reasons to the end user directly involve life cycle costs:

1. *It is unnecessarily complex.* If the control system architecture were implemented with a true peer-to-peer structure, the controller-level network could be eliminated with no loss in functionality. The end-user derives no benefit from the extra level of the hierarchy and, in fact, is negatively affected by the extra cost and complexity associated with having to install, configure, and maintain a second control level network based on a different technology.

2. *It is still proprietary.* Although the devices on the device network are LONWORKS and may even be built to the LONMARK standard, the centralized controllers and the control algorithms they contain are not. They require custom programming with proprietary tools, and proprietary network management tools are required. This prohibits the end user from achieving one of the real goals of open standards: freedom of choice for modifications, additions, implementation of new functions, and maintenance.

3. *It is not possible to communicate with any point, at any time, from anywhere on the network.* Because the architecture consists of multiple layers of control, it is not possible to communicate directly between devices on separate channels. Acquiring data translated through separate protocols twice and stored in a global database that may be minutes old is unacceptable. This architecture limits the information flow between devices, the ease of implementation of control algorithms, and ultimately the usefulness of the system.

The Box is Cracked. Now Think Out of It!

In summary, the system architecture shown in **Figure 1** is cumbersome and costly for end-users and systems integrators and it confuses the uninformed buyer who is led to believe he is purchasing an open system because it is based upon a technology that was conceived to provide openness. The multi-tier control architecture is actually a collection of small LONWORKS networks. These small LONWORKS networks contain relatively few peer-to-peer devices. Instead of open network management software coordinating information transfer, there is proprietary black box software managing the controller-level network. This software is valuable because it hides the complexity of the two-tier architecture from the end-user. The manufacturer can therefore charge a premium for it and he can be sure the user will require his services at some point in the future. In this architecture, even though there is interoperability on the device level network, system wide communication is provided by the controllers; LONWORKS devices can only share data directly with other LONWORKS devices on their local channel.

The lowest cost and most powerful way to deploy LONWORKS is to build highly distributed peer-to-peer systems, as shown in **Figure 2**. Note that while this requires a paradigm shift in implementation of control algorithms, it also results in lower cost, more adaptable systems. As end users and systems integrators have now realigned their thinking and accepted this solution over hierarchical solutions, market demand has naturally evolved. End users and owners now want to implement truly open systems. The issue, therefore, has become one of how to provide an infrastructure to tie the LONWORKS devices and channel segments together and provide the functionality that has traditionally resided in a proprietary controller.
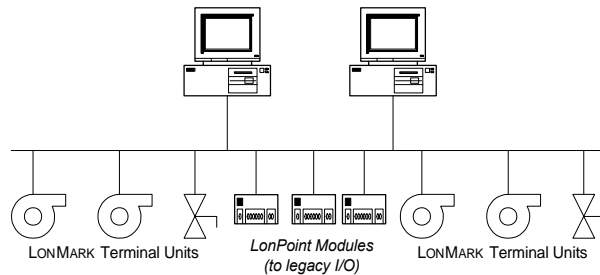

Figure 2. A fully distributed LONWORKS system

It is inevitable that control systems will evolve to a truly open, standards-based peer-to-peer architecture in a manner similar to what has happened in the information systems markets. The only question is how quickly. LONWORKS is the crucial foundation, providing the open standards implemented in high-volume, low cost Neuron Chips. To accelerate the evolution of the market, more is needed, and Echelon has invested heavily in products and tools to enable system integrators to be able to realize the benefits *today*, rather than years from now. Echelon s new LonPoint System family of products allows systems integrators to build complete solutions using LONMARK products from multiple vendors today. These solutions distribute the control algorithms and legacy I/O interface to the LONWORKS device level, eliminating the cost and complexity of supervisory controllers and controller networks. The LonPoint devices, along with the rapidly increasing numbers of LONMARK devices available from multiple vendors, constitute a truly open, single-level, peer-to-peer control network. The LonPoint interface modules allow system integrators to integrate legacy devices, that do not themselves include a Neuron Chip and transceiver, into a truly open system; and these modules also include powerful software function blocks which can be combined to create almost any control algorithm. The LonPoint Scheduler module can be configured to implement scheduling and event-driven mode control to parts or all of the system. Thus the incremental cost of adding control functionality is very low. Most importantly, spreading the control logic among the nodes eliminates the need for expensive hierarchical controllers and eliminates the cost and complexity associated with installing and maintaining a controller-level network. And the LonMaker for Windows Integration Tool makes the design, configuration, installation, and maintenance of interoperable systems a snap.

As important as the LonPoint devices are, it is just as important for the success of system integrators to have powerful, easy-to-use tools for system design, documentation, configuration, installation, monitoring, and human-machine interface (HMI). Echelon s LONWORKS Network Services (LNS) operating system provides the foundation for interoperable network tools, bringing the power of client-server architecture and component-based software design into control networks. LNS allows multiple system integrators, managers, application services and maintenance personnel to simultaneously access network data from any number of client tools. Client tools can interface to LNS using standard Windows interfaces, greatly simplifying the task of developing tools. For

example, a manufacturer of a LONMARK device can quite quickly develop an *LNS plug-in,* which is a graphical, point and click Windows program that makes it easy for a system integrator to select customization parameters for the application programs built into the device, in order to adapt it to the particular purpose. No more arcane programming languages and proprietary hand-held tools!

The LonMaker for Windows Integration Tool is a software package for designing, installing, and maintaining multi-vendor, open, interoperable LONWORKS¨ control networks. It combines the powerful client-server architecture of LNS with the highly popular Visio graphical user interface. The result is a tool that is sophisticated enough to design, commission, and maintain a distributed control network, yet economical enough to be left behind as a maintenance tool. With LonMaker for Windows, the physical design of a network is as simple as dragging and dropping device icons onto a drawing and selecting the channel they attach to. Functional network design is as simple as dragging the devices application function blocks onto the drawing and connecting inputs and outputs to determine which function blocks use what network variables. To set the customizable parameters for a specific device or function block, just click on the drawing icon and LonMaker launches the appropriate LNS plug-in for that device. Once the design is complete, it is self-documented in the drawing. LNS ensures that the design data base, the drawing itself, and the parameters downloaded into the network devices all are identical and kept synchronized as moves, adds, and changes occur.

Flat is Where it's At!

One of the more popular arguments advanced against the flat control system architecture by those holders of the sacred proprietary banner is that a higher-speed backbone is needed to transfer data. Most of this thought process comes from trying to design control systems using the old paradigm: gather all the information in the big black box and transfer it en masse upon request. Properly designed, few control systems require throughput greater than 1 megabit per second, which the LONWORKS technology readily accommodates. A good network control protocol sends short concise messages and it only sends them when they are needed. The messages are only seen within the control device community in which they are required. How often do you need to send your 10 Mbyte PowerPoint® file to a sensor on your control network? The *real* reasons to consider incorporation of other transport protocols into the control system design are:

1. *1.Use of existing communications infrastructure.* Chances are good there is going to be a lot of fiber cable, coax cable, or twisted pairs of wires running through the building. Typically only a small percentage of the potential bandwidth is used.

2. *2.Increases in distance and delivery.* TCP/IP networks currently cover the planet. They are designed to provide for long distance communication. One could design standalone wide-area LONWORKS systems to deliver information from Boston to Bangladesh, but it would not be very cost effective. Why not leverage the existing networks?

3. *3.Leveraging existing organizational data transfer mechanisms.* Data on a control network is just that, data. People need information to gain knowledge and make decisions. Today information is gained by sitting down at a personal computer to organize and collate the data through software programs. This information is then shared with others through a network of these computers. It seems sensible to design a control system that provides the data from the device I/O level to the business level network.

With the distributed control architecture shown in figure 2, users can, in fact, use high-speed backbones as a transport mechanism for their LONWORKS messages if they desire. They should simply do so using standard data transport techniques like TCP/IP instead of proprietary protocols. As shown in **Figure 3,** the system now uses *tunneling routers* between channel segments, instead of gateways. LONWORKS messages are tunneled into the TCP/IP packets and sent over the TCP/IP

network. If you think of a LONWORKS packet as a letter (the data) inside an envelope (the packet addressing information) and delivered to its addressees by the LONWORKS network, then a tunneling router simply encloses this LONWORKS envelope inside a bigger envelope, with a different kind of addressing, and the wide-area network delivers this to the addressed remote LONWORKS network segment, where the outside envelope is discarded and the LONWORKS envelope is placed onto the local network segment. This makes the system easier to install, monitor, troubleshoot, and maintain since the system is now one integrated network, with complete connectivity between all points. This means, for example, that a tool connected anywhere can interact with any node on any segment.

LONWORKS to TCP/IP routers provide a seamless, transparent connection from LONWORKS network segments to an Ethernet or wide-area backbone network. The end result is a consistent, powerful building automation system that is LONWORKS-based from sensors to facilities management software. Such a unified architecture can significantly reduce the life-cycle cost of the system, and can enable new functionality by taking advantage of IP technologies such as the Web and Internet. These devices are already available from a number of vendors and a LONMARK standardization effort is well underway.

An important benefit of this flat approach is that, unlike today's architecture with gateways, custom programming of the routers is not required whenever a tool needs access to a new point on a remote segment. Another important benefit is that this approach easily extends over the Internet or an Intranet, allowing geographically remote tools to access the network.
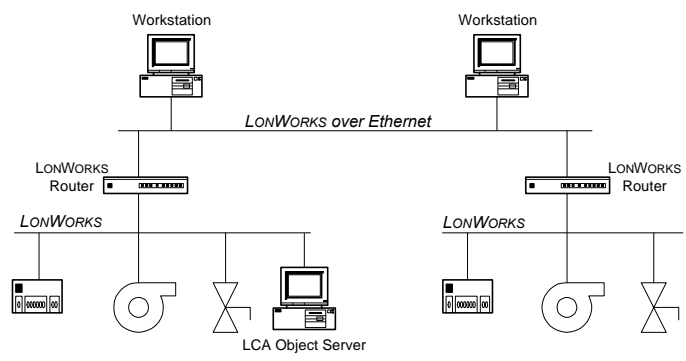

Figure 3. A fully distributed LONWORKS system using an Ethernet backbone

The LonPoint System makes available the parts and pieces that systems integrators were previously missing to create a network infrastructure when they attempt to construct an interoperable system. As open systems integrators win more projects, the demand for flat architectures will rise. This rising demand will attract the attention of manufacturers of sensors and actuators. These manufacturers will then incorporate LONWORKS into their products in order to satisfy this demand. This will lead to ever increasing numbers of open products and tools that will provide real empowerment for owners and end users.

Are You Starting to Feel Like Jack?

One of the truly perplexing issues facing a specifier, user, or integrator in the commercial controls industry today concerns which building protocol to support. With the long awaited completion of the BACnet protocol specification, many people are tempted to rush forward in pursuit of truly interoperable solutions with BACnet. When faced with the reality of writing a specification and implementing a solution, reality sets in - which standard do we support: BACnet or LONMARK?

It is helpful to remember where the industry has come from and where it should be going. Many large manufacturers have great concerns about the impact on their proprietary service business if

they introduce an entire line of controls that plug and play . Rather than adopt a proven standard, some are now advocating a multi-tiered approach in which their systems will be based on their version of the BACnet protocol with some LONMARK devices thrown in for good measure. Even when standardization of the BACnet protocol is supported through independent verification, it is likely to be implemented in the wrong way by those that fear open systems. Many manufacturers will use BACnet to extend their gateway approach for as long as possible in order to continue to maintain their control over an installed customer base. They want to shove the end user back into the box. The question becomes, if LONWORKS networks are truly interoperable, and capable of performing any control function with or without BACnet, why use BACnet?

In fact, the market should embrace BACnet to the extent that it leverages the user s ability to demand openness from the proprietary legacy systems with which they are burdened. Reference the architecture in figure 4.
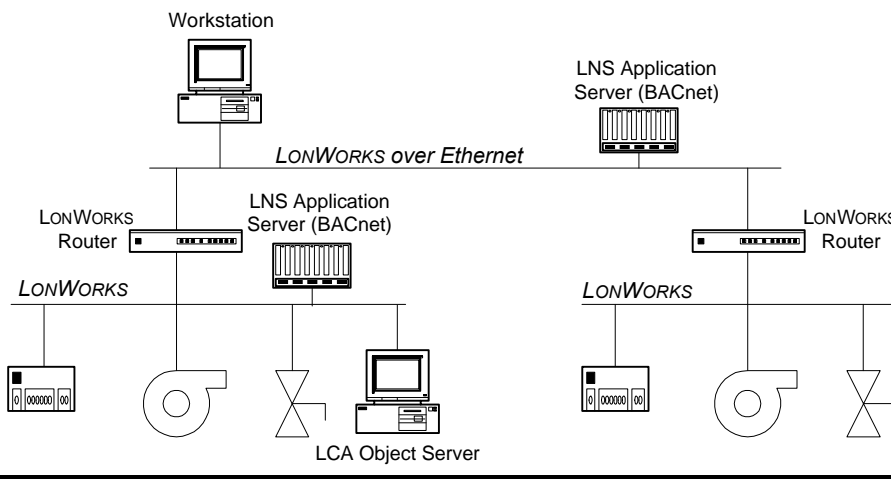

Figure 4. A fully distributed LONWORKS system with an Ethernet backbone using BACnet Servers

In this architecture, subsystems can communicate with legacy systems using BACnet-style servers, just as they do in figure 1. Unlike figure 1, however, there is complete network connectivity as in figure 3. In this architecture, the value of interoperability is high, since any LONWORKS device can share data with any other LONWORKS device   no matter where they are located in the system. This approach provides the infrastructure for system installation, monitoring, troubleshooting, and maintenance and it provides the infrastructure to allow BACnet servers to communicate with one another.

For any building owner or consulting engineer seeking to implement a truly interoperable control system today, the time has come to move beyond theoretical talk. They must evaluate the standards, determine where they fit into an overall architectural scheme, and look at what reasonably can be built at reasonable cost with product from reputable systems vendors. A standard has been chosen. It will serve the facility over its full life cycle, delivering maximum value for the owner.

It is important to remember that the BACnet standard was developed by and for the U.S. HVAC industry alone. It does not necessarily address the needs of other building controls industry segments, such as lighting, security, and fire/life safety systems, nor is it likely to be widely embraced as a standard in those industries. Moreover, it certainly does not meet the needs of the industrial controls industry or many other controls industries. LONWORKS, on the other hand, was designed with the flexibility to meet the requirements of all industries: it is an approved standard in many industries worldwide, and is the de facto standard in many others. The

LONMARK Interoperability Association, with almost 200 member companies, has active task groups defining detailed application interoperability standards for all segments of the building controls industry as well as many other industries. As a result it can be stated with high confidence that far more manufacturers will be producing a far larger variety of control products in far higher volumes at far lower prices with far better support tools than will ever be the case for BACnet.

The LONWORKS control networks platform is optimized for use with sensors, actuators, and controllers that must communicate in a control environment. The protocol can be implemented through a single, inexpensive chip or other standard microprocessors to which the open LonTalk protocol has been ported. The platform's ability to use multiple, low-cost media delivers a very cost-effective solution in almost any environment. In addition, the inherent scalability of the platform allows applications to utilize thousands of nodes in multiple domains without the need for any central 'supervisory' control node. It's time to quit bowing to the proprietary powers that be and go open. WIDE OPEN!