

LonWorks and PC/104: A winning combination

By Tracy Markie and Jodiane Jones

The vision that launched LonWorks was to develop a control network capable of serving a wide variety of industries, based on a "universal" technology that would not require adaptation for specific applications. For this reason, LonWorks was designed to meet the technical requirements of lower-level sensor/actuator, mid-level device, and higher-level control/fieldbus applications (see Figure 1).

The majority of standard computing platforms and the most widely used operating systems support LonWorks, including Windows NT, Windows, DOS and VxWorks. By integrating hardware and software with a communications protocol, LonWorks offers a total control network solution dedicated to performing both communication and application tasks.

The Neuron chip advantage

Introduced in 1991, the LonWorks control-networking platform was originally developed by Echelon Corporation and is now supported by Motorola and Toshiba. Neuron chips manufactured by both companies form the heart of most LonWorks nodes (real-world devices). As a semi-dedicated family of microcontrollers, Neurons have programmable I/O lines and memory interfaces and are capable of performing the same functions as a microcontroller. The key difference,

however, is that Neuron chips are also able to communicate with each other via the LonTalk protocol and an external transceiver, allowing the creation of networks with up to 32,000 intelligent devices (see Figure 2).

The transceiver stage of a LonWorks node is decoupled from the controller, which is a separate device. This allows LonWorks networks to be constructed using transceivers that support a variety of transmission media including:

- standard twisted pair wire
- power lines
- coax cable
- RF channels

In addition, all standard network topologies are also supported:

- buses
- stars
- rings
- combinations of the above

Fast, efficient protocol

The LonTalk protocol follows the seven-layer OSI model, each layer optimized for control network applications. Recently released to the public, the LonTalk protocol uses a common message-based communications scheme that can be ported to any processor. The protocol features high throughput with up to 1,000 packets per second, while

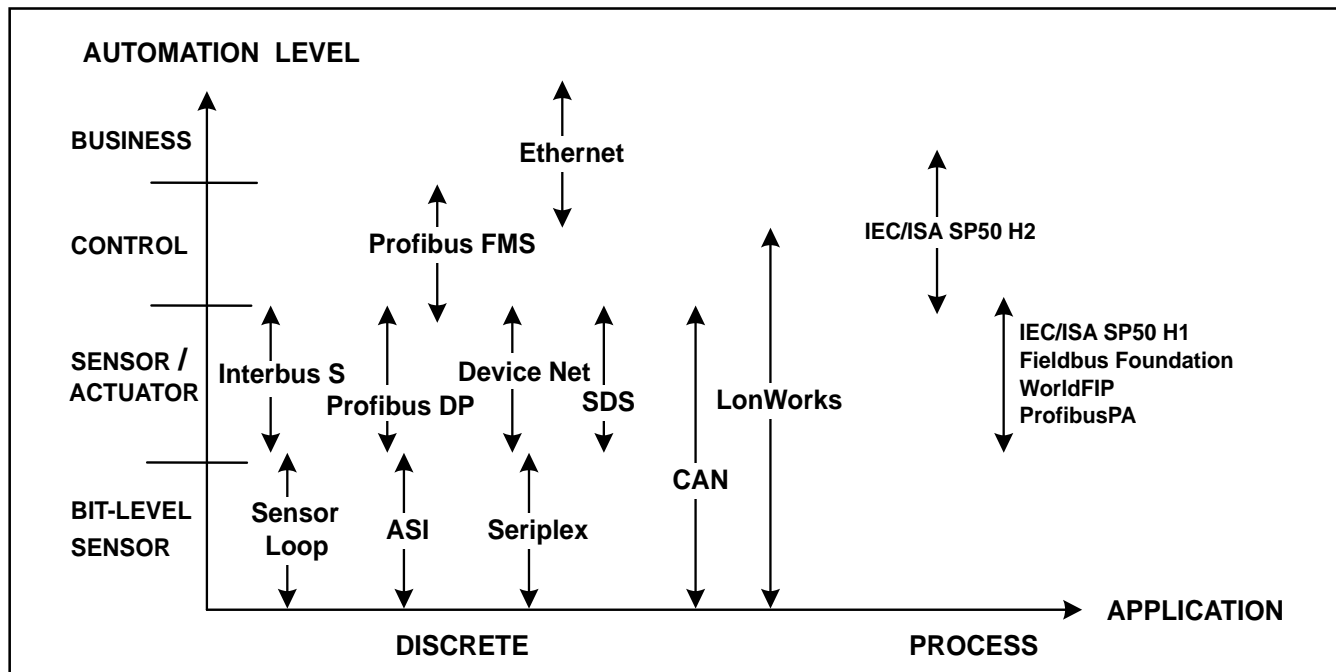


Figure 1

LonWorks and PC/104

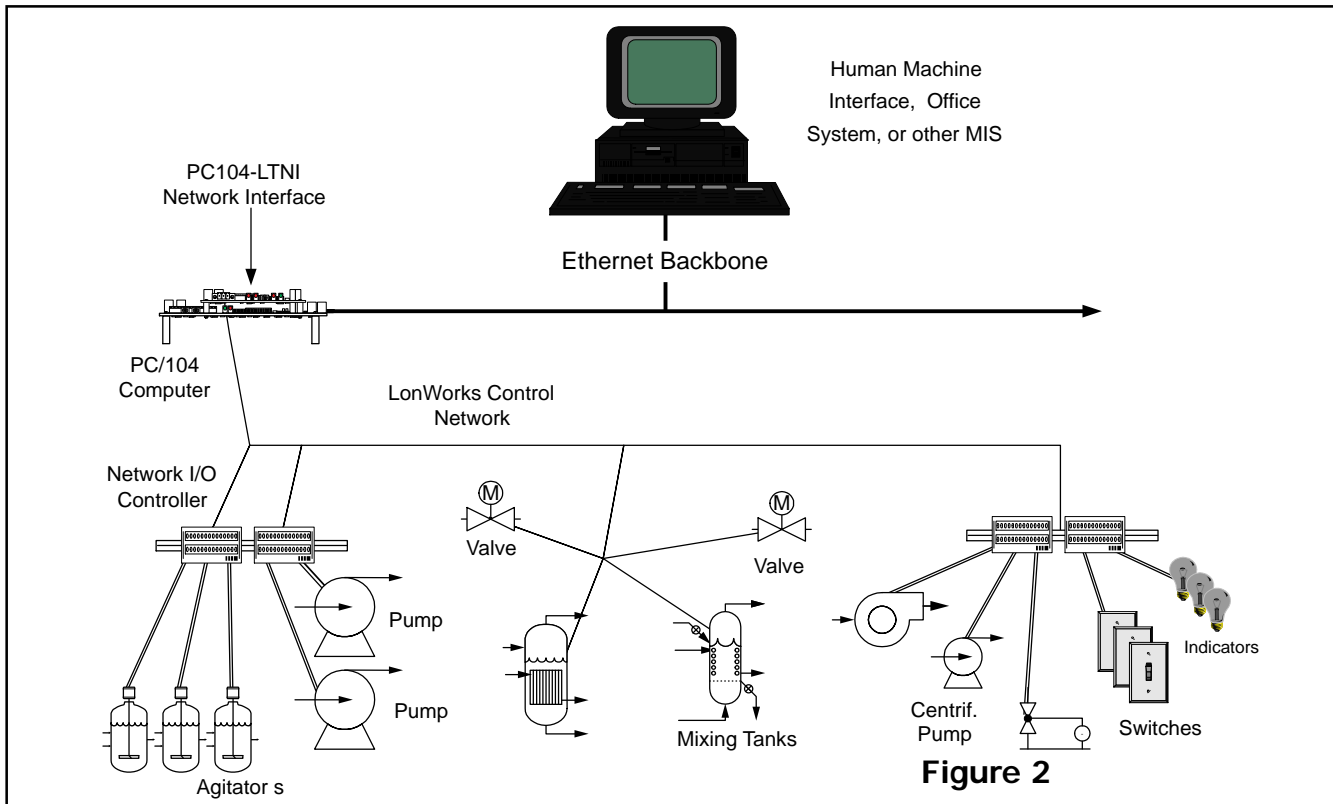


Figure 2

it maintains an immunity to overloads through predictive media access.

Other attributes of the protocol include:

- 16-bit CRC
- error detection
- large address space
- automatically configured routers
- configurable retry counters and timers
- deterministic performance through optional priority
- fast response time through optional authentication

LonWorks meets PC/104

The synergy between LonWorks technology and the PC/104 platform brings benefits to the embedded market that were not previously realized. Serving as one of the many examples of this union, Engenuity Systems' PC/104 to LonTalk Network Interface (Figure 3) has been used to

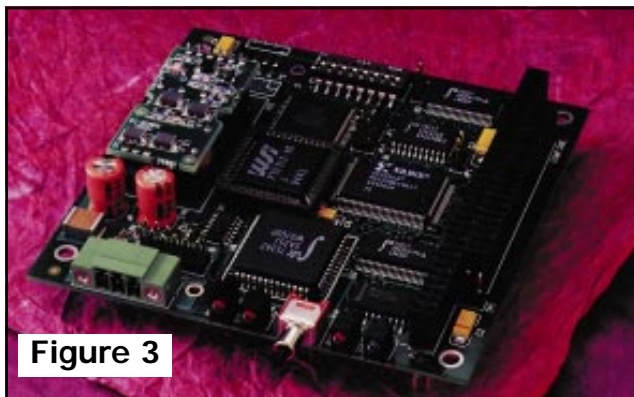


Figure 3

implement embedded control solutions for such diverse applications as:

- machine control
- HVAC
- farm irrigation
- traffic management
- petroleum field valve automation

The reasons behind the decision to combine LonWorks with PC/104 are as varied as the applications, but a few common themes emerge:

- the compact form factor, rugged construction, and low cost of PC/104
- an architecture that provides PC/software compatibility
- the ability to run real-time operating systems

The attributes of LonWorks provide even more advantages for embedded applications in need of compact, distributed control:

- reduced wiring
- scalability
- ability to control items at distances of up to 2000 meters

However, an application does not have to be spread over long distances for a user to realize the benefits of PC/104 and LonWorks. KLA-Tencor, a manufacturer of semiconductor equipment, provides a good example of an application where devices are located just a few meters apart. By integrating the PC/104 and LonWorks combination as part of its machine control system, KLA-Tencor has realized reductions in:

- wiring
- maintenance
- installation time
- hardware costs

Benefits that are less direct but no less important include:

- enhanced diagnostic capabilities
- reconfigurability of the system
- reduction in the inventory parts necessary to support a machine

Figure 4 illustrates the dynamics of a conventional PC/104 control system, while Figure 5 provides a contrasting view of the LonWorks PC/104 control network.

Standardization efforts

Considering the number of control networks currently on the market, it is unlikely that users will ever see an agreed-upon “Universal” standard. From this point, it would take years for a true defacto standard to emerge – if at all. However, LonWorks has been adopted by many industry standards organizations as the accepted standard *for their market*.

The following represents a partial but impressive list from a cross-section of major industries:

- SEMI (Semiconductor Equipment Material International) recently selected the LonWorks protocol as one of the sensor bus standards for semiconductor manufacturing. In fact, LonWorks networks are already installed in over half the semiconductor manufacturing plants around the world.
- The American Society of Heating, Air Conditioning and Refrigeration Engineers (ASHRAE) and the American National Standards Institute (ANSI) included part of the LonWorks protocol in the BACNet standard. LonWorks is also being written into the European CEN TC247 standard

for building control, and the LonTalk protocol is part of the specification for sensor actuator networks.

- LonWorks has been selected as the forecourt communication standard by the International Forecourt Standards Forum (IFSF), a consortium of multinational oil companies. European forecourts (gas stations) rely on LonWorks networks to control pumps, tank gauges, electric signage, car washes, payment terminals, lighting, security, refrigeration, and other building services.
- Within the transportation industry, the Association of American Railroads has chosen LonWorks network technology as the solution for converting over one million rail cars to electronically controlled pneumatic braking systems.
- The AGATE Industry Consortium, managed by NASA, has selected the LonWorks protocol as part of the standards for next-generation civilian aircraft.
- The Electronic Industries Association (EIA) and the Integrated Home Systems (HIS) technical committee has approved a new-home networking standard, EIA 709, based on LonWorks network technology.

Governing organizations

Today, more than five million LonWorks devices are installed worldwide, meeting a wide spectrum of application requirements. Adding to the momentum, over 3,500 vendors now provide off-the-shelf products and services to numerous industries. In order to unite and promote the growing number of users and vendors of LonWorks products, two independent organizations have been formed: LonMark and LonUsers International.

Founded in August of 1994 by 36 companies, the LonMark organization currently has over 200 members who provide three basic functions:

- define design guidelines that enable OEMs to build interoperable products based on LonWorks technology

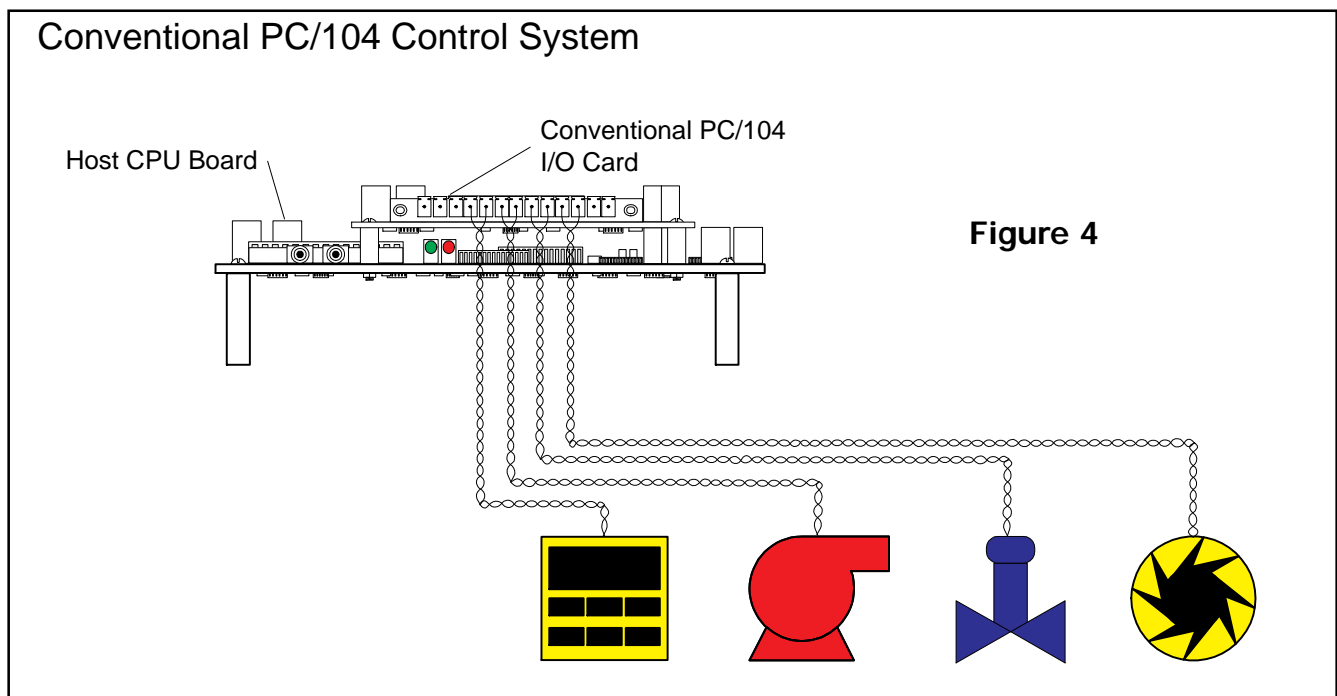


Figure 4

LonWorks PC/104 Control Network

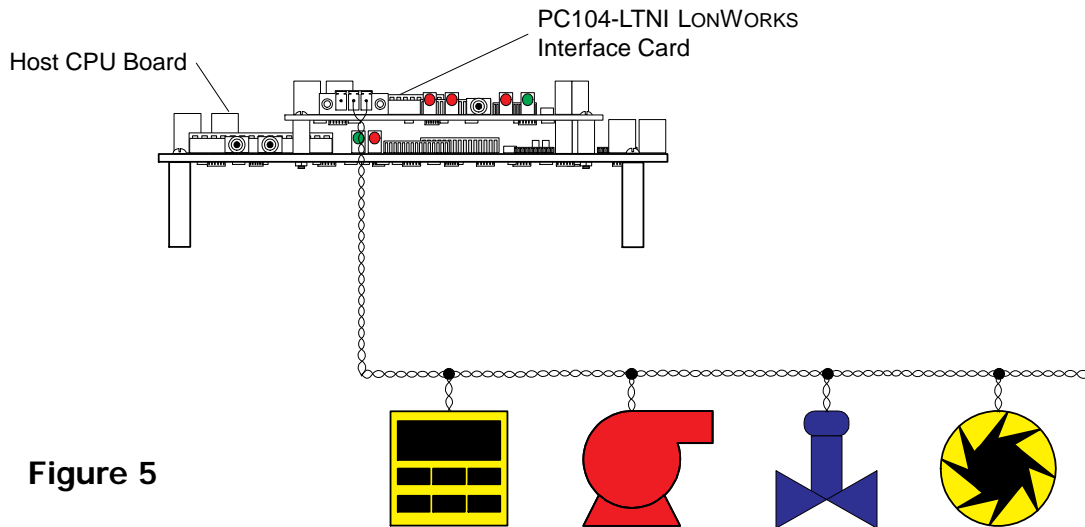


Figure 5

- certify products that meet the LonMark standards
- promote the user of LonMark-certified products in open, interoperable control systems

The second major association, LonUsers International, refers to the conference and exhibition held annually for users and vendors of LonWorks products. The United States conference is held in the spring, and the European conference is held in the fall. Small users groups are also active in Japan, France, Germany, Italy, the Netherlands, Scandinavia and the United Kingdom. These localized groups meet regularly to discuss the latest technological developments and applications for LonWorks products.

Summary

More and more system designers and integrators are looking at the PC/104 and LonWorks union for their control network solution. This synergistic combination provides a dependable control network dedicated to performing both communication and application tasks, along with the benefits of a compact, yet rugged form factor for PC compatible or real-time applications. With many industries adopting LonWorks as an industry standard, and many users preferring to use PC/104 versus other more expensive and less flexible form factors, the growing availability of products and services for both technologies makes this combination an increasingly popular choice for real-world solutions with proven performance.Ω

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Engenuity Systems website: www.engenuity.com
 LonMarks website: www.lonmark.org
 LonUsers International: www.echelon/lonusers

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