

Ethernet Adoption Encourages Open Protocols

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Engineers and system designers can exchange information around the world using instant messaging, Web browsers, and e-mail protocols based on Ethernet. The impact on our daily jobs is part of a larger trend described in the book *The World Is Flat* by Thomas Friedman. Friedman describes how broad Ethernet adoption, combined with open protocols and widely adopted platforms such as the World Wide Web, causes a dramatic shift in the global economy. In his words, the global economy is becoming “flat.” In addition to delivering data in the global economy, Ethernet is well suited for distributed test and industrial automation systems. New Ethernet standards have increased bandwidth from 10 Mb/s in 1983 to 1 Gb/s in 1998. It will take several years for the new 10GBASE-T standard (2006) to reach comparable price points with the currently deployed 1GBASE-T and 100BASE-T standards. With Ethernet, as well as PCI Express and USB, industrial automation and test systems can operate with higher performance at lower costs.

Improving Ethernet Predictability

However, one of the challenges of using Ethernet in industrial automation and test and measurement applications is the relatively high jitter of Ethernet transfers, which limits event synchronization with standard Ethernet to about 10 ms. This relatively low level of determinism is not acceptable for most test and industrial applications.

	PXI Backplane	PXI Multichassis	IEEE 1588	NTP on IP
Skew	-0.002 ns	-0.5 ns	-100 ns	-3x10 ⁶ ns
Distance	-0.5 m	<200 m	<400 m	Worldwide
Sample rates	100s of MHz	100s of MHz	<100 KHz	<10 Hz
Async trigger	✓	✓	-	-
Physical connection	Backplane	Coaxial cable	CAT 5 Ethernet	Ethernet, etc.
Topology	User-defined	User-defined	Autoresolve, master/slave	Peer-to-peer

One way of addressing this is the IEEE 1588 precision time protocol (PTP), introduced in 2002, which provides a global common clock domain for all IEEE 1588 nodes on the network. IEEE 1588 time stamps data and synchronizes local clocks with submicrosecond skew. The final synchronization skew between the local clocks depends on several factors, including the resolution and accuracy of the clocks in each node, IEEE 1588 synchronization rate, and network topology. The National Instruments PCI-1588 PTP interface synchronizes distributed IEEE 1588 devices. Table 1 illustrates the range of synchronization alternatives available by comparing synchronization using a PXI backplane, PXI multichassis, IEEE 1588 over Ethernet, and network time protocol (NTP) on IP.

Typically, as the distance between nodes increases so does the clock skew. Technologies such as IEEE 1588 reduce the effect of Ethernet transfer jitter on skew.

Test and Measurement — Ethernet Distributes PC Core

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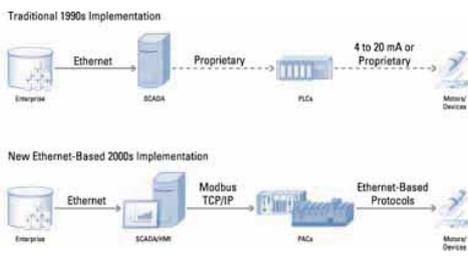
Ethernet has been used to distribute test and measurement systems since the advent of PC-based instruments in the mid-1980s. This was followed by traditional boxed instruments and GPIB-to-Ethernet converters in the early 1990s. In 1995 National Instruments, as part of the VXIbus Consortium, developed the TCP/IP Instrument Protocol Specification, more commonly known as VXI-11. It adapts the IEEE 488 GPIB standard to Ethernet in much the same way as USB-TMC does for USB.

In test and measurement applications, engineers can use Ethernet to distribute traditional boxed, PC-based, or PXI-based instruments. Typically, these systems are used to measure large devices (for example, airplane wings) or geographically distributed systems (for example, regional power grids or cyclotrons).

In 2005, a new Ethernet-based standard, LAN Extensions for Instrumentation (LXI), was introduced with the goal of increasing interoperability. It uses many other standards including VXI-11, IEEE 1588, and HTTP. LXI also has defined how to build hybrid multiplatform systems that include PXI, LAN, USB, and GPIB instruments so engineers can optimize price and performance across platforms.

Industrial Automation - Rapid Ethernet Adoption Continues

In industrial applications, engineers benefit by taking advantage of a low-cost Ethernet networking infrastructure. Industrial switches bring Ethernet to plant and factory floors by extending the temperature range and adding industrial features such as quality of service (QoS) and multicast broadcast storm protection.



Historically, Ethernet networks have shared data between SCADA systems and enterprise databases; however, over the last five years, Ethernet has penetrated further into the plant as shown in Figure 1. Today, engineers use Ethernet with Modbus TCP/IP for communication between SCADA/HMI systems, programmable logic controllers (PLCs), and programmable automation controllers (PACs). Modbus TCP/IP provides open, multivendor connectivity from HMI displays to traditional PLCs. According to the ARC Advisory Group, Modbus TCP/IP was the leading industrial bus for devices shipped in 2004.

In recent years, more protocols are adopting Ethernet to take advantage of the lower costs and installed infrastructure. New Ethernet-based protocols such as NI Deterministic Ethernet, EtherCAT, Ethernet/IP, PROFINET, and others are emerging.

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For more information, visit the URL listed at the bottom of this article to read a white paper on “Understanding Ethernet-Based Industrial Automation Protocols.”

Ethernet Flattens Test and Industrial Automation

As globalization is flattening the way people communicate and businesses operate, Ethernet adoption is flattening test and measurement by reducing the synchronizing skew of distributed measurements over longer distances. Ethernet is flattening industrial automation by offering open, lower-cost communication alternatives. With open platforms that embrace Ethernet and other PC-based technologies such as USB and PCI Express, engineers can develop distributed multivendor systems that meet the most challenging measurement and automation application needs.

For more information on IEEE 1588, instrument control, Ethernet expansion I/O, time-triggered networks, and industrial automation protocols, visit ni.com/info [1] and enter nsi7108.

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