LXI – the new LAN standard for networking T&M equipment

The LXI standard is based on Ethernet, the widely used communications standard for LANs. This is just one of the reasons why LXI is widely supported by leading manufacturers of T&M equipment.

LXI – the successor of GPIB

The LAN eXtensions for Instrumentation (LXI) standard for controlling T&M equipment and test systems combines the advantages of rack&stack instruments, offering GPIB interfaces and powerful firmware functions, with the benefits of modular, compact VXI/PXI systems (see box on next page). LXI, which is based on the Ethernet standard, defines a uniform, interoperable LAN implementation, allowing T&M instruments to be easily integrated into modular test systems. As the LAN standard is backward compatible with previous versions, it protects existing investments.

Ethernet has a long tradition: At about the same time that the GPIB interface was introduced, Ethernet was developed and also standardized (IEEE 802.3). Unlike the GPIB interface, whose transfer rate is limited due to technological reasons, Ethernet technology could be continuously accelerated. Initially providing a meager 3 Mbit/s, 100BaseT and Gigabit LANs are now state of the art – with further enhancements in the pipeline.

The spreading use of the Internet further advanced Ethernet; today, every PC is equipped with a LAN interface as standard. Moreover, the new wireless technologies enhance the LAN capabilities by additional applications.

These are ample reasons for leading manufacturers of T&M equipment to support the new LXI standard. Web servers are integrated in LXI devices, allowing interface and instrument settings to be made simply via a web browser. The programming interfaces for the test software are IVI-C or IVI-COM drivers (IVI stands for interchangeable virtual instrumentation). In addition, the precision timing protocol (PTP) of the IEEE 1588 standard for synchronizing clocks in

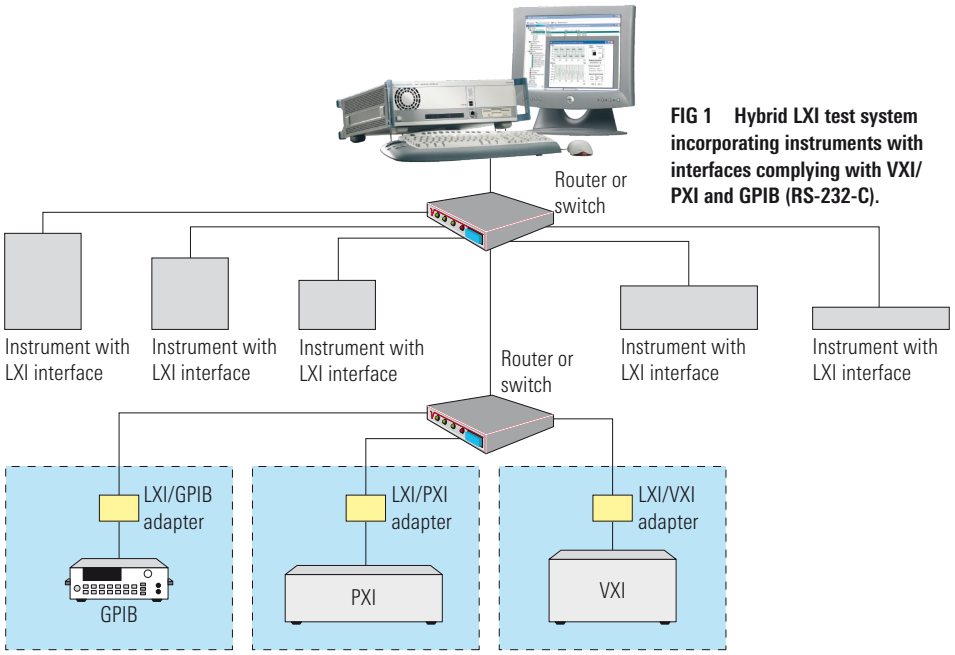


FIG 1 Hybrid LXI test system incorporating instruments with interfaces complying with VXI/PXI and GPIB (RS-232-C).

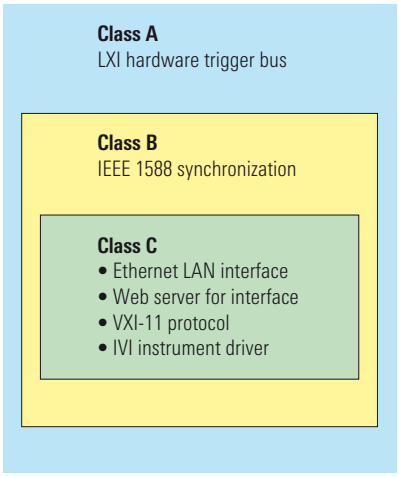


FIG 2 The functionality of the three classes of LXI instruments.

LAN nodes as well as an eight-channel hardware trigger interface are earmarked for LXI to further expand trigger and synchronization functions. Another future capability is the configuration of hybrid test systems, which will integrate VXI/PXI systems and conventional GPIB instruments via LXI adapters (FIG 1).

Three classes of LXI instruments

LXI-compliant instruments or modules are divided into three classes, A, B and C, with the functionality of the classes hierarchically based one upon the other (FIG 2). All instruments of these three classes can be integrated in a test system and combined with each other according to the requirements and application at hand.

Class C

LXI instruments complying with class C are characterized by a common LAN implementation. This includes the capability of automatically detecting LXI instruments in a LAN via the Discovery protocol in accordance with VXI-11. Other definitions and functions such as LAN configuration initialize (LCI) – which resets the LAN configuration – make it easy to integrate these LXI instruments in a LAN-based test system. Owing to a uniform interface, the instruments can be configured via a web browser.

Class C instruments are programmed by means of IVI drivers (APIs), which were standardized by the IVI Foundation. The architecture of these drivers and their interoperability are important prerequisites for system integration.

Class B

Class B compliant instruments are additionally equipped with synchronization

GPIB – reliable for 30 years

The GPIB interface has been the standard for controlling T&M equipment in automatic test systems for more than 30 years. It has proved to be a reliable and flexible tool in a wide variety of implementations and systems. The GPIB interface was steadily improved during this time to make the integration of test systems faster and less expensive: The standard was enhanced by standardizing the programming commands (SCPI). Moreover, based on this standardization, a uniform driver architecture was implemented and the APIs for the instrument classes (IVI drivers) defined.

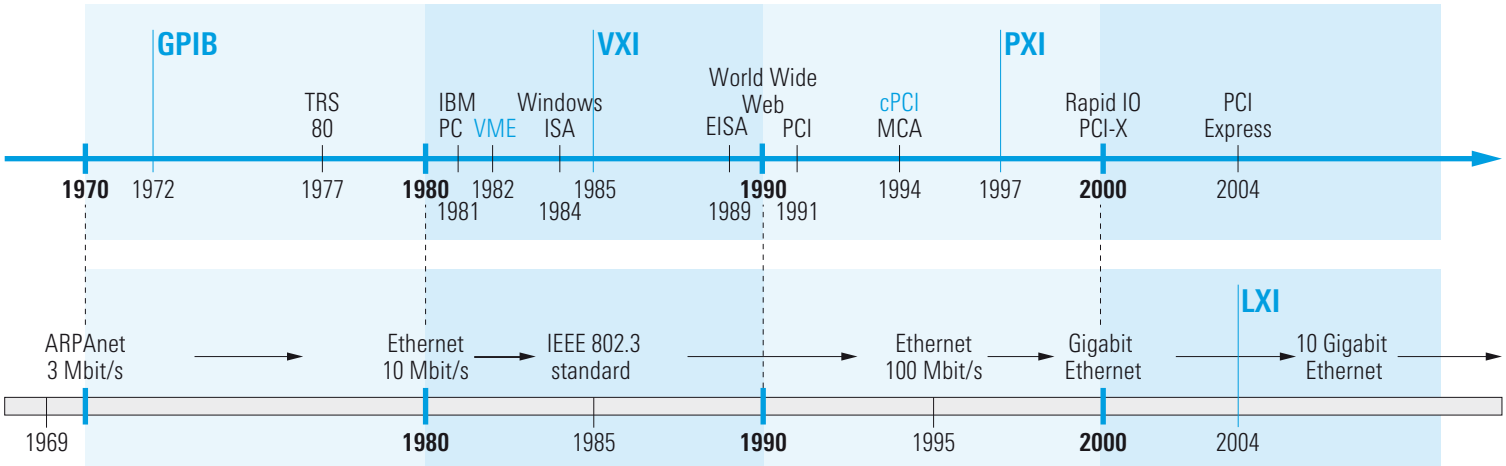
Today, the GPIB interface is increasingly faced with its limitations – first, it was never able to establish itself as a standard PC interface (and must therefore be retrofitted); second, the transfer rate, being limited to maximally 1 Mbyte/s for technological reasons, is very narrow.

Widely used: VXI and PXI

Parallel to the conventional rack&stack instruments with GPIB interface, compact systems based on card bus technology were developed, particularly for military and aerospace test systems (VME and PCI bus). This solution was continuously enhanced and established itself as standard (VXI and subsequently PXI). These modular T&M instruments and systems with plug-in cards are used in a wide range of test applications that require high data throughput and compact dimensions. However, a drawback of the VXI and PXI systems is the module chassis required for accommodating the plug-in cards as well as the slot 0 controller for controlling the modules.

FIG 3 shows the development of the different systems and standards over the years.

FIG 3 The evolution of GPIB, VXI and PXI compared with the Ethernet LAN technology.



mechanisms defined in the IEEE 1588 standard. Thus, high-precision time synchronization of better than 10 ns can be achieved in a 100BaseT LAN. This technique largely avoids the latency times typical of LAN and ensures precise timing, which is indispensable in T&M applications.

Class B is based on common timer events tied to absolute times, which consequently allow very precise synchronization of test system sequences. Data that is to be transferred via LAN can be marked with the exact detection time by means of time stamps. Thus, the recorded data can also be correlated from different sources in distributed systems. Especially the capability to exactly trigger and synchronize widely distributed systems via the precision timing protocol of the IEEE 1588 standard opens up completely new applications.

Class A

In addition to the functions of the other two instrument classes, LXI instruments in accordance with class A are equipped with an eight-channel hardware trigger interface (LVDS interface), whose type of connector, pin assignment and electrical characteristics are defined in the LXI standard. Via this interface, instruments can be connected either in a daisy chain or star configuration (FIG 4). Trigger cable lengths of up to 20 m are thus feasible. The trigger channels can be configured individually as input or output channels; plus, they offer a wired-or function.

The LXI Consortium

The LXI Consortium was founded in September 2004 with the objective to define an open, LAN-based standard for test systems. Today, the LXI Consortium has more than 40 members, including the most renowned manufacturers of T&M equipment, numerous system integrators and end customers. Rohde&Schwarz has been a strategic member since November 2004 and is represented, together with eight other companies, on the Consortium's Board of Directors (www.lxistandard.org).

Instruments of classes A and B can generate and receive software triggers via LAN messages (UDP and TCP/IP messages) – as currently done in test systems as well. Thus, LXI instruments can communicate with each other without involving the controller (peer to peer). The different trigger and synchronization capabilities in LXI can be configured via the controller by means of an enhanced IVI interface (LXI Sync).

The world's first LXI-validated spectrum analyzers

The LXI Consortium has already confirmed the compliance of the first instruments with the standard: In February 2006, the R&S®FSL, R&S®FSP, R&S®FSU and R&S®FSQ families from Rohde&Schwarz were the world's first spectrum analyzers to be officially certified as compliant with LXI class C. They may now carry the LXI logo.

As a strategic member of the LXI Consortium, Rohde&Schwarz promotes the development of the standard: In April 2006, the first Plug Fest outside the USA was held at the company's headquarters in Munich – with more than 65 representatives from instrument manufacturers, system integrators, customers and the press participating. During this meeting, the R&S®SMU 200 A and R&S®SMATE 200 A vector signal generators were also tested and certified to be LXI-compliant.

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FIG 4 Class A instruments are equipped with an LXI hardware trigger interface and can be connected in a daisy chain or star configuration.