

The Benefits of Using LAN eXtensions for Instrumentation (LXI) in Automotive Functional Test

White Paper

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Today's automotive industry is highly competitive. There is intense pressure on electronics manufacturers to boost quality while lowering costs. Activities such as electrical functional test are often viewed as necessary evils that must provide a high return on investment (ROI). LXI can help maximize performance, minimize cost and extend capital investments into the future. This article will explore the benefits associated with using LXI in Automotive Functional test.

Ease of use

Automotive electronics manufacturers must bring new products to market quickly. Instruments need to be connected quickly. Systems need to be up and running as soon as possible. LXI solves four key problems developers would typically face:

1. **I/O interface** – Rather than an MXI (Multisystem eXtention Interface) or GPIB (General Purpose Interface Bus) interface, LXI uses Ethernet, as shown in Figure 1. Ethernet eliminates the need to install an additional interface card in the PC (personal computer). There are no proprietary cables or software.

2. **PC configuration** – PXI (Pci eXtension for Instrumentation) card cage is an extension of PC backplane, the whole system must be rebooted every time a card is inserted or removed. With LXI, PC's do not require rebooting when connecting or disconnecting instruments. Some modular LXI instruments allow for "hot-docking" of cards while the power is on.

3. **Drivers** – PXI systems requires test engineers to download and install device drivers. The LXI standard specifies the user of IVI-COM (Interchangeable Virtual Instrument – Component Object Model) drivers, making it easier to work in a variety of development environments. Some LXI instruments can be programmed directly through Standard Commands for Programmable Instruments (SCPI) when greater functionality of performance is required.

4. **Internet interface yielding rapid software development** – Diagnosing problems in PXI and VXI devices can be difficult with no front panel interface. Bench top LXI instruments have a front panel interface making it easy for developers to experiment with an instrument. The built-in internet interface in most modular LXI instruments make it possible to learn and control the instrument by simply opening an internet browser on the connected PC. The browser function makes it easier to see what is happening with the equipment, simplifying system support and ensuring greater uptime.

Figure 1. LXI Interface I/O Configuration

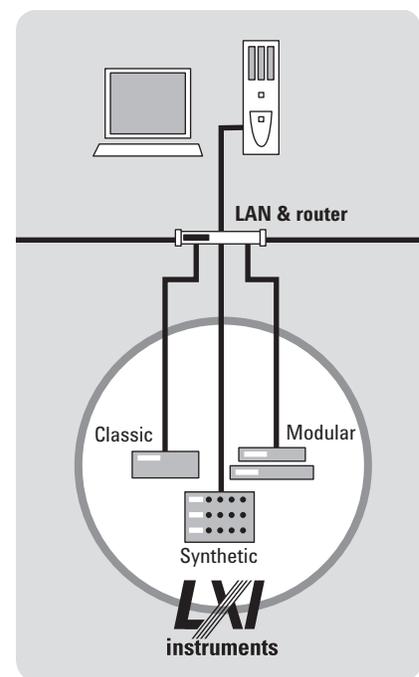
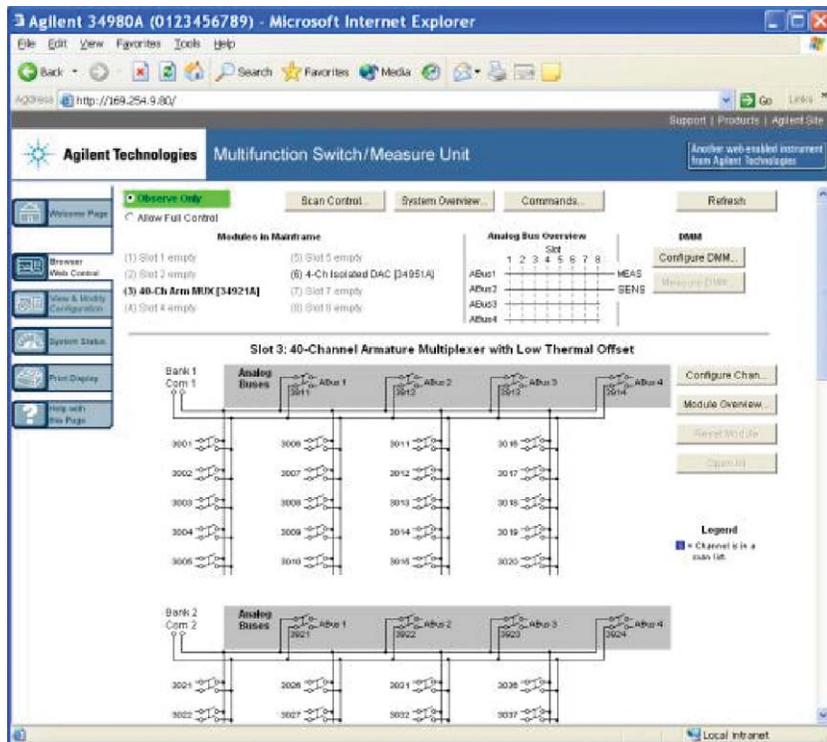


Figure 2. Example of Internet Interface



Performance

Automotive electronics testing includes complex power train control modules requiring hundreds of tests to very simple sensor modules and data intensive telematic and infotainment modules that may involve time-consuming transfers

of huge data files, etc. These tests can challenge GPIB's maximum data rate of roughly 1 megabytes-per-second and local area network (LAN) I/O transfer speed is becoming a non-issue with 1 gigabyte-per-second connections becoming commonplace and 10 gigabytes-per-second on the way.

Cost

Minimizing the overall cost of test requires fast, reliable testing at the lowest price possible. Often test system architectures bases on a mainframe to house multiple instruments have too much overhead to be cost competitive compared to individual test components. In many cases, an instrument-by-instrument price comparison will show up to 40 percent reductions in the cost of LXI versus PXI hardware. LXI instruments generally offer a choice between drivers or SCPI reducing the learning curve other platforms require.

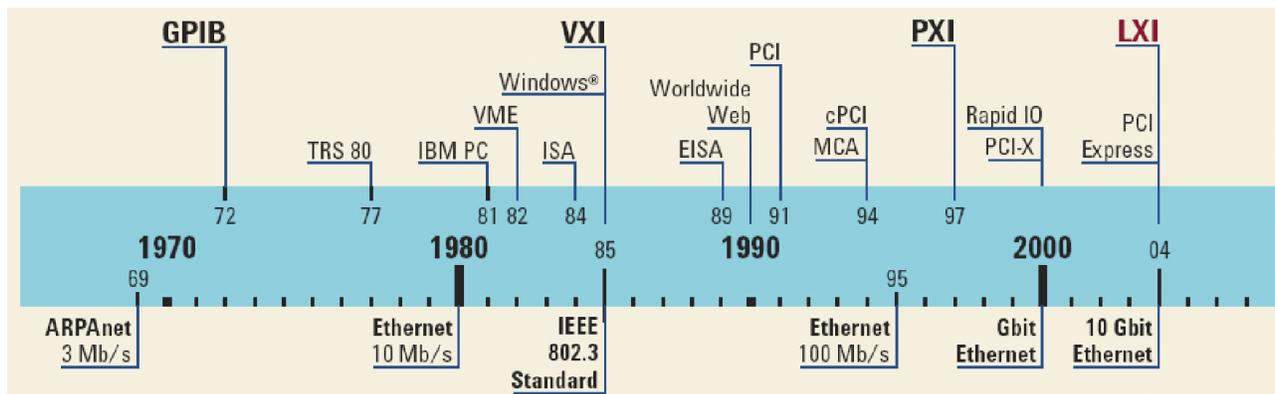
Scalability

In a card cage-based system, devices can quickly fill every slot. The addition of just one more device requires another card cage and computer interface. For systems requiring just a few cards, the card cage adds cost and consumes space. LXI instruments provide the desired functionality, making it easy to upgrade functionality without adding a card cage or computer interface.

Longevity

Over the past 30 years LAN performance has continuously improved while maintaining backward compatibility. Ethernet will continue as a dominant force in the computer industry for a long time to come. Figure 3 shows a pictorial view of the technology timeline.

Figure 3. Historic industry view



Flexibility

The use of LAN makes it possible to place the LXI-based subsystem farther from the host PC and closer to the unit under test as shown in Figure 4. This can be beneficial in two ways. First, the instruments can be physically located in critical areas if needed and second, control of the instrument can be achieved thousands of miles away and monitored by many at the same time. In the automotive electronics business, test systems and test plan development are often done on different continents than where the actual manufacturing occurs. Remote control, due to LXI's flexible use of the WEB, allows connectivity to be achieved around the world providing almost instant feedback to anyone allowed on the network to control and observe instruments that are physically far away. In many cases remote debugging can significantly reduce manufacturing down time saving productivity efficiency and potential late delivery penalties.

Rack space

An LXI-based functional test system could be assembled in a rack as small as 750 mm tall. Not being bound to a card cage offer four key advantages addressed by LXI:

1. No card size constraints
2. Self-contained shielding per instrument
3. Cooling that is optimized as needed
4. Only enough power for the job

Distributed systems

Card cage-based solutions limit the optimal instrumentation placement in a test rack. Certain applications for durability test systems, research and development test systems, or production test systems can have LXI instruments placed where the measurement needs to be made. The ability to put the stimulus and measurement instruments where they are needed — with minimal or no cabling back to the core of the system — is a feature unique to LXI.

IEEE synchronization

One second of test time per module may be worth thousands of dollars. LXI provides a new way to improve test execution time: self-triggered measurements based on a precise real-time clock are synchronized from instrument to instrument, as represented in Figure 5.

Figure 4. LXI-based subsystem

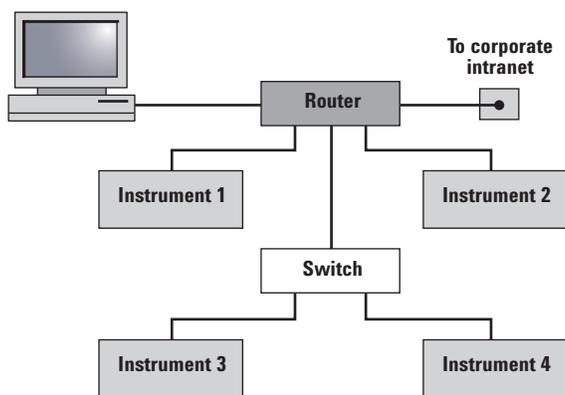
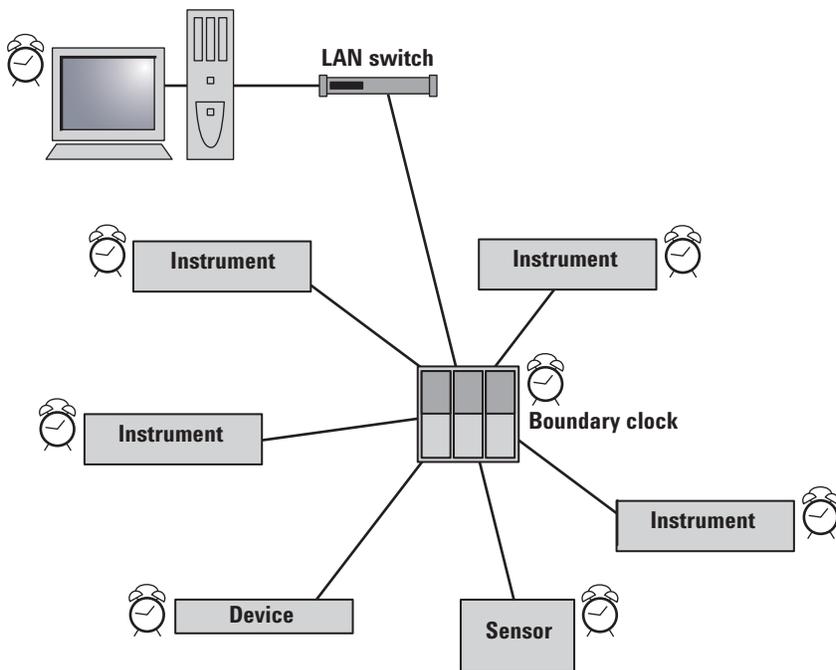


Figure 5. Instrument to instrument real-time clock synchronization pictorial



System integration considerations using LAN

Using Ethernet in your automotive test systems can introduce some risks. Using a LAN to control or monitor your tests can open the door to inadvertent or malicious threats to your test system. These risks can be handled effectively with the right system architecture. The best strategy is to create a protected, private LAN for the test system. Of course, if your system controller is connected to the corporate LAN or the Internet, it is vulnerable just as any computer is. The usual and necessary precautions that guard your corporate PCs should be employed to protect your test system controller.

There are other risks that could cause inadvertent system configuration changes within the isolated network of the system. Configuring the test instruments for dynamic rather than static IP addresses may cause unexpected operation. For example, if DHCP (Dynamic Host Control Protocol) is active the IP addresses of two power supplies could be reversed when the system is powered, the device under test (DUT) could receive the wrong voltages at the wrong points and cause severe damage. There are two straightforward solutions to avoid these pitfalls.

1. Router-based solution

Employing an inexpensive LAN router, often under \$100, provides a buffer between the test system and the corporate intranet. A router is a standalone box with multiple LAN connectors. One connector is for the external or “public” network and others are for the internal or “private” network. A router links the two types of networks through high-level communication protocols such as TCP/IP (Transmission Control Protocol/Internet Protocol). Routers allow one- and two-way communication between devices.

This approach offers several advantages. It protects the test system from the potential hazards carried on the intranet or Internet. It prevents unwanted types of outside access by limiting communication to only those devices that reside within the private LAN. It shields the system from intranet congestion by isolating all but local traffic. The router does all this while giving the PC controller unhindered access to the system and the “public” network.

2. PC-based solution

A PC-based solution can be accomplished by adding a second LAN card to the system controller and activating ICS (Internet Connection Sharing) in Windows® XP. This allows the PC to serve as the router in the network. ICS routes traffic from one LAN card to the other and provides NAT (Network Address Translation) capabilities for the private network addresses.

This method has advantages in common with the router-based solution. If the host PC is configured to use DHCP rather than a static IP address then it will have to rely on the corporate intranet being functional and able to provide an IP address. This approach requires the system designer to be comfortable with configuring the network settings of the PC.

Of the two solutions described above, the router-based system is more flexible and easier to set up and maintain. It is also important to note that for integrated systems DHCP should be disabled in the instruments of the system. When instruments are used on the bench top it may be desirable to have DHCP enabled for easy set up and configuration. However in a system the instruments should have static IP addresses to avoid system resources from getting reassigned.

Migrating existing automotive functional test systems to LXI

Unlike consumer electronics, automotive electronics must be supportable for 10, 15, or more years. It is important that automotive functional test systems be viable and supportable much longer than systems for other applications. As mentioned previously, LXI provides longevity and addresses this need of automotive functional test systems.

The transition to LXI does not require revolutionary changes to your testing strategy or your systems. The migration of existing system designs can take place in evolutionary steps. LXI-based systems start with a PC with a built-in LAN port. There are no physical modifications necessary to the system controller PC other than adding a LAN port for the system LAN if it does not already have one. A device such as the Agilent E5810A LAN/GPIB gateway makes it easy to include older, GPIB-only instruments in LAN-based test systems. It is a straightforward migration of your systems from GPIB to a LAN backbone. This approach makes your current investments in instruments and applications forward compatible to LXI. For more information about using hybrid instrument protocols from GPIB to VXI, PXI, and LXI, see Agilent’s application notes “AN1465-65 Migrating System Software from GPIB to LAN/LXI”, and “AN1465-26 Modifying a GPIB System to Include LAN/LXI A Step-by-Step Example”

Conclusion

LXI is built for the long haul and is well-suited to automotive electronics test.

As discussed herein, its main benefits are in cost, scalability and ease-of-use. LXI offers advantages in performance, longevity, flexibility, synchronization and rack space. With the right architecture and implementation of simple steps, any risks associated with using Ethernet can be minimized or eliminated.

References

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3. Agilent application note *Migrating System Software from GPIB to LAN/LXI*, AN1465-65, available at www.agilent.com
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LXI is the LAN-based successor to GPIB, providing faster, more efficient connectivity. Agilent is a founding member of the LXI consortium.

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