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VXI-11 vs LXI

INTRODUCTION

VXI-11 is the Roddy Dangerfield of the instrumentation specifications. Few engineers have heard of it or know what the VXI-11 Specification is or does.

On the other hand, most engineers have heard about LXI as the 'standard' for Ethernet Instrumentation but what is its real capabilities and limitations? Is it a universal standard?

The purpose of this Application Note is to describe the two specifications and show how they fit in with today's instrumentation systems.

COMMON CONCEPTS

Both the LXI and VXI-11 Specifications describe a LAN oriented test system where instruments are interconnected with an TCP/IP IEEE 802.3 network system. The goal is to produce an economical test system that does not need any special Controllers or bulky cables and has the speed and data transfer capabilities needed for a modern test system.

THE VXI-11 SPECIFICATION

The VXI-11 Specification[1] was created in the early 1990s by the VXIbus Consortium as part of a suite of instrument specifications that defined the then new VXI Instrument concept. VXI-11 defines a network instrument protocol to be used for controller - device communication over a TCP/IP network. The communications and programming paradigms supported by the VXI-11 specification are similar in nature to the techniques supported by the IEEE 488.2 Standard. The protocol described allows ASCII-based communications to take place between a controller and a device over a computer network. From a user's perspective, this is very much like controlling a standard GPIB/IEEE-488.2 instrument.

The VXI Specification has three sub-specifications:

VXI-11.1 is for VXIbus Slot 0 Controllers. This specification was apparently never used.

VXI-11.2 is for Ethernet to GPIB Gateways that control multiple GPIB Instruments. Examples are ICS's Model 8065 and Agilent's E5810A.

VXI-11.3 is for 488.2 Instruments with Ethernet interfaces. VXI-11.3 Instruments may also be LXI Instruments.

The VXI-11 Specification uses Open Network Computing (ONC) Remote Procedure Calls (RPC) on top of the Internet Protocol Suite. The use of ONC/RPC is for the specification of the protocol on the network only, and does not specify a particular application interface. The VXI-11 Specification provides a RPC library (RPCL) in the base document.

Most operating systems have an available rpcgen utility that converts RPCL into the appropriate files for that operating system so that a user can write a client or server application. Because of this RPCL conversion, VXI-11 devices are universally programmable and manufacturers of VXI-11 devices do not have to supply drivers tailored to each operating system, kernel or system build that their customers are using. This means that any instrument of device that complies with the VXI-11 Specification can be easily controlled from any UNIX, LINUX or UNIX-like operating system (SUN-OS, Apple OS-X, HP-UX, etc).

When the VXI-11 Specification was generated, the VXI Consortium also defined a higher-level API called the Virtual Instrument Software Architecture (VISA) that abstracts different instrument buses (GPIB, Serial, VXI) into a single unified API. National Instruments (NI) and Hewlet-Packard (HP), now Agilent, generated VISA libraries that are VXI-11 compliant. The original VISA libraries were written for Windows operating systems but have since been ported over to Apple's OS X, HP-UX and RedHat LINUX (kernels 2.4 and 2.6)[2]. Users who write programs that make VISA calls can control VXI-11 devices just as they would a GPIB device by changing the VISA resource definition.

The VXI-11 Specification only defines the communication protocol and the way that client applications will address the VXI-11 device. It does not dictate packaging or any other non-communication items.

THE LXI STANDARD

LXI stands for LAN eXtesions for Instrumentation and is supported by the LXI Consortium[3]. Their goal for the LXI Standard is to give users a common experience when using LXI instruments and to solve the timing issues with Ethernet-based test systems.

All LXI Instruments incorporate a Web server that makes it easy to link to the instrument with a Web browser, to configure its network settings and in some cases, do simple tasks like set a relay or take a reading.

All LXI instruments are programmable somehow. But it's not always clear what options you have and how to choose among them.

The LXI standard mandates that every LXI instrument must have an Interchangeable Virtual Instrument (IVI) driver. The IVI Foundation defines a standard driver application programming interface (API) for programmable instruments. Currently, there are two IVI driver formats: IVI-COM for working with COM-based development environments and IVI-C for working in traditional programming languages. IVI drivers are only certified for Windows.

LXI instrument manufacturers may supply other ways to program their instruments so it's not always mandatory to work with an IVI driver. This alternate programming capability varies from instrument to instrument.

Depending upon the instrument, you may be able to control it through VISA. Over Ethernet, VISA supports two different technologies for communications. One is the VXI-11 protocol which has become the de facto standard for all Ethernet-based instrumentation. It supports concepts familiar to users of GPIB such as the capability for instruments to request service and for computers to interrupt a measurement in progress. The LXI 1.0 and 1.1 standards require that LXI instruments implement basic VXI-11 capabilities for instrument identification. This may be changed in future versions of the LXI Standard per the LXI Consortium.

The other network protocol supported by VISA is a raw TCP/IP socket, which you can use with instruments that do not fully implement VXI-11. Some instrument designers forgo the complexities of VXI-11 and only implement a simple network port through which you can send commands and receive responses. This usually means that those instruments do not implement an asynchronous notification mechanism such as service requests.

On the physical side, the LXI Standard has tried to standardize the placement of the basic items on an instrument. The power switch is to be on the left-hand side of the instrument and the Power and LAN indicators are the first two LEDs. A LAN Reset button that resets the instrument's network settings to their default value it to be located on instrument's the rear panel.

The LXI Standard uses a minimal VXI-11 protocol to implement the discovery process. The first part of this requirement is creating the portmapper access for a broadcast packet to Port 111. The response to a broadcast command is either the port address or no response at all. The second part of the portmapper is supporting a standard RPC to a second port, typically Port 1024, to support the VXI-11 commands. The LXI instrument must respond to the *IDN? query with the standard IEEE-488.2 IDN string. This process only requires 5 VXI-11 commands and one IEEE-488.2 Common Command.

The LXI Standard provides for three classes of instruments:
Class C is for standard LXI Devices.
Class B is for LXI Devices that support the IEEE 1588 Precision Time Protocol. The IEEE 1588 interface allows devices to execute triggered functions equivalent to those available over GPIB with similar or better timing accuracy.
Class A is for LXI Devices that support IEEE 1588 operation and a wired trigger bus interface. The wired trigger bus provides a standardized capability of supporting trigger events between devices whose timing accuracy is limited by the physical limitations of cables and LXI Device hardware. The trigger functionality is broadly equivalent to the backplane triggers of modular instruments in card cages, though cable lengths may typically be longer than backplane trigger lengths.

If you want to take advantage of the advanced features of LXI Class A and B instruments, such as software synchronization over the LAN, you can work with a special API called IviLxiSync, which comes with each specific driver from each vendor. With IviLxiSync, you can configure an instrument to participate in IEEE 1588 time synchronization through a Web page and have the data automatically time stamped, or you also can set up LAN and Wired Trigger Bus triggers with SCPI commands. The purpose of the IviLxiSync API is to make that job easier. However, because each vendor supplies its own IviLxiSync API with its instrument drivers, you have to use a different library for each instrument.

Per articles in LXI Connexion[4], the use of the LXI instrument drivers varies widely. Some users are very happy to have pre written drop-in drivers they can use right away for system development without worrying how they are implemented. Other users want to look inside to see how the driver is implemented and to be able to adapt the driver to meet their needs. The availability of driver source code in a language they're familiar with can be problematic. In addition, some instrument vendors contract driver work to third parties, making it even more difficult to get good support. On the other hand, drivers that ship with source code native to their development environment are easily understandable by end users.

The result of the LXI Standard and the LXI Consortium's work is that LXI is widely recognized for Ethernet-based test systems but that the use of LXI instruments is limited by the omissions in the Standard. The LXI Standard does not specify a communication protocol - VXI-11 is only required for instrument discovery. This forces the user to having to use the supplied IVI drivers and to work in a Windows operating system. The Standard also does not specify that a LXI instrument must comply with the IEEE-488.2

Standard. This takes us back to the pre-1978 days of unknown instrument behavior.

While many LXI vendors are building LXI instruments so they conform to the IEEE-488.2 Standard and are providing alternate programming methods, there is no guarantee that this is so. It is up to the user to carefully review any prospective LXI instrument to see if it is IEEE-488.2 compliant and if it will work in his operating system.

SUMMARY

VXI-11 is a relatively unknown Ethernet communication specification that allows instruments to be used with virtually any operating system. It guarantees the user an IEEE-488.2 compliant instrument and GPIB like operation. The VXI-11 Specification does not address instrument timing, physical appearance or other physical parameters.

LXI has a reputation about it which makes users happy but underneath it lacks a communication protocol and a definition of an instrument's basic operation that guarantees easy use in a multitude of systems. The LXI Consortium has tackled the timing issue which can be a problem in Ethernet systems and has come up with two solutions: the IEEE 1588 Precision Time Protocol and the LXI hard wired trigger bus. LXI is very much Windows centric with its emphasis on IVI Drivers although specific instruments might provide some more widely usable programming methods. The LXI Standard does not provide the information necessary to program LXI Instruments. In addition, it does not require that LXI Instruments conform to the IEEE-488.2 standard.

There is a great deal of overlap with the two specifications and some vendors make instruments that comply with both specifications. This is the best of both worlds since VXI-11 compliance guarantees you several ways to communicate with the instrument, a minimum set of common commands and expected 488.2 behavior from the instrument. Users purchasing LXI only instruments should read the instrument's specification carefully and be clear on what commands the instrument responds to, how it functions and if it can be controlled with your test program language and operating system.

References

Note 1: VXI-11 description based on VXI-11 Specification Revision 1.0 dated 1995. Copies available from the VXI Consortium at http://www.vxi.org/?q=node/206

Note 2: Third party VISA libraries for HP-UX and LINUX from Test and Measurement Systems, Inc.

Note 3: For more information about the LXI Consortium visit http://www.lxistandard.org/

Note 4: LXI description based on the LXI Standard revision 1.1 and articles published in the LXI Connexion magazine. The full text is available at http://www.lxiconnexion.com/articles.shtml