Using the LXI standard in switching systems

David Owen describes how products based on the LXI (LAN extensions for instrumentation) standard can be used to support switching functions in test systems.

Signal management, which is using switching systems to route instrumentation and stimulus to appropriate test point on a unit under test, has a very crucial role to play in most electronics test. The sharing of resources, connection of calibration references, load management, and many other functions are all controlled by signal management.

Pickering Interfaces has been involved in the development of complete switching systems since its first products were introduced in 1988. Using the knowledge based developed by its sister company, Pickering Relays, Pickering Interfaces was able to develop a range of switching systems based around a proprietary standard – its System 10 and 20 products – which provided GPIB or RS232 control of the relays.

Even at that time there was a recognised demand for switching platforms that were based on open modular standards and Pickering introduced switching products based on the VXI and the PXI standards. The PXI standard, despite doubts expressed by some, has proven to be an excellent basis for switching products. Although the PXI form factor is small the development costs are low once the initial entry barriers have been crossed and speed of development is high, enabling a large variety of standard and custom switching solutions to be made available in response to user demand as adoption of the PXI standard increased.

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Ubiquitous Ethernet

GPIB instruments have more recently had their control interfaces supplemented by a LAN connection that can be used as an alternative control mechanism. Ethernet connections are ubiquitous on system controllers, and the connection cables are easily managed, have a latching mechanism and have virtually no restrictions on distance.

However, there was no agreed standard for controlling an instrument through a LAN connection, so users found that manufacturers solved the problems in different ways. In some ways this is rather like the situation 30 years ago when GPIB (originally HPIB) was introduced. No two manufacturers did things the same way. As occurred on GPIB, a more cohesive approach is now being taken.

Standardisation of LAN connections for instrumentation is taking a major leap forward following the introduction of the LXI standard. Standardisation started in the second half of 2004 and the LXI Consortium (http://www.lxistandard.org ) was formed to develop and refine it. Many of the major T&M companies have joined the consortium, including Pickering Interfaces, who are now Strategic Level members. The first publicly released version of the standard was made available at Autotestcon 2005.

The LXI standard defines LAN controlled instruments that behave in a similar and consistent way when they are connected to a network. Each instrument has its own web interface that can be used to set up the instrument and report its status. The LAN interface can be used to control some functions. An IVI driver on the client PC is used to provide programmatic control of the LXI device over the LAN interface.

In most cases LXI devices are considered to be self contained – they have their own power source, LAN connector and case. They are intended to be small compared to the competing PXI standard.
to their bench instrument versions and be controlled from an external controller, so generally they have no front panel user interface. User connections are recommended to be on the front of the instrument and power and LAN on the rear. An LXI device providing this level of performance is referred to as a Class C Device, it meets all the essential requirements of the LXI standard.

Two further classes of LXI device are defined that are intended to provide more deterministic response to trigger events. The Class B devices include a timing facility based on IEEE1588 that allows users to trigger events in the system at specified times (including immediately). This can be used to make the LAN timing of measurements more deterministic, permitting timing accuracies of a few 10’s of ns to be achieved.

A Class A device includes both the IEEE 1588 features and a wired trigger interface that can be used to physically connect instruments together with an 8 bus trigger interconnection. This provides a more deterministic way of responding to trigger events since only internal hardware and cable interconnect delays affect response times.

Comparison of LXI

There has been speculation that PXI and LXI are competing standards, a view that Pickering does not share. In many ways they are sufficiently different that there will be clear case where one is better for a particular solution than another.

The table in figure 1 clearly illustrates these differences, and these differences are valid for both switching and instrumentation applications.

For LXI instruments they are largely platform agnostic, whereas PXI is very dependent on the PC architecture (and in practice Windows). LXI Devices do not have many mechanical or electrical constraints, but PXI have to conform to the PXI standard in order to benefit from the multi-vendor chassis platform. They can also have quite different speed drivers as well.

Although PXI has the faster connection speeds it relies on processing data in the controlling PC – so it inherently needs a high speed interconnect for some functions. An LXI system might be expected to process data within the LXI Devices and simply has to report the results.

For switching, speed differences are of little consequence because in practice the speed of change of switching systems is constrained by mechanical components. The mechanical and electrical constraints of PXI can influence what can be cost effectively supported in PXI, but the cost overheads of a LXI Device can limit the minimum functionality that can be cost effectively supported.

As ever, one standard does not fit all. Revision 1.0 of the LXI standard is now available and the LXI Consortium will work on newer revisions to cover additional areas and improve on the existing content. All new standards face a period of time when companies seek to launch products conforming to the standard as quickly as possible in order to encourage users to embrace the new technology, but it takes time before a new standard has the breadth of product availability of legacy standards. Lack of availability of a wide range of products can act as deterrent to users being able to move from, for example, GPIB to LXI as soon as they would like.

In the case of Pickering Interfaces the company has a very large range of PXI switching products that have been developed in the last 7 years and a smaller range of older designs that are housed in a GPIB chassis (System 10 and System 20). Pickering Interfaces recognised that there are a significant number of users for whom PXI was the natural answer to their switching needs, but there are many other users who would prefer to use a different control method that provides a barrier between the system controller and the switching hardware.

Years of effort

Replicating the breadth of switching products available in PXI across LXI though would create many years of effort in both hardware and software. For that reason a decision was taken to leverage the existing PXI switching products into LXI, essentially producing a level playing field for the two formats immediately that a suitable LXI product was introduced, and that led directly to the Pickering Interfaces 60-100 LXI Chassis.

The use of the LXI architecture for switching makes sense for many test applications. In the area of legacy test systems, where a migration path to newer systems are planned, LXI can be selected to replace older GPIB Based switching systems. From a software standpoint, there is no easy answer to migrating older test programs. However, modern software does make the change relatively simple.

If the test system is primarily PC Based, LXI based switching simplifies the issue of PCI Bus enumeration as the switch system is not on the PCI bus. So powering down the switching system will not force rebooting of the controller when maintenance/upgrade are required.

When compared to a pure PXI switching application, the costs of a controller for the LXI switch systems are far less as the application is slower and less bus intensive. So the overall costs of a switch system based on LXI are likely lower than an equivalent PXI implementation.

The 60-100 chassis system was initially developed around a commercially available
The hardware provides a means of physically controlling the PXI modules installed in the backplane, for external control and monitoring. LXI requires the use of a standardised programming interface (IVI) and web interfacing. The control route taken to supporting the PXI modules is shown in figure 3.

**Module control**

The client PC has an installed driver and discovery software that communicates through the client Ethernet interface to the 60-100 chassis. The 60-100 provides an Ethernet interface, discovery server and web server that interface to the control software that in turn controls the PXI modules.

The drivers provided include IVI compliant custom and class drivers that communicate through the Ethernet connection, using a proprietary command set, to the 60-100 control sub-systems which then manage the connection and handle the physical interface to the PXI cards.

Also provided is a programming interface based on the Pickering kernel driver, suitably adapted to the 60-100.

Physically the 60-100 implements these control and management functions on a single board embedded PC using flash memory cards to avoid the problems of supporting hard drives, ensuring the program information remains even if unexpected power interruptions occur. The embedded PC has a PCI interface that is connected to the PXI backplane through a bridge, making the PXI modules appear as an extension to the 60-100 embedded PC’s PCI bus.

Only a small proportion of the internal flash memory is used for the system functions, leaving room for the memory to be loaded with other data, including the drivers, manuals and data sheets.

In principle the 60-100 can accept any 3U switching module, but in practice suitable software drivers need to be available that run the module in accordance with Pickering’s software control model.

**User choice**

Users will benefit because they do not have to make the choice of what switching platform to use simply on the grounds of product availability – Pickering Interfaces becomes ‘platform agnostic’. Other versions of the 60-100 will be introduced with more available slots so that more diverse applications or more complex switching modules can be included.

The 60-100 LXI Chassis is supplied with software support for all its PXI switching modules, in the future this will be expanded to include support for key instrumentation items such as a high performance DMM. LXI only products will be developed, particularly in areas where LXI has a technical advantage over PXI because of its relatively high mechanical and electrical freedom compared to PXI. However, PXI has advantages where there is a need for a mixture of switching functions that can be densely packed since in a chassis. For those applications where Pickering is the selected supplier the user has a choice of staying with a PXI environment or choosing to operate the modules through an LXI environment.

It seems the future is bright for both PXI and LXI standards supporting switching functions in test systems.

David Owen is the PXI Business Development Manager for Pickering Interfaces.