Test systems move to the desktop

By Eric Starkloff
PXI and Instrument Control Platform Manager
National Instruments
E-mail: eric.starkloff@ni.com

Testing is a key facet in any electronic product. Test is used throughout the design flow of a product: From the modeling of components in the initial design, to testing the first prototype, to the functional test system on a manufacturing line.

For high-volume manufacturing and very complex devices, high-end automated test equipment (ATE) based on proprietary technology has traditionally been used. The propriety ATE solutions have their drawbacks, though. A sophisticated ATE system used in manufacturing test typically costs several hundred thousand dollars, takes months to develop and is difficult to modify to meet the needs of future products. Despite these drawbacks, the need to meet throughput and coverage requirements has kept a select few requiring propriety this type of solution.

As technology continues to evolve, however, commercial technologies have developed parallel and capable proprietary ATE. Just as computers that once filled entire rooms have shrunk in size with steadily increasing capability, sophisticated ATE is now available for desktop use with the cost, flexibility and performance demanded by a majority of electronic testing applications.

In the past, applications requiring a high-end automated test system had few choices–they typically required a tester from a test-systems integrator built largely on proprietary hardware and software. Not only were these systems large and expensive but they left the user highly dependent on the vendor. An example of typical proprietary ATE is represented in **Figure 1**.

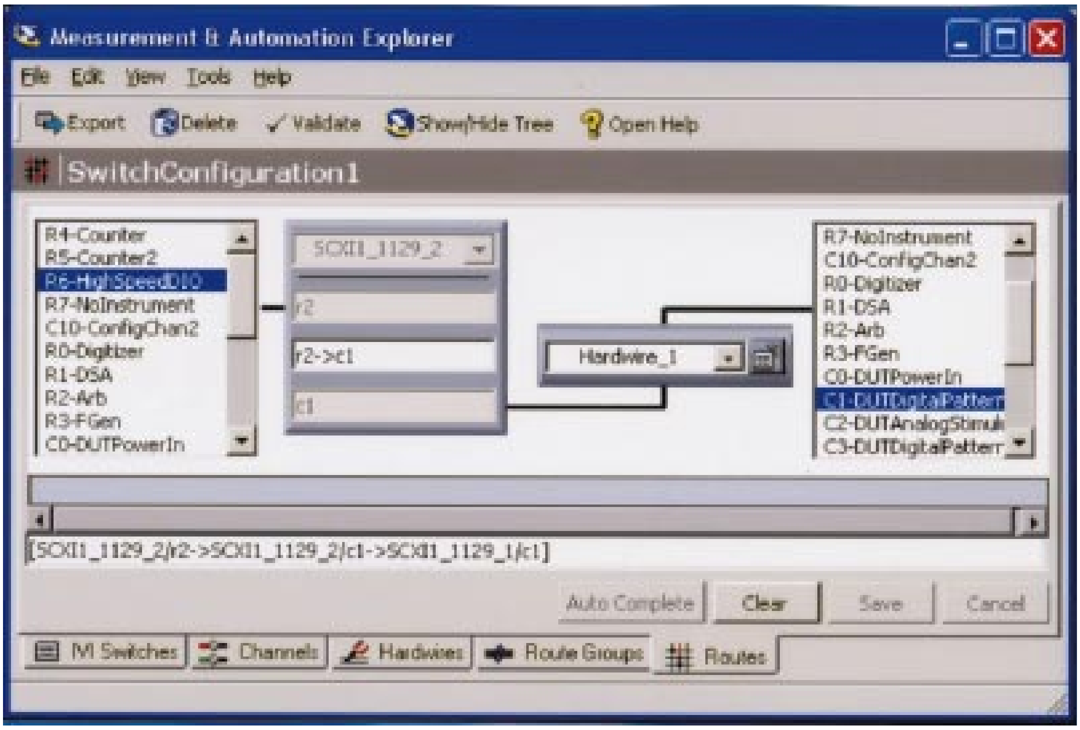

Figure 1: A typical proprietary ATE system.

The state of the ATE market resembles the automotive market about 100 years ago. In 1907, Henry Ford made bold claims about his plans for the automotive industry. At the time, Ford was a relatively small player among over 30 manufacturers. Ford claimed of his automobile:

ìIt will be so low in price that no man making a good salary will be unable to own oneÖthe horse will disappear from our highways and the automobile will be taken for grantedî.

Of course, Ford did achieve his goal and he did it by changing the way automobiles were manufactured. Fordís disruptive technology of mass production completely changed the cost structure of the automotive industry and significantly broadened the market for automobiles. He referred to this as ìDemocratizing the Automobileî.

Proprietary ATE is similar to the pre-1907 automobiles. Certainly many applications still require high-end, custom-made ATE just as race cars and exotic sports cars are still made by hand, as in 1907. The vast majority of the world, however, requires more flexible, less expensive test solutions that take advantage of widely available commercial technology. The availability of such technologies is in essence democratizing ATE, making it available to a very broad set of scientists and engineers for automated testing.

The development of the democratized ATE first began with GPIB standardizing connectivity to instruments. In 1975, IEEE Standard 488-1975 defined the general-purpose interface bus (GPIB), which still serves today as the standardized interface between PCs and standalone instrumentation. Prior to GPIB, automating test instrumentation proved to be a daunting task. It was necessary to build expensive custom hardware and low-level software for each instrument that needed to be automated–a task that alone could easily take many months.

In the 1980s, the PC software revolution began. Starting with Appleís MacOS, users began interfacing to computers using sophisticated graphical user interfaces, rather than simply low-level text and assembly languages. Engineers and scientists quickly began to benefit from the availability of productivity software tailored for particular applications. Graphical test development tools were introduced, bringing a new level of productivity to software used for automating instrumentation.

With graphical development and other productivity-enhancing tools, creating an automated test system no longer required a sophisticated computer scientist; rather, the expert in the device or technology under test could use their expertise in the application to build a test system.

As graphical development tools evolved, it grew to encompass more functionality than just traditional instrument control. Today, it is used extensively to create applications for data acquisition, image processing and motion control and factory automation. With these broad capabilities of graphical development, ATE systems have expanded to encompass what were once considered peripheral functions, such as visual inspection, motion control and enterprise integration.

In 1987, the introduction of VXI defined a modular platform for instrumentation. The goal of VXI was to provide a format where an engineer could build a test system by selecting the measurement modules needed from different vendors to create a highly customized, scalable test system. But VXI maintained a software architecture much like GPIB, where each vendor defined the functions and communication paradigm for each module. Thus, although VXI delivered a modular hardware framework, the software for each module resided in a silo with no interaction among modules and very little commonality in programming. This made creating VXI systems a challenge. The result was that VXI never achieved broad industry acceptance as a modular hardware platform but instead was confined to high-end applications and used primarily by vendors of large expensive ATE.

In 1997, the introduction of PXI (PCI eXtensions for Instrumentation) combined the latest commercial hardware and software technologies with concepts and technologies derived from ATE, such as sophisticated timing and triggering for high-performance measurements. By exploiting commercial PC and digitizer technologies, PXI provides the high performance of proprietary ATE but at a much lower cost.

Just as other electronics industries have been able to deliver order-of-magnitude advances in performance in smaller and smaller packages, PXI provides performance exceeding VXI and GPIB in considerably less space–A PXI measurement device measures 100mm-by-160mm. PXI truly makes it possible to have sophisticated ATE on a desktop.

Further, PXI provides a diverse set of measurement and control capabilities, including vision, motion and real-time control, providing important functionality integrated into the same platform as the traditional electrical measurements.

The small size, low cost and flexibility of PXI make it applicable to a wide set of applications, including research, desktop ATE, field measurement and high-end manufacturing test

To fully deliver on the promise of PXI to provide a tightly integrated measurement and control platform, it is essential to have software architecture that defines a common interface to different types of hardware, instead of having vendor-defined ìsilosî that communicate with each module in a PXI system. This software layer, which resides between the test development environments and the hardware, is called Measurement and Control Services. Measurement and Control Services include driver engines, flexible, high-level application programming interfaces (APIs) and a configuration manager. Although often hidden in a system, this software provides the glue to integrate hardware devices and often ends up being one of the most important elements of a system.

Another piece of most proprietary ATE systems is test management software, commonly called a Test Executive. The functions of this software include:

- Organizing a set of test routines
- Sequencing, branching and looping through tests
- Collecting and organizing test results
- Providing a consistent user interface to different tests

Because this software is typically created for a single type of tester, however, it lacks flexibility and scalability. Further, it is not widely used and therefore is not adopted by a large set of users, integrators and third parties.

Today, Test Executives are available from a number of vendors. They typically provide the ability to connect to a number of different test development tools and an array of reporting and databasing capabilities. These programs take much of the monotony out of creating, maintaining and documenting a set of test programs and ultimately make us more productive in creating test systems.

Once the development of broad based test management environment that provides the key features of software typically found on proprietary ATE was introduced, important ATE technology was brought to a very broad set of users. Anyone doing automated testing who wanted to organize, execute and record information from a set of test routines was able to.

Just like test management software, switch management systems have long been used on ATE systems. It is used to name and organize channels, assist in switch routing and manage routes through switch matrices. This functionality is essential to use medium-to-large switch matrices productively and manage switch routing, especially among multiple products under test. But like propriety test management software, propriety switch management systems usually only worked on one vendorís test system and lacked flexibility and scalability.

Today, commercially available, intuitive switch management and routing software has alleviated this problem. Switch management and routing software provides switch management directly from the development environment or test management system, so that the switching in a system becomes all but transparent to the test developer. An example of the latest advanced in ATE technologies is Switch Executive from National Instruments. Switch Executive is a comprehensive switch management tool that works with switch modules is multiple platforms, including PXI, VXI and GPIB.

Taking full advantage of commercial technologies results in an automated test system that can fit the needs of a very broad set of scientists and engineers for automated testing. Two types of engineers that significantly benefit from the democratization of the ATE system are manufacturing test and design engineers.

Manufacturing test systems have been the primary user of proprietary ATE systems for many years. As devices have increased in sophistication, though, the cost of the systems to test these devices has escalated rapidly. As a result, the cost of testing has become a proportionally larger percentage of the manufacturing cost of many products. **Figure 3** shows this trend for integrated circuit fabrication.

Due to this trend, there is increasing focus on lowering the cost of testing for manufacturing applications. Todayís commercial technologies provide a far lower cost of testing to end-users and test-system integrators by increasing both their test-system performance and development productivity while significantly lowering the overall cost of ownership.

For electronic design, ATE on the desktop provides a flexible, low-cost platform for testing products from the initial design through the final verification. Electronic designers are all familiar with electronic design tools that have revolutionized the design process in the last 20 years using the PC as a key enabling technology. Desktop ATE promises a similar revolutionary gain in productivity for the design engineer. Using commercial technologies and high-productivity test software tools, design engineers can spend less time testing their products and more time designing them.