NATIONAL INSTRUMENTS

4 Approaches to Solve Today's Obsolescence Challenges in Aerospace and Defense

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In the aerospace and defense industry, the terms "sustainment" and "obsolescence management" are common, and it's easy to understand why. Unlike conventional consumer products such as cellular phones, which have a lifespan of only a few years, "products" in aerospace and defense are produced and supported for decades. For example, the Boeing B-52 Stratofortress was first introduced in 1954, and is expected to remain in service until the 2040s after nearly a century on the market. This poses unique challenges to test engineers who must maintain a fleet of test stations based on legacy and, in many cases, obsolete equipment. Test engineers spend as much as 50 percent of their time (or even more in some cases) actively dealing with obsolescence in their test program sets (TPSs). To make matters worse, these TPSs were often written in ancient software languages, with little to no documentation, by someone who is likely long retired.

Given this massive challenge, many vendors want to help test engineers develop their next TPSs, but that doesn't overcome the obsolescence challenge these engineers face right now. You, as a test engineer, can take four different approaches to solve your obsolescence challenge today.

Reactive Obsolescence Management Strategies

The four main strategies to reactively address obsolescence are:

- Last-time buy
- Drop-in replacement
- Redesigning around a similar component
- Integrating a new component or migrating to a new platform

This paper doesn't focus on last-time buy or drop-in replacement because the pros and cons are obvious. They require little to no engineering or revalidation cost; however, they may lead to large up-front capital expenditures and increased risk. With a last-time buy, you own 100 percent of the supply risk, and the support for that component likely is close to expiring or has completely expired. With a drop-in replacement, you often have a light validation effort, but you may face yet another obsolescence challenge in the near future. This is especially true for instruments based on the legacy VXI platform.

This paper examines the latter two approaches and identifies some options in the marketplace today.

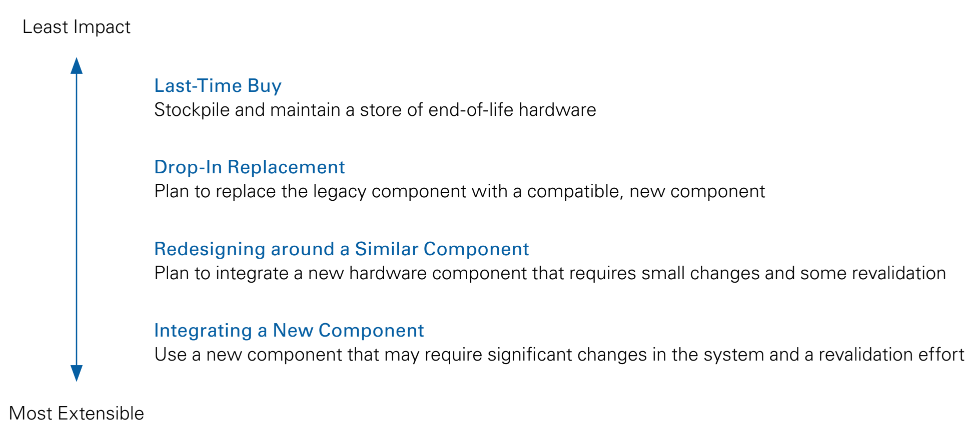

Figure 1. The four approaches to meeting obsolescence challenges range greatly in cost and extensibility.

A New Way Forward

When dealing with obsolescence in an ideal world, you would have infinite resources to plan a completely new tester from the ground up. However, you have limited time and budget to deal with an obsolete component in your test system. Though they are concerned with capital budgets, test leaders also must consider the operational expenses when upgrading technology in their testers. An in-depth research study conducted by Dr. David R. Carey, an associate professor of electrical engineering at Wilkes University, found that the cost to rewrite a TPS due to the replacement of legacy or obsolete instrumentation is approximately $150,000 USD per TPS. Multiply that figure across dozens of TPSs for several programs, and the costs can be staggering. Therefore, engineers should consider modern test platforms whenever possible to streamline the validation effort. One such platform is PXI.

Powered by software, PXI is a rugged PC-based platform for measurement and automation systems. It combines PCI electrical-bus features with the modular, Eurocard packaging of CompactPCI and then adds specialized synchronization buses and key software features. PXI is both a high-performance and low-cost deployment platform for applications such as manufacturing test, military and aerospace, machine monitoring, automotive, and industrial test. Developed in 1997 and launched in 1998, PXI is an open industry standard governed by the PXI Systems Alliance (PXISA), a group of more than 70 companies chartered to promote the PXI standard, ensure interoperability, and maintain the PXI specification.

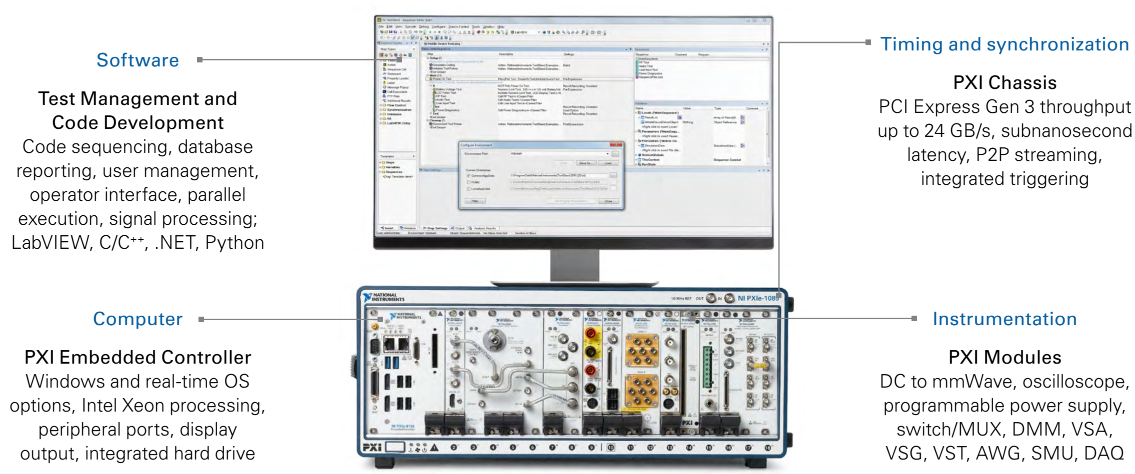

Figure 2. PXI is a rugged PC-based platform for measurement and automation systems.

NI offers more than 600 different PXI modules ranging from DC to mmWave. Because PXI is an open industry standard, nearly 1,500 products are available from more than 70 different instrument vendors. With standard processing and control functions designated to a controller, PXI instruments need to contain only the actual instrumentation circuitry, which provides effective performance in a small footprint. Combined with a chassis and controller, PXI systems feature high-throughput data movement using PCI Express bus interfaces and subnanosecond synchronization with integrated timing and triggering.

Frost & Sullivan, a market research leader, has maintained a study since 2007 that shows the historical and projected future deployments of industrial technology platforms. In 2016, Frost & Sullivan updated the numbers, which show a continuing, drastic decline in deployed VXI systems.

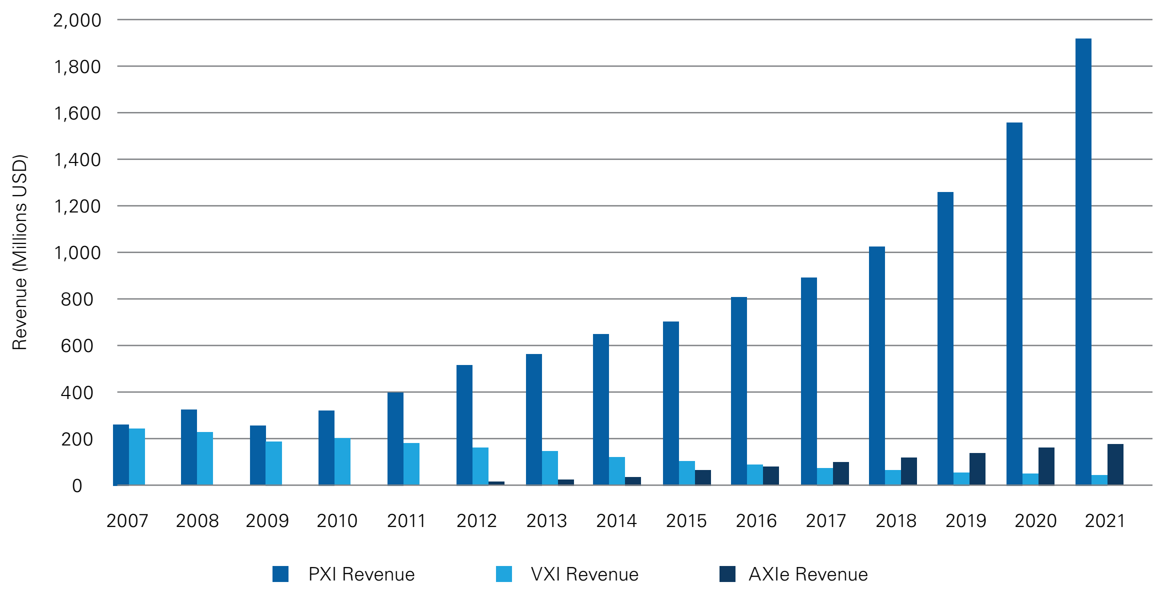

Figure 3. PXI deployments continue to grow at a steady rate and will continue to dominate test and measurement platform deployments.

This decline in VXI deployments will make it difficult for vendors to maintain the economy of offering VXI products for sale. In contrast, PXI deployments continue to grow at a steady rate and will continue to dominate test and measurement platform deployments. For that reason, you should use caution when considering drop-in replacements instead of migrating to a new platform like PXI, especially when they require revalidation.

Taking an "Ooch Approach" to a Modern Platform

Making the switch to a new platform is risky because it can introduce a lot of technical debt. For example, making a minor change from a VXI-based instrument to a PXI-based instrument could introduce significant technical challenges on the software side of the TPS including driver, OS, and IDE compatibility. Therefore, to make a platform change and use the new technology, test engineers are seemingly forced to "go all in" at significant risk. But you can choose from several products to help you "ooch" into a new platform like PXI.

Astronics Test Systems: Bridging Technology Using PXI-VXI Adapters/Carriers

With a bridge method, you can use your existing VXI infrastructure by replacing a single VXI instrument with a new PXI instrument in the same VXI slot. This means you can upgrade your aging VXI instrument suite with PXI instruments one by one without the need for infrastructure changes. Note that you can host one or two PXI/PXI Express modules in a single VXI slot (with mechanical provisions provided). In addition, you can add a signal conditioning board using a PMC slot in the rear of the unit to help replace any legacy instrument functionality that is not already addressed by the PXI modules. Once you have replaced all the VXI modules, then you can easily replace the chassis and controller. This incremental obsolescence migration plan fits well with programs that have tight funding requirements or need to minimize station downtime.

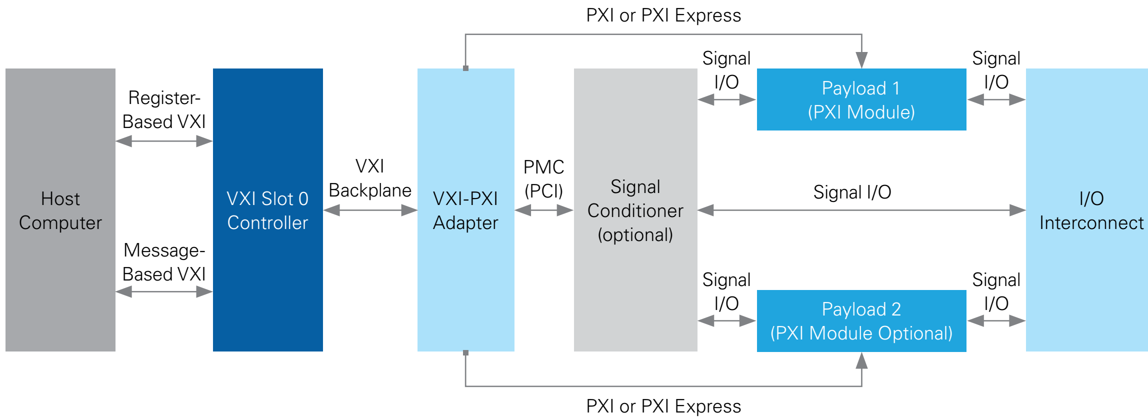

Figure 4. Generic Block Diagram for Connecting PXI Modules to a VXI System via a Bridge/Carrier (Image courtesy of Astronics Test Systems.)

One of these bridges, the Astronics VX407C PXI-VXI adapter, is typically used to bridge PXI register I/O to VXI for quasi-register-based operation. Another Astronics PXI-VXI adapter, the 6084H, is used to embed PXI or PXI Express modules in the VXI bus for message-based operation through the use of SCPI or other commands.

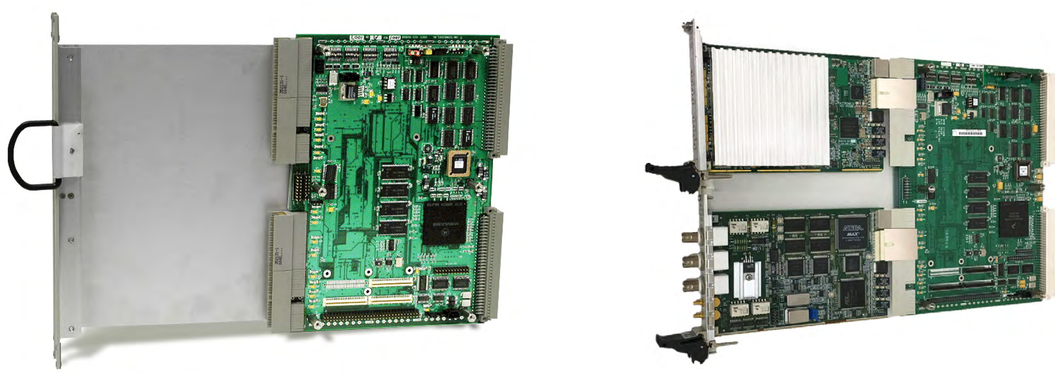

Figure 5. The Astronics VX407C and 6084H PXI-VXI adapters can help simplify the migration to a new platform. (Image courtesy of Astronics Test Systems.)

The advantage of the VX407C is simplicity: you simply map the PXI register I/O to a register location on the VX407C. The VX407C firmware transmits the data to/from the I/O space of the PXI module automatically. The resulting instrument DLL code changes are mostly cut and paste, so the cost to bridge a PXI DLL driver to the VX407C-hosted PXI module(s) is relatively small. This is a great approach for replacing register-based VXI modules.

The 6084H is more complex than the VX407C solution, but it is ideal if the original VXI is message-based and requires command-level compatibility. The PXI/PXI Express driver DLL must be embedded in the 6084H's firmware. Then you can avoid modifying and reverifying system software.

Learn more about the Astronics PXI-VXI carrier solution.

Hiller Measurements: Large-Form-Factor PXI Chassis

One challenge with moving from VXI to PXI is the loss of space available to each module. Hiller Measurements (HM) has designed a unique solution to this challenge. The HM P-XLe chassis addresses VXI obsolescence by leveraging the open architecture of the standard 3U PXI platform. It was developed to accommodate measurement science that cannot be managed in the Eurocard PXI format and to work with the commercially obsolete VXI standard. Ideal for applications that require reconfigurable RF interface units, high channel counts, and I/O connectivity both from the front and rear of the chassis, the P-XLe allows cohabitation of standard 3U PXI modules and P-XLe modules.

Figure 6. The P-XLe chassis was developed to accommodate measurement science that cannot be managed in the Eurocard PXI format. It is ideally suited for the commercially obsolete VXI standard. (Image courtesy of Hiller Measurements.)

A single-slot P-XLe module has a 3U region for circuitry that supports the PXI standard, including interface connectors for connection to a 3U PXI standard backplane as well as peripheral connections in the 3U region opposite the backplane for interface connectors. It also consists of a 6U region for circuitry that supports the expanded capabilities of the P-XL system with peripheral connections in the front and rear of the module.

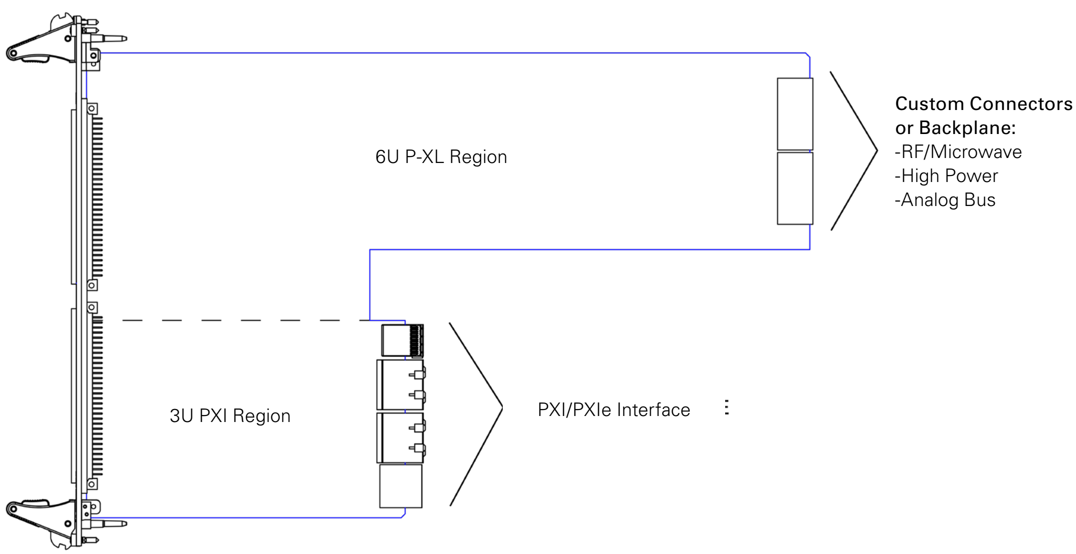

Figure 7. P-XLe modules have a 3U PXI region and a 6U P-XL region in a single slot. (Image courtesy of Hiller Measurements.)

The P-XLe chassis houses PXI and P-XLe modules and controllers simultaneously and connects them with a high-performance PXI backplane to provide all power, cooling, and timing and synchronization capabilities. Additionally, the P-XLe chassis offers easy integration with Virginia Panel Corporation (VPC) and Mac Panel hardware to accommodate the chassis and I/O.

> "The majority of legacy VXI systems used our popular VPC 9025 and 9050 series receivers and have a large installed base of ITAs. Hiller P-XLe modules are designed to match legacy functionality, connector I/O, and pin maps. This aids in migration to new test systems supporting the existing ITAs. VPC can provide wire harnesses from the PXI/PXIe instruments to the test receiver to facilitate this migration."
>
> Kevin Leduc, VP/GM of Sales, Virginia Panel Corporation (VPC)

Learn more about the Hiller Measurements P-XLe chassis.

ADVINT: Source Code Transformation

Many legacy TPSs were developed in now outdated languages such as ATLAS and Fortran. ADVINT's Chameleon code transformer provides customized automated software source code conversion that preserves your existing TPS investment when migrating to new test systems. The tool converts old programming languages to modern software development environments via customizable and extensible XML language translation models based on your specific application programming needs.

The multilingual-capable Chameleon helps you convert to NI LabWindows™/CVI, IVI instrument drivers, and other software dialects. It provides traceability between newly generated target code and legacy code via a systematic model-based translation process. It also supports formatted output to facilitate readability/maintainability in accordance with various style guide requirements.

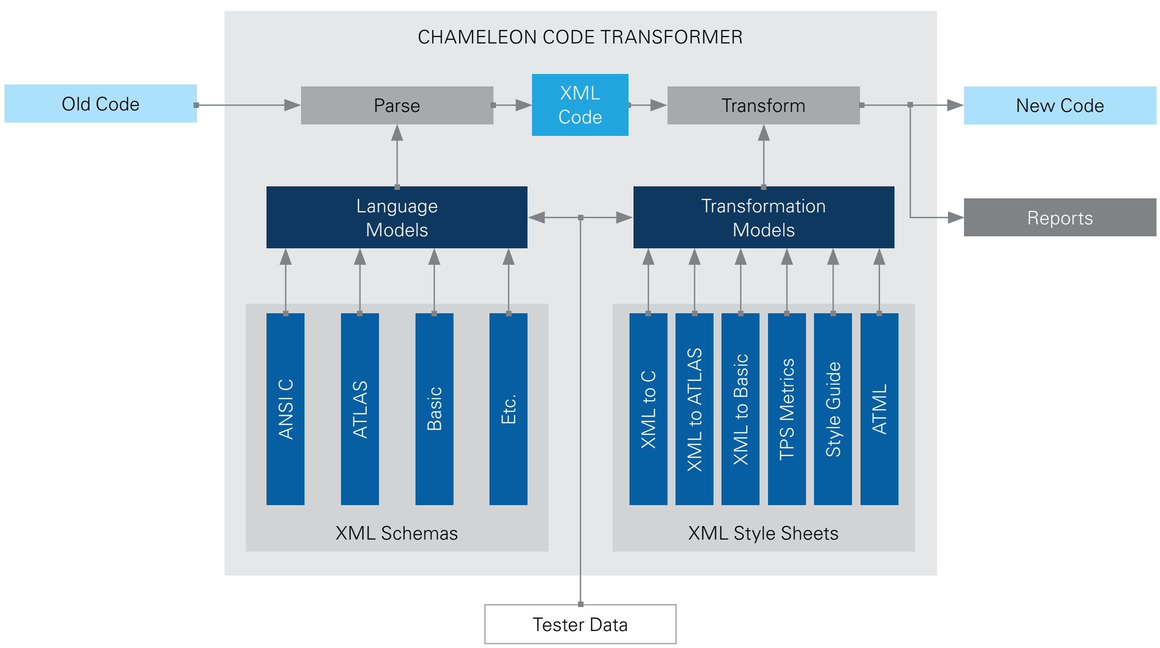

Figure 8. Chameleon greatly reduces software rehost cost and development time while increasing quality and traceability. (Image courtesy of ADVINT.)

Chameleon generates TPS metric reports that give you technical insight into the source via its query-based report generation capability. The reports feature unique XML style sheets to help you extract and format the data you need. You can use these reports to determine the magnitude and focus of your modeling effort and help automate TPS documentation generation.

Chameleon greatly reduces software rehost cost and development time while increasing quality and traceability. Once the initial model is verified for the first test program, you can use it for subsequent test programs from the same legacy test system and update it as needed. Chameleon has been demonstrated to provide code conversion for as low as $1 per line of code when converting test programs from a legacy ATE. Manual conversion can take as much as an engineering hour per line of code and cost over 100 times as much.

Learn more about ADVINT's source code transformation services.

NI: FPGA-Based Digital Interfacing

Many TPSs require interfacing with devices, such as devices under test, to communicate with them or between different subsystems. That communication is sometimes over an uncommon or custom digital protocol. If any hardware in these applications is facing obsolescence, test engineers must find a replacement. An off-the-shelf replacement is unlikely, but if one exists, it's probably expensive. In this situation, FPGA technology can help. You can use FPGAs to define the hardware personality through software, which makes them a popular solution. But FPGA technology traditionally has involved home-grown, custom design, which comes with a significant maintenance burden and risk.

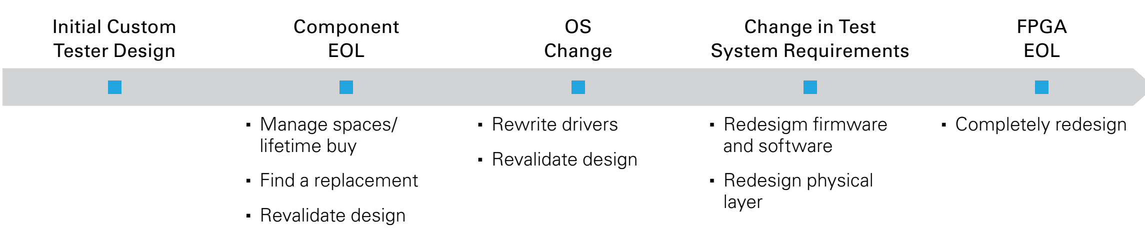

Figure 9. Managing the life cycle of a home-grown FPGA-based system presents a significant maintenance burden and risk.

Instead, you should consider taking advantage of the FPGA-enabled PXI modules from NI. This approach bridges the gap between a fixed-function instrument and full custom design. With an off-the-shelf solution, you have a higher-level starting point. You also don't have to worry about the extra burden of designing and maintaining a custom solution.

With the LabVIEW FPGA Module, you can more efficiently and effectively design complex systems with a highly integrated development environment, IP libraries, a high-fidelity simulator, and debugging features. You can create embedded FPGA VIs that combine direct access to I/O with user-defined LabVIEW logic to define custom hardware for applications such as digital protocol communication.

When you're designing a replacement for a digital instrument, FPGAs offer a lot of flexibility for customization. But if you need to implement a standard protocol, you should use already developed

IP cores. In addition to the several that NI provides, New Wave Design and Verification offers many IP cores that you can deploy directly to NI FPGA-based hardware.

NI IP	
UART	Serial RapidIO
SPI	1GbE UDP
I2C	CPRI
RS232	JESD204B
Xilinx Aurora 64b/66b	JTAG
Xilinx Aurora 8b/10b	RFFE

New Wave IP	
Fibre Channel Link Layer	1394b GP2Lynx
Fibre Channel ASM	1394b AS5643
Fibre Channel RDMA	sFPDP
Fibre Channel AV	ARINC 818
1394b PHY	HOTLink II
1394b OHCI	High Speed Data Bus

Table 1. NI and New Wave Design and Verification FPGA IP Cores for Digital Communications

Learn more about what is possible with LabVIEW FPGA.

Planning for the Future

Dealing with obsolescence is common for a test engineer in the aerospace and defense industry. Though you spend a lot of time examining and addressing the obsolescence challenges of today, you need to consider the challenges of tomorrow. When developing your next TPS, have an obsolescence plan. Technology is constantly evolving, and the components you buy today will likely have shorter lifespans than your TPS. Having the right processes in place when developing a TPS can help you mitigate obsolescence before it becomes a significant burden.

Next Steps

Learn more about proactive approaches to future obsolescence challenges

Explore NI's offering for developing TPSs in electrical functional test