WHITE PAPERS

Strategies to Manage Obsolescence in Aerospace and Defense Test

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, aerospace and defense systems can last for decades. 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).

NI has served the aerospace and defense industry for decades with disruptive, PXI-based instrumentation and application software that reduce the overall cost and risk associated with the test and support of your products. In these articles, we'll share not only some of the insights we've identified to meet the challenges you face today but also strategies and best practices to help you avoid these challenges in the future.

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.

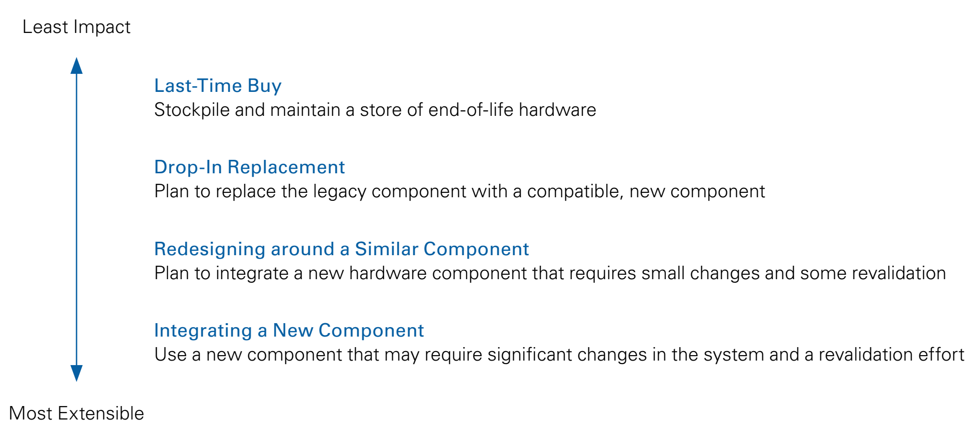


Figure 1. The four approaches to meeting obsolescence challenges range greatly in cost and extensibility.

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.

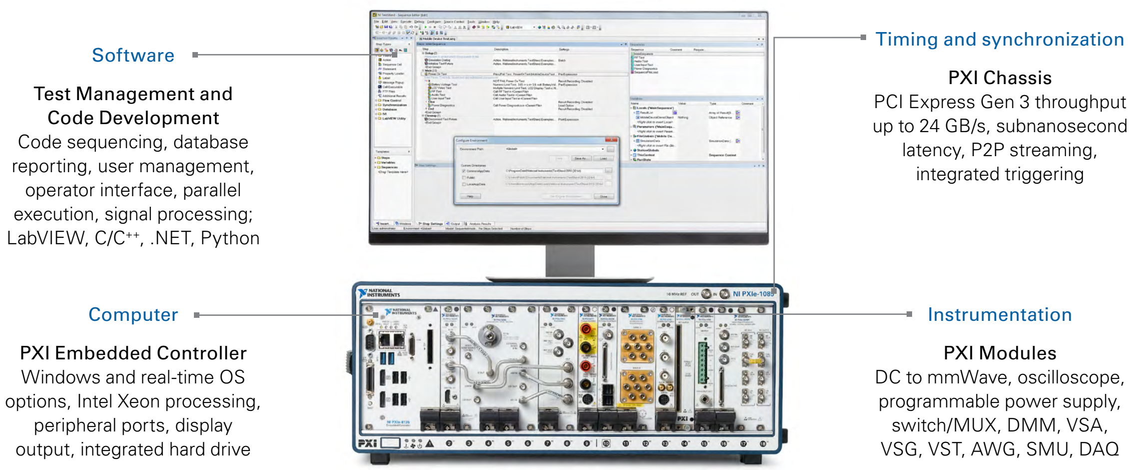


Figure 2. PXI is a rugged PC-based platform for measurement and automation systems.

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.

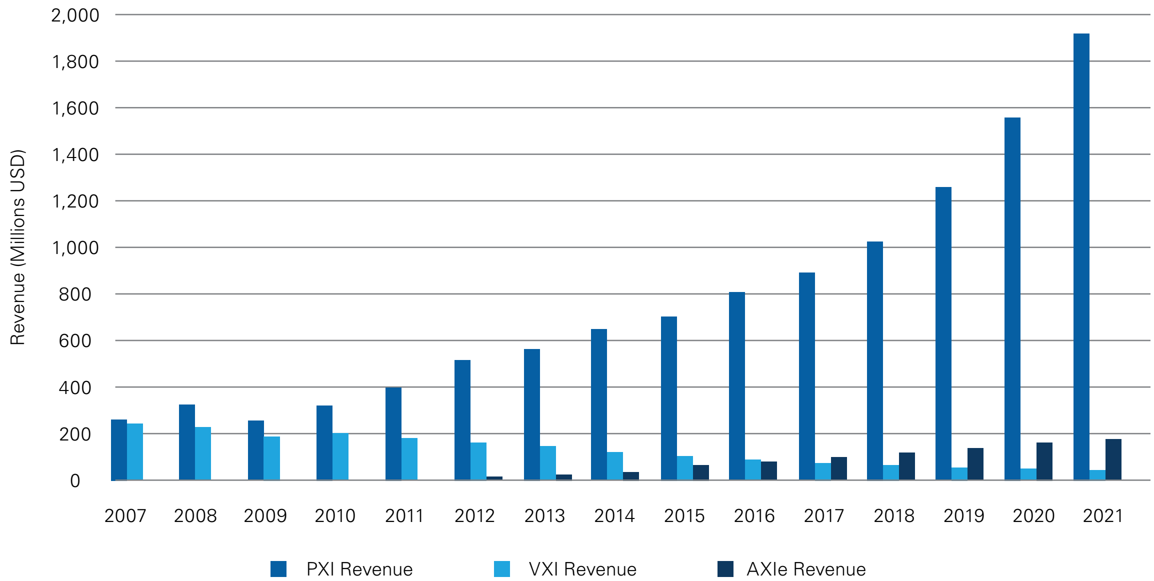


Figure 3. PXI deployments continue to grow at a steady rate and will continue to dominate test and measurement platform deployments.

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.

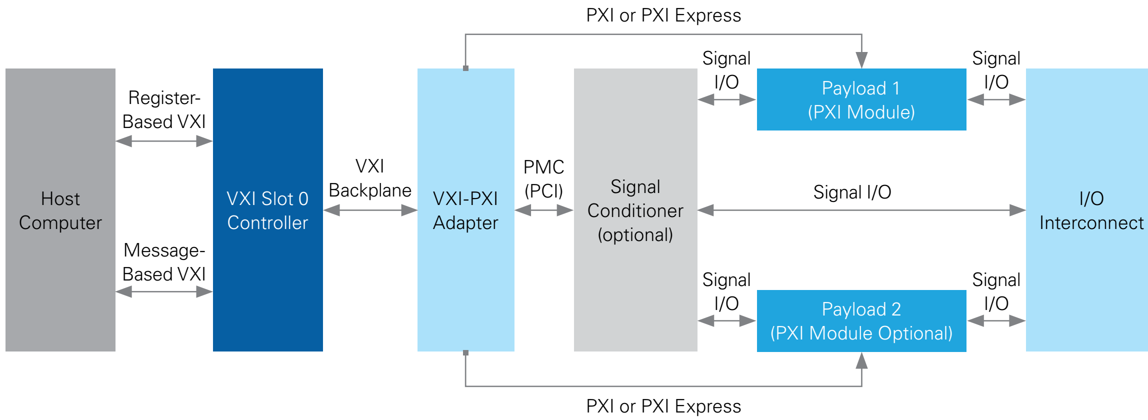


Figure 4. Generic Block Diagram for Connecting PXI Modules to a VXI System via a Bridge/Carrier (Image courtesy of Astronics Test Systems.)

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.

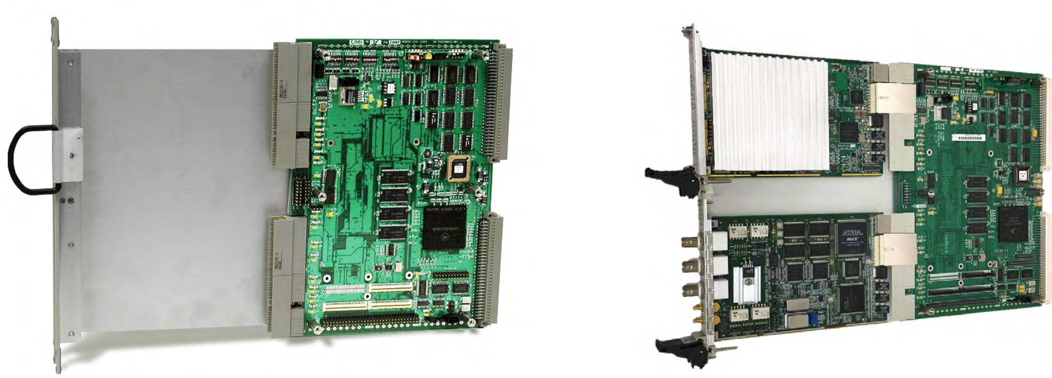


Figure 5. The Astronics VX407C and 6084H PXI-VXI adapters can help simplify the migration to a new platform. (Image courtesy of Astronics Test Systems.)

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.

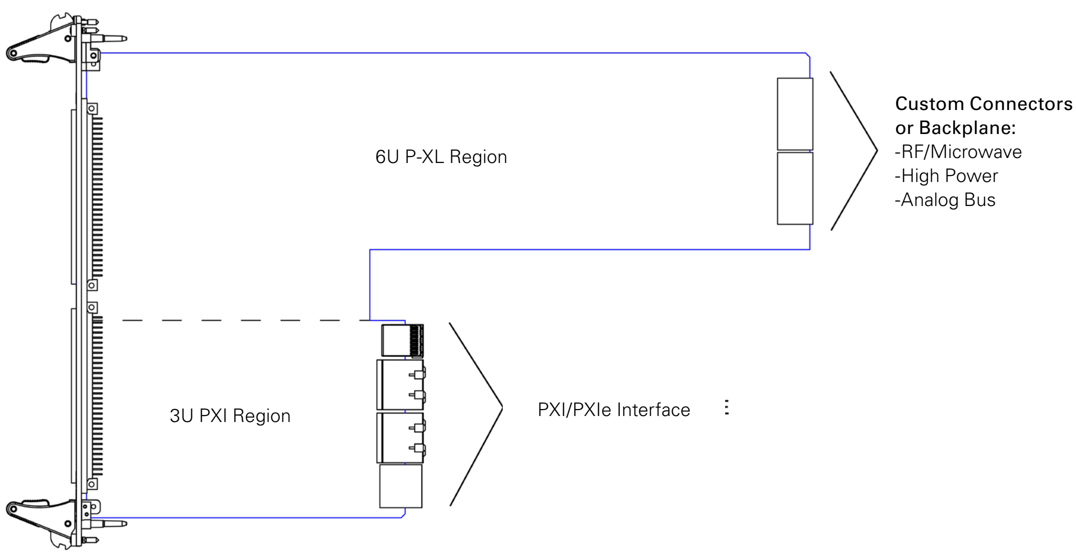


Figure 7. P-XLe modules have a 3U PXI region and a 6U P-XL region in a single slot. (Image courtesy of Hiller Measurements.)

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.

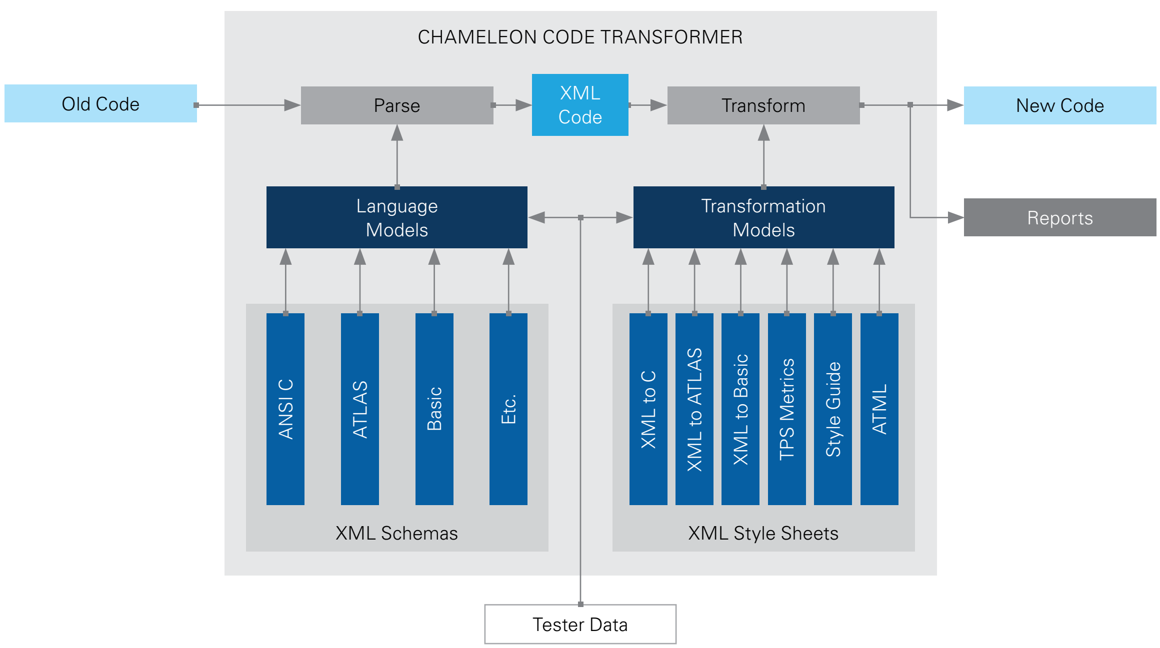


Figure 8. Chameleon greatly reduces software rehost cost and development time while increasing quality and traceability. (Image courtesy of ADVINT.)

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.

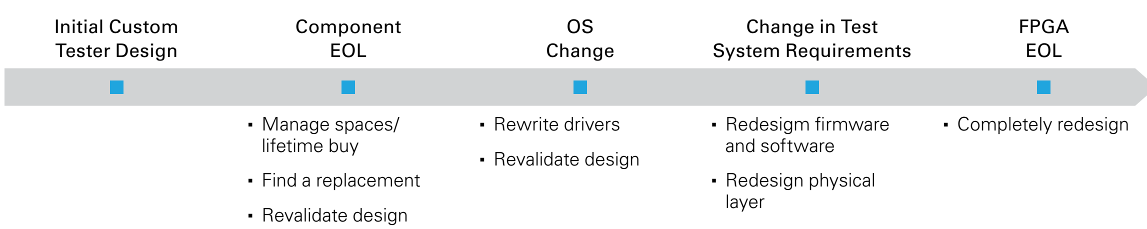


Figure 9. Managing the life cycle of a home-grown FPGA-based system presents a significant maintenance burden and risk.

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

Solving Tomorrow's Obsolescence Management Challenges with System Design

CONTENTS

Test systems built to manufacture and support aerospace and defense platforms generally need to remain in service for the lifetime of that platform, or at least long enough to perform planned sustainment over 20 or 30 years. Most test systems are not built in a way that includes sustainment engineering as part of the initial design.

Consider using these best practices in operations implementation, hardware acquisition, and software design to reduce the sustainment burden of handling obsolescence in test systems long before the equipment goes end of life. Following these best practices can cut the number of engineering hours by half, or more, and reduce associated costs by hundreds of thousands, or even millions, of dollars over the lifetime of the test system.

Focus on Sustainment and Obsolescence in Operational Decision Making

Designing a test system for long-life operation means making decisions with the entire life cycle of the system in mind.

Choose Reliable Platforms and Vendors

One of the ways you can improve your obsolescence-readiness decision-making process is to choose the right lifetime-optimized products and vendors who emphasize engineering for a long-life cycle.

Two high-level best practices in choosing building blocks for your long-life test systems are to work with commercial off-the-shelf (COTS) tools and use industry-standard platforms that are managed by multiple vendors and end users. Several government associations, test and measurement industry committees, and private organizations are working toward standardized and interoperable platforms with many suppliers. Some examples are the Sensor Open Systems Architecture (SOSA) and PXI Systems Alliance (PXISA). Purchasing from vendors who cooperate with these organizations ensures that the platforms you use have been vetted and offer multiple options for long-term sustainment.

Some engineering tools vendors have policies, services, and cooperative engagements. These policies can extend all the way to new product development. For instance, new PXI products and instruments developed by NI must support multiple releases of LabVIEW and maintain operational continuity from version to version. The PXI-4060 model of the PXI Digital Multimeter (DMM) that was introduced in 1998 uses the same "Fetch" function for measurements in the NI-DMM instrument driver as the PXIe-4081 DMM that was released in 2017.

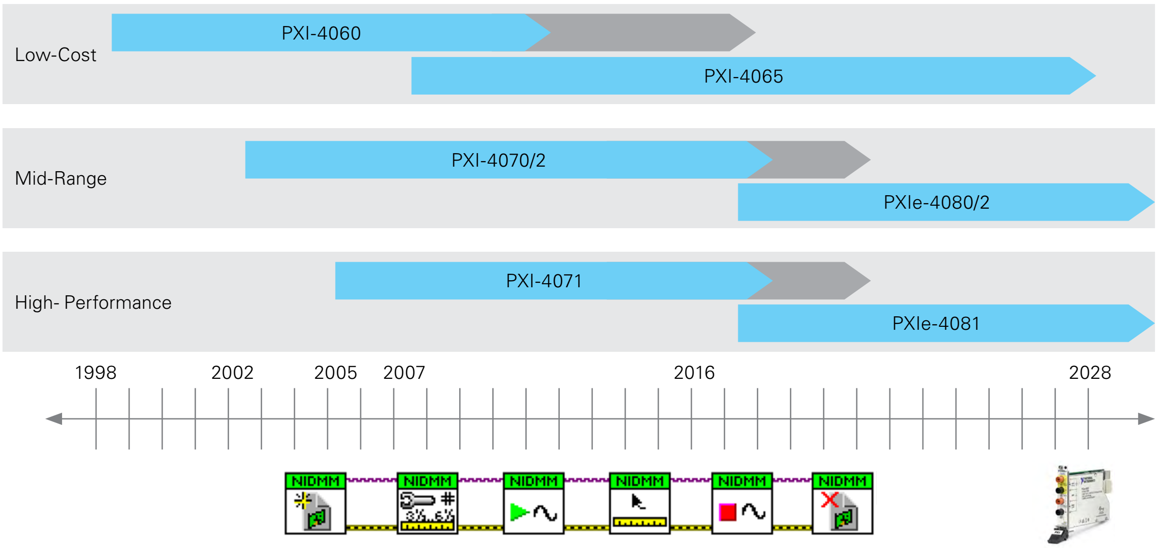


Figure 1. NI DMMs have used the same driver functions since the first one was released. The PXIe-4081 DMM operates with the same code that was written to work with the PXI-4060 in 1998.

Cooperate with Your Vendor

The best long-term test systems are built on platforms that feature sustainment plans continually updated with all the essential life-cycle information for the system's hardware components. Obtaining life-cycle information requires establishing a cooperative relationship and good communication with suppliers. It also requires diligent suppliers who create plans. Instrument vendors should empower you to plan for technology evolution in your system, even sharing roadmap information where possible. They should also provide services ranging from up-front consulting on product selection to long-term extended service agreements to meet your specific needs.

If you have decades-old products like the PXI-4060 DMM in your test system, NI is happy to regularly engage in a life-cycle review of that test system to measure the risk of obsolescence of each instrument and consider timelines for technology insertions. See Figure 2 for an example of a technology life-cycle review. By engaging in reviews like this, you can plan a single technology insertion project to replace multiple aging components at the same time. This reduces engineering effort and cost and prevents unforeseen obsolescence events. Then, instead of fighting fires, you can properly plan the headcount and budget you need to refresh technology and investigate new products and capabilities from the vendor to extend the features of your test systems.

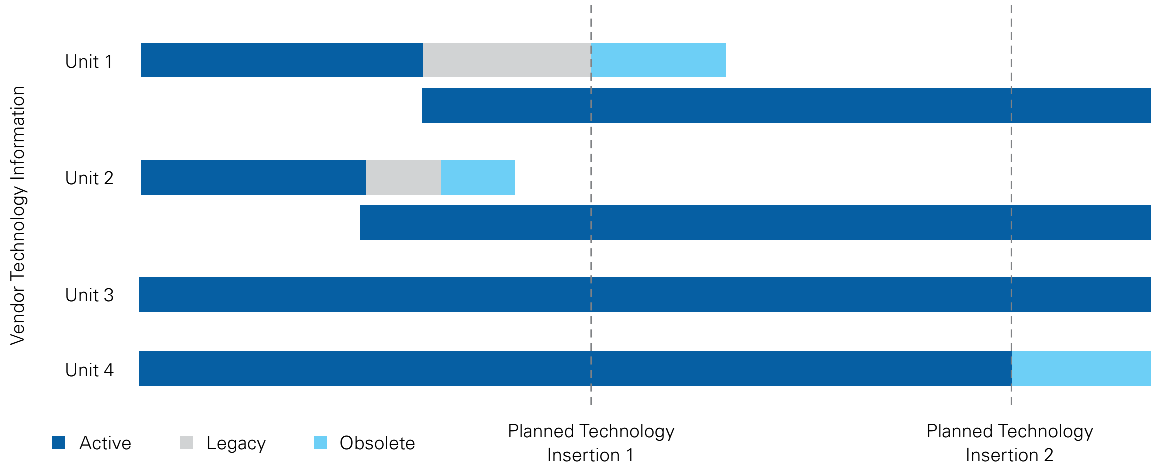


Figure 2. This is an example life-cycle review and the resulting plan for replacing instrumentation with more modern options. Planning technology insertions with your tools vendors reduces the downtime risk of your test system.

The following sections on hardware and software best practices explore how to choose new products to build into your test systems. They also discuss how to select the vendors for those new products.

> "CACI's relationship with NI has grown to a level of mutual trust as we work together to deliver high-quality, sustainable test solutions at affordable prices."
>
> Paul Pankratz, CACI

Cooperate with Procurement

Once you have selected the right products and vendors, you can improve your decision-making operation by involving your acquisition team in defining the system. If you can identify critical equipment or vendor features that will save money on other tools and engineering effort over the lifetime of the system, you can work with the purchasing team to include those as requirements in the final system. That significantly simplifies the proposal and purchasing process.

Document an Obsolescence Management Plan

The last operational step to improve sustainability is to implement an obsolescence management plan in the documentation of the system at the time of delivery. This plan should offer information for replacing all system components including when they should be replaced, how critical each component is to the operation of the test system, and how much risk is introduced by the obsolescence or replacement of that component. The criticality and risk are the most important pieces of information to capture in this plan. The team designing the test system often knows far more about these issues than those maintaining the system 20 years later and can explain the effort needed to replace each component. See Figure 3 for an example obsolescence management plan.

Component	Plan of Record	Replacement Component	Timing	Criticality and Risk
Custom Cable	Drop-In Replacement (Vendor-Supplied)	Custom Cable	Immediate	Medium and Low
1 kΩ Resistor Network	Drop-In Replacement (Vendor-Supplied)	1 kΩ Resistor Network	Immediate	Low and Low
Racal 4152A DMM	Replace with Similar (Vendor-Supplied)	NI PXIe-4080 DMM	Technology Refresh	Medium and Medium
Windows XP	Replace with New (Vendor-Supplied)	Windows 10	Technology Refresh	High and Medium
Virtex-2 FPGA	Last Time Buy	N/A	N/A	High and Low

Figure 3. A test system should have an obsolescence plan that describes how to handle the end of life for any component in the system. The plan should list all the factors that contributed to that decision including the criticality and risk of that component becoming obsolete.

Hardware Selection and Integration

You should always consider the sustainability of each piece of hardware you select when designing a new test system to operate for decades. Just as important, however, are the vendor services for sustaining the system and the skills needed to operate and maintain it over time.

COTS Components

The most sustainable test systems are built with COTS components. Using COTS products expands the user base for a given product, which improves the likelihood that the product will be properly maintained. Test hardware from large vendors has many users, so updates to firmware, drivers, and the hardware life cycle are planned carefully to reduce impact across a wide user base.

Open Industry Standard

To ensure that your test system can be sustained over decades, you need to select a hardware platform that is continually growing as well. Then you can avoid completely redesigning a test system architecture when a single component goes end of life or when you need new measurement capabilities. Open industry platforms such as PXI, VXI, and GPIB deliver the benefits of multiple vendors who are innovating on the hardware platforms through instrumentation hardware competition. This competition fosters healthy platform growth and a constant supply of new products to meet the needs of advanced test systems.

The PXISA includes more than 70 test and measurement vendors who oversee the maintenance and innovation of the PXI test hardware platform, which is an open-standard platform. Growth of the PXI platform has been rapid since the adoption of the standard in 1998. In addition to a vast product offering, PXI is expected to continually grow for the foreseeable future, as shown in Figure 4, making it an ideal platform for use in long-term test systems.

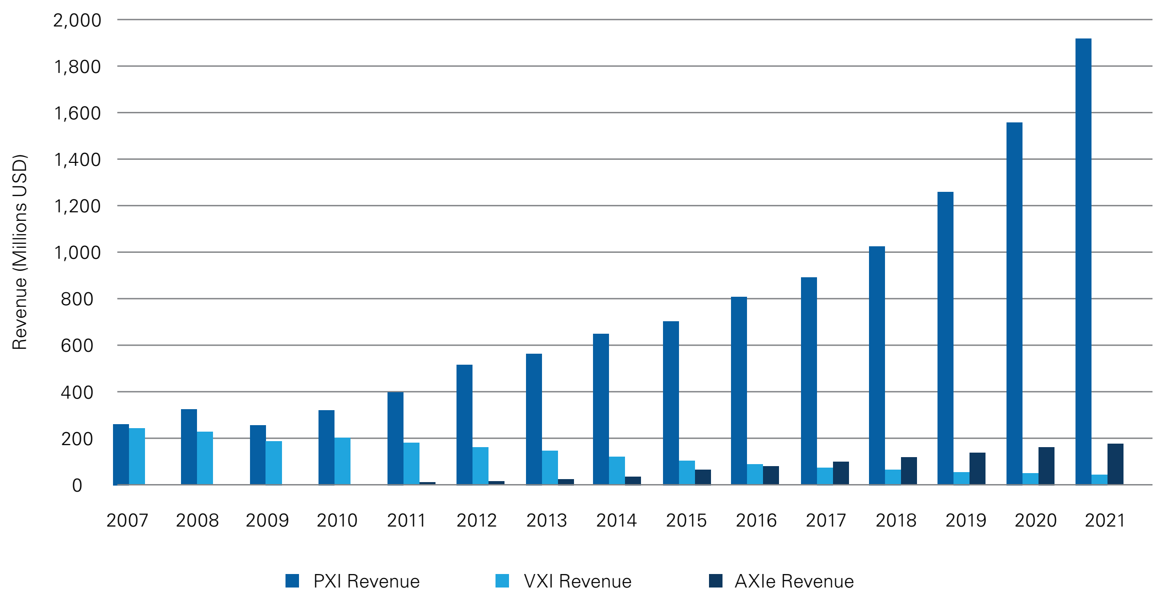


Figure 4. PXI is the dominant plug-in test instrumentation platform on the market today. Experts project continued growth for PXI over other modular test instrumentation platforms for the foreseeable future.

Plug-In, Modular Hardware Architecture

Open standards that have modular, plug-in components further decrease system costs by maximizing component reuse and reducing technology insertion effort. Replacing a traditional instrument means accounting for size, heat generation, power consumption, and other factors. Upgrading or replacing a modular instrument is as easy as removing the old instrument from its slot in the carrier and replacing it with the new one.

Plug-in architectures also simplify test system expansion. Test systems built for longevity are often required to incorporate more I/O over time to test new features or line replaceable units (LRUs). Having test systems that can stand the test of time requires an instrumentation platform with a large portfolio of products that can perform tests on DC, analog, digital, and RF signals at various levels with accuracy and speed.

Synthetic or Software-Defined Instrumentation

Test hardware in modern test systems often needs to perform many measurements and tests. Instruments with software-configured measurements have the flexibility to take the right measurement and get the results needed. Many times, these instruments have extensive code compatibility with other instruments using industry-standard APIs, like VISA or IVI, or well-engineered vendor-defined APIs. Combining the right complementary hardware and software tools can facilitate the design of long-term test system architectures.

Instruments with open FPGAs add another level of compatibility by helping you design the firmware of an instrument and reuse that firmware on compatible instruments as necessary. This type of customization isn't always necessary, but it can help promote important features that could go obsolete over time.

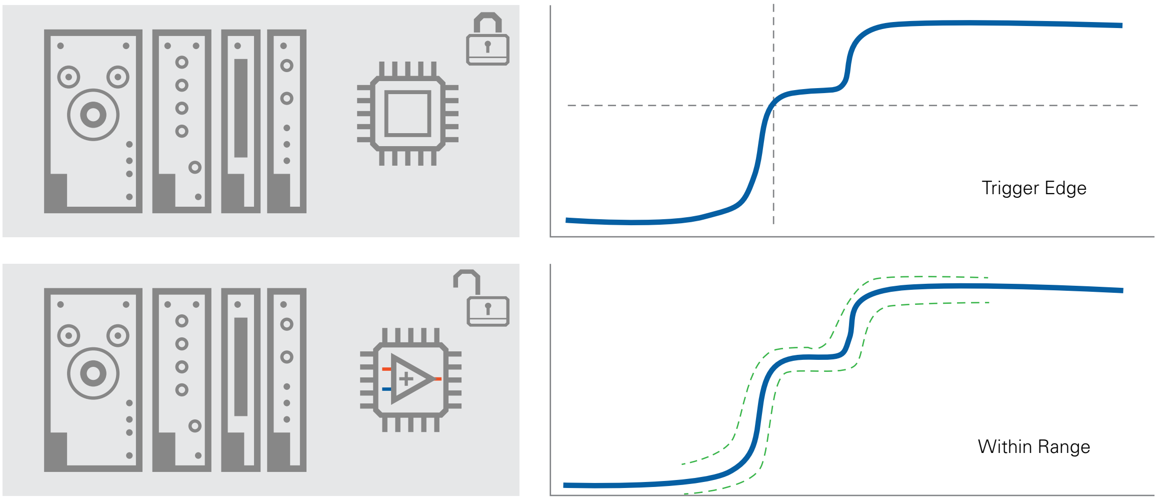
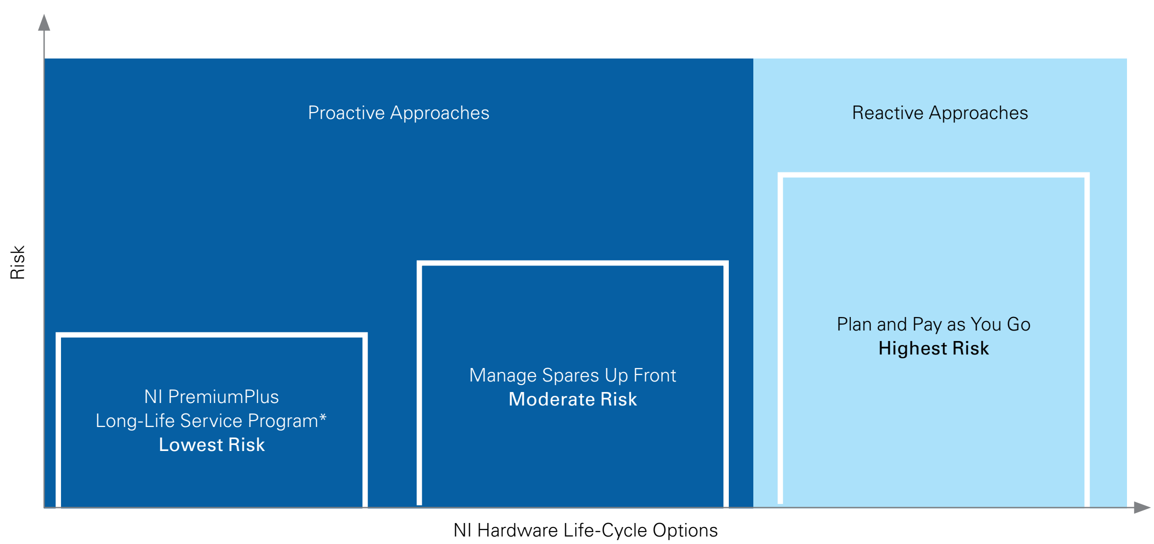


Figure 5. NI devices with programmable FPGAs help you create custom measurement features like triggers and signal processing as well as interoperative device firmware.

Hardware Platform Investment and Support

Another sustainability step is to ensure that test products are manufactured by vendors who have strong track records for continual bug fixes and software support updates as well as the ability to provide replacement products for aging ones. Without vendor support, you may have difficulty troubleshooting technical issues and unforeseeable problems in the system.

A good hardware vendor also provides options for warranties on instrument function, calibration services and instructions, repair plans, and even the ability to reserve spare hardware to ensure minimal downtime if instruments in the test system break down. NI offers several levels of service contracts, from coverage on a single instrument to system-wide coverage that lasts up to 20 years.



*Available durations depend on hardware life-cycle phase at the time of purchase.

Figure 6. Collaborate with NI on a service program that extends the life cycle of your NI products for up to 20 years. You can use this preconfigured program as is or customize it to meet your specific application needs.

Reduce obsolescence risk and ensure long-term serviceability with the NI Long-Life Service Program.

Software Tools and Architecture

The test software architecture you select may be even more important than the software platforms you choose to build a sustainable test system.

COTS Software Tools

As mentioned, using COTS software tools can significantly increase the sustainability of test systems. COTS tools have wide user bases and are maintained by large, specialized software development teams. This means your software organization's maintenance effort is significantly reduced. Consider an older application built to work on Windows XP that needs to be ported to Windows 10 as a result of Department of Defense mandates. If the application development environment (ADE) used to develop the code does not support Windows 10, the test program must be completely reconstructed.

Companies that sell high-volume enterprise software tools can also offer tailored purchasing agreements and software subscriptions that meet specific billing needs or defined terms and conditions.

Test Software Toolchain and Interoperability

The ideal software package should minimize the effort to develop and expand the test program and, thus, streamline the productivity of software engineers while minimizing their sustainment effort over the lifetime of the test system.

To match the pace of technology acceleration, maximize engineering efficiency, and minimize software maintenance effort, test systems must be flexible and use ADEs that can withstand structural changes by working with multiple hardware and software platforms. Software developers may be forced to use multiple ADEs for different projects if the tools do not meet the needs or interoperate with the tools of each project. Imagine that your test program requires a new measurement performed by an instrument that is not in the test set. If your development software does not support this new hardware, then you may have to substantially change the application.

To incorporate these changes into the test program easily and quickly, you need scalable software. Examples of tools that improve the programming experience include easy-to-use application programming interfaces (APIs) that minimize the need to learn hardware caveats and ready-to-use example code that serves as a starting point for any application. Software tools should also simplify performing new analysis on data acquired from hardware by providing analysis functions or delivering interoperability with tools like MathWorks MATLAB® or Python, which offer complex data analysis.

Software tools should also include features that maximize the ability to reuse code. Some software tools do this by helping you create libraries or code repositories through interactive configuration utilities or by supporting drivers that use a standard communication protocol to help you program multiple instruments with the same API. NI instrument drivers are built to support multiple families and generations of instrumentation to maintain code compatibility over time.

Modular Software Architecture

Don't get locked into an inflexible test program by building a monolithic architecture; instead, plan ahead by building layers that perform separate test operations. In a monolithic architecture, the test program for the unit under test (UUT) includes code that manages test flow control, test execution, UUT stimulus, measurement analysis, limit checking, result logging, operator user interfaces, and instrument resource scheduling. This single source of functionality means that any new test requirements that arise because of an obsolescence event force you to revalidate the entire test system.

Instead, create a modular software architecture that has separate code bases for all critical test system functions. Test management software like TestStand handles common test program tasks such as test flow control, test execution, result logging, limit checking, operator user interfaces, and instrument resource scheduling. Test code should be responsible for tasks specific to the UUT like stimulus, measurement, and analysis functionality.

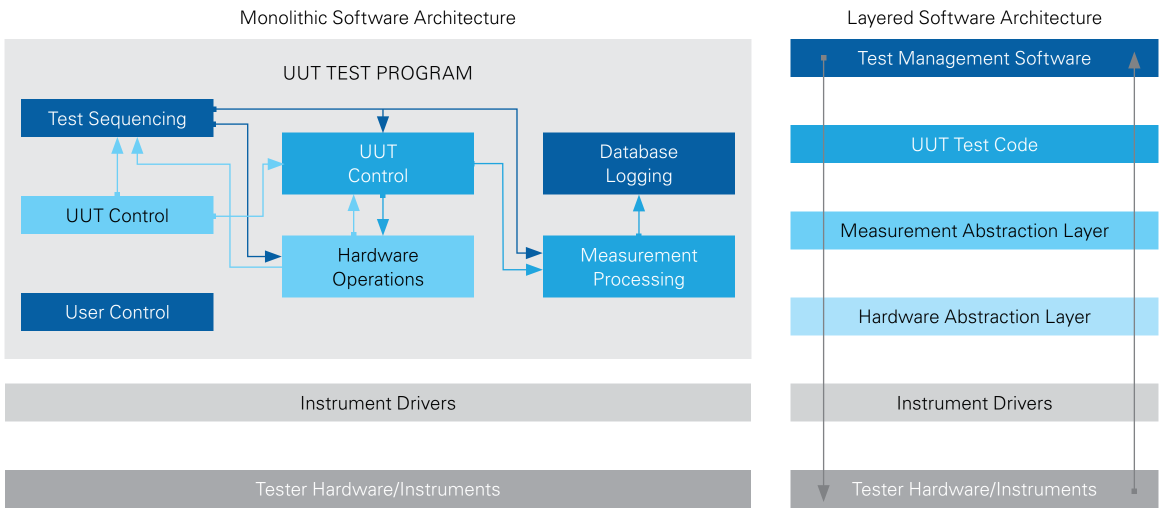


Figure 7. A single code base to handle all test program tasks seems like a good way to develop until it becomes inflated and difficult to change or repair. Using smaller, modular code bases for different tasks keeps a test system more extensible.

Functional Abstraction Layers

Perhaps the most significant software technique to protect a test system against inevitable hardware obsolescence events is using hardware abstraction layers (HALs) and measurement abstraction layers (MALs).

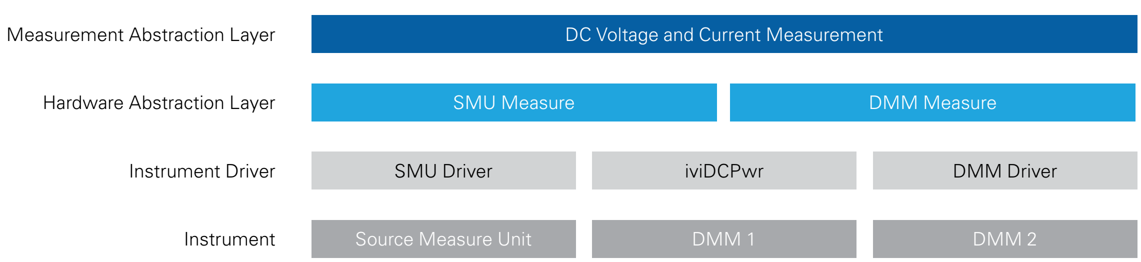


Figure 8. A MAL and HAL empower test engineers to choose the test result needed and allow the test system architect to maintain instrument driver and hardware interoperability.

Industry-standard instrument drivers like IVI can provide a quick and easy starting point for function abstraction, but they often fall short when you want to use specific features of new instruments that do not conform to standard driver function calls.

MALs help you develop high-level code that performs necessary functions without your defining specific instrument settings or communication. They also give the test system the ability to choose the correct and available resource to deliver a given test function. In some cases, a function in the MAL translates to a specific instrument, but some instrument functions overlap and could be used to complete tests in place of a busy or malfunctioning device. A good example of this is taking current measurements with a DMM. You can use a source measure unit (SMU) to take that measurement in many cases more effectively.

For a MAL to operate properly, you need an abstraction layer that handles instrument selection and communication. This layer is the HAL, which enables the code base to execute the function in the MAL from any specific instrument and device configuration in the system. Building these layers into your code gives you the flexibility to change instruments without altering measurement analysis code, the tester's user interface, or the overall test structure.

Learn the best practices and see the functional implementation NI test engineers used to develop an effective hardware abstraction layer (HAL) and measurement abstraction layer (MAL) architecture.

Technical Support and Training

A best-in-class vendor has on-demand technical support engineers to assist with any obstacles you may encounter or with getting started using hardware. NI offers on-demand technical support, classroom and online courses, and skills certifications programs. Certifications help you as a team leader measure the skills of developers on your team and give you a method to evaluate new engineers or contractors who may join your teams to help complete projects.

Learn more about NI training courses, professional certifications, and on-demand skill certifications in the NI badge program.

Next Steps

Discover strategies for handling reactive obsolescence events.

Explore the NI test engineering HAL and MAL in this 30-minute webinar.

Learn about NI's solution for electronics maintenance test.