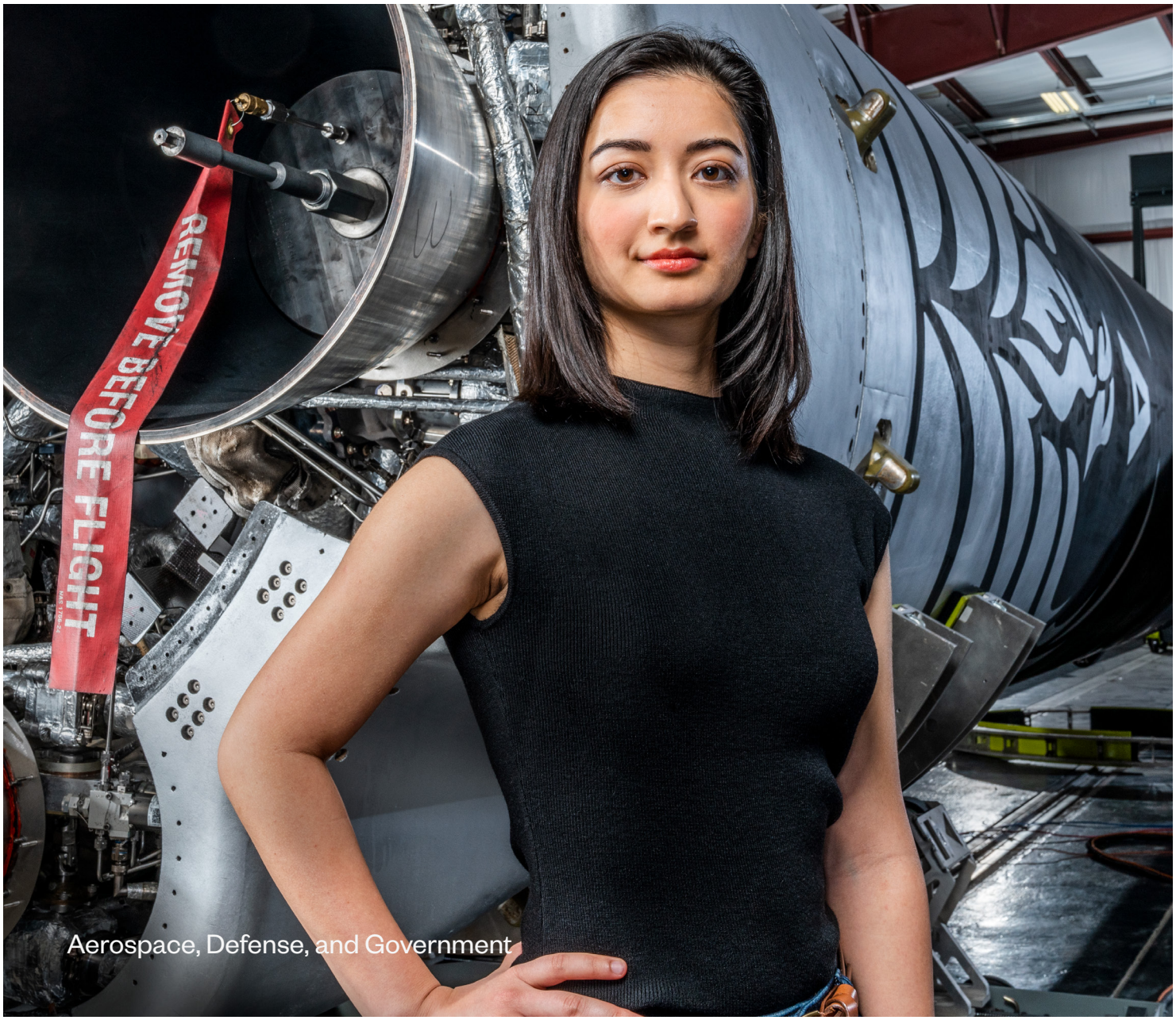
Test Engineering Insights



Aerospace, Defense, and Government

Test Engineering Insights for Aerospace, Defense, and Government

A Note to Test Engineering and Operations Leaders

Whether you're planning for your next program bid, preparing for compliance with CMMC 2.0, or portfolio-managing software engineers to support a growing inventory of legacy testers, you are consistently evaluated on your ability to manage schedule, budget, and risk. You are not alone. Aerospace and defense organizations across the world are being asked to develop new electromagnetic capabilities, share and analyze data across operational domains, manage new and often unbudgeted corporate or government mandates, and maintain legacy test equipment for years longer than originally planned.

NI has served the aerospace and defense industry for decades with disruptive, PXI-based instrumentation and application software that reduces the overall cost and risk associated with the design, validation, test, and support of your mission-critical products and platforms. In these articles, we'll share some of the insights and best practices we've identified working with thousands of engineers and leadership teams to manage risk and ultimately generate a sustainable market advantage for you through advancements in test engineering and operational support.

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Luke Schreier
Vice President and General Manager
of Aerospace, Defense, and Government Business

Gain a Competitive Edge through Test

Implement better test strategies that not only mitigate risk but also enable you to proactively leverage your test department to win programs.

The pressure to win bids in the aerospace and defense industry is intense. For years, government clients and Primes have been tightening their budgets and delegating more project risk to subcontractors. As a program manager, you may frequently find yourself in tough competitive situations that require you to propose the lowest possible cost to win the bid. However, winning programs with high design complexity often adds pressures of increased risk and short delivery times.

When looking to reduce program cost, the test function is a tempting target. Test is often perceived as a roadblock in product development: a necessary evil plagued with time and cost overruns. Therefore, test funds often get cut when budgets shrink and schedules tighten. And then tensions rise as test managers feel stuck. The test requirements for these programs are increasingly complex, yet test managers have less time and budget to meet them.

The Inflection Point of Test

This tension is a symptom of a test strategy that hasn't evolved to meet new business pressures. Most aerospace and defense organizations start designing test systems when product development is mostly complete. This practice was sufficient when technology was simpler and time and cost pressures were less intense, but it cannot scale with a changing industry. If test continues to be an afterthought in your product development process, the cost of test, whether that is capital cost or development time, will continue to increase as product complexity increases. The industry has reached an inflection point, and real change is required to reduce the cost of test to scale to meet the business needs.

The good news is that you can implement better test strategies that not only mitigate risk but also enable you to proactively leverage your test department to win programs and grow revenue. A more integrated test strategy can give you a competitive edge by allowing you to optimize for capital expense, product quality, and/or time to market. This has already been proven in other industries.

The consumer electronics and automotive industries have faced these same challenges for years. Consider

the leaps of technology in automobiles; today's luxury car now has about 100 million lines of code. Yet even though test coverage must increase as automobile complexity increases, global competition and consumer expectations dictate that release schedules stay constant and prices stay competitive. Automotive companies simply do not have the luxury to wait until after they have designed the product to start building their tests. Test must be part of the design cycle from the very beginning. Now that aerospace and defense organizations are experiencing these tremendous time and cost pressures, you must start shifting your test strategy or risk losing revenue.

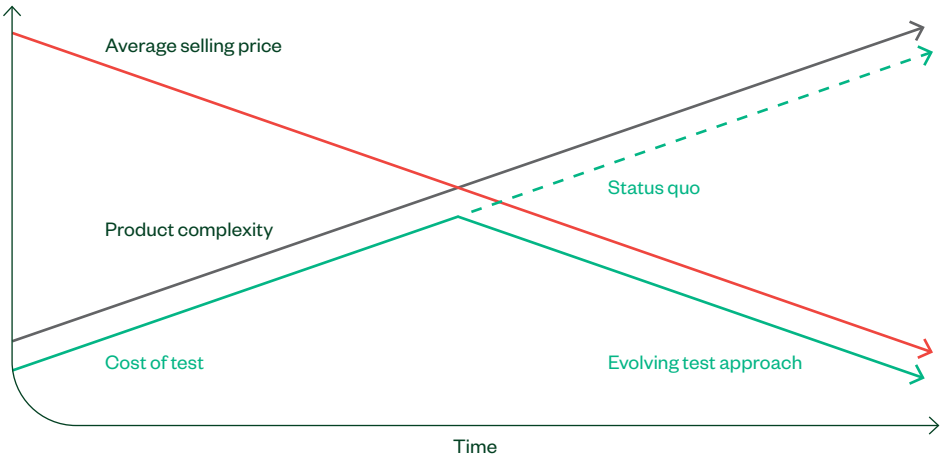
Winning through Test Integration

If you want to use your test department to win business, you must integrate test into the design cycle from the beginning. Companies who test and design concurrently have more efficient development cycles and maximize test coverage without letting schedules slip. By integrating test earlier, you are enabling your test department to better understand client needs. Instead of taking a one-size-fits-all approach to test, test engineers can optimize across different vectors—time, cost, and quality—to more directly meet customer needs.

For example, if a client is particularly cost sensitive, the test department can choose less expensive hardware to lower capital cost, perhaps trading off test times or test coverage. Alternatively, if a quick design turnaround is most critical, test engineers may choose more off-the-shelf components at a higher capital expense or sacrifice some customization in their software design. Keep in mind, however, that the ability to effectively optimize for varying technical and cost requirements hinges on a flexible test platform. This way, test engineers can adapt through both hardware and software to meet complex requirements while maximizing software reuse.

In addition to having a flexible test platform, you must include the test department early, even during the initial design planning. A critical functional change like this requires a high level of communication and consensus across the organization. As a test and measurement expert for more than 40 years, NI has helped thousands of companies across various industries undertake similar integration efforts. In addition to offering the world's most flexible test and measurement platform, NI has the expertise to help assess your current practices, facilitate manager forums and business discussions, and recommend areas for optimization. With commitment and collaboration, you can transform test from a roadblock into a competitive edge for your business.

The Inflection Point of Test Cost versus Complexity



> To improve service and increase productivity, we created an environment of collaboration within our company. An important part of this vision was selecting a global standardized test platform, and NI offers the most complete platform to accomplish this.
>
> **Vice President of Engineering Test**
> A Major Aerospace Company

Calculate Total Cost of Ownership

Get ahead of your constantly shrinking budgets and schedules by understanding the cost drivers of your test organization.

The aerospace and defense market has changed. Organizations and programs need to optimize product technology and the value of their business processes to win contracts. This is especially true now that contractors and suppliers are taking on more of the risk in project budgets and schedules.

Building consensus on how best to adapt design and test in the face of these changes can be tough. Using aging business models for test can lead to varied perspectives on funding across organizational silos or a rigid view that organizations must spend less on test by reducing budgets, shortening schedules, and/or lowering capital expenditures. These policies to reduce test expense often delay the delivery of projects and test sets to manufacturing because of extended implementations of new test solutions or stalemates of internal divisions trying to make decisions within large organizations.

How do you know if your organization is over- or underinvested in test? To answer this question, you need to identify a data-driven perspective of test expense. NI has helped many aerospace and defense test organizations make significant changes to lower cost and deliver extraordinary value to operations using a total cost of ownership model.

Total Cost of Ownership

Total cost of ownership (TCO) is a business concept that helps you calculate the overall cost of owning or operating equipment, business units, or an entire organization. You can use this method for many purposes. In this case, TCO shows the relative cost of operating a test facility, team, or specific test set to evaluate the effects of new investments or methodology that could significantly lower costs. TCO has three cost components:

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Development costs include the planning, hardware, and software tools that are used to validate the design, develop an initial solution, and justify the time and effort of the developers. These costs come from building new test sets that could range from a new multipurpose platform test solution for many products, to a dedicated tester for a specific product, or even to the deployment of a new product on an existing test platform. Development costs are often the smallest contributor to TCO, but they can be more significant when the tester is built for a broader purpose.

02

Deployment costs follow, and they include all the equipment and effort involved in making the test solution

ready for customers. The most obvious part of this is the capital expenditure needed to procure all the equipment and the engineering effort to assemble automated test equipment (ATE) and deploy software. You also have the cost of processing efforts, which often include hundreds of purchase orders and clerical sign-offs.

03

Operational and maintenance costs are generally the largest contributor to TCO, especially in aerospace and defense organizations, because test equipment is purchased on a 10- to 15-year service expectation. They are also the most overlooked costs when evaluating test systems and strategy. Operational and maintenance costs are so large because they don't stay the same no matter the age or purchase date of the test equipment. Aging test equipment, legacy components sparing, outdated power circuitry and equipment functionality, and rents for floor space all contribute to ongoing operational costs. Operations managers must weigh these costs against the risk and cost of production downtime should a test set component fail. Operational and maintenance costs also include operator wages and training, utility rates, installation of power or cooling to accommodate test equipment, and last, but certainly not least, maintenance costs. Maintenance costs can be anything from test equipment calibration, to component failures, to legacy component replacement. The engineering effort to change test program sets, insert new technology to avoid obsolescence costs, or upgrade to address changing requirements might be categorized as maintenance costs or as development costs depending on the roles and makeup of your test organization.

TCO Success

NI has worked with numerous companies over the last four decades to implement a financial model framework for quantifying TCO specifically designed for test organizations. In these engagements, NI gives insight into the data based on experience with tens of thousands of test projects. At the outcome of these discussions, NI is able to offer extensive recommendations on proper hardware and software tools, test software architecture, parallel test unit under test connectivity, and test data management.

For example, NI has worked with several tactical radio equipment suppliers to create specific TCO models and understand their cost drivers. Because of the insights and recommendations NI provided during TCO model delivery, those tactical radio suppliers chose to standardize on the NI test platform. One engineering director said of the TCO engagement with NI, "In our military business, performance and reliability are literally a matter of life and death. The National Instruments platform gave us the ability to significantly scale our production test throughput by 400 percent with ROI [return on investment] of 185 percent while rigidly maintaining the quality and performance standards that our military radios are known for."

The engineering manager who implemented the new test system added, "We successfully standardized on the NI platform to reduce our production test costs by 74 percent and will save millions of dollars this year and for years to come."

Quantified Business Impact of Test

TCO gives you a tool to quantify the financial impact of test on your organization. Additionally, it models the effects of changes by quantifying the ROI and payback period of investing internal research and development in the upkeep and modernization of ATE. This can lead to a minimized total cost of test, an improved cost-to-defect ratio, and, ultimately, an optimized test organization. The process of understanding and measuring your TCO presents an excellent opportunity to understand other decision makers in your organization and build consensus. Understanding the effects of investments in development, deployment, and operational and maintenance processes allows you to justify the budget to impact cost savings in your organization.

We successfully standardized on the NI platform to reduce our production test costs by 74 percent and will save millions of dollars this year and for years to come.

Engineering Director
Tactical Radio Supplier

↑ 185%
Increase in return on investment

↓ 74%
Decrease in production test costs

Use Total Cost of Ownership to Justify Test Investment

Test is much more than a technical exercise. It is a critical business function. Use total cost of ownership to fully characterize the importance of test when asking for budget and winning new business.

The success of aerospace and defense organizations hinges on their ability to deliver a quality product on time and on budget. Although design innovation and new features make a product compelling to the market, delivering that product within budget and schedule constraints is nearly impossible without frequent, reliable, and rigorous testing. Unfortunately, test is often viewed as a technical exercise rather than a critical business function. Aerospace and defense organizations consistently face pressure to remove it from their budgets to deliver cutting-edge technology on time.

Using only the initial capital investment in test equipment as the primary metric for evaluating the importance of this function does not correctly characterize the benefits of test organizations. Determining and using total cost of ownership (TCO) is a more comprehensive way for you to properly evaluate the full impact of test. It can also be a powerful tool for justifying investment in your test organization.

Evaluate Budget and ROI

Understanding TCO drives informed return on investment (ROI) decisions. Consider a company using a functioning but outdated manual test system. Looking at just the initial investment would suggest that maintaining the status quo is the most cost-

effective decision. However, a TCO view demonstrates that operation cost, test time, and quality concerns from human error pose a strong business case for upgrading the system. It also shows that the long-term returns on an initial investment justify the request for budget.

When you weigh options for investing in new tools and upgrades for your testbeds, a TCO perspective shows that keeping test systems up to date ensures a future of uninterrupted testing. This includes investing in reliable commercial off-the-shelf (COTS) products rather than leaning on internal research and development (IRAD) as the source for all innovation. Although no one knows as much about your needs as your own organization, sourcing products from within can lead to headaches down the line. The burden of maintaining an in-house product only increases with time as the product becomes more antiquated and those with the tribal knowledge of the product move on. Additionally, COTS products are vetted and purchased by companies globally, so known issues are public and fixes are reliable.

Testing in-house components can also be a challenge. When a single organization is responsible for developing custom test hardware and performing component tests, the test process can become incestuous and yield compromised results, so product quality and reliability suffer. Although perpetuating aging systems and sourcing new technology from within may seem cheaper initially, the larger impacts to the business make this a costlier option in the long run. By considering the TCO of a reliable testbed—including the long-term ramifications of an investment—you can make more informed budget decisions and realize the greatest ROI.

Win New Business

You can also use TCO to highlight the test investment you are making when working to build investor confidence and win new business. Investors are concerned with features, but they ultimately want assurance that you are releasing a reliable product. By showcasing test as a critical business function, you can provide a more credible guarantee to stakeholders that their investment has the greatest probability of successful return. This creates a track record of reliable business that you can use to win new bids and include as part of a test function's TCO.

Additionally, evaluating TCO allows you to quantify risks that can have catastrophic business impacts, such as the cost of failure. Success or failure is easily evaluated for space companies that have a finite number of opportunities to prove their products in a year. A failure can equate to hundreds of millions of dollars in lost investments. This cost of failure for aerospace and defense organizations is often multiple orders of magnitude greater than the investment in test equipment that would help prevent these failures in the first place. By effectively evaluating TCO, you can better understand the critical business impacts of rigorous testing and prove your company's commitment to test when winning new business.

Guarantee Continued Success by Investing in Test

Comprehensive testing is an important function for any successful technology company, but it is crucial to aerospace and defense organizations. However, the mandate to operate within time and budget constraints can put pressures on this vital business function. By understanding and using TCO, you can justify new investment in your test organization and prove the importance of test to your organization when building investor confidence.

> It is critical for us to complete high-quality designs within budget and schedule to continue to win business and ensure customer value. We have developed a productive partnership with NI that helps us meet these challenges, leveraging its latest technology platforms and best practice knowledge in enterprise-level test execution.

Vice President of Program Management
Tactical Radio Supplier

Manage Program Risk: COTS Versus Custom

Basing test systems on commercial off-the-shelf (COTS) technology offloads the burden of part maintenance and obsolescence management so you can use your expertise to produce state-of-the-art aerospace and defense assets instead of building custom test rack components.

As technology continues to advance, test systems must evolve to keep pace. With both product design talent and an intimate knowledge of test system requirements available in-house, producing custom hardware and software for test systems internally can seem like a good option. Historically, internally designed and produced solutions were the only viable option in some areas of test to achieve the required customization and performance. However, these solutions often require significant upfront engineering effort, present long-term maintenance responsibility, and can make it difficult to design in the latest industry advancements as they become available. Field-programmable gate arrays (FPGAs) have empowered engineers to create innumerable custom solutions to meet their needs, but they have also allowed instrumentation vendors to create COTS solutions that not only meet specification requirements but can offer industry proven flexibility. Proper design of FPGA-enabled devices and their drivers can also ensure that test systems achieve the longevity required to support program lifecycles. COTS-based tools purchased from reputable vendors address two major concerns: part maintenance/obsolescence and custom engineering.

Part Maintenance/ Obsolescence

To adhere to program schedules, the desired life expectancy of test systems can far outweigh the lifecycles of the parts that compose them. Aerospace organizations incur significant risk and cost to source hard-to-find components to maintain systems based on custom in-house designs. Additionally, companies must spend dedicated time ensuring that these parts are still available while reaching agreements with vendors to procure them beyond their active lifecycles.

A proactive and comprehensive approach to managing hardware obsolescence includes working with a vendor who proactively communicates, offers form/fit/function hardware replacements, and provides continuity in the software/hardware driver platform. Basing a test system on COTS products from a trusted vendor significantly offloads the maintenance and part obsolescence responsibility to the vendor and places the burden of lifecycle management on a reliable source rather than making it an in-house project. Offloading this responsibility reduces the overall cost of test, significantly lowers risk, and shortens time to market.

Custom Engineering

Traditionally, aerospace and defense organizations have relied on a lot of non-recurring engineering (NRE) for test rack components like signal conditioning or connectivity. Although these system-specific requirements may seem unique, they can still be served by COTS solutions if the solution is customizable. Investing in a software-defined platform that allows for user-driven customizability and expansion ensures you can account for the uniqueness of your design and evolving requirements without heavily investing in NRE.

For example, software defined radios (SDRs), used in a wide variety of applications from direction finding to spectral monitoring, deliver amplified benefits when built with COTS technology. The concept of an SDR is based on the simple architecture of a processor or embedded system paired with an RF front end.

Though you can create custom SDRs in house, their maintenance and integration prove challenging. On top of hardware design and maintenance, custom driver development and software integration can be a tremendous burden. USRP SDRs based on COTS technology offer flexibility for software developers through the Ettus Research USRP Hardware Driver (UHD) and the NI-USRP driver. You can connect with the vibrant community of USRP users across multiple software ecosystems in addition to using the IP already available for USRP SDRs. Additionally, because of driver consistency across USRP hardware, you can use the same software throughout the design, prototype, and deployment phases of your development process. This helps to accelerate the transition from lab-based testbed to fielded system.

Another example of how COTS tools can simplify the design process is hardware-in-the-loop (HIL) test. HIL is a common methodology for verifying embedded software used in aerospace control systems like line replaceable units (LRUs). Although unique connectivity and signal paths are often necessary for the specific LRU being tested, most HIL systems are comprised of similar building blocks and can be completed with vendor-provided, customizable COTS tools.

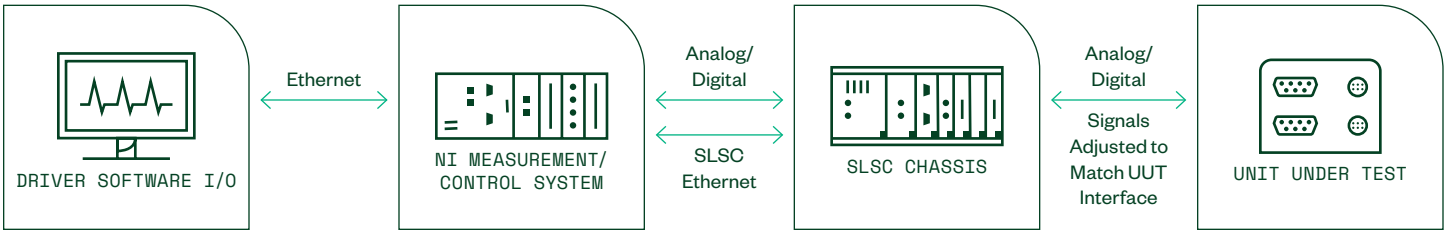
A standard LRU test system consists of a unit under test interfaced to a mass interconnect or interface panel that is connected to signal conditioning, switching, power supplies, loads, and simulation I/O. A set of aircraft systems models and test software operate the hardware to interface with and simulate components in the larger system to test the LRU. This common signal path flow often leads to customized signal conditioning for sensor simulation, specific loads, or unique switching topologies to add fault insertion or other phenomena for software testing. Traditionally, these aspects had to be addressed by in-house designs, but new advancements in COTS technology, such as NI's switch load and signal conditioning (SLSC) hardware, offer a common hardware framework. The SLSC platform is well-documented, which allows engineers to build custom modules while also empowering vendors who specialize in HIL test to offer common signal conditioning, switching, fault insertion, and loading in COTS modules.

COTS Tools for Uninterrupted Program Cycles

You are the expert when it comes to defining your test requirements and ensuring that your product is comprehensively tested. Custom engineering often seems like the best solution to leverage your unique expertise, but it can place a greater burden on a test organization, reduce your velocity to release a test solution, and limit testing to in-house knowledge rather than expanding it to incorporate the latest industry developments. By using COTS tools, you can ensure that your organization is free to innovate on new designs rather than saddled with the burden of maintaining antiquated, in-house components. Additionally, with advancements in COTS tools, you can offload custom signal conditioning and fault insertion to vendor products and take advantage of an entire test system based on a consistent platform that is customizable through software.

> Using (NI) COTS technology further promotes our goal to focus the attention on building HIL test systems and rigs, not developing advanced hardware.
>
> **Anders Tunströmer**
> Saab Aeronautics

SAAB Embedded Software Test System Diagram



Drive Operational Performance with System and Data Management

Reduce the operational costs of aging test equipment through distributed system and data management strategies.

The test and verification of avionics systems are integral to ensuring the reliability, availability, and quality of aerospace and defense assets. Organizations depend on modern software analysis, test, and verification tools to help speed up the availability, certification, and deployment of mission-critical systems. As programs evolve through their active lifespans, companies must balance the desire to adopt new technologies while preserving support for legacy assets with long life cycles. According to CACI, a solutions-oriented services provider for the American Department of Defense community, government test equipment is typically required to support the weapon system end-items a minimum of 10 to 15 years. These requirements demand sound automated test system and data management strategies that integrate into existing workflows to ensure asset availability and adaptability to fast-paced industry changes.

With the departure from a cost-plus contract paradigm, the need to efficiently manage automated test systems escalates. Development risk shifts to contractors through the enforcement of fixed-cost models, which makes controlling development and test costs increasingly important. These costs are directly impacted by the need to ensure both the effectiveness and quality of increasingly complex assets before they are used in operational settings. The maintenance of aging test systems adds significant cost to the equation because it demands modular and scalable solutions that evolve to accommodate the needs of both legacy and future assets.

Improve Business Results through Actionable Insights

Automated test systems generate massive amounts of data on the order of terabytes and potentially even exabytes per day. Hidden in these oceans of data is valuable information that can directly impact business decisions, so the need to securely track, audit, and manage data associated with test and verification systems is paramount. The trustworthiness and availability of this data are critical and directly translate into product quality, reliability, and availability.

Effective data management strategies incorporate data from multiple distributed sources and produce various levels of insights. These strategies need to incorporate capabilities for quickly finding, analyzing, and reporting test data both at the test system and enterprise levels. This includes metadata standardization and data quality checks to ensure all data is consistent regardless of where it originates. You need solutions for quickly finding important pieces of information across multiple locations to save valuable time and resources. You also need to automate data analysis processes to generate reports that expose actionable insights in a timely manner.

Optimize Operations Efficiency with a Systems Management Approach

You can reduce your operational costs and maintenance burden with

an effective strategy for managing test assets and operational data. This requires test equipment that you can dynamically customize and maintain over program lifecycles to quickly adapt to your changing needs. And as technology trends make operations more distributed, you must be able to efficiently standardize configurations across sites to reduce setup and commissioning costs. More distributed systems also require you to remotely track and manage the status and condition of deployed equipment to ensure sustained operation. Finally, you must implement systems that provide real-time visibility into test results as well as accessibility across the organization to put the right insights in front of the right stakeholders to drive informed business decisions. The implementation of these strategies requires solutions that seamlessly integrate with your existing workflows to minimize risk and downtimes.

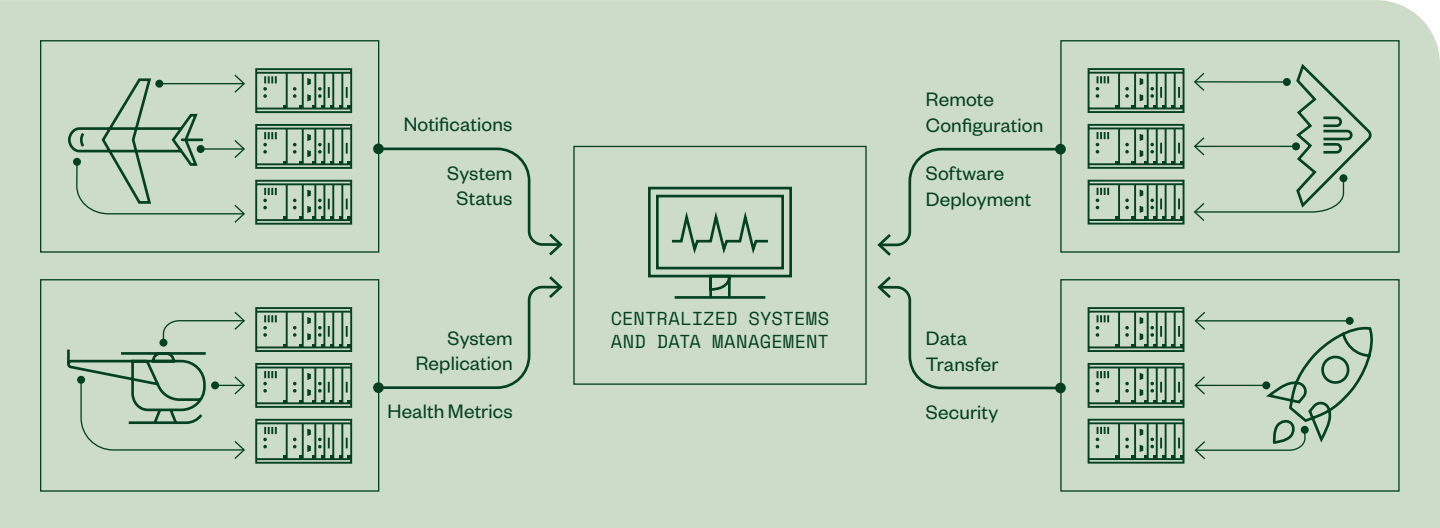
Sound system management strategies address needs such as provisioning, configuration, diagnostics, and device administration. They also help you remotely configure and visualize detailed system and device information, including settings, interfaces, installed software, and task history. In addition, best-in-class system management tools offer performance management capabilities such as dashboards for monitoring key system metrics like calibration state, memory usage, disk utilization, and uptime. They can also produce alarms or notifications based on triggers or thresholds. The combination of these strategies steadily increases system uptime, improves configuration compliance, and optimizes your overall test organization. Failing to implement effective system management strategies that offer these capabilities can negatively impact test requirement coverage and increase schedule and budget risks.

Leverage State-of-the-Art System and Data Management Solutions

By effectively managing test assets and harvesting insights from test data, aerospace and defense organizations can develop a competitive edge in a rapidly changing industry. Adopting disruptive platforms that seamlessly integrate system and data management capabilities allows you to improve operational performance and reduce maintenance costs. One example is NI SystemLink™ application software, which empowers test engineering teams to connect, deploy, and manage automated test and measurement systems—and their data—from a centralized location. SystemLink improves operational efficiency with intuitive system configuration and performance management tools that reduce maintenance cost and increase reliability. It also integrates with the NI Data Management Software Suite, an enterprise software solution that provides a complete workflow for standardizing data across teams, mining it for useful information, transforming it through automated analysis, and delivering reports with valuable insights. These solutions, along with effective system and data management strategies, help reduce costs and schedule risks to ensure you continue to meet program milestones long into the future.

> With limited depot maintenance funding, government test equipment is typically required to support the weapon system end-items a minimum of 10 to 15 years.
>
> **David Finnie**
> Technical Program Manager, CACI

Distributed System and Data Management



Minimize Test System Maintenance Costs

The cost to rewrite a TPS due to the replacement of legacy/obsolete instrumentation in a test system is approximately $150k per TPS. When multiplied across dozens of TPSs per test system and three to five generations of test equipment over the life of a test system, the potential savings in TPS costs alone are very significant. Any efforts that vendors can make to smooth this transition will prove to be invaluable.

David R. Carey
Associate Professor of Electrical Engineering, Wilkes University

Make the right decisions to minimize the complete lifecycle costs of your automated test equipment.

There is a common misconception in test organizations that if the technology within test sets doesn't change, then maintenance costs will remain constant. In reality, the costs of maintaining improperly managed test sets can grow at an exponential rate. To avoid that exponential growth in cost, your engineering teams need to update technology over time. But the cost to update test software during a technology refresh can reach hundreds of thousands of dollars per test program set (TPS). To reduce the overall cost of automated test equipment (ATE) maintenance, your organization needs to proactively set technology refresh policies, identify technology options that avoid TPS changes, and build a proper software architecture to reduce TPS revalidation cost.

Proactive Lifecycle Technology Planning

Your team must consider new technologies to extend the capability of your test system while understanding the trade-offs of proactively and reactively addressing the lifecycle situations of each system component. Untimely and significant end-of-life (EOL) occurrences can cause tens of millions of dollars in unplanned last-time-buy (LTB) costs or force the investment of internal research and development at the expense of new product development. No matter how you slice it, it's painful, and real-world constraints of justification, prioritization, and budget could derail your planning efforts.

Stay ahead of the situation by proactively identifying ATE component criticality and evaluating the mean time between failure of test system components. This allows your team to plan for EOL events and changing requirements in the ATE in a scheduled cadence. From a total cost of ownership (TCO) perspective, you may be able to take advantage of an LTB opportunity for a low-cost component that avoids the pains of revalidating the TPS. Keep in mind this limits your options for addressing future test requirements.

At NI, we understand how critical technology lifecycles are to your ATE. We can discuss the lifecycle management and technology insertion opportunities that best align with your schedules and risk tolerances. We also have long-term service options to guarantee the availability and service of critical components. By making these decisions early in the

lifecycle, you can budget for them as the test set moves across business units from manufacturing to operations and support.

Minimize TPS Revalidation with Compatible Hardware Migration

The aerospace and defense industry appropriately embraced standardization on VXI, a modular, commercial off-the-shelf (COTS) test platform. But VXI obsolescence and diminishing support for legacy instruments are forcing programs to migrate to stable alternatives like PXI. With 20 years on the market and nearly 70 vendors offering more than 1,500 PXI instruments, this technology will continue to provide increased value and a steady stream of innovation to long-lifecycle ATE systems.

The capital cost required to modernize hardware is typically far less than that of updating and revalidating software. Because of the criticality of the system and the tight regulations for requirements tracking and software validation, simply opening, saving, and revalidating a TPS or a test sequence, can cost hundreds of thousands of dollars. This creates an environment where companies must rethink their software strategies or risk losing money to sustain legacy testers.

Since minor software changes can greatly impact TPS compatibility, we at NI strive to offer TPS-compatible hardware migration options through development and partnerships with companies like Astronics Corporation. This includes preserving driver functionality, APIs, and dependencies between driver versions. Astronics is also incorporating VXI instruments in the PXI platform, which preserves TPS compatibility with legacy systems.

Reduce TPS Changes with a Tiered Software Architecture

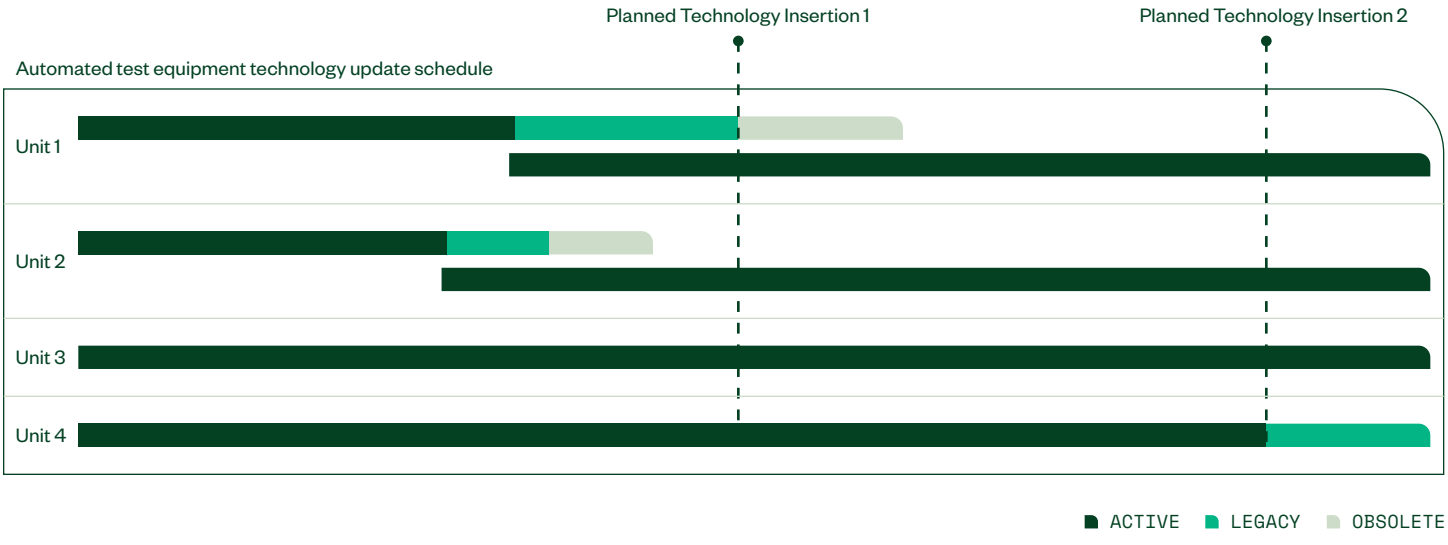
Another way to avoid costly and extensive changes to a TPS is to build your test software in a tiered architecture with abstraction layers that are intended to perform specific functions and isolate other elements from change. To build a proper test software architecture, you can either retain a large team of software engineers in house to create and maintain all layers of that architecture or identify developers who have skills in the COTS software tools needed to build such an architecture most effectively. Best practices for requirements tracking and test system design methodology will make those teams even more effective and help the next generation of test engineers maintain the system and introduce changes.

NI continues to invest in building a test software architecture for the long term. We are the only company offering the right software tools at every functional level—from the instrument drivers to the test code module and abstraction layer development, to test execution management and deployed system management.

Justify Proactive Lifecycle Investment

Operation, maintenance, and development costs can be significantly affected at any point in the lifecycle of an existing test set through technology obsolescence, changing requirements, or TPS transition. In the 40 years since our first sale to Kelly Air Force Base, NI has become a critical technology partner for the aerospace and defense community. We have developed a deep understanding of the business and technological challenges that come with designing, building, and supporting mission-critical test systems through our work with thousands of engineering teams across the industry. We can help you make the right business and technical decisions today to avoid staggering maintenance costs in the future. Doing so will help you justify the return on investment for proactive planning, technology insertion, and test software architecture improvement.

Plan Technology Insertions That Coincide with Vendor Component Lifecycle Events



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NI Services and Support

Long Life Service Program
Reduce the risk of obsolescence for long-term deployments through collaborative planning, guaranteed same-model serviceability beyond a product's active life, and optional technology refresh services.

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Meet your more advanced needs for compliance, such as ISO 17025, with our calibration services. You can also use advanced replacement and expedited or on-site calibration options to improve uptime.

Consultation and Integration
Leverage our extensive network of Alliance Partners and NI engineers for technical consulting, system integration, and migration assistance to help you reduce risk and complete projects faster.

Turnkey Solutions
Meet your test requirements faster with turnkey test systems created by our Alliance Partners for the aerospace and defense industry.

Training and Certification
Be confident you have the skills needed to design and develop high-quality applications that will scale. NI provides specialized training plans for aerospace and defense applications.

Global Support
Rely on more than 30 service locations worldwide, including repair centers, calibration labs, and logistics hubs, and more than 700 support and systems engineers in 49 countries—all using one consistent service network.

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