

SOLUTION BROCHURE

# Wireless Standards Validation Test

Cellular, GPS, and Connectivity Functionality for Smart Electronics

## Solution Overview

Smart, connected devices are proof that product designs are getting more complex. Test engineers need to validate modern designs that incorporate connectivity standards (Zigbee, Bluetooth, WiFi) as well as GPS and cellular. Also, they need to manage change requests from in-flux designs, address a large mix of instrumentation to cover requirements, and (hopefully) automate the final test system to improve productivity, all while keeping the design moving through to production. NI's wireless standards validation test system is a collection of test-focused hardware and software for building open, flexible, compact test systems for wireless standard validation.

# Contents

- Solution Overview ..... 1
- Solution Architecture ..... 3
  - Key Features ..... 3
- PXI System Overview ..... 4
- NI Test Platform Benefits ..... 5
- Signal Input and Output Hardware ..... 6
  - PXI I/O and Instrumentation ..... 6
  - NI Vector Signal Transceiver ..... 7
- NI Software for HIL Test ..... 8
  - NI RFmx ..... 8
  - NI VST Soft Front Panel ..... 9
  - TestStand Test Executive Software for Automation ..... 10
  - LabVIEW Systems-Engineering Software ..... 10
  - NI Instrument-Specific Drivers and APIs ..... 11
  - SystemLink™ Software ..... 12
- Infrastructure Elements for Validation Test Systems ..... 13
  - PXI Chassis ..... 13
  - PXI Controllers ..... 14
  - Mechanical, Power, and Safety Infrastructure ..... 14
  - ATE Core Configurations ..... 15
  - Mass Interconnect ..... 16
- Hardware Services ..... 18
- Support Services ..... 19
- NI Alliance Partners ..... 20



# Solution Architecture

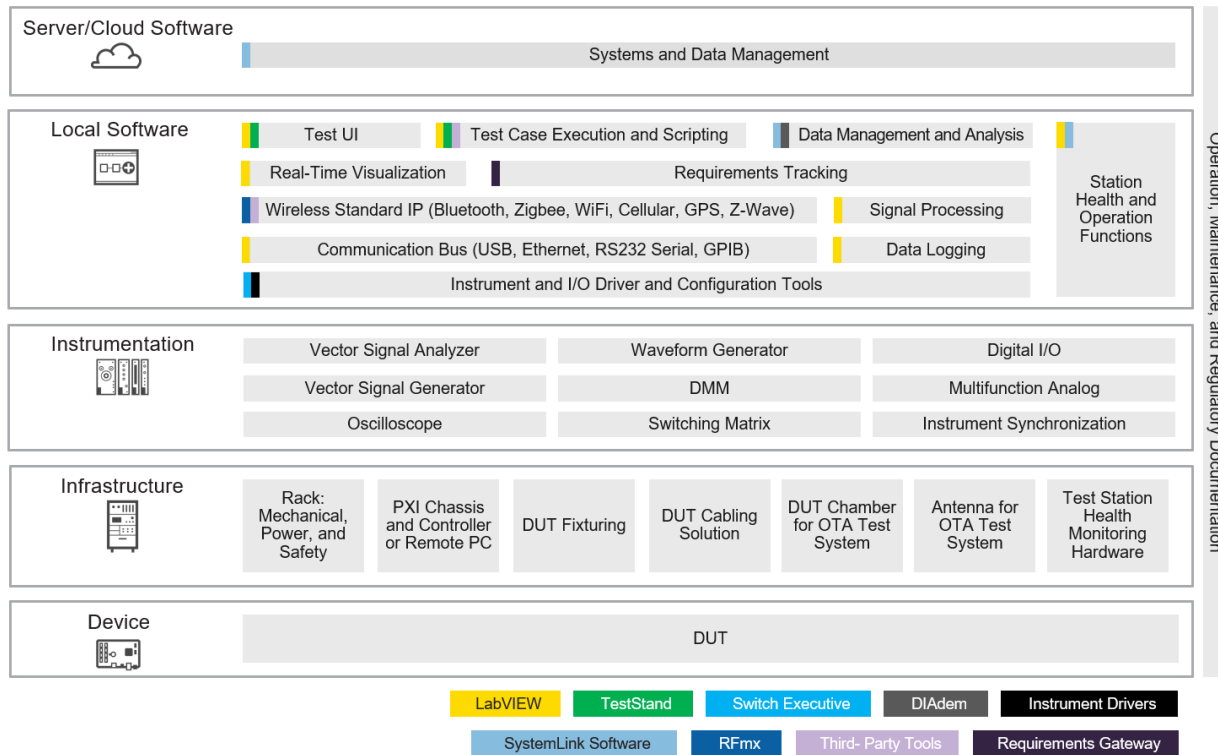


Figure 1. Solution Architecture

## Key Features

- Build a test system with a smaller footprint using PXI systems that combine modular instrumentation and signal I/O with timing and synchronization in a single chassis
- Test a variety of cellular and connectivity standards with the NI PXI Vector Signal Transceiver (VST) that combines software defined radio architecture with RF instrument class performance in a single PXI module
- Build, deploy, and automate your test system with TestStand test management software
- Control third-party instruments, program NI measurement hardware, and generate custom test reports with LabVIEW systems engineering software
- Combine COTS convenience with DIY flexibility with the configuration-based workflows of NI's application software for wireless design and test

## PXI System Overview

PXI is a PC-based system that combines PCIe electrical-bus features, a modular chassis, I/O synchronization technology, and user-defined or application-specific test software. PXI is an open industry standard governed by the PXI Systems Alliance, a group of more than 70 global test companies. NI was one of the pioneer companies that formed PXI, and is recognized as a leader in PXI test and measurement devices.



**Figure 2.** PXI chassis (18-slot shown) combine modular instrumentation, timing and synchronization technology, and test-centric software to form the core of a complete test rack.

PXI instrumentation includes:

- Analog and digital I/O
- Digital multimeter
- Oscilloscope/digitizer
- Waveform generator
- Switch and timing/synchronization
- Source measure unit (SMU)
- Programmable DC power supply
- Electronic load
- Instrument control and synchronization
- FPGA processing boards

---

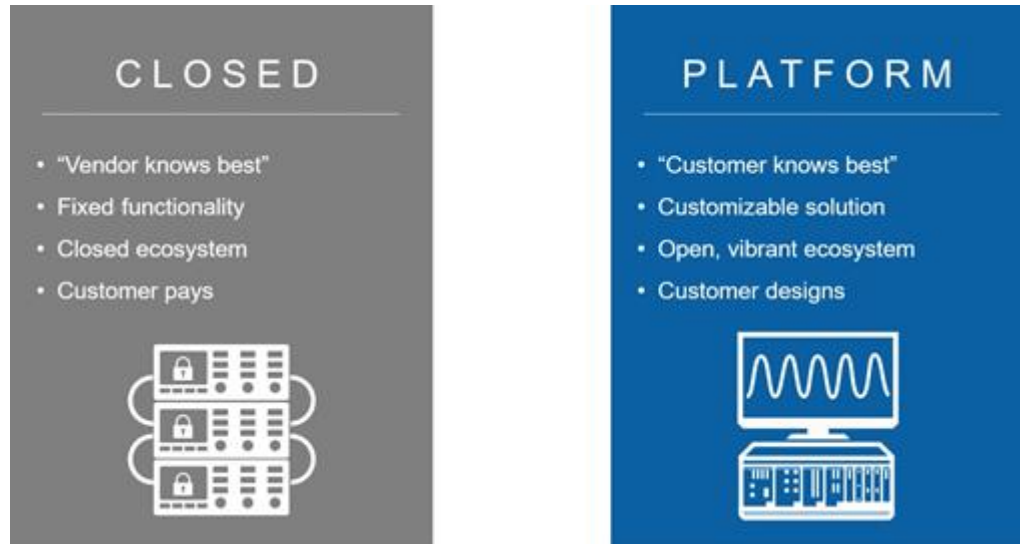
*“PXI chassis are a staple of our test systems, as is LabVIEW.”*

*Anthony Lambert, Engineer, Abbott Laboratories*

---

## NI Test Platform Benefits

- Build a universal test architecture for high reuse across test types and programs with NI's open and secure platform
- Better utilize data and more efficiently manage systems with NI's enterprise-ready cloud-based tools
- Easily integrate third-party equipment and customize software and hardware to meet unique test requirements
- Take advantage of an ecosystem of expert HIL specialty partners



**Figure 3.** Platform solutions are ideal for systems that need customization and the ability to keep up with change requests.

# Signal Input and Output Hardware

## PXI I/O and Instrumentation

NI offers more than 600 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 contain only the actual instrumentation circuitry, achieving 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.



### Oscilloscopes

Sample at speeds of up to 12.5 GS/s with 5 GHz of analog bandwidth, featuring numerous triggering modes and deep onboard memory



### Digital Multimeters

Measure voltage (up to 1000 V), current (up to 3A), resistance, inductance, capacitance, frequency, and period, and run diode tests



### Digital Instruments

Perform semiconductor device characterization and production test with timing sets and per-channel pin parametric measurement unit (PPMU)



### Waveform Generators

Generate standard functions including sine, square, triangle, and ramp, as well as user-defined, arbitrary waveforms



### Frequency Counters

Perform counter-timer tasks such as event counting and encoder position, and make period, pulse, and frequency measurements



### SMUs

Combine high-precision source-and-measure capability with channel density, deterministic hardware sequencing, and NI SourceAdapt technology



### Power Supplies and Loads

Supply programmable DC power (including some modules with isolated channels, output disconnect functionality, and remote sense)



### FPGA Custom Processing

Provide high-performance I/O and powerful FPGAs for applications that require more than standard instruments can offer



### Switches (Matrix and MUX)

Utilize a variety of relay types and row/column configurations to simplify wiring in automated test systems



### Vector Signal Transceivers

Combine a vector signal generator and vector signal analyzer with FPGA-based, real-time signal processing and control



### GPIB, Serial, and Ethernet

Integrate non-PXI instruments into a PXI system through various instrument control interfaces



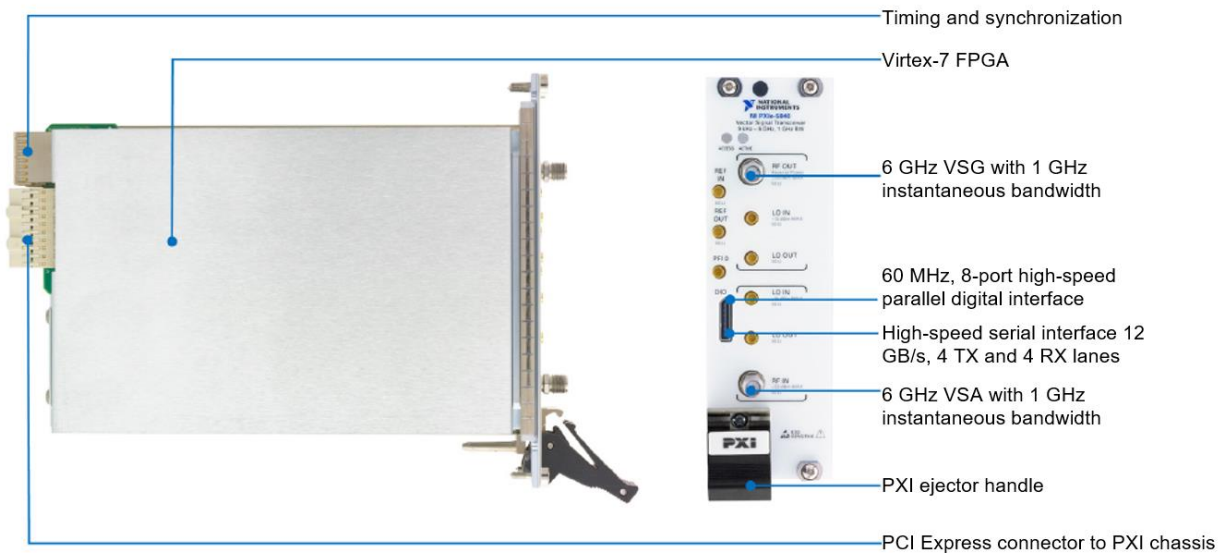
### Data Acquisition Modules

Measure electrical or physical phenomena with a mix of analog I/O, digital I/O, counter/timer, and trigger functionality

## NI Vector Signal Transceiver

The PXI [VST](#) combines an RF and baseband vector signal analyzer and generator with a user-programmable FPGA and high-speed serial and parallel digital interfaces for real-time signal processing and control. With 1 GHz of instantaneous RF or complex I/Q bandwidth, the NI VST is ideally suited for a wide range of applications, including 802.11ac/ax device testing, 5G design and testing, radio frequency integrated circuit testing, radar prototyping, spectrum monitoring, and more.

The VST incorporates the fast measurement speed and small form factor of a production test box with the flexibility and high performance of an R&D-grade box instrument. This means that you can use the VST to test a variety of cellular and wireless standards, including Bluetooth, LTE Advanced Pro, and IEEE 802.11ax, with an error vector magnitude of better than -50 dB (0.5%) at 5.8 GHz. In addition, you can easily expand the VST's small PXI Express form factor to support multiple input, multiple output (MIMO) configurations. The baseband VST can be tightly synchronized with the PXIe-5840 RF VST to subnanosecond accuracy, offering a complete solution for wireless chipset RF and baseband differential I/Q testing. The VST software, built on LabVIEW FPGA, features several starting points for your application, including application IP, reference designs, examples, and LabVIEW sample projects, while giving you the ability to fully customize the onboard processing.



**Figure 4.** Validation engineers use the NI VST combined with NI RFmx toolkits and LabVIEW engineering software to test multiple wireless standards in a single, compact test system.

### Key Benefits:

- Build MIMO systems with multiple VSTs synchronized in a single PXI chassis
- Cover requirements for 5G, 802.11ax, and more, with instantaneous RF bandwidth of up to 1 GHz
- Test wideband-signal error vector magnitude performance with best-in-class, patented inphase and quadrature calibration techniques



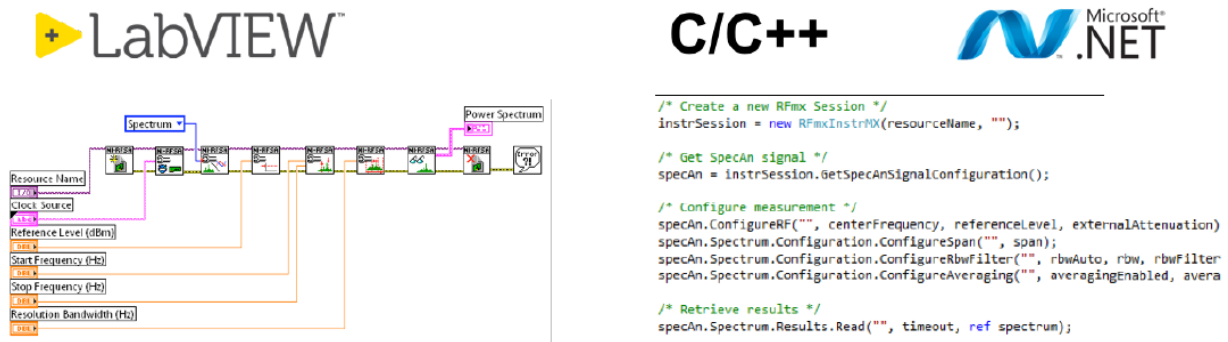
# NI Software for HIL Test

## NI RFmx

NI RFmx provides an intuitive, easy-to-use programming API that offers advanced measurement configuration. Use its highly-optimized API to perform tasks ranging from digital and analog modulated signal measurements to RF spectral measurements, including channel power, adjacent channel power, and power spectrum. You also can automate programs with accurate, high-performance, standard-based measurements for LTE-A, WCDMA/HSPA+, GSM/EDGE, Bluetooth, Bluetooth LE, and more. In addition to supporting cellular and general-purpose measurements with RFmx, NI offers wireless test standards software for GPS/GNSS simulation and FM/RDS. The WLAN Test Toolkit gives you direct and fine control over IEEE 802.11a/b/g/n/ac and ax signal generation and analysis, as well as 802.11j/p/ah/af waveforms, with industry-leading speed and accuracy.

### Key Benefits:

- Configure real-time tasks
- Visualize data and manage test execution
- Run automated tests



**Figure 5.** Add VST functionality to a test system with LabVIEW or text-based languages for increased flexibility and code reuse (shown here as power spectrum measurement programming).



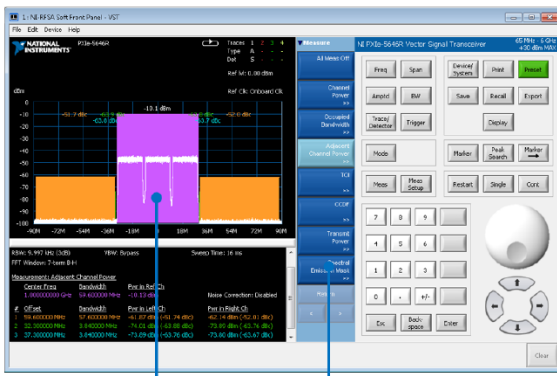
## NI VST Soft Front Panel

The simplest software use model for the VST is the soft front panel experience. With the soft front panel, quickly and easily configure the RF signal generator or analyzer to debug fixtures and obtain fast measurement results. For example, Figure 6 shows how to configure the VST for an adjacent channel power measurement.

### Key Benefits:

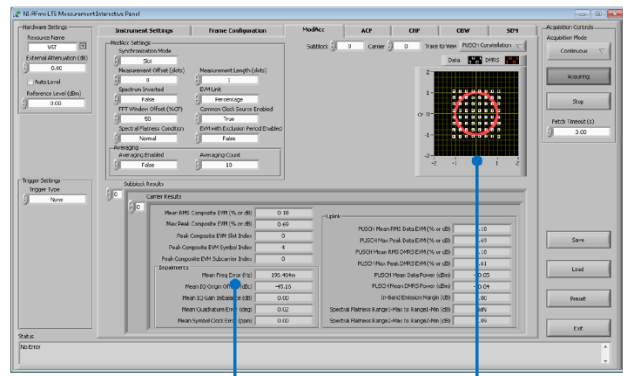
- Shorter time to data
- Multiple interactive examples available

NI-RFSA Soft Front Panel  
Virtual Spectrum Analyzer



Measurements and  
Spectrum Display      Configure  
Measurement Settings

NI-RFmx Interactive Examples  
For 2G to LTE Advanced



LTE Measurement  
Results      LTE  
Constellation

**Figure 6.** Configure the NI VST for quick measurements using the RFSA and RFSG soft front panels; other interactive examples act as soft front panels for different standards.

## TestStand Test Executive Software for Automation

[TestStand](#) ready-to-run test management software is designed to help you quickly develop and execute transaction processing system (TPS) software. You can extend TPS functionality by developing TestStand test sequences that integrate code modules written in a variety of programming languages, including G in LabVIEW, C/C++, .NET, and Python. TestStand also provides extensible plug-ins for reporting, database logging, and connectivity to other enterprise systems. You can deploy test systems to production with easy-to-use operator interfaces.

### Key Benefits:

- Customize test sequences to meet every requirement
- Automate saving and reporting test data
- Increase test throughput with parallel testing
- Efficiently replicate and deploy test systems
- Troubleshoot test systems with integrated debugging tools
- Customize user interfaces to meet testing needs



**Figure 7.** Use TestStand test executive software to build and deploy automated systems faster.

## LabVIEW Systems-Engineering Software

[LabVIEW](#) offers a graphical programming approach that helps you visualize every aspect of your application, including hardware configuration, measurement data, and debugging. This visualization makes it simple to integrate measurement hardware from any vendor, represent complex logic on the diagram, develop data analysis algorithms, and design custom engineering user interfaces.

### Key Benefits:

- Reduce system setup with access to thousands of instrument drivers, example programs, and documentation to connect to virtually any instrument.
- Use hundreds of instrument-specific example code modules and included measurement libraries to reduce development time

- Reuse existing code libraries from languages including C/C++/C#, .NET, Python, and MathWorks MATLAB® software
- Quickly create professional user interfaces to visualize test outcomes
- Build proficiency with extensive online and in-person training options for both new users and certified NI tool architects

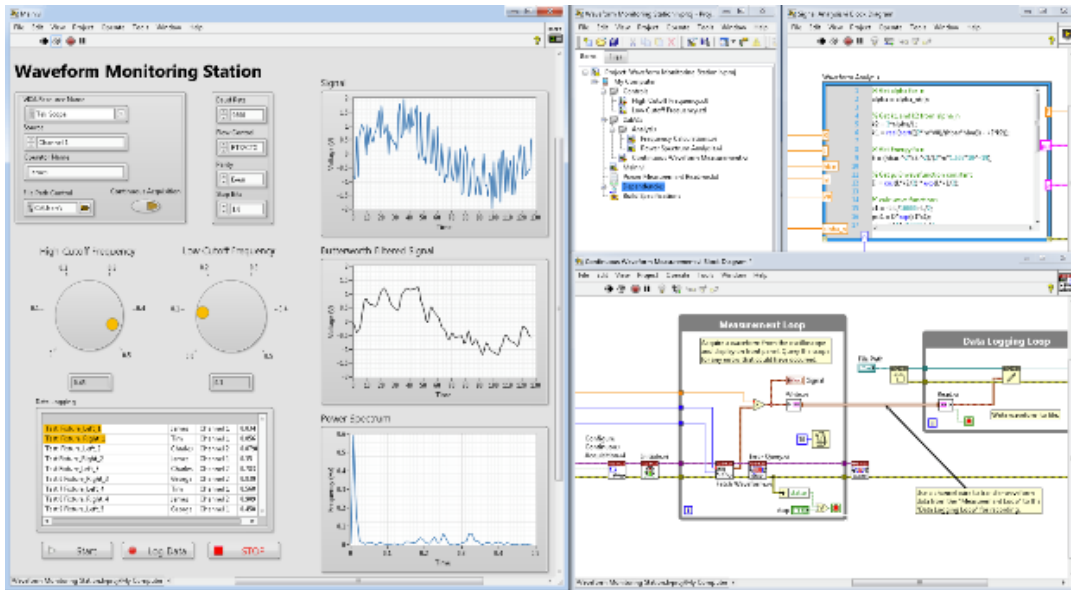


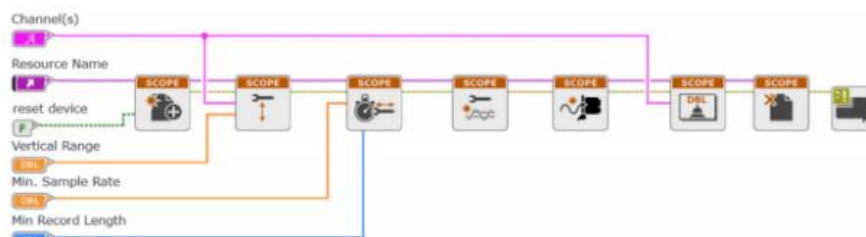
Figure 8. LabVIEW Software Interface

*“Our team uses a common hardware platform across testing of numerous products. Reusability of common hardware configurations and utilization of common LabVIEW code simplifies development of new test systems.”*

*Brian Teschendorf, Software Engineer, Boston Scientific Corporation*

## NI Instrument-Specific Drivers and APIs

NI measurement driver software includes best-in-class APIs that work with a variety of development options, such as LabVIEW, C, C#, Python, and others. To ensure long-term interoperability of our instruments, the driver APIs are the same for all past and current instruments. Also, the driver software provides access to help files, documentation, and dozens of ready-to-run shipping examples you can use as a starting point for your application.



**Figure 9.** LabVIEW API Example for NI PXI Instrumentation

```
// DAQmx analog voltage channel and timing parameters
DAQmxErrChk(DAQmxCreateTask("", &taskHandle));
DAQmxErrChk(DAQmxCreateAnalogVoltageChan(taskHandle, "Dev1/ai0", "", DAQmx_Val_Cfg_Default, -10.0, 10.0, DAQmx_Val_Volts, NULL));
DAQmxErrChk(DAQmxCfgSampClkTiming(taskHandle, "", 10000.0, DAQmx_Val_Rising, DAQmx_Val_FiniteSamps, 1000));
// DAQmx Start Code
DAQmxErrChk(DAQmxStartTask(taskHandle));
// DAQmx Read Code
DAQmxErrChk(DAQmxReadAnalogF64(taskHandle, 1000, 10.0, DAQmx_Val_GroupByChannel, data, 1000, &read, NULL));
// Stop and clear task
```

**Figure 10.** C API Function Call Example for NI-DAQmx

```
import niscopes
with niscopes.Session("Dev1") as session:
    session.channels[0].configure_vertical(range=1.0, coupling=niscopes.VerticalCoupling.AC)
    session.channels[1].configure_vertical(range=10.0, coupling=niscopes.VerticalCoupling.DC)
    session.configure_horizontal_timing(min_sample_rate=50000000, min_num_pts=1000, ref_position=50.0, r
with session.initiate():
    waveforms = session.channels[0,1].fetch(num_records=5)
    for wfm in waveforms:
        print('Channel {0}, record {1} samples acquired: {2:,}\n'.format(wfm.channel, wfm.record, len(wf

# Find all channel 1 records (Note channel name is always a string even if integers used in channel)
chan1 = [wfm for wfm in waveforms if wfm.channel == '0']

# Find all record number 3
rec3 = [wfm for wfm in waveforms if wfm.record == 3]
```

**Figure 11.** Code Example for NI Instrument Capture in Python

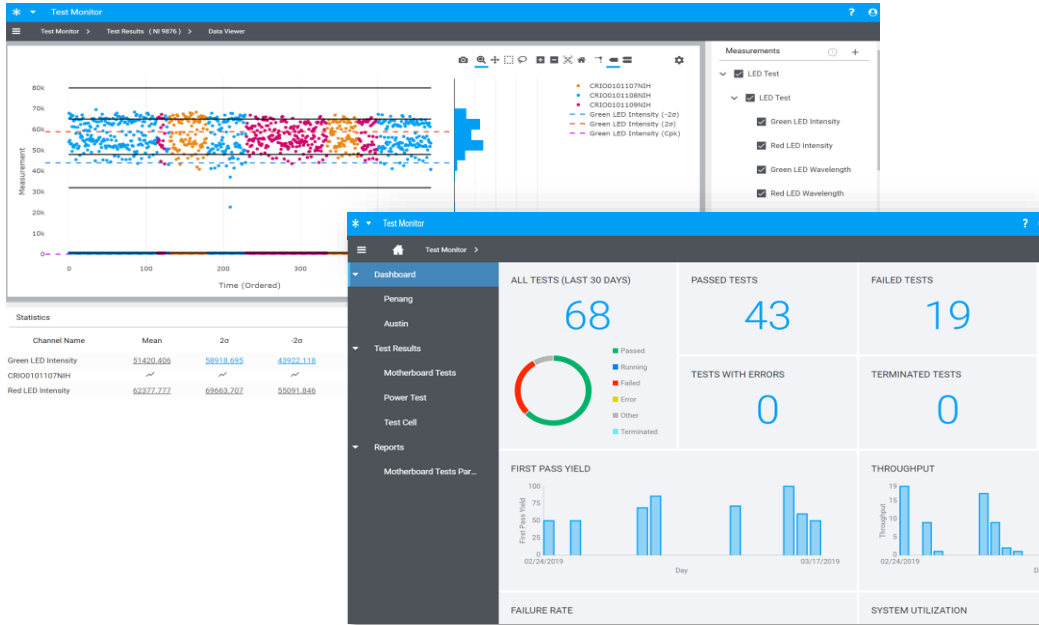
## SystemLink™ Software

SystemLink software eliminates the manual tasks related to keeping test systems current and healthy. From automating software updates to monitoring system health, SystemLink software delivers key information that improves situational awareness and test readiness. Utilizing an automation and connectivity framework, SystemLink software aggregates test and measurement data from all test systems into a centralized data repository. You can have ready access to asset utilization, calibration forecasts, and test-result history, trends, and production metrics data to make proactive decisions on capital expense, maintenance events, and test or product modifications.

SystemLink software is comprised of four modules—Software Configuration, Asset, Test, and TDM Data Finder. These modules provide application-specific capabilities that use the SystemLink server for data communication, transmission, and movement, as well as services for managing NI and non-NI instruments, software packages, alarms and notifications, and dashboards.

Key Benefits:

- Centrally manage distribution software
- Perform remote device configuration and diagnostics
- Automatically prepare your data from multiple test systems
- Automate data analysis and report generation



**Figure 12.** Dashboards built with SystemLink software help monitor test-station status and high-level data output.

## Infrastructure Elements for Validation Test Systems

While the infrastructure around a test station isn't typically recognized in test-coverage specifications, it plays a vital part in ongoing test-station operation. Carefully considering test infrastructure component quality, practicality, and functionality ensures long-term test-station success. NI provides many of the key infrastructure elements and partners with an ecosystem of trusted vendors to make recommendations on how to complete a fully operational deployed system.

### PXI Chassis

A PXI chassis equates to a desktop PC mechanical enclosure and motherboard. It provides power, cooling, synchronization, and a communication bus to the system; and supports multiple instrumentation modules within the same enclosure. PXI uses commercial PC-based PCI and PCI Express bus technology with rugged modular packaging (CompactPCI). Chassis range in size from four to 18 slots to fit the needs of any application, whether its deployed as a portable, benchtop, rack-mount, or embedded system.



**Figure 13.** PXI chassis connect PXI instruments to a high-bandwidth communication and synchronization bus.

## PXI Controllers

PXI controllers provide a high-performance in-chassis embedded computer. Embedded controllers have extended temperature, shock, and vibration specifications and include the latest in PC component technology and standard prefferal connectivity. Controllers comes preconfigured with LabVIEW Real-Time or Microsoft Windows and all device drivers preinstalled. NI's embedded controllers also include managed life cycles and vendor support to ensure test system longevity and compatibility with the PXI ecosystem.

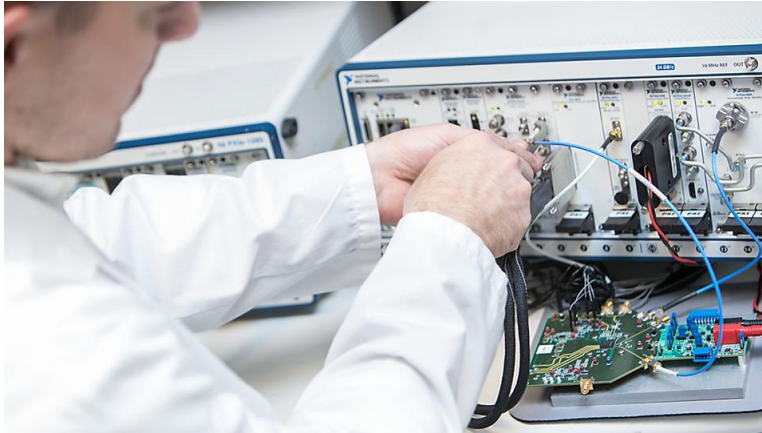


**Figure 14.** PXI controllers integrate PC elements into a PXI-based test system.

## Mechanical, Power, and Safety Infrastructure

PXI systems come in a variety of options for deployment, ranging from small, 4-slot chassis that take up little space on a desk, to 18-slot systems that can stack in a rack to minimize test-system floorspace. The more automated, synchronized instruments and measurements needed, the more value PXI adds to a test system.





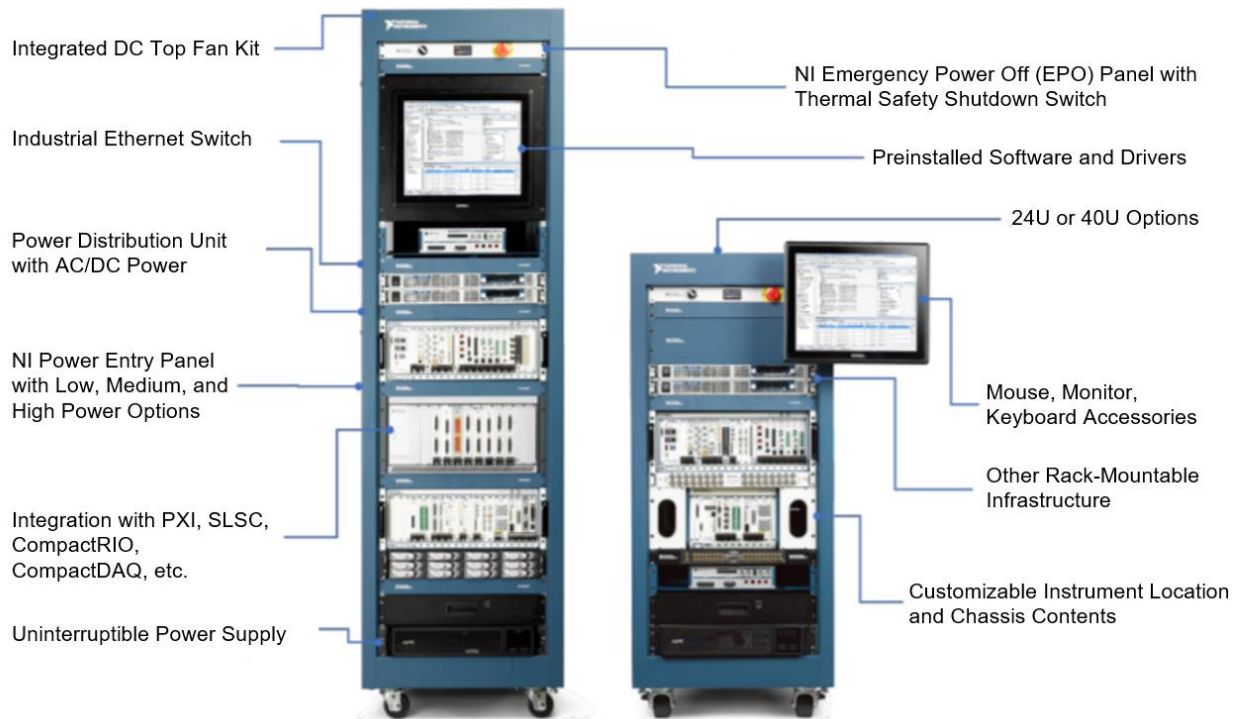
**Figure 15.** Many PXI systems are deployed on a desktop or workbench, which is ideal when you need multiple instruments but have no desire to build a full rack.

## ATE Core Configurations

Not all racks are created equally: Rack vendors seeking to reduce costs can compromise accessibility, durability, mobility, and reliability. NI has standardized a mechanical, power, and safety infrastructure for deploying rack-based automated test systems with trustworthy, high-quality components in a flexible, easy-to-maintain system.

[ATE Core Configurations](#) streamline your automated test-system procurement and control costs and timelines with single-vendor expedited preassembled, configured systems delivery. Reduce time and cost associated with multiple purchase orders by acquiring a full tester from one vendor, and having it shipped directly to your site anywhere in the world (IEC 61010-01-compliant). Each system is delivered with reusable packaging materials ideal for future redeployment.





**Figure 16.** Use an ATE Core Configuration to get quality rack components, preassembled and delivered to your dock—all from a single vendor.

Benefit from a single warranty covering your system, repair and replace parts from a single source, and trust NI's single service program to sustain your entire system. NI-configured systems save time and money while accelerating system deployments.

---

*"By standardizing on NI's ATE core configs, we were able to reduce the time it takes to build new testers by 40%."*

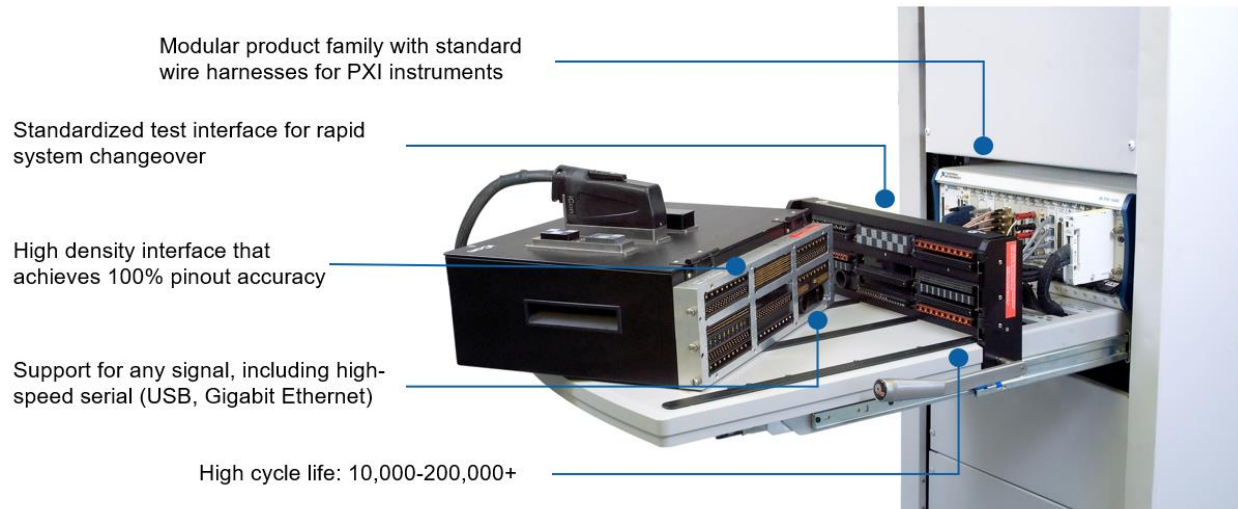
*Chris Becher, Engineering Manager, Alstom Signaling*

---

## Mass Interconnect

Quickly swap DUTs and reuse more of your test system with a mass fixturing and interconnection solution. This modular best practice includes both the instrumentation and the test interface to:

- Allow rapid system changeover through a standardized approach
- Not compromise test coverage by supporting a full range of signals from the DUT
- Minimize downtime and reduce maintenance with reliable long-term operation



**Figure 17.** Modular Mass Interconnect

## Featured Product Partner: Virginia Panel Corporation (VPC)

For almost 60 years, dedicated VPC employees have provided reliable mass interconnect solutions. VPC designs, manufactures, and markets interface connector products for commercial, consumer electronic, medical, telecommunications, aerospace, and automotive applications.

For more information, email [info@vpc.com](mailto:info@vpc.com).



## Hardware Services

Test station development and deployment is only half of the story. Best practice dictates that you consider station sustaining and maintenance from day one.

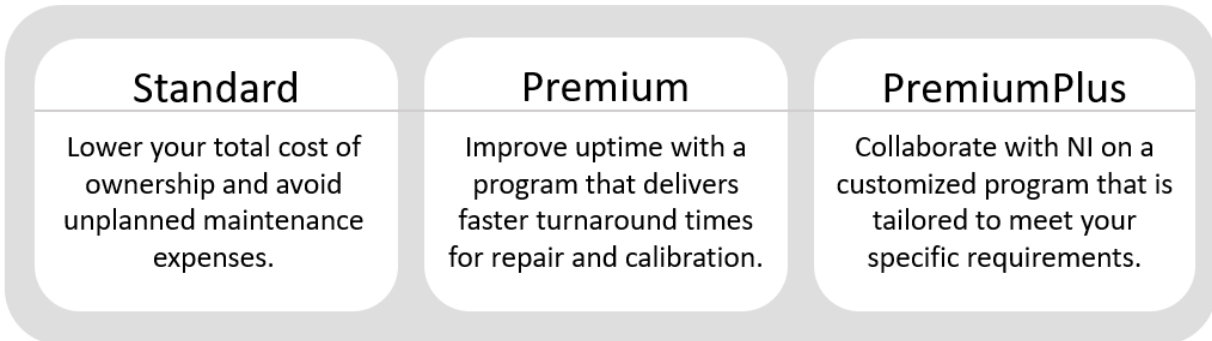


Figure 18. Instrumentation Hardware Service Levels

- **Budget Control:** Predict operational costs and avoid unforeseen maintenance expenses.
- **Minimize Downtime:** Get your systems back up and running within days, hours, or minutes with sparing programs, advance replacement services, and repair contracts.
- **Manage Life-Cycle Changes:** Manage technology refreshes and product obsolescence with roadmap consulting and life-cycle services programs encompassing one to twenty years.
- **Simplify Logistics:** Simplify hardware maintenance logistics and overhead with NI support.
- **Maintain Standards:** Utilize ISO 9001-traceable calibration and ISO/IEC 17025-accredited calibration services delivered on-site and through expedited shipping for confidence and convenience.
- **Speed Deployment:** Get up and running with custom installation that includes app software, custom documentation generation, individual logo/labeling, and system recovery images.
- **Quickly Troubleshoot:** Minimize development delays by consulting with experienced applications engineers based in more than 40 countries to meet your local needs in your local language.

---

*“In the 25+ years I’ve been dealing with NI, I’ve always found their personnel to be uniformly bright, enthusiastic, and genuinely concerned with helping their customers succeed.”*

*Cary Long, Software Engineer*

---

## Support Services

Change initiatives are common within test teams. Whether building a new test strategy, driving a technology refresh, or extending the life cycle of an existing project, product schedules and budgets are often high-risk. Managing this risk is a tricky balance between meticulous planning and agile design choices.

Utilizing consultation, educational resources, and ongoing support programs can mean the difference between a culture of missed deadlines and budgetary strain, and a culture of on-time, on-target delivery. NI consultation, integration, and education services offer guidance and industry expertise to help build and execute a practical plan to achieve your business and operational outcomes.

## Methodology Consulting Services

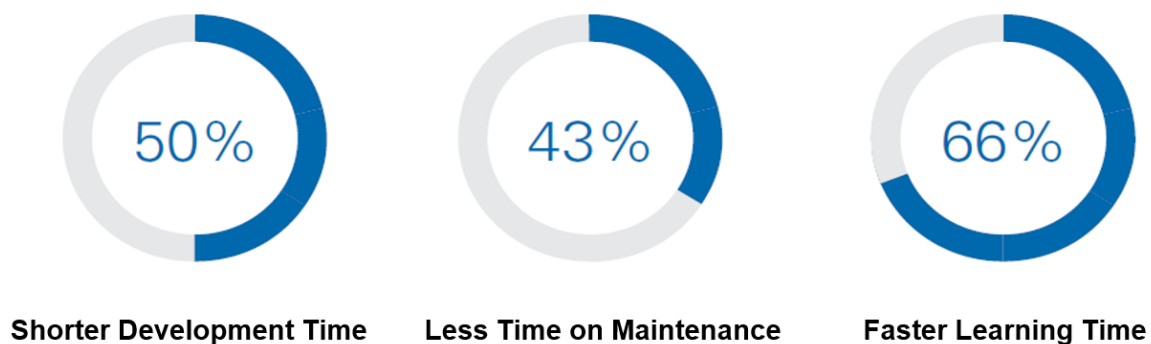
Planning and project management consulting helps build a project-execution plan that keeps teams on track to hit major development milestones. Work together with NI to establish priorities, identify the right resources, and make trade-offs to optimize cost without putting projects at risk.

## Integration Engineering Services

With global solution centers and NI engineers in more than 40 countries supported by more than 900 Alliance Partner companies, NI delivers design and development assistance in every region and industry. NI engineers help you mitigate risk, develop faster, and reduce costs through project management, architecture development, and system documentation to deliver an integrated solution.

## Education Services

Test teams new to NI software and seasoned veterans of the platform alike benefit from investing in their education through learning resources designed for personal and team proficiency. NI provides a comprehensive customer education program designed to increase productivity, reduce development time, and improve your team's ability to engineer robust, maintainable applications with NI products. Tailor the experience to fit any schedule with online, in-person, and flexible programs.

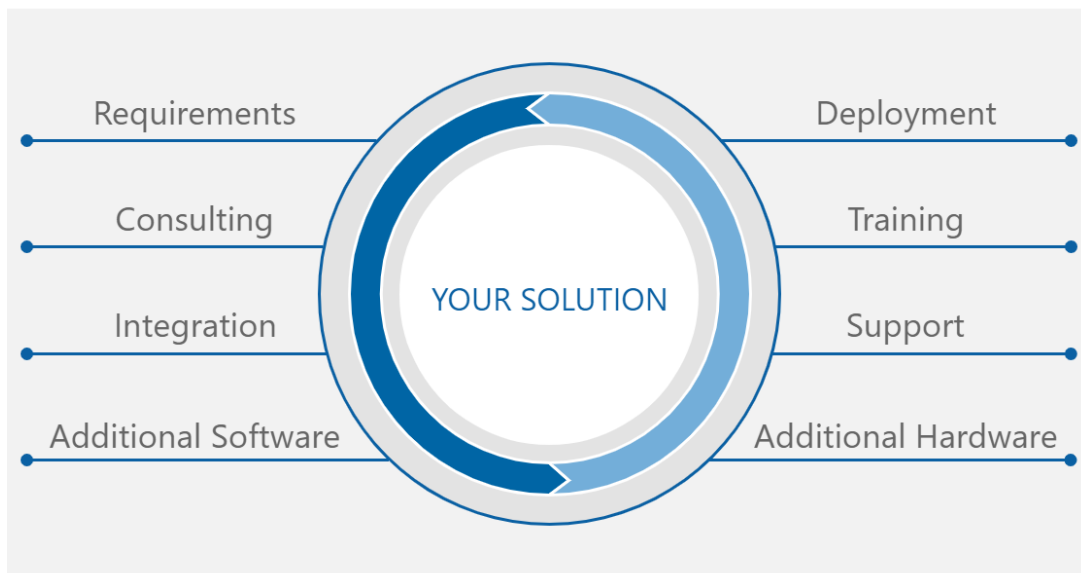


**Figure 19.** Engineers who have adopted NI education services save time in development and maintenance and learn faster.

## NI Alliance Partners

Best-in-class test engineering teams realize that there is seldom a simple question of in-house development versus outsourced development. Instead, they realize how complex it is to decide how to balance development teams to optimize for deployment schedule, bandwidth, domain specific expertise, proficiency development, and available budget.

NI Alliance Partners are uniquely positioned to support your business with the service that it requires, including strategic design, system integration, specialist tools, software IP, and ongoing support. More than 1,000 NI Alliance Partners, each certified and vouched for by NI and positioned globally, stand ready to consult with you on projects and provide complete solutions based on NI's productive software and modular hardware.



**Figure 20.** Alliance Partners can help ensure your success.

©2020 National Instruments. All rights reserved. CompactRIO, DIAdem, LabVIEW, National Instruments, NI, NI CompactDAQ, NI VeriStand, ni.com, SourceAdapt, and TestStand are trademarks of National Instruments. A National Instruments Alliance Partner is a business entity independent from National Instruments and has no agency, partnership, or joint-venture relationship with National Instruments. MATLAB® is a registered trademark of The MathWorks, Inc. Other product and company names listed are trademarks or trade names of their respective companies.