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Best Practices for Building Automated Test Systems

Smarter Test for Advanced Aerospace and Defense Electronics

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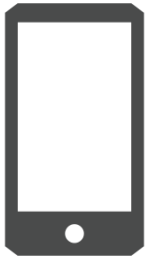
ni.com/aerospace-defense

Best Practices Depend on Your Perspective



Latest Consumer Device

B-52 Stratofortress

Challenges of ATS Development and Proliferation

Development

- Fixed schedule & budget
- Future technology insertion
- Common vs. custom

Maintenance

- Long product life cycle
- Obsolete equipment
- Instrument failure
- Costly TPS changes
- Total cost of ownership

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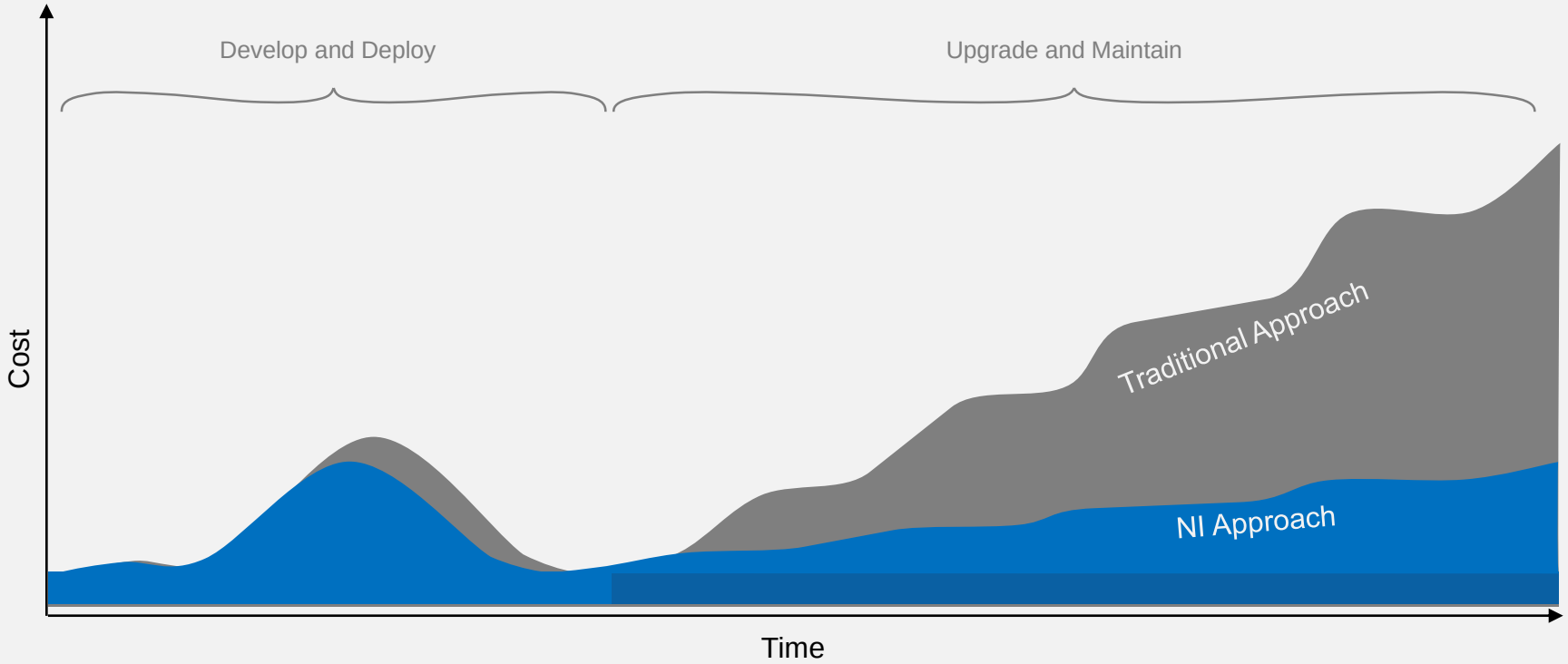
Total Cost of Owning an Automated Test System



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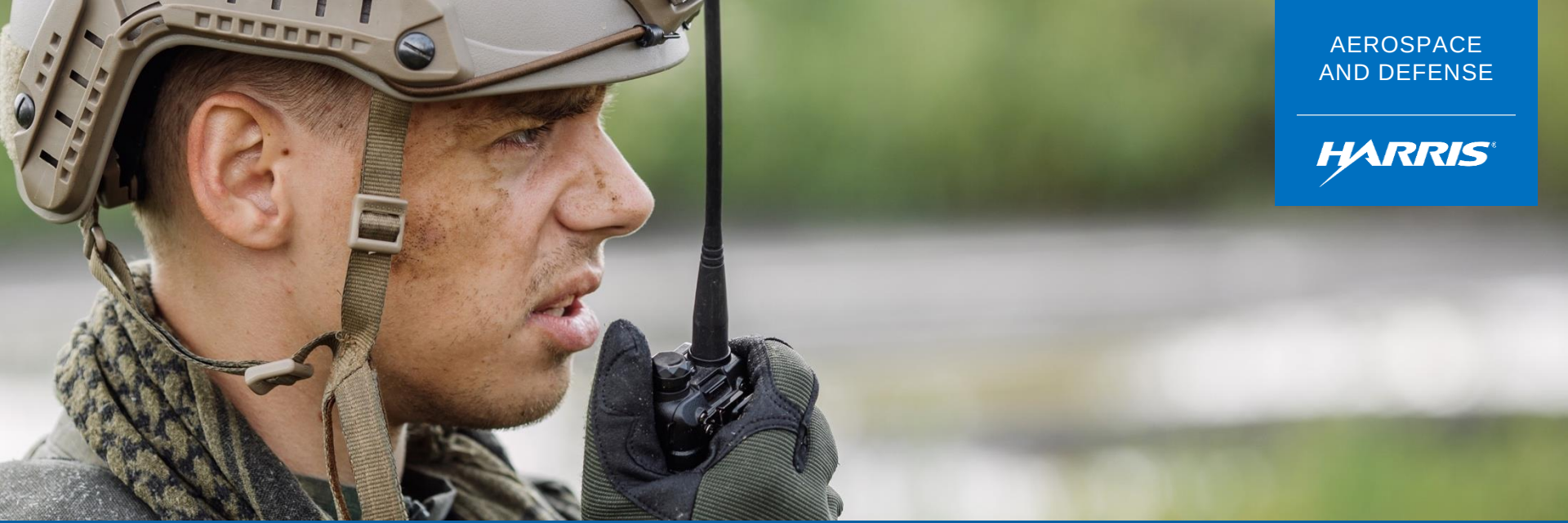

AEROSPACE AND DEFENSE

HARRIS

Harris Reduces Cost of Test While Increasing Test Throughput 400% with NI

“Harris Platform uses the ability to significantly increase our production test throughput by 400 percent with an ROI of 185 percent while carefully maintaining the quality and performance standards that our military radios are known for.”

74% Decrease in Cost of Test

83% Reduction in Floor Space

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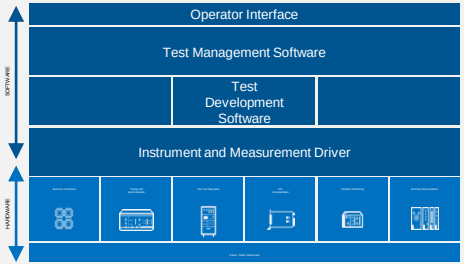
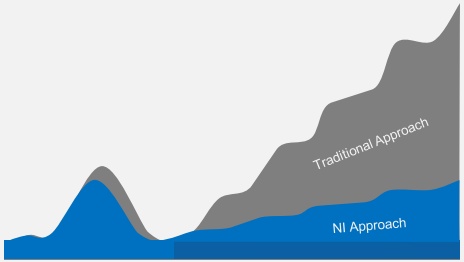
3 Best Practices for Architecting an ATE System



Develop a Scalable & Reusable Software Architecture

Standardize on the Latest Off-the-Shelf Hardware



Plan for Obsolescence

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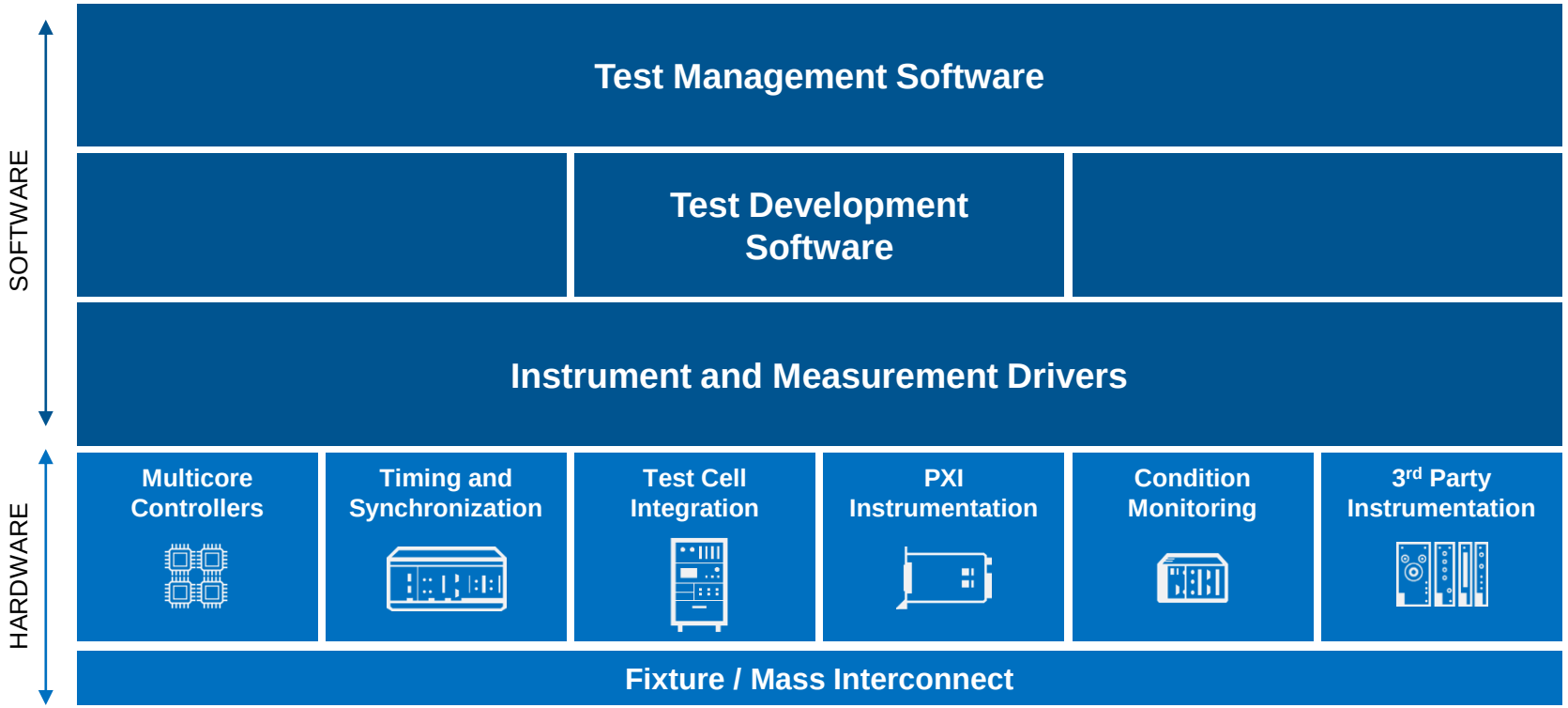
Develop a Scalable & Reusable Software Architecture

Architecture of an Automated Test System



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Architecture of an Automated Test System

SOFTWARE

NI TestStand
Sequencing, Test Management, Test Deployment, Reporting, User Management

NI LabVIEW
Graphical IDE with measurement and analysis libraries and UI design

NI LabWindows™/CVI
ANSI C IDE with measurement and analysis libraries and UI design

Other Software
C, C++, C#, .NET, Python, Measurement Studio

Instrument and Measurement Driver
IVI, VISA, NI-DAQ, NI-DMM, NI-SCOPE, NI-FGEN, NI-HSDIO, NI-RFmx, 3rd Party Hardware

HARDWARE

Multicore Controllers

Timing and Synchronization

Test Cell Integration

PXI Instrumentation

Condition Monitoring

3rd Party Instrumentation

Fixture / Mass Interconnect

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Separating Software Responsibilities

COMMON

Test Management Software

- Limit checking
- Integration of system-level requirements
- Results processing
- Shared measurements
- Operator interface
- User management
- Test flow control

UNIQUE

Test Development Software

- Instrument control
- Stimulus
- Analysis code
- DUT control
- DSP
- Tracking of individual test requirements

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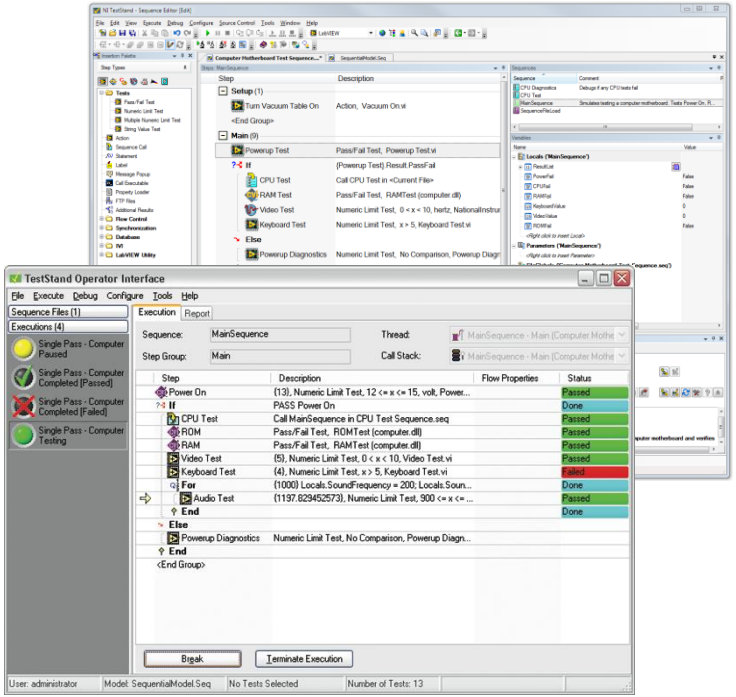
TestStand

Industry-Standard Test Management Software

- Author, execute, and debug test sequences
- Leverage test code developed in **any language**
- Test many devices in parallel
- Generate reports
- Integrate with databases
- Extend the software to meet custom requirements
- Develop professional operator interfaces



6,000+
COMPANIES WORLDWIDE

10,000+
EXISTING DEVELOPERS

1500+
NEW DEVELOPERS TRAINED ANNUALLY

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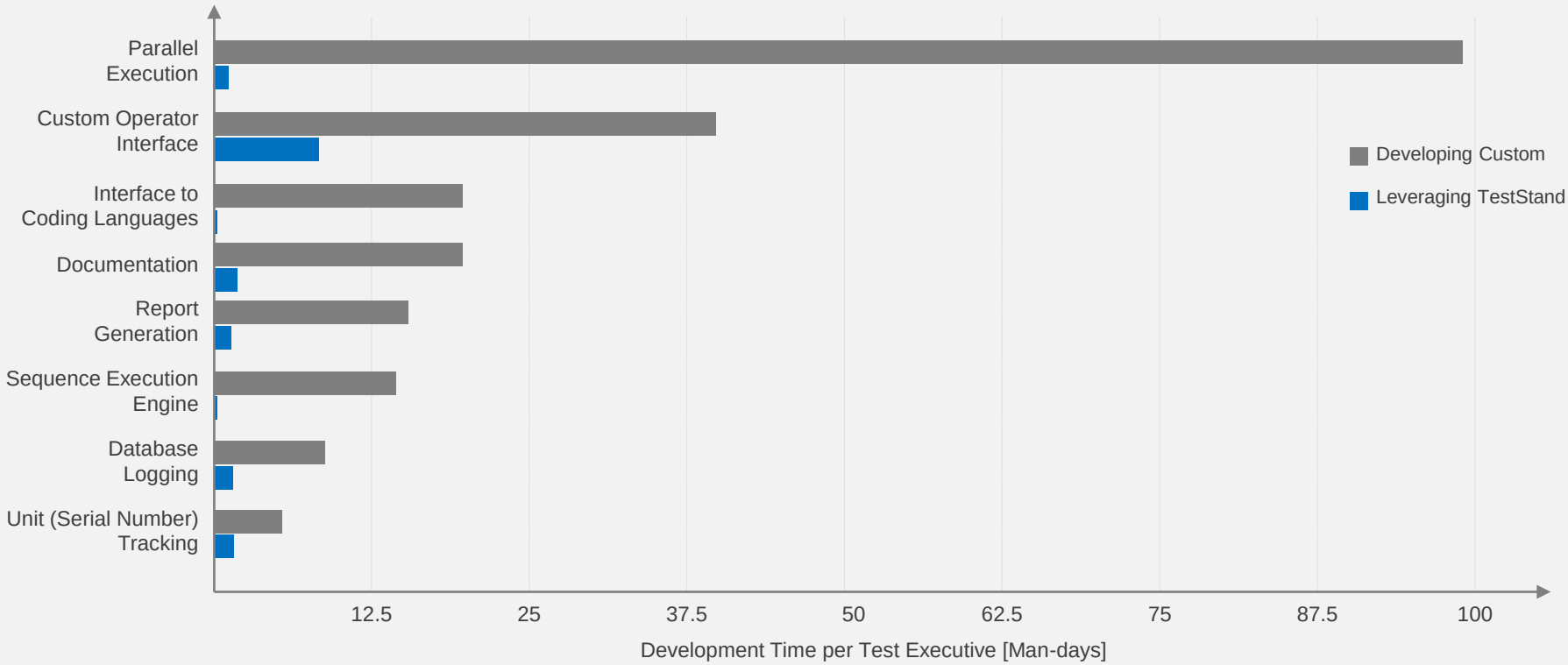
Increase Productivity with COTS Test Management Software



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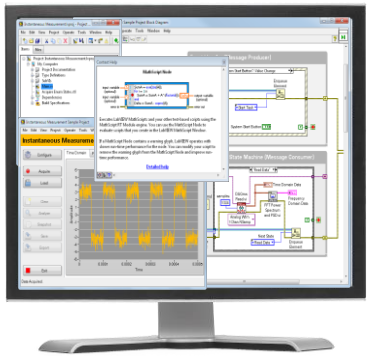
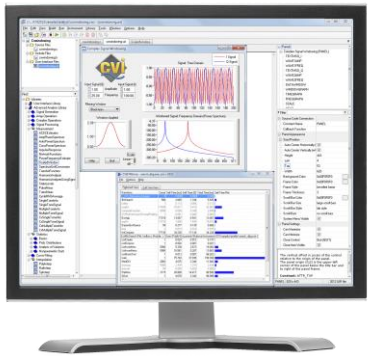
TPS Application Development Environments (ADEs)

NI LabVIEW



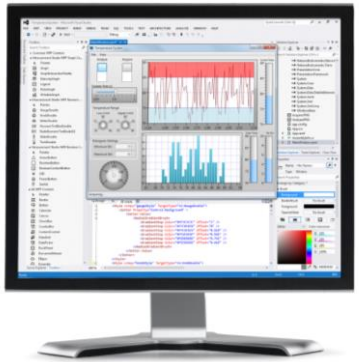
System Design Software

NI LabWindows/CVI



Proven ANSI C IDE & Engineering Toolbox

NI Measurement Studio



.NET Tools Designed for Engineering

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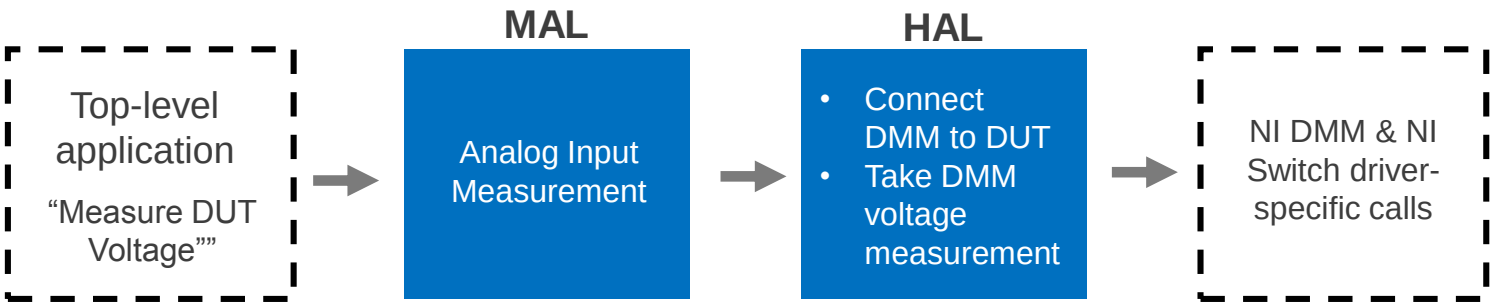
Architecting for Scalability and Reusability

Hardware Abstraction Layer (HAL): layer of programming that allows an automated test system to interact with a hardware device at a general or abstract level rather than at a detailed hardware level

Measurement Abstraction Layer (MAL): layer of programming that allows an automated test system to interact with a DUT through high-level actions rather than at a detailed hardware level



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Implementing an Abstracted Architecture

Abstraction is a spectrum –
start by taking advantage of out-of-the box abstraction layers

Hardware Abstraction

- NI family drivers
  - NI DMM support for all 40XX instruments
- IVI compliant drivers

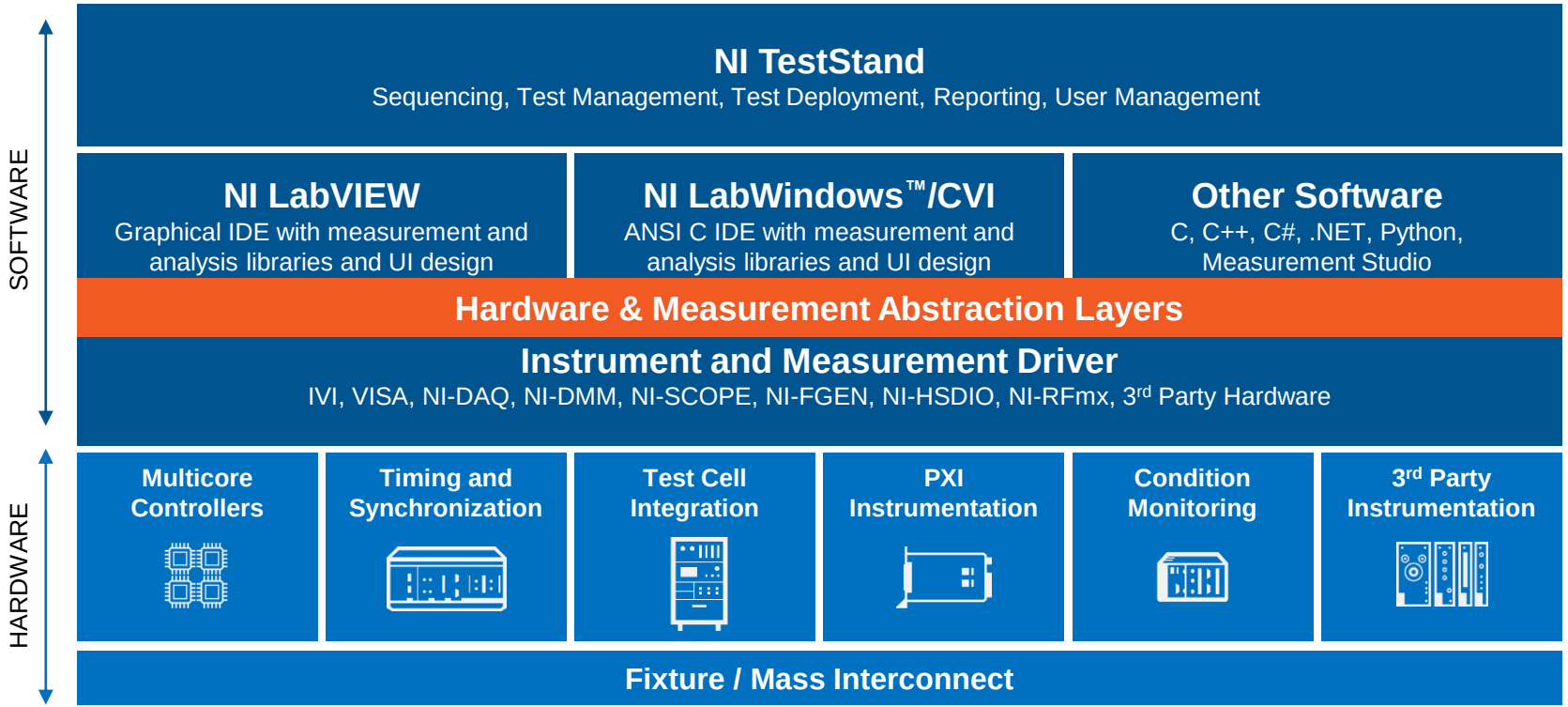
- Custom HAL

Measurement Abstraction

- TestStand Custom Step Types
- LabVIEW subVIs
- NI Switch Executive

- Custom MAL

Hardware and Measurement Abstraction Layers



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NI-DMM Hardware Abstraction

Low-Cost
PXI-4060
PXI-4065

Mid-Range
PXI-4070/2
PXIe-4080/2

High Performance
PXI-4071
PXIe-4081

1998 2002 2005 2007 2016 2028

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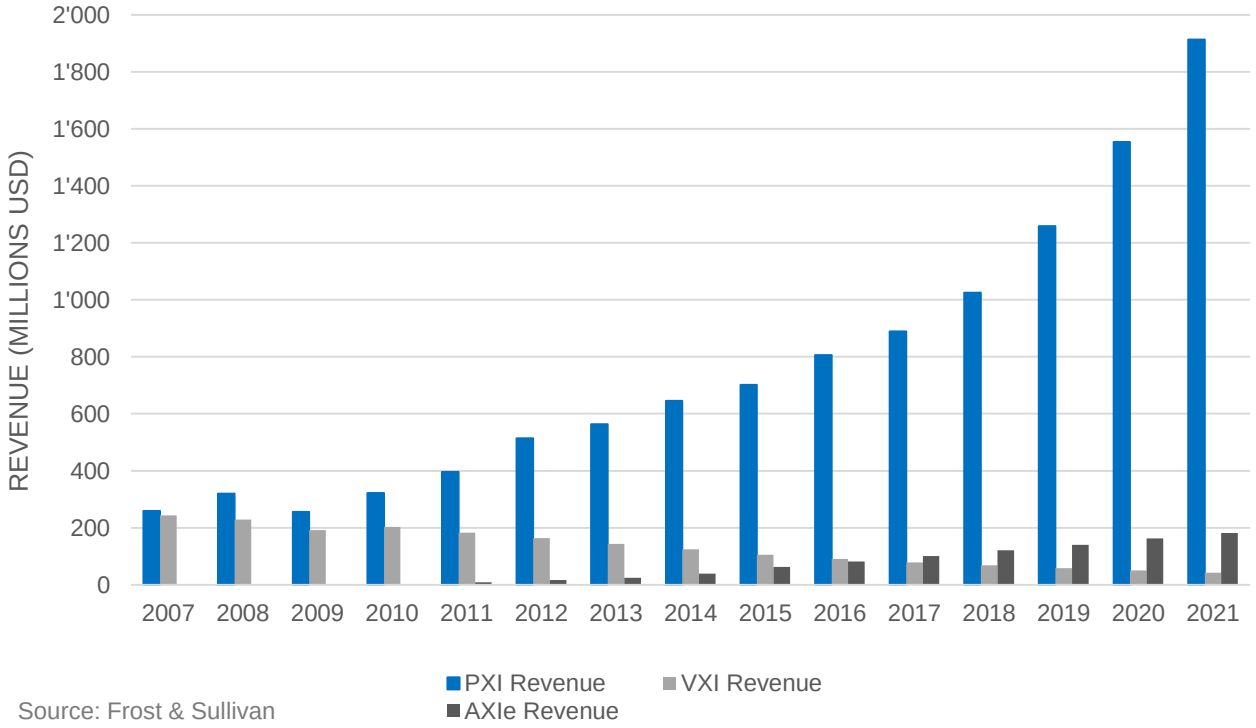
9X Reduction in Test Development Time

60% Code Reuse

“By leveraging commercial off-the-shelf software technologies such as TestStand and LabVIEW, our Automated Test Engineering team was able to achieve up to 60 percent code reuse for each automated test and reduce overall test development time by up to 9X. Using the NI certification program, coupled with in-house training, we were able to develop the skills necessary to produce robust, flexible code and maintain it across over 200 test benches.”

Standardize on the Latest Off-the-Shelf Hardware

Modular Instrumentation (PXI) Drives ATE



Source: Frost & Sullivan

- Founded in 1997
- 60+ Vendors
- 2000+ Modules
- Latest Technology
- Growing Market Share

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NI's Industry-Leading Test & Measurement Platform

PXIe-5162
4ch, 1.5GHz,
10-bit Digitizer

PXI-4081
7½-digit, 1kV Precision
DMM

PXIe-5668R
26.5 GHz VSA with
765 MHz Bandwidth

PXIe-4135
Precision System SMU
10 fA Sensitivity

PXIe-5646R
6GHz Vector Signal
Transceiver

PXIe-1085
PXI Chassis
24 GB/s Throughput

PXIe-8880
PXIe Controller
8 Core Intel Xeon

NI LabVIEW
System Design
Software

NI TestStand
Test Management
Software

PXIe-2543
6GHz, 8ch, Solid-State Mux

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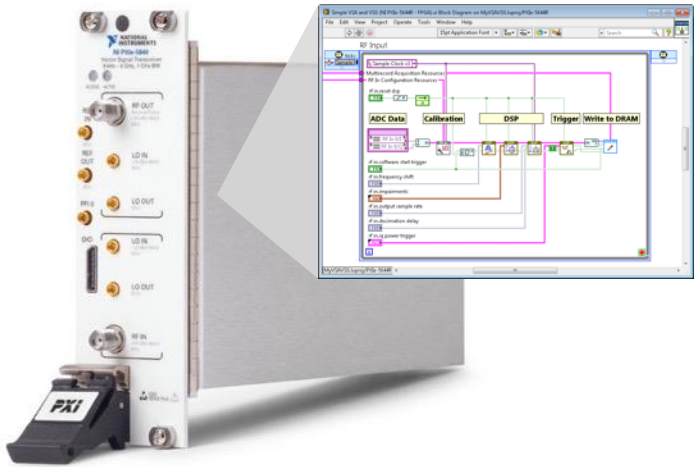
2nd Generation Vector Signal Transceiver

Features at a Glance

- User-programmable FPGA with LabVIEW
- 1 GHz of instantaneous bandwidth for advanced digital predistortion test and wideband signals
- Excellent accuracy enables measurement of 802.11ax error vector magnitude performance of -50 dB
- FPGA enables measurement speeds up to 10X faster than traditional instrumentation
- Small size and tight synchronization allow for up to 8x8 MIMO configuration in a single 18-slot chassis



Application Areas

- Wireless test
- Semiconductor test
- Automotive radar

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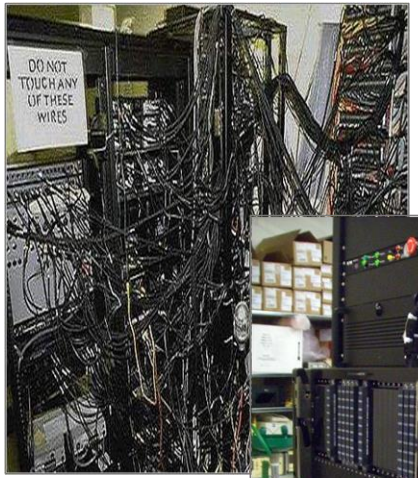
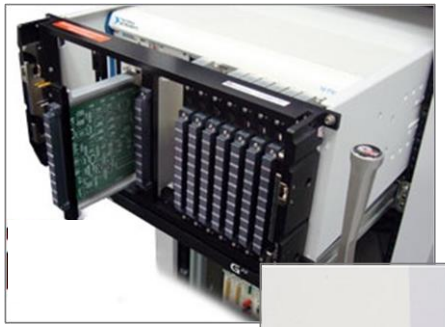
Mass Interconnect and ITAs



VS.



PCB-Based
or
Cabled Connection

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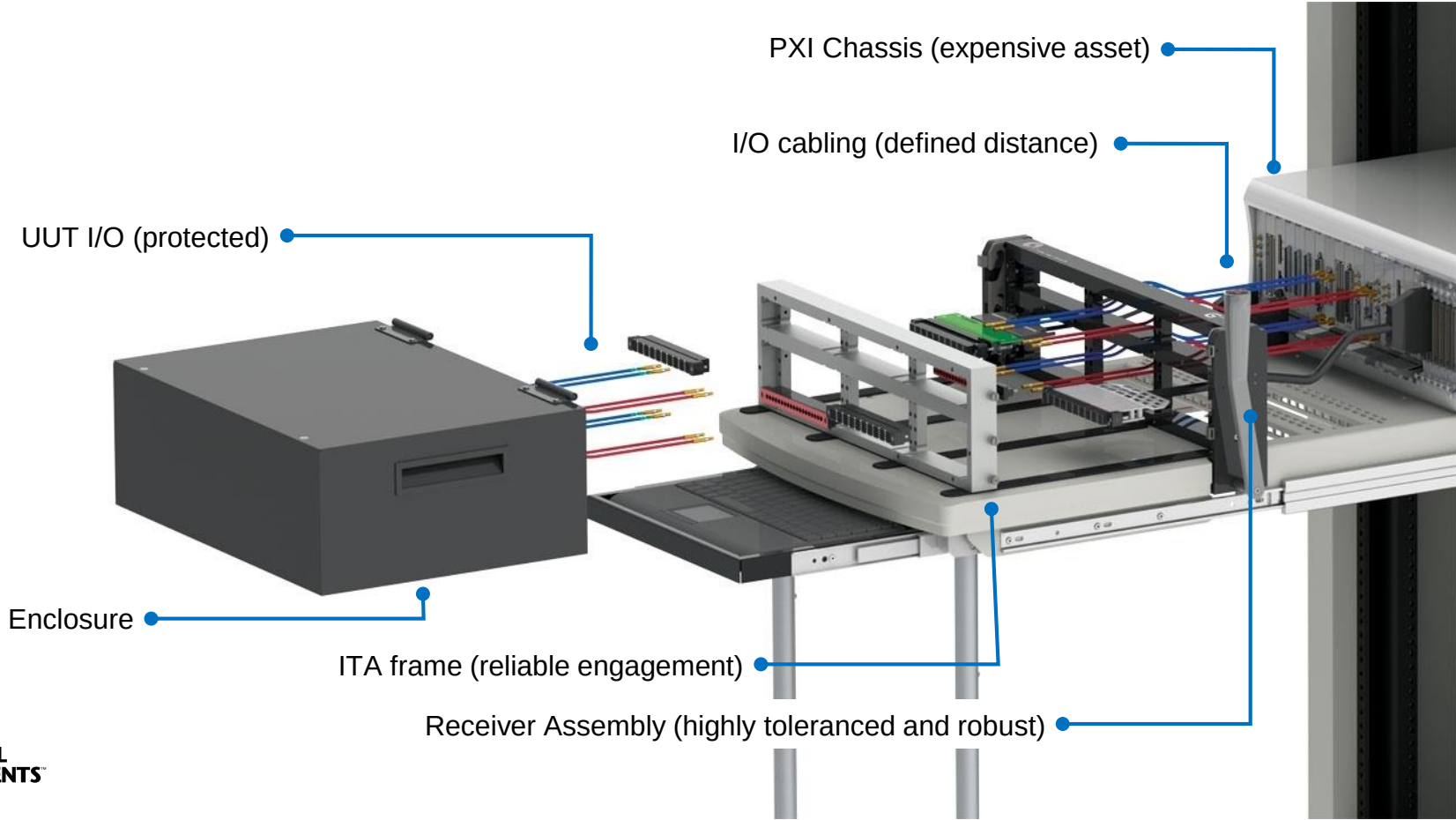
Elements of a Typical Mass Interconnect



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Standardize, Standardize, Standardize

How many DC programmable power supplies are in your library?

How about 6½-digit DMMs?

General Rule:

Standardize what you can, as fast as you can,
if the differences aren't adding value.

NI ATE Core Configurations Make Standardization Easier

Standardized starting point for in-house ATE development

40U Configuration

24U Configuration

Category	Details
Mechanical	40U and 24U Rack Height with industrial-grade casters and mounting rails
Power	Power Distribution Unit, Power Entry Panel, and Optional Uninterruptible Power Supply
Safety	Emergency Power Off, Thermal Shutdown, Multi-Level Circuit Protection
Instrumentation	PXI, cDAQ, cRIO, SLSC, 3rd Party
Cooling	24 VDC Fan Kit, Air Filtration
Cabling	Integrated Cable Management and 10/100 ENET Switch

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Plan for Obsolescence

Life Cycle Management Practices

Proactive / Strategic

- Modular open architectures
- Technology roadmapping
- Planned system upgrades
- Technology insertion planning
- Life cycle analysis and monitoring
- Formal lifecycle strategy

Reactive / Tactical

- Alternate source
- Substitution
- Redefine requirement
- Emulation
- Lifetime Buy
- Redesign
- Reverse Engineer
- Reclamation

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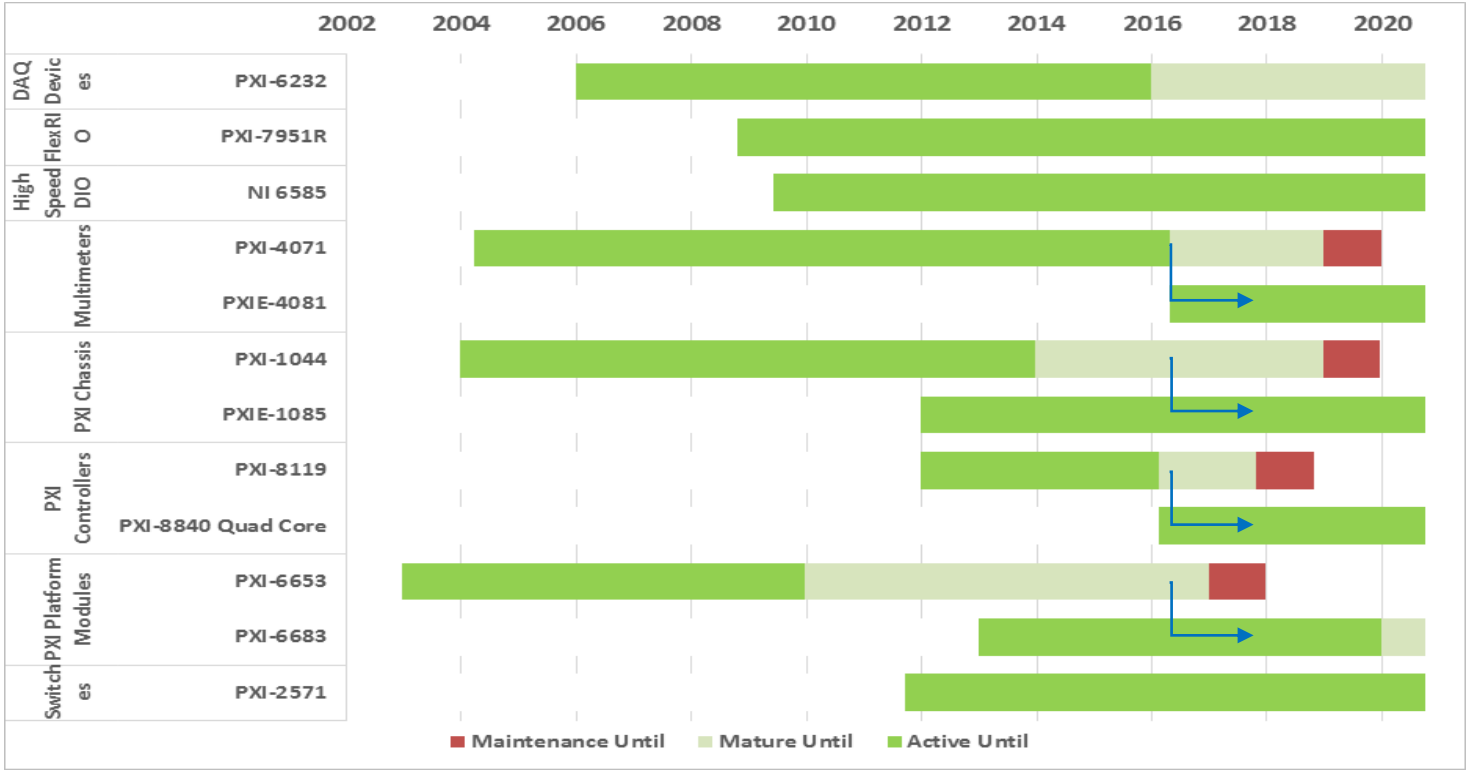
Example Life Cycle Analysis



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23% Decrease in LRU Repair Time

80% Reduction in Quality Deficiency Reports

18 Obsolete Test Set Replaced

“CACI selected many NI instruments for the core of the CBATS test system based on the relationship with the company and the quality of its 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."

CACI

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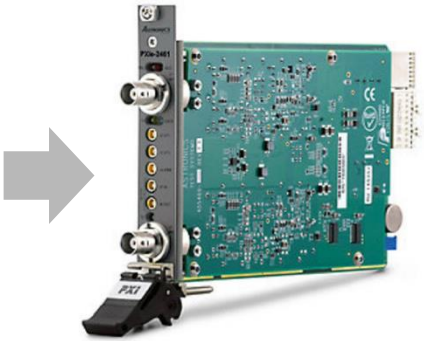
NI and Astronics Collaborate on VXI to PXI Transition

Astronics VXIbus 2461C
2-channel, 200 MHz Frequency Time Interval Counter



Astronics 2461 for PXI Express
2-channel, 200MHz Frequency Time Interval Counter

Astronics PXIe-2461
2-channel, 200MHz Frequency Time Interval Counter

Astronics PXIe-6943
32-channel, 200MB/s Digital I/O Module

Astronics PXIe-3352
Rubidium Clock Source Module

Astronics PXIe-1209
100MHz Pulse Pattern Generator Module

"Full TPS and Driver Compatibility"

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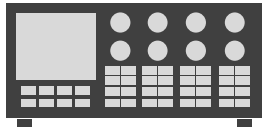
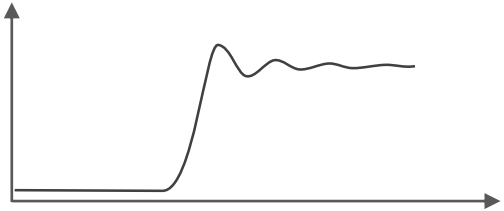
Emulating Legacy Instrumentation

Challenge

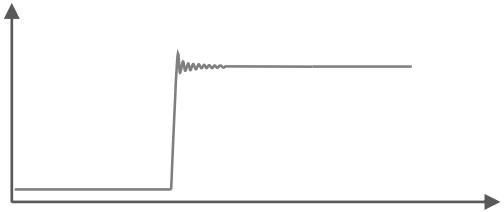
- Previous Instrument is End-of-Life
- New Instrument Behavior
- Test System Depends on Old Behavior
  - Trigger Types
  - Analog Bandwidth
  - Sampling Rate
  - Dynamic Range



Legacy Instrument

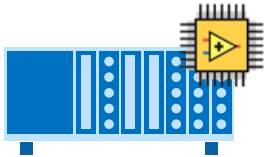


New Box Instrument

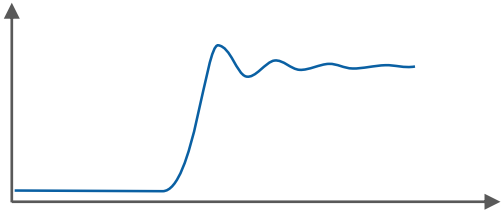


Solution

- Software-Defined Instrumentation
- Digital Signal Processing
- FPGA Technology



Software-Defined Instrument



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Real-Time Spectrum Analysis

100% POI with Full Accuracy on 320 ns Minimum Duration Signals from 20 Hz to 26.5 GHz

765 MHz analysis BW and real-time DSP throughput of up to 62 million FFTs

"NI's PXIe technology provides unparalleled scalability, upgradeability and technology insertion capability that minimizes obsolescence, repair and test program portability issues that plague box instruments"

RADX® TECHNOLOGIES, INC.

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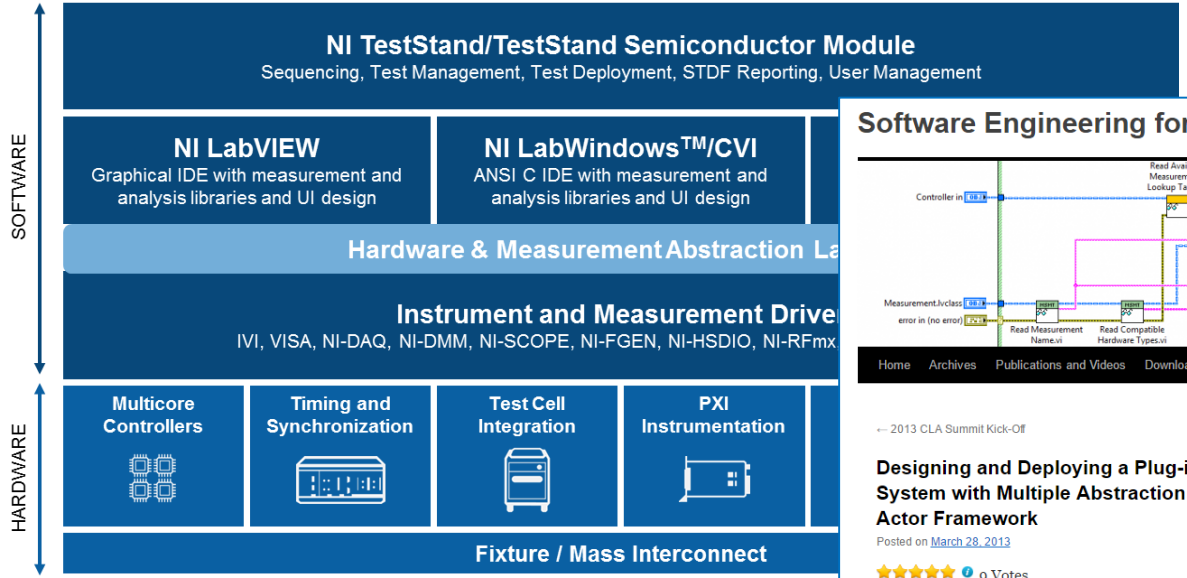
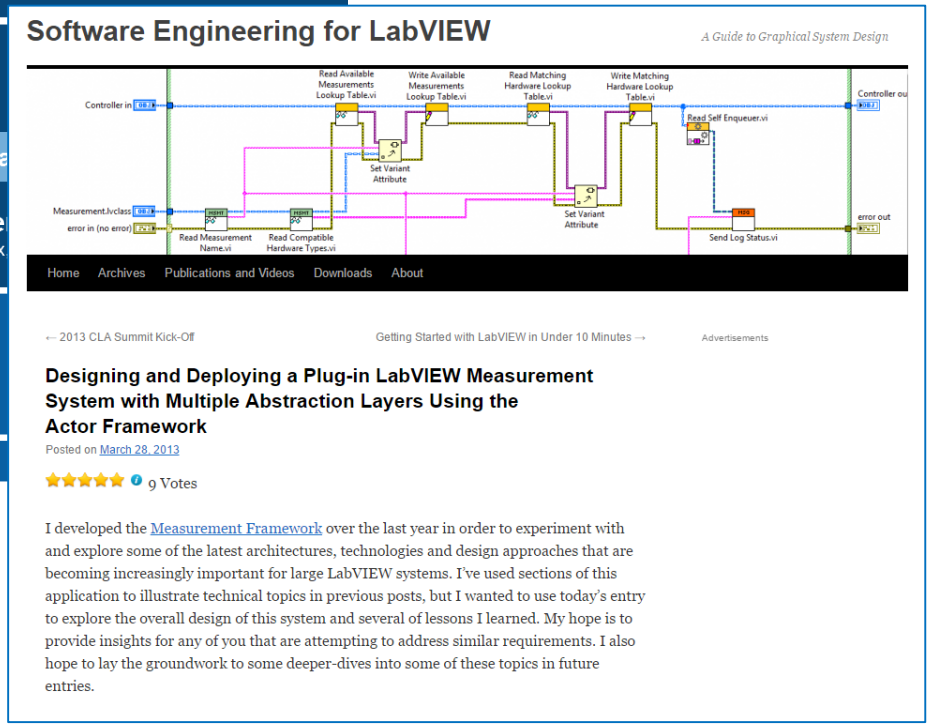
Summary

Architecture of an Automated Test System With Abstraction





Fundamentals of Building a Test System

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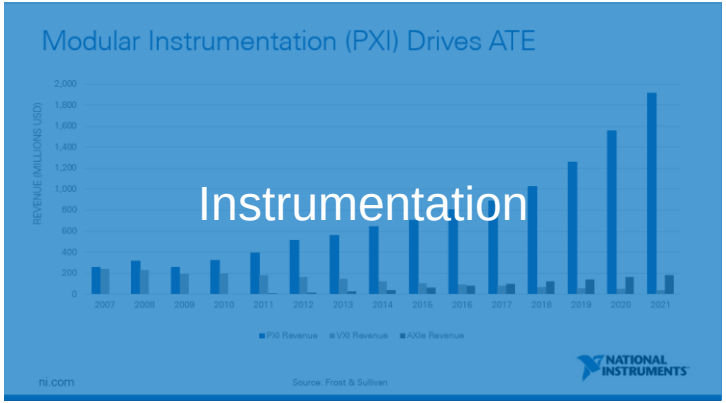
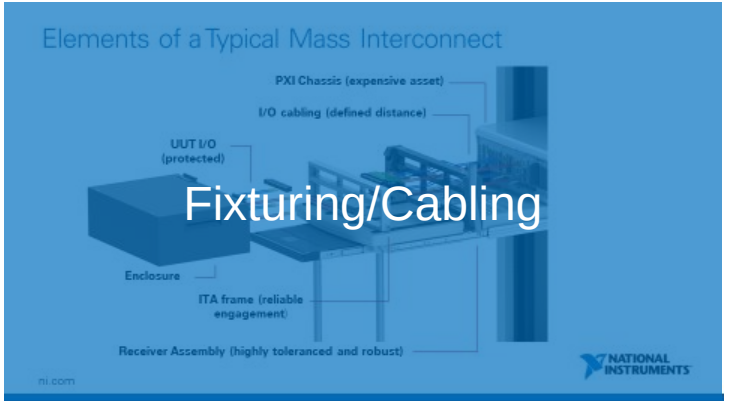
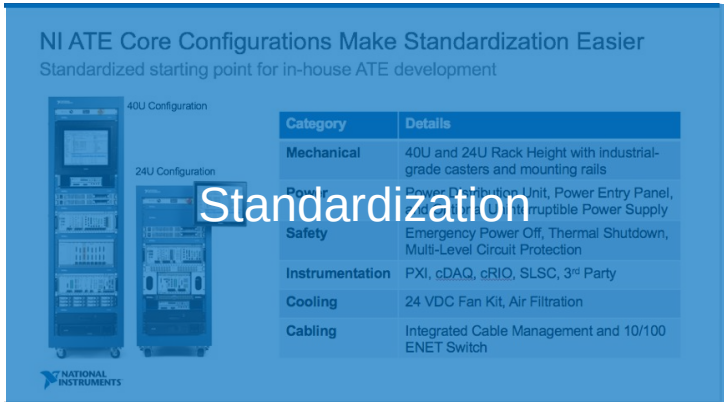
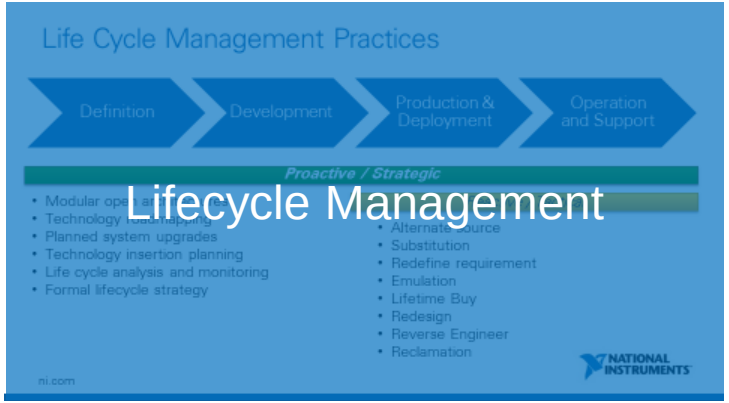
ATE Hardware Architecture Considerations









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Global Service and Support, Locally Delivered

*Provides NI Repair, Calibration, and Inventory Services

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