Gas Combustion Testing With LabVIEW
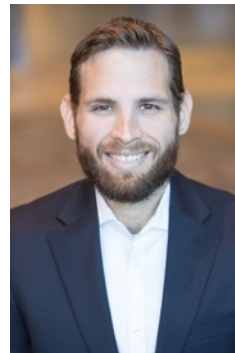
Asa Kirby

Senior Product Manager

Abstract

The growing complexity of design validation and production test are leading the industry in exciting new directions. Learn about new trends in the industry which are developing in response to these challenges, and how you can take advantage of these trends with NI LabVIEW and data acquisition products.

Agenda

The Problem

- What are the challenges facing product testing and design validation?

The Trends

- How is the industry responding to these challenges?

Who is National Instruments?

- How does NI approach these problems and integrate these trends?

The Solution

- How can you take advantage of these trends to save time, effort, and money?

The Problem

National Instruments

Growing Product Complexity

- Increased capability and customization requires more advanced testing.
- I/O counts grow exponentially; even wiring management becomes challenging.
- Types of I/O become more varied, and measurement quality must increase.
- Software plays a growing role in product functionality, and must be considered.

Growing Regulatory and Certification Requirements

- Accuracy and precision of measurements must increase, and be traceable.
- Slight variations in standards force largely duplicative tests.
- Regional certifications compound the problem, growing the required test matrix.
- You can no longer "spot check" a design; full design validation under all conditions is the new normal.
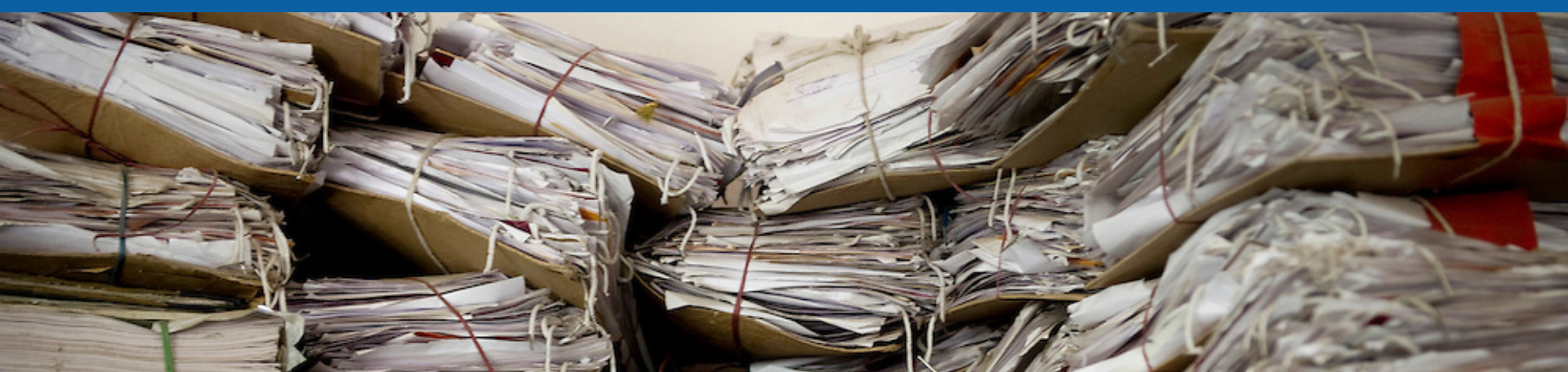
Growing Quantity of Data

- Increased testing produces exponentially more test results.
- Gaining insight from the increased volume of test results becomes difficult.
- Storing results without proper (or any) analysis has become common.

The Trends

Increased Measurement Automation

- Develop automatic data acquisition to take the measurements you need.
- Integrate inline analysis to generate data insight automatically.
- Automate report generation and record keeping.
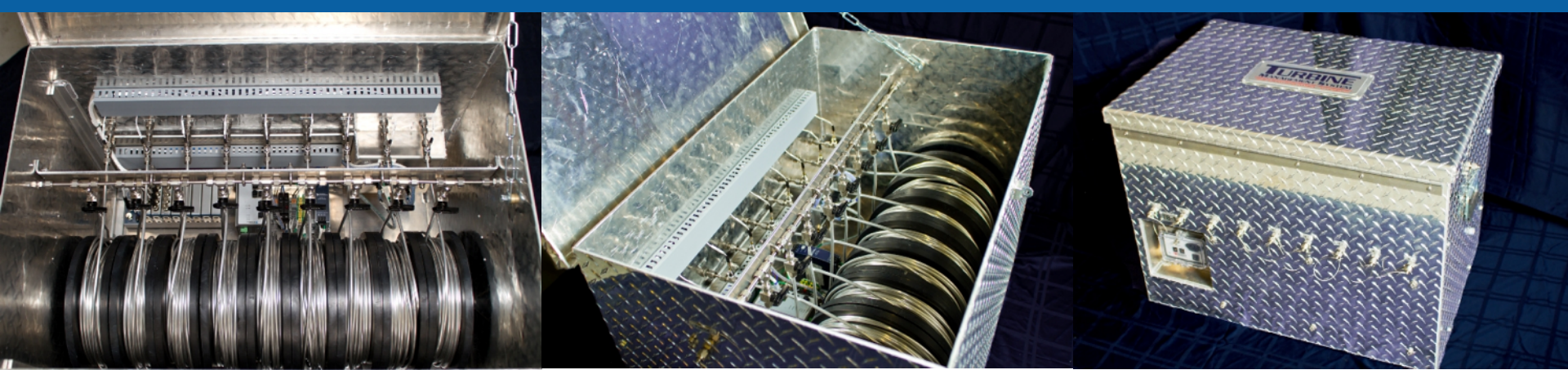
Increased System Modularity

- Create data acquisition modules for specific products or components.
- Modules reduce cabling and enable easy I/O expansion and customization.
- Develop software to dynamically respond to connected modules.
- Managing complex modules or systems using IT based services (IIoT).

CMS-1000 Combustion Dynamic Monitoring System is a product of Turbine Technology Services Corp.
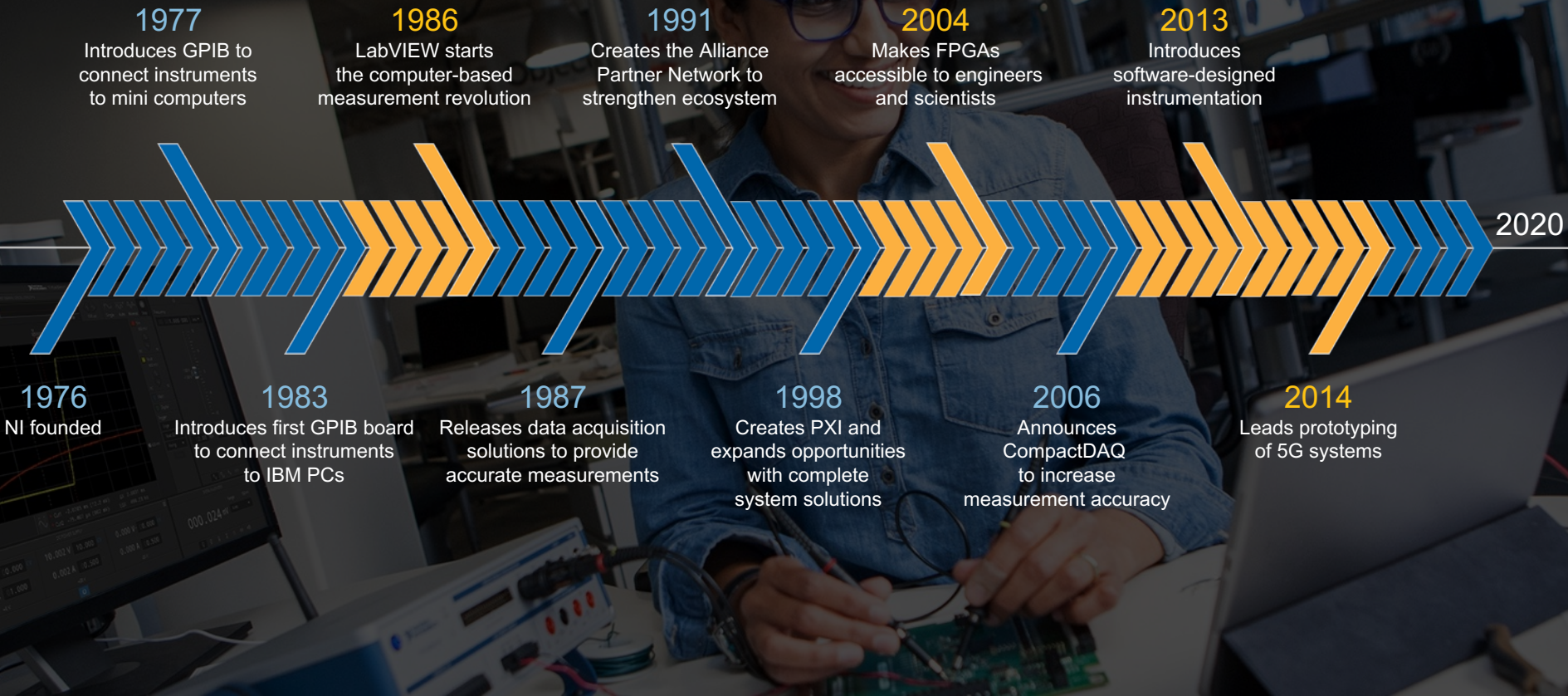
Mission Statement

NI equips engineers and scientists with systems that accelerate productivity, innovation, and discovery.

Accelerating Engineering for More Than Four Decades

1977 — Introduces GPIB to connect instruments to mini computers

1986 — LabVIEW starts the computer-based measurement revolution

1991 — Creates the Alliance Partner Network to strengthen ecosystem

2004 — Makes FPGAs accessible to engineers and scientists

2013 — Introduces software-designed instrumentation

2020

1976 — NI founded

1983 — Introduces first GPIB board to connect instruments to IBM PCs

1987 — Releases data acquisition solutions to provide accurate measurements

1998 — Creates PXI and expands opportunities with complete system solutions

2006 — Announces CompactDAQ to increase measurement accuracy
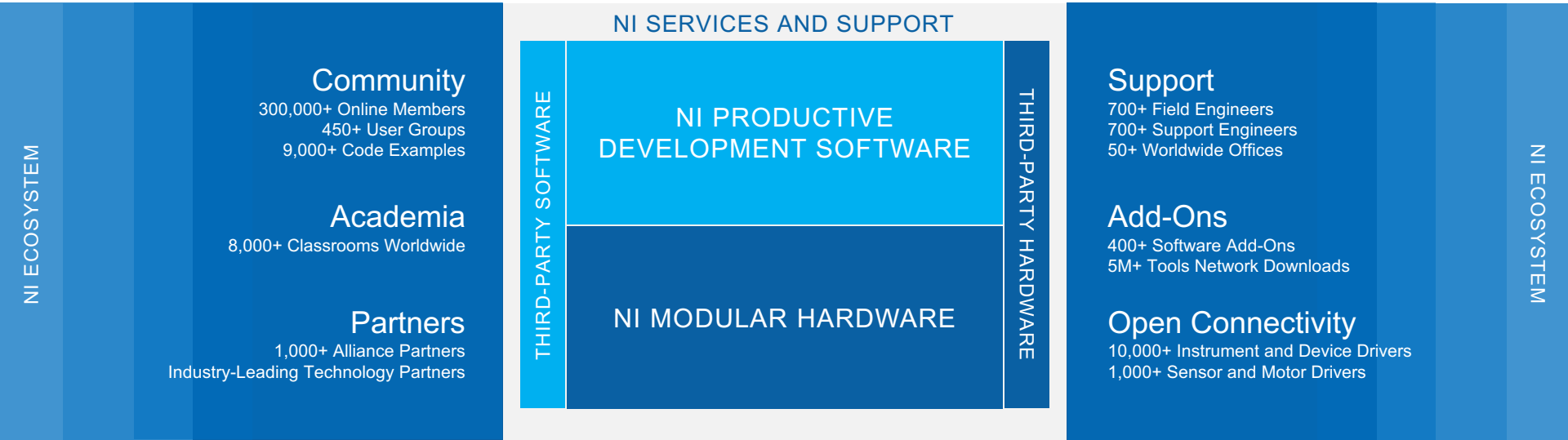
2014 — Leads prototyping of 5G systems

A software-centric platform that accelerates the development and increases the productivity of test, measurement, and control systems.

ONE-PLATFORM APPROACH

NI SERVICES AND SUPPORT

THIRD-PARTY SOFTWARE	NI PRODUCTIVE DEVELOPMENT SOFTWARE	THIRD-PARTY HARDWARE
WEB SERVICES		ARDUINO
PYTHON		ETHERNET
C/C#/.NET		USB
The MathWorks, Inc. SOFTWARE		GPIB
VHDL	NI MODULAR HARDWARE	SERIAL
GNU RADIO		LXI/VXI
AND MORE		AND MORE

ONE-PLATFORM APPROACH

NI ECOSYSTEM

Community
300,000+ Online Members
450+ User Groups
9,000+ Code Examples

Academia
8,000+ Classrooms Worldwide

Partners
1,000+ Alliance Partners
Industry-Leading Technology Partners

THIRD-PARTY SOFTWARE

NI SERVICES AND SUPPORT

NI PRODUCTIVE DEVELOPMENT SOFTWARE

NI MODULAR HARDWARE

THIRD-PARTY HARDWARE

Support
700+ Field Engineers
700+ Support Engineers
50+ Worldwide Offices

Add-Ons
400+ Software Add-Ons
5M+ Tools Network Downloads

Open Connectivity
10,000+ Instrument and Device Drivers
1,000+ Sensor and Motor Drivers

NI ECOSYSTEM

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Modular Hardware Allows You to Customize

Complete I/O Coverage
With More Than 600 Modules

Highest Data Throughput
With PCI Express

Software Extensibility
With Apps, IP, and Toolkits

Parallel Measurement Execution
With Latest Multicore Processors

Real-Time Measurements
With Timing and Synchronization

Measurement Acceleration
With User-Programmable FPGAs

Reduced Size, Power, and Weight
With Form Factor Variants

Increased Measurement Range
With Latest ADC/DAC

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Flexible Software Protects Your Investments

▶ LabVIEW™

TestStand   VeriStand   DIAdem   NI InsightCM™ Enterprise

Multisim   LabWindows™/CVI   Measurement Studio   Third-Party Software

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The mark LabWindows is used under a license from Microsoft Corporation. Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

The Solution

Architecture of an Integrated Measurement System

CompactDAQ is a portable, rugged DAQ platform that integrates connectivity and signal conditioning into modular I/O for directly interfacing to any sensor or signal.
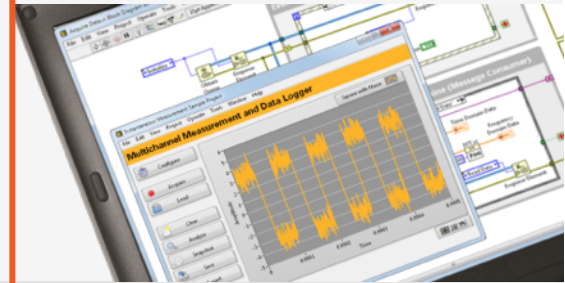
Sensor	Measurement Device		Software	
	Signal Conditioning	Analog-to-Digital Converter	Driver Software	Application Software

Traditional Hardware Components

Mixed-Measurement Systems Usually Involve Additional Connectivity and Conditioning

Sensors/Signals

- Thermocouple
- Accelerometer
- Strain Gage
- Solar Cell

(etc)

Physical Connectivity

- Screw Term TC Jack
- BNC SMB
- Screw Term RJ50
- Screw Term Banana

Signal Conditioning

- Amplification, Cold-Junction Compensation, Filtering
- Excitation, Anti-Alias Filtering, Dynamic Range
- Voltage Excitation, Bridge Configuration, Linearization, Filtering
- Isolation

ADC

CompactDAQ is an Integrated, Modular Solution

Sensors/Signals

C Series IO Modules

Thermocouple

Accelerometer

Strain Gage

Solar Cell

(etc)

CompactDAQ Platform

Chassis

Controller

ASIC
- Analog I/O
- Digital I/O
- Specialized I/O
- Bus Protocols

WES7
RTOS

ASIC
- Analog I/O
- Digital I/O
- Specialized I/O
- Bus Protocols

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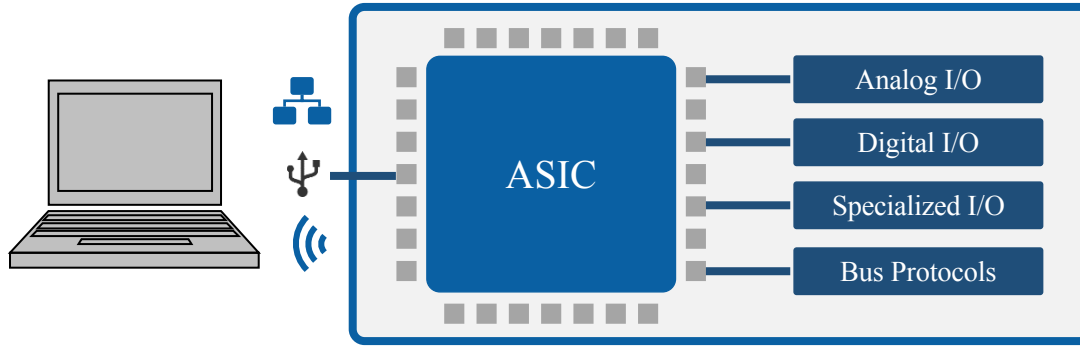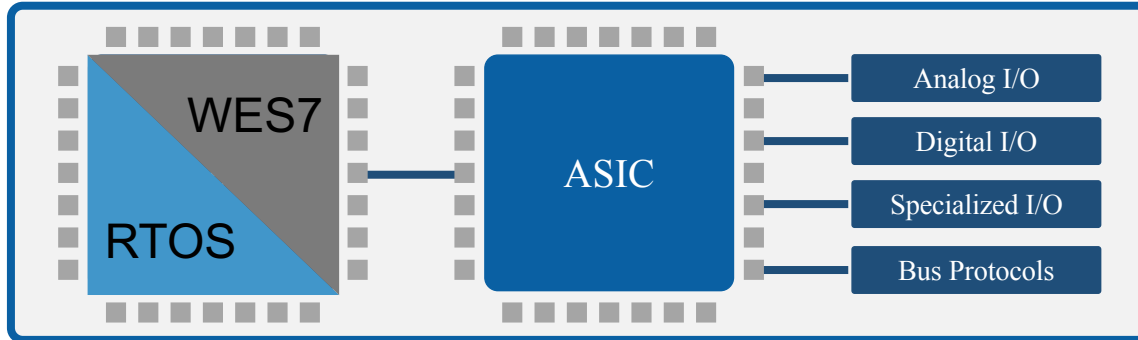
CompactDAQ Chassis

Customize Your System

Holds 1, 4, 8, or 14 C Series I/O modules
Mix and match from 60 sensor specific modules
USB, Ethernet, or Wi-Fi connectivity

Flexible Software

Measure in minutes with NI-DAQmx
Identical code works on any communication bus
API for LabVIEW, C/C++, C#, and VB .NET

Advanced Timing and Synchronization

Hardware-timed tasks with different rates
Synchronize modules within and across chassis
Four built-in 32 bit general purpose counters

Test and
Verification

Monitoring and
Visualization

CompactDAQ Controllers
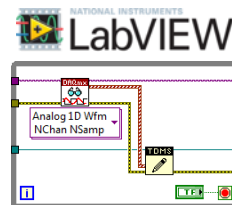
Simplify System Complexity
Integrated PC and signal conditioning
Built in RS232, CAN/LIN, and trigger ports
Removable SD data storage

Easy Measurements and Logging
Familiar experience with Windows 7
Easy streaming and logging with DAQmx
Port code from existing systems

Deploy Anywhere
-40 to 70 deg C operating temperature
5g vibration, 50 g shock
Class 1, Div II location certified
Ventless

Transportation   Datalogging   ni.com

The CompactDAQ Family

A Custom System for Your Application
Mix and match from the entire family of measurement-specific, auto-detected, hot-swappable C Series modules.

A Module for Any Measurement
Over 60 measurement-specific modules integrate everything you need for a range of signal types, channel counts, and rates.

Same Code, Any Bus
Whether you've chosen to use USB, Ethernet, Wi-Fi, or use an integrated controller identical code will run across each bus making scalability simple.

Choose the Right Form Factor for You
Available 1-, 4-, 8- and 14-slot chassis to accommodate up to 448 channels per chassis in tethered or stand-alone form.

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CompactDAQ Chassis with TSN

TSN Synchronization

Sub-microsecond accuracy
Trigger based on time

Integrated Network Switch

Daisy-chaining for simple expansion
Link redundancy protocols

Rugged Specifications

-40 to 70º C temp range
50g shock, 5g vibration
Hazardous locations certifications

DAQmx Channel Expansion

Automatic multi-chassis synchronization
Simple programming with single task

Deploy Closer To Your DUT

Scale Effortlessly

Meet Your Exact I/O Needs

Streamline Configuration

ni.com

CompactDAQ with TSN

Deploy Anywhere
Increase accuracy with reliable operation closer to your sensor

Scale Effortlessly
Precise timing and synchronization regardless of system size with TSN

Streamline Configuration
Integrated switch simplifies setup and wiring with daisy chaining

Meet Your Exact I/O Needs
Wide Breadth of Modular I/O for frequently changing requirements

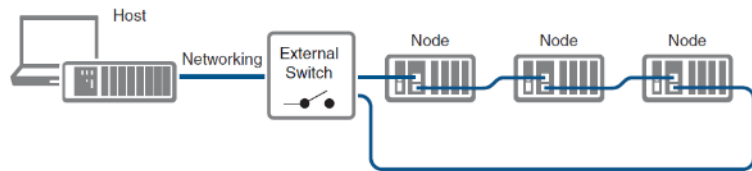# Selecting a Modular Topology for Your System
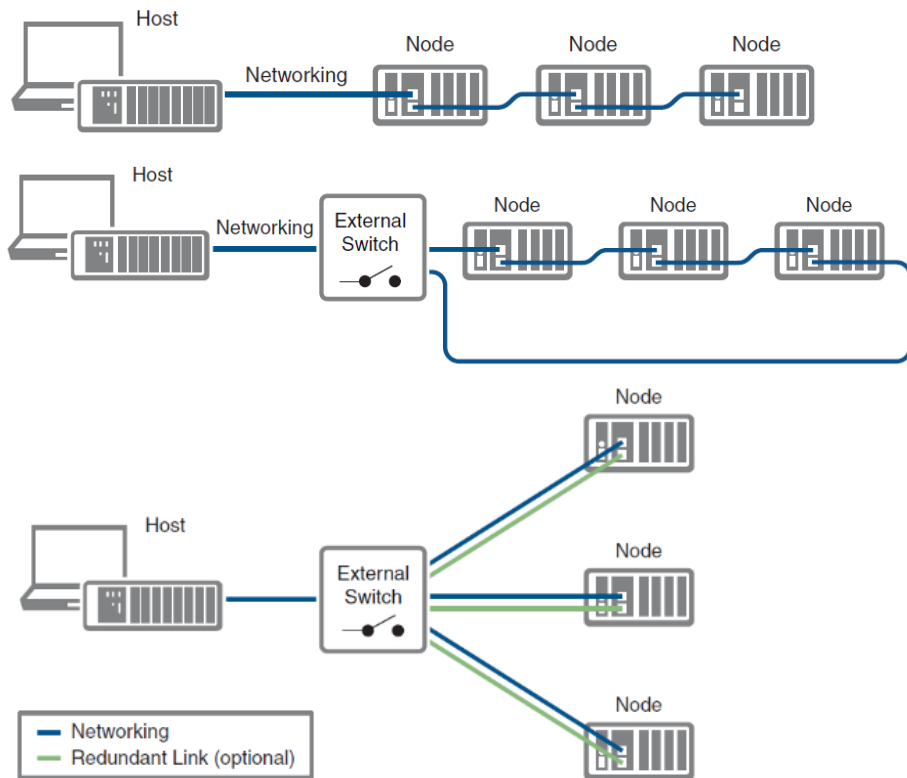
Selecting a Topology for Your Application

Line Topology

- Pros:
  - Simple and inexpensive installation, expansion, and troubleshooting.
  - No external hardware needed.
  - Ideal for low number of nodes.

- Cons:
  - Any unpowered node and/or node failure disrupts network communication.
  - Failure of any Ethernet cable and/or improper cable termination disrupts network communication.
  - Addition or removal of any node can disrupt network communication.
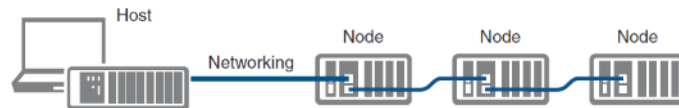
Selecting a Topology for Your Application

Ring Topology

- Pros:
  - Simple and inexpensive installation and expansion.
  - Failure of any single Ethernet cable does not disrupt network communication.
  - Ideal for a local networking solution.

- Cons:
  - Network traffic patterns can make troubleshooting difficult.
  - Requires an external switch.

Selecting a Topology for Your Application

Star Topology

- Pros:
  - Unpowered nodes and/or node failure does not disrupt network communication with other nodes
  - Additional nodes or heavier network traffic affects network performance less than the other topologies
  - Simple installation, expansion, and troubleshooting

- Cons:
  - Most costly of the recommended topologies
  - Requires an external switch
  - Covers the least distance
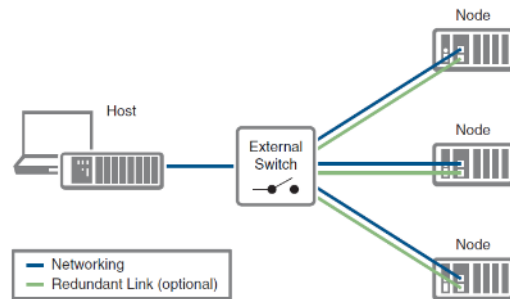
C Series I/O Modules

Over 100 NI and Partner Modules

- Analog Input
- Analog Output
- Digital I/O
- Relay Output
- Counter, Pulse Generation
- Communication
- Motion Control
- Wireless
- Engine Control

Other Module Benefits

Signal Conditioning

Rugged Mechanicals

Isolation Barrier

Certifications

NI C Series I/O Modules

Integrated DAQ, Signal Conditioning, & Connectivity

Built-in Signal Conditioning
Direct connection to sensors for temperature, pressure, acceleration, strain, load cell, etc

Guaranteed Accuracy
NIST traceable calibration
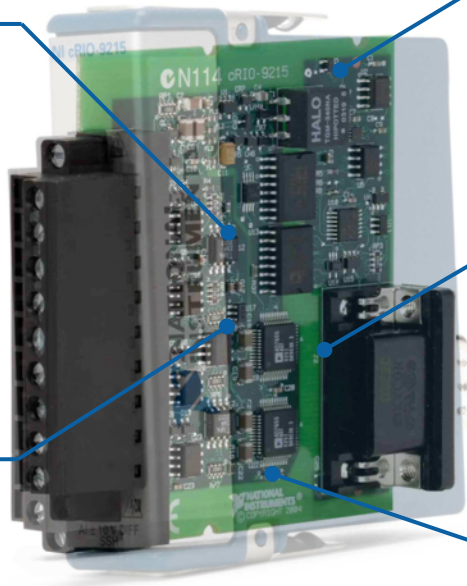
Signal to Backplane Isolation Barrier
Safety, noise immunity, common mode rejection

High Quality Measurements
Streaming up to 102.4 kS/s/ch @ 24-bits or 1MS/s/ch @ 16-bits

Per Module ADCs
Simultaneous sampling

Architecture of an Integrated Measurement System

CompactDAQ is a portable, rugged DAQ platform that integrates connectivity and signal conditioning into modular I/O for directly interfacing to any sensor or signal.
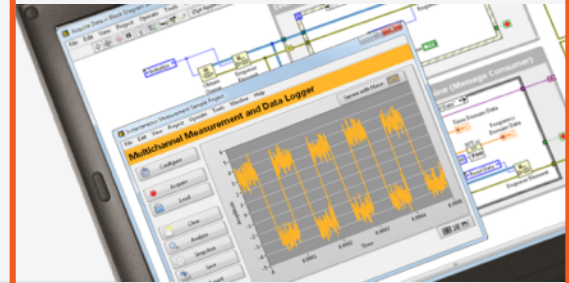
Sensor	Measurement Device		Software	
	Signal Conditioning	Analog-to-Digital Converter	Driver Software	Application Software

Three Decades of Innovation

1986 — Release on the Macintosh

1990 — Compiled language

1993 — Macintosh, Sun and Windows

1997 — Software engineering

1998 — Real-Time enabled

2000 — Internet ready

2003 — FPGA programming

2005 — Distributed system design

2006 — Textual math object-oriented programming

2007 — Multicore optimized

2008 — Web services

2009 — Models of computation

2010 — Focus on software performance

2011 — Focus on stability for long-term systems

2012 — Proficiency integration including e-Learning

2013 — Productivity features focus

2014 — Data-driven decision capabilities

2015 — Write code faster. Write faster code.

2016 — Channel wires

2017 — Complex system design

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LabVIEW™

Integrate Hardware. Visualize Data. *Accelerate Engineering.*

LabVIEW NXG 1.0

LabVIEW 2017

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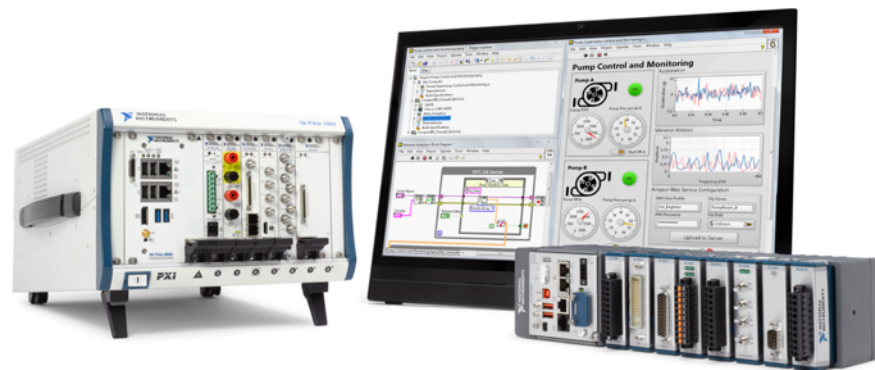
LabVIEW NXG 1.0

Intuitive Engineering Workflows
Take Your First Measurement Faster

Iterative Data Exploration
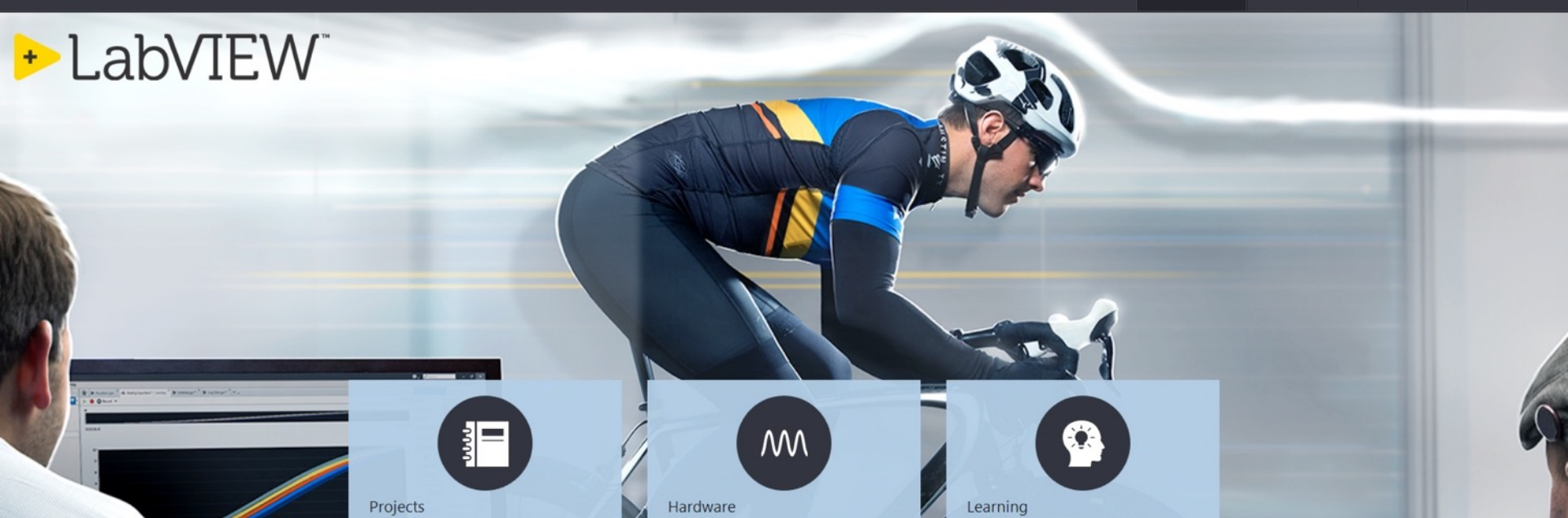*Instantly Explore Your Engineering Data*

Productive System Customization
Accelerate Your Development with an Enhanced Editor

Interactive Learning and Help Content
Learn What's Needed to Build the Project at Hand

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LabVIEW NXG 1.0 Demonstration

ni.com

Initutive Engineering Workflows

Take Your First Measurement Faster

Minimize the time to your first measurement using hardware auto-discovery and interactive panels—
programming optional.

Automatic Driver Detection

Contextual hardware documentation

DAQ signal type discovery

Instant Access to Signals From Hardware

Interactive Configuration of Hardware Channels

Efficiently Manage Configurations Across Channels

Iterative Data Exploration

Instantly Explore Your Engineering Data

Rapidly gain insight into real-world signals using integrated data capture and analysis tools.

Capture Data Directly From a Signal's Chart
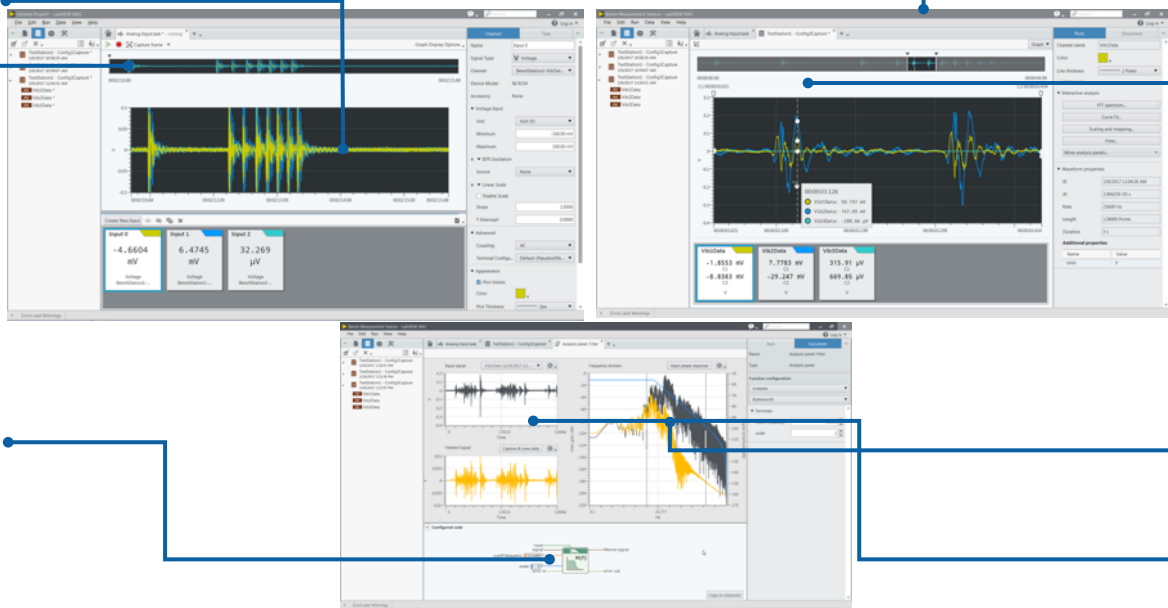
Data Pane to Manage Every Capture

Use an Automatically Configured Analysis VI for In-Line Processing

Zoom-In on the Most Important Part of a Signal

Sweep Through Individual Data Points

Real-Time Editing of Analysis Parameters

Instantly Apply Analysis to Data Set

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Productive System Customization

Accelerate Your Development with an Enhanced Editor

Reduce your development time for common tasks, such as UI design and diagram programming, using enhanced coding productivity features.

Multiple Document Interface

Support for Multiple Programming Languages

Multilevel Hierarchy Integrated Debug Window

Real-Time Visualization of Code

Zoom

Easy Discovery of Settings and Properties

User Interface Design Layout Tools

Modern UI Engineering Objects

Integrated Learning and Help Content

Quickly Learn What's Needed to Build Your Project

Get your next project done faster with interactive in-product learning and example programs you can use as a starting point to customize your test and measurement system.

In-Product Universal Search

Guided Lessons With Code and Workbooks

Hundreds of example programs….

Integrated triggers