NI Solutions for Space

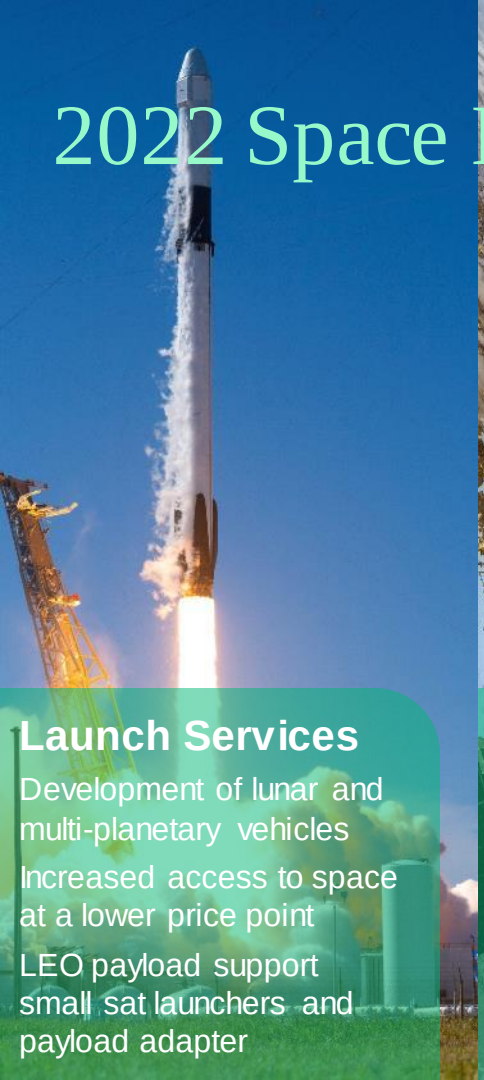
Space Industry Business Development Manager

Paul Bouagnon

linkedin.com/in/paulbouagnon/

- BDM Overview
  - Ensuring the success of our leading space customers
  - Responsible for NIs space industry investments
  - Developing our space partnerships
- Over 10 years of NI experience
  - AE >> AM >> BDM
- Industry Experience: Aerospace and Defense, Transportation, and Semi/Consumer Electronics,

2022 Space Industry Trends

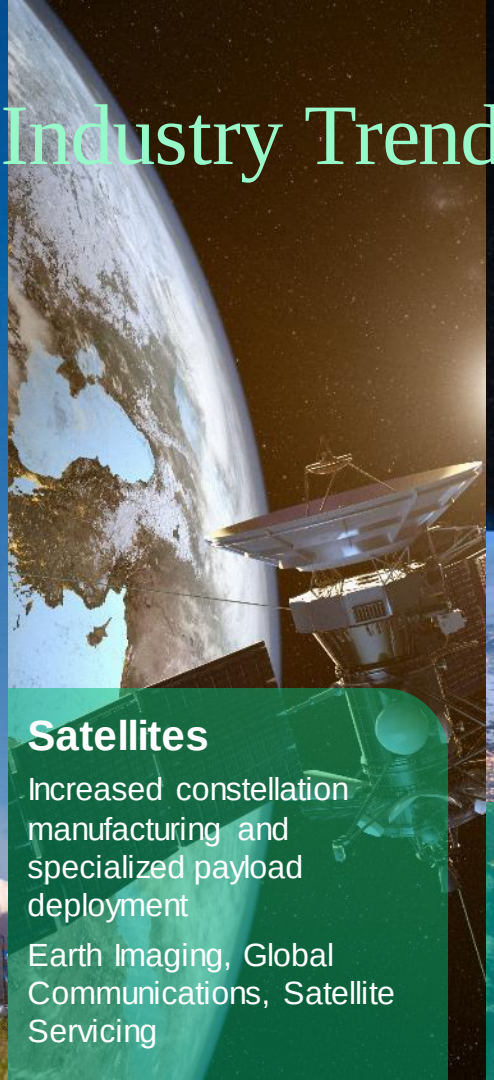


Launch Services

Development of lunar and multi-planetary vehicles

Increased access to space at a lower price point

LEO payload support small sat launchers and payload adapter



Satellites

Increased constellation manufacturing and specialized payload deployment

Earth Imaging, Global Communications, Satellite Servicing

Space Habitats

Growth of LEO Economy

ISS Decommission in 2030

Multiple Commercial Space Stations

Ground Segment

Multi orbit and multi frequency ground station support

EW considerations for critical infrastructure

Space Trends Challenges

Market Challenges

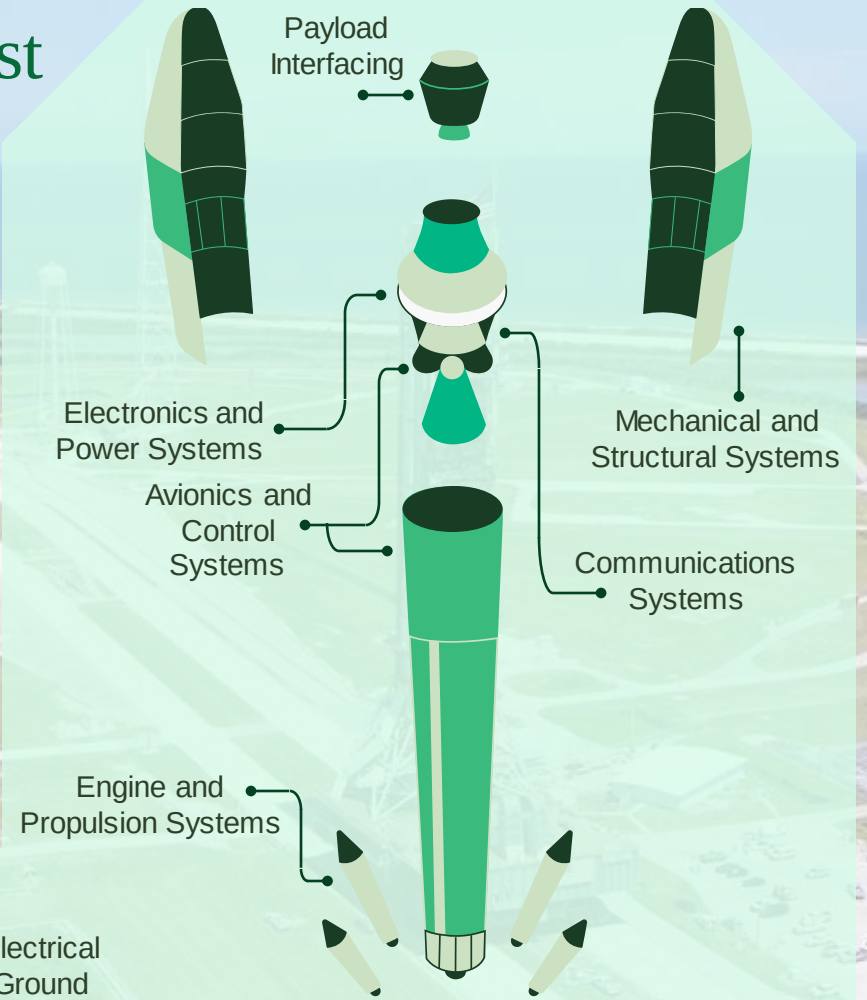
- Increased investment and competition
- Increased customer cost pressure
- Time to market pressure
- Mission critical and human safe systems

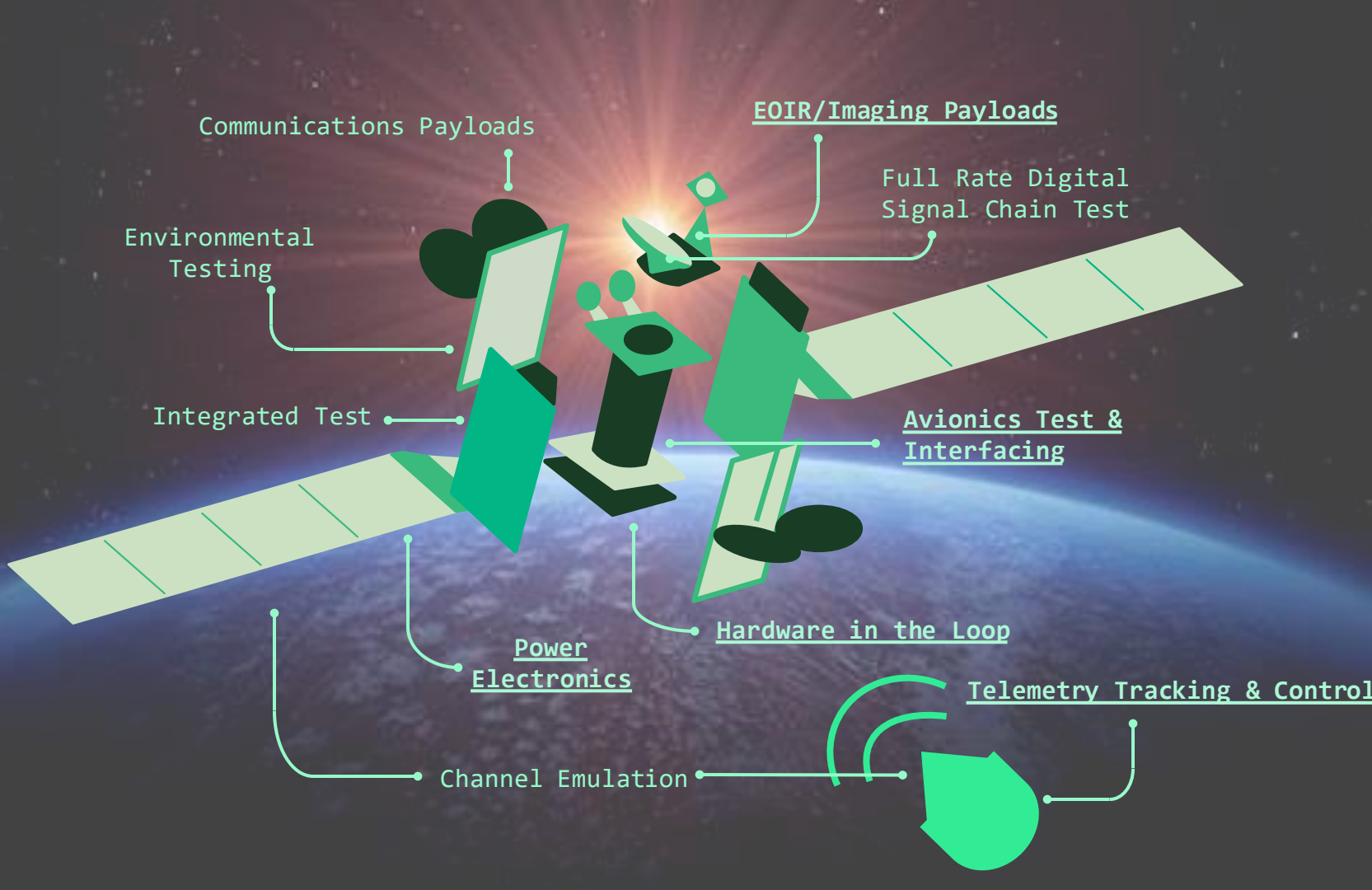
Technology Challenges

- Scaling production volumes
- More complex payloads
- HW quality and reliability
- More software and autonomy

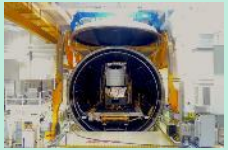
NI and Launch Vehicle Test

Design | Validate | Produce | Maintain




Communications Payloads
EOIR/Imaging Payloads
Full Rate Digital Signal Chain Test
Environmental Testing
Integrated Test
Avionics Test & Interfacing
Hardware in the Loop
Power Electronics
Telemetry Tracking & Control
Channel Emulation

NI Space Application Areas

Launch Segment	 Avionics HW Test	 HIL and Integration Test	 Telemetry, Datalinks, and Comms Components	 Environmental, Structural, and Mechanical Test
Satellite Segment	 Avionics HW Test	 SATCOM, Telemetry, and Datalinks	 HIL and Integration Test	 EOIR and RADAR Payloads
Ground Segment	 Electronic Ground Support Equipment	 Engine Test	 Launch Operations	 SATCOM, Telemetry, and Datalinks

Enterprise Test, Data, and Systems Management Software

NI Platform at a Glance

BROAD NI HARDWARE & SOFTWARE PORTFOLIO

Instrumentation

- Oscilloscopes
- High-Speed Digital I/O
- DMM and SMU
- Signal Generators
- Switching
- RF Analyzers and Generators

DAQ and Control

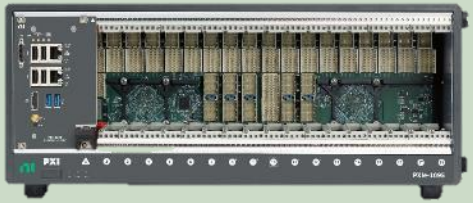
- Multifunction I/O
- Counter/Timer/Clock
- Digital I/O
- Analog Input/Output
- Vision and Motion
- FPGA/Reconfigurable I/O

Interfaces

- GPIB, USB, LAN
- RS232/RS485
- CAN, LIN, DeviceNet
- SCSI, Ethernet
- VXI/VME
- Boundary Scan/JTAG

Application Software

- SystemLink
- LabVIEW
- VeriStand
- TestStand
- InstrumentStudio
- FlexLogger



THE DIY APPROACH TO SPACE TEST

Manufacturing Execution System (MES)

Systems Management | Test Management | Data Management | Real-Time Dashboards | Operations Modeling

Analytics & Operations

Test UI | Sequence Editor | Data Connectivity and Publishing

Test Architecture/Sequence

Test Steps | Debug UI

Abstraction Layers

Instrument Drivers/Configuration Tools

DUT Control Functions

DUT Handler Functions

Station Health and Operation Functions

Application Software

Analog and Digital I/O | Digital Multimeter | Oscilloscope/Digitizer

Waveform Generator | Switch | Source Measure Unit

Programmable DC Power Supply | Electronic Load | Instrument Control and Synchronization

Instrumentation

Rack: Mechanical, Power, and Safety | Display | Test Station Health Monitoring Hardware | Computer/ Controller | Fixture and Chamber | Connector/ Mass Interconnect | DUT Handler

Infrastructure

DUT

Device

NI PRODUCT | BUILT USING NI PRODUCTS | BUILT USING NI ECOSYSTEM TOOLS | FROM END USER OR THIRD PARTY

LabVIEW | SystemLink | TestStand | InstrumentStudio | Instrument Specific Drivers and APIs | Switch Executive

Operation, Maintenance, and Regulatory Documentation

Core mechanical, power, and safety infrastructure for a test system

(Configured System)

NI ATE Core Configurations

- Faster development – standardized starting point for test system design
- Highly customizable – using the PXI Advisor system configurator
- Simplified procurement – simplified BOM and vendor management
- Expedited delivery – delivered in days, not weeks or months
- Simplified global deployments - IEC 61010 safety certified configurations

Looking for a turn-key solution?
NI has over 1,000 Alliance Partners ready to help.
ni.com/alliance

NI Models of Engagement

1. Instrumentation Vendor
2. Test System Vendor
3. Test Solution
4. Test Engineering & Solution Service
5. Outsourced Test Engineering, Solution, and Sustaining Services Provider

Customer — Ownership Model — NI/Partner





Avionics, Payload, and RF Test

Automated Avionics Board and Box Level Test

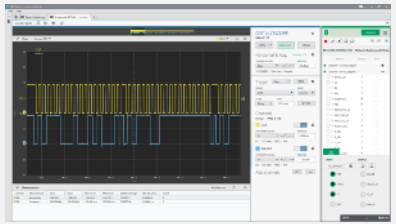
UP/DOWNSTREAM DATA-SHARING

Design | **Validation** | **Production**

LAB USE CASES RANGE FROM

Rapid, Interactive Debugging

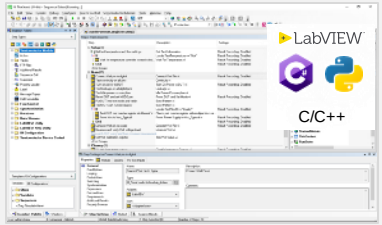
Instrument Studio™



SAME INSTRUMENTATION

Fully Automated Validation

TestStand™



SHARED MEASUREMENT FRAMEWORK &
CONFIGURATIONS ACCELERATE TIME TO AUTOMATION

Focal Plane Tester / Emulator System

Test Automation Software

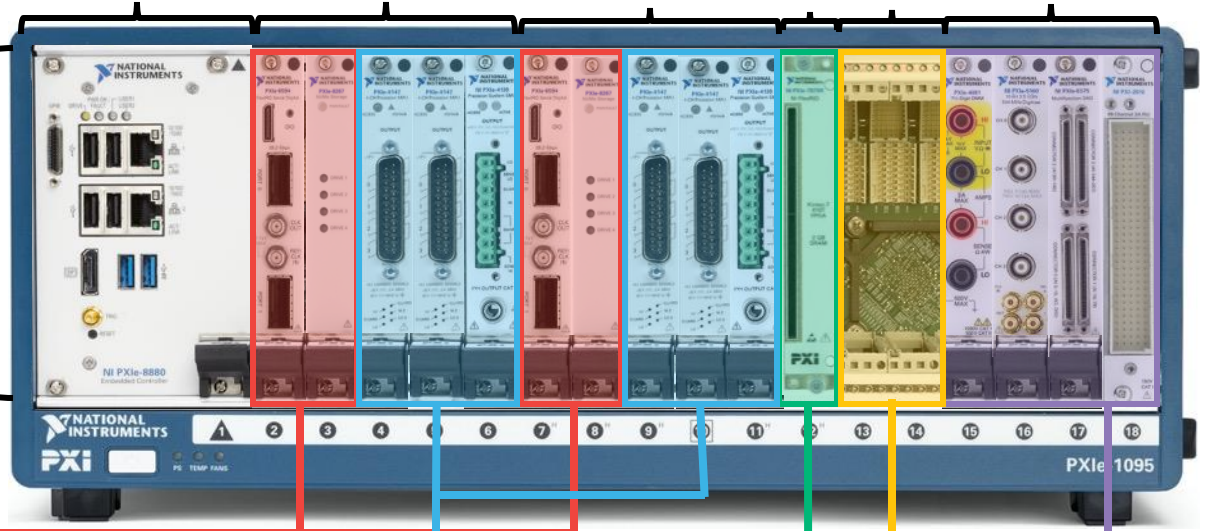
TestStand LabVIEW python

Host
- Pass / Fail Analysis
- Record / Playback / Emulation
- Image Processing
- Image Analysis

FPGA – Inline Processing
- Custom Digital Protocol
- Image Formatting
- Target ID and Track

VIVADO

Embedded Controller | 24 MGTs + RAID 9 Biases | 24 MGTs + RAID 9 Biases | DIO | Expansion | Mixed IO



FPA Serial Interface
- FPGA Based High Speed Digital IO
- Customer Defined Data Interface
- In Chassis RAID for Data Streaming

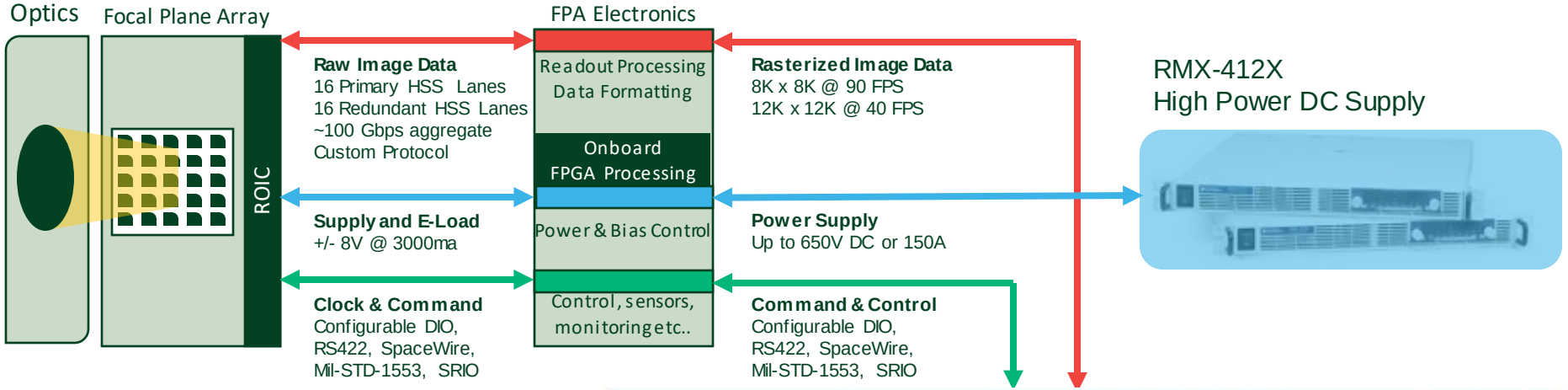
FPA Programable Power Supply and Bias
- Emulation Loads
- Power 50W to 200W
- Control & Bias Supplies

DIO Control
- Discrete 3.3V
- RS422
- JTAG
- Clocking
- C&C – Spacewire etc...

Room for Expansion

Electronics Test
- Thermocouples
- Thermistors
- Short/Open
- Voltage / Current
- Signal Switching

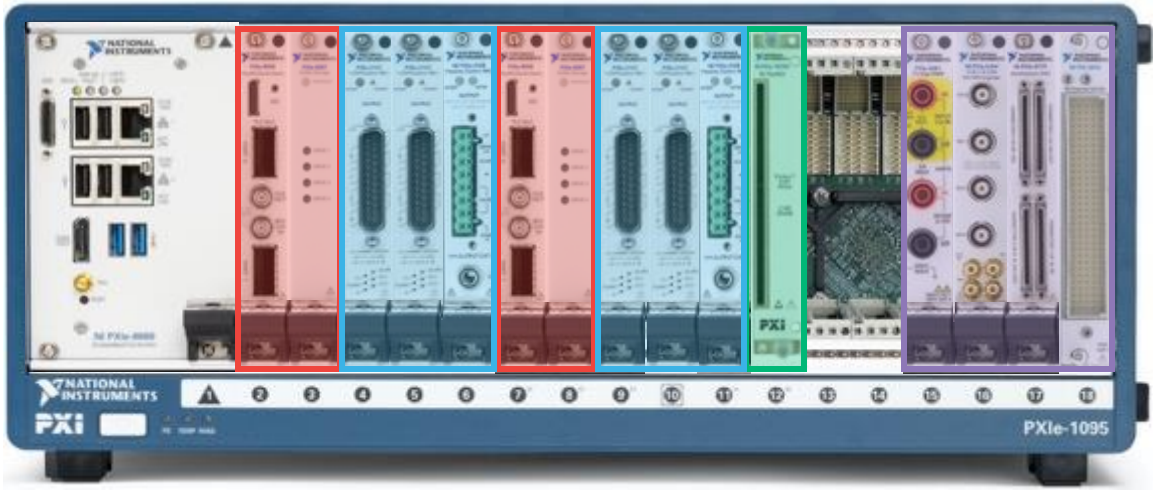
Payload System Level Test



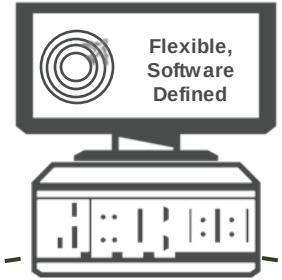
Common Tests

- Validate FPA Electronics Data Stream
- Emulated Mission Processing Systems (HIL)
- Complete Subsystem Validation Independent of Platform systems

Digital Control
DC Power
High Speed Data
Mixed IO



RF, Digital, and FPGA Hardware Platform

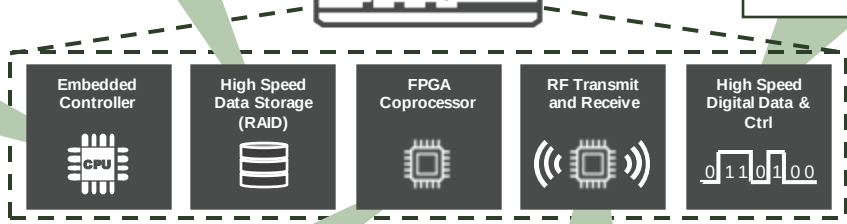


High Speed RAID Storage

- Up to 5 GB/s, 4 TB in-chassis
- Up to 5 GB/s, 24 TB external
- Based on NVMe technology

Embedded Controllers

- High Performance Intel Chipsets
- Solid State HDD
- Deep DRAM Options
- High-performance PCIe Interface



High Speed Digital I/O

- Up to 12.5 Gbps
- 24 TX and RX Lanes
- Xilinx Kintext-7 and Virtex-7 FPGAs
- 2GB Onboard DRAM
- Gen 2x8 PXIe

Programmable DIO for Control

- SE, DE, LVDS
- Up to 1 Gbps
- RS 422/485

FPGA Coprocessing

- Xilinx FPGAs – V7, K7, KU
- LabVIEW FPGA & Vivado
- NI P2P Streaming PCIe Gen3x8

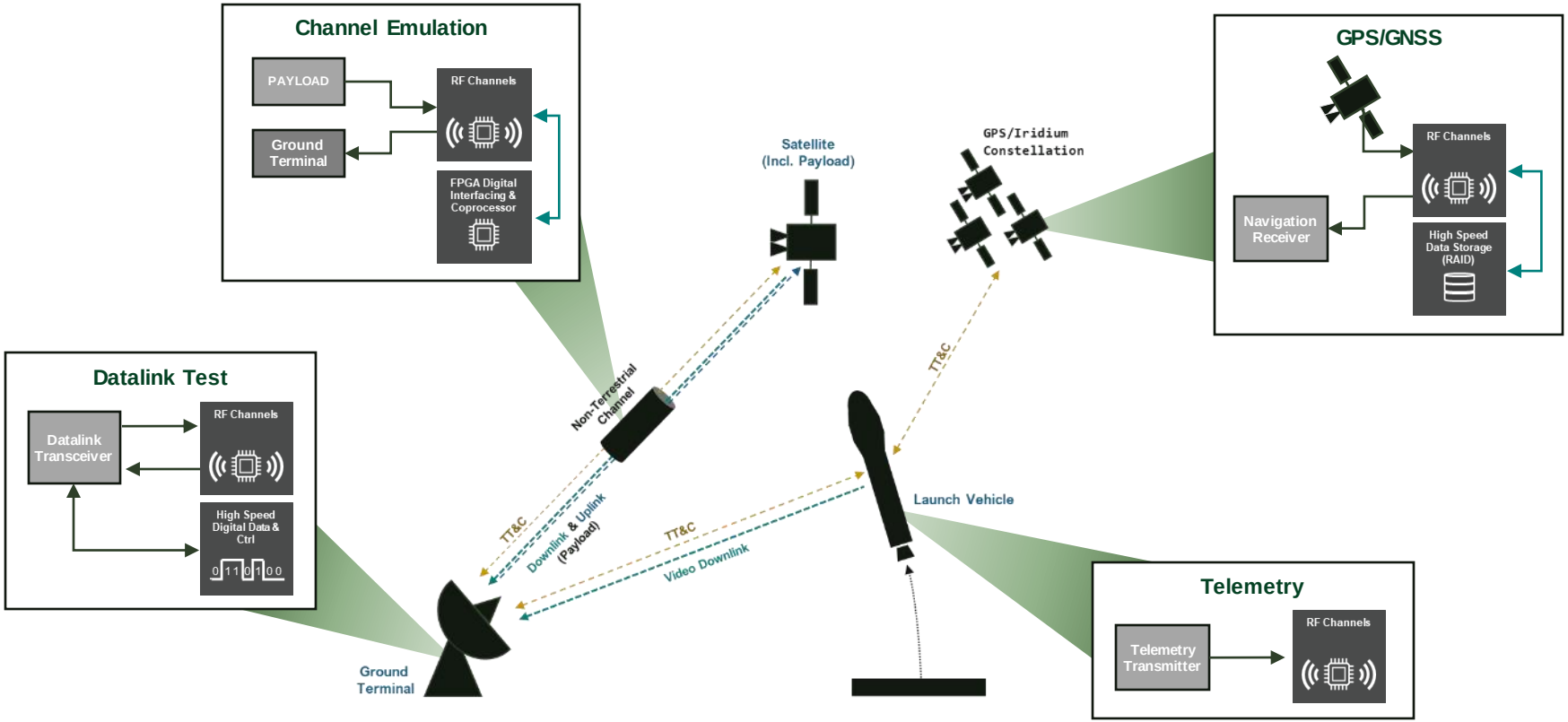
High Performance RF

- Integrated Transceivers
- Versatile Frequency Coverage – 9 kHz to 44 GHz
- Wide Instantaneous Bandwidth – Up to 1 GHz
- Integrated FPGA
- Instrumentation Level Performance & Calibration

FlexRIO "Custom" Instruments

- Latest data converters
- Large, open FPGAs
- Focus on raw performance, typical specs
- High channel density & bandwidth

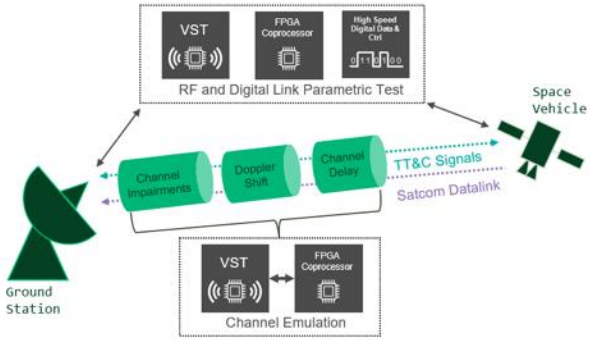
Subassembly Functional Test and System Validation

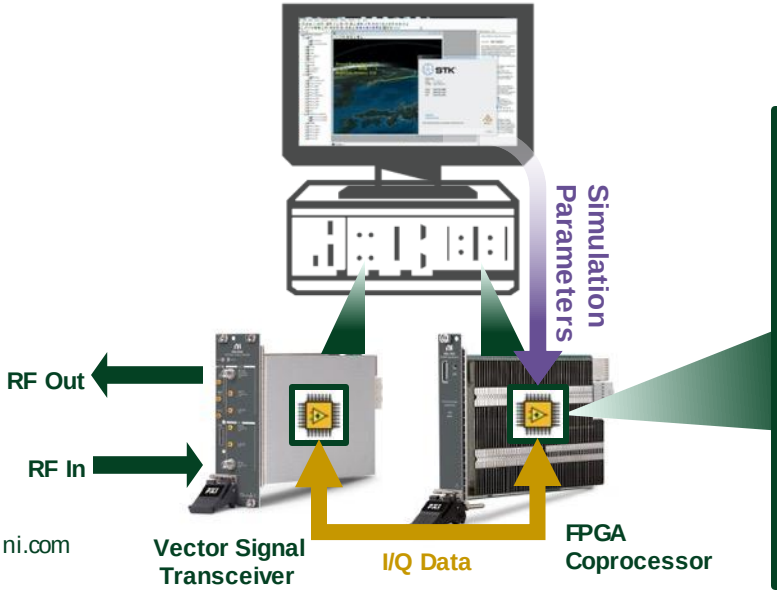


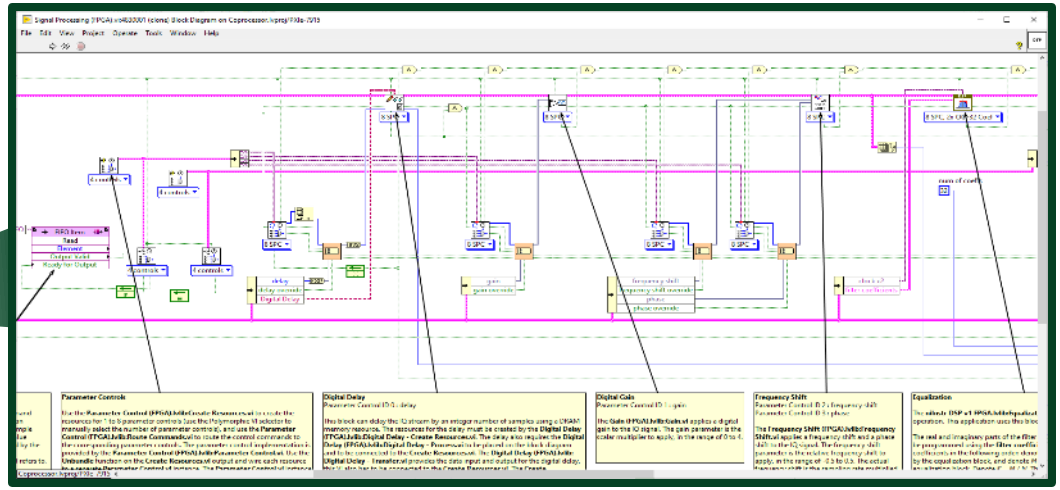
Satellite Link Emulator – Tech Demo

Validate next generation satellite datalinks by connecting simulation software with real-time hardware in the loop test.

In this demonstration, a channel emulator is implemented on the NI PXI platform and Vector Signal Transceiver (VST). Integration into Ansys STK allows for channel model parameters to be updated in real-time based on accurately simulated links between satellite and ground stations.



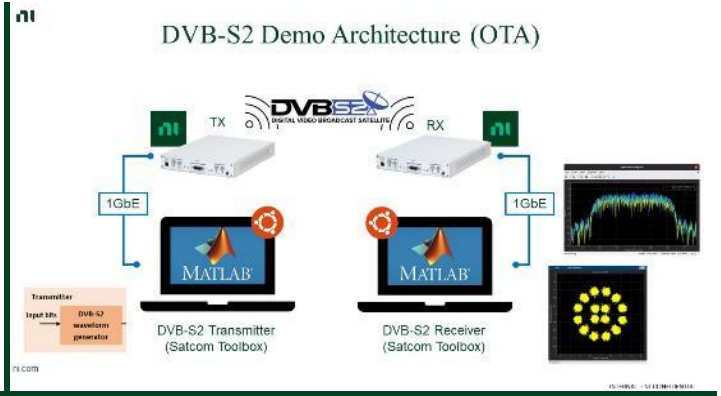


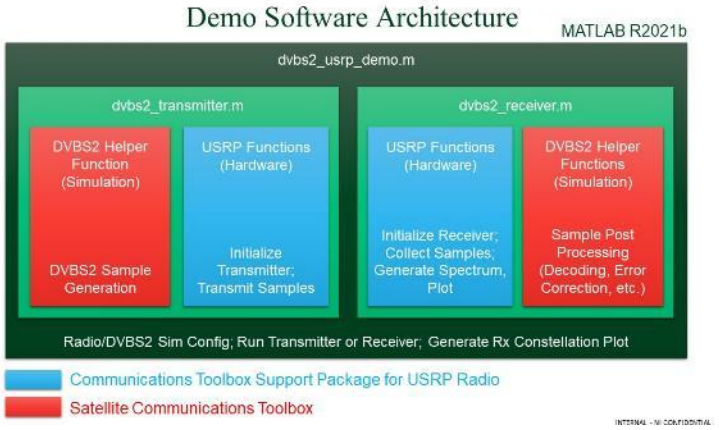


Satcom DVB-S2 Simulation with MATLAB

Objective: Integrate NI USRP X310s with MATLAB DVB-S2 simulation software to transmit and receive DVB-S2 samples over the air (OTA). Demonstrates steps between pure waveform simulation (MATLAB) and transmitting real data using hardware (NI).

Market Segments
Communications Navigation Surveillance (CNS)





Demonstrated Concepts and Capabilities

NI hardware integration (USRPs) into MathWorks DVB-S2 simulation example

Real transmission of Satcom waveform samples

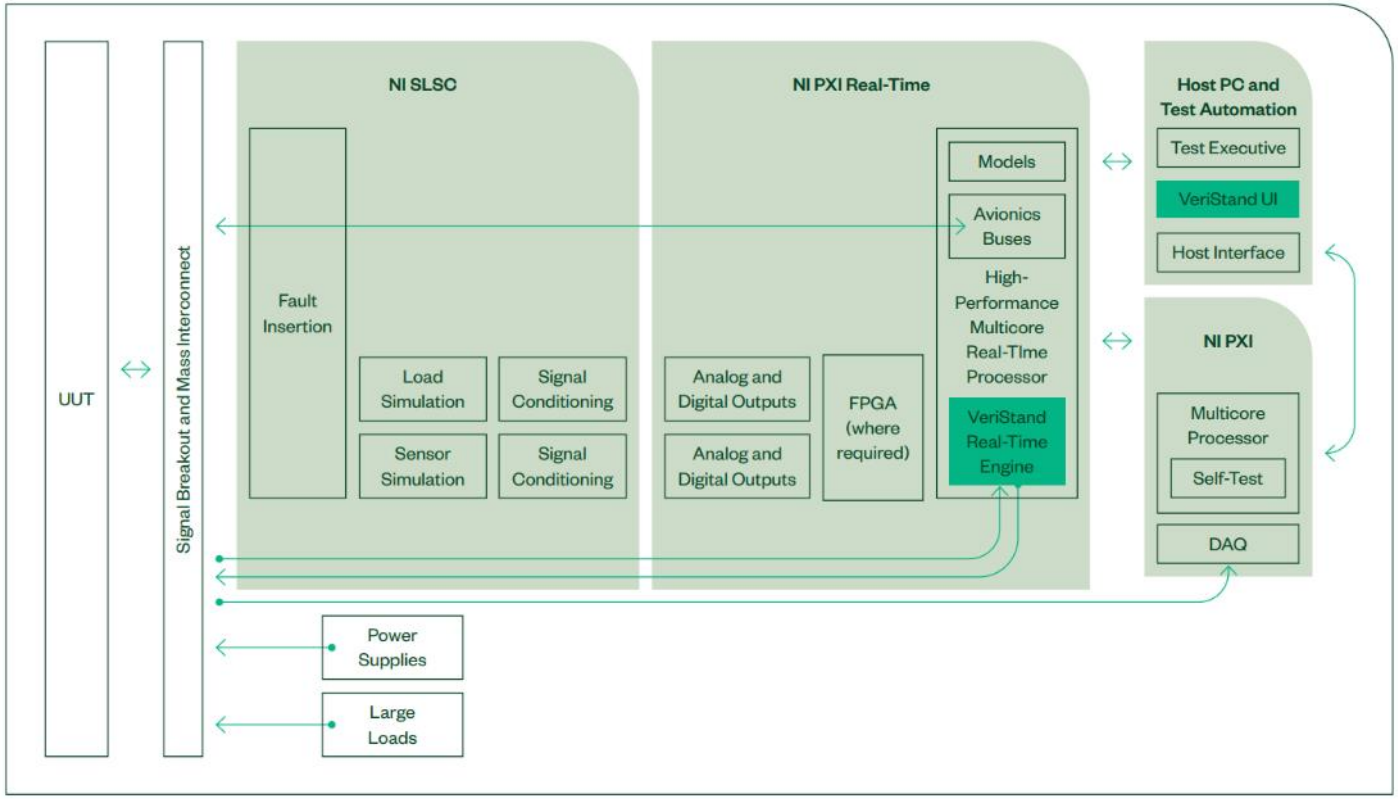
A starting point for customers interested in leveraging NI USRPs for Satcom waveform development

Technical Approach

NI USRP X310s, GPPs, MATLAB + Toolkits

Hardware-in-the-Loop Test

HIL Test System Reference Architecture and Signal Flow



NI LRU Test System Reference Architecture

Documentation

LRUTS 1.0 User Manual

Defined Software Components

LabVIEW

VeriStand

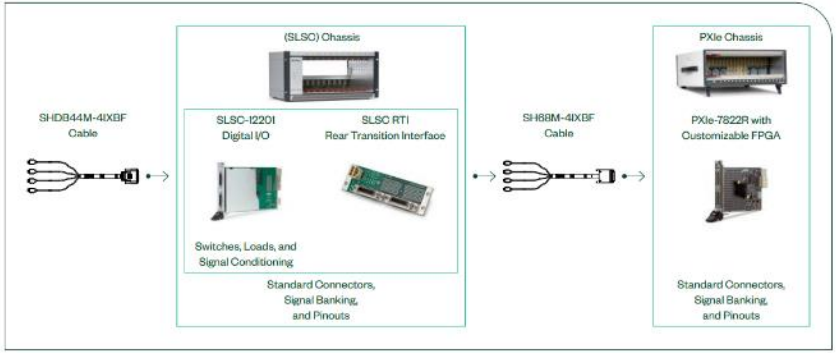
Defined Hardware Components

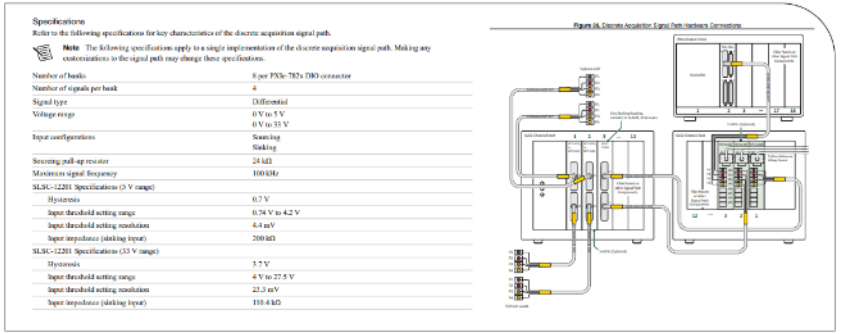
SLSC

PXI

Defined Signal Paths

Example Signal Path Definition and Specifications





Specifications

Refer to the following specifications for key characteristics of the discrete acquisition signal path.

Note The following specifications apply to a single implementation of the discrete acquisition signal path. Making any customizations to the signal path may change these specifications.

Number of banks	8 per PXIe-782x DIO connector
Number of signals per bank	4
Signal type	Differential
Voltage range	0 V to 5 V 0 V to 33 V
Input configurations	Sourcing Sinking
Sensing pull-up resistor	24 kΩ
Maximum signal frequency	100 kHz
SLSC-12201 Specifications (5 V range)	
Hysteresis	0.7 V
Input threshold setting range	0.74 V to 4.2 V
Input threshold setting resolution	4.4 mV
Input impedance (sinking input)	200 kΩ
SLSC-12201 Specifications (33 V range)	
Hysteresis	3.7 V
Input threshold setting range	4 V to 27.5 V
Input threshold setting resolution	27.3 mV
Input impedance (sinking input)	110.4 kΩ

Complete SET/Tech180 System-on-Demand Test System

Test System Requirements, Signal Types, and Loads

NI LRU Test System Reference Architecture

SET and Tech180 SoD Defined Signal Paths

System-on-Demand Catalog, Implementations & Software

Additional COTS Products
Signal types
Communications Buses
Mass interconnect
Power supplies, Loads
Racks, etc.

Additional Software Support

Documentation and databases of signal type & communication bus implementations and test capabilities

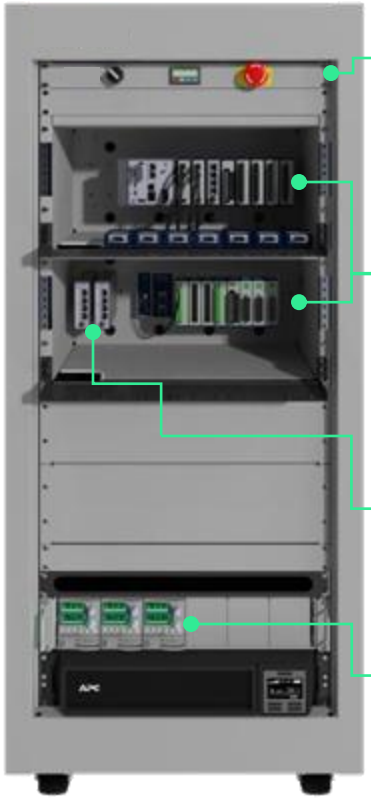
Automated Test System Design and Integration

Fully documented systems that can be easily augmented with more signal paths or test capabilities already specified by SoD.

To learn more, attend the **From Tip to Tail: Solving Defense Aircraft Test Challenges** @ 2:30pm

Power Systems Testing

Battery Test System Measurement Rack



ATE Core Configuration

Standardized ATE infrastructure, 19" rack with UPS, power distribution, emergency stop

CompactRIO and CompactDAQ for Measurement and Control I/O

- **BMS/BMB Communication –** CAN communication to controllers
- **HVIL Measurement –** Signal sourced by BMS: PWM, digital, or analog current
- **Voltage Measurement –** Ch-Ch isolated for measuring cell voltages
- **Thermocouple Measurement** – Ch-GND isolated for module or pack temps
- **Digital Input** – External ECU signals such as contactor state and relay feedback
- **HVIL Control** – Make/break of HVIL loop for functional test
- **PWM Output** – Crash signal generation, auxiliary PWM signals
- **Digital Output –** Ignition signal, etc.
- **Other:** RS-232/485, Ethernet, or CAN for communication to chamber, chiller

*I/O can be added or removed to customize tester for specific applications

FieldDAQ for In-Chamber Measurements

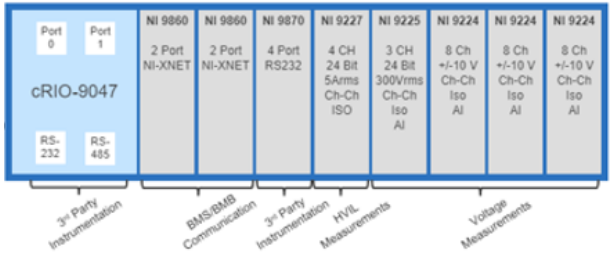
Rugged Synchronized Measurement Devices (Temp, Voltage, Strain/Bridge, IEPE)

RMX Power Supplies for BMS/DUT power

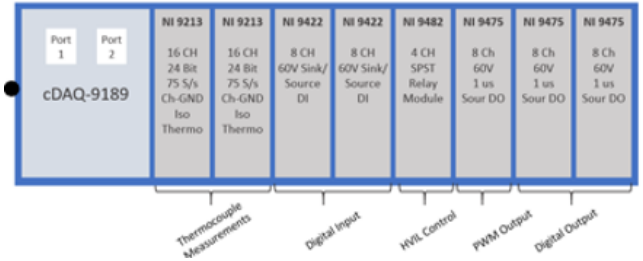
- 0-60V, 3.5A, 210W per module
- Expansion slots for additional supplies

Example Module Configuration

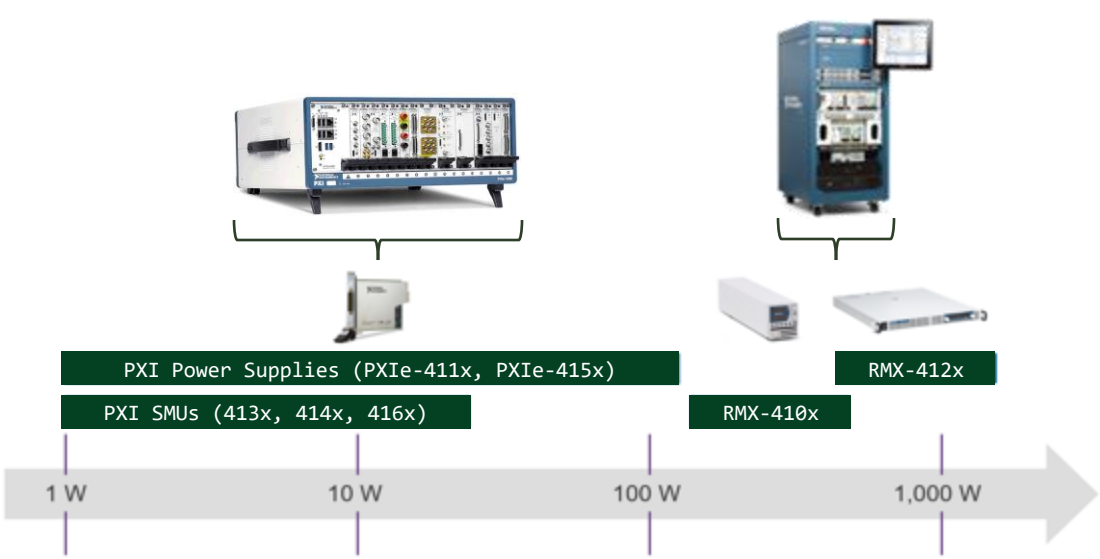
CompactRIO: Controller, Measurement I/O

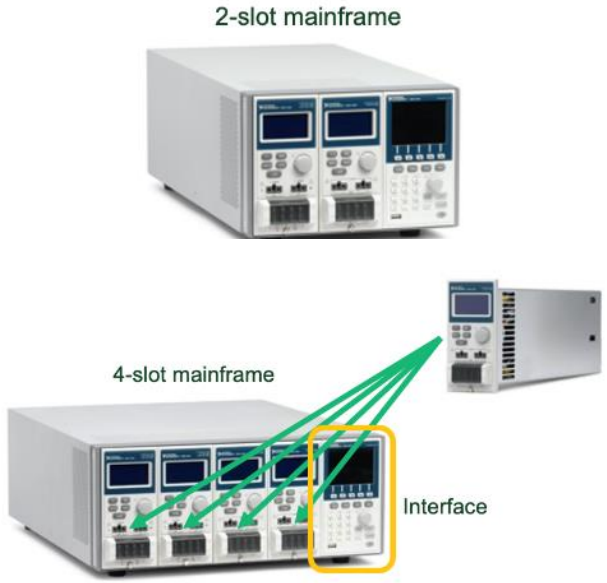


CompactDAQ: Measurement I/O Expansion



DC Power Supplies and E-Loads





	PXI-411x Power Supplies	*RMX-410x Power Supplies*	*RMX-412x Power Supplies*
Output Power Range	9 W to 120 W	200 W to 864 W	750 W to 1500 W
Voltage Range	-20 V to 60 V	0 V to 100 V	0 V to 650 V
Current Range	0 to 6 A	0 A to 40 A	0 A to 150 A
Density (Channels/4U)	34 to 42	12	4

Key Specifications

- Max voltage: 500V
- Max current: 70A
- Max Power: 350W
- Up to 8ch per mainframe
- Communicate over USB, RS232, or LAN

Target Industries: Transportation, ADG, Consumer Electronics

Target Applications: Power source validation and production test, load simulation

Common Tests:

Current/voltage limits, slew rate

Battery discharge

Output power vs. efficiency

NI Investment in Electrification

Strategic Investments and Acquisitions to Increase Portfolio and Capabilities

Power Electronics

NHR from NI

HEINZINGER AUTOMOTIVE GMBH

System Integration

kratzer AUTOMATION TEST SYSTEMS is now NI

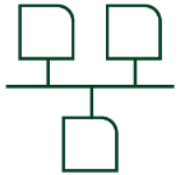
Structural Test, Engine Test, and Launch Operations

Static Structural Test Reference Architecture

- A reference architecture for structural and mechanical engineering teams performing static and fatigue test on aircraft, launch vehicles, and missiles
- Static Structural Test Reference Architecture provides detailed system design/installation instructions to simplify design, purchasing, and deployment
- Reduces deployment cost and schedule risk with enhanced system design
- Includes digital engineering-ready software tools and database connectivity

MECHANICAL STRUCTURE

MEASUREMENT SENSORS AND INSTRUMENTATION



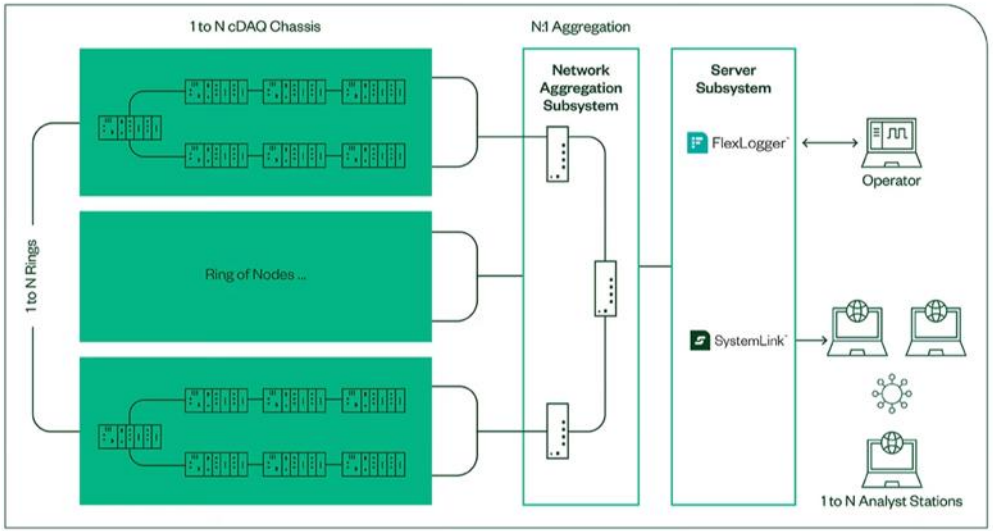
INSTRUMENTATION NETWORKING

TEST CONTROL, DATALOGGING, AND STORAGE

TEST OPERATORS, TECHNICIANS AND DATA ANALYSTS

Static Structural Test Reference Architecture

- Up to 2000 strain measurement channels via networked rings of CompactDAQ chassis
- Time-Sensitive Networking synchronizes data across all channels and introduces redundancy
- FlexLogger, SystemLink, and Static Data Viewer simplify system bring up, configuration, datalogging, and analysis
- Analysts access test data remotely via industry-standard databases with no additional software licenses



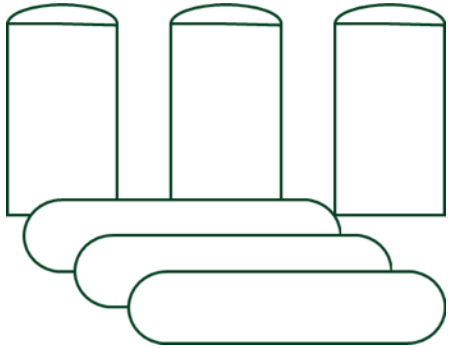
Launch Operations and Engine Test

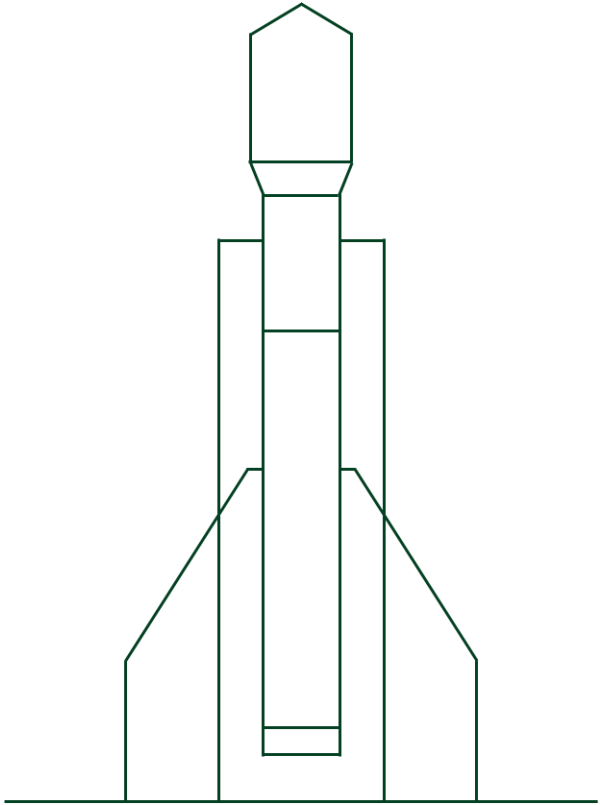
A successful launch and test of a space vehicle requires coordination across a complex array of functions.

Launch operations systems prioritize:

- Safety
- Reliability
- Accuracy

The NI Launch Operations architecture provides systems for monitoring and controlling launch operations systems.





Launch Ops and Engine Test Architecture

MIL Spec Circular Connectors | Commercial Connectors

Enclosure

Cable Management

Enclosure & Cabling

Isolation | Filter | Status Indicator | Solid State Relays | Intrinsic Barrier

Analog Voltage | Analog Current | Temperature (TC/RTD) | Vibration | Strain | Digital I/O | Relay | Frequency

Instrumentation

C-Series and PXI Modules

CompactRIO Controller | CompactDAQ Chassis | PXI Chassis

Control System

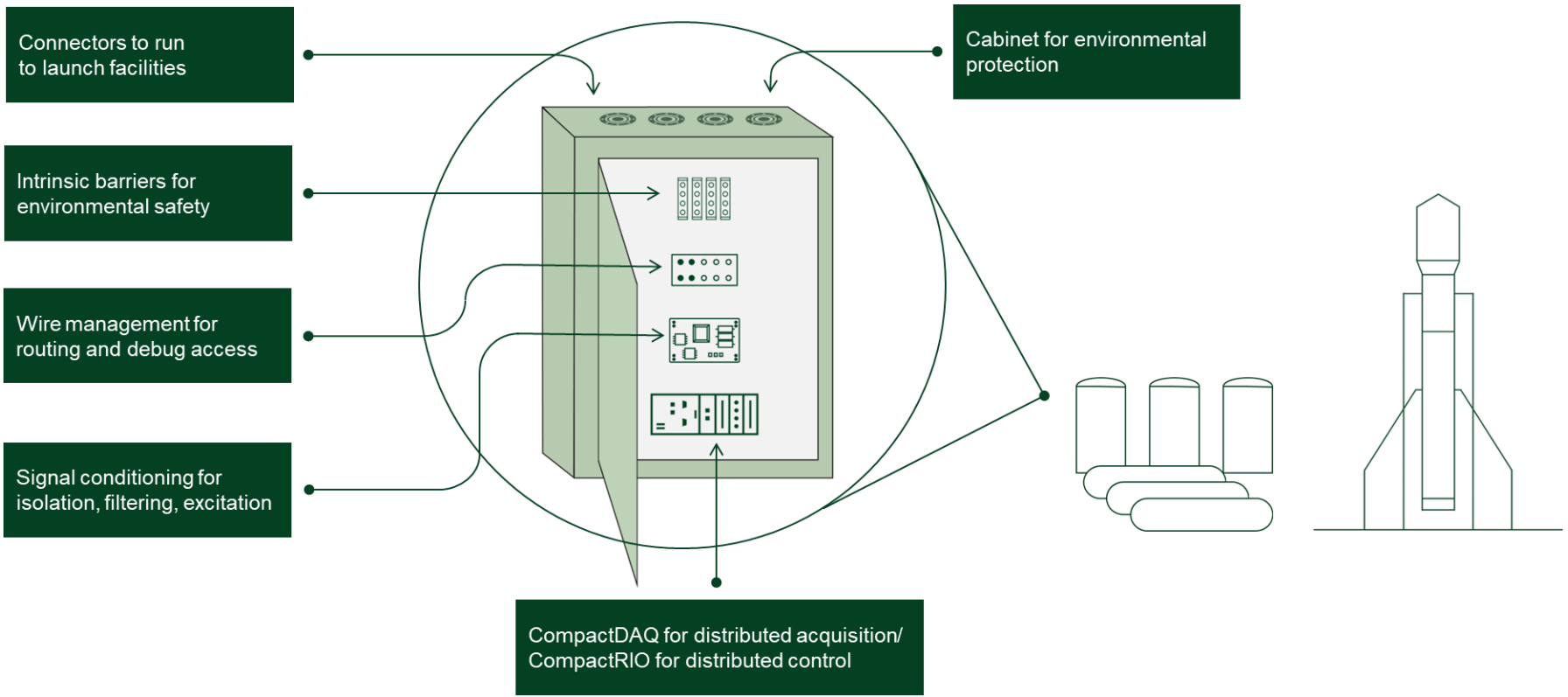
LabVIEW | C++ | Python

Windows | Linux / Linux Real-Time

Software

Operation, Maintenance, and Regulatory Requirements

Launch Operations Control / Monitoring System



Summary

Recap/Call to Action

Follow up through NI Connect app

Come chat with me and our AEs

Demos/Sessions:

Tech180 HIL/SIL System – Tues. 2:30 PM

Satellite Link Emulator Tech Demo

Satcom DVB-S2 Simulation Demo

Structural Test Demo

Rocket on Expo Floor

Propulsion Test Session – Wed. 11:15 AM