Testing EV Battery?

This is what top performance looks like

Becca Stussman

SW Developer

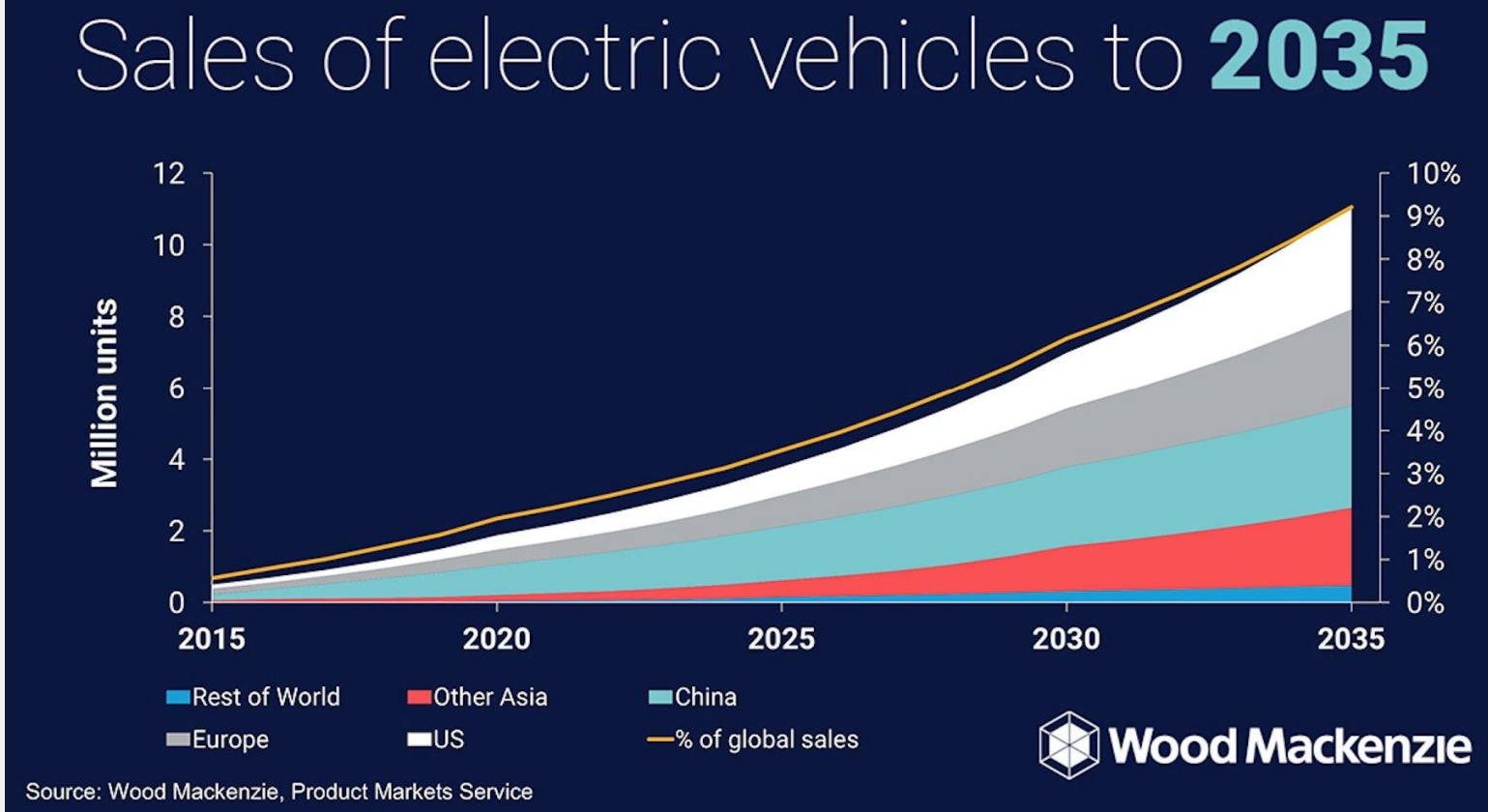
DMC

Ben Black, Ph.D.

Business Development Manager

NI

Our Way to Zero Emissions



Testing Batteries Is a Multidimensional Challenge

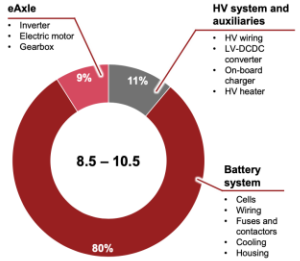
Cost

The battery cells comprise most of the BEV powertrain costs – a closer look at its value chain is imperative

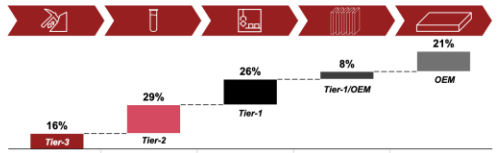
Enable value chain optimization: Significance of battery and cell costs for BEV

Typical cost breakdown BEV powertrain

OEM production costs 2020, 60kWh/100kW, volume class
€ thousand



Automotive battery value chain and value share



Raw materials and precursors	Processing of battery materials	Production of single cells	Production of cell modules	Assembly of battery system
• Main materials – Cobalt – Nickel – Lithium – Graphite – Solvents	• Main materials – Active materials (e.g. NCM, graphite) – Electrolyte – Separator foil – Cell housings	• Main processes – Mixing and electrode coating – Winding/stapling – Electrolyte filling – Sealing – Formation and ageing	• Main processes – Stapling – Electrical connection (power/signal) • Main sub-assemblies – Module controller – Cell connectors	• Main processes – Housing assembly – Electrical assembly • Main sub-assemblies – HV contactors – BMS – Module connectors

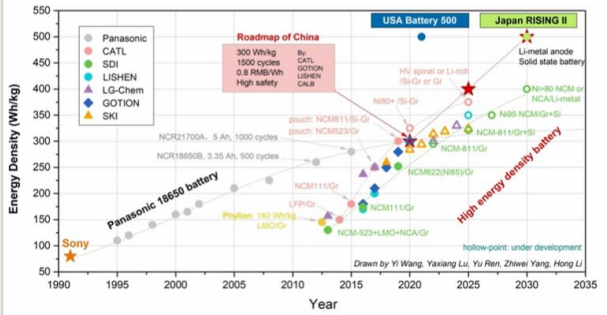
Strategy&

Complexity

BatteryBits

Technology Map: Energy Density Target and Progress

Roadmap of energy density goals



Energy Density Achieved:

On the road:

CATL: 279.56 Wh/kg (Leap Motor T03)

SKI: 269.44 Wh/kg (Arcfox Alpha-T)

LG-Chem: 257.10 Wh/kg (Tesla Model 3)

USA Battery 500:

350 Wh/kg, 350 cycles (Li/NMC 622 Pouch Cell)

*Source: Battery 2030+ Roadmap; Redrawn from Li, et al, cited from Figure 1 in Energy Storage Materials, 23(2019) 144-153

Overview | **Industry** | Research | Talent | Policy | Predictions

Scale

northvolt

Why Northvolt | Products | Environment | Career | Solutions

Future of energy

Volvo Cars and Northvolt accelerate shift to electrification with new 3,000-job battery plant in Gothenburg, Sweden

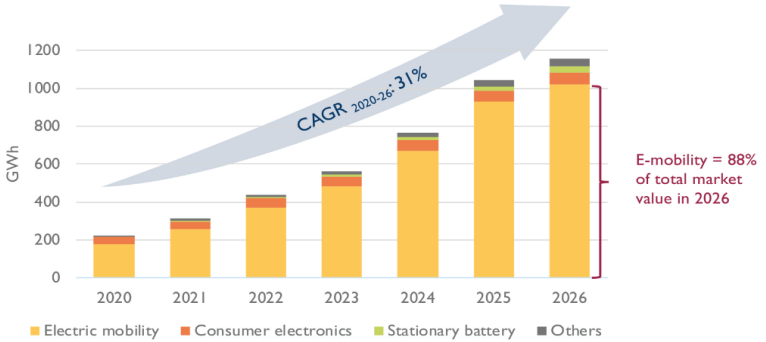
February 04, 2022

Volvo Cars and Northvolt have selected Gothenburg to establish a new 50 GWh battery manufacturing plant which will commence operations in 2025.

Speed

2020 - 2026 total Li-ion battery cell demand in GWh

(Source: Status of the Rechargeable Li-ion Battery Industry 2021 report, Yole Développement, 2021)



YOLE Développement

© 2021 | www.yole.fr – www.i-micronews.com

Battery Characteristics Causing Test Challenges

- Accelerate Time to Market
- Make Better Batteries
- Reduce Total Cost of Test

Temperature Dependency	Long Test Times	Constant Changes
High Power Hazard	Expensive	Agressive Program Schedule

Performance of:

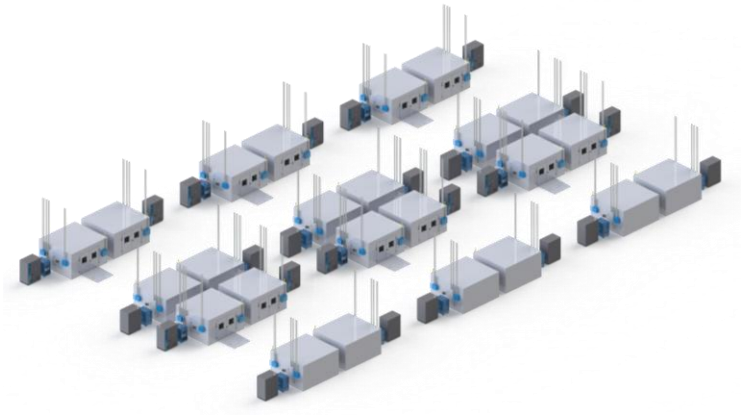
- Engineering Team
- Test Operations
- EV Battery

Test Engineering Is Hard

RESEARCH AND DEVELOPMENT → VALIDATION ← PRODUCTION

Software and Hardware Development | Virtual Test | Prototyping | Component Characterization | Durability | System Integration | Field Test | Process Tests | End of Line Test

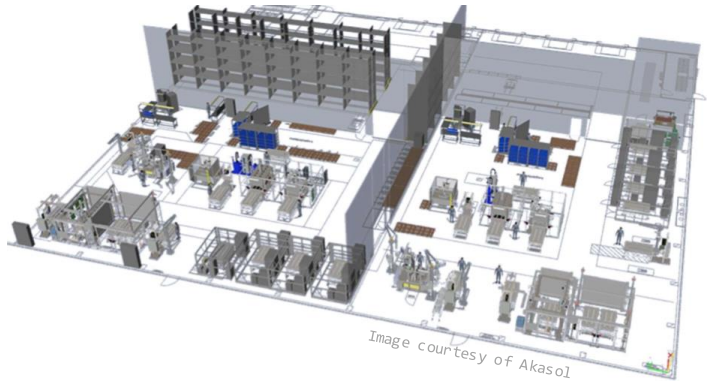
Research and Validation Labs



Open and Flexible Solution Stack

- Data Analytics
- Data & Systems Management
- Test Software (Control/Sequencing)
- Control System (Comms, Measurements, Safety)
- Power Electronics
- Lab/Line Infrastructure
- Connectivity and Fixturing
- Commissioning, Operation, Maintenance

Battery Production Lines



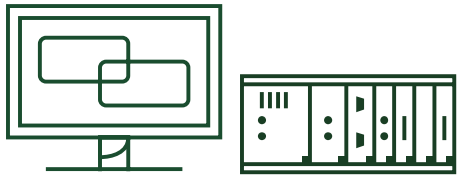
Connected Workflow

← INCREASE PRODUCTIVITY DEEPEN SYSTEM INSIGHT LOWER TOTAL COST OF TEST →

The Right Approach to Have Control Over your Test Strategy

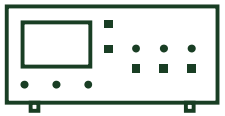
Fully Customized System

"Customer Does Everything"
Costly (Time, Upkeep)
No Ecosystem
Customer Maintains



Open Platform-Based System

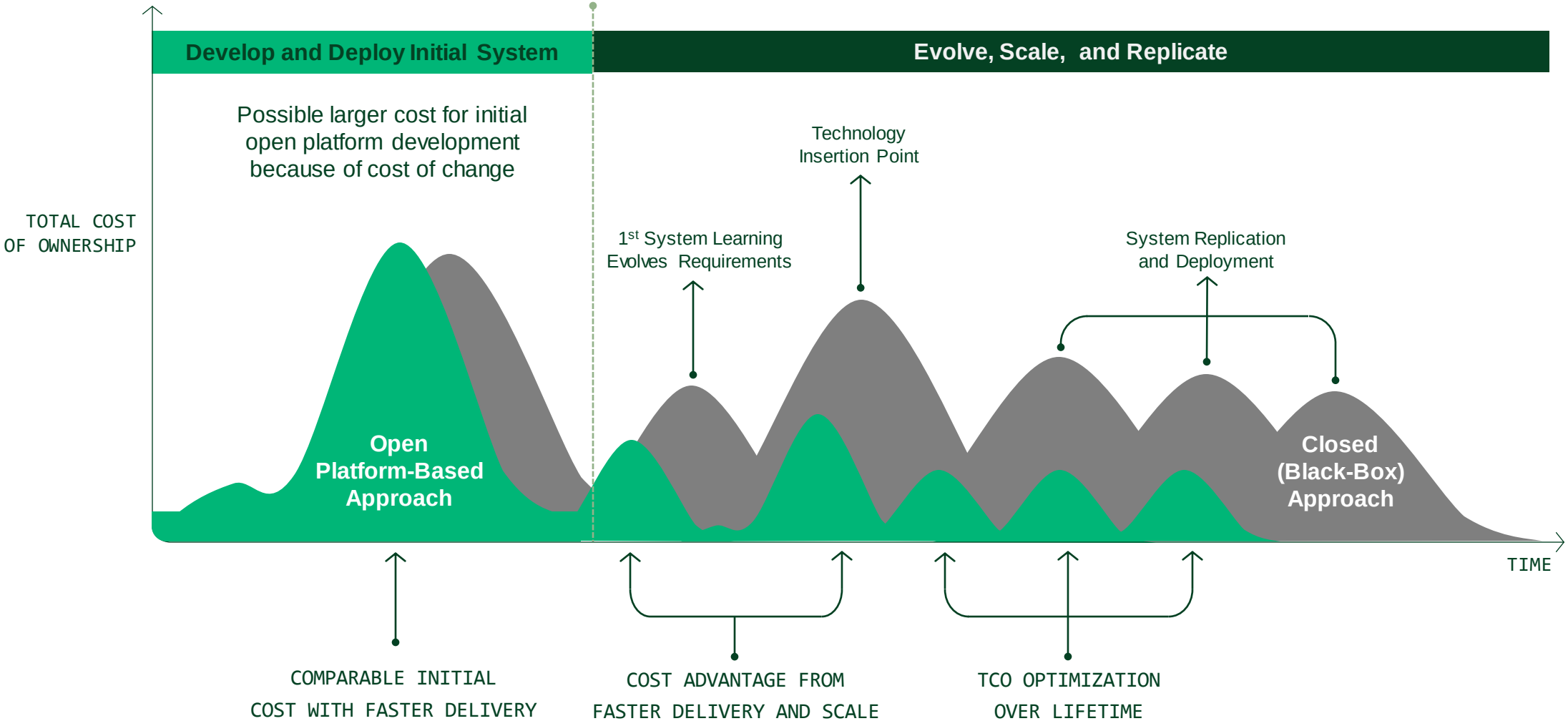
"Customer Knows Best"
Customizable Solution
Open, Valuable Ecosystem
Customer Designs



Closed Turnkey System

"Vendor Knows Best"
Fixed Functionality
Closed Ecosystem
Customer Pays

Test Cell Implementation | Total Cost of Ownership



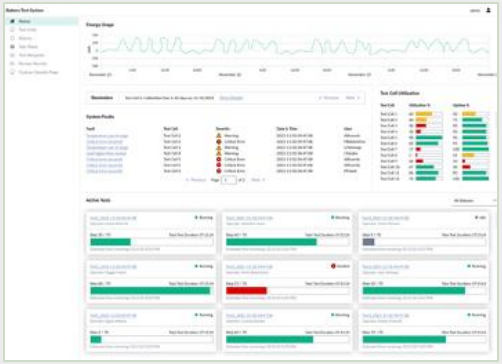
Open vs Closed for Battery Test | What If ?

Add or swap a third-party battery cycler

Integrate non-proprietary I/O

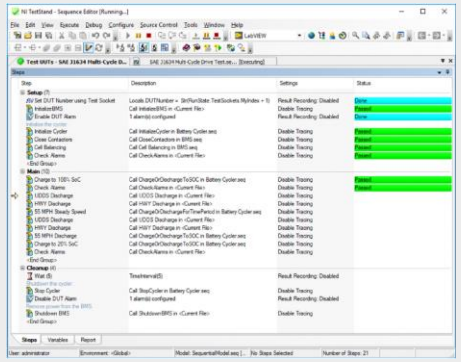
Add a device or virtual ECU with a specific communication protocol

Add measurement channels to meet new requirements

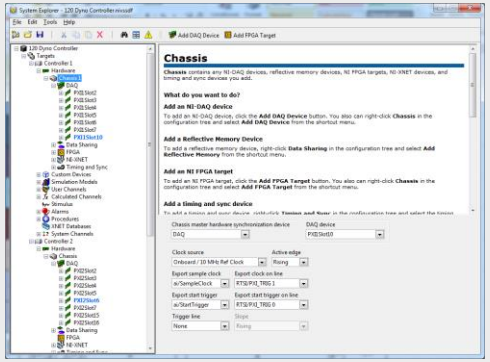


CYCLER

CYCLER



CYCLER



Facility-Level | **User-Level** | **Application-Level** | **Hardware-Level**

NH Research from NI

HEINZINGER AUTOMOTIVE GMBH

Elektro-Automatik

KEYSIGHT TECHNOLOGIES

YOKOGAWA

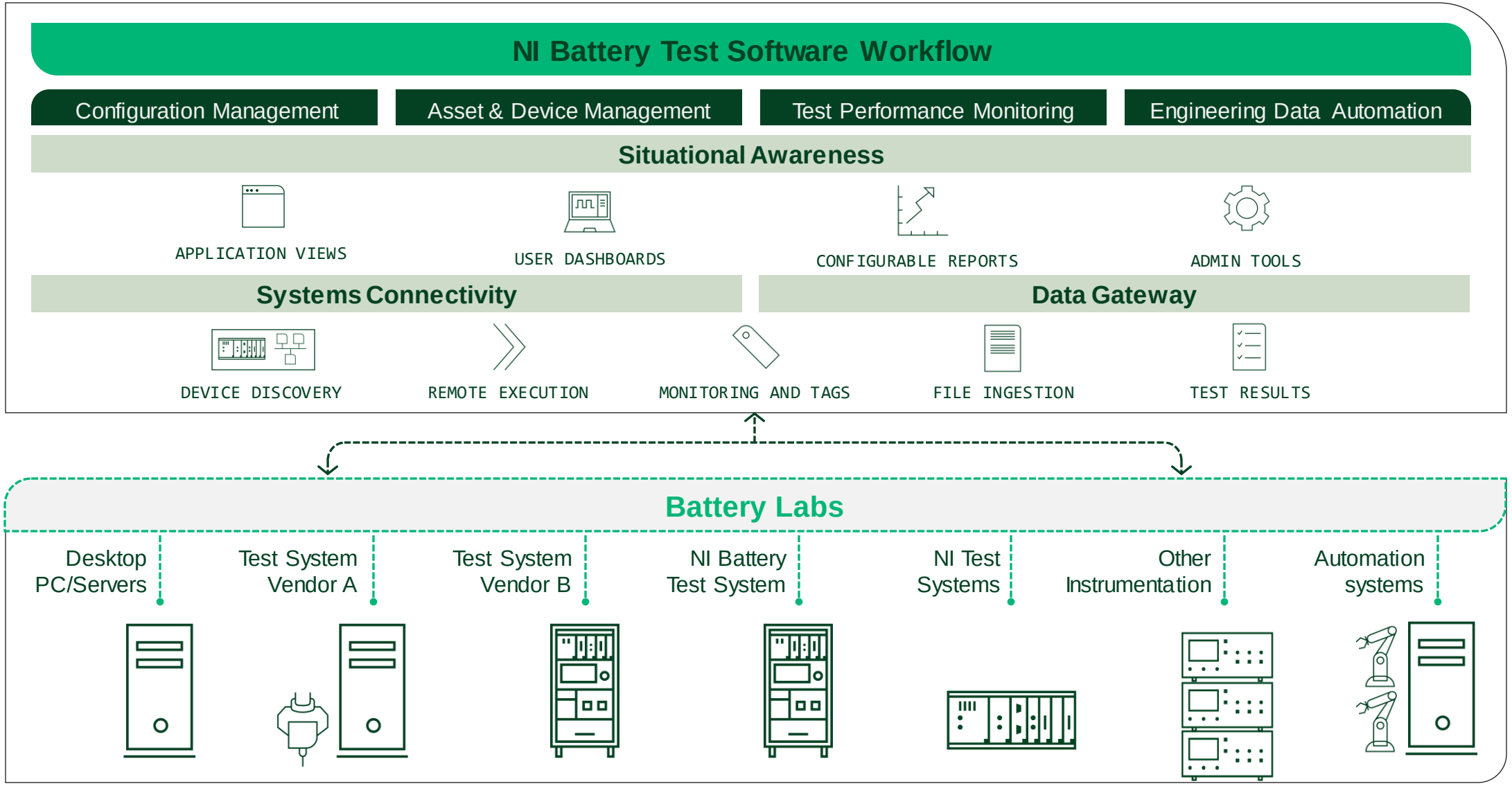
Webasto Feel the Drive

kratzer AUTOMATION

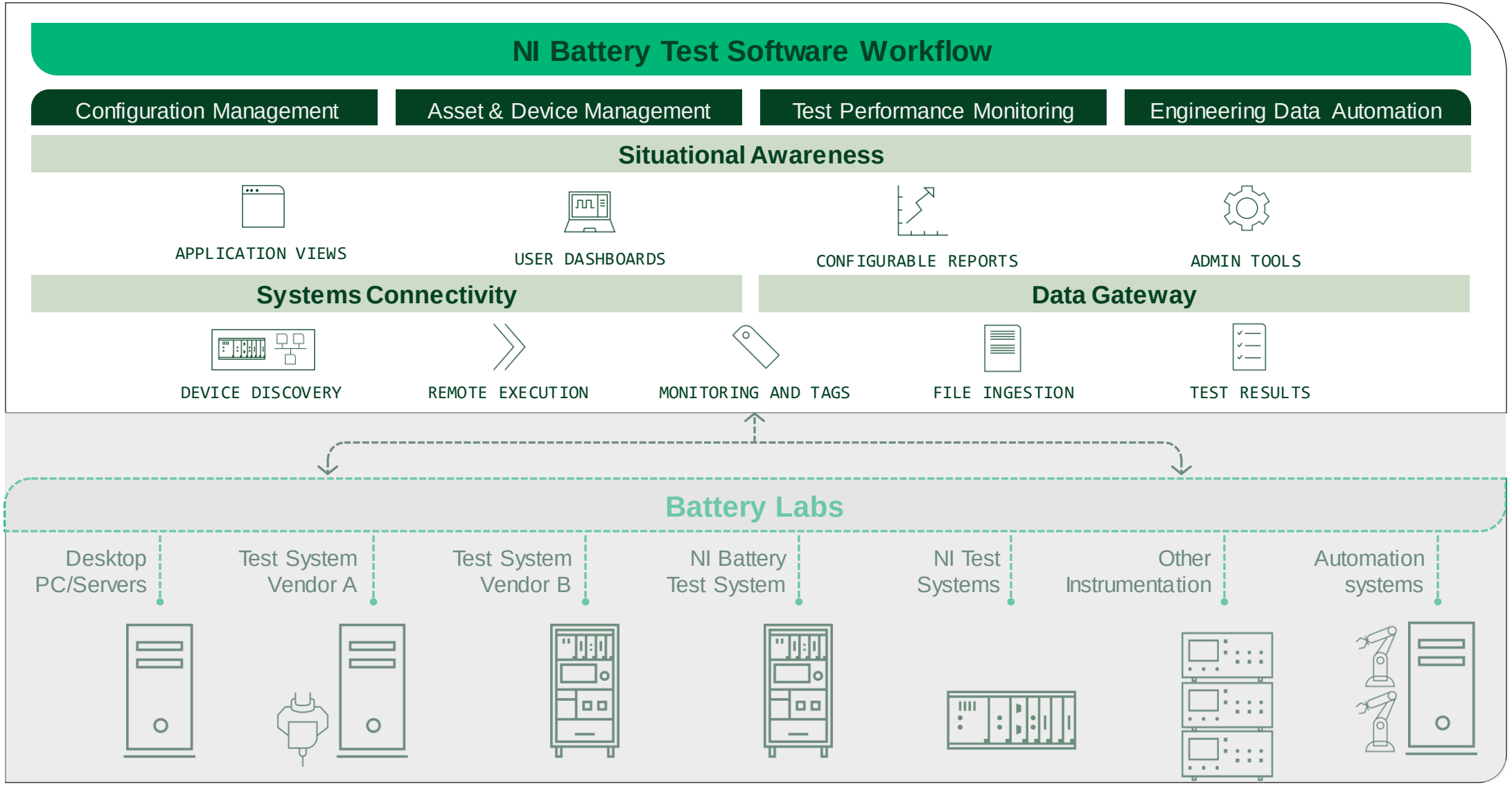
Digatron power electronics

SPECIFIC CYCLER

Mapping NI Battery Test Software Workflow to Your Needs

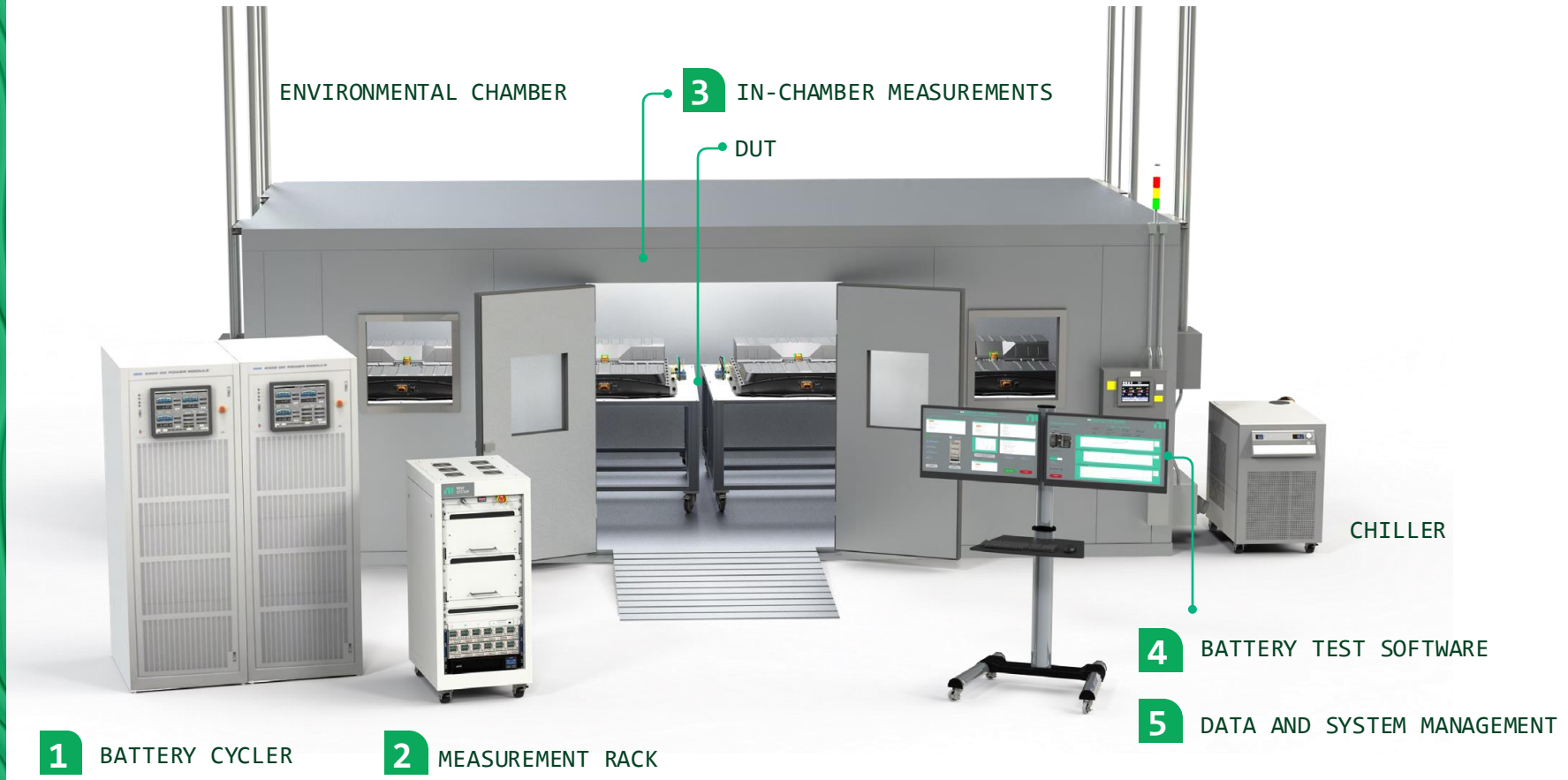


Mapping NI Battery Test Software Workflow to Your Needs



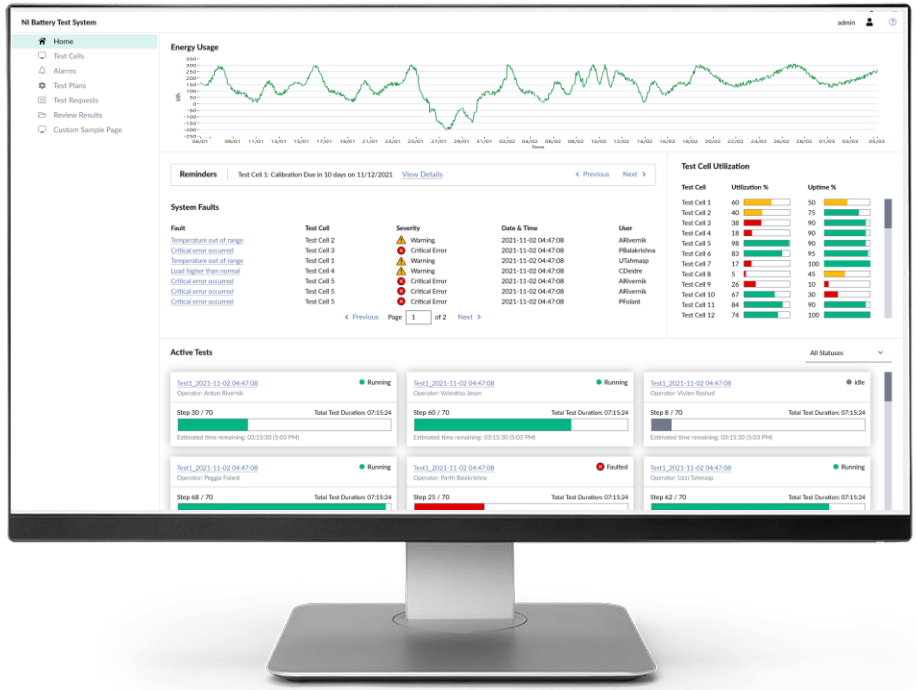
NI Battery Test System

NI Battery Test System (BTS)



1. Connection to power electronics, less rework
2. Scalable measurements at low cost per channel
3. Rugged in-chamber measurements
4. Open, out-of-the-box or custom battery test software
5. Customized data dashboards for facility management

NI Battery Test System Software Workflow



FACILITY-LEVEL

Manage Facility

Plan and monitor test asset utilization
Monitor energy usage
Maintenance

USER-LEVEL

Run a Test

Execute test script
Monitor test results (pass/fail)
Real-time measurements

APPLICATION-LEVEL

Write a Test

Sequencing
Time-dependent or critical sequencing
Test recovery

HARDWARE-LEVEL

Define the Test Cell

Measurement and stimulus
Test cell abstraction

Add the DUT

CAN database
Safe operation limits
Lossless logging
DUT abstraction

Integrating and Customizing the BTS

SW Solutions Offerings

DMC

Smart People. Expert Solutions.

DMC Background

Established in 1996, DMC serves customers worldwide from offices in Chicago, Austin, Boston, Cincinnati, Dallas, Denver, Houston, Nashville, New York, San Diego, Seattle, St. Louis, and Washington D.C.

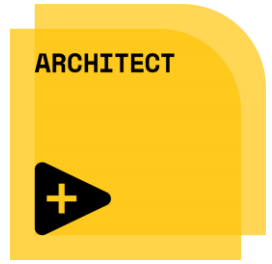
185+
employees & growing

National Instruments Certifications

Center of Excellence

Integration Partner

SYSTEM INTEGRATOR



CSIA CERTIFIED

ISO 9001

DMC, NI, and the BTS

2008

DMC Releases Initial Battery Test Offerings

10+ years

DMC expands across battery pack, module, and BMS test for validation, HIL, and production test domains

DMC, NI, and the BTS

2008 — DMC Releases Initial Battery Test Offerings

DMC consistently delivering battery test solutions to clients

2019 — NI BTS Partnership

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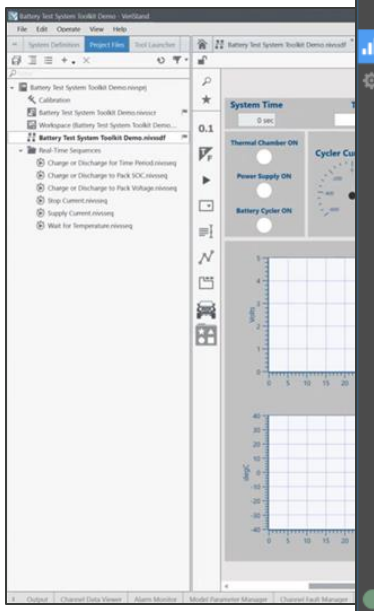
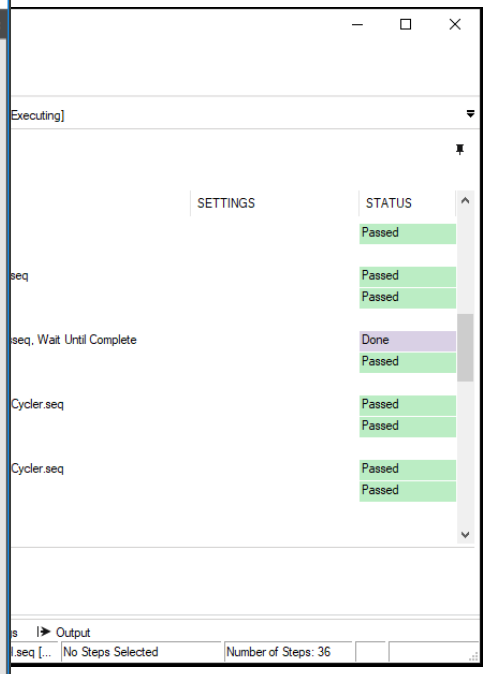




DMC, NI, and the BTS

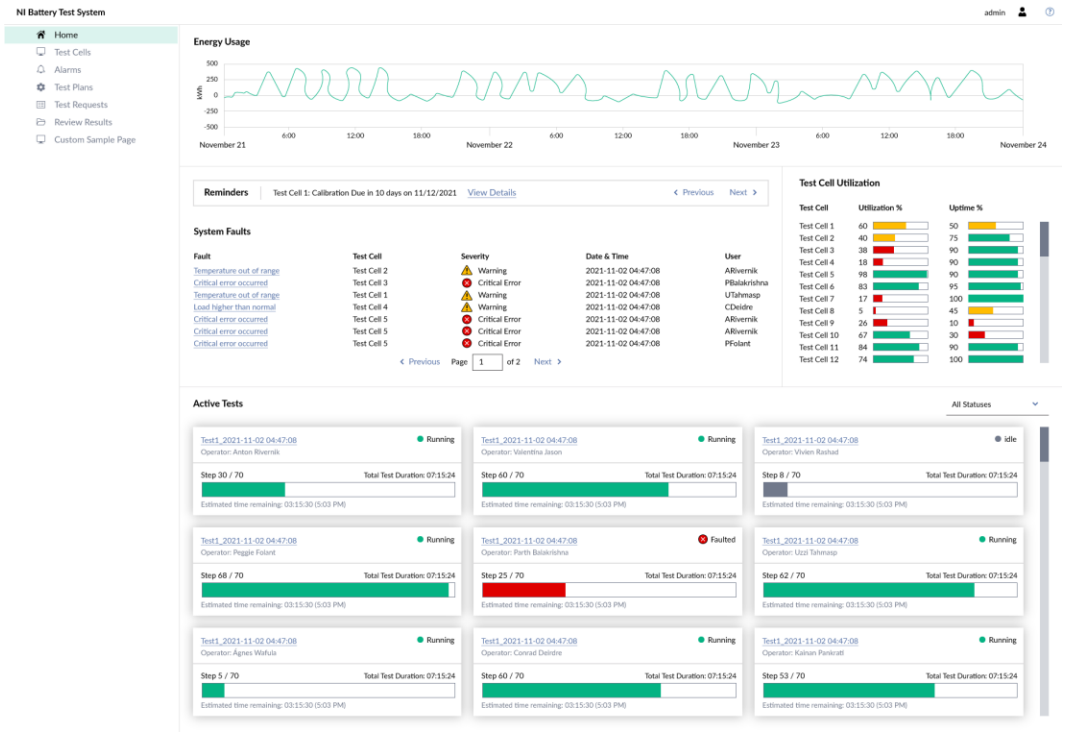
2008 — DMC Releases Initial Battery Test Offerings

DMC consistently delivering battery test solutions to clients

2019 — NI BTS Partnership

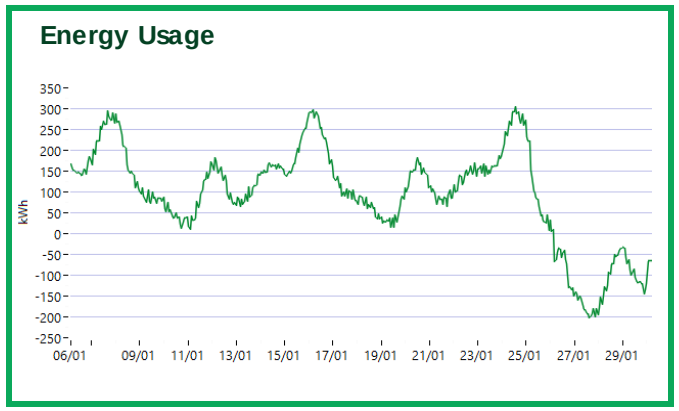
2020 — BTS 2.0

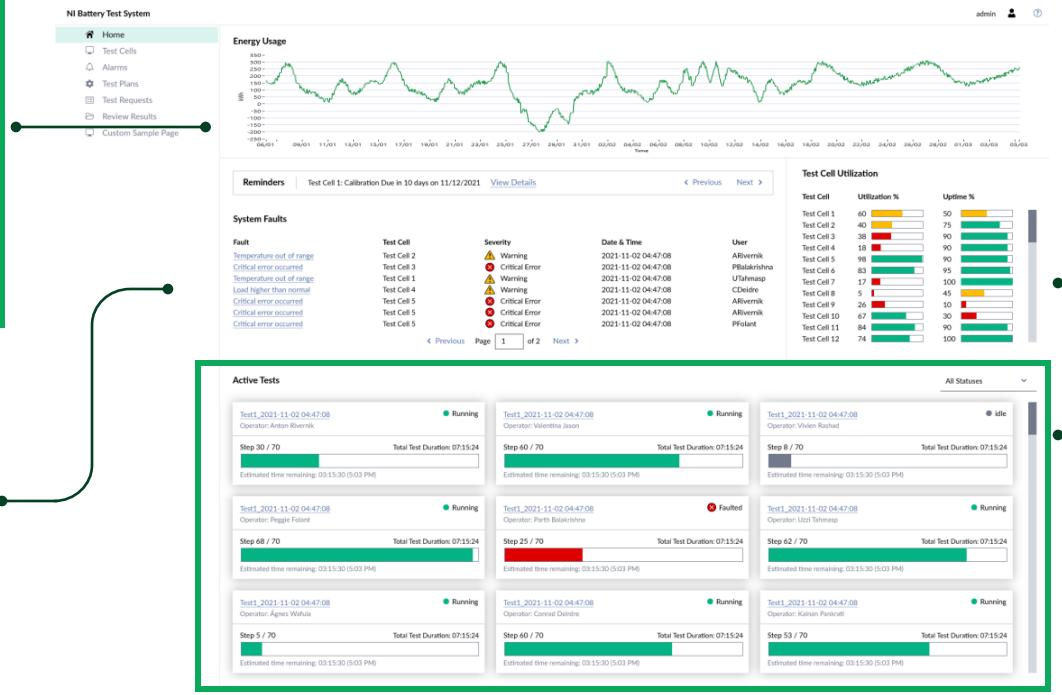
2021 to Present — BTS 3.0

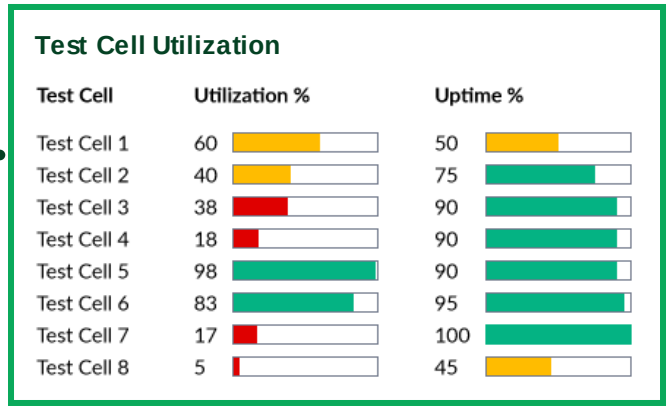


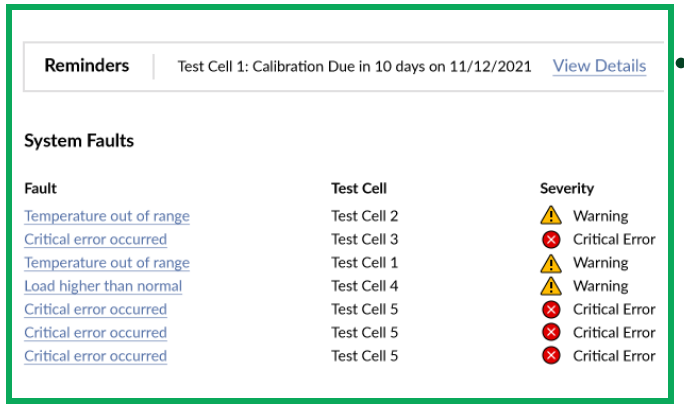
BTS 3.0 Overview

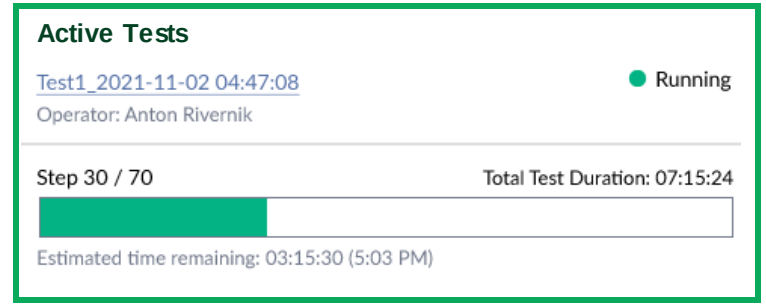
Management Dashboards | Laboratory/Facility Level



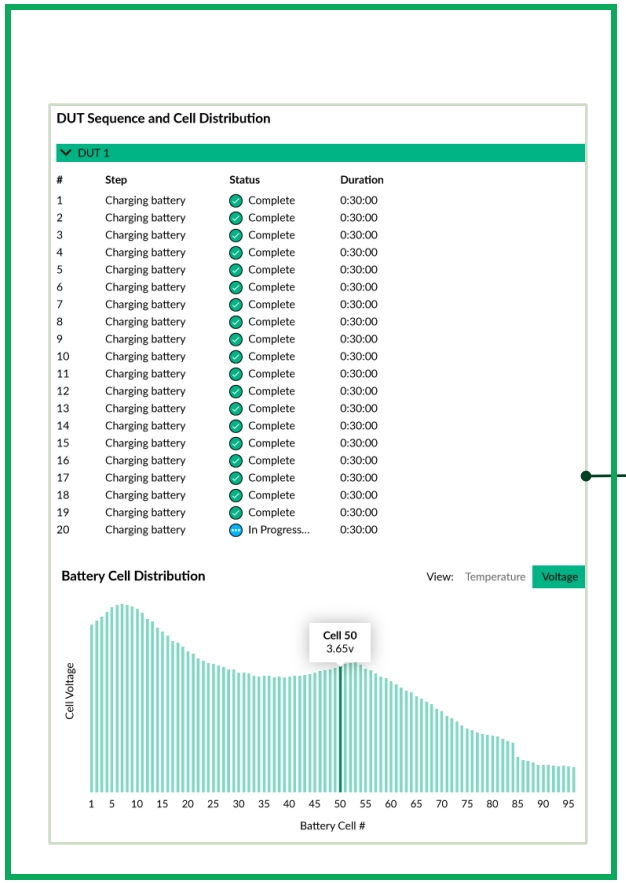


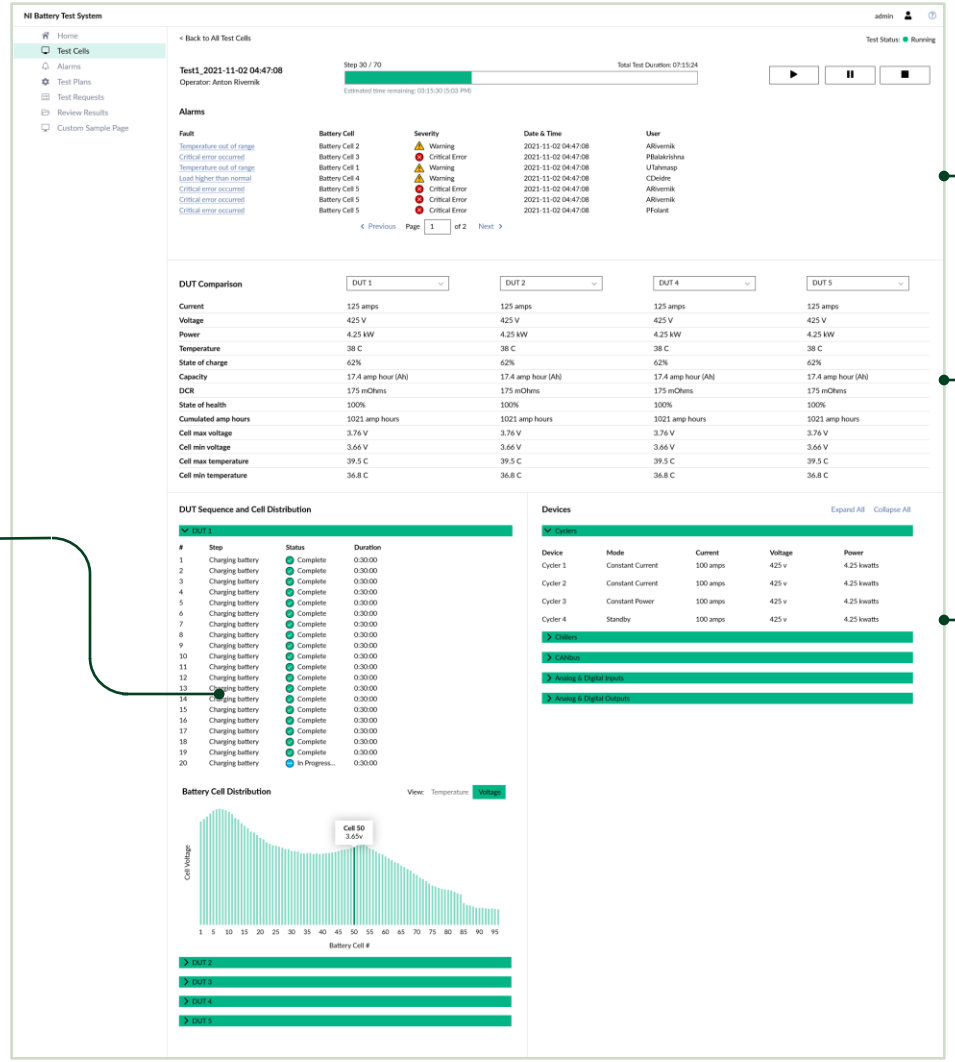


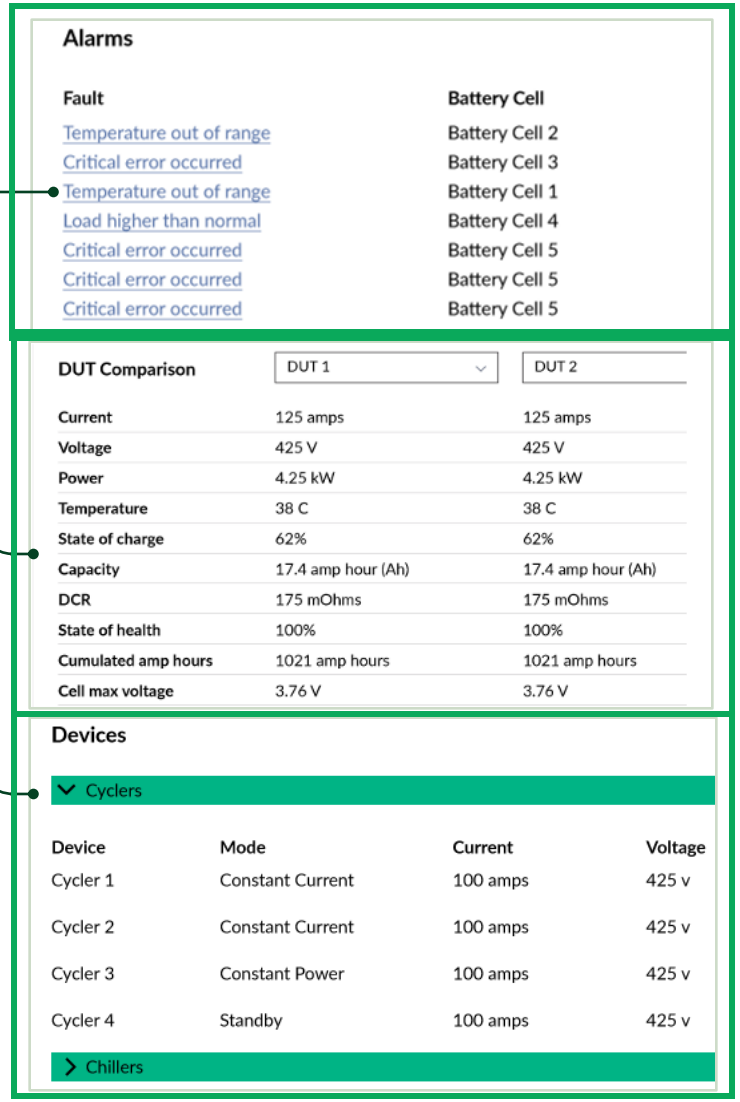




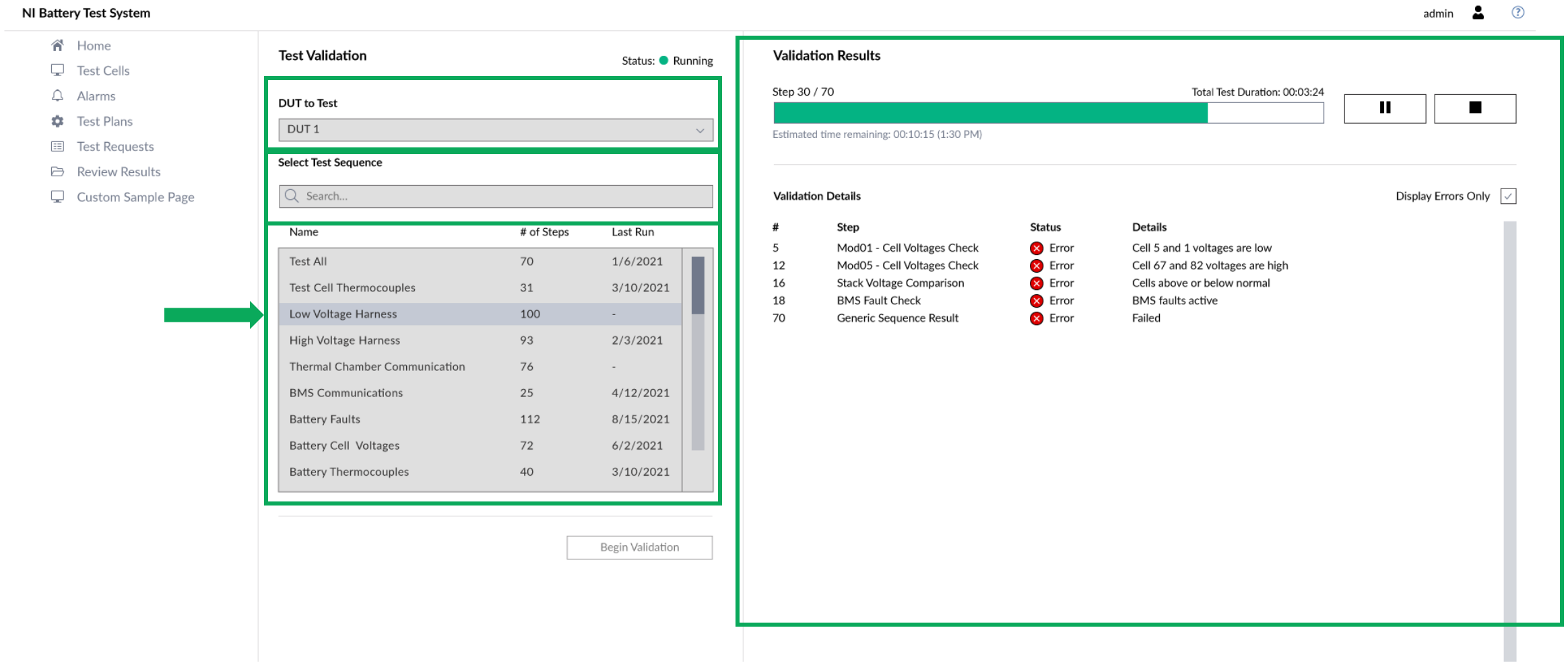
Management Dashboards | Test Cell Level







Management Dashboards | Validation



Management Dashboards | DUT Connections

NI Battery Test System

admin

- Home
- Test Cells
- Alarms
- Test Plans
- Test Requests
- Review Results
- Custom Sample Page

DUT Connections

Selected DUT

DUT 1

Documentation

Search...

- E-Stop Check
- Thermal Chamber Check
- Low Voltage Harness Connection
- High Voltage Harness Connection
- Coolant Line Connections
- Thermocouple Placement
- MSD Placement

High Voltage Harness Connection

Laboratory test cell instructions listed here...

Would we like to indicate the source of the information in the list at the left: for example, laboratory test cell or DUT?

Is there any need for an edit mode for this, where the user could live edit and upload images, adjust text, etc.

Connection Instructions For High Voltage Harness on Battery Pack Model Z128

Preparing Connectors for Mating

- Per laboratory safety requirements, ensure proper PPE is worn at all times
- Identify and locate high voltage harness from battery cycler [Figure 1]
- Visually inspect connector for wear or damage
- Identify and locate mating connection on battery pack [Figure 2]
- Visually inspect connector for wear or damage

Figure 1: Battery cycler cable

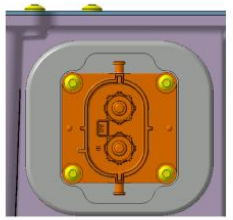


Figure 2: Battery pack bulkhead connection

Making the High Voltage Connections

- [x] Pick up the high voltage connector from the battery cycler cable
- [x] Rotate the engagement handle to the open position
- [ ] Engage the high voltage connector into the battery pack bulkhead connector
- [ ] Rotate the engagement handle to the locked position
- [ ] The engagement of the connection should be smooth and continuous, if it is not, consult with test engineering

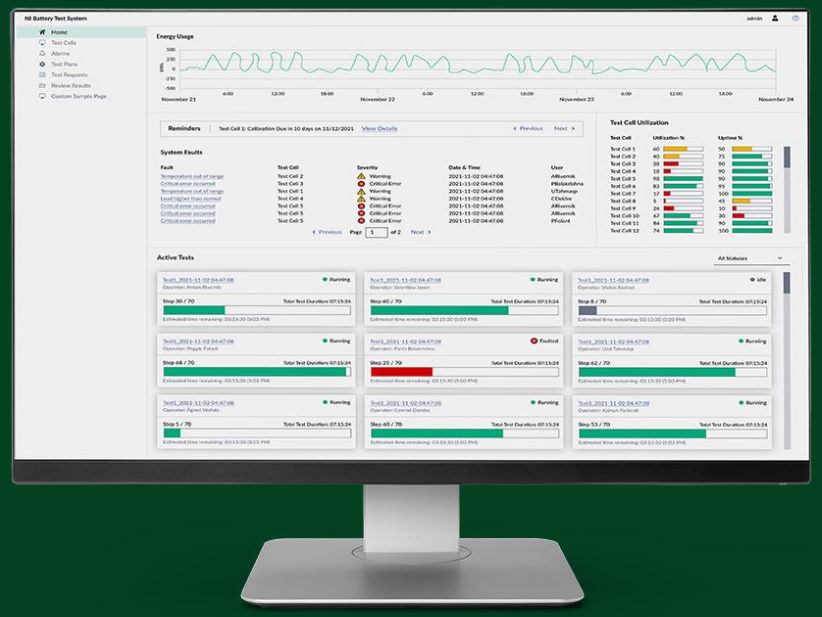
Verifying the High Voltage Connections

- Use the push-pull-push method and ensure the connection is seated securely
- Run the high-voltage connection validation test to electrically check the connection

ENGINEERING TEAM PERFORMANCE

Video

BTS 3.0 UI



Integrating the BTS with DMC

DMC Project Process

Exploration → **Delivery**

Discovery
- Business Requirements
- Technical Requirement
- Lifecycle Planning
- Acquisition Planning
- Cost/Benefit Analysis
- Proof of Concept

Design
- PM Plan and Strategy
- UX/UI
- Electrical & Mechanical Design
- Prototyping
- Data Services
- Software Design
- Connectivity
- Platform Selection

Development
- Software
- Hardware
- Data Storage
- Device Connectivity
- Security and Access
- Data Presentation

FAT
- Device Integration
- System Level Test
- Simulated

Install
- Field Wiring
- IO Checkout
- Field Device Testing

SAT
- Device Integration
- System Level Test
- Simulated

Support
- Documentation
- Client Training
- System Support
- Source Code Delivery

Lifecycle
- Software Upgrades
- License Management
- Hardware Calibration

Example of Customer X Needs

Exploration → **Delivery**

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- Source Code Delivery

Lifecycle
- Software Upgrades
- License Management
- Hardware Calibration

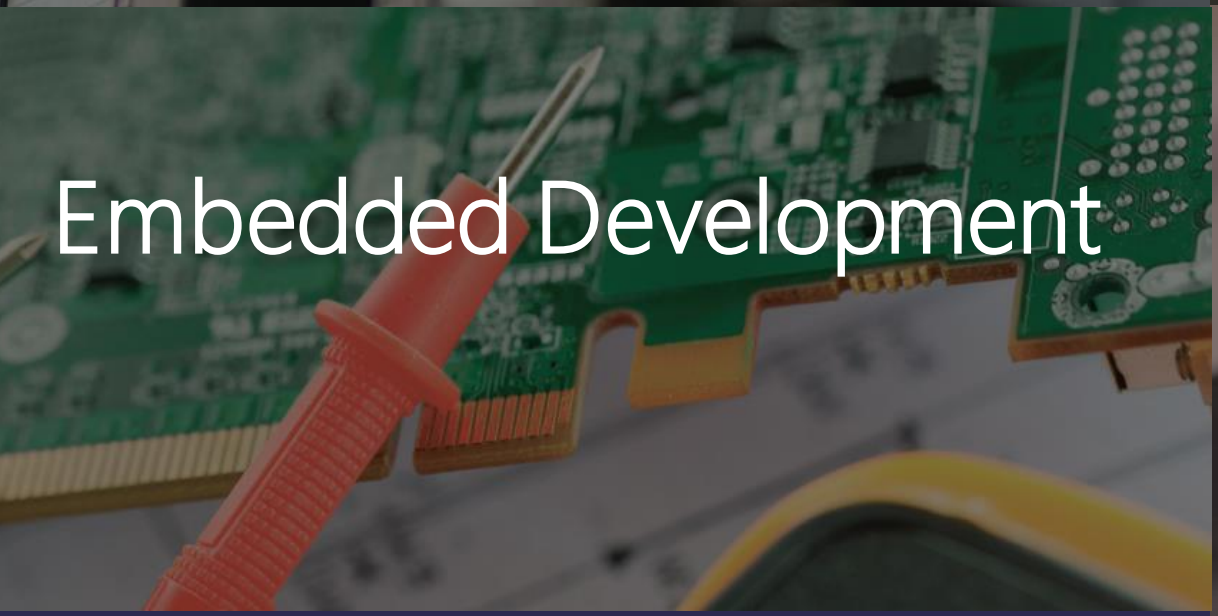
Note: This is a generalization, many items may involve collaboration depending on the scenario

BTS Integration/Customization Services

- Custom web page screens, workflow modifications
- Local UI development
- TestStand configuration and sequence development
- VeriStand system definition file configuration
  - Channel and alias definition
  - Real-Time sequences
  - Alarms and safety procedures
- Custom device driver development

About DMC

DMC Offerings



Manufacturing Automation & Intelligence

PLC Programming ›

Motion Control Engineering and Servo Systems ›

Vision Inspection ›

HMI & SCADA Programming ›

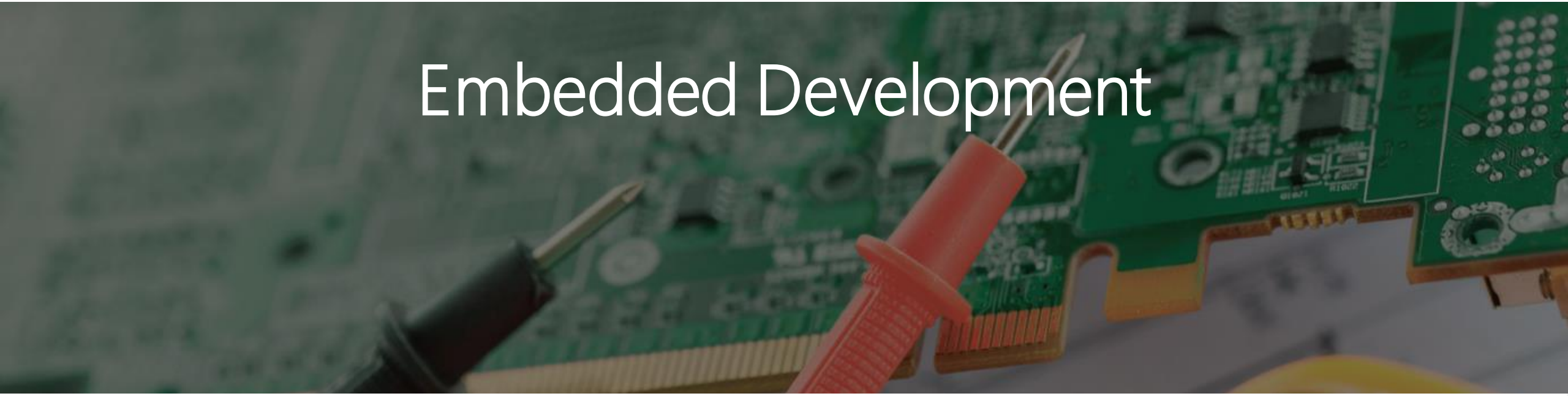
Robotics ›

Manufacturing Execution Systems Services ›

Infrastructure Engineering ›

Industrial Networking and Cybersecurity ›

Embedded Development



Product Development ›

Circuit Design ›

Low-Power Embedded Design ›

Embedded Device Connectivity ›

FPGA Programming ›

Embedded User Interface Design ›

Firmware Programming ›

Embedded Systems Platforms ›

Application Development

PC Application Development ›

Web Application Development ›

Machine Learning ›

User Interface Design ›

IoT Solutions ›

Mobile Application Development ›

Digital Workplace Solutions

SharePoint ›

Purchase Microsoft Licenses / Subscriptions ›

Office 365 ›

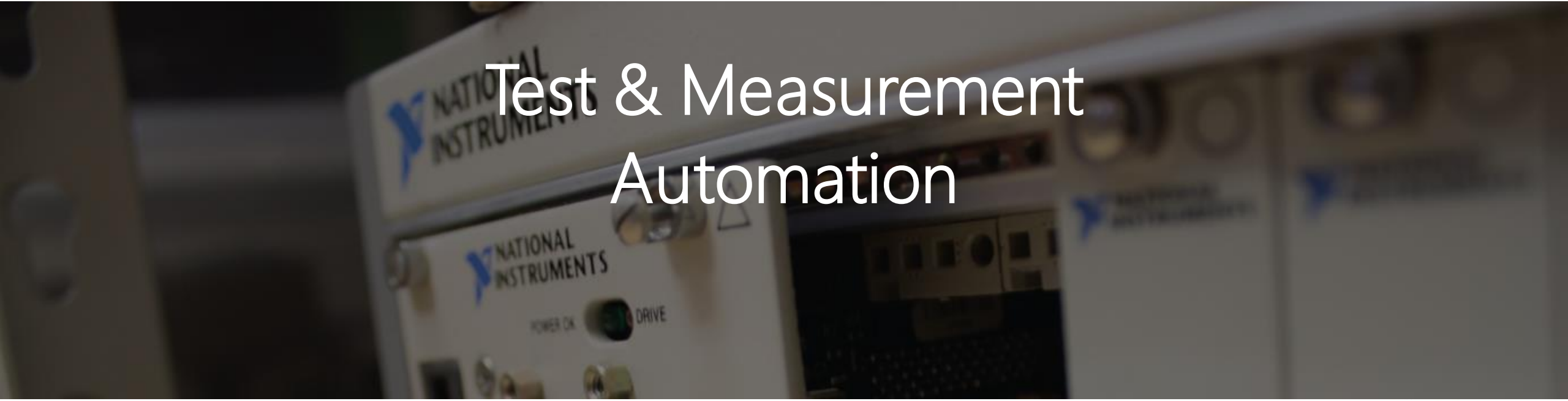
Microsoft Azure Cloud Solutions and Services ›

Business Intelligence ›

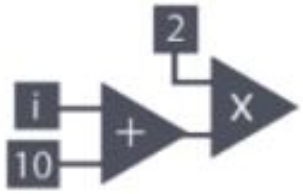
Custom Application Development ›

Enterprise Mobility + Security ›

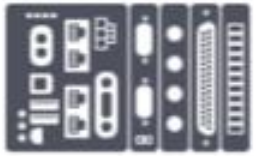
The Power Platform ›



Test & Measurement Automation



LabVIEW Programming ›



LabVIEW Programming for Real-Time and FPGA ›

Battery Pack Test Systems ›

Automated Test Stand Design ›

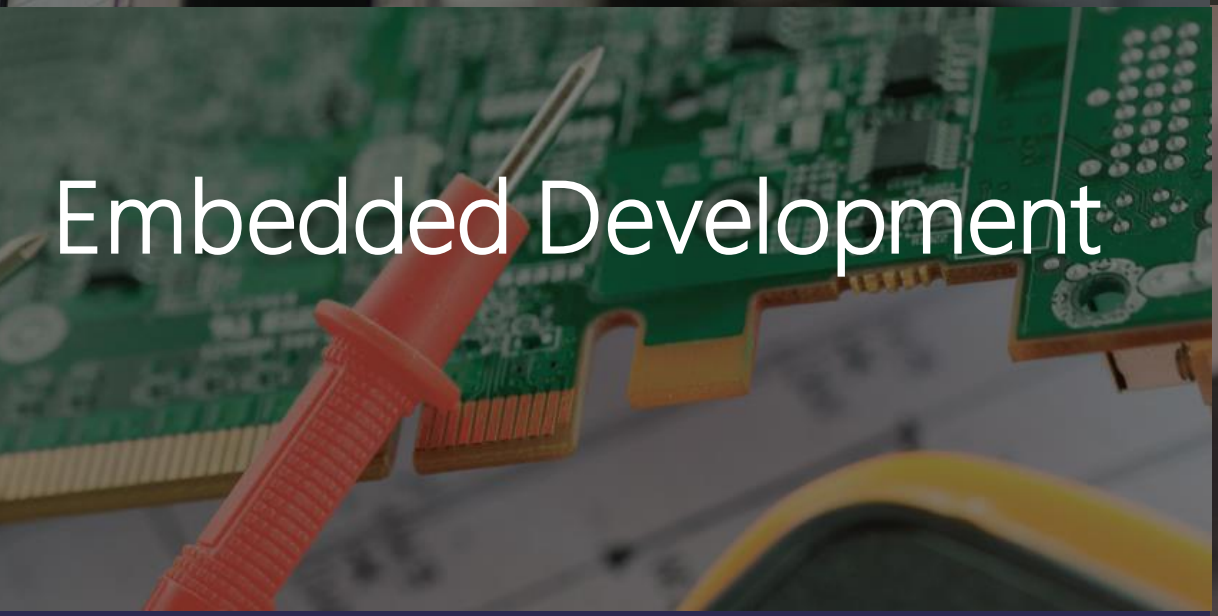
Automated Safety, Power, and Compliance Test Systems ›

LabVIEW Vision Application Development ›

Appliance Testing ›

Cloud Enabled Test & Measurement Systems ›

DMC Offerings



Questions?