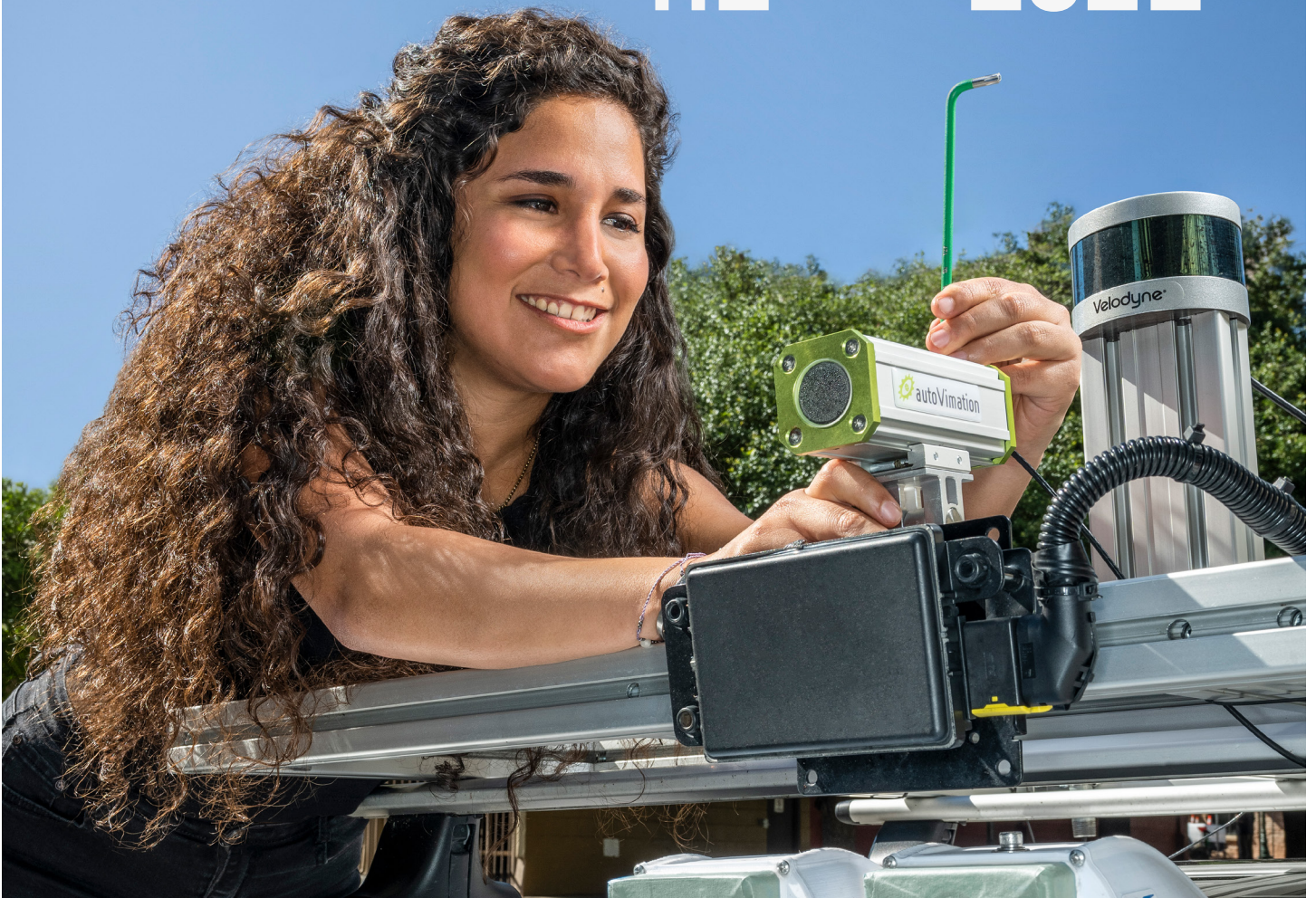


AUTOMOTIVE JOURNAL

H2 + 2022



**GM Uses Data to
Achieve All Electric Future**

**Jaguar Land Rover and NI
Join Forces on ADAS Solutions**

**Women Break Gender
Stereotypes in EV Innovation**



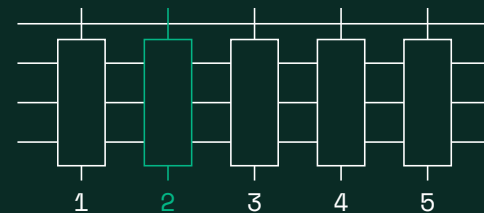
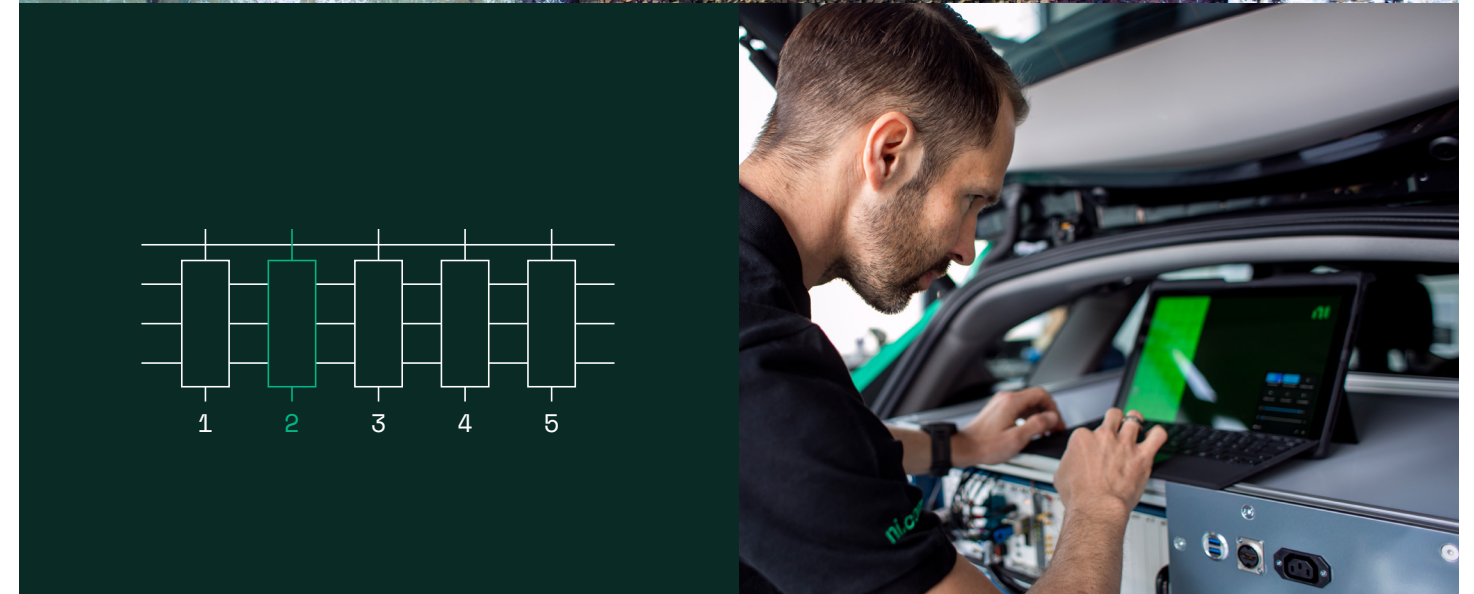
Overcoming Industry Obstacles Together

As the shifting sands continue to wreak havoc across the automotive supply chain, the concept of partnering with our customers has never been more important. The uncertainty that clouds the future of autonomous and electric vehicles means that the investments being made to build out the infrastructure to test these complex supercomputers on wheels must be malleable. This ideology is further emphasized when you consider how sustainability and diversity shape the way companies view their roles in the world.

At NI, we embrace our core value of being an expert connector: nurturing symbiotic relationships

throughout the ecosystem that further our purpose. Like building recurring neural pathways in our brains, we work diligently to connect the pieces needed to test the complex technologies that define our cars. NI's platform interoperability drives this technical openness, and our lifecycle analytics platform fires the neurons (so to speak) throughout the system to expose critical insights.

This issue of the Automotive Journal explores how leading companies are partnering with NI to accelerate the performance of their next-generation vehicles. There is a better way. Let us show you how.



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Photo courtesy of GM

Challenge

Safeguard the quality of millions of battery cells, modules, and packs for GM's Ultium-based electric vehicles (EVs); eliminate blind spots throughout the battery cell engineering process; and develop high-performance EV batteries faster, at scale, and at a lower cost.

Solution

Develop a secure, scalable, and open data platform that helps GM engineers derive insights from data to make decisions and help better understand their batteries and customers.

GM Uses Data to Achieve All Electric Future

General Motors has made bold commitments toward creating an all-electric future, and it is making significant investments to deliver on these commitments. Apart from the expansion of GM's manufacturing capacity for EV batteries, the company has created the Ultium platform, an all-electric vehicle (EV) architecture and propulsion system that includes drive units, motors, power electronics, controls, and, of course, the battery.

With Ultium, GM is consolidating on a platform to build a variety of EVs, from a pickup truck to a luxury SUV to a commercial delivery vehicle. As expected, this consolidation offers large benefits of scale, but it also presents the big responsibility of ensuring every single component is the best it can be regarding safety, cost, and performance. This is especially important for the battery, down to every single cell.

To safeguard the quality of every cell on every pack, GM is working with NI on its battery cell engineering process to give its engineers visibility into all test data so they can make decisions to optimize product performance.

Data Enables Scale

The EV battery holds the secret to enable EV adoption at scale, so test teams feel a lot of pressure to define and execute test plans and quickly use insights from the test data to make decisions and safely speed up development and deployment. But how much battery data needs to be analyzed to truly have zero blind spots and achieve this scale?

To get an idea, consider this example. A Hummer EV battery pack contains 24 modules with eight cell groups per module. Each cell group requires a voltage measurement about 10 times per second, resulting in 1,920 voltage measurements being collected every second. Finally, these tests can run up to a year. Multiplying for every second in 365 days, you get 60,549,120,000 voltage measurements per year—well over 60 billion measurements just for voltage. Now add the many other measurements like current or temperature, and you get a better idea of how much data needs to be analyzed to be used, just from test. However, to fully test an Ultium battery pack to the standards of safety and performance GM is committed to, data from other processes, test stations, manufacturing, etc., will need to be used. This means that engineers must deal with not only a huge amount of data but also a large variety of formats.

The end-to-end process to extract the insights from all this data to make it useful to GM engineers involves data ingestion, aggregation, contextualization, engineering, processing, and tagging, among other steps. With traditional solutions, this may all be possible, but traditional methods will not help you achieve the scale and speed needed. A paradigm shift is necessary.

Break Tradition to Unleash Data

The traditional way of using test data implies running the test, generating the report, analyzing it, making decisions, and eventually getting to production. Though it gets the job done, it severely limits the ability to shorten times since reports are static, are not always available to everyone, take time to be generated, and don't proactively help predict what's going to happen with the test. Leaving this old way behind requires data to be constantly ingested, monitored, analyzed, and made available. This is exactly what GM is doing to ensure its

Historical Thinking and Paradigm Shift

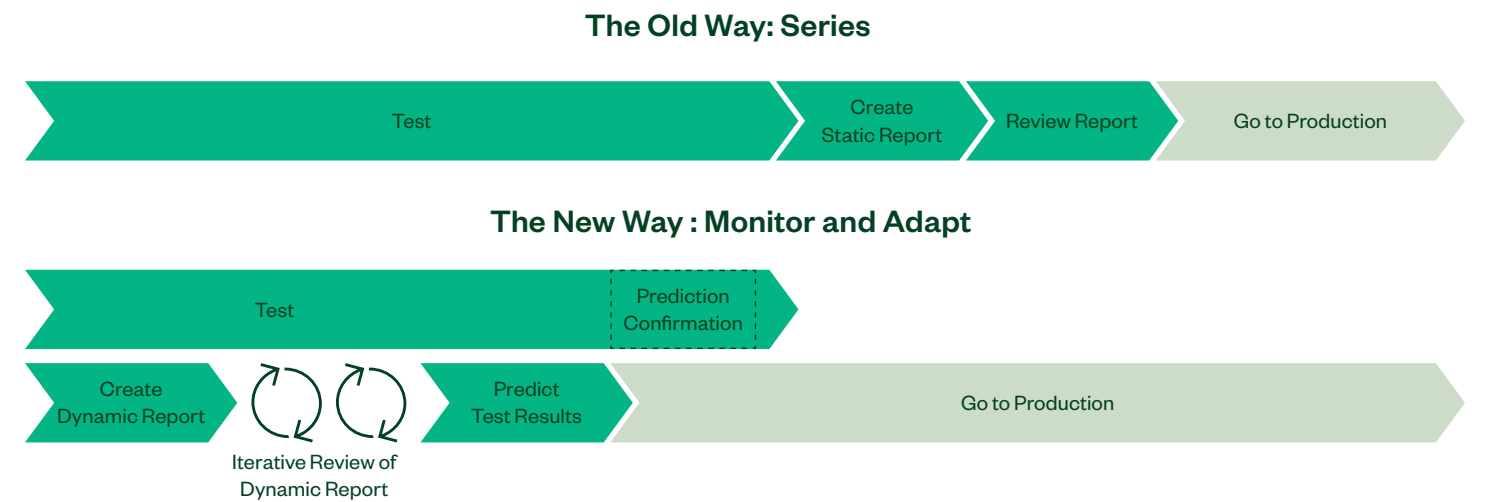


FIGURE 01 Using data to enable scale and speed requires a paradigm shift from sequential processes to a continuously monitored and adaptable process.

“With NI’s SystemLink™ software, we can deliver our test data to all engineers in a secure and easy way to enable them to view their data and save templates for follow-up tests—all in near real time.”

Ciro Spigno
Group Manager, Battery Systems and Analytics, GM

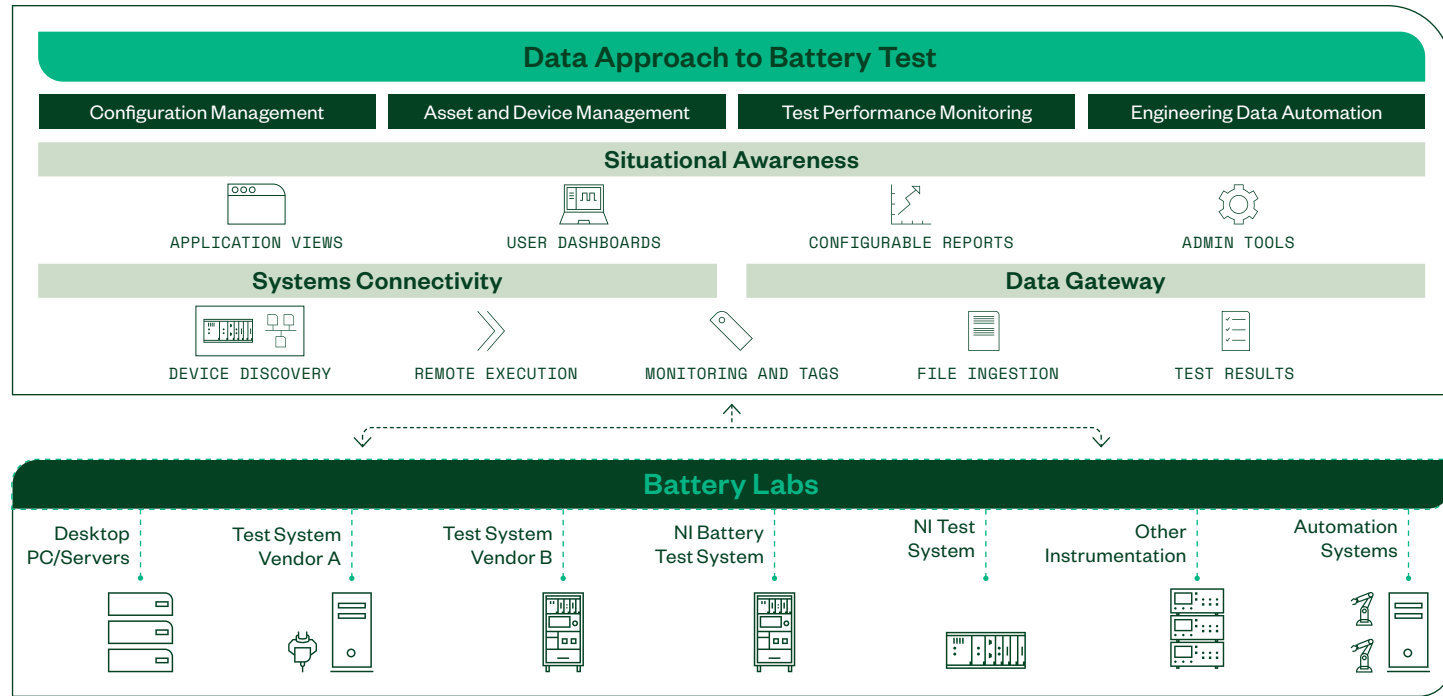


FIGURE 02
NI's data approach to battery test automates the end-to-end process to help engineers derive insights from test data.

engineers, data scientists, and expert personnel have on-demand access to the data they need to make decisions in near real time.

To enable this ability, GM is investing in a web-based, cloud-computing toolset; personnel; and a data platform that includes NI SystemLink™ software as part of the architecture. The data platform must be:


- Secure to protect the insights of GM's battery cell engineering through access control, authentication, and encryption capabilities
- Scalable to save thousands of hours of manual work by automating the end-to-end process from data ingestion to making it available on-demand; this would preserve the flexibility and independence for GM engineering needs
- Open to ensure sustainability, compliance, and compatibility with GM's IT infrastructure so that GM engineers can use open-source tools, different databases, and programming languages as well as define the dashboards and customization they need to analyze the data and generate the insights


GM's data platform will heavily use SystemLink's attributes to provide engineers with the data they need and the ability to use it to improve GM's products. Additionally, the compatibility with GM's IT infrastructure will make it sustainable and provide a path for GM to be vendor-independent as the company continues to grow its battery cell operations.

Commitment to Test Data

At NI, we believe that data elevates the role of test from a pass/fail process to an enabler of product performance, so we continue to invest in EV test and lifecycle analytics solutions to enable automotive market leaders like GM transform their businesses and help the world get to an all-electric future faster.

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Battery analytics

ni CONNECT

2022 AUSTIN



KEYNOTE

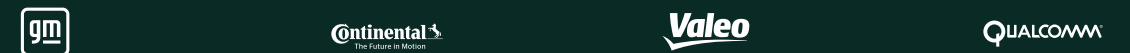
"We're working with NI on a long-term, sustainable solution that allows us to connect all the battery test data to quickly develop the insights that we need. The solution must be secure and scalable, and it needs to be open."

Steve Tarnowsky,
Director of Global Battery Cell Engineering, GM,
at NI Connect, May 2022

1,342 CUSTOMERS VIRTUALLY

816 CUSTOMERS ATTENDED

CUSTOMER PRESENCE



60+ CLOSED-DOOR CUSTOMER MEETINGS REPRESENTING MULTIPLE ACCOUNT ORGANIZATIONS AND KEY STAKEHOLDERS

32 TECHNICAL SESSIONS ON EV, ADAS, ANALYTICS, AND MORE

19 AUTOMOTIVE SOLUTIONS ON DISPLAY

CONNECTED AUTOMOTIVE ECOSYSTEM





The Perks (and Problems) of Test Data

From autonomous vehicles to dependable electric vehicle (EV) batteries, test helps ensure that safe, reliable, and innovative products enter the market. This critical phase of product development generates valuable data and, in turn, actionable insights. In other words, we can use data to uncover trends, correct errors, improve performance, and more. Sounds simple enough, right?

Knowing how to harness data and respond to improvements in the data landscape, however, is a challenge that affects us all. Small test teams and large, established tech companies alike are struggling to take full advantage of data. Although we may be generating data that can help our products reach peak performance, it doesn't matter if we can't access it, study it, protect it, and communicate our findings properly.

When it comes to data management, security, and scalability, the challenges we face are real—but they're not insurmountable. If we can identify and remove the obstacles that lead to data inefficiencies and gaps, we can find effective remedies, fully leverage test, focus on innovation, and stay ahead of the competition.

New Solutions to Old Problems

Data challenges have existed since the "information explosion," but emerging technology is reigniting the need to remain competitive. In the past, as long as you were using data in any capacity, you were sure to grow. But it's no longer enough to be efficient—to remain competitive, you must be willing to constantly innovate. After all, in an innovation-driven economy, the biggest value comes from optimizing your products and services, and we do so through data.

Today we have more data available to us than at any other point in history, and we need this data to make informed decisions. Engineers need it to safeguard products and ensure performance, and other parts of a business, like marketing and operations, need it to improve their strategies.

One challenge that some companies face involves having too much data. Say you have an unlimited amount of data at your fingertips. How can you tell what's valuable and what isn't?

An overabundance of data isn't a new problem, but more companies are revisiting how to take control of it in the wake of emerging ancillary technologies that weren't previously available.

As cloud infrastructure, artificial intelligence, and machine learning evolve and converge, they afford solutions to a glut of data. For example, machine learning has the capacity to sort through massive amounts of data to identify trends, discover hidden patterns, predict potential situations, and adjust to them automatically. These insights subsequently inform decisions and can optimize the entire product development lifecycle and positively impact companies' bottom lines.

These same technologies are key to addressing three other major data challenges that impede innovation and competitiveness: security, scalability, and openness.

Security

In talking about the sanctity of data and the ways that it can positively impact key growth metrics, it's imperative to consider the security behind keeping that data safe and out of a competitor's grasp. When you choose a solution, there must be guarantees that your data is safe. One factor to consider is access control, which goes beyond just ensuring that individuals at your company have access to data—there must be peace of mind in knowing that individuals or contract manufacturers have access only to the data they need and not to data beyond the site and test station where they work.

Another security factor is storage location. Choosing between an on-premise solution versus a cloud solution like Microsoft Azure or Amazon Web Services is a decision that your IT and engineering teams must agree on. Investing in secure data solutions is one critical way to mitigate unnecessary risk and is an important data challenge to address.

Scalability

Data challenges are not unique to any one industry or company, regardless of size. In fact, the more you grow, the more challenging collecting and sorting through data become. One example of this is a company that uses 10 test systems that run 24x7, and for that number of systems, it needs two days per week to extract, clean, and analyze the data, which then gets manually uploaded. When looking at the company's scalability, this manual methodology is simply unsustainable.

There are methods to scale efficiently to get the most out of your data that do not require sacrificing time and energy. For example, tasks like data ingesting, aggregating, engineering, processing, analyzing, and reporting can be accomplished through automation, which saves teams thousands of hours and allows companies to take full advantage of data insights that might otherwise not be available or wouldn't be available as quickly as needed. Additionally, as companies reimagine what data can do for them and look to break down data silos, several have found success through tools like SystemLink™ software, which has helped teams maintain a competitive advantage and save time. Regardless of the direction your team takes to grow and evolve, remaining competitive in this market demands innovation. General Motors is one customer innovating as it strives to have 1 million EVs on the roads by 2025. At NI Connect, GM's director of Global Battery Cell Engineering, Steve Tarnowsky, told the crowd how GM was innovating with data as it scales its Ultium platform. He said, "We must safeguard the quality of every cell in every pack, and we're working with NI on a data-driven approach to ensure that there are zero blind spots in our battery engineering process and to enable battery performance optimization."

Openness

In talking about why it's crucial to keep data safe and, for some companies, on-premises, it's clear that companies value their independence. Reimagining your data solutions should not mean changing every aspect of your organization and the ways in which the people in it operate. That's why it's important to adopt solutions that work with the tools already in place and that are easy to integrate into existing infrastructure. To enable your success, analytics solutions from NI are open, interoperable, compatible with existing technologies, and IT friendly. Openness enables easy adoption of new technology by the test groups implementing it and the IT teams supporting it.

Data Drives Decisions

Getting the most valuable and actionable insights from test data is important, and not just for your company's bottom line. Data ensures safety for users and drives optimal product performance that builds trust in your product and in your organization.

If you own an EV, having a guarantee that the battery won't overheat and fail is critical. When you're eventually sitting in a fully autonomous car, you want peace of mind knowing that the manufacturing required to build a self-driving car underwent rigorous testing to ensure its safety in every situation. These assurances come from test data. Data helps teams improve performance, and if those products happen to fail, data drives decisions that ensure they can fail safely.

Humanity once conquered fire, and that led to a revolutionary new way of living. Since then, we've mastered agricultural innovation and spurred the industrial revolution. Dominating the data revolution and capturing the full potential of data insights are key to unlocking the next phase of human innovation.

Tackling these data challenges is no simple task, but we can work together and Engineer Ambitiously™ to find viable solutions that support everyone's goals.

Author



STEPHANIE AMRITE
PRINCIPAL SOLUTIONS MARKETER,
ENTERPRISE SOFTWARE, NI

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Jaguar Land Rover and NI Join Forces on ADAS Solutions

As mentioned in previous articles and interviews, the path to Vision Zero and, in particular, to Zero Collisions is a tough one. Advanced driver assistance systems (ADAS) and autonomous driving functionality will be the key enablers to get us there, but they can't be achieved alone. As you have heard from NI and our partners, an ecosystem of subject matter experts can make all the difference. But the ultimate litmus test is hearing it from an end users—in this case, Mark Flinders and Marek Krezalek at Jaguar Land Rover.



Ashish Naik, Director of Business Development, ADAS/AD, NI: Mark and Marek, what are your roles at Jaguar Land Rover?

Mark Flinders: I'm the manager of the vehicle engineering and instrumentation teams in the Assisted and Automated Driving (AAD) department. AAD does everything from features and systems for meeting legal and national standards to research work on self-driving vehicles. My team looks after all elements of setting up production vehicles for AAD feature, system, and component testing, ranging from creating the measurement technique and ground truth systems to developing and integrating new systems, features, and sensors into vehicles for research and development. We also assist in building closed-loop vehicle setups and in training our companies' safety drivers. I joined Jaguar Land Rover in 2004 after spending eight years working for a global powertrain consultancy doing hardware-in-the-loop (HIL) design, engine test bed support, rapid control prototype system modeling, and more. Since joining Jaguar Land Rover, I have been promoted several times, working in most roles in electrical engineering. I was responsible for all the embedded software hosted on production electronic control units (ECUs), and I managed the brakes and steering production hardware electronics and software. As you can see, you can make quite a career here. Working for Jaguar Land Rover is my dream job; I love the technology, the cars, the people, and I completely love AAD.

Marek Krezalek: As a senior technical specialist for AAD in verification and validation, I support all other technical specialists and product owners with my experience, knowledge, ideas, and assistance to deliver best-in-class verification and validation of Jaguar Land Rover AAD features.

I joined Jaguar Land Rover in 2019, coming in with Tier 1 experience after working for a few automotive suppliers in worldwide locations. Joining Jaguar Land Rover was

a fundamental step in my career. It provides many opportunities to influence products delivered to our end customers. I also get the privilege of working with people like Mark who are full of passion and motivation to learn, try new methods, and explore engineering solutions to deliver fully validated and verified products. These all work together to make Jaguar Land Rover vehicles easier to drive, and even more enjoyable.

AN: We have partnered on developing one of your AAD applications. Can you share a bit about that application and its importance in the work you do?

MK: We're working on the next generation of AAD features that deliver the next levels of driving automation and driver support and give our customers a modern luxury experience. We are collaborating with NI to deliver solutions we need as part of an early technology partnership designed to build a core framework around standards like PXI, LabVIEW, and other parts of the wider NI ecosystem. We have been incredibly involved in the ADAS logger application development, having run prerelease versions of it for nearly 12 months.

MF: We have been working hard to rationalize our toolchain and integrate several new products from NI in our development. In the AAD vehicle technology space, we must solve several use cases that include logging, calibration, rapid prototyping, simulation in the cloud, component test bench, and more. The ecosystem of tools, processes, hardware, software, storage, computing, operating systems, sensors, interface standards, synchronization, localization, and ground truth is extremely complex, even before accounting for legacy system support. As the system requirements for all these use cases get more demanding over time, we must also drive efficiency, cost reduction, synergy, and robustness into this toolchain. It's difficult to design and deliver a toolchain that covers all the use cases while being technically advanced enough for state-of-the-art operation so that it can be delivered operational and

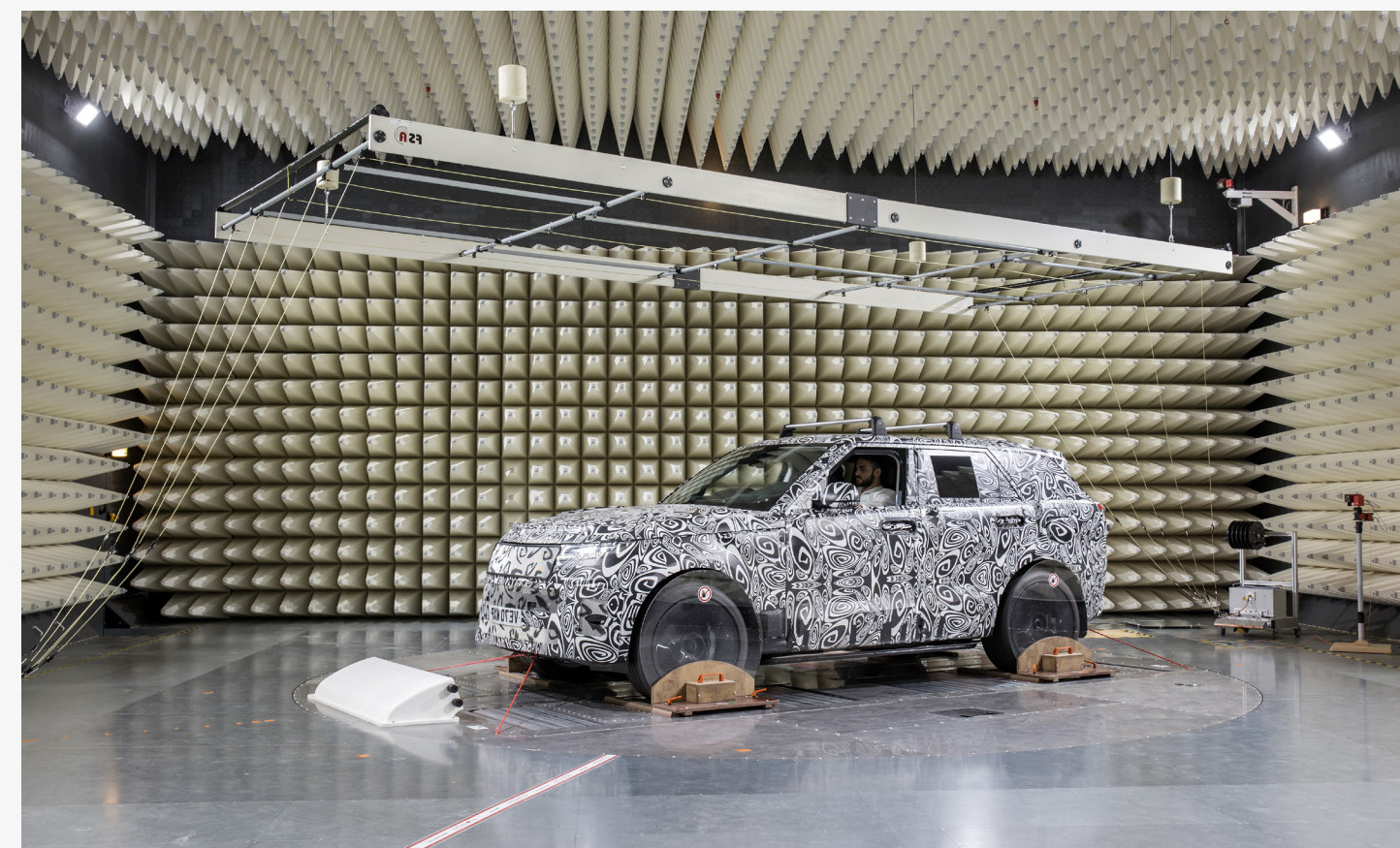
working every day. This all has to be done without massive support infrastructure while taking the everyday knocks a real system gets. It takes time, investment, commitment, and a long-term vision to develop and deliver this system in advance of business needs. To be clear, there is only so much high-specification computing, electronic, and software technology—fully integrated and working reliably—that you can fit into one vehicle. We have learned some tough lessons over the years and have refined the approach with help from some great suppliers and partners.

AN: NI's vision and goal is to provide a data- and software-connected validation workflow for ADAS and autonomous driving that is enabled by an open partner ecosystem. What's your perspective on this?

MF: NI brought together a collection of internal technologies adapted for our domain and worked very openly with others to deliver further key elements. From the onset with NI, we were very honest about the wide scope of our use cases (see previous response) and the flexibility and scalability requirements. We have not seen all that goes on behind the scenes to build up this open partner process, but we have seen the results of it so far that have led to solutions that fit our needs very well. There are always challenges when looking at the wider automotive electronics and software landscape—challenges like file formats, interface standards, storage, camera video acquisition, and cross-domain logging synchronization. We, and the entire

automotive industry, don't have all the answers to these complex challenges yet, but the work we have done with NI and other partners in this ecosystem leads me to think that we are on the right track and can make it work when we need it to—for today and in the future.

MK: I would like to echo Mark's response and build on it further, as partnerships have been critical for our success. Earlier this year, we announced a new partnership between Jaguar Land Rover and NVIDIA. This relationship is another significant step in our evolution toward becoming a leading high-tech company. What does it mean to become a leading high-tech company? In the past, we primarily managed innovation—suppliers provided us with their technologies and then we, simply speaking, deployed it. Nowadays, with the technology partnerships between Jaguar Land Rover, NVIDIA, and NI, we are taking significant ownership and control of innovation, which allows us to transform from what you would consider a traditional high-tech-oriented OEM to a leading high-tech company.



AN: Seagate is one of the many partners that NI has brought in to jointly tackle ADAS and autonomous driving in-vehicle data logging with Jaguar Land Rover. How has this worked out for you so far? What benefits have you seen up to this point?

MF: This is a great example of a partnership that has been a win-win. The use cases around storage are hard to meet and the current solutions all have compromises. It is a very specialized area at the cutting edge, and you really want a partner with scale who knows this area inside and out. NI introduced us to Seagate, and we shared with them the same vision and use case as we looked for the win-win among the three of us. I expect that we wouldn't have considered Seagate LYVE Mobile without NI's introduction. Furthermore, NI made it quite easy for all of us to work together as a group on our joint development.

AN: But what if you need to bring in another partner and their technology that is not covered by the NI ecosystem?

MF: Honesty between all parties is particularly important to me. We get the best results only when everyone is honest and we all respect each other. During the early stages of working with NI, we made it clear where we found adopting NI's ecosystem approach to be challenging, and we asked NI to work with partners that most people would consider competitors. Jaguar Land Rover wants to develop a vehicle- and domain-wide data acquisition and data handling process. To do this, we need to address existing deep integrations of other companies' products, too. Jaguar Land Rover introduced a series of projects for which we asked NI and other companies to work together on specific proofs of concept to determine the feasibility and the gap between where we are now and where we want to be in the future. NI and the other partners made what could have been an exceedingly challenging task relatively easy. NI took a lead position as the system integrator, and everyone respected their relative technology "spaces." The results give me as the customer and overall system integrator some interesting choices for future logging, calibration, and rapid prototyping setups. The key point that is relevant to this format is that NI listened to our needs, accepted the reality of the use cases, and worked hard to apply their technology to the problem with the other partners involved.

MK: Another notable example is the strategic partnership with NVIDIA. Though this partner was introduced by Jaguar Land Rover, the three of us quickly turned things into a coherent working model. The open technology and mindset from NI have made it very straightforward to tackle challenges together, explore new technologies, use experience from other high-tech industries, adapt quickly, check results, and then be able to react accordingly. The collaboration between Jaguar Land Rover, NI, and NVIDIA delivers many opportunities to define new standards and best practices in AAD verification and validation.

Delivered solutions and methods will stay and evolve the industry for many years to come.

AN: Jaguar Land Rover is recruiting talent in various countries globally. What should people interested in applying know about Jaguar Land Rover as a technology company?

MK: Like I mentioned before, we have evolved as a company quite a bit and are still doing so. Previously, we were primarily looking for project or program manager profiles, as this was the primary job that had to be done when managing innovation. With the shift to a leading high-tech company and taking more control over innovation in-house again, there is the clear need for engineers like Mark and me. That means if you want to be part of developing state-of-the-art, modern luxury vehicles paired with exquisite design and end-to-end engineering, then Jaguar Land Rover needs to be on top of your employer list. Moreover, as amplified through COVID but not only driven by it, we have embarked on a "work from where you are" journey. We are creating hubs across all of Europe to allow talented engineers to work from various places such as United Kingdom, Hungary, Ireland, Germany, Spain, or Italy. This evolution allows us to be more flexible and create some nice benefits in terms of work-life balance.

MF: Like Marek has alluded to, our history, products, and brands are global icons. In one way or another, I have worked on all the products we have made in the past 10 years, and, again, I love what we do—the technology, the people, the passion. I have been working in this field for 25 years, and, today, I am doing some of the most exciting work I have ever done. Where else do you get to work with radars, scanning lasers, cameras, server-level computing, and network technology all in the context of our great vehicles? Engineers all over the world should apply to work at Jaguar Land Rover because we are doing some amazing, innovative, and groundbreaking things. We are looking for people skilled in NI technology and other hardware and software domains. We are searching across Europe but are not limited to that continent for talent. To learn more, visit jaguarlandrover.com.

AN: Thank you both for taking the time. We are thrilled to see how our partnership and the wider NI ecosystem can continue to work together to solve the challenges of the ADAS and AD validation workflow. It has been great to join forces with you on the path toward zero collisions, and, aided by our partnership, we look forward to accomplishing Vision Zero.

[More about ADAS](#)



Accelerating Parallel Test of Multiple Infotainment Systems at a Tier 1 Supplier

Abstract

New product introduction timelines for infotainment systems are tight. As soon as a leading Tier 1 supplier knew the preliminary specifications of its next-generation infotainment system for a German OEM, it turned to NOFFZ to discuss validation testers. Within four months, the supplier needed NOFFZ to design, build, and install 12 parameter and monitoring test systems. NOFFZ was confident that its Universal Tester Platform (UTP) and the team's expertise could solve this challenge.

Background

A global Tier 1 supplier turned to NOFFZ with a test request for premium infotainment systems. NOFFZ designed the tester based on the available preliminary device under test (DUT) specifications to meet the timeline. Less than 3.5 months were left from ordering to final prototype tester delivery. The tester needed to be prepared for the product validation phase as a parameter and monitoring test system. The tester had to cover the various I/Os (22 different types including audio, camera, display, CAN-FD, and Automotive Ethernet signals) as well as the integrated wireless and connectivity standards. The setup needed to be modular to incorporate possible future upgrades or reuses. On top, the configuration for testing six DUTs in parallel had to fit in one standard 19 in. rack.

Challenges

01. Number of Connections to Be Tested

The infotainment system for a German premium OEM is the main unit in the vehicle, which combines the instrument cluster and infotainment functionality. It is a so-called convergence or one-box product and controls the cluster, head-up, and in-vehicle infotainment (IVI) display.

On the compact housing, the system contains 16 ports only on the rear side. In total, each DUT has 22 different hardware types on the I/O list. They sum up to 50 I/Os in total per DUT. To no surprise, the infotainment systems support multiple audio sources and sinks like Bluetooth, microphones, and internal and external amplifiers. The number of displays inside a vehicle depends on the end-user configuration. Besides the central display and the instrument cluster head-up display, co-driver displays are becoming more popular. While a rear-view camera is more or less standard in premium vehicles, cameras inside the vehicle are optional. The system needs to support up to four additional camera inputs for selfie cams and driver or occupant monitoring systems. In total, the video test requirement includes four display outputs and five camera inputs (GMSL1/2). Rounding out the I/O list are Automotive Ethernet, Ethernet, CAN-FD, GNSS, and microphone inputs and output.

NOFFZ designed the test systems based on commercial off-the-shelf (COTS) components. Through extensive research on available instruments for the best technical solution, NOFFZ's standard guideline of about 80% standard instrumentation and 20% customer-specific equipment was applied.

The final instrument list included NOFFZ PDU, UPS, NOFFZ SCU with six DUT-specific modules (signal conditioning unit), and RF distribution. An IPC was connected to two NI PXI chassis using one cabled PCI Express (MXI) bridge. The first chassis contains two PXI Multifunction I/O Modules (PXIe-6345) that offer analog

I/O, digital I/O, and four timers as well as a special measurement card for DUT power consumption in all stages. Placed on top of the rack, the second chassis hosted NI Automotive Camera interface modules for GMSL. Depending on the DUT variant, the chassis was equipped with up to four Automotive Camera interfaces (PXIe-1487) with eight output channels each. Power supply units from TDK-Lambda and Ethernet/CAN interface modules completed the solution. Most instruments were installed in a 40 in. rack including accessories like single-board computers, Ethernet switches, and a monitor. The thermal design turned out to be another challenge since the rack was really packed.

02. Exchangeable Interface Box Individually Configured for up to Six DUTs

The optimum number for testing multiple DUTs in parallel is dictated by the number of DUTs the temperature chamber can support. Therefore, the requirement for each test rack to account for testing six DUTs in parallel was defined.

Engineers from the Tier 1 supplier demanded the installation of a custom specific interface (CSI) box that needed to be individually configured for up to six DUTs with loads, BIAS-Ts, and so on. This box needed to be exchangeable and able to provide standard connections for LF-signals and RF standard connections like SMA, Mini-FAKRA, and more for the other signals.

At the same time, all radio inputs to a single tester needed to enter through a single coaxial input and be split inside the test stand to be routed to individual connectors for each DUT.

To account for all the requirements, NOFFZ configured the rack using a VPC interconnection (receiver). The CSI box was placed in front of the VPC receiver on a sliding table. A hand gear for locking and releasing the CSI box was mounted on the operator side of the rack. Of course, the CSI connections needed to match the connections of the VPC receiver. Still, both components were easy to change if the tester was repurposed or modified.

In summary, the CSI box is a smart solution that covered three main tasks. First and foremost, it connected all the non-critical (non-high-speed) signals of the DUT to the test system. In addition, it covered the level adjustments of the measurement signals. Finally, it accommodated smaller equipment for speakers and USB tests.



03. Compact Test System with Upgrade Options for Reuse (Future-Proof)

The test system had to be built in an off-the-shelf 19 inch rack no bigger than 42U. Two main use and upgrade ideas were considered while writing the specifications. If additional hardware was required for parametric testing, continuous monitoring testers needed to be upgradable to support that functionality. The cabling between the DUT and the test system needed to be a length of 3 m to be used with a climate chamber. Cabling needed to be selected in accordance with the temperature range of the climate chamber.

Another future-proof design aspect was the use of the CSI box. The VPC components could be easily exchanged. The software framework also was scalable and extendable to meet upcoming test needs.

Summary and Outlook

Close collaboration and early involvement were crucial to the success of this project. In the meantime, 16 testers were deployed.

Companion test systems have already been ordered for other departments. For example, the video inputs of the premium infotainment system were to be tested in an EMC laboratory. For this, only manual contacting was an option. In addition, all instruments had to be powered by a battery that covered 10 hours of operation. The solution provided by NOFFZ included an NI PXI DC chassis and two more NI Automotive Camera Interface modules (PXIe-1487).



In addition to the competent consulting, compact design, and quick setup of the test systems, the service and flexibility of NOFFZ were key. During the product introduction of the infotainment system, changing requirements had to be accommodated. Further testers and upgrades for different products and variants—in total 20 systems—were installed with the leading Tier 1 supplier. Up until now four of these EMC testers were deployed successfully.

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Photo courtesy of Zacia

Women Break Gender Stereotypes in EV Innovation

What comes to mind when you think of electric vehicle (EV) innovation? Maybe the aspiration toward a zero-emission future? Perhaps complex lithium batteries? What about Mexico? What about a woman-owned and operated EV manufacturer? Zacia is an all-woman-owned startup based in Puebla, Mexico, and the first and only Mexican brand of EVs. As I've explored about the Zacia brand and cars, I have reassessed what it means to Engineer Ambitiously™ and learned more than a few lessons on innovation.

Innovation has many facets, and it's helpful to occasionally step back and discover where it is happening. By doing so, we can achieve a renewed sense of what "innovation" means. My work at NI immerses me in technology so much that I occasionally forget how innovation refers to the introduction of something new, including the methods, the processes, and, more importantly, the people behind the innovation.

"Zacia is an electric, zero-emissions car from a Mexican company committed to sustainability, responsible mobility, and creating a clean city that's better for you, your children, and future generations."



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YOUR TEST & AUTOMATION EXPERTS.



ADAS. E-MOBILITY. CONNECTIVITY.

Breaking a 120-Year-Old Pattern

Zacua describes itself as “a company that always seeks the welfare of society.” A Mexican equity pioneer, the company teaches women who join the company as cleaners or other “blue collar” roles a robust set of skills—an entire discipline even—to help them become part of a community of innovative female regional industry leaders that designs and assembles these cutting-edge and boundary-breaking EVs by hand.

The company itself was founded in 2017. Zacua inaugurated its assembly plant in Puebla in mid-2018, and it is still a small startup manufacturer. Because each of its cars is produced with such precision and care without the help of automated machinery, its production line allows employees to assemble an average of one vehicle per day. Zacua employees say that because they produced the first 100% EV assembled in Mexico, they “differentiate [themselves] from the rest, being more daring and innovative, with outstanding features, such as savings, an exceptional driving experience, and environmentally friendly technology.”

In addition to producing the cars themselves, Zacua employees are impacting the local EV infrastructure by establishing 150 charging stations across Mexico City. These will be mapped in a smartphone application along with all other functional charging stations in Mexico City.

“Zacua is the first car globally, in more than 120 years of history, to be assembled by a 100% female team.”

Nazareth Black
CEO, Zacua

Changing the Faces of Engineering

During a recent press conference, Zacua CEO Nazareth Black discussed two issues that must be addressed before Zacua can fulfill its mission: 1. the car industry was built on the environmentally harmful combustion engine and 2. cars were built by and for men. Zacua employs mostly females for its engineering center as well as its factory mechanics team.

Black actively promotes the inclusion and empowerment of women as part of her vision for the automotive industry. She oversees the company from the perspective of a woman who believes men have, for too long, dominated the automotive industry on a global level. These efforts aim to meet a company policy of equity and inclusion as well as to promote women in the automotive sector. These monumental efforts are making a tangible impact on the faces of engineering.

Let’s face it. The engineering talent pipeline hasn’t changed much over the last 20+ years. That is where the story of Zacua and NI intersect. [NI’s 2030 corporate impact strategy report](#), Engineering Hope, outlines NI’s vision and aspirational goals for making a measurable, positive impact on society and the environment by 2030. The long-term plan to advance diversity, equity, and sustainability furthers NI’s promise to Engineer Ambitiously. The Engineering Hope strategy outlines 15 aspirational goals and commitments aligned to three key pillars:




<p>01 Changing the Faces of Engineering</p> 	<p>02 Building an Equitable and Thriving Society</p> 	<p>03 Engineering a Healthy Planet</p> 
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Photo courtesy of Zacua

Building a diverse and inclusive workforce is more than just the right thing to do. Our teams at NI should reflect the diversity of our customers and the communities where we live and work. Collaborating with people from diverse backgrounds opens our minds and spurs innovation. Additionally, it brings more people into the field. The global technology sector is **projected to have a shortage** of 4.3 million workers by 2030, so attracting more diverse people to the industry helps keep up with this growth while providing more equitable access to high-paying jobs.


The value of diversity does not stop with the societal impact; it also has a quantifiable impact on a company’s revenue. Kazique Prince, NI’s director of Diversity, Equity, and Inclusion (DEI), addressed the need for greater diversity in the workplace in the [Q2 2022 Automotive Journal](#). “Research and literature have been clear: organizations that do well in [the areas of DEI] versus those that don’t make more money. In fact, they make on average \$500 million more than those organizations that don’t.”

Impacting Generations to Come

As the mother of a daughter who is incredibly innovative and endlessly inquisitive at the young age of 3, I get excited thinking about the opportunities she will have that were unavailable to her grandmother 40 years ago or even to me within the last 15 years. Zacua is leading the way in Mexican EV innovation and breaking centuries-old gender stereotypes while staying firmly rooted in Mexican heritage and identity. Black writes “In this world there is so much to do, so much to improve, so much to build. And it all begins by building in our minds that better world for everyone.” I am inspired to see companies like Zacua emphasizing diversity, equity, and inclusion in their engineering, operations, and manufacturing. Their example continues to inspire the world and generate new perspectives on how to Engineer Ambitiously. To quote Black, “when one of us takes a step, we all move forward.”

*This article reflects the author’s opinion and is not sponsored by Zacua in any way.

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No Shortcuts to Vision Zero

Software-connected test systems from NI create vast efficiencies across the product lifecycle, from early simulations to final shipment. This means you can deliver superior quality and optimal performance faster, on the road to Vision Zero.

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ADAS Vehicle Fleet Improves Workflow and Data Management

Ensuring safe operation at all levels of automated driving is vital to consumer adoption of the new technology. Nowadays, engineering teams struggle with the need for vast amounts of high-quality data to train, test, and guarantee higher validation test coverage of their perception algorithms and hardware.

In cooperation with Konrad Technologies, Seagate Technology, and VSI Labs, key partners across the advanced driver assistance systems (ADAS) and autonomous driving (AD) ecosystem, NI announced the deployment of a fleet of vehicles in Europe, the United States, and China that will enable ADAS/AD engineering teams to address top challenges related to data volume, quality, access, and utilization. The vehicles are equipped with a high-performance in-vehicle data recording and storage solution from NI and its partners.

This collaboration further enables a connected workflow by combining best-in-class technologies across the global ecosystem and provides a solution to deliver autonomous driving safer and faster to the road.

ADAS data recording is one of the most complex challenges for the ADAS and AD domain because data from multiple sensor modalities (camera, radar, lidar, ultrasonics, infrared, IMUs/INS, GNSS, and vehicle networks) must be logged synchronously and analyzed together to train and validate the performance of safety functions and features. The amount of data the research vehicles collect will help advance ADAS solutions to the next level.

Through this initiative, NI and its partners will research, develop, and demonstrate industry-leading capabilities involved in recording high-quantity and high-quality sensor data in the field; efficient data movement via data transfer services; and increased data utilization for training, analysis, and validation of algorithms in the lab.

This collaboration is a great step forward for the development of the PXI high-performance data-logging system featuring the synchronized collection of real-world scenario data from several sensors. This data can be used later for the data replay to ADAS engine control units (ECUs) to test perception algorithms and improve the overall performance.

In North America, VSI Labs will conduct research while driving its ADAS recording-equipped vehicle across the United States to improve the use of data throughout the entire ADAS and AD engineering workflow. The data collected on the road will also help NI and its partners further evolve their joint solutions, which range from data recording and simulation to digital twins and hardware-in-the-loop testing.

VSI Labs regularly hits the road for long-distance drives to collect data and showcase its sponsors' tech. The company hosts Drive Series events over several days while en route to its destination.

Using real-world scenarios to test and validate the safety and performance of ADAS allows NI to offer its customers innovative solutions. Join NI at one of the upcoming events to learn more about its solutions:

- **ADAS and Autonomous Vehicle Technology Expo**—September 7–8, 2022, San Jose, California, US
- **AutoSens**—September 12–14, 2022, Brussels, Belgium
- **Automotive Testing Expo**—October 25–27, 2022, Novi, Michigan, US
- **Register for NI Connect**—November 9, 2022, Munich, Germany

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A CATR Radar Test System on Another Level

Radar sensor technology plays a significant role in autonomous driving. Specifically, imaging radars are gaining traction due to high-resolution capabilities; multiple input, multiple output (MIMO) antennas; and a wide aperture with better long-range target recognition and longer far-field distances. All these new test challenges require more complex test equipment. To cost-effectively keep up with technology, today's radar test solutions must be fast, accurate, smart, compact, and adaptable.

Customer Needs

01

A compact antenna test range (CATR) anechoic chamber to allow the creation of a high-quality quiet zone to perform at a significantly shorter distance

02

Simultaneous movement along individual dual-axis trajectories with a highly accurate device under test (DUT) motion during the calibration process

03

Fast cycle times for testing and calibration and parallel handling of more than one DUT

04

Rare floor space or limited ceiling height to accommodate huge test chambers for increasing far-field distances

05

Full integration into the existing production environment with highly flexible tester control and application software

NI + NOFFZ ADVANTAGE

- Compact test bench tailored to your specific test and automation needs to fit your production environment
- Modular, flexible, and adaptable radar test system to keep up with new requirement requests and future-proof your investment
- Ready-to-use turnkey solution with global on-site support, service coverage, and short-term manufacturing capabilities
- Fast, accurate, and efficient test system optimized for production that facilitates the transition from radar sensor development to economical mass production

NI and NOFFZ Technologies partnered to develop a fast and accurate CATR test system optimized for production test. Save cost, use space more efficiently, and easily adapt to new requirements by combining the NOFFZ UTP 5069 chamber, automation, and software with NI VRTS for a system that is ready for the next generation of radar technology.

“The innovative CATR chamber design combined with NI’s technology elevates our UTP radar test systems to a new level. Next-generation imaging and 3D/4D radar sensors can now be calibrated and tested in a state-of-the-art tester environment in high volume.”

Oliver Poos
Principal Engineer, ADAS, NOFFZ Technologies

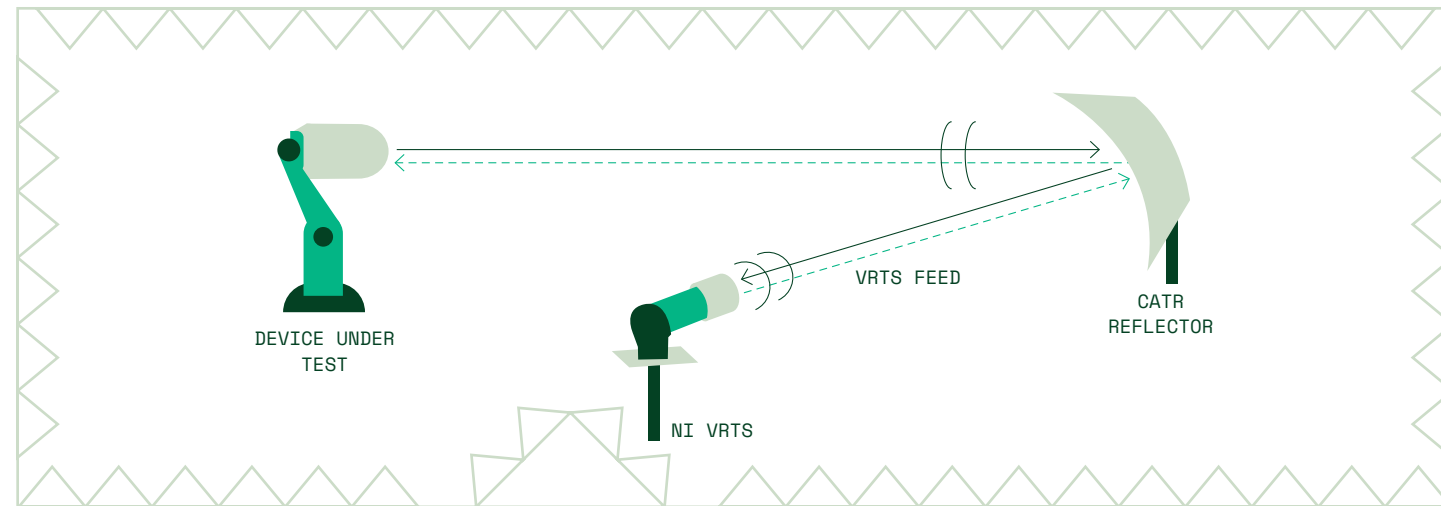


FIGURE 01
CATR Test System Internal Diagram Setup

NI + NOFFZ Solution

01
The UTP 5069 end-of-line (EOL) radar sensor test system features the best reflection suppression with absorption analysis inside the CATR chamber and a small footprint for big imaging radar sensors

02
The 4 GHz NI Vehicle Radar Test System (VRTS) helps you perform highly repeatable and accurate radar obstacle simulation and parametric measurements in parallel, which reduces test time

03
Optional dual nest loading and unloading station reduces test cycle time

04
The robot arm positions the DUT very precisely inside the quiet zone and allows highly accurate DUT motion in azimuth and elevation for best calibration results

05
Individual application software based on the NOFFZ UTP Suite helps you achieve synchronized DUT motion, parallel measurements, variant management, individual database connectivity, and more

KEY SPECIFICATIONS

Quiet zone diameter	22 cm or more depending on CATR reflector dimension
Frequency range	76-81 GHz
Bandwidth	4 GHz
Target simulation	NI.COM/VRTS
Dimensions of test chamber setup	1,200 x 2,700 x 2,200 mm (W x D x H)*

*Dimensions depend on frequency



FIGURE 02
Design View of the CATR Test System

An NI Partner is a business entity independent from NI and has no agency or joint-venture relationship and does not form part of any business associations with NI.

Contact NOFFZ

System Integration on Your Terms

NI and NOFFZ Technologies offer a variety of solution integration options customized to your RF testing and automation requirements. NOFFZ has more than 20 years of experience as an NI Partner and more than 25 years of experience working on automotive solutions. NOFFZ is headquartered in Germany with global representation and manufacturing.

Contact NOFFZ Technologies or your NI account manager to learn more about how we can help you increase product quality and accelerate testing timelines.

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ADC's Complete ICV Simulation and Verification Solution

As a strategic direction in the development of the automobile industry, intelligent connected vehicles (ICVs) are in the initial stage of commercialization, undergoing rapid technological evolution and accelerated industry layout. The industry currently faces opportunities, risks, and challenges and requires standardized management measures. At present, China has released "Opinions on Strengthening the Management of Connected Vehicles (Intelligent Networked Vehicles) Manufacturers and Product Access," which presents 11 requirements for strengthening data and cybersecurity management, standardizing online software upgrades, and enhancing product management and assurance measures. The industry has reached a consensus on using the multipillar certification approach to test and evaluate automated driving in order to support product approval management. Due to the complexity of the automated driving system (ADS) and function verification, simulation testing and verification have become an indispensable part of the product approval management process.

Enterprises are actively building a "closed data loop" platform in the smart driving field. This means that data is used to guide business and practices, while iterative optimization is performed within a closed loop. This process generated application requirements for data processing tools, scenario management platforms, and simulation and reproduction. Automotive Data of China (ADC) also created a complete ICV simulation and verification solution that extends from data collection and scenario database construction to simulation testing and verification.

In terms of data collection, ADC has a comprehensive data collection and handling process and a wealth of experience in data collection vehicle modification, sensor installation design, vehicle multisensor calibration, and data collection and management. ADC has built a model system of versatile sensor development interfaces to ensure convenient sensor system integration and expansion and laid the foundation for developing reusable sensor interfaces and data collection services. ADC has developed efficient parsing and integrated processing technology for multisensor heterogeneous data to filter out redundant and invalid information between sensors, reduce the software processing load, ensure data accuracy, and form an efficient and lightweight data collection platform.

ADC's standard data collection platform is built on collection software, a hardware system, and vehicle features. Generally, it is equipped with one smart camera; seven high-definition cameras in the front, rear, front left, front right, rear left, rear right, and cab positions; one millimeter-wave radar with high resolution; one low-thread/high-thread lidar ground truth system; a high-precision inertial navigation system (INS); and weather monitoring devices. The platform can be customized based on actual requirements (Figure 01). The collection hardware obtains different types of signals. The collection software handles and stores the signals received by sensors and cleans, denoises, and desensitizes data through the proprietary data cleaning platform. In addition, NdsCleaner, the scenario data processing software developed by ADC, can normalize data collected from different collection platforms, convert the format of scenario data into ROS and ASEva, use the same frequency for different data sources, and filter scenario data. Data processed by the collection platform can be used to construct the autonomous driving scenario database, analyze

driving behavior, design test objectives and verification rules, benchmark and evaluate sensor performance, and label ICV environment perception data.

With respect to scenario database construction, ADC has developed a mature scenario toolchain, scenario database, and simulation testing application system through years of operations and exploration in the driving scenario field. The driving scenario toolchain integrates six modules: the scenario data collection platform, scenario data analysis platform, scenario data labeling platform, data analysis platform, scenario conversion tools, and scenario big data management platform. Its functions include data collection, processing, labeling, management, and application. Based on different requirements, ADC constructs two scenario databases: the typical scenario database and continuous scenario database. All data is managed by the management platform in a unified manner. Scenarios in the scenario databases can be used as the primary sources for simulation test cases and provide test content for these cases. With advanced simulation software and devices, users can perform model-in-the-loop (MIL), hardware-in-the-loop (HIL), driver-in-the-loop (DIL), vehicle-in-the-loop (VIL), and other simulation tests. According to the autonomous driving development process and data requirements, ADC builds the framework and related tools for constructing scenario databases based on natural driving data in the V-cycle development process, performs data-driven transformations in the ICV development and test fields, and constructs team-related capabilities.

Simulation testing and verification are indispensable parts of product approval management. The real-time performance, modeling and simulation capabilities, and data traceability of the

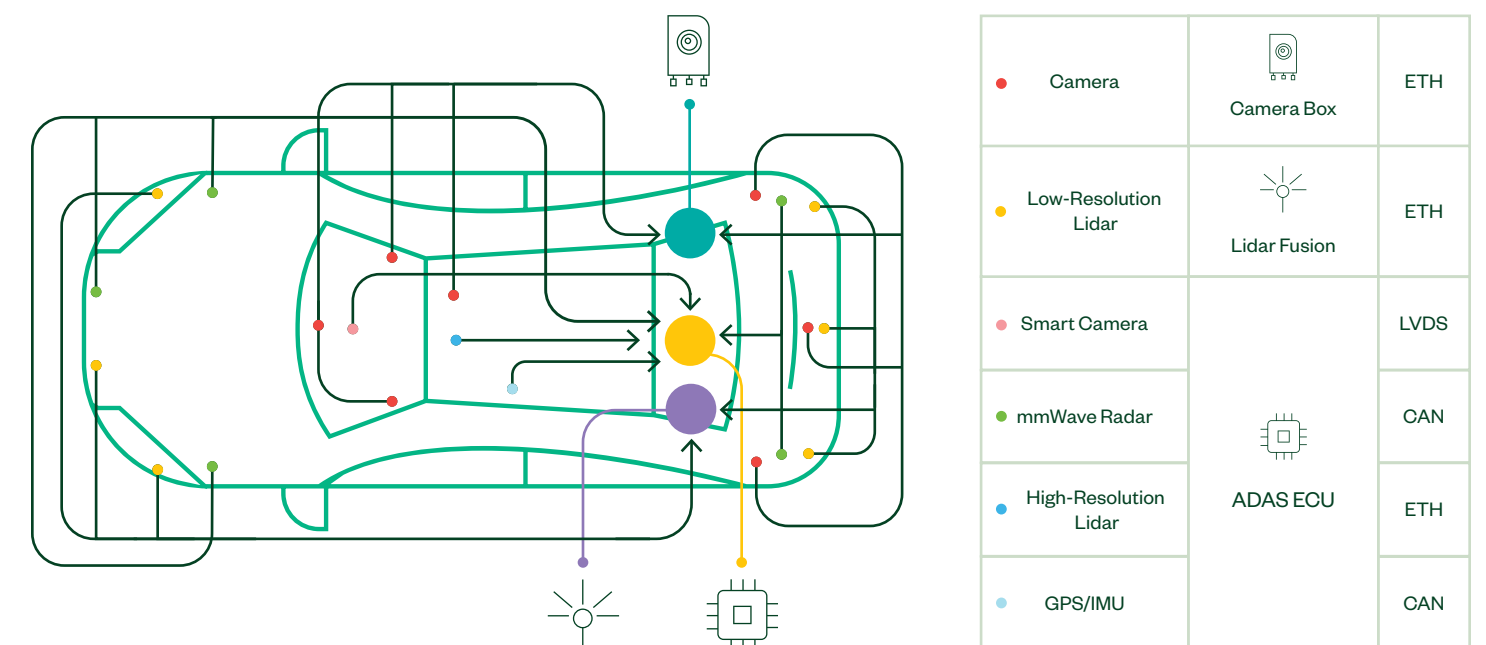


FIGURE 01
Collection Platform Configuration Solution

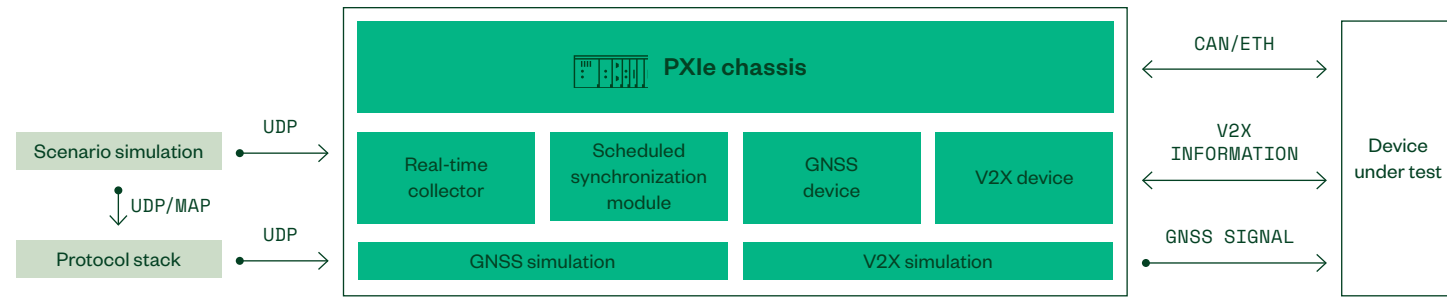


FIGURE 02
V2X Simulation Testing Platform

simulation testing platform affect the credibility of the simulation toolchain. Therefore, high requirements must be met when building the simulation platform. Based on NI products, ADC has built a complete smart driving HIL simulation and verification platform, which includes a software platform, a hardware platform, and simulation modeling. The full development process involves sensor and dynamics modeling, simulation device development, and platform integration debugging. NI VeriStand software is highly adaptable and can develop data communication interfaces that are compatible with other platforms in the toolchain to form a closed data loop platform based on the integration scenario simulation software, dynamics models, and sensor models of the testing management software. NI hardware provides various real-time processors and I/O modules. Based on open industry standards, they ensure that customers apply the latest PC technology to HIL testing. With powerful multicore processors, FPGAs, and data collection technologies, NI PXI hardware helps

improve measurement scope and performance. Some NI PXI products provide industry-leading frequency and precision specifications. The high sampling rate, high resolution, real-time system capabilities, and other features of NI's hardware system ensure high data precision and quality for the simulation toolchain.

In addition, ADC offers a vehicle-to-everything (V2X) simulation testing system based on NI products (see Figure 02). The underlying layer of the simulation system constructs the RF environment simulation function based on NI RF transceivers. The PXIe-5841 PXI Vector Signal Transceiver implements GNSS signal simulation, and the USRP-2954R USRP Software Defined Radio Device controls the sending and receiving of V2X communication signals. The 3D traffic scenario simulation provides virtual traffic scenario test cases to display 3D test scenario information and test case statuses in real time. Data generated in scenarios is transmitted to the hardware in real time to dynamically generate V2X signals,

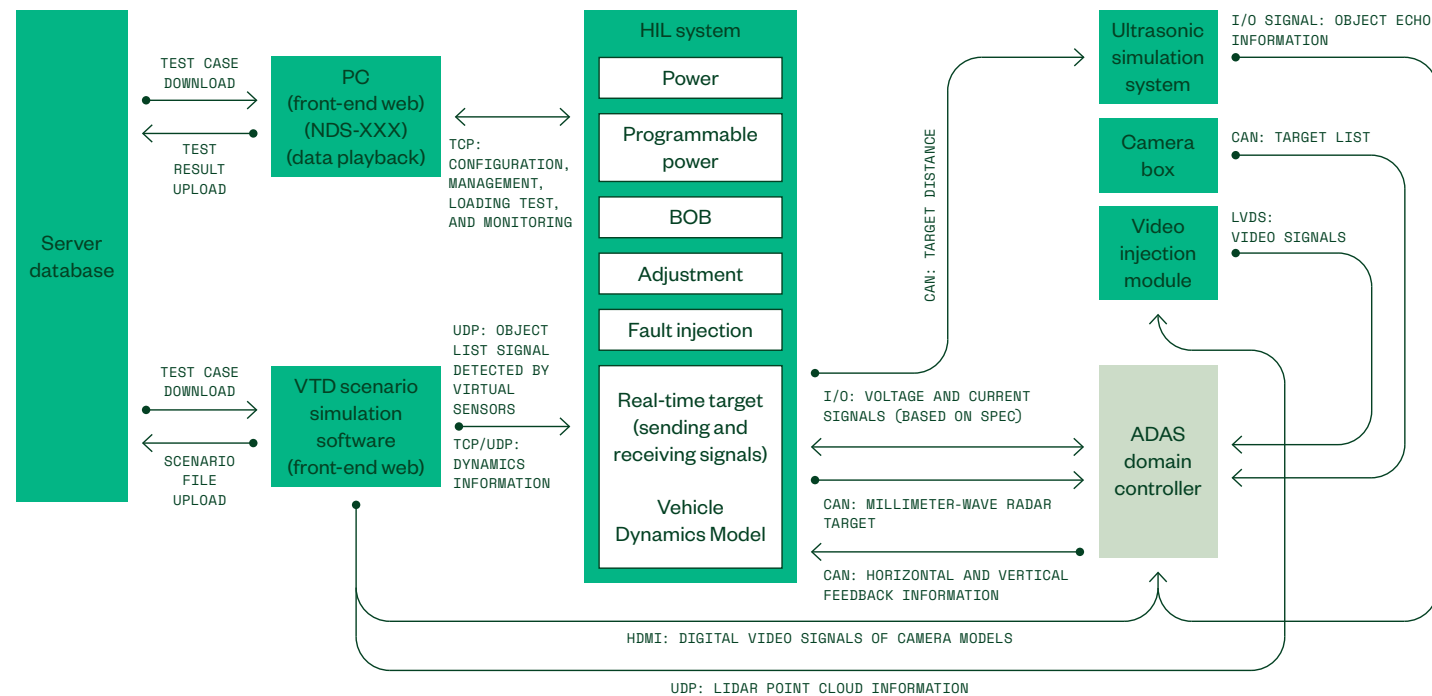
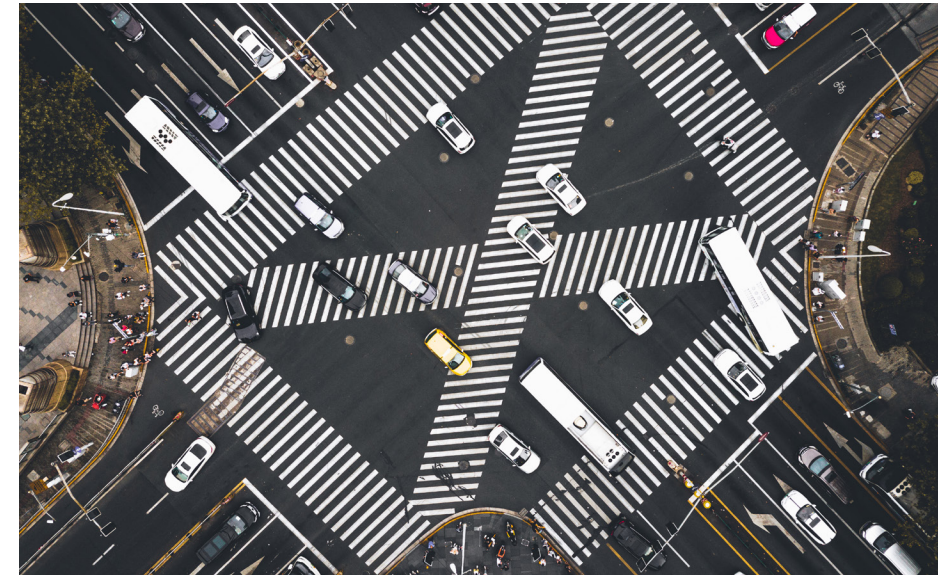


FIGURE 03
Smart Driving HIL Simulation and Verification Platform



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GNSS signals, and CAN signals. The V2X vehicle-mounted unit of the device under test (DUT) provides feedback and early warning based on its own information (CAN signals), V2X information, and GPS information to complete the HIL test.

In its industry partner ecosystem, ADC has provided a complete ICV simulation solution that extends from data collection and scenario database construction to simulation and verification for many automakers in China. For one leading automaker, ADC provided massive volumes of driving data and abundant driving scenario databases, established a server database, and built a complete HIL simulation testing platform (see Figure 03). The testing platform contains the VTD scenario simulation software, CarSim vehicle dynamics software, VeriStand verification management software, ECU-TEST automated testing software, an HIL cabinet, a real-time processor, a video injection module, and ultrasonic hardline simulation hardware. Using this testing platform, the automaker performs simulation, verification, and automated testing, completing the entire ICV simulation and verification process from data collection to simulation and verification.

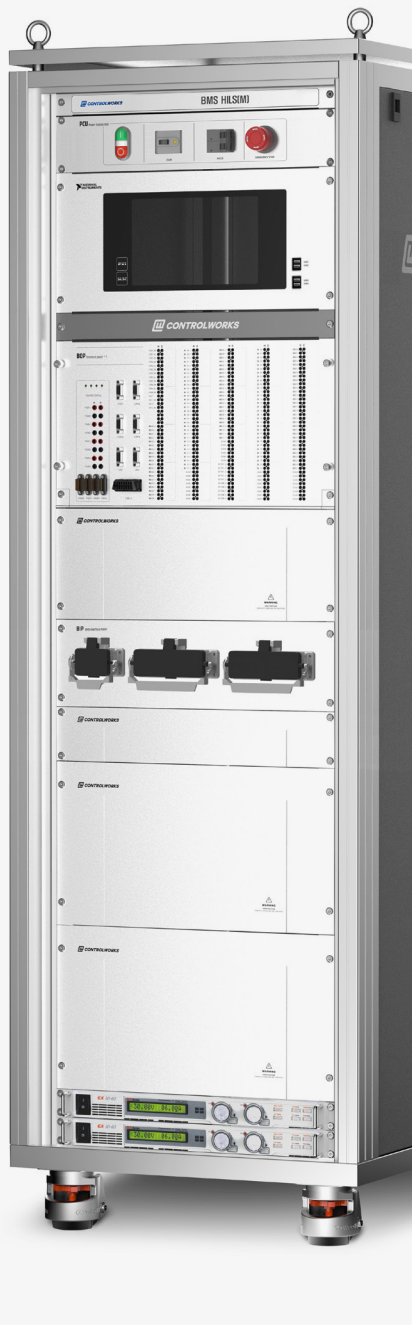
In the future, ADC will continue to build full-stack in-loop simulation toolchains based on massive data resources and scenario simulation. In constructing advanced autonomous driving vehicle simulation platforms and engineering verification services, ADC will work with NI to provide high-quality service for a wide range of intelligent automakers and research institutions and quickly deploy solutions for handling advanced autonomous driving regulation requirements and lab capability building.

Customer:
INZI Controls

Partner:
CONTROLWORKS

Application Area:
BMS HILs (ADV)

Solution name:
HILSmart®



BMS HIL Solution Cuts Test Time and Cost at INZI Controls

INZI Controls is a Korean company that has provided automotive industry solutions for the past 40 years. With the recent electrification trend, the company expanded its business to electric vehicle (EV) control units and invested accordingly in its R&D and other capabilities.

Customer Challenges

In 2021, INZI Controls set the goal of developing its first battery management system (BMS) to meet the needs of EV automakers. However, the company found that establishing an appropriate development environment that could respond to the various needs of customers and automatically verify the performance and quality of its BMS product was challenging. To meet this challenge, INZI Controls used BMS hardware-in-the-loop systems (HILs) from CONTROLWORKS, which offers the world-class quality, flexibility, and performance INZI Controls needed to meet its goals.

CONTROLWORKS Solution

CONTROLWORKS is a top (HILs) expert company in Korea with vast know-how and experience in working with major domestic carmakers for 12 years. CONTROLWORKS' differentiation in the market includes high-performance hardware, rapid local support, competitive prices, and high-quality engineering services. Additionally, CONTROLWORKS provides highly reliable hardware and software solutions like CE-certified battery cell simulators and Test Manager, the test automation software based on the NI PXI platform. The software has been extensively used by CONTROLWORKS' customers over time.

CONTROLWORKS' know-how, experience, and channel scalability expand to multidomain HIL systems including vehicle control unit (VCU), on-board charger (OBC), low-voltage DC-DC converter (LDC), motor control unit (MCU), and battery cell simulator (BCS) systems. Based on NI PXI hardware, CONTROLWORKS solutions can sustainably grow with a customer's needs and next-generation controller development. For these reasons, INZI Controls chose CONTROLWORKS to supply the total solution needed for BMS development reliably and quickly in Korea.

BMS HIL Simulator

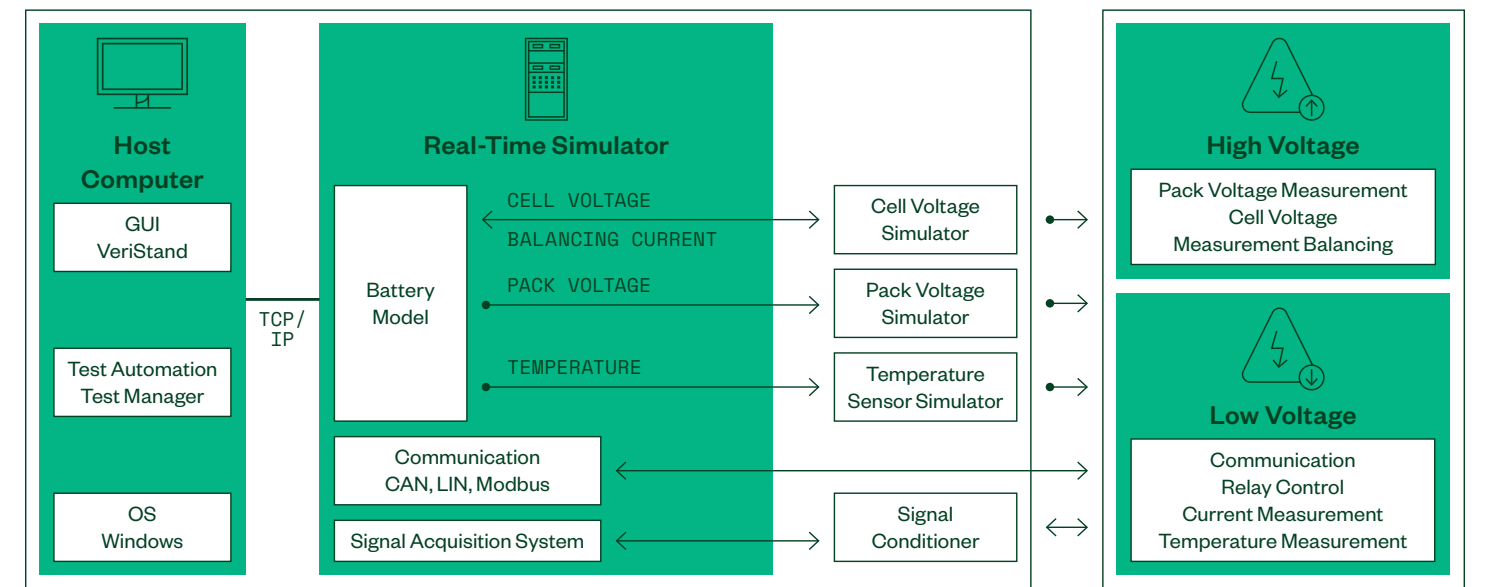


FIGURE 01 CONTROLWORKS BMS HIL Simulator Components

Before the implementation, many tests had to be conducted manually. With the CONTROLWORKS solution, INZI Controls can now test more scenarios automatically in less time, which greatly contributes to increasing the reliability of the new BMS.

The BMS is a critical controller in EVs, and any malfunction can cause serious damage and risk to the vehicle and its occupants and surroundings. Therefore, the BMS verification process must be carried out without any margin of error.

After ensuring safety through BMS-only verification, the battery pack-level verification needs to be implemented under multiple scenarios. Organizing and managing the different environments and tests manually would make verification less effective, so the automation that the CONTROLWORKS solution provides significantly saves time and effort on testing without compromising quality.

Additionally, if needed, the BMS HILs provide an environment that can more effectively verify the BMS's hardware and software in a pack-less environment. This is because they can simulate each function of the BMS and the electronic equipment

of the battery pack to provide an environment similar to the actual pack. Moreover, CONTROLWORKS' precise battery cell simulator allows the emulation of the closest environment to the actual cell. Finally, flawless verification through BMS HILs helps developers secure reliable verification data, which can be reflected in better BMS design and development. As a result, developers can expect to save about 30% of the test time under numerous test scenarios and to expedite the launch of a new BMS 20% faster than originally planned.

Future Forecasts

The prototype development of INZI Controls' first BMS will be delivered to various domestic and foreign OEM companies throughout 2022. After BMS development is successfully completed, INZI Controls plans to create other ecofriendly controllers. It also expects continuing collaboration, starting with the NI PXI-based BMS HILs of CONTROLWORKS and expanding to multidomain HILs.

“It was our first challenge, but now we have a smooth development process thanks to HILSmart of CONTROLWORKS. We were able to truly focus on the most important things that we must complete in the reliable development environment.”

R&D engineer
INZI Controls

Customer:
Major US Truck Manufacturer

Application Area:
Digital Engineering

Challenge

Develop, test, and validate the power electronics model and controllers for the truck manufacturer's DC Fast-Charging System (DCFCS) for EV charging stations, which would be installed on the Trans-Canada Highway—one of the longest highways in the world with a length of 7,821 km.

Solution

Use OPAL-RT's eHS FPGA-based Power Electronics toolbox and a cRIO-9082, an NI Reconfigurable Embedded Chassis, to deploy the control algorithms and perform the real-time simulation of the controller.

Proof Points

The final converter's configuration involved:

- An isolated DC-AC-DC converter that enabled serial/parallel configuration at the EV end
- 10 kHz in switching frequency that reduced the size of the output filter and the magnetics
- A phase-shift gating control strategy that provided soft-switching conditions
- Unidirectional power flow from the H-bridge at the front end and diode rectifier at the EV end

OPAL-RT and NI Solution Helps Engineer DC Fast-Charging Systems

Electric vehicles (EVs) have, until now, taken far longer to recharge than it takes to fill up a tank of gasoline, and yet they're becoming very popular. The missing piece has always been a fast recharge of 20 to 30 minutes. This solution has been slow to evolve because the existing infrastructure was not engineered for this challenge and its speed or volume of electricity delivered.

Enter University of Toronto's Centre for Applied Power Electronics (CAPE), partnering with energy storage company eCAMION, in one of Canada's most ambitious EV infrastructure projects: build a DCFCS for EV charging stations on the Trans-Canada Highway, one of the longest highways in the world with a length of 7,821 km.¹

Challenges

The very concept of fast charging implies a large amount of energy in a short time (it's a bandwidth or throughput issue). University of Toronto Professor Reza Iravani and his team from CAPE considered a new model, where electricity is stored in and discharged from local high-capacity batteries that are then refilled by the preexisting infrastructure between users. These local battery storage units then become part of a larger system to reduce the impact of DCFCSs on the electrical infrastructure. Though this seemed to solve the throughput issue, the engineering challenges remained.

Objective

As the first and determining part of its challenge, CAPE's team needed to develop control algorithms for its DCFCS, along with a local large-volume battery storage system. Team members decided to deploy the control algorithms on a cRIO-9082, an NI Reconfigurable Embedded Chassis for real-time simulation. For the battery storage system, they partnered with eCAMION, a Toronto-based company with accumulated expertise in developing solutions for issues specific to EV adoption in existing infrastructures.

They also needed to simulate the power electronics model for the fast chargers, configure the power electronics converter, fine-tune its controller design, and complete development with a 60 kW prototype.

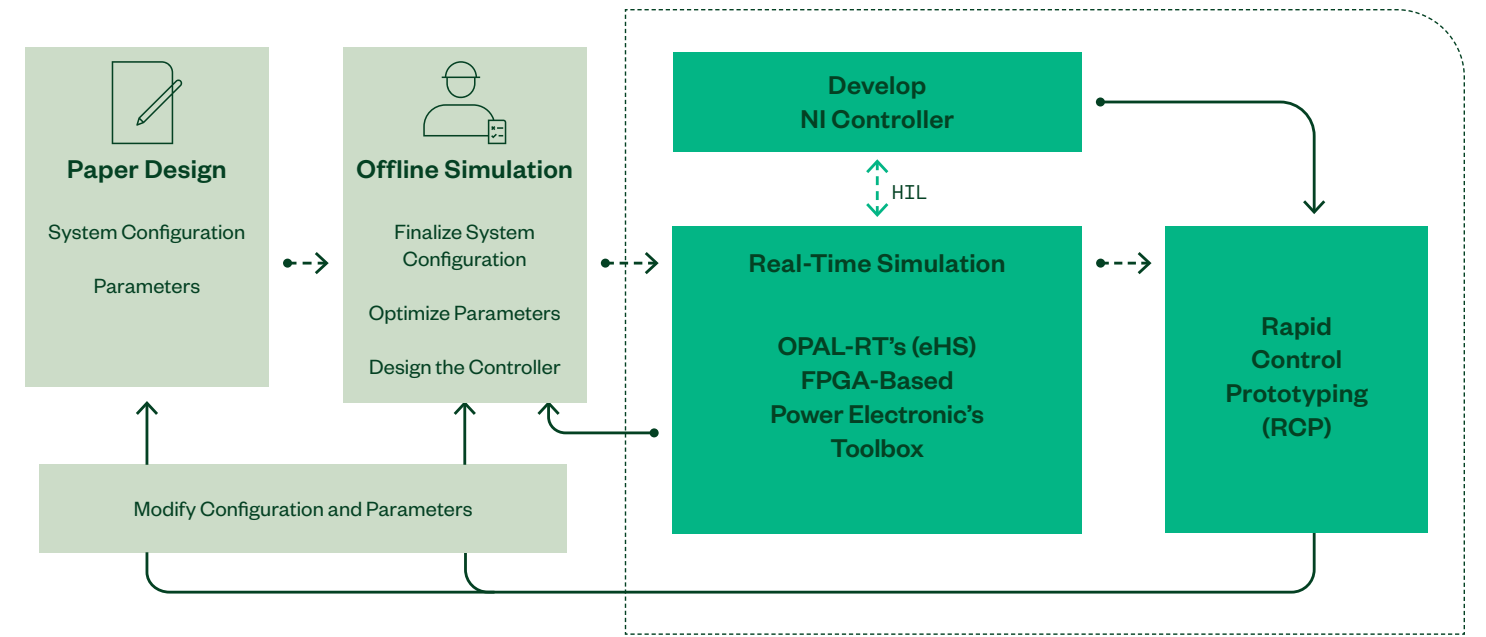


FIGURE 01
Development Process

Due to the need for two fast-charging sequences (one from battery to car and the other from grid to battery afterward), CAPE's team had to achieve higher charging voltage by connecting two chargers in series and implementing the local controller (LC) on the cRIO-9082.

Additionally, team members had to develop and test (in real time and through hardware-in-the-loop simulation) the LC of the grid interface's AC/DC converter on the cRIO-9082. Finally, they had to develop the supervisory control (SC) that coordinates the stations' LCs.

Each new station was designed to consist of an energy storage system that uses large-format lithium-ion batteries and multiple outlets so that several cars could be charged at once. The stations were to be equipped with Level 3 chargers, which typically use a 480 V system that can fully charge EVs in about 30 minutes. Level 2 chargers, found in homes and commonly seen in parking garages, use a 240 V system and can fully recharge vehicles in about eight to 10 hours.³

TYPE OF CHARGING	VOLTAGE	CHARGE TIME*
Level 1	110 V	8-20 hours
Level 2	240 V	8-10 hours
Level 3	480 V	20-30 hours

*CHARGING TIMES VARY DEPENDING ON FACTORS SUCH AS TEMPERATURE, CURRENT LEVEL OF BATTERY CHARGE, AND BATTERY CAPACITY.⁴

Solutions and Development

After starting the development process on paper to determine system configuration and parameters, CAPE's team went to offline simulation for finalizing the configuration, optimizing the parameters, and designing the controller.

Team members then used OPAL-RT's eHS FPGA-based Power Electronics toolbox for real-time simulation of the controller.


At this stage, an actual NI controller was introduced and simulated through HIL testing. In turn, this NI controller underwent rapid control prototyping (RCP) to ensure that it functioned as required. This process was heavily iterative and alternated between simulation types as lessons learned from various stages were integrated into further testing iterations.

Results

OPAL-RT's eHS FPGA-based Power Electronics toolbox—used throughout the course of the development of the units—allowed the engineers to, in their own words:


01

Expedite the development process




02

Lower the development costs



03

Reduce safety risks inherent in developing the systems at high voltage and current



Project organizers believe the EV charging network will reduce emissions by an estimated 0.7 million tons over the first five years of its operation.⁵

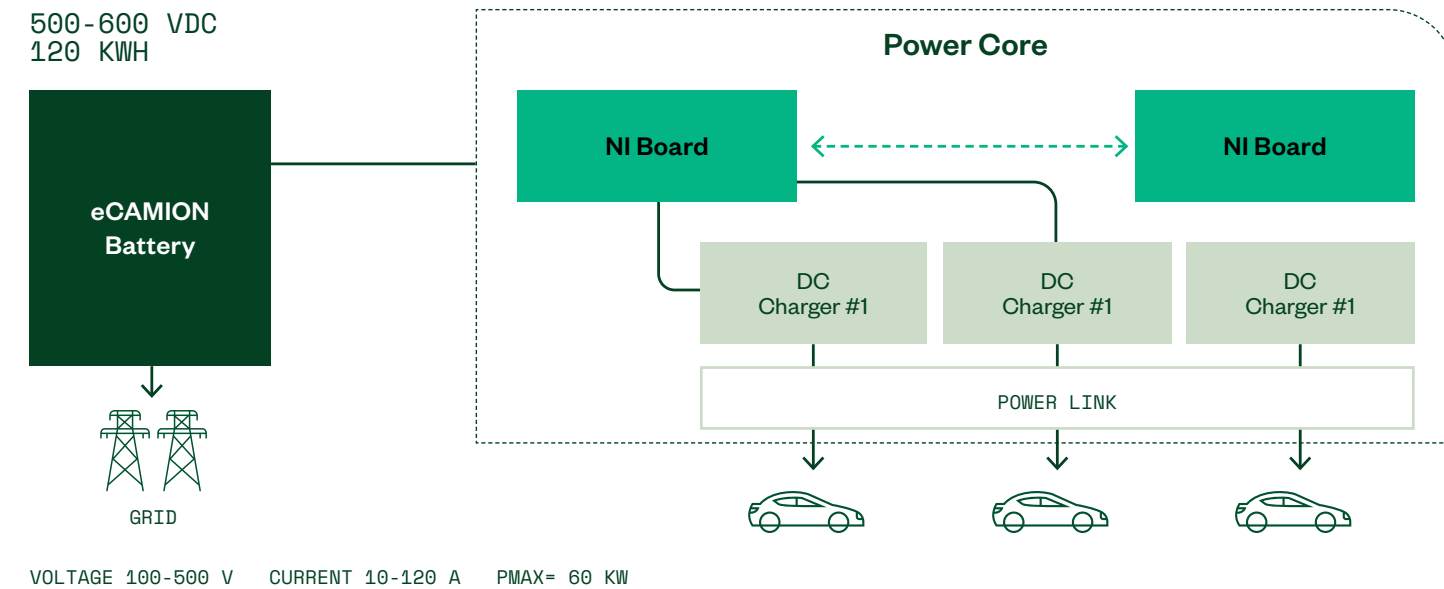


FIGURE 02
Charging Station: Three Charger Units

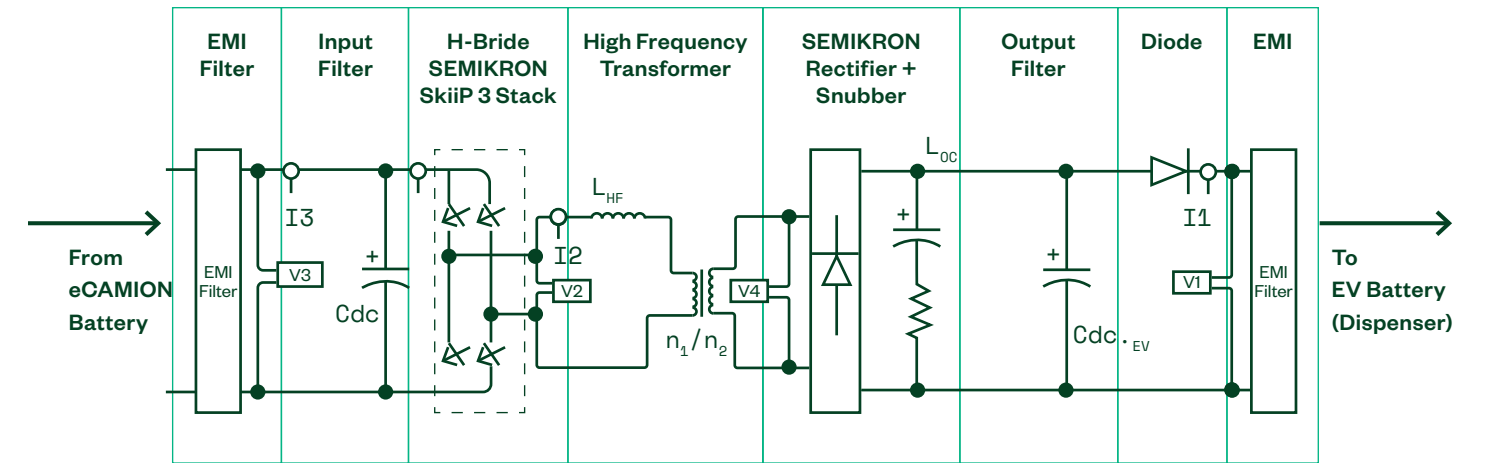


FIGURE 03
Circuit Elements of One Charger Unit (Power Core)


OPAL-RT thus played a central role in one of the most ambitious EV infrastructure projects yet to take place, worldwide, through its eHS FPGA-based Power Electronics toolbox.

The final product was UL and ESA approved. The final converter was developed in less than two years and its final configuration involved:

- An isolated DC-AC-DC converter that enabled serial/parallel configuration at the EV end
- 10 kHz in switching frequency that reduced the size of the output filter and the magnetics
- A phase-shift gating control strategy that provided soft-switching conditions
- Unidirectional power flow from the H-bridge at the front end and diode rectifier at the EV end

¹ [HTTPS://WWW.ROADTRAFFIC-TECHNOLOGY.COM/FEATURES/FEATURE-THE-WORLDS-LONGEST-HIGHWAYS/](https://www.roadtraffic-technology.com/features/feature-the-worlds-longest-highways/)
² [HTTPS://NEWS.ENGINEERING.UTORONTO.CA/REDUCING-RANGE-ANXIETY-ELECTRIC-VEHICLES-SPEEDING-CHARGING-TIME/](https://news.engineering.utoronto.ca/reducing-range-anxiety-electric-vehicles-speeding-charging-time/)
³ [HTTPS://WWW.ECAMION.COM/FAST-CHARGING-STATIONS-FOR-ELECTRIC-VEHICLES-COMING-TO-TRANS-CANADA-HIGHWAY/](https://www.ecamion.com/fast-charging-stations-for-electric-vehicles-coming-to-trans-canada-highway/)
⁴ [HTTP://WWW.MTO.GOV.ON.CA/ENGLISH/VEHICLES/ELECTRIC/CHARGING-ELECTRIC-VEHICLE.SHTML](http://www.mto.gov.on.ca/english/vehicles/electric/charging-electric-vehicle.shtml)
⁵ [HTTPS://WWW.CANADIANMANUFACTURING.COM/MANUFACTURING/ENERGY-STORAGE-FIRMS-BUILDING-EV-CHARGING-NETWORK-ALONG-TRANS-CANADAHIGHWAY-197770/](https://www.canadianmanufacturing.com/manufacturing/energy-storage-firms-building-ev-charging-network-along-trans-canadahighway-197770/)

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Performance is what drives you.

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2022 Event Schedule

ADAS & Autonomous Vehicle Technology Expo San Jose, Ca, USA

SEPT
7-8

Visit us at booth 3026 to learn how we can help you streamline development of ADAS/AD with a unified test architecture designed for interoperability between Replay and HIL in the same system. Discover how to develop faster by leveraging work across design and validation through NI's single toolchain to perform reliable tests at each stage, and future-proof your systems with a flexible solution. **More info.**

AutoSens Brussels, Belgium

SEPT
12-14

AutoSens is the world's leading community for ADAS and autonomous vehicle technology development. Visit us at booth number 1 to learn more about how we can help you solve challenges along the ADAS/AD Workflow in Record, Replay, and HIL. Be on the lookout for our green NI ADAS Logging Car on the show floor! **More info.**

The Battery Show US Novi, MI, USA

SEPT
13-15

Visit us in booth 3100 at The Battery Show where we will be showcasing our battery test solutions for both validation and production. Discover how we can help you increase automation, performance, and enable you to efficiently scale your test to meet the growing demands of EV test. **More info.**

Automotive Testing Expo Novi, MI, USA

OCT
25-27

We will be showcasing our latest innovations in EV and ADAS validation. Don't miss seeing our new Battery Test System 3.0, which enables scalability of EV battery testing through advanced simulation and automation capabilities. Learn about our new partnership with VSI Labs, Konrad Technologies, and Seagate to accelerate ADAS testing on the road and in real-world scenarios. **More Info.**

NI Connect Munich Munich, Germany

NOV
9TH

Save the date and join us at the International Congress Center, where you will be surrounded by fellow engineers and industry leaders who are passionate about accelerating the development of innovative technology that performs flawlessly. **More Info.**



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