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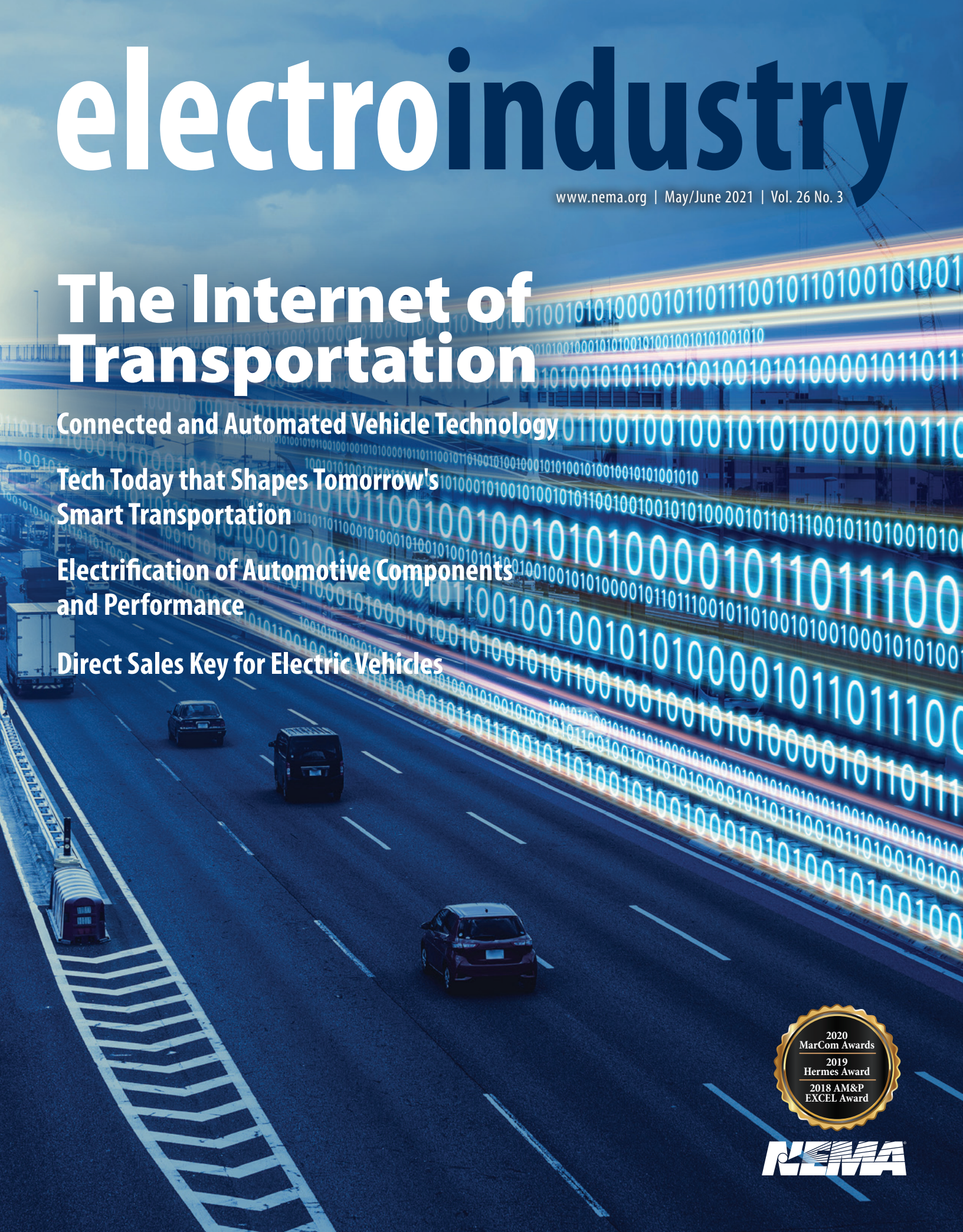

The Internet of Transportation

Connected and Automated Vehicle Technology

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Electrification of Automotive Components and Performance

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Electrified Transportation Is Coming. Is our Industry Ready?

In this transportation-themed issue of *electroindustry,* two of my worlds are colliding: my past life at General Motors and my current life at Schneider Electric. This confluence is a timely one: electrification, infrastructure, and industrial policy are big agenda topics in D.C.

Most analysts recognize that the age of diesel- and gasoline-powered transportation is coming to an end. Three U.S. states, including California, have announced future bans on sales of new internal combustion engine (ICE) vehicles, with more states likely to follow. Major automakers are phasing out internal combustion drivetrains, and companies like my own are transitioning to 100 percent electric fleets. Electric vehicle (EV) sales are expected to overtake ICE vehicles in market share by 2040.[1] The electrification of shipping, rail, and air travel is also taking root.

If electricity is the new oil, so is data. As much as this energy transition is about electrification, it is also about digitalization. Successfully managing large-scale electrified transportation will depend on finding ways to refine data into insights, whether matters like autonomous vehicle AI or fleet charging management software.

Factoring in all the layers of electrified transportation—infrastructure for trucking, shipping, rail, and passenger vehicles—the industry that ties it all together is electrical manufacturing. Our industry will clearly play a pivotal role. But are we ready?

Residential and fleet charging raise questions about the industry's readiness. Charging a single EV draws about the same load as the rest of the home, and charging two EVs would almost certainly require adding new electrical service in most existing U.S. homes. So, what happens when everyone is driving these vehicles? Our industry does not as yet have firm answers for these critical questions:

- When 9-to-5 commuters plug in their EVs around dinner time, how will we make sure the demand spike does not cause a neighborhood brownout?
- How do we prevent or moderate EV fleets from pulling from the grid during peak energy use?
- If a storm brings down portions of the grid, how do we make sure electrified transportation systems continue to function?

Rome was not built in a day, and our infrastructure will not be either. Solving these questions is not a matter of needing more technological know-how. We know what will be essential: decentralized, decarbonized, and digitalized energy management. Renewable energy microgrids are already capable of charging entire EV fleets and thereby easing pressure on the grid.

Where we need progress is on collaboration and coordination throughout the transportation ecosystem. After all, if the system itself is changing, we need a systems-based approach that manages the journey of electricity from the grid to plug. No single company controls this entire system. We need to work together.

That is why I am so excited that this issue focuses on transportation. We will hear about financing ideas for local agencies, the role of 5G, shared Standards for connected vehicle communication, and more. I hope these ideas will help you see beyond your part of the system—the future of our electrified and connected transportation infrastructure depends on it.

Annette Kay Clayton
Chair, NEMA Board of Governors

1 BNEF Electric Vehicle Outlook, 2020

Bryan Mulligan
President, Applied Information

Driving Electric, Connected, and Autonomous Vehicles

With self-driving electric vehicles offering supercharging capabilities and improved efficiency, the future of transportation is nearer than we think. Electric, connected, and autonomous driving is no longer a dream for the future but rather the new standard for road safety, efficiency, and connectivity.

We recently tested the current semi-autonomous vehicle technology capabilities with the self-driving Tesla Model S equipped with Internet of Things (IoT) tracking equipment. In the 912-mile journey from North Atlanta to Daytona Beach and back, a Rattler remote monitoring device gathered data to better understand what it means to drive electric, connected, and autonomous vehicles.

ELECTRIC

Advancements in trip planning, the growing abundance of supercharging stations, and range capabilities improvements have largely solved previous concerns around electric vehicles' charging. Tesla's new charging architecture, V3 Superchargers with liquid-cooled cables, has allowed for charging rates of up to 250kW (620 Amps at 400 Volt) and 950 miles of range per hour of charging. In the test drive, a 40-minute supercharging pit stop boosted the car's battery capacity by approximately 80 percent and increased the available driving range by more than 300 miles. These advances in electric vehicle charging have improved driver confidence in using electric vehicles for long-distance driving.

CONNECTED

Modern vehicles' connectivity charges provide drivers with several amenities, including advanced infotainment systems and navigational tools. More importantly, online connectivity, such as that in the Model S used in this test, delivers a situational overview of available chargers at charging stations nearby, or superchargers during longer journeys. In the latest test, the Tesla Trip Planner feature showed the driver its Super-charging points along the defined route, required charging times to complete the trip, and chargers' availability at each location. Such innovations in connectivity give drivers a clear picture of when to stop for a charge, how long to charge, and if chargers are available all the way to the final destination with sufficient battery charge and no concerns about running out of power.

AUTONOMOUS

Although full vehicle autonomy is still a work in progress, connected vehicle technology advancements continue to improve semi-autonomous vehicles' self-driving capabilities and reduce the need for driver input.

The Tesla Model S was put to the test to determine the current state of autonomous driving and long-distance travel. This assessed autonomous driving capabilities when traveling along highways, which requires the ability to overtake other vehicles and navigate challenges, such as on-ramps, off-ramps, and interchanges.

The Rattler device was installed to track the percentage time, and percentage distance traveled while in Tesla's Autopilot mode. After recording 2,300 data points on the 912-mile trip, the average result showed 91.9 percent of the total driving time, and 98.7 percent of the total distance were driven on Autopilot.

From these results, it is clear that autonomous long-distance driving has reached an impressive level of sophistication, whereas driving on city streets with signalized intersections and turns (the remaining five miles, or percentage of non-autonomous driving time), still needs improvement. Infrastructure involvement and the creation of Standards and data interchange will play a key role in improving autonomous driving outside highway applications. However, our test drive experience suggests that semi-autonomous vehicles' current capabilities greatly reduce driving fatigue during long-distance journeys.

The technology we have readily available to us is very effective under the right conditions and is steadily improving. With more and more vehicle manufacturers releasing electric cars with advanced capabilities available at prices more comparable to gas vehicles, there are fewer reasons to continue driving gas cars.

Connected, safer, more efficient vehicles are a reality. The future is now, and it is electric, connected, and autonomous.

Editor's note: Caryn Vorster contributed to this column.

Mr. Mulligan is the Chair of the NEMA Transportation Management Systems and Associated Control Devices Section and a Member of the NEMA Board of Governors.

NEMA President Announces Retirement

Kevin J. Cosgriff, President and CEO of the National Electrical Manufacturers Association (NEMA), will retire from NEMA at the end of 2021. During his seven years leading NEMA, Mr. Cosgriff strengthened the electrical equipment and medical imaging industries by modernizing NEMA industry Standards processes, expanding market analytical offerings, and overseeing focused and effective advocacy.

"It has been a privilege to serve such an exceptional and nationally important group of Member companies and lead a truly wonderful team," said Cosgriff. "I was fortunate to have an engaged and dedicated Board of Governors, expert company representatives, and a creative and entrepreneurial staff of professionals. I am especially proud of our employees for their energy and willingness to try new things. As NEMA closes in on its hundredth anniversary, the association is poised for an equally bright and electrified second century."

"On behalf of the entire NEMA Board of Governors past and present, I would like to thank Kevin for his outstanding leadership, unwavering commitment to our industries, and many important achievements," said NEMA Board Chair Annette Clayton, President and CEO of Schneider Electric. "His strong leadership will serve us incredibly well for the opportunities ahead, including greater electrification of our society, digitalized and connected devices of all types, and advanced manufacturing informed by data analysis and machine learning."

Mr. Cosgriff's contributions to NEMA follow a distinguished career in the United States Navy. As a Vice Admiral he commanded the U.S. Naval Forces Central Command and the U.S. Fifth Fleet, directing naval forces in the Middle East.

A search for Mr. Cosgriff's successor is being led by Jacqueline Arends of Russell Reynolds Associates. Interested candidates may email Russell Reynolds at NEMACEO@russellreynolds.com.

Carolyn Hull Receives ANSI 2021 Next Generation Award

The Medical Imaging & Technology Alliance (MITA), the leading organization and collective voice of medical imaging and radiopharmaceutical manufacturers, innovators, and product developers, today announced that Carolyn Hull, General Secretary – DICOM in MITA, has been distinguished as the 2020-2021 recipient of the American National Standards Institute (ANSI) Next Generation Award.

The award is given to an individual who has been engaged in standardization or conformity assessment activities for fewer than eight years and who has, during this time, demonstrated vision, leadership, dedication, and significant contributions to her or his chosen field.

"It is with immense pride that we congratulate Carolyn for her well-deserved recognition," said Patrick Hope, Executive Director of MITA. "Through her consistent deep engagement, strong Standards knowledge, and creative vision, she has made important contributions to the standardization system and MITA alike. We look forward to her continued growth and success both now and in the future."

The Next Generation Award is part of the ANSI annual leadership and service awards program. This long-standing tradition recognizes the dedication and hard work of individuals who contribute to and participate in U.S. and global voluntary Standards-setting and conformity assessment activities.

To learn more about ANSI and its annual awards program, click here.

NEMA Rail Electrification Recommendations Address Nevada Governor's Order

The NEMA Rail Electrification Council (REC) has provided recommendations in the recently released 2021 Rail Plan of the Department of Transportation of the State of Nevada (NVSRP), explaining the benefits of electrifying rail transportation and employing railroad right of way for siting electric transmission.

The REC rail electrification ideas reflect steps toward implementing the Nevada Governor's Executive Order, which calls for "support for transportation electrification and demand management, including infrastructure, fleet procurement, alternative funding mechanisms, and other programs." The Federal Railroad Administration mandates state rail plans, but only one other state has ever raised electrification in its plan.

The REC recommended that Nevada begin examining an electrified rail system's economic, operational, and environmental benefits in the plan.

Rail electrification in Nevada can contribute to:

1. enhancing the efficiency of in-state and interstate supply chains
2. fostering job creation via new freight transload facilities, warehousing, and industrial development particularly at mineral extraction sites
3. improving the environment by reducing diesel emissions and promoting investment in renewable energy resources
4. supporting the production and transmission of electricity, particularly renewable energy resources

The Nevada State Rail Plan is being formulated in a transportation and energy environment that is increasingly transformational. The plan lists three specific factors that call for a coordinated planning process among transportation providers, land and energy developers, and utility companies.

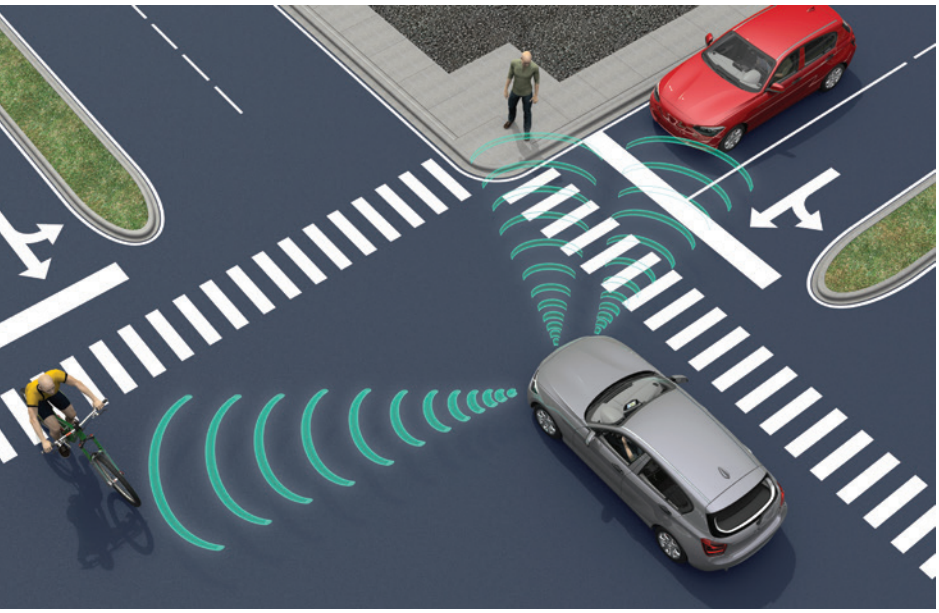
First, freight rail traffic is inherently interstate, which is particularly relevant in the Southwest. Nevada is becoming an industrial, commercial,

and trans-shipment hub for commerce serving surrounding states. Second, Nevada will affect and be affected by national trends such as the rising public policy focus on climate change, public health, air quality, electrical grid integration, and the foreseeable electrification of highway transportation. Third is the advent of new technologies such as industrial-scale batteries, energy storage, distributed electric generation, high-voltage electric transmission facilities, and fuel cells.

The plan also stresses the key issues of government guidance and support for rail electrification, supply chain disruption, interoperability, and cost that will need to be analyzed. It emphasizes that privately owned rail companies should be supported in pursuing electrification as feasible, strategically smart, and in their long-term economic self-interest. The REC looks forward to supporting Connect Rail Nevada as it seeks to improve Nevada's rail transportation, the States commitment to clean energy production, and the state's economic development overall.

By Steve Griffith, Industry Director, NEMA

The Shrinking Spectrum and Its Impacts on Vehicle Safety



Imagine a future where your vehicle could warn you about a slippery road or a pedestrian stepping into the street. Where your car helps you avoid collisions and congestion. Where your car pays your tolls and your parking. Well, the future is near!

To provide these valuable services and others, vehicles must be connected to the moving and stationary parts of the traffic system around them through intelligent transportation systems (ITS). NEMA Members manufacture a variety of ITS equipment and infrastructure, including traffic controllers, signal displays, conflict monitors, dynamic message signs, communications interfaces, software, and firmware modules.

The technology that allows vehicles to communicate with other vehicles, infrastructure, and even pedestrians is known as "vehicle-to-everything" or "V2X" technology. V2X communications systems are used to reduce fatalities, congestion, and environmental impact by conveying important information about inclement weather, nearby accidents, and road conditions, as well as adjusting traffic signals to give emergency vehicles priority in heavy traffic.

V2X communication systems use a short-range wireless signal for transferring information to compatible systems. This signal relies on a specific 75 MHz band of wavelengths in the wireless spectrum at 5.9 GHz known as the "safety band" or the "safety spectrum." The safety spectrum has traditionally been reserved for transportation-related communications among the devices that support connected and automated vehicles.

In a November 2020 decision, however, the U.S. Federal Communications Commission (FCC) reallocated 45 MHz of this spectrum for use by unlicensed devices, thereby cutting the safety spectrum in half. By giving away 45 MHz for Wi-Fi use, only 30 MHz remains for all V2X needs. The numerous V2X applications that rely on the safety spectrum are unlikely to fit in the remaining bandwidths. Affected parties had hoped the FCC would not take this action as the Commission recently made the 6 GHz band available for Wi-Fi and other unlicensed uses, providing extensive additional bandwidth.

This decision has created opposition among industry and government agencies alike. On behalf of its Members, NEMA raised concerns in comments on March 9 and April 26 where we provided information about the extensive research, development, and testing already undertaken in preparation for deployment in this specific band. NEMA also signed on to three V2X Coalition letters in 2020.

While NEMA will continue engaging with its V2X coalition partners to urge the FCC to listen to the safety experts and rethink its decision to reallocate this important safety spectrum, a bigger question for the industry is how to move forward with deployments given the new spectrum allocations.

That is where the new Standard NEMA TS 10 *Connected Vehicle Infrastructure Roadside Equipment*, is relevant. That Standard provides solutions to practical applications such as emergency vehicle signal preemption, pedestrian crossing ahead, and entering school or work zones. These applications will realize the promise of connected vehicles, reducing crashes, and improving traffic.

By Stacy Tatman, Senior Manager, Government Relations and Legal Analysis, NEMA

NEMA Document Addresses Vehicle-to-Infrastructure Communications

NEMA has published a harmonized technical specification that facilitates vehicle-to-infrastructure (V2I) communication regardless of the type of device or underlying technology. NEMA TS 10 *Connected Vehicle Infrastructure-Roadside Equipment*, was developed collaboratively by NEMA Members of the Transportation Management Systems and Associated Control Devices Section along with input from the broader Intelligent Transportation Systems (ITS) industry, State Departments of Transportation, and certification bodies to address the current industry gaps by providing procurement solutions for infrastructure owners and operators specific applications needs such as emergency vehicle signal preemption, pedestrian crossing ahead, and entering school or work zones.

NEMA TS 10 supports standardized over-the-air wireless messaging, applications, and cybersecurity elements with connected vehicles. It also enables agencies to have confidence in procuring infrastructure equipment that remains interoperable and effective as technology advances. It harmonizes communication protocols from the roadside unit to the central system with NTCIP 1218 v01 *Object Definitions for Roadside Units (RSUs)* and establishes the RSU certification process with an emphasis on test and conformity assessment leading to the use of Security Credential Management System (SCMS) certificates. It also allows the coexistence of multiple communication technologies (e.g., dedicated short range communications (DSRC) and cellular vehicle-to-everything (C-V2X). The NEMA Transportation Management System Section is already looking ahead to future work projects related to NEMA TS 10. these include revisions based on the recent Federal Communication Commission (FCC) 5.9 GHz rulemaking, development of implementation guideline, a FAQ webpage and possible walkthrough webinar.

By Kezhen Shen, Program Manager, NEMA

NEMA Welcomes Its Newest Members!

3M

AIQ Solutions, Inc.

Axis Lighting

Caption Health, Inc.

HeartFlow, Inc.

maiData Corporation

MiE America, Inc.

Newell-PSN, LLC

Spectrum Dynamics Medical

New Associate Member, Freeport-McMoRan

Florida Touts Connected and Automated Vehicle Technology Program

Raj Ponnaluri, PhD, P.E., PTOE, PMP, State Connected Vehicles, Arterials, and Managed Lanes Engineer, Florida Department of Transportation

Connected and automated vehicle (CAV) technologies can save lives and provide enhanced mobility services to motorists, vulnerable road users, first responder agencies, and all road users. The Florida Department of Transportation (FDOT) has made significant progress implementing CAV technologies in Florida to improve safety and enhance mobility since the beginning of an initiative in 2016.

The FDOT CAV program has adopted the Department's mission to provide a safe transportation system that ensures the mobility of people and goods and the vision of providing a transportation network that is congestion and fatality free. The CAV program also supports the Department's Vital Few initiatives of improving safety, enhancing mobility, inspiring innovation, and fostering talent.

FDOT has developed the CAV Business Plan (BP)[1] and identified the action items to transition from "Early Implementation Phase" (2019-2020) to "Full-Scale Implementation and Operations Phase" (2020 and beyond).

The BP includes seven priority focus areas:

1. Policies and Governance
2. Program Funding
3. Education and Outreach
4. Industry Outreach and Partnerships
5. Technical Standards and Specifications Development
6. Implementation Readiness
7. Deployment and Implementation

CAV Projects Undertaken by FDOT

FDOT has 29 CAV projects in different phases, including planning, design, or operations.[2] The focus of the projects ranges from the deployment of CAV devices to CAV data management and security systems.

FDOT has implemented Signal Phase and Timing (SPaT) projects in Tallahassee, Gainesville, Pinellas, and Osceola County. The long-term strategy of FDOT is to get all traffic signals on the state highway system CAV-ready.

FDOT is also implementing three of Florida's Regional Advanced Mobility Elements (FRAME) projects along I-75, I-4, and US 41 routes that are focused on integrated corridor management (ICM). FRAME projects include the deployment of roadside units (RSUs), broadcasting SPaT information, ICM systems, transit signal priority, freight, and pedestrian/bicyclist safety applications.

FDOT is exploring ways to leverage smart work zone (SWZ) technologies to improve safety and enhance mobility. FDOT is in the process of developing an SWZ Action Plan for mainstreaming technology deployment at the work zones for enhanced monitoring and operation.

FDOT recognizes that CAV technology will generate a tremendous amount of data, which, if properly used, will allow for quantum leaps in the way transportation systems are managed.

FDOT has conceptualized and is going to acquire a statewide vehicle-to-everything (V2X) data program. The V2X Data Exchange Platform (DEP) is intended to encompass FDOT operational, in development, and planned CAV project corridors. The system includes taking CAV data to make real-time and predictive decisions and assist interested parties in the auto industry, research, traffic engineering, and other areas. The system will enable FDOT to disseminate real-time CAV information to automobile original equipment manufacturers (AOEMs).

Implementing security measures is also vital to ensure the seamless operation of CAV technologies. FDOT is implementing a Security Credential Management System (SCMS) in all CAV projects through a statewide contract. SCMS uses security certificates for signing messages transferred between roadside units and on-board units. SCMS ensures the messages being transferred are not altered and that they originate from and are received by trusted sources. FDOT is also exploring what additional security aspects a CAV project may include and what proactive measures may be needed in the future.

Interagency and Industry Coordination/Collaboration

FDOT is partnering with local agencies to deploy safety- and mobility-focused CAV technologies. The Technology Applications Partnerships for Local Agencies (TAPs-LA) program has been created under FDOT leadership to foster the adoption of CAV technologies.

Under the cutting-edge initiative called Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies (I-STREET), FDOT has been inviting transportation industry leaders to participate and innovate transportation technologies for a variety of use cases.

Testing and Development

Florida is home to SunTrax, a large-scale facility being developed by FDOT and Florida's Turnpike Enterprise, dedicated to the research, development, and testing of emerging technologies in safe and controlled environments. SunTrax facilitates testing of a wide range of applications, including freeway, arterial, and urban scenarios.

FDOT collaborates with universities and research institutes to document CAV project assessments and outcomes. FDOT is keen to document the lessons learned to identify the best practices and updates procedures regularly. FDOT is collaborating on the Federal Highway Administration (FHWA) Cooperative Automation Research Mobility Applications (CARMA) research initiative to leverage its CAV deployments. Automated, Connected, Electric, and Shared (ACES) is also making significant momentum in FDOT with research and development, policy design, and coordination with interested parties.

Technical Specifications for CAV Deployments

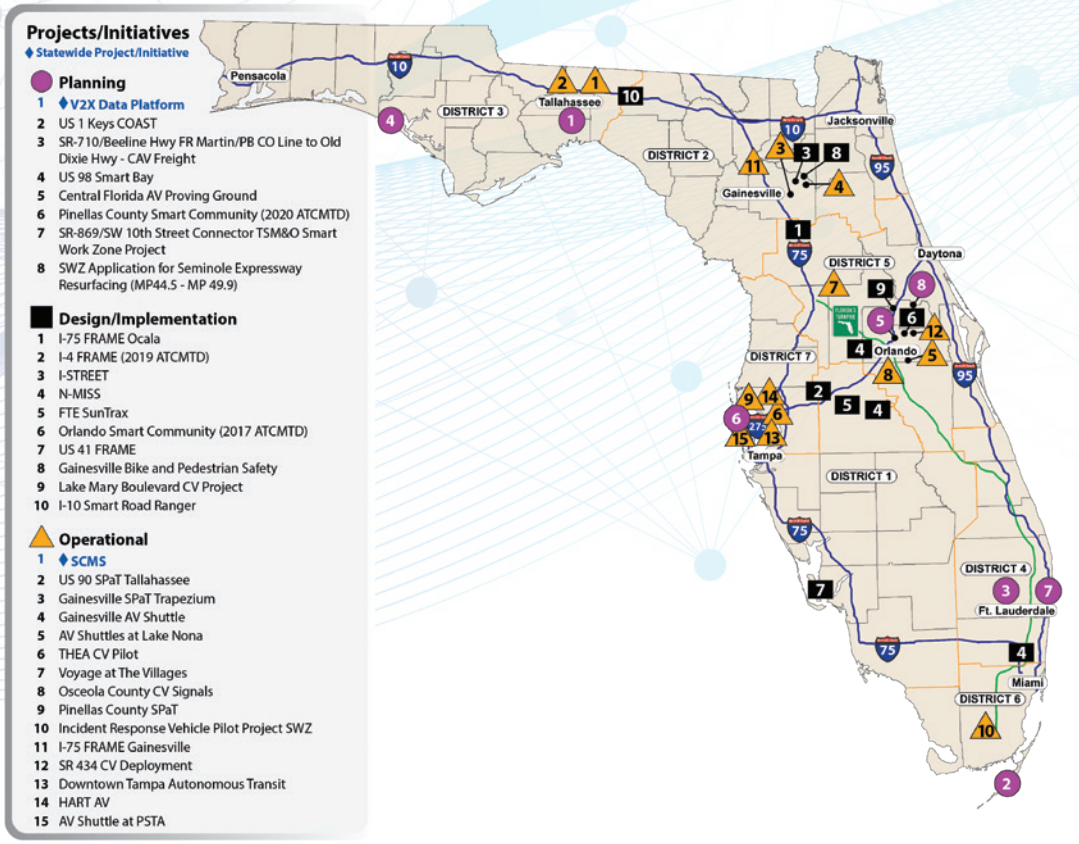
Developing and updating current technical Standards and specifications is one of the focus areas of the FDOT CAV BP. FDOT has developed project-specific technical special provisions and modified special provisions at the early stage of CAV deployments. FDOT has developed a developmental specification[3] in compliance with other national Standards and specifications by the United States Department of Transportation (USDOT), National Electrical Manufacturers Association (NEMA), SAE International, Institute of Electrical and Electronics Engineers (IEEE), Institute of Transportation Engineers (ITE), etc. FDOT is committed to working with local and national agencies to keep its infrastructure updated and interoperable to ensure safety and enhance mobility for the people of Florida.

In addition to leading Florida's connected vehicles, arterial management, and managed lanes programs, Mr. Ponnaluri assists with the development of the Transportation Systems Management & Operations.

1 Florida's Connected and Automated Vehicles (CAV) Business Plan (January 2019)

2 Florida's Connected and Automated Vehicle (CAV) Initiative (Last visited on 2/25/2021)

3 FDOT Developmental Specification Section 681 - https://bit.ly/3mShTkx



Today's Technology Advancements Shape Tomorrow's Smart Transportation

Jim Misener, Senior Director, Product Management and the Global V2X Ecosystem Lead, Qualcomm

Technology advances in cellular communication have ushered in an era of ubiquitous connectivity. Smart transportation is about disseminating information about the transportation network from an underlying network of sensors, infrastructure, and communication devices to build operating solutions and services for an intelligent transport system (ITS). An ITS that is safe, efficient, and inclusive—and that serves the societal needs of modern living—will need to reap the benefits of both the cellular and the transportation network.

The ITS rubric is broad. Solutions that are key to autonomous vehicles are available across the board—from connectivity and telematics to in-vehicle compute. Road owners and users alike benefit from unparalleled tools for personal mobility, safety, and environmentally friendly transportation services, including automated driving.

ITS empowers its users with meaningful information, facilitating a wide range of services from pre-trip planning and en route information, to advanced road safety services and paving the path to enhanced automated driving. While such applications bring obvious benefits to road users, they also provide actionable insight to private entities such as transportation planners working alongside government agencies on optimal operations strategies.

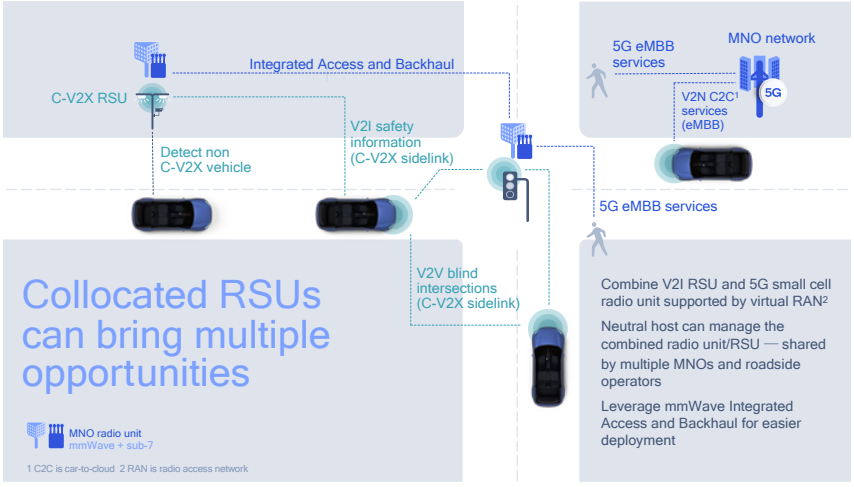
Transportation planners can use the information to project travel demand. The demand information can help to determine optimal deployment of transportation infrastructure, advanced public transit services, and placement of ITS-enabled transportation pricing and demand management systems such as electronic toll collection or variable parking fees.

Planners can also benefit from insights into arterial road usage, traffic conditions, and congestion reports in shaping our neighborhoods and reducing greenhouse gas emissions.

Importantly, according to the World Health Organization,[1] approximately 1.35 million people annually lose their lives in road traffic crashes, and more than half of the deaths are vulnerable road users such as pedestrians, bike riders, and motorcyclists.

In a smart transportation system, we need vehicles to communicate with each other and the road infrastructure reliably. The traffic management center (TMC), which oversees overall traffic control of a city or region, can be hosted in a central cloud that harnesses the information from a wide distribution of edge clouds located throughout the city. Vehicular networks are highly dynamic, so edge servers need to be located closer to the real action, providing local analytics, context, and faster processing.

Thus, vehicle-to-infrastructure communication becomes imperative for a comprehensively integrated ITS, which complements the growing network of connected vehicles exchanging information and significantly improving road safety. Cellular-Vehicle-to-Everything (C-V2X) is a core technology underpinning an evolving smart transportation framework of connected vehicles and road infrastructure. C-V2X, which includes vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I), uses a direct communication mode or sidelink without relying on the cellular network. Vehicle-to-network (V2N) communication, on the other hand, requires participation from the mobile network operators (MNOs) to provide services through the cellular network to vehicles and other vulnerable road users. V2N has been available roughly for over two decades now, supporting various telematics and traffic applications.

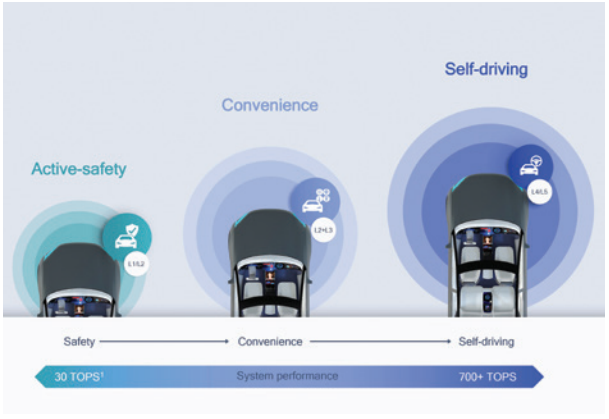


Integrating C-V2X with the V2N can deliver measurable safety and traffic benefits, in addition to significant economic benefits to all stakeholders. By granting roadside access to MNOs, transportation planners and road operators can share the cost of equipping our roads with infrastructure nodes, called roadside units (RSUs).

At the same time, MNOs can benefit from getting roadside access for additional small cell installation to expand their cellular coverage. We believe public-private partnerships can thus go a long way in creating smart transportation solutions that are economically feasible and sustainable. By working closely with several organizations, including multiple departments of transportation (DoT), metropolitan organizations, local agencies, and technology providers, unique solutions around C-V2X are achievable as a first step toward an ITS of the future.

To support an ITS of connected vehicles, roads, and infrastructure, we envision the need for car-to-cloud services to provide efficient application, content, and service management. A comprehensive set of secure services and life cycle management, such as over-the-air software updates, provides added value throughout the stages of a vehicle's life cycle. Such enhancements open up possibilities to a wide range of multi-tiered streaming, location-based, and personalization experiences and services for users.

According to the National Highway Traffic Safety Administration, about 90 percent of motor vehicle crashes can be attributed at least in part to human error. Automotive companies and tier-one OEMs have a real opportunity to lead with autonomous or self-driving vehicles to drastically reduce human-error-led accidents for increased road safety. The systematic approach of building an autonomy stack leverages proven AI capabilities that focus on perception, planning, action, and connectivity for autonomous driving.



The proliferation of smartphones has contributed immensely to the rising expectations of enhanced personal mobility choices. There is a strong connection between personal mobility and economic mobility.

This is where mobility on demand such as bus rapid transit and various other shared ride services can revolutionize transportation systems by maximizing automation opportunities and providing personal mobility services that are safer, affordable, reliable, and available to all.

3GPP Releases 14 and 15 introduced the direct communication mode, or sidelink, delivering latency-sensitive basic safety applications using C-V2X, without relying on the cellular network. As we continue to innovate on 5G NR technologies, Release 16+ sidelink brings several enhancements in the form of higher throughput, lower latency, and enhanced reliability.

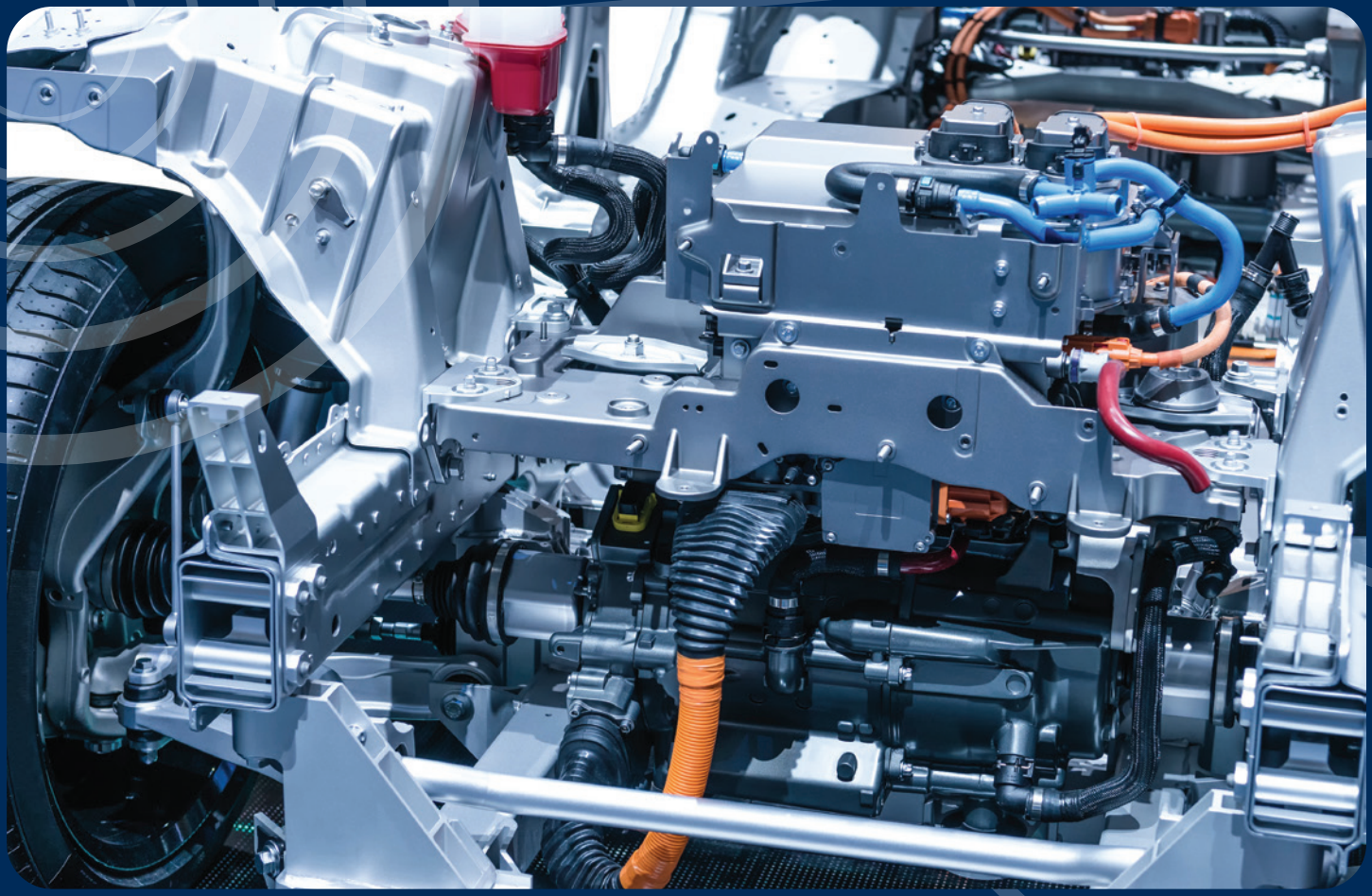
All of these are expected to greatly enhance autonomous driving through perception sharing, path planning, real-time local updates, and coordinated driving. These features facilitate the next generation of ITS solutions for multiple autonomous driving applications such as fleet management systems, advanced driver assistance systems, mobility, and parking services, in addition to greatly reducing emissions for a cleaner environment.

At the heart of our smart transportation vision lies an integrated communication and transportation network that brings several societal benefits. Through our thought leadership, strong 5G roadmap, proven AI capabilities, and a host of other enabling technologies such as advanced positioning, extended reality, multi-mode modem and RFFE, power management, and Wi-Fi/Bluetooth, we are shaping a new era of smart transportation for advanced road safety, enhanced personal mobility, and environmental sustainability.

Mr. Misener was an early pioneer in vehicle-highway automation and vehicle safety communication at the California Partners for Advanced Transit and Highways (PATH) at the University of California, Berkeley.

1 https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries

The Effect of Electrification on Automotive Components and Performance



Eric Hustedt, Chief of Engineering, and Richard Meaux, Chief Marketing Officer, Exro Technologies

As electric vehicles (EVs) gain acceptance, the components within automotive vehicles shift from complicated mechanical assemblies like high gear count transmissions and combustion engines to mechanically simple electric powertrains comprising a battery inverter (dc to ac converter) and an electric motor.

While hybrid systems have been available for a while now, they present a remarkable increase in vehicle complexity and powertrain weight as electric assist was added to the existing combustion engine powertrain.

Electric powertrains come with their own technical challenges, though. Typical combustion engines have a relatively narrow operating speed range than an electric machine and require multi-speed transmissions to match the road speed to the engine speed. For electric, the machines can operate effectively over a much wider speed range, and therefore, in theory at least, don't require gearboxes. That helps reduce system costs and keeps the powertrain components simple. While an electric motor does have a vast speed range, it still has limits. The rotor structure bounds the upper-speed range, and the inverter current limits the peak torque production and, therefore, the cost of the inverter itself. For high-performance cars, where very high maximum speeds are demanded, a two-speed gearbox may still be needed with conventional three-phase drives to reach the desired peak performance.

This speed or torque trade-off is due to the nature of electric machines. The current density in the stator slots (i.e., ampere-turns) produces torque, and voltage produces speed, or more specifically, battery voltage

limits speed. All electric machines, when excited, produce a voltage at their terminals proportional to their rotating speed—which at some point in the speed range reaches the battery voltage—and at that point producing meaningful torque becomes more difficult.

Machine designers are then presented with the choice of selecting appropriate turn count. One can choose to increase turn count, which easily produces large ampere turn numbers from a given inverter current output and produces high torque. However, those same turns that make it easy to produce torque also produce more voltage. This limits the high-speed capability. Alternatively, a machine with fewer turns will spin to high speeds but require a large phase current to produce torque. This trade-off invariably requires a compromise in some aspects of performance. Like high-performance vehicles or heavy-duty vehicles, some EV applications still require multi-speed gearboxes or increased motor size and quantity to reach desired performance, which inevitably adds to the vehicle's cost and weight.

For example, an electric vehicle in Germany is expected to feel peppy in the city. Still, it must also be able to cruise at above 200 KPH on the autobahn, challenging to achieve without two-speed gearboxes. Another example would be a heavily laden commercial vehicle must have the torque to overcome friction to get moving, yet still drive efficiently at highway speeds. This electric vehicle today is likely fitted with two or even three gearboxes to maintain that performance.

The shift to pure electric powertrains presents another challenge to traditional automotive industries, as the skillset requirement is different. For example, manufacturing and servicing an electric vehicle with battery voltages in the 300-750V range requires awareness in high-voltage safety and training more aligned with an electrical technician than what might be taught to mechanics.

From an automotive production standpoint, some traditional mechanical parts will continue to be required. Wheels still need wheel bearings, steering linkages still need to connect the steering unit to the front wheels, and suspensions must still absorb road imperfections. However, many precision mechanical components will disappear, primarily the combustion engine and its complex gearboxes. Even differentials may not be needed anymore to some extent, with innovations like dual motor e-axles. This presents a significant shift in automotive design and manufacturing skill set from precise mechanical part manufacturing to complex electronics manufacturing.

As electric vehicle powertrain technology improves enough to remove the additional mechanical components, like the gearboxes and additional motors, and still enhance traditional performance, then the mass adoption of electric vehicles will accelerate the conventional automotive industry's shift. Auto manufacturers will standardize hiring or outsourcing new skill sets more aligned with electrified components, and tier-one suppliers of electric powertrains may become more vertically integrated within their production.

The automotive industry's electrification will drastically simplify the manufactured components required for producing standard electric vehicles while also being able to improve on traditional vehicle performance across the speed range.

The NEMA Automotive Component Council was formed to address product regulations, component qualification programs, and Standards gaps in an automotive market that is becoming increasingly electrified.

More information about the Council can be found at www.nema.org/directory/nema-councils/automotive-components-council ei

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Mr. Hustedt has more than 20 years of experience leading innovations in all facets of automotive power electronics.

Mr. Meaux has had diverse experiences in the power conversion industry, beginning his career with GE as part of the Commercial Leadership Program.

Why Plugging into Direct Sales is Key for Electric Vehicles

James Chen
Vice President of Public Policy and Chief Regulatory Counsel, Rivian

James "Jim" Chen brings nearly 30 years of experience to Rivian in the areas of policy, law, and regulation for the automotive industry.

A debate is unfolding nationwide over whether new automobile manufacturers should have the freedom to sell their vehicles directly to customers or be required to operate through third-party franchise dealers. This contention is actually about something very simple that exists in every part of the economy—a direct relationship between a manufacturer and a customer—but it has become a flashpoint with massive implications for the American auto industry's future global competitiveness.

Rivian and Tesla, Lordstown, Lucid, and other EV-dedicated manufacturers want the freedom to use the direct sales system to improve the customer experience and streamline operations. A broad coalition of free-market advocates, consumer interest groups, environmental advocates, and other experts are united in seeing why direct sales are important and will have far more benefits than downsides. But franchise dealers at the state and national level oppose any alternative method for buying new cars. Here, we explain some of the histories of dealer protection laws and why direct sales are so essential for a more robust American auto market.

WHY DOES THIS RESTRICTION EXIST IN THE FIRST PLACE?

The dealer-franchise sales model emerged in the early 1900s to enable early automakers to focus on production, while dealerships managed distribution. Laws protecting dealers were established mid-century to prevent opportunistic behavior from their own franchising manufacturers.

While dealer protections may have served an important purpose in the 20th Century, dealer associations have pushed for those protections to be cemented and expanded to companies that never entered the franchise system at all. For this reason, Tesla has a specific settlement in 9 states (including Georgia, Washington, and New York) to use direct sales, but other new manufacturers are blocked from doing the same.

In 21 states including California, Massachusetts, Illinois, and Florida, new EV companies are eligible to apply for and receive a dealer license to conduct sales of as a regulated dealer. This gives consumers full access to their products by enabling manufacturers to invest in the state, establish a retail location, hire local workers, and introduce their products to motorists.

Whether a state is open or closed to direct sales, the vehicle can still be purchased online and delivered to the customer. But in closed states, customers are faced with unnecessary inconveniences like increased paperwork and having to travel outside the state to pick up their vehicle. We know that the best way to sell electric vehicles is to get drivers behind the wheel: Direct sales allows customers to interact with the vehicle, go for test drives, speak to a product specialist, and ask questions about the car and ownership experience.

WHY DIRECT SALES MATTER FOR EVS

In 2020, 80 percent of electric vehicles sold were through direct sales, while a simple calculation of EVs sold per manufacturer divided by number of dealers shows that the average franchise dealership in the United States only sold 5-10 EVs. There are several reasons why EV manufacturers need direct sales to grow and scale.

- **Franchise Dealerships are Reluctant to Sell EVs**: A study by the Sierra Club found that 74 percent of auto dealerships nationwide do not have a single EV on their lot for sale. The study found that even at dealerships where EVs were available, consumers were still not being given important information about charging, battery range, and financial incentives impacting their purchase.

- **EVs Cut Service Revenue for Dealerships**: Traditional franchise dealerships earn an estimated 40% of their gross profits from servicing gas-powered vehicles. With only 10% of the moving parts and no need for petrochemical lubricants, EVs do not require the same level of service, making the franchise dealership model untenable in its current form for the electric future. By contrast, EV companies do not use servicing as a profit center.
- **Competition and Innovation**: Direct sales creates a better marketplace for consumers. A study by Cox Automotive shows that only 1 in 3 customers is satisfied with the franchise dealer sales model, and 7 in 10 would prefer a "brand experience center" where they can learn about the vehicle without being in a high-pressure sales environment. The dealer business model depends on high volume and rapid turnover—direct sales allows companies to offer customers a different, no-pressure experience and evolve.

THE BIGGER PICTURE

The companies leveraging a direct sales model—Tesla, Rivian, Lordstown, Lucid, and others—are American companies creating tens of thousands of domestic manufacturing and engineering jobs. They are all-in on EVs from the start, while larger automakers are still balancing a transition away from internal combustion vehicles. The United States has always been a proud leader of the automotive industry, but these outdated distribution laws must change to maintain global competitiveness.

Franchise dealerships oppose allowing a new sales model to break their monopoly on new vehicle sales, but just because a product has been sold a certain way for a long time doesn't mean it should be the only option forever. Significantly, allowing direct sales doesn't interfere with their existing contracts with traditional automakers, and they can continue doing business as usual. In fact, in the years since Tesla entered the market—from 2012 to 2019—total dealership sales grew by 52 percent nationwide, and employment grew by 18 percent, according to data from the NADA. Direct sales states outperformed closed states by both metrics.

Electric vehicles are one of the most exciting growth opportunities for the electrical manufacturing industry—beyond the vehicles themselves, this shift is giving rise to a proliferation of charging opportunities at home, work, and in public. The growing EV-ecosystem is also accelerating development of battery storage solutions and other vehicle-to-grid or vehicle-to-home integrations that will allow further research, development, and innovation. Direct sales are one of the most powerful policy levers to accelerate EV deployment at no cost to the taxpayer or downsides to implementation—it simply allows access so that electric vehicles can thrive.

SPOTLIGHT

I Am the Electroindustry

In our everyday lives, it is easy to assume that everything around us is perfectly safe. We assume that the charger for our phone won't catch on fire. We assume that wiring in our house is sufficient to power whatever we plug into it. We assume that the green light we see means it is safe to proceed through the intersection.

It takes a lot of work for these assumptions to hold true, and the NEMA commitment to publishing and improving the Standards in many diverse fields is critical to this.

As Director of Engineering for Eberle Design Inc., a manufacturer of intelligent and safety centric traffic equipment, I am committed to continuing to innovate within our industry to adapt to an ever-changing world. Whether this is through improvements to the conflict monitors and detectors used in the intersection today or through development of new Edge computing devices and roadside units, EDI is ready to develop and deliver reliable, safe, and resilient products.

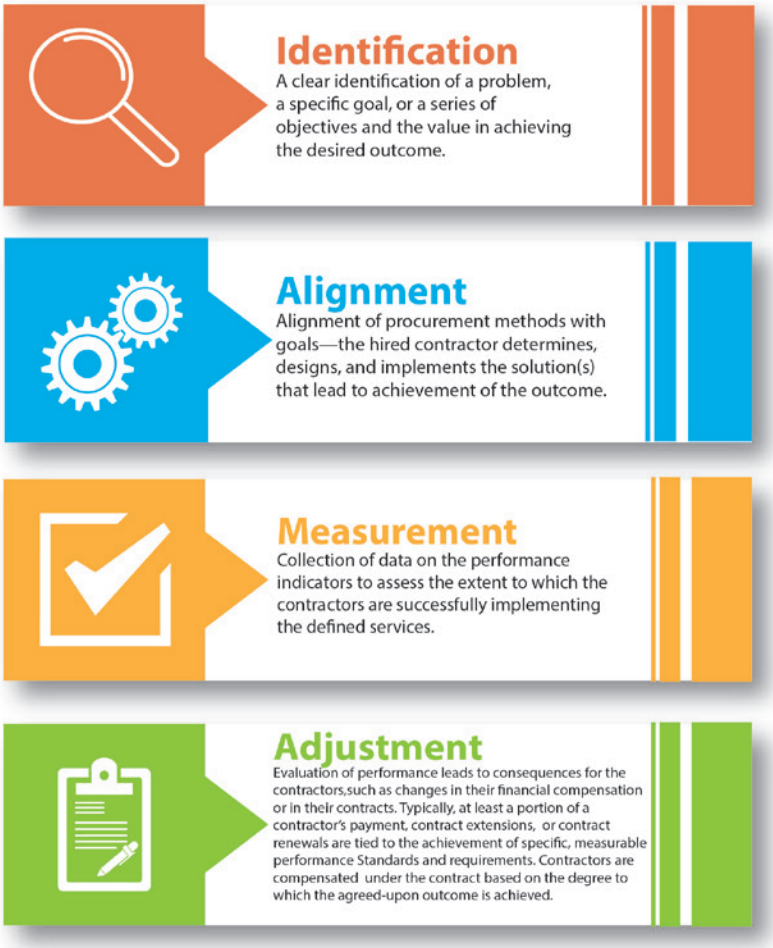
With our recent acquisition by PPG, EDI hopes to advocate for the expansion and unification of Standards on a global stage, leading to safer, more reliable products for everyone.

Ethan Coxsey, Director of Engineering, Eberle Design

Administration Moves Toward Outcomes-Based Contracting

Stacy Tatman
Senior Manager, Government Relations and Legal Analysis, NEMA

The Federal government spends $600 billion annually on contracting goods and services.[1] With the issuance of Executive Order (EO) 14005, "*Ensuring the Future Is Made in All of America by All of America's Workers*," [2] President Biden seeks to ensure that "the Federal government is investing taxpayer dollars in American businesses—both small and large." In the Administration's effort to support the manufacturing capabilities and technology needed "to build a clean energy future and strengthen our national security," [3] the EO mandates that the Federal Acquisition Regulatory Council (Council) "shall consider proposing for notice and public comment amendments to the applicable provisions in the Federal Acquisition Regulation (FAR), title 48, Code of Federal Regulations."[4]



The EO directs that the Council's proposal would require FAR to identify domestic end products where domestic content is "measured by the value that is added to the product through U.S.-based production or U.S. job-supporting economic activity…"[5] The proposal would also include an increase in the "price preferences for domestic end products and domestic construction materials." [6]

This shift in focus from emphasizing value over price considerations marks a clear move toward outcomes-based contracting. The purpose of an outcome-based contract (OBC) is to obtain better value, better performance, and lower costs. Because OBC ties compensation to a contractor's ability to meet, or exceed, defined program outcomes in a meaningful and measurable way, it incentives the contractors to devise the most effective and efficient way to perform the work for which they are hired.

NEMA has promoted OBC and recently published an issue paper on the subject.[7] OBC is a form of contracting comprised of four discrete characteristics: identification, alignment, measurement, and adjustment:[8,9]

NEMA has specifically supported this concept in connection with transportation issues. Today's roadway infrastructure has evolved from traditional concrete and asphalt foundations to complex systems that utilize sophisticated communication and information technologies applied throughout the entire transportation system. To address these complex roadway infrastructure needs, OBC is quickly becoming the standard for best practice.

1 https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/25/president-biden-to-sign-executive-order-strengthening-buy-american-provisions-ensuring-future-of-america-is-made-in-america-by-all-of-americas-workers/.
2 https://www.federalregister.gov/documents/2021/01/28/2021-02038/ensuring-the-future-is-made-in-all-of-america-by-all-of-americas-workers.
3 https://www.whitehouse.gov/briefing-room/statements-releases/2021/01/25/president-biden-to-sign-executive-order-strengthening-buy-american-provisions-ensuring-future-of-america-is-made-in-america-by-all-of-americas-workers/.
4 https://www.federalregister.gov/documents/2021/01/28/2021-02038/ensuring-the-future-is-made-in-all-of-america-by-all-of-americas-workers.
5 *Id.*
6 *Id.*
7 https://www.nema.org/docs/default-source/nema-documents-libraries/whitepaper-on-outcomes-based-contracting.pdf?sfvrsn=f3ad2716_2.
8 https://pwc.blogs.com/deals/2015/08/outcome-based-contracts.html.
9 https://hwpi.harvard.edu/files/govlabs/files/results_driven_contracting_overview.pdf.

Bryan P. Holland, MCP, CStd.
Senior Field Representative, Southern Region, NEMA

EV-Ready Opportunities and Challenges

In a 1917 interview, Thomas A. Edison said:

> *"The growth of the electric vehicle has been hindered by lack of charging facilities. It's a funny business when so few central stations realize that there is a market for the sale of current for charging electric cars. The public is in a curious position of wanting to buy something for which there is no place to go."*

A century later, the public remains in this same curious position of wanting to charge electric vehicles (EVs) at home and work or when using parking lots and garages; however, the availability of electrical vehicle supply (EVSE) or EV-ready infrastructure has yet to become a standard amenity in most U.S. communities. While several industries, like airports and hotels, have seen the value in providing charging for customers, there is little consistency in the quantity, capacity, ratings, arrangements, and availability of EVSE at these locations. And while a scattering of communities have implemented model EV-ready ordinances to provide charging at public venues and in business districts, the technical requirements for the selection, installation, and use of EVSE has not found a place in model Codes and Standards.

An effort was made during the 2019 International Code Council (ICC) Group B Code Development Cycle to add mandatory EV-ready provisions to the International Energy Conservation Code (IECC) by a coalition made up of many interested parties. Along with other industry advocates, NEMA supported this effort at the ICC Committee Action Hearings.

Ultimately, the residential and commercial EV-ready provisions of the IECC were rescinded by an Appeals Committee that determined EV-ready requirements are not within the scope of the IECC, despite overwhelming industry disagreement with that assessment.

Still, there is some light at the end of the tunnel. In late 2020, ICC assembled an exploratory group to begin a dialogue on what opportunities and challenges exist in the marketplace for community electrification and EV-ready infrastructure. In March 2021, ICC announced the formation of an Energy and Carbon Advisory Council charged with the development and dissemination of coordinated and comprehensive strategies that will help communities address their energy-efficiency and climate mitigation goals in the coming years and decades.

Ann Brandstadter
Manager, Standards Publications and Marketing, NEMA

Standard for Digital Imaging and Security Now Available

Digital Imaging and Communications in Security Information Object Definitions (IODs) provides a data interchange protocol and interoperable, extensible file format to facilitate data information interchange (e.g., demographic information, x-ray radiographs, CT images, material-specific information, trace detection signatures, threat assessment) of objects of inspection (e.g., checked luggage, carry-on luggage, parcels, personnel, etc.) for security screening applications.

NEMA IIC 1 v02A-2020 is available on the NEMA Standards Store for $309.

Other recently published Standards:

Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers Rated Not More Than 600 V NEMA ICS 2.3-2019 is available for $100.

Power Quality Monitors: From a Transient Perspective NEMA VSP P3-2020 is available for $45.

American National Standard for Indoor AC High Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear—Conformance Test Procedures ANSI C37.54-2002 (R2010, R2020) is available for $129.

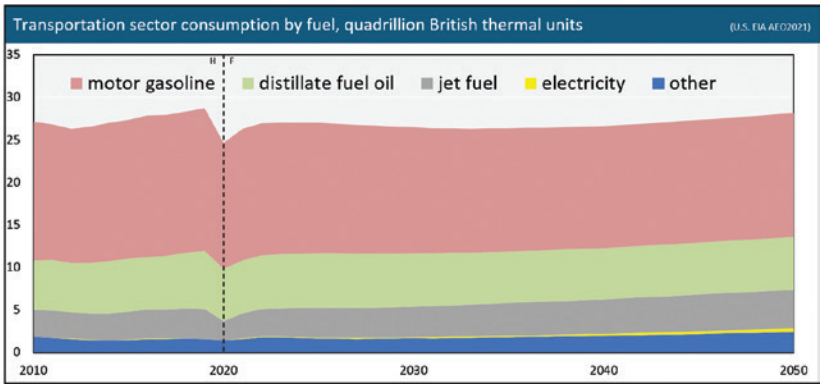
Electricity Demand in Transportation Lags Despite Changes in Public and Corporate Policies

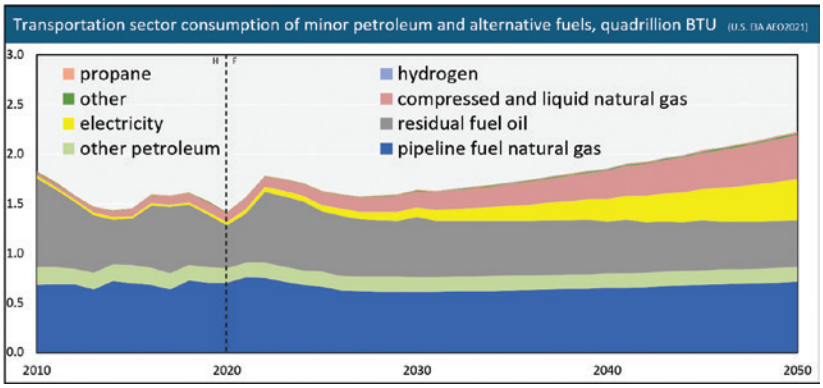
Fred Ashton
Senior Economist, NEMA

From passenger vehicles to commercial fleets to rail, the transportation sector is thought to have the most significant potential for increased electricity demand, according to the Annual Energy Outlook 2021 from the U.S. Energy Information Administration.[1] The prospect of transportation electrification has prompted state and local governments to adjust regulations, and corporations to reconfigure product lines and invest in the necessary infrastructure to promote electric vehicles' adoption.

In September 2020, California grabbed headlines when Governor Gavin Newsom signed an executive order banning the sale of new combustion-engine vehicles by 2035. Similar plans followed this first-in-the-nation policy in New Jersey and Massachusetts. Internationally, the U.K. plans to stop the sale of gas- and diesel-powered cars and vans by 2030.

After seeing changes in policy and consumer demand, several traditional motor vehicle manufacturers recently committed to phasing out internal combustion engines in favor of electric vehicles (EVs).





- GM announced that their light-duty vehicles will be fully electric by 2035, and they plan to release 30 EV models by 2025.
- Volvo will sell only EVs and hybrids by 2025.
- Bentley plans to manufacture only EVs by 2030.

The EIA forecasts electricity as a percent of transportation sector fuel consumption will grow glacially from 0.1 percent in 2020 to nearly 1.5 percent by 2050. As a percentage of total electricity consumption in the economy, transportation will account for just under 3 percent by 2050. According to the projections, among alternative fuel sources, electricity is expected to be one of the fastest-growing through mid-century.

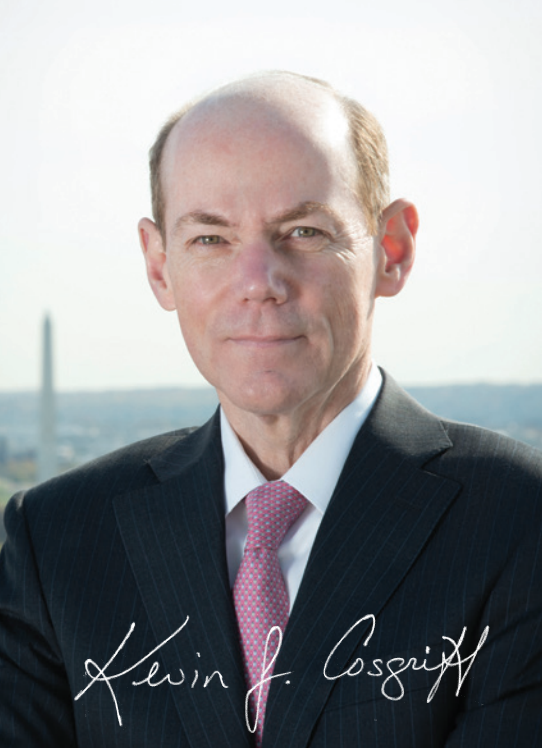
The underwhelming uptick of electricity in the transportation sector seems counterintuitive to the policy and manufacturing changes expected over the next 20 years. The EIA notes that "current laws and regulations are not projected to induce much market growth." They add that "both vehicle sales and utilization (miles driven) would need to increase substantially for EVs to raise electric power demand." The EIA acknowledges that its estimates are based on current law and provides alternative scenarios based on economic growth rate assumptions, not hypothetical policy changes. Increased incentives to purchase EVs and tighter tailpipe emissions regulation could speed transportation electrification. According to a study by Boston Consulting Group, continued technology-driven declines in battery costs will likely propel EV demand by the end of the decade.[2]

According to *The New York Times*,[3] fewer than 1 percent of vehicles on the road are electric. By 2035, that number is expected to increase to 13 percent. Even by 2050, when the *Times* predicts EVs will make up 60 percent of sales, most vehicles on the road will still use gasoline as a fuel source. Despite increased investment in charging infrastructure and improved EV technology, the shift to electric and alternative fuel sources will take decades.

1 https://www.eia.gov/outlooks/aeo/

2 https://www.bcg.com/en-us/publications/2020/drive-electric-cars-to-the-tipping-point

3 https://www.nytimes.com/interactive/2021/03/10/climate/electric-vehicle-fleet-turnover.html#:~:text=Vehicles%20on%20the%20road%20in%202021&text=Fewer%20than%201%20percent%20are,the%20road%20would%20be%20electric.



Turning Data into Insights for First Responders

Today's digital technologies and systems generate, process, transmit, analyze, and display tremendous amounts of data, turning information into meaningful insights and actions. NEMA Members' connected products are guiding users' decision-making, improving efficiency, speed, and accuracy—something especially important for first responders.

When a 911 call comes to a command center, first responders need to quickly assess the situation, get to the location, and adapt to on-site conditions to save lives. They are aided in this by two types of systems manufactured by Members of the NEMA Transportation and Building Systems Divisions: connected vehicle roadside equipment, and cloud-based fire and life safety systems.

The recently published NEMA TS 10 Standard, *Connected Vehicle Infrastructure Roadside Equipment,* focuses on specific applications for how vehicles interact with roadside infrastructure. For example, emergency vehicle signal preemption allows first responder vehicles to request signal preemption through equipped intersections to get to a destination sooner. Preemption is already happening in Alpharetta, Georgia, where officials are installing systems in traffic cabinets that can sense emergency vehicles and change signals to allow them to pass quickly at 100 of the city's 129 signalized intersections. The triggering devices are installed on all fire service vehicles and others in Alpharetta's Department of Public Safety hierarchy.

During the recent NEMA Fire, Life Safety, and Emerging Technology Forum, Members and guests discussed cloud-based life system data for first responders. Building systems such as fire, heating, ventilation, and air conditioning, lighting, and security all provide data today, albeit siloed within a particular building. A cloud-based system could identify the type of emergency (e.g., fire, carbon monoxide, gas leak, etc.) as well as valuable secondary information related to occupant data (e.g., how many people are in the building, where they are located, what is their current direction of travel in relation to the event). This system could be tailored to respond based on whether the building is industrial, retail, or apartments and provide additional verification of the event before personnel are dispatched. Having that information handy would prevent resources being wasted on a false alarm from a common event, such as humidity from a hotel shower tripping an emergency sensor. Having this data updated in real-time would allow the incident commander to share the data via multiple devices such as tablets and cell phones and give on-site personnel the ability to make instantaneous informed decisions without going back to the command center.

While there are obstacles to this vision of a connected future, they can be overcome, and our Members will play a vital role in that. The next issue of *electroindustry*, which will focus on redesigning or repurposing buildings for the future, will explore those options and discuss how building systems are adapting to the times using data and technology.

Coming Next

July/August
Building Systems Redesigning and Repurposing Buildings for the Future
September/October
Industrial Products & Systems What Will the Global Economy Look Like in 2025?
November/December
Building Infrastructure Backbone of Our Connected Future

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