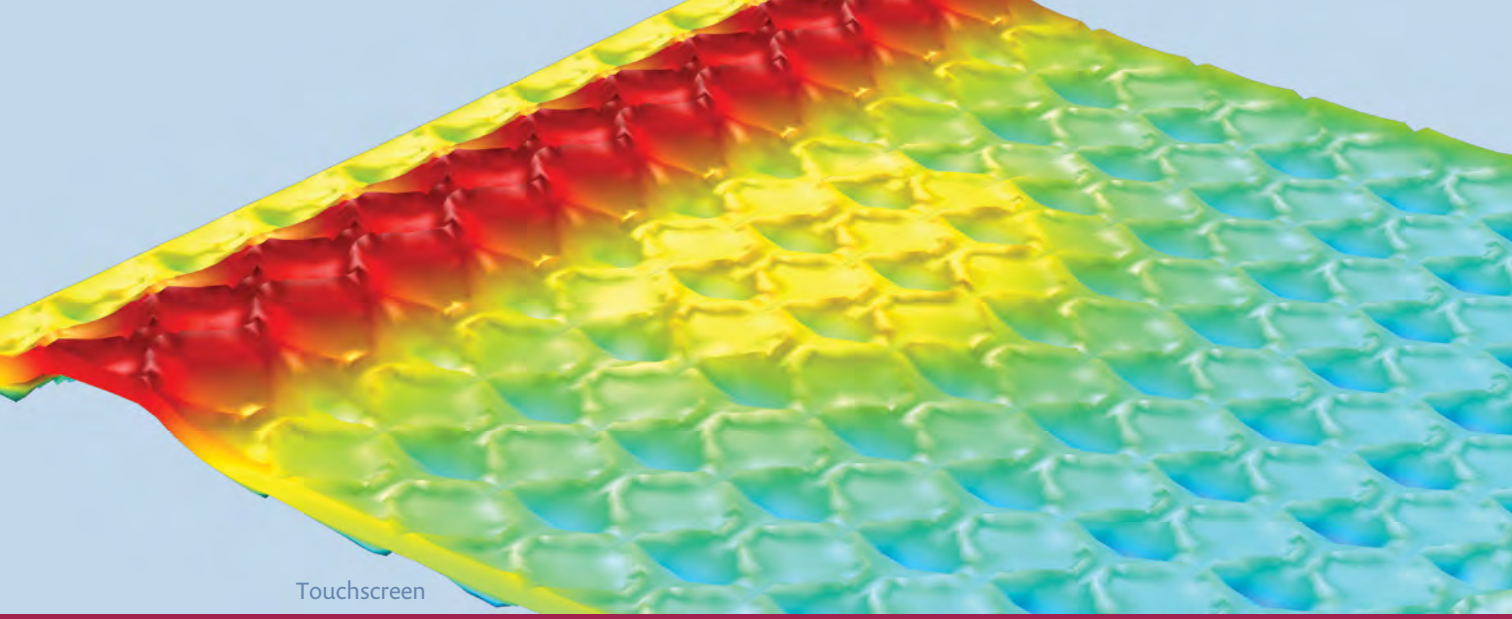

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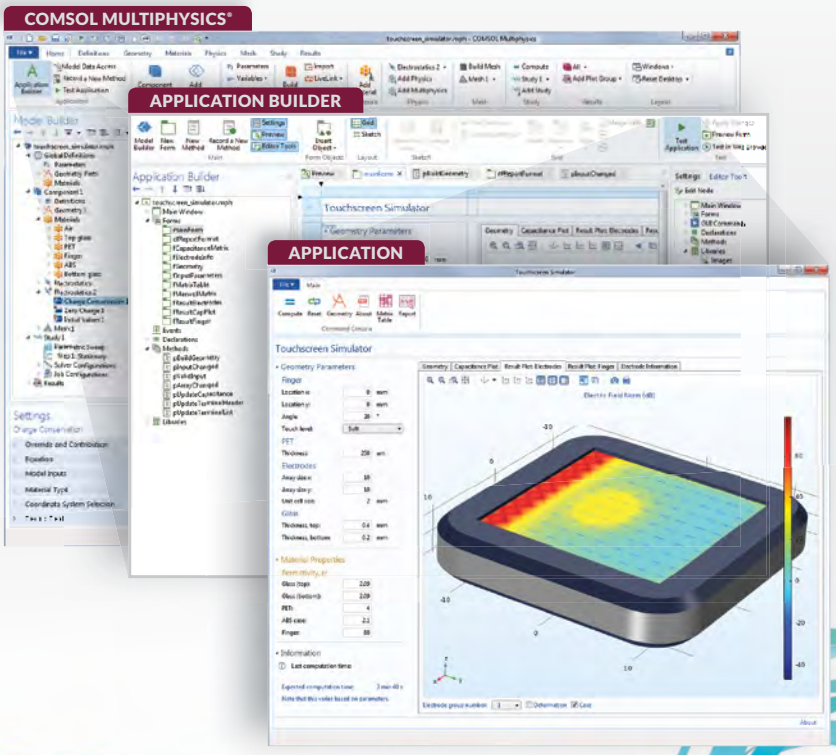

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EDITORIAL

Vital Transformation

Almost lost in discussions about autonomous-driving technology are the "other" road users and how they fit into the driverless, robotic-vehicle future.

If you're like me, you have personal mobility options depending on weather, termperature, length of destination and the cargo requirements of any given journey. The car is my primary mode. But I can also roll out my motorcycle or my bicycle. And I can walk—also known as "pedestrian mode" when viewed from the seats of the other mobility devices.

Unfortunately, only one of those mobility modes offers me, the driver/occupant, the safety that comes with advanced driver-assistance systems. If I'm biking or walking across a street, I'm often a vulnerable target for distracted drivers. In fact, motorcyclists, cyclists and pedestrians comprise about 50% of the annual 1.25 million deaths caused by traffic accidents worldwide, according to the **World Health Organization**.

With X2Safe, ZF TRW proves it is an innovative software player.

If I'm lucky, my optical or radar signature will be picked up by the vehicle's ADAS. It will alert the driver, or engage automatic braking/steering action to prevent me from getting squashed. But my safety improves significantly if we both "see" each other in enough time for both of us to take action and avoid any impact. To that end, I recently watched ZF TRW engineers demonstrate its new "intelligent algorithm," X2Safe, that convinced me a safer future for bikers, cyclists and pedestrians is here.

The system enables all road users, including pedestrians, to communicate with one another using smart phones, smart watches, in-vehicle V2V and V2X systems—or even smart helmets for bikers. X2Safe users serve as sensor points, continuously submitting movement data to the cloud. The algorithm then processes that data to determine whether there is a risk of collision with a vehicle or other road users.

If such situations occur, a collision warning is triggered both in the vehicle and on the smartphone, watch, etc., of the other road user before they have seen each other—or before the car's ADAS sensor array and processor have recognized the danger.

The power of X2Safe lies in its ability to individually analyze the behavior of all road users in terms of possible danger and react accordingly. If a pedestrian does not wait at a red light or crosses the road at a place invisible to drivers, the algorithm deems this behavior particularly "unsafe" and assigns a higher individual risk.

There's power, too, in the system's ability to apply context to evaluate the situation. ZF TRW's algorithm processes not only road-user information but also that of danger zones, such as tricky roads or hidden bus stops.

Perhaps more remarkable than X2Safe's capability to reduce car-to-bike and car-to-pedestrian collisions is that it was invented and developed by **ZF**—famous for transmission engineering and manufacturing. The 101-year-old maker of Zeppelin gearboxes and master of milling, broaching and hobbing now, with TRW in the fold, is increasingly focused on game-changing algorithms and cloud-based technologies.

"Our company is in the process of transforming itself for the digital world," Malgorzata Wiklinska, head of ZF TRW's advanced research group, told me at the demonstration in California. It was her computer-science team that created X2Safe and is developing it into a potentially lucrative new product with widespread implications.

Such transformations are vital for creating increasingly connected and safe mobility solutions—for drivers, riders and walkers alike.

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SUPPLIER EYE

The impact of shifting to the 'softer' side

Welcome to Supplier Eye, *a new monthly column that explores the changes facing our industry and analyzes the impact—of new technologies, regulations, business dynamics and consumer desires—on the OEM-supplier ecosystem. IHS Markit Managing Director Michael Robinet guides readers through the increasingly complex mobility maze with his nearly 30 years' experience as a top analyst, backed by his company's industry-leading market intelligence.*

When new technologies sweep across an industry, suppliers inevitably face new risks and challenges. And so it is with vehicle electrification, connectivity and automated/autonomous driving systems—three interrelated trends that are already changing vehicle design, engineering and manufacturing.

The steady evolution of cars, trucks, buses and virtually anything with wheels into 'mobility systems'—ultimately battery powered, their energy replenished with a charging cord and capable of driving, navigating and parking without human input—will continue to force changes throughout the supply chain.

For those enterprises not yet so accustomed, the climbing rate of sophisticated electronic content and the management thereof is adding significant complexity into their world. Advanced driver assistance systems (ADAS) are forcing a re-think of driver and occupant information displays. Will self-driving vehicles need gauge clusters and center stacks, let alone buttons and dials? Why have a cabin heater when temperature-sensing seat fabric is more effective? Much of the interior and its human-machine interface will be transformed.

Powertrains have become 'propulsion systems' that require some added degree of electric power or assist in order to comply with stringent emissions rules for the next decade. Even the electrification of suspension dampers is as much for optimizing vehicle aerodynamics (and potentially, energy recuperation) as it is for providing occupant comfort and sharp driving dynamics.

Indeed, virtually every major vehicle system is electronically governed or integrates a form of mechatronics. This is driving many to seek new partnerships or acquisitions in these areas while a larger chunk of the core technology ER&D shifts to the supplier domain, particularly the Tier 1s who are engaging with startup innovators. While this shift is solidly entrenched, it wasn't always this way.

Michael Robinet
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"Suppliers must examine their role as vehicle electronic content increases."

In the late 1990s, implementation of 42/14-volt electrical systems was slated to spread across the industry. Talk about technology disruption: Wiring, switches, connectors, motors and lighting were all expected to undergo a quantum change to enable the new dual-voltage power net.

Several reasons were behind this impending revolution to unseat the 12-volt incumbent—mainly the lack of alternator efficiency and ever-more voltage-hungry electrical and electronics feature content driven primarily by the German luxury brands.

Designs were set for production, new electrical protocols devised and tooling was ready. But suppliers and OEMs found ways to stretch the proven 12-volt power net without significant cost or disruption. The 42-volt revolt quietly subsided.

Fast-forward to 2017 and the adoption of 48/12-volt power nets as detailed in the feature on page 18. Though history might indicate that cost, complexity, industrial inertia and the lack of a track record would slow this technology's implementation, economies of scale will eventually prevail. Virtually every supplier involved in OE, aftermarket and vehicle repair will be impacted by the eventual wholesale shift to 48-V structures. The question is when and how swiftly?

The industry's adoption of 48-V hybridized systems is only a surrogate for the numerous shifts the industry is making with respect to vehicle electrification, software integration, enhanced electronic control and improved communication. Suppliers of all stripes increasingly are being classified as purveyors of 'hard' parts versus 'soft' parts. As soft parts—electronics, software and electrical components—increase as a share of total vehicle cost, this will place increased pressure on others to examine their own ecosystem for increased exposure to the 'softer' side.

As vehicle affordability will continue as a broader issue, suppliers must examine their role. In this era of substantive change, there are knowns and unknowns. Increased electronic content and its profound impact fits squarely in the former. ■

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SAE STANDARDS NEWS

Focus for 2017: Cyber, connected-car, EV charging, vehicle autonomy

Our new section, SAE Standards News, *aims to update readers on the extensive activity in the SAE Global Ground Vehicle Standards development arena, by more than 800 ground vehicle committees comprised of volunteers from global industry stakeholders and SAE GVS staff who support the committee work.*

Jennifer Shuttleworth
Associate Editor
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SAE's Standards activities related to ADAS, connected vehicles, cybersecurity, EVs and hybrids are "immense," says Keith Wilson.

Cybersecurity, connected and automated vehicles and EV charging are the technology trends dominating **SAE** Ground Vehicle Standards work for 2017—a year that is shaping up to be the busiest ever, noted Keith Wilson, Project Manager, Technical Programs.

Wilson, based in SAE's Troy, MI, offices, updated *Automotive Engineering* on recent activity in his group. You can search http://standards.sae.org/ for the status of any of the standards listed below.

Cybersecurity Guidebook—SAE J3061: This is the first automotive product of its kind, according to Wilson, covering a vital topic that has "far reaching" aspects across all mobility sectors. The standard's best practices are intended to be flexible, pragmatic, and adaptable in their applications within the vehicle industry as well as to other cyber-physical vehicle systems (e.g., commercial and military vehicles, trucks, buses), Wilson noted, and he promises more to come in this area.

Speaking of J3061, SAE is conducting a webinar training package "Keys to Creating a Cybersecurity Process from the J3061 Process Framework" offered by SAE experts on the standard. Two sessions were given in 2016, and three sessions are slated for 2017. More details can be found at http://training.sae.org/webseminars/wb1604/.

Connected Vehicle—SAE J2735, J2945/1, J3067: An area of prodigious standards activity as industry experts and SAE work to keep pace with the vehicle technology that is emerging in this area. Wilson explained that the **U.S. Dept. of Transportation** issued a proposed rule on Dec. 13, 2016 that would advance the deployment of connected vehicle technologies throughout the U.S. light vehicle fleet. The Notice of Proposed Rulemaking would enable vehicle-to-vehicle (V2V) communication technology on all new light-duty vehicles, enabling a multitude of new crash-avoidance applications that, once fully deployed, could prevent hundreds of thousands of crashes each year by helping vehicles "talk" to each other (www.nhtsa.gov/About-NHTSA/Press-Releases/nhtsa_v2v_proposed_rule_12132016). He reports that SAE has a contract with the **Federal Highway Admin.** to accelerate the development of industry standards in this important vehicle technology.

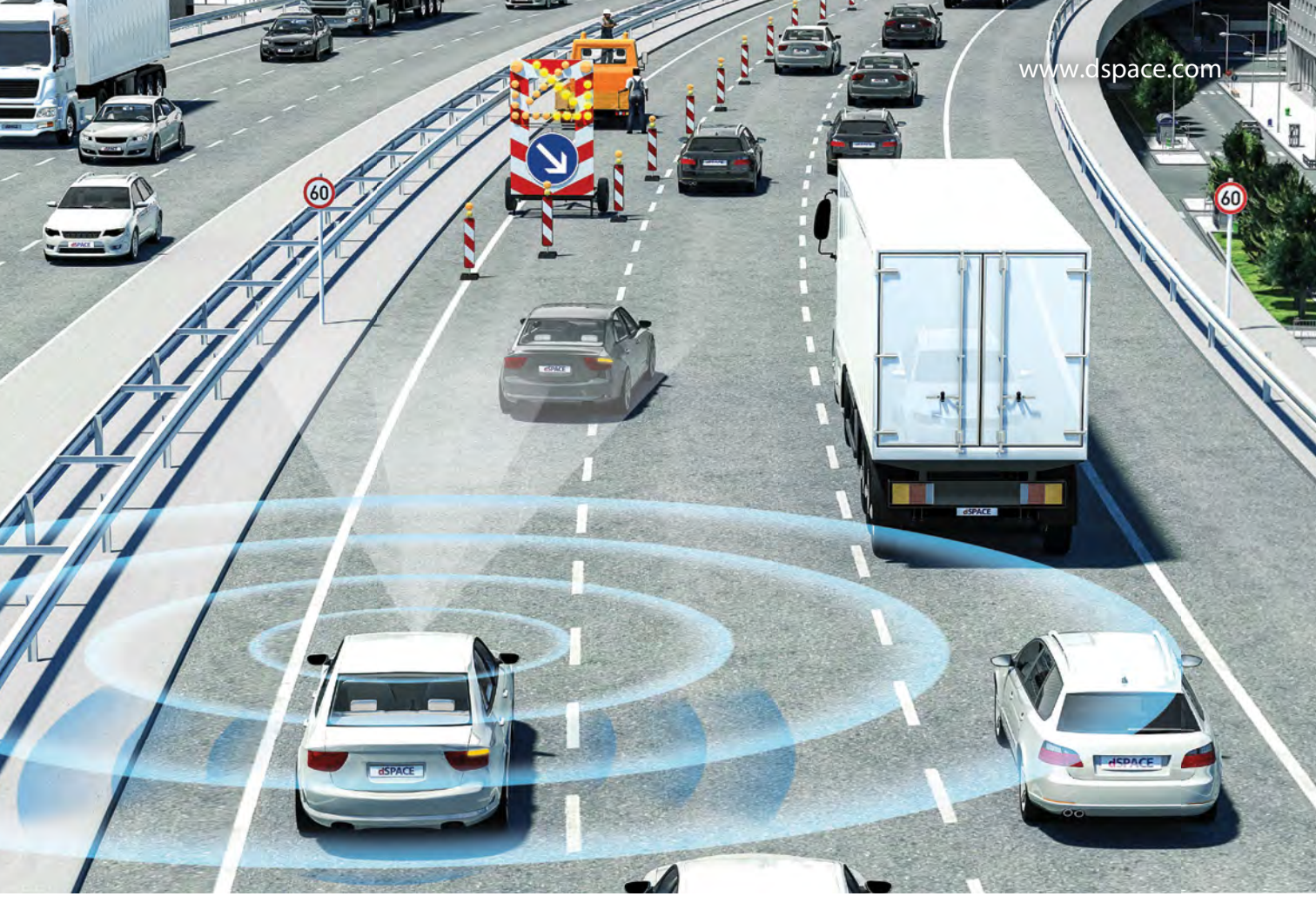
As SAE approaches its fifth year of federal-agency funding support related to this area, new Connected Vehicle standards are nearing publication including SAE J2945/0, J2945/2 & J2945/9.

EV charging—SAE J2954: Wilson says electrified vehicle charging is one of the most active and broadest areas of focus for SAE standards committees for 2017. EV charging goes hand in hand with the flurry of standards activity related to electric-vehicle batteries and other EV and hybrid systems, he said. That arena has seen the proliferation of electrified propulsion systems in the commercial vehicle sector as well, including electric and hybrid buses, delivery vans, on- and off-highway trucks and construction and ag equipment.

SAE Standards Committee activities include overhead charging devices for transit buses, large capacity plug-in chargers for commercial vehicles and wireless charging for both passenger and commercial vehicles. Additionally, there are standards under development for the vehicle-to-grid (V2G) interface. "EV charging doesn't only encompass power transfer; it's communicating with your service provider," Wilson noted. "If you pull into a parking lot in a public parking space and there's a charger there, you can connect to it. You can set it up to charge for X number of hours and to charge at different levels. And, of course, there are different costs"—and the need for standards at multiple levels; see also SAE J3105, J3068, J2953, J2836, J2847 & J2931.

Levels of Vehicle Automated Driving—SAE J3016: "Automated vehicles are made from the building blocks of ADAS [advanced driver assistance systems] and connected-vehicle technology," Wilson said. "We have an immense amount of activity going on in those building blocks," including the human-factors area (how the driver and vehicle communicate back and forth).

Published in the second half of 2016, SAE J3016 provides a taxonomy for automated and autonomous driving systems ranging from SAE Level 0 (fully manual driving) to Level 5 (complete autonomous operation). The standard is the only one of its kind and is cited in the recently released **NHTSA** Federal Automated Vehicle Policy, according to Wilson. ■



Innovative Driver Assistance Systems – On the Road to Autonomous Driving

The idea of self-driving vehicles offers great potential for innovation, but the development effort has to stay manageable, despite increasing complexity. And it can — with a well-coordinated tool chain for the development of multisensor applications. Be it function development, virtual validation or hardware-in-the-loop simulation, you can benefit from perfectly matched tools that interact smoothly throughout all the development steps. From integrating environment sensors or V2X communication, modeling vehicles and traffic scenarios, or running virtual test drives, get your autonomous driving functions on the road — safely!

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AUTONOMOUS DEVELOPMENT

Continental demonstrates new sensing tech for SAE Level 4 capability

A Jeep Grand Cherokee fitted with Continental technology self-climbs a 30-degree rock-laden grade. (Kami Buchholz photo)

A braking and cruise-control system that can move a vehicle up and down steep off-road hills. Vehicles that can detect at-risk road users not in the driver's field of vision. These production-ready and production-intent technologies are in **Continental**'s product pipeline.

Pedestrians, joggers and bicyclists are vulnerable to a vehicle impact when hidden from a driver's sight. While a camera-equipped vehicle can alert its driver to someone partially concealed by a parked car or other obstruction, even earlier detection is possible.

Continental is testing the use of ultra-wideband sensors to identify at-risk road users. These proximity-based sensors, like those used in key fobs, are located on the side mirrors and on the passenger-side C-pillar of a demonstrator car tested by *Automotive Engineering* recently at the supplier's Brimley, MI, Development Center. A sensor-equipped safety dummy stands in for a wandering pedestrian.

By triangulating the sensor signals, the sedan's communication network detects the safety dummy "target" three to four seconds earlier than a vehicle using cameras.

"This demonstration is a thought-starter. We have to start thinking about how to avoid accidents with vulnerable road users in order to have a solution in the future," said Jeremy McClain, Continental's North American Director of Systems and Technology, Chassis & Safety Division.

The 'Cruising Chauffeur'

Like V2V and V2I communications, knowing the precise location of a road user can help prevent an accident. Said software engineer Ganesh Adireddy, "It's all about sharing information from the pedestrian road user, who in actual use likely would have a smart phone, a smart watch, or a special transponder." Short-range communication can identify a person's position more accurately and do so more quickly than GPS.

Precise location information is critically relevant in autonomous driving scenarios, which is why Continental's "Cruising Chauffeur" feature is designed to add another layer of sensing capability to compliment long- and short-range radars and cameras. According to Eric Mertz, senior staff technical specialist for the V2X team, Continental's M2XPro algorithm fuses GPS and vehicle sensor data.

"There are situations, like an urban canyon, where a GPS signal reflects off buildings," Mertz noted. "And when that happens, it gives a false indication of where you're at in the city." By incorporating M2XPro with the Cruising Chauffeur's existing communication technology, positioning accuracy below 1.5 m (5 ft) is expected, he said.

Automated lane change and lane-change recommendation capabilities were added recently to the Cruising Chauffeur demo vehicles, according to Steffen Hartmann, test and validation engineer involved with the automated driving project. When a Cruising Chauffeur vehicle is in


Continental's Tim Buchert holds the MK C1 braking system. (Kami Buchholz photo)

automated driving mode, a driver's turn signal movement tells the car to make a lane change if it's safe to do so. A lane change recommendation occurs via the HMI interface if a vehicle in front of the Cruising Chauffeur slows down.

Engineering teams in the U.S., Mexico, Germany, Japan, and Shanghai are working on the Cruising Chauffeur. "We're making more and more steps toward our final **SAE** Level 4 automated driving vehicle," said Hartmann. Continental officials expect technology for highly automated driving to be ready by 2020 and fully automated driving technology to be ready by 2025.

Tip-toeing off road

Continental is production-ready with its MK C1 electronic brake system with Off-Road Cruise Control (OCC). The MK C1 portion of the system recently debuted on the European-market **Alfa Romeo** Giulia.

The innovative MK C1 unit integrates brake actuation, brake booster, and control systems. It weighs 13 lb (6 kg), about 4.4-6.6 lb (2-3 kg) less than a traditional system. According to Tim Buchert, a vehicle test engineer with the electronic braking systems group, the electro-hydraulic MK C1 uses a linear actuator instead of the two- or six-piston pump that's in conventional braking systems.

During a demonstration, a **Jeep** Grand Cherokee equipped with the MK C1 only required the driver to steer the SUV after the OCC was set at 1.2 mph (1.9 km/h). The vehicle climbed a rocky 30° grade. It also moved itself down, and up, a similarly steep grade while in reverse. "The system is silent when building up brake pressure, so there isn't any NVH or pulsating as the vehicle climbs or descends the hill," Buchert explained. "In a hybrid driving application, you can hit the brake pedal to send a deceleration request to the electric motors. The vehicle will slow down using the electric motors and over time slowly fade-in conventional braking."

Kami Buchholz

ELECTRONICS

Pour your next EV battery?

While electric propulsion appears destined to supplant the internal combustion engine at some point in the future, the laws of economics and market forces will likely keep ICEs around for decades. Batteries for EVs remain expensive. Packs are heavy and recharging takes longer than pumping liquid fuel into a tank. Despite their many advantages, EV disadvantages are hard to ignore.

Enter **Tanktwo** and a truly novel approach to the basics of EV batteries.

The basis of EV batteries today starts with a small component collectively known as a cell. Typical cells are shaped as cylinders or rectangular slabs. What makes them attractive to electrified-vehicle battery makers is they already are widely used in consumer electronics. Cells are combined into modules, modules into a highly engineered, static battery pack.

Tanktwo's vision is a battery pack composed of egg-shaped String Cells. The Finland-based company's founders exploited their background in telecommunications to create 'smart' cells that contain small, programmed computers. Poured (literally) into an inexpensive passive container with contacts on the inside, they create a String Battery.

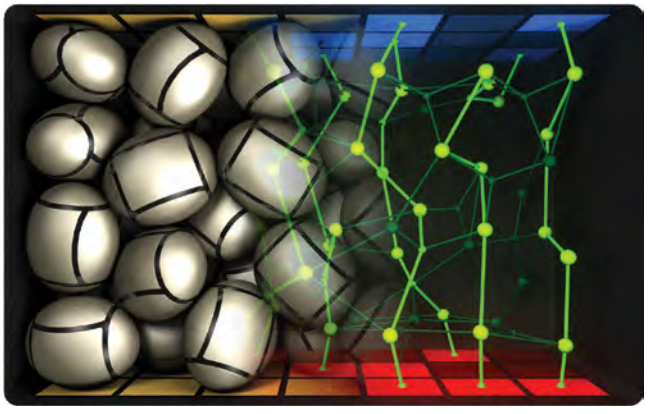
Conventional batteries too big

One of the biggest benefits of the String Battery lies in a problem with current battery concepts—capacity rigidly designed from the outset, according to Bert Holtappels CEO of Tanktwo, which has an office in New York.

"These systems are inefficient because they need to be over dimensioned with significant margin, so that the likelihood of field failure is within an acceptable margin," he said. Some EV makers are delivering cars with 100 kW·h battery packs when their owners might drive only 12,000 mi (12,300 km) per year, meaning that "most of the depreciation of the battery is coming from aging, not wear"—a costly loss of an asset, Holtappels explained.

Sizing the Tanktwo String Battery container for the maximum scenario requires filling only as many cells as needed for a typical


The String Cell from Tanktwo replaces a "dumb" battery cell with one with multiple pressure contacts on its skin and a computer to make it "smart." The cells shown here have 6 external contacts.



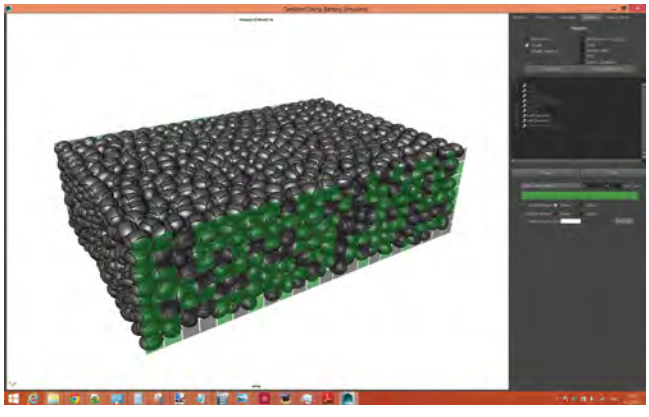
String Cells automatically "string" connections together without human intervention to create a functioning pack they call a String Battery. Stringing algorithms continually monitor the network and create new ones as needed.

usage, plus a healthy margin. The container would recharge the cells through the today's conventional **SAE** J1772 plug. "This prevents underutilization of the pack," he explained. "During the period he owns the vehicle, the same customer could visit the dealer and get an upgrade to the battery pack quite easily."

The simplest version of the swapping device resembles a glorified Shop Vac. Holtappels recognizes that the more ambitious goal of convenient and fast battery swapping requires an infrastructure change that could inhibit adoption—think hydrogen fuel cell vehicles. "That might come naturally over time," he speculated.

Efficient by design

There are some other potential efficiencies of the String Cell approach. Current battery packs need to level the charge between cells in each module. So, if one cell has deteriorated by, say 20%,



Simulated illustration of a String Battery. Inflatable bladders made from silicone apply mechanical pressure to keep the cells in place while in a moving vehicle. The company claims that for cells with 6 contacts there are enough connections to get 98% utilization or greater. Contact degradation and possible corrosion over time can be handled a number of ways, according to the company.

the rest of the cells in the module must bleed off energy to balance the cells within the module. So, each module is limited by the deterioration of any individual cell.

This also causes traditional packs to need large safety margins. Often, this means a battery designed to maintain an 8 kW·h capacity over the life of the car might start out with 14 or 16 kW·h.

Because String Cells are 'smart', the pack is not limited by the least-charged cell. As Holtappels describes it, if an individual cell deteriorates by 20%, the cell is simply bypassed for 20% of the time when the pack is contributing power. Each cell contributes to the pack to the best of its ability without any need to bleed off charge.

He estimates this as providing 10% more energy efficiency when compared to traditional pack designs with the same rated energy.

"Our packs can last much longer on a practical level as well," Holtappels claimed. "Most companies [think they should retire their] pack from the vehicle even when it is still 70% usable. For String Cells, anything over 10% of initial capacity is okay for each cell."

Dead or semi-dead cells that would be ruinous in a traditional pack can be bypassed in a String Battery and easily replaced at a service or swap event, the company claims. So the packs are sized for the mean, not the worst case. The containers they go into also are fairly simple. Important components, such as bus communications and wire harnesses are already commoditized. Because of the unique character of the String Cells, there is flexibility in the shape of the container.

"This technique is agnostic about the battery cell chemistry: any improvement in the chemistry of cells would also improve the String Battery," he said.

According to Holtappels, a couple of industry partners are already working with Tanktwo on initial deployments, including Firefly with an electric service vehicle. In these cases, the rapid battery replacement—3 minutes according to the company—was an important factor.

"This is definitely an out-of-the-box idea, but it seems quite challenging," observed Dr. Menahem Anderman of **Total Battery Consulting.** Interviewed by the author for this article, Dr. Anderman would like to see future trials prove out the quality of the 'dynamic' electrical contacts between the cells and examine complexity, cost and reliability in real life.

"I believe it will be quite a stretch to make a real viable system out of the concept," he said. There is no doubt the Tanktwo principals are just as aware of the challenges. Stay tuned.

Bruce Morey

Magna's CTO talks innovation and disruption

Magna's Swamy Kotagiri sees many benefits in collaborating with the 'start-up ecosystem' on innovative technologies. (Lindsay Brooke photo)

Swamy Kotagiri, **Magna International**'s Chief Technology Officer, will discuss how to foster an innovative organizational culture during a Leadership Summit roundtable, April 4 at the **SAE** WCX17 in Detroit. He spoke recently with *Automotive Engineering* on this topic at Magna's Troy, MI, offices during the company's annual Innovation Awards activity.

Accepting the potential for failure seems inherent in an innovative culture, correct?

The acceptance for risk changes depending on what stages of R&D you are in. The rigor and discipline come after I have to spend a significant sum of money to make a prototype; that's where I approach the threshold between low risk and higher risk. In my general terminology, 70-80% of it is more a step approach of what we know very well—optimizing the product in some way. The other 20-30% is disrupting something that exists today or making a quantum jump. I'd say we currently have three or four projects like that in corporate.

How do you choose between keeping innovation in house or partnering with an outsider—or maybe acquiring a start-up to do it?

There are various models we consider. One is, we can go to a research institute or university which is known in that field. We work with them on a defined package which usually is proving out the fundamental science. If we get past that phase, usually we bring it back in [to Magna] because then it's application development.

Then there are certain technologies—semiconductors, optical imagers, radars, ultrasonics, even some materials—whose primary applications lie somewhere besides automotive. In these it's more of an alliance—we have to make such platforms applicable to automotive regarding functional safety and reliability aspects that are usually far more stringent. This gives our partner a chance to enter a market and can offer us a chance to be first to market overall.

For example, certain materials can sense temperature—can I use them in a seat fabric? 3D printing has made a lot of things possible in tooling, making it extremely efficient to make a part which we couldn't make before. We don't have to own a piece of such enablers because we own the product and its functionality. I think these relationships are no longer a choice, but a 'must'.

Do decisions to "go outside or keep it in house" keep you up at night?

It keeps me interested! But we believe the start-up 'ecosystem' is extremely agile and it gives an opportunity to get a group of really talented people to work in a system that is not driven by a large organization. That's the key. So if we believe there is a technology that we need to drive, we'll work with them [start-up] but we don't necessarily need to own all of it. They bring the idea and fundamental science behind it, but they don't have the automotive specification of what's required five years from now. They don't have to go through the 'churn,' come up with a prototype and hit a 2019 production target. A lot of start-ups can't think that way. But they don't have to waste two years of time working on an assumption, either.

It's been really useful to work with start-ups—some are investments, some are partnerships, some are alliances and some are 'scaled' versions which over time become part of Magna. And we realize sometimes we don't want to constrain them and make their technology exclusive to Magna.

Is Magna a disruptive-technology company?

We have processes and products—hydroforming, seat foams, the Stow n' Go seating concept—that have been game-changers and first-to-market in automotive. The most important thing for us is to keep an open mind about what could happen in the next 5 to 10 years. There are disruptions that will come not only in product—some could also be business models about how mobility will be defined. We have to understand it and be ready to participate in it. Filling a need before anybody else does is, to me, being disruptive.

Lindsay Brooke

Patton's NEW CAMPAIGN

As new SAE International President for 2017, Doug Patton will advocate STEM, "cultivation" of prospective young engineers.

From his elevated position with the American arm of automotive megasupplier **Denso**, Doug Patton has a commanding view of the engineering landscape—and some power to help shape it.

With the added new influence of the 2017 **SAE** International Presidency behind him, he plans to do as much as he can to help shape up what he sees as a somewhat wobbly system for producing engineers in a stream large enough to meet the expanding needs of mobility industries.

"One of my goals as president is to focus on STEM [science, technology, engineering, and mathematics] because I realize there is a lack of engineers coming through the pipeline," said Patton, who in addition to being a Senior Director at Denso Corp. of Japan is Executive Vice President of Engineering and Chief Technical Officer at Denso International America. "We, SAE, need to make an impact on young 'pre-engineers,' in grade school, in high school, and in college—cultivate them from the beginning."

Cybersecurity will be the other major focus area of his SAE presidency, he said in an interview with *Automotive Engineering*.

Patton's work history in two of the three mobility sectors served by SAE gives him broad perspective into the many cross-sector challenges that engineers and companies face. Before joining Denso in 1986, he worked at Caterpillar as a release engineer and senior market analyst. He has been an SAE Member since 1987, with a long list of volunteer stints on various SAE boards and committees over the years.

"It's quite an honor to be SAE President," he said. "When I look at who has held this position in the past, they are very distinguished individuals—and not just in the auto sector, but also in the aero sector and the heavy-duty area. I hope I can influence other individuals to aspire to be SAE President in the future."

Regarding his second presidential focus area, cybersecurity, Patton said: "One of the things we can do is learn from the aerospace industry, because they've already faced some of the challenges. But for ag, construction, on-highway, truck, automotive—cybersecurity is becoming more and more of a challenge. So it is important that we have standards [e.g., SAE's J3061] and methodologies and ways to protect the product. SAE can play a role in developing those, so I want to promote that activity."

Incoming 2017 SAE International President Doug Patton intends to focus the organization's energies on training engineers, educating and encouraging "pre-engineers" and making SAE a central player in automotive cybersecurity development.

Although not one of his specific focus areas, Patton identified additive manufacturing as a cross-sector technology for which SAE standardization efforts will "drive harmony across product lines—all the way down to the service level of the product. The more standardization we have, the more cost-effective the world becomes."

Automated driving systems is a technology area in which SAE is having significant influence and its recently released standard defining the six levels of automated-driving systems ("J3016: Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems") was in Fall 2016 incorporated into official U.S. federal policy.

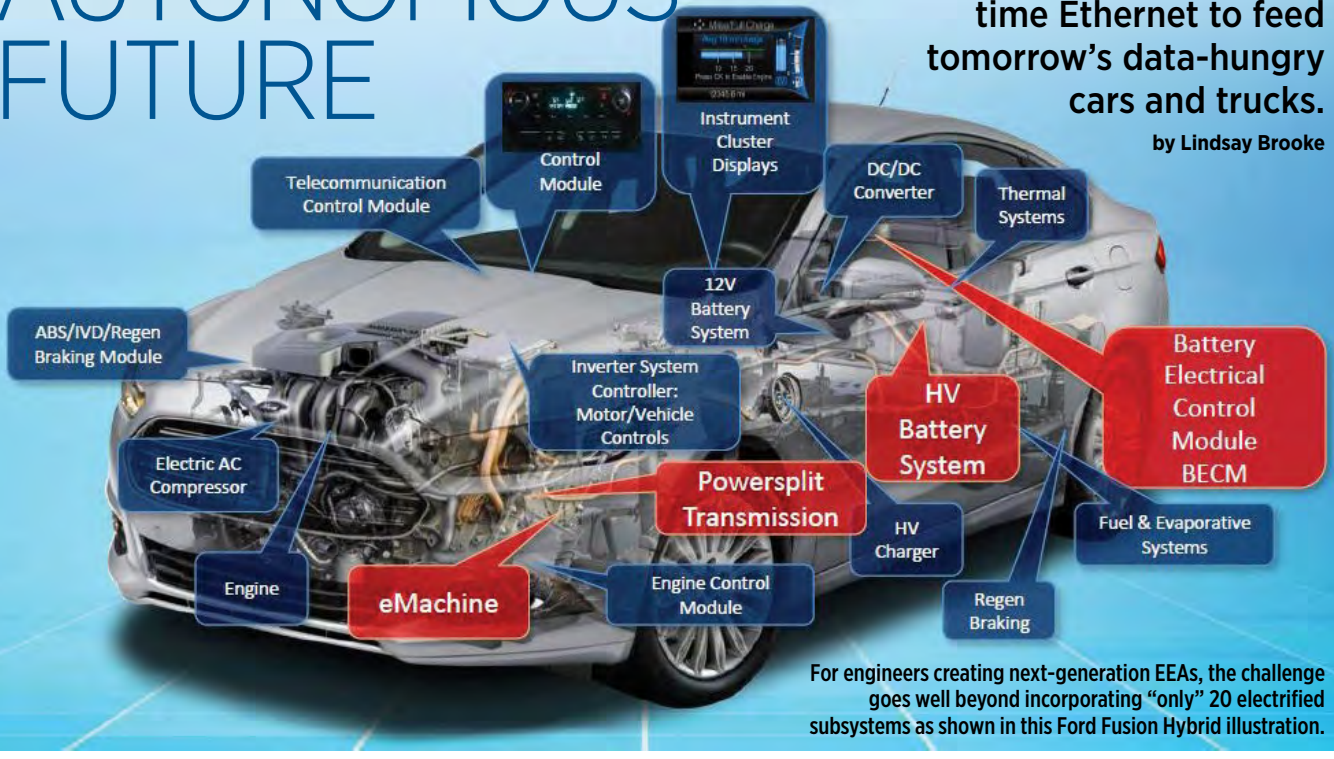
As an aside, Patton noted that the continued development of artificial intelligence is a key tool that needs to be further expanded so engineers can program automated vehicles in a way that allows them to navigate unforeseeable road situations with the same adaptability as a human driver.

Patrick Ponticel

NEW EEAs FOR THE CONNECTED, AUTONOMOUS FUTURE

OEMs and their Tier-1 partners are revamping vehicle electronic and electrical architectures with "über brain" central computers and real-time Ethernet to feed tomorrow's data-hungry cars and trucks.

by Lindsay Brooke



For engineers creating next-generation EEAs, the challenge goes well beyond incorporating "only" 20 electrified subsystems as shown in this Ford Fusion Hybrid illustration.

The connected, electrified and eventually driverless vehicle revolution has a less publicized but equally important back story—the development of next-generation electrical and electronic architectures. The new scalable, global EEAs in the pipeline at major OEMs are considered vital for supporting the ever-ravenous data-processing needs of future cars and trucks.

EEAs historically have been evolutionary technology. Their significant rethinking has been a long time coming—over 30 years, in fact. The last real game-changer was the advent of CAN, the Controller Area Network protocol launched by **Bosch** in 1983. Introduced into the market by **BMW** on its 1986 850 coupe, the CAN bus has been the EEA's workhorse—a centralized network bus which broadcasts all of a vehicle's data traffic and allows the various controllers and sensors to communicate.

The move to CAN buses improved system efficiency, interoperability and helped reduce complexity, which in turn enabled a reduction in wiring, saving up to 100 lb (45 kg) per vehicle and freeing up critical package space.

"CAN and LAN [Local Area Network] are stable technologies that have given us a lot of flexibility in the design," noted Kevin Layden, **Ford**'s Director of Electrified Powertrain Engineering. "But while we're seeing more features being put onto the CAN network, we also have far more sensor inputs and high-draw features today."

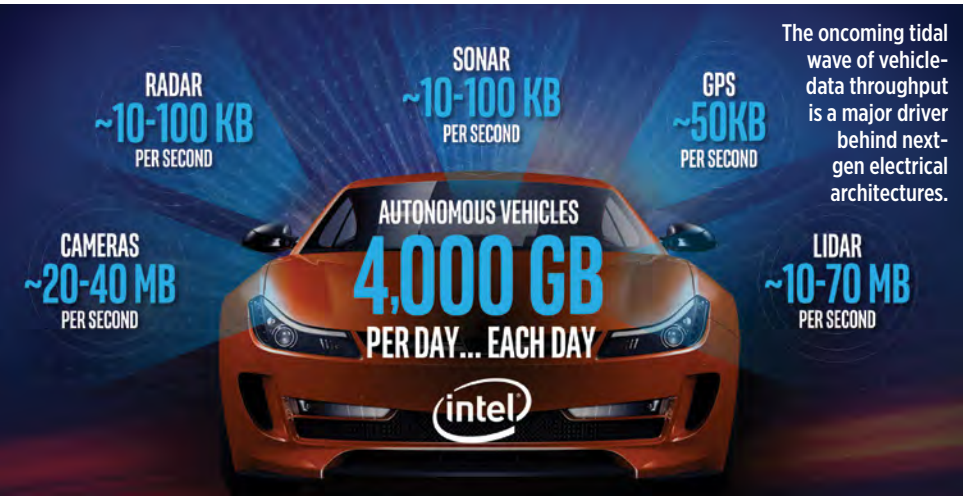
Layden and other experts say CAN-bus architectures suffer from lack of bandwidth and throughput to cope with the data traffic-handling, cybersecurity and eventually machine-learning capabilities needed for future vehicles.

"The huge data-processing requirements that come from fusing data from multiple sensors for automated driving are pushing the limits of available microprocessor technology that's been developed for automotive applications," explained Tim Frazier, Bosch North America President of automotive electronics.

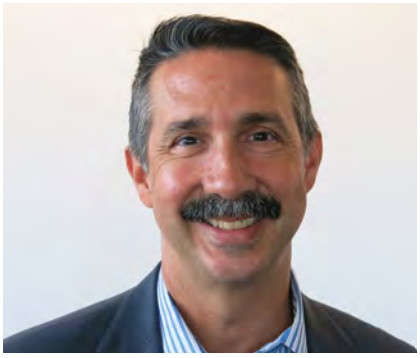
Experts who spoke with *Automotive Engineering* for this article say CAN will continue to play a role in EEA sub-nets. But its fast-rising competitor Ethernet offers 1,000 times more bandwidth. Also known as **IEEE** 802.3 protocol, Ethernet "is gaining ground for high-speed, high-capacity applications such as active safety because it's so well proven—it's in every house and PC," said Andy Whydell, Global Engineering Director at **ZF TRW**.

Whydell considers Ethernet to be a supplemental technology "because it's running in parallel with CAN," he explained. "Where you don't have high-bandwidth needs, it's still cheaper to use CAN as the basis rather than upgrade to Ethernet. It also means you're not filling up your Ethernet bus with low-priority traffic such as seat-adjustment commands. So we can break out more critical safety-related systems for Ethernet and keep more comfort-related ones on the CAN."

One of many experts who is bullish on Ethernet, Whydell notes that another protocol, FlexRay, also is faster than CAN but more expensive.



The oncoming tidal wave of vehicle-data throughput is a major driver behind next-gen electrical architectures.



Bosch North America VP Tim Frazier sees the industry moving from today's domain architectures to zone-type configurations that will help reduce wiring-harness mass by up to 20%. (Lindsay Brooke photo)

Big processing, centralized control

Currently OEMs use a distributed-type architecture where a plethora of sub-net ECUs work across each other to offer features and functions to the driver. But they're "reaching the tipping point in terms of capability," explained Matt Schroeder, **GM** Executive Director, Vehicle System Engineering.

He noted that GM, currently developing its new 'Global-B' architecture due in 2019, is "looking at how to do things differently to allow a broader set of even more advanced features to work with each other in a distributed fashion—and also protect the customer from a cybersecurity aspect."

Domain controllers will remain a consistent cornerstone of all the architectures, Schroeder said. He noted that the nature of distributive architecture "will only increase as you start to blend navigation with active safety features. The system fundamentals aren't that much different, but the needs on the customer end are far greater."

Processing rates of 1 GB per second and faster offered by 1-Gbit real-time Ethernet are envisioned by autonomous-driving system planners. Schroeder comments: "In terms of capability it'll be like putting a mainframe computer, hardened to automotive specification, into the vehicle."

Moving to such massively powerful central computers to handle the new data-processing regime in conjunction with broadband data communication with the cloud, was a hot topic among engineers at the 2016 **SAE** Convergence conference. **Delphi** CTO Jeff Owens calls the trend "both evolutionary and revolutionary." The evolutionary part is driven by higher data for specific-zone applications—for example, the need for more current for a hybrid overlay on an existing architecture.

The revolutionary part is rethinking the architecture using a multi-domain controller (MDC)—an "über brain," he calls it—designed to do the same work as multiple ECUs to reduce system complexity, cost and mass. Delphi, ZF TRW, Bosch and other suppliers have such hardware in production or in the works.

VW-Audi is on such a course. Its 'Zed Faust' (Z-Fast) program is rethinking the EEA for their active-safety domain which includes the vehicle's radar, LiDAR, vision systems, driver-state monitoring and various related sensors and actuators. There's a lot of high-speed processing going on. This led Audi to design an architecture for the future that brings a "heavy lifting" central processor to serve as an arbitrator and decision-maker between the subsystems, into an MDC.

Unveiled on an autonomous A8 concept in 2014, the Zed-Faust's compact main board, powered by an **Nvidia** K1 chip with 192-core GPU, processes dozens of sensor inputs to calculate how the vehicle should safely navigate and drive according to road and traffic conditions. The next-generation central vehicle computer, expected to enter production by 2019, will feature a higher degree of hardware integration and greater scalability.

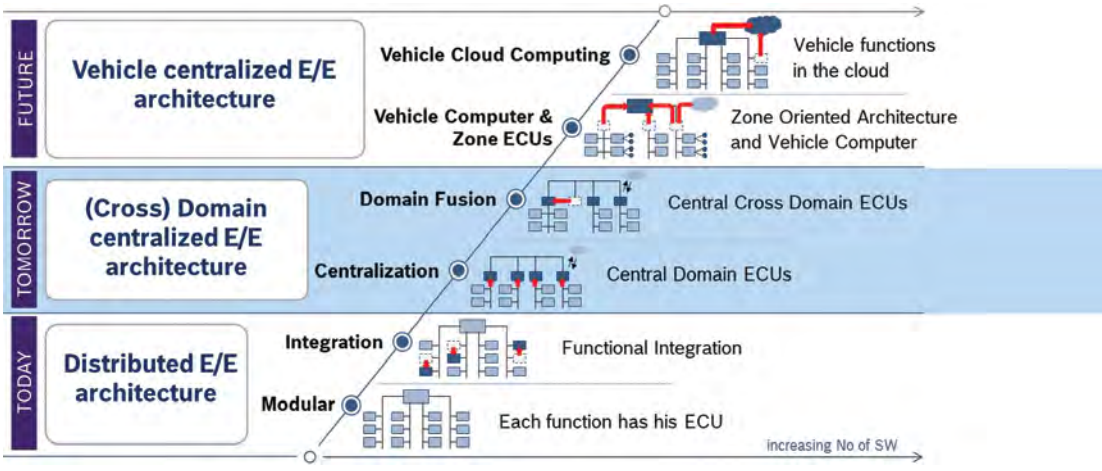
"What Audi is doing with this is future-proofing their architecture," Owens observed. The idea is that a succeeding generation of sensors will arrive dramatically smaller and because the heavy-lifting data processing will be done centrally, the front-end processing—including 'time-of-flight' information, thermal management—allows engineers to avoid high-end microprocessors in each of the sensors, making them more affordable.

While some current systems can be reflashed for upgrades, most don't have memory headroom—old data must be off-loaded before they'll accept more. With an MDC there's enough memory headroom and processing speed that Audi will be able to add features for a long time. Owens believes that "the really forward-thinking OEs see this [central vehicle controllers] as an architectural shift for the future."

Reconfigurable designs

Engineers developing the next-generation EEAs say they're aiming for a standardized hardware platform that, as GM's Schroeder put it,

NEW EEAs FOR THE CONNECTED, AUTONOMOUS FUTURE



Bosch's strategic view of the technology march toward future EEAs.

"can expand and contract appropriately to meet the capability and cost needs up and down the product portfolio. Creating unique architectures is expensive."

Dr. Alberto Vincentelli, noted E/E and computer science professor at the **University of California-Berkeley**, agrees. He told an SAE Convergence panel discussion that "the key metrics for architecture to take care of new requirements are flexibility and reconfigurability. If you start a new architecture it can be reconfigured dynamically which extends its practical life," Dr. Vincentelli asserted. "Design is one issue—but more important is adapting," he said.

Who would have authority over the central processor in terms of vehicle integration—Tier 1 or OEM? That depends, said ZF TRW's Whydell.

"We're in production with some already and I describe them as like 'an automotive smart phone,'" he said. "Like the processor in your phone you can customize it with various apps to do your own configuration. So, for example, ZF would provide the processor and the OEM would then decide where to get the 'apps,' so to speak. They could also buy them from us or write them themselves, or contract a software-specialist company to develop some of the functions that goes into that box."

Greater inter- and intra-system flexibility is a goal of **AUTOSAR**, the Automotive Open System Architecture development partnership. Its Adaptive Platform, expected to be completed this year, is designed to help engineers create more flexible architectures. AUTOSAR Adaptive will provide a software framework for more complex systems and help engineers increase bandwidth by implementing Ethernet.

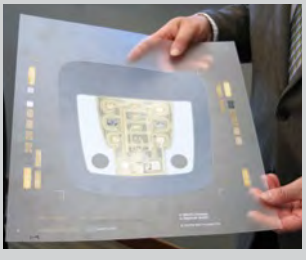
The AUTOSAR Adaptive Platform, currently set for

A wiring revolution: Flexible Hybrid Electronics

While internet pundits like to crow that "print is dead" in the media business, print is just getting started in next-generation vehicle electrical architectures. Imagine a wiring harness printed in electrically-conductive ink on a thin, stretchable and flexible substrate with sensors embedded into the substrate. Known as flexible hybrid electronics (FHE), this technology is manufactured using a combination of high-precision printing technology and advanced electronics. The result is lightweight, package-efficient and physically flexible circuitry.

"FHE is basically printing the circuits on a large roll of film," explained Dan Lawrence, program manager at the **IQM Research Institute**, an advanced-technology incubator in Ann Arbor, MI. He noted that it can be "incorporated into any substrate—an injection-molded door inner panel or the physical structure of the vehicle. Headliners, the centerstack HMI, the roof panel incorporating photovoltaics (which are also approaching printability) and RFID antenna," just to name a few applications.

FHE enables electronic/electrical solutions that aren't possible with current hard-board circuits, Lawrence told *Automotive Engineering*. It integrates multiple functions and components. "In some vehicle subsystems FHE has demonstrated a 16:1 reduction in connectors alone, versus conventional harnesses," he said.



An example of a Flexible Hybrid Electronics printed-film circuit for next-gen EEAs shown by IQMRI's Dan Lawrence. (Brooke photo)

The technology is scalable and allows microcontrollers, processors and LEDs to be coupled to the larger-area printed structures using conventional Molex-type connectors during the injection-mold step to enable vehicle sensing, lighting and other functionality, he said. And it's already been in volume automotive production—Ford quietly used FHE in the 2013 Fusion's overhead console; about 150,000 units were produced.

Led by **SAE** Fellow Mike Dudzik who serves as the organization's president, IQMRI is working with automotive, military and other sectors to commercialize FHE as part of the private-public consortium (see **NextFlex.us**) created by the **U.S. Dept. of Defense** in 2015. Total funding over five years is $171 M. IQMRI is responsible for "evangelizing" FHE within the automotive, military land vehicle, and appliance sectors. It has conducted a study of FHE—its opportunities and potential challenges to commercialization, with industry partners,

Andy Whydell at ZF TRW likens the powerful new central vehicle processors to "automotive smart phones" that will be customized by OEMs and Tier 1s for various applications.

completion in 2017, is designed to help engineers create more flexible architectures. AUTOSAR Adaptive will provide a standardized software framework for more complex systems and help engineers increase bandwidth by implementing Ethernet. Not a replacement for AUTOSAR, the new standard will likely see its first application in ADAS. It can also aid infotainment system development by providing a more seamless integration into a standard operating system with more connectivity and graphics computing power. According to GM's Schroeder, AUTOSAR 4.x serves as the foundation of the new Global-B EEA.

Architectural flexibility is a keyword at Bosch, whose electrical engineering teams have various next-gen EEA solutions underway to meet customer requests. "The technology is moving incredibly quickly," noted Tim Frazier. He sees EEAs progressing from the incumbent distributed architectures to a cross-domain (APAS, powertrain, body and infotainment head unit) configuration, using a building-block approach and propelled by 1-Gbit Ethernet.

"Zone architectures are the future," Frazier asserted. Moving to them from the domain architecture environment (see chart) will eliminate 15-20% of wiring harness weight, he maintained.

On to the cloud

"We currently have a 'split technology' between the cloud and the vehicle—do we need a revolutionary architectural breakthrough, or can we manage it with the architectures we've got?" asked Elliot Garbus, **Intel** VP of IoT Solutions Group and the Transportation Solutions Div., during his keynote at the 2016 SAE Convergence.

Real-time computing won't be done in the cloud. But looking longer term, Garbus sees a new architectural model enabling "highly reliable, real-time wireless connectivity that's ubiquitous." But he doesn't see it coming any time soon, not even with 5G.

"What we'll continue to see is significant computing in the vehicle that enables it to operate autonomously, with the cloud used for non-real-time activities as well as the near-real-time coordination around traffic conditions, weather developments, etc.," he explained. And security will be rooted largely in firmware and software over-the-air updates (FOTA and SOTA).

In any security attack the hackers are looking for the weak link and those links will shift and the threat model will likely evolve over time. "This requires a systematic design approach—hardware and software working together across the entire vehicle and up through what's happening in the cloud," Garbus said. ■

Lawrence noted. The study will be completed in February.

"We're working with companies across the industry and there's market 'pull' from the OEMs and the various tiers for this technology as a platform," he said. "We're looking to sign companies up for our study and join NextFlex to guide research fund allocation. Once common barriers to commercialization are covercome, participants can apply those learnings to advance their competitiveness."

IQMRI is looking to add some laboratory and demonstration capability as well as prototyping for creating small-scale batches for industry evaluation. Lawrence explained that the FHE platform is close to being commercialization-ready.

For more information, contact Dan Lawrence: dan.lawrence@iqmri.org. 734-709-8550. Also see www.manufacturing.gov.

—LB

Bridging the power gap with 48 volts

The 48-V power net shown in this Delphi schematic will be a key enabler for new vehicle electronic and electrical features.

New 48-V technologies are poised to arrive in volume to help meet CO_2 regulations and satisfy the "vampire" power demands of new electrical subsystems and accessories.

by Lindsay Brooke

The hybrid **Lincoln** MKZ I'm driving feels like it's floating on air as we hustle down I-75, the combustion engine having been shut off by a clever bit of electrification. On this long, flat stretch of highway the ICE is just along for the ride, not "turning and burning" as the aircraft guys like to say. There's an EV-like quality to this operating mode and it has clearly boosted this car's feeling of overall refinement during my brief test drive.

"We're in 'sailing mode'—pretty nice for steady-state operation, huh?" asks Dr. Matti Vint, director-engineering R&D at **Valeo North America**, as he looks up from behind a laptop in the passenger seat. Vint has been demonstrating this 48-volt-equipped Lincoln to interested OEMs all week. "Very cool indeed," I reply, or something to that effect.

But the sailing function (in which the hybrid system can provide some propulsion assist under light load conditions when the ICE is shut off) is only one customer-delighting aspect of the Valeo 48/12-V hybrid system. Engine downsizing is another. So is the system's ability to serve as a buffer within the car's conventional driveline making torque-converter engagement literally imperceptible, even under my heavy right foot.

And the 48-V delivers a meaty wallop of supplemental torque, allowing me to easily squeal the front tires during a WOT launch in Valeo's parking lot. A little bit of Mustang GT in your MKZ, sir?

After our demo drive, Dr. Vint pops the Lincoln's hood and decklid to show me the guts of the 48-V system. Up front there's a compact

Dr. Matti Vint and Valeo North America's 48-V demonstrator vehicle that combines greater fuel efficiency with tire-chirping performance. (Lindsay Brooke photo)

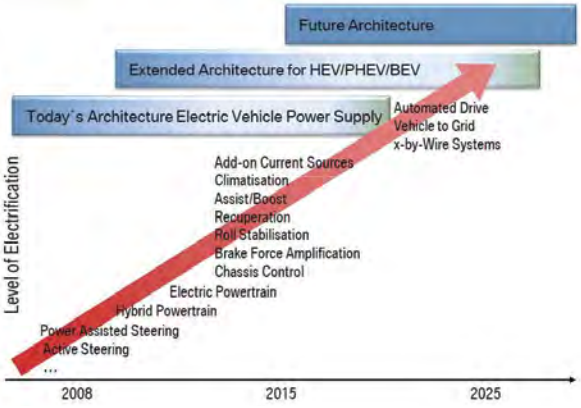
liquid-cooled belt-starter generator (BSG) tucked into a dark corner way down in the P0 (front-end accessory drive) topology. Dr. Vint points to Valeo's own e-supercharger, a highly effective device for optimizing Miller-cycle engines and improving hybrid-vehicle driveability. It's an integral part of Valeo's 48-V system strategy. In the car's trunk reside a 48-V controller, high-efficiency (~96%) bi-directional DC/DC converter and a compact, air-cooled 8 a·h Li-ion battery from **A123 Systems**.

Such set-ups I've seen a lot of recently, during various 48-V demonstration drives with **Continental**, **Delphi**, **AVL**, **BorgWarner** and **Schaeffler**. Though not production vehicles, all have displayed impressive on-road performance, lack of NVH intrusiveness and capability to deliver up to 12% improvement in vehicle fuel efficiency, engineers from the companies say. **Bosch**, **Ricardo**, **FEV** and others also have 48-V systems on the road and in the works.

And the 48-V system's inherently lower currents enable cables with smaller cross-sections to be used, reducing vehicle mass by up to 10 kg (22 lb) which also helps reduce CO_2 emissions.

Satisfying the "vampires"

The global Tier 1s are battling for 48-V system supply contracts that are expected to reach 13.4 million vehicles per year globally by 2025—about 10% of total industry volume, according to analyst Christian Mueller, with industry forecaster **IHS Markit**. Another recent study by



BMW's view of the trajectory of vehicle electrification within increasing on-board power requirements.

Navigant Research, Low Voltage Vehicle Electrification, is less optimistic; it forecasts global sales of 48-V vehicles to reach 9 million in 2025. C-segment vehicles are expected to be the largest market.

"Typical low-voltage mild hybrids alone will not get your fleet below 95 g CO_2 per kilometer," Mueller asserts. "You have to go plug-in full hybrid or have a significant proportion of BSG in your lineup." The 48-V system can be used for extended stop-start functionality, 'sailing' on the highway and for low-speed self-parking applications.

But its real benefit is in boosting on-vehicle electrical power from 2.5 kW to 10 kW, thus enabling a growing list of power-gobbling features not related to the vehicle's actual propulsion: electric power steering (≤2 kW), e-compressor (3 kW - 7 kW), electric AC compressor (≤3.5 kW), 'smart' cooling pumps (≤400 W), windshield heaters (≤700 W) and electro-hydraulic brakes (≤900 W).

"The new generation of high-load accessories, particularly e-boosters, e-chargers and active chassis control systems are huge 'vampires' in their power needs," observed Mary Ann Wright, vice president of engineering at battery maker **Johnson Controls** and a former **Ford** hybrid engineer.

Such subsystems can run on the 48-V power net and indirectly contribute to the reduction of fuel consumption, Wright said, while the parallel 12-V system continues to handle basic hotel loads.

Racing to be first to deploy 48-V hybrids in 2017, Continental has announced its system (also featuring an e-turbo) is on the new **Renault** Scenic MPV, Valeo has the **Audi** SQ7 and Mercedes recently unveiled new engine families designed to incorporate 48-V hybridization from yet-unannounced suppliers. (See SAE.org for related articles.) **VW**-owned **Bentley** is powering the active roll control system of its Bentayga SUV with a Schaeffler-developed 48-V system.

Bridging the power gap with 48 volts

Audi's eROT dynamic chassis control system is one of many power-hungry subsystems in development that require 48-V power.

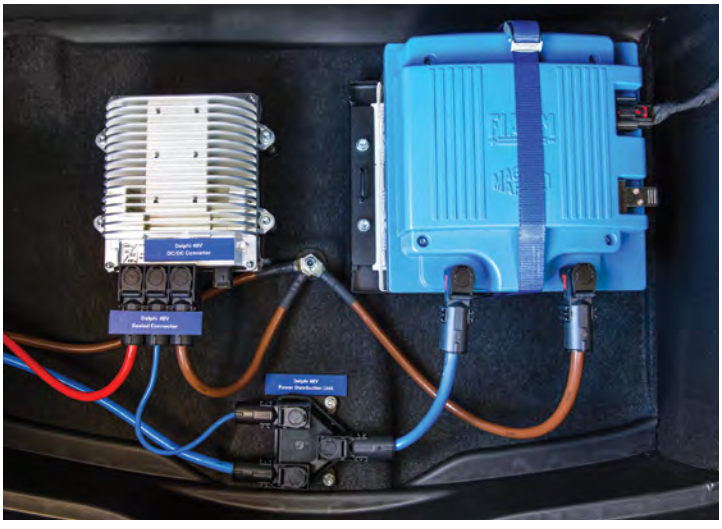
At its Paris investor meeting last fall, Valeo executives noted that the company has more than 25 contracts for 48V systems in China, Europe, India and Korea. Continental's hybrid-electric business unit chief Rudolf Stark said his company has 48-V production programs in the pipeline for both gasoline and diesel vehicles in North America, Europe and China; he expects 20% of new vehicles worldwide will be equipped with a 48-V system by 2025.

A plethora of creative technologies are being developed for future 48-V power. Audi's eROT (electromechanical rotary) suspension dampers are powered by a 48-V battery mounted to the car's axle, replacing traditional hydraulic shocks. The units enable electric energy to be recovered from the compression and rebound strokes—effectively "harvesting" energy from every dip and pothole.

Audi engineers believe eROT, while a "vampire" in terms of energy consumption, can reduce fuel consumption by ~ 0.7 L per 100 km. And while traditional dampers generate waste heat, the eROT units can generate energy to be used for other vehicle functions. The system, expected to enter production for 2018, offers a wide range of compression and rebound tuning to suit ride comfort, handling or both.

$500 system cost

While they do not offer real electric-only drive capablity, 48-V BSG-type hybrid systems have "a good balance and better capacity for capturing braking regen energy, up to about 60% of that available—and it's a good stop-start enabler," noted Dr. Mazen Hammoud, Ford's Powertrain Director for Asia Pacific, at the 2015 SAE Hybrid & Electric Vehicle Symposium.



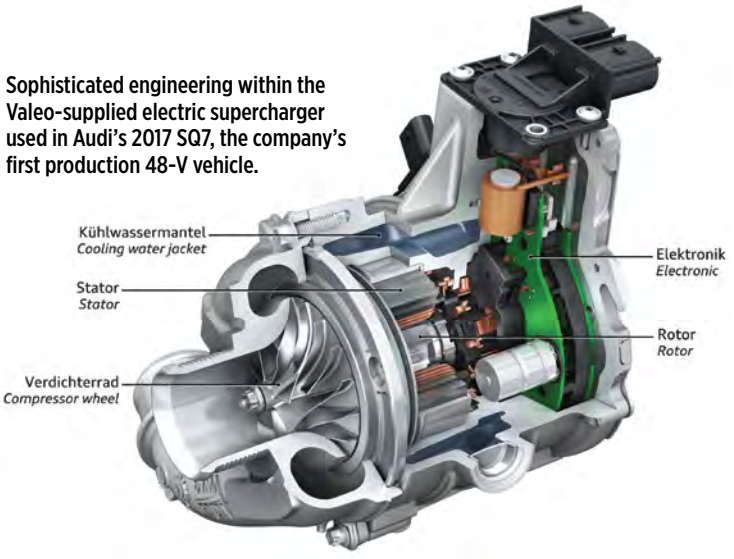
Inside the trunk of Delphi's Honda Civic diesel 48-V demo vehicle are DC-DC module (left), power distribution unit and fan-cooled Li-ion battery. (Lindsay Brooke photo)

Perhaps best of all, the technology has undeniable "bang for the buck"—about 30% of the cost of a high-voltage full hybrid system while delivering about 70% of the benefit, said engineer Sam Abuelsamid, senior research analyst with Navigant Research. "They're one of the most cost-effective solutions to continue reducing fuel consumption and emissions," he noted.

Dr. Byung Ki Ahn, **Hyundai**'s Director of Alt-Fuel Vehicle Engineering, agrees. "Cost efficiency is the big attraction—about $500 per system," he told *Automotive Engineering*.

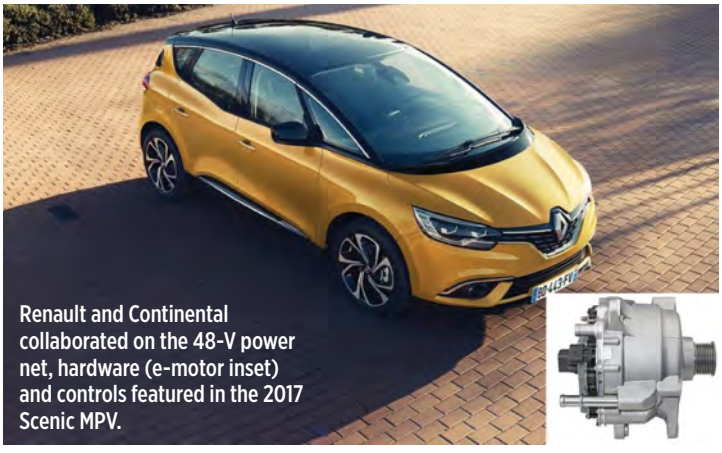
The fuel economy gains "are not as great as with a full hybrid," Dr. Ahn explained, but 48-V systems "are still worth it for meeting all the government regulations. We're making a lot of hybrids," he said, "but even with them we probably can't meet all the standards and regulations such as the EV mandate and the EU's 95 g CO_2/km rule. We need all means possible and in that sense 48-V could be an option. We are looking at it."

New regulatory hurdles that concern Dr. Ahn and his colleagues include the more aggressive WLTP (Worldwide harmonized Light vehicles Test Procedures), which call for additional reductions in CO_2



Sophisticated engineering within the Valeo-supplied electric supercharger used in Audi's 2017 SQ7, the company's first production 48-V vehicle.

Battery suppliers are engineering modular energy storage solutions dedicated to 48-V systems. This JCI example features lithium nickel-manganese-cobalt (Li-NMC) cell chemistry.



Renault and Continental collaborated on the 48-V power net, hardware (e-motor inset) and controls featured in the 2017 Scenic MPV.

emissions from the current NEDC (New European Drive Cycle) test. The WLTP aims to reduce by half the CO_2 reduction that is currently gained from 12-V stop-start systems. Supplier and OEM engineers are encouraged that the 48-V BSG systems will help them meet the new more real-world-focused test cycles.

Non-plug-in hybrid vehicles will feel 48-V's impact the most, the experts reckon. JCI's Wright believes 48V "will seriously challenge any hybrids going forward, because of its cost and performance."

Higher cost 48-V systems with greater capability are poised for introduction. The P1 through P4 vehicle topologies—e-motor positioned at the front of the crankshaft (P1), between engine and transmission (P2), behind the transmission (P3) and on the rear axle (P4)—are in development at various suppliers. Continental's P2 system co-developed with Schaeffler allows all-electric driving at up to 31 mph (50 km/h) with a claimed fuel savings of up to 25% greater fuel efficiency than a non-hybridized model, according to Juergen Wiesenberger, director of the hybrid vehicles business unit.

"Big business"

Suppliers develop complete systems with the hope that OEMs will purchase them rather than target-source a motor here and a DC converter there. Packages have thus emerged: for example, Valeo's 48-V offerings include the basic Hybrid4All based on the 48-V BSG; the e4Boost which adds the e-supercharger and the e4Sport introduced at the 2016 Paris show—it adds a 48-V electric rear axle drive. To reduce system cost, an air-cooled BSG is in the pipeline for 2017.

Engineering leaders interviewed for this article generally agree that 48-V systems will serve as a "bridge technology" between current mild HEVs and full EVs. "It's a transitional propulsion technology between today and the plug-in world," observed IHS analyst Mueller. "But what is the timeframe until that happens—particularly in the U.S. where fuel prices are expected to remain low for quite some time? OEMs will do whatever is necessary to achieve the regulations at that time."

"It's a gap-bridging technology from today to the high-voltage systems," commented Dr. Ray Kuczera, Vice President of Global Product Technology, **GKN Driveline**. He said his engineers "potentially see 48-V doing some boosting on the rear axle, adding a 48-V motor and battery to give some 'sailing' capabilities, some extra power and certainly some energy recuperation. It's an interesting technology. We could be a Tier-2 player in it because it's a good fit for our axles."

His colleague Jochen Weiland, GKN's head of business development, argues that the 48-V solution is being driven mostly by suppliers who have a big stake in extending the life of ICE-based propulsion. "That's why the BorgWarners, Schaefflers and Contis are pushing 48-V—they have a lot of content on the combustion engine side," Weiland said.

BorgWarner CTO Chris Thomas has another view. "I don't see 48-V necessarily as a 'bridge' from today's hybrids to high voltage EVs. "Some automakers will go across the board with 48-V for their engines and combustion systems then have a small portion as hybrids as balance to meet their CO_2 and CAFE standards."

For BorgWarner, the fast-rising 48-V tide "is huge business for us—I've got requests from three different OEMs to have a 48-V workshop by the end of this year," Thomas said last November. ■

Autonomy, connectivity headline the **2017 CONSUMER ELECTRONICS SHOW**

The automotive component of CES expands as global anticipation for automated driving and enhanced connectivity intensifies.

By Terry Costlow and Bill Visnic

Delphi showcases next-gen autonomous system at CES

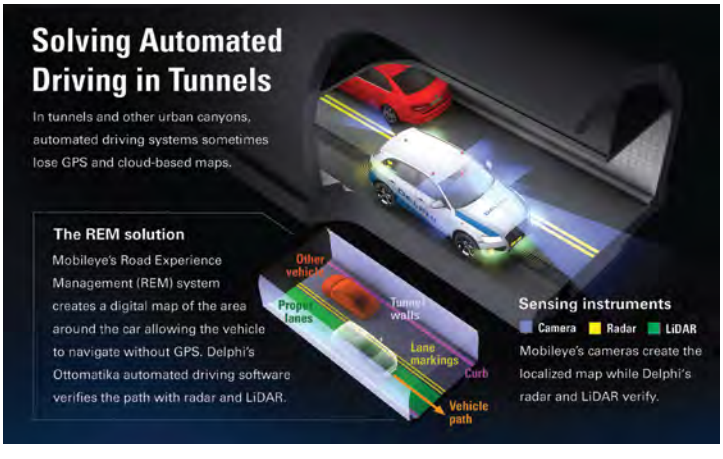
Delphi uses CES 2017 to demonstrate an advanced new automated-driving technology platform the company plans to make available to automakers by 2019 as a complete system to enable vehicles to operate with SAE Level 4-5 fully autonomous capability.

The Delphi technology platform, called Central Sensing Localization and Planning (CSLP), leverages the latest supercomputing microprocessor chip from **Intel**, as well as a new sensor-fusion processor and tri-focal camera hardware from Israel-based machine-vision specialist **Mobileye**.

But apart from the pure microprocessing power Delphi's assembled for the CSLP system, perhaps its most unique advance is new, Mobileye-developed software called Road Experience Management. REM provides the vehicle with crowd-sourced information to create an ultra-precise, real-time map that Mobileye said "is a prerequisite for safe autonomous driving."

The Las Vegas demonstration during CES 2017 is on a 6.3-mi (10.1-km) course comprised of public roads that Delphi claimed is "the most complex automated drive ever publicly demonstrated on an urban and highway combined route."

At a media information background session prior to the CES unveiling of the CSLP system, Glen De Vos, vice-president of services for Delphi, enthused that the CES demonstration is "the first time we will showcase this (combined Delphi, Mobileye and Intel technology) together. We couldn't be more excited.



Newly developed REM software, furnished by Delphi partner Mobileye, is a key enabler for Delphi's new CSLP automated-driving technology platform.

Delphi demonstration vehicle fitted with the company's latest automated-driving technology under test in Pittsburgh, home to the company's Ottomatika driving-software engineering unit.

"Three factors will separate the leader from the pack in the race to offer driverless vehicles by 2019," De Vos continued in a release: "best-in-class perception sensors such as cameras, radar and LiDAR, automotive experience and computer processing speed."

De Vos told the media the system, because of its advanced vision-sensing and software, will be less-expensive than others being developed that rely on still-costly LiDAR sensors to generate adequate data about the environment around the vehicle.

He said Delphi projects its turnkey system will cost on the order of $5,000, but that figure is of course expected to plummet as costs are reduced and sales volumes increase. He also said Delphi currently has no "committed customers" for the system.

In August 2016, Delphi announced its partnership with Mobileye to develop the sensor-fusion aspects required for high-level automated driving. A few months later, the company confirmed it had enlisted Intel to supply the advanced processing chipset that will enable trillions of calculations per second.

In 2015, Delphi acquired **Ottomatika**, an automated-driving software engineering specialist spun off from research at **Carnegie Mellon University**. It was Ottomatika driving-software algorithms that subsequently helped Delphi achieve a fully autonomous cross-country vehicle trip in 2015.

It is Mobileye's latest vision-sensing hardware and software, however, that is at the center of the Delphi CLSP system's sensor-fusion and software capabilities—particularly the REM software "overlay" on its EyeQ 4/5 System-on-a-Chip microprocessor. This enables the camera-vision capabilities alone to position the vehicle with a 10-cm (3.9-in) accuracy—even in the absence of a Global Positioning System (GPS) signal.

Dan Galves, senior vice-president and chief communications officer, said of REM, "This really is what Mobileye is offering to the industry." He added that in internal development, a test vehicle was able to drive autonomously using only camera vision after just four circuits of a congested portion of I-75 near Detroit supplied the necessary visual data for REM.

The REM software is "really in the validation phase right now," said Galves, who added that Mobileye also has supplied the REM software to EyeQ-based vision systems being used by **GM**, **Nissan** and **Volkswagen**.

Real-time understanding of the "local" environment with REM is "the key element of automated driving" using Delphi's new autonomous-technology platform, said De Vos. He explained that the company's recent automated mobility on demand (AMOD) pilot program in Singapore will adopt the REM-based system. Delphi also plans AMOD demonstration programs in North America and Europe (likely candidate cities in the U.S. include Pittsburgh and Boston).

Ironically, despite the high-powered processing capacity Delphi is building into its CLSP platform with the help of Mobileye and Intel, the REM software itself does not require much memory capacity. The roadside signs, buildings and countless other fixed landmarks throughout the nation that the system employs for a large portion of its localization "knowledge" only needs about 60 GB of data storage.

But at least for now, advanced camera vision and REM isn't replacing the highly-accurate, real-time onboard mapping capability available from LiDAR sensing. Delphi's De Vos said the CES demonstration vehicles will have six electromechanical LiDAR sensors, not to mention radar, to augment vision sensing.

Delphi sees AMOD projects as the likely first candidates for high-level (SAE Level 4-5) autonomous driving. De Vos noted that autonomous buses, mobility "pods" and individual ride-share passenger cars probably will be the best initial deployments for high-level autonomy. ■

Details of the suite of hardware and software technologies that comprise the CSLP platform Delphi said will be ready for the road in 2019.

Connect2Car is SAE's largest-ever CES program

SAE International Connect2Car conference during CES 2017 program is a full-day program that the organization promises "brings the best of current automotive technology discussions to CES."

Four Connect2Car sessions broadly encompass three of the industry's most-pertinent discussion areas: technology integration for connected vehicles, defining standards for automotive software development and demystifying the technology of the modern automobile. The program consists of the following sessions:

- **Reversing Babel: A United Language for the Connected Car**
  Babel is the story of one language becoming many—resulting in a dispersion of mankind throughout the world. But its lesson is still clear: a united language has incredible strength and benefit. There is discernable benefit when vehicles, homes, traffic signs, mobile phones and things all speak a united language.
- **Accelerating Connected-Car Software Development**
  Compared to mobile and internet development, connected-car development is in its infancy; if there's one lesson learned from mature markets, it's the need to lower the barriers to entry into the connected car to stimulate innovation, developers and solutions. That will be done via abstraction layers, open APIs, SDKs and development kits, developer programs, standards, and platforms that connect everything together—similar to the progression seen in the mobile-device industry.
- **Hacking the Modern-day Car: A Hands-on How-to**
  The contemporary vehicle is filled with sensors, computers and networks. Yet vehicles remain a mystery to many schooled in computer networking, software and communications. This how-to session will demystify the modern-day vehicle and show what tools are needed to explore (and maybe even modify) its electronic networks.
- **Connecting with Confidence**
  This interactive panel discussion provides insights and new ideas for automotive OEMs and supplier executives, technologists, marketers, consumer electronics leaders, mobile-app developers and aftermarket entrepreneurs focusing on enhancing the driver experience and accelerating the deployment of mobile technologies.

Connectivity advances dominate CES

If there's any doubt that connectivity is the next wave for advanced features and functions, it should dissipate after **CES** 2017. A multitude of advances in over-the-air updates and security are showcased at CES, setting the stage for auto-industry technology rollouts throughout the year.

Automotive's presence at the show, run by the **Consumer Technology Association**, continues to expand. A Self-Driving Technology Marketplace section is being added to highlight driverless mobility. Nine automakers and eleven Tier 1 suppliers will be among the 128 vehicle technology exhibitors, a slight increase over 121 exhibitors at CES 2106. An unspecified number of auto industry suppliers will demonstrate their latest advances in back rooms.

Technologies associated with connectivity will be the centerpiece in many of these demos. The third wave or third phase—loosely defined concepts for cloud connectivity and/or advanced driver assistance—will be mentioned in many booths.

One such connectivity conversation comes from **Visteon**, which is using CES to roll out a new infotainment system designed with connectivity as a central feature. Dubbed Phoenix, it consolidates Visteon's infotainment platforms with those gained in the 2014 acquisition of Johnson Controls' electronic business. The focus on Internet connections brings many factors into account.

"When you talk connectivity, you need to look at over the air (OTA) updates," said Tim Yerdon, Vice President of Design and Connected Services at Visteon. "When you talk about OTA, you need to talk about security. Security can't be overlaid; we started by looking at silicon for a fresh platform that focuses on security going up to the cloud."

Many different technologies must be considered to mesh with connectivity channels that will evolve over the vehicle's lifetime. 3G and 4G cellular networks are the current standards, but 5G networks are expected to arrive around 2020.

System developers must also consider vehicle-to-vehicle (V2V) communications, which many say is needed for advanced safety and autonomous driving. But if governments don't mandate V2V, rollouts of dedicated short range communications (DSRC) modems may be slow. Design teams are examining ways that cellular links can fill the gap and provide some safety benefits now touted for V2V.

"There are cases where you don't need the low latency of DSRC," said Alex Klotz, Director for Advanced R&D, Interior, at **Continental**. "It may be better to send some data to the cloud. A warning about black ice may come from a car that's a mile away. That's too far for V2X, but it's still beneficial data because the black ice won't disappear that quickly."

Companies are also examining "fog computing." It fits between the immediacy of V2X and slower cloud connections, using regional towers that have enough computing power to determine what data coming from vehicles is important enough to be transmitted to nearby vehicles. However, its role won't be determined until towers are constructed.

Connected-car architectures also push smart phones and apps to the forefront. Linking vehicles to an environment where year-long cycles are glacial requires an open platform, one that lets developers create apps that can be ported to vehicles quickly and easily. Many design teams feel that's best provided by using standards like HTML5, which is widely used on the Web.

"Our Phoenix platform is the first to be designed from the ground up using HTML5," Yerdon said. "We feel that's the right place to be for the future. With HTML5, you can create and test apps at the simulation level, you don't need to have hardware built and ready."

The infotainment evolution also highlights two trends driven in part by the growing role of consumer electronics in vehicle design—partnerships and industry consolidation. Both are intertwined in a recent partnership between **Airbiquity** and **Harman International**. Airbiquity is integrating Harman's Intrusion Detection and Prevention System, which identifies hack attacks, with its cloud-based Choreo service delivery platform. ■

Visteon's new Phoenix connectivity platform was designed from the start for wireless updates and security.

HMI progress: more features, less system complexity

Human machine interfaces are changing rapidly as radio head units handle more functions and connect to diverse systems inside and outside the vehicle. HMI systems are being consolidated, handling cluster control and other functions, while head-up displays (HUD) finally seem poised to gain greater industry and customer acceptance.

HMIs are becoming a major vehicle differentiator as they link drivers to the Internet and manage the myriad options now available inside the vehicle. The need to reduce driver distraction also comes into play in many of the new HMIs demonstrated at CES.

Such changes are forcing design teams to make HMIs more intuitive, even adapting to changing driving conditions so drivers have the right options for the relevant driving conditions.

"HMIs are not one size fits all, they need to understand what the driver needs," said Alex Klotz, Director for Advanced R&D, Interior, at **Continental**. "If someone's on a dark, icy road they don't know, why would you put a phone call through? Also, the needs of someone taking their family on a trip are different than someone driving alone, where they may want a more sporty drive."

These interfaces are expanding their scope to include cell phones, apps and navigation while also handling music from a range of sources. The cloud is also becoming both an input infotainment source and an extension of the vehicle's computing architecture, providing both infotainment from the Web and connections to the servers that make up the cloud. Cloud computing gives HMIs more power so they can do more.

"You need the cloud to orchestrate the large matrix of demands," said Scott Frank, Marketing Vice President at **Airbiquity**. "All the information and data needs to be tracked. With cloud connectivity, the vehicle will not only warn you that have a rolling flat [tire], the car will pull up the navigation system to show you options for taking the car in for repairs."

As the volume of inputs and outputs grow, the number of electronic control units may shrink. Many HMI systems are now managing the instrument cluster.

"When you combine the cluster and the infotainment system, software with safety requirements will run next to apps on the infotainment center," said John Wall, Senior Vice President at **QNX Software Systems**. "Secure firmware like our Hypervisor is needed to separate functions so problems in one area don't impact other programs."

The ability to isolate programs and operating environments will grow as design teams consolidate ECUs. Powerful multicore processors let engineers build domain controllers that handle a number of related functions, isolating them both on hardware and software.

Connectivity is among the many factors that prompt Continental's Alex Klotz to note that "HMIs are not one size fits all."

"Our domain controller uses multiple cores to drive the HUD, the cluster and infotainment," said Tim Yerdon, Vice President of Design and Connected Services at **Visteon**. "On the software side, it uses a hypervisor. One core runs the cluster, Linux runs infotainment on another core, and Android is on another core that runs apps. If something crashes, it just crashes that core."

HMIs may finally include HUDs now that combiner technologies make them more affordable. Combiners use a dedicated display surface house on the dashboard, a configuration that's far simpler to implement than systems that put imagery on the windshield. A technology that's been limited to a niche within the luxury segment may finally go more mainstream.

"HUD's success has been predicted for years," Yerdon said. "Its compound annual growth rates now look great, though it's growing from a small base." The primary benefit is that displays can show plenty of information directly in the driver's view so eyeballs aren't drawn down to center-stack screens. High resolution displays make it possible to present information from many sources.

"HUD can provide rich information from the cloud," Klotz said. "If vehicle systems don't provide it, people will use their smart phones and be distracted." ■

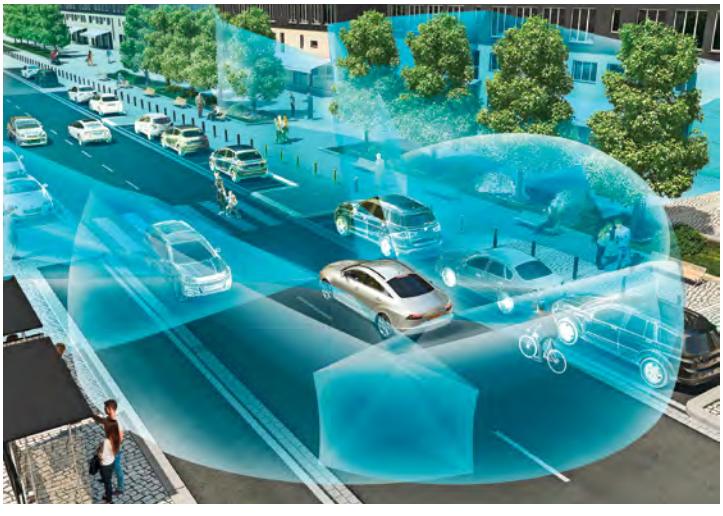
Continental: motorcycles join the 'swarm,' solid-state LiDAR

Megasupplier **Continental** headlined its CES grab-bag of technology introductions with a system to facilitate bringing motorcycles into the connected-vehicle ecosystem, a production-ready-looking biometric "log-in" for vehicle startup and personalization and a solid-state LiDAR sensor that adds to the supplier's growing range of vital sensor hardware.

Continental calls the motorcycle connectivity system "eHorizon" and said the technology seeks to help cyclists figuratively "see around corners," by leveraging crowd-sourced information about road conditions to help avoid situations that are particularly dangerous to two-wheelers. For the eHorizon system, however, Continental uses the term "swarm intelligence" (somehow seems more appropriate for motorcycles)—instead of crowd-sourcing—to describe the continuous supply of cloud data about obstacles along the chosen route, including occurrences such as oil on the road. The info is relayed to the rider through a special instrument cluster with special safety-related hazard icons; the rider can set preferences for data priority—while an accompanying smartphone app uses Bluetooth connectivity with eHorizon to provide features such as turn-by-turn navigation and keyless ignition.

The eHorizon system uses "swarm intelligence" to make motorcycle riding safer and more connected.

Biometrics present the opportunity for a heightened level of vehicle security and personalization, Continental said.



Solid-state 3-D LiDAR provides a comprehensive real-time view of the vehicle's surroundings, regardless of environmental conditions.

Meanwhile, Continental signals its intent to be a significant force in sensor hardware with its CES display of Hi-res 3D Flash LiDAR (HFL), a completely solid-state LiDAR sensor array to address the critical need for cost-effective and more packaging-friendly LiDAR for advanced driver-assistance features and fully autonomous vehicles. The company said the technology, which has been well-vetted in the aerospace sector, "provides a significantly more comprehensive and detailed view of the entire vehicle environment—both during the day and night—and works reliably even in adverse weather conditions."

Of a more-visible gee-whiz nature is Continental's melding of conventional keyless access/pushbutton-start smart with biometrics to create a "smart access" arrangement that goes beyond current functionalities. The start button's biometric fingerprint reader offers additional security by allowing only authorized persons to start the engine. Then, face-recognition (by onboard camera) brings additional personalization potential—mirror, seat, audio and climate-control settings, pre-loaded destinations—can be directly associated with a specific individual. Prior to CES, the company did not indicate any specific OEM customers for the biometric smart-access system, but it appeared production-ready. ■

New Ford Fiesta claims B-car tech leadership

It may look similar to the current model, but **Ford** describes its next-generation Fiesta as the "world's most technologically advanced small car."

Revealed in Cologne at the company's latest "Go Further" event that signals what's in the design, technology and engineering pipeline, the new Fiesta will project Ford's determination to produce models with "more premium appearance," complemented by other aspects of quality ascendance.

For the Fiesta, these span everything from quieter cabins (road noise reduced by a claimed 7%), more luxury touches and enhanced safety, to achievement of improved build quality that even includes analysis of noise frequencies produced during parts stamping to identify any component that is below required quality standards.

The Fiesta variants now include an Active crossover, marking the introduction of the Active category scheduled to join the Ford model range. Just how "active" the Fiesta Active will be is not yet clear; Ford describes it as having SUV-inspired styling with roofbars and raised ride height. It will be added to the range after the launch at a later, unspecified date.

Clearly a Ford Fiesta, but the new generation is more sculpted and gets an even larger front grille. A design aim was to achieve a "more premium appearance." Shown is the ST-Line version.

An opening panoramic roof is one of the luxury touches available for the new Fiesta.

Taking the B-car upscale

Engine choice includes a 103-kW (138-hp) 1.0-L Ecoboost triple and an 88-kW (118 hp)1.5-L diesel 4-cyl. (Ford also announced cylinder deactivation for its diminutive triple.) A new 6-speed manual transmission with reduced internal friction is also introduced. Although not yet officially confirmed, the best Fiesta CO_2 emission figure is 82 g/km (equivalent to 66.5 mpg). An ST-Line Fiesta has sport suspension and sporty styling touches.

A high-performance ST is expected. The Fiesta will be manufactured in both 3- and 5-door hatchback configurations.

Jim Farley, Ford's Executive Vice President and President Europe, Middle East and Africa, says the evolutionary and highly mature new car brings technologies and features that customers for small cars "could only have dreamed of just a few years ago."

Cabin noise reduction

Ford targeted cabin noise reduction as a must for the Fiesta; a 15% torsionally stiffer body structure helps. It uses 36% more boron steel incorporated in key areas such as the upper section of the B-pillars where a T-section more effectively transfers side-impact energy into the roof. The car also gets stiffer front subframe attachment points, welded twistbeam attachment points, reduced NVH via powertrain isolation and an acoustic windshield. All this supports claims of a best-in-class interior road noise level of 29.3 sone at 100 km/h.

"We have paid a lot of attention to elements and features that customers notice, without realizing it, from panel gaps to pedal feel," explained Darren Palmer, small car vehicle line director, Ford of Europe.

Safety engineering

Fiesta is the first Ford in Europe to undergo computer simulation crash tests of a complete vehicle using advanced new FEA to generate more effective optimization of safety features. Interestingly, the introduction of a locking seatbelt tongue to help prevent belt slippage during an accident is described as obviating the need for a driver kneebag.

Complementing the luxury touches are 15 driver examples of specific assistance technologies including cameras (two), radars (three) and ultrasonic sensors (a dozen). They work together to provide 360° ambient monitoring and a 130-m forward scan range.

Cross Traffic Alert is claimed by Ford as a first in the small Ford's sector. Adaptive cruise control is available.

Excellent and nimble handling has always been a major part of the all generations of Fiesta. The new car is claimed to have 10% more cornering grip than the outgoing model, partly due to electronic torque vectoring. Front track is wider by 30 mm (1.1 in), rear by 10 mm. The wheelbase is increased by just 4 mm, overall body length by 71 mm, and width grows by 12 mm. Eighteen-inch wheels are an option.

Braking distances from 100 km/h (62 mph) are shorter by 8%, the engineers claim. Steering friction is reduced by 20% and steering response benefits from the use of double-bonded suspension bushings. Twice as stiff as those on the "old" Fiesta, the new bushings "bulge in a specific shape" to better deal with road imperfections and to complement the larger rear-suspension twistbeam to reduce the effect of small bumps and also contribute to reduced cabin road noise.

Stuart Birch

LA auto show: Mazda's all-new CX-5 bringing diesel engine for North America

Mazda says the 2017 CX-5 is all-new, but its major dimensions almost exactly replicate the current model, seemingly indicating the company believes its established footprint is near-perfect for the compact-crossover market (Bill Visnic photo).

Mazda made no secret it would unveil an all-new CX-5 compact crossover—now one of its best-selling models in the U.S.—at the 2016 Los Angeles auto show. The surprise Mazda saved for the day after the 2017 CX-5's introduction was that the new version of the company's popular crossover will offer a diesel-engine option for the North American market.

It will be Mazda's first-ever U.S. diesel when it goes on sale in the second half of 2017.

Big torque, less clatter

The company did not provide specifications for the Skyactiv-D 2.2.-L four cylinder slated for the U.S.-specification CX-5, but Akira Marumoto, Mazda executive vice president, promised it will "have the torque of an engine almost twice its size," while delivering "fuel efficiency at the hybrid level."

Mazda sources told *Automotive Engineering* the diesel engine is a new architecture designed from the outset to be coupled with selective catalytic reduction (SCR) exhaust aftertreatment. The current Skyactive diesel engine family—used extensively in Japan and once earmarked for U.S.-market vehicles such as the Mazda6 sedan—does not employ SCR technology. The lack of SCR likely is what caused Mazda to suspend its initial plans for deployment of the diesel in the U.S.; in wake of the Volkswagen diesel-emissions scandal that also centered largely on VW's desire to use diesels without costly SCR technology, hindsight might indicate Mazda was wise not to deploy its non-SCR diesel in the U.S.

At the Los Angeles auto show unveiling of the 2017 CX-5 and announcement of the new diesel-engine availability, Marumoto admitted that developing a diesel to reliably comply with U.S. emissions standards "took longer than expected," but added, "I can promise this engine will not disappoint."

He also said that Mazda has engineered unique technologies for the new, all-aluminum Skyactiv-D engine to dampen diesel clatter, dubbing them "Natural Sound Smoother" and "Natural Sound Frequency Control," without elaborating further. Sources did say, however, that exceptional efficiency and low emissions are expected because of the new engine's extremely low compression ratio, which is projected to be near or even equal to the company's gasoline 4-cylinder.

The current Skyactiv diesel 4-cylinder has a compression ratio of 14:1—Mazda claims it to be the diesel-world's lowest—while the Skyactiv gasoline four-cylinder used in the 2016 CX-5 crossover has a 13:1 compression ratio. Mazda did not provide any guidance on power or torque for the new 2.2-L Skyactiv-D, but the output of the current Skyactiv diesel might offer useful reference, that engine developing a listed 173 hp (129 kW) and 310 lb·ft (420 N·m).

The company further promised the 2.2-L Skyactiv-D will uphold Mazda's reputation for engaging driving characteristics thanks to its high torque output and a focus on revving willingly to high rpm.

New CX-5

The new 2017 CX-5 seems an ideal candidate for Mazda's first-ever diesel: its styling is husky and assertive, with a grille that closely mimics the recently launched CX-9 large crossover. The new crossover's interior also appears upgraded and more substantial and the company promised improved interior quietness and refinement.

In size, however, the 2017 CX-5 closely mimics the current model. The 106.3-in (2700-mm) wheelbase is the same, and the 2017 model's 179.1-in (4549-mm) overall length and 72.5-in (1842-mm) width are within a couple tenths of the current CX-5. Mazda did not yet list curb weights for the 2017 CX-5 lineup, but the current model in top-trim all-wheel-drive form weighs 3589 lb (1628 kg).

Mazda said the new CX-5 has an increase in torsional rigidity of 15.5% and there is increased use of ultra-high-tensile steel, including 1180 MPa steel for the A-pillars and 980 MPa steel for the side sills and B-pillars.

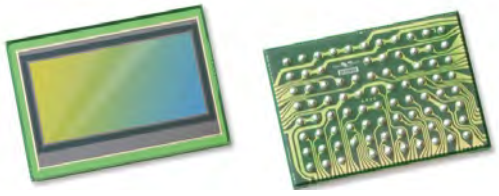
The front suspension continues with a MacPherson strut layout and there is a multilink design for the rear suspension. Mazda is incorporating its recently introduced G-Vectoring Control (http://articles.sae.org/15002) to sharpen corner turn-in characteristics.

The 2017 CX-5 will launch early next year; for now, Mazda indicates the only gasoline engine used will be the 2.5-L Skyactiv-G; the current CX-5 also offers the smaller 2.0-L version of the Skyactiv-G. The company's early specifications also list only a 6-speed automatic transmission as being coupled with the 2.5-L engine. For the diesel-engine launch time frame, company officials would not commit to anything narrower than the second half of 2017.

Bill Visnic

SPOTLIGHT: SENSORS

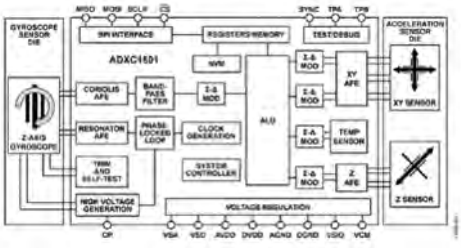
1.7-megapixel automotive image sensor



The OV10650 from **OmniVision Technologies**, Inc. (Santa Clara, CA) is a wide-format image sensor that captures high-quality color images and video in a 2:1 aspect ratio. Built on OmniVision's 4.2-µm OmniBSI split-pixel technology, the company claims the OV10650 delivers 1820 x 940 resolution at up to 60 frames per second and 120 dB of dynamic range with best-in-class low-light. The sensor is compatible with OmniVision's powerful new image signal processing companion chips (OV491 and OV495) for display-based automotive applications. Packaged in an AEC-Q100 Grade 2-qualified, compact 9.5 x 6.8-mm (0.4 x 0.3-in) chip scale package, the OV10650 contains an advanced set of features to enable ISO26262 ASIL B-rated camera systems. According to the company, the OV10650 is suited for next-generation rear video mirrors using wide high-resolution displays that enable the driver to make better, more-informed decisions, especially in challenging driving conditions due to increased situational and spatial awareness around the vehicle.

For more information, visit http://info.hotims.com/65847-400

Integrated accelerometer/gyro combo sensor



The fully integrated ADXC150x series of inertial combo sensors from **Analog Devices**, Inc. (Norwood, MA) brings together reliability and accuracy with shock and vibration immunity at a reduced footprint. According to the company, the ADXC150x combo sensor family overcomes the substantial challenges associated with integrating an automotive-grade gyroscope and accelerometer in a single package. These combo sensors integrate up to 4 degrees of freedom into a single device, which not only reduces component count and expensive, time-consuming custom integration, but also improves inertial sensing accuracy and reliability. Yaw gyro drift over temperature is less than 1 degree/s (typical), and the internal temperature sensor calibrates the output to provide excellent stability across the temperature range of -40 to +105°C (-40 to +221°F). The ADXC150x also features comprehensive electromechanical fail-safe routines and continuously monitors device health to ensure the integrity of the data.

For more information, visit http://info.hotims.com/65847-401

High-performance thermoplastic elastomer

Typical Properties of Injection Molding Elastomers for Automotive Interior Parts

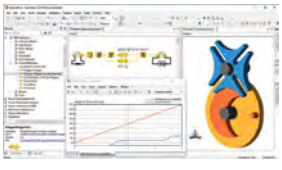
Typical Properties	Test Method	EPDM Rubber	High-Flow TPV	Sarlink® TPE ML-2355B
Hardness, Shore A Injection molded, 1 in. Injection molded, 15 in.	ISO 868	54 51	61 57	57 52
Density, g/cc	ISO 1183	1.165	0.846	1.059
Tensile strength, MPa At break At 500% elongation	ISO 37	12.8 1.0	4.8 2.0	5.3 1.7
Elongation at break, %	ISO 37	753	460	678
Compression set, % 22 hrs at 70 °C 70 hrs at 90 °C	ISO 815	26 40	45 60	50 70
Brittleness point, °C	ISO 812	-52 (break)	< -60 (no break)	< -60 (no break)

Source: Teknor Apex Company

Sarlink ML-2355B from **Teknor Apex** Co. (Pawtucket, RI) is a new styrene block copolymer thermoplastic elastomer (TPE-S) for automotive interior parts such as cable ducts and grommets. It exhibits improved injection moldability compared with other elastomers while providing competitive physical properties and meeting stringent OEM requirements, the company claims. Sarlink ML-2355B has been approved for use in cable ducts by **Volkswagen Audi Group**. Used to guide cables in their route through spaces in pillars and other structures surrounding the passenger compartment, these ducts are complex parts with long flow paths and many undercuts. The compound exhibits reduced viscosity for improved moldability, a wider processing window, and greater weld-line strength to facilitate air-assist de-molding.

For more information, visit http://info.hotims.com/65847-402

System simulation software



SimulationX (3.8) from **ESI Group** (Farmington Hills, MI) is the latest version of the software platform for dynamic multiphysics system simulation, customizable to the specific needs of diverse industries. The company claims it delivers significant enhancements and additional features for the simulation of drive systems, electromechanics, hydraulics, mechanics and pneumatics in industries including transportation, energy, industrial and mobile machinery, as well as mining. Supporting the open-source modeling language Modelica, ESI's SimulationX features flexible, easy-to-use and open architecture. It offers comprehensive integrated libraries of realistic physical models that are useful as a reference in a variety of industrial fields where the intersection of physics disciplines (including mechanics, electronics, controls) is increasingly advanced (e.g., electric or hybrid powertrain applications).

For more information, visit http://info.hotims.com/65847-403

Four-channel around-view systems decoder

Intersil Corp. (Milpitas, CA) offers a four-channel analog video decoder with MIPI-CSI2 output interface that supports the latest generation of system-on-a-chip (SOCs) and application processors used in automotive around-view systems—the industry's first, claims the company. The ISL79985 is the newest member of Intersil's video decoder family, and it replaces up to nine discrete components with a single chip to preserve critical board space. According to Intersil, the device delivers superior four-channel analog decoding performance for generating 360-degree around-view video to detect objects around the vehicle and assist drivers with backup and parking. Additionally, the ISL7998x family includes the new ISL79986 with a line-interleaved BT.656 interface.

For more information, visit http://info.hotims.com/65847-404

Automotive-qualified chipset for V2X

Autotalks' (Kfar Netter, Israel) next-generation V2X devices embed a mobility-optimized modem, support dual-antenna with optimal and flexible RX/TX (receiver/transmitter) diversity, perform line-rate message ECDSA (Elliptic Curve Digital Signature Algorithm) verification of the entire link capacity and embed an ultra-low-latency V2X HSM (Hardware Security Module). In addition, Autotalks' next generation was designed for cryptoagility and scalability and is capable of operating at a high temperature range. Autotalks' chipset was selected by **Denso** and will be at the center of the company's global V2X platform for automakers' mass market projects. According to Autotalks, the prototyping phase has already started for a high-volume start of production in 2019 that targets the North America market.

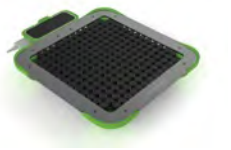
For more information, visit http://info.hotims.com/65847-405

Automotive relays and sockets

CIT Relay & Switch (Minneapolis, MN), a division of **Circuit Interruption Technology**, Inc., offers automotive relays from low current up to a highest switching capacity of 80 amps with voltages ranging from 6-V DC to 72-V DC. PC pin and quick connect mounting methods offer multiple choices for the design engineer, along with the option of mounting tabs in plastic and metal. CIT also offers automotive relays with a shroud option and sockets for mounting solutions. Pricing ranges are dependent upon options and volume.

For more information, visit http://info.hotims.com/65847-406

Mid-air haptics evaluation and prototyping



Ultrahaptics' (Bristol, England) development platform allows companies looking to evolve innovative control solutions a route to evaluate and appreciate the benefits of gesture controls enhanced by tactile feedback sensations. The self-contained, plug-and-play UHDK5 TOUCH provides a complete hardware and software package with an architecture that can readily be embedded in product designs, from prototypes through to volume production. With its patented core technology, Ultrahaptics uses ultrasound to provide a unique touch sensation, enabling users to "feel" virtual buttons, switches, dials and other objects in mid-air. Touchless controls are hygienic for use in industrial environments, while their use for automotive infotainment and dashboard functions enhances safety, allowing drivers to keep their eyes on the road.

For more information, visit http://info.hotims.com/65847-407

Application lifecycle management module

As part of **Arena Solutions**' (Foster City, CA) 2016 Fall Release, Arena Verify adds requirements and defect management to the company's product offering. These capabilities result in what the company claims is a comprehensive, cloud-based product-development platform that unites engineering, quality and operations disciplines in the creation of innovative connected products. Arena Verify helps bring this comprehensive product development platform together. According to Arena Solutions, when defects are discovered, the entire process is captured within the product record. As a result, Arena Verify provides internal stakeholders and the extended supply chain with complete information on the issue.

For more information, visit http://info.hotims.com/65847-408

Automotive display driver integrated circuit

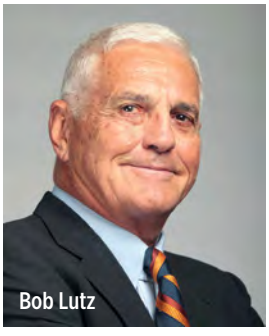
Designed for the automotive market, **Synaptics** Inc. (San Jose, CA) offers a new R6A354 display driver integrated circuit (DDIC) solution. According to company claims, the ClearView R6A354 is the industry's first automotive DDIC to leverage image enhancing technologies, including color enhancement, local area auto-contrast optimization, sunlight readability enhancement, 6-axis hue control and independent white-point adjustment, thus enabling OEMs and their Tier 1 suppliers to customize screens for product differentiation. The device supports a broad range of resolutions from HD to Full HD and accommodates screens up to 15-in or larger in a cascaded DDIC implementation. R6A354 also supports free-form and curved displays.

For more information, visit http://info.hotims.com/65847-409

Lutz on Great Engineers

Great Q&A with Bob Lutz! [November 2016] When I joined Chrysler right out of college in 1985 there weren't, in my opinion, many engineering executives at Highland Park whom any of us young enthusiasts would have considered to be "car guys." I'm talking about two or three levels of "technical" people above me. Most of the top guys would have been fine with producing dishwashers for Frigidaire. It wasn't until Lutz, Castaing, Theodore, Robertson, Gale and a few other key leaders took the company reins—I'll even include Bob Eaton before the Daimler takeover—that our company came alive and started to build vehicles that were actually exciting and interesting. Lutz was one spark behind this product, design and engineering renaissance but it was the entire team around him that got us firing on all cylinders.

Ramman440
via email


Bob Lutz

Fun interview with Bob Lutz in *Automotive Engineering*!

Jeremy Goddard
via email

I agree with Bob Lutz—a student's grade point average often has nothing to do with their ability to lead an engineering team or be an effective technical asset. Some of the best people we have in our engineering group are good because they're not afraid to jump in and do what it takes to make things right. Dirty fingernails indeed! I've worked with engineering managers whom I wouldn't want to change the oil in my car let alone lead a program. Take intelligent risks? Not them.

Pistolpete
via email

"I agree with Lutz—a student's GPA often has nothing to do with their ability to lead an engineering team or be an effective technical asset."

READERS: Let us know what you think about *Automotive Engineering* magazine. Email the Editor at Lindsay.Brooke@sae.org

COMPANIES MENTIONED

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AD INDEX

Kathy Winters listens to a reporter's question at a technology event. (Lindsay Brooke photo)

Intel inside the cloud-based data future

Kathy Winters has been re-introducing herself in auto industry circles lately. Last summer, the well-known **Delphi** engineering executive joined **Intel** as General Manager of the Automated Driving Solutions Division (ASD)—the chip maker's-fast growing group dedicated to advanced driver assistance systems (ADAS) and automated-vehicle technology. Soon after, *Automotive Engineering* and Winters re-connected for a discussion about automated driving's need for intense data-processing capability.

With the increasing use of processors in the vehicle and the need for more processing power, is Intel now officially a Tier 1 in some cases?
We're still a Tier 2 but kind of a 'hybrid'—we're actually a Tier 2 development partner because we're helping to architect the system. If you look at our engagement with **BMW** for example, we're very 'hands-on,' working more directly with them and (machine-vision specialist) **Mobileye**. There will always be a Tier 1 in that mix, I would say, doing the integration. So we're bridging a gap.

The biggest opportunity for us is to do both the in-vehicle piece—which requires heavy data processing, filtering and transmission for the ADAS sensor fusion—and to understand the 5G connection in the vehicle and then really put in that 'data center' with the learnings and apps that have to be there.

The data center will be understanding where the cars around you are, sending out traffic information and helping to optimize road use at the best times.

The 'data center' will be in the cloud?
Correct. There is an enormous amount of in-vehicle data that's coming off the radar, vision systems, LiDAR and from the V2V connection—from other vehicles. The vehicle when it's in automated mode needs to react and path-plan, executing split-second decision-making. That has to come from the cloud and it involves communicating with other vehicles, all with minimal latency. We need a super-fast computing cloud, so we'll need 5G: we need the 'pipeline' and the speed.

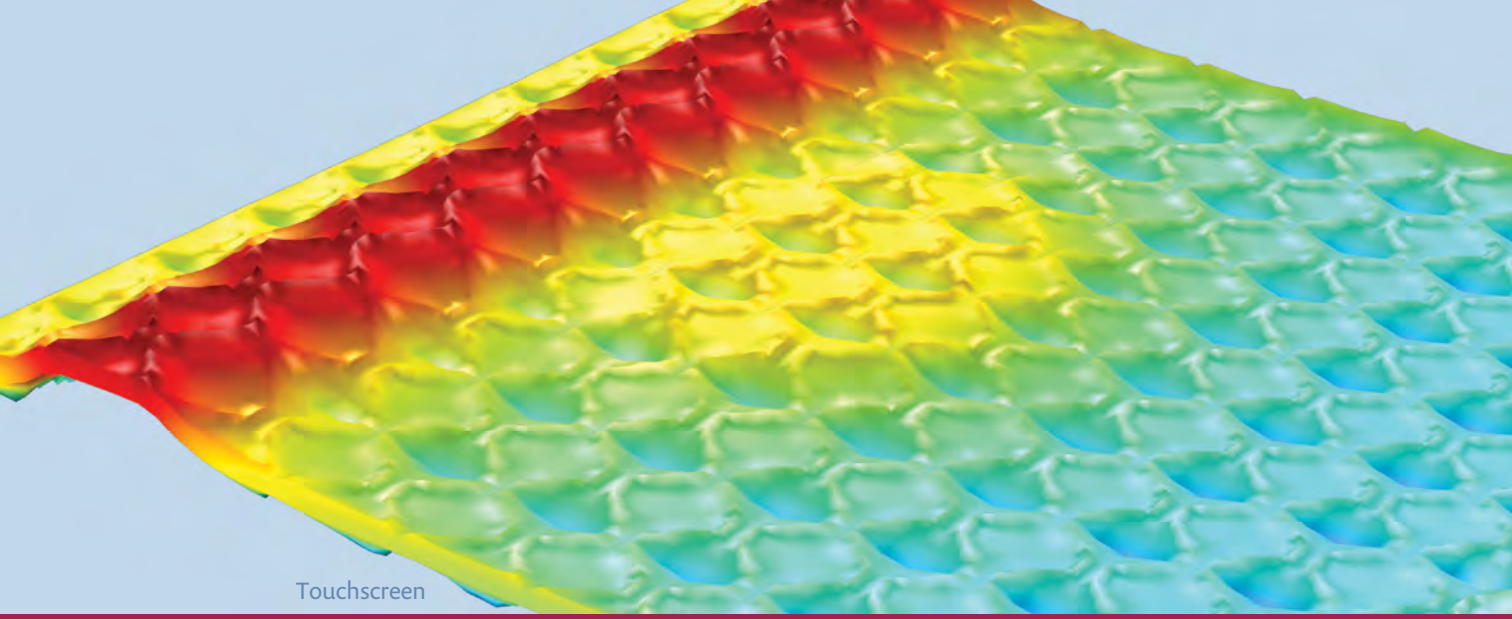
Do you expect the data center to ever become an off-the-shelf technology solution?
Nothing's off-the-shelf in this space yet. We want to get to a really well-defined platform, potentially something that could be (widely) used and not require everybody in the industry to have to reinvent their own.

The subject of latency and speed to and from the cloud is getting a lot of discussion among ADAS engineers.
Decision processing may have to be less than a millisecond. The vehicle will also need the ability to upgrade and upload new software. Over-the-air (OTA) is driving a lot of memory and storage. Do you keep the old load and the new load in parallel, or wait to completely flash-out a new engine controller? Now that OTA is a reality, how do you partition it and how much storage and memory do you need onboard to make the appropriate upgrades?

What's your view of the SAE Level 3 and driver re-engagement debate—when and how the automated car hands back control to the human?
Today Intel and others are focused on Levels 2, 3, 4 because active safety is and will continue to be really big business. But some folks are being more disruptive and going straight to the end game of full autonomy. The mobility-on-demand guys want to get the human driver out—that's what their business case is focused on. They're the ones driving the pace to Level 4 faster than the folks who are incrementally ratcheting up safety on the way to Level 4. I see a place for both.

This revolution won't happen all at once.
There will be a very interesting dynamic on our roads during the next 10 years, with traditional car owners driving fully manually in traffic with Level 2 and 3 vehicles as well as robo-fleet vehicles. It will take years to push those older Level 0 vehicles out of the car parc. But all the 'Smart City' initiatives are really going to drive more and better data and use cases for our development going forward.

Lindsay Brooke



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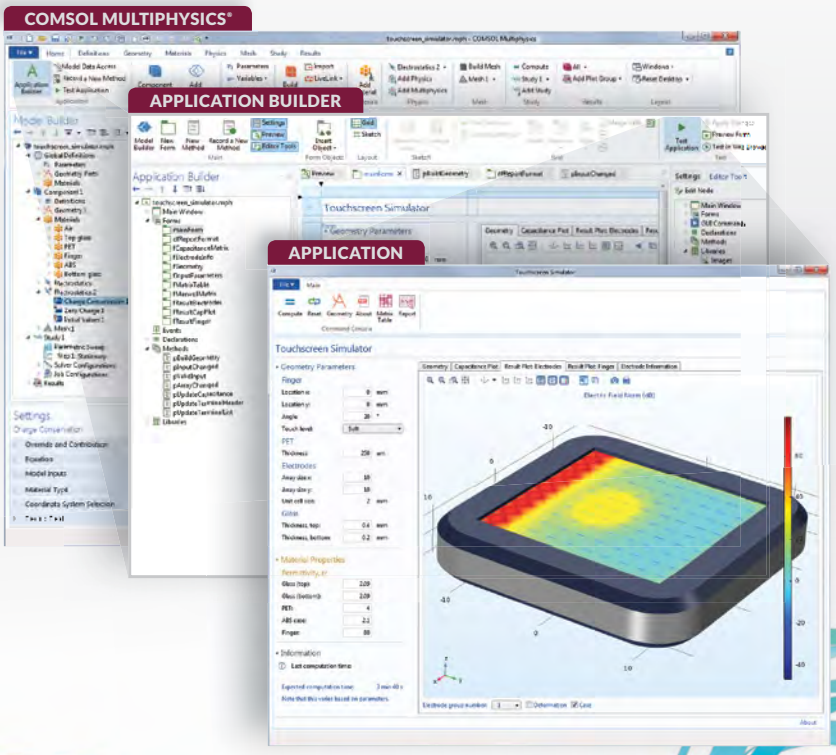

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