WARDSAUTO™

THE BIG STORY / SEPTEMBER 2018

They're Heeere!

AUTONOMOUS VEHICLES NO LONGER SCIENCE FICTION

Cover caption: Mercedes-Benz F 015.

It's official. Autonomous vehicles are a reality.

Operating along a 1-mile (1.6-km) route in downtown Detroit, purpose-built AVs are now in commercial use, shuttling up to 500 workers daily from parking lots to their offices in buildings scattered about a small section of the city.

The vehicles, converted Polaris GEM neighborhood electric vehicles, can travel at speeds up to 25 mph (40 km/h), but traffic and stoplights put the average at less than 20 mph (32 km/h).

The project is the work of May Mobility, an Ann Arbor, MI-based tech start-up that is responsible for the vehicle's Level 4 (geo-fenced) autonomous drive system. The vehicles themselves are converted to 6-passenger people carriers by contract assembler and parts supplier Magna at its facility in Troy, MI.

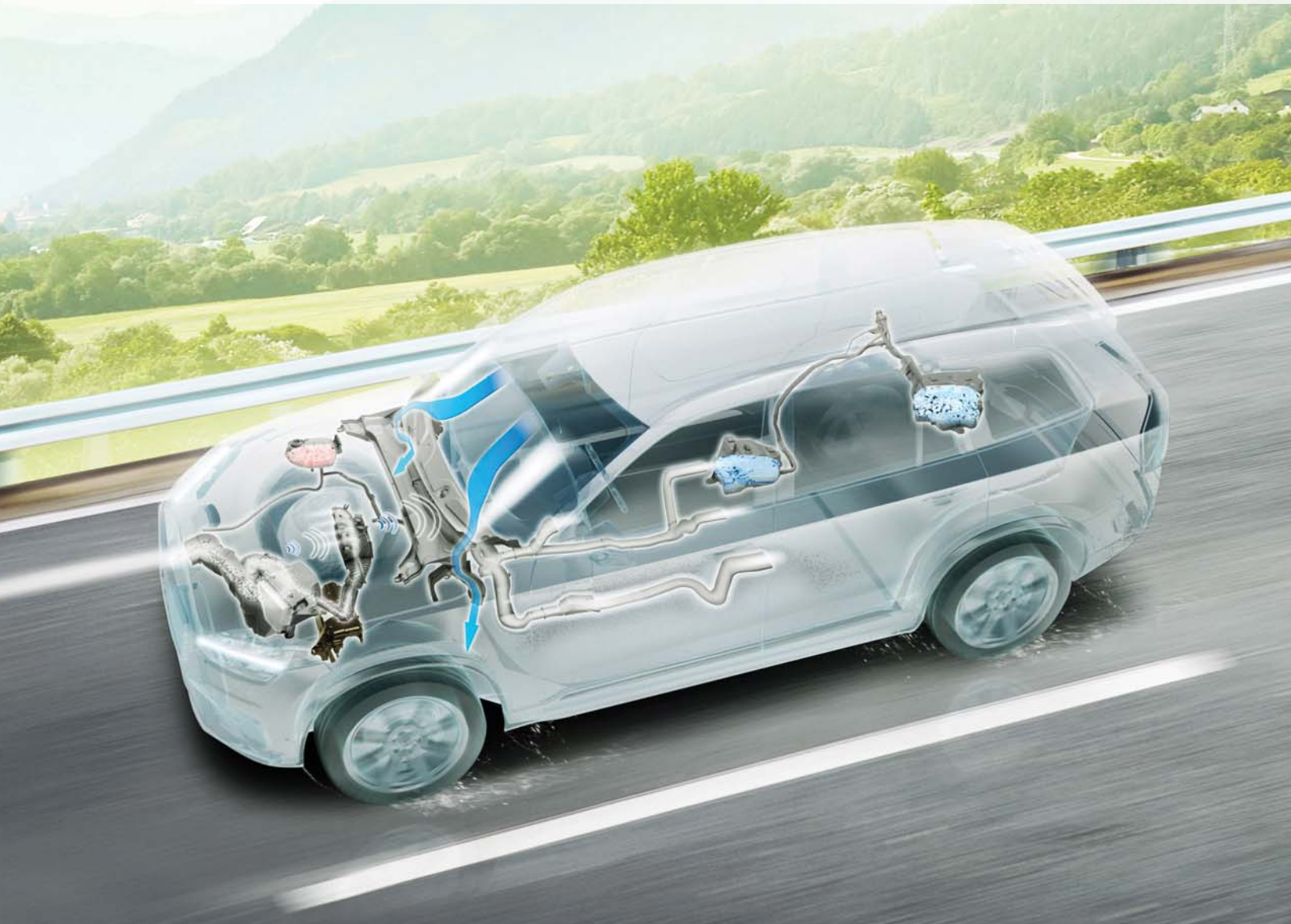
May Mobility's Detroit shuttle.

RÖCHLING

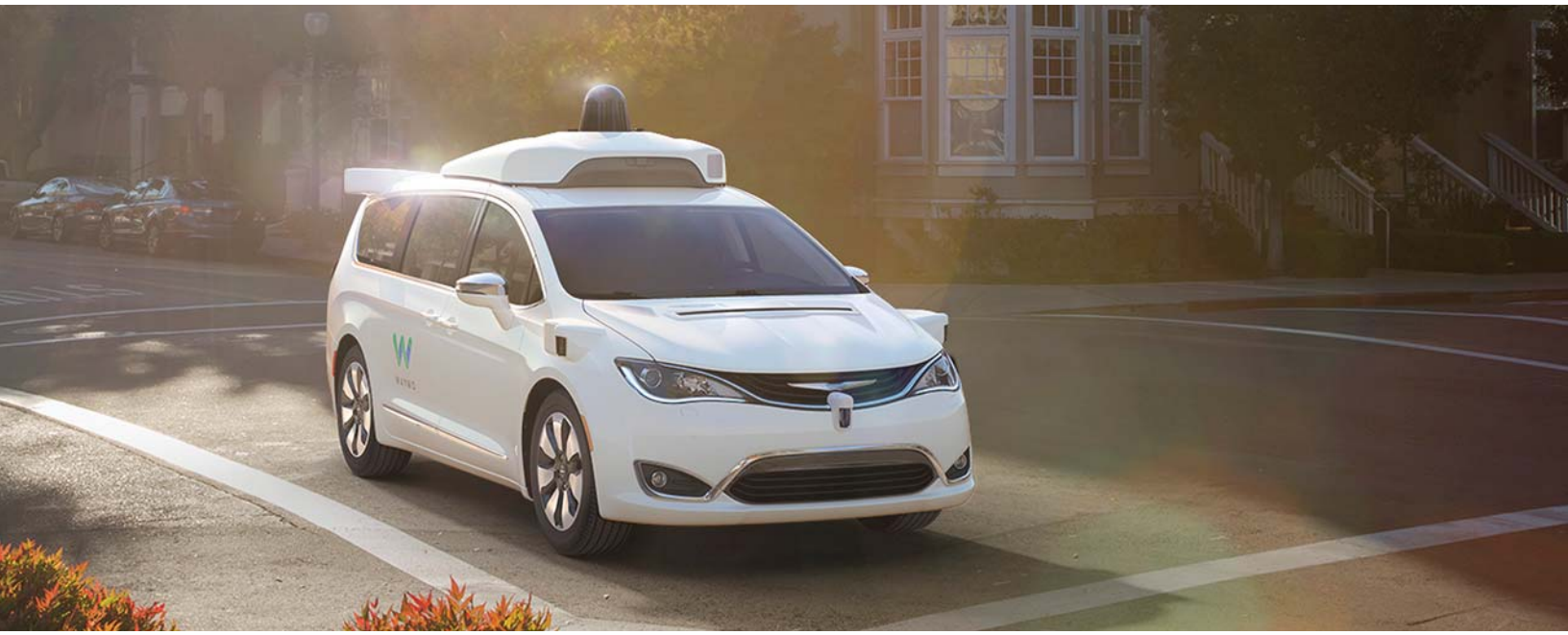
Allow Engines to Breathe.

Maximize Pure Airflow. Tune Sound on Demand.

Temperature Resistance. Longevity.
Maximum Performance. Sound Design.



www.roechling.com



Waymo to put 60,000 Chrysler Pacifica AVs into service.

Putting them to use are a couple of companies run by Dan Gilbert, owner of the NBA's Cleveland Cavaliers and a local businessman who is helping to lead Detroit's downtown renaissance.

For now, a person is aboard to drive the shuttle if necessary, but the plan is to eventually remove the T-bar steering mechanism and pedals and simply monitor the vehicle remotely from May Mobility's operational center located in the shadows of General Motors' Detroit headquarters.

The company foresees expanding its service to other corporate campuses and municipalities soon.

"This is no longer a science project," May Mobility Chief Operating Officer Alisyn Malek declares ahead of a ribbon-cutting ceremony that launched the service in June. "This is real transportation."

Of course, May Mobility is far from alone in the pursuit of AV technology and associated business models.

Other pilot programs are in place at college and corporate campuses and along public roads throughout the U.S. and world.

Waymo, a division of Google parent Alphabet, is purchasing more than 60,000 Chrysler Pacifica Hybrid minivans from FCA US and

GM ready to deploy Chevrolet Bolts without steering wheels and pedals.

20,000 I-Pace battery-electric vehicles from Jaguar Land Rover for AV mobility services it will offer in Phoenix, Atlanta and potentially other U.S. markets beginning later this year. GM is planning to place Chevrolet Bolt battery-electric vehicles, sans steering wheel and pedals, into mobility service in 2019.

Ride-hailing firms Uber and Lyft also are working toward deployment of AV fleets. Mercedes has similar plans for 2020, and BMW and Ford are aiming to place self-driving vehicles into mobility projects by 2021. Other automakers have near-term targets as well, including Hyundai, Volkswagen and Volvo.

GM forecasts that once ride-hailing costs fall below $1 per mile in 2025 from $2-$3 today – in part from removing the driver – mobility services will account for 20% of the miles driven and a $750 billion annual market. Profit margins in the sector are predicted to be double the return from selling a vehicle.

In a recently released report, "The Autonomous Vehicle Roadmap," Wards Intelligence looked at where the market is

CHANGE**DRIVEN**

OUR FORWARD-LOOKING TECHNOLOGIES WILL SUSTAINABLY CHANGE TOMORROW'S MOBILITY. EXPERIENCE OUR INNOVATIVE SOLUTIONS FOR COMBUSTION ENGINES, HYBRID AND ELECTRIC DRIVES. TECHNOLOGIES BY RHEINMETALL.
SOLUTIONS FOR A CHANGING WORLD.

WWW.US.RHEINMETALL-AUTOMOTIVE.COM

KOLBENSCHMIDT PIERBURG MOTORSERVICE

RHEINMETALL AUTOMOTIVE

Today's AVs trace their start back to the 2004 DARPA Grand Challenge, in which not a single entry made it past the final mark.

headed, when it will arrive and who among traditional automakers and suppliers and non-traditional disruptors will lead the way.

Spoiler alert: Don't expect fully autonomous vehicles to arrive in dealer showrooms anytime soon. AVs are unlikely to make a huge impact on transporting people near-term, beyond the limited mobility-scheme applications and some sophisticated highway-pilot features for retail-car buyers. Package transport represents a much better business case for AV developers over the next few years.

15 Years in the Making

A car that drives itself has been the vision of futurists almost since the automobile was invented, but the concept didn't begin to exhibit real potential until the turn of the century.

That's when the U.S. Defense Advanced Research Projects Agency (DARPA), formed amid the Sputnik frenzy in 1958 to close the technology gap with Russia, hosted its first Grand Challenge event.

The 2004 contest called on

Progress came quickly, as five vehicles made it to the finish in the DARPA Grand Challenge's second year.

developers to produce a vehicle that could travel on its own along a 150-mile (240-km) stretch of Interstate 15 from Barstow, CA, to the Nevada border. A winner went undeclared after not a single entrant made it to the 8-mile (13-km) mark.

But rapid progress followed. The next year, five vehicles finished the course. Five years later, Italy's University of Parma operated an autonomous car 9,940 miles (16,000 km) through nine countries before ending its journey in Shanghai. In 2012, a self-driving Audi TT navigated the twisting 12.4-mile (20-km) road to the top of Pikes Peak, CO, in a run that took just 27 minutes.

Now the industry is entering a second stage in the autonomous-vehicle era, where the focus is moving beyond the systems and software needed to make AVs work and toward creation of new profit centers made possible by this emerging technology.

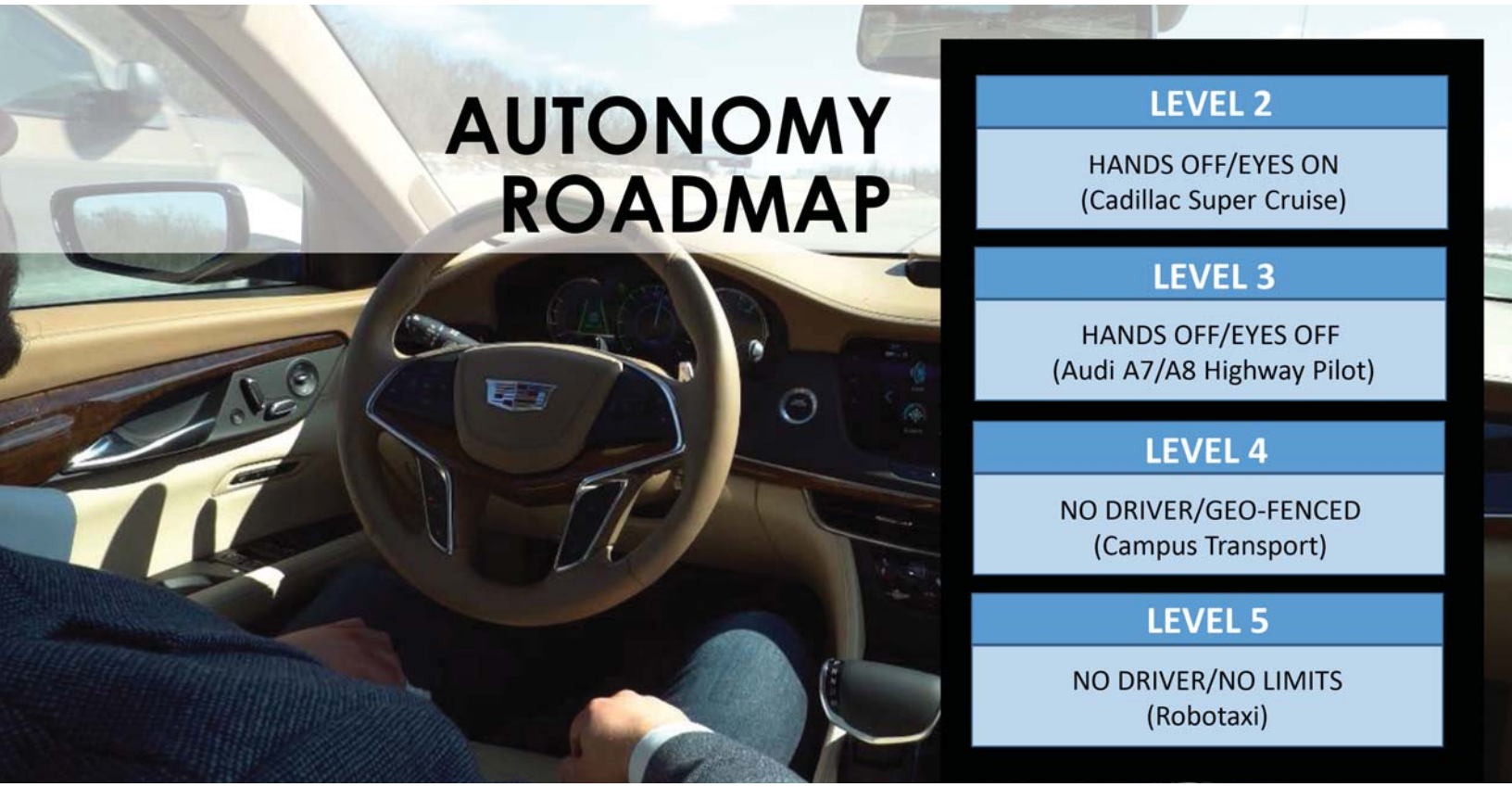
"We're having true business discussions now – less so of 'Let me show you what we can do,'" Danny Shapiro, senior director-

At Nemak we care.

We care about our **customer**, our employees, our communities, and our products. This **focus** drives **innovation**, which each of our 20,000 employees pursue every day without compromise. We are committed to creating a culture based on **trust**, and embracing **collaboration** to achieve superior quality in everything we do. At Nemak we **respect** each other, celebrate diversity, and recognize our **responsibility** to the health, safety, and well-being of our environment and our people. Stretching across 16 countries globally, our culture guides us in our mission of developing **innovative lightweighting** solutions for the global automotive industry and the advancement of **sustainable mobility**.

Join us in our journey.
careers.nemak.com

Nemak
Innovative Lightweighting



automotive for chipmaker NVIDIA, told *The Wall Street Journal* on the sidelines of CES 2018 in Las Vegas.

What's an Autonomous Vehicle

The SAE has defined six levels of autonomous technology, starting with Level 0, meaning no automated features, and topping off at Level 5 with a car that can drive anywhere, anytime without an operator. The industry is firmly into Level 2 today with such advanced driver-assistance technologies as lane-keeping and adaptive cruise control that still require the full attention of the human driver.

But a movement toward Level 3 is under way, most notably with the introduction of highway pilot technology such as the Audi Traffic Jam Assist system offered in Europe. Level 3 marks the

Level 3 highway-pilot technology best near-term opportunity for automakers to monetize their AV R&D.

hands-off/eyes-off stage, where the vehicle pilots itself on the highway from entrance ramp to exit without requiring attention from the driver.

It is important to note the Audi system is not all the way there yet. Some industry insiders refer to it as a Level 2.5, because it is limited to speeds of up to 39 mph (63 km/h). A full Level 3 system should be able to function at maximum freeway speeds and possibly even beyond today's posted limits. Achieving those high speeds will take faster, more accurate decision-making and require new electronics architectures designed around the concept of sensor fusion, Audi officials say.

Suppliers, including Aptiv, Visteon, Aurora, Magnetti Marelli, Mentor Graphics, Baidu, Zenuity and Magna, are working on single multi-domain controllers designed to collect data from vehicle sensors tied to steering, braking, radar, vision and other systems and crunch the information at high speed to determine

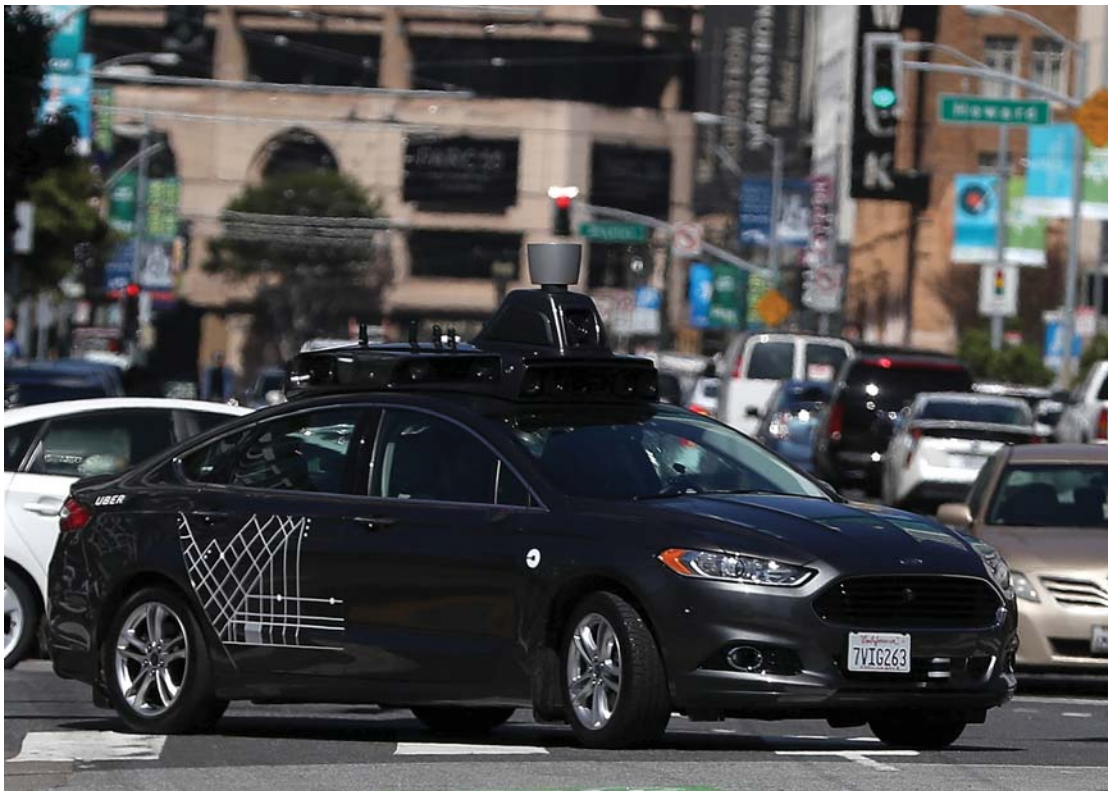
WE ARE SHAPING MOBILITY FOR TOMORROW

There's an inherent curiosity among Schaeffler's automotive engineers. Creating new paths to develop ideas and thinking beyond barriers is as important now as it was when the company first began in 1949.

As an internationally renowned supplier and development partner, Schaeffler has remained dedicated to the pursuit of innovation since its inception. Together with our customers, suppliers and research partners, Schaeffler is hard at work developing tomorrow's solutions – today.

www.schaeffler.com

SCHAEFFLER



Autonomous Ford Fusion undergoes testing by Uber in San Francisco.

the vehicle's path forward. The move to a centralized processor is expected to cut onboard microcontrollers to just a handful, from a typical 60-80 today.

By SAE definition, Level 4 is a vehicle without a steering wheel or pedals (or where such driver controls become inoperable) that can travel autonomously, but only within a geofenced area. This is the type of vehicle headed for use in ride-hailing services such as Waymo's or Lyft's.

Undoubtedly, AV performance still needs to improve overall, as evidenced by the March 2018 incident in which a pedestrian was struck and killed by a self-driving Uber test vehicle (Volvo XC90) in Tempe, AZ. The event has heightened concern about whether automated-driving technology is up to the task. Take AVs out of the rather ideal climate of Arizona and their ability to perform consistently becomes even less certain.

In part, interest in AVs is being driven by a desire to reach zero fatalities worldwide, meaning

AVs will require computing power beyond the supercomputer speeds of a decade ago, Visteon says.

automated driving must be safer than human driving if the technology is to reach critical mass. That's a tough task, particularly when it comes to the vehicle reacting quickly and properly in the one-in-a-million situations that are likely to arise, making Level 5 capability far from certain.

Visteon CEO Sachin Lawande notes some of the technical challenges ahead in a presentation to a 2017 Baird investor conference. For AVs to be safe, he said, they must be able to detect objects at least 650 feet (200 m) ahead and determine the way forward with lightning speed. At 70 mph (113 km/h), Lawande points out, a car travels nearly 200 ft. (60 m) every two seconds and takes about 330 ft. (100 m) to come to a complete, comfortable (non-panic) stop.

"It's true that 90% of accidents are caused by driver (error), so intuitively you say, of course, an autonomous car is safer," Daimler CEO Dieter Zetsche says. But in between those accidents, "the human being is doing a damn good job. To avoid these accidents…is not that difficult (for autonomous cars). But to become as good as a human being in


SAE
INTERNATIONAL®
MOVE FORWARD.
Join these members—and 127,000 more—to move forward, wherever you are in your career. SAE International membership gives you access to the tools, resources, opportunities and network you need, including:
• **Member Connection**—an online forum where you can learn, connect and collaborate with fellow mobility engineers
• **Opportunities to Get Involved**—from inspiring the next generation of engineers to participating in a standards development committee
• **Discounts**—on SAE events, books, journals and magazines
JOIN SAE TODAY
sae.org/membership
P1821594

the in-between is a damn tough task."

Making the leap from Level 2 to Level 4 AVs will take a 40-fold increase in processing horsepower, from 500 gigaflops today to as much as 20 teraflops, Visteon says. Even a more basic Level 3 highway-pilot system will require a still-considerable 10 teraflops of computing capacity, a level that exceeds supercomputer speeds of just a decade ago.

"The automotive industry has never packed as much processing power in the car as they are about to get into," Visteon's Lawande tells Wards, adding liquid cooling may be needed to dissipate the enormous heat generated by these high-capacity domain controllers.

Such computing power isn't in production today for use in vehicles, but more powerful automotive-grade microprocessors are coming.

NVIDIA's latest-generation DrivePX platform, also known as Pegasus and to be available for commercial testing this year, is capable of 320 trillion operations per second, more than 10 times the speed of processors used in initial AV test applications, for example.

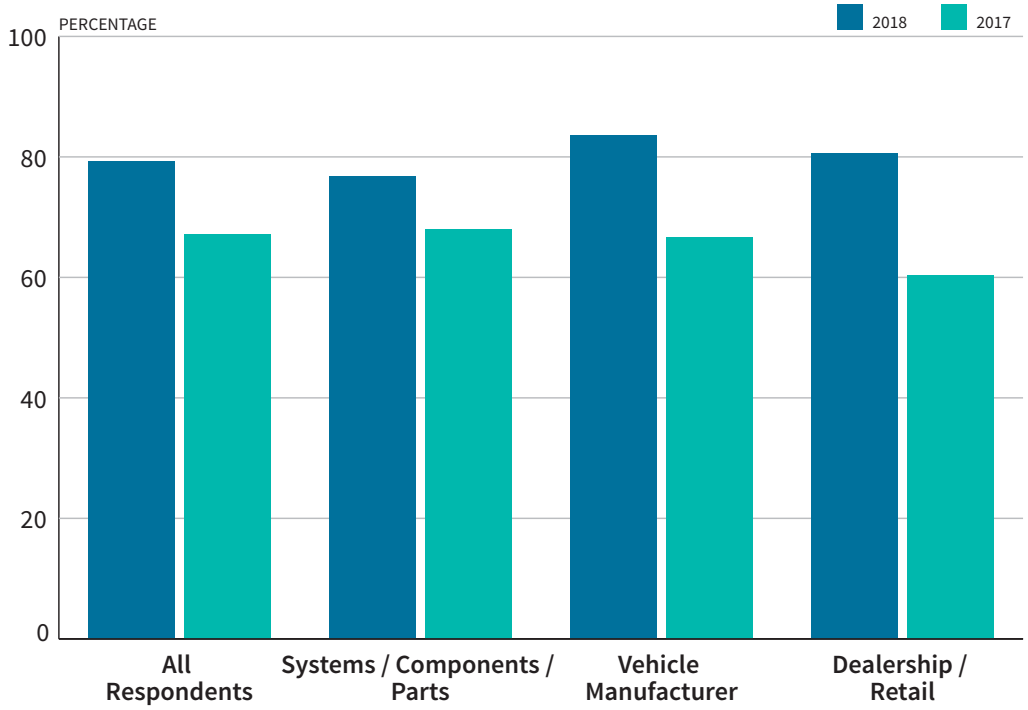
Help Wanted: Regulatory

As noted, a key goal of AV development is to reduce vehicle-related fatalities, which number about 1.25 million annually worldwide, including nearly 40,000 in the U.S. Consultancy KPMG projects driverless vehicles could halve accident frequency by 2030.

But the industry is looking for more input and movement from policymakers worldwide, because without decisions on testing and certification, automakers can't get to the first stages of AV and advanced-ADAS rollout.

General Motors, for instance, is still waiting for approval of a waiver request that would allow its Chevrolet Bolts without steering wheels to operate on U.S. roads. Audi has not targeted release of its highway pilot system in the U.S. yet, citing regulatory uncertainties.

The government has not provided enough guidance/regulations to date for autonomous vehicles.



Source: Wards Intelligence 2018 Autonomous Vehicle Trends Survey

Beyond safety standards, policymakers potentially could take actions that would incentivize the market for AV technology, beginning with Level 3 systems. High-occupancy-vehicle (HOV) lanes could be converted into high-speed AV lanes, a move that likely would help spur sales of highway-pilot technology, for instance.

It is unclear how much of a chilling effect the Uber pedestrian fatality will have on regulation and policy, but even prior to that event there was growing impatience over the lack of action and consistency.

In a Wards Intelligence survey conducted in August 2017, 32.9% of respondents said the government was providing adequate guidance. But in a follow-up survey in February 2018, that figure dropped to 20.7%. OEMs appear

PLASTICS ENABLING GLOBAL AUTOMOTIVE DESIGN

NOVEMBER 7, 2018

CALL FOR NOMINATIONS

- MOST INNOVATIVE USE OF PLASTICS AWARDS

For more info and to submit nominations, go to: www.speautomotive.com/innovation-awards-gala.

SPE AUTOMOTIVE 48TH-ANNUAL INNOVATION AWARDS COMPETITION & GALA

HONORING THE BEST IN AUTOMOTIVE PLASTICS

The Automotive Division of the Society of Plastics Engineers (SPE®) is announcing a "Call for Nominations" for its 48th-annual ***Automotive Innovation Awards Gala,*** the oldest and largest recognition event in the automotive and plastics industries. This year's Awards Gala will be held Wednesday, **November 7, 2018** at the Burton Manor in Livonia, Mich. Winning part nominations ***(due by September, 15, 2018)*** in 10 different categories, and the teams that developed them, will be honored with a **Most Innovative Use of Plastics** award. A **Grand Award** will be presented to the winning team from all category award winners.

SPONSORSHIP OPPORTUNITIES

This annual event currently draws over 800 OEM engineers, automotive and plastics industry executives, and media. A variety of sponsorship packages - including tables at the banquet, networking receptions, advertising in the program book, signage at the event and more are available. Contact Teri Chouinard of Intuit Group at teri@intuitgroup.com.

INNOVATIVE PART COMPETITION CATEGORIES:

- Additive Manufacturing
- Aftermarket
- Body Exterior
- Body Interior
- Chassis/Hardware
- Environmental
- Materials
- Process, Assembly & Enabling Technologies
- Powertrain
- Safety

& Hall of Fame

2017 SPONSORS

VIP RECEPTION & AFTERGLOW SPONSOR

Celanese — The chemistry inside innovation™

MAIN RECEPTION SPONSOR

سابك sabic

WINE & FLOWERS SPONSOR

DUPONT

STUDENT PROGRAM SPONSOR

faurecia

PARTS DISPLAY SPONSOR

TECHNO POLYMER AMERICA INC.

GOLD SPONSORS

Advanced Composites — Mitsui Chemicals Group

American Chemistry Council — Plastics Division

ARKEMA — INNOVATIVE CHEMISTRY

BASF — We create chemistry

INTEVA PRODUCTS

SILVER SPONSOR

LOTTE ADVANCED MATERIALS

ADVERTISING SPONSOR

INEOS STYROLUTION — Driving Success. Together.

BRONZE SPONSORS

ASCEND PERFORMANCE MATERIALS

BOREALIS

ChasePlastics

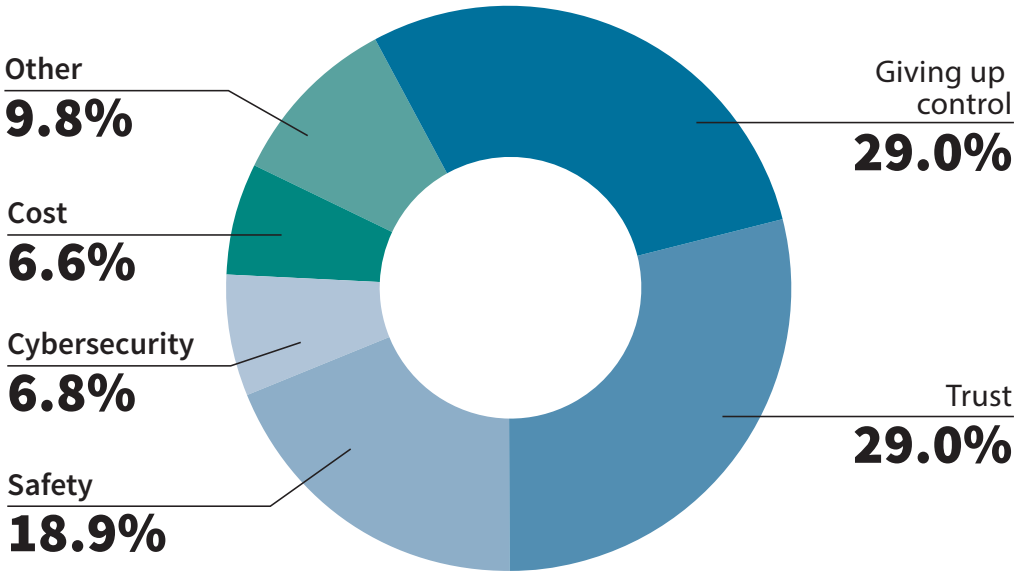
covestro

DSM — BRIGHT SCIENCE. BRIGHTER LIVING.

ExxonMobil

IAC

PENDA



Source: Wards Intelligence 2018 Autonomous Vehicle Trends Survey

the most frustrated, with 83.5% saying not enough was being done. In the most recent poll, 70.6% said government regulation was vital to further development of AV technology.

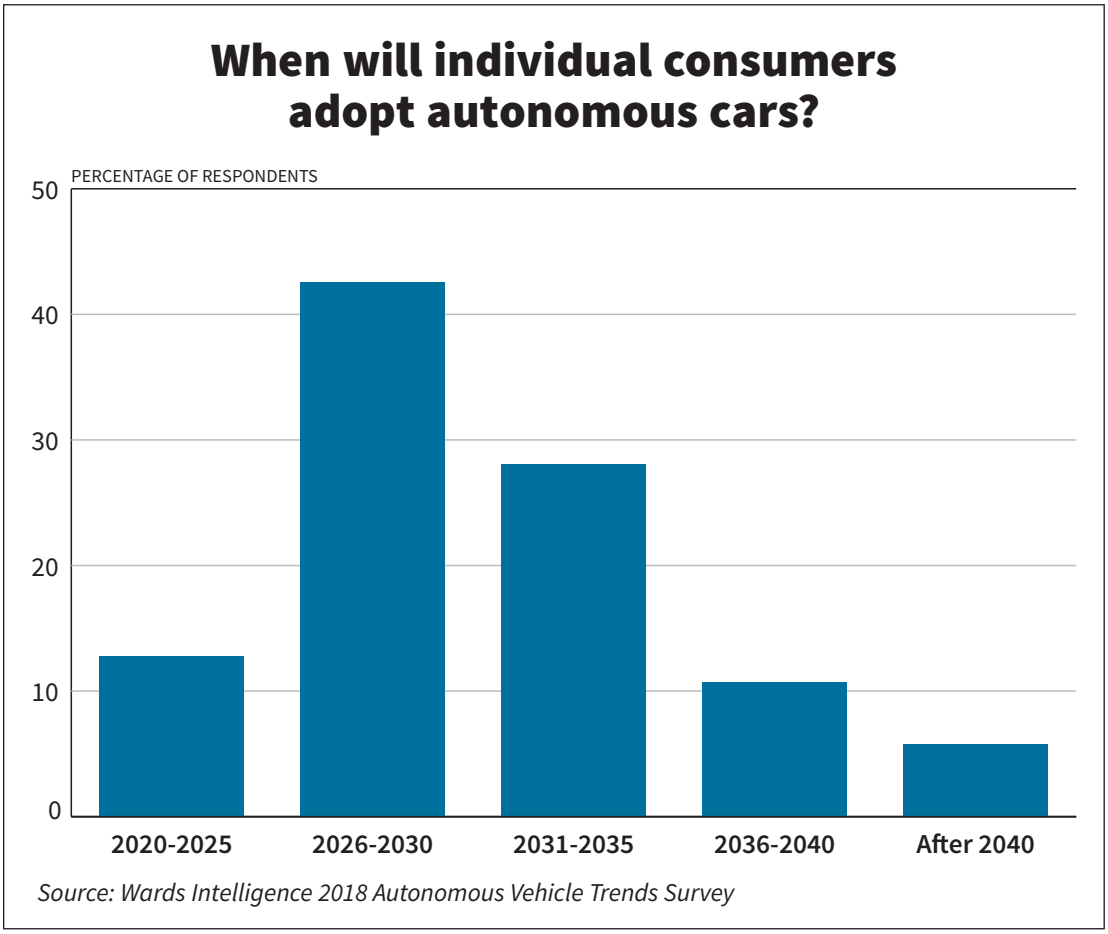
Timetables

Consumers remain fickle, and a true read on market acceptance of AVs probably won't be possible until the public becomes more widely exposed to the technology.

But so far, trends have been less than favorable.

A survey by Deloitte finds 62% of Chinese consumers don't believe AVs will be safe, and that's the best result of the six countries polled. In South Korea, 81% of consumers expect automated vehicles to be unsafe, followed by Japan (79%), the U.S. (74%), Germany (72%) and India (64%).

A 2017 AAA survey shows only



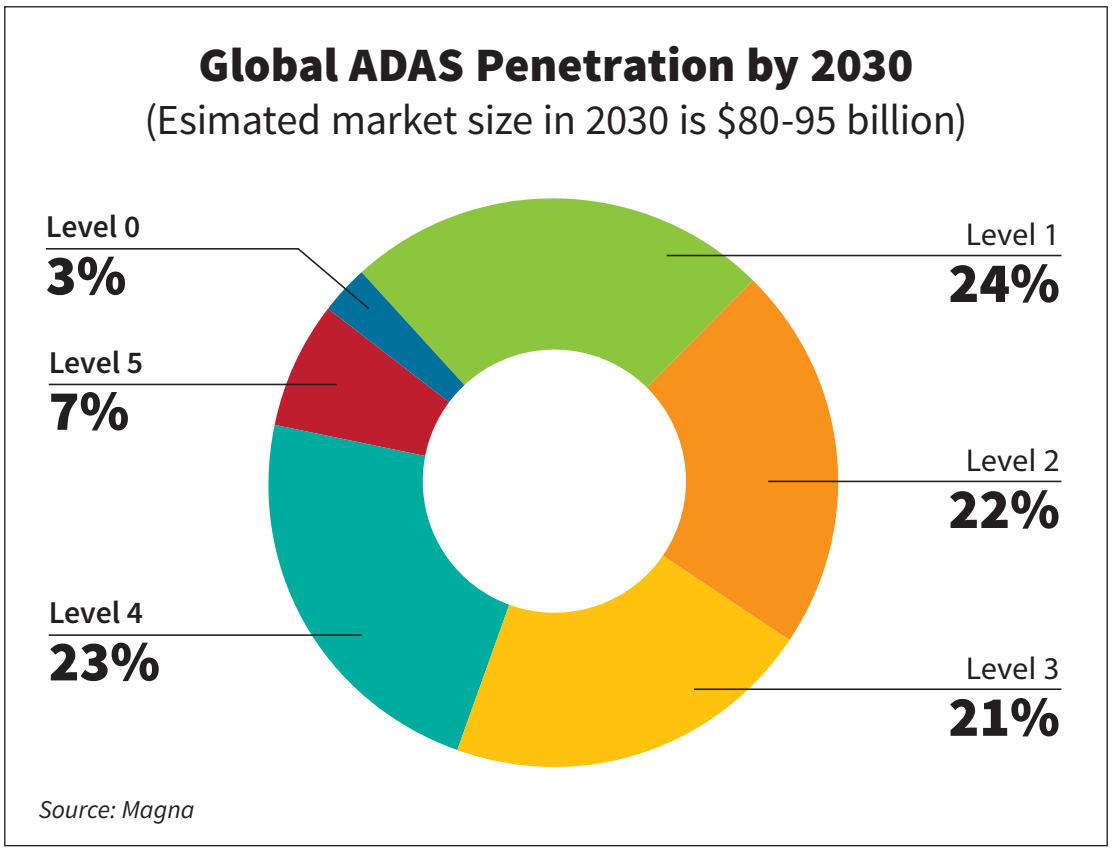
Source: Wards Intelligence 2018 Autonomous Vehicle Trends Survey

13% of U.S. drivers would feel safer sharing the road with self-driving vehicles, with 46% indicating they would feel less safe.

Deloitte also says individual consumers won't want to spend much on the technology, finding U.S. buyers willing to pay only about $925 extra for automated-driving capability, far below the expected cost of about $5,000 in 2030. Willingness to pay is even less in China ($700) and Germany ($360), the consultancy says.

In its report, Wards Intelligence identifies two main channels for monetizing AV investment, retail and fleet, with the fleet path branching off in multiple directions around people-focused mobility services and package-moving commercial operations.

With the expected long run-up ahead before full Level 5 AVs are



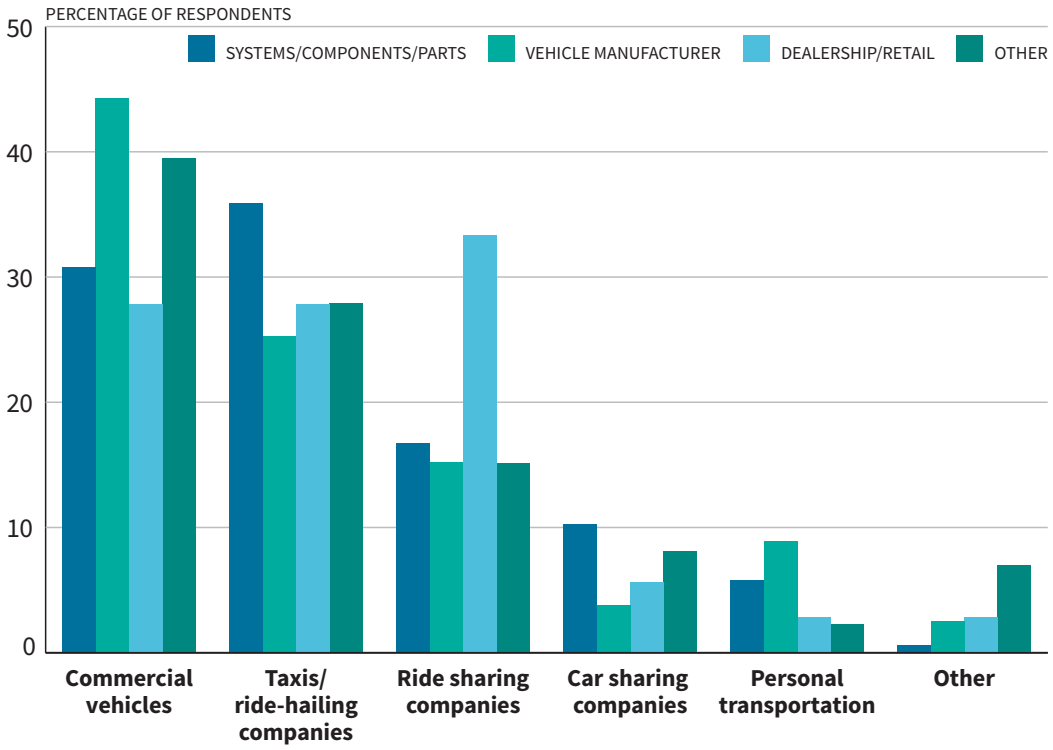
in the hands of individual car buyers in appreciable numbers, it will be important for automakers and suppliers to monetize their investments in advanced technology in stages by offering retail buyers new ADAS and safety features.

This already is beginning to happen on luxury models with such systems as GM's Super Cruise and Audi's Traffic Jam Assist.

"I am personally of the opinion there is a significant proliferation of Levels 1, 2 and 3 still to be had," says Swamy Kotagiri, chief technology officer at auto supplier Magna. "In spite of all the (AV) discussions, the (ADAS) penetration rate still is in the single digits, and in the foreseeable future there is a huge amount of demand (that will come) from there.

"And once the consumer starts getting a little bit more comfortable and the market starts emerging, (that) will actually drive the next step towards autonomy."

Who will be the first adopters of autonomous vehicle technology?



Source: Wards Intelligence 2018 Autonomous Vehicle Trends Survey

Magna forecasts the ADAS market, including Level 4 and 5 technologies, at $80 billion-$90 billion worldwide in 2030.

By 2023, robo-parking is likely to be made available to individual car buyers as well, Wards Intelligence predicts. This technology would allow the vehicle to locate an available public parking spot and drive itself to the location, then return when summoned to pick up the driver.

Level 5 vehicles won't become available to retail customers before 2030, the report concludes.

"The technology goes fast, so it's extremely hard to forecast," Dennis Nobelius, CEO of Zenuity, a software joint venture between Volvo Car and supplier Autoliv, says of Level 5 autonomy. "But I don't see

WARDS INTELLIGENCE™

AI IN AUTOMOTIVE REPORT

Artificial Intelligence is poised to become the pilot of tomorrow's autonomous vehicles. This special report from Wards Intelligence defines and examines AI technology, estimates where the industry stands in its deployment, potential applications beyond autonomy and the tremendous challenge traditional OEMs and suppliers face in ramping up their expertise in the field.

This report is intended for:

- Product Planners
- Market Analysts
- Academics
- Others who would benefit from a detailed examination of the industry's plans for implementing AI

OEMS COVERED:

- BMW
- DAIMLER
- FORD
- GM
- TESLA
- TOYOTA
- VW GROUP
- VOLVO
- WAYMO

KEY INTEGRATORS/CHIP MAKERS/DISRUPTERS:

- BAIDU
- BOSCH
- CONTINENTAL
- DELPHI
- DENSO
- INTEL
- MAGNA
- NVIDIA
- QUALCOMM
- VALEO
- VISTEON
- ZF

Learn More and Purchase at:

WardsIntelligence.com/insights

it in the next five to 10 years."

Magna's Kotagiri agrees: "It's a long way away (to) purely Level 5."

A strong business case can be made for Level 4 geofenced technology in the light-commercial vehicle sector in the 2020-2021 timeframe. Schemes to move packages around in driverless vehicles face fewer hurdles than those designed to move human passengers, where consumer comfort levels and user experience issues come into play.

The additional cost of AV technology could be offset somewhat in cargo vehicles by taking out content associated with a human driver that no longer is required. Commercial transport companies also could more easily offset the technology costs if there is a corresponding reduction in labor needed. This is a sector Silicon Valley startup Nuro is aiming at with a self-driving pod designed to carry up to 250 lbs. (113 kg) of cargo.

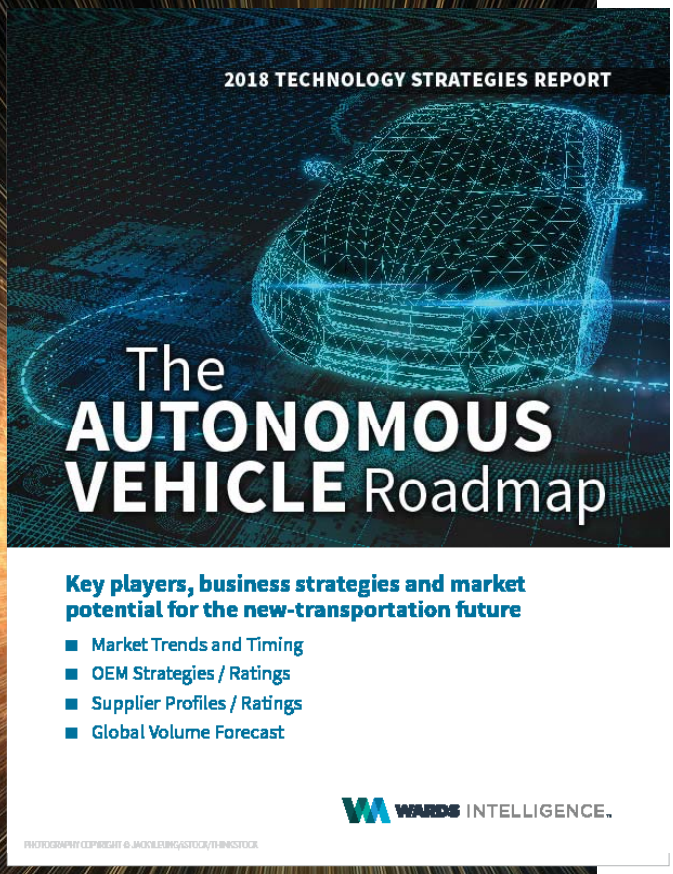
"Unmanned delivery will be a game-changer for local commerce," Nuro cofounder Dave Ferguson predicts.

In all, Wards Intelligence forecasts Level 4 and higher AVs will make up about 10% of global new-vehicle sales by 2030, or about 10 million units.

So, who is leading the race? Among the three dozen companies evaluated in the Wards Intelligence report, five automakers and six suppliers/disruptors rose to the top. Automaker's making the report's A grade include: BMW, Daimler, GM, Renault-Nissan-Mitsubishi and Volkswagen. Others landing in the top tier are Aptiv, Bosch, Continental, Hitachi NVIDIA and Waymo.

But it is a race. And, as the May Mobility project proves, more jockeying for the lead is likely as AVs begin to roll out in bigger numbers. **WA**

This story was written by Wards Executive Director-Content David E. Zoia. He can be reached at dzoia@wardsauto.com



WARDS INTELLIGENCE™

AUTONOMOUS VEHICLE REPORT

Rapid advancements in technology, including more sophisticated radar, vision and lidar sensors; the expanding capacity and capability of microcontrollers; faster-responding actuators and controllers; and the promise of machine learning via complex, artificial-intelligence-driven software, has the auto industry on a march toward automated driving.

This report examines those issues, along with:

- How and when the market will take shape worldwide
- Where the best near-term business cases are with retail customers, commercial-vehicle operators and mobility-service providers
- Which automakers and suppliers/disruptors will emerge as the dominant players in this new industry sector

OEMS COVERED:

- BMW
- DAIMLER
- FCA
- FORD
- GM
- HONDA
- HYUNDAI
- JAGUAR LAND ROVER
- PSA GROUP
- MITSUBISHI
- NISSAN
- RENAULT
- TESLA
- TOYOTA
- VW GROUP
- VOLVO

Learn More and Purchase at:

WardsIntelligence.com/insights