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International Automotive Electronics Congress in Ludwigsburg: June 19-20

As I have every year for nearly two decades, I will attend this rewarding conference in Ludwigsburg, Germany. It’s a favorite of mine because I come away with a better understanding of where our global industry is headed. The topics and the speakers, selected by a panel of leading lights from the German automotive electronics industry, are consistently first rate.

This year’s lineup of speakers is even more representative of our international community, with presentations by executives representing Chinese, American, Austrian, Dutch, Israeli and English companies. As in past years, however, most of the 25 presenters work for German companies. I’m especially looking forward to these presentations:

- Rolf Zöller, head of E/E development, Volkswagen: The Effects of End-to-End Electronics Architecture on the Value Chain
- Alex Shi, CEO, Banma Technologies: AliOS’s Chinese Style Innovation and Chinese OS National Strategy (Developed by Alibaba, AliOS is an operating system aimed at cars, mobile, industrial and IoT devices. Banma is a joint venture between SAIC and Dongfeng Peugeot Citroën started in 2018.)
- Simon Fürst, general manager of software-based features, BMW: Adaptive Autosar, from Standardization to Series Application
- Thomas Kropf, senior vice president, automotive systems integrations, Robert Bosch: The New Connected Car Development Paradigm: From Vehicle Computer to Automotive Cloud
- Thomas Müller, executive vice president, electrics/electronics, Audi: The Killer E/E Function
- Alexander Lautz, senior vice president 5G, Deutsche Telekom: HAD and 5G – A Paradigm Shift of the Automotive and Telecommunications Sectors
- Dror Jerushalmi, CEO and founder, Valens: HDBaseT Automotive – Driving the In-Vehicle Architecture of the Future
- Axel Schmidt, managing director, Accenture GmbH: Artificial Intelligence in the Automotive Industry: Moving Digital Disruption to the Next Level

For more on the conference please visit Automobil Elektronik Kongress.
Regulation Bottlenecks Hinder Autonomous Driving Rollouts

Many extremely difficult challenges stand in the way of mass market introductions of L4 and even L3 vehicles. Affordable lidar sensors are not nearly ready. Maps that are precise and fresh enough to locate the vehicle in its lane if the sensors fail are not yet available for the vast majority of the world’s roads. Computing hardware is too expensive and requires too much power. Simulation, essential to making the case that computers can drive more safely than humans, is still being developed. Cybersecurity to protect vehicles from hacking is not yet in place. Consumers are wary, understandably so.

Yet another obstacle is regulation. Current regulations that detail the requirements essential to selling vehicles that are safe for operation by humans do not accommodate vehicles driven by computers. This has been obvious for years. The politics of updating those regulations is not only tedious and time consuming, but the drafters don’t yet know how to specify a safe autonomous vehicle. They won’t know how until many more AVs are road tested and proven safer than human drivers. Technology has to lead regulation.

Laws for testing autonomous vehicles on public roads vary by region, country and, in the United States, by state. At present, 21 states allow AV testing on public roads. Once testing is completed and products are deemed ready for the market, legal exemptions have to be won in every country where the carmaker plans to offer the self-driving feature or vehicle. Before a mass market for autonomous vehicles can flourish, globally harmonized performance regulations that standardize technical requirements must be formalized. The United Nations World Forum for Harmonization of Vehicle Regulations initiated that effort in February 2015.

**Audi A8 Traffic Jam Pilot**

The rollout of the 2019 Audi A8, the world’s first production automobile developed especially for Level 3 automated driving, is a good example of the difficulties carmakers face. The car is able to drive itself under certain conditions on expressways up to 60 km/h without the driver needing to pay attention at all. “Drivers can turn their attention from the traffic and the car’s steering to do things like answer their email, write text messages, tend to their appointment calendar, read the news, or plan for their vacation,”
declares Audi. As the system nears the limits of its capabilities, the vehicle prompts the driver several seconds in advance to take over the task of driving.

The new A8 goes on sale in 2018, but the L3 traffic jam pilot will be activated only in countries where L3 is permitted, and initially that will be limited to Europe. All member countries in the EC are obliged to follow the UN regulations, but the work to update those regulations to accommodate autonomous vehicles is not nearly complete. For now, carmakers are forced to seek exemptions from the existing regulations on a country-by-country basis. The German government passed legislation in May 2017 allowing automated driving when a licensed driver is at the wheel (L3), but details such as how to hand control back to the driver are still being finalized.

Forward Progress with Global Harmonization

The World Forum for Harmonization of Vehicle Regulations (Working Party 29) only recently cleared the decks to focus on the task of updating Regulation 79 for Levels 3 and 4. Reg. 79 contains requirements for vehicle steering. The rewrite was undertaken by the GRRF (a French acronym for Working Party on Brakes and Running Gear). The GRRF’s update to Reg. 79 for Level 2 was just approved on March 12, 2018. It amends the requirements for automatically commanded (ADAS) steering functions such as lane guidance and lane keeping.

Mass-market vehicle manufacturers successfully lobbied the regulators to finalize standards for automation Levels 1 and 2, basically ADAS, before addressing the far more complicated issues attached to L3 and L4 systems. That agenda did not necessarily serve the interests of premium carmakers, notably Audi, who has an L3 feature nearly ready to launch. While the original goal of the UN was to have regulations in place that would support L3 and L4 autonomous driving on expressways by September 2018, those revisions are going to take considerably more time.

Francois Guichard, technical secretary of the GRRF, explained. “While premium carmakers such as Volvo, Audi, Daimler and BMW have been pushing for quicker progress on L3 and L4 regulations, non-premium carmakers preferred to slow the process down. They have already developed some Level 2 technology and the priority for them is to have these international regulations so they can sell their products in many countries,” he said, adding, “I now hope that in two or three years we will have full clarity for some Level 3 and Level 4 systems, not all of them, but those that
would be driven on highways or autobahns. L4 in cities will take some more years.”

**Regulatory Holdups in U.S.**
While the United States is not bound to the UN regulations, representatives from the U.S. are chairing one of its groups and contributing to the development of the global technical regulations. Those regulations could well be mirrored in U.S. law and become part of the Federal Motor Vehicle Safety Standards for new vehicles, with which carmakers must certify compliance.

As of now, autonomous vehicles cannot be sold in the United States. Carmakers can petition the National Highway Traffic Safety Administration (NHTSA) for an exemption for up to 2,500 vehicles per year. But, and this is a big but, the carmaker has to provide detailed analysis showing how the exempted autonomous vehicle provides an overall safety level at least equal to non-exempt vehicles.

Congress could pass laws that are less restrictive than current law. The House passed the SELF DRIVE Act, which ramps up the number of exemptions to 25,000 in year one. That bill’s passage now depends on the Senate. The Senate has been working on a bill known as AV START, which would allow each carmaker to sell up to 15,000 self-driving vehicles in year one, up to 80,000 in year three and no cap in the fourth year. As with the House bill, OEMs must demonstrate to regulators that the vehicles are as safe as current ones.

Regardless, the Senate bill is now on hold due to serious safety concerns. In a letter written to Senate leadership, a group representing 27 safety, public health and consumer groups asserted that, “Allowing the public sale of unproven autonomous vehicle technologies, granting automakers broad and unsafe exemptions from existing federal standards, and ignoring the need for the U.S. Department of Transportation to issue minimum safety requirements will have disastrous consequences for public safety and public acceptance of driverless cars.” Any U.S. safety requirements will be years in the making. ◆
VW Spearheads V2X Based on 802.11p in Europe

In 2019, Volkswagen will equip all of its high-volume brands sold in Europe with V2X communications systems as standard equipment. Trucks and buses from MAN and Scania, as well as Volkswagen light commercial trucks, will also get V2X.

Volkswagen issued a press release in June 2017 outlining plans to start fitting its vehicles with V2X communications gear based on the 802.11p standard, also known as DSRC or WLANp. That created some confusion, because Audi was publicly supporting cellular-V2X, a competing communications protocol. In October, Volkswagen Group chief digital officer, Johann Jungwirth, indicated that the carmaker wanted to rethink its commitment to 802.11p. “We have to speak with one voice, one decision and one direction,” he told me at the time.

The direction now: Volkswagen will take the engineering lead with 802.11p in Europe, and Audi will take the engineering lead on C-V2X, both LTE-V2X and 5G in China, where the government is favoring the cellular approach. Whether or not Audi will soon introduce vehicles to the European market with 802.11p communications modules is not yet known.

The three German carmakers often cooperate to introduce new technologies that conform to the same standards in order to build economies of scale into the components they buy, but neither Daimler nor BMW has indicated an intention to follow Volkswagen’s lead. “I hope that our commitment to V2X and to 802.11p will lead to implementation strategies by all OEMs,” urged Mr. Jungwirth.

In the United States, where Volkswagen is in discussion with the Department of Transportation and other carmakers, the carmaker is waiting to see if the government will follow through on a proposed mandate to require that carmakers install V2X communications modules based on 802.11p in new vehicles.

Day-One Infrastructure-Based Services
One of the difficulties delaying a decision by more carmakers to introduce V2X technology is that many of the promised safety benefits that would come from vehicles talking to each other—the V2V component of V2X—would take years to be realized. Despite Volkswagen’s steep rollout strategy and its dominance in the European market, it will take time to get a sufficient number of V2V-equipped
vehicles on the road to significantly reduce road accidents. Volkswagen Group sold a total of 3.2 million Volkswagen, SEAT and Skoda branded vehicles in Europe in 2017.

Regardless, Volkswagen expects customers to experience benefits on day one because their vehicles will get communications from emergency vehicles and from road-side infrastructure, for example construction-zone warnings and traffic signal information. One possible use case would be to synchronize traffic signals with vehicles so they are able to automatically adapt cruising speed to minimize fuel-wasting stops at red lights. Volkswagen has not disclosed its rollout strategy for features based on an 802.11p infrastructure, although initial features are likely to come from the list below.

**Day 1 C-ITS Services**

- **Hazardous Location Notifications**
  - Slow or stationary vehicle(s) & traffic ahead warning
  - Road works warning
  - Weather conditions
  - Emergency brake light
  - Emergency vehicle approaching

- **Signage Applications**
  - In-vehicle signage
  - In-vehicle speed limits
  - Signal violation / intersection safety
  - Traffic signal priority request by designated vehicles
  - Green light optimal speed advisory
  - Probe vehicle data
  - Shock wave damping (aimed at smooth traffic flow in dense traffic)

Source: An EU Strategy on Cooperative, Connected and Automated Mobility

“Infrastructure is ahead of us,” said Mr. Jungwirth. “The first $300 million in infrastructure investments are committed and are in rollout. We are working with the municipalities, with cities, governing bodies and companies like Siemens. This is part of what drove our commitment.”

Mr. Jungwirth is referring to the C-Roads project involving 16 European Member States plus Norway, Switzerland and Australia, who are investing €350 million in road safety services based on a mix of short- and long-range communications. One of the objectives of the C-Roads project is to promote interoperability among 802.11p and LTE-V2X (cellular-V2X) implementations, both for vehicle-to-vehicle and vehicle-to-infrastructure communications.

The Hansen Report on Automotive Electronics, March 2018
www.hansenreport.com
Another project that will drive the buildout of V2X infrastructure in Europe is C-ITS Corridor, which has the goal of providing connected-vehicle support along a corridor from the city of Rotterdam in the Netherlands through Germany to Vienna, Austria. “Each country has agreed to equip infrastructure with roadside equipment for V2X use cases,” said Michael Venus, an executive with Siemens Deutschland Mobility. “Units are already in place in the Netherlands on the A58 autobahn. Units are also being tested in Vienna.” Two key applications listed on the C-ITS Corridor website are road-works warning and the collection of vehicle traffic data for road management.

Siemens has been participating in V2X and 802.11p tests in Europe, the U.S. and Australia for nearly ten years. Over that period it has sold roughly 500 roadside units. The market seems different now to Mr. Venus. “Volkswagen’s announcement has given the technology a real push. Now we will see even more connected-vehicle deployments on the infrastructure side,” he said.

The Argument for 802.11p vs. Cellular-V2X

NXP, the provider of RoadLINK DSRC chipsets to Siemens and probable provider to Volkswagen, recently issued a white paper that aggressively makes the case for 802.11p over LTE-V2X.

♦ Readiness: The first LTE-V2X chipsets will not be available until the end of 2018. Widescale field testing won’t be able to start until 2019.
♦ Compatibility: Release 15 will not be backward compatible with Release 14 hardware and applications. Release 14 will be obsolete before it is even deployed.
♦ Range: Simulated range performance based on real measured performance of the NXP RoadLINK DSRC chipset gives a best-in-class figure of >500 m compared with 240 m for LTE-V2X.

Mr. Jungwirth summarized Volkswagen’s reasons for deciding to go with 802.11p: “One, the standard is developed; it is running on vehicles today. That is important because every year counts, every vehicle equipped with the technology helps. Two, automotive grade chipsets are available now. And three, the [5.9 GHz] frequency band has been reserved for these use cases. When you put all the arguments together, it was a very clear decision for us. It is the right thing.”
The Company Profile: HERE International

**Thumbnail Sketch**

**Headquarters:** Eindhoven, the Netherlands  
**2016 Sales:** €1,156 million  
**R&D:** 55.4% of sales  
**2016 Net Margin:** (11.4%)  
**Cash Provided by Operating Activities:** €105 million  
**Debt:** €598 million*  
**Net Worth:** €1,831 million*  
**Employees:** 8,500 as of February 2018  
**Main Product:** Digital maps and location services  
**Market:** Automotive accounted for 70% of sales in 2016  
**2017 Sales:** Approximately €1,000**  
**2017 Sales per Employee:** €120,482, approximately  
**Major Owners:** Audi, BMW and Daimler each own 25% of HERE; Intel owns 15%.  
*As of December 31, 2016  
**Hansen Report estimate

**Background**

In 2008, Nokia paid shareholders €5.7 billion to acquire NAVTEQ, at the time the largest supplier of map data for car navigation systems, mobile phones and other platforms. NAVTEQ, formerly Navigation Technologies, had been in the map data business since the late 1980s. Nokia ran the NAVTEQ business along with its own Nokia Maps, which incorporated software from previous acquisition target, Gate 5. Nokia launched the HERE business and brand in 2012.

When Nokia refocused its strategy to concentrate on the networking business, HERE accounted for less than 10% of its revenue, and Nokia started looking for a buyer. Recognizing HERE’s potential, companies including Uber, Apple, Facebook, Alibaba and others expressed interest. Eventually, Audi, BMW and Daimler, who all...
were current users of HERE data, acquired HERE from Nokia for €2.8 billion in December 2015.

HERE has not shown a profit recently. The company invested 55% of its sales in R&D in 2016, the most recent year of financial reporting the company has made available at press time. That level of reinvestment will continue in the near term. Additional funds will come from new investors. “Building high-definition maps is not something for the faint of heart,” said Edzard Overbeek, CEO. Mr. Overbeek joined HERE in March 2016 from Cisco, where he spent 16 years. In his last position he was responsible for the company’s Global Services organization with more than $12 billion in revenue and 15,000 employees.

Beyond 2020, Mr. Overbeek sees a broad market for HERE products and services that goes well beyond high-definition maps: “Think of a city in the next 10 to 15 years where everything is driving autonomously. All that movement has to be managed and orchestrated—platooning on highways, slowing cars in the city centers, doing handoffs between fully autonomous driving and manual driving. That is a massive opportunity where we are already recruiting teams to start thinking along those lines. How can we create an end-to-end management system for mobility? Location is at the heart of all of this.”

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<th>Distinctions Claimed by HERE</th>
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<td>World’s number-one provider of location data to carmakers; HERE maps are embedded in 100 million vehicles.</td>
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<td>HERE maps can be found in four out of five car navigation systems in North America and Europe.</td>
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<td>World’s greatest automotive- and enterprise-grade map coverage</td>
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<td>Lowest map defects per million opportunities vs. the competition</td>
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<td>Beginning in mid-2018, HERE Safety Services will be offered for the first time in production vehicles, by BMW.</td>
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Automotive
HERE earns revenue from carmakers who license its location stack. The cost of each license depends on what data packages are being delivered. The offerings range from basic maps for navigation to a selection of premium content such as traffic data or the location of electric-vehicle charge stations.

HERE’s product portfolio can be thought of in three layers: Content is the lowest, with platform in the middle, and services and applications on top. Sales to automotive customers account for 70% of HERE sales, almost all of which is map content. Most of the remaining automotive revenue comes from traffic services, which account for a single-digit percent of the automotive total.

HERE provides information to customers in Europe, the Americas and the rest of the world, with the exception of China, Korea and Japan. In Japan, HERE partners with Pioneer’s Increment P subsidiary. In China, HERE works in partnership with NavInfo. HERE began offering traffic services in 2004, the same time as Inrix but before Google and TomTom entered the market. With nearly 400,000 probe vehicles providing HERE with fresh data, the company expects to pick up share from the traffic services market leaders.

Numerous other automotive service offerings are available such as hazard warnings and road signs. Others will soon ramp up, on-street parking, for example. The services are derived from crowd-sourced data supplied by carmakers. To motivate carmakers to provide data, HERE is applying what it calls the Give-Get business model. Each contributor gets a share of revenue derived from their data in proportion to the quantity of data supplied.

Strategy: Automotive and Beyond
When Mr. Overbeek joined the company in October 2016 as CEO, the three carmakers who owned HERE wanted to find other carmakers to invest, and from there jointly collect data from which high-definition maps could be built. High-definition maps are needed to support autonomous driving. But Mr. Overbeek urged the company to think more broadly. “Very early in strategy sessions we came to the conclusion that we have an opportunity to build something that goes beyond the autonomous driving use case for HD maps. That market is very important, but we also need to be realistic,” cautioned Mr. Overbeek. “It will be three to five years before we have the first autonomous cars, and then for a couple of decades we will have a combination of autonomous and non-autonomous cars on the road. When you

Top Automotive Customers
Listed alphabetically:
BMW
Daimler
Ford
GM
Renault Nissan
Toyota
VW
look at our journey from paper to digital maps, from 2D to 3D and now to high definition, and from there to indoor, online and offline, you can start to see a world where that digital representation becomes a vector orientation for everything that needs to find its way in the physical world. We have an opportunity to become the eyes of things, whether those things are cars, drones or robots.”

To pursue that opportunity HERE seeks investors that have experience building platforms on which services and applications can be built, platforms that can be scaled from cars to robots, drones, ships, essentially to any IoT device that relies on precise location data. To do that we need participation from powerful tech communities such as semiconductor, middleware and infrastructure companies. Intel took a 15% stake in HERE in January 2017. A couple of other companies from outside the auto industry are expected to join the group of investors later this year. Today the auto industry accounts for 70% of HERE’s sales; five years from now automotive, while growing, could be down to 50% as HERE leverages its data in other markets.

Meanwhile, HERE is having discussions with major carmakers in the U.S. and Asia who would contribute their vehicle probe data to the pool from Audi, Daimler and BMW, which comes mostly from vehicles in Europe. “In the next three to five years, we will have access to tens of millions of cars,” said Mr. Overbeek. “It would be great if that grows to 40 million or 50 million cars sending us real-time sensor data.” Under HERE’s Give-Get business model, revenue from safety or location services based on that data would be shared with the carmaker partners.

In December 2016, HERE announced the Chinese companies, Tencent and NavInfo, and the Singapore sovereign wealth fund, GIC, were investing to share
10% of the company among them. Facing opposition from CFIUS (Committee on Foreign Investment in the United States) and from HERE’s legal advisors, the proposed deal was abandoned in September 2017. HERE and NavInfo currently operate a joint venture company in China and HERE has reached a commercial agreement with the tech giant Tencent. According to HERE, Tencent is exploring the use of mapping and location platform services from HERE in its own products and services both in China and internationally.

**Intel/Mobileye**

Among the many companies HERE has partnered with, the relationship with Intel is among its most significant. Mobileye, the dominant provider of camera-based ADAS IP, is a subsidiary of Intel. Mobileye and HERE are both developing high definition maps that are able to support autonomous driving. Each company has a different approach to the way they extract map data from raw sensor data and have been cooperating to see what they can learn from each other.

“OEMs, BMW for example, get Mobileye RSD [road segment data] out of the Mobileye cameras they put in their vehicles. BMW then gives that RSD to us to use as a source for updating our maps,” said Ralf Herrtwich, head of HERE’s automotive business group. That will also be the case for Audi, if it adopts Mobileye’s next-generation SoC widely. Audi’s new A8 model uses an EyeQ SoC. Daimler isn’t a Mobileye customer. Dr. Herrtwich joined HERE in November 2016 after 20 years at Daimler in various roles, the last as director of vehicle automation and chassis systems.

HERE and Mobileye are developing a scalable proof-of-concept architecture that supports real-time updates of HD maps. “By leveraging our partnership we will get faster to market on a global scale,” said Mr. Overbeek. “That is why Amnon [Shashua] and I have almost biweekly calls, to make that work.” Intel and HERE
are also working on a location algorithm that can be embedded in chipsets for drones and robots. Intel has a 15% equity stake in HERE.

**Continental/Ygomi**

“With Continental now investing in HERE, we have a new work item on our agenda,” said Dr. Herrtwich. Continental has been working with Ygomi on a road database for automated driving. “We are looking at how well we would be able to integrate not just the Mobileye data, but also the Road DB data that Ygomi developed on behalf of Conti, into our map database. Given that we set up our system to be supportive of different data collected from different vehicles, we actually see no major obstacle in integrating the Road DB data. But first we need to see how good that data actually is. We have had a chance to work with Mobileye data for quite some time. Now we need to get started on the Road DB.”

**Advanced Telematics Systems**

HERE completed its acquisition of ATS in January 2018. Based in Germany with 35 employees, ATS has been developing secure over-the-air update technology, which is becoming increasingly essential as more cloud-connected cars are brought to market with the ability to accept software updates. The company’s OTA platform can potentially be used for map updates. “Every OEM is having conversations with us around ATS,” said Mr. Overbeek. “Whether you are computing in the car, in a data center or backend, you need to have a data handoff with the vehicle.” HERE also plans to offer ATS’s OTA technology as a standalone product within its automotive portfolio.

**HD Live Map**

Among the many developments underway at HERE, its high-definition map product called HD Live Map will almost certainly have the greatest impact on sales. With precision in the range of 22-40 centimeters, HD maps will not only support automated driving, but the higher precision will bring traditional route guidance to the next level. “Instead of saying to the customer, ‘take the left-most lane,’ our navigation system will know exactly which lane you are in, and ask you to ‘move one lane to the left,’” said Dr. Herrtwich. Other location-based services provided by HERE will also benefit from the upgraded precision of HERE’s maps.

HERE’s HD Live Map business will accelerate as vehicles with L3 and higher autonomous driving functionality are brought to market. HERE is responding to two segments of the market. The first segment, targeting customer-owned vehicles, will support automation on limited access expressways. Carmakers want to offer highway automation on a worldwide basis starting in 2020. HERE says its
HD database will soon be ready in those areas where carmakers want to start their testing. Thus far, more than half a million kilometers of HD maps, mostly of limited access roads, have been created. Later this year the number will grow to one million kilometers.

The second market that HERE is addressing with its HD maps is robo-taxis, which will operate in limited areas, a particular city, or routes within the city. For those applications, all roads down to class five will be mapped. “This is the next area we will support with our maps. If a customer comes to us and says ‘I plan to build a robo-taxi service in City A,’ we will provide the HD map for that location. Taken city by city, the robo-taxi market will be considerably more fragmented than the highly automated driving on highways market. “HAD is a big future market for us, because it takes our core business to the next level,” noted Dr. Herrtwich.

HERE’s goal is make HD maps that can be used in any automated vehicles, anywhere in the world. In its partnerships with NavInfo and Pioneer, HERE is creating HD maps for China and Japan, respectively.

Data Collection and Processing
While HERE maps today are accurate in the 22 to 40 cm range, improvements are coming. HERE operates 400 vehicles that drive the world’s roads collecting data from which the maps are built. About one-third of those vehicles have been updated with the latest suite of sensors, including a panoramic camera system and two lidar sensors. These lidar-equipped vehicles collect some 28 TB of data per day with accuracy down to centimeters. This so-called base map is the foundation of HD Live Map.

More new collection vehicles are coming, but they are expensive and the process is time consuming, so HERE has been signing agreements with carmakers to enable data collection from production vehicles. This crowd-sourced data adds features such as drive paths, lane markings and road signs. HERE aggregates the sensor inputs to determine the precise location of each artifact.

It has also been developing technology to change a process that was largely manual into one that is semi-automated. While quality checks are still done manually, in Mumbai, HERE has been able to automate most of the steps in the generation of its HD map by using deep learning algorithms. By the end of 2017, 36% of HERE’s map changes were completed through automated workflows. “This was a big step for us this year, as we were able to move fairly quickly from a few thousand kilometers to several hundred thousand kilometers of roads in our HD map,” said Dr. Herrtwich. The data ingestion and processing algorithms were
developed at HERE’s largest HD development sites: Chicago, Illinois; Berkeley, California; and Boulder, Colorado.

Making certain that map content is fresh is especially relevant to autonomous driving. It can only be done if you are able to ingest data at scale. Starting nine months ago, every new Mercedes, BMW and Audi that hit the road is delivering data to HERE. Thus far, HERE is getting probe data from roughly 400,000 vehicles.

Because you will never have a map that has the same precision and level of freshness throughout the entire world, HERE has come up with a concept it calls the Quality Index. Carmakers that use HERE’s HD Live Maps for autonomous driving would use the Quality Index to modulate the speed at which the vehicle is allowed to travel autonomously. “On a piece of road where the QI is low, perhaps resulting from the fact that a vehicle hasn’t recently sent a report for that road segment, the vehicle’s speed could be reduced,” said Dr. Herrtwich. “The feedback we are getting from customers on this is encouraging.”

Navigation Software
HERE has recently entered the market for navigation software, which could be bundled with HD Live Map. About two years ago it booked an order with JLR, and in September, at the 2017 Frankfurt Motor Show, HERE announced that it had won an order for its navigation software from Audi for the new A8. From there it will be rolled out to other Audi models as well as to Porsche and to some high-end Volkswagen models. An order has also been booked with Honda and with JLR for the second generation of the HERE navigation software.

HERE OS
At the 2018 CES, HERE showcased HERE OS, not an operating system but a software layer that sits atop the Linux, QNX or Android operating system, on which a selection of navigation software components such as routing, estimated time of arrival calculation and alternative routes can easily be integrated. By abstracting individual navigation components, HERE will be able to customize its navigation offering, making it easy for carmakers to substitute a software component they may favor for the one offered by HERE. “An additional benefit of the HERE OS architecture is that we can now build features that seamlessly link from the in-vehicle hardware, to the smartphone and the Web,” said Dr. Herrtwich. ◆
2017 Year-End Financial Results Roundup:  
Aptiv, Autoliv, Delphi, Lear, Visteon

**Aptiv** (the former Delphi Automotive, minus the Powertrain Systems business, spun off in December 2017)  
**2017 Sales**: $12,884 million  
**Change from 2016**: up 4.7%  
**2017 Operating Margin**: 11.0%, compared with 12.5% in 2016  
**Outlook for 2018**: Aptiv’s guidance for 2018 puts sales in the range of $13,400 million to $13,800 million.

Regionally, sales were up 9% in Europe, 10% in Asia and 24% in South America. North America was down 3%. General Motors, Aptiv’s largest customer, accounted for 13% of sales, followed by Volkswagen with 9% of sales, and FCA with 7%.

Three-quarters of Aptiv’s revenue comes from its new Signal and Power Solutions segment, formerly called Electrical/Electronic Architecture, which mainly produces wiring harnesses. Signal and Power Solutions accounted for 82% of Aptiv’s operating revenue. The business segment that was Delphi Electronics and Safety is now called Advanced Safety and User Experience.

With the powertrain business split off, Aptiv is focused on advanced technology solutions for safety, connectivity and electrification. The company employs more than 6,000 software engineers.

In October 2017, Aptiv acquired nuTonomy, a Boston-based developer of autonomous driving software, and moved its own autonomous driving development to a new technology center in Boston, now co-located with nuTonomy. Early in the year Aptiv completed the acquisition of Movimento, a company with over-the-air software updating technology.

**Autoliv**

**2017 Sales**: $10,382.6 million  
**Change from 2016**: up 3.1%  
**2017 Operating Margin**: 5.8%, considerably lower than the 8.4% operating margin recorded in 2016. The company partially attributes the decline to ongoing capacity alignments, antitrust-related settlement costs, and the separation of its primary business segments (see below).
Outlook for 2018: Autoliv expects negative currency effects of 3%, and a decline in organic sales in the Electronics business of approximately 3%. Profitability will decline due to increased RD&E. In Passive Safety, organic sales are expected to grow by more than 10%.

Sales for the Passive Safety segment amounted to $8,134.6 million for 2017, which is 3.1% higher than the previous year. Sales in the Electronics segment increased 4.8%, to $2,322.2 million. The Electronics segment includes airbag controls, sensors and software for active safety, radar- and camera-based ADAS and autonomous driving systems, as well as brake controls.

Late in 2017 Autoliv announced its intent to spin off its Electronics business segment into a publicly traded company to be called Veoneer. The company expects the spinoff to be completed in the third quarter of 2018. Electronics products accounted for 22% of Autoliv’s total sales in 2017. The Passive Safety business will retain the Autoliv name.

Autoliv explained the reasoning behind the spinoff:

Our segments today operate as two different businesses where the pace of technology advancements and RD&E investments for growth and innovation are much greater in Electronics. Consequently, this drives significantly different skill sets and talent in our people between the two organizations. This also results in two businesses where the sales growth rates over the near and longer term are quite different. ... And lastly, the two companies likely attract different shareholder types who potentially have different time horizons of returns on their investments.

In April 2017, Autoliv and Volvo Car launched their 50-50 joint venture called Zenuity to develop ADAS and autonomous driving software. Volvo will use the resulting products in its vehicles, and Autoliv can sell Zenuity products to third parties.

In September, Autoliv acquired Fotonic i Norden AB, a lidar and time-of-flight camera business based in Sweden.

Delphi Technologies (Until December 4, 2017, this business operated as Dephi’s Powertrain Systems segment.)

2017 Sales: $4,849 million
Change from 2016: up 8.1%
2017 Operating Margin: 9.2%, compared with 7.1% in 2016
**Outlook for 2018:** For the full year as a stand-alone company Delphi Technologies estimates growth between 1% and 5%, with revenue in the range of $4,900 million and $5,100 million.

The Powertrain segment’s product portfolio included ICE systems and components, software and control electronics, and power electronics for electric vehicle drive systems. The new Delphi Technologies adds aftermarket service parts to that portfolio. The aftermarket portion of the business accounted for nearly 20% of total sales. Aftermarket sales grew 2% in 2017. Powertrain sales were up 10%, due to increased vehicle production. The largest regional growth segment for the company was Asia Pacific, where sales increased 24%, primarily in China.

**Lear**

**2017 Sales:** $20,467 million  
**Change from 2016:** up 10.3%  
**2017 Operating Margin:** 8.4%, nearly the same as 2016  
**Outlook for 2018:** Assuming global vehicle production coming in at 95.1 million vehicles, Lear expects sales in the range of $21.4 billion to $21.6 billion while maintaining an operating margin consistent with the two prior years.

Ford is Lear’s largest customer, accounting for 19% of total sales, followed by GM with 18%, FCA with 10% and Daimler at 9%.

Lear’s Seating segment accounted for 78% of total sales in 2017. Seating revenue increased by 10.6% over the prior year, reflecting Lear’s acquisition of the seating business of the French company Grupo Antolin, with approximately €300 million in sales. The acquisition bolstered Lear’s position in the European market, notably with Grupo Antolin customers such as Peugeot Citroën, Daimler, Renault Nissan and Volkswagen.

Lear’s E-Systems segment accounted for 22% of sales, most of it wire harnesses, along with terminals, connectors and electronic modules, including products for 48-volt architectures. E-Systems also supplies connectivity, V2X and connected gateway modules with secure over-the-air software update capability. In line with its strategy to expand capability in connectivity, in January 2018, Lear closed on the purchase of the Israeli company EXO.
Technologies. EXO developed GPS technology that provides centimeter-level location accuracy to support V2X and autonomous driving applications.

**Visteon**

**2017 Sales**: $3,146 million, all of it in the Electronics segment  
**Change from 2016**: Down slightly, by less than half a percent, largely due to Visteon divesting its “Other” reporting segment, primarily the remaining HVAC operations  
**2017 Net Margin**: 5.6%  
**Outlook for 2018**: $3,175 million to $3,275 million in sales

For a recent in-depth look at Visteon, please see the Company Profile in the December 2017/January 2018 issue of the *Hansen Report*. ◆