Table of Contents

Interest in Electronics Hardware Updates Is Growing 2
Intel Promotes Self-Driving Safety Standard Based Initially on RSS Model 5
LMC Automotive Sees Global LV Sales Growth Slowing 7
BrainChip to Sample Its Neuromorphic SoCs in Q3 2019 8
The Company Profile: Valeo 11
Interest in Electronics Hardware Updates Is Growing

Some carmakers have begun to seriously consider how they might refresh the vehicle’s electronics with more powerful computers during the vehicle’s lifetime. Cars are lasting longer. A lifespan of 12 years and more than 200,000 miles of service is commonplace for vehicles today. Soon cars will be capable of over-the-air (OTA) software updates that will extend their useful life. Inevitably, hardware updates are also coming.

“Before the end of a car’s lifespan, you have outdated electronics,” suggested Stefan Poledna, CEO of TTTech Auto. “After five years of service and the two years it took to develop the vehicle, you have electronics that are seven years old. That is not a good thing. We are totally convinced that the time for hardware updates is now. It is not only about OTA software updates; you need to refresh hardware over the life of the vehicle.”

TTTech has been developing software and hardware concepts to support hardware updates. “The trend toward virtualization, hypervisors, software deployment over the air, and a more modular approach is clearly coming,” suggested Mr. Poledna. “The only question is how quickly is it going to happen. In discussions with our customers, they are saying it won’t be the next generation, 2021-22, but the following one, 2023-24, that is the probable time frame.”

The interest in hardware updates is not yet widespread. The topic only occasionally comes up in my discussions with our industry’s thought leaders. For example, in 2014 Elmar Frickenstein, who was BMW’s top E/E at the time, told me that he worked unsuccessfully with Nvidia to create a [prototype] piggyback board for head units. “We checked in the smartphone and tablet industries, but we could not find a solution for hardware updates that worked,” he said at the time. So BMW instead concentrated on updating software.

Ricky Hudi, who explored making infotainment systems updatable with hardware when he ran E/E development at Audi, said in a recent email that “the need is still relevant and becomes even more so in future cars as
software updates over the [vehicle’s] lifetime will require upgrades of computing power and other resources.” Now a consultant, Mr. Hudi is a co-founder of TTTech Auto.

While premium carmakers and some new entrants have been exploring ways to refresh electronics hardware in the field after sale, most mass-market vehicle developers probably aren’t, at least not yet. “We haven’t even figured out how to benefit from OTA software updates,” said one executive who didn’t want to be quoted. “We’ve got to do that first.” Cost is also a challenge. Implementing an architecture and packaging infrastructure flexible enough to accommodate new, more capable SoCs five or seven years out would be a burden on the bill of materials.

Günther Kraft, who is responsible for hardware and mechanical development at Harman, has over the last six months seen just two RFQs from OEMs interested in hardware upgradability, one involving a digital cockpit and the other a telematics solution. Neither request led to an order for Harman due to the added cost of providing hardware flexibility.

Harman has a few hardware update approaches in mind that could be implemented in the 2021 time frame but sees greater promise beginning in 2024, as OEMs turn to centralized computing architectures. “There could be one, two or three central computers per car,” said Mr. Kraft. “With those you will have the possibility to have more flexibility with updates and upgrades.”

Anup Sable, CTO of KPIT Technologies, agrees that hardware upgradability will become more feasible as carmakers move to two or three compute-intensive controllers to handle autonomous driving, HMI and vehicle control functions. “Each computer would be on a very high speed backplane with expandable slots to bring in more compute power or specialty functionality such as GPUs and NPUs (neural processing units).”

Willard Tu, senior director of Xilinx’s automotive business unit, is seeing interest in hardware updates, mostly from the companies that are developing self-driving vehicles. “As the algorithms are refreshed with new training, the neural networks they were using at the start of production may have to be upgraded,” he suggested.

According to Mr. Tu, vehicle developers are taking a modular approach with their hardware, similar to the way data centers use racks that can accommodate multiple new blades as needed. “They know they will need
more compute capability and don’t want to be stuck with one configuration for the life of the vehicle.”

Xilinx is developing a compute platform that features a board with four computer acceleration sockets. “Think of it as four blades. You could plug in four FPGAs, or a combination of four processors from different suppliers, for example from Intel, AMD and Nvidia,” suggested Mr. Tu.

TTTech has been working on a hardware/software in-car compute platform (ICCP) designed to support hardware updates. It also features a modular electronics system similar to what is used in data centers. The software piece is based on hypervisor technology that can create and run virtual machines. As new boards are added, they come under hypervisor management. New software is then downloaded to the new hardware over the air. TTTech is currently developing prototypes for a solution where each blade can hold up to four SoCs, and multiple blades could be added. The blades could be water- or air-cooled.

Andrew Poliak, vice president of product planning, strategy and innovation at Panasonic Automotive Systems, described a simpler approach to hardware upgrades, which employs phone projection technology such as MirrorLink, CarPlay, Android Auto, SDL or Baidu’s CarLife, without relying on the driver’s brought-in phone. “Imagine you are a carmaker in China selling cars equipped with a low-end IVI system that can handle projection mode. The carmaker could then implement post-sale upgrades by embedding a screen-less phone in the vehicle that is equipped to handle a variety of connected-vehicle applications, navigation for example, and project those features to the head unit’s user interface,” Mr. Poliak said, adding, “You will see some of this technology launched in 2020-2021.” This type of upgrade strategy would be aimed both at consumers and large mobility fleets. ◆
Intel Promotes Self-Driving Safety Standard Based Initially on RSS Model

Jack Weast, senior principal engineer for Intel’s automated driving group and vice president of automated vehicle standards at Mobileye, has been tasked with organizing a global effort to develop a safety standard for autonomous vehicles. Mr. Weast wants the industry to work together to respond to the toughest question autonomous vehicle developers struggle to answer: How can we prove to society and to safety regulators that self-driving vehicles are safe? A big piece of what makes that question so difficult is concerns about artificial intelligence.

As a first step, Mobileye, an Intel company, has contributed and opened up to the industry its engineering approach to safe automated driving, which is presented in a paper first published in September 2017. “On a Formal Model of Safe and Scalable Self-Driving Cars,” is authored by Shai Shalev-Shwartz, Shaked Shammah and Amnon Shashua. Professor Shashua is senior vice president at Intel and president and CEO of Mobileye. Professor Shalev-Shwartz is a senior fellow at Intel and CTO of Mobileye. A living document, the paper has been updated six times as more is learned and feedback is received. The last update was made in October 2018.

The authors propose a mathematical model for safety assurance they call Responsibility-Sensitive Safety (RSS). According to the paper, “A model-based approach to safety is required, but the existing functional safety and ASIL requirements in the automotive industry are not designed to cope with multi-agent environments. Hence the need for a formal model of safety.”

RSS formalizes human notions of safe driving into a verifiable model with logically provable rules. It defines appropriate responses and ensures that only safe decisions are made by the automated vehicle. It further ensures that the automated vehicle will do everything it can to avoid getting involved in unsafe situations initiated by others.

“Safety shouldn’t be proprietary,” said Mr. Weast. “We believe that safety should be something that is common across all products and vehicles in the market. That is why we decided to contribute this openly. Let’s use RSS as a starting point and look at creating a standard in the industry that we can all use. We can innovate all we want with our proprietary AI stuff, but all of our products should be equally safe.”
While acknowledging that AI is a very useful and very powerful tool, Mr. Weast noted that “By definition it is probabilistic, meaning there is always going to be a very real and measurable chance that the AI based algorithm will propose an action that is unsafe. … There are many people who think that artificial intelligence is the solution for everything, but we think there are risks with that. It is infeasible and impractical to gather enough statistical evidence to prove with any kind of assurance that a probabilistic-based safety model is safe enough. … AV safety should be deterministic.”

Instead, Mobileye is proposing a “doer-checker” architecture. “In robotics you have elements of the system doing planning, whether it’s trajectory or moving a robotic arm, and then you have the checker, an independent layer that makes sure the proposed action is safe,” explained Mr. Weast. “There are three stages in classical robotics: sense, plan and act. We have inserted a deterministic layer between plan and act that acts as a double check, providing a safety seal for planning.”

This safety layer inserted into the software stack takes the environmental model, what the world is, and takes the proposed trajectories or actions from the AI-based driving policy algorithm, compares the two and asks, does the plan violate my safety model?

There is good reason for the industry to cooperate openly in the development and adoption of a standard safety model. According to the Mobileye paper, such a standard for autonomous vehicles could potentially reduce fatality rates compared with human-driven vehicles by “three orders of magnitude, namely to a probability of $10^{-9}$ per hour. … [which is equivalent to] the probability that a wing will spontaneously detach from an aircraft in midair.”

“If you continue to have bad actors out there doing things in an unsafe manner, it is not going to take too many more fatal accidents for regulators to shut the whole market down,” cautioned Mr. Weast. “Regulators need to trust and believe that these things are safe.”

Mobileye and Intel want to collaborate with other autonomous vehicle developers on the verification of the RSS model. “We think that we have a model here that’s correct. We’ve proven it to the extent that we can but getting more eyes on it and getting more contributors is necessary to build that industry-wide consensus needed to convince governments and consumers that this is correct.”

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On January 8th at CES 2019, Intel announced that Valeo has agreed to support the RSS model for safe autonomous vehicle decision-making and to cooperate on the development and promotion of a technology-neutral, industry-driven standard that is acceptable to government regulators.

Baidu announced in July 2018 that it planned to work with Intel to integrate and commercially deploy the RSS model in both the open-source Project Apollo and commercial Apollo Pilot programs. At CES this month Baidu demonstrated the world’s first open-source software implementation of RSS, which can be used with or without Intel technology.

LMC Automotive Sees Global LV Sales Growth Slowing

Automotive intelligence provider LMC Automotive predicts global sales of light vehicles will grow at just 2.2% annually from 2018 through 2021. Since 2009, when the automotive industry was slammed by the Great Recession, through 2017, global vehicle sales grew at 5.1% annually driven largely by the expanding market in China. 2018 saw the first decline in unit sales after eight consecutive years of growth. LMC forecasts light vehicle sales to top 100 million early in the next decade.
BrainChip to Sample Its Neuromorphic SoCs in Q3 2019

According to the market intelligence firm Tractica, the artificial intelligence acceleration chipset market for all applications, including automotive, will quickly grow from about $4 billion in 2018 to $66 billion by 2025. Some of those devices will support training, but the vast majority will run the inference engines (neural network processors) operating at the edge, which draw their conclusions about the data they are seeing based on their training.

While GPUs and FPGAs will account for much of the edge acceleration market early on, there has been quite a lot of interest in neuromorphic computing devices, which are designed to learn the way the human brain learns. Elliott Garbus, who ran Intel’s Automotive Solutions Division until May 2017, told us that he saw neuromorphic technology as an opportunity to replace the GPU neural network processors operating at the edge. “One of the challenges with autonomous driving today is that the power consumption is quite high. When I was at Intel, the OEMs wanted the ADAS CPU’s power consumption to be below 15 watts. At the time, autonomous driving computers were consuming between one and three kilowatts; they were often water cooled. Neuromorphic devices are an opportunity to get rid of a GPU-based inference engine.”

Neuromorphic computing devices running neural-network inference engines aboard vehicles could be in the market sooner than people think. BrainChip
**Holdings**, the publicly traded Australian neuromorphic chip pioneer, plans to begin sampling its neuromorphic system-on-chip (NSoC) in Q3 2019. The company expects revenue from automotive applications to begin in 2021 or 2022 at the earliest. BrainChip chose to implement its spiking neural networks (SNNs) using CMOS logic with embedded static RAM to make the chips as easy to manufacture as possible. Founded in 2013, the company is presently operating at approximately a $1 million run rate of sales.

Neural networks based on NSoCs operate at significantly lower power levels than neural networks based on GPUs. “Low power is their primary advantage,” asserted Robert Beachler, senior vice president of marketing and business development at BrainChip. “We are designing a sub-one-watt device that can do object recognition and tracking based on multiple sensors inputs. … Presently we are getting 1,400 images/sec/watt at 88% accuracy on the CIFAR-10 dataset.”

BrainChip Holdings claims to be the world’s first company to develop a commercial hardware implementation of a spiking neural network architecture that is uniquely suited to tasks associated with ADAS and autonomous driving. Spiking neural networks are seen as the third-generation neural network model. (See the graphic on page 8.) Convolutional neural networks (CNNs), or deep learning, were the second generation. SNNs consume less power than traditional CNNs because they replace the math-intensive convolutions and back-propagation training methods with biologically inspired neuron functions and feed-forward training methodologies.

Mr. Bleacher explained further: “Instead of doing matrix multiplication as CNNs do, a spiking neural network is actually emulating the biological function of a neuron, which exchanges information in the brain in the form of spikes. We emulate those spikes as digital data.” The synaptic connections, firing thresholds, and spiking information are all modeled as standard digital logic, not math functions. This substantially reduces overall power consumption for the same functionality as CNNs.

BrainChip is aiming its chip technology at the inference engines (neural networks) that will operate aboard the vehicle, rather than at neural network training, which takes place away from the vehicle. Two or three of BrainChip’s SNN devices could potentially process outputs from six cameras, locating and classifying objects. Similarly, one or two devices could process lidar sensor outputs, depending on the complexity of the network.
BrainChip was involved with a successful proof-of-concept demonstration with an automotive system supplier who wanted to see if the company’s SNN technology could infer the height of objects based on output from ultrasound sensors. It would be helpful to know, for example, if a sensed object is indeed an obstacle or if it is short enough that the vehicle could comfortably back over it.

Intel reportedly has been developing neuromorphic devices at least since 2012. Intel acquired the neuromorphic chip company Nervana in 2016. A test version of Intel’s Loihi SNN chip was released to developers earlier this year. The company aims to accelerate neuromorphic technology development through a new consortium of academic, government and industry research groups called the Intel Neuromorphic Research Community.

IBM has been researching neural network chips for nearly a decade, starting with the DARPA-funded research program called SyNAPSE. IBM’s TrueNorth SNN chip, first produced in 2014, has been used by researchers but is not a commercial, production-volume product.

**Challenges**

While the ecosystem to train and architect convolutional neural networks is up and running, the ecosystem for spiking neural networks is just getting started. “Today pretty much all of the more sophisticated carmakers and tier-one suppliers have people on staff who understand convolutional neural networks,” Mr. Beachler said, “but they don’t have expertise in spiking networks. However, there has been a surge of people who can create SNNs in academia who will soon be entering the workforce.” BrainChip has developed a semi-automated system to transfer CNNs into the spiking domain, but that process still requires a lot of human intervention. Plenty of other obstacles remain, but these will be overcome, especially if neuromorphic devices prove to be significantly less power hungry than GPUs. ◆
The Company Profile: Valeo

**Thumbnail Sketch**

**Headquarters:** Paris, France; [www.valeo.com](http://www.valeo.com)

**2017 Sales:** €18,550 million

**R&D:** 6.1% of sales

**Capitalized Development Expenditure:** 3.1%

**EBITDA Margin:** 13.1%

**Operating Margin:** 8.0%

**Free Cash Flow:** €278 million

**Working Capital:** €263 million*

**Net Debt:** €1,852 million*

**Total Shareholders’ Equity:** €4,414 million*

**Market Capitalization:** €5.99 billion as of November 19, 2018

**Major Customers:** The two largest customers are Renault and Volkswagen Group, which together account for more than 30% of sales.

**Employees:** 111,600, of whom 17,900 are in R&D*

**Sales per Employee:** €168,952

*At year end 2017

**Background**

From its founding in 1923, first as a distributor and later a manufacturer of brake linings and clutch facings, Valeo has evolved into one of the leading global suppliers to the automotive industry—number one in driving assistance, electrical, lighting, and wiper systems, and number two in transmission and thermal systems. The business is organized in four major business groups: Comfort and Driving Assistance Systems, Powertrain Systems, Thermal Systems, and the largest, Visibility Systems, which produces lighting and windshield wiper products.

**Valeo Sales by Business Group**

2017 Total Sales: €18,550 million

- **Visibility, 31.3%**
- **Comfort and Driving Assistance, 19.4%**
- **Powertrain, 23.2%**
- **Thermal, 27.0%**

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In its 95 years in business, Valeo has made a series of strategic acquisitions and diversified its product portfolio. Multiple international partnerships have enabled its expansion into all the major regional automotive markets. Valeo’s global footprint spans five continents with 185 plants (80 of them in Asia) and 56 R&D centers. In 2017 the company invested 6.1% of sales in R&D, a large percentage of which went to developing and expanding the company’s sensor and electrical machine technology. Valeo aligns its product portfolio with three major trends driving the automotive industry: electrification, autonomous driving and connectivity.

Original equipment sales account for nearly 87% of Valeo’s revenue. Global vehicle sales growth has slowed in the past two years, a trend that is likely to continue into 2019. At the end of Q3 2018, Valeo revised its guidance on operating profit and cash flow downward, citing a market slowdown in China and

<table>
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<tr>
<th>Business Group</th>
<th>2013 Sales (€ billions)</th>
<th>2017 Sales (€ billions)</th>
<th>2017 EBITDA Margin</th>
<th>2013 – 2017 CAGR of Sales</th>
<th>2021 Sales* (€ billions)</th>
<th>2021 EBITDA Margin*</th>
<th>2017-2021 CAGR of Sales*</th>
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<tr>
<td>Comfort and Driving Assistance</td>
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<td>3.6</td>
<td>14.5%</td>
<td>13.1%</td>
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<td>4.3</td>
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<td>6.1%</td>
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<tr>
<td>Thermal Systems</td>
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<td>5.0</td>
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<tr>
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* Valeo projections
the delayed certification of vehicles in Europe to the new emissions tests under the Worldwide Harmonized Light-Duty Vehicle Test Procedure (WLTP). Rising raw material costs are also a factor, and the company has initiated a plan aimed at “reducing capital expenditure by €100 million compared with 2017 and cutting costs by around €100 million,” according to a statement by CEO Jacques Aschenbroich.

Following the Q3 revised forecast, Moody’s Investors Service maintained its investment-grade Baa2 rating (moderate credit risk) for Valeo but revised its outlook from stable to negative. Moody’s also believes Valeo is well positioned to benefit from the three big disrupters at work in the industry today: electrification, connectivity and autonomous vehicles. Standard & Poor’s maintained its BBB/Stable rating for the company, but noted it has “limited headroom” at that level.

**Valeo Share Price One-Year History**

Valeo’s share price declined by nearly 60% in 2018.

Software Capability

Valeo doesn’t classify its engineers according to specific disciplines, but the majority of them are involved with software at least part of the time. More than 75% of Valeo products have a software component, according to Guillaume Devauchelle, vice president of innovation and scientific development. He is in charge of technology scouting for the company. Prior to this he headed up the group’s R&D teams. Mr. Devauchelle joined the company in 2000 following
Valeo’s acquisition of Sylea, where he served as senior vice president. His first position at Valeo was general manager for electronics.

Valeo Egypt is the company’s main software development center, with 1,600 engineers, at present, working on embedded software modules and systems for vehicles. These engineers developed Valeo’s Park4U automated parking feature, for example. In 2018, Valeo expanded the facility and is in the process of hiring an additional 400 engineers. Valeo Egypt works in cooperation with all Valeo R&D centers globally.

**Electrical Machines and Power Electronics**
Valeo expects its Powertrain Systems group to grow sales at the rate of 14% per year from 2016 through 2021. Much of that growth can be attributed to the strong market for Valeo’s electrical machines and power electronics.

Valeo says it is the world’s top supplier of alternators, with a 30% share of the global market. The company produces 30 million alternators per year, successfully competing against Bosch and Denso, two much larger companies. According to Mr. Devauchelle, Valeo’s thermal systems competence has been valuable in designing alternators with superior heat management properties compared with others on the market. The placement of magnets in the rotors allows for high efficiency in a smaller package while keeping the inexpensive claw pole architecture. Temperature control is important for minimizing the usage of rare-earth magnets, which keeps cost low. In addition, an optimized stator winding process and a higher copper filling ratio improve efficiency and allow for a smaller diameter unit.

While nearly all the alternators that Valeo ships operate at 12 volts, the company expects demand for its 48-volt machines to accelerate, especially in Europe as carmakers respond...
to stronger CO2 emissions regulations with more hybrid and electric vehicles. Demand for such vehicles is also receiving a boost from the declining interest in vehicles with diesel engines. Valeo expects mild hybrids to make up more than 25% of the world vehicle market in 2026.

**Valeo Siemens eAutomotive GmbH**

**Headquarters:** Erlangen, Germany  
**Founded:** December 2016  
**Ownership:** 50-50 Valeo and Siemens JV  
**2022 Sales Projection:** €2 billion according to Valeo  
**Order Intake:** €10.8 billion as of June 2018  
**Products:** High-voltage electric motors, DC/DC converters, inverters and onboard chargers  
**Employees:** 1,600

The Valeo Siemens joint venture is focused on providing electrical machines and electronics to the high-voltage (60V and above) portion of the plug-in hybrid and battery electric vehicle markets. Valeo on its own serves the low voltage (12V and 48V) segment of the electric and hybrid vehicle markets. Order intake, which reached €6.1 billion by year-end 2017, had already climbed to €10 billion by February 2018.

Given the joint venture’s high order intake, Valeo's R&D and capital investments needed to deliver future shipments are also high. This will have a 0.4% to 0.5% negative impact on Valeo's income in 2018. By 2022 when the JV’s sales rise to more than €2 billion, EBITDA margin is expected to be similar to Valeo’s.

**Sensors**

Valeo produces all the key sensors required for ADAS and autonomous driving. Ultrasonic sensors, used primarily in parking systems today, are its highest volume sensor. Valeo’s 24 GHz and 77/79 GHz radar sensors are used primarily for blind-spot detection. Its camera systems are based on Mobileye image-processing technology. Valeo’s SCALA sensor is the world’s first lidar sensor to find series production.

◆ **Ultrasonic sensors**

Valeo currently produces 120 million ultrasonic sensors per year, according to Mr. Devauychelle, up from 65 million in 2013. While ultrasonic sensors are used almost
exclusively in parking systems today, Valeo has completed research aimed at improving their range and resolution. Fifteen to 20 meters of range is feasible, Mr. Devauchelle noted, which could make ultrasonic an inexpensive alternative to radar for blind spot detection. “Valeo is building a 360-degree ultrasonic cocoon that can be used to detect the location of vehicles in adjacent lanes, including the blind spots,” he said.

◆ SCALA Laser Scanner
SCALA, the world’s first mass-produced automotive laser scanner, was launched on the updated Audi A8 in the spring of 2018. The Traffic Jam Pilot feature on the A8 employs the SCALA lidar scanner combined with radar and camera, to survey the area in front of the vehicle for obstacles. While many SCALA-equipped A8s have been sold, the Traffic Jam Pilot feature has not yet been activated and won’t be activated until national and regional highway safety regulators give Level 3 self-driving features their blessing. “Demand for SCALA will bloom as soon as L3 is permitted,” Mr. Devauchelle asserted. Laser sensors are essential to L3 through L5 self-driving features.

Valeo, along with a slew of its competitors, has been hard at work developing solid-state alternatives to mechanical lidar sensors like SCALA, which scan the scene by means of rotating mirrors. Despite the enthusiasm surrounding a compact, low-cost, solid-state solution, today’s rotating-mirror lidar may prove to be more than an intermediate solution. “As the learning curve with SCALA is becoming more and more interesting, it is more difficult to achieve the same performance with a single solid-state lidar sensor,” said Mr. Devauchelle.

Valeo’s second-generation mechanical scanning lidar, SCALA 2, due in 2019, will have more beams, with three times the vertical field of view of SCALA 1, as well as better resolution. SCALA is based on an initial solution from Ibeo Automotive. ZF owns 40% of Ibeo Automotive.

◆ Sensor Fusion
As part of an agreement reached between Valeo and Mobileye in 2015 to jointly design and industrialize a range of camera solutions and sensor fusion products using Mobileye’s EyeQ SoCs and computer vision algorithms, Valeo can offer exclusive solutions that fuse the output from Valeo’s SCALA lidar with camera outputs. The data fusion software has been developed by Valeo.

Sensor fusion technology from Valeo can assign weights to the various sensor outputs depending on the environment (sunset, fog, rain, etc.) or location (highway, city, etc.). “Cameras are better at classifying vehicles, pedestrians and
other objects, whereas SCALA is better at accurately measuring the distance to those objects,” noted Mr. Devauchelle. Fusing the output from the two sensors lets each sensor’s strengths step in for the other sensor’s weaknesses.

Being able to build a single image from four different cameras is a Valeo specialty, according to Mr. Devauchelle. The company’s 360Vue system provides drivers multiple views of the vehicle’s immediate environment to help drivers maneuver around obstacles and see around corners while parking.

◆ Sensor Cleaning
Valeo has developed a range of fully automated cleaning systems to keep sensors fully operational for ADAS and autonomous driving. The cleaning systems for cameras include several types of nozzles, usually with a small retractable arm that sprays the right amount of cleaning fluid onto the external glass. These can be combined with drying systems and with de-icing features to ensure performance in the winter. The company has also developed what it calls everView Centricam, which keeps the camera clean by quickly spinning the external glass. Further, Valeo has developed software algorithms that analyze the camera image to determine when cleaning is required. Valeo’s cleaning technology for lidar sensors will be fitted onto the vehicles of a leading German brand in 2020.

Strategy
Valeo’s business strategy has not changed from four years ago when we last profiled the company. Then as now, the strategy was based on two growth drivers, innovations in the fields of CO2 emissions reduction and intuitive driving, along with geographic expansion in high growth potential regions, particularly Asia. Products and technologies that have been in series production for less than three years accounted for 50% of Valeo’s total order intake of €27.6 billion for 2017. Order intake was up 17% from the prior year.

Of its four business groups Valeo’s Comfort and Driving Assistance Systems group benefited from the most R&D investment as a percentage of sales in 2017: 11.5% of sales, compared with 6.1% for all of Valeo. Much of that investment went to sensor development, especially lidar, blind-spot radar and camera sensors. In 2017 Valeo picked up its fourth camera customer since the start of its technology partnership with Mobileye in 2015. Earlier this year, Valeo stated that it expects 10% annual growth in sales for its Comfort and Driving Assistance Systems group between 2016 and 2021. The group reported sales of €3.6 billion for 2017.

Valeo’s Powertrain Systems group will grow even faster, says the company: 14% per year from 2016 through 2021. While 12-volt alternators dominate the group’s
shipments, Valeo touted the promise of its 12-volt electric superchargers and starter-alternators that handle the start-stop function. Also showing promise are 48-volt electric superchargers, DC/DC converters and starter-alternators.

The Visibility Systems group grew by 25% in 2017, due largely to Valeo’s 55% takeover of Ichikoh, Japan’s leading automotive lighting company. Ichikoh was fully consolidated by Valeo on February 1, 2017. “Thanks to this alliance we are very strong in LED lighting,” said Mr. Devauchelle.

**Growth in Asia, Focus on China**

As Valeo sees it, Asia is vital to its marketing strategy. Valeo has been operating in China since 1984. In July 2018, Valeo entered into a strategic cooperation involving Baidu’s Apollo self-driving autonomous driving platform. Mr. Devauchelle: “China is Valeo’s largest market. We have more factories in China than in any other country.” Asia accounted for 33% of Valeo’s OEM sales in 2017, up from 27% in 2016.

In 2017, Asia accounted for 50% of the world’s automotive production; 29% of the world’s vehicles were produced in China. According to Valeo’s Integrated Report: “China is the leading producer of electric vehicles worldwide. Starting in 2024, the country will apply the most stringent emissions regulations in the world, helping to accelerate the trend toward powertrain electrification. To speed up development of the autonomous vehicle, Valeo has formed a number of technology partnerships in Asia, particularly in China, Japan and South Korea.”

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**Distinctions Claimed by Valeo**

- World’s first supplier to offer start-stop systems
- Global market share leader in driving assistance systems
- World’s largest portfolio of driving assistance sensors
- SCALA (lidar), the world’s first mass-produced lidar sensor
- World’s top supplier of wiper systems
- World’s number-one supplier of thermal management systems for buses
- World’s leader in lighting systems
- Number-one supplier of 360-degree cameras to the top three U.S. carmakers
- World’s number-one alternator supplier, shipping 30 million units per year
### Valeo’s Major Products

#### POWERTRAIN SYSTEMS
- Transmission systems
- Dual dry clutches
- Dual wet clutches
- Clutches with or without self-adjusting technology
- Clutch discs
- Clutch facings
- Release bearings
- Hydraulic clutch actuators
- Flexible flywheels
- Dual mass flywheels
- Pendulum dampers
- Torque converters

#### Electrical Systems and Hybrid and Electric Vehicle Systems
- Stop-start machines
- Belt-driven starter alternators
- Reinforced starters
- Electric drivetrains including:
  - Power electronics (inverters, chargers, DC/DC converters) for hybrids and EVs
  - Electric motor drives
  - Range extender generators
  - 48V machines and electronics

#### Engine Management Systems and Air Management Systems
- EGR and air intake modules
- Electric superchargers

#### THERMAL SYSTEMS
- Climate Control
- Air-conditioning systems and modules
- Evaporators
- Heater cores
- Multi-zone HVAC units
- Battery thermal management
- Rear air conditioning
- Electric radiators for instant cabin heating
- Air-conditioning systems with storage evaporators for stop-start vehicles

#### Electrical Systems and Hybrid and Electric Vehicle Systems
- Electric air conditioning for hybrid vehicles
- Bus air conditioning
- Air quality products
  - Particle, gas and odor filters
  - Fragrance diffusers and ionizers

#### Powertrain Thermal Systems
- Heating and cooling products
  - Radiators
  - Condensers
  - Oil coolers
  - Fan/motor systems
  - Cooling modules
- Air intake cooling modules
- Charge air coolers (air and water)
- EGR coolers
- Low-energy heating systems for electric vehicles

#### Air-Conditioning Compressors
- Rotary vane
- Fixed cylinder
- Variable cylinder
- Electric compressors
- Front-end modules

#### COMFORT AND DRIVING ASSISTANCE SYSTEMS
- Driving Assistance
  - Safe4U active pedestrian protection systems
  - Park4U semiautomatic parking systems
  - Rain/light/humidity detection systems
  - ParkVue rearview visibility systems
  - Blind spot and reversing detection systems
  - 360Vue multi-camera systems
  - LaneGuide lane departure systems
  - Ultrasonic sensors
  - Radar sensors
  - Camera sensors
  - LIDAR sensors
  - LED sensors
  - Laser scanners

#### Interior Controls and Electronics
- Top column body control modules
- Body control modules
- Battery management modules
- Switching and driver interface panels for HVAC and multimedia control
- Control panel displays
- Steering angle sensors
- Torque
- Telematics control units
- Interior vehicle microphones
- Driver/interior monitoring systems

#### VISIBILITY SYSTEMS
- Lighting Systems
  - Main headlamps with LED, xenon or halogen technology
  - Camera-assisted adaptive headlamps
  - Daytime running lights, LED or incandescent
  - Sensor cleaning
  - Rear and high-mounted stop lamps, LED or incandescent
  - LED-based interior lighting systems
  - Interior and exterior mirror systems
  - Fog and auxiliary lights
  - Lighting and signaling controllers
  - Cigar lighters
  - Multifunction sockets
  - USB ports

#### Wiper Systems
- Arm and flat/traditional blade sets, including AquaBlade
- Wiping systems with mechanisms or electronics
- Windshield de-icing and washing systems
- Rear wiping systems
- Wiper motors