The Promise of CMOS Radar

The radar sensors used today for blind-spot detection and adaptive cruise control employ millimeter wave integrated circuits made from silicon germanium (SiGe) semiconductors. But change is in store for the way radar sensors are made and applied.

NXP, Texas Instruments, Fujitsu Labs, Infineon and the Belgium nonprofit, nanoelectronics R&D lab, imec, have been developing CMOS-based, radar integrated circuits, which require significantly less power than their SiGe equivalents. And if a sufficiently large market can be found to fund the large investments needed to produce them, CMOS radar chips could be priced low enough to substitute for not only SiGe-based radar, but also for ultrasonic sensors, in some applications.

NXP’s automotive CTO, Lars Reger, anticipates a cocoon of 10 or more postage-stamp-sized (3 cm²) two-chip CMOS radar sensors, consisting of a microcontroller and transceiver, that would provide a 360-degree view around the vehicle, useful not only for blind-spot detection and adaptive cruise control, but also for parking assist, rear cross-traffic alert, lane-change assist, automatic emergency braking (including for pedestrians) and eventually, fully autonomous driving. According to Mr. Reger, operating at frequencies of either 77 GHz (with 1 MHz bandwidth) or 79 GHz (with 4 MHz bandwidth), CMOS radar of varying degrees of capability can perform in short-, mid- and long-range applications, as far as 250 meters.

NXP has already created samples of a 40 nm, one-chip transceiver, which has three send and four receive channels (or antennas.) The company is working with Hella’s 50:50 jointventure partner, InnoSenT.

Hella will have exclusive rights to the technology. “Hella is already the market leader with 24 GHz radar, now they want to be the one driving fastest into the CMOS radar domain,” said Mr. Reger. “NXP is also working with Google, who has samples, as well as nearly a dozen other potential partners. … Volume production will start in 2018 or 2019, when you will see it in cars.” NXP’s roadmap calls for a single-chip radar sensor, consisting of the transceiver integrated with the microcontroller, two or three years later.

Imec, which conducts R&D projects jointly with paying customers, is also developing single-chip 79 GHz radar solutions, but in 28 nm CMOS. It is already working with Panasonic and will soon disclose the name of one of its other partners, a major automotive chip maker. “Our more aggressive partners see simple CMOS-based sensors coming to market in maybe two years,” said Wim Van Thillo, program director at imec. “Our more conservative customers think it will be more like five years.”

That aggressive partner is almost certainly not Panasonic, who said in an email to the Hansen Report that they have not yet decided to produce a CMOS-based radar sensor. According to Panasonic, the inability of CMOS to provide sufficient output power will limit its application to short distances, using multiple sensors.

Much Depends on Price

NXP’s Lars Reger believes that CMOS radar will be disruptive to the automotive radar market. Over the next decade it will “clearly substitute for silicon germanium radar,” the current technology. And while “CMOS radar will never reach the cost lev-
els of ultrasonic sensors ... some carmakers might want to replace ultrasonic sensors with radar or there might be hybrid parking systems with a mix of radar and ultrasonic. ... Radar is more robust, has longer range and is more accurate than ultrasonic sensors. And you can mount radar invisibly behind the bumper and get rid of those ultrasonic transducers you see. Carmakers don’t like them.”

With CMOS the high-frequency parts and the microcontroller can be integrated onto a single chip. “Whether that makes business sense is a different discussion, because the price points of CMOS are completely different from silicon germanium,” suggested imec’s Mr. Van Thillo. “Typically, in high volumes CMOS is a very low-cost technology, but the non-recurring engineering cost is much higher. ... For radar, it does seem the volumes are coming, especially with autonomous driving. There could be ten radars per car, not just high-end cars but every car.”

Michael Klar, director of radar system development for Bosch, thinks CMOS could potentially replace SiGe radar chips over the next ten years. “Cost is the main open question for CMOS. Will there be enough volume to cover the higher mask costs for the production of CMOS chips compared to silicon germanium?”

NXP’s Mr. Reger has talked about offering the radar front-end and microcontroller in a price range between $10 and $20, at least initially. “Of course there would be steep cost down curves depending on which year you are looking at,” he noted.

That price is quite a bit above Bosch’s target. “A radar chip should definitely cost below $4,” suggested Dr. Klar. “Ultrasonic sensors cost much less than $4. “But if somebody offers a radar sensor with more detection range and more features than ultrasonic, then OEMs would probably be willing to pay that much [for the chip].”

Bosch has been studying if it should adopt CMOS radar for future systems and has not yet made a decision to do so. “At this stage [CMOS] shows good performance in principle, but there are some open topics,” said Dr. Klar. “For example, can the voltage-controlled oscillator provide sufficient output power over the whole temperature range? The RF performance of silicon germanium is actually better than CMOS, because it is bipolar technology. The big advantage of CMOS is the high integration of the digital paths. If they are able to integrate the RF stuff in this chip and generate really high volumes, then you will have cost advantage.”

But assuming a price of $10 for a CMOS chip, comparable solutions based on silicon germanium are available at a comparable cost.

SiGe Still Has Legs

Still improving, silicon germanium radar technology is a moving target. Infineon is the world’s top supplier of 77 GHz radar chips, the high-frequency parts of which are implemented using silicon germanium integrated circuits. Infineon has lately seen its market accelerate. Since 2009, when it first introduced radar chips to the market, Infineon has produced 20 million chips; 10 million of those were produced in just the last 12 months.

Infineon is currently offering a two-chip radar solution, not including the microcontroller. The transmitter-receiver chip is in SiGe with a CMOS companion chip handling the drive circuitry.

In two or three years Infineon will offer a single-chip SiGe radar solution, exclusive of the microcontroller. “The dimensions including the antennas are very similar to what NXP showed earlier this year at CES, [3 cm]!” said Ralf Bornefeld, vice president and general manager for sense and control at Infineon. “There is no reason why a highly integrated silicon germanium chip should be bigger than what NXP has shown.”

Infineon is also developing CMOS-based radar in the belief that a simple CMOS radar solution can replace ultrasonic sensors for highly automated parking functions. “This is a high-volume application that is well suited to CMOS,” said Mr. Bornefeld. “Lower volume, higher performance applications will benefit from silicon germanium maybe for another ten years. ... We believe we’ll see a co-existence of both technologies for a while longer.”

In an email, Paolo Ruffino, ADAS marketing manager at STMicroelectronics, wrote: “SiGe will not be replaced by CMOS for quite a long time. ... SiGe provides output power that cannot be achieved by CMOS technology. In order to compete with SiGe’s lower cost, CMOS chips would have to be highly integrated, with everything done on the same chip. And then integration would limit the flexibility to offer a range of performance features such as the number of channels.”

A leading supplier of SiGe radar, STMicroelectronics has thus far shipped more than 35 million 24 GHz SiGe radar chips for short- and mid-range wide-angle applications such as blind-spot detection.

High-Frequency CMOS Radar Will Compete for 24 GHz Applications, Eventually

A disadvantage of 24 GHz radar is the dimension of its antennas. Sized according to the half-wavelength of the radio signal, antenna dimensions are smaller at higher frequency. High-frequency radar at 77 GHz or 79 GHz is considerably smaller and therefore more easily integrated into the vehicle than 24 GHz.

Today, Hella’s market-leading 24 GHz radar business is robust, as demand accelerates for low-cost blind-spot detection, lane-change assist, and rear cross-traffic alert features in high volume C-, B- and even A-segment vehicles. Volkswagen chose Hella’s latest 24 GHz radar system for the Volkswagen Golf last year. “This product would not have been possible with a 77...
Roundup 2015: Conti, Gentex, Mobileye, Mobis, Visteon

Continental Automotive Group
2015 Sales: €23,575 million
Change from 2014: up 12.8%
EBIT Margin: 8.5% compared with 5.7% in 2014
Outlook for 2016: Continental expects Automotive Group sales to increase by more than 5% to approximately €25 billion with an adjusted EBIT margin of at least 8.5%.

The Automotive Group, which includes the Chassis and Safety, Powertrain and Interiors businesses, accounted for 60% of corporate sales in 2015. Each of the three businesses showed impressive growth. Sales were up 12.4% in Chassis and Safety, up 8.8% in Powertrain, and the Interiors division increased sales 16.5% over the prior year. Five business units comprise the Interiors division, including two in the industry’s hottest product segments: Instrumentation and Driver HMI, and Infotainment and Connectivity. Continental invested 8.9% of automotive sales in automotive R&D.

In July 2015, Continental solidified its software capability with the acquisition of Elektrobit Automotive Group. The two companies have a longstanding business relationship, and Elektrobit will continue to operate as a standalone company within Continental. Elektrobit is already developing augmented reality software for its new parent.

In March 2016, the company acquired the high-resolution, 3D Flash lidar business unit of California-based Advanced Scientific Concepts. According to Continental, the sensor technology provides real time machine vision as well as environmental mapping functions.

Gentex
2015 Sales: $1,543.6 million
Change from 2014: up 12.2%
2015 Net Margin: 20.6%, down slightly from the prior year
Outlook for 2016: Sales between $1.64 billion and $1.72 billion, based on IHS light vehicle production forecast

Gentex attributes sales growth to a 14% overall increase in automatic-dimming mirror shipments. Sales of exterior auto-dimming mirrors in North America were particularly strong, showing a 37% increase. Sales of HomeLink modules grew 29%, excluding revenue from HomeLink integrated into mirrors.

In February 2016, NHTSA approved the use of Gentex’s Full Display Mirror in the Cadillac CT6 launched in 2016. The mirror can function as a standard interior auto-dimming mirror or as a display for the rear-mounted camera for a better view of what is behind the vehicle. Gentex notes that the ruling does not mean a display can replace a standard mirror, but that a regulatory-compliant mirror can also serve as a display.

Mobileye
2015 Sales: $240.9 million
Change from 2014: up 67.7%
Net Margin: 28.4%, compared with a loss of 21% in 2014
Guidance for 2016: Revenue in the range of $336 million to $340 million

According to Mobileye’s CEO, the company’s huge sales growth was driven by “ongoing NCAP and regulatory support that will secure our growth for years to come.” Sales to OEMs accounted for 84% of total revenue. Carmakers seeking the highest, 5-star NCAP rating are increasingly offering ADAS features, including automatic emergency braking and pedestrian detection, in non-luxury models. Unit sales of Mobileye’s EyeQ ADAS microprocessors increased 67% in 2015, to 4.4 million. Average selling price of the EyeQ chips was $43.90, nearly the same as the prior year.

In January 2016, at CES Mobileye announced it plans to begin creating maps for autonomous driving based on data gathered from Mobileye-camera-equipped vehicles already on the road. GM and Volkswagen said they would be cooperating with Mobileye on the project.

Hyundai Mobis
2015 Sales: KRW 36 trillion ($30 billion)
Change from 2014: up 2.5%
Operating Margin: 8.1%, compared with 8.9% in 2014

The Module (chassis, cockpit and front-end) Assembly and Core Parts business, which accounts for the bulk of Mobis’ sales, grew by 3% in 2015, with help from increased high-end car sales, according to Mobis. Sales of aftermarket parts, which provided 18% of total sales, were nearly flat. Operating margin in the aftermarket division was an impressive 21.2%.

Hyundai Mobis exhibited new technology at CES 2016, its first appearance at the Las Vegas show, including a suite of ADAS products and a head-up display.

Visteon
2015 Sales: $3,245 million
Change from 2014: up 25.5%
Net Margin: 72%, including $2.3 billion in net income from discontinued operations, associated with the sale of the HVCC climate control joint venture
Outlook for 2016: Sales are forecast to remain at $3.2 billion in 2016.

The consolidation of the former JCI electronics business, acquired in 2014, contributed $691 million to Visteon’s sales growth in 2015. After years of post-bankruptcy restructuring, the company’s focus is now squarely on cockpit electronics; electronics products accounted for 97% of sales. Instrument clusters and information displays together accounted for 55% of sales in 2015. Infotainment, audio, telematics and HUDs made up the remainder. At the 2016 Consumer Electronics Show, Visteon announced it would launch an “industry-first” cockpit domain controller with a European carmaker in 2018.

With 31% of sales, Ford is Visteon’s largest customer, followed by Mazda with 17%, and Renault Nissan with 14%. Regional sales are well balanced: 37% of sales come from Asia, 32% from Europe and 29% from North America.

Visteon CEO, Sachin Lawande, has been clear about Visteon’s short-term strategy to target connected car applications. In January 2016, the company announced an agreement to acquire AllGo Systems, headquartered in Bangalore, India, for $15 million plus up to $7 million in contingency payments. According to Mr. Lawande, AllGo has “a global presence and a strong portfolio of intellectual property related to in-vehicle infotainment, media and connectivity solutions.”
The Company Profile...  Lear Electrical

Lear Corp.
Headquarters: Southfield, Michigan
2015 Sales: $18,211.4 million
R&D: 0.7% of sales
Capital Expenditures: 2.7% of sales
Interest Expense: 0.5% of sales
Operating Margin: 6.5%
Net Margin: 4.1%
Cash Flow from Operations: $1,271.1 million
Working Capital: $1,506 million*
Long-Term Debt: $1,928.5 million*
Stockholders' Equity: $3,144 million*
Market Cap: $8.38 billion as of April 21, 2016

Major Products: Seats and wire harnesses
Top Customers: Ford, 23% of sales; GM, 20%; BMW, 10%
Employees: 136,200**
Sales per Employee: $133,711

Lear Electrical Segment
2015 Sales: $4,113 million
R&D: approximately 5% of sales
Top Customers: Ford and General Motors
Employees: 54,000**, of whom 2,500 are engineers
Sales per Employee: $76,167

*As of April 2, 2016
**As of December 31, 2015

Background
In 1917, American Metal Products set up operations in Detroit to make seating assemblies and other components for automobiles and airplanes. By 1941 the company was serving seven automotive OEMs including GM, Ford and Chrysler, and several auto parts suppliers. American Metal Products was taken over by Lear Siegler in 1964. In the next decade Lear Siegler grew into a global conglomerate serving multiple markets. Lear Siegler was bought by an investment group in 1987, and the following year a management buyout of the General Seating Division separated the automotive business, which eventually became Lear Seating Corporation. Lear Seating went public in 1994 and changed the company name to Lear Corporation. The company estimates that it holds the number-two position in the $60 million global seat system business. Seating accounts for 77% of Lear’s sales.

The 1999 acquisition of United Technologies Automotive and the 2004 acquisition of terminal and connector supplier Grote & Hartmann expanded Lear’s product line to include complete automotive electrical distribution systems and electronics. This company profile covers the Electrical business segment only, which accounts for 23% of total Lear sales.

Connectivity Strategy
With two recent acquisitions, completed in 2015, Lear began implementing a new strategy, one that positions it well to capitalize on the connectivity megatrend currently transforming the automotive industry globally. “We really wanted to bring in very strong capabilities in cellular, wi-fi, GPS, cybersecurity, DSRC, all those key areas for connectivity,” said Frank Orsini, Lear senior vice president and president of the Electrical division. “We made two key acquisitions that allowed us to immediately enter this connectivity space with real strength and credibility from a technical standpoint.”

Lear acquired intellectual property and technology (including software stacks and capability) from Autonet Mobile in August 2015. Autonet’s technology directly connects onboard vehicle systems with the Internet using cellular networks. Arada Systems, acquired in November 2015, specializes in secure vehicle to vehicle and vehicle to infrastructure communications via DSRC. The two acquisitions brought 60 new employees, 50 of whom are software engineers, but no sales from ongoing businesses.

Vehicle connectivity is one of the hottest trends in the automotive industry today and Lear faces formidable competition from the likes of Continental, Bosch, Denso, Harman and many others.
Lear Electrical

Lear Electrical Sales by Product

- **2015 Sales Total**: $4,113 million
- **Wire Harnesses**: 68%
- **Electronics**: 25%
- **Terminals and Connectors**: 7%

Electronics Product Ranked by Sales:
- #1 Body control modules
- #2 Smart junction boxes
- #3 Lighting
- #4 Audio

Lear Electrical Sales by Region

- **2015 Sales Total**: $4,113 million
- **Europe**: 46.9%
- **Asia**: 23.0%
- **North America**: 27.3%
- **South America**: 2.8%

◆ **Over the Air Updates**
Lear already had strong RF technology, used for decades in its remote keyless entry products. It is also a major supplier of gateway modules, a central communications hub that oversees communications among different vehicle domains. The Autonet and Arada acquisitions brought not only wireless technologies but also cybersecurity capability, which Lear can apply as it works with customers to develop over-the-air software update solutions. Lear has branded its new connectivity expertise as Lear Connexus.

OTA updating will be essential for autonomous driving and for keeping vehicle control systems optimized to reduce warranty costs and avoid costly safety-related recalls. Autonet had already been sending over-the-air programming through that central gateway to securely reach everything in the vehicle,” explained Steve Rober, vice president of global electronics engineering. “We can monitor all the traffic in the vehicle to make sure there are no unwanted intrusions.”

Lear expects automotive data throughput will grow from 15 megabytes per second in 2013 to 350 MB per second in 2020. “You are going to be continuously gathering data from the vehicle and sending that data to the cloud, and when that data is processed you’ll be able to add new features to the car. In the long term the smartphone may even replace the key fob. All that data needs to move to and from the vehicle efficiently,” noted Mr. Rober.

A German carmaker has contracted with Lear to develop a connected gateway module capable of receiving over-the-air software updates. The company is also in discussions with U.S., European and Asian carmakers for similar development projects.

Vehicles capable of updates are on a fast growth track. By 2020 one-fifth of new production, or some 26 million vehicles produced globally, will have the ability to accept software updates over the air, according to IHS.

◆ **V2X**

The U.S. Department of Transportation says it is committed to and moving forward with a mandate for vehicle-to-vehicle communications via dedicated short range communications (DSRC). To date, General Motors is the only carmaker to publicly commit to bringing V2V to a production vehicle. GM announced it will equip one model, the 2017 Cadillac CTS, with a DSRC module. In Europe, carmakers are not sold on DSRC as the best solution and are considering LTE Direct cellular for V2X.

“Each technology has its benefits,” Mr. Rober asserted. “A lot of vehicles are coming equipped with cellular, 4G LTE and beyond, so the cellular modem is already in place. But there are distinct advantages to direct communications between vehicles with DSRC. Latency is less, and if you are doing blind spot detection or collision warning even milliseconds count.”

With its recent acquisitions, Lear plans to be ready to serve both markets, regardless of which technology wins out. “From a supplier standpoint, we at Lear tried to put ourselves in a position where we can handle either technology. The capabilities in DSRC that Arada brought are very strong. With the cellular capabilities from both Arada and Autonet we are extremely well positioned,” said Mr. Orsini.

Embedded cellular modems will grow from 20 million units in 2015 to 55 million units in 2020, an annual growth rate of 22.5% according to IHS.

Electronics Products

Electronics accounted for roughly $1.1 billion in sales for Lear in 2015. The company employs more than 600 software engineers globally, including those that came with Autonet and Arada, most of whom write in embedded C code and specialize in high-end body control applications including lighting and audio.

◆ **Body Control Modules (BCM)**

Body control modules comprise the largest product group in Lear’s electronics portfolio. “We supply some of the most highly integrated, complex body control modules in the industry today,” Mr. Orsini said. One of the things Lear prides itself on is the ability to optimize not only the electronics in the BCM, but also the associated wire, terminals and connectors. “For example, for BMW we supply a body control module that consolidates five different modules into one. We did both the hardware and software engineering,” said Mr. Orsini. Lear reduced BMW’s body module count on several models, including the 7 series, from seven to two modules. The next iteration will complete the integration, leaving just one BCM.
“This integration involves not just the box, the small modules for the wipers, door, headlamp, things like that,” noted Mr. Rober. “You can optimize the wire harness, everything associated with the data and electrical movements in the car, including the software design. By consolidating five modules into one you’re also removing the weight from those different housings and wiring, so it’s mechanical and electrical integration as well.”

◆ Solid State Smart Junction Boxes

Lear was the first supplier to introduce smart junction boxes, in 1999, adding electronics to traditional junction boxes to increase functionality and add value. In 2015, Lear was first to market with a solid state smart junction box. Replacing fuses with MOSFETs allows for reductions in packaging size and wire gauge. In addition to the weight and cost savings, and more accurate fusing, the solid state smart junction boxes provide greater freedom in the electrical system design. Since they don’t require access for servicing, solid state smart junction boxes can be located anywhere in the vehicle.

Lear’s first customer in production with solid state junction boxes is JLR, and Lear is quoting the product for many other customers as they develop new electrical architectures.

◆ Lighting

Lear became involved in the LED headlamp business through its long experience with body control modules. “LED lighting control is becoming so complex and so highly technical that it is really an extension of what we’ve been doing in body control. Our manufacturing processes for the two product lines are very similar,” said Mr. Orsini. Lear produces hardware and software for a matrix LED headlamp module, including LED placement on a board, but does not do the headlamp assembly.

“The software platform we use started with the earliest functions for headlamp leveling and direction. That became the foundation for this full pixel array, where you can actually shape the beam and get more precise control,” explained Mr. Rober. “The first of these matrix beams had only about 48 LEDs. We are going over 100, to 256 and ultimately 1,024 separate LEDs. Accurate placement of those LEDs on the board becomes critical.”

Lear supplies carmakers directly in some cases, and in others serves as a tier two to lighting suppliers who integrate Lear electronics into their full assemblies for shipment to the end customers. Lear is contracted by the OEM who may specify Lear modules in a lighting assembly built by a supplier such as Hella. Lear is currently working with Audi and Mercedes.

◆ Audio Amplifiers for High-End Cars

Lear offers premium audio amplifiers, sound system integration and tuning primarily for multichannel amplifier sound systems installed in high-end vehicles such as Bentley and the Audi A8. A small piece of Lear’s electronics sales, the audio business, located in one facility in Kronach, Germany, came as part of Lear’s 1999 acquisition of United Technologies Automotive.

“These amplifier systems basically have a central controller and a number of digital signal processors to effectively shape the sound for specific locations in the vehicle. With software, we tune the system to sound the best in certain points in the car,” said Mr. Rober.

Lear is focused on the high-end systems but also works on some mid-range audio applications. By removing elements of the hardware and/or software the architecture can be scaled down as required. In addition to Audi and Bentley, Lear has booked audio business with JLR and Mercedes.

Electrical Business

Lear generates roughly 23% of sales from its Electrical division. Approximately two-thirds of that revenue comes from wiring harnesses, which are produced in some 30 facilities in primarily low labor cost countries. According to the company it is one of only four suppliers with global capability in both traditional and high power electrical systems.

The main challenge for harness designers is how to accommodate more features and functions without adding to the size and weight of the harness, and the key, noted Lear’s vice president of electrical engineering, Bill Presley, is integration.

Lear’s proprietary development tool suite called Lear Virtual Proving Grounds (LVPG) helps engineers optimize the design of a vehicle’s electrical architecture efficiently and quickly, essential for keeping up with today’s shorter vehicle development cycles and for making the harness as lightweight as possible. Launched in 2014, LVPG gives Lear the ability to simulate every aspect of the electrical and mechanical design prior to building any physical parts.

While similar tools are available from suppliers such as Mentor Graphics, and Lear has a good working relationship with Mentor, Mr. Presley noted that none sufficiently met Lear’s objectives. “There are very good tools for electrical simulation and very good tools for mechanical simulation, but no tools that kept the electrical world and the mechanical worlds aligned such that you could simulate every single aspect,” he said. “On the mechanical side, our simulation philosophy is completely different from anybody else. Now when we

Distinctions Claimed by Lear

◆ First to market with 0.13 mm² copper clad steel wire
◆ First to market with smart junction boxes, in 1999
◆ First to market with solid state smart junction boxes
◆ First to market with aluminum printed circuit board
◆ First to market with LED matrix headlamp beam control
◆ Introduced world’s most integrated body control module

Lear Electrical

Wiring Trends

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<td>Functions</td>
<td>165</td>
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<td>800-1,250</td>
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While circuit counts and functionality have increased, integration and more efficient architectures have contributed to a 62% reduction in the number of modules in a typical vehicle, from 65 to 25, a level where it is likely to remain, according to Mr. Presley. Driving circuit counts higher now is the growth in high speed data buses. Lear’s competitors in electronics modules include Continental, Delphi Automotive, Denso, Bosch and others.

Source: Lear
make an architectural change we’ll also understand what it does to the size of the bundles, the copper weight, how it is going to impact stresses on the harness itself when you put it in the vehicle, or how our manufacturing processes will impact it.”

According to Lear, its expertise in electrical architecture design and optimization typically reduces the weight and size of a consumer’s design by 15% to 20%. Using alternative materials for insulation and cladding, and substituting alloys and aluminum for copper can bring another 10% weight reduction and an additional 5% to 10% reduction in the size of the harness.

Substituting aluminum wire for copper is no longer done for cost savings, but for the weight advantages aluminum affords, Mr. Presley said, in 2 mm² and larger cross sections.

Over the past 18 months, Lear has been revamping its portfolio of terminals and connectors, specifically to include terminals that are 20% smaller than what is currently in use but have the same current carrying capability as the larger size. According to Mr. Presley, 90% of wiring in today’s cars is signal wiring, circuits that could use wire that is .08 mm² or smaller, instead of the .35 mm² to .22 mm² that is used today. The switch to smaller gauges has been held up by the lack of terminals to fit them.

“What is typical in the market now is really double the size they need to be,” he said. Lear’s new terminals are currently in production validation testing and should be in high volume production by the end of this year. According to Lear, none of its competitors offer a similar product.

In the $70 billion automotive wire harness market, Lear competes with Yazaki, Delphi, Sumitomo Electric, Leoni and others.

Promising New Products

◆ 48 Volts

The April 2016 Hansen Report featured an interview with Alfons Graf, director and automotive system architect at Infineon, who thinks that 48-volt architectures will not find high volume production in the near term. Lear sees the market developing somewhat differently. According to Mr. Orsini, “From Lear’s perspective, this is a very real industry trend. We believe it is going to be seen more and more as development projects transition into production platforms. We have three programs right now that are slated for production in the 2018-2019 timeframe.” Four more development projects are underway that could likely lead to future orders.

Lear is seeing a mix of applications for 48 volts headed for production, for fuel economy and to add high-end content such as electric turbocharging, active suspension and mild hybrids. Lear offers complete 48-volt architecture development and optimization as well as 48-volt wire harness, power distribution boxes, terminals and connectors, DC/DC converters, traction inverters and smart junction boxes.

◆ Wireless Charging of EVs, HEVs

In response to customer requests, Lear has been delivering prototype wireless charging systems for electric vehicles, both for 400 volts and in some cases 800 volts. Several OEMs have been working with the SAE on a standard for wireless charging but it has yet to be published. “We have gotten requests for 3 kW, 7 kW and 11 kW charging systems,” said Mr. Orsini.

According to Lear, plug-in charging is still the norm, but wireless is coming closer in terms of efficiency and will be phased in gradually. Lear intends to supply full wireless charging systems including wall mount units, floor pads and vehicle receiving pads equipped with living object and foreign object detection capability. No volume orders have yet been received.

Why Lear

Among global automotive wire harness suppliers, Lear ranked fifth in sales in 2015. The company operates 66 facilities in 27 countries, consistently sitting production of its most labor intensive products in low labor cost countries. Lear recently launched a new terminal and connector plant in China and has plans for a new wire facility there as well. “We are continually investing in the business, putting plants and capital investments in different areas to support our production requirements and customer diversification,” Mr. Orsini said. “We will ship close to 300 million parts this year, [including pins and terminals] with single digit ppm quality performance.”

Lear has launched 15 first-to-market innovations over the last three years, and plans to launch 17 more in the next three years.◆

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<td>Fuse and pre-fuse boxes</td>
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Radar...

GHz sensor because it would have been too costly,” said Kristian Doescher, head of global marketing, original equipment at Hella. “Despite the promise of CMOS, we expect the market for 24 GHz radar to grow, especially in the volume segments, at least for the next ten years.”

Another possible CMOS radar application, according to Dietmar Stapel, head of radar-based driver assistance systems at Hella, is gesture recognition inside the vehicle. “We are looking at this; Google is also looking at this for consumer electronics. When it becomes popular there, it will probably come to the vehicle.” If a single-chip, 77 MHz CMOS radar sensor finds applications with sufficiently high volumes, for example in gesture recognition, not only in the vehicle but in other consumer electronics applications, then that chip would provide a significant cost alternative to 24 GHz radar. “That is possible but not before 2020,” suggested Dr. Stapel.

More CMOS Radar Work to Be Done

There are huge amounts of possible improvements to CMOS radar to make the technology ready for automotive applications, according to imec’s Mr. Van Thillo. He grouped possible improvements into three categories: perception performance, robustness of the sensor, and integration of the sensor into the car.

“Perception performance means doing more with radar. We can go way beyond radar’s basic ranging and detection functionality. One example we are working on is characterization of targets. Rather than saying, ‘there is something out there,’ we could say ‘this is a pedestrian.’ Not imager based, but radar based pedestrian detection is very beneficial in circumstances where the camera might fail, for instance when the sun is very low and shining into the camera, or when there is fog, when it is night, or when the camera’s lens is dirty.” Imec’s algorithmic work on perception can apply not only to CMOS radar, but also to SiGe radar.

Another imec perception project focuses on the sensor itself. “If you daisy chain multiple sensors or create a sensor with more antenna paths, you improve angular resolution,” Mr. Van Thillo explained. “We are building a MIMO (multiple-input, multiple-output) radar. Like with a camera, the more pixels you have, the greater the angular resolution.”

As for improvements in robustness, imec is investigating what can be done to handle the likely dramatic increase in interference as the number of cars with radar and the number of radar sensors per car go up. As for improving integration into the car, radar sensors today fit in the palm of your hand, but imec is trying to build radar that fits on your fingertip. “If you could reduce the power consumption and thermal requirements, then you could integrate them into the car’s nooks and crannies that were not possible before,” said Mr. Van Thillo. “As we develop autonomous cars, full 3D perception based on radar will have to come. We need a redundant sensing facility to cameras.”

Laird...

(GLObal NAivation Satellite System) radio, along with CAN or Ethernet connectivity. The antenna is mounted on the roof with a box for the electronics underneath. The SAM also includes a built-in encrypted security chip to prevent hacks.

Laird launched an earlier version of its smart antenna module with BMW in 2015 and is working with other U.S. and European carmakers interested in similar concepts. They are targeting 2019 or 2020 for introduction.

“The trend is toward smart antennas because OEMs want to save on coaxial cable, and they like the enhanced performance,” noted Dr. Duzdar.

4G Cellular

Now that the FCC has auctioned off the old TV frequency spectrum, cell phone signals in the U.S. now go all the way down to 400 MHz from 6 GHz, according to Dr. Duzdar. “So now you can have up to one gigabit per second of data streaming,” he said. “But that requires a distributed antenna system, multiple antennas. For 4G we now offer a MIMO (multiple input, multiple output) configuration consisting of two antennas; one is transmit receive, the other is receive only.”

5G cellular will provide even greater bandwidth, but that will require as many as six antennas in the vehicle. Finding the right location and packaging for the additional antennas will be difficult.

Bluetooth Low Energy (BLE)

One of the biggest changes coming to wireless communications aboard the vehicle is Bluetooth Low Energy, the power-and-application-friendly version of Bluetooth, built for the Internet of Things. “BLE will obsolete keyless entry by 2020,” predicted Dr. Duzdar.

Instead of dedicated key fobs, smartphone apps will provide access to the vehicle. “You can have the vehicle detect people as they approach. BLE can replace passive entry. It can replace remote start. Depending on the application, the antenna could be placed on the roof or in the headliner and activate the vehicle from within 150 to 200 meters,” he said.

Other New Antenna Products

“Antennas are no longer just antennas,” said Dr. Duzdar. Laird has developed a sample and is working with major U.S. carmakers on its Camtenna, a rear-facing, high-definition camera packaged into an antenna housing. That product could launch around 2019.

Laird has also developed a prototype of its Adaptive Antenna Module, which includes electronics to compensate for cable losses if carmakers decide to put the DSRC radio somewhere other than in the antenna. That product is similar to the Compenser or booster, developed by Novero, which lets the driver put his cellphone on a pad in the vehicle and couple the phone antenna to the external antenna. The Compenser compensates for cable signal losses between the pad and an antenna on the roof.