Onboard Sensing
Potentially More Effective
Saving Lives than V2X

As the Safety Pilot field test of V2X (vehicle-to-vehicle and vehicle-to-infrastructure) communications gets underway in the United States, the potential for V2X communications is getting a lot of attention. If the test can show that a significant number of lives would be saved if vehicles were equipped with two-way communications gear that informed other cars of their speed and direction, the U.S. government could require carmakers to install V2X equipment in new vehicles. Or, a more likely scenario, the government could strongly encourage adoption of V2X by highlighting the technology as part of its New Car Assessment Program. The U.S. National Highway Traffic Safety Administration will decide about possible V2X rulemaking in 2013.

Although government and industry executives believe that V2X promises to be the next big thing in safety after radar and cameras, a study done by Autoliv indicates the safety benefits from onboard sensor systems will far outweigh V2X’s benefits for many years to come. Investments in the development of safety systems based on onboard sensors would have much quicker returns in terms of lives saved and accidents prevented.

We spoke recently with Colm Boran, director of motion control systems at Autoliv. We caught his “V2X vs. Onboard Sensing” presentation at Convergence 2012 and talked with him later by phone. According to his presentation, the biggest drawback of V2X systems is the long time it will take before enough vehicles are equipped to make an impact. In contrast, onboard sensing systems based on radar and camera sensors don’t depend on a critical mass of other vehicles being equipped or on the infrastructure.

Carmakers Speak
Panelists Discuss
What’s Next and What’s Needed

Last month at the SAE Convergence 2012 Transportation Electronics Conference, top electrical engineers from General Motors, Ford, Fiat, Audi, Toyota and Nissan answered a host of questions about the obstacles and challenges they face, about standards, what they are trying to accomplish and where automotive electronics technology is headed. It was my pleasure to again organize and moderate this important biennial Carmakers Speak panel session. Here are some highlights of the panelists’ responses both to my questions and to some excellent questions submitted by session attendees.

Only Modest Agreement on Standards

◆ 48 Volts

More than a year ago Volkswagen, Audi, Porsche, BMW and Daimler announced the creation of a standard 48-volt sub-bus that replaces the 12-volt alternator and starter with a 48-volt machine, while adding a DC-to-DC converter and a 48-volt battery. The 12-volt battery system remains otherwise unchanged. “Forty-eight volts will give us the additional power we need for new features, better start-stop functionality, air conditioning when the engine is stopped, much better recuperation, electrical [suspension] damping, electrical turbocharger and so on,” said Ricky Hudi, chief executive engineer for E/E at Audi. None of the other panelists said they would adopt the 48-volt standard in a high-volume application within the next five years.

◆ Autosar

GM, Ford, Fiat and Audi said they would be in high volume with a fully compliant Autosar application in five years, although according to Fiat’s top electrical engineer, Alan Amici, “The introduction of Autosar has been more difficult than we expected in terms of the supply base being ready to provide it and the tools providers being ready to support it.”

Nissan and Toyota have for years been studying Autosar but are not yet saying they will definitely bring it to high volume production. “While we are not ready to declare a time frame, we are not ruling it out,” said Wayne Powell, general manager of electrical systems at Toyota Technical Center in Ann Arbor. Mr. Hudi said Audi began its adoption of Autosar 3.2 but is “moving with continuous steps upward” toward Autosar 4.0.

◆ Genivi

Like Autosar, the Genivi infotainment system standard promoted by BMW supports software reuse, but none of the panelists committed to using a Genivi platform in high-volume production within five years. While not onboard with Genivi, Toyota’s Mr. Powell said, “Toyota fully embraces automotive-grade Linux,” on which Genivi is based. Toyota is a member of the Linux Foundation. Mr. Powell also indicated Toyota’s interest in applying software based on HTML5, the open source Hypertext Markup Language widely used for presenting multimedia content on the Web. None of the other panelists indicated support for either Linux or HTML5. (GM was among the first to implement Linux in cars, first on the Volt, then on the 2013 Cadillac XTS in the new CUE infotainment system.)

◆ Ethernet

BMW has been a leading advocate of using Ethernet in vehicle applications, starting with Ethernet links to download software to the vehicle and later moving to Ethernet links to multiple cameras. BMW has indicated its interest in eventually using an Ethernet backbone to connect the vehicle’s domain computers. I asked the panelists if they were planning to use Ethernet links in high volume. Only the Audi and Ford panelists answered positively. Mr. Hudi said Audi would use Ethernet for diagnostics. Ford’s
V2X systems have another major limitation. Accidents involving pedestrians and bicyclists account for 12% of all accidents, a category that V2X is not likely to address anytime soon. Whereas, systems based on onboard radar or cameras can be effective at avoiding collisions with passengers and bicyclists.

“I personally believe onboard sensing will save more lives,” said Mr. Boran. “Especially in markets like Asia, South America, India and elsewhere, where pedestrians and bicyclists are the majority of the people who get killed in motor vehicle accidents. V2V or V2I systems won’t protect them.”

Onboard sensing also has its limitations, since radar and camera views of hazards can be blocked by fixed or moving obstructions, and cameras will not see through all bad weather. “One scenario where onboard sensing is next to useless is when you have a vehicle sailing through an intersection coming at you sideways, and your view of that guy is blocked by buildings or whatever. Those crashes, which are often deadly, can’t be helped by onboard sensing. V2V certainly has a place there.”

Taking account of the limitations of each technology and the vehicle fleet penetration of safety systems based on each approach, Autoliv estimated the number of fatal crashes each would save. Those estimates are tabulated below. Onboard sensing has a clear advantage over V2X, even out to 2030, when a 25% penetration of V2X is assumed. 

<table>
<thead>
<tr>
<th>Types of Fatal Crashes Prevented</th>
<th>2012 - 2020*</th>
<th>2012 - 2030*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OBS</td>
<td>V2X</td>
</tr>
<tr>
<td>Forward Collision Warning/Mitigation</td>
<td>192</td>
<td>20</td>
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<tr>
<td>Single-vehicle crashes</td>
<td>1,036</td>
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<tr>
<td>Side-View Assist/Blind-Spot Warning</td>
<td>86</td>
<td>50</td>
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<tr>
<td>Lane-Departure Warning/Prevention</td>
<td>444</td>
<td>50</td>
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<tr>
<td>Total</td>
<td>2,950</td>
<td>277</td>
</tr>
</tbody>
</table>

*Number of crashes for the period. Assumes 30,000 fatal crashes in 2012.

Carmakers Speak...

Continued from page 1

global director of electronic systems engineering, Graydon Reitz, said, “We have a lot of interest in it for camera applications, video, so there is a fair likelihood we would have it in high volume in five years.”

**FlexRay**

Only Audi indicated high-volume adoption of FlexRay, the safety critical bus protocol used in chassis control systems. “We had to use FlexRay,” said Audi’s Mr. Hudi. “The CAN bus in certain applications was fully loaded. We needed a deterministic network, and for that FlexRay is still the best solution in the world.”

**Device Connectivity**

Connecting smartphones to cars continues to be a headache. Mr. Powell noted that Toyota spends a lot of money making sure all the different versions of Bluetooth phones actually work with its vehicles. “We really wish Bluetooth were a standard,” he quipped.

While many different approaches have been offered that take device connectivity beyond Bluetooth, only one common denominator emerged from the panel: Apple. To link iPhones to vehicle displays and switches, all carmakers are obliged to use Apple’s proprietary iPod Out protocol. The iPhone 5 with its new, proprietary 8-pin, all-digital Lightning connector won’t work in cars without an Apple-certified adapter to the old 30-pin port.

According to Ford’s Graydon Reitz, “Apple doesn’t want to use Bluetooth because there is so much variability. I’m sure they’ve approached all of us [on the panel]. They want to use Wi-Fi as the key in-vehicle [link] because the standards are tighter.”

When you consider that three of every four smartphones shipped globally in the third quarter of 2012 used Google’s Android operating system, according to International Data Corp., Apple’s sway with carmakers seems outsized.

**Wireless Device Charging**

Advocates will have to wait some years before wireless phone charging comes to vehicles. Carmakers are inclined to install charging pads in their vehicles, but the cell phone industry has not coalesced around any one standard. “The charging pad is ready to go but the phone makers aren’t embedding the coils into thier phones yet,” said Alan Amici. “You need an adapter, but people aren’t buying them. And worse, multiple charging format standards are being debated.”

At least three wireless power standards organizations are promoting different approaches: the Power Matters Alliance backed by Google, AT&T, GM and others; Samsung and Qualcomm’s Alliance for Wireless Power; and the Wireless Power Consortium supporting the standard known as Qi, backed by LG Electronics, Samsung, HTC, Motorola Mobility, Nokia and others. According to EE Times, Qi is gaining traction, especially in Japan. Intel is promoting its proprietary Wireless Charging Technology standard.

**Functional Safety**

In contrast to their slow embrace of some standards, panelists were supportive of ISO 26262. “We have ISO 26262 projects under development and will deploy it over large swaths of the company over time,” said Alan Amici, as the other panelist indicated agreement.

**How Suppliers Can Help**

The carmakers pointed to several areas where they are especially challenged and open to more support from the supply community.

**Energy Efficiency and the Cost of Electrification**

GM Volt chief engineer, Andrew Farah, is concerned about electrical efficiency, not only for electric vehicles, but for all GM vehicles. “These days every watt counts and so does every penny of added cost. In the high-voltage area, the batteries are too expensive, obviously. But also at issue is the high cost of the electric motor and the power electronics. ... Depending on how much you spend on the infotainment systems, DC to DC converters can be the second most expensive [electrical] item in an electrified vehicle,” said Mr. Farah. “If we could agree on voltages, package size and control interfaces, we could come up with standard DC to DC converters. That would kick up volume and bring down cost.”

**Complexity and Other Challenges**

On-time development of high-quality software is a crucial component of a carmaker’s success, and software content in the average vehicle continues to increase.

“What keeps me awake at night is software delivery, on time, with quality,” said Ford’s Mr. Reitz. “Software is a huge value-add for us. How can suppliers help? Staff up your software resources early and in sufficient quantity. We struggle with infotainment delivery and driver assistance feature delivery. Insufficient software resources are often the root cause of those struggles.”

However you measure complexity, by lines of software code or number of features, panelists were in complete agreement that complexity is definitely rising. And further, expectations are also rising as carmakers look to have new features trickle down-market more quickly and as development cycles become shorter, as short as 18 months.

Panelists made a number of suggestions about what the industry can do to cope with the problem. Fiat’s Mr. Amici wants suppliers to bring to his development group technology that is mature and ready to go. “Suppliers need to show us their innovation roadmaps six to 12 months before development starts. ... You could try a different architecture, where perhaps you go to four domain controllers instead of 50 ECUs. But the complexity would still be there. I don’t see an easy way out.”

Nissan’s director of electrical and electronics engineering for North America, John Schnoes, thinks software reuse is a key ingredient to coping with complexity. “Intellectual property is expensive; you cannot afford to recreate and recreate. What is needed are good, long-term relationships with suppliers.”

**Systems Engineering**

Several panelists suggested that systems engineering could offer answers to the complexity challenge. “Systems engineering is a little underestimated in my opinion,” said Audi’s Mr. Hudi. “Systems engineering requires a deep understanding of how a system functions. It requires an understanding of mechanics, of materials, of electronics hardware and software. You can find plenty of engineers who specialize in hardware or software, but those who...
Background

Hella has been a player in the lighting business since 1899 when the business named Westfälische Metall Industrie AG came into being, producing candle and kerosene lamps. The Hella name was first trademarked in 1910 for acetylene gas headlamps that incorporated lenses and mirrors. In 1923, the Lüdenscheider Hueck family took over the majority of the company’s shares and the company remains family-owned today. It was converted into the KGaA (partnership limited by shares) structure in 2003, a move that gave the company access to capital markets but preserves the family’s shareholdings. Following the company’s general guidelines, the shareholders invest approximately 75% of Hella's profits back into the company each year.

Incredibly, Hella has managed to maintain positive EBIT margins even during the economic downturn of 2009. The company is on sound financial footing. Borrowing is limited: Hella paid just 1% of sales in interest payments in the last fiscal year. In February 2012, Moody’s raised its rating on Hella to Baa2, medium investment grade subject to moderate credit risk, with a stable outlook.

Strengths and Strategy

While widely known for its lighting products, sales of OE automotive electronics are nearly as large. “As valuable as our heritage in lighting is, and as much as we emphasize growing that business, it is also important to sharpen our branding and recognition as a player in electronics,” said Martin Fischer, CEO of Hella’s Electronics Division in the Americas. Hella recently announced its new branding slogan, “Technology with Vision,” which means to reflect both its lighting heritage and expertise as well as a forward-looking investment in electronics.

Another key element in Hella’s strategy is a balanced portfolio between its automotive product line and the aftermarket and special applications businesses. Special applications include commercial and off-road vehicle products and lighting for airports, streets and interior settings. Aftermarket sales accounted for 21% of total sales in fiscal 2012; special applications were just 6.5%. Dr. Fischer sees potential for significant growth in both sectors.

Hella’s growth over the last one-hundred-plus years has been almost entirely organic, a strategy that has been and will continue to be strongly supported by the family shareholders. The few acquisitions the company has made have been small technology or engineering firms with whom it had already developed working relationships.

International Market Development

Hella is a global company, with 70 operations in more than 30 countries. Regions outside Europe account for 42% of...
Hella anticipates the vehicle market in China will be equivalent to the combined total sales, and more than 48% of automotive OEM sales. Hella supports its customers around the world, including in China, India, Brazil and Mexico as they localize their sources of OEM parts. The company recently expanded its production facilities in Mexico and will begin manufacturing electronics in Brazil through a partnership with Sao Paulo-based Emicol.

Hella invests not only in manufacturing for the local markets, but in global E/E and lighting design and development as well. The company recently established a 120-person development facility in Guadalajara, Mexico, and is in the process of setting up a new development center in Nanjing, China, specializing in energy management and lighting technology. Hella anticipates the vehicle market in China will be equivalent to the combined markets in Europe and North America by 2025.

A Hella competence center in China has full responsibility for the design and development of passive entry/passive start electronics for all emerging markets, not just China. Other competence centers outside Germany include one in Slovenia, which is responsible for all single-function lamps, such as fog lamps or CHMSLs, whether they are LEDs or conventional technology. A competence center in India drives development of all body computers destined for emerging markets. Hella’s U.S.-based operation has global responsibility for fuel pump controllers and seat control units.

Hella has focused its R&D resources in response to two major automotive industry trends: energy management and safety. R&D investments are directed toward new technologies to reduce CO2 emissions and fuel consumption, intelligent energy management components and innovative driver assistance systems.

Partnerships and Joint Ventures

Hella’s globalization strategy is built on both wholly-owned subsidiary companies serving local markets and on strategic partnerships and joint ventures. Hella sees its ten joint ventures as a way to leverage its international investments, advance technological innovation and provide entry into previously unserved markets and customers. By partnering with other suppliers, Hella is better equipped to compete with larger, broad-line tier-one suppliers including Bosch, Continental, Denso and Delphi.

Hella prides itself on maintaining good relations with its joint venture partners, which is key to their long-term success. “For us it starts with finding the right partners, where there is not only a fit in terms of geographical focus or product strength, but where we also find a cultural fit, a similar perspective on business,” noted Dr. Fischer. “If these culturally-fitting parents give the joint venture a good start, with enough capital, resources and know-how and then give them the freedom to do their business with less and less interference, these ventures can succeed.”

Joint ventures accounted for approximately €2 billion of sales in FY 2012, 6800 million of which went to Hella.

**Behr Hella Thermocontrol GmbH** (BHTC) is a 50-50 joint venture with Behr founded in 1999. With roughly €300 million in sales and more than 1,200 employees, BHTC designs, develops and produces automotive climate control systems and components.

**Intedis**, established in 2001 with Leoni, employs 50 people in Würzburg, Germany. Intedis specializes in the design of electrical and electronic systems architectures. Hella owns 50%.

**Mando Hella Electronics (MHE)**, 50-50 JV with Mando in South Korea, was formed in 2008 and produces electronics and driver assistance systems. MHE expects to nearly double sales in 2013. Among its top-selling products are chassis control units, sensors, steering power packs and radar sensors.

**Hella Samlip (HSL) Electronics** is another JV in South Korea, established in 2000. Through HSL, Hella provides electronic components such as its accelerator pedal sensor and intelligent battery sensor to Korean automakers.

**Changchun Hella Faway Automotive Lighting** in China was just established in 2012, providing lighting parts and accessories primarily to the Chinese carmaker FAW. Hella’s share of the joint venture is 49%. A joint venture with the Chinese carmaker BAIC will be announced in the end of 2012.

**Hella Gutmann Solutions**, 87.5% owned by Hella, specializes in diagnostics tools for garages.

**Hella Behr Plastic Omnium (HBPO)**, founded in 1999, employs 1,300 people making front-end modules at 18 production sites. Hella’s equity is 33.3%.

**Electronics Division Product Highlights**

Hella’s Electronics Division is supported by 13 development sites in six countries and 11 production sites in eight countries. Its product portfolio includes body electronics, energy management products, driver assistance systems and a wide range of sensors and actuators.

- CIPOS (contactless inductive position) sensors, in production since the
Hella KGaA Hueck & Co.

1990s, are a core product for Hella, according to Dr. Fischer, and its top selling component line. “I have seen imitations, but I don’t think anyone else has close to the technology or performance of ours,” he asserted. “The sensor is very linear in its characteristics and doesn’t need much correction or tuning.” Hella’s CIPOS sensors are highly robust with regard to mechanical impacts and temperature range. With an annual production of 40 million units, CIPOS applications include accelerator pedal position sensing, steering angle and steering torque sensing, throttle position, transmission range, and are stable in high temperature applications in the engine compartment, including turbochargers.

◆ The second most important components in terms of sales are Hella’s electric vacuum pumps, demand for which is being driven by the trend toward downsized engines. Optimized for fuel efficiency, direct injection gasoline engines may create insufficient vacuum to supply the brake booster. Today, 20% to 25% of vehicles in North America are equipped with electric vacuum pumps, which can be more easily packaged in the engine compartment than mechanical vacuum pumps. Since the electric pumps can be switched on and off, they provide a modest 0.5 mpg improvement in fuel economy. Hella sees increasing penetration of electric vacuum pumps as carmakers try to eke out further fuel savings to meet more stringent CAFE requirements.

◆ Intelligent battery sensors are Hella’s third-highest selling component, and sales will increase along with the penetration of stop-start systems. For stop start to function correctly, accurate measurement of the battery’s state of health and state of charge is required to ensure that sufficient cranking power is available to restart the engine. According to Hella, approximately 40% of new vehicles in Europe are equipped with stop start. In the U.S. penetration stands at less than 5%, according to Bosch, but is expected to reach 50% of new vehicles in four years.

Hella also makes DC/DC converters and voltage stabilizers, as well as lithium-ion battery management systems for hybrid and electric vehicles. At the Convergence 2012 conference in October, Hella demonstrated its Enhanced Start Stop concept for gasoline and diesel vehicles, which can shut down the engine at speeds up to 60 mph if the vehicle is coasting. Such a system would require an additional, higher voltage battery to power braking, steering and other vehicle functions while the engine is off, plus additional energy-management electronics.

◆ Hella is benefiting from increasing demand for its engine compartment actuators, particularly turbo actuators. The company has been making turbo actuators since 1999, when it began supplying them to Honeywell for diesel engines. Hella’s offering includes the actuator with an electric motor, a CIPOS inductive sensor and a small gear box to control the position of the vanes in diesel turbochargers. Electric turbo actuators are now finding their way to gasoline engine applications as engines are downsized. Because the exhaust gas is much hotter, gasoline turbochargers use a waste gate rather than variable vanes to control airflow. Waste gates are traditionally controlled pneumatically, but applying electric waste gate actuators allows for more precise control and therefore higher fuel savings.

According to BorgWarner, the market for turbochargers is expected to grow at an annual rate of more than 9%, from 32 million units today to nearly 50 million by 2017. Hella expects 25% market growth globally for all engine compartment actuator applications through 2020.

◆ Hella is a tier-one supplier of 24-GHz-radar-based driver assistance systems for lane change assist, blind spot detection, pre-crash rear collision warning and cross traffic alert. It makes the sensors and provides the complete package, including the warning algorithms. Two rear-facing sensors detect the position and speed of vehicles approaching from behind or pulling alongside the vehicle within a range of 75 meters. In 2012, Hella will produce two million radar sensors.

In September 2012, Hella acquired 50% of radar specialist InnoSenT (Bavaria). Through a new joint venture, the two companies will develop radar sensors including higher frequency ranges up to 122 GHz.

Electric Power Steering (EPS) ECUs
Hella has been in the EPS business for more than 10 years, including supplying TRW with steering torque sensors for electrohydraulic steering systems. Production of Hella’s newest electronic product, EPS electronic control units, only began in May 2010, but one million units are
already in the field, according to Frederic Laure, head of advanced product development for steering. Current run rate of the ECUs is 1.8 million units, and Hella has booked orders for 2.7 million units. By 2014 Hella expects to hit an annual run rate of 2.7 million units.

Hella is a tier-two supplier to Volkswagen through ZF Lenksysteme (ZFLS), a joint venture of Bosch and ZF. Hella shares the ZFLS ECU business equally with Bosch, but as a shareholder in ZFLS, Bosch will take about 60% of the business in the next few years. Hella is in discussions with other potential customers.

Hella designed the ECU to be easily customized for different vehicle models and configurations. “From the beginning, we considered the many variants that may arise on the market. We also designed the ECU designed for steering. Current run rate of the ECU is 1.8 million units, and Hella has booked orders for 2.7 million units. By 2014 Hella expects to hit an annual run rate of 2.7 million units.

Hella feels it has a competitive advantage in that it has expertise in both lighting and automotive electronics. That competence will become increasingly important as LED lighting applications grow, given that by 2020 roughly 50% of what comprises LED lighting will be electronics. LEDs are the fastest-growing part of Hella’s lighting business. In the long term, xenon headlamps will be replaced by LED headlamps, according to Mr. Pietzonka. He anticipates that by the end of the decade, 70% of vehicles sold each year in Europe will have LED headlamps, 20% will be halogen and 10% xenon.

Since LEDs are two to five times more expensive than halogen headlamps, the total European market for headlamps will grow quickly: from €2.3 billion in 2010 to €4.5 billion by 2020, an annual growth rate of 6.9%.

Despite the cost differential compared with halogen and xenon, LED headlamps are migrating fairly quickly to non-luxury models. Hella first supplied a full LED headlamp in 2008 for the Cadillac Escalade. Just five years later, Audi introduced the 2013 A3 compact with Hella’s full LED headlamps. Hella can provide an LED solution with the performance of halogen lighting for two to three times the cost of halogen. The highest performance, full feature LED lighting systems can cost up to six times more than conventional headlamps.

LED Advantages

- More styling options than other lighting technology: LED headlamps can be much slimmer and only a couple of centimeters high.
- No maintenance, due to shock resistance
- LED headlamps will last for the operating life of the car, between 6,000 and 7,000 hours. Halogen bulbs have a lifetime of 800-1,000 hours; xenon lasts between 2,500 and 3,000 hours.
- LEDs are a scalable light source, from output equivalent to halogen to much higher performance.
- More energy efficient than xenon
- LEDs’ white light is similar to daylight and causes less fatigue than halogen light.
- LED arrays work well in adaptive front lighting systems; each LED chip can be independently controlled.

Distinctions Claimed by Hella

- Owns 15% of the global market for automotive lighting products
- First headlamp with glare-free high beam, in 2010
- World’s number-one maker of accelerator pedal sensors (25 million produced per year)
- Number one or two in market share for vacuum pumps, oil level sensors, battery management systems, and rain/light sensors.

The Company Profile Continued

<table>
<thead>
<tr>
<th>Location</th>
<th>Employees</th>
<th>Turnover</th>
<th>Major Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamm Bockum-Hövel, Germany</td>
<td>924 (Dec 2011)</td>
<td>€502.8 million (FY 12)</td>
<td>Body electronics, energy management, driver assistance</td>
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<td>Recklinghausen, Germany</td>
<td>856 (Feb 2011)</td>
<td>€425 million (FY 11)</td>
<td>Lighting electronics, sensors, actuators</td>
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<td>Bremen, Germany</td>
<td>571 (Feb 2011)</td>
<td>€167 million (FY 11)</td>
<td>Sensors, actuators</td>
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<tr>
<td>Timisoara and Arad, Romania</td>
<td>340 (Apr 2011)</td>
<td>€95 million (FY 11)</td>
<td>Body electronics, engine actuators, pumps, sensors, heating control modules</td>
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<tr>
<td>Dhankot, India</td>
<td>680 (Feb 2011)</td>
<td>€24 million (FY 11)</td>
<td>Lighting electronics</td>
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<tr>
<td>Xiamen, China</td>
<td>420 (Mar 2011)</td>
<td>€27 million (FY 11)</td>
<td>Relays</td>
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<td>Shanghai, China</td>
<td>1,021 (Jan 2012)</td>
<td>€156.1 million (FY 12)</td>
<td>Body electronics, sensors, lighting electronics, actuators</td>
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<td>Flora, IL, USA</td>
<td>275 (May 2011)</td>
<td>€132.6 million (FY 11)</td>
<td>Body electronics, sensors, vacuum pumps</td>
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<td>San Jose Iturbide, Mexico</td>
<td>340 (Feb 2011)</td>
<td>€107 million (FY 12)</td>
<td>Actuators, CIPOS, junction box modules, lighting electronics</td>
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<tr>
<td>Seoul, South Korea</td>
<td>224 (Mar 2011)</td>
<td>€80 million (2011)</td>
<td>ECU, sensors, driver assistance systems</td>
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</tbody>
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Continued from page 3

cross functional disciplines, you don’t find them so often.”

"Unfortunately, we have a patchwork of different [engineering] tools that we use. We don’t have a suite of tools that cover the entire process,” noted Mr. Amici. “The reason is that each OEM has a different organization, different structure, different process, which makes it difficult for the tool maker. What we end up with must be customized.”

Two Phone Modems
For many years GM’s OnStar, and telematics systems like it, have relied on embedded phone modems, whereas Ford Sync relies on the driver’s portable device to deliver features. I asked the panelists if future vehicles will likely rely on both. Today a number of carmakers already offer both, and the panelists seemed to agree that is what carmakers will increasingly do in the future.

“Safety-critical things will need to be embedded,” said Toyota’s Mr. Powell. “Features directly related to operating the vehicle [such as diagnostics] will also require an embedded modem. The connected car is not going to be here tomorrow, because we still lack a ubiquitous connection, and that’s something customers can’t tolerate. In fact, as we transition to LTE, the coverage will actually drop a bit for a while. But people are already connected through their smart phones,” Toyota’s Entune infotainment system already provides features and content via the customer’s phone.

Cloud-Based Features
Carmakers will increasingly rely on computing and data storage capability in the cloud to deliver infotainment features to the vehicle. “One of the benefits of the cloud is that you can use it to bring cutting-edge technology to market late in the development cycle,” noted Nissan’s Mr. Schnoes.

“We struggle with the ability to understand natural language commands,” said Ford’s Mr. Reitz. “We want 99.9% voice-recognition accuracy and hope to get that by leveraging off-board computing.”

Audi already uses the cloud to get traffic updates from INRIX every three minutes and to provide voice access to Google’s point of interest database. “There will be more and more cloud computing, especially for navigation and speech recognition,” agreed Mr. Hudi. “But even in ten years we won’t have reached the final state where everything comes out of the cloud, because cell coverage will still be limited.”

Given the unreliability of the communications link, carmakers won’t soon use the cloud in vehicle control systems.

Vehicle Software Updates
According to the panelists, carmakers will increasingly rely on remote software updates to keep their vehicles fresh. “We are already doing that on a limited basis now with OnStar,” said Mr. Farah. “We can change the Bluetooth profiles to keep them up to date. There is nothing that stands in our way to do that further, except we have to make sure the update is reliable and that there is sufficient bandwidth so the car isn’t kept out of service too long while the update is being completed.”

Toyota is able to update some of its Entune system over the air and the amount of software that’s updatable is growing, according to Mr. Powell. “We have to do that to stay current with phone technology. Between the day we start developing the car and the day it’s introduced, there will be two or three iterations of phone technology. And then there are three more after we sell the car, so being able to refresh cars is key for us.”

Ford just completed updates to its MyFord Touch and MyLincoln Touch infotainment systems using thumb drives and SD cards mailed to vehicle owners, but it is developing the capability to deliver over-the-air updates. Ford won’t rely on the customer’s own phone to make those updates. “If we are trying to send something like 16 GB of data, I don’t think customers are going to want to use their data plans. Maybe we’d use a Wi-Fi connection while the vehicle is parked in the garage.”

HMI
Capacitive touch switches, panels and displays will continue to find application in the HMIs of future models. Most of the carmakers indicated they are exploring multiple modes of input and feedback for infotainment and cabin controls including touch screens, switches, voice and haptics. Ford’s Mr. Reitz sees a more judicious use of capacitive switches going forward, given the response to MyFord Touch and MyLincoln Touch. “[Capacitive switches] are probably not appropriate for high use features, but I think for low frequency-of-use features, heated seats for example, they are appropriate.” For high frequency-of-use features, he said, “things as simple as knobs and mechanical switches” could be a better approach.

J.D. Power and Associates’ Multimedia Quality and Satisfaction

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<th>AM/FM/Single CD Player/Satellite Radio/Navigation</th>
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<td>Bosch</td>
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Source: J.D. Power and Associates’ 2012 U.S. Multimedia Quality and Satisfaction Study

In August, J.D. Power and Associates released the 2012 U.S. Multimedia Quality and Satisfaction Study, based on responses from 74,000 participants who purchased or leased a 2012 model-year vehicle. Quality rankings in the category of AM/FM/Satellite Radio/Navigation (at left) are based on problems per 100 vehicles, with a lower score indicating higher quality.

The top five features (in order) that most positively affected satisfaction were: premium-branded audio systems, steering-wheel controls, satellite radio, navigation and MP3-capable CD players.

For more information and results, visit jdpower.com.